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September 1, 2023

Submitted via electronic mail

Ms. Ann Bekta
Wisconsin Department of Natural Resources
2514 Morse Street
Janesville, WI 53545

Subject: **Plan of Operations Modification Request – Addendum #2**
Initial Permitting of CCR Landfill
Wisconsin Power and Light Company
Dry Ash Disposal Facility (WDNR License #3025)
Columbia Energy Center
Portage, WI

Dear Ms. Bekta,

On behalf of Wisconsin Power and Light Company (WPL), Alliant Energy is submitting this Addendum #2 to the Plan of Operations Modification intended to meet the requirements of NR 514.045 for Initial Permitting of a CCR Landfill. The additional information is in response to the Department's March 8, 2023 letter requesting more information in order to determine that the Plan of Operation is complete for the Dry Ash Disposal Facility located at the Columbia Energy Center (#3025).

Thank you very much for your consideration of this initial submittal. If you have any questions or comments regarding this information, please call me at (608) 458-3853.

Regards,

Jeff Maxted
Manager – Environmental Services
Alliant Energy

CC: Tyler Sullivan – Wisconsin DNR
Eric Sandvig, Director of Operations – Columbia Energy Center
Brian Clepper, Lead GENCO Environmental Specialist – Columbia Energy Center
Phil Gearing, Eric Nelson – SCS Engineers

September 1, 2023
File No. 25222260.00

Ms. Ann Bekta
Wisconsin Department of Natural Resources
2514 Morse Lane
Janesville, WI 53545

Subject: Addendum No. 2 to Plan of Operation Modification Request WDNR CCR Code Update
Dry Ash Disposal Facility, License #3025
Columbia Energy Center
Town of Pacific, Columbia County, Wisconsin

Dear Ms. Bekta:

On behalf of Wisconsin Power and Light Company (WPL), SCS Engineers (SCS) prepared this Addendum No. 2 to the Plan Modification Request/ Wisconsin Department of Natural Resources (WDNR) Coal Combustion Residuals (CCR) Code Update for the Dry Ash Disposal Facility, License No. 3025, at the Columbia Energy Center. The original Plan Modification Request/WDNR CCR Code Update was submitted on December 12, 2022, and Addendum No. 1 was submitted on February 1, 2023.

This addendum covers additional information for the WDNR CCR Code Update dated December 2022 to demonstrate compliance with NR 514.045 including the following:

- Federal jurisdictional status of wetlands 1 and 2.
- Measures taken to prevent take of lizards.
- Additional Stormwater Management items including the facility's Wisconsin Pollutant Discharge Elimination System (WPDES) permit, storm water runoff calculations originally provided in the May 25, 2022, plan modification request/plan of operation update, and the landfill's most recent Tier 2 industrial stormwater pollution prevention plan (SWPPP).
- Revised final cover design and related items.
- Appendix C1 closure topography.
- Groundwater monitoring system demonstration.
- Updated sampling plan.
- Revised closure schedule.
- Revised long-term care plan.
- Plan for the care and maintenance of the leachate collection system tanks and pumps.
- Phase 2 Module 12 and Module 13 liner design and associated final cover.
- Leachate/Surface Water Pond abandonment.
- Phase 1, Modules 5 and 6 Final Cover Permanent Haul Road.
- Specific monitoring well preventive action limits (PALs) for hardness and alkalinity.

WPL's response to the WDNR's incompleteness letter on these topics is provided in the enclosed report.

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If you have any questions regarding this addendum, please contact Jeff Maxted with Alliant Energy at (608) 458-3853.

Sincerely,

Mark R. Huber, PE
Design Director
SCS Engineers

Phil Gearing, PE
Senior Project Manager
SCS Engineers

MJT/AJR/PEG/MRH

cc: Tyler Sullivan, WDNR
Jeff Maxted, Alliant Energy
Matt Bizjack, Alliant Energy
Brian Clepper, WPL

Encl. Addendum No. 2

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Plan of Operation Modification Request
WDNR CCR Code Update
Addendum No. 2

Columbia Dry Ash Disposal Facility
Pardeeville, Wisconsin

Prepared for:

Wisconsin Power and Light Company
Columbia Energy Center
W8375 Murray Road
Pardeeville, Wisconsin 53954

SCS ENGINEERS

25222260.00 | September 1, 2023

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CERTIFICATIONS

"I, Phillip E. Gearing, hereby certify that I am a licensed professional engineer in the State of Wisconsin in accordance with the requirements of ch. A-E 4, Wis. Adm. Code; that this document has been prepared in accordance with the Rules of Professional Conduct in ch. A-E 8, Wis. Adm. Code; and that, to the best of my knowledge, all information contained in this document is correct and the document was prepared in compliance with all applicable requirements in chs. NR 500 to 538, Wis. Adm. Code."

, Senior Project Manager E-45115
Signature, title and P.E. number

September 1, 2023
Date

"I, Thomas J. Karwoski, hereby certify that I am a licensed professional geologist in the State of Wisconsin in accordance with the requirements of ch. GHSS 2, Wis. Adm. Code; that the preparation of this document has not involved any unprofessional conduct as detailed in ch. GHSS 5, Wis. Adm. Code; and that, to the best of my knowledge, all information contained in this document is correct and the document was prepared in compliance with all applicable requirements in chs. NR 500 to 538, Wis. Adm. Code."

, Senior Hydrogeologist
Signature, title

September 1, 2023
Date

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1.0 INTRODUCTION

On behalf of Wisconsin Power and Light Company (WPL), SCS Engineers (SCS) prepared this Plan of Operation Modification (Plan Mod) Request – Addendum No. 2 for the Columbia Dry Ash Disposal (COL) Facility. This Addendum addresses additional information for the Wisconsin Department of Natural Resources (WDNR) Coal Combustion Residuals (CCR) Code Update dated December 2022 to demonstrate compliance with NR 514.045. WPL's response to the WDNR's incompleteness letter, dated March 8, 2023, is provided in this addendum. The incompleteness letter is provided in **Appendix A**.

A summary checklist of applicable regulatory requirements of NR 504.045 conditions is presented as **Table 1**.

A summary of all applicable conditions of WDNR issued approvals or orders that are active and subject to compliance at the time of this Plan Mod has been prepared in accordance with NR 514.07(6m). The summary is presented in **Appendix B, Table B-1**.

2.0 FEDERAL JURISDICTIONAL STATUS OF WETLANDS 1 AND 2

*"1. **S. NR 504.04(4)(a), Wis. Adm. Code:** Provide a discussion and any correspondence or permits issued from the U.S. Army Corps of Engineers (ACOE) on the federal jurisdictional status of Wetlands 1 and 2. A letter from the department regarding the state jurisdictional status of Wetlands 1 and 2 is included in Appendix A1 of the December 14, 2022, Plan of Operation Modification, however, no discussion or correspondence from the U.S. ACOE on the federal jurisdictional status is provided."*

Phase 2, Modules 10 and 11 are not located in wetlands. No federally or state-mapped wetlands are present within the Phase 2, Module 10 and 11 area, and the area is not adjacent to Waters of the United States, which are referenced in 40 CFR 232.2 and defined in 40 CFR 120.2, based on a wetland delineation of undeveloped areas within the Ash Disposal Facility (ADF) conducted in 2017. In addition, no mapped wetland indicator soils were present in the Phase 2, Module 10 and 11 area. The wetland delineation conducted in 2017 identified one area ("Wetland 1") within the Phase 2, Module 10 and 11 area that met Wisconsin wetland criteria. However, "Wetland 1" is not located adjacent to jurisdictional waters defined in 40 CFR 120.2 and was exempted from state wetland regulations as artificial by the WDNR.

Wetland 2 is also non jurisdictional because it is a lined leachate contact water pond. Historically, the areas of Wetland 1 and 2 were farm fields before plant activity.

3.0 MEASURES TAKEN TO PREVENT TAKE OF LIZARDS

*"2. **S. NR 504.04(4)(b), Wis. Adm. Code:** Clarify/specify what measures were taken to prevent the take of the lizard. Also clarify/specify if continued operation of the landfill may result in a take of the lizard and what measures will be taken to prevent the take of the lizard."*

For previous grubbing operations, trees and brush were cut above ground level during frozen conditions and stumps were removed post May 1st. Vegetation was kept under 6-inches throughout the growing season or until construction activities were complete. These avoidance measures will be

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utilized throughout the remainder of onsite landfill construction activities to minimize the potential for take of the lizard.

4.0 ADDITIONAL STORMWATER MANAGEMENT ITEMS

*"3. **S. NR 504.04(4)(c), Wis. Adm. Code:** Provide a copy of the facility's Wisconsin Pollutant Discharge Elimination System (WPDES) permit, as well as the storm water runoff calculations originally provided in the May 25, 2022, plan modification request/plan of operation update. Provide a copy of the landfill's most recent Tier 2 industrial stormwater pollution prevention plan (SWPPP)."*

The facility's current WPDES permit is included in **Appendix C.1**.

The storm water runoff calculations originally provided in the May 25, 2022 plan modification request/plan of operation update, were provided in the Plan Modification, Addendum No. 1 dated February 1, 2023 as Appendix B1.4.

The facility's current Tier 2 SWPPP is included in **Appendix C.2**.

5.0 REVISED FINAL COVER DESIGN AND RELATED ITEMS

*"4. **S. NR 504.07(4), Wis. Adm. Code:** Provide a revised final cover design that includes a clay capping layer or a soil barrier layer with a geocomposite clay layer (GCL). The current GCL final cover design does not include a soil barrier layer and therefore, does not meet the code requirements. Provide revisions to the design/construction items that would be affected by the addition of a clay capping layer or a GCL with a two-foot soil barrier layer, including the following:*

A final cover system (see **Detail 4**, **Plan Sheet 24**) is proposed for the future remaining areas of final cover north of Module 1. The cover consists of the following components, from bottom to top:

- 3-inch-thick grading layer
- 12-inch-thick capillary break/barrier soil
- 12-inch-thick clay barrier soil
- GCL
- 40-mil polyethylene geomembrane
- Geocomposite drainage layer
- 30-inch-thick rooting zone layer
- 6-inch-thick topsoil layer

The geocomposite drainage layer properties are specified in the Construction Quality Assurance/Quality Control Plan (CQA/QCP) (**Appendix D**). Unit gradient calculations are included in **Appendix E.1** to confirm that water infiltrating the final cover will be contained within the drainage layers (sand or geocomposite) and will not result in unstable final cover slope conditions. **Appendix E.1** includes a calculation for the internal shear strength requirement for the GCL within the final cover.

The proposed final cover system within a small portion of Module 1 and 2 (see **Plan Sheets 7** and **12** and **Detail 3**, **Plan Sheet 24**) will have a sand drainage layer instead of the geocomposite drainage with the following components from, bottom to top:

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- 3-inch-thick grading layer
- 12-inch-thick capillary break/barrier soil
- 12-inch-thick clay barrier soil
- GCL
- 40-mil polyethylene geomembrane
- 12-inch-thick drainage layer (sand)
- 18-inch-thick rooting zone layer
- 6-inch-thick topsoil layer

The sand drainage layer will be used when new final cover is installed above existing final cover with a sand drainage layer to avoid having a geocomposite drainage layer draining into a sand layer with a potential different hydraulic conductivity.

5.1 CLAY BORROW SOURCE

> *"a. S. NR 504.075, Wis. Adm. Code: Provide remaining clay available at the New Haven clay borrow source, propose a new clay borrow or soil barrier layer borrow source for material needed for the revised final cover design."*

A Plan Modification Addendum dated November 2, 2015, included Clay Borrow Site documentation. This plan modification addendum provides applicable revisions for the clay borrow site documentation. This documentation along with the clay volume calculation in **Appendix E.2** demonstrate that Area 3 of the clay borrow site and the existing clay stockpile at the Columbia Dry Ash Disposal site will provide enough clay to construct the Modules 12 and 13 composite liner systems (requiring 2-foot-thick clay liners) as well as the final cover (requiring 1 foot thick clay barrier soil). No other changes to the November 2015 Plan Modification Addendum are requested with this addendum.

5.1.1 Water Levels

Groundwater monitoring well nests were installed at the clay borrow site before the first phase of clay excavation in 2016. The well nests are used to evaluate groundwater uplift forces on the proposed excavation bottoms. Water levels were collected at the site before the clay borrow excavation activities for Modules 5 and 6 liner construction, and again in 2023. Water level measurements recorded at the clay borrow site to date are provided as **Table 1** in **Appendix E.2**. Comparison of the measured groundwater elevations to previously completed uplift evaluations, were acceptable.

5.1.2 Clay Quantity

Clay volume calculations are contained in **Appendix E.2**. The estimated remaining clay volume at the New Haven clay borrow area is approximately 99,181 cubic yards. This volume assumes that the bottom elevation for the excavations in Area 3 is limited to 819 feet above mean sea level (amsl) based on future uplift analyses as discussed in the November 2015 Plan Modification Addendum. This volume was calculated using AutoCAD Civil 3D. The estimated clay volume remaining in the stockpile at the COL facility is approximately 14,100 cubic yards, based on an AutoCAD Civil 3D volume calculation. The total clay volume available including the clay borrow area and onsite stockpile is approximately 113,300 cubic yards.

The extents of clay placement for construction of the liner of Modules 12 and 13 and remaining final cover at the COL facility is proposed as shown in **Appendix E.2**. The estimated volume of clay

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required to build the remaining phases of landfill liner (Modules 12 and 13) and remaining final cover at the COL facility is approximately 97,000 cubic yards. This volume includes a contingency for clay shrinkage of 20 percent. The clay required is less than the 115,181 cubic yards of available clay in the on-site stockpile and in Area 3 of the clay borrow area.

5.1.3 Clay Borrow Site Restoration

A copy of the Reclamation Plan approved by Adams County was provided as Appendix H in the 2015 Plan Modification Addendum. WPL will consult with Adams County after approval of this Plan Modification to discuss possible revisions to the Reclamation Plan and restoration grades.

5.2 FINAL COVER DESIGN TOPOGRAPHY

> *"b. S. NR 514.06, Wis. Adm. Code: Provide the information in this section that will change due to the revised final cover design such as a revised final topography plan sheet and revised closure costs."*

A revised final topography plan sheets are provided on **Plan Sheet 7** and **Plan Sheet 12**. Revised closure costs are provided in **Appendix E.3**.

5.3 CONSTRUCTION QUALITY CONTROL AND ASSURANCE (CQA) PLAN

> *"c. SS. NR 514.07(1)(i) and (j), Wis. Adm. Code: Provide updated construction quality control and assurance plans which reflect the revised final cover design."*

An updated CQA plan which reflects the revised final cover design, including barrier layer requirements, is provided in **Appendix D**.

5.4 REVISED CLOSURE PLAN

> *"d. S. NR 514. 07(10)(1)(c)2, Wis. Adm. Code: Provide a revised closure plan that includes a description of the methods and procedures to be used to install the revised final cover."*

An updated closure plan which describes the methods and procedures to be used to install the revised final cover is provided in **Appendix F**.

6.0 APPENDIX C1 CLOSURE TOPOGRAPHY

> *"5. **SS. NR 514.045(1)(a) and NR 500.05(6)(h), Wis. Adm. Code:** Provide a plan sheet that depicts the closure topography. The plan sheet included in the closure plan in Appendix C1 of the December 14, 2022, Plan of Operation Modification does not depict the closure topography of Modules 10 and 11."*

The December 14, 2022 Plan of Operation modification Closure Plan (Appendix C1), was updated and a revised Closure Plan, including the closure topography of Modules 10 and 11, was provided in the Plan Modification, Addendum No. 1 dated February 1, 2023, as Appendix C3. The Closure Plan has been updated to include items addressed in this Plan Mod Addendum and is included in **Appendix F**. **Plan Sheet 7** shows the final cover topography if Module 13 is not constructed and Plan **Sheet 12** shows the final cover topography if Module 13 is constructed.

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7.0 GROUNDWATER MONITORING SYSTEM DEMONSTRATION

Groundwater monitoring and reporting at the COL facility is currently performed to comply with the requirements of both the approved Plan of Operations for the site and the Federal CCR Rule (40 CFR 257.90-98). Groundwater monitoring and reporting under the Wisconsin CCR regulations is expected to replace monitoring and reporting requirements under the federal CCR Rule following United States Environmental Protection Agency (U.S. EPA) approval of Wisconsin's CCR regulations. Groundwater monitoring and reporting under the approved site monitoring program (non-CCR well monitoring), which predated both the Federal CCR Rule and NR 514.045, will continue.

The CCR groundwater monitoring system includes the monitoring wells included in the attached CCR Groundwater Monitoring System Plan (**Appendix G**).

Sections 7.1 and **8.0** below relate only to the CCR wells. A separate monitoring system, including non-CCR wells and other monitoring points, exists at the site and will continue to be monitored. This non-CCR monitoring system predates NR 514.045. The non-CCR monitoring system is summarized in Table 2 of **Appendix H**. Requested changes to the non-CCR monitoring system, intended to reduce overlap and streamline groundwater monitoring and reporting of both the CCR monitoring system and the non-CCR monitoring system, are summarized in **Section 9.0** and in Table 2 of **Appendix H**.

> *"6. **S. NR 514.045(1)(h), Wis. Adm. Code:** Provide the groundwater monitoring system demonstration."*

Specific requirements of NR 507.15(3), with responses, are listed below.

7.1 CCR GROUNDWATER MONITORING REQUIREMENTS UNDER NR 507.15 (3)

NR 507.15 (3)

> *"CCR LANDFILLS. In addition to the detection groundwater monitoring system required under s. NR 507.19, the owner or operator of a CCR landfill that accepts CCR on or after October 19, 2015, shall also submit a plan establishing a separate CCR groundwater monitoring system for the purpose of monitoring groundwater quality in the uppermost aquifer in accordance with this chapter. The plan shall be submitted with the plan of operation modification for initial permitting in accordance with s. NR 514.045 or in the feasibility report under ch. NR 512."*

The CCR Groundwater Monitoring System Plan is included as **Appendix G**.

7.1.1 Groundwater Monitoring Plan Requirements Under NR 507.15(3)(a) through (e)

The CCR Groundwater Monitoring System Plan, including the requirements of and responses to NR 507.15(3)(a) through (e), is included as **Appendix G**.

7.1.2 Compliance With NR 507.15(3)(f)

NR 507.15 (3)(f)

> *"A sampling plan that includes the CCR groundwater monitoring system shall be submitted to the department in accordance with s. NR 507.16 and the requirements under s. NR 140.16. The*

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sampling plan shall include consistent sampling and analysis procedures that are designed to ensure the production of monitoring results that provide an accurate representation of groundwater quality in the uppermost aquifer at the upgradient and downgradient CCR wells and that provide a characterization of leachate quality generated by the CCR landfill. The sampling plan shall be implemented as approved in writing by the department."

A sampling plan that includes the CCR groundwater monitoring system is included as **Appendix H.** The sampling plan also includes monitoring at non-CCR wells and other monitoring points. Requested changes to the non-CCR monitoring program are included in **Section 9.0**.

7.1.3 Compliance With NR 507.15 (3)(g)

NR 507.15 (3)(g)

"The sampling plan shall include sampling and analytical methods that are appropriate for groundwater sampling and that accurately measure all required monitoring parameters under ch. NR 507, Appendix I in groundwater samples. The CCR landfill owner or operator shall obtain and analyze samples in accordance with the approved sampling plan under par. (f) and the requirements under s. NR 507.17."

Sampling and analytical methods are described in the sampling plan (**Appendix H**).

7.1.4 Compliance With NR 507.15 (3)(h)

NR 507.15 (3)(h)

"In addition to the field measurements required under s. NR 507.17 (1), the groundwater elevations shall be measured in each CCR well immediately prior to purging, each time groundwater is sampled. The owner or operator of the CCR landfill shall determine the rate and direction of groundwater flow each time groundwater is sampled and report the result to the department in accordance with s. NR 507.26. Groundwater elevations in wells that monitor the same CCR landfill shall be measured within a timeframe short enough to avoid temporal variations in groundwater flow that could preclude accurate determination of groundwater flow rate and direction."

Measurement of groundwater elevations is included in the sampling procedures described in the sampling plan (**Appendix H**).

Groundwater elevation data will be reported to the department semiannually in accordance with NR 507.26. The rate and direction of groundwater flow will be determined for each semiannual sampling event.

We request clarification from the Department regarding the preferred format for electronic submittal of groundwater flow rate and direction as required by NR 507.26(3)(a).

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7.1.5 Compliance With NR 507.15 (3)(i)

NR 507.15 (3)(i)

> *"The owner or operator of the CCR landfill shall establish baseline groundwater quality in accordance with s. NR 507.18 for each CCR well and for each of the constituents required under ch. NR 507 Appendix I, Table 1A and in accordance with the approved sampling plan."*

Baseline groundwater quality will be established for each CCR well in accordance with NR 507.18 and for each constituent required under NR 507 Appendix I, Table 1A.

An additional sampling round is needed to calculate preventive action limits (PALs) for lithium at MW-302, and alkalinity and hardness at MW-310 due to exclusion of outliers. Baseline sampling of CCR wells associated with Modules 10 and 11 is ongoing. Baseline sampling of CCR wells associated with Modules 12 and/or 13 will be completed following installation of the wells. PALs and, if applicable, Alternative Concentration Limits (ACLs) for these wells will be submitted to the department following the completion of baseline sampling.

Baseline groundwater quality calculations for CCR wells associated with Modules 1 through 6 were calculated in accordance with NR 507.27 and WDNR's guidance for calculating PALs and ACLs (PUB-WA-1105). **Table 2** summarizes proposed PALs for the CCR wells associated with Modules 1 through 6. PAL calculations are included in **Appendix I**. Monitoring data are available for some wells and parameters from as early as the 1980s, before the construction of the ADF. Where appropriate, these historical data were incorporated into PAL and ACL calculations. Historical data are shown in **Appendix J** but excluded from calculations for wells and parameters where recent concentrations are substantially less than historic concentrations.

Concentrations of some constituents appear to reflect impacts not related to the ADF, including road salt application, agricultural activities, and historical ash management activities at the site. Nitrite + nitrate concentrations appear to be associated with agricultural land use. Nitrate concentrations in groundwater in Columbia County are variable, and PAL or Enforcement Standards (ES) exceedances in supply wells are fairly common. Lines of evidence indicating that elevated boron, chloride, and sulfate concentrations at MW-33AR, MW-34A, MW-302, MW-309, and/or MW-310 are due to an alternative source other than the ADF have been presented in Alternate Source Demonstrations under the Federal CCR Rule. These lines of evidence include:

- Elevated levels of boron, chloride, and sulfate were present in the area west of the landfill, where MW-33AR, MW-34A, and MW-302 are located, before the landfill was constructed. Groundwater monitoring performed in 1977 and 1978 as part of the Feasibility Study for the landfill permitting showed that wells located along the west side of the future landfill footprint had elevated results for sulfate, chloride, and specific conductance. The 1978 Feasibility Study for the ADF discusses the influence of the ash pond effluent ditch on groundwater west of the proposed site. The former ash pond effluent ditch carried effluent from the ash ponds located north of the plant, and flowed south between the west side of the current landfill and the substation.

- Monitoring performed under the existing state program documents that the concentrations of boron, chloride, and sulfate were elevated before CCR disposal in the landfill began and have decreased since the landfill has been in operation. Routine groundwater monitoring for the COL ADF began after the Plan of Operation was approved and prior to initial CCR disposal. The earliest data available from the WDNR Groundwater

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Environmental Monitoring System (GEMS) database is from September 1984. Initial placement of CCR in test plots in Module 1 of the ADF was approved in October 1984, and CCR disposal began sometime after that. Therefore, the initial groundwater monitoring results in the GEMS database represent pre-disposal conditions for the landfill. Historical data from GEMS are included in the graphs in **Appendix I** for reference, but were not used to calculate ACLs.

- Groundwater flow directions have changed through time due to changes in water management at the plant, so that groundwater impacted by the effluent ditch formerly flowed to the east, under the landfill, and is now flowing west and/or north.

- The variations in chloride results for well MW-33AR since detection monitoring under the CCR Rule was initiated have not correlated with boron concentrations, as would be expected for a CCR leachate source; therefore, an alternative source is more likely.

- MW-309 and MW-310 are located adjacent to the plant entrance road, where elevated chloride concentrations due to road salt impacts are likely.

Table 3 summarizes wells and parameters with PAL exceedances, and **Table 4** summarizes calculated ACLs for wells and parameters with confirmed PAL exceedances. ACL calculations are included in **Appendix I**. Exemptions in accordance with NR 507.29 and NR 140.28 are requested for the following wells and parameters associated with Modules 1 through 6:

- Beryllium at MW-310
- Boron at MW-33AR, MW-34A, and MW-302
- Chloride at MW-33AR, MW-309, and MW-310
- Manganese at MW-301
- Nitrite + Nitrate as N at MW-33AR, MW-34A, and MW-301
- Sulfate at MW-33AR and MW-34A
- Thallium at MW-309 and MW-310

For the public health parameters other than nitrate, the requested exemptions are justified under NR 140.28(3)(b) and (4)(b) because:

- The proposed facility is designed to achieve the lowest possible concentrations that are technically and economically feasible for the substances with exemptions requested.
- For any parameters with baseline concentrations above the PAL but below the ES, the proposed facility will not cause the concentration of the substance to exceed the ES at a point of standards application.
- For any parameters with baseline concentrations above the ES:
  - The existing or anticipated increase in the concentration of the substance will not cause an increased threat to public health or welfare, and
  - The proposed facility will not cause an incremental increase in the concentration of the substance that exceeds the PAL.

For the public welfare parameters and nitrate, the requested exemptions are justified under NR 140.28(3)(a) and (4)(a) because:

- The proposed facility is designed to achieve the lowest possible concentrations that are technically and economically feasible for the substances with exemptions requested.

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- The existing or anticipated increase in the concentration of the substance due to the proposed facility does not present a threat to public health or welfare.

For purposes of this evaluation, the proposed facility is the Columbia ADF. The design of the existing Columbia ADF Modules 1 through 6 and 10 and 11, and proposed Modules 12 and 13, are part of the justification for the requested exemptions. The design features of the proposed and existing facility that justify the NR 140 exemptions include the liner system, leachate collection system, cover system, and the associated monitoring systems.

7.1.6 Compliance With NR 507.15 (3)(j)

NR 507.15 (3)(j)

> *"The owner or operator of the CCR landfill shall measure total recoverable metals concentrations when measuring groundwater quality for each CCR well. Measurement of total recoverable metals includes both the particulate fraction and dissolved fraction of metals in natural waters. To ensure this, groundwater samples from CCR wells may not be field filtered prior to analysis."*

Sampling methods, including collection of unfiltered samples at CCR monitoring wells, are described in the sampling plan (**Appendix H**).

7.1.7 Compliance With NR 507.15 (3)(k)

NR 507.15 (3)(k)

> *"The owner or operator of the CCR landfill shall notify the department in writing within 60 days of completing sampling and analysis at any CCR well when a groundwater standard at the point of standards application has been attained or exceeded in accordance with s. NR 507.30."*

The department will be notified in writing if a groundwater standard at a point of standards application has been attained or exceeded.

NR 500.03(204) defines "sampling period" as the month in which a sample is collected. NR 507.15(3)(k) requires a notification to the department within 60 days of "completing sampling and analysis." For the purpose of establishing reporting deadlines under the Federal CCR Rule, WPL considers analysis to be complete when all laboratory quality assurance and quality control is complete and the analytical report is issued.

It is unclear whether this requirement requires a notification within 60 days of the end of the sampling period (in accordance with NR 507.30) or within 60 days of completing sampling and analysis (as stated in NR 507.15(3)(k)). WPL requests clarification from the Department regarding the correct deadline for notification when a groundwater standard at the point of standards application has been attained or exceeded, noting that due to the time required for laboratory analysis, quality assurance, and quality control, analytical reports are often issued after the end of a sampling period.

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7.1.8 Compliance With NR 507.15 (3)(L)

NR 507.15 (3)(L)

"The owner or operator of a CCR landfill shall conduct detection groundwater monitoring at all CCR wells consistent with the requirements of this section and s. NR 507.19. Detection groundwater monitoring shall include groundwater monitoring for all constituents appropriate for CCR wells as listed under ch. NR 507 Appendix I, Table 1A and additional parameters if approved by the department in writing and in accordance with all of the following:

1. *The minimum monitoring frequency for the constituents approved by the department as part of the detection groundwater monitoring shall be semi-annual during the active life of the CCR landfill and the post-closure period. For existing and new CCR landfills and all lateral expansions of CCR landfills, baseline groundwater quality shall be established at each CCR monitoring well in accordance with s. NR 507.18. This includes the collection of a minimum of 8 independent groundwater quality samples for each CCR well, each of which shall be analyzed for all constituents appropriate for CCR landfills as listed under ch. NR 507 Appendix I, Tables 1A and 3 and any additional parameters approved by the department in writing.*

The sampling plan is included as **Appendix H.** Detection monitoring will be performed at CCR wells on a semiannual basis. Baseline groundwater quality shall be established at each CCR monitoring well in accordance with NR 507.18. Baseline sampling included additional sampling events at existing wells for constituents listed in NR 507 Appendix I, Tables 1A and 3, such as manganese, that were not collected to meet background sampling requirements of the Federal CCR Rule (see 40 CFR 257.97(b)) because the parameters are not included Appendix III or IV to 40 CFR Part 257. Baseline groundwater quality calculations are summarized in **Tables 2** and **4**, and discussed above in Section 7.1.5. Baseline sampling at monitoring wells MW-313, MW-314, and MW-315, downgradient of Modules 10 and 11, is ongoing.

2. *The number and methodology of groundwater quality samples collected and analyzed for each CCR well during subsequent semiannual sampling events shall be consistent with the approved sampling plan under s. NR 507.16, and shall account for any unique characteristics of the site. The CCR landfill owner or operator shall inform the department in accordance with s. NR 507.26 of any CCR well that purges dry, is damaged or obstructed, or in any way is rendered such that a sample was unable to be collected from the well during a scheduled sampling event and shall propose remedial actions to correct the problem prior to the next sampling event.*

The sampling plan is included as **Appendix H.** Notifications in accordance with NR 507.26 shall be made when the sampling event data are submitted.

3. *The owner or operator of the CCR landfill shall notify the department and respond in accordance with s. NR 507.30 when a groundwater standard at the point of standards application has been attained or exceeded at any CCR well. This response includes the establishment of an assessment monitoring program meeting the requirements under s. NR 508.06, unless the exceedance is determined by the department to be from a source other than the CCR landfill, or that the groundwater standard exceedance resulted from error in sampling, analysis, or natural variation in background groundwater quality in accordance with s. NR 508.06 (2) (f) 2.*

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Notifications and response in accordance with NR 570.30 shall be made when required. WPL requests clarification on the deadline for providing required notifications.

4. *For the purposes of determining the point of standards application for a groundwater quality exceedance at a CCR well, the horizontal distance for the design management zone under s. NR 140.22 (3) (a) for a CCR landfill is 0 feet from the waste boundary and may not be expanded by the department under s. NR 140.22 (3) (b). The waste boundary shall include the horizontal space taken up by any liner, dike, or other barrier designed to contain CCR waste."*

WPL acknowledges that the point of standards application for a groundwater monitoring exceedance at a CCR well is 0 feet from the waste boundary, which is consistent with the Federal CCR Rule. Compliance monitoring wells will be located as close as practicable to the waste boundary. Factors that may require siting wells further from the waste boundary include overhead or buried utility lines, slopes, landfill haul roads or access roads, storm water management features, rail lines and rights-of-way, and other site features.

7.1.9 Compliance With NR 507.15 (3)(m)

NR 507.15 (3)(m)

"The owner or operator of a CCR landfill shall prepare an annual groundwater monitoring and corrective action report for submittal to the department. The annual groundwater monitoring and corrective action report shall be placed in the written operating record and posted on a publicly accessible internet site under s. NR 506.17 (2) and (3) no later than January 31 of the year following the calendar year a groundwater monitoring system has been approved by the department, and annually thereafter. For the preceding calendar year, the annual report shall document the status of the groundwater monitoring and any corrective action implemented at the CCR landfill, summarize key actions completed, describe any problems encountered, discuss actions to resolve the problems, and project key activities for the upcoming year. At a minimum, the annual groundwater monitoring and corrective action report shall contain all of the following information, to the extent available:

1. *A map, aerial image, or diagram showing the CCR landfill and all upgradient and downgradient monitoring wells, including the well identification numbers, that are part of the groundwater monitoring for the CCR landfill.*

2. *Identification of any monitoring wells that were installed or decommissioned during the preceding year, along with a narrative description of why those actions were taken.*

3. *In addition to all the monitoring data obtained under par. (L), a summary including the number of groundwater samples that were collected for analysis for each upgradient and downgradient well, the dates the samples were collected, and whether the sample was required by detection monitoring or assessment monitoring.*

4. *A narrative discussion of any transition between monitoring including the date and circumstances for transitioning from detection monitoring to assessment monitoring in addition to identifying any constituents detected above ch. NR 140 standards.*

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5. *A section at the beginning of the annual report that provides an overview of the current status of groundwater monitoring and corrective action for the CCR landfill. At a minimum, the summary shall include all of the following:*

a. At the start of the current annual reporting period, whether the CCR landfill was operating under detection monitoring or assessment monitoring.

b. At the end of the current annual reporting period, whether the CCR landfill was operating under detection monitoring or assessment monitoring.

c. If it was determined by the owner or operator that there was a groundwater quality exceedance under ch. NR 140 for one or more constituents listed under ch. NR 507 Appendix I for CCR wells, a listing of those constituents, the names of the monitoring wells associated with the exceedances, and the date when the assessment monitoring was initiated for the CCR landfill.

d. If corrective action measures were required, the date when the assessment of corrective measures was initiated for the CCR landfill, the date when the public informational hearing under s. NR 508.06 (3) (e) was held for the discussion of the results of the remedial action options report, and the date when the assessment of corrective measures was completed.

e. If a remedy was required under ch. NR 508 during the annual reporting period, the date of remedy selection, and whether remedial activities were initiated or are ongoing during the annual reporting period."

Annual groundwater monitoring and corrective action reports will be submitted in accordance with the above criteria for monitoring wells included in the CCR well monitoring program.

Biennial groundwater monitoring reports under the pre-existing environmental monitoring program (Table 2 of **Appendix H**) are currently submitted in January of odd-numbered years. The most recent report was submitted on January 31, 2023. With the approval of the Department, future reports for the non-CCR well monitoring program will be submitted annually, to coincide with the annual reporting under 507.15 (3)(m).

8.0 UPDATED SAMPLING PLAN

*"7. **S. NR 514.045(1)(i), Wis. Adm. Code:** Provide an updated sampling plan."*

8.1 UPDATED SAMPLING PLAN UNDER NR 514.045 (1)(g)

NR 514.045 (1)(i)

"An updated sampling plan that addresses the requirements under s. NR 507.15 (3)."

The sampling plan is included as **Appendix H.**

8.1.1 Sampling Plan Requirements Under NR 507.15 (3)

The sampling plan is included as **Appendix H.** Specific requirements under NR 507.15(3) are discussed above in **Section 7.1**.

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9.0 SAMPLING PLAN REVISIONS FOR NON-CCR WELLS

A revised sampling table for Non-CCR wells and other monitoring points is included as Table 2 in Appendix H.

9.1 NON-CCR MONITORING NETWORK SAMPLING PLAN REVISIONS

Requested revisions to the existing monitoring plan are summarized below. Graphs showing historical data for parameters proposed for removal from the sampling plan are included as Appendix J:

9.1.1 Monitoring Point Updates

The following changes to the list of monitoring points included in the non-CCR monitoring program are requested:

- Re-characterization of monitoring wells MW-33AR, MW-34A, and MW-84A as CCR monitoring wells that will be sampled under the requirements of NR 507.15(3).
- Removal of monitoring wells MW-91A and MW-91B from the monitoring program. These wells are located within the Dry ADF limits.
- Re-characterization of LP-1 as a sampling point will be used to monitor leachate quality under the requirements of NR 507.15(3)(f).

9.1.2 Parameter List Updates

The following revisions to the sampling parameter list for non-CCR monitoring points are requested. These requests represent a reduction in the parameter list to include only those parameters listed in Tables 2 and 5 of NR 507, Appendix I for landfills accepting fly ash and bottom ash, plus select metals. These requested revisions would remove most parameters that are not required under detection monitoring, with the understanding that some parameters may be required in the future if an assessment monitoring program is initiated at the site.

Graphs of historical data referenced below are included in Appendix J.

- Removal of chloride from the parameter list for non-CCR monitoring wells.
  - Chloride has been included in semiannual sampling events at the site since 2015, and prior to that was included in sampling events in the 1980s.
  - NR 140 PAL exceedances for chloride have been detected in some site wells since chloride was added back into the sampling program; however, these have consistently been attributed to road salt application and not to the ADF.
  - Chloride will remain on the parameter list for supply wells HC-1, HC-2, and HC-3. Chloride concentrations at these wells have increased in recent years and have exceeded the NR 140 public welfare PAL (125 milligrams per liter [mg/L]) at HC-1 during most monitoring events since 2020.

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- Removal of Nitrite + Nitrate as Nitrogen (nitrite + nitrate – N) from the parameter list for non-CCR monitoring wells.
  - Nitrite + nitrate – N has been included in monitoring events since 2015.
  - Concentrations at some site monitoring wells typically exceed the NR 140 PAL; however, these concentrations appear to be associated with agricultural land use. Nitrate concentrations in groundwater in Columbia County are variable, and PAL or Enforcement Standards (ES) exceedances in supply wells are fairly common.
  - Nitrite + nitrate – N will remain on the parameter list for supply wells HC-1, HC-2, and HC-3. Concentrations at HC-3 are typically slightly above the PAL.
- Removal of aluminum from the parameter list for non-CCR monitoring wells.
  - Aluminum has been included in monitoring events since 2015.
  - Concentrations exceeded the NR 140 PAL in several site wells during the October 2019 sampling event. This single event with elevated concentrations is anomalous, may be due to laboratory error, and does not appear to reflect actual groundwater quality at the site.
  - Aluminum results at site monitoring wells are typically non-detect.
  - Aside from anomalous results in October 2019, aluminum results at MW-37A and MW-84A have exceeded the PAL during single events. These exceedances were not confirmed in subsequent samples and do not appear to be associated with the ADF.
- Removal of barium from the parameter list for non-CCR monitoring wells.
  - Barium has been included in sampling events since 1996.
  - No PAL exceedance for barium has been detected in a site monitoring well.
- Removal of cadmium from the parameter list for non-CCR monitoring wells.
  - Cadmium has been included in the monitoring program since 2011.
  - No confirmed NR 140 PAL exceedances have been detected in site groundwater monitoring wells since this parameter was added to the monitoring program.
- Removal of chromium from the parameter list for non-CCR monitoring wells.
  - Chromium has been included in sampling events at the site since 1996.
  - No confirmed NR 140 PAL exceedances have been detected at site monitoring wells, with the exception of MW-91A/MW-91AR, located within the permitted landfill limits.
  - Concentrations at supply well HC-2 exceeded the PAL in the early 1990s, but have not exceeded the PAL since 1996 and the concentration trend is downward or stable.

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- Removal of mercury from the parameter list for non-CCR monitoring wells.
  - Mercury has been included in the monitoring program since 2011, and no NR 140 PAL exceedance has been detected at any site monitoring well.
- Removal of selenium from the parameter list for non-CCR monitoring wells.
  - Selenium has been included in the monitoring program since 2011.
  - No confirmed PAL exceedance has been detected, with the exception of monitoring well MW-91AR and MW-91B, located within the permitted landfill limits. Selenium concentration trends at these wells have decreased and stabilized below the PAL.

9.2 NON-CCR REPORTING SCHEDULE REVISION

A revision of the reporting schedule for the non-CCR monitoring program, from biennial reports submitted January 31st of odd-numbered years to annual reports coinciding with the reporting schedule in NR 507.15 (3)(m) is requested. This change is intended to support a holistic approach to groundwater data reporting and Departmental review for the ADF.

9.3 PAL AND ACL CALCULATIONS

Well-specific PALs and ACLs have not previously been calculated for the site. Applicable PALs and ACLs will be calculated and submitted for departmental review with the CCR monitoring well baseline calculations. Baseline groundwater quality calculations have been calculated in accordance with NR 507.27 and WDNR's guidance for calculating PALs and ACLs (PUB-WA-1105). Table 5 summarizes proposed PALs for the non-CCR monitoring wells. PAL calculations are included in Appendix I.

A summary of NR 140 standards exceedances at monitoring wells included in the monitoring plan (Table 2 of Appendix H) is presented in Table 6, and proposed ACLs are summarized in Table 7. PAL and ACL calculations are included in Appendix I.

Monitoring data are available for some wells and parameters from as early as the 1980s, before the construction of the ADF. Where appropriate, these historical data were incorporated into PAL and ACL calculations. Historical data are shown in Appendix I but excluded from calculations for wells and parameters where recent concentrations are substantially less than historic concentrations. Concentrations of some constituents appear to reflect impacts not related to the ADF, including road salt application, agricultural activities, and historical ash management activities at the site.

Table 7 summarizes exemption requests for wells and parameters with confirmed PAL exceedances. Exemptions in accordance with NR 507.29 and NR 140.28 are requested for the following parameters at non-CCR monitoring wells:

- Arsenic: MW-86, MW-92A, and MW-92B
- Boron: MW-33BR and MW-34B
- Chloride : MW-37A and MW-86
- Molybdenum: MW-33BR
- Nitrite + Nitrate as N: MW-33BR, MW-34B, MW-83, and MW-92A
- Sulfate: MW-33BR

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For the public health parameters other than nitrate, the requested exemptions are justified under NR 140.28(3)(b) and (4)(b) because:

- The proposed facility is designed to achieve the lowest possible concentrations that are technically and economically feasible for the substances with exemptions requested.
- For any parameters with baseline concentrations above the PAL but below the ES, the proposed facility will not cause the concentration of the substance to exceed the ES at a point of standards application.
- For any parameters with baseline concentrations above the ES,
  - The existing or anticipated increase in the concentration of the substance will not cause an increased threat to public health or welfare; and
  - The proposed facility will not cause an incremental increase in the concentration of the substance that exceeds the PAL.

For the public welfare parameters and nitrate, the requested exemptions are justified under NR 140.28(3)(a) and (4)(a) because:

- The proposed facility is designed to achieve the lowest possible concentrations that are technically and economically feasible for the substances with exemptions requested.
- The existing or anticipated increase in the concentration of the substance due to the proposed facility does not present a threat to public health or welfare.

For purposes of this evaluation, the proposed facility is the Columbia ADF. The design of the existing Columbia ADF Modules 1 through 6 and 10 and 11, and proposed Modules 12 and 13, are part of the justification for the requested exemptions. The design features of the proposed and existing facility that justify the NR 140 exemptions include the liner system, leachate collection system, cover system, and the associated monitoring systems.

10.0 REVISED CLOSURE SCHEDULE

*"8. **S. NR 514. 07(10)(1)(c)6, Wis. Adm. Code:** Provide a closure schedule that provides sufficient information to describe the sequential steps that will be taken to close the CCR landfill, including installation of the final cover system, and the estimated timeframes to complete each step or phase of CCR landfill closure."*

An updated closure plan which details the sequential steps for the installation of the final cover system and estimated timeframes to complete each step is provided in **Appendix F**.

11.0 REVISED LONG-TERM CARE PLAN

*"9. **S. NR 514.07(10)(1)(d)1.d, Wis. Adm. Code:** Provide a revised long-term care plan that addresses monitoring in accordance with the sampling plan.*

*10. **S. NR 514. 07(10)(1)(e), Wis. Adm. Code:** Provide a revised long-term care plan that includes leachate collection line video camera inspections per s. NR 506.07(5)(e), Wis. Adm. Code."*

A revised long-term care plan that addresses monitoring in accordance with the sampling plan and includes leachate collection line video camera inspections is provided in **Appendix K**.

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12.0 PLAN FOR THE CARE AND MAINTENANCE OF THE LEACHATE COLLECTION SYSTEM TANKS AND PUMPS

> *"11. **Condition 6 of the department's July 28, 2022, plan of operation approval modification:** Provide an operation plan that addresses the care and maintenance of the tanks, and pumps as well as the means to monitor the tank and manholes secondary containment systems."*

Care and maintenance of the future leachate tanks and pumps will be performed per the equipment manufacturer's recommendations. After installation, recommendations will be provided for specific maintenance activities. Secondary containment systems for tanks and the Module 1 and 2 Sumps will be monitored for leaks during routine inspections. Piping infrastructure will be pressure tested before placed into use. Cathodic protection for the leachate underground storage tank will be inspected during the life of the components.

13.0 MODULE 12 LINER DESIGN, OR PROPOSAL FOR THE REMOVAL OF THE MODULE 11 LINER RUNOUT

> *"12. **Condition 8 of the department's July 28, 2022, plan of operation approval modification:** Provide the design for the construction of Module 12 liner or a proposal for removal of the liner runout from Module 11 and timing of construction of the north berm for Module 11."*

On June 23, 2022, WPL announced that the Columbia Energy Center will retire no later than June 1, 2026. The extended plant life may require additional CCR disposal space. To prepare the Dry ADF for potential future expansion into Modules 12 and 13, the north side of the Module 11 includes a liner tie-in berm as shown on **Detail 1** on **Plan Sheet 19**.

To provide operational flexibility, WPL is proposing three scenarios for permitting:

1. Closure of the ADF, Modules 1 through 6 and Module 10 and 11 (**Section 0**).
2. Develop Module 12. Closure of the ADF, Modules 1 through 6 and Module 10 through 12 (**Section 15.0**).
3. Develop Modules 12 and 13. Closure of the ADF, Modules 1 through 6 and 10 through 13. (**Section 0**).

The decision to construct Module 12 or Module 13 will be based on CCR filling volumes and densities during ongoing plant operations and Primary and Secondary Ash Pond closure activities.

During the 2022 and 2023 construction seasons, Module 10 and 11 liner was constructed as shown on **Plan Sheet 2**. The north liner side slope of Module 11 and the east liner side slopes of Modules 5 and 6 will not be constructed until the need for Modules 12 and 13 has been determined.

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14.0 SCENARIO 1: CLOSURE OF THE CURRENT ASH DISPOSAL FACILITY

If it is determined that additional liner modules are not needed, WPL will close the ADF without construction of Module 12 or Module 13. Modules 1 through 6, and 10 and 11 would be closed. In this scenario:

- The north liner side slope of Module 11 will be extended to the proposed final cover tie-in berm as shown by the blue lines on **Detail 1** on **Plan Sheet 12** in the July 18, 2022 Addendum No. 1 to the Plan Modification Request/Plan of Operation Update.

- There are no other changes to the base grades, waste limits, or final cover grades presented in the in the July 18, 2022 Addendum No. 1 to the Plan Modification Request/Plan of Operation Update.

- The final cover will be constructed as shown on **Figure 1** of the February 1, 2023 Addendum No. 1 Plan of Operation Modification Request WDNR Code Update.

14.1 CAPACITY

Total airspace of the ADF for Scenario 1 is listed below:

- **Scenario 1**: 2,596,262 cubic yards

Documentation for volume calculations completed by SCS are provided in **Appendix E.5**. The disposal capacity volume calculations were performed using the AutoCAD Civil 3D program.

15.0 SCENARIOS 2 AND 3: DEVELOPMENT OF MODULE 12 OR 12 AND 13.

Two additional scenarios are proposed beyond closing the current constructed modules.

- **Scenario 2**: Development of Module 12
- **Scenario 3**: Development of Module 12 and 13

The following sections describe each of the scenarios in detail.

15.1 ENGINEERING DESIGN MODIFICATIONS AND RATIONALE

The ADF design is currently approved under the alternative design criteria for landfills designed primarily for the disposal of high-volume industrial waste, as allowed by NR 504.10. This section addresses design changes to the ADF related to construction of Module 12 or Module 12 and 13, which will accommodate future potential filling needs. A description of each design change, a discussion of updated or current information regarding approved alternative design features that will remain a part of the ADF design, is provided in the following sections.

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15.1.1 Capacity

Total airspace of the ADF for Scenarios 2 and 3 are listed below:

- **Scenario 2**: 3,207,520 cubic yards
- **Scenario 3**: 3,630,075 cubic yards

Documentation for volume calculations completed by SCS are provided in **Appendix E.5**. The disposal capacity volume calculations were performed using the AutoCAD Civil 3D program.

The ADF permitted air space is 6,045,000 cubic yards, as noted in the WDNR January 28, 2011 Plan of Operation Update approval letter. The addition of Module 12 or Module 12 and 13 does not exceed the permitted air space.

15.1.2 Subbase and Base Grades

The currently approved design for the ADF includes base grades for Phase 1, Modules 1 through 6 and Phase 2, Modules 10 and 11 only. Base grades for Module 12 or Module 12 and 13 in Phase 2 have been designed and included in this Plan Mod Request WDNR CCR Code Update Addendum No. 2. Subbase grades for Module 12 are shown on **Plan Sheet 3**, and base grades are shown on **Plan Sheet 4**. Subbase grades for Modules 12 and 13 are shown on **Plan Sheet 8**, and base grades are shown on **Plan Sheet 9.**

The subbase grades and base grades for Scenario 2 and 3 were developed to maintain at least 5 feet of separation between the bottom of the liner and the record high groundwater table (October 2018). The high-water table near the low point of the ADF liner is approximately 788.5 above mean sea level (msl). The lowest portion of the liner system is the bottom of the Module 12 leachate collection sump with a bottom of clay liner elevation of 799.0 msl and the Module 13 sump elevation of 800 msl. Exclusive of sumps and leachate line undercuts, the separation distance between the high-water table is at least 10 feet. The high-water table and liner grades are shown on the cross-sections (**Plan Sheets 14, 15,** and **16**).

Modules 5 and 6 liners were constructed in 2021 to allow a future tie-in to Phase 2 Modules 12, if constructed.

15.1.3 Composite Liner System

No changes to the currently approved composite liner system design are included in this Plan Mod Request Addendum. The approved composite liner system consists of the following from bottom to top:

- 2 feet of compacted clay
- GCL
- 60-mil High-density polyethylene (HDPE) geomembrane

15.1.3.1 Compacted Clay Liner

The 2 feet of clay was added to the liner system in 2011 with a plan modification, which was approved on September 14, 2011. Compacted clay material for ADF is sourced from a nonmetallic mining site in Adams County. The clay was approved as a borrow source in November 2015. The clay needed for construction of Modules 10 and 11 was imported to COL in 2021 and stockpiled east of

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Modules 5 and 6. The clay stockpile volumes, clay borrow site volumes, and amount of clay required for Module 12 or Module 12 and Module 13 liner construction provided as calculations in **Appendix E.2**.

15.1.3.2 Geosynthetic Clay Liner

GCLs used in the construction of the liner and final cover systems at the ADF will meet the specifications of NR 504.07(4)(a)1 to 11. Specifications for the GCL are discussed in the CQA/QCP provided in **Appendix D**. Liner GCL installed in Modules 2 through 6 and Modules 10 and 11 was polymer enhanced and originally compatibility tested with SDA material before its use. GCL will continue to be polymer enhanced for Scenarios 2 and 3.

A parametric static veneer slope stability calculation and a calculation for the internal shear strength requirement for the GCL were performed to assess the composite liner system. The calculations were submitted in Appendix D3 of the May 25, 2022 Plan Modification Request – Plan of Operation Update, which was approved on July 28, 2022. The previously approved 2022 calculations are provided in **Appendix E.1** for reference.

15.1.3.3 Geomembrane Liner

A 60-mil HDPE geomembrane will be placed directly above the GCL as currently approved. The geomembrane will meet the specifications of NR 504.07(3). Construction specifications for the geomembrane are discussed in the CQA/QCP.

15.1.4 Leachate/Contact Water Management System

This section addresses the proposed methods for managing leachate and contact water during active ADF filling operations and after the ADF is closed. Contact water in this Plan Mod Addendum is defined as leachate that runs off CCR surfaces as opposed to leachate that infiltrates through the CCR to the leachate collection system. Contact water flows and volumes are estimated from storm water modeling calculations while leachate flows and volumes are calculated from leachate generation rates in NR 504.06. Both leachate and contact water are managed as leachate per NR 500 regulations.

15.1.4.1 Leachate Management During Active Filling

Under current operations leachate from Phase 1 Modules 1 and 2 is conveyed by gravity to the Leachate/Surface Water Pond. Except for Module 1, the ADF liner system includes a leachate drainage layer and perforated leachate collection piping as shown on **Detail 4**, **Plan Sheet 17**. Module 1 has a screened bottom ash drainage layer and a single perforated drain on the east end of the module. The existing leachate collection lines and Module 1 perforated drain discharge to the Leachate/Surface Water Pond. Leachate and contact water from Phase 1 Modules 3 through 6 are conveyed to Modules 10 and 11 where the leachate and contact water are pumped to the Leachate/Surface Water Pond. Leachate from Mod 3 flows through a leachate collection line into the Mod 10 leachate collection line. Leachate from Modules 4, 5, and 6 flows through collection lines to the collection line in Module 11. During pond closure activities in 2023, the pond closure contractor is pumping leachate and contact water from Modules 10 and 11 to the Leachate/Surface Water Pond with trash pumps and temporary hoses. When the pond closure construction is complete, WPL will pump leachate and contact water from the Module 10 and 11 leachate collection sumps to the Leachate/Surface Water Pond via the pumps, side slope risers, and permanent piping in Modules 10 and 11.

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Interim cover and rain covers are used to limit the generation of leachate and contact water. WPL pumps leachate from the Leachate/Surface Water Pond to a scraper mounted water wagon for transport to the Plant for disposal per the WPDES permit.

If Module 12 is constructed, leachate in Module 5 and 6 will be diverted to the Module 12 via leachate collection piping. If Module 13 is constructed, leachate from Module 6 will be diverted to Module 13 with leachate from Module 5 continuing to flow to the Module 12. The leachate collection system in Module 12 or Module 13 will not be connected to the existing Phase 1 leachate collection system until WDNR approves construction of the Modules. Following WDNR approval of Module construction, the following leachate collection system modifications will be made for each of the scenarios:

Scenario 2:

- The leachate collection line in Module 5 will be connected to the leachate collection line in Module 12.
- The leachate collection header between Module 5 and Module 4 will be plugged to direct leachate from Module 5 into Module 12.
- Leachate from the Module 6 header will be diverted to Module 12.

After the modifications, leachate from Modules 4 and 11 will be conveyed by gravity to a leachate collection sump in Module 11. Leachate from Modules 5, 6, and 12 will be conveyed by gravity to a leachate collection sump in Module 12.

Scenario 3:

- The leachate collection line in Module 5 will be connected to the leachate collection line in Module 12.
- The leachate collection header between Module 5 and Module 4 will be plugged to direct leachate from Module 5 into Module 12.
- The leachate collection line in Module 6 will be connected to the leachate collection line in Module 13.
- The leachate collection header between Module 6 and Module 5 will be plugged to direct leachate from Module 6 into Module 13.

After the modifications, leachate from Modules 4 and 11 will be conveyed by gravity to a leachate collection sump in Module 11. Leachate from Modules 5 and 12 will be conveyed by gravity to a leachate collection sump in Module 12. Leachate from Modules 6 and 13 will be conveyed by gravity to a leachate collection sump in Module 13.

15.1.4.2 Leachate Management During Closed Conditions

Following final closure of the ADF, leachate will be diverted from the Leachate/Surface Water Pond to a leachate storage tank. With final cover placed over the ADF, contact water management will no longer be required. Following final cover placement, the following leachate collection system modifications will be made:

- Leachate sumps will be installed on the leachate collection lines from Modules 1 and 2 (see Plan Sheets 5 and 10).

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- Leachate pumps in the Module 1 and 2 sumps will pump leachate to the leachate storage tank.
- Leachate from the Modules 10, 11, and potential 12 and 13 sumps will be pumped to the leachate storage tank.

Leachate in the storage tank will be hauled to a wastewater treatment plant, pending approval from the receiving facility.

15.1.4.3 Leachate Drainage Layer and Piping

No changes to the approved leachate collection piping materials or leachate drainage layer are proposed with this Plan Mod Addendum. Leachate collection system material specifications are provided in the current CQA/QCP (**Appendix D**). Calculations showing the leachate collection system has the hydraulic capacity to maintain less than 1 foot of head over the liner during active and closed conditions per NR 504.06(5)(a) were submitted in Appendix D3 of the May 25, 2022 Plan Modification Request – Plan of Operation Update, which was approved on July 28, 2022. The previously approved 2022 calculations are provided in **Appendix E.4** for reference.

Pipe bedding filter calculations will be updated using actual materials selected for construction prior to installation. Specifications for filter, pipe bedding, and drainage layer materials are provided in the CQA/QCP (**Appendix D**).

A pipe filter analysis was performed to confirm that the size of the leachate collection line perforations is compatible with the pipe bedding aggregate. This calculation was submitted in Appendix D2 of the May 25, 2022 Plan Modification Request – Plan of Operation Update, which was approved on July 28, 2022. The previously approved 2022 calculations are provided in **Appendix E.1** for reference. This calculation shows that the ½-inch-diameter perforations shown on **Detail 4, Plan Sheet 17** are suitable for the pipe bedding material specified for construction of the leachate collection system.

A geomembrane puncture resistance calculation was also performed to determine the required geotextile cushion specifications for the geotextile to be installed between the geomembrane and pipe bedding material in the leachate collection trenches. This calculation indicates that a minimum geotextile mass per unit area of 1,100 grams per square meter is required to protect the geomembrane beneath the leachate collection pipes from puncture (**Appendix E.1**). The required geotextile mass per unit area can be provided with a single layer of 32-oz/sy geotextile.

The current design includes cleanout access for leachate collection piping. Leachate cleanouts will be installed at the locations shown on **Plan Sheets 5** and **10**. Leachate cleanout details are provided on **Detail 6, Plan Sheet 17.**

Leachate collection line lengths will not exceed 1,200 feet. Due to the granular nature of the native soils at the site, consolidation settlement of fine-grained soils will not occur. Therefore, settlement calculations confirming that a minimum pipe slope of 0.5 percent will be maintained, were not completed previously as discussed in NR 504.06(6)(c).

The 6-inch HDPE leachate collection piping was evaluated for pipe strength using construction/operation loads and post-closure loads to confirm that the materials are acceptable for construction (**Appendix E.1**). Six-inch SDR 11 HDPE pipe will continue to be used for leachate collection/cleanout lines.

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15.1.4.4 Leachate Sumps and Force Mains

Leachate collection sumps will be constructed on the eastern end of Module 12 and Module 13 (see **Plan Sheets 5** and **10**). The sumps will be constructed as shown on **Detail 1, Plan Sheet 21**. Calculations supporting sump sizing are provided in **Appendix E.4**.

The sump riser pipe will be 18-inch-diameter, SDR17 HDPE pipe. The pipe strength calculation in **Appendix E.2** confirms that the proposed pipe is suitable for the design loads over the sumps. The side slope risers will terminate in a vault as shown on **Detail 4, Plan Sheet 22**. The vault will provide access to pump discharge piping and facilitate removal of the pumps for maintenance.

The leachate pumps and discharge piping have been designed and sized for active filling conditions and final closure conditions. Initially, higher capacity pumps will be installed in the side slope risers to manage leachate and contact water while the ADF is open. Smaller pumps and discharge piping will be installed after the ADF is closed. Leachate pump and piping calculations for active filling and post closure conditions are provided in **Appendix E.4**.

Leachate and contact water is currently pumped to the Leachate/Surface Water Pond. During larger rainfall events, some contact water storage in Modules 12 and 13 will be required. During a 25-year, 24-hour storm event, the water level in Modules 12 and 13 will reach approximate elevation 796.6 ft msl. The leachate pumps in the Modules 12 and 13 will pump the water to Leachate/Surface Water Pond in approximately 114 hours (4 days and 18 hours) following a 25-year, 24-hour storm event with an open area of approximately 8.5 acres. Dual contained HDPE leachate force mains will be installed as shown on **Plan Sheets 5** and **10**. Under active filling conditions the leachate pumps will discharge to the larger diameter force main to the Leachate/Surface Water Pond. Following ADF final closure, the leachate pumps will discharge to smaller diameter piping to the Leachate Storage Tank.

As noted above, when the ADF is closed, leachate sumps will be installed to facilitate pumping leachate from Modules 1 and 2 to the Leachate Storage Tanks. Pump sizing calculations are in **Appendix E.4**.

15.1.4.5 Leachate/Surface Water Pond

Leachate and contact water from Module 1 through 6, and Modules 10 and 11 is currently discharged to the existing Leachate/Surface Water Pond located to the east of Module 2. The pond has a 30-mil PVC liner along the bottom and sides to approximate elevation 797. Water in the Leachate/Surface Water Pond is periodically pumped to a leachate hauling vehicle and discharged to the Primary Ash Pond or applied to the active fill area for dust control.

SCS evaluated the capacity of the Leachate/Surface Water Pond for two purposes:

- Verify that the pond provides at least 4 days of leachate storage capacity based on leachate generation rates described in NR 512.12(3).

- Determine the maintenance water level elevation during different phases of ADF development such that the pond can contain contact water from a 25-year, 24-hour storm event within the lined limits of the pond.

To verify that the Leachate/Surface Water Pond provides at least 4 days of leachate storage capacity, the amount of leachate generated on a daily basis was calculated based on leachate generation rates provided in NR 512.12(3). The leachate generation rate was calculated

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assuming all areas of Phase 1 without final cover are open, Phase 2 Modules 10 and 11 are open, and new Module 12 is open (i.e., 6 inches per year over the active area). The leachate volume generated over 4 days is approximately 55,500 gallons, which is significantly lower than the maximum Leachate Surface Water Pond storage volume of 1,455,700 gallons.

The Leachate/Surface Water Pond capacity to manage contact water was evaluated by SCS under the proposed Primary and Secondary Ash Pond closure filling sequence in the Plan Modification Request/Plan of Operation Update dated May 2022. The evaluation showed that the Leachate/Surface Water Pond can contain contact water from 7.8 acres of open area during a 25-year, 24-hour storm event. Therefore, the filling sequence was developed to limit open area by use of interim cover and rain cover.

The pond capacity evaluation assumes that the pond will have no more than 6 inches of standing water before the storm event. During the 25-year, 24-hour storm event, the water level in the pond will reach a maximum level of 796.97 msl, which is at the top of the pond liner elevation of 796.97 msl. This approach to evaluating the storage capacity of the Leachate/Surface Water pond was previously approved by the WDNR in 2018, 2021, and 2022 as part of a rain cover plan modification approval for future module construction.

The capacity of the Leachate/Surface Water Pond was determined from the HydroCAD modeling presented in **Appendix E.4**. The modeling was developed to establish the maximum operating level in the pond required to contain the subsequent runoff within the lined limits under various rainfall events. The results of this evaluation are presented in Figures 1A and 2A within **Appendix E.4**. The modeling results indicate that the Leachate/Surface Water Pond has the capacity to accommodate runoff from the 25-year, 24-hour storm event, assuming the operating water levels in the pond presented in Figures 1A and 2A are maintained. The maximum allowable open area and contact water sump area during filling of Module 12 and 13 is 8.51 acres.

The modeling involved delineating watersheds to the pond, including those outside of the active module area that drain to the pond. The HydroCAD model was then used to generate the runoff hydrograph. Active filling areas were assumed to be impermeable. By routing the runoff from the contributing drainage areas into the pond, the HydroCAD model estimated the peak water elevation in the pond resulting from a 25-year, 24-hour storm event. The amount of freeboard available in the lined pond area was then used to determine the maximum allowable operating water level in the pond. The HydroCAD modeling simulation is included in **Appendix E.4**.

15.1.4.6 Leachate Storage Tank

Following closure of the ADF, a 15,000-gallon underground leachate storage tank will be installed east of Module 1 as shown on **Plan Sheets 5** and **10**. Details for the storage tank and associated load out facility are shown on **Details 2** and **3**, **Plan Sheet 22**.

15.1.4.7 Leachate Headwells

Leachate headwells will be installed in Module 12 and Module 13 (see **Plan Sheet 10** and **Detail 3, Plan Sheet 17**). Based on the pipe filter calculation (**Appendix E.1**), a slot size of 0.01 inches (No. 10 or 10 slot) is acceptable for the leachate headwells.

The leachate headwell in Module 5 will be abandoned following WDNR approval of Module 12 liner construction. This headwell will no longer be accessible after filling begins in Module 12. If Module 13 is constructed, the leachate headwell in Module 6 will be abandoned.

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15.1.5 Final Cover System

The proposed final cover system is discussed in **Section 5.0**. Final cover grades for each of the Scenarios 2 and 3 are shown on **Plan Sheet 7 and Plan Sheet 12**, respectively.

15.1.5.1 Slope Stability

Interim waste slopes and final grade waste slopes were evaluated in terms of global slope stability to determine the slope stability safety factors (**Appendix E.1**). Slope stability safety factors meeting the recommended minimum values were calculated based on the analyses.

15.1.5.2 Intermediate Drainpipes and Toe Drainpipes

In accordance with NR 504.07(6)(a), drainage analyses were performed to assess the design and construction requirements for the final cover. **Appendix E.1** contains the pipe flow calculations to confirm that the intermediate drain pipes and toe drain pipes are suitable to collect and discharge flow from the drainage layers. Toe drain outlet pipes will be installed at a maximum spacing of one per 200 feet of toe drain. Additional intermediate drainage pipes discharging to the intermediate swales and downslope flumes will be installed in the final cover converging flow areas. Details of the final cover drainage piping are provided on **Plan Sheets 7** and **12**. Drain sock geotextile calculations for sand drainage layer pipes will be performed as described in the CQA/QCP (**Appendix D**).

15.1.5.3 Final Cover Phasing

WPL is currently planning to install final cover over the western slopes of Modules 2 through 5 in 2024. Final cover construction over the balance of the ADF will be placed at a later date based on pending plant decommissioning planning.

15.1.6 Surface Water Management System

The currently approved surface water management system for the ADF consists of a network of diversion berms, downslope channels and flumes, perimeter ditches, culverts, and a sedimentation basin. Diversion berms located on the final cover of Modules 1 and 2 and the intermediate cover of Modules 2, 3, and 4 direct surface water runoff to the sedimentation basin located south of the ADF.

Proposed final grades for Scenario 2 are shown on **Plan Sheet 7** and Scenario 3 on **Plan Sheet 12**. The plan sheets show proposed diversion berms, downslope channels and flumes, energy dissipators, perimeter swales, and culverts that will direct surface water runoff from the final cover to the sedimentation basins. Details of the final cover and perimeter drainage features are shown on **Plan Sheets 25** and **26**.

Storm water runoff calculations in **Appendix E.6.1** show that the proposed final cover features, perimeter drainage features, and sedimentation basin can handle runoff from a 25-year, 24-hour storm event, and that they can safely pass the 100-year, 24-hour storm event.

Erosion controls that will be installed prior to ADF construction activities are shown on **Plan Sheets 7** and **12**, and erosion control details are shown on **Plan Sheet 28**.

Most of the final cover system drains to the sedimentation basin located south of the ADF. The portion of the north final cover system below the lowest diversion berms will drain to an existing infiltration area on the north side of Murray Road, designated the North Infiltration Area in the storm water calculations. Storm water calculations show that runoff from the 25-Year, 24-hour and 100-

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year, 24-hour storm events will not overflow the infiltration area. The high water levels in the infiltration area are shown on **Detail 8**, **Plan Sheet 27**. No improvements to the infiltration area are needed to manage runoff from the northern portion of the final cover system.

15.1.7 Site Access

The existing ADF entrance near the northeast corner of Module 6 will be maintained and used for construction of either scenarios 2 or 3, as well as plant operations, including hauling of leachate from the Leachate/Surface Water Pond.

With the construction of potential future module liner, the access road extending around Modules 10 and 11 and around the south side of the Leachate/Surface Water Pond with remain, providing vehicle access to the Leachate/Surface Water Pond and Modules 1 and 2 (see **Plan Sheets 7** and **12**).

15.2 FILLING SEQUENCE AND OPERATIONS

15.2.1 Module 12 Filling Operations

Following WDNR Module 12 liner construction approval, an initial lift of CCR will be placed across the bottom of the module. This initial lift of waste will be 3 feet thick to protect the underlying composite liner materials from CCR placement traffic. Well graded material will be used for the initial lift placed over the leachate collection sumps to allow for good drainage. Once the initial lift has been completed, waste will be placed in lifts of 6 to 12 inches progressing across approximately the western 2/3rds of Module 12. The eastern end of Module 12 will be left open to allow for contract water management. CCR will be graded to eliminate ponding and provide positive drainage. Interior CCR surfaces should be sloped at a minimum of 1 percent.

15.2.2 Module 12 and 13 Filling Operations

Following WDNR Modules 12 and 13 liner construction approval, an initial lift of CCR will be placed across the bottom of the module. This initial lift of waste will be 3 feet thick to protect the underlying composite liner materials from CCR placement traffic. Well graded material will be used for the initial lift placed over the leachate collection sumps to allow for good drainage. Once the initial lift has been completed, waste will be placed in lifts of 6 to 12 inches progressing across approximately the western 2/3rds of Modules 12 and 13. The eastern end of Modules 12 and 13 will be left open to allow for contract water management. CCR will be graded to eliminate ponding and provide positive drainage. Interior CCR surfaces should be sloped at a minimum of 1 percent

15.2.3 Intermediate Cover

CCR will be placed to exterior and interim waste grades so that intermediate cover (2 feet) can be placed and seeded in accordance with Condition of Approval No. 13 of the October 8, 1984 Plan of Operation Addendum Approval. Intermediate cover will be placed in areas where filling will not occur for a period of 1 year or more. Prior to placement of additional waste in an area with intermediate cover, the intermediate cover will be removed.

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15.3 ENVIRONMENTAL MONITORING PROGRAM

Once constructed, liquid levels at leachate head wells will continue to be monitored monthly. No other changes to the environmental monitoring program are proposed at this time. The monitoring program is summarized on **Plan Sheet 13**.

Monitoring wells MW-313, MW-314, and MW-315 are located within the proposed footprint of Module 12, and the wells extend below the proposed subbase grades. These wells will be abandoned according to the requirements of NR 141.25(2)(c) prior to construction of Module 12.

For Scenario 2, after construction of Module 12, additional wells will be installed north of Module 12 for CCR Rule purposes. They will be located within the permitted disposal area and may be used under the future state program.

For Scenario 3, after construction of Modules 12 and 13, additional wells will be installed north of Module 13 for CCR Rule purposes. They will be located within the permitted disposal area and may be used under the future state program.

15.4 FINANCIAL RESPONSIBILITY

For purposes of demonstrating financial responsibility under NR 520, premature site closure costs are estimated as "the total cost of closure for the point in time during operation of the facility when the extent and manner of its operation makes closure most expensive." For this facility, this point in time would occur when either scenario 2 or 3 is constructed and waste placement has occurred. Scenario 1 financial responsibility was submitted with the Modules 10 and 11 plan of operation modification submittal.

The closure cost estimate includes installing the final cover system, seeding and vegetating the final cover, completing construction of the surface water management system, and preparing a closure documentation report. Final cover installation includes placing the grading layer; placing the barrier layer; installing the GCL and geomembrane; installing drainage layer or geocomposite materials; constructing storm water management features; placing the soil components of the final cover; and seeding, fertilizing, and mulching the cover. The estimated premature closure cost for each of scenarios 2 and 3 are presented in **Appendix E.3**. A 10 percent contingency has been included in the cost estimate. Updated long-term care costs are provided in **Appendix E.3**.

16.0 LEACHATE/CONTACT WATER POND ABANDONMENT STRATEGY

"13. Provide a leachate/contact water pond abandonment strategy and transition to use of the leachate storage tank."

During final closure of the ADF, the Leachate/Surface Water Pond will be closed in accordance with NR 213. Pond closure will include:

- Removing accumulated sediment above the liner and placing it in the ADF.
- Removing the liner and disposing of it in the ADF or an offsite landfill.
- Backfilling the depression with onsite general fill materials and restoring the area.

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17.0 PHASE 1, MODULES 5 AND 6 FINAL COVER PERMANENT HAUL ROAD

"14. Provide a design for the Phase 1, Modules 5 and 6 final cover permanent haul road."

The Phase 1, Modules 5 and 6 final cover permanent haul road has been designed as shown on **Detail 4, Plan Sheet 25.** Final grade waste slopes and access road slopes were evaluated in terms of global slope stability to determine the slope stability safety factors (**Appendix E.1**). Slope stability safety factors meeting the recommended minimum values were calculated based on the analyses. Unit gradient calculations are included in **Appendix E.1** to confirm that water infiltrating the final cover will be contained within the drainage layers (geocomposite) and will not result in unstable final cover slope conditions above the access road.

18.0 SPECIFIC MONITORING WELL PALS FOR HARDNESS AND ALKALINITY

"In addition to the above items, a sitewide preventive action limit (PAL) for specific conductance was discussed in a May 15, 1997, letter from the department (for both the active and closed landfills). Although the sitewide PAL has been accepted since then, it doesn't appear the sitewide PAL was formalized in an approval. It doesn't appear that specific monitoring well PALs for hardness and alkalinity have been proposed and subsequently approved either. The initial CCR permitting of the Dry Ash Disposal Facility is a good opportunity to address these items. The department believes that specific monitoring well PALs for specific conductance, hardness, and alkalinity should be calculated and proposed for the Dry Ash Disposal Facility's non-CCR wells, in addition to the CCR groundwater monitoring system requirements described in s. NR 514.045(1)(h), Wis. Adm. Code. Please include this item in a future addendum."

Proposed PALs for non-CCR monitoring wells are addressed in **Section 9.3**.

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Tables

1 Coal Combustion Residual (CCR) Landfill Plan of Operation Modification for Initial Permitting Checklist
2 Proposed Preventive Action Limits for Indicator Parameters, CCR Monitoring Wells
3 Groundwater Results Exceeding NR 140 Standards - CCR Monitoring Wells
4 Proposed Alternative Concentration Limits for Public Health and Welfare Parameters, CCR Monitoring Wells
5 Proposed Preventive Action Limits for Indicator Parameters, Non-CCR Monitoring Wells
6 Groundwater Results Exceeding NR 140 Standards – Non-CCR Monitoring Wells
7 Proposed Alternative Concentration Limits for Public Health and Welfare Parameters, Non-CCR Monitoring Wells

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Table 1.
Coal Combustion Residual (CCR) Landfill Plan of Operation Modification for Initial Permitting Checklist
Section NR 514.045, Wis. Adm. Code
Wisconsin Power and Light Company - Columbia Dry Ash and Ash Pond Disposal Facilities / SCS Engineers Project #25222260.00

REGULATORY REQUIREMENTS	COMPLETE?			LOCATION	COMMENTS
	Y	N	NA		
NR 514.045(1)(a) Does the submittal meet the requirements under s. NR 500.05, including the certifications required under s. NR 500.05(4)?					
NR 500.05 GENERAL SUBMITTAL REQUIREMENTS.					
(1) Has payment of the review fee of $30,500 been received? Note: The department sends an invoice to the facility contact upon receipt of the submittal. Payment is due within 30 days of receipt of the invoice.					
(2) Has a cover letter detailing the desired action been submitted?				Addendum 1 and 2, Cover Letter	
(3) Have the appropriate number of written and electronic copies been submitted to the department?				N/A	
(4) Are the report and plan sheets submitted under the seals and certifications of a licensed professional engineer and professional geologist?					
(5) Technical Procedures:					
Were all test procedures specified in the report?				N/A	
Were all technical procedures used to investigate the facility current standard procedures?				N/A	
Were explanations and reasons given for deviations from any current standard method?				N/A	
(6) Do all maps, plan sheets, drawings, isometrics, cross-sections, figures, photographs and tables meet the following requirements?					
(a) No larger than 32 inches by 44 inches and no smaller than 8 ½ inches x 11 inches. Note: Section NR 514.045, Wis. Adm. Code requires engineering plans be drawn on standard 24 inch by 36-inch plan sheets.					
(b) Appropriate scale to show all required detail in sufficient clarity.					
(c) ___numbered ___legends for all symbols ___referenced in the narrative ___horizontal & vertical scales ___titled ___drafting and origination dates					
(d) Use uniform scales.				Addendum 1, Figures 1 - 8; Addendum 2, Plan Set	
(e) Contain a north arrow.					
(f) Use mean sea level as the basis for all elevations.					
(g) Contain a survey grid based on monuments established in the field and which utilize a coordinate system and datum, such as state plane coordinates, Universal Transverse Mercator (UTM), or Wisconsin Transverse Mercator.					
(h) Show original topography and a grid system shown on the plan sheets that show construction, operation, and closure topography.					
(i) Any cross-sections: ___Show survey grid locations, ___Reference major plan sheets, ___Include a reduced diagram of plan view showing cross-section location.				N/A	
(7) A table of contents listing all sections of the submittal.				Report Table of Contents	
(8) An appendix listing the following: ___names of all references ___all raw data ___testing and sampling procedures ___calculations				Report Appendicies	
NR 514.045(1)(b) Does the submittal include a demonstration that all phases of the CCR landfill meet the performance criteria under s. NR 504.04(4)(a), (b), and (c)?					
NR 504.04(4) PERFORMANCE STANDARDS. Will the proposed landfill cause the following:					
(a) A significant adverse impact on wetlands? ___yes ___no Has a practicable alternatives analysis and a wetland functional values analysis been completed in accordance with ch. NR 103, if a wetland will be affected by the proposed landfill or any noncommercial soil borrow source activity? Note: See DNR wetland regulation website (https://dnr.wisconsin.gov/topic/Wetlands/permits) to help determine if a wetland permit may be needed per s. 281.36, Stats.				Addendum 1, Report Section 2.1.1 Addendum 2, Report Section 2.0	
(b) A take of an endangered or threatened species in accordance with s. 29.604, Stats? ___yes ___no				Addendum 1, Report Section 2.1.2 Addendum 2, Report Section 3.0	
(c) A detrimental effect on any surface water? ___yes ___no Note: Exemptions are not granted.				Addendum 1, Report Section 2.1.3	
For new CCR landfills or a lateral expansion of a CCR landfill, if the landfill failed to make the demonstration showing compliance with the criteria above, has the landfill ceased placing CCR in the CCR landfill per NR 514.045(5)(b)?				N/A	
NR 514.045(1)(c) Does the submittal include a demonstration that all phases of the CCR landfill meet the locational criteria under s. NR 504.04(3)(g), (h), and (i)?					
NR 504.04(3) LOCATIONAL CRITERIA. Are the proposed limits of filling within:					
(g) 200 feet of a fault that has had displacement in Holocene time? ___yes ___no ___If yes, was an exemption requested?				Addendum 1, Report Section 2.2.1	

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Table 1.
Coal Combustion Residual (CCR) Landfill Plan of Operation Modification for Initial Permitting Checklist
Section NR 514.045, Wis. Adm. Code
Wisconsin Power and Light Company - Columbia Dry Ash and Ash Pond Disposal Facilities / SCS Engineers Project #25222260.00

REGULATORY REQUIREMENTS	COMPLETE?			LOCATION	COMMENTS
	Y	N	NA		
(h) Seismic impact zones? ___yes ___no ___If yes, was an exemption requested?				Addendum 1, Report Section 2.2.2	
(i) Unstable areas? ___yes ___no ___If yes, was an exemption requested?				Addendum 1, Report Section 2.2.3	
For new CCR landfills or a lateral expansion of a CCR landfill, if the landfill failed to make the demonstration showing compliance with the criteria above, has the landfill ceased placing CCR in the CCR landfill per NR 514.045(5)(b)?				N/A	
NR 514.045(1)(c) (continued) Does the demonstration for unstable areas address all of the following factors, at a minimum, when determining whether an area is unstable:					
1. On-site or local soil conditions that may result in significant differential settling.				Addendum 1, Report Section 2.2.4	
2. On-site or local geologic or geomorphologic features.				Addendum 1, Report Section 2.2.5	
3. On-site or local human-made features or events both surface and subsurface.				Addendum 1, Report Section 2.2.6	
For existing CCR landfills that do not comply with the location criteria for unstable areas specified above, has the owner or operator, within 6 months of the determination, done the following per NR 514.045(5)(a): ___ceased placing CCR and non-CCR waste streams into the CCR landfill ___closed the CCR landfill in accordance with the requirements under s. NR 506.083 Note: This timeframe does not apply if the owner or operator complies with the alternative closure procedures under s. NR 506.083 (7).				N/A	
NR 514.045(1)(d) Does the submittal include a demonstration that the facility or practices near floodplains will not cause the following effects:					
___Restrict the flow of the regional flood ___Reduce the temporary water storage capacity of the floodplain ___Result in washout of solid waste so as to pose a hazard to human life, wildlife, or land or water resources. Note: NR 504.04(3)(c) also requires no person may establish, construct, operate, maintain, or permit the use of property for a landfill where the limits of filling are or would be within a floodplain.				Addendum 1, Report Section 2.3.1	
For new CCR landfills or a lateral expansion of a CCR landfill, if the landfill failed to make the demonstration showing compliance with the criteria above, has the landfill ceased placing CCR in the CCR landfill per NR 514.045 (5)(b)?				N/A	
NR 514.045(1)(e) Does the submittal include a demonstration that the facility or practices will not result in the destruction or adverse modifications of the critical habitat of endangered or threatened species as identified in s. NR 27.03(1)?				Addendum 1, Report Section 2.4.1 Addendum 2, Report Section 3.0	
For new CCR landfills or a lateral expansion of a CCR landfill, if the landfill failed to make the demonstration showing compliance with the criteria above, has the landfill ceased placing CCR in the CCR landfill per NR 514.045 (5)(b)?				N/A	
NR 514.045(1)(f) Does the submittal include a demonstration that the CCR landfill design meets requirements under s. NR 504.12 or an alternate design under s. NR 504.10? Does the demonstration include a design report, engineering drawings, and calculations? Note: Complete NR 504.12 and if applicable NR 504.10 (for an alternate design) of the NR 504 Design and Construction Criteria Completeness Checklist.				Addendum 1, Report Section 3.0 Addendum 2, Report Section 15.0	
For new CCR landfills or a lateral expansion of a CCR landfill, if the landfill failed to make the demonstration showing compliance with NR 504.12 and NR 504.10 (for an alternate design), has the landfill ceased placing CCR in the CCR landfill per NR 514.045(5)(b)?				N/A	
NR 514.045(1)(g) Does the submittal include all of the plans required under s. NR 514.07(10)?					
NR 514.07(10) PLAN OF OPERATION. Does the submittal include all of the following:					
(a) A CCR fugitive dust control plan in accordance with all of the following:					
1. The plan shall identify and describe the CCR fugitive dust control measures the owner will use to minimize CCR from becoming airborne at the facility. The owner shall select and include in the CCR fugitive dust control plan the CCR fugitive dust control measures that are most appropriate for site conditions, along with an explanation. See s. NR 514.07 (10)(a)1. for control measure examples.				Addendum 1, Appendix C1, Measures for Controlling Fugitive Dust	
2. The plan shall include procedures to wet CCR with water to a moisture content that will prevent wind dispersal, but will not result in free liquids. In lieu of water, wetting of CCR may be accomplished with an appropriate chemical dust suppression agent.				Addendum 1, Appendix C1, Procedure for Conditioning CCR Prior to Placement	
3. The plan shall include a description of the procedures the owner will follow to periodically assess the effectiveness of the control plan. At a minimum, the assessment shall include a visual inspection at least every 7 days, unless the CCR landfill is inactive, and all areas are covered by intermediate or final cover.				Addendum 1, Appendix C1, Visual Inspections	
4. The plan shall be modified in accordance with s. NR 514.04 (6) whenever there is a change in conditions that may substantially affect the plan of operation.				Addendum 1, Appendix C1, Procedure for Periodic Review of CCR Fugitive Dust Control Plan	
5. The plan shall address the preparation of an annual fugitive dust control report in accordance with s. NR 506.20 (3)(a).				Addendum 1, Appendix C1, Procedure for Periodic Review of CCR Fugitive Dust Control Plan	
(b) A run-on and run-off control system plan that includes all of the following:					

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Table 1.
Coal Combustion Residual (CCR) Landfill Plan of Operation Modification for Initial Permitting Checklist
Section NR 514.045, Wis. Adm. Code
Wisconsin Power and Light Company - Columbia Dry Ash and Ash Pond Disposal Facilities / SCS Engineers Project #25222260.00

REGULATORY REQUIREMENTS	COMPLETE?			LOCATION	COMMENTS
	Y	N	NA		
1. A run-on and run-off control system designed in accordance with the requirements under s. NR 504.12 (2).				Addendum 1, Appendix C2, Section 2.0	
2. Plan sheets depicting the location of run-on and run-off control features, detail drawings, and supporting engineering calculations.				Addendum 1, Appendix C2, Figures and Appendix A	
3. Construction procedures and a schedule for construction.				Addendum 1, Appendix C2, Section 2.3	
4. Modification every 5 years from the date of the most recent plan approval or whenever there is a change in conditions that may substantially affect the written plan in effect. The modification shall be requested by the owner in accordance with s. NR 514.04 (6) prior to the 5-year deadline.				Addendum 1, Appendix C2, Section 4.0	
(c) A written closure plan in accordance with all requirements under NR 514.06 (10) and all of the following:					
1. A narrative description of how the CCR landfill will be closed, including a description of the steps necessary to close the CCR unit at any point during the active life of the CCR unit, consistent with recognized and generally accepted good engineering practices.				Addendum 2, Appendix F, Section 2.0	
2. A description of the final cover system, designed in accordance with s. NR 504.07, and the methods and procedures to be used to install the final cover. Note: Complete NR 504.07 of the NR 504 Design and Construction Criteria Completeness Checklist.				Addendum 2, Appendix F, Section 3.0	
3. A demonstration, including a narrative discussion, of how final closure will meet the performance standards under s. NR 506.083 (6).				Addendum 2, Appendix F, Section 3.0	
4. An estimate of the maximum volume in cubic yards of CCR that will be disposed on-site over the active life of the CCR landfill.				Addendum 2, Appendix F, Section 4.0	
5. An estimate of the largest area of the CCR landfill that will require a final cover at any time during the CCR landfill's active life.				Addendum 2, Appendix F, Section 5.0	
6. A schedule for completion of all closure activities, including an estimate of the year in which all closure activities for the CCR landfill will be completed.				Addendum 2, Appendix F, Section 6.0 and 7.0	
7. The plan shall be modified in accordance with s. NR 514.04 (6) whenever there is a change in conditions that may substantially affect the written closure plan or unanticipated events necessitate a revision of the written closure plan.				Addendum 2, Appendix F, Section 9.0	
8. If closure of the CCR landfill will be accomplished through removal of CCR from the CCR landfill, the closure plan shall be modified and approved by the department prior to implementation in accordance with s. NR 514.04 (6).				N/A	
(d) A written long-term care plan that addresses all of the following:					
1. A description of the monitoring and maintenance activities and the frequency at which those activities will be performed. The activities shall include, at a minimum, all of the following: ___Long-term care activities specified under s. NR 514.06 (11). ___Maintaining the integrity and effectiveness of the final cover system, including making repairs as necessary. ___Maintaining the effectiveness of the leachate collection and removal system and operating the leachate collection and removal system in accordance with the requirements under s. NR 504.12 (3) (a). ___Maintaining the groundwater monitoring system and monitoring the groundwater in accordance with ch. NR 507 and the sampling plan approval.				Addendum 2, Appendix K, Section 2.0	
2. The name, address, telephone number, and email address of the person or office to contact about the facility during long-term care.				Addendum 2, Appendix K, Section 3.0	
3. A description of the planned uses of the property during long-term care. Post- closure uses may not disturb the integrity of the final cover, liner, or other component of the landfill, or function of the monitoring systems unless approved in writing by the department. A written request for approval as part of the plan of operation submittal or a modification shall include a demonstration that disturbance of any part of the CCR landfill will not increase the potential threat to human health or the environment.				Addendum 2, Appendix K, Section 4.0	
NR 514.045(1) (h) Does the submittal include a demonstration that the CCR groundwater monitoring system complies with the requirements under s. NR 507.15(3), including documentation of the design, installation, and development of any CCR wells?					
NR 507.15(3) CCR LANDFILLS. In addition to the detection groundwater monitoring system required under s. NR 507.19, the CCR landfill owner shall submit a plan establishing a separate CCR groundwater monitoring system for the purpose of monitoring groundwater quality in the uppermost aquifer. The plan shall be submitted with the plan of operation modification for initial permitting in accordance with s. NR 514.045 or in the feasibility report under ch. NR 512. The plan shall include all of the following:				Addendum 2, Report Section 7.0	
(a) Does the monitoring system consist of a sufficient number of CCR monitoring wells, installed at appropriate locations and depths?				Addendum 2, Report Section 7.1.1	
Are the CCR wells adequate to yield groundwater samples from the uppermost aquifer that accurately represent upgradient groundwater quality that has not been affected by leakage from CCR landfill and downgradient groundwater quality passing the waste boundary of the CCR landfill?				Addendum 2, Report Section 7.1.1	
Are the downgradient monitoring wells installed to ensure detection of groundwater contamination in the uppermost aquifer, including all known or suspected contaminant pathways?				Addendum 2, Report Section 7.1.1	
(b) Has the number, spacing, and depths of monitoring wells that are part of the CCR groundwater monitoring system plan based upon site-specific technical information that includes the following? ___Aquifer thickness ___Groundwater flow rate ___Groundwater flow direction, including seasonal and temporal fluctuations in groundwater flow				Addendum 2, Report Section 7.1.1	

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Table 1.
Coal Combustion Residual (CCR) Landfill Plan of Operation Modification for Initial Permitting Checklist
Section NR 514.045, Wis. Adm. Code
Wisconsin Power and Light Company - Columbia Dry Ash and Ash Pond Disposal Facilities / SCS Engineers Project #25222260.00

REGULATORY REQUIREMENTS	COMPLETE?			LOCATION	COMMENTS
	Y	N	NA		
Does the monitoring system consider the saturated and unsaturated geologic units and fill materials overlying the uppermost aquifer, materials comprising the uppermost aquifer and materials comprising the confining unit defining the lower boundary of the uppermost aquifer, including thicknesses, stratigraphy, lithology, hydraulic conductivities, porosities, and effective porosities?				Addendum 2, Report Section 7.1.1	
(c) Does the monitoring system plan include the minimum number of monitoring wells necessary to meet performance standards specified under (a) based on the site- specific information specified under (b).?				Addendum 2, Report Section 7.1.1	
1. Does the groundwater monitoring system plan contain a minimum of one upgradient and 3 downgradient monitoring wells to be designated as CCR wells?				Addendum 2, Report Section 7.1.1	
2. Does the groundwater monitoring system contain additional monitoring wells as necessary to accurately represent the background groundwater quality in the uppermost aquifer that has not been affected by leakage from the CCR landfill and the quality of groundwater passing the waste boundary of the CCR landfill?				Addendum 2, Report Section 7.1.1	
(d) Have the monitoring wells been designed and installed in accordance with NR 507.06 and regularly inspected in accordance with NR 507.13?				Addendum 2, Report Section 7.1.1	
(e) Has the documentation of the design, installation, development, and decommissioning of all wells and measurement/sampling devices been performed in accordance with NR 507.14 and NR 141, where applicable? This includes submission of all required forms to the department in the timeframes specified.				Addendum 2, Report Section 7.1.1	
NR 514.045 (i) Does the submittal include an updated sampling plan that addresses the requirements under s. NR 507.15(3)?					
NR 507.15(3) CCR LANDFILLS. Does the sampling plan address all of the following:					
(f) A sampling plan, which includes the CCR groundwater monitoring system, in accordance with s. NR 507.16 and the requirements under s. NR 140.16. Note: Complete NR 507.16(1) below.				Addendum 2, Report Section 7.1.2	
Does the sampling plan include consistent sampling and analysis procedures designed to ensure the production of monitoring results that provide an accurate representation of groundwater results that provide an accurate representation of groundwater quality in the uppermost aquifer at the upgradient and downgradient CCR wells and that provide a characterization of leachate quality generated by the CCR landfill?				Addendum 2, Report Section 7.1.2	
(g) Does the sampling plan include sampling and analytical methods that are appropriate for groundwater sampling and that accurately measure all required monitoring parameters under ch. NR 507, Appendix I in groundwater samples?				Addendum 2, Report Section 7.1.3	
Does the sampling plan specify the CCR landfill owner or operator obtain and analyze samples in accordance with the sampling plan and the requirements under s. NR 507.17?				Addendum 2, Report Section 7.1.3	
(h) In addition to the field measurements required under s. NR 507.17(1), does the plan include measurement of the groundwater elevations in each CCR well immediately prior to purging, each time groundwater is sampled.				Addendum 2, Report Section 7.1.4	
Does the plan include determination of the rate and direction of groundwater flow each time groundwater is sampled and reporting the result to the department in accordance with s. NR 507.26?				Addendum 2, Report Section 7.1.4	
Does the plan include that groundwater elevations in wells that monitor the same CCR landfill be measured within a timeframe short enough to avoid temporal variations in groundwater flow that could preclude accurate determination of groundwater flow rate and direction?				Addendum 2, Report Section 7.1.4	
(i) Has the owner/operator established baseline groundwater quality levels for each CCR monitoring well in accordance with NR 507.18 for each CCR well and for each of the constituents required under ch. NR 507 Appendix I, Table 1A and the sampling plan?				Addendum 2, Report Section 7.1.5	
(j) Has the owner/operator measured the total recoverable metal concentrations when measuring groundwater quality for each CCR monitoring well?				Addendum 2, Report Section 7.1.6	
Does measurement of total recoverable metals include both the particulate fraction and dissolved fraction of metals in natural waters? To ensure this, groundwater samples from CCR wells may not be field filtered prior to analysis.				Addendum 2, Report Section 7.1.6	
(k) Does the plan specify the owner/operator notify the department in writing within 60 days of completing sampling and analysis at any CCR well when a groundwater standard at the point of standards application has been attained or exceeded in accordance with s. NR 507.30?				Addendum 2, Report Section 7.1.7	
(L) Does the plan specify the owner/operator conduct detection groundwater monitoring at all CCR monitoring wells in accordance with NR 507.19 and all of the following?				Addendum 2, Report Section 7.1.8	
Does detection groundwater monitoring include groundwater monitoring for all constituents appropriate for CCR wells as listed under ch. NR 507 Appendix I, Table 1A and additional parameters as required by the department.				Addendum 2, Report Section 7.1.8	
1. Is the minimum monitoring frequency semi-annual for detection groundwater monitoring?				Addendum 2, Report Section 7.1.8	
Has baseline groundwater quality been established at each CCR monitoring well in accordance with s. NR 507.18? This includes collection of a minimum of 8 independent groundwater quality samples for each CCR well, analyzed for constituents' approval for CCR landfills as listed under ch. NR 507 Appendix I, Tables 1A and 3 and additional parameters as required by the department.				Addendum 2, Report Section 7.1.8	
2. Does the plan specify the number and methodology of groundwater quality samples be collected and analyzed for each CCR well during subsequent sampling events consistent with the approved sampling plan?				Addendum 2, Report Section 7.1.8	
Does the plan specify the CCR landfill owner or operator inform the department in accordance with s. NR 507.26 of any CCR well that purges dry, is damaged or obstructed, or in any way is rendered such that a sample was unable to be collected from the well during a scheduled sampling event and does the plan specify the owner or operator propose remedial actions to correct the problem prior to the next sampling event?				Addendum 2, Report Section 7.1.8	
3. Does the plan specify the owner or operator of the CCR landfill notify the department and respond in accordance with s. NR 507.30 when a groundwater standard at the point of standards application has been attained or exceeded at any CCR well? This includes the establishment of an assessment monitoring program meeting the requirements under s. NR 508.06, unless the exceedance is determined by the department to be from a source other than the CCR landfill, or that the groundwater standard exceedance resulted from error in sampling, analysis, or natural variation in background groundwater quality in accordance with s. NR 508.06(2)(f)2.				Addendum 2, Report Section 7.1.8	

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Section NR 514.045, Wis. Adm. Code
Wisconsin Power and Light Company - Columbia Dry Ash and Ash Pond Disposal Facilities / SCS Engineers Project #25222260.00

REGULATORY REQUIREMENTS	COMPLETE?			LOCATION	COMMENTS
	Y	N	NA		
4. Does the plan specify the point of standards application for a groundwater quality exceedance at a CCR well, the horizontal distance for the design management zone under s. NR 140.22(3)(a) for a CCR landfill is 0 feet from the waste boundary and may not be expanded by the department under s. NR 140.22(3)(b)? The waste boundary includes the horizontal space taken up by any liner, dike or other barrier designed to contain CCR waste.				Addendum 2, Report Section 7.1.8	
(m) Does the plan specify the owner or operator of the CCR landfill prepare an annual groundwater monitoring and corrective action report for submittal to the department, placement in the written operating record and position g on the publicly accessible internet site under s. NR 506.17(2) and (3) no later than January 31 of the year following the calendar year a groundwater monitoring system has been approved by the department, and annually thereafter?				Addendum 2, Report Section 7.1.9	
Does the plan specify that the annual report document the status of the groundwater monitoring and any corrective action implemented at the CCR landfill, summarize key activities completed, describe any problems encountered, discuss actions to resolve the problems, and project key activities for the upcoming year?				Addendum 2, Report Section 7.1.9	
Does the plan specify the annual groundwater monitoring and corrective action report contain, at a minimum the information included in ss. NR 507.15(3)(m) 1. – 5.				Addendum 2, Report Section 7.1.9	
NR 507.16(1) SAMPLING PLAN. Does the sampling plan include the following information:					
(a) An 8 1/2 by 11 inch site map showing locations of all sample points and devices. An 11 by 17 inch site map may be included if clarity is compromised using the 8 1/2 by 11 inch size. Different symbols shall be used to differentiate types of monitoring devices such as groundwater monitoring wells, collection lysimeters and gas monitoring wells. Each sample point shall be labeled.				Addendum 2, Appendix H	
(b) A sample schedule, including all of the following: ___1. The months that each sample point is to be sampled. ___2. The sampling period, as designated by the department. ___3. The list of parameters that are to be analyzed for in the sample from each monitoring device during each month that sampling occurs.				Addendum 2, Appendix H	
(c) Procedures for field measurements, including all of the following: ___1. The order in which wells should be sampled if the groundwater has been impacted by regulated or other activities. ___2. The procedures and type of equipment used to measure water level elevations. ___3. The procedures and type of equipment used to measure temperature, pH, conductivity and procedures to determine turbidity, odor and color.				Addendum 2, Appendix H	
(d) Procedures for purging wells, including all of the following: ___1. Procedures to purge wells prior to collecting samples. ___2. Procedures for determining the volume of water to be removed from each well. ___3. The type of equipment used to purge wells. ___4. The rate of flow while purging, when applicable. ___5. Procedures to clean purging equipment between wells. ___6. The amount of time required between purging and sampling.				Addendum 2, Appendix H	
(e) Procedures for obtaining samples from wells, including all of the following: ___1. Procedures and type of equipment used to retrieve samples. ___2. Volume of sample required for analysis. ___3. Procedures and type of equipment to filter samples, including when to filter and when not to filter samples, if applicable. ___4. The rate of flow when sampling, when applicable. ___5. Procedures and type of equipment to physically and chemically preserve samples. ___6. Procedures to clean sampling equipment following sampling of one well and prior to sampling the next well.				Addendum 2, Appendix H	
(f) Procedures for establishing field quality assurance and quality control, including all of the following: ___1. Field blank, duplicate sample and trip blank procedures. ___2. The frequency at which the field blanks, duplicate samples and trip blanks will be collected or processed.				Addendum 2, Appendix H	
(g) Special procedures to sample water supply wells.				Addendum 2, Appendix H	
(h) Special procedures to sample leachate headwells and other devices.				Addendum 2, Appendix H	
(i) Chain of custody procedures, including persons responsible for sampling and methods for transporting samples to the laboratory.				Addendum 2, Appendix H	

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Table 2. Proposed Preventive Action Limits for Indicator Parameters, CCR Monitoring Wells
Columbia Energy Center Ash Disposal Facility / SCS Engineers Project #25222260.00

Well Name	License #3018 DNR ID #	Alkalinity, Total (mg/L as CaCO3) (00410)	Calcium, Total (mg/L) (00916)	Hardness, Total (mg/L as CaCO3) (00900)	Lithium, Total (µg/L) (01132)	Total Dissolved Solids (mg/L) (00360)	Field Specific Conductance (umhos/cm at 25C) (00094)	Field pH, Lower and Upper PALs (Standard Units) (00400)
MW-33AR	063	310	150	390	3.0	850	1,400	6.6 / 8.7
MW-34A	020	310	91	410	1.0	540	820	6.6 / 8.7
MW-84A	038	460	100	490	1.0	550	830	6.3 / 8.4
MW-301	100	690	160	720	1.3	650	1,200	5.8 / 7.9
MW-302	102	420	120	450	NC	610	900	6.3 / 8.4
MW-309	104	490	180	1,200	1.7	2,100	4,300	6.5 / 8.6
MW-310	106	NC	80	NC	1.7	990	2,000	6.7 / 8.8
MW-311	108	380	90	400	1.1	510	740	6.6 / 8.7

Abbreviations:
mg/L = milligrams per liter
µg/L = micrograms per liter
CaCO3 = calcium carbonate
PALs = preventive action limits
umhos/cm = micromhos per centimeter
NC = Eight results not available due to removal of outlier(s). PALs will be submitted at a later date, when eight results are available.

Created by: MDB Date: 8/9/2023
Revised by: MDB Date: 8/9/2023
Checked by: AJR Date: 8/14/2023

I:\25222260.00\Data and Calculations\Groundwater PALs ACLs\[Tables X-X_PAL and ACL summaries.xls]Table 7_Non CCR ACLs

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Table 3.
Groundwater Results Exceeding NR 140 Standards - CCR Monitoring Wells
Columbia Energy Center Ash Disposal Facility, Modules 1-3 and 4-6

Parameter	PAL	ES	Well	Sample Date	Result	Exceedance Type
Antimony, Total (µg/L)	1.2	6	No Exceedances			
Arsenic, Total (µg/L	1	10	MW-310	6/23/2018	1.2	PAL
			MW-33AR	10/13/2016	1.2	PAL
Barium, Total (mg/L)	0.4	2	No Exceedances			
Beryllium, Total (µg/L	0.4	4	MW-310	4/23/2018	0.72 J	*
				6/23/2018	0.59 J	*
			MW-84A	4/14/2021	0.47	PAL
Boron, Total (µg/L)	200	1000	MW-302	4/11/2017	322	PAL
				6/6/2017	671	PAL
				8/8/2017	833	PAL
				10/24/2017	691	PAL
				4/24/2018	1950	ES
				9/21/2018	203	PAL
				10/22/2018	296	PAL
				4/2/2019	254	PAL
				10/9/2019	246	PAL
				5/29/2020	611	PAL
				10/8/2020	648	PAL
				4/13/2021	521	PAL
				10/14/2021	495	PAL
				4/12/2022	389	PAL
				10/27/2022	374	PAL
				4/27/2023	541	PAL
			MW-33AR	12/21/2015	954	PAL
				4/5/2016	813	PAL
				7/7/2016	794	PAL
				10/13/2016	827	PAL
				12/29/2016	812	PAL
				1/25/2017	763	PAL
				4/11/2017	760	PAL
				6/6/2017	692	PAL
				8/7/2017	697	PAL
				10/24/2017	678	PAL
				4/24/2018	601	PAL
				9/21/2018	683	PAL
				10/22/2018	682	PAL
				4/2/2019	568	PAL
				10/8/2019	548	PAL
				5/28/2020	566	PAL
				10/8/2020	569	PAL
				4/13/2021	473	PAL
				10/12/2021	564	PAL
				4/12/2022	558	PAL
				10/27/2022	586	PAL
				4/27/2023	532	PAL
			MW-34A	12/21/2015	230	PAL
				12/21/2015	205	PAL
				4/5/2016	220	PAL
				7/7/2016	216	PAL
				10/13/2016	212	PAL

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Table 3.
Groundwater Results Exceeding NR 140 Standards - CCR Monitoring Wells
Columbia Energy Center Ash Disposal Facility, Modules 1-3 and 4-6

Parameter	PAL	ES	Well	Sample Date	Result	Exceedance Type
Boron, Total (µg/L), continued	200	1,000	MW-34A, continued	12/29/2016	224	PAL
				1/25/2017	214	PAL
				4/11/2017	214	PAL
				6/6/2017	201	PAL
				8/7/2017	205	PAL
				10/24/2017	208	PAL
				4/24/2018	209	PAL
				9/21/2018	241	PAL
				10/22/2018	233	PAL
				4/2/2019	204	PAL
				10/8/2019	207	PAL
				5/28/2020	210	PAL
				10/8/2020	213	PAL
				4/13/2021	203	PAL
				10/12/2021	212	PAL
				4/12/2022	237	PAL
				10/27/2022	264	PAL
				4/26/2023	220	PAL
Cadmium, Total (µg/L)	0.5	5	MW-309	6/23/2018	0.58 J	*
			MW-310	6/23/2018	0.78 J	*
			MW-33AR	10/13/2016	0.66 J	*
			MW-34A	10/13/2016	0.51 J	*
			MW-84A	4/14/2021	0.53 J	*
Chloride, Total (mg/L)	125	250	MW-309	2/21/2018	147	PAL
				3/23/2018	157	PAL
				4/23/2018	157	PAL
				5/24/2018	141	PAL
				6/23/2018	203	PAL
				7/23/2018	557	ES
				8/22/2018	811	ES
				9/21/2018	329	ES
				4/2/2019	145	PAL
				5/29/2020	350	ES
				10/8/2020	575	ES
				4/13/2021	390	ES
				10/14/2021	519	ES
				4/12/2022	319	ES
				10/26/2022	796	ES
				4/26/2023	372	ES
			MW-310	8/22/2018	139	PAL
				9/21/2018	152	PAL
				10/8/2019	190	PAL
				5/29/2020	128	PAL
				10/8/2020	310	ES
				12/11/2020	227	PAL
				4/13/2021	227	PAL
				6/11/2021	220	PAL
				10/26/2022	323	ES
				11/30/2022	215	PAL
				4/26/2023	128	PAL

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Table 3.
Groundwater Results Exceeding NR 140 Standards - CCR Monitoring Wells
Columbia Energy Center Ash Disposal Facility, Modules 1-3 and 4-6

Parameter	PAL	ES	Well	Sample Date	Result	Exceedance Type
Chloride, Total (mg/L), continued	125	250	MW-33AR	4/24/2018	188	PAL
				4/2/2019	229	PAL
				10/8/2019	153	PAL
Chromium, Total (µg/L)	10	100	No Exceedances			
Cobalt, Total (µg/L)	8	40	No Exceedances			
Copper, Total (µg/L)	130	1,300	No Exceedances			
Fluoride, Total (mg/L)	0.8	4	No Exceedances			
Lead, Total (µg/L)	1.5	15	MW-301	4/13/2022	3.1	PAL
Manganese, Total (µg/L)	25	50	MW-301	10/27/2022	280	ES
				12/2/2022	47.2	PAL
				1/12/2023	28.1	PAL
				2/21/2023	28	PAL
			MW-302	1/13/2023	28.4	PAL
			MW-311	2/21/2023	85.2	ES
Mercury, Total (µg/L)	0.2	2	No Exceedances			
Molybdenum, Total (µg/L)	8	40	MW-302	12/22/2015	8.9	PAL
				4/5/2016	8.0	PAL
Nitrogen (NO2 + NO3), Total (mg/L)	2	10	MW-301	3/28/2023	2.1	PAL
				4/27/2023	2.4	PAL
			MW-311	4/26/2023	2.1	PAL
			MW-33AR	04/14/2015	2.8	PAL
				10/07/2015	3.8	PAL
				04/05/2016	3.6	PAL
				10/13/2016	2.8	PAL
				04/11/2017	2.5	PAL
			MW-34A	04/14/2015	6.2	PAL
				10/07/2015	8.6	PAL
				04/05/2016	11.2	ES
				10/13/2016	9.8	PAL
				04/11/2017	11.0	ES
				04/24/2018	7.7	PAL
				10/12/2021	2.9	PAL
				04/12/2022	3.5	PAL
				10/27/2022	4.7	PAL
				10/27/2022, dup	4.8	PAL
				12/2/2022	4.7	PAL
				1/13/2023	4.4	PAL
				2/21/2023	4.8	PAL
				3/27/2023	4.6	PAL
				4/26/2023	4.5	PAL
				4/26/2023, dup	4.6	PAL
				5/31/2023	4.7	PAL
				6/30/2023	4.4	PAL
Selenium, Total (µg/L)	10	50	No Exceedances			
Silver, Total (µg/L)	10	50	No Exceedances			

09/28/2023 - Classification: Internal - ECRM13153872

Table 3.
Groundwater Results Exceeding NR 140 Standards - CCR Monitoring Wells
Columbia Energy Center Ash Disposal Facility, Modules 1-3 and 4-6

Parameter	PAL	ES	Well	Sample Date	Result	Exceedance Type
Sulfate, Total (mg/L)	125	250	MW-309	4/26/2023	143	PAL
				6/29/2023	147	PAL
			MW-33AR	12/29/2016	132	PAL
				1/25/2017	133	PAL
				4/11/2017	139	PAL
				6/6/2017	151	PAL
				8/7/2017	164	PAL
				10/24/2017	175	PAL
				4/24/2018	163	PAL
				4/2/2019	201	PAL
				10/8/2019	182	PAL
				4/12/2022	155	PAL
				10/27/2022	153	PAL
			MW-34A	4/24/2018	144	PAL
				9/21/2018	141	PAL
				4/12/2022	146	PAL
				10/27/2022	169	PAL
Thallium, Total (µg/L)	0.4	2	MW-301	12/29/2016	0.48 J	*
				4/2/2019	0.48 J	*
			MW-309	4/23/2018	0.83 J	*
				6/23/2018	0.57 J	*
				7/23/2018	0.42 J	*
			MW-310	4/23/2018	0.73 J	*
				6/23/2018	0.9 J	*
				7/23/2018	0.44 J	*
			MW-33AR	10/13/2016	0.76 J	*
			MW-34A	10/13/2016	0.68 J	*
			MW-84A	4/14/2021	0.66 J	*
Zinc, Total (µg/L)	2,500	5,000	No Exceedances			

Notes:

PAL = NR 140 Preventive Action Limit µg/L = micrograms per liter dup = Duplicate Sample
ES = NR 140 Enforcement Standard mg/L = milligrams per liter

*: Numeric result is over PAL, but result is below method detection limit (J flag) and thus is not considered a PAL exceedance.

Prepared by: MDB, 8/4/2023
Checked by: NLB 8/8/2023

09/28/2023 - Classification: Internal - ECRM13153872

Table 4. Proposed Alternative Concentration Limits for Public Health and Welfare Parameters, CCR Monitoring Wells
Columbia Energy Center Ash Disposal Facility / SCS Engineers Project #25222260.00

Well	License # 03025 DNR ID #	Beryllium, Total	Boron, Total	Chloride, Total	Manganese, Total	Nitrite + Nitrate as Nitrogen, Total	Sulfate, Total	Thallium, Total
		PAL = 0.4 ES = 4 µg/L	PAL = 0.2 ES = 1 mg/L	PAL = 125 ES = 250 (mg/L)	PAL = 25 ES = 50 (µg/L)	PAL = 2 ES = 10 (mg/L)	PAL = 125 ES = 250 (mg/L)	PAL = 0.4 ES = 2 (µg/L)
MW-33AR	063	--	0.92	180	--	3.4	200	--
MW-34A	020	--	0.25	--	--	12	160	--
MW-84A	038	--	--	--	--	--	--	--
MW-301	100	--	--	--	48	2.7	--	--
MW-302	102	--	1.3	--	--	--	--	--
MW-309	104	--	--	820	--	--	--	0.89
MW-310	106	0.78	--	330	--	--	--	1.3
MW-311	108	--	--	--	--	--	--	--

Abbreviations:
PAL = NR 140 preventive action limit
ES = NR 140 enforcement standard
ACLs = Alternative concentration limits

mg/L = milligrams per liter
µg/L = micrograms per liter

Created by: MDB Date: 8/9/2023
Revised by: MDB Date: 8/9/2023
Checked by: AJR Date: 8/14/2023

I:\25222260.00\Data and Calculations\Groundwater PALs ACLs\[Tables X-X_PAL and ACL summaries.xls]Table 2_CCR PALs

09/28/2023 - Classification: Internal - ECRM13153872

Table 5. Proposed Preventive Action Limits for Indicator Parameters, Non-CCR Monitoring Wells
Columbia Energy Center Ash Disposal Facility / SCS Engineers Project #25222260.00

Well Name	License #03025 DNR ID #	Alkalinity, Total Filtered (mg/L as CaCO3) (39036)	Field Specific Conductance (umhos/cm at 25C) (00094)	Hardness, Total Filtered (mg/L as CaCO3) (22413)
MW-33BR	065	340	1,000	350
MW-34B	021	290	900	330
MW-37A	022	420	1,800	590
MW-83	059	260	700	260
MW-84B	039	440	800	440
MW-86	041	510	2,600	650
MW-92A	055	530	1,100	560
MW-92B	057	590	970	610

Abbreviations:
mg/L = milligrams per liter
PALs = preventive action limits
CaCO3 = calcium carbonate
umhos/cm = micromhos per centimeter

Created by: MDB Date: 8/9/2023
Revised by: MDB Date: 8/9/2023
Checked by: AJR Date: 8/14/2023

I:\25222260.00\Data and Calculations\Groundwater PALs ACLs\[Tables X-X_PAL and ACL summaries.xls]Table 4_CCR ACLs

09/28/2023 - Classification: Internal - ECRM13153872

Table 6.
Groundwater Results Exceeding NR 140 Standards - Non-CCR Monitoring Wells
Columbia Energy Center Ash Disposal Facility, License #03025

Parameter	PAL	ES	Well	Sample Date	Result	Exceedance Type
Aluminum, Dissolved (µg/L)	40	200	MW-37A	10/9/2019	43.6 J	*
				4/13/2022	55.6 J	*
			MW-84B	10/9/2019	43.3 J	*
			MW-86	10/9/2019	51	PAL
			MW-92A	10/9/2019	42.4 J	*
			MW-92B	10/9/2019	61.3	PAL
			MW-93A^	4/24/2023	41.7 J	*
Arsenic, Dissolved (µg/L)	1	10	MW-34B	10/25/2022	1.5	PAL
			MW-86	10/25/2002	1.0	PAL
				10/27/2009	1.3	PAL
			MW-92A	10/25/2002	1.0	PAL
				10/27/2009	1.5	PAL
			MW-92B	10/16/1996	1.4	PAL
				4/8/1997	2.2	PAL
				4/14/1998	2.5	PAL
				10/27/1998	2.4 J	*
				4/16/1999	2.4 J	*
				10/4/2000	2.2 J	*
				10/30/2001	1.9 J	*
				4/25/2002	2.5	PAL
				10/25/2002	2.8	PAL
				10/29/2003	2.7 J	*
				4/27/2004	2.7	PAL
				10/12/2004	2.8	PAL
				4/14/2005	2	PAL
				10/26/2005	1.6	PAL
				4/13/2006	2.2	PAL
				10/12/2006	1.8	PAL
				4/10/2007	2.3	PAL
				10/30/2007	2.2	PAL
				4/17/2008	1.6	PAL
				10/10/2008	1.7	PAL
				4/22/2009	2.5	PAL
				10/27/2009	2.6	PAL
				4/14/2010	2.2	PAL
				10/20/2010	1.9 J	*
				4/6/2011	2.8	PAL
				10/21/2011	2.8	PAL
				4/4/2012	2.5	PAL
				10/3/2012	2.6	PAL
				4/18/2013	2.6	PAL
				10/14/2013	1.7	PAL
				4/17/2014	2.1	PAL
				10/2/2014	2.3	PAL
				4/13/2015	2.4	PAL
				10/8/2015	2.1	PAL
				4/8/2016	2.1	PAL
				10/13/2016	2.2	PAL
				10/5/2017	2.3	PAL
				10/25/2018	2.3	PAL

09/28/2023 - Classification: Internal - ECRM13153872

Table 6.
Groundwater Results Exceeding NR 140 Standards - Non-CCR Monitoring Wells
Columbia Energy Center Ash Disposal Facility, License #03025

Parameter	PAL	ES	Well	Sample Date	Result	Exceedance Type
Arsenic, Dissolved (µg/L), continued	1	10	MW-92B, continued	4/3/2019	2.1	PAL
				10/9/2019	1.9	PAL
				5/29/2020	2.6	PAL
				10/9/2020	2.1	PAL
				4/15/2021	2.3	PAL
				10/14/2021	2.2	PAL
				4/13/2022	2.2	PAL
				10/25/2022	1.4	PAL
				4/24/2023	2.2	PAL
			MW-33BR	10/12/2004	1.4	PAL
				10/26/2005	1.1 J	*
				4/13/2006	1.0 J	*
				4/14/2010	1.8 J	*
Barium, Dissolved (µg/L)	400	2,000	No Exceedances			
Boron, Dissolved (mg/L)	0.2	1	MW-33BR	4/29/2003	0.59	PAL
				10/30/2003	0.66	PAL
				4/27/2004	0.63	PAL
				10/12/2004	0.6	PAL
				4/15/2005	0.58	PAL
				10/26/2005	0.6	PAL
				4/13/2006	0.56	PAL
				10/12/2006	0.55	PAL
				4/11/2007	0.48	PAL
				10/31/2007	0.53	PAL
				4/17/2008	0.529	PAL
				10/10/2008	0.517	PAL
				4/21/2009	0.549	PAL
				10/27/2009	0.555	PAL
				4/14/2010	0.54 J	PAL
				10/20/2010	0.62	PAL
				4/6/2011	0.56	PAL
				10/20/2011	0.53	PAL
				4/4/2012	0.48	PAL
				10/4/2012	0.51	PAL
				4/17/2013	0.561	PAL
				10/14/2013	0.495	PAL
				4/16/2014	0.507	PAL
				10/2/2014	0.524	PAL
				4/13/2015	0.498	PAL
				10/7/2015	0.495	PAL
				4/7/2016	0.457	PAL
				10/13/2016	0.454	PAL
				4/11/2017	0.401	PAL
				10/4/2017	0.385	PAL
				4/24/2018	0.375	PAL
				10/22/2018	0.348	PAL
				4/2/2019	0.324	PAL
				10/8/2019	0.325	PAL
				5/29/2020	0.267	PAL
				10/8/2020	0.235	PAL

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Table 6.
Groundwater Results Exceeding NR 140 Standards - Non-CCR Monitoring Wells
Columbia Energy Center Ash Disposal Facility, License #03025

Parameter	PAL	ES	Well	Sample Date	Result	Exceedance Type
Boron, Dissolved (mg/L), continued	0.2	1	MW-33BR, continued	4/14/2021	0.311	PAL
				10/12/2021	0.355	PAL
				4/13/2022	0.3	PAL
				10/25/2022	0.284	PAL
				4/26/2023	0.474	PAL
			MW-34B	12/17/1984	2.21	ES
				3/7/1985	1.56	ES
				6/14/1985	2	ES
				9/18/1985	2.06	ES
				12/12/1985	1.62	ES
				3/21/1986	2.72	ES
				6/20/1986	2.3	ES
				9/18/1986	2.18	ES
				3/20/1987	0.92	PAL
				6/5/1987	1.84	ES
				9/9/1987	1.59	ES
				12/9/1987	0.92	PAL
				3/10/1988	0.95	PAL
				9/9/1988	1.76	ES
				12/7/1988	0.83	PAL
				6/16/1989	0.25	PAL
				3/29/1990	0.4	PAL
				6/14/1990	0.6	PAL
				9/5/1990	0.6	PAL
				12/10/1990	0.6	PAL
				3/5/1991	0.7	PAL
				6/3/1991	0.5	PAL
				9/6/1991	0.57	PAL
				12/4/1991	0.46	PAL
				3/3/1992	0.45	PAL
				6/2/1992	0.55	PAL
				9/1/1992	0.3	PAL
				12/2/1992	0.24	PAL
				3/10/1993	0.47	PAL
				6/2/1993	0.51	PAL
				9/14/1993	0.42	PAL
				12/7/1993	0.44	PAL
				9/13/1994	0.37	PAL
				12/6/1994	0.34	PAL
				3/7/1995	0.59	PAL
				6/6/1995	0.45	PAL
				9/6/1995	0.37	PAL
				4/30/1996	0.61	PAL
				10/16/1996	0.27	PAL
				4/8/1997	0.69	PAL
				10/20/1997	0.39	PAL
				4/14/1998	0.72	PAL
				10/27/1998	0.52	PAL
				4/16/1999	0.55	PAL
				10/21/1999	0.61	PAL

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Table 6.
Groundwater Results Exceeding NR 140 Standards - Non-CCR Monitoring Wells
Columbia Energy Center Ash Disposal Facility, License #03025

Parameter	PAL	ES	Well	Sample Date	Result	Exceedance Type
Boron, Dissolved (mg/L), continued	0.2	1	MW-34B, continued	4/20/2000	0.4	PAL
				10/4/2000	0.52	PAL
				4/3/2001	0.62	PAL
				10/30/2001	0.46	PAL
				4/25/2002	0.43	PAL
				10/24/2002	0.35	PAL
				4/29/2003	0.33	PAL
				10/29/2003	0.5	PAL
				4/27/2004	0.4	PAL
				10/12/2004	0.33	PAL
				4/15/2005	0.24	PAL
				10/26/2005	1	ES
				4/13/2006	1	ES
				10/12/2006	0.75	PAL
				4/11/2007	0.82	PAL
				10/31/2007	0.5	PAL
				4/17/2008	0.278	PAL
				10/10/2008	0.404	PAL
				4/21/2009	0.291	PAL
				10/27/2009	0.307	PAL
				10/20/2010	0.38	PAL
				4/6/2011	0.23	PAL
				4/7/2016	0.209	PAL
				10/13/2016	0.224	PAL
				4/11/2017	0.254	PAL
				10/4/2017	0.44	PAL
				10/22/2018	0.222	PAL
				10/8/2019	0.444	PAL
				5/29/2020	0.507	PAL
				10/8/2020	0.349	PAL
				4/14/2021	0.216	PAL
			MW-37A	9/7/1984	0.22	PAL
			MW-84B	9/7/1984	0.25	PAL
				6/7/1988	0.42	PAL
				12/7/1988	0.23	PAL
				12/6/1994	0.69	PAL
			MW-86	9/7/1984	0.24	PAL
				3/21/1986	0.23	PAL
				12/7/1988	0.26	PAL
			MW-83	4/8/1997	0.3	PAL
				10/20/1997	0.79	PAL
				4/14/1998	0.29	PAL
				10/27/1998	0.64	PAL
				4/16/1999	0.33	PAL
				10/21/1999	0.9	PAL
				4/20/2000	0.43	PAL
				10/4/2000	1	ES
				4/3/2001	0.21	PAL
				10/30/2001	0.61	PAL
				4/25/2002	0.24	PAL

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Table 6.
Groundwater Results Exceeding NR 140 Standards - Non-CCR Monitoring Wells
Columbia Energy Center Ash Disposal Facility, License #03025

Parameter	PAL	ES	Well	Sample Date	Result	Exceedance Type
Boron, Dissolved (mg/L), continued	0.2	1	MW-83, continued	10/24/2002	0.53	PAL
				4/29/2003	0.24	PAL
				10/30/2003	0.61	PAL
				4/27/2004	0.39	PAL
				10/12/2004	0.21	PAL
				4/15/2005	0.31	PAL
Cadmium, Dissolved (µg/L)	0.5	5	MW-34B	4/11/2017	0.55 J	*
				10/25/2022	0.74 J	*
Chloride, Dissolved (mg/L) (2015-present) Chloride, Total or Dissolved (mg/L) (1984 - 1987)	125	250	MW-34B	12/17/1984	523	ES
				3/7/1985	275	ES
				6/14/1985	192	PAL
				9/18/1985	226	PAL
				12/12/1985	444	ES
				3/21/1986	426	ES
				6/20/1986	372	ES
				6/5/1987	208	PAL
Chloride, Dissolved (mg/L) (2015-present) Chloride, Total or Dissolved (mg/L) (1984 - 1987) continued	125	250	MW-37A	9/7/1984	255	ES
				12/17/1984	253	ES
				3/7/1985	286	ES
				6/14/1985	319	ES
				10/8/2015	226	PAL
				10/5/2017	142	PAL
				10/23/2018	279	ES
				4/3/2019	144	PAL
				5/29/2020	149	PAL
				10/8/2020	233	PAL
			MW-84B	9/7/1984	261	ES
				12/17/1984	257	ES
				3/7/1985	269	ES
				6/14/1985	258	ES
				9/18/1985	239	PAL
				12/12/1985	284	ES
				3/21/1986	261	ES
				6/20/1986	290	ES
			MW-86	9/7/1984	489	ES
				12/17/1984	547	ES
				3/7/1985	577	ES
				6/14/1985	556	ES
				9/18/1985	560	ES
				12/12/1985	504	ES
				3/21/1986	493	ES
				6/20/1986	509	ES
				4/14/2015	176	PAL
				10/8/2015	153	PAL
				4/7/2016	218	PAL
				10/13/2016	334	ES
				4/11/2017	225	PAL
				10/5/2017	389	ES
				4/25/2018	277	ES
				10/24/2018	282	ES

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Table 6.
Groundwater Results Exceeding NR 140 Standards - Non-CCR Monitoring Wells
Columbia Energy Center Ash Disposal Facility, License #03025

Parameter	PAL	ES	Well	Sample Date	Result	Exceedance Type
Chloride Dissolved (mg/L), continued	125	250	MW-86, continued	4/3/2019	428	ES
				10/9/2019	322	ES
				5/29/2020	304	ES
				10/9/2020	342	ES
				4/15/2021	284	ES
				10/14/2021	407	ES
				4/13/2022	484	ES
				10/25/2022	470	ES
				4/24/2023	323	ES
Chromium, Dissolved (µg/L)	10	100	No Exceedances			
Manganese, Dissolved (µg/L)	25	50	MW-93A^	4/13/2022	277	ES
				10/26/2022	64.1	ES
Mercury, Dissolved (µg/L)	0.2	2	No Exceedances			
Molybdenum, Dissolved (µg/L)	8	40	MW-92A	10/21/2011	8.2	PAL
			MW-33BR	4/6/2011	13	PAL
				10/20/2011	14	PAL
				4/4/2012	11	PAL
				10/4/2012	12	PAL
				4/17/2013	15.3	PAL
				10/14/2013	9.6	PAL
				4/16/2014	9.8	PAL
				10/2/2014	9.5	PAL
				4/13/2015	10.1	PAL
				4/7/2016	8.5	PAL
Nitrogen (NO2 + NO3) (mg/L)	2	10	MW34B	4/13/2015	4.8	PAL
				10/7/2015	4.7	PAL
				4/7/2016	5.6	PAL
				10/13/2016	9.2	PAL
				4/11/2017	5.1	PAL
				10/4/2017	5.9	PAL
				4/24/2018	2.6	PAL
				10/22/2018	6.3	PAL
				4/2/2019	7.6	PAL
				10/8/2019	8.1	PAL
				5/29/2020	7.3	PAL
				10/8/2020	7.4	PAL
				4/14/2021	10.0	ES
				10/12/2021	18.0	ES
				4/13/2022	4.3	PAL
				10/25/2022	4.7	PAL
				4/26/2023	4.7	PAL
			MW-92A	4/13/2015	4.6	PAL
				10/8/2015	2.6	PAL
				4/8/2016	2.7	PAL
				5/29/2020	2.6	PAL
				10/9/2020	4.1	PAL
				4/15/2021	3.5	PAL
				10/14/2021	7.3	PAL
				4/13/2022	9.1	PAL
				10/25/2022	3.4	PAL

09/28/2023 - Classification: Internal - ECRM13153872

Table 6.
Groundwater Results Exceeding NR 140 Standards - Non-CCR Monitoring Wells
Columbia Energy Center Ash Disposal Facility, License #03025

Parameter	PAL	ES	Well	Sample Date	Result	Exceedance Type
Nitrogen (NO2 + NO3) (mg/L), continued	2	10	MW-83	10/13/2016	2.1	PAL
				10/9/2019	2.0	PAL
				4/27/2023	3.1	PAL
			MW-33BR	4/13/2015	6.0	PAL
				10/7/2015	6.1	PAL
				4/7/2016	6.0	PAL
				10/13/2016	6.1	PAL
				4/11/2017	4.6	PAL
				10/4/2017	5.2	PAL
				4/24/2018	5.1	PAL
				10/22/2018	4.5	PAL
				4/2/2019	4.8	PAL
				10/8/2019	5.1	PAL
				5/29/2020	5.6	PAL
				10/8/2020	7.0	PAL
				4/14/2021	6.6	PAL
				10/12/2021	5.7	PAL
				4/13/2022	4.7	PAL
				10/25/2022	4.7	PAL
				4/26/2023	3.7	PAL
Selenium, Dissolved (µg/L)	10	50	MW-92B	4/6/2011	12	PAL
Sulfate, Dissolved (mg/L)	125	250	MW-33BR	4/29/2003	180	PAL
				10/30/2003	210	PAL
				4/27/2004	210	PAL
				10/12/2004	210	PAL
				4/15/2005	200	PAL
				10/26/2005	190	PAL
				4/13/2006	180	PAL
				10/12/2006	180	PAL
				4/11/2007	170	PAL
				10/31/2007	180	PAL
				4/17/2008	193	PAL
				10/10/2008	164	PAL
				4/21/2009	167	PAL
				10/27/2009	152	PAL
				4/14/2010	160	PAL
				10/20/2010	160	PAL
				4/6/2011	150	PAL
				10/20/2011	140	PAL
				4/4/2012	140	PAL
				10/4/2012	140	PAL
			MW-34B	3/7/1985	181	PAL
				6/14/1985	195	PAL
				12/12/1985	285	ES
				3/21/1986	329	ES
				6/20/1986	211	PAL
				9/18/1986	199	PAL
				3/20/1987	247	PAL
				6/5/1987	244	PAL

09/28/2023 - Classification: Internal - ECRM13153872

Table 6.
Groundwater Results Exceeding NR 140 Standards - Non-CCR Monitoring Wells
Columbia Energy Center Ash Disposal Facility, License #03025

Parameter	PAL	ES	Well	Sample Date	Result	Exceedance Type
Sulfate, Dissolved (mg/L), continued	125	250	MW-34B, continued	9/9/1987	138	PAL
				12/9/1987	229	PAL
				3/10/1988	221	PAL
				6/7/1988	220	PAL
				9/9/1988	262	ES
				12/7/1988	327	ES
				3/21/1989	245	PAL
				3/22/1989	245	PAL
				6/16/1989	180	PAL
				9/6/1989	170	PAL
				12/5/1989	175	PAL
				3/29/1990	200	PAL
				6/14/1990	300	ES
				9/5/1990	240	PAL
				12/10/1990	220	PAL
				3/5/1991	240	PAL
				6/3/1991	180	PAL
				9/6/1991	190	PAL
				12/4/1991	170	PAL
				3/3/1992	240	PAL
				6/2/1992	160	PAL
				9/1/1992	160	PAL
				12/2/1992	130	PAL
				3/10/1993	140	PAL
				6/2/1993	140	PAL
				9/14/1993	140	PAL
				12/7/1993	140	PAL
				3/7/1995	160	PAL
				6/6/1995	170	PAL
				9/6/1995	190	PAL
				4/30/1996	180	PAL
				4/8/1997	150	PAL
				10/20/1997	140	PAL
				4/14/1998	230	PAL
				10/27/1998	200	PAL
				4/16/1999	180	PAL
				10/21/1999	150	PAL
				4/20/2000	150	PAL
				10/4/2000	170	PAL
				4/3/2001	200	PAL
				10/30/2001	180	PAL
				4/25/2002	180	PAL
				10/24/2002	210	PAL
				4/29/2003	150	PAL
				10/29/2003	170	PAL
				4/15/2005	180	PAL
				10/26/2005	280	ES
				10/12/2006	170	PAL

09/28/2023 - Classification: Internal - ECRM13153872

Table 6.
Groundwater Results Exceeding NR 140 Standards - Non-CCR Monitoring Wells
Columbia Energy Center Ash Disposal Facility, License #03025

Parameter	PAL	ES	Well	Sample Date	Result	Exceedance Type
Sulfate, Dissolved (mg/L), continued	125	250	MW-86	3/15/1994	150	PAL
				4/16/1999	140	PAL
			MW-83	4/8/1997	150	PAL
				10/20/1997	200	PAL
				10/27/1998	200	PAL
				4/16/1999	130	PAL
				10/21/1999	240	PAL
				4/20/2000	170	PAL
				10/4/2000	230	PAL
				4/3/2001	200	PAL
				10/30/2001	270	ES
				10/24/2002	210	PAL
				10/30/2003	140	PAL

Notes:

PAL = Preventive Action Limit µg/L = micrograms per liter dup = Duplicate Sample
ES = Enforcement Standard mg/L = milligrams per liter

*: Numeric result is over PAL, but result is below method detection limit (J flag) and thus is not considered a PAL exceedance.

^: MW-93A was installed in 2022, and baseline sampling is ongoing.

Prepared by: MDB, 8/8/2023
Checked by: RM 8/9/2023

09/28/2023 - Classification: Internal - ECRM13153872

Table 7. Proposed Alternative Concentration Limits for Public Health and Welfare Parameters, Non-CCR Monitoring Wells
Columbia Energy Center Ash Disposal Facility / SCS Engineers Project #25222260.00

Well	License # 03025 DNR ID #	Arsenic	Boron	Chloride	Molybdenum	Nitrite + Nitrate - Nitrogen	Sulfate
		PAL = 1 ES = 10 (µg/L)	PAL = 0.2 ES = 1 (mg/L)	PAL = 125 ES = 250 (mg/L)	PAL = 8 ES = 40 (µg/L)	PAL = 2 ES = 10 (mg/L)	PAL = 125 ES = 250 (mg/L)
MW-33BR	065	--	0.70	--	15	7.2	250
MW-34B	021	--	0.78	--	--	15	--
MW-37A	022	--	--	280	--	--	--
MW-83	059	--	--	--	--	3.3	--
MW-84B	039	--	--	--	--	--	--
MW-86	041	1.2	--	630	--	--	--
MW-92A	055	1.2	--	--	--	7.7	--
MW-92B	057	3.3	--	--	--	--	--

Abbreviations:
PAL = NR 140 preventive action limit
ES = NR 140 enforcement standard
ACLs = Alternative concentration limits

µg/L = micrograms per liter
mg/L = milligrams per liter

Created by: MDB Date: 8/9/2023
Revised by: MDB Date: 8/9/2023
Checked by: AJR Date: 8/14/2023

I:\25222260.00\Data and Calculations\Groundwater PALs ACLs\[Tables X-X_PAL and ACL

09/28/2023 - Classification: Internal - ECRM13153872

Figures

1 Fill Sequence – Module 12
2 Fill Sequence – Module 12 and 13

09/28/2023 - Classification: Internal - ECRM13153872

540,500 N | 541,000 N | 541,500 N | 542,000 N | 542,500 N | 543,000 N | 543,500 N

2,123,500 E | 2,124,000 E | 2,124,500 E | 2,125,000 E

COAL PILE

SOUTH SEDIMENTATION BASIN

WPDES POND

EXISTING FINAL COVER

ESTIMATED INTERMEDIATE COVER

ACTIVE AREA
(ESTIMATED OPEN AREA 5.5 ACRES)

MODULE 12 LINER
(ESTIMATED 0.5 ACRES)

LEACHATE/ SURFACE WATER POND

C. M. ST. P. & P. RR.

MURRAY ROAD

MW-311 | MW-83 | SG-4 | MW-33AR | MW-33B | MW-34A | MW-34B | MW-88B | MW-88A | MW-85 | MW-85B | MW-302 | MW-5R | MW-310 | MW-309 | MW-92B | MW-92A | MW-37B | MW-37A | MW-91AR | MW-91B | LP-1 | MW-301 | MW-312 | MW-93B | MW-93A | MW-86 | MW-84A | MW-84B | MW-17

LS1

LH-10A | LH-10B | LH-11A | LH-11B

LEGEND

- DRY ASH DISPOSAL FACILITY LIMITS
- LIMITS OF WASTE
- FINAL COVER LIMITS
- PAVED ROAD
- UNPAVED ROAD
- VEGETATION
- FENCE
- EXISTING GRADE (10' INTERVAL)
- EXISTING GRADE (2' INTERVAL)
- SWALE
- EDGE OF WATER
- WETLAND
- PROPOSED GRADE (10' INTERVAL)
- PROPOSED GRADE (2' INTERVAL)
- PROPOSED PERIMETER ROAD
- PROPOSED SWALE
- PROPOSED CULVERT
- EXISTING FINAL COVER
- ESTIMATED INTERMEDIATE COVER
- ACTIVE FILLING AREA
- UNFILLED MODULE 12 LINER AREA FOR CONTACT WATER PUMPING

NOTES:

1. PROPOSED GRADES ARE CONCEPTUAL. ACTUAL GRADES WILL BE BASED ON PLANT OPERATIONS.

100 0 100

SCALE: 1" = 100'

N

L:\2023\23D_SW\Drawings\Figure 1-2 Filling Seq - 8-30-2023 10:45:47 AM

DRAWN BY: KP
CHECKED BY: RR/MRH
APPROVED BY: MRH 08/30/2023

PROJECT NO. 25222260.01
DRAWN: 07/24/2023
REVISED: 08/15/2023

Wisconsin Power and Light Company
WISCONSIN POWER AND LIGHT COLUMBIA ENERGY CENTER W8375 MURRAY ROAD PARDEEVILLE, WISCONSIN 53954

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ENGINEER

PLAN OF OPERATION UPDATE
COLUMBIA ENERGY CENTER
COLUMBIA ASH DISPOSAL FACILITY
TOWN OF PACIFIC, WISCONSIN

SITE

FILL SEQUENCE – MODULE 12

FIGURE 1

09/28/2023 - Classification: Internal - ECRM13153872

540,500 N | 541,000 N | 541,500 N | 542,000 N | 542,500 N | 543,000 N | 543,500 N

2,123,500 E | 2,124,000 E | 2,124,500 E | 2,125,000 E

COAL PILE

SOUTH SEDIMENTATION BASIN

WPDES POND

LEACHATE/ SURFACE WATER POND

EXISTING FINAL COVER

ESTIMATED INTERMEDIATE COVER

ACTIVE AREA (ESTIMATED OPEN AREA 7.8 ACRES)

MODULE 13 LINER (ESTIMATED 0.7 ACRES)

C. M. ST. P. & P. RR.

MURRAY ROAD

MW-5R, MW-17, MW-83, MW-84A, MW-84B, MW-85, MW-85B, MW-86, MW-88A, MW-88B, MW-91AR, MW-91B, MW-92A, MW-92B, MW-93A, MW-93B, MW-301, MW-302, MW-309, MW-310, MW-311, MW-312, MW-33AR, MW-33B, MW-34A, MW-34B, MW-37A, MW-37B, SG-4, LP-1, LS

LH-10A, LH-10B, LH-11A, LH-11B

LEGEND

- DRY ASH DISPOSAL FACILITY LIMITS
- LIMITS OF WASTE
- FINAL COVER LIMITS
- PAVED ROAD
- UNPAVED ROAD
- VEGETATION
- FENCE
- 810 EXISTING GRADE (10' INTERVAL)
- EXISTING GRADE (2' INTERVAL)
- SWALE
- EDGE OF WATER
- WETLAND
- 800 PROPOSED GRADE (10' INTERVAL)
- 802 PROPOSED GRADE (2' INTERVAL)
- PROPOSED PERIMETER ROAD
- PROPOSED SWALE
- PROPOSED CULVERT
- EXISTING FINAL COVER
- ESTIMATED INTERMEDIATE COVER
- ACTIVE FILLING AREA
- UNFILLED MODULE 13 LINER AREA FOR CONTACT WATER PUMPING

NOTES:

1. PROPOSED GRADES ARE CONCEPTUAL. ACTUAL GRADES WILL BE BASED ON PLANT OPERATIONS.

100 0 100

SCALE: 1" = 100'

N

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PROJECT NO. 2522260.01
DRAWN: 07/24/2023
REVISED: 08/15/2023

DRAWN BY: KP
CHECKED BY: RR/MRH
APPROVED BY: MRH 08/30/2023

Wisconsin Power and Light Company

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PLAN OF OPERATION UPDATE
COLUMBIA ENERGY CENTER
COLUMBIA COUNTY DISPOSAL FACILITY
TOWN OF PACIFIC, WISCONSIN

SITE

FILL SEQUENCE – MODULE 12 AND 13

FIGURE 2

09/28/2023 - Classification: Internal - ECRM13153872

Plan Sheets

Sheet 1 Title Sheet
Sheet 2 Existing Conditions
Sheet 3 Subbase Grades (Module 12)
Sheet 4 Base Grades (Module 12)
Sheet 5 Leachate Collection System (Module 12)
Sheet 6 Top of Waste Grades (Module 12)
Sheet 7 Final Grades (Module 12)
Sheet 8 Subbase Grades (Modules 12 and 13)
Sheet 9 Base Grades (Modules 12 and 13)
Sheet 10 Leachate Collection System (Modules 12 and 13)
Sheet 11 Top of Waste Grades (Modules 12 and 13)
Sheet 12 Final Grades (Modules 12 and 13)
Sheet 13 Site Monitoring and Long Term Care Plan
Sheet 14 Cross Sections – 2,214,650 East and 2,124,900 East
Sheet 15 Cross Sections – 543,000 North
Sheet 16 Cross Sections – 543,300 North
Sheet 17 Details
Sheet 18 Details
Sheet 19 Details
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Sheet 22 Details
Sheet 23 Details
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Sheet 27 Details
Sheet 28 Details

09/28/2023 - Classification: Internal - ECRM13153872

PLAN OF OPERATION UPDATE
COLUMBIA ENERGY CENTER

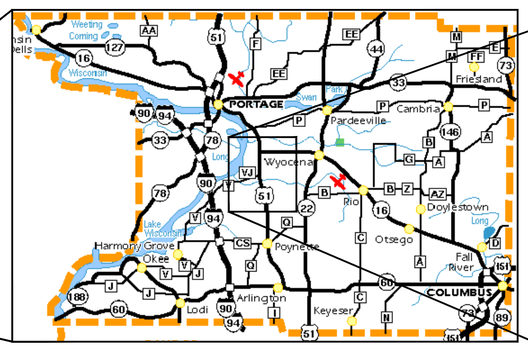
COLUMBIA DRY ASH DISPOSAL FACILITY
LICENSE NO. 03025
TOWN OF PACIFIC
COLUMBIA COUNTY, WISCONSIN

PREPARED FOR: WISCONSIN POWER AND LIGHT COMPANY
COLUMBIA ENERGY CENTER

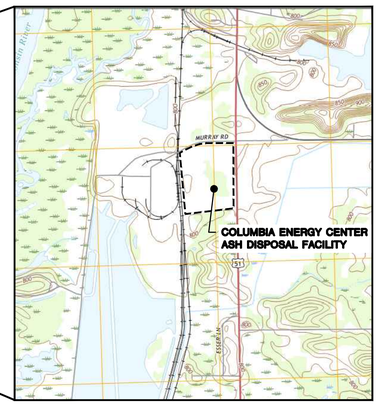
PREPARED BY: SCS ENGINEERS
MADISON, WISCONSIN

DATE: AUGUST 2023

WISCONSIN



COLUMBIA COUNTY



SITE LOCATOR MAP
APPROXIMATE SCALE: 1"=2,000'

INDEX

Sheet Number	Sheet Title
1	TITLE SHEET
2	EXISTING CONDITIONS
3	SUBBASE GRADES (MODULE 12)
4	BASE GRADES (MODULE 12)
5	LEACHATE COLLECTION SYSTEM (MODULE 12)
6	TOP OF WASTE GRADES (MODULE 12)
7	FINAL GRADES (MODULE 12)
8	SUBBASE GRADES (MODULES 12 AND 13)
9	BASE GRADES (MODULES 12 AND 13)
10	LEACHATE COLLECTION SYSTEM (MODULES 12 AND 13)
11	TOP OF WASTE GRADES (MODULES 12 AND 13)
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13	SITE MONITORING AND LONG TERM CARE PLAN
14	CROSS SECTIONS - 2,214,650 EAST AND 2,124,900 EAST
15	CROSS SECTION - 543,000 NORTH
16	CROSS SECTION - 543,300 NORTH
17	DETAILS
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19	DETAILS
20	DETAILS
21	DETAILS
22	DETAILS
23	DETAILS
24	DETAILS
25	DETAILS
26	DETAILS
27	DETAILS
28	DETAILS

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PLAN OF OPERATION UPDATE
COLUMBIA ENERGY CENTER
COLUMBIA DRY ASH DISPOSAL FACILITY
TOWN OF PACIFIC, WISCONSIN
SITE

TITLE SHEET

SHEET 1 of 28

PROJECT NO.	25222260.01	DRAWN BY:	KP
DRAWN:	07/20/2023	CHECKED BY:	RR\MRH
REVISED:	08/29/2023	APPROVED BY:	MRH 08/31/2023

Wisconsin Power and Light Company
CLIENT

WISCONSIN POWER AND LIGHT
COLUMBIA ENERGY CENTER
W8375 MURRAY ROAD
PARDEEVILLE, WISCONSIN 53954

09/28/2023 - Classification: Internal - ECRM13153872

540,500 N | 541,000 N | 541,500 N | 542,000 N | 542,500 N | 543,000 N | 543,500 N

2,123,500 E | 2,124,000 E | 2,124,500 E | 2,125,000 E

COAL PILE

SOUTH SEDIMENTATION BASIN

WPDES POND

ROCK CHUTE

C. M. ST. P. & P. RR.

PHASE 1

EXISTING MODULE 1

EXISTING MODULE 2

EXISTING MODULE 3

EXISTING MODULE 4

EXISTING MODULE 5

EXISTING MODULE 6

FINAL COVER AREA

INTERMEDIATE COVER AREA

PHASE 2

EXISTING MODULE 10

EXISTING MODULE 11

PROPOSED MODULE 12

PROPOSED MODULE 13

CLAY STOCKPILE

LEACHATE/ SURFACE WATER POND

MURRAY ROAD

MW-311 | MW-83 | SG-4 | MW-33AR | MW-33B | MW-34A | MW-34B | MW-88B | MW-85 | MW-85B | MW-302 | MW-5R | LS-1 | MW-310 | MW-309 | MW-92B | MW-92A | LS-3R | MW-91AR | MW-91B | MW-89A/B | MW-313 | MW-37A | MW-314 | MW-315 | MW-312 | MW-301 | MW-17 | MW-84A | MW-84B | MW-86 | MW-93B | MW-93A

18" CMP
N. INV. = 807.226
S. INV. = 806.916

24" CMP
N. INV. = 806.81
S. INV. = 807.54

30" HDPE
N. INV. = 808.10
S. INV. = 807.71

24" HDPE
N. INV. = 805.40
S. INV. = 804.71

24" HDPE
N. INV. = 805.40
S. INV. = 804.76

TOP OF POND LINER ELEVATION = 796.97

24" HDPE
E. INV. = 815.70
W. INV. = 814.56

LH-2 | LH-5 | LH-6 | LP-1 | LH-10A | LH-10B | LH-11A | LH-11B

LEGEND

- DRY ASH DISPOSAL FACILITY LIMITS
- LIMITS OF WASTE
- LINER PHASE/MODULE LIMIT
- FINAL COVER LIMITS
- APPROXIMATE EXISTING INTERMEDIATE COVER LIMITS/AREA
- LIMITS OF 2' THICK CLAY LINER
- PAVED ROAD
- UNPAVED ROAD
- RAILROAD TRACKS
- VEGETATION
- FENCE
- OVERHEAD UTILITY
- EXISTING GRADE (10' INTERVAL)
- EXISTING GRADE (2' INTERVAL)
- SWALE
- EDGE OF WATER
- WETLAND
- CULVERT
- TRANSMISSION TOWER
- UTILITY POLE
- MONITORING WELL
- PIEZOMETER
- WATER SUPPLY WELL
- STAFF GAUGE
- SURFACE WATER SAMPLE LOCATION
- LEACHATE HEADWELL
- LEACHATE RISER/CLEANOUT
- LYSIMETER MANHOLE
- ABANDONED MONITORING WELL
- ABANDONED PIEZOMETER
- ABANDONED TEMPORARY WATER TABLE WELL
- BENCHMARK

SURVEY CONTROL TABLE			
BM	NORTHING	EASTING	ELEVATION
5	545,255.97	2,123,490.03	804.65
6	543,461.54	2,123,405.36	834.12
200	543,198.15	2,122,700.71	807.33
201	545,080.64	2,121,666.84	803.68
202	541,479.47	2,123,890.79	803.46
301	541,814.021	2,125,202.881	819.014
302	543,282.51	2,125,161.48	837.643

NOTES:

1. BASE MAP CREATED FROM AERIAL SURVEY BY KBM, FLOWN DECEMBER 1, 2014, AND GROUND SURVEYS BY SCS ENGINEERS IN MAY 2019, DECEMBER 2020, NOVEMBER 2021, AND DECEMBER 2021, AND BY DRONE SURVEYS BY AMES IN NOVEMBER 2022, JANUARY 2023, AND JUNE 2023.
2. MONITORING WELL LOCATIONS AND ELEVATIONS SURVEYED BY WISCONSIN POWER AND LIGHT, INC. IN DECEMBER 1994, NOVEMBER 1996, APRIL 2003, AUGUST 2012, AND JANUARY 2016, AND BY SCS ENGINEERS IN MAY 2019.
3. WETLANDS OUTSIDE FACILITY LIMITS ARE FROM THE MAY 19, 2015 ASSURED WETLAND DELINEATION PERFORMED BY STANTEC. WETLANDS INSIDE FACILITY LIMITS ARE FROM THE OCTOBER 18, 2017 ASSURED WETLAND DELINEATION PERFORMED BY MACH IV.
4. UTILITY LOCATIONS ARE APPROXIMATE AND NOT ALL UTILITIES ARE SHOWN.
5. LIMITS OF INTERMEDIATE FINAL COVER ARE A PROJECTION OF WHAT WILL BE COVERED BY THE POND CLOSURE CONTRACTOR AT THE COMPLETION OF THE POND CLOSURE PROJECT.

100 0 100

SCALE: 1" = 100'

N

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PROJECT NO.	25222260.01
DRAWN:	07/20/2023
REVISED:	08/31/2023
DRAWN BY:	KP
CHECKED BY:	RR\MRH
APPROVED BY:	MRH 08/31/2023

Wisconsin Power and Light Company

CLIENT

WISCONSIN POWER AND LIGHT COLUMBIA ENERGY CENTER W8375 MURRAY ROAD PARDEEVILLE, WISCONSIN 53954

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ENGINEER

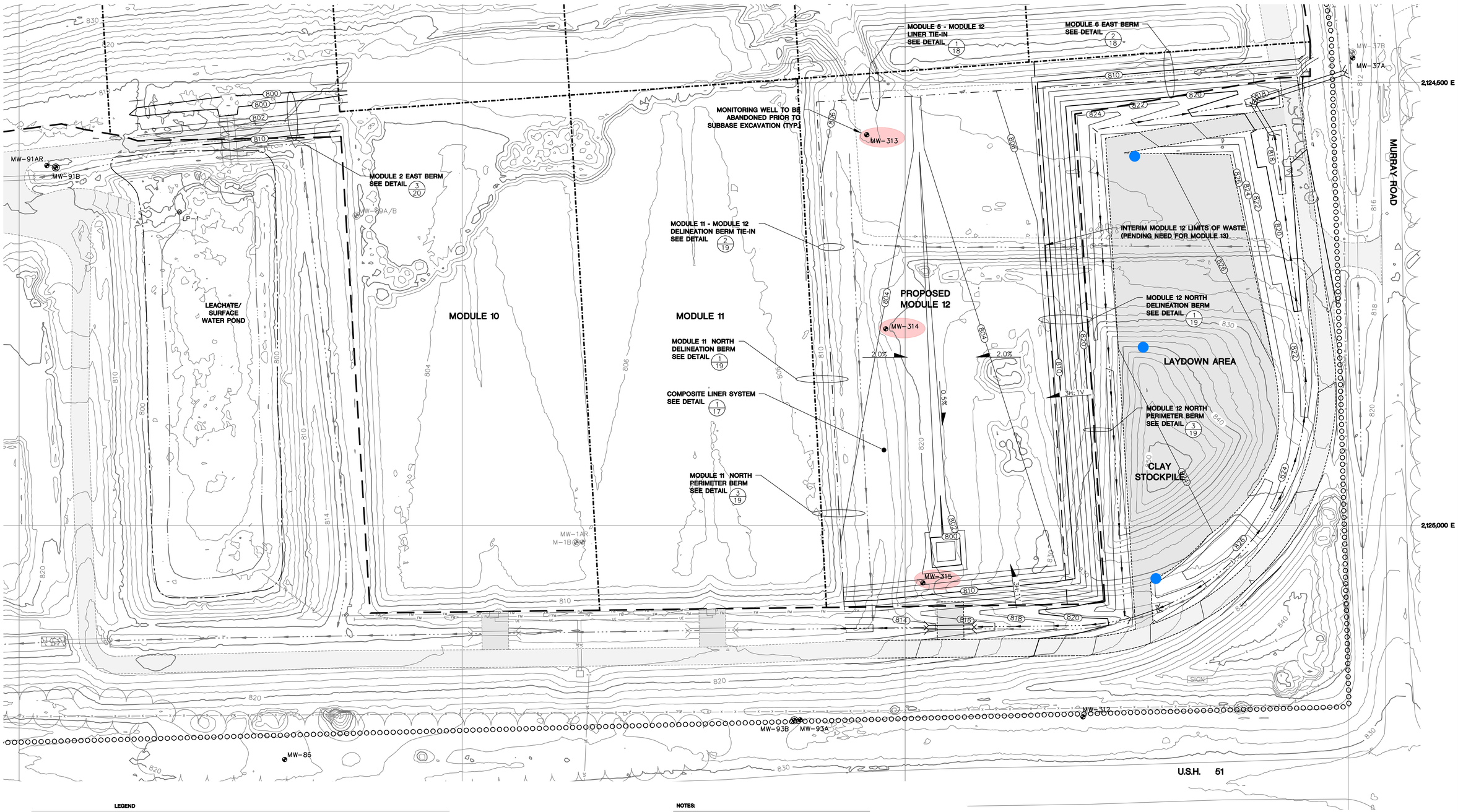
PLAN OF OPERATION UPDATE
COLUMBIA ENERGY CENTER
ASH DISPOSAL FACILITY
TOWN OF PACIFIC, WISCONSIN

SITE

EXISTING CONDITIONS

SHEET
2 of 28

09/28/2023 - Classification: Internal - ECRM13153872



LEGEND

	DRY ASH DISPOSAL FACILITY LIMITS		SWALE
	LIMITS OF WASTE		EDGE OF WATER
	LINER PHASE/MODULE LIMIT		WETLAND
	LIMITS OF CONSTRUCTED 2' THICK CLAY LINER	800	PROPOSED GRADE (10' INTERVAL)
	PAVED ROAD	802	PROPOSED GRADE (2' INTERVAL)
	UNPAVED ROAD		PROPOSED PERIMETER ROAD
	VEGETATION		PROPOSED SWALE
	FENCE		PROPOSED CULVERT
810	EXISTING GRADE (10' INTERVAL)	2.0%	PROPOSED SLOPE AND DIRECTION
	EXISTING GRADE (2' INTERVAL)		PROPOSED MODULE 12 MONITORING WELL

NOTES:

1. SEE SHEET 2 FOR BASE MAP LEGEND ITEMS AND NOTES.
2. PROPOSED GRADES WITHIN MODULE 12 REPRESENT BOTTOM OF 2' THICK CLAY LINER (SUBBASE GRADE).
3. EROSION CONTROL SILT FENCE/FILTER SOCK INSTALLED AROUND THE PERIMETER OF DISTURBANCE AREAS AND STOCKPILES.

50 0 50

SCALE: 1" = 50'

N

PROJECT NO.	25222260.01
DRAWN:	07/24/2023
REVISED:	08/31/2023
DRAWN BY:	KP
CHECKED BY:	RR\MRH
APPROVED BY:	MRH 08/31/2023

CLIENT

Wisconsin Power and Light Company

WISCONSIN POWER AND LIGHT
COLUMBIA ENERGY CENTER
W8375 MURRAY ROAD
PARDEEVILLE, WISCONSIN 53954

ENGINEER

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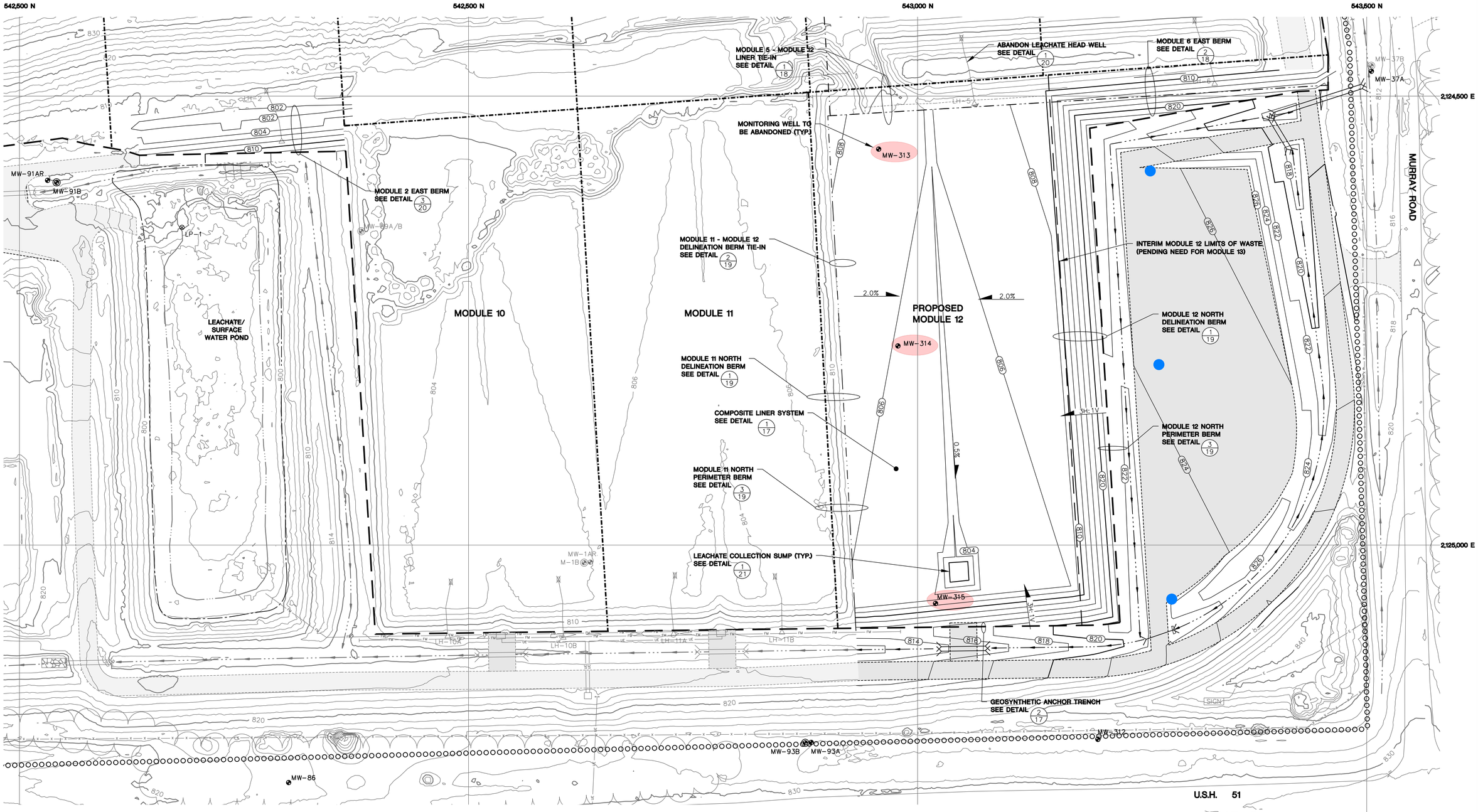
SITE

PLAN OF OPERATION UPDATE
COLUMBIA ENERGY CENTER
COLUMBIA DRY ASH DISPOSAL FACILITY
TOWN OF PACIFIC, WISCONSIN

SUBBASE GRADES (MODULE 12)

SHEET

09/28/2023 - Classification: Internal - ECRM13153872



LEGEND

	DRY ASH DISPOSAL FACILITY LIMITS		SWALE
	LIMITS OF WASTE		EDGE OF WATER
	LINER PHASE/MODULE LIMIT		WETLAND
	LIMITS OF CONSTRUCTED 2' THICK CLAY LINER	800	PROPOSED GRADE (10' INTERVAL)
	PAVED ROAD	802	PROPOSED GRADE (2' INTERVAL)
	UNPAVED ROAD		PROPOSED PERIMETER ROAD
	VEGETATION		PROPOSED SWALE
	FENCE		PROPOSED CULVERT
810	EXISTING GRADE (10' INTERVAL)	2.0%	PROPOSED SLOPE AND DIRECTION
	EXISTING GRADE (2' INTERVAL)		PROPOSED MODULE 12 MONITORING WELL

NOTES:

1. SEE SHEET 2 FOR BASE MAP LEGEND ITEMS AND NOTES.
2. PROPOSED GRADES WITHIN MODULE 12 REPRESENT TOP OF 2' THICK CLAY LINER (BASE GRADE).

50 0 50

SCALE: 1" = 50'

N

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DRAWN BY:	KP
CHECKED BY:	RR\MRH
APPROVED BY:	MRH 08/31/2023

CLIENT

Wisconsin Power and Light Company

WISCONSIN POWER AND LIGHT
COLUMBIA ENERGY CENTER
W8375 MURRAY ROAD
PARDEEVILLE, WISCONSIN 53954

ENGINEER

SCS ENGINEERS
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PLAN OF OPERATION UPDATE
COLUMBIA ENERGY CENTER
COLUMBIA DRY ASH DISPOSAL FACILITY
TOWN OF PACIFIC, WISCONSIN

BASE GRADES (MODULE 12)

SHEET

4 of 28

542,500 N | 542,500 N | 543,000 N | 543,500 N

2,124,500 E

2,125,000 E

PIPE BOOT SEE DETAIL 4/20

MODULE 2 EAST BERM SEE DETAIL 3/20

MOD 1 LEACHATE SUMP SEE DETAIL 1/23

MOD 2 LEACHATE SUMP SEE DETAIL 2/23

LEACHATE LOADOUT PAD SEE DETAIL 3/22

LEACHATE STORAGE TANK SEE DETAIL 2/22

LEACHATE/ SURFACE WATER POND

LEACHATE FORCEMAIN AND TRENCH SEE DETAIL 5/17

LEACHATE FORCEMAIN CLEANOUT MANHOLE (TYP.) SEE DETAIL 1/22

MODULE 10

MODULE 11

CUT 6-INCH DIAMETER SDR 17 HDPE LEACHATE COLLECTION PIPE AND CAP BOTH ENDS (SEE NOTE 3) SEE DETAIL 3/18

MODULE 5 - MODULE 12 LINER TIE-IN SEE DETAIL 1/18

MONITORING WELL TO BE ABANDONED (TYP.)

MODULE 11 - MODULE 12 DELINEATION BERM TIE-IN SEE DETAIL 2/19

MODULE 11 NORTH PERIMETER BERM SEE DETAIL 3/19

MODULE 11 NORTH DELINEATION BERM SEE DETAIL 1/19

COMPOSITE LINER SYSTEM SEE DETAIL 1/17

LEACHATE COLLECTION PIPE (TYP.) SEE DETAIL 4/17

LEACHATE COLLECTION SUMP (TYP.) SEE DETAIL 1/21

LEACHATE INCLINED RISER PUMP SEE DETAIL 3/21

INCLINED RISER PIPE AND LEACHATE VAULT (TYP.) SEE DETAIL 4/22

2"/4" DUAL CONTAINED HDPE SDR 11/17 PIPE

LEACHATE FORCEMAIN AND TRENCH SEE DETAIL 5/17

4"/8" DUAL CONTAINED HDPE SDR 11/17 PIPE

LEACHATE HEADWELL (TYP.) SEE DETAIL 3/17

ABANDON LEACHATE HEAD WELL SEE DETAIL 1/20

MODULE 6 EAST BERM SEE DETAIL 2/18

EXTEND LEACHATE HEAD WELL SEE DETAIL 2/20

PROPOSED MODULE 12

2.0%

6.5%

3H:1V

INTERIM MODULE 12 LIMITS OF WASTE (PENDING NEED FOR MODULE 13)

MODULE 12 NORTH DELINEATION BERM SEE DETAIL 1/19

MODULE 12 NORTH PERIMETER BERM SEE DETAIL 3/19

GEOSYNTHETIC ANCHOR TRENCH SEE DETAIL 2/17

LEACHATE PUMP CONTROL PANEL SEE DETAIL 2/21

LEACHATE CLEANOUT SEE DETAIL 6/17

MURRAY ROAD

U.S.H. 51

MW-91AR, MW-91B, MW-99A/B, MW-313, MW-314, MW-37A, MW-37B, MW-1AR, M-1B, MW-10B, MW-93B, MW-93A, MW-312, MW-86

LH-5, LH-10B, LH-11A

LEGEND

DRY ASH DISPOSAL FACILITY LIMITS	SWALE
LIMITS OF WASTE	EDGE OF WATER
LINER PHASE/MODULE LIMIT	WETLAND
LIMITS OF CONSTRUCTED 2' THICK CLAY LINER	PROPOSED GRADE (10' INTERVAL)
PAVED ROAD	PROPOSED GRADE (2' INTERVAL)
UNPAVED ROAD	PROPOSED PERIMETER ROAD
VEGETATION	PROPOSED SWALE
FENCE	PROPOSED CULVERT
EXISTING GRADE (10' INTERVAL)	PROPOSED SLOPE AND DIRECTION
EXISTING GRADE (2' INTERVAL)	PROPOSED MODULE 12 MONITORING WELL
PROPOSED 6" DIAMETER PERFORATED SDR 11 HDPE LEACHATE COLLECTION LINE	
PROPOSED 6" DIAMETER SOLID SDR 11 HDPE PIPE	
PROPOSED LEACHATE COLLECTION SYSTEM CLEANOUT	
PROPOSED INCLINED RISER PIPE AND LEACHATE VAULT	
PROPOSED LEACHATE MANHOLE SUMP	
PROPOSED LEACHATE FORCEMAIN CLEANOUT MANHOLE	
PROPOSED LEACHATE FORCEMAIN	
PROPOSED UNDERGROUND ELECTRIC	

NOTES:

1. SEE SHEET 2 FOR BASE MAP LEGEND ITEMS AND NOTES.
2. PROPOSED GRADES WITHIN MODULE 12 REPRESENT TOP OF 2' THICK CLAY LINER (BASE GRADE).
3. LEACHATE COLLECTION LINE CUTTING AND CAPPING TO OCCUR AFTER WDNR APPROVAL OF MODULE 12 LINER CONSTRUCTION.

50 0 50

SCALE: 1" = 50'

N

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09/28/2023 - Classification: Internal - ECRM13153872

KP | DRAWN BY: | PROJECT NO. 25222260.01

RR\MRH | CHECKED BY: | DRAWN: 07/24/2023

MRH: 08/31/2023 | APPROVED BY: | REVISED: 08/31/2023

WISCONSIN POWER AND LIGHT COLUMBIA ENERGY CENTER W8375 MURRAY ROAD PARDEEVILLE, WISCONSIN 53954

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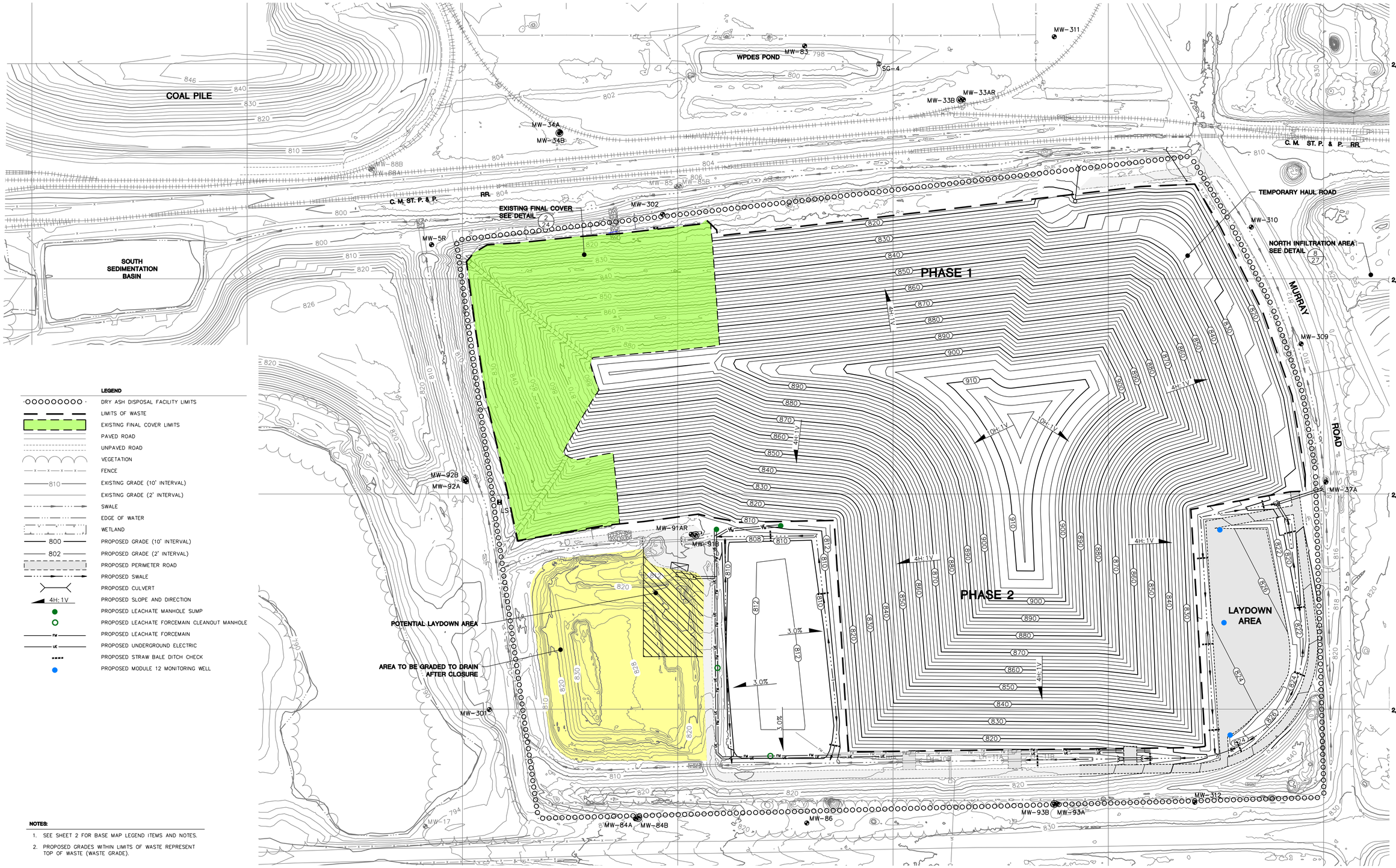
PLAN OF OPERATION UPDATE
COLUMBIA ENERGY CENTER
COAL COMBUSTION RESIDUAL FACILITY
TOWN OF PACIFIC, WISCONSIN

SITE

LEACHATE COLLECTION SYSTEM (MODULE 12)

SHEET 5 of 28



NOTES:

1. SEE SHEET 2 FOR BASE MAP LEGEND ITEMS AND NOTES.
2. PROPOSED GRADES WITHIN LIMITS OF WASTE REPRESENT TOP OF WASTE (WASTE GRADE).

100 0 100

SCALE: 1" = 100'

N

PROJECT NO.	25222260.01
DRAWN:	07/24/2023
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DRAWN BY:	KP
CHECKED BY:	RR\MRH
APPROVED BY:	MRH 08/31/2023

CLIENT

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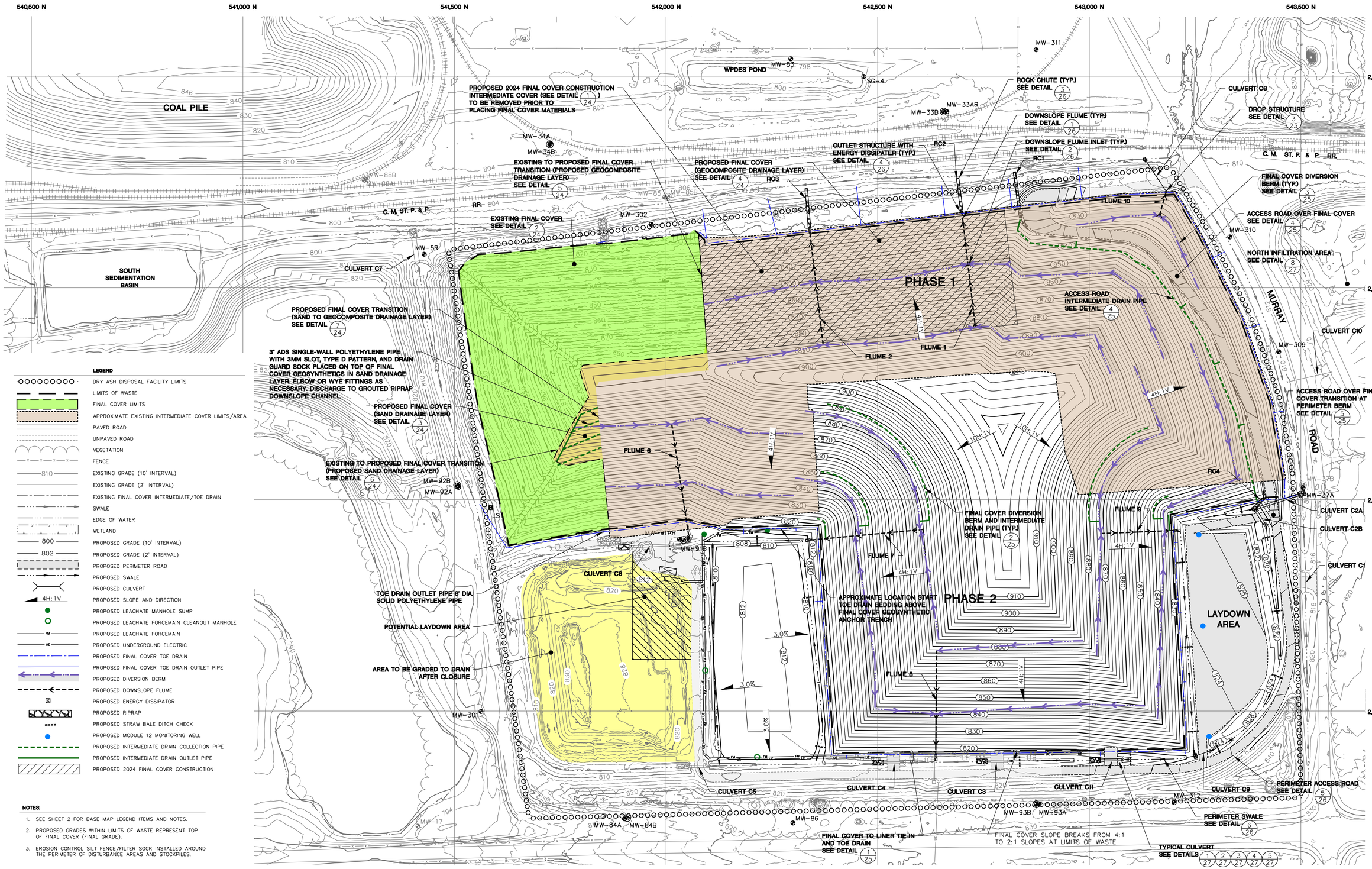
PLAN OF OPERATION UPDATE
COLUMBIA ENERGY CENTER
COLUMBIA DRY ASH DISPOSAL FACILITY
TOWN OF PACIFIC, WISCONSIN

TOP OF WASTE GRADES (MODULE 12)

SHEET

6 of 28

09/28/2023 - Classification: Internal - ECRM13153872



LEGEND

- DRY ASH DISPOSAL FACILITY LIMITS
- LIMITS OF WASTE
- FINAL COVER LIMITS
- APPROXIMATE EXISTING INTERMEDIATE COVER LIMITS/AREA
- PAVED ROAD
- UNPAVED ROAD
- VEGETATION
- FENCE
- EXISTING GRADE (10' INTERVAL)
- EXISTING GRADE (2' INTERVAL)
- EXISTING FINAL COVER INTERMEDIATE/TOE DRAIN
- SWALE
- EDGE OF WATER
- WETLAND
- PROPOSED GRADE (10' INTERVAL)
- PROPOSED GRADE (2' INTERVAL)
- PROPOSED PERIMETER ROAD
- PROPOSED SWALE
- PROPOSED CULVERT
- PROPOSED SLOPE AND DIRECTION
- PROPOSED LEACHATE MANHOLE SUMP
- PROPOSED LEACHATE FORCEMAIN CLEANOUT MANHOLE
- PROPOSED LEACHATE FORCEMAIN
- PROPOSED UNDERGROUND ELECTRIC
- PROPOSED FINAL COVER TOE DRAIN
- PROPOSED FINAL COVER TOE DRAIN OUTLET PIPE
- PROPOSED DIVERSION BERM
- PROPOSED DOWNSLOPE FLUME
- PROPOSED ENERGY DISSIPATOR
- PROPOSED RIPRAP
- PROPOSED STRAW BALE DITCH CHECK
- PROPOSED MODULE 12 MONITORING WELL
- PROPOSED INTERMEDIATE DRAIN COLLECTION PIPE
- PROPOSED INTERMEDIATE DRAIN OUTLET PIPE
- PROPOSED 2024 FINAL COVER CONSTRUCTION

NOTES:

1. SEE SHEET 2 FOR BASE MAP LEGEND ITEMS AND NOTES.
2. PROPOSED GRADES WITHIN LIMITS OF WASTE REPRESENT TOP OF FINAL COVER (FINAL GRADE).
3. EROSION CONTROL SILT FENCE/FILTER SOCK INSTALLED AROUND THE PERIMETER OF DISTURBANCE AREAS AND STOCKPILES.

100 0 100

SCALE: 1" = 100'

N

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CHECKED BY: RR,MRH
APPROVED BY: MRH 08/31/2023

PROJECT NO. 25222260.01
DRAWN: 07/24/2023
REVISED: 08/31/2023

WISCONSIN POWER AND LIGHT
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W8375 MURRAY ROAD
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PLAN OF OPERATION UPDATE
COLUMBIA ENERGY CENTER
COLUMBIA ASH DISPOSAL FACILITY
TOWN OF PACIFIC, WISCONSIN

SITE

FINAL GRADES
(MODULE 12)

SHEET
7 of 28

09/28/2023 - Classification: Internal - ECRM13153872

542,500 N | 542,500 N | 543,000 N | 543,500 N

2,124,500 E

2,125,000 E

MODULE 6 - MODULE 13 LINER TIE-IN SEE DETAIL (1/18)

MONITORING WELL TO BE ABANDONED PRIOR TO SUBBASE EXCAVATION (TYP.)

MODULE 2 EAST BERM SEE DETAIL (3/20)

MODULE 12-MODULE 13 DELINEATION BERM TIE-IN SEE DETAIL (2/19)

MODULE 11 - MODULE 12 DELINEATION BERM TIE-IN SEE DETAIL (2/19)

COMPOSITE LINER SYSTEM SEE DETAIL (1/17)

GEOSYNTHETIC ANCHOR TRENCH SEE DETAIL (2/17)

MW-91AR
MW-91B
MW-99A/B
LP-1
MW-37B
MW-37A
MW-313
MW-314
MW-315
MW-1AR
M-1B
MW-86
MW-93B
MW-93A
MW-312

LEACHATE/ SURFACE WATER POND

MODULE 10

MODULE 11

PROPOSED MODULE 12

PROPOSED MODULE 13

MURRAY ROAD

U.S.H. 51

SIGN

2.0%

0.5%

3H:1V

LEGEND

- DRY ASH DISPOSAL FACILITY LIMITS
- LIMITS OF WASTE
- LINER PHASE/MODULE LIMIT
- LIMITS OF CONSTRUCTED 2' THICK CLAY LINER
- PAVED ROAD
- UNPAVED ROAD
- VEGETATION
- FENCE
- 810 EXISTING GRADE (10' INTERVAL)
- EXISTING GRADE (2' INTERVAL)
- SWALE
- EDGE OF WATER
- WETLAND
- 800 PROPOSED GRADE (10' INTERVAL)
- 802 PROPOSED GRADE (2' INTERVAL)
- PROPOSED PERIMETER ROAD
- PROPOSED SWALE
- PROPOSED CULVERT
- 2.0% PROPOSED SLOPE AND DIRECTION
- PROPOSED MODULE 13 MONITORING WELL

NOTES:

1. SEE SHEET 2 FOR BASE MAP LEGEND ITEMS AND NOTES.
2. PROPOSED GRADES WITHIN MODULES 12 AND 13 REPRESENT BOTTOM OF 2' THICK CLAY LINER (SUBBASE GRADE).
3. EROSION CONTROL SILT FENCE/FILTER SOCK INSTALLED AROUND THE PERIMETER OF DISTURBANCE AREAS AND STOCKPILES.

50 0 50

SCALE: 1" = 50'

N

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CHECKED BY:	RR\MRH
APPROVED BY:	MRH: 09/31/2023
PROJECT NO.	25222260.01
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Wisconsin Power and Light Company
WISCONSIN POWER AND LIGHT COLUMBIA ENERGY CENTER W8375 MURRAY ROAD PARDEEVILLE, WISCONSIN 53954

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PLAN OF OPERATION UPDATE
COLUMBIA ENERGY CENTER
COMBINED ASH DISPOSAL FACILITY
TOWN OF PACIFIC, WISCONSIN

SITE

SUBBASE GRADES (MODULES 12 AND 13)

SHEET
8 of 28

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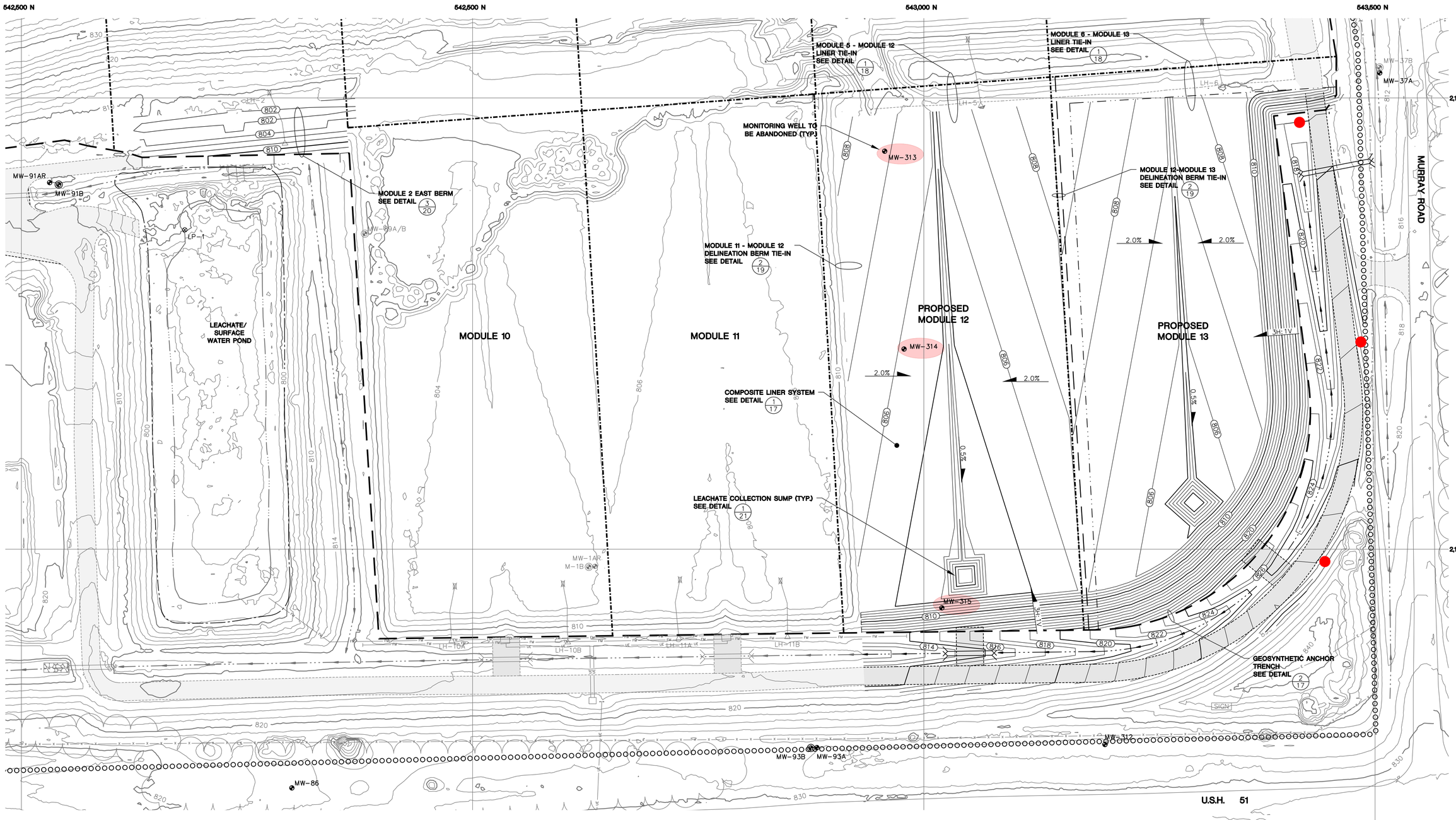
09/28/2023 - Classification: Internal - ECRM13153872



LEGEND

	DRY ASH DISPOSAL FACILITY LIMITS		SWALE
	LIMITS OF WASTE		EDGE OF WATER
	LINER PHASE/MODULE LIMIT		WETLAND
	LIMITS OF CONSTRUCTED 2' THICK CLAY LINER	800	PROPOSED GRADE (10' INTERVAL)
	PAVED ROAD	802	PROPOSED GRADE (2' INTERVAL)
	UNPAVED ROAD		PROPOSED PERIMETER ROAD
	VEGETATION		PROPOSED SWALE
	FENCE		PROPOSED CULVERT
810	EXISTING GRADE (10' INTERVAL)	2.0%	PROPOSED SLOPE AND DIRECTION
	EXISTING GRADE (2' INTERVAL)		PROPOSED MODULE 13 MONITORING WELL

NOTES:

1. SEE SHEET 2 FOR BASE MAP LEGEND ITEMS AND NOTES.
2. PROPOSED GRADES WITHIN MODULES 12 AND 13 REPRESENT TOP OF 2' THICK CLAY LINER (BASE GRADE).

50 0 50

SCALE: 1" = 50'

N

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CHECKED BY:	RR\MRH
APPROVED BY:	MRH 08/31/2023

CLIENT

Wisconsin Power and Light Company

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COLUMBIA ENERGY CENTER
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PLAN OF OPERATION UPDATE
COLUMBIA ENERGY CENTER
COLUMBIA DRY ASH DISPOSAL FACILITY
TOWN OF PACIFIC, WISCONSIN

BASE GRADES
(MODULES 12 AND 13)

SHEET

9 of 28

09/28/2023 - Classification: Internal - ECRM13153872

542,500 N

542,500 N

543,000 N

543,500 N

2,124,500 E

2,125,000 E

PIPE BOOT SEE DETAIL 4/20

MODULE 2 EAST BERM SEE DETAIL 3/20

MOD 1 LEACHATE SUMP SEE DETAIL 1/23

MOD 2 LEACHATE SUMP SEE DETAIL 2/23

LEACHATE LOADOUT PAD SEE DETAIL 3/22

LEACHATE STORAGE TANK SEE DETAIL 2/22

LEACHATE/ SURFACE WATER POND

LEACHATE FORCEMAIN AND TRENCH SEE DETAIL 5/17

LEACHATE FORCEMAIN CLEANOUT MANHOLE (TYP.) SEE DETAIL 1/22

2"/4" DUAL CONTAINED HDPE SDR 11/17 PIPE

ABANDON LEACHATE HEAD WELL SEE DETAIL 1/20

CUT 6-INCH DIAMETER SDR 17 HDPE LEACHATE COLLECTION PIPE AND CAP BOTH ENDS (SEE NOTE 3) SEE DETAIL 3/18

MODULE 5 - MODULE 12 LINER TIE-IN SEE DETAIL 1/18

MODULE 6 - MODULE 13 LINER TIE-IN SEE DETAIL 1/18

ABANDON LEACHATE HEAD WELL SEE DETAIL 1/20

MONITORING WELL TO BE ABANDONED (TYP.)

MODULE 11 - MODULE 12 DELINEATION BERM TIE-IN SEE DETAIL 2/19

MODULE 12-MODULE 13 DELINEATION BERM TIE-IN SEE DETAIL 2/19

COMPOSITE LINER SYSTEM SEE DETAIL 1/17

LEACHATE COLLECTION PIPE (TYP.) SEE DETAIL 4/17

LEACHATE COLLECTION SUMP (TYP.) SEE DETAIL 1/21

LEACHATE INCLINED RISER PUMP (TYP.) SEE DETAIL 3/21

INCLINED RISER PIPE AND LEACHATE VAULT (TYP.) SEE DETAIL 4/22

4"/8" DUAL CONTAINED HDPE SDR 11/17 PIPE

LEACHATE HEADWELL (TYP.) SEE DETAIL 3/17

LEACHATE PUMP CONTROL PANEL (TYP.) SEE DETAIL 2/21

LEACHATE CLEANOUT (TYP.) SEE DETAIL 6/17

GEOSYNTHETIC ANCHOR TRENCH SEE DETAIL 2/17

MODULE 10

MODULE 11

PROPOSED MODULE 12

PROPOSED MODULE 13

MURRAY ROAD

U.S.H. 51

MW-91AR
MW-91B
MW-89A/B
MW-1AR
M-1B
MW-93B
MW-93A
MW-86
MW-313
MW-314
MW-315
MW-312
MW-37B
MW-37A

LH-10B
LH-11A
LH-11B
LH-5
LH-6

2.0%
3H:1V
6.5%

LEGEND

DRY ASH DISPOSAL FACILITY LIMITS	SWALE	PROPOSED 6" DIAMETER PERFORATED SDR 11 HDPE LEACHATE COLLECTION LINE
LIMITS OF WASTE	EDGE OF WATER	PROPOSED 6" DIAMETER SOLID SDR 11 HDPE PIPE
LINER PHASE/MODULE LIMIT	WETLAND	PROPOSED LEACHATE COLLECTION SYSTEM CLEANOUT
LIMITS OF CONSTRUCTED 2' THICK CLAY LINER	800 PROPOSED GRADE (10' INTERVAL)	PROPOSED INCLINED RISER PIPE AND LEACHATE VAULT
PAVED ROAD	802 PROPOSED GRADE (2' INTERVAL)	PROPOSED LEACHATE FORCEMAIN CLEANOUT MANHOLE
UNPAVED ROAD	PROPOSED PERIMETER ROAD	PROPOSED LEACHATE COLLECTION SUMP
VEGETATION	PROPOSED SWALE	FM PROPOSED LEACHATE FORCEMAIN
FENCE	PROPOSED CULVERT	UE PROPOSED UNDERGROUND ELECTRIC
810 EXISTING GRADE (10' INTERVAL)	2.0% PROPOSED SLOPE AND DIRECTION	
EXISTING GRADE (2' INTERVAL)	PROPOSED MODULE 13 MONITORING WELL	

NOTES:

1. SEE SHEET 2 FOR BASE MAP LEGEND ITEMS AND NOTES.
2. PROPOSED GRADES WITHIN MODULES 12 AND 13 REPRESENT TOP OF 2' THICK CLAY LINER (BASE GRADE).

50 0 50

SCALE: 1" = 50'

N

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DRAWN:	03/24/2023
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DRAWN BY:	KP
CHECKED BY:	RR\MRH
APPROVED BY:	MRH 08/31/2023

Wisconsin Power and Light Company

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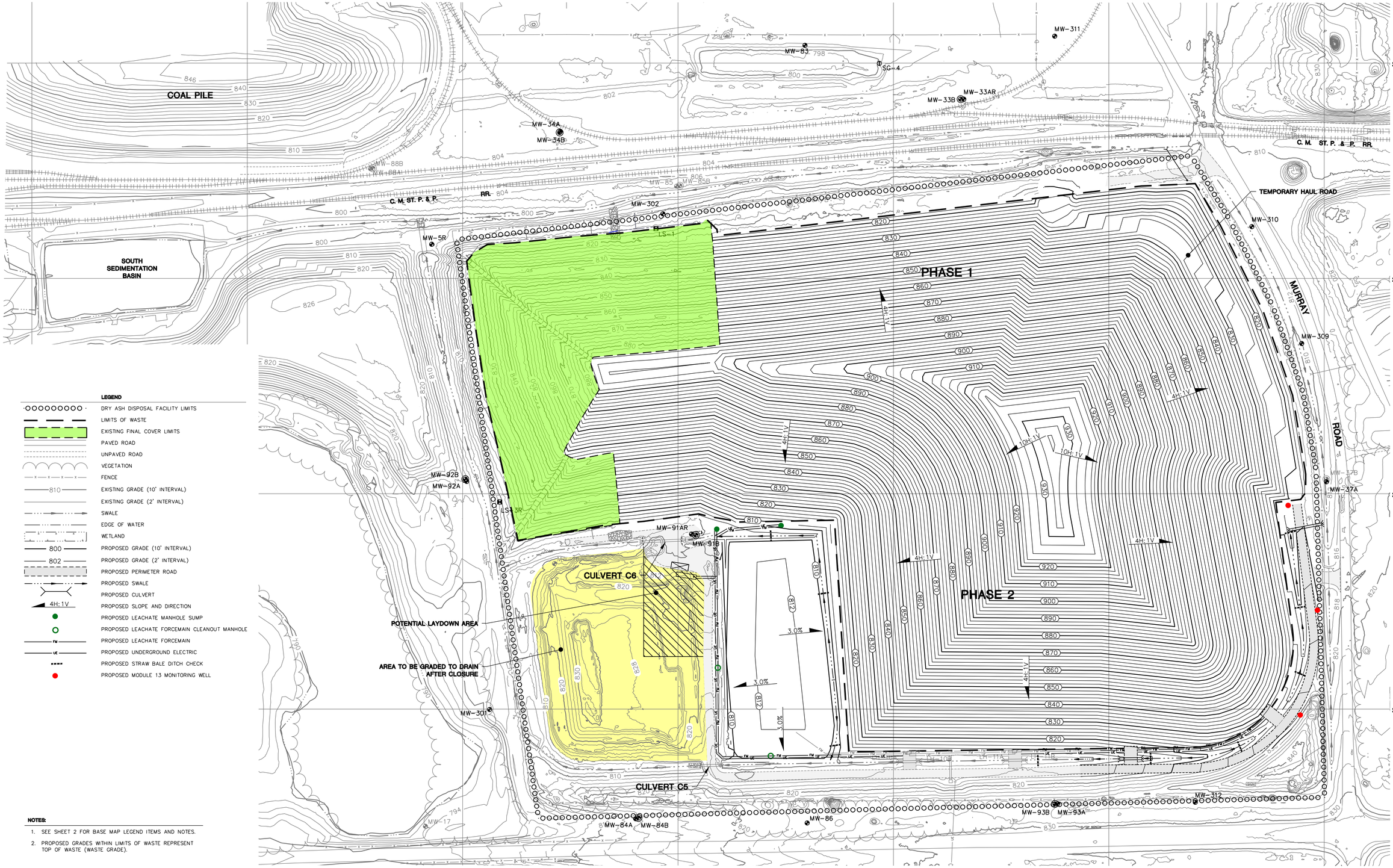
PLAN OF OPERATION UPDATE
COLUMBIA ENERGY CENTER
COLUMBIA COUNTY LANDFILL FACILITY
TOWN OF PACIFIC, WISCONSIN

SITE

LEACHATE COLLECTION SYSTEM (MODULES 12 AND 13)

SHEET 10 of 28

09/28/2023 - Classification: Internal - ECRM13153872



LEGEND

- DRY ASH DISPOSAL FACILITY LIMITS
- LIMITS OF WASTE
- EXISTING FINAL COVER LIMITS
- PAVED ROAD
- UNPAVED ROAD
- VEGETATION
- FENCE
- 810 EXISTING GRADE (10' INTERVAL)
- EXISTING GRADE (2' INTERVAL)
- SWALE
- EDGE OF WATER
- WETLAND
- 800 PROPOSED GRADE (10' INTERVAL)
- 802 PROPOSED GRADE (2' INTERVAL)
- PROPOSED PERIMETER ROAD
- PROPOSED SWALE
- PROPOSED CULVERT
- 4H:1V PROPOSED SLOPE AND DIRECTION
- PROPOSED LEACHATE MANHOLE SUMP
- PROPOSED LEACHATE FORCEMAIN CLEANOUT MANHOLE
- fm PROPOSED LEACHATE FORCEMAIN
- ue PROPOSED UNDERGROUND ELECTRIC
- PROPOSED STRAW BALE DITCH CHECK
- PROPOSED MODULE 13 MONITORING WELL

NOTES:

1. SEE SHEET 2 FOR BASE MAP LEGEND ITEMS AND NOTES.
2. PROPOSED GRADES WITHIN LIMITS OF WASTE REPRESENT TOP OF WASTE (WASTE GRADE).

100 0 100
SCALE: 1" = 100'

N

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DRAWN: 05/17/18
REVISED: 08/31/2023

DRAWN BY: KP
CHECKED BY: RR,MRH
APPROVED BY: MRH 08/31/2023

Wisconsin Power and Light Company
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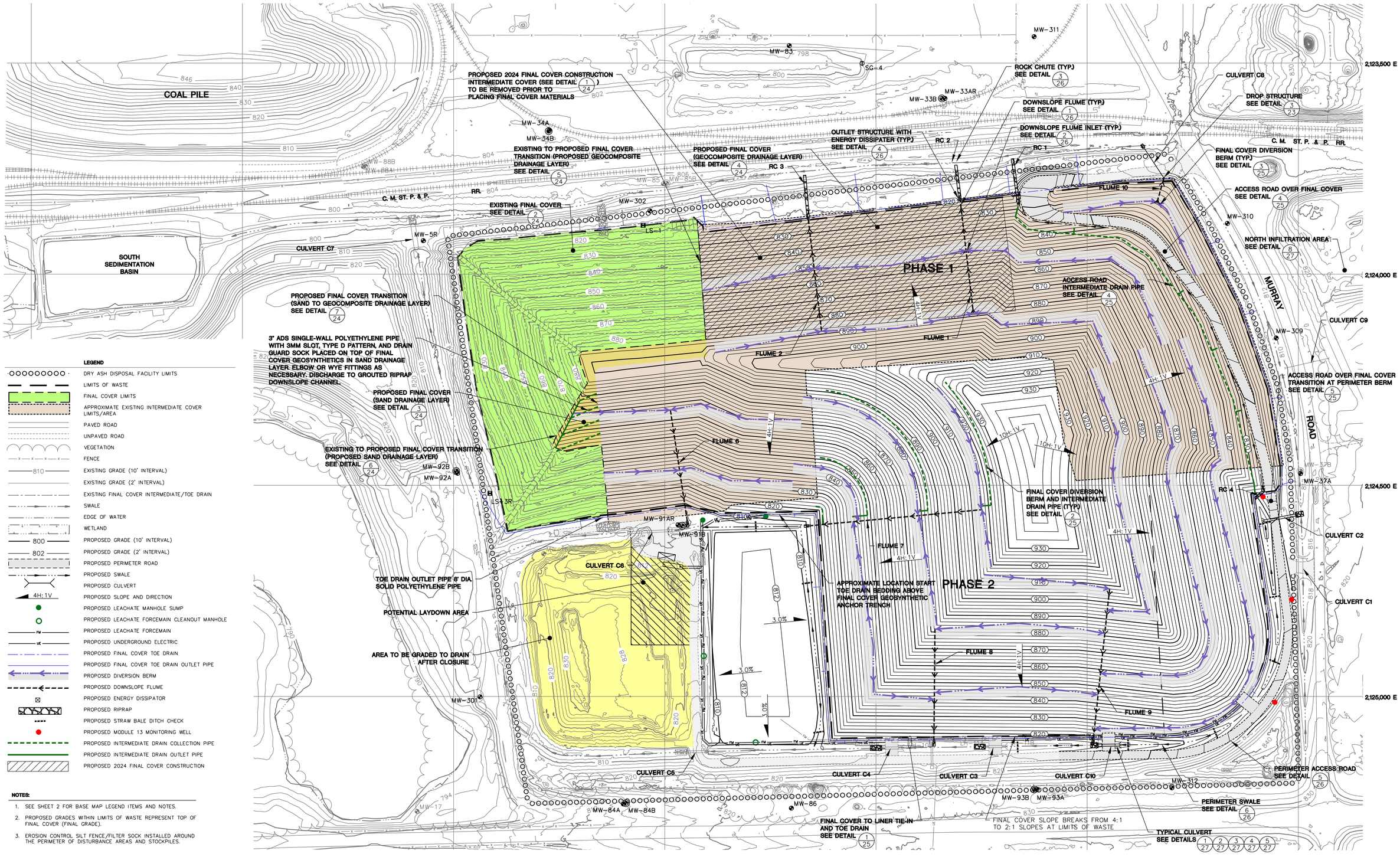
PLAN OF OPERATION UPDATE
COLUMBIA ENERGY CENTER
COLUMBIA COUNTY, DRY ASH DISPOSAL FACILITY
TOWN OF PACIFIC, WISCONSIN

SITE

TOP OF WASTE GRADES
(MODULES 12 AND 13)

SHEET
11 of 28

09/28/2023 - Classification: Internal - ECRM13153872



LEGEND

- DRY ASH DISPOSAL FACILITY LIMITS
- LIMITS OF WASTE
- FINAL COVER LIMITS
- APPROXIMATE EXISTING INTERMEDIATE COVER LIMITS/AREA
- PAVED ROAD
- UNPAVED ROAD
- VEGETATION
- FENCE
- EXISTING GRADE (10' INTERVAL)
- EXISTING GRADE (2' INTERVAL)
- EXISTING FINAL COVER INTERMEDIATE/TOE DRAIN
- SWALE
- EDGE OF WATER
- WETLAND
- PROPOSED GRADE (10' INTERVAL)
- PROPOSED GRADE (2' INTERVAL)
- PROPOSED PERIMETER ROAD
- PROPOSED SWALE
- PROPOSED CULVERT
- PROPOSED SLOPE AND DIRECTION
- PROPOSED LEACHATE MANHOLE SUMP
- PROPOSED LEACHATE FORCEMAIN CLEANOUT MANHOLE
- PROPOSED LEACHATE FORCEMAIN
- PROPOSED UNDERGROUND ELECTRIC
- PROPOSED FINAL COVER TOE DRAIN
- PROPOSED FINAL COVER TOE DRAIN OUTLET PIPE
- PROPOSED DIVERSION BERM
- PROPOSED DOWNSLOPE FLUME
- PROPOSED ENERGY DISSIPATOR
- PROPOSED RIPRAP
- PROPOSED STRAW BALE DITCH CHECK
- PROPOSED MODULE 13 MONITORING WELL
- PROPOSED INTERMEDIATE DRAIN COLLECTION PIPE
- PROPOSED INTERMEDIATE DRAIN OUTLET PIPE
- PROPOSED 2024 FINAL COVER CONSTRUCTION

NOTES:

1. SEE SHEET 2 FOR BASE MAP LEGEND ITEMS AND NOTES.
2. PROPOSED GRADES WITHIN LIMITS OF WASTE REPRESENT TOP OF FINAL COVER (FINAL GRADE).
3. EROSION CONTROL SILT FENCE/FILTER SOCK INSTALLED AROUND THE PERIMETER OF DISTURBANCE AREAS AND STOCKPILES.

100 0 100

SCALE: 1" = 100'

N

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DRAWN BY:	KP
CHECKED BY:	RR\MRH
APPROVED BY:	MRH 08/31/2023
PROJECT NO.	25222260.01
DRAWN:	05/17/18
REVISED:	08/31/2023

WISCONSIN POWER AND LIGHT
W8375 MURRAY ROAD
PARDEEVILLE, WISCONSIN 53954

Wisconsin Power and Light Company

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PLAN OF OPERATION UPDATE
COLUMBIA ENERGY CENTER
COLUMBIA ASH DISPOSAL FACILITY
TOWN OF PACIFIC, WISCONSIN

SITE

FINAL GRADES
(MODULES 12 AND 13)

SHEET
12 of 28

09/28/2023 - Classification: Internal - ECRM13153872

Table 1. NR 507.15(3) Groundwater Monitoring Program
CCR Monitoring Program
Wisconsin Power and Light - Columbia Ash Disposal Facility

Landfill Modules and Monitoring Points		Parameters - Detection Monitoring	Parameters - Assessment Monitoring (if required)	Frequency
Groundwater				
All Modules (Background Wells)	MW-84A	Alkalinity	Antimony	Semiannual (April/October)
	MW-301	Boron	Arsenic	
Modules 1-3	MW-302	Calcium	Barium	
	MW-33AR	Hardness	Beryllium	
	MW-34A	Chloride	Cadmium	
Modules 4-6	MW-309	Fluoride	Chromium	
	MW-310	Sulfate	Cobalt	
	MW-311	TDS	Copper	
Modules 10-11	MW-313^	Field Conductivity	Fluoride	
	MW-314^	Field pH	Lead	
	MW-315^	Field Temperature	Lithium	
		Groundwater Elevation	Manganese	
			Mercury	
			Molybdenum	
			Nitrate + Nitrite (as N)	
			Selenium	
			Silver	
			Thallium	
			Zinc	
Module 12 or Modules 12-13	Additional Wells as Installed		Radium 226 and Radium 228, combined	
Leachate				
All Modules*	LP-1*	BOD_5		Semiannual (April/October)
		Field conductivity (at 25 deg C)		
All Modules*	Leachate Collection Tank*	Field pH		
		Alkalinity		
		Boron		
		Cadmium		
		Chloride		
		COD		
		Hardness		
		Iron		
		Lead		
		Manganese		
		Mercury		
		Selenium		
		Total suspended solids		
		Antimony		
		Beryllium		
		Cobalt		
		Fluoride		
		Lithium		
		Molybdenum		
		Radium 226 and 228, combined		
		Sulfate		
		Thallium		
		Semivolatile organic compound scan		Annual

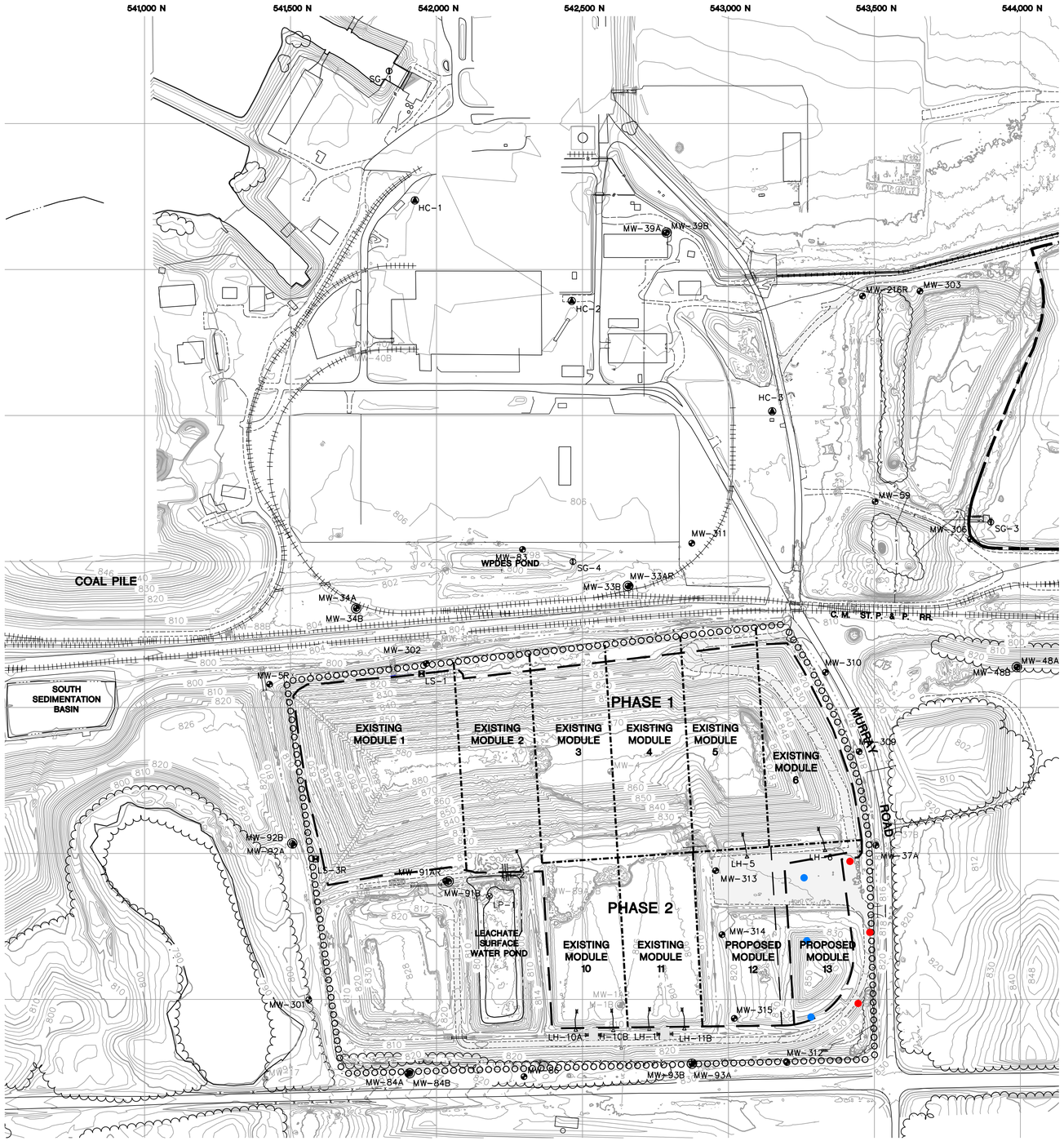
^: MW-313, MW-314, and MW-315 will be abandoned prior to construction of Module 12.
*: At a later date, the leachate collection system will be converted to discharge all leachate to the Leachate Collection Tank.

Table 2. Non-CCR Well Groundwater Monitoring Program
Wisconsin Power and Light - Columbia Dry Ash Disposal Facility
License #3025

Monitoring Points	Parameters	Frequency
Detection Groundwater Monitoring, Non-CCR Wells		
MW-33BR MW-34B MW-37A MW-83 MW-84B MW-86 MW-92A MW-92B MW-93A	Groundwater elevation Field odor, color, and turbidity Field temperature, conductivity at 25° C, and pH Metals, dissolved (Arsenic, Boron, Molybdenum) Sulfate, dissolved Total Hardness, dissolved (mg/L as $CaCO_3$) Alkalinity, dissolved	Semiannual (April and October)
Water Supply Wells		
HC-1 HC-2 HC-3	Field odor, color, and turbidity Field temperature, conductivity at 25° C, and pH Nitrate + Nitrite as N, total Metals, total (Arsenic, Boron, Molybdenum) Sulfate, total Chloride, total Total Hardness (mg/L as $CaCO_3$) Alkalinity	Semiannual (April and October)
Lysimeters		
LS-1 LS-3R	Field odor, color, and turbidity Field temperature, conductivity at 25° C, and pH Alkalinity Metals, total (Arsenic, Boron, Molybdenum) Total Hardness (mg/L as CaCO3) Chloride, total COD Total Kjeldahl Nitrogen (TKN) Sulfate, total	Semiannual (April and October)
Leachate Head Wells		
LH-2, LH-3^, LH-4^, LH-5, LH-6, LH-10A, LH-10B^, LH-11A, LH-11B^	Leachate head	Monthly

^ LH-10A/B and LH-11A/B will replace LH-3 and LH-4 in the monitoring program.

Maintenance/Inspection Item	Comments
Site Inspection & Compliance Certification	Annual inspections and compliance certifications for 40 years
Final Cover Maintenance	
Settlement Repair	Fill/regrade two spots as required to maintain positive drainage
Erosion Repair	As required
Vegetation Maintenance	
Mowing	Mow annually or as required
Revegetation of Bare Areas	Place seed, fertilizer, and mulch as required
Storm Water Runoff Management System Maintenance	
Sediment Accumulation	Remove sediment as required
Erosion Repair	As required
Leachate Collection System Maintenance	
Leachate Collection Line Cleaning	Clean annually
Groundwater Monitoring Well Maintenance	Repair any damage as required



LEGEND

- DRY ASH DISPOSAL FACILITY LIMITS
- LIMITS OF WASTE
- LINER PHASE/MODULE LIMIT
- PAVED ROAD
- UNPAVED ROAD
- RAILROAD TRACKS
- VEGETATION
- FENCE
- OVERHEAD UTILITY
- EXISTING GRADE (10' INTERVAL)
- EXISTING GRADE (2' INTERVAL)
- SWALE
- EDGE OF WATER
- WETLAND
- CULVERT
- TRANSMISSION TOWER
- UTILITY POLE
- MONITORING WELL
- PIEZOMETER
- WATER SUPPLY WELL
- STAFF GAUGE
- SURFACE WATER SAMPLE LOCATION
- LEACHATE HEADWELL
- LEACHATE RISER/CLEANOUT
- LYSIMETER MANHOLE
- ABANDONED MONITORING WELL
- ABANDONED PIEZOMETER
- ABANDONED TEMPORARY WATER TABLE WELL
- BENCHMARK
- PROPOSED MODULE 12 MONITORING WELL
- PROPOSED MODULE 13 MONITORING WELL

NOTES:

1. SEE SHEET 2 FOR BASE MAP NOTES.

200 0 200
SCALE: 1" = 200'

DRAWN BY: KP
CHECKED BY: RR\MRH
APPROVED BY: MRH 08/31/2023

PROJECT NO. 25222260.01
DRAWN: 07/20/2023
REVISED: 08/29/2023

WISCONSIN POWER AND LIGHT COLUMBIA ENERGY CENTER W8375 MURRAY ROAD PARDEEVILLE, WISCONSIN 53954

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PLAN OF OPERATION UPDATE
COLUMBIA ENERGY CENTER
COLUMBIA ASH DISPOSAL FACILITY
TOWN OF PACIFIC, WISCONSIN

SITE

SITE MONITORING AND LONG TERM CARE PLAN

SHEET
13 of 28

L:\25\22260.001\Drawings\Monitoring Map, 8/31/2023 2:31:43 PM

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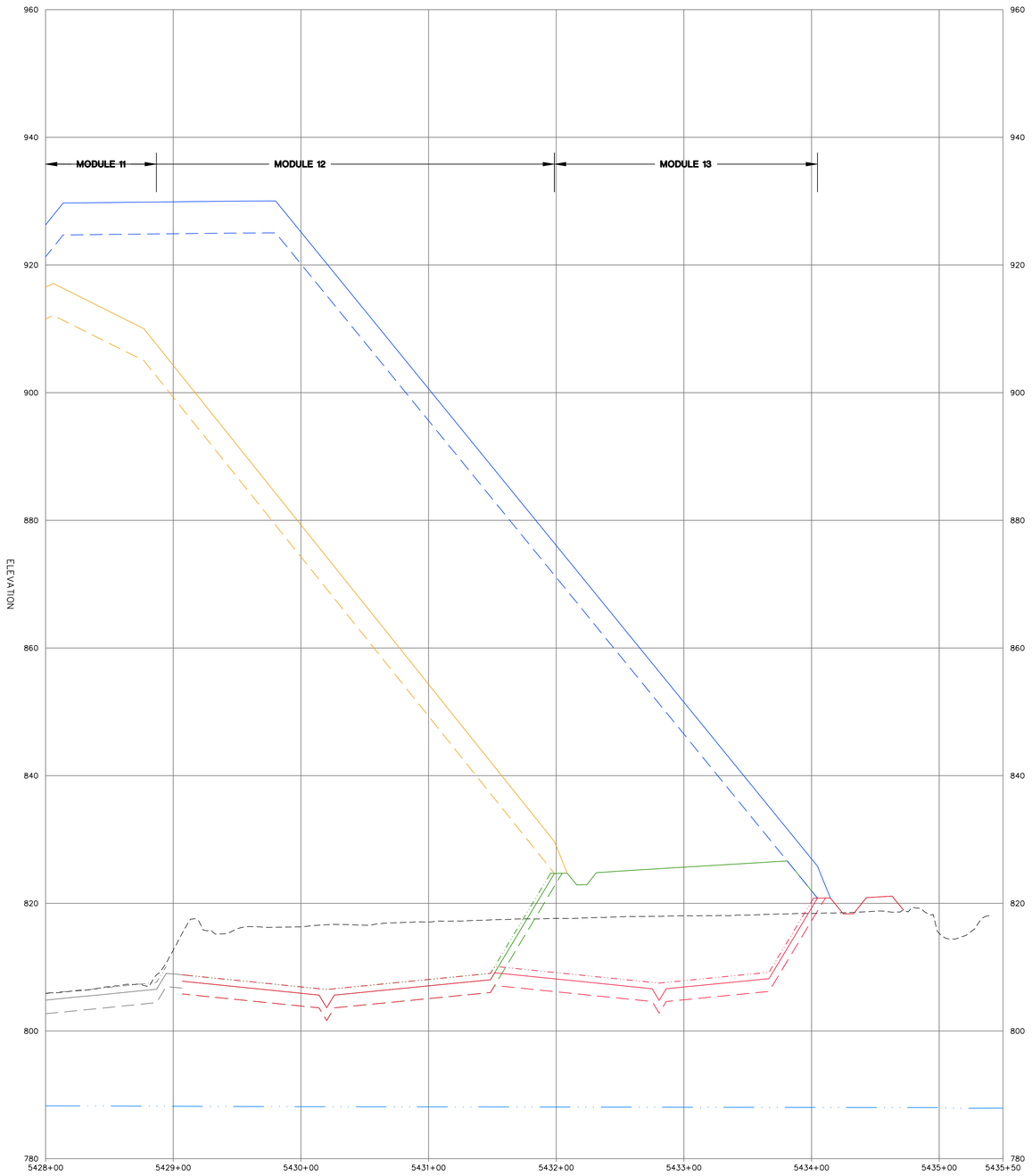
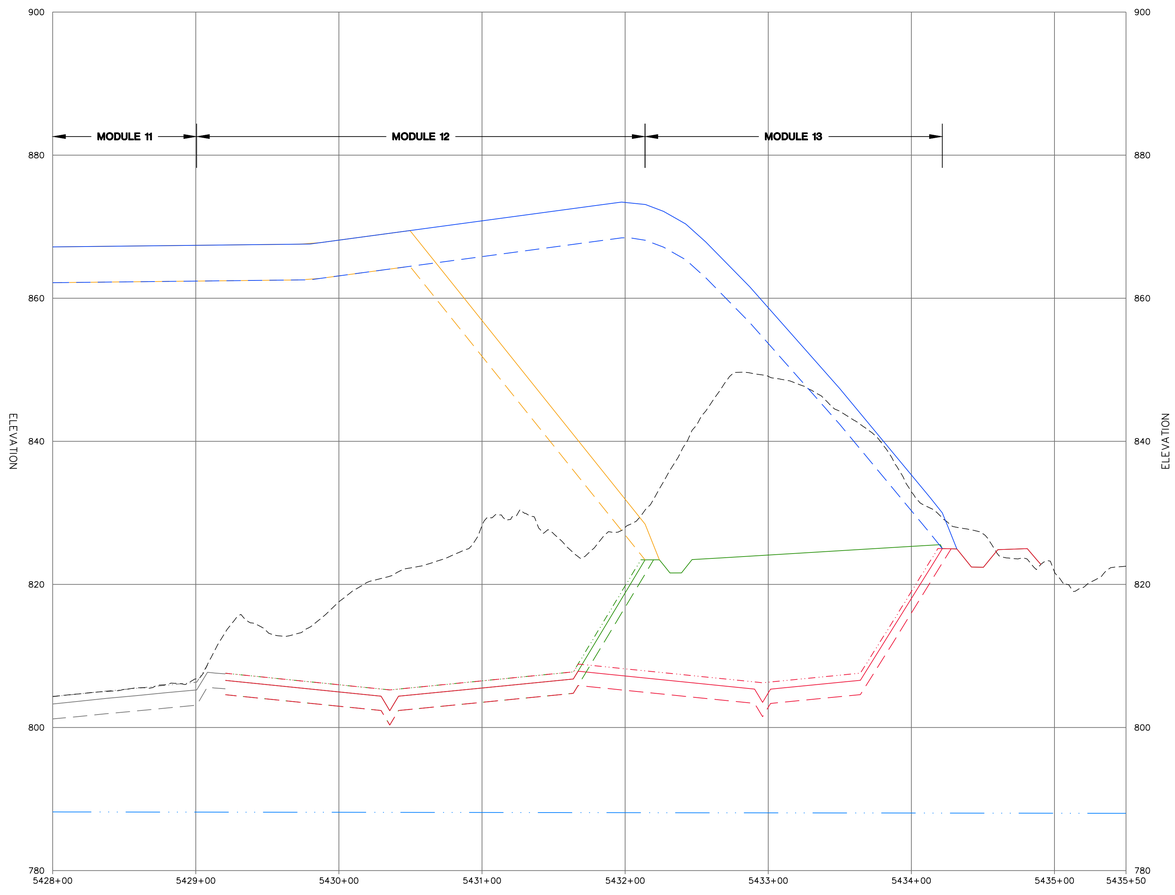


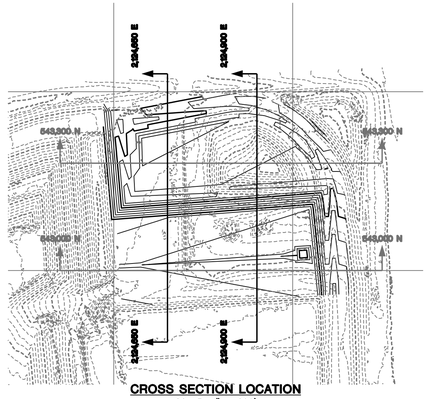
2124650 EAST



2124900 EAST

LEGEND

- EXISTING GRADE (06/06/2023)
- DOCUMENTED SUBBASE GRADE
- DOCUMENTED BASE GRADE
- DOCUMENTED DRAINAGE LAYER
- PROPOSED MODULE 12 SUBBASE GRADE
- PROPOSED MODULE 12 BASE GRADE
- PROPOSED MODULE 12 DRAINAGE LAYER
- PROPOSED MODULE 12 WASTE GRADE
- PROPOSED MODULE 12 FINAL GRADE
- PROPOSED MODULE 12 AND 13 SUBBASE GRADE
- PROPOSED MODULE 12 AND 13 BASE GRADE
- PROPOSED MODULE 12 AND 13 DRAINAGE LAYER
- PROPOSED MODULE 12 AND 13 WASTE GRADE
- PROPOSED MODULE 12 AND 13 FINAL GRADE
- HIGH WATER TABLE (OCTOBER 2018)



CROSS SECTION LOCATION
SCALE: 1" = 200'

0 50
HORIZONTAL SCALE: 1" = 50'
VERTICAL SCALE: 1" = 10'
VERTICAL EXAGGERATION = 5X

DRAWN BY:	KP
CHECKED BY:	RR\MRH
APPROVED BY:	MRH 08/31/2023
PROJECT NO.	25222260.01
DRAWN:	05/17/18
REVISED:	08/30/2023

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PLAN OF OPERATION UPDATE
COLUMBIA ENERGY CENTER
COLUMBIA DRY ASH DISPOSAL FACILITY
TOWN OF PACIFIC, WISCONSIN

SITE

CROSS SECTIONS – 2,214,650 EAST AND 2,124,900 EAST

SHEET
14 of 28

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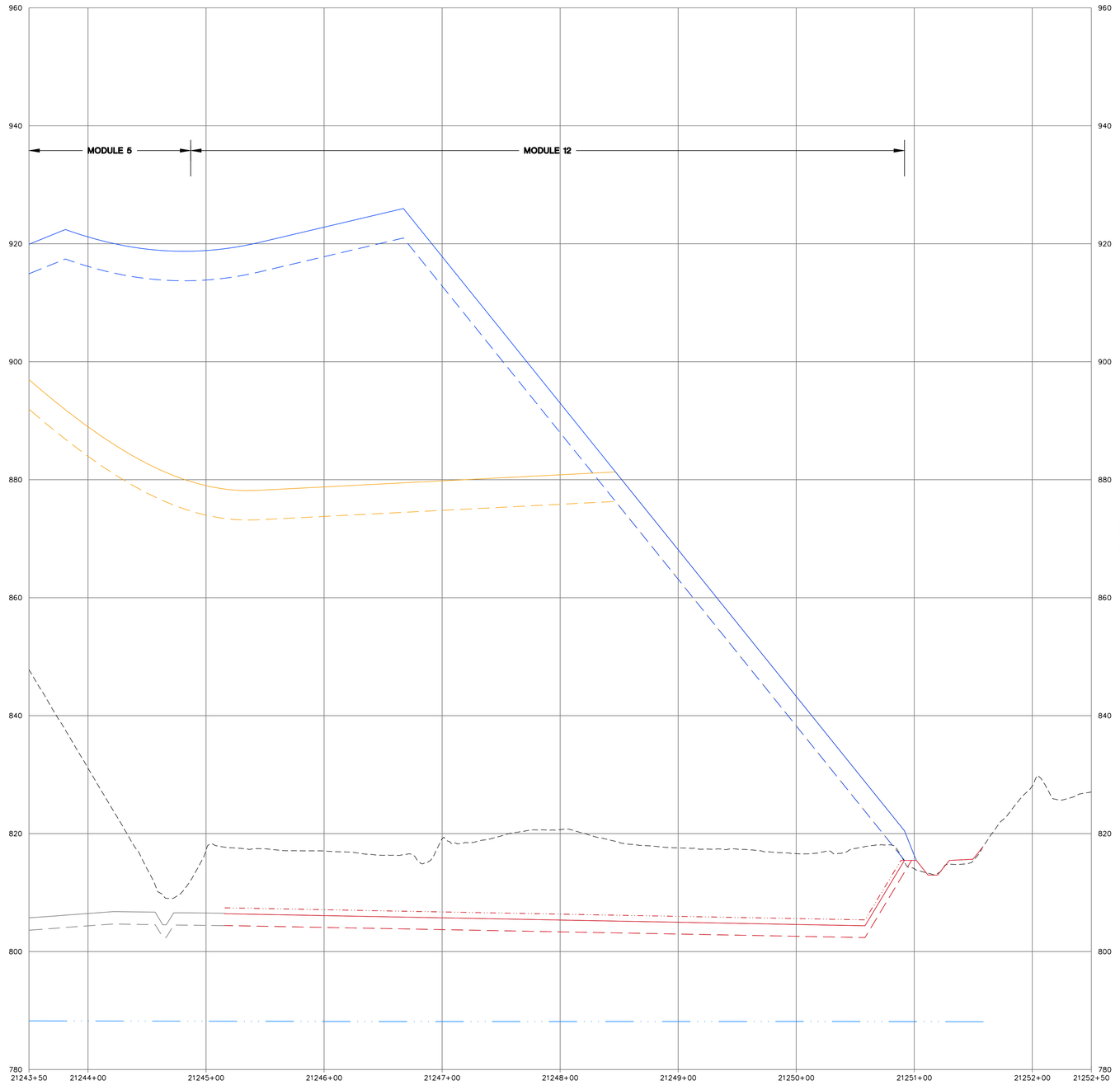

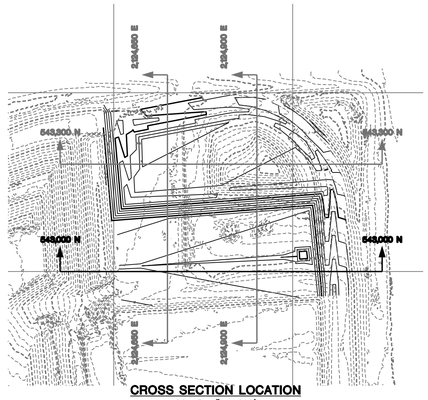

CROSS SECTION LOCATION
SCALE: 1" = 200'

LEGEND

- EXISTING GRADE (06/06/2023)
- DOCUMENTED SUBBASE GRADE
- DOCUMENTED BASE GRADE
- DOCUMENTED DRAINAGE LAYER
- PROPOSED MODULE 12 WASTE GRADE
- PROPOSED MODULE 12 FINAL GRADE
- PROPOSED MODULE 12 AND 13 SUBBASE GRADE
- PROPOSED MODULE 12 AND 13 BASE GRADE
- PROPOSED MODULE 12 AND 13 DRAINAGE LAYER
- PROPOSED MODULE 12 AND 13 WASTE GRADE
- PROPOSED MODULE 12 AND 13 FINAL GRADE
- HIGH WATER TABLE (OCTOBER 2018)

0 50
HORIZONTAL SCALE: 1" = 50'
VERTICAL SCALE: 1" = 10'
VERTICAL EXAGGERATION = 5X

DRAWN BY: KP
CHECKED BY: RR\MRH
APPROVED BY: MRH 08/31/2023

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PLAN OF OPERATION UPDATE
COLUMBIA ENERGY CENTER
COLUMBIA DRY ASH DISPOSAL FACILITY
TOWN OF PACIFIC, WISCONSIN

SITE

CROSS SECTION – 543,000 NORTH

SHEET
15 OF 28

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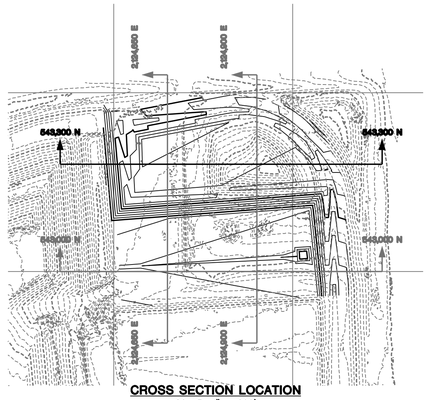

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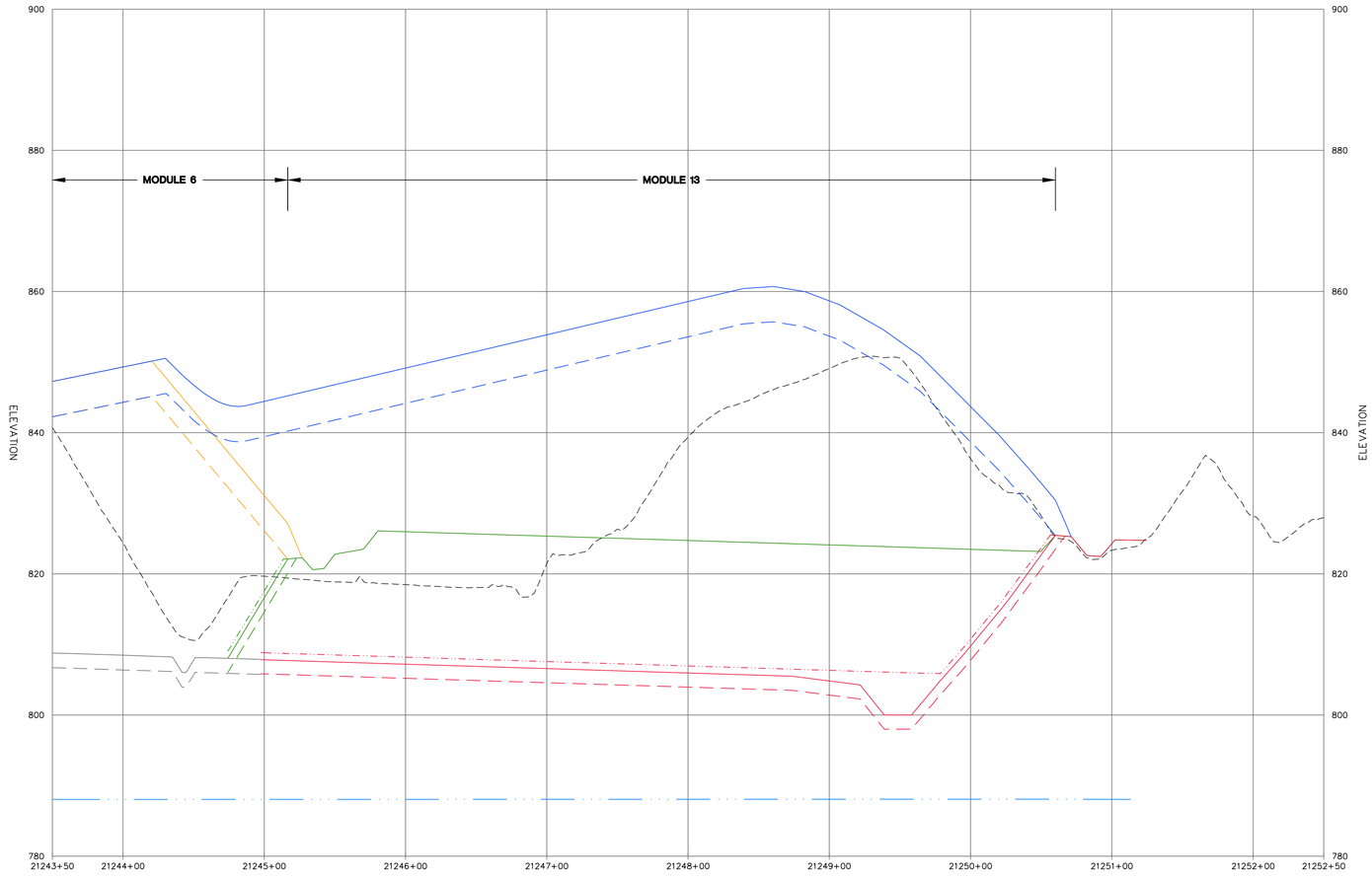
SCALE: 1" = 200'



543300 NORTH

LEGEND

- EXISTING GRADE (06/06/2023)
- DOCUMENTED SUBBASE GRADE
- DOCUMENTED BASE GRADE
- DOCUMENTED DRAINAGE LAYER
- PROPOSED MODULE 12 SUBBASE GRADE
- PROPOSED MODULE 12 BASE GRADE
- PROPOSED MODULE 12 DRAINAGE LAYER
- PROPOSED MODULE 12 WASTE GRADE
- PROPOSED MODULE 12 FINAL GRADE
- PROPOSED MODULE 12 AND 13 SUBBASE GRADE
- PROPOSED MODULE 12 AND 13 BASE GRADE
- PROPOSED MODULE 12 AND 13 DRAINAGE LAYER
- PROPOSED MODULE 12 AND 13 WASTE GRADE
- PROPOSED MODULE 12 AND 13 FINAL GRADE
- HIGH WATER TABLE (OCTOBER 2018)

0 50
HORIZONTAL SCALE: 1" = 50'
VERTICAL SCALE: 1" = 10'
VERTICAL EXAGGERATION = 5X

DRAWN BY: KP
CHECKED BY: RR\MRH
APPROVED BY: MRH 08/31/2023

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REVISED: 08/30/2023

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PLAN OF OPERATION UPDATE
COLUMBIA ENERGY CENTER
COLUMBIA ASH DISPOSAL FACILITY
TOWN OF PACIFIC, WISCONSIN

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CROSS SECTION – 543,300 NORTH

SHEET
16 of 28

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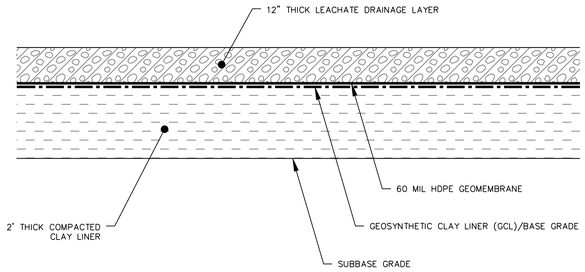
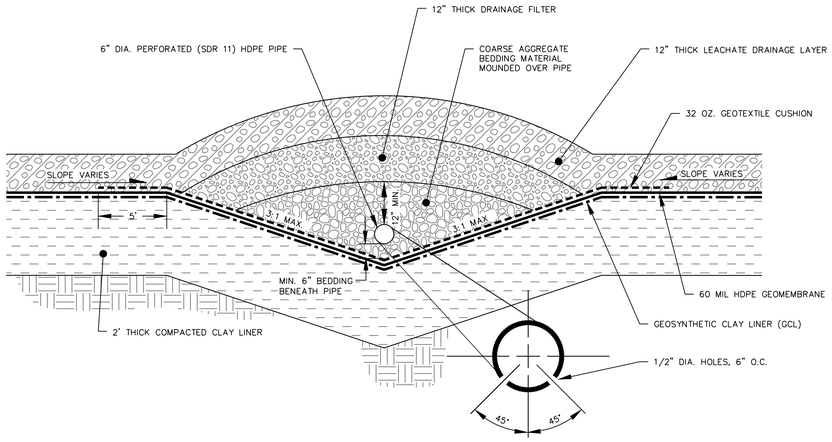
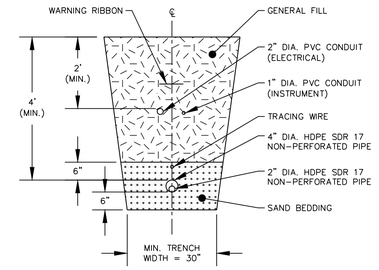


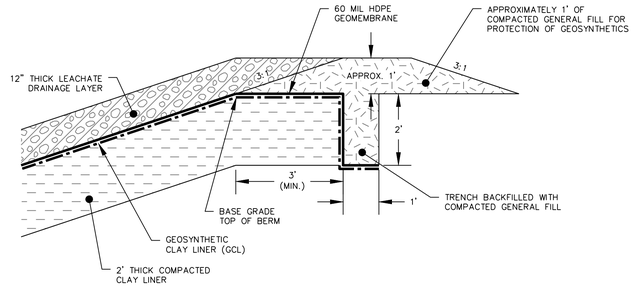
1/17 COMPOSITE LINER SYSTEM
SCALE: 1" = 2'



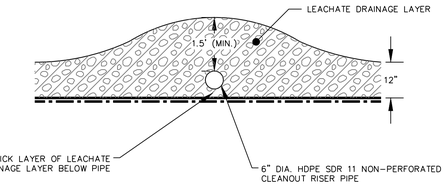
4/17 LEACHATE COLLECTION LINE (EAST-WEST)
SCALE: 1" = 5'

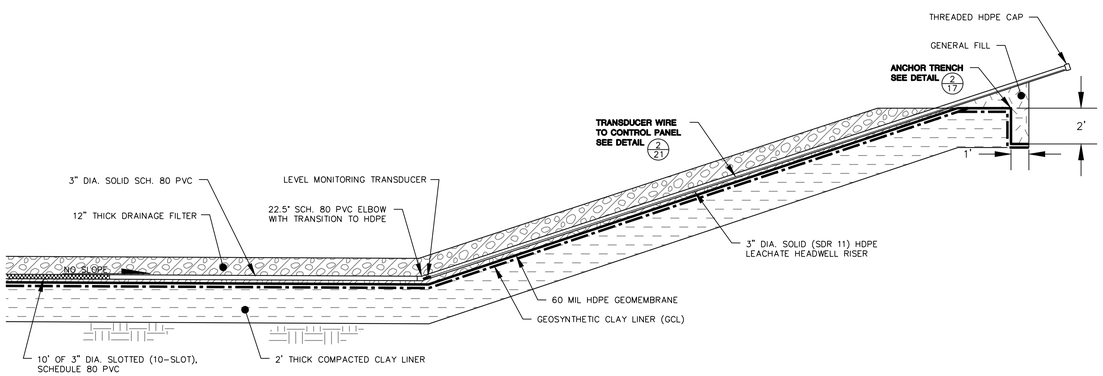


5/17 LEACHATE FORCEMAIN AND TRENCH
NOT TO SCALE

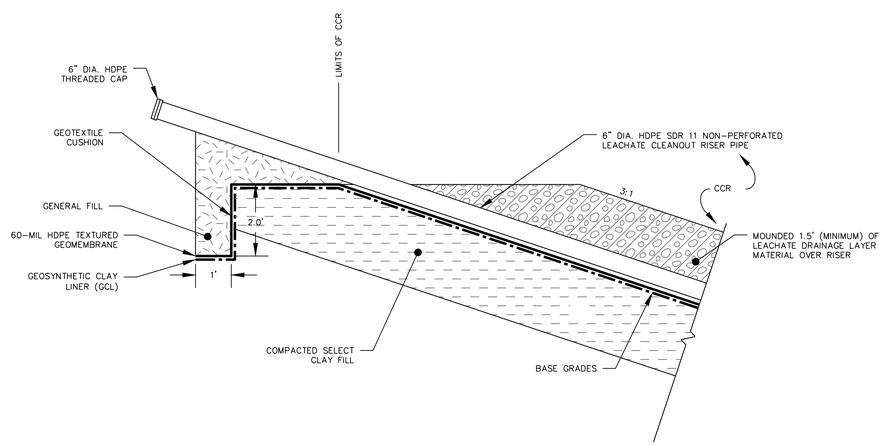


2/17 GEOSYNTHETIC ANCHOR TRENCH
SCALE: 1" = 2'





3/17 LEACHATE HEADWELL
SCALE: 1" = 4'



6/17 LEACHATE CLEANOUT
NOT TO SCALE

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CHECKED BY: RR\MRH
APPROVED BY: MRH 08/31/2023

PROJECT NO. 2522260.01
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REVISED: 08/31/2023

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COLUMBIA ENERGY CENTER
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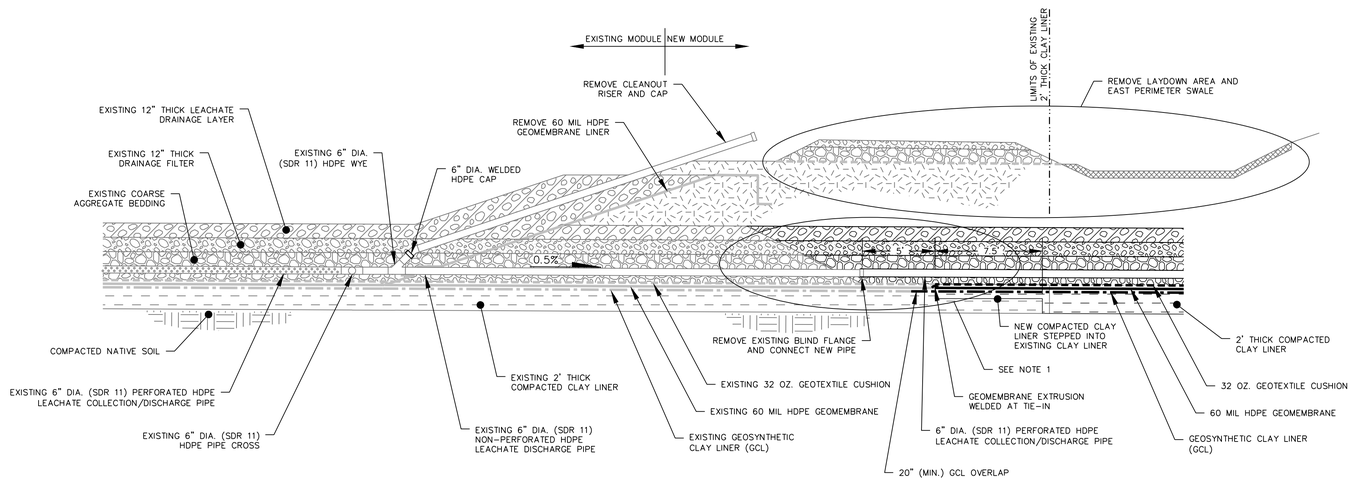
PLAN OF OPERATION UPDATE
COLUMBIA ENERGY CENTER
COLUMBIA ASH DISPOSAL FACILITY
TOWN OF PACIFIC, WISCONSIN

SITE

DETAILS

SHEET
17 of 28

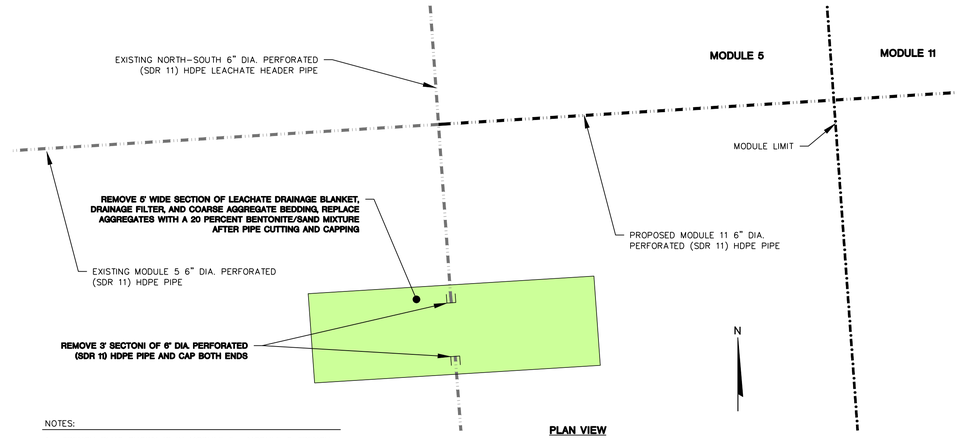
09/28/2023 - Classification: Internal - ECRM13153872



NOTES:

1. PLACEMENT OF LEACHATE DRAINAGE MATERIAL, DRAINAGE FILTER, COARSE AGGREGATE BEDDING AND PIPE CONNECTIONS TO BE MADE FOLLOWING WDNR APPROVAL OF MODULE 12 AND 13 LINER CONSTRUCTION.

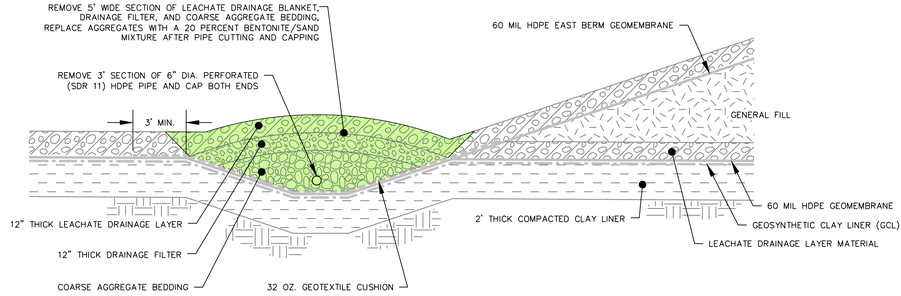
1/18 MODULE 5-6 - MODULE 12-13 LINER TIE-IN
SCALE: 1" = 5'



NOTES:

1. TRENCH PLUG SHOWN IS IN MODULE 5. MODULE 6 TRENCH PLUG WILL BE SIMILAR, IF MODULE 13 IS CONSTRUCTED.

PLAN VIEW

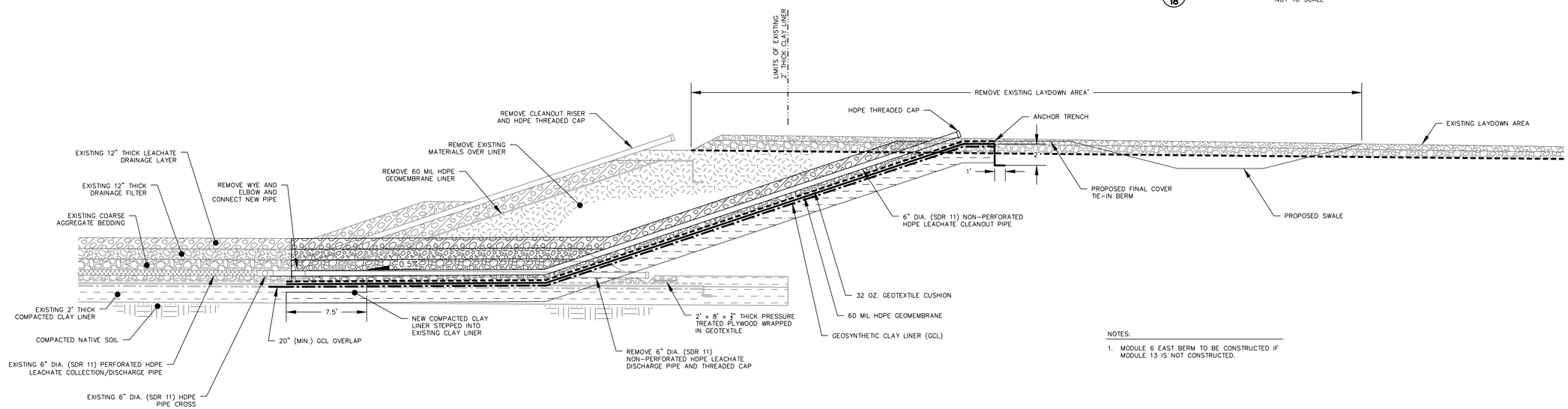


NOTES:

1. SEE DETAIL 1/18 FOR ADDITIONAL MODULE 5 AND 6 EAST BERM MODIFICATIONS AND TIE-IN TO MODULES 12 AND 13 LINERS.

SECTION VIEW

3/18 LEACHATE HEADER TRENCH PLUG
NOT TO SCALE



NOTES:

1. MODULE 6 EAST BERM TO BE CONSTRUCTED IF MODULE 13 IS NOT CONSTRUCTED.

2/18 MODULE 6 EAST BERM
SCALE: 1" = 5'

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DRAWN BY: KP
CHECKED BY: RR\MRH
APPROVED BY: MRH: 08/31/2023

PROJECT NO. 2522260.01
DRAWN: 05/17/18
REVISED: 08/31/2023

WISCONSIN POWER AND LIGHT COLUMBIA ENERGY CENTER W8375 MURRAY ROAD PARDEEVILLE, WISCONSIN 53954

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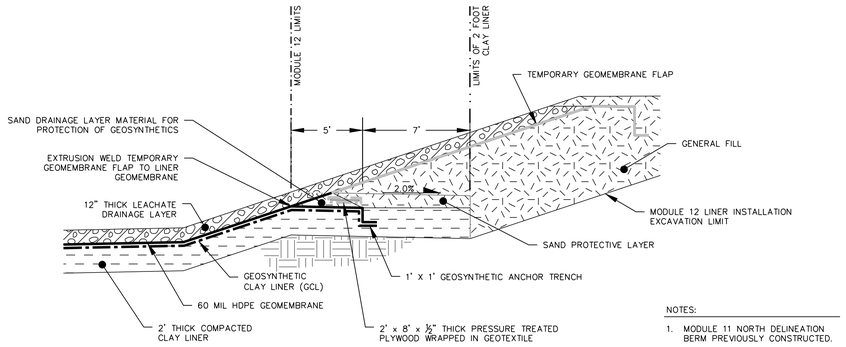
PLAN OF OPERATION UPDATE
COLUMBIA ENERGY CENTER
COLUMBIA COUNTY LANDFILL FACILITY
TOWN OF PACIFIC, WISCONSIN

SITE

DETAILS

SHEET
18 of 28

09/28/2023 - Classification: Internal - ECRM13153872

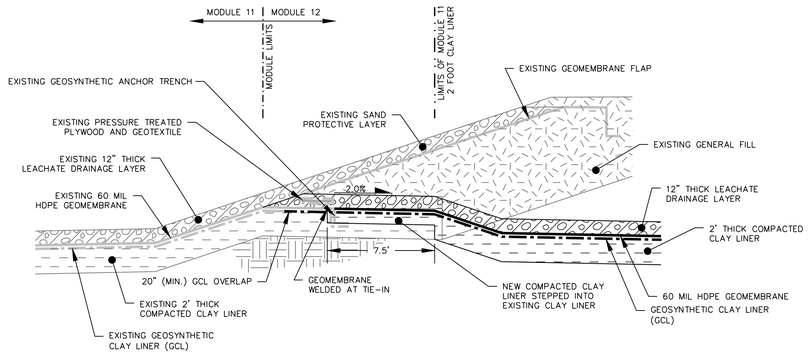


NOTES:

1. MODULE 11 NORTH DELINEATION BERM PREVIOUSLY CONSTRUCTED.

MODULES 11 AND 12 NORTH DELINEATION BERM

1/19 SCALE: 1" = 5'

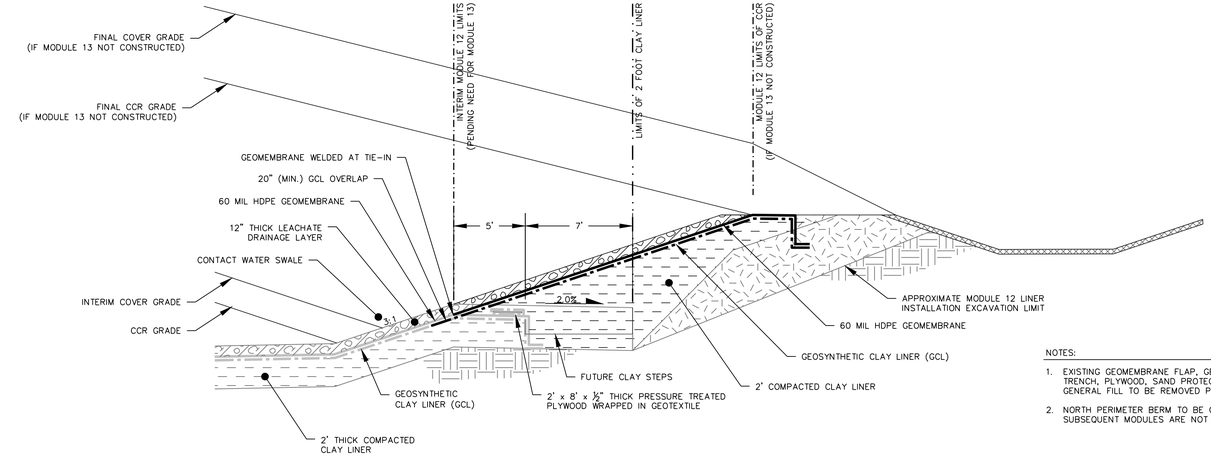


NOTES:

1. DELINEATION BERM TIE-IN TO BE CONSTRUCTED IF SUBSEQUENT MODULES ARE CONSTRUCTED.
2. EXISTING GEOMEMBRANE FLAP, GEOSYNTHETICS ANCHOR TRENCH, PLYWOOD, SAND PROTECTIVE LAYER, AND GENERAL FILL TO BE REMOVED PRIOR TO LINER TIE-IN.

MODULE 11-MODULE 12 AND MODULE 12-MODULE 13 DELINEATION BERM TIE-IN

2/19 SCALE: 1" = 5'



NOTES:

1. EXISTING GEOMEMBRANE FLAP, GEOSYNTHETICS ANCHOR TRENCH, PLYWOOD, SAND PROTECTIVE LAYER, AND GENERAL FILL TO BE REMOVED PRIOR TO LINER TIE-IN.
2. NORTH PERIMETER BERM TO BE CONSTRUCTED IF SUBSEQUENT MODULES ARE NOT CONSTRUCTED.

MODULES 11 AND 12 NORTH PERIMETER BERM

3/19 SCALE: 1" = 5'

SCS ENGINEERS
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APPROVED BY:	MRH 08/31/2023
PROJECT NO.	25222260.01
DRAWN:	05/17/18
REVISED:	08/31/2023

CLIENT: Wisconsin Power and Light Company
WISCONSIN POWER AND LIGHT COLUMBIA ENERGY CENTER W8375 MURRAY ROAD PARDEEVILLE, WISCONSIN 53954

SITE: PLAN OF OPERATION UPDATE
COLUMBIA ENERGY CENTER
COLUMBIA ASH DISPOSAL FACILITY
TOWN OF PACIFIC, WISCONSIN

DETAILS

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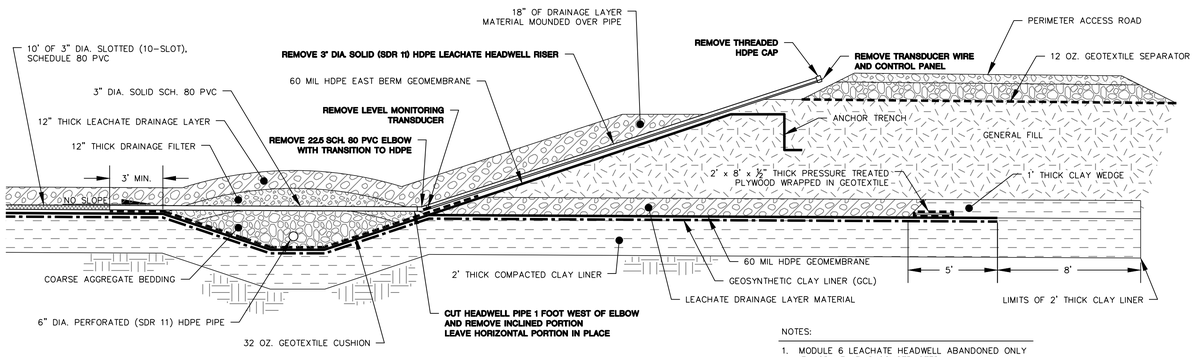
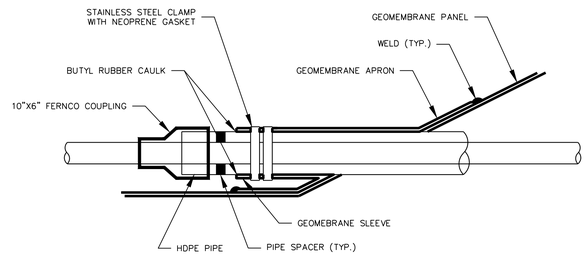


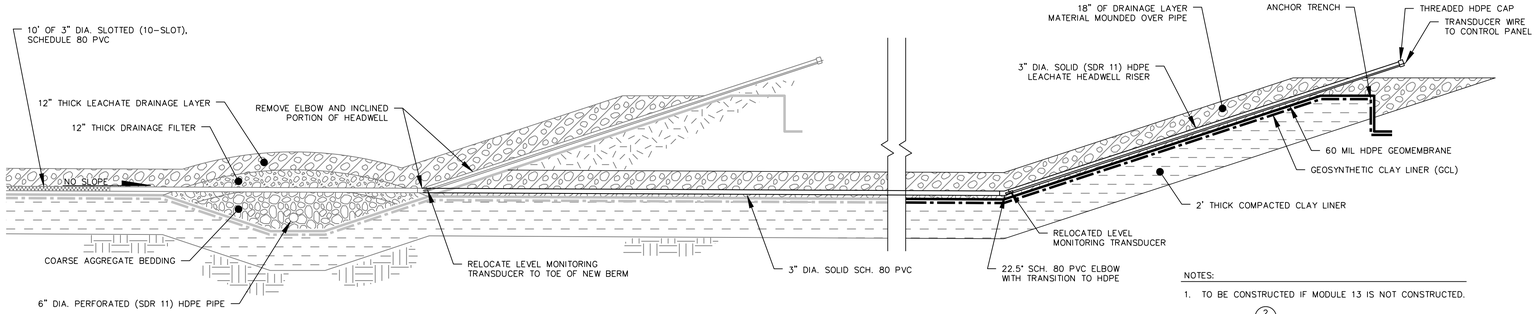
NOTES:

1. MODULE 6 LEACHATE HEADWELL ABANDONED ONLY IF MODULE 13 IS CONSTRUCTED.

1/20 MODULE 5 AND 6 LEACHATE HEADWELL ABANDONMENT
SCALE: 1" = 4'



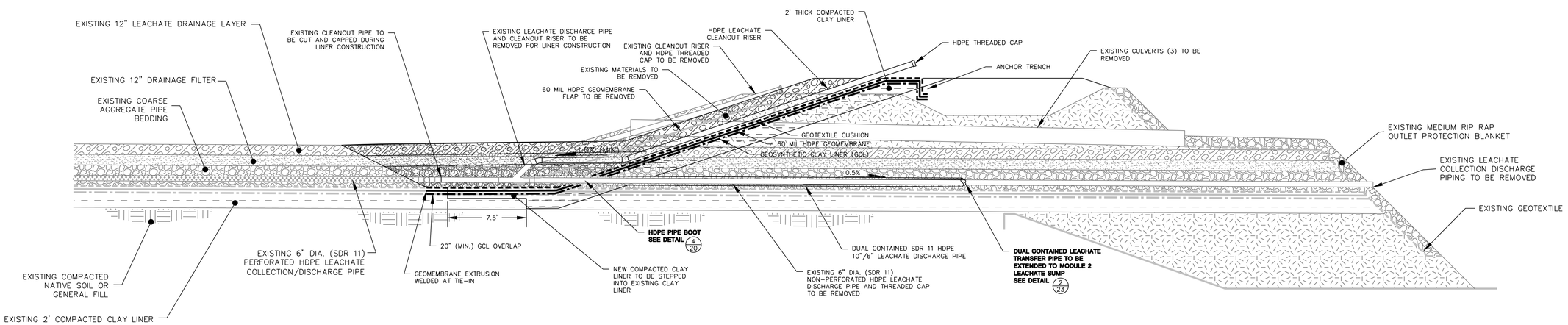
4/20 HDPE PIPE BOOT
NOT TO SCALE



NOTES:

1. TO BE CONSTRUCTED IF MODULE 13 IS NOT CONSTRUCTED.
2. SEE DETAIL 2/18 FOR ADDITIONAL MODULE 5 AND 6 EAST BERM MODIFICATIONS.

2/20 MODULE 6 LEACHATE HEADWELL EXTENSION
SCALE: 1" = 4'



3/20 MODULE 2 EAST BERM
SCALE: 1" = 5'

SCS ENGINEERS
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APPROVED BY: MRH 08/31/2023

PROJECT NO. 25222260.01
DRAWN: 05/17/18
REVISED: 08/31/2023

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PARDEEVILLE, WISCONSIN 53954

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TOWN OF PACIFIC, WISCONSIN

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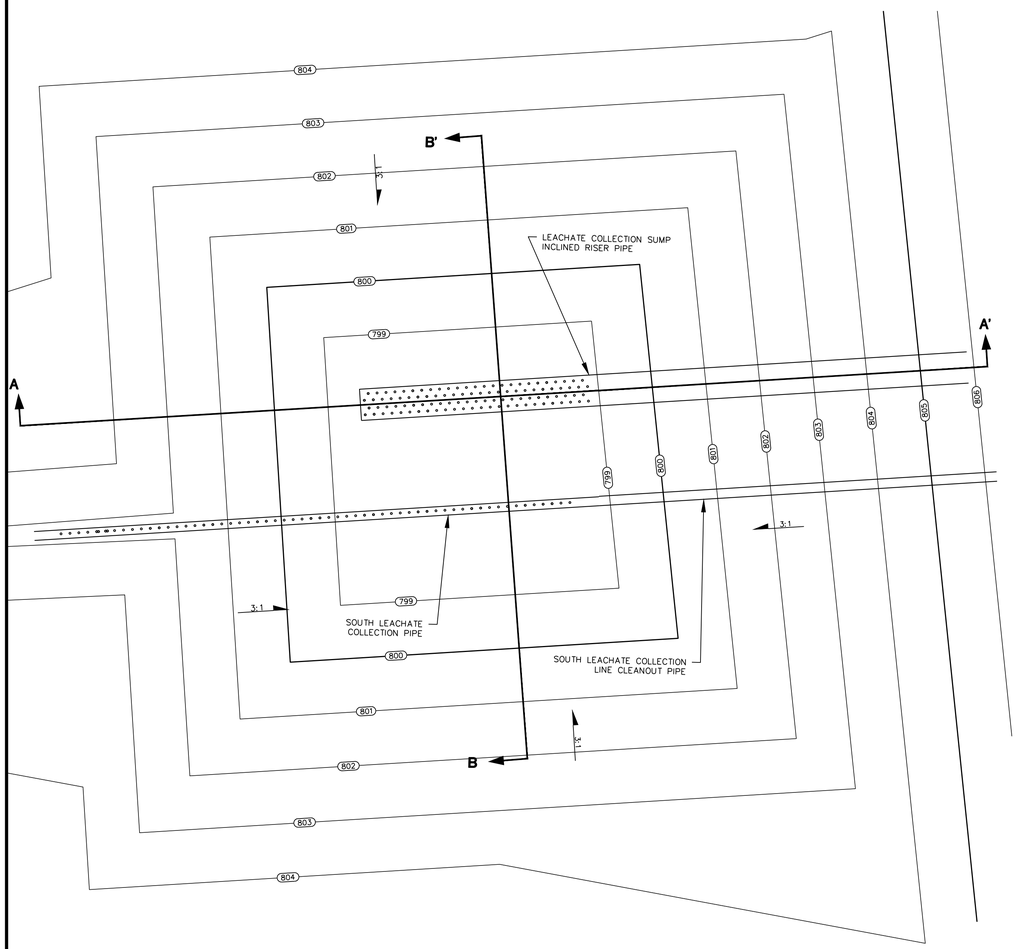
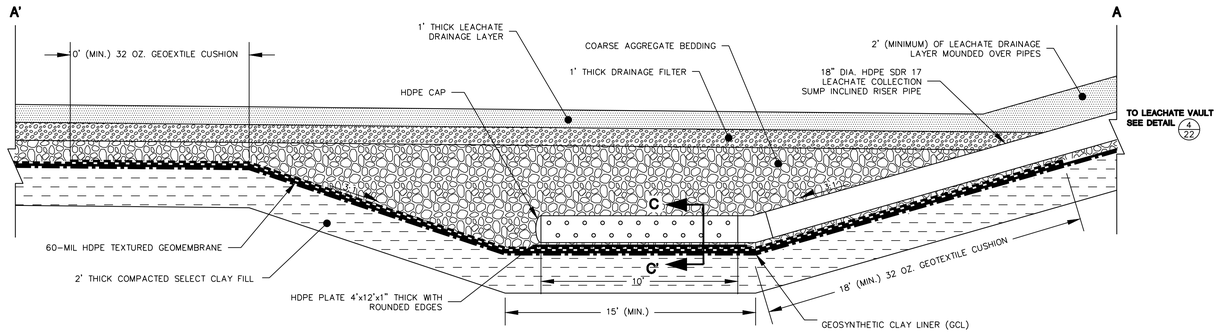
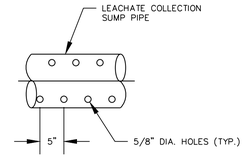
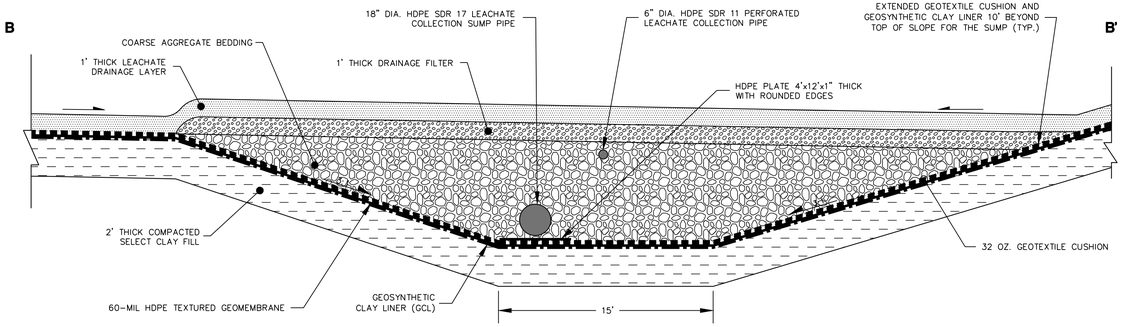




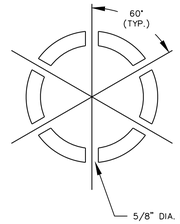
SECTION A-A'
(NOT TO SCALE)



LEACHATE COLLECTION SUMP PERFORATION
(NOT TO SCALE)



SECTION B-B'
(NOT TO SCALE)

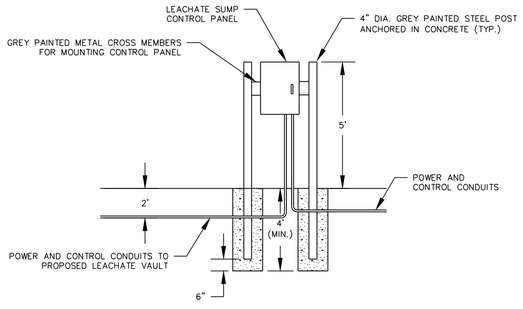


SECTION C-C'
(NOT TO SCALE)

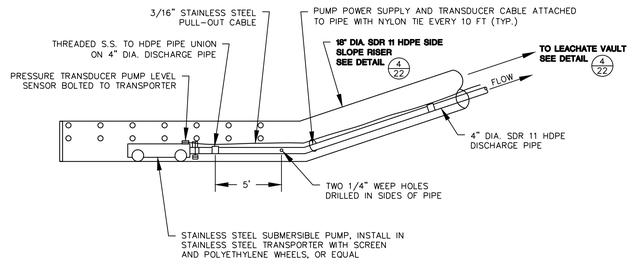
NOTES:

1. DETAIL IS OF THE MODULE 12 SUMP, THE MODULE 13 SUMP IS SIMILAR.
2. ALL 90° ELBOWS ON LEACHATE PIPING CONSIST OF LONG SWEEP ELBOWS OR TWO 45° ELBOWS.

1/21 LEACHATE COLLECTION SUMP
NOT TO SCALE



2/21 LEACHATE PUMP CONTROL PANEL
NOT TO SCALE



3/21 LEACHATE INCLINED RISER PUMP
NOT TO SCALE

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PROJECT NO. 25222260.01
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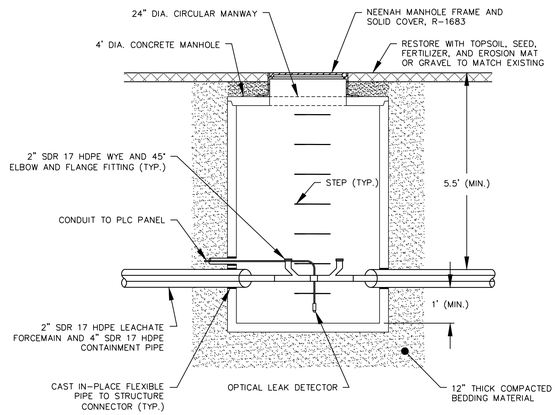
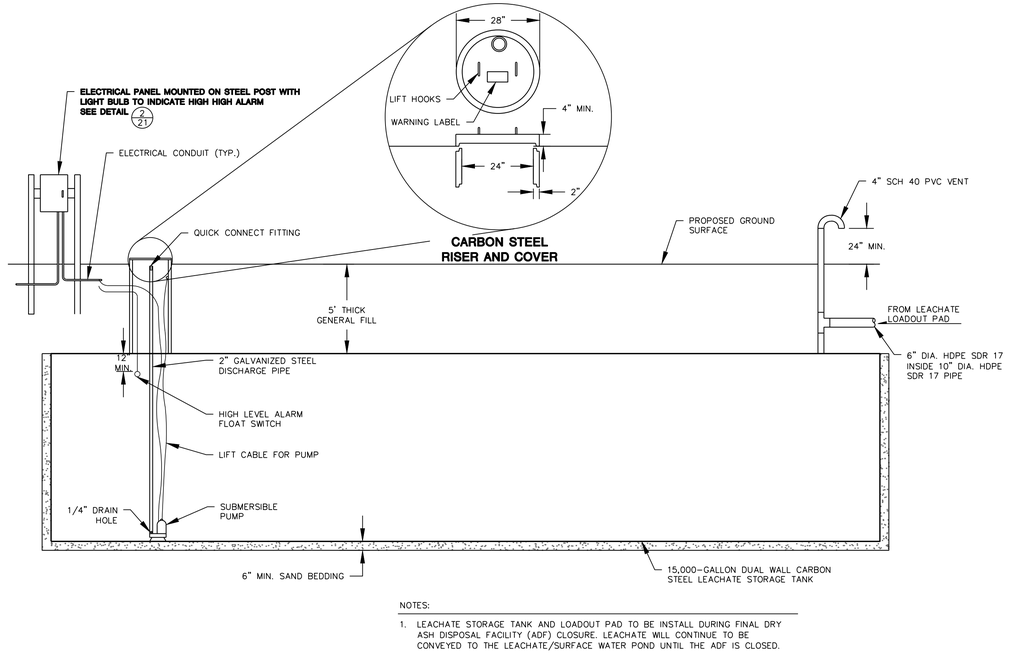


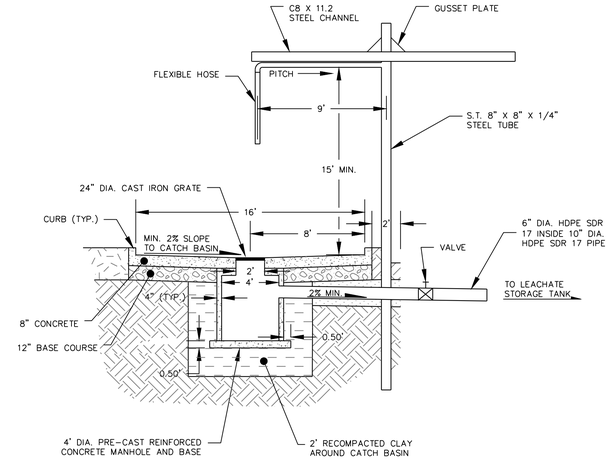
LEACHATE FORCEMAIN CLEANOUT MANHOLE
1/22
NOT TO SCALE



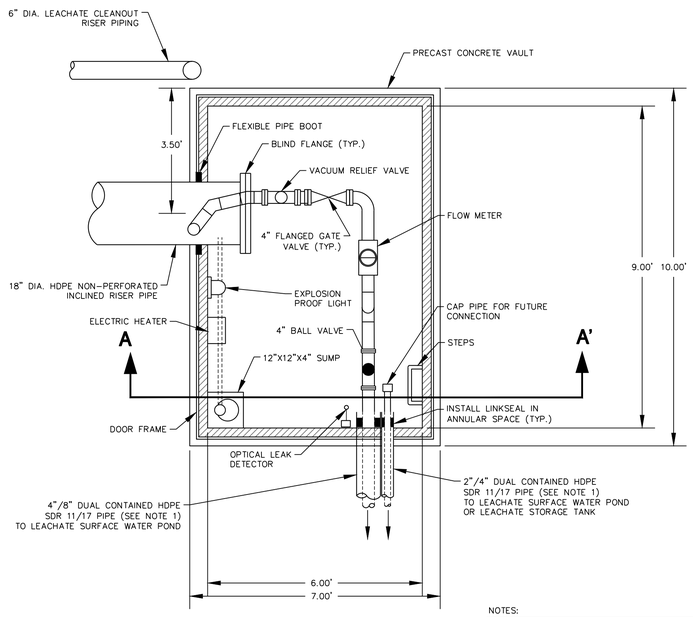
NOTES:

1. LEACHATE STORAGE TANK AND LOADOUT PAD TO BE INSTALL DURING FINAL DRY ASH DISPOSAL FACILITY (ADF) CLOSURE. LEACHATE WILL CONTINUE TO BE CONVEYED TO THE LEACHATE/SURFACE WATER POND UNTIL THE ADF IS CLOSED.

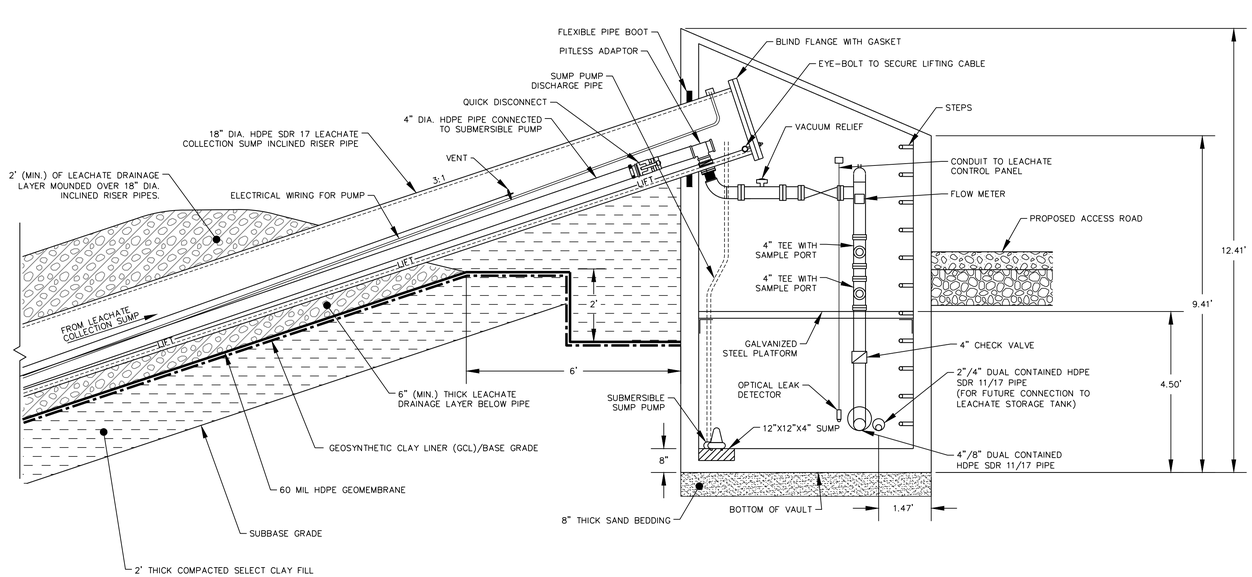
LEACHATE STORAGE TANK
2/22
NOT TO SCALE



LEACHATE LOADOUT PAD
3/22
NOT TO SCALE



PLAN VIEW
(SCALE: 1" = 2')



SECTION A-A'
(SCALE: 1" = 2')

NOTES:

1. INITIALLY LEACHATE SUMP DISCHARGE PIPING WILL BE CONNECTED TO THE 4"/8" DUAL CONTAINED FORCE MAIN TO THE LEACHATE/SURFACE WATER POND. AFTER THE ADF IS CLOSED, THE DISCHARGE PIPING WIL BE CONNECTED TO THE 2"/4" DUAL CONTAINED FORCE MAIN TO THE LEACHATE STORAGE TANK.

INCLINED RISER PIPE AND LEACHATE VAULT
4/22
NOT TO SCALE

SCS ENGINEERS
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PLAN OF OPERATION UPDATE
COLUMBIA ENERGY CENTER
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APPROVED BY:	MRH 08/31/2023
PROJECT NO.	25222260.01
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PARDEEVILLE, WISCONSIN 53954

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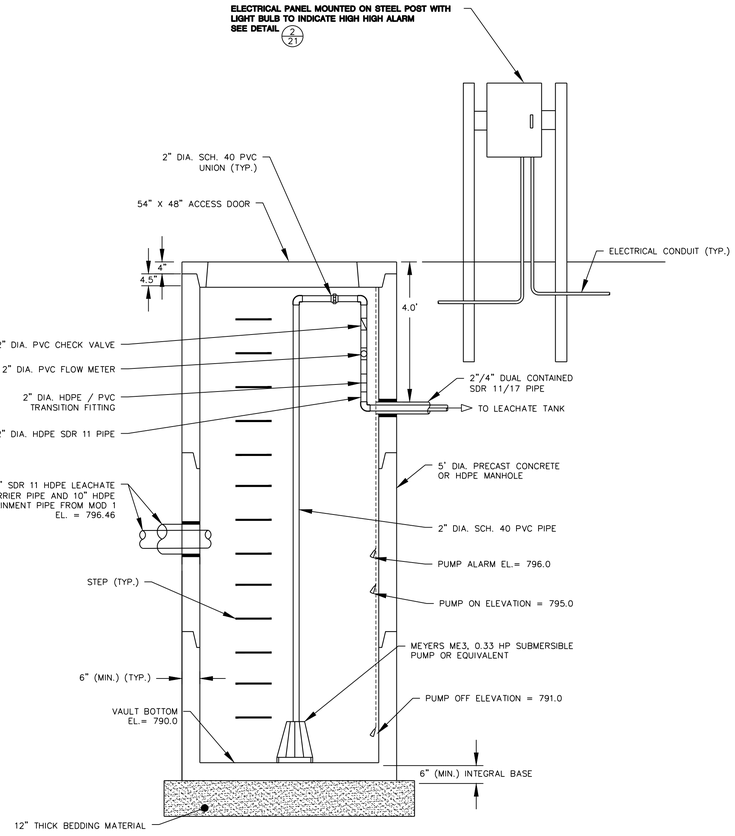
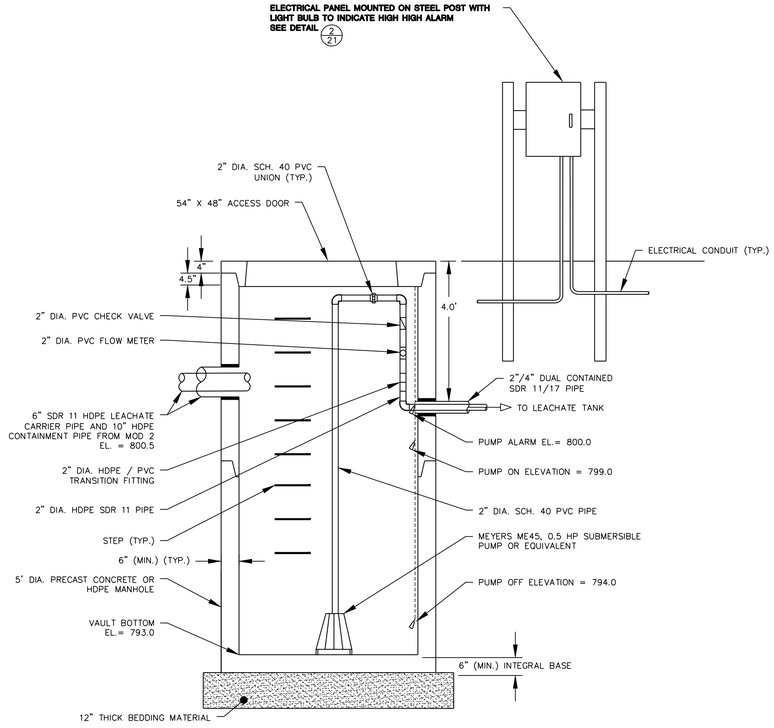


NOTES:

1. MOD 1 LEACHATE SUMP TO BE INSTALL DURING FINAL DRY ASH DISPOSAL FACILITY (ADF) CLOSURE. LEACHATE WILL CONTINUE TO BE CONVEYED TO THE LEACHATE/SURFACE WATER POND UNTIL THE ADF IS CLOSED.

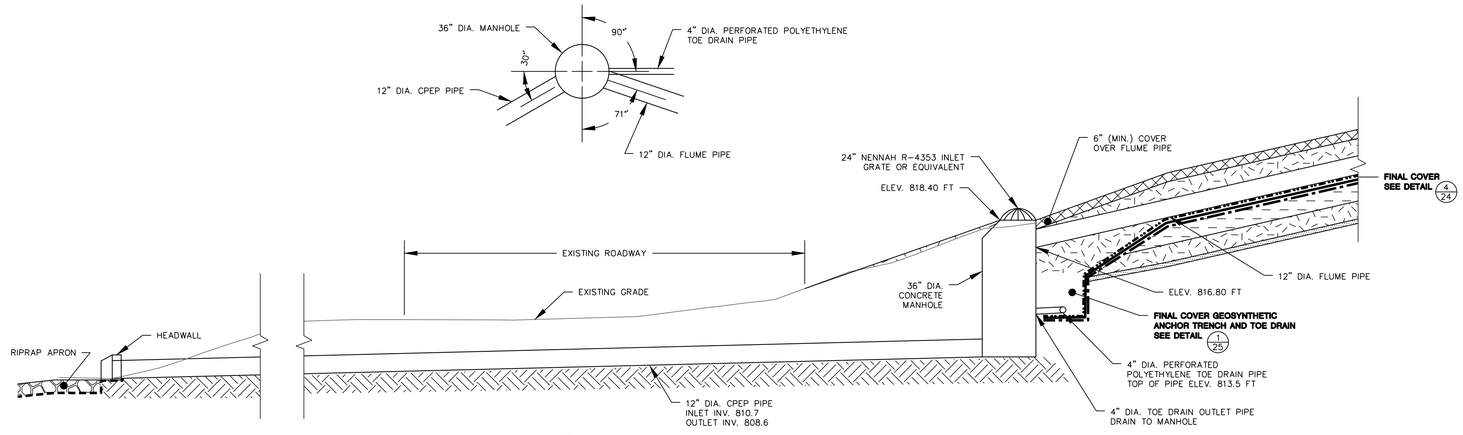
1/23 MOD 1 LEACHATE SUMP
NOT TO SCALE



NOTES:

1. MOD 2 LEACHATE SUMP TO BE INSTALL DURING FINAL DRY ASH DISPOSAL FACILITY (ADF) CLOSURE. LEACHATE WILL CONTINUE TO BE CONVEYED TO THE LEACHATE/SURFACE WATER POND UNTIL THE ADF IS CLOSED.

2/23 MOD 2 LEACHATE SUMP
NOT TO SCALE



3/23 DROP STRUCTURE
NOT TO SCALE

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APPROVED BY: MRH 08/31/2023

PROJECT NO. 25222260.01
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W8375 MURRAY ROAD
PARDEEVILLE, WISCONSIN 53954

Wisconsin Power and Light Company

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COLUMBIA ENERGY CENTER
COLUMBIA DRY ASH DISPOSAL FACILITY
TOWN OF PACIFIC, WISCONSIN

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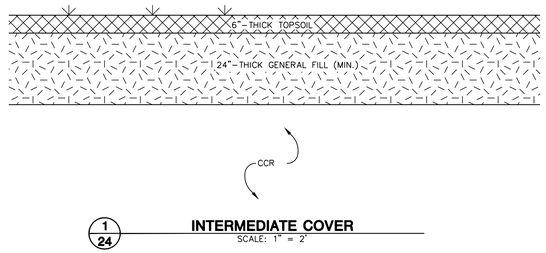
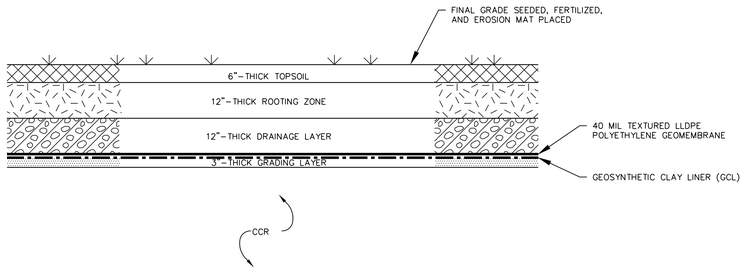
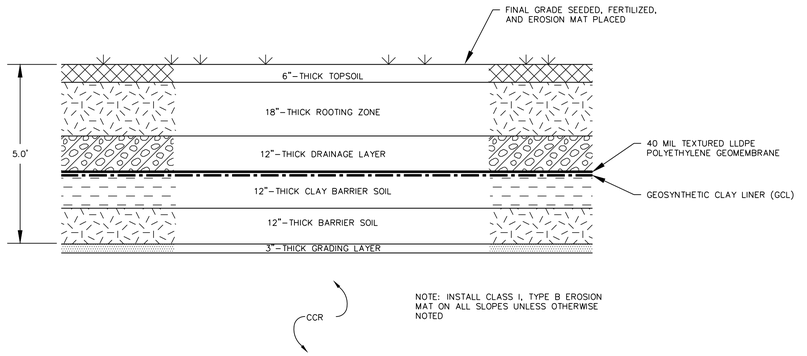


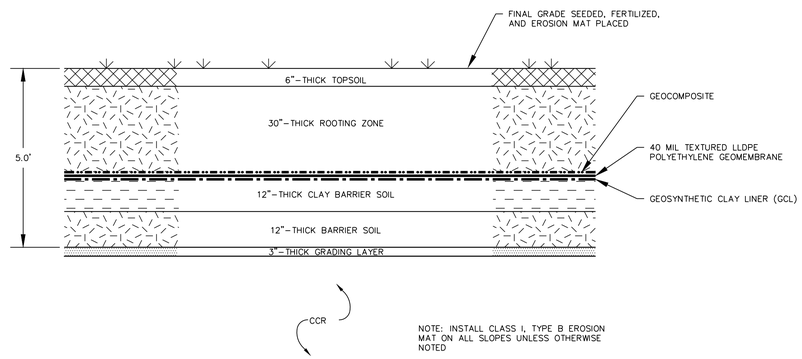
1/24 INTERMEDIATE COVER
SCALE: 1" = 2'



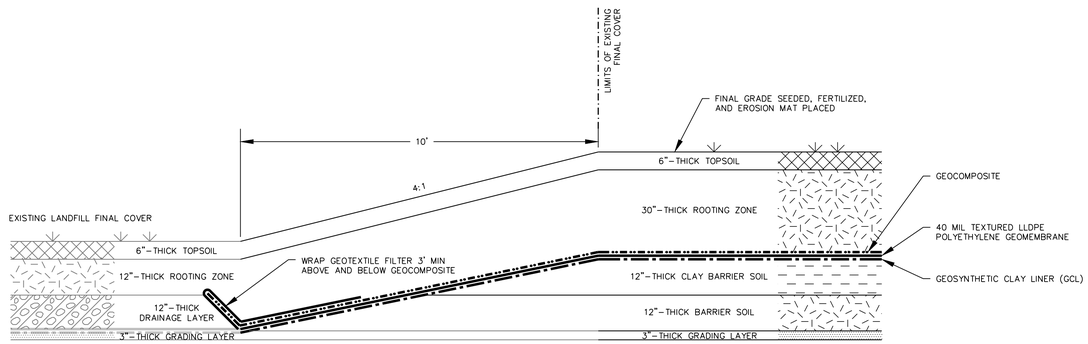
2/24 EXISTING FINAL COVER
SCALE: 1" = 2'



3/24 PROPOSED FINAL COVER (SAND DRAINAGE LAYER)
SCALE: 1" = 2'



4/24 PROPOSED FINAL COVER (GEOCOMPOSITE DRAINAGE LAYER)
SCALE: 1" = 2'



NOTES:

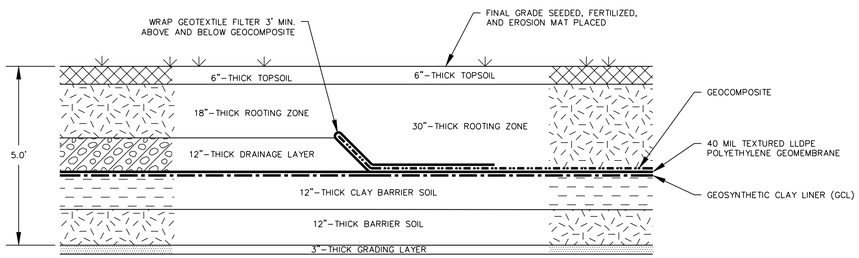
1. DETAIL VIEW IS SHOWN IN THE DIRECTION OF FINAL COVER SLOPE (TRANSITION PARALLEL TO FLOW).

5/24 EXISTING TO PROPOSED FINAL COVER TRANSITION (PROPOSED GEOCOMPOSITE DRAINAGE LAYER)
SCALE: 1" = 2'

NOTES:

1. DETAIL VIEW IS SHOWN PERPENDICULAR TO FINAL COVER SLOPE (TRANSITION PERPENDICULAR TO FLOW).

6/24 EXISTING TO PROPOSED FINAL COVER TRANSITION (PROPOSED SAND DRAINAGE LAYER)
SCALE: 1" = 2'



NOTES:

1. DETAIL VIEW IS SHOWN IN THE DIRECTION OF FINAL COVER SLOPE (TRANSITION PARALLEL TO FLOW).

7/24 PROPOSED FINAL COVER TRANSITION (SAND TO GEOCOMPOSITE DRAINAGE LAYER)
SCALE: 1" = 2'

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CHECKED BY: RR\MRH
APPROVED BY: MRH 08/31/2023

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CLIENT
Wisconsin Power and Light Company
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ENGINEER

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24 of 28

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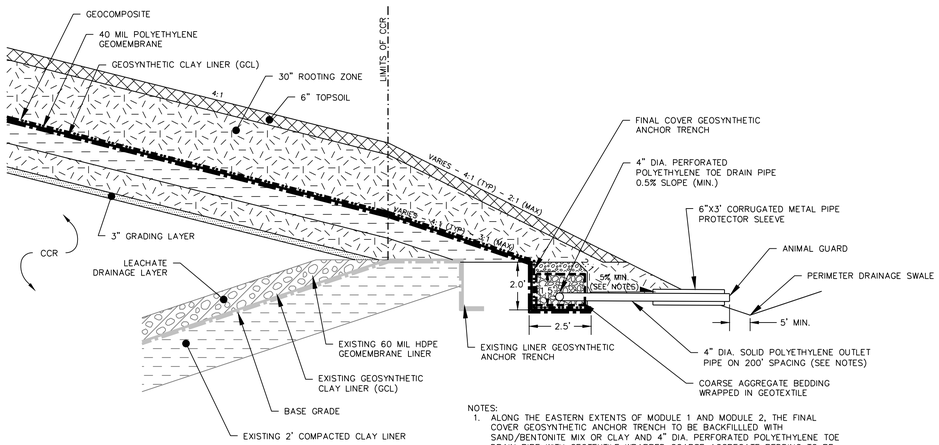
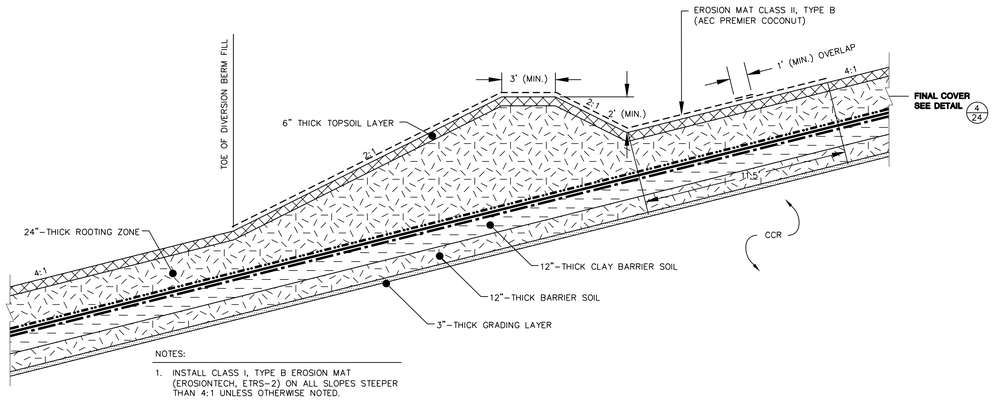


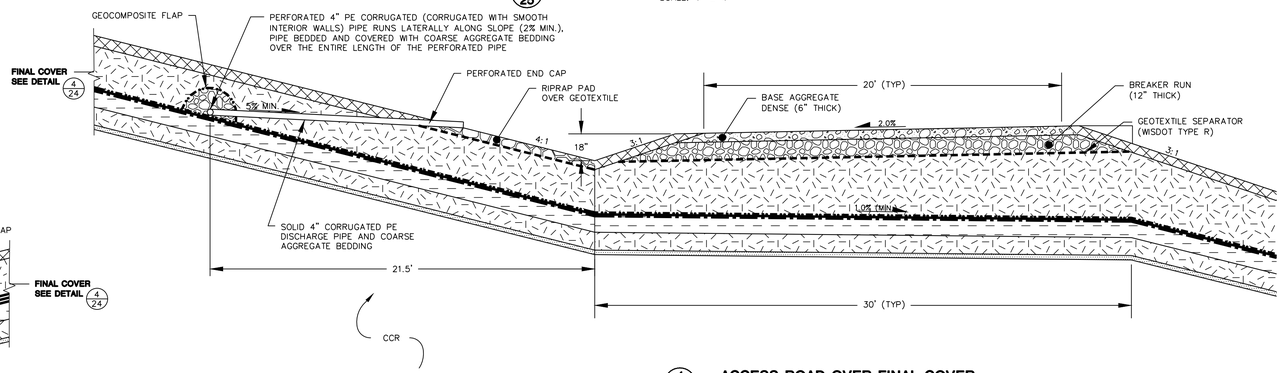
NOTES:
1. ALONG THE EASTERN EXTENTS OF MODULE 1 AND MODULE 2, THE FINAL COVER GEOSYNTHETIC ANCHOR TRENCH TO BE BACKFILLLED WITH SAND/BENTONITE MIX OR CLAY AND 4" DIA. PERFORATED POLYETHYLENE TOE DRAIN PIPE WITH GEOTEXTILE WRAPPED COARSE AGGREGATE BEDDING TO BE PLACED ABOVE THE BACKFILLED ANCHOR TRENCH IN CONTACT WITH THE GEOCOMPOSITE TO MAINTAIN MINIMUM SLOPES. SEE PLAN VIEW.
2. THE OUTLET PIPE ALONG THE EASTERN EXTENTS OF MODULE 1 IS SPACED GREATER THAN 200 FT AND HAS A SLOPE OF 0.25%. THE OUTLET PIPE AT THIS LOCATION IS TO BE 8" DIA. SOLID POLYETHYLENE PIPE. SEE PLAN VIEW.

1/25 FINAL COVER TO LINER TIE-IN AND TOE DRAIN
SCALE: 1" = 3'

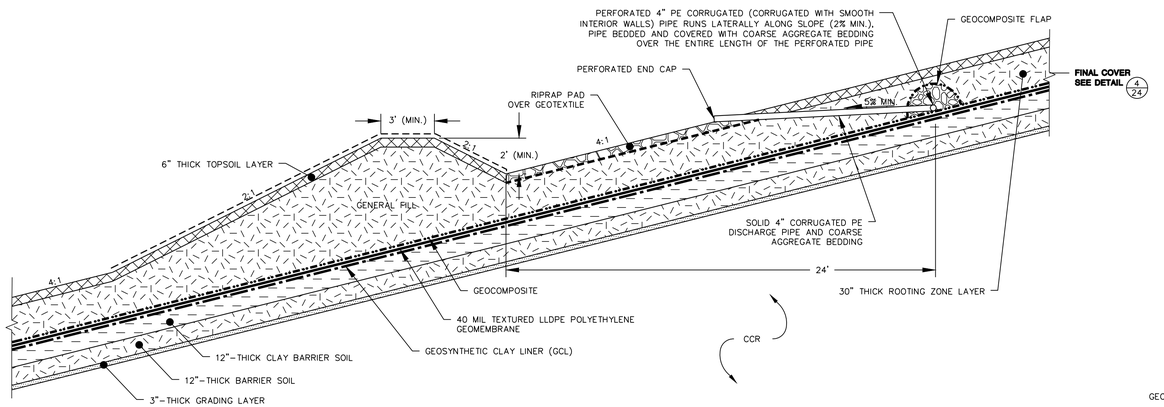


NOTES:
1. INSTALL CLASS I, TYPE B EROSION MAT (EROSIONTECH, ETRS-2) ON ALL SLOPES STEEPER THAN 4:1 UNLESS OTHERWISE NOTED.

3/25 FINAL COVER DIVERSION BERM
SCALE: 1" = 4'

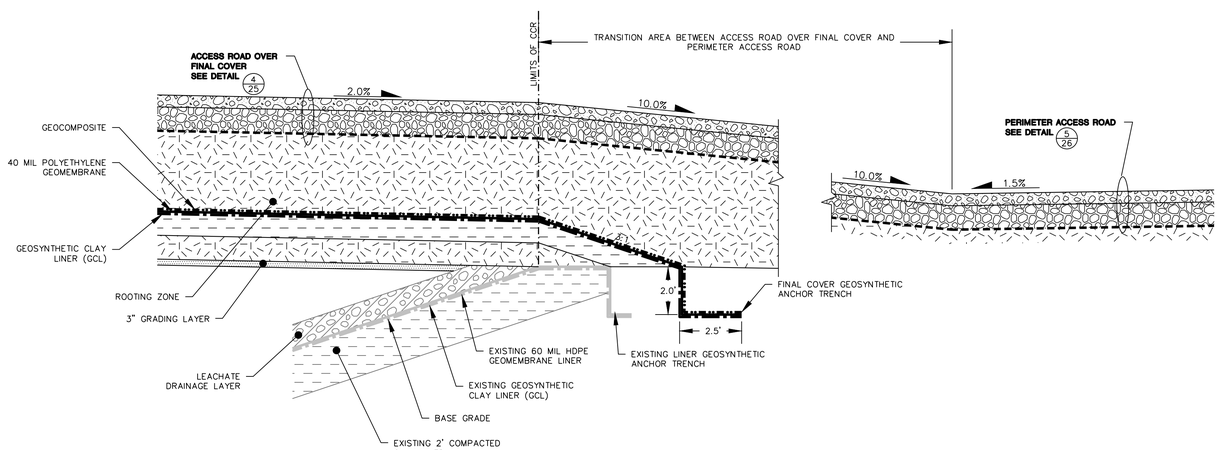


4/25 ACCESS ROAD OVER FINAL COVER
SCALE: 1" = 4'



NOTES:
1. INSTALL CLASS I, TYPE B EROSION MAT (EROSIONTECH, ETRS-2) ON ALL SLOPES STEEPER THAN 4:1 UNLESS OTHERWISE NOTED.

2/25 FINAL COVER DIVERSION BERM AND INTERMEDIATE DRAIN PIPE
SCALE: 1" = 4'



5/25 ACCESS ROAD OVER FINAL COVER TRANSITION AT PERIMETER BERM
SCALE: 1" = 3'

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PHONE: (608) 224-2830
ENGINEER

PLAN OF OPERATION UPDATE
COLUMBIA ENERGY CENTER
COLUMBIA COMBINED ASH DISPOSAL FACILITY
TOWN OF PACIFIC, WISCONSIN
SITE

DETAILS

SHEET
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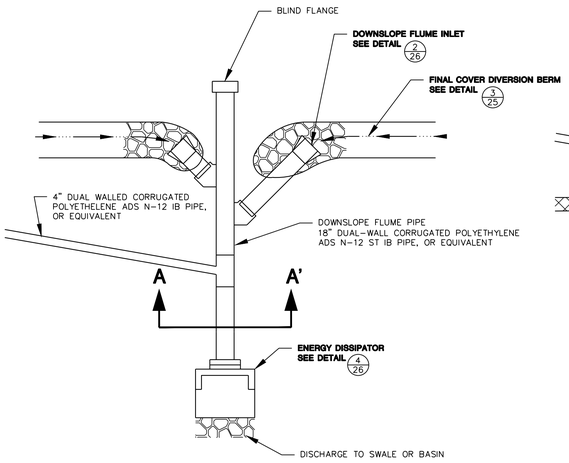
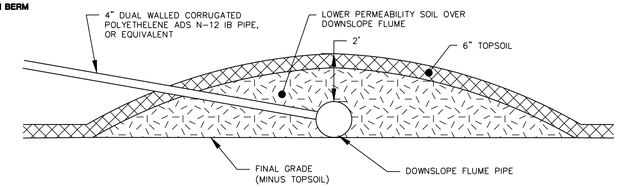
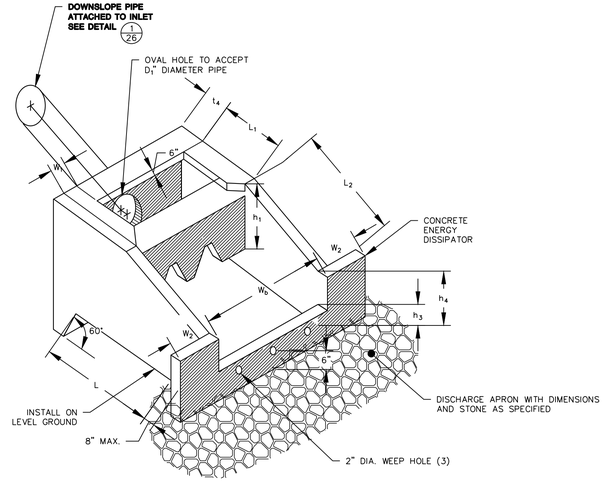




SECTION A-A'

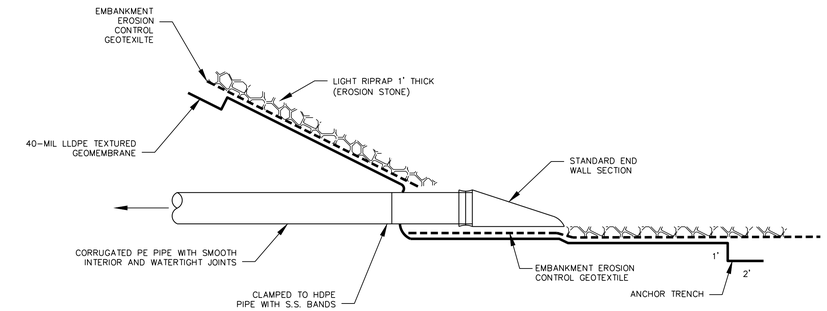
1/26 DOWNSLOPE FLUME
NOT TO SCALE



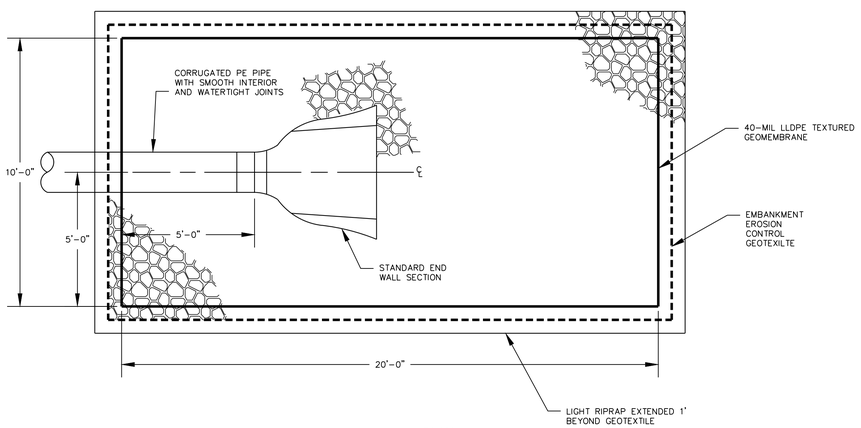
MODULE 12 DESIGN															
FLUME	D1 (IN)	WB	h1	h3	h4	L	L1	L2	W1	W2	t4	CHUTE WIDTH (FT)	APRON WIDTH (FT)	APRON LENGTH (FT)	THICKNESS (IN)	STONE TYPE
FLUME 1	18	6	4.58	1	2.5	8	3.42	4.58	0.5	1.67	0.5	6	6	10	12	SELECT CRUSHED MATERIAL, TYPE R
FLUME 2																
FLUME 6																
FLUME 7																
FLUME 8																
FLUME 9																

MODULE 12+13 DESIGN															
FLUME	D1 (IN)	WB	h1	h3	h4	L	L1	L2	W1	W2	t4	CHUTE WIDTH (FT)	APRON WIDTH (FT)	APRON LENGTH (FT)	THICKNESS (IN)	STONE TYPE
FLUME 1	18	6	4.58	1	2.5	8	3.42	4.58	0.5	1.67	0.5	6	6	10	12	SELECT CRUSHED MATERIAL, TYPE R
FLUME 2																
FLUME 6																
FLUME 7																
FLUME 9																

4/26 OUTLET STRUCTURE WITH ENERGY DISSIPATOR
NOT TO SCALE

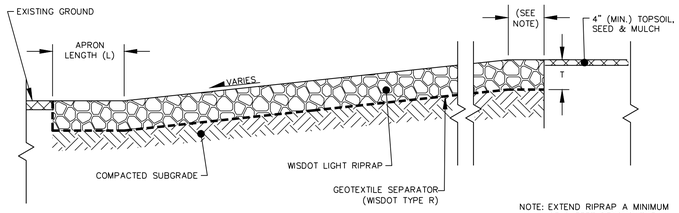


INLET SECTION



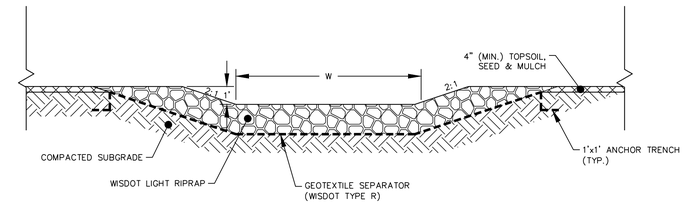
PLAN

2/26 DOWNSLOPE FLUME INLET
NOT TO SCALE



NOTE: EXTEND RIPRAP A MINIMUM OF 2 FEET BEYOND THE TOP OF THE SLOPE.

PROFILE VIEW

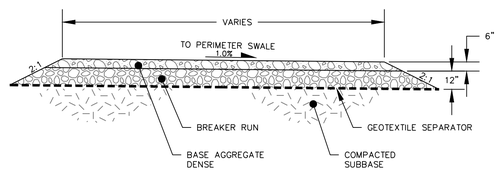


SECTION VIEW

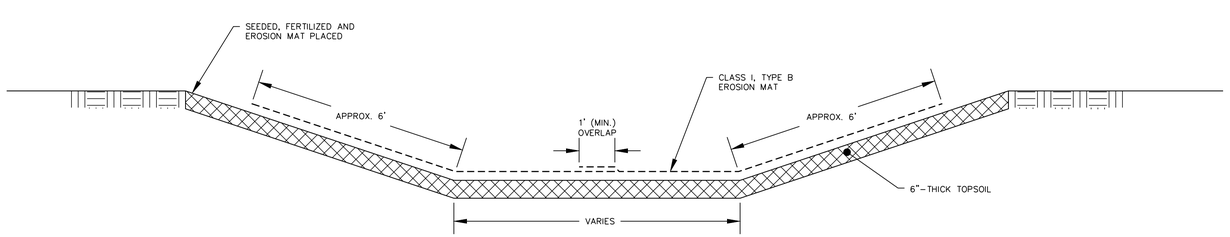
MODULE 12 DESIGN			
ROCK CHUTE	W (FT)	T (IN)	APRON LENGTH, L (FT)
RC1	8	4	2
RC2	6	12	7
RC3	6	8	5
RC4	6	9	6

MODULE 12+13 DESIGN			
ROCK CHUTE	W (FT)	T (IN)	APRON LENGTH, L (FT)
RC1	8	4	2
RC2	6	12	7
RC3	6	8	5
RC4	6	9	6

3/26 ROCK CHUTE
NOT TO SCALE



5/26 PERIMETER ACCESS ROAD
NOT TO SCALE



6/26 PERIMETER SWALE
NOT TO SCALE

SCS ENGINEERS
2830 DARGY DRIVE MADISON, WI 53718-6751
PHONE: (608) 224-2830

DRAWN BY: KP
CHECKED BY: RR\MRH
APPROVED BY: MRH 08/31/2023

PROJECT NO. 25222260.01
DRAWN: 05/17/18
REVISED: 08/31/2023

WISCONSIN POWER AND LIGHT COLUMBIA ENERGY CENTER W8375 MURRAY ROAD PARDEEVILLE, WISCONSIN 53954

Wisconsin Power and Light Company

CLIENT

PLAN OF OPERATION UPDATE
COLUMBIA ENERGY CENTER
COLUMBIA COUNTY, WISCONSIN
TOWN OF PACIFIC, WISCONSIN

SITE

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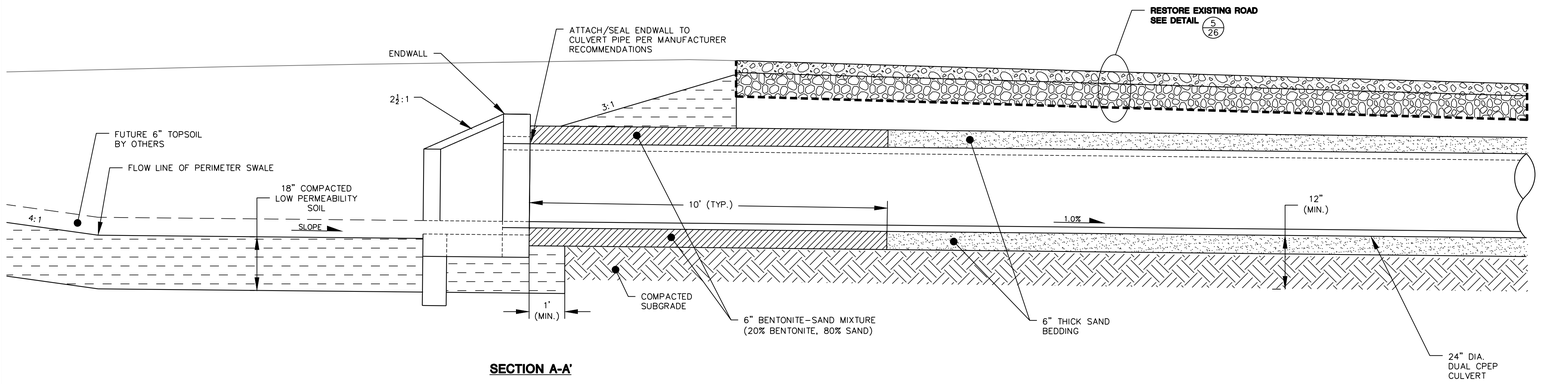
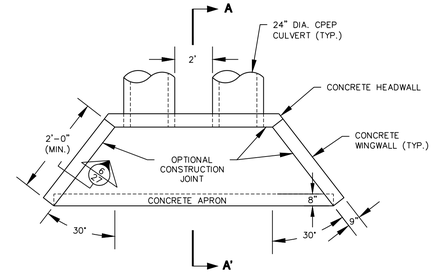
09/28/2023 - Classification: Internal - ECRM13153872



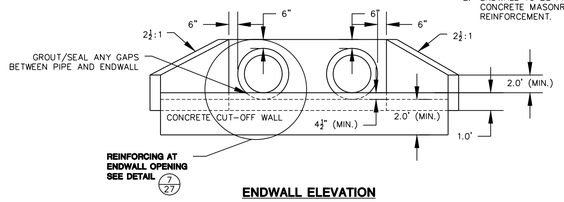
SECTION A-A'

1/27 CULVERT INLET
SCALE: 1" = 2'



ENDWALL PLAN VIEW

NOTES:
1. MATCH FILL SLOPES TO CONFORM TO WINGWALLS.
2. ENDWALL TO BE PRECAST CONCRETE OR CONCRETE MASONRY WITH STEEL REINFORCEMENT.



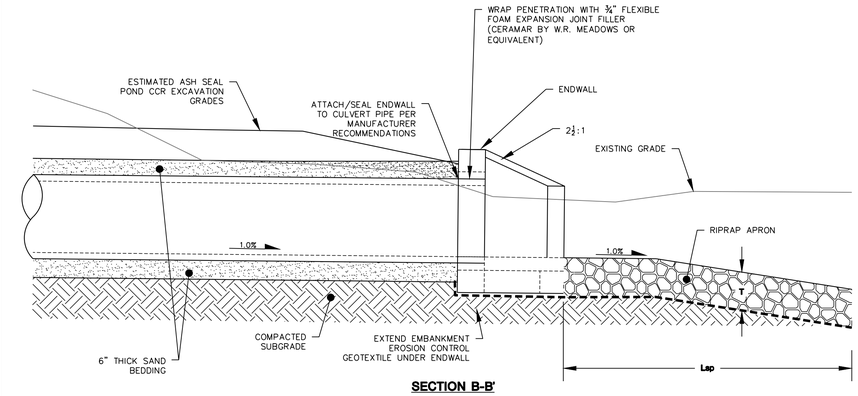
ENDWALL ELEVATION

2/27 CULVERT INLET ENDWALL
NOT TO SCALE

MODULE 12 DESIGN				
CULVERT	NUMBER OF BARRELS	DIAMETER (IN)	UPSTREAM INVERT (FT)	DOWNSTREAM INVERT (FT)
C1	1	24	815.70	814.55
C2a	2	18	817.60	814.00
C2b	2	12	818.00	817.60
C3	2	30	811.17	810.90
C4	2	30	809.86	809.60
C5	2	30	807.57	807.15
C6	2	24	805.40	804.76
C7	2	42	796.64	796.34
C8	1	12	810.70	808.60
C9	1	12	822.00	821.79
C10	1	24	807.54	806.81
C11	2	30	817.68	817.40

MODULE 12 DESIGN				
RIPRAP APRON	T (in)	L_{sp} (ft)	W_{sp} (ft)	WisDOT RIPRAP CLASSIFICATION/ GEOTEXTILE SEPARATOR
CULVERT 2A	6	17	SEE NOTE 1	SELECT CRUSHED MATERIAL, TYPE R
CULVERT 2B	6	11	SEE NOTE 1	SELECT CRUSHED MATERIAL, TYPE R
CULVERT 3	20	26	SEE NOTE 1	LIGHT RIPRAP, TYPE R
CULVERT 4	20	27	SEE NOTE 1	LIGHT RIPRAP, TYPE R
CULVERT 5	20	28	SEE NOTE 1	LIGHT RIPRAP, TYPE R
CULVERT 6	20	25	SEE NOTE 1	LIGHT RIPRAP, TYPE R
CULVERT 8	6	10	SEE NOTE 1	SELECT CRUSHED MATERIAL, TYPE R
CULVERT 9	6	8	SEE NOTE 1	SELECT CRUSHED MATERIAL, TYPE R
CULVERT 11	20	26	SEE NOTE 1	LIGHT RIPRAP, TYPE R

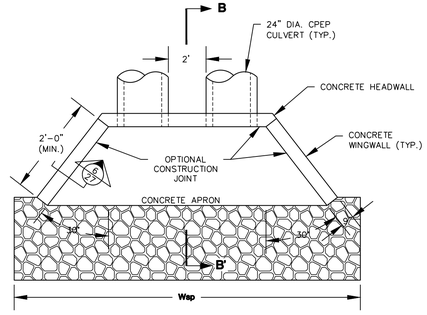
NOTES:
1. FOR DISCHARGES TO CHANNELS, PLACE RIPRAP ALONG CHANNEL BOTTOM AND UP SIDE OF CHANNEL



SECTION B-B'

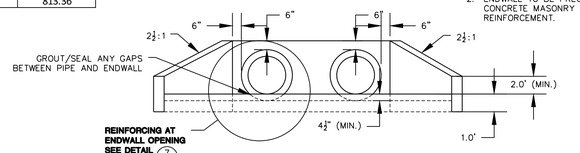
3/27 CULVERT OUTLET
SCALE: 1" = 2'

MODULE 12+13 DESIGN				
CULVERT	NUMBER OF BARRELS	DIAMETER (IN)	UPSTREAM INVERT (FT)	DOWNSTREAM INVERT (FT)
C1	1	24	815.70	814.55
C2	2	24	817.83	814.00
C3	2	30	811.17	810.90
C4	2	30	809.86	809.60
C5	2	30	807.57	807.15
C6	2	24	805.40	804.76
C7	2	42	796.64	796.34
C8	1	12	810.70	808.60
C9	1	24	807.54	806.81
C10	2	24	814.96	813.36



ENDWALL PLAN VIEW

NOTES:
1. MATCH FILL SLOPES TO CONFORM TO WINGWALLS.
2. ENDWALL TO BE PRECAST CONCRETE OR CONCRETE MASONRY WITH STEEL REINFORCEMENT.

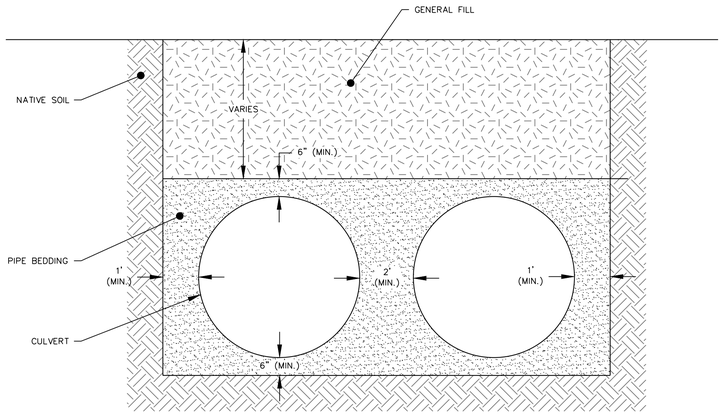


ENDWALL ELEVATION

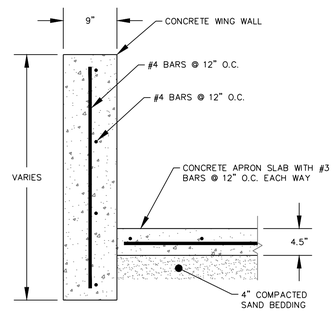
MODULE 12+13 DESIGN				
RIPRAP APRON	T (in)	L_{sp} (ft)	W_{sp} (ft)	WisDOT RIPRAP CLASSIFICATION/ GEOTEXTILE SEPARATOR
CULVERT 2	6	19	SEE NOTE 1	SELECT CRUSHED MATERIAL, TYPE R
CULVERT 3	20	26	SEE NOTE 1	LIGHT RIPRAP, TYPE R
CULVERT 4	20	27	SEE NOTE 1	LIGHT RIPRAP, TYPE R
CULVERT 5	20	28	SEE NOTE 1	LIGHT RIPRAP, TYPE R
CULVERT 8	6	10	SEE NOTE 1	SELECT CRUSHED MATERIAL, TYPE R
CULVERT 10	6	18	SEE NOTE 1	SELECT CRUSHED MATERIAL, TYPE R

NOTES:
1. FOR DISCHARGES TO CHANNELS, PLACE RIPRAP ALONG CHANNEL BOTTOM AND UP SIDE OF CHANNEL

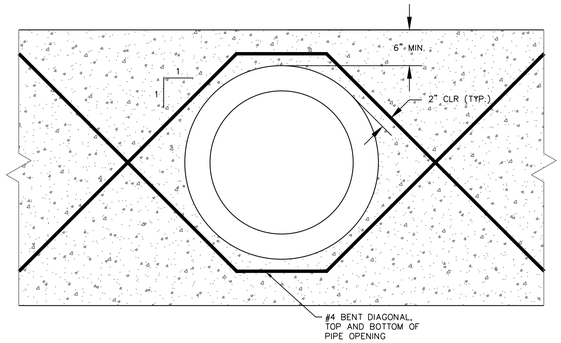
4/27 CULVERT OUTLET ENDWALL
NOT TO SCALE



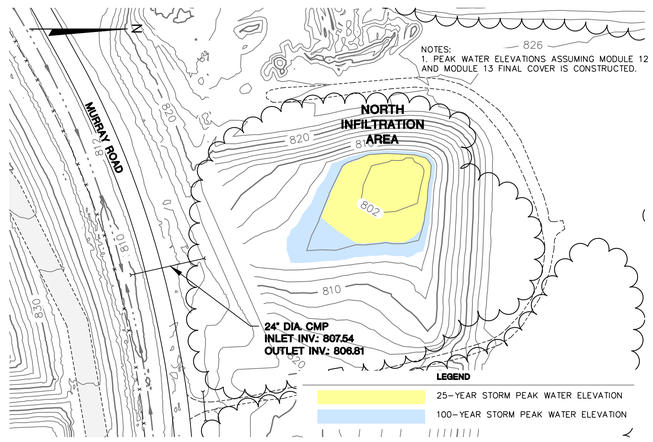
5/27 CULVERT TRENCH
NOT TO SCALE



6/27 REINFORCEMENT AT APRON ENDWALL
SCALE: 1" = 1'



7/27 REINFORCEMENT AT ENDWALL OPENING
SCALE: 1" = 1'



8/27 NORTH INFILTRATION AREA
SCALE: 1" = 100'

SCS ENGINEERS
2830 DAIRY DRIVE MADISON, WI 53718-6751
PHONE: (608) 224-2830

DRAWN BY: KP
CHECKED BY: RR\MRH
APPROVED BY: MRH 08/31/2023
PROJECT NO. 25222260.01
DRAWN: 05/17/18
REVISED: 08/31/2023

Wisconsin Power and Light Company
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PLAN OF OPERATION UPDATE
COLUMBIA ENERGY CENTER
COLUMBIA ASH DISPOSAL FACILITY
TOWN OF PACIFIC, WISCONSIN

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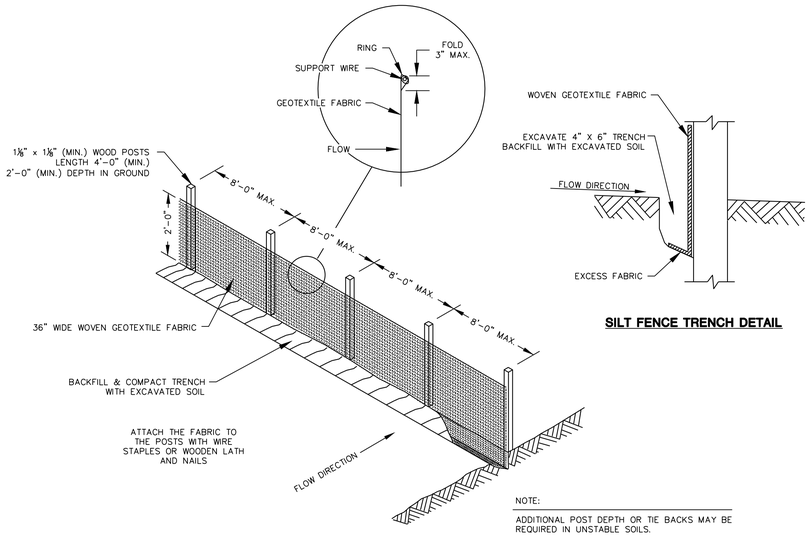
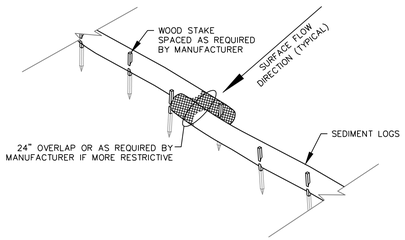
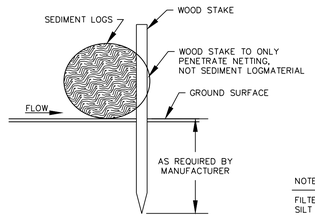


SILT FENCE TRENCH DETAIL

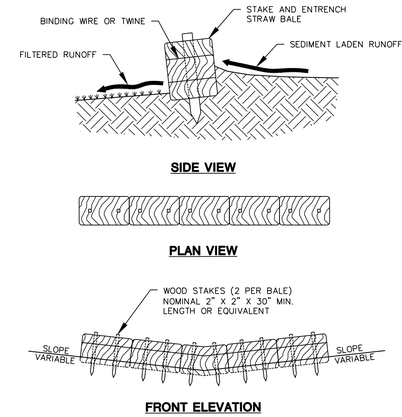
1/28 SILT FENCE
NOT TO SCALE



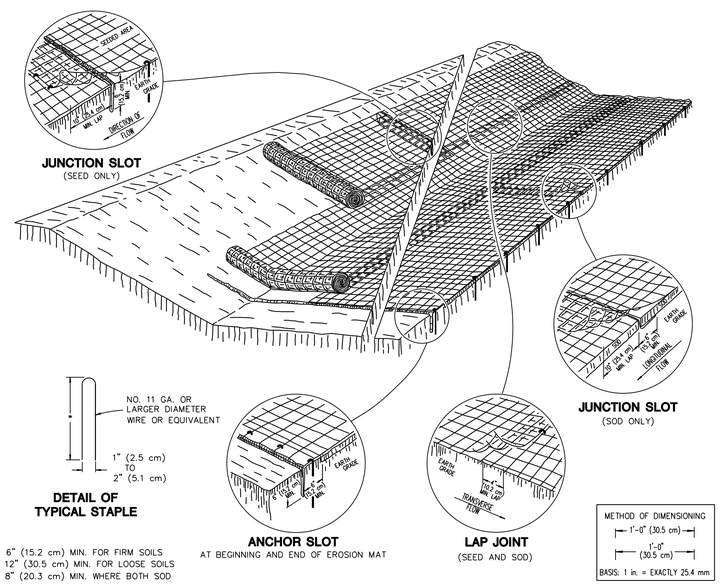


NOTE:
FILTER SOCK MAY BE USED IN PLACE OF SILT FENCE WITH ENGINEER APPROVAL.

2/28 FILTER SOCK
NOT TO SCALE



3/28 STRAW BALE DITCH CHECK
NOT TO SCALE



4/28 CHANNEL EROSION MAT
NOT TO SCALE

EROSION MAT NOTES:

DETAILS OF CONSTRUCTION, MATERIALS AND WORKMANSHIP NOT SHOWN ON THIS DRAWING SHALL CONFIRM TO THE PERTINENT REQUIREMENTS OF THE SPECIFICATIONS

VARIATIONS IN THE DIMENSIONS OR MATERIALS SHOWN HEREON SHALL BE PERTINENT IF THEY PROVIDE EQUIVALENT PROTECTION AND MATERIAL STRENGTH AND IF PRIOR APPROVAL OF THE ENGINEER IS OBTAINED

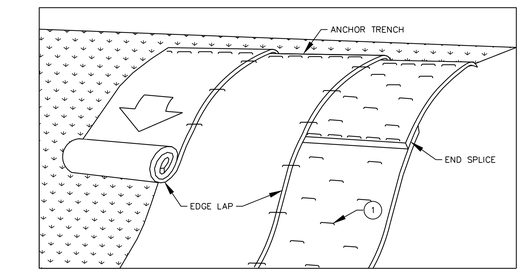
LAP JOINTS SHALL NOT BE PLACED IN THE BOTTOM OF V-SHAPED SWALEES.

JUNCTION SLOTS ON ADJACENT STRIPS OF MATTING SHALL BE STAGGERED A MINIMUM OF 4 FEET (1.219 m) APART.

EDGES OF THE EROSION MAT SHALL BE IMPRESSED IN THE SOIL.

EROSION MAT SHALL BE INSTALL OVER SEEDING AND FERTILIZER.

JUNCTION OR ANCHOR SLOTS SHALL BE AT MAXIMUM INTERVALS OF 100 FEET (30.48 m) ON GRADES UP TO AND INCLUDING 3 PERCENT, AND 50 FEET (15.24 m) ON GRADES EXCEEDING 3 PERCENT.



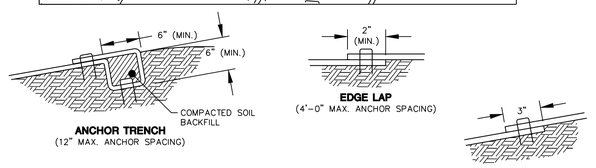


TABLE 1

MAX. SLOPE	MIN. ANCHORS
≤ 3:1	1.5/yd²
2:1	2/yd²
1:1	2.5/yd²

① SECURE BLANKET TO GROUND ACCORDING TO MANUFACTURER'S RECOMMENDED ANCHORING PATTERN AND MINIMUM SHOWN IN TABLE 1.

5/28 NON-CHANNEL EROSION MAT
NOT TO SCALE

SCS ENGINEERS
2830 DAIRY DRIVE MADISON, WI 53718-6751
PHONE: (608) 224-2830

DRAWN BY: KP
CHECKED BY: RR\MRH
APPROVED BY: MRH 08/31/2023

PROJECT NO. 25222260.01
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WISCONSIN POWER AND LIGHT
COLUMBIA ENERGY CENTER
W8375 MURRAY ROAD
PARDEEVILLE, WISCONSIN 53954

Wisconsin Power and Light Company

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Appendix A

Correspondence

09/28/2023 - Classification: Internal - ECRM13153872

State of Wisconsin
DEPARTMENT OF NATURAL RESOURCES
3911 Fish Hatchery Road
Fitchburg WI 53711-5397

Tony Evers, Governor
Adam N. Payne, Secretary
Telephone 608-266-2621
Toll Free 1-888-936-7463
TTY Access via relay - 711

March 8, 2023

File Ref: FID 111049180
Columbia County
SW Correspondence

Mr. Jeff Maxted
Alliant Energy Corporation
4902 North Biltmore Lane
Madison, WI 53718-2148

Subject: Incompleteness Determination for the Plan of Operation Approval Modification for Initial Permitting of Coal Combustion Residuals (CCR) Landfill for the Wisconsin Power and Light Company Dry Ash Disposal Facility, License #3025

Dear Mr. Maxted:

The Department of Natural Resources (department) has reviewed for completeness the plan of operation modification ("the plan") for initial permitting of a CCR Landfill submitted on behalf of Wisconsin Power and Light Company by Alliant Energy Corporation entitled: "Plan of Operation Modification Request Initial Permitting of CCR Landfill, Wisconsin Power and Light Company, Dry Ash Disposal Facility (WDNR License #3025), Columbia Energy Center, Portage, WI" dated December 14, 2022 and received by the department on December 14, 2022, and an addendum entitled "Plan of Operations Modification Request – Addendum #1, Initial Permitting of CCR Landfill, Wisconsin Power and Light Company, Dry Ash Disposal Facility (WDNR License #3025), Columbia Energy Center, Portage, WI" dated February 1, 2023 and received by the department on February 1, 2023.

The department has determined the plan is not complete since the minimum requirements of chs. NR 500 to 520, Wis. Adm. Code, have not been met in accordance with s. NR 514.045, Wis. Adm. Code. The department understands the complexity of the new CCR rules and its implementation and will be available to discuss the following items while you work to prepare the addenda to your initial submittal.

The following information must be provided in order for the department to issue a determination that the plan is complete:

1. **S. NR 504.04(4)(a), Wis. Adm. Code:** Provide a discussion and any correspondence or permits issued from the U.S. Army Corps of Engineers (ACOE) on the federal jurisdictional status of Wetlands 1 and 2. A letter from the department regarding the state jurisdictional status of Wetlands 1 and 2 is included in Appendix A1 of the December 14, 2022, Plan of Operation Modification, however, no discussion or correspondence from the U.S. ACOE on the federal jurisdictional status is provided.

2. **S. NR 504.04(4)(b), Wis. Adm. Code:** Clarify/specify what measures were taken to prevent the take of the slender glass lizard (Ophisaurus attenuatus). Also clarify/specify if continued operation of the landfill may result in a take of the slender glass lizard and what measures will be taken to prevent the take of the slender glass lizard.

3. **S. NR 504.04(4)(c), Wis. Adm. Code:** Provide a copy of the facility's Wisconsin Pollutant Discharge Elimination System (WPDES) permit, as well as the storm water runoff calculations originally provided in

09/28/2023 - Classification: Internal - ECRM13153872

the May 25, 2022, plan modification request/plan of operation update. Provide a copy of the landfill's most recent Tier 2 industrial stormwater pollution prevention plan (SWPPP).

4. **S. NR 504.07(4), Wis. Adm. Code:** Provide a revised final cover design that includes a clay capping layer or a soil barrier layer with a geocomposite clay layer (GCL). The current GCL final cover design does not include a soil barrier layer and therefore, does not meet the code requirements. Provide revisions to the design/construction items that would be affected by the addition of a clay capping layer or a GCL with a two-foot soil barrier layer, including the following:

    a. S. NR 504.075, Wis. Adm. Code: Provide remaining clay available at the New Haven clay borrow source, propose a new clay borrow or soil barrier layer borrow source for material needed for the revised final cover design.

    b. S. NR 514.06, Wis. Adm. Code: Provide the information in this section that will change due to the revised final cover design such as a revised final topography plan sheet and revised closure costs.

    c. SS. NR 514.07(1)(i) and (j), Wis. Adm. Code: Provide updated construction quality control and assurance plans which reflect the revised final cover design.

    d. S. NR 514. 07(10)(1)(c)2, Wis. Adm. Code: Provide a revised closure plan that includes a description of the methods and procedures to be used to install the revised final cover.

5. **SS. NR 514.045(1)(a) and NR 500.05(6)(h), Wis. Adm. Code:** Provide a plan sheet that depicts the closure topography. The plan sheet included in the closure plan in Appendix C1 of the December 14, 2022, Plan of Operation Modification does not depict the closure topography of Modules 10 and 11.

6. **S. NR 514.045(1)(h), Wis. Adm. Code:** Provide the groundwater monitoring system demonstration.

7. **S. NR 514.045(1)(i), Wis. Adm. Code:** Provide an updated sampling plan.

8. **S. NR 514. 07(10)(1)(c)6, Wis. Adm. Code:** Provide a closure schedule that provides sufficient information to describe the sequential steps that will be taken to close the CCR landfill, including installation of the final cover system, and the estimated timeframes to complete each step or phase of CCR landfill closure.

9. **S. NR 514.07(10)(1)(d)1.d, Wis. Adm. Code**: Provide a revised long-term care plan that addresses monitoring in accordance with the sampling plan.

10. **S. NR 514. 07(10)(1)(e), Wis. Adm. Code:** Provide a revised long-term care plan that includes leachate collection line video camera inspections per s. NR 506.07(5)(e), Wis. Adm. Code.

11. **Condition 6 of the department's July 28, 2022, plan of operation approval modification:** Provide an operation plan that addresses the care and maintenance of the tanks, and pumps as well as the means to monitor the tank and manholes secondary containment systems.

12. **Condition 8 of the department's July 28, 2022, plan of operation approval modification:** Provide the design for the construction of Module 12 liner or a proposal for removal of the liner runout from Module 11 and timing of construction of the north berm for Module 11.

13. Provide a leachate/contact water pond abandonment strategy and transition to use of the leachate storage tank.

14. Provide a design for the Phase 1, Modules 5 and 6 final cover permanent haul road.

In addition to the above items, a sitewide preventive action limit (PAL) for specific conductance was discussed in a May 15, 1997, letter from the department (for both the active and closed landfills). Although the sitewide PAL has been accepted since then, it doesn't appear the sitewide PAL was formalized in an approval. It doesn't appear that specific monitoring well PALs for hardness and alkalinity have been proposed and subsequently approved either. The initial CCR permitting of the Dry Ash Disposal Facility is a good opportunity to address these items. The department believes that specific monitoring well PALs for specific conductance, hardness, and alkalinity should be calculated and proposed for the Dry Ash Disposal Facility's non-CCR wells, in addition to the CCR groundwater monitoring system requirements described in s. NR 514.045(1)(h), Wis. Adm. Code. Please include this item in a future addendum.

This incompleteness determination is not a denial of your proposal, but merely indicates that additional information is needed to continue the department's review. Submittal of this information does not ensure approval, nor does it preclude the department from requiring additional information if continued review indicates it is needed

If you have questions regarding this approval, please contact Ann Bekta at 608-287-4492 or ann.bekta@wisconsin.gov or Tyler Sullivan at 608-516-3962 or tyler.sullivan@wisconsin.gov.

Sincerely,

Bridget Kelly
Waste and Materials Management Program Supervisor
South Central Region

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Appendix B

Approval Conditions Summary

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Table B
Approval Condition Status Summary Table
Columbia Energy Center Ash Disposal Facility

Condition No.	Description	Status	Comments
September 30, 1980 Feasibility Approval			
1	Approval for disposal of fly ash and bottom ash; does not apply to fly ash and scrubber sludge	Superseded	
2	Submit final engineering plans for no more than a 10-year operation period	Superseded (10/8/84; C3)	
3	Abandon private and commercial wells within 1,200 feet of modules prior to disposal in that module	Active	
4	Submit groundwater monitoring plan	Superseded by subsequent plan mods	Monitoring currently performed in accordance with 3/11/96 Plan Mod and 1/19/00 Plan Mod
5	Requires design adjustments as necessary to maintain maximum site life of 31 years	Superseded	
6	Where filling will not occur for 6 months or more must have 2-foot intermediate soil cover; for 1 year or more, intermediate cover must be seeded	Superseded (10/8/84; C13)	
7	Contaminated water must be utilized as part of disposal operation or circulated through a treatment process prior to discharge	Comparable code	
8	Control dust	Comparable code	
9	Addresses stockpiling locations	Inactive	
10	Address requirements in NR 180.13 in POO	Comparable code	Addressed in 2010 POO Update
11	Operation of the site	Comparable code	
12	Final cover to include 6 inches of topsoil	Comparable code	
13	Protect wetland areas to the south	Comparable code	
June 30, 1983 Plan of Operation Approval			
1	Site development in accordance with POO	Superseded (1/11/91, Cond. A)	
2	Approval limited to disposal of solid waste in Phase I, Module 1	Alternative proposed	
3	Establish ash handling procedures	Superseded (10/8/84; Cond. 8)	

Table B-1 (cont.)

Condition No.	Description	Status	Comments
June 30, 1983 Plan of Operation Approval (continued)			
4	Maintain facility in compliance with Feasibility approval and no significant impact on environment	Active	
5	Requires ash handling and evaluation plan be submitted before start-up	Superseded	
6	Initial site construction	Inactive	
7	Construct sedimentation basin in accordance with plans	Inactive	Existing basin construction has been approved; new basin construction will be in accordance with 2010 POO Update
8	Backfilling requirements for areas receiving waste	Comparable code	
9	Abandon wells within 1,200 feet of disposal operations	Comparable code	
10	Prior to each phase being licensed, inspection by WDNR and proof of financial responsibility required	Comparable code	
11	Contaminated water must be utilized as part of disposal operation or circulated through a treatment process prior to discharge	Superseded (10/8/84; Cond. 11)	
12	Do not fill in areas where ice has formed; remove ice from active disposal area	Superseded (10/8/84; Cond. 12)	
13	Confine active area to smallest practical area	Superseded (10/8/84; Cond. 13)	
14	Slope and seed all bare soil areas not part of daily operations	Active	
15	Addressed locations of new monitoring wells to be installed	Inactive	
16	Addressed lysimeter locations and design	Inactive	
17	Addressed groundwater monitoring program	Superseded	Monitoring currently performed in accordance with 3/11/96 Plan Mod and 1/19/00 Plan Mod
18	If 0.95 level of significant difference in water quality is found, notify WDNR in writing within 5 days of evaluation and retest within 10 days	Superseded (10/8/84; Cond. 16)	
19	Inform WDNR within 5 days of resampling and undertake investigative action if significant difference confirmed	Superseded	Monitoring currently performed in accordance with 3/11/96 Plan Mod and 1/19/00 Plan Mod

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Table B-1 (cont.)

Condition No.	Description	Status	Comments
June 30, 1983 Plan of Operation Approval (continued)			
20	Addressed groundwater table monitoring requirements	Superseded	Monitoring currently performed in accordance with 3/11/96 Plan Mod and 1/19/00 Plan Mod
21	Close facility in accordance with POO approval, addendums, ch. NR 180.13(12)	Superseded/ Comparable code	Closure in accordance with 2010 POO Update
22	As reach final grades, place 3 feet sandy soils and 6 inches topsoil on side slopes	Alternative proposed	
23	Get WDNR approval for off-site topsoil sources	Inactive	
24	Module 1 final cover slopes: 2% top, 4H:1V sideslopes	Comparable code	
25	Requires long-term care	Comparable code	
26	Addressed long-term care requirements	Comparable code	
27	Addressed minimum proof of net worth	Comparable code	
October 8, 1984 Plan of Operation Addendum Approval			
1	Confirmed Condition 1 of POO Approval unless sufficient testing performed	Superseded (1/11/91, Cond. a)	
2	Assigned Carl Diehls as person responsible for daily operation	Inactive	
3	Update POO every 10 years to reflect current solid waste disposal requirements and practices	Active	
4	Establishes stabilized ash permeability criteria	Inactive	
5	Department reserves right to revoke feasibility approval and conditions of approval	Comparable code	
6	Addresses pilot program for field densities	Inactive	
7	Addressed intentional omission of letter from POO approval	Inactive	
8	Modified timeframe for condition 3 of POO Approval	Inactive	
9	Modified condition 8 of POO Approval from requiring 95% to 90% Modified proctor	Comparable code	
10	Clarifies condition 9 of POO Approval	Comparable code	
11	Leachate must be treated. Denied 1000umhos/cm max conductivity for releasing leachate to environment.	Comparable code	

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Table B-1 (cont.)

Condition No.	Description	Status	Comments
October 8, 1984 Plan of Operation Addendum Approval (continued)			
12	Snow and ice must be removed before placing ash for structural reasons	Active	
13	Smallest active area possible. 2' of cover if inactive for +1yr, seeded as soon as possible, remove before use	Active	
14	Well/Lysimeter location corrections. Leak test modified.	Inactive	
15	Annual metal tests dropped except wells HC1, HC2, HC3. Maintains quarterly sampling of 8 indicator parameters.	Inactive/ Superseded	Monitoring currently performed in accordance with 3/11/96 Plan Mod and 1/19/00 Plan Mod
16	0.95 level of significance changed to 0.01	Inactive	
17	Moisture content test plots to be separate, not contiguous (5' separation)	Inactive	
18	All test plots finished by October 1984	Inactive	
19	Two extra test plots in winter by WPL to compare winter operations	Inactive	
20	Field permeability tests req'd, 3/test plot	Inactive	
21	Lysimeter req'd under 6 original test plots and design suggestions	Inactive	
22	Leachate testing req'd for lysimeters	Inactive	
23	Undisturbed samples needed for permeability tests	Inactive	
24	Placement report to evaluate handling procedures, QC, test data, and suitability to be reported	Inactive	
25	Department and Inspection req'd	Inactive	
February 26, 1985 Construction Documentation & Plan Modification Approval			
1	Site construction documentation changes are approved by WDNR	Inactive	
2	Access road relocation approved	Inactive	
3	Phase 1 area reduction approved (west)	Inactive	
4	Sedimentation basin drainage re-routing approved, no erosion	Inactive	
5	Module 1 drainage field corrected, reported for licensing	Inactive	
6	Abandoned wells MW-1, MW-3A, and MW-3B to be documented	Inactive	
7	Lysimeter location correction	Inactive	
8	GW Monitoring well location & intent (#25)	Inactive	
9	Three background water samples req'd on lysimeters before licensing	Inactive	

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Table B-1 (cont.)

Condition No.	Description	Status	Comments
February 26, 1985 Construction Documentation & Plan Modification Approval (continued)			
10	Monitor water quality on well-by-well basis over time	Superseded	Monitoring currently performed in accordance with 3/11/96 Plan Mod and 1/19/00 Plan Mod
11	Background samples also report water quality parameters (color, odor, turbidity, precision, accuracy)	Superseded	Monitoring currently performed in accordance with 3/11/96 Plan Mod and 1/19/00 Plan Mod
12	Report any reason for not completing four replicate samples/year	Superseded	Monitoring currently performed in accordance with 3/11/96 Plan Mod and 1/19/00 Plan Mod
13	C20 not modified until proposed alternatives for MWs are submitted	Inactive	
14	MW Prefixes, C20 modification. Water levels must be determined for 2nd quarter, missing or lost can be substituted with nearby wells, MW-62 to be replaced.	Inactive	
15	Include MW37A, MW37B, MW81 in water table monitoring program	Superseded	Monitoring currently performed in accordance with 3/11/96 Plan Mod and 1/19/00 Plan Mod
16	All wells included in licensing to be found and protected. Abandoned wells reported correctly.	Inactive	
17	Well information form to be completed for all existing wells and map of all monitoring points be submitted by 6/1/88	Inactive	
18	Certified property deed 11/24/1984 accepted.	Inactive	
February 19, 1987 POO Conditional Approval			
1	GWM results reported to DNR, NR 140	Superseded	Monitoring currently performed in accordance with 3/11/96 Plan Mod and 1/19/00 Plan Mod
July 10, 1987 Plan Modification Approval			
-	Reduced ash/earthwork quantities for Module 5 of Phase 1	Superseded	New phasing plan in 2000 POU

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Table B-1 (cont.)

Condition No.	Description	Status	Comments
December 21, 1988 Plan Modification Approval			
1	Module 3 approved, 2, 4-16 still needed	Superseded by new phasing plan	
2	Module 3 documented with NR 516	Comparable code	
3	No ash into Module 3 until approved by DNR	Comparable code	
4	MW-82 nest relocated. New nest will have: water table observation, piezometer.	Inactive	Monitoring currently performed in accordance with 3/11/96 Plan Mod and 1/19/00 Plan Mod
5	2 new GWM locations & piezometer @ MW-85	Inactive	Monitoring currently performed in accordance with 3/11/96 Plan Mod and 1/19/00 Plan Mod
6	Background water quality defined at new and relocated wells by NR 508.14	Inactive	
7	Abandon wells MW25, MW82A, MW82B. Grout boreholes	Inactive	
8	Replacement, additional, and abandoned well construction complete by 12/30/1989.	Inactive	
9	All well work per NR 508. Report submitted to DNR by 2/15/1989.	Inactive	
July 13, 1990 Construction Documentation Approval			
-	South portion, Phase 1, Module 3 approved	Inactive	
January 11, 1991 Plan Modification Approval			
(a)	Test Burn coal information to be submitted 60 days prior to disposal	Active	
(b)	Test Burn ash cannot be placed in initial 2' base layer	Active	
(c)	Long-term disposal of similar ash possible given DNR approval	Active	
(d)	Test burn ash to be approved before disposal in normal ash landfill	Active	
August 16, 1994 Plan Modification Approval			
1	Preconstruction report to DNR 2 weeks prior to construction activities	Comparable code	
2	Inform DNR engineer 1 week prior to construction events	Superseded	
3	Ash on geomembrane placement procedure	Inactive	
4	Double layer of bentonite blanket around culvert piping where exits lined area	Inactive	

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Table B-1 (cont.)

Condition No.	Description	Status	Comments
August 16, 1994 Plan Modification Approval (continued)			
5	Bentonite mat and geomembrane in open channel to lined pond	Inactive	
6	Geomembrane test requirements	Comparable code	
7	Geomembrane welding test requirements	Comparable code	
8	Document all seams/connections/tests	Comparable code	
9	QA personnel requirements	Comparable code	
10	Construction Documents submitted to DNR within 90 days of completion of Module 1	Inactive	
March 11, 1996 Plan Modification Approval			
1	Within 120 days, install wells, staff gauges, and piezometers in Module 1	Inactive	
2	GW monitoring modifications	Active	Monitoring currently performed in accordance with 3/11/96,1/19/00, and 1/28/11 Plan Mods
3	GW monitoring modifications: schedule, quality points, parameters, water level points (Ash Landfill)	Active	Monitoring currently performed in accordance with 3/11/96,1/19/00, and 1/28/11 Plan Mods
4	WPL to submit results w/in 60 days of sampling	Superseded by 1/28/11 Plan Mod	
5	Inactive/abandoned wells reported by June 1996	Inactive	
6	GWM summary received Jan 31st each year	Superseded by 1/28/11 Plan Mod	
7	Preventive action limits from WPL to be proposed, and alternatives requested	Comparable Code	
8	Plan modification required before additional module or phase construction	Inactive	2010 Plan of Operation Update includes proposed design
March 29, 1996 Construction Documentation Approval			
-	Culvert in NE corner, semiannual inspection	Inactive	
January 19, 2000 Expedited Plan Modification			
-	Dissolved iron no longer required parameter. Reporting/submittal changes.	Active	

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Table B-1 (cont.)

Condition No.	Description	Status	Comments
November 2, 2000 Plan of Operation Update Approval			
1	POU submitted every 10 yrs.	Inactive	
March 29, 2010 Final Cover Construction Documentation Approval			
	Approved construction documentation for 3.1 acres of final cover construction	Inactive	
January 28, 2011 Plan of Operation Update Approval			
	Approved the POU and proposed modifications in the November 12, 2010 POU and December 23, 2010 Addendum No. 1 to the 2010 POU	Active	
1	This approval is limited to a 10-year period beginning on the date of this approval.	Active	
2	A minimum geotextile mass per unit areas of 1,100 grams per square meter (from calculations provide in the report) shall be used to protect the geomembrane beneath the leachate collection pipes from puncture.	Active	
3	The drainage blanket material shall have a minimum hydraulic conductivity of 1 x 10^{-2} cm/sec greater per NR 504.06(5)(tm), Wis. Adm. Code.	Active	
4	The geosynthetic clay liner component of the composite liner shall meet the requirements of NR 504.06(7), Wis. Adm. Code.	Active	
5	The geomembrane component of the composite liner shall have a nominal geomembrane thickness of 60 mils per NR 504.06(3)(a), Wis. Adm. Code.	Active	
6	The constructed liner geomembrane shall be subjected to leak location testing conducted in accordance with NR 516.07(2)(d), Wis. Adm. Code.	Active	
7	The leachate collection lines shall be cleaned per NR 506.07(5)(c), Wis. Adm. Code.	Active	
8	The Department's environmental engineer assigned to the site shall be informed a minimum of one week prior to each of the construction events listed below, in order to allow a Department representative to observe the work. A fee shall be paid to the Department for each required inspection in accordance with s. NR 520.04(5), Wis. Adm. Code. The inspection fees shall be paid at the	Superseded by 7/28/23 Plan Mod	

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Table B-1 (cont.)

Condition No.	Description	Status	Comments
	time the construction documentation review fee is submitted to the Department. Liner a. Placement of the geosynthetic clay liner (GCL). b. Placement of the geomembrane over the GCL. c. Installation of the leachate collection pipe and pipe boots. d. Placement of drainage blanket material over the geomembrane. Final Cover e. Placement and compaction of the grading layer below the GCL. f. Placement of the GCL. g. Placement of the geomembrane over the GCL. h. Placement of the drainage layer and drain pipe over the geomembrane This condition supersedes Condition 2 of the Department's August 16, 1994 approval.		
9	Prior to acceptance of FGD wastes (SDA ash) WPL shall characterize the waste streams and submit the results to the Department for approval to dispose of this material at the site. The waste characterization shall include, at a minimum, the requirements of NR 506.09, Wis. Adm. Code, the ASTM water leach test or other appropriate leach test, and total elemental analysis (metals). The submittal shall also include a discussion of waste handling and disposal procedures for the material. The results of the characterization may require changes to the landfill liner system, final cover system, leachate disposal, landfill operations and/or environmental monitoring.	Active	
10	Fly ash generated at the Nelson Dewey plant in Cassville is approved for disposed at this facility. If the waste stream generated by the Nelson Dewey facility changes, prior to acceptance WPL shall characterize	Active	

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Table B-1 (cont.)

Condition No.	Description	Status	Comments
	the waste stream and submit the results to the Department for approval to dispose of this material at the site. The waste characterization shall include, at a minimum, the requirements of NR 506.08, Wis. Adm. Code, the ASTM water leach test or other appropriate leach test, and total elemental analysis (metals). The results of the characterization may require changes to the landfill liner system, final cover system, leachate disposal, landfill operations and/or environmental monitoring.		
11	Environmental monitoring during both the active and the post-closure perpetual-care periods shall be performed in accordance with the tables in the attached project summary. WPL shall document and submit all results of the environmental monitoring covered in this approval to the Waste and Materials Management Program in accordance with s. NR 507.26, Wis. Adm. Code. This monitoring program supersedes the monitoring programs described in previous approvals.	Active	
12	Revised proof of financial responsibility for closure and long term care shall be provided to the Department by April 1, 2011, in accordance with ch. NR 520, Wis. Adm. Code. The proof of financial responsibility shall be established based upon the approved costs contained in the attached tables.	Inactive	Completed
May 2, 2011, WDNR Clay Liner Recommendation			
	The Department recommends that WPL place 2 feet of clay below the GCL and follow the clay specifications contained in NR 504.06(2)(a), Wis. Adm. Code. The clay borrow source should be investigated as specified in NR 504.075 (5), Wis. Adm. Code.	Active	

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Table B-1 (cont.)

Condition No.	Description	Status	Comments
September 14, 2011 Plan of Operation Modification Approval			
	Approved addition of 2 feet of clay to the approved composite liner system and two commercial clay borrow sites	Active	
1	A geologist, geological engineer or soils technician shall be at the clay borrow sources at all times that clay is to be excavated from the sources to identify the liner quality clay.	Active	
2	The clay liner shall be constructed and documented in accordance with NR 516, Wis. Adm. Code.	Active	
3	The Department's environmental engineer assigned to the site shall be informed a minimum of one week prior to each of the construction events listed below, in order to allow a Department representative to observe the work. A fee shall be paid to the Department for each required inspection in accordance with s. NR 520.04(5), Wis. Adm. Code. The inspection fees shall be paid at the time the construction documentation review fee is submitted to the Department. a. Clay placement	Superseded by 7/28/23 Plan Mod	
February 13, 2012 Liner Construction Documentation Approval			
	Phase 1, Module 2 Construction Documentation approval	Inactive	
1	WPL shall evaluate the leachate/surface water pond capacity prior to Phase 1, Module 3 liner construction to determine if changes are necessary in landfill operations to accommodate the lower pond liner elevation. This evaluation shall be submitted to the Department a minimum of 60 days prior to beginning Phase 1, Module 3 construction.	Inactive	Completed

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Table B-1 (cont.)

Condition No.	Description	Status	Comments
December 16, 2014 Plan of Operation Approval Modification			
	Acceptance of Spray Dryer Absorber (SDA) in Module 2/Composite Lined Areas	Active	
1	The SDA waste disposal shall be limited to the areas of the landfill that have a composite liner system as approved in the Department's September 14, 2011 plan of operation approval modification and January 28, 2011 plan of operation approval.	Active	
2	WPL shall submit a report to the Department within 180 days of the date of this approval that includes: how the moisture content limits the range of compaction; what compaction methods work; and what test methods will be used to determine that the target densities have been achieved. The report shall also address the effects of seasonal conditions on densities.	Active	
3	Environmental monitoring during both the active and the post-closure perpetual-care periods shall be performed in accordance with the attached tables. WPL shall document and submit all results of the environmental monitoring covered in this approval to the Waste and Materials Management Program in accordance with s. NR 507.26, Wis. Adm. Code. This condition supersedes condition 11 of the Department's January 28, 2011 approval.	Superseded by 7/28/23 Plan Mod	
February 20, 2015 Expedited Plan Modification for SDA Byproduct			
	Acceptance of SDA material in Module 1 – rescinds Condition 1 of Department's December 14, 2014 plan of operation approval modification.	Active	

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Table B-1 (cont.)

Condition No.	Description	Status	Comments
November 13, 2015 Plan of Operation Approval			
	New Haven Clay Borrow Source Approved	Active	
1	At all times during clay excavation, a 25-foot setback shall be maintained between the clay borrow area disturbance and the boundary of the delineated wetlands except in the area of the access road.	Active	
2	Any accumulated sediment shall be removed from the silt fences and any repairs necessary to the silt fencing shall be made as soon as practicable after each rain event.	Active	
3	A geologist, geological engineer or soils technician shall be at the clay borrow sources at all times that clay is to be excavated from the sources to identify the liner quality clay.	Active	
4	Alliant Energy shall notify the Department's waste management engineer assigned to this site a minimum of 1 week prior to beginning each of the construction events listed below for the purpose of allowing the Department to inspect the work. A fee shall be paid to the Department for each required inspection in accordance with s. NR 520.04(5), Wis. Adm. Code. The inspection fees shall be paid at the time the construction documentation review fee is submitted to the Department. a. Clay excavation activities at the borrow source for Phase 1.	Active	
July 1, 2016 Plan of Operation Approval Modification			
	Rain Cover System	Active	
1	WPL shall evaluate the leachate/surface water pond capacity prior to Phase 1, Module 4 liner construction to determine if changes are necessary in landfill operations or design to accommodate the additional leachate to be generated by Phase 1, Module 4. The evaluation and proposed operational/design modifications shall be submitted to the Department a	Inactive	Completed

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Table B-1 (cont.)

Condition No.	Description	Status	Comments
	minimum of 90 days prior to beginning Phase 1, Module 4 construction.		
August 22, 2016 Phase 1, Module 3 Liner Construction Documentation Approval			
	Approved construction of Phase 1, Module 3 Liner	Inactive	
January 25, 2017 2016 Final Cover Construction Documentation Approval			
	Approved construction of 2.8 acres of final cover in Phase 1, Module 1 and 2	Inactive	
June 6, 2018 Rain Cover System, Plan of Operation Approval Modification			
1	For future modules, the preconstruction report shall contain the storm water calculations performed to determine if a rain cover is needed or not.	Active	
2	If a rain cover is required in a module, the preconstruction report shall contain the rain cover product identification, material properties, and installation recommendations from the manufacturer.	Active	
3	If a rain cover is required in a module, the installed limits of the rain cover shall be surveyed and provided along with photographic documentation of the installation in the construction documentation report for each module, or as an addendum to the construction documentation report.	Active	
July 13, 2018, New Haven Clay Borrow Monitoring Well Abandonment Exemption			
--	Approved use of bentonite chips for abandonment of MW-26P	Inactive	
September 14, 2018 Phase 1, Module 4 Liner Construction Documentation Approval			
	Approved construction documentation for approx. 4.2 acres of liner of Module 4, also included installation of three CCR groundwater monitoring wells, restoration of Phase 1 excavation at New Haven clay borrow source per the nonmetallic mining reclamation permit from Adams County, abandonment of MW-26 and MW-26P	Inactive	
1	A report shall be submitted to the department within 10 days of completion of the removal of the Phase 1, Module 3/Module 4 berm geomembrane and the connection of the north/south leachate collection pipe. The work shall be completed prior to any waste placement in Phase 1, Module 4.	Inactive	Completed

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Table B-1 (cont.)

Condition No.	Description	Status	Comments
March 13, 2020 No Objection to the Expedited Plan Modification, 10-Year Plan of Operation Update Extension			
	The expedited plan modification was requested under s. NR 514.09(1)(a)10, Wis. Adm. Code, regarding a 1-year extension to Condition 1 of the department's January 28, 2011 plan of operation approval modification. The extension would provide WPL with additional time to consider operational and regulatory changes that are anticipated in 2020. WPL will continue to operate the landfill in accordance with all other conditions of the January 28, 2011 approval, as amended and updated by subsequent approvals from the department.	Superseded	
March 19, 2021 No Objection to the Expedited Plan Modification, Disposal of Filter Bags and Plan of Operation Update Extension			
	Approval to dispose Pulse Jet Fabric Filter (PJFF) bags in the landfill during an upcoming maintenance outage at the plant. The PJFF bags are used to capture particulate matter (scrubber byproduct solids) within the Air Quality Control System (AQCS) baghouse. Landfill operators will create a disposal area within the center of the module and will landfill the waste in consolidated area to prevent future leachate migration and stability concerns. Operators would spray water during transfer of the waste into the disposal area, as needed, to minimize fugitive dust.	Active	
	Extension would be in addition to the 1-year extension previously approved by the department on March 13, 2020. WPL will continue to operate the landfill in accordance with all other conditions of the January 28, 2011 approval, as amended and updated by subsequent approvals from the department.	Active	

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Table B-1 (cont.)

Condition No.	Description	Status	Comments
November 30, 2021 Conditional Plan of Operation Approval Modification for Updated Closure and Long-Term Care Costs			
	Approval of the requested modification to the plan of operation for updated closure and long-term care costs		
1	Revised proof of financial responsibility for closure and long-term care shall be established in accordance with ch. NR 520, Wis. Adm. Code, within 120 days of the date of this approval. The proof of financial responsibility shall be established based upon the approved closure and long-term care cost estimates included in the attached Tables 1 and 2.	Active	
2	Revised closure and long-term care costs shall be included in the 10-year plan of operation update which is due by January 28, 2024. The costs shall reflect changes to leachate collection and management due to the closure of the primary ash pond where the leachate is currently managed.	Active	
December 10, 2021 Phase 1, Modules 5 and 6 Liner Construction Documentation Approval			
	Approved construction of Phase 1, Modules 5 and 6 Liner	Inactive	
July 28, 2022 Conditional Plan of Operation Approval Modification for the 10-year Update			
1	All leachate pumps and flow recording devices shall be maintained to ensure that leachate is pumped out of the landfill as required and the reported flows are accurate.	Active	
2	In case of leachate extraction pump malfunction, the pump shall be repaired or replaced in a timely manner to allow for gravity drainage of leachate in accordance with s. NR 506.07(5), Wis. Adm. Code.	Active	
3	WPL shall submit abandonment documentation for the leachate head wells in Modules 3 and 4 (LH-3 and LH-4); documentation is due to the department within 90 days of being abandoned.	Completed	

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Table B-1 (cont.)

Condition No.	Description	Status	Comments
July 28, 2022 Conditional Plan of Operation Approval Modification for the 10-year Update (continued)			
4	WPL shall install two leachate headwells per module for Modules 10 and 11 per NR 504.09(2)(i), Wis. Adm. Code.	Completed	
5	WPL shall submit leachate tank manufacture installation instruction and pump performance criteria per NR 514.07(13), Wis. Adm. Code prior to tank installation.	Active	
6	WPL shall submit an operational plan which addresses the care and maintenance of the tanks and pumps, by February 1, 2023. The plan shall also address the means to monitor the tank and manholes secondary containment systems.	Active	
7	WPL shall submit construction documentation for the installation of leachate manholes, leachate forcemain and leachate storage tank, per s. NR 516.04, Wis. Adm. Code.	Active	
8	WPL shall submit the design for the construction of Module 12 liner or submit a proposal for removal of the liner runout from Module 11 and timing of construction of the north berm for Module 11, by February 1, 2023.	Active	
9	The Department's waste management engineer assigned to this site shall be notified a minimum of one week prior to beginning each of the construction events listed below for the purpose of allowing the department to inspect the work. A fee shall be paid to the department for each required inspection in accordance with s. NR 520.04(5), Wis. Adm. Code. The inspection fees shall be paid at the time the construction documentation review fee is submitted to the department. Liner Construction Events a. Sub-base grade excavation and storm water controls b. Clay placement	Active	

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Table B-1 (cont.)

Condition No.	Description	Status	Comments
	c. Geocomposite clay liner/geomembrane deployment d. Sump construction/side slope riser placement e. Drainage blanket placement/leachate line installation f. Leak location survey and/or repairs Final Cover Construction Events g. Geosynthetic clay liner installation h. Geomembrane cap installation/seaming i. Drainage layer installation (sand or geocomposite) j. Rooting zone and topsoil placement Other Construction Events k. Leachate forcemain/Modules 2 and 3 manholes l. Leachate storage tanks and secondary containment structures This condition supersedes condition 8 of the department's January 28, 2011, approval and condition 3 of the department's September 14, 2011, approval.		
10	Environmental monitoring shall be performed in accordance with the attached Table 1. WPL shall document and submit all results of the environmental monitoring covered in this approval in accordance with s. NR 507.26, Wis. Adm. Code. This condition supersedes condition 3 of the department's December 16, 2014, approval.	Active	
11	Proof of financial responsibility for closure and long-term care shall be adjusted in accordance with ch. NR 520, Wis. Adm. Code, within 60 days of the date of this approval. The proof of financial responsibility shall be established based upon the approved closure and long-term care cost estimates included in the attached Tables 2 and 3.	Active	

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Table B-1 (cont.)

Condition No.	Description	Status	Comments
May 30, 2023 Phase 2, Modules 10 and 11 Liner Construction Documentation Approval			
1	Within 30 days of completion, a letter documenting the installation of the following items shall be submitted to the department for concurrence: a. Installation of an electrical transformer and underground utility east of Module 10 to power the leachate collection pumps. b. Installation of the leachate collection pump system, including force main piping, vaults, and electrical components. c. Installation of telemetry and transducers to leachate headwells in Phase 2, Modules 10 and 11.	Active	

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Appendix C

Stormwater Management Items

09/28/2023 - Classification: Internal - ECRM13153872

C.1 Facility's Current WPDES Permit

09/28/2023 - Classification: Internal - ECRM13153872

STATE OF WISCONSIN DEPARTMENT OF NATURAL RESOURCES

GENERAL PERMIT TO DISCHARGE UNDER THE WISCONSIN POLLUTANT DISCHARGE ELIMINATION SYSTEM
WPDES Permit No. WI-S067831-6

In compliance with the provisions of ch. 283, Wis. Stats., and chs. NR 151 and 216, Wis. Adm. Code, a landowner of a construction site engaging in land disturbing construction activities including clearing, grading and/or excavating, but excluding storm water discharges within Indian Country, that discharges

STORM WATER ASSOCIATED WITH LAND DISTURBING CONSTRUCTION ACTIVITY

is authorized to discharge storm water to waters of the state provided that the discharge is in accordance with the conditions set forth in this permit.

Unless notified in writing by the Department of Natural Resources (department) to the contrary, the effective date of coverage under this permit is 14 working days after an applicant's complete Notice of Intent has been received by the department.

Permit coverage continues until submittal of a Notice of Termination for a project and terminates upon written confirmation by the department. The maximum period of permit coverage for any project is limited to 3 years per Notice of Intent. Therefore, after 3 years of initial permit coverage, the permittee is no longer authorized to discharge under this permit unless another Notice of Intent for the original project including the application fee is submitted to retain coverage under this permit or a reissued version of this permit.

State of Wisconsin Department of Natural Resources
For the Secretary

By _____ September 30, 2021
Brian Weigel, Director Date
Bureau of Watershed Management

PERMIT EFFECTIVE DATE: October 1, 2021 **EXPIRATION DATE:** September 30, 2026

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1. APPLICABILITY CRITERIA

1.1 Eligibility

1.1.1 Subject to the provisions of sections 1.1.3, 1.1.4 and 1.2.1 through 1.2.6:

1.1.1.1 Under the applicability criteria in s. NR 216.42, Wis. Adm. Code, this general Wisconsin Pollutant Discharge Elimination System (WPDES) permit is applicable to all new and existing storm water discharges from land disturbing construction activity occurring after the effective date of this permit until permit coverage is terminated in accordance with section 2.7 or automatically terminates under section 2.8. Construction activities eligible for coverage by this permit are those that involve land disturbing construction activity affecting or anticipated to affect one acre or more of land.

1.1.1.2 The department may require the landowner of any storm water discharge associated with land disturbing construction activity to apply for and obtain a storm water discharge permit if the storm water discharge is contributing to the violation of a water quality standard or contributing significant pollution to waters of the state.

1.1.2 This permit also authorizes pit and trench dewatering discharges at a construction site covered under this permit subject to the following conditions:

1.1.2.1 Dewatering is from a trench or pit not meeting the definition of a well as defined under s. 281.34(1)(h), Wis. Stats., and regulated under ch. NR 812, Wis. Adm. Code.

1.1.2.2 Dewatering discharge is treated in accordance with the department's sediment control dewatering technical standard 1061 or equivalent methodology.

1.1.2.3 Dewatering is not from an area subject to remedial action operations or from an area containing contamination that would be subject to remedial action operations.

Note[1]: Examples of some dewatering activities that may be regulated by this permit include dewatering of construction pits, sewer extension construction, pipe trenches, and other similar operations. The department's sediment control dewatering technical standard 1061 is available at: https://dnr.wi.gov/topic/stormwater/standards/const_standards.html.

Note[2]: Dewatering well systems with a combined pumping capacity of 70 gallons per minute or more may require temporary high capacity dewatering well approval. Dewatering well systems must meet the requirements of ch. NR 812, Wis. Adm. Code.

Note[3]: Discharges from dewatering well systems may require coverage under a wastewater general permit for dewatering operations. The wastewater permit for dewatering operations is available at: https://dnr.wisconsin.gov/sites/default/files/topic/Wastewater/WI0049344permit.pdf.

Note[4]: Dewatering discharges at construction sites or properties where there is environmental pollution and/or a discharge of a hazardous substance subject to regulation under chs. 289 or 292, Wis. Stats, may require additional approvals and be subject to the Contaminated Groundwater from Remedial Action Operations General Permit (WI-0046566-07-0). Chapter 292, Wis. Stats., defines "remedial action."

1.1.3 This permit authorizes storm water discharges from land disturbing construction activities

that may become mixed with other storm water discharges. Subject to compliance with the terms and conditions of this permit, storm water discharges from temporary support activities such as portable concrete or asphalt batch plants, equipment staging yards, material storage areas, excavated material disposal areas, and borrow areas are authorized under this permit provided that the support activity is directly related to and part of the construction site covered under this permit. The erosion control plan required under section 3.1 of this permit shall include provisions to prevent and control the discharge of pollutants to waters of the state from any temporary support activity. This permit does not authorize a support activity that is a commercial operation serving multiple unrelated construction sites or that operates beyond the completion of the permitted construction site associated with the support activity. Other storm water or wastewater discharges that require coverage under another general or individual WPDES permit are not authorized under this permit such as wastewater discharges from washout and cleanout of stucco, paint, form release oils, curing compounds and other construction materials; fuels, oils and other pollutants used in vehicle operation and maintenance; and soaps or solvents used in vehicle and/or equipment washing.

1.1.4 Storm water discharges associated with industrial activity that are subject to an industrial storm water WPDES permit or which are issued an individual WPDES construction site storm water discharge permit are not authorized by this permit.

Note: For example, non-metallic mining is an industrial activity that includes land disturbance as a normal part of its operation and such land disturbance is regulated under an industrial stormwater permit for that activity. If an industrial facility underwent construction or expanded its operations and land disturbance is not a normal part of its operations, then coverage under this permit would be applicable.

1.1.5 This general permit does not apply to construction sites otherwise eligible for this permit where the department determines, pursuant to s. NR 216.51(5), Wis. Adm. Code, that coverage under an individual WPDES storm water discharge permit is more appropriate. The department may require individual permit coverage for storm water discharge from a construction site otherwise eligible for coverage under this permit if any of the following occur:

1.1.5.1 The storm water discharge from a construction site is determined to be a significant source of pollution and more appropriately regulated by an individual WPDES storm water discharge permit.

1.1.5.2 The storm water discharge from a construction site is not in compliance with the terms and conditions of this general permit or subch. III of ch. NR 216, Wis. Adm. Code.

1.1.5.3 A change occurs in the availability of demonstrated technology or best management practices (BMPs) for the control or abatement of pollutants from the storm water discharge.

1.1.5.4 Effluent limitations or standards are promulgated for a storm water discharge from the construction site different from the conditions contained in ch. 216, Wis. Adm. Code.

1.2 Exclusions

The following are not eligible for coverage under this permit:

1.2.1 Storm water discharges within Indian Country.

Note: Indian County is defined under 18 USC §1151 and includes all lands within the exterior boundaries of federally recognized Indian reservations and on lands held in federal trust status. Facilities that are located within Indian Country should contact the United States Environmental Protection Agency (USEPA) to apply for permit coverage. Dischargers that previously held permit coverage under previous versions of this permit are no longer eligible for coverage under this permit and must contact USEPA to apply.

USEPA's website contains information on the Construction General Permit: https://www.epa.gov/npdes/stormwater-discharges-construction-activities. Proposed discharges within Indian country who are seeking coverage under the NPDES construction permit should verify eligibility for coverage under the general permit. Discharges not eligible may require individual permits from USEPA.

1.2.2 Land disturbing construction activity and associated storm water discharges that affect wetlands, unless the department determines that the land disturbing construction activity and associated storm water discharges comply with the wetland water quality standards provisions in ch. NR 103, Wis. Adm. Code. A landowner applying for permit coverage under section 2.1 shall provide information to the department with the application documenting whether wetlands are present in the project area and how the presence or absence of wetlands was determined. The storm water management plan in section 3.4.3 shall include the technical basis for the chosen BMPs and describe how the chosen practices do not cause adverse impacts to receiving water quality.

Note: The department's wetland screening and delineation procedures are available at: https://dnr.wi.gov/topic/stormwater/construction/.

1.2.3 Land disturbing construction activity and associated storm water discharges that affect endangered and threatened resources, unless the department determines that the land disturbing construction activity and associated storm water discharges comply with the endangered and threatened resource protection requirements of s. 29.604, Wis. Stats., and ch. NR 27, Wis. Adm. Code.

1.2.4 Land disturbing construction activity and associated storm water discharges that affect any historic property that is listed property, or on the inventory or on the list of locally designated historic places under s. 44.45, Wis. Stats., unless the department determines that the land disturbing construction activity and associated storm water discharges will not have an adverse effect on any historic property pursuant to s. 44.40(3), Wis. Stats.

1.2.5 Storm water discharges that the department, prior to authorization of coverage under this permit, determines will cause or have reasonable potential to cause or contribute to an excursion above any applicable water quality standard. Where such determinations have been made prior to authorization, the department may notify the applicant that an individual permit application is necessary.

1.2.6 Storm water discharges from transportation activity carried out under the direction and supervision of the Wisconsin Department of Transportation.

Note: "Transportation activity" has the meaning given in s. 30.2022(1g), Wis. Stats. Section 283.33(4m)(b)1., Wis. Stats., directs the Department of Natural Resources to issue a distinct general permit that authorizes the Department of Transportation to discharge storm water from

the site of a transportation activity.

1.3 Authorization

1.3.1 A landowner planning a land disturbing construction activity of one acre or more shall submit a completed Notice of Intent (NOI) to the department in accordance with the requirements of section 2.1 of this permit to be authorized to discharge storm water under this permit.

1.3.2 Only a landowner or person who becomes a qualified landowner, and who submits an NOI in compliance with section 2 of this permit is authorized to discharge storm water from a land disturbing construction activity of one acre or more under the terms and conditions of this permit.

1.4 More than One General Permit Can Apply

This permit may be issued to existing holders of general or individual WPDES permits, resulting in multiple WPDES permits for some sites. Facilities having other permits which do not regulate storm water discharges from land disturbing construction activities shall be subject to this permit when construction activities will disturb one acre or more of land at the site. However, storm water discharges from land disturbing construction activity associated with the normal operation of an industrial facility do not require coverage under this permit when it is regulated under an industrial storm water permit pursuant to subch. II of NR 216, Wis. Adm. Code.

1.5 Transfers

A permittee who does not intend to control the permitted activities on the site may transfer authorization under this permit to the person who will control the permitted activities. The transfer shall occur upon written notification, signed by both the current permittee and the proposed permittee and sent via certified or registered mail to the department. Unless the department notifies the permittee to the contrary, the department will recognize this permit coverage transfer upon receipt of written notification. The department may require additional information to be filed prior to granting the transfer of permit coverage. The department may, if appropriate, require an application for an individual WPDES storm water discharge permit.

Note: Transfer of permit coverage may not occur where the original landowner still owns a portion of the construction site that requires permit coverage. Where multiple landowners are required to have construction site permit coverage, each must file an NOI with the department. Multiple landowners may utilize the same erosion control and storm water management plans if the plans address the specific needs of the construction site that they own.

Note: The Transfer of Coverage form (Form 3400-222) is available on the department's website at: https://dnr.wisconsin.gov/topic/Stormwater/construction/forms.html.

1.6 Authorized Local Program

Section NR 216.415, Wis. Adm. Code, establishes the requirements for a municipal authorized local program. The landowner of a construction site regulated by an authorized local program shall comply with this section 1.6.

Note: Currently, Waukesha County is the only municipality with an authorized local program conditionally-approved by the department. The department will not approve any other municipal authorized local program until revisions to the applicable sections of ch. NR 216, Wis. Adm. Code, are promulgated.

1.6.1 Unless otherwise directed by the department, a landowner regulated by an authorized local program shall comply with the ordinances established by the authorized local program and reviewed by the department as part of the establishment and management of the authorized local program. For Waukesha County, the ordinances are contained in Chapter 14, article VIII of the County Code of Ordinances (available at: https://www.waukeshacounty.gov/globalassets/parks--land-use/land-conservation/stormwater/final-2005-storm-water-ordinance---waukesha-co-web-version.pdf).

1.6.2 Notwithstanding the establishment of an authorized local program, a landowner regulated by an authorized local program who has submitted a permit application in accordance with section 1.6.3 shall comply with this permit. The department may enforce against the landowner of a construction site for a violation of this permit.

1.6.3 A landowner regulated by an authorized local program shall comply with the application requirements established by the authorized local program under s. NR 216.415(6), Wis. Adm. Code.

1.6.4 If an authorized local program is terminated pursuant to s. NR 216.415(10), Wis. Adm. Code, the department will notify an affected landowner in writing with instructions on how to remain in compliance with this permit.

2. NOTICE OF INTENT, NOTICE OF TERMINATION, AND MINIMUM CONTROL REQUIREMENTS

2.1 Application Procedures

2.1.1 Except as provided in section 1.6.3, a person required to obtain coverage under this permit (applicant) for storm water discharge from a construction site shall submit a completed NOI to the department in accordance with the requirements of subch. III of ch. NR 216, Wis. Adm. Code. At a minimum, the applicant shall submit the completed NOI to the department in accordance with the requirements of this section, at least 14 working days prior to beginning any land disturbing construction activities. The department may confer permit coverage within the 14 working days or may withhold permit coverage beyond 14 working days to request additional information or to review project compliance with erosion control, storm water management, wetland protection, endangered and threatened resources, or historic property requirements. In either case, the department will notify the applicant in writing. The applicant shall submit the NOI electronically through the department's construction site electronic application process. The Notice of Intent requires applicants to provide information on the applicant, facility location, and applicable information pursuant to ss. NR 216.46 and NR 216.47 Wis. Adm. Code.

Note: The department's construction site electronic application process webpage is available at: http://dnr.wi.gov/topic/Stormwater/construction/forms.html. For applicants with no computer capability, the department may accept a paper version of the NOI application on a case-by-case basis. The paper application must be obtained directly by contacting the department at 888-936-7463 or by writing to the Wisconsin DNR, Storm Water Program – WT/3, Box 7921, Madison, Wisconsin 53707-7921. Submittal of the paper application must be accompanied by a letter from the department approving its use.

2.1.2 The applicant shall submit erosion control and storm water management plans as described in Section 3 of this permit to the department as required by s. NR 216.44(2), Wis. Adm. Code, with the NOI.

2.1.3 The applicant shall submit the application fee to the department in accordance with s. NR 216.43(2), Wis. Adm. Code.

2.1.4 The NOI form shall be signed in accordance with s. NR 216.43(3), Wis. Adm. Code.

2.2 Permit Certificate

The permittee shall post the permit certificate (DNR Publication # WT-813 rev. 10/11) in a conspicuous place on the construction site. The department will provide the permit certificate to the permittee with the letter of permit coverage.

Note: The requirement to post the permit certificate in a conspicuous place on the construction site is intended to provide the public an easily accessible and viewable document with contact information for the construction site. The department recommends posting the certificate near each main entrance to the construction site in a location where it is legible from a public right-of-way. Permittees should consider providing sufficient weather protection to avoid the certificate from becoming unreadable.

2.3 Failure to Notify

Persons who fail to notify the department of their intent to be covered under this permit and who discharge storm water to waters of the state associated with land disturbing construction activities of one acre or more, are in violation of ch. 283, Wis. Stats., ch. NR 216, Wis. Adm. Code. Failure to

obtain permit coverage may result in forfeitures of up to $10,000 per day, pursuant to s. 283.91(2), Wis. Stats.

2.4 Incomplete Notice of Intent
Within 14 working days after the date the department receives the NOI, the department may require an applicant to submit data necessary to complete any deficient NOI or may require the applicant to submit a complete new NOI when the deficiencies are extensive or the appropriate application process has not been used.

2.5 Date Coverage Effective
Unless notified by the department to the contrary, applicants who submit a complete NOI in accordance with the provisions of subch. III of ch. NR 216, Wis. Adm. Code, are authorized to discharge storm water from land disturbing construction sites under the terms and conditions of this permit 14 working days after the date the department receives the NOI. The department may deny coverage under this permit and require submittal of an application for an individual WPDES permit based on a review of the completed NOI or other information.

2.6 Use of Information
All information contained in the NOI other than that specified as confidential by the department shall be available to the public. Confidential treatment will be considered only for information identified in documents submitted by the applicant separate from non-confidential information which meets the requirements of s. 283.55(2)(c), Wis. Stats., and for which written application for confidentiality has been made pursuant to s. NR 2.19, Wis. Adm. Code.

2.7 Notice of Termination
Permittees shall submit a Notice of Termination (NOT) to the department within 45 days after a construction site has undergone final stabilization, temporary sediment control practices have been removed and all land disturbing construction activities that required coverage under this permit have ceased. The NOT shall be submitted consistent with all of the following:

2.7.1 The permittee shall submit the NOT on the electronic form available from the department.

Note: Electronic forms are available at https://dnr.wisconsin.gov/topic/Stormwater/construction/forms.html. For applicants with no computer capability, the department may accept a paper version of the NOT on a case-by-case basis. The paper form must be obtained directly by contacting the department at 888-936-7463 or by writing to the Wisconsin DNR, Storm Water Program – WT/3, Box 7921, Madison, Wisconsin 53707-7921. Submittal of the paper form must be accompanied by a letter from the department approving its use.

2.7.2 The Permittee shall sign the NOT form in accordance with s. NR 216.43(3), Wis. Adm. Code.

2.7.3 The department shall use the information submitted with the NOT as basis for confirming or denying termination of coverage.

2.7.4 The department shall provide written confirmation of permit coverage termination to the permittee. Termination of coverage shall not be effective until the department provides confirmation to the permittee.

2.8 Permit Coverage Renewal and Automatic Termination

The maximum period of permit coverage for any project is limited to three years per NOI. After three years of initial permit coverage, the permittee is no longer authorized to discharge under this permit unless renewal of coverage is granted by the department. A permittee may request renewal of coverage under this permit or a reissued version of this permit by submitting an electronic form to the department and paying the application fee for the total area of project disturbance. Reapplication for coverage must occur prior to the end of the three-year period. Unless a permittee renews permit coverage, the department may automatically terminate the initial permit coverage after three years. The permittee is responsible for determining whether a renewal of permit coverage is necessary.

2.9 Minimum Control Requirements

The permittee shall design, install, and maintain BMPs to meet the applicable performance standard in either s. NR 151.11, Wis. Adm. Code, for construction sites that are not transportation facilities or s. NR 151.23, Wis. Adm. Code, for transportation facility construction sites.

2.9.1 Evaluation and implementation of BMPs

The permittee shall utilize the following BMPs:

2.9.1.1 Limiting the size and duration of exposed soil areas subject to erosion via staging of land disturbance. This includes temporary stabilization of areas that will not be subject to further land disturbance during winter months.

2.9.1.2 Develop a spill prevention and response plan.

2.9.1.3 Encourage infiltration through maintaining natural buffers around surface waters and directing storm water to vegetated areas.

2.9.1.4 Utilizing BMPs for which the department has developed technical standards or equivalent methodology.

Note**:** The storm water technical standards are available on the department's internet site at: https://dnr.wi.gov/topic/stormwater/standards/.

2.9.2 BMP Design

The permittee shall consider all of the following factors when designing BMPs:

2.9.2.1 The expected amount, frequency, intensity, and duration of precipitation.

2.9.2.2 The nature of storm water runoff and run-on at the site. Factors such as expected flow from impervious surfaces, slopes, and site drainage features shall be considered. Best Management Practices shall be designed to meet the applicable requirements for erosion and sediment control and post- construction storm water management.

2.9.2.3 The soil type and range of soil particle sizes expected to be present on the site.

2.9.2.4 Both existing and proposed topography.

Note**:** Clearing, grubbing, and topsoil stripping are types of land disturbance that usually occur before mass grading. Therefore, temporary controls are needed for features that are present in existing topography that may not be present in proposed topography.

2.9.2.5 The proposed construction schedule, if known.

2.9.2.6 Good engineering design practices, including use of applicable technical standards or their or equivalent methodology.

2.9.3 Installation of BMPs

The permittee shall install the following by the time each phase of construction activities has begun:

2.9.3.1 Before land disturbing construction activities in any portion of the site begins, install and direct water to any erosion or sediment controls that prevent or treat discharges from the initial site clearing, grading, excavating, and other land disturbing construction activities.

Note: The requirement to install BMPs prior to each phase of construction activities for the site does not apply to the land disturbance associated with the actual installation of these BMPs. The permittee shall take all reasonable actions to minimize the discharges of pollutants during the installation of storm water BMPs.

2.9.3.2 Following the installation of these initial controls, install and direct water to all BMPs needed to control discharges prior to subsequent land disturbing activities.

2.9.4 Maintenance of BMPs

The permittee shall ensure that all BMPs are maintained and remain effective operating condition during permit coverage and are protected from activities that would reduce their effectiveness. The permittee shall**:**

2.9.4.1 Follow any specific maintenance requirements for the BMPs used to comply with this permit.

2.9.4.2 Initiate any needed maintenance work so that it is completed by the close of the next business day. The permittee shall repair or replace storm water BMPs as necessary within 24 hours of an inspection performed in accordance with section 4.5 of this permit or after notification by the department that repair or replacement is needed.

Note: A permittee's operator may assist a permittee to comply with these provisions where the operator has a contract or other agreement with the permittee to meet these requirements.

2.9.5 Corrective Actions

If a selected BMP is ineffective in meeting the requirements of this permit, the permittee shall comply with the corrective action requirements in section 3.3.

2.9.6 Compliance with Runoff Management Performance Standards

The permittee shall comply with the construction site performance standards in s. NR 151.11(6m), (7) and (8), Wis. Adm. Code, for construction sites that are not transportation facilities or s. NR 151.23(4m),(5) and (6), Wis. Adm. Code, for transportation facility construction sites. The BMPs installed to meet the performance standards shall be maintained to meet the control and/or treatment capability of the practice. In accordance with section 3.2.6 of this permit, the permittee shall ensure that any permanent structures installed to meet a post- construction performance standard in ss. NR 151.121 to 151.128, Wis. Adm. Code, or ss. NR 151.241 to 151.248, Wis. Adm. Code, are maintained to meet the treatment capability as designed.

2.9.7 Unauthorized Discharges

09/28/2023 - Classification: Internal - ECRM13153872

This permit authorizes storm water discharges from land disturbing construction activities that may become mixed with other storm water discharges. Other storm water or wastewater discharges that require coverage under another general or individual WPDES permit are not authorized under this permit such as wastewater discharges from washout and cleanout of concrete, paint, form release oils, curing compounds and other construction materials; fuels, oils and other pollutants used in vehicle operation and maintenance; and soaps or solvents used in vehicle and/or equipment washing.

09/28/2023 - Classification: Internal - ECRM13153872

3. EROSION CONTROL AND STORM WATER MANAGEMENT PLANS

3.1 Erosion Control Plan Requirements

The landowner or applicant shall develop a site-specific construction site erosion control plan for each construction site regulated under subch. III of ch. NR 216, Wis. Adm. Code. The erosion control plan shall include all of the following:

3.1.1 Description of the construction site and the nature of the land disturbing construction activity, including representation of the limits of land disturbance on a USGS 7.5-minute series topographical map or equivalent.

Note: The map requirement can be met for applicants using the department's electronic permit submittal process that includes an outline of the disturbed area on the surface water data viewer, or submits a shape file with the outline as required in the application process.

3.1.2 Description of the intended timing and sequence of major land disturbing construction activities for major portions of the construction site, such as grubbing, excavating, or grading.

Note: The department encourages inclusion of a staging map, dividing sites into smaller areas with proposed dates for start of land disturbance in each area, start of temporary stabilization, and final stabilization for each area on the map. This staging map is strongly encouraged for all projects expected to have more than 50 acres of land disturbance or land disturbance extending more than 24 months from initial disturbance to final stabilization.

3.1.3 Estimates of the total area of the construction site and the total area that is expected to be disturbed by construction activities.

3.1.4 Available data describing the surface soil as well as subsoils.

3.1.5 Name of immediate named receiving water from the USGS 7.5-minute series topographic maps or department surface water data viewer, and whether the receiving water is an outstanding resource water (ORW), exceptional resource water (ERW), or an impaired water. See Section 4.2 to 4.4 for additional requirements related to designated surface waters.

Note: ORWs and ERWs are listed in ss. NR 102.10 and 102.11, Wis. Adm. Code, respectively. Also, a list of ORWs and ERWs may be found on the department's internet site at: https://dnr.wi.gov/topic/surfacewater/orwerw.html.

3.1.6 Description of BMPs and actions that together meet the applicable performance standard in either s. NR 151.11, Wis. Adm. Code, for construction sites that are not transportation facilities or s. NR 151.23, Wis. Adm. Code, for transportation facility construction sites. If BMPs cannot be designed and implemented to meet the sediment reduction performance standard, the construction site erosion control plan shall include a written and site-specific explanation of why the performance standard is not attainable.

Note: Department-approved erosion and sediment control technical standards can be obtained through the department's storm water internet site at: https://dnr.wi.gov/topic/stormwater/standards/const_standards.html.

3.1.7 The construction site erosion control plan shall include a description of appropriate erosion and sediment control BMPs that will be installed and maintained at the construction site to prevent or reduce pollutants from reaching waters of the state. The construction site erosion control plan shall clearly describe the appropriate erosion and sediment control BMPs for each major land disturbing construction activity and the timing during the period of land disturbing construction activity that the erosion and sediment control BMPs will be implemented. Erosion and sediment control BMPs shall be implemented in accordance with either s. NR 151.11(8), Wis. Adm. Code, for construction sites that are not transportation facilities or s. NR 151.23(6), Wis. Adm. Code, for transportation facility construction sites. The description of erosion and sediment control BMPs shall include the following minimum requirements:

3.1.7.1 Description of interim and permanent stabilization practices, including a schedule for implementing the practices. The construction site erosion control plan shall ensure that existing vegetation is preserved where feasible and that disturbed portions of the construction site are stabilized as soon as practicable.

3.1.7.2 Description of any structural practices to divert flow away from exposed soils, store flows or otherwise limit runoff and the discharge of pollutants from the construction site.

3.1.7.3 Management of overland flow at all areas of the construction site, unless otherwise controlled by outfall controls.

3.1.7.4 Trapping of sediment in channelized flow.

3.1.7.5 Staging land disturbing construction activities to limit exposed soil areas subject to erosion.

3.1.7.6 Protection of downslope drainage inlets where they occur.

3.1.7.7 Prevent tracking of sediment from the construction site onto roads and other paved surfaces.

3.1.7.8 Prevent the discharge of sediment as part of site de-watering.

3.1.7.9 Protect separate storm drain inlet structures from receiving sediment.

3.1.7.10 Clean up of off-site sediment deposits.

3.1.7.11 Stabilization of drainage ways.

3.1.7.12 Prevent the discharge of sediment eroding from soil stockpiles existing for more than 7 days.

3.1.7.13 Prevent the transport by runoff into waters of the state of untreated wash water from vehicle and wheel washing.

3.1.7.14 Installation of permanent stabilization practices as soon as possible after final grading.

3.1.7.15 Description of erosion and sediment control practices put in place for the winter to prevent soil from leaving the construction site during periods of winter and spring thaw and rains.

3.1.7.16 Description of the expected level of sediment control on the construction site that achieves compliance with s. NR 151.11 or 151.23, Wis. Adm. Code, where applicable. The construction site erosion control plan shall document compliance with the 5 tons per acre per year sediment performance standard using the procedures provided by the department to estimate soil loss and sediment discharge from sheet and rill erosion and measures to limit sediment discharge from concentrated flows and steep slopes. This requirement is in addition to providing the minimum control measures in subsections of 3.1.7 of this permit and is not intended to result in reduction of erosion and sediment control measures.

Note: The department developed the Construction Site Soil Loss and Sediment Discharge Calculation Guidance, dated September 2017. This guidance document establishes a procedure to document compliance with the 5 tons per acre per year sediment performance standard for construction sites. The guidance is available on the department's internet site at: https://dnr.wi.gov/topic/stormwater/publications.html.

3.1.7.17 Use and storage of chemicals, cement and other compounds and materials used on the construction site shall be managed during the construction period to prevent their transport by runoff into waters of the state.

3.1.7.18 Minimization of dust to the maximum extent practicable.

3.1.7.19 Minimization of soil compaction and preservation of topsoil.

3.1.7.20 Minimization of land disturbing construction activity on slopes of 20% or more.

3.1.7.21 Spill prevention and response procedures.

3.1.7.22 Additional items necessary to address site-specific conditions.

3.2 Erosion Control Map The construction site erosion control plan shall include a site map with the following items:

3.2.1 Existing topography and drainage patterns, roads and surface waters.

Note: Contour maps at 1- or 2-foot intervals are preferred. Many counties have topographic information available in geographic information system format.

3.2.2 Boundaries of the construction site.

3.2.3 Drainage patterns and approximate slopes anticipated after major grading activities.

Note: Proposed contour maps at 1- or 2-foot intervals are preferred.

3.2.4 Areas of soil disturbance.

3.2.5 Location of erosion and sediment control BMPs identified in the construction site erosion control plan.

3.2.6 Location of areas where stabilization practices will be employed.

3.2.7 Areas that will be vegetated following land disturbing construction activities.

3.2.8 Area and location of wetland acreage on the construction site and locations where storm water is discharged to a surface water or wetland within one-quarter mile downstream of the construction site.

3.2.9 Areas that will be used for infiltration of post-construction storm water runoff.

3.2.10 A method of referencing locations within the site, such as an alphanumeric or equivalent coordinate system for the entire construction site.

3.2.11 Additional items necessary to depict site-specific conditions.

Note: The department encourages inclusion of notes communicating erosion and sediment control requirements to those working on the construction site. The department has a list of recommended notes at: https://dnr.wi.gov/topic/stormwater/documents/WTErosionControlNotes.pdf.

3.3 Erosion and Sediment Control Plan Implementation Requirements

The permittee or the permittee's representative shall implement and maintain, as required by this permit and subch. III of NR 216, Wis. Adm. Code, all BMPs specified in the construction site erosion control plan from the start of land disturbing construction activities until final stabilization of the construction site. Implementation shall include all of the following:

3.3.1 Sediment control BMPs shall be constructed and placed in operation prior to runoff entering waters of the state.

Note: While regional treatment facilities are appropriate for control of post-construction pollutants they should not be used for construction site sediment removal.

3.3.2 No solid materials, including building materials, may be discharged in violation of chs. 30 and 31, Wis. Stats., or 33 USC 1344 or a U.S. Army Corps of Engineers Section 404 permit issued under 33 USC 1344.

3.3.3 Velocity dissipation devices shall be placed at discharge locations and along the length of any outfall channel as necessary to provide a non-erosive flow from the structure to a watercourse so that the natural physical and biological characteristics and functions of the watercourse are maintained and protected.

3.3.4 Sediment basins and traps used for sediment removal shall be constructed and operated in accordance with good engineering practices and design standards.

Note: The department maintains technical standards for sediment basin and traps: https://dnr.wisconsin.gov/topic/Stormwater/standards/const_standards.html.

3.3.5 All maintenance shall be done in accordance with technical standards developed pursuant to subch. V of ch. NR 151, Wis. Adm. Code, and the erosion control plan. Where measures are not in accordance with the technical standards, a description of the procedures used to maintain effective operating conditions of vegetation, erosion and sediment control BMPs and other protective measures shall be identified in the erosion control plan.

Note**:** The storm water technical standards are available on the department's internet site at: https://dnr.wi.gov/topic/stormwater/standards/const_standards.html.

3.4 Storm Water Management Plan Requirements

3.4.1 A storm water management plan shall be developed to address pollution caused by storm water discharges from the site after construction is completed, including rooftops, parking lots, roadways and maintained landscaped or grassy areas. A storm water management plan shall be developed prior to submitting a NOI to the department.

Note: The requirements of sections 4.2 to 4.4 of this permit apply to erosion control and storm water management plans for all construction sites regulated under this permit.

3.4.2 The storm water management plan shall meet the applicable performance standards in ch. NR 151, Wis. Adm. Code, as follows:

3.4.2.1 For construction sites that are not transportation facilities, meet the applicable performance standards in ss. NR 151.121 through NR 151.128, Wis. Adm. Code.

3.4.2.2 For transportation facility construction sites, meet the applicable performance standards in ss. NR 151.241 through NR 151.249, Wis. Adm. Code.

3.4.3 The storm water management plan shall include a description of the BMPs that will be installed during the construction process to control total suspended solids and peak flow, enhance infiltration, maintain or restore protective areas and reduce petroleum in runoff that will occur after construction has been completed. The storm water management plan shall include an explanation of the technical basis used to select the BMPs

Note: Storm water management post-construction technical standards developed per Subch. V NR 151, Wis. Adm. Code, can be obtained at: https://dnr.wisconsin.gov/topic/Stormwater/standards/postconst_standards.html. For final stabilization after construction is completed the establishment of a perennial vegetative cover the procedures for permanent seeding in accordance with the department's seeding technical standard 1059 or equivalent methodology shall be followed.

3.4.4 When permanent infiltration systems are used, appropriate on-site testing shall be conducted to determine if seasonal high groundwater elevation or top of bedrock is within 5 feet of the bottom of the proposed infiltration system.

3.4.5 Storm water BMPs shall be adequately separated from wells to prevent contamination of drinking water, and the following minimum separation distances shall be met:

3.4.5.1 Storm water infiltration systems and ponds shall be located at least 400 feet from a well serving a community water system unless the department concurs that a lesser separation distance would provide adequate protection of a well from contamination.

3.4.5.2 Storm water BMPs shall be located with a minimum separation distance from any well serving a non-community or private water system as listed within s. NR 812.08, Wis. Adm. Code.

Note: Chapter NR 815, Wis. Adm. Code, regulates injection wells including storm water injection wells. Construction or use of a well to dispose of storm water directly into groundwater is prohibited under s. NR 815.11(5), Wis. Adm. Code.

3.4.6 For any permanent structures, provisions shall be made for long-term maintenance with the municipality or other responsible party. For an NOI submitted to the department, a copy of the signed long-term maintenance agreement shall be submitted to the department with the NOI unless the department agrees that it may be submitted by an alternative date prior to termination of permit coverage. The department may withhold permit coverage until the long-term maintenance agreement is submitted to the department.

Note: The long-term maintenance agreement is an important requirement and the department wants to ensure that appropriate steps are being taken to secure the agreement. The department encourages the landowner to obtain a municipal agreement for long-term maintenance of regional treatment structures. Long-term storm water BMPs should be maintained after permit termination in accordance with the maintenance agreement and NR 216.005, Wis. Adm. Code.

3.5 Amendments

3.5.1 The permittee shall amend the erosion control and/or storm water management plans if any of the following occurs:

3.5.1.1 There is a change in design, construction, operation or maintenance at the construction site, which has the reasonable potential for the discharge of pollutants and has not otherwise been addressed in the erosion control and storm water management plans.

3.5.1.2 There is a change in the sequence, schedule, or phasing of construction at the construction site which has a reasonable potential to cause an exceedance of the 5 tons per acre per year sediment performance standard.

3.5.1.3 The actions required by the erosion control and storm water management plans fail to reduce the impacts of pollutants carried by construction site storm water runoff.

3.5.2 For construction sites for which there has been earlier department review of the erosion control and storm water management plans, if the permittee identifies changes needed in either plan, the permittee shall notify the department regional storm water contact at least 5 working days prior to making the changes in the plan.

Note: Land disturbance outside the limits depicted in plans submitted to the department, an increase in proposed impervious area, or changes to the design of post-construction site treatment practices typically require changes to the erosion control or storm water management plans. The department may require a permittee to file a new notice of intent if the amended site requires resource screening of additional area, the amended site no longer meets an exemption from post-construction performance standards under ss. NR 151.121 to 151.125, Wis. Adm. Code, the plans do not meet one or more requirements of sub. III of NR 216, Wis. Adm. Code, or the conditions of a permit issued pursuant to this subchapter.

3.5.3 The department may, upon request of a permittee or upon finding of just cause, modify the compliance and reporting schedules or any requirement of a storm water discharge permit.

4. WATER QUALITY STANDARDS, MONITORING, AND RECORDS

4.1 Water Quality Standards

This permit specifies the conditions under which storm water may be discharged to waters of the state for the purpose of achieving water quality standards contained in chs. NR 102 through 105, NR 140, and NR 207, Wis. Adm. Code. For the term of this permit, compliance with water quality standards will be addressed by adherence to general narrative-type storm water discharge limitations, compliance with the applicable performance standards of subch. III or IV of ch. NR 151, Wis. Adm. Code, and implementation of the erosion control and storm water management plans and BMPs. A permittee with a construction site covered under this permit shall select, install, implement and maintain BMPs as necessary to meet applicable water quality standards. Unless notified by the department in writing to the contrary, compliance with the applicable performance standards of subch. III or IV of ch. NR 151, Wis. Adm. Code, shall be deemed as stringent as necessary to ensure that storm water discharges covered by this permit do not cause or contribute to an excursion above any applicable water quality standard.

4.2 Outstanding and Exceptional Resource Waters

4.2.1 Before beginning land-disturbing construction activity, the permittee shall determine whether any part of its construction or post-construction site storm water will discharge to an outstanding resource water (ORW) or exceptional resource water (ERW). ORWs and ERWs are listed in ss. NR 102.10 and 102.11, Wis. Adm. Code, respectively.

Note: The department recommends that an applicant for permit coverage check for ORWs and ERWs during project planning prior to submitting an NOI. A list of ORWs and ERWs may be found on the department's internet site at: https://dnr.wi.gov/topic/surfacewater/orwerw.html.

4.2.2 The permittee may not establish a new storm water discharge of pollutants directly to an ORW or an ERW unless the discharge of pollutants is equal to or less than existing levels of pollutants immediately upstream of the discharge site. The erosion control and storm water management plans required under section 3 of this permit shall include BMPs designed to meet this requirement for a new storm water discharge.

4.2.2.1 "New storm water discharge" means a storm water discharge that would first occur after the permittee's start date of coverage under this permit to a surface water to which the construction site or post-construction site did not previously discharge storm water.

4.2.3 The permittee's erosion control and storm water management plans required under this permit shall be designed to prevent the discharge of sediment and other pollutants to any ORW or ERW in excess of the background level within the water body. Unless notified by the department in writing to the contrary, compliance with the applicable performance standards of subch. III or IV of ch. NR 151, Wis. Adm. Code, shall be deemed in compliance with the requirements of this section. If the department has sufficient site-specific data to determine that the permittee's construction or post-construction site storm water will discharge a pollutant in excess of the background level within an ORW or ERW, then the department shall notify the permittee in writing that the permittee shall include a written section in the erosion control and storm water management plans that discusses and identifies the management practices and control measures the permittee will implement to prevent the discharge of any pollutant in excess of the background level within the water body. This section of the permittee's plans shall specifically identify control measures and practices that will collectively be used to prevent the discharge of a pollutant in excess of the background level within the water body.

Note: Reducing or eliminating surface water discharges to an ORW or ERW by infiltrating runoff is a method to help prevent the discharge of pollutants to an ORW or ERW in excess of background levels. It is expected that post-construction storm water management practices will be designed to maintain or increase infiltration rates for the site as compared to pre-development infiltration rates for areas that discharge to any ORW or ERW. However, prohibitions, exclusions, or exemptions from infiltrating runoff may apply to runoff from potential sources of contamination or into areas that are prone to groundwater contamination as identified in s. NR 151.12(5)(c)5. and 6., Wis. Adm. Code, or s. NR 151.124(3) and (4), Wis. Adm. Code. Infiltration systems shall be designed to comply with the groundwater quality standards contained in ch. NR 140, Wis. Adm. Code.

4.2.4 Protective areas of at least 75 feet shall be maintained adjacent to any ORW and ERW as required under ss. NR 151.12 (5)(d), NR 151.125, 151.24(6), or NR 151.245, Wis. Adm. Code.

4.3 Fish and Aquatic Life Waters

4.3.1 Before beginning land-disturbing construction activity, the permittee shall determine if the site will have a storm water discharge to a fish and aquatic life water as defined in s. NR 102.13, Wis. Adm. Code.

Note: The department recommends that an applicant check for fish and aquatic life waters during project planning prior to submitting an NOI. Most receiving waters of the state are classified as a fish and aquatic life water and this classification includes all surface waters of the state except ORWs, ERWs, Great Lakes system waters and variance water identified within ss. NR 104.05 to 104.10, Wis. Adm. Code. The department may be consulted if the applicant is not certain of the classification.

4.3.2 The permittee may not establish a new storm water discharge of pollutants to a fish and aquatic life water if the discharge will result in the significant lowering of water quality of the fish and aquatic life water. Significant lowering of water quality is defined within ch. NR 207, Wis. Adm. Code. If discharges result in the significant lowering of water quality, the procedures of s. NR 207.04 (c) 1., Wis. Adm. Code may apply, and the permittee shall include this as additional information pursuant to s. NR 216.48 (3), Wis. Adm. Code. Unless notified by the department in writing to the contrary, compliance with the applicable performance standards of subch. III or IV of ch. NR 151, Wis. Adm. Code, shall be deemed in compliance with the requirements of this section. “New storm water discharge” has the meaning given in section 4.2.2.1 of this permit.

4.4 Impaired Water Bodies and Total Maximum Daily Load Requirements

4.4.1 “Pollutant(s) of concern” means a pollutant that is contributing to the impairment of a water body.

4.4.2 Before beginning land-disturbing construction activity, the permittee shall determine whether any part of its construction or post-construction site storm water will discharge to an impaired water body listed in accordance with Section 303(d)(1) of the federal Clean Water Act, 33 USC §1313(d)(1)(C), and the implementing regulation of the US Environmental Protection Agency, 40 CFR §130.7(c)(1). Impaired waters are those that are not meeting applicable water quality standards.

Note: The list of Wisconsin impaired surface water bodies may be obtained by contacting the department or by searching for keyword “impaired waters” on the department’s internet site. The department updates the list approximately every two years. The updated list is effective upon

approval by the USEPA. The current list may be found on the department's Internet site at: https://dnr.wisconsin.gov/topic/SurfaceWater/ConditionLists.html.

4.4.3 A permittee that will discharge a pollutant of concern via storm water to an impaired water body shall include a written section in the erosion control and storm water management plans that specifically identifies control measures and management practices that will collectively be used to reduce, with the goal of eliminating, the storm water discharge of pollutant(s) of concern that contribute to the impairment of the water body and explain why these control measures and management practices were chosen as opposed to other alternatives. Unless notified by the department in writing to the contrary, compliance with the applicable performance standards of subch. III or IV of ch. NR 151, Wis. Adm. Code, shall be deemed to be compliance with the requirements of this section.

4.4.4 The permittee may not establish a new storm water discharge of a pollutant of concern to an impaired water body or increase an existing discharge of a pollutant of concern to an impaired water body unless the new or increased discharge causes the receiving water to meet applicable water quality standards, or the discharge is consistent with a USEPA approved total maximum daily load (TMDL) allocation for the impaired water body. Unless notified by the department in writing to the contrary, compliance with the applicable performance standards of subch. III or IV of ch. NR 151, Wis. Adm. Code, shall be deemed to be compliance with the requirements of this section. "New storm water discharge" has the meaning given in section 4.2.2.1 of this permit.

4.4.5 Before beginning land-disturbing construction activity, the permittee shall determine whether any part of its construction or post-construction site storm water will discharge a pollutant of concern via storm water to a water body included in a State and Federal approved TMDL. If so, the permittee shall assess whether the TMDL wasteload allocation for the facility's discharge will be met through the existing erosion control and storm water management plans and compliance with the applicable performance standards of subch. III or IV of ch. NR 151, Wis. Adm. Code, or whether changes to the plans are necessary.

Note: The department recommends that an applicant for permit coverage check for approved TMDLs during project planning prior to submitting an NOI. State and Federal approved TMDLs can be identified by contacting the department, or by searching for keyword "TMDL" on the department's internet site at dnr.wi.gov. The current State and Federal approved Final TMDLs may be found on the department's internet site at: https://dnr.wisconsin.gov/topic/TMDLs.

4.4.6 After determining whether the construction or post-construction site storm water discharge is included in a USEPA approved TMDL and determining that any TMDL wasteload allocation for the construction or post-construction site's discharge is not being met, the permittee shall amend the erosion control and storm water management plans. The amended plans shall include the necessary control measures to meet the requirements of the USEPA approved TMDL wasteload allocation for the construction or post-construction site. If a specific wasteload allocation has not been assigned to the construction or post-construction site under a TMDL, compliance with the applicable performance standards of subch. III or IV of ch. NR 151, Wis. Adm. Code, and this permit shall be deemed to be compliance with the TMDL.

4.5 Inspections and Maintenance
The permittee shall:

4.5.1 Conduct the following construction site inspections:

4.5.1.1 Weekly inspections of erosion and sediment control BMPs; and

4.5.1.2 Inspections of erosion and sediment control BMPs within 24 hours after a rainfall event of 0.5 inches or greater. A "rainfall event" may be considered to be the total amount of rainfall recorded in any continuous 24-hour period.

Note: More frequent visual monitoring is recommended for activities such as dewatering and trackout.

4.5.2 Repair or replace erosion and sediment control BMPs as necessary within 24 hours of an inspection or notification indicating that repair or replacement is needed.

4.5.3 Maintain, at the construction site or via an internet site, weekly written reports of all inspections conducted by or for the permittee. If an internet site method is used, the landowner shall provide the internet address to the department prior to its use. Weekly inspection reports shall include all of the following:

4.5.3.1 The date, time and exact location of the inspection.

4.5.3.2 The name of the individual who performed the inspection.

4.5.3.3 An assessment of the condition of erosion and sediment control BMPs.

4.5.3.4 A description of any erosion and sediment control installation or maintenance performed in response to the inspection.

4.5.3.5 A description of the present phase of construction at the site and any schedule modifications that may increase sediment discharge.

Note: The department has developed an inspection report form that includes the above items and it is available through the department's storm water Internet site at: https://dnr.wisconsin.gov/topic/Stormwater/construction/forms.html.

4.5.4 Submit the information maintained in accordance with section 4.5.3 to the department upon request.

4.6 Records

4.6.1 The permittee shall retain records of all construction site inspections, copies of all reports and plans required by this permit, and records of all data used to obtain coverage under this permit. Minimum periods of retention are as follows:

4.6.1.1 If there is a secure location, such as a construction site trailer, the erosion control and storm water management plans and amendments to the erosion control and storm water management plans shall be retained at the construction site until permit coverage is terminated.

4.6.1.2 All reports required by subch. III of ch. NR 216, Wis. Adm. Code, or information submitted to obtain coverage under this permit, including the erosion control and storm water management plans, amendments, and background information used in their preparation, shall be kept by the permittee for a period of at least 3 years from the date of termination of permit coverage.

4.6.2 A landowner operating a construction site under approved municipal erosion and sediment plans, grading plans, or storm water management plans shall also submit signed copies of the NOI to the local agency approving the plans. If storm water from the construction site discharges to a municipal separate storm sewer system that is operating pursuant to a municipal storm water discharge permit issued pursuant to subch. I of ch. NR 216, Wis. Adm. Code, then a signed copy of the NOI shall also be sent to the operator of the system.

4.6.3 Upon request by the department the permittee shall provide a copy of the erosion control and storm water management plans, construction site inspections and any additional data requested, within 5 working days to the department, to the operator of the municipal storm sewer system that receives the discharge, and any municipal agency approving erosion and sediment plans, grading plans or storm water management plans. Additional information may be requested by the department for resource waters that require additional protection such as outstanding or exceptional resource waters, or other sensitive water resources.

4.7 Compliance with Other Applicable Regulations

4.7.1 The erosion control and storm water management plans shall document other applicable municipal regulatory provisions, compliance with which will also meet the requirements of this permit. Subject to the requirements for uniform statewide standards established by the department under s. 281.33(3), Wis. Stats., if these municipal provisions are more stringent than those provisions appearing in this permit issued pursuant to subch. III of ch. NR 216, Wis. Adm. Code, the erosion control and storm water management plans shall also include a description of how compliance with the municipal provisions will be achieved.

4.7.2 The erosion control and storm water management plans shall comply with applicable state plumbing regulations.

4.8 Department Actions

4.8.1 The department may notify the permittee at any time that the erosion control and storm water management plans do not meet one or more of the minimum requirements of subch. III of ch. NR 216, Wis. Adm. Code, or this permit, for reducing and preventing the discharge of pollutants. The notification shall identify those provisions that are not being met by the erosion control and storm water management plan and identify which provisions of the plan require modification in order to meet the requirements. Within the time frame identified by the department in its notification, the permittee shall make the required changes to the erosion control and storm water management plans, perform all actions required by the revised plans, and submit to the department a written certification that the requested changes have been made and implemented, and such other information the department requires. The department may revoke coverage under this permit for failure to comply with this section or it may take action under s. 283.89, Wis. Stats., or both. The landowner of a construction site where the department has revoked coverage under this permit may not discharge storm water to waters of the state from the construction site unless an individual WPDES permit for storm water discharge is issued to the landowner.

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4.8.2 The department shall withdraw a construction site from coverage under this permit and issue an individual WPDES permit upon written request of the discharger. This permit authorizing storm water discharges from the construction site remains in effect until the department acts on such a request and issues a specific individual WPDES permit.

4.8.3 The department may deny coverage under this permit and require submittal of an application for an individual WPDES storm water discharge permit based on a review of the completed NOI or other relevant information. The landowner of a construction site denied or revoked coverage under this permit may not discharge storm water to waters of the state from the construction site until an individual WPDES permit for storm water discharge is issued to the landowner.

4.8.4 The department may require the landowner of any storm water discharge covered by this permit, to apply for and obtain an individual WPDES storm water discharge permit if any of the following occur:

4.8.4.1 The storm water discharge is determined to be a significant source of pollution and more appropriately regulated by an individual WPDES storm water discharge permit.

4.8.4.2 The storm water discharge is not in compliance with the terms and conditions of subch. III of ch. NR 216, Wis. Adm. Code, or of this permit.

4.8.4.3 A change occurs in the availability of demonstrated technology or BMPs for the control or abatement of pollutants from the storm water discharge.

4.8.4.4 Effluent limitations or standards are promulgated for a storm water discharge that is different than the conditions contained in subch. III of ch. NR 216, Wis. Adm. Code.

4.8.5 Any person may submit a written request to the department that it take action under section 4.8.4 above.

5. GENERAL CONDITIONS

The general conditions in s. NR 205.07(1), (3), and (5), Wis. Adm. Code, are hereby incorporated by reference into this permit, except for s. NR 205.07(1)(n) and(3)(b), Wis. Adm. Code. Under s. NR 205.08(9), Wis. Adm. Code, dischargers covered under a storm water general permit are not required to submit an application for reissuance unless directed to do so by the department under s. NR 216.22(9), Wis. Adm. Code. The requirements for spill reporting are in section 5.5 below.

Note[1]: Chapter NR 205 is available at the following website: https://docs.legis.wisconsin.gov/code/admin_code/nr/200.

Note[2]: Activities performed in wetland areas, in floodplains, or near shorelands may require permits or approvals through applicable state law, state regulations, or county or local ordinances. Additionally, state permits and/or contracts required by chs. 30, 31 and 87, Wis. Stats. and s. 281.36, Wis. Stats. (or Wisconsin Administrative Code promulgated under these laws), and federal permits may be applicable.

5.1 Continuation of the Expired General Permit As provided in s. NR 205.08(9), Wis. Adm. Code, and s. 227.51, Wis. Stats., the terms and conditions of this general permit shall continue to apply until this general permit is reissued or revoked or until an individual permit is issued for the discharge to which the general permit applied.

5.2 Liabilities under Other Laws Nothing in this permit shall be construed to preclude the institution of any legal action or relieve the permittee from any responsibilities, liabilities, or penalties to which the permittee is or may be subject under Section 311 of the federal Clean Water Act (33 USC s. 1321), any applicable federal, state, or local law or regulation under authority preserved by Section 510 of the Clean Water Act (33 USC s. 1370).

5.3 Severability The provisions of this permit are severable, and if any provisions of this permit or the application of any provision of this permit to any circumstance is held invalid the remainder of this permit shall not be affected thereby.

5.4 Spill Reporting The permittee shall notify the department immediately of any release or spill of a hazardous substance to the environment in accordance with s. 292.11, Wis. Stats., and ch. NR 706, Wis. Adm. Code.

Note: The 24-hour toll free spills hotline number is (800) 943-0003. Information about hazardous substance spills is available from the department's website at: https://dnr.wisconsin.gov/topic/Spills.

5.5 Submitting Records Unless otherwise specified, any reports submitted to the department in accordance with this permit shall be submitted to the appropriate department regional storm water contact or to the Wisconsin DNR, Storm Water Program – WT/3, Box 7921, Madison, WI 53707-7921.

5.6 Enforcement Any violation of s. 283.33, Wis. Stats., ch. NR 216, Wis. Adm. Code, or this permit is enforceable under s. 283.89, Wis. Stats.

5.6.1 Upon becoming aware of any permit noncompliance that may endanger public health or the environment, the permittee shall report this information by a telephone call to the Department regional storm water specialist within 24 hours. A written report describing the noncompliance shall be submitted to the Department regional storm water specialist within 5 days after the permittee became aware of the noncompliance. The Department may waive the written report on a case-by-case basis based on the oral report received within 24 hours. The written report shall contain a description of the noncompliance and its cause; the period of noncompliance, including exact dates and times; the steps

taken or planned to reduce, eliminate, and prevent reoccurrence of the noncompliance; and if the noncompliance has not been corrected, the length of time it is expected to continue.

5.7 Petition to Move to Individual Permit Coverage Any person may submit a written request to the department to withdraw coverage under this general permit and to replace it with an individual storm water permit under s. NR 205.08(5), Wis. Adm. Code.

6. DEFINITIONS

Definitions for some of the terms found in this permit are as follows:

6.1 Authorized Local Program means a municipality that has received a conditional approval from the department pursuant to s. NR 216.415, Wis. Adm. Code.

6.2 Best Management Practices or BMPs means structural or non-structural measures, practices, techniques or devices employed to avoid or minimize soil, sediment or pollutants carried in runoff to waters of the state.

6.3 Construction Site means an area upon which one or more land disturbing construction activities occur that in total will disturb one acre or more of land, including areas that are part of a larger common plan of development or sale where multiple separate and distinct land disturbing construction activities may be taking place at different times on different schedules but under one plan such that the total disturbed area is one acre or more.

6.4 Department means the State of Wisconsin Department of Natural Resources.

6.5 Erosion means the process by which the land's surface is worn away by the action of wind, water, ice or gravity.

6.6 Final Stabilization means that all land disturbing construction activities at the construction site have been completed and that a uniform perennial vegetative cover has been established with a density of at least 70% of the cover for the unpaved areas and areas not covered by permanent structures or that employ equivalent permanent stabilization measures.

6.7 Infiltration means the entry and movement of precipitation or runoff into or through soil.

6.8 Infiltration System means a device or practice such as a basin, trench, rain garden or swale designed specifically to encourage infiltration, but does not include natural infiltration in pervious surfaces such as lawns, redirecting of rooftop downspouts onto lawns or minimal infiltration from practices, such as swales or road side channels designed for conveyance and pollutant removal only.

6.9 Land Disturbing Construction Activity means any man-made alteration of the land surface resulting in a change in the topography or existing vegetative or non-vegetative soil cover that may result in storm water runoff and lead to increased soil erosion and movement of sediment into waters of the state. Land disturbing construction activity includes, but is not limited to, clearing and grubbing, demolition, excavating, pit trench dewatering, filling and grading activities.

6.10 Landowner means any person holding fee title, an easement or other interest in property that allows the person to undertake land disturbing construction activity on the property.

6.11 Municipality means any city, town, village, county, county utility district, town sanitary district, town utility district, school district or metropolitan sewage district or any other public entity created pursuant to law and having authority to collect, treat or dispose of sewage, industrial wastes, storm water or other wastes.

6.12 Performance Standard means a narrative or measurable number specifying the minimum acceptable outcome for a facility or practice.

6.13 Permittee means a person who has applied for and received WPDES permit coverage for storm

water discharge under NR 216, Wis. Adm. Code, and this permit.

6.14 Sediment means settleable solid material that is transported by runoff, suspended within runoff or deposited by runoff away from its original location.

6.15 Stabilize means the process of making a site steadfast or firm, minimizing soil movement by the use of practices such as mulching and seeding, sodding, landscaping, paving, graveling or other appropriate measures.

6.16 Storm Water means runoff from precipitation including rain, snow, ice melt or similar water that moves on the land surface via sheet or channelized flow.

6.17 Storm Water Management Plan means a comprehensive plan designed to reduce the discharge of pollutants from storm water, after the site has undergone final stabilization, following completion of the construction activity.

6.18 Waters of the State means those portions of Lake Michigan and Lake Superior within the boundaries of Wisconsin, all lakes, bays, rivers, streams, springs, ponds, wells, impounding reservoirs, marshes, water courses, drainage systems and other surface water or groundwater, natural or artificial, public or private within the state or under its jurisdiction, except those waters which are entirely confined and retained completely upon the property of a person.

6.19 Working Day means any day except Saturday and Sunday and holidays designated in s. 230.35(4)(a), Wis. Stats.

6.20 WPDES Permit means a Wisconsin Pollutant Discharge Elimination System permit issued pursuant to ch. 283, Wis. Stats.

C.2 Facility's Current Tier 2 SWPPP

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Storm Water Pollution Prevention Plan

Ash Landfill Operations for
Columbia Dry Ash Disposal Facility (License #3025)
Columbia County, Wisconsin

Prepared for:

Wisconsin Power and Light Company
Columbia Energy Center
W8375 Murray Road
Pardeeville, Wisconsin 53954

SCS ENGINEERS

25222157.00 | July 18, 2023

2830 Dairy Drive
Madison, WI 53718-6751
608-224-2830

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STORM WATER POLLUTION PREVENTION PLAN
CERTIFICATION PAGE

COLUMBIA DRY ASH DISPOSAL FACILITY
COLUMBIA ENERGY CENTER
COLUMBIA COUNTY, WISCONSIN

July 2023

SCS Engineers prepared this Storm Water Pollution Prevention Plan for the Columbia Energy Center Dry Ash Disposal facility in accordance with the provisions in Chapter 283 and NR216, Wisconsin Statutes.

"I certify under penalty of law that this document and all attachments were prepared under direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations"

Name_____Eric Sandvig_____

Title___Director Operations WPL Generation___

Wisconsin Power and Light Co.

Signature_____

Date_____

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1.0 INTRODUCTION

1.1 SWPPP UPDATE

This Storm Water Pollution Prevention Plan (SWPPP) Update includes the following updates from the April 2022 SWPPP to reflect the construction of Phase 2, Modules 10 and 11:

- **Figure 2** (Existing Conditions)
- **Figure 3** (Drainage Areas and Outfalls) Modules 10 and 11)
- Section 1.4.2 (Phased Development Description)
- Section 1.4.3 (Site Drainage and Outfalls)
- Section 2.1 (Ash Landfill Operations)
- **Attachment H** (SWPPP Revision and Review Log Sheet)

1.2 PURPOSE AND CONTENT

This SWPPP for coal combustion residuals (CCR) landfill operations has been prepared for the Columbia Dry Ash Disposal facility (landfill) located in Section 27, T12N, R9E, Town of Pacific, Columbia County, Wisconsin. The property is used for CCR disposal for the adjacent Columbia Energy Center located at W8375 Murray Road in Pardeeville, Wisconsin. The Columbia Energy Center operates under a separate Wisconsin Pollutant Discharge Elimination System (WPDES) Tier 2 Industrial Facilities General Permit No. WI-S067857-5 (Tier 2 General Permit) and associated SWPPP, Version 2, Revision 3 dated February 2016. Wisconsin Power and Light Company (WPL) operates the Columbia Energy Center, which it co owns with Wisconsin Public Service and Madison Gas and Electric. The landfill is permitted by the Wisconsin Department of Natural Resources (WDNR) solid waste regulations (License #3025). **Figure 1** shows the site location.

This report has been prepared to meet the requirements of the Tier 2 General Permit, effective May 31, 2021. A copy of the Tier 2 General Permit is included in **Appendix A**.

The primary goal of the SWPPP is to reduce the amount of pollutants potentially contained in storm water runoff. To help accomplish this goal, this plan identifies potential sources of pollution on this site that may reasonably be expected to affect the quality of storm water discharges associated with facility activities. The plan also describes the implementation of practices that are to be used to reduce the potential for those pollutants to contaminate storm water runoff or to treat the storm water runoff prior to discharging to surface or ground waters.

This SWPPP is prepared in accordance with good engineering practices. The objectives of the SWPPP are to do the following:

- Summarize major activities conducted at the facility (**Sections 1.0** and **2.0**).
- Inventory exposed materials and summarize storm water sampling requirements for the facility (**Sections 1.0** and **2.0**).

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- Identify potential source areas of storm water contamination and significant polluting materials (**Section 2.0**).
- Identify Best Management Practices (BMPs) for facility activities (**Section 3.0**).
- Identify impacts of BMPs (**Section 4.0**).
- Identify the individuals who will implement this SWPPP (**Section 1.0**).
- Provide information on required storm water inspections (**Section 6.0** and **Attachments B** and **C**).
- Summarize storm water discharge regulatory applicability and implementation schedule (**Attachment D**).
- Discuss training requirements (**Section 7.0** and **Attachment E**).
- Provide a means of recordkeeping for storm water-related documents at the facility (**Section 8.0**).
- Provide a non-storm water discharge assessment (**Attachment F**).
- Fulfill the landfill operating license and WPDES requirements (**Attachment A**).

This plan is organized consistent with information required in SWPPPs as specified in the Tier 2 General Permit and NR 216.

WPL will maintain a copy of this plan on site and make it available to the WDNR upon request.

1.3 STORM WATER POLLUTION PREVENTION TEAM

The storm water pollution prevention team is a designated group of people that are responsible for ensuring the proper development and implementation of the SWPPP. Members of the team include representatives of WPL, who are familiar with the landfill and manage its operation.

The team is responsible for defining an appropriate set of goals for the facility storm water management program. In addition, the team must be aware of any changes to the facility and implement necessary changes to the SWPPP. The table below summarizes the team member roster including each member's position, phone number, location, and responsibilities.

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Table 1. Storm Water Pollution Prevention Team

SWPPP Team Position	Phone Number	Location	Responsibilities
SWPPP Coordinator: Brian Clepper, SWPPP Coordinator (Lead Generation Environmental Specialist)	Office: (608) 742-0713 Mobile: (608) 234-2770	WPL Columbia Energy Center, Pardeeville, WI	• Coordinate the development, implementation, evaluation, maintenance, and amendment of the SWPPP • Coordinate facility compliance with the specific actions identified in the SWPPP • Maintain BMPs • Conduct monitoring activities • Manage inspections and records • Prepare and submit reports (to be kept on file at the facility) • Serve as facility contact for WDNR
Back Up SWPPP Coordinator: Jeff Nelson (Ops Manager)	Office: (608) 742-0716	WPL Columbia Energy Center, Pardeeville, WI	

1.4 SITE DESCRIPTION AND DRAINAGE BASE MAP

1.4.1 Site Description

The site is located in the Section 27, Township 12 North, Range 9 East, Town of Pacific, Columbia County, Wisconsin (see **Figure 1**). The current site conditions are shown on **Figure 2**. A majority of the fly ash and bottom ash generated by the Columbia plant is sold for beneficial use. Fly ash and bottom ash that is not beneficially used is disposed of in the landfill. Columbia Energy Center's Air Quality Control System (AQCS) also produces flue gas desulfurization (FGD) waste that is placed in the landfill. The FGD waste is a mixture of dry FGD particulates (calcium salts and unused lime reagent), some fly ash, and spent carbon from mercury control systems. The Columbia dry ash disposal facility consists of approximately 62.5 acres, of which approximately 5.8 acres are closed (i.e., have final cover in place), approximately 9.7 acres are currently covered with intermediate cover, approximately 8.6 acres are covered with rain cover, approximately 8.8 acres are currently active and approximately 28 acres will be developed as future modules for ash disposal. There are two ponds related to the ash disposal facility, which are further described in **Section 1.4.3**. There are no buildings located on the ash disposal facility property. **Figure 2** shows the site layout.

1.4.2 Phased Development Description

The landfill will be developed in phases. **Figure 2** shows the current status of development of the various phases/modules of the landfill. The phased approach minimizes disturbance and erosion and reduces the amount of ash exposed to storm water. Because the site conditions change with the landfill development and closure phases, the SWPPP will be reviewed and updated as necessary on an annual basis.

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Phase 1 includes the western side of the facility and includes Modules 1 through 6. Phase 2 is the eastern side of the facility and includes Modules 7 through 12. Currently Module 1 is fully covered with either final cover or intermediate cover, the majority of Module 2 and Module 3 is covered with intermediate cover, and Modules 4, 5, and 6 are partially covered with intermediate cover. The active area of the landfill includes portions of Modules 2, 3, 4, 5, and 6. Modules 10 and 11 have been constructed and will begin accepting CCR in June 2023.

Clean storm water from intermediate cover is directed away from open areas using diversion berms. New diversion berms will be constructed to form the perimeter of a storm water containment area. The berms will prevent contact water from running onto the intermediate cover; then contact water from open areas of Modules 2, 3, 4, 5, 6, 10, and 11 will be collected in the leachate/surface water pond as CCR is placed (see **Section 1.4.3**).

Until ash is placed, clean storm water collected in Module 10 and Module 11 will discharge via pumps to the proposed swales then to the south sedimentation basin. As filling begins, new diversion berms will be constructed to form the perimeter of a storm water containment area. The berms will prevent contact water from running onto the unfilled areas of the modules; then contact water from Module 10 and Module 11 will be collected in the leachate/surface water pond as ash is placed (see **Section 1.4.3**).

The remaining modules are undeveloped except for drainage features, soil stockpiles, and access roads located in portions of the permitted landfill footprint.

New modules will be developed to meet the waste capacity needs of the Columbia Energy Center. New module construction will include earthwork required to establish liner subbase grades. Earthmoving equipment, which may include excavators, dozers, front end loaders, scrapers, and haul trucks, will be used to develop liner subbase grades and construct the liner and leachate collection systems in the new modules. Similar equipment will be used to place CCR in the landfill. The modules will be filled and covered in phases as they reach capacity. Further information on the phasing, filling, and closure is presented in the approved Plan of Operation.

1.4.3 Site Drainage and Outfalls

The existing site topography is shown on **Figure 2**. The facility utilizes a series of swales, diversion berms, downslope channels, perimeter swales, and culverts that direct storm water to one of three areas, as described below:

- **Leachate/Surface Water Pond:** The pond is designed to collect storm water runoff that has been in contact with CCR. Runoff collected in the pond is pumped into a truck and hauled to the generating station to be incorporated in process/industrial wastewater. The leachate/surface water pond is pumped on an as-needed basis to maintain water levels and freeboard, as defined in the approved Plan of Operation.

- **South Sedimentation Basin:** The basin is designed to collect storm water runoff from closed landfill areas, areas with intermediate cover, access roads, and undeveloped landfill areas. Runoff collected in the basin discharges via an outfall structure to a wetland or infiltrates to groundwater.

- **Vegetated Low Area:** The area collects storm water runoff from a portion of undeveloped landfill area and a portion of intermediate cover, access roads, Murray Road, and portions of stockpiles. Runoff is collected from these areas in the Murray Road ditch and

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discharges through a culvert under Murray Road to the low area on the north side of the road.

Figure 3 shows the leachate/surface water pond, south sedimentation basin, and the culvert to the vegetated low area, along with their post construction drainage areas following 2022 construction of Module 10 and Module 11. The storm water/contact water management systems have been designed in accordance with WDNR solid waste regulations, and more information on the drainage system can be found in the Plan of Operation.

The property has two storm water outfalls (Table 1) as shown on Figure 3. Outfall SW001 is the outlet of the south sedimentation basin. The outfall discharges into the south sedimentation basin which discharges to a wetland or infiltrates to groundwater. The outlet structure of the basin can handle a 25-year, 24-hour storm. The wetland ultimately discharges to an unnamed tributary to the Wisconsin River. The sedimentation basin typically has no standing water.

Outfall SW002 is the inlet side of the culvert located on the north side of the facility under Murray Road. This outfall discharges to the low area across Murray Road where runoff infiltrates to groundwater in a low area.

1.5 POTENTIAL SOURCES OF STORM WATER POLLUTION

The activities and materials that may be sources of storm water pollution include the following:

- Landfill operations
- Module construction
- Access roads
- Soil stockpiles
- Outdoor equipment storage
- Vehicle fueling

Materials handled and used at the facility that may be exposed to precipitation include bottom ash, fly ash, FGD waste solid mixture (approximate recycled fly ash and gypsum [90 percent] and pebble lime [10 percent]), soil, fuel, oil, and lubricants if equipment leaks. Section 2.0 describes the potential pollution sources in more detail.

1.6 DISCHARGE TO OUTSTANDING AND EXCEPTIONAL RESOURCE WATERS REVIEW

The site does not discharge to an outstanding resource water (ORW) or exceptional resource water (ERW). This conclusion is based on a search performed using the WDNR's Surface Water Data Viewer, an interactive, searchable online map. Supporting information is included in Attachment G.

1.7 DISCHARGE TO IMPAIRED WATERBODIES

Unless infiltrated, surface water discharges of storm water from the site ultimately discharge to an impaired waterbody listed in accordance with Section 303 (d) (1) of the Federal Clean Water Act. Annual checks of the status of the waterbody will be conducted by the SWPPP Coordinator prior to February 15th. Refer to Section 6.4.1 for more details regarding this review.

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1.8 DISCHARGE TO FISH AND AQUATIC LIFE WATERS REVIEW

The storm water discharge from the south sedimentation basin does not immediately enter a fish and aquatic life waters. Water discharged via SW001 to the sedimentation basin is discharged to the groundwater or an adjacent wetland. Water discharged via SW002 and through the Murray Road culvert is discharged to a low area where it infiltrates to the groundwater. The existing outfall locations are shown on **Figure 3**. The wetland adjacent to the sedimentation basin ultimately discharges to an unnamed tributary to the Wisconsin River, which is a fish and aquatic life water. A discussion of the site outfall is presented in **Section 1.4.3**. With the storm water runoff BMPs utilized at the facility, and review of the sources area on a regular basis as outlined by this SWPPP, the site operations are not expected to result in a significant lowering of wetland quality.

1.9 MONITORING DATA

Monitoring information for the facility is kept on-site with the SWPPP records. WPL monitors storm water runoff in accordance with the Tier 2 General Permit (see **Section 6.0**).

2.0 DESCRIPTION OF POTENTIAL POLLUTION SOURCES

2.1 ASH LANDFILL OPERATIONS

The following materials are associated with the landfilling activities:

- **FGD waste:** Fly ash, gypsum, and pebble lime is hauled from the plant and disposed in the active module of the landfill.
- **Bottom Ash:** Bottom ash is hauled in from the primary ash pond area during construction of new modules to construct the leachate drainage layer. Bottom ash that is not beneficially used may be disposed in the active module.
- **Fly Ash:** Fly ash that is not beneficially used may be disposed in the active module.
- **Soil materials:** These materials are brought in, as necessary, from on-site excavation or stockpiles and from off-site borrow areas. This material is used as liner, cover, road way material, and to promote the growth of vegetation.

The landfill design includes a leachate/contact water collection system and final cover surface water management system designed to effectively collect and route storm water runoff to the appropriate locations (refer to **Section 1.4.3**). Both of these systems have been designed to meet the requirements of Chapter NR 504, Wisconsin Administrative Code. Storm water that comes in contact with waste is collected by the leachate/contact water collection system. The leachate is routed to the leachate/surface water pond via the leachate collection pipes and contact water swales. The leachate/surface water pond is currently pumped and hauled to the plant, as discussed in **Section 1.4.3**.

The final cover surface water management system collects and routes storm water runoff from the cover in a controlled manner while minimizing erosion and the off-site migration of sediment. Storm water runoff from the closed landfill, access roads, and undeveloped portions of the site is routed to the south sedimentation basin to settle out suspended solids before discharging off site. The sedimentation basin is sized to accommodate a 25-year, 24-hour storm event. A portion of Module 6

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intermediate cover and a portion of future Module 13 area discharges to the north vegetated low spot.

If storm water was to come into contact with this potential pollution source area, the pollutants that may be present are leachate/contact water, FGD mixture, bottom ash, fly ash, and sediment. Because the landfill includes a leachate/contact water collection and storm water management system, the potential for impact to storm water is minimal.

2.2 ACCESS ROADS

Hauling of FGD, bottom ash, and soil is performed along access roads throughout the facility (see Figure 2). FGD is hauled to the landfill via access roads from the landfill entrance. The access roads are constructed of gravel material. The site access roads drain to the south sedimentation basin or the leachate/surface water pond via swales. The gravel roads minimize mud tracking onto paved surfaces. Facility personnel sweep paved surfaces when mud tracking occurs.

Access roads are possible sources of storm water pollution due to the high activity of vehicle traffic and the potential for equipment breakdowns. If storm water was to come into contact with this potential pollution source area, the potential pollutants include hydraulic fluids, antifreeze, leachate, FGD, bottom ash, fly ash, and sediment.

2.3 SOIL STOCKPILES

Excess soil is stockpiled on site from excavations performed during landfill and ancillary feature development or closure events. Existing stockpiles, which have been stabilized with vegetation, are shown on Figure 2. New stockpiles or disturbance of existing stockpiles may result from construction of Modules 10 and 11. If storm water was to come in contact with this potential pollution area, the potential pollutant is sediment. Runoff from the stockpiles is collected by perimeter ditches and routed to the sedimentation basin or the low area north of Murray Road.

2.4 OUTDOOR EQUIPMENT STORAGE

Outdoor equipment storage includes outdoor parking of landfill equipment and construction equipment during construction events.

Landfill equipment is parked overnight on the landfill. Construction equipment is parked in the construction area or laydown area. The pollutants that may be present include petroleum-based products. Runoff that may come into contact with any leaks or spills from the equipment would be routed to the leachate/surface water pond or through swales to the South Sedimentation Basin.

2.5 VEHICLE FUELING

Landfill equipment is fueled within the coal yard area at the adjacent generating station and within the area of active landfill operations. Contractor construction equipment may be fueled at the landfill during module construction or closure activities. For fueling occurring within the limits of waste, storm water that may come in contact with any leaks or spills from the tank would be routed to the leachate/surface water pond. The pollutants that may be present from these sources include diesel, unleaded gasoline, and hydraulic fluid.

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3.0 BEST MANAGEMENT PRACTICES

Storm water pollution prevention is achieved through implementing certain procedures, practices, and preventative maintenance that will reduce or eliminate potential storm water pollution sources (identified in **Section 2.0**). These procedures and practices are defined as BMPs. This section presents the following BMPs that apply to general facility operations:

- Spill Prevention and Response
- Pollution Prevention Training

This section also presents BMPs that are specific to the following activities at the facility:

- Ash Landfilling Operations
- Site Construction Events
- Material Hauling on Access Roads
- Vehicle and Equipment Fueling
- Soil Stockpiling
- Housekeeping
- Outdoor Equipment Storage
- Sedimentation Basin

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3.1 GENERAL BEST MANAGEMENT PRACTICES

3.1.1 Spill Prevention and Response

General Activity: Spill Prevention and Response	
BMP Objective: To reduce or eliminate the potential for significant material spills at the facility.	
Practice	**Implementation Schedule/Frequency**
• In the event of a spill incident of any quantity, call: **EMERGENCY COORDINATOR:** **Brian Clepper (608) 742-0713 (work)** **(608) 234-2770 (cell)** **Alternate if above is not available:** **Columbia Control Room: (608) 742-0733** **Shift Supervisor: (608) 742-0730** • **Spill Management** – Manage in accordance with the spill response flow chart provided in **Table 2 and Columbia Energy Center SPCC Plan**. • **Good Housekeeping** – Keep material storage/usage areas clean and clear of debris. Slipping or tripping while handling materials may cause spills. • **Maintaining Containers** – Maintain containers that store significant materials in good condition. Dents and/or rust are weak points on containers that could rupture and release materials. Containers in poor condition should be replaced. • **Handling Containers** – Take proper care during container handling. Containers that are moved too fast could spill material by hitting objects that could puncture container and/or tip over. • **Storing Containers** – Store containers upright with the lids securely attached. • **Dispensing Materials** – Take proper care while dispensing liquids. Use funnels when transferring liquids. Dispense liquids slowly to prevent overfilling and spillage. If available, use auto-shutoff nozzles while fueling equipment. • **Maintaining Equipment** – Maintain equipment and inspect frequently to identify potential leakage points. • **Spill Response** – Clean up incidental spills immediately with absorbent materials.	As required

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Table 2. Oil Spill Notification Procedures

Agency/ Organization	Contact	Circumstances	When to Notify
State Agencies			
WDNR Spill Reporting Hotline	1-800-943-0003	1. Discharge that threatens public health, welfare or the environment, **or** 2. Discharge that produces a sheen on water and/or threatens navigable waters, **or** 3. One gallon or more of flammable liquid (e.g., gasoline) onto unpaved ground, **or** 4. Five gallons or more of combustible liquid (e.g., diesel) onto unpaved ground.	**Immediately** (verbal)
Federal Agencies			
National Response Center (NRC)	1-800-424-8802 www.nrc.uscg.mil	Discharge reaching navigable waters.	**Immediately** (verbal)
U.S. Environmental Protection Agency (U.S. EPA) Region V (hotline)	1-800-621-8431	Discharge reaching navigable waters.	**Immediately** (verbal)
U.S. EPA Region V Regional Administrator	U.S. EPA Region 5 77 W. Jackson Blvd. Chicago, IL 60604	Discharge of 1,000 gallons or more; or second discharge of 42 gallons or more over a 12-month period.	Written notification within 60 days (see **SPCC Plan**)
Local Agencies			
Fire Department	911	Discharge that poses emergency conditions, regardless of the volume discharged.	**Immediately** (verbal)
Columbia County Emergency Management	608-742-4166	Discharge that poses emergency conditions, regardless of the volume discharged.	**Immediately** (verbal)

Notes:

1. In the event of spills or other environmental incidents of any quantity, the Emergency Coordinator shall be contacted. The Emergency Coordinator shall inform Alliant Energy Environmental Services management consistent with Alliant Energy Policy ENV107.

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2. In the event of an environmental site inspection by authorized representatives of federal, state, or local regulatory agencies, the Emergency Coordinator shall be contacted. Additionally, Alliant Energy Policy ENV 102 shall be followed.

3.1.2 Pollution Prevention Training

General Activity: Pollution Prevention Training		
BMP Objective: To familiarize the pollution prevention team, responsible employees, and contractors with the requirements of this SWPPP and methods for its implementation. Training is further discussed in **Section 7.0**.		
Training	**Attendees**	**Implementation Schedule/Frequency**
Storm Water Pollution Prevention Plan Training	Pollution Prevention Team and Responsible Employees	Initially/Annually

3.2 ACTIVITY SPECIFIC BEST MANAGEMENT PRACTICES

3.2.1 Ash Landfilling Operations

Facility Activity: FGD/Bottom Ash/Fly Ash Handling and Disposal	
BMP Objective: To reduce exposure of FGD/ash to precipitation/storm water runoff during landfill operations.	
Practice	**Implementation Schedule/Frequency**
• Operate the facility in accordance with the requirements of the landfill's license. • Minimize the amount of open cell area. • Route storm water that has come into contact with FGD/ash to the leachate/surface water pond. Storm water that enters the active cell must be treated as leachate and routed to the leachate/surface water pond. • Route storm water runoff that has not come in to contact with FGD/ash to the south sedimentation basin. Storm water that comes in contact with intermediate cover may be routed to the sedimentation basin. • Temporarily close active areas by installing rain flaps or placing intermediate cover and diverting runoff to the south sedimentation basin to reduce the active landfill area. • Construct diversion berms and downslope flumes along final cover slopes to minimize erosion along the final cover. • Maintain contact water levels in the contact water pond in accordance with the most recent "Leachate/Surface Water Pond Capacity Evaluation" (current version as of the date of this SWPPP update is March 2022, as presented in the 2022 POO Update).	As needed during activity

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Facility Activity: FGD/Bottom Ash/Fly Ash Handling and Disposal	
BMP Objective: To reduce exposure of FGD/ash to precipitation/storm water runoff during landfill operations.	
Practice	**Implementation Schedule/Frequency**
• For areas with temporary rain cover installed: – Do not place CCR on top of rain cover. – Inspect water that collects on areas with rain cover for evidence of leachate or contact water impacts. If evidence of leachate or contact water are noted, plug the discharge to surface water and repair/address source of leachate/contact water. Discharge water to leachate pond, haul water to the primary ash pond, or use for dust control within limits of waste. – Repair damaged rain cover using a geosynthetic installer with similar qualifications to the company that originally installed it. – Remove rain cover prior to placing CCR. Rain cover may be removed in sections as waste placement progresses.	As needed during activity
– Inspect rain cover, including berms and anchoring, after significant precipitation events (greater than 0.5 inch) to ensure that leachate or contact water has not run onto the temporary rain cover.	After precipitation events ≥ 0.5 inch
– Inspect operations to ensure that storm water runoff is being properly handled (i.e., water in contact with FGD/ash is collected in the leachate/surface water pond and water not in contact with FGD/ash is routed to the sedimentation basin). – Ensure that any berms, rain cover, sedimentation basin, or other sediment removal or storm water conveyance and diversion structures are in good condition.	During each SWPPP inspection

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3.2.2 Site Construction Events

Facility Activity: Construction Events at the Facility (e.g., liner or final cover construction events)	
BMP Objective: To reduce off-site discharge of sediment during construction events.	
Practice	**Implementation Schedule/Frequency**
• Minimize the amount of disturbed area. • Divert runoff around the disturbed area. • Maintain gravel access road to reduce material tracking to public streets. • Keep the construction area clear of debris. • Place silt fence or silt sock downslope of disturbed areas and prior to wetlands/waterways, prior to the start of disturbance. • Implement additional erosion control practices as applicable to the construction event. Refer to WDNR construction site erosion and sediment control standards (http://dnr.wi.gov/topic/Stormwater/standards/const_standards.html). • Develop a construction site erosion control plan as part of the detailed site construction plans. • Install, inspect, and maintain all sediment control practices in accordance with the associated WDNR Technical Standard (http://dnr.wi.gov/topic/Stormwater/standards/const_standards.html). • Implement BMPs to limit sediment discharge to no more than 5 tons/acre/year, to the maximum extent practicable, from initial grading to final stabilization. Refer to WDNR guidance document EGAD No. 3800-2017-03 (Construction Site Soil Loss and Sediment Discharge Calculation Guidance), including prescriptive compliance areas, when evaluate soil loss. • Install, inspect and maintain BMPs in accordance with WDNR Conservation Practice standards (http://dnr.wi.gov/topic/Stormwater/standards/const_standards.html). • Minimize the amount of disturbance to the extent practicable. • Divert runoff around disturbed areas. • Maintain gravel access road to reduce material tracking to public streets. Clean up sediment tracked onto public streets by the end of each working day. • Keep the construction area clear of debris. • Place silt fence or silt sock downslope of disturbed areas and prior to wetlands/waterways prior to the start of disturbance. • Locate stockpiles outside of drainage ways and divert run-on around stockpile areas using diversion swales as needed. • Commence temporary stabilization activities when land disturbing construction activities have temporarily ceased and will not resume for a period exceeding 14 calendar days. [ref. NR 151.105(6)(d)]. • Vegetate stockpiles when not in use for 6 months or more. [ref NR 506.07(1)(r)].	As required during activity

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Facility Activity: Construction Events at the Facility (e.g., liner or final cover construction events)	
BMP Objective: To reduce off-site discharge of sediment during construction events.	
Practice	**Implementation Schedule/Frequency**
• Install BMPs (e.g., silt fence/silt sock) around stockpiles that will be in existence for more than 7 days. [ref NR 151.11(6m)6.]. • Protect runoff channels as necessary to prevent scour and erosion that generates sediment. • Stabilize (seed, gravel, pave) areas as soon as practical upon completion of construction. • For areas of the landfill which will not contain solid waste and are to be vegetated, seed and mulch/erosion mat no later than 90 days after completion of construction or by October 15, whichever is earlier, and if construction is completed after September 15, no later than June 15 of the following year. [ref. NR 506.07(2)(c)]. • For landfill closure areas, seed, fertilize, and mulch/erosion mat within 180 days after ceasing to accept solid waste, or if solid waste termination is after September 15, by June 15 of the following year. [ref. NR 506.08(4)] • Refer to WDNR Guidance Document #3800-2016-01 (Storm Water Discharge Permit Coverage at Solid Waste Landfills) for additional background/guidance.	As required during activity
• Inspect public streets for off-site tracking of sediment. Clean material tracked on public roads. Do not flush with water.	Daily
• Inspect erosion control practices. Repair as necessary.	Weekly and within 24 hours after a precipitation event that produces 0.5 inch of rain or more during a 24-hour period.

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3.2.3 Material Hauling on Access Roads

Facility Activity: FGD/Ash/Soil Hauling on Facility Access Roads	
BMP Objective: To reduce exposure of ash and soil to precipitation/storm water runoff during ash hauling.	
Practice	**Implementation Schedule/Frequency**
• Maintain gravel access road to reduce material tracking to public streets. • Keep the access roads clear of debris. • Repair any damage to access roads. • Do not overfill trucks with FGD/ash/soil. • Control dust from access roads by watering. Do not water the access roads to the extent that runoff is produced from the watering activities. • Clean material tracked on public roads.	As required during activity
• Inspect access roads for signs of damage. • Inspect access roads for signs of contamination.	During each SWPPP inspection

3.2.4 Vehicle and Equipment Fueling

Facility Activity: Equipment Fueling	
BMP Objective: To reduce exposure of fuel to precipitation/storm water runoff that may result from spills or leaks.	
Practice	**Implementation Schedule/Frequency**
• Equipment operator must be present at all times during fueling. • If drip pans are not available to collect drips, use dry cleanup methods (i.e., absorbent wipes, granular floor dry) for fueling area spills. • Replace faulty fueling equipment. • Dispose of any fuel spills or leaks properly.	As needed during activity
• Inspect fueling equipment for leaks/failures. • Inspect fueling area for evidence of spills/leaks.	During each SWPPP inspection

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3.2.5 Soil Stockpiling

Facility Activity: Creating and Maintaining Soil Stockpiles	
BMP Objective: To reduce erosion of soil stockpiles during precipitation/storm water events.	
Practice	**Implementation Schedule/Frequency**
• Minimize the size and number of soil stockpiles needed by properly planning construction and excavation activities. • Locate stockpiles outside of drainage ways and divert run-on around stockpile areas using diversion swales as needed. • Vegetate stockpiles when not in use for 6 months or more. • Install BMPs (e.g., silt fence/silt sock) around stockpiles that will be in existence for more than 7 days. [ref NR 151.11(6m)6.]. • Provide additional BMPs during active excavating or placement of soil in stockpile area such as silt fence/silt sock along areas downslope of exposed area.	As needed during activity
• Inspect stockpiles for signs of erosion. • Ensure that any silt fence, silt sock, or other sediment removal or storm water diversion structures are in good condition.	During each SWPPP inspection

3.2.6 Housekeeping

Facility Activity: Housekeeping	
BMP Objective: To reduce exposure of all potentially significant polluting materials at the facility to precipitation/storm water runoff during everyday activities.	
Practice	**Implementation Schedule/Frequency**
• Ensure that waste debris is picked up on a regular basis. • Train employees in site inspection and basic cleanup procedures. • Maintain records and internal reporting procedures in the event of a release to the environment. • Clearly indicate proper disposal locations for various waste types at the facility.	As needed during activity
• Inspect disposal areas for signs that volume of disposal space is inadequate, and for cleanliness. • Inspect facility for signs that good housekeeping procedures are not being followed.	During each SWPPP inspection

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3.2.7 Outdoor Equipment Storage

Facility Activity: Outdoor Storage of Equipment	
BMP Objective: To minimize potential storm water impacts from the outdoor storage of materials and equipment not covered by other items above.	
Practice	**Implementation Schedule/Frequency**
• Keep the storage areas clean of debris. • Repair or replace damaged (e.g., holes, nonfunctioning seals, etc.) containers and equipment. • Periodically wash containers and trucks in doors. • Maintain equipment and containers as described in **Section 3.1.1**.	As required during activity
• Inspect bins and equipment for signs of damage or leaks. • Inspect surrounding area for signs of contamination.	During each SWPPP inspection

3.2.8 Sedimentation Basin

Facility Activity: Storm Water Quality BMP	
BMP Objective: To remove suspended solids from storm water runoff prior to off-site discharge.	
Practice	**Implementation Schedule/Frequency**
• Remove sediment as necessary to maintain active storage volume and proper function. Manage sediment in accordance with Chapter NR 528, Wisconsin Administrative Code.	As needed
• Inspect basins for signs of erosion, contamination, breaching, clogging of outfall structure, and sediment buildup. • Remove any debris from the basin area. • Inspect area for signs of contamination.	During each SWPPP inspection
• Conduct quarterly inspections as described in **Section 6.1**. • Conduct semi-annual dry weather inspections as described in **Section 6.2**.	Quarterly/Semi-annually, as noted

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4.0 SUMMARY OF POTENTIAL POLLUTANTS AFTER IMPLEMENTING BEST MANAGEMENT PRACTICES

Implementation of BMPs at the facility is designed to reduce the potential for source area storm water contamination (see **Section 3.0**), with only allowable non-storm water discharges remaining. This SWPPP identifies pollutants that are likely to contaminate storm water discharges to waters of the state following implementation of source area control BMPs.

At a minimum, all of the following pollutants will be considered for their potential to contaminate storm water:

1. Any pollutant for which an effluent limitation is contained in any WPDES permit issued to the facility by the WDNR.

2. Any pollutant contained in a categorical effluent limitation or pretreatment standard to which the facility is subject.

3. Any Section 313 water priority chemical for which the facility has reporting requirements and which has the potential for contaminating storm water.

4. Any other toxic or hazardous pollutants from present or past activity at the site that remain in contact with precipitation or storm water and which could be discharged to the waters of the state and which are not regulated by another environmental program.

Through review of the facility chemical handling and storage practices, no chemicals, including those listed above, are found likely to contaminate storm water discharges to waters of the state after implementation of the BMPs.

Sources of allowable non-storm water discharges from the facility include fire suppression water and landscape watering. If these types of activities are performed at the facility, the resulting storm water discharges will either be routed through the storm water management systems (see **Section 1.4.3**) or discharge via sheet flow off site.

5.0 COMPLIANCE WITH RUNOFF PERFORMANCE STANDARDS

The facility is not subject to the post-construction performance standards of NR 151.122 and 123, Wisconsin Administrative Code. These standards will only be applicable if an expansion to the facility is proposed.

6.0 FACILITY MONITORING PLAN AND IMPLEMENTATION SCHEDULE

Facility monitoring consists of quarterly facility inspections, non-storm water discharge inspections, and completion of WDNR Form 3400-176, the Annual Facility Site Compliance Inspection (AFSCI) report. The purpose of such monitoring and review is to evaluate storm water outfalls for the presence of non-storm water discharges, and evaluate the effectiveness of the pollution prevention activities in controlling contamination of storm water runoff. The SWPPP implementation schedule is detailed in **Attachment D**. Record-keeping requirements are addressed in **Section 8.0**.

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6.1 QUARTERLY VISUAL INSPECTIONS

Coverage under a Tier 2 General Permit requires a quarterly visual inspection of the storm water runoff. The inspections will take place during daylight hours within 30 minutes, but not to exceed 60 minutes, after storm water runoff begins discharging at the outfall. These inspections will check storm water for physical properties such as odor, color, turbidity, suspended solids, foam, oil sheen, or other obvious indicators of non-storm water discharge. Information reported will include the inspection date, inspection personnel, visual quality of the storm water discharge, and probable sources of any observed non-storm water discharge. In addition, quarterly inspections serve as a visual evaluation of the facility to identify conditions that may give rise to contamination of storm water. The quarterly inspection is a way to confirm that chosen BMPs are in place and working. A Quarterly Facility SWPPP Inspection Form is included in Attachment B.

In the event a visual inspection cannot be performed due to adverse weather conditions or other monitoring waivers listed in Section 4.3.3 of the General Permit, provide documentation for the reason the visual examination could not be performed. Adverse weather conditions which may prevent visual inspections include dangerous weather conditions for personnel (i.e., local flooding, high winds, tornadoes, electrical storms, etc.) or conditions that otherwise make sample collection impractical (i.e., drought, etc.).

6.2 NON-STORM WATER DISCHARGES

Storm water outfalls will be evaluated for non-storm water contributions to the storm drainage system. Evaluations of non-storm water discharges shall take place during dry periods, and may be conducted using either visual end of pipe inspection or detailed testing including dye testing, smoke testing, or video camera observation. For end of pipe visual screening, the evaluation shall be performed at least twice per year at each outfall. Instances of dry weather flow, stains, sludge, color, odor, or other indications of a non-storm water discharge shall be recorded. For dye testing, smoke testing, or video camera observation methods, the evaluation shall be performed at least every 5 years, or a lesser period if deemed necessary by the WDNR.

Any unauthorized non-storm water discharges must be eliminated or covered under another permit. Following is a list of non-storm water discharges or flows that are not considered illicit, unless they are identified as a significant source of contamination:

- Uncontaminated pumped groundwater
- Uncontaminated groundwater infiltration
- Water line flushing
- Landscape irrigation
- Diverted stream flows
- Discharges from potable water sources
- Foundation drains
- Air conditioning condensation
- Irrigation water
- Lawn watering
- Flows from riparian habitats and wetlands
- Fire fighting
- Street wash water

A worksheet and certification form is included in Attachment F.

6.3 ANNUAL FACILITY SITE COMPLIANCE INSPECTION

The AFSCI consists of a comprehensive facility inspection and a review of the effectiveness of the SWPPP. The inspection will be adequate to verify that the site drainage conditions and potential pollution sources identified in the SWPPP remain accurate, and that the BMPs prescribed in the SWPPP are being implemented, properly operated, and adequately maintained. In addition, the

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quarterly inspections will be reviewed, the site will be inspected for evidence of pollution, and equipment will be inspected. Information reported will include the inspection date, inspection personnel, scope of the inspection, observations, assessment of BMPs, corrective actions taken, and revisions needed in the SWPPP.

WDNR Form 3400-176, the AFSCI report, will be completed when conducting this review. The report (**Attachment C**) will be completed each year and kept on file with the SWPPP. No submittal to the WDNR is required for Tier 2 facilities.

The SWPPP implementation schedule is detailed in **Attachment D**.

6.4 ANNUAL IMPAIRED WATERBODY AND TOTAL MAXIMUM DAILY LOAD REVIEW

By February 15th of each year, an annual review will be performed to determine whether the facility discharges a pollutant of concern via storm water to an impaired waterbody or a waterbody included in a state- and federally-approved total maximum daily load (TMDL). The results of these evaluations will be documented with the AFSCI (see **Section 6.3**) and in **Attachment G**. Further details on performing these reviews are presented in the following sections.

6.4.1 Impaired Waterbody Review

Impaired waters are those listed as not meeting applicable surface water quality standards, and are also referred to as 303(d) waters. In accordance with the Tier 2 General Permit, a facility covered under the permit may not create a new source of discharge or increase an existing discharge of a pollutant of concern into an impaired waterbody unless the new or increased discharge causes the receiving water to meet applicable water quality standards, or the discharge is consistent with a TMDL allocation that has been approved by the Environmental Protection Agency (EPA).

The WDNR maintains a list of impaired waterbodies on their website. The information includes the pollutant of concern for each specific waterbody. A searchable list of waterbodies considered impaired can be found on the WDNR website at: http://dnr.wi.gov/water/impairedSearch.aspx.

Attachment G includes results of the annual reviews.

Because the site ultimately discharges to an impaired waterbody, **Section 6.4.3** has been incorporated into the SWPPP to identify control measures and management practices that will collectively be used to reduce, with the goal of eliminating, the storm water discharge of pollutant(s) contributing to the impairment.

6.4.2 Total Maximum Daily Load Waterbody Review

TMDL's are developed for impaired waterbodies. TMDL is the amount of pollutant that may be discharged into a waterbody that has been deemed acceptable by the EPA. TMDL levels are dependent on the specific waterbody.

A list of waterbodies included in a TMDL can be found on the WDNR website at: http://dnr.wi.gov/water/impairedSearch.aspx?status=TMDL+Approved.

Attachment G includes results of the annual reviews.

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6.4.3 Measures to Reduce Pollutants of Concern

Because the site can ultimately discharge to an impaired waterbody (see **Attachment G**), the facility controls and operations have been evaluated to determine if the known pollutants of concern (polychlorinated biphenyls [PCBs] and mercury) are present and if control measures and management practices implemented at the site reduce the discharge of these pollutants to the impaired waterbodies.

- The landfill does not have direct sources of mercury on site; however, mercury residuals can be present in the scrubber by-product, which is landfilled along with the ash. All storm water that comes in contact with the scrubber by-product is diverted to the leachate collection system and discharged into the PVC-lined Leachate/Surface Water Pond.

- The landfill does not have sources of PCBs on site.

The facility is inspected regularly in accordance with the requirements of the General Permit (see **Section 6.0**) and the facility's inspection and monitoring requirements (see **Section 3.1.1**). Site personnel will implement additional operational improvements or BMPs that may be identified during inspections to further reduce the contaminants of concern.

7.0 PERSONNEL TRAINING

Appropriate training and instruction is necessary to carry out the pollution prevention activities presented in this plan. Training shall be conducted in the areas of:

- BMPs
- Environmental Health and Safety Incidents
- Familiarity with SWPPP

Once each calendar year, a training session will be held with the SWPPP team members covering the above items. SWPPP team members will be responsible for training additional personnel as deemed necessary and documenting (signed by the SWPPP team member and the employee being trained) that this has been accomplished. All new personnel will be trained as they enter positions where they would have pollution prevention responsibilities. A training record form can be found in **Attachment E**.

8.0 RECORDKEEPING

A record of all quarterly facility inspections and AFSCI reports will be maintained. Example forms are included in **Attachments B** and **C**.

A record of training activities and personnel involved will be maintained. This record is included in **Attachment E**.

A copy of the Tier 2 General Permit is included in **Attachment A**.

Records of all monitoring information and copies of all reports required by this permit will be retained on site at the facility for a minimum of 5 years from the date of the sample, measurement, report, or application. These records will be made available to the WDNR upon request. It is recommended that

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copies of the recordkeeping forms be made from the originals in this report and maintained in a central file.

9.0 PLAN REVIEW

It is the facility's responsibility to initiate changes to this plan as changes are made to the facility. The SWPPP coordinator will conduct an annual review of the SWPPP to determine if an update is needed. At a minimum, it should be updated when permits are renewed. In addition, the SWPPP will be amended and submitted to WDNR if the facility expands, experiences any operations modifications or changes to BMPs, or changes any significant material handling or storage practices that will result in significant increases in the exposure of pollutants to storm water. The amended SWPPP will have a description of the new activities that contribute to the increased pollutant loading, planned source control activities, and an estimate of the new or increased discharge of pollutants following treatment and a description of the new or increased discharge on storm water treatment facilities, if applicable. WPL must notify the WDNR in the event of any facility operational changes that could result in additional significant storm water contamination.

The SWPPP will also be amended and submitted to WDNR if WPL or the WDNR determines that the SWPPP is ineffective in controlling storm water pollutants discharged to the waters of the state.

Attachment H includes a log to track amendments and reviews to the SWPPP.

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Table 1

Storm Water Outfalls

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Table 1. Storm Water Outfalls
Wisconsin Power and Light Company Columbia Dry Ash Disposal Facility
Pardeeville, Wisconsin

Outfall	Area Description (See Figures 1 and 2)	Outfall Description (See Figure 3 and Note)	Status
SW01	Storm water runoff from the non-active modules at the dry ash disposal facility.	Inlet to the south sediment basin. The basin outlet structure discharging to the south into a wetland and/or water infiltrates to groundwater in the basin.	Existing outfall
SW02	Storm water runoff from undeveloped modules, intermediate cover, stockpiles, and paved access road.	Culvert inlet on the south side of Murray Road. Water infiltrates to groundwater in a low spot on the north side of Murray Road.	Existing outfall

I:\25222157.00\Deliverables\Landfill SWPPP Update\SWPPP Table 1.doc

Figures

1 Site Location Map
2 Existing Conditions
3 Drainage Areas and Outfalls

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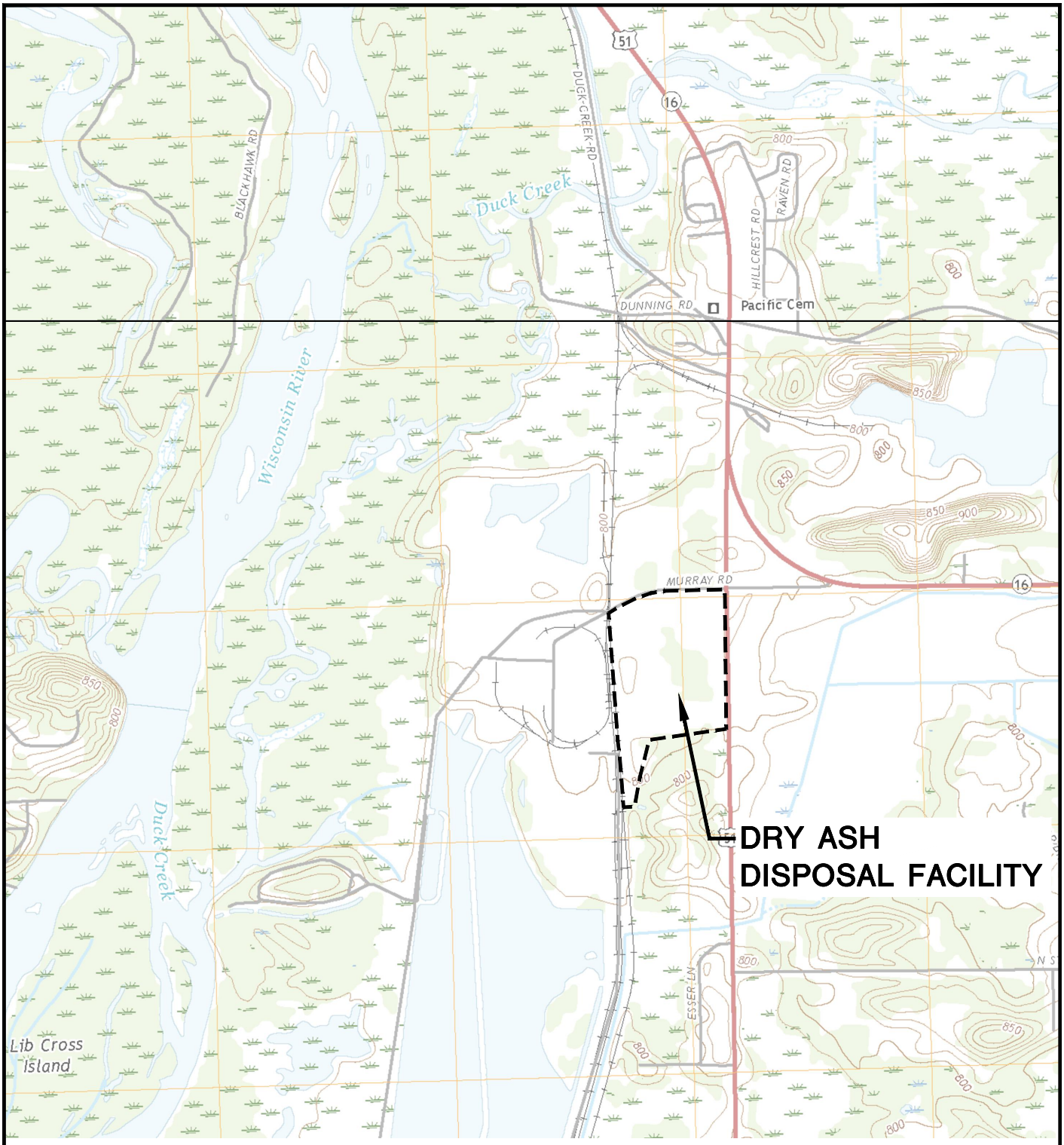

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POYNETTE QUADRANGLE
WISCONSIN–COLUMBIA CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)
2018
SCALE: 1" = 2,000'

CLIENT	WISCONSIN POWER AND LIGHT COMPANY COLUMBIA ENERGY CENTER W8375 MURRAY ROAD PARDEEVILLE, WI 53954	SITE	WISCONSIN POWER AND LIGHT COLUMBIA ENERGY CENTER PARDEEVILLE, WI

SITE LOCATION MAP

PROJECT NO.	25220183.00	DRAWN BY:	RJG
DRAWN:	12/02/2019	CHECKED BY:	PG
REVISED:	02/28/2022	APPROVED BY:	EJN 04/18/2022

ENGINEER

SCS ENGINEERS
2830 DAIRY DRIVE MADISON, WI 53718-6751
PHONE: (608) 224-2830

FIGURE
1

I:\25220183.00\Drawings\SWPPP Update\1_SITE LOCATION.dwg, 4/18/2022 11:51:34 AM

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LEGEND

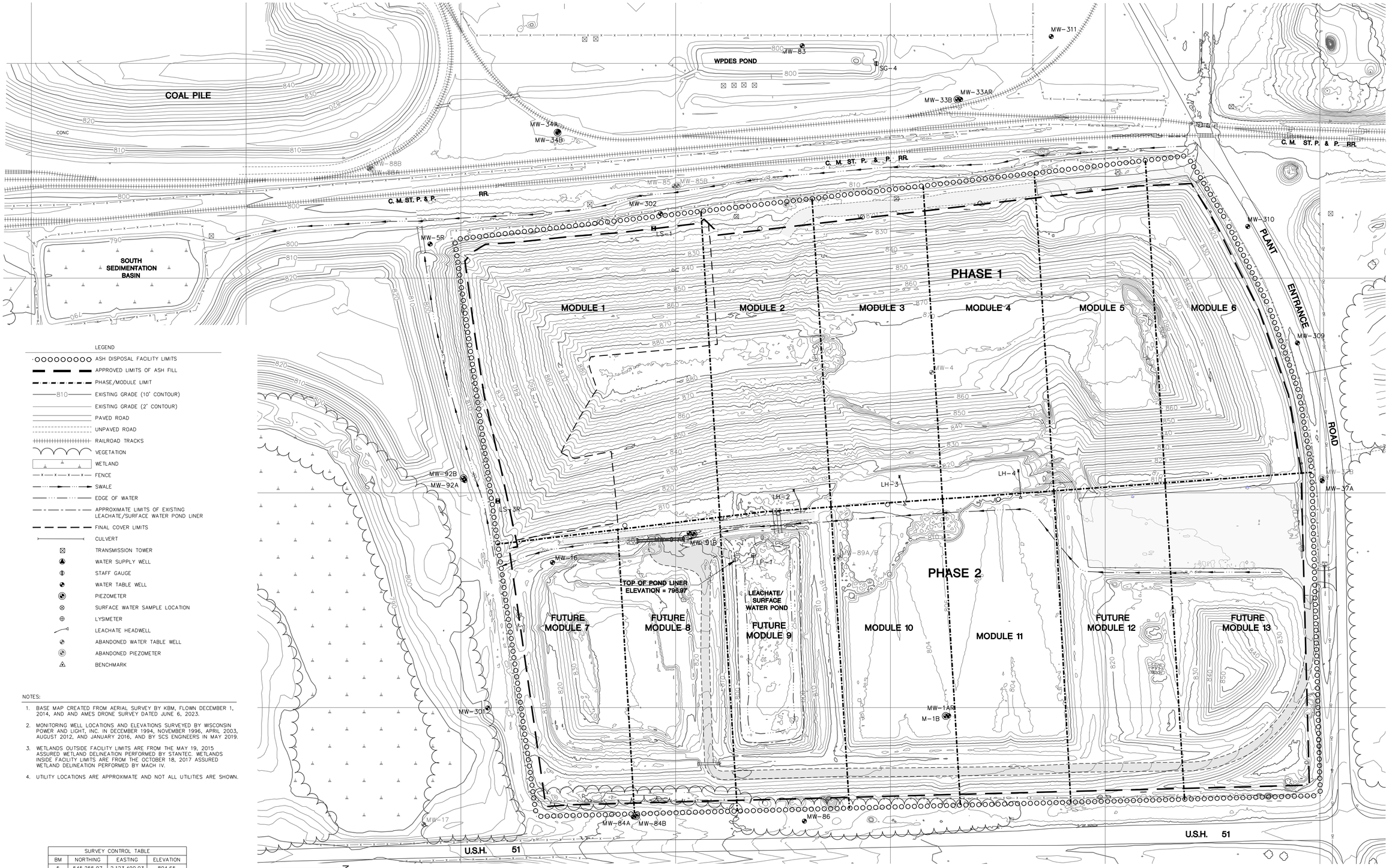
- ASH DISPOSAL FACILITY LIMITS
- APPROVED LIMITS OF ASH FILL
- PHASE/MODULE LIMIT
- 810 EXISTING GRADE (10' CONTOUR)
- EXISTING GRADE (2' CONTOUR)
- PAVED ROAD
- UNPAVED ROAD
- RAILROAD TRACKS
- VEGETATION
- WETLAND
- FENCE
- SWALE
- EDGE OF WATER
- APPROXIMATE LIMITS OF EXISTING LEACHATE/SURFACE WATER POND LINER
- FINAL COVER LIMITS
- CULVERT
- TRANSMISSION TOWER
- WATER SUPPLY WELL
- STAFF GAUGE
- WATER TABLE WELL
- PIEZOMETER
- SURFACE WATER SAMPLE LOCATION
- LYSIMETER
- LEACHATE HEADWELL
- ABANDONED WATER TABLE WELL
- ABANDONED PIEZOMETER
- BENCHMARK

NOTES:

1. BASE MAP CREATED FROM AERIAL SURVEY BY KBM, FLOWN DECEMBER 1, 2014, AND AND AMES DRONE SURVEY DATED JUNE 6, 2023.
2. MONITORING WELL LOCATIONS AND ELEVATIONS SURVEYED BY WISCONSIN POWER AND LIGHT, INC. IN DECEMBER 1994, NOVEMBER 1996, APRIL 2003, AUGUST 2012, AND JANUARY 2016, AND BY SCS ENGINEERS IN MAY 2019.
3. WETLANDS OUTSIDE FACILITY LIMITS ARE FROM THE MAY 19, 2015 ASSURED WETLAND DELINEATION PERFORMED BY STANTEC. WETLANDS INSIDE FACILITY LIMITS ARE FROM THE OCTOBER 18, 2017 ASSURED WETLAND DELINEATION PERFORMED BY MACH IV.
4. UTILITY LOCATIONS ARE APPROXIMATE AND NOT ALL UTILITIES ARE SHOWN.

SURVEY CONTROL TABLE			
BM	NORTHING	EASTING	ELEVATION
5	545,255.97	2,123,490.03	804.65
6	543,461.54	2,123,405.36	834.12
18	540,900.39	2,125,381.39	801.87
19	543,233.12	2,125,317.67	829.97

NOTE: BM5 AND BM18 ARE LOCATED OUTSIDE THE LIMITS OF THIS EXISTING CONDITIONS DRAWING.



PROJECT NO.	25217156.00	DRAWN BY: RJG/SB
DRAWN:	07/13/2016	CHECKED BY: RJG/BLP
REVISED:	06/23/2023	APPROVED BY: PEC 07/18/2023

WISCONSIN POWER AND LIGHT
COLUMBIA ENERGY CENTER
W8375 MURRAY ROAD
PARDEEVILLE, WISCONSIN 53954

Wisconsin Power and Light Company

CLIENT

SCS ENGINEERS
2830 DAIRY DRIVE MADISON, WI 53718-6751
PHONE: (608) 224-2830

ENGINEER

STORM WATER POLLUTION PREVENTION PLAN
COLUMBIA DRY ASH DISPOSAL FACILITY
TOWN OF PACIFIC, WISCONSIN

SITE

EXISTING CONDITIONS

FIGURE 2

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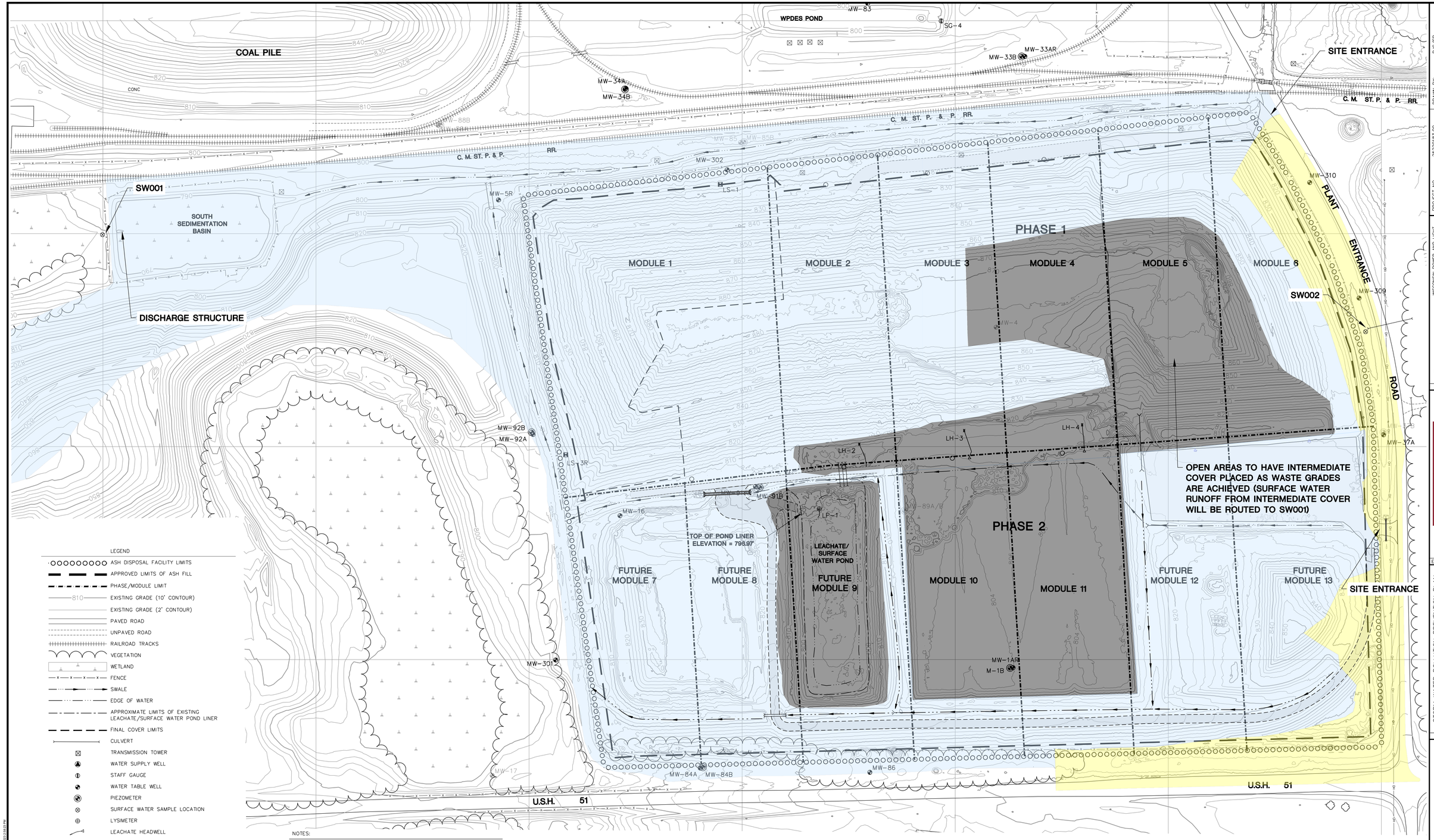

LEGEND

- ASH DISPOSAL FACILITY LIMITS
- APPROVED LIMITS OF ASH FILL
- PHASE/MODULE LIMIT
- 810 EXISTING GRADE (10' CONTOUR)
- EXISTING GRADE (2' CONTOUR)
- PAVED ROAD
- UNPAVED ROAD
- RAILROAD TRACKS
- VEGETATION
- WETLAND
- FENCE
- SWALE
- EDGE OF WATER
- APPROXIMATE LIMITS OF EXISTING LEACHATE/SURFACE WATER POND LINER
- FINAL COVER LIMITS
- CULVERT
- TRANSMISSION TOWER
- WATER SUPPLY WELL
- STAFF GAUGE
- WATER TABLE WELL
- PIEZOMETER
- SURFACE WATER SAMPLE LOCATION
- LYSIMETER
- LEACHATE HEADWELL
- ABANDONED WATER TABLE WELL
- ABANDONED PIEZOMETER
- BENCHMARK
- ACTIVE LANDFILL DRAINAGE AREA (TO LEACHATE/SURFACE WATER POND)
- SW01 OUTFALL DRAINAGE AREA
- SW02 OUTFALL DRAINAGE AREA

NOTES:

1. BASE MAP CREATED FROM AERIAL SURVEY BY KBM, FLOWN DECEMBER 1, 2014 AND AND AMES DRONE SURVEY DATED JUNE 6, 2023.
2. COLUMBIA ASH DISPOSAL SWPPP COVERS ALL SHADED AREAS.
3. IMPERVIOUS AREA INCLUDES GRAVEL ACCESS ROADS, PORTIONS OF US HWY 51, MURRAY ROAD AND MODULE 5, 6, 10, AND 11. MODULE 5, 6, 10, AND 11 ARE CURRENTLY COVERED WITH A RAIN COVER (IMPERVIOUS LAYER) AND WATER IS DIVERTED TO SWALES THAT DISCHARGE TO SOUTH SEDIMENTATION BASIN.

N

100 0 100

SCALE: 1" = 100'

OUTFALL DRAINAGE AREAS

OUTFALL	DRAINAGE AREA (ACRES)	IMPERVIOUS AREA (ACRES)	% IMPERVIOUS	% PERVIOUS
SW01	52.8	4	7.1	92.9
SW02	6.4	1.2	19	81

PROJECT NO. 2520183.00
DRAWN: 07/13/2016
REVISED: 06/23/2023
DRAWN BY: RJG/SB
CHECKED BY: RJG/BLP
APPROVED BY: PEC 07/18/2023

CLIENT: Wisconsin Power and Light Company
WISCONSIN POWER AND LIGHT COLUMBIA ENERGY CENTER
W8375 MURRAY ROAD
PARDEEVILLE, WISCONSIN 53954

ENGINEER: SCS ENGINEERS
2830 DAIRY DRIVE MADISON, WI 53718-6751
PHONE: (608) 224-2830

STORM WATER POLLUTION PREVENTION PLAN
COLUMBIA DRY ASH DISPOSAL FACILITY
TOWN OF PACIFIC, WISCONSIN

SITE

DRAINAGE AREAS AND OUTFALLS

FIGURE 3

09/28/2023 - Classification: Internal - ECRM13153872

Attachment A

WPDES General Storm Water Permit

Wisconsin Pollutant Discharge Elimination System
Tier 2 Industrial Facilities General Permit for Storm Water Associated with Industrial Activity
Permit No. S067857-5

(Note: This update to the Tier 2 General Permit was issued on May 31, 2021, and expires on June 2, 2025.)

09/28/2023 - Classification: Internal - ECRM13153872

STATE OF WISCONSIN
DEPARTMENT OF NATURAL RESOURCES

GENERAL PERMIT TO DISCHARGE UNDER THE WISCONSIN POLLUTANT DISCHARGE ELIMINATION SYSTEM WPDES PERMIT NO. WI-S067857-5

TIER 2 INDUSTRIAL FACILITIES

In compliance with the provisions of ch. 283, Wis. Stats., and ch. NR 216, Wis. Adm. Code, any **Tier 2** facility as defined in ch. NR 216, Wis. Adm. Code, and located in the State of Wisconsin, excluding section 2.5.1, that discharges

STORM WATER ASSOCIATED WITH INDUSTRIAL ACTIVITY

and meeting the applicability criteria in section 2 of this permit and that receives a letter from the Wisconsin Department of Natural Resources (Department) granting coverage under this permit, is authorized to discharge storm water to waters of the state provided that the discharge is in accordance with the conditions set forth in this permit.

This permit is issued by the Department and covers storm water discharges from the facility as of the **Start Date** of permit coverage to the permittee. For initial permit coverage, the Department will transmit a cover letter to the permittee stating that the facility is covered under this permit. Initial coverage under this permit will become effective at a facility beginning upon the **Start Date** specified by the Department in the cover letter. For an existing facility with permit coverage under a previously issued version of the Tier 2 general permit, coverage under this permit will become effective at the facility beginning upon the **Effective Date** below. For these facilities, the **Effective Date** is the **Start Date.**

State of Wisconsin Department of Natural Resources
For the Secretary

By _____ May 14, 2021
Brian Weigel, Director Date
Bureau of Watershed Management

PERMIT EFFECTIVE DATE: May 31, 2021 **PERMIT EXPIRATION DATE:** June 2, 2025

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Note: Information about the Department of Natural Resources' storm water program, this general permit, forms, and other helpful resources is available at https://dnr.wisconsin.gov/topic/Stormwater.

1. APPLICATION REQUIREMENTS

1.1 Initial Permit Coverage The owner or operator of a Tier 2 industrial facility type listed in s. NR 216.21(2)(b), Wis. Adm. Code, and not previously covered under the Tier 2 general permit shall submit a complete Notice of Intent (NOI) to the Department to apply for coverage under an industrial storm water discharge permit in accordance with the time frames in s. NR 216.22(2), Wis. Adm. Code. Within 30 calendar days of receipt of the NOI, the Department will evaluate the information submitted in the NOI to determine whether the NOI is complete, whether additional information is needed for review, whether the facility will be covered under this permit or an individual permit, or whether coverage under a permit will be denied. Based upon this evaluation, unless notified to the contrary by the Department, within 30 calendar days of receipt of the NOI, the Department will transmit a cover letter to the owner or operator indicating the **Start Date** upon which permit coverage becomes effective at the facility with instructions on where to download the permit from the Department website. In the alternative, a hard copy of the permit will be mailed to the owner or operator of the facility upon request.

Note: The NOI form (Form 3400-163), information about submitting via the Department's Water ePermitting System, and general permit are available for download from the Department website at: https://dnr.wi.gov/topic/stormwater/industrial/forms.html. The Notice of Intent requires applicants to provide information on the applicant, facility location, applicability and operations information, storm water discharge information, and non-storm water discharge information.

1.2 Existing Permit Coverage Unless the Department makes a determination for an individual WPDES permit under section 2.5.7, a Tier 2 industrial facility type listed in s. NR 216.21(2)(b), Wis. Adm. Code, with existing Tier 2 general permit coverage prior to the **Effective Date** of this permit is automatically covered under this permit as of the **Effective Date**. For these permittees, the **Effective Date** is the permittee's **Start Date.** The Department will notify the owner or operator of the facility's continued coverage under this permit with instructions on where to download the permit from the Department website. In the alternative, a hard copy of the permit will be mailed to the owner or operator of the facility upon request.

Note: The general permit is available on the Department website at: https://dnr.wi.gov/topic/stormwater/industrial/forms.html.

1.3 No Exposure Certification The owner or operator of a facility not currently covered under this permit that has submitted a Conditional No Exposure Certification to the Department in accordance with s. NR 216.21(3), Wis. Adm. Code, but that has been denied a No Exposure Exclusion by the Department shall apply for permit coverage in accordance with section 1.1 of this permit within 14-working days of being notified by the Department of the denial. The owner or operator of a facility that has previously been granted a No Exposure Exclusion by the Department but that has had that exclusion revoked shall apply for permit coverage in accordance with section 1.1 of this permit within 14-working days of being notified by the Department of the revocation.

1.4 Permit Coverage Transfers A permittee who will no longer control the permitted industrial facility may request that permit coverage be transferred to the person who will control the industrial facility. The transfer request shall be signed by both the permittee and the new owner or operator and sent electronically through the Department's Water ePermitting System. The Department may require additional information including an NOI to be filed prior to transferring permit coverage. Coverage is not transferred until the Department sends notification of transfer approval to the new owner or operator. The transfer request shall contain the following information:

1.4.1 The name and address of the facility.

1.4.2 The Facility Identification Number.

1.4.3 The names of the persons involved in the transfer, their signatures, and date of signatures.

1.4.4 A description of any significant changes in the operation of the facility.

1.4.5 A statement of acknowledgement by the transferee that it will be the permittee of record and is responsible for compliance with the permit.

Note: The Transfer of Coverage form (Form 3400-222) and information about submitting via the Department's Water ePermitting System are available on the Department website at: https://dnr.wi.gov/topic/stormwater/industrial/forms.html.

1.5 Permit Coverage Terminations

If the permittee no longer claims coverage under this permit, the permittee shall submit a signed Notice of Termination (NOT) to the Department in accordance with s. NR 216.32, Wis. Adm. Code.

Note: The NOT form (Form 3400-170) and information about submitting via the Department's Water ePermitting System are available on the Department website at: https://dnr.wi.gov/topic/stormwater/industrial/forms.html.

2. PERMIT APPLICABILITY CRITERIA

2.1 Applicability This permit applies to point sources at facilities which discharge contaminated storm water associated with industrial activity to waters of the state, either directly or via a separate storm sewer system, originating from industrial facilities belonging to:

2.1.1 Manufacturing facilities described by the following SIC codes:

SIC	Description
20--	Food & Kindred Products
21--	Tobacco Products
22--	Textile Mill Products
23--	Apparel & Other Textile Products
2434	Wood Kitchen Cabinets
25--	Furniture & Fixtures
265-	Paperboard Containers & Boxes
267-	Misc. Converted Paper Products
27--	Printing, Publishing, & Allied Industries
283-	Drugs
285-	Paints & Allied Products
30--	Rubber & Misc. Plastics Products
31--	Leather & Leather Products
323-	Products of Purchased Glass
34--	Fabricated Metal Products
35--	Industrial & Commercial Machinery & Computer Equipment
36--	Electronic & Other Electrical Equipment & Components
37--	Transportation Equipment
38--	Instruments & Related Products
39--	Misc. Manufacturing Industries
4221	Farm Product Warehousing & Storage
4222	Refrigerated Warehousing & Storage
4225	General Warehousing & Storage

Note: Facilities in SIC codes 311-, 3441 and 373- are included in s. NR 216.21(2)(a) 1. as Tier 1 facilities.

2.1.2 Transportation facilities described by the following SIC codes that have vehicle maintenance shops, equipment cleaning operations, or airport de-icing operations. This only applies to those portions of these facilities that are either involved in vehicle maintenance including rehabilitation, mechanical repairs, painting, fueling, lubrication, and associated parking areas, or involved in cleaning operations, or de-icing operations, or that are listed as a pollution source area under s. NR 216.27(3)(e):

SIC	Description
40--	Railroad Transportation
41--	Local & Interurban Passenger Transit
42--	Trucking & Warehousing
43--	U.S. Postal Service
44--	Water Transportation

45--	Transportation by Air
5171	Petroleum Bulk Stations & Terminals

2.1.3 Facilities described by the following SIC codes, including active and inactive mining operations. This permit only applies where storm water runoff has come into contact with any overburden, raw material, intermediate product, finished product, by-product, or waste material.

SIC	Description
10--	Metal Mining
12--	Coal Mining
13--	Oil & Gas Extraction
14--	Non-metallic Minerals, except fuels

Note: An industry-specific general permit has been developed by the Department that regulates both process and storm water discharges associated non-metallic mining operations, SIC code 14--. While the Department intends to cover non-metallic mining operations under the industry-specific general permit, it may alternatively cover storm water discharges associated with non-metallic mining operations under this Tier 2 general permit. This permit does not apply to non-coal mining operations which have been released from applicable state or federal reclamation requirements after December 17, 1990; nor to coal mining operations released from the performance bond issued to the facility by the appropriate Surface Mining Control and Reclamation Act authority under 30 USC 1201 et seq. and 16 USC 470 et seq. Production, processing, or treatment operations or transmission facilities associated with oil and gas extraction are included only if there has been a discharge of storm water after November 16, 1987 containing a reportable quantity of a pollutant, or if a storm water discharge contributed to a violation of a water quality standard.

2.1.4 Facilities subject to storm water effluent limitation guidelines, new or existing source performance standards, or toxic pollutant effluent standards under 33 USC 1251, 1311, 1314 (b) and (c), 1316 (b) and (c), 1317 (b) and (c), 1326 (c), except for those facilities identified in paragraph A.(1) that do not have contaminated storm water.

2.1.5 Treatment works treating domestic sewage or any other sewage sludge or wastewater treatment device or system, used in the storage, treatment, recycling, and reclamation of municipal or domestic sewage, including land dedicated to the disposal of sewage sludge that are located within the confines of the facility, with a design flow of one million gallons per day or more, or required to have an approved pretreatment program. Not included are farm lands, domestic gardens or lands used for sludge management where sludge is beneficially reused and which are not physically located in the confines of the facility, or areas that are in compliance with Section 405 of the Clean Water Act under 33 USC s. 1345.

2.1.6 Hazardous waste treatment, storage, and disposal facilities, including those operating under interim status or a permit under Subtitle C of the Resource Conservation and Recovery Act (RCRA), 42 USC 6901 et seq.

2.1.7 Landfills, land application sites, and open dumps that receive or have received any industrial waste from any of the facilities identified in this section 2.1 of this permit, including those subject to regulation under subtitle D of RCRA, 42 USC 6901 et seq., or ch. 289, Wis. Stats. For purposes of this section, landfills include those landfills for construction and demolition waste disposal.

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2.1.8 Steam electric power generating facilities, including coal handling sites but not including offsite transformer or electric substations.

2.1.9 Facilities described in SIC code 2951 for asphalt paving mixes and block, and facilities described in SIC codes 3271, 3272 and 3273 for cement products.

Note: In 1997, the North American Industry Classification System (NAICS) was developed as the standard for use by Federal agencies in classifying business establishments and has been adopted by Federal agencies to replace the SIC Code system. As a result, an industrial facility identified in sections 2.1.1 through 2.1.9 of this permit may have an NAICS Code assigned to it by a Federal agency, trade association, or other organization. If needed, the Department may use Federal data to convert the NAICS Code to the corresponding SIC Code for purposes of determining the applicability of this permit to the facility.

2.1.10 Facilities originally covered under a Tier 1 general permit, but subsequently covered under a Tier 2 general permit pursuant to s. NR 216.23(3), Wis. Adm. Code.

2.2 Authorized Discharges This permit authorizes storm water point source discharges to waters of the State from industrial activities identified in section 2.1 of this permit. This permit also authorizes the discharge of storm water commingled with flows contributed by process and non-process wastewater, provided those flows are regulated by other WPDES permits, if required.

2.3 Movement to Tier One Coverage In accordance with s. NR 216.23(4), Wis. Adm. Code, the Department may revoke coverage under this permit. In this case, the permittee shall reapply for Tier 1 general permit coverage.

2.4 Exclusions This permit does not apply to any of the following:

2.4.1 Diffused surface drainage or agricultural storm water discharges.

2.4.2 Non−storm water discharges.

2.4.3 Non−storm water discharges for which coverage under an individual or general WPDES permit is not required, including landscape irrigation, diverted stream flows, uncontaminated groundwater infiltration, uncontaminated pumped groundwater, discharges from potable water sources, foundation drains, air conditioning condensation, irrigation water, lawn watering, individual residential car washing, flows from riparian habitats and wetlands and fire fighting.

2.4.4 Inactive, closed or capped landfills that have no potential for contamination of storm water. The Department shall make a determination of contamination potential on a case−by−case basis.

2.4.5 Remedial action discharges or discharges authorized by a WPDES permit for discharging contaminated or uncontaminated groundwater.

2.4.6 Areas located on plant lands that are segregated from the industrial activities of the plant, such as office buildings and accompanying parking lots, if the drainage from the segregated areas is not mixed with contaminated storm water drainage.

2.4.7 Storm water discharges into a municipal combined sewer system.

Note: Areas where this exclusion may apply include portions of the City of Milwaukee, the City of Superior, and the Village of Shorewood.

2.4.8 Storm water discharges from an industrial facility for which the owner or operator has submitted a Conditional No Exposure Certification to the Department in accordance with s. NR 216.21(3), Wis. Adm. Code, provided that the Department concurs with the no exposure certification and the conditions under which a No Exposure Exclusion was granted remain in effect.

2.5 Discharges Not Covered by this Permit The following are not authorized under this permit:

2.5.1 Storm water discharges within Indian Country.

Note: Indian County is defined under 18 USC §1151 and includes all lands within the exterior boundaries of federally recognized Indian reservations and on lands held in federal trust status. Facilities that currently do not have storm water discharge permit coverage and are located within Indian Country should contact the United States Environmental Protection Agency (USEPA) to apply. For existing discharges covered under a National Pollution Discharge Elimination System (NPDES) permit from USEPA, discharges will continue to be covered by a NPDES permit. Dischargers that previously held permit coverage under previous versions of this permit after September 30, 2001, are no longer eligible for coverage under this permit and must contact USEPA to apply.

USEPA's website contains information on the Multi-Sector General Permit: https://www.epa.gov/npdes/stormwater-discharges-industrial-activities. Facilities should verify eligibility for coverage under the general permit or determine if an individual permit is needed. Information on how to apply for the Multi-Sector General Permit can be accessed here: https://epanet.zendesk.com/hc/en-us/articles/360001508168-How-to-Create-a-NOI-for-MSGP-PPT-.

2.5.2 Discharges of hazardous substances that are required to be reported under ch. NR 706, Wis. Adm. Code.

2.5.3 Storm water discharges that affect wetlands, unless the Department determines that the storm water discharges comply with the wetland water quality standards provisions in ch. NR 103, Wis. Adm. Code.

2.5.4 Storm water discharges that affect endangered and threatened resources, unless the Department determines that the storm water discharges comply with the endangered and threatened resource protection requirements of s. 29.604, Wis. Stats., and ch. NR 27, Wis. Adm. Code.

2.5.5 Storm water discharges that affect any historic property that is listed property, or on the inventory or on the list of locally designated historic places under s. 44.45, Wis. Stats., unless the Department determines that the storm water discharges will not have an adverse effect on any historic property pursuant to s. 44.40(3), Wis. Stats.

2.5.6 Storm water discharges from land disturbing construction activity affecting one acre or more of land that require storm water permit coverage under subch. III of NR 216, Wis. Adm. Code, for new construction, reconstruction, or expansion of an industrial facility.

Note: Storm water discharges from areas of bare soil due to the normal industrial operation of the facility are covered under this permit provided those areas are managed in accordance with section 3.3.2.8.2.

2.5.7 Facilities where the Department makes a determination, pursuant to s. 283.35(3), Wis. Stats. or

s. NR 216.25(3), Wis. Adm. Code, that a storm water discharge is more appropriately covered under an individual WPDES permit. The Department may make this determination if one or more of the following conditions are met:

2.5.7.1 The storm water discharge is potentially a significant source of pollution and more appropriately regulated by an individual WPDES storm water discharge permit.

2.5.7.2 The facility is not in compliance with the terms and condition of this permit or Subchapter II of ch. NR 216, Wis. Adm. Code.

2.5.7.3 Numeric effluent limitations or standards are promulgated for a storm water discharge covered by this permit.

2.5.7.4 Storm water discharges that are regulated by permits containing storm water effluent limitations.

2.5.8 Storm water discharges in violation of the regulation of injection wells under ch. NR 815, Wis. Adm. Code.

Note: Information about the Department's injection well program may be found at: https://dnr.wi.gov/topic/wells/uiw.html.

2.5.9 Discharges associated with activities subject to any of the federal effluent limitation guidelines listed in Table 1 below:

Table 1.

Regulated Activity	**40 CFR Part/Subpart**
Discharges resulting from spray down or intentional wetting of logs at wet deck storage areas	Part 429, Subpart I
Runoff from phosphate fertilizer manufacturing facilities that comes into contact with any raw materials, finished product, by-products or waste products (SIC 2874)	Part 418, Subpart A
Runoff from asphalt emulsion facilities	Part 443, Subpart A
Runoff from material storage piles at cement manufacturing facilities	Part 411, Subpart C
Mine dewatering discharges at crushed stone, construction sand and gravel, or industrial sand mining facilities	Part 436, Subparts B, C, and D
Runoff from hazardous waste landfills	Part 445, Subpart A
Runoff from non-hazardous waste landfills	Part 445, Subpart B
Runoff from coal storage piles at steam electric generating facilities	Part 423
Runoff containing urea from airfield pavement deicing at existing and new primary airports with 1,000 or more annual non-propeller aircraft departures	Part 449

Note: The federal effluent limitations guidelines are available at the following website: https://www.epa.gov/eg/industrial-effluent-guidelines. Discharges associated with activities subject to any of the federal effluent limitation guidelines listed in Table 1 require coverage under a separate WPDES general permit or individual permit. However, these industrial facilities still require coverage under this permit for discharges not subject to the federal effluent limitation guidelines listed in Table 1.

2.6 Water Quality Standards

2.6.1 This permit specifies the conditions under which storm water may be discharged to waters of the state for the purpose of achieving water quality standards contained in chs. NR 102 through 105, NR 140, and NR 207, Wis. Adm. Code. For the term of this permit, compliance with water quality standards will be addressed by adherence to general narrative-type storm water discharge limitations and implementation of a storm water pollution prevention plan.

2.6.2 This permit does not authorize storm water discharges that the Department, prior to authorization of coverage under this permit, determines will cause or have reasonable potential to cause or contribute to an excursion above any applicable water quality standard. Where such determinations have been made prior to authorization, the Department may notify the applicant that an individual permit application is necessary. However, the Department may authorize coverage under this permit where the storm water pollution prevention plan required under this permit will include appropriate controls and implementation procedures designed to bring the storm water discharge into compliance with water quality standards.

2.7 Outstanding and Exceptional Resource Waters

2.7.1 Storm water discharges from industrial facilities covered under a previously issued version of this permit shall comply with sections 2.7.2 through 2.7.5 as of the **Effective Date**. Storm water discharges from industrial facilities covered under this permit after the **Effective Date** shall comply with sections 2.7.2 through 2.7.5 as of the **Start Date** of coverage under this permit.

2.7.2 The permittee shall determine whether any part of its facility discharges storm water to an outstanding resource water (ORW) or exceptional resource water (ERW). ORWs and ERWs are listed in ss. NR 102.10 and 102.11, Wis. Adm. Code, respectively.

Note: A list of ORWs and ERWs may be found on the Department website at: https://dnr.wi.gov/topic/surfacewater/orwerw.html.

2.7.3 The permittee may not establish a new storm water discharge of pollutants directly to an ORW or an ERW unless the discharge of pollutants is equal to or less than existing levels of pollutants immediately upstream of the discharge site. The storm water pollution prevention plan required under section 3 of this permit shall include practices designed to meet this requirement for new discharges.

2.7.3.1 "New storm water discharge" or "new discharge" means a storm water discharge that would first occur after the permittee's **Start Date** of coverage under this permit to a surface water to which the facility did not previously discharge storm water, and does not include an increase in a storm water discharge to a surface water to which the facility discharged on or before coverage under this permit.

2.7.4 The permittee may increase an existing storm water discharge directly to an ERW only if the increased discharge will not cause a significant lowering of water quality and the discharge is to accommodate to important economic or social development.

2.7.5 The permittee may increase an existing storm water discharge to an ORW only if the increased discharge of pollutants is equal to or less than the background levels of the pollutant upstream of the discharge and the discharge is to accommodate to important economic or social development.

2.8 Impaired Water Bodies and Total Maximum Daily Load Requirements

2.8.1 "Pollutant(s) of concern" means a pollutant that is contributing to the impairment of a water body.

2.8.2 By February 15th of each calendar year, the permittee shall perform an annual check to determine whether its facility discharges a pollutant of concern via storm water to an impaired water body listed in accordance with Section 303 (d) (1) of the Federal Clean Water Act, 33 USC §1313 (d) (1) (C), and the implementing regulation of the U.S. Environmental Protection Agency (USEPA), 40 CFR §130.7 (c) (1). Impaired waters are those listed as not meeting applicable surface water quality standards. The results of the annual check shall be documented with the Annual Facility Site Compliance Inspection required under section 4.3.1 of this permit.

Note: The Department updates the list approximately every two years. The updated list is effective upon approval by the USEPA. The current list may be found on the Department website at: https://dnr.wi.gov/topic/impairedwaters/.

2.8.3 A permittee that discharges a pollutant of concern via storm water to an impaired water body shall, within 180 days of the annual check that determines the facility discharges to an impaired water body, include a written section in the storm water pollution prevention plan that specifically identifies source area pollution prevention controls and storm water best management practices that will collectively be used to reduce, with the goal of eliminating, the storm water discharge of pollutant(s) of concern that contribute to the impairment of the water body and explain why these controls and practices were chosen as opposed to other alternatives. Changes identified in the storm water pollution prevention plan shall be implemented with the 180-day timeframe.

Note: For a permittee that discharges a pollutant of concern via storm water to an impaired water body, amending the storm water pollution prevention plan will be required after the initial annual check and if subsequent annual checks indicate additional pollutants of concern have been added, additional water bodies have been designated as impaired, or other relevant changes to the designation have occurred.

2.8.4 The permittee may not establish a new storm water discharge of a pollutant of concern to an impaired water body or significantly increase an existing discharge of a pollutant of concern to an impaired water body unless the new or increased discharge does not contribute to the receiving water impairment, or the discharge is consistent with a State and Federal approved total maximum daily load (TMDL) allocation for the impaired water body.

2.8.4.1 "New storm water discharge" or "new discharge" has the meaning given in section 2.7.3.1 of this permit.

2.8.5 By February 15th each calendar year, the permittee shall perform an annual check to determine whether its facility discharges a pollutant of concern via storm water to a water body included in a State and Federal approved TMDL. If so, the permittee shall assess whether any TMDL wasteload allocation for the facility's discharge is being met through the existing pollution prevention controls and storm water best management practices or whether additional controls or treatment are necessary and feasible. The assessment of the feasibility of additional controls or treatment shall focus on the ability to improve

pollution prevention and treatment system effectiveness and the adequacy of implementation and maintenance of the additional controls or treatment. The results of the annual check shall be documented with the Annual Facility Site Compliance Inspection required under section 4.3.1 of this permit.

Note: The current State and Federal approved TMDLs may be found on the Department website at: https://dnr.wi.gov/topic/tmdls/.

2.8.6 Within 180 days of the annual check that determines the facility discharges to a TMDL allocated water body, a permittee that is included in a State and Federal approved TMDL shall submit to the Department a proposed implementation plan for the storm water discharge that meets the requirements of the State and Federal approved TMDL wasteload allocation for the facility. The proposed TMDL implementation plan shall specify any feasible pollution prevention and treatment improvements that could be made and specify any revisions or redesigns that could be implemented to increase the effectiveness of the permittee's storm water pollution prevention controls and treatment practices. The TMDL implementation plan shall also specify a time schedule for implementation of the improvements, revisions or redesigns necessary to meet the wasteload allocation for the facility. If a specific wasteload allocation has not been assigned to the facility under a TMDL, compliance with this permit shall be deemed to be in compliance with the TMDL.

2.9 Fish and Aquatic Life Waters

2.9.1 The permittee shall determine whether it will have a storm water discharge to a fish and aquatic life water as defined in s. NR 102.13, Wis. Adm. Code.

Note: Most receiving waters of the state are classified as a fish and aquatic life waters and this classification includes all surface waters of the state except ORWs, ERWs, Great Lakes system waters and variance water identified within ss. NR 104.05 through 104.10, Wis. Adm. Code. The Department may be consulted if the permittee is not certain of the classification.

2.9.2 The permittee may not establish a new storm water discharge of pollutants to a fish and aquatic life water if the discharge will result in the significant lowering of water quality of the fish and aquatic life water. Significant lowering of water quality is defined within ch. NR 207, Wis. Adm. Code.

2.9.2.1 "New storm water discharge" or "new discharge" has the meaning given in section 2.7.3.1 of this permit.

2.9.3 If the permittee's facility has an existing storm water discharge to a fish and aquatic life water, it may not increase the discharge of pollutants if the increased discharge would result in a significant lowering of water quality.

2.9.4 Any increased or new discharge of storm water authorized under this permit shall be to accommodate to important economic or social development.

2.10 Toxic Pollutants In accordance with s. NR 102.12 Wis. Adm. Code, a new discharge and increased discharge as defined in ch. NR 207, Wis. Adm. Code, of persistent, bioaccumulating toxic substances to the Great Lakes waters or their tributaries shall be avoided or limited to the maximum extent practicable. Any new or increased discharge of these substances is prohibited unless the permittee certifies that the new or increased discharge is necessary after utilization of best technology in process or control using waste minimization, pollution prevention, municipal pretreatment programs, material substitution or other means of commercially available technologies which have demonstrated capability for similar applications.

2.11 Minimum Source Area Control Requirements All permittees shall comply with the following minimum source area control requirements. The Storm Water Pollution Prevention Plan required under section 3 shall identify how each source area control requirement will be met. Source area controls shall be utilized to prevent storm water from becoming contaminated at the facility. Structural source area controls that are either proposed or in place at the facility shall be indicated on the facility drainage base map described in section 3.3.2.2 of this permit. The permittee shall:

2.11.1 Minimize exposure of pollutants associated with the potential sources of storm water contamination identified in section 3.3.2.4 of this permit.

2.11.2 Use good house-keeping measures such as sweeping, appropriate storage, and proper management of waste materials and dumpsters/compactors.

2.11.3 Maintain both structural and non-structural control measures, institute preventive maintenance for vehicles and equipment, and perform routine visual inspections.

2.11.4 Minimize the potential for leaks, spills, and other releases that may contaminate storm water, and institute spill prevention and response measures, including spill reporting described in section 6.5 of this permit.

2.11.5 Stabilize areas of bare soil with vegetation or through permanent land cover to control soil erosion, or when that is not possible, implement best management practices to meet the requirements of section 3.3.2.8.2 of this permit.

2.11.6 Construct and maintain salt storage facilities so that neither precipitation nor storm water runoff can come into contact with the stored salt in order to minimize pollutant discharges.

2.11.6.1 Salt storage piles shall be constructed on an impervious, curbed surface to prevent salt or brine from passing through the base and reaching waters of the state. Salt storage piles shall be enclosed by a building or structure with walls and a cover sufficient to prevent contact between precipitation and the salt and to prevent wind from eroding the salt or carrying any amount of the substance into potential contact with the waters of the state. Alternatively, for permittees that use brine and have salt storage piles on impervious curbed surfaces, install a means of diverting contaminated storm water to a brine treatment system for process use.

2.11.6.2 Any salt spillage resulting from activities such as loading or unloading, shall be immediately cleaned up to minimize contact with storm water.

2.11.7 Train and raise awareness of employees as appropriate on storm water pollution prevention, the requirements of this permit, and their specific responsibilities in implementing any of the requirements, practices, or activities of this permit or the Storm Water Pollution Prevention Plan.

2.11.8 Evaluate the facility for the presence of non-storm water discharges as specified in section 4.2. of this permit.

Note: This permit does not cover non-storm water discharges. See section 2.3.
2.11.9 Minimize dust and off-site tracking of soil, raw materials, intermediate products, final products, or waste materials.

2.11.10 If applicable, use a combination of storm water contact control or containment, drainage controls, or diversions to control SARA Title III Section 313 "Water Priority Chemicals" (42 USC s. 11023 (c)) potentially discharged through the action of storm water runoff, leaching, or wind.

2.12 Compliance with Runoff Management Performance Standards The owner or operator of a facility subject to the performance standards in s. NR 151.12 or ss. NR 151.121 to 151.128, Wis. Adm. Code, shall describe in the Storm Water Pollution Prevention Plan the best management practices necessary to maintain compliance with the applicable performance standards in s. NR 151.12 or ss. NR 151.121 to 151.128, Wis. Adm. Code, for those areas that are described in s. NR 151.12(2) or s. NR 151.121(2), Wis. Adm. Code, respectively. Best management practices installed to meet the performance standards in s. NR 151.12 or s. NR 151.121 to 151.128, Wis. Adm. Code, shall be maintained to meet the treatment capability as originally designed.

2.13 Post-Construction Performance Standards for Landfills For landfills, post-construction storm water best management practices constructed after the effective date of this permit shall be in compliance with the performance standards in ss. NR 151.122 and NR 151.123, Wis. Adm. Code.

Note: The infiltration performance standard in s. NR 151.124, Wis. Adm. Code, does not apply to landfills.

3. STORM WATER POLLUTION PREVENTION PLAN

3.1 Storm Water Pollution Prevention Plan Required In accordance with s. NR 216.27, Wis. Adm. Code, and section 3.3 of this permit, the owner or operator of a facility requiring coverage under this permit shall prepare a Storm Water Pollution Prevention Plan (SWPPP) prior to applying for permit coverage under s. NR 216.22, Wis. Adm. Code.

3.2 Incorporation by Reference When plans are developed or activities conducted in accordance with other federal, state or local regulatory programs that meet the requirements of section 3.3.2 of this permit, the plans may be incorporated by the permittee into the SWPPP by reference.

3.3 Purpose and Content of a Storm Water Pollution Plan

3.3.1 Purpose of the Plan Any SWPPP prepared to comply with this permit shall do all of the following:

3.3.1.1 Identify sources of storm water and non-storm water contamination to the storm water drainage system.

3.3.1.2 Identify and prescribe appropriate "source area control" type best management practices designed to prevent storm water contamination from occurring.

3.3.1.3 Identify and prescribe "storm water treatment" type best management practices to reduce pollutants in contaminated storm water prior to discharge.

3.3.1.4 Prescribe actions needed either to bring non-storm water discharges under an appropriate WPDES permit or to remove these discharges from the storm drainage system.

3.3.1.5 Prescribe an implementation schedule so as to ensure that the storm water management actions prescribed in the SWPPP are carried out in a timely manner and evaluated on a regular basis.

3.3.2 Required Plan Content The SWPPP shall contain, at a minimum, the following items and provisions:

3.3.2.1 Pollution Prevention Individual The SWPPP shall identify by job title the specific individual who has primary responsibility for all aspects of SWPPP development and implementation and identify any other individuals concerned with SWPPP development or implementation, and their respective roles. The specific individual who has primary responsibility shall develop, evaluate, maintain and revise the SWPPP, and carry out the specific management actions identified in the SWPPP, including maintenance practices, monitoring activities, preparing and submitting reports, recordkeeping, and serving as facility contact for the Department.

3.3.2.2 Facility Site Description and Drainage Base Map The SWPPP shall contain a short summary of the major activities conducted at various locations throughout the facility. The SWPPP shall also include a facility drainage base map depicting all of the following:

3.3.2.2.1 How storm water drains on, through and from the facility to groundwater, surface water, or wetlands.

3.3.2.2.2 The facility property boundaries.

3.3.2.2.3 The storm drainage collection and disposal system including all surface and subsurface conveyances.

3.3.2.2.4 Any secondary containment structures.

3.3.2.2.5 The location of all outfalls that discharge channelized flow to groundwater, surface water or wetlands, including outfalls recognized as permitted outfalls under another WPDES permit, numbered for reference.

3.3.2.2.6 The drainage area boundary for each outfall.

3.3.2.2.7 The surface area in acres draining to each outfall, including the percentage that is impervious such as paved, roofed or highly compacted soil, and the percentage that is pervious such as grassy areas and woods.

3.3.2.2.8 Existing structural storm water controls.

3.3.2.2.9 The name and location of receiving waters.

3.3.2.2.10 The location of activities and materials that have the potential to contaminate storm water.

3.3.2.3 Summary of Existing Sampling Data or Observations The SWPPP shall summarize any results of available storm water sampling data or other observations that characterize the quality of storm water discharges or identifying sources of storm water contamination. Available data that characterizes the quality of storm water discharges under dry weather flow conditions shall also be included, except when such data has been or will be reported to the Department under another WPDES permit.

3.3.2.4 Potential Sources of Storm Water Contamination The SWPPP shall identify any significant pollutants or activities associated with the storm water pollution source areas identified in this permit. When possible, specific pollutants likely to be present in storm water as a result of contact with specific materials shall also be listed. The SWPPP shall identify all potential source areas of storm water contamination, including but not limited to:

3.3.2.4.1 Outdoor manufacturing areas.

3.3.2.4.2 Rooftops contaminated by industrial activity, exhaust vents, or a pollution control device.

3.3.2.4.3 Industrial plant yards.

3.3.2.4.4 Storage and maintenance areas for material handling equipment.

3.3.2.4.5 Immediate access roads and rail lines owned or operated by the permittee.

3.3.2.4.6 Material handling sites including storage, loading, unloading, transportation, or conveyance of any raw material, finished product, intermediate product and by-product or waste areas.

3.3.2.4.7 Storage areas (including tank farms) for raw materials, finished and intermediate products.

3.3.2.4.8 Disposal or application of wastewater.

3.3.2.4.9 Areas containing residual pollutants from past industrial activity.

3.3.2.4.10 Areas of significant soil erosion, including areas of bare soil.

3.3.2.4.11 Refuse sites.

3.3.2.4.12 Vehicle maintenance and cleaning areas.

3.3.2.4.13 Washing areas for equipment, vehicles, containers, or other items.

3.3.2.4.14 Shipping and receiving areas.

3.3.2.4.15 Manufacturing buildings.

3.3.2.4.16 Residual treatment, storage, and disposal sites.

3.3.2.4.17 Any other areas capable of contaminating storm water runoff.

3.3.2.5 Status of Non-Storm Water Discharges to the Storm Sewer The SWPPP shall identify all known contaminated and uncontaminated sources of non-storm water discharges to the storm sewer system or waters of the state and indicate which are covered by WPDES permits. The SWPPP shall contain the results of the non-storm water discharge monitoring required by s. NR 216.28, Wis. Adm. Code. If monitoring is not feasible due to the lack of suitable access to an appropriate monitoring location, the SWPPP shall include a statement that the monitoring could not be conducted and an explanation of the reasons why.

3.3.2.6 Source Area Control Best Management Practices The SWPPP shall rely, to the maximum extent practicable, on the use of source area control best management practices designed to prevent storm water from becoming contaminated at the facility. Source area control best management practices that are either proposed or in place at the facility shall be indicated on the facility drainage base map described in section 3.3.2.2 of this permit. The SWPPP shall provide for the use of the following source area control best management practices:

3.3.2.6.1 Activities to stabilize areas of bare soil with vegetation or through permanent land cover to control soil erosion.

3.3.2.6.2 Good house-keeping measures, preventive maintenance measures, visual inspections, spill prevention and response measures, and employee training and awareness.

3.3.2.6.3 Manage salt storage facilities so that neither precipitation nor storm water runoff can come into contact with the stored salt in order to minimize pollutant discharges. Alternatively, for permittees that use brine and have salt storage piles on impervious curbed surfaces, install and

maintain a means of diverting contaminated storm water to a brine treatment system for process use.

3.3.2.6.4 Use of a combination of storm water contact control or containment, drainage controls, or diversions to control SARA Title III Section 313 "Water Priority Chemicals" (42 USC s. 11023 (c)) potentially discharged through the action of storm water runoff, leaching, or wind.

3.3.2.7 Residual Pollutants The SWPPP shall identify pollutants that are likely to contaminate storm water discharges to waters of the state following implementation of source area control best management practices. Past sampling data collected at the facility or at sufficiently similar outfalls at other facilities may be used in making this determination. At a minimum, the following pollutants shall be considered for their potential to contaminate storm water:

3.3.2.7.1 Any pollutant for which an effluent limitation is contained in any discharge permit issued to the permittee, for this facility, by the Department.

3.3.2.7.2 Any pollutant contained in a categorical effluent limitation or pre-treatment standard to which the facility is subject.

3.3.2.7.3 Any SARA Title III Section 313 "Water Priority Chemical" (42 USC s. 11023 (c)) for which the permittee, for this facility, has reporting requirements and which has the potential for contaminating storm water.

3.3.2.7.4 Any other toxic or hazardous pollutants from present or past activity at the site that remain in contact with precipitation or storm water and which could be discharged to the waters of the state, and which are not regulated by another environmental program.

3.3.2.7.5 Any of the following parameters which might be present in significant concentrations: Oil and grease, pH, total suspended solids, 5-day biological oxygen demand, and chemical oxygen demand.

3.3.2.8 Storm Water Treatment Best Management Practices When source area control best management practices are not practicable or are inadequate to control storm water pollution, or when the Department determines source area control best management practices are inadequate to achieve a water quality standard, the SWPPP shall prescribe appropriate storm water treatment practices as needed to reduce the pollutants in contaminated storm water prior to discharge to waters of the state. Proposed or existing storm water treatment practices shall be shown on the facility drainage basin map described in section 3.3.2.2 of this permit. The SWPPP shall provide for the following types of storm water treatment practices:

3.3.2.8.1 Storm water significantly contaminated with petroleum products shall be treated for oil and grease removal by an adequately sized, designed, and functioning wastewater treatment device. Coverage under a separate individual or general permit is required for discharges of storm water from oil/water treatment devices. Under s. 281.41, Wis. Stats., prior Department approval of plans for oil and grease removal devices may be required.

3.3.2.8.2 Storm water discharges contaminated by sediment eroding from areas of bare soil that cannot be stabilized by pavement, gravel, vegetation, or other permanent land cover shall be treated by best management practices designed, installed and maintained to achieve compliance with the

construction site performance standards in s. NR 151.11(6m), Wis. Adm. Code, and in accordance with the Department's Construction Site Erosion and Sediment Control Technical Standards.

Note: The Construction Site Erosion and Sediment Control Technical Standards are available at the following Department website: https://dnr.wi.gov/topic/stormwater/standards/const_standards.html.

3.3.2.9 Facility Monitoring The SWPPP shall include provisions for complying with the monitoring requirements specified in s. NR 216.28, Wis. Adm. Code, and section 4 of this permit. The SWPPP shall include a checklist of inspections to be made during the annual facility site inspection required by s. NR 216.28(2), Wis. Adm. Code. The SWPPP shall also identify for each outfall the type of monitoring that will be conducted, such as non-storm discharge monitoring and storm water discharge quality inspections.

3.3.2.10 SWPPP Implementation Schedule The SWPPP shall include an implementation schedule for the requirements of this permit that meet the compliance timeframes set forth in this permit.

3.3.2.11 Certification and Signature The SWPPP shall be signed in accordance with s. NR 216.22(7), Wis. Adm. Code, and contain the following statement:

"I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

3.4 Amending a SWPPP Unless an alternative timeframe is specified by the Department, the permittee shall amend and submit the SWPPP to the department within 30 days of the occurrence of any of the following circumstances:

3.4.1 When expansion, production increases, process modifications, changes in material handling or storage, or other activities are planned which will result in significant increases in the exposure of pollutants to storm water discharged either to waters of the state or to storm water treatment devices. The amendment shall contain a description of the new activities that contribute to the increased pollutant loading, planned source control activities that will be used to control pollutant loads, an estimate of the new or increased discharge of pollutants following treatment, and when appropriate, a description of the effect of the new or increased discharge on existing storm water treatment facilities.

3.4.2 The comprehensive annual facility site compliance inspection, quarterly visual inspection of storm water quality, or other information reveals that the provisions of the SWPPP are ineffective in controlling storm water pollutants discharged to waters of the state.

3.4.3 Upon written notice that the Department finds the SWPPP to be ineffective in achieving the conditions of this permit.

3.5 Storm Water Discharges to Outstanding and Exceptional Resource Waters If the permittee's industrial storm water will discharge to an outstanding resource water or exceptional resource water, the permittee shall include a written section in the SWPPP that discusses and identifies the management practices and control measures the permittee will implement to prevent the discharge of any pollutant(s) in excess of the background

level within the water body. This section of the permittee's plan shall specifically identify control measures and practices that will collectively be used to prevent the discharge of pollutants in excess of the background level within the water body.

4. MONITORING REQUIREMENTS

4.1 Purpose Monitoring includes site inspections and non-storm water discharge assessments. The purpose of monitoring is to evaluate storm water outfalls for the presence of non-storm water discharges, and to evaluate the effectiveness of the permittee's pollution prevention activities in controlling contamination of storm water discharges.

4.2 Evaluation of Non-Storm Water Discharges

4.2.1 The permittee shall evaluate all storm water outfalls for non-storm water contributions to the storm drainage system for the duration of this permit. Any monitoring shall be representative of non-storm water discharges from the facility. Evaluations shall take place during dry periods, and may include either end of pipe screening or detailed testing of the storm sewer collection system. Either of the following monitoring procedures is acceptable:

4.2.1.1 A detailed testing of the storm sewer collection system may be performed. Acceptable testing methods include dye testing, smoke testing, or video camera observation. The Department may require a re-test after 5 years or a lesser period as deemed necessary by the Department.

4.2.1.2 End of pipe screening shall consist of visual observations made at least twice per year at each outfall of the storm sewer collection system. Instances of dry weather flow, stains, sludge, color, odor, or other indications of a non-storm water discharge shall be recorded.

Note: The department recommends compiling photographic documentation of visual observations made during non-storm water discharge evaluations.

4.2.2 In addition to maintaining results on-site at the facility, results of the non-storm water evaluations shall be included in the SWPPP required in section 3.3.2.5 of this permit and the Annual Facility Site Compliance Inspection report required in section 5.2 of this permit. Information reported shall include the date of testing, test method, outfall location, testing results, and potential significant sources of non-storm water discovered through testing. Upon discovering non-storm water flows that are not covered under another WPDES permit, the permittee shall either immediately seek coverage under another permit from the Department or eliminate the non-storm water flow.

4.2.3 Any permittee unable to evaluate an outfall for non-storm water discharges shall sign a statement certifying that this requirement could not be complied with, and include a copy of the statement in the SWPPP and the Annual Facility Site Compliance Inspection report. The statement shall be submitted to the Department within 30 days after the permittee determines that it is unable to evaluate an outfall.

4.3 Evaluation of Storm Water Discharges The permittee shall evaluate storm water outfalls for storm water contributions to the storm drainage system. Any monitoring shall be representative of storm water discharges from the facility.

4.3.1 Annual Facility Site Compliance Inspection Permittees shall perform and document the results of an Annual Facility Site Compliance Inspection (AFSCI). The AFSCI shall be adequate to verify that the site drainage conditions and potential pollution sources identified in the SWPPP remain accurate, and that the best management practices prescribed in the SWPPP are being implemented, properly operated and adequately maintained. Information reported shall include the inspection date, inspection personnel, scope of the inspection, major observations, and revisions needed in the SWPPP.

The AFCSI Report Form can be accessed at the following website:
https://dnr.wi.gov/files/PDF/forms/3400/3400-176.pdf

4.3.2 Quarterly Visual Monitoring Permittees shall perform and document quarterly visual inspections of storm water discharge quality at each storm water discharge outfall. Inspections shall be conducted within the first 30 minutes of discharge or as soon thereafter as practical, but not exceeding 60 minutes. The inspections shall include any observations of color, odor, turbidity, floating solids, foam, oil sheen, or other obvious indicators of storm water pollution. Information reported shall include the inspection date, inspection personnel, visual quality of the storm water discharge, and probable sources of any observed storm water contamination.

The Quarterly Visual Inspection Form can be accessed at the following website:
https://dnr.wi.gov/files/PDF/forms/3400/3400-176a.pdf

4.3.3 Monitoring Waivers The Department may waive specific monitoring requirements for the following reasons:

4.3.3.1 The permittee indicates that either an employee could not reasonably be present at the facility at the time of the snowmelt or runoff event, or that attempts to meet the monitoring requirement would endanger employee safety or well-being.

4.3.3.2 The permittee indicates that there were no snow melt or runoff events large enough to conduct a quarterly visual inspection at an outfall. A waiver is automatically granted for a quarter where the permittee sufficiently documents and retains records demonstrating that there were no snow melt or runoff events large enough to conduct a quarterly visual inspection at the facility during that quarter. Documentation and records used to qualify for an automatic waiver shall be submitted to the Department upon request.

4.3.3.3 The facility is inactive or remote facility (such as an inactive mining operation) where the permittee demonstrates that monitoring and inspection activities are impractical or unnecessary. At a minimum, the Department shall establish an alternative requirement that the permittee make site inspections by a qualified individual at least once in every 3-year period.

4.3.3.4 The permittee demonstrates to the Department's satisfaction that the sources of storm water contamination are outside of the permittee's property boundary and are not associated with the permittee's activities. The demonstration shall be presented in the SWPPP or AFSCI report and submitted to the Department for evaluation.

5. COMPLIANCE AND REPORTING REQUIREMENTS

5.1 SWPPP Compliance and Reporting Requirements

5.1.1 An owner or operator of a facility requiring coverage under this permit shall prepare a Storm Water Pollution Prevention Plan (SWPPP) prior to applying for permit coverage under s. NR 216.22, Wis. Adm. Code, and shall submit the SWPPP summary to the Department when applying for coverage under this permit. For existing facilities that previously operated without required permit coverage and without a SWPPP as required, the owner or operator shall immediately develop a SWPPP, submit the SWPPP summary to the Department when applying for coverage under this permit, and implement the SWPPP to achieve compliance with this permit in the shortest practicable time. A facility has the option to submit their full SWPPP in lieu of the SWPPP summary when applying for coverage.

5.1.2 The SWPPP shall conform to the requirements specified in s. NR 216.27 (3), Wis. Adm. Code, and section 3.3 of this permit.

5.1.3 The SWPPP shall be kept at the facility and made available to the Department for inspection and copying upon request. If storm water discharges from the facility enter a municipal separate storm sewer system covered under a storm water permit pursuant to Subchapter I of ch. NR 216, Wis. Adm. Code, the SWPPP shall be made available to the owner or operator of the municipal separate storm sewer system for inspection and copying upon request.

5.1.4 Unless an alternate implementation schedule is specified by the Department, the SWPPP shall be implemented in accordance with the implementation schedule developed under section 3.3.2.10 of this permit.

5.1.5 The permittee shall keep the SWPPP current and amend it as necessary to correct deficiencies in the SWPPP as they are identified. The permittee shall amend the SWPPP and submit it to the Department in the event of any facility operational changes that may result in additional significant storm water contamination.

5.2 Monitoring Compliance and Reporting Requirements

5.2.1 The permittee shall conduct the first Annual Facility Site Compliance Inspection (AFSCI) within 12 months of the **Start Date** of coverage under this general permit. Subsequent AFSCIs shall be conducted and AFSCI reports prepared by the permittee by the anniversary of the **Start Date** for each year of coverage under this permit. Reports shall be written on forms available from the Department and shall contain information from the AFSCI, the quarterly visual inspection, and the non-storm water evaluation. Copies of all AFSCI reports, quarterly visual inspections and nonstorm water monitoring reports shall be maintained on site at the facility and made available to the Department for inspection and copying upon request for the duration of permit coverage.

Note: The AFSCI Report form, Quarterly Visual Inspection form, and Storm Water Chemical Analysis Report form are available on the Department website at:
https://dnr.wi.gov/topic/stormwater/industrial/forms.html.

5.2.2 Quarterly visual inspections of storm water discharge quality shall be conducted by the permittee four times annually by the anniversary date of **Start Date** of coverage under the permit.

5.3 Discharges to Regulated Municipal Separate Storm Sewer Systems

5.3.1 Permittees regulated under this permit with storm water discharges and non-storm water discharges entering a municipal separate storm sewer system covered under a storm water permit pursuant to Subchapter I of ch. NR 216, Wis. Adm. Code, shall provide information on these discharges to the owner or operator of the municipal separate storm sewer system upon request. Information the permittee shall provide includes the area or sub-areas of the facility draining to the municipal separate storm sewer system, the nature of industrial activity and potential storm water contamination sources in the areas draining to the system, the nature and number of non-storm water discharges to the system, storm water best management practices employed at the facility and their effectiveness at pollutant removal, storm water monitoring data, and copies of the SWPPP and AFSCI reports.

5.3.2 Upon discovering a previously unknown non-storm water discharge to the municipal separate storm sewer system that is not authorized to discharge under a required WPDES permit or that is an illicit discharge as defined by s. NR 216.002(11), Wis. Adm. Code, the permittee shall immediately report the discharge to the owner or operator of the municipal separate storm sewer system.

5.3.3 The permittee shall immediately report spills or dumping of materials that enter the municipal separate storm sewer system to the owner or operator of the system.

5.3.4 In accordance with the owner or operator's established authority to control discharges to its municipal separate storm sewer system, the permittee shall assist the owner or operator of the system with detecting and eliminating illicit discharges to the system to the maximum extent practicable if the owner or operator finds that the source of an illicit discharge may originate from the permittee's facility.

6. GENERAL CONDITIONS The general conditions in s. NR 205.07(1), (3), and (5), Wis. Adm. Code, are hereby incorporated by reference into this permit, except for s. NR 205.07(1)(n) and(3)(b), Wis. Adm. Code. Under s. NR 205.08(9), Wis. Adm. Code, dischargers covered under a storm water general permit are not required to submit an application for reissuance unless directed to do so by the Department under s. NR 216.22(9), Wis. Adm. Code. The requirements for spill reporting are in section 6.5 below.

Note: Chapter NR 205 is available at the following website: https://docs.legis.wisconsin.gov/code/admin_code/nr/200.

6.1 Work near Surface Waters and Wetlands Activities performed in wetland areas, in floodplains, or near shorelands may require permits or approvals through applicable state law, state regulations, or county or local ordinances. Additionally, state permits or contracts required by chs. 30, 31 and 87, Wis. Stats. and s. 281.36, Wis. Stats. (or Wisconsin Administrative Code promulgated under these laws), and federal permits may be applicable.

6.2 Continuation of the Expired General Permit As provided in s. NR 205.08(9), Wis. Adm. Code, and s. 227.51, Wis. Stat., the terms and conditions of this general permit shall continue to apply until this general permit is reissued or revoked or until an individual permit is issued for the discharge to which the general permit applied.

6.3 Petition to Move to Individual Permit Coverage Any person may submit a written request to the department to withdraw coverage under this general permit and to replace it with an individual storm water permit under s. NR 216.25(4), Wis. Adm. Code.

6.4 Liabilities under Other Laws Nothing in this permit shall be construed to preclude the institution of any legal action or relieve the permittee from any responsibilities, liabilities, or penalties to which the permittee is or may be subject under Section 311 of the federal Clean Water Act (33 USC s. 1321), any applicable federal, state, or local law or regulation under authority preserved by Section 510 of the Clean Water Act (33 USC s. 1370).

6.5 Severability The provisions of this permit are severable, and if any provisions of this permit or the application of any provision of this permit to any circumstance is held invalid the remainder of this permit shall not be affected thereby.

6.6 Spill Reporting The permittee shall notify the Department immediately of any release or spill of a hazardous substance to the environment in accordance with s. 292.11, Wis. Stats., and ch. NR 706, Wis. Adm. Code.

Note: The 24-hour toll free spills hotline number is (800) 943-0003. Information about hazardous substance spills is available from the Department's website at: https://dnr.wi.gov/topic/Spills/.

6.7 Submitting Records Any forms or reports submitted to the Department of Natural Resources in accordance with this permit shall be submitted via the Department's Water ePermitting System available at: https://dnr.wi.gov/topic/stormwater/industrial/forms.html.

6.8 Enforcement Any violation of s. 283.33, Wis. Stats., ch. NR 216, Wis. Adm. Code, or this permit is enforceable under s. 283.89, Wis. Stats.

6.9 Permit Fee A storm water discharge permit fee shall be paid annually for each industrial facility covered under this permit. The permittee will be billed by the Department annually in May of each year and the fee is

due by June 30 of each year in accordance with s. NR 216.30, Wis. Adm. Code. A permittee may be referred to the Wisconsin Department of Revenue for the collection of any unpaid storm water fee.

Attachment B1

Quarterly Site Inspection Form

09/28/2023 - Classification: Internal - ECRM13153872

ATTACHMENT B1
Quarterly Site Inspection Form
WPL – Columbia Dry Ash Disposal Facility

Location: Columbia Dry Ash Disposal Facility Pardeeville, WI	Inspector (print name):
Date:	Signature:
Time:	Weather at time of inspection: ❑ Clear ❑Cloudy ❑ Rain ❑ Sleet ❑ Fog ❑ Snow ❑ High Winds ❑ Other: Temperature:
Have any previously unidentified discharges of pollutants occurred since the last inspection? ❑Yes ❑No If yes, describe:	
Are there any discharges occurring at the time of inspection? ❑Yes ❑No If yes, describe:	

	Yes	No	
SWPPP and Site Map: Have a copy of the SWPPP and site map with you during the inspection so that you can ensure they are current and accurate. Use it as an aide in recording the location of any issues you identify during the inspection. • Is the Site Map current and accurate? • Is the SWPPP inventory of activities, materials and products current? Any new potential pollutant sources must be added to the map and reflected in the SWPPP.			**Findings and Remedial Action Documentation:** Describe any findings below and the schedule for remedial action completion including the date initiated and date completed or expected to be completed.

09/28/2023 - Classification: Internal - ECRM13153872

ATTACHMENT B1 (CONTINUED)
Quarterly Facility SWPPP Inspection Form
WPL – Columbia Dry Ash Disposal Facility

Vehicle/Equipment Areas:	**Yes**	**No**	**NA**	**Findings and Remedial Action Documentation:**
Equipment cleaning: Is equipment washed and/or cleaned only in designated areas? • Observe washing: Is all wash water captured and properly disposed of?				
Equipment fueling: • Are all fueling areas free of contaminant buildup and evidence of chronic leaks/spills? • Are all chemical liquids, fluids, and petroleum products, on an impervious surface? • Does fuel storage tanks have secondary containment? • Are chemical liquids and fluids covered from precipitation?				
Construction Areas: • Are erosion control practices (e.g., silt fence) in place? • Are erosion control practices in good condition? • Are there signs of sediment entering wetlands, waterbodies or discharging off-site? • Is the construction area free of debris? • Are chemical liquids and fluids covered from precipitation? Add any additional site-specific BMPs: _____ _____ _____ _____ _____				

09/28/2023 - Classification: Internal - ECRM13153872

ATTACHMENT B1 (CONTINUED)
Quarterly Facility SWPPP Inspection Form
WPL – Columbia Dry Ash Disposal Facility

Equipment maintenance:	**Yes**	**No**	**NA**	**Findings and Remedial Action Documentation:**
• Are maintenance tools, equipment, and materials stored indoors? • Are all drums and containers of fluids stored with proper cover and containment? • Are exteriors of containers kept outside free of deposits? • Are any vehicles and/or equipment leaking fluids? Identify leaking equipment. • Is there evidence of leaks or spills since last inspection? Identify and address. • Are materials, equipment, and activities located so that leaks are contained in existing containment and diversion systems (confine the storage of leaky or leak-prone vehicles and equipment awaiting maintenance to protected areas)? Add any additional site-specific BMPs: _____ _____ _____ _____				

09/28/2023 - Classification: Internal - ECRM13153872

ATTACHMENT B1 (CONTINUED)
Quarterly Facility SWPPP Inspection Form
WPL – Columbia Dry Ash Disposal Facility

Ash Landfill Operations:	**Yes**	**No**	**NA**	**Findings and Remedial Action Documentation:**
Ash Handling and Disposal Areas:				
• Are diversion and collection structures in place and directing contact water to the contact water basin and swale?				
• Are diversion structures diverting storm water that has not come into contact with waste from active landfill areas?				
• Final cover and intermediate cover in good condition? Any signs of erosion?				
Stockpiling Areas:				
• Are stockpiles being used?				
• Are stockpiles vegetated? Are there signs of erosion?				
• Is silt fence around stockpiles that are being used?				
• Other BMPs being used?				
• Are there signs of off-site discharge of sediment from the stockpiles?				
Haul Roads:				
• Roads in good condition?				
• Roads clear of debris?				
• Are leaks detected on roads?				
• Repairs needed?				
Rain Cover:				
• Are contact water levels in the contract water pond being maintained in accordance with the most recent "Leachate/Surface Water Pond Capacity Evaluation"?				
• Are areas with rain cover in place free of CCR placement above the rain cover?				
• Does water that has collected on the rain cover show evidence of leachate/contact water impacts?				
• Is there any damage to the rain cover?				
Add any additional site-specific BMPs: _____ _____ _____ _____				

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ATTACHMENT B1 (CONTINUED)
Quarterly Facility SWPPP Inspection Form
WPL – Columbia Dry Ash Disposal Facility

I. POTENTIAL POLLUTANT SOURCE AREA INSPECTION AND BEST MANAGEMENT PRACTICES EVALUATION				
Good Housekeeping BMPs:	**Yes**	**No**	**NA**	**Findings and Remedial Action Documentation:**
1. Are paved surfaces free of accumulated dust/sediment and debris? • Date of last vacuum/sweep _____ • Are there areas of erosion or sediment/dust sources that discharge to storm drains?				
2. Are gravel access road surfaces in good condition? • Are there areas of erosion that need repair? • Are roads watered for dust control?				
3. Are all waste receptacles located outdoors: • In good condition? • Not leaking contaminants? • Closed when is not being accessed? • External surfaces and area free of excessive contaminant buildup?				
4. Are the following areas free of accumulated dust/sediment, debris, contaminants, and/or spills/leaks of fluids? • Material storage areas • Maintenance shop • Equipment staging areas (loaders, trailers, etc.) • Other areas of industrial activity: _____ _____ _____ _____ _____ _____ _____ _____				

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ATTACHMENT B1 (CONTINUED)
Quarterly Facility SWPPP Inspection Form
WPL – Columbia Dry Ash Disposal Facility

Spill Response and Equipment: Are spill kits available, in the following locations? • Ash Handling Equipment Are contaminated absorbent materials properly disposed of?	**Yes**	**No**	**NA**	**Findings and Remedial Action Documentation:**
I. POTENTIAL POLLUTANT SOURCE AREA INSPECTION AND BEST MANAGEMENT PRACTICES EVALUATION				
Waste (non-landfill) Storage Areas: • Are waste storage containers in good condition (no holes, leaks, non-functioning seals)? • Are outdoor containers covered? • Is container full of waste and requires off-site disposal? • Is there litter/debris surrounding the storage container? • Are there signs of contamination around the storage container (e.g., stained soil)?	**Yes**	**No**	**NA**	**Findings and Remedial Action Documentation:**
Storm water BMPs and Treatment Structures: Visually inspect all storm water BMPs and treatment structures devices and outfalls shown on the Site Map. 1.Are the detention/sedimentation basin(s) functioning properly? • Erosion on the embankment? • Signs of contamination? • Outfall structure clean? • Woody vegetation growing on the embankment? • Sediment buildup? • Free of debris? • Are diversion berms, downslope flumes, energy dissipaters, perimeter ditches and culverts used to divert and direct discharges adequate and in good condition?	**Yes**	**No**	**NA**	**Findings and Remedial Action Documentation:**

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ATTACHMENT B1 (CONTINUED)
Quarterly Facility SWPPP Inspection Form
WPL – Columbia Dry Ash Disposal Facility

II. CORRECTIVE ACTION AND SWPPP MODIFICATIONS DESCRIPTIONS: Additional space to describe inspection findings and corrective actions if needed. Provide brief explanation of the general location and the rationale for the additional or different BMPs.

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Attachment B2

Quarterly Wet Weather Outfall Inspection Form

09/28/2023 - Classification: Internal - ECRM13153872

ATTACHMENT B2
Quarterly Wet Weather Outfall Inspection Form
WPL – Columbia Dry Ash Disposal Facility

This form should be kept as part of your Storm Water Pollution Prevention Plan. It does not have to be submitted to the Wisconsin Department of Natural Resources unless requested.

Quarterly visual inspections at each storm water discharge outfall should be performed when sufficient runoff occurs during daylight hours. Try to make observations within the first 30 minutes after runoff begins discharging from the outfall or as soon as practical, but no later than 60 minutes. If you find visible pollution, note the probable source and list any possible Best Management Practices that could be used to reduce or eliminate the problem.

WPL – Columbia Dry Ash Disposal Facility Pardeeville, Wisconsin	Date of Inspection: __ / __ / 20__ __
Quarter (circle): **1** (Jan-Mar) **2** (Apr-Jun) **3** (Jul-Sep) **4** (Oct-Dec)	
Time Rainfall Began: _____ : _____ am pm	
Name of Inspector (print):	
Signature:	

See **Figure 2 and 3** for outfall locations, drainage areas, and potential sources of pollution.

Outfall SW01: Inlet to South Sedimentation Basin	Time of Observation: __ : __ am pm ***(Must be within 60 minutes of time rainfall began).***
Color: ☐Clear ☐Red ☐Yellow ☐Brown ☐Other:	
Odor: ☐None ☐Musty ☐Sewage ☐Rotten Egg ☐Other:	
Clarity: ☐Clear ☐Cloudy ☐Opaque ☐Suspended Solids ☐Other:	
Floatables: ☐None ☐Foam ☐Garbage ☐Oily Sheen ☐Other:	
Deposits/Stains: ☐None ☐Oily ☐Sludge ☐Sediments ☐Other	
Comments (*include possible causes of any contamination noted and possible BMPs to control*):	

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ATTACHMENT B2 (CONTINUED)
Quarterly Facility SWPPP Inspection Form
WPL – Columbia Dry Ash Disposal Facility

Outfall SW02: Inlet to Murray Road Culvert	Time of Observation: __ : __ am pm ***(Must be within 60 minutes of time rainfall began).***
Color: ☐Clear ☐Red ☐Yellow ☐Brown ☐Other:	
Odor: ☐None ☐Musty ☐Sewage ☐Rotten Egg ☐Other:	
Clarity: ☐Clear ☐Cloudy ☐Opaque ☐Suspended Solids ☐Other:	
Floatables: ☐None ☐Foam ☐Garbage ☐Oily Sheen ☐Other:	
Deposits/Stains: ☐None ☐Oily ☐Sludge ☐Sediments ☐Other	
Comments (*include possible causes of any contamination noted and possible BMPs to control*):	

Other Comments/Observations: *(Please note any additional comments/observations regarding source areas and associated BMPs described in Section 3.0 that require follow-up or improvement)*

The following outfalls could not be evaluated during this quarter due to the following reason(s):	
☐ Extended drought	Outfall(s):
☐ Dangerous Weather	Outfall(s):
☐ Extended Freeze	Outfall(s):
☐ Storms did not occur during normal business hours	Outfall(s):
☐ Other (comment below)	Outfall(s):
Other reasons outfall(s) could not be evaluated this quarter:	

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Attachment C

Annual Facility Site Compliance Inspection Report

09/28/2023 - Classification: Internal - ECRM13153872

State of Wisconsin
Department of Natural Resources
PO Box 7921, Madison WI 53707-7921
dnr.wisconsin.gov

Annual Facility Site Compliance Inspection Report (AFSCI)

For Storm Water Discharges Associated With Industrial Activity Under Wisconsin Pollutant Discharge Elimination System (WPDES) Permit

Form 3400-176 (R 07/21)

Notice: This form is authorized by s. NR 216.29(2), Wis. Adm. Code. Submittal of a completed form to the Department is mandatory for industrial facilities covered under a Tier 1 storm water general permit. Facilities covered under a Tier 1 permit are not required to submit AFSCI reports after submittal of the second AFSCI report, unless so directed by the Department. However, these inspections and quarterly visual inspections shall still be conducted and results shall be kept on site for Department inspection. Facilities covered under a Tier 2 storm water general, industry-specific general or individual permit shall keep the results of their AFSCI and quarterly visual inspections on site for Department inspection. Failure to comply with these regulations may result in fines up to $25,000 per day pursuant to s. 283.91, Wis. Stats.

Personally identifiable information on this form may be used for other water quality program purposes.

Please type or clearly print your answers to all questions.

Section I: Facility/Site Information

Facility/Site Name (As Appears on Permit Authorization)		County	
Location Address/Description (if different from mailing address below)		State: WI	ZIP Code
◯ City ◯ Township ◯ Village of	Facility Identification Number (FID) and/or FIN Number if known: FID	FIN	

Section II: Facility/Site Contact Person

Local Contact Person	Mailing Address (if different than site location address)		
Title/Position Title	Municipality (if different than above)		
Telephone (include area code)	State: WI	ZIP Code (if different from above)	
E-mail address or Website (if applicable)		Fax (include area code)	

Section III: Certification & Signature

(Person attesting to the accuracy and completeness of Annual Facility Site Compliance Inspection Report.)

This form must be signed by an official representative of the permitted facility in accordance with s. NR 216.22(7), Wis. Adm. Code. See instructions on page 4. If this form is not signed, or is found to be incomplete, it will be returned.

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Signature of Authorized Representative	Telephone Number (include area code)		
Type or Print Name	Company Name		
Position Title	Mailing Address		
Date Signed (mm/mm/yyyy)	Municipality	State: WI	ZIP Code

How to Use this Form:

The first level of storm water monitoring consists of a comprehensive annual facility site compliance inspection (AFSCI) to determine if your facility is operating in compliance with your Storm Water Pollution Prevention Plan (SWPPP). You should use the results of this inspection to determine the extent to which your SWPPP needs to be updated to prevent pollution from new source areas, as well as to correct any inadequacies that the plan may have in handling existing source areas. This first level of monitoring is addressed in Section IV of this Annual Report on page 2.

The second level of storm water monitoring consists of quarterly visual observations of storm water leaving the site during runoff events caused by snow-melt or rainfall. This is a practical, low cost tool for identifying obvious contamination of storm water discharges, and can also help identify which practices are ineffective. The goal of quarterly inspections is to obtain results from a set of four inspections that are distributed as evenly as possible throughout the year and which depict runoff quality during each of the four seasons. This second level of monitoring is addressed in Section V of this Annual Report on page 3.

Section IV: Annual Facility Site Compliance Inspection

The Annual Facility Site Compliance Inspection shall be adequate to verify that: your Storm Water Pollution Prevention Plan (SWPPP) remains current; potential pollution sources at your facility are identified; the facility site map and drainage map remain accurate; and that the Best Management Practices prescribed in your SWPPP are being implemented, properly operated, and adequately maintained.

Name of Person Conducting Inspection	Inspection Date
Employer	Telephone Number

Your inspection should start with a review of your written SWPPP kept at your facility. The SWPPP should be amended if, through these inspections, you find that the provisions in your SWPPP are ineffective in controlling contaminated storm water from being discharged from your facility. Notify the department if amendments to your SWPPP have been made based on the results of this Annual Facility Site Compliance Inspection Report that address significant operational or source area changes at the facility.

1.	Has your SWPPP been updated to include current Non-Storm Water Discharge Evaluation results (examples of non-storm water discharges include contact cooling water, non-contact cooling water, other process wastewaters, or illicit discharges identified during the evaluation period)?	◯ Yes	◯ No	◯ N/A
2.	Has there been construction at your facility that affects the site map, drainage conditions, or exposed materials?	◯ Yes	◯ No	◯ N/A
3.	Has your SWPPP been amended for any changes in facility operations that could be identified as new source areas for contamination of storm water?	◯ Yes	◯ No	◯ N/A
4.	Are there any other areas capable of contaminating storm water runoff that have not been addressed in the SWPPP?	◯ Yes	◯ No	◯ N/A
5.	Are there any materials at the facility that are handled, stored, or disposed of in a manner to allow exposure to storm water that are not currently addressed in your SWPPP?	◯ Yes	◯ No	◯ N/A
6.	Are there any vehicle or equipment maintenance or material handling activities conducted outdoors that have not been addressed in your SWPPP?	◯ Yes	◯ No	◯ N/A
7.	Are outside areas kept in a neat and orderly condition?	◯ Yes	◯ No	◯ N/A
8.	Are regular housekeeping inspections conducted and observed issues addressed?	◯ Yes	◯ No	◯ N/A
9.	Are there spots, pools, puddles, or other traces/residuals of oils, grease, or other chemicals on the ground?	◯ Yes	◯ No	◯ N/A
10.	Are particulates on the ground from industrial operations or processes being controlled?	◯ Yes	◯ No	◯ N/A
11.	Are there any leaking equipment, pipes or containers or heavy oxidation/rusting on containers?	◯ Yes	◯ No	◯ N/A
12.	Do drips, spills, or leaks occur when materials are being transferred from one source to another?	◯ Yes	◯ No	◯ N/A
13.	Are drips or leaks from vehicles or equipment being controlled (i.e. compactors, forklifts, semis, hydraulic loading docks, etc.)?	◯ Yes	◯ No	◯ N/A
14.	Are cleanup procedures used for spilled solids?	◯ Yes	◯ No	◯ N/A
15.	Are absorbent materials (floor dry, kitty litter, etc.) regularly used to absorb spills?	◯ Yes	◯ No	◯ N/A
16.	Are ventilation systems and drain pipes free of discoloration, residue or corrosion?	◯ Yes	◯ No	◯ N/A
17.	Are Best Management Practices implemented to reduce or eliminate contamination of storm water from source areas at the facility?	◯ Yes	◯ No	◯ N/A
18.	Are Best Management Practices adequately maintained?	◯ Yes	◯ No	◯ N/A
19.	Are changes to your SWPPP needed to correct plan inadequacies to effectively control a discharge of contaminated storm water from your facility?	◯ Yes	◯ No	◯ N/A
20.	Are areas of soil erosion present at your facility that require amendments to the SWPPP to address?	◯ Yes	◯ No	◯ N/A
21.	Are filtration or settling treatment practices evaluated, functioning, and adequately maintained?	◯ Yes	◯ No	◯ N/A

Comments/ Questions or Concerns:

Section V: Quarterly Visual Inspection Reports

Quarterly Visual Inspections at each storm water discharge outfall on your site can be a valuable assessment tool and are required by the Tier 1, Tier 2, and Nonmetallic Mining Industrial Storm Water General Permits. These inspections should be performed when sufficient runoff occurs during daylight hours. Try to make observations within the first 30 minutes after runoff begins discharging from the outfall or soon thereafter as practical, but no later than 60 minutes. If you find visible pollution, note the probable source and list any possible Best Management Practices that will be used to reduce or eliminate the problem. Make any necessary changes to your Storm Water Pollution Prevention Plan based on the results of your Quarterly Visual Inspections. Notify the department if amendments to your SWPPP are made based on inspections and include significant operational or source area changes at the facility. If you were unable to evaluate an outfall during a specific quarter, this should be indicated along with a reason as to why this could not be done.

	Date of Inspection			
Outfall Number	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter

Briefly summarize what you found when conducting your Quarterly Visual Inspections. (Include any observations of color, odor, turbidity, floating solids, foam, oil sheen, or any other indications of storm water pollution and the probable sources of any observed storm water contamination.)

Instructions

Section I: Facility/Site Information

Provide the name of the facility as it appears on the permit application or permit cover letter and location address. If known, provide the Facility Identification (FID) and/or FIN Number assigned by the WDNR. Facility Identification (FID) and/or FIN Number can be found by a query at the following website: https://dnr.wi.gov/topic/stormwater/data/industrial/index.asp.

Section II: Facility/Site Contact Person

Provide the local contact person information for the facility. The mailing address should be given for the facility contact person if it is different from the facility site location address information.

Section III: Certification & Signature

State Statutes provide for severe penalties for submitting false information on this AFSCI form. State regulations require this form be signed by an Authorized Representative as follows:

a. For a corporation, by a principal executive officer of at least the level of Vice President, or a duly authorized representative having overall responsibility for the operation covered by this permit.
b. For a unit of government, a principal executive officer, a ranking elected official, or other duly authorized representative.
c. For a partnership, by a general partner; for a sole proprietorship, by the proprietor.
d. For a limited liability company, by member or manager.

If the Authorized Representative has changed, please complete the following form: https://dnr.wi.gov/files/PDF/forms/3400/3400-220.pdf and mail the completed form to the appropriate mailing address below. Updated forms can also be emailed directly to programmatic staff assigned for the county where the facility is located. Storm Water staff can be found by accessing the following weblink: https://dnr.wisconsin.gov/topic/Stormwater/contacts.html

Section IV: Annual Facility Site Compliance Inspection

Provide the name of the person conducting the inspection, inspection date, name of employer, and telephone number. Check the appropriate box for each of the listed questions and provide explanations in the comment box as needed.

Notify Storm Water Staff if SWPPP amendments in section IV of the Annual Facility Site Compliance Inspections address significant operational or source areas at the facility. Staff assignments by county are found at the following weblink: https://dnr.wisconsin.gov/topic/Stormwater/contacts.html

Section V: Quarterly Visual Inspection Reports

Provide the outfall number in the table and the dates of each quarterly visual inspection. Summarize the findings of your visual inspections in the space provided below the table. Attach additional sheets or Quarterly Visual Inspections if needed. The Quarterly Visual Inspection - Field Sheet can be accessed at the following weblink: https://dnr.wisconsin.gov/topic/Stormwater/industrial/forms.html.

Notify Storm Water Staff if SWPPP amendments in section V of the Annual Facility Site Compliance Inspections address significant operational or source areas at the facility. Staff assignments by county are found at the following weblink: https://dnr.wisconsin.gov/topic/Stormwater/contacts.html

Submittal of Electronic Information or Mailing Address

The Department utilizes an online e-permitting system that allows permittees to electronically submit information. This form may be submitted electronically at the following website: https://dnr.wisconsin.gov/permits/water. If directed to do so, mail this completed form to the Wisconsin Department of Natural Resources (WDNR) office associated with the county of the facility site location as follows:

NORTHERN REGION (NOR)			
Ashland	Forest	Price	WDNR Eau Claire Service Center
Barron	Iron	Rusk	1300 W Clairemont Ave
Bayfield	Langlade	Sawyer	Eau Claire, WI 54701
Burnett	Lincoln	Taylor	(715) 839-1636
Douglas	Oneida	Vilas	
Florence	Polk	Washburn	

NORTHEAST REGION (NER)			
Brown	Manitowoc	Shawano	WDNR Northeast Regional Headquarters
Calumet	Marinette	Waupaca	2984 Shawano Avenue
Door	Marquette	Waushara	Green Bay, WI 54313-6727
Fond du Lac	Menominee	Winnebago	(920) 662-5100
Green Lake	Oconto		
Kewaunee	Outagamie		

WEST CENTRAL REGION (WCR)			
Adams	Jackson	Pierce	WDNR Eau Claire Service Center
Buffalo	Juneau	Portage	1300 W Clairemont Ave
Chippewa	La Crosse	St. Croix	Eau Claire, WI 54701
Clark	Marathon	Trempealeau	(715) 839-1636
Crawford	Monroe	Vernon	
Dunn	Pepin	Wood	
Eau Claire			

SOUTH CENTRAL REGION (SCR)			
Columbia	Green	Richland	WDNR South Central Regional Headquarters
Dane	Iowa	Rock	3911 Fish Hatchery Road
Dodge	Jefferson	Sauk	Fitchburg, WI 53711
Grant	LaFayette		(608) 275-3266

SOUTHEAST REGION (SER)			
Kenosha	Racine	Washington	WDNR SER Headquarters
Milwaukee	Sheboygan	Waukesha	940 W. St. Paul Ave.
Ozaukee	Walworth		Milwaukee, WI 53233
			(414) 477-1119

Attachment D

Regulatory Applicability and Implementation Schedule

09/28/2023 - Classification: Internal - ECRM13153872

ATTACHMENT D
Regulatory Applicability and Implementation Schedule

In response to the finalization of federal storm water regulations found in Title 40 of the Code of Federal Regulations (40 CFR) Parts 122, 123, and 124, the Wisconsin Department of Natural Resources (WDNR) developed a program to implement these storm water discharge regulations. Provisions that implement the federally mandated storm water program are contained in Chapter NR 216 of the Wisconsin Administrative Code (NR 216). These State regulations outline the Storm Water Permit Program, which is administered by the Bureau of Watershed Management, Storm Water Permits Program, of the WDNR.

The facility maintains a Wisconsin Pollutant Discharge Elimination System (WPDES) General Permit for the Discharge of Storm Water Associated with Tier 2 Industrial Facilities No. SO67857-5 (Tier 2 General Permit). The Tier 2 General Permit is provided in Attachment A. The Tier 2 General Permit authorizes the discharge of storm water associated with industrial activity. This Storm Water Pollution Prevention Plan (SWPPP) is required as part of the Plan of Operation for the landfill.

The following table cross-references the requirements of NR 216 and the Tier 2 General Permit to the SWPPP. Note that Tier 2 facilities have no monitoring requirements (NR 216.27(3)(d) and (k)) and do not require storm water treatment practices at this time (NR 216.27(3)(j)).

Tier 2 General Permit Reference	NR 216 Citation	SWPPP Cross Reference
Complete Drainage Map	NR 216.27(3)(c)	Figures 1, 2 and 3 of this SWPPP
Complete Inventory of Significant Polluting Materials	NR 216.27(3)(f)	Sections 1.0 and 2.0
Summary of Major Activities Conducted at the Facility	NR 216.27(3)(b)	Sections 1.0 and 2.0
Describe Appropriate Best Management Practices	NR 216.27(3)(h)	Section 3.0
Evaluate Discharge Sources for Non-Storm Water Discharges	NR 216.27(3)(g)	Attachment F
Identify Potential Source Areas of Storm Water Contamination	NR 216.27(3)(e)	Sections 1.0 and 2.0
Identify Potential Areas of Storm Water Pollutants Following the Implementation of BMPs	NR 216.27(3)(I) & (j)	Section 4.0
Develop an Implementation Schedule for the SWPPP	NR 216.27(3)(I)	Section 6.0 and Attachment D
Identify Personnel Responsible for Implementing the SWPPP	NR 216.27(3)(a)	Section 7.0
Signature of Principal Executive Officer as in NR 216.26(7)	NR 216.27(3)(m)	Page iii
Provide Information on Required Storm Water Inspections		Section 6.0 and Attachments B and C

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ATTACHMENT D
SWPPP Implementation Schedule

Item	Quarter			
	1	2	3	4
Annual Facility Site Compliance Inspection (AFSCI)	✓[1]			
Quarterly Visual Monitoring Inspections[2]	✓	✓	✓	✓
Non-storm Water Discharge Inspections[3]				
Annual Review for Discharge Water Body Status (Impaired Water Body and TMDL)[4]	✓			

Notes:

1. AFSCI must be prepared by the anniversary of the Start Date of coverage. AFSCI reports must be kept on file at the facility. No WDNR submission is required.
2. Inspections are to be performed within the first 30 minutes of discharge or as soon thereafter as practical, but not to exceed 60 minutes.
3. Non-storm water discharge inspections must take place during dry weather periods. If non-storm water discharge evaluation consists of end of pipe screening, perform at least twice per year at each outfall. If the evaluation consists of dye testing, smoke testing, or video camera observation, perform at least every 5 years, or a lesser period if deemed necessary by WDNR.
4. By February 15th of each calendar year, perform a review to determine whether the facility discharges a pollutant of concern to an impaired water body or water body included in a state and federally-approved TMDL. See **Section 6.4** of SWPPP for further information.

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Attachment E

SWPPP Training Record

09/28/2023 - Classification: Internal - ECRM13153872

ATTACHMENT E
SWPPP Training Record

Date of Training	Name of Trainee (Please Print)	Type of Training		Signature of Trainee	Signature of Trainer
		Initial	Refresher		

09/28/2023 - Classification: Internal - ECRM13153872

Attachment F

SWPPP Non-Storm Water Discharge Certification

09/28/2023 - Classification: Internal - ECRM13153872

ATTACHMENT F
SWPPP Non-Storm Water Discharge Assessment and Certification

Evaluations of non-storm water discharges shall take place during dry periods of weather at each outfall. Complete one page for each outfall.

Include results of evaluations in the Annual Facility Site Compliance Inspection (AFSCI) Report as required in Section 4.2 of the General Permit.

If Wisconsin Power and Light personnel are unable to evaluate an outfall for non-storm water discharges, check the box for the corresponding outfall and sign the statement certifying that this requirement could not be complied with. Include a copy of the statement in the SWPPP and the AFSCI report. The statement shall be submitted to the Wisconsin Department of Natural Resources within 30 days after Wisconsin Power and Light determines that it is unable to evaluate an outfall.

Method of Evaluation Used (Check one):

☐ Option 1 Detailed Testing of Storm Sewer Collection System (dye testing, smoke testing, or video camera observation) – If Option 1 is used, sign and date in the section below and attach testing documentation.

☒ Option 2 Visual End-of-Pipe Screening of Each Storm Water Outfall Performed Twice Per Year - If Option 2 is used, complete all sections of this form.

Columbia Dry Ash Disposal Facility Columbia Energy Center W8375 Murray Road, Pardeeville, WI 53954«Fac_ZIP_Code»	Date of Evaluation: ____ / ____ / 20___ ___
Name of Inspector (print):	
Signature:	

If there are indications of non-storm water discharge for any outfall, notify the SWPPP Coordinator. The SWPPP Coordinator will evaluate the source and determine whether it is exempt from WPDES permitting under Section 2.4.3 of the General Permit, or covered under another permit. If not exempt or covered under another permit, the non-storm water discharge must be eliminated or coverage under another permit must be obtained. See Figure 2 for outfall locations.

Outfall SW001			Time of Evaluation: ___ : ___ am pm
Check if any of the following indications of a non-storm water discharge are present:			
Dry weather flow?	☐ No	☐ Yes - Describe:	
Staining present?	☐ No	☐ Yes - Describe:	
Sludge present?	☐ No	☐ Yes - Describe:	
Color?	☐ No	☐ Yes - Describe:	
Odor?	☐ No	☐ Yes - Describe:	
Other indications of non-storm water discharge? ☐ No ☐ Yes - Explain below:			
☐ This outfall could not be evaluated for non-storm water discharges; this requirement could not be complied with. Reason: Signature:_____			

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ATTACHMENT F (CONTINUED)
SWPPP Non-Storm Water Discharge Assessment and Certification

Outfall SW002	Time of Evaluation: ___ : ___ am pm
Check if any of the following indications of a non-storm water discharge are present:	
Dry weather flow? ☐ No	☐ Yes - Describe:
Staining present? ☐ No	☐ Yes - Describe:
Sludge present? ☐ No	☐ Yes - Describe:
Color? ☐ No	☐ Yes - Describe:
Odor? ☐ No	☐ Yes - Describe:
Other indications of non-storm water discharge? ☐ No ☐ Yes - Explain below:	
☐ This outfall could not be evaluated for non-storm water discharges; this requirement could not be complied with. Reason: Signature:_____	

09/28/2023 - Classification: Internal - ECRM13153872

Attachment G

Receiving Water Classification Review Information

09/28/2023 - Classification: Internal - ECRM13153872

ATTACHMENT G
Receiving Water Classification Review Information

Category	Instructions for Reviewing Classification (See Note)
Exceptional Resource Water (ERW) and Outstanding Resource Water (ORW) Review Results & Impaired Waters and TMDL Review	WDNR website • http://dnr.wi.gov/water • Click "Impaired Waters" Enter "1179900" into the "Enter Water Name or WBIC" entry and hit the "Search" button. • Click on the Official Name "Wisconsin River" link that goes with Start Mile 90.6 and End Mile 115.81. Note any impairments listed in the top section of this page. Note any TMDLs listed. • Click on "View Water Details." • Look in the Overview tab and note if Mill Creek is listed as Outstanding or Exceptional Resource Water.

Note: WDNR webpage addresses and links can change. If problems arise with the search directions listed above, contact SCS at (608) 224-2830.

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ATTACHMENT G (CONTINUED)
Receiving Water Classification Review Information

Annual Receiving Waters Review Record
(To be performed by February 15th of each year)

Date of Review	Person Performing Review (Print Name)	Receiving Water(s) Classified As Any of the Following?				Comments
		ORW? (If Y, see Section 1.5 of SWPPP)	ERW? (If Y, see Section 1.5 of SWPPP)	Impaired? (If Y, see Section 6.4.1 of SWPPP)	Approved TMDL? (If Y, see Section 6.4.2 of SWPPP)	
2/15/22	Rick Guenther, SCS Engineers	N	N	Y	N	Unnamed tributary of the Wisconsin River is not listed as an impaired water body. Wisconsin River is listed as an impaired water body for PCBs and mercury.
5/30/23	Rick Guenther, SCS Engineers	N	N	Y	Y (for Duck Creek)	No change other than including Duck Creek as an impaired water body for total phosphorus
		Y / N	Y / N	Y / N	Y / N	
		Y / N	Y / N	Y / N	Y / N	
		Y / N	Y / N	Y / N	Y / N	
		Y / N	Y / N	Y / N	Y / N	
		Y / N	Y / N	Y / N	Y / N	
		Y / N	Y / N	Y / N	Y / N	
		Y / N	Y / N	Y / N	Y / N	
		Y / N	Y / N	Y / N	Y / N	
		Y / N	Y / N	Y / N	Y / N	
		Y / N	Y / N	Y / N	Y / N	
		Y / N	Y / N	Y / N	Y / N	
		Y / N	Y / N	Y / N	Y / N	

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Attachment H

SWPPP Revision & Review Log Sheet

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ATTACHMENT H
COLUMBIA DRY ASH DISPOSAL FACILITY
WPL – COLUMBIA ENERGY CENTER
SWPPP Revision & Review Log Sheet

Date of Revision	Completed By	Comments
October 2016	Rick Guenther, PE (*SCS Engineers*)	Creation of the SWPPP
August 2018	Betsy Powers, PE *(SCS Engineers)*	Update to incorporate Module 4 construction
April 2021	Rick Guenther, PE (*SCS Engineers*)	Update to include staff changes, existing conditions and proposed construction of Mod 5/6
March 2022	Rick Guenther, PE (SCS Engineers)	Update to existing conditions and proposed construction of Mods 10 and 11
June 2023	Rick Guenther, PE (SCS Engineers)	Update to existing conditions with construction of Mods 10 and 11

This log sheet documents all annual reviews and revisions made to the plan.

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Appendix D

Construction Quality Assurance/Quality Control Plan

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Construction Quality Assurance / Quality Control Plan

Primary/Secondary Ash Pond Closure and Dry Ash Disposal Facility
Wisconsin Power and Light Company
Columbia Energy Center

Prepared for:

Wisconsin Power and Light Company
Columbia Energy Center
W8375 Murray Road
Pardeeville, Wisconsin 53954

SCS ENGINEERS

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1.0 INTRODUCTION

1.1 PURPOSE AND SCOPE

The purpose of this Construction Quality Assurance (CQA) Plan is to address the quality assurance during the Primary and Secondary Ash Pond closure construction, and the Dry Ash Disposal Facility liner and final cover systems construction at the Wisconsin Power and Light Company – Columbia Energy Center. The Plan addresses the earthen materials (fly ash, bottom ash, sand, aggregate, general soil, select clay fill, barrier layer soil, and topsoil), synthetic materials (geotextile, geomembrane, geosynthetic clay liner [GCL], geocomposite, and rain cover), and piping.

This CQA Plan provides procedures for the construction, testing, and documentation of Work components in adherence to their design and regulatory requirements.

The scope of this CQA Plan includes general CQA requirements concerning roles, responsibilities, and qualifications of the parties involved; the preconstruction meeting; the geosynthetic preconstruction report, general inspection, and documentation procedures; and the documentation report. This CQA Plan establishes requirements for the construction procedures and observation, field and laboratory testing frequency and methods, and acceptance for each component of the pond closures, and Dry Ash Disposal Facility liner and final cover systems. Geosynthetic testing and acceptance standards are based on the Geosynthetic Research Institute (GRI) Test Methods GM 13 and GM 17, and on currently accepted industry standards and practice.

This plan is intended to serve as a guide and can be modified to reflect current industry standards with regard to laboratory testing methods, testing procedures, testing requirements, and applicable regulations. Any changes from this plan will be discussed in the geosynthetics preconstruction report and/or the documentation report as required.

The following sources were used in developing this plan:

- Geosynthetic Research Institute, GRI Standard GCL 3, “Test Methods, Required Properties, and Testing Frequencies of Geosynthetic Clay Liners (GCLs),” revision 5, November 21, 2019.
- Geosynthetic Research Institute, GRI Standard GT12(a), “Test Methods and Properties for Nonwoven Geotextiles Used as Protection (or Cushioning) Materials,” revision 2, March 3, 2016.
- Geosynthetic Research Institute, GRI Standard GM 13, “Standard Specification for Test Methods, Test Properties, and Testing Frequency for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes,” revision 16, March 17, 2021.
- Geosynthetic Research Institute, GRI Standard GM 17, “Standard Specification for Test Methods, Test Properties, and Testing Frequency for Linear Low Density Polyethylene (LLDPE) Smooth and Textured Geomembranes,” revision 14, March 17, 2021.
- Geosynthetic Research Institute, GRI Standard GM 19a, “Seam Strength and Related Properties of Thermally Bonded Homogeneous Polyolefin Geomembranes/Barriers,” revision 10, March 18, 2021.

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- Geosynthetic Research Institute, GRI Standard GM22, "Test Methods, Required Properties and Testing Frequencies for Scrim Reinforced Polyethylene Barriers Used in Exposed Temporary Applications," revision 4, February 18, 2016.

- Geosynthetic Research Institute, GRI Test Method GM 6, "Standard Practice for Pressurized Air Channel Test for Dual Seamed Geomembranes," revised 1994.

- American Society for Testing and Materials (ASTM), Annual Book of ASTM Standards, most recent version.

- Environmental Protection Agency (EPA) Technical Guidance Document EPA/530-SW-86-031 titled "Construction Quality Assurance for Hazardous Waste Land Disposal Facilities."

- EPA Technical Guidance Document EPA/530-SW-86-007, titled "Design, Construction, and Evaluation of Clay Liners for Hazardous Waste Facilities."

- NR 500, Wisconsin Administrative Code.

- Code of Federal Regulations, Title 40, Part 257 [40 CFR 257], Subpart D – Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments.

- Wisconsin Department of Transportation, Standard Specifications for Highway and Bridge Construction.

1.2 QUALITY ASSURANCE AND QUALITY CONTROL

Quality assurance and quality control are defined as follows:

- **Quality assurance** – A planned and systematic pattern of all means and actions designed to provide adequate confidence that material or services meet contractual and regulatory requirements. This is typically performed to ensure that delivered materials or services are of desired quality.

- **Quality control** – Those actions that provide a means to measure and regulate the characteristics of a material or service to meet contractual and regulatory requirements. This typically is performed by or for the provider of the materials or services as a control mechanism on the quality of the provider's efforts.

In the context of this CQA Plan, the terms are further defined as follows:

- **Quality assurance** refers to the means and actions employed by the CQA Officer to ensure conformity of the systems' installation with the CQA Plan, the construction specifications, and the construction plans.

- **Quality control** refers to those actions taken by the manufacturer, fabricator, or construction/installer to provide materials and workmanship that meet the requirements of the CQA Plan, the construction plans, and the construction specifications. Some testing efforts required by this CQA Plan may serve as both quality control and quality assurance measures.

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1.3 GENERAL TESTING REQUIREMENTS

This CQA Plan includes references to test procedures of the ASTM and the GRI. Test procedure references are always to the latest approved version up to the date of this document, unless specifically stated otherwise in this document.

Testing will be performed in strict accordance with the referenced test procedure and the description included in this plan, unless indicated otherwise. Any deviations to test procedures called out in this plan must be approved, in writing, by the CQA Officer or Company prior to commencement of any work.

2.0 CQA ROLES, RESPONSIBILITIES, AND QUALIFICATIONS

2.1 CQA OFFICER

The CQA Officer will supervise and be responsible for all observations, testing, and related construction documentation as described in this CQA Plan. The CQA Officer will be responsible for preparing the construction acceptance report to certify substantial compliance with appropriate permit and regulatory agency. The CQA Officer will be a professional engineer registered in the state of Wisconsin. The Company or operator shall notify the Wisconsin Department of Natural Resources (WDNR) of the designated CQA Officer and provide the department with that person's contact information.

The CQA Officer may delegate daily observation, documentation, testing, and sampling duties to a qualified technician or engineer with experience in the assigned aspect of construction that will serve as the Resident Project Representative (RPR). Although these duties may be delegated, the CQA Officer will retain the responsibility for these activities.

2.2 RESIDENT PROJECT REPRESENTATIVE

The RPR will carry out daily observation, documentation, testing, and sampling duties under the direct supervision of the CQA Officer. The RPR will be a qualified technician or engineer with experience in the assigned aspect of construction. The RPR will observe and document construction and installation procedures. The RPR will prepare daily summary reports and will routinely transmit the reports to the CQA Officer. The RPR will immediately notify the CQA Officer of problems or deviations from the CQA Plan or construction plans and specifications. Reporting, documentation, and resolution of problems and deficiencies will be carried out as described in Section 4.0. The RPR will not have authority to approve design or specification changes without the consent of the CQA Officer and the Company.

2.3 SOILS TESTING LABORATORY

The soils testing laboratory retained will be experienced in construction soil testing in accordance with ASTM and other applicable standards. The selected laboratory will be responsive to the project needs by providing test results within reasonable time frames. This will include providing verbal communication on the status of ongoing tests and immediate communication of test results as needed to facilitate ongoing construction. Final laboratory reports will be certified by the soil testing laboratory and submitted to the CQA Officer.

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2.4 GEOSYNTHETICS TESTING LABORATORY / LABORATORIES

The geosynthetics testing laboratory/laboratories will have experience in testing geosynthetics in accordance with standards developed by ASTM, GRI, and other applicable test standards. The selected laboratory/laboratories will be responsive to the project needs by providing test results within reasonable time frames. Final laboratory reports will be certified by the geosynthetics testing laboratory/laboratories and will be submitted to the CQA Officer.

2.5 CONSTRUCTION CONTRACTOR

The Construction Contractor's role will be to furnish earthwork, construction, and piping installation; and to provide overall construction responsibility for the completion of the pond closures, and Dry Ash Disposal Facility liner and final cover components. The Construction Contractor will be experienced in landfill construction and be familiar with geosynthetic installations. The term "Contractor" is used interchangeably with "Construction Contractor" in this plan.

2.6 GEOSYNTHETICS INSTALLER

The Geosynthetics Installers are the companies hired by the Contractor to install the geosynthetic components referenced in this plan, and to perform the nondestructive seam testing of the geomembranes required by this plan. The term "Installer" is used throughout this plan when reference is made to the tasks and responsibilities of a Geosynthetics Installer.

The Installer will be trained and qualified to install the various geosynthetic components covered by this plan. The Installer of the geomembrane will be approved and/or licensed by the manufacturer. The Installer will submit a copy of the approval letter or license to the CQA Officer and/or Company.

Prior to confirmation of any contractual agreements, the Installer of the geomembranes will provide the CQA Officer and/or the Company with the following written information, which must be approved by the CQA Officer and/or Company.

- Corporate background and information.

- Installation capabilities:
  Information on equipment and personnel.
  Resumes of personnel.
  Quality control manual for installation.

- A list of at least 10 completed facilities, totaling a minimum of two million square feet for which the Installer has completed the installation of polyethylene geomembrane. For each installation, the following information will be provided:
  Purpose of facility, its location, and date of installation.
  Project manager, designer, manufacturer, and fabricator (if any).
  Thickness and type of polyethylene geomembrane and the surface area of the installed geomembrane.

The Installer of the geomembranes will provide a copy of the tensiometer certification, indicating the date in which the tensiometer was calibrated prior to start of any seaming operations. The Installer is responsible for delays caused to the project until tensiometer certification is delivered to the RPR.

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Tensiometers used in the state of Wisconsin are required to be calibrated within 90 days prior to the start of the project. The Installer is responsible to meet this requirement, and must supply a copy of the certification at the time of mobilization to the job site.

All personnel performing geomembrane-seaming operations will be qualified by experience and by successfully passing seaming tests for the seaming methods to be used. At least one seamer shall have experience seaming a minimum of one million square feet of polyethylene geomembrane using the same type of seaming apparatus in use at the site. The most experienced seamer, the "master seamer," will provide direct supervision, as required, over less experienced seamers. No field seaming will take place without a master seamer present.

The Installer of the geomembranes will provide the CQA Officer with a list of proposed seaming and testing personnel, and their professional records, prior to the installation of the geomembranes. The CQA Officer and Company will review this document. The CQA Officer and/or Company will not accept any proposed seaming personnel deemed insufficiently experienced. The Installer will designate one representative as the Superintendent, who will represent the Installer at all site meetings, and who will be responsible for acting as the Installer's spokesman on site.

3.0 PRECONSTRUCTION ACTIVITIES

3.1 PRECONSTRUCTION MEETING

Prior to commencement of each phase of construction at the ash disposal facility, a preconstruction meeting will be held. This meeting will include the parties involved in the construction, including the CQA Officer or designated representative, the RPR, the Construction Contractor, and the Company.

The purpose of this meeting is to begin the planning and coordination of construction tasks, to identify potential problems that might cause difficulties and/or delays in construction, to properly interpret the design intent, and to present the CQA Plan to all of the parties involved. It is important that the rules regarding testing, repairs, etc., be known and accepted by each party to this plan.

Specific topics considered for this meeting include the following:

- Review critical design details of the project, including the plans and specifications.
- Review measures for pond dewatering or dredging.
- Review measures for sediment dewatering/conditioning including geotextile tubes if used for dewatering.
- Review measures for surface water runoff and siltation control.
- Make appropriate modifications to the CQA Plan (if necessary).
- Review the roles and responsibilities of each party.
- Review lines of authority and communication.
- Review methods for documenting and reporting and for distributing documents and reports.

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- Review requirements of the soil testing laboratory and the geosynthetics testing laboratory regarding sample sizes, methods of collection, and shipment. Also, review turn times for sample data and their implications on the construction schedule, pending receipt of acceptance data.

- Review the number and locations of the tests required for soil and geosynthetic components.

- Review methods of subbase grade or soil barrier layer surface preparation and approval prior to GCL and geomembrane placement.

- Outline procedures for packaging and storing archive samples.

- Review repair procedures.

- Review the time schedule for all operations.

- Establish procedures for deployment of materials over completed geomembranes emphasizing protection of the geomembrane.

- Observe where the site survey benchmarks are located, and review methods for maintaining vertical and horizontal control.

- Review permit documentation requirements.

- Review the survey documentation tables and plans that identify the locations where survey documentation information is required.

- Conduct a site walk-around to review material storage locations and general conditions relative to construction.

- Set up a time and place for regular construction progress meetings.

Minutes prepared by the CQA Officer or other party designated by Company will be distributed to all parties involved in the construction project.

3.2 GEOSYNTHETIC PRECONSTRUCTION SUBMITTAL

Prior to the installation of geosynthetic materials, a preconstruction submittal will be prepared and submitted to the WDNR. The submittal will contain, at a minimum, the following:

- Identification of the fabricators and Installers selected for the geomembrane and other geosynthetics.

- Information on the chosen geosynthetic products.

- Certification from the GCL manufacturer that the GCL product is free of broken-off needles from the needle punching process.

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- Final version of the CQA Plan, incorporating input from the selected Installer, and documenting qualifications of the third-party CQA firm and testing laboratories.

- Any modifications to the installation plan, with final proposed version of the panel layout diagram and any revisions to the details of seaming, patching, penetrations, use of prefabricated specialty sections, or repair methods.

- Any changes in geosynthetics acceptance values, test method references, and/or test procedures.

- For final cover with sand drainage layer, include filter analyses for:

  Drainage layer sand and rooting zone soil to determine if a geotextile filter is required.

  Drain sock around intermediate drain pipes in drainage layer to be compatible with drainage layer sand particle sizes and permeability.

- Results of direct shear testing (ASTM D5321 or D6243) performed on the applicable geosynthetic interfaces and other required tests, as presented in the table below. This table also specifies the required minimum acceptance values required for the testing.

Construction Item	Required Peak Interface Friction Angle or Other Testing	Minimum Required Acceptance Value[1]
Liner System Construction	Subbase Soil or Select Clay Fill/GCL[3]	(5)
	GCL/Textured HDPE Geomembrane[2]	(5)
	Textured HDPE Geomembrane/Drainage Layer [4]	(5)
	GCL Hydrated Internal Shear Strength[2]	59 psf
Final Cover Construction	Barrier Layer Soil/GCL[2]	20.6 degrees
	GCL/Textured LLDPE Geomembrane[2]	20.6 degrees
	Textured LLPE Geomembrane/Drainage Layer[4]	20.6 degrees
	Textured LLDPE Geomembrane/Geocomposite	20.6 degrees
	Geocomposite/Rooting Zone [4]	20.6 degrees
	GCL Hydrated Internal Shear Strength[2]	131 psf

Notes:
1. Direct shear testing of wet interface at normal stresses of 200, 400, and 600 psf. Use a maximum shear rate of 0.004 inch/minute for interfaces with soil or GCL.
2. GCL hydrated for 48 hours under 300 psf and for 24 hours under load prior to shear. Barrier layer soil compacted wet of optimum to 90 percent of modified Proctor maximum dry density or 95 percent of standard Proctor maximum dry density.
3. Select clay fill compacted to 90 percent of modified Proctor maximum dry density at moisture contents of at least 2 percent wet of optimum. Subbase soil compacted to 90 percent of modified Proctor maximum dry density. Select clay fill compacted to 95 percent of standard Proctor maximum dry density at moisture contents of at least optimum. Subbase soil compacted to 95 percent of standard Proctor maximum dry density.
4. Drainage layer or rooting zone prepared by lightly tamping.
5. Required test values are shown on the adhesion vs. interface friction angle figure below.

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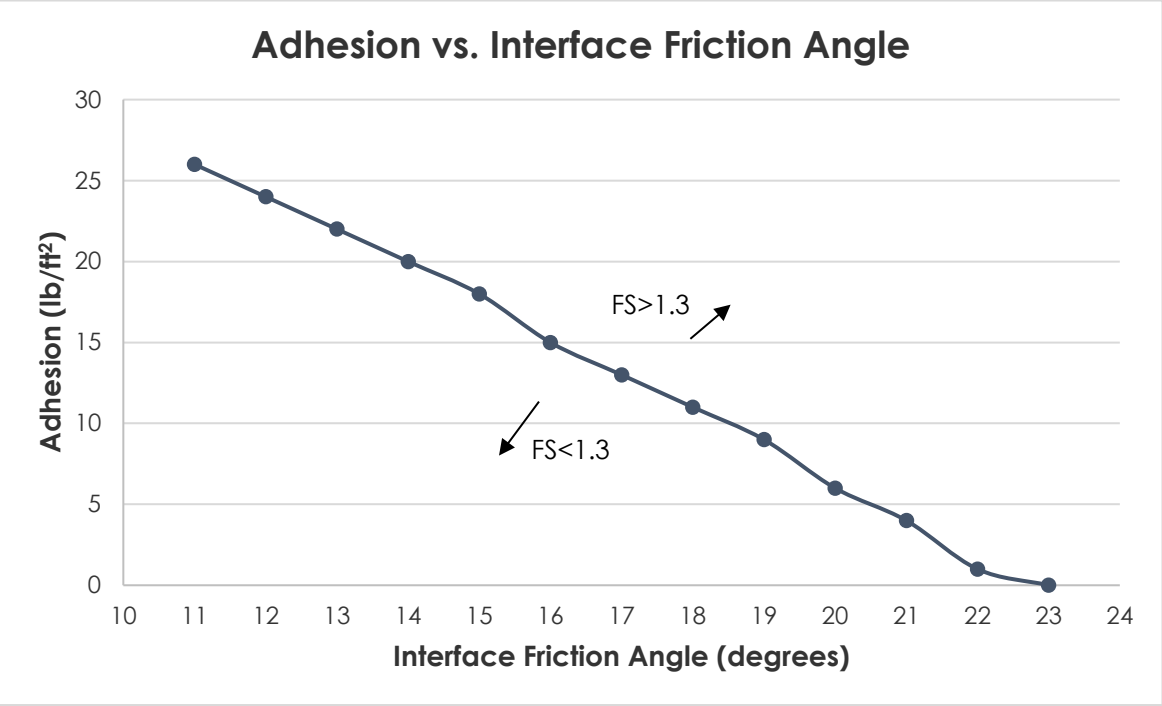

Direct shear testing is to be performed for each construction event unless the materials to be used are the same as those that were tested for a previous construction event. The CQA Officer and Company shall determine whether testing is required for each construction event.

3.3 GEOSYNTHETIC PRECONSTRUCTION MEETING

Prior to placement of geosynthetics, a geosynthetic preconstruction meeting will be held. This meeting will include the parties involved in the construction, including the CQA Officer, the RPR, the Construction Contractor, the Geosynthetic Installer, the Company, and possibly a WDNR representative.

The purpose of this meeting is to establish the lines of communication; define the Contractor's role and responsibility during the geosynthetic deployment; and review the proposed panel layout, planned seaming methods, Installer's CQC Plan, and this CQA Plan defining the rules regarding testing, repairs, etc.

Specific topics considered for this meeting include the following:

- Review critical design details of the project, including plans and specifications.
- Review Contractor's plan for surface water control.
- Make appropriate modifications to the CQA Plan (if necessary).
- Review the roles and responsibilities of each party.
- Review the lines of authority and communication.

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- Review methods for documenting, reporting, and distributing documents and reports.
- Review requirements of the Geosynthetic Testing Laboratory regarding sample sizes, methods of collection, and shipment. Review turn times for samples and their implications on the construction schedule.
- Review the number and frequency of tests.
- Review methods of subbase grade or grading layer surface preparation and approval prior to geosynthetic placement.
- Establish rules for writing on the geosynthetic (i.e., who is authorized to write, what can be written, and which color of paint).
- Outline procedures for packing and storing of samples.
- Review geosynthetic panel layout drawing and numbering system.
- Establish appropriate times for trial seams, size of destructive tests, and chain of custody for destructive samples.
- Review repair procedures.
- Review the time schedule for all operations.
- Review final walk-through procedures.
- Review proposed method to deploy materials over geosynthetic material.
- Review survey requirements prior to Installer de-mobilizing from site.
- Set timetable for regular construction meeting.

Minutes prepared by the CQA Officer or other party designated by the Company will be distributed to all parties involved in the construction project.

4.0 GENERAL CONSTRUCTION OBSERVATION AND DOCUMENTATION

This section describes general documentation procedures to be implemented, including the use of forms, the identification and resolution of problems or deficiencies, and photographic documentation.

4.1 PROGRESS MEETINGS

Progress meetings will be held regularly at a location set by Company. At a minimum, field supervisory and CQA personnel will attend the meeting. The purposes of the meeting are as follows:

- Discuss safety issues or current safety topics.
- Review work activity and location since last meeting.

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- Discuss Contractor's and Installer's personnel and equipment assignments.
- Review work schedule.
- Discuss possible problems or issues to resolve.
- Review test data.
- Review data documentation requirements and submittal status.

Minutes prepared by Company-designated representative will be transmitted to all parties involved.

4.2 DAILY REPORTS

A daily summary report will be prepared by the CQA Officer, or the RPR, under the direct supervision of the CQA Officer, for each day of activity and will include the following information:

- Date, project name, location, report preparer's name, and the names of representatives on-site performing CQA.

- Time work starts and ends each construction workday, along with the duration and reason for work stoppages (i.e., weather delay, equipment shortage or problem, labor shortage, etc.).

- Data on weather conditions, including temperature, wind speed and direction, cloud cover, and precipitation.

- Construction Contractor's workforce roster, equipment in use, and materials delivered or removed from the job site.

- Identification and discussion of any major deviations from the approved plan and corrective actions taken.

- Chronological description of work in progress, including locations and type of work performed.

- Summary of meetings held and a list of those in attendance.

- Summary of relevant conversations that pertain to the project and who conversations were with.

- Identification of laboratory samples collected, marked, and delivered to laboratory, or clear reference to the document containing such information.

- An accurate record of calibrations, recalibrations, or standardizations performed on field testing equipment, including actions taken as a result of re-calibrations, plus the results of other data recording, such as geomembrane seam barrel temperature.

Each representative will prepare field data sheets containing the following information:

- Test number, sample location, and test required.
- Type of documentation.
- The procedures used.
- Test data.

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- Field test results.
- Personnel involved in the documentation and sampling activities.
- Initials of the person performing the documentation and initials of the person checking the documentation.

4.3 FORMS, CHECKLISTS, AND DATA SHEETS

Forms developed for the purpose of documenting the construction and geosynthetic installation are to be supplied to the Company's assigned Project Manager prior to the start of construction and/or installation for review and approval. Additional forms developed during the course of the project to document specific aspects of the project will also be supplied to the Company's assigned Project Manager for review and approval.

4.4 PROBLEM/DEFICIENCY IDENTIFICATION AND CORRECTIVE ACTION FORMS, CHECKLISTS, AND DATA SHEETS

Problem and/or deficiency identification and corrective action will be documented in the daily summary report when a construction material or activity is observed or tested that does not meet the requirements set forth in this CQA Plan. The Summary report should clearly reference other reports, photographs, or forms that contain data or observations leading to the determination of the problem or deficiency. Problem and/or deficiency identification and corrective action documentation may include the following information:

- A description of the problem or deficiency, including reference to supplemental data or observations responsible for determining the problem or deficiency.
- The location of the problem or deficiency, including how and when the problem or deficiency was discovered, and an estimate of how long the problem or deficiency has existed.
- A list of possible causes of the problem or deficiency.
- A recommended corrective action for resolving the problem or deficiency. If the corrective action has already been implemented, then the observations and documentation to show that the problem or deficiency has been resolved must be included.
- All parties involved in the corrective action and those responsible for resolution.
- If the problem or deficiency has not been resolved by the end of the day that it was discovered, the daily summary report must clearly state that it is an unresolved problem or deficiency. Subsequent daily summary reports will indicate the status of the problem or deficiency until it is resolved.
- A problem or deficiency report or log may be created to track problems or deficiencies as the project progresses.

If the problem or deficiency has not been resolved, the CQA Officer and the preparer will discuss the necessary corrective actions. The CQA Officer will work with the Company and the Contractor to implement actions as necessary to resolve the problem or deficiency. A description of such problems

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or deficiencies and corrective actions implemented will be included in the Construction Documentation Report.

The CQA Officer, working with the Company and the Contractor, will determine if the problem or deficiency is an indication of a situation that may require changes to the plans or specifications and/or the CQA Plan. The CQA Officer and the Company must approve revisions to the plans or specifications or the CQA Plan. WDNR will be consulted prior to making changes to the CQA Plan or specifications, if needed, to obtain their concurrence. Documentation of changes will be incorporated into the Construction Documentation Report.

4.5 PHOTOGRAPHIC DOCUMENTATION

Photographs will be taken to document all aspects of the installation, problems, deficiencies, and corrective actions. Photographs in any format will be stored in a permanent protective file by the CQA Officer or the RPR. All photographs in all formats are to be turned over to the Company upon completion of the Documentation Report. The Company will designate whom the photographs are returned to.

For photographs provided in the final documentation report, the following information will be recorded:

- Date.
- Location where photograph was taken, including information regarding the orientation of the photograph. (e.g., looking north).
- Description of the subject matter.
- Unique identifying number for reference in other reports.
- Name or initials of photographer.

4.6 SURVEYING

Documentation surveying requirements for the pond closure components, and for the Dry Ash Disposal Facility liner system and composite cover system component are defined in the respective sections. All required thicknesses noted in each section are measured vertically. Personnel experienced in construction surveying will perform required surveying.

Documentation surveys shall be stamped by a registered land surveyor or Professional Engineer licensed in the State of Wisconsin.

4.7 DOCUMENTATION REPORT

A report documenting all aspects of construction will be prepared. The report will be prepared in accordance with the requirements of NR 516. A Professional Engineer registered in the state of Wisconsin will certify the report. In addition to the Dry Ash Disposal Facility liner and cover construction, the documentation report will include the following sections:

- Introduction
- Preconstruction Activities
- Pond Closure Excavation/Grading
- Dry Ash Disposal Facility coal combustion residuals (CCR) Filling/Grading
- Surface Drainage Features

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- Construction Quality Assurance / Quality Control Plan
- Restoration

5.0 PRIMARY AND SECONDARY ASH POND CLOSURE

5.1 GENERAL

This section includes the quality assurance requirements for the Primary Ash Pond and Secondary Ash Pond excavation/removal and final grading.

5.2 PROCEDURES AND OBSERVATIONS

The RPR will observe the removal and final grading activities in the Primary and Secondary Ash Ponds, and will document relevant observations to support certification of the following requirements:

- Dewatering procedures, schedule, and discharge location.
- Primary and Secondary Ash Pond excavation/removal procedures, material dewatering procedures and dewatering location, schedule, and dewatering discharge location.
- Visual observations to confirm removal of CCR and approvals (see Subsection 5.3).
- Final grading of the Primary and Secondary Ash Pond after the Owner issues written approval of CCR removal.

5.3 FIELD MONITORING AND SAMPLING, LABORATORY TESTING, AND ACCEPTANCE CRITERIA

The RPR may collect periodic water quality control samples for laboratory testing during Primary and Secondary Ash Ponds dewatering discharge, for laboratory testing, to verify the results of sampling completed by the Contractor. Testing will follow the requirements detailed in Specification 31 22 40.

The contractor will not proceed with filling/grading of the Primary and Secondary Ash Ponds until the CQA Officer and Owner have approved CCR excavation/removal activities within the Primary and Secondary Ash Ponds in writing.

6.0 DRY ASH DISPOSAL FACILITY FILLING AND GRADING

6.1 GENERAL

This section includes the quality assurance requirements for the Dry Ash Disposal Facility, including placement, compaction, and grading of fill material above the liner system to develop subgrades/top of CCR grades within the Dry Ash Disposal Facility.

Fill material consists of accumulated sediment, CCR, impacted soil, possible concrete or construction debris, and other materials removed during implementation of the Ash Pond Closure. Fill material may be obtained from the following sources:

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- CCR in the Primary Ash Pond and Secondary Ash Pond.
- Demolition materials.

Field tests and survey measurements will be recorded in the daily summary reports (see Section 4.2) as record construction data, including locations (by coordinates) and elevations of all field tests and laboratory sample points.

6.2 PROCEDURES AND OBSERVATIONS

The RPR will observe the fill placement and compaction, and final cover subgrade grading activities in the Dry Ash Disposal Facility; and will document relevant observations to support certification of the following requirements:

- The RPR will observe the final cover subgrade preparation to document that the CCR fill materials are in substantial conformance with the placement specifications.

- For existing erosion stone that will not be salvaged, mixing of erosion stone with granular material to fill voids between stone pieces.

- Adequate moisture conditioning and/or mixing of wet fill to prevent future appreciable settlement of fill below closure area final cover.

- Fill placement in lift thicknesses of 12 inches or less prior to compaction with a large self-propelled compactor. The RPR will assess the adequacy of compaction based on visual observation of the fill surface at the time of compaction.

- Final grading and compaction of Dry Ash Disposal Facility fill areas (final cover subgrade) prior to final cover construction in accordance with 40 CFR 257.102(d)(2). The RPR will observe whether the final subgrade is suitable based on a rut depth of no more than one inch when the subgrade is traversed by rubber-tired vehicles.

6.3 FIELD MONITORING AND SAMPLING, LABORATORY TESTING, AND ACCEPTANCE CRITERIA

The Dry Ash Disposal Facility final cover subgrade areas will be acceptable for stabilization confirmation, by proof rolling or other method approved by Engineer, when filling is complete to the approximate design final cover subgrades, as determined by the RPR.

The Dry Ash Disposal Facility final cover areas will be acceptable for final cover construction when filling is complete to the approximate design final cover subgrade, as determined by the RPR, and the subgrade has been accepted.

6.4 SURVEYING

The Dry Ash Disposal Facility final cover subgrades will be surveyed as described in Section 7.4. All survey measurements will be recorded in the daily summary reports (see Subsection 4.2) as record construction data.

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7.0 SUBGRADE PREPARATION AND SUBBASE GENERAL FILL

7.1 GENERAL

This section includes the quality assurance requirements for preparation of the subgrade prior to placement of the Dry Ash Disposal Facility liner and final cover system, including placement, compaction, and grading of general fill soil required to establish the subbase grade below the liner. General fill soil will consist of inorganic soil with primarily sand-size particles from site cuts and the on-site overburden berm/stockpiles. General fill soil in direct contact with the GCL will have a maximum particle size of 2 inches. All subbase field tests, soil sample types, and survey measurements will be recorded in the daily summary reports (see Subsection 4.2) as record construction data, including locations (by coordinates) and elevations of all field tests and laboratory sample points.

7.2 PROCEDURES AND OBSERVATIONS

The RPR will observe the subgrade preparation for the liner and final cover areas, and the general fill placement activities to establish the disposal facility subbase grades. The RPR will document relevant observations to support certification of the following requirements:

- The RPR will observe the disposal facility liner system subbase preparation, including subgrade preparation and general fill placement to establish the subbase grades, to document that the compacted subbase is in substantial conformance with the placement specifications.

- For fill placed to establish the disposal facility subbase grades, the RPR will periodically observe loads of general fill for general conformance to material specifications and may randomly sample loads. The RPR will perform routine conformance sampling as defined in Subsection 7.3 (Sampling Requirements and Acceptance Criteria).

- All trees, stumps, roots, boulders, debris, and other material capable of deteriorating in situ material strength or of creating a preferential pathway for contaminants shall be completely removed.

- No frozen soil will be used for backfilling. Any frozen soil in the compaction work area will be removed.

- Loose lift thickness for general fill soil compaction will not exceed 12 inches.

- Upon completion of the disposal facility final ash grades, the RPR will visually observe the final cover subgrade for signs of soft or yielding spots. Any soft or yielding spots will be excavated and replaced with compacted ash fill.

- Unacceptable compaction density as defined by Subsection 7.3 (Sampling Requirements and Acceptance Criteria), will be reported to the CQA Officer by the RPR. Corrective action will consist of moisture-conditioning of the soil and/or additional compactive effort as necessary.

- Upon completion of the final grades, the RPR will visually observe the subgrade for signs of soft or yielding spots. Any soft or yielding spots will be excavated and replaced with

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compacted fill. General fill placed for the liner system subbase will be placed in accordance with Subsection 7.2.

- Stones and other penetrating objects 2 inches or larger protruding from the surface of the liner subbase grade or the cover subgrade will be removed. The RPR will observe the liner subbase and cover subgrade during this process, and will document the removal of stones and other objects by the Contractor. The top of the liner system subbase and cover subgrade shall be smooth-drum rolled to provide a smooth surface for placement of the liner and cover layers. Ruts greater than one inch will be repaired by filling with acceptable general fill and smooth-drum rolling.

- Field densities using methods described in Subsection 7.3.1 will be measured to document that the in-place soil is in substantial conformance with the required density below the liner system.

7.3 SAMPLING REQUIREMENTS AND ACCEPTANCE CRITERIA

Field and laboratory sampling frequencies are based on the area or volume of material placed to establish the disposal facility subbase grades, as specified in s. NR 516.07. This section describes the required analyses, methods, sample frequencies, and acceptance limits. The RPR will perform field tests and will collect soil samples for laboratory analysis.

7.3.1 Field Testing

The following field testing methods will be used by the RPR during construction:

Parameter	**Test Method**
Soil density and moisture content	ASTM D6938

Field density and moisture content tests will be performed on a 100-foot grid pattern for each 1-foot thickness of compacted subbase general fill placed below the liner system. The grid pattern will be offset on alternate lifts. In confined areas where compaction equipment is hindered or hand compaction is necessary, a minimum of two field density and moisture content tests will be performed for each 1-foot thickness of subbase fill. The RPR will conduct a minimum of one field density test per 5,000 cubic yards.

7.3.2 Field Testing Acceptance Criteria

Acceptance criteria for field density will require soil compaction to a minimum of 90 percent of the Modified Proctor (ASTM D1557) maximum dry density, or a minimum of 95 percent of the Standard Proctor (ASTM D698) maximum dry density.

7.3.3 Laboratory Testing

Routine laboratory testing of the subbase fill below the liner system will be performed on samples of the subbase fill borrow area. Soil characteristics will be determined from representative samples.

Representative (grab) samples will be obtained on the basis of three criteria. First, an initial sample will be obtained from the subbase fill borrow source and analyzed prior to construction. This will confirm soil characteristics and provide an initial maximum dry density and optimum moisture content for field moisture/density testing. Second, routine samples will be obtained for every

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5,000 cubic yards placed. Third, in the event that changes in physical appearance or soil characteristics are observed, a sample will be obtained and analyzed. The maximum dry density and optimum moisture content values used for compaction testing may be adjusted during the course of subbase construction based on the results of the above sampling.

The following laboratory test method will be performed by the Soils Testing Laboratory on samples collected by the RPR:

Parameter	**Test Method**
Moisture/Density using Modified or Standard Proctor compaction	ASTM D1557 [a,b] or ASTM D698 [a,b]
Atterberg Limits	ASTM D4318
Grain-size analysis	ASTM D6913/D7928 [c]

Notes:
(a) Five-point Proctor analysis required for first and second sampling criteria.
(b) A one-point Proctor analysis may be utilized for representative samples collected for the third sampling criteria (apparent changes in soil quality) to verify applicability of previously analyzed moisture-density relationships. If the result does not verify applicability, then a five-point analysis will be performed in accordance with the first sampling criteria.
(c) Distribution to be reported through the 0.002 mm particle size.

Samples of the borrow area or stockpiled soil will be collected by the RPR prior to the use of the material and whenever physical appearance or other changes are noticeable. These samples will be submitted to the Soils Testing Laboratory for the above testing.

7.4 SURVEYING

The Dry Ash Disposal Facility subbase grades and final ash grades will be surveyed on a 50-foot grid pattern (or a 100-foot grid pattern for final cover construction areas greater than 4 acres) and at key locations. Key locations include breaks in grade, toes of slopes, midpoints, and tops of sideslopes. In the alignment for leachate collection lines, the bottom of trench elevations will be surveyed at 25-foot intervals (±0.1 foot tolerance).

8.0 SELECT CLAY FILL

8.1 GENERAL

This section includes the quality assurance requirements for placement, backfilling, and compaction of select clay fill. Compacted select clay fill will be used in constructing the Dry Ash Disposal Facility liner.

The select clay fill will be obtained from off-site clay borrow sources.

All field tests, soil sample types, and survey measurements will be recorded in the daily summary reports (see Subsection 4.2) as record construction data, including locations (by coordinates) and elevations of all field tests and laboratory sample points.

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8.2 PROCEDURES AND OBSERVATIONS

The RPR will observe compacted select clay fill construction activities and will document relevant observations to support certification of the following requirements:

- The RPR will confirm the uniformity of the removed soil to be used as select clay fill. Soil placement will be monitored for segregation and removal of unsuitable material and for changes in soil type, color, texture, and moisture content.

- The Construction Contractor will segregate and/or remove unsuitable materials such as granular soil, silty or sandy clay not meeting acceptance criteria, boulders, cobbles, and organic material. A maximum clod size of 4 inches is allowed. Clods should be able to be broken down with normal construction equipment.

- The RPR will observe clay placement and will measure field densities and moisture contents, using methods described in **Subsection 8.3** (Sampling Requirements and Acceptance Criteria), to document that the compacted clay liner is in substantial conformance with the placement specifications and that soil placement has been conducted in a manner to achieve a uniform, homogeneous clay mass.

- Voids created by nuclear density gauge (NDG) probes or Shelby tubes will be backfilled with granular bentonite.

- Compaction equipment used shall have a minimum static weight of 30,000 pounds.

- Clay layers will be constructed in lift heights no greater than 6 inches after compaction using footed compaction equipment having feet at least as long as the loose lift height.

- Each lift of clay will be sufficiently compacted to ensure that the clay is completely remolded.

- Areas of unacceptable hydraulic conductivity, density, or moisture content, as defined by **Subsection 8.3** (Sampling Requirements and Acceptance Criteria), will be documented by the RPR. Corrective action will consist of moisture-conditioning of the soil and/or additional compactive effort as necessary. Methods for moisture-conditioning soil are described in the next bullet item. Following corrective actions, such areas will be retested.

- If necessary, surfaces of liner to receive successive lifts of clay will be moisture-conditioned either by scarification and addition of water where desiccated, or by discing and air drying where saturated to promote effective bonding of lifts. Following scarification, water will be applied with a spray bar applicator or equivalent method to achieve uniform distribution.

- Clay placement will be performed in a manner to achieve continuous and complete keying together of clay liner construction areas. Stepped joints will be utilized to connect lateral segments of clay liner construction by excavating a minimum of two steps with a minimum width of 5 feet along the edge of the existing liner and overlapping them.

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- No frozen soil will be used for select clay fill liner construction. Frozen soil in the compaction work area will be removed.

- Stones 2 inches or larger and other penetrating objects protruding from the surface of the final lift of compacted select clay fill will be removed to avoid puncturing the geomembrane. Stones or other penetrating objects larger than 4 inches in the lower lifts will be removed. The RPR will observe the liner during this process and will document the removal of stones and other objects by the Contractor. Voids made by the removal of stones or other objects will be filled with clay soil or bentonite, and the entire liner surface will be rolled with a smooth-drum compactor. Ruts greater than 1 inch will be repaired by filling in with compacted select clay fill and smooth-drum rolling.

- Preconstruction planning will be undertaken to sequence construction activities to minimize the length of time any completed clay surface will be exposed prior to receiving protective cover. Protective cover will be provided by the installation of the geomembrane and shall be completed in the same construction season as the geomembrane construction.

8.3 SAMPLING REQUIREMENTS AND ACCEPTANCE CRITERIA

Field and laboratory sampling frequencies are based on the area or volume of material placed, as specified in s. NR 516.06. This section describes the required analyses, methods, sample frequencies, and acceptance limits. The RPR will perform field tests and will collect soil samples for laboratory analysis.

8.3.1 Field Testing

The following field testing methods will be used by the RPR during construction:

Parameter	**Test Method**
Moisture content and soil density	ASTM D6938

Field density and moisture content tests will be performed on a 100-foot grid pattern for each 1-foot thickness of compacted select clay fill placed. The grid pattern will be offset on alternate lifts. In confined areas where compaction equipment is hindered or hand compaction is necessary, a minimum of two field density and moisture content tests will be performed for each 1-foot thickness of clay placed.

8.3.2 Field Testing Acceptance Criteria

Acceptance criteria for field density will require soil compaction to a minimum of 90 percent of the Modified Proctor (ASTM D1557) maximum dry density, or a minimum of 95 percent of the Standard Proctor (ASTM D698) maximum dry density. Moisture content requirements will be at least 2 percent wet of optimum if using the Modified Proctor, and at least wet of optimum if using the Standard Proctor, in accordance with s. NR 504.06(2)(f)(3). The acceptable range will be based on Proctor moisture-density relationships and compaction versus permeability relationships.

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8.3.3 Laboratory Testing

Routine laboratory testing of the clay liner soil will be performed on samples from the clay borrow area and on the in-place clay soil samples collected by the RPR. Samples for determining in-place properties will be collected by pushing Shelby tubes. Soil characteristics will be determined from representative samples and from Shelby tube samples.

8.3.4 Undisturbed Sample Analysis

One undisturbed sample will be taken for each acre or less for every 1-foot thickness of clay placed and will be submitted to the Soils Testing Laboratory.

The following analyses will be performed on all undisturbed samples obtained:

Parameter	Test Method
Moisture content and dry density	ASTM D2216 and D7263
Atterberg limits	ASTM D4318
Grain-size analysis	ASTM D6913/D7928 [a]

Note:
[a] Distribution to be reported through 0.002 mm particle size.

One of every three undisturbed samples will also be analyzed for hydraulic conductivity as follows:

Parameter	Test Method [a]
Hydraulic conductivity	ASTM D5084 or SW 846 EPA Method 9100

Note:
[a] Using effective stresses no greater than 5 psi and hydraulic gradients of 30 or less.

8.3.5 Representative Sample Analysis

Representative (grab) samples will be obtained on the basis of three criteria. First, an initial sample will be obtained from the clay borrow source and analyzed prior to construction. This will confirm soil characteristics and provide an initial maximum dry density and optimum moisture content for field moisture/density testing. Second, routine samples will be obtained for every 5,000 cubic yards placed. Third, in the event that changes in physical appearance or soil characteristics are observed, a sample will be obtained and analyzed. The maximum dry density and optimum moisture content values used for compaction testing may be adjusted during the course of liner construction based on the results of the above sampling.

The following laboratory analyses will be performed on all representative samples obtained:

Parameter	Test Method
Moisture-density relationship using	ASTM D1557 [a, b]
Modified/Standard Proctor compaction	ASTM D698 [a, b]
Atterberg limits	ASTM D4318
Grain-size analysis	ASTM D6913/D7928 [c]

Notes:
[a] Five-point Proctor analysis required for first and second sampling criteria.

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(b) A one-point Proctor analysis may be utilized for representative samples collected for the third sampling criteria (apparent changes in soil quality) to verify applicability of previously analyzed moisture-density relationships. If the result does not verify applicability, then a five-point analysis will be performed in accordance with the first sampling criteria.

(c) Distribution to be reported through the 0.002 mm particle size.

8.3.6 Laboratory Testing Acceptance Criteria

- A minimum 50 percent by weight which passes the #200 sieve.
- A saturated hydraulic conductivity of 1 x 10^{-7} cm/s or less, when compacted to 90 percent Modified or 95 percent Standard Proctor density.
- An average liquid limit of 25 or greater, with no values less than 20.
- An average plasticity index of 12 or greater, with no values less than 10.

8.4 THICKNESS DOCUMENTATION

The top of clay liner grades will be surveyed on the same 50-foot grid pattern and at key locations surveyed for subbase grades. Key locations include breaks in grade, toes of slopes, mid-points, and tops of sideslopes. In the alignment for leachate collection lines, bottom of trench elevations will be surveyed at 25-foot intervals in the same locations surveyed for trench undercuts. The clay liner thickness will be determined at surveyed locations and reported in a tabular fashion. The minimum acceptable liner thickness will be 2 feet (+0.1 foot tolerance) measured vertically.

9.0 GRADING LAYER SOIL

9.1 GENERAL

This section includes the quality assurance requirements for placement, compaction, and grading of the Dry Ash Disposal Facility final cover grading layer soil. Grading layer soil will be soil excavated/removed from site cuts or from the on-site overburden berm/stockpiles, with primarily fine-grained to fine-sand sized particles and a maximum particle size of 2 inches.

All survey measurements will be recorded in the daily summary reports (see Subsection 4.2) as record construction data.

9.2 PROCEDURES AND OBSERVATIONS

The RPR will observe grading layer soil placement activities and will document relevant observations to support certification requirements. The RPR will periodically observe loads of grading layer material for general conformance to material specifications. Ruts greater than 1 inch will be repaired by filling in with acceptable grading layer soil and smooth-drum rolling.

9.3 THICKNESS DOCUMENTATION

Top of grading layer grades will be surveyed on an approximate 50-foot grid (or 100-foot grid for areas greater than 4 acres), and at other key locations such as breaks in grade and toes of slope. The minimum acceptable thickness will be 0.25 foot (+0.1 foot tolerance) for the grading layer.

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10.0 DRAINAGE MATERIALS

10.1 GENERAL

Drainage material includes:

Dry Ash Disposal Facility Liner System:

- Leachate drainage layer
- Drainage filter
- Coarse aggregate bedding

Dry Ash Disposal Facility Final Cover System:

- Final cover drainage layer
- Coarse aggregate bedding

Leachate drainage layer material will consist of imported sand. Other drainage materials will consist of imported material. Limestone and dolomite stone will not be used for the liner system drainage materials unless no other suitable material is reasonably available.

All drainage material sample types and survey measurements will be recorded in the daily summary reports (see Subsection 4.2) as record construction data, including locations (by coordinates) of all laboratory sample points.

10.2 PROCEDURES AND OBSERVATIONS

The RPR will observe drainage material placement activities and will document relevant observations to support certification of the following requirements:

- The RPR will periodically observe loads of drainage material for general conformance to material specifications and may randomly sample loads. The RPR will perform routine conformance sampling as defined in Subsection 10.3.

- No trucks or heavy equipment will travel directly on the geosynthetics. Only low ground pressure tracked equipment [less than 5 pounds per square inch (psi)] may operate over the geosynthetics when there is a minimum 12-inch-thick layer of drainage material in-place. Rubber-tired equipment may not travel over the geosynthetics unless a minimum of three feet of drainage material is in place. Procedures for deployment of drainage material overlying the geomembrane will be planned at the preconstruction meeting. Special requirements for geomembrane protection and equipment necessary to deploy materials must be approved by the CQA Officer.

- Care will be exercised during placement of the drainage material to prevent undue damage to pipes and geosynthetics. Aggregate will not be dropped from a height greater than 3 feet above the pipe trench.

- A geotextile cushion will be placed between the geomembrane and the coarse aggregate bedding material in the leachate collection trenches.

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- A minimum of 6 inches of coarse aggregate bedding material will be placed under leachate collection pipes prior to pipe placement, and a minimum of 12 inches of coarse aggregate bedding material will be placed over the top of the leachate collection pipes.

- If drainage material is stockpiled on site prior to use, measures will be taken to minimize contamination by fines such as wind-blown particles and surface soil during loading operations.

10.3 SAMPLING REQUIREMENTS AND ACCEPTANCE CRITERIA

Field sampling and laboratory testing frequencies are based on proportionate sampling of construction areas or volumes of material placed as specified by s. NR 516.06. This section describes the required analyses, methods, sampling frequencies, and acceptance limits. The RPR will collect soil samples for laboratory analysis.

10.3.1 Field Testing

No field testing will be required for drainage material. However, as stated in **Subsection 10.2** above, the RPR will perform visual inspection of this material for conformance to material specifications and may randomly sample deliveries.

10.3.2 Laboratory Testing

Representative (grab) samples may be obtained from the proposed leachate drainage layer, drainage filter, final cover drainage layer, and coarse aggregate bedding material sources prior to delivery of the material. The source sampling frequency will be dependent on the apparent uniformity of the source and must be approved by the CQA Officer.

Grab samples of drainage material will be collected and analyzed as follows:

Soil Type	**Frequency**	**Parameter**	**Test Method**
Final Cover Drainage Layer/Leachate Drainage Layer	1/1,000 CY [(a)]	Grain-size	ASTM D6913[(b)]
Final Cover Drainage Layer/Leachate Drainage Layer	1/2,500 CY [(c)]	Remolded hydraulic conductivity	ASTM D2434
Drainage Filter	1/1,000 LF of trench[(d)]	Grain-size	ASTM D6913[(b)]
Coarse aggregate bedding (along leachate collection piping)	1/1,000 LF of trench[(d)]	Grain-size	ASTM D6913 or C136[(b)]
Coarse aggregate bedding (along final cover toe or intermediate drain pipe)	1/1,000 CY	Grain-size	ASTM D6913 or C136[(b)]

Notes:
[(a)] For lesser volumes, a minimum of four samples will be tested.
[(b)] Testing is required only to the #200 sieve.
[(c)] For lesser volumes, a minimum of two samples will be tested.
[(d)] For documentation areas with less than 3,000 feet of pipe trench, a minimum of three samples will be tested.

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Laboratory Testing Acceptance Criteria

The final cover drainage layer will consist of imported material and have the following properties:

- Contain no more than 5 percent by weight of fines passing the #200 sieve.
- Have a maximum particle diameter of ¼ inch.
- Have a remolded hydraulic conductivity of at least 1 x 10^{-2} cm/s or greater at the anticipated field density.

Filter calculations will need to be performed as described in **Section 3.2** to determine final cover drainage layer material filter requirements with rooting zone soil and intermediate drain pipe drain sock.

The leachate drainage layer will consist of imported sand and have the following properties:

- Contain no more than 5 percent by weight of fines passing the #200 sieve.
- Have a maximum particle diameter of ¼ inch.
- Have a remolded hydraulic conductivity of at least 1 x 10^{-2} cm/s or greater at the anticipated field density.

Drainage filter will consist of imported material and have the following gradation:

Sieve Size	% Passing by Weight
1-inch	100
3/4-inch	90-100
3/8-inch	60-95
#4	20-70
#8	5-40
#16	0-15
#30	0-5

An alternate drainage filter specification will be determined by the CQA Officer if the leachate drainage layer or coarse aggregate bedding material is altered.

Coarse aggregate bedding will consist of Wisconsin Department of Transportation (WisDOT) Size No. 2 Coarse Aggregate, adjusted to have 100 percent passing the 1½ inch sieve, and have the following properties:

- Have a uniformity coefficient less than four.
- Contain no more than 5 percent by weight passing the #4 sieve.
- Have a maximum particle diameter of 1½ inches.
- Have a subrounded particle shape.

Filter calculations will need to be performed to confirm that the leachate drainage layer is compatible with the drainage filter.

10.4 THICKNESS DOCUMENTATION

The finished elevation of the leachate drainage layer will be surveyed on a 50-foot grid, which coincides with the grid used for the liner system subbase surface. The finished elevation of the final cover drainage layer will be surveyed on a 50-foot grid (or 100-foot grid for areas greater than

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4 acres), which coincides with the grid used for the grading layer surface. The minimum acceptable thickness will be 1 foot (+ 0.1 foot tolerance). The contractor may use a GPS dozer and hand-held GPS station to control thickness.

Coarse aggregate bedding placed along leachate collection pipe alignments will be surveyed for elevation prior to pipe placement and following pipe backfilling at 25-foot intervals to document the thickness of bedding placed below pipe inverts and above the top of pipe. The minimum acceptable pipe bedding thickness for the leachate collection pipe will be 6 inches below and 12 inches above the piping (+0.1 foot tolerance).

10.5 LEACHATE DRAINAGE PIPING

Leachate that enters the leachate drainage layer will flow to a leachate collection pipe in each constructed module. All leachate collection piping will consist of a 6-inch standard dimension ratio (SDR) 11 HDPE and shall be installed as recommended by the manufacturer. Each leachate collection pipe will be placed at the bottom of the module. The leachate collection piping will be sloped at 0.5 percent and will be bedded in coarse aggregate.

10.6 FINAL COVER DRAINAGE PIPING

Surface water that enters the final cover drainage layer will flow to corrugated polyethylene pipe that will be placed at the toe of the slope and at intermediate locations. The subsurface water collection piping will be sloped at a minimum of 0.5 percent, and will be bedded in coarse aggregate at the final cover toe and in drainage material for intermediate drainage pipes.

11.0 ROOTING ZONE SOIL

11.1 GENERAL

This section includes the quality assurance requirements for placement and grading of the rooting zone soil within the Dry Ash Disposal Facility final cover. The rooting zone soil will be soil with primarily sand-sized particles excavated/removed from site cuts or from the on-site overburden berms/stockpiles.

11.2 PROCEDURES AND OBSERVATIONS

The RPR will observe rooting zone soil layer placement activities and will document relevant observations to support certification requirements.

11.3 SAMPLING REQUIREMENTS AND LABORATORY TESTING

Field sampling and laboratory testing of the rooting zone material is required to determine the filter requirements between the rooting zone soil and granular drainage layer, or between the rooting zone soil and the geotextile of the geocomposite drainage layer. A minimum of one rooting zone sample per phase of final cover construction will be collected for laboratory testing. The RPR will collect soil samples for laboratory analysis.

One or more representative (grab) samples will be obtained from the proposed rooting zone material source(s) prior to hauling/delivery of the material. The source sampling frequency will be dependent on the apparent uniformity of the source and must be approved by the CQA Officer.

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Grab samples of rooting zone material will be collected and analyzed as follows:

Parameter	Test Method
Grain-size analysis	ASTM D6913

Filter calculations will need to be performed to determine if the rooting zone material is compatible with the granular drainage layer without a filter, or to determine the geotextile properties of the geocomposite drainage layer to be compatible with the rooting zone material.

11.4 THICKNESS DOCUMENTATION

Top of rooting zone will be documented on an approximate 50-foot grid (or 100-foot grid for areas greater than 4 acres) and at other key locations, such as breaks in grade, toes of slope, midpoints, and tops of slopes. The minimum acceptable thickness will be one foot (+0.1-foot tolerance). Thickness of the rooting zone layer will be monitored during placement through the use of 6-inch-diameter, 3-foot-long cardboard tubes placed on the geomembrane. Marks will be placed on the tubes at 1 foot perpendicular to the drainage layer for reference during rooting zone layer placement.

12.0 TOPSOIL AND SEEDING

This section includes the CQA requirements for excavating and placing topsoil and for fertilizing, seeding, mulching, and watering topsoil for vegetation. Topsoil is the final layer of soil material installed in the Dry Ash Disposal Facility final cover, along the outside slopes of the perimeter berms, along the ditches, and in other perimeter areas. A clay topsoil, having a USCS group symbol of lean clay (CL) or fat clay (CH), will be placed within the Dry Ash Disposal Facility final cover areas to minimize surface water infiltration. Topsoil will be obtained from on-site topsoil or imported from off-site source identified by the Contractor.

All survey measurements will be recorded in the daily summary reports (see Subsection 4.2) as record construction data.

12.1 PROCEDURES AND OBSERVATIONS

The RPR will observe topsoil placement activities and will document relevant observations to support certification of the following requirements:

- The RPR will confirm the source and uniformity of topsoil used. Soil excavation and placement will be monitored for minimization of inorganic soil not compatible for establishment of vegetation.
- Prior to seeding, the topsoil will be worked to prepare a suitable seedbed.
- Fertilizing, seeding, and mulching will be performed in a timely manner.

12.2 SAMPLING REQUIREMENTS AND LABORATORY TESTING

Field sampling and laboratory testing of the final cover clay topsoil material is required to determine the USCS group symbol. A minimum of one clay topsoil sample per phase of final cover construction will be collected for laboratory testing The RPR will collect soil samples for laboratory analysis.

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One or more representative (grab) samples will be obtained from the proposed clay topsoil material source(s) prior to hauling/delivery of the material. The source sampling frequency will be dependent on the apparent uniformity of the source and must be approved by the CQA Officer.

Grab samples of clay topsoil material will be collected and analyzed as follows:

Parameter	**Test Method**
Atterberg limits	ASTM D4318
Grain-size analysis	ASTM D6913

12.3 ACCEPTANCE CRITERIA

The topsoil will be suitable for establishment and long-term maintenance of the selected vegetation seed mix with appropriate fertilization. Clay topsoil for the final cover will have a USCS group symbol of CL or CH based on the results of the laboratory testing.

The following seed mix from WisDOT specification Section 360 "Seeding," Right of Way Permanent Seed Mixture No. 20 shall be used on the Dry Ash Disposal Facility final cover:

- 6 percent Kentucky Bluegrass
- 24 percent Hard Fescue
- 40 percent Tall Fescue
- 30 percent Perennial Rye Grass

The final cover seeding rate will be 3 pounds per 1,000 square feet.

12.4 THICKNESS DOCUMENTATION

The thickness of topsoil placement on the Dry Ash Disposal Facility final cover will be documented on a 50-foot grid (or 100-foot grid for areas greater than 4 acres). Thickness will be determined by surveying or other acceptable method approved by the Company. The minimum acceptable topsoil thickness for the final cover will be 0.5 foot (+0.1 foot tolerance). The minimum acceptable thickness for all other areas will be 4 inches.

13.0 GEOTEXTILE

13.1 GENERAL

This section of the CQA Plan applies to the non-woven geotextile used as a geomembrane cushion in the Dry Ash Disposal Facility liner system, as a filter, and as a separator for other construction activities.

13.2 PRE-INSTALLATION

13.2.1 Manufacturing

The geotextile will be supplied to the site in factory rolls. Prior to the delivery of any geotextile rolls, the Geotextile Manufacturer will provide the CQA Officer with the Manufacturer's Quality Control Plan (MQCP) used for the production of the geotextile.

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The Geotextile Manufacturer will provide certification, based on tests performed in accordance with the methods listed in Tables 13-1, 13-2, and 13-3, that the geotextile supplied under this plan will meet the material specifications listed in Tables 13-1, 13-2, and 13-3. These tests may be performed by the Geotextile Manufacturer's laboratory or a laboratory contracted by the manufacturer. Additionally, the manufacturer will provide certification that the MQCP was fully implemented for the geotextile materials supplied under this plan. The manufacturer shall provide documentation to verify the results of the manufacturer's CQC Plan implementation required by the CQA Officer.

The geotextile rolls will be tested and evaluated prior to acceptance. The CQA Officer may perform/require additional testing (i.e., conformance testing) as required by detailed specifications or as required in the judgment of the CQA Officer to verify that the geotextile meets the specifications.

13.2.2 Delivery, Handling, and Storage of Geotextile Rolls

Each geotextile roll to be used at the Dry Ash Disposal Facility will be marked by the Geotextile Manufacturer with the following information (on a durable gummed label, or equivalent, on the inside of the core, and on the outside of the protective wrapping for the roll):

- Name of manufacturer
- Style and type number
- Roll length and width
- Batch (or lot) number
- Nominal product thickness
- Date of manufacture
- Roll number

The Geotextile Manufacturer will use the following guidelines in packaging, wrapping, and preparing all geotextile rolls for shipment:

- When cores are required, those that have a crushing strength sufficient to avoid collapse or other damage while in use will be used.

- Each roll will be covered with a wrapping material that will protect the geotextile from damage due to shipment, water, sunlight, or contaminants.

The following practices will be used as minimum in receiving and storing geotextile rolls in the designated storage area at the job site:

- While unloading or transferring the geotextile rolls from one location to another, care will be taken to prevent damage to the wrapping or the geotextile itself. If practicable, the Installer/Contractor may use forklift trucks fitted with poles that can be inserted into the cores of rolls. The poles will be at least two-thirds the length of the rolls, to prevent breaking the cores and possibly damaging the geotextile. Rolls will not be dragged.

- The geotextile rolls will be stored in such a manner so as to ensure that they are adequately protected from the following:
  Precipitation
  Ultraviolet radiation, including sunlight

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Strong oxidizing chemicals, acids or bases
Flames, including welding sparks
Temperatures in excess of 160°F
Soiling

The RPR will observe and document, throughout the pre-installation, installation, and post-installation periods, that the Installer provides adequate handling equipment used for moving geotextile rolls and that the equipment and handling methods used do not pose unnecessary risk of damage. The Installer/ Contractor is responsible for the means and methods to implement the work.

The Installer will be responsible for ensuring that all materials installed meet specifications. The RPR will maintain a log of geotextile roll deliveries. The following information, at a minimum, will be recorded on the log for each shipment received at the job site:

- Date of delivery at the job site
- For each roll of geotextile, the roll number and batch (or lot) number

13.3 INSTALLATION

This section describes the quality assurance requirements applicable to the installation, observation, and documentation of geotextile.

13.3.1 Placement

The Installer will install all geotextile in such a manner as to ensure that it is not damaged and in a manner that complies with the following requirements:

- In the presence of wind, all geotextile will be secured by suitable methods. The temporary securing material will be left in place until replaced with cover material, if applicable.

- In-place geotextile will be cut with special care to protect other materials from damage that could be caused by the cutting of the geotextile.

- The Installer will take necessary precautions to prevent damage to any underlying layers during placement of geotextile.

- During placement of geotextile, care will be taken not to entrap in the geotextile any stones, excessive dust, or moisture that could damage the geotextile.

- A visual examination of the geotextile will be carried out over the entire surface after the installation by Installer to ensure that no potentially harmful objects, such as needles, are present.

- RPR will observe and document that the above items are performed by the Installer.

13.3.2 Seams and Overlaps

The following requirements will be met with regard to seaming and overlapping of geotextile rolls:

- Geotextile seams will be continuously sewn unless heat bonding is approved by the CQA Officer and Company. Geotextile will be overlapped 6 inches prior to seaming. The sewing

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method and stitch type will be per manufacturer's recommendation, but must be approved by the CQA Officer. Overlapping of geotextile without sewing may be acceptable for certain applications (e.g., seams under riprap) with approval from the CQA Officer and Company.

- Sewing will be performed with thread made from the same base material as the geotextile, or suitable equivalent.

- The Installer will pay particular attention to seams to ensure that no materials could be inadvertently trapped beneath the geotextile.

The RPR will be responsible for observing and documenting that the Installer performs the above provisions in an acceptable manner.

13.4 POST-INSTALLATION

13.4.1 Final Examination

The RPR will perform a final geotextile examination after the installation of each geotextile layer has been completed. The objectives of the final examination are as follows:

- To examine for the presence of holes, tears, or other deterioration.

- To examine geotextile for excessive tension due to stretching of the fabric during installation.

- To examine for the presence of foreign objects (e.g., stones, soil clods) beneath the geotextile.

If there will be an extended time delay between completion of the geotextile and the start of the installation of any other cover, then the Installer will make provisions, by temporarily securing the geotextile by using suitable methods, to protect the geotextile from wind uplift. The RPR will document the placement of the temporary securing methods in the daily report. Geotextiles will be covered with designated overlying material within 30 days of installation to prevent extended exposure to sunlight.

13.4.2 Placement of Soils Materials

The Construction Contractor will place all soil materials located on top of a geotextile in such a manner as to minimize the following:

- Damage to the geotextile and underlying layers.
- Slippage of the geotextile on underlying layers.
- Excessive tensile stresses imposed on the geotextile.

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Table 13-1. Geotextile Filter Acceptance Specifications

Property	Units	Type of Criterion	Acceptance Value[1]	Test Method
Apparent Opening Size	Mm	Range	0.074-0.180	ASTM D4751
Grab Tensile Properties[2] Tensile Strength Break Elongation	 lb %	 Minimum Minimum	 200 50	ASTM D4632
Permittivity	gal/min/ft^2	Minimum	90	ASTM D4491
Mass Per Unit Area	oz/yd^2	Minimum	7.2	ASTM D5261
Puncture Resistance (pin) [(3)]	lb	Minimum	100	ASTM D4833
Puncture Resistance (CBR) [(3)]	lb	Minimum	500	ASTM D6241
Trapezoidal Tear[2]	lb	Minimum	80	ASTM D4533
UV Resistance[4]	%	Minimum	70	ASTM D7238

Notes:
1. Values are based on discussions with acceptable manufacturers and represent production values at the time this document was prepared. Minimum values are based on -2 standard deviations from the average production values.
2. These tests will be performed and results reported in both the machine and cross directions.
3. Geotextile to meet puncture resistance (pin) or puncture resistance (CBR) specification.
4. Evaluation to be based on 2.0-inch strip tensile specimens after 500 hours exposure.
5. Filter calculations will need to be performed as described in **Section 3.2** to determine final cover drainage layer material filter requirements with rooting zone soil and intermediate drain pipe drain sock. The geotextile properties for these filters may be different than the geotextile filter properties in **Table 13-1**.

Table 13-2. Geotextile Cushion Acceptance Criteria

Property	Units	Test Method	12 oz/yd^2 Acceptable Value	16 oz/yd^2 Acceptable Value	32 oz/yd^2 Acceptable Value
Grab tensile properties[(1)] Tensile strength Break elongation	 lb %	 ASTM D4632 ASTM D4632	 300 50	 370 50	 500 50
Mass per unit area	oz/yd^2	ASTM D5261	12	16	32
Puncture (CBR) strength[(2)]	lb	ASTM D6241	800	900	1,700
Puncture (pin) strength[(2)]	lb	ASTM D4833	140	170	300
Trapezoidal tear strength	lb	ASTM D4533	115	145	215
UV resistance[(3)]	%	ASTM D7238	70	70	70

Notes:
1. These tests will be performed and results reported in both the machine and cross directions.
2. Geotextile to meet puncture resistance (pin) or puncture resistance (CBR) specification.
3. Evaluation to be on 2-inch strip tensile specimens after 500 hours exposure.
4. All values are minimum average except UV resistance, which is a minimum value.
5. Geotextile cushion between aggregate and geomembrane liner may consist of one layer of 32 ounce per square yard (osy) geotextile, two layers of 16 osy geotextile, or three layers of 12 osy geotextile.

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Table 13-3. Geotextile Separator Acceptance Criteria

Property	Units	Test Method	Value[1]
Grab tensile properties			
Tensile strength	lb	ASTM D4632	305
Break elongation	%	ASTM D4632	15
Puncture Strength (pin)[2]	lb	ASTM D4833	140
Puncture Strength (CBR)[2]	lb	ASTM D6241	800
Apparent Opening Size	mm	ASTM D4751	0.60
Permittivity	S^{-1}	ASTM D4491	0.40

Notes:
1. All numerical values represent minimum average roll values except apparent opening size, which is a maximum average value. Average test results from all rolls in a lot must conform to the tabulated values.
2. Geotextile to meet puncture resistance (pin) or puncture resistance (CBR) specification.

14.0 GEOSYNTHETIC CLAY LINER

This section covers the quality assurance requirements for Pre-installation (includes GCL manufacturer), Installation, and Post-installation. The terms Pre-installation, Installation, and Post-Installation are applicable only to the GCL installation and do not apply to the overall construction of the Dry Ash Disposal Facility.

14.1 GENERAL

This section of the CQA Plan applies to the GCL used in the Dry Ash Disposal Facility liner system and the final cover.

14.2 PRE-INSTALLATION

Pre-installation activities are designed to help ensure that a high-quality product is being manufactured and that it is properly delivered, handled, and stored to maintain its quality.

14.2.1 Manufacturer's Quality Control Plan

The manufacturer of each component of the GCL and the GCL itself shall have a MQCP to ensure their product meets all the stated minimum properties. These manufacturers include the bentonite supplier, the geotextile manufacturer, and the GCL manufacturer.

Bentonite Supplier

The bentonite supplier shall have a MQCP, which is adhered to in the manufacturing process. This plan shall include the following information:

- Documentation that the bentonite is sodium bentonite.
- Testing that demonstrates that the bentonite meets specified gradation requirements.
- Testing that indicates that the bentonite meets specified index test requirements.
- Testing that demonstrates that the bentonite has not been treated with synthetic chemicals or polymers for the final cover system.

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Polymer-enhanced bentonite is required for the liner system GCL.

At a minimum, the manufacturer shall perform the tests shown in Table 14-1.

Geotextile Manufacturer

The geotextile manufacturer shall have a MQCP, which is adhered to in their manufacturing process. This plan shall include the following provisions:

- Testing that demonstrates that the product is made of specified polymers.
- Testing that demonstrates that the product meets certain minimum average roll values (for geotextile).

GCL Manufacturer

The GCL Manufacturer shall have a MQCP, which describes the procedures for accomplishing quality in the final product. At a minimum, the manufacturer shall perform the tests shown in Table 14-1.

This MQCP shall also dictate the following requirements:

- Overlap alignment lines are to be marked on the edges.
- Completed rolls are to be securely wrapped in plastic.
- Completed rolls are to be stored indoors. Provisions are to be in place to prevent rolls from being stacked too high, to be kept dry, and to prevent damage during handling.
- Quality Control certification is to be provided.

14.2.2 Materials

The GCL shall consist of a layer of pure sodium bentonite clay encapsulated between two geotextiles, and shall comply with all of the manufacturing processes and physical/chemical criteria listed in this section. Polymer-enhanced bentonite shall be used for the liner system GCL.

The bentonite clay utilized in the manufacturing of the GCL, as well as any accessory bentonite clay provided for the seaming and detail work, shall meet the manufacturer's requirements, as specified in their MQCP. The bentonite used in the manufacturing of the GCL shall also meet the requirements of Table 14-1.

The geotextile components of the GCL, and the geosynthetics clay liner itself, shall meet the minimum requirements of their respective MQCP. The GCL shall also meet the requirements of Table 14-1.

14.2.3 GCL Delivery, Handling, and Storage

The GCL panels shall be supplied to the site in factory-produced rolls. The manufacturer shall supply GCL panels to the job site in standard factory roll dimensions.

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Each roll of GCL supplied to the site shall be labeled with the following information:

- Name of manufacturer
- Product type and identification number
- Batch (or lot) number
- Date manufactured
- Roll number

The GCL Manufacturer will ensure that the crushing strength of all GCL roll cores will be sufficient to avoid collapse or other damage while in use.

The rolls of GCL are to be carefully unloaded by the Contractor upon delivery to the site. At a minimum, the following practices should be followed in receiving and storing GCL rolls:

- While unloading or transferring the GCL rolls from one location to another, prevent damage to the GCL.

- For standard rolls, a steel support should be inserted through the roll core. The slings or lifting chains should be attached at one end to the support pipe and the other end to the bucket of a front-end loader or lifting device. A spreader bar should be used to support and spread the slings. The bar and support pipe must be long enough to prevent damage to the edges of the GCL during hoisting.

- Alternate methods of unloading or transferring GCL rolls must be approved by the RPR.

- The rolls of GCL will be stored in their original, unopened, wrapped cover in a clean, dry area. The GCL should be stored off the ground on pallets or by other suitable techniques that provide continuous support over the entire length of the roll. The stored GCL shall be covered with a heavy, protective tarpaulin or stored beneath a roof. Care should be used to protect the GCL from the following:
  Precipitation
  Ultraviolet radiation
  Strong oxidizing chemicals, acids, and bases
  Flames, including welding sparks
  Temperatures in excess of 160°F

The RPR will be responsible, throughout the pre-installation, installation, and post-installation periods, for observing and documenting that the Installer provides adequate handling equipment used for moving GCL rolls and that the equipment used does not damage the GCL.

The RPR will be responsible for making certain that the manufacturer, type, and thickness of each roll are correct. The RPR will maintain a log of all GCL delivered to the job site. The following information, at a minimum, will be recorded on the log for each shipment delivered to the job site:

- Date of receipt of delivery at job site.
- For each GCL roll delivered to the site, the roll number and batch (or lot) number.

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14.2.4 Submittals

Prior to GCL installation, the GCL Manufacturer and GCL Installer will submit the following information to the CQA Officer.

GCL Manufacturer/Production Information

- Corporate background and information.
- MQCP for bentonite, geotextile, and GCL manufacturers.
- Project reference list consisting of the principal details of at least ten projects totaling at least eight million square feet of GCL installation, if required by the RPR or the CQA Officer.
- Results of tests conducted by the bentonite supplier and the geotextile supplier to document the quality of the materials used to manufacture the GCL rolls assigned to the job.
- Copy of Quality Control certifications, signed by the manufacturer. Each quality control certificate shall include roll identification numbers and results of quality control tests.
- Written certification from the manufacturer that the GCL meets the project specifications, that the GCL has been continuously inspected and found to be needle-free through magnetic and metal detection tests, that the bentonite will not shift during transportation or installation, and that the bentonite and geotextile materials meet the manufacturer's specifications.

GCL Installer Information

- Corporate background information.
- Project reference list of at least five projects totaling one million square feet, if required by RPR or CQA Officer.
- List of personnel performing field operations, along with pertinent experience information, if required by RPR or CQA Officer.

The proposed panel placement diagram identifying placement of the GCL panels and seams, as well as additional details that deviate from the engineering drawings, shall be submitted prior to installation if required by the CQA Officer. The layout should be drawn to scale, shall include information such as dimensions and details, and shall be adequate for use as a construction plan.

14.3 INSTALLATION

The following installation procedures are designed to ensure the effectiveness of the GCL in meeting its design requirements and to simplify the deployment procedures. These procedures are to be followed by the Installer, unless the Installer proposes alternate procedures in writing to the CQA Officer and the CQA Officer approves these alternate procedures.

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14.3.1 Testing Requirements

This subsection describes the test methods, including sampling procedures and frequencies (if applicable), and the role of the Geosynthetic Testing Laboratory in testing the GCL roll samples. Unless specified otherwise, all sampling procedures will be performed in accordance with the referenced test method defined in this section.

Testing Methods

GCL roll samples will be collected at the Manufacturer's plant by a technician of the Geosynthetic Testing Laboratory or on site by the RPR and Contractor. Sample sizes shall be as required by the Geosynthetic Testing Laboratory. GCL samples will be collected and tested in accordance with the test methods specified in GCL roll samples will be collected at the Manufacturer's plant by a technician of the Geosynthetic Testing Laboratory or on site by the RPR and Contractor. Sample sizes shall be as required by the Geosynthetic Testing Laboratory. GCL samples will be collected and tested in accordance with the test methods specified in Table 14-1.

The Geosynthetic Testing Laboratory will be responsible for performing the tests on samples submitted to them. Results of tests performed will be reported to the RPR and CQA Officer. Retesting of GCL rolls for quality assurance purposes, because of failure to meet any or all of the acceptance specifications in this section, can only be authorized by the CQA Officer or Company.

Procedures for Determining GCL Roll Test Failures

Table 14-1 lists the specifications that are applicable to the GCL. For any referenced test method that requires the testing of multiple specimens, the criteria in Table 14-1 shall be met based on the average results of the multiple specimen tests.

The following Procedure will be used for interpreting results relative to acceptance or rejection of rolls, lots, and shipments of GCL to the site:

- If the test values meet the stated specifications, then the roll and batch will be accepted for use at the job site. If the sample represents all rolls from an entire shipment, then the entire shipment will also be considered accepted.

- If the result does not meet the specification, then the roll and the batch shall be retested at Contractor's expense using specimens either from the original roll sample or from another sample collected by the RPR. For retesting, two additional tests shall be performed for the failed test procedure. (Each additional test shall consist of multiple specimen tests if multiple specimens are called for in the failed test procedure.) If both of the retests are acceptable, then the roll and batch shall be considered to have passed this particular acceptance test; if either of the two additional tests fails, then the roll and batch shall be considered unsuitable without further recourse. RPR may obtain samples from other rolls in the batch. On the basis of testing these samples, the CQA Officer may choose to accept a portion of the batch while rejecting the remainder.

If retesting does not result in passing test results as defined in the preceding paragraph, or if there is any other nonconformity with the material specifications, the Contractor shall withdraw the rolls from use in the project at the Contractor's sole risk, cost, and expense. Once withdrawn, the same rolls shall not be resubmitted for use. Cost and expense for removing this GCL from the site and replacing it with acceptable GCL shall be the sole risk and responsibility of the Contractor.

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14.3.2 Required Equipment

The following installation equipment is required on site:

- Front-end loader, crane, or other similar equipment. The selected piece of equipment shall not cause damage to the subgrade, such as rutting. The Installer shall verify in the presence of the RPR that the selected piece of equipment does not damage the subgrade.
- A spreader bar to prevent slings from damaging the ends of the rolls.
- Several steel pipes to be inserted into the roll's core for lifting.
- Wooden pallets for aboveground storage of the GCL rolls.
- Heavy waterproof tarps for protecting all GCL rolls.
- Sandbags for securing the GCL during installation and for the tarps.
- Adhesive or tape for securing patches.
- Granular bentonite for seams, patches, and penetrations.

14.3.3 Surface/Subgrade Preparation

GCL installation will not begin until a proper subgrade has been prepared to accept the GCL. Base material will be select clay fill for the liner and grading layer for the final cover. Foreign materials and protrusions should be removed, and all cracks and voids should be filled, and the surface made smooth and uniformly sloping. Unless otherwise required by the contract specification and drawings, the prepared surface should be free from excessive moisture, loose earth, or rocks larger than 2 inches in diameter, rubble, and other foreign matter. The subgrade should be uniformly compacted to ensure against localized settlement and rutting under wheel loads, and should be smoothed with a smooth drum or vibratory roller.

The surface on which the GCL is to be placed should be maintained in a firm, clean, and smooth condition; free of standing water during GCL installation. Vehicle traffic on the subgrade of the GCL shall be restricted to the minimum weight and number of machines needed to deploy the GCL. Vehicles shall be operated to minimize the formation of ruts and surface deformations.

14.3.4 Deployment

As each roll is moved from the storage area, the Installer or RPR should remove the labels for storage in the project file.

The rolls of GCL should be brought to the area to be lined with a front-end loader and support pipe set up such that the roll of GCL is fully supported across its length. A spreader bar or similar device should be used to prevent the lifting chains or slings from damaging the edges. Dragging of the GCL should be minimized.

The Contractor shall ensure that, and the RPR will verify that, the following criteria are being met:

- The equipment used does not damage the GCL by handling, excessive heat, leakage of hydrocarbons, or by other means.

- The prepared surface underlying the GCL has not deteriorated since previous acceptance, and that it is still acceptable at the time of GCL placement.

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- Personnel working on the GCL do not smoke, wear damaging clothing, or engage in other activities that could damage the GCL.
- The method used to unroll the GCL does not cause damage to the GCL, and/or the subgrade.
- The method used to place the rolls minimizes wrinkles (especially wrinkles between adjacent panels).

Do not place GCL during precipitation, in the presence of excessive moisture, in any area of ponded water, or during excessive winds. The GCL must be dry when installed and must be dry when covered.

The non-woven side of the GCL should face upwards, and the scrim side of the GCL should face downwards (unless otherwise dictated by project requirements). The GCL will be placed over the prepared surface in such a manner, which minimizes material handling.

The GCL panels should be placed in a manner that ensures sufficient overlap as described in Subsection 14.3.5. Whenever possible, horizontal seams should not occur on slopes steeper the 7H:1V. If horizontal seams are required on slopes, seams should be staggered to provide no end seams within 25 feet up- or downslope on adjacent panels.

The cover material (i.e., geomembrane) should be placed over the GCL during the same day as the placement of the GCL. Only those GCL rolls, which can be covered that same day, should be unpacked and placed in position.

When wind conditions can affect installation, the GCL installation should be started at the upwind side of the project and proceed downwind. The leading edge of the GCL should be secured at all times with sandbags or other means sufficient to hold it down during high winds.

The GCL should be installed in a relaxed condition and should be free of tension or stress upon completion of the installation. Stretching of the GCL to fit will not be allowed. Deployed rolls (panels) should be straightened by the installation personnel to smooth out creases or irregularities.

The RPR will visually inspect the geotextile quality, bentonite uniformity, and the degree of hydration, if any, of the GCL. Any areas in need of repair shall be marked.

14.3.5 Seaming

Once the first panel has been deployed, adjoining panels should be laid with a 6-inch minimum overlap on longitudinal seams, and 20 inches on the panel end seams, depending on project specifications. Six inch and 20-inch overlap lines shall be marked on the GCL to assist in obtaining the proper overlap. When connecting GCL panels from a prior construction phase to a new construction phase, a minimum 1-foot overlap should be provided between the previously placed panels and the newly placed panels. All dirt, gravel, or other debris should be removed from the overlap area of the GCL.

Seam overlaps, whenever possible, should be placed such that the direction of flow is from the top panel to the underlying panel to form a shingle effect.

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If the GCL requires a granular bentonite seam, then the overlapping panel edge should be pulled back and granular sodium bentonite should be poured continuously along all seams and lap areas for the panel edge to the 6-inch lap line, at a minimum application rate of one-quarter pound per lineal foot.

14.3.6 Patches/Repairs

Irregular shapes, cuts, or tears in the installed GCL should be covered with sufficient GCL to provide a 12-inch overlap in all directions beyond the damaged area. A layer of granular bentonite shall be placed in the overlap zone in accordance with the Manufacturer's recommendations. An epoxy-based adhesive, or other approved method, shall be used to secure the patch during backfill operations.

14.3.7 Penetration Seals

The GCL should be sealed around penetrations, pipes, and structures in accordance with the recommendations of the GCL manufacturer.

14.3.8 Covering GCL

Only the amount of GCL that can be inspected, repaired, and covered in the same day should be deployed. The GCL must be covered the same day it is installed.

Geosynthetics

When covering the GCL, precautions shall be taken to prevent damage to the GCL by restricting heavy equipment traffic. Place a slip-sheet over the GCL to allow the textured geomembrane to slide into its proper position. The slip-sheet shall be removed after the geomembrane is in place.

Any leading edge of panels of GCL left unprotected must be covered with heavy, waterproof tarp that is secured and protected with sandbags or other ballast.

GCL Panels at the End of a Phase

This section applies to GCL panels located at the end of a phase of construction that will be connected to GCL panels during construction of a future phase. The edge of the GCL panels shall be protected from excess soil moisture contact by placement of plastic construction film rolled over both the top and bottom sides for at least a 2-foot width along the edge of the GCL panels. The overlying geomembrane shall extend beyond the edge of the GCL. Soil shall be placed over the edges of the geosynthetics to divert water away from the buried edges and to impose overburden pressure to minimize swelling of the GCL.

14.3.9 Submittals

During GCL installation, the GCL Installer shall submit the following information to the CQA Officer:

- Daily records/logs prepared by the Installer documenting work performed, personnel involved, general working conditions, and any problems encountered or anticipated on the project. These records shall be submitted on a weekly basis.
- Copy of subgrade acceptance forms by the Installer.
- Quality control documentation.

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Table 14-1. GCL Material Tests, Test Methods, and Acceptance Criteria

	Property	Test Method	Units	Criterion	Acceptance Value[1]	Minimum Conformance Testing Frequency[2][3]
Bentonite properties	Free swell	ASTM D5890	ml/2g	Minimum	24	1/100,000 sf
	Fluid loss	ASTM D5891	ml	Maximum	18	Not required
Physical GCL Properties	Grab strength[6]	ASTM D6768	lb/in	MARV[4]	23	1/100,000 sf
	Bentonite mass per unit area[5]	ASTM D5993	psf	Minimum	0.75	1/40,000 sf
	Peel strength[6]	ASTM D6496	lb/in	Minimum	2.1	1/100,000 sf
	Index flux	ASTM D5887	$m^3/m^2/sec$	Maximum	1×10^{-8}	1/100,000 sf
	Permeability	ASTM D5887	cm/sec	Maximum	5×10^{-9}	Not required
	Hydraulic Conductivity[7]	ASTM D6766	cm/sec	Maximum	5×10^{-9}	Note 8
	Loss on Ignition	ASTM D7626 modified	Percent	Note 9	Note 9	1 test[10]
	Fann Viscosity	API 13A Section 9 modified	Centipose	Note 9	Note 9	1 test[10]

Notes:
1. Values are based on representative manufacturer's product data current acceptable industry standards and practice.
2. CQA Officer to coordinate conformance testing at the specified frequencies (minimum) on the GCL rolls supplied to the project.
3. Conformance testing is not required if GCL manufacturer provides testing documentation at the required frequency prior to shipping.
4. MARV = Minimum average roll value.
5. Bentonite mass/unit area reported at zero percent moisture content.
6. Grab and peel strength testing performed in the machine and cross direction. Acceptance value is for the machine direction (MD) test.
7. Hydraulic conductivity (compatibility) test for the liner GCL performed using site-generated leachate.
8. One test is required for the liner GCL. The test must be repeated if there is a change in site's coal combustion residuals (CCR) properties, or if the GCL product or the polymer used to enhance the bentonite in the GCL changes.
9. Testing of polymer-enhanced bentonite from liner GCL. Manufacturer's test results will be used to compare with results from conformance testing coordinated by CQA Officer.
10. CQA Officer to coordinate conformance testing of polymer-enhanced liner GCL rolls supplied to the project.
11. Refer to **Section 3.2** for direct shear test requirements.

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15.0 GEOMEMBRANE

15.1 GENERAL

This section of the CQA Plan applies to the polyethylene geomembranes used in the Dry Ash Disposal Facility liner and final cover systems.

15.2 PRE-INSTALLATION

This section describes the quality control measures that are applicable to the polyethylene resin manufacturers, geomembrane manufacturers, and finished geomembrane roll delivery to the site prior to installation. The geomembrane must be fabricated from polyethylene resin.

In the event that geomembrane materials are obtained from a different manufacturer or are made from different resins, seam samples formed by joining the original and the proposed geomembrane may be tested to confirm the construction compatibility of the two-geomembrane materials. Prior to the use of the new geomembrane material, a minimum of two seamed samples (as described above) may be submitted to the geosynthetics laboratory for destructive seam testing as described in Subsection 15.4.5. The CQA Officer will review the testing results prior to authorizing the use of the new geomembrane material.

The geomembrane will be supplied to the site in factory rolls. No factory seams will be used to prepare larger panels of geomembrane for delivery to the site.

15.2.1 Manufacturing

Material Specifications

The required geomembrane material for final cover construction is textured 40-mil LLDPE. The approved geomembrane material for the liner system construction is textured 60-mil HDPE.

Quality Control Requirements

Prior to the delivery of any geomembrane rolls to the site, the Geomembrane Manufacturer will provide the Company and/or the CQA Officer with the following information:

- The resin supplier, location of supplier's production plant(s), and resin brand name and product number.
- Any results of tests conducted by the Geomembrane Manufacturer and/or the Resin Manufacturer testing laboratories to document the quality of the resin used in fabricating the geomembrane.
- The Quality Control Plan that the Geomembrane Manufacturer will be using for the geomembrane being supplied.

Every roll of geomembrane for delivery to the site must be manufactured and inspected by the Geomembrane Manufacturer according to the following requirements:

- First quality polyethylene resin must be used.

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- The geomembrane must contain no more than a maximum of 1 percent by weight of additives, filler, or extenders, excluding carbon black.

- The geomembrane must have no striations, roughness (except where textured geomembrane is specified), or bubbles on the surface.

- The geomembrane must be free of holes, blisters, undispersed raw materials, or any other sign of contamination by foreign matter.

The Geomembrane Manufacturer will routinely perform density (ASTM D1505) and melt index (ASTM D1238) tests on the raw resin to document the quality of the HDPE or LLDPE resin used to manufacture the geomembrane rolls assigned to this project.

Manufacturer's Certification

The Geomembrane Manufacturer will test the geomembrane produced for the site according to the test methods and frequencies listed in **Table 15-1**. The Geomembrane Manufacturer will provide certification, based on tests performed by either the Geomembrane Manufacturer's laboratory or other outside laboratory contracted by the Geomembrane Manufacturer that the geomembrane supplied under this plan will meet the specifications presented in **Table 15-2**, except as noted in **Subsection 15.3.1** under Procedures for Determining Geomembrane Roll Test Failures. Additionally, the manufacturer will provide certification that the MQCP was fully implemented for the geomembrane material supplied under this plan. The manufacturer will provide documentation to verify results of the MQCP implementation if requested by the CQA Officer.

15.2.2 Delivery, Handling, and Storage of Geomembrane Rolls

The geomembrane will be protected during shipment from excessive heat or cold, puncture, cutting, or other damaging or deleterious conditions. The geomembrane rolls will be stored on site in a designated area and will be protected from long-term ultraviolet exposure prior to actual installation.

Each geomembrane roll will be marked by the Geomembrane Manufacturer with the following information (on a durable gummed label, or equivalent, on the inside of core):

- Name of manufacturer
- Product type and identification number (if any)
- Roll length and width
- Batch (or lot) number
- Nominal product thickness
- Date manufactured
- Roll (or field panel) number

When cores are required for preparing geomembrane for shipment, the manufacturer will use cores with sufficient crushing strength to prevent collapse or other damage while in use.

The following practices will be used as a minimum in receiving and storing geomembrane rolls in the designated storage area at the job site:

- While unloading or transferring the geomembrane rolls from one location to another, care will be taken to prevent damage to the geomembrane itself. The preferred method involves using a spreader-bar, straps, and a loader. Rolls will not be dragged.

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- Geomembrane rolls will be stored in a manner so as to ensure that they are adequately protected from the following:
  Equipment damage
  Strong oxidizing chemicals, acids, or bases
  Flames, including welding sparks
  Temperature in excess of 160°F
  Dust and dirt

The RPR will observe and document, throughout the pre-installation, installation, and post-installation periods that the Installer provided adequate handling equipment for moving geomembrane rolls and that the equipment and the handling methods used do not pose unnecessary risk of damage. The Installer is responsible for the means and methods to implement the work.

The Installer will be responsible for ensuring that all material installed meet specifications (i.e., that the roll marking label information indicates required specifications and properly represents materials). The RPR will maintain a log of geomembrane roll deliveries. The following information, at a minimum, will be recorded on the log for each shipment received at the job site:

- Date of delivery at job site.
- For each geomembrane roll, the roll number and batch (or lot) number.

15.3 INSTALLATION

This section includes discussion of geomembrane roll testing requirements, earthwork required for geomembrane placement, placement of the geomembrane, defects and repairs of geomembrane, and requirements applicable to other materials in contact with the geomembrane. Subsection 16.4 describes the installation and testing requirements for geomembrane seams.

All parties involved in the installation of the geomembranes will be familiar with geomembrane and will focus on protecting the geomembrane from damage during construction activities.

15.3.1 Testing Requirements

This subsection describes the test methods, including sampling procedures and frequencies, and the role of the geosynthetics-testing laboratory in testing the geomembrane roll samples. Subsection 15.2.1, under Quality Control Requirements, describes the test methods that are performed on an infrequent basis to demonstrate the uniformity of resin used to fabricate geomembrane shipped to the job site. Seam testing is described in Subsections 15.4.4 and 15.4.5.

Testing Methods

A representative of the Geosynthetic Testing Laboratory at the geomembrane manufacturer's plant will collect geomembrane roll samples. The rate of sampling will be one per 100,000 square feet of geomembrane produced for delivery to the site. At least one sample will also be obtained for each geomembrane production batch for each shipment. The Installer will not ship to, or receive at the site, geomembrane from more than two production batches in any single shipment without the prior written approval of the CQA Officer and/or Company.

Samples collected will be of a size determined by the Geosynthetic Testing Laboratory. The laboratory technician will indicate the MD on the sample.

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Table 15-1 lists the tests and the test methods to be performed on HDPE or LLDPE geomembrane roll samples. The specifications and methods used in evaluating the results are discussed below under "Procedures for Determining Geomembrane Roll Test Failures." Unless specified otherwise, sample specimens will be prepared in accordance with the referenced test method. The results for tear resistance and each of the tensile property tests will be reported for both the machine and cross direction.

The Geosynthetics Testing Laboratory will be responsible for performing the tests on samples submitted to them as described above under Test Methods. The results of the tests performed will be reported to the CQA Officer and the RPR.

Retesting of geomembrane rolls for quality assurance purposes because of failure to meet any or all of the acceptance specifications listed in Table 15-2 can only be authorized by the CQA Officer and/or Company.

The Geomembrane Manufacturer and/or Installer may perform their own tests according to the methods and procedures defined in Table 15-1; however, the results will only be applicable to their own quality control needs. The results will not be substituted for the quality assurance testing described herein.

Procedures for Determining Geomembrane Roll Test Failures

Table 13-2 lists the acceptance specifications for HDPE and LLDPE geomembranes. For those tests where results are reported for both machine and cross direction, each result will be compared to the listed specification to determine acceptance.

The following procedure will be used for interpreting results:

- If the test values meet the stated specification in Table 15-2, then the roll and the lot will be accepted for use at the job site. If the sample represents all rolls from an entire shipment, then the entire shipment will also be considered accepted.

- If the result does not meet the specifications, then the roll and the batch may be retested using specimens either from the original roll sample or from another sample collected by the Geosynthetic Laboratory technician or the RPR. For retesting, two additional tests will be performed for the failed test procedure. (Each additional test will consist of multiple specimen tests if multiple specimens are called for in the test procedure). If both of the retests are acceptable, then the roll and batch will be considered to have passed this particular acceptance test; if either of the two additional tests fail, then the roll and batch will be considered unsuitable without further recourse. The CQA Officer may obtain samples from other rolls in the batch. On the basis of testing these samples, the CQA Officer may choose to accept a portion of the batch while rejecting the remainder.

If retesting does not result in passing test results as defined in the preceding paragraph, or if there is any other nonconformity with the material specifications, then the Installer will withdraw the rolls from use in the project at the Installer's sole risk and expense. The Installer will be responsible at his/her sole risk, cost, and expense for removing this geomembrane from the site and replacing it with acceptable geomembrane.

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15.3.2 Earthwork

The Construction Contractor will be responsible for preparing the supporting soil according to the plans and specifications. For the installation of any of the geomembrane, the Installer will certify in writing that the surface on which the geomembrane will be installed is acceptable. This certification of acceptance will be reported by the Installer prior to the start of geomembrane installation in the area under consideration. Unacceptable areas noted by the Installer will be immediately reported to the RPR.

The installation surface will also be examined by the RPR. The daily observation will be documented in the daily report. The Construction Contractor or Installer will rework areas determined to be unacceptable until acceptable.

15.3.3 Placement

Location and Panel Layout Drawing

A panel layout drawing for the geomembrane installation covered by this plan will be prepared by the Installer prior to the installation and submitted to the CQA Officer and Company. The proposed panel layout drawing will show the proposed location and orientation of geomembrane panels to be installed in relation to slope, collection trenches, anchor trench, and phase boundaries. The panel layout drawing will be submitted to the WDNR prior to the preconstruction meeting if required. The Company and CQA Officer will review the proposed panel layout drawing and document that it is consistent with accepted practice and the construction plans and specifications.

Installation Techniques

Geomembrane panels will be installed by placing one at a time, and each panel will be seamed by the end of the day on which it was placed. Panels shall be installed such that all seams run perpendicular to the contour lines of the slope.

The RPR will document that the condition of the supporting soil has not changed detrimentally during installation. The RPR will notify the Installer and the Construction Contractor of any damage done (i.e., rutting by equipment used to deploy geomembrane) to the supporting soil prior to panel seaming. It is the responsibility of the Installer to remove the deployed panel to allow the Construction Contractor to repair the supporting soil. The RPR will observe and document the repair of the supporting soil. The RPR will inform the Installer that the method of deployment will be observed during further deployment, and if damage to supporting soil continues, deployment will be stopped and an alternate means of deployment is to be developed. The RPR will document these events and conversations in the daily summary report.

The Installer will take the following precautions while installing the geomembrane:

- Ensure the equipment used does not damage the geomembrane by the way it is handled, by excessive heat, by leakage of hydrocarbons, or by other means.
- Ensure fuel storage on the geomembrane has secondary containment.
- Ensure the personnel working on the geomembrane do not smoke, wear damaging clothing, or engage in other activities that could damage the geomembrane.

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- Ensure that the method used to deploy the geomembrane does not cause scratches or crimps in the geomembrane.
- Ensure that the method used to deploy the rolls minimizes wrinkles.
- Ensure that the geomembrane is adequately loaded to prevent wind uplift.
- Minimize the amount of direct contact with the geomembrane and limit the number of personnel that are allowed on the geomembrane once QC and QA is completed.
- Ensure that only approved equipment is allowed on the surface of the geomembrane (i.e., generators, test equipment). The use of motorized vehicles is not permitted without written approval from the Company and the CQA Officer and/or the RPR.

Weather Conditions

Geomembrane will not be placed in an area of ponded water or during precipitation events. Geomembrane may not be deployed in the presence of excessive winds unless approved by the CQA Officer or Company. The Installer must receive written approval from the CQA Officer or Company to deploy geomembrane in temperature below 32°F.

Damages

The RPR will examine each panel for damage after placement and will determine which panels, or panel portions, should be rejected, repaired, or accepted. Damaged panels or portions that have been rejected will be marked, removed, and recorded by the RPR.

15.3.4 Defects and Repairs

This section applies to all defects and repairs resulting from examinations, tests, or visual observations performed on the geomembrane material itself and on the seams used in joining rolls in the field.

Identification

All seam and non-seam areas of the geomembrane will be examined and documented by the RPR for identification of defects, holes, blisters, undispersed raw material, and any signs of contamination by any foreign matter. Because light reflected by the geomembrane helps to detect defects, the surface of the geomembrane will be clean at the time of examination. The RPR will complete a final examination of the geomembrane in areas in which both the Installer and the RPR have completed their QC and QA, respectively. The RPR will document areas in which a final examination has been completed, and the Installer will limit personnel access to the completed area. The RPR and the Installer will perform a final examination over the entire geomembrane at the completion of the project. The Installer and/or the Construction Contractor will clean any area that is insufficiently clean to complete the final examination.

Evaluation

Each suspect area identified will be nondestructively tested using the vacuum box test method, air test, or spark test method. The RPR will approve the proper test method for each suspect location.

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Repair Procedures
Any portion of the geomembrane exhibiting a flaw or failing a destructive or nondestructive test will be repaired. Several procedures exist for the repair of these areas. The procedures available include the following:

- Patching is used to repair large holes, tears, undispersed raw materials, and contamination by foreign matter.
- Grinding and rewelding are used to repair small sections of extruded seams.
- Spot welding or seaming is used to repair small tears, pinholes, or other minor, localized flaws.
- Capping is used to repair large lengths of failed seams.
- Other procedures may be used at the recommendation of the Installer if agreed upon by the CQA Officer and the RPR.
- Removal and replacement is used to replace non-conforming or damaged panels or portions thereof.

The repair procedures, materials, and techniques will be approved in advance of the specific repair by the CQA Officer, RPR, and Installer. At a minimum, the following provisions will be satisfied:

- Patches or caps will extend at least 6 inches beyond the edge of the defect, and all corners of patches will be rounded with a radius of at least 3 inches.
- The type of geomembrane (i.e., smooth or textured) used for repairs will be approved by the RPR prior to completing repairs.

Examination of Repairs

Each repair will be numbered and logged by the RPR. Each repair will be nondestructively tested according to **Subsection 15.4.4**. Repairs that pass the above testing will be considered to be adequate, except that large caps may be of sufficient extent to require destructive seam sampling and testing, at the discretion of the RPR, according to the provisions of **Subsection 15.4.5**.

Failed tests indicate that the repair was inadequate, and the repair will be redone and retested until a passing result is obtained. The RPR will document that all repairs have been subjected to nondestructive testing and will record the number of each repair, the date, and the test outcome.

Large Wrinkles

When seaming of the geomembrane is completed, the RPR will examine the geomembrane for wrinkles. Wrinkles that are higher than they are wide should be smoothed, cut, and seamed by the Installer. The wrinkle repair will be done in accordance with the equipment and procedures described in **Subsections 15.4.2** and **15.4.3** (General Seaming Procedures), respectively, and it will be nondestructively tested using the vacuum box test method described in **Subsection 15.4.4**.

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15.4 FIELD SEAMING

This section covers the quality assurance procedures on seams used to join the rolls of geomembrane into a continuous layer. The installation of each of the geomembranes at the landfill will include 100 percent nondestructive testing of all field seams for joining adjacent rolls of geomembranes to document that no openings or gaps exist between geomembrane sheets. In addition, destructive testing will be performed at a routine interval for determining the strength and mode of failure of field seams in both the shear and peel modes.

The allowable field seam methods, equipment, personnel qualifications, and destructive and nondestructive testing methods are described in this section.

15.4.1 Panel/Seam Layout

No horizontal seams will be allowed on slopes greater than 5 horizontal to 1 vertical. In corners and at other odd-shaped geometric intersections, the number of horizontal seams will be minimized. A seam numbering system comparable and compatible with the geomembrane roll numbering system will be agreed upon at the preconstruction meeting (Subsection 3.3).

15.4.2 Seaming Equipment

The approved process for production field seaming (roll to roll) are the dual hot wedge (fusion-type) seam method and the extrusion fillet welding process. The extrusion fillet weld process will be used for specialty seams and repair seams (nonproduction). No other processes can be used without prior written authorization from the CQA Officer and the RPR. Only equipment that has been specifically approved by make and model will be used. Dual track welding should be used on panel to panel seams whenever possible.

Dual Hot Wedge Process

The Installer will meet the following requirements regarding the use, availability, and cleaning of the equipment to be used at the job site:

- An automated self-propelled type of apparatus will be used.
- The welding apparatus will be equipped to continuously monitor applicable temperatures.
- One spare operable seaming device will be maintained on site at all times.
- Equipment used for seaming will not damage the geomembrane.
- The geomembrane will be protected in areas of heavy traffic to prevent damage discussed in Subsection 15.3.3.
- For cross seams, the edge of the cross seam will be ground to a smooth incline (top and bottom) prior to welding.
- For cross seams, the intersecting dual hot wedge seam will be patched using the extrusion fillet process described below.

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- The electric generator for the equipment will be placed on a smooth base in such a way that no damage occurs to the geomembrane. Similarly, a smooth insulating plate or fabric will be placed beneath the hot equipment after use.

The Installer will keep records for each seamer performing dual hot wedge seaming, including welding machine I.D. number, ambient temperature, and machine operating temperatures. These data will be recorded at intervals as agreed upon at the preconstruction meeting.

Extrusion Fillet Process

The Installer will meet the following requirements regarding the use, availability, and cleaning of the extrusion welding equipment to be used at the job site:

- The welding equipment will be equipped to continuously monitor temperature at the nozzle.
- One spare seaming device will be maintained on site at all times.
- Equipment used for seaming will not damage the geomembrane.
- The geomembrane will be protected in areas of heavy traffic to prevent damage.
- The extruder will be cleaned and purged prior to beginning seaming, and at any time seaming operations are stopped, until all heat-degraded extrudate has been removed from the barrel. Purged extrudate will not be placed on the geomembrane.
- The electric generator for the equipment will be placed on a smooth base in such a way that no damage occurs to the geomembrane. Similarly, a smooth insulating plate or fabric will be placed beneath the hot equipment after use.
- Grinding geomembrane surfaces for welding preparation will not be performed more than one hour prior to seaming.

The Installer and, if applicable, the Geomembrane Manufacturer will provide documentation to the CQA Officer regarding the quality of the extrudate used in the welding apparatus. At a minimum, the extrudate will be compatible with the base material and will contain the same grade and quality of polyethylene resins as used in the base material.

The Installer will keep records for each seamer performing extrusion weld seaming, including welding machine I.D. number, extrudate, and ambient temperature. These data will be recorded at intervals as agreed upon at the preconstruction meeting.

15.4.3 Initial Requirements

Personnel Qualifications

All personnel performing seaming operations will be qualified by experience and successfully passing seaming tests for the type of seaming equipment to be used. At least one seamer will have experience in seaming a minimum one million square feet of polyethylene geomembrane using the same type of seaming apparatus used at the ash disposal facility. The most experienced seamer, the "master seamer," will have direct supervisory responsibility at the job site.

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The Installer will provide a list of proposed seaming personnel and their experience records to the CQA Officer and the RPR for their review and approval.

Weather Conditions

The weather conditions under which geomembrane seaming can be performed are as follows:

- Unless otherwise authorized in writing by the CQA Officer, no seaming will be attempted or performed at an ambient temperature below 32°F (0°C) or above 104°F (40°C).
- Geomembrane will be dry and protected from wind.
- Seaming will not be performed in areas where ponded water has collected below the surface of the geomembrane.

If the Installer wishes to use methods that may allow seaming at ambient temperatures below 32°F or above 104°F, the Installer will demonstrate and certify that the methods and techniques used to perform the seaming produce seams that are entirely equivalent to seams produced at temperatures above 50°F and below 104°F, and that the overall quality of the geomembrane will not be adversely affected.

The RPR will document the following:

- Ambient temperature at which seaming is performed.
- Any precipitation events that occurred at the site, including the time of such occurrences, the intensity, and the amount of the event.

The RPR will inform the CQA Officer if any of the weather conditions are not being fulfilled. The CQA Officer will stop or postpone the geomembrane seaming when weather conditions are unacceptable.

Overlapping and Temporary Bond

The Installer will be responsible for ensuring that the following requirements are met:

- Panels of geomembrane will have a finished overlap of a minimum of 3 inches for extrusion welding and 4 inches for fusion welding; but in any event, sufficient overlap will be provided to allow peel tests to be performed on the seam.
- No solvents or adhesives will be used on the geomembrane unless the CQA Officer has approved the product in writing. Approval can only be obtained by submitting samples and data sheets to the CQA Officer for evaluation.
- Procedures used to temporarily bond adjacent geomembrane panels must not damage the geomembrane; in particular, the temperature of the hot air at the nozzle of any spot-welding apparatus will be controlled such that the geomembrane is protected at all times against potential damage.

Trial Seams

Trial seams will be made on fragments of geomembrane to document that seaming conditions are adequate. For each seaming apparatus used and for each seamer, such trial seams will be made at the beginning of each seaming period, following work interruptions, following changes to machine

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settings for temperature or speed, at changes in weather, and at least once for every five hours of seaming activities. Trial seams are to be run using the materials the seaming will be used for (i.e., smooth to smooth, smooth to textured, textured to textured). At a minimum, one trial seam per welding machine will be made at the start of each day by each seaming technician performing welding that day. Also, each seamer will make at least two trial seams each full day of welding.

The trial seams will be examined by the Installer and RPR for squeeze-out, foot pressure applied by the seaming equipment, and general appearance. If the seam fails any of these examinations, it will be repeated. If the second trial seam fails these examinations, the welding apparatus and seamer are not allowed to seam until the Installer can demonstrate the cause of the failure. Once the Installer has made the necessary corrections to the welding equipment, the seamer and apparatus are required to pass two trial seams prior to beginning seaming. The RPR will document the reason for the failure and all subsequent trial seams.

The trial seam samples will be at least 3 feet long by 1 foot wide after seaming, with the seam centered lengthwise. Seam overlap will be as indicated above under Overlapping and Temporary Bond.

Three adjoining specimens, each 1-inch wide, will be cut from each end of the trial seam sample by the Installer. The specimens will be tested by the Installer in shear and peel, respectively, using a field tensiometer. If a specimen fails, then the entire test will be repeated using two additional specimens cut from each end of the trial seam sample. If the second set of specimens also fails, then the seaming apparatus and seamer will not be accepted and will not be used for seaming until the deficiencies are corrected and two successful trial seams are achieved.

The remainder of the trial seam sample will be identified and marked by the RPR as follows:

- The sample will be assigned a number and marked as to welding apparatus used and the seamers name.
- The date, time, applicable welding equipment operating temperatures, and ambient temperature at the time of seaming will be noted.
- Whether the sample passes or fails will be recorded.

The RPR will observe trial seam procedures and record on field log forms. The RPR will retain the trial weld sample as an archive sample.

Seam Preparation

The Installer will ensure that the following conditions for each of the geomembrane installations covered by this plan are met:

- Prior to seaming, the seam area is clean and free of moisture, dust, dirt, debris of any kind, and foreign material.
- If seam overlap grinding is required, then the grinding process will be completed according to the Geomembrane Manufacturer's instructions within one hour of the seaming operation, and in a way that will not damage the geomembrane or cause excessive striation of the geomembrane surface.

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- Seams will be aligned so as to minimize the number of wrinkles and fishmouths.

General Seaming Procedures

Unless otherwise specified, the general seaming procedures to be used by the Installer for each of the geomembrane installations covered by this plan, and observed by the RPR, will be as follows:

- A firm subbase will be provided to achieve proper support for seaming.
- Fishmouths or wrinkles at the seam overlaps will be cut along the ridge of the wrinkle in order to achieve a flat overlap. The cut fishmouths or wrinkles will be seamed, and any portion where the overlap is inadequate will then be patched with the same geomembrane (including thickness) extending a minimum of 6 inches beyond the cut in all directions.
- If seaming operations are to be conducted at night, adequate illumination will be provided.

15.4.4 Nondestructive Testing

Each field seam will be nondestructively tested over its full length using one of the methods described in this section. The purpose of nondestructive testing is to determine the continuity of the seams.

Nondestructive testing, at this stage of development, does not provide any information on the strength of seams. Seam strengths will be determined by destructive testing methods that are described in Subsection 15.4.5. Failure of any of the nondestructive or destructive tests will require the repair of the failed section according to the procedures contained in Subsection 15.3.4.

Nondestructive testing as described in this section will be performed on seams for every geomembrane installation covered by this plan. The recommended test methods for conducting the nondestructive seam testing are the air pressure test for dual hot wedge seams, the vacuum box test for extrusion fillet welds, and leak location testing. These three nondestructive testing methods are described below.

The RPR will perform the following documentation tasks:

- Observe nondestructive seam testing and examine seams for squeeze-out, foot pressure, and general appearance. Failure of these criteria will be considered as failure of the seam and repair or reconstruction will be required.
- Document location, date, test unit number, name of tester, and outcome of all testing.
- Inform the Installer and CQA Officer of any required repairs.
- Document that appropriate repairs are made and that the repairs are retested nondestructively with passing results.

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Air Pressure Testing

The following test procedures are applicable only to dual hot wedge seams. The equipment for performing the test should meet the following minimum requirements:

- An air compressor or hand pump equipped with a pressure gauge and regulator capable of producing and sustaining a pressure between 25 to 30 pounds per square inch gauge (psig) and mounted on a cushion to protect the geomembrane surface.

- Fittings, rubber hose, valves, etc., to operate the equipment, and a sharp hollow needle or other approved pressure feed device.

Air pressure testing will be performed according to the following procedure (ASTM D5820 and GRI GM 6):

1. Seal both ends of the seam to be tested.

2. Insert needle or other approved pressure feed device into the air space at one end of the dual hot wedge seam.

3. Energize the air compressor or hand pump to the pressure indicated in **Table 15-3**, based on the material type and thickness. Maintain the indicated pressure during a two-minute stabilization period. At the end of the stabilization period, record the time and the pressure in the seam.

4. Remove the flexible hose that connects the pressure gauge to the air pump. Observe the pressure gauge for the evaluation period indicated in **Table 15-3**. Record the time and pressure in the seam at the end of the test period.

5. If the pressure difference between the two recorded readings exceeds the maximum allowable pressure drop indicated in **Table 15-3**, or if the pressure does not stabilize within the evaluation period, one more pressure-monitoring interval is allowed.

6. If the pressure loss over both evaluation intervals exceeds the allowable pressure drop, or if the pressure does not stabilize, then the seam fails the test.

7. If the pressure loss over either evaluation interval does not exceed the allowable pressure drop, then the seam may be deemed by the Installer to have passed the test.

8. The Installer must verify that the air channel tested was not obstructed by noting a release of air pressure at the end of the tested seam interval opposite the pressure gauge. If this does not happen, the air channel is blocked and the Installer must take the appropriate steps to ensure that the entire seam passes a non-destructive test.

For any seam interval that fails the air pressure nondestructive test, additional nondestructive testing or visual inspection will be used to identify, if possible, the faulty area of the seam. The faulty area will be repaired and retested. If the faulty area cannot be identified, then the entire seam will be repaired and retested.

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Vacuum Box Test

Vacuum box testing (ASTM D5641) is to be used on those seams made by the extrusion fillet process, to locate precisely the defects identified from air pressure testing, or to evaluate suspect seam and non-seam areas as discussed in **Subsection 15.3.4**.

Vacuum box testing equipment must meet the following minimum standards:

- A five-sided vacuum box with an open bottom, a clear viewing panel on top and a pliable gasket attached to the bottom.
- A vacuum pump and gauge capable of achieving a minimum vacuum of 2 pounds psig [4 inches of mercury (Hg)] and a maximum vacuum of 5 psig.

The following procedure will be used in performing the vacuum box test:

1. Clean the seams to be tested so that they are relatively free from soil or foreign objects that might prohibit a good seal from being formed between the vacuum chamber and the geomembrane.
2. Energize the vacuum pump to a minimum of 4 inches Hg of vacuum (or approximately 2 psig).
3. Wet a strip of geomembrane approximately twice the size of the vacuum box with the soapy solution.
4. Place and center the vacuum box with the gasket in contact with the geomembrane surface over the wetted area of the seam.
5. Applying a normal force to the top of the vacuum box, close the bleed valve and open the vacuum valve. Check to make certain that a tight seal is created between the geomembrane and the vacuum box.
6. With the vacuum drawn, use the viewing panel to examine the geomembrane seam for bubbles resulting from the flow of air through the seam.
7. Remove the vacuum box by first closing the vacuum valve and then opening the bleed valve. Proceed to Step 8 if bubbles appear in Step 6. If no bubbles appear in Step 6, then proceed directly to Step 9.
8. If bubbles appear through the geomembrane, mark the defective area for repair according to the provisions of **Subsection 15.3.4**. All repairs will be tested until nondestructive results are passing.
9. Move the vacuum box along the seam to be tested, overlapping the previously tested area by no less than 3 inches.

15.4.5 Destructive Seam Testing

Destructive seam testing will be performed on the geomembrane seams covered by this plan. Destructive seam testing is performed to determine the strength of the seam in both shear and peel failure modes. Destructive seam testing will be performed within 24 hours of sampling either in an

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on-site laboratory by personnel under the direction of the CQA Officer or within 24 hours after it is received at the geosynthetics testing laboratory.

Location and Sampling Frequency

The RPR will select locations where seam samples will be cut out for the destructive testing. Test locations will be determined during seaming at the RPR's discretion. Suspicion of excess crystallinity, contamination, offset welds, or any other potential causes of an imperfect seam may prompt selection of such locations. The Installer will not be informed in advance of any location where seam samples will be taken.

The minimum frequency of sample collection will be one test location per every 500 linear feet of seam length per welding apparatus, or every 1,000 linear feet if leak location testing is completed. This minimum frequency will be taken as an average for the entire installation area.

Sampling Procedure

Samples will be cut under the direction of the RPR as the seaming progresses. For each sample location, the following information will be documented:

- Assigned sample number.
- Sample location on layout drawing.
- The reason for collecting the sample (e.g., as part of statistical testing program, suspicious seam, etc.). Record this by the sample number.
- For the peel test, which geomembrane is the top and which is the bottom with respect to seams performed using dual hot wedge (fusion) weld techniques.

Specimens for qualitative field testing will be taken and tested prior to shipping of the laboratory sample. Samples for field tensiometer testing shall be 1 inch wide by 12 inches long with the seam centered parallel to the width. The distance between the two samples will be 42 inches measured from inside edge to inside edge. If both samples pass the field tensiometer test described below under **Field Test Methods**, then the sample for laboratory testing will be taken according to the procedure described below.

The sample for laboratory testing will be located between the two samples used for field-testing. Therefore, the laboratory sample will be 12 inches wide by 42 inches long with the seam centered lengthwise. The sample will be cut by the Installer into three parts and distributed as follows:

- A sample, 12 inches by 12 inches, will be kept by the Installer for testing, if so desired.
- A sample, 12 inches by 12 inches, will be given to the Company for record storage.
- A sample, 12 inches by 18 inches, will be transmitted to the Geosynthetics Testing Laboratory by the RPR.

The Installer, in accordance with the repair procedures described in **Subsection 15.3.4**, will immediately repair all holes cut into the geomembrane resulting from destructive seam sampling. The repaired area will be nondestructively tested in accordance with the requirements of **Subsection 15.4.4**.

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End-of-Seam Sampling

In addition to the 42-inch sample cut for laboratory testing, an additional sample will be cut from each end of each continuous production field seam 100 lineal feet in length or longer for field-testing as described below. These samples, often referred to as bones, need to be only 1 inch wide and can be cut from the portion of the seam that extends into/past the anchor trench so as not to require an additional repair.

Field Test Methods

The three 1-inch-wide samples described above under Sampling Procedure, as well as the end-of-seam samples described above under End-of-Seam Sampling, will be field-tested for peel and two samples tested for shear. Testing will be performed using a field tensiometer or equivalent device to qualitatively determine the mode of failure. The tensile testing machine will be equipped with electrically controlled and smoothly moving jaw separation apparatus, will be capable of adjustments and defined settings for jaw separation rate, and will display jaw separation rates and tensile loadings exerted on the geomembrane samples. Tensile testing machines will be accompanied by documentation for calibration conducted within three months of the start of geomembrane installation. Geomembrane samples will be prepared for field analyses by use of templates and cutting tools that prepare uniformly sized samples.

The seam will be considered passing if the failure in both peel and shear does not occur within the seam. If the samples fail the field tensiometer test, then the repair procedures of Subsection 15.3.4 for the holes left by the cutout samples, and the seam reconstruction procedures for the repair of the defective seam, discussed later in this subsection, will be implemented.

Laboratory Test Methods

Laboratory testing of the destructive seam samples will be performed by the Geosynthetics Testing Laboratory under the direction of the CQA Officer. All destructive seam tests, whether performed on a trial seam sample (as described above) or on samples cut out from productions seams, will be performed in general accordance with the methodology of ASTM D6392, which stipulates that at least five specimens will be tested in shear and five in peel. Samples will be cut in alternating order (e.g., shear & peel, peel & shear) and will also be tested in the order of cutting, to determine if any trend in seam quality along the length of the sample exists. All specimens will be cut as 1-inch-wide strips to ensure that the seam does not exceed the test gauge length of the specimen.

The following tests will be performed on each seam sample submitted for laboratory testing:

- Shear and peel maximum tension is the maximum load per unit width of a 1-inch-wide specimen expressed in pounds per inch of width in both the shear and peel mode, according to ASTM D6392 and GRI GM19a.

- Shear elongation at break is the extension at break expressed as a percentage of the initial distance between the edge of the fused track and the nearer grip. This distance should be the same on both sides of the seam and is usually 2 inches. No referenced ASTM test exists for this procedure as defined; however, the specimen will be elongated to a maximum of 100 percent with any failures of individual specimens noted. For specimens that fail below 100 percent elongation, the value at which failure occurred will be noted on the results.

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- **Peel seam separation** estimates the area of seam interface separation expressed as a percentage of the original area.

Also, for both the seam shear and peel tension test, an indication will be given for each specimen tested that defines the locus of the failure. The loci will be defined in accordance with GRI GM19.

For shear tests, the following values will be reported for each specimen tested:

- Maximum tension in pounds per inch.
- Elongation at break indicating at what percentage the specimen failed (up to a tested maximum of 100).
- The locus of failure using the above designations.

For peel test, the following values will be reported for each specimen tested:

- Maximum tension in pounds per inch.
- Seam separation expressed as percent of original seam area.
- Locus of failure.

For each set of five specimens, the mean and standard deviation will be calculated and reported for the shear maximum tension and peel maximum tension.

Role of Testing Laboratory

The Geosynthetics Testing Laboratory will be responsible for performing the tests on samples submitted to them as described above. The results of tests performed will be reported to the CQA Officer and the RPR. Retesting of seams, because of failure to meet any or all of the specifications listed below, can only be authorized by the CQA Officer.

The Geomembrane Manufacturer and/or the Installer may perform their own quality control testing in accordance with the methods and procedures defined above under Laboratory Test Methods; however, the results, if substantially different from those obtained by the Geosynthetics Testing Laboratory or on-site laboratory, may only be used to request a retesting by the Geosynthetics Testing Laboratory or on-site testing laboratory. All quality assurance test results from the Geosynthetics Testing Laboratory or on-site laboratory govern over any test results from the Geomembrane Manufacturer or Installer. Only the CQA Officer or Company is authorized to approve a retesting request.

Procedures for Determining Destructive Seam Test Failures

The procedures described in this section apply to the destructive testing procedures defined above under Field Test Methods and Laboratory Test Methods. Procedures for repairing failed seams are given in **Subsection 15.3.4** of this plan.

The results from the shear and peel tests for the HDPE and LLDPE geomembrane will be evaluated against the criteria presented in **Table 15-4**.

All of the tabular criteria for each respective geomembrane type must be met for a given seam to be considered acceptable.

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The installer has the following two options in determining the repair boundary whenever a seam has failed either the field tensiometer testing or laboratory destructive testing:

- The seam can be reconstructed between any two previously tested and passed destructive seam test locations.

- The Installer can trace the welding path to an intermediate location (at a 10-foot minimum from the point of the failed test in each direction) and request that the field tensiometer tests be performed at these intermediate locations. If the field tensiometer sample results are acceptable, then the seam will be reconstructed between these intermediate locations. If either sample fails, then the process will be repeated until acceptable destructive seam tests have been performed in both directions away from the original failed sample location. All retesting of seams according to this procedure will use the sampling methodology described earlier in this plan under Sampling Procedure.

- The tracing of a failed seam test will continue until the seam boundary is located; tracking will continue into previous day's work, if needed.

For seams reconstructed due to a failing destructive seam sample that are in excess of 50 feet long, an additional sample taken from the reconstructed zone must pass destructive seam testing.

The RPR will be responsible for documenting all actions, including test results submitted by the Geosynthetics Testing Laboratory, taken in conjunction with seam testing. The RPR will also be responsible for keeping the CQA Officer informed on seam testing results and seaming process.

15.5 POST-INSTALLATION

Each component covered by this plan will be examined by the RPR. Any defects, whether due to failed seams, pinholes, or other penetrations, will be repaired.

Placement of the sand drainage layer material or final cover geocomposite drainage layer will proceed as soon as practical following the RPR's testing and acceptance of completed geomembrane areas. The drainage material will provide ultraviolet protection, thermal installation, and protection from physical damage.

Low ground pressure tracked equipment (less than 5 psi) will be used to place the sand drainage layer material over the geomembrane, or to place final cover rooting zone material over the geocomposite and geomembrane. A minimum of 1 foot of cover material is required between the geomembrane and the low ground pressure equipment. A minimum of 2 feet of cover soil is required between the geomembrane and all other tracked or flotation wheeled equipment. A minimum of 3 feet of cover soil is required between the geomembrane and all rubber-tired vehicles. To prevent movement of the geomembrane and folding of wrinkles, placement of the drainage material shall be performed during cooler temperatures to the extent possible using methods of placement, which minimize wrinkling. Any noncompliance with the above requirements will be reported by the RPR to the CQA Officer.

15.6 ELECTRICAL RESISTIVITY LEAK DETECTION SURVEY

Upon completion of construction of the leachate collection system for each phase of development, an electrical resistivity leak detection survey will be performed over the entire surface of the lined

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area in accordance with ASTM D7007 or an equivalent method approved by the CQA Officer and Company.

15.6.1 Electrical Resistivity Contractor Requirements

The electrical resistivity testing contractor shall have a minimum of five years of experience in performing electrical leak location surveys including surveying at least one million square feet of geomembrane using this method on at least five different projects, unless otherwise approved by the Company.

15.6.2 Test Procedure

The leak location contractor shall demonstrate in a manner acceptable to the CQA Officer and Company that the leak detection equipment and field procedures are capable of detecting a 0.25-inch-diameter leak using an actual or artificial leak. The leak detection capability must be demonstrated when the leak is midway between four measurement grid points; detecting the leak when the measurement is directly over the leak will not be sufficient. The peak-to-peak signal amplitude must be at least three times the peak-to-peak signal obtained under the same conditions with the excitation signal disconnected. The leak location survey must be conducted such that the leak detection measurements are no further apart than the spacing used to demonstrate the leak detection capability.

The Contractor will prepare the lined area for the leak location survey, including performing the following tasks:

- Insulating the edges of the geomembrane by leaving a width of dry exposed geomembrane around the perimeter of the geomembrane. This can be accomplished by only partially backfilling the anchor trench, leaving a strip uncovered around the perimeter, or extending the geomembrane outside the anchor trench and leaving its edge exposed.

- Isolating any other electrical paths, if present, that connect the drainage layer on the geomembrane to earth ground.

- Removing any standing water on the surface of the drainage layer covering the primary liner. The survey cannot be done if the ground is frozen or if there is ice or snow on top of the gravel.

- If necessary, wetting the area to be surveyed with water (via water truck, hoses, or other method approved by the CQA Officer) in order to maintain good electrical contact with the drainage layer material during the survey.

If any leaks are indicated by the leak location survey, the Contractor shall excavate the drainage layer around the area of the leak, open the geotextile, and electrically isolate the leak from the surrounding drainage material. The leak location contractor will then record measurements in the area around the excavation to determine if additional leaks are in the area. The Geomembrane Installer shall repair the leak, vacuum box test the repair, and repair the geotextile. The Contractor will then backfill the area around the repaired leak. Resistivity testing shall be completed over required areas to confirm additional leaks in the area are not present/marked by original detected defect.

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The CQA Officer will observe the electrical resistivity testing.

15.6.3 Reports

Upon completion of each leak survey, the electrical resistivity contractor shall submit a report to the CQA Officer and the Company documenting the results of the leak location survey. The report shall document the methodology used, the locations and descriptions of the leaks, and a diagram of the facility showing the approximate leak locations.

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Table 15-1. Geomembrane Tests and Test Methods

Property	Test Method	Minimum Manufacturer's Testing Frequency (1)	Minimum Conformance Testing Frequency (2)
Asperity height	ASTM D7466	Every 2nd roll(3)	Not required
Carbon black content	ASTM D4218(4)	1/20,000 lb	Not required
Carbon black dispersion	ASTM D5596	1/45,000 lb	Not required
Melt flow index	ASTM D1238	1/batch	1/100,000 sf(5)
Density	ASTM D1505/D792	1/200,000 lb	1/100,000 sf(5)
Tear resistance	ASTM D1004	1/45,000 lb	Not required
Puncture resistance	ASTM D4833	1/45,000 lb	Not required
Tensile properties(6) Break stress Break elongation Yield stress (HDPE) Yield elongation (HDPE)	ASTM D6693 Type IV specimen	1/20,000 lb	1/100,000 sf(7)
Single point notched constant load (SPNCL)(8,9)	ASTM D5397	1 per every 2 resin lots	(11)
Oxidative induction time (OIT) – percent retained after 90 days(10)	ASTM D8117	1/formulation	Not required
Thickness	ASTM D5994 (textured)	10 times/roll	5 places/roll

Notes:
1. Manufacturer to perform quality control testing at the specified frequencies (minimum) on the geomembrane rolls supplied to the project.
2. CQA Officer to coordinate conformance testing at the specified frequencies (minimum) on the geomembrane rolls supplied to the project.
3. Alternate the measurement side for double-sided textured sheet.
4. Other methods such as D1603 (tube furnace) or D6370 (TGA) are acceptable if an appropriate correlation to D4218 (muffle furnace) can be established.
5. In addition to the minimum frequency noted, a minimum of one test for each batch of resin used to manufacture the rolls delivered on site must be performed, unless documentation is provided which shows the manufacturer performed testing at the same frequencies.
6. MD and cross machine direction (XMD) average values should be on the basis of five test specimens each direction.
   Yield elongation is calculated using a gauge length of 1.3 inches.
   Break elongation is calculated using a gauge length of 2.0 inches.
7. In addition to the minimum frequency noted, a minimum of one test for each batch of resin used to manufacture the rolls delivered on site must be performed.
8. For evaluation of stress crack resistance.
9. Not tested on LLDPE products per GRI GM17.
10. Evaluate samples at 30 and 60 days to compare with 90-day response.
11. A minimum of one test for each batch of HDPE resin used to manufacture rolls delivered on site unless documentation is provided that shows manufacturer performed testing at the same frequency.

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Table 15-2. HDPE / LLDPE Textured Geomembrane Acceptance Criteria

Property	Units	Type of Criterion	60-mil HDPE Acceptable Value[1]	40-mil LLDPE Acceptable Value[1]
Asperity height	Mils	Minimum average	16	16
Carbon black content	%	Range	2.0-3.0	2.0-3.0
Carbon black dispersion	N/A	Range	Note 2	Note 2
Melt flow index	g/10 min	Maximum	1.0	1.0
Density	g/ml	Maximum (LLDPE)/Minimum average (HDPE)	0.940	0.939
Tear resistance	Lb	Minimum average	42	22
Puncture resistance	Lb	Minimum average	90	44
Tensile Properties [3] Break stress Break elongation Yield stress Yield elongation	 lb/in % lb/in %	 Minimum average Minimum average Minimum average Minimum average	 90 100 126 12	 60 250 Not applicable Not applicable
Thickness	Mil	Minimum average	57[4]	38[5]

Notes:
1. Values for HDPE are primarily from Table 2(a) of GRI GM13 standards. Values for LLDPE are primarily from Table 2(a) of GRI GM17 standards.
2. Carbon black dispersion (only near spherical agglomerates) for ten different views: nine views in Category 1 or 2, and no more than one view in Category 3.
3. MD and XMD average values to be on basis of five test specimens each direction. Break elongation is calculated using gauge length of 2.0 inches. Yield elongation is calculated using a gauge length of 1.3 inches.
4. Lowest allowable individual for eight out of ten values is 54 mil. Lowest allowable individual of ten values is 51 mil.
5. Lowest allowable individual for eight out of ten values is 36 mil. Lowest allowable individual of ten values is 34 mil.
6. Refer to **Section 3.2** for direct shear test requirements.

Table 15-3. Geomembrane Air Pressure Testing Standards and Acceptance Values [1]

Geomembrane Type and Thickness[2]	Air Inflation Schedule		Evaluation Time (Minutes)[3]	Maximum Allowable Pressure Drop (psi)
	Minimum Pressure (psi)	Maximum Pressure (psi)		
40-mil LLDPE	20	30	2	4.0
60-mil HDPE	27	30	5	3.0

Notes:
1. All values are based on GRI Test Method GM6, revised 1994.
2. All values apply to both smooth and textured geomembrane for the type and thickness indicated.
3. Evaluation time starts after the initial 2-minute stabilization period.

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Table 15-4. Geomembrane Seam Tests, Test Methods, and Acceptance Criteria

Property	Test Method	Units	Type of Criterion	60-mil HDPE Acceptance Values[1]	40-mil LLDPE Acceptance Values[1]
Shear strength[2]	ASTM D6392	ppi	Minimum	120	60
Shear elongation[3]	GRI GM19a	%	Minimum	50	50
Peel strength[2] Fusion	ASTM D6392	ppi	Minimum	91	50
Peel strength[2] Extrusion	ASTM D6392	ppi	Minimum	78	44
Peel separation	GRI GM19a	%	Maximum	25	25

Notes:
1. Values are based on GRI standard specification GM19a. For double fusion welded seams, both tracks shall be tested for compliance with values listed. The following are unacceptable locus-of-break codes:
   Fusion: AD and AD-BRK greater than 25 percent.
   Extrusion: AD1, AD2, and AD-WLD.

   Separation in plane (SIP) is acceptable if strength, shear elongation, and peel separation criteria are met.
2. Five out of five test specimens must pass the locus-of-break, shear elongation, and peel separation.
3. Five out of the five test specimens must meet these requirements.
4. Omit elongation measurements for field testing.

16.0 PIPING

16.1 GENERAL

This section includes quality assurance requirements for piping used throughout the facility. Piping will be used in the Dry Ash Disposal Facility in the construction of the following items:

- Leachate head well
- Leachate collection piping
- Leachate collection sump side slope riser
- Leachate force mains

This section is divided into three major subheadings, which cover the quality assurance requirements for pre-installation (includes piping manufacturers and fabricators), installation, and post-installation (includes the final observation and documentation of piping installations prior to installation of other materials over and around the pipe). The terms pre-installation, installation, and post-installation are applicable only to the piping installation and do not apply to the overall construction of the landfill facility.

Individual pipe sizes and SDRs to be used for each individual pipe installation are not detailed in this section; the construction plans and specifications will be used for the determination of correct size and wall thickness.

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16.2 PRE-INSTALLATION

16.2.1 Manufacturing

16.2.1.1 High Density Polyethylene

HDPE pipe must be made from extra high molecular weight (EHMW) polyethylene (PE) resin, and must also have a cell classification of 445574C (PE 4710) as defined by ASTM D3350.

16.2.1.2 Polyvinyl Chloride

All polyvinyl chloride (PVC) pipe fittings must be PVC molded fittings. Extruded fittings may not be used unless specifically approved in writing by the CQA Officer.

16.2.1.3 Pipe Fabrication

The Piping Fabricator will be responsible for perforating the pipe delivered by the Piping Manufacturer according to the plans and specifications.

16.2.1.4 Delivery, Handling, and Storage

Pipe will be protected during shipment from excessive heat or cold, puncture, or other damaging or deleterious conditions. The pipe will be stored on site in a manner suitable to protect it from long-term ultraviolet exposure prior to actual installation.

The RPR will be responsible throughout the pre-construction, construction, and post-construction periods for observing and documenting that the Contractor provides adequate handling equipment for moving pipe and that the equipment and handling methods used do not pose any risk of damage.

The RPR will maintain a log of pipe deliveries throughout the installation. The pipe size and type at a minimum will be recorded on the log for each shipment received at the job site.

16.3 INSTALLATION

16.3.1 Connections

16.3.1.1 HDPE Pipe

Unless approved otherwise by the CQA Officer, HDPE pipe connections will be made by the butt fusion procedure. The following procedure will be used regarding butt fusion seams:

- Seams will be made at the Manufacturer's recommended temperature for fusing pipe and fittings.
- For pipe diameter sizes 4 inches (nominal) and larger, seams will be made using the hydraulic fusion machines. For pipe diameters of less than 4 inches, manual fusion equipment can be used.

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- Care will be taken to make certain that adequate pressures are used for fusing pipes and that sufficient cooling periods are allowed prior to testing, bending, or backfilling of pipe sections.

Joints for corrugated pipe must be made with snap couplings.

16.3.1.2 PVC Pipe

Unless approved otherwise by the CQA Officer, all PVC pipe connections will be made according to the Standard Practice for Making Solvent-Cemented Joints with PVC pipe and fittings, ASTM D2855. Particular care will be taken regarding required set and cure times for solvent-cemented joints, which vary for ambient temperature conditions. Joints will not be subjected to stresses by moving or backfilling prior to the specified set times, ASTM D2855. Only original quality solvent cement may be used since expired shelf life and deteriorated cements may cause inadequate connections. The solvent cement shall comply with the requirements of ASTM D2564 and shall be applied in strict accordance with manufacturer's specifications.

16.3.1.3 Placement

Pipe placement will be done in accordance with the following procedure and requirements:

- Piping will be bedded and backfilled according to the plans and specifications.
- Piping placement will not be performed in the presence of excessive moisture. The RPR will document that this condition is fulfilled. Additionally, the RPR will document that the supporting backfill has not been damaged by weather conditions. The RPR will inform the CQA Officer if any of the above conditions are not fulfilled for evaluation of the necessity of corrective action.
- The prepared surface underlying the piping will not show evidence of deterioration since previous acceptance and must be acceptable prior to piping placement.
- The method used to place the piping will not cause damage to the piping and will not disturb the supporting backfill.
- The pipe bedding material will be shovel-sliced, or compacted to the spring line of the pipe to ensure proper bedding.
- Observations and measurements will be made to ensure that the pipes are of the specified size and dimension ratio, manufactured of the specified material, and that pipe perforations are sized and spaced as specified.
- The RPR will observe and document all pipe installation. Deviations from the plans and specifications will be brought to the attention of the CQA Officer for evaluation and the necessity of corrective action.
- Each piping system will be flushed with water. Jet flushing will be used wherever possible. Hydraulic flushing will be performed for other accessible points. The RPR will observe and document that each flushing operation is carried out and will document that the pipes are free flowing. Any system that does not flush properly will be immediately reported to the CQA Officer, and corrective action will be taken to remedy the problem.

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- All piping will be located as noted in the plans and specifications. Locations, grades, and size requirements are specified on the details of the plan set. Observations and surveying measurements will be made to ensure that the pipes are placed at the specified locations and grades. Deviations from the plans and specifications will be brought to the attention of the CQA Officer for evaluation of the necessity of corrective action.

- Non-perforated pipe will be pressure tested. Pipes shall be pressure tested at 5 psi for 60 minutes. A system pressure of 4.5 or greater after 60 minutes will be considered passing. The RPR will observe and document that this operation is carried out and that the pipes are airtight.

- A video camera inspection will be conducted on all leachate collection pipes after the pipe cleaning. The video camera inspection shall extend a minimum of 300 feet into the base grade of each collection line. The RPR will observe and document the video inspection. Any obstructions, damage, or other concerns will be immediately reported to the CQA Officer for evaluation and the necessity for corrective action.

16.3.2 Damage

The RPR will examine each pipe after placement for damage. The RPR will advise the CQA Officer as to which pipes will be rejected, repaired, or accepted. Damaged pipes or portions of pipes that have been rejected will be marked and removed from the installation area and documented by the RPR.

16.4 POST-INSTALLATION

Pipe invert elevation will be documented every 25 linear feet by survey or every 50 feet if a total station or laser equipment is used, as well as at key points, including changes in grade, intersections, and end points. The minimum allowable tolerance for grade is 0.10 foot at each location. The minimum average slope shall be in accordance with the design drawings.

17.0 RAIN COVER

17.1 GENERAL

This section of the CQA Plan applies to the rain cover used to divert clean storm water away from the leachate collection system in the Dry Ash Disposal Facility during CCR placement prior to completion of the final cover.

17.2 PRE-INSTALLATION

17.2.1 Manufacturing

The rain cover will be supplied to the site in fabricated panels. Prior to delivery of any rain cover panels, the Rain Cover Manufacturer will provide certification, based on tests performed in accordance with the methods listed in **Table 17-1**, that the rain cover supplied under this plan will meet the material specifications listed in **Table 17-1**.

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17.2.1.1 Delivery, Handling, and Storage

Rain cover panels will be packaged in UV protected wrap marked with the manufacturer's name and the product identification. Panels will be off-loaded using a forklift or similar equipment and stored on pallets. Care will be taken while unloading or transferring panels to prevent damage to the wrapping or the rain cover panel itself. The Installer/Contractor is responsible for ensuring that each rain cover panel meets the specifications, and is responsible for the means and methods to implement the work. The RPR will maintain a log of rain cover panel deliveries including any observed damage to panels during delivery and unloading.

17.3 INSTALLATION

17.3.1 Placement

The Installer will install all rain cover in such a manner as to ensure that it is not damaged and in a manner that complies with the following requirements:

- Prior to placement, inspect subgrade to confirm it is suitable for rain cover placement.
- Position and deploy rain cover panels in accordance with Manufacturer instructions.
- Avoid deploying rain cover during windy conditions.
- Observe panels for defects or damage. Repair or replace damaged or defective panels as approved by the CQA Officer.
- Only deploy rain cover panels that will be seamed during the day of placement.
- Install ballast while panels are deployed and seamed. Place panels loosely to accommodate expansion and contraction due to changing weather and temperature.
- Secure perimeter of rain cover with ballast or in anchor trenches.
- RPR will observe and document that the above items are performed by the Installer/Contractor.

17.3.2 Seams and Overlaps

The following requirements will be met with regard to seaming and overlapping of rain cover panels:

- Panel seams will be continuously sewn. The sewing method and stitch type will be per Manufacturer's recommendation, but must be approved by the CQA Officer.
- Sewing will be performed with thread meeting the Manufacturer's recommendations.
- Repair defective seams by cutting out the defective seam and re-seaming. Missing stitches in seam areas can be made by sewing a section 24 inches before and after the defect. Single seams that require repair over more than 20 percent of the total seam length will be completely removed and re-sewn.

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The RPR will be responsible for observing and documenting that the Installer/Contractor performs the above provisions in an acceptable manner.

17.4 POST-INSTALLATION

17.4.1 Final Examination

The RPR will perform a final rain cover examination after the installation has been completed. The objectives of the final examination are as follows:

- To examine for the presence of holes, tears, or other deterioration.
- To examine for completion of seaming.
- To examine rain cover for excessive tension due to stretching of the material during installation.
- To examine for the presence of foreign objects (e.g., stones, debris) beneath the rain cover.
- To examine that installation of ballast and/or use of anchor trenches appears to meet the Manufacturer's recommendations.

Table 17-1. Rain Cover Acceptance Criteria

Property	Units	Test Method	Value[1]
Grab tensile properties [3] Tensile strength Break elongation	 lb %	 ASTM D7004 ASTM D7004	 76 14
Puncture Strength (CBR)	lb	ASTM D6241	220
Thickness [2]	mils	ASTM D751	10
Weight	lb/1000 ft^2	ASTM D751	53
Tongue Tear	lb	ASTM D5884	40
Bursting Strength [4]	$lb/in.^2$	ASTM D3786	85
Water Vapor Transmission (WVT) [6]	g/m^2-day	ASTM E96	0.7
Oxidative Induction Time (OIT) (a) Standard OIT (b) High Pressure OIT	 min. min.	 ASTM D3895 ASTM D5885	 (5) 1000
UV Resistance (a) Strength and Elongation retained after 10,000 light hours (b) Response to bending	fluorescent light method	ASTM D7238 ASTM D7003 GRI GM16	 50% no cracking

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Notes:
1. All numerical values are based on GRI standard specification GM22 and represent minimum or minimum average values, except WVT, which is a maximum value. Average test results from all rolls in a lot must conform to the tabulated values.
2. The thickness value is measured in the valleys created by the scrim reinforcement, i.e., ply to ply thickness between scrim should be measured.
3. If the reinforcement is aligned in any direction other than the machine and transverse directions, specimen shall be cut such that reinforcing yarns are oriented parallel to the central axis of the tension testing machine.
4. Test should be conducted on an ASTM D3786 Mullen Burst type device with a diaphragm under the product. In addition, the center of the circular test specimen should be equidistant between sets of parallel yarns.
5. Not recommended since the high temperatures of the STD-OIT test produces an unrealistic result for some of the antioxidants used in these materials.
6. Performed at 23° ±0.5°C temperature and 50 percent ±5 percent relative humidity.

18.0 GEOCOMPOSITE

18.1 GENERAL

This section covers the quality assurance requirements for pre-installation, installation, and post installation of geocomposites. The terms pre-installation, installation, and post-installation are applicable only to the geocomposite and do not apply to the overall construction of the final cover systems. Geocomposite will be installed for the drainage layer (geocomposite) within the final cover in areas where geocomposite drainage layer will be installed in place of sand drainage layer.

18.2 PRE-INSTALLATION

18.2.1 Manufacturing

The geotextile portion of the geocomposite will be composed of a nonwoven, needle punched, polyester or polypropylene geotextile. The geocomposite manufacturer will ensure that the geotextile portion of the geocomposite meets the material specifications listed in Table 18-1.

The geonet portion of the geocomposite must be fabricated for HDPE resin, and fabricated geonet must be classified as Type III, Class C, and Category 4 or 5, as defined by ASTM D1248. The geonet will be manufactured by extruding two sets of strands to form a three-dimensional structure to provide planar flow. The geocomposite manufacturer will ensure that the geonet portion of the geocomposite meets the material specifications listed in Table 18-1. The geocomposite manufacturer will ensure that the geocomposite meets the transmissivity specification listed in Table 18-1.

The geocomposite rolls will be tested by the manufacturer and evaluated by the CQA Officer prior to acceptance. The CQA Officer may perform/require additional testing (i.e., conformance testing) as required by detailed specifications or as required in the judgment of the CQA Officer to verify that the geocomposite meets the specifications.

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18.2.2 Delivery, Handling, and Storage of Geocomposite Rolls

Each geocomposite roll, for use at the landfill facility, will be marked by the geocomposite manufacturer with the following information (on a durable gummed label, or equivalent, on the side core and on the outside protective wrapping for the roll):

- Name of manufacturer
- Style and type number
- Roll length and width
- Batch (or lot) number, if applicable
- Date manufactured
- Direction of unrolling
- Roll number

The geocomposite manufacturer will use the following guidelines in packing, wrapping, and preparing all geocomposite rolls for shipment:

- When cores are required, those that have a crushing strength sufficient to avoid collapse or other damage while in use will be used.

- Each roll will be covered with a wrapping material that will protect the geotextile from damage due to shipment, water, sunlight, or contaminants.

At a minimum, the following practices will be followed in receiving and storing geocomposite rolls in the covered storage area at the job site:

- While unloading or transferring the geocomposite rolls from one location to another, care will be taken to prevent damage to the geocomposite.

- If practicable, forklift trucks fitted with poles that can be inserted into the cores of the rolls will be used.

- The poles will be at least two-thirds the length of the rolls to avoid breaking the cores and possibly damaging the geocomposite.

- Rolls will not be dragged.

- The geocomposite rolls will be stored in a manner so as to ensure that they are adequately covered to protect the geocomposite from the following:
  Precipitation
  Ultraviolet radiation
  Strong oxidizing chemicals, acids, or bases
  Flames, including welding sparks
  Temperature in excess of 160°F

The RPR will be responsible throughout the pre-installation, installation, and the post-installation periods for observing and documenting that the installer provides adequate handling equipment used for moving geocomposite rolls and that the equipment used does not damage the geocomposite rolls.

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The RPR will maintain a log of geocomposite roll deliveries. The following information, at a minimum, will be recorded on the log for each shipment received at the job site:

- Date of delivery at the job site.
- For each geocomposite roll, the following information: roll number and batch (or lot) number, if applicable.

18.3 TESTING REQUIREMENTS

Refer to Table 18-1 for transmissivity conformance testing requirements for the geocomposite drainage layer to be in the final cover. Refer to Table 18-1 for hydraulic conductivity ratio or gradient ratio testing requirements for the upper geotextile of the geocomposite drainage layer. Refer to Section 3 for direct shear testing requirements.

18.4 INSTALLATION

18.4.1 Placement

The installer will install all geocomposite in such a manner so as to ensure that it is not damaged in any way, and in a manner that complies with the following:

- The geocomposite will be securely anchored, as shown on the Drawings and specifications, and then rolled down slope in such a manner so as to continually keep the geocomposite in tension. The geocomposite will be positioned by hand after being unrolled to minimize wrinkles, if needed. Horizontal placement of the geocomposite on sideslopes will not be allowed.
- In the presence of wind, all geocomposite will be secured by suitable means. The temporary weighted material will be left in place until replaced with cover material as shown on the design drawings and specifications.
- Cutting will be done according to manufacturer's recommendations.
- The installer will take necessary precautions to prevent damage to any underlying layers during placement of the geocomposite.
- During placement of geocomposite, care will be taken not to entrap any stones, excessive dust, or moisture that could cause clogging of the drainage system, and/or stones that could damage the adjacent geomembrane.
- The geocomposite will not be welded or tack-welded to the geomembrane.

The RPR will observe and document that the installer performs each of the above steps. Any noncompliance with the above requirements will be recorded and reported by the RPR.

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18.4.2 Overlaps and Joining

The following requirements will be used with regard to the overlapping and joining of geocomposite rolls:

General

- The installer will pay particular attention to the overlapped areas to ensure that no earthen or foreign materials could be inadvertently trapped beneath the geocomposite.

Geotextile Portion of Geocomposite

- The geotextile portion of the geocomposite will be overlapped 4 to 6 inches.
- Geotextile seams will be continuously sewn unless heat bonding is approved by the CQA Officer and Owner. The sewing method and stitch type will be per manufacturer's recommendation, but must be approved by the CQA Officer. Overlapping of geotextile without sewing may be acceptable for certain applications with approval from the CQA Officer and Owner.
- Sewing will be performed with thread made from the same base material as the geotextile, or suitable equivalent.

Geonet Portion of Geocomposite

- The geonet portion will be overlapped a minimum of 4 inches.
- Ties will secure geonet overlaps.
- Tying will be performed with pull ties. Ties will be white or brightly colored for easy identification. Metallic devices will not be used under any circumstances.
- Ties will be placed at 5-foot intervals along the length of the panels and at 12-inch intervals at end-to-end connections of panels.

The RPR will observe and document that the installer performs each of the above steps. Any noncompliance with the above requirements will be reported by the RPR to the CQA Officer.

18.4.3 Repairs

Any tears or other defects in the geocomposite will be repaired by placing a patch with minimum overlaps described in Section 18.4.2. The patch will be secured to the original geocomposite by tying every 6 inches. If the tear or other defect width is more than 50 percent of the roll width, the damaged area will be cut out and replaced with new geocomposite. Tying will be as indicated in Section 18.4.2. These procedures apply to seams and/or patches required for piping penetrations in the final cover.

The RPR will examine and document that the repair of any geocomposite is performed according to the above procedure.

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18.5 POST-INSTALLATION

Final Acceptance

The RPR will perform a final geocomposite examination after installation has been completed. The objectives of this step are as follows:

- To examine the geocomposite for the presence of tears or defects.
- To examine overlaps to make certain that they are in conformance with the requirements of Subsection 18.4.2.

If any portion of the geocomposite requires repairs due the above examination, they will then be performed according to the procedures in Subsection 18.4.3.

If there will be an extended delay between completion of the geocomposite and the start of the installation of any overlaying cover, the installer will make provisions, by placing temporary securing means, to protect the geocomposite from wind uplift.

18.5.1 Placement of Soil Materials

The contractor will place all soil materials located on top of the geocomposite in such a manner so as to minimize the following:

- Damage to the geocomposite.
- Slippage of the geocomposite on underlying layers.
- Excessive tensile stresses imposed on the geocomposite.

Low ground pressure tracked equipment (less than 5 psi) will be used to place the protective cover over the geocomposite. A minimum of 1 foot of cover material is required between the geocomposite and the low ground pressure equipment. A minimum of 2 feet of cover is required between the geocomposite and all other tracked or flotation wheeled equipment. A minimum of 30 inches of cover soil is required between the geocomposite and all rubber-tired vehicles.

Any noncompliance with the above requirements will be recorded and reported by the RPR to the CQA Officer.

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Table 18-1. Geocomposite Tests, Test Methods, and Acceptance Criteria

Property	Units	Acceptance Value	Test	Criterion
Geocomposite (1)				
Ply Adhesion	lb/in	0.5	ASTM D7005	Min. Average
Transmissivity(4)	m^2/sec	$1.19x10^{-3}$	ASTM D4716	Min. Average
Geonet Core(2)				
Thickness	mils	200	ASTM D5199	Min. Average
Density	g/cu cm	0.94	ASTM D1505	Min. Average
Carbon Black Content	Percent	2	ASTM D1603/4218	Min. Average
Geotextile(2)				
Mass per Unit Area	oz/yd^2	6	ASTM D5261	Min. Average
Grab Tensile	lb	160	ASTM D4632	Min. Average
Puncture Strength (Pin) (5)	lb	90	ASTM D4833	Min. Average
Puncture Strength (CBR) (5)	lb	435	ASTM D6241	Min. Average
AOS, US sieve	US Sieve No.	70	ASTM D4751	Max. Average
Permittivity	sec^{-2}	1.5	ASTM D4491	Min. Average
Flow Rate	gpm/ft^2	110	ASTM D4491	Min. Average
Gradient Ratio or Hydraulic Conductivity Ratio (6)	Ratio	(6)	ASTM D5101 or ASTM D5567	Approximate Range

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Notes:

1. The geocomposite shall be manufactured by heat bonding the geotextile to the geonet on both sides. No burn through geotextiles nor glue or adhesive shall be permitted.
2. Component properties prior to the lamination.
3. Refer to **Section 3** for direct shear test requirements.
4. Conformance testing with a 100-hour test is required for the geocomposite drainage layer of the final cover to confirm the transmissivity of geocomposite sandwiched between textured LLDPE geomembrane and lightly tamped rooting zone material at a vertical pressure of 300 psf. A minimum transmissivity of 1.19×10^{-3} m^2/sec is required at a hydraulic gradient of 0.25. If the topsoil or rooting zone properties change, or if there is new, site-specific information, the required transmissivity may be re-evaluated and submitted with the final cover pre-construction report.
5. Geotextile to meet puncture strength (pin) or puncture strength (CBR) specification.
6. Gradient ratio or hydraulic conductivity ratio testing of the upper geotextile with rooting zone soil. Acceptable ratios are approximately 0.4 to 0.8 for hydraulic conductivity ratio or less than 3.0 for gradient ratio.

19.0 SOIL BARRIER LAYER

19.1 GENERAL

This section includes the quality assurance requirements for placing, backfilling, and compacting the barrier layer soil in the final cover system. The 24-inch-thick soil barrier layer will consist of on-site or imported soil.

19.2 SUBGRADE PREPARATION

The Contractor will be responsible for the preparation of the subgrade of the barrier layer. Subgrade preparation may include top-of-waste regrading, grading layer placement, or top of grading layer regrading, at the discretion of the Owner.

The subgrade will consist of a minimum 3-inch-thick soil grading layer placed on top of the waste. The soil grading layer will consist of general fill material obtained from on site or off site (see **Section 9**). If topsoil material was used as part of the grading layer placed during normal landfill operations, the Contractor will remove and salvage the temporary topsoil layer. The CQA Officer or RPR will inspect the subgrade, upon completion of the grading layer work and will verify, at a minimum, the following:

- Survey of verified lines and grades as described in **Subsection 9.3**.
- The grading layer soil meets the depth criteria in the project specifications and CQA plan.

The RPR will indicate to the Contractor any observed locations that are not adequate for the placement of the barrier layer during final cover construction. The Contractor will repair defects in the subgrade soil such that the properties of the repaired areas meet the minimum subgrade requirements.

19.3 PROCEDURES AND OBSERVATIONS

The RPR will observe and document barrier layer construction activities to support certification of the following requirements:

- The RPR will confirm the uniformity of the barrier layer soil and will monitor for segregation and removal of unsuitable material and for changes in soil type, color,

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texture, and moisture content. The Contractor will segregate and/or remove unsuitable materials, such as soil not meeting acceptance criteria, boulders, cobbles, and organic material.

- The RPR will observe the barrier layer placement and will measure field densities and moisture contents (see **Subsection 19.4**) to document that the barrier layer is in substantial conformance with the specifications and that soil placement has been conducted in a manner to achieve a uniform, homogeneous mass.

- The RPR will backfill with granular bentonite, or a bentonite-soil mixture, voids created by nuclear density gauge probes.

- The RPR will document areas of unacceptable density or moisture content, as defined by **Subsection 19.4**. The Contractor will perform corrective action that will consist of the moisture-conditioning of the soil and/or additional compactive effort, as necessary. The RPR will retest the area, following corrective actions.

- The Contractor will place each lift of barrier layer material in approximate 1-foot lifts.

- The RPR will verify that compaction equipment has a minimum static weight of 30,000 pounds or has a minimum static weight 15,000 pounds that is capable of vibrating to produce a minimum dynamic compaction force of 30,000 pounds.

- The RPR will verify that compaction equipment used to compact the barrier layer has compaction feet a minimum of 6 inches long.

- The Contractor will not use frozen soil in the barrier layer and will remove frozen soil from the compaction work area.

- The Contractor will remove stones and other penetrating objects 1 inch or larger protruding from the surface of the final lift of the barrier layer to avoid puncturing the overlying geosynthetics. The RPR will document the removal of the stones and other objects. The Contractor will fill with barrier layer soil or bentonite any voids made by the removal of stones, and the entire cover surface will be rolled with a smooth-drum compactor.

- Preconstruction planning will be undertaken to sequence construction activities to minimize the length of time a completed barrier layer surface will be exposed prior to receiving protective cover. Protective cover will be provided by the installation of the GCL and subsequently the geomembrane.

19.4 SAMPLING REQUIREMENTS AND ACCEPTANCE CRITERIA

This section describes the required analyses, methods, sample frequencies, and acceptance limits of the barrier layer. The RPR will collect soil samples for laboratory analysis. The RPR will record the field sample locations in the daily construction reports or field data sheets as record construction data, including locations and lift locations of the laboratory sample points.

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19.4.1 Field Testing

The RPR will use the following field-testing methods during construction of the barrier layer:

Parameter	Test Method
Moisture content and Field density	ASTM D6938

Moisture content and field density tests will be performed in accordance with NR 516.07(2m)(b)(1) using a nuclear density gauge on a 100-foot grid pattern for each 1-foot thickness of barrier layer soil placed. The testing grid pattern will be offset on each subsequent layer of tests. In confined areas where compaction equipment is hindered or hand compaction is necessary, a minimum of two field density and moisture content tests will be performed for each 1-foot thickness of barrier layer soil placed.

19.4.2 Field Testing Acceptance Criteria

Acceptance criteria for field density will require soil compaction to a minimum of 90 percent of the Modified Proctor (ASTM D1557) maximum dry density or to a minimum of 95 percent of the Standard Proctor (ASTM D698) maximum dry density and at a moisture content wet of optimum moisture content.

19.4.3 Laboratory Testing

Routine laboratory testing of the barrier layer soil will be performed on samples from the borrow area or on-site stockpile (representative). Soil characteristics will be determined from the representative samples.

Representative Sample Analysis

Representative (grab) samples will be obtained on the basis of three criteria. First, an initial sample will be obtained from the borrow source (if not used in construction of a prior phase) and analyzed prior to construction. This will confirm soil characteristics and provide an initial maximum dry density and optimum moisture content for field moisture/density testing. Second, routine samples will be obtained for every 5,000 cubic yards placed. Third, in the event that changes in physical appearance or soil characteristics are observed, a sample will be obtained and analyzed. The maximum dry density and optimum moisture content values used for compaction testing may be adjusted during the course of cover construction based on the results of the above sampling.

The following laboratory analyses will be performed on the representative samples obtained:

Parameter	Test Method
Moisture-density relationship using Modified or Standard Proctor compaction	ASTM D1557 [1, 2]/ ASTM D698 [1, 2]
Atterberg limits [c]	ASTM D4318
Grain-size analysis	ASTM D6913 and D7928 [3]

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Notes:
1. Five-point Proctor analysis required, except as described in Note 2, below.
2. One-point Proctor analysis may be utilized for representative samples collected for apparent changes in soil quality to verify applicability of previously analyzed moisture-density relationships. If the result does not verify applicability, then a five-point analysis will be performed in accordance with the first sampling criteria.
3. Distribution is to be reported through the 0.002 mm particle size.

19.4.4 Laboratory Testing Acceptance Criteria

The following acceptance criteria will apply to the barrier layer.

- The upper 1 foot of the barrier layer will have a maximum particle diameter of 2 inches and the lower 1 foot of the barrier layer will have a maximum particle diameter of 4 inches.

- Fine grained-soil or well-graded sandy soil with fines meeting the USCS soil types ML, CL, CH, SM, or SC, or dual-symbol classifications composed of those soil types, with at least 25 percent by weight passing the #200 sieve.

19.5 THICKNESS DOCUMENTATION

The bottom of the final cover barrier layer (top of grading layer) will be surveyed on a maximum 100-foot grid pattern (maximum 50-foot grid pattern if the final cover construction is less than 4 acres) and at key locations on the final cover. Key locations include breaks in grade, top of slopes, and limits of final cover construction. The barrier layer thickness will be determined at the top of grading layer surveyed locations and reported in a tabular fashion in the Construction Documentation Report. The minimum acceptable barrier layer thickness will be 2 feet.

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Appendix E

Calculations

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E.1 Geotechnical Calculations

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Purpose: Evaluate the Module 12 and 13 landfill liner side slope drainage layer for static veneer slope stability. The following calculations evaluate the static veneer slope stability of the 3:1 slope.

References: 1. Koerner, Robert M. & Te-Yang Soong, Analysis and Design of Veneer Cover Soils, Geosynthetic Research Institute.
2. U.S. Department of Transportation - Federal Highway Administration Recycled Materials, Coal Bottom Ash User's Guide

Calculation:

$$FS = (-b + (b^2 - 4 * a * c)^{1/2}) / (2 * a)$$

$$a = (W_A - N_A * \cos\beta) * \cos\beta$$

$$b = -((W_A - N_A * \cos\beta) * \sin\beta * \tan\phi + (N_A * \tan\delta + C_a) * \sin\beta * \cos\beta + (C + W_P * \tan\phi) * \sin\beta)$$

$$c = (N_A * \tan\delta + C_a) * (\sin\beta)^2 * \tan\phi$$

$$N_A = W_A * \cos\beta$$

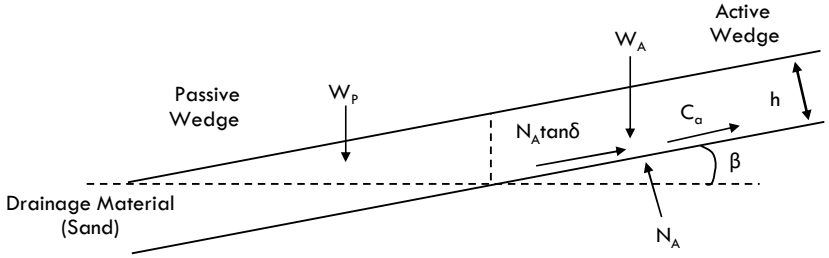
$$W_A = \gamma * h^2 * (L / h - 1 / \sin\beta - \tan\beta / 2)$$

$$W_P = (\gamma * h^2) / \sin 2\beta)$$

$$C_a = c_a (L - h / \sin\beta)$$

Where:

- FS = Factor of Safety
- a, b, & c = intermediate variables (calculated variable)
- N_A = Effective force normal to the failure plane of the active wedge (calculated variable)
- W_A = Total weight of active wedge (calculated variable)
- W_P = Total weight of passive wedge (calculated variable)
- β = Soil slope angle beneath the geomembrane = 18.421 degrees = 0.3215 radians, based on liner slope of 3 to 1
- ϕ = Friction angle of the sand drainage layer material = 30 degrees = 0.5236 radians, based on experience
- δ = Interface friction angle for liner system geosynthetics (to be determined)
- c_a = Adhesion for liner system geosynthetics at active wedge (to be determined), Variable
- γ = Unit weight of the drainage layer material = 125 pcf, based on conservative wet density of sand
- C = Cohesive force along the failure plane of the passive wedge, assumed = 0 for drainage layer material
- C_a = Adhesive force of the active wedge for the liner system geosynthetics
- h = Thickness of the drainage layer material = 1 foot, based on base design
- L = Length of slope measured along the geomembrane = 82 feet, based on base design



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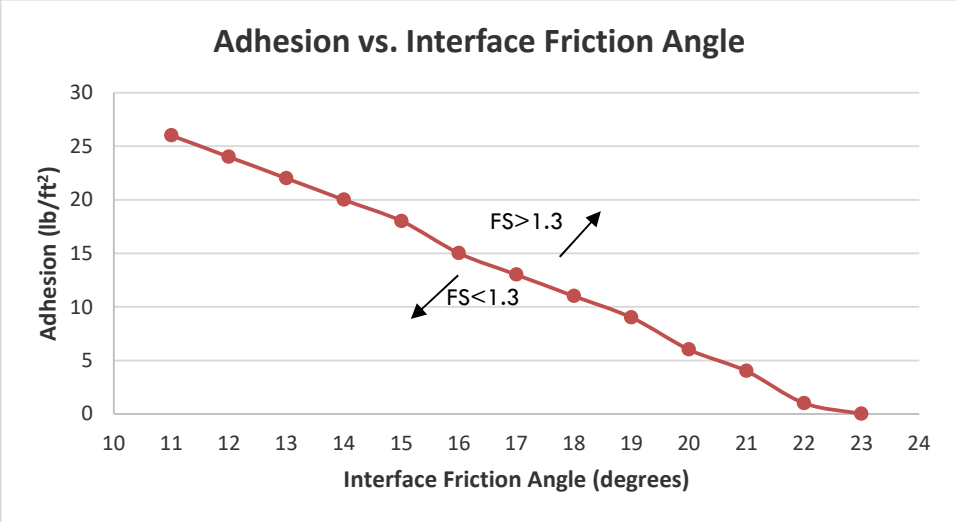
Calculation:

(cont.)

δ (deg)	δ (rad)	c_a (lb/ft^2)	W_A (lb/ft)	W_P (lb/ft)	N_A (lb/ft)	C_a (lb/ft)	a (lb/ft)	b (lb/ft)	c (lb/ft)	FS
11	0.192	26	9,834	208	9,330	2049.7	932	-1,375	223	1.3
12	0.2094	24	9,834	208	9,330	1,892	932	-1,379	223	1.3
13	0.2269	22	9,834	208	9,330	1,734	932	-1,383	224	1.3
14	0.2443	20	9,834	208	9,330	1,577	932	-1,387	225	1.3
15	0.2618	18	9,834	208	9,330	1,419	932	-1,392	226	1.3
16	0.2793	15	9,834	208	9,330	1,183	932	-1,374	222	1.3
17	0.2967	13	9,834	208	9,330	1,025	932	-1,380	224	1.3
18	0.3142	11	9,834	208	9,330	867	932	-1,386	225	1.3
19	0.3316	9	9,834	208	9,330	710	932	-1,393	226	1.3
20	0.3491	6	9,834	208	9,330	473	932	-1,377	223	1.3
21	0.3665	4	9,834	208	9,330	315	932	-1,385	225	1.3
22	0.384	1	9,834	208	9,330	79	932	-1,371	222	1.3
23	0.4014	0	9,834	208	9,330	0	932	-1,405	228	1.3



Conclusion: The landfill liner side slope drainage layer was evaluated for static veneer slope stability along its longest slope. Calculations were performed to determine the minimum adhesion necessary for a range of interface friction angles to reach a FS of 1.3 or greater. Each interface friction angle and the coinciding adhesion was graphed in order to easily determine if a material interface is acceptable along the side slope.

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SCS ENGINEERS		Sheet No.	1 of 1
		Calc. No.	
		Rev. No.	
Job No. 25220183.00	Job: Columbia Dry Ash Disposal Facility	By: MJT	Date: 03/02/22
Client: WPL	Subject: GCL Internal Shear for Liner System	Chk'd: DLN	Date: 04/13/22

Purpose: Determine the maximum shear stress acting on a Geosynthetic Clay Liner (GCL) and the GCL internal shear strength required to provide a minimum slope stability safety factor (FS) of 1.5 for the liner system.

Approach: Use maximum shear stress formula and assumed values.

References: Design of GCL Barrier for Final Cover Side Slope Applications, Gregory N. Richardson, Ph.D., P.E., Geosynthetics '97-541

Calculation: The maximum shear stress acting on the GCL can be calculated as follows:

$$\tau_{act} = W_T \sin \beta$$

$$\beta = 18.4^{\circ}$$

$$W_T = \gamma \times h$$

Where: γ = Sand Unit Weight = 125 pcf

h = Drainage Layer Thickness = 1 ft

$$W_T = 125 \text{ psf}$$

$$\tau_{act} = 39.5 \text{ psf}$$

$$FS = \frac{\tau_{resist}}{\tau_{act}} = 1.5$$

$$\tau_{resist} = FS \times \tau_{act} = 1.5 \times 39.5 = 59 \text{ psf}$$

Assumptions: Slope angle, $\beta = 18.4^{\circ}$ (3:1 horizontal / vertical liner side slope

Sand unit weight, $\gamma = 125$ pcf

Conclusion: For a total weight of the leachate drainage layer of 125 psf and a slope angle of 3:1, the maximum shear stress will be 39.46 psf. A minimum GCL internal shear strength of 59.19 psf is required to provide a slope stability safety factor of 1.5.

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SCS ENGINEERS

		Sheet No.	1 of 1
		Calc. No.	
		Rev. No.	
Job No. 25220183.00	Job: Columbia Dry Ash Disposal Facility	By: MJT	Date: 03/03/2022
Client: WPL	Subject: Pipe Filter Analysis	Chk'd: DLN	Date: 04/13/2022

Purpose: To demonstrate that the filter design criteria are met for the sand leachate drainage layer in relation to the head well piping perforation size. Also to demonstrate that the filter design criteria are met for the leachate collection and sump riser pipe bedding in relation to the pipe hole size. The hole or slot size of the pipes must be designed to limit pipe bedding material from entering the pipe.

Approach: Determine the pipe perforation and pipe hole relationship as specified in the Naval Facilities Engineering Command (NAVFAC) Design Manual (US Navy, 1986).

References: Naval Facilities Engineering Command, US Navy, Soil Mechanics, Design Manual 7.01, September 1986.
ASTM E11, Standard Specification for Wire Cloth and Sieves for testing purposes.

Assumptions: Assuming the head well piping slot size is No.10 or an approximate width of 0.01 inches.
Assuming the leachate collection and sump riser pipe hole size is 1/2" diameter

Calculation: **Pipe Perforation Relationship** (to avoid loss of filter material into collection and riser pipe perforations)

D_{85F}/Slot width > 1.2 to 1.4 D_{85F}/Hole Diameter > 1.0 to 1.2

Where D_{85F} = particle size at which 85% of total pipe bedding particles are finer by weight.

Headwell Piping

	Filter				Pipe Slot			
(for 1.2)	D_{85}	=	0.3	mm	Size	=	0.01	inches
(for 1.4)	D_{85}	=	0.36	mm	Size	=	0.254	mm

Pipe Perforation Relationship

(for 1.2)	D_{85F}/Slot width	=	1.2	OK
(for 1.4)	D_{85F}/Slot width	=	1.4	OK

From ASTM E11, No. 50 U.S. Standard sieve opening size is close to 0.30 mm.

Leachate Collection Piping

	Filter				Pipe Slot			
(for 1.2)	D_{85}	=	15	mm	Size	=	0.5	inches
(for 1.4)	D_{85}	=	12.7	mm	Size	=	12.7	mm

Pipe Hole Relationship

(for 1.2)	D_{85F}/Hole width	=	1.2	OK

Conclusion: To avoid movement of leachate drainage layer particles into No. 10 size pipe slots, no more than 85% of the sand particles should pass a No. 50 sieve. To avoid movement of the leachate collection and sump riser pipe bedding material into the piping holes, no more than 85% of the pipe bedding particles should pass a 1/2 inch sieve.

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Purpose: Perform a puncture analysis on the geomembrane to determine the geotextile cushion requirements for the geotextile beneath the leachate collection pipe bedding.

Approach: Use the GRI-Method (Koerner 2008)

References: Modification to the "GRI-Method" for the RFCR-Factor used in the Design of Geotextiles for Puncture Protection of Geomembranes; Robert M. Koerner, Ph.D, P.E., NAE; November 28, 2008, GRI White Paper #14.

Calculation: The following geomembrane puncture analysis was completed to show which factors control the recommended geotextile mass per unit area.

$$FS = \frac{P_{allow}}{P_{act}} \qquad (1)$$

Where:
- FS = factor of safety
- P_{act} = actual pressure due to the applied normal stress, e.g., landfill contents
- P_{allow} = allowable pressure using different types of geotextiles and site-specific conditions

$$P_{allow} = \left(50 + 0.00045 \frac{M}{H^2} \right) \left[\frac{1}{MF_S \times MF_{PD} \times MF_A} \right] \left[\frac{1}{RF_{CBD} \times RF_{CR}} \right] \qquad (2)$$

Where:
- P_{allow} = allowable pressure (kPa)
- M = geotextile mass per unit area (g/m^2)
- H = protrusion height (m)
- MF_S = modification factor for protrusion shape
- MF_{PD} = modification factor for packing density
- MF_A = modification factor for arching in solids
- RF_{CBD} = reduction factor for long-term chemical/biological degradation, and
- RF_{CR} = reduction factor for long-term creep

Assumptions:

H	= 25mm (1inch)	=	0.025	m
MF_S	= Sub Rounded	=	0.5	
MF_{PD}	= Dense, 25mm (1inch)	=	0.67	
MF_A	= Geostatic, deep	=	0.25	
RF_{CBD}	= Mild leachate	=	1.1	
RF_{CR}	= 25mm (1inch) @ geotextile mass per unit area (gm/m^2) of 1,100	=	1.5	

Calculation: Calculate allowable waste fill height using a factor of safety of 3.0 Due to creep effects, a minimum geotextile mass per unit area of 1,100 g/m^2 will control the design.

$$FS = \frac{P_{allow}}{P_{act}}$$

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Assumptions: Solid waste density = 135 pcf = 21.13 kN/m^3

Peak Height of Waste = 127 feet = 38.71 meters

Calculation:

P_{act} = Solid Waste Density X Peak Height of Waste

$$P_{act} = \frac{P_{allow}}{FS} = \frac{P_{allow}}{3}$$

$$P_{allow} = \left(50 + 0.00045 \frac{M}{H^2} \right) \left[\frac{1}{MF_S \times MF_{PD} \times MF_A} \right] \left[\frac{1}{RF_{CBD} \times RF_{CR}} \right]$$

P_{act}	FS	P_{allow}	M	Recommendation	Max. Allowable Fill Height (feet)
2,031	3	6,093	1,100	See Below	315

Available geotextile cushion thicknesses include:

M (g/m^2)	M (oz/yd^2)
406	12
542	16
675	20
812	24
950	28
1080	32

Conclusion: Due to creep effects, the minimum required geotextile mass per unit area of 1,100 g/m^2 controls the design. Based on the puncture analysis, 3 layers of a 12 oz/yd^2 geotextile, 2 layers of a 16 oz/yd^2 geotextile, or a 32 oz/yd^2 geotextile will be acceptable for use below the leachate pipe bedding.

The maximum allowable fill height is 315 feet which is higher than the maximum design height of 127 feet.

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Purpose: To evaluate the pipe strength of 6-in. dia., SDR 11 HDPE leachate collection piping in the base system of the Columbia Dry Ash Disposal Facility Modules 12 and 13 using designed properties and parameters.

Approach: Use referenced formulas to determine the maximum height waste can be placed above the leachate piping and the specific physical pipe properties necessary to perform adequately.

References:
1. Plastics Pipe Institute, 2nd Edition Handbook of PE Pipe, Buried PE Pipe Design (Attachment 1)
2. ISCO Industries, Typical Physical Properties and Dimension Charts, www.isco-pipe.com (Attachment 2)
3. "Soil Reaction for Buried Flexible Pipe", Amster K. Howard, U.S. Bureau of Reclamation
4. Plan of Operation, Metro Landfill Western Expansion, Appendix F - "Report on Metro Landfill - Pipe Design", Watkins, 1989
5. U.S. Department of Transportation, Federal Highway Administration, Recycled Materials, Coal Ash User's Guide
6. "HDPE Leachate Collection Pipe Design by Fundamentals of Mechanics", Harrison and Watkins, 1996, Nineteenth International Madison Waste Conference.
7. SCS Engineers, Plan of Operation Update, Dry Ash Disposal Facility, Columbia Energy Center, Final Grades (Modules 12 and 13) Plan Sheet, August 2023

Assumptions:
1. Waste above the piping is assumed to be wet.
2. Wet waste unit weight is a conservative 135 pcf from research and typical project experience values.
3. Live loads are negligible above the piping. The maximum fill height over an 6-in SDR 11 HDPE pipe will be 127 feet for the current design.
4. Leachate collection pipes will be 6-in., SDR 11 HDPE in Modules 12 and 13.
5. Allowable compressive stress for HDPE pipe is 1,000 psi (Plastic Pipe Institute, Attachment 1).

Calculations: **Pipe Loading, P_y** $P_y = DL + LL$

where, P_y = Pipe Load, lb/in²
DL = Dead Load, lb/in²
LL = Live Load, lb/in²

Dead Load, *DL* $DL = \frac{\gamma \cdot H}{144}$

where,

γ	=	Fill Unit Weight, lb/ft³	=	**135**	(waste unit weight)
H	=	Height of cover, ft	=	**127**	(max. waste height)
DL	=	Dead Load, lb/in²	=	**119**	

In our case the live load = 0, due to limited live loads above the piping after placement.

So, P_y = DL = **119** lb/in²

Assuming, 6 inch SDR 11 HDPE for leachate collection piping

Outer Diameter of Pipe (OD) = **6.625** **in.** (From Attachment 2)

Min. Pipe wall thickness (t) = **0.602** **in.** (From Attachment 2)

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Calculations: **Deflection**

(cont.) A deflection of 5 to 7.5% has become the standard for limiting deflection in flexible pipes. Based on Figure 7.16 in Uni-Bell (1991) and Watkins (1989) a vertical strain of greater than 5% will never be reached for flexible pipe bedded in compacted gravel, independent of vertical soil pressure. At 90% compaction the vertical strain will always be less than 2%. The height of fill over the pipe is not a factor when the pipe is well bedded in gravel. These findings are consistent for HDPE piping with the Harrison and Watkins (1996) paper.

Wall Crushing

where, σ = Compressive Stress, lb/in²
T = Wall Thrust, lb/in
A = Area of Pipe Wall, in²/in

$$\sigma = \frac{T}{A}$$

Wall Thrust, *T*

$$T = \frac{P_y \cdot D_0}{2}$$

SDR 11 HDPE Piping

where,	P_y	= Vertical Fill Pressure lb/in²	=	**119**	(Previously Calculated)
	D_0	= Outside Diameter, in	=	**6.625**	(SDR 11, 6-inch)
	T	= Wall Thrust, lb/in	=	**394**	
	A	= Area of Pipe Wall, in²/in	=	**0.602**	(Solid=Thickness)

So, σ = Compressive Stress, lb/in² = **655**

Result: The allowable compressive strength of HDPE pipe is approximately 1,000 psi, so the calculated compressive stress values are acceptable and wall crushing of the pipe will be avoided when the pipe is at least SDR 11, 6-inch diameter for the leachate collection pipe.

Leachate Collection Piping Maximum Height - SDR 11 HDPE

For	P_y	= Vertical Fill Pressure lb/in²	=	**182**	
	D_0	= Outside Diameter, in	=	**6.625**	(SDR 11, 6-inch)
	T	= Wall Thrust, lb/in	=	**602**	
	A	= Area of Pipe Wall, in²/in	=	**0.602**	(Solid=Thickness)

So, σ = Compressive Stress, lb/in² = **1,000**

Maximum Height (feet) = Py*(144)/γ = **194**

Result: The maximum height of fill above the 6-inch SDR 11 HDPE piping is 194 feet for a fill unit weight of 135 lb/ft³ to maintain the required minimum factor of safety against wall crushing. Wall crushing controls the maximum fill height that can be placed above the leachate collection pipes. The maximum fill height above the 6-inch diameter piping when Modules 1-6 and Modules 10-13 are filled will be approximately 127 feet, which is lower than the maximum allowable fill height.

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Attachment 1

From the Handbook of PE Pipe 2008, Second Edition by the Plastics Pipe Institute

TABLE C.1
Allowable Compressive Stress for 73°F (23°C)

	Pe Pipe Material Designation Code (1)					
	PE 2406		PE3408		PE 4710	
	PE 2708		PE 3608			
			PE 3708			
			PE 3710			
			PE 4708			
	psi	MPa	psi	MPa	psi	MPa
Allowable Compressive Stress	800	5.52	1000	6.90	1150	7.93

(1) See Chapter 5 for an explanation of the PE Pipe Material Designation Code.

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Attachment 2

From the ISCO Product Catalog dated Q4 2020

IPS ASTM STANDARDS ISCO

For reference only. Actual dimensions may vary.
Solo para referencia. Las dimensiones reales pueden variar.

ASTM MATERIALS Materiales ASTM

PE4710 HDPE PIPE SIZES IPS AND LARGE DIAMETER METRIC

PE4710 Tamaños HDPE tuberías IPS y Diámetro Grande Métrico

DR		11			13.5			15.5		
PE4710 Pressure Rating Resistencia a la Presión		200 psi			160 psi			138 psi		
Nom. OD DE Nominal (in)	Actual OD DE Actual (in)	Min Wall Espesor Mínimo de Pared (in)	Avg ID DI Promedio (in)	Weight Peso (lb/ft)	Min Wall Espesor Mínimo de Pared (in)	Avg ID DI Promedio (in)	Weight Peso (lb/ft)	Min Wall Espesor Mínimo de Pared (in)	Avg ID DI Promedio (in)	Weight Peso (lb/ft)
¾"	1.05	0.095	0.848	0.13	---	---	---	---	---	---
1"	1.315	0.12	1.062	0.2	---	---	---	---	---	---
1¼"	1.66	0.151	1.34	0.314	---	---	---	---	---	---
1½"	1.9	0.173	1.534	0.411	---	---	---	---	---	---
2"	2.375	0.216	1.917	0.642	0.176	2.002	0.534	0.153	2.05	0.47
3"	3.5	0.318	2.825	1.395	0.259	2.95	1.16	0.226	3.021	1.02
4"	4.5	0.409	3.633	2.31	0.333	3.793	1.92	0.29	3.885	1.687
5"	5.563	0.506	4.491	3.523	0.412	4.689	2.928	0.359	4.802	2.58
6"	6.625	0.602	5.348	4.93	0.491	5.585	4.152	0.427	5.719	3.656
8"	8.625	0.784	6.963	8.47	0.639	7.271	7.04	0.556	7.445	6.197
10"	10.75	0.977	8.678	13.16	0.796	9.062	10.932	0.694	9.28	9.626
12"	12.75	1.159	10.293	18.51	0.944	10.748	15.38	0.823	11.006	13.53
14"	14	1.273	11.302	22.32	1.037	11.801	18.54	0.903	12.085	16.31
16"	16	1.455	12.916	29.15	1.185	13.487	24.22	1.032	13.812	21.3
18"	18	1.636	14.531	36.89	1.333	15.173	30.651	1.161	15.538	26.95
20"	20	1.818	16.145	45.541	1.481	16.859	37.84	1.29	17.265	33.28
22"	22	2	17.76	55.105	1.63	18.545	45.79	1.419	18.991	39.712
24"	24	2.182	19.375	65.58	1.778	20.231	54.49	1.548	20.717	47.92
26"	26	2.364	20.989	77.44	1.926	21.917	64.261	1.677	22.444	56.532
28"	28	2.545	22.604	89.785	2.074	23.603	74.522	1.806	24.17	65.563
30"	30	2.727	24.218	103.076	2.222	25.289	85.543	1.935	25.897	75.264
32"	32	2.909	25.833	117.285	2.37	26.975	97.324	2.065	27.623	85.672
34"	34	3.091	27.447	132.411	2.519	28.661	109.905	2.194	29.35	96.714
36"	36	3.273	29.062	148.454	2.667	30.347	123.208	2.323	31.076	108.424
42"	42	3.818	33.906	202.039	3.111	35.404	167.675	2.71	36.255	147.568
48"	48	4.364	38.749	278.27	3.556	40.461	216.74	3.097	41.435	192.774
54"	54	4.909	43.59	352.14	4.00	45.75	286.94	3.484	46.614	243.921
1600mm/63"	62.99	---	---	---	4.667	53.107	390.58	4.065	54.383	340.15
1800mm	70.87	---	---	---	5.2*	60.1*	Call	---	---	---
2000mm	78.74	---	---	---	5.8*	66.8*	Call	---	---	---
2250mm	88.58	---	---	---	---	---	---	---	---	---
2500mm	98.43	---	---	---	---	---	---	---	---	---
2720mm	107.1	---	---	---	---	---	---	---	---	---
2800mm	110.2	---	---	---	---	---	---	---	---	---
3000mm	118.1	---	---	---	---	---	---	---	---	---
3500mm	137.8	---	---	---	---	---	---	---	---	---

1. Pressures are based on using water at 23°C (73°F).
2. Average inside diameter calculated using actual OD and minimum wall plus 6% for use in estimating fluid flows. Actual ID will vary.
3. Other piping sizes or DR's may be available upon request.
4. Standard Lengths:
   - 40' for 2"-24"
   - 50' for 26" and larger
   - Coils available for ¾ - 4" (6" by special order)

*DR 13.6

1. Las presiones están basadas en el uso de agua a 23°C (73°F).
2. El diámetro interno promedio calculado el diámetro externo real y la pared mínima más 6% para uso la estimación de flujos de fluidos. El diámetro interno real variará.
3. Otros tamaños o DR de tubería pueden estar disponibles bajo pedido.
4. Longitudes estándar
   - 40 pies para 2" -24 pulgadas
   - 50 pies para 26 pulgadas o mayores
   - Bobinas disponibles para ¾ a 4 pulgadas (6 pulgadas para pedidos especiales)

09/28/2023 - Classification: Internal - ECRM13153872

Purpose: To evaluate the pipe strength of 18-in. dia., SDR 17 HDPE sump riser piping in the base system of the Columbia Dry Ash Disposal Facility Modules 12 and 13 using designed properties and parameters.

Approach: Use referenced formulas to determine the maximum height waste can be placed above the sump riser piping and the specific physical pipe properties necessary to perform adequately.

References:

1. Plastics Pipe Institute, 2nd Edition Handbook of PE Pipe, Buried PE Pipe Design (Attachment 1)
2. ISCO Industries, Typical Physical Properties and Dimension Charts, www.isco-pipe.com (Attachment 2)
3. "Soil Reaction for Buried Flexible Pipe", Amster K. Howard, U.S. Bureau of Reclamation
4. Plan of Operation, Metro Landfill Western Expansion, Appendix F - "Report on Metro Landfill - Pipe Design", Watkins, 1989
5. U.S. Department of Transportation, Federal Highway Administration, Recycled Materials, Coal Ash User's Guide
6. "HDPE Leachate Collection Pipe Design by Fundamentals of Mechanics", Harrison and Watkins, 1996, Nineteenth International Madison Waste Conference.
8. SCS Engineers, Plan of Operation Update, Dry Ash Disposal Facility, Columbia Energy Center, Base and Final Grades (Modules 12 and 13) Plan Sheets, August 2023

Assumptions:

1. Waste above the piping is assumed to be wet.
2. Wet waste unit weight is a conservative 135 pcf from research and typical project experience values.
3. Live loads are negligible above the piping. The maximum fill height over an 18-in SDR 17 HDPE pipe will be 55 feet for the current design.
4. Sump riser pipes will be 18-in., SDR 17 HDPE in Modules 12 and 13.
5. Allowable compressive stress for HDPE pipe is 1,000 psi (Plastic Pipe Institute, Attachment 1).

Calculations: **Pipe Loading, P_y** $P_y = DL + LL$

where, P_y = Pipe Load, lb/in²
DL = Dead Load, lb/in²
LL = Live Load, lb/in²

Dead Load, *DL* $DL = \frac{\gamma \cdot H}{144}$

where,	γ	=	Fill Unit Weight, lb/ft³	=	**135**	(waste unit weight)
	H	=	Height of cover, ft	=	**55**	(max. waste height)
	DL	=	Dead Load, lb/in²	=	**52**	

In our case the live load = 0, due to limited live loads above the piping after placement.

So, P_y = DL = 52 lb/in²

Assuming, 18 inch SDR 17 HDPE for leachate sump riser piping

Outer Diameter of Pipe (OD) = 18 in. (From Attachment 2)

Min. Pipe wall thickness (t) = 1.059 in. (From Attachment 2)

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Calculations: **Deflection**

(cont.) A deflection of 5 to 7.5% has become the standard for limiting deflection in flexible pipes. Based on Figure 7.16 in Uni-Bell (1991) and Watkins (1989) a vertical strain of greater than 5% will never be reached for flexible pipe bedded in compacted gravel, independent of vertical soil pressure. At 90% compaction the vertical strain will always be less than 2%. The height of fill over the pipe is not a factor when the pipe is well bedded in gravel. These findings are consistent for HDPE piping with the Harrison and Watkins (1996) paper.

Wall Crushing

where, σ = Compressive Stress, lb/in²
T = Wall Thrust, lb/in
A = Area of Pipe Wall, in²/in

$$\sigma = \frac{T}{A}$$

Wall Thrust, *T*

$$T = \frac{P_y \cdot D_0}{2}$$

SDR 17 HDPE Piping

where,	P_y	= Vertical Fill Pressure lb/in²	=	**52**	(Previously Calculated)
	D_0	= Outside Diameter, in	=	**18.000**	(SDR 17, 18-inch)
	T	= Wall Thrust, lb/in	=	**464**	
	A	= Area of Pipe Wall, in²/in	=	**1.059**	(Solid=Thickness)

So, σ = Compressive Stress, lb/in² = **438**

Result: The allowable compressive strength of HDPE pipe is approximately 1,000 psi, so the calculated compressive stress values are acceptable and wall crushing of the pipe will be avoided when the pipe is at least SDR 17, 18-inch diameter for the sump riser pipe.

Sump Riser Piping Maximum Height - SDR 17 HDPE

For	P_y	= Vertical Fill Pressure lb/in²	=	**118**	
	D_0	= Outside Diameter, in	=	**18.000**	(SDR 17, 18-inch)
	T	= Wall Thrust, lb/in	=	**1,059**	
	A	= Area of Pipe Wall, in²/in	=	**1.059**	(Solid=Thickness)

So, σ = Compressive Stress, lb/in² = **1,000**

Maximum Height (feet) = Py*(144)/γ = **126**

Result: The maximum height of fill above the 18-inch SDR 17 HDPE piping is 126 feet for a fill unit weight of 135 lb/ft³ to maintain the required minimum factor of safety against wall crushing. Wall crushing controls the maximum fill height that can be placed above the sump riser pipes. The maximum fill height above the 18-inch diameter piping when Modules 12 and 13 are filled will be approximately 55 feet, which is lower than the maximum allowable fill height.

09/28/2023 - Classification: Internal - ECRM13153872

Attachment 1

From the Handbook of PE Pipe 2008, Second Edition by the Plastics Pipe Institute

TABLE C.1
Allowable Compressive Stress for 73°F (23°C)

	Pe Pipe Material Designation Code (1)					
	PE 2406		PE3408		PE 4710	
	PE 2708		PE 3608			
			PE 3708			
			PE 3710			
			PE 4708			
	psi	MPa	psi	MPa	psi	MPa
Allowable Compressive Stress	800	5.52	1000	6.90	1150	7.93

(1) See Chapter 5 for an explanation of the PE Pipe Material Designation Code.

09/28/2023 - Classification: Internal - ECRM13153872

Attachment 2

From the ISCO Product Catalog dated Q4 2020

ISCO ASTM STANDARDS IPS

For reference only. Actual dimensions may vary.
Solo para referencia. Las dimensiones reales pueden variar.

PE4710 HDPE PIPE SIZES IPS AND LARGE DIAMETER METRIC

PE4710 Tamaños HDPE tuberías IPS y Diámetro Grande Métrico

DR		17			19			21		
PE4710 Pressure Rating Resistencia a la Presión		125 psi			111 psi			100 psi		
Nom. OD DE Nominal (in)	Actual OD DE Actual (in)	Min Wall Espesor Mínimo de Pared (in)	Avg ID DI Promedio (in)	Weight Peso (lb/ft)	Min Wall Espesor Mínimo de Pared (in)	Avg ID DI Promedio (in)	Weight Peso (lb/ft)	Min Wall Espesor Mínimo de Pared (in)	Avg ID DI Promedio (in)	Weight Peso (lb/ft)
¾"	1.05	---	---	---	---	---	---	---	---	---
1"	1.315	---	---	---	---	---	---	---	---	---
1¼"	1.66	---	---	---	---	---	---	---	---	---
1½"	1.9	---	---	---	---	---	---	---	---	---
2"	2.375	0.14	2.079	0.431	---	---	---	---	---	---
3"	3.5	0.206	3.064	0.94	---	---	---	0.167	3.147	0.757
4"	4.5	0.265	3.939	1.55	0.237	3.998	1.39	0.214	4.046	1.27
5"	5.563	0.327	4.869	2.36	0.293	4.942	2.12	0.265	5.001	1.94
6"	6.625	0.39	5.799	3.36	0.349	5.886	3.01	0.315	5.956	2.75
8"	8.625	0.507	7.549	5.69	0.454	7.663	5.1	0.411	7.754	4.662
10"	10.75	0.632	9.409	8.834	0.566	9.551	7.92	0.512	9.665	7.242
12"	12.75	0.75	11.16	12.43	0.671	11.327	11.14	0.607	11.463	10.19
14"	14	0.824	12.254	14.983	0.737	12.438	13.43	0.667	12.587	12.282
16"	16	0.941	14.005	19.57	0.842	14.215	17.54	0.762	14.385	16.042
18"	18	1.059	15.755	24.77	0.947	15.992	22.2	0.857	16.183	20.304
20"	20	1.176	17.506	30.58	1.053	17.768	27.41	0.952	17.981	25.07
22"	22	1.294	19.256	37	1.158	19.545	33.162	1.048	19.779	30.33
24"	24	1.412	21.007	44.031	1.263	21.322	39.47	1.143	21.577	36.1
26"	26	1.529	22.758	51.856	1.368	23.099	46.701	1.238	23.375	42.486
28"	28	1.647	24.508	60.154	1.474	24.876	54.189	1.333	25.173	49.266
30"	30	1.765	26.259	69.068	1.579	26.653	62.196	1.429	26.971	56.585
32"	32	1.882	28.009	78.557	1.684	28.429	70.755	1.524	28.77	64.37
34"	34	2	29.76	88.7	1.789	30.206	79.865	1.619	30.568	72.657
36"	36	2.118	31.511	99.457	1.895	31.983	89.571	1.714	32.366	81.446
42"	42	2.471	36.762	135.372	2.211	37.314	121.925	2	37.76	110.874
48"	48	2.824	42.014	176.813	2.526	42.644	159.198	2.286	43.154	144.833
54"	54	3.176	47.266	223.713	2.842	47.975	201.502	2.571	48.549	183.253
1600mm/63"	62.99	3.706	55.143	303.398	3.315	55.97	273.362	3	56.631	249.57
1800mm	70.87	4.169	62.029	Call	---	---	---	3.375	63.712	Call
2000mm	78.74	4.632	68.921	Call	---	---	---	3.75	70.791	Call
2250mm	88.58	5.211	77.536	Call	---	---	---	4.218	79.64	Call
2500mm	98.43	5.79	86.151	Call	---	---	---	4.687	88.489	Call
2720mm	107.1	---	---	---	---	---	---	5.1	96.6	Call
2800mm	110.2	---	---	---	---	---	---	5.3	99.4	Call
3000mm	118.1	---	---	---	---	---	---	5.6	106.5	Call
3500mm	137.8	---	---	---	---	---	---	6.6	124.3	Call

1. Pressures are based on using water at 23°C (73°F).
2. Average inside diameter calculated using actual OD and minimum wall plus 6% for use in estimating fluid flows. Actual ID will vary.
3. Other piping sizes or DR's may be available upon request.
4. Standard Lengths:
   - 40' for 2"-24"
   - 50' for 26" and larger
   - Coils available for ¾ - 4" (6" by special order)

1. Las presiones están basadas en el uso de agua a 23°C (73°F)
2. El diámetro interno promedio calculado el diámetro externo real y la pared mínima más 6% para uso la estimación de flujos de fluidos. El diámetro interno real variará.
3. Otros tamaños o DR de tubería pueden estar disponibles bajo pedido.
4. Longitudes estándar
   - 40 pies para 2 -24 pulgadas
   - 50 pies para 26 pulgadas o mayores
   - Bobinas disponibles para ¾ a 4 pulgadas (6 pulgadas para pedidos especiales)

ASTM MATERIALS Materiales ASTM

09/28/2023 - Classification: Internal - ECRM13153872

August 31, 2023
File No. 25222260.00

TECHNICAL MEMORANDUM

ANALYSIS BY: Niko Villanueva

REVIEWED BY: Deb Nelson
Keith Gilkey
Phil Gearing

SUBJECT: Slope Stability Analyses
Plan of Operation 2023 Update
Columbia Dry Ash Disposal Facility

PURPOSE

The purposes of the slope stability analyses were to evaluate:

- The final 4H:1V final cover slope in Module 12/Module 13 at the highest final cover grade.
- The interim 3H:1V waste slope in Modules 12/13 at the highest waste grade.
- The access road over 4H:1V final cover slope through Module 6.

CONCLUSION

The attached results confirm that the interim waste slopes will be stable during the construction and operation of the disposal facility modules and that the final grade slope, as well as the overlying access road, will be stable post-closure of the disposal facility.

APPROACH

SCS Engineers (SCS) evaluated the waste mass slope stability of Modules 12/13 during interim waste filling conditions at the most critical/highest waste grades. The Modules 12/13 interim 3H:1V waste slope analyzed is the northern filling face with a maximum waste fill height of approximately 122 feet above the base grade corresponding to a peak elevation of approximately 912 feet above mean sea level. The interim waste slopes were evaluated for block failure and optimized circular failure.

SCS completed analysis for this waste slope by iteratively modifying the coal combustion residual (CCR) friction angle to determine the minimum friction angle required for a safety factor of 1.3. This calculated CCR friction angle was used in the other analyzed sections. The calculated CCR friction

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angle of 23.5 degrees is still conservative based on assumed published values of stabilized CCR in the range of 35 to 45 degrees (see Reference 7).

SCS evaluated the final grade slope stability of longest final cover slope at the most critical/highest final grade cross-section within the Modules 12/13 footprint. The critical cross-section analyzed is through the Modules 12/ 13 waste mass with slope of 4H:1V, a maximum waste fill height of approximately 130 feet above base grades, and a peak elevation of approximately 938 feet above mean sea level. The final grade slope was evaluated for block failure and optimized circular failure.

SCS evaluated the final grade slope stability of the final grade access road. The critical cross section analyzed is through Module 6 final cover with slope of 4H:1V, and 1% slope under the access road. The shoulder of the access road has a 3H:1V slope. The access road was evaluated for block failure and optimized circular failure.

RESULTS

The calculated safety factors for each slope section and failure type are shown in the attached summary table.

SCS recommends a minimum safety factor of 1.3 for the interim waste slopes and 1.5 for the final grade slopes and the access road. The results indicate that the interim waste slopes and final grade slopes have acceptable minimum safety factors.

REFERENCES

1. SCS Engineers, Columbia Dry Ash Disposal Facility, Module 3 Liner Construction, 2016, existing composite liner grades and material properties for geosynthetics.

2. SCS Engineers, Columbia Dry Ash Disposal Facility, 2018 Module 4 Liner Construction, 2018, existing composite liner grades and material properties for subbase, clay, and drainage layer.

3. SCS Engineers, Columbia Dry Ash Disposal Facility, Module 5-6 Liner Construction, 2021, existing composite liner grades and material properties for subbase, clay, and drainage layer.

4. SCS Engineers, Columbia Dry Ash Disposal Facility, Plan of Operation 2022 Update, 2022, Module 10-11 composite liner grades, interim waste filling stages, and final grades.

5. TRI/Environmental, Interface Friction Test Results, 2016, for 2016 Module 3 Liner Construction, and Modules 1 and 2 Cover Construction.

6. TRI/Environmental, Consolidated-Undrained Triaxial Compression Test Results for FGD Material, 2015, material properties for CCR (SCS Project No. 25214049.00).

7. U.S. Department of Transportation, Federal Highway Administration, Recycled Materials, User Guidelines for Waste and Byproduct Materials in Pavement Construction.

8. Stabilization of FGD By-Products by Using Fly Ash, Cement, and Sialite, 2009 WOCA Conference.

9. Geo-Slope International, Ltd., GeoStudio 2023.1.2, Version 23.1.2.11, Slope/W slope stability software.

10. SCS Engineers, Plan Modification Request/Plan of Operation Update, Dry Ash Disposal Facility, Columbia Energy Center, Base Grade and Final Grade Plan Sheets, August 2023.

ASSUMPTIONS

- Sand drainage layers in each of the existing and future modules have the same properties.
- Geosynthetics installed for each of the module composite liners have the same properties.
- Clay material for each of the module composite liners have the same properties.
- CCR waste material will be the same in each of the existing and future modules.
- A waste fill slope of 3H:1V is representative of the design interim waste slopes.
- The groundwater elevation will remain below the elevation at the base of the landfill liner system.
- The access road vehicle is a John Deere 410 off-road haul truck with a fully loaded weight capacity of approximately 152,000 pounds. The surcharge load on the road will be 630 pcf over the truck width.
- The disposal facility will be operated to prevent development of liquid pressures, or seepage forces, within the waste, and there will be no buildup of leachate above the top of the drainage layer.
- The disposal facility will be operated to prevent placement of weak layers of waste within the overall waste mass.
- Optimized circular and sliding block failure stability analyses are appropriate to evaluate the waste interim grade, final grade, and access road slope stability.
- Material properties are as shown in the table below, based on the indicated references and assumed values based on experience. Friction angles for soils are conservative assumed values based on soil type, published typical values, and SCS experience. The CCR friction angle is a calculated conservative value that is in line with assumed published values, and the CCR unit weight is based on 2015 triaxial compression test results by TRI/Environmental for CCR.

Table 1. Material Properties Summary Table

Material	Unit Weight (pcf)	Friction Angle (degrees)	Cohesion (psf)	Reference
Subbase	120	30	0	1, 2, and 3
Clay	125	28	0	1, 2, and 3
Geosynthetics	58	24.3	0	5, 10
Drainage Layer	115	30	0	2 and 3
CCR	86	23.5(1)	0	6, 7, 8, and Calculation
Soil Barrier Layer	125	28	0	10
Geotextile	58	30	0	5, 10
Rooting Zone/Sand	120	30	0	10
Road Aggregate	135	35	0	10

Notes:
(1) CCR friction angle iteratively calculated for minimum value for a safety factor of 1.3 for Module 12/13 interim 3H:1V analysis. Calculated CCR friction angle was used in the other analyzed sections.

Attachments: Calculations organized as follows:

- Factor of Safety Summary Table
- Cross Section Locations
- Slope/W Outputs

NV/jsn/DLN/KRG/PEG

I:\25222260.00\Data and Calculations\Geotech Calculations\Slope Stability\2023 Tech Memo and Attachments\Tech Memo_2023 Update Stability Analysis_230831.docx

Slope Stability Analysis
Factor of Safety Results Summary
Columbia Dry Ash Disposal Facility / SCS Project No. 25222260.00

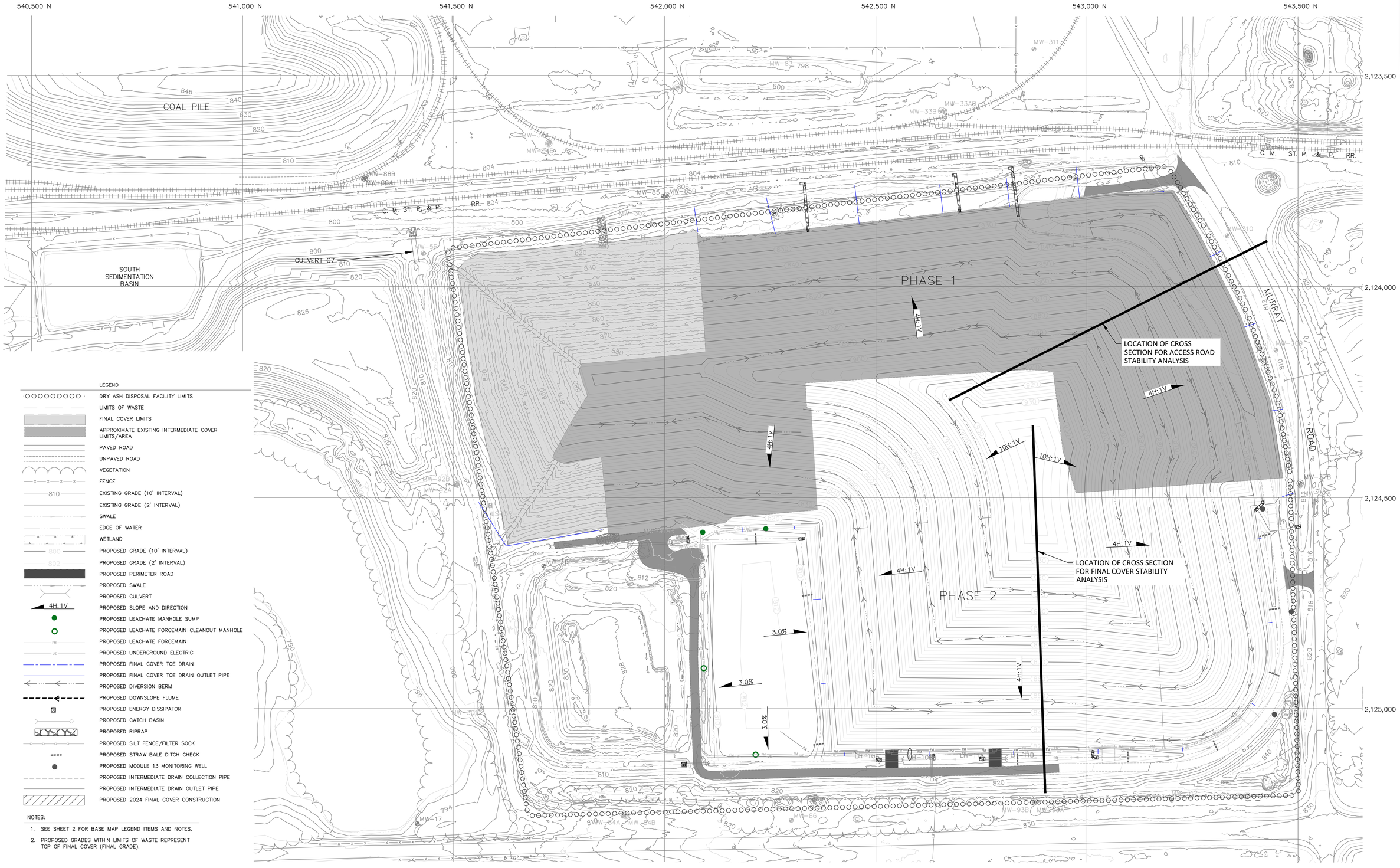
Scenario Analyzed	Calculated Safety Factor	Recommended Minimum Safety Factor
Interim Waste Conditions (Module 12-13 Interim 3H:1V Waste Slope)		
Optimized Circular (Rotational Failure)	1.306[(1)]	1.300
Block (Translational Failure)	1.61	1.300
Final Grade (Module 12-13 Final Cover 4H:1V Slope)		
Optimized Circular (Rotational Failure)	1.745	1.500
Block (Translational Failure)	2.073	1.500
Access Road (Overlying 4H:1V Final Cover Slope)		
Optimized Circular (Rotational Failure)	1.709	1.500
Block (Translational Failure)	1.724	1.500

Notes:
1. Coal combustion residual (CCR) friction angle iteratively calculated for minimum value for a safety factor of 1.3.

Updated by: NV, 08/02/2023
Checked by: DLN, 08/30/2023

I:\25222260.00\Data and Calculations\Geotech Calculations\Slope Stability\2023 Tech Memo and Attachments\[A1_Slope Stability_FS Results Summary Table_230802.xlsx]FS Results Summary

09/28/2023 - Classification: Internal - ECRM13153872



DRAWN BY: KRG
CHECKED BY: XX
APPROVED BY: XXX

PROJECT NO. PROJECT
DRAWN: 05/17/18
REVISED: 08/28/23

WISCONSIN POWER AND LIGHT
COLUMBIA ENERGY CENTER
W8375 MURRAY ROAD
PARDEEVILLE, WISCONSIN 53954

Wisconsin Power and Light Company

CLIENT

SCS ENGINEERS
2830 DAIRY DRIVE MADISON, WI 53718-6751
PHONE: (608) 224-2830

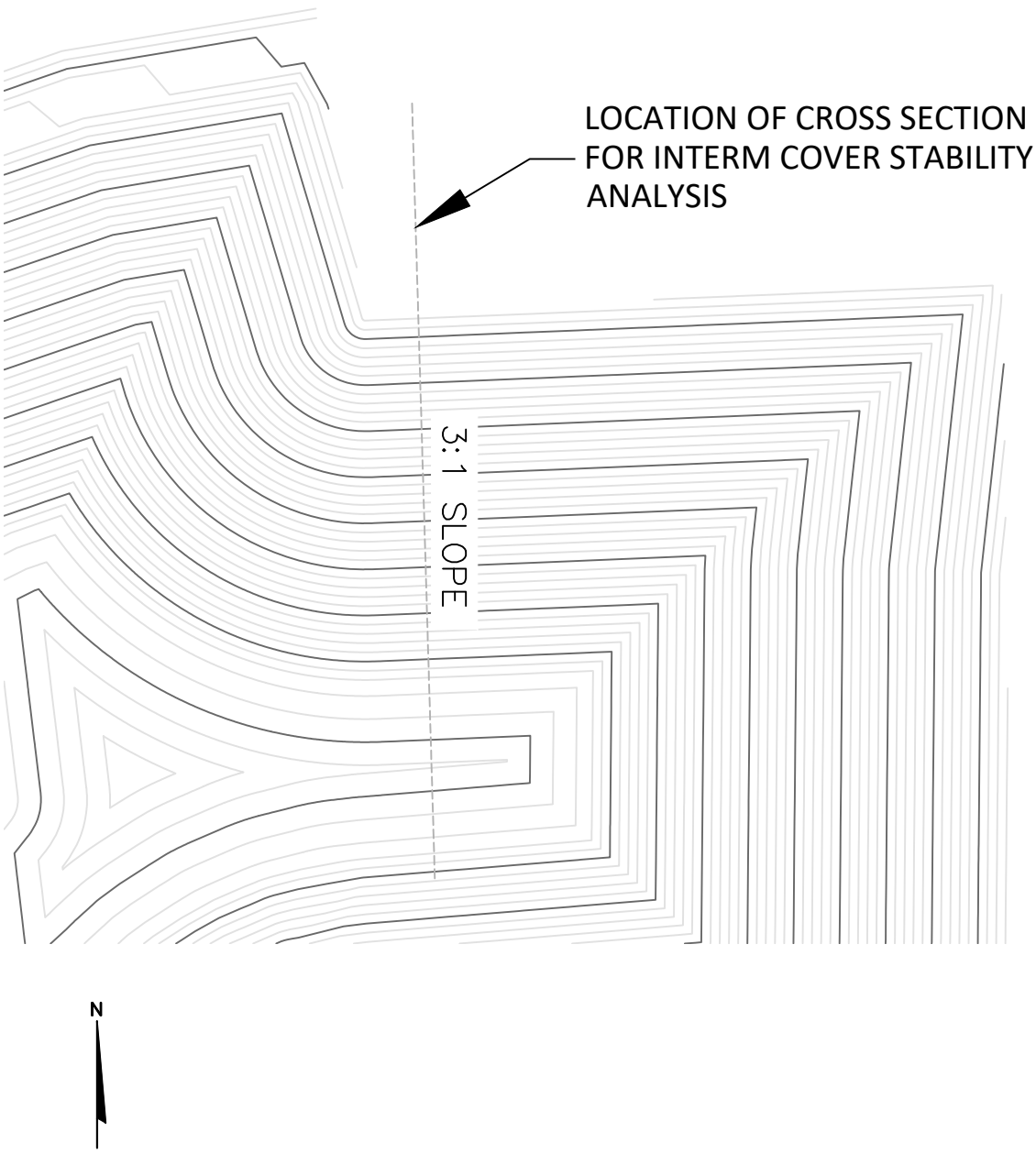
ENGINEER

PLAN OF OPERATION UPDATE
COLUMBIA ENERGY CENTER
COLUMBIA DRY ASH DISPOSAL FACILITY
TOWN OF PACIFIC, WISCONSIN

SITE

STABILITY ANALYSIS CROSS SECTION LOCATIONS

FIGURE
E1



CLIENT	WISCONSIN POWER AND LIGHT COMPANY COLUMBIA ENERGY CENTER W8375 MURRAY ROAD PARDEEVILLE, WI 53954	SITE	PLAN OF OPERATION UPDATE COLUMBIA DRY ASH DISPOSAL FACILITY TOWN OF PACIFIC, WISCONSIN

LOCATION OF INTERM
GRADES STABILITY ANALYSIS
CROSS SECTION

PROJECT NO.	25222260.00	DRAWN BY:	KRG
DRAWN:	08/02/2022	CHECKED BY:	DLN
REVISED:	08/28/2023	APPROVED BY:	PEG

ENGINEER

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2830 DAIRY DRIVE MADISON, WI 53718-6751
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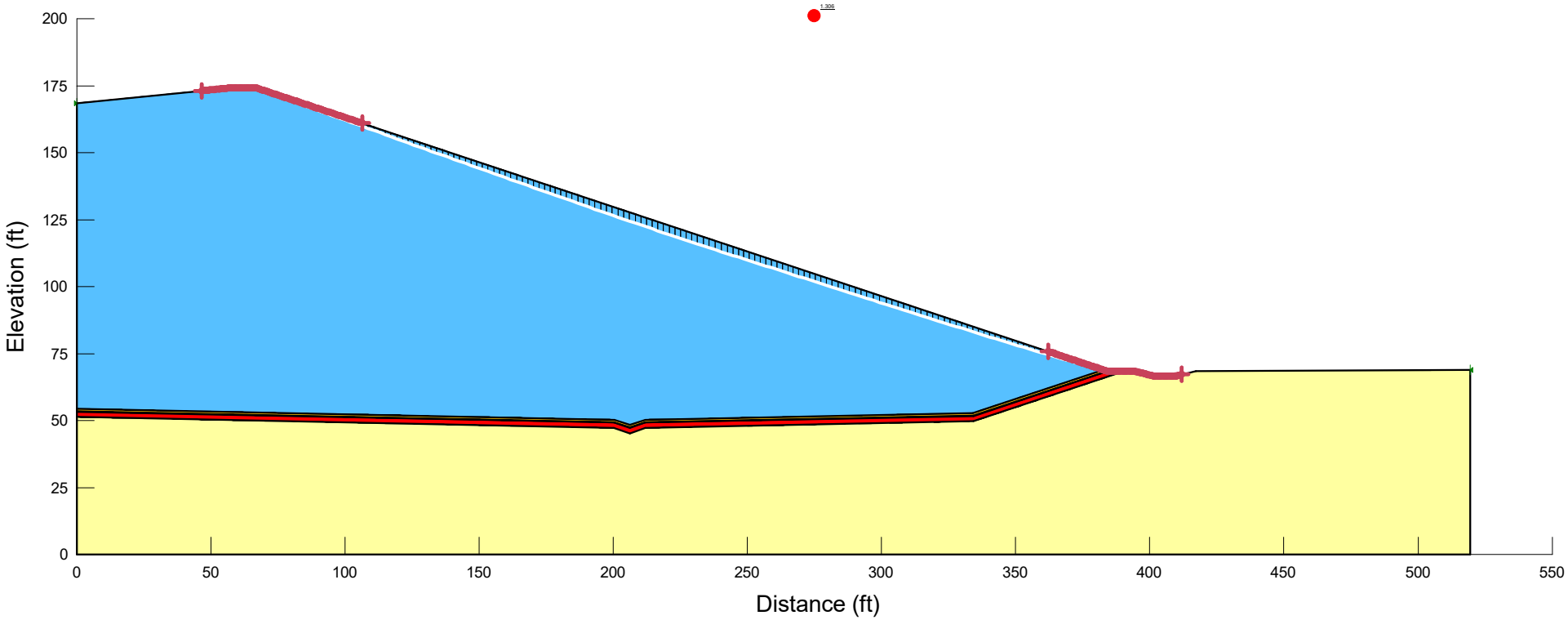
FIGURE
E2

09/28/2023 - Classification: Internal - ECRM1315387 2
I:\25222260.00\Data and Calculations\Geotech Calculations\Slope Stability\E2 Interim Slope Section.dwg, 8/28/2023 2:18:55 PM

Title: Columbia Mod 12-13 Interim Conditions
Name: Optimized Circular_FS=1.3
Method: Bishop
Last Edited By: Villanueva, Niko

F of S: 1.306
F of S Rank (Analysis): 1 of 51,006 slip surfaces
Last Solved Date: 8/2/2023, Last Solved Time: 3:30:24 PM

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	CCR	Mohr-Coulomb	86	0	23.5
	Clay	Mohr-Coulomb	125	0	28
	Drainage Layer	Mohr-Coulomb	115	0	30
	Geosynthetics	Mohr-Coulomb	58	0	24.3
	Subbase	Mohr-Coulomb	120	0	30



Optimized Circular_FS=1.3

Report generated using GeoStudio 2023.1.1. Copyright © 2023 Bentley Systems, Incorporated.

File Information

File Version: 11.05
Title: Columbia Mod 12-13 Interim Conditions 3:1 Slope
Created By: Villanueva, Niko
Last Edited By: Gilkey, Keith
Revision Number: 27
Date: 08/07/2023
Time: 09:58:32 AM
Tool Version: 23.1.1.829
File Name: COL_Mod12-13_Interim Conditions.gsz
Directory: I:\25222260.00\Data and Calculations\Geotech Calculations\Slope Stability\SlopeW\
Last Solved Date: 08/28/2023
Last Solved Time: 01:19:10 PM

Project Settings

Unit System: U.S. Customary Units

Analysis Settings

Optimized Circular_FS=1.3

Kind: SLOPE/W
Analysis Type: Bishop
Settings
- PWP Conditions from: (none)
- Unit Weight of Water: 62.4 pcf

Slip Surface
- Direction of movement: Left to Right
- Use Passive Mode: No
- Slip Surface Option: Entry and Exit
- Critical slip surfaces saved: 10
- Optimize Critical Slip Surface Location: Yes
- Optimizations Settings
  - Maximum Iterations: 2,000
  - Starting Points: 8
  - Ending Points: 16
  - Driving Side Maximum Convex Angle: 5 °
  - Resisting Side Maximum Convex Angle: 1 °
- Tension Crack Option: (none)

Distribution
- F of S Calculation Option: Constant

Convergence
- Geometry Settings
  - Minimum Slip Surface Depth: 0.1 ft
  - Number of Columns: 150
- Factor of Safety Convergence Settings

Maximum Number of Iterations: 20,000
Tolerable difference in F of S: 0.001

Materials

CCR

Slope Stability Material Model: Mohr-Coulomb
Unit Weight: 86 pcf
Effective Cohesion: 0 psf
Effective Friction Angle: 23.5 °
Phi-B: 0 °

Clay

Slope Stability Material Model: Mohr-Coulomb
Unit Weight: 125 pcf
Effective Cohesion: 0 psf
Effective Friction Angle: 28 °
Phi-B: 0 °

Drainage Layer

Slope Stability Material Model: Mohr-Coulomb
Unit Weight: 115 pcf
Effective Cohesion: 0 psf
Effective Friction Angle: 30 °
Phi-B: 0 °

Geosynthetics

Slope Stability Material Model: Mohr-Coulomb
Unit Weight: 58 pcf
Effective Cohesion: 0 psf
Effective Friction Angle: 24.3 °
Phi-B: 0 °

Subbase

Slope Stability Material Model: Mohr-Coulomb
Unit Weight: 120 pcf
Effective Cohesion: 0 psf
Effective Friction Angle: 30 °
Phi-B: 0 °

Slip Surface Entry and Exit

Left Type: Range
Left-Zone Left Coordinate: (46.59062, 173.12871) ft
Left-Zone Right Coordinate: (106.54318, 161) ft
Left-Zone Increment: 100
Right Type: Range
Right-Zone Left Coordinate: (362.19284, 75.78345) ft
Right-Zone Right Coordinate: (412, 67.22491) ft
Right-Zone Increment: 100
Radius Increments: 4

Slip Surface Limits

Left Coordinate: (0, 168.49196) ft
Right Coordinate: (519.45834, 68.88205) ft

Geometry

Name: Default Geometry

Settings

View: 2D
Element Thickness: 1 ft

Points

	X	Y
Point 1	0 ft	51.34809 ft
Point 2	200.19951 ft	47.31405 ft
Point 3	206.14741 ft	45.33145 ft
Point 4	212.095 ft	47.31198 ft
Point 5	334.29245 ft	49.73507 ft
Point 6	390.42013 ft	68.42378 ft
Point 7	390.59413 ft	68.42454 ft
Point 8	394.34772 ft	68.44017 ft
Point 9	401.75147 ft	66.62062 ft
Point 10	409.75552 ft	66.6544 ft
Point 11	417.15984 ft	68.53647 ft
Point 12	519.45834 ft	68.88205 ft
Point 13	519.45834 ft	0 ft
Point 14	0 ft	0 ft
Point 15	0 ft	54.44831 ft
Point 16	0 ft	53.44811 ft
Point 17	200.21671 ft	49.41372 ft
Point 18	206.14743 ft	47.43686 ft
Point 19	212.07782 ft	49.41166 ft
Point 20	334.27528 ft	51.83475 ft
Point 21	384.18447 ft	68.4529 ft
Point 22	382.60264 ft	68.98018 ft
Point 23	334.10353 ft	52.83154 ft
Point 24	211.90606 ft	50.40845 ft
Point 25	206.14759 ft	48.49089 ft
Point 26	200.38878 ft	50.41046 ft
Point 27	0 ft	53.34809 ft
Point 28	200.19951 ft	49.31405 ft
Point 29	206.14741 ft	47.33145 ft
Point 30	212.095 ft	49.31198 ft
Point 31	334.29245 ft	51.73507 ft
Point 32	384.34265 ft	68.40018 ft
Point 33	386.24265 ft	68.40557 ft
Point 34	386.24265 ft	67.50557 ft
Point 35	386.34265 ft	67.50557 ft

Point 36	386.34265 ft	68.40601 ft
Point 37	386.34265 ft	68.50557 ft
Point 38	384.34265 ft	68.50557 ft
Point 39	0 ft	168.49196 ft
Point 40	66.5815 ft	174.32056 ft
Point 41	58.24521 ft	174.28859 ft

Regions

	Material	Points	Area
Region 1	Subbase	1,2,3,4,5,6,7,8,9,10,11,12,13,14	28,504 ft²
Region 2	Drainage Layer	15,16,17,18,19,20,21,22,23,24,25,26	386.75 ft²
Region 3	Geosynthetics	16,27,28,29,30,31,32,33,34,35,36,37,38,21,20,19,18,17	39.07 ft²
Region 4	Clay	27,1,2,3,4,5,6,36,35,34,33,32,31,30,29,28	774.67 ft²
Region 5	CCR	39,15,26,25,24,23,22,40,41	29,542 ft²

Slip Results

Slip Surfaces Analysed: 46903 of 51006 converged

Current Slip Surface

Slip Surface: 51,006
Factor of Safety: 1.306
Volume: 695.49644 ft³
Weight: 59,812.727 lbf
Resisting Moment: 50,841,807 lbf·ft
Activating Moment: 38,936,047 lbf·ft
Resisting Force: 23,408.102 lbf
Activating Force: 17,938.848 lbf
Slip Rank: 1 of 51,006 slip surfaces
Exit: (382.78319, 68.919998) ft
Entry: (66.579471, 174.32055) ft
Radius: 153.07166 ft
Center: (885.3998, 2,069.3162) ft

Slip Columns

	X	Y	PWP	Base Normal Stress	Frictional Strength	Cohesive Strength	Suction Strength	Base Material
Column 1	66.58049 ft	174.32017 ft	0 psf	0.029738458 psf	0.01293065 psf	0 psf	0 psf	CCR
Column 2	67.73459 ft	173.88130 ft	0 psf	4.1901142 psf	1.8219135 psf	0 psf	0 psf	CCR
Column 3	70.04078 ft	173.00435 ft	0 psf	12.451389 psf	5.4140179 psf	0 psf	0 psf	CCR
Column 4	72.34697 ft	172.12740 ft	0 psf	20.712663 psf	9.0061223 psf	0 psf	0 psf	CCR
Column 5	74.65315 ft	171.25045 ft	0 psf	28.973938 psf	12.598227 psf	0 psf	0 psf	CCR
Column 6	76.95934 ft	170.37350 ft	0 psf	37.235212 psf	16.190331 psf	0 psf	0 psf	CCR
Column	79.20885	169.54584	0	43.500805	18.914688	0 psf	0 psf	CCR

7	ft	ft	psf	psf	psf			
Column 8	81.40169 ft	168.76748 ft	0 psf	47.147318 psf	20.500237 psf	0 psf	0 psf	CCR
Column 9	83.59454 ft	167.98912 ft	0 psf	50.793832 psf	22.085787 psf	0 psf	0 psf	CCR
Column 10	85.78738 ft	167.21076 ft	0 psf	54.440346 psf	23.671336 psf	0 psf	0 psf	CCR
Column 11	87.98022 ft	166.43240 ft	0 psf	58.086859 psf	25.256885 psf	0 psf	0 psf	CCR
Column 12	90.17307 ft	165.65404 ft	0 psf	61.733373 psf	26.842434 psf	0 psf	0 psf	CCR
Column 13	92.36591 ft	164.87568 ft	0 psf	65.379887 psf	28.427984 psf	0 psf	0 psf	CCR
Column 14	94.55875 ft	164.09732 ft	0 psf	69.0264 psf	30.013533 psf	0 psf	0 psf	CCR
Column 15	96.75159 ft	163.31896 ft	0 psf	72.672914 psf	31.599082 psf	0 psf	0 psf	CCR
Column 16	98.94444 ft	162.54060 ft	0 psf	76.319427 psf	33.184631 psf	0 psf	0 psf	CCR
Column 17	101.13728 ft	161.76224 ft	0 psf	79.965941 psf	34.770181 psf	0 psf	0 psf	CCR
Column 18	103.30055 ft	160.98728 ft	0 psf	83.94283 psf	36.499381 psf	0 psf	0 psf	CCR
Column 19	105.43426 ft	160.21572 ft	0 psf	88.573452 psf	38.512833 psf	0 psf	0 psf	CCR
Column 20	107.56797 ft	159.44415 ft	0 psf	93.204074 psf	40.526285 psf	0 psf	0 psf	CCR
Column 21	109.70168 ft	158.67259 ft	0 psf	97.834696 psf	42.539737 psf	0 psf	0 psf	CCR
Column 22	111.83538 ft	157.90103 ft	0 psf	102.46532 psf	44.553188 psf	0 psf	0 psf	CCR
Column 23	113.96909 ft	157.12946 ft	0 psf	107.09594 psf	46.56664 psf	0 psf	0 psf	CCR
Column 24	116.10280 ft	156.35790 ft	0 psf	111.72656 psf	48.580092 psf	0 psf	0 psf	CCR
Column 25	118.23651 ft	155.58634 ft	0 psf	116.35718 psf	50.593544 psf	0 psf	0 psf	CCR
Column 26	120.37022 ft	154.81477 ft	0 psf	120.98781 psf	52.606996 psf	0 psf	0 psf	CCR
Column 27	122.50392 ft	154.04321 ft	0 psf	125.61843 psf	54.620448 psf	0 psf	0 psf	CCR
Column 28	124.63763 ft	153.27165 ft	0 psf	130.24905 psf	56.633899 psf	0 psf	0 psf	CCR
Column 29	126.77134 ft	152.50008 ft	0 psf	134.87967 psf	58.647351 psf	0 psf	0 psf	CCR
Column 30	128.90505 ft	151.72852 ft	0 psf	139.5103 psf	60.660803 psf	0 psf	0 psf	CCR
Column 31	131.03527 ft	150.96444 ft	0 psf	143.90592 psf	62.572076 psf	0 psf	0 psf	CCR
Column 32	133.16201 ft	150.20785 ft	0 psf	147.57233 psf	64.166276 psf	0 psf	0 psf	CCR
Column 33	135.28874 ft	149.45125 ft	0 psf	151.23874 psf	65.760477 psf	0 psf	0 psf	CCR

Column 34	137.41548 ft	148.69466 ft	0 psf	154.90515 psf	67.354677 psf	0 psf	0 psf	CCR
Column 35	139.54222 ft	147.93806 ft	0 psf	158.57156 psf	68.948877 psf	0 psf	0 psf	CCR
Column 36	141.66895 ft	147.18147 ft	0 psf	162.23797 psf	70.543077 psf	0 psf	0 psf	CCR
Column 37	143.79569 ft	146.42487 ft	0 psf	165.90438 psf	72.137278 psf	0 psf	0 psf	CCR
Column 38	145.92243 ft	145.66828 ft	0 psf	169.57079 psf	73.731478 psf	0 psf	0 psf	CCR
Column 39	148.04916 ft	144.91168 ft	0 psf	173.2372 psf	75.325678 psf	0 psf	0 psf	CCR
Column 40	150.17590 ft	144.15509 ft	0 psf	176.90361 psf	76.919878 psf	0 psf	0 psf	CCR
Column 41	152.30264 ft	143.39850 ft	0 psf	180.57002 psf	78.514079 psf	0 psf	0 psf	CCR
Column 42	154.42937 ft	142.64190 ft	0 psf	184.23643 psf	80.108279 psf	0 psf	0 psf	CCR
Column 43	156.55611 ft	141.88531 ft	0 psf	187.90284 psf	81.702479 psf	0 psf	0 psf	CCR
Column 44	158.68285 ft	141.12871 ft	0 psf	191.56925 psf	83.29668 psf	0 psf	0 psf	CCR
Column 45	160.80958 ft	140.37212 ft	0 psf	195.23566 psf	84.89088 psf	0 psf	0 psf	CCR
Column 46	162.93632 ft	139.61552 ft	0 psf	198.90207 psf	86.48508 psf	0 psf	0 psf	CCR
Column 47	165.06306 ft	138.85893 ft	0 psf	202.56848 psf	88.07928 psf	0 psf	0 psf	CCR
Column 48	167.18979 ft	138.10233 ft	0 psf	206.23489 psf	89.673481 psf	0 psf	0 psf	CCR
Column 49	169.31653 ft	137.34574 ft	0 psf	209.9013 psf	91.267681 psf	0 psf	0 psf	CCR
Column 50	171.38820 ft	136.61143 ft	0 psf	213.43539 psf	92.804351 psf	0 psf	0 psf	CCR
Column 51	173.40481 ft	135.89940 ft	0 psf	216.50015 psf	94.136944 psf	0 psf	0 psf	CCR
Column 52	175.42142 ft	135.18737 ft	0 psf	219.5649 psf	95.469538 psf	0 psf	0 psf	CCR
Column 53	177.43802 ft	134.47534 ft	0 psf	222.62966 psf	96.802131 psf	0 psf	0 psf	CCR
Column 54	179.45463 ft	133.76331 ft	0 psf	225.69441 psf	98.134724 psf	0 psf	0 psf	CCR
Column 55	181.47124 ft	133.05128 ft	0 psf	228.75917 psf	99.467318 psf	0 psf	0 psf	CCR
Column 56	183.55171 ft	132.32028 ft	0 psf	231.87626 psf	100.82267 psf	0 psf	0 psf	CCR
Column 57	185.69605 ft	131.57029 ft	0 psf	234.58812 psf	102.00182 psf	0 psf	0 psf	CCR
Column 58	187.84039 ft	130.82031 ft	0 psf	237.29998 psf	103.18097 psf	0 psf	0 psf	CCR
Column 59	189.98473 ft	130.07032 ft	0 psf	240.01184 psf	104.36012 psf	0 psf	0 psf	CCR

Column 60	192.12907 ft	129.32034 ft	0 psf	242.72369 psf	105.53927 psf	0 psf	0 psf	CCR
Column 61	194.27341 ft	128.57035 ft	0 psf	245.43555 psf	106.71842 psf	0 psf	0 psf	CCR
Column 62	196.41774 ft	127.82037 ft	0 psf	248.14741 psf	107.89756 psf	0 psf	0 psf	CCR
Column 63	198.56208 ft	127.07038 ft	0 psf	250.85927 psf	109.07671 psf	0 psf	0 psf	CCR
Column 64	200.70642 ft	126.32040 ft	0 psf	253.57113 psf	110.25586 psf	0 psf	0 psf	CCR
Column 65	202.85076 ft	125.57041 ft	0 psf	256.28298 psf	111.43501 psf	0 psf	0 psf	CCR
Column 66	204.99510 ft	124.82043 ft	0 psf	258.99484 psf	112.61416 psf	0 psf	0 psf	CCR
Column 67	207.13944 ft	124.07044 ft	0 psf	261.7067 psf	113.79331 psf	0 psf	0 psf	CCR
Column 68	209.26771 ft	123.34386 ft	0 psf	264.3559 psf	114.94522 psf	0 psf	0 psf	CCR
Column 69	211.37990 ft	122.64068 ft	0 psf	264.28736 psf	114.91541 psf	0 psf	0 psf	CCR
Column 70	213.49209 ft	121.93750 ft	0 psf	264.21881 psf	114.88561 psf	0 psf	0 psf	CCR
Column 71	215.60428 ft	121.23433 ft	0 psf	264.15027 psf	114.85581 psf	0 psf	0 psf	CCR
Column 72	217.71647 ft	120.53115 ft	0 psf	264.08172 psf	114.826 psf	0 psf	0 psf	CCR
Column 73	219.82866 ft	119.82797 ft	0 psf	264.01318 psf	114.7962 psf	0 psf	0 psf	CCR
Column 74	221.94085 ft	119.12479 ft	0 psf	263.94463 psf	114.76639 psf	0 psf	0 psf	CCR
Column 75	224.05305 ft	118.42161 ft	0 psf	263.87609 psf	114.73659 psf	0 psf	0 psf	CCR
Column 76	226.16524 ft	117.71843 ft	0 psf	263.80754 psf	114.70678 psf	0 psf	0 psf	CCR
Column 77	228.27743 ft	117.01525 ft	0 psf	263.739 psf	114.67698 psf	0 psf	0 psf	CCR
Column 78	230.38962 ft	116.31208 ft	0 psf	263.67045 psf	114.64717 psf	0 psf	0 psf	CCR
Column 79	232.50181 ft	115.60890 ft	0 psf	263.60191 psf	114.61737 psf	0 psf	0 psf	CCR
Column 80	234.61400 ft	114.90572 ft	0 psf	263.53336 psf	114.58757 psf	0 psf	0 psf	CCR
Column 81	236.81778 ft	114.17639 ft	0 psf	263.42442 psf	114.5402 psf	0 psf	0 psf	CCR
Column 82	239.11312 ft	113.42092 ft	0 psf	262.677 psf	114.21521 psf	0 psf	0 psf	CCR
Column 83	241.40848 ft	112.66545 ft	0 psf	261.92958 psf	113.89022 psf	0 psf	0 psf	CCR
Column 84	243.57960 ft	111.96250 ft	0 psf	261.21188 psf	113.57816 psf	0 psf	0 psf	CCR
Column 85	245.62650 ft	111.31209 ft	0 psf	258.7319 psf	112.49983 psf	0 psf	0 psf	CCR

Column 86	247.67341 ft	110.66168 ft	0 psf	256.25192 psf	111.42151 psf	0 psf	0 psf	CCR
Column 87	249.72031 ft	110.01126 ft	0 psf	253.77194 psf	110.34318 psf	0 psf	0 psf	CCR
Column 88	251.76721 ft	109.36085 ft	0 psf	251.29196 psf	109.26485 psf	0 psf	0 psf	CCR
Column 89	253.81411 ft	108.71044 ft	0 psf	248.81198 psf	108.18653 psf	0 psf	0 psf	CCR
Column 90	255.86102 ft	108.06003 ft	0 psf	246.332 psf	107.1082 psf	0 psf	0 psf	CCR
Column 91	257.90792 ft	107.40961 ft	0 psf	243.85202 psf	106.02988 psf	0 psf	0 psf	CCR
Column 92	259.95482 ft	106.75920 ft	0 psf	241.37204 psf	104.95155 psf	0 psf	0 psf	CCR
Column 93	262.00172 ft	106.10879 ft	0 psf	238.89206 psf	103.87322 psf	0 psf	0 psf	CCR
Column 94	264.04862 ft	105.45837 ft	0 psf	236.41208 psf	102.7949 psf	0 psf	0 psf	CCR
Column 95	266.09553 ft	104.80796 ft	0 psf	233.9321 psf	101.71657 psf	0 psf	0 psf	CCR
Column 96	268.14243 ft	104.15755 ft	0 psf	231.45212 psf	100.63825 psf	0 psf	0 psf	CCR
Column 97	270.18933 ft	103.50714 ft	0 psf	228.97214 psf	99.559919 psf	0 psf	0 psf	CCR
Column 98	272.23623 ft	102.85672 ft	0 psf	226.49216 psf	98.481593 psf	0 psf	0 psf	CCR
Column 99	274.28314 ft	102.20631 ft	0 psf	224.01218 psf	97.403267 psf	0 psf	0 psf	CCR
Column 100	276.33004 ft	101.55590 ft	0 psf	221.5322 psf	96.324941 psf	0 psf	0 psf	CCR
Column 101	278.42490 ft	100.88613 ft	0 psf	219.06082 psf	95.250357 psf	0 psf	0 psf	CCR
Column 102	280.56772 ft	100.19701 ft	0 psf	217.10705 psf	94.400834 psf	0 psf	0 psf	CCR
Column 103	282.71054 ft	99.50788 ft	0 psf	215.15328 psf	93.55131 psf	0 psf	0 psf	CCR
Column 104	284.85336 ft	98.81876 ft	0 psf	213.19951 psf	92.701787 psf	0 psf	0 psf	CCR
Column 105	286.99618 ft	98.12964 ft	0 psf	211.24574 psf	91.852264 psf	0 psf	0 psf	CCR
Column 106	289.13900 ft	97.44052 ft	0 psf	209.29197 psf	91.00274 psf	0 psf	0 psf	CCR
Column 107	291.28182 ft	96.75139 ft	0 psf	207.3382 psf	90.153217 psf	0 psf	0 psf	CCR
Column 108	293.42464 ft	96.06227 ft	0 psf	205.38443 psf	89.303693 psf	0 psf	0 psf	CCR
Column 109	295.71917 ft	95.32194 ft	0 psf	203.35924 psf	88.423116 psf	0 psf	0 psf	CCR
Column 110	298.16540 ft	94.53041 ft	0 psf	201.50547 psf	87.617072 psf	0 psf	0 psf	CCR
Column 111	300.61163 ft	93.73888 ft	0 psf	199.6517 psf	86.811028 psf	0 psf	0 psf	CCR

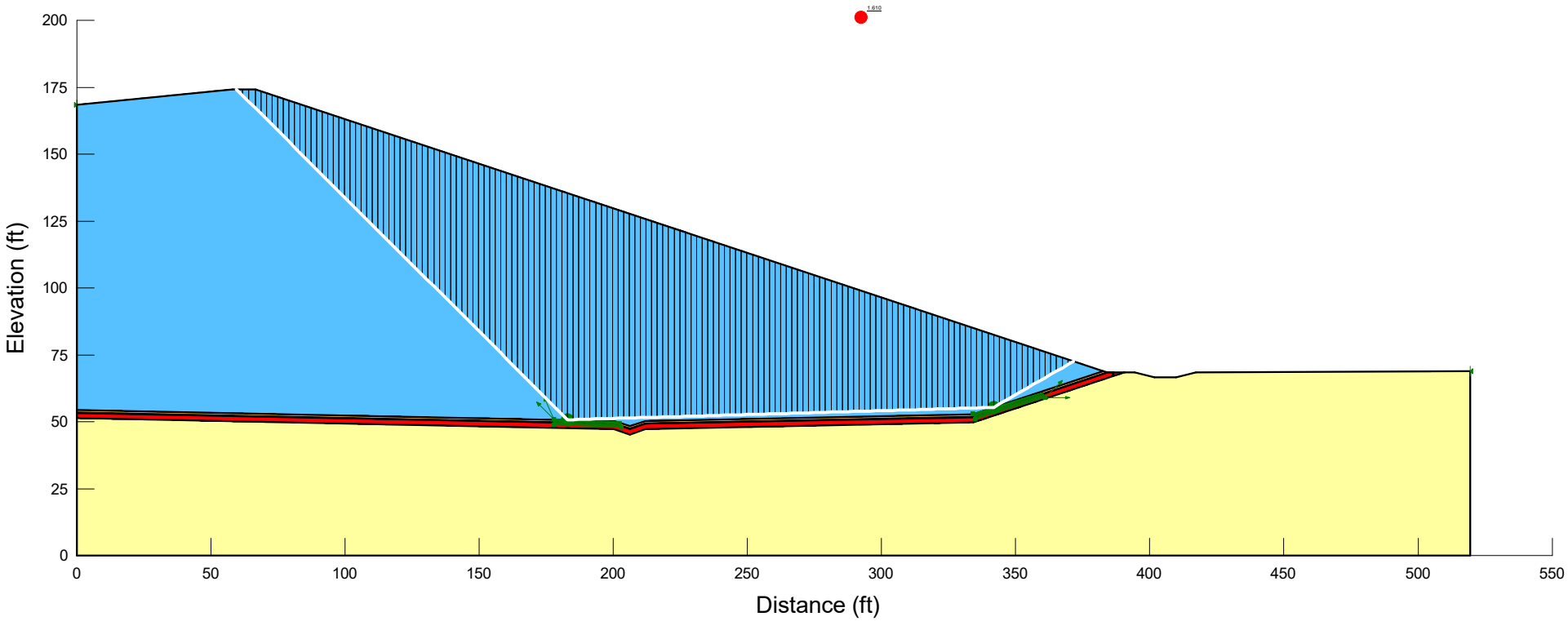
Column 112	302.91346 ft	93.00204 ft	0 psf	197.7276 psf	85.974406 psf	0 psf	0 psf	CCR
Column 113	305.07088 ft	92.31991 ft	0 psf	194.84809 psf	84.722359 psf	0 psf	0 psf	CCR
Column 114	307.22831 ft	91.63778 ft	0 psf	191.96857 psf	83.470312 psf	0 psf	0 psf	CCR
Column 115	309.38573 ft	90.95564 ft	0 psf	189.08906 psf	82.218264 psf	0 psf	0 psf	CCR
Column 116	311.54315 ft	90.27351 ft	0 psf	186.20955 psf	80.966217 psf	0 psf	0 psf	CCR
Column 117	313.70057 ft	89.59138 ft	0 psf	183.33004 psf	79.71417 psf	0 psf	0 psf	CCR
Column 118	315.85800 ft	88.90924 ft	0 psf	180.45053 psf	78.462122 psf	0 psf	0 psf	CCR
Column 119	318.01542 ft	88.22711 ft	0 psf	177.57102 psf	77.210075 psf	0 psf	0 psf	CCR
Column 120	320.17284 ft	87.54498 ft	0 psf	174.6915 psf	75.958028 psf	0 psf	0 psf	CCR
Column 121	322.33026 ft	86.86284 ft	0 psf	171.81199 psf	74.705981 psf	0 psf	0 psf	CCR
Column 122	324.48769 ft	86.18071 ft	0 psf	168.93248 psf	73.453933 psf	0 psf	0 psf	CCR
Column 123	326.64511 ft	85.49858 ft	0 psf	166.05297 psf	72.201886 psf	0 psf	0 psf	CCR
Column 124	328.77373 ft	84.83343 ft	0 psf	162.96735 psf	70.860218 psf	0 psf	0 psf	CCR
Column 125	330.87355 ft	84.18526 ft	0 psf	158.92995 psf	69.104708 psf	0 psf	0 psf	CCR
Column 126	332.97337 ft	83.53709 ft	0 psf	154.89255 psf	67.349198 psf	0 psf	0 psf	CCR
Column 127	335.07320 ft	82.88892 ft	0 psf	150.85516 psf	65.593688 psf	0 psf	0 psf	CCR
Column 128	337.17302 ft	82.24075 ft	0 psf	146.81776 psf	63.838178 psf	0 psf	0 psf	CCR
Column 129	339.27284 ft	81.59258 ft	0 psf	142.78036 psf	62.082668 psf	0 psf	0 psf	CCR
Column 130	341.37266 ft	80.94441 ft	0 psf	138.74297 psf	60.327158 psf	0 psf	0 psf	CCR
Column 131	343.47248 ft	80.29624 ft	0 psf	134.70557 psf	58.571648 psf	0 psf	0 psf	CCR
Column 132	345.57230 ft	79.64807 ft	0 psf	130.66817 psf	56.816138 psf	0 psf	0 psf	CCR
Column 133	347.67213 ft	78.99990 ft	0 psf	126.63078 psf	55.060628 psf	0 psf	0 psf	CCR
Column 134	349.77195 ft	78.35173 ft	0 psf	122.59338 psf	53.305118 psf	0 psf	0 psf	CCR
Column 135	351.87177 ft	77.70356 ft	0 psf	118.55598 psf	51.549608 psf	0 psf	0 psf	CCR
Column 136	353.98692 ft	77.06536 ft	0 psf	113.81717 psf	49.489113 psf	0 psf	0 psf	CCR
Column 137	356.11740 ft	76.43712 ft	0 psf	107.40211 psf	46.699767 psf	0 psf	0 psf	CCR

Column 138	358.24789 ft	75.80887 ft	0 psf	100.98706 psf	43.910421 psf	0 psf	0 psf	CCR
Column 139	360.37837 ft	75.18063 ft	0 psf	94.572 psf	41.121076 psf	0 psf	0 psf	CCR
Column 140	362.50885 ft	74.55239 ft	0 psf	88.156945 psf	38.33173 psf	0 psf	0 psf	CCR
Column 141	364.63933 ft	73.92414 ft	0 psf	81.741889 psf	35.542385 psf	0 psf	0 psf	CCR
Column 142	366.76981 ft	73.29590 ft	0 psf	75.326834 psf	32.753039 psf	0 psf	0 psf	CCR
Column 143	368.90030 ft	72.66765 ft	0 psf	68.911778 psf	29.963694 psf	0 psf	0 psf	CCR
Column 144	371.03078 ft	72.03941 ft	0 psf	62.496723 psf	27.174348 psf	0 psf	0 psf	CCR
Column 145	373.14453 ft	71.45006 ft	0 psf	54.002694 psf	23.48104 psf	0 psf	0 psf	CCR
Column 146	375.24156 ft	70.89961 ft	0 psf	42.253635 psf	18.372403 psf	0 psf	0 psf	CCR
Column 147	377.33859 ft	70.34916 ft	0 psf	30.504575 psf	13.263767 psf	0 psf	0 psf	CCR
Column 148	379.43562 ft	69.79871 ft	0 psf	18.755516 psf	8.1551303 psf	0 psf	0 psf	CCR
Column 149	381.54339 ft	69.24543 ft	0 psf	6.9462823 psf	3.0203295 psf	0 psf	0 psf	CCR
Column 150	382.69291 ft	68.94369 ft	0 psf	0.6589839 psf	0.38046453 psf	0 psf	0 psf	Drainage Layer

Title: Columbia Mod 12-13 Interim Conditions
Name: Block_FS=1.3
Method: Janbu
Last Edited By: Villanueva, Niko

F of S: 1.610
F of S Rank (Analysis): 1 of 234,256 slip surfaces
Last Solved Date: 8/2/2023, Last Solved Time: 3:33:10 PM

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	CCR	Mohr-Coulomb	86	0	23.5
	Clay	Mohr-Coulomb	125	0	28
	Drainage Layer	Mohr-Coulomb	115	0	30
	Geosynthetics	Mohr-Coulomb	58	0	24.3
	Subbase	Mohr-Coulomb	120	0	30



Block_FS=1.3

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File Information

File Version: 11.05
Title: Columbia Mod 12-13 Interim Conditions 3:1 Slope
Created By: Villanueva, Niko
Last Edited By: Gilkey, Keith
Revision Number: 27
Date: 08/07/2023
Time: 09:58:32 AM
Tool Version: 23.1.1.829
File Name: COL_Mod12-13_Interim Conditions.gsz
Directory: I:\25222260.00\Data and Calculations\Geotech Calculations\Slope Stability\SlopeW\
Last Solved Date: 08/28/2023
Last Solved Time: 01:23:04 PM

Project Settings

Unit System: U.S. Customary Units

Analysis Settings

Block_FS=1.3

Kind: SLOPE/W
Analysis Type: Janbu
Settings
- PWP Conditions from: (none)
- Unit Weight of Water: 62.4 pcf

Slip Surface
- Direction of movement: Left to Right
- Use Passive Mode: No
- Slip Surface Option: Block
- Critical slip surfaces saved: 10
- Restrict Block Crossing: No
- Optimize Critical Slip Surface Location: No
- Tension Crack Option: (none)

Distribution
- F of S Calculation Option: Constant

Convergence
- Geometry Settings
  - Minimum Slip Surface Depth: 0.1 ft
  - Number of Columns: 150
- Factor of Safety Convergence Settings
  - Maximum Number of Iterations: 100
  - Tolerable difference in F of S: 0.001

Materials

CCR

Slope Stability Material Model: Mohr-Coulomb
Unit Weight: 86 pcf
Effective Cohesion: 0 psf
Effective Friction Angle: 23.5 °
Phi-B: 0 °

Clay

Slope Stability Material Model: Mohr-Coulomb
Unit Weight: 125 pcf
Effective Cohesion: 0 psf
Effective Friction Angle: 28 °
Phi-B: 0 °

Drainage Layer

Slope Stability Material Model: Mohr-Coulomb
Unit Weight: 115 pcf
Effective Cohesion: 0 psf
Effective Friction Angle: 30 °
Phi-B: 0 °

Geosynthetics

Slope Stability Material Model: Mohr-Coulomb
Unit Weight: 58 pcf
Effective Cohesion: 0 psf
Effective Friction Angle: 24.3 °
Phi-B: 0 °

Subbase

Slope Stability Material Model: Mohr-Coulomb
Unit Weight: 120 pcf
Effective Cohesion: 0 psf
Effective Friction Angle: 30 °
Phi-B: 0 °

Slip Surface Limits

Left Coordinate: (0, 168.49196) ft
Right Coordinate: (519.45834, 68.88205) ft

Slip Surface Block

Left Grid
- Upper Left: (178, 51) ft
- Lower Left: (178, 49) ft
- Lower Right: (203, 48) ft
- X Increments: 10
- Y Increments: 10
- Starting Angle: 115 °
- Ending Angle: 135 °

Angle Increments: 3

Right Grid

Starting Angle: 0 °

Ending Angle: 45 °

Upper Left: (334, 53) ft

Lower Left: (335, 51) ft

Lower Right: (361, 59) ft

X Increments: 10

Y Increments: 10

Angle Increments: 3

Geometry

Name: Default Geometry

Settings

View: 2D

Element Thickness: 1 ft

Points

	X	Y
Point 1	0 ft	51.34809 ft
Point 2	200.19951 ft	47.31405 ft
Point 3	206.14741 ft	45.33145 ft
Point 4	212.095 ft	47.31198 ft
Point 5	334.29245 ft	49.73507 ft
Point 6	390.42013 ft	68.42378 ft
Point 7	390.59413 ft	68.42454 ft
Point 8	394.34772 ft	68.44017 ft
Point 9	401.75147 ft	66.62062 ft
Point 10	409.75552 ft	66.6544 ft
Point 11	417.15984 ft	68.53647 ft
Point 12	519.45834 ft	68.88205 ft
Point 13	519.45834 ft	0 ft
Point 14	0 ft	0 ft
Point 15	0 ft	54.44831 ft
Point 16	0 ft	53.44811 ft
Point 17	200.21671 ft	49.41372 ft
Point 18	206.14743 ft	47.43686 ft
Point 19	212.07782 ft	49.41166 ft
Point 20	334.27528 ft	51.83475 ft
Point 21	384.18447 ft	68.4529 ft
Point 22	382.60264 ft	68.98018 ft
Point 23	334.10353 ft	52.83154 ft
Point 24	211.90606 ft	50.40845 ft
Point 25	206.14759 ft	48.49089 ft
Point 26	200.38878 ft	50.41046 ft
Point 27	0 ft	53.34809 ft
Point 28	200.19951 ft	49.31405 ft
Point 29	206.14741 ft	47.33145 ft

Point 30	212.095 ft	49.31198 ft
Point 31	334.29245 ft	51.73507 ft
Point 32	384.34265 ft	68.40018 ft
Point 33	386.24265 ft	68.40557 ft
Point 34	386.24265 ft	67.50557 ft
Point 35	386.34265 ft	67.50557 ft
Point 36	386.34265 ft	68.40601 ft
Point 37	386.34265 ft	68.50557 ft
Point 38	384.34265 ft	68.50557 ft
Point 39	0 ft	168.49196 ft
Point 40	66.5815 ft	174.32056 ft
Point 41	58.24521 ft	174.28859 ft

Regions

	Material	Points	Area
Region 1	Subbase	1,2,3,4,5,6,7,8,9,10,11,12,13,14	28,504 ft²
Region 2	Drainage Layer	15,16,17,18,19,20,21,22,23,24,25,26	386.75 ft²
Region 3	Geosynthetics	16,27,28,29,30,31,32,33,34,35,36,37,38,21,20,19,18,17	39.07 ft²
Region 4	Clay	27,1,2,3,4,5,6,36,35,34,33,32,31,30,29,28	774.67 ft²
Region 5	CCR	39,15,26,25,24,23,22,40,41	29,542 ft²

Slip Results

Slip Surfaces Analysed: 175692 of 234256 converged

Current Slip Surface

Slip Surface: 218,739
Factor of Safety: 1.610
Volume: 14,659.824 ft³
Weight: 1,260,744.9 lbf
Resisting Moment: 71,899,110 lbf·ft
Activating Moment: 41,317,828 lbf·ft
Resisting Force: 510,914.88 lbf
Activating Force: 317,436.82 lbf
Slip Rank: 1 of 234,256 slip surfaces
Exit: (371.64688, 72.632102) ft
Entry: (59.506573, 174.29343) ft
Radius: 171.79774 ft
Center: (240.40937, 199.70876) ft

Slip Columns

	X	Y	PWP	Base Normal Stress	Frictional Strength	Cohesive Strength	Suction Strength	Base Material
Column 1	60.68573 ft	173.11427 ft	0 psf	80.15187 psf	34.851025 psf	0 psf	0 psf	CCR
Column 2	63.04404 ft	170.75596 ft	0 psf	240.45561 psf	104.55307 psf	0 psf	0 psf	CCR
Column 3	65.40235 ft	168.39765 ft	0 psf	400.75935 psf	174.25512 psf	0 psf	0 psf	CCR

Column 4	67.62095 ft	166.17905 ft	0 psf	527.83503 psf	229.5092 psf	0 psf	0 psf	CCR
Column 5	69.69985 ft	164.10015 ft	0 psf	621.68266 psf	270.31531 psf	0 psf	0 psf	CCR
Column 6	71.77875 ft	162.02125 ft	0 psf	715.53028 psf	311.12142 psf	0 psf	0 psf	CCR
Column 7	73.85766 ft	159.94234 ft	0 psf	809.37791 psf	351.92753 psf	0 psf	0 psf	CCR
Column 8	75.93656 ft	157.86344 ft	0 psf	903.22553 psf	392.73364 psf	0 psf	0 psf	CCR
Column 9	78.01546 ft	155.78454 ft	0 psf	997.07316 psf	433.53975 psf	0 psf	0 psf	CCR
Column 10	80.09436 ft	153.70564 ft	0 psf	1,090.9208 psf	474.34586 psf	0 psf	0 psf	CCR
Column 11	82.17326 ft	151.62674 ft	0 psf	1,184.7684 psf	515.15196 psf	0 psf	0 psf	CCR
Column 12	84.25217 ft	149.54783 ft	0 psf	1,278.616 psf	555.95807 psf	0 psf	0 psf	CCR
Column 13	86.33107 ft	147.46893 ft	0 psf	1,372.4637 psf	596.76418 psf	0 psf	0 psf	CCR
Column 14	88.40997 ft	145.39003 ft	0 psf	1,466.3113 psf	637.57029 psf	0 psf	0 psf	CCR
Column 15	90.48887 ft	143.31113 ft	0 psf	1,560.1589 psf	678.3764 psf	0 psf	0 psf	CCR
Column 16	92.56777 ft	141.23223 ft	0 psf	1,654.0065 psf	719.18251 psf	0 psf	0 psf	CCR
Column 17	94.64667 ft	139.15333 ft	0 psf	1,747.8542 psf	759.98862 psf	0 psf	0 psf	CCR
Column 18	96.72558 ft	137.07442 ft	0 psf	1,841.7018 psf	800.79472 psf	0 psf	0 psf	CCR
Column 19	98.80448 ft	134.99552 ft	0 psf	1,935.5494 psf	841.60083 psf	0 psf	0 psf	CCR
Column 20	100.88338 ft	132.91662 ft	0 psf	2,029.397 psf	882.40694 psf	0 psf	0 psf	CCR
Column 21	102.96228 ft	130.83772 ft	0 psf	2,123.2447 psf	923.21305 psf	0 psf	0 psf	CCR
Column 22	105.04118 ft	128.75882 ft	0 psf	2,217.0923 psf	964.01916 psf	0 psf	0 psf	CCR
Column 23	107.12008 ft	126.67992 ft	0 psf	2,310.9399 psf	1,004.8253 psf	0 psf	0 psf	CCR
Column 24	109.19899 ft	124.60101 ft	0 psf	2,404.7875 psf	1,045.6314 psf	0 psf	0 psf	CCR
Column 25	111.27789 ft	122.52211 ft	0 psf	2,498.6352 psf	1,086.4375 psf	0 psf	0 psf	CCR
Column 26	113.35679 ft	120.44321 ft	0 psf	2,592.4828 psf	1,127.2436 psf	0 psf	0 psf	CCR
Column 27	115.43569 ft	118.36431 ft	0 psf	2,686.3304 psf	1,168.0497 psf	0 psf	0 psf	CCR
Column 28	117.51459 ft	116.28541 ft	0 psf	2,780.178 psf	1,208.8558 psf	0 psf	0 psf	CCR
Column 29	119.59350 ft	114.20650 ft	0 psf	2,874.0257 psf	1,249.6619 psf	0 psf	0 psf	CCR

Column 30	121.67240 ft	112.12760 ft	0 psf	2,967.8733 psf	1,290.468 psf	0 psf	0 psf	CCR
Column 31	123.75130 ft	110.04870 ft	0 psf	3,061.7209 psf	1,331.2741 psf	0 psf	0 psf	CCR
Column 32	125.83020 ft	107.96980 ft	0 psf	3,155.5685 psf	1,372.0802 psf	0 psf	0 psf	CCR
Column 33	127.90910 ft	105.89090 ft	0 psf	3,249.4162 psf	1,412.8864 psf	0 psf	0 psf	CCR
Column 34	129.98800 ft	103.81200 ft	0 psf	3,343.2638 psf	1,453.6925 psf	0 psf	0 psf	CCR
Column 35	132.06691 ft	101.73309 ft	0 psf	3,437.1114 psf	1,494.4986 psf	0 psf	0 psf	CCR
Column 36	134.14581 ft	99.65419 ft	0 psf	3,530.959 psf	1,535.3047 psf	0 psf	0 psf	CCR
Column 37	136.22471 ft	97.57529 ft	0 psf	3,624.8067 psf	1,576.1108 psf	0 psf	0 psf	CCR
Column 38	138.30361 ft	95.49639 ft	0 psf	3,718.6543 psf	1,616.9169 psf	0 psf	0 psf	CCR
Column 39	140.38251 ft	93.41749 ft	0 psf	3,812.5019 psf	1,657.723 psf	0 psf	0 psf	CCR
Column 40	142.46142 ft	91.33858 ft	0 psf	3,906.3495 psf	1,698.5291 psf	0 psf	0 psf	CCR
Column 41	144.54032 ft	89.25968 ft	0 psf	4,000.1972 psf	1,739.3352 psf	0 psf	0 psf	CCR
Column 42	146.61922 ft	87.18078 ft	0 psf	4,094.0448 psf	1,780.1413 psf	0 psf	0 psf	CCR
Column 43	148.69812 ft	85.10188 ft	0 psf	4,187.8924 psf	1,820.9474 psf	0 psf	0 psf	CCR
Column 44	150.77702 ft	83.02298 ft	0 psf	4,281.74 psf	1,861.7535 psf	0 psf	0 psf	CCR
Column 45	152.85592 ft	80.94408 ft	0 psf	4,375.5876 psf	1,902.5597 psf	0 psf	0 psf	CCR
Column 46	154.93483 ft	78.86517 ft	0 psf	4,469.4353 psf	1,943.3658 psf	0 psf	0 psf	CCR
Column 47	157.01373 ft	76.78627 ft	0 psf	4,563.2829 psf	1,984.1719 psf	0 psf	0 psf	CCR
Column 48	159.09263 ft	74.70737 ft	0 psf	4,657.1305 psf	2,024.978 psf	0 psf	0 psf	CCR
Column 49	161.17153 ft	72.62847 ft	0 psf	4,750.9781 psf	2,065.7841 psf	0 psf	0 psf	CCR
Column 50	163.25043 ft	70.54957 ft	0 psf	4,844.8258 psf	2,106.5902 psf	0 psf	0 psf	CCR
Column 51	165.32933 ft	68.47067 ft	0 psf	4,938.6734 psf	2,147.3963 psf	0 psf	0 psf	CCR
Column 52	167.40824 ft	66.39176 ft	0 psf	5,032.521 psf	2,188.2024 psf	0 psf	0 psf	CCR
Column 53	169.48714 ft	64.31286 ft	0 psf	5,126.3686 psf	2,229.0085 psf	0 psf	0 psf	CCR
Column 54	171.56604 ft	62.23396 ft	0 psf	5,220.2163 psf	2,269.8146 psf	0 psf	0 psf	CCR
Column 55	173.64494 ft	60.15506 ft	0 psf	5,314.0639 psf	2,310.6207 psf	0 psf	0 psf	CCR

Column 56	175.72384 ft	58.07616 ft	0 psf	5,407.9115 psf	2,351.4269 psf	0 psf	0 psf	CCR
Column 57	177.80275 ft	55.99725 ft	0 psf	5,501.7591 psf	2,392.233 psf	0 psf	0 psf	CCR
Column 58	179.88165 ft	53.91835 ft	0 psf	5,595.6068 psf	2,433.0391 psf	0 psf	0 psf	CCR
Column 59	181.96055 ft	51.83945 ft	0 psf	5,689.4544 psf	2,473.8452 psf	0 psf	0 psf	CCR
Column 60	184.04474 ft	50.83026 ft	0 psf	7,310.068 psf	3,178.508 psf	0 psf	0 psf	CCR
Column 61	186.13421 ft	50.89079 ft	0 psf	7,244.4513 psf	3,149.9771 psf	0 psf	0 psf	CCR
Column 62	188.22368 ft	50.95132 ft	0 psf	7,178.8345 psf	3,121.4461 psf	0 psf	0 psf	CCR
Column 63	190.31316 ft	51.01184 ft	0 psf	7,113.2177 psf	3,092.9151 psf	0 psf	0 psf	CCR
Column 64	192.40263 ft	51.07237 ft	0 psf	7,047.6009 psf	3,064.3841 psf	0 psf	0 psf	CCR
Column 65	194.49211 ft	51.13289 ft	0 psf	6,981.9841 psf	3,035.8531 psf	0 psf	0 psf	CCR
Column 66	196.58158 ft	51.19342 ft	0 psf	6,916.3673 psf	3,007.3221 psf	0 psf	0 psf	CCR
Column 67	198.67105 ft	51.25395 ft	0 psf	6,850.7505 psf	2,978.7911 psf	0 psf	0 psf	CCR
Column 68	200.76053 ft	51.31447 ft	0 psf	6,785.1337 psf	2,950.2601 psf	0 psf	0 psf	CCR
Column 69	202.85000 ft	51.37500 ft	0 psf	6,719.517 psf	2,921.7291 psf	0 psf	0 psf	CCR
Column 70	204.93947 ft	51.43553 ft	0 psf	6,653.9002 psf	2,893.1981 psf	0 psf	0 psf	CCR
Column 71	207.02895 ft	51.49605 ft	0 psf	6,588.2834 psf	2,864.6671 psf	0 psf	0 psf	CCR
Column 72	209.11842 ft	51.55658 ft	0 psf	6,522.6666 psf	2,836.1362 psf	0 psf	0 psf	CCR
Column 73	211.20789 ft	51.61711 ft	0 psf	6,457.0498 psf	2,807.6052 psf	0 psf	0 psf	CCR
Column 74	213.29737 ft	51.67763 ft	0 psf	6,391.433 psf	2,779.0742 psf	0 psf	0 psf	CCR
Column 75	215.38684 ft	51.73816 ft	0 psf	6,325.8162 psf	2,750.5432 psf	0 psf	0 psf	CCR
Column 76	217.47632 ft	51.79868 ft	0 psf	6,260.1995 psf	2,722.0122 psf	0 psf	0 psf	CCR
Column 77	219.56579 ft	51.85921 ft	0 psf	6,194.5827 psf	2,693.4812 psf	0 psf	0 psf	CCR
Column 78	221.65526 ft	51.91974 ft	0 psf	6,128.9659 psf	2,664.9502 psf	0 psf	0 psf	CCR
Column 79	223.74474 ft	51.98026 ft	0 psf	6,063.3491 psf	2,636.4192 psf	0 psf	0 psf	CCR
Column 80	225.83421 ft	52.04079 ft	0 psf	5,997.7323 psf	2,607.8882 psf	0 psf	0 psf	CCR
Column 81	227.92368 ft	52.10132 ft	0 psf	5,932.1155 psf	2,579.3572 psf	0 psf	0 psf	CCR

Column 82	230.01316 ft	52.16184 ft	0 psf	5,866.4987 psf	2,550.8262 psf	0 psf	0 psf	CCR
Column 83	232.10263 ft	52.22237 ft	0 psf	5,800.8819 psf	2,522.2953 psf	0 psf	0 psf	CCR
Column 84	234.19211 ft	52.28289 ft	0 psf	5,735.2652 psf	2,493.7643 psf	0 psf	0 psf	CCR
Column 85	236.28158 ft	52.34342 ft	0 psf	5,669.6484 psf	2,465.2333 psf	0 psf	0 psf	CCR
Column 86	238.37105 ft	52.40395 ft	0 psf	5,604.0316 psf	2,436.7023 psf	0 psf	0 psf	CCR
Column 87	240.46053 ft	52.46447 ft	0 psf	5,538.4148 psf	2,408.1713 psf	0 psf	0 psf	CCR
Column 88	242.55000 ft	52.52500 ft	0 psf	5,472.798 psf	2,379.6403 psf	0 psf	0 psf	CCR
Column 89	244.63947 ft	52.58553 ft	0 psf	5,407.1812 psf	2,351.1093 psf	0 psf	0 psf	CCR
Column 90	246.72895 ft	52.64605 ft	0 psf	5,341.5644 psf	2,322.5783 psf	0 psf	0 psf	CCR
Column 91	248.81842 ft	52.70658 ft	0 psf	5,275.9477 psf	2,294.0473 psf	0 psf	0 psf	CCR
Column 92	250.90789 ft	52.76711 ft	0 psf	5,210.3309 psf	2,265.5163 psf	0 psf	0 psf	CCR
Column 93	252.99737 ft	52.82763 ft	0 psf	5,144.7141 psf	2,236.9853 psf	0 psf	0 psf	CCR
Column 94	255.08684 ft	52.88816 ft	0 psf	5,079.0973 psf	2,208.4544 psf	0 psf	0 psf	CCR
Column 95	257.17632 ft	52.94868 ft	0 psf	5,013.4805 psf	2,179.9234 psf	0 psf	0 psf	CCR
Column 96	259.26579 ft	53.00921 ft	0 psf	4,947.8637 psf	2,151.3924 psf	0 psf	0 psf	CCR
Column 97	261.35526 ft	53.06974 ft	0 psf	4,882.2469 psf	2,122.8614 psf	0 psf	0 psf	CCR
Column 98	263.44474 ft	53.13026 ft	0 psf	4,816.6301 psf	2,094.3304 psf	0 psf	0 psf	CCR
Column 99	265.53421 ft	53.19079 ft	0 psf	4,751.0134 psf	2,065.7994 psf	0 psf	0 psf	CCR
Column 100	267.62368 ft	53.25132 ft	0 psf	4,685.3966 psf	2,037.2684 psf	0 psf	0 psf	CCR
Column 101	269.71316 ft	53.31184 ft	0 psf	4,619.7798 psf	2,008.7374 psf	0 psf	0 psf	CCR
Column 102	271.80263 ft	53.37237 ft	0 psf	4,554.163 psf	1,980.2064 psf	0 psf	0 psf	CCR
Column 103	273.89211 ft	53.43289 ft	0 psf	4,488.5462 psf	1,951.6754 psf	0 psf	0 psf	CCR
Column 104	275.98158 ft	53.49342 ft	0 psf	4,422.9294 psf	1,923.1444 psf	0 psf	0 psf	CCR
Column 105	278.07105 ft	53.55395 ft	0 psf	4,357.3126 psf	1,894.6135 psf	0 psf	0 psf	CCR
Column 106	280.16053 ft	53.61447 ft	0 psf	4,291.6959 psf	1,866.0825 psf	0 psf	0 psf	CCR
Column 107	282.25000 ft	53.67500 ft	0 psf	4,226.0791 psf	1,837.5515 psf	0 psf	0 psf	CCR

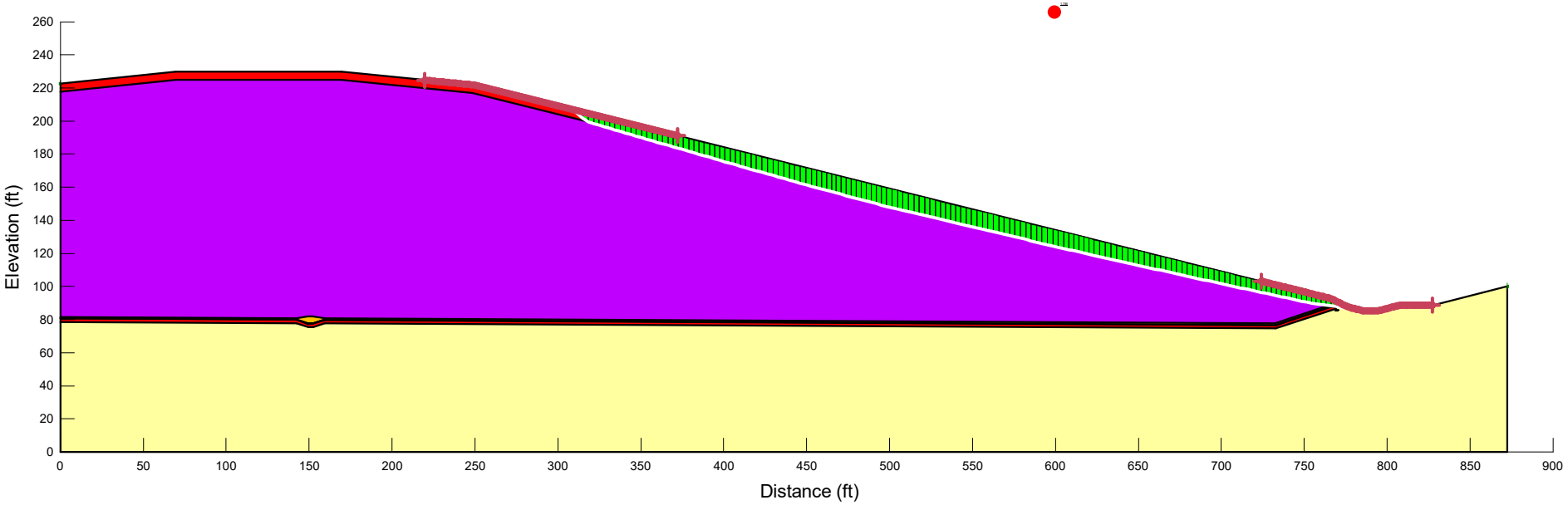
Column 108	284.33947 ft	53.73553 ft	0 psf	4,160.4623 psf	1,809.0205 psf	0 psf	0 psf	CCR
Column 109	286.42895 ft	53.79605 ft	0 psf	4,094.8455 psf	1,780.4895 psf	0 psf	0 psf	CCR
Column 110	288.51842 ft	53.85658 ft	0 psf	4,029.2287 psf	1,751.9585 psf	0 psf	0 psf	CCR
Column 111	290.60789 ft	53.91711 ft	0 psf	3,963.6119 psf	1,723.4275 psf	0 psf	0 psf	CCR
Column 112	292.69737 ft	53.97763 ft	0 psf	3,897.9951 psf	1,694.8965 psf	0 psf	0 psf	CCR
Column 113	294.78684 ft	54.03816 ft	0 psf	3,832.3783 psf	1,666.3655 psf	0 psf	0 psf	CCR
Column 114	296.87632 ft	54.09868 ft	0 psf	3,766.7616 psf	1,637.8345 psf	0 psf	0 psf	CCR
Column 115	298.96579 ft	54.15921 ft	0 psf	3,701.1448 psf	1,609.3035 psf	0 psf	0 psf	CCR
Column 116	301.05526 ft	54.21974 ft	0 psf	3,635.528 psf	1,580.7726 psf	0 psf	0 psf	CCR
Column 117	303.14474 ft	54.28026 ft	0 psf	3,569.9112 psf	1,552.2416 psf	0 psf	0 psf	CCR
Column 118	305.23421 ft	54.34079 ft	0 psf	3,504.2944 psf	1,523.7106 psf	0 psf	0 psf	CCR
Column 119	307.32368 ft	54.40132 ft	0 psf	3,438.6776 psf	1,495.1796 psf	0 psf	0 psf	CCR
Column 120	309.41316 ft	54.46184 ft	0 psf	3,373.0608 psf	1,466.6486 psf	0 psf	0 psf	CCR
Column 121	311.50263 ft	54.52237 ft	0 psf	3,307.444 psf	1,438.1176 psf	0 psf	0 psf	CCR
Column 122	313.59211 ft	54.58289 ft	0 psf	3,241.8273 psf	1,409.5866 psf	0 psf	0 psf	CCR
Column 123	315.68158 ft	54.64342 ft	0 psf	3,176.2105 psf	1,381.0556 psf	0 psf	0 psf	CCR
Column 124	317.77105 ft	54.70395 ft	0 psf	3,110.5937 psf	1,352.5246 psf	0 psf	0 psf	CCR
Column 125	319.86053 ft	54.76447 ft	0 psf	3,044.9769 psf	1,323.9936 psf	0 psf	0 psf	CCR
Column 126	321.95000 ft	54.82500 ft	0 psf	2,979.3601 psf	1,295.4626 psf	0 psf	0 psf	CCR
Column 127	324.03947 ft	54.88553 ft	0 psf	2,913.7433 psf	1,266.9317 psf	0 psf	0 psf	CCR
Column 128	326.12895 ft	54.94605 ft	0 psf	2,848.1265 psf	1,238.4007 psf	0 psf	0 psf	CCR
Column 129	328.21842 ft	55.00658 ft	0 psf	2,782.5098 psf	1,209.8697 psf	0 psf	0 psf	CCR
Column 130	330.30789 ft	55.06711 ft	0 psf	2,716.893 psf	1,181.3387 psf	0 psf	0 psf	CCR
Column 131	332.39737 ft	55.12763 ft	0 psf	2,651.2762 psf	1,152.8077 psf	0 psf	0 psf	CCR
Column 132	334.48684 ft	55.18816 ft	0 psf	2,585.6594 psf	1,124.2767 psf	0 psf	0 psf	CCR
Column 133	336.57632 ft	55.24868 ft	0 psf	2,520.0426 psf	1,095.7457 psf	0 psf	0 psf	CCR

Column 134	338.66579 ft	55.30921 ft	0 psf	2,454.4258 psf	1,067.2147 psf	0 psf	0 psf	CCR
Column 135	340.75526 ft	55.36974 ft	0 psf	2,388.809 psf	1,038.6837 psf	0 psf	0 psf	CCR
Column 136	342.86596 ft	56.01543 ft	0 psf	2,670.429 psf	1,161.1356 psf	0 psf	0 psf	CCR
Column 137	344.99788 ft	57.24630 ft	0 psf	2,472.6194 psf	1,075.1255 psf	0 psf	0 psf	CCR
Column 138	347.12980 ft	58.47716 ft	0 psf	2,274.8099 psf	989.11549 psf	0 psf	0 psf	CCR
Column 139	349.26172 ft	59.70803 ft	0 psf	2,077.0003 psf	903.10544 psf	0 psf	0 psf	CCR
Column 140	351.39364 ft	60.93889 ft	0 psf	1,879.1908 psf	817.0954 psf	0 psf	0 psf	CCR
Column 141	353.52556 ft	62.16975 ft	0 psf	1,681.3812 psf	731.08536 psf	0 psf	0 psf	CCR
Column 142	355.65748 ft	63.40062 ft	0 psf	1,483.5717 psf	645.07532 psf	0 psf	0 psf	CCR
Column 143	357.78940 ft	64.63148 ft	0 psf	1,285.7621 psf	559.06528 psf	0 psf	0 psf	CCR
Column 144	359.92132 ft	65.86235 ft	0 psf	1,087.9526 psf	473.05523 psf	0 psf	0 psf	CCR
Column 145	362.05324 ft	67.09321 ft	0 psf	890.143 psf	387.04519 psf	0 psf	0 psf	CCR
Column 146	364.18516 ft	68.32408 ft	0 psf	692.33344 psf	301.03515 psf	0 psf	0 psf	CCR
Column 147	366.31708 ft	69.55494 ft	0 psf	494.52389 psf	215.02511 psf	0 psf	0 psf	CCR
Column 148	368.44900 ft	70.78580 ft	0 psf	296.71433 psf	129.01506 psf	0 psf	0 psf	CCR
Column 149	370.58092 ft	72.01667 ft	0 psf	98.904777 psf	43.005021 psf	0 psf	0 psf	CCR

Title: Columbia Mod 12-13 Full Buildout
Name: Optimized Circular_FS=1.5
Method: Bishop
Last Edited By: Villanueva, Niko

F of S: 1.745
F of S Rank (Analysis): 1 of 51,006 slip surfaces
Last Solved Date: 08/30/2023, Last Solved Time: 07:35:34 AM

Color	Name	Slope Stability Material Model	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)
	CCR	Mohr-Coulomb	86	0	23.5
	Clay	Mohr-Coulomb	125	0	28
	Drainage Layer	Mohr-Coulomb	115	0	30
	Geosynthetics	Mohr-Coulomb	58	0	24.3
	Subbase	Mohr-Coulomb	120	0	30



Optimized Circular_FS=1.5

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File Information

File Version: 11.05
Title: Columbia Mod 12-13 Full Buildout
Created By: Villanueva, Niko
Last Edited By: Villanueva, Niko
Revision Number: 56
Date: 08/30/2023
Time: 07:34:03 AM
Tool Version: 23.1.1.829
File Name: COL_Mod12-13_Full Buildout.gsz
Directory: I:\25222260.00\Data and Calculations\Geotech Calculations\Slope Stability\SlopeW\
Last Solved Date: 08/30/2023
Last Solved Time: 07:35:34 AM

Project Settings

Unit System: U.S. Customary Units

Analysis Settings

Optimized Circular_FS=1.5

Kind: SLOPE/W
Analysis Type: Bishop
Settings
- PWP Conditions from: (none)
- Unit Weight of Water: 62.4 pcf

Slip Surface
- Direction of movement: Left to Right
- Use Passive Mode: No
- Slip Surface Option: Entry and Exit
- Critical slip surfaces saved: 10
- Optimize Critical Slip Surface Location: Yes
- Optimizations Settings
  - Maximum Iterations: 2,000
  - Starting Points: 8
  - Ending Points: 16
  - Driving Side Maximum Convex Angle: 5 °
  - Resisting Side Maximum Convex Angle: 1 °
- Tension Crack Option: (none)

Distribution
- F of S Calculation Option: Constant

Convergence
- Geometry Settings
  - Minimum Slip Surface Depth: 0.1 ft
  - Number of Columns: 150
- Factor of Safety Convergence Settings
  - Maximum Number of Iterations: 30,000
  - Tolerable difference in F of S: 0.001

Materials

CCR

Slope Stability Material Model: Mohr-Coulomb
Unit Weight: 86 pcf
Effective Cohesion: 0 psf

Effective Friction Angle: 23.5 °
Phi-B: 0 °

Clay

Slope Stability Material Model: Mohr-Coulomb
Unit Weight: 125 pcf
Effective Cohesion: 0 psf
Effective Friction Angle: 28 °
Phi-B: 0 °

Drainage Layer

Slope Stability Material Model: Mohr-Coulomb
Unit Weight: 115 pcf
Effective Cohesion: 0 psf
Effective Friction Angle: 30 °
Phi-B: 0 °

Geosynthetics

Slope Stability Material Model: Mohr-Coulomb
Unit Weight: 58 pcf
Effective Cohesion: 0 psf
Effective Friction Angle: 24.3 °
Phi-B: 0 °

Subbase

Slope Stability Material Model: Mohr-Coulomb
Unit Weight: 120 pcf
Effective Cohesion: 0 psf
Effective Friction Angle: 30 °
Phi-B: 0 °

Slip Surface Entry and Exit

Left Type: Range
Left-Zone Left Coordinate: (219.68881, 224.73412) ft
Left-Zone Right Coordinate: (372.17498, 191.11662) ft
Left-Zone Increment: 100
Right Type: Range
Right-Zone Left Coordinate: (723.92456, 103.25913) ft
Right-Zone Right Coordinate: (827.14488, 88.78332) ft
Right-Zone Increment: 100
Radius Increments: 4

Slip Surface Limits

Left Coordinate: (0, 222.8) ft
Right Coordinate: (872.23081, 100) ft

Geometry

Name: Default Geometry

Settings

View: 2D
Element Thickness: 1 ft

Points

	X	Y
Point 1	768.91041 ft	87.74349 ft
Point 2	766.02664 ft	87.74317 ft
Point 3	732.66754 ft	76.62354 ft
Point 4	159.35647 ft	79.79909 ft

Point 5	152.46501 ft	77.58553 ft
Point 6	149.45787 ft	77.54639 ft
Point 7	142.29499 ft	79.95559 ft
Point 8	0 ft	80.72488 ft
Point 9	0 ft	78.63599 ft
Point 10	142.29493 ft	77.86789 ft
Point 11	149.45787 ft	75.41847 ft
Point 12	152.46501 ft	75.45626 ft
Point 13	159.35619 ft	77.75007 ft
Point 14	732.66724 ft	74.58984 ft
Point 15	768.91041 ft	86.64701 ft
Point 16	872.23081 ft	100 ft
Point 17	828.17946 ft	88.78332 ft
Point 18	808.17769 ft	88.78332 ft
Point 19	794.02935 ft	85.24543 ft
Point 20	786.03116 ft	85.24543 ft
Point 21	776.0289 ft	87.7443 ft
Point 22	769.01095 ft	87.8435 ft
Point 23	769.01041 ft	85.84317 ft
Point 24	770.01041 ft	85.84317 ft
Point 25	770.01041 ft	85.74351 ft
Point 26	768.91041 ft	85.74351 ft
Point 27	0 ft	0 ft
Point 28	872.23081 ft	0 ft
Point 29	764.03814 ft	88.23984 ft
Point 30	732.49201 ft	77.72453 ft
Point 31	159.6047 ft	80.8285 ft
Point 32	152.35619 ft	82.00202 ft
Point 33	148.97182 ft	82.00419 ft
Point 34	142.29493 ft	80.97938 ft
Point 35	0 ft	81.74787 ft
Point 36	0 ft	80.82487 ft
Point 37	142.31162 ft	80.0555 ft
Point 38	149.47361 ft	77.64661 ft
Point 39	152.44871 ft	77.68532 ft
Point 40	159.34108 ft	79.89918 ft
Point 41	732.65158 ft	76.72363 ft
Point 42	766.01041 ft	87.84317 ft
Point 43	249.53 ft	221.75 ft
Point 44	169.53 ft	229.75 ft
Point 45	69.53 ft	229.75 ft
Point 46	0 ft	222.8 ft
Point 47	0 ft	217.82 ft
Point 48	69.78 ft	224.75 ft
Point 49	169.28 ft	224.75 ft
Point 50	248.67 ft	216.81 ft
Point 51	769.01041 ft	87.84351 ft
Point 52	766.02664 ft	92.74317 ft
Point 53	766.02718 ft	87.74317 ft
Point 54	768.91095 ft	87.74349 ft
Point 55	768.91095 ft	85.7435 ft
Point 56	770.01095 ft	85.7435 ft
Point 57	770.01095 ft	85.84316 ft
Point 58	769.01095 ft	85.84316 ft
Point 59	766.01095 ft	87.84316 ft
Point 60	732.65213 ft	76.72363 ft
Point 61	159.34162 ft	79.89918 ft
Point 62	152.44925 ft	77.68532 ft

Point 63	149.47415 ft	77.6466 ft
Point 64	142.31216 ft	80.0555 ft
Point 65	142.29553 ft	79.95558 ft
Point 66	149.45841 ft	77.54639 ft
Point 67	152.46555 ft	77.58552 ft
Point 68	159.35701 ft	79.79909 ft
Point 69	732.66808 ft	76.62354 ft
Point 70	768.91095 ft	85.74351 ft
Point 71	770.01041 ft	85.84316 ft
Point 72	769.01095 ft	85.84317 ft
Point 73	732.65159 ft	76.72363 ft
Point 74	159.34161 ft	79.89918 ft
Point 75	149.4741 ft	77.64662 ft
Point 76	142.29501 ft	79.95558 ft
Point 77	149.45839 ft	77.5464 ft
Point 78	159.357 ft	79.79909 ft
Point 79	732.66755 ft	76.62354 ft

Regions

	Material	Points	Area
Region 1	Clay	1,53,69,79,3,68,78,67,66,77,6,76,8,9,10,11,12,13,14,15	1,576.1 ft²
Region 2	Subbase	16,17,18,19,20,21,22,72,24,71,57,56,55,70,26,15,14,13,12,11,10,9,27,28	68,366 ft²
Region 3	Drainage Layer	29,30,31,32,33,34,35,36,37,64,75,39,40,74,61,41,73,42	769.27 ft²
Region 4	Clay	43,44,45,46,47,48,49,50,29,42,51,22,21,52	3,896.4 ft²
Region 5	CCR	50,49,48,47,35,34,33,32,31,30,29	72,914 ft²
Region 6	Geosynthetics	53,1,54,70,55,56,57,71,58,72,22,59,60,73,41,61,74,62,63,75,64,37,36,8,76,65,77,66,67,78,68,3,79,69	77.457 ft²

Slip Results

Slip Surfaces Analysed: 39342 of 51006 converged

Current Slip Surface

Slip Surface: 51,006
Factor of Safety: 1.745
Volume: 4,009.1179 ft³
Weight: 435,365.84 lbf
Resisting Moment: 6.698018e+08 lbf·ft
Activating Moment: 3.8392957e+08 lbf·ft
Resisting Force: 179,103.91 lbf
Activating Force: 102,795.44 lbf
Slip Rank: 1 of 51,006 slip surfaces
Exit: (785.97288, 85.259989) ft
Entry: (308.50283, 207.02019) ft
Radius: 210.34059 ft
Center: (1,393.2702, 3,660.481) ft

Slip Columns

	X	Y	PWP	Base Normal Stress	Frictional Strength	Cohesive Strength	Suction Strength	Base Material
Column 1	310.14171 ft	205.75520 ft	0 psf	86.593136 psf	46.042387 psf	0 psf	0 psf	Clay
Column 2	313.41948 ft	203.22520 ft	0 psf	259.77941 psf	138.12716 psf	0 psf	0 psf	Clay

Column 3	316.70451 ft	200.68961 ft	0 psf	433.34934 psf	230.41593 psf	0 psf	0 psf	Clay
Column 4	319.95630 ft	198.94705 ft	0 psf	604.21909 psf	262.72194 psf	0 psf	0 psf	CCR
Column 5	323.16761 ft	198.00312 ft	0 psf	615.54908 psf	267.64836 psf	0 psf	0 psf	CCR
Column 6	326.37891 ft	197.05920 ft	0 psf	626.87907 psf	272.57478 psf	0 psf	0 psf	CCR
Column 7	329.59021 ft	196.11527 ft	0 psf	638.20907 psf	277.5012 psf	0 psf	0 psf	CCR
Column 8	332.80152 ft	195.17134 ft	0 psf	649.53906 psf	282.42762 psf	0 psf	0 psf	CCR
Column 9	336.01282 ft	194.22742 ft	0 psf	660.86906 psf	287.35404 psf	0 psf	0 psf	CCR
Column 10	339.22413 ft	193.28349 ft	0 psf	672.19905 psf	292.28046 psf	0 psf	0 psf	CCR
Column 11	342.43543 ft	192.33957 ft	0 psf	683.52904 psf	297.20689 psf	0 psf	0 psf	CCR
Column 12	345.64674 ft	191.39564 ft	0 psf	694.85904 psf	302.13331 psf	0 psf	0 psf	CCR
Column 13	348.85804 ft	190.45171 ft	0 psf	706.18903 psf	307.05973 psf	0 psf	0 psf	CCR
Column 14	352.06934 ft	189.50779 ft	0 psf	717.51902 psf	311.98615 psf	0 psf	0 psf	CCR
Column 15	355.28065 ft	188.56386 ft	0 psf	728.84902 psf	316.91257 psf	0 psf	0 psf	CCR
Column 16	358.45208 ft	187.63799 ft	0 psf	740.22605 psf	321.85945 psf	0 psf	0 psf	CCR
Column 17	361.58365 ft	186.73018 ft	0 psf	750.2683 psf	326.22594 psf	0 psf	0 psf	CCR
Column 18	364.71522 ft	185.82237 ft	0 psf	760.31055 psf	330.59243 psf	0 psf	0 psf	CCR
Column 19	367.84679 ft	184.91456 ft	0 psf	770.3528 psf	334.95893 psf	0 psf	0 psf	CCR
Column 20	370.97836 ft	184.00675 ft	0 psf	780.39504 psf	339.32542 psf	0 psf	0 psf	CCR
Column 21	374.10993 ft	183.09894 ft	0 psf	790.43729 psf	343.69192 psf	0 psf	0 psf	CCR
Column 22	377.24149 ft	182.19113 ft	0 psf	800.47954 psf	348.05841 psf	0 psf	0 psf	CCR
Column 23	380.37306 ft	181.28332 ft	0 psf	810.52179 psf	352.4249 psf	0 psf	0 psf	CCR
Column 24	383.50463 ft	180.37551 ft	0 psf	820.56404 psf	356.7914 psf	0 psf	0 psf	CCR
Column 25	386.63620 ft	179.46769 ft	0 psf	830.60629 psf	361.15789 psf	0 psf	0 psf	CCR
Column 26	389.76777 ft	178.55988 ft	0 psf	840.64854 psf	365.52439 psf	0 psf	0 psf	CCR
Column 27	392.89934 ft	177.65207 ft	0 psf	850.69079 psf	369.89088 psf	0 psf	0 psf	CCR
Column 28	396.03091 ft	176.74426 ft	0 psf	860.73303 psf	374.25737 psf	0 psf	0 psf	CCR
Column 29	399.16247 ft	175.83645 ft	0 psf	870.77528 psf	378.62387 psf	0 psf	0 psf	CCR
Column 30	402.29404 ft	174.92864 ft	0 psf	880.81753 psf	382.99036 psf	0 psf	0 psf	CCR
Column 31	405.42561 ft	174.02083 ft	0 psf	890.85978 psf	387.35686 psf	0 psf	0 psf	CCR
Column 32	408.55718 ft	173.11302 ft	0 psf	900.90203 psf	391.72335 psf	0 psf	0 psf	CCR
Column 33	411.68875 ft	172.20521 ft	0 psf	910.94428 psf	396.08985 psf	0 psf	0 psf	CCR

Column 34	414.82032 ft	171.29740 ft	0 psf	920.98653 psf	400.45634 psf	0 psf	0 psf	CCR
Column 35	418.04195 ft	170.37935 ft	0 psf	932.12055 psf	405.29755 psf	0 psf	0 psf	CCR
Column 36	421.35365 ft	169.45106 ft	0 psf	940.21248 psf	408.81602 psf	0 psf	0 psf	CCR
Column 37	424.66535 ft	168.52277 ft	0 psf	948.30441 psf	412.33449 psf	0 psf	0 psf	CCR
Column 38	427.97705 ft	167.59449 ft	0 psf	956.39634 psf	415.85296 psf	0 psf	0 psf	CCR
Column 39	431.28875 ft	166.66620 ft	0 psf	964.48827 psf	419.37143 psf	0 psf	0 psf	CCR
Column 40	434.60045 ft	165.73791 ft	0 psf	972.5802 psf	422.88991 psf	0 psf	0 psf	CCR
Column 41	437.91214 ft	164.80963 ft	0 psf	980.67213 psf	426.40838 psf	0 psf	0 psf	CCR
Column 42	441.22384 ft	163.88134 ft	0 psf	988.76406 psf	429.92685 psf	0 psf	0 psf	CCR
Column 43	444.53554 ft	162.95305 ft	0 psf	996.85599 psf	433.44532 psf	0 psf	0 psf	CCR
Column 44	447.84724 ft	162.02477 ft	0 psf	1,004.9479 psf	436.96379 psf	0 psf	0 psf	CCR
Column 45	451.15894 ft	161.09648 ft	0 psf	1,013.0398 psf	440.48226 psf	0 psf	0 psf	CCR
Column 46	454.47064 ft	160.16819 ft	0 psf	1,021.1318 psf	444.00073 psf	0 psf	0 psf	CCR
Column 47	457.59438 ft	159.30603 ft	0 psf	1,029.8793 psf	447.80426 psf	0 psf	0 psf	CCR
Column 48	460.53016 ft	158.50997 ft	0 psf	1,034.9039 psf	449.98902 psf	0 psf	0 psf	CCR
Column 49	463.46594 ft	157.71392 ft	0 psf	1,039.9285 psf	452.17378 psf	0 psf	0 psf	CCR
Column 50	466.40171 ft	156.91788 ft	0 psf	1,044.9531 psf	454.35853 psf	0 psf	0 psf	CCR
Column 51	469.33749 ft	156.12183 ft	0 psf	1,049.9777 psf	456.54329 psf	0 psf	0 psf	CCR
Column 52	472.31393 ft	155.31721 ft	0 psf	1,055.2757 psf	458.84693 psf	0 psf	0 psf	CCR
Column 53	475.33104 ft	154.50404 ft	0 psf	1,060.0442 psf	460.92034 psf	0 psf	0 psf	CCR
Column 54	478.34815 ft	153.69087 ft	0 psf	1,064.8127 psf	462.99375 psf	0 psf	0 psf	CCR
Column 55	481.36526 ft	152.87769 ft	0 psf	1,069.5812 psf	465.06716 psf	0 psf	0 psf	CCR
Column 56	484.38237 ft	152.06452 ft	0 psf	1,074.3497 psf	467.14056 psf	0 psf	0 psf	CCR
Column 57	487.39948 ft	151.25134 ft	0 psf	1,079.1182 psf	469.21397 psf	0 psf	0 psf	CCR
Column 58	490.41659 ft	150.43817 ft	0 psf	1,083.8868 psf	471.28738 psf	0 psf	0 psf	CCR
Column 59	493.43370 ft	149.62500 ft	0 psf	1,088.6553 psf	473.36078 psf	0 psf	0 psf	CCR
Column 60	496.57821 ft	148.82414 ft	0 psf	1,097.1704 psf	477.06329 psf	0 psf	0 psf	CCR
Column 61	499.85012 ft	148.03561 ft	0 psf	1,094.8056 psf	476.03503 psf	0 psf	0 psf	CCR
Column 62	503.12204 ft	147.24708 ft	0 psf	1,092.4408 psf	475.00677 psf	0 psf	0 psf	CCR
Column 63	506.39395 ft	146.45855 ft	0 psf	1,090.0759 psf	473.9785 psf	0 psf	0 psf	CCR
Column 64	509.66587 ft	145.67002 ft	0 psf	1,087.7111 psf	472.95024 psf	0 psf	0 psf	CCR

Column 65	512.93778 ft	144.88148 ft	0 psf	1,085.3463 psf	471.92198 psf	0 psf	0 psf	CCR
Column 66	516.20970 ft	144.09295 ft	0 psf	1,082.9814 psf	470.89372 psf	0 psf	0 psf	CCR
Column 67	519.48161 ft	143.30442 ft	0 psf	1,080.6166 psf	469.86546 psf	0 psf	0 psf	CCR
Column 68	522.75353 ft	142.51589 ft	0 psf	1,078.2517 psf	468.8372 psf	0 psf	0 psf	CCR
Column 69	526.02544 ft	141.72736 ft	0 psf	1,075.8869 psf	467.80894 psf	0 psf	0 psf	CCR
Column 70	529.18802 ft	140.96820 ft	0 psf	1,073.8558 psf	466.9258 psf	0 psf	0 psf	CCR
Column 71	532.24125 ft	140.23842 ft	0 psf	1,071.1569 psf	465.75226 psf	0 psf	0 psf	CCR
Column 72	535.29448 ft	139.50865 ft	0 psf	1,068.4579 psf	464.57871 psf	0 psf	0 psf	CCR
Column 73	538.34771 ft	138.77887 ft	0 psf	1,065.7589 psf	463.40516 psf	0 psf	0 psf	CCR
Column 74	541.40094 ft	138.04909 ft	0 psf	1,063.0599 psf	462.23161 psf	0 psf	0 psf	CCR
Column 75	544.55978 ft	137.29768 ft	0 psf	1,060.5259 psf	461.1298 psf	0 psf	0 psf	CCR
Column 76	547.82423 ft	136.52463 ft	0 psf	1,057.0528 psf	459.61963 psf	0 psf	0 psf	CCR
Column 77	551.08868 ft	135.75158 ft	0 psf	1,053.5796 psf	458.10945 psf	0 psf	0 psf	CCR
Column 78	554.35313 ft	134.97854 ft	0 psf	1,050.1064 psf	456.59927 psf	0 psf	0 psf	CCR
Column 79	557.61758 ft	134.20549 ft	0 psf	1,046.6333 psf	455.08909 psf	0 psf	0 psf	CCR
Column 80	560.88203 ft	133.43244 ft	0 psf	1,043.1601 psf	453.57892 psf	0 psf	0 psf	CCR
Column 81	564.14647 ft	132.65940 ft	0 psf	1,039.6869 psf	452.06874 psf	0 psf	0 psf	CCR
Column 82	567.41092 ft	131.88635 ft	0 psf	1,036.2138 psf	450.55856 psf	0 psf	0 psf	CCR
Column 83	570.67537 ft	131.11330 ft	0 psf	1,032.7406 psf	449.04839 psf	0 psf	0 psf	CCR
Column 84	573.93982 ft	130.34026 ft	0 psf	1,029.2674 psf	447.53821 psf	0 psf	0 psf	CCR
Column 85	577.20427 ft	129.56721 ft	0 psf	1,025.7942 psf	446.02803 psf	0 psf	0 psf	CCR
Column 86	580.46872 ft	128.79416 ft	0 psf	1,022.3211 psf	444.51785 psf	0 psf	0 psf	CCR
Column 87	583.73317 ft	128.02111 ft	0 psf	1,018.8479 psf	443.00768 psf	0 psf	0 psf	CCR
Column 88	586.99761 ft	127.24807 ft	0 psf	1,015.3747 psf	441.4975 psf	0 psf	0 psf	CCR
Column 89	590.26206 ft	126.47502 ft	0 psf	1,011.9016 psf	439.98732 psf	0 psf	0 psf	CCR
Column 90	593.52651 ft	125.70197 ft	0 psf	1,008.4284 psf	438.47714 psf	0 psf	0 psf	CCR
Column 91	596.79096 ft	124.92893 ft	0 psf	1,004.9552 psf	436.96697 psf	0 psf	0 psf	CCR
Column 92	600.05541 ft	124.15588 ft	0 psf	1,001.482 psf	435.45679 psf	0 psf	0 psf	CCR
Column 93	603.31986 ft	123.38283 ft	0 psf	998.00888 psf	433.94661 psf	0 psf	0 psf	CCR
Column 94	606.47852 ft	122.65026 ft	0 psf	995.76287 psf	432.97002 psf	0 psf	0 psf	CCR
Column 95	609.53141 ft	121.95816 ft	0 psf	989.99576 psf	430.46241 psf	0 psf	0 psf	CCR

Column 96	612.58429 ft	121.26607 ft	0 psf	984.22865 psf	427.9548 psf	0 psf	0 psf	CCR
Column 97	615.63718 ft	120.57397 ft	0 psf	978.46154 psf	425.44719 psf	0 psf	0 psf	CCR
Column 98	618.69006 ft	119.88187 ft	0 psf	972.69443 psf	422.93958 psf	0 psf	0 psf	CCR
Column 99	621.74295 ft	119.18978 ft	0 psf	966.92732 psf	420.43197 psf	0 psf	0 psf	CCR
Column 100	624.98277 ft	118.45139 ft	0 psf	960.6082 psf	417.68433 psf	0 psf	0 psf	CCR
Column 101	628.40952 ft	117.66671 ft	0 psf	954.77523 psf	415.14809 psf	0 psf	0 psf	CCR
Column 102	631.83627 ft	116.88203 ft	0 psf	948.94226 psf	412.61184 psf	0 psf	0 psf	CCR
Column 103	635.26302 ft	116.09734 ft	0 psf	943.1093 psf	410.07559 psf	0 psf	0 psf	CCR
Column 104	638.68977 ft	115.31266 ft	0 psf	937.27633 psf	407.53935 psf	0 psf	0 psf	CCR
Column 105	642.11652 ft	114.52798 ft	0 psf	931.44336 psf	405.0031 psf	0 psf	0 psf	CCR
Column 106	645.45015 ft	113.77637 ft	0 psf	926.39638 psf	402.80861 psf	0 psf	0 psf	CCR
Column 107	648.69066 ft	113.05784 ft	0 psf	918.95572 psf	399.57332 psf	0 psf	0 psf	CCR
Column 108	651.93117 ft	112.33931 ft	0 psf	911.51506 psf	396.33803 psf	0 psf	0 psf	CCR
Column 109	655.17168 ft	111.62077 ft	0 psf	904.0744 psf	393.10274 psf	0 psf	0 psf	CCR
Column 110	658.41218 ft	110.90224 ft	0 psf	896.63374 psf	389.86745 psf	0 psf	0 psf	CCR
Column 111	661.65269 ft	110.18371 ft	0 psf	889.19308 psf	386.63216 psf	0 psf	0 psf	CCR
Column 112	664.89320 ft	109.46517 ft	0 psf	881.75242 psf	383.39687 psf	0 psf	0 psf	CCR
Column 113	668.13371 ft	108.74664 ft	0 psf	874.31176 psf	380.16157 psf	0 psf	0 psf	CCR
Column 114	671.37421 ft	108.02811 ft	0 psf	866.87111 psf	376.92628 psf	0 psf	0 psf	CCR
Column 115	674.61472 ft	107.30957 ft	0 psf	859.43045 psf	373.69099 psf	0 psf	0 psf	CCR
Column 116	677.85523 ft	106.59104 ft	0 psf	851.98979 psf	370.4557 psf	0 psf	0 psf	CCR
Column 117	681.09574 ft	105.87251 ft	0 psf	844.54913 psf	367.22041 psf	0 psf	0 psf	CCR
Column 118	684.32338 ft	105.16099 ft	0 psf	837.31073 psf	364.07307 psf	0 psf	0 psf	CCR
Column 119	687.53817 ft	104.45649 ft	0 psf	829.24559 psf	360.56625 psf	0 psf	0 psf	CCR
Column 120	690.75295 ft	103.75198 ft	0 psf	821.18046 psf	357.05942 psf	0 psf	0 psf	CCR
Column 121	693.96773 ft	103.04748 ft	0 psf	813.11532 psf	353.5526 psf	0 psf	0 psf	CCR
Column 122	697.18252 ft	102.34298 ft	0 psf	805.05019 psf	350.04578 psf	0 psf	0 psf	CCR
Column 123	700.39730 ft	101.63847 ft	0 psf	796.98505 psf	346.53896 psf	0 psf	0 psf	CCR
Column 124	703.61208 ft	100.93397 ft	0 psf	788.91991 psf	343.03214 psf	0 psf	0 psf	CCR
Column 125	706.82687 ft	100.22947 ft	0 psf	780.85478 psf	339.52532 psf	0 psf	0 psf	CCR
Column 126	710.04165 ft	99.52497 ft	0 psf	772.78964 psf	336.0185 psf	0 psf	0 psf	CCR

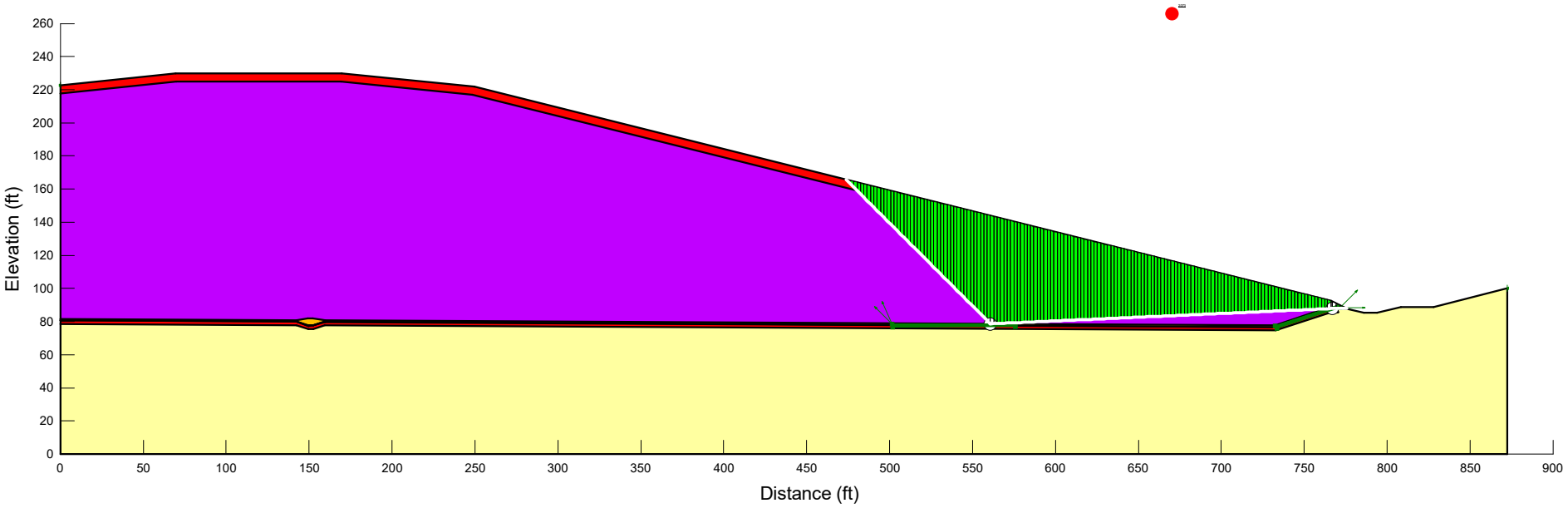
Column 127	713.25643 ft	98.82046 ft	0 psf	764.72451 psf	332.51168 psf	0 psf	0 psf	CCR
Column 128	716.47122 ft	98.11596 ft	0 psf	756.65937 psf	329.00486 psf	0 psf	0 psf	CCR
Column 129	719.59880 ft	97.43481 ft	0 psf	748.96071 psf	325.65738 psf	0 psf	0 psf	CCR
Column 130	722.63918 ft	96.77700 ft	0 psf	740.6362 psf	322.03779 psf	0 psf	0 psf	CCR
Column 131	725.67956 ft	96.11920 ft	0 psf	732.31169 psf	318.41819 psf	0 psf	0 psf	CCR
Column 132	728.71994 ft	95.46139 ft	0 psf	723.98719 psf	314.79859 psf	0 psf	0 psf	CCR
Column 133	731.76032 ft	94.80359 ft	0 psf	715.66268 psf	311.17899 psf	0 psf	0 psf	CCR
Column 134	734.80070 ft	94.14579 ft	0 psf	707.33817 psf	307.55939 psf	0 psf	0 psf	CCR
Column 135	737.84109 ft	93.48798 ft	0 psf	699.01366 psf	303.93979 psf	0 psf	0 psf	CCR
Column 136	740.88147 ft	92.83018 ft	0 psf	690.68915 psf	300.32019 psf	0 psf	0 psf	CCR
Column 137	743.92185 ft	92.17237 ft	0 psf	682.36465 psf	296.70059 psf	0 psf	0 psf	CCR
Column 138	746.96223 ft	91.51457 ft	0 psf	674.04014 psf	293.08099 psf	0 psf	0 psf	CCR
Column 139	750.00261 ft	90.85676 ft	0 psf	665.71563 psf	289.46139 psf	0 psf	0 psf	CCR
Column 140	752.96270 ft	90.30768 ft	0 psf	660.0558 psf	287.00043 psf	0 psf	0 psf	CCR
Column 141	755.84249 ft	89.86732 ft	0 psf	636.91515 psf	276.93859 psf	0 psf	0 psf	CCR
Column 142	758.72228 ft	89.42696 ft	0 psf	613.7745 psf	266.87675 psf	0 psf	0 psf	CCR
Column 143	761.62830 ft	88.98260 ft	0 psf	580.35843 psf	308.58205 psf	0 psf	0 psf	Clay
Column 144	764.56053 ft	88.53422 ft	0 psf	546.43685 psf	290.54563 psf	0 psf	0 psf	Clay
Column 145	767.55552 ft	88.07625 ft	0 psf	466.13834 psf	247.85015 psf	0 psf	0 psf	Clay
Column 146	770.82052 ft	87.57699 ft	0 psf	328.47082 psf	189.64272 psf	0 psf	0 psf	Subbase
Column 147	774.29277 ft	87.04603 ft	0 psf	182.87759 psf	105.58442 psf	0 psf	0 psf	Subbase
Column 148	777.68623 ft	86.52713 ft	0 psf	91.734141 psf	52.962731 psf	0 psf	0 psf	Subbase
Column 149	781.00089 ft	86.02027 ft	0 psf	55.040484 psf	31.777639 psf	0 psf	0 psf	Subbase
Column 150	784.31555 ft	85.51342 ft	0 psf	18.346828 psf	10.592546 psf	0 psf	0 psf	Subbase

09/28/2023 Classification: Internal ECRM13153872

Title: Columbia Mod 12-13 Full Buildout
Name: Block_FS=1.5
Method: Janbu
Last Edited By: Villanueva, Niko

F of S: 2.073
F of S Rank (Analysis): 1 of 234,256 slip surfaces
Last Solved Date: 08/30/2023, Last Solved Time: 07:51:00 AM

Color	Name	Slope Stability Material Model	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)
	CCR	Mohr-Coulomb	86	0	23.5
	Clay	Mohr-Coulomb	125	0	28
	Drainage Layer	Mohr-Coulomb	115	0	30
	Geosynthetics	Mohr-Coulomb	58	0	24.3
	Subbase	Mohr-Coulomb	120	0	30



Block_FS=1.5

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File Information

File Version: 11.05
Title: Columbia Mod 12-13 Full Buildout
Created By: Villanueva, Niko
Last Edited By: Villanueva, Niko
Revision Number: 59
Date: 08/30/2023
Time: 07:48:22 AM
Tool Version: 23.1.1.829
File Name: COL_Mod12-13_Full Buildout.gsz
Directory: I:\25222260.00\Data and Calculations\Geotech Calculations\Slope Stability\SlopeW\
Last Solved Date: 08/30/2023
Last Solved Time: 07:51:00 AM

Project Settings

Unit System: U.S. Customary Units

Analysis Settings

Block_FS=1.5

Kind: SLOPE/W
Analysis Type: Janbu
Settings
- PWP Conditions from: (none)
- Unit Weight of Water: 62.4 pcf

Slip Surface
- Direction of movement: Left to Right
- Use Passive Mode: No
- Slip Surface Option: Block
- Critical slip surfaces saved: 10
- Restrict Block Crossing: No
- Optimize Critical Slip Surface Location: No
- Tension Crack Option: (none)

Distribution
- F of S Calculation Option: Constant

Convergence
- Geometry Settings
  - Minimum Slip Surface Depth: 0.1 ft
  - Number of Columns: 150
- Factor of Safety Convergence Settings
  - Maximum Number of Iterations: 30,000
  - Tolerable difference in F of S: 0.001

Materials

CCR

Slope Stability Material Model: Mohr-Coulomb
Unit Weight: 86 pcf
Effective Cohesion: 0 psf
Effective Friction Angle: 23.5 °
Phi-B: 0 °

Clay

Slope Stability Material Model: Mohr-Coulomb

Unit Weight: 125 pcf
Effective Cohesion: 0 psf
Effective Friction Angle: 28 °
Phi-B: 0 °

Drainage Layer

Slope Stability Material Model: Mohr-Coulomb
Unit Weight: 115 pcf
Effective Cohesion: 0 psf
Effective Friction Angle: 30 °
Phi-B: 0 °

Geosynthetics

Slope Stability Material Model: Mohr-Coulomb
Unit Weight: 58 pcf
Effective Cohesion: 0 psf
Effective Friction Angle: 24.3 °
Phi-B: 0 °

Subbase

Slope Stability Material Model: Mohr-Coulomb
Unit Weight: 120 pcf
Effective Cohesion: 0 psf
Effective Friction Angle: 30 °
Phi-B: 0 °

Slip Surface Limits

Left Coordinate: (0, 222.8) ft
Right Coordinate: (872.23081, 100) ft

Slip Surface Block

Left Grid
- Upper Left: (501.66323, 78.59637) ft
- Lower Left: (501.71597, 76.77685) ft
- Lower Right: (575.63085, 76.85596) ft
- X Increments: 10
- Y Increments: 10
- Starting Angle: 115 °
- Ending Angle: 135 °
- Angle Increments: 3

Right Grid
- Upper Left: (732.31286, 77.23832) ft
- Lower Left: (733.52148, 75.77333) ft
- Lower Right: (771.48024, 88.43235) ft
- X Increments: 10
- Y Increments: 10
- Angle Increments: 3

Geometry

Name: Default Geometry

Settings

View: 2D
Element Thickness: 1 ft

Points

	X	Y
Point 1	768.91041 ft	87.74349 ft
Point 2	766.02664 ft	87.74317 ft
Point 3	732.66754 ft	76.62354 ft

Point 4	159.35647 ft	79.79909 ft
Point 5	152.46501 ft	77.58553 ft
Point 6	149.45787 ft	77.54639 ft
Point 7	142.29499 ft	79.95559 ft
Point 8	0 ft	80.72488 ft
Point 9	0 ft	78.63599 ft
Point 10	142.29493 ft	77.86789 ft
Point 11	149.45787 ft	75.41847 ft
Point 12	152.46501 ft	75.45626 ft
Point 13	159.35619 ft	77.75007 ft
Point 14	732.66724 ft	74.58984 ft
Point 15	768.91041 ft	86.64701 ft
Point 16	872.23081 ft	100 ft
Point 17	828.17946 ft	88.78332 ft
Point 18	808.17769 ft	88.78332 ft
Point 19	794.02935 ft	85.24543 ft
Point 20	786.03116 ft	85.24543 ft
Point 21	776.0289 ft	87.7443 ft
Point 22	769.01095 ft	87.8435 ft
Point 23	769.01041 ft	85.84317 ft
Point 24	770.01041 ft	85.84317 ft
Point 25	770.01041 ft	85.74351 ft
Point 26	768.91041 ft	85.74351 ft
Point 27	0 ft	0 ft
Point 28	872.23081 ft	0 ft
Point 29	764.03814 ft	88.23984 ft
Point 30	732.49201 ft	77.72453 ft
Point 31	159.6047 ft	80.8285 ft
Point 32	152.35619 ft	82.00202 ft
Point 33	148.97182 ft	82.00419 ft
Point 34	142.29493 ft	80.97938 ft
Point 35	0 ft	81.74787 ft
Point 36	0 ft	80.82487 ft
Point 37	142.31162 ft	80.0555 ft
Point 38	149.47361 ft	77.64661 ft
Point 39	152.44871 ft	77.68532 ft
Point 40	159.34108 ft	79.89918 ft
Point 41	732.65158 ft	76.72363 ft
Point 42	766.01041 ft	87.84317 ft
Point 43	249.53 ft	221.75 ft
Point 44	169.53 ft	229.75 ft
Point 45	69.53 ft	229.75 ft
Point 46	0 ft	222.8 ft
Point 47	0 ft	217.82 ft
Point 48	69.78 ft	224.75 ft
Point 49	169.28 ft	224.75 ft
Point 50	248.67 ft	216.81 ft
Point 51	769.01041 ft	87.84351 ft
Point 52	766.02664 ft	92.74317 ft
Point 53	766.02718 ft	87.74317 ft
Point 54	768.91095 ft	87.74349 ft
Point 55	768.91095 ft	85.7435 ft
Point 56	770.01095 ft	85.7435 ft
Point 57	770.01095 ft	85.84316 ft
Point 58	769.01095 ft	85.84316 ft
Point 59	766.01095 ft	87.84316 ft
Point 60	732.65213 ft	76.72363 ft
Point 61	159.34162 ft	79.89918 ft

Point 62	152.44925 ft	77.68532 ft
Point 63	149.47415 ft	77.6466 ft
Point 64	142.31216 ft	80.0555 ft
Point 65	142.29553 ft	79.95558 ft
Point 66	149.45841 ft	77.54639 ft
Point 67	152.46555 ft	77.58552 ft
Point 68	159.35701 ft	79.79909 ft
Point 69	732.66808 ft	76.62354 ft
Point 70	768.91095 ft	85.74351 ft
Point 71	770.01041 ft	85.84316 ft
Point 72	769.01095 ft	85.84317 ft
Point 73	732.65159 ft	76.72363 ft
Point 74	159.34161 ft	79.89918 ft
Point 75	149.4741 ft	77.64662 ft
Point 76	142.29501 ft	79.95558 ft
Point 77	149.45839 ft	77.5464 ft
Point 78	159.357 ft	79.79909 ft
Point 79	732.66755 ft	76.62354 ft

Regions

	Material	Points	Area
Region 1	Clay	1,53,69,79,3,68,78,67,66,77,6,76,8,9,10,11,12,13,14,15	1,576.1 ft²
Region 2	Subbase	16,17,18,19,20,21,22,72,24,71,57,56,55,70,26,15,14,13,12,11,10,9,27,28	68,366 ft²
Region 3	Drainage Layer	29,30,31,32,33,34,35,36,37,64,75,39,40,74,61,41,73,42	769.27 ft²
Region 4	Clay	43,44,45,46,47,48,49,50,29,42,51,22,21,52	3,896.4 ft²
Region 5	CCR	50,49,48,47,35,34,33,32,31,30,29	72,914 ft²
Region 6	Geosynthetics	53,1,54,70,55,56,57,71,58,72,22,59,60,73,41,61,74,62,63,75,64,37,36,8,76,65,77,66,67,78,68,3,79,69	77.457 ft²

Slip Results

Slip Surfaces Analysed: 70472 of 234256 converged

Current Slip Surface

Slip Surface: 230,157
Factor of Safety: 2.073
Volume: 10,076.604 ft³
Weight: 924,351.53 lbf
Resisting Moment: 40,261,081 lbf·ft
Activating Moment: 21,196,838 lbf·ft
Resisting Force: 385,720.03 lbf
Activating Force: 186,047.9 lbf
Slip Rank: 1 of 234,256 slip surfaces
Exit: (775.71947, 87.898943) ft
Entry: (473.69516, 165.75963) ft
Radius: 146.39865 ft
Center: (639.76145, 185.22481) ft

Slip Columns

	X	Y	PWP	Base Normal Stress	Frictional Strength	Cohesive Strength	Suction Strength	Base Material
Column 1	474.82486 ft	164.62994 ft	0 psf	84.31206 psf	44.829518 psf	0 psf	0 psf	Clay
Column 2	477.08425 ft	162.37054 ft	0 psf	252.93618 psf	134.48855 psf	0 psf	0 psf	Clay

Column 3	479.34365 ft	160.11115 ft	0 psf	421.5603 psf	224.14759 psf	0 psf	0 psf	Clay
Column 4	481.47737 ft	157.97743 ft	0 psf	578.95722 psf	251.73776 psf	0 psf	0 psf	CCR
Column 5	483.48541 ft	155.96938 ft	0 psf	686.02951 psf	298.29412 psf	0 psf	0 psf	CCR
Column 6	485.49346 ft	153.96134 ft	0 psf	793.1018 psf	344.85048 psf	0 psf	0 psf	CCR
Column 7	487.50150 ft	151.95329 ft	0 psf	900.1741 psf	391.40684 psf	0 psf	0 psf	CCR
Column 8	489.50954 ft	149.94525 ft	0 psf	1,007.2464 psf	437.96319 psf	0 psf	0 psf	CCR
Column 9	491.51759 ft	147.93720 ft	0 psf	1,114.3187 psf	484.51955 psf	0 psf	0 psf	CCR
Column 10	493.52563 ft	145.92916 ft	0 psf	1,221.391 psf	531.07591 psf	0 psf	0 psf	CCR
Column 11	495.53368 ft	143.92111 ft	0 psf	1,328.4633 psf	577.63227 psf	0 psf	0 psf	CCR
Column 12	497.54172 ft	141.91307 ft	0 psf	1,435.5356 psf	624.18863 psf	0 psf	0 psf	CCR
Column 13	499.54977 ft	139.90502 ft	0 psf	1,542.6079 psf	670.74498 psf	0 psf	0 psf	CCR
Column 14	501.55781 ft	137.89698 ft	0 psf	1,649.6801 psf	717.30134 psf	0 psf	0 psf	CCR
Column 15	503.56586 ft	135.88893 ft	0 psf	1,756.7524 psf	763.8577 psf	0 psf	0 psf	CCR
Column 16	505.57390 ft	133.88089 ft	0 psf	1,863.8247 psf	810.41406 psf	0 psf	0 psf	CCR
Column 17	507.58195 ft	131.87284 ft	0 psf	1,970.897 psf	856.97041 psf	0 psf	0 psf	CCR
Column 18	509.58999 ft	129.86480 ft	0 psf	2,077.9693 psf	903.52677 psf	0 psf	0 psf	CCR
Column 19	511.59804 ft	127.85675 ft	0 psf	2,185.0416 psf	950.08313 psf	0 psf	0 psf	CCR
Column 20	513.60608 ft	125.84871 ft	0 psf	2,292.1139 psf	996.63949 psf	0 psf	0 psf	CCR
Column 21	515.61413 ft	123.84067 ft	0 psf	2,399.1862 psf	1,043.1958 psf	0 psf	0 psf	CCR
Column 22	517.62217 ft	121.83262 ft	0 psf	2,506.2585 psf	1,089.7522 psf	0 psf	0 psf	CCR
Column 23	519.63022 ft	119.82458 ft	0 psf	2,613.3308 psf	1,136.3086 psf	0 psf	0 psf	CCR
Column 24	521.63826 ft	117.81653 ft	0 psf	2,720.4031 psf	1,182.8649 psf	0 psf	0 psf	CCR
Column 25	523.64631 ft	115.80849 ft	0 psf	2,827.4754 psf	1,229.4213 psf	0 psf	0 psf	CCR
Column 26	525.65435 ft	113.80044 ft	0 psf	2,934.5477 psf	1,275.9776 psf	0 psf	0 psf	CCR
Column 27	527.66240 ft	111.79240 ft	0 psf	3,041.6199 psf	1,322.534 psf	0 psf	0 psf	CCR
Column 28	529.67044 ft	109.78435 ft	0 psf	3,148.6922 psf	1,369.0904 psf	0 psf	0 psf	CCR
Column 29	531.67848 ft	107.77631 ft	0 psf	3,255.7645 psf	1,415.6467 psf	0 psf	0 psf	CCR
Column 30	533.68653 ft	105.76826 ft	0 psf	3,362.8368 psf	1,462.2031 psf	0 psf	0 psf	CCR
Column 31	535.69457 ft	103.76022 ft	0 psf	3,469.9091 psf	1,508.7594 psf	0 psf	0 psf	CCR
Column 32	537.70262 ft	101.75217 ft	0 psf	3,576.9814 psf	1,555.3158 psf	0 psf	0 psf	CCR
Column 33	539.71066 ft	99.74413 ft	0 psf	3,684.0537 psf	1,601.8721 psf	0 psf	0 psf	CCR

Column 34	541.71871 ft	97.73608 ft	0 psf	3,791.126 psf	1,648.4285 psf	0 psf	0 psf	CCR
Column 35	543.72675 ft	95.72804 ft	0 psf	3,898.1983 psf	1,694.9849 psf	0 psf	0 psf	CCR
Column 36	545.73480 ft	93.71999 ft	0 psf	4,005.2706 psf	1,741.5412 psf	0 psf	0 psf	CCR
Column 37	547.74284 ft	91.71195 ft	0 psf	4,112.3429 psf	1,788.0976 psf	0 psf	0 psf	CCR
Column 38	549.75089 ft	89.70390 ft	0 psf	4,219.4152 psf	1,834.6539 psf	0 psf	0 psf	CCR
Column 39	551.75893 ft	87.69586 ft	0 psf	4,326.4875 psf	1,881.2103 psf	0 psf	0 psf	CCR
Column 40	553.76698 ft	85.68781 ft	0 psf	4,433.5597 psf	1,927.7666 psf	0 psf	0 psf	CCR
Column 41	555.77502 ft	83.67977 ft	0 psf	4,540.632 psf	1,974.323 psf	0 psf	0 psf	CCR
Column 42	557.78307 ft	81.67173 ft	0 psf	4,647.7043 psf	2,020.8794 psf	0 psf	0 psf	CCR
Column 43	559.79111 ft	79.66368 ft	0 psf	4,754.7766 psf	2,067.4357 psf	0 psf	0 psf	CCR
Column 44	561.80308 ft	78.70480 ft	0 psf	5,846.4191 psf	2,542.0954 psf	0 psf	0 psf	CCR
Column 45	563.81897 ft	78.79509 ft	0 psf	5,794.8437 psf	2,519.6697 psf	0 psf	0 psf	CCR
Column 46	565.83487 ft	78.88538 ft	0 psf	5,743.2682 psf	2,497.2441 psf	0 psf	0 psf	CCR
Column 47	567.85076 ft	78.97567 ft	0 psf	5,691.6927 psf	2,474.8184 psf	0 psf	0 psf	CCR
Column 48	569.86666 ft	79.06596 ft	0 psf	5,640.1172 psf	2,452.3928 psf	0 psf	0 psf	CCR
Column 49	571.88255 ft	79.15625 ft	0 psf	5,588.5417 psf	2,429.9671 psf	0 psf	0 psf	CCR
Column 50	573.89844 ft	79.24654 ft	0 psf	5,536.9663 psf	2,407.5415 psf	0 psf	0 psf	CCR
Column 51	575.91434 ft	79.33683 ft	0 psf	5,485.3908 psf	2,385.1158 psf	0 psf	0 psf	CCR
Column 52	577.93023 ft	79.42712 ft	0 psf	5,433.8153 psf	2,362.6901 psf	0 psf	0 psf	CCR
Column 53	579.94613 ft	79.51741 ft	0 psf	5,382.2398 psf	2,340.2645 psf	0 psf	0 psf	CCR
Column 54	581.96202 ft	79.60770 ft	0 psf	5,330.6644 psf	2,317.8388 psf	0 psf	0 psf	CCR
Column 55	583.97791 ft	79.69799 ft	0 psf	5,279.0889 psf	2,295.4132 psf	0 psf	0 psf	CCR
Column 56	585.99381 ft	79.78828 ft	0 psf	5,227.5134 psf	2,272.9875 psf	0 psf	0 psf	CCR
Column 57	588.00970 ft	79.87857 ft	0 psf	5,175.9379 psf	2,250.5619 psf	0 psf	0 psf	CCR
Column 58	590.02559 ft	79.96886 ft	0 psf	5,124.3624 psf	2,228.1362 psf	0 psf	0 psf	CCR
Column 59	592.04149 ft	80.05915 ft	0 psf	5,072.787 psf	2,205.7105 psf	0 psf	0 psf	CCR
Column 60	594.05738 ft	80.14944 ft	0 psf	5,021.2115 psf	2,183.2849 psf	0 psf	0 psf	CCR
Column 61	596.07328 ft	80.23973 ft	0 psf	4,969.636 psf	2,160.8592 psf	0 psf	0 psf	CCR
Column 62	598.08917 ft	80.33002 ft	0 psf	4,918.0605 psf	2,138.4336 psf	0 psf	0 psf	CCR
Column 63	600.10506 ft	80.42031 ft	0 psf	4,866.4851 psf	2,116.0079 psf	0 psf	0 psf	CCR
Column 64	602.12096 ft	80.51060 ft	0 psf	4,814.9096 psf	2,093.5823 psf	0 psf	0 psf	CCR

Column 65	604.13685 ft	80.60089 ft	0 psf	4,763.3341 psf	2,071.1566 psf	0 psf	0 psf	CCR
Column 66	606.15274 ft	80.69118 ft	0 psf	4,711.7586 psf	2,048.731 psf	0 psf	0 psf	CCR
Column 67	608.16864 ft	80.78147 ft	0 psf	4,660.1831 psf	2,026.3053 psf	0 psf	0 psf	CCR
Column 68	610.18453 ft	80.87176 ft	0 psf	4,608.6077 psf	2,003.8796 psf	0 psf	0 psf	CCR
Column 69	612.20043 ft	80.96205 ft	0 psf	4,557.0322 psf	1,981.454 psf	0 psf	0 psf	CCR
Column 70	614.21632 ft	81.05234 ft	0 psf	4,505.4567 psf	1,959.0283 psf	0 psf	0 psf	CCR
Column 71	616.23221 ft	81.14263 ft	0 psf	4,453.8812 psf	1,936.6027 psf	0 psf	0 psf	CCR
Column 72	618.24811 ft	81.23292 ft	0 psf	4,402.3058 psf	1,914.177 psf	0 psf	0 psf	CCR
Column 73	620.26400 ft	81.32321 ft	0 psf	4,350.7303 psf	1,891.7514 psf	0 psf	0 psf	CCR
Column 74	622.27989 ft	81.41350 ft	0 psf	4,299.1548 psf	1,869.3257 psf	0 psf	0 psf	CCR
Column 75	624.29579 ft	81.50379 ft	0 psf	4,247.5793 psf	1,846.9001 psf	0 psf	0 psf	CCR
Column 76	626.31168 ft	81.59408 ft	0 psf	4,196.0039 psf	1,824.4744 psf	0 psf	0 psf	CCR
Column 77	628.32758 ft	81.68437 ft	0 psf	4,144.4284 psf	1,802.0487 psf	0 psf	0 psf	CCR
Column 78	630.34347 ft	81.77465 ft	0 psf	4,092.8529 psf	1,779.6231 psf	0 psf	0 psf	CCR
Column 79	632.35936 ft	81.86494 ft	0 psf	4,041.2774 psf	1,757.1974 psf	0 psf	0 psf	CCR
Column 80	634.37526 ft	81.95523 ft	0 psf	3,989.7019 psf	1,734.7718 psf	0 psf	0 psf	CCR
Column 81	636.39115 ft	82.04552 ft	0 psf	3,938.1265 psf	1,712.3461 psf	0 psf	0 psf	CCR
Column 82	638.40705 ft	82.13581 ft	0 psf	3,886.551 psf	1,689.9205 psf	0 psf	0 psf	CCR
Column 83	640.42294 ft	82.22610 ft	0 psf	3,834.9755 psf	1,667.4948 psf	0 psf	0 psf	CCR
Column 84	642.43883 ft	82.31639 ft	0 psf	3,783.4 psf	1,645.0692 psf	0 psf	0 psf	CCR
Column 85	644.45473 ft	82.40668 ft	0 psf	3,731.8246 psf	1,622.6435 psf	0 psf	0 psf	CCR
Column 86	646.47062 ft	82.49697 ft	0 psf	3,680.2491 psf	1,600.2178 psf	0 psf	0 psf	CCR
Column 87	648.48651 ft	82.58726 ft	0 psf	3,628.6736 psf	1,577.7922 psf	0 psf	0 psf	CCR
Column 88	650.50241 ft	82.67755 ft	0 psf	3,577.0981 psf	1,555.3665 psf	0 psf	0 psf	CCR
Column 89	652.51830 ft	82.76784 ft	0 psf	3,525.5226 psf	1,532.9409 psf	0 psf	0 psf	CCR
Column 90	654.53420 ft	82.85813 ft	0 psf	3,473.9472 psf	1,510.5152 psf	0 psf	0 psf	CCR
Column 91	656.55009 ft	82.94842 ft	0 psf	3,422.3717 psf	1,488.0896 psf	0 psf	0 psf	CCR
Column 92	658.56598 ft	83.03871 ft	0 psf	3,370.7962 psf	1,465.6639 psf	0 psf	0 psf	CCR
Column 93	660.58188 ft	83.12900 ft	0 psf	3,319.2207 psf	1,443.2382 psf	0 psf	0 psf	CCR
Column 94	662.59777 ft	83.21929 ft	0 psf	3,267.6453 psf	1,420.8126 psf	0 psf	0 psf	CCR
Column 95	664.61366 ft	83.30958 ft	0 psf	3,216.0698 psf	1,398.3869 psf	0 psf	0 psf	CCR

Column 96	666.62956 ft	83.39987 ft	0 psf	3,164.4943 psf	1,375.9613 psf	0 psf	0 psf	CCR
Column 97	668.64545 ft	83.49016 ft	0 psf	3,112.9188 psf	1,353.5356 psf	0 psf	0 psf	CCR
Column 98	670.66135 ft	83.58045 ft	0 psf	3,061.3433 psf	1,331.11 psf	0 psf	0 psf	CCR
Column 99	672.67724 ft	83.67074 ft	0 psf	3,009.7679 psf	1,308.6843 psf	0 psf	0 psf	CCR
Column 100	674.69313 ft	83.76103 ft	0 psf	2,958.1924 psf	1,286.2587 psf	0 psf	0 psf	CCR
Column 101	676.70903 ft	83.85132 ft	0 psf	2,906.6169 psf	1,263.833 psf	0 psf	0 psf	CCR
Column 102	678.72492 ft	83.94161 ft	0 psf	2,855.0414 psf	1,241.4073 psf	0 psf	0 psf	CCR
Column 103	680.74081 ft	84.03190 ft	0 psf	2,803.466 psf	1,218.9817 psf	0 psf	0 psf	CCR
Column 104	682.75671 ft	84.12219 ft	0 psf	2,751.8905 psf	1,196.556 psf	0 psf	0 psf	CCR
Column 105	684.77260 ft	84.21248 ft	0 psf	2,700.315 psf	1,174.1304 psf	0 psf	0 psf	CCR
Column 106	686.78850 ft	84.30277 ft	0 psf	2,648.7395 psf	1,151.7047 psf	0 psf	0 psf	CCR
Column 107	688.80439 ft	84.39306 ft	0 psf	2,597.164 psf	1,129.2791 psf	0 psf	0 psf	CCR
Column 108	690.82028 ft	84.48335 ft	0 psf	2,545.5886 psf	1,106.8534 psf	0 psf	0 psf	CCR
Column 109	692.83618 ft	84.57364 ft	0 psf	2,494.0131 psf	1,084.4278 psf	0 psf	0 psf	CCR
Column 110	694.85207 ft	84.66393 ft	0 psf	2,442.4376 psf	1,062.0021 psf	0 psf	0 psf	CCR
Column 111	696.86797 ft	84.75422 ft	0 psf	2,390.8621 psf	1,039.5764 psf	0 psf	0 psf	CCR
Column 112	698.88386 ft	84.84451 ft	0 psf	2,339.2867 psf	1,017.1508 psf	0 psf	0 psf	CCR
Column 113	700.89975 ft	84.93480 ft	0 psf	2,287.7112 psf	994.72513 psf	0 psf	0 psf	CCR
Column 114	702.91565 ft	85.02509 ft	0 psf	2,236.1357 psf	972.29948 psf	0 psf	0 psf	CCR
Column 115	704.93154 ft	85.11538 ft	0 psf	2,184.5602 psf	949.87382 psf	0 psf	0 psf	CCR
Column 116	706.94743 ft	85.20567 ft	0 psf	2,132.9847 psf	927.44816 psf	0 psf	0 psf	CCR
Column 117	708.96333 ft	85.29596 ft	0 psf	2,081.4093 psf	905.02251 psf	0 psf	0 psf	CCR
Column 118	710.97922 ft	85.38625 ft	0 psf	2,029.8338 psf	882.59685 psf	0 psf	0 psf	CCR
Column 119	712.99512 ft	85.47654 ft	0 psf	1,978.2583 psf	860.1712 psf	0 psf	0 psf	CCR
Column 120	715.01101 ft	85.56683 ft	0 psf	1,926.6828 psf	837.74554 psf	0 psf	0 psf	CCR
Column 121	717.02690 ft	85.65711 ft	0 psf	1,875.1074 psf	815.31989 psf	0 psf	0 psf	CCR
Column 122	719.04280 ft	85.74740 ft	0 psf	1,823.5319 psf	792.89423 psf	0 psf	0 psf	CCR
Column 123	721.05869 ft	85.83769 ft	0 psf	1,771.9564 psf	770.46857 psf	0 psf	0 psf	CCR
Column 124	723.07458 ft	85.92798 ft	0 psf	1,720.3809 psf	748.04292 psf	0 psf	0 psf	CCR
Column 125	725.09048 ft	86.01827 ft	0 psf	1,668.8055 psf	725.61726 psf	0 psf	0 psf	CCR
Column 126	727.10637 ft	86.10856 ft	0 psf	1,617.23 psf	703.19161 psf	0 psf	0 psf	CCR

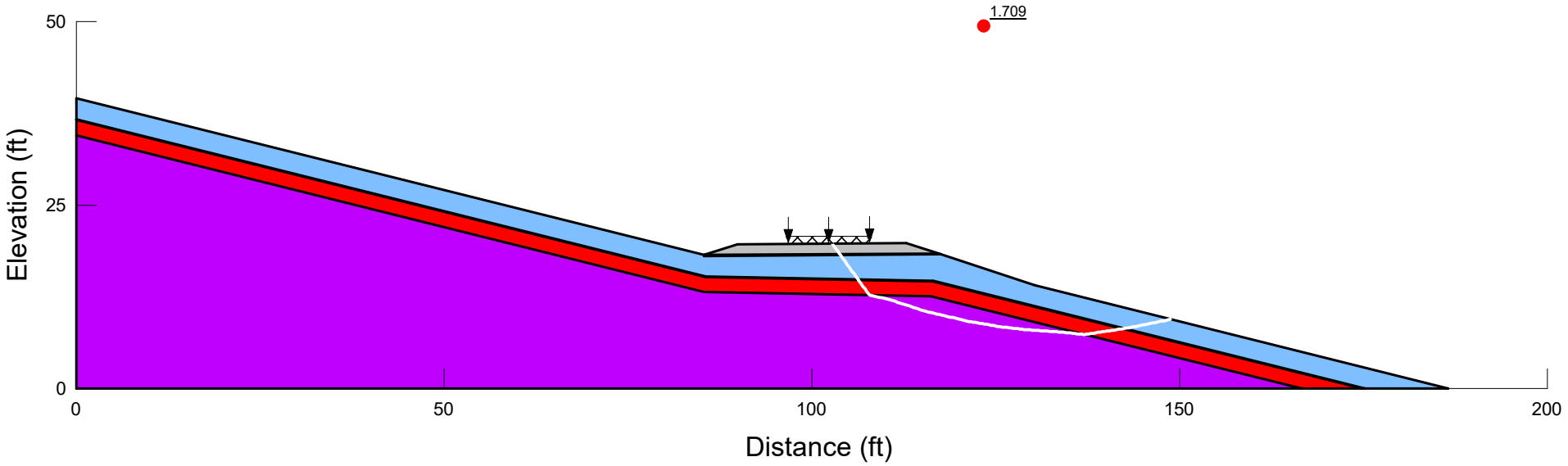
Column 127	729.12227 ft	86.19885 ft	0 psf	1,565.6545 psf	680.76595 psf	0 psf	0 psf	CCR
Column 128	731.13816 ft	86.28914 ft	0 psf	1,514.079 psf	658.34029 psf	0 psf	0 psf	CCR
Column 129	733.15405 ft	86.37943 ft	0 psf	1,462.5035 psf	635.91464 psf	0 psf	0 psf	CCR
Column 130	735.16995 ft	86.46972 ft	0 psf	1,410.9281 psf	613.48898 psf	0 psf	0 psf	CCR
Column 131	737.18584 ft	86.56001 ft	0 psf	1,359.3526 psf	591.06333 psf	0 psf	0 psf	CCR
Column 132	739.20173 ft	86.65030 ft	0 psf	1,307.7771 psf	568.63767 psf	0 psf	0 psf	CCR
Column 133	741.21763 ft	86.74059 ft	0 psf	1,256.2016 psf	546.21201 psf	0 psf	0 psf	CCR
Column 134	743.23352 ft	86.83088 ft	0 psf	1,204.6262 psf	523.78636 psf	0 psf	0 psf	CCR
Column 135	745.24942 ft	86.92117 ft	0 psf	1,153.0507 psf	501.3607 psf	0 psf	0 psf	CCR
Column 136	747.26531 ft	87.01146 ft	0 psf	1,101.4752 psf	478.93505 psf	0 psf	0 psf	CCR
Column 137	749.28120 ft	87.10175 ft	0 psf	1,049.8997 psf	456.50939 psf	0 psf	0 psf	CCR
Column 138	751.29710 ft	87.19204 ft	0 psf	998.32424 psf	434.08374 psf	0 psf	0 psf	CCR
Column 139	753.31299 ft	87.28233 ft	0 psf	946.74877 psf	411.65808 psf	0 psf	0 psf	CCR
Column 140	755.32889 ft	87.37262 ft	0 psf	895.17329 psf	389.23242 psf	0 psf	0 psf	CCR
Column 141	757.34478 ft	87.46291 ft	0 psf	843.59781 psf	366.80677 psf	0 psf	0 psf	CCR
Column 142	759.36067 ft	87.55320 ft	0 psf	792.02233 psf	344.38111 psf	0 psf	0 psf	CCR
Column 143	761.37657 ft	87.64349 ft	0 psf	740.44686 psf	321.95546 psf	0 psf	0 psf	CCR
Column 144	763.21133 ft	87.72567 ft	0 psf	702.67465 psf	405.6894 psf	0 psf	0 psf	Drainage Layer
Column 145	765.03239 ft	87.80723 ft	0 psf	653.80591 psf	377.47502 psf	0 psf	0 psf	Drainage Layer
Column 146	766.55335 ft	87.87535 ft	0 psf	582.26311 psf	309.59478 psf	0 psf	0 psf	Clay
Column 147	768.15998 ft	87.89894 ft	0 psf	472.25478 psf	251.10232 psf	0 psf	0 psf	Clay
Column 148	770.31984 ft	87.89894 ft	0 psf	337.32485 psf	179.3588 psf	0 psf	0 psf	Clay
Column 149	772.47969 ft	87.89894 ft	0 psf	202.39491 psf	107.61528 psf	0 psf	0 psf	Clay
Column 150	774.63955 ft	87.89894 ft	0 psf	67.464969 psf	35.87176 psf	0 psf	0 psf	Clay

09/28/2023 Classification: Internal ECRM13153872

Title: Columbia Mod 12-13 Access Road
Name: Optimized Circular_FS=1.5
Method: Bishop
Last Edited By: Villanueva, Niko

F of S: 1.709
F of S Rank (Analysis): 1 of 10,572 slip surfaces
Surcharge (Unit Weight): 630 pcf
Last Solved Date: 08/23/2023, Last Solved Time: 09:55:54 AM

Color	Name	Slope Stability Material Model	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)
	CCR	Mohr-Coulomb	86	0	23.5
	Clay	Mohr-Coulomb	125	0	28
	Geosynthetics	Mohr-Coulomb	58	0	24.3
	Geotextile	Mohr-Coulomb	58	0	30
	Road Aggregate	Mohr-Coulomb	135	0	35
	Rooting Zone/Sand	Mohr-Coulomb	120	0	30



Optimized Circular_FS=1.5

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File Information

File Version: 11.05
Title: Columbia Mod 12-13 Access Road
Created By: Villanueva, Niko
Last Edited By: Villanueva, Niko
Revision Number: 122
Date: 08/23/2023
Time: 09:51:08 AM
Tool Version: 23.1.1.829
File Name: COL_Mod12-13_Access Road_3H1V.gsz
Directory: I:\25222260.00\Data and Calculations\Geotech Calculations\Slope Stability\SlopeW\
Last Solved Date: 08/23/2023
Last Solved Time: 09:55:54 AM

Project Settings

Unit System: U.S. Customary Units

Analysis Settings

Optimized Circular_FS=1.5

Kind: SLOPE/W
Analysis Type: Bishop
Settings
- PWP Conditions from: (none)
- Unit Weight of Water: 62.4 pcf

Slip Surface
- Direction of movement: Left to Right
- Use Passive Mode: No
- Slip Surface Option: Entry and Exit
- Critical slip surfaces saved: 10
- Optimize Critical Slip Surface Location: Yes
- Optimizations Settings
  - Maximum Iterations: 2,000
  - Starting Points: 8
  - Ending Points: 16
  - Driving Side Maximum Convex Angle: 5 °
  - Resisting Side Maximum Convex Angle: 1 °
- Tension Crack Option: (none)

Distribution
- F of S Calculation Option: Constant

Convergence
- Geometry Settings
  - Minimum Slip Surface Depth: 0.1 ft
  - Number of Columns: 150
- Factor of Safety Convergence Settings

Maximum Number of Iterations: 30,000
Tolerable difference in F of S: 0.001

Materials

CCR

Slope Stability Material Model: Mohr-Coulomb
Unit Weight: 86 pcf
Effective Cohesion: 0 psf
Effective Friction Angle: 23.5 °
Phi-B: 0 °

Clay

Slope Stability Material Model: Mohr-Coulomb
Unit Weight: 125 pcf
Effective Cohesion: 0 psf
Effective Friction Angle: 28 °
Phi-B: 0 °

Geosynthetics

Slope Stability Material Model: Mohr-Coulomb
Unit Weight: 58 pcf
Effective Cohesion: 0 psf
Effective Friction Angle: 24.3 °
Phi-B: 0 °

Rooting Zone/Sand

Slope Stability Material Model: Mohr-Coulomb
Unit Weight: 120 pcf
Effective Cohesion: 0 psf
Effective Friction Angle: 30 °
Phi-B: 0 °

Road Aggregate

Slope Stability Material Model: Mohr-Coulomb
Unit Weight: 135 pcf
Effective Cohesion: 0 psf
Effective Friction Angle: 35 °
Phi-B: 0 °

Geotextile

Slope Stability Material Model: Mohr-Coulomb
Unit Weight: 58 pcf
Effective Cohesion: 0 psf
Effective Friction Angle: 30 °
Phi-B: 0 °

Slip Surface Entry and Exit

Left Type: Range
Left-Zone Left Coordinate: (78.91665, 19.808399) ft
Left-Zone Right Coordinate: (108.8813, 19.83983) ft

Left-Zone Increment: 30
Right Type: Range
Right-Zone Left Coordinate: (109.43572, 19.845042) ft
Right-Zone Right Coordinate: (150.00821, 9.142644) ft
Right-Zone Increment: 30
Radius Increments: 10

Slip Surface Limits

Left Coordinate: (0, 39.537491) ft
Right Coordinate: (186.5395, 0) ft

Surcharge Loads

Surcharge Load 1

Surcharge (Unit Weight): 630 pcf
Direction: Vertical

Coordinates

	X	Y
	96.84206 ft	20.783361 ft
	107.8622 ft	20.783361 ft

Geometry

Name: Default Geometry

Settings

View: 2D
Element Thickness: 1 ft

Points

	X	Y
Point 1	112.87744 ft	19.877396 ft
Point 2	89.91043 ft	19.661493 ft
Point 3	85.31702 ft	18.208312 ft
Point 4	117.29 ft	18.41 ft
Point 5	85.31765 ft	18.108314 ft
Point 6	117.58 ft	18.31 ft
Point 7	130.28 ft	14.08 ft
Point 8	0 ft	39.537491 ft
Point 9	0 ft	36.702121 ft
Point 10	85.59619 ft	15.303152 ft
Point 11	116.51412 ft	14.68512 ft
Point 12	175.28247 ft	0 ft
Point 13	186.5395 ft	0 ft
Point 14	0 ft	36.599043 ft
Point 15	85.58289 ft	15.203397 ft
Point 16	116.50083 ft	14.585366 ft

Point 17	174.86997 ft	0 ft
Point 18	0 ft	34.537491 ft
Point 19	85.31702 ft	13.208312 ft
Point 20	116.23507 ft	12.590279 ft
Point 21	166.62008 ft	0 ft
Point 22	0 ft	0 ft

Regions

	Material	Points	Area
Region 1	Road Aggregate	1,2,3,4	40.095 ft²
Region 2	Geotextile	4,3,5,6	3.241 ft²
Region 3	Rooting Zone/Sand	7,6,5,3,8,9,10,11,12,13	531.75 ft²
Region 4	Geosynthetics	10,9,14,15,16,17,12,11	17.952 ft²
Region 5	Clay	16,15,14,18,19,20,21,17	350.11 ft²
Region 6	CCR	20,19,18,22,21	2,752.8 ft²

Slip Results

Slip Surfaces Analysed: 8730 of 10572 converged

Current Slip Surface

Slip Surface: 10,572
Factor of Safety: 1.709
Volume: 257.46814 ft³
Weight: 29,861.711 lbf
Resisting Moment: 798,807.09 lbf·ft
Activating Moment: 467,413.8 lbf·ft
Resisting Force: 14,053.471 lbf
Activating Force: 8,738.6005 lbf
Slip Rank: 1 of 10,572 slip surfaces
Exit: (148.7607, 9.4548574) ft
Entry: (102.81763, 19.782828) ft
Radius: 21.246033 ft
Center: (135.55203, 58.237563) ft

Slip Columns

	X	Y	PWP	Base Normal Stress	Frictional Strength	Cohesive Strength	Suction Strength	Base Material
Column 1	102.98675 ft	19.539875 ft	0 psf	416.97639 psf	291.97001 psf	0 psf	0 psf	Road Aggregate
Column 2	103.32498 ft	19.053968 ft	0 psf	457.28021 psf	320.19105 psf	0 psf	0 psf	Road Aggregate
Column 3	103.66321 ft	18.568061 ft	0 psf	497.58404 psf	348.41209 psf	0 psf	0 psf	Road Aggregate
Column 4	103.86734 ft	18.274802 ft	0 psf	555.5742 psf	320.76091 psf	0 psf	0 psf	Geotextile
Column 5	104.06699 ft	17.987985 ft	0 psf	575.9994 psf	332.55341 psf	0 psf	0 psf	Rooting Zone/Sand
Column	104.39625	17.514966	0	613.16315	354.00991	0 psf	0 psf	Rooting

6	ft	ft	psf	psf	psf			Zone/Sand
Column 7	104.70699 ft	17.079336 ft	0 psf	658.41853 psf	380.13812 psf	0 psf	0 psf	Rooting Zone/Sand
Column 8	104.99922 ft	16.681095 ft	0 psf	690.19252 psf	398.48284 psf	0 psf	0 psf	Rooting Zone/Sand
Column 9	105.29144 ft	16.282854 ft	0 psf	721.96651 psf	416.82756 psf	0 psf	0 psf	Rooting Zone/Sand
Column 10	105.58366 ft	15.884613 ft	0 psf	753.7405 psf	435.17228 psf	0 psf	0 psf	Rooting Zone/Sand
Column 11	105.87589 ft	15.486372 ft	0 psf	785.51449 psf	453.517 psf	0 psf	0 psf	Rooting Zone/Sand
Column 12	106.16811 ft	15.088131 ft	0 psf	817.28848 psf	471.86172 psf	0 psf	0 psf	Rooting Zone/Sand
Column 13	106.35146 ft	14.838256 ft	0 psf	896.70745 psf	404.87894 psf	0 psf	0 psf	Geosynthetics
Column 14	106.53606 ft	14.586694 ft	0 psf	875.54461 psf	465.53533 psf	0 psf	0 psf	Clay
Column 15	106.83076 ft	14.185081 ft	0 psf	909.79611 psf	483.74717 psf	0 psf	0 psf	Clay
Column 16	107.12545 ft	13.783467 ft	0 psf	944.04761 psf	501.95902 psf	0 psf	0 psf	Clay
Column 17	107.42015 ft	13.381854 ft	0 psf	978.29912 psf	520.17087 psf	0 psf	0 psf	Clay
Column 18	107.71485 ft	12.980240 ft	0 psf	1,012.5506 psf	538.38271 psf	0 psf	0 psf	Clay
Column 19	107.86881 ft	12.770425 ft	0 psf	608.76308 psf	323.68507 psf	0 psf	0 psf	Clay
Column 20	107.88514 ft	12.759206 ft	0 psf	810.88297 psf	431.15412 psf	0 psf	0 psf	Clay
Column 21	108.05570 ft	12.720411 ft	0 psf	824.2937 psf	358.4131 psf	0 psf	0 psf	CCR
Column 22	108.37737 ft	12.647244 ft	0 psf	830.80461 psf	361.24412 psf	0 psf	0 psf	CCR
Column 23	108.69904 ft	12.574077 ft	0 psf	837.31551 psf	364.07515 psf	0 psf	0 psf	CCR
Column 24	109.02071 ft	12.500910 ft	0 psf	843.82642 psf	366.90617 psf	0 psf	0 psf	CCR
Column 25	109.34238 ft	12.427743 ft	0 psf	850.33732 psf	369.73719 psf	0 psf	0 psf	CCR
Column 26	109.66405 ft	12.354576 ft	0 psf	856.84823 psf	372.56821 psf	0 psf	0 psf	CCR
Column 27	109.98572 ft	12.281409 ft	0 psf	863.35913 psf	375.39923 psf	0 psf	0 psf	CCR
Column 28	110.30739 ft	12.208242 ft	0 psf	869.87004 psf	378.23026 psf	0 psf	0 psf	CCR
Column 29	110.61880 ft	12.123666 ft	0 psf	858.45061 psf	373.26495 psf	0 psf	0 psf	CCR
Column 30	110.91995 ft	12.027681 ft	0 psf	866.60168 psf	376.80914 psf	0 psf	0 psf	CCR
Column 31	111.22110 ft	11.931697 ft	0 psf	874.75276 psf	380.35332 psf	0 psf	0 psf	CCR
Column 32	111.52225 ft	11.835713 ft	0 psf	882.90384 psf	383.89751 psf	0 psf	0 psf	CCR

Column 33	111.82341 ft	11.739728 ft	0 psf	891.05491 psf	387.4417 psf	0 psf	0 psf	CCR
Column 34	112.12456 ft	11.643744 ft	0 psf	899.20599 psf	390.98589 psf	0 psf	0 psf	CCR
Column 35	112.42571 ft	11.547760 ft	0 psf	907.35706 psf	394.53008 psf	0 psf	0 psf	CCR
Column 36	112.72686 ft	11.451775 ft	0 psf	915.50814 psf	398.07427 psf	0 psf	0 psf	CCR
Column 37	113.02683 ft	11.356169 ft	0 psf	917.24799 psf	398.83078 psf	0 psf	0 psf	CCR
Column 38	113.32561 ft	11.260941 ft	0 psf	912.57661 psf	396.7996 psf	0 psf	0 psf	CCR
Column 39	113.63904 ft	11.158843 ft	0 psf	904.99296 psf	393.50214 psf	0 psf	0 psf	CCR
Column 40	113.96711 ft	11.049874 ft	0 psf	900.22892 psf	391.43067 psf	0 psf	0 psf	CCR
Column 41	114.29519 ft	10.940905 ft	0 psf	895.46487 psf	389.35921 psf	0 psf	0 psf	CCR
Column 42	114.62326 ft	10.831936 ft	0 psf	890.70083 psf	387.28774 psf	0 psf	0 psf	CCR
Column 43	114.95134 ft	10.722967 ft	0 psf	885.93679 psf	385.21628 psf	0 psf	0 psf	CCR
Column 44	115.27941 ft	10.613998 ft	0 psf	881.17275 psf	383.14482 psf	0 psf	0 psf	CCR
Column 45	115.57539 ft	10.528768 ft	0 psf	896.68343 psf	389.88905 psf	0 psf	0 psf	CCR
Column 46	115.83926 ft	10.467275 ft	0 psf	890.6373 psf	387.26012 psf	0 psf	0 psf	CCR
Column 47	116.10313 ft	10.405782 ft	0 psf	884.59117 psf	384.63119 psf	0 psf	0 psf	CCR
Column 48	116.36795 ft	10.344069 ft	0 psf	879.64813 psf	382.48189 psf	0 psf	0 psf	CCR
Column 49	116.50747 ft	10.311554 ft	0 psf	877.53551 psf	381.5633 psf	0 psf	0 psf	CCR
Column 50	116.64343 ft	10.279871 ft	0 psf	875.33411 psf	380.6061 psf	0 psf	0 psf	CCR
Column 51	116.90206 ft	10.219600 ft	0 psf	871.31658 psf	378.85923 psf	0 psf	0 psf	CCR
Column 52	117.16069 ft	10.159330 ft	0 psf	867.29905 psf	377.11236 psf	0 psf	0 psf	CCR
Column 53	117.43500 ft	10.095404 ft	0 psf	866.51197 psf	376.77013 psf	0 psf	0 psf	CCR
Column 54	117.73805 ft	10.024782 ft	0 psf	866.02807 psf	376.55972 psf	0 psf	0 psf	CCR
Column 55	118.05415 ft	9.951117 ft	0 psf	862.61689 psf	375.0765 psf	0 psf	0 psf	CCR
Column 56	118.37025 ft	9.877453 ft	0 psf	859.20571 psf	373.59327 psf	0 psf	0 psf	CCR
Column 57	118.68636 ft	9.803789 ft	0 psf	855.79453 psf	372.11005 psf	0 psf	0 psf	CCR
Column 58	119.00246 ft	9.730125 ft	0 psf	852.38334 psf	370.62683 psf	0 psf	0 psf	CCR

Column 59	119.31856 ft	9.656461 ft	0 psf	848.97216 psf	369.1436 psf	0 psf	0 psf	CCR
Column 60	119.63466 ft	9.582797 ft	0 psf	845.56098 psf	367.66038 psf	0 psf	0 psf	CCR
Column 61	119.95076 ft	9.509133 ft	0 psf	842.1498 psf	366.17715 psf	0 psf	0 psf	CCR
Column 62	120.26686 ft	9.435468 ft	0 psf	838.73862 psf	364.69393 psf	0 psf	0 psf	CCR
Column 63	120.58297 ft	9.361804 ft	0 psf	835.32744 psf	363.21071 psf	0 psf	0 psf	CCR
Column 64	120.89907 ft	9.288140 ft	0 psf	831.91625 psf	361.72748 psf	0 psf	0 psf	CCR
Column 65	121.21517 ft	9.214476 ft	0 psf	828.50507 psf	360.24426 psf	0 psf	0 psf	CCR
Column 66	121.52489 ft	9.151643 ft	0 psf	836.78531 psf	363.84461 psf	0 psf	0 psf	CCR
Column 67	121.82824 ft	9.099642 ft	0 psf	831.92249 psf	361.73019 psf	0 psf	0 psf	CCR
Column 68	122.13158 ft	9.047640 ft	0 psf	827.05966 psf	359.61578 psf	0 psf	0 psf	CCR
Column 69	122.43493 ft	8.995639 ft	0 psf	822.19684 psf	357.50136 psf	0 psf	0 psf	CCR
Column 70	122.73827 ft	8.943637 ft	0 psf	817.33402 psf	355.38695 psf	0 psf	0 psf	CCR
Column 71	123.04161 ft	8.891636 ft	0 psf	812.4712 psf	353.27253 psf	0 psf	0 psf	CCR
Column 72	123.34496 ft	8.839634 ft	0 psf	807.60838 psf	351.15812 psf	0 psf	0 psf	CCR
Column 73	123.64830 ft	8.787633 ft	0 psf	802.74556 psf	349.0437 psf	0 psf	0 psf	CCR
Column 74	123.95165 ft	8.735631 ft	0 psf	797.88273 psf	346.92929 psf	0 psf	0 psf	CCR
Column 75	124.25499 ft	8.683630 ft	0 psf	793.01991 psf	344.81487 psf	0 psf	0 psf	CCR
Column 76	124.55833 ft	8.631628 ft	0 psf	788.15709 psf	342.70046 psf	0 psf	0 psf	CCR
Column 77	124.86168 ft	8.579627 ft	0 psf	783.29427 psf	340.58604 psf	0 psf	0 psf	CCR
Column 78	125.16502 ft	8.527625 ft	0 psf	778.43145 psf	338.47163 psf	0 psf	0 psf	CCR
Column 79	125.46837 ft	8.475624 ft	0 psf	773.56862 psf	336.35721 psf	0 psf	0 psf	CCR
Column 80	125.76779 ft	8.432283 ft	0 psf	778.36888 psf	338.44442 psf	0 psf	0 psf	CCR
Column 81	126.06330 ft	8.397603 ft	0 psf	772.23426 psf	335.77701 psf	0 psf	0 psf	CCR
Column 82	126.35880 ft	8.362923 ft	0 psf	766.09963 psf	333.1096 psf	0 psf	0 psf	CCR
Column 83	126.65430 ft	8.328243 ft	0 psf	759.96501 psf	330.44219 psf	0 psf	0 psf	CCR
Column 84	126.94981 ft	8.293563 ft	0 psf	753.83039 psf	327.77478 psf	0 psf	0 psf	CCR

Column 85	127.24531 ft	8.258882 ft	0 psf	747.69576 psf	325.10737 psf	0 psf	0 psf	CCR
Column 86	127.54082 ft	8.224202 ft	0 psf	741.56114 psf	322.43996 psf	0 psf	0 psf	CCR
Column 87	127.83632 ft	8.189522 ft	0 psf	735.42652 psf	319.77255 psf	0 psf	0 psf	CCR
Column 88	128.13182 ft	8.154842 ft	0 psf	729.29189 psf	317.10514 psf	0 psf	0 psf	CCR
Column 89	128.42733 ft	8.120162 ft	0 psf	723.15727 psf	314.43773 psf	0 psf	0 psf	CCR
Column 90	128.71716 ft	8.092523 ft	0 psf	724.6398 psf	315.08235 psf	0 psf	0 psf	CCR
Column 91	129.00131 ft	8.071925 ft	0 psf	717.59804 psf	312.02051 psf	0 psf	0 psf	CCR
Column 92	129.28546 ft	8.051328 ft	0 psf	710.55627 psf	308.95866 psf	0 psf	0 psf	CCR
Column 93	129.56962 ft	8.030730 ft	0 psf	703.51451 psf	305.89681 psf	0 psf	0 psf	CCR
Column 94	129.85377 ft	8.010132 ft	0 psf	696.47274 psf	302.83497 psf	0 psf	0 psf	CCR
Column 95	130.13792 ft	7.989534 ft	0 psf	689.43098 psf	299.77312 psf	0 psf	0 psf	CCR
Column 96	130.43024 ft	7.968345 ft	0 psf	683.65272 psf	297.26066 psf	0 psf	0 psf	CCR
Column 97	130.73072 ft	7.946564 ft	0 psf	679.13796 psf	295.29759 psf	0 psf	0 psf	CCR
Column 98	131.03119 ft	7.924782 ft	0 psf	674.62321 psf	293.33452 psf	0 psf	0 psf	CCR
Column 99	131.33167 ft	7.903001 ft	0 psf	670.10846 psf	291.37145 psf	0 psf	0 psf	CCR
Column 100	131.63215 ft	7.881220 ft	0 psf	665.59371 psf	289.40838 psf	0 psf	0 psf	CCR
Column 101	131.93263 ft	7.859439 ft	0 psf	661.07895 psf	287.44531 psf	0 psf	0 psf	CCR
Column 102	132.23311 ft	7.837658 ft	0 psf	656.5642 psf	285.48224 psf	0 psf	0 psf	CCR
Column 103	132.53358 ft	7.815877 ft	0 psf	652.04945 psf	283.51917 psf	0 psf	0 psf	CCR
Column 104	132.83406 ft	7.794096 ft	0 psf	647.5347 psf	281.5561 psf	0 psf	0 psf	CCR
Column 105	133.13454 ft	7.772315 ft	0 psf	643.01994 psf	279.59303 psf	0 psf	0 psf	CCR
Column 106	133.44519 ft	7.746577 ft	0 psf	635.43867 psf	276.2966 psf	0 psf	0 psf	CCR
Column 107	133.76601 ft	7.716882 ft	0 psf	631.18338 psf	274.44634 psf	0 psf	0 psf	CCR
Column 108	134.08682 ft	7.687188 ft	0 psf	626.92808 psf	272.59609 psf	0 psf	0 psf	CCR
Column 109	134.40764 ft	7.657494 ft	0 psf	622.67279 psf	270.74583 psf	0 psf	0 psf	CCR
Column 110	134.72845 ft	7.627800 ft	0 psf	618.41749 psf	268.89558 psf	0 psf	0 psf	CCR

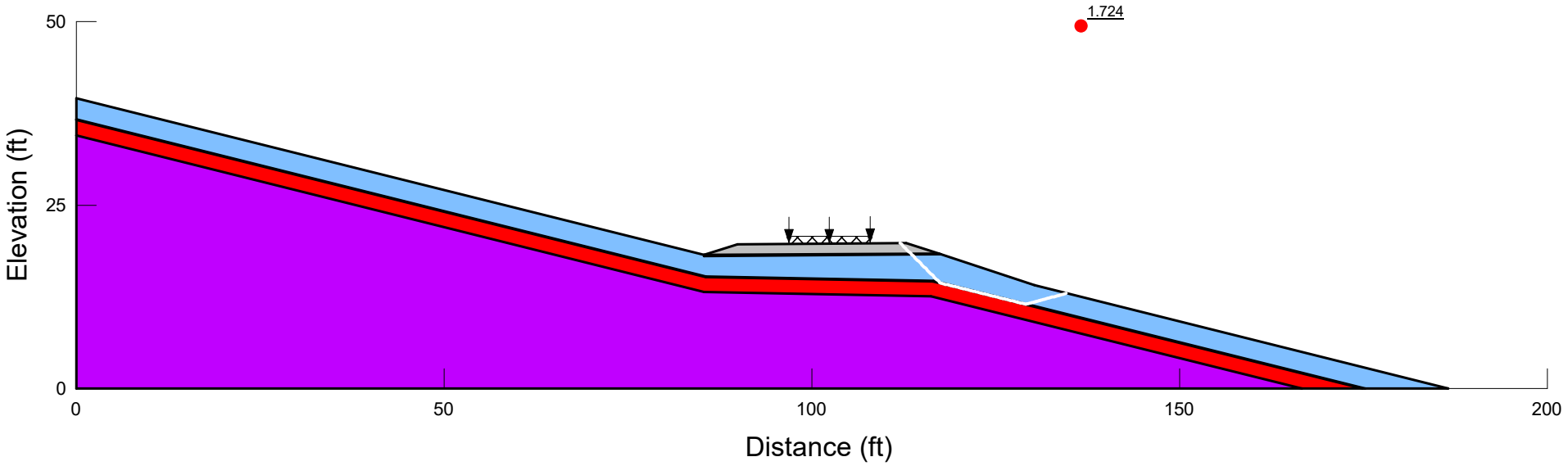
Column 111	135.04927 ft	7.598105 ft	0 psf	614.1622 psf	267.04532 psf	0 psf	0 psf	CCR
Column 112	135.36119 ft	7.566917 ft	0 psf	607.90836 psf	264.32608 psf	0 psf	0 psf	CCR
Column 113	135.66421 ft	7.534234 ft	0 psf	604.29235 psf	262.75379 psf	0 psf	0 psf	CCR
Column 114	135.96723 ft	7.501551 ft	0 psf	600.67635 psf	261.18151 psf	0 psf	0 psf	CCR
Column 115	136.27025 ft	7.468869 ft	0 psf	597.06034 psf	259.60923 psf	0 psf	0 psf	CCR
Column 116	136.57327 ft	7.436186 ft	0 psf	593.44434 psf	258.03694 psf	0 psf	0 psf	CCR
Column 117	136.87629 ft	7.403503 ft	0 psf	589.82833 psf	256.46466 psf	0 psf	0 psf	CCR
Column 118	137.03706 ft	7.388548 ft	0 psf	627.74274 psf	272.95031 psf	0 psf	0 psf	CCR
Column 119	137.20234 ft	7.413293 ft	0 psf	624.81493 psf	332.21999 psf	0 psf	0 psf	Clay
Column 120	137.51439 ft	7.460010 ft	0 psf	608.45182 psf	323.51957 psf	0 psf	0 psf	Clay
Column 121	137.82644 ft	7.506727 ft	0 psf	592.08872 psf	314.81916 psf	0 psf	0 psf	Clay
Column 122	138.13849 ft	7.553444 ft	0 psf	575.72561 psf	306.11874 psf	0 psf	0 psf	Clay
Column 123	138.45054 ft	7.600161 ft	0 psf	559.36251 psf	297.41832 psf	0 psf	0 psf	Clay
Column 124	138.76259 ft	7.646878 ft	0 psf	542.9994 psf	288.7179 psf	0 psf	0 psf	Clay
Column 125	139.07464 ft	7.693595 ft	0 psf	526.63629 psf	280.01748 psf	0 psf	0 psf	Clay
Column 126	139.38669 ft	7.740312 ft	0 psf	510.27319 psf	271.31707 psf	0 psf	0 psf	Clay
Column 127	139.69874 ft	7.787029 ft	0 psf	493.91008 psf	262.61665 psf	0 psf	0 psf	Clay
Column 128	140.01079 ft	7.833746 ft	0 psf	477.54698 psf	253.91623 psf	0 psf	0 psf	Clay
Column 129	140.32284 ft	7.880463 ft	0 psf	461.18387 psf	245.21581 psf	0 psf	0 psf	Clay
Column 130	140.63489 ft	7.927180 ft	0 psf	444.82076 psf	236.5154 psf	0 psf	0 psf	Clay
Column 131	140.94694 ft	7.973897 ft	0 psf	428.45766 psf	227.81498 psf	0 psf	0 psf	Clay
Column 132	141.25899 ft	8.020614 ft	0 psf	412.09455 psf	219.11456 psf	0 psf	0 psf	Clay
Column 133	141.57104 ft	8.067331 ft	0 psf	395.73145 psf	210.41414 psf	0 psf	0 psf	Clay
Column 134	141.84910 ft	8.107971 ft	0 psf	380.27546 psf	202.19605 psf	0 psf	0 psf	Clay
Column 135	142.09318 ft	8.142536 ft	0 psf	367.7688 psf	195.54614 psf	0 psf	0 psf	Clay
Column 136	142.34686 ft	8.178461 ft	0 psf	355.90849 psf	160.69885 psf	0 psf	0 psf	Geosynthetics

Column 137	142.69826 ft	8.228224 ft	0 psf	345.80605 psf	199.65121 psf	0 psf	0 psf	Rooting Zone/Sand
Column 138	143.05551 ft	8.285168 ft	0 psf	332.81623 psf	192.15154 psf	0 psf	0 psf	Rooting Zone/Sand
Column 139	143.33049 ft	8.336813 ft	0 psf	317.38137 psf	183.24022 psf	0 psf	0 psf	Rooting Zone/Sand
Column 140	143.62365 ft	8.394759 ft	0 psf	302.58048 psf	174.69492 psf	0 psf	0 psf	Rooting Zone/Sand
Column 141	143.93498 ft	8.459008 ft	0 psf	284.24227 psf	164.10735 psf	0 psf	0 psf	Rooting Zone/Sand
Column 142	144.24632 ft	8.523256 ft	0 psf	265.90406 psf	153.51978 psf	0 psf	0 psf	Rooting Zone/Sand
Column 143	144.55766 ft	8.587504 ft	0 psf	247.56585 psf	142.93221 psf	0 psf	0 psf	Rooting Zone/Sand
Column 144	144.86899 ft	8.651753 ft	0 psf	229.22764 psf	132.34464 psf	0 psf	0 psf	Rooting Zone/Sand
Column 145	145.18033 ft	8.716001 ft	0 psf	210.88943 psf	121.75707 psf	0 psf	0 psf	Rooting Zone/Sand
Column 146	145.49167 ft	8.780249 ft	0 psf	192.55122 psf	111.1695 psf	0 psf	0 psf	Rooting Zone/Sand
Column 147	145.80300 ft	8.844498 ft	0 psf	174.213 psf	100.58192 psf	0 psf	0 psf	Rooting Zone/Sand
Column 148	146.11434 ft	8.908746 ft	0 psf	155.87479 psf	89.994354 psf	0 psf	0 psf	Rooting Zone/Sand
Column 149	146.42567 ft	8.972995 ft	0 psf	137.53658 psf	79.406783 psf	0 psf	0 psf	Rooting Zone/Sand
Column 150	146.73701 ft	9.037243 ft	0 psf	119.19837 psf	68.819212 psf	0 psf	0 psf	Rooting Zone/Sand
Column 151	147.04835 ft	9.101491 ft	0 psf	100.86016 psf	58.231641 psf	0 psf	0 psf	Rooting Zone/Sand
Column 152	147.35968 ft	9.165740 ft	0 psf	82.521949 psf	47.64407 psf	0 psf	0 psf	Rooting Zone/Sand
Column 153	147.67102 ft	9.229988 ft	0 psf	64.183738 psf	37.056499 psf	0 psf	0 psf	Rooting Zone/Sand
Column 154	147.98236 ft	9.294236 ft	0 psf	45.845527 psf	26.468928 psf	0 psf	0 psf	Rooting Zone/Sand
Column 155	148.29369 ft	9.358485 ft	0 psf	27.507316 psf	15.881357 psf	0 psf	0 psf	Rooting Zone/Sand
Column 156	148.60503 ft	9.422733 ft	0 psf	9.1691055 psf	5.2937855 psf	0 psf	0 psf	Rooting Zone/Sand

Title: Columbia Mod 12-13 Access Road
Name: Block_FS=1.5
Method: Janbu
Last Edited By: Villanueva, Niko

F of S: 1.724
F of S Rank (Analysis): 1 of 234,256 slip surfaces
Surcharge (Unit Weight): 630 pcf
Last Solved Date: 08/23/2023, Last Solved Time: 10:14:59 AM

Color	Name	Slope Stability Material Model	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)
	CCR	Mohr-Coulomb	86	0	23.5
	Clay	Mohr-Coulomb	125	0	28
	Geosynthetics	Mohr-Coulomb	58	0	24.3
	Geotextile	Mohr-Coulomb	58	0	30
	Road Aggregate	Mohr-Coulomb	135	0	35
	Rooting Zone/Sand	Mohr-Coulomb	120	0	30



Block_FS=1.5

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File Information

File Version: 11.05
Title: Columbia Mod 12-13 Access Road
Created By: Villanueva, Niko
Last Edited By: Villanueva, Niko
Revision Number: 124
Date: 08/23/2023
Time: 10:14:01 AM
Tool Version: 23.1.1.829
File Name: COL_Mod12-13_Access Road_3H1V.gsz
Directory: I:\25222260.00\Data and Calculations\Geotech Calculations\Slope Stability\SlopeW\
Last Solved Date: 08/23/2023
Last Solved Time: 10:14:58 AM

Project Settings

Unit System: U.S. Customary Units

Analysis Settings

Block_FS=1.5

Kind: SLOPE/W
Analysis Type: Janbu
Settings
- PWP Conditions from: (none)
- Unit Weight of Water: 62.4 pcf

Slip Surface
- Direction of movement: Left to Right
- Use Passive Mode: No
- Slip Surface Option: Block
- Critical slip surfaces saved: 10
- Restrict Block Crossing: No
- Optimize Critical Slip Surface Location: No
- Tension Crack Option: (none)

Distribution
- F of S Calculation Option: Constant

Convergence
- Geometry Settings
  - Minimum Slip Surface Depth: 0.1 ft
  - Number of Columns: 150
- Factor of Safety Convergence Settings
  - Maximum Number of Iterations: 100
  - Tolerable difference in F of S: 0.001

Materials

CCR

Slope Stability Material Model: Mohr-Coulomb
Unit Weight: 86 pcf
Effective Cohesion: 0 psf
Effective Friction Angle: 23.5 °
Phi-B: 0 °

Clay

Slope Stability Material Model: Mohr-Coulomb
Unit Weight: 125 pcf
Effective Cohesion: 0 psf
Effective Friction Angle: 28 °
Phi-B: 0 °

Geosynthetics

Slope Stability Material Model: Mohr-Coulomb
Unit Weight: 58 pcf
Effective Cohesion: 0 psf
Effective Friction Angle: 24.3 °
Phi-B: 0 °

Rooting Zone/Sand

Slope Stability Material Model: Mohr-Coulomb
Unit Weight: 120 pcf
Effective Cohesion: 0 psf
Effective Friction Angle: 30 °
Phi-B: 0 °

Road Aggregate

Slope Stability Material Model: Mohr-Coulomb
Unit Weight: 135 pcf
Effective Cohesion: 0 psf
Effective Friction Angle: 35 °
Phi-B: 0 °

Geotextile

Slope Stability Material Model: Mohr-Coulomb
Unit Weight: 58 pcf
Effective Cohesion: 0 psf
Effective Friction Angle: 30 °
Phi-B: 0 °

Slip Surface Limits

Left Coordinate: (0, 39.537491) ft
Right Coordinate: (186.5395, 0) ft

Slip Surface Block

Left Grid

Upper Left: (105.31355, 15.853234) ft
Lower Left: (105.22097, 14.202143) ft
Lower Right: (120.46655, 13.230005) ft
X Increments: 10
Y Increments: 10
Starting Angle: 115 °
Ending Angle: 135 °
Angle Increments: 3

Right Grid
Upper Left: (122.69352, 13.67688) ft
Lower Left: (122.4491, 12.521425) ft
Lower Right: (155.15737, 4.611001) ft
X Increments: 10
Y Increments: 10
Angle Increments: 3

Surcharge Loads

Surcharge Load 1

Surcharge (Unit Weight): 630 pcf
Direction: Vertical

Coordinates

	X	Y
	96.9402 ft	20.742933 ft
	107.91703 ft	20.742933 ft

Geometry

Name: Default Geometry

Settings

View: 2D
Element Thickness: 1 ft

Points

	X	Y
Point 1	112.87744 ft	19.877396 ft
Point 2	89.91043 ft	19.661493 ft
Point 3	85.31702 ft	18.208312 ft
Point 4	117.29 ft	18.41 ft
Point 5	85.31765 ft	18.108314 ft
Point 6	117.58 ft	18.31 ft
Point 7	130.28 ft	14.08 ft
Point 8	0 ft	39.537491 ft
Point 9	0 ft	36.702121 ft
Point 10	85.59619 ft	15.303152 ft
Point 11	116.51412 ft	14.68512 ft
Point 12	175.28247 ft	0 ft
Point 13	186.5395 ft	0 ft

Point 14	0 ft	36.599043 ft
Point 15	85.58289 ft	15.203397 ft
Point 16	116.50083 ft	14.585366 ft
Point 17	174.86997 ft	0 ft
Point 18	0 ft	34.537491 ft
Point 19	85.31702 ft	13.208312 ft
Point 20	116.23507 ft	12.590279 ft
Point 21	166.62008 ft	0 ft
Point 22	0 ft	0 ft

Regions

	Material	Points	Area
Region 1	Road Aggregate	1,2,3,4	40.095 ft²
Region 2	Geotextile	4,3,5,6	3.241 ft²
Region 3	Rooting Zone/Sand	7,6,5,3,8,9,10,11,12,13	531.75 ft²
Region 4	Geosynthetics	10,9,14,15,16,17,12,11	17.952 ft²
Region 5	Clay	16,15,14,18,19,20,21,17	350.11 ft²
Region 6	CCR	20,19,18,22,21	2,752.8 ft²

Slip Results

Slip Surfaces Analysed: 233976 of 234256 converged

Current Slip Surface

Slip Surface: 144,946
Factor of Safety: 1.724
Volume: 59.378416 ft³
Weight: 7,134.8484 lbf
Resisting Moment: 30,069.202 lbf·ft
Activating Moment: 17,647.289 lbf·ft
Resisting Force: 3,242.053 lbf
Activating Force: 1,880.6689 lbf
Slip Rank: 1 of 234,256 slip surfaces
Exit: (134.62224, 12.993273) ft
Entry: (112.01875, 19.869324) ft
Radius: 11.580067 ft
Center: (124.88928, 21.588336) ft

Slip Columns

	X	Y	PWP	Base Normal Stress	Frictional Strength	Cohesive Strength	Suction Strength	Base Material
Column 1	112.09030 ft	19.797766 ft	0 psf	6.9339626 psf	4.8552129 psf	0 psf	0 psf	Road Aggregate
Column 2	112.23342 ft	19.654650 ft	0 psf	20.801888 psf	14.565639 psf	0 psf	0 psf	Road Aggregate
Column 3	112.37653 ft	19.511534 ft	0 psf	34.669813 psf	24.276064 psf	0 psf	0 psf	Road Aggregate
Column 4	112.51965 ft	19.368419 ft	0 psf	48.537738 psf	33.98649 psf	0 psf	0 psf	Road Aggregate

Column 5	112.66277 ft	19.225303 ft	0 psf	62.405663 psf	43.696916 psf	0 psf	0 psf	Road Aggregate
Column 6	112.80588 ft	19.082187 ft	0 psf	76.273589 psf	53.407342 psf	0 psf	0 psf	Road Aggregate
Column 7	112.95551 ft	18.932564 ft	0 psf	88.209495 psf	61.764953 psf	0 psf	0 psf	Road Aggregate
Column 8	113.11164 ft	18.776433 ft	0 psf	98.213381 psf	68.76975 psf	0 psf	0 psf	Road Aggregate
Column 9	113.26777 ft	18.620301 ft	0 psf	108.21727 psf	75.774547 psf	0 psf	0 psf	Road Aggregate
Column 10	113.42390 ft	18.464170 ft	0 psf	118.22115 psf	82.779344 psf	0 psf	0 psf	Road Aggregate
Column 11	113.55245 ft	18.335621 ft	0 psf	130.28018 psf	75.217297 psf	0 psf	0 psf	Geotextile
Column 12	113.67975 ft	18.208324 ft	0 psf	135.07325 psf	77.984575 psf	0 psf	0 psf	Rooting Zone/Sand
Column 13	113.83337 ft	18.054696 ft	0 psf	143.70491 psf	82.96807 psf	0 psf	0 psf	Rooting Zone/Sand
Column 14	113.98700 ft	17.901068 ft	0 psf	152.33658 psf	87.951564 psf	0 psf	0 psf	Rooting Zone/Sand
Column 15	114.14063 ft	17.747440 ft	0 psf	160.96824 psf	92.935058 psf	0 psf	0 psf	Rooting Zone/Sand
Column 16	114.29426 ft	17.593812 ft	0 psf	169.59991 psf	97.918553 psf	0 psf	0 psf	Rooting Zone/Sand
Column 17	114.44788 ft	17.440184 ft	0 psf	178.23157 psf	102.90205 psf	0 psf	0 psf	Rooting Zone/Sand
Column 18	114.60151 ft	17.286557 ft	0 psf	186.86324 psf	107.88554 psf	0 psf	0 psf	Rooting Zone/Sand
Column 19	114.75514 ft	17.132929 ft	0 psf	195.49491 psf	112.86904 psf	0 psf	0 psf	Rooting Zone/Sand
Column 20	114.90877 ft	16.979301 ft	0 psf	204.12657 psf	117.85253 psf	0 psf	0 psf	Rooting Zone/Sand
Column 21	115.06240 ft	16.825673 ft	0 psf	212.75824 psf	122.83603 psf	0 psf	0 psf	Rooting Zone/Sand
Column 22	115.21602 ft	16.672045 ft	0 psf	221.3899 psf	127.81952 psf	0 psf	0 psf	Rooting Zone/Sand
Column 23	115.36965 ft	16.518417 ft	0 psf	230.02157 psf	132.80301 psf	0 psf	0 psf	Rooting Zone/Sand
Column 24	115.52328 ft	16.364789 ft	0 psf	238.65323 psf	137.78651 psf	0 psf	0 psf	Rooting Zone/Sand
Column 25	115.67691 ft	16.211162 ft	0 psf	247.2849 psf	142.77 psf	0 psf	0 psf	Rooting Zone/Sand
Column 26	115.83054 ft	16.057534 ft	0 psf	255.91656 psf	147.7535 psf	0 psf	0 psf	Rooting Zone/Sand
Column 27	115.98416 ft	15.903906 ft	0 psf	264.54823 psf	152.73699 psf	0 psf	0 psf	Rooting Zone/Sand
Column 28	116.13779 ft	15.750278 ft	0 psf	273.1799 psf	157.72049 psf	0 psf	0 psf	Rooting Zone/Sand
Column 29	116.29142 ft	15.596650 ft	0 psf	281.81156 psf	162.70398 psf	0 psf	0 psf	Rooting Zone/Sand
Column 30	116.44505 ft	15.443022 ft	0 psf	290.44323 psf	167.68748 psf	0 psf	0 psf	Rooting Zone/Sand

Column 31	116.59867 ft	15.289395 ft	0 psf	299.07489 psf	172.67097 psf	0 psf	0 psf	Rooting Zone/Sand
Column 32	116.75230 ft	15.135767 ft	0 psf	307.70656 psf	177.65446 psf	0 psf	0 psf	Rooting Zone/Sand
Column 33	116.90593 ft	14.982139 ft	0 psf	316.33822 psf	182.63796 psf	0 psf	0 psf	Rooting Zone/Sand
Column 34	117.05956 ft	14.828511 ft	0 psf	324.96989 psf	187.62145 psf	0 psf	0 psf	Rooting Zone/Sand
Column 35	117.21319 ft	14.674883 ft	0 psf	333.60155 psf	192.60495 psf	0 psf	0 psf	Rooting Zone/Sand
Column 36	117.36121 ft	14.526862 ft	0 psf	343.27191 psf	198.18813 psf	0 psf	0 psf	Rooting Zone/Sand
Column 37	117.45270 ft	14.435371 ft	0 psf	369.66238 psf	166.90896 psf	0 psf	0 psf	Geosynthetics
Column 38	117.52649 ft	14.401765 ft	0 psf	439.4875 psf	198.43621 psf	0 psf	0 psf	Geosynthetics
Column 39	117.65489 ft	14.369798 ft	0 psf	439.30039 psf	198.35173 psf	0 psf	0 psf	Geosynthetics
Column 40	117.80467 ft	14.332507 ft	0 psf	437.88932 psf	197.71461 psf	0 psf	0 psf	Geosynthetics
Column 41	117.95445 ft	14.295216 ft	0 psf	436.47825 psf	197.07749 psf	0 psf	0 psf	Geosynthetics
Column 42	118.10423 ft	14.257926 ft	0 psf	435.06718 psf	196.44037 psf	0 psf	0 psf	Geosynthetics
Column 43	118.25400 ft	14.220635 ft	0 psf	433.65612 psf	195.80324 psf	0 psf	0 psf	Geosynthetics
Column 44	118.40378 ft	14.183345 ft	0 psf	432.24505 psf	195.16612 psf	0 psf	0 psf	Geosynthetics
Column 45	118.55356 ft	14.146054 ft	0 psf	430.83398 psf	194.529 psf	0 psf	0 psf	Geosynthetics
Column 46	118.70334 ft	14.108763 ft	0 psf	429.42291 psf	193.89188 psf	0 psf	0 psf	Geosynthetics
Column 47	118.85312 ft	14.071473 ft	0 psf	428.01184 psf	193.25476 psf	0 psf	0 psf	Geosynthetics
Column 48	119.00290 ft	14.034182 ft	0 psf	426.60077 psf	192.61763 psf	0 psf	0 psf	Geosynthetics
Column 49	119.15268 ft	13.996892 ft	0 psf	425.1897 psf	191.98051 psf	0 psf	0 psf	Geosynthetics
Column 50	119.30246 ft	13.959601 ft	0 psf	423.77863 psf	191.34339 psf	0 psf	0 psf	Geosynthetics
Column 51	119.45223 ft	13.922310 ft	0 psf	422.36756 psf	190.70627 psf	0 psf	0 psf	Geosynthetics
Column 52	119.60201 ft	13.885020 ft	0 psf	420.95649 psf	190.06914 psf	0 psf	0 psf	Geosynthetics
Column 53	119.75179 ft	13.847729 ft	0 psf	419.54542 psf	189.43202 psf	0 psf	0 psf	Geosynthetics
Column 54	119.90157 ft	13.810439 ft	0 psf	418.13435 psf	188.7949 psf	0 psf	0 psf	Geosynthetics
Column 55	120.05135 ft	13.773148 ft	0 psf	416.72328 psf	188.15778 psf	0 psf	0 psf	Geosynthetics
Column 56	120.20113 ft	13.735858 ft	0 psf	415.31222 psf	187.52066 psf	0 psf	0 psf	Geosynthetics

Column 57	120.35091 ft	13.698567 ft	0 psf	413.90115 psf	186.88353 psf	0 psf	0 psf	Geosynthetics
Column 58	120.50069 ft	13.661276 ft	0 psf	412.49008 psf	186.24641 psf	0 psf	0 psf	Geosynthetics
Column 59	120.65046 ft	13.623986 ft	0 psf	411.07901 psf	185.60929 psf	0 psf	0 psf	Geosynthetics
Column 60	120.80024 ft	13.586695 ft	0 psf	409.66794 psf	184.97217 psf	0 psf	0 psf	Geosynthetics
Column 61	120.95002 ft	13.549405 ft	0 psf	408.25687 psf	184.33504 psf	0 psf	0 psf	Geosynthetics
Column 62	121.09980 ft	13.512114 ft	0 psf	406.8458 psf	183.69792 psf	0 psf	0 psf	Geosynthetics
Column 63	121.24958 ft	13.474823 ft	0 psf	405.43473 psf	183.0608 psf	0 psf	0 psf	Geosynthetics
Column 64	121.39936 ft	13.437533 ft	0 psf	404.02366 psf	182.42368 psf	0 psf	0 psf	Geosynthetics
Column 65	121.54914 ft	13.400242 ft	0 psf	402.61259 psf	181.78656 psf	0 psf	0 psf	Geosynthetics
Column 66	121.69892 ft	13.362952 ft	0 psf	401.20152 psf	181.14943 psf	0 psf	0 psf	Geosynthetics
Column 67	121.84869 ft	13.325661 ft	0 psf	399.79045 psf	180.51231 psf	0 psf	0 psf	Geosynthetics
Column 68	121.99847 ft	13.288371 ft	0 psf	398.37938 psf	179.87519 psf	0 psf	0 psf	Geosynthetics
Column 69	122.14825 ft	13.251080 ft	0 psf	396.96832 psf	179.23807 psf	0 psf	0 psf	Geosynthetics
Column 70	122.29803 ft	13.213789 ft	0 psf	395.55725 psf	178.60094 psf	0 psf	0 psf	Geosynthetics
Column 71	122.44781 ft	13.176499 ft	0 psf	394.14618 psf	177.96382 psf	0 psf	0 psf	Geosynthetics
Column 72	122.59759 ft	13.139208 ft	0 psf	392.73511 psf	177.3267 psf	0 psf	0 psf	Geosynthetics
Column 73	122.74737 ft	13.101918 ft	0 psf	391.32404 psf	176.68958 psf	0 psf	0 psf	Geosynthetics
Column 74	122.89715 ft	13.064627 ft	0 psf	389.91297 psf	176.05246 psf	0 psf	0 psf	Geosynthetics
Column 75	123.04692 ft	13.027336 ft	0 psf	388.5019 psf	175.41533 psf	0 psf	0 psf	Geosynthetics
Column 76	123.19670 ft	12.990046 ft	0 psf	387.09083 psf	174.77821 psf	0 psf	0 psf	Geosynthetics
Column 77	123.34648 ft	12.952755 ft	0 psf	385.67976 psf	174.14109 psf	0 psf	0 psf	Geosynthetics
Column 78	123.49626 ft	12.915465 ft	0 psf	384.26869 psf	173.50397 psf	0 psf	0 psf	Geosynthetics
Column 79	123.64604 ft	12.878174 ft	0 psf	382.85762 psf	172.86685 psf	0 psf	0 psf	Geosynthetics
Column 80	123.79582 ft	12.840883 ft	0 psf	381.44655 psf	172.22972 psf	0 psf	0 psf	Geosynthetics
Column 81	123.94560 ft	12.803593 ft	0 psf	380.03548 psf	171.5926 psf	0 psf	0 psf	Geosynthetics
Column 82	124.09538 ft	12.766302 ft	0 psf	378.62442 psf	170.95548 psf	0 psf	0 psf	Geosynthetics

Column 83	124.24515 ft	12.729012 ft	0 psf	377.21335 psf	170.31836 psf	0 psf	0 psf	Geosynthetics
Column 84	124.39493 ft	12.691721 ft	0 psf	375.80228 psf	169.68123 psf	0 psf	0 psf	Geosynthetics
Column 85	124.54471 ft	12.654431 ft	0 psf	374.39121 psf	169.04411 psf	0 psf	0 psf	Geosynthetics
Column 86	124.69449 ft	12.617140 ft	0 psf	372.98014 psf	168.40699 psf	0 psf	0 psf	Geosynthetics
Column 87	124.84427 ft	12.579849 ft	0 psf	371.56907 psf	167.76987 psf	0 psf	0 psf	Geosynthetics
Column 88	124.99405 ft	12.542559 ft	0 psf	370.158 psf	167.13275 psf	0 psf	0 psf	Geosynthetics
Column 89	125.14383 ft	12.505268 ft	0 psf	368.74693 psf	166.49562 psf	0 psf	0 psf	Geosynthetics
Column 90	125.29361 ft	12.467978 ft	0 psf	367.33586 psf	165.8585 psf	0 psf	0 psf	Geosynthetics
Column 91	125.44338 ft	12.430687 ft	0 psf	365.92479 psf	165.22138 psf	0 psf	0 psf	Geosynthetics
Column 92	125.59316 ft	12.393396 ft	0 psf	364.51372 psf	164.58426 psf	0 psf	0 psf	Geosynthetics
Column 93	125.74294 ft	12.356106 ft	0 psf	363.10265 psf	163.94713 psf	0 psf	0 psf	Geosynthetics
Column 94	125.89272 ft	12.318815 ft	0 psf	361.69158 psf	163.31001 psf	0 psf	0 psf	Geosynthetics
Column 95	126.04250 ft	12.281525 ft	0 psf	360.28052 psf	162.67289 psf	0 psf	0 psf	Geosynthetics
Column 96	126.19228 ft	12.244234 ft	0 psf	358.86945 psf	162.03577 psf	0 psf	0 psf	Geosynthetics
Column 97	126.34206 ft	12.206944 ft	0 psf	357.45838 psf	161.39865 psf	0 psf	0 psf	Geosynthetics
Column 98	126.49184 ft	12.169653 ft	0 psf	356.04731 psf	160.76152 psf	0 psf	0 psf	Geosynthetics
Column 99	126.64161 ft	12.132362 ft	0 psf	354.63624 psf	160.1244 psf	0 psf	0 psf	Geosynthetics
Column 100	126.79139 ft	12.095072 ft	0 psf	353.22517 psf	159.48728 psf	0 psf	0 psf	Geosynthetics
Column 101	126.94117 ft	12.057781 ft	0 psf	351.8141 psf	158.85016 psf	0 psf	0 psf	Geosynthetics
Column 102	127.09095 ft	12.020491 ft	0 psf	350.40303 psf	158.21303 psf	0 psf	0 psf	Geosynthetics
Column 103	127.24073 ft	11.983200 ft	0 psf	348.99196 psf	157.57591 psf	0 psf	0 psf	Geosynthetics
Column 104	127.39051 ft	11.945909 ft	0 psf	347.58089 psf	156.93879 psf	0 psf	0 psf	Geosynthetics
Column 105	127.54029 ft	11.908619 ft	0 psf	346.16982 psf	156.30167 psf	0 psf	0 psf	Geosynthetics
Column 106	127.69007 ft	11.871328 ft	0 psf	344.75875 psf	155.66455 psf	0 psf	0 psf	Geosynthetics
Column 107	127.83984 ft	11.834038 ft	0 psf	343.34768 psf	155.02742 psf	0 psf	0 psf	Geosynthetics
Column 108	127.98962 ft	11.796747 ft	0 psf	341.93662 psf	154.3903 psf	0 psf	0 psf	Geosynthetics

Column 109	128.13940 ft	11.759457 ft	0 psf	340.52555 psf	153.75318 psf	0 psf	0 psf	Geosynthetics
Column 110	128.28918 ft	11.722166 ft	0 psf	339.11448 psf	153.11606 psf	0 psf	0 psf	Geosynthetics
Column 111	128.43896 ft	11.684875 ft	0 psf	337.70341 psf	152.47894 psf	0 psf	0 psf	Geosynthetics
Column 112	128.58874 ft	11.647585 ft	0 psf	336.29234 psf	151.84181 psf	0 psf	0 psf	Geosynthetics
Column 113	128.73852 ft	11.610294 ft	0 psf	334.88127 psf	151.20469 psf	0 psf	0 psf	Geosynthetics
Column 114	128.88830 ft	11.573004 ft	0 psf	333.4702 psf	150.56757 psf	0 psf	0 psf	Geosynthetics
Column 115	129.03807 ft	11.535713 ft	0 psf	332.05913 psf	149.93045 psf	0 psf	0 psf	Geosynthetics
Column 116	129.13212 ft	11.522199 ft	0 psf	378.79113 psf	171.03075 psf	0 psf	0 psf	Geosynthetics
Column 117	129.23189 ft	11.548934 ft	0 psf	379.70229 psf	219.22122 psf	0 psf	0 psf	Rooting Zone/Sand
Column 118	129.39314 ft	11.592140 ft	0 psf	366.92589 psf	211.84476 psf	0 psf	0 psf	Rooting Zone/Sand
Column 119	129.55439 ft	11.635347 ft	0 psf	354.1495 psf	204.46831 psf	0 psf	0 psf	Rooting Zone/Sand
Column 120	129.71563 ft	11.678553 ft	0 psf	341.3731 psf	197.09185 psf	0 psf	0 psf	Rooting Zone/Sand
Column 121	129.87688 ft	11.721759 ft	0 psf	328.59671 psf	189.7154 psf	0 psf	0 psf	Rooting Zone/Sand
Column 122	130.03813 ft	11.764965 ft	0 psf	315.82031 psf	182.33894 psf	0 psf	0 psf	Rooting Zone/Sand
Column 123	130.19938 ft	11.808171 ft	0 psf	303.04391 psf	174.96249 psf	0 psf	0 psf	Rooting Zone/Sand
Column 124	130.35487 ft	11.849834 ft	0 psf	291.54096 psf	168.32125 psf	0 psf	0 psf	Rooting Zone/Sand
Column 125	130.50460 ft	11.889955 ft	0 psf	281.31146 psf	162.41524 psf	0 psf	0 psf	Rooting Zone/Sand
Column 126	130.65433 ft	11.930076 ft	0 psf	271.08195 psf	156.50924 psf	0 psf	0 psf	Rooting Zone/Sand
Column 127	130.80406 ft	11.970196 ft	0 psf	260.85244 psf	150.60323 psf	0 psf	0 psf	Rooting Zone/Sand
Column 128	130.95380 ft	12.010317 ft	0 psf	250.62293 psf	144.69722 psf	0 psf	0 psf	Rooting Zone/Sand
Column 129	131.10353 ft	12.050438 ft	0 psf	240.39343 psf	138.79121 psf	0 psf	0 psf	Rooting Zone/Sand
Column 130	131.25326 ft	12.090558 ft	0 psf	230.16392 psf	132.8852 psf	0 psf	0 psf	Rooting Zone/Sand
Column 131	131.40299 ft	12.130679 ft	0 psf	219.93441 psf	126.97919 psf	0 psf	0 psf	Rooting Zone/Sand
Column 132	131.55272 ft	12.170800 ft	0 psf	209.7049 psf	121.07318 psf	0 psf	0 psf	Rooting Zone/Sand
Column 133	131.70246 ft	12.210920 ft	0 psf	199.4754 psf	115.16717 psf	0 psf	0 psf	Rooting Zone/Sand
Column 134	131.85219 ft	12.251041 ft	0 psf	189.24589 psf	109.26116 psf	0 psf	0 psf	Rooting Zone/Sand

Column 135	132.00192 ft	12.291162 ft	0 psf	179.01638 psf	103.35516 psf	0 psf	0 psf	Rooting Zone/Sand
Column 136	132.15165 ft	12.331282 ft	0 psf	168.78687 psf	97.449147 psf	0 psf	0 psf	Rooting Zone/Sand
Column 137	132.30139 ft	12.371403 ft	0 psf	158.55737 psf	91.543138 psf	0 psf	0 psf	Rooting Zone/Sand
Column 138	132.45112 ft	12.411524 ft	0 psf	148.32786 psf	85.637129 psf	0 psf	0 psf	Rooting Zone/Sand
Column 139	132.60085 ft	12.451644 ft	0 psf	138.09835 psf	79.73112 psf	0 psf	0 psf	Rooting Zone/Sand
Column 140	132.75058 ft	12.491765 ft	0 psf	127.86884 psf	73.825111 psf	0 psf	0 psf	Rooting Zone/Sand
Column 141	132.90032 ft	12.531886 ft	0 psf	117.63934 psf	67.919102 psf	0 psf	0 psf	Rooting Zone/Sand
Column 142	133.05005 ft	12.572006 ft	0 psf	107.40983 psf	62.013093 psf	0 psf	0 psf	Rooting Zone/Sand
Column 143	133.19978 ft	12.612127 ft	0 psf	97.180321 psf	56.107084 psf	0 psf	0 psf	Rooting Zone/Sand
Column 144	133.34951 ft	12.652248 ft	0 psf	86.950813 psf	50.201076 psf	0 psf	0 psf	Rooting Zone/Sand
Column 145	133.49925 ft	12.692368 ft	0 psf	76.721306 psf	44.295067 psf	0 psf	0 psf	Rooting Zone/Sand
Column 146	133.64898 ft	12.732489 ft	0 psf	66.491799 psf	38.389058 psf	0 psf	0 psf	Rooting Zone/Sand
Column 147	133.79871 ft	12.772610 ft	0 psf	56.262291 psf	32.483049 psf	0 psf	0 psf	Rooting Zone/Sand
Column 148	133.94844 ft	12.812730 ft	0 psf	46.032784 psf	26.57704 psf	0 psf	0 psf	Rooting Zone/Sand
Column 149	134.09817 ft	12.852851 ft	0 psf	35.803276 psf	20.671031 psf	0 psf	0 psf	Rooting Zone/Sand
Column 150	134.24791 ft	12.892972 ft	0 psf	25.573769 psf	14.765022 psf	0 psf	0 psf	Rooting Zone/Sand
Column 151	134.39764 ft	12.933092 ft	0 psf	15.344261 psf	8.8590133 psf	0 psf	0 psf	Rooting Zone/Sand
Column 152	134.54737 ft	12.973213 ft	0 psf	5.1147537 psf	2.9530044 psf	0 psf	0 psf	Rooting Zone/Sand

Purpose: To evaluate the possible sliding of the access road on the final cover of the landfill.

Approach: Use assumed parameters from the 2023 Columbia Dry Ash Disposal Facility Plan of Operation to determine the factor of safety for the access road design.

References:

1. Landfill Design.com

2. "Designing with Geosynthetics," R.M. Koerner, Prentice Hall Publishing Co., Englewood Cliffs, NJ, 1998.

3. "Geosynthetic Design Guidance for Hazardous Waste Landfill Cells and Surface Impoundments," G.N. Richardson and R.M. Koerner, 1987.

4. SCS Engineers, Plan Modification Request/Plan of Operation Update, Dry Ash Disposal Facility, COL Energy Center, Final Grades Plan Sheet, August 2023.

Calculation:

The factor of safety is given as follows:

$$FS = \frac{\text{Resisting Forces}}{\text{Driving Forces}}$$

The advised minimum FS:

FS	Type of Load
3	Static
2	Dynamic

Static Factor of Safety (FS_{STATIC}) :

$$FS_{STATIC} = \frac{F_{shear}}{(W_s + W_v) \cdot \sin\beta}$$

Dynamic Factor of Safety ($FS_{DYNAMIC}$) :

$$FS_{DYNAMIC} = \frac{F_{shear}}{(W_s + W_v) \cdot \sin\beta + F_{deceleration}}$$

Where:

W_s = Weight of Roadway = $\gamma * w * L * t$

W_v = Weight of Vehicle (metric tons)

$F_{deceleration}$ = Vehicle braking force = $0.3 * W_v$

F_{shear} = $(W_s + W_v) \cdot \cos\beta \cdot \tan\delta$

And:

γ = Unit weight of the base layer

w = Ramp width

L = Ramp length

t = Ramp thickness

β = Slope

δ = Friction interface angle

The lowest shear force will be used in the calculations resulting from different interfaces.

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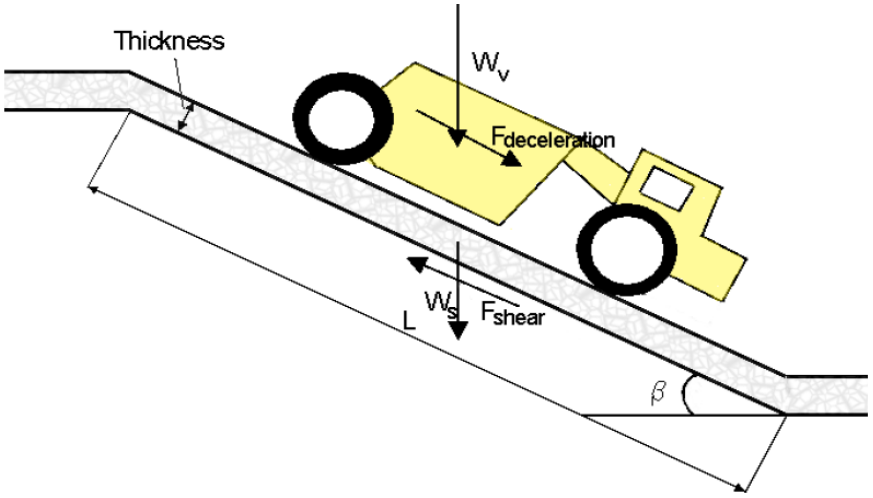
Calculation:
(cont.)



Vehicle Weight (W_v)	=	68,966	kg	or	152,000	lbs
Base Layer Unit Weight (γ)	=	2,160	kg/m^3	or	135	pcf
$F_{acceleration}$	=	20,690	kg			
Friction Angles (δ)						
Soil to Geocomposite	=	21	degrees			
Geomembrane to Geocomposite	=	21	degrees			
GCL to Geomembrane	=	30	degrees			
Soil to GCL	=	21	degrees			
Base Layer (Clay)	=	28	degrees			
Base Layer (Ash)	=	23.5	degrees			
Road Thickness	=	1.22	meters	or	4	ft
Road Centerline Sliding						
Road Width (W)	=	6.1	meters	or	20	ft
Road Length (L)	=	103.7	meters	or	340	ft
Slope (β)	=	5.7	degrees	or	10	%
Weight of Roadway (W_s)	=	1,664,950	kg			
F_{shear}	=	661,932	kg			

FS_{static}	=	3.96	**> 3.0**	OK
$FS_{dynamic}$	=	3.52	**> 2.0**	OK

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Assumptions: 1. Columbia currently uses a John Deere 410 off-road truck for hauling CCR. The fully loaded weight capacity is approximately 152,000 pounds.

2. A conservative minimum interface friction angle of 21 degrees is assumed for the final cover geosynthetics based on the final cover slope stability analyses.
3. Road thickness is depth from top of road to geomembrane.
4. Unit weight of the base layer is based on road building material.
5. A final cover interface friction angle of 30 degrees for the GCL to geomembrane interface is based on 2016 testing for the Modules 1 and 2 cover construction documentation.

Conclusions: The service road design is acceptable and will be stable under assumed loading conditions.

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SCS ENGINEERS

		Sheet No.	1 of 1
		Calc. No.	
		Rev. No.	
Job No. 25222260.00	Job: Columbia Dry Ash Disposal Facility	By: MJT	Date: 08/02/2023
Client: WPL	Subject: Pipe Sizing - Sand Drainage Layer	Chk'd: DLN	Date: 08/10/23

Purpose: To size the toe drain and intermediate drain corrugated HDPE piping to accommodate the final cover sand subsurface drainage.

Approach: Use the Darcy equation to determine the worst case flow rate to the pipe. Use Manning's equation to determine if the designed pipe size (3 inches) for the given flow rate is acceptable.

Calculation: **Toe Drain (Outlet Pipes)**

Darcy's Equation, Q=KiA

Where: i = hydraulic gradient, for 4:1 slope = 0.25

A = X-Section of flow area (200ft x 1ft), for 200 ft pipe spacing and 1 ft thick drainage layer = 200 ft^2

k = Permeability of drainage material = 0.01 cm/s

so, Q = flow rate = k X i X A = 0.016 cfs

Manning's Equation

$$Q = \frac{1.49}{n} \times 3.14 \times r^2 \times \left(\frac{r}{2}\right)^{2/3} \times slope^{1/2}$$

Where: n = Manning's Number for corrugated HDPE pipe = 0.015

r = Radius of pipe = 1.5 inches = 0.125 feet

slope = 0.005

so, Q = 0.0543 cfs

Result: 0.054 is greater than 0.016 cfs, so a 3-inch outlet pipe at the toe is acceptable.

Intermediate Drain (Collection Pipes, including toe)

Darcy's Equation $Q_{in}=K_{veg} \times i \times A = K_{veg} \times 1 \times L \times 1 \times FS$

Inflow of water in 1-ft thick drainage sand (unit gradient)

k_{veg} = Permeability of the vegetative supporting soil = 0.000042 cm/sec

L_h = Drainage pipe spacing or length of slope measured horizontally = 371 ft

FS = Overall factor of safety for drainage = 2.0

so, Q_{in} = 28.952 cm^3/s

Q_{in} = 0.0010 cfs

Mannings Equation

Where: n = Manning's Number for corrugated HDPE pipe = 0.015

r = Radius of pipe = 1.5 inches = 0.125 feet

slope = 0.005

so, Q = 0.0543 cfs

Result: 0.054 is greater than 0.001 cfs, so a 3-inch collection pipe is acceptable.

Conclusion: Based on the flow for the intermediate and toe piping, a 3" pipe is adequate.

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Purpose: To determine the maximum length of slope that the final cover drainage layer (sand) can carry infiltrating water and remain stable.

Approach: Use the unit gradient method to determine the maximum slope length.

References:

1. Landfilldesign.com

2. "GRI-GC8, Determination of the Allowable Flow Rate of a Drainage Geocomposite". Geosynthetics Research Institute, 2001

3. "Beyond a factor-of-safety value, i.e., the probability of failure". GRI Newsletter/Report, Vol. 15, no. 3

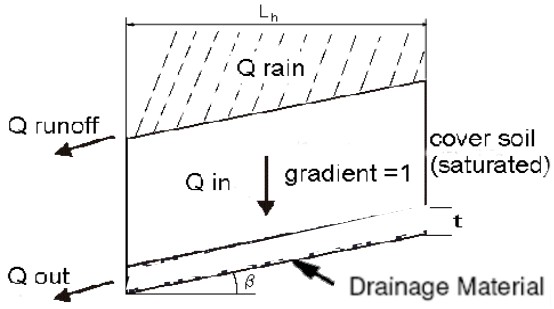
4. "Designing with Geosynthetics". R.M. Koerner, Prentice Hall Publishing Co., Englewood Cliffs, NJ, 1998

5. "Hydraulic Design of Geosynthetic and Granular Liquid Collection Layers". J. P. Giroud, J. G. Zornberg and A. Zhao, Geosynthetics International, Vol. 7, Nos 4-5

6. "Lateral Drainage Design update - part 2". G. N. Richardson, J. P. Giroud and A. Zhao, Geotechnical Fabrics Report, March 2002

7. HELP Model "User's Guide", Table 4: Default Soil, Waste, and Geosynthetic Characteristics

8. SCS Engineers, Plan of Operation Update, Dry Ash Disposal Facility, Columbia Energy Center, Final Grades (Modules 12 and 13) Plan Sheet, August 2023



With Darcy's Law:

$$Q = k \times i \times A$$

Inflow of water in the Drainage Material

$$Q_{in} = k_{veg} \times i \times A = k_{veg} \times 1 \times L_h \times 1$$

Outflow of water from the geocomposite at the toe of the slope

$$Q_{out} = k_{drain} \times i \times A = k_{drain} \times t \times \sin\beta$$

This results in a required k_{drain} of:

$$k_{drain} = \frac{k_{veg} \times L_h}{t \times \sin\beta} \times FS$$

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Assumptions: 1. Soil hydraulic gradient *i* = 1.0.

2. Top soil will be clay. Soil permeability is 4.2 x 10^{-5} cm/sec for a CL clay from HELP model user's guide.

3. Drainage Layer hydraulic gradient = sinβ where β=14˚ (4:1 horizontal/vertical final cover slope).

4. Maximum horizontal final cover slope length from crest to toe drain is 371 feet as shown in Module 1 on the final grades plan sheet.

5. The minimum hydraulic conductivity ($k_{drain,ave}$) is 1.0 x 10^{-2} cm/s for the sand.

6. Cover drainage layer thickness t = 1 foot.

Calculation: Constants

L_h	=	Drainage pipe spacing or length of slope measured horizontally	=	See Below	
k_{veg}	=	Permeability of the vegetative supporting soil	=	0.000042	cm/sec
S	=	The liner's slope, **S** = tan **b**	=	25%	b = 14˚
FS_{slope}	=	Minimum factor of safety against sliding, for drainage layer/geomembrane interface	=	1.5	
$\delta_{req'd}$	=	Minimum interface friction angle = $\tan^{-1}$(FS*tan(b))	=	20.6	degrees

Determine the maximum slope length for the given minimum required drainage layer permeability

L_h (feet)	L_h (meter)	$k_{drain, req}$ (cm/s)	
30	9.1	7.69E-03	Design

Conclusions: The design has an intermediate pipe every 30 feet spaced evenly up the slope. The intermediate pipe spacing design with the sand material has a factor of safety of 1.95.

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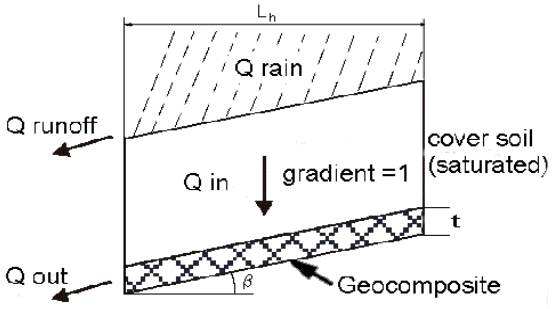
Purpose: To determine the maximum length of slope that the final cover drainage geocomposite can carry infiltrating water and remain stable. Also determine the recommended minimum friction angle for final cover side slope stability. Note: This calculation does not include the flow convergence areas where a separate calculation is required.

Approach: Use the unit gradient method to determine the maximum slope length.

References:

1. Landfilldesign.com - Lateral Drainage System - Single Slope, Unit Gradient Method
2. "GRI-GC8, Determination of the Allowable Flow Rate of a Drainage Geocomposite". Geosynthetics Research Institute, 2001.
3. "Beyond a factor-of-safety value, i.e., the probability of failure". GRI Newsletter/Report, Vol. 15, no. 3.
4. "Designing with Geosynthetics". R.M. Koerner, Prentice Hall Publishing Co., Englewood Cliffs, NJ, 1998.
5. "Hydraulic Design of Geosynthetic and Granular Liquid Collection Layers". J. P. Giroud, J. G. Zornberg and A. Zhao, Geosynthetics International, Vol. 7, Nos 4-5.
6. "Lateral Drainage Design update - part 2". G. N. Richardson, J. P. Giroud and A. Zhao, Geotechnical Fabrics Report, March 2002.
7. Giroud, Zornberg, and Zhao, 2000, "Hydraulic Design of Liquid Collection Layers", Geosynthetics International
8. SCS Engineers, Plan of Operation Update, Dry Ash Disposal Facility, Columbia Energy Center, Final Grades (Modules 12 and 13) Plan Sheet, August 2023
9. HELP Model "User's Guide" in conjunction with GRI report #19, pages 34-37 (Leachate Collection System)



With Darcy's law:

$$Q = k * i * A$$

Inflow of water in the geocomposite

$$Q_{in} = k_{veg} * i * A = k_{veg} * 1 * L_h * 1$$

Outflow of water from the geocomposite at the toe of the slope

$$Q_{out} = k_{comp} * i * A = k_{comp} * i * t * 1 = \theta_{required} * \sin\beta \quad = \theta * i * 1 \text{ where } \theta = k_{comp} * t$$

Inflow equals outflow (Factor of Safety = 1)

$$Q_{in} = Q_{out}$$

This results in a required transmissivity of the geocomposite of:

$$\theta_{required} = \frac{k_{veg} * L_h}{\sin\beta}$$

Which results in the ultimate transmissivity after multiplying by the Total Serviceability Factor (TSF)

$$\theta_{ultimate} = \theta_{required} * FS_d * RF_{in} * RF_{cr} * RF_{cc} * RF_{bc}$$

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Assumptions: 1. Soil hydraulic gradient i = 1.0.

2. Top soil will be clay. Soil permeability is 4.2 x 10^{-5} cm/sec for a CL clay from HELP model user's guide.

3. Geocomposite hydraulic gradient = sinβ where β=14˚ (4:1 horizontal/vertical final cover slope).

4. Factor of safety and transmissivity reduction factors are from recommended values in GRI report #19 (Leachate collection system example) and HELP model "Users Guide"

5. Maximum horizontal final cover slope length from crest to toe drain is 570 feet as shown on Final Grades (Modules 12 and 13) plan sheet. This includes 128' of 10:1 slope length at the peak.

Calculation: Constants

L_h	=	Drainage pipe spacing or length of slope measured horizontally	=	See Below	
k_{veg}	=	Permeability of the vegetative supporting soil	=	0.000042	cm/sec
S	=	The liner's slope, **S** = tan **b**	=	25%	b = 14 ˚
FS_{slope}	=	Minimum factor of safety against sliding, for soil/geocomposite or geocomposite/geomembrane interfaces	=	1.5	
$\delta_{req'd}$	=	Minimum interface friction angle = $\tan^{-1}$(FS*tan(b))	=	20.6	degrees
FS_d	=	Overall factor of safety for drainage	=	2.0	
RF_{in}	=	Intrusion Reduction Factor	=	1.1	
RF_{cr}	=	Creep Reduction Factor	=	1.2	
RF_{cc}	=	Chemical Clogging Reduction Factor	=	1.1	
RF_{bc}	=	Biological Clogging Reduction Factor	=	1.4	

Determine the maximum slope length for a given ultimate transmissivity

Θ_{ult} (m^2/sec)	L_h (meter)	L_h (feet)
1.00E-03	146.5	481

Determine the ultimate transmissivity based on a given slope length

L_h (feet)	L_h (meter)	Θ_{ult} (m^2/sec)	
570	173.7	1.19E-03	~ Total slope length
285	86.9	5.93E-04	~ 1/2 of total slope length
190	57.9	3.96E-04	~ 1/3 of total slope length

Conclusions: If no intermediate drainage outlets were constructed on the final cover, a minimum transmissivity of 1.19 x 10^{-3} m^2/sec would need to be obtained.

A minimum interface friction angle of 20.6 degrees between cover soil and geocomposite is required to achieve a minimum recommended final cover slope stability safety factor of 1.5.

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Calc. No.			
Rev. No.			
Job No. 25222260.00	Job: Columbia Dry Ash Disposal Facility	By: MJT	Date: 08/04/23
Client: WPL	Subject: Cover Geocomposite Toe Drain Pipe Sizing Calc.	Chk'd: DLN	Date: 08/11/23

Purpose: To size the collection piping toe drain and space the outlet piping to accommodate the final cover geocomposite drainage.

Approach: Use the Darcy equation to determine the worst case flow rate to the pipe. Use Manning's equation to determine if the designed pipe size (4 inches) for the given flow rate is acceptable. Also determine what would be acceptable bedding material based on pipe hole / perforation size.

References:
1. SCS Engineers, Plan of Operation, Columbia Dry Ash Disposal Facility, Cover Unit Gradient Calculation, August 2023
2. NAVFAC DM 7, Design Criteria for Protective Filters
3. Advanced Drainage Systems (ADS), Inc. Drainage Handbook, Section 3-0 Hydraulics, July 2010
4. Advanced Drainage Systems (ADS), Inc. Technical Note (TN 1.01) Dual Wall HDPE Perforation Patterns, January 2015

Calculation:

Infiltration Flow / Collection Pipe Flow Capacity

Darcy's Equation, $Q_{in}=K_{veg} \times i \times A = K_{veg} \times 1 \times L_h \times 1 \times FS$

Inflow of water into geocomposite from surface = Inflow of water into collection pipe

K_{veg} = 4.2E-05 cm/s , [permeability of topsoil]

L_h = 570 ft , [longest horizontal length between collection pipes]

L_h = 173.7 m , (longest horizontal length between collection pipes)

FS (drainage) = 2.0 [Factor of safety, to account for variation in cover soil]

Q_{in}= 44.48 cm^3/s , [per linear foot of pipe]

Q_{in}= **0.0016** cfs [required collection pipe capacity]

Required geocomposite transmissivity (from Cover Unit Gradient Calculation)

$\Theta_{req} = (K_{veg} \times L_h) / i * FS$ where, i = 0.25

Θ_{req} = 5.84E-04 m^2/sec

Geocomposite Flow Capacity / Outlet Pipe Flow Capacity

Darcy's Equation, $Q = k \times i \times A$ Q = flow rate

$A = L \times t$ t = thickness

$\Theta = k \times t$ k = permeability

so, $Q = \Theta \times i \times L$ Θ = transmissivity

i = 0.25 [hydraulic gradient, for 4:1 slope]

L = 293 ft [length of collection pipe (i.e. spacing between outlet pipe)]

Θ_{req} = 6.28E-03 ft^2/s [required transmissivity of geocomposite]

Q = **0.460** cfs [required outlet pipe capacity]

Design Pipe Flow

Manning's Equation,

$Q= (1.49/n) \times (3.14 \times r^2) \times (r / 2)^{2/3} \times (slope)^{1/2}$

Where,

n = 0.012 [Manning's Number for corrugated HDPE pipe with smooth interior]

r = 2.0 in , [Radius of 4" pipe]

r = 0.167 ft , (Radius of 4" pipe)

Q = **0.146** cfs [Collection Pipe at 0.5% slope]

Q = **0.292** cfs [Collection Pipe at 2% slope]

Q = **0.462** cfs [Outlet Pipe at 5% slope, 'min. design slope']

Q = **1.461** cfs [Outlet Pipe at 50% (2:1) slope]

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Bedding Stone Diameter Sizing

Perforation design of 4" pipe (from ADS)

Maximum slot length = 0.875 inch

Maximum slot width = 0.125 inch

*Slot width will control the size of bedding stone

D_{85F} / Slot Width > (1.2 to 1.4) , [From the NAVFAC DM 7 Manual]

D_{85F} = (0.125 inch) * 1.2 = 0.150 inch

D_{85F} = (0.125 inch) * 1.4 = 0.175 inch

so, a bedding stone with a D_{85F} between 0.150 and 0.175 inch or larger would be acceptable.

Conclusion: Based on the outlet pipe estimated flow, a 4-inch pipe spaced at 293 ft or less would be adequate.
The design outlet pipe spacing is a maximum of 200 ft.
A 4" diameter collection pipe (toe drain) at a 2% slope (typical), and a minimum of 0.5% slope, is suitable to collect the expected drainage layer flow.
For a 0.125 inch perforated pipe slot width, bedding stone diameter should be between 0.150 and 0.175 inch (equivalent to the No. 4 sieve) or larger.

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Purpose: To size the final cover geocomposite collection piping (toe drain) and space the outlet piping to accommodate the final cover geocomposite drainage in the southernmost corner, near Module 1, 2, and 3.

Approach: Use the Darcy equation to determine the worst case flow rate to the pipe. Use Manning's equation to determine if the designed pipe size (4-in collection piping and 8-in outlet piping) for the given flow rate is acceptable. Also determine what would be acceptable bedding material based on pipe hole / perforation size.

References:
1. SCS Engineers, Plan of Operation, Columbia Dry Ash Disposal Facility, Cover Unit Gradient Calculation, August 2023
2. NAVFAC DM 7, Design Criteria for Protective Filters
3. Advanced Drainage Systems (ADS), Inc. Drainage Handbook, Section 3-0 Hydraulics, July 2010
4. Advanced Drainage Systems (ADS), Inc. Technical Note (TN 1.01) Dual Wall HDPE Perforation Patterns, January 2015

Calculation:

Infiltration Flow / Collection Pipe Flow Capacity

Darcy's Equation, $Q_{in}=K_{veg} \times i \times A = K_{veg} \times 1 \times L_h \times 1 \times FS$

Inflow of water into geocomposite from surface = Inflow of water into collection pipe

K_{veg} = 4.2E-05 cm/s , [permeability of topsoil]

L_h = 570 ft , [longest horizontal length between collection pipes]

L_h = 173.7 m , (longest horizontal length between collection pipes)

FS (drainage) = 2.0 [Factor of safety, to account for variation in cover soil]

Q_{in}= 44.48 cm^3/s , [per linear foot of pipe]

Q_{in}= **0.0016** cfs [required collection pipe capacity]

Required geocomposite transmissivity (from Cover Unit Gradient Calculation)

$\Theta_{req} = (K_{veg} \times L_h) / i * FS$ where, i = 0.25

Θ_{req} = 5.84E-04 m^2/sec

Geocomposite Flow Capacity / Outlet Pipe Flow Capacity

Darcy's Equation, $Q = k \times i \times A$ Q = flow rate

$A = L \times t$ t = thickness

$\Theta = k \times t$ k = permeability

so, $Q = \Theta \times i \times L$ Θ = transmissivity

i = 0.25 [hydraulic gradient, for 4:1 slope]

L = 417 ft [length of collection pipe (i.e. spacing between outlet pipe)]

Θ_{req} = 6.28E-03 ft^2/s [required transmissivity of geocomposite]

Q = **0.655** cfs [required outlet pipe capacity]

Design Pipe Flow

Manning's Equation,

$Q= (1.49/n) \times (3.14 \times r^2) \times (r / 2)^{2/3} \times (slope)^{1/2}$

Where,

n = 0.012 [Manning's Number for corrugated HDPE pipe with smooth interior]

r = 2.0 in , [Radius of 4" pipe] r = 4.0 in , [Radius of 8" pipe]

r = 0.167 ft , (Radius of 4" pipe) r = 0.333 ft , (Radius of 8" pipe)

Q = **0.146** cfs [4" Collection Pipe at 0.5% slope, 'min. design slope']

Q = **0.292** cfs [4" Collection Pipe at 2% slope]

Q = **0.656** cfs [8" Outlet Pipe at 0.25% slope]

Q = **9.277** cfs [8" Outlet Pipe at 50% (2:1) slope]

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Bedding Stone Diameter Sizing

Perforation design of 4" pipe (from ADS)

Maximum slot length = 0.875 inch

Maximum slot width = 0.125 inch

*Slot width will control the size of bedding stone

D_{85F} / Slot Width > (1.2 to 1.4) , [From the NAVFAC DM 7 Manual]

D_{85F} = (0.125 inch) * 1.2 = 0.150 inch

D_{85F} = (0.125 inch) * 1.4 = 0.175 inch

so, a bedding stone with a D_{85F} between 0.150 and 0.175 inch or larger would be acceptable.

Conclusion: Based on the outlet pipe estimated flow, an 8-inch pipe spaced at 417 ft or less would be adequate.
The design outlet pipe spacing is 335 ft at the south end, near Module 1.
A 4" diameter collection pipe (toe drain) at a 2% slope (typical), and a minimum of 0.5% slope, is suitable to collect the expected drainage layer flow.
For a 0.125 inch perforated pipe slot width, bedding stone diameter should be between 0.150 and 0.175 inch (equivalent to the No. 4 sieve) or larger.

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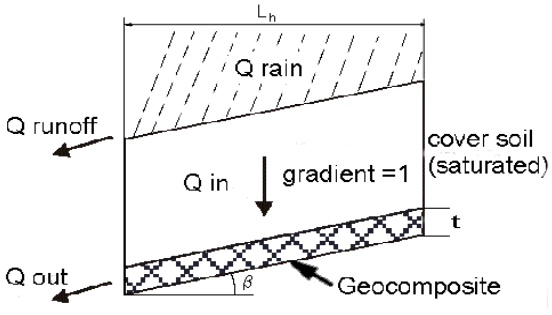
Purpose: To determine the maximum length of slopes that the final cover drainage geocomposite can carry infiltrating water and remain stable above the Final Cover Access Road.

Approach: Use the unit gradient method to determine the maximum slope length.

References:

1. Landfilldesign.com - Lateral Drainage System - Single Slope, Unit Gradient Method
2. "GRI-GC8, Determination of the Allowable Flow Rate of a Drainage Geocomposite". Geosynthetics Research Institute, 2001.
3. "Beyond a factor-of-safety value, i.e., the probability of failure". GRI Newsletter/Report, Vol. 15, no. 3.
4. "Designing with Geosynthetics". R.M. Koerner, Prentice Hall Publishing Co., Englewood Cliffs, NJ, 1998.
5. "Hydraulic Design of Geosynthetic and Granular Liquid Collection Layers". J. P. Giroud, J. G. Zornberg and A. Zhao, Geosynthetics International, Vol. 7, Nos 4-5.
6. "Lateral Drainage Design update - part 2". G. N. Richardson, J. P. Giroud and A. Zhao, Geotechnical Fabrics Report, March 2002.
7. Giroud, Zornberg, and Zhao, 2000, "Hydraulic Design of Liquid Collection Layers", Geosynthetics International
8. SCS Engineers, Plan of Operation Update, Dry Ash Disposal Facility, Columbia Energy Center, Final Grades (Module 12 and 13) Plan Sheet, August 2023
9. HELP Model "User's Guide", Table 1 - Default Low Density Soil Characteristics
10. Soong, T.Y. and Koerner, R.M. (1997), "The Design of Drainage Systems over Geosynthetically Lined Slopes", Geosynthetics Research Institute, Report #19.



With Darcy's law:

$$Q = k * i * A$$

Inflow of water in the geocomposite

$$Q_{in} = k_{veg} * i * A = k_{veg} * 1 * L_h * 1$$

Outflow of water from the geocomposite at the toe of the slope

$$Q_{out} = k_{comp} * i * A = k_{comp} * i * t * 1 = \theta_{required} * \sin\beta \quad = \theta * i * 1 \text{ where } \theta = k_{comp} * t$$

Inflow equals outflow (Factor of Safety = 1)

$$Q_{in} = Q_{out}$$

This results in a required transmissivity of the geocomposite of:

$$\theta_{required} = \frac{k_{veg} * L_h}{\sin\beta}$$

Which results in the ultimate transmissivity after multiplying by the Total Serviceability Factor (TSF)

$$\theta_{ultimate} = \theta_{required} * FS_d * RF_{in} * RF_{cr} * RF_{cc} * RF_{bc}$$

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4:1 final cover geocomposite slope above access road

Assumptions: 1. Soil hydraulic gradient i = 1.0.

2. Top soil will be clay. Soil permeability is 4.2 x 10^{-5} cm/sec for a CL clay from HELP model user's guide.

3. Geocomposite hydraulic gradient = sinβ where β=14˚ (4:1 horizontal/vertical final cover slope).

4. Factor of safety and transmissivity reduction factors are from recommended values in GRI report #19 (Leachate collection system example) and HELP model "Users Guide"

5. Maximum horizontal final cover slope length at 4:1 slope above the road is 495 feet as shown on Final Grades (Module 12 and 13) plan sheet. This includes 95' of 10:1 slope length at the peak.

Calculation: Constants

L_h	=	Drainage pipe spacing or length of slope measured horizontally	=	See Below		
k_{veg}	=	Permeability of the vegetative supporting soil	=	0.000042	cm/sec	
S	=	The liner's slope, **S** = tan **b**	=	25%	b =	14 ˚

FS_d	=	Overall factor of safety for drainage	=	2.0
RF_{in}	=	Intrusion Reduction Factor	=	1.1
RF_{cr}	=	Creep Reduction Factor	=	1.2
RF_{cc}	=	Chemical Clogging Reduction Factor	=	1.1
RF_{bc}	=	Biological Clogging Reduction Factor	=	1.4

Determine the ultimate transmissivity based on a given slope length

L_h (feet)	L_h (meter)	Θ_{ult} (m^2/sec)	
495	150.9	1.03E-03	~ Total slope length (4:1 slope above access road only)

Conclusion: If no intermediate drainage outlets were constructed on the final cover, above the Final Cover Access Road, a minimum transmissivity of 1.03 x 10^{-3} m^2/sec would need to be obtained.

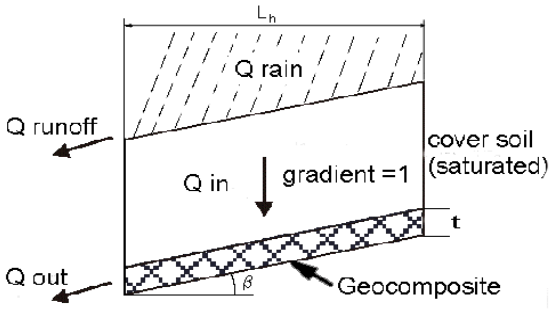
09/28/2023 - Classification: Internal - ECRM13153872

Purpose: To determine the geocomposite drainage requirements in the final cover where flow converges in the final cover corner including Modules 3, 4, 10, and 11 and the final cover corner including Modules 5, 6, 11, and 12 so the final cover drainage geocomposite can carry infiltrating water and remain stable. Also to determine the recommended minimum interface friction angle for final cover stability.

Approach: Use the unit gradient method and flow path geometry to determine the geocomposite transmissivity required at locations within the converging flow area.

References:

1. Landfilldesign.com - Lateral Drainage System - Single Slope, Unit Gradient Method
2. "GRI-GC8, Determination of the Allowable Flow Rate of a Drainage Geocomposite". Geosynthetics Research Institute, 2001.
3. "Beyond a factor-of-safety value, i.e., the probability of failure". GRI Newsletter/Report, Vol. 15, no. 3.
4. "Designing with Geosynthetics". R.M. Koerner, Prentice Hall Publishing Co., Englewood Cliffs, NJ, 1998.
5. "Hydraulic Design of Geosynthetic and Granular Liquid Collection Layers". J. P. Giroud, J. G. Zornberg and A. Zhao, Geosynthetics International, Vol. 7, Nos 4-5.
6. "Lateral Drainage Design update - part 2". G. N. Richardson, J. P. Giroud and A. Zhao, Geotechnical Fabrics Report, March 2002.
7. Giroud, Zornberg, and Zhao, 2000, "Hydraulic Design of Liquid Collection Layers", Geosynthetics International
8. SCS Engineers, Plan of Operation Update, Dry Ash Disposal Facility, Columbia Energy Center, Final Grades (Module 12) Plan Sheet, August 2023
9. HELP Model "User's Guide" in conjunction with GRI report #19, pages 34-37 (Leachate Collection System)



With Darcy's law:

$$Q = k * i * A$$

Inflow of water in the geocomposite

$$Q_{in} = k_{veg} * i * A = k_{veg} * 1 * L_h * 1$$

Outflow of water from the geocomposite at the toe of the slope

$$Q_{out} = k_{comp} * i * A = k_{comp} * i * t * 1 = \theta_{required} * \sin\beta$$

= θ*i*1 where θ = k_{comp} * t (minimum allowable outflow to keep head within geocomposite)

Inflow equals outflow (Factor of Safety = 1)

$$Q_{in} = Q_{out}$$

This results in a required transmissivity of the geocomposite of:

$$\theta_{required} = \frac{k_{veg} * L_h}{\sin\beta}$$

Which results in the ultimate transmissivity after multiplying by the Total Serviceability Factor (TSF)

$$\theta_{ultimate} = \theta_{required} * FS_d * RF_{in} * RF_{cr} * RF_{cc} * RF_{bc}$$

09/28/2023 - Classification: Internal - ECRM13153872

Assumptions: 1. Soil hydraulic gradient *i* = 1.0.

2. Top soil will be clay. Soil permeability is 4.2 x 10^{-5} cm/sec for a CL clay from HELP model user's guide.

3. Geocomposite hydraulic gradient = sinβ where β=14˚ (4:1 horizontal/vertical final cover slope).

4. Factor of safety and transmissivity reduction factors are from recommended values in GRI report #19 (Leachate collection system example) and HELP model "Users Guide"

5. Flow paths A-E and F-J are as shown on attached drawing. Assume circular arc with radius measured from the corner of the toe drain.

6. Intermediate drainage piping will be used along the slope to divert flow from the drainage layer to the diversion berms and downslope flume.

Calculation: Constants

L_h	=	Drainage pipe spacing or length of slope measured horizontally	=	See Below	
k_{veg}	=	Permeability of the vegetative supporting soil	=	0.000042	cm/sec
S	=	The liner's slope, **S** = tan **b**	=	25%	b = 14˚
FS_{slope}	=	Minimum factor of safety against sliding, for soil/geocomposite or geocomposite/geomembrane interfaces	=	1.5	
$\delta_{req'd}$	=	Minimum interface friction angle = $\tan^{-1}$(FS*tan(b))	=	20.6	degrees
FS_d	=	Overall factor of safety for drainage	=	2.0	
RF_{in}	=	Intrusion Reduction Factor	=	1.1	
RF_{cr}	=	Creep Reduction Factor	=	1.2	
RF_{cc}	=	Chemical Clogging Reduction Factor	=	1.1	
RF_{bc}	=	Biological Clogging Reduction Factor	=	1.4	
w	=	Geocomposite width at drainage outlet			
A	=	Final cover plan area upslope of geocomposite drainage outlet			

Determine the maximum slope length for a given ultimate transmissivity

Min. Θ_{req} = A X k_{veg} / (w X sinβ)

For the outlet at the corner, use minimum 5 foot width and 2 foot width of geocomposite to connect the toe drain to drain the converging flow area:

Area	A (sq. feet)	w (feet)	w (meter)	Min. Θ_{ult} (m^2/sec)	Proposed Θ_{ult} (m^2/sec)
Area 1 Toe Drain	468	5	1.52	2.01E-04	1.00E-03
Area 4 Toe Drain	181	2	0.61	1.95E-04	1.00E-03

The toe drainage areas, Area 1 and Area 4, include only converging flow below the lowest intermediate drainage piping, as flow above this area is diverted. There are intermediate drainage pipes in Areas 1 and 4 which divert flow from the outlet corner to the downslope flume.

For converging flow in a circular arc, from radius R-top to radius R-bottom:

L = R-top - R-bottom

w-bot = w-top * (R-bot/R-top)

A = L* (1+ (R-bot/R-top))/2 (assuming unit width at top and trapezoid vs arc to simplify)

Θult-bot = (Θult calculated for L) * R-top/R-bot * (1+ (R-bot/R-top))/2

09/28/2023 - Classification: Internal - ECRM13153872

Calculation: (Cont.) For the southern convergence area, flow paths A-E, calculate Θult for selected R-bot values to determine appropriate geocomposite products as flow converges down the slope:

Flow Path	R-top (feet)	R-bot (feet)	L_h (feet)	L_h (meters)	Θ_{ult} (m^2/sec)	Proposed Θ_{ult} (m^2/sec)
Area 1						
A1	138	26	112	34	7.57E-04	1.00E-03
B1	136	27	109	33	7.03E-04	1.00E-03
C1	133	27	106	32	6.70E-04	1.00E-03
D1	129	25	104	31	6.74E-04	1.00E-03
E1	125	23	102	31	7.04E-04	1.00E-03
Area 2						
A2	298	138	160	48	5.35E-04	1.00E-03
B2	291	136	155	47	5.21E-04	1.00E-03
C2	284	133	151	46	5.09E-04	1.00E-03
D2	277	129	148	45	5.00E-04	1.00E-03
E2	269	125	144	43	4.79E-04	1.00E-03
Area 3						
A3	353	298	55	16	1.23E-04	1.00E-03
B3	393	291	102	31	2.57E-04	1.00E-03
C3	460	284	176	53	4.90E-04	1.00E-03
D3	481	277	204	62	5.99E-04	1.00E-03
E3	447	269	178	54	5.08E-04	1.00E-03

Conclusions: For the southern final cover corner including Modules 3, 4, 10, and 11 proposed design with intermediate slope outlets and a toe-of-slope drainage outlet, placement of geocomposite with the required transmissivities to the minimum lengths/areas shown in the table above and on the attached drawing will provide adequate drainage for the converging flow.

A minimum interface friction angle of 20.6 degrees for the geocomposite, geomembrane, and GCL interfaces is required to achieve a minimum recommended final cover slope stability safety factor of 1.5.

09/28/2023 - Classification: Internal - ECRM13153872

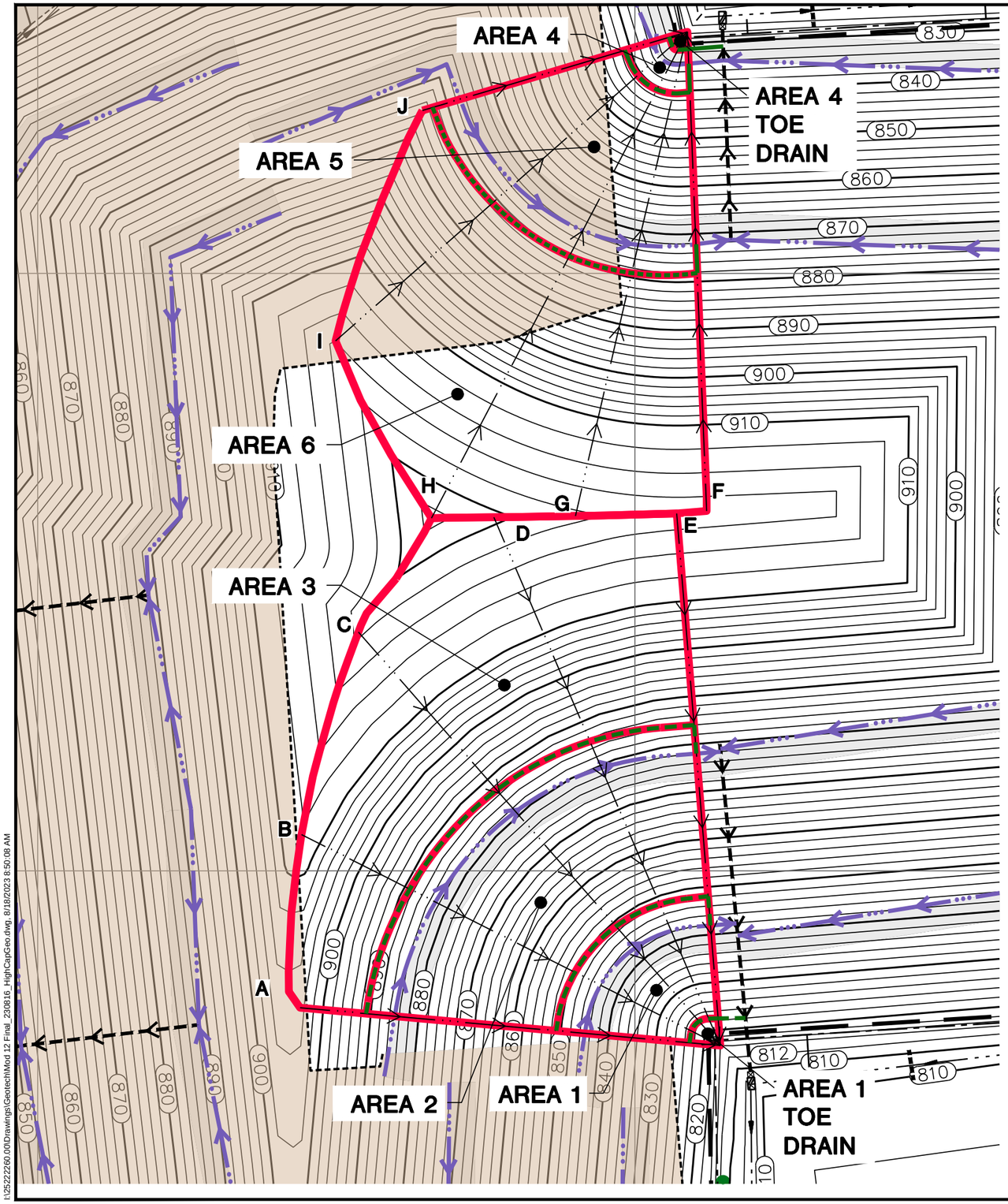
Calculation: (Cont.) For the northern convergence area, flow paths F-J, calculate Θult for selected R-bot values to determine appropriate geocomposite products as flow converges down the slope:

Flow Path	R-top (feet)	R-bot (feet)	L_h (feet)	L_h (meters)	Θ_{ult} (m^2/sec)	Proposed Θ_{ult} (m^2/sec)
Area 4						
F4	51	15	36	10	1.55E-04	1.00E-03
G4	53	15	38	11	1.76E-04	1.00E-03
H4	55	17	38	11	1.64E-04	1.00E-03
I4	55	17	38	11	1.64E-04	1.00E-03
J4	55	16	39	11	1.72E-04	1.00E-03
Area 5						
F5	202	51	151	46	8.06E-04	1.00E-03
G5	207	53	154	46	7.97E-04	1.00E-03
H5	212	55	157	47	8.06E-04	1.00E-03
I5	217	55	162	49	8.56E-04	1.00E-03
J5	223	55	168	51	9.10E-04	1.00E-03
Area 6						
F6	401	202	199	60	6.32E-04	1.00E-03
G6	416	207	209	63	6.69E-04	1.00E-03
H6	460	212	248	75	8.39E-04	1.00E-03
I6	392	217	175	53	5.25E-04	1.00E-03
J6	232	223	9	2	1.44E-05	1.00E-03

Conclusions: For the northern final cover corner including Modules 5, 6, 11, and 12 area proposed design with intermediate slope outlets and a toe-of-slope drainage outlet, placement of geocomposite with the required transmissivities to the minimum lengths/areas shown in the table above and on the attached drawing will provide adequate drainage for the converging flow.

A minimum interface friction angle of 20.6 degrees for the geocomposite, geomembrane, and GCL interfaces is required to achieve a minimum recommended final cover slope stability safety factor of 1.5.

09/28/2023 - Classification: Internal - ECRM13153872



LEGEND

- LIMITS OF WASTE
- LINER PHASE/MODULE LIMIT
- PROPOSED GRADE (10' INTERVAL)
- PROPOSED GRADE (2' INTERVAL)
- PROPOSED SWALE
- PROPOSED DIVERSION BERM
- PROPOSED DOWNSLOPE FLUME
- PROPOSED ENERGY DISSIPATOR
- PROPOSED RIPRAP
- CONVERGENCE FLOW PATH
- PERFORATED SUBSURFACE PIPING
- SOLID SUBSURFACE PIPING

DRAFT

N

100 0 100

SCALE: 1" = 100'

GEOTECHNICAL CALCULATION – FLOW CONVERGENCE
FINAL GRADES (MODULE 12)

FIGURE 1

SCS ENGINEERS
2830 DAIRY DRIVE MADISON, WI 53718-6751
PHONE: (608) 224-2830

ENGINEER

COLUMBIA ENERGY CENTER
PLAN OF OPERATION UPDATE
TOWN OF PACIFIC, WISCONSIN
COLUMBIA DRY ASH DISPOSAL FACILITY

SITE

WISCONSIN POWER AND LIGHT
COLUMBIA ENERGY CENTER
W8375 MURRAY ROAD
PARDEEVILLE, WISCONSIN 53954

CLIENT

PROJECT NO.	25222260.00	DRAWN BY: KP/MJT
DRAWN:	08/03/2023	CHECKED BY: DN/BSS
REVISED:	08/17/2023	APPROVED BY:

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Purpose: To size the collection piping (Toe Drain and Final Cover Road Intermediate Drain) and space the outlet piping to accommodate the final cover geocomposite drainage.

Approach: Use the Darcy equation to determine the worst case flow rate to the pipe. Use Manning's equation to determine if the designed pipe size (4 inches) for the given flow rate is acceptable. Also determine what would be acceptable bedding material based on pipe hole / perforation size.

References:
1. SCS Engineers, Plan of Operation, Columbia Dry Ash Disposal Facility, Cover Unit Gradient Calculation, August 2023
2. NAVFAC DM 7, Design Criteria for Protective Filters
3. Advanced Drainage Systems (ADS), Inc. Drainage Handbook, Section 3-0 Hydraulics, July 2010
4. Advanced Drainage Systems (ADS), Inc. Technical Note (TN 1.01) Dual Wall HDPE Perforation Patterns, January 2015

Calculation:

Infiltration Flow / Collection Pipe Flow Capacity

Darcy's Equation, $Q_{in}=K_{veg} \times i \times A = K_{veg} \times 1 \times L_h \times 1 \times FS$

Inflow of water into geocomposite from surface = Inflow of water into collection pipe

K_{veg} = 4.2E-05 cm/s , [permeability of topsoil]

L_h = 495 ft , [longest horizontal length between collection pipes]

L_h = 150.9 m , (longest horizontal length between collection pipes)

FS (drainage) = 2.0 [Factor of safety, to account for variation in cover soil]

Q_{in}= 38.63 cm^3/s , [per linear foot of pipe]

Q_{in}= **0.0014** cfs [required collection pipe capacity]

Required geocomposite transmissivity (from Cover Unit Gradient Calculation)

$\Theta_{req} = (K_{veg} \times L_h) / i * FS$ where, i = 0.25

Θ_{req} = 5.07E-04 m^2/sec

Geocomposite Flow Capacity / Outlet Pipe Flow Capacity

Darcy's Equation, $Q = k \times i \times A$ Q = flow rate

$A = L \times t$ t = thickness

$\Theta = k \times t$ k = permeability

so, $Q = \Theta \times i \times L$ Θ = transmissivity

i = 0.25 [hydraulic gradient, for 4:1 slope]

L = 338 ft [length of collection pipe (i.e. spacing between outlet pipe)]

Θ_{req} = 5.45E-03 ft^2/s [required transmissivity of geocomposite]

Q = **0.461** cfs [required outlet pipe capacity]

Design Pipe Flow

Manning's Equation,

$Q= (1.49/n) \times (3.14 \times r^2) \times (r / 2)^{2/3} \times (slope)^{1/2}$

Where,

n = 0.012 [Manning's Number for corrugated HDPE pipe with smooth interior]

r = 2.0 in , [Radius of 4" pipe]

r = 0.167 ft , (Radius of 4" pipe)

Q = **0.146** cfs [Collection Pipe at 0.5% slope]

Q = **0.292** cfs [Collection Pipe at 2% slope]

Q = **0.462** cfs [Outlet Pipe at 5% slope, 'min. design slope']

Q = **1.461** cfs [Outlet Pipe at 50% (2:1) slope]

09/28/2023 - Classification: Internal - ECRM13153872

Bedding Stone Diameter Sizing

Perforation design of 4" pipe (from ADS)

Maximum slot length =	0.875	inch
Maximum slot width =	0.125	inch

*Slot width will control the size of bedding stone

D_{85F} / Slot Width > (1.2 to 1.4) , [From the NAVFAC DM 7 Manual]

D_{85F} = (0.125 inch) * 1.2 =	0.150	inch
D_{85F} = (0.125 inch) * 1.4 =	0.175	inch

so, a bedding stone with a D_{85F} between 0.150 and 0.175 inch or larger would be acceptable.

Conclusion: Based on the outlet pipe estimated flow, a 4-inch pipe spaced at 338 ft or less would be adequate. The design outlet pipe spacing is a maximum of 200 ft.

A 4" diameter collection pipe (toe drain and final cover access road intermediate drain) at a 2% slope (typical), and a minimum of 0.5% slope, is suitable to collect the expected drainage layer flow.

For a 0.125 inch perforated pipe slot width, bedding stone diameter should be between 0.150 and 0.175 inch (equivalent to the No. 4 sieve) or larger.

09/28/2023 - Classification: Internal - ECRM13153872

Purpose: To size the collection piping and space the outlet piping to accommodate the final cover subsurface drainage in the flow convergence areas.

Approach: Use the Darcy equation to determine the worst case flow rate to the pipe. Use Manning's equation to determine if the designed pipe size (4 inches) for the given flow rate is acceptable. Also determine what would be acceptable bedding material based on pipe hole / perforation size.

References:
1. SCS Engineers, Plan of Operation,Columbia Dry Ash Disposal Facility, Cover Unit Gradient Calculation, August 2023
2. NAVFAC DM 7, Design Criteria for Protective Filters
3. Advanced Drainage Systems (ADS), Inc. Drainage Handbook, Section 3-0 Hydraulics, July 2010
4. Advanced Drainage Systems (ADS), Inc. Technical Note (TN 1.01) Dual Wall HDPE Perforation Patterns, January 2015

Calculation:

Infiltration Flow / Collection Pipe Flow Capacity

Darcy's Equation: $Q_{in}=K_{veg} \times i \times A = K_{veg} \times 1 \times L_h \times 1 \times FS$

Inflow of water into geocomposite from surface = Inflow of water into collection pipe

K_{veg} = Permeability of topsoil (cm/s)

L_h = Longest horizontal length between collection pipes

FS (drainage) = Factor of safety, to account for variation in cover soil

Q_{in} = Required collection pipe capacity, per linear foot of pipe

Required geocomposite transmissivity (from Cover Unit Gradient Calculation)

$\Theta_{req} = (K_{veg} \times L_h) / i * FS$ where, i = 0.25

Geocomposite Flow Capacity / Outlet Pipe Flow Capacity

Darcy's Equation: $Q = k \times i \times A$ Q = flow rate

$A = L \times t$ t = thickness

$\Theta = k \times t$ k = permeability

so, $Q = \Theta \times i \times L$ Θ = transmissivity

i = hydraulic gradient, for 4:1 slope

L_{out} = length of collection pipe (i.e. spacing between outlet pipe) (ft)

Θ_{req} = Required transmissivity of geocomposite (ft^2/s)

Q_{out} = Required collection pipe capacity, per linear foot of pipe

Design Pipe Flow

Manning's Equation: $Q= (1.49/n) \times (3.14 \times r^2) \times (r / 2)^{2/3} \times (slope)^{1/2}$

Where, n = 0.012 = Manning's Number for corrugated HDPE pipe with smooth interior

r = 2.0 = Radius of 4" pipe (in)

r = 0.1667 = Radius of 4" pipe (ft)

So, Q = **0.2922** = Collection Pipe at 2% slope (cfs)

Q = **0.462** = Outlet Pipe at 5% slope, 'min. design slope' (cfs)

Q = **1.461** = Outlet Pipe at 50% (2:1) slope (cfs)

09/28/2023 - Classification: Internal - ECRM13153872

Calculation: (cont.)

	K_{veg} (cm/s)	L_h (ft)	L_h (m)	FS	Collection Pipe Flow Capacity Q_{in} (cm^3/s)	Collection Pipe Flow Capacity Q_{in} (cfs)	Θ_{req} (m^2/s)	Outlet Pipe Flow Capacity L_{out} (ft)	Outlet Pipe Flow Capacity Q_{out} (cfs)
Area 1	4.2E-05	112	34.1	2.0	8.74	**0.0003**	1.1E-04	40	**0.012**
Area 2	4.2E-05	160	48.8	2.0	12.49	**0.0004**	1.6E-04	190	**0.084**
Area 3	4.2E-05	204	62.2	2.0	15.92	**0.0006**	2.1E-04	400	**0.225**
Area 4	4.2E-05	39	11.9	2.0	3.04	**0.0001**	4.0E-05	25	**0.003**
Area 5	4.2E-05	168	51.2	2.0	13.11	**0.0005**	1.7E-04	75	**0.035**
Area 6	4.2E-05	248	75.6	2.0	19.35	**0.0007**	2.5E-04	285	**0.195**
Area 1 Toe Drain	4.2E-05	27	8.2	2.0	2.11	**0.0001**	2.8E-05	10	**0.001**
Area 4 Toe Drain	4.2E-05	17	5.2	2.0	1.33	**0.00005**	1.7E-05	10	**0.0005**

See the Figure in the Unit Gradient - Converging Flow Area calculation for Area locations.

Design Pipe Flow

(from Sheet 1)

Q = **0.292** = Collection Pipe at 2% slope (cfs)

Q = **0.462** = Outlet Pipe at 5% slope, 'min. design slope' (cfs)

Q = **1.461** = Outlet Pipe at 50% (2:1) slope (cfs)

Bedding Stone Diameter Sizing

Perforation design of 4" pipe (from ADS)

Maximum slot length = 0.875 inch

Maximum slot width = 0.125 inch

*Slot width will control the size of bedding stone

D_{85F} / Slot Width > (1.2 to 1.4) , [From the NAVFAC DM 7 Manual]

D_{85F} = (0.125 inch) * 1.2 = 0.150 inch

D_{85F} = (0.125 inch) * 1.4 = 0.175 inch

So, a bedding stone with a D_{85F} between 0.150 and 0.175 inch or larger would be acceptable.

Conclusion: Based on the outlet pipe estimated flow, one 4" outlet pipe in each flow convergence area would be adequate.

A 4" diameter collection pipe at a 2% slope is suitable to collect the expected drainage layer flow.

For a 0.125 inch perforated pipe slot width, bedding stone diameter should be between 0.150 and 0.175 inch (equivalent to a No. 4 sieve) or larger.

A 4" diameter outlet pipe at a 5% slope is suitable to handle the expected drainage layer flow.

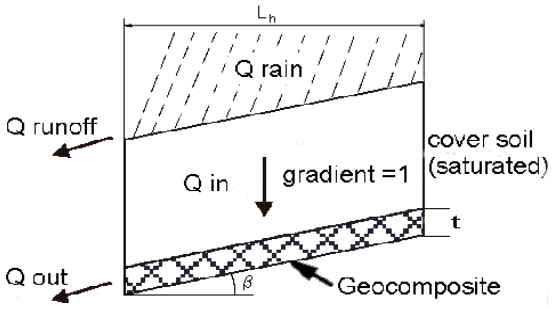
09/28/2023 - Classification: Internal - ECRM13153872

Purpose: To determine the geocomposite drainage requirements in the final cover where flow converges in the final cover corner including Modules 3, 4, 10, and 11 so the final cover drainage geocomposite can carry infiltrating water and remain stable. Also to determine the recommended minimum interface friction angle for final cover stability.

Approach: Use the unit gradient method and flow path geometry to determine the geocomposite transmissivity required at locations within the converging flow area.

References:

1. Landfilldesign.com - Lateral Drainage System - Single Slope, Unit Gradient Method
2. "GRI-GC8, Determination of the Allowable Flow Rate of a Drainage Geocomposite". Geosynthetics Research Institute, 2001.
3. "Beyond a factor-of-safety value, i.e., the probability of failure". GRI Newsletter/Report, Vol. 15, no. 3.
4. "Designing with Geosynthetics". R.M. Koerner, Prentice Hall Publishing Co., Englewood Cliffs, NJ, 1998.
5. "Hydraulic Design of Geosynthetic and Granular Liquid Collection Layers". J. P. Giroud, J. G. Zornberg and A. Zhao, Geosynthetics International, Vol. 7, Nos 4-5.
6. "Lateral Drainage Design update - part 2". G. N. Richardson, J. P. Giroud and A. Zhao, Geotechnical Fabrics Report, March 2002.
7. Giroud, Zornberg, and Zhao, 2000, "Hydraulic Design of Liquid Collection Layers", Geosynthetics International
8. SCS Engineers, Plan of Operation Update, Dry Ash Disposal Facility, Columbia Energy Center, Final Grades (Modules 12 and 13) Plan Sheet, August 2023
9. HELP Model "User's Guide" in conjunction with GRI report #19, pages 34-37 (Leachate Collection System)



With Darcy's law:

$$Q = k * i * A$$

Inflow of water in the geocomposite

$$Q_{in} = k_{veg} * i * A = k_{veg} * 1 * L_h * 1$$

Outflow of water from the geocomposite at the toe of the slope

$$Q_{out} = k_{comp} * i * A = k_{comp} * i * t * 1 = \theta_{required} * \sin\beta$$

= θ*i*1 where θ = k_{comp} * t (minimum allowable outflow to keep head within geocomposite)

Inflow equals outflow (Factor of Safety = 1)

$$Q_{in} = Q_{out}$$

This results in a required transmissivity of the geocomposite of:

$$\theta_{required} = \frac{k_{veg} * L_h}{\sin\beta}$$

Which results in the ultimate transmissivity after multiplying by the Total Serviceability Factor (TSF)

$$\theta_{ultimate} = \theta_{required} * FS_d * RF_{in} * RF_{cr} * RF_{cc} * RF_{bc}$$

09/28/2023 - Classification: Internal - ECRM13153872

Assumptions: 1. Soil hydraulic gradient i = 1.0.

2. Top soil will be clay. Soil permeability is 4.2 x 10^{-5} cm/sec for a CL clay from HELP model user's guide.

3. Geocomposite hydraulic gradient = sinβ where β=14° (4:1 horizontal/vertical final cover slope).

4. Factor of safety and transmissivity reduction factors are from recommended values in GRI report #19 (Leachate collection system example) and HELP model "Users Guide"

5. Flow paths A-E are as shown on attached drawing. Assume circular arc with radius measured from the corner of the toe drain.

6. Intermediate drainage piping will be used along the slope to divert flow from the drainage layer to the diversion berms and downslope flume.

Calculation: Constants

L_h	=	Drainage pipe spacing or length of slope measured horizontally	=	See Below	
k_{veg}	=	Permeability of the vegetative supporting soil	=	0.000042	cm/sec
S	=	The liner's slope, **S** = tan **β**	=	25%	β = 14°
FS_{slope}	=	Minimum factor of safety against sliding, for soil/geocomposite or geocomposite/geomembrane interfaces	=	1.5	
$\delta_{req'd}$	=	Minimum interface friction angle = $\tan^{-1}(FS_{slope}*\tan(b))$	=	20.6	degrees
FS_d	=	Overall factor of safety for drainage	=	2.0	
RF_{in}	=	Intrusion Reduction Factor	=	1.1	
RF_{cr}	=	Creep Reduction Factor	=	1.2	
RF_{cc}	=	Chemical Clogging Reduction Factor	=	1.1	
RF_{bc}	=	Biological Clogging Reduction Factor	=	1.4	
w	=	Geocomposite width at drainage outlet			
A	=	Final cover plan area upslope of geocomposite drainage outlet			

Determine the maximum slope length for a given ultimate transmissivity

Min. Θ_{req} = A X k_{veg} / (w X sinβ)

For the outlet at the corner, use minimum 5 foot width of geocomposite to connect the toe drain to drain the converging flow area:

Area	A (sq. feet)	w (feet)	w (meter)	Min. Θ_{ult} (m^2/sec)	Proposed Θ_{ult} (m^2/sec)
Area 1 Toe Drain	519	5	1.52	2.23E-04	1.00E-03

The toe drainage area, Area 1 Toe Drain, includes only converging flow below the lowest intermediate drainage piping, as flow above this area is diverted. There are intermediate drainage pipes in Area 1 which diverts flow from the outlet corner to the downslope flume.

For converging flow in a circular arc, from radius R-top to radius R-bottom:

L = R-top - R-bottom

w-bot = w-top * (R-bot/R-top)

A = L* (1+ (R-bot/R-top))/2 (assuming unit width at top and trapezoid vs arc to simplify)

Θult-bot = (Θult calculated for L) * R-top/R-bot * (1+ (R-bot/R-top))/2

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Calculation: (Cont.) For the southern convergence area, flow paths A-E, calculate Θult for selected R-bot values to determine appropriate geocomposite products as flow converges down the slope:

Flow Path	R-top (feet)	R-bot (feet)	L_h (feet)	L_h (meters)	Θ_{ult} (m^2/sec)	Proposed Θ_{ult} (m^2/sec)
Area 1						
A1	148	32	116	35	6.95E-04	1.00E-03
B1	144	32	112	34	6.60E-04	1.00E-03
C1	138	26	112	34	7.57E-04	1.00E-03
D1	131	21	110	33	8.43E-04	1.00E-03
E1	126	20	106	32	8.25E-04	1.00E-03
Area 2						
A2	308	148	160	48	5.22E-04	1.00E-03
B2	299	144	155	47	5.11E-04	1.00E-03
C2	290	138	152	46	5.04E-04	1.00E-03
D2	280	131	149	45	4.99E-04	1.00E-03
E2	270	126	144	43	4.77E-04	1.00E-03
Area 3						
A3	363	308	55	16	1.23E-04	1.00E-03
B3	408	299	109	33	2.76E-04	1.00E-03
C3	446	290	156	47	4.21E-04	1.00E-03
D3	433	280	153	46	4.14E-04	1.00E-03
E3	420	270	150	45	4.06E-04	1.00E-03
Area 4						
C4	470	446	24	7	5.08E-05	1.00E-03
D4	545	433	112	34	2.71E-04	1.00E-03
E4	514	420	94	28	2.20E-04	1.00E-03

Conclusions: For the proposed convergence area design with intermediate slope outlets and a toe-of-slope drainage outlet, placement of geocomposite with the required transmissivities to the minimum lengths/areas shown in the table above and on the attached drawing will provide adequate drainage for the converging flow.

A minimum interface friction angle of 20.6 degrees for the geocomposite, geomembrane, and GCL interfaces is required to achieve a minimum recommended final cover slope stability safety factor of 1.5.

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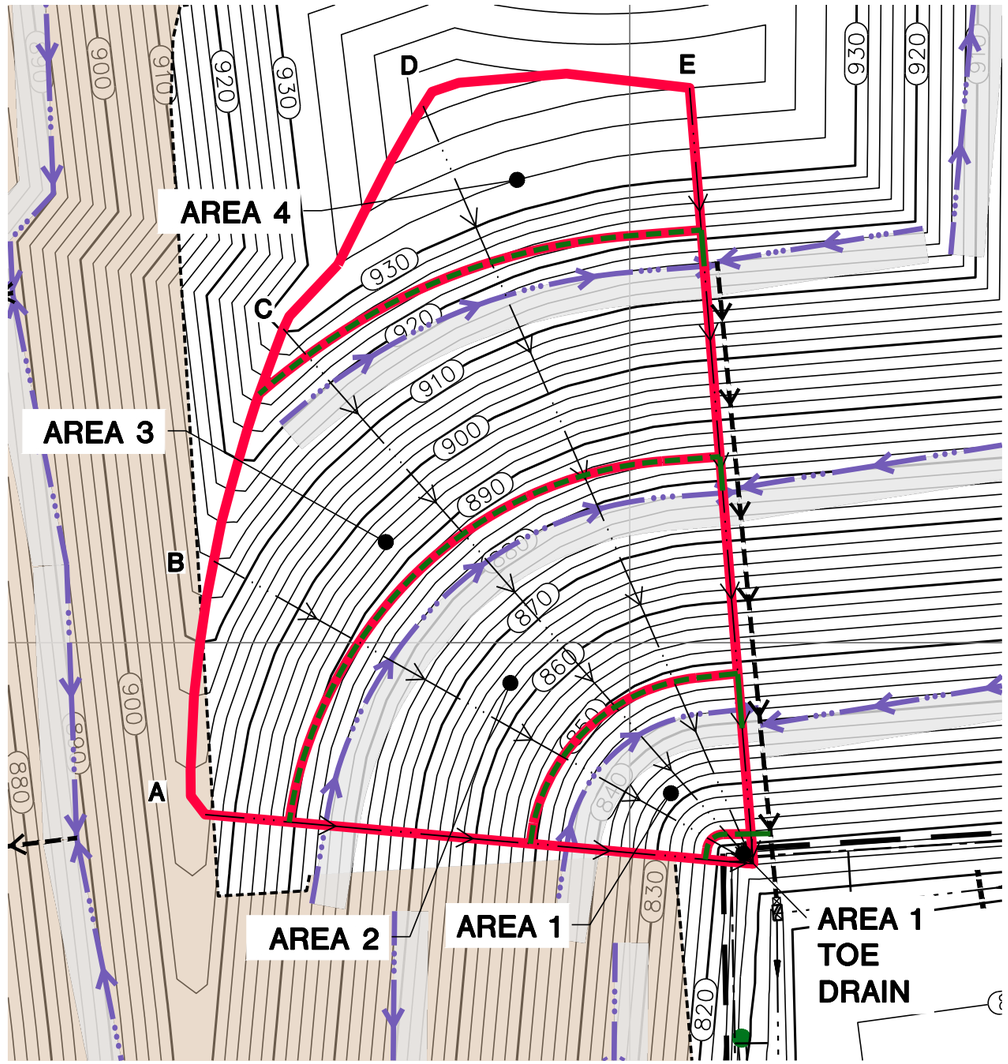

LEGEND

- LIMITS OF WASTE
- LINER PHASE/MODULE LIMIT
- 840 — PROPOSED GRADE (10' INTERVAL)
- PROPOSED GRADE (2' INTERVAL)
- PROPOSED SWALE
- PROPOSED DIVERSION BERM
- PROPOSED DOWNSLOPE FLUME
- PROPOSED ENERGY DISSIPATOR
- PROPOSED RIPRAP
- CONVERGENCE FLOW PATH
- PERFORATED SUBSURFACE PIPING
- SOLID SUBSURFACE PIPING

DRAFT

N

100 0 100

SCALE: 1" = 100'

GEOTECHNICAL CALCULATION – FLOW CONVERGENCE
FINAL GRADES (MODULES 12 AND 13)

FIGURE 1

SCS ENGINEERS
2830 DAIRY DRIVE MADISON, WI 53718-6751
PHONE: (608) 224-2830

ENGINEER

COLUMBIA ENERGY CENTER
PLAN OF OPERATION UPDATE
TOWN OF PACIFIC, WISCONSIN
COLUMBIA DRY ASH DISPOSAL FACILITY

SITE

WISCONSIN POWER AND LIGHT
COLUMBIA ENERGY CENTER
W8375 MURRAY ROAD
PARDEEVILLE, WISCONSIN 53954

CLIENT

PROJECT NO.	25222260.00	
DRAWN:	08/03/2023	DRAWN BY: KP/MJT
REVISED:	08/17/2023	CHECKED BY: DN/BSS
		APPROVED BY:

I:\25222260.00\Drawings\Geotech\Mod 12-13 Final_230816_HighCapGeo.dwg, 8/18/2023 8:53:05 AM

09/28/2023 - Classification: Internal - ECRM13153872

Purpose: To size the collection piping and space the outlet piping to accommodate the final cover subsurface drainage in the flow convergence areas.

Approach: Use the Darcy equation to determine the worst case flow rate to the pipe. Use Manning's equation to determine if the designed pipe size (4 inches) for the given flow rate is acceptable. Also determine what would be acceptable bedding material based on pipe hole / perforation size.

References:
1. SCS Engineers, Plan of Operation, Columbia Dry Ash Disposal Facility, Cover Unit Gradient Calculation, August 2023
2. NAVFAC DM 7, Design Criteria for Protective Filters
3. Advanced Drainage Systems (ADS), Inc. Drainage Handbook, Section 3-0 Hydraulics, July 2010
4. Advanced Drainage Systems (ADS), Inc. Technical Note (TN 1.01) Dual Wall HDPE Perforation Patterns, January 2015

Calculation: **Infiltration Flow / Collection Pipe Flow Capacity**

Darcy's Equation: $Q_{in}=K_{veg} \times i \times A = K_{veg} \times 1 \times L_h \times 1 \times FS$

Inflow of water into geocomposite from surface = Inflow of water into collection pipe

K_{veg} = Permeability of topsoil (cm/s)

L_h = Longest horizontal length between collection pipes

FS (drainage) = Factor of safety, to account for variation in cover soil

Q_{in} = Required collection pipe capacity, per linear foot of pipe

Required geocomposite transmissivity (from Cover Unit Gradient Calculation)

$\Theta_{req} = (K_{veg} \times L_h) / i * FS$ where, i = 0.25

Geocomposite Flow Capacity / Outlet Pipe Flow Capacity

Darcy's Equation: $Q = k \times i \times A$ Q = flow rate

$A = L \times t$ t = thickness

$\Theta = k \times t$ k = permeability

so, $Q = \Theta \times i \times L$ Θ = transmissivity

i = hydraulic gradient, for 4:1 slope

L_{out} = length of collection pipe (i.e. spacing between outlet pipe) (ft)

Θ_{req} = Required transmissivity of geocomposite (ft^2/s)

Q_{out} = Required collection pipe capacity, per linear foot of pipe

Design Pipe Flow

Manning's Equation: $Q= (1.49/n) \times (3.14 \times r^2) \times (r / 2)^{2/3} \times (slope)^{1/2}$

Where, n = 0.012 = Manning's Number for corrugated HDPE pipe with smooth interior

r = 2.0 = Radius of 4" pipe (in)

r = 0.1667 = Radius of 4" pipe (ft)

So, Q = **0.292** = Collection Pipe at 2% slope (cfs)

Q = **0.462** = Outlet Pipe at 5% slope, 'min. design slope' (cfs)

Q = **1.461** = Outlet Pipe at 50% (2:1) slope (cfs)

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Calculation: (cont.)

	K_{veg} (cm/s)	L_h (ft)	L_h (m)	FS	Collection Pipe Flow Capacity: Q_{in} (cm^3/s)	Collection Pipe Flow Capacity: Q_{in} (cfs)	Θ_{req} (m^2/s)	Outlet Pipe Flow Capacity: L_{out} (ft)	Outlet Pipe Flow Capacity: Q_{out} (cfs)
Area 1	4.2E-05	116	35.4	2.0	9.05	**0.0003**	1.2E-04	45	**0.014**
Area 2	4.2E-05	160	48.8	2.0	12.49	**0.0004**	1.6E-04	200	**0.088**
Area 3	4.2E-05	156	47.5	2.0	12.17	**0.0004**	1.6E-04	410	**0.176**
Area 4	4.2E-05	112	34.1	2.0	8.74	**0.0003**	1.1E-04	320	**0.099**
Area 1 Toe Drain	4.2E-05	32	9.8	2.0	2.50	**0.0001**	3.3E-05	10	**0.001**

See the Figure in the Unit Gradient - Converging Flow Area calculation for Area locations.

Design Pipe Flow

(from Sheet 1)

Q = **0.292** = Collection Pipe at 2% slope (cfs)

Q = **0.462** = Outlet Pipe at 5% slope, 'min. design slope' (cfs)

Q = **1.461** = Outlet Pipe at 50% (2:1) slope (cfs)

Bedding Stone Diameter Sizing

Perforation design of 4" pipe (from ADS)

Maximum slot length = 0.875 inch

Maximum slot width = 0.125 inch

*Slot width will control the size of bedding stone

D_{85F} / Slot Width > (1.2 to 1.4) , [From the NAVFAC DM 7 Manual]

D_{85F} = (0.125 inch) * 1.2 = 0.150 inch

D_{85F} = (0.125 inch) * 1.4 = 0.175 inch

So, a bedding stone with a D_{85F} between 0.150 and 0.175 inch or larger would be acceptable.

Conclusion: Based on the outlet pipe estimated flow, one 4" outlet pipe in each flow convergence area would be adequate.

A 4" diameter collection pipe at a 2% slope is suitable to collect the expected drainage layer flow.

For a 0.125 inch perforated pipe slot width, bedding stone diameter should be between 0.150 and 0.175 inch (equivalent to a No. 4 sieve) or larger.

A 4" diameter outlet pipe at a 5% slope is suitable to collect the expected drainage layer flow.

09/28/2023 - Classification: Internal - ECRM13153872

SCS ENGINEERS

		Sheet No.	1 of 1
		Calc. No.	
		Rev. No.	
Job No. 25222260.00	Job: Columbia Dry Ash Disposal Facility	By: MJT	Date: 07/18/23
Client: WPL	Subject: GCL Internal Shear on Final Cover	Chk'd: DLN	Date: 07/25/23

Purpose: Determine the maximum shear stress acting on a Geosynthetic Clay Liner (GCL) and the GCL internal shear strength required to provide a minimum slope stability safety factor (FS) of 1.5 for the final cover.

Approach: Use maximum shear stress formula and assumed values.

References: Design of GCL Barrier for Final Cover Side Slope Applications, Gregory N. Richardson, Ph.D., P.E., Geosynthetics '97-541

Calculation: The maximum shear stress acting on the GCL can be calculated as follows:

$$\tau_{act} = W_T \sin \beta$$

$$\beta = 14^{\circ}$$

$$W_T = \gamma \times h$$

Where: γ = Soil Unit Weight = 120 pcf

h = Cover Thickness = 3.0 ft

$$W_T = 360 \text{ psf}$$

$$\tau_{act} = 87.1 \text{ psf}$$

$$FS = \frac{\tau_{resist}}{\tau_{act}} = 1.5$$

$$\tau_{resist} = FS \times \tau_{act} = 1.5 \times 87.1 = 131 \text{ psf}$$

Assumptions: Slope angle, $\beta = 14^{\circ}$ (4:1 horizontal / vertical final cover slope)

Soil unit weight, $\gamma = 120$ pcf

Conclusion: For a total weight of the final cover system of 360 psf and a slope angle of 4:1, the maximum shear stress will be 87.1 psf. A minimum GCL internal shear strength of 131 psf is required to provide a slope stability safety factor of 1.5.

09/28/2023 - Classification: Internal - ECRM13153872

E.2 Clay Borrow Calculations

09/28/2023 - Classification: Internal - ECRM13153872

SCS ENGINEERS

		Sheet No.	1
		Calc. No.	
		Rev. No.	
Job No. 25222260.00	Job: Columbia Dry Ash Disposal Facility	By: MJT	Date: 08/18/23
Client: WPL	Subject: Clay Volume Calculation	Chk'd: PEG	Date: 08/18/23

Purpose: Determine the volume of liner-quality and cover-quality clay material available at the Town of New Haven clay borrow source.

References:

1. Clay Volume Calculation (Town of New Haven clay borrow site) by SCS Engineers dated 9/17/2015, Appendix D of the Plan of Operations Modification - Addendum #1 dated 11/2/2015.
2. Survey of clay stockpile location at the Columbia Ash Disposal Facility (ADF) dated 06/23/2021.
3. Survey of clay stockpile at the ADF as of 06/27/23 and Civil 3D volume calculation by SCS Engineers.
4. Figure 1, Clay Borrow Site Proposed Excavation by SCS Engineers dated 08/01/2023.
5. Final Grades (Modules 12 and 13) drawing by SCS Engineers dated August 2023.
6. Existing Conditions drawing and Base Grades (Modules 12 and 13) drawing by SCS Engineers dated August 2023.

Assumptions:

1. Base of clay stockpile on site is estimated based on a June 23, 2021 topo, prior to clay stockpile placement. Clay base elevation range from 819.02' to 834.55'.
2. Thickness of clay required for the liner is 2'.
3. Thickness of clay required for the final cover is 1'.
4. 20% additional volume is assumed for clay shrinkage contingency.

Calculations:

Clay stockpiled on site: 14,122 cy (Based on volume calculations)
Clay remaining at clay borrow site: 99,181 cy

Phase	Module	Limits of Waste (ft^2)	Limits of Waste (acres)	Existing Final Cover (ft^2)	Proposed Final Cover, Sand (ft^2)	Proposed Final Cover, Geocomposite (ft^2)
1	1	360,848	8.28	246,985	23,565	90,297
1	2	176,456	4.05	5,185	791	170,481
1	3	173,290	3.98	N/A	N/A	173,290
1	4	176,240	4.05	N/A	N/A	176,240
1	5	179,251	4.12	N/A	N/A	179,251
1	6	165,253	3.79	N/A	N/A	165,253
2	10	149,157	3.42	N/A	N/A	149,157
2	11	151,628	3.48	N/A	N/A	151,628
2	12	202,610	4.65	N/A	N/A	202,610
2	13	108,151	2.48	N/A	N/A	108,151

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Calculations (cont.):

Clay Required = Module Area (ft^2) X Clay depth (ft) X 1 cy / 27 ft^3

Liner Clay Depth	=	2	ft
Cover Clay Depth	=	1	ft

Clay required:	**Liner Clay Layer**		**Final Cover Clay**	
Module 1	Existing		3,344	cy
Module 2	Existing		6,314	cy
Module 3	Existing		6,418	cy
Module 4	Existing		6,527	cy
Module 5	Existing		6,639	cy
Module 6	Existing		6,120	cy
Module 10	Existing		5,524	cy
Module 11	Existing		5,616	cy
Module 12	15,008	cy	7,504	cy
Module 13	8,011	cy	4,006	cy
TOTAL	23,019	cy	58,013	cy

Total with 20% additional volume for clay shrinkage contingency =

27,623	cy	69,616	cy
Total Clay Required =		97,239	cy
Clay stockpiled on site =		14,122	cy
Clay needed from clay borrow site =		83,117	cy
Clay remaining in Area 3 at clay borrow site =		99,181	cy

Conclusion:

Based on clay borrow calculations, there is sufficient liner-quality and cover-quality clay material available at the Town of New Haven clay borrow source.

09/28/2023 - Classification: Internal - ECRM13153872

SCS Engineers

2830 Dairy Drive

Madison, WI 53718-6751

Surface Report
Project Name:
I:\25222260.00\Drawings\Civil\Area 3 Pond Grading Full Area to 819.dwg
Report Date: 4/6/2023 10:06:04 AM

Client: WPL
Project Description:
Prepared by: Kirk Peterson

Linear Units: USSurveyFoot	**Area Units:** squareFoot	**Volume Units:** cubicYard

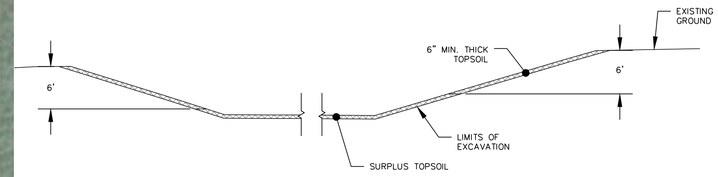
---

Surface: Vol -Area 3 Full to Elev 819
Description: Graded full pond area from existing grade to elevation 819, compared to top of clay surface (1.4' below existing) for clay volume. Ignore fill volume.

Area 2D: 208204.526	Area 3D: 212986.736
Elevation Max: 1.403	Elevation Min: -19.648
Number of Points: 19422	Number of Triangles: 38400

Volume Surface: Vol -Area 3 Full to Elev 819
Description: Graded full pond area from existing grade to elevation 819, compared to top of clay surface (1.4' below existing) for clay volume. Ignore fill volume.

Volume Cut: 99181.425	Volume Fill: 190.109	Volume Total: -98991.316
Compare Surface: Area 3 Full Base Surface: AIM_Existing_Ground (bottom of topsoil)		



TYPICAL POND RESTORATION SECTION

(SCALE: 1" = 10')

LEGEND

- EXISTING GRADE (2' CONTOUR)
- EXISTING GRADE (10' CONTOUR)
- PROPOSED EXCAVATION GRADE (1' CONTOUR)
- PROPOSED EXCAVATION GRADE (5' CONTOUR)
- EXISTING POND OUTLET
- PROPOSED POND OUTLET
- PROPERTY LINE
- ROAD RIGHT-OF-WAY
- ROAD CENTER LINE
- QUARTER SECTION LINE
- WETLAND
- 25' WETLAND SETBACK FOR CLAY EXCAVATION
- EXISTING MONITORING WELL
- EXISTING PIEZOMETER
- EXISTING ACCESS ROAD
- PROPOSED ACCESS ROAD

NOTES:

1. TOPOGRAPHIC BASE MAP WAS COMPILED FROM ADAMS COUNTY, WISCONSIN, 2010 LIDAR DATA AND SCS ENGINEERS SURVEY ON NOVEMBER 10, 2015 AND JULY 1, 2016, AND JULY 30, 2018, AS WELL AS, A COM, INC. SURVEY ON NOVEMBER 9, 2017.
2. MAY 18, 2018 AERIAL PHOTOGRAPH SOURCES: ESRI, DIGITALGLOBE, GEOEYE, I-CUBED, USDA FSA, USGS, AEX, GETMAPPING, AEROGRID, IGN, IGP, SWISSTOPO, AND THE GIS USER COMMUNITY.
3. RESTORED 2021 CLAY BORROW EXCAVATION AREA CONTOURS FROM SURVEY PERFORMED BY SCS ENGINEERS IN OCTOBER AND NOVEMBER 2021.
4. WETLAND LIMITS BASED ON WETLAND DELINEATION PERFORMED BY HDR, INC. ON OCTOBER 9, 2014.
5. PROPERTY, RIGHT-OF-WAY, CENTER LINE, QUARTER SECTION, AND FENCING LOCATIONS BASED ON SENGLAUB PARCEL MAP PROVIDED BY ALLIANT ON JANUARY 5, 2015.
6. 25-FOOT CLAY EXCAVATION SETBACK FROM WETLAND LIMITS IS BASED ON THE TOWN OF NEW HAVEN CLAY BORROW SITE INITIAL SITE INSPECTION LETTER FROM THE WISCONSIN DEPARTMENT OF NATURAL RESOURCES DATED NOVEMBER 25, 2014.
7. CLAY BORROW SITE IS LOCATED NORTH OF GOLDEN AVENUE, TOWN OF NEW HAVEN, ADAMS COUNTY, WISCONSIN

N

60 0 60

SCALE: 1" = 60'

DRAWN BY: KP
CHECKED BY:
APPROVED BY:

PROJECT NO. 25222260.00
DRAWN: 04/06/2023
REVISED: 08/01/2023

CLIENT
Wisconsin Power and Light Company
WISCONSIN POWER AND LIGHT
COLUMBIA ENERGY CENTER
W8375 MURRAY ROAD
PARDEEVILLE, WISCONSIN 53954

ENGINEER
SCS ENGINEERS
2830 DAIRY DRIVE, MADISON, WI 53718-6751
PHONE: (608) 224-2830

SITE
COLUMBIA DRY ASH DISPOSAL FACILITY
TOWN OF PACIFIC, WISCONSIN

SHEET
CLAY BORROW SITE
PROPOSED EXCAVATION
1 of 1

09/28/2023 - Classification: Internal - ECRM13153872

E.3 Closure Cost Estimates

09/28/2023 - Classification: Internal - ECRM13153872

E.3.1 Module 12 Closure Cost Estimates

09/28/2023 - Classification: Internal - ECRM13153872

Table 1. Closure Cost Estimate
Alliant Energy - Columbia Energy Center - Ash Disposal Facility
Plan of Operation Modification Addendum, Module 12 Scenario
Permit #3025
SCS Project #25222260.00

Total Area of Closure (acres): 34.0
Date of Estimate: 8/31/23

Major Cost Item	Unit	2023 Unit Cost	Quantity	Total Estimated Cost[1]
Closure and Post Closure Document Revisions				
Pre-closure Construction Documents	Lump Sum	$50,000	1	$50,000
Site Preparation, Earthwork, and Final Grading				
Mobilization	Lump Sum	$500,000	1	$500,000
Subgrade Preparation - Grading Top 1 foot	Acre	$5,500	34.0	$187,165
Erosion Control				
Silt Fence	Linear Foot	$3.60	5,400	$19,440
Final Cap Construction (Final Cover System, Sand Drainage Layer, Portions of Modules 1 and 2)				
Remove Temporary Intermediate Cover (2.5 feet)	Cubic Yards	$6.30	2,300	$14,490
Grading Layer Placement - Place from Onsite (0.25 feet)	Cubic Yards	$23.00	300	$6,900
Lower Barrier Layer (Onsite Sand) (1.0 foot)	Cubic Yards	$7.70	1,000	$7,700
Upper Barrier Layer (Clay) (1.0 foot)	Cubic Yards	$18.00	1,000	$18,000
GCL Installation - Purchase and Install	Square Feet	$1.05	25,000	$26,250
40-mil LLDPE Geomembrane - Purchase and Install	Square Feet	$0.90	25,000	$22,500
Drainage Layer (1.0 foot)	Cubic Yards	$54.00	1,000	$54,000
Rooting Zone - Place from Onsite (1.0 foot)	Cubic Yards	$9.60	1,000	$9,600
Topsoil - Purchase, Import, and Place (0.5 feet)	Cubic Yards	$38.00	500	$19,000
Intermediate Drainage Piping	Linear Foot	$6.00	500	$3,000
Seed, Fertilizer, Mulch	Acre	$9,400	0.6	$5,264
Erosion Mat	Acre	$13,500	0.6	$7,560
Final Cap Construction (Final Cover System, Geocomposite, North of Module 1)				
Remove Temporary Intermediate Cover (2.5 feet)	Cubic Yards	$6.30	72,800	$458,640
Grading Layer Placement - Place from Onsite (0.25 feet)	Cubic Yards	$23.00	13,500	$310,500
Lower Barrier Layer (Onsite Sand) (1 foot)	Cubic Yards	$7.70	54,000	$415,800
Upper Barrier Layer (Clay) (1 foot)	Cubic Yards	$18.00	54,000	$972,000
GCL Installation - Purchase and Install	Square Feet	$1.05	1,460,000	$1,533,000
40-mil LLDPE Geomembrane - Purchase and Install	Square Feet	$0.90	1,460,000	$1,314,000
Geocomposite drainage layer	Square Feet	$1.65	1,460,000	$2,409,000
Rooting Zone - Place from Onsite (2.5 feet)	Cubic Yards	$9.60	135,000	$1,296,000
Topsoil - Purchase, Import, and Place (0.5 feet)	Cubic Yards	$38.00	27,000	$1,026,000
Intermediate Drainage Piping	Linear Foot	$19.00	2,200	$41,800
Seed, Fertilizer, Mulch	Acre	$9,400	33.5	$314,618
Erosion Mat	Acre	$13,500	33.5	$451,845
Access Road over Final Cover				
Geotextile Separator	Square Feet	$0.50	25,000	$12,500
Breaker Run (1 foot)	Cubic Yards	$42.00	1,000	$42,000
Base Aggregate (0.5 feet)	Cubic Yards	$48.00	500	$24,000

Table 1. Closure Cost Estimate
Alliant Energy - Columbia Energy Center - Ash Disposal Facility
Plan of Operation Modification Addendum, Module 12 Scenario
Permit #3025
SCS Project #25222260.00

Total Area of Closure (acres): 34.0
Date of Estimate: 8/31/23

Major Cost Item	Unit	2023 Unit Cost	Quantity	Total Estimated Cost[1]
Storm Water Management				
Diversion Berms	Linear Foot	$12.30	7,900	$97,170
Down Slope Flumes	Linear Foot	$208.00	1,600	$332,800
Energy Dissipators	Each	$13,300.00	6	$79,800
Drop Structure Manhole	Each	$5,000.00	1	$5,000
Perimeter Toe Drain Collection Pipe, Outlet Pipe, and Stone	Linear Foot	$19.00	5,800	$110,200
Probable Construction Cost				***$12,197,542***
Engineering and Technical Services				
Final Cover Construction Documentation and Administration and Compliance Certifications (Assumed 15% of Construction, Large Closure Area)	Lump Sum	$1,822,200	1	$1,822,200
Legal, Financial, and Administrative Services				
All legal, financial, and administrative services (Assumed 2.5% of Construction, Large Closure Area)	Lump Sum	$303,700	1	$303,700
			Subtotal:	$14,323,400
			Contingency (10%):	$1,432,300
			Total Estimated Closure Cost:	**$15,755,700**

Notes:
1. Costs are based on experience with similar projects.
2. The total worst-case closure cost applies to Phase 1 and Modules 10, 11, and 12.
Closure of Phase 1 includes the remaining portions of Modules 1-6, which do not have final cover.

Updated By: MJT, 8/23/2023, PEG, 8/24/2023
Checked/Revised by: BSS, 08/30/2023

I:\25222260.00\Data and Calculations\Cost Estimates\[COL_Financial Responsibility_Estimate_Tables_2023 POO Update - Mod 12.xlsx]Table 1 - Closure Costs

Table 2. Long-Term Care Cost Estimate
Alliant Energy - Columbia Energy Center - Ash Disposal Facility
Plan of Operation Modification Addendum, Module 12 Scenario
Permit #3025
SCS Project #25222260.00

Date of Estimate: 8/31/23
Inflation Factor: Not Used – Estimates were prepared in current dollars

Major Cost Item	Unit	2023 Unit Cost	Quantity	Average Cost per Year[1]	Cost Source and Quantity Notes
General Care					
Repair erosion/reseed	Acre	$10,400	2.0	$20,800	Assumes 5% of the total closure area
Mowing	Acre	$200	79.6	$16,000	39.8 acres per event, and two events per year.
Maintenance of Drainage Features - Annually	Lump Sum	$5,000	1	$5,000	Assumes 1 discharge location is repaired per year and Sedimentation Basin Cleaning 1 per 10 years
Perimeter Roads - Annually	Lump Sum	$2,000	1	$2,000	Allowance
Leachate Management System Operation and Maintenance					
Leachate Line Cleaning and Televising	Linear Feet	$0.38	5,900	$2,300	Estimated unit cost from experience; quantity from existing and proposed piping in Phase 1 and 2; cleaning performed every year and televising every 5 years. Unit rate has been annualized.
Operation and Maintenance	Lump Sum	$5,000	1	$5,000	Estimated cost
Inspections					
Annual Inspection by PE	Lump Sum	$5,000	1	$5,000	Assumes one site visit and PE-certified Inspection Report per year.
Environmental Monitoring					
Groundwater Monitoring - Sampling and Expenses	Lump Sum	$17,000	1	$17,000	Assumes two rounds of groundwater sampling at CCR and non-CCR monitoring points under approved state monitoring program.
Groundwater Monitoring - Laboratory	Lump Sum	$9,600	1	$9,600	Assumes two rounds of groundwater sampling at CCR and non-CCR monitoring points under approved state monitoring program.
Well Maintenance, Repair, and Replacement	Lump Sum	$14,000	1	$14,000	Assumes replacement of one well every other year during the post-closure care period plus annual maintenance and repairs (minor).
Annual Reporting					
Data Management and Reporting to WDNR	Lump Sum	$48,100	1	$48,100	Assumes semiannual reporting and annual for CCR and non-CCR wells
Legal, Financial, and Administrative Services					
All legal, financial, and administrative services (Assumed 10% of Annual Costs)	%	10%	1	$14,480	
			Annual Long-Term Care Subtotal:	$159,300	
			Contingency (10%):	$16,000	
			Annual Long-Term Care Cost:	$175,300	
			40-Year Post-Closure Cost (40 x Annual Long-Term Care Cost):	**$7,012,000**	

Assumptions/Notes:
1. Costs are based on experience with similar projects or RSMeans construction cost data.

Updated By: MJT, 8/23/2023, PEG, 8/24/2023
Checked by: BSS, 08/30/2023

I:\25222260.00\Data and Calculations\Cost Estimates\[COL_Financial Responsibility_Estimate_Tables_2023 POO Update - Mod 12.xlsx]Table 2 - Long Term Care Costs

09/28/2023 - Classification: Internal - ECRM13153872

E.3.2 Modules 12 and 13 Closure Cost Estimates

09/28/2023 - Classification: Internal - ECRM13153872

Table 1. Closure Cost Estimate
Alliant Energy - Columbia Energy Center - Ash Disposal Facility
Plan of Operation Modification Addendum, Module 12 and 13 Scenario
Permit #3025
SCS Project #25222260.00

Total Area of Closure (acres): 36.5
Date of Estimate: 8/31/23

Major Cost Item	Unit	2023 Unit Cost	Quantity	Total Estimated Cost[1]
Closure and Post Closure Document Revisions				
Pre-closure Construction Documents	Lump Sum	$50,000	1	$50,000
Site Preparation, Earthwork, and Final Grading				
Mobilization	Lump Sum	$500,000	1	$500,000
Subgrade Preparation - Grading Top 1 foot	Acre	$5,500	36.5	$200,805
Erosion Control				
Silt Fence	Linear Foot	$3.60	5,400	$19,440
Final Cap Construction (Final Cover System, Sand Drainage Layer, Portions of Modules 1 and 2)				
Remove Temporary Intermediate Cover (2.5 feet)	Cubic Yards	$6.30	2,300	$14,490
Grading Layer Placement - Place from Onsite (0.25 feet)	Cubic Yards	$23.00	300	$6,900
Lower Barrier Layer (Onsite Sand) (1.0 foot)	Cubic Yards	$7.70	1,000	$7,700
Upper Barrier Layer (Clay) (1.0 foot)	Cubic Yards	$18.00	1,000	$18,000
GCL Installation - Purchase and Install	Square Feet	$1.05	25,000	$26,250
40-mil LLDPE Geomembrane - Purchase and Install	Square Feet	$0.90	25,000	$22,500
Drainage Layer (1.0 foot)	Cubic Yards	$54.00	1,000	$54,000
Rooting Zone - Place from Onsite (1.0 foot)	Cubic Yards	$9.60	1,000	$9,600
Topsoil - Purchase, Import, and Place (0.5 feet)	Cubic Yards	$38.00	500	$19,000
Intermediate Drainage Piping	Linear Foot	$6.00	500	$3,000
Seed, Fertilizer, Mulch	Acre	$9,400	0.6	$5,264
Erosion Mat	Acre	$13,500	0.6	$7,560
Final Cap Construction (Final Cover System, Geocomposite, North of Module 1)				
Remove Temporary Intermediate Cover (2.5 feet)	Cubic Yards	$6.30	72,800	$458,640
Grading Layer Placement - Place from Onsite (0.25 feet)	Cubic Yards	$23.00	14,500	$333,500
Lower Barrier Layer (Onsite Sand) (1 foot)	Cubic Yards	$7.70	58,000	$446,600
Upper Barrier Layer (Clay) (1 foot)	Cubic Yards	$18.00	58,000	$1,044,000
GCL Installation - Purchase and Install	Square Feet	$1.05	1,570,000	$1,648,500
40-mil LLDPE Geomembrane - Purchase and Install	Square Feet	$0.90	1,570,000	$1,413,000
Geocomposite drainage layer	Square Feet	$1.65	1,570,000	$2,590,500
Rooting Zone - Place from Onsite (2.5 feet)	Cubic Yards	$9.60	145,000	$1,392,000
Topsoil - Purchase, Import, and Place (0.5 feet)	Cubic Yards	$38.00	29,000	$1,102,000
Intermediate Drainage Piping	Linear Foot	$19.00	2,200	$41,800
Seed, Fertilizer, Mulch	Acre	$9,400	36.0	$337,930
Erosion Mat	Acre	$13,500	36.0	$485,325
Access Road over Final Cover				
Geotextile Separator	Square Feet	$0.50	25,000	$12,500
Breaker Run (1 foot)	Cubic Yards	$42.00	1,000	$42,000
Base Aggregate (0.5 feet)	Cubic Yards	$48.00	500	$24,000

Table 1. Closure Cost Estimate
Alliant Energy - Columbia Energy Center - Ash Disposal Facility
Plan of Operation Modification Addendum, Module 12 and 13 Scenario
Permit #3025
SCS Project #25222260.00

Total Area of Closure (acres): 36.5
Date of Estimate: 8/31/23

Major Cost Item	Unit	2023 Unit Cost	Quantity	Total Estimated Cost[1]
Storm Water Management				
Diversion Berms	Linear Foot	$12.30	9,700	$119,310
Down Slope Flumes	Linear Foot	$208.00	2,000	$416,000
Energy Dissipators	Each	$13,300.00	6	$79,800
Drop Structure Manhole	Each	$5,000.00	1	$5,000
Perimeter Toe Drain Collection Pipe, Outlet Pipe, and Stone	Linear Foot	$19.00	5,700	$108,300
Probable Construction Cost				***$13,065,214***
Engineering and Technical Services				
Final Cover Construction Documentation and Administration and Compliance Certifications (Assumed 15% of Construction, Large Closure Area)	Lump Sum	$1,952,300	1	$1,952,300
Legal, Financial, and Administrative Services				
All legal, financial, and administrative services (Assumed 2.5% of Construction, Large Closure Area)	Lump Sum	$325,400	1	$325,400
			Subtotal:	$15,342,900
			Contingency (10%):	$1,534,300
			Total Estimated Closure Cost:	**$16,877,200**

Notes:
1. Costs are based on experience with similar projects.
2. The total worst-case closure cost applies to Phase 1 and Modules 10, 11, 12 and 13.
Closure of Phase 1 includes the remaining portions of Modules 1-6, which do not have final cover.

Updated By: MJT, 8/23/2023, PEG, 8/24/2023
Checked/Revised by: BSS, 08/30/2023

I:\25222260.00\Data and Calculations\Cost Estimates\[COL_Financial Responsibility_Estimate_Tables_2023 POO Update - Mod 12 and 13.xlsx]Table 1 - Closure Cos

Table 2. Long-Term Care Cost Estimate
Alliant Energy - Columbia Energy Center - Ash Disposal Facility
Plan of Operation Modification Addendum, Module 12 and 13 Scenario
Permit #3025
SCS Project #25222260.00

Date of Estimate: 8/31/23
Inflation Factor: Not Used – Estimates were prepared in current dollars

Major Cost Item	Unit	2023 Unit Cost	Quantity	Average Cost per Year[1]	Cost Source and Quantity Notes
General Care					
Repair erosion/reseed[2]	Acre	$10,400	2.1	$22,000	Assumes 5% of the total closure area
Mowing	Acre	$200	84.6	$17,000	42.3 acres per event, and two events per year.
Maintenance of Drainage Features - Annually	Lump Sum	$5,000	1	$5,000	Assumes 1 discharge location is repaired per year and Sedimentation Basin Cleaning 1 per 10 years
Perimeter Roads - Annually	Lump Sum	$2,000	1	$2,000	Allowance
Leachate Management System Operation and Maintenance					
Leachate Line Cleaning and Televising	Linear Feet	$0.38	5,900	$2,300	Estimated unit cost from experience; quantity from existing and proposed piping in Phase 1 and 2; cleaning performed every year and televising every 5 years. Unit rate has been annualized.
Operation and Maintenance	Lump Sum	$5,000	1	$5,000	Estimated cost
Inspections					
Annual Inspection by PE	Lump Sum	$5,000	1	$5,000	Assumes one site visit and PE-certified Inspection Report per year.
Environmental Monitoring					
Groundwater Monitoring - Sampling and Expenses	Lump Sum	$17,000	1	$17,000	Assumes two rounds of groundwater sampling under approved state monitoring program.
Groundwater Monitoring - Laboratory	Lump Sum	$9,600	1	$9,600	Assumes two rounds of groundwater sampling under approved state monitoring program.
Well Maintenance, Repair, and Replacement	Lump Sum	$14,000	1	$14,000	Assumes replacement of one well every other year during the post-closure care period plus annual maintenance and repairs (minor).
Annual Reporting					
Data Management and Reporting to WDNR	Lump Sum	$48,100	1	$48,100	Assumes semiannual reporting and biennial
Legal, Financial, and Administrative Services					
All legal, financial, and administrative services (Assumed 10% of Annual Costs)	%	10%	1	$14,700	
			Annual Long-Term Care Subtotal:	$161,700	
			Contingency (10%):	$16,200	
			Annual Long-Term Care Cost:	$177,900	
40-Year Post-Closure Cost (40 x Annual Long-Term Care Cost):				**$7,116,000**	

Assumptions/Notes:
1. Costs are based on experience with similar projects or RSMeans construction cost data.

Updated By: MJT, 8/23/2023, PEG, 8/24/2023
Checked by: BSS, 08/30/2023

I:\25222260.00\Data and Calculations\Cost Estimates\[COL_Financial Responsibility_Estimate_Tables_2023 POO Update - Mod 12 and 13.xlsx]Table 2 - Long Term Care Costs

09/28/2023 - Classification: Internal - ECRM13153872

E.4 Leachate Calculations

09/28/2023 - Classification: Internal - ECRM13153872

Hydraulic Capacity Calculations for Leachate Drainage Layer

Purpose:

To determine whether the maximum head in the leachate drainage blanket exceeds 1 foot during active and post-closure conditions, per NR 504.06(5)(a).

Approach:

The maximum head is calculated for 2 cases: active life (Case 1) and post-closure conditions (Case 2).

To estimate the maximum head in the leachate collection system drainage layer (Moore, 1982):

$h_{max} = (L/2n) [sqrt(e/k + tan^2 a) - tan a]$

where: h_{max} = hydraulic head build up

e = infiltration rate

k = permeability of the drainage layer

L = length of the flow path to the leachate piping (maximum)

a = slope of the base liner in direction of flow

n = porosity of the drainage layer

References:

Moore, C.A., 1982, Landfill and Surface Impoundment Performance Evaluation, Revised Ed., USEPA Publication SW-869A.

Assumptions:

For both Cases:

a = 2% min. = 1.146 degrees (required by NR 504.06(2)(d))

L = 130 feet (required by NR 504.06(5)(a))

For Case 1, active life:

k =0.01 cm/sec (CQA plan)

e = 6 in/year (per NR 512.12(3)(a))

n = 0.4 (typical for stone)

For Case 2, post-closure, reduced hydraulic conductivity

k = 0.001 cm/sec (required by NR 514.07(8)(c)3.c.), post-closure assume K is 10% of original 1 cm/sec)

e = 1 in/year (per NR 512.12(3)(a))

n = 0.2 (assume porosity is also reduced due to clogging post-closure)

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Hydraulic Capacity Calculations (continued)

Calculations:

$h_{max} = (L/2n) [sqrt(e/k + tan^2 a) - tan a]$

For Case 1, active life w/o leachate recirculation:

tan α	=	0.02				
L	=	130	ft			
k	=	0.01	cm/sec			
e	=	6	inches/year	x	2.54 cm/inch	/ ((86400 sec/day)(365 day/year))
		4.8E-07	cm/sec			
n	=	0.4				
h_{max}	=	0.19	ft			

For Case 2, post-closure, reduced hydraulic conductivity

tan α	=	0.02				
L	=	130	ft			
k	=	0.001	cm/sec			
e	=	1	inches/year	x	2.54 cm/inch	/ ((86400 sec/day)(365 day/year))
		8.1E-08	cm/sec			
n	=	0.2				
h_{max}	=	0.62	ft			

Conclusion:

The hydraulic capacity of the leachate drainage layer is adequate to convey the leachate to the collection pipe under active conditions and post-closure conditions.

09/28/2023 - Classification: Internal - ECRM13153872

Job No. 25222260.00	Job: Columbia Dry Ash Disposal Facility	By: MJT	Date: 8/21/23
Client: Wisconsin Power & Light	Subject: Leachate Pump Design, Pond	Chk'd: KRG	Date: 8/29/23

Purpose:

To size the leachate sump pumps during filling to pump from the leachate sumps to the Leachate Pond under the following scenarios:

1. Pumping from the Sump in Module 13 to the leachate pond, with all pumps operating at the same time.
2. Pumping from the Sump in Module 13 to the leachate pond, with only that pump operating.
3. Pumping from the Sump in Module 12 to the leachate pond, with all pumps operating at the same time.
4. Pumping from the Sump in Module 12 to the leachate pond, with only that pump operating.

Approach:

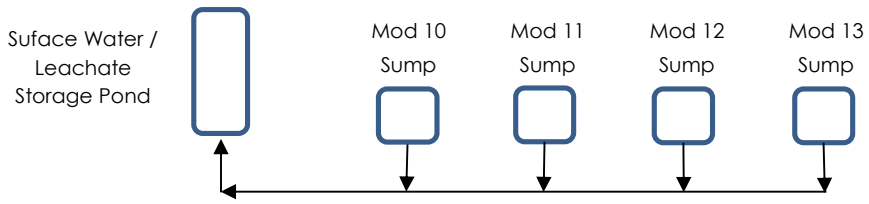
Determine the total dynamic head that the pump will operate against under various pumping rates.

The total dynamic head is a combination of the static head and friction losses from fittings and flow through the pipe.

Plot the resulting system curve on a representative pump curve to determine the suitability of a pump.

Calculations:

Pump System Layout



Pipe Header Lengths	Pipe Length		Pipe Material
Mod 10 Vault to Leachate Pond	280	ft	6" HDPE
Mod 11 Vault to Mod 10 Vault	246	ft	4" HDPE
Mod 12 Vault to Mod 11 Vault	268	ft	4" HDPE
Mod 13 Vault to Mod 12 Vault	347	ft	4" HDPE
Sump to Vault (Modules 10, 11, and 12)	64	ft	4" HDPE
Sump to Vault (Module13)	90	ft	4" HDPE

Results:

For the time period when Modules 10, 11, 12 and 13 are still open and the leachate storage pond is in operation: For Module 12, a EPG model 61-1 5.0 HP pump will pump at 123 GPM when all pumps in Modules 10, 11, 12, and 13 are operating at the same time and at 190 GPM when only the Module 12 pump is running. For Module 13, a EPG model 61-1 5.0 HP pump will pump at 95 GPM when all pumps in Modules 10, 11, 12, and 13 are operating at the same time and at 160 GPM when only the Module 13 pump is running.

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Calculations (cont.):

Static Heads Elevations:

Mod 10 Sump	797.0
Mod 11 Sump	799.0
Mod 12 Sump	800.0
Mod 12 High Point*	820.5
Mod 13 Sump	801.0
Mod 13 High Point*	830.5
Leachate Pond Oultet	798.0

* Assumed to be 3.5' above base ground surface elevation

Static Heads:

Mod 12 Vault to Leachate Pond	=	20.5	ft.
Mod 13 Vault to Leachate Pond	=	29.5	ft.

Fittings and Equivalent Length (see Sheet 8)

Mod 13 Sump to Mod 13 Vault	Eq. Length (ft)				Total Eq. Length (ft)
Vacuum Relief Valve, 4"	1	X	110	=	110
Gate Valve, 4"	1	X	275	=	275
Flow Meter, 4"	1	X	110	=	110
Check Valve, 4"	1	X	25	=	25
Ball Valve, 4"	1	X	110	=	110
Tee, 4"	2	X	23	=	46
90˚ Elbow, 4"	2	X	11	=	22
			Total:		698
Mod 13 Sump to Mod 12 Vault					
Actual Length (4" HDPE)					437
			Equivalent Length =		1135

From Mod 10/11/12 Sump to Vault	Eq. Length (ft)				Total Eq. Length (ft)
Vacuum Relief Valve, 4"	1	X	110	=	110
Gate Valve, 4"	1	X	275	=	275
Flow Meter, 4"	1	X	110	=	110
Check Valve, 4"	1	X	25	=	25
Ball Valve, 4"	1	X	110	=	110
Tee, 4"	3	X	23	=	69
90˚ Elbow, 4"	1	X	11	=	11
			Total:		710
Actual Length (4" HDPE)					64
			Equivalent Length =		774

Mod 10 Vault to Leachate Pond	Eq. Length (ft)				Total Eq. Length (ft)
4" to 6" enlargement	1	X	3.5	=	3.5
45˚ Elbow, 6"	1	X	10	=	10
			Total:		13.5
Actual Length (6" HDPE)					280
			Equivalent Length =		293.5

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Calculations (cont.):

Scenario 1A - All System Pumps (4) Operating, Pumping from Mod 13 to Leachate Pond

Assuming: 50 gpm at Mod 10 Vault, Mod 11 Vault, Mod 12 Vault, and Mod 13 Vault

Flowrate (GPM)	Static Head (Ft)	Equivalent Length (Ft)	Head Loss Per 100 Ft.	Head Loss (Ft)	Total Dynamic Head (Ft)
4" Pipe (Mod 13 Sump to Mod 12 Vault)					
50	29.5	1,135	0.15	1.70	31.2
4" Pipe (Mod 12 Vault to Mod 11 Vault)					
100	0	268	0.55	1.47	1.5
4" Pipe (Mod 11 Vault to Mod 10 Vault)					
150	0	246	1.17	2.88	2.9
6" Pipe (Mod 10 Vault to Leachate Pond)					
200	0	294	0.30	0.88	0.9
				Total Dynamic Head (ft):	**36.4**

Scenario 1B - All System Pumps (4) Operating, Pumping from Mod 13 to Leachate Pond

Assuming: 150 gpm at Mod 10 Vault, Mod 11 Vault, Mod 12 Vault, and Mod 13 Vault

Flowrate (GPM)	Static Head (Ft)	Equivalent Length (Ft)	Head Loss Per 100 Ft.	Head Loss (Ft)	Total Dynamic Head (Ft)
4" Pipe (Mod 13 Sump to Mod 12 Vault)					
150	29.5	1,135	1.17	13.28	42.8
4" Pipe (Mod 12 Vault to Mod 11 Vault)					
300	0	268	4.23	11.34	11.3
4" Pipe (Mod 11 Vault to Mod 10 Vault)					
450	0	246	8.97	22.07	22.1
6" Pipe (Mod 10 Vault to Leachate Pond)					
600	0	294	2.40	7.06	7.1
				Total Dynamic Head (ft):	**83.2**

Scenario 1C - All System Pumps (4) Operating, Pumping from Mod 13 to Leachate Pond

Assuming: 200 gpm at Mod 10 Vault, Mod 11 Vault, Mod 12 Vault, and Mod 13 Vault

Flowrate (GPM)	Static Head (Ft)	Equivalent Length (Ft)	Head Loss Per 100 Ft.	Head Loss (Ft)	Total Dynamic Head (Ft)
4" Pipe (Mod 13 Sump to Mod 12 Vault)					
200	29.5	1,135	2.00	22.70	52.2
4" Pipe (Mod 12 Vault to Mod 11 Vault)					
400	0	268	7.21	19.32	19.3
4" Pipe (Mod 11 Vault to Mod 10 Vault)					
600	0	246	14.25	35.06	35.1
6" Pipe (Mod 10 Vault to Leachate Pond)					
800	0	294	3.89	11.42	11.4
				Total Dynamic Head (ft):	**118.0**

09/28/2023 - Classification: Internal - ECRM13153872

Calculations (cont.):

Scenario 2A - Only Module 13 Pump Operating, Pumping from Mod 13 to Leachate Pond

Assuming: 100 gpm at Mod 13 Vault

Flowrate (GPM)	Static Head (Ft)	Equivalent Length (Ft)	Head Loss Per 100 Ft.	Head Loss (Ft)	Total Dynamic Head (Ft)
4" Pipe (Mod 13 Sump to Mod 12 Vault)					
100	29.5	1,135	0.55	6.24	35.7
4" Pipe (Mod 12 Vault to Mod 11 Vault)					
100	0	268	0.55	1.47	1.5
4" Pipe (Mod 11 Vault to Mod 10 Vault)					
100	0	246	0.55	1.35	1.4
6" Pipe (Mod 10 Vault to Leachate Pond)					
100	0	294	0.08	0.23	0.2
				Total Dynamic Head (ft):	**38.8**

Scenario 2B - Only Module 13 Pump Operating, Pumping from Mod 13 to Leachate Pond

Assuming: 150 gpm at Mod 13 Vault

Flowrate (GPM)	Static Head (Ft)	Equivalent Length (Ft)	Head Loss Per 100 Ft.	Head Loss (Ft)	Total Dynamic Head (Ft)
4" Pipe (Mod 13 Sump to Mod 12 Vault)					
150	29.5	1,135	1.17	13.28	42.8
4" Pipe (Mod 12 Vault to Mod 11 Vault)					
150	0	268	1.17	3.14	3.1
4" Pipe (Mod 11 Vault to Mod 10 Vault)					
150	0	246	1.17	2.88	2.9
6" Pipe (Mod 10 Vault to Leachate Pond)					
150	0	294	0.18	0.53	0.5
				Total Dynamic Head (ft):	**49.3**

Scenario 2C - Only Module 13 Pump Operating, Pumping from Mod 13 to Leachate Pond

Assuming: 250 gpm at Mod 13 Vault

Flowrate (GPM)	Static Head (Ft)	Equivalent Length (Ft)	Head Loss Per 100 Ft.	Head Loss (Ft)	Total Dynamic Head (Ft)
4" Pipe (Mod 13 Sump to Mod 12 Vault)					
250	29.5	1,135	3.02	34.28	63.8
4" Pipe (Mod 12 Vault to Mod 11 Vault)					
250	0	268	3.02	8.09	8.1
4" Pipe (Mod 11 Vault to Mod 10 Vault)					
250	0	246	3.02	7.43	7.4
6" Pipe (Mod 10 Vault to Leachate Pond)					
250	0	294	0.46	1.35	1.4
				Total Dynamic Head (ft):	**80.6**

09/28/2023 - Classification: Internal - ECRM13153872

Calculations (cont.):

Scenario 3A - All System Pumps (4) Operating, Pumping from Mod 12 to Leachate Pond

Assuming: 100 gpm at Mod 10 Vault, Mod 11 Vault, Mod 12 Vault, and Mod 13 Vault

Flowrate (GPM)	Static Head (Ft)	Equivalent Length (Ft)	Head Loss Per 100 Ft.	Head Loss (Ft)	Total Dynamic Head (Ft)
4" Pipe (Mod 12 Sump to Mod 12 Vault)					
100	20.5	774	0.55	4.26	24.8
4" Pipe (Mod 12 Vault to Mod 11 Vault)					
200	0	268	2.00	5.36	5.4
4" Pipe (Mod 11 Vault to Mod 10 Vault)					
300	0	246	4.23	10.41	10.4
6" Pipe (Mod 10 Vault to Leachate Pond)					
400	0	294	1.10	3.23	3.2
				Total Dynamic Head (ft):	**43.8**

Scenario 3B - All System Pumps (4) Operating, Pumping from Mod 12 to Leachate Pond

Assuming: 150 gpm at Mod 10 Vault, Mod 11 Vault, Mod 12 Vault, and Mod 13 Vault

Flowrate (GPM)	Static Head (Ft)	Equivalent Length (Ft)	Head Loss Per 100 Ft.	Head Loss (Ft)	Total Dynamic Head (Ft)
4" Pipe (Mod 12 Sump to Mod 12 Vault)					
150	20.5	774	1.17	9.06	29.6
4" Pipe (Mod 12 Vault to Mod 11 Vault)					
300	0	268	4.23	11.34	11.3
4" Pipe (Mod 11 Vault to Mod 10 Vault)					
450	0	246	8.97	22.07	22.1
6" Pipe (Mod 10 Vault to Leachate Pond)					
600	0	294	2.40	7.06	7.1
				Total Dynamic Head (ft):	**70.0**

Scenario 3C - All System Pumps (4) Operating, Pumping from Mod 12 to Leachate Pond

Assuming: 200 gpm at Mod 10 Vault, Mod 11 Vault, Mod 12 Vault, and Mod 13 Vault

Flowrate (GPM)	Static Head (Ft)	Equivalent Length (Ft)	Head Loss Per 100 Ft.	Head Loss (Ft)	Total Dynamic Head (Ft)
4" Pipe (Mod 12 Sump to Mod 12 Vault)					
200	20.5	774	2.00	15.48	36.0
4" Pipe (Mod 12 Vault to Mod 11 Vault)					
400	0	268	7.21	19.32	19.3
4" Pipe (Mod 11 Vault to Mod 10 Vault)					
600	0	246	14.25	35.06	35.1
6" Pipe (Mod 10 Vault to Leachate Pond)					
800	0	294	3.89	11.42	11.4
				Total Dynamic Head (ft):	**101.8**

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Calculations (cont.):

Scenario 4A - Only Module 12 Pump Operating, Pumping from Mod 12 to Leachate Pond

Assuming: 100 gpm at Mod 12 Vault

Flowrate (GPM)	Static Head (Ft)	Equivalent Length (Ft)	Head Loss Per 100 Ft.	Head Loss (Ft)	Total Dynamic Head (Ft)
4" Pipe (Mod 12 Sump to Mod 12 Vault)					
100	20.5	774	0.55	4.26	24.8
4" Pipe (Mod 12 Vault to Mod 11 Vault)					
100	0	268	0.55	1.47	1.5
4" Pipe (Mod 11 Vault to Mod 10 Vault)					
100	0	246	0.55	1.35	1.4
6" Pipe (Mod 10 Vault to Leachate Pond)					
100	0	294	0.08	0.23	0.2
			Total Dynamic Head (ft):		**27.8**

Scenario 4B - Only Module 12 Pump Operating, Pumping from Mod 12 to Leachate Pond

Assuming: 150 gpm at Mod 12 Vault

Flowrate (GPM)	Static Head (Ft)	Equivalent Length (Ft)	Head Loss Per 100 Ft.	Head Loss (Ft)	Total Dynamic Head (Ft)
4" Pipe (Mod 12 Sump to Mod 12 Vault)					
150	20.5	774	1.17	9.06	29.6
4" Pipe (Mod 12 Vault to Mod 11 Vault)					
150	0	268	1.17	3.14	3.1
4" Pipe (Mod 11 Vault to Mod 10 Vault)					
150	0	246	1.17	2.88	2.9
6" Pipe (Mod 10 Vault to Leachate Pond)					
150	0	294	0.18	0.53	0.5
			Total Dynamic Head (ft):		**36.1**

Scenario 4C - Only Module 12 Pump Operating, Pumping from Mod 12 to Leachate Pond

Assuming: 350 gpm at Mod 12 Vault

Flowrate (GPM)	Static Head (Ft)	Equivalent Length (Ft)	Head Loss Per 100 Ft.	Head Loss (Ft)	Total Dynamic Head (Ft)
4" Pipe (Mod 12 Sump to Mod 12 Vault)					
350	20.5	774	5.63	43.58	64.1
4" Pipe (Mod 12 Vault to Mod 11 Vault)					
350	0	268	5.63	15.09	15.1
4" Pipe (Mod 11 Vault to Mod 10 Vault)					
350	0	246	5.63	13.85	13.8
6" Pipe (Mod 10 Vault to Leachate Pond)					
350	0	294	0.86	2.52	2.5
			Total Dynamic Head (ft):		**95.5**

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Engineering & Design Data

FLOW VELOCITY & FRICTION LOSS

SDR 21

Flow Rate (Gallons per Minute)	Flow Velocity (ft/sec.)	Friction Loss (Ft. Water/ 100ft)	Friction Loss (psi/ 100ft)	Flow Velocity (ft/sec.)	Friction Loss (Ft. Water/ 100ft)	Friction Loss (psi/ 100ft)	Flow Velocity (ft/sec.)	Friction Loss (Ft. Water/ 100ft)	Friction Loss (psi/ 100ft)	Flow Velocity (ft/sec.)	Friction Loss (Ft. Water/ 100ft)	Friction Loss (psi/ 100ft)	Flow Velocity (ft/sec.)	Friction Loss (Ft. Water/ 100ft)	Friction Loss (psi/ 100ft)	Flow Velocity (ft/sec.)	Friction Loss (Ft. Water/ 100ft)	Friction Loss (psi/ 100ft)	Flow Velocity (ft/sec.)	Friction Loss (Ft. Water/ 100ft)	Friction Loss (psi/ 100ft)	Flow Velocity (ft/sec.)	Friction Loss (Ft. Water/ 100ft)	Friction Loss (psi/ 100ft)	Flow Rate (Gallons per Minute)
GPM	1/2"			3/4"			1"			1-1/4"			1-1/2"			2"			2-1/2"			3"			GPM
1				0.49	0.16	0.07	0.30	0.05	0.02	0.19	0.01	0.01	0.14	0.01	0.00	0.09	0.00	0.00	0.06	0.00	0.00	0.04	0.00	0.00	1
2				0.99	0.56	0.24	0.60	0.17	0.07	0.37	0.05	0.02	0.28	0.03	0.01	0.18	0.01	0.00	0.12	0.00	0.00	0.08	0.00	0.00	2
5				2.46	3.06	1.33	1.49	0.91	0.39	0.93	0.29	0.12	0.71	0.15	0.06	0.45	0.05	0.02	0.31	0.02	0.01	0.21	0.01	0.00	5
7				3.45	5.71	2.48	2.09	1.69	0.73	1.30	0.53	0.23	0.99	0.27	0.12	0.63	0.09	0.04	0.43	0.04	0.02	0.29	0.01	0.01	7
10				4.93	11.06	4.80	2.99	3.27	1.42	1.86	1.03	0.45	1.41	0.53	0.23	0.90	0.18	0.08	0.61	0.07	0.03	0.41	0.03	0.01	10
15	4"			7.39	23.44	10.16	4.48	6.93	3.00	2.79	2.18	0.95	2.12	1.12	0.49	1.35	0.37	0.16	0.92	0.15	0.06	0.62	0.06	0.02	15
20	0.50	0.03	0.01	9.86	39.94	17.31	5.97	11.81	5.12	3.72	3.72	1.61	2.83	1.91	0.83	1.80	0.64	0.28	1.23	0.25	0.11	0.83	0.10	0.04	20
25	0.62	0.04	0.02	5"			7.47	17.85	7.74	4.65	5.63	2.44	3.53	2.89	1.25	2.25	0.97	0.42	1.53	0.38	0.16	1.03	0.14	0.06	25
30	0.75	0.06	0.03	0.49	0.02	0.01	8.96	25.02	10.85	5.58	7.89	3.42	4.24	4.05	1.75	2.70	1.35	0.59	1.84	0.53	0.23	1.24	0.20	0.09	30
35	0.87	0.08	0.03	0.57	0.03	0.01	10.45	33.28	14.43	6.51	10.49	4.55	4.94	5.38	2.33	3.15	1.80	0.78	2.15	0.71	0.31	1.44	0.27	0.12	35
40	1.00	0.10	0.04	0.65	0.04	0.02				7.43	13.44	5.83	5.65	6.89	2.99	3.60	2.31	1.00	2.45	0.90	0.39	1.65	0.34	0.15	40
45	1.12	0.13	0.05	0.73	0.04	0.02	6"			8.36	16.71	7.25	6.36	8.57	3.72	4.05	2.87	1.24	2.76	1.12	0.49	1.86	0.43	0.19	45
50	1.25	0.15	0.07	0.82	0.05	0.02	0.58	0.02	0.01	9.29	20.31	8.81	7.06	10.42	4.52	4.50	3.49	1.51	3.06	1.37	0.59	2.06	0.52	0.23	50
60	1.50	0.21	0.09	0.98	0.08	0.03	0.69	0.03	0.01				8.48	14.60	6.33	5.41	4.89	2.12	3.68	1.91	0.83	2.48	0.73	0.32	60
70	1.75	0.29	0.12	1.14	0.10	0.04	0.81	0.04	0.02				9.89	19.43	8.42	6.31	6.50	2.82	4.29	2.55	1.10	2.89	0.97	0.42	70
75	1.87	0.32	0.14	1.22	0.12	0.05	0.86	0.05	0.02				10.59	22.08	9.57	6.76	7.39	3.20	4.60	2.89	1.25	3.09	1.10	0.48	75
80	2.00	0.37	0.16	1.31	0.13	0.06	0.92	0.06	0.02							7.21	8.32	3.61	4.90	3.26	1.41	3.30	1.25	0.54	80
90	2.24	0.46	0.20	1.47	0.16	0.07	1.04	0.07	0.03	8"						8.11	10.35	4.49	5.52	4.06	1.76	3.71	1.55	0.67	90
100	2.49	0.55	0.24	1.63	0.20	0.09	1.15	0.08	0.04	0.68	0.02	0.01				9.01	12.58	5.46	6.13	4.93	2.14	4.13	1.88	0.82	100
125	3.12	0.84	0.36	2.04	0.30	0.13	1.44	0.13	0.06	0.85	0.04	0.02							7.66	7.46	3.23	5.16	2.85	1.23	125
150	3.74	1.17	0.51	2.45	0.42	0.18	1.73	0.18	0.08	1.02	0.05	0.02							9.19	10.45	4.53	6.19	3.99	1.73	150
175	4.36	1.56	0.68	2.86	0.56	0.24	2.01	0.24	0.10	1.19	0.07	0.03							10.73	13.90	6.03	7.22	5.31	2.30	175
200	4.99	2.00	0.87	3.26	0.71	0.31	2.30	0.30	0.13	1.36	0.08	0.04										8.25	6.80	2.95	200
250	6.24	3.02	1.31	4.08	1.08	0.47	2.88	0.46	0.20	1.70	0.13	0.06										10.31	10.27	4.45	250
300	7.48	4.23	1.84	4.90	1.51	0.65	3.45	0.65	0.28	2.04	0.18	0.08													300
350	8.73	5.63	2.44	5.71	2.01	0.87	4.03	0.86	0.37	2.38	0.24	0.10													350
400	9.98	7.21	3.13	6.53	2.57	1.12	4.61	1.10	0.48	2.71	0.30	0.13													400
450	11.22	8.97	3.89	7.35	3.20	1.39	5.18	1.37	0.59	3.05	0.38	0.16													450
500				8.16	3.89	1.69	5.76	1.66	0.72	3.39	0.46	0.20													500
750							8.64	3.52	1.53	5.09	0.97	0.42													750
1000										6.79	1.66	0.72													1000
1250										8.48	2.51	1.09													1250

NOTE: Spears® recommends that Flow Velocities be maintained at or below 5 feet per second in large diameter piping systems (i.e. 6" diameter and larger) to minimize the potential for hydraulic shock. Refer to Spears® engineering section entitled "Hydraulic Shock" for additional information. Friction loss data based on utilizing mean wall dimensions to determine average ID; actual ID may vary.

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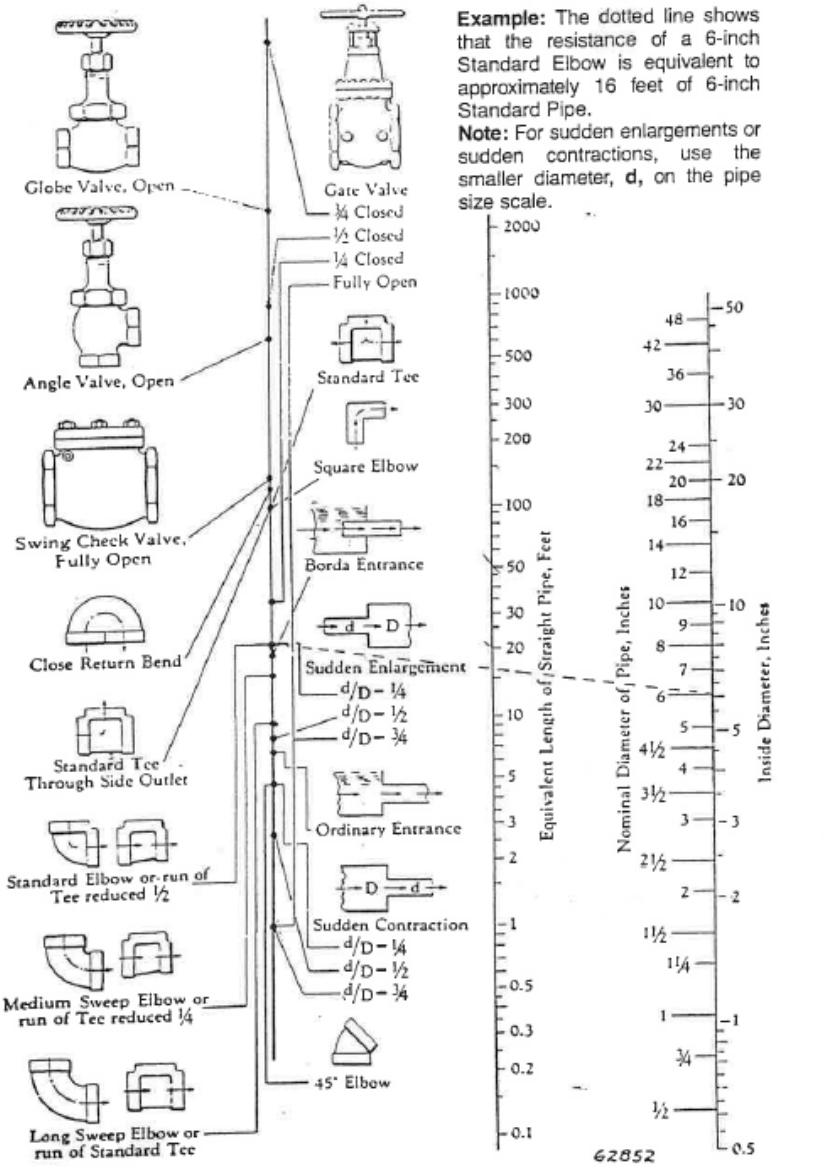
FRICTION-WATER-PIPE FITTINGS

Friction of Water *(Continued)*
Resistance of Valves and Fittings to Flow of Fluids in Equivalent Length of Pipe



From Crane Co. Technical Paper No. 409. Data based on the above chart are satisfactory for most applications; for more detailed data and information refer to pages 3-110 to page 3-120 which are based on Crane Co. Technical Paper No. 410.

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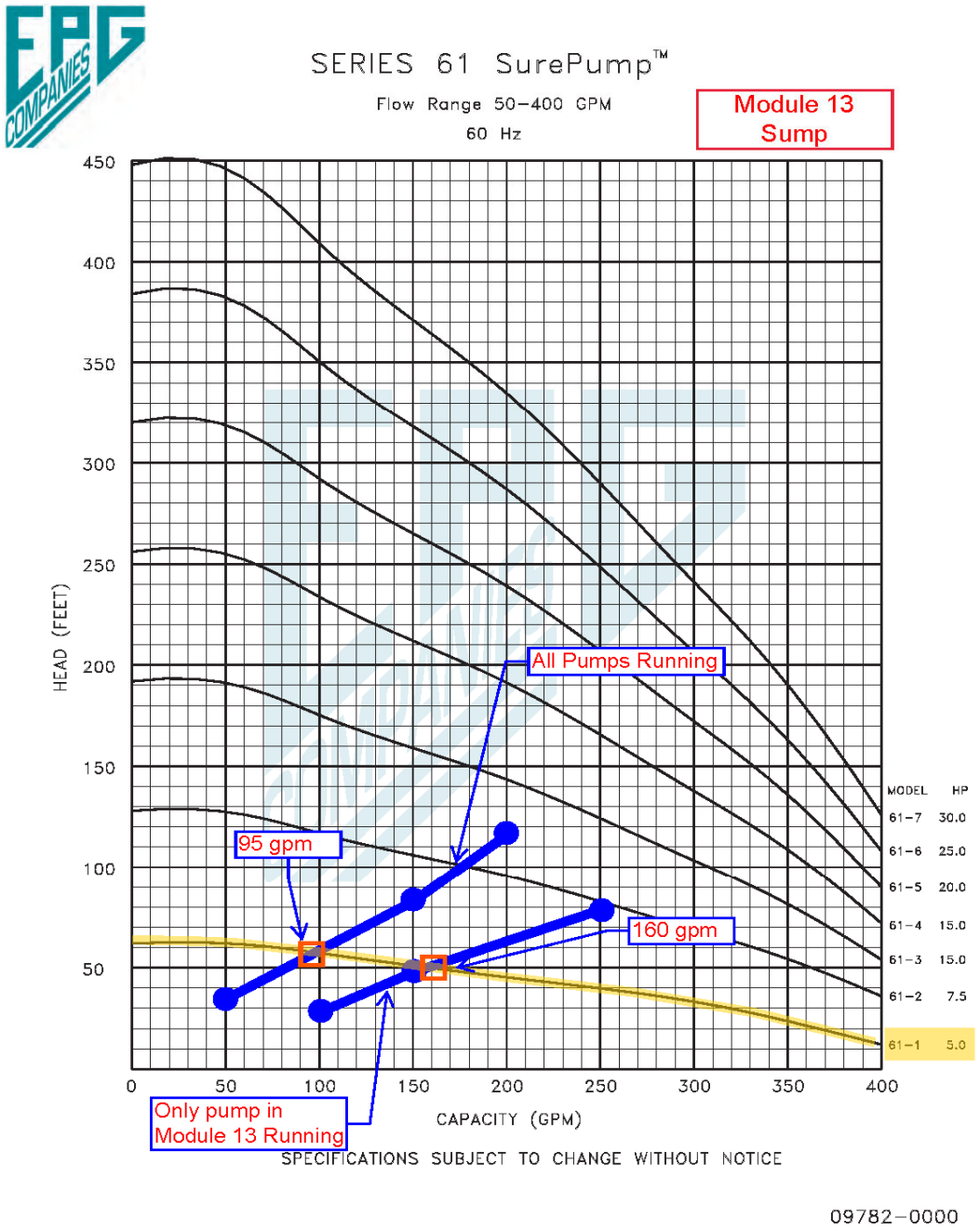

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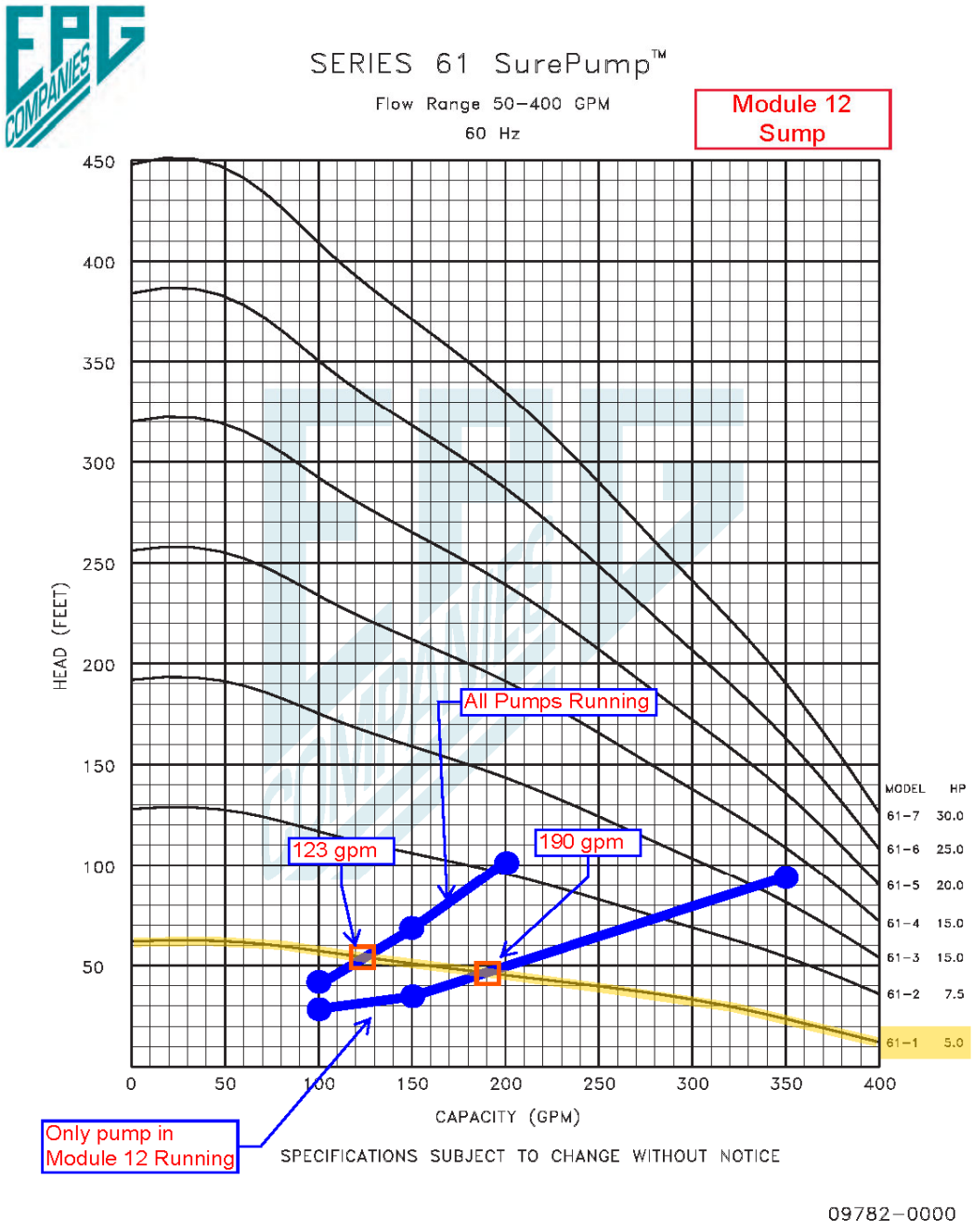

I:\25222260.00\Data and Calculations\Leachate\E4-2_Mod 12-13_Sump to Leachate Pond Pump Sizing Checked Sheet10_Curve2

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SCS ENGINEERS

		Sheet No. 1 of 4	
		Calc. No.	
		Rev. No.	
Job No. 25222260.00	Job: Columbia Dry Ash Disposal Facility	By: MJT	Date: 8/28/23
Client: Wisconsin Power & Light	Subject: Sump Volume and Pump Capacity	Chk'd: KRG	Date: 8/29/23

Leachate Sump Volume and Pump Capacity Calculations

Purpose:

To demonstrate that the volume in the leachate sumps and the capacity of the sump pump in Module 12 will adequately control the leachate to maintain accumulation within the sump and intersecting collection trenches, in accordance with NR 504.06(5)(j)1.

Approach:

Estimate the leachate generation rate to each sump assuming an annual leachate collection rate of 6 inches specified by NR 504.06(5)(j)1.

Calculate the sump volume based on the sump geometry shown in the Plan Mod/Plan of Operation plan set. The available volume is determined by calculating the overall sump volume between the pump on and off levels, minus the volume occupied by the granular bedding.

Determine the pumping intervals by dividing the available volume of the sump by the daily leachate generation rate. (This is the number of times the sump will fill and be required to be pumped on a daily basis.)

Identify commercially available pumps that can meet the required pumping interval calculated above.

Assumptions:

The sump in Module 12 will collect leachate from Modules 5, 6, and 12.

The leachate sumps will be filled with a granular material with a porosity of 40 percent.

Leachate generation is estimated assuming the entire area is open.

The annual leachate collection rate during open/active conditions is 6 inches per month, per NR 504.06(5)(j)1.

The pump on liquid level will occur below the bottom of the incoming leachate trenches. The pump off level will occur at 1 foot above the sump bottom.

Results:

The leachate generation rate for the sump during open/active conditions is 5,606 gal/day.
Refer to Sheet 2 for the generation rates for the sump.

The functional capacity in the sump, accounting for the stone porosity and solids buildup is 3,427 gallons.
Refer to Sheet 3 for the sump volume calculation.

The leachate sump pump is adequately sized to handle the estimated worst-case leachate volume at Module 12 with estimated filling times of 14.7 hours (Sheet 4)

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Calculations:

Estimate an annual leachate collection volume based on a 6 inch per year generation rate for open conditions and an 1 inch per year generation rate for closed conditions.

Area	Sq. Ft.	Acre
Mod 1	360,841	8.28
Mod 2	171,313	3.93
Mod 3	173,212	3.98
Mod 4	176,240	4.05
Mod 5	179,251	4.12
Mod 6	165,253	3.79
Mod 10	149,157	3.42
Mod 11	151,628	3.48
Mod 12	202,610	4.65
	Total:	39.70

The sump in Module 12 will contain leachate from Module 5, 6, and 12, total area = 12.56 ac.

Open Conditions

6 inches per year for leachate collection:

Infiltration from precip=(6 in/yr)x(1 ft/12 in)x(43,560 sf/ac)x(7.48 gal/cf)x(1 yr/365 days)= 446.3 gal/acre/day

Closed Conditions

1 inches per year for precipitation:

Infiltration from precip=(1 in/yr)x(1 ft/12 in)x(43,560 sf/ac)x(7.48 gal/cf)x(1 yr/365 days)= 74.4 gal/acre/day

Calculate the maximum leachate generation rate to the sump under open/active conditions and closed conditions.

Sump Location	Average Leachate Collection Rate (gal/acre/day)	Area to Sump (acres)	Leachate Generation Rate (gal/day)
Open/Active Condition			
Module 12	446.3	12.56	5,606
Closed Condition			
Module 12	74.4	12.56	934

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Sump Volumes

Module 12 (Base dimensions 15 ft. x 15 ft.)

Module 12	EL	Area (sf)	Volume (cf)	Cum Vol (cf)
Base	799	229	0	0
Pump Off	800	447	0	0
	801	737	592	592
Pump On	802	1133	935	1,527
	803	2407	1,770	3,297

Notes: Sump dimensions assumes 4:1 side slopes.
Areas of sump obtained from AutoCAD drawings of base grades.

Calculations:

Calculate the sump volume:

The sump has the dimensions and slopes as indicated on the sump detail in the Plan of Operation addendum plan set.

The general sump configuration is summarized below:

Module 12 operating volume = 1,527 cf x 7.48 gal/cf = 11,424 gal

Assuming 40% porosity for the coarse aggregate in the sump, the available capacity for leachate is as follows:

Module 12 Available Volume = 0.40 x sump operating vol. = 4,569 gal

Estimate sump filling time based on the leachate generation rates and sump volumes:

For Open/Active Conditions with leachate recirculation:

Fill Time = Operating Volume (gal)/(Leachate Generation Rate (gal/day) x 24 hrs/day)

Phase	Available Volume (gals)	25% Reduced Available Volume to Account for Solids Buildup	Leachate Generation Rate (gal/day)	Fill Time (hours)
Module 12	4,569	3,427	5,606	14.7

For Closed Conditions

Phase	Available Volume (gals)	25% Reduced Available Volume to Account for Solids Buildup	Leachate Generation Rate (gal/day)	Fill Time (hours)
Module 12	4,569	3,427	934	88.0

Sump filling times provide adequate pump rest time during active conditions with open and closed conditions.

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Calculations:

Determine preliminary pumping rates and times based on assumed sump filling rate plus 50% margin for higher flows.

Filling rate (gpm) = Sump Volume (gal) / Sump Fill Time (hr) / 60 min/hr

Dewatering Time (hr) = Sump Volume (gal) / (Pumping Rate - Filling Rate (gpm)) / 60 min/hr

Pump Rest Time (hr) = Sump Fill Time (hr)

Open Conditions (pump will pump at 123 gpm with all pumps running, see pump sizing calculation)

Phase	Available Sump Volume, gal	Sump Fill Time, hrs	Filling Rate, gpm	Pumping Rate, gpm	Dewatering Time, hrs	Pump Rest Time, hrs
Mod 12	3,427	14.7	3.9	123	0.5	14.2

Closed Conditions (pump will pump at 15.5 gpm with all pumps running, see pump sizing calculation)

Phase	Operating Sump Volume, gal	Sump Fill Time, hrs	Filling Rate, gpm	Pumping Rate, gpm	Dewatering Time, hrs	Pump Rest Time, hrs
Mod 12	3,427	88.0	0.6	15	4.0	84.0

The required pumping rates are readily achievable with available pumps, such as EPG Model 61 series.

Conclusion:

The required pumping rates for dewatering are achievable with available pumps. The sumps are adequately sized to maintain liquid level within the sump based on peak generation rate of 6" of leachate collection per year.

09/28/2023 - Classification: Internal - ECRM13153872

Leachate Sump Volume and Pump Capacity Calculations

Purpose:

To demonstrate that the volume in the leachate sumps and the capacity of the sump pumps in Modules 12 and 13 will adequately control the leachate to maintain accumulation within the sump and intersecting collection trenches, in accordance with NR 504.06(5)(j)1.

Approach:

Estimate the leachate generation rate to each sump assuming an annual leachate collection rate of 6 inches specified by NR 504.06(5)(j)1.

Calculate the sump volume based on the sump geometry shown in the Plan Mod/Plan of Operation plan set. The available volume is determined by calculating the overall sump volume between the pump on and off levels, minus the volume occupied by the granular bedding.

Determine the pumping intervals by dividing the available volume of the sump by the daily leachate generation rate. (This is the number of times the sump will fill and be required to be pumped on a daily basis.)

Identify commercially available pumps that can meet the required pumping interval calculated above.

Assumptions:

The sump in Module 12 will collect leachate from Modules 5 and 12. The sump in Module 13 will collect leachate from Modules 6 and 13.

The leachate sumps will be filled with a granular material with a porosity of 40 percent.

Leachate generation is estimated assuming the entire area is open.

The annual leachate collection rate during open/active conditions is 6 inches per month, per NR 504.06(5)(j)1.

The pump on liquid level will occur below the bottom of the incoming leachate trenches. The pump off level will occur at 1 foot above the sump bottom.

Results:

The leachate generation rate for each sump during open/active conditions ranges from 2,801 to 3,913 gal/day. with the highest generation rate occurring in Module 12. Refer to Sheet 2 for the generation rates for each sump.

The functional capacity in the sumps, accounting for the stone porosity and solids buildup ranges from 3,427 to 3,434 gallons. Refer to Sheet 3 for the sump volume calculation.

The leachate sump pumps are adequately sized to handle the estimated worst-case leachate volume at Modules 12 and 13 with estimated filling times ranging from 21.0 hours to 29.4 hours (Sheet 4).

09/28/2023 - Classification: Internal - ECRM13153872

Calculations:

Estimate an annual leachate collection volume based on a 6 inch per year generation rate for open conditions and an 1 inch per year generation rate for closed conditions.

Area	Sq. Ft.	Acre
Mod 1	360,841	8.28
Mod 2	171,313	3.93
Mod 3	173,212	3.98
Mod 4	176,240	4.05
Mod 5	179,251	4.12
Mod 6	165,253	3.79
Mod 10	149,157	3.42
Mod 11	151,628	3.48
Mod 12	202,610	4.65
Mod 13	108,151	2.48
Total:	42.19	

The sump in Module 12 will contain leachate from Module 5 and 12, total area = 8.77 ac.
The sump in Module 13 will contain leachate from Module 6 and 13, total area = 6.28 ac.

Open Conditions

6 inches per year for leachate collection:

Infiltration from precip=(6 in/yr)x(1 ft/12 in)x(43,560 sf/ac)x(7.48 gal/cf)x(1 yr/365 days)= 446.3 gal/acre/day

Closed Conditions

1 inches per year for precipitation:

Infiltration from precip=(1 in/yr)x(1 ft/12 in)x(43,560 sf/ac)x(7.48 gal/cf)x(1 yr/365 days)= 74.4 gal/acre/day

Calculate the maximum leachate generation rate to each sump under open/active conditions and closed conditions.

Sump Location	Average Leachate Collection Rate (gal/acre/day)	Area to Sump (acres)	Leachate Generation Rate (gal/day)
Open/Active Condition			
Module 12	446.3	8.77	3,913
Module 13	446.3	6.28	2,801
Closed Condition			
Module 12	74.4	8.77	652
Module 13	74.4	6.28	467

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Sump Volumes

Module 12 (Base dimensions 15 ft. x 15 ft.)

Module 12	EL	Area (sf)	Volume (cf)	Cum Vol (cf)
Base	799	229	0	0
Pump Off	800	447	0	0
	801	737	592	592
Pump On	802	1133	935	1,527
	803	2407	1,770	3,297

Notes: Sump dimensions assumes 4:1 side slopes.
Areas of sump obtained from AutoCAD drawings of base grades.

Module 13 (Base dimensions 15 ft. x 15 ft.)

Module 13	EL	Area (sf)	Volume (cf)	Cum Vol (cf)
Base	800	236	0	0
Pump Off	801	456	0	0
	802	747	602	602
Pump On	803	1110	929	1,530
	804	1757	1,434	2,964

Note: Sump dimensions assumes 4:1 side slopes.
Areas of sump obtained from AutoCAD drawings of base grades.

Calculations:

Calculate the sump volume:

The sumps have the dimensions and slopes as indicated on the sump detail in the Plan of Operation addendum plan set.
The general sump configuration is summarized below:

Module 12 operating volume =	1,527	cf	x	7.48	gal/cf	=	11,424 gal
Module 13 operating volume =	1,530	cf	x	7.48	gal/cf	=	11,448 gal

Assuming 40% porosity for the coarse aggregate in the sump, the available capacity for leachate is as follows:

Module 12 Available Volume = 0.40 x sump operating vol. = 4,569 gal
Module 13 Available Volume = 0.40 x sump operating vol. = 4,579 gal

Estimate sump filling time based on the leachate generation rates and sump volumes:

For Open/Active Conditions with leachate recirculation:

Fill Time = Operating Volume (gal)/(Leachate Generation Rate (gal/day) x 24 hrs/day)

Phase	Available Volume (gals)	25% Reduced Available Volume to Account for Solids Buildup	Leachate Generation Rate (gal/day)	Fill Time (hours)
Module 12	4,569	3,427	3,913	21.0
Module 13	4,579	3,434	2,801	29.4

For Closed Conditions

Phase	Available Volume (gals)	25% Reduced Available Volume to Account for Solids Buildup	Leachate Generation Rate (gal/day)	Fill Time (hours)
Module 12	4,569	3,427	652	126.1
Module 13	4,579	3,434	467	176.5

Sump filling times provide adequate pump rest time during active conditions with open and closed conditions.

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Calculations:

Determine preliminary pumping rates and times based on assumed sump filling rate plus 50% margin for higher flows.

Filling rate (gpm) = Sump Volume (gal) / Sump Fill Time (hr) / 60 min/hr

Dewatering Time (hr) = Sump Volume (gal) / (Pumping Rate - Filling Rate (gpm)) / 60 min/hr

Pump Rest Time (hr) = Sump Fill Time (hr)

Open Conditions (pumps will pump at 123 and 95 gpm with all pumps running, see pump sizing calculation)

Phase	Available Sump Volume, gal	Sump Fill Time, hrs	Filling Rate, gpm	Pumping Rate, gpm	Dewatering Time, hrs	Pump Rest Time, hrs
Mod 12	3,427	21.0	2.7	123	0.5	20.5
Mod 13	3,434	29.4	1.9	95	0.6	28.8

Closed Conditions (pumps will pump at 15.5 gpm with all pumps running, see pump sizing calculation)

Phase	Operating Sump Volume, gal	Sump Fill Time, hrs	Filling Rate, gpm	Pumping Rate, gpm	Dewatering Time, hrs	Pump Rest Time, hrs
Mod 12	3,427	126.1	0.5	15	3.9	122.2
Mod 13	3,434	176.5	0.3	15	3.9	172.6

The required pumping rates are readily achievable with available pumps, such as EPG Model 61 series.

Conclusion:

The required pumping rates for dewatering are achievable with available pumps. The sumps are adequately sized to maintain liquid level within the sump based on peak generation rate of 6" of leachate collection per year.

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Job No. 25222260.00	Job: Columbia Dry Ash Disposal Facility	By: MJT	Date: 8/15/23
Client: Wisconsin Power & Light	Subject: Leachate Pump Design	Chk'd: KRG	Date: 8/31/23

Purpose:

To size the leachate sump pumps under the following scenarios:

1. Pumping from the Sump in Module 13 (furthest sump from leachate tank) to the leachate tank, with all pumps operating at the same time.
2. Pumping from the Sump in Module 13 (furthest sump from leachate tank) to the leachate tank, with only that pump operating.
3. Pumping from the Sump in Module 12 to the leachate tank, with only that pump operating.
4. Pumping from the Sump in Module 11 to the leachate tank, with only that pump operating.
5. Pumping from the Sump in Module 10 to the leachate tank, with only that pump operating.
6. Pumping from the Sump in Module 2 to the leachate tank, with only that pump operating.
7. Pumping from the Sump in Module 2 to the leachate tank, with all pumps operating.

Approach:

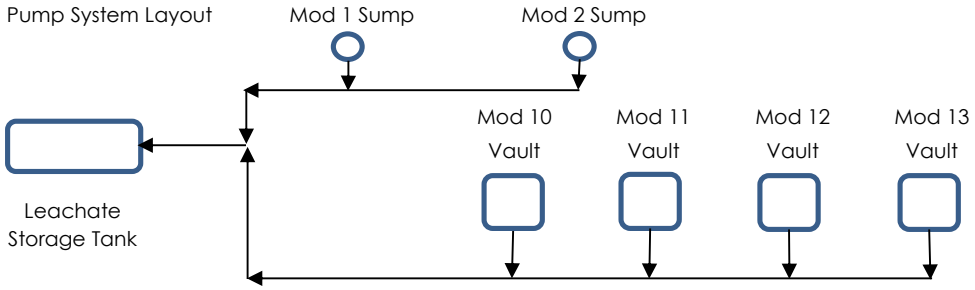
Determine the total dynamic head that the pump will operate against under various pumping rates.

The total dynamic head is a combination of the static head and friction losses from fittings and flow through the pipe.

Plot the resulting system curve on a representative pump curve to determine the suitability of a pump.

Calculations:

Pump System Layout



Pipe Header Lengths	Pipe Length		Pipe Material
Mod 2 Sump to Mod 1 Sump	164	ft	2" HDPE
Mod 1 Sump to Leachate Tank Tee	110	ft	2" HDPE
Leachate Tank Tee to Leachate Tank	49	ft	2" HDPE
Mod 10 Vault to Leachate Tank Tee	861	ft	2" HDPE
Mod 11 Vault to Mod 10 Vault	246	ft	2" HDPE
Mod 12 Vault to Mod 11 Vault	268	ft	2" HDPE
Mod 13 Vault to Mod 12 Vault	347	ft	2" HDPE
Sump to Vault (Modules 10, 11, and 12)	64	ft	4" HDPE
Sump to Vault (Module13)	90	ft	4" HDPE

Results:

For Mod 1 and Mod 2, the EPG Series 7, Model 7-1, 0.5 hp pump will pump 17 gpm when all pumps are operating and 29 gpm when only one pump is running. (See pump curve on Page 19)

For the sumps in Mods 10 through 13, the EPG Series 7, Model 7-4, 1.0 hp pump will pump 15 gpm when all pumps are running and 37.5 gpm when only one pump is running. (See Page 15)

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Calculations (cont.):

Static Heads Elevations:

Mod 1:	Pump Off Elevation	=	791.0
Mod 2:	Pump Off Elevation	=	794.0
Mod 2 High Point*			810.0
Mod 10 Sump			797.0
Mod 10 High Point			815.7
Mod 11 Sump			799.0
Mod 11 High Point			817.0
Mod 12 Sump			800.0
Mod 12 High Point**			820.5
Mod 13 Sump			801.0
Mod 13 High Point**			830.5
Leachate Tank***			807.0

* Assumed to be 1.0' below ground surface elevation

** Assumed to be 3.5' above base ground surface elevation

*** Assumed to be 5' below ground surface elevation

Static Heads:

Mod 2 Sump to Leachate Tank	=	16.0	ft.
Mod 10 Sump to Leachate Tank	=	18.7	ft.
Mod 11 Sump to Leachate Tank	=	18.0	ft.
Mod 12 Sump to Leachate Tank	=	20.5	ft.
Mod 13 Sump to Leachate Tank	=	29.5	ft.

Fittings and Equivalent Length (see Sheet 15)

From Mod 2 Sump to Mod 1 Tee	Eq. Length (ft)				Total Eq. Length (ft)
90˚ Elbows, 2"	3	X	5.5	=	16.5
Union Fitting, 2"	1	X	2	=	2
Flow Meter, 2"	1	X	55	=	55
Check Valve, 2"	1	X	15	=	15
45˚ Elbows, 2"	1	X	2.5	=	2.5
Tee, 2"	1	X	13	=	13
			Total:		104
Actual Length (2" HDPE)					164
			Equivalent Length =		268

From Leachate FM Tee to Leachate Tank	Eq. Length (ft)				Total Eq. Length (ft)
Tee, 2"	1	X	13	=	13
90˚ Elbows, 2" (at Tank)	3	X	5.5	=	16.5
			Total:		29.5
Actual Length (2" HDPE)					49
			Equivalent Length =		78.5

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Calculations (cont.):

Fittings and Equivalent Length, cont. (see Sheet 15)

Mod 13 Sump to Mod 13 Vault	Eq. Length (ft)				Total Eq. Length (ft)
Vacuum Relief Valve, 4"	1	X	110	=	110
Gate Valve, 4"	1	X	275	=	275
Flow Meter, 4"	1	X	110	=	110
Check Valve, 4"	1	X	25	=	25
Ball Valve, 4"	1	X	110	=	110
Tee, 4"	2	X	23	=	46
4" to 2" reduction	1	X	4	=	4
Actual Length (4" HDPE)					90
			Equivalent Length =		770

Mod 13 Vault to Mod 12 Vault					
90˚ Elbow, 2"	2	X	5.5	=	11
Actual Length (2" HDPE)					347
			Equivalent Length =		358

From Mod 10/11/12 Sump to Vault	Eq. Length (ft)				Total Eq. Length (ft)
Vacuum Relief Valve, 4"	1	X	110	=	110
Gate Valve, 4"	1	X	275	=	275
Flow Meter, 4"	1	X	110	=	110
Check Valve, 4"	1	X	25	=	25
Ball Valve, 4"	1	X	110	=	110
Tee, 4"	3	X	23	=	69
4" to 2" reduction	1	X	4	=	4
Actual Length (4" HDPE)					64
			Equivalent Length =		767

From Mod 12 Vault to Mod 11 Vault					
90˚ Elbow, 2"	1	X	5.5	=	5.5
Actual Length (2" HDPE)					268
			Equivalent Length =		273.5

From Mod 11 Vault to Mod 10 Vault					
90˚ Elbow, 2"	1	X	5.5	=	5.5
Actual Length (2" HDPE)					246
			Equivalent Length =		251.5

From Mod 10 Vault to Leachate FM Tee					
Tee, 2"	5	X	13	=	65
45˚ Elbows, 2"	4	X	2.5	=	10
Actual Length (2" HDPE)					861
			Equivalent Length =		936

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Calculations (cont.):

Scenario 1A - All System Pumps (6) Operating, Pumping from Mod 13 to Leachate Tank

Assuming: 5 gpm pumping rate at Mod 1, Mod 2
5 gpm at Mod 10 Vault, Mod 11 Vault, Mod 12 Vault, and Mod 13 Vault

Flowrate (GPM)	Static Head (Ft)	Equivalent Length (Ft)	Head Loss Per 100 Ft.	Head Loss (Ft)	Total Dynamic Head (Ft)
4" Pipe (Mod 13 Sump to Mod 13 Vault)					
5	29.5	770	0.01	0.08	29.6
2" Pipe (Mod 13 Vault to Mod 12 Vault)					
5	0	358	0.08	0.27	0.3
2" Pipe (Mod 12 Vault to Mod 11 Vault)					
10	0	274	0.24	0.66	0.7
2" Pipe (Mod 11 Vault to Mod 10 Vault)					
15	0	252	0.50	1.26	1.3
2" Pipe (Mod 10 Vault to Leachate Tank Tee)					
20	0	936	0.85	7.96	8.0
2" Pipe (Leachate Tank Tee to Leachate Tank)					
30	0	79	1.8	1.41	1.4
				Total Dynamic Head (ft):	**41.1**

Scenario 1B - All System Pumps (6) Operating, Pumping from Mod 13 to Leachate Tank

Assuming: 5 gpm pumping rate at Mod 1, Mod 2
15 gpm at Mod 10 Vault, Mod 11 Vault, Mod 12 Vault, and Mod 13 Vault

Flowrate (GPM)	Static Head (Ft)	Equivalent Length (Ft)	Head Loss Per 100 Ft.	Head Loss (Ft)	Total Dynamic Head (Ft)
4" Pipe (Mod 13 Sump to Mod 13 Vault)					
15	29.5	770	0.02	0.15	29.7
2" Pipe (Mod 13 Vault to Mod 12 Vault)					
15	0	358	0.50	1.79	1.8
2" Pipe (Mod 12 Vault to Mod 11 Vault)					
30	0	274	1.80	4.92	4.9
2" Pipe (Mod 11 Vault to Mod 10 Vault)					
45	0	252	3.82	9.61	9.6
2" Pipe (Mod 10 Vault to Leachate Tank Tee)					
60	0	936	6.50	60.84	60.8
2" Pipe (Leachate Tank Tee to Leachate Tank)					
70	0	79	8.65	6.79	6.8
				Total Dynamic Head (ft):	**113.6**

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Calculations (cont.):

Scenario 1C - All System Pumps (6) Operating, Pumping from Mod 13 to Leachate Tank

Assuming: 5 gpm pumping rate at Mod 1, Mod 2
20 gpm at Mod 10 Vault, Mod 11 Vault, Mod 12 Vault, and Mod 13 Vault

Flowrate (GPM)	Static Head (Ft)	Equivalent Length (Ft)	Head Loss Per 100 Ft.	Head Loss (Ft)	Total Dynamic Head (Ft)
4" Pipe (Mod 13 Sump to Mod 13 Vault)					
20	29.5	770	0.04	0.31	29.8
2" Pipe (Mod 13 Vault to Mod 12 Vault)					
20	0	358	0.85	3.04	3.0
2" Pipe (Mod 12 Vault to Mod 11 Vault)					
40	0	274	3.07	8.40	8.4
2" Pipe (Mod 11 Vault to Mod 10 Vault)					
60	0	252	6.50	16.35	16.3
2" Pipe (Mod 10 Vault to Leachate Tank Tee)					
80	0	936	11.08	103.71	103.7
2" Pipe (Leachate Tank Tee to Leachate Tank)					
90	0	79	13.78	10.82	10.8
				Total Dynamic Head (ft):	**172.1**

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Calculations (cont.):

Scenario 2A - Pump at Module 13 Sump Operating, Pumping from Mod 13 to Leachate Tank, all other pumps off

Assuming: 20 gpm pumping rate at Mod 13 Vault

Flowrate (GPM)	Static Head (Ft)	Equivalent Length (Ft)	Head Loss Per 100 Ft.	Head Loss (Ft)	Total Dynamic Head (Ft)
4" Pipe (Mod 13 Sump to Mod 13 Vault)					
20	29.5	770	0.04	0.31	29.8
2" Pipe (Mod 13 Vault to Mod 12 Vault)					
20	0	358	0.85	3.04	3.0
2" Pipe (Mod 12 Vault to Mod 11 Vault)					
20	0	274	0.85	2.32	2.3
2" Pipe (Mod 11 Vault to Mod 10 Vault)					
20	0	252	0.85	2.14	2.1
2" Pipe (Mod 10 Vault to Leachate Tank Tee)					
20	0	936	0.85	7.96	8.0
2" Pipe (Leachate Tank Tee to Leachate Tank)					
20	0	79	0.85	0.67	0.7
				Total Dynamic Head (ft):	**45.9**

Scenario 2B - Pump at Module 13 Sump Operating, Pumping from Mod 13 to Leachate Tank, all other pumps off

Assuming: 35 gpm pumping rate at Mod 13 Vault

Flowrate (GPM)	Static Head (Ft)	Equivalent Length (Ft)	Head Loss Per 100 Ft.	Head Loss (Ft)	Total Dynamic Head (Ft)
4" Pipe (Mod 13 Sump to Mod 13 Vault)					
35	29.5	770	0.11	0.85	30.3
2" Pipe (Mod 13 Vault to Mod 12 Vault)					
35	0	358	2.40	8.59	8.6
2" Pipe (Mod 12 Vault to Mod 11 Vault)					
35	0	274	2.40	6.56	6.6
2" Pipe (Mod 11 Vault to Mod 10 Vault)					
35	0	252	2.40	6.04	6.0
2" Pipe (Mod 10 Vault to Leachate Tank Tee)					
35	0	936	2.40	22.46	22.5
2" Pipe (Leachate Tank Tee to Leachate Tank)					
35	0	79	2.4	1.88	1.9
				Total Dynamic Head (ft):	**75.9**

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Calculations (cont.):

Scenario 2C - Pump at Module 13 Sump Operating, Pumping from Mod 13 to Leachate Tank, all other pumps off

Assuming: 45 gpm pumping rate at Mod 13 Vault

Flowrate (GPM)	Static Head (Ft)	Equivalent Length (Ft)	Head Loss Per 100 Ft.	Head Loss (Ft)	Total Dynamic Head (Ft)
4" Pipe (Mod 13 Sump to Mod 13 Vault)					
45	29.5	770	0.17	1.31	30.8
2" Pipe (Mod 13 Vault to Mod 12 Vault)					
45	0	358	3.82	13.68	13.7
2" Pipe (Mod 12 Vault to Mod 11 Vault)					
45	0	274	3.82	10.45	10.4
2" Pipe (Mod 11 Vault to Mod 10 Vault)					
45	0	252	3.82	9.61	9.6
2" Pipe (Mod 10 Vault to Leachate Tank Tee)					
45	0	936	3.82	35.76	35.8
2" Pipe (Leachate Tank Tee to Leachate Tank)					
45	0	79	3.82	3.00	3.0
				Total Dynamic Head (ft):	**103.3**

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Calculations (cont.):

Scenario 3A - Pump at Module 12 Sump Operating, Pumping from Mod 12 to Leachate Tank, all other pumps off

Assuming: 25 gpm pumping rate at Mod 12 Vault

Flowrate (GPM)	Static Head (Ft)	Equivalent Length (Ft)	Head Loss Per 100 Ft.	Head Loss (Ft)	Total Dynamic Head (Ft)
4" Pipe (Mod 12 Sump to Mod 12 Vault)					
25	20.5	767	0.06	0.46	21.0
2" Pipe (Mod 12 Vault to Mod 11 Vault)					
25	0	274	1.29	3.53	3.5
2" Pipe (Mod 11 Vault to Mod 10 Vault)					
25	0	252	1.29	3.24	3.2
2" Pipe (Mod 10 Vault to Leachate Tank Tee)					
25	0	936	1.29	12.07	12.1
2" Pipe (Leachate Tank Tee to Leachate Tank)					
25	0	79	1.29	1.01	1.0
				Total Dynamic Head (ft):	**40.8**

Scenario 3B - Pump at Module 12 Sump Operating, Pumping from Mod 12 to Leachate Tank, all other pumps off

Assuming: 35 gpm pumping rate at Mod 12 Vault

Flowrate (GPM)	Static Head (Ft)	Equivalent Length (Ft)	Head Loss Per 100 Ft.	Head Loss (Ft)	Total Dynamic Head (Ft)
4" Pipe (Mod 12 Sump to Mod 12 Vault)					
35	20.5	767	0.11	0.84	21.3
2" Pipe (Mod 12 Vault to Mod 11 Vault)					
35	0	274	2.40	6.56	6.6
2" Pipe (Mod 11 Vault to Mod 10 Vault)					
35	0	252	2.40	6.04	6.0
2" Pipe (Mod 10 Vault to Leachate Tank Tee)					
35	0	936	2.40	22.46	22.5
2" Pipe (Leachate Tank Tee to Leachate Tank)					
35	0	79	2.40	1.88	1.9
				Total Dynamic Head (ft):	**58.3**

Scenario 3C - Pump at Module 12 Sump Operating, Pumping from Mod 12 to Leachate Tank, all other pumps off

Assuming: 45 gpm pumping rate at Mod 12 Vault

Flowrate (GPM)	Static Head (Ft)	Equivalent Length (Ft)	Head Loss Per 100 Ft.	Head Loss (Ft)	Total Dynamic Head (Ft)
4" Pipe (Mod 12 Sump to Mod 12 Vault)					
45	20.5	767	0.17	1.30	21.8
2" Pipe (Mod 12 Vault to Mod 11 Vault)					
45	0	274	3.82	10.45	10.4
2" Pipe (Mod 11 Vault to Mod 10 Vault)					
45	0	252	3.82	9.61	9.6
2" Pipe (Mod 10 Vault to Leachate Tank Tee)					
45	0	936	3.82	35.76	35.8
2" Pipe (Leachate Tank Tee to Leachate Tank)					
45	0	79	3.82	3.00	3.0
				Total Dynamic Head (ft):	**80.6**

Calculations (cont.):

Scenario 4A - Pump at Module 11 Sump Operating, Pumping from Mod 11 to Leachate Tank, all other pumps off

Assuming: 30 gpm pumping rate at Mod 11 Vault

Flowrate (GPM)	Static Head (Ft)	Equivalent Length (Ft)	Head Loss Per 100 Ft.	Head Loss (Ft)	Total Dynamic Head (Ft)
4" Pipe (Mod 11 Sump to Mod 11 Vault)					
30	18.0	767	0.08	0.61	18.6
2" Pipe (Mod 11 Vault to Mod 10 Vault)					
30	0.0	252	1.80	4.53	4.5
2" Pipe (Mod 10 Vault to Leachate Tank Tee)					
30	0	936	1.80	16.85	16.8
2" Pipe (Leachate Tank Tee to Leachate Tank)					
30	0	79	1.80	1.41	1.4
				Total Dynamic Head (ft):	**41.4**

Scenario 4B - Pump at Module 11 Sump Operating, Pumping from Mod 11 to Leachate Tank, all other pumps off

Assuming: 40 gpm pumping rate at Mod 11 Vault

Flowrate (GPM)	Static Head (Ft)	Equivalent Length (Ft)	Head Loss Per 100 Ft.	Head Loss (Ft)	Total Dynamic Head (Ft)
4" Pipe (Mod 11 Sump to Mod 11 Vault)					
40	18.0	767	0.14	1.07	19.1
2" Pipe (Mod 11 Vault to Mod 10 Vault)					
40	0.0	252	3.07	7.72	7.7
2" Pipe (Mod 10 Vault to Leachate Tank Tee)					
40	0	936	3.07	28.74	28.7
2" Pipe (Leachate Tank Tee to Leachate Tank)					
40	0	79	3.07	2.41	2.4
				Total Dynamic Head (ft):	**57.9**

Scenario 4C - Pump at Module 11 Sump Operating, Pumping from Mod 11 to Leachate Tank, all other pumps off

Assuming: 50 gpm pumping rate at Mod 11 Vault

Flowrate (GPM)	Static Head (Ft)	Equivalent Length (Ft)	Head Loss Per 100 Ft.	Head Loss (Ft)	Total Dynamic Head (Ft)
4" Pipe (Mod 11 Sump to Mod 11 Vault)					
50	18.0	767	0.21	1.61	19.6
2" Pipe (Mod 11 Vault to Mod 10 Vault)					
50	0.0	252	4.64	11.67	11.7
2" Pipe (Mod 10 Vault to Leachate Tank Tee)					
50	0	936	4.64	43.43	43.4
2" Pipe (Leachate Tank Tee to Leachate Tank)					
50	0	79	4.64	3.64	3.6
				Total Dynamic Head (ft):	**78.4**

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Calculations (cont.):

Scenario 5A - Pump at Module 10 Sump Operating, Pumping from Mod 10 to Leachate Tank, all other pumps off

Assuming: 30 gpm pumping rate at Mod 10 Vault

Flowrate (GPM)	Static Head (Ft)	Equivalent Length (Ft)	Head Loss Per 100 Ft.	Head Loss (Ft)	Total Dynamic Head (Ft)
4" Pipe (Mod 10 Sump to Mod 10 Vault)					
30	18.7	767	0.08	0.61	19.3
2" Pipe (Mod 10 Vault to Leachate Tank Tee)					
30	0	936	1.80	16.85	16.8
2" Pipe (Leachate Tank Tee to Leachate Tank)					
30	0	79	1.80	1.41	1.4
				Total Dynamic Head (ft):	**37.6**

Scenario 5B - Pump at Module 10 Sump Operating, Pumping from Mod 10 to Leachate Tank, all other pumps off

Assuming: 40 gpm pumping rate at Mod 10 Vault

Flowrate (GPM)	Static Head (Ft)	Equivalent Length (Ft)	Head Loss Per 100 Ft.	Head Loss (Ft)	Total Dynamic Head (Ft)
4" Pipe (Mod 10 Sump to Mod 10 Vault)					
40	18.7	767	0.14	1.07	19.8
2" Pipe (Mod 10 Vault to Leachate Tank Tee)					
40	0	936	3.07	28.74	28.7
2" Pipe (Leachate Tank Tee to Leachate Tank)					
40	0	79	3.07	2.41	2.4
				Total Dynamic Head (ft):	**50.9**

Scenario 5C - Pump at Module 10 Sump Operating, Pumping from Mod 10 to Leachate Tank, all other pumps off

Assuming: 50 gpm pumping rate at Mod 10 Vault

Flowrate (GPM)	Static Head (Ft)	Equivalent Length (Ft)	Head Loss Per 100 Ft.	Head Loss (Ft)	Total Dynamic Head (Ft)
4" Pipe (Mod 10 Sump to Mod 10 Vault)					
50	18.7	767	0.21	1.61	20.3
2" Pipe (Mod 10 Vault to Leachate Tank Tee)					
50	0	936	4.64	43.43	43.4
2" Pipe (Leachate Tank Tee to Leachate Tank)					
50	0	79	4.64	3.64	3.6
				Total Dynamic Head (ft):	**67.4**

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Calculations (cont.):

Scenario 6A - Pump at Module 2 Sump Operating, Pumping from Mod 2 to Leachate Tank, all other pumps off

Assuming: 5 gpm pumping rate at Mod 2 Sump

Flowrate (GPM)	Static Head (Ft)	Equivalent Length (Ft)	Head Loss Per 100 Ft.	Head Loss (Ft)	Total Dynamic Head (Ft)
2" Pipe (Mod 2 Sump to Mod 1 Sump Tee)					
5	16.0	268	0.08	0.20	16.2
2" Pipe (Mod 1 Sump Tee to Leachate Tank Tee)					
5	0	110	0.08	0.08	0.1
2" Pipe (Leachate Tank Tee to Leachate Tank)					
5	0	79	0.08	0.06	0.1
				Total Dynamic Head (ft):	**16.3**

Scenario 6B - Pump at Module 2 Sump Operating, Pumping from Mod 2 to Leachate Tank, all other pumps off

Assuming: 25 gpm pumping rate at Mod 2 Sump

Flowrate (GPM)	Static Head (Ft)	Equivalent Length (Ft)	Head Loss Per 100 Ft.	Head Loss (Ft)	Total Dynamic Head (Ft)
2" Pipe (Mod 2 Sump to Mod 1 Sump Tee)					
25	16.0	268	1.29	3.46	19.5
2" Pipe (Mod 1 Sump Tee to Leachate Tank Tee)					
25	0	110	1.29	1.42	1.4
2" Pipe (Leachate Tank Tee to Leachate Tank)					
25	0	79	1.29	1.01	1.0
				Total Dynamic Head (ft):	**21.9**

Scenario 6C - Pump at Module 2 Sump Operating, Pumping from Mod 2 to Leachate Tank, all other pumps off

Assuming: 40 gpm pumping rate at Mod 2 Sump

Flowrate (GPM)	Static Head (Ft)	Equivalent Length (Ft)	Head Loss Per 100 Ft.	Head Loss (Ft)	Total Dynamic Head (Ft)
2" Pipe (Mod 2 Sump to Mod 1 Sump Tee)					
40	16.0	268	3.07	8.23	24.2
2" Pipe (Mod 1 Sump Tee to Leachate Tank Tee)					
40	0	110	3.07	3.38	3.4
2" Pipe (Leachate Tank Tee to Leachate Tank)					
40	0	79	3.07	2.41	2.4
				Total Dynamic Head (ft):	**30.0**

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Calculations (cont.):

Scenario 7A - All System Pumps (6) Operating, Pumping from Mod 2 Sump to Leachate Tank

Assuming: 5 gpm pumping rate at Mod 1, Mod 2
10 gpm at Mod 10 Vault, Mod 11 Vault, Mod 12 Vault, and Mod 13 Vault

Flowrate (GPM)	Static Head (Ft)	Equivalent Length (Ft)	Head Loss Per 100 Ft.	Head Loss (Ft)	Total Dynamic Head (Ft)
2" Pipe (Mod 2 Sump to Mod 1 Sump Tee)					
5	16.0	268	0.075	0.20	16.2
2" Pipe (Mod 1 Sump Tee to Leachate Tank Tee)					
10	0	110	0.24	0.26	0.3
2" Pipe (Leachate Tank Tee to Leachate Tank)					
50	0	79	4.64	3.64	3.6
				Total Dynamic Head (ft):	**20.1**

Scenario 7B - All System Pumps (6) Operating, Pumping from Mod 2 Sump to Leachate Tank

Assuming: 15 gpm pumping rate at Mod 1, Mod 2
10 gpm at Mod 10 Vault, Mod 11 Vault, Mod 12 Vault, and Mod 13 Vault

Flowrate (GPM)	Static Head (Ft)	Equivalent Length (Ft)	Head Loss Per 100 Ft.	Head Loss (Ft)	Total Dynamic Head (Ft)
2" Pipe (Mod 2 Sump to Mod 1 Sump Tee)					
15	16.0	268	0.5	1.34	17.3
2" Pipe (Mod 1 Sump Tee to Leachate Tank Tee)					
30	0	110	1.8	1.98	2.0
2" Pipe (Leachate Tank Tee to Leachate Tank)					
70	0	79	8.65	6.79	6.8
				Total Dynamic Head (ft):	**26.1**

Scenario 7C - All System Pumps (6) Operating, Pumping from Mod 2 Sump to Leachate Tank

Assuming: 30 gpm pumping rate at Mod 1, Mod 2
10 gpm at Mod 10 Vault, Mod 11 Vault, Mod 12 Vault, and Mod 13 Vault

Flowrate (GPM)	Static Head (Ft)	Equivalent Length (Ft)	Head Loss Per 100 Ft.	Head Loss (Ft)	Total Dynamic Head (Ft)
2" Pipe (Mod 2 Sump to Mod 1 Sump Tee)					
30	16.0	268	1.8	4.82	20.8
2" Pipe (Mod 1 Sump Tee to Leachate Tank Tee)					
60	0	110	6.5	7.15	7.2
2" Pipe (Leachate Tank Tee to Leachate Tank)					
100	0	79	16.75	13.15	13.1
				Total Dynamic Head (ft):	**41.1**

09/28/2023 - Classification: Internal - ECRM13153872

Engineering & Design Data

FLOW VELOCITY & FRICTION LOSS

SDR 13.5

Flow Rate (Gallons/ Minute)	cubic ft/sec	1/2" Velocity (ft/s)	1/2" Friction Head Loss (ft water/ 100ft)	1/2" Friction Pressure (psi/ 100ft)	3/4" Velocity (ft/s)	3/4" Friction Head Loss (ft water/ 100ft)	3/4" Friction Pressure (psi/ 100ft)	1" Velocity (ft/s)	1" Friction Head Loss (ft water/ 100ft)	1" Friction Pressure (psi/ 100ft)	1-1/4" Velocity (ft/s)	1-1/4" Friction Head Loss (ft water/ 100ft)	1-1/4" Friction Pressure (psi/ 100ft)	1-1/2" Velocity (ft/s)	1-1/2" Friction Head Loss (ft water/ 100ft)	1-1/2" Friction Pressure (psi/ 100ft)	2" Velocity (ft/s)	2" Friction Head Loss (ft water/ 100ft)	2" Friction Pressure (psi/ 100ft)	2-1/2" Velocity (ft/s)	2-1/2" Friction Head Loss (ft water/ 100ft)	2-1/2" Friction Pressure (psi/ 100ft)	3" Velocity (ft/s)	3" Friction Head Loss (ft water/ 100ft)	3" Friction Pressure (psi/ 100ft)	Flow Rate (Gallons/ Minute)
GPM		1/2"			3/4"			1"			1-1/4"			1-1/2"			2"			2-1/2"			3"			GPM
1	0.002	0.85	1.03	0.45	0.54	0.34	0.15																			1
2	0.004	1.69	2.05	0.89	1.07	0.68	0.29	0.68	0.40	0.17	0.42	0.13	0.06	0.32	0.065	0.028	0.20	0.03	0.013							2
5	0.011	4.22	11.58	5.01	2.68	3.82	1.65	1.69	1.24	0.54	1.05	0.39	0.17	0.80	0.20	0.088	0.51	0.075	0.033	0.35	0.038	0.016	0.24	0.02	0.009	5
7	0.016	5.91	21.24	9.20	3.75	7.01	3.03	2.36	2.28	0.99	1.47	0.72	0.31	1.12	0.37	0.16	0.72	0.125	0.054	0.49	0.53	0.023	0.33	0.03	0.012	7
10	0.022	8.44	40.46	17.52	5.35	13.34	5.78	3.37	4.33	1.87	2.10	1.37	0.59	1.60	0.71	0.31	1.02	0.24	0.10	0.70	0.09	0.039	0.47	0.04	0.017	10
15	0.033	4"			8.03	28.27	12.24	5.06	9.18	3.97	3.15	2.91	1.26	2.40	1.50	0.65	1.53	0.50	0.22	1.04	0.20	0.087	0.70	0.08	0.035	15
20	0.045	0.57	0.04	0.017	10.70	48.17	20.86	6.74	15.64	6.77	4.21	4.96	2.91	3.20	2.55	1.10	2.04	0.85	0.37	1.39	0.34	0.15	0.94	0.13	0.056	20
25	0.056	0.71	0.06	0.026	5"			8.43	23.65	10.24	5.26	7.49	3.24	4.00	3.85	1.67	2.55	1.29	0.56	1.74	0.51	0.22	1.17	0.190.	082	25
30	0.067	0.85	0.09	0.035	0.56	0.03	0.013	10.11	33.15	14.35	6.31	10.50	4.55	4.80	5.40	2.34	3.05	1.80	0.78	2.09	0.71	0.31	1.41	0.27	0.12	30
35	0.078	0.99	0.11	0.048	0.65	0.04	0.017				7.36	13.97	6.05	5.60	7.19	3.11	3.57	2.40	1.04	2.44	0.95	0.41	1.64	0.36	0.16	35
40	0.089	1.14	0.14	0.060	0.74	0.05	0.022				8.41	17.90	7.75	6.40	9.20	3.98	4.08	3.07	1.33	2.78	1.21	0.52	1.88	0.46	0.20	40
45	0.100	1.28	0.17	0.074	0.84	0.06	0.026	6"			9.46	22.26	9.64	7.20	11.44	4.95	4.59	3.82	1.65	3.13	1.51	0.65	2.11	0.58	0.25	45
50	0.111	1.42	0.21	0.091	0.93	0.07	0.030	0.69	0.03	0.013	10.52	27.05	11.71	8.00	13.91	6.02	5.10	4.64	2.01	3.48	1.83	0.79	2.35	0.70	0.30	50
60	0.134	1.70	0.29	0.13	1.12	0.10	0.043	0.79	0.04	0.017				9.60	19.50	8.44	6.12	6.50	2.81	4.18	2.57	1.11	2.82	0.98	0.42	60
70	0.156	1.99	0.38	0.16	1.30	0.14	0.061	0.92	0.06	0.026							7.14	8.65	3.75	4.87	3.42	1.48	3.29	1.31	0.57	70
75	0.167	2.13	0.44	0.19	1.40	0.16	0.069	0.98	0.07	0.030							7.65	9.83	4.26	5.22	3.88	1.68	3.52	1.49	0.65	75
80	0.178	2.27	0.49	0.21	1.49	0.18	0.078	1.05	0.08	0.035							8.16	11.08	4.80	5.57	4.37	1.89	3.76	1.68	0.73	80
90	0.201	2.56	0.61	0.26	1.67	0.22	0.095	1.18	0.09	0.039							9.18	13.78	5.97	6.27	5.44	2.36	4.23	2.09	0.90	90
100	0.223	2.84	0.74	0.32	1.86	0.27	0.12	1.31	0.11	0.048							10.20	16.75	7.25	6.96	6.61	2.86	4.70	2.54	1.10	100
125	0.279	3.55	1.13	0.49	2.33	0.40	0.18	1.64	0.17	0.074										8.70	10.01	4.33	5.88	3.84	1.66	125
150	0.334	4.26	1.58	0.68	2.79	0.56	0.24	1.97	0.24	0.10										10.44	14.01	6.07	7.04	5.37	2.33	150
175	0.390	4.97	2.10	0.91	3.26	0.75	0.33	2.30	0.32	0.14													8.22	7.15	3.10	175
200	0.446	5.68	2.69	1.16	3.72	0.96	0.42	2.62	0.41	0.18													9.39	9.15	3.96	200
250	0.557	7.10	4.07	1.76	4.66	1.46	0.63	3.28	0.62	0.27													11.74	13.86	6.00	250
300	0.668	8.52	5.69	2.46	5.58	2.03	0.88	3.93	0.87	0.38																300
350	0.780	9.94	7.58	3.29	6.52	2.70	1.17	4.59	1.16	0.50																350
400	0.891	11.36	9.70	4.20	7.44	3.46	1.50	5.24	1.48	0.64																400
450	1.003				8.37	4.31	1.87	5.90	1.84	0.80																450
500	1.114				9.30	5.24	2.27	6.56	2.23	0.97																500
750								9.83	4.73	2.05																750
1000	2.228							13.11	8.06	3.49																1000

NOTE: Spears® recommends that Flow Velocities be maintained at or below 5 feet per second in large diameter piping systems (i.e. 6" diameter and larger) to minimize the potential for hydraulic shock. Refer to Spears® engineering section entitled "Hydraulic Shock" for additional information. Friction loss data based on utilizing mean wall dimensions to determine average ID; actual ID may vary.

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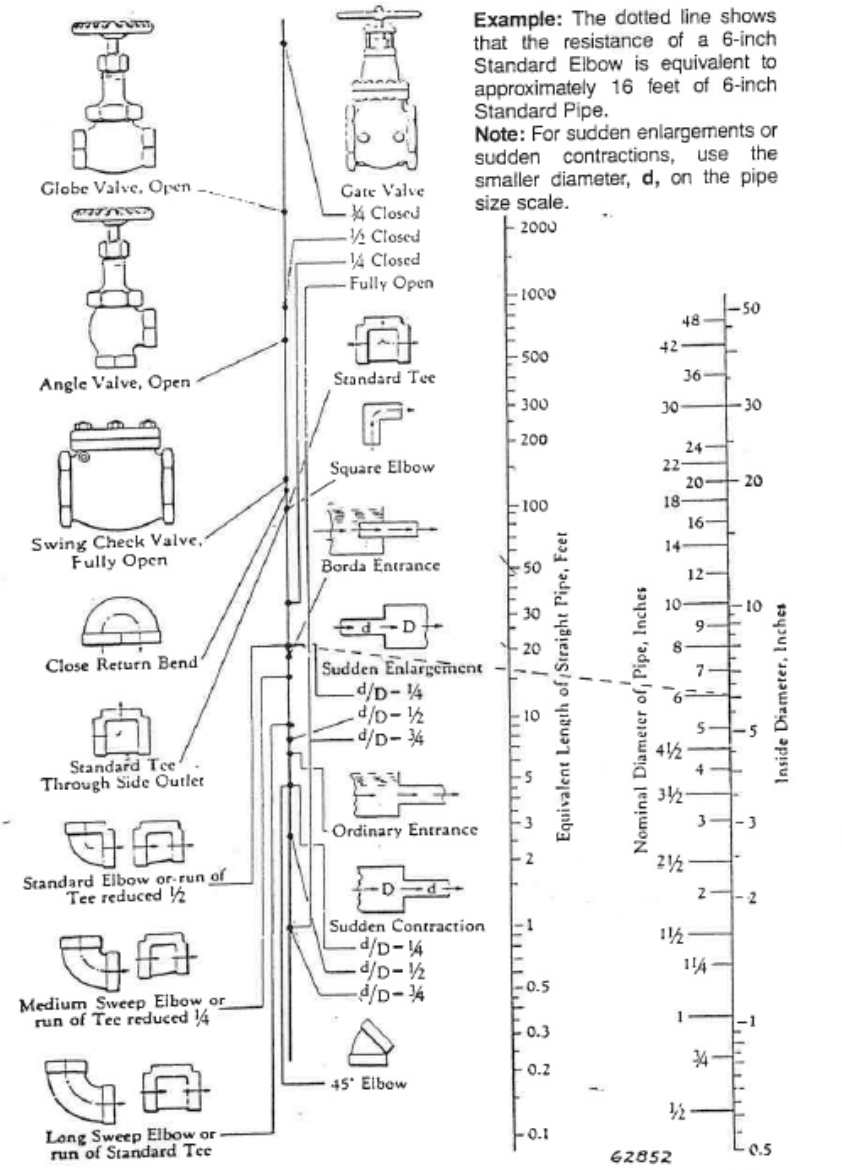
FRICTION-WATER-PIPE FITTINGS

Friction of Water *(Continued)*
Resistance of Valves and Fittings to Flow of Fluids in Equivalent Length of Pipe



From Crane Co. Technical Paper No. 409. Data based on the above chart are satisfactory for most applications; for more detailed data and information refer to pages 3-110 to page 3-120 which are based on Crane Co. Technical Paper No. 410.

3-121

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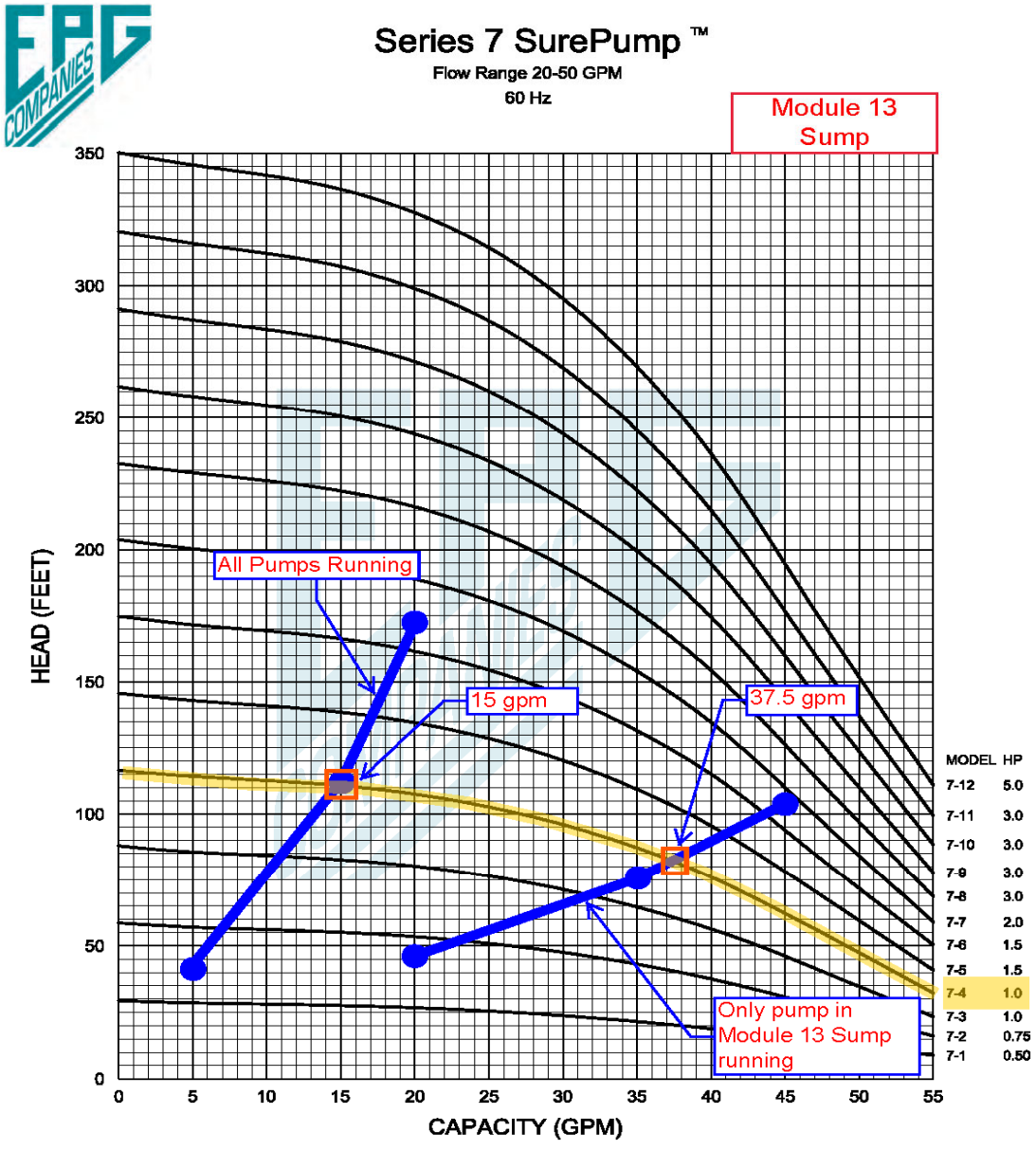

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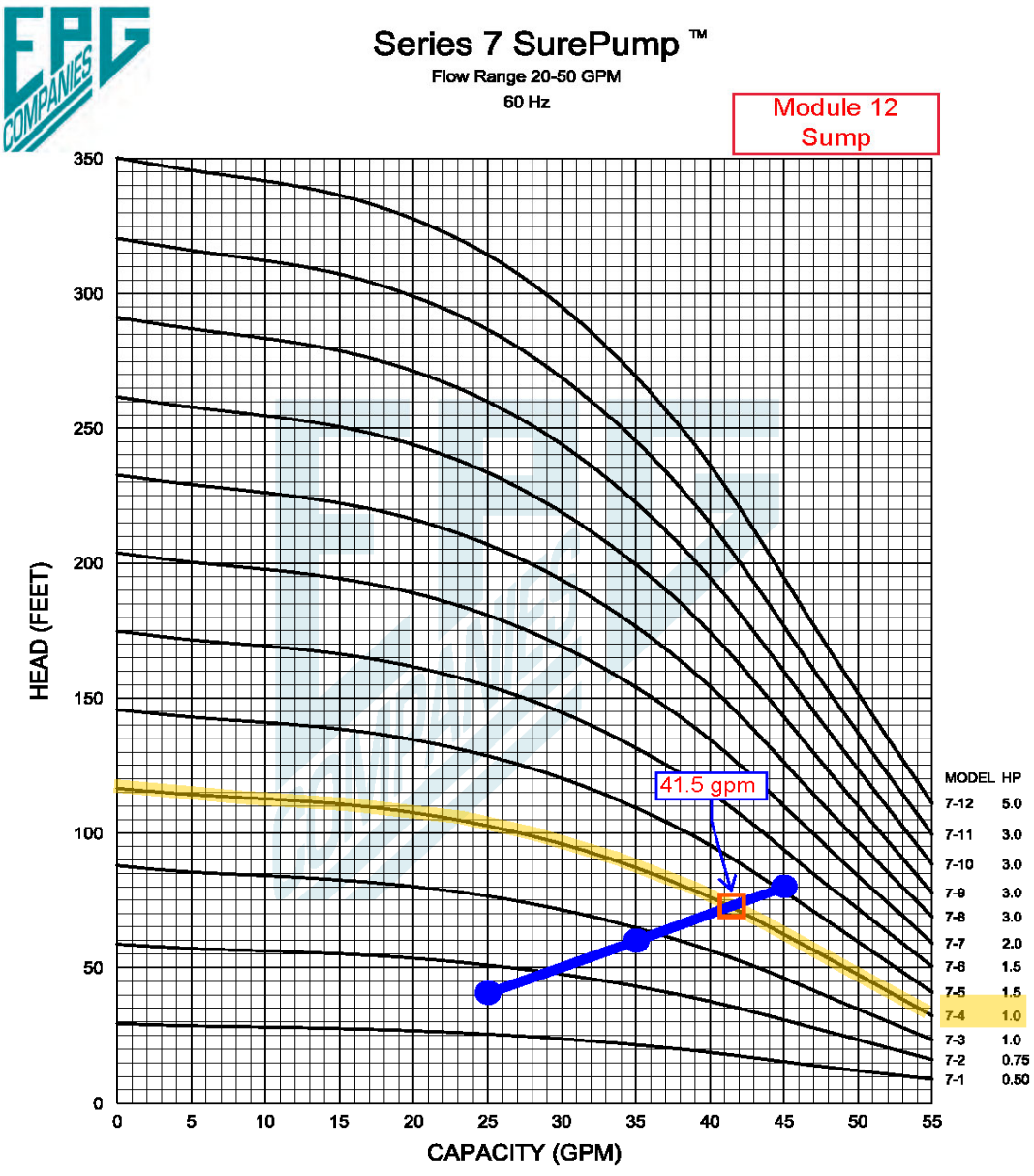

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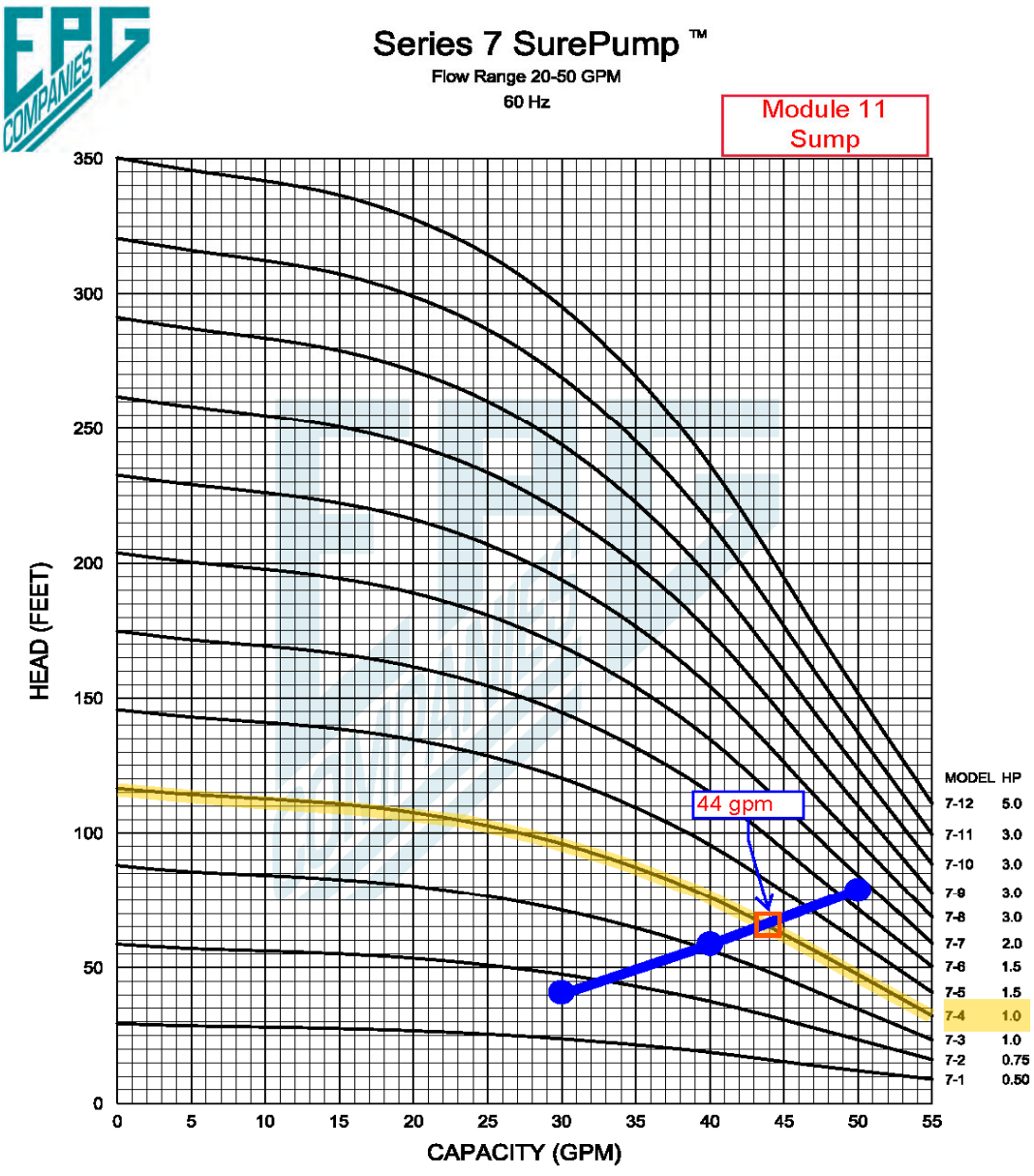

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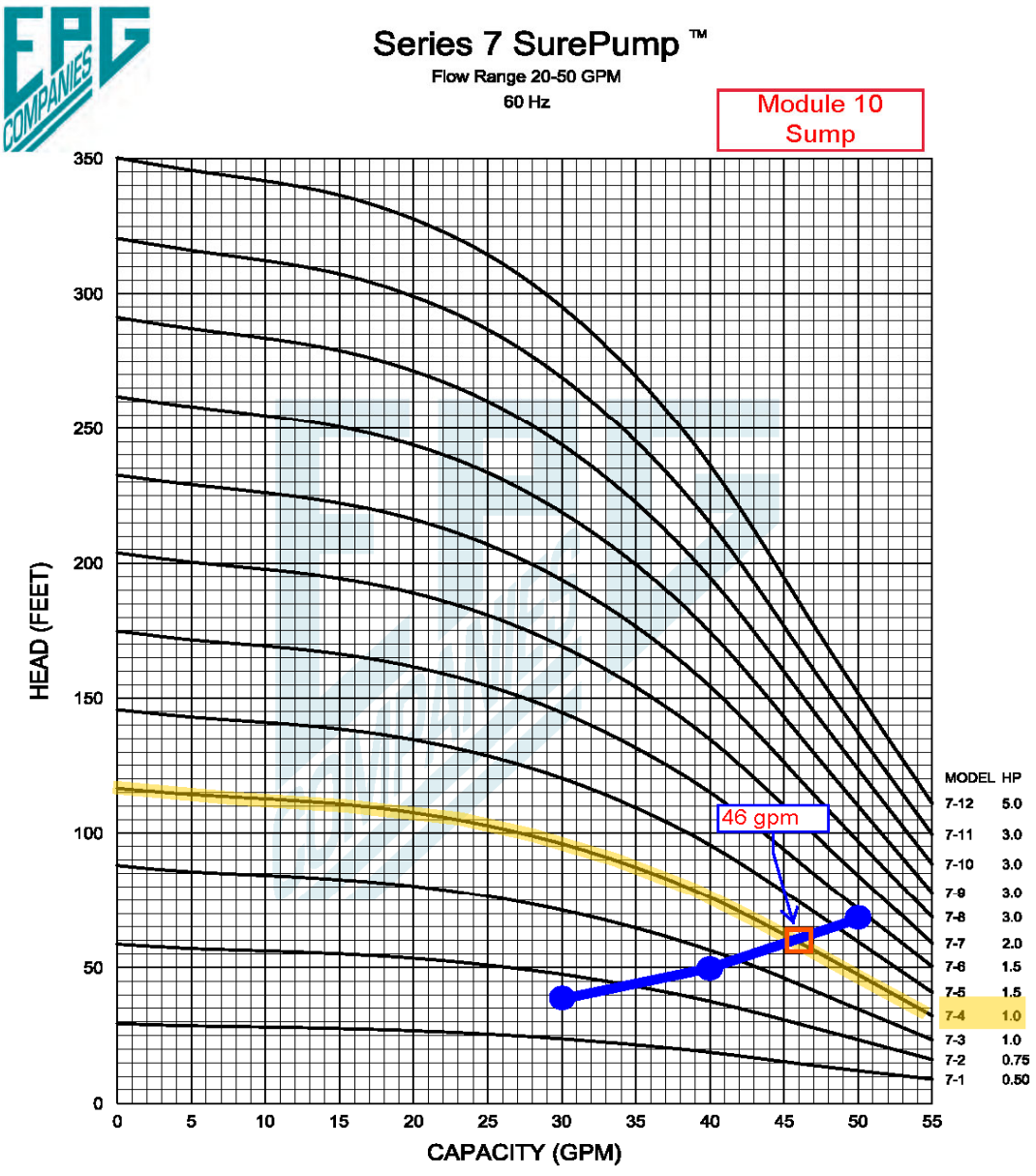

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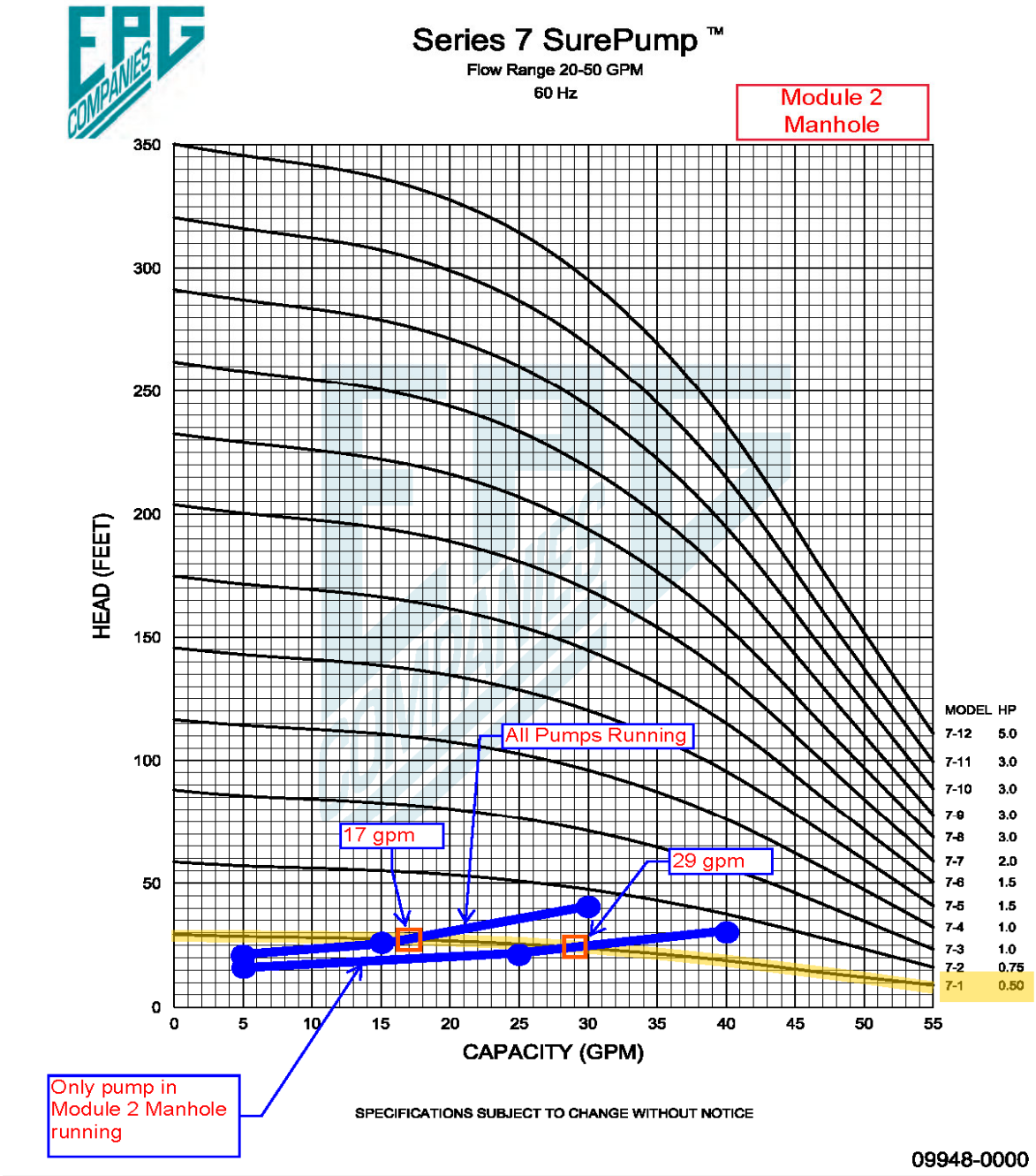

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09/28/2023 - Classification: Internal - ECRM13153872

SCS ENGINEERS

		Sheet No. 1 of 5	
		Calc. No.	
		Rev. No.	
Job No. 25222260.00	Job: Columbia Dry Ash Disposal Facility	By: MJT	Date: 8/31/23
Client: Wisconsin Power & Light	Subject: Sump Volume and Pump Capacity	Chk'd: KRG	Date: 9/1/23

Modules 1 and 2 Sump Volume and Pump Capacity Calculations

Purpose:

To demonstrate that the volume in the leachate sumps and the capacity of the sump pumps in Modules 1 and 2 will adequately control the leachate to maintain accumulation within the sump and intersecting collection trenches, in accordance with NR 512.12(3).

Approach:

Estimate the leachate generation rate to each sump assuming leachate collection rates specified by NR 512.12(3).

Calculate the sump volume based on the sump dimensions shown in the Plan of Operation plan set. The available volume is determined by calculating the volume between the pump on and off levels.

Determine the pumping intervals by dividing the available volume of the sump by the daily leachate generation rate. (This is the number of times the sump will fill and be required to be pumped on a daily basis.)

Identify commercially available pumps that can meet the required pumping interval calculated above.

Assumptions:

The sump for Module 1 will collect leachate from Module 1. The sump for Module 2 will collect leachate from Module 2.

Module 1 and 2 are covered with Final Cover and Intermediate Cover

	Module 1	Module 2
Final Cover (Acres)	5.67	0.12
Interm Cover (Acres)	2.61	3.81

The leachate generation rate during Interm Cover conditions is 6 inches per year, per NR NR 512.12(3)(a).

The leachate generation rate for Final Cover conditions is 1 inch per year per NR NR 512.12(3)(b).

Results:

The leachate generation rate for each sump during open/active conditions ranges from 293 to 1,711 gal/day. with the highest generation rate occurring in Module 2. Refer to Sheet 2 for the generation rates for each sump.

The functional capacity in the sumps, accounting for the pumping levels is 587 gallons.

Refer to Sheet 3 and 4 for the sump volume calculation.

The leachate sumps are adequately sized to handle the estimated worst-case leachate volume at Modules 1 and 2, with estimated filling times ranging from 10.3 hours to 60.2 hours (Sheet 3).

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Calculations:

Estimate an annual leachate collection volume based on a 6 inch per year generation rate for open conditions and an 1 inch per year generation rate for closed conditions.

Open Conditions

6 inches per year leachate collection rate:

Infiltration from precip=(6 in/year)x(1 ft/12 in)x(43,560 sf/ac)x(7.48 gal/cf)x(1 yr/365 day)= 446.3 gal/acre/day

Closed Conditions

1 inches per year leachate collection rate:

Infiltration from precip=(1 in/yr)x(1 ft/12 in)x(43,560 sf/ac)x(7.48 gal/cf)x(1 yr/365 day)= 74.4 gal/acre/day

Calculate the maximum leachate generation rate to each sump under open/active conditions and closed conditions.

Location	Average Leachate Collection Rate (gal/acre/day)	Area (acres)	Leachate Generation Rate (gal/day)
Current Condition			
Module 1 (Final Cover)	74.4	5.67	422
Module 1 (Interm Cover)	446.3	2.61	1,167
Module 1 Total			1,588
Module 2 (Final Cover)	74.4	0.12	9
Module 2 (Interm Cover)	446.3	3.81	1,702
Module 2 Total			1,711
Closed Condition			
Module 1	74.4	8.28	616
Module 2	74.4	3.93	293

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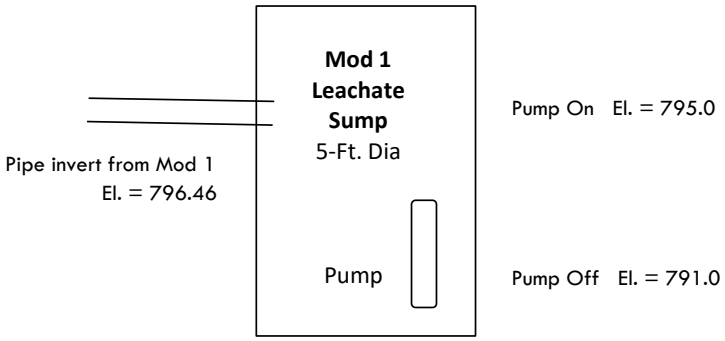
Sump Volumes

Sump (For Module 1)



5 Ft. Diameter Sump Volume = $\pi \times r^2 \times 7.48$ gal/cf
= $3.14 \times 2.5^2 \times 7.48$
= 147 gal/ft

Mod 1 Sump volume = 376 gal.ft x 4 ft
= 587 gal

Calculations:

	Available Volume in Mod 1 Sump (gals)	Leachate Generation Rate (gal/day)	Fill Time (hours)
Module 1 (Current Conditions)	587	1,588	8.9
Module 1 (Final Conditions)	587	616	22.9

Sump filling times provide adequate pump rest time during active conditions with open and closed conditions.

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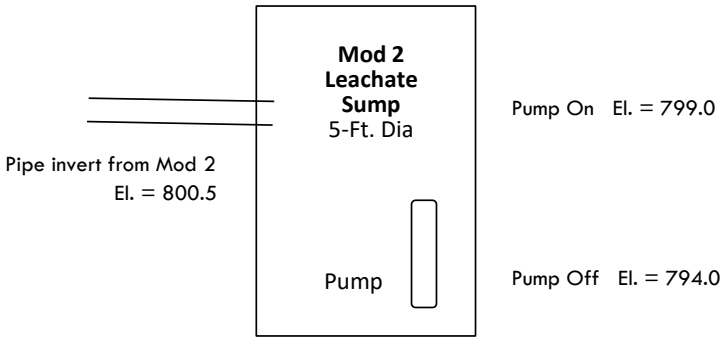
Sump Volumes

Sump (For Module 2)



5 Ft. Diameter Sump Volume = $\pi \times r^2 \times 7.48$ gal/cf
= $3.14 \times 2.5^2 \times 7.48$
= 147 gal/ft

Mod 2 Sump volume = 376 gal.ft x 5 ft
= 734 gal

Calculations:

	Available Volume in Mod 2 Sump (gals)	Leachate Generation Rate (gal/day)	Fill Time (hours)
Module 2 (Current Conditions)	734	1,711	10.3
Module 2 (Final Conditions)	734	293	60.2

Sump filling times provide adequate pump rest time during active conditions with open and closed conditions.

09/28/2023 - Classification: Internal - ECRM13153872

Calculations:

Determine preliminary pumping rates and times based on assumed sump filling rate

Filling rate (gpm) = Sump Volume (gal) / Sump Fill Time (hr) / 60 min/hr

Dewatering Time (hr) = Sump Volume (gal) / (Pumping Rate - Filling Rate (gpm)) / 60 min/hr

Pump Rest Time (hr) = Sump Fill Time (hr)

Mod 1 Sump - (assume pump will pump at 17 gpm with all pumps running, see pump sizing calculation)

	Available Sump Volume, gal	Sump Fill Time, hrs	Filling Rate, gpm	Pumping Rate, gpm	Dewatering Time, hrs	Pump Rest Time, hrs
Mod 1 (Current Conditions)	587	8.9	1.1	17.0	0.6	8.9
Mod 1 (Final Conditions)	587	22.9	0.4	17.0	0.6	22.9

Mod 2 Sump - (assume pump will pump at 17 gpm with all pumps running, see pump sizing calculation)

	Available Sump Volume, gal	Sump Fill Time, hrs	Filling Rate, gpm	Pumping Rate, gpm	Dewatering Time, hrs	Pump Rest Time, hrs
Mod 2 (Current Conditions)	587	10.3	1.0	17.0	0.6	10.3
Mod 2 (Final Conditions)	587	60.2	0.2	17.0	0.6	60.2

Conclusion:

The required pumping rates are readily achievable with available pumps, such as EPG Model 5 series.

09/28/2023 - Classification: Internal - ECRM13153872

SCS ENGINEERS

Sheet No.	1		
Calc. No.			
Rev. No.			
Job No. 25222260.00	Job: Columbia Dry Ash Disposal Facility	By: MJT	Date : 8/21/2023
Client: Wisconsin Power & Light	Subject: Leachate Storage Capacity	Chk'd KRG	Date: 8/24/23

Leachate Generated at the Site During Closed Conditions

Purpose:

To determine the amount of leachate storage required when the site is closed and final cover is installed. Leachate will be collected and pumped to a storage tank.

Approach:

Determine the area of final cover, use 1 inch/year for leachate generation per NR 512.12(3)(b).
Determine the leachate generated per day and the tank volume needed to store 4 days of leachate.

Assumptions:

The site is fully constructed (Modules 1 - 6, and 10 - 13 are constructed)
There is final cover on all Modules with a leachate generation rate of 1 inch/year

Calculations:

Entire Area of Filling (Final Cover):

Mod 1	8.28	acres	Mod 5	4.12	acres	Mod 11	3.48	acres
Mod 2	4.05	acres	Mod 6	3.79	acres	Mod 12	4.65	acres
Mod 3	3.98	acres	Mod 10	3.42	acres	Mod 13	2.48	acres
Mod 4	4.05	acres						
			Total:	**42.30**	**acres**			

Final Cover (Volume per day)

$$42.30 \text{ acres} \times 1 \frac{\text{in}}{\text{yr}} \times \frac{1 \text{ ft}}{12 \text{ in}} \times 43{,}560 \frac{\text{ft}^2}{\text{acre}} \times \frac{1 \text{ yr}}{365 \text{ days}}$$

$$= 420.7 \frac{\text{ft}^3}{\text{day}} \times 7.48 \frac{\text{gal}}{\text{ft}^3} = 3{,}147 \frac{\text{gallons}}{\text{day}} \times 4 \text{ days}$$

= 12,587 gallons

Results: 4 days of leachate production when the site is 100% covered in final cover requires a 15,000 gallon storage tank.

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Purpose:

To size the leachate loadout facility pump.

Approach:

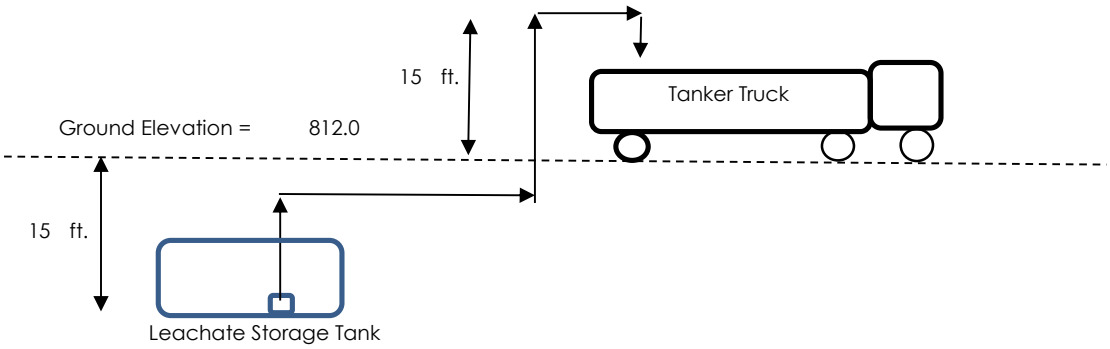
Determine the total dynamic head that the pump will operate against under various pumping rates.

The total dynamic head is a combination of the static head and friction losses from fittings and flow through the pipe.

Plot the resulting system curve on a representative pump curve to determine the suitability of a pump.

Calculations:

Pump System Layout



Assume 2.5 in. diameter pipe

Pipe Length = 75 ft.

Static Head

Tank Pump: Pump Off Elevation = 797.0 Assumes: 5 feet of cover over tank

10 feet tank diameter

Loadout Gantry Elev. = 827.0

Assumes: Gantry is 15 feet above the ground surface

Static Head = 827.0 - 797.0 = 30.0 feet

Results:

The Goulds Pump Model 2GFK3212G, 3.2 hp, 200V will pump at 138 gpm. (See Sheet 5)

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Calculations (cont.):

Fittings and Equivalent Length (see Sheet 4)

From Pump to Loadout	Eq. Length (ft)				Total Eq. Length (ft)
90° Elbows, 2.5"	3	X	10	=	30
Union Fitting, 2.5"	1	X	4	=	4
Check Valve, 2.5"	1	X	15	=	15
			Total:		49
Actual Length (2.5" Steel)					75
			Equivalent Length =		124

Flowrate (GPM)	Static Head (Ft)	Equivalent Length (Ft)	Head Loss Per 100 Ft.	Head Loss (Ft)	Total Dynamic Head (Ft)
2.5" Pipe (Pump to Loadout)					
75	30	124	3.88	4.81	34.8
100	30	124	6.61	8.20	38.2
125	30	124	10.01	12.41	42.4
150	30	124	14.01	17.37	47.4

09/28/2023 - Classification: Internal - ECRM13153872

Engineering & Design Data

FLOW VELOCITY & FRICTION LOSS

SDR 13.5

Flow Rate (Gallons/ Minute)	cubic ft/sec	Velocity (ft/s)	Friction Head Loss (ft water/ 100ft)	Friction Pressure (psi/ 100ft)	Velocity (ft/s)	Friction Head Loss (ft water/ 100ft)	Friction Pressure (psi/ 100ft)	Velocity (ft/s)	Friction Head Loss (ft water/ 100ft)	Friction Pressure (psi/ 100ft)	Velocity (ft/s)	Friction Head Loss (ft water/ 100ft)	Friction Pressure (psi/ 100ft)	Velocity (ft/s)	Friction Head Loss (ft water/ 100ft)	Friction Pressure (psi/ 100ft)	Velocity (ft/s)	Friction Head Loss (ft water/ 100ft)	Friction Pressure (psi/ 100ft)	Velocity (ft/s)	Friction Head Loss (ft water/ 100ft)	Friction Pressure (psi/ 100ft)	Velocity (ft/s)	Friction Head Loss (ft water/ 100ft)	Friction Pressure (psi/ 100ft)	Flow Rate (Gallons/ Minute)
GPM		1/2"			3/4"			1"			1-1/4"			1-1/2"			2"			2-1/2"			3"			GPM
1	0.002	0.85	1.03	0.45	0.54	0.34	0.15																				1
2	0.004	1.69	2.05	0.89	1.07	0.68	0.29	0.68	0.40	0.17	0.42	0.13	0.06	0.32	0.065	0.028	0.20	0.03	0.013								2
5	0.011	4.22	11.58	5.01	2.68	3.82	1.65	1.69	1.24	0.54	1.05	0.39	0.17	0.80	0.20	0.088	0.51	0.075	0.033	0.35	0.038	0.016	0.24	0.02	0.009	5
7	0.016	5.91	21.24	9.20	3.75	7.01	3.03	2.36	2.28	0.99	1.47	0.72	0.31	1.12	0.37	0.16	0.72	0.125	0.054	0.49	0.53	0.023	0.33	0.03	0.012	7
10	0.022	8.44	40.46	17.52	5.35	13.34	5.78	3.37	4.33	1.87	2.10	1.37	0.59	1.60	0.71	0.31	1.02	0.24	0.10	0.70	0.09	0.039	0.47	0.04	0.017	10
15	0.033	4"			8.03	28.27	12.24	5.06	9.18	3.97	3.15	2.91	1.26	2.40	1.50	0.65	1.53	0.50	0.22	1.04	0.20	0.087	0.70	0.08	0.035	15
20	0.045	0.57	0.04	0.017	10.70	48.17	20.86	6.74	15.64	6.77	4.21	4.96	2.91	3.20	2.55	1.10	2.04	0.85	0.37	1.39	0.34	0.15	0.94	0.13	0.056	20
25	0.056	0.71	0.06	0.026	5"			8.43	23.65	10.24	5.26	7.49	3.24	4.00	3.85	1.67	2.55	1.29	0.56	1.74	0.51	0.22	1.17	0.19 0.	082	25
30	0.067	0.85	0.08	0.035	0.56	0.03	0.013	10.11	33.15	14.35	6.31	10.50	4.55	4.80	5.40	2.34	3.05	1.80	0.78	2.09	0.71	0.31	1.41	0.27	0.12	30
35	0.078	0.99	0.11	0.048	0.65	0.04	0.017				7.36	13.97	6.05	5.60	7.19	3.11	3.57	2.40	1.04	2.44	0.95	0.41	1.64	0.36	0.16	35
40	0.089	1.14	0.14	0.060	0.74	0.05	0.022				8.41	17.90	7.75	6.40	9.20	3.98	4.08	3.07	1.33	2.78	1.21	0.52	1.88	0.46	0.20	40
45	0.100	1.28	0.17	0.074	0.84	0.06	0.026	6"			9.46	22.26	9.64	7.20	11.44	4.95	4.59	3.82	1.65	3.13	1.51	0.65	2.11	0.58	0.25	45
50	0.111	1.42	0.21	0.091	0.93	0.07	0.030	0.66	0.03	0.013	10.52	27.05	11.71	8.00	13.91	6.02	5.10	4.64	2.01	3.48	1.83	0.79	2.35	0.70	0.30	50
60	0.134	1.70	0.29	0.13	1.12	0.10	0.043	0.79	0.04	0.017				9.60	19.50	8.44	6.12	6.50	2.81	4.18	2.57	1.11	2.82	0.98	0.42	60
70	0.156	1.99	0.38	0.16	1.30	0.14	0.061	0.92	0.06	0.026							7.14	8.65	3.75	4.87	3.42	1.48	3.29	1.31	0.57	70
75	0.167	2.13	0.44	0.19	1.40	0.16	0.069	0.98	0.07	0.030							7.65	9.83	4.26	5.22	3.88	1.68	3.52	1.49	0.65	75
80	0.178	2.27	0.49	0.21	1.49	0.18	0.078	1.05	0.08	0.035							8.16	11.08	4.80	5.57	4.37	1.89	3.76	1.68	0.73	80
90	0.201	2.56	0.61	0.26	1.67	0.22	0.095	1.18	0.09	0.039							9.18	13.78	5.97	6.27	5.44	2.36	4.23	2.09	0.90	90
100	0.223	2.84	0.74	0.32	1.86	0.27	0.12	1.31	0.11	0.048							10.20	16.75	7.25	6.96	6.61	2.86	4.70	2.54	1.10	100
125	0.279	3.55	1.13	0.49	2.33	0.40	0.18	1.64	0.17	0.074										8.70	10.01	4.33	5.88	3.84	1.66	125
150	0.334	4.26	1.58	0.68	2.79	0.56	0.24	1.97	0.24	0.10										10.44	14.01	6.07	7.04	5.37	2.33	150
175	0.390	4.97	2.10	0.91	3.26	0.75	0.33	2.30	0.32	0.14													8.22	7.15	3.10	175
200	0.446	5.68	2.69	1.16	3.72	0.96	0.42	2.62	0.41	0.18													9.39	9.15	3.96	200
250	0.557	7.10	4.07	1.76	4.66	1.46	0.63	3.28	0.62	0.27													11.74	13.86	6.00	250
300	0.668	8.52	5.69	2.46	5.58	2.03	0.88	3.93	0.87	0.38																300
350	0.780	9.94	7.58	3.29	6.52	2.70	1.17	4.59	1.16	0.50																350
400	0.891	11.36	9.70	4.20	7.44	3.46	1.50	5.24	1.48	0.64																400
450	1.003				8.37	4.31	1.87	5.90	1.84	0.80																450
500	1.114				9.30	5.24	2.27	6.56	2.23	0.97																500
750								9.83	4.73	2.05																750
1000	2.228							13.11	8.06	3.49																1000

NOTE: Spears® recommends that Flow Velocities be maintained at or below 5 feet per second in large diameter piping systems (i.e. 6" diameter and larger) to minimize the potential for hydraulic shock. Refer to Spears® engineering section entitled "Hydraulic Shock" for additional information. Friction loss data based on utilizing mean wall dimensions to determine average ID; actual ID may vary.

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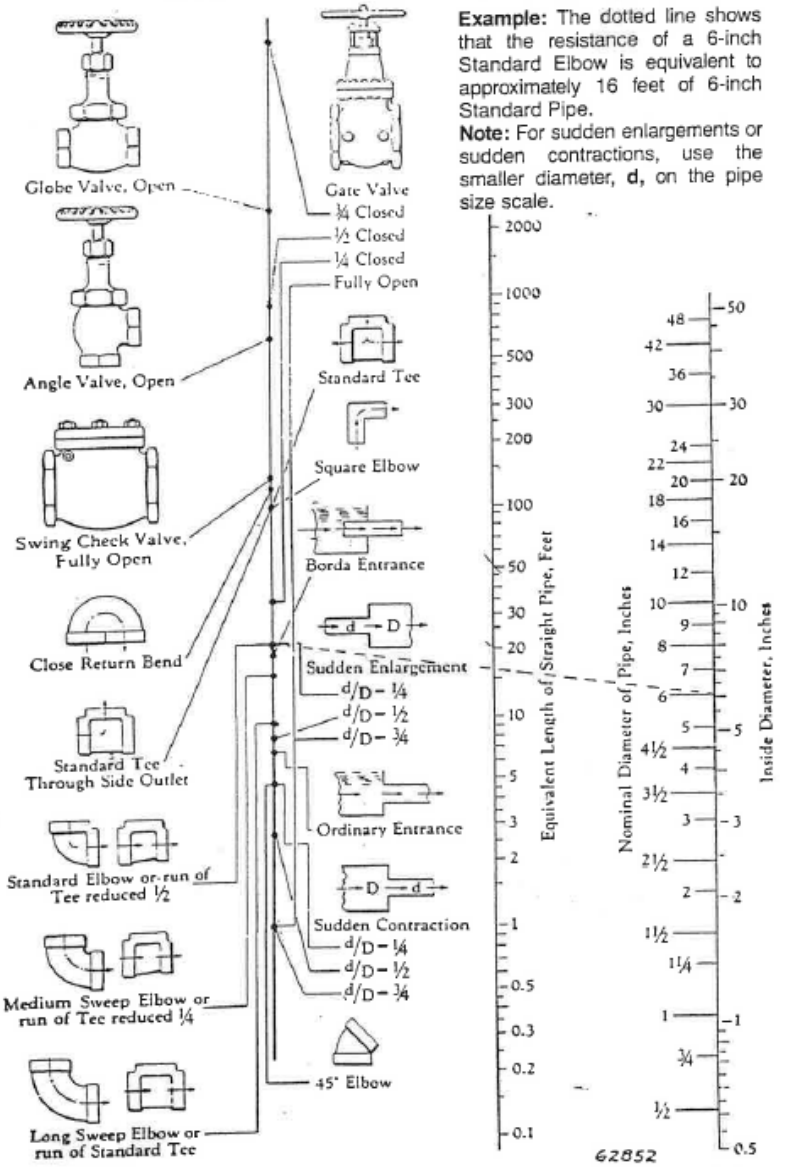
FRICTION-WATER-PIPE FITTINGS

Friction of Water *(Continued)*
Resistance of Valves and Fittings to Flow of Fluids in Equivalent Length of Pipe



From Crane Co. Technical Paper No. 409. Data based on the above chart are satisfactory for most applications; for more detailed data and information refer to pages 3-110 to page 3-120 which are based on Crane Co. Technical Paper No. 410.

3-121

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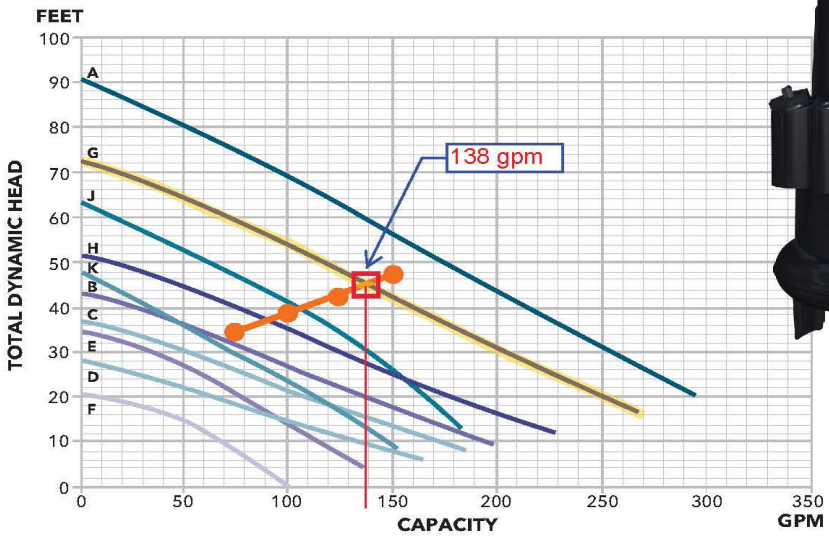
Wastewater

Goulds Water Technology Questions? Call 1-800-810-1053

2" GFK & GFV

Goulds Water Technology GFK Series Submersible Sewage Pump

PERFORMANCE CURVE



PRODUCT SPECIFICATIONS

GWT Part No.	Impeller Type	Curve ID	Voltage	HP	Rated Current
2GFV1212F	Vortex	F	200	1.2	3.8
2GFV1213F	Vortex	F	230	1.2	4
2GFV1214F	Vortex	F	460	1.2	2
2GFV1712E	Vortex	E	200	1.7	5.1
2GFV1713E	Vortex	E	230	1.7	5
2GFV1714E	Vortex	E	460	1.7	2.5
2GFV3212K	Vortex	K	200	3.2	9.8
2GFV3213K	Vortex	K	230	3.2	8.8
2GFV3214K	Vortex	K	460	3.2	4.4
2GFK1212D	K	D	200	1.2	3.8
2GFK1213D	K	D	230	1.2	4
2GFK1214D	K	D	460	1.2	2
2GFV3812J	Vortex	J	200	3.8	12
2GFV3813J	Vortex	J	230	3.8	10.2
2GFV3814J	Vortex	J	460	3.8	5.1

GWT Part No.	Impeller Type	Curve ID	Voltage	HP	Rated Current
2GFK1712C	K	C	200	1.7	5.1
2GFK1713C	K	C	230	1.7	5
2GFK1714C	K	C	460	1.7	2.5
2GFK1712B	K	B	200	1.7	5.1
2GFK1713B	K	B	230	1.7	5
2GFK1714B	K	B	460	1.7	2.5
2GFK2412H	K	H	200	2.4	7.7
2GFK2413H	K	H	230	2.4	7.2
2GFK2414H	K	H	460	2.4	3.6
2GFK3212G	K	G	200	3.2	9.8
2GFK3213G	K	G	230	3.2	8.8
2GFK3214G	K	G	460	3.2	4.4
2GFK3812A	K	A	200	3.8	12
2GFK3813A	K	A	230	3.8	10.2
2GFK3814A	K	A	460	3.8	5.1

Order Online: www.PumpCatalog.com

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SCS ENGINEERS

Sheet No.	1		
Calc. No.			
Rev. No.			
Job No. 25222260.00	Job: Columbia Dry Ash Disposal Facility	By: MJT	Date : 8/21/2023
Client: Wisconsin Power & Light	Subject: Leachate Generated over 4 Days	Chk'd: KRG	Date: 8/24/23

Leachate Generated at the Site During Open Conditions

Purpose:

To determine the volume of leachate generated over 4 days during open conditions and determine if the storage capacity of the Leachate Storage Pond is sufficient to contain the leachate.

Approach:

Estimate the leachate generated over 4 days assuming a leachate generation rate of 6 inches per year.
Determine the volume of storage available in the Leachate/Surface Water Pond based on the existing contours.

Assumptions:

The site is fully constructed (Modules 1 - 6, and 10 - 13 are constructed)
There is final cover on a portion of Module 1, which does not generate leachate.
There is final cover on the west side of Modules 2 through 4, which does not generate leachate.
The remainder of the site is considered open conditions, with a leachate generation rate of 6 inches/year.
The Leachate/Surface Water Pond can contain 194,617 cubic feet of water. (1,455,735 gallons)
The Leachate/Surface Water Pond has 0.5 feet of water in the pond prior to the start of storage and the top elevation of the pond storage area is at elevation 796.97 ft.

Calculations:

Areas of open conditions:

Mod 1	2.62	acres	Mod 5	4.12	acres	Mod 11	3.48	acres
Mod 2	2.38	acres	Mod 6	3.79	acres	Mod 12	4.65	acres
Mod 3	2.41	acres	Mod 10	3.42	acres	Mod 13	2.48	acres
Mod 4	2.65	acres						
			Total:	**32.00**	**acres**			

Leachate Generated in 4 days:

$$32.00 \text{ acres} \times 6 \frac{\text{in}}{\text{yr}} \times \frac{1 \text{ ft}}{12 \text{ in}} \times 43{,}560 \frac{\text{ft}^2}{\text{acre}} \times \frac{1 \text{ yr}}{365 \text{ days}}$$

$$= 1{,}909 \frac{\text{ft}^3}{\text{day}} \times 7.48 \frac{\text{gal}}{\text{ft}^3} = 14{,}283 \frac{\text{gallons}}{\text{day}} \times 4 \text{ days}$$

$$= 57{,}132 \text{ gallons}$$

Results: The Leachate/Surface Water Pond has adequate volume to contain 4 days of leachate generation.

Classification: Internal - ECRM13158872

SCS ENGINEERS

		Sheet No.	1/1
		Calc. No.	
		Rev. No.	
Job No. 25220183.00	Job: Columbia Dry Ash Disposal Facility	By: KRG	Date: 2/17/22
Client: Wisconsin Power & Light	Subject: Hydraulic Capacity of LCS Pipe	Chk'd: MRS	Date: 4/8/22

Pipe Capacity Calculation

Purpose:

To confirm the leachate conveyance pipe is adequately sized for the flows expected.

Approach:

Estimate the amount of leachate that will be conveyed to the leachate collection pipe based on the leachate collection rate of 6 inches per year (NR 504.06(5)(j)1).
(Reference Leachate Sump Volume and Pump Capacity Calculations for this part of calculation.)
Use Manning's equation to estimate the maximum flow capacity of the pipe.

Assumptions:

Leachate flow from Modules 4, 5, and 6 flows through Module 11 to a collection sump.

From Leachate Sump Sizing and Pump Capacity Calculations, the estimated peak average leachate collection rate during active life **446.3** gal/acre/day.

The largest drainage basin area to a leachate collection pipe is approximately **16.39** acres

6" dia. leachate collection pipes are proposed

The inner diameter of 6" dia. HDPE SDR 11 pipe is **5.348** = 0.45 ft

Calculations:

Convert estimated peak average leachate flow to cfs:

446 gal/acre/day x 16.39 acres/[(1,440 min/day x 60 sec/min x 7.48 gal/cf] = 0.01 cfs

Using Mannings equation, calculate pipe flow capacity: $Q_{max} = (1.49/n) \times A \times R^{2/3} \times S^{1/2}$

where:

Q_{max} = Maximum flow rate

n = Mannings coefficient = 0.010 plastic pipe

A = Area of pipe = $(\pi) \times D^2/4$ 0.16 sf 6" dia. .pipe

R = Hydraulic radius = Area / Wetted perimeter = D/4 = 0.111

S = slope = **0.005** ft/ft (0.5%)

$Q_{max} = (1.49/.01) \times (A) \times (R^{0.667}) \times (S^{0.5})$

Q_{max} = 0.38 cfs

Results:

The flow capacity of the 6" dia. leachate collection pipe is 0.38 cfs. The worst-case flow rate is 0.01 cfs. Therefore, the leachate collection pipe is adequately designed to accommodate the maximum flow rates expected to be generated at the site.

09/28/2023 - Classification: Internal - ECRM13153872

SCS ENGINEERS				
Job No.	25222260.00	SHEET NO.	1	
Job:	Columbia Energy Center	CALC. NO.		
Client	WPL	REV. NO.	2	
Subject	Module 12/13 - Leachate/Surface Water Pond Evaluation	BY	SJL	DATE 8/28/23
		CHK'D.	RJG	DATE 8/30/23

Purpose:

The purpose of the leachate/surface water pond evaluation is to determine the following based on the as-built leachate/surface water pond top of liner elevation of 796.97 (see Background section below):

- The maximum amount of open area during each filling phase in order to maintain the peak water elevation resulting from the 25-year, 24-hour storm event at the maximum allowable 796.97.
- Based on the amount of allowable open area determined from the above, determine the maximum starting water elevations in the leachate/surface water pond to accommodate 1, 2, 5, and 10-year, 24-hour storm events without overtopping.

Background:

- During construction of Module 2, the top of the leachate/surface water pond liner was determined to be at elevation 796.97.
- Previous calculations submitted to the WDNR on January 30, 2018 and March 10, 2021, evaluated the leachate/surface water pond capacity based on the as-built pond liner elevation.
- A similar evaluation was performed for Module 3 and 4 construction and then Module 5 and 6 construction that produced a chart of maximum leachate/surface water pond starting elevations vs. rainfall storage capacity.
- Module 10 and 11 were constructed in 2002 and CCR placement began in 2023.
- Module 12 and 13 will be constructed if additional airspace is required before the plant is closed.
- The Filling Phases 0 - 4 were previously submitted and approved by WDNR in 2022 as part of the Plan Modification Request - Plan of Operations Update that covered modules up to Module 10-11.

Approach:

- Use the previously developed HydroCAD storm water model to model the below four filling scenarios.
    1. Filling Phase 5 – Assumes portions of Module 11 and 12 are contributing to the leachate/surface water pond while material is placed from the pond closure and the plant. See **Figure 1** for filling grades and contributing area.
    2. Filling Phase 6 – Assumes portions of Module 12 and 13 are contributing to the leachate/surface water pond while material is placed from the pond closure and the plant. See **Figure 2** for filling grades and contributing area.

Assumptions:

- CCR surfaces and intermediate cover areas were assumed to be impermeable (CN=98).
- The top of pond liner elevation is 796.97 (see Background section).
- Time of Concentration is 20 minutes for open areas.

Results:

1. Maximum allowable open area and contact water sump area during filling of Module 12 and 13 is 8.51 acres.

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2. Filling Phase 5:
    - The contributing area of landfill to the leachate/surface water pond is 6.24 acres for the leachate/surface water pond to accommodate the runoff from a 25-year, 24-hour storm without overtopping. This acreage includes the open landfill area plus the contact water sump area.
    - The remainder of landfill would need to be closed/covered with final or intermediate cover and routed away from the pond.
    - **Figure 1** shows a proposed filling sequence, and **Figure 1a** shows the various operating levels of the leachate/surface water pond to accommodate the various storm events with the additional cover in place.

3. Filling Phase 6:
    - The contributing area of landfill to the leachate/surface water pond is 8.475 acres for the leachate/surface water pond to accommodate the runoff from a 25-year, 24-hour storm without overtopping. This acreage includes the open landfill area plus the contact water sump area.
    - The remainder of landfill would need to be closed/covered with final or intermediate cover and routed away from the pond.
    - **Figure 2** shows a proposed filling sequence, and **Figure 2a** shows the various operating levels of the leachate/surface water pond to accommodate the various storm events with the additional cover in place.

The HydroCAD reports for the maximum open contributing area, each scenario modeled are attached.

I:\25222260.00\Data and Calculations\Leachate\230728_Leachate_Surface Water Pond Evaluation_POO Calc writeup.docx

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540,500 N | 541,000 N | 541,500 N | 542,000 N | 542,500 N | 543,000 N | 543,500 N

2,123,500 E | 2,124,000 E | 2,124,500 E | 2,125,000 E

COAL PILE

SOUTH SEDIMENTATION BASIN

WPDES POND

EXISTING FINAL COVER

ESTIMATED INTERMEDIATE COVER

ACTIVE AREA
(ESTIMATED OPEN AREA 5.5 ACRES)

MODULE 12 LINER
(ESTIMATED 0.5 ACRES)

LEACHATE/ SURFACE WATER POND

C. M. ST. P. & P. RR.

MURRAY ROAD

MW-311 | MW-83 | SG-4 | MW-33AR | MW-33B | MW-34A | MW-34B | MW-88B | MW-88A | MW-85 | MW-85B | MW-302 | MW-5R | MW-310 | MW-309 | MW-92B | MW-92A | MW-37B | MW-37A | MW-91AR | MW-91B | LP-1 | MW-301 | MW-312 | MW-93B | MW-93A | MW-86 | MW-84A | MW-84B | MW-17

LS1

LH-10A | LH-10B | LH-11A | LH-11B

LEGEND

- DRY ASH DISPOSAL FACILITY LIMITS
- LIMITS OF WASTE
- FINAL COVER LIMITS
- PAVED ROAD
- UNPAVED ROAD
- VEGETATION
- FENCE
- EXISTING GRADE (10' INTERVAL)
- EXISTING GRADE (2' INTERVAL)
- SWALE
- EDGE OF WATER
- WETLAND
- PROPOSED GRADE (10' INTERVAL)
- PROPOSED GRADE (2' INTERVAL)
- PROPOSED PERIMETER ROAD
- PROPOSED SWALE
- PROPOSED CULVERT
- EXISTING FINAL COVER
- ESTIMATED INTERMEDIATE COVER
- ACTIVE FILLING AREA
- UNFILLED MODULE 12 LINER AREA FOR CONTACT WATER PUMPING

NOTES:

1. PROPOSED GRADES ARE CONCEPTUAL. ACTUAL GRADES WILL BE BASED ON PLANT OPERATIONS.

100 0 100

SCALE: 1" = 100'

N

L:\2023\23D_SW\Drawings\Figure 1-2 Filling Seq - 8-30-2023 10:45:47 AM

DRAWN BY: KP
CHECKED BY: RR/MRH
APPROVED BY: MRH 08/30/2023

PROJECT NO. 25222260.01
DRAWN: 07/24/2023
REVISED: 08/15/2023

Wisconsin Power and Light Company
WISCONSIN POWER AND LIGHT COLUMBIA ENERGY CENTER W8375 MURRAY ROAD PARDEEVILLE, WISCONSIN 53954

CLIENT

SCS ENGINEERS
2830 DAIRY DRIVE MADISON, WI 53718-6751
PHONE: (608) 224-2830

ENGINEER

PLAN OF OPERATION UPDATE
COLUMBIA ENERGY CENTER
COLUMBIA ASH DISPOSAL FACILITY
TOWN OF PACIFIC, WISCONSIN

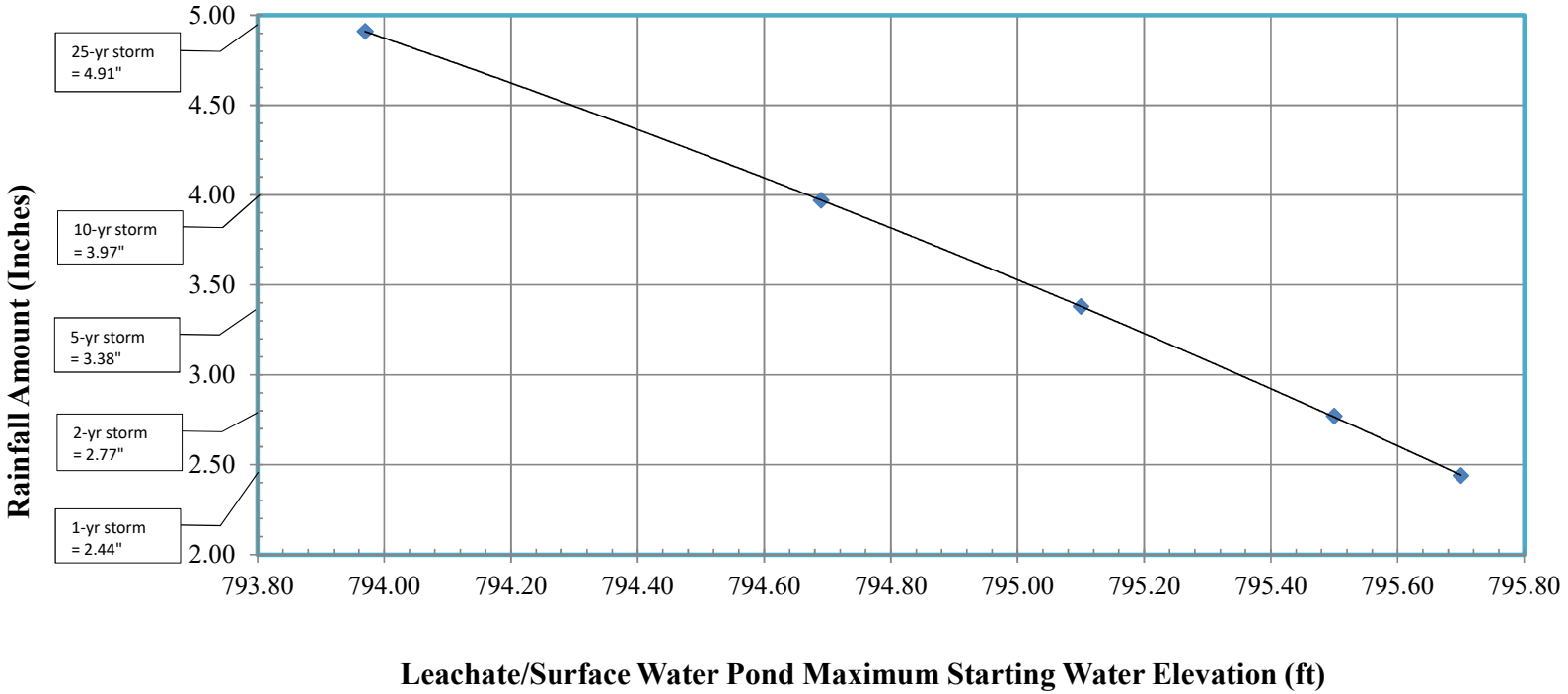
SITE

FILL SEQUENCE – MODULE 12

FIGURE 1

09/28/2023 - Classification: Internal - ECRM13153872

Figure 1A
Columbia Energy Center
Phase 5 Filling- Open Landfill Area
Leachate/Surface Water Pond Maximum Starting Water Elevation



Notes/Assumptions:

1. Maximum starting water elevations based on 2011 Mod 2 as-built survey which determined the top of pond liner elevation = 796.97.
2. Maximum starting water elevation assumes no freeboard.
3. Previously developed HydroCAD model utilized with curve number for intermediate cover areas and ash surfaces assumed at CN = 98.
4. HydroCAD model assumes drainage areas contributing to pond include (Figure 1):
   - Landfill open area plus contact water sump area = 6.24 acres.
   - Leachate/Surface Water Pond Area, 2.98 acres.
5. Maximum open area per HydroCAD model during filling is 8.51 acres.

I:\25220183.00\Data and Calculations\Leachate_Surface Water Pond Evaluation\Issued for Permitting_POO Update\

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540,500 N | 541,000 N | 541,500 N | 542,000 N | 542,500 N | 543,000 N | 543,500 N

2,123,500 E | 2,124,000 E | 2,124,500 E | 2,125,000 E

COAL PILE

SOUTH SEDIMENTATION BASIN

WPDES POND

LEACHATE/ SURFACE WATER POND

EXISTING FINAL COVER

ESTIMATED INTERMEDIATE COVER

ACTIVE AREA (ESTIMATED OPEN AREA 7.8 ACRES)

MODULE 13 LINER (ESTIMATED 0.7 ACRES)

C. M. ST. P. & P. RR.

MURRAY ROAD

MW-5R, MW-17, MW-83, MW-84A, MW-84B, MW-85, MW-85B, MW-86, MW-88A, MW-88B, MW-91AR, MW-91B, MW-92A, MW-92B, MW-93A, MW-93B, MW-301, MW-302, MW-309, MW-310, MW-311, MW-312, MW-33AR, MW-33B, MW-34A, MW-34B, MW-37A, MW-37B, SG-4, LP-1, LS

LH-10A, LH-10B, LH-11A, LH-11B

LEGEND

- DRY ASH DISPOSAL FACILITY LIMITS
- LIMITS OF WASTE
- FINAL COVER LIMITS
- PAVED ROAD
- UNPAVED ROAD
- VEGETATION
- FENCE
- 810 EXISTING GRADE (10' INTERVAL)
- EXISTING GRADE (2' INTERVAL)
- SWALE
- EDGE OF WATER
- WETLAND
- 800 PROPOSED GRADE (10' INTERVAL)
- 802 PROPOSED GRADE (2' INTERVAL)
- PROPOSED PERIMETER ROAD
- PROPOSED SWALE
- PROPOSED CULVERT
- EXISTING FINAL COVER
- ESTIMATED INTERMEDIATE COVER
- ACTIVE FILLING AREA
- UNFILLED MODULE 13 LINER AREA FOR CONTACT WATER PUMPING

NOTES:

1. PROPOSED GRADES ARE CONCEPTUAL. ACTUAL GRADES WILL BE BASED ON PLANT OPERATIONS.

100 0 100

SCALE: 1" = 100'

N

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PROJECT NO. 2522260.01
DRAWN: 07/24/2023
REVISED: 08/15/2023

DRAWN BY: KP
CHECKED BY: RR/MRH
APPROVED BY: MRH 08/30/2023

Wisconsin Power and Light Company

WISCONSIN POWER AND LIGHT COLUMBIA ENERGY CENTER W8375 MURRAY ROAD PARDEEVILLE, WISCONSIN 53954

CLIENT

SCS ENGINEERS
2830 DAIRY DRIVE MADISON, WI 53718-6751
PHONE: (608) 224-2830

ENGINEER

PLAN OF OPERATION UPDATE
COLUMBIA ENERGY CENTER
COLUMBIA COUNTY DISPOSAL FACILITY
TOWN OF PACIFIC, WISCONSIN

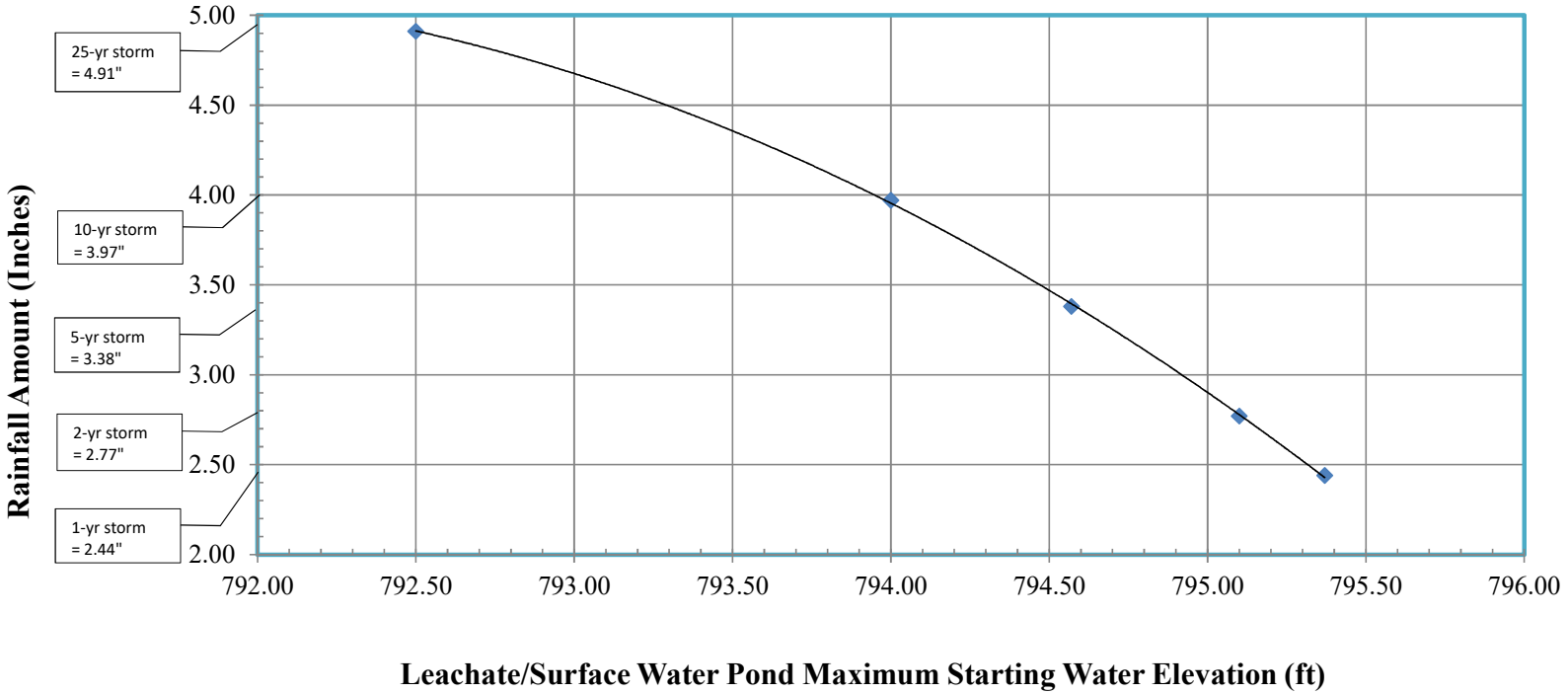
SITE

FILL SEQUENCE – MODULE 12 AND 13

FIGURE 2

09/28/2023 - Classification: Internal - ECRM13153872

Figure 2A
Columbia Energy Center
Phase 6 Filling- Open Landfill Area
Leachate/Surface Water Pond Maximum Starting Water Elevation

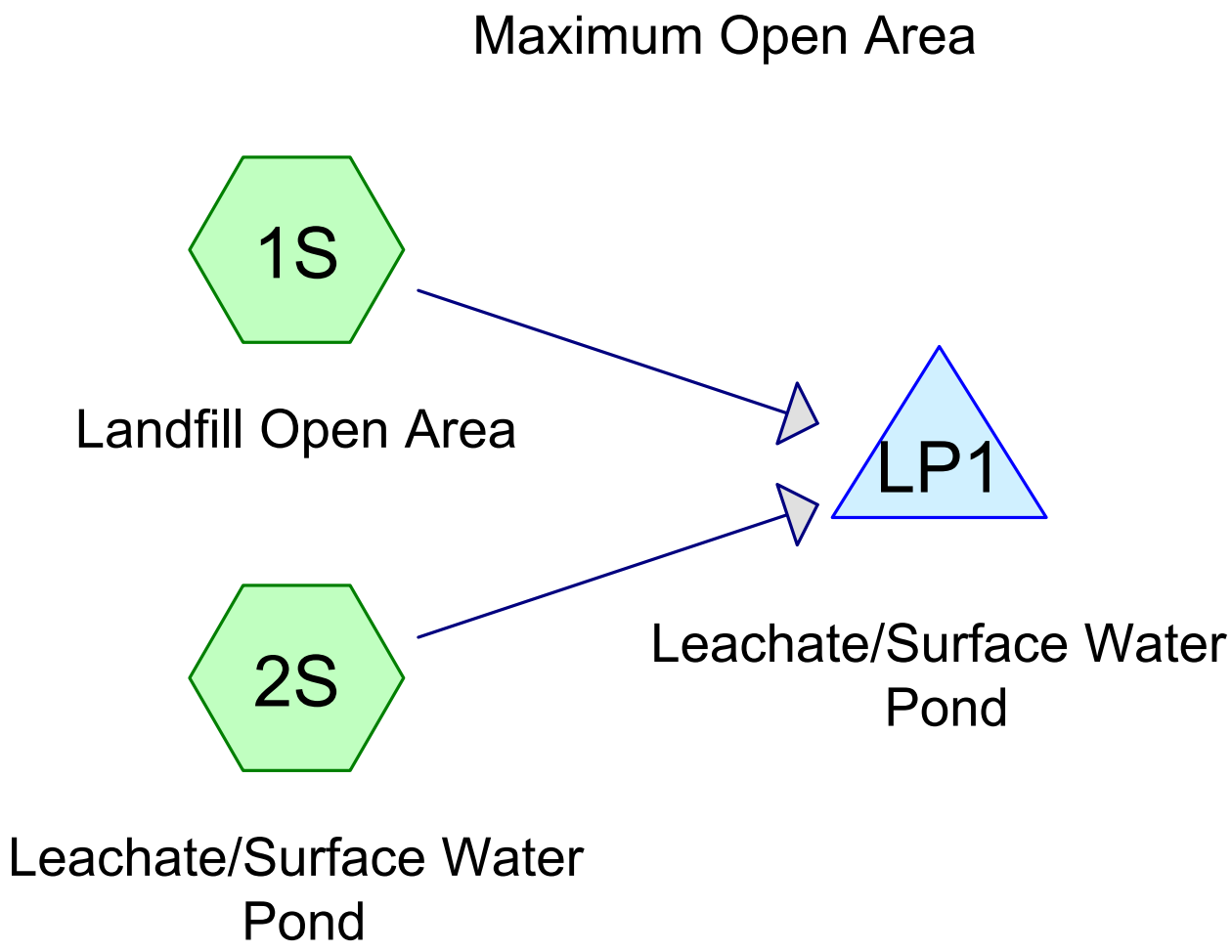


Notes/Assumptions:

1. Maximum starting water elevations based on 2011 Mod 2 as-built survey which determined the top of pond liner elevation = 796.97.
2. Maximum starting water elevation assumes no freeboard.
3. Previously developed HydroCAD model utilized with curve number for intermediate cover areas and ash surfaces assumed at CN = 98.
4. HydroCAD model assumes drainage areas contributing to pond include (Figure 2):
   - Landfill open area plus contact water sump area = 8.475 acres.
   - Leachate/Surface Water Pond Area, 2.98 acres.
5. Maximum open area per HydroCAD model during filling is 8.51 acres.

I:\25220183.00\Data and Calculations\Leachate_Surface Water Pond Evaluation\Issued for Permitting_POO Update\

09/28/2023 - Classification: Internal - ECRM13153872



Phase 12 Filling

Phase 13 Filling

Subcat Reach Pond Link

Routing Diagram for 230817_WPL Columbia_Leachate Pond Evaluation
Prepared by SCS Engineers, Printed 8/17/2023
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Rainfall Events Listing (selected events)

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	25-yr, 24-hr storm	MSE 24-hr	4	Default	24.00	1	4.91	2

Time span=0.00-33.00 hrs, dt=0.05 hrs, 661 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1S: Landfill Open Area Runoff Area=8.510 ac 100.00% Impervious Runoff Depth=4.67"
Tc=20.0 min CN=98 Runoff=34.73 cfs 3.314 af

Subcatchment2S: Leachate/Surface Runoff Area=2.980 ac 100.00% Impervious Runoff Depth=4.67"
Tc=0.0 min CN=98 Runoff=21.19 cfs 1.161 af

Pond LP1: Leachate/SurfaceWater Pond Peak Elev=796.97' Storage=197,946 cf Inflow=39.03 cfs 4.475 af
Outflow=0.00 cfs 0.000 af

Summary for Subcatchment 1S: Landfill Open Area

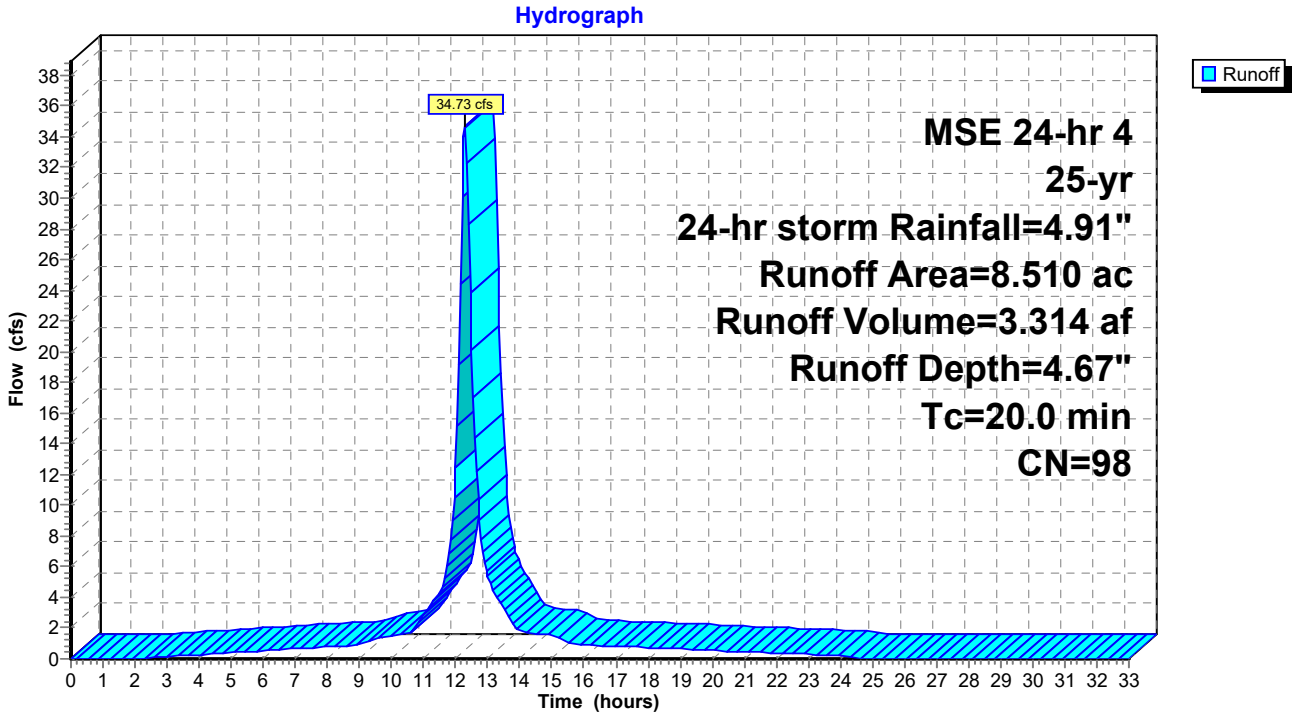
Runoff = 34.73 cfs @ 12.28 hrs, Volume= 3.314 af, Depth= 4.67"
Routed to Pond LP1 : Leachate/Surface Water Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr storm Rainfall=4.91"

	Area (ac)	CN	Description
*	8.510	98	Mod 2 - 11 Open Area
	8.510		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.0					**Direct Entry, Estimated**

Subcatchment 1S: Landfill Open Area



Summary for Subcatchment 2S: Leachate/Surface Water Pond

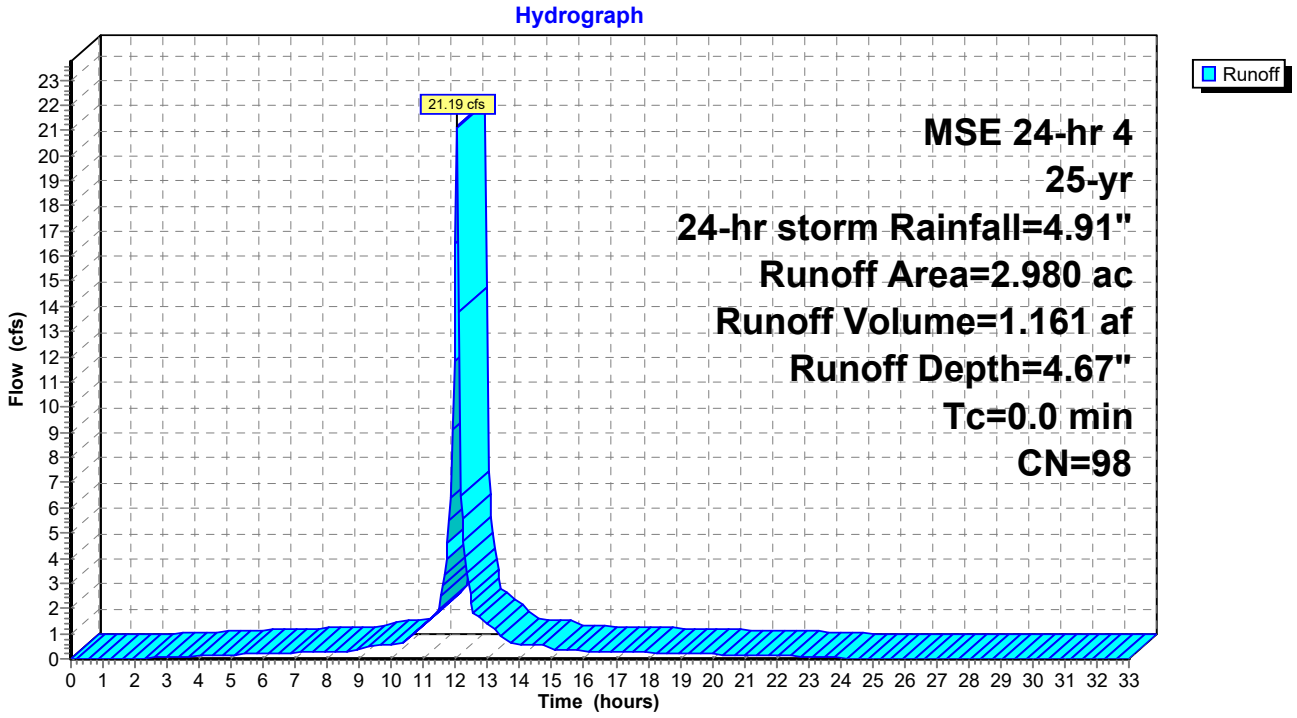
Runoff = 21.19 cfs @ 12.04 hrs, Volume= 1.161 af, Depth= 4.67"
Routed to Pond LP1 : Leachate/Surface Water Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr storm Rainfall=4.91"

	Area (ac)	CN	Description
*	2.980	98	Leachate Surface Water Pond
	2.980		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry,**

Subcatchment 2S: Leachate/Surface Water Pond



Summary for Pond LP1: Leachate/Surface Water Pond

Inflow Area = 11.490 ac,100.00% Impervious, Inflow Depth = 4.67" for 25-yr, 24-hr storm event
Inflow = 39.03 cfs @ 12.27 hrs, Volume= 4.475 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

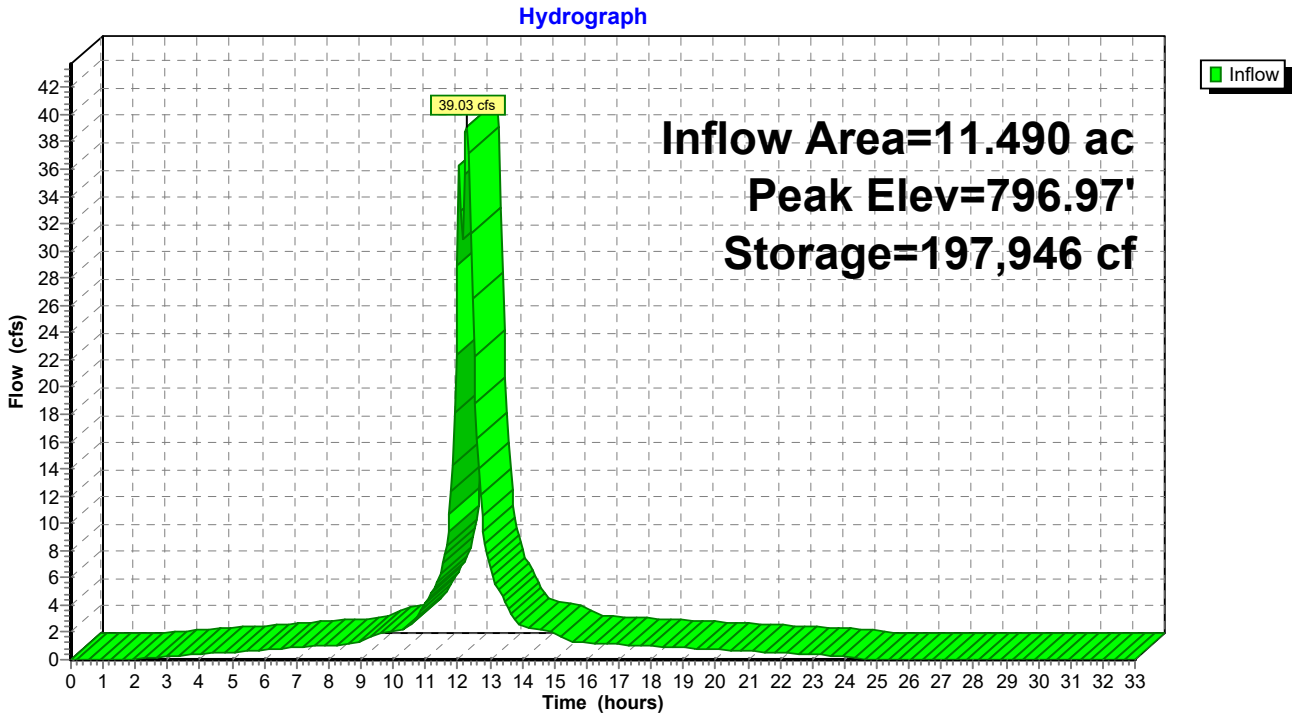
Routing by Stor-Ind method, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
Starting Elev= 792.50' Surf.Area= 11,070 sf Storage= 3,030 cf
Peak Elev= 796.97' @ 25.15 hrs Surf.Area= 61,611 sf Storage= 197,946 cf (194,915 cf above start)
Flood Elev= 796.97' Surf.Area= 61,588 sf Storage= 197,647 cf (194,617 cf above start)

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	792.00'	405,390 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

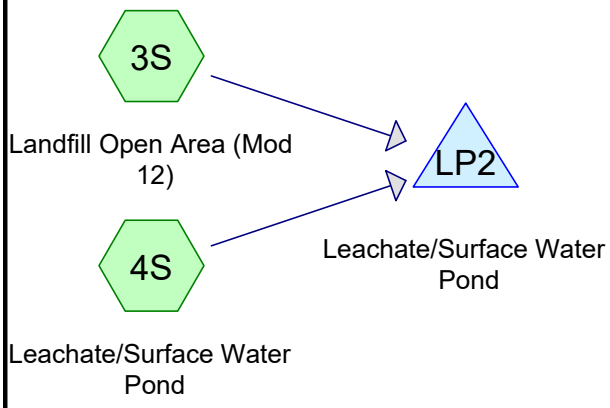
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
792.00	1,051	0	0
794.00	41,126	42,177	42,177
796.00	56,885	98,011	140,188
798.00	66,581	123,466	263,654
800.00	75,155	141,736	405,390

Pond LP1: Leachate/Surface Water Pond

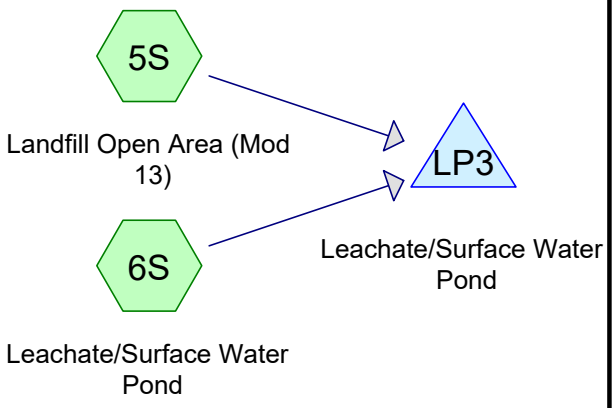


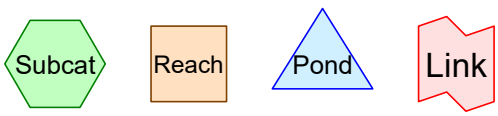
25-Year Storm Analysis

Phase 12 Filling



Phase 13 Filling





Routing Diagram for 230817_WPL Columbia_Leachate Pond Evaluation
Prepared by SCS Engineers, Printed 8/18/2023
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09/28/2023 - Classification: Internal - ECRM13153872

Rainfall Events Listing (selected events)

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	25-yr, 24-hr storm	MSE 24-hr	4	Default	24.00	1	4.91	2

Time span=0.00-33.00 hrs, dt=0.05 hrs, 661 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment3S: Landfill Open Area Runoff Area=6.240 ac 100.00% Impervious Runoff Depth=4.67"
Tc=20.0 min CN=98 Runoff=25.47 cfs 2.430 af

Subcatchment4S: Leachate/Surface Runoff Area=2.980 ac 100.00% Impervious Runoff Depth=4.67"
Tc=0.0 min CN=98 Runoff=21.19 cfs 1.161 af

Subcatchment5S: Landfill Open Area Runoff Area=8.475 ac 100.00% Impervious Runoff Depth=4.67"
Tc=20.0 min CN=98 Runoff=34.59 cfs 3.301 af

Subcatchment6S: Leachate/Surface Runoff Area=2.980 ac 100.00% Impervious Runoff Depth=4.67"
Tc=0.0 min CN=98 Runoff=21.19 cfs 1.161 af

Pond LP2: Leachate/SurfaceWater Pond Peak Elev=796.97' Storage=197,360 cf Inflow=32.30 cfs 3.591 af
Outflow=0.00 cfs 0.000 af

Pond LP3: Leachate/SurfaceWater Pond Peak Elev=796.97' Storage=197,353 cf Inflow=38.89 cfs 4.461 af
Outflow=0.00 cfs 0.000 af

09/28/2023 - Classification: Internal - ECRM13153872

Summary for Subcatchment 3S: Landfill Open Area (Mod 12)

Runoff = 25.47 cfs @ 12.28 hrs, Volume= 2.430 af, Depth= 4.67"
Routed to Pond LP2 : Leachate/Surface Water Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr storm Rainfall=4.91"

	Area (ac)	CN	Description
*	6.240	98	Mod 12 Open Area
	6.240		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.0					**Direct Entry, Estimated**

Summary for Subcatchment 4S: Leachate/Surface Water Pond

Runoff = 21.19 cfs @ 12.04 hrs, Volume= 1.161 af, Depth= 4.67"
Routed to Pond LP2 : Leachate/Surface Water Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr storm Rainfall=4.91"

	Area (ac)	CN	Description
*	2.980	98	Leachate Surface Water Pond
	2.980		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry,**

Summary for Subcatchment 5S: Landfill Open Area (Mod 13)

Runoff = 34.59 cfs @ 12.28 hrs, Volume= 3.301 af, Depth= 4.67"
Routed to Pond LP3 : Leachate/Surface Water Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr storm Rainfall=4.91"

	Area (ac)	CN	Description
*	8.475	98	Mod 13 Open Area
	8.475		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.0					**Direct Entry, Estimated**

09/28/2023 - Classification: Internal - ECRM13153872

Summary for Subcatchment 6S: Leachate/Surface Water Pond

Runoff = 21.19 cfs @ 12.04 hrs, Volume= 1.161 af, Depth= 4.67"
Routed to Pond LP3 : Leachate/Surface Water Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr storm Rainfall=4.91"

	Area (ac)	CN	Description
*	2.980	98	Leachate Surface Water Pond
	2.980		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry,**

Summary for Pond LP2: Leachate/Surface Water Pond

Inflow Area = 9.220 ac,100.00% Impervious, Inflow Depth = 4.67" for 25-yr, 24-hr storm event
Inflow = 32.30 cfs @ 12.06 hrs, Volume= 3.591 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
Starting Elev= 793.97' Surf.Area= 40,525 sf Storage= 40,952 cf
Peak Elev= 796.97' @ 25.15 hrs Surf.Area= 61,565 sf Storage= 197,360 cf (156,408 cf above start)
Flood Elev= 796.97' Surf.Area= 61,588 sf Storage= 197,647 cf (156,695 cf above start)

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	792.00'	405,390 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
792.00	1,051	0	0
794.00	41,126	42,177	42,177
796.00	56,885	98,011	140,188
798.00	66,581	123,466	263,654
800.00	75,155	141,736	405,390

Summary for Pond LP3: Leachate/Surface Water Pond

Inflow Area = 11.455 ac,100.00% Impervious, Inflow Depth = 4.67" for 25-yr, 24-hr storm event
Inflow = 38.89 cfs @ 12.27 hrs, Volume= 4.461 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs

09/28/2023 - Classification: Internal - ECRM13153872

Starting Elev= 792.50' Surf.Area= 11,070 sf Storage= 3,030 cf
Peak Elev= 796.97' @ 25.15 hrs Surf.Area= 61,564 sf Storage= 197,353 cf (194,323 cf above start)
Flood Elev= 796.97' Surf.Area= 61,588 sf Storage= 197,647 cf (194,617 cf above start)

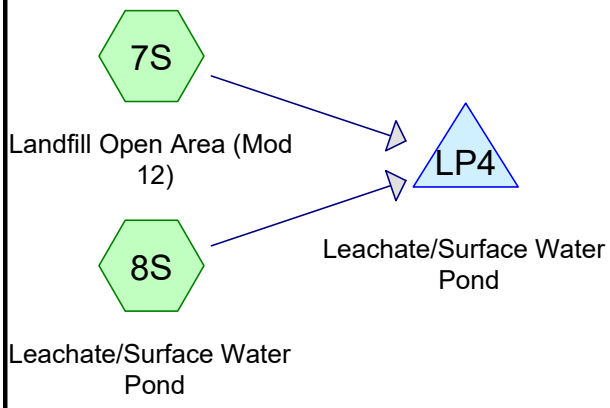
Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	792.00'	405,390 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

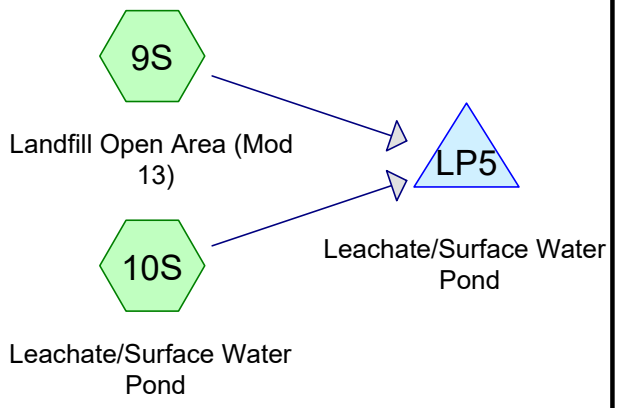
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
792.00	1,051	0	0
794.00	41,126	42,177	42,177
796.00	56,885	98,011	140,188
798.00	66,581	123,466	263,654
800.00	75,155	141,736	405,390

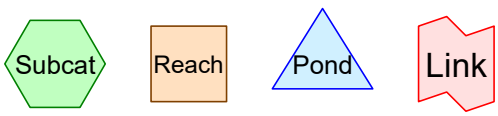
10-Year Storm Analysis

Phase 12 Filling



Phase 13 Filling





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Rainfall Events Listing (selected events)

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	10-yr, 24-hr storm	MSE 24-hr	4	Default	24.00	1	3.97	2

Time span=0.00-33.00 hrs, dt=0.05 hrs, 661 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment7S: Landfill Open Area Runoff Area=6.240 ac 100.00% Impervious Runoff Depth=3.74"
Tc=20.0 min CN=98 Runoff=20.53 cfs 1.942 af

Subcatchment8S: Leachate/Surface Runoff Area=2.980 ac 100.00% Impervious Runoff Depth=3.74"
Tc=0.0 min CN=98 Runoff=17.09 cfs 0.928 af

Subcatchment9S: Landfill Open Area Runoff Area=8.475 ac 100.00% Impervious Runoff Depth=3.74"
Tc=20.0 min CN=98 Runoff=27.88 cfs 2.638 af

Subcatchment10S: Leachate/Surface Runoff Area=2.980 ac 100.00% Impervious Runoff Depth=3.74"
Tc=0.0 min CN=98 Runoff=17.09 cfs 0.928 af

Pond LP4: Leachate/SurfaceWater Pond Peak Elev=796.97' Storage=197,440 cf Inflow=26.02 cfs 2.870 af
Outflow=0.00 cfs 0.000 af

Pond LP5: Leachate/SurfaceWater Pond Peak Elev=796.97' Storage=197,491 cf Inflow=31.34 cfs 3.566 af
Outflow=0.00 cfs 0.000 af

09/28/2023 - Classification: Internal - ECRM13153872

Summary for Subcatchment 7S: Landfill Open Area (Mod 12)

Runoff = 20.53 cfs @ 12.29 hrs, Volume= 1.942 af, Depth= 3.74"
Routed to Pond LP4 : Leachate/Surface Water Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 10-yr, 24-hr storm Rainfall=3.97"

	Area (ac)	CN	Description
*	6.240	98	Mod 12 Open Area
	6.240		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.0					**Direct Entry, Estimated**

Summary for Subcatchment 8S: Leachate/Surface Water Pond

Runoff = 17.09 cfs @ 12.04 hrs, Volume= 0.928 af, Depth= 3.74"
Routed to Pond LP4 : Leachate/Surface Water Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 10-yr, 24-hr storm Rainfall=3.97"

	Area (ac)	CN	Description
*	2.980	98	Leachate Surface Water Pond
	2.980		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry,**

Summary for Subcatchment 9S: Landfill Open Area (Mod 13)

Runoff = 27.88 cfs @ 12.29 hrs, Volume= 2.638 af, Depth= 3.74"
Routed to Pond LP5 : Leachate/Surface Water Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 10-yr, 24-hr storm Rainfall=3.97"

	Area (ac)	CN	Description
*	8.475	98	Mod 13 Open Area
	8.475		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.0					**Direct Entry, Estimated**

09/28/2023 - Classification: Internal - ECRM13153872

Summary for Subcatchment 10S: Leachate/Surface Water Pond

Runoff = 17.09 cfs @ 12.04 hrs, Volume= 0.928 af, Depth= 3.74"
Routed to Pond LP5 : Leachate/Surface Water Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 10-yr, 24-hr storm Rainfall=3.97"

	Area (ac)	CN	Description
*	2.980	98	Leachate Surface Water Pond
	2.980		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry,**

Summary for Pond LP4: Leachate/Surface Water Pond

Inflow Area = 9.220 ac,100.00% Impervious, Inflow Depth = 3.74" for 10-yr, 24-hr storm event
Inflow = 26.02 cfs @ 12.06 hrs, Volume= 2.870 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
Starting Elev= 794.69' Surf.Area= 46,563 sf Storage= 72,430 cf
Peak Elev= 796.97' @ 25.15 hrs Surf.Area= 61,571 sf Storage= 197,440 cf (125,010 cf above start)
Flood Elev= 796.97' Surf.Area= 61,588 sf Storage= 197,647 cf (125,218 cf above start)

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	792.00'	405,390 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
792.00	1,051	0	0
794.00	41,126	42,177	42,177
796.00	56,885	98,011	140,188
798.00	66,581	123,466	263,654
800.00	75,155	141,736	405,390

Summary for Pond LP5: Leachate/Surface Water Pond

Inflow Area = 11.455 ac,100.00% Impervious, Inflow Depth = 3.74" for 10-yr, 24-hr storm event
Inflow = 31.34 cfs @ 12.27 hrs, Volume= 3.566 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs

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Starting Elev= 794.00' Surf.Area= 41,126 sf Storage= 42,177 cf
Peak Elev= 796.97' @ 25.15 hrs Surf.Area= 61,575 sf Storage= 197,491 cf (155,314 cf above start)
Flood Elev= 796.97' Surf.Area= 61,588 sf Storage= 197,647 cf (155,470 cf above start)

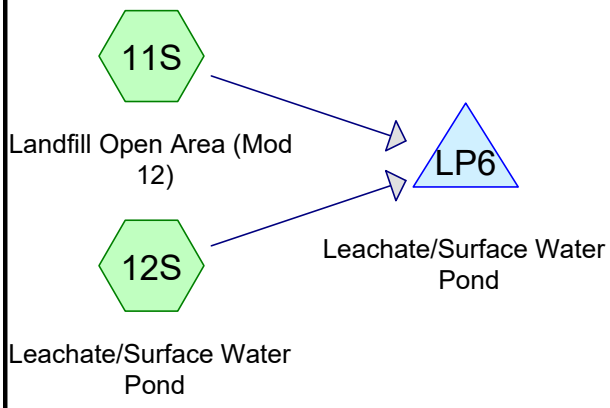
Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	792.00'	405,390 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

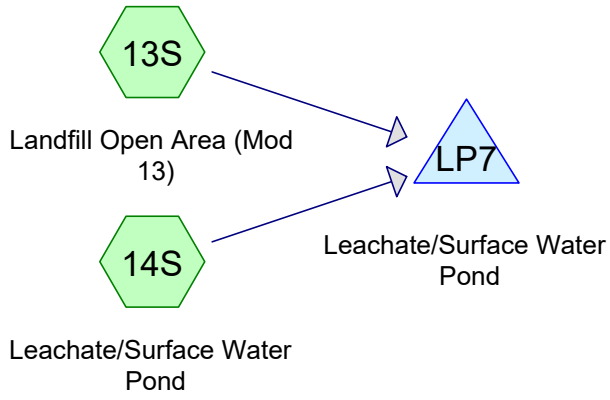
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
792.00	1,051	0	0
794.00	41,126	42,177	42,177
796.00	56,885	98,011	140,188
798.00	66,581	123,466	263,654
800.00	75,155	141,736	405,390

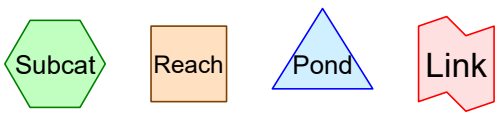
5-Year Storm Analysis

Phase 12 Filling



Phase 13 Filling





Routing Diagram for 230817_WPL Columbia_Leachate Pond Evaluation
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Rainfall Events Listing (selected events)

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	5-yr, 24-hr storm	MSE 24-hr	4	Default	24.00	1	3.38	2

Time span=0.00-33.00 hrs, dt=0.05 hrs, 661 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment11S: Landfill Open Area Runoff Area=6.240 ac 100.00% Impervious Runoff Depth=3.15"
Tc=20.0 min CN=98 Runoff=17.42 cfs 1.636 af

Subcatchment12S: Leachate/Surface Runoff Area=2.980 ac 100.00% Impervious Runoff Depth=3.15"
Tc=0.0 min CN=98 Runoff=14.51 cfs 0.781 af

Subcatchment13S: Landfill Open Area Runoff Area=8.475 ac 100.00% Impervious Runoff Depth=3.15"
Tc=20.0 min CN=98 Runoff=23.66 cfs 2.222 af

Subcatchment14S: Leachate/Surface Runoff Area=2.980 ac 100.00% Impervious Runoff Depth=3.15"
Tc=0.0 min CN=98 Runoff=14.51 cfs 0.781 af

Pond LP6: Leachate/SurfaceWater Pond Peak Elev=796.97' Storage=197,502 cf Inflow=22.07 cfs 2.418 af
Outflow=0.00 cfs 0.000 af

Pond LP7: Leachate/SurfaceWater Pond Peak Elev=796.97' Storage=197,748 cf Inflow=26.60 cfs 3.004 af
Outflow=0.00 cfs 0.000 af

Summary for Subcatchment 11S: Landfill Open Area (Mod 12)

Runoff = 17.42 cfs @ 12.29 hrs, Volume= 1.636 af, Depth= 3.15"
Routed to Pond LP6 : Leachate/Surface Water Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 5-yr, 24-hr storm Rainfall=3.38"

	Area (ac)	CN	Description
*	6.240	98	Mod 12 Open Area
	6.240		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.0					**Direct Entry, Estimated**

Summary for Subcatchment 12S: Leachate/Surface Water Pond

Runoff = 14.51 cfs @ 12.04 hrs, Volume= 0.781 af, Depth= 3.15"
Routed to Pond LP6 : Leachate/Surface Water Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 5-yr, 24-hr storm Rainfall=3.38"

	Area (ac)	CN	Description
*	2.980	98	Leachate Surface Water Pond
	2.980		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry,**

Summary for Subcatchment 13S: Landfill Open Area (Mod 13)

Runoff = 23.66 cfs @ 12.29 hrs, Volume= 2.222 af, Depth= 3.15"
Routed to Pond LP7 : Leachate/Surface Water Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 5-yr, 24-hr storm Rainfall=3.38"

	Area (ac)	CN	Description
*	8.475	98	Mod 13 Open Area
	8.475		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.0					**Direct Entry, Estimated**

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Summary for Subcatchment 14S: Leachate/Surface Water Pond

Runoff = 14.51 cfs @ 12.04 hrs, Volume= 0.781 af, Depth= 3.15"
Routed to Pond LP7 : Leachate/Surface Water Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 5-yr, 24-hr storm Rainfall=3.38"

	Area (ac)	CN	Description
*	2.980	98	Leachate Surface Water Pond
	2.980		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry,**

Summary for Pond LP6: Leachate/Surface Water Pond

Inflow Area = 9.220 ac,100.00% Impervious, Inflow Depth = 3.15" for 5-yr, 24-hr storm event
Inflow = 22.07 cfs @ 12.06 hrs, Volume= 2.418 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
Starting Elev= 795.10' Surf.Area= 49,793 sf Storage= 92,183 cf
Peak Elev= 796.97' @ 25.15 hrs Surf.Area= 61,576 sf Storage= 197,502 cf (105,320 cf above start)
Flood Elev= 796.97' Surf.Area= 61,588 sf Storage= 197,647 cf (105,464 cf above start)

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	792.00'	405,390 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
792.00	1,051	0	0
794.00	41,126	42,177	42,177
796.00	56,885	98,011	140,188
798.00	66,581	123,466	263,654
800.00	75,155	141,736	405,390

Summary for Pond LP7: Leachate/Surface Water Pond

Inflow Area = 11.455 ac,100.00% Impervious, Inflow Depth = 3.15" for 5-yr, 24-hr storm event
Inflow = 26.60 cfs @ 12.27 hrs, Volume= 3.004 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs

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Starting Elev= 794.57' Surf.Area= 45,617 sf Storage= 66,899 cf
Peak Elev= 796.97' @ 25.15 hrs Surf.Area= 61,596 sf Storage= 197,748 cf (130,850 cf above start)
Flood Elev= 796.97' Surf.Area= 61,588 sf Storage= 197,647 cf (130,748 cf above start)

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	792.00'	405,390 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
792.00	1,051	0	0
794.00	41,126	42,177	42,177
796.00	56,885	98,011	140,188
798.00	66,581	123,466	263,654
800.00	75,155	141,736	405,390

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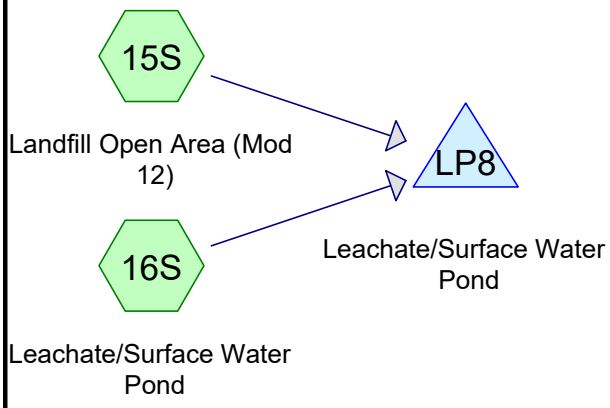
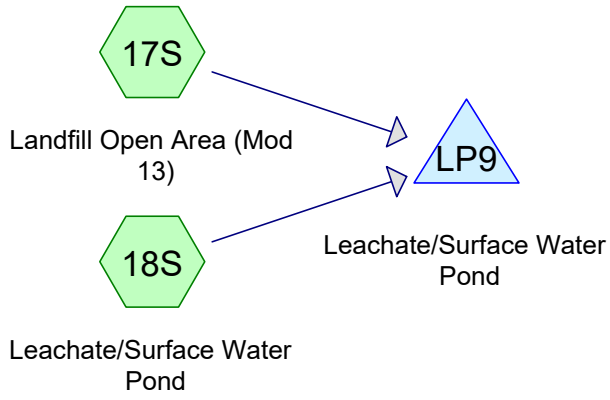
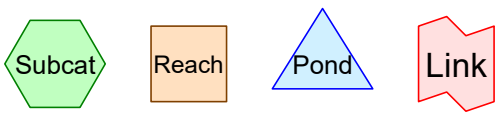
2-Year Storm Analysis

Phase 12 Filling



Phase 13 Filling





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Rainfall Events Listing (selected events)

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	2-yr, 24-hr storm	MSE 24-hr	4	Default	24.00	1	2.77	2

Time span=0.00-33.00 hrs, dt=0.05 hrs, 661 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment15S: Landfill Open Area Runoff Area=6.240 ac 100.00% Impervious Runoff Depth=2.54"
Tc=20.0 min CN=98 Runoff=14.19 cfs 1.320 af

Subcatchment16S: Leachate/Surface Runoff Area=2.980 ac 100.00% Impervious Runoff Depth=2.54"
Tc=0.0 min CN=98 Runoff=11.83 cfs 0.631 af

Subcatchment17S: Landfill Open Area Runoff Area=8.475 ac 100.00% Impervious Runoff Depth=2.54"
Tc=20.0 min CN=98 Runoff=19.28 cfs 1.793 af

Subcatchment18S: Leachate/Surface Runoff Area=2.980 ac 100.00% Impervious Runoff Depth=2.54"
Tc=0.0 min CN=98 Runoff=11.83 cfs 0.631 af

Pond LP8: Leachate/SurfaceWater Pond Peak Elev=796.97' Storage=197,715 cf Inflow=17.97 cfs 1.951 af
Outflow=0.00 cfs 0.000 af

Pond LP9: Leachate/SurfaceWater Pond Peak Elev=796.97' Storage=197,769 cf Inflow=21.68 cfs 2.424 af
Outflow=0.00 cfs 0.000 af

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Summary for Subcatchment 15S: Landfill Open Area (Mod 12)

Runoff = 14.19 cfs @ 12.29 hrs, Volume= 1.320 af, Depth= 2.54"
Routed to Pond LP8 : Leachate/Surface Water Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 2-yr, 24-hr storm Rainfall=2.77"

	Area (ac)	CN	Description
*	6.240	98	Mod 12 Open Area
	6.240		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.0					**Direct Entry, Estimated**

Summary for Subcatchment 16S: Leachate/Surface Water Pond

Runoff = 11.83 cfs @ 12.04 hrs, Volume= 0.631 af, Depth= 2.54"
Routed to Pond LP8 : Leachate/Surface Water Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 2-yr, 24-hr storm Rainfall=2.77"

	Area (ac)	CN	Description
*	2.980	98	Leachate Surface Water Pond
	2.980		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry,**

Summary for Subcatchment 17S: Landfill Open Area (Mod 13)

Runoff = 19.28 cfs @ 12.29 hrs, Volume= 1.793 af, Depth= 2.54"
Routed to Pond LP9 : Leachate/Surface Water Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 2-yr, 24-hr storm Rainfall=2.77"

	Area (ac)	CN	Description
*	8.475	98	Mod 13 Open Area
	8.475		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.0					**Direct Entry, Estimated**

Summary for Subcatchment 18S: Leachate/Surface Water Pond

Runoff = 11.83 cfs @ 12.04 hrs, Volume= 0.631 af, Depth= 2.54"
Routed to Pond LP9 : Leachate/Surface Water Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 2-yr, 24-hr storm Rainfall=2.77"

	Area (ac)	CN	Description
*	2.980	98	Leachate Surface Water Pond
	2.980		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry,**

Summary for Pond LP8: Leachate/Surface Water Pond

Inflow Area = 9.220 ac,100.00% Impervious, Inflow Depth = 2.54" for 2-yr, 24-hr storm event
Inflow = 17.97 cfs @ 12.06 hrs, Volume= 1.951 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
Starting Elev= 795.50' Surf.Area= 52,945 sf Storage= 112,730 cf
Peak Elev= 796.97' @ 25.15 hrs Surf.Area= 61,593 sf Storage= 197,715 cf (84,985 cf above start)
Flood Elev= 796.97' Surf.Area= 61,588 sf Storage= 197,647 cf (84,917 cf above start)

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	792.00'	405,390 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
792.00	1,051	0	0
794.00	41,126	42,177	42,177
796.00	56,885	98,011	140,188
798.00	66,581	123,466	263,654
800.00	75,155	141,736	405,390

Summary for Pond LP9: Leachate/Surface Water Pond

Inflow Area = 11.455 ac,100.00% Impervious, Inflow Depth = 2.54" for 2-yr, 24-hr storm event
Inflow = 21.68 cfs @ 12.27 hrs, Volume= 2.424 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs

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Starting Elev= 795.10' Surf.Area= 49,793 sf Storage= 92,183 cf
Peak Elev= 796.97' @ 25.15 hrs Surf.Area= 61,597 sf Storage= 197,769 cf (105,586 cf above start)
Flood Elev= 796.97' Surf.Area= 61,588 sf Storage= 197,647 cf (105,464 cf above start)

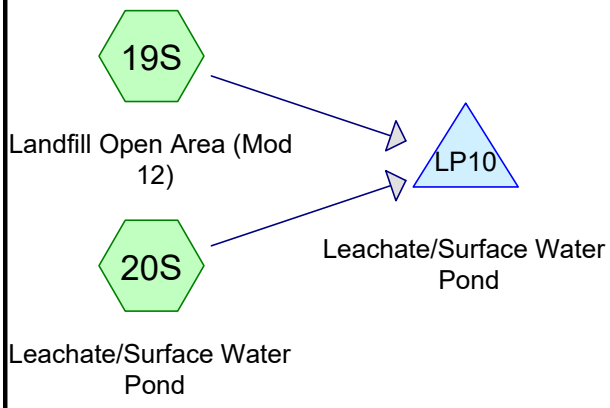
Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	792.00'	405,390 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

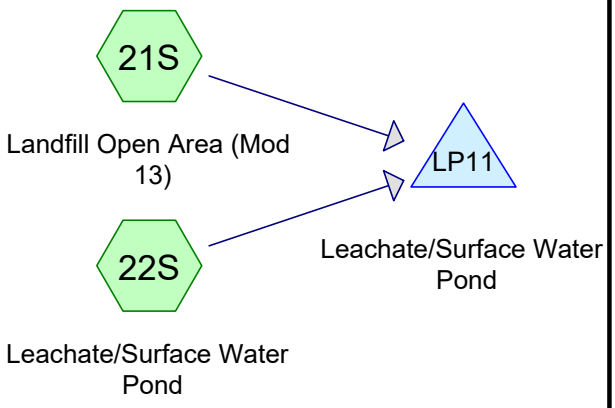
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
792.00	1,051	0	0
794.00	41,126	42,177	42,177
796.00	56,885	98,011	140,188
798.00	66,581	123,466	263,654
800.00	75,155	141,736	405,390

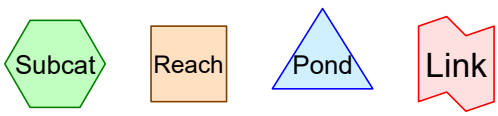
1-Year Storm Analysis

Phase 12 Filling



Phase 13 Filling





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Rainfall Events Listing (selected events)

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	1-yr, 24-hr storm	MSE 24-hr	4	Default	24.00	1	2.44	2

Time span=0.00-33.00 hrs, dt=0.05 hrs, 661 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment19S: Landfill Open Area Runoff Area=6.240 ac 100.00% Impervious Runoff Depth=2.21"
Tc=20.0 min CN=98 Runoff=12.44 cfs 1.150 af

Subcatchment20S: Leachate/Surface Runoff Area=2.980 ac 100.00% Impervious Runoff Depth=2.21"
Tc=0.0 min CN=98 Runoff=10.38 cfs 0.549 af

Subcatchment21S: Landfill Open Area Runoff Area=8.475 ac 100.00% Impervious Runoff Depth=2.21"
Tc=20.0 min CN=98 Runoff=16.90 cfs 1.562 af

Subcatchment22S: Leachate/Surface Runoff Area=2.980 ac 100.00% Impervious Runoff Depth=2.21"
Tc=0.0 min CN=98 Runoff=10.38 cfs 0.549 af

Pond LP10: Leachate/SurfaceWater Peak Elev=796.97' Storage=197,478 cf Inflow=15.75 cfs 1.699 af
Outflow=0.00 cfs 0.000 af

Pond LP11: Leachate/SurfaceWater Peak Elev=796.97' Storage=197,853 cf Inflow=19.01 cfs 2.111 af
Outflow=0.00 cfs 0.000 af

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Summary for Subcatchment 19S: Landfill Open Area (Mod 12)

Runoff = 12.44 cfs @ 12.29 hrs, Volume= 1.150 af, Depth= 2.21"
Routed to Pond LP10 : Leachate/Surface Water Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 1-yr, 24-hr storm Rainfall=2.44"

	Area (ac)	CN	Description
*	6.240	98	Mod 12 Open Area
	6.240		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.0					**Direct Entry, Estimated**

Summary for Subcatchment 20S: Leachate/Surface Water Pond

Runoff = 10.38 cfs @ 12.04 hrs, Volume= 0.549 af, Depth= 2.21"
Routed to Pond LP10 : Leachate/Surface Water Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 1-yr, 24-hr storm Rainfall=2.44"

	Area (ac)	CN	Description
*	2.980	98	Leachate Surface Water Pond
	2.980		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry,**

Summary for Subcatchment 21S: Landfill Open Area (Mod 13)

Runoff = 16.90 cfs @ 12.29 hrs, Volume= 1.562 af, Depth= 2.21"
Routed to Pond LP11 : Leachate/Surface Water Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 1-yr, 24-hr storm Rainfall=2.44"

	Area (ac)	CN	Description
*	8.475	98	Mod 13 Open Area
	8.475		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.0					**Direct Entry, Estimated**

09/28/2023 - Classification: Internal - ECRM13153872

Summary for Subcatchment 22S: Leachate/Surface Water Pond

Runoff = 10.38 cfs @ 12.04 hrs, Volume= 0.549 af, Depth= 2.21"
Routed to Pond LP11 : Leachate/Surface Water Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 1-yr, 24-hr storm Rainfall=2.44"

	Area (ac)	CN	Description
*	2.980	98	Leachate Surface Water Pond
	2.980		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry,**

Summary for Pond LP10: Leachate/Surface Water Pond

Inflow Area = 9.220 ac,100.00% Impervious, Inflow Depth = 2.21" for 1-yr, 24-hr storm event
Inflow = 15.75 cfs @ 12.06 hrs, Volume= 1.699 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
Starting Elev= 795.70' Surf.Area= 54,521 sf Storage= 123,477 cf
Peak Elev= 796.97' @ 25.15 hrs Surf.Area= 61,574 sf Storage= 197,478 cf (74,001 cf above start)
Flood Elev= 796.97' Surf.Area= 61,588 sf Storage= 197,647 cf (74,170 cf above start)

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	792.00'	405,390 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
792.00	1,051	0	0
794.00	41,126	42,177	42,177
796.00	56,885	98,011	140,188
798.00	66,581	123,466	263,654
800.00	75,155	141,736	405,390

Summary for Pond LP11: Leachate/Surface Water Pond

Inflow Area = 11.455 ac,100.00% Impervious, Inflow Depth = 2.21" for 1-yr, 24-hr storm event
Inflow = 19.01 cfs @ 12.27 hrs, Volume= 2.111 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs

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Starting Elev= 795.37' Surf.Area= 51,921 sf Storage= 105,914 cf
Peak Elev= 796.97' @ 25.15 hrs Surf.Area= 61,604 sf Storage= 197,853 cf (91,939 cf above start)
Flood Elev= 796.97' Surf.Area= 61,588 sf Storage= 197,647 cf (91,733 cf above start)

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	792.00'	405,390 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
792.00	1,051	0	0
794.00	41,126	42,177	42,177
796.00	56,885	98,011	140,188
798.00	66,581	123,466	263,654
800.00	75,155	141,736	405,390

E.5 Volume Calculations

09/28/2023 - Classification: Internal - ECRM13153872

Purpose: To determine the following airspace volumes

1. Airspace in Dry Ash Disposal Facility (ADF) with Module 1-6 and Modules 10 through 11 constructed
2. Airspace in Dry Ash Disposal Facility (ADF) with Module 1-6 and Modules 10 through 12 constructed
3. Airspace in Dry Ash Disposal Facility (ADF) with Module 1-6 and Modules 10 through 13 constructed

Approach: Use AutoCAD Civil 3D software to compare surfaces from the following data:

1. The total airspace in Phase 1 Modules 1 - 6 and Phase 2 Modules 10 through 11 was calculated using AutoCAD Civil 3D surfaces. As-built base grades (Figure 1) are based on construction documented grades Waste grades are based on the 2022 Plan of Operation Modification Request proposed waste grades (Figure 2).

2. The total airspace in Phase 1 Modules 1 - 6 and Phase 2 Modules 10 through 12 was calculated using AutoCAD Civil 3D surfaces. As-built base grades (Figure 3) are based on construction documented grades and proposed base grades for Module 12. Waste grades are based on the 2023 Plan of Operation Modification Request, Addendum No. 2 proposed waste grades (Figure 4).

3. The total airspace in Phase 1 Modules 1 - 6 and Phase 2 Modules 10 through 13 was calculated using AutoCAD Civil 3D surfaces. As-built base grades (Figure 5) are based on construction documented grades and proposed base grades for Modules 12-13. Waste grades are based on the 2023 Plan of Operation Modification Request, Addendum No. 2 proposed waste grades (Figure 6).

Results:

Total airspace in Modules 1-6 and Modules 10-11 = 2,596,262 cubic yards
(see attached AutoCAD Civil 3D report).

Total airspace in Modules 1-6 and Modules 10-12 = 3,207,520 cubic yards
(see attached AutoCAD Civil 3D report).

Total airspace in Modules 1-6 and Modules 10-13 = 3,630,075 cubic yards
(see attached AutoCAD Civil 3D report).

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Surface Report
Project Name:
I:\25222260.00\Drawings\Civil\Airspace 2023\Total Airspace Vol.dwg
Report Date: 8/30/2023 1:28:26 PM

Client: Alliant
Project Description: Columbia Plan of Operation Update
Prepared by: KP

Linear Units: foot	**Area Units:** squareFoot	**Volume Units:** cubicYard

Surface: Vol - Total Airspace (Mod 10-11)
Description: total airspace volume surface from base grades to waste grades through Module 11. Subtract 1' drainage layer for final airspace.

Area 2D: 1568771.199	Area 3D: 1637412.816
Elevation Max: 98.458	Elevation Min: -12.273
Number of Points: 13204	Number of Triangles: 25588

Surface: Vol - Total Airspace (Mod 12)
Description: total airspace volume surface from base grades to waste grades through Module 12. Subtract 1' drainage layer for final airspace.

Area 2D: 1725844.456	Area 3D: 1798272.141
Elevation Max: 111.031	Elevation Min: -4.612
Number of Points: 25608	Number of Triangles: 50458

Surface: Vol - Total Airspace (Mod 13)
Description: total airspace volume surface from base grades to waste grades through Module 12. Subtract 1' drainage layer for final airspace.

Area 2D: 1833694.680	Area 3D: 1910725.684
Elevation Max: 128.895	Elevation Min: -4.655
Number of Points: 22476	Number of Triangles: 44223

Volume Surface: Vol - Total Airspace (Mod 10-11)
Description: total airspace volume surface from base grades to waste grades through Module 11. Subtract 1' drainage layer for final airspace.

Volume Cut: 740.176	Volume Fill: 2642283.786	Volume Total: 2641543.610
Compare Surface: Composite Final Waste Grades Base Surface: Composite Base Grades (through Mod 11)	Drainage Layer = 45,282 cubic yards CCR Volume = 2,641,544 cubic yards - 45,282 cubic yards = **2,596,262 cubic yards**	

Volume Surface: Vol - Total Airspace (Mod 12)

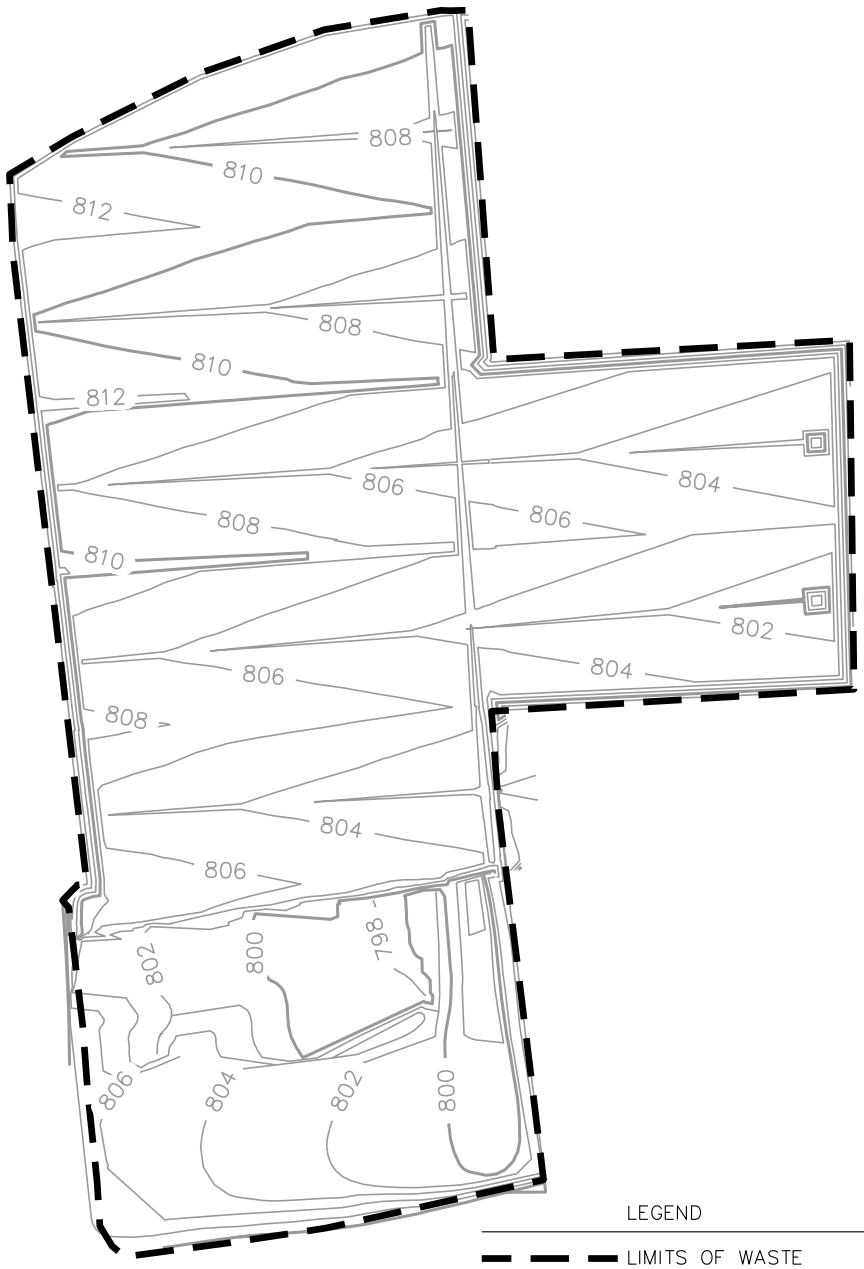
Description: total airspace volume surface from base grades to waste grades through Module 12. Subtract 1' drainage layer for final airspace.

Volume Cut: 52.314	Volume Fill: 3259010.655	Volume Total: 3258958.342
Compare Surface: Pr-Waste Grades (Mod 2-12 Capped) Base Surface: Composite Base Grades (through Mod 12)	Drainage Layer = 51,438 cubic yards CCR Volume = 3,258,958 cubic yards - 51,438 cubic yards = **3,207,520 cubic yards**	

Volume Surface: Vol - Total Airspace (Mod 13)

Description: total airspace volume surface from base grades to waste grades through Module 12. Subtract 1' drainage layer for final airspace.

Volume Cut: 52.908	Volume Fill: 3685558.884	Volume Total: 3685505.977
Compare Surface: Pr-Waste Grades (Mod 2-13 Capped) Base Surface: Composite Base Grades (through Mod 13)	Drainage Layer = 55,431 cubic yards CCR Volume = 3,685,506 cubic yards - 55,431 cubic yards = **3,630,075 cubic yards**	



LEGEND

- LIMITS OF WASTE
- BASE GRADE (2' CONTOUR)
- BASE GRADE (10' CONTOUR)

NOTES:

1. BASE GRADES SURFACE BUILT FROM AS-BUILT GRADES FROM MODULES 1-6 AND MODULES 10-11.
2. AIRSPACE VOLUMES BASED ON TOP OF LEACHATE DRAINAGE LAYER (1' ABOVE BASE GRADES).

300 0 300

SCALE: 1" = 300'

CLIENT	WISCONSIN POWER AND LIGHT COMPANY COLUMBIA ENERGY CENTER W8375 MURRAY ROAD PARDEEVILLE, WI 53954	SITE	PLAN OF OPERATION MODIFICATION REQUEST, ADDENDUM 2 DRY ASH DISPOSAL FACILITY COLUMBIA ENERGY CENTER TOWN OF PACIFIC, WISCONSIN

COMPOSITE BASE GRADES (MODULE 10-11)

PROJECT NO.	25222260.00	DRAWN BY:	KP/MJT
DRAWN:	05/23/2022	CHECKED BY:	PEG
REVISED:	08/31/2023	APPROVED BY:	PEG 09/01/2023

ENGINEER
SCS ENGINEERS
2830 DAIRY DRIVE MADISON, WI 53718-6751
PHONE: (608) 224-2830

FIGURE 1

I:\25222260.00\Drawings\Civil\Airspace 2023\Total Airspace Vol_Figures.dwg, 9/1/2023 7:24:06 AM

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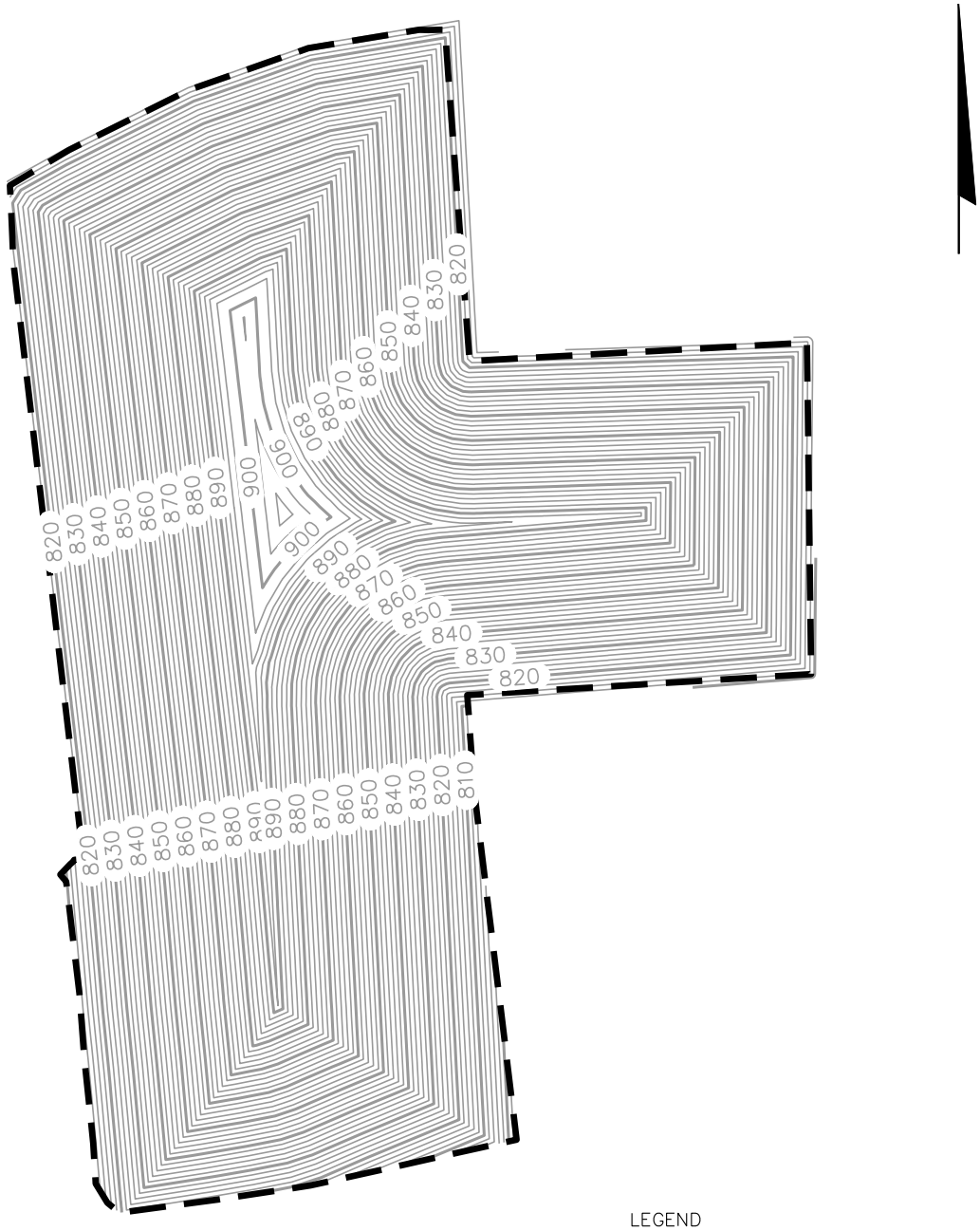

300 0 300

SCALE: 1" = 300'

NOTES:

1. FINAL WASTE SURFACE BUILT FROM PROPOSED PHASE 1 TOP OF WASTE GRADES AND PROPOSED MODULES 10–11 TOP OF WASTE GRADES.

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COMPOSITE FINAL WASTE GRADES (MODULE 10–11)

PROJECT NO.	25222260.00	DRAWN BY:	KP/MJT
DRAWN:	05/23/2022	CHECKED BY:	PEG
REVISED:	08/31/2023	APPROVED BY:	PEG 09/01/2023

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FIGURE 2

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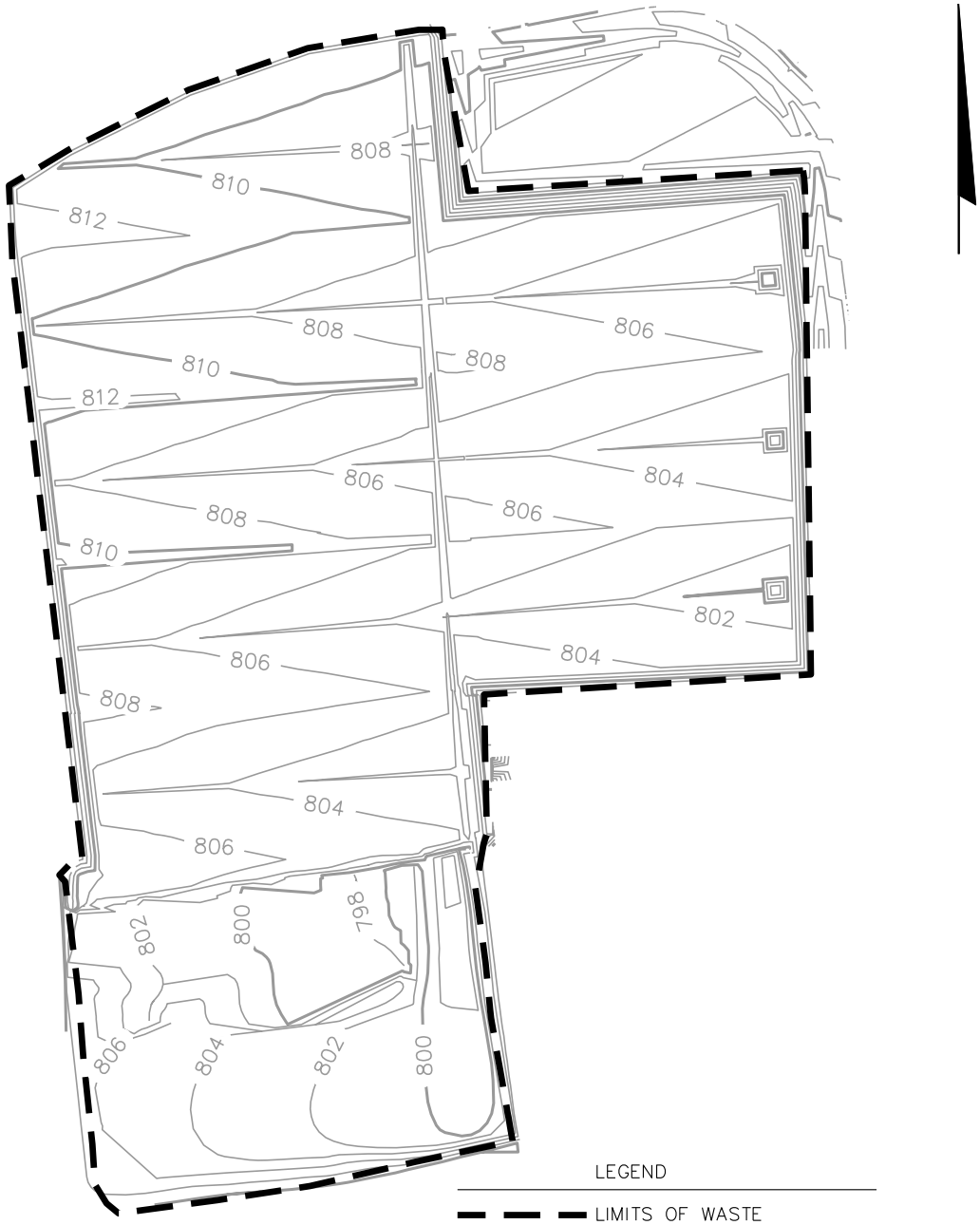

LEGEND

- LIMITS OF WASTE
- BASE GRADE (2' CONTOUR)
- BASE GRADE (10' CONTOUR)

NOTES:

1. BASE GRADES SURFACE BUILT FROM AS-BUILT GRADES FROM MODULES 1-6 AND MODULES 10-11, AND PROPOSED GRADES FOR MODULE 12.
2. AIRSPACE VOLUMES BASED ON TOP OF LEACHATE DRAINAGE LAYER (1' ABOVE BASE GRADES).

300 0 300

SCALE: 1" = 300'

CLIENT	WISCONSIN POWER AND LIGHT COMPANY COLUMBIA ENERGY CENTER W8375 MURRAY ROAD PARDEEVILLE, WI 53954	SITE	PLAN OF OPERATION MODIFICATION REQUEST, ADDENDUM 2 DRY ASH DISPOSAL FACILITY COLUMBIA ENERGY CENTER TOWN OF PACIFIC, WISCONSIN

COMPOSITE BASE GRADES (MODULE 12)

PROJECT NO.	25222260.00	DRAWN BY:	KP/MJT
DRAWN:	05/23/2022	CHECKED BY:	PEG
REVISED:	08/31/2023	APPROVED BY:	PEG 09/01/2023

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FIGURE 3

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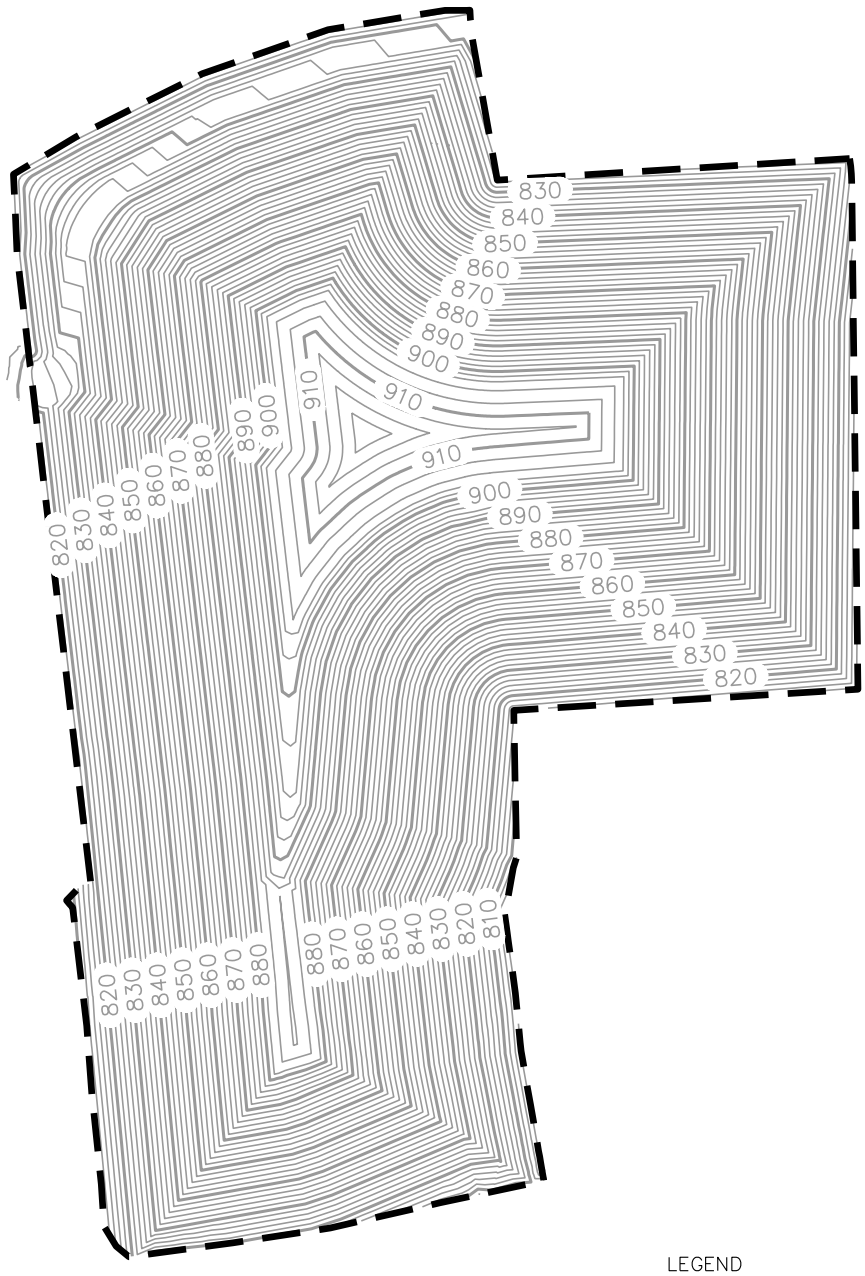

LEGEND

- LIMITS OF WASTE
- WASTE GRADE (2' CONTOUR)
- WASTE GRADE (10' CONTOUR)

NOTES:

1. FINAL WASTE SURFACE BUILT FROM PROPOSED PHASE 1 TOP OF WASTE GRADES AND PROPOSED MODULES 10–12 TOP OF WASTE GRADES.

300 0 300

SCALE: 1" = 300'

CLIENT	WISCONSIN POWER AND LIGHT COMPANY COLUMBIA ENERGY CENTER W8375 MURRAY ROAD PARDEEVILLE, WI 53954	SITE	PLAN OF OPERATION MODIFICATION REQUEST, ADDENDUM 2 DRY ASH DISPOSAL FACILITY COLUMBIA ENERGY CENTER TOWN OF PACIFIC, WISCONSIN

COMPOSITE FINAL WASTE GRADES (MODULE 12)

PROJECT NO.	25222260.00	DRAWN BY:	KP/MJT
DRAWN:	05/23/2022	CHECKED BY:	PEG
REVISED:	08/31/2023	APPROVED BY:	PEG 09/01/2023

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FIGURE 4

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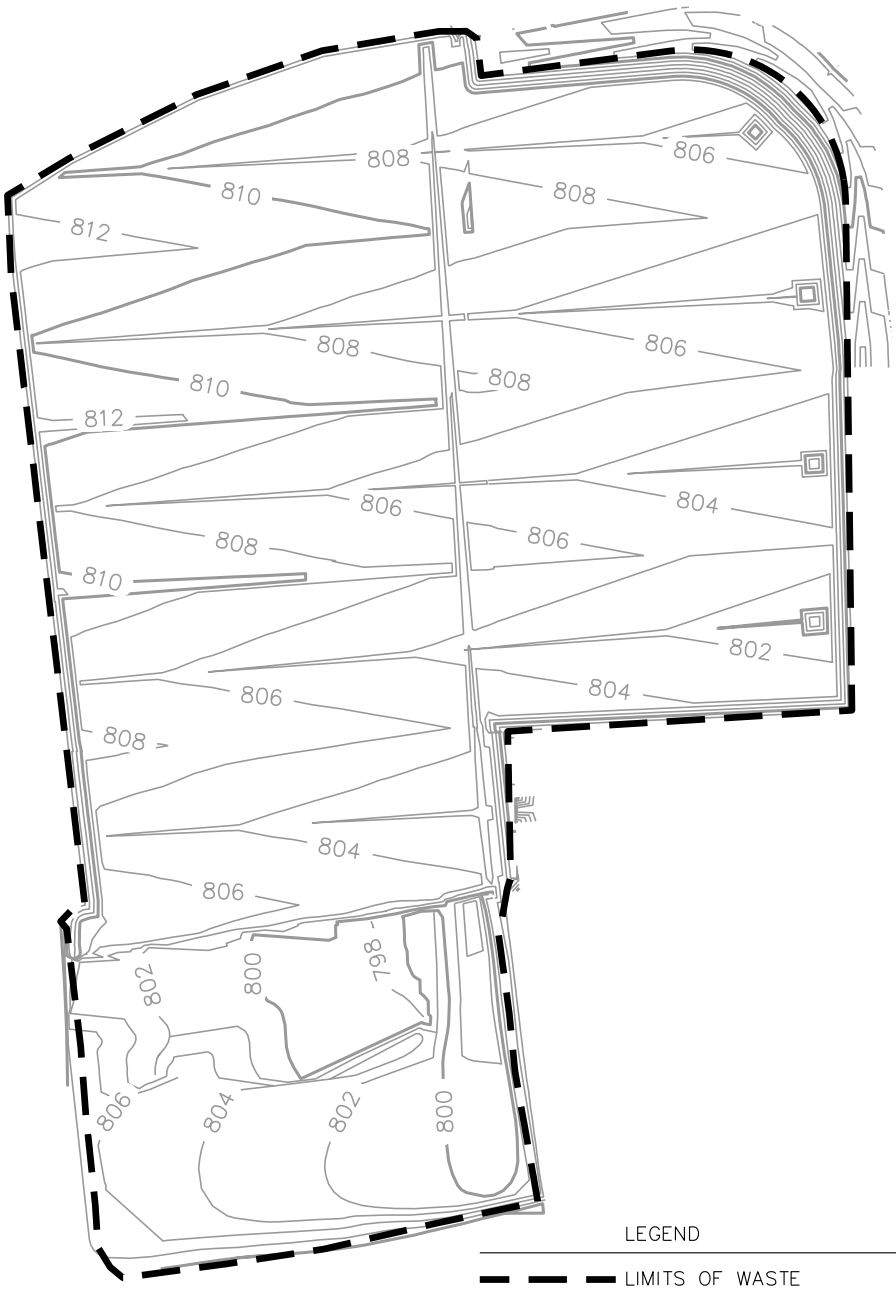

LEGEND

- LIMITS OF WASTE
- BASE GRADE (2' CONTOUR)
- BASE GRADE (10' CONTOUR)

NOTES:

1. BASE GRADES SURFACE BUILT FROM AS-BUILT GRADES FROM MODULES 1-6 AND MODULES 10-11, AND PROPOSED GRADES FOR MODULES 12-13.
2. AIRSPACE VOLUMES BASED ON TOP OF LEACHATE DRAINAGE LAYER (1' ABOVE BASE GRADES).

300 0 300

SCALE: 1" = 300'

CLIENT	WISCONSIN POWER AND LIGHT COMPANY COLUMBIA ENERGY CENTER W8375 MURRAY ROAD PARDEEVILLE, WI 53954	SITE	PLAN OF OPERATION MODIFICATION REQUEST, ADDENDUM 2 DRY ASH DISPOSAL FACILITY COLUMBIA ENERGY CENTER TOWN OF PACIFIC, WISCONSIN

COMPOSITE BASE GRADES (MODULES 12 AND 13)

PROJECT NO.	25222260.00	DRAWN BY:	KP/MJT
DRAWN:	05/23/2022	CHECKED BY:	PEG
REVISED:	08/31/2023	APPROVED BY:	PEG 09/01/2023

ENGINEER
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FIGURE 5

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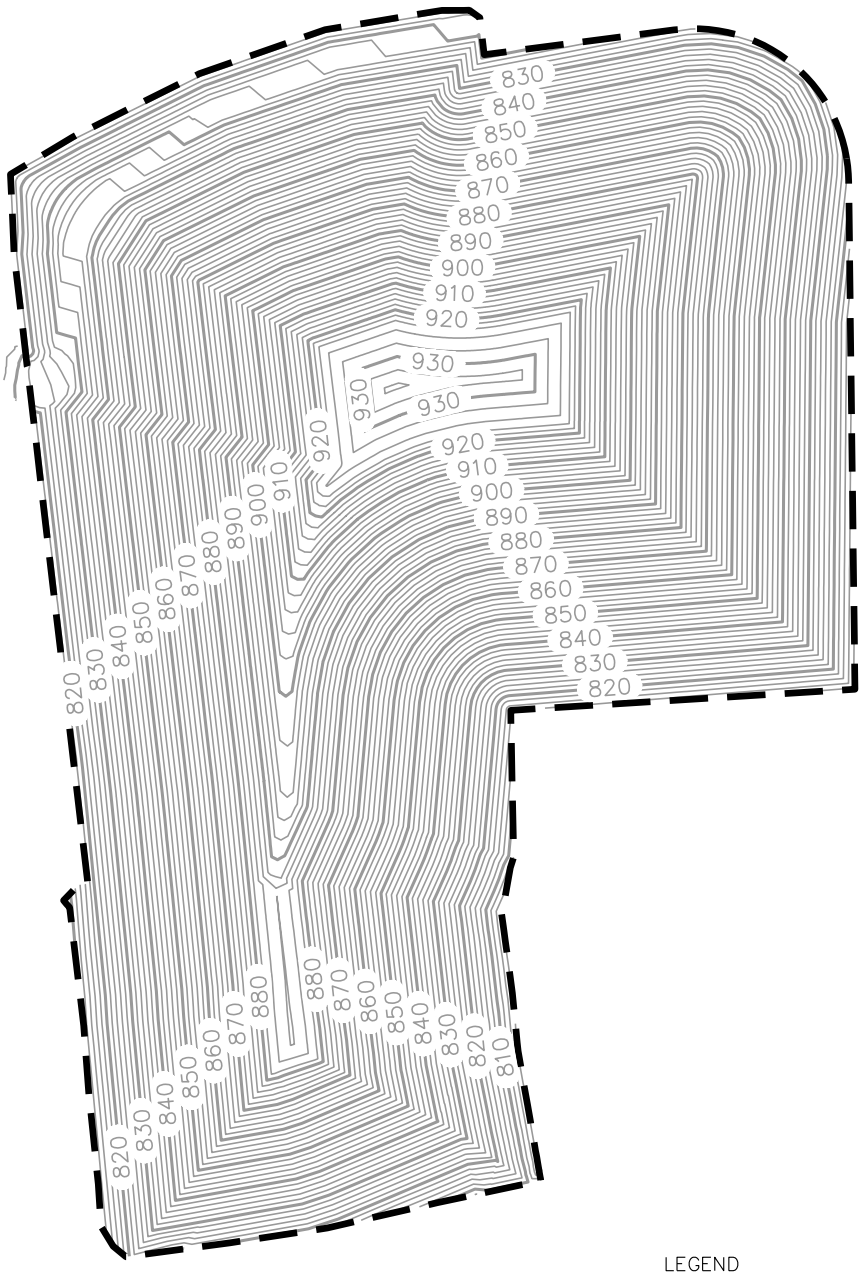

NOTES:

1. FINAL WASTE SURFACE BUILT FROM PROPOSED PHASE 1 TOP OF WASTE GRADES AND PROPOSED MODULES 10–13 TOP OF WASTE GRADES.

CLIENT	WISCONSIN POWER AND LIGHT COMPANY COLUMBIA ENERGY CENTER W8375 MURRAY ROAD PARDEEVILLE, WI 53954	SITE	PLAN OF OPERATION MODIFICATION REQUEST, ADDENDUM 2 DRY ASH DISPOSAL FACILITY COLUMBIA ENERGY CENTER TOWN OF PACIFIC, WISCONSIN

COMPOSITE FINAL WASTE GRADES (MODULES 12 AND 13)

PROJECT NO.	25222260.00	DRAWN BY:	KP/MJT
DRAWN:	05/23/2022	CHECKED BY:	PEG
REVISED:	08/31/2023	APPROVED BY:	PEG 09/01/2023

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FIGURE 6

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E.6 Stormwater Calculations

09/28/2023 - Classification: Internal - ECRM13153872

E.6.1 Module 12 Stormwater Calculations

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Storm Water Management Calculations

Purpose:
The purpose of the storm water runoff calculations is to demonstrate that the existing storm water sedimentation basin and proposed storm water management features included in the Module 12 Plan Modification Request can accommodate and safely convey the runoff from a 25-year, 24-hour storm event and 100-year, 24-hour storm event during post closure conditions.

Items addressed in these calculations:

- Swales
- Culverts
- Diversion Berms
- Downslope Flumes & Energy Dissipators
- Rock Chutes
- Discharge Aprons
- Sedimentation Basin
- North Infiltration Area

The proposed storm water management conditions are shown on **Figure 1**.
The calculations support the capacity check of the following existing storm water management feature:

Feature	Purpose	Design Method
Swales	Convey storm water runoff from adjacent areas to culverts and offsite during post construction conditions	HydroCAD runoff modeling and Swale Calculation
Culverts	Convey storm water from the final cover perimeter swales during post construction conditions	HydroCAD runoff modeling and HY-8 Culvert Model
Diversion Berms	Reduce storm water runoff from final cover slopes and to divert water to perimeter swales during post construction conditions	HydroCAD runoff modeling and Diversion Berm Calculations
Downslope Flumes & Energy Dissipators	Convey storm water from diversion berms down slope to swales and offsite drainage features during post construction conditions	HydroCAD runoff modeling and Downslope Flume Calculations
Rock Chutes	Erosion protection and convey storm water from energy dissipators to existing swale during post construction conditions	HydroCAD runoff modeling and Rock Chute Calculation
Discharge Aprons	Erosion protection from culvert discharge at culvert outlets	HydroCAD runoff modeling and Riprap Apron Calculation
Sedimentation Basin	To safely handle 25-year, 24-hour storm event without overtopping the 100-year, 24-hour spillway.	HydroCAD runoff modeling
North Infiltration Area	To safely handle 25-year, 24-hour and 100-year, 24-hour storm events without overtopping or backing up the inlet pipe.	HydroCAD runoff modeling

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Approach:

Hydrograph Generation

HydroCAD was used to model the storm water management system and develop the hydrographs using TR-20 methodologies. The model is designed to simulate the surface runoff response of a watershed to a precipitation event. Input parameters for the model include precipitation depth for the design storm events from NOAA ATLAS 14, contributing drainage areas, runoff curve numbers, and time of concentration.

Swale Sizing

The proposed swales were sized for the 25-year, 24-hour storm event. A WisDOT HEC-15 spreadsheet based on Manning's equation was used to calculate the depth of flow and velocity in the swales using the swale geometry and peak flow in the swales (as determined by the Hydrograph Generation models).

Culvert Sizing

Culverts were sized for the 25-year, 24-hour storm event using the HY-8 computer model developed by the US Department of Transportation, Federal Highway Administration.

Diversion Berms

Diversion berms were sized for the 25-year, 24-hour storm event. A WisDOT HEC-15 spreadsheet based on Manning's Equation was used to calculate the depth of flow and velocity in the swale using the swale geometry and peak flow for the storm event (as determined by the Hydrograph Generation Calculations).

Downslope Flumes and Energy Dissipators Sizing

Flumes and energy dissipators were sized for the 25-year, 24-hour storm event. Manning's equation and the orifice equation were used to size the flumes. Energy dissipators were sized using tables from the reference book "Hydraulic Design of Energy Dissipators for Culverts and Channels" US Department of Transportation, Federal Highway Administration, July 2006.

Rock Chute Sizing

Rock chutes were sized for the 25-year, 24-hour storm event. Rock Chutes were sized based on the flow to each culvert location. The Iowa NRCS Rock Chute Design spreadsheet was used to size the chute and riprap.

Discharge Apron Sizing

Riprap aprons were sized for the 25-year, 24-hour storm event using equations in Section 5.2 – Riprap Blanket of WisDOT FDM 13-35-5. The riprap aprons were sized based on the flow to the culvert location. The riprap stone sizing was used to specify the thickness and geometry of the riprap discharge apron.

Sedimentation Basin Sizing

Route the proposed construction and existing drainage runoff through the sedimentation basin to confirm the basin can handle the 25-year, 24-hour storm event and to safely pass the 100-year, 24-hour storm event. HydroCAD was used to model the runoff flow through the basin outfall (as determined by the Hydrograph Generation model).

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North Infiltration Area Verification

The depressional area located north of the Module 12 Plan Modification construction area acts as a infiltration area and accepts portions of the drainage runoff. Route the proposed construction and existing drainage runoff flowing to the North Infiltration Area to confirm the area can handle the 25-year, 24-hour and 100-year, 24-hour storm events without overtopping or backing up the inlet pipe. HydroCAD was used to model the runoff flow into this area (as determined by the Hydrograph Generation model).

Key Assumptions:

- Drainage areas and time of concentration flow paths are as shown on **Figure 1** for Post Construction Conditions.

- An MSE4 rainfall distribution was used based on NRCS Wisconsin rainfall distribution regions.

  The precipitation depth for the 25-year, 24-hour storm was assumed to be 4.91 inches, based on NOAA ATLAS 14 Point Precipitation Frequency Estimates (NOAA's National Weather Service Hydrometeorological Design Studies Center Precipitation Frequency Data Server).

  The precipitation depth for the 100-year, 24-hour storm was assumed to be 6.59 inches, based on NOAA ATLAS 14 Point Precipitation Frequency Estimates.

- Runoff curve numbers were based on tables presented in Urban Hydrology for Small Watersheds, and were assumed as follows and as listed in the modeling.

Cover Type	CN
Final Cover	69 – Pasture/grassland/range in good condition, hydrologic soil group (HSG) (B/C assumed mid value between each soil group)
Pasture, grassland or range	39 – Pasture/grassland/range, Good, HSG A
Gravel	96 – Gravel, HSG A
Water Surface	98 – Water Surface, HSG A

- Type A soil group for non-disturbed areas outside the landfill as soils are loamy sand.
- Other assumptions are included with the calculations attached to this appendix.

Results:

Hydrograph Generation

The hydrograph modeling results for the 25-year and 100-year, 24-hour storm events are included in the Post Construction Conditions Hydrograph Generation section.

Swale Sizing

The proposed swales will be constructed as shown on the Drawings. The swales have the capacity to safely convey the both the 25-year, 24-hour storm events and maintain a minimum 0.5 foot of freeboard. Refer to the Swale Sizing section.

Appropriate erosion control product was selected based on the velocities and shear stress in the swales. Refer to the Swale Sizing section below for the evaluation.

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Culvert Sizing

Culverts will be as shown in the Drawings. The culverts have the capacity to safely convey the 25-year, 24-hour storm event. Refer to the Culvert Sizing Section for the detailed calculations.

Diversion Berm Sizing

The proposed final berms will be constructed as shown on the Drawings. The diversion berms will contain the runoff from the 25-year, 24-hour storm event. Refer to the Diversion Berm Design section.

Downslope Flume and Energy Dissipator Sizing

The downslope flumes and energy dissipaters will be constructed as shown on the Drawings. The downslope flumes are designed to contain the runoff from the 25-year, 24-hour storm event. Energy dissipators at the bottom of the downslope flumes have been designed to handle the peak velocities. Refer to the Downslope Flume and Energy Dissipator Sizing section below for detailed calculations.

Rock Chute Sizing

The proposed rock chutes will be constructed as shown in the Drawings. The rock chutes will accommodate the runoff from the 25-year, 24-hour storm event. Refer to the Rock Chute Sizing section.

Discharge Apron Sizing

The proposed riprap aprons will be constructed as shown in the Drawings. The aprons will accommodate the runoff from the 25-year, 24-hour storm event. Refer to Discharge Apron Sizing for design calculations.

Sedimentation Basin Sizing

The existing sedimentation basin has the capacity to safely contain the 25-year, 24-hour storm event and safely pass the 100-year, 24-hour storm event through the emergency spillway.

As shown in the HydroCAD model, the water elevation in both basin areas for each storm event is provided below:

Basin Area	Basin Crest Elevation (ft MSL)	Basin Spillway Elevation (ft MSL)	Peak Elevation 25-year storm (ft MSL)	Peak Elevation 100-year storm (ft MSL)
Existing Sedimentation Basin	794.00	793.00	792.18	793.23

North Infiltration Area Verification

The North Infiltration Area can safely contain the 25-year, 24-hour storm event and the 100-year, 24-hour storm event without overtopping or backing up the inlet pipe at Murray Road.

As shown in the HydroCAD model, the water elevation in both basin areas for each storm event is provided below:

Basin Area	Basin Crest Elevation (ft MSL)	Basin Inlet Pipe Elevation (ft MSL)	Peak Elevation 25-year storm (ft MSL)	Peak Elevation 100-year storm (ft MSL)
North Basin	810.00	806.81	803.89	805.24

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CULVERT C7
2-42" CMPs
INLET INV.: 796.64/796.34
OUTLET INV.: 796.34/796.04
LENGTH: 60.2 FT

CULVERT C8
INLET INV.: 810.70
OUTLET INV.: 808.60
LENGTH: 85.60 FT

WPDES POND

COAL PILE

C. M. ST. P. & P. RR.

FLUME 3 (EXISTING)

SWALE S4.1
SWALE S4.2
SWALE S4.3
SWALE S4.4
SWALE S4.5
SWALE S4.6

ROCK CHUTE 1
ROCK CHUTE 2
ROCK CHUTE 3

FLUME 10
ROADSIDE DITCH 5
ROADSIDE DITCH 4
ROADSIDE DITCH 3
ROADSIDE DITCH 2
ROADSIDE DITCH 1

MURRAY ROAD

CULVERT C10
INLET INV.: 807.54
OUTLET INV.: 806.81
LENGTH: 99.86 FT

NORTH POND

CULVERT C2A
INLET INV.: 817.60
OUTLET INV.: 814.00
LENGTH: 74.54 FT

CULVERT C2B
INLET INV.: 818.00
OUTLET INV.: 817.83
LENGTH: 52.21 FT

CULVERT C1
INLET INV.: 815.70
OUTLET INV.: 814.55
LENGTH: 51.878 FT

SWALE S5.1
SWALE S5.2

SOUTH SEDIMENTATION BASIN

EXISTING ROCK CHUTE (FLUME 4)
EXISTING ROCK CHUTE (FLUME 5)

FLUME 1
FLUME 2
FLUME 6
FLUME 7
FLUME 8
FLUME 9

AREA 1
AREA 2
AREA 3
AREA 4
AREA 5
AREA 6
AREA 7
AREA 8
AREA 9
AREA 10
AREA 11
AREA 12
AREA 13
AREA 14
AREA 15
AREA 16
AREA 17
AREA 18
AREA 19
AREA 20
AREA 21
AREA 22
AREA 23
AREA 24
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AREA 26
AREA 27
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AREA 29
AREA 30
AREA 31
AREA 32
AREA 33
AREA 34
AREA 35
AREA 36
AREA 37
AREA 38
AREA 39
AREA 40
AREA 41
AREA 42a
AREA 42b
AREA 43
AREA 44
AREA 45
AREA 46
AREA 47
AREA 48
AREA 50
AREA 52
AREA 53
AREA 54
AREA 55
AREA 56
AREA 57
AREA 58
AREA 59
AREA 60
AREA 61
AREA 62
AREA 63
AREA 64
AREA 65
AREA 66
AREA 67
AREA 68
AREA 69

SWALE S1.0
SWALE S1.1
SWALE S1.2
SWALE S1.3
SWALE S1.4
SWALE S1.5
SWALE S1.6
SWALE S1.7
SWALE S1.8
SWALE S1.9
SWALE S2.1
SWALE S2.2
SWALE S2.3
SWALE S3.1
SWALE S3.2
SWALE S3.3
SWALE S3.4
SWALE S3.5

CULVERT C3
INLET INV.: 811.17
OUTLET INV.: 810.90
LENGTH: 50.00 FT

CULVERT C4
INLET INV.: 809.86
OUTLET INV.: 809.60
LENGTH: 50.00 FT

CULVERT C5
INLET INV.: 807.57
OUTLET INV.: 807.15
LENGTH: 50.00 FT

CULVERT C6
INLET INV.: 805.40
OUTLET INV.: 804.76/804.71
LENGTH: 104.55 FT

CULVERT C9
INLET INV.: 822.00
OUTLET INV.: 821.79
LENGTH: 36.7 FT

CULVERT C11
INLET INV.: 817.68
OUTLET INV.: 817.40
LENGTH: 56.00 FT

AREA TO BE GRADED TO DRAIN AFTER CLOSURE

LEGEND

- DRY ASH DISPOSAL FACILITY LIMITS
- LIMITS OF WASTE
- LINER PHASE/MODULE LIMIT
- FINAL COVER LIMITS
- APPROXIMATE INTERMEDIATE COVER LIMITS/AREA
- PAVED ROAD
- UNPAVED ROAD
- VEGETATION
- FENCE
- 810 EXISTING GRADE (10' INTERVAL)
- EXISTING GRADE (2' INTERVAL)
- SWALE
- EDGE OF WATER
- WETLAND
- 840 PROPOSED PHASE 1 FINAL GRADE (10' INTERVAL)
- PROPOSED PHASE 1 FINAL GRADE (2' INTERVAL)
- 840 PROPOSED GRADE (10' INTERVAL)
- PROPOSED GRADE (2' INTERVAL)
- PROPOSED PERIMETER ROAD
- PROPOSED SWALE
- PROPOSED CULVERT
- PROPOSED LEACHATE COLLECTION SYSTEM CLEANOUT
- PROPOSED LEACHATE VAULT
- PROPOSED LEACHATE FORCEMAIN
- PROPOSED UNDERGROUND ELECTRIC
- PROPOSED DIVERSION BERM
- PROPOSED DOWNSLOPE FLUME
- PROPOSED ENERGY DISSIPATOR
- PROPOSED RIPRAP
- DRAINAGE AREA DIVIDES
- FLOW PATH

NOTES:

1. SEE SHEET 2 OF PLAN OF OPERATION UPDATE (2023) PLAN SET FOR BASE MAP LEGEND ITEMS AND NOTES.
2. PROPOSED GRADES REPRESENT TOP OF FINAL COVER (FINAL GRADE).

N

125 0 125

SCALE: 1" = 125'

S.A.L.
DRAWN BY: MJT
CHECKED BY:
APPROVED BY: MRH 08/31/2023

PROJECT NO. 25222260.01
DRAWN: 8/1/2023
REVISED: 08/31/2023

WISCONSIN POWER AND LIGHT
COLUMBIA ENERGY CENTER
2019 AGENCY ROAD
PARDEEVILLE, WISCONSIN 53954

Wisconsin Power and Light Company

CLIENT

SCS ENGINEERS
2830 DARY DRIVE MADISON, WI 53718-6751
PHONE: (608) 224-2830

ENGINEER

PLAN OF OPERATION UPDATE
COLUMBIA ENERGY CENTER
COLUMBIA DRY ASH DISPOSAL FACILITY
TOWN OF PACIFIC, WISCONSIN

SITE

FINAL GRADES
(MODULE 12)

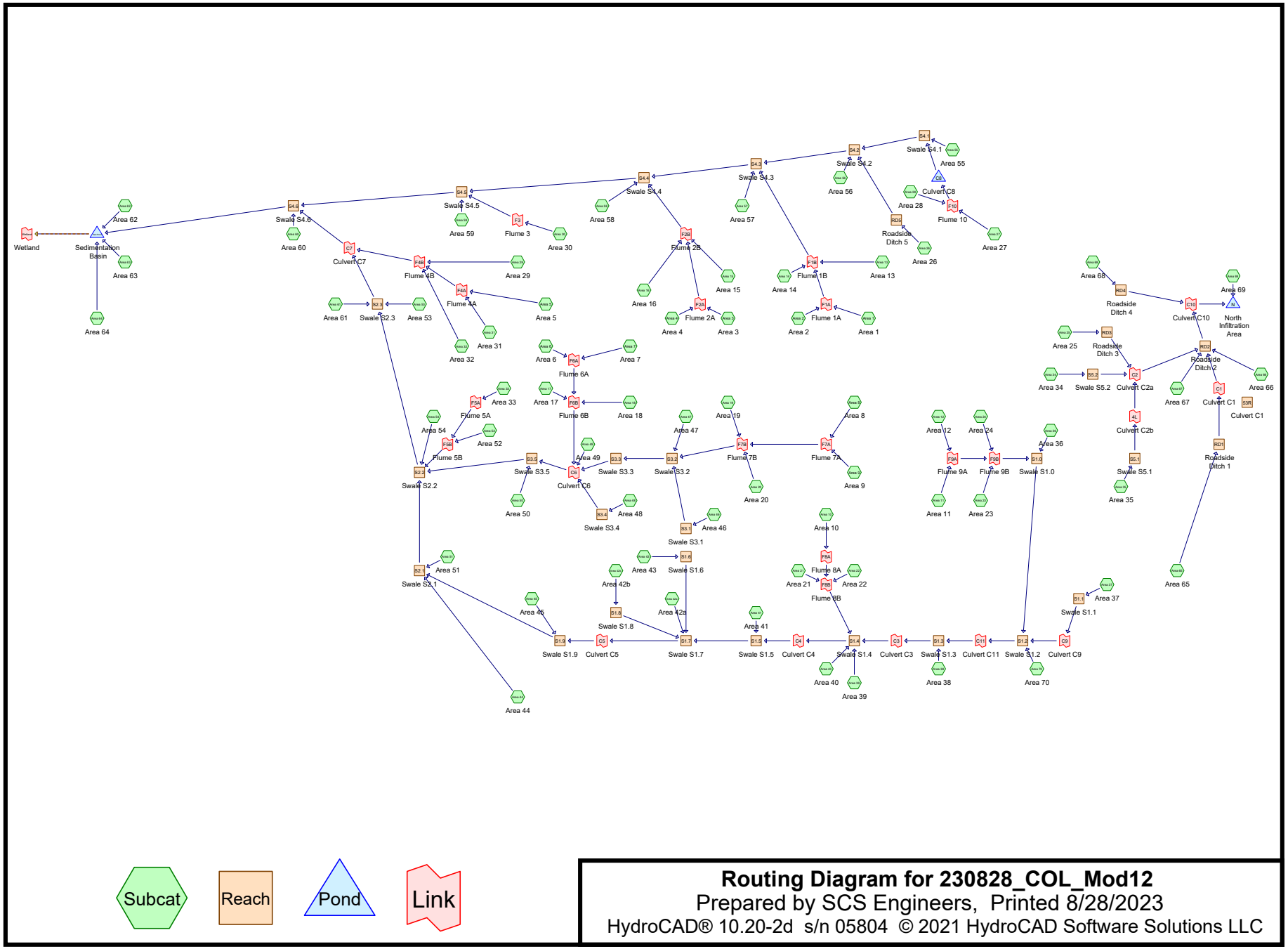
SHEET
1 of 1

09/28/2023 - Classification: Internal - ECRM13153872

Post Construction Conditions Hydrograph Generation

- 25-year, 24-hour Storm Event
- 100-year, 24-hour Storm Event

09/28/2023 - Classification: Internal - ECRM13153872


Wetland
Sedimentation Basin
Area 62
Area 63
Area 64
Swale S4.6
Area 60
Swale S4.5
Area 59
Flume 3
Area 30
Swale S4.4
Area 58
Swale S4.3
Area 57
Swale S4.2
Area 56
Swale S4.1
Area 55
Culvert C8
Area 28
Flume 10
Area 27
Roadside Ditch 5
Area 26
Culvert C7
Flume 4B
Area 29
Flume 2B
Area 15
Area 16
Flume 2A
Area 4
Area 3
Flume 1B
Area 14
Area 13
Flume 1A
Area 2
Area 1
Area 61
Swale S2.3
Area 53
Flume 4A
Area 5
Area 31
Area 32
Area 6
Flume 6A
Area 7
Area 17
Flume 6B
Area 18
Flume 5A
Area 33
Area 54
Area 52
Flume 5B
Swale S2.2
Area 49
Swale S3.5
Culvert C6
Swale S3.3
Swale S3.2
Area 47
Area 19
Flume 7B
Flume 7A
Area 8
Area 9
Area 20
Area 50
Swale S3.4
Area 48
Swale S3.1
Area 46
Area 10
Area 12
Area 24
Flume 9A
Flume 9B
Swale S1.0
Area 36
Area 11
Area 23
Area 68
Roadside Ditch 4
Area 69
Culvert C10
North Infiltration Area
Area 25
Roadside Ditch 3
Roadside Ditch 2
Area 34
Swale S5.2
Culvert C2a
Area 67
Culvert C1
Area 66
Culvert C1
Culvert C2b
Swale S5.1
Area 35
Roadside Ditch 1
Area 65
Swale S2.1
Area 51
Area 43
Swale S1.6
Area 42b
Flume 8A
Area 21
Area 22
Flume 8B
Area 10
Area 45
Swale S1.8
Area 42a
Area 41
Swale S1.1
Area 37
Swale S1.9
Culvert C5
Swale S1.7
Swale S1.5
Culvert C4
Swale S1.4
Culvert C3
Swale S1.3
Culvert C11
Swale S1.2
Culvert C9
Area 40
Area 39
Area 38
Area 70
Area 44
Subcat
Reach
Pond
Link
Routing Diagram for 230828_COL_Mod12
Prepared by SCS Engineers, Printed 8/28/2023
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Rainfall Events Listing

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	25-yr, 24-hr	MSE 24-hr	4	Default	24.00	1	4.91	2
2	100-yr, 24-hr	MSE 24-hr	4	Default	24.00	1	6.59	2

Time span=0.00-72.00 hrs, dt=0.05 hrs, 1441 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

SubcatchmentArea 1: Area 1 Runoff Area=1.141 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=500' Tc=6.5 min CN=69 Runoff=3.32 cfs 0.180 af

SubcatchmentArea 10: Area 10 Runoff Area=0.791 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=354' Tc=6.4 min CN=69 Runoff=2.31 cfs 0.125 af

SubcatchmentArea 11: Area 11 Runoff Area=0.885 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=288' Tc=6.4 min CN=69 Runoff=2.59 cfs 0.140 af

SubcatchmentArea 12: Area 12 Runoff Area=2.206 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=628' Tc=6.7 min CN=69 Runoff=6.39 cfs 0.348 af

SubcatchmentArea 13: Area 13 Runoff Area=1.610 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=712' Tc=5.3 min CN=69 Runoff=4.83 cfs 0.254 af

SubcatchmentArea 14: Area 14 Runoff Area=0.626 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=333' Tc=4.5 min CN=69 Runoff=1.94 cfs 0.099 af

SubcatchmentArea 15: Area 15 Runoff Area=0.620 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=331' Tc=4.4 min CN=69 Runoff=1.93 cfs 0.098 af

SubcatchmentArea 16: Area 16 Runoff Area=0.943 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=464' Tc=5.9 min CN=69 Runoff=2.80 cfs 0.149 af

SubcatchmentArea 17: Area 17 Runoff Area=0.571 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=315' Tc=4.4 min CN=69 Runoff=1.78 cfs 0.090 af

SubcatchmentArea 18: Area 18 Runoff Area=0.990 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=424' Tc=4.7 min CN=69 Runoff=3.04 cfs 0.156 af

SubcatchmentArea 19: Area 19 Runoff Area=1.179 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=385' Tc=4.7 min CN=69 Runoff=3.62 cfs 0.186 af

SubcatchmentArea 2: Area 2 Runoff Area=0.557 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=303' Tc=4.7 min CN=69 Runoff=1.71 cfs 0.088 af

SubcatchmentArea 20: Area 20 Runoff Area=1.057 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=419' Tc=4.7 min CN=69 Runoff=3.24 cfs 0.167 af

SubcatchmentArea 21: Area 21 Runoff Area=0.434 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=374' Tc=4.5 min CN=69 Runoff=1.35 cfs 0.068 af

SubcatchmentArea 22: Area 22 Runoff Area=1.442 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=489' Tc=4.8 min CN=69 Runoff=4.40 cfs 0.227 af

SubcatchmentArea 23: Area 23 Runoff Area=1.252 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=435' Tc=4.7 min CN=69 Runoff=3.84 cfs 0.197 af

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SubcatchmentArea 24: Area 24 Runoff Area=1.846 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=701' Tc=5.4 min CN=69 Runoff=5.53 cfs 0.291 af

SubcatchmentArea 25: Area 25 Runoff Area=1.552 ac 0.00% Impervious Runoff Depth=2.64"
Flow Length=123' Slope=0.2500 '/' Tc=3.9 min CN=78 Runoff=6.95 cfs 0.341 af

SubcatchmentArea 26: Area 26 Runoff Area=0.616 ac 0.00% Impervious Runoff Depth=2.13"
Flow Length=109' Slope=0.2500 '/' Tc=3.8 min CN=72 Runoff=2.25 cfs 0.109 af

SubcatchmentArea 27: Area 27 Runoff Area=0.149 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=211' Tc=1.2 min CN=69 Runoff=0.52 cfs 0.023 af

SubcatchmentArea 28: Area 28 Runoff Area=0.126 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=59' Slope=0.2500 '/' Tc=2.5 min CN=69 Runoff=0.44 cfs 0.020 af

SubcatchmentArea 29: Area 29 Runoff Area=1.228 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=647' Tc=5.7 min CN=69 Runoff=3.66 cfs 0.194 af

SubcatchmentArea 3: Area 3 Runoff Area=0.348 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=298' Tc=4.8 min CN=69 Runoff=1.06 cfs 0.055 af

SubcatchmentArea 30: Area 30 Runoff Area=0.427 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=362' Tc=3.8 min CN=69 Runoff=1.38 cfs 0.067 af

SubcatchmentArea 31: Area 31 Runoff Area=0.223 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=296' Tc=3.7 min CN=69 Runoff=0.72 cfs 0.035 af

SubcatchmentArea 32: Area 32 Runoff Area=0.655 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=642' Tc=5.0 min CN=69 Runoff=1.98 cfs 0.103 af

SubcatchmentArea 33: Area 33 Runoff Area=0.237 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=348' Tc=4.0 min CN=69 Runoff=0.76 cfs 0.037 af

SubcatchmentArea 34: Area 34 Runoff Area=0.424 ac 0.00% Impervious Runoff Depth=2.29"
Flow Length=78' Slope=0.2500 '/' Tc=3.1 min CN=74 Runoff=1.73 cfs 0.081 af

SubcatchmentArea 35: Area 35 Runoff Area=0.993 ac 0.00% Impervious Runoff Depth=2.46"
Flow Length=126' Tc=4.4 min CN=76 Runoff=4.05 cfs 0.204 af

SubcatchmentArea 36: Area 36 Runoff Area=2.594 ac 0.00% Impervious Runoff Depth=3.19"
Flow Length=183' Tc=2.2 min CN=84 Runoff=14.85 cfs 0.689 af

SubcatchmentArea 37: Area 37 Runoff Area=0.306 ac 0.00% Impervious Runoff Depth=0.66"
Flow Length=133' Tc=4.5 min CN=50 Runoff=0.24 cfs 0.017 af

SubcatchmentArea 38: Area 38 Runoff Area=1.430 ac 0.00% Impervious Runoff Depth=1.52"
Flow Length=156' Slope=0.2500 '/' Tc=4.1 min CN=64 Runoff=3.58 cfs 0.181 af

SubcatchmentArea 39: Area 39 Runoff Area=0.742 ac 0.00% Impervious Runoff Depth=1.45"
Flow Length=145' Tc=4.3 min CN=63 Runoff=1.74 cfs 0.090 af

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SubcatchmentArea 4: Area 4 Runoff Area=0.288 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=296' Tc=4.0 min CN=69 Runoff=0.92 cfs 0.045 af

SubcatchmentArea 40: Area 40 Runoff Area=0.620 ac 0.00% Impervious Runoff Depth=1.00"
Flow Length=168' Tc=9.6 min CN=56 Runoff=0.72 cfs 0.051 af

SubcatchmentArea 41: Area 41 Runoff Area=0.739 ac 0.00% Impervious Runoff Depth=1.00"
Flow Length=141' Tc=7.2 min CN=56 Runoff=0.98 cfs 0.061 af

SubcatchmentArea 42a: Area 42a Runoff Area=0.871 ac 0.00% Impervious Runoff Depth=1.59"
Flow Length=144' Slope=0.0500 '/' Tc=7.8 min CN=65 Runoff=2.00 cfs 0.116 af

SubcatchmentArea 42b: Area 42b Runoff Area=0.712 ac 0.00% Impervious Runoff Depth=2.05"
Flow Length=102' Slope=0.0500 '/' Tc=7.3 min CN=71 Runoff=2.19 cfs 0.122 af

SubcatchmentArea 43: Area 43 Runoff Area=0.769 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=139' Slope=0.0500 '/' Tc=7.7 min CN=69 Runoff=2.14 cfs 0.121 af

SubcatchmentArea 44: Area 44 Runoff Area=1.416 ac 0.00% Impervious Runoff Depth=0.18"
Flow Length=941' Slope=0.0260 '/' Tc=22.0 min CN=39 Runoff=0.06 cfs 0.022 af

SubcatchmentArea 45: Area 45 Runoff Area=2.792 ac 0.00% Impervious Runoff Depth=1.32"
Flow Length=419' Tc=14.7 min CN=61 Runoff=3.88 cfs 0.306 af

SubcatchmentArea 46: Area 46 Runoff Area=2.044 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=138' Tc=4.0 min CN=69 Runoff=6.52 cfs 0.322 af

SubcatchmentArea 47: Area 47 Runoff Area=0.457 ac 0.00% Impervious Runoff Depth=1.97"
Flow Length=122' Slope=0.2500 '/' Tc=3.9 min CN=70 Runoff=1.53 cfs 0.075 af

SubcatchmentArea 48: Area 48 Runoff Area=1.194 ac 0.00% Impervious Runoff Depth=2.21"
Flow Length=98' Slope=0.0500 '/' Tc=7.2 min CN=73 Runoff=3.99 cfs 0.220 af

SubcatchmentArea 49: Area 49 Runoff Area=0.079 ac 0.00% Impervious Runoff Depth=2.13"
Flow Length=143' Tc=5.1 min CN=72 Runoff=0.27 cfs 0.014 af

SubcatchmentArea 5: Area 5 Runoff Area=0.986 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=608' Tc=6.6 min CN=69 Runoff=2.87 cfs 0.155 af

SubcatchmentArea 50: Area 50 Runoff Area=3.726 ac 0.00% Impervious Runoff Depth=2.05"
Flow Length=391' Tc=11.1 min CN=71 Runoff=9.80 cfs 0.636 af

SubcatchmentArea 51: Area 51 Runoff Area=0.698 ac 0.00% Impervious Runoff Depth=0.18"
Flow Length=100' Slope=0.0600 '/' Tc=6.8 min CN=39 Runoff=0.03 cfs 0.011 af

SubcatchmentArea 52: Area 52 Runoff Area=0.475 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=425' Tc=4.5 min CN=69 Runoff=1.48 cfs 0.075 af

SubcatchmentArea 53: Area 53 Runoff Area=1.618 ac 0.00% Impervious Runoff Depth=1.18"
Flow Length=384' Tc=4.2 min CN=59 Runoff=2.98 cfs 0.160 af

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SubcatchmentArea 54: Area 54 Runoff Area=0.826 ac 0.00% Impervious Runoff Depth=1.12"
Flow Length=126' Slope=0.2500 '/' Tc=3.9 min CN=58 Runoff=1.45 cfs 0.077 af

SubcatchmentArea 55: Area 55 Runoff Area=1.089 ac 0.00% Impervious Runoff Depth=1.12"
Flow Length=158' Tc=4.3 min CN=58 Runoff=1.86 cfs 0.102 af

SubcatchmentArea 56: Area 56 Runoff Area=1.194 ac 0.00% Impervious Runoff Depth=1.18"
Flow Length=221' Tc=4.4 min CN=59 Runoff=2.17 cfs 0.118 af

SubcatchmentArea 57: Area 57 Runoff Area=2.220 ac 0.00% Impervious Runoff Depth=0.88"
Flow Length=240' Tc=4.6 min CN=54 Runoff=2.69 cfs 0.162 af

SubcatchmentArea 58: Area 58 Runoff Area=2.476 ac 0.00% Impervious Runoff Depth=1.12"
Flow Length=263' Tc=4.7 min CN=58 Runoff=4.13 cfs 0.231 af

SubcatchmentArea 59: Area 59 Runoff Area=1.683 ac 0.00% Impervious Runoff Depth=0.82"
Flow Length=146' Slope=0.2345 '/' Tc=4.1 min CN=53 Runoff=1.90 cfs 0.115 af

SubcatchmentArea 6: Area 6 Runoff Area=0.504 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=258' Tc=3.4 min CN=69 Runoff=1.66 cfs 0.079 af

SubcatchmentArea 60: Area 60 Runoff Area=2.001 ac 0.00% Impervious Runoff Depth=0.33"
Flow Length=318' Tc=20.8 min CN=43 Runoff=0.24 cfs 0.055 af

SubcatchmentArea 61: Area 61 Runoff Area=2.177 ac 0.00% Impervious Runoff Depth=0.18"
Flow Length=149' Tc=8.2 min CN=39 Runoff=0.09 cfs 0.033 af

SubcatchmentArea 62: Area 62 Runoff Area=0.594 ac 0.00% Impervious Runoff Depth=0.66"
Flow Length=147' Slope=0.0544 '/' Tc=7.6 min CN=50 Runoff=0.39 cfs 0.032 af

SubcatchmentArea 63: Area 63 Runoff Area=1.509 ac 100.00% Impervious Runoff Depth=4.67"
Tc=0.0 min CN=98 Runoff=10.73 cfs 0.588 af

SubcatchmentArea 64: Area 64 Runoff Area=5.227 ac 0.00% Impervious Runoff Depth=0.18"
Flow Length=701' Tc=7.9 min CN=39 Runoff=0.22 cfs 0.079 af

SubcatchmentArea 65: Area 65 Runoff Area=3.035 ac 0.00% Impervious Runoff Depth=0.51"
Flow Length=886' Slope=0.0068 '/' Tc=38.9 min CN=47 Runoff=0.61 cfs 0.128 af

SubcatchmentArea 66: Area 66 Runoff Area=0.409 ac 0.00% Impervious Runoff Depth=1.18"
Flow Length=52' Slope=0.1154 '/' Tc=3.1 min CN=59 Runoff=0.81 cfs 0.040 af

SubcatchmentArea 67: Area 67 Runoff Area=0.755 ac 0.00% Impervious Runoff Depth=0.71"
Flow Length=86' Slope=0.2326 '/' Tc=3.5 min CN=51 Runoff=0.71 cfs 0.045 af

SubcatchmentArea 68: Area 68 Runoff Area=1.671 ac 0.00% Impervious Runoff Depth=0.71"
Flow Length=126' Tc=4.0 min CN=51 Runoff=1.52 cfs 0.099 af

SubcatchmentArea 69: Area 69 Runoff Area=9.875 ac 0.00% Impervious Runoff Depth=0.29"
Flow Length=1,337' Tc=16.6 min CN=42 Runoff=0.99 cfs 0.238 af

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SubcatchmentArea 7: Area 7 Runoff Area=0.936 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=541' Tc=5.3 min CN=69 Runoff=2.81 cfs 0.148 af

SubcatchmentArea 70: Area 70 Runoff Area=0.694 ac 0.00% Impervious Runoff Depth=1.67"
Flow Length=127' Slope=0.2500 '/' Tc=3.9 min CN=66 Runoff=1.94 cfs 0.096 af

SubcatchmentArea 8: Area 8 Runoff Area=2.114 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=371' Tc=6.6 min CN=69 Runoff=6.16 cfs 0.333 af

SubcatchmentArea 9: Area 9 Runoff Area=0.810 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=292' Tc=6.3 min CN=69 Runoff=2.37 cfs 0.128 af

Reach 53R: Culvert C1 Avg. Flow Depth=0.00' Max Vel=0.00 fps
24.0" Round Pipe n=0.012 L=51.9' S=0.0222 '/' Capacity=36.48 cfs Outflow=0.00 cfs 0.000 af

Reach RD1: Roadside Ditch 1 Avg. Flow Depth=0.10' Max Vel=1.34 fps Inflow=0.61 cfs 0.128 af
n=0.030 L=440.6' S=0.0188 '/' Capacity=47.16 cfs Outflow=0.60 cfs 0.128 af

Reach RD2: Roadside Ditch 2 Avg. Flow Depth=0.40' Max Vel=2.70 fps Inflow=11.19 cfs 0.838 af
n=0.030 L=433.0' S=0.0162 '/' Capacity=72.77 cfs Outflow=10.57 cfs 0.838 af

Reach RD3: Roadside Ditch 3 Avg. Flow Depth=0.62' Max Vel=3.79 fps Inflow=6.95 cfs 0.341 af
n=0.030 L=821.0' S=0.0288 '/' Capacity=20.76 cfs Outflow=5.77 cfs 0.341 af

Reach RD4: Roadside Ditch 4 Avg. Flow Depth=0.12' Max Vel=1.05 fps Inflow=1.52 cfs 0.099 af
n=0.030 L=495.6' S=0.0090 '/' Capacity=54.26 cfs Outflow=0.92 cfs 0.099 af

Reach RD5: Roadside Ditch 5 Avg. Flow Depth=0.38' Max Vel=3.65 fps Inflow=2.25 cfs 0.109 af
n=0.030 L=288.0' S=0.0531 '/' Capacity=28.18 cfs Outflow=2.01 cfs 0.109 af

Reach S1.0: Swale S1.0 Avg. Flow Depth=0.93' Max Vel=2.44 fps Inflow=30.93 cfs 1.665 af
n=0.030 L=551.3' S=0.0039 '/' Capacity=118.85 cfs Outflow=26.03 cfs 1.665 af

Reach S1.1: Swale S1.1 Avg. Flow Depth=0.03' Max Vel=0.99 fps Inflow=0.24 cfs 0.017 af
n=0.030 L=98.0' S=0.0396 '/' Capacity=376.93 cfs Outflow=0.22 cfs 0.017 af

Reach S1.2: Swale S1.2 Avg. Flow Depth=0.57' Max Vel=4.60 fps Inflow=27.11 cfs 1.778 af
n=0.030 L=170.0' S=0.0242 '/' Capacity=294.55 cfs Outflow=26.46 cfs 1.778 af

Reach S1.3: Swale S1.3 Avg. Flow Depth=0.55' Max Vel=4.94 fps Inflow=27.98 cfs 1.960 af
n=0.030 L=212.6' S=0.0293 '/' Capacity=324.28 cfs Outflow=27.48 cfs 1.960 af

Reach S1.4: Swale S1.4 Avg. Flow Depth=0.73' Max Vel=4.09 fps Inflow=32.89 cfs 2.521 af
n=0.030 L=72.2' S=0.0144 '/' Capacity=227.36 cfs Outflow=32.85 cfs 2.521 af

Reach S1.5: Swale S1.5 Avg. Flow Depth=1.02' Max Vel=2.73 fps Inflow=33.64 cfs 2.583 af
n=0.030 L=148.0' S=0.0045 '/' Capacity=126.50 cfs Outflow=33.34 cfs 2.583 af

Reach S1.6: Swale S1.6 Avg. Flow Depth=0.20' Max Vel=1.12 fps Inflow=2.14 cfs 0.121 af
n=0.030 L=179.7' S=0.0050 '/' Capacity=134.06 cfs Outflow=1.95 cfs 0.121 af

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Reach S1.7: Swale S1.7 Avg. Flow Depth=1.04' Max Vel=3.05 fps Inflow=38.89 cfs 2.941 af
n=0.030 L=252.0' S=0.0054 '/' Capacity=139.68 cfs Outflow=38.11 cfs 2.941 af

Reach S1.8: Swale S1.8 Avg. Flow Depth=0.31' Max Vel=1.88 fps Inflow=2.19 cfs 0.122 af
n=0.030 L=245.8' S=0.0099 '/' Capacity=90.14 cfs Outflow=1.99 cfs 0.122 af

Reach S1.9: Swale S1.9 Avg. Flow Depth=0.99' Max Vel=3.48 fps Inflow=41.96 cfs 3.247 af
n=0.030 L=422.0' S=0.0075 '/' Capacity=163.67 cfs Outflow=40.72 cfs 3.247 af

Reach S2.1: Swale S2.1 Avg. Flow Depth=1.34' Max Vel=3.22 fps Inflow=40.74 cfs 3.279 af
n=0.030 L=389.0' S=0.0054 '/' Capacity=97.05 cfs Outflow=39.80 cfs 3.279 af

Reach S2.2: Swale S2.2 Avg. Flow Depth=1.30' Max Vel=3.34 fps Inflow=66.42 cfs 6.023 af
n=0.030 L=411.0' S=0.0049 '/' Capacity=152.61 cfs Outflow=65.44 cfs 6.023 af

Reach S2.3: Swale S2.3 Avg. Flow Depth=1.00' Max Vel=4.74 fps Inflow=66.33 cfs 6.216 af
n=0.030 L=307.0' S=0.0130 '/' Capacity=249.72 cfs Outflow=65.84 cfs 6.216 af

Reach S3.1: Swale S3.1 Avg. Flow Depth=0.37' Max Vel=1.62 fps Inflow=6.52 cfs 0.322 af
n=0.030 L=357.0' S=0.0050 '/' Capacity=133.76 cfs Outflow=5.46 cfs 0.322 af

Reach S3.2: Swale S3.2 Avg. Flow Depth=0.76' Max Vel=2.46 fps Inflow=20.49 cfs 1.211 af
n=0.030 L=34.0' S=0.0050 '/' Capacity=133.95 cfs Outflow=20.35 cfs 1.211 af

Reach S3.3: Swale S3.3 Avg. Flow Depth=0.58' Max Vel=3.39 fps Inflow=20.35 cfs 1.211 af
n=0.030 L=200.0' S=0.0130 '/' Capacity=215.99 cfs Outflow=19.21 cfs 1.211 af

Reach S3.4: Swale S3.4 Avg. Flow Depth=0.47' Max Vel=1.99 fps Inflow=3.99 cfs 0.220 af
n=0.030 L=283.0' S=0.0071 '/' Capacity=76.21 cfs Outflow=3.61 cfs 0.220 af

Reach S3.5: Swale S3.5 Avg. Flow Depth=1.27' Max Vel=2.27 fps Inflow=39.25 cfs 2.554 af
n=0.030 L=318.5' S=0.0024 '/' Capacity=93.14 cfs Outflow=37.05 cfs 2.554 af

Reach S4.1: Swale S4.1 Avg. Flow Depth=0.14' Max Vel=1.62 fps Inflow=2.74 cfs 0.145 af
n=0.030 L=240.0' S=0.0153 '/' Capacity=70.22 cfs Outflow=2.38 cfs 0.145 af

Reach S4.2: Swale S4.2 Avg. Flow Depth=0.26' Max Vel=2.12 fps Inflow=6.29 cfs 0.372 af
n=0.030 L=259.3' S=0.0127 '/' Capacity=63.88 cfs Outflow=5.84 cfs 0.372 af

Reach S4.3: Swale S4.3 Avg. Flow Depth=0.73' Max Vel=1.82 fps Inflow=18.75 cfs 1.155 af
n=0.030 L=362.9' S=0.0027 '/' Capacity=108.12 cfs Outflow=16.68 cfs 1.155 af

Reach S4.4: Swale S4.4 Avg. Flow Depth=0.75' Max Vel=2.26 fps Inflow=22.06 cfs 1.732 af
n=0.030 L=495.6' S=0.0040 '/' Capacity=132.85 cfs Outflow=21.14 cfs 1.732 af

Reach S4.5: Swale S4.5 Avg. Flow Depth=0.59' Max Vel=3.07 fps Inflow=22.26 cfs 1.915 af
n=0.030 L=411.1' S=0.0097 '/' Capacity=465.89 cfs Outflow=21.79 cfs 1.915 af

Reach S4.6: Swale S4.6 Avg. Flow Depth=1.24' Max Vel=5.00 fps Inflow=89.57 cfs 8.673 af
n=0.030 L=537.0' S=0.0112 '/' Capacity=499.25 cfs Outflow=88.39 cfs 8.673 af

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Reach S5.1: Swale S5.1 Avg. Flow Depth=0.20' Max Vel=2.00 fps Inflow=4.05 cfs 0.204 af
n=0.030 L=428.0' S=0.0154 '/' Capacity=235.24 cfs Outflow=3.50 cfs 0.204 af

Reach S5.2: Swale S5.2 Avg. Flow Depth=0.10' Max Vel=1.89 fps Inflow=1.73 cfs 0.081 af
n=0.030 L=183.6' S=0.0331 '/' Capacity=344.73 cfs Outflow=1.51 cfs 0.081 af

Pond C8: Culvert C8 Peak Elev=811.21' Storage=0.000 af Inflow=0.95 cfs 0.043 af
12.0" Round Culvert n=0.012 L=85.6' S=0.0245 '/' Outflow=0.96 cfs 0.043 af

Pond N: North Infiltration Area Peak Elev=803.89' Storage=20,733 cf Inflow=11.60 cfs 1.175 af
Outflow=1.40 cfs 1.175 af

Pond Sed Pond: Sedimentation Basin Peak Elev=792.17' Storage=175,109 cf Inflow=90.06 cfs 9.372 af
6.223 af Primary=10.22 cfs 3.149 af Secondary=0.00 cfs 0.000 af Tertiary=0.00 cfs 0.000 af Outflow=15.75 cfs 9.372 af

Link 4L: Culvert C2b Inflow=3.50 cfs 0.204 af
Primary=3.50 cfs 0.204 af

Link C1: Culvert C1 Inflow=0.60 cfs 0.128 af
Primary=0.60 cfs 0.128 af

Link C10: Culvert C10 Inflow=11.21 cfs 0.937 af
Primary=11.21 cfs 0.937 af

Link C11: Culvert C11 Inflow=26.46 cfs 1.778 af
Primary=26.46 cfs 1.778 af

Link C2: Culvert C2a Inflow=10.41 cfs 0.626 af
Primary=10.41 cfs 0.626 af

Link C3: Culvert C3 Inflow=27.48 cfs 1.960 af
Primary=27.48 cfs 1.960 af

Link C4: Culvert C4 Inflow=32.85 cfs 2.521 af
Primary=32.85 cfs 2.521 af

Link C5: Culvert C5 Inflow=38.11 cfs 2.941 af
Primary=38.11 cfs 2.941 af

Link C6: Culvert C6 Inflow=30.03 cfs 1.918 af
Primary=30.03 cfs 1.918 af

Link C7: Culvert C7 Inflow=68.10 cfs 6.703 af
Primary=68.10 cfs 6.703 af

Link C9: Culvert C9 Inflow=0.22 cfs 0.017 af
Primary=0.22 cfs 0.017 af

Link F10: Flume 10 Inflow=0.95 cfs 0.043 af
Primary=0.95 cfs 0.043 af

Link F1A: Flume 1A Inflow=4.96 cfs 0.268 af
Primary=4.96 cfs 0.268 af

Link F1B: Flume 1B Inflow=11.65 cfs 0.620 af
Primary=11.65 cfs 0.620 af

Link F2A: Flume 2A Inflow=1.98 cfs 0.100 af
Primary=1.98 cfs 0.100 af

Link F2B: Flume 2B Inflow=6.58 cfs 0.347 af
Primary=6.58 cfs 0.347 af

Link F3: Flume 3 Inflow=1.38 cfs 0.067 af
Primary=1.38 cfs 0.067 af

Link F4A: Flume 4A Inflow=3.47 cfs 0.191 af
Primary=3.47 cfs 0.191 af

Link F4B: Flume 4B Inflow=9.10 cfs 0.488 af
Primary=9.10 cfs 0.488 af

Link F5A: Flume 5A Inflow=0.76 cfs 0.037 af
Primary=0.76 cfs 0.037 af

Link F5B: Flume 5B Inflow=2.23 cfs 0.112 af
Primary=2.23 cfs 0.112 af

Link F6A: Flume 6A Inflow=4.38 cfs 0.227 af
Primary=4.38 cfs 0.227 af

Link F6B: Flume 6B Inflow=9.20 cfs 0.473 af
Primary=9.20 cfs 0.473 af

Link F7A: Flume 7A Inflow=8.53 cfs 0.461 af
Primary=8.53 cfs 0.461 af

Link F7B: Flume 7B Inflow=15.13 cfs 0.814 af
Primary=15.13 cfs 0.814 af

Link F8A: Flume 8A Inflow=2.31 cfs 0.125 af
Primary=2.31 cfs 0.125 af

Link F8B: Flume 8B Inflow=7.92 cfs 0.421 af
Primary=7.92 cfs 0.421 af

Link F9A: Flume 9A Inflow=8.97 cfs 0.487 af
Primary=8.97 cfs 0.487 af

Link F9B: Flume 9B Inflow=18.15 cfs 0.976 af
Primary=18.15 cfs 0.976 af

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Link Wetland: Wetland

Inflow=10.22 cfs 3.149 af
Primary=10.22 cfs 3.149 af

Summary for Subcatchment Area 1: Area 1

Runoff = 3.32 cfs @ 12.14 hrs, Volume= 0.180 af, Depth= 1.89"
Routed to Link F1A : Flume 1A

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
1.141	69	Pasture/grassland/range, Fair, HSG B
1.141		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.7	60	0.1000	0.27		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
1.8	40	0.2500	0.36		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.1	16	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.9	384	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
6.5	500	Total			

Summary for Subcatchment Area 10: Area 10

Runoff = 2.31 cfs @ 12.14 hrs, Volume= 0.125 af, Depth= 1.89"
Routed to Link F8A : Flume 8A

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.791	69	Pasture/grassland/range, Fair, HSG B
0.791		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.2	71	0.1000	0.28		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
1.4	29	0.2500	0.34		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.4	88	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.4	166	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
6.4	354	Total			

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Summary for Subcatchment Area 11: Area 11

Runoff = 2.59 cfs @ 12.14 hrs, Volume= 0.140 af, Depth= 1.89"
Routed to Link F9A : Flume 9A

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.885	69	Pasture/grassland/range, Fair, HSG B
0.885		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.2	71	0.1000	0.28		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
1.4	29	0.2500	0.34		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.6	119	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.2	69	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
6.4	288	Total			

Summary for Subcatchment Area 12: Area 12

Runoff = 6.39 cfs @ 12.14 hrs, Volume= 0.348 af, Depth= 1.89"
Routed to Link F9A : Flume 9A

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
2.206	69	Pasture/grassland/range, Fair, HSG B
2.206		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.7	40	0.1000	0.25		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
2.5	60	0.2500	0.39		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.3	56	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.2	472	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
6.7	628	Total			

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Summary for Subcatchment Area 13: Area 13

Runoff = 4.83 cfs @ 12.13 hrs, Volume= 0.254 af, Depth= 1.89"
Routed to Link F1B : Flume 1B

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
1.610	69	Pasture/grassland/range, Fair, HSG B
1.610		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.1	31	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.4	581	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
5.3	712	Total			

Summary for Subcatchment Area 14: Area 14

Runoff = 1.94 cfs @ 12.11 hrs, Volume= 0.099 af, Depth= 1.89"
Routed to Link F1B : Flume 1B

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.626	69	Pasture/grassland/range, Fair, HSG B
0.626		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.2	50	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.5	183	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
4.5	333	Total			

Summary for Subcatchment Area 15: Area 15

Runoff = 1.93 cfs @ 12.11 hrs, Volume= 0.098 af, Depth= 1.89"
Routed to Link F2B : Flume 2B

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.620	69	Pasture/grassland/range, Fair, HSG B
0.620		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.2	50	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.4	181	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
4.4	331	Total			

Summary for Subcatchment Area 16: Area 16

Runoff = 2.80 cfs @ 12.14 hrs, Volume= 0.149 af, Depth= 1.89"
Routed to Link F2B : Flume 2B

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.943	69	Pasture/grassland/range, Fair, HSG B
0.943		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.7	100	0.1500	0.35		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.5	95	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.7	269	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
5.9	464	Total			

Summary for Subcatchment Area 17: Area 17

Runoff = 1.78 cfs @ 12.11 hrs, Volume= 0.090 af, Depth= 1.89"
Routed to Link F6B : Flume 6B

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.571	69	Pasture/grassland/range, Fair, HSG B
0.571		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.2	44	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.4	171	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
4.4	315	Total			

Summary for Subcatchment Area 18: Area 18

Runoff = 3.04 cfs @ 12.12 hrs, Volume= 0.156 af, Depth= 1.89"
Routed to Link F6B : Flume 6B

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.990	69	Pasture/grassland/range, Fair, HSG B
0.990		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.2	46	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.7	278	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
4.7	424	Total			

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Summary for Subcatchment Area 19: Area 19

Runoff = 3.62 cfs @ 12.12 hrs, Volume= 0.186 af, Depth= 1.89"
Routed to Link F7B : Flume 7B

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
1.179	69	Pasture/grassland/range, Fair, HSG B
1.179		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.3	60	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.6	225	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
4.7	385	Total			

Summary for Subcatchment Area 2: Area 2

Runoff = 1.71 cfs @ 12.12 hrs, Volume= 0.088 af, Depth= 1.89"
Routed to Link F1A : Flume 1A

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.557	69	Pasture/grassland/range, Fair, HSG B
0.557		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.2	100	0.1950	0.39		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.1	22	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.4	181	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
4.7	303	Total			

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Summary for Subcatchment Area 20: Area 20

Runoff = 3.24 cfs @ 12.12 hrs, Volume= 0.167 af, Depth= 1.89"
Routed to Link F7B : Flume 7B

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
1.057	69	Pasture/grassland/range, Fair, HSG B
1.057		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.3	57	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.6	262	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
4.7	419	Total			

Summary for Subcatchment Area 21: Area 21

Runoff = 1.35 cfs @ 12.11 hrs, Volume= 0.068 af, Depth= 1.89"
Routed to Link F8B : Flume 8B

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.434	69	Pasture/grassland/range, Fair, HSG B
0.434		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.1	15	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.6	259	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
4.5	374	Total			

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Summary for Subcatchment Area 22: Area 22

Runoff = 4.40 cfs @ 12.12 hrs, Volume= 0.227 af, Depth= 1.89"
Routed to Link F8B : Flume 8B

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
1.442	69	Pasture/grassland/range, Fair, HSG B
1.442		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.2	49	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.8	340	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
4.8	489	Total			

Summary for Subcatchment Area 23: Area 23

Runoff = 3.84 cfs @ 12.12 hrs, Volume= 0.197 af, Depth= 1.89"
Routed to Link F9B : Flume 9B

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
1.252	69	Pasture/grassland/range, Fair, HSG B
1.252		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.2	50	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.7	285	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
4.7	435	Total			

Summary for Subcatchment Area 24: Area 24

Runoff = 5.53 cfs @ 12.13 hrs, Volume= 0.291 af, Depth= 1.89"
Routed to Link F9B : Flume 9B

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
1.846	69	Pasture/grassland/range, Fair, HSG B
1.846		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.2	43	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.4	558	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
5.4	701	Total			

Summary for Subcatchment Area 25: Area 25

Runoff = 6.95 cfs @ 12.10 hrs, Volume= 0.341 af, Depth= 2.64"
Routed to Reach RD3 : Roadside Ditch 3

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
1.024	69	Pasture/grassland/range, Fair, HSG B
0.528	96	Gravel surface, HSG A
1.552	78	Weighted Average
1.552		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.1	23	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
3.9	123	Total			

Summary for Subcatchment Area 26: Area 26

Runoff = 2.25 cfs @ 12.10 hrs, Volume= 0.109 af, Depth= 2.13"
Routed to Reach RD5 : Roadside Ditch 5

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.543	69	Pasture/grassland/range, Fair, HSG B
0.073	96	Gravel surface, HSG A
0.616	72	Weighted Average
0.616		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.0	9	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
3.8	109	Total			

Summary for Subcatchment Area 27: Area 27

Runoff = 0.52 cfs @ 12.08 hrs, Volume= 0.023 af, Depth= 1.89"
Routed to Link F10 : Flume 10

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.149	69	Pasture/grassland/range, Fair, HSG B
0.149		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.7	12	0.2500	0.28		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.5	199	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
1.2	211	Total			

Summary for Subcatchment Area 28: Area 28

Runoff = 0.44 cfs @ 12.09 hrs, Volume= 0.020 af, Depth= 1.89"
Routed to Link F10 : Flume 10

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

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Area (ac)	CN	Description
0.126	69	Pasture/grassland/range, Fair, HSG B
0.126		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.5	59	0.2500	0.39		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"

Summary for Subcatchment Area 29: Area 29

Runoff = 3.66 cfs @ 12.13 hrs, Volume= 0.194 af, Depth= 1.89"
Routed to Link F4B : Flume 4B

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
1.228	69	Pasture/grassland/range, Fair, HSG B
1.228		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.0	6	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.9	541	0.0200	4.80	23.38	**Trap/Vee/Rect Channel Flow, Existing Diversion Berm** Bot.W=0.00' D=1.18' Z= 4.0 & 3.0 '/' Top.W=8.26' n= 0.030 Earth, grassed & winding
5.7	647	Total			

Summary for Subcatchment Area 3: Area 3

Runoff = 1.06 cfs @ 12.12 hrs, Volume= 0.055 af, Depth= 1.89"
Routed to Link F2A : Flume 2A

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.348	69	Pasture/grassland/range, Fair, HSG B
0.348		100.00% Pervious Area

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Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.2	100	0.1950	0.39		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.2	36	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.4	162	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
4.8	298	Total			

Summary for Subcatchment Area 30: Area 30

Runoff = 1.38 cfs @ 12.10 hrs, Volume= 0.067 af, Depth= 1.89"
Routed to Link F3 : Flume 3

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.427	69	Pasture/grassland/range, Fair, HSG B
0.427		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.9	70	0.2500	0.40		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.8	227	0.0200	4.80	23.38	**Trap/Vee/Rect Channel Flow, Existing Diversion Berm** Bot.W=0.00' D=1.18' Z= 4.0 & 3.0 '/' Top.W=8.26' n= 0.030 Earth, grassed & winding
0.1	65	0.2500	12.26	441.43	**Trap/Vee/Rect Channel Flow, Riprap Flume** Bot.W=12.00' D=2.00' Z= 3.0 '/' Top.W=24.00' n= 0.078 Riprap, 12-inch
3.8	362	Total			

Summary for Subcatchment Area 31: Area 31

Runoff = 0.72 cfs @ 12.10 hrs, Volume= 0.035 af, Depth= 1.89"
Routed to Link F4A : Flume 4A

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.223	69	Pasture/grassland/range, Fair, HSG B
0.223		100.00% Pervious Area

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Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.1	77	0.2500	0.41		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.5	157	0.0200	4.80	23.38	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.18' Z= 4.0 & 3.0 '/' Top.W=8.26' n= 0.030 Earth, grassed & winding
0.1	62	0.2500	12.26	441.43	**Trap/Vee/Rect Channel Flow, Riprap Flume** Bot.W=12.00' D=2.00' Z= 3.0 '/' Top.W=24.00' n= 0.078 Riprap, 12-inch
3.7	296	Total			

Summary for Subcatchment Area 32: Area 32

Runoff = 1.98 cfs @ 12.12 hrs, Volume= 0.103 af, Depth= 1.89"
Routed to Link F4B : Flume 4B

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.655	69	Pasture/grassland/range, Fair, HSG B
0.655		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.1	11	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.8	314	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Existing Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
0.3	217	0.2500	12.26	441.43	**Trap/Vee/Rect Channel Flow, Riprap Flume** Bot.W=12.00' D=2.00' Z= 3.0 '/' Top.W=24.00' n= 0.078 Riprap, 12-inch
5.0	642	Total			

Summary for Subcatchment Area 33: Area 33

Runoff = 0.76 cfs @ 12.11 hrs, Volume= 0.037 af, Depth= 1.89"
Routed to Link F5A : Flume 5A

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

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Area (ac)	CN	Description
0.237	69	Pasture/grassland/range, Fair, HSG B
0.237		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.3	83	0.2500	0.42		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.5	138	0.0200	4.80	23.38	**Trap/Vee/Rect Channel Flow, Existing Diversion Berm** Bot.W=0.00' D=1.18' Z= 4.0 & 3.0 '/' Top.W=8.26' n= 0.030 Earth, grassed & winding
0.2	127	0.2500	12.26	441.43	**Trap/Vee/Rect Channel Flow, Riprap Flume** Bot.W=12.00' D=2.00' Z= 3.0 '/' Top.W=24.00' n= 0.078 Riprap, 12-inch
4.0	348	Total			

Summary for Subcatchment Area 34: Area 34

Runoff = 1.73 cfs @ 12.10 hrs, Volume= 0.081 af, Depth= 2.29"
Routed to Reach S5.2 : Swale S5.2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.346	69	Pasture/grassland/range, Fair, HSG B
0.078	96	Gravel surface, HSG A
0.424	74	Weighted Average
0.424		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.1	78	0.2500	0.41		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"

Summary for Subcatchment Area 35: Area 35

Runoff = 4.05 cfs @ 12.11 hrs, Volume= 0.204 af, Depth= 2.46"
Routed to Reach S5.1 : Swale S5.1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.745	69	Pasture/grassland/range, Fair, HSG B
0.248	96	Gravel surface, HSG A
0.993	76	Weighted Average
0.993		100.00% Pervious Area

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Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.3	70	0.1736	0.35		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.9	30	0.0050	0.58		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.77"
0.1	12	0.0050	1.44		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.1	14	0.1766	2.94		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
4.4	126	Total			

Summary for Subcatchment Area 36: Area 36

Runoff = 14.85 cfs @ 12.08 hrs, Volume= 0.689 af, Depth= 3.19"
Routed to Reach S1.0 : Swale S1.0

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
1.120	69	Pasture/grassland/range, Fair, HSG B
1.474	96	Gravel surface, HSG A
2.594	84	Weighted Average
2.594		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.5	100	0.0140	1.11		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.77"
0.2	32	0.0140	2.40		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.5	40	0.0050	1.44		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.0	11	0.5000	4.95		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
2.2	183	Total			

Summary for Subcatchment Area 37: Area 37

Runoff = 0.24 cfs @ 12.14 hrs, Volume= 0.017 af, Depth= 0.66"
Routed to Reach S1.1 : Swale S1.1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

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Area (ac)	CN	Description
0.249	39	Pasture/grassland/range, Good, HSG A
0.057	96	Gravel surface, HSG A
0.306	50	Weighted Average
0.306		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.4	72	0.1736	0.35		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.8	28	0.0050	0.57		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.77"
0.2	19	0.0050	1.44		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.1	14	0.1766	2.94		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
4.5	133	Total			

Summary for Subcatchment Area 38: Area 38

Runoff = 3.58 cfs @ 12.11 hrs, Volume= 0.181 af, Depth= 1.52"
Routed to Reach S1.3 : Swale S1.3

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.395	39	Pasture/grassland/range, Good, HSG A
0.886	69	Pasture/grassland/range, Fair, HSG B
0.149	96	Gravel surface, HSG A
1.430	64	Weighted Average
1.430		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.3	56	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
4.1	156	Total			

Summary for Subcatchment Area 39: Area 39

Runoff = 1.74 cfs @ 12.11 hrs, Volume= 0.090 af, Depth= 1.45"
Routed to Reach S1.4 : Swale S1.4

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

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Area (ac)	CN	Description
0.225	39	Pasture/grassland/range, Good, HSG A
0.436	69	Pasture/grassland/range, Fair, HSG B
0.081	96	Gravel surface, HSG A
0.742	63	Weighted Average
0.742		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.3	23	0.0050	1.44		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.2	22	0.0833	2.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
4.3	145	Total			

Summary for Subcatchment Area 4: Area 4

Runoff = 0.92 cfs @ 12.11 hrs, Volume= 0.045 af, Depth= 1.89"
Routed to Link F2A : Flume 2A

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.288	69	Pasture/grassland/range, Fair, HSG B
0.288		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.4	49	0.0820	0.24		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.6	247	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
4.0	296	Total			

Summary for Subcatchment Area 40: Area 40

Runoff = 0.72 cfs @ 12.19 hrs, Volume= 0.051 af, Depth= 1.00"
Routed to Reach S1.4 : Swale S1.4

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

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Area (ac)	CN	Description
0.317	39	Pasture/grassland/range, Good, HSG A
0.243	69	Pasture/grassland/range, Fair, HSG B
0.060	96	Gravel surface, HSG A
0.620	56	Weighted Average
0.620		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.2	81	0.0245	0.16		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
1.0	19	0.2500	0.31		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.1	29	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.2	20	0.0050	1.44		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.1	19	0.1053	2.27		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
9.6	168	Total			

Summary for Subcatchment Area 41: Area 41

Runoff = 0.98 cfs @ 12.16 hrs, Volume= 0.061 af, Depth= 1.00"
Routed to Reach S1.5 : Swale S1.5

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.389	39	Pasture/grassland/range, Good, HSG A
0.270	69	Pasture/grassland/range, Fair, HSG B
0.080	96	Gravel surface, HSG A
0.739	56	Weighted Average
0.739		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.5	49	0.0408	0.18		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
2.1	47	0.2500	0.37		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.2	4	0.0050	0.39		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.77"
0.2	19	0.0050	1.44		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.2	22	0.1136	2.36		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
7.2	141	Total			

Summary for Subcatchment Area 42a: Area 42a

Runoff = 2.00 cfs @ 12.16 hrs, Volume= 0.116 af, Depth= 1.59"
Routed to Reach S1.7 : Swale S1.7

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.249	39	Pasture/grassland/range, Good, HSG A
0.489	69	Pasture/grassland/range, Fair, HSG B
0.133	96	Gravel surface, HSG A
0.871	65	Weighted Average
0.871		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.3	100	0.0500	0.23		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.5	44	0.0500	1.57		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
7.8	144	Total			

Summary for Subcatchment Area 42b: Area 42b

Runoff = 2.19 cfs @ 12.15 hrs, Volume= 0.122 af, Depth= 2.05"
Routed to Reach S1.8 : Swale S1.8

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.655	69	Pasture/grassland/range, Fair, HSG B
0.057	96	Gravel surface, HSG A
0.712	71	Weighted Average
0.712		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.3	100	0.0500	0.23		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.0	2	0.0500	1.57		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
7.3	102	Total			

Summary for Subcatchment Area 43: Area 43

Runoff = 2.14 cfs @ 12.15 hrs, Volume= 0.121 af, Depth= 1.89"
Routed to Reach S1.6 : Swale S1.6

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.769	69	Pasture/grassland/range, Fair, HSG B
0.769		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.3	100	0.0500	0.23		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.4	39	0.0500	1.57		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
7.7	139	Total			

Summary for Subcatchment Area 44: Area 44

Runoff = 0.06 cfs @ 13.20 hrs, Volume= 0.022 af, Depth= 0.18"
Routed to Reach S2.1 : Swale S2.1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
1.416	39	Pasture/grassland/range, Good, HSG A
1.416		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.5	100	0.0260	0.18		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
2.9	194	0.0260	1.13		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
9.6	647	0.0260	1.13		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
22.0	941	Total			

Summary for Subcatchment Area 45: Area 45

Runoff = 3.88 cfs @ 12.25 hrs, Volume= 0.306 af, Depth= 1.32"
Routed to Reach S1.9 : Swale S1.9

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

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Area (ac)	CN	Description
0.797	39	Pasture/grassland/range, Good, HSG A
1.938	69	Pasture/grassland/range, Fair, HSG B
0.057	96	Gravel surface, HSG A
2.792	61	Weighted Average
2.792		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.3	100	0.0500	0.23		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
1.3	119	0.0500	1.57		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.1	22	0.1905	3.06		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
6.0	178	0.0050	0.49		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
14.7	419	Total			

Summary for Subcatchment Area 46: Area 46

Runoff = 6.52 cfs @ 12.11 hrs, Volume= 0.322 af, Depth= 1.89"
Routed to Reach S3.1 : Swale S3.1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
2.044	69	Pasture/grassland/range, Fair, HSG B
2.044		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.2	38	0.2632	3.59		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
4.0	138	Total			

Summary for Subcatchment Area 47: Area 47

Runoff = 1.53 cfs @ 12.11 hrs, Volume= 0.075 af, Depth= 1.97"
Routed to Reach S3.2 : Swale S3.2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

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Area (ac)	CN	Description
0.435	69	Pasture/grassland/range, Fair, HSG B
0.022	96	Gravel surface, HSG A
0.457	70	Weighted Average
0.457		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.1	22	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
3.9	122	Total			

Summary for Subcatchment Area 48: Area 48

Runoff = 3.99 cfs @ 12.15 hrs, Volume= 0.220 af, Depth= 2.21"
Routed to Reach S3.4 : Swale S3.4

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
1.031	69	Pasture/grassland/range, Fair, HSG B
0.163	96	Gravel surface, HSG A
1.194	73	Weighted Average
1.194		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.2	98	0.0500	0.23		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"

Summary for Subcatchment Area 49: Area 49

Runoff = 0.27 cfs @ 12.12 hrs, Volume= 0.014 af, Depth= 2.13"
Routed to Link C6 : Culvert C6

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.070	69	Pasture/grassland/range, Fair, HSG B
0.009	96	Gravel surface, HSG A
0.079	72	Weighted Average
0.079		100.00% Pervious Area

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Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.5	90	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
1.2	10	0.0500	0.14		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.1	10	0.0500	1.57		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.2	15	0.0050	1.44		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.1	18	0.1390	2.61		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
5.1	143	Total			

Summary for Subcatchment Area 5: Area 5

Runoff = 2.87 cfs @ 12.14 hrs, Volume= 0.155 af, Depth= 1.89"
Routed to Link F4A : Flume 4A

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.986	69	Pasture/grassland/range, Fair, HSG B
0.986		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.2	31	0.1000	0.24		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
2.8	69	0.2500	0.40		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.0	9	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.5	419	0.0200	4.80	23.38	**Trap/Vee/Rect Channel Flow, Existing Diversion Berm** Bot.W=0.00' D=1.18' Z= 4.0 & 3.0 '/' Top.W=8.26' n= 0.030 Earth, grassed & winding
0.1	80	0.2500	12.26	441.43	**Trap/Vee/Rect Channel Flow, Riprap Flume** Bot.W=12.00' D=2.00' Z= 3.0 '/' Top.W=24.00' n= 0.078 Riprap, 12-inch
6.6	608	Total			

Summary for Subcatchment Area 50: Area 50

Runoff = 9.80 cfs @ 12.20 hrs, Volume= 0.636 af, Depth= 2.05"
Routed to Reach S3.5 : Swale S3.5

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

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Area (ac)	CN	Description
3.470	69	Pasture/grassland/range, Fair, HSG B
0.256	96	Gravel surface, HSG A
3.726	71	Weighted Average
3.726		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.3	100	0.0500	0.23		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.9	83	0.0500	1.57		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
2.9	208	0.0289	1.19		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
11.1	391	Total			

Summary for Subcatchment Area 51: Area 51

Runoff = 0.03 cfs @ 12.51 hrs, Volume= 0.011 af, Depth= 0.18"
Routed to Reach S2.1 : Swale S2.1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.698	39	Pasture/grassland/range, Good, HSG A
0.698		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.8	100	0.0600	0.25		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"

Summary for Subcatchment Area 52: Area 52

Runoff = 1.48 cfs @ 12.11 hrs, Volume= 0.075 af, Depth= 1.89"
Routed to Link F5B : Flume 5B

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.475	69	Pasture/grassland/range, Fair, HSG B
0.475		100.00% Pervious Area

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Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.5	90	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.8	219	0.0200	4.80	23.38	**Trap/Vee/Rect Channel Flow, Existing Diversion Berm** Bot.W=0.00' D=1.18' Z= 4.0 & 3.0 '/' Top.W=8.26' n= 0.030 Earth, grassed & winding
0.2	116	0.2500	12.26	441.43	**Trap/Vee/Rect Channel Flow, Riprap Flume** Bot.W=12.00' D=2.00' Z= 3.0 '/' Top.W=24.00' n= 0.078 Riprap, 12-inch
4.5	425	Total			

Summary for Subcatchment Area 53: Area 53

Runoff = 2.98 cfs @ 12.12 hrs, Volume= 0.160 af, Depth= 1.18"
Routed to Reach S2.3 : Swale S2.3

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
1.079	69	Pasture/grassland/range, Fair, HSG B
0.539	39	Pasture/grassland/range, Good, HSG A
1.618	59	Weighted Average
1.618		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.1	77	0.2500	0.41		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.8	237	0.0200	4.80	23.38	**Trap/Vee/Rect Channel Flow, Existing Diversion Berm** Bot.W=0.00' D=1.18' Z= 4.0 & 3.0 '/' Top.W=8.26' n= 0.030 Earth, grassed & winding
0.3	70	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
4.2	384	Total			

Summary for Subcatchment Area 54: Area 54

Runoff = 1.45 cfs @ 12.11 hrs, Volume= 0.077 af, Depth= 1.12"
Routed to Reach S2.2 : Swale S2.2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

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Area (ac)	CN	Description
0.520	69	Pasture/grassland/range, Fair, HSG B
0.306	39	Pasture/grassland/range, Good, HSG A
0.826	58	Weighted Average
0.826		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.1	26	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
3.9	126	Total			

Summary for Subcatchment Area 55: Area 55

Runoff = 1.86 cfs @ 12.12 hrs, Volume= 0.102 af, Depth= 1.12"
Routed to Reach S4.1 : Swale S4.1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.526	39	Pasture/grassland/range, Good, HSG A
0.405	69	Pasture/grassland/range, Fair, HSG B
0.158	96	Gravel surface, HSG A
1.089	58	Weighted Average
1.089		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.5	80	0.2000	0.38		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.2	20	0.0500	1.34		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.77"
0.1	10	0.0050	1.44		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.5	48	0.0625	1.75		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
4.3	158	Total			

Summary for Subcatchment Area 56: Area 56

Runoff = 2.17 cfs @ 12.12 hrs, Volume= 0.118 af, Depth= 1.18"
Routed to Reach S4.2 : Swale S4.2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

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Area (ac)	CN	Description
0.580	39	Pasture/grassland/range, Good, HSG A
0.433	69	Pasture/grassland/range, Fair, HSG B
0.181	96	Gravel surface, HSG B
1.194	59	Weighted Average
1.194		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.6	121	0.2314	3.37		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
4.4	221	Total			

Summary for Subcatchment Area 57: Area 57

Runoff = 2.69 cfs @ 12.13 hrs, Volume= 0.162 af, Depth= 0.88"
Routed to Reach S4.3 : Swale S4.3

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
1.134	39	Pasture/grassland/range, Good, HSG A
1.086	69	Pasture/grassland/range, Fair, HSG B
2.220	54	Weighted Average
2.220		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.8	140	0.1857	3.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
4.6	240	Total			

Summary for Subcatchment Area 58: Area 58

Runoff = 4.13 cfs @ 12.13 hrs, Volume= 0.231 af, Depth= 1.12"
Routed to Reach S4.4 : Swale S4.4

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

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Area (ac)	CN	Description
0.939	39	Pasture/grassland/range, Good, HSG A
1.537	69	Pasture/grassland/range, Fair, HSG B
2.476	58	Weighted Average
2.476		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.9	163	0.1718	2.90		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
4.7	263	Total			

Summary for Subcatchment Area 59: Area 59

Runoff = 1.90 cfs @ 12.12 hrs, Volume= 0.115 af, Depth= 0.82"
Routed to Reach S4.5 : Swale S4.5

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.898	39	Pasture/grassland/range, Good, HSG A
0.785	69	Pasture/grassland/range, Fair, HSG B
1.683	53	Weighted Average
1.683		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.9	100	0.2345	0.42		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.2	46	0.2345	3.39		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
4.1	146	Total			

Summary for Subcatchment Area 6: Area 6

Runoff = 1.66 cfs @ 12.10 hrs, Volume= 0.079 af, Depth= 1.89"
Routed to Link F6A : Flume 6A

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.504	69	Pasture/grassland/range, Fair, HSG B
0.504		100.00% Pervious Area

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Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.9	72	0.2500	0.41		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.5	186	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Existing Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
3.4	258	Total			

Summary for Subcatchment Area 60: Area 60

Runoff = 0.24 cfs @ 12.55 hrs, Volume= 0.055 af, Depth= 0.33"
Routed to Reach S4.6 : Swale S4.6

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
1.871	39	Pasture/grassland/range, Good, HSG A
0.000	96	Gravel surface, HSG A
0.130	96	Gravel surface, HSG A
2.001	43	Weighted Average
2.001		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.7	100	0.0074	0.11		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
4.7	169	0.0074	0.60		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.4	49	0.0800	1.98		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
20.8	318	Total			

Summary for Subcatchment Area 61: Area 61

Runoff = 0.09 cfs @ 12.53 hrs, Volume= 0.033 af, Depth= 0.18"
Routed to Reach S2.3 : Swale S2.3

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
2.177	39	Pasture/grassland/range, Good, HSG A
2.177		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.4	66	0.0303	0.17		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
1.6	34	0.2500	0.35		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.2	49	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
8.2	149	Total			

Summary for Subcatchment Area 62: Area 62

Runoff = 0.39 cfs @ 12.18 hrs, Volume= 0.032 af, Depth= 0.66"
Routed to Pond Sed Pond : Sedimentation Basin

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.479	39	Pasture/grassland/range, Good, HSG A
0.115	96	Gravel surface, HSG A
0.594	50	Weighted Average
0.594		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.1	100	0.0544	0.24		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.5	47	0.0544	1.63		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
7.6	147	Total			

Summary for Subcatchment Area 63: Area 63

Runoff = 10.73 cfs @ 12.04 hrs, Volume= 0.588 af, Depth= 4.67"
Routed to Pond Sed Pond : Sedimentation Basin

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
1.509	98	Water Surface, HSG A
1.509		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry,**

Summary for Subcatchment Area 64: Area 64

Runoff = 0.22 cfs @ 12.53 hrs, Volume= 0.079 af, Depth= 0.18"
Routed to Pond Sed Pond : Sedimentation Basin

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
5.227	39	Pasture/grassland/range, Good, HSG A
5.227		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.5	75	0.0933	0.28		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
1.3	25	0.2500	0.33		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.0	10	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.8	381	0.0265	7.85	109.92	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=2.00' Z= 4.0 & 3.0 '/' Top.W=14.00' n= 0.030 Earth, grassed & winding
0.8	162	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.5	48	0.0500	1.57		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
7.9	701	Total			

Summary for Subcatchment Area 65: Area 65

Runoff = 0.61 cfs @ 12.73 hrs, Volume= 0.128 af, Depth= 0.51"
Routed to Reach RD1 : Roadside Ditch 1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
2.616	39	Pasture/grassland/range, Good, HSG A
0.039	69	Pasture/grassland/range, Fair, HSG B
0.380	96	Gravel surface, HSG A
3.035	47	Weighted Average
3.035		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
16.2	100	0.0068	0.10		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
22.7	786	0.0068	0.58		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
38.9	886	Total			

Summary for Subcatchment Area 66: Area 66

Runoff = 0.81 cfs @ 12.10 hrs, Volume= 0.040 af, Depth= 1.18"
Routed to Reach RD2 : Roadside Ditch 2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.213	39	Pasture/grassland/range, Good, HSG A
0.104	69	Pasture/grassland/range, Fair, HSG B
0.092	96	Gravel surface, HSG A
0.409	59	Weighted Average
0.409		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.1	52	0.1154	0.28		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"

Summary for Subcatchment Area 67: Area 67

Runoff = 0.71 cfs @ 12.12 hrs, Volume= 0.045 af, Depth= 0.71"
Routed to Reach RD2 : Roadside Ditch 2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.524	39	Pasture/grassland/range, Good, HSG A
0.139	69	Pasture/grassland/range, Fair, HSG B
0.092	96	Gravel surface, HSG A
0.755	51	Weighted Average
0.755		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.5	86	0.2326	0.41		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"

Summary for Subcatchment Area 68: Area 68

Runoff = 1.52 cfs @ 12.12 hrs, Volume= 0.099 af, Depth= 0.71"
Routed to Reach RD4 : Roadside Ditch 4

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
1.016	39	Pasture/grassland/range, Good, HSG A
0.620	69	Pasture/grassland/range, Fair, HSG B
0.035	96	Gravel surface, HSG A
1.671	51	Weighted Average
1.671		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.2	26	0.1538	2.75		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
4.0	126	Total			

Summary for Subcatchment Area 69: Area 69

Runoff = 0.99 cfs @ 12.52 hrs, Volume= 0.238 af, Depth= 0.29"
Routed to Pond N : North Infiltration Area

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
9.360	39	Pasture/grassland/range, Good, HSG A
0.515	96	Gravel surface, HSG A
9.875	42	Weighted Average
9.875		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.5	100	0.0200	0.16		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
1.7	100	0.0200	0.99		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
4.4	1,137	0.0193	4.31	32.30	**Trap/Vee/Rect Channel Flow, Roadside Ditch** Bot.W=0.00' D=1.00' Z= 5.0 & 10.0 '/' Top.W=15.00' n= 0.030
16.6	1,337	Total			

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Summary for Subcatchment Area 7: Area 7

Runoff = 2.81 cfs @ 12.13 hrs, Volume= 0.148 af, Depth= 1.89"
Routed to Link F6A : Flume 6A

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.936	69	Pasture/grassland/range, Fair, HSG B
0.936		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.1	100	0.2070	0.40		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.2	46	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.0	395	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
5.3	541	Total			

Summary for Subcatchment Area 70: Area 70

Runoff = 1.94 cfs @ 12.11 hrs, Volume= 0.096 af, Depth= 1.67"
Routed to Reach S1.2 : Swale S1.2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.153	39	Pasture/grassland/range, Good, HSG A
0.441	69	Pasture/grassland/range, Fair, HSG B
0.100	96	Gravel surface, HSG A
0.694	66	Weighted Average
0.694		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.1	27	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
3.9	127	Total			

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Summary for Subcatchment Area 8: Area 8

Runoff = 6.16 cfs @ 12.14 hrs, Volume= 0.333 af, Depth= 1.89"
Routed to Link F7A : Flume 7A

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
2.114	69	Pasture/grassland/range, Fair, HSG B
2.114		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.5	100	0.1000	0.30		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.2	26	0.1000	2.21		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.6	121	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.3	124	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
6.6	371	Total			

Summary for Subcatchment Area 9: Area 9

Runoff = 2.37 cfs @ 12.14 hrs, Volume= 0.128 af, Depth= 1.89"
Routed to Link F7A : Flume 7A

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.810	69	Pasture/grassland/range, Fair, HSG B
0.810		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.2	71	0.1000	0.28		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
1.4	29	0.2500	0.34		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.4	89	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.3	103	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
6.3	292	Total			

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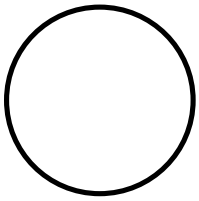
Summary for Reach 53R: Culvert C1

Bank-Full Depth= 2.00' Flow Area= 3.1 sf, Capacity= 36.48 cfs

24.0" Round Pipe
n= 0.012 Corrugated PP, smooth interior
Length= 51.9' Slope= 0.0222 '/'
Inlet Invert= 815.70', Outlet Invert= 814.55'



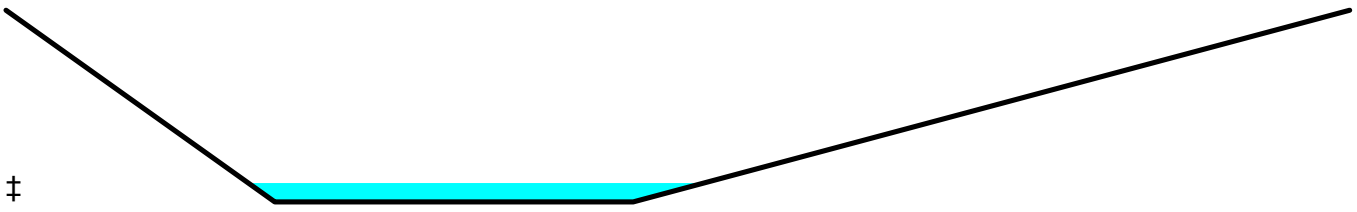
Summary for Reach RD1: Roadside Ditch 1

Inflow Area = 3.035 ac, 0.00% Impervious, Inflow Depth = 0.51" for 25-yr, 24-hr event
Inflow = 0.61 cfs @ 12.73 hrs, Volume= 0.128 af
Outflow = 0.60 cfs @ 12.89 hrs, Volume= 0.128 af, Atten= 2%, Lag= 9.5 min
Routed to Link C1 : Culvert C1

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.34 fps, Min. Travel Time= 5.5 min
Avg. Velocity = 0.62 fps, Avg. Travel Time= 11.8 min

Peak Storage= 197 cf @ 12.80 hrs
Average Depth at Peak Storage= 0.10' , Surface Width= 5.08'
Bank-Full Depth= 1.00' Flow Area= 9.5 sf, Capacity= 47.16 cfs

4.00' x 1.00' deep channel, n= 0.030
Side Slope Z-value= 3.0 8.0 '/' Top Width= 15.00'
Length= 440.6' Slope= 0.0188 '/'
Inlet Invert= 824.00', Outlet Invert= 815.70'



Summary for Reach RD2: Roadside Ditch 2

Inflow Area = 7.168 ac, 0.00% Impervious, Inflow Depth = 1.40" for 25-yr, 24-hr event
Inflow = 11.19 cfs @ 12.19 hrs, Volume= 0.838 af
Outflow = 10.57 cfs @ 12.26 hrs, Volume= 0.838 af, Atten= 6%, Lag= 4.5 min
Routed to Link C10 : Culvert C10

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.70 fps, Min. Travel Time= 2.7 min
Avg. Velocity = 0.78 fps, Avg. Travel Time= 9.2 min

Peak Storage= 1,703 cf @ 12.22 hrs
Average Depth at Peak Storage= 0.40' , Surface Width= 13.91'
Bank-Full Depth= 1.00' Flow Area= 16.0 sf, Capacity= 72.77 cfs

6.00' x 1.00' deep channel, n= 0.030
Side Slope Z-value= 10.0 '/' Top Width= 26.00'
Length= 433.0' Slope= 0.0162 '/'
Inlet Invert= 814.55', Outlet Invert= 807.54'

‡

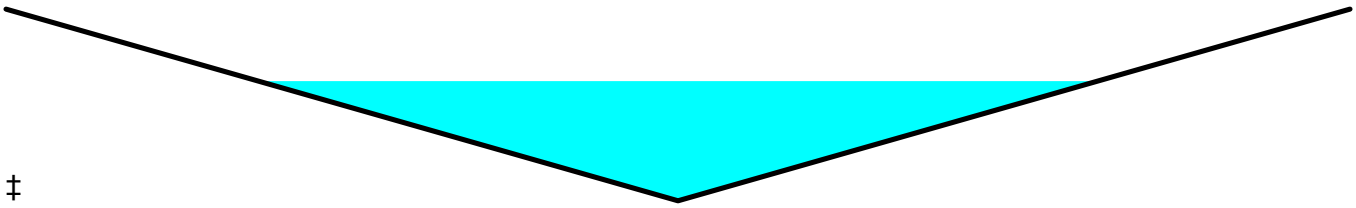
Summary for Reach RD3: Roadside Ditch 3

Inflow Area = 1.552 ac, 0.00% Impervious, Inflow Depth = 2.64" for 25-yr, 24-hr event
Inflow = 6.95 cfs @ 12.10 hrs, Volume= 0.341 af
Outflow = 5.77 cfs @ 12.20 hrs, Volume= 0.341 af, Atten= 17%, Lag= 5.9 min
Routed to Link C2 : Culvert C2a

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.79 fps, Min. Travel Time= 3.6 min
Avg. Velocity = 1.26 fps, Avg. Travel Time= 10.8 min

Peak Storage= 1,282 cf @ 12.14 hrs
Average Depth at Peak Storage= 0.62' , Surface Width= 5.00'
Bank-Full Depth= 1.00' Flow Area= 4.0 sf, Capacity= 20.76 cfs

0.00' x 1.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 8.00'
Length= 821.0' Slope= 0.0288 '/'
Inlet Invert= 841.47', Outlet Invert= 817.83'



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Summary for Reach RD4: Roadside Ditch 4

Inflow Area = 1.671 ac, 0.00% Impervious, Inflow Depth = 0.71" for 25-yr, 24-hr event
Inflow = 1.52 cfs @ 12.12 hrs, Volume= 0.099 af
Outflow = 0.92 cfs @ 12.35 hrs, Volume= 0.099 af, Atten= 39%, Lag= 13.6 min
Routed to Link C10 : Culvert C10

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.05 fps, Min. Travel Time= 7.9 min
Avg. Velocity = 0.37 fps, Avg. Travel Time= 22.6 min

Peak Storage= 447 cf @ 12.21 hrs
Average Depth at Peak Storage= 0.12' , Surface Width= 8.49'
Bank-Full Depth= 1.00' Flow Area= 16.0 sf, Capacity= 54.26 cfs

6.00' x 1.00' deep channel, n= 0.030
Side Slope Z-value= 10.0 '/' Top Width= 26.00'
Length= 495.6' Slope= 0.0090 '/'
Inlet Invert= 812.00', Outlet Invert= 807.54'

‡

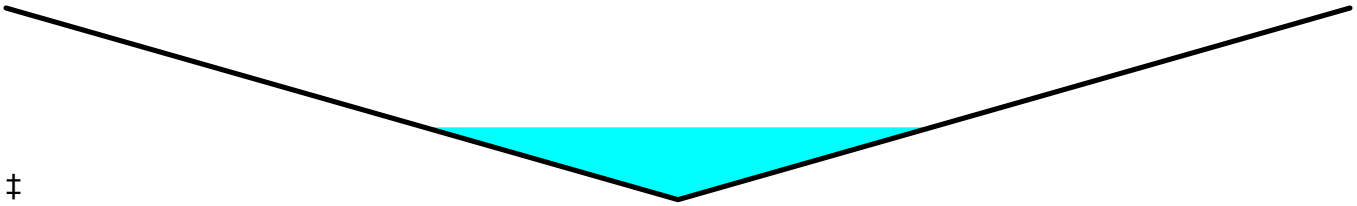
Summary for Reach RD5: Roadside Ditch 5

Inflow Area = 0.616 ac, 0.00% Impervious, Inflow Depth = 2.13" for 25-yr, 24-hr event
Inflow = 2.25 cfs @ 12.10 hrs, Volume= 0.109 af
Outflow = 2.01 cfs @ 12.14 hrs, Volume= 0.109 af, Atten= 11%, Lag= 2.5 min
Routed to Reach S4.2 : Swale S4.2

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.65 fps, Min. Travel Time= 1.3 min
Avg. Velocity = 1.38 fps, Avg. Travel Time= 3.5 min

Peak Storage= 164 cf @ 12.12 hrs
Average Depth at Peak Storage= 0.38' , Surface Width= 3.02'
Bank-Full Depth= 1.00' Flow Area= 4.0 sf, Capacity= 28.18 cfs

0.00' x 1.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 8.00'
Length= 288.0' Slope= 0.0531 '/'
Inlet Invert= 841.47', Outlet Invert= 826.18'



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Summary for Reach S1.0: Swale S1.0

Inflow Area = 8.783 ac, 0.00% Impervious, Inflow Depth = 2.27" for 25-yr, 24-hr event
Inflow = 30.93 cfs @ 12.10 hrs, Volume= 1.665 af
Outflow = 26.03 cfs @ 12.21 hrs, Volume= 1.665 af, Atten= 16%, Lag= 6.2 min
Routed to Reach S1.2 : Swale S1.2

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.44 fps, Min. Travel Time= 3.8 min
Avg. Velocity = 0.56 fps, Avg. Travel Time= 16.5 min

Peak Storage= 6,031 cf @ 12.14 hrs
Average Depth at Peak Storage= 0.93' , Surface Width= 15.46'
Bank-Full Depth= 2.00' Flow Area= 32.0 sf, Capacity= 118.85 cfs

8.00' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 24.00'
Length= 551.3' Slope= 0.0039 '/'
Inlet Invert= 823.92', Outlet Invert= 821.75'

‡

Summary for Reach S1.1: Swale S1.1

Inflow Area = 0.306 ac, 0.00% Impervious, Inflow Depth = 0.66" for 25-yr, 24-hr event
Inflow = 0.24 cfs @ 12.14 hrs, Volume= 0.017 af
Outflow = 0.22 cfs @ 12.20 hrs, Volume= 0.017 af, Atten= 10%, Lag= 3.5 min
Routed to Link C9 : Culvert C9

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 0.99 fps, Min. Travel Time= 1.6 min
Avg. Velocity = 0.72 fps, Avg. Travel Time= 2.3 min

Peak Storage= 24 cf @ 12.16 hrs
Average Depth at Peak Storage= 0.03' , Surface Width= 8.24'
Bank-Full Depth= 2.00' Flow Area= 32.0 sf, Capacity= 376.93 cfs

8.00' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 24.00'
Length= 98.0' Slope= 0.0396 '/'
Inlet Invert= 825.88', Outlet Invert= 822.00'

‡

Summary for Reach S1.2: Swale S1.2

Inflow Area = 9.783 ac, 0.00% Impervious, Inflow Depth = 2.18" for 25-yr, 24-hr event
Inflow = 27.11 cfs @ 12.20 hrs, Volume= 1.778 af
Outflow = 26.46 cfs @ 12.22 hrs, Volume= 1.778 af, Atten= 2%, Lag= 1.0 min
Routed to Link C11 : Culvert C11

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 4.60 fps, Min. Travel Time= 0.6 min
Avg. Velocity = 1.08 fps, Avg. Travel Time= 2.6 min

Peak Storage= 998 cf @ 12.21 hrs
Average Depth at Peak Storage= 0.57' , Surface Width= 12.57'
Bank-Full Depth= 2.00' Flow Area= 32.0 sf, Capacity= 294.55 cfs

8.00' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 24.00'
Length= 170.0' Slope= 0.0242 '/'
Inlet Invert= 821.79', Outlet Invert= 817.68'

‡

Summary for Reach S1.3: Swale S1.3

Inflow Area = 11.213 ac, 0.00% Impervious, Inflow Depth = 2.10" for 25-yr, 24-hr event
Inflow = 27.98 cfs @ 12.21 hrs, Volume= 1.960 af
Outflow = 27.48 cfs @ 12.24 hrs, Volume= 1.960 af, Atten= 2%, Lag= 1.3 min
Routed to Link C3 : Culvert C3

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 4.94 fps, Min. Travel Time= 0.7 min
Avg. Velocity = 1.19 fps, Avg. Travel Time= 3.0 min

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Peak Storage= 1,194 cf @ 12.22 hrs
Average Depth at Peak Storage= 0.55' , Surface Width= 12.40'
Bank-Full Depth= 2.00' Flow Area= 32.0 sf, Capacity= 324.28 cfs

8.00' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 24.00'
Length= 212.6' Slope= 0.0293 '/'
Inlet Invert= 817.40', Outlet Invert= 811.17'

‡

Summary for Reach S1.4: Swale S1.4

Inflow Area = 15.242 ac, 0.00% Impervious, Inflow Depth = 1.99" for 25-yr, 24-hr event
Inflow = 32.89 cfs @ 12.20 hrs, Volume= 2.521 af
Outflow = 32.85 cfs @ 12.21 hrs, Volume= 2.521 af, Atten= 0%, Lag= 0.6 min
Routed to Link C4 : Culvert C4

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 4.09 fps, Min. Travel Time= 0.3 min
Avg. Velocity = 1.00 fps, Avg. Travel Time= 1.2 min

Peak Storage= 580 cf @ 12.21 hrs
Average Depth at Peak Storage= 0.73' , Surface Width= 13.88'
Bank-Full Depth= 2.00' Flow Area= 32.0 sf, Capacity= 227.36 cfs

8.00' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 24.00'
Length= 72.2' Slope= 0.0144 '/'
Inlet Invert= 810.90', Outlet Invert= 809.86'

‡

Summary for Reach S1.5: Swale S1.5

Inflow Area = 15.981 ac, 0.00% Impervious, Inflow Depth = 1.94" for 25-yr, 24-hr event
Inflow = 33.64 cfs @ 12.21 hrs, Volume= 2.583 af
Outflow = 33.34 cfs @ 12.23 hrs, Volume= 2.583 af, Atten= 1%, Lag= 1.5 min
Routed to Reach S1.7 : Swale S1.7

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.73 fps, Min. Travel Time= 0.9 min
Avg. Velocity = 0.66 fps, Avg. Travel Time= 3.7 min

Peak Storage= 1,830 cf @ 12.22 hrs
Average Depth at Peak Storage= 1.02' , Surface Width= 16.18'
Bank-Full Depth= 2.00' Flow Area= 32.0 sf, Capacity= 126.50 cfs

8.00' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 24.00'
Length= 148.0' Slope= 0.0045 '/'
Inlet Invert= 809.60', Outlet Invert= 808.94'

‡

Summary for Reach S1.6: Swale S1.6

Inflow Area = 0.769 ac, 0.00% Impervious, Inflow Depth = 1.89" for 25-yr, 24-hr event
Inflow = 2.14 cfs @ 12.15 hrs, Volume= 0.121 af
Outflow = 1.95 cfs @ 12.23 hrs, Volume= 0.121 af, Atten= 9%, Lag= 4.7 min
Routed to Reach S1.7 : Swale S1.7

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.12 fps, Min. Travel Time= 2.7 min
Avg. Velocity = 0.32 fps, Avg. Travel Time= 9.2 min

Peak Storage= 316 cf @ 12.19 hrs
Average Depth at Peak Storage= 0.20' , Surface Width= 9.60'
Bank-Full Depth= 2.00' Flow Area= 32.0 sf, Capacity= 134.06 cfs

8.00' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 24.00'
Length= 179.7' Slope= 0.0050 '/'
Inlet Invert= 809.85', Outlet Invert= 808.95'

‡

Summary for Reach S1.7: Swale S1.7

Inflow Area = 18.333 ac, 0.00% Impervious, Inflow Depth = 1.93" for 25-yr, 24-hr event
Inflow = 38.89 cfs @ 12.22 hrs, Volume= 2.941 af
Outflow = 38.11 cfs @ 12.27 hrs, Volume= 2.941 af, Atten= 2%, Lag= 2.7 min
Routed to Link C5 : Culvert C5

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.05 fps, Min. Travel Time= 1.4 min
Avg. Velocity = 0.74 fps, Avg. Travel Time= 5.7 min

Peak Storage= 3,186 cf @ 12.25 hrs
Average Depth at Peak Storage= 1.04' , Surface Width= 16.32'
Bank-Full Depth= 2.00' Flow Area= 32.0 sf, Capacity= 139.68 cfs

8.00' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 24.00'
Length= 252.0' Slope= 0.0054 '/'
Inlet Invert= 808.94', Outlet Invert= 807.57'

‡

Summary for Reach S1.8: Swale S1.8

Inflow Area = 0.712 ac, 0.00% Impervious, Inflow Depth = 2.05" for 25-yr, 24-hr event
Inflow = 2.19 cfs @ 12.15 hrs, Volume= 0.122 af
Outflow = 1.99 cfs @ 12.21 hrs, Volume= 0.122 af, Atten= 9%, Lag= 3.8 min
Routed to Reach S1.7 : Swale S1.7

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.88 fps, Min. Travel Time= 2.2 min
Avg. Velocity = 0.56 fps, Avg. Travel Time= 7.3 min

Peak Storage= 265 cf @ 12.17 hrs
Average Depth at Peak Storage= 0.31' , Surface Width= 4.38'
Bank-Full Depth= 2.00' Flow Area= 17.0 sf, Capacity= 90.14 cfs

2.50' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 2.0 4.0 '/' Top Width= 14.50'
Length= 245.8' Slope= 0.0099 '/'
Inlet Invert= 810.00', Outlet Invert= 807.57'

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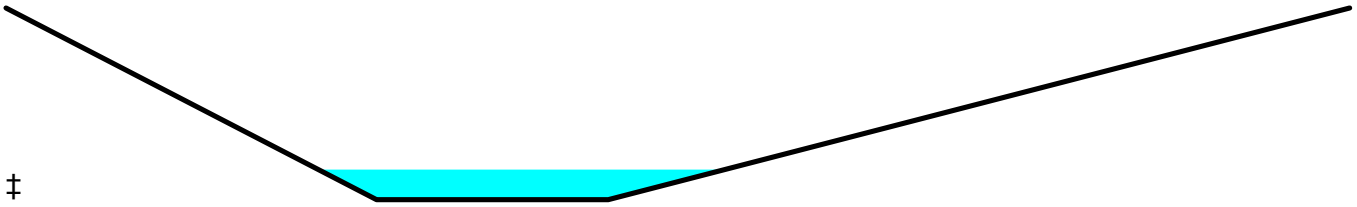

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Summary for Reach S1.9: Swale S1.9

Inflow Area = 21.125 ac, 0.00% Impervious, Inflow Depth = 1.84" for 25-yr, 24-hr event
Inflow = 41.96 cfs @ 12.27 hrs, Volume= 3.247 af
Outflow = 40.72 cfs @ 12.33 hrs, Volume= 3.247 af, Atten= 3%, Lag= 3.8 min
Routed to Reach S2.1 : Swale S2.1

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.48 fps, Min. Travel Time= 2.0 min
Avg. Velocity = 0.84 fps, Avg. Travel Time= 8.4 min

Peak Storage= 5,006 cf @ 12.30 hrs
Average Depth at Peak Storage= 0.99' , Surface Width= 15.93'
Bank-Full Depth= 2.00' Flow Area= 32.0 sf, Capacity= 163.67 cfs

8.00' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 24.00'
Length= 422.0' Slope= 0.0075 '/'
Inlet Invert= 807.15', Outlet Invert= 804.00'

‡

Summary for Reach S2.1: Swale S2.1

Inflow Area = 23.239 ac, 0.00% Impervious, Inflow Depth = 1.69" for 25-yr, 24-hr event
Inflow = 40.74 cfs @ 12.33 hrs, Volume= 3.279 af
Outflow = 39.80 cfs @ 12.40 hrs, Volume= 3.279 af, Atten= 2%, Lag= 3.9 min
Routed to Reach S2.2 : Swale S2.2

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.22 fps, Min. Travel Time= 2.0 min
Avg. Velocity = 0.86 fps, Avg. Travel Time= 7.5 min

Peak Storage= 4,870 cf @ 12.36 hrs
Average Depth at Peak Storage= 1.34' , Surface Width= 14.71'
Bank-Full Depth= 2.00' Flow Area= 24.0 sf, Capacity= 97.05 cfs

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4.00' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 20.00'
Length= 389.0' Slope= 0.0054 '/'
Inlet Invert= 806.10', Outlet Invert= 804.00'

‡

Summary for Reach S2.2: Swale S2.2

Inflow Area = 40.438 ac, 0.00% Impervious, Inflow Depth = 1.79" for 25-yr, 24-hr event
Inflow = 66.42 cfs @ 12.32 hrs, Volume= 6.023 af
Outflow = 65.44 cfs @ 12.38 hrs, Volume= 6.023 af, Atten= 1%, Lag= 3.7 min
Routed to Reach S2.3 : Swale S2.3

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.34 fps, Min. Travel Time= 2.0 min
Avg. Velocity = 0.80 fps, Avg. Travel Time= 8.5 min

Peak Storage= 8,100 cf @ 12.35 hrs
Average Depth at Peak Storage= 1.30' , Surface Width= 20.38'
Bank-Full Depth= 2.00' Flow Area= 36.0 sf, Capacity= 152.61 cfs

10.00' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 26.00'
Length= 411.0' Slope= 0.0049 '/'
Inlet Invert= 804.00', Outlet Invert= 802.00'

‡

Summary for Reach S2.3: Swale S2.3

Inflow Area = 44.233 ac, 0.00% Impervious, Inflow Depth = 1.69" for 25-yr, 24-hr event
Inflow = 66.33 cfs @ 12.38 hrs, Volume= 6.216 af
Outflow = 65.84 cfs @ 12.41 hrs, Volume= 6.216 af, Atten= 1%, Lag= 2.0 min
Routed to Link C7 : Culvert C7

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 4.74 fps, Min. Travel Time= 1.1 min
Avg. Velocity = 1.15 fps, Avg. Travel Time= 4.5 min

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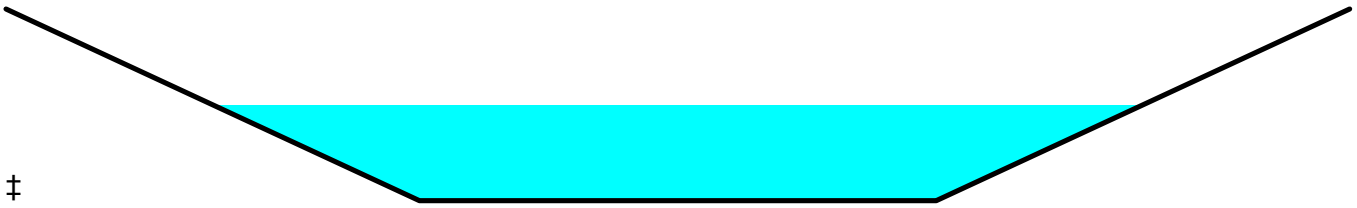
Peak Storage= 4,294 cf @ 12.40 hrs
Average Depth at Peak Storage= 1.00' , Surface Width= 17.99'
Bank-Full Depth= 2.00' Flow Area= 36.0 sf, Capacity= 249.72 cfs

10.00' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 26.00'
Length= 307.0' Slope= 0.0130 '/'
Inlet Invert= 802.00', Outlet Invert= 798.00'



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Summary for Reach S3.1: Swale S3.1

Inflow Area = 2.044 ac, 0.00% Impervious, Inflow Depth = 1.89" for 25-yr, 24-hr event
Inflow = 6.52 cfs @ 12.11 hrs, Volume= 0.322 af
Outflow = 5.46 cfs @ 12.21 hrs, Volume= 0.322 af, Atten= 16%, Lag= 5.9 min
Routed to Reach S3.2 : Swale S3.2

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.62 fps, Min. Travel Time= 3.7 min
Avg. Velocity = 0.42 fps, Avg. Travel Time= 14.2 min

Peak Storage= 1,242 cf @ 12.15 hrs
Average Depth at Peak Storage= 0.37' , Surface Width= 10.94'
Bank-Full Depth= 2.00' Flow Area= 32.0 sf, Capacity= 133.76 cfs

8.00' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 24.00'
Length= 357.0' Slope= 0.0050 '/'
Inlet Invert= 809.85', Outlet Invert= 808.07'

‡

Summary for Reach S3.2: Swale S3.2

Inflow Area = 7.661 ac, 0.00% Impervious, Inflow Depth = 1.90" for 25-yr, 24-hr event
Inflow = 20.49 cfs @ 12.14 hrs, Volume= 1.211 af
Outflow = 20.35 cfs @ 12.15 hrs, Volume= 1.211 af, Atten= 1%, Lag= 0.4 min
Routed to Reach S3.3 : Swale S3.3

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.46 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 0.65 fps, Avg. Travel Time= 0.9 min

Peak Storage= 285 cf @ 12.14 hrs
Average Depth at Peak Storage= 0.76' , Surface Width= 14.07'
Bank-Full Depth= 2.00' Flow Area= 32.0 sf, Capacity= 133.95 cfs

8.00' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 24.00'
Length= 34.0' Slope= 0.0050 '/'
Inlet Invert= 798.00', Outlet Invert= 797.83'

‡

Summary for Reach S3.3: Swale S3.3

Inflow Area = 7.661 ac, 0.00% Impervious, Inflow Depth = 1.90" for 25-yr, 24-hr event
Inflow = 20.35 cfs @ 12.15 hrs, Volume= 1.211 af
Outflow = 19.21 cfs @ 12.17 hrs, Volume= 1.211 af, Atten= 6%, Lag= 1.7 min
Routed to Link C6 : Culvert C6

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.39 fps, Min. Travel Time= 1.0 min
Avg. Velocity = 0.89 fps, Avg. Travel Time= 3.7 min

Peak Storage= 1,187 cf @ 12.16 hrs
Average Depth at Peak Storage= 0.58' , Surface Width= 12.61'
Bank-Full Depth= 2.00' Flow Area= 32.0 sf, Capacity= 215.99 cfs

8.00' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 24.00'
Length= 200.0' Slope= 0.0130 '/'
Inlet Invert= 808.00', Outlet Invert= 805.40'

‡

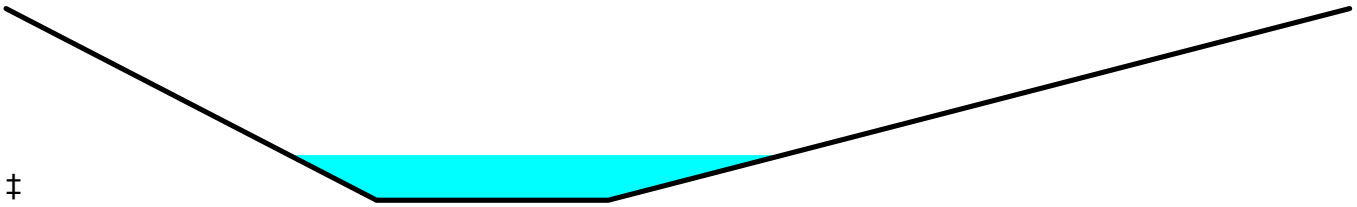
Summary for Reach S3.4: Swale S3.4

Inflow Area = 1.194 ac, 0.00% Impervious, Inflow Depth = 2.21" for 25-yr, 24-hr event
Inflow = 3.99 cfs @ 12.15 hrs, Volume= 0.220 af
Outflow = 3.61 cfs @ 12.22 hrs, Volume= 0.220 af, Atten= 9%, Lag= 4.1 min
Routed to Link C6 : Culvert C6

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.99 fps, Min. Travel Time= 2.4 min
Avg. Velocity = 0.59 fps, Avg. Travel Time= 8.0 min

Peak Storage= 520 cf @ 12.17 hrs
Average Depth at Peak Storage= 0.47' , Surface Width= 5.32'
Bank-Full Depth= 2.00' Flow Area= 17.0 sf, Capacity= 76.21 cfs

2.50' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 2.0 4.0 '/' Top Width= 14.50'
Length= 283.0' Slope= 0.0071 '/'
Inlet Invert= 810.00', Outlet Invert= 808.00'



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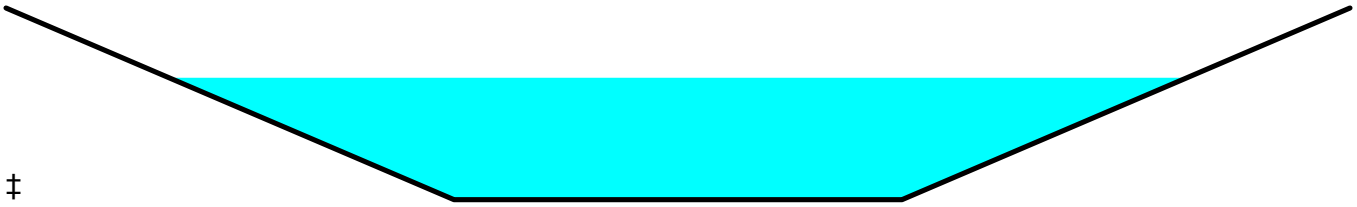
Summary for Reach S3.5: Swale S3.5

Inflow Area = 15.661 ac, 0.00% Impervious, Inflow Depth = 1.96" for 25-yr, 24-hr event
Inflow = 39.25 cfs @ 12.17 hrs, Volume= 2.554 af
Outflow = 37.05 cfs @ 12.24 hrs, Volume= 2.554 af, Atten= 6%, Lag= 4.5 min
Routed to Reach S2.2 : Swale S2.2

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.27 fps, Min. Travel Time= 2.3 min
Avg. Velocity = 0.60 fps, Avg. Travel Time= 8.9 min

Peak Storage= 5,295 cf @ 12.20 hrs
Average Depth at Peak Storage= 1.27' , Surface Width= 18.17'
Bank-Full Depth= 2.00' Flow Area= 32.0 sf, Capacity= 93.14 cfs

8.00' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 24.00'
Length= 318.5' Slope= 0.0024 '/'
Inlet Invert= 804.76', Outlet Invert= 803.99'



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Summary for Reach S4.1: Swale S4.1

Inflow Area = 1.364 ac, 0.00% Impervious, Inflow Depth = 1.28" for 25-yr, 24-hr event
Inflow = 2.74 cfs @ 12.10 hrs, Volume= 0.145 af
Outflow = 2.38 cfs @ 12.18 hrs, Volume= 0.145 af, Atten= 13%, Lag= 4.4 min
Routed to Reach S4.2 : Swale S4.2

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.62 fps, Min. Travel Time= 2.5 min
Avg. Velocity = 0.43 fps, Avg. Travel Time= 9.3 min

Peak Storage= 363 cf @ 12.14 hrs
Average Depth at Peak Storage= 0.14' , Surface Width= 11.01'
Bank-Full Depth= 1.00' Flow Area= 13.5 sf, Capacity= 70.22 cfs

10.00' x 1.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 3.0 '/' Top Width= 17.00'
Length= 240.0' Slope= 0.0153 '/'
Inlet Invert= 811.94', Outlet Invert= 808.26'

‡

Summary for Reach S4.2: Swale S4.2

Inflow Area = 3.174 ac, 0.00% Impervious, Inflow Depth = 1.41" for 25-yr, 24-hr event
Inflow = 6.29 cfs @ 12.15 hrs, Volume= 0.372 af
Outflow = 5.84 cfs @ 12.21 hrs, Volume= 0.372 af, Atten= 7%, Lag= 3.6 min
Routed to Reach S4.3 : Swale S4.3

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.12 fps, Min. Travel Time= 2.0 min
Avg. Velocity = 0.53 fps, Avg. Travel Time= 8.1 min

Peak Storage= 732 cf @ 12.17 hrs
Average Depth at Peak Storage= 0.26' , Surface Width= 11.81'
Bank-Full Depth= 1.00' Flow Area= 13.5 sf, Capacity= 63.88 cfs

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10.00' x 1.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 3.0 '/' Top Width= 17.00'
Length= 259.3' Slope= 0.0127 '/'
Inlet Invert= 808.26', Outlet Invert= 804.97'

‡

Summary for Reach S4.3: Swale S4.3

Inflow Area = 9.328 ac, 0.00% Impervious, Inflow Depth = 1.49" for 25-yr, 24-hr event
Inflow = 18.75 cfs @ 12.14 hrs, Volume= 1.155 af
Outflow = 16.68 cfs @ 12.24 hrs, Volume= 1.155 af, Atten= 11%, Lag= 5.7 min
Routed to Reach S4.4 : Swale S4.4

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.82 fps, Min. Travel Time= 3.3 min
Avg. Velocity = 0.46 fps, Avg. Travel Time= 13.2 min

Peak Storage= 3,352 cf @ 12.18 hrs
Average Depth at Peak Storage= 0.73' , Surface Width= 15.14'
Bank-Full Depth= 2.00' Flow Area= 34.0 sf, Capacity= 108.12 cfs

10.00' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 3.0 '/' Top Width= 24.00'
Length= 362.9' Slope= 0.0027 '/'
Inlet Invert= 804.97', Outlet Invert= 804.00'

‡

Summary for Reach S4.4: Swale S4.4

Inflow Area = 14.003 ac, 0.00% Impervious, Inflow Depth = 1.48" for 25-yr, 24-hr event
Inflow = 22.06 cfs @ 12.20 hrs, Volume= 1.732 af
Outflow = 21.14 cfs @ 12.31 hrs, Volume= 1.732 af, Atten= 4%, Lag= 6.5 min
Routed to Reach S4.5 : Swale S4.5

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.26 fps, Min. Travel Time= 3.6 min
Avg. Velocity = 0.58 fps, Avg. Travel Time= 14.2 min

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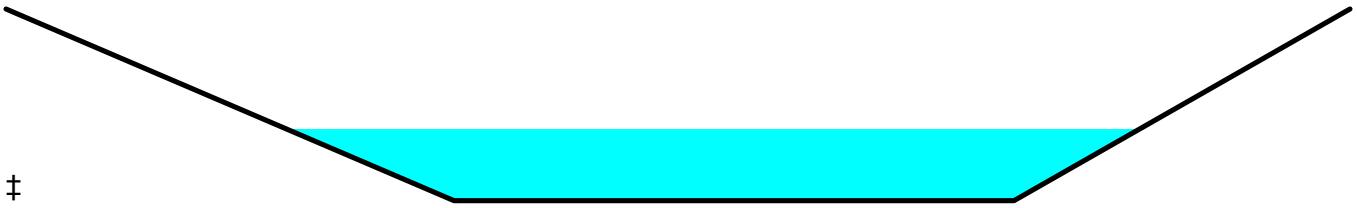
Peak Storage= 4,669 cf @ 12.25 hrs
Average Depth at Peak Storage= 0.75' , Surface Width= 15.23'
Bank-Full Depth= 2.00' Flow Area= 34.0 sf, Capacity= 132.85 cfs

10.00' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 3.0 '/' Top Width= 24.00'
Length= 495.6' Slope= 0.0040 '/'
Inlet Invert= 804.00', Outlet Invert= 802.00'



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Summary for Reach S4.5: Swale S4.5

Inflow Area = 16.113 ac, 0.00% Impervious, Inflow Depth = 1.43" for 25-yr, 24-hr event
Inflow = 22.26 cfs @ 12.30 hrs, Volume= 1.915 af
Outflow = 21.79 cfs @ 12.37 hrs, Volume= 1.915 af, Atten= 2%, Lag= 3.9 min
Routed to Reach S4.6 : Swale S4.6

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.07 fps, Min. Travel Time= 2.2 min
Avg. Velocity = 0.85 fps, Avg. Travel Time= 8.0 min

Peak Storage= 2,934 cf @ 12.33 hrs
Average Depth at Peak Storage= 0.59' , Surface Width= 14.14'
Bank-Full Depth= 3.00' Flow Area= 61.5 sf, Capacity= 465.89 cfs

10.00' x 3.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 3.0 '/' Top Width= 31.00'
Length= 411.1' Slope= 0.0097 '/'
Inlet Invert= 802.00', Outlet Invert= 798.00'

‡

Summary for Reach S4.6: Swale S4.6

Inflow Area = 65.439 ac, 0.00% Impervious, Inflow Depth = 1.59" for 25-yr, 24-hr event
Inflow = 89.57 cfs @ 12.40 hrs, Volume= 8.673 af
Outflow = 88.39 cfs @ 12.45 hrs, Volume= 8.673 af, Atten= 1%, Lag= 3.3 min
Routed to Pond Sed Pond : Sedimentation Basin

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 5.00 fps, Min. Travel Time= 1.8 min
Avg. Velocity = 1.27 fps, Avg. Travel Time= 7.1 min

Peak Storage= 9,563 cf @ 12.42 hrs
Average Depth at Peak Storage= 1.24' , Surface Width= 18.69'
Bank-Full Depth= 3.00' Flow Area= 61.5 sf, Capacity= 499.25 cfs

10.00' x 3.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 3.0 '/' Top Width= 31.00'
Length= 537.0' Slope= 0.0112 '/'
Inlet Invert= 798.00', Outlet Invert= 792.00'

‡

Summary for Reach S5.1: Swale S5.1

Inflow Area = 0.993 ac, 0.00% Impervious, Inflow Depth = 2.46" for 25-yr, 24-hr event
Inflow = 4.05 cfs @ 12.11 hrs, Volume= 0.204 af
Outflow = 3.50 cfs @ 12.20 hrs, Volume= 0.204 af, Atten= 14%, Lag= 5.7 min
Routed to Link 4L : Culvert C2b

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.00 fps, Min. Travel Time= 3.6 min
Avg. Velocity = 0.55 fps, Avg. Travel Time= 13.0 min

Peak Storage= 769 cf @ 12.15 hrs
Average Depth at Peak Storage= 0.20' , Surface Width= 9.63'
Bank-Full Depth= 2.00' Flow Area= 32.0 sf, Capacity= 235.24 cfs

8.00' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 24.00'
Length= 428.0' Slope= 0.0154 '/'
Inlet Invert= 825.20', Outlet Invert= 818.60'

‡

Summary for Reach S5.2: Swale S5.2

Inflow Area = 0.424 ac, 0.00% Impervious, Inflow Depth = 2.29" for 25-yr, 24-hr event
Inflow = 1.73 cfs @ 12.10 hrs, Volume= 0.081 af
Outflow = 1.51 cfs @ 12.14 hrs, Volume= 0.081 af, Atten= 13%, Lag= 2.8 min
Routed to Link C2 : Culvert C2a

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.89 fps, Min. Travel Time= 1.6 min
Avg. Velocity = 0.70 fps, Avg. Travel Time= 4.4 min

Peak Storage= 156 cf @ 12.11 hrs
Average Depth at Peak Storage= 0.10' , Surface Width= 8.81'
Bank-Full Depth= 2.00' Flow Area= 32.0 sf, Capacity= 344.73 cfs

8.00' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 24.00'
Length= 183.6' Slope= 0.0331 '/'
Inlet Invert= 823.91', Outlet Invert= 817.83'

‡

Summary for Pond C8: Culvert C8

Inflow Area = 0.275 ac, 0.00% Impervious, Inflow Depth = 1.89" for 25-yr, 24-hr event
Inflow = 0.95 cfs @ 12.08 hrs, Volume= 0.043 af
Outflow = 0.96 cfs @ 12.08 hrs, Volume= 0.043 af, Atten= 0%, Lag= 0.1 min
Primary = 0.96 cfs @ 12.08 hrs, Volume= 0.043 af
Routed to Reach S4.1 : Swale S4.1

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 811.21' @ 12.08 hrs Surf.Area= 0.000 ac Storage= 0.000 af
Flood Elev= 819.00' Surf.Area= 0.000 ac Storage= 0.001 af

Plug-Flow detention time= 0.2 min calculated for 0.043 af (100% of inflow)
Center-of-Mass det. time= 0.2 min (830.2 - 830.0)

Volume	Invert	Avail.Storage	Storage Description
#1	810.70'	0.001 af	**3.00'D x 7.00'H Vertical Cone/Cylinder**

Device	Routing	Invert	Outlet Devices
#1	Primary	810.70'	**12.0" Round Culvert** L= 85.6' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 810.70' / 808.60' S= 0.0245 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.79 sf

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Primary OutFlow Max=0.89 cfs @ 12.08 hrs HW=811.18' (Free Discharge)
1=Culvert (Inlet Controls 0.89 cfs @ 2.37 fps)

Summary for Pond N: North Infiltration Area

Inflow Area = 18.714 ac, 0.00% Impervious, Inflow Depth = 0.75" for 25-yr, 24-hr event
Inflow = 11.60 cfs @ 12.28 hrs, Volume= 1.175 af
Outflow = 1.40 cfs @ 13.94 hrs, Volume= 1.175 af, Atten= 88%, Lag= 99.8 min
Primary = 1.40 cfs @ 13.94 hrs, Volume= 1.175 af
Routed to nonexistent node 1L

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 803.89' @ 13.94 hrs Surf.Area= 16,766 sf Storage= 20,733 cf

Plug-Flow detention time= 178.4 min calculated for 1.174 af (100% of inflow)
Center-of-Mass det. time= 178.3 min (1,059.6 - 881.2)

Volume	Invert	Avail.Storage	Storage Description
#1	802.00'	256,569 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
802.00	5,140	0	0
804.00	17,424	22,564	22,564
806.00	32,191	49,615	72,179
808.00	46,130	78,321	150,500
810.00	59,939	106,069	256,569

Device	Routing	Invert	Outlet Devices
#1	Primary	802.00'	**3.600 in/hr Exfiltration over Surface area**

Primary OutFlow Max=1.40 cfs @ 13.94 hrs HW=803.89' (Free Discharge)
1=Exfiltration (Exfiltration Controls 1.40 cfs)

Summary for Pond Sed Pond: Sedimentation Basin

Inflow Area = 72.769 ac, 2.07% Impervious, Inflow Depth = 1.55" for 25-yr, 24-hr event
Inflow = 90.06 cfs @ 12.45 hrs, Volume= 9.372 af
Outflow = 15.75 cfs @ 13.56 hrs, Volume= 9.372 af, Atten= 83%, Lag= 66.6 min
Discarded = 5.53 cfs @ 13.56 hrs, Volume= 6.223 af
Primary = 10.22 cfs @ 13.56 hrs, Volume= 3.149 af
Routed to Link Wetland : Wetland
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Routed to Link Wetland : Wetland
Tertiary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Routed to Link Wetland : Wetland

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Peak Elev= 792.17' @ 13.56 hrs Surf.Area= 66,370 sf Storage= 175,109 cf
Flood Elev= 794.00' Surf.Area= 75,797 sf Storage= 304,443 cf

Plug-Flow detention time= 186.0 min calculated for 9.366 af (100% of inflow)
Center-of-Mass det. time= 185.9 min (1,047.5 - 861.6)

Volume	Invert	Avail.Storage	Storage Description
#1	789.00'	304,443 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
789.00	27,325	0	0
790.00	55,972	41,649	41,649
791.00	61,532	58,752	100,401
792.00	65,703	63,618	164,018
793.00	69,675	67,689	231,707
794.00	75,797	72,736	304,443

Device	Routing	Invert	Outlet Devices
#1	Primary	787.70'	**15.0" Round Culvert** L= 40.0' RCP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 787.70' / 787.50' S= 0.0050 '/' Cc= 0.900 n= 0.011 Concrete pipe, straight & clean, Flow Area= 1.23 sf
#2	Device 1	791.00'	**30.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Device 1	790.50'	**0.8" Vert. Orifice/Grate X 4.00** C= 0.600 Limited to weir flow at low heads
#4	Device 1	790.00'	**0.8" Vert. Orifice/Grate X 4.00** C= 0.600 Limited to weir flow at low heads
#5	Device 1	789.00'	**0.5" Vert. Orifice/Grate X 14.00 columns** X 6 rows with 6.0" cc spacing C= 0.600 Limited to weir flow at low heads
#6	Secondary	792.50'	**20.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64
#7	Tertiary	793.00'	**158.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64
#8	Discarded	789.00'	**3.600 in/hr Exfiltration over Surface area**

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Discarded OutFlow Max=5.53 cfs @ 13.56 hrs HW=792.17' (Free Discharge)
└**8=Exfiltration** (Exfiltration Controls 5.53 cfs)

Primary OutFlow Max=10.22 cfs @ 13.56 hrs HW=792.17' (Free Discharge)
└**1=Culvert** (Inlet Controls 10.22 cfs @ 8.33 fps)
  ├**2=Orifice/Grate** (Passes < 25.54 cfs potential flow)
  ├**3=Orifice/Grate** (Passes < 0.09 cfs potential flow)
  ├**4=Orifice/Grate** (Passes < 0.10 cfs potential flow)
  └**5=Orifice/Grate** (Passes < 0.74 cfs potential flow)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=789.00' (Free Discharge)
└**6=Broad-Crested Rectangular Weir**(Controls 0.00 cfs)

Tertiary OutFlow Max=0.00 cfs @ 0.00 hrs HW=789.00' (Free Discharge)
└**7=Broad-Crested Rectangular Weir**(Controls 0.00 cfs)

Summary for Link 4L: Culvert C2b

Inflow Area = 0.993 ac, 0.00% Impervious, Inflow Depth = 2.46" for 25-yr, 24-hr event
Inflow = 3.50 cfs @ 12.20 hrs, Volume= 0.204 af
Primary = 3.50 cfs @ 12.20 hrs, Volume= 0.204 af, Atten= 0%, Lag= 0.0 min
Routed to Link C2 : Culvert C2a

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link C1: Culvert C1

Inflow Area = 3.035 ac, 0.00% Impervious, Inflow Depth = 0.51" for 25-yr, 24-hr event
Inflow = 0.60 cfs @ 12.89 hrs, Volume= 0.128 af
Primary = 0.60 cfs @ 12.89 hrs, Volume= 0.128 af, Atten= 0%, Lag= 0.0 min
Routed to Reach RD2 : Roadside Ditch 2

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link C10: Culvert C10

Inflow Area = 8.839 ac, 0.00% Impervious, Inflow Depth = 1.27" for 25-yr, 24-hr event
Inflow = 11.21 cfs @ 12.27 hrs, Volume= 0.937 af
Primary = 11.21 cfs @ 12.27 hrs, Volume= 0.937 af, Atten= 0%, Lag= 0.0 min
Routed to Pond N : North Infiltration Area

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link C11: Culvert C11

Inflow Area = 9.783 ac, 0.00% Impervious, Inflow Depth = 2.18" for 25-yr, 24-hr event
Inflow = 26.46 cfs @ 12.22 hrs, Volume= 1.778 af
Primary = 26.46 cfs @ 12.22 hrs, Volume= 1.778 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S1.3 : Swale S1.3

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Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link C2: Culvert C2a

Inflow Area = 2.969 ac, 0.00% Impervious, Inflow Depth = 2.53" for 25-yr, 24-hr event
Inflow = 10.41 cfs @ 12.20 hrs, Volume= 0.626 af
Primary = 10.41 cfs @ 12.20 hrs, Volume= 0.626 af, Atten= 0%, Lag= 0.0 min
Routed to Reach RD2 : Roadside Ditch 2

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link C3: Culvert C3

Inflow Area = 11.213 ac, 0.00% Impervious, Inflow Depth = 2.10" for 25-yr, 24-hr event
Inflow = 27.48 cfs @ 12.24 hrs, Volume= 1.960 af
Primary = 27.48 cfs @ 12.24 hrs, Volume= 1.960 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S1.4 : Swale S1.4

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link C4: Culvert C4

Inflow Area = 15.242 ac, 0.00% Impervious, Inflow Depth = 1.99" for 25-yr, 24-hr event
Inflow = 32.85 cfs @ 12.21 hrs, Volume= 2.521 af
Primary = 32.85 cfs @ 12.21 hrs, Volume= 2.521 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S1.5 : Swale S1.5

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link C5: Culvert C5

Inflow Area = 18.333 ac, 0.00% Impervious, Inflow Depth = 1.93" for 25-yr, 24-hr event
Inflow = 38.11 cfs @ 12.27 hrs, Volume= 2.941 af
Primary = 38.11 cfs @ 12.27 hrs, Volume= 2.941 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S1.9 : Swale S1.9

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link C6: Culvert C6

Inflow Area = 11.935 ac, 0.00% Impervious, Inflow Depth = 1.93" for 25-yr, 24-hr event
Inflow = 30.03 cfs @ 12.16 hrs, Volume= 1.918 af
Primary = 30.03 cfs @ 12.16 hrs, Volume= 1.918 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S3.5 : Swale S3.5

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

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Summary for Link C7: Culvert C7

Inflow Area = 47.325 ac, 0.00% Impervious, Inflow Depth = 1.70" for 25-yr, 24-hr event
Inflow = 68.10 cfs @ 12.41 hrs, Volume= 6.703 af
Primary = 68.10 cfs @ 12.41 hrs, Volume= 6.703 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S4.6 : Swale S4.6

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link C9: Culvert C9

Inflow Area = 0.306 ac, 0.00% Impervious, Inflow Depth = 0.66" for 25-yr, 24-hr event
Inflow = 0.22 cfs @ 12.20 hrs, Volume= 0.017 af
Primary = 0.22 cfs @ 12.20 hrs, Volume= 0.017 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S1.2 : Swale S1.2

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link F10: Flume 10

Inflow Area = 0.275 ac, 0.00% Impervious, Inflow Depth = 1.89" for 25-yr, 24-hr event
Inflow = 0.95 cfs @ 12.08 hrs, Volume= 0.043 af
Primary = 0.95 cfs @ 12.08 hrs, Volume= 0.043 af, Atten= 0%, Lag= 0.0 min
Routed to Pond C8 : Culvert C8

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link F1A: Flume 1A

Inflow Area = 1.698 ac, 0.00% Impervious, Inflow Depth = 1.89" for 25-yr, 24-hr event
Inflow = 4.96 cfs @ 12.13 hrs, Volume= 0.268 af
Primary = 4.96 cfs @ 12.13 hrs, Volume= 0.268 af, Atten= 0%, Lag= 0.0 min
Routed to Link F1B : Flume 1B

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link F1B: Flume 1B

Inflow Area = 3.934 ac, 0.00% Impervious, Inflow Depth = 1.89" for 25-yr, 24-hr event
Inflow = 11.65 cfs @ 12.13 hrs, Volume= 0.620 af
Primary = 11.65 cfs @ 12.13 hrs, Volume= 0.620 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S4.3 : Swale S4.3

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

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Summary for Link F2A: Flume 2A

Inflow Area = 0.636 ac, 0.00% Impervious, Inflow Depth = 1.89" for 25-yr, 24-hr event
Inflow = 1.98 cfs @ 12.11 hrs, Volume= 0.100 af
Primary = 1.98 cfs @ 12.11 hrs, Volume= 0.100 af, Atten= 0%, Lag= 0.0 min
Routed to Link F2B : Flume 2B

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link F2B: Flume 2B

Inflow Area = 2.199 ac, 0.00% Impervious, Inflow Depth = 1.89" for 25-yr, 24-hr event
Inflow = 6.58 cfs @ 12.12 hrs, Volume= 0.347 af
Primary = 6.58 cfs @ 12.12 hrs, Volume= 0.347 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S4.4 : Swale S4.4

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link F3: Flume 3

Inflow Area = 0.427 ac, 0.00% Impervious, Inflow Depth = 1.89" for 25-yr, 24-hr event
Inflow = 1.38 cfs @ 12.10 hrs, Volume= 0.067 af
Primary = 1.38 cfs @ 12.10 hrs, Volume= 0.067 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S4.5 : Swale S4.5

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link F4A: Flume 4A

Inflow Area = 1.209 ac, 0.00% Impervious, Inflow Depth = 1.89" for 25-yr, 24-hr event
Inflow = 3.47 cfs @ 12.14 hrs, Volume= 0.191 af
Primary = 3.47 cfs @ 12.14 hrs, Volume= 0.191 af, Atten= 0%, Lag= 0.0 min
Routed to Link F4B : Flume 4B

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link F4B: Flume 4B

Inflow Area = 3.092 ac, 0.00% Impervious, Inflow Depth = 1.89" for 25-yr, 24-hr event
Inflow = 9.10 cfs @ 12.13 hrs, Volume= 0.488 af
Primary = 9.10 cfs @ 12.13 hrs, Volume= 0.488 af, Atten= 0%, Lag= 0.0 min
Routed to Link C7 : Culvert C7

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

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Summary for Link F5A: Flume 5A

Inflow Area = 0.237 ac, 0.00% Impervious, Inflow Depth = 1.89" for 25-yr, 24-hr event
Inflow = 0.76 cfs @ 12.11 hrs, Volume= 0.037 af
Primary = 0.76 cfs @ 12.11 hrs, Volume= 0.037 af, Atten= 0%, Lag= 0.0 min
Routed to Link F5B : Flume 5B

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link F5B: Flume 5B

Inflow Area = 0.712 ac, 0.00% Impervious, Inflow Depth = 1.89" for 25-yr, 24-hr event
Inflow = 2.23 cfs @ 12.11 hrs, Volume= 0.112 af
Primary = 2.23 cfs @ 12.11 hrs, Volume= 0.112 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S2.2 : Swale S2.2

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link F6A: Flume 6A

Inflow Area = 1.440 ac, 0.00% Impervious, Inflow Depth = 1.89" for 25-yr, 24-hr event
Inflow = 4.38 cfs @ 12.11 hrs, Volume= 0.227 af
Primary = 4.38 cfs @ 12.11 hrs, Volume= 0.227 af, Atten= 0%, Lag= 0.0 min
Routed to Link F6B : Flume 6B

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link F6B: Flume 6B

Inflow Area = 3.001 ac, 0.00% Impervious, Inflow Depth = 1.89" for 25-yr, 24-hr event
Inflow = 9.20 cfs @ 12.11 hrs, Volume= 0.473 af
Primary = 9.20 cfs @ 12.11 hrs, Volume= 0.473 af, Atten= 0%, Lag= 0.0 min
Routed to Link C6 : Culvert C6

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link F7A: Flume 7A

Inflow Area = 2.924 ac, 0.00% Impervious, Inflow Depth = 1.89" for 25-yr, 24-hr event
Inflow = 8.53 cfs @ 12.14 hrs, Volume= 0.461 af
Primary = 8.53 cfs @ 12.14 hrs, Volume= 0.461 af, Atten= 0%, Lag= 0.0 min
Routed to Link F7B : Flume 7B

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

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Summary for Link F7B: Flume 7B

Inflow Area = 5.160 ac, 0.00% Impervious, Inflow Depth = 1.89" for 25-yr, 24-hr event
Inflow = 15.13 cfs @ 12.13 hrs, Volume= 0.814 af
Primary = 15.13 cfs @ 12.13 hrs, Volume= 0.814 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S3.2 : Swale S3.2

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link F8A: Flume 8A

Inflow Area = 0.791 ac, 0.00% Impervious, Inflow Depth = 1.89" for 25-yr, 24-hr event
Inflow = 2.31 cfs @ 12.14 hrs, Volume= 0.125 af
Primary = 2.31 cfs @ 12.14 hrs, Volume= 0.125 af, Atten= 0%, Lag= 0.0 min
Routed to Link F8B : Flume 8B

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link F8B: Flume 8B

Inflow Area = 2.667 ac, 0.00% Impervious, Inflow Depth = 1.89" for 25-yr, 24-hr event
Inflow = 7.92 cfs @ 12.12 hrs, Volume= 0.421 af
Primary = 7.92 cfs @ 12.12 hrs, Volume= 0.421 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S1.4 : Swale S1.4

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link F9A: Flume 9A

Inflow Area = 3.091 ac, 0.00% Impervious, Inflow Depth = 1.89" for 25-yr, 24-hr event
Inflow = 8.97 cfs @ 12.14 hrs, Volume= 0.487 af
Primary = 8.97 cfs @ 12.14 hrs, Volume= 0.487 af, Atten= 0%, Lag= 0.0 min
Routed to Link F9B : Flume 9B

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link F9B: Flume 9B

Inflow Area = 6.189 ac, 0.00% Impervious, Inflow Depth = 1.89" for 25-yr, 24-hr event
Inflow = 18.15 cfs @ 12.13 hrs, Volume= 0.976 af
Primary = 18.15 cfs @ 12.13 hrs, Volume= 0.976 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S1.0 : Swale S1.0

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

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Summary for Link Wetland: Wetland

Inflow Area = 72.769 ac, 2.07% Impervious, Inflow Depth = 0.52" for 25-yr, 24-hr event
Inflow = 10.22 cfs @ 13.56 hrs, Volume= 3.149 af
Primary = 10.22 cfs @ 13.56 hrs, Volume= 3.149 af, Atten= 0%, Lag= 0.0 min
Routed to nonexistent node 1L

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Time span=0.00-72.00 hrs, dt=0.05 hrs, 1441 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

SubcatchmentArea 1: Area 1 Runoff Area=1.141 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=500' Tc=6.5 min CN=69 Runoff=5.61 cfs 0.302 af

SubcatchmentArea 10: Area 10 Runoff Area=0.791 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=354' Tc=6.4 min CN=69 Runoff=3.91 cfs 0.210 af

SubcatchmentArea 11: Area 11 Runoff Area=0.885 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=288' Tc=6.4 min CN=69 Runoff=4.37 cfs 0.235 af

SubcatchmentArea 12: Area 12 Runoff Area=2.206 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=628' Tc=6.7 min CN=69 Runoff=10.79 cfs 0.585 af

SubcatchmentArea 13: Area 13 Runoff Area=1.610 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=712' Tc=5.3 min CN=69 Runoff=8.11 cfs 0.427 af

SubcatchmentArea 14: Area 14 Runoff Area=0.626 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=333' Tc=4.5 min CN=69 Runoff=3.29 cfs 0.166 af

SubcatchmentArea 15: Area 15 Runoff Area=0.620 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=331' Tc=4.4 min CN=69 Runoff=3.27 cfs 0.164 af

SubcatchmentArea 16: Area 16 Runoff Area=0.943 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=464' Tc=5.9 min CN=69 Runoff=4.72 cfs 0.250 af

SubcatchmentArea 17: Area 17 Runoff Area=0.571 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=315' Tc=4.4 min CN=69 Runoff=3.01 cfs 0.151 af

SubcatchmentArea 18: Area 18 Runoff Area=0.990 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=424' Tc=4.7 min CN=69 Runoff=5.14 cfs 0.262 af

SubcatchmentArea 19: Area 19 Runoff Area=1.179 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=385' Tc=4.7 min CN=69 Runoff=6.12 cfs 0.313 af

SubcatchmentArea 2: Area 2 Runoff Area=0.557 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=303' Tc=4.7 min CN=69 Runoff=2.89 cfs 0.148 af

SubcatchmentArea 20: Area 20 Runoff Area=1.057 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=419' Tc=4.7 min CN=69 Runoff=5.49 cfs 0.280 af

SubcatchmentArea 21: Area 21 Runoff Area=0.434 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=374' Tc=4.5 min CN=69 Runoff=2.28 cfs 0.115 af

SubcatchmentArea 22: Area 22 Runoff Area=1.442 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=489' Tc=4.8 min CN=69 Runoff=7.45 cfs 0.382 af

SubcatchmentArea 23: Area 23 Runoff Area=1.252 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=435' Tc=4.7 min CN=69 Runoff=6.50 cfs 0.332 af

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SubcatchmentArea 24: Area 24 Runoff Area=1.846 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=701' Tc=5.4 min CN=69 Runoff=9.33 cfs 0.489 af

SubcatchmentArea 25: Area 25 Runoff Area=1.552 ac 0.00% Impervious Runoff Depth=4.10"
Flow Length=123' Slope=0.2500 '/' Tc=3.9 min CN=78 Runoff=10.67 cfs 0.531 af

SubcatchmentArea 26: Area 26 Runoff Area=0.616 ac 0.00% Impervious Runoff Depth=3.48"
Flow Length=109' Slope=0.2500 '/' Tc=3.8 min CN=72 Runoff=3.67 cfs 0.179 af

SubcatchmentArea 27: Area 27 Runoff Area=0.149 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=211' Tc=1.2 min CN=69 Runoff=0.86 cfs 0.039 af

SubcatchmentArea 28: Area 28 Runoff Area=0.126 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=59' Slope=0.2500 '/' Tc=2.5 min CN=69 Runoff=0.74 cfs 0.033 af

SubcatchmentArea 29: Area 29 Runoff Area=1.228 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=647' Tc=5.7 min CN=69 Runoff=6.17 cfs 0.325 af

SubcatchmentArea 3: Area 3 Runoff Area=0.348 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=298' Tc=4.8 min CN=69 Runoff=1.80 cfs 0.092 af

SubcatchmentArea 30: Area 30 Runoff Area=0.427 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=362' Tc=3.8 min CN=69 Runoff=2.33 cfs 0.113 af

SubcatchmentArea 31: Area 31 Runoff Area=0.223 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=296' Tc=3.7 min CN=69 Runoff=1.22 cfs 0.059 af

SubcatchmentArea 32: Area 32 Runoff Area=0.655 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=642' Tc=5.0 min CN=69 Runoff=3.35 cfs 0.174 af

SubcatchmentArea 33: Area 33 Runoff Area=0.237 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=348' Tc=4.0 min CN=69 Runoff=1.28 cfs 0.063 af

SubcatchmentArea 34: Area 34 Runoff Area=0.424 ac 0.00% Impervious Runoff Depth=3.69"
Flow Length=78' Slope=0.2500 '/' Tc=3.1 min CN=74 Runoff=2.76 cfs 0.130 af

SubcatchmentArea 35: Area 35 Runoff Area=0.993 ac 0.00% Impervious Runoff Depth=3.89"
Flow Length=126' Tc=4.4 min CN=76 Runoff=6.35 cfs 0.322 af

SubcatchmentArea 36: Area 36 Runoff Area=2.594 ac 0.00% Impervious Runoff Depth=4.75"
Flow Length=183' Tc=2.2 min CN=84 Runoff=21.62 cfs 1.027 af

SubcatchmentArea 37: Area 37 Runoff Area=0.306 ac 0.00% Impervious Runoff Depth=1.44"
Flow Length=133' Tc=4.5 min CN=50 Runoff=0.66 cfs 0.037 af

SubcatchmentArea 38: Area 38 Runoff Area=1.430 ac 0.00% Impervious Runoff Depth=2.69"
Flow Length=156' Slope=0.2500 '/' Tc=4.1 min CN=64 Runoff=6.48 cfs 0.321 af

SubcatchmentArea 39: Area 39 Runoff Area=0.742 ac 0.00% Impervious Runoff Depth=2.60"
Flow Length=145' Tc=4.3 min CN=63 Runoff=3.20 cfs 0.161 af

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SubcatchmentArea 4: Area 4 Runoff Area=0.288 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=296' Tc=4.0 min CN=69 Runoff=1.55 cfs 0.076 af

SubcatchmentArea 40: Area 40 Runoff Area=0.620 ac 0.00% Impervious Runoff Depth=1.96"
Flow Length=168' Tc=9.6 min CN=56 Runoff=1.57 cfs 0.101 af

SubcatchmentArea 41: Area 41 Runoff Area=0.739 ac 0.00% Impervious Runoff Depth=1.96"
Flow Length=141' Tc=7.2 min CN=56 Runoff=2.11 cfs 0.120 af

SubcatchmentArea 42a: Area 42a Runoff Area=0.871 ac 0.00% Impervious Runoff Depth=2.79"
Flow Length=144' Slope=0.0500 '/' Tc=7.8 min CN=65 Runoff=3.58 cfs 0.202 af

SubcatchmentArea 42b: Area 42b Runoff Area=0.712 ac 0.00% Impervious Runoff Depth=3.38"
Flow Length=102' Slope=0.0500 '/' Tc=7.3 min CN=71 Runoff=3.63 cfs 0.201 af

SubcatchmentArea 43: Area 43 Runoff Area=0.769 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=139' Slope=0.0500 '/' Tc=7.7 min CN=69 Runoff=3.63 cfs 0.204 af

SubcatchmentArea 44: Area 44 Runoff Area=1.416 ac 0.00% Impervious Runoff Depth=0.63"
Flow Length=941' Slope=0.0260 '/' Tc=22.0 min CN=39 Runoff=0.43 cfs 0.074 af

SubcatchmentArea 45: Area 45 Runoff Area=2.792 ac 0.00% Impervious Runoff Depth=2.41"
Flow Length=419' Tc=14.7 min CN=61 Runoff=7.53 cfs 0.561 af

SubcatchmentArea 46: Area 46 Runoff Area=2.044 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=138' Tc=4.0 min CN=69 Runoff=11.02 cfs 0.542 af

SubcatchmentArea 47: Area 47 Runoff Area=0.457 ac 0.00% Impervious Runoff Depth=3.28"
Flow Length=122' Slope=0.2500 '/' Tc=3.9 min CN=70 Runoff=2.55 cfs 0.125 af

SubcatchmentArea 48: Area 48 Runoff Area=1.194 ac 0.00% Impervious Runoff Depth=3.58"
Flow Length=98' Slope=0.0500 '/' Tc=7.2 min CN=73 Runoff=6.45 cfs 0.357 af

SubcatchmentArea 49: Area 49 Runoff Area=0.079 ac 0.00% Impervious Runoff Depth=3.48"
Flow Length=143' Tc=5.1 min CN=72 Runoff=0.44 cfs 0.023 af

SubcatchmentArea 5: Area 5 Runoff Area=0.986 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=608' Tc=6.6 min CN=69 Runoff=4.85 cfs 0.261 af

SubcatchmentArea 50: Area 50 Runoff Area=3.726 ac 0.00% Impervious Runoff Depth=3.38"
Flow Length=391' Tc=11.1 min CN=71 Runoff=16.26 cfs 1.050 af

SubcatchmentArea 51: Area 51 Runoff Area=0.698 ac 0.00% Impervious Runoff Depth=0.63"
Flow Length=100' Slope=0.0600 '/' Tc=6.8 min CN=39 Runoff=0.32 cfs 0.036 af

SubcatchmentArea 52: Area 52 Runoff Area=0.475 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=425' Tc=4.5 min CN=69 Runoff=2.50 cfs 0.126 af

SubcatchmentArea 53: Area 53 Runoff Area=1.618 ac 0.00% Impervious Runoff Depth=2.23"
Flow Length=384' Tc=4.2 min CN=59 Runoff=5.93 cfs 0.300 af

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SubcatchmentArea 54: Area 54 Runoff Area=0.826 ac 0.00% Impervious Runoff Depth=2.13"
Flow Length=126' Slope=0.2500 '/' Tc=3.9 min CN=58 Runoff=2.95 cfs 0.147 af

SubcatchmentArea 55: Area 55 Runoff Area=1.089 ac 0.00% Impervious Runoff Depth=2.13"
Flow Length=158' Tc=4.3 min CN=58 Runoff=3.79 cfs 0.194 af

SubcatchmentArea 56: Area 56 Runoff Area=1.194 ac 0.00% Impervious Runoff Depth=2.23"
Flow Length=221' Tc=4.4 min CN=59 Runoff=4.33 cfs 0.221 af

SubcatchmentArea 57: Area 57 Runoff Area=2.220 ac 0.00% Impervious Runoff Depth=1.78"
Flow Length=240' Tc=4.6 min CN=54 Runoff=6.17 cfs 0.330 af

SubcatchmentArea 58: Area 58 Runoff Area=2.476 ac 0.00% Impervious Runoff Depth=2.13"
Flow Length=263' Tc=4.7 min CN=58 Runoff=8.43 cfs 0.441 af

SubcatchmentArea 59: Area 59 Runoff Area=1.683 ac 0.00% Impervious Runoff Depth=1.70"
Flow Length=146' Slope=0.2345 '/' Tc=4.1 min CN=53 Runoff=4.54 cfs 0.238 af

SubcatchmentArea 6: Area 6 Runoff Area=0.504 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=258' Tc=3.4 min CN=69 Runoff=2.81 cfs 0.134 af

SubcatchmentArea 60: Area 60 Runoff Area=2.001 ac 0.00% Impervious Runoff Depth=0.90"
Flow Length=318' Tc=20.8 min CN=43 Runoff=1.18 cfs 0.150 af

SubcatchmentArea 61: Area 61 Runoff Area=2.177 ac 0.00% Impervious Runoff Depth=0.63"
Flow Length=149' Tc=8.2 min CN=39 Runoff=0.97 cfs 0.114 af

SubcatchmentArea 62: Area 62 Runoff Area=0.594 ac 0.00% Impervious Runoff Depth=1.44"
Flow Length=147' Slope=0.0544 '/' Tc=7.6 min CN=50 Runoff=1.14 cfs 0.071 af

SubcatchmentArea 63: Area 63 Runoff Area=1.509 ac 100.00% Impervious Runoff Depth=6.35"
Tc=0.0 min CN=98 Runoff=14.43 cfs 0.799 af

SubcatchmentArea 64: Area 64 Runoff Area=5.227 ac 0.00% Impervious Runoff Depth=0.63"
Flow Length=701' Tc=7.9 min CN=39 Runoff=2.36 cfs 0.273 af

SubcatchmentArea 65: Area 65 Runoff Area=3.035 ac 0.00% Impervious Runoff Depth=1.20"
Flow Length=886' Slope=0.0068 '/' Tc=38.9 min CN=47 Runoff=1.99 cfs 0.304 af

SubcatchmentArea 66: Area 66 Runoff Area=0.409 ac 0.00% Impervious Runoff Depth=2.23"
Flow Length=52' Slope=0.1154 '/' Tc=3.1 min CN=59 Runoff=1.60 cfs 0.076 af

SubcatchmentArea 67: Area 67 Runoff Area=0.755 ac 0.00% Impervious Runoff Depth=1.53"
Flow Length=86' Slope=0.2326 '/' Tc=3.5 min CN=51 Runoff=1.86 cfs 0.096 af

SubcatchmentArea 68: Area 68 Runoff Area=1.671 ac 0.00% Impervious Runoff Depth=1.53"
Flow Length=126' Tc=4.0 min CN=51 Runoff=3.98 cfs 0.213 af

SubcatchmentArea 69: Area 69 Runoff Area=9.875 ac 0.00% Impervious Runoff Depth=0.83"
Flow Length=1,337' Tc=16.6 min CN=42 Runoff=5.65 cfs 0.684 af

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SubcatchmentArea 7: Area 7 Runoff Area=0.936 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=541' Tc=5.3 min CN=69 Runoff=4.72 cfs 0.248 af

SubcatchmentArea 70: Area 70 Runoff Area=0.694 ac 0.00% Impervious Runoff Depth=2.89"
Flow Length=127' Slope=0.2500 '/' Tc=3.9 min CN=66 Runoff=3.41 cfs 0.167 af

SubcatchmentArea 8: Area 8 Runoff Area=2.114 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=371' Tc=6.6 min CN=69 Runoff=10.41 cfs 0.560 af

SubcatchmentArea 9: Area 9 Runoff Area=0.810 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=292' Tc=6.3 min CN=69 Runoff=4.01 cfs 0.215 af

Reach 53R: Culvert C1 Avg. Flow Depth=0.00' Max Vel=0.00 fps
24.0" Round Pipe n=0.012 L=51.9' S=0.0222 '/' Capacity=36.48 cfs Outflow=0.00 cfs 0.000 af

Reach RD1: Roadside Ditch 1 Avg. Flow Depth=0.19' Max Vel=2.00 fps Inflow=1.99 cfs 0.304 af
n=0.030 L=440.6' S=0.0188 '/' Capacity=47.16 cfs Outflow=1.96 cfs 0.304 af

Reach RD2: Roadside Ditch 2 Avg. Flow Depth=0.51' Max Vel=3.14 fps Inflow=18.53 cfs 1.460 af
n=0.030 L=433.0' S=0.0162 '/' Capacity=72.77 cfs Outflow=17.64 cfs 1.460 af

Reach RD3: Roadside Ditch 3 Avg. Flow Depth=0.74' Max Vel=4.23 fps Inflow=10.67 cfs 0.531 af
n=0.030 L=821.0' S=0.0288 '/' Capacity=20.76 cfs Outflow=9.18 cfs 0.531 af

Reach RD4: Roadside Ditch 4 Avg. Flow Depth=0.24' Max Vel=1.52 fps Inflow=3.98 cfs 0.213 af
n=0.030 L=495.6' S=0.0090 '/' Capacity=54.26 cfs Outflow=2.99 cfs 0.213 af

Reach RD5: Roadside Ditch 5 Avg. Flow Depth=0.46' Max Vel=4.14 fps Inflow=3.67 cfs 0.179 af
n=0.030 L=288.0' S=0.0531 '/' Capacity=28.18 cfs Outflow=3.30 cfs 0.179 af

Reach S1.0: Swale S1.0 Avg. Flow Depth=1.21' Max Vel=2.81 fps Inflow=49.33 cfs 2.668 af
n=0.030 L=551.3' S=0.0039 '/' Capacity=118.85 cfs Outflow=43.23 cfs 2.668 af

Reach S1.1: Swale S1.1 Avg. Flow Depth=0.06' Max Vel=1.42 fps Inflow=0.66 cfs 0.037 af
n=0.030 L=98.0' S=0.0396 '/' Capacity=376.93 cfs Outflow=0.61 cfs 0.037 af

Reach S1.2: Swale S1.2 Avg. Flow Depth=0.76' Max Vel=5.41 fps Inflow=45.42 cfs 2.871 af
n=0.030 L=170.0' S=0.0242 '/' Capacity=294.55 cfs Outflow=44.63 cfs 2.871 af

Reach S1.3: Swale S1.3 Avg. Flow Depth=0.74' Max Vel=5.86 fps Inflow=47.67 cfs 3.192 af
n=0.030 L=212.6' S=0.0293 '/' Capacity=324.28 cfs Outflow=46.84 cfs 3.192 af

Reach S1.4: Swale S1.4 Avg. Flow Depth=1.00' Max Vel=4.85 fps Inflow=58.99 cfs 4.161 af
n=0.030 L=72.2' S=0.0144 '/' Capacity=227.36 cfs Outflow=58.04 cfs 4.161 af

Reach S1.5: Swale S1.5 Avg. Flow Depth=1.38' Max Vel=3.22 fps Inflow=59.91 cfs 4.281 af
n=0.030 L=148.0' S=0.0045 '/' Capacity=126.50 cfs Outflow=59.49 cfs 4.281 af

Reach S1.6: Swale S1.6 Avg. Flow Depth=0.27' Max Vel=1.35 fps Inflow=3.63 cfs 0.204 af
n=0.030 L=179.7' S=0.0050 '/' Capacity=134.06 cfs Outflow=3.33 cfs 0.204 af

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Reach S1.7: Swale S1.7 Avg. Flow Depth=1.41' Max Vel=3.58 fps Inflow=69.04 cfs 4.888 af
n=0.030 L=252.0' S=0.0054 '/' Capacity=139.68 cfs Outflow=67.28 cfs 4.888 af

Reach S1.8: Swale S1.8 Avg. Flow Depth=0.41' Max Vel=2.20 fps Inflow=3.63 cfs 0.201 af
n=0.030 L=245.8' S=0.0099 '/' Capacity=90.14 cfs Outflow=3.32 cfs 0.201 af

Reach S1.9: Swale S1.9 Avg. Flow Depth=1.35' Max Vel=4.11 fps Inflow=74.80 cfs 5.449 af
n=0.030 L=422.0' S=0.0075 '/' Capacity=163.67 cfs Outflow=72.74 cfs 5.449 af

Reach S2.1: Swale S2.1 Avg. Flow Depth=1.75' Max Vel=3.74 fps Inflow=73.27 cfs 5.559 af
n=0.030 L=389.0' S=0.0054 '/' Capacity=97.05 cfs Outflow=71.33 cfs 5.559 af

Reach S2.2: Swale S2.2 Avg. Flow Depth=1.78' Max Vel=3.97 fps Inflow=121.32 cfs 10.154 af
n=0.030 L=411.0' S=0.0049 '/' Capacity=152.61 cfs Outflow=119.32 cfs 10.154 af

Reach S2.3: Swale S2.3 Avg. Flow Depth=1.38' Max Vel=5.67 fps Inflow=121.74 cfs 10.568 af
n=0.030 L=307.0' S=0.0130 '/' Capacity=249.72 cfs Outflow=120.67 cfs 10.568 af

Reach S3.1: Swale S3.1 Avg. Flow Depth=0.50' Max Vel=1.94 fps Inflow=11.02 cfs 0.542 af
n=0.030 L=357.0' S=0.0050 '/' Capacity=133.76 cfs Outflow=9.75 cfs 0.542 af

Reach S3.2: Swale S3.2 Avg. Flow Depth=1.02' Max Vel=2.89 fps Inflow=35.67 cfs 2.034 af
n=0.030 L=34.0' S=0.0050 '/' Capacity=133.95 cfs Outflow=35.48 cfs 2.034 af

Reach S3.3: Swale S3.3 Avg. Flow Depth=0.78' Max Vel=4.03 fps Inflow=35.48 cfs 2.034 af
n=0.030 L=200.0' S=0.0130 '/' Capacity=215.99 cfs Outflow=33.84 cfs 2.034 af

Reach S3.4: Swale S3.4 Avg. Flow Depth=0.61' Max Vel=2.29 fps Inflow=6.45 cfs 0.357 af
n=0.030 L=283.0' S=0.0071 '/' Capacity=76.21 cfs Outflow=5.88 cfs 0.357 af

Reach S3.5: Swale S3.5 Avg. Flow Depth=1.68' Max Vel=2.64 fps Inflow=67.72 cfs 4.259 af
n=0.030 L=318.5' S=0.0024 '/' Capacity=93.14 cfs Outflow=63.93 cfs 4.259 af

Reach S4.1: Swale S4.1 Avg. Flow Depth=0.22' Max Vel=2.07 fps Inflow=5.28 cfs 0.267 af
n=0.030 L=240.0' S=0.0153 '/' Capacity=70.22 cfs Outflow=4.68 cfs 0.267 af

Reach S4.2: Swale S4.2 Avg. Flow Depth=0.38' Max Vel=2.70 fps Inflow=11.92 cfs 0.667 af
n=0.030 L=259.3' S=0.0127 '/' Capacity=63.88 cfs Outflow=11.06 cfs 0.667 af

Reach S4.3: Swale S4.3 Avg. Flow Depth=1.07' Max Vel=2.24 fps Inflow=35.42 cfs 2.039 af
n=0.030 L=362.9' S=0.0027 '/' Capacity=108.12 cfs Outflow=32.72 cfs 2.039 af

Reach S4.4: Swale S4.4 Avg. Flow Depth=1.10' Max Vel=2.81 fps Inflow=44.75 cfs 3.062 af
n=0.030 L=495.6' S=0.0040 '/' Capacity=132.85 cfs Outflow=42.89 cfs 3.062 af

Reach S4.5: Swale S4.5 Avg. Flow Depth=0.88' Max Vel=3.85 fps Inflow=45.33 cfs 3.413 af
n=0.030 L=411.1' S=0.0097 '/' Capacity=465.89 cfs Outflow=44.02 cfs 3.413 af

Reach S4.6: Swale S4.6 Avg. Flow Depth=1.73' Max Vel=6.01 fps Inflow=168.51 cfs 14.952 af
n=0.030 L=537.0' S=0.0112 '/' Capacity=499.25 cfs Outflow=165.78 cfs 14.952 af

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Reach S5.1: Swale S5.1 Avg. Flow Depth=0.27' Max Vel=2.36 fps Inflow=6.35 cfs 0.322 af
n=0.030 L=428.0' S=0.0154 '/' Capacity=235.24 cfs Outflow=5.76 cfs 0.322 af

Reach S5.2: Swale S5.2 Avg. Flow Depth=0.13' Max Vel=2.27 fps Inflow=2.76 cfs 0.130 af
n=0.030 L=183.6' S=0.0331 '/' Capacity=344.73 cfs Outflow=2.42 cfs 0.130 af

Pond C8: Culvert C8 Peak Elev=811.38' Storage=0.000 af Inflow=1.60 cfs 0.073 af
12.0" Round Culvert n=0.012 L=85.6' S=0.0245 '/' Outflow=1.60 cfs 0.073 af

Pond N: North Infiltration Area Peak Elev=805.24' Storage=49,884 cf Inflow=25.48 cfs 2.356 af
Outflow=2.22 cfs 2.356 af

Pond Sed Pond: Sedimentation Basin Peak Elev=793.23' Storage=247,875 cf Inflow=169.90 cfs 16.095 af
22 af Primary=11.55 cfs 5.267 af Secondary=33.59 cfs 2.497 af Tertiary=43.71 cfs 1.010 af Outflow=94.78 cfs 16.095 af

Link 4L: Culvert C2b Inflow=5.76 cfs 0.322 af
Primary=5.76 cfs 0.322 af

Link C1: Culvert C1 Inflow=1.96 cfs 0.304 af
Primary=1.96 cfs 0.304 af

Link C10: Culvert C10 Inflow=20.55 cfs 1.672 af
Primary=20.55 cfs 1.672 af

Link C11: Culvert C11 Inflow=44.63 cfs 2.871 af
Primary=44.63 cfs 2.871 af

Link C2: Culvert C2a Inflow=16.75 cfs 0.983 af
Primary=16.75 cfs 0.983 af

Link C3: Culvert C3 Inflow=46.84 cfs 3.192 af
Primary=46.84 cfs 3.192 af

Link C4: Culvert C4 Inflow=58.04 cfs 4.161 af
Primary=58.04 cfs 4.161 af

Link C5: Culvert C5 Inflow=67.28 cfs 4.888 af
Primary=67.28 cfs 4.888 af

Link C6: Culvert C6 Inflow=52.51 cfs 3.209 af
Primary=52.51 cfs 3.209 af

Link C7: Culvert C7 Inflow=124.99 cfs 11.388 af
Primary=124.99 cfs 11.388 af

Link C9: Culvert C9 Inflow=0.61 cfs 0.037 af
Primary=0.61 cfs 0.037 af

Link F10: Flume 10 Inflow=1.60 cfs 0.073 af
Primary=1.60 cfs 0.073 af

Link F1A: Flume 1A Inflow=8.37 cfs 0.450 af
Primary=8.37 cfs 0.450 af

Link F1B: Flume 1B Inflow=19.59 cfs 1.043 af
Primary=19.59 cfs 1.043 af

Link F2A: Flume 2A Inflow=3.34 cfs 0.169 af
Primary=3.34 cfs 0.169 af

Link F2B: Flume 2B Inflow=11.13 cfs 0.583 af
Primary=11.13 cfs 0.583 af

Link F3: Flume 3 Inflow=2.33 cfs 0.113 af
Primary=2.33 cfs 0.113 af

Link F4A: Flume 4A Inflow=5.87 cfs 0.320 af
Primary=5.87 cfs 0.320 af

Link F4B: Flume 4B Inflow=15.35 cfs 0.820 af
Primary=15.35 cfs 0.820 af

Link F5A: Flume 5A Inflow=1.28 cfs 0.063 af
Primary=1.28 cfs 0.063 af

Link F5B: Flume 5B Inflow=3.77 cfs 0.189 af
Primary=3.77 cfs 0.189 af

Link F6A: Flume 6A Inflow=7.42 cfs 0.382 af
Primary=7.42 cfs 0.382 af

Link F6B: Flume 6B Inflow=15.57 cfs 0.795 af
Primary=15.57 cfs 0.795 af

Link F7A: Flume 7A Inflow=14.41 cfs 0.775 af
Primary=14.41 cfs 0.775 af

Link F7B: Flume 7B Inflow=25.54 cfs 1.368 af
Primary=25.54 cfs 1.368 af

Link F8A: Flume 8A Inflow=3.91 cfs 0.210 af
Primary=3.91 cfs 0.210 af

Link F8B: Flume 8B Inflow=13.41 cfs 0.707 af
Primary=13.41 cfs 0.707 af

Link F9A: Flume 9A Inflow=15.16 cfs 0.819 af
Primary=15.16 cfs 0.819 af

Link F9B: Flume 9B Inflow=30.63 cfs 1.640 af
Primary=30.63 cfs 1.640 af

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Link Wetland: Wetland

Inflow=88.85 cfs 8.773 af
Primary=88.85 cfs 8.773 af

Summary for Subcatchment Area 1: Area 1

Runoff = 5.61 cfs @ 12.14 hrs, Volume= 0.302 af, Depth= 3.18"
Routed to Link F1A : Flume 1A

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
1.141	69	Pasture/grassland/range, Fair, HSG B
1.141		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.7	60	0.1000	0.27		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
1.8	40	0.2500	0.36		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.1	16	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.9	384	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
6.5	500	Total			

Summary for Subcatchment Area 10: Area 10

Runoff = 3.91 cfs @ 12.14 hrs, Volume= 0.210 af, Depth= 3.18"
Routed to Link F8A : Flume 8A

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.791	69	Pasture/grassland/range, Fair, HSG B
0.791		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.2	71	0.1000	0.28		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
1.4	29	0.2500	0.34		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.4	88	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.4	166	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
6.4	354	Total			

Summary for Subcatchment Area 11: Area 11

Runoff = 4.37 cfs @ 12.14 hrs, Volume= 0.235 af, Depth= 3.18"
Routed to Link F9A : Flume 9A

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.885	69	Pasture/grassland/range, Fair, HSG B
0.885		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.2	71	0.1000	0.28		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
1.4	29	0.2500	0.34		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.6	119	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.2	69	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
6.4	288	Total			

Summary for Subcatchment Area 12: Area 12

Runoff = 10.79 cfs @ 12.14 hrs, Volume= 0.585 af, Depth= 3.18"
Routed to Link F9A : Flume 9A

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
2.206	69	Pasture/grassland/range, Fair, HSG B
2.206		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.7	40	0.1000	0.25		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
2.5	60	0.2500	0.39		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.3	56	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.2	472	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
6.7	628	Total			

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Summary for Subcatchment Area 13: Area 13

Runoff = 8.11 cfs @ 12.12 hrs, Volume= 0.427 af, Depth= 3.18"
Routed to Link F1B : Flume 1B

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
1.610	69	Pasture/grassland/range, Fair, HSG B
1.610		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.1	31	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.4	581	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
5.3	712	Total			

Summary for Subcatchment Area 14: Area 14

Runoff = 3.29 cfs @ 12.11 hrs, Volume= 0.166 af, Depth= 3.18"
Routed to Link F1B : Flume 1B

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.626	69	Pasture/grassland/range, Fair, HSG B
0.626		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.2	50	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.5	183	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
4.5	333	Total			

Summary for Subcatchment Area 15: Area 15

Runoff = 3.27 cfs @ 12.11 hrs, Volume= 0.164 af, Depth= 3.18"
Routed to Link F2B : Flume 2B

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.620	69	Pasture/grassland/range, Fair, HSG B
0.620		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.2	50	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.4	181	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
4.4	331	Total			

Summary for Subcatchment Area 16: Area 16

Runoff = 4.72 cfs @ 12.13 hrs, Volume= 0.250 af, Depth= 3.18"
Routed to Link F2B : Flume 2B

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.943	69	Pasture/grassland/range, Fair, HSG B
0.943		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.7	100	0.1500	0.35		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.5	95	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.7	269	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
5.9	464	Total			

Summary for Subcatchment Area 17: Area 17

Runoff = 3.01 cfs @ 12.11 hrs, Volume= 0.151 af, Depth= 3.18"
Routed to Link F6B : Flume 6B

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.571	69	Pasture/grassland/range, Fair, HSG B
0.571		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.2	44	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.4	171	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
4.4	315	Total			

Summary for Subcatchment Area 18: Area 18

Runoff = 5.14 cfs @ 12.11 hrs, Volume= 0.262 af, Depth= 3.18"
Routed to Link F6B : Flume 6B

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.990	69	Pasture/grassland/range, Fair, HSG B
0.990		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.2	46	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.7	278	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
4.7	424	Total			

Summary for Subcatchment Area 19: Area 19

Runoff = 6.12 cfs @ 12.11 hrs, Volume= 0.313 af, Depth= 3.18"
Routed to Link F7B : Flume 7B

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
1.179	69	Pasture/grassland/range, Fair, HSG B
1.179		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.3	60	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.6	225	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
4.7	385	Total			

Summary for Subcatchment Area 2: Area 2

Runoff = 2.89 cfs @ 12.11 hrs, Volume= 0.148 af, Depth= 3.18"
Routed to Link F1A : Flume 1A

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.557	69	Pasture/grassland/range, Fair, HSG B
0.557		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.2	100	0.1950	0.39		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.1	22	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.4	181	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
4.7	303	Total			

Summary for Subcatchment Area 20: Area 20

Runoff = 5.49 cfs @ 12.11 hrs, Volume= 0.280 af, Depth= 3.18"
Routed to Link F7B : Flume 7B

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
1.057	69	Pasture/grassland/range, Fair, HSG B
1.057		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.3	57	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.6	262	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
4.7	419	Total			

Summary for Subcatchment Area 21: Area 21

Runoff = 2.28 cfs @ 12.11 hrs, Volume= 0.115 af, Depth= 3.18"
Routed to Link F8B : Flume 8B

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.434	69	Pasture/grassland/range, Fair, HSG B
0.434		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.1	15	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.6	259	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
4.5	374	Total			

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Summary for Subcatchment Area 22: Area 22

Runoff = 7.45 cfs @ 12.12 hrs, Volume= 0.382 af, Depth= 3.18"
Routed to Link F8B : Flume 8B

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
1.442	69	Pasture/grassland/range, Fair, HSG B
1.442		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.2	49	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.8	340	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
4.8	489	Total			

Summary for Subcatchment Area 23: Area 23

Runoff = 6.50 cfs @ 12.11 hrs, Volume= 0.332 af, Depth= 3.18"
Routed to Link F9B : Flume 9B

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
1.252	69	Pasture/grassland/range, Fair, HSG B
1.252		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.2	50	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.7	285	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
4.7	435	Total			

Summary for Subcatchment Area 24: Area 24

Runoff = 9.33 cfs @ 12.13 hrs, Volume= 0.489 af, Depth= 3.18"
Routed to Link F9B : Flume 9B

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
1.846	69	Pasture/grassland/range, Fair, HSG B
1.846		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.2	43	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.4	558	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
5.4	701	Total			

Summary for Subcatchment Area 25: Area 25

Runoff = 10.67 cfs @ 12.10 hrs, Volume= 0.531 af, Depth= 4.10"
Routed to Reach RD3 : Roadside Ditch 3

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
1.024	69	Pasture/grassland/range, Fair, HSG B
0.528	96	Gravel surface, HSG A
1.552	78	Weighted Average
1.552		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.1	23	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
3.9	123	Total			

Summary for Subcatchment Area 26: Area 26

Runoff = 3.67 cfs @ 12.10 hrs, Volume= 0.179 af, Depth= 3.48"
Routed to Reach RD5 : Roadside Ditch 5

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.543	69	Pasture/grassland/range, Fair, HSG B
0.073	96	Gravel surface, HSG A
0.616	72	Weighted Average
0.616		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.0	9	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
3.8	109	Total			

Summary for Subcatchment Area 27: Area 27

Runoff = 0.86 cfs @ 12.07 hrs, Volume= 0.039 af, Depth= 3.18"
Routed to Link F10 : Flume 10

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.149	69	Pasture/grassland/range, Fair, HSG B
0.149		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.7	12	0.2500	0.28		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.5	199	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
1.2	211	Total			

Summary for Subcatchment Area 28: Area 28

Runoff = 0.74 cfs @ 12.09 hrs, Volume= 0.033 af, Depth= 3.18"
Routed to Link F10 : Flume 10

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

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Area (ac)	CN	Description
0.126	69	Pasture/grassland/range, Fair, HSG B
0.126		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.5	59	0.2500	0.39		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"

Summary for Subcatchment Area 29: Area 29

Runoff = 6.17 cfs @ 12.13 hrs, Volume= 0.325 af, Depth= 3.18"
Routed to Link F4B : Flume 4B

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
1.228	69	Pasture/grassland/range, Fair, HSG B
1.228		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.0	6	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.9	541	0.0200	4.80	23.38	**Trap/Vee/Rect Channel Flow, Existing Diversion Berm** Bot.W=0.00' D=1.18' Z= 4.0 & 3.0 '/' Top.W=8.26' n= 0.030 Earth, grassed & winding
5.7	647	Total			

Summary for Subcatchment Area 3: Area 3

Runoff = 1.80 cfs @ 12.12 hrs, Volume= 0.092 af, Depth= 3.18"
Routed to Link F2A : Flume 2A

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.348	69	Pasture/grassland/range, Fair, HSG B
0.348		100.00% Pervious Area

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Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.2	100	0.1950	0.39		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.2	36	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.4	162	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
4.8	298	Total			

Summary for Subcatchment Area 30: Area 30

Runoff = 2.33 cfs @ 12.10 hrs, Volume= 0.113 af, Depth= 3.18"
Routed to Link F3 : Flume 3

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.427	69	Pasture/grassland/range, Fair, HSG B
0.427		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.9	70	0.2500	0.40		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.8	227	0.0200	4.80	23.38	**Trap/Vee/Rect Channel Flow, Existing Diversion Berm** Bot.W=0.00' D=1.18' Z= 4.0 & 3.0 '/' Top.W=8.26' n= 0.030 Earth, grassed & winding
0.1	65	0.2500	12.26	441.43	**Trap/Vee/Rect Channel Flow, Riprap Flume** Bot.W=12.00' D=2.00' Z= 3.0 '/' Top.W=24.00' n= 0.078 Riprap, 12-inch
3.8	362	Total			

Summary for Subcatchment Area 31: Area 31

Runoff = 1.22 cfs @ 12.10 hrs, Volume= 0.059 af, Depth= 3.18"
Routed to Link F4A : Flume 4A

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.223	69	Pasture/grassland/range, Fair, HSG B
0.223		100.00% Pervious Area

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Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.1	77	0.2500	0.41		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.5	157	0.0200	4.80	23.38	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.18' Z= 4.0 & 3.0 '/' Top.W=8.26' n= 0.030 Earth, grassed & winding
0.1	62	0.2500	12.26	441.43	**Trap/Vee/Rect Channel Flow, Riprap Flume** Bot.W=12.00' D=2.00' Z= 3.0 '/' Top.W=24.00' n= 0.078 Riprap, 12-inch
3.7	296	Total			

Summary for Subcatchment Area 32: Area 32

Runoff = 3.35 cfs @ 12.12 hrs, Volume= 0.174 af, Depth= 3.18"
Routed to Link F4B : Flume 4B

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.655	69	Pasture/grassland/range, Fair, HSG B
0.655		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.1	11	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.8	314	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Existing Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
0.3	217	0.2500	12.26	441.43	**Trap/Vee/Rect Channel Flow, Riprap Flume** Bot.W=12.00' D=2.00' Z= 3.0 '/' Top.W=24.00' n= 0.078 Riprap, 12-inch
5.0	642	Total			

Summary for Subcatchment Area 33: Area 33

Runoff = 1.28 cfs @ 12.10 hrs, Volume= 0.063 af, Depth= 3.18"
Routed to Link F5A : Flume 5A

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.237	69	Pasture/grassland/range, Fair, HSG B
0.237		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.3	83	0.2500	0.42		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.5	138	0.0200	4.80	23.38	**Trap/Vee/Rect Channel Flow, Existing Diversion Berm** Bot.W=0.00' D=1.18' Z= 4.0 & 3.0 '/' Top.W=8.26' n= 0.030 Earth, grassed & winding
0.2	127	0.2500	12.26	441.43	**Trap/Vee/Rect Channel Flow, Riprap Flume** Bot.W=12.00' D=2.00' Z= 3.0 '/' Top.W=24.00' n= 0.078 Riprap, 12-inch
4.0	348	Total			

Summary for Subcatchment Area 34: Area 34

Runoff = 2.76 cfs @ 12.09 hrs, Volume= 0.130 af, Depth= 3.69"
Routed to Reach S5.2 : Swale S5.2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.346	69	Pasture/grassland/range, Fair, HSG B
0.078	96	Gravel surface, HSG A
0.424	74	Weighted Average
0.424		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.1	78	0.2500	0.41		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"

Summary for Subcatchment Area 35: Area 35

Runoff = 6.35 cfs @ 12.11 hrs, Volume= 0.322 af, Depth= 3.89"
Routed to Reach S5.1 : Swale S5.1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.745	69	Pasture/grassland/range, Fair, HSG B
0.248	96	Gravel surface, HSG A
0.993	76	Weighted Average
0.993		100.00% Pervious Area

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Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.3	70	0.1736	0.35		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.9	30	0.0050	0.58		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.77"
0.1	12	0.0050	1.44		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.1	14	0.1766	2.94		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
4.4	126	Total			

Summary for Subcatchment Area 36: Area 36

Runoff = 21.62 cfs @ 12.08 hrs, Volume= 1.027 af, Depth= 4.75"
Routed to Reach S1.0 : Swale S1.0

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
1.120	69	Pasture/grassland/range, Fair, HSG B
1.474	96	Gravel surface, HSG A
2.594	84	Weighted Average
2.594		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.5	100	0.0140	1.11		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.77"
0.2	32	0.0140	2.40		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.5	40	0.0050	1.44		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.0	11	0.5000	4.95		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
2.2	183	Total			

Summary for Subcatchment Area 37: Area 37

Runoff = 0.66 cfs @ 12.12 hrs, Volume= 0.037 af, Depth= 1.44"
Routed to Reach S1.1 : Swale S1.1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

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Area (ac)	CN	Description
0.249	39	Pasture/grassland/range, Good, HSG A
0.057	96	Gravel surface, HSG A
0.306	50	Weighted Average
0.306		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.4	72	0.1736	0.35		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.8	28	0.0050	0.57		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.77"
0.2	19	0.0050	1.44		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.1	14	0.1766	2.94		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
4.5	133	Total			

Summary for Subcatchment Area 38: Area 38

Runoff = 6.48 cfs @ 12.11 hrs, Volume= 0.321 af, Depth= 2.69"
Routed to Reach S1.3 : Swale S1.3

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.395	39	Pasture/grassland/range, Good, HSG A
0.886	69	Pasture/grassland/range, Fair, HSG B
0.149	96	Gravel surface, HSG A
1.430	64	Weighted Average
1.430		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.3	56	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
4.1	156	Total			

Summary for Subcatchment Area 39: Area 39

Runoff = 3.20 cfs @ 12.11 hrs, Volume= 0.161 af, Depth= 2.60"
Routed to Reach S1.4 : Swale S1.4

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

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Area (ac)	CN	Description
0.225	39	Pasture/grassland/range, Good, HSG A
0.436	69	Pasture/grassland/range, Fair, HSG B
0.081	96	Gravel surface, HSG A
0.742	63	Weighted Average
0.742		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.3	23	0.0050	1.44		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.2	22	0.0833	2.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
4.3	145	Total			

Summary for Subcatchment Area 4: Area 4

Runoff = 1.55 cfs @ 12.10 hrs, Volume= 0.076 af, Depth= 3.18"
Routed to Link F2A : Flume 2A

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.288	69	Pasture/grassland/range, Fair, HSG B
0.288		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.4	49	0.0820	0.24		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.6	247	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
4.0	296	Total			

Summary for Subcatchment Area 40: Area 40

Runoff = 1.57 cfs @ 12.18 hrs, Volume= 0.101 af, Depth= 1.96"
Routed to Reach S1.4 : Swale S1.4

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

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Area (ac)	CN	Description
0.317	39	Pasture/grassland/range, Good, HSG A
0.243	69	Pasture/grassland/range, Fair, HSG B
0.060	96	Gravel surface, HSG A
0.620	56	Weighted Average
0.620		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.2	81	0.0245	0.16		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
1.0	19	0.2500	0.31		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.1	29	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.2	20	0.0050	1.44		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.1	19	0.1053	2.27		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
9.6	168	Total			

Summary for Subcatchment Area 41: Area 41

Runoff = 2.11 cfs @ 12.15 hrs, Volume= 0.120 af, Depth= 1.96"
Routed to Reach S1.5 : Swale S1.5

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.389	39	Pasture/grassland/range, Good, HSG A
0.270	69	Pasture/grassland/range, Fair, HSG B
0.080	96	Gravel surface, HSG A
0.739	56	Weighted Average
0.739		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.5	49	0.0408	0.18		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
2.1	47	0.2500	0.37		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.2	4	0.0050	0.39		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.77"
0.2	19	0.0050	1.44		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.2	22	0.1136	2.36		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
7.2	141	Total			

Summary for Subcatchment Area 42a: Area 42a

Runoff = 3.58 cfs @ 12.15 hrs, Volume= 0.202 af, Depth= 2.79"
Routed to Reach S1.7 : Swale S1.7

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.249	39	Pasture/grassland/range, Good, HSG A
0.489	69	Pasture/grassland/range, Fair, HSG B
0.133	96	Gravel surface, HSG A
0.871	65	Weighted Average
0.871		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.3	100	0.0500	0.23		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.5	44	0.0500	1.57		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
7.8	144	Total			

Summary for Subcatchment Area 42b: Area 42b

Runoff = 3.63 cfs @ 12.15 hrs, Volume= 0.201 af, Depth= 3.38"
Routed to Reach S1.8 : Swale S1.8

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.655	69	Pasture/grassland/range, Fair, HSG B
0.057	96	Gravel surface, HSG A
0.712	71	Weighted Average
0.712		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.3	100	0.0500	0.23		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.0	2	0.0500	1.57		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
7.3	102	Total			

Summary for Subcatchment Area 43: Area 43

Runoff = 3.63 cfs @ 12.15 hrs, Volume= 0.204 af, Depth= 3.18"
Routed to Reach S1.6 : Swale S1.6

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.769	69	Pasture/grassland/range, Fair, HSG B
0.769		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.3	100	0.0500	0.23		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.4	39	0.0500	1.57		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
7.7	139	Total			

Summary for Subcatchment Area 44: Area 44

Runoff = 0.43 cfs @ 12.47 hrs, Volume= 0.074 af, Depth= 0.63"
Routed to Reach S2.1 : Swale S2.1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
1.416	39	Pasture/grassland/range, Good, HSG A
1.416		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.5	100	0.0260	0.18		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
2.9	194	0.0260	1.13		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
9.6	647	0.0260	1.13		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
22.0	941	Total			

Summary for Subcatchment Area 45: Area 45

Runoff = 7.53 cfs @ 12.24 hrs, Volume= 0.561 af, Depth= 2.41"
Routed to Reach S1.9 : Swale S1.9

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

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Area (ac)	CN	Description
0.797	39	Pasture/grassland/range, Good, HSG A
1.938	69	Pasture/grassland/range, Fair, HSG B
0.057	96	Gravel surface, HSG A
2.792	61	Weighted Average
2.792		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.3	100	0.0500	0.23		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
1.3	119	0.0500	1.57		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.1	22	0.1905	3.06		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
6.0	178	0.0050	0.49		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
14.7	419	Total			

Summary for Subcatchment Area 46: Area 46

Runoff = 11.02 cfs @ 12.10 hrs, Volume= 0.542 af, Depth= 3.18"
Routed to Reach S3.1 : Swale S3.1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
2.044	69	Pasture/grassland/range, Fair, HSG B
2.044		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.2	38	0.2632	3.59		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
4.0	138	Total			

Summary for Subcatchment Area 47: Area 47

Runoff = 2.55 cfs @ 12.10 hrs, Volume= 0.125 af, Depth= 3.28"
Routed to Reach S3.2 : Swale S3.2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

09/28/2023 - Classification: Internal - ECRM13153872

Area (ac)	CN	Description
0.435	69	Pasture/grassland/range, Fair, HSG B
0.022	96	Gravel surface, HSG A
0.457	70	Weighted Average
0.457		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.1	22	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
3.9	122	Total			

Summary for Subcatchment Area 48: Area 48

Runoff = 6.45 cfs @ 12.15 hrs, Volume= 0.357 af, Depth= 3.58"
Routed to Reach S3.4 : Swale S3.4

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
1.031	69	Pasture/grassland/range, Fair, HSG B
0.163	96	Gravel surface, HSG A
1.194	73	Weighted Average
1.194		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.2	98	0.0500	0.23		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"

Summary for Subcatchment Area 49: Area 49

Runoff = 0.44 cfs @ 12.12 hrs, Volume= 0.023 af, Depth= 3.48"
Routed to Link C6 : Culvert C6

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.070	69	Pasture/grassland/range, Fair, HSG B
0.009	96	Gravel surface, HSG A
0.079	72	Weighted Average
0.079		100.00% Pervious Area

09/28/2023 - Classification: Internal - ECRM13153872

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.5	90	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
1.2	10	0.0500	0.14		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.1	10	0.0500	1.57		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.2	15	0.0050	1.44		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.1	18	0.1390	2.61		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
5.1	143	Total			

Summary for Subcatchment Area 5: Area 5

Runoff = 4.85 cfs @ 12.14 hrs, Volume= 0.261 af, Depth= 3.18"
Routed to Link F4A : Flume 4A

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.986	69	Pasture/grassland/range, Fair, HSG B
0.986		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.2	31	0.1000	0.24		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
2.8	69	0.2500	0.40		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.0	9	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.5	419	0.0200	4.80	23.38	**Trap/Vee/Rect Channel Flow, Existing Diversion Berm** Bot.W=0.00' D=1.18' Z= 4.0 & 3.0 '/' Top.W=8.26' n= 0.030 Earth, grassed & winding
0.1	80	0.2500	12.26	441.43	**Trap/Vee/Rect Channel Flow, Riprap Flume** Bot.W=12.00' D=2.00' Z= 3.0 '/' Top.W=24.00' n= 0.078 Riprap, 12-inch
6.6	608	Total			

Summary for Subcatchment Area 50: Area 50

Runoff = 16.26 cfs @ 12.19 hrs, Volume= 1.050 af, Depth= 3.38"
Routed to Reach S3.5 : Swale S3.5

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

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Area (ac)	CN	Description
3.470	69	Pasture/grassland/range, Fair, HSG B
0.256	96	Gravel surface, HSG A
3.726	71	Weighted Average
3.726		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.3	100	0.0500	0.23		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.9	83	0.0500	1.57		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
2.9	208	0.0289	1.19		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
11.1	391	Total			

Summary for Subcatchment Area 51: Area 51

Runoff = 0.32 cfs @ 12.19 hrs, Volume= 0.036 af, Depth= 0.63"
Routed to Reach S2.1 : Swale S2.1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.698	39	Pasture/grassland/range, Good, HSG A
0.698		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.8	100	0.0600	0.25		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"

Summary for Subcatchment Area 52: Area 52

Runoff = 2.50 cfs @ 12.11 hrs, Volume= 0.126 af, Depth= 3.18"
Routed to Link F5B : Flume 5B

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.475	69	Pasture/grassland/range, Fair, HSG B
0.475		100.00% Pervious Area

09/28/2023 - Classification: Internal - ECRM13153872

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.5	90	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.8	219	0.0200	4.80	23.38	**Trap/Vee/Rect Channel Flow, Existing Diversion Berm** Bot.W=0.00' D=1.18' Z= 4.0 & 3.0 '/' Top.W=8.26' n= 0.030 Earth, grassed & winding
0.2	116	0.2500	12.26	441.43	**Trap/Vee/Rect Channel Flow, Riprap Flume** Bot.W=12.00' D=2.00' Z= 3.0 '/' Top.W=24.00' n= 0.078 Riprap, 12-inch
4.5	425	Total			

Summary for Subcatchment Area 53: Area 53

Runoff = 5.93 cfs @ 12.11 hrs, Volume= 0.300 af, Depth= 2.23"
Routed to Reach S2.3 : Swale S2.3

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
1.079	69	Pasture/grassland/range, Fair, HSG B
0.539	39	Pasture/grassland/range, Good, HSG A
1.618	59	Weighted Average
1.618		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.1	77	0.2500	0.41		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.8	237	0.0200	4.80	23.38	**Trap/Vee/Rect Channel Flow, Existing Diversion Berm** Bot.W=0.00' D=1.18' Z= 4.0 & 3.0 '/' Top.W=8.26' n= 0.030 Earth, grassed & winding
0.3	70	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
4.2	384	Total			

Summary for Subcatchment Area 54: Area 54

Runoff = 2.95 cfs @ 12.11 hrs, Volume= 0.147 af, Depth= 2.13"
Routed to Reach S2.2 : Swale S2.2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

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Area (ac)	CN	Description
0.520	69	Pasture/grassland/range, Fair, HSG B
0.306	39	Pasture/grassland/range, Good, HSG A
0.826	58	Weighted Average
0.826		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.1	26	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
3.9	126	Total			

Summary for Subcatchment Area 55: Area 55

Runoff = 3.79 cfs @ 12.11 hrs, Volume= 0.194 af, Depth= 2.13"
Routed to Reach S4.1 : Swale S4.1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.526	39	Pasture/grassland/range, Good, HSG A
0.405	69	Pasture/grassland/range, Fair, HSG B
0.158	96	Gravel surface, HSG A
1.089	58	Weighted Average
1.089		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.5	80	0.2000	0.38		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.2	20	0.0500	1.34		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.77"
0.1	10	0.0050	1.44		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.5	48	0.0625	1.75		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
4.3	158	Total			

Summary for Subcatchment Area 56: Area 56

Runoff = 4.33 cfs @ 12.11 hrs, Volume= 0.221 af, Depth= 2.23"
Routed to Reach S4.2 : Swale S4.2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

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Area (ac)	CN	Description
0.580	39	Pasture/grassland/range, Good, HSG A
0.433	69	Pasture/grassland/range, Fair, HSG B
0.181	96	Gravel surface, HSG B
1.194	59	Weighted Average
1.194		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.6	121	0.2314	3.37		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
4.4	221	Total			

Summary for Subcatchment Area 57: Area 57

Runoff = 6.17 cfs @ 12.12 hrs, Volume= 0.330 af, Depth= 1.78"
Routed to Reach S4.3 : Swale S4.3

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
1.134	39	Pasture/grassland/range, Good, HSG A
1.086	69	Pasture/grassland/range, Fair, HSG B
2.220	54	Weighted Average
2.220		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.8	140	0.1857	3.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
4.6	240	Total			

Summary for Subcatchment Area 58: Area 58

Runoff = 8.43 cfs @ 12.12 hrs, Volume= 0.441 af, Depth= 2.13"
Routed to Reach S4.4 : Swale S4.4

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

09/28/2023 - Classification: Internal - ECRM13153872

Area (ac)	CN	Description
0.939	39	Pasture/grassland/range, Good, HSG A
1.537	69	Pasture/grassland/range, Fair, HSG B
2.476	58	Weighted Average
2.476		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.9	163	0.1718	2.90		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
4.7	263	Total			

Summary for Subcatchment Area 59: Area 59

Runoff = 4.54 cfs @ 12.11 hrs, Volume= 0.238 af, Depth= 1.70"
Routed to Reach S4.5 : Swale S4.5

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.898	39	Pasture/grassland/range, Good, HSG A
0.785	69	Pasture/grassland/range, Fair, HSG B
1.683	53	Weighted Average
1.683		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.9	100	0.2345	0.42		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.2	46	0.2345	3.39		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
4.1	146	Total			

Summary for Subcatchment Area 6: Area 6

Runoff = 2.81 cfs @ 12.10 hrs, Volume= 0.134 af, Depth= 3.18"
Routed to Link F6A : Flume 6A

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.504	69	Pasture/grassland/range, Fair, HSG B
0.504		100.00% Pervious Area

09/28/2023 - Classification: Internal - ECRM13153872

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.9	72	0.2500	0.41		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.5	186	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Existing Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
3.4	258	Total			

Summary for Subcatchment Area 60: Area 60

Runoff = 1.18 cfs @ 12.39 hrs, Volume= 0.150 af, Depth= 0.90"
Routed to Reach S4.6 : Swale S4.6

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
1.871	39	Pasture/grassland/range, Good, HSG A
0.000	96	Gravel surface, HSG A
0.130	96	Gravel surface, HSG A
2.001	43	Weighted Average
2.001		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.7	100	0.0074	0.11		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
4.7	169	0.0074	0.60		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.4	49	0.0800	1.98		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
20.8	318	Total			

Summary for Subcatchment Area 61: Area 61

Runoff = 0.97 cfs @ 12.21 hrs, Volume= 0.114 af, Depth= 0.63"
Routed to Reach S2.3 : Swale S2.3

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
2.177	39	Pasture/grassland/range, Good, HSG A
2.177		100.00% Pervious Area

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Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.4	66	0.0303	0.17		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
1.6	34	0.2500	0.35		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.2	49	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
8.2	149	Total			

Summary for Subcatchment Area 62: Area 62

Runoff = 1.14 cfs @ 12.16 hrs, Volume= 0.071 af, Depth= 1.44"
Routed to Pond Sed Pond : Sedimentation Basin

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.479	39	Pasture/grassland/range, Good, HSG A
0.115	96	Gravel surface, HSG A
0.594	50	Weighted Average
0.594		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.1	100	0.0544	0.24		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.5	47	0.0544	1.63		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
7.6	147	Total			

Summary for Subcatchment Area 63: Area 63

Runoff = 14.43 cfs @ 12.04 hrs, Volume= 0.799 af, Depth= 6.35"
Routed to Pond Sed Pond : Sedimentation Basin

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
1.509	98	Water Surface, HSG A
1.509		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry,**

Summary for Subcatchment Area 64: Area 64

Runoff = 2.36 cfs @ 12.21 hrs, Volume= 0.273 af, Depth= 0.63"
Routed to Pond Sed Pond : Sedimentation Basin

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
5.227	39	Pasture/grassland/range, Good, HSG A
5.227		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.5	75	0.0933	0.28		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
1.3	25	0.2500	0.33		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.0	10	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.8	381	0.0265	7.85	109.92	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=2.00' Z= 4.0 & 3.0 '/' Top.W=14.00' n= 0.030 Earth, grassed & winding
0.8	162	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.5	48	0.0500	1.57		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
7.9	701	Total			

Summary for Subcatchment Area 65: Area 65

Runoff = 1.99 cfs @ 12.64 hrs, Volume= 0.304 af, Depth= 1.20"
Routed to Reach RD1 : Roadside Ditch 1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
2.616	39	Pasture/grassland/range, Good, HSG A
0.039	69	Pasture/grassland/range, Fair, HSG B
0.380	96	Gravel surface, HSG A
3.035	47	Weighted Average
3.035		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
16.2	100	0.0068	0.10		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
22.7	786	0.0068	0.58		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
38.9	886	Total			

Summary for Subcatchment Area 66: Area 66

Runoff = 1.60 cfs @ 12.10 hrs, Volume= 0.076 af, Depth= 2.23"
Routed to Reach RD2 : Roadside Ditch 2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.213	39	Pasture/grassland/range, Good, HSG A
0.104	69	Pasture/grassland/range, Fair, HSG B
0.092	96	Gravel surface, HSG A
0.409	59	Weighted Average
0.409		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.1	52	0.1154	0.28		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"

Summary for Subcatchment Area 67: Area 67

Runoff = 1.86 cfs @ 12.11 hrs, Volume= 0.096 af, Depth= 1.53"
Routed to Reach RD2 : Roadside Ditch 2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.524	39	Pasture/grassland/range, Good, HSG A
0.139	69	Pasture/grassland/range, Fair, HSG B
0.092	96	Gravel surface, HSG A
0.755	51	Weighted Average
0.755		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.5	86	0.2326	0.41		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"

Summary for Subcatchment Area 68: Area 68

Runoff = 3.98 cfs @ 12.11 hrs, Volume= 0.213 af, Depth= 1.53"
Routed to Reach RD4 : Roadside Ditch 4

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
1.016	39	Pasture/grassland/range, Good, HSG A
0.620	69	Pasture/grassland/range, Fair, HSG B
0.035	96	Gravel surface, HSG A
1.671	51	Weighted Average
1.671		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.2	26	0.1538	2.75		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
4.0	126	Total			

Summary for Subcatchment Area 69: Area 69

Runoff = 5.65 cfs @ 12.32 hrs, Volume= 0.684 af, Depth= 0.83"
Routed to Pond N : North Infiltration Area

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
9.360	39	Pasture/grassland/range, Good, HSG A
0.515	96	Gravel surface, HSG A
9.875	42	Weighted Average
9.875		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.5	100	0.0200	0.16		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
1.7	100	0.0200	0.99		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
4.4	1,137	0.0193	4.31	32.30	**Trap/Vee/Rect Channel Flow, Roadside Ditch** Bot.W=0.00' D=1.00' Z= 5.0 & 10.0 '/' Top.W=15.00' n= 0.030
16.6	1,337	Total			

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Summary for Subcatchment Area 7: Area 7

Runoff = 4.72 cfs @ 12.12 hrs, Volume= 0.248 af, Depth= 3.18"
Routed to Link F6A : Flume 6A

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.936	69	Pasture/grassland/range, Fair, HSG B
0.936		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.1	100	0.2070	0.40		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.2	46	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.0	395	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
5.3	541	Total			

Summary for Subcatchment Area 70: Area 70

Runoff = 3.41 cfs @ 12.10 hrs, Volume= 0.167 af, Depth= 2.89"
Routed to Reach S1.2 : Swale S1.2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.153	39	Pasture/grassland/range, Good, HSG A
0.441	69	Pasture/grassland/range, Fair, HSG B
0.100	96	Gravel surface, HSG A
0.694	66	Weighted Average
0.694		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.1	27	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
3.9	127	Total			

Summary for Subcatchment Area 8: Area 8

Runoff = 10.41 cfs @ 12.14 hrs, Volume= 0.560 af, Depth= 3.18"
Routed to Link F7A : Flume 7A

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
2.114	69	Pasture/grassland/range, Fair, HSG B
2.114		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.5	100	0.1000	0.30		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.2	26	0.1000	2.21		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.6	121	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.3	124	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
6.6	371	Total			

Summary for Subcatchment Area 9: Area 9

Runoff = 4.01 cfs @ 12.14 hrs, Volume= 0.215 af, Depth= 3.18"
Routed to Link F7A : Flume 7A

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.810	69	Pasture/grassland/range, Fair, HSG B
0.810		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.2	71	0.1000	0.28		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
1.4	29	0.2500	0.34		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.4	89	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.3	103	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
6.3	292	Total			

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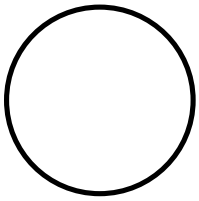
Summary for Reach 53R: Culvert C1

Bank-Full Depth= 2.00' Flow Area= 3.1 sf, Capacity= 36.48 cfs

24.0" Round Pipe
n= 0.012 Corrugated PP, smooth interior
Length= 51.9' Slope= 0.0222 '/'
Inlet Invert= 815.70', Outlet Invert= 814.55'



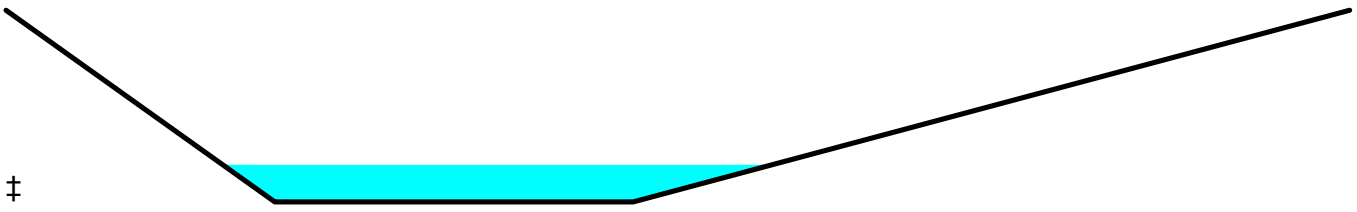
Summary for Reach RD1: Roadside Ditch 1

Inflow Area = 3.035 ac, 0.00% Impervious, Inflow Depth = 1.20" for 100-yr, 24-hr event
Inflow = 1.99 cfs @ 12.64 hrs, Volume= 0.304 af
Outflow = 1.96 cfs @ 12.74 hrs, Volume= 0.304 af, Atten= 1%, Lag= 6.5 min
Routed to Link C1 : Culvert C1

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.00 fps, Min. Travel Time= 3.7 min
Avg. Velocity = 0.80 fps, Avg. Travel Time= 9.2 min

Peak Storage= 434 cf @ 12.68 hrs
Average Depth at Peak Storage= 0.19' , Surface Width= 6.14'
Bank-Full Depth= 1.00' Flow Area= 9.5 sf, Capacity= 47.16 cfs

4.00' x 1.00' deep channel, n= 0.030
Side Slope Z-value= 3.0 8.0 '/' Top Width= 15.00'
Length= 440.6' Slope= 0.0188 '/'
Inlet Invert= 824.00', Outlet Invert= 815.70'



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Summary for Reach RD2: Roadside Ditch 2

Inflow Area = 7.168 ac, 0.00% Impervious, Inflow Depth = 2.44" for 100-yr, 24-hr event
Inflow = 18.53 cfs @ 12.17 hrs, Volume= 1.460 af
Outflow = 17.64 cfs @ 12.24 hrs, Volume= 1.460 af, Atten= 5%, Lag= 4.0 min
Routed to Link C10 : Culvert C10

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.14 fps, Min. Travel Time= 2.3 min
Avg. Velocity = 0.90 fps, Avg. Travel Time= 8.1 min

Peak Storage= 2,485 cf @ 12.20 hrs
Average Depth at Peak Storage= 0.51' , Surface Width= 16.30'
Bank-Full Depth= 1.00' Flow Area= 16.0 sf, Capacity= 72.77 cfs

6.00' x 1.00' deep channel, n= 0.030
Side Slope Z-value= 10.0 '/' Top Width= 26.00'
Length= 433.0' Slope= 0.0162 '/'
Inlet Invert= 814.55', Outlet Invert= 807.54'

‡

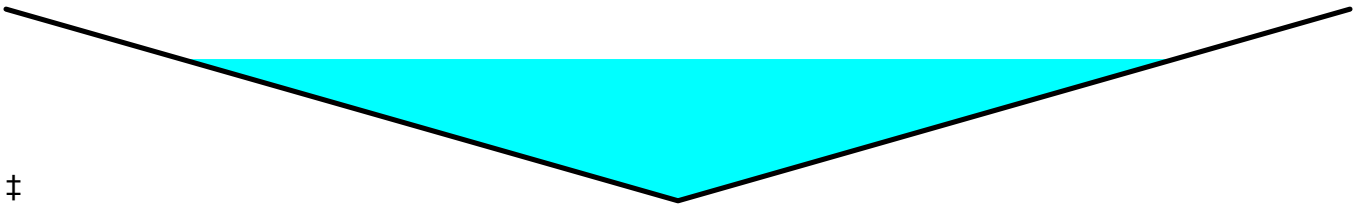
Summary for Reach RD3: Roadside Ditch 3

Inflow Area = 1.552 ac, 0.00% Impervious, Inflow Depth = 4.10" for 100-yr, 24-hr event
Inflow = 10.67 cfs @ 12.10 hrs, Volume= 0.531 af
Outflow = 9.18 cfs @ 12.19 hrs, Volume= 0.531 af, Atten= 14%, Lag= 5.4 min
Routed to Link C2 : Culvert C2a

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 4.23 fps, Min. Travel Time= 3.2 min
Avg. Velocity = 1.37 fps, Avg. Travel Time= 10.0 min

Peak Storage= 1,795 cf @ 12.14 hrs
Average Depth at Peak Storage= 0.74' , Surface Width= 5.92'
Bank-Full Depth= 1.00' Flow Area= 4.0 sf, Capacity= 20.76 cfs

0.00' x 1.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 8.00'
Length= 821.0' Slope= 0.0288 '/'
Inlet Invert= 841.47', Outlet Invert= 817.83'



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Summary for Reach RD4: Roadside Ditch 4

Inflow Area = 1.671 ac, 0.00% Impervious, Inflow Depth = 1.53" for 100-yr, 24-hr event
Inflow = 3.98 cfs @ 12.11 hrs, Volume= 0.213 af
Outflow = 2.99 cfs @ 12.26 hrs, Volume= 0.213 af, Atten= 25%, Lag= 9.0 min
Routed to Link C10 : Culvert C10

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.52 fps, Min. Travel Time= 5.4 min
Avg. Velocity = 0.44 fps, Avg. Travel Time= 18.6 min

Peak Storage= 991 cf @ 12.17 hrs
Average Depth at Peak Storage= 0.24' , Surface Width= 10.77'
Bank-Full Depth= 1.00' Flow Area= 16.0 sf, Capacity= 54.26 cfs

6.00' x 1.00' deep channel, n= 0.030
Side Slope Z-value= 10.0 '/' Top Width= 26.00'
Length= 495.6' Slope= 0.0090 '/'
Inlet Invert= 812.00', Outlet Invert= 807.54'

‡

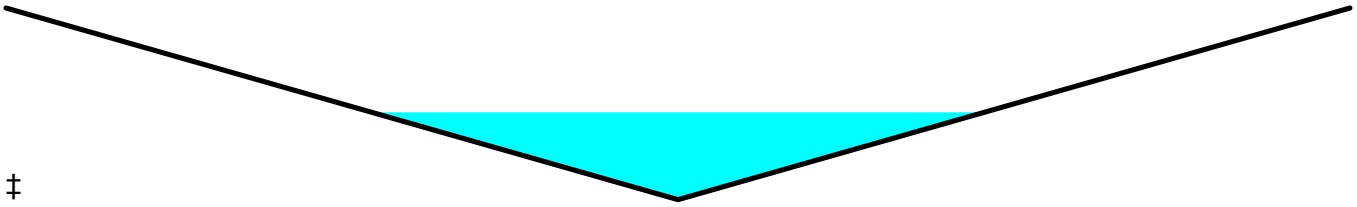
Summary for Reach RD5: Roadside Ditch 5

Inflow Area = 0.616 ac, 0.00% Impervious, Inflow Depth = 3.48" for 100-yr, 24-hr event
Inflow = 3.67 cfs @ 12.10 hrs, Volume= 0.179 af
Outflow = 3.30 cfs @ 12.14 hrs, Volume= 0.179 af, Atten= 10%, Lag= 2.2 min
Routed to Reach S4.2 : Swale S4.2

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 4.14 fps, Min. Travel Time= 1.2 min
Avg. Velocity = 1.52 fps, Avg. Travel Time= 3.2 min

Peak Storage= 238 cf @ 12.12 hrs
Average Depth at Peak Storage= 0.46' , Surface Width= 3.64'
Bank-Full Depth= 1.00' Flow Area= 4.0 sf, Capacity= 28.18 cfs

0.00' x 1.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 8.00'
Length= 288.0' Slope= 0.0531 '/'
Inlet Invert= 841.47', Outlet Invert= 826.18'



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Summary for Reach S1.0: Swale S1.0

Inflow Area = 8.783 ac, 0.00% Impervious, Inflow Depth = 3.64" for 100-yr, 24-hr event
Inflow = 49.33 cfs @ 12.10 hrs, Volume= 2.668 af
Outflow = 43.23 cfs @ 12.19 hrs, Volume= 2.668 af, Atten= 12%, Lag= 5.6 min
Routed to Reach S1.2 : Swale S1.2

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.81 fps, Min. Travel Time= 3.3 min
Avg. Velocity = 0.63 fps, Avg. Travel Time= 14.5 min

Peak Storage= 8,548 cf @ 12.14 hrs
Average Depth at Peak Storage= 1.21' , Surface Width= 17.67'
Bank-Full Depth= 2.00' Flow Area= 32.0 sf, Capacity= 118.85 cfs

8.00' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 24.00'
Length= 551.3' Slope= 0.0039 '/'
Inlet Invert= 823.92', Outlet Invert= 821.75'

‡

Summary for Reach S1.1: Swale S1.1

Inflow Area = 0.306 ac, 0.00% Impervious, Inflow Depth = 1.44" for 100-yr, 24-hr event
Inflow = 0.66 cfs @ 12.12 hrs, Volume= 0.037 af
Outflow = 0.61 cfs @ 12.16 hrs, Volume= 0.037 af, Atten= 7%, Lag= 2.0 min
Routed to Link C9 : Culvert C9

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.42 fps, Min. Travel Time= 1.1 min
Avg. Velocity = 0.74 fps, Avg. Travel Time= 2.2 min

Peak Storage= 45 cf @ 12.14 hrs
Average Depth at Peak Storage= 0.06' , Surface Width= 8.45'
Bank-Full Depth= 2.00' Flow Area= 32.0 sf, Capacity= 376.93 cfs

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8.00' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 24.00'
Length= 98.0' Slope= 0.0396 '/'
Inlet Invert= 825.88', Outlet Invert= 822.00'

‡

Summary for Reach S1.2: Swale S1.2

Inflow Area = 9.783 ac, 0.00% Impervious, Inflow Depth = 3.52" for 100-yr, 24-hr event
Inflow = 45.42 cfs @ 12.19 hrs, Volume= 2.871 af
Outflow = 44.63 cfs @ 12.20 hrs, Volume= 2.871 af, Atten= 2%, Lag= 0.8 min
Routed to Link C11 : Culvert C11

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 5.41 fps, Min. Travel Time= 0.5 min
Avg. Velocity = 1.22 fps, Avg. Travel Time= 2.3 min

Peak Storage= 1,428 cf @ 12.20 hrs
Average Depth at Peak Storage= 0.76' , Surface Width= 14.09'
Bank-Full Depth= 2.00' Flow Area= 32.0 sf, Capacity= 294.55 cfs

8.00' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 24.00'
Length= 170.0' Slope= 0.0242 '/'
Inlet Invert= 821.79', Outlet Invert= 817.68'

‡

Summary for Reach S1.3: Swale S1.3

Inflow Area = 11.213 ac, 0.00% Impervious, Inflow Depth = 3.42" for 100-yr, 24-hr event
Inflow = 47.67 cfs @ 12.20 hrs, Volume= 3.192 af
Outflow = 46.84 cfs @ 12.21 hrs, Volume= 3.192 af, Atten= 2%, Lag= 1.0 min
Routed to Link C3 : Culvert C3

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 5.86 fps, Min. Travel Time= 0.6 min
Avg. Velocity = 1.34 fps, Avg. Travel Time= 2.6 min

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Peak Storage= 1,724 cf @ 12.20 hrs
Average Depth at Peak Storage= 0.74' , Surface Width= 13.92'
Bank-Full Depth= 2.00' Flow Area= 32.0 sf, Capacity= 324.28 cfs

8.00' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 24.00'
Length= 212.6' Slope= 0.0293 '/'
Inlet Invert= 817.40', Outlet Invert= 811.17'

‡

Summary for Reach S1.4: Swale S1.4

Inflow Area = 15.242 ac, 0.00% Impervious, Inflow Depth = 3.28" for 100-yr, 24-hr event
Inflow = 58.99 cfs @ 12.17 hrs, Volume= 4.161 af
Outflow = 58.04 cfs @ 12.18 hrs, Volume= 4.161 af, Atten= 2%, Lag= 0.6 min
Routed to Link C4 : Culvert C4

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 4.85 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 1.13 fps, Avg. Travel Time= 1.1 min

Peak Storage= 867 cf @ 12.18 hrs
Average Depth at Peak Storage= 1.00' , Surface Width= 16.00'
Bank-Full Depth= 2.00' Flow Area= 32.0 sf, Capacity= 227.36 cfs

8.00' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 24.00'
Length= 72.2' Slope= 0.0144 '/'
Inlet Invert= 810.90', Outlet Invert= 809.86'

‡

Summary for Reach S1.5: Swale S1.5

Inflow Area = 15.981 ac, 0.00% Impervious, Inflow Depth = 3.21" for 100-yr, 24-hr event
Inflow = 59.91 cfs @ 12.18 hrs, Volume= 4.281 af
Outflow = 59.49 cfs @ 12.21 hrs, Volume= 4.281 af, Atten= 1%, Lag= 1.7 min
Routed to Reach S1.7 : Swale S1.7

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.22 fps, Min. Travel Time= 0.8 min
Avg. Velocity = 0.76 fps, Avg. Travel Time= 3.3 min

Peak Storage= 2,761 cf @ 12.20 hrs
Average Depth at Peak Storage= 1.38' , Surface Width= 19.04'
Bank-Full Depth= 2.00' Flow Area= 32.0 sf, Capacity= 126.50 cfs

8.00' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 24.00'
Length= 148.0' Slope= 0.0045 '/'
Inlet Invert= 809.60', Outlet Invert= 808.94'

‡

Summary for Reach S1.6: Swale S1.6

Inflow Area = 0.769 ac, 0.00% Impervious, Inflow Depth = 3.18" for 100-yr, 24-hr event
Inflow = 3.63 cfs @ 12.15 hrs, Volume= 0.204 af
Outflow = 3.33 cfs @ 12.21 hrs, Volume= 0.204 af, Atten= 8%, Lag= 3.8 min
Routed to Reach S1.7 : Swale S1.7

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.35 fps, Min. Travel Time= 2.2 min
Avg. Velocity = 0.36 fps, Avg. Travel Time= 8.2 min

Peak Storage= 448 cf @ 12.18 hrs
Average Depth at Peak Storage= 0.27' , Surface Width= 10.19'
Bank-Full Depth= 2.00' Flow Area= 32.0 sf, Capacity= 134.06 cfs

8.00' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 24.00'
Length= 179.7' Slope= 0.0050 '/'
Inlet Invert= 809.85', Outlet Invert= 808.95'

‡

Summary for Reach S1.7: Swale S1.7

Inflow Area = 18.333 ac, 0.00% Impervious, Inflow Depth = 3.20" for 100-yr, 24-hr event
Inflow = 69.04 cfs @ 12.21 hrs, Volume= 4.888 af
Outflow = 67.28 cfs @ 12.24 hrs, Volume= 4.888 af, Atten= 3%, Lag= 2.3 min
Routed to Link C5 : Culvert C5

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.58 fps, Min. Travel Time= 1.2 min
Avg. Velocity = 0.84 fps, Avg. Travel Time= 5.0 min

Peak Storage= 4,824 cf @ 12.22 hrs
Average Depth at Peak Storage= 1.41' , Surface Width= 19.25'
Bank-Full Depth= 2.00' Flow Area= 32.0 sf, Capacity= 139.68 cfs

8.00' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 24.00'
Length= 252.0' Slope= 0.0054 '/'
Inlet Invert= 808.94', Outlet Invert= 807.57'

‡

Summary for Reach S1.8: Swale S1.8

Inflow Area = 0.712 ac, 0.00% Impervious, Inflow Depth = 3.38" for 100-yr, 24-hr event
Inflow = 3.63 cfs @ 12.15 hrs, Volume= 0.201 af
Outflow = 3.32 cfs @ 12.20 hrs, Volume= 0.201 af, Atten= 9%, Lag= 3.3 min
Routed to Reach S1.7 : Swale S1.7

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.20 fps, Min. Travel Time= 1.9 min
Avg. Velocity = 0.63 fps, Avg. Travel Time= 6.5 min

Peak Storage= 380 cf @ 12.17 hrs
Average Depth at Peak Storage= 0.41' , Surface Width= 4.98'
Bank-Full Depth= 2.00' Flow Area= 17.0 sf, Capacity= 90.14 cfs

2.50' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 2.0 4.0 '/' Top Width= 14.50'
Length= 245.8' Slope= 0.0099 '/'
Inlet Invert= 810.00', Outlet Invert= 807.57'

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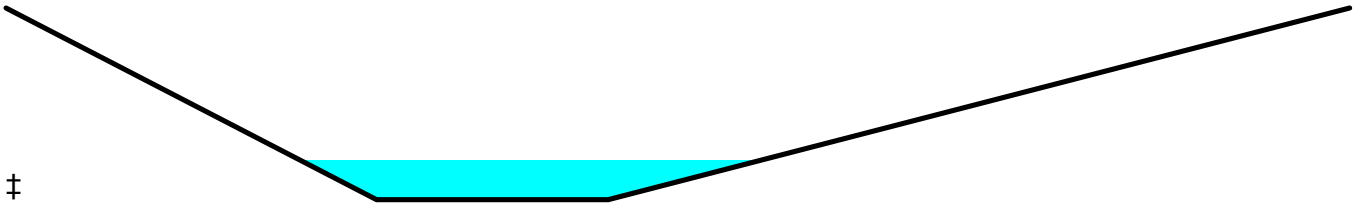

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Summary for Reach S1.9: Swale S1.9

Inflow Area = 21.125 ac, 0.00% Impervious, Inflow Depth = 3.10" for 100-yr, 24-hr event
Inflow = 74.80 cfs @ 12.24 hrs, Volume= 5.449 af
Outflow = 72.74 cfs @ 12.30 hrs, Volume= 5.449 af, Atten= 3%, Lag= 3.2 min
Routed to Reach S2.1 : Swale S2.1

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 4.11 fps, Min. Travel Time= 1.7 min
Avg. Velocity = 0.96 fps, Avg. Travel Time= 7.4 min

Peak Storage= 7,601 cf @ 12.26 hrs
Average Depth at Peak Storage= 1.35' , Surface Width= 18.77'
Bank-Full Depth= 2.00' Flow Area= 32.0 sf, Capacity= 163.67 cfs

8.00' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 24.00'
Length= 422.0' Slope= 0.0075 '/'
Inlet Invert= 807.15', Outlet Invert= 804.00'

‡

Summary for Reach S2.1: Swale S2.1

Inflow Area = 23.239 ac, 0.00% Impervious, Inflow Depth = 2.87" for 100-yr, 24-hr event
Inflow = 73.27 cfs @ 12.30 hrs, Volume= 5.559 af
Outflow = 71.33 cfs @ 12.35 hrs, Volume= 5.559 af, Atten= 3%, Lag= 3.2 min
Routed to Reach S2.2 : Swale S2.2

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.74 fps, Min. Travel Time= 1.7 min
Avg. Velocity = 0.98 fps, Avg. Travel Time= 6.6 min

Peak Storage= 7,518 cf @ 12.32 hrs
Average Depth at Peak Storage= 1.75' , Surface Width= 18.04'
Bank-Full Depth= 2.00' Flow Area= 24.0 sf, Capacity= 97.05 cfs

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4.00' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 20.00'
Length= 389.0' Slope= 0.0054 '/'
Inlet Invert= 806.10', Outlet Invert= 804.00'

‡

Summary for Reach S2.2: Swale S2.2

Inflow Area = 40.438 ac, 0.00% Impervious, Inflow Depth = 3.01" for 100-yr, 24-hr event
Inflow = 121.32 cfs @ 12.28 hrs, Volume= 10.154 af
Outflow = 119.32 cfs @ 12.34 hrs, Volume= 10.154 af, Atten= 2%, Lag= 3.2 min
Routed to Reach S2.3 : Swale S2.3

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.97 fps, Min. Travel Time= 1.7 min
Avg. Velocity = 0.92 fps, Avg. Travel Time= 7.5 min

Peak Storage= 12,489 cf @ 12.31 hrs
Average Depth at Peak Storage= 1.78' , Surface Width= 24.21'
Bank-Full Depth= 2.00' Flow Area= 36.0 sf, Capacity= 152.61 cfs

10.00' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 26.00'
Length= 411.0' Slope= 0.0049 '/'
Inlet Invert= 804.00', Outlet Invert= 802.00'

‡

Summary for Reach S2.3: Swale S2.3

Inflow Area = 44.233 ac, 0.00% Impervious, Inflow Depth = 2.87" for 100-yr, 24-hr event
Inflow = 121.74 cfs @ 12.34 hrs, Volume= 10.568 af
Outflow = 120.67 cfs @ 12.36 hrs, Volume= 10.568 af, Atten= 1%, Lag= 1.6 min
Routed to Link C7 : Culvert C7

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 5.67 fps, Min. Travel Time= 0.9 min
Avg. Velocity = 1.32 fps, Avg. Travel Time= 3.9 min

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Peak Storage= 6,590 cf @ 12.35 hrs
Average Depth at Peak Storage= 1.38' , Surface Width= 21.06'
Bank-Full Depth= 2.00' Flow Area= 36.0 sf, Capacity= 249.72 cfs

10.00' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 26.00'
Length= 307.0' Slope= 0.0130 '/'
Inlet Invert= 802.00', Outlet Invert= 798.00'

‡

Summary for Reach S3.1: Swale S3.1

Inflow Area = 2.044 ac, 0.00% Impervious, Inflow Depth = 3.18" for 100-yr, 24-hr event
Inflow = 11.02 cfs @ 12.10 hrs, Volume= 0.542 af
Outflow = 9.75 cfs @ 12.19 hrs, Volume= 0.542 af, Atten= 12%, Lag= 5.2 min
Routed to Reach S3.2 : Swale S3.2

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.94 fps, Min. Travel Time= 3.1 min
Avg. Velocity = 0.48 fps, Avg. Travel Time= 12.5 min

Peak Storage= 1,797 cf @ 12.14 hrs
Average Depth at Peak Storage= 0.50' , Surface Width= 12.02'
Bank-Full Depth= 2.00' Flow Area= 32.0 sf, Capacity= 133.76 cfs

8.00' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 24.00'
Length= 357.0' Slope= 0.0050 '/'
Inlet Invert= 809.85', Outlet Invert= 808.07'

‡

Summary for Reach S3.2: Swale S3.2

Inflow Area = 7.661 ac, 0.00% Impervious, Inflow Depth = 3.19" for 100-yr, 24-hr event
Inflow = 35.67 cfs @ 12.14 hrs, Volume= 2.034 af
Outflow = 35.48 cfs @ 12.14 hrs, Volume= 2.034 af, Atten= 1%, Lag= 0.3 min
Routed to Reach S3.3 : Swale S3.3

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.89 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 0.74 fps, Avg. Travel Time= 0.8 min

Peak Storage= 420 cf @ 12.14 hrs
Average Depth at Peak Storage= 1.02' , Surface Width= 16.18'
Bank-Full Depth= 2.00' Flow Area= 32.0 sf, Capacity= 133.95 cfs

8.00' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 24.00'
Length= 34.0' Slope= 0.0050 '/'
Inlet Invert= 798.00', Outlet Invert= 797.83'

‡

Summary for Reach S3.3: Swale S3.3

Inflow Area = 7.661 ac, 0.00% Impervious, Inflow Depth = 3.19" for 100-yr, 24-hr event
Inflow = 35.48 cfs @ 12.14 hrs, Volume= 2.034 af
Outflow = 33.84 cfs @ 12.17 hrs, Volume= 2.034 af, Atten= 5%, Lag= 1.3 min
Routed to Link C6 : Culvert C6

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 4.03 fps, Min. Travel Time= 0.8 min
Avg. Velocity = 1.02 fps, Avg. Travel Time= 3.3 min

Peak Storage= 1,746 cf @ 12.15 hrs
Average Depth at Peak Storage= 0.78' , Surface Width= 14.27'
Bank-Full Depth= 2.00' Flow Area= 32.0 sf, Capacity= 215.99 cfs

8.00' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 24.00'
Length= 200.0' Slope= 0.0130 '/'
Inlet Invert= 808.00', Outlet Invert= 805.40'

‡

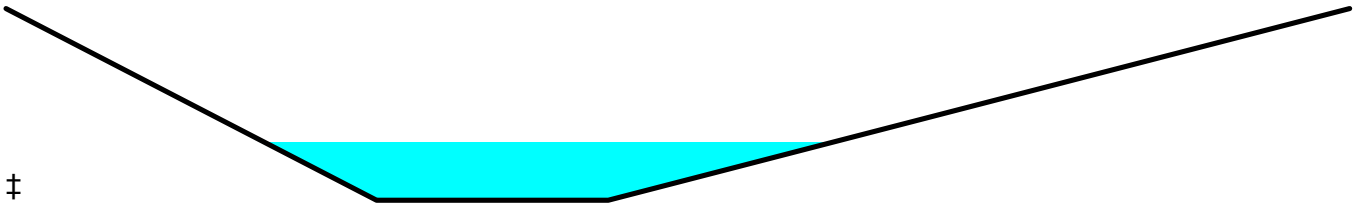
Summary for Reach S3.4: Swale S3.4

Inflow Area = 1.194 ac, 0.00% Impervious, Inflow Depth = 3.58" for 100-yr, 24-hr event
Inflow = 6.45 cfs @ 12.15 hrs, Volume= 0.357 af
Outflow = 5.88 cfs @ 12.20 hrs, Volume= 0.357 af, Atten= 9%, Lag= 3.6 min
Routed to Link C6 : Culvert C6

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.29 fps, Min. Travel Time= 2.1 min
Avg. Velocity = 0.66 fps, Avg. Travel Time= 7.1 min

Peak Storage= 743 cf @ 12.17 hrs
Average Depth at Peak Storage= 0.61' , Surface Width= 6.15'
Bank-Full Depth= 2.00' Flow Area= 17.0 sf, Capacity= 76.21 cfs

2.50' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 2.0 4.0 '/' Top Width= 14.50'
Length= 283.0' Slope= 0.0071 '/'
Inlet Invert= 810.00', Outlet Invert= 808.00'



‡

Summary for Reach S3.5: Swale S3.5

Inflow Area = 15.661 ac, 0.00% Impervious, Inflow Depth = 3.26" for 100-yr, 24-hr event
Inflow = 67.72 cfs @ 12.16 hrs, Volume= 4.259 af
Outflow = 63.93 cfs @ 12.22 hrs, Volume= 4.259 af, Atten= 6%, Lag= 3.7 min
Routed to Reach S2.2 : Swale S2.2

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.64 fps, Min. Travel Time= 2.0 min
Avg. Velocity = 0.68 fps, Avg. Travel Time= 7.8 min

Peak Storage= 7,862 cf @ 12.19 hrs
Average Depth at Peak Storage= 1.68' , Surface Width= 21.43'
Bank-Full Depth= 2.00' Flow Area= 32.0 sf, Capacity= 93.14 cfs

8.00' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 24.00'
Length= 318.5' Slope= 0.0024 '/'
Inlet Invert= 804.76', Outlet Invert= 803.99'

‡

Summary for Reach S4.1: Swale S4.1

Inflow Area = 1.364 ac, 0.00% Impervious, Inflow Depth = 2.35" for 100-yr, 24-hr event
Inflow = 5.28 cfs @ 12.10 hrs, Volume= 0.267 af
Outflow = 4.68 cfs @ 12.16 hrs, Volume= 0.267 af, Atten= 11%, Lag= 3.3 min
Routed to Reach S4.2 : Swale S4.2

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.07 fps, Min. Travel Time= 1.9 min
Avg. Velocity = 0.50 fps, Avg. Travel Time= 8.0 min

Peak Storage= 556 cf @ 12.12 hrs
Average Depth at Peak Storage= 0.22' , Surface Width= 11.51'
Bank-Full Depth= 1.00' Flow Area= 13.5 sf, Capacity= 70.22 cfs

10.00' x 1.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 3.0 '/' Top Width= 17.00'
Length= 240.0' Slope= 0.0153 '/'
Inlet Invert= 811.94', Outlet Invert= 808.26'

‡

Summary for Reach S4.2: Swale S4.2

Inflow Area = 3.174 ac, 0.00% Impervious, Inflow Depth = 2.52" for 100-yr, 24-hr event
Inflow = 11.92 cfs @ 12.14 hrs, Volume= 0.667 af
Outflow = 11.06 cfs @ 12.18 hrs, Volume= 0.667 af, Atten= 7%, Lag= 2.8 min
Routed to Reach S4.3 : Swale S4.3

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.70 fps, Min. Travel Time= 1.6 min
Avg. Velocity = 0.62 fps, Avg. Travel Time= 7.0 min

Peak Storage= 1,118 cf @ 12.15 hrs
Average Depth at Peak Storage= 0.38' , Surface Width= 12.66'
Bank-Full Depth= 1.00' Flow Area= 13.5 sf, Capacity= 63.88 cfs

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10.00' x 1.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 3.0 '/' Top Width= 17.00'
Length= 259.3' Slope= 0.0127 '/'
Inlet Invert= 808.26', Outlet Invert= 804.97'

‡

Summary for Reach S4.3: Swale S4.3

Inflow Area = 9.328 ac, 0.00% Impervious, Inflow Depth = 2.62" for 100-yr, 24-hr event
Inflow = 35.42 cfs @ 12.14 hrs, Volume= 2.039 af
Outflow = 32.72 cfs @ 12.21 hrs, Volume= 2.039 af, Atten= 8%, Lag= 4.6 min
Routed to Reach S4.4 : Swale S4.4

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.24 fps, Min. Travel Time= 2.7 min
Avg. Velocity = 0.53 fps, Avg. Travel Time= 11.4 min

Peak Storage= 5,330 cf @ 12.17 hrs
Average Depth at Peak Storage= 1.07' , Surface Width= 17.49'
Bank-Full Depth= 2.00' Flow Area= 34.0 sf, Capacity= 108.12 cfs

10.00' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 3.0 '/' Top Width= 24.00'
Length= 362.9' Slope= 0.0027 '/'
Inlet Invert= 804.97', Outlet Invert= 804.00'

‡

Summary for Reach S4.4: Swale S4.4

Inflow Area = 14.003 ac, 0.00% Impervious, Inflow Depth = 2.62" for 100-yr, 24-hr event
Inflow = 44.75 cfs @ 12.17 hrs, Volume= 3.062 af
Outflow = 42.89 cfs @ 12.26 hrs, Volume= 3.062 af, Atten= 4%, Lag= 5.4 min
Routed to Reach S4.5 : Swale S4.5

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.81 fps, Min. Travel Time= 2.9 min
Avg. Velocity = 0.67 fps, Avg. Travel Time= 12.3 min

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Peak Storage= 7,560 cf @ 12.21 hrs
Average Depth at Peak Storage= 1.10' , Surface Width= 17.71'
Bank-Full Depth= 2.00' Flow Area= 34.0 sf, Capacity= 132.85 cfs

10.00' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 3.0 '/' Top Width= 24.00'
Length= 495.6' Slope= 0.0040 '/'
Inlet Invert= 804.00', Outlet Invert= 802.00'

‡

Summary for Reach S4.5: Swale S4.5

Inflow Area = 16.113 ac, 0.00% Impervious, Inflow Depth = 2.54" for 100-yr, 24-hr event
Inflow = 45.33 cfs @ 12.26 hrs, Volume= 3.413 af
Outflow = 44.02 cfs @ 12.31 hrs, Volume= 3.413 af, Atten= 3%, Lag= 3.2 min
Routed to Reach S4.6 : Swale S4.6

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.85 fps, Min. Travel Time= 1.8 min
Avg. Velocity = 0.98 fps, Avg. Travel Time= 7.0 min

Peak Storage= 4,750 cf @ 12.28 hrs
Average Depth at Peak Storage= 0.88' , Surface Width= 16.18'
Bank-Full Depth= 3.00' Flow Area= 61.5 sf, Capacity= 465.89 cfs

10.00' x 3.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 3.0 '/' Top Width= 31.00'
Length= 411.1' Slope= 0.0097 '/'
Inlet Invert= 802.00', Outlet Invert= 798.00'

‡

Summary for Reach S4.6: Swale S4.6

Inflow Area = 65.439 ac, 0.00% Impervious, Inflow Depth = 2.74" for 100-yr, 24-hr event
Inflow = 168.51 cfs @ 12.34 hrs, Volume= 14.952 af
Outflow = 165.78 cfs @ 12.39 hrs, Volume= 14.952 af, Atten= 2%, Lag= 2.7 min
Routed to Pond Sed Pond : Sedimentation Basin

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 6.01 fps, Min. Travel Time= 1.5 min
Avg. Velocity = 1.44 fps, Avg. Travel Time= 6.2 min

Peak Storage= 14,973 cf @ 12.36 hrs
Average Depth at Peak Storage= 1.73' , Surface Width= 22.14'
Bank-Full Depth= 3.00' Flow Area= 61.5 sf, Capacity= 499.25 cfs

10.00' x 3.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 3.0 '/' Top Width= 31.00'
Length= 537.0' Slope= 0.0112 '/'
Inlet Invert= 798.00', Outlet Invert= 792.00'

‡

Summary for Reach S5.1: Swale S5.1

Inflow Area = 0.993 ac, 0.00% Impervious, Inflow Depth = 3.89" for 100-yr, 24-hr event
Inflow = 6.35 cfs @ 12.11 hrs, Volume= 0.322 af
Outflow = 5.76 cfs @ 12.19 hrs, Volume= 0.322 af, Atten= 9%, Lag= 5.0 min
Routed to Link 4L : Culvert C2b

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.36 fps, Min. Travel Time= 3.0 min
Avg. Velocity = 0.60 fps, Avg. Travel Time= 11.9 min

Peak Storage= 1,042 cf @ 12.14 hrs
Average Depth at Peak Storage= 0.27' , Surface Width= 10.15'
Bank-Full Depth= 2.00' Flow Area= 32.0 sf, Capacity= 235.24 cfs

8.00' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 24.00'
Length= 428.0' Slope= 0.0154 '/'
Inlet Invert= 825.20', Outlet Invert= 818.60'

‡

Summary for Reach S5.2: Swale S5.2

Inflow Area = 0.424 ac, 0.00% Impervious, Inflow Depth = 3.69" for 100-yr, 24-hr event
Inflow = 2.76 cfs @ 12.09 hrs, Volume= 0.130 af
Outflow = 2.42 cfs @ 12.13 hrs, Volume= 0.130 af, Atten= 12%, Lag= 2.2 min
Routed to Link C2 : Culvert C2a

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.27 fps, Min. Travel Time= 1.3 min
Avg. Velocity = 0.72 fps, Avg. Travel Time= 4.2 min

Peak Storage= 211 cf @ 12.11 hrs
Average Depth at Peak Storage= 0.13' , Surface Width= 9.08'
Bank-Full Depth= 2.00' Flow Area= 32.0 sf, Capacity= 344.73 cfs

8.00' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 24.00'
Length= 183.6' Slope= 0.0331 '/'
Inlet Invert= 823.91', Outlet Invert= 817.83'

‡

Summary for Pond C8: Culvert C8

Inflow Area = 0.275 ac, 0.00% Impervious, Inflow Depth = 3.18" for 100-yr, 24-hr event
Inflow = 1.60 cfs @ 12.08 hrs, Volume= 0.073 af
Outflow = 1.60 cfs @ 12.08 hrs, Volume= 0.073 af, Atten= 0%, Lag= 0.1 min
Primary = 1.60 cfs @ 12.08 hrs, Volume= 0.073 af
Routed to Reach S4.1 : Swale S4.1

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 811.38' @ 12.08 hrs Surf.Area= 0.000 ac Storage= 0.000 af
Flood Elev= 819.00' Surf.Area= 0.000 ac Storage= 0.001 af

Plug-Flow detention time= 0.2 min calculated for 0.073 af (100% of inflow)
Center-of-Mass det. time= 0.2 min (817.4 - 817.3)

Volume	Invert	Avail.Storage	Storage Description
#1	810.70'	0.001 af	**3.00'D x 7.00'H Vertical Cone/Cylinder**

Device	Routing	Invert	Outlet Devices
#1	Primary	810.70'	**12.0" Round Culvert** L= 85.6' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 810.70' / 808.60' S= 0.0245 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.79 sf

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Primary OutFlow Max=1.49 cfs @ 12.08 hrs HW=811.35' (Free Discharge)
└**1=Culvert** (Inlet Controls 1.49 cfs @ 2.75 fps)

Summary for Pond N: North Infiltration Area

Inflow Area = 18.714 ac, 0.00% Impervious, Inflow Depth = 1.51" for 100-yr, 24-hr event
Inflow = 25.48 cfs @ 12.26 hrs, Volume= 2.356 af
Outflow = 2.22 cfs @ 14.45 hrs, Volume= 2.356 af, Atten= 91%, Lag= 131.5 min
Primary = 2.22 cfs @ 14.45 hrs, Volume= 2.356 af
Routed to nonexistent node 1L

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 805.24' @ 14.45 hrs Surf.Area= 26,590 sf Storage= 49,884 cf

Plug-Flow detention time= 286.6 min calculated for 2.354 af (100% of inflow)
Center-of-Mass det. time= 286.6 min (1,151.8 - 865.2)

Volume	Invert	Avail.Storage	Storage Description
#1	802.00'	256,569 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
802.00	5,140	0	0
804.00	17,424	22,564	22,564
806.00	32,191	49,615	72,179
808.00	46,130	78,321	150,500
810.00	59,939	106,069	256,569

Device	Routing	Invert	Outlet Devices
#1	Primary	802.00'	**3.600 in/hr Exfiltration over Surface area**

Primary OutFlow Max=2.22 cfs @ 14.45 hrs HW=805.24' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 2.22 cfs)

Summary for Pond Sed Pond: Sedimentation Basin

Inflow Area = 72.769 ac, 2.07% Impervious, Inflow Depth = 2.65" for 100-yr, 24-hr event
Inflow = 169.90 cfs @ 12.39 hrs, Volume= 16.095 af
Outflow = 94.78 cfs @ 12.65 hrs, Volume= 16.095 af, Atten= 44%, Lag= 15.8 min
Discarded = 5.92 cfs @ 12.65 hrs, Volume= 7.322 af
Primary = 11.55 cfs @ 12.65 hrs, Volume= 5.267 af
Routed to Link Wetland : Wetland
Secondary = 33.59 cfs @ 12.65 hrs, Volume= 2.497 af
Routed to Link Wetland : Wetland
Tertiary = 43.71 cfs @ 12.65 hrs, Volume= 1.010 af
Routed to Link Wetland : Wetland

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

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Peak Elev= 793.23' @ 12.65 hrs Surf.Area= 71,081 sf Storage= 247,875 cf
Flood Elev= 794.00' Surf.Area= 75,797 sf Storage= 304,443 cf

Plug-Flow detention time= 154.9 min calculated for 16.084 af (100% of inflow)
Center-of-Mass det. time= 154.9 min (1,001.3 - 846.4)

Volume	Invert	Avail.Storage	Storage Description
#1	789.00'	304,443 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
789.00	27,325	0	0
790.00	55,972	41,649	41,649
791.00	61,532	58,752	100,401
792.00	65,703	63,618	164,018
793.00	69,675	67,689	231,707
794.00	75,797	72,736	304,443

Device	Routing	Invert	Outlet Devices
#1	Primary	787.70'	**15.0" Round Culvert** L= 40.0' RCP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 787.70' / 787.50' S= 0.0050 '/' Cc= 0.900 n= 0.011 Concrete pipe, straight & clean, Flow Area= 1.23 sf
#2	Device 1	791.00'	**30.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Device 1	790.50'	**0.8" Vert. Orifice/Grate X 4.00** C= 0.600 Limited to weir flow at low heads
#4	Device 1	790.00'	**0.8" Vert. Orifice/Grate X 4.00** C= 0.600 Limited to weir flow at low heads
#5	Device 1	789.00'	**0.5" Vert. Orifice/Grate X 14.00 columns** X 6 rows with 6.0" cc spacing C= 0.600 Limited to weir flow at low heads
#6	Secondary	792.50'	**20.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64
#7	Tertiary	793.00'	**158.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64
#8	Discarded	789.00'	**3.600 in/hr Exfiltration over Surface area**

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Discarded OutFlow Max=5.92 cfs @ 12.65 hrs HW=793.23' (Free Discharge)
└**8=Exfiltration** (Exfiltration Controls 5.92 cfs)

Primary OutFlow Max=11.55 cfs @ 12.65 hrs HW=793.23' (Free Discharge)
└**1=Culvert** (Inlet Controls 11.55 cfs @ 9.41 fps)
- **2=Orifice/Grate** (Passes < 35.29 cfs potential flow)
- **3=Orifice/Grate** (Passes < 0.11 cfs potential flow)
- **4=Orifice/Grate** (Passes < 0.12 cfs potential flow)
- **5=Orifice/Grate** (Passes < 0.94 cfs potential flow)

Secondary OutFlow Max=33.55 cfs @ 12.65 hrs HW=793.23' (Free Discharge)
└**6=Broad-Crested Rectangular Weir** (Weir Controls 33.55 cfs @ 2.30 fps)

Tertiary OutFlow Max=43.39 cfs @ 12.65 hrs HW=793.23' (Free Discharge)
└**7=Broad-Crested Rectangular Weir** (Weir Controls 43.39 cfs @ 1.20 fps)

Summary for Link 4L: Culvert C2b

Inflow Area = 0.993 ac, 0.00% Impervious, Inflow Depth = 3.89" for 100-yr, 24-hr event
Inflow = 5.76 cfs @ 12.19 hrs, Volume= 0.322 af
Primary = 5.76 cfs @ 12.19 hrs, Volume= 0.322 af, Atten= 0%, Lag= 0.0 min
Routed to Link C2 : Culvert C2a

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link C1: Culvert C1

Inflow Area = 3.035 ac, 0.00% Impervious, Inflow Depth = 1.20" for 100-yr, 24-hr event
Inflow = 1.96 cfs @ 12.74 hrs, Volume= 0.304 af
Primary = 1.96 cfs @ 12.74 hrs, Volume= 0.304 af, Atten= 0%, Lag= 0.0 min
Routed to Reach RD2 : Roadside Ditch 2

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link C10: Culvert C10

Inflow Area = 8.839 ac, 0.00% Impervious, Inflow Depth = 2.27" for 100-yr, 24-hr event
Inflow = 20.55 cfs @ 12.24 hrs, Volume= 1.672 af
Primary = 20.55 cfs @ 12.24 hrs, Volume= 1.672 af, Atten= 0%, Lag= 0.0 min
Routed to Pond N : North Infiltration Area

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link C11: Culvert C11

Inflow Area = 9.783 ac, 0.00% Impervious, Inflow Depth = 3.52" for 100-yr, 24-hr event
Inflow = 44.63 cfs @ 12.20 hrs, Volume= 2.871 af
Primary = 44.63 cfs @ 12.20 hrs, Volume= 2.871 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S1.3 : Swale S1.3

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Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link C2: Culvert C2a

Inflow Area = 2.969 ac, 0.00% Impervious, Inflow Depth = 3.97" for 100-yr, 24-hr event
Inflow = 16.75 cfs @ 12.18 hrs, Volume= 0.983 af
Primary = 16.75 cfs @ 12.18 hrs, Volume= 0.983 af, Atten= 0%, Lag= 0.0 min
Routed to Reach RD2 : Roadside Ditch 2

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link C3: Culvert C3

Inflow Area = 11.213 ac, 0.00% Impervious, Inflow Depth = 3.42" for 100-yr, 24-hr event
Inflow = 46.84 cfs @ 12.21 hrs, Volume= 3.192 af
Primary = 46.84 cfs @ 12.21 hrs, Volume= 3.192 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S1.4 : Swale S1.4

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link C4: Culvert C4

Inflow Area = 15.242 ac, 0.00% Impervious, Inflow Depth = 3.28" for 100-yr, 24-hr event
Inflow = 58.04 cfs @ 12.18 hrs, Volume= 4.161 af
Primary = 58.04 cfs @ 12.18 hrs, Volume= 4.161 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S1.5 : Swale S1.5

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link C5: Culvert C5

Inflow Area = 18.333 ac, 0.00% Impervious, Inflow Depth = 3.20" for 100-yr, 24-hr event
Inflow = 67.28 cfs @ 12.24 hrs, Volume= 4.888 af
Primary = 67.28 cfs @ 12.24 hrs, Volume= 4.888 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S1.9 : Swale S1.9

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link C6: Culvert C6

Inflow Area = 11.935 ac, 0.00% Impervious, Inflow Depth = 3.23" for 100-yr, 24-hr event
Inflow = 52.51 cfs @ 12.15 hrs, Volume= 3.209 af
Primary = 52.51 cfs @ 12.15 hrs, Volume= 3.209 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S3.5 : Swale S3.5

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

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Summary for Link C7: Culvert C7

Inflow Area = 47.325 ac, 0.00% Impervious, Inflow Depth = 2.89" for 100-yr, 24-hr event
Inflow = 124.99 cfs @ 12.36 hrs, Volume= 11.388 af
Primary = 124.99 cfs @ 12.36 hrs, Volume= 11.388 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S4.6 : Swale S4.6

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link C9: Culvert C9

Inflow Area = 0.306 ac, 0.00% Impervious, Inflow Depth = 1.44" for 100-yr, 24-hr event
Inflow = 0.61 cfs @ 12.16 hrs, Volume= 0.037 af
Primary = 0.61 cfs @ 12.16 hrs, Volume= 0.037 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S1.2 : Swale S1.2

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link F10: Flume 10

Inflow Area = 0.275 ac, 0.00% Impervious, Inflow Depth = 3.18" for 100-yr, 24-hr event
Inflow = 1.60 cfs @ 12.08 hrs, Volume= 0.073 af
Primary = 1.60 cfs @ 12.08 hrs, Volume= 0.073 af, Atten= 0%, Lag= 0.0 min
Routed to Pond C8 : Culvert C8

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link F1A: Flume 1A

Inflow Area = 1.698 ac, 0.00% Impervious, Inflow Depth = 3.18" for 100-yr, 24-hr event
Inflow = 8.37 cfs @ 12.13 hrs, Volume= 0.450 af
Primary = 8.37 cfs @ 12.13 hrs, Volume= 0.450 af, Atten= 0%, Lag= 0.0 min
Routed to Link F1B : Flume 1B

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link F1B: Flume 1B

Inflow Area = 3.934 ac, 0.00% Impervious, Inflow Depth = 3.18" for 100-yr, 24-hr event
Inflow = 19.59 cfs @ 12.12 hrs, Volume= 1.043 af
Primary = 19.59 cfs @ 12.12 hrs, Volume= 1.043 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S4.3 : Swale S4.3

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

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Summary for Link F2A: Flume 2A

Inflow Area = 0.636 ac, 0.00% Impervious, Inflow Depth = 3.18" for 100-yr, 24-hr event
Inflow = 3.34 cfs @ 12.11 hrs, Volume= 0.169 af
Primary = 3.34 cfs @ 12.11 hrs, Volume= 0.169 af, Atten= 0%, Lag= 0.0 min
Routed to Link F2B : Flume 2B

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link F2B: Flume 2B

Inflow Area = 2.199 ac, 0.00% Impervious, Inflow Depth = 3.18" for 100-yr, 24-hr event
Inflow = 11.13 cfs @ 12.12 hrs, Volume= 0.583 af
Primary = 11.13 cfs @ 12.12 hrs, Volume= 0.583 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S4.4 : Swale S4.4

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link F3: Flume 3

Inflow Area = 0.427 ac, 0.00% Impervious, Inflow Depth = 3.18" for 100-yr, 24-hr event
Inflow = 2.33 cfs @ 12.10 hrs, Volume= 0.113 af
Primary = 2.33 cfs @ 12.10 hrs, Volume= 0.113 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S4.5 : Swale S4.5

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link F4A: Flume 4A

Inflow Area = 1.209 ac, 0.00% Impervious, Inflow Depth = 3.18" for 100-yr, 24-hr event
Inflow = 5.87 cfs @ 12.13 hrs, Volume= 0.320 af
Primary = 5.87 cfs @ 12.13 hrs, Volume= 0.320 af, Atten= 0%, Lag= 0.0 min
Routed to Link F4B : Flume 4B

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link F4B: Flume 4B

Inflow Area = 3.092 ac, 0.00% Impervious, Inflow Depth = 3.18" for 100-yr, 24-hr event
Inflow = 15.35 cfs @ 12.13 hrs, Volume= 0.820 af
Primary = 15.35 cfs @ 12.13 hrs, Volume= 0.820 af, Atten= 0%, Lag= 0.0 min
Routed to Link C7 : Culvert C7

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

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Summary for Link F5A: Flume 5A

Inflow Area = 0.237 ac, 0.00% Impervious, Inflow Depth = 3.18" for 100-yr, 24-hr event
Inflow = 1.28 cfs @ 12.10 hrs, Volume= 0.063 af
Primary = 1.28 cfs @ 12.10 hrs, Volume= 0.063 af, Atten= 0%, Lag= 0.0 min
Routed to Link F5B : Flume 5B

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link F5B: Flume 5B

Inflow Area = 0.712 ac, 0.00% Impervious, Inflow Depth = 3.18" for 100-yr, 24-hr event
Inflow = 3.77 cfs @ 12.11 hrs, Volume= 0.189 af
Primary = 3.77 cfs @ 12.11 hrs, Volume= 0.189 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S2.2 : Swale S2.2

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link F6A: Flume 6A

Inflow Area = 1.440 ac, 0.00% Impervious, Inflow Depth = 3.18" for 100-yr, 24-hr event
Inflow = 7.42 cfs @ 12.11 hrs, Volume= 0.382 af
Primary = 7.42 cfs @ 12.11 hrs, Volume= 0.382 af, Atten= 0%, Lag= 0.0 min
Routed to Link F6B : Flume 6B

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link F6B: Flume 6B

Inflow Area = 3.001 ac, 0.00% Impervious, Inflow Depth = 3.18" for 100-yr, 24-hr event
Inflow = 15.57 cfs @ 12.11 hrs, Volume= 0.795 af
Primary = 15.57 cfs @ 12.11 hrs, Volume= 0.795 af, Atten= 0%, Lag= 0.0 min
Routed to Link C6 : Culvert C6

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link F7A: Flume 7A

Inflow Area = 2.924 ac, 0.00% Impervious, Inflow Depth = 3.18" for 100-yr, 24-hr event
Inflow = 14.41 cfs @ 12.14 hrs, Volume= 0.775 af
Primary = 14.41 cfs @ 12.14 hrs, Volume= 0.775 af, Atten= 0%, Lag= 0.0 min
Routed to Link F7B : Flume 7B

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

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Summary for Link F7B: Flume 7B

Inflow Area = 5.160 ac, 0.00% Impervious, Inflow Depth = 3.18" for 100-yr, 24-hr event
Inflow = 25.54 cfs @ 12.13 hrs, Volume= 1.368 af
Primary = 25.54 cfs @ 12.13 hrs, Volume= 1.368 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S3.2 : Swale S3.2

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link F8A: Flume 8A

Inflow Area = 0.791 ac, 0.00% Impervious, Inflow Depth = 3.18" for 100-yr, 24-hr event
Inflow = 3.91 cfs @ 12.14 hrs, Volume= 0.210 af
Primary = 3.91 cfs @ 12.14 hrs, Volume= 0.210 af, Atten= 0%, Lag= 0.0 min
Routed to Link F8B : Flume 8B

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link F8B: Flume 8B

Inflow Area = 2.667 ac, 0.00% Impervious, Inflow Depth = 3.18" for 100-yr, 24-hr event
Inflow = 13.41 cfs @ 12.12 hrs, Volume= 0.707 af
Primary = 13.41 cfs @ 12.12 hrs, Volume= 0.707 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S1.4 : Swale S1.4

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link F9A: Flume 9A

Inflow Area = 3.091 ac, 0.00% Impervious, Inflow Depth = 3.18" for 100-yr, 24-hr event
Inflow = 15.16 cfs @ 12.14 hrs, Volume= 0.819 af
Primary = 15.16 cfs @ 12.14 hrs, Volume= 0.819 af, Atten= 0%, Lag= 0.0 min
Routed to Link F9B : Flume 9B

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link F9B: Flume 9B

Inflow Area = 6.189 ac, 0.00% Impervious, Inflow Depth = 3.18" for 100-yr, 24-hr event
Inflow = 30.63 cfs @ 12.13 hrs, Volume= 1.640 af
Primary = 30.63 cfs @ 12.13 hrs, Volume= 1.640 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S1.0 : Swale S1.0

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

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Summary for Link Wetland: Wetland

Inflow Area = 72.769 ac, 2.07% Impervious, Inflow Depth = 1.45" for 100-yr, 24-hr event
Inflow = 88.85 cfs @ 12.65 hrs, Volume= 8.773 af
Primary = 88.85 cfs @ 12.65 hrs, Volume= 8.773 af, Atten= 0%, Lag= 0.0 min
Routed to nonexistent node 1L

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

09/28/2023 - Classification: Internal - ECRM13153872

Swale Sizing

SCS ENGINEERS

		Sheet No:	1 of 3
		Calc. No.	
		Rev. No.	2
Job No. 25222260.00	Project: Columbia Energy Center MOD 12	By: SJL	Date: 8/28/23
Client: WPL	Subject: Swale Sizing	Chk'd: RJG	Date: 8/28/23

Purpose:

To size the proposed swales to accommodate the 25-year, 24-hour storm event and determine required erosion matting.

References:

1. WisDOT Facilities Development Manual Chapter 13, Section 30-15 - Grass Lined Channels.
2. Design of Roadside Channels with Flexible Linings, HEC-15, USDOT FHWA.
3. HydroCAD Report: COL_Mod12_HydroCAD Report
4. Wisconsin Department of Natural Resources Conservation Practice Standard 1053 - Channel Erosion Mat.

Approach:

Use the HydroCAD Model results to obtain the peak flow during a 25-year, 24-hour storm event.
Use Grass Lined Channel Design WisDOT Spreadsheet, FDM 13-30 Attachment 15.2 (from Reference #1) to size the swale for each design swale cross section. The WisDOT spreadsheet incorporates the design guidelines and equations described in "Design of Roadside Channels with Flexible Linings", HEC-15, USDOT FHWA (Reference #2).
Confirm the swale is stable and has enough capacity for the design flow rate.
Use Standard 1053 (see Reference #4) to select appropriate erosion control mat based on shear stress and application.

Assumptions:

1. Swales geometry shown on the drawing set.
2. Assume the following parameters per Section 15.2 - Grass Lining Properties from Reference #1:
   Vegetation Retardance Class = C for Swales
   Vegetation Condition = Good
   Vegetation Growth Form = Turf
3. Assume cohesive soil type with ASTM Soil Class SC and a Plasticity Index (PI) of 16.

Calculations:

From the HydroCAD Report, the 25-year, 24-hour peak discharge rates in the swales are

Swales:	25-year		25-year		25-year
Swale S1.0 =	30.9 cfs	**Swale S2.1 =**	40.7 cfs	**Swale S4.1 =**	2.7 cfs
Swale S1.1 =	0.24 cfs	**Swale S2.2 =**	66.4 cfs	**Swale S4.2 =**	6.3 cfs
Swale S1.2 =	27.1 cfs	**Swale S2.3 =**	66.3 cfs	**Swale S4.3 =**	18.8 cfs
Swale S1.3 =	28.0 cfs	**Swale S3.1 =**	6.5 cfs	**Swale S4.4 =**	22.1 cfs
Swale S1.4 =	32.9 cfs	**Swale S3.2 =**	20.5 cfs	**Swale S4.5 =**	22.3 cfs
Swale S1.5 =	33.6 cfs	**Swale S3.3 =**	20.4 cfs	**Swale S4.6 =**	90.0 cfs
Swale S1.6 =	2.1 cfs	**Swale S3.4 =**	4.0 cfs	**Swale S5.1 =**	4.1 cfs
Swale S1.7 =	38.9 cfs	**Swale S3.5 =**	39.3 cfs	**Swale S5.2 =**	1.7 cfs
Swale S1.8 =	2.2 cfs				
Swale S1.9 =	42.0 cfs				
Roadside Ditch 1 =	0.6 cfs	**Roadside Ditch 2 =**	11.2 cfs	**Roadside Ditch 3 =**	7.0 cfs
Roadside Ditch 4 =	1.5 cfs	**Roadside Ditch 5 =**	2.3 cfs		

Use the WisDOT Grass Swale Design Spreadsheet (Page 2) to determine the flow depth, velocity and shear stress in the swales.

Results:

The swales are adequately designed to accommodate the flows from the 25-year, 24-hour storm event.
The swales are stable at the design flow rates.

Use Class I, Type B erosion mat for all swales except Roadside Ditch 3 and 5 should be Class II, Type B if regraded.

SCS ENGINEERS

Job No. 25222260.00
Client: WPL

Project: Columbia Energy Center MOD 12
Subject: Swale Sizing

Sheet No: 2 of 3
Calc. No.
Rev. No.
By: SJL Date: 8/28/23
Chk'd: RJG Date: 8/28/23

Channel/Ditch Geometry	Swale S1.0 =	Swale S1.1 =	Swale S1.2 =	Swale S1.3 =	Swale S1.4 =	Swale S1.5 =	Swale S1.6 =	Swale S1.7 =	Swale S1.8 =	Swale S1.9 =	Swale S2.1 =	Swale S2.2 =	Swale S2.3 =	Swale S3.1 =	Swale S3.2 =	Swale S3.3 =	Swale S3.4 =	Swale S3.5 =	Swale S4.1 =	Swale S4.2 =	Swale S4.3 =	Swale S4.4 =	Swale S4.5 =	Swale S4.6 =	Swale S5.1 =	Swale S5.2 =	Roadside Ditch 1 =	Roadside Ditch 2 =	Roadside Ditch 3 =	Roadside Ditch 4 =	Roadside Ditch 5 =
Channel Slope, S_0 (ft/ft)	0.0039	0.0396	0.0242	0.0293	0.0144	0.0045	0.005	0.0054	0.0099	0.0075	0.0054	0.0049	0.0130	0.0050	0.0050	0.0130	0.0071	0.0024	0.0153	0.0127	0.0027	0.0040	0.0097	0.0112	0.0154	0.0331	0.0188	0.0162	0.0288	0.0090	0.0531
Channel Bottom Width, B (ft)	8	8	8	8	8	8	8	8	2.5	8	4	10	10	8	8	8	2.5	8	10	10	10	10	10	10	8	8	4	6	0	6	0
Channel Side Slope, z_1	4	4	4	4	4	4	4	4	2	4	4	4	4	4	4	4	2	4	4	4	4	4	4	4	4	4	3	10	4	10	4
Channel Side Slope, z_2	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3	3	3	3	3	4	4	4	8	10	4	10	4
Flow Depth, d (ft) Solve iteratively	1.72	0.065	0.78	0.73	1.05	1.69	0.46	1.67	0.58	1.52	2.00	2.03	1.38	0.78	1.30	0.88	0.85	2.28	0.29	0.47	1.49	1.38	0.96	1.70	0.39	0.19	0.20	0.62	0.85	0.33	0.49
Safety Factor, SF	1.0	1.0	1.0	1.0	1.0	3.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Vegetation/Soil Parameters																															
Vegetation Retardance Class	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
Vegetation Condition	good	good	good	good	good	good	good	good	good	good	good	good	good	good	good	good	good	good	good	good	good	good	good	good	good	good	good	good	good	good	good
Vegetation Growth Form	turf	turf	turf	turf	turf	turf	turf	turf	turf	turf	turf	turf	turf	turf	turf	turf	turf	turf	turf	turf	turf	turf	turf	turf	turf	turf	turf	turf	turf	turf	turf
Soil Type	cohesive	cohesive	cohesive	cohesive	cohesive	cohesive	cohesive	cohesive	cohesive	cohesive	cohesive	cohesive	cohesive	cohesive	cohesive	cohesive	cohesive	cohesive	cohesive	cohesive	cohesive	cohesive	cohesive	cohesive	cohesive	cohesive	cohesive	cohesive	cohesive	cohesive	cohesive
D_{50} (in) (Set at 0.00 for cohesive soils)																															
ASTM Soil Class	SC	SC	SC	SC	SC	SC	SC	SC	SC	SC	SC	SC	SC	SC	SC	SC	SC	SC	SC	SC	SC	SC	SC	SC	SC	SC	SC	SC	SC	SC	SC
Plasticity Index, PI	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16
Results Summary																															
Design Q (ft^3/s)	30.9	0.2	27.1	28.0	32.9	33.6	2.1	38.9	2.2	42.0	40.0	66.4	66.3	6.5	20.5	20.4	4.0	39.3	2.7	6.3	18.8	22.1	22.3	90.0	4.1	1.7	0.6	11.2	7.0	1.5	2.3
1. Swales geometry shown on the drawing se	31.2	0.2	27.0	27.9	32.6	34.0	2.1	38.7	2.2	41.7	39.5	65.9	66.2	6.6	20.3	20.2	4.0	39.4	2.8	6.3	18.6	22.2	22.6	90.0	4.0	1.7	0.6	11.0	7.0	1.5	2.3
Difference Between Design & Calc. Flow (%)	0.9%	-2.5%	-0.4%	-0.3%	-0.9%	0.9%	-1.1%	-0.4%	1.1%	-0.5%	-1.3%	-0.8%	-0.1%	1.1%	-0.9%	-0.9%	-0.1%	0.3%	0.4%	0.4%	-1.0%	0.7%	1.6%	0.0%	-0.2%	0.9%	-1.5%	-1.8%	0.6%	-1.7%	0.4%
Stable (Yes or No)	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Channel Parameters																															
Vegetation Height, h (ft)	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67
Grass Roughness Coefficient, C_n	0.238	0.238	0.238	0.238	0.238	0.238	0.238	0.238	0.238	0.238	0.238	0.238	0.238	0.238	0.238	0.238	0.238	0.238	0.238	0.238	0.238	0.238	0.238	0.238	0.238	0.238	0.238	0.238	0.238	0.238	0.238
Cover Factor, C_f	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Noncohesive Soil																															
Soil Grain Roughness, n_s	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016
Permissible Soil Shear Stress, τ_s (lb/ft^2)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Cohesive Soil																															
Porosity, e	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35
Soil Coefficient 1, c_1	1.0700	1.0700	1.0700	1.0700	1.0700	1.0700	1.0700	1.0700	1.0700	1.0700	1.0700	1.0700	1.0700	1.0700	1.0700	1.0700	1.0700	1.0700	1.0700	1.0700	1.0700	1.0700	1.0700	1.0700	1.0700	1.0700	1.0700	1.0700	1.0700	1.0700	1.0700
Soil Coefficient 2, c_2	14.30	14.30	14.30	14.30	14.30	14.30	14.30	14.30	14.30	14.30	14.30	14.30	14.30	14.30	14.30	14.30	14.30	14.30	14.30	14.30	14.30	14.30	14.30	14.30	14.30	14.30	14.30	14.30	14.30	14.30	14.30
Soil Coefficient 3, c_3	47.700	47.700	47.700	47.700	47.700	47.700	47.700	47.700	47.700	47.700	47.700	47.700	47.700	47.700	47.700	47.700	47.700	47.700	47.700	47.700	47.700	47.700	47.700	47.700	47.700	47.700	47.700	47.700	47.700	47.700	47.700
Soil Coefficient 4, c_4	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42
Soil Coefficient 5, c_5	-0.61	-0.61	-0.61	-0.61	-0.61	-0.61	-0.61	-0.61	-0.61	-0.61	-0.61	-0.61	-0.61	-0.61	-0.61	-0.61	-0.61	-0.61	-0.61	-0.61	-0.61	-0.61	-0.61	-0.61	-0.61	-0.61	-0.61	-0.61	-0.61	-0.61	-0.61
Soil Coefficient 6, c_6	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010
Permissible Soil Shear Stress, τ_s (lb/ft^2)	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080
Total Permissible Shear Stress, τ_s (lb/ft^2)	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080
Cross Sectional Area, A (ft^2)	25.594	0.537	8.674	7.972	12.810	24.944	4.526	24.516	2.459	21.402	24.000	36.784	21.418	8.674	17.160	10.138	4.293	39.034	3.194	5.473	22.670	20.465	12.826	27.115	3.673	1.617	0.989	7.564	2.856	3.069	0.960
Wetted Perimeter, P (ft)	22.18	8.54	14.43	14.02	16.66	21.94	11.79	21.77	6.19	20.53	20.49	26.74	21.38	14.43	18.72	15.26	7.91	26.80	12.11	13.42	20.86	20.05	16.99	22.39	11.17	9.53	6.19	18.46	6.97	12.63	4.04
Hydraulic Radius, R (ft)	1.154	0.063	0.601	0.569	0.769	1.137	0.384	1.126	0.397	1.042	1.171	1.376	1.002	0.601	0.917	0.664	0.543	1.456	0.264	0.408	1.087	1.021	0.755	1.211	0.329	0.170	0.160	0.410	0.410	0.243	0.238
Top Width, T (ft)	21.76	8.52	14.24	13.84	16.40	21.52	11.68	21.36	5.98	20.16	20.00	26.24	21.04	14.24	18.40	15.04	7.60	26.24	12.03	13.29	20.43	19.66	16.72	21.90	11.08	9.48	6.15	18.40	6.76	12.60	3.92
Hydraulic Depth, D (ft)	1.176	0.063	0.609	0.576	0.781	1.159	0.388	1.148	0.411	1.062	1.200	1.402	1.018	0.609	0.933	0.674	0.565	1.488	0.266	0.412	1.110	1.041	0.767	1.238	0.331	0.171	0.161	0.411	0.423	0.244	0.245
Froude Number (Q design)	0.198	0.308	0.703	0.813	0.507	0.223	0.132	0.260	0.247	0.334	0.264	0.267	0.540	0.171	0.216	0.427	0.218	0.146	0.295	0.317	0.137	0.187	0.355	0.526	0.337	0.461	0.267	0.399	0.664	0.174	0.838
Channel Shear Stress, τ_o (lb/ft^2)	0.28	0.16	0.91	1.04	0.69	0.32	0.12	0.38	0.25	0.49	0.39	0.42	0.81	0.19	0.29	0.54	0.24	0.22	0.25	0.32	0.18	0.25	0.46	0.85	0.32	0.35	0.19	0.41	0.74	0.14	0.79
Actual Shear Stress, τ_s (lb/ft^2)	0.42	0.16	1.18	1.33	0.94	0.47	0.14	0.56	0.36	0.71	0.67	0.62	1.12	0.24	0.41	0.71	0.38	0.34	0.28	0.37	0.25	0.34	0.58	1.19	0.37	0.38	0.23	0.63	1.52	0.19	1.62
Mannings n	0.084	0.107	0.053	0.050	0.059	0.080	0.119	0.075	0.089	0.068	0.074	0.072	0.055	0.099	0.084	0.065	0.090	0.093	0.088	0.080	0.100	0.088	0.069	0.054	0.080	0.077	0.099	0.072	0.057	0.113	0.056
Average Velocity, V (ft/s)	1.21	0.45	3.13	3.51	2.57	1.35	0.47	1.59	0.89	1.96	1.67	1.81	3.10	0.75	1.19	2.01	0.93	1.01	0.86	1.15	0.83	1.08	1.74	3.32	1.10	1.07	0.62	1.48	2.43	0.50	2.34
Calculated Flow, Q (ft^3/s)	31.2	0.2	27.0	27.9	32.6	34.0	2.1	38.7	2.2	41.7	39.5	65.9	66.2	6.6	20.3	20.2	4.0	39.4	2.8	6.3	18.6	22.2	22.6	90.0	4.0	1.7	0.6	11.0	7.0	1.5	2.3
Difference Between Design & Calc. Flow (%)	0.9%	-2.0%	-0.4%	-0.3%	-0.9%	0.9%	-1.1%	-0.4%	1.1%	-0.5%	-1.3%	-0.8%	-0.1%	1.1%	-0.9%	-0.9%	-0.1%	0.3%	0.4%	0.4%	-1.0%	0.7%	1.6%	0.0%	-0.2%	0.9%	-1.5%	-1.8%	0.6%	-1.7%	0.4%
Effective Shear on Soil Surface, τ_e (lb/ft^2)	0.002	0.000	0.011	0.014	0.007	0.002	0.000	0.003	0.001	0.004	0.003	0.003	0.009	0.001	0.001	0.004	0.001	0.001	0.001	0.001	0.001	0.001	0.003	0.010	0.001	0.002	0.001	0.003	0.012	0.000	0.013
Total Permissible Shear on Veg., τ_{max} (lb/ft^2)	22.08	35.83	8.79	7.82	10.89	20.03	44.32	17.60	24.79	14.47	17.14	16.22	9.47	30.67	22.08	13.22	25.35	27.07	24.24	20.03	31.30	24.24	14.90	9.13	20.03	18.56	30.67	16.22	10.17	39.96	9.81
Stable (Y or N)	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

Source: Grass Lined Channel Design WisDOT Spreadsheet, FDM 13-30 Attachment 15.2

09/28/2023 - Classification: Internal - ECRM13153872

Channel Erosion Mat

(1053)

Wisconsin Department of Natural Resources
Conservation Practice Standard

To differentiate applications WisDOT organizes erosion mats into three classes of mats, which are further broken down into various Types.

A. **Class I**: A short-term duration (minimum of 6 months), light duty, organic ECRM with plastic or biodegradable netting.

   1. **Type A** – Only suitable for slope applications, not channel applications.

   2. **Type B** – Double netted product for use in channels where the calculated (design) shear stress is 1.5 lbs/ft^2 or less.

B. **Class II**: A long-term duration (three years or greater), organic ECRM.

   1. **Type A** – Jute fiber only for use in channels to reinforce sod.

   2. **Type B** – For use in channels where the calculated (design) shear stress is 2.0 lbs/ft^2 or less. Made with plastic or biodegradable mat.

   3. **Type C** – A woven mat of 100% organic material for use in channels where the calculated (design) shear stress is 2.0 lbs/ft^2 or less. Applicable for use in environmentally sensitive areas where plastic netting is inappropriate.

C. **Class III**: A permanent 100% synthetic ECRM or TRM. Class I, Type B erosion mat or Class II, Type B or C erosion mat must be placed over a soil filled TRM.

   1. **Type A** – An ECRM for use in channels where the calculated (design) shear stress of 2.0 lbs/ft^2 or less.

   2. **Type B** – A TRM for use in channels where the calculated (design) shear stress of 2.0 lbs/ft^2 or less.

   3. **Type C** – A TRM for use in channels where the calculated (design) shear stress of 3.5 lbs/ft^2 or less.

   4. **Type D** – A TRM for use in channels where the calculated (design) shear stress of 5.0 lbs/ft^2 or less.

09/28/2023 - Classification: Internal - ECRM13153872

Culvert Sizing

SCS ENGINEERS

		Sheet No:	1/26
		Calc. No.	
		Rev. No.	3
Job No. 25222260.00	Job: Columbia Energy Center MOD 12	By: SJL	Date: 8/28/23
Client: WPL	Subject: Culvert Sizing	Chk'd: RJG	Date: 8/28/23

Purpose:

To size the post closure culverts to accommodate the 25-year, 24-hour storm event.

References:

1. HY-8 7.40 Computer Model
2. HydroCAD Report: COL_Mod12_HydroCAD Report
3. Figure 1 - Final Grades (Module 12)

Approach:

1. Create culvert crossing in HY-8 and input data from Reference #2 and #3.
2. Adjust diameter size and number of culverts in model until design flow does not over top berm/road crossing.

Assumptions:

1. Assume the tailwater channel data is a based on discharge swale or rock chute geometry (Reference #2).
2. Culverts are circular, PE Pipe with smooth interior, and with square edge with headwall.
3. Culvert elevatons,lengths, and slopes based on Figure 1 (Reference #3).
4. Roadway data for crossing based on Figure 1 (Reference #3).
5. Discharge flows from HydroCAD report (Refence #2).

Calculations:

See attached HY-8 Model output reports for C1 through C11

Results:

The culverts are adequately designed to accommodate the flows from the 25-year, 24-hour storm event.

Culvert	Dia. (ft)	# of Barrels	Upstream Invert (ft)	Downstream Invert (ft)	Slope (%)	Length (ft)
C1	2	1	815.70	814.55	2.22	52
C2a	1.5	2	817.60	814.00	4.83	75
C2b	1	2	818.00	817.60	1.00	40
C3	2.5	2	811.17	810.90	0.54	50
C4	2.5	2	809.86	809.60	0.52	50
C5	2.5	2	807.57	807.15	0.84	50
C6	2	2	805.40	804.76	0.61	105
C7	3.5	2	796.64	796.34	0.50	60
C8	1	1	810.70	808.60	2.45	86
C9	1	1	822.00	821.79	0.57	37
C10	2	1	807.54	806.81	0.73	100
C11	2.5	2	817.68	817.40	0.50	56

Culvert Data: Culvert C1

Site Data - Culvert C1

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 815.70 ft
Outlet Station: 51.88 ft
Outlet Elevation: 814.55 ft
Number of Barrels: 1

Culvert Data Summary - Culvert C1

Barrel Shape: Circular
Barrel Diameter: 2.00 ft
Barrel Material: Smooth HDPE
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge with Headwall
Inlet Depression: None

Table 2 - Culvert Summary Table: Culvert C1

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.60 cfs	0.60 cfs	816.05	0.35	0.287	1-S2n	0.18	0.27	0.18	0.29	4.28	1.23
0.74 cfs	0.74 cfs	816.09	0.39	0.310	1-S2n	0.20	0.29	0.20	0.31	4.64	1.29
0.87 cfs	0.87 cfs	816.13	0.43	0.331	1-JS1t	0.21	0.32	1.48	0.33	0.35	1.35
1.01 cfs	1.01 cfs	816.16	0.46	0.350	1-JS1t	0.23	0.35	1.50	0.35	0.40	1.40
1.14 cfs	1.14 cfs	816.19	0.49	0.368	1-S2n	0.24	0.37	0.24	0.36	5.29	1.44
1.28 cfs	1.28 cfs	816.22	0.52	0.385	1-JS1t	0.26	0.39	1.53	0.38	0.50	1.48
1.42 cfs	1.42 cfs	816.25	0.55	0.401	1-JS1t	0.27	0.41	1.54	0.39	0.54	1.52
1.55 cfs	1.55 cfs	816.28	0.58	0.416	1-JS1t	0.28	0.43	1.56	0.41	0.59	1.55
1.69 cfs	1.69 cfs	816.30	0.60	0.430	1-JS1t	0.29	0.45	1.57	0.42	0.64	1.59
1.82 cfs	1.82 cfs	816.33	0.63	0.444	1-JS1t	0.30	0.47	1.58	0.43	0.68	1.62
1.96 cfs	1.96 cfs	816.35	0.65	0.458	1-JS1t	0.31	0.49	1.60	0.45	0.73	1.65

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 815.70 ft,
Outlet Elevation (invert): 814.55 ft
Culvert Length: 51.89 ft,
Culvert Slope: 0.0222

Tailwater Data for Crossing: Culvert C1

Table 3 - Downstream Channel Rating Curve (Crossing: Culvert C1)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
0.60	815.99	0.29	1.23	0.34	0.57
0.74	816.01	0.31	1.29	0.36	0.58
0.87	816.03	0.33	1.35	0.39	0.59

1.01	816.05	0.35	1.40	0.41	0.59
1.14	816.06	0.36	1.44	0.43	0.60
1.28	816.08	0.38	1.48	0.45	0.60
1.42	816.09	0.39	1.52	0.46	0.60
1.55	816.11	0.41	1.55	0.48	0.61
1.69	816.12	0.42	1.59	0.49	0.61
1.82	816.13	0.43	1.62	0.51	0.61
1.96	816.15	0.45	1.65	0.52	0.62

Tailwater Channel Data - Culvert C1

Tailwater Channel Option: Triangular Channel
Side Slope (H:V): 6.00 (_:1)
Channel Slope: 0.0188
Channel Manning's n: 0.0450
Channel Invert Elevation: 815.70 ft

Roadway Data for Crossing: Culvert C1

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 50.00 ft
Crest Elevation: 819.06 ft
Roadway Surface: Gravel
Roadway Top Width: 30.00 ft

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow
Minimum Flow: 0.60 cfs
Design Flow: 0.60 cfs
Maximum Flow: 1.96 cfs

Table 4 - Summary of Culvert Flows at Crossing: Culvert C1

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert C1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
816.05	0.60	0.60	0.00	1
816.09	0.74	0.74	0.00	1
816.13	0.87	0.87	0.00	1
816.16	1.01	1.01	0.00	1
816.19	1.14	1.14	0.00	1
816.22	1.28	1.28	0.00	1
816.25	1.42	1.42	0.00	1
816.28	1.55	1.55	0.00	1
816.30	1.69	1.69	0.00	1
816.33	1.82	1.82	0.00	1
816.35	1.96	1.96	0.00	1
819.06	22.61	22.61	0.00	Overtopping

Culvert Data: C2a

Site Data - C2a

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 817.60 ft
Outlet Station: 74.54 ft
Outlet Elevation: 814.00 ft
Number of Barrels: 2

Culvert Data Summary - C2a

Barrel Shape: Circular
Barrel Diameter: 1.50 ft
Barrel Material: Smooth HDPE
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge with Headwall (Ke=0.5)
Inlet Depression: None

Table 3 - Culvert Summary Table: C2a

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
10.41 cfs	10.41 cfs	818.90	1.30	0.0*	1-S2n	0.46	0.88	0.46	0.52	11.19	1.99
11.12 cfs	11.12 cfs	818.96	1.36	0.0*	1-S2n	0.48	0.91	0.51	0.54	10.53	2.03
11.84 cfs	11.84 cfs	819.02	1.42	0.0*	1-S2n	0.50	0.94	0.52	0.56	10.95	2.07
12.55 cfs	12.55 cfs	819.08	1.48	0.0*	1-S2n	0.51	0.97	0.52	0.58	11.51	2.11
13.27 cfs	13.27 cfs	819.14	1.54	0.0*	5-S2n	0.53	1.00	0.53	0.60	11.98	2.14
13.98 cfs	13.98 cfs	819.20	1.60	0.0*	5-S2n	0.54	1.02	0.57	0.61	11.33	2.18
14.70 cfs	14.70 cfs	819.27	1.67	0.0*	5-S2n	0.56	1.05	0.58	0.63	11.54	2.21
15.41 cfs	15.41 cfs	819.33	1.73	0.0*	5-S2n	0.57	1.08	0.59	0.65	11.84	2.25
16.13 cfs	16.13 cfs	819.40	1.80	0.0*	5-S2n	0.59	1.10	0.60	0.66	12.17	2.28
16.84 cfs	16.77 cfs	819.47	1.87	0.0*	5-S2n	0.60	1.12	0.60	0.68	12.77	2.31
17.56 cfs	17.05 cfs	819.50	1.90	0.0*	5-S2n	0.60	1.13	0.60	0.70	12.83	2.34

* Full Flow Headwater elevation is below inlet invert.

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 817.60 ft,
Outlet Elevation (invert): 814.00 ft
Culvert Length: 74.63 ft,
Culvert Slope: 0.0483

Tailwater Data for Crossing: Culvert C2a

Table 5 - Downstream Channel Rating Curve (Crossing: Culvert C2a)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
10.41	814.52	0.52	1.99	0.16	0.53

11.12	814.54	0.54	2.03	0.17	0.54
11.84	814.56	0.56	2.07	0.17	0.54
12.55	814.58	0.58	2.11	0.18	0.54
13.27	814.60	0.60	2.14	0.19	0.54
13.98	814.61	0.61	2.18	0.19	0.55
14.70	814.63	0.63	2.21	0.20	0.55
15.41	814.65	0.65	2.25	0.20	0.55
16.13	814.66	0.66	2.28	0.21	0.55
16.84	814.68	0.68	2.31	0.21	0.55
17.56	814.70	0.70	2.34	0.22	0.55

Tailwater Channel Data - Culvert C2a

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 8.00 ft
Side Slope (H:V): 4.00 (_:1)
Channel Slope: 0.0050
Channel Manning's n: 0.0300
Channel Invert Elevation: 814.00 ft

Roadway Data for Crossing: Culvert C2a

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 27.00 ft
Crest Elevation: 819.46 ft
Roadway Surface: Gravel
Roadway Top Width: 20.00 ft

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow
Minimum Flow: 10.41 cfs
Design Flow: 10.41 cfs
Maximum Flow: 17.56 cfs

Table 6 - Summary of Culvert Flows at Crossing: Culvert C2a

Headwater Elevation (ft)	Total Discharge (cfs)	C2a Discharge (cfs)	Roadway Discharge (cfs)	Iterations
818.90	10.41	10.41	0.00	1
818.96	11.12	11.12	0.00	1
819.02	11.84	11.84	0.00	1
819.08	12.55	12.55	0.00	1
819.14	13.27	13.27	0.00	1
819.20	13.98	13.98	0.00	1
819.27	14.70	14.70	0.00	1
819.33	15.41	15.41	0.00	1
819.40	16.13	16.13	0.00	1
819.47	16.84	16.77	0.05	13
819.50	17.56	17.05	0.50	7
819.46	16.69	16.69	0.00	Overtopping

Culvert Data: C2b

Site Data - C2b

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 818.00 ft
Outlet Station: 40.00 ft
Outlet Elevation: 817.60 ft
Number of Barrels: 2

Culvert Data Summary - C2b

Barrel Shape: Circular
Barrel Diameter: 1.00 ft
Barrel Material: Smooth HDPE
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge with Headwall (Ke=0.5)
Inlet Depression: None

Table 12 - Culvert Summary Table: C2b

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
3.50 cfs	3.50 cfs	819.00	0.84	1.002	1-S1f	0.47	0.56	1.00	0.20	2.23	1.98
3.73 cfs	3.73 cfs	819.04	0.88	1.035	1-S1f	0.49	0.58	1.00	0.21	2.37	2.03
3.95 cfs	3.95 cfs	819.07	0.91	1.070	1-S1f	0.51	0.60	1.00	0.22	2.52	2.07
4.18 cfs	4.18 cfs	819.11	0.95	1.106	1-S1f	0.52	0.62	1.00	0.22	2.66	2.11
4.40 cfs	4.40 cfs	819.14	0.98	1.143	1-S1f	0.54	0.63	1.00	0.23	2.80	2.15
4.63 cfs	4.63 cfs	819.18	1.01	1.183	1-S1f	0.56	0.65	1.00	0.24	2.95	2.19
4.86 cfs	4.86 cfs	819.22	1.05	1.223	4-FFf	0.57	0.67	1.00	0.24	3.09	2.23
5.08 cfs	5.08 cfs	819.27	1.09	1.266	4-FFf	0.59	0.68	1.00	0.25	3.24	2.26
5.31 cfs	5.31 cfs	819.31	1.13	1.310	4-FFf	0.61	0.70	1.00	0.26	3.38	2.30
5.53 cfs	5.53 cfs	819.36	1.16	1.356	4-FFf	0.63	0.71	1.00	0.26	3.52	2.33
5.76 cfs	5.76 cfs	819.40	1.20	1.403	4-FFf	0.64	0.73	1.00	0.27	3.67	2.36

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 818.00 ft,
Outlet Elevation (invert): 817.60 ft
Culvert Length: 40.00 ft,
Culvert Slope: 0.0100

Tailwater Data for Crossing: Culvert C2b

Table 23 - Downstream Channel Rating Curve (Crossing: Culvert C2b)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
3.50	818.80	0.20	1.98	0.19	0.81
3.73	818.81	0.21	2.03	0.20	0.82
3.95	818.82	0.22	2.07	0.21	0.82

4.18	818.82	0.22	2.11	0.21	0.83
4.40	818.83	0.23	2.15	0.22	0.83
4.63	818.84	0.24	2.19	0.23	0.83
4.86	818.84	0.24	2.23	0.23	0.84
5.08	818.85	0.25	2.26	0.24	0.84
5.31	818.86	0.26	2.30	0.25	0.84
5.53	818.86	0.26	2.33	0.25	0.85
5.76	818.87	0.27	2.36	0.26	0.85

Tailwater Channel Data - Culvert C2b

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 8.00 ft
Side Slope (H:V): 4.00 (_:1)
Channel Slope: 0.0154
Channel Manning's n: 0.0300
Channel Invert Elevation: 818.60 ft

Roadway Data for Crossing: Culvert C2b

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 12.00 ft
Crest Elevation: 819.46 ft
Roadway Surface: Gravel
Roadway Top Width: 19.00 ft

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow
Minimum Flow: 3.50 cfs
Design Flow: 3.50 cfs
Maximum Flow: 5.76 cfs

Table 24 - Summary of Culvert Flows at Crossing: Culvert C2b

Headwater Elevation (ft)	Total Discharge (cfs)	C2b Discharge (cfs)	Roadway Discharge (cfs)	Iterations
819.00	3.50	3.50	0.00	1
819.04	3.73	3.73	0.00	1
819.07	3.95	3.95	0.00	1
819.11	4.18	4.18	0.00	1
819.14	4.40	4.40	0.00	1
819.18	4.63	4.63	0.00	1
819.22	4.86	4.86	0.00	1
819.27	5.08	5.08	0.00	1
819.31	5.31	5.31	0.00	1
819.36	5.53	5.53	0.00	1
819.40	5.76	5.76	0.00	1
819.46	6.02	6.02	0.00	Overtopping

Culvert Data: C3

Site Data - C3

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 811.17 ft
Outlet Station: 50.00 ft
Outlet Elevation: 810.90 ft
Number of Barrels: 2

Culvert Data Summary - C3

Barrel Shape: Circular
Barrel Diameter: 2.50 ft
Barrel Material: Smooth HDPE
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge with Headwall
Inlet Depression: None

Table 4 - Culvert Summary Table: C3

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
27.48 cfs	27.48 cfs	813.00	1.83	1.207	1-S2n	1.13	1.25	1.14	0.89	6.31	2.68
29.42 cfs	29.42 cfs	813.08	1.91	1.286	1-S2n	1.17	1.29	1.18	0.92	6.43	2.73
31.35 cfs	31.35 cfs	813.16	1.99	1.366	1-S2n	1.22	1.34	1.23	0.95	6.54	2.79
33.29 cfs	33.29 cfs	813.23	2.06	1.446	1-S2n	1.26	1.38	1.27	0.98	6.64	2.84
35.22 cfs	35.22 cfs	813.31	2.14	1.528	1-S2n	1.31	1.42	1.31	1.01	6.73	2.88
37.16 cfs	37.16 cfs	813.38	2.21	1.611	1-S2n	1.35	1.46	1.36	1.04	6.83	2.93
39.10 cfs	39.10 cfs	813.45	2.28	1.695	1-S2n	1.39	1.50	1.40	1.07	6.91	2.97
41.03 cfs	41.03 cfs	813.53	2.36	1.781	1-S2n	1.43	1.54	1.44	1.10	7.00	3.01
42.97 cfs	42.97 cfs	813.60	2.43	1.868	1-S2n	1.48	1.58	1.48	1.13	7.07	3.05
44.90 cfs	44.90 cfs	813.68	2.51	1.956	5-S2n	1.52	1.61	1.53	1.15	7.15	3.09
46.84 cfs	46.84 cfs	813.76	2.59	2.046	5-S2n	1.56	1.65	1.57	1.18	7.22	3.13

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

Inlet Elevation (invert): 811.17 ft,

Outlet Elevation (invert): 810.90 ft

Culvert Length: 50.00 ft,

Culvert Slope: 0.0054

Tailwater Data for Crossing: Culvert C3

Table 7 - Downstream Channel Rating Curve (Crossing: Culvert C3)

Flow (cfs)	Water Surface	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number

	Elev (ft)				
27.48	812.06	0.89	2.68	0.28	0.57
29.42	812.10	0.92	2.73	0.29	0.58
31.35	812.13	0.95	2.79	0.30	0.58
33.29	812.16	0.98	2.84	0.31	0.58
35.22	812.19	1.01	2.88	0.32	0.58
37.16	812.22	1.04	2.93	0.33	0.59
39.10	812.25	1.07	2.97	0.33	0.59
41.03	812.27	1.10	3.01	0.34	0.59
42.97	812.30	1.13	3.05	0.35	0.59
44.90	812.33	1.15	3.09	0.36	0.59
46.84	812.35	1.18	3.13	0.37	0.60

Tailwater Channel Data - Culvert C3

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 8.00 ft

Side Slope (H:V): 4.00 (_:1)

Channel Slope: 0.0050

Channel Manning's n: 0.0300

Channel Invert Elevation: 811.17 ft

Roadway Data for Crossing: Culvert C3

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 29.00 ft

Crest Elevation: 813.80 ft

Roadway Surface: Gravel

Roadway Top Width: 30.00 ft

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 27.48 cfs

Design Flow: 27.48 cfs

Maximum Flow: 46.84 cfs

Table 8 - Summary of Culvert Flows at Crossing: Culvert C3

Headwater Elevation (ft)	Total Discharge	C3 Discharge (cfs)	Roadway Discharge	Iterations

	(cfs)		(cfs)	
813.00	27.48	27.48	0.00	1
813.08	29.42	29.42	0.00	1
813.16	31.35	31.35	0.00	1
813.23	33.29	33.29	0.00	1
813.31	35.22	35.22	0.00	1
813.38	37.16	37.16	0.00	1
813.45	39.10	39.10	0.00	1
813.53	41.03	41.03	0.00	1
813.60	42.97	42.97	0.00	1
813.68	44.90	44.90	0.00	1
813.76	46.84	46.84	0.00	1
813.80	47.92	47.92	0.00	Overtopping

Culvert Data: C4

Site Data - C4

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 809.86 ft
Outlet Station: 50.00 ft
Outlet Elevation: 809.60 ft
Number of Barrels: 2

Culvert Data Summary - C4

Barrel Shape: Circular
Barrel Diameter: 2.50 ft
Barrel Material: Smooth HDPE
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge with Headwall (Ke=0.5)
Inlet Depression: None

Table 7 - Culvert Summary Table: C4

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
32.85 cfs	32.85 cfs	811.91	2.05	1.438	1-S2n	1.27	1.37	1.27	0.89	6.53	3.18
35.37 cfs	35.37 cfs	812.00	2.14	1.544	1-S2n	1.32	1.42	1.33	0.93	6.66	3.25
37.89 cfs	37.89 cfs	812.10	2.24	1.653	1-S2n	1.38	1.48	1.39	0.96	6.77	3.32
40.41 cfs	40.41 cfs	812.20	2.34	1.763	1-S2n	1.44	1.53	1.44	1.00	6.88	3.38
42.93 cfs	42.93 cfs	812.29	2.43	1.876	1-S2n	1.50	1.57	1.50	1.03	6.98	3.44
45.45 cfs	45.45 cfs	812.39	2.53	1.991	5-S2n	1.55	1.62	1.56	1.06	7.07	3.50
47.96 cfs	47.96 cfs	812.49	2.63	2.108	5-S2n	1.61	1.67	1.61	1.09	7.15	3.55
50.48 cfs	50.48 cfs	812.60	2.74	2.228	5-S2n	1.67	1.71	1.67	1.12	7.24	3.61
53.00 cfs	53.00 cfs	812.70	2.84	2.350	5-S2n	1.73	1.75	1.73	1.15	7.31	3.66
55.52 cfs	55.52 cfs	812.81	2.95	2.475	5-S2n	1.79	1.80	1.79	1.18	7.36	3.71
58.04 cfs	58.04 cfs	813.00	3.07	3.139	7-M2c	1.86	1.84	1.84	1.21	7.51	3.75

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 809.86 ft,
Outlet Elevation (invert): 809.60 ft
Culvert Length: 50.00 ft,
Culvert Slope: 0.0052

Tailwater Data for Crossing: Culvert C4

Table 13 - Downstream Channel Rating Curve (Crossing: Culvert C4)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
32.85	810.76	0.89	3.18	0.39	0.68
35.37	810.80	0.93	3.25	0.41	0.68
37.89	810.83	0.96	3.32	0.42	0.69

40.41	810.86	1.00	3.38	0.44	0.69
42.93	810.90	1.03	3.44	0.45	0.69
45.45	810.93	1.06	3.50	0.46	0.69
47.96	810.96	1.09	3.55	0.48	0.70
50.48	810.99	1.12	3.61	0.49	0.70
53.00	811.02	1.15	3.66	0.50	0.70
55.52	811.05	1.18	3.71	0.51	0.70
58.04	811.07	1.21	3.75	0.53	0.71

Tailwater Channel Data - Culvert C4

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 8.00 ft
Side Slope (H:V): 4.00 (_:1)
Channel Slope: 0.0070
Channel Manning's n: 0.0300
Channel Invert Elevation: 809.87 ft

Roadway Data for Crossing: Culvert C4

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 29.00 ft
Crest Elevation: 813.14 ft
Roadway Surface: Gravel
Roadway Top Width: 30.00 ft

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow
Minimum Flow: 32.85 cfs
Design Flow: 32.85 cfs
Maximum Flow: 58.04 cfs

Table 14 - Summary of Culvert Flows at Crossing: Culvert C4

Headwater Elevation (ft)	Total Discharge (cfs)	C4 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
811.91	32.85	32.85	0.00	1
812.00	35.37	35.37	0.00	1
812.10	37.89	37.89	0.00	1
812.20	40.41	40.41	0.00	1
812.29	42.93	42.93	0.00	1
812.39	45.45	45.45	0.00	1
812.49	47.96	47.96	0.00	1
812.60	50.48	50.48	0.00	1
812.70	53.00	53.00	0.00	1
812.81	55.52	55.52	0.00	1
813.00	58.04	58.04	0.00	1
813.14	62.27	62.27	0.00	Overtopping

Culvert Data: C5

Site Data - C5

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 807.57 ft
Outlet Station: 50.00 ft
Outlet Elevation: 807.15 ft
Number of Barrels: 2

Culvert Data Summary - C5

Barrel Shape: Circular
Barrel Diameter: 2.50 ft
Barrel Material: Smooth HDPE
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge with Headwall (Ke=0.5)
Inlet Depression: None

Table 8 - Culvert Summary Table: C5

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
38.11 cfs	38.11 cfs	809.81	2.24	1.502	1-S2n	1.20	1.48	1.25	1.06	7.80	2.95
41.03 cfs	41.03 cfs	809.92	2.35	1.631	1-S2n	1.25	1.54	1.30	1.10	7.94	3.01
43.94 cfs	43.94 cfs	810.04	2.47	1.762	1-S2n	1.31	1.59	1.36	1.14	8.08	3.07
46.86 cfs	46.86 cfs	810.15	2.58	1.897	5-S2n	1.36	1.65	1.41	1.18	8.22	3.13
49.78 cfs	49.78 cfs	810.27	2.70	2.034	5-S2n	1.41	1.70	1.46	1.22	8.34	3.18
52.70 cfs	52.70 cfs	810.40	2.83	2.175	5-S2n	1.46	1.75	1.51	1.25	8.47	3.24
55.61 cfs	55.61 cfs	810.52	2.95	2.320	5-S2n	1.51	1.80	1.57	1.29	8.59	3.29
58.53 cfs	58.53 cfs	810.66	3.09	2.468	5-S2n	1.57	1.84	1.62	1.32	8.71	3.33
61.45 cfs	61.45 cfs	810.80	3.23	2.925	5-S2n	1.62	1.89	1.67	1.35	8.82	3.38
64.36 cfs	63.52 cfs	810.90	3.33	3.019	5-S2n	1.66	1.92	1.71	1.39	8.89	3.42
67.28 cfs	64.67 cfs	810.96	3.39	3.072	5-S2n	1.68	1.94	1.73	1.42	8.94	3.47

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 807.57 ft,
Outlet Elevation (invert): 807.15 ft
Culvert Length: 50.00 ft,
Culvert Slope: 0.0084

Tailwater Data for Crossing: Culvert C5

Table 15 - Downstream Channel Rating Curve (Crossing: Culvert C5)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
38.11	808.63	1.06	2.95	0.33	0.59
41.03	808.67	1.10	3.01	0.34	0.59
43.94	808.71	1.14	3.07	0.36	0.59

46.86	808.75	1.18	3.13	0.37	0.60
49.78	808.79	1.22	3.18	0.38	0.60
52.70	808.82	1.25	3.24	0.39	0.60
55.61	808.86	1.29	3.29	0.40	0.60
58.53	808.89	1.32	3.33	0.41	0.60
61.45	808.92	1.35	3.38	0.42	0.61
64.36	808.96	1.39	3.42	0.43	0.61
67.28	808.99	1.42	3.47	0.44	0.61

Tailwater Channel Data - Culvert C5

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 8.00 ft
Side Slope (H:V): 4.00 (_:1)
Channel Slope: 0.0050
Channel Manning's n: 0.0300
Channel Invert Elevation: 807.57 ft

Roadway Data for Crossing: Culvert C5

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 28.00 ft
Crest Elevation: 810.85 ft
Roadway Surface: Gravel
Roadway Top Width: 20.00 ft

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow
Minimum Flow: 38.11 cfs
Design Flow: 38.11 cfs
Maximum Flow: 67.28 cfs

Table 16 - Summary of Culvert Flows at Crossing: Culvert C5

Headwater Elevation (ft)	Total Discharge (cfs)	C5 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
809.81	38.11	38.11	0.00	1
809.92	41.03	41.03	0.00	1
810.04	43.94	43.94	0.00	1
810.15	46.86	46.86	0.00	1
810.27	49.78	49.78	0.00	1
810.40	52.70	52.70	0.00	1
810.52	55.61	55.61	0.00	1
810.66	58.53	58.53	0.00	1
810.80	61.45	61.45	0.00	1
810.90	64.36	63.52	0.81	10
810.96	67.28	64.67	2.58	7
810.85	62.52	62.52	0.00	Overtopping

Culvert Data: C6

Site Data - C6

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 805.40 ft
Outlet Station: 104.56 ft
Outlet Elevation: 804.76 ft
Number of Barrels: 2

Culvert Data Summary - C6

Barrel Shape: Circular
Barrel Diameter: 2.00 ft
Barrel Material: Smooth HDPE
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Mitered to Conform to Slope
Inlet Depression: None

Table 1 - Culvert Summary Table: C6

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
30.03 cfs	30.03 cfs	807.77	2.37	1.750	5-S2n	1.33	1.40	1.33	0.80	6.77	3.22
32.28 cfs	32.28 cfs	807.95	2.55	1.956	5-S2n	1.40	1.45	1.41	0.84	6.84	3.30
34.53 cfs	34.53 cfs	808.15	2.75	2.170	5-S2n	1.48	1.50	1.48	0.87	6.92	3.38
36.77 cfs	36.77 cfs	808.36	2.96	2.848	7-M2c	1.57	1.54	1.54	0.90	7.07	3.45
39.02 cfs	38.66 cfs	808.54	3.14	2.934	7-M2c	1.65	1.58	1.58	0.93	7.26	3.52
41.27 cfs	39.50 cfs	808.63	3.23	2.974	7-M2c	1.70	1.60	1.60	0.97	7.35	3.58
43.52 cfs	40.15 cfs	808.69	3.29	3.007	7-M2c	1.74	1.61	1.61	1.00	7.41	3.65
45.77 cfs	40.72 cfs	808.75	3.35	3.037	7-M2c	1.78	1.62	1.62	1.02	7.47	3.71
48.01 cfs	41.23 cfs	808.81	3.41	3.066	7-M2c	2.00	1.63	1.63	1.05	7.53	3.77
50.26 cfs	41.69 cfs	808.86	3.46	3.094	7-M2c	2.00	1.64	1.64	1.08	7.58	3.82
52.51 cfs	42.13 cfs	808.91	3.51	3.122	7-M2c	2.00	1.64	1.64	1.11	7.62	3.88

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 805.40 ft,
Outlet Elevation (invert): 804.76 ft
Culvert Length: 104.56 ft,
Culvert Slope: 0.0061

Tailwater Data for Crossing: Culvert C6

Table 1 - Downstream Channel Rating Curve (Crossing: Culvert C6)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
30.03	805.36	0.80	3.22	0.35	0.68
32.28	805.40	0.84	3.30	0.37	0.68
34.53	805.43	0.87	3.38	0.38	0.68
36.77	805.46	0.90	3.45	0.39	0.69

39.02	805.49	0.93	3.52	0.41	0.69
41.27	805.53	0.97	3.58	0.42	0.69
43.52	805.56	1.00	3.65	0.43	0.70
45.77	805.58	1.02	3.71	0.45	0.70
48.01	805.61	1.05	3.77	0.46	0.70
50.26	805.64	1.08	3.82	0.47	0.70
52.51	805.67	1.11	3.88	0.48	0.71

Tailwater Channel Data - Culvert C6

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 10.00 ft
Side Slope (H:V): 2.00 (_:1)
Channel Slope: 0.0070
Channel Manning's n: 0.0300
Channel Invert Elevation: 804.56 ft

Roadway Data for Crossing: Culvert C6

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 15.00 ft
Crest Elevation: 808.50 ft
Roadway Surface: Gravel
Roadway Top Width: 100.00 ft

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow
Minimum Flow: 30.03 cfs
Design Flow: 30.03cfs
Maximum Flow: 52.51 cfs

Table 2 - Summary of Culvert Flows at Crossing: Culvert C6

Headwater Elevation (ft)	Total Discharge (cfs)	C6 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
807.77	30.03	30.03	0.00	1
807.95	32.28	32.28	0.00	1
808.15	34.53	34.53	0.00	1
808.36	36.77	36.77	0.00	1
808.54	39.02	38.66	0.34	12
808.63	41.27	39.50	1.75	8
808.69	43.52	40.15	3.35	7
808.75	45.77	40.72	5.03	6
808.81	48.01	41.23	6.78	6
808.86	50.26	41.69	8.56	5
808.91	52.51	42.13	10.37	5
808.50	38.24	38.24	0.00	Overtopping

Culvert Data: C7

Site Data - C7

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 796.64 ft
Outlet Station: 60.20 ft
Outlet Elevation: 796.34 ft
Number of Barrels: 2

Culvert Data Summary - C7

Barrel Shape: Circular
Barrel Diameter: 3.50 ft
Barrel Material: Corrugated Steel
Embedment: 0.00 in
Barrel Manning's n: 0.0240
Culvert Type: Straight
Inlet Configuration: Square Edge with Headwall
Inlet Depression: None

Table 5 - Culvert Summary Table: C7

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
68.10 cfs	68.10 cfs	799.54	2.62	2.904	2-M2c	2.56	1.81	1.81	1.09	6.79	4.35
73.79 cfs	73.79 cfs	799.69	2.75	3.048	2-M2c	2.74	1.89	1.89	1.14	6.98	4.46
79.48 cfs	79.48 cfs	799.83	2.89	3.191	2-M2c	2.98	1.96	1.96	1.18	7.17	4.56
85.17 cfs	85.17 cfs	799.97	3.02	3.334	2-M2c	3.50	2.03	2.03	1.23	7.35	4.65
90.86 cfs	90.86 cfs	800.12	3.15	3.477	2-M2c	3.50	2.10	2.10	1.27	7.53	4.74
96.54 cfs	96.54 cfs	800.26	3.29	3.620	7-M2c	3.50	2.17	2.17	1.31	7.71	4.82
102.23 cfs	102.23 cfs	800.41	3.43	3.765	7-M2c	3.50	2.24	2.24	1.35	7.88	4.90
107.92 cfs	107.92 cfs	800.55	3.57	3.913	7-M2c	3.50	2.30	2.30	1.39	8.06	4.98
113.61 cfs	113.61 cfs	800.71	3.71	4.065	7-M2c	3.50	2.36	2.36	1.43	8.23	5.06
119.30 cfs	119.30 cfs	800.86	3.85	4.224	7-M2c	3.50	2.42	2.42	1.47	8.41	5.13
124.99 cfs	124.99 cfs	801.03	4.00	4.393	7-M2c	3.50	2.48	2.48	1.50	8.58	5.20

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 796.64 ft,
Outlet Elevation (invert): 796.34 ft
Culvert Length: 60.20 ft,
Culvert Slope: 0.0050

Tailwater Data for Crossing: Culvert C7

Table 9 - Downstream Channel Rating Curve (Crossing: Culvert C7)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
68.10	796.69	1.09	4.35	0.68	0.84

73.79	796.74	1.14	4.46	0.71	0.84
79.48	796.78	1.18	4.56	0.74	0.85
85.17	796.83	1.23	4.65	0.77	0.85
90.86	796.87	1.27	4.74	0.79	0.86
96.54	796.91	1.31	4.82	0.82	0.86
102.23	796.95	1.35	4.90	0.84	0.86
107.92	796.99	1.39	4.98	0.87	0.87
113.61	797.03	1.43	5.06	0.89	0.87
119.30	797.07	1.47	5.13	0.92	0.87
124.99	797.10	1.50	5.20	0.94	0.88

Tailwater Channel Data - Culvert C7

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 10.00 ft
Side Slope (H:V): 4.00 (_:1)
Channel Slope: 0.0100
Channel Manning's n: 0.0300
Channel Invert Elevation: 795.60 ft

Roadway Data for Crossing: Culvert C7

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 50.00 ft
Crest Elevation: 802.50 ft
Roadway Surface: Gravel
Roadway Top Width: 60.00 ft

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow
Minimum Flow: 68.10 cfs
Design Flow: 68.10 cfs
Maximum Flow: 124.99 cfs

Table 10 - Summary of Culvert Flows at Crossing: Culvert C7

Headwater Elevation (ft)	Total Discharge (cfs)	C7 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
799.54	68.10	68.10	0.00	1
799.69	73.79	73.79	0.00	1
799.83	79.48	79.48	0.00	1
799.97	85.17	85.17	0.00	1
800.12	90.86	90.86	0.00	1
800.26	96.54	96.54	0.00	1
800.41	102.23	102.23	0.00	1
800.55	107.92	107.92	0.00	1
800.71	113.61	113.61	0.00	1
800.86	119.30	119.30	0.00	1
801.03	124.99	124.99	0.00	1
802.50	162.83	162.83	0.00	Overtopping

Culvert Data: C8

Site Data - C8

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 810.70 ft
Outlet Station: 85.63 ft
Outlet Elevation: 808.60 ft
Number of Barrels: 1

Culvert Data Summary - C8

Barrel Shape: Circular
Barrel Diameter: 1.00 ft
Barrel Material: Smooth HDPE
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge with Headwall
Inlet Depression: None

Table 6 - Culvert Summary Table: C8

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.96 cfs	0.96 cfs	811.27	0.57	0.315	1-JS1f	0.27	0.41	1.00	0.23	1.22	1.44
1.02 cfs	1.02 cfs	811.30	0.60	0.335	1-JS1f	0.28	0.43	1.00	0.24	1.30	1.47
1.09 cfs	1.09 cfs	811.32	0.62	0.356	1-JS1f	0.29	0.44	1.00	0.24	1.39	1.49
1.15 cfs	1.15 cfs	811.34	0.64	0.377	1-JS1f	0.30	0.45	1.00	0.25	1.47	1.52
1.22 cfs	1.22 cfs	811.37	0.67	0.399	1-JS1f	0.30	0.47	1.00	0.26	1.55	1.55
1.28 cfs	1.28 cfs	811.39	0.69	0.421	1-JS1f	0.31	0.48	1.00	0.27	1.63	1.57
1.34 cfs	1.34 cfs	811.41	0.71	0.444	1-JS1f	0.32	0.49	1.00	0.27	1.71	1.59
1.41 cfs	1.41 cfs	811.43	0.73	0.467	1-JS1f	0.33	0.50	1.00	0.28	1.79	1.61
1.47 cfs	1.47 cfs	811.45	0.75	0.492	1-JS1f	0.34	0.51	1.00	0.29	1.87	1.63
1.54 cfs	1.54 cfs	811.47	0.77	0.516	1-JS1f	0.34	0.53	1.00	0.29	1.96	1.65
1.60 cfs	1.60 cfs	811.49	0.79	0.542	1-JS1f	0.35	0.54	1.00	0.30	2.04	1.67

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 810.70 ft,
Outlet Elevation (invert): 808.60 ft
Culvert Length: 85.63 ft,
Culvert Slope: 0.0245

Tailwater Data for Crossing: Culvert C8

Table 11 - Downstream Channel Rating Curve (Crossing: Culvert C8)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
0.96	810.93	0.23	1.44	0.29	0.61
1.02	810.94	0.24	1.47	0.30	0.61
1.09	810.94	0.24	1.49	0.31	0.61

1.15	810.95	0.25	1.52	0.31	0.62
1.22	810.96	0.26	1.55	0.32	0.62
1.28	810.97	0.27	1.57	0.33	0.62
1.34	810.97	0.27	1.59	0.34	0.62
1.41	810.98	0.28	1.61	0.35	0.63
1.47	810.99	0.29	1.63	0.36	0.63
1.54	810.99	0.29	1.65	0.37	0.63
1.60	811.00	0.30	1.67	0.37	0.63

Tailwater Channel Data - Culvert C8

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 2.00 ft
Side Slope (H:V): 4.00 (_:1)
Channel Slope: 0.0200
Channel Manning's n: 0.0450
Channel Invert Elevation: 810.70 ft

Roadway Data for Crossing: Culvert C8

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 50.00 ft
Crest Elevation: 824.00 ft
Roadway Surface: Paved
Roadway Top Width: 24.00 ft

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow
Minimum Flow: 0.96 cfs
Design Flow: 0.96 cfs
Maximum Flow: 1.60 cfs

Table 12 - Summary of Culvert Flows at Crossing: Culvert C8

Headwater Elevation (ft)	Total Discharge (cfs)	C8 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
811.27	0.96	0.96	0.00	1
811.30	1.02	1.02	0.00	1
811.32	1.09	1.09	0.00	1
811.34	1.15	1.15	0.00	1
811.37	1.22	1.22	0.00	1
811.39	1.28	1.28	0.00	1
811.41	1.34	1.34	0.00	1
811.43	1.41	1.41	0.00	1
811.45	1.47	1.47	0.00	1
811.47	1.54	1.54	0.00	1
811.49	1.60	1.60	0.00	1
824.00	11.48	11.48	0.00	Overtopping

Culvert Data: C9

Site Data - C9

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 822.00 ft
Outlet Station: 36.70 ft
Outlet Elevation: 821.79 ft
Number of Barrels: 1

Culvert Data Summary - C9

Barrel Shape: Circular
Barrel Diameter: 1.00 ft
Barrel Material: Smooth HDPE
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge with Headwall
Inlet Depression: None

Table 9 - Culvert Summary Table: C9

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.22 cfs	0.22 cfs	822.26	0.26	0.072	1-JS1t	0.19	0.19	0.28	0.07	1.23	0.38
0.26 cfs	0.26 cfs	822.28	0.28	0.080	1-JS1t	0.20	0.21	0.29	0.08	1.39	0.41
0.30 cfs	0.30 cfs	822.31	0.31	0.088	1-JS1t	0.22	0.22	0.29	0.08	1.55	0.43
0.34 cfs	0.34 cfs	822.33	0.33	0.096	1-JS1t	0.23	0.24	0.30	0.09	1.71	0.45
0.38 cfs	0.38 cfs	822.35	0.35	0.104	1-S2n	0.24	0.25	0.24	0.10	2.56	0.47
0.42 cfs	0.42 cfs	822.36	0.36	0.112	1-JS1t	0.25	0.27	0.31	0.10	1.99	0.49
0.45 cfs	0.45 cfs	822.38	0.38	0.119	1-JS1t	0.27	0.28	0.32	0.11	2.13	0.51
0.49 cfs	0.49 cfs	822.40	0.40	0.127	1-JS1t	0.28	0.29	0.32	0.11	2.26	0.52
0.53 cfs	0.53 cfs	822.41	0.41	0.135	1-S2n	0.29	0.30	0.29	0.12	2.83	0.54
0.57 cfs	0.57 cfs	822.43	0.43	0.142	1-S2n	0.30	0.31	0.30	0.12	2.89	0.55
0.61 cfs	0.61 cfs	822.45	0.45	0.150	1-S2n	0.31	0.32	0.31	0.13	2.94	0.57

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 822.00 ft,
Outlet Elevation (invert): 821.79 ft
Culvert Length: 36.70 ft,
Culvert Slope: 0.0057

Tailwater Data for Crossing: Culvert C9

Table 17 - Downstream Channel Rating Curve (Crossing: Culvert C9)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
0.22	822.07	0.07	0.38	0.02	0.26
0.26	822.08	0.08	0.41	0.02	0.27
0.30	822.08	0.08	0.43	0.03	0.27

0.34	822.09	0.09	0.45	0.03	0.27
0.38	822.10	0.10	0.47	0.03	0.28
0.42	822.10	0.10	0.49	0.03	0.28
0.45	822.11	0.11	0.51	0.03	0.28
0.49	822.11	0.11	0.52	0.03	0.28
0.53	822.12	0.12	0.54	0.04	0.28
0.57	822.12	0.12	0.55	0.04	0.29
0.61	822.13	0.13	0.57	0.04	0.29

Tailwater Channel Data - Culvert C9

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 8.00 ft
Side Slope (H:V): 4.00 (_:1)
Channel Slope: 0.0050
Channel Manning's n: 0.0450
Channel Invert Elevation: 822.00 ft

Roadway Data for Crossing: Culvert C9

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 50.00 ft
Crest Elevation: 824.00 ft
Roadway Surface: Paved
Roadway Top Width: 24.00 ft

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow
Minimum Flow: 0.22 cfs
Design Flow: 0.22 cfs
Maximum Flow: 0.61 cfs

Table 18 - Summary of Culvert Flows at Crossing: Culvert C9

Headwater Elevation (ft)	Total Discharge (cfs)	C9 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
822.26	0.22	0.22	0.00	1
822.28	0.26	0.26	0.00	1
822.31	0.30	0.30	0.00	1
822.33	0.34	0.34	0.00	1
822.35	0.38	0.38	0.00	1
822.36	0.42	0.42	0.00	1
822.38	0.45	0.45	0.00	1
822.40	0.49	0.49	0.00	1
822.41	0.53	0.53	0.00	1
822.43	0.57	0.57	0.00	1
822.45	0.61	0.61	0.00	1
824.00	4.50	4.50	0.00	Overtopping

Culvert Data: C10

Site Data - C10

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 807.54 ft
Outlet Station: 99.86 ft
Outlet Elevation: 806.81 ft
Number of Barrels: 1

Culvert Data Summary - C10

Barrel Shape: Circular
Barrel Diameter: 2.00 ft
Barrel Material: Corrugated Steel
Embedment: 0.00 in
Barrel Manning's n: 0.0240
Culvert Type: Straight
Inlet Configuration: Thin Edge Projecting
Inlet Depression: None

Table 10 - Culvert Summary Table: C10

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
11.21 cfs	11.21 cfs	809.68	1.98	2.141	7-M2c	2.00	1.20	1.20	0.27	5.69	2.88
12.14 cfs	12.14 cfs	809.83	2.11	2.288	7-M2c	2.00	1.25	1.25	0.28	5.87	2.96
13.08 cfs	13.08 cfs	810.00	2.24	2.465	7-M2c	2.00	1.30	1.30	0.29	6.04	3.03
14.01 cfs	14.01 cfs	810.29	2.38	2.747	7-M2c	2.00	1.35	1.35	0.30	6.22	3.10
14.95 cfs	14.95 cfs	810.59	2.52	3.054	7-M2c	2.00	1.39	1.39	0.31	6.40	3.17
15.88 cfs	15.88 cfs	810.91	2.67	3.374	7-M2c	2.00	1.44	1.44	0.32	6.57	3.23
16.81 cfs	16.81 cfs	811.25	2.83	3.710	7-M2c	2.00	1.48	1.48	0.33	6.75	3.29
17.75 cfs	17.75 cfs	811.57	3.00	4.030	7-M2c	2.00	1.52	1.52	0.34	6.94	3.35
18.68 cfs	18.68 cfs	811.93	3.18	4.386	7-M2c	2.00	1.56	1.56	0.35	7.13	3.40
19.62 cfs	19.62 cfs	812.30	3.36	4.762	7-M2c	2.00	1.59	1.59	0.36	7.32	3.46
20.55 cfs	20.55 cfs	812.69	3.56	5.146	7-M2c	2.00	1.63	1.63	0.37	7.51	3.51

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 807.54 ft,
Outlet Elevation (invert): 806.81 ft
Culvert Length: 99.86 ft,
Culvert Slope: 0.0073

Tailwater Data for Crossing: Culvert C10

Table 19 - Downstream Channel Rating Curve (Crossing: Culvert C10)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
11.21	807.81	0.27	2.88	0.93	1.07
12.14	807.82	0.28	2.96	0.97	1.08
13.08	807.83	0.29	3.03	1.01	1.09

14.01	807.84	0.30	3.10	1.05	1.09
14.95	807.85	0.31	3.17	1.09	1.10
15.88	807.86	0.32	3.23	1.13	1.10
16.81	807.87	0.33	3.29	1.16	1.11
17.75	807.88	0.34	3.35	1.20	1.11
18.68	807.89	0.35	3.40	1.24	1.12
19.62	807.90	0.36	3.46	1.27	1.12
20.55	807.91	0.37	3.51	1.30	1.13

Tailwater Channel Data - Culvert C10

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 12.00 ft
Side Slope (H:V): 10.00 (_:1)
Channel Slope: 0.0560
Channel Manning's n: 0.0450
Channel Invert Elevation: 807.54 ft

Roadway Data for Crossing: Culvert C10

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 50.00 ft
Crest Elevation: 812.87 ft
Roadway Surface: Paved
Roadway Top Width: 24.00 ft

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow
Minimum Flow: 11.21 cfs
Design Flow: 11.21 cfs
Maximum Flow: 20.55 cfs

Table 20 - Summary of Culvert Flows at Crossing: Culvert C10

Headwater Elevation (ft)	Total Discharge (cfs)	C10 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
809.68	11.21	11.21	0.00	1
809.83	12.14	12.14	0.00	1
810.00	13.08	13.08	0.00	1
810.29	14.01	14.01	0.00	1
810.59	14.95	14.95	0.00	1
810.91	15.88	15.88	0.00	1
811.25	16.81	16.81	0.00	1
811.57	17.75	17.75	0.00	1
811.93	18.68	18.68	0.00	1
812.30	19.62	19.62	0.00	1
812.69	20.55	20.55	0.00	1
812.87	21.01	21.01	0.00	Overtopping

Culvert Data: C11

Site Data - C11

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 817.68 ft
Outlet Station: 56.00 ft
Outlet Elevation: 817.40 ft
Number of Barrels: 2

Culvert Data Summary - C11

Barrel Shape: Circular
Barrel Diameter: 2.50 ft
Barrel Material: Smooth HDPE
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge with Headwall
Inlet Depression: None

Table 11 - Culvert Summary Table: C11

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
26.46 cfs	26.46 cfs	819.47	1.79	1.298	1-S2n	1.13	1.22	1.13	1.08	6.11	1.99
28.28 cfs	28.28 cfs	819.55	1.87	1.367	1-S2n	1.17	1.27	1.18	1.12	6.21	2.03
30.09 cfs	30.09 cfs	819.62	1.94	1.438	1-S2n	1.22	1.31	1.22	1.15	6.31	2.06
31.91 cfs	31.91 cfs	819.69	2.01	1.509	1-S2n	1.26	1.35	1.26	1.19	6.41	2.10
33.73 cfs	33.73 cfs	819.76	2.08	1.581	1-S2n	1.30	1.39	1.31	1.23	6.50	2.13
35.55 cfs	35.55 cfs	819.83	2.15	1.654	1-S2n	1.34	1.43	1.35	1.26	6.58	2.17
37.36 cfs	37.36 cfs	819.90	2.22	1.728	1-S2n	1.39	1.46	1.39	1.29	6.66	2.20
39.18 cfs	39.18 cfs	819.97	2.29	1.803	1-S2n	1.43	1.50	1.43	1.32	6.74	2.23
41.00 cfs	41.00 cfs	820.04	2.36	1.880	1-S2n	1.47	1.54	1.47	1.36	6.81	2.25
42.81 cfs	42.81 cfs	820.11	2.43	1.958	1-S2n	1.51	1.57	1.51	1.39	6.88	2.28
44.63 cfs	44.63 cfs	820.18	2.50	2.037	1-S2n	1.55	1.61	1.56	1.42	6.94	2.31

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 817.68 ft,
Outlet Elevation (invert): 817.40 ft
Culvert Length: 56.00 ft,
Culvert Slope: 0.0050

Tailwater Data for Crossing: Culvert C11

Table 21 - Downstream Channel Rating Curve (Crossing: Culvert C11)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
26.46	818.76	1.08	1.99	0.34	0.39
28.28	818.80	1.12	2.03	0.35	0.39
30.09	818.83	1.15	2.06	0.36	0.40

31.91	818.87	1.19	2.10	0.37	0.40
33.73	818.91	1.23	2.13	0.38	0.40
35.55	818.94	1.26	2.17	0.39	0.40
37.36	818.97	1.29	2.20	0.40	0.40
39.18	819.00	1.32	2.23	0.41	0.40
41.00	819.04	1.36	2.25	0.42	0.40
42.81	819.07	1.39	2.28	0.43	0.41
44.63	819.10	1.42	2.31	0.44	0.41

Tailwater Channel Data - Culvert C11

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 8.00 ft
Side Slope (H:V): 4.00 (_:1)
Channel Slope: 0.0050
Channel Manning's n: 0.0450
Channel Invert Elevation: 817.68 ft

Roadway Data for Crossing: Culvert C11

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 50.00 ft
Crest Elevation: 821.40 ft
Roadway Surface: Paved
Roadway Top Width: 24.00 ft

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow
Minimum Flow: 26.46 cfs
Design Flow: 26.46 cfs
Maximum Flow: 44.63 cfs

Table 22 - Summary of Culvert Flows at Crossing: Culvert C11

Headwater Elevation (ft)	Total Discharge (cfs)	C11 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
819.47	26.46	26.46	0.00	1
819.55	28.28	28.28	0.00	1
819.62	30.09	30.09	0.00	1
819.69	31.91	31.91	0.00	1
819.76	33.73	33.73	0.00	1
819.83	35.55	35.55	0.00	1
819.90	37.36	37.36	0.00	1
819.97	39.18	39.18	0.00	1
820.04	41.00	41.00	0.00	1
820.11	42.81	42.81	0.00	1
820.18	44.63	44.63	0.00	1
821.40	70.72	70.72	0.00	Overtopping

Diversion Berm Sizing

Purpose:

To size the post closure diversion berms on the final cover to accommodate the 25-year, 24-hour storm event.

References:

1. WisDOT Facilities Development Manual Chapter 13, Section 30-15 - Grass Lined Channels.
2. Design of Roadside Channels with Flexible Linings, HEC-15, USDOT FHWA.
3. HydroCAD Report: COL_Mod12_HydroCAD Report
4. Wisconsin Department of Natural Resources Conservation Practice Standard 1053 - Channel Erosion Mat.

Approach:

Use the Post Closure HydroCAD Model results to obtain the peak flow during a 25-year, 24-hour storm event along the diversion berms.

Use Grass Lined Channel Design WisDOT Spreadsheet, FDM 13-30 Attachment 15.2 (from Reference #1) to size the swale for each design swale cross section. The WisDOT spreadsheet incorporates the design guidelines and equations described in "Design of Roadside Channels with Flexible Linings", HEC-15, USDOT FHWA (Reference #2).

Confirm the swale is stable and has enough capacity for the design flow rate.

Assumptions:

1. Assume the channel geometry is a v-notch swale with one sideslope at 4:1 and one sideslope at 2:1 and a depth of 2.0 ft.
2. Assume 2.0% slope along the flowpath of the diversion swale.
3. Assume the following parameters per Section 15.2 - Grass Lining Properties from Reference #1:
   Vegetation Retardance Class = C for Swales
   Vegetation Condition = Good
   Vegetation Growth Form = Turf
4. Assume cohesive soil type with ASTM Soil Class SC and a Plasticity Index (PI) of 16.

Calculations:

From the HydroCAD Report, the peak flow rate along the diversion berms are as follows:

Areas		Areas		Areas	
1	3.32 cfs	10	2.31 cfs	18	3.04 cfs
2	1.71 cfs	11	2.59 cfs	19	3.35 cfs
3	1.06 cfs	12	6.39 cfs	20	3.24 cfs
4	0.92 cfs	13	4.83 cfs	21	1.35 cfs
6	1.66 cfs	14	1.94 cfs	22	4.40 cfs
7	2.81 cfs	15	1.93 cfs	23	3.84 cfs
8	6.16 cfs	16	2.80 cfs	24	5.53 cfs
9	2.37 cfs	17	1.78 cfs		

Use highest flow to confirm diversion berm functions.

Use the Grass Swale Design Spreadsheet (Page 2) to determine the flow depth, velocity and shear stress in the swales.

Results:

The diversion berms are adequately designed to accommodate the flows from the 25-year, 24-hour storm event. The diversion berms are stable at the design flow rates. The design flow depth of 2.0 feet maintains at least 0.5 ft of freeboard during the 25-year, 24-hour storm event. Based on shear stress, use erosion mat Class I, Type B along the flow path of the diversion berms.

Channel/Ditch Geometry	*Area 12*
Channel Slope, S_o (ft/ft)	**0.02**
Channel Bottom Width, B (ft)	**0**
Channel Side Slope, z_1	**4**
Channel Side Slope, z_2	**2**
Flow Depth, d (ft) Solve iteratively	**1.02**
Safety Factor, SF	**1.0**
Vegetation/Soil Parameters	
Vegetation Retardance Class	**C**
Vegetation Condition	**good**
Vegetation Growth Form	**turf**
Soil Type	**cohesive**
D_{75} (in) (Set at 0.00 for cohesive soils)	
ASTM Soil Class	**SC**
Plasticity Index, PI	**16**
Results Summary	
Design Q (ft^3/s)	**6.4**
Calculated Q (ft^3/s)	6.5
Difference Between Design & Calc. Flow (%)	1.9%
Stable (Yes or No)	**YES**
Channel Parameters	
Vegetation Height, h (ft)	0.67
Grass Roughness Coefficient, C_n	0.238
Cover Factor, C_f	0.90
Noncohesive Soil	
Soil Grain Roughness, n_s	0.016
Permissible Soil Shear Stress, τ_p (lb/ft^2)	N/A
Cohesive Soil	
Porosity, e	0.35
Soil Coefficient 1, c_1	1.0700
Soil Coefficient 2, c_2	14.30
Soil Coefficient 3, c_3	47.700
Soil Coefficient 4, c_4	1.42
Soil Coefficient 5, c_5	-0.61
Soil Coefficient 6, c_6	0.00010
Permissible Soil Shear Stress, τ_p (lb/ft^2)	0.080
Total Permissible Shear Stress, τ_p (lb/ft^2)	0.080
Cross Sectional Area, A (ft^2)	3.121
Wetted Perimeter, P (ft)	6.49
Hydraulic Radius, R (ft)	0.481
Top Width, T (ft)	6.12
Hydraulic Depth, D (ft)	0.510
Froude Number (Q design)	0.515
Channel Shear Stress, τ_o (lb/ft^2)	0.60
Actual Sheer Stress, τ_d (lb/ft^2)	1.27
Mannings n	0.062
Average Velocity, V (ft/s)	2.05
Calculated Flow, Q (ft^3/s)	6.5
Difference Between Design & Calc. Flow (%)	1.9%
Effective Shear on Soil Surface, τ_e (lb/ft^2)	0.008
Total Permissible Shear on Veg., $\tau_{p,veg}$ (lb/ft^2)	12.03
Stable (Y or N)	YES

Source: Grass Lined Channel Design WisDOT Spreadsheet, FDM 13-30 Attachment 15.2

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Channel Erosion Mat

(1053)

Wisconsin Department of Natural Resources
Conservation Practice Standard

To differentiate applications WisDOT organizes erosion mats into three classes of mats, which are further broken down into various Types.

A. **Class I**: A short-term duration (minimum of 6 months), light duty, organic ECRM with plastic or biodegradable netting.

1. **Type A** – Only suitable for slope applications, not channel applications.

2. **Type B** – Double netted product for use in channels where the calculated (design) shear stress is 1.5 lbs/ft^2 or less.

B. **Class II**: A long-term duration (three years or greater), organic ECRM.

1. **Type A** – Jute fiber only for use in channels to reinforce sod.

2. **Type B** – For use in channels where the calculated (design) shear stress is 2.0 lbs/ft^2 or less. Made with plastic or biodegradable mat.

3. **Type C** – A woven mat of 100% organic material for use in channels where the calculated (design) shear stress is 2.0 lbs/ft^2 or less. Applicable for use in environmentally sensitive areas where plastic netting is inappropriate.

C. **Class III**: A permanent 100% synthetic ECRM or TRM. Class I, Type B erosion mat or Class II, Type B or C erosion mat must be placed over a soil filled TRM.

1. **Type A** – An ECRM for use in channels where the calculated (design) shear stress of 2.0 lbs/ft^2 or less.

2. **Type B** – A TRM for use in channels where the calculated (design) shear stress of 2.0 lbs/ft^2 or less.

3. **Type C** – A TRM for use in channels where the calculated (design) shear stress of 3.5 lbs/ft^2 or less.

4. **Type D** – A TRM for use in channels where the calculated (design) shear stress of 5.0 lbs/ft^2 or less.

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SCS ENGINEERS

		Sheet No.	1 of 5
		Calc. No.	
		Rev. No.	
Job No. 25222260.00	Project: Columbia Energy Center MOD 12	By: SJL	Date: 8/14/23
Client: WPL	Subject: Diversion Berm Spacing Calculation	Chk'd: RJG	Date: 8/18/23

Purpose:

Determine the spacing between diversion berms on the landfill final cover, with the goal of maintaining ≤ 3 ton/acre of soil loss along the final cover.

References

1. "Predicting Rainfall Erosion Losses," USDA Agriculture Handbook Number 537, 1978. (Figure 1 on Sheet 2 and Tables 10 and 13 on Sheet 4).
2. Erosion and Sediment Control Handbook," Goldman, Jackson, & Bursztynsky, 1986. (Table 5.5 on Sheet 5).
3. Rainfed retention probabilities computed for different cropping tillage systems. Agricultural Water Management, A.W. Mills & G.W. Thomas, 1985. Table 5.10 on Sheet 3)
4. Columbia Energy Center POO Update Drawings

Approach:

Use the Universal Soil Loss Equation (USLE) to determine diversion berm spacing.

USLE Equation: $A = R * K * LS * C * P$

where: A = Average annual soil loss, tons/acre
R = Rainfall and runoff erosivity index
K = Soil erodibility factor, tons/acre
LS = Slope length and steepness factor
C = Cover management factor
P = Practice factor

or $LS = \frac{A}{R \times K \times C \times P}$

Assumptions:

A =	3	tons/acre
R =	145	see Figure 1 on Sheet 2 (Reference #1)
K =	0.38	see Table 5.10 on Sheet 3 for Loamy Very Fine Sand (Reference #3)
C =	0.0064	see Table 10 on Sheet 4, assuming 90% cover (Reference #1)
P =	1.0	assume no support practice used

Calculation:

$$LS = \frac{A}{R \times K \times C \times P} = \frac{3}{145 \times 0.38 \times 0.0064 \times 1.0} = 8.51$$

From the LS Values Table (Sheet 5), based on the 4:1 final cover slope, the LS value of 8.51 fallso between the slope distance of 200 and 250 feet. Use linear interpolation between the LS values for 200 and 250 feet to determine the slope length value for the 4:1 slope.

Slope Length @ 200 ft LS= 8.33
Slope Length @ 250 ft LS= 9.31

Slope length for the calculate LS factor = 209 ft

Results:

The maximum distance between diversion berms along the final cover to maintain less than 3 tons/acre soil loss is 209 ft.

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SCS ENGINEERS

Sheet No.	2 of 5		
Calc. No.			
Rev. No.			
Job No. 25222260.00	Project: Columbia Energy Center MOD 12	By: SJL	Date: 8/14/23
Client: WPL	Subject: Diversion Berm Spacing Calculation	Chk'd: RJG	Date: 8/18/23

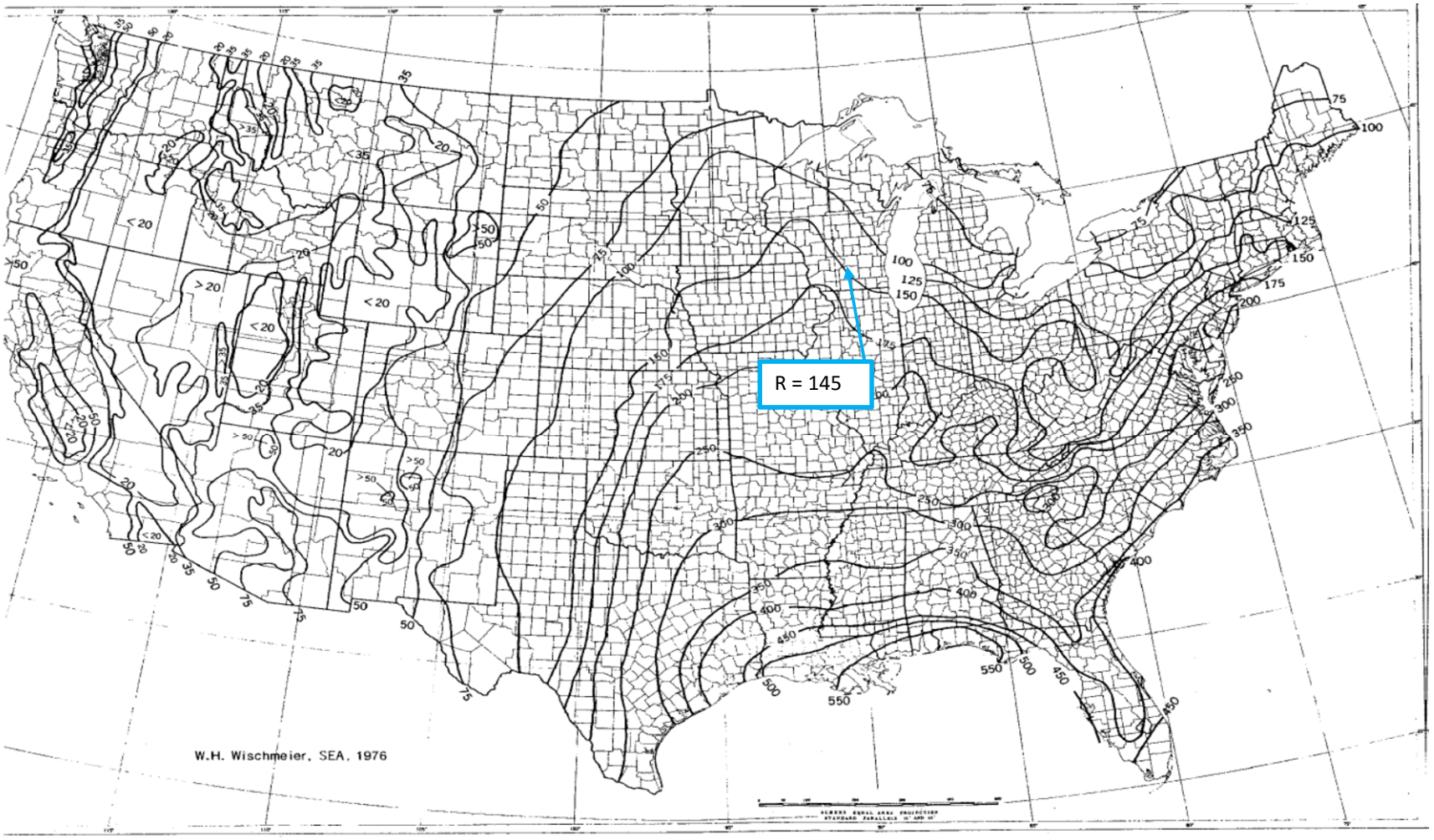

FIGURE 1.—Average annual values of the rainfall erosion index.

Source: "Predicting Rainfall Erosion Losses," USDA Agriculture Handbook Number 537, 1978.

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Table 5.10. Soil Erodibility Factor K_{fact} (after Stewart et al. 1975)[a]

	P_{om}(%)		
Textural Class	<0.5	2	4
Sand	0.05	0.03	0.02
Fine sand	0.16	0.14	0.10
Very finesand	0.42	0.36	0.28
Loamy sand	0.12	0.10	0.08
Loamy finesand	0.24	0.20	0.16
Loamy veryfine sand	0.44	0.38	0.30
Sandy loam	0.27	0.24	0.19
Fine sandyloam	0.35	0.30	0.24
Very fine sandy loam	0.47	0.41	0.33
Loam	0.38	0.34	0.29
Silt loam	0.48	0.42	0.33
Silt	0.60	0.52	0.42
Sandy clayloam	0.27	0.25	0.21
Clay loam	0.28	0.25	0.21
Silty clayloam	0.37	0.32	0.26
Sandy clay	0.14	0.13	0.12
Silty clay	0.25	0.23	0.19
Clay		0.13-0.2	

(a) The values shown are estimated averages of broad ranges of specific soil values. When a texture is near the border line of two texture classes, use the average of the two K_{fact} values.

In addition, the values shown are commensurate with the English units used in the cited reference (and as used in the source-term module input files). To obtain analagous values in the metric units used in this report, the above values should be multiplied by 1.292.

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TABLE 10.—*Factor* **C** *for permanent pasture, range, and idle land*[1]

Vegetative canopy		Cover that contacts the soil surface						
Type and height[2]	Percent cover[3]		Percent ground cover					
		Type[4]	0	20	40	60	80	95+
No appreciable canopy		G	0.45	0.20	0.10	0.042	0.013	0.003
		W	.45	.24	.15	.091	.043	.011
Tall weeds or short brush with average drop fall height of 20 in	25	G	.36	.17	.09	.038	.013	.003
		W	.36	.20	.13	.083	.041	.011
	50	G	.26	.13	.07	.035	.012	.003
		W	.26	.16	.11	.076	.039	.011
	75	G	.17	.10	.06	.032	.011	.003
		W	.17	.12	.09	.068	.038	.011
Appreciable brush or bushes, with average drop fall height of 6½ ft	25	G	.40	.18	.09	.040	.013	.003
		W	.40	.22	.14	.087	.042	.011
	50	G	.34	.16	.08	.038	.012	.003
		W	.34	.19	.13	.082	.041	.011
	75	G	.28	.14	.08	.036	.012	.003
		W	.28	.17	.12	.078	.040	.011
Trees, but no appreciable low brush. Average drop fall height of 13 ft	25	G	.42	.19	.10	.041	.013	.003
		W	.42	.23	.14	.089	.042	.011
	50	G	.39	.18	.09	.040	.013	.003
		W	.39	.21	.14	.087	.042	.011
	75	G	.36	.17	.09	.039	.012	.003
		W	.36	.20	.13	.084	.041	.011

[1] The listed **C** values assume that the vegetation and mulch are randomly distributed over the entire area.

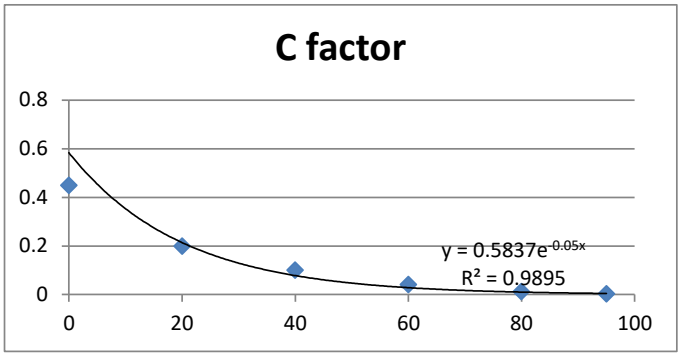
[2] Canopy height is measured as the average fall height of water drops falling from the canopy to the ground. Canopy effect is inversely proportional to drop fall height and is negligible if fall height exceeds 33 ft.

[3] Portion of total-area surface that would be hidden from view by canopy in a vertical projection (a bird's-eye view).

[4] G: cover at surface is grass, grasslike plants, decaying compacted duff, or litter at least 2 in deep.
W: cover at surface is mostly broadleaf herbaceous plants (as weeds with little lateral-root network near the surface) or undecayed residues or both.

Interpolated value
C = 0.0064

Source: "Predicting Rainfall Erosion Losses," USDA Agriculture Handbook Number 537, 1978.



= 90 % cover 0.0065

TABLE 5.5 LS Values* (10)

Slope ratio	Slope gradient s, %	LS values for following slope lengths l, ft (m)									
		10 (3.0)	20 (6.1)	30 (9.1)	40 (12.2)	50 (15.2)	60 (18.3)	70 (21.3)	80 (24.4)	90 (27.4)	100 (30.5)
	0.5	0.06	0.07	0.07	0.08	0.08	0.09	0.09	0.09	0.09	0.10
100:1	1	0.08	0.09	0.10	0.10	0.11	0.11	0.12	0.12	0.12	0.12
	2	0.10	0.12	0.14	0.15	0.16	0.17	0.18	0.19	0.19	0.20
	3	0.14	0.18	0.20	0.22	0.23	0.25	0.26	0.27	0.28	0.29
	4	0.16	0.21	0.25	0.28	0.30	0.33	0.35	0.37	0.38	0.40
20:1	5	0.17	0.24	0.29	0.34	0.38	0.41	0.45	0.48	0.51	0.53
	6	0.21	0.30	0.37	0.43	0.48	0.52	0.56	0.60	0.64	0.67
	7	0.26	0.37	0.45	0.52	0.58	0.64	0.69	0.74	0.78	0.82
12½:1	8	0.31	0.44	0.54	0.63	0.70	0.77	0.83	0.89	0.94	0.99
	9	0.37	0.52	0.64	0.74	0.83	0.91	0.98	1.05	1.11	1.17
10:1	10	0.43	0.61	0.75	0.87	0.97	1.06	1.15	1.22	1.30	1.37
	11	0.50	0.71	0.86	1.00	1.12	1.22	1.32	1.41	1.50	1.58
8:1	12.5	0.61	0.86	1.05	1.22	1.36	1.49	1.61	1.72	1.82	1.92
	15	0.81	1.14	1.40	1.62	1.81	1.98	2.14	2.29	2.43	2.56
6:1	16.7	0.96	1.36	1.67	1.92	2.15	2.36	2.54	2.72	2.88	3.04
5:1	20	1.29	1.82	2.23	2.58	2.88	3.16	3.41	3.65	3.87	4.08
4½:1	22	1.51	2.13	2.61	3.02	3.37	3.69	3.99	4.27	4.53	4.77
4:1	25	1.86	2.63	3.23	3.73	4.16	4.56	4.93	5.27	5.59	5.89
	30	2.51	3.56	4.36	5.03	5.62	6.16	6.65	7.11	7.54	7.95
3:1	33.3	2.98	4.22	5.17	5.96	6.67	7.30	7.89	8.43	8.95	9.43
	35	3.23	4.57	5.60	6.46	7.23	7.92	8.55	9.14	9.70	10.22
2⅔:1	40	4.00	5.66	6.93	8.00	8.95	9.80	10.59	11.32	12.00	12.65
	45	4.81	6.80	8.33	9.61	10.75	11.77	12.72	13.60	14.42	15.20
2:1	50	5.64	7.97	9.76	11.27	12.60	13.81	14.91	15.94	16.91	17.82
	55	6.48	9.16	11.22	12.96	14.48	15.87	17.14	18.32	19.43	20.48
1¾:1	57	6.82	9.64	11.80	13.63	15.24	16.69	18.03	19.28	20.45	21.55
	60	7.32	10.35	12.68	14.64	16.37	17.93	19.37	20.71	21.96	23.15
1½:1	66.7	8.44	11.93	14.61	16.88	18.87	20.67	22.32	23.87	25.31	26.68
	70	8.98	12.70	15.55	17.96	20.08	21.99	23.75	25.39	26.93	28.39
	75	9.78	13.83	16.94	19.56	21.87	23.95	25.87	27.66	29.34	30.92
1¼:1	80	10.55	14.93	18.28	21.11	23.60	25.85	27.93	29.85	31.66	33.38
	85	11.30	15.98	19.58	22.61	25.27	27.69	29.90	31.97	33.91	35.74
	90	12.02	17.00	20.82	24.04	26.88	29.44	31.80	34.00	36.06	38.01
	95	12.71	17.97	22.01	25.41	28.41	31.12	33.62	35.94	38.12	40.18
1:1	100	13.36	18.89	23.14	26.72	29.87	32.72	35.34	37.78	40.08	42.24

Slope ratio	Slope gradient s, %	LS values for following slope lengths l, ft (m)																			
		150 (46)	200 (61)	250 (76)	300 (91)	350 (107)	400 (122)	450 (137)	500 (152)	600 (183)	700 (213)	800 (244)	900 (274)	1000 (305)
	0.5	0.10	0.11	0.11	0.12	0.12	0.13	0.13	0.13	0.14	0.14	0.14	0.15	0.15
100:1	1	0.14	0.14	0.15	0.16	0.16	0.16	0.17	0.17	0.18	0.18	0.19	0.19	0.20
	2	0.23	0.25	0.26	0.28	0.29	0.30	0.32	0.33	0.34	0.36	0.37	0.39	0.40
	3	0.32	0.35	0.38	0.40	0.42	0.43	0.45	0.46	0.49	0.51	0.54	0.55	0.57
	4	0.47	0.53	0.58	0.62	0.66	0.70	0.73	0.76	0.82	0.87	0.92	0.96	1.00
20:1	5	0.66	0.76	0.85	0.93	1.00	1.07	1.13	1.20	1.31	1.42	1.51	1.60	1.69
	6	0.82	0.95	1.06	1.16	1.26	1.34	1.43	1.50	1.65	1.78	1.90	2.02	2.13
	7	1.01	1.17	1.30	1.43	1.54	1.65	1.75	1.84	2.02	2.18	2.33	2.47	2.61
12½:1	8	1.21	1.40	1.57	1.72	1.85	1.98	2.10	2.22	2.43	2.62	2.80	2.97	3.13
	9	1.44	1.66	1.85	2.03	2.19	2.35	2.49	2.62	2.87	3.10	3.32	3.52	3.71
10:1	10	1.68	1.94	2.16	2.37	2.56	2.74					3.87	4.11	4.33
	11	1.93	2.23	2.50	2.74	2.95	3					4.47	4.74	4.99
8:1	12.5	2.35	2.72	3.04	3.33	3.59	3					5.43	5.76	6.08
	15	3.13	3.62	4.05	4.43	4.79	5					7.24	7.68	8.09
6:1	16.7	3.72	4.30	4.81	5.27	5.69	6					8.60	9.12	9.62
5:1	20	5.00	5.77	6.45	7.06	7.63	8.16	8.65	9.12	9.99	10.79	11.54	12.24	12.90
4½:1	22	5.84	6.75	7.54	8.26	8.92	9.54	10.12	10.67	11.68	12.62	13.49	14.31	15.08
4:1	25	7.21	8.33	9.31	10.20	11.02	11.78	12.49	13.17	14.43	15.58	16.66	17.67	18.63
	30	9.74	11.25	12.57	13.77	14.88	15.91	16.87	17.78	19.48	21.04	22.49	23.86	25.15
3:1	33.3	11.55	13.34	14.91	16.33	17.64	18.86	20.00	21.09	23.10	24.95	26.67	28.29	29.82
	35	12.52	14.46	16.16	17.70	19.12	20.44	21.68	22.86	25.04	27.04	28.91	30.67	32.32
2⅔:1	40	15.50	17.89	20.01	21.91	23.67	25.30	26.84	28.29	30.99	33.48	35.79	37.96	40.01
	45	18.62	21.50	24.03	26.33	28.44	30.40	32.24	33.99	37.23	40.22	42.99	45.60	48.07
2:1	50	21.83	25.21	28.18	30.87	33.34	35.65	37.81	39.85	43.66	47.16	50.41	53.47	56.36
	55	25.09	28.97	32.39	35.48	38.32	40.97	43.45	45.80	50.18	54.20	57.94	61.45	64.78
1¾:1	57	26.40	30.48	34.08	37.33	40.32	43.10	45.72	48.19	52.79	57.02	60.96	64.66	68.15
	60	28.35	32.74	36.60	40.10	43.31	46.30	49.11	51.77	56.71	61.25	65.48	69.45	73.21
1½:1	66.7	32.68	37.74	42.19	46.22	49.92	53.37	56.60	59.66	65.36	70.60	75.47	80.05	84.38
	70	34.77	40.15	44.89	49.17	53.11	56.78	60.23	63.48	69.54	75.12	80.30	85.17	89.78
	75	37.87	43.73	48.89	53.56	57.85	61.85	65.60	69.15	75.75	81.82	87.46	92.77	97.79
1¼:1	80	40.88	47.20	52.77	57.81	62.44	66.75	70.80	74.63	81.76	88.31	94.41	100.13	105.55
	85	43.78	50.55	56.51	61.91	66.87	71.48	75.82	79.92	87.55	94.57	101.09	107.23	113.03
	90	46.55	53.76	60.10	65.84	71.11	76.02	80.63	84.99	93.11	100.57	107.51	114.03	120.20
	95	49.21	56.82	63.53	69.59	75.17	80.36	85.23	89.84	98.42	106.30	113.64	120.54	127.06
1:1	100	51.74	59.74	66.79	73.17	79.03	84.49	89.61	94.46	103.48	111.77	119.48	126.73	133.59

Interpolate with

*Calculated from

$$LS = \left(\frac{65.41 \times s^2}{s^2 + 10{,}000} + \frac{4.56 \times s}{\sqrt{s^2 + 10{,}000}} + 0.065\right)\left(\frac{l}{72.5}\right)^m$$

LS = topographic factor
l = slope length, ft (m × 0.3048)
s = slope steepness,
m = exponent dependent upon slope steep
(0.2 for slopes < 1%, 0.3 for slopes 1 t
0.4 for slopes 3.5 to 4.5%, and
0.5 for slopes > 5%)

FROM "EROSION & SEDIMENT CONTROL HANDBOOK", Goldman, Jackson, + Bursztynsky, 1986

5.20 5.21

Source: Erosion and Sediment Control Handbook," Goldman, Jackson, & Bursztynsky, 1986.

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Downslope Flume & Energy Dissipator Sizing

SCS ENGINEERS

		Sheet No:	1 of 4
		Calc. No.	
		Rev. No.	2
Job No. 25222260.00	Project: Columbia Energy Center MOD 12	By: SJL	Date: 8/28/23
Client: WPL	Subject: Downslope Pipe and Inlet Sizing	Chk'd: RJG	Date: 8/28/23

Purpose:

To size the downslope pipe and inlet to accommodate the 25-year, 24-hour storm event.

References:

1. HydroCAD Report: COL_Mod12_HydroCAD Report

Approach:

Use the orifice equation to size the downslope pipe inlet. Size the inlet for the largest diversion berm flow rate and apply that inlet size to all downslope pipe inlets. Confirm the head (h) acting on the orifice will not overtop the diversion berm depth of 2.0 ft.

Use Manning's equation to size the downslope pipe based on the largest diversion berm flow rate. Confirm the pipe has capacity for the design flow under open channel flow conditions.

Assumptions:

1. Orifice coefficient = 0.63
2. Assume the orifice head (h) acts on the centerline of the inlet pipe.
3. Manning's n = 0.012 (For smooth walled HDPE pipe: http://www.engineeringtoolbox.com/mannings-roughness-d_799.html)
4. Size flumes under the vegetated cover condition.

From the HydroCAD Report (Reference 1) , the peak discharge to each downslope flume resulting from a 25-year, 24-hour storm is as follows*:

Flume 1		**Flume 2**		**Flume 3 Existing)**		**Flume 4 (Existing)**		**Flume 5 (Existing)**	
Area 1	3.32	Area 3	1.06						
Area 2	1.71	Area 4	0.92						
Area 13	4.83	Area 15	1.93						
Area 14	1.94	Area 16	2.80						
Total =	11.80		6.71		0		0		0

Flume 6		**Flume 7**		**Flume 8**		**Flume 9**		**Flume 10**	
Area 6	1.66	Area 8	6.16	Area 10	2.31	Area 11	2.59	Area 27	0.52
Area 7	2.81	Area 9	2.37	Area 21	1.35	Area 12	6.39	Area 28	0.44
Area 17	1.78	Area 19	3.62	Area 22	4.40	Area 23	3.84		
Area 18	3.04	Area 20	3.24			Area 24	5.53		
Total =	9.29	Total =	15.39	Total =	8.06	Total =	18.35	Total =	0.96

** Please note that the total flow rate at each flume calculated above may not reflect the flow rate shown in the HydroCAD Model due to the inflow to the flume occuring at different times during the storm event. The calculation above reflects the peak flow rate.*

Results:

Based on the inlet sizing calculation, an 18" diameter inlet will convey the stormwater runoff from the largest flow rate to an inlet (Area 12).

Based on the Manning's calculation for flow within the pipe, the 12" diameter downslope pipe will accommodate the design flow for Flumes under open channel flow conditions. Although the flow for the downslope pipes can be handled by 12" dia. pipes, for ease of construction, all downslope pipes will be 18" dia with the exception of Flume 10.
Flume 10 will be constructed with a 12" dia pipe based on the drainage area and anticipated flow rate.

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Calculations:

Size the downslope pipe inlet:

From the HydroCAD report (Reference #1), the maximum 25-year, 24-hour flow along a diversion berm is 6.39 cfs
in HydroCAD model). Area 12 Inlet

Orifice Equation: $Q = C * A * (2 * g * h)^{0.5}$

where: Q = flow rate (cfs) = 6.39 (From above)
C = orifice coefficient = 0.63 (See assumption #1)
A = orifice area (sf) = 1.77 (area of 18" diameter pipe) Actual Pipe Diameter = 18 inches
g = gravity (ft/sec^2)= 32
h = orifice head acting on centerline (ft)
$h = (Q/(C * A))^2/(2 * g)$ = 0.5 ft
Given Assumption #2, depth of flow along diversion berm = h + D/2/12 = 1.26 ft = 15.1 inches

The diversion swale depth of 2 ft is sufficient to prevent overtopping at the downslope pipe inlet locations. The depth of the diversion berm increases at the entrance of the down slope pipes due to mounding of the soil over the pipe.

Size the downslope flume pipe:

Use Manning's equation to size the downslope pipe.

Manning's Equation: Q = (1.49/n) x A x R^(2/3) x S^(1/2)
where: Q = Flow Rate, cfs
n = Manning's Roughness Coefficient
A = Flow Area, sf
R = Hydraulic Radius, ft (= A/P)
S = Channel Slope, ft/ft

For flow rates < 20 cfs, assume a 12" diameter downslope flume:

Use 18.35 cfs to Flume 9 to check sizing (max flow to a flume that is < 20 cfs)

Design Criteria

Pipe Diameter (in) = D = 12
Pipe Slope (ft/ft) = S = 0.25
Manning's Roughness Coefficient = n = 0.012

See Downslope Flume 7 pipe flow calculator on Sheet 3

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Calculations (Continued): **Flume 9** **18.35**

Manning Formula Uniform Pipe Flow at Given Slope and Depth

Inputs:

Pipe Diameter, d_o	12	in
Manning Roughness, n	0.0120	
Pressure slope (possibly equal to pipe slope), S_o	0.2500	slope
Percent of (or ratio to) full depth (100% or 1 if flowing full)	0.7788	fraction

Results:

Flow, Q	18.3513	ft^3/s
Velocity, v	27.9622	ft/s
Velocity head, hv	12.1517	ft
Flow Area, A	0.6563	ft^2
Wetted Perimeter, P	2.1623	ft
Hydraulic Radius	0.3035	ft
Top Width, T	0.8301	ft
Froude Number, F	5.63	
Shear Stress (tractive force), τ	12.1539	psf

Version 2.0 (20 June 2017)

HawsEDC Calculators

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Calculations (Continued): **Flume 9** **18.35**

Manning Formula Uniform Pipe Flow at Given Slope and Depth

Inputs:

Pipe Diameter, d_o	18	in
Manning Roughness, n	0.0120	
Pressure slope (possibly equal to pipe slope), S_o	0.2500	slope
Percent of (or ratio to) full depth (100% or 1 if flowing full)	0.3906	fraction

Results:

Flow, Q	18.3546	ft^3/s
Velocity, v	28.7059	ft/s
Velocity head, hv	12.8066	ft
Flow Area, A	0.6394	ft^2
Wetted Perimeter, P	2.0253	ft
Hydraulic Radius	0.3157	ft
Top Width, T	1.4637	ft
Froude Number, F	7.77	
Shear Stress (tractive force), τ	9.1435	psf

Version 2.0 (20 June 2017)

HawsEDC Calculators

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SCS ENGINEERS

Sheet No. 1 of 7			
Calc. No.			
Rev. No.			
Job No. 25222260.00	Project: Columbia Energy Center MOD 12	By: SJL	Date: 8/28/23
Client: WPL	Subject: Energy Dissipator Sizing	Chk'd: RJG	Date: 8/28/23

Purpose:

To size an energy dissipator structure and riprap apron at the outlet of the downslope flume pipes.

References:

1. "Hydraulic Design of Energy Dissipators for Culverts and Channels," HEC-14, Third Edition, July 2006, USDOT FHWA.
2. Downslope Pipe and Inlet Sizing calculation (for pipe size, flow rate, and pipe velocity).
3. HydroCAD Report: COL_Mod12_HydroCAD Report
4. Facilities Development Manual Chapter 13, Section 13-30 - Rock Riprap Lined Chutes.
5. WisDOT FDM Table 25.1

Approach:

Use the downslope pipe outlet velocity to size an energy dissipator structure (USBR Type VI Impact Basin) following the design approach outlined in Section 9.4 of Reference #1.

Use Rock Chute Data Spreadsheet, FDM 13-30-30 Attachment 30.1 (from Reference #5) to design the rock chute.

For construction purposes use the maximum flow to size all dissipators and riprap apron.

Assumptions:

1. Riprap specific gravity = 2.65
2. From the HydroCAD Report, the 25-year, 24-hour peak discharge to each downslope flume is as follows*:

Flume 1		**Flume 2**		**Flume 3 Existing)**		**Flume 4 (Existing)**		**Flume 5 (Existing)**	
Area 1	3.32	Area 3	1.06						
Area 2	1.71	Area 4	0.92						
Area 13	4.83	Area 15	1.93						
Area 14	1.94	Area 16	2.80						
Total =	11.80		6.71		0		0		0

Flume 6		**Flume 7**		**Flume 8**		**Flume 9**		**Flume 10**
Area 6	1.66	Area 8	6.16	Area 10	2.31	Area 11	2.59	This flume discharges directly into a concrete catch basin at the toe of slope, therefore, no energy dissipator is needed.
Area 7	2.81	Area 9	2.37	Area 21	1.35	Area 12	6.39	
Area 17	1.78	Area 19	3.62	Area 22	4.40	Area 23	3.84	
Area 18	3.04	Area 20	3.24			Area 24	5.53	
Total =	9.29	Total =	15.39	Total =	8.06	Total =	18.35	

** Please note that the total flow rate at each flume calculated above may not reflect the flow rate shown in the HydroCAD Model due to the inflow to the flume occuring at different times during the storm event. The calculation above reflects the peak flow rate.*

Using Figure 9.14 (See Sheet 4), enter the Froude Number and the Energy from Step 2 to determine the from the downslope flume pipe and inlet sizing calculation.

Results:

The energy dissipator structures for the 18" dia. downslope flume pipes will consist of dissipator structures with widths (W_B) of 6 feet, with the remaining dimensions from Table 9.2 on Sheets 5 and 6.

Riprap at the Flume energy dissipator outlets will consist of WisDOT Select Crush Material (D50= 2.2 inches) (See Page 3). The riprap apron footprint will be based on the energy dissipator width, the outlet swale geometry, and as shown on the Plan Set.

Calculations:

For 18" dia. downslope flume pipes

From Reference #2:

Flow rate (Q) = 18.35 cfs

Pipe velocity (V) = 28.7 ft/s

Flow area (A) = Q/V = 0.64 sf

Design procedure from pg. 9-40 of Reference #1:

Step 1: Compute the Equivalent Depth of Flow Entering Dissipator:

$Y_e = (A/2)^{1/2}$ where: Ye = Equivalent depth

A = Area (from above)

Y_e = 0.57 ft

Step 2: Compute the Froude Number and the energy at the end of the pipe:

$Fr = V/[(g*Y_e)^{1/2}]$ where: Fr = Froude Number

V = Velocity (from above)

g = Gravity constant (32.2 ft/sec^2)

Fr = 6.7 Y_e = Equivalent depth (from Step 1 above)

$H_o = Y_e+V^2/2g$ where: H_o = Energy at the end of the pipe

Y_e = Equivalent depth (from above)

V = Velocity (from above)

Ho = 13.4 ft g = Gravity constant (32.2 ft/sec^2)

Step 3: Determine H_e/W_B and calculate the required width of the energy dissipator:

Using Figure 9.14 (See Sheet 4), enter the Froude Number and the Energy from Step 2 to determine the width of the energy dissipator.

From Figure 9.14, H_o/W_B = 2.55

$W_B = H_o/(H_o/W_B)$ W_B = 5.2 ft.

Use W_B = 6.0 ft.

Step 4: Obtain the remaining energy dissipator dimensions from Table 9.2 from Reference #1 (see Sheets 5 and 6)

Step 5: Size the riprap at the structure outlet

From Reference #5, use Rock Chute Design spreadsheet (see Sheet 3)

Calculations:

Step 5: Determine the exit velocity from the energy dissiaptor structure and size the riprap apron at the structure outlet.

Use the relationship:

$H_B = Q/(W_B \times V_B) + V_B^2 / 2g = H_o \times (1-H_L/H_o)$

Where:

Q = 18.4 cfs, flowrate
W_B = 6.0 ft, width of energy dissipator
g = 32.2 ft/s^2, gravity
H_O 13.4 Energy at end of pipe
H_L/H_O 75 %, Energy loss (From Figure 9.15 from Reference #1, see Sheet 3)
V_B = Velocity at exit of dissipator (ft/s)
HB = Energy at exit of dissipator (ft)

Calculate HB using the second part of the equation:

$H_B = H_o \times (1-H_L/H_o)$

H_B = 3.41 ft

Using trial and error, select values for V_B and use the first part of the equation to calculate H_B:

Try V_B = 1.255 ft/s H_B = 3.41 ft

Based on the energy dissipator structure exit velocity, calculate the riprap size at the dissipator outlet.

From Equation 10.6 from Reference #1:

$D_{50} = (0.692 / (S-1)) \times (V^2/2g)$

Where:

S = 2.65 Specific gravity (See Assumption #1)
V = 1.26 Velocity = V_B from above.
D_{50} = riprap size

$D_{50\ Calc'd}$ = 0.010 feet

Round the calculated D_{50} up to the nearest IDOT standard riprap size:

$D_{50\ Design}$ = 0.18 feet Use = Select Crushed Material with geotextile Type R

Riprap Type	D_{50} (inches)	D_{50} (feet)	Riprap Thickness (in)	Geotextile Type
Select Crushed Material	2.2	0.18	5	Type R
Light Riprap	10	0.83	12	Type R
Medium Riprap	12.5	1.04	18	Type HR
Heavy Riprap	16	1.33	24	Type HR
Extra-Heavy Riprap	20	1.67	30	Type HR

from Reference 5

09/28/2023 - Classification: Internal - ECRM13153872

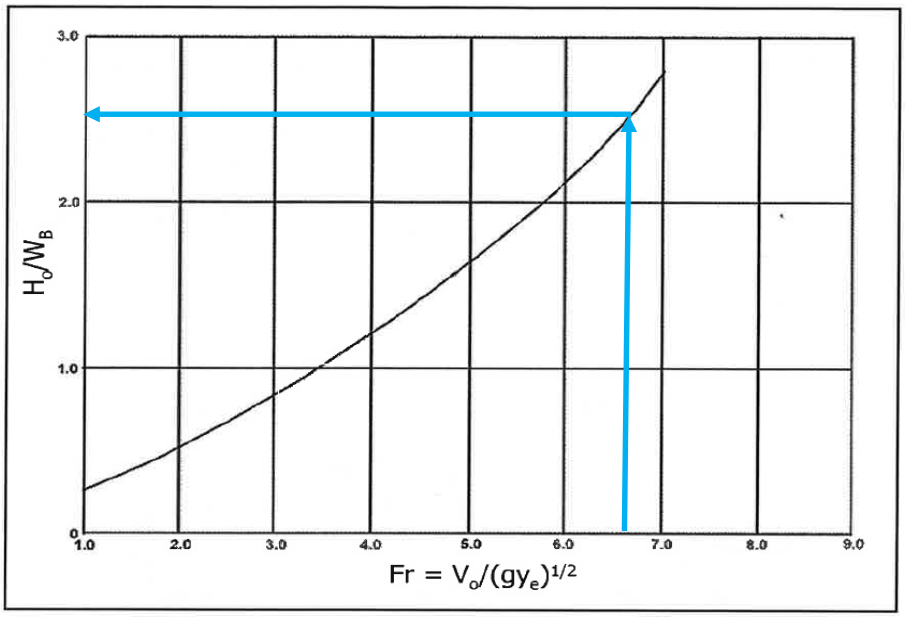


Figure 9.14. Design Curve for USBR Type VI Impact Basin

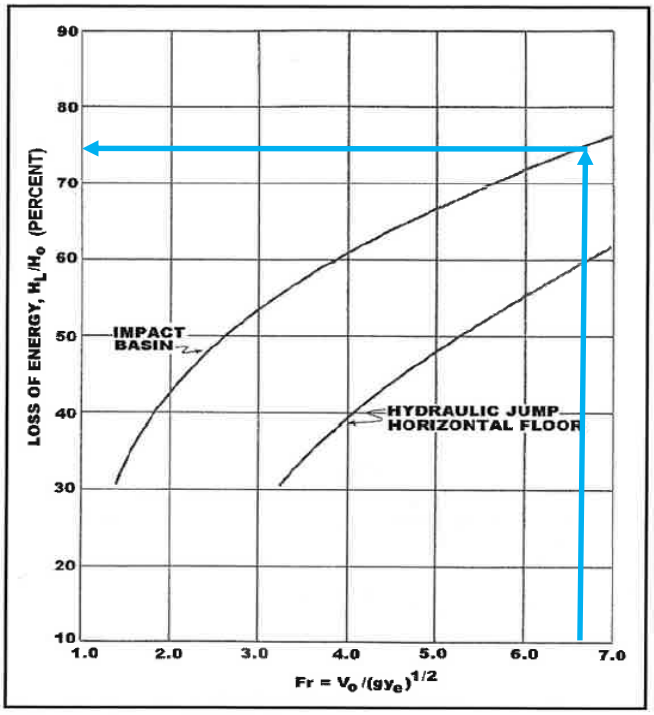


Figure 9.15. Energy Loss of USBR Type VI Impact Basin versus Hydraulic Jump

09/28/2023 Classification: Internal - ECRM13153872
Calc_Draft

Table 9.2 (CU). USBR Type VI Impact Basin Dimensions (ft) (AASHTO, 2005)

W_B	h_1	h_2	h_3	h_4	L	L_1	L_2
4.	3.08	1.50	0.67	1.67	5.42	2.33	3.08
5.	3.83	1.92	0.83	2.08	6.67	2.92	3.83
6.	4.58	2.25	1.00	2.50	8.00	3.42	4.58
7.	5.42	2.58	1.17	2.92	9.42	4.00	5.42
8.	6.17	3.00	1.33	3.33	10.67	4.58	6.17
9.	6.92	3.42	1.50	3.75	12.00	5.17	6.92
10.	7.58	3.75	1.67	4.17	13.42	5.75	7.67
11.	8.42	4.17	1.83	4.58	14.58	6.33	8.42
12.	9.17	4.50	2.00	5.00	16.00	6.83	9.17
13.	10.17	4.92	2.17	5.42	17.33	7.42	10.00
14.	10.75	5.25	2.33	5.83	18.67	8.00	10.75
15.	11.50	5.58	2.50	6.25	20.00	8.50	11.50
16.	12.25	6.00	2.67	6.67	21.33	9.08	12.25
17.	13.00	6.33	2.83	7.08	21.50	9.67	13.00
18.	13.75	6.67	3.00	7.50	23.92	10.25	13.75
19.	14.58	7.08	3.17	7.92	25.33	10.83	14.58
20.	15.33	7.50	3.33	8.33	26.58	11.42	15.33

W_B	W_1	W_2	t_1	t_2	t_3	t_4	t_5
4.	0.33	1.08	0.50	0.50	0.50	0.50	0.25
5.	0.42	1.42	0.50	0.50	0.50	0.50	0.25
6.	0.50	1.67	0.50	0.50	0.50	0.50	0.25
7.	0.50	1.92	0.50	0.50	0.50	0.50	0.25
8.	0.58	2.17	0.50	0.58	0.58	0.50	0.25
9.	0.67	2.50	0.58	0.58	0.67	0.58	0.25
10.	0.75	2.75	0.67	0.67	0.75	0.67	0.25
11.	0.83	3.00	0.67	0.75	0.75	0.67	0.33
12.	0.92	3.00	0.67	0.83	0.83	0.75	0.33
13.	1.00	3.00	0.67	0.92	0.83	0.83	0.33
14.	1.08	3.00	0.67	1.00	0.92	0.92	0.42
15.	1.17	3.00	0.67	1.00	1.00	1.00	0.42
16.	1.25	3.00	0.75	1.00	1.00	1.00	0.50
17.	1.33	3.00	0.75	1.08	1.00	1.00	0.50
18.	1.33	3.00	0.75	1.08	1.08	1.08	0.58
19.	1.42	3.00	0.83	1.17	1.08	1.08	0.58
20.	1.50	3.00	0.83	1.17	1.17	1.17	0.67

Classification: Internal - ECRM13153872

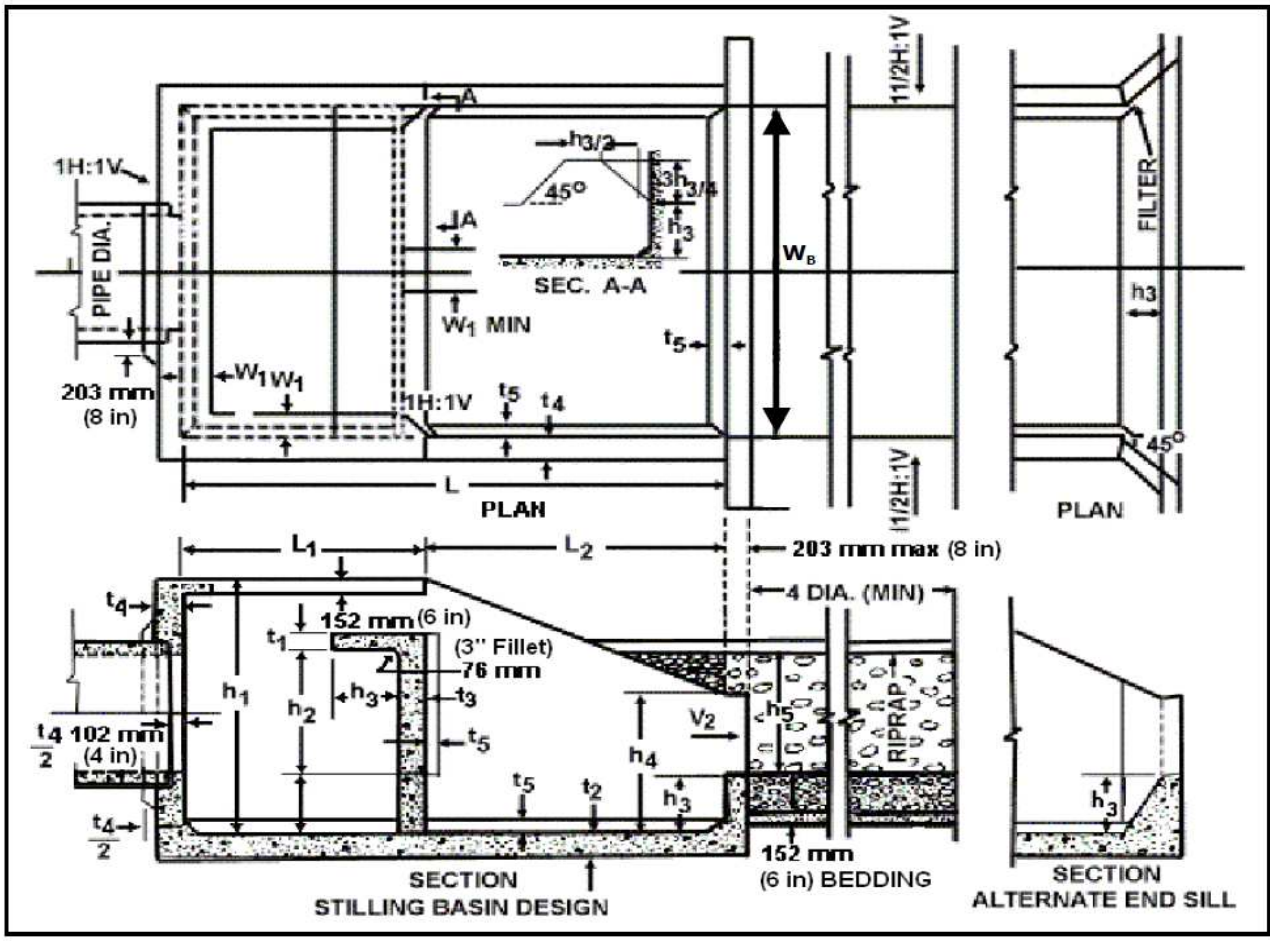


Figure 9.13. USBR Type VI Impact Basin

Classification: Internal - ECRM13153872

Calculations (Continued):

Downslope Flume 9 - Velocity Calculator (Q = 18.35 cfs)

Manning Formula Uniform Pipe Flow at Given Slope and Depth

Inputs:

Pipe Diameter, d_o	18	in
Manning Roughness, n	0.0120	
Pressure slope (possibly equal to pipe slope), S_o	0.2500	slope
Percent of (or ratio to) full depth (100% or 1 if flowing full)	0.3906	fraction

Results:

Flow, Q	18.3546	ft^3/s
Velocity, v	28.7059	ft/s
Velocity head, hv	153.6794	in
Flow Area, A	0.6394	ft^2
Wetted Perimeter, P	2.0253	ft
Hydraulic Radius	0.3157	ft
Top Width, T	1.4637	ft
Froude Number, F	7.77	
Shear Stress (tractive force), τ	9.1435	psf

Version 2.0 (20 June 2017)

HawsEDC Calculators

Rock Chute Sizing

SCS ENGINEERS

		Sheet No:	1 of 5
		Calc. No.	
		Rev. No.	3
Job No. 25222260.00	Job: Columbia Energy Center MOD12	By: SJL	Date: 8/28/23
Client: WPL	Subject: Rock Chute Sizing & Riprap Size	Chk'd: RJG	Date: 8/28/23

Purpose:

To size the rock chutes to accommodate the 25-year, 24-hour storm event.

References:

1. Rock Chute Design Data spreadsheet Version WI-April-2005, Based on Design of Rock Chutes by Robinson, Rice, Kadavy, ASAE, 1998.
2. HydroCAD Report: COL_Mod12_HydroCAD Report
3. Figure 1 - Final Grades (Module 12)
4. Stable 25.1 Typical Particle Sizes of Native Sands at 75 Percent Passing (D75) from WisDOT Facilities. Development Manual (FDM).

Approach:

1. Enter Inlet Channel data based on culvert apron or swale geometry Reference #2 and #3.
2. Enter Chute data based on slope from Reference #3, start the width, Bw equal to inlet channel Bw.
3. Enter Outlet Channel data based on Reference #3, start the width, Bw equal to inlet channel Bw.
4. Enter drainage area, apron elevations, flow (Q), and rainfall.
5. Adjust Bw for Chute and Outlet Channel until spreadsheet shows the rock chute "will" function adequately.
6. Determine rip rap classification based on D50 weight per Reference #4.

Assumptions:

1. Assume side slopes of chute and outlet channel are 2:1.
2. Assume Factor of Safey is 1.2.
3. n-value is based on proposed conditions at the channel.
4. Assume Outlet apron depth, d is 1.0 ft.
5. Freeboard is 1.0 ft.
6. Use 25-year, 24-hour storm event flow (Reference #2) for Q_{high} and Q_{low}.
7. Classification of riprap is based on weight (Reference #4).

Calculations:

See attached spreadsheet calcs for each rock chute.

Results:

The rock chutes are adequately designed to accommodate the flows from the 25-year, 24-hour storm event.

Rock Chute	Width (ft)	Thickness (in)	Apron Width (ft)	Apron Length (ft)	D_{50} (in)	WisDOT Rip Rap Classification
RC1	8	4	8	2	2	Select Crushed Material, Type R
RC2	6	12	6	7	5.9	Light Riprap Type R
RC3	6	8	6	5	3.8	Light Riprap Type R
RC4	6	9	6	6	3.8	Light Riprap, Type R

Rock Chute Design Data

(Version WI-April-2005, Based on Design of Rock Chutes by Robinson, Rice, Kadavy, ASAE, 1998)
Revised for WisDOT 9/2010

Project: COL - Mod 12 RC1 **County:** Columbia
Designer: SJL **Checked by:** RJG
Date: August 28, 2023 **Date:** 08/28/23

Input Geometry:

Upstream Channel		Chute			Downstream Channel	
Bottom Width =	0.0 ft.	Bottom Width =	8.0 ft.		Bottom Width =	8.0 ft.
Side slopes =	4.0 (m:1)	Factor of safety =	1.20 (SF)	1.2 Min	Side slopes =	2.0 (m:1)
Mannings n value =	0.030	Side slopes =	2.0 (z:1) →	2.0:1 max.	Mannings n value =	0.045
Bed slope =	0.0600 ft./ft.	Bed slope =	0.1769 ft./ft →	3.0:1 max.	Bed slope =	0.0050 ft./ft.
Note: Use procedures 13-30-15 or 13-30-25 for upstream and downstream Mannings n		Freeboard =	1.0 ft. →			
		Outlet apron depth, d =	1.0 ft.		Base flow =	0.0 cfs

Flow and Elevation Data:

Apron elev. --- Inlet = 829.0 ft. ------ Outlet 806.0 ft. --- (H_{drop} = 22 ft.)

Degree of angularity = 1

Q_{high} = Runoff from design storm
Q_5 = Runoff from a 5-year,24-hour storm

1 --> 50% angular, 50% rounded
2 --> 100 % rounded

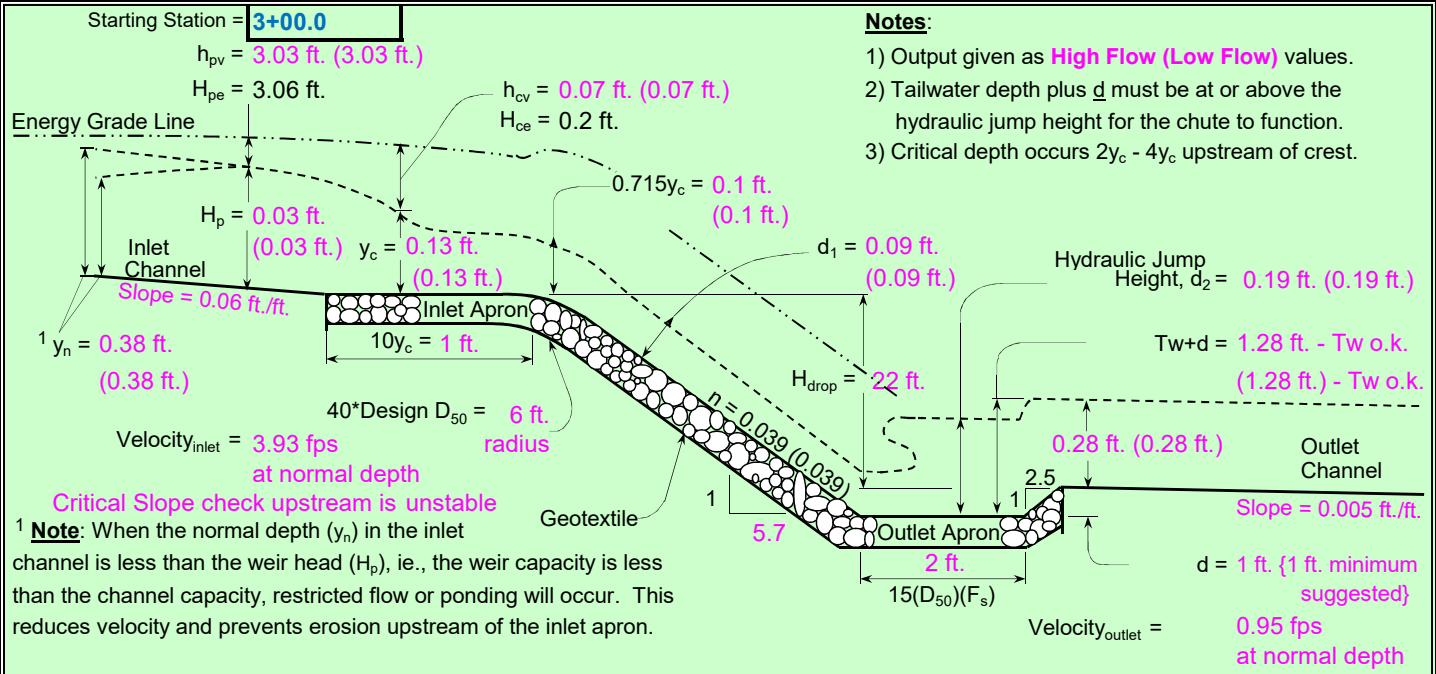
Q_{high} = 2.3 cfs High flow storm through chute → Tw (ft.) = Program
Q_{low} = 2.3 cfs Low flow storm through chute → Tw (ft.) = Program

Note: The total required capacity is routed through the chute (principal spillway) or in combination with an auxiliary spillway.

Input tailwater (Tw): 0.18 1.20

Profile and Cross Section (Output):

Starting Station = 3+00.0

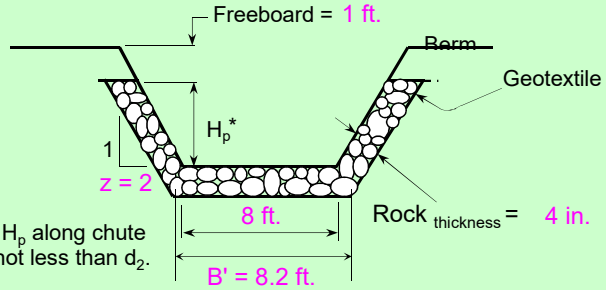


Notes:
1) Output given as **High Flow (Low Flow)** values.
2) Tailwater depth plus d must be at or above the hydraulic jump height for the chute to function.
3) Critical depth occurs 2y_c - 4y_c upstream of crest.

[1] **Note**: When the normal depth (y_n) in the inlet channel is less than the weir head (H_p), ie., the weir capacity is less than the channel capacity, restricted flow or ponding will occur. This reduces velocity and prevents erosion upstream of the inlet apron.

Profile Along Centerline of Chute

Typical Cross Section



* Use H_p along chute but not less than d_2.

	0.28 cfs/ft.	Equivalent unit discharge
SF =	1.20	Factor of safety (multiplier)
d_1 =	0.09 ft.	Normal depth in chute
n-value =	0.039	Manning's roughness coefficient
D_{50}(SF) =	2 in.	Minimum Design D_{50}*
2(D_{50})(SF) =	4 in.	Rock chute thickness
Tw + d =	1.28 ft.	Tailwater above outlet apron
d_2 =	0.19 ft.	Hydraulic jump height
*** The outlet	will	function adequately

High Flow Storm Information

Rock Chute Design Data

(Version WI-April-2005, Based on Design of Rock Chutes by Robinson, Rice, Kadavy, ASAE, 1998)
Revised for WisDOT 9/2010

Project: COL - Mod 12 RC2 **County:** Columbia
Designer: SJL **Checked by:** RJG
Date: August 28, 2023 **Date:** 08/28/23

Input Geometry:

Upstream Channel		Chute			Downstream Channel	
Bottom Width =	6.0 ft.	Bottom Width =	6.0 ft.		Bottom Width =	6.0 ft.
Side slopes =	1.0 (m:1)	Factor of safety =	1.20 (SF)	1.2 Min	Side slopes =	2.0 (m:1)
Mannings n value =	0.012	Side slopes =	2.0 (z:1)	2.0:1 max.	Mannings n value =	0.045
Bed slope =	0.0001 ft./ft.	Bed slope =	0.2319 ft./ft	3.0:1 max.	Bed slope =	0.0050 ft./ft.
Note: Use procedures 13-30-15 or 13-30-25 for upstream and downstream Mannings n		Freeboard =	1.0 ft.			
		Outlet apron depth, d =	1.0 ft.		Base flow =	0.0 cfs

Flow and Elevation Data:

Apron elev. --- Inlet = 820.0 ft. ---- Outlet 804.0 ft. --- (H_{drop} = 15 ft.)

Degree of angularity = 1

Q_{high} = Runoff from design storm
Q_5 = Runoff from a 5-year,24-hour storm

1 --> 50% angular, 50% rounded
2 --> 100 % rounded

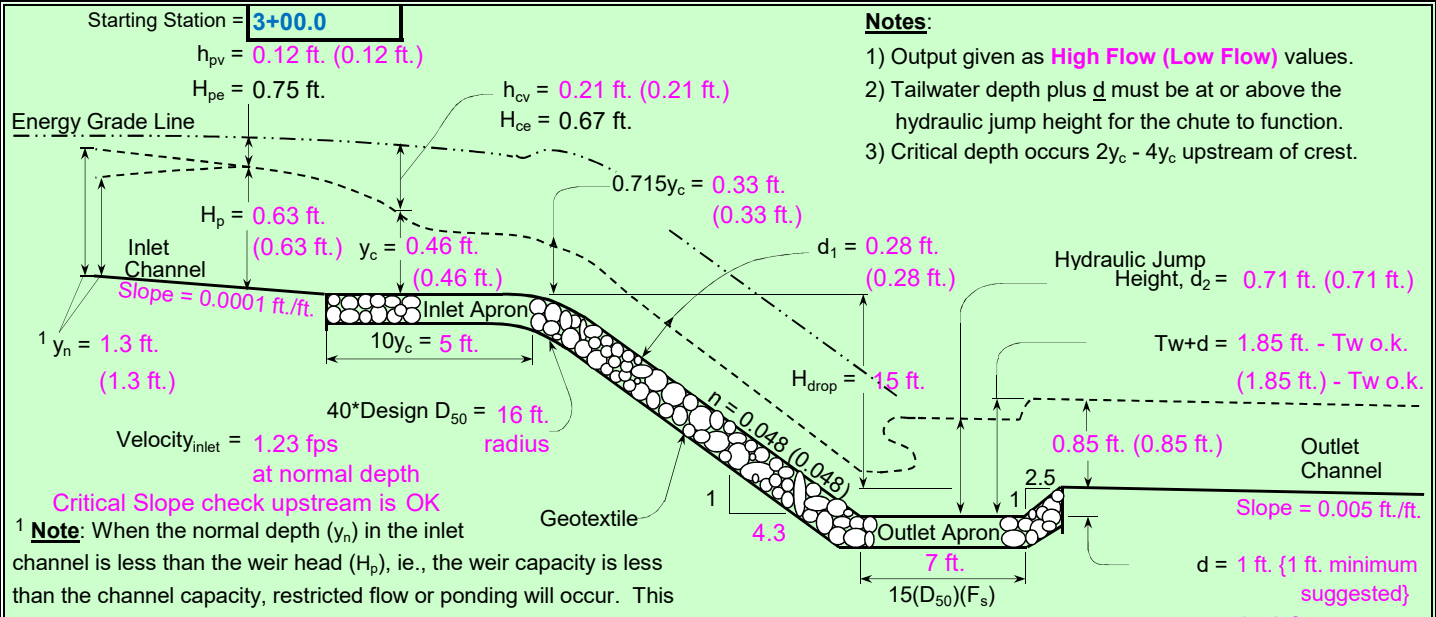
Q_{high} = 11.7 cfs High flow storm through chute → Tw (ft.) = Program
Q_{low} = 11.7 cfs Low flow storm through chute → Tw (ft.) = Program

Note: The total required capacity is routed through the chute (principal spillway) or in combination with an auxiliary spillway.

Input tailwater (Tw): 0.23 1.20

Profile and Cross Section (Output):

Starting Station = 3+00.0

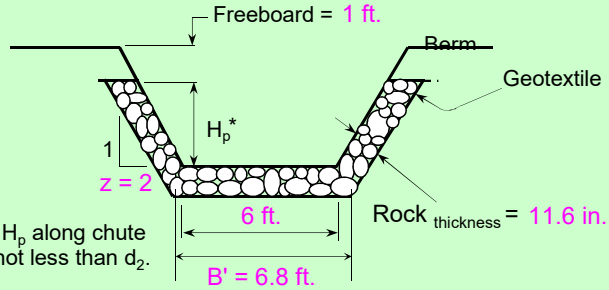


Notes:
1) Output given as **High Flow (Low Flow)** values.
2) Tailwater depth plus d must be at or above the hydraulic jump height for the chute to function.
3) Critical depth occurs 2y_c - 4y_c upstream of crest.

[1] **Note**: When the normal depth (y_n) in the inlet channel is less than the weir head (H_p), ie., the weir capacity is less than the channel capacity, restricted flow or ponding will occur. This reduces velocity and prevents erosion upstream of the inlet apron.

Profile Along Centerline of Chute

Typical Cross Section



* Use H_p along chute but not less than d_2.

	1.79 cfs/ft.	Equivalent unit discharge
SF =	1.20	Factor of safety (multiplier)
d_1 =	0.28 ft.	Normal depth in chute
n-value =	0.048	Manning's roughness coefficient
D_{50}(SF) =	5.8 in.	Minimum Design D_{50}*
2(D_{50})(SF) =	11.6 in.	Rock chute thickness
Tw + d =	1.85 ft.	Tailwater above outlet apron
d_2 =	0.71 ft.	Hydraulic jump height
*** The outlet	will	function adequately

High Flow Storm Information

Rock Chute Design Data

(Version WI-April-2005, Based on Design of Rock Chutes by Robinson, Rice, Kadavy, ASAE, 1998)
Revised for WisDOT 9/2010

Project: COL - Mod 12 RC3 **County:** Columbia
Designer: SJL **Checked by:** RJG
Date: August 28, 2023 **Date:** 08/28/23

Input Geometry:

Upstream Channel		Chute			Downstream Channel	
Bottom Width =	6.0 ft.	Bottom Width =	6.0 ft.		Bottom Width =	6.0 ft.
Side slopes =	1.0 (m:1)	Factor of safety =	1.20 (SF)	1.2 Min	Side slopes =	2.0 (m:1)
Mannings n value =	0.012	Side slopes =	2.0 (z:1)	2.0:1 max.	Mannings n value =	0.045
Bed slope =	0.0001 ft./ft.	Bed slope =	0.1545 ft./ft	3.0:1 max.	Bed slope =	0.0050 ft./ft.
Note: Use procedures 13-30-15 or 13-30-25 for upstream and downstream Mannings n		Freeboard =	1.0 ft.			
		Outlet apron depth, d =	1.0 ft.		Base flow =	0.0 cfs

Flow and Elevation Data:

Apron elev. --- Inlet = 821.0 ft. ---- Outlet 804.0 ft. --- (H_{drop} = 16 ft.)

Degree of angularity = 1

Q_{high} = Runoff from design storm
Q_5 = Runoff from a 5-year,24-hour storm
1 --> 50% angular, 50% rounded
2 --> 100 % rounded

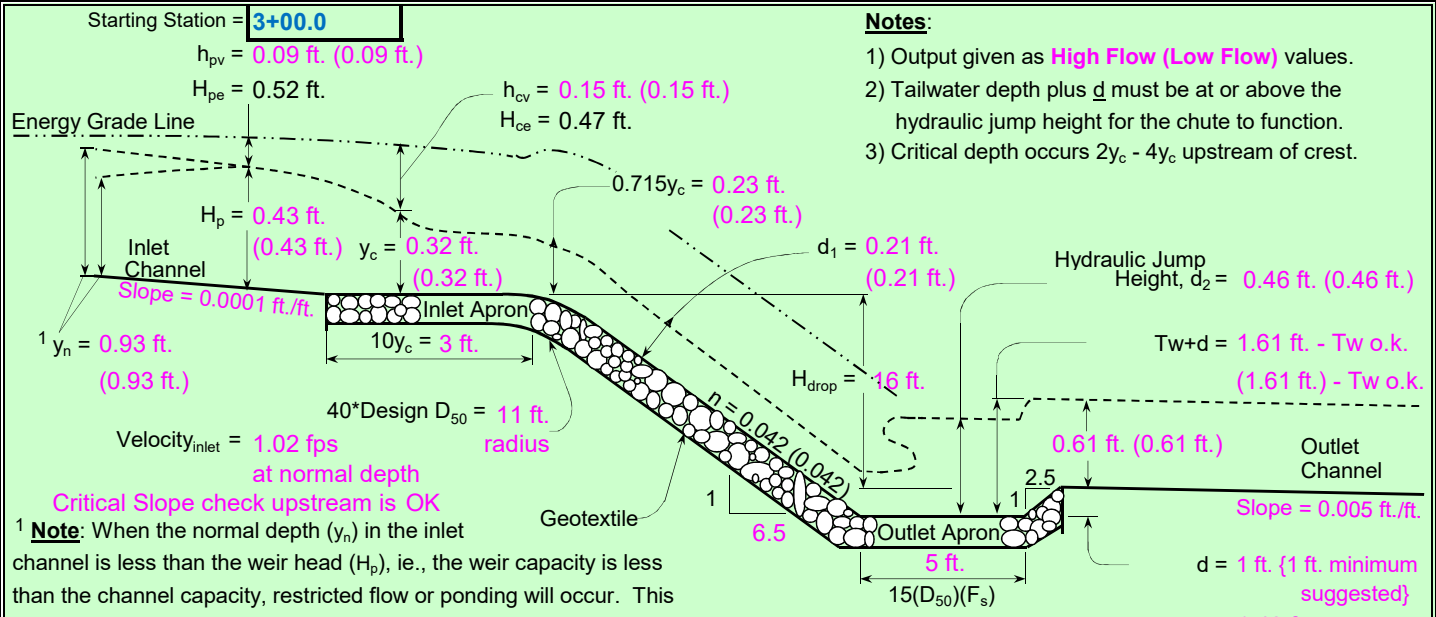
Q_{high} = 6.6 cfs High flow storm through chute → Tw (ft.) = Program
Q_{low} = 6.6 cfs Low flow storm through chute → Tw (ft.) = Program

Note: The total required capacity is routed through the chute (principal spillway) or in combination with an auxiliary spillway.

Input tailwater (Tw): 0.15 1.20

Profile and Cross Section (Output):

Starting Station = 3+00.0

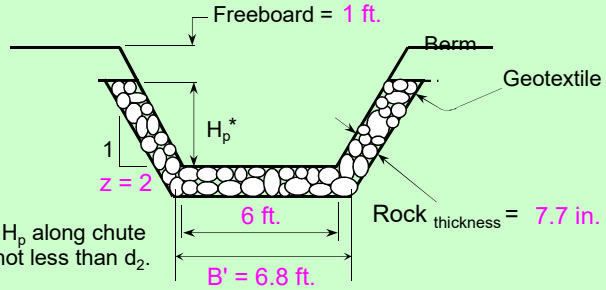


Notes:
1) Output given as **High Flow (Low Flow)** values.
2) Tailwater depth plus d must be at or above the hydraulic jump height for the chute to function.
3) Critical depth occurs 2y_c - 4y_c upstream of crest.

[1] **Note**: When the normal depth (y_n) in the inlet channel is less than the weir head (H_p), ie., the weir capacity is less than the channel capacity, restricted flow or ponding will occur. This reduces velocity and prevents erosion upstream of the inlet apron.

Profile Along Centerline of Chute

Typical Cross Section



* Use H_p along chute but not less than d_2.

	1.04 cfs/ft.	Equivalent unit discharge
SF =	1.20	Factor of safety (multiplier)
d_1 =	0.21 ft.	Normal depth in chute
n-value =	0.042	Manning's roughness coefficient
D_{50}(SF) =	3.8 in.	Minimum Design D_{50}*
2(D_{50})(SF) =	7.7 in.	Rock chute thickness
Tw + d =	1.61 ft.	Tailwater above outlet apron
d_2 =	0.46 ft.	Hydraulic jump height
*** The outlet	will	function adequately

High Flow Storm Information

Rock Chute Design Data

(Version WI-April-2005, Based on Design of Rock Chutes by Robinson, Rice, Kadavy, ASAE, 1998)
Revised for WisDOT 9/2010

Project: COL - Mod 12 RC4 **County:** Columbia
Designer: RJG **Checked by:** SJL
Date: August 28, 2023 **Date:** 08/28/23

Input Geometry:

Upstream Channel		Chute			Downstream Channel	
Bottom Width =	4.0 ft.	Bottom Width =	6.0 ft.		Bottom Width =	6.0 ft.
Side slopes =	4.0 (m:1)	Factor of safety =	1.20 (SF)	1.2 Min	Side slopes =	2.0 (m:1)
Mannings n value =	0.045	Side slopes =	2.0 (z:1) →	2.0:1 max.	Mannings n value =	0.045
Bed slope =	0.0288 ft./ft.	Bed slope =	0.2212 ft./ft →	3.0:1 max.	Bed slope =	0.0050 ft./ft.
Note: Use procedures 13-30-15 or 13-30-25 for upstream and downstream Mannings n		Freeboard =	1.0 ft. →			
		Outlet apron depth, d =	1.0 ft.		Base flow =	0.0 cfs

Flow and Elevation Data:

Apron elev. --- Inlet = 824.9 ft. ---- Outlet 817.6 ft. --- (H_{drop} = 6.3 ft.)

Degree of angularity = 1

Q_{high} = Runoff from design storm
Q_5 = Runoff from a 5-year,24-hour storm

1 --> 50% angular, 50% rounded
2 --> 100 % rounded

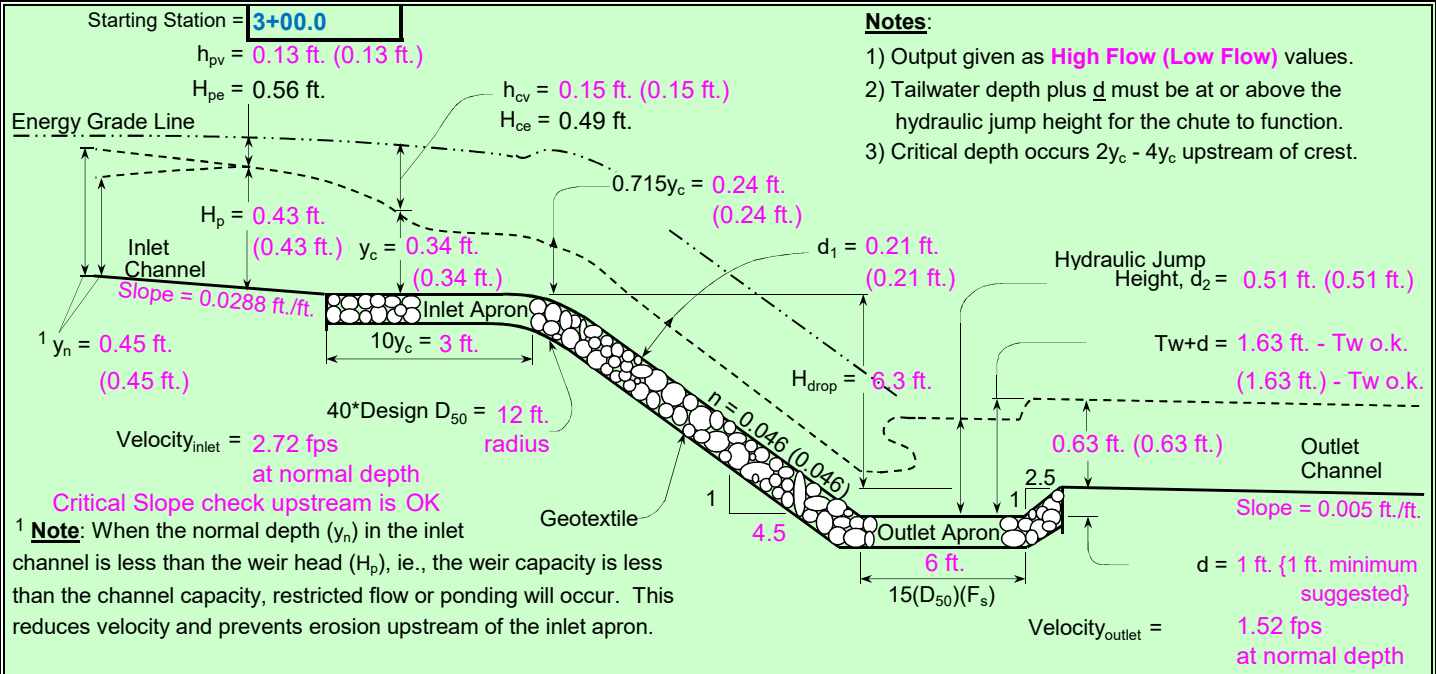
Q_{high} = 7.0 cfs High flow storm through chute → Tw (ft.) = Program
Q_{low} = 7.0 cfs Low flow storm through chute → Tw (ft.) = Program

Note: The total required capacity is routed through the chute (principal spillway) or in combination with an auxiliary spillway.

Input tailwater (Tw): 0.22 1.20

Profile and Cross Section (Output):

Starting Station = 3+00.0

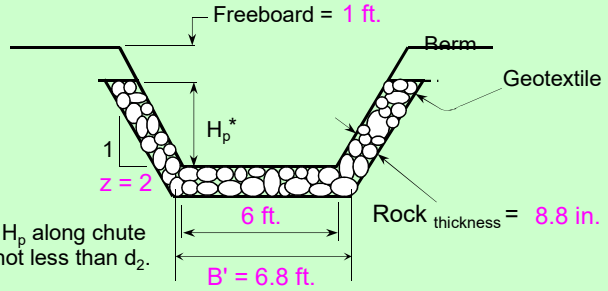


[1] **Note**: When the normal depth (y_n) in the inlet channel is less than the weir head (H_p), ie., the weir capacity is less than the channel capacity, restricted flow or ponding will occur. This reduces velocity and prevents erosion upstream of the inlet apron.

Notes:
1) Output given as **High Flow (Low Flow)** values.
2) Tailwater depth plus d must be at or above the hydraulic jump height for the chute to function.
3) Critical depth occurs 2y_c - 4y_c upstream of crest.

Profile Along Centerline of Chute

Typical Cross Section



* Use H_p along chute but not less than d_2.

	1.1 cfs/ft.	Equivalent unit discharge
SF =	1.20	Factor of safety (multiplier)
d_1 =	0.21 ft.	Normal depth in chute
n-value =	0.046	Manning's roughness coefficient
D_{50}(SF) =	4.4 in.	Minimum Design D_{50}*
2(D_{50})(SF) =	8.8 in.	Rock chute thickness
Tw + d =	1.63 ft.	Tailwater above outlet apron
d_2 =	0.51 ft.	Hydraulic jump height
*** The outlet	will	function adequately

High Flow Storm Information

Riprap Apron Sizing

SCS ENGINEERS

Sheet No.	1 of 2		
Calc. No.			
Rev. No.			
Job No. 25222260.00	Job: Columbia Energy Center MOD 12	By: SJL	Date: 8/28/23
Client: WPL	Subject: Riprap Sizing at Culvert Outlet	Chk'd: RJG	Date: 8/28/23

Purpose:

To size the riprap apron dimensions at proposed culvert locations C2, C3, C4, C5, C6, C8, C9, and C11 based on a 25-year, 24 hour storm event:

References:

1. "Energy Dissipators," Wisconsin Department of Transportation (WisDOT), Facilities Development Manual (FDM) 13-35-5.
2. HydroCAD Report: COL_Mod12_HydroCAD Report
3. "Rock Riprap Lined Channels," WisDOT FDM 13-30-25.
4. Culvert Sizing Calculation.
5. WisDOT FDM Chapter 13, Section 30 - Rock Riprap Lined Chutes

Approach:

Use the equations in Section 5.2 - Riprap Blanket of WisDOT FDM 13-35-5 (Energy Dissipators) to determine the average size of stone (d_{50}) and riprap apron length. Round up the calculated d_{50} to the nearest WisDOT standard riprap size.

Use WisDOT FDM 13-35 Attachment 5.2 to determine the width of the riprap apron for discharges to a flat area. For discharges to channels, extend riprap across the channel bottom and up the sides.

Assumptions:

Assume riprap apron thickness (T) is 2 * d_{50} to protect against washout and undercutting of the riprap.

Assume tailwater depth, TW = 0.40 * D_o

Assume max TW conditions for the riprap apron width.

Assume that when there are multiple culverts, the total discharge to the culverts is distributed evenly through each barrel.

Calculation:

From WisDOT Section 5.2 - Riprap Blanket:

$$d_{50}/D_o = 0.020\ (D_o/TW)\ (Q/D_o^{5/2})^{4/3}$$

$$L_{sp}/D_o = 1.7\ (Q/D_o^{5/2}) + 8$$

Or:

$$d_{50} = 0.02 \times (D_o/TW) \times (Q/D_o^{5/2})^{4/3} \times D_o$$

$$L_{sp} = (1.7\ (Q/D_o^{5/2}) + 8) \times D_o$$

where: D_o = Diameter or width of culvert (ft)

Q = Flow rate (cfs) (discharge rate through culvert, from Worst Case Condition HydroCAD Model (Reference #2))

TW = Tail water depth (ft)

d_{50} = Average size of stone (ft)

L_{sp} = Length of stone protection (Apron Length) (ft)

Location	Total Flow (Q, cfs)	Number of Pipes	D_o (ft)	Q (cfs)	TW (ft)	$d_{50\ calculated}$	$d_{50\ Design}$	L_{sp}
Culvert C2a	10.41	2	1.5	5.2	0.60	0.18	0.18	17
Culvert C2b	3.50	2	1	1.8	0.40	0.11	0.18	11
Culvert C3	27.48	2	2.5	13.7	1.00	0.19	0.83	26
Culvert C4	32.85	2	2.5	16.4	1.00	0.25	0.83	27
Culvert C5	38.11	2	2.5	19.1	1.00	0.30	0.83	28
Culvert C6	30.03	2	2	15.0	0.80	0.37	0.83	25
Culvert C8	0.96	1	1	1.0	0.40	0.05	0.18	10
Culvert C9	0.22	1	1	0.2	0.40	0.01	0.18	8
Culvert C11	26.46	2	2.5	13.2	1.00	0.18	0.83	26

Results:

Below is a summary of the d_{50} , thickness (T), and configuration of the riprap apron. Also refer to WisDOT FDM Attachment 5.2 (Sheet 2) for details on apron layout. Use WisDOT Light Riprap at culvert discharge.

Location	d_{50} (in)	T (in)	L_{sp} (ft)	W_{sp} (ft)	WisDOT Riprap sizes
Culvert C2a	2.2	6	17	See Note 1	Select Crushed Material
Culvert C2b	2.2	6	11	See Note 1	Select Crushed Material
Culvert C3	10.0	20	26	See Note 1	Light Riprap
Culvert C4	10.0	20	27	See Note 1	Light Riprap
Culvert C5	10.0	20	28	See Note 1	Light Riprap
Culvert C6	10.0	20	25	See Note 1	Light Riprap
Culvert C8	2.2	6	10	See Note 1	Select Crushed Material
Culvert C9	2.2	6	8	See Note 1	Select Crushed Material
Culvert C11	10.0	20	26	See Note 1	Light Riprap

1. For discharges to channels, place riprap along channel bottom and up side of channel.

09/28/2023 - Classification: Internal - ECRM13153872

E.6.2 Modules 12 and 13 Stormwater Calculations

09/28/2023 - Classification: Internal - ECRM13153872

Storm Water Management Calculations

Purpose:
The purpose of the storm water runoff calculations is to demonstrate that the existing storm water sedimentation basin and proposed storm water management features included in the Module 12 and 13 Plan Modification Request can accommodate and safely convey the runoff from a 25-year, 24-hour storm event and 100-year, 24-hour storm event during post closure conditions.

Items addressed in these calculations:

- Swales
- Culverts
- Diversion Berms
- Downslope Flumes & Energy Dissipators
- Rock Chutes
- Discharge Aprons
- Sedimentation Basin
- North Infiltration Area

The proposed storm water management conditions are shown on **Figure 1**.
The calculations support the capacity check of the following existing storm water management feature:

Feature	Purpose	Design Method
Swales	Convey storm water runoff from adjacent areas to culverts and offsite during post construction conditions	HydroCAD runoff modeling and Swale Calculation
Culverts	Convey storm water from the final cover perimeter swales during post construction conditions	HydroCAD runoff modeling and HY-8 Culvert Model
Diversion Berms	Reduce storm water runoff from final cover slopes and to divert water to perimeter swales during post construction conditions	HydroCAD runoff modeling and Diversion Berm Calculations
Downslope Flumes & Energy Dissipators	Convey storm water from diversion berms down slope to swales and offsite drainage features during post construction conditions	HydroCAD runoff modeling and Downslope Flume Calculations
Rock Chutes	Erosion protection and convey storm water from energy dissipators to existing swale during post construction conditions	HydroCAD runoff modeling and Rock Chute Calculation
Discharge Aprons	Erosion protection from culvert discharge at culvert outlets	HydroCAD runoff modeling and Riprap Apron Calculation
Sedimentation Basin	To safely handle 25-year, 24-hour storm event without overtopping the 100-year, 24-hour spillway.	HydroCAD runoff modeling
North Infiltration Area	To safely handle 25-year, 24-hour and 100-year, 24-hour storm events without overtopping or backing up the inlet pipe.	HydroCAD runoff modeling

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Approach:

Hydrograph Generation

HydroCAD was used to model the storm water management system and develop the hydrographs using TR-20 methodologies. The model is designed to simulate the surface runoff response of a watershed to a precipitation event. Input parameters for the model include precipitation depth for the design storm events from NOAA ATLAS 14, contributing drainage areas, runoff curve numbers, and time of concentration.

Swale Sizing

The proposed swales were sized for the 25-year, 24-hour storm event. A WisDOT HEC-15 spreadsheet based on Manning's equation was used to calculate the depth of flow and velocity in the swales using the swale geometry and peak flow in the swales (as determined by the Hydrograph Generation models).

Culvert Sizing

Culverts were sized for the 25-year, 24-hour storm event using the HY-8 computer model developed by the US Department of Transportation, Federal Highway Administration.

Diversion Berms

Diversion berms were sized for the 25-year, 24-hour storm event. A WisDOT HEC-15 spreadsheet based on Manning's Equation was used to calculate the depth of flow and velocity in the swale using the swale geometry and peak flow for the storm event (as determined by the Hydrograph Generation Calculations).

Downslope Flumes and Energy Dissipators Sizing

Flumes and energy dissipators were sized for the 25-year, 24-hour storm event. Manning's equation and the orifice equation were used to size the flumes. Energy dissipators were sized using tables from the reference book "Hydraulic Design of Energy Dissipators for Culverts and Channels" US Department of Transportation, Federal Highway Administration, July 2006.

Rock Chute Sizing

Rock chutes were sized for the 25-year, 24-hour storm event. Rock Chutes were sized based on the flow to each culvert location. The Iowa NRCS Rock Chute Design spreadsheet was used to size the chute and riprap.

Discharge Apron Sizing

Riprap aprons were sized for the 25-year, 24-hour storm event using equations in Section 5.2 – Riprap Blanket of WisDOT FDM 13-35-5. The riprap aprons were sized based on the flow to the culvert location. The riprap stone sizing was used to specify the thickness and geometry of the riprap discharge apron.

Sedimentation Basin Sizing

Route the proposed construction and existing drainage runoff through the sedimentation basin to confirm the basin can handle the 25-year, 24-hour storm event and to safely pass the 100-year, 24-hour storm event. HydroCAD was used to model the runoff flow through the basin outfall (as determined by the Hydrograph Generation model).

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North Infiltration Area Verification

The depressional area located north of the Module 12 Plan Modification construction area acts as a infiltration area and accepts portions of the drainage runoff. Route the proposed construction and existing drainage runoff flowing to the North Infiltration Area to confirm the area can handle the 25-year, 24-hour and 100-year, 24-hour storm events without overtopping or backing up the inlet pipe. HydroCAD was used to model the runoff flow into this area (as determined by the Hydrograph Generation model).

Key Assumptions:

- Drainage areas and time of concentration flow paths are as shown on **Figure 1** for Post Construction Conditions.

- An MSE4 rainfall distribution was used based on NRCS Wisconsin rainfall distribution regions.

  The precipitation depth for the 25-year, 24-hour storm was assumed to be 4.91 inches, based on NOAA ATLAS 14 Point Precipitation Frequency Estimates (NOAA's National Weather Service Hydrometeorological Design Studies Center Precipitation Frequency Data Server).

  The precipitation depth for the 100-year, 24-hour storm was assumed to be 6.59 inches, based on NOAA ATLAS 14 Point Precipitation Frequency Estimates.

- Runoff curve numbers were based on tables presented in Urban Hydrology for Small Watersheds, and were assumed as follows and as listed in the modeling.

Cover Type	CN
Final Cover	69 – Pasture/grassland/range in good condition, hydrologic soil group (HSG) (B/C assumed mid value between each soil group)
Pasture, grassland or range	39 – Pasture/grassland/range, Good, HSG A
Gravel	96 – Gravel, HSG A
Water Surface	98 – Water Surface, HSG A

- Type A soil group for non-disturbed areas outside the landfill as soils are loamy sand.
- Other assumptions are included with the calculations attached to this appendix.

Results:

Hydrograph Generation

The hydrograph modeling results for the 25-year and 100-year, 24-hour storm events are included in the Post Construction Conditions Hydrograph Generation section.

Swale Sizing

The proposed swales will be constructed as shown on the Drawings. The swales have the capacity to safely convey the both the 25-year, 24-hour storm events and maintain a minimum 0.5 foot of freeboard. Refer to the Swale Sizing section.

Appropriate erosion control product was selected based on the velocities and shear stress in the swales. Refer to the Swale Sizing section below for the evaluation.

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Culvert Sizing

Culverts will be as shown in the Drawings. The culverts have the capacity to safely convey the 25-year, 24-hour storm event. Refer to the Culvert Sizing Section for the detailed calculations.

Diversion Berm Sizing

The proposed final berms will be constructed as shown on the Drawings. The diversion berms will contain the runoff from the 25-year, 24-hour storm event. Refer to the Diversion Berm Design section.

Downslope Flume and Energy Dissipator Sizing

The downslope flumes and energy dissipaters will be constructed as shown on the Drawings. The downslope flumes are designed to contain the runoff from the 25-year, 24-hour storm event. Energy dissipators at the bottom of the downslope flumes have been designed to handle the peak velocities. Refer to the Downslope Flume and Energy Dissipator Sizing section below for detailed calculations.

Rock Chute Sizing

The proposed rock chutes will be constructed as shown in the Drawings. The rock chutes will accommodate the runoff from the 25-year, 24-hour storm event. Refer to the Rock Chute Sizing section.

Discharge Apron Sizing

The proposed riprap aprons will be constructed as shown in the Drawings. The aprons will accommodate the runoff from the 25-year, 24-hour storm event. Refer to Discharge Apron Sizing for design calculations.

Sedimentation Basin Sizing

The existing sedimentation basin has the capacity to safely contain the 25-year, 24-hour storm event and safely pass the 100-year, 24-hour storm event through the emergency spillway.

As shown in the HydroCAD model, the water elevation in both basin areas for each storm event is provided below:

Basin Area	Basin Crest Elevation (ft MSL)	Basin Spillway Elevation (ft MSL)	Peak Elevation 25-year storm (ft MSL)	Peak Elevation 100-year storm (ft MSL)
Existing Sedimentation Basin	794.00	793.00	792.00	793.20

North Infiltration Area Verification

The North Infiltration Area can safely contain the 25-year, 24-hour storm event and the 100-year, 24-hour storm event without overtopping or backing up the inlet pipe at Murray Road.

As shown in the HydroCAD model, the water elevation in both basin areas for each storm event is provided below:

Basin Area	Basin Crest Elevation (ft MSL)	Basin Inlet Pipe Elevation (ft MSL)	Peak Elevation 25-year storm (ft MSL)	Peak Elevation 100-year storm (ft MSL)
North Basin	810.00	806.81	803.86	805.23

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COAL PILE

WPDES POND

C. M. ST. P. & P. RR.

CULVERT C7
2-42" CMPs
INLET INV.: 796.64/796.34
OUTLET INV.: 796.34/796.04
LENGTH: 60.2 FT

CULVERT C8
INLET INV.: 810.70
OUTLET INV.: 808.60
LENGTH: 85.60 FT

FLUME 3
(EXISTING)

SWALE S4.1
SWALE S4.2
SWALE S4.3
SWALE S4.4
SWALE S4.5
SWALE S4.6

ROCK
CHUTE 1
ROCK
CHUTE 2
ROCK
CHUTE 3

FLUME 10
ROADSIDE
DITCH 5
ROADSIDE
DITCH 4
ROADSIDE
DITCH 3
ROADSIDE
DITCH 2
ROADSIDE
DITCH 1

MURRAY ROAD

CULVERT C9
INLET INV.: 807.54
OUTLET INV.: 806.81
LENGTH: 99.86 FT

NORTH
POND

CULVERT C2
INLET INV.: 817.83
OUTLET INV.: 814.00
LENGTH: 74.54 FT

CULVERT C1
INLET INV.: 815.70
OUTLET INV.: 814.55
LENGTH: 51.878 FT

SWALE S5.1

SOUTH
SEDIMENTATION
BASIN

EXISTING
ROCK CHUTE
(FLUME 4)

EXISTING ROCK
CHUTE (FLUME 5)

FLUME 1
FLUME 2
FLUME 6
FLUME 7
FLUME 8
FLUME 9

SWALE S2.1
SWALE S2.2
SWALE S2.3

SWALE
S3.1
SWALE S3.2
SWALE S3.3
SWALE S3.4
SWALE S3.5

SWALE S1.1
SWALE S1.2
SWALE S1.3
SWALE S1.4
SWALE S1.5
SWALE S1.6
SWALE S1.7
SWALE S1.8

AREA TO BE GRADED
TO DRAIN AFTER
CLOSURE

CULVERT C6
INLET INV.: 805.40
OUTLET INV.: 804.76/804.71
LENGTH: 104.555 FT

CULVERT C5
INLET INV.: 807.57
OUTLET INV.: 807.15
LENGTH: 50.00 FT

CULVERT C4
INLET INV.: 809.86
OUTLET INV.: 809.60
LENGTH: 50.00 FT

CULVERT C3
INLET INV.: 811.17
OUTLET INV.: 810.90
LENGTH: 50.00 FT

CULVERT C10
INLET INV.: 814.96
OUTLET INV.: 813.36
LENGTH: 50.00 FT

AREA 1 AREA 2 AREA 3 AREA 4 AREA 5 AREA 6 AREA 7 AREA 8 AREA 9 AREA 10 AREA 11 AREA 12 AREA 13 AREA 14 AREA 15 AREA 16 AREA 17 AREA 18 AREA 19 AREA 20 AREA 21 AREA 22 AREA 23 AREA 24 AREA 25 AREA 26 AREA 27 AREA 28 AREA 29 AREA 31 AREA 32 AREA 33 AREA 34 AREA 35 AREA 36 AREA 37 AREA 38 AREA 39 AREA 40 AREA 41 AREA 42 AREA 43 AREA 44 AREA 45 AREA 46 AREA 47 AREA 48 AREA 50 AREA 51 AREA 52 AREA 53 AREA 54 AREA 55 AREA 56 AREA 57 AREA 58 AREA 59 AREA 60 AREA 61 AREA 62 AREA 63 AREA 64 AREA 65 AREA 66 AREA 67 AREA 68 AREA 69 AREA 70 AREA 71

LEGEND

- DRY ASH DISPOSAL FACILITY LIMITS
- LIMITS OF WASTE
- LINER PHASE/MODULE LIMIT
- FINAL COVER LIMITS
- APPROXIMATE INTERMEDIATE COVER LIMITS/AREA
- PAVED ROAD
- UNPAVED ROAD
- VEGETATION
- FENCE
- EXISTING GRADE (10' INTERVAL)
- EXISTING GRADE (2' INTERVAL)
- SWALE
- EDGE OF WATER
- WETLAND
- PROPOSED PHASE 1 FINAL GRADE (10' INTERVAL)
- PROPOSED PHASE 1 FINAL GRADE (2' INTERVAL)
- PROPOSED GRADE (10' INTERVAL)
- PROPOSED GRADE (2' INTERVAL)
- PROPOSED PERIMETER ROAD
- PROPOSED SWALE
- PROPOSED CULVERT
- PROPOSED LEACHATE COLLECTION SYSTEM CLEANOUT
- PROPOSED LEACHATE VAULT
- PROPOSED LEACHATE FORCEMAIN
- PROPOSED UNDERGROUND ELECTRIC
- PROPOSED DIVERSION BERM
- PROPOSED DOWNSLOPE FLUME
- PROPOSED ENERGY DISSIPATOR
- PROPOSED RIPRAP
- DRAINAGE AREA DIVIDES
- FLOW PATH

NOTES:

1. SEE SHEET 2 OF PLAN OF OPERATION UPDATE (2023) PLAN SET FOR BASE MAP LEGEND ITEMS AND NOTES.
2. PROPOSED GRADES REPRESENT TOP OF FINAL COVER (FINAL GRADE).

N

125 0 125

SCALE: 1" = 125'

S.A.L.
DRAWN BY:
MJT
CHECKED BY:
MRH 08/31/2023
APPROVED BY:

PROJECT NO. 25222260.01
DRAWN: 08/01/2023
REVISED: 08/31/2023

WISCONSIN POWER AND LIGHT
COLUMBIA ENERGY CENTER
2019 W. CHESTNUT ST.
PARDEEVILLE, WISCONSIN 53954

Wisconsin Power and Light Company

CLIENT

SCS ENGINEERS
2830 DARY DRIVE MADISON, WI 53718-6751
PHONE: (608) 224-2830

ENGINEER

PLAN OF OPERATION UPDATE
COLUMBIA ENERGY CENTER
COLUMBIA DRY ASH DISPOSAL FACILITY
TOWN OF PACIFIC, WISCONSIN

SITE

FINAL GRADES
(MODULES 12 AND 13)

SHEET
1 of 1

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Post Construction Conditions Hydrograph Generation

- 25-year, 24-hour Storm Event
- 100-year, 24-hour Storm Event

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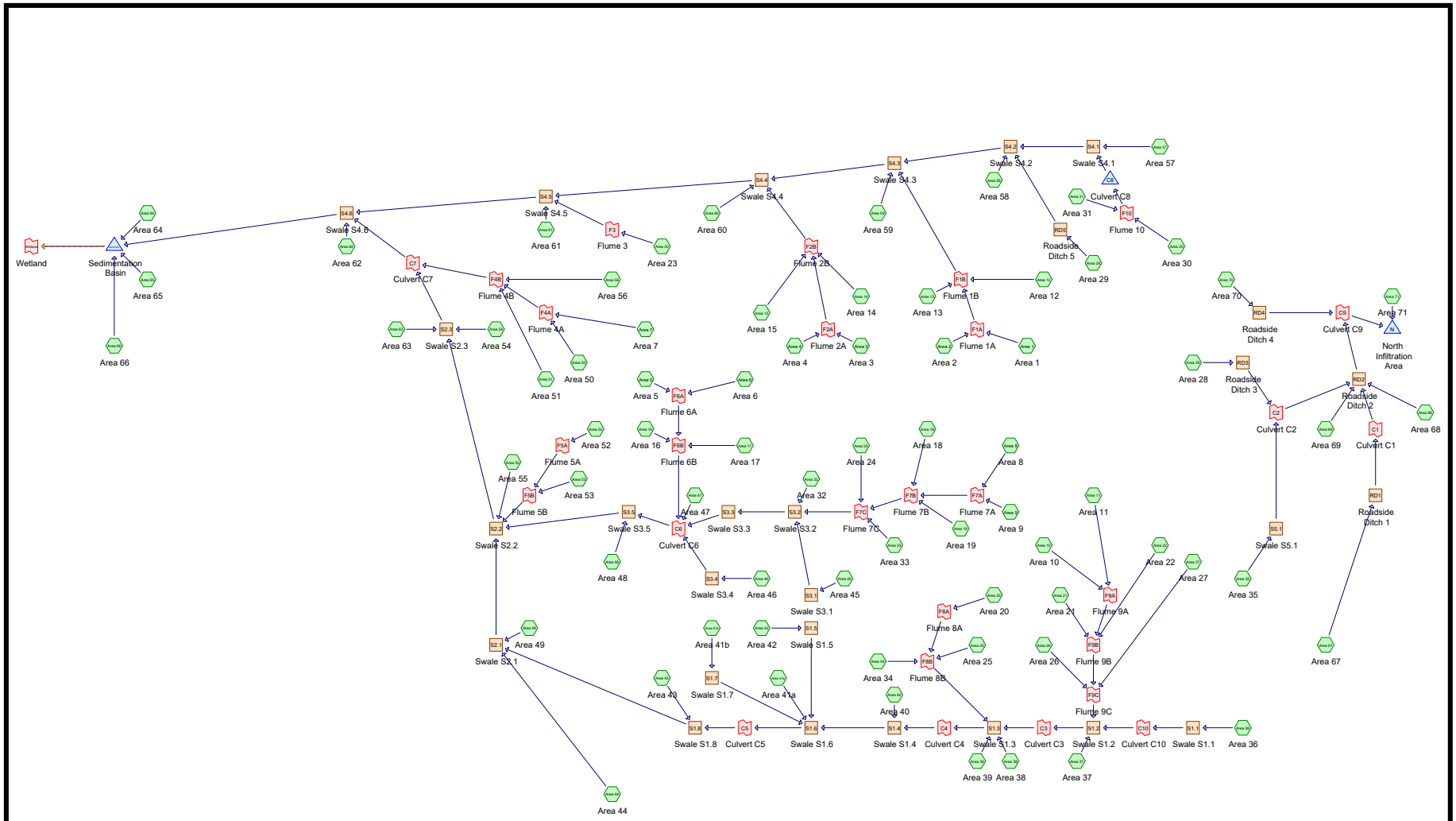

Routing Diagram for 230828_COL_Mod12+13

Prepared by SCS Engineers, Printed 8/28/2023

HydroCAD® 10.20-2d s/n 05804 © 2021 HydroCAD Software Solutions LLC

Rainfall Events Listing

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	25-yr, 24-hr	MSE 24-hr	4	Default	24.00	1	4.91	2
2	100-yr, 24-hr	MSE 24-hr	4	Default	24.00	1	6.59	2

Time span=0.00-72.00 hrs, dt=0.05 hrs, 1441 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

SubcatchmentArea 1: Area 1 Runoff Area=1.296 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=364' Tc=6.7 min CN=69 Runoff=3.75 cfs 0.204 af

SubcatchmentArea 10: Area 10 Runoff Area=0.573 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=321' Tc=6.4 min CN=69 Runoff=1.68 cfs 0.090 af

SubcatchmentArea 11: Area 11 Runoff Area=1.872 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=796' Tc=7.6 min CN=69 Runoff=5.22 cfs 0.295 af

SubcatchmentArea 12: Area 12 Runoff Area=1.610 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=712' Tc=5.3 min CN=69 Runoff=4.83 cfs 0.254 af

SubcatchmentArea 13: Area 13 Runoff Area=0.626 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=333' Tc=4.5 min CN=69 Runoff=1.94 cfs 0.099 af

SubcatchmentArea 14: Area 14 Runoff Area=0.620 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=331' Tc=4.4 min CN=69 Runoff=1.93 cfs 0.098 af

SubcatchmentArea 15: Area 15 Runoff Area=0.943 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=464' Tc=5.9 min CN=69 Runoff=2.80 cfs 0.149 af

SubcatchmentArea 16: Area 16 Runoff Area=0.571 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=315' Tc=4.4 min CN=69 Runoff=1.78 cfs 0.090 af

SubcatchmentArea 17: Area 17 Runoff Area=0.990 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=424' Tc=4.7 min CN=69 Runoff=3.04 cfs 0.156 af

SubcatchmentArea 18: Area 18 Runoff Area=1.656 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=508' Tc=4.8 min CN=69 Runoff=5.06 cfs 0.261 af

SubcatchmentArea 19: Area 19 Runoff Area=0.689 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=286' Tc=4.3 min CN=69 Runoff=2.16 cfs 0.109 af

SubcatchmentArea 2: Area 2 Runoff Area=0.557 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=303' Tc=4.7 min CN=69 Runoff=1.71 cfs 0.088 af

SubcatchmentArea 20: Area 20 Runoff Area=0.381 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=306' Tc=4.3 min CN=69 Runoff=1.19 cfs 0.060 af

SubcatchmentArea 21: Area 21 Runoff Area=0.516 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=312' Tc=4.3 min CN=69 Runoff=1.62 cfs 0.081 af

SubcatchmentArea 22: Area 22 Runoff Area=2.579 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=1,146' Tc=6.4 min CN=69 Runoff=7.54 cfs 0.407 af

SubcatchmentArea 23: Area 23 Runoff Area=0.427 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=362' Tc=3.8 min CN=69 Runoff=1.38 cfs 0.067 af

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SubcatchmentArea 24: Area 24 Runoff Area=1.177 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=385' Tc=4.7 min CN=69 Runoff=3.61 cfs 0.186 af

SubcatchmentArea 25: Area 25 Runoff Area=0.682 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=349' Tc=4.5 min CN=69 Runoff=2.12 cfs 0.108 af

SubcatchmentArea 26: Area 26 Runoff Area=0.677 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=341' Tc=4.5 min CN=69 Runoff=2.10 cfs 0.107 af

SubcatchmentArea 27: Area 27 Runoff Area=2.594 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=1,357' Tc=6.9 min CN=69 Runoff=7.46 cfs 0.409 af

SubcatchmentArea 28: Area 28 Runoff Area=2.159 ac 0.00% Impervious Runoff Depth=2.29"
Flow Length=125' Slope=0.2500 '/' Tc=3.9 min CN=74 Runoff=8.44 cfs 0.412 af

SubcatchmentArea 29: Area 29 Runoff Area=0.616 ac 0.00% Impervious Runoff Depth=2.13"
Flow Length=109' Slope=0.2500 '/' Tc=3.8 min CN=72 Runoff=2.25 cfs 0.109 af

SubcatchmentArea 3: Area 3 Runoff Area=0.348 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=298' Tc=4.8 min CN=69 Runoff=1.06 cfs 0.055 af

SubcatchmentArea 30: Area 30 Runoff Area=0.149 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=211' Tc=1.2 min CN=69 Runoff=0.52 cfs 0.023 af

SubcatchmentArea 31: Area 31 Runoff Area=0.126 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=59' Slope=0.2500 '/' Tc=2.5 min CN=69 Runoff=0.44 cfs 0.020 af

SubcatchmentArea 32: Area 32 Runoff Area=0.457 ac 0.00% Impervious Runoff Depth=1.97"
Flow Length=122' Slope=0.2500 '/' Tc=3.9 min CN=70 Runoff=1.53 cfs 0.075 af

SubcatchmentArea 33: Area 33 Runoff Area=1.056 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=419' Tc=4.7 min CN=69 Runoff=3.24 cfs 0.167 af

SubcatchmentArea 34: Area 34 Runoff Area=0.434 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=374' Tc=4.5 min CN=69 Runoff=1.35 cfs 0.068 af

SubcatchmentArea 35: Area 35 Runoff Area=1.218 ac 0.00% Impervious Runoff Depth=2.29"
Flow Length=104' Tc=4.6 min CN=74 Runoff=4.58 cfs 0.233 af

SubcatchmentArea 36: Area 36 Runoff Area=1.185 ac 0.00% Impervious Runoff Depth=1.59"
Flow Length=106' Tc=4.1 min CN=65 Runoff=3.12 cfs 0.157 af

SubcatchmentArea 37: Area 37 Runoff Area=1.291 ac 0.00% Impervious Runoff Depth=1.38"
Flow Length=120' Slope=0.2500 '/' Tc=3.9 min CN=62 Runoff=2.93 cfs 0.149 af

SubcatchmentArea 38: Area 38 Runoff Area=0.795 ac 0.00% Impervious Runoff Depth=1.45"
Flow Length=155' Tc=4.3 min CN=63 Runoff=1.86 cfs 0.096 af

SubcatchmentArea 39: Area 39 Runoff Area=0.620 ac 0.00% Impervious Runoff Depth=1.00"
Flow Length=168' Tc=9.6 min CN=56 Runoff=0.72 cfs 0.051 af

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SubcatchmentArea 4: Area 4 Runoff Area=0.288 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=296' Tc=4.0 min CN=69 Runoff=0.92 cfs 0.045 af

SubcatchmentArea 40: Area 40 Runoff Area=0.739 ac 0.00% Impervious Runoff Depth=1.00"
Flow Length=141' Tc=7.2 min CN=56 Runoff=0.98 cfs 0.061 af

SubcatchmentArea 41a: Area 41a Runoff Area=0.871 ac 0.00% Impervious Runoff Depth=1.59"
Flow Length=144' Slope=0.0500 '/' Tc=7.8 min CN=65 Runoff=2.00 cfs 0.116 af

SubcatchmentArea 41b: Area 41b Runoff Area=0.712 ac 0.00% Impervious Runoff Depth=2.05"
Flow Length=102' Slope=0.0500 '/' Tc=7.3 min CN=71 Runoff=2.19 cfs 0.122 af

SubcatchmentArea 42: Area 42 Runoff Area=0.769 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=139' Slope=0.0500 '/' Tc=7.7 min CN=69 Runoff=2.14 cfs 0.121 af

SubcatchmentArea 43: Area 43 Runoff Area=2.792 ac 0.00% Impervious Runoff Depth=1.32"
Flow Length=419' Tc=14.7 min CN=61 Runoff=3.88 cfs 0.306 af

SubcatchmentArea 44: Area 44 Runoff Area=1.416 ac 0.00% Impervious Runoff Depth=0.18"
Flow Length=941' Slope=0.0260 '/' Tc=22.0 min CN=39 Runoff=0.06 cfs 0.022 af

SubcatchmentArea 45: Area 45 Runoff Area=2.044 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=138' Tc=4.0 min CN=69 Runoff=6.52 cfs 0.322 af

SubcatchmentArea 46: Area 46 Runoff Area=0.769 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=139' Slope=0.0500 '/' Tc=7.7 min CN=69 Runoff=2.14 cfs 0.121 af

SubcatchmentArea 47: Area 47 Runoff Area=0.079 ac 0.00% Impervious Runoff Depth=2.13"
Flow Length=143' Tc=5.1 min CN=72 Runoff=0.27 cfs 0.014 af

SubcatchmentArea 48: Area 48 Runoff Area=3.726 ac 0.00% Impervious Runoff Depth=2.05"
Flow Length=391' Tc=11.1 min CN=71 Runoff=9.80 cfs 0.636 af

SubcatchmentArea 49: Area 49 Runoff Area=0.698 ac 0.00% Impervious Runoff Depth=0.18"
Flow Length=100' Slope=0.0600 '/' Tc=6.8 min CN=39 Runoff=0.03 cfs 0.011 af

SubcatchmentArea 5: Area 5 Runoff Area=0.504 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=258' Tc=3.4 min CN=69 Runoff=1.66 cfs 0.079 af

SubcatchmentArea 50: Area 50 Runoff Area=0.223 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=296' Tc=3.7 min CN=69 Runoff=0.72 cfs 0.035 af

SubcatchmentArea 51: Area 51 Runoff Area=0.655 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=642' Tc=5.0 min CN=69 Runoff=1.98 cfs 0.103 af

SubcatchmentArea 52: Area 52 Runoff Area=0.237 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=348' Tc=4.0 min CN=69 Runoff=0.76 cfs 0.037 af

SubcatchmentArea 53: Area 53 Runoff Area=0.475 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=425' Tc=4.5 min CN=69 Runoff=1.48 cfs 0.075 af

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SubcatchmentArea 54: Area 54 Runoff Area=1.618 ac 0.00% Impervious Runoff Depth=1.18"
Flow Length=384' Tc=4.2 min CN=59 Runoff=2.98 cfs 0.160 af

SubcatchmentArea 55: Area 55 Runoff Area=0.826 ac 0.00% Impervious Runoff Depth=1.12"
Flow Length=126' Slope=0.2500 '/' Tc=3.9 min CN=58 Runoff=1.45 cfs 0.077 af

SubcatchmentArea 56: Area 56 Runoff Area=1.228 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=647' Tc=5.7 min CN=69 Runoff=3.66 cfs 0.194 af

SubcatchmentArea 57: Area 57 Runoff Area=1.089 ac 0.00% Impervious Runoff Depth=1.12"
Flow Length=158' Tc=4.3 min CN=58 Runoff=1.86 cfs 0.102 af

SubcatchmentArea 58: Area 58 Runoff Area=1.194 ac 0.00% Impervious Runoff Depth=1.18"
Flow Length=221' Tc=4.4 min CN=59 Runoff=2.17 cfs 0.118 af

SubcatchmentArea 59: Area 59 Runoff Area=2.220 ac 0.00% Impervious Runoff Depth=0.88"
Flow Length=240' Tc=4.6 min CN=54 Runoff=2.69 cfs 0.162 af

SubcatchmentArea 6: Area 6 Runoff Area=0.936 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=541' Tc=5.3 min CN=69 Runoff=2.81 cfs 0.148 af

SubcatchmentArea 60: Area 60 Runoff Area=2.476 ac 0.00% Impervious Runoff Depth=1.12"
Flow Length=263' Tc=4.7 min CN=58 Runoff=4.13 cfs 0.231 af

SubcatchmentArea 61: Area 61 Runoff Area=1.683 ac 0.00% Impervious Runoff Depth=0.82"
Flow Length=146' Slope=0.2345 '/' Tc=4.1 min CN=53 Runoff=1.90 cfs 0.115 af

SubcatchmentArea 62: Area 62 Runoff Area=2.001 ac 0.00% Impervious Runoff Depth=0.33"
Flow Length=318' Tc=20.8 min CN=43 Runoff=0.24 cfs 0.055 af

SubcatchmentArea 63: Area 63 Runoff Area=2.177 ac 0.00% Impervious Runoff Depth=0.18"
Flow Length=149' Tc=8.2 min CN=39 Runoff=0.09 cfs 0.033 af

SubcatchmentArea 64: Area 64 Runoff Area=0.594 ac 0.00% Impervious Runoff Depth=0.66"
Flow Length=147' Slope=0.0544 '/' Tc=7.6 min CN=50 Runoff=0.39 cfs 0.032 af

SubcatchmentArea 65: Area 65 Runoff Area=1.509 ac 100.00% Impervious Runoff Depth=4.67"
Tc=0.0 min CN=98 Runoff=10.73 cfs 0.588 af

SubcatchmentArea 66: Area 66 Runoff Area=5.227 ac 0.00% Impervious Runoff Depth=0.18"
Flow Length=701' Tc=7.9 min CN=39 Runoff=0.22 cfs 0.079 af

SubcatchmentArea 67: Area 67 Runoff Area=3.035 ac 0.00% Impervious Runoff Depth=0.51"
Flow Length=886' Slope=0.0068 '/' Tc=38.9 min CN=47 Runoff=0.61 cfs 0.128 af

SubcatchmentArea 68: Area 68 Runoff Area=0.251 ac 0.00% Impervious Runoff Depth=0.29"
Flow Length=52' Slope=0.1154 '/' Tc=3.1 min CN=42 Runoff=0.03 cfs 0.006 af

SubcatchmentArea 69: Area 69 Runoff Area=0.913 ac 0.00% Impervious Runoff Depth=0.46"
Flow Length=86' Slope=0.2326 '/' Tc=3.5 min CN=46 Runoff=0.36 cfs 0.035 af

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SubcatchmentArea 7: Area 7 Runoff Area=0.986 ac 0.00% Impervious Runoff Depth=1.89"
Flow Length=608' Tc=6.6 min CN=69 Runoff=2.87 cfs 0.155 af

SubcatchmentArea 70: Area 70 Runoff Area=1.671 ac 0.00% Impervious Runoff Depth=0.71"
Flow Length=126' Tc=4.0 min CN=51 Runoff=1.52 cfs 0.099 af

SubcatchmentArea 71: Area 71 Runoff Area=9.875 ac 0.00% Impervious Runoff Depth=0.29"
Flow Length=1,337' Tc=16.6 min CN=42 Runoff=0.99 cfs 0.238 af

SubcatchmentArea 8: Area 8 Runoff Area=35,545 sf 0.00% Impervious Runoff Depth=1.89"
Flow Length=348' Tc=3.6 min CN=69 Runoff=2.66 cfs 0.129 af

SubcatchmentArea 9: Area 9 Runoff Area=10,716 sf 0.00% Impervious Runoff Depth=1.89"
Flow Length=144' Tc=2.3 min CN=69 Runoff=0.86 cfs 0.039 af

Reach RD1: Roadside Ditch 1 Avg. Flow Depth=0.10' Max Vel=1.34 fps Inflow=0.61 cfs 0.128 af
n=0.030 L=440.6' S=0.0188 '/' Capacity=47.16 cfs Outflow=0.60 cfs 0.128 af

Reach RD2: Roadside Ditch 2 Avg. Flow Depth=0.39' Max Vel=2.69 fps Inflow=11.23 cfs 0.814 af
n=0.030 L=433.0' S=0.0162 '/' Capacity=72.77 cfs Outflow=10.38 cfs 0.814 af

Reach RD3: Roadside Ditch 3 Avg. Flow Depth=0.67' Max Vel=3.99 fps Inflow=8.44 cfs 0.412 af
n=0.030 L=821.0' S=0.0288 '/' Capacity=20.76 cfs Outflow=7.09 cfs 0.412 af

Reach RD4: Roadside Ditch 4 Avg. Flow Depth=0.12' Max Vel=1.05 fps Inflow=1.52 cfs 0.099 af
n=0.030 L=495.6' S=0.0090 '/' Capacity=54.26 cfs Outflow=0.92 cfs 0.099 af

Reach RD5: Roadside Ditch 5 Avg. Flow Depth=0.38' Max Vel=3.65 fps Inflow=2.25 cfs 0.109 af
n=0.030 L=288.0' S=0.0531 '/' Capacity=28.18 cfs Outflow=2.01 cfs 0.109 af

Reach S1.1: Swale S1.1 Avg. Flow Depth=0.14' Max Vel=2.32 fps Inflow=3.12 cfs 0.157 af
n=0.030 L=321.0' S=0.0319 '/' Capacity=338.34 cfs Outflow=2.76 cfs 0.157 af

Reach S1.2: Swale S1.2 Avg. Flow Depth=0.76' Max Vel=3.60 fps Inflow=30.31 cfs 1.696 af
n=0.030 L=202.8' S=0.0108 '/' Capacity=196.86 cfs Outflow=28.58 cfs 1.696 af

Reach S1.3: Swale S1.3 Avg. Flow Depth=0.76' Max Vel=4.15 fps Inflow=34.68 cfs 2.079 af
n=0.030 L=72.2' S=0.0144 '/' Capacity=227.36 cfs Outflow=34.14 cfs 2.079 af

Reach S1.4: Swale S1.4 Avg. Flow Depth=1.03' Max Vel=2.73 fps Inflow=35.12 cfs 2.141 af
n=0.030 L=148.0' S=0.0045 '/' Capacity=126.50 cfs Outflow=33.65 cfs 2.141 af

Reach S1.5: Swale S1.5 Avg. Flow Depth=0.20' Max Vel=1.12 fps Inflow=2.14 cfs 0.121 af
n=0.030 L=179.7' S=0.0050 '/' Capacity=134.06 cfs Outflow=1.95 cfs 0.121 af

Reach S1.6: Swale S1.6 Avg. Flow Depth=1.04' Max Vel=3.05 fps Inflow=39.20 cfs 2.499 af
n=0.030 L=252.0' S=0.0054 '/' Capacity=139.68 cfs Outflow=37.41 cfs 2.499 af

Reach S1.7: Swale S1.7 Avg. Flow Depth=0.31' Max Vel=1.88 fps Inflow=2.19 cfs 0.122 af
n=0.030 L=245.8' S=0.0099 '/' Capacity=90.14 cfs Outflow=1.99 cfs 0.122 af

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Reach S1.8: Swale S1.8 Avg. Flow Depth=0.98' Max Vel=3.45 fps Inflow=41.27 cfs 2.805 af
n=0.030 L=422.0' S=0.0075 '/' Capacity=163.67 cfs Outflow=39.57 cfs 2.805 af

Reach S2.1: Swale S2.1 Avg. Flow Depth=1.31' Max Vel=3.17 fps Inflow=39.58 cfs 2.837 af
n=0.030 L=389.0' S=0.0054 '/' Capacity=97.05 cfs Outflow=38.03 cfs 2.837 af

Reach S2.2: Swale S2.2 Avg. Flow Depth=1.29' Max Vel=3.33 fps Inflow=65.64 cfs 5.558 af
n=0.030 L=411.0' S=0.0049 '/' Capacity=152.61 cfs Outflow=64.61 cfs 5.558 af

Reach S2.3: Swale S2.3 Avg. Flow Depth=0.99' Max Vel=4.71 fps Inflow=65.54 cfs 5.750 af
n=0.030 L=307.0' S=0.0130 '/' Capacity=249.72 cfs Outflow=64.79 cfs 5.750 af

Reach S3.1: Swale S3.1 Avg. Flow Depth=0.37' Max Vel=1.62 fps Inflow=6.52 cfs 0.322 af
n=0.030 L=357.0' S=0.0050 '/' Capacity=133.76 cfs Outflow=5.46 cfs 0.322 af

Reach S3.2: Swale S3.2 Avg. Flow Depth=0.79' Max Vel=2.48 fps Inflow=22.25 cfs 1.287 af
n=0.030 L=34.0' S=0.0050 '/' Capacity=133.95 cfs Outflow=21.76 cfs 1.287 af

Reach S3.3: Swale S3.3 Avg. Flow Depth=0.60' Max Vel=3.48 fps Inflow=21.76 cfs 1.287 af
n=0.030 L=200.0' S=0.0130 '/' Capacity=215.99 cfs Outflow=20.93 cfs 1.287 af

Reach S3.4: Swale S3.4 Avg. Flow Depth=0.33' Max Vel=1.67 fps Inflow=2.14 cfs 0.121 af
n=0.030 L=283.0' S=0.0071 '/' Capacity=76.21 cfs Outflow=1.94 cfs 0.121 af

Reach S3.5: Swale S3.5 Avg. Flow Depth=1.27' Max Vel=2.26 fps Inflow=39.57 cfs 2.531 af
n=0.030 L=318.5' S=0.0024 '/' Capacity=93.14 cfs Outflow=36.85 cfs 2.531 af

Reach S4.1: Swale S4.1 Avg. Flow Depth=0.14' Max Vel=1.62 fps Inflow=2.74 cfs 0.145 af
n=0.030 L=240.0' S=0.0153 '/' Capacity=70.22 cfs Outflow=2.38 cfs 0.145 af

Reach S4.2: Swale S4.2 Avg. Flow Depth=0.26' Max Vel=2.12 fps Inflow=6.29 cfs 0.372 af
n=0.030 L=259.3' S=0.0127 '/' Capacity=63.88 cfs Outflow=5.84 cfs 0.372 af

Reach S4.3: Swale S4.3 Avg. Flow Depth=0.74' Max Vel=1.83 fps Inflow=19.18 cfs 1.179 af
n=0.030 L=362.9' S=0.0027 '/' Capacity=108.12 cfs Outflow=17.09 cfs 1.179 af

Reach S4.4: Swale S4.4 Avg. Flow Depth=0.75' Max Vel=2.28 fps Inflow=22.46 cfs 1.757 af
n=0.030 L=495.6' S=0.0040 '/' Capacity=132.85 cfs Outflow=21.52 cfs 1.757 af

Reach S4.5: Swale S4.5 Avg. Flow Depth=0.60' Max Vel=3.08 fps Inflow=22.64 cfs 1.939 af
n=0.030 L=411.1' S=0.0097 '/' Capacity=465.89 cfs Outflow=22.15 cfs 1.939 af

Reach S4.6: Swale S4.6 Avg. Flow Depth=1.24' Max Vel=5.00 fps Inflow=89.26 cfs 8.232 af
n=0.030 L=537.0' S=0.0112 '/' Capacity=499.25 cfs Outflow=87.87 cfs 8.232 af

Reach S5.1: Swale S5.1 Avg. Flow Depth=0.22' Max Vel=2.09 fps Inflow=4.58 cfs 0.233 af
n=0.030 L=478.0' S=0.0154 '/' Capacity=235.22 cfs Outflow=3.89 cfs 0.233 af

Pond C8: Culvert C8 Peak Elev=811.21' Storage=0.000 af Inflow=0.95 cfs 0.043 af
12.0" Round Culvert n=0.012 L=85.6' S=0.0245 '/' Outflow=0.96 cfs 0.043 af

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Pond N: North Infiltration Area Peak Elev=803.86' Storage=20,107 cf Inflow=11.66 cfs 1.151 af
Outflow=1.38 cfs 1.151 af

Pond Sed Pond: Sedimentation Basin Peak Elev=792.00' Storage=164,114 cf Inflow=89.59 cfs 8.931 af
6.100 af Primary=10.00 cfs 2.831 af Secondary=0.00 cfs 0.000 af Tertiary=0.00 cfs 0.000 af Outflow=15.47 cfs 8.931 af

Link C1: Culvert C1 Inflow=0.60 cfs 0.128 af
Primary=0.60 cfs 0.128 af

Link C10: Culvert C10 Inflow=2.76 cfs 0.157 af
Primary=2.76 cfs 0.157 af

Link C2: Culvert C2 Inflow=10.95 cfs 0.645 af
Primary=10.95 cfs 0.645 af

Link C3: Culvert C3 Inflow=28.58 cfs 1.696 af
Primary=28.58 cfs 1.696 af

Link C4: Culvert C4 Inflow=34.14 cfs 2.079 af
Primary=34.14 cfs 2.079 af

Link C5: Culvert C5 Inflow=37.41 cfs 2.499 af
Primary=37.41 cfs 2.499 af

Link C6: Culvert C6 Inflow=30.67 cfs 1.895 af
Primary=30.67 cfs 1.895 af

Link C7: Culvert C7 Inflow=67.17 cfs 6.238 af
Primary=67.17 cfs 6.238 af

Link C9: Culvert C9 Inflow=11.16 cfs 0.913 af
Primary=11.16 cfs 0.913 af

Link F10: Flume 10 Inflow=0.95 cfs 0.043 af
Primary=0.95 cfs 0.043 af

Link F1A: Flume 1A Inflow=5.38 cfs 0.292 af
Primary=5.38 cfs 0.292 af

Link F1B: Flume 1B Inflow=12.06 cfs 0.645 af
Primary=12.06 cfs 0.645 af

Link F2A: Flume 2A Inflow=1.98 cfs 0.100 af
Primary=1.98 cfs 0.100 af

Link F2B: Flume 2B Inflow=6.58 cfs 0.347 af
Primary=6.58 cfs 0.347 af

Link F3: Flume 3 Inflow=1.38 cfs 0.067 af
Primary=1.38 cfs 0.067 af

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Link F4A: Flume 4A	Inflow=3.47 cfs 0.191 af Primary=3.47 cfs 0.191 af
Link F4B: Flume 4B	Inflow=9.10 cfs 0.488 af Primary=9.10 cfs 0.488 af
Link F5A: Flume 5A	Inflow=0.76 cfs 0.037 af Primary=0.76 cfs 0.037 af
Link F5B: Flume 5B	Inflow=2.23 cfs 0.112 af Primary=2.23 cfs 0.112 af
Link F6A: Flume 6A	Inflow=4.38 cfs 0.227 af Primary=4.38 cfs 0.227 af
Link F6B: Flume 6B	Inflow=9.20 cfs 0.473 af Primary=9.20 cfs 0.473 af
Link F7A: Flume 7A	Inflow=3.51 cfs 0.167 af Primary=3.51 cfs 0.167 af
Link F7B: Flume 7B	Inflow=10.65 cfs 0.537 af Primary=10.65 cfs 0.537 af
Link F7C: Flume 7C	Inflow=17.47 cfs 0.889 af Primary=17.47 cfs 0.889 af
Link F8A: Flume 8A	Inflow=1.19 cfs 0.060 af Primary=1.19 cfs 0.060 af
Link F8B: Flume 8B	Inflow=4.66 cfs 0.236 af Primary=4.66 cfs 0.236 af
Link F9A: Flume 9A	Inflow=6.88 cfs 0.386 af Primary=6.88 cfs 0.386 af
Link F9B: Flume 9B	Inflow=15.84 cfs 0.874 af Primary=15.84 cfs 0.874 af
Link F9C: Flume 9C	Inflow=25.24 cfs 1.389 af Primary=25.24 cfs 1.389 af
Link Wetland: Wetland	Inflow=10.00 cfs 2.831 af Primary=10.00 cfs 2.831 af

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Summary for Subcatchment Area 1: Area 1

Runoff = 3.75 cfs @ 12.14 hrs, Volume= 0.204 af, Depth= 1.89"
Routed to Link F1A : Flume 1A

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
1.296	69	Pasture/grassland/range, Fair, HSG B
1.296		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.2	93	0.1000	0.30		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.5	7	0.2500	0.26		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.7	151	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.3	113	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
6.7	364	Total			

Summary for Subcatchment Area 10: Area 10

Runoff = 1.68 cfs @ 12.14 hrs, Volume= 0.090 af, Depth= 1.89"
Routed to Link F9A : Flume 9A

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.573	69	Pasture/grassland/range, Fair, HSG B
0.573		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.6	79	0.1000	0.29		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
1.1	21	0.2500	0.32		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.3	53	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.4	168	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
6.4	321	Total			

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Summary for Subcatchment Area 11: Area 11

Runoff = 5.22 cfs @ 12.15 hrs, Volume= 0.295 af, Depth= 1.89"
Routed to Link F9A : Flume 9A

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
1.872	69	Pasture/grassland/range, Fair, HSG B
1.872		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.4	96	0.1000	0.30		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.3	4	0.2500	0.23		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.4	90	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.5	606	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
7.6	796	Total			

Summary for Subcatchment Area 12: Area 12

Runoff = 4.83 cfs @ 12.13 hrs, Volume= 0.254 af, Depth= 1.89"
Routed to Link F1B : Flume 1B

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
1.610	69	Pasture/grassland/range, Fair, HSG B
1.610		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.1	31	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.4	581	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
5.3	712	Total			

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Summary for Subcatchment Area 13: Area 13

Runoff = 1.94 cfs @ 12.11 hrs, Volume= 0.099 af, Depth= 1.89"
Routed to Link F1B : Flume 1B

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.626	69	Pasture/grassland/range, Fair, HSG B
0.626		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.2	50	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.5	183	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
4.5	333	Total			

Summary for Subcatchment Area 14: Area 14

Runoff = 1.93 cfs @ 12.11 hrs, Volume= 0.098 af, Depth= 1.89"
Routed to Link F2B : Flume 2B

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.620	69	Pasture/grassland/range, Fair, HSG B
0.620		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.2	50	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.4	181	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
4.4	331	Total			

Summary for Subcatchment Area 15: Area 15

Runoff = 2.80 cfs @ 12.14 hrs, Volume= 0.149 af, Depth= 1.89"
Routed to Link F2B : Flume 2B

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.943	69	Pasture/grassland/range, Fair, HSG B
0.943		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.7	100	0.1500	0.35		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.5	95	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.7	269	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
5.9	464	Total			

Summary for Subcatchment Area 16: Area 16

Runoff = 1.78 cfs @ 12.11 hrs, Volume= 0.090 af, Depth= 1.89"
Routed to Link F6B : Flume 6B

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.571	69	Pasture/grassland/range, Fair, HSG B
0.571		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.2	44	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.4	171	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
4.4	315	Total			

Summary for Subcatchment Area 17: Area 17

Runoff = 3.04 cfs @ 12.12 hrs, Volume= 0.156 af, Depth= 1.89"
Routed to Link F6B : Flume 6B

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.990	69	Pasture/grassland/range, Fair, HSG B
0.990		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.2	46	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.7	278	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
4.7	424	Total			

Summary for Subcatchment Area 18: Area 18

Runoff = 5.06 cfs @ 12.12 hrs, Volume= 0.261 af, Depth= 1.89"
Routed to Link F7B : Flume 7B

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
1.656	69	Pasture/grassland/range, Fair, HSG B
1.656		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	88	0.2045	0.39		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
1.0	420	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
4.8	508	Total			

Summary for Subcatchment Area 19: Area 19

Runoff = 2.16 cfs @ 12.11 hrs, Volume= 0.109 af, Depth= 1.89"
Routed to Link F7B : Flume 7B

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.689	69	Pasture/grassland/range, Fair, HSG B
0.689		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.2	50	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.3	136	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
4.3	286	Total			

Summary for Subcatchment Area 2: Area 2

Runoff = 1.71 cfs @ 12.12 hrs, Volume= 0.088 af, Depth= 1.89"
Routed to Link F1A : Flume 1A

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.557	69	Pasture/grassland/range, Fair, HSG B
0.557		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.2	100	0.1950	0.39		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.1	22	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.4	181	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
4.7	303	Total			

Summary for Subcatchment Area 20: Area 20

Runoff = 1.19 cfs @ 12.11 hrs, Volume= 0.060 af, Depth= 1.89"
Routed to Link F8A : Flume 8A

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.381	69	Pasture/grassland/range, Fair, HSG B
0.381		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.0	7	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.5	199	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
4.3	306	Total			

Summary for Subcatchment Area 21: Area 21

Runoff = 1.62 cfs @ 12.11 hrs, Volume= 0.081 af, Depth= 1.89"
Routed to Link F9B : Flume 9B

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.516	69	Pasture/grassland/range, Fair, HSG B
0.516		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.0	7	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.5	205	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
4.3	312	Total			

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Summary for Subcatchment Area 22: Area 22

Runoff = 7.54 cfs @ 12.14 hrs, Volume= 0.407 af, Depth= 1.89"
Routed to Link F9B : Flume 9B

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
2.579	69	Pasture/grassland/range, Fair, HSG B
2.579		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.1	21	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
2.5	1,025	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
6.4	1,146	Total			

Summary for Subcatchment Area 23: Area 23

Runoff = 1.38 cfs @ 12.10 hrs, Volume= 0.067 af, Depth= 1.89"
Routed to Link F3 : Flume 3

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.427	69	Pasture/grassland/range, Fair, HSG B
0.427		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.9	70	0.2500	0.40		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.8	227	0.0200	4.80	23.38	**Trap/Vee/Rect Channel Flow, Existing Diversion Berm** Bot.W=0.00' D=1.18' Z= 4.0 & 3.0 '/' Top.W=8.26' n= 0.030 Earth, grassed & winding
0.1	65	0.2500	12.26	441.43	**Trap/Vee/Rect Channel Flow, Riprap Flume** Bot.W=12.00' D=2.00' Z= 3.0 '/' Top.W=24.00' n= 0.078 Riprap, 12-inch
3.8	362	Total			

Summary for Subcatchment Area 24: Area 24

Runoff = 3.61 cfs @ 12.12 hrs, Volume= 0.186 af, Depth= 1.89"
Routed to Link F7C : Flume 7C

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
1.177	69	Pasture/grassland/range, Fair, HSG B
1.177		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.3	60	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.6	225	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
4.7	385	Total			

Summary for Subcatchment Area 25: Area 25

Runoff = 2.12 cfs @ 12.11 hrs, Volume= 0.108 af, Depth= 1.89"
Routed to Link F8B : Flume 8B

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.682	69	Pasture/grassland/range, Fair, HSG B
0.682		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.2	50	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.5	199	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
4.5	349	Total			

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Summary for Subcatchment Area 26: Area 26

Runoff = 2.10 cfs @ 12.11 hrs, Volume= 0.107 af, Depth= 1.89"
Routed to Link F9C : Flume 9C

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.677	69	Pasture/grassland/range, Fair, HSG B
0.677		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.2	50	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.5	191	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
4.5	341	Total			

Summary for Subcatchment Area 27: Area 27

Runoff = 7.46 cfs @ 12.15 hrs, Volume= 0.409 af, Depth= 1.89"
Routed to Link F9C : Flume 9C

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
2.594	69	Pasture/grassland/range, Fair, HSG B
2.594		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	99	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
3.1	1,258	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
6.9	1,357	Total			

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Summary for Subcatchment Area 28: Area 28

Runoff = 8.44 cfs @ 12.10 hrs, Volume= 0.412 af, Depth= 2.29"
Routed to Reach RD3 : Roadside Ditch 3

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
1.735	69	Pasture/grassland/range, Fair, HSG B
0.424	96	Gravel surface, HSG A
2.159	74	Weighted Average
2.159		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.1	25	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
3.9	125	Total			

Summary for Subcatchment Area 29: Area 29

Runoff = 2.25 cfs @ 12.10 hrs, Volume= 0.109 af, Depth= 2.13"
Routed to Reach RD5 : Roadside Ditch 5

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.543	69	Pasture/grassland/range, Fair, HSG B
0.073	96	Gravel surface, HSG A
0.616	72	Weighted Average
0.616		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.0	9	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
3.8	109	Total			

Summary for Subcatchment Area 3: Area 3

Runoff = 1.06 cfs @ 12.12 hrs, Volume= 0.055 af, Depth= 1.89"
Routed to Link F2A : Flume 2A

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.348	69	Pasture/grassland/range, Fair, HSG B
0.348		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.2	100	0.1950	0.39		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.2	36	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.4	162	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
4.8	298	Total			

Summary for Subcatchment Area 30: Area 30

Runoff = 0.52 cfs @ 12.08 hrs, Volume= 0.023 af, Depth= 1.89"
Routed to Link F10 : Flume 10

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.149	69	Pasture/grassland/range, Fair, HSG B
0.149		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.7	12	0.2500	0.28		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.5	199	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
1.2	211	Total			

Summary for Subcatchment Area 31: Area 31

Runoff = 0.44 cfs @ 12.09 hrs, Volume= 0.020 af, Depth= 1.89"
Routed to Link F10 : Flume 10

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.126	69	Pasture/grassland/range, Fair, HSG B
0.126		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.5	59	0.2500	0.39		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"

Summary for Subcatchment Area 32: Area 32

Runoff = 1.53 cfs @ 12.11 hrs, Volume= 0.075 af, Depth= 1.97"
Routed to Reach S3.2 : Swale S3.2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.435	69	Pasture/grassland/range, Fair, HSG B
0.022	96	Gravel surface, HSG A
0.457	70	Weighted Average
0.457		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.1	22	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
3.9	122	Total			

Summary for Subcatchment Area 33: Area 33

Runoff = 3.24 cfs @ 12.12 hrs, Volume= 0.167 af, Depth= 1.89"
Routed to Link F7C : Flume 7C

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

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Area (ac)	CN	Description
1.056	69	Pasture/grassland/range, Fair, HSG B
1.056		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.3	57	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.6	262	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
4.7	419	Total			

Summary for Subcatchment Area 34: Area 34

Runoff = 1.35 cfs @ 12.11 hrs, Volume= 0.068 af, Depth= 1.89"
Routed to Link F8B : Flume 8B

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.434	69	Pasture/grassland/range, Fair, HSG B
0.434		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.1	15	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.6	259	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
4.5	374	Total			

Summary for Subcatchment Area 35: Area 35

Runoff = 4.58 cfs @ 12.11 hrs, Volume= 0.233 af, Depth= 2.29"
Routed to Reach S5.1 : Swale S5.1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

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Area (ac)	CN	Description
0.986	69	Pasture/grassland/range, Fair, HSG B
0.232	96	Gravel surface, HSG A
1.218	74	Weighted Average
1.218		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.3	70	0.1736	0.35		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.6	20	0.0050	0.53		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.77"
0.7	10	0.1766	0.24		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.0	4	0.1766	2.94		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
4.6	104	Total			

Summary for Subcatchment Area 36: Area 36

Runoff = 3.12 cfs @ 12.11 hrs, Volume= 0.157 af, Depth= 1.59"
Routed to Reach S1.1 : Swale S1.1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.322	39	Pasture/grassland/range, Good, HSG A
0.696	69	Pasture/grassland/range, Fair, HSG B
0.167	96	Gravel surface, HSG A
1.185	65	Weighted Average
1.185		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.4	72	0.1736	0.35		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.6	20	0.0050	0.53		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.77"
0.1	14	0.1766	2.94		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
4.1	106	Total			

Summary for Subcatchment Area 37: Area 37

Runoff = 2.93 cfs @ 12.11 hrs, Volume= 0.149 af, Depth= 1.38"
Routed to Reach S1.2 : Swale S1.2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

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Area (ac)	CN	Description
0.415	39	Pasture/grassland/range, Good, HSG A
0.743	69	Pasture/grassland/range, Fair, HSG B
0.133	96	Gravel surface, HSG A
1.291	62	Weighted Average
1.291		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.1	20	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
3.9	120	Total			

Summary for Subcatchment Area 38: Area 38

Runoff = 1.86 cfs @ 12.11 hrs, Volume= 0.096 af, Depth= 1.45"
Routed to Reach S1.3 : Swale S1.3

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.263	39	Pasture/grassland/range, Good, HSG A
0.409	69	Pasture/grassland/range, Fair, HSG B
0.123	96	Gravel surface, HSG A
0.795	63	Weighted Average
0.795		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.1	14	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.2	17	0.0050	1.44		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.2	24	0.0833	2.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
4.3	155	Total			

Summary for Subcatchment Area 39: Area 39

Runoff = 0.72 cfs @ 12.19 hrs, Volume= 0.051 af, Depth= 1.00"
Routed to Reach S1.3 : Swale S1.3

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

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Area (ac)	CN	Description
0.317	39	Pasture/grassland/range, Good, HSG A
0.243	69	Pasture/grassland/range, Fair, HSG B
0.060	96	Gravel surface, HSG A
0.620	56	Weighted Average
0.620		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.2	81	0.0245	0.16		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
1.0	19	0.2500	0.31		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.1	29	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.2	20	0.0050	1.44		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.1	19	0.1053	2.27		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
9.6	168	Total			

Summary for Subcatchment Area 4: Area 4

Runoff = 0.92 cfs @ 12.11 hrs, Volume= 0.045 af, Depth= 1.89"
Routed to Link F2A : Flume 2A

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.288	69	Pasture/grassland/range, Fair, HSG B
0.288		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.4	49	0.0820	0.24		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.6	247	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
4.0	296	Total			

Summary for Subcatchment Area 40: Area 40

Runoff = 0.98 cfs @ 12.16 hrs, Volume= 0.061 af, Depth= 1.00"
Routed to Reach S1.4 : Swale S1.4

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

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Area (ac)	CN	Description
0.389	39	Pasture/grassland/range, Good, HSG A
0.270	69	Pasture/grassland/range, Fair, HSG B
0.080	96	Gravel surface, HSG A
0.739	56	Weighted Average
0.739		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.5	49	0.0408	0.18		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
2.1	47	0.2500	0.37		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.2	4	0.0050	0.39		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.77"
0.2	19	0.0050	1.44		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.2	22	0.1136	2.36		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
7.2	141	Total			

Summary for Subcatchment Area 41a: Area 41a

Runoff = 2.00 cfs @ 12.16 hrs, Volume= 0.116 af, Depth= 1.59"
Routed to Reach S1.6 : Swale S1.6

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.249	39	Pasture/grassland/range, Good, HSG A
0.489	69	Pasture/grassland/range, Fair, HSG B
0.133	96	Gravel surface, HSG A
0.871	65	Weighted Average
0.871		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.3	100	0.0500	0.23		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.5	44	0.0500	1.57		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
7.8	144	Total			

Summary for Subcatchment Area 41b: Area 41b

Runoff = 2.19 cfs @ 12.15 hrs, Volume= 0.122 af, Depth= 2.05"
Routed to Reach S1.7 : Swale S1.7

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.655	69	Pasture/grassland/range, Fair, HSG B
0.057	96	Gravel surface, HSG A
0.712	71	Weighted Average
0.712		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.3	100	0.0500	0.23		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.0	2	0.0500	1.57		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
7.3	102	Total			

Summary for Subcatchment Area 42: Area 42

Runoff = 2.14 cfs @ 12.15 hrs, Volume= 0.121 af, Depth= 1.89"
Routed to Reach S1.5 : Swale S1.5

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.769	69	Pasture/grassland/range, Fair, HSG B
0.769		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.3	100	0.0500	0.23		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.4	39	0.0500	1.57		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
7.7	139	Total			

Summary for Subcatchment Area 43: Area 43

Runoff = 3.88 cfs @ 12.25 hrs, Volume= 0.306 af, Depth= 1.32"
Routed to Reach S1.8 : Swale S1.8

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

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Area (ac)	CN	Description
0.797	39	Pasture/grassland/range, Good, HSG A
1.938	69	Pasture/grassland/range, Fair, HSG B
0.057	96	Gravel surface, HSG A
2.792	61	Weighted Average
2.792		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.3	100	0.0500	0.23		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
1.3	119	0.0500	1.57		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.1	22	0.1905	3.06		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
6.0	178	0.0050	0.49		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
14.7	419	Total			

Summary for Subcatchment Area 44: Area 44

Runoff = 0.06 cfs @ 13.20 hrs, Volume= 0.022 af, Depth= 0.18"
Routed to Reach S2.1 : Swale S2.1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
1.416	39	Pasture/grassland/range, Good, HSG A
1.416		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.5	100	0.0260	0.18		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
2.9	194	0.0260	1.13		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
9.6	647	0.0260	1.13		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
22.0	941	Total			

Summary for Subcatchment Area 45: Area 45

Runoff = 6.52 cfs @ 12.11 hrs, Volume= 0.322 af, Depth= 1.89"
Routed to Reach S3.1 : Swale S3.1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

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Area (ac)	CN	Description
2.044	69	Pasture/grassland/range, Fair, HSG B
2.044		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.2	38	0.2632	3.59		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
4.0	138	Total			

Summary for Subcatchment Area 46: Area 46

Runoff = 2.14 cfs @ 12.15 hrs, Volume= 0.121 af, Depth= 1.89"
Routed to Reach S3.4 : Swale S3.4

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.769	69	Pasture/grassland/range, Fair, HSG B
0.769		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.3	100	0.0500	0.23		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.4	39	0.0500	1.57		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
7.7	139	Total			

Summary for Subcatchment Area 47: Area 47

Runoff = 0.27 cfs @ 12.12 hrs, Volume= 0.014 af, Depth= 2.13"
Routed to Link C6 : Culvert C6

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.070	69	Pasture/grassland/range, Fair, HSG B
0.009	96	Gravel surface, HSG A
0.079	72	Weighted Average
0.079		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.5	90	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
1.2	10	0.0500	0.14		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.1	10	0.0500	1.57		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.2	15	0.0050	1.44		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.1	18	0.1390	2.61		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
5.1	143	Total			

Summary for Subcatchment Area 48: Area 48

Runoff = 9.80 cfs @ 12.20 hrs, Volume= 0.636 af, Depth= 2.05"
Routed to Reach S3.5 : Swale S3.5

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
3.470	69	Pasture/grassland/range, Fair, HSG B
0.256	96	Gravel surface, HSG A
3.726	71	Weighted Average
3.726		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.3	100	0.0500	0.23		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.9	83	0.0500	1.57		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
2.9	208	0.0289	1.19		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
11.1	391	Total			

Summary for Subcatchment Area 49: Area 49

Runoff = 0.03 cfs @ 12.51 hrs, Volume= 0.011 af, Depth= 0.18"
Routed to Reach S2.1 : Swale S2.1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

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Area (ac)	CN	Description
0.698	39	Pasture/grassland/range, Good, HSG A
0.698		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.8	100	0.0600	0.25		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"

Summary for Subcatchment Area 5: Area 5

Runoff = 1.66 cfs @ 12.10 hrs, Volume= 0.079 af, Depth= 1.89"
Routed to Link F6A : Flume 6A

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.504	69	Pasture/grassland/range, Fair, HSG B
0.504		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.9	72	0.2500	0.41		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.5	186	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Existing Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
3.4	258	Total			

Summary for Subcatchment Area 50: Area 50

Runoff = 0.72 cfs @ 12.10 hrs, Volume= 0.035 af, Depth= 1.89"
Routed to Link F4A : Flume 4A

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.223	69	Pasture/grassland/range, Fair, HSG B
0.223		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.1	77	0.2500	0.41		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.5	157	0.0200	4.80	23.38	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.18' Z= 4.0 & 3.0 '/' Top.W=8.26' n= 0.030 Earth, grassed & winding
0.1	62	0.2500	12.26	441.43	**Trap/Vee/Rect Channel Flow, Riprap Flume** Bot.W=12.00' D=2.00' Z= 3.0 '/' Top.W=24.00' n= 0.078 Riprap, 12-inch
3.7	296	Total			

Summary for Subcatchment Area 51: Area 51

Runoff = 1.98 cfs @ 12.12 hrs, Volume= 0.103 af, Depth= 1.89"
Routed to Link F4B : Flume 4B

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.655	69	Pasture/grassland/range, Fair, HSG B
0.655		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.1	11	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.8	314	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Existing Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
0.3	217	0.2500	12.26	441.43	**Trap/Vee/Rect Channel Flow, Riprap Flume** Bot.W=12.00' D=2.00' Z= 3.0 '/' Top.W=24.00' n= 0.078 Riprap, 12-inch
5.0	642	Total			

Summary for Subcatchment Area 52: Area 52

Runoff = 0.76 cfs @ 12.11 hrs, Volume= 0.037 af, Depth= 1.89"
Routed to Link F5A : Flume 5A

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

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Area (ac)	CN	Description
0.237	69	Pasture/grassland/range, Fair, HSG B
0.237		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.3	83	0.2500	0.42		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.5	138	0.0200	4.80	23.38	**Trap/Vee/Rect Channel Flow, Existing Diversion Berm** Bot.W=0.00' D=1.18' Z= 4.0 & 3.0 '/' Top.W=8.26' n= 0.030 Earth, grassed & winding
0.2	127	0.2500	12.26	441.43	**Trap/Vee/Rect Channel Flow, Riprap Flume** Bot.W=12.00' D=2.00' Z= 3.0 '/' Top.W=24.00' n= 0.078 Riprap, 12-inch
4.0	348	Total			

Summary for Subcatchment Area 53: Area 53

Runoff = 1.48 cfs @ 12.11 hrs, Volume= 0.075 af, Depth= 1.89"
Routed to Link F5B : Flume 5B

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.475	69	Pasture/grassland/range, Fair, HSG B
0.475		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.5	90	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.8	219	0.0200	4.80	23.38	**Trap/Vee/Rect Channel Flow, Existing Diversion Berm** Bot.W=0.00' D=1.18' Z= 4.0 & 3.0 '/' Top.W=8.26' n= 0.030 Earth, grassed & winding
0.2	116	0.2500	12.26	441.43	**Trap/Vee/Rect Channel Flow, Riprap Flume** Bot.W=12.00' D=2.00' Z= 3.0 '/' Top.W=24.00' n= 0.078 Riprap, 12-inch
4.5	425	Total			

Summary for Subcatchment Area 54: Area 54

Runoff = 2.98 cfs @ 12.12 hrs, Volume= 0.160 af, Depth= 1.18"
Routed to Reach S2.3 : Swale S2.3

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

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Area (ac)	CN	Description
1.079	69	Pasture/grassland/range, Fair, HSG B
0.539	39	Pasture/grassland/range, Good, HSG A
1.618	59	Weighted Average
1.618		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.1	77	0.2500	0.41		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.8	237	0.0200	4.80	23.38	**Trap/Vee/Rect Channel Flow, Existing Diversion Berm** Bot.W=0.00' D=1.18' Z= 4.0 & 3.0 '/' Top.W=8.26' n= 0.030 Earth, grassed & winding
0.3	70	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
4.2	384	Total			

Summary for Subcatchment Area 55: Area 55

Runoff = 1.45 cfs @ 12.11 hrs, Volume= 0.077 af, Depth= 1.12"
Routed to Reach S2.2 : Swale S2.2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.520	69	Pasture/grassland/range, Fair, HSG B
0.306	39	Pasture/grassland/range, Good, HSG A
0.826	58	Weighted Average
0.826		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.1	26	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
3.9	126	Total			

Summary for Subcatchment Area 56: Area 56

Runoff = 3.66 cfs @ 12.13 hrs, Volume= 0.194 af, Depth= 1.89"
Routed to Link F4B : Flume 4B

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

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Area (ac)	CN	Description
1.228	69	Pasture/grassland/range, Fair, HSG B
1.228		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.0	6	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.9	541	0.0200	4.80	23.38	**Trap/Vee/Rect Channel Flow, Existing Diversion Berm** Bot.W=0.00' D=1.18' Z= 4.0 & 3.0 '/' Top.W=8.26' n= 0.030 Earth, grassed & winding
5.7	647	Total			

Summary for Subcatchment Area 57: Area 57

Runoff = 1.86 cfs @ 12.12 hrs, Volume= 0.102 af, Depth= 1.12"
Routed to Reach S4.1 : Swale S4.1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.526	39	Pasture/grassland/range, Good, HSG A
0.405	69	Pasture/grassland/range, Fair, HSG B
0.158	96	Gravel surface, HSG A
1.089	58	Weighted Average
1.089		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.5	80	0.2000	0.38		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.2	20	0.0500	1.34		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.77"
0.1	10	0.0050	1.44		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.5	48	0.0625	1.75		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
4.3	158	Total			

Summary for Subcatchment Area 58: Area 58

Runoff = 2.17 cfs @ 12.12 hrs, Volume= 0.118 af, Depth= 1.18"
Routed to Reach S4.2 : Swale S4.2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

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Area (ac)	CN	Description
0.580	39	Pasture/grassland/range, Good, HSG A
0.433	69	Pasture/grassland/range, Fair, HSG B
0.181	96	Gravel surface, HSG B
1.194	59	Weighted Average
1.194		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.6	121	0.2314	3.37		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
4.4	221	Total			

Summary for Subcatchment Area 59: Area 59

Runoff = 2.69 cfs @ 12.13 hrs, Volume= 0.162 af, Depth= 0.88"
Routed to Reach S4.3 : Swale S4.3

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
1.134	39	Pasture/grassland/range, Good, HSG A
1.086	69	Pasture/grassland/range, Fair, HSG B
2.220	54	Weighted Average
2.220		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.8	140	0.1857	3.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
4.6	240	Total			

Summary for Subcatchment Area 6: Area 6

Runoff = 2.81 cfs @ 12.13 hrs, Volume= 0.148 af, Depth= 1.89"
Routed to Link F6A : Flume 6A

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.936	69	Pasture/grassland/range, Fair, HSG B
0.936		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.1	100	0.2070	0.40		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.2	46	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.0	395	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
5.3	541	Total			

Summary for Subcatchment Area 60: Area 60

Runoff = 4.13 cfs @ 12.13 hrs, Volume= 0.231 af, Depth= 1.12"
Routed to Reach S4.4 : Swale S4.4

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.939	39	Pasture/grassland/range, Good, HSG A
1.537	69	Pasture/grassland/range, Fair, HSG B
2.476	58	Weighted Average
2.476		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.9	163	0.1718	2.90		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
4.7	263	Total			

Summary for Subcatchment Area 61: Area 61

Runoff = 1.90 cfs @ 12.12 hrs, Volume= 0.115 af, Depth= 0.82"
Routed to Reach S4.5 : Swale S4.5

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.898	39	Pasture/grassland/range, Good, HSG A
0.785	69	Pasture/grassland/range, Fair, HSG B
1.683	53	Weighted Average
1.683		100.00% Pervious Area

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Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.9	100	0.2345	0.42		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.2	46	0.2345	3.39		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
4.1	146	Total			

Summary for Subcatchment Area 62: Area 62

Runoff = 0.24 cfs @ 12.55 hrs, Volume= 0.055 af, Depth= 0.33"
Routed to Reach S4.6 : Swale S4.6

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
1.871	39	Pasture/grassland/range, Good, HSG A
0.000	96	Gravel surface, HSG A
0.130	96	Gravel surface, HSG A
2.001	43	Weighted Average
2.001		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.7	100	0.0074	0.11		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
4.7	169	0.0074	0.60		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.4	49	0.0800	1.98		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
20.8	318	Total			

Summary for Subcatchment Area 63: Area 63

Runoff = 0.09 cfs @ 12.53 hrs, Volume= 0.033 af, Depth= 0.18"
Routed to Reach S2.3 : Swale S2.3

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
2.177	39	Pasture/grassland/range, Good, HSG A
2.177		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.4	66	0.0303	0.17		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
1.6	34	0.2500	0.35		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.2	49	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
8.2	149	Total			

Summary for Subcatchment Area 64: Area 64

Runoff = 0.39 cfs @ 12.18 hrs, Volume= 0.032 af, Depth= 0.66"
Routed to Pond Sed Pond : Sedimentation Basin

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.479	39	Pasture/grassland/range, Good, HSG A
0.115	96	Gravel surface, HSG A
0.594	50	Weighted Average
0.594		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.1	100	0.0544	0.24		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.5	47	0.0544	1.63		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
7.6	147	Total			

Summary for Subcatchment Area 65: Area 65

Runoff = 10.73 cfs @ 12.04 hrs, Volume= 0.588 af, Depth= 4.67"
Routed to Pond Sed Pond : Sedimentation Basin

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
1.509	98	Water Surface, HSG A
1.509		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry,**

Summary for Subcatchment Area 66: Area 66

Runoff = 0.22 cfs @ 12.53 hrs, Volume= 0.079 af, Depth= 0.18"
Routed to Pond Sed Pond : Sedimentation Basin

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
5.227	39	Pasture/grassland/range, Good, HSG A
5.227		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.5	75	0.0933	0.28		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
1.3	25	0.2500	0.33		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.0	10	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.8	381	0.0265	7.85	109.92	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=2.00' Z= 4.0 & 3.0 '/' Top.W=14.00' n= 0.030 Earth, grassed & winding
0.8	162	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.5	48	0.0500	1.57		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
7.9	701	Total			

Summary for Subcatchment Area 67: Area 67

Runoff = 0.61 cfs @ 12.73 hrs, Volume= 0.128 af, Depth= 0.51"
Routed to Reach RD1 : Roadside Ditch 1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
2.616	39	Pasture/grassland/range, Good, HSG A
0.039	69	Pasture/grassland/range, Fair, HSG B
0.380	96	Gravel surface, HSG A
3.035	47	Weighted Average
3.035		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
16.2	100	0.0068	0.10		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
22.7	786	0.0068	0.58		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
38.9	886	Total			

Summary for Subcatchment Area 68: Area 68

Runoff = 0.03 cfs @ 12.29 hrs, Volume= 0.006 af, Depth= 0.29"
Routed to Reach RD2 : Roadside Ditch 2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.227	39	Pasture/grassland/range, Good, HSG A
0.024	69	Pasture/grassland/range, Fair, HSG B
0.251	42	Weighted Average
0.251		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.1	52	0.1154	0.28		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"

Summary for Subcatchment Area 69: Area 69

Runoff = 0.36 cfs @ 12.14 hrs, Volume= 0.035 af, Depth= 0.46"
Routed to Reach RD2 : Roadside Ditch 2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.695	39	Pasture/grassland/range, Good, HSG A
0.218	69	Pasture/grassland/range, Fair, HSG B
0.913	46	Weighted Average
0.913		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.5	86	0.2326	0.41		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"

Summary for Subcatchment Area 7: Area 7

Runoff = 2.87 cfs @ 12.14 hrs, Volume= 0.155 af, Depth= 1.89"
Routed to Link F4A : Flume 4A

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
0.986	69	Pasture/grassland/range, Fair, HSG B
0.986		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.2	31	0.1000	0.24		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
2.8	69	0.2500	0.40		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.0	9	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.5	419	0.0200	4.80	23.38	**Trap/Vee/Rect Channel Flow, Existing Diversion Berm** Bot.W=0.00' D=1.18' Z= 4.0 & 3.0 '/' Top.W=8.26' n= 0.030 Earth, grassed & winding
0.1	80	0.2500	12.26	441.43	**Trap/Vee/Rect Channel Flow, Riprap Flume** Bot.W=12.00' D=2.00' Z= 3.0 '/' Top.W=24.00' n= 0.078 Riprap, 12-inch
6.6	608	Total			

Summary for Subcatchment Area 70: Area 70

Runoff = 1.52 cfs @ 12.12 hrs, Volume= 0.099 af, Depth= 0.71"
Routed to Reach RD4 : Roadside Ditch 4

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
1.016	39	Pasture/grassland/range, Good, HSG A
0.620	69	Pasture/grassland/range, Fair, HSG B
0.035	96	Gravel surface, HSG A
1.671	51	Weighted Average
1.671		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.2	26	0.1538	2.75		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
4.0	126	Total			

Summary for Subcatchment Area 71: Area 71

Runoff = 0.99 cfs @ 12.52 hrs, Volume= 0.238 af, Depth= 0.29"
Routed to Pond N : North Infiltration Area

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (ac)	CN	Description
9.360	39	Pasture/grassland/range, Good, HSG A
0.515	96	Gravel surface, HSG A
9.875	42	Weighted Average
9.875		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.5	100	0.0200	0.16		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
1.7	100	0.0200	0.99		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
4.4	1,137	0.0193	4.31	32.30	**Trap/Vee/Rect Channel Flow, Roadside Ditch** Bot.W=0.00' D=1.00' Z= 5.0 & 10.0 '/' Top.W=15.00' n= 0.030
16.6	1,337	Total			

Summary for Subcatchment Area 8: Area 8

Runoff = 2.66 cfs @ 12.10 hrs, Volume= 0.129 af, Depth= 1.89"
Routed to Link F7A : Flume 7A

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (sf)	CN	Description
35,545	69	Pasture/grassland/range, Fair, HSG B
35,545		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.9	59	0.1695	0.33		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.7	289	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
3.6	348	Total			

Summary for Subcatchment Area 9: Area 9

Runoff = 0.86 cfs @ 12.09 hrs, Volume= 0.039 af, Depth= 1.89"
Routed to Link F7A : Flume 7A

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

Area (sf)	CN	Description
10,716	69	Pasture/grassland/range, Fair, HSG B
10,716		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.1	48	0.2500	0.38		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.2	96	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
2.3	144	Total			

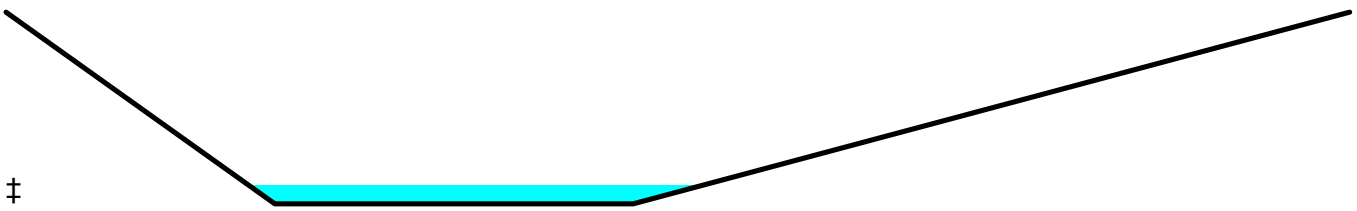
Summary for Reach RD1: Roadside Ditch 1

Inflow Area = 3.035 ac, 0.00% Impervious, Inflow Depth = 0.51" for 25-yr, 24-hr event
Inflow = 0.61 cfs @ 12.73 hrs, Volume= 0.128 af
Outflow = 0.60 cfs @ 12.89 hrs, Volume= 0.128 af, Atten= 2%, Lag= 9.5 min
Routed to Link C1 : Culvert C1

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.34 fps, Min. Travel Time= 5.5 min
Avg. Velocity = 0.62 fps, Avg. Travel Time= 11.8 min

Peak Storage= 197 cf @ 12.80 hrs
Average Depth at Peak Storage= 0.10' , Surface Width= 5.08'
Bank-Full Depth= 1.00' Flow Area= 9.5 sf, Capacity= 47.16 cfs

4.00' x 1.00' deep channel, n= 0.030
Side Slope Z-value= 3.0 8.0 '/' Top Width= 15.00'
Length= 440.6' Slope= 0.0188 '/'
Inlet Invert= 824.00', Outlet Invert= 815.70'



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Summary for Reach RD2: Roadside Ditch 2

Inflow Area = 7.576 ac, 0.00% Impervious, Inflow Depth = 1.29" for 25-yr, 24-hr event
Inflow = 11.23 cfs @ 12.20 hrs, Volume= 0.814 af
Outflow = 10.38 cfs @ 12.28 hrs, Volume= 0.814 af, Atten= 8%, Lag= 4.8 min
Routed to Link C9 : Culvert C9

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.69 fps, Min. Travel Time= 2.7 min
Avg. Velocity = 0.79 fps, Avg. Travel Time= 9.1 min

Peak Storage= 1,686 cf @ 12.24 hrs
Average Depth at Peak Storage= 0.39' , Surface Width= 13.85'
Bank-Full Depth= 1.00' Flow Area= 16.0 sf, Capacity= 72.77 cfs

6.00' x 1.00' deep channel, n= 0.030
Side Slope Z-value= 10.0 '/' Top Width= 26.00'
Length= 433.0' Slope= 0.0162 '/'
Inlet Invert= 814.55', Outlet Invert= 807.54'

‡

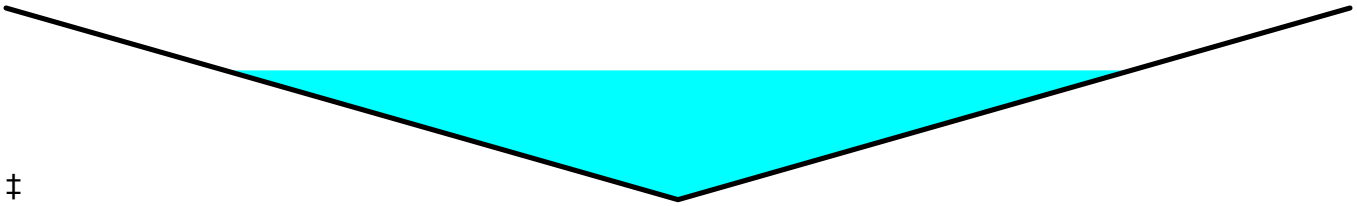
Summary for Reach RD3: Roadside Ditch 3

Inflow Area = 2.159 ac, 0.00% Impervious, Inflow Depth = 2.29" for 25-yr, 24-hr event
Inflow = 8.44 cfs @ 12.10 hrs, Volume= 0.412 af
Outflow = 7.09 cfs @ 12.20 hrs, Volume= 0.412 af, Atten= 16%, Lag= 5.7 min
Routed to Link C2 : Culvert C2

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.99 fps, Min. Travel Time= 3.4 min
Avg. Velocity = 1.34 fps, Avg. Travel Time= 10.2 min

Peak Storage= 1,491 cf @ 12.14 hrs
Average Depth at Peak Storage= 0.67' , Surface Width= 5.39'
Bank-Full Depth= 1.00' Flow Area= 4.0 sf, Capacity= 20.76 cfs

0.00' x 1.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 8.00'
Length= 821.0' Slope= 0.0288 '/'
Inlet Invert= 841.47', Outlet Invert= 817.83'



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Summary for Reach RD4: Roadside Ditch 4

Inflow Area = 1.671 ac, 0.00% Impervious, Inflow Depth = 0.71" for 25-yr, 24-hr event
Inflow = 1.52 cfs @ 12.12 hrs, Volume= 0.099 af
Outflow = 0.92 cfs @ 12.35 hrs, Volume= 0.099 af, Atten= 39%, Lag= 13.6 min
Routed to Link C9 : Culvert C9

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.05 fps, Min. Travel Time= 7.9 min
Avg. Velocity = 0.37 fps, Avg. Travel Time= 22.6 min

Peak Storage= 447 cf @ 12.21 hrs
Average Depth at Peak Storage= 0.12' , Surface Width= 8.49'
Bank-Full Depth= 1.00' Flow Area= 16.0 sf, Capacity= 54.26 cfs

6.00' x 1.00' deep channel, n= 0.030
Side Slope Z-value= 10.0 '/' Top Width= 26.00'
Length= 495.6' Slope= 0.0090 '/'
Inlet Invert= 812.00', Outlet Invert= 807.54'

‡

Summary for Reach RD5: Roadside Ditch 5

Inflow Area = 0.616 ac, 0.00% Impervious, Inflow Depth = 2.13" for 25-yr, 24-hr event
Inflow = 2.25 cfs @ 12.10 hrs, Volume= 0.109 af
Outflow = 2.01 cfs @ 12.14 hrs, Volume= 0.109 af, Atten= 11%, Lag= 2.5 min
Routed to Reach S4.2 : Swale S4.2

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.65 fps, Min. Travel Time= 1.3 min
Avg. Velocity = 1.38 fps, Avg. Travel Time= 3.5 min

Peak Storage= 164 cf @ 12.12 hrs
Average Depth at Peak Storage= 0.38' , Surface Width= 3.02'
Bank-Full Depth= 1.00' Flow Area= 4.0 sf, Capacity= 28.18 cfs

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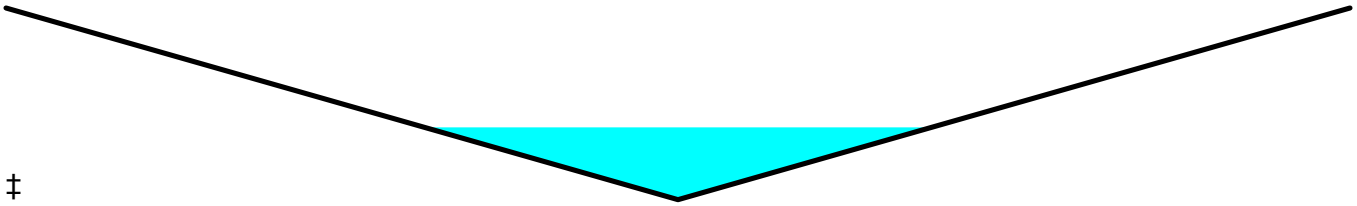
0.00' x 1.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 8.00'
Length= 288.0' Slope= 0.0531 '/'
Inlet Invert= 841.47', Outlet Invert= 826.18'



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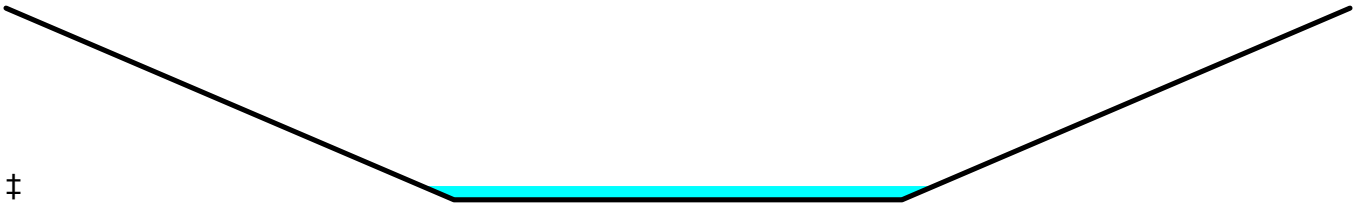
Summary for Reach S1.1: Swale S1.1

Inflow Area = 1.185 ac, 0.00% Impervious, Inflow Depth = 1.59" for 25-yr, 24-hr event
Inflow = 3.12 cfs @ 12.11 hrs, Volume= 0.157 af
Outflow = 2.76 cfs @ 12.18 hrs, Volume= 0.157 af, Atten= 12%, Lag= 4.2 min
Routed to Link C10 : Culvert C10

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.32 fps, Min. Travel Time= 2.3 min
Avg. Velocity = 0.74 fps, Avg. Travel Time= 7.3 min

Peak Storage= 398 cf @ 12.14 hrs
Average Depth at Peak Storage= 0.14' , Surface Width= 9.16'
Bank-Full Depth= 2.00' Flow Area= 32.0 sf, Capacity= 338.34 cfs

8.00' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 24.00'
Length= 321.0' Slope= 0.0319 '/'
Inlet Invert= 825.20', Outlet Invert= 814.96'



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Summary for Reach S1.2: Swale S1.2

Inflow Area = 11.287 ac, 0.00% Impervious, Inflow Depth = 1.80" for 25-yr, 24-hr event
Inflow = 30.31 cfs @ 12.14 hrs, Volume= 1.696 af
Outflow = 28.58 cfs @ 12.17 hrs, Volume= 1.696 af, Atten= 6%, Lag= 1.5 min
Routed to Link C3 : Culvert C3

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.60 fps, Min. Travel Time= 0.9 min
Avg. Velocity = 1.00 fps, Avg. Travel Time= 3.4 min

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Peak Storage= 1,690 cf @ 12.15 hrs
Average Depth at Peak Storage= 0.76' , Surface Width= 14.05'
Bank-Full Depth= 2.00' Flow Area= 32.0 sf, Capacity= 196.86 cfs

8.00' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 24.00'
Length= 202.8' Slope= 0.0108 '/'
Inlet Invert= 813.36', Outlet Invert= 811.17'

‡

Summary for Reach S1.3: Swale S1.3

Inflow Area = 14.199 ac, 0.00% Impervious, Inflow Depth = 1.76" for 25-yr, 24-hr event
Inflow = 34.68 cfs @ 12.16 hrs, Volume= 2.079 af
Outflow = 34.14 cfs @ 12.16 hrs, Volume= 2.079 af, Atten= 2%, Lag= 0.4 min
Routed to Link C4 : Culvert C4

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 4.15 fps, Min. Travel Time= 0.3 min
Avg. Velocity = 1.18 fps, Avg. Travel Time= 1.0 min

Peak Storage= 602 cf @ 12.16 hrs
Average Depth at Peak Storage= 0.76' , Surface Width= 14.05'
Bank-Full Depth= 2.00' Flow Area= 32.0 sf, Capacity= 227.36 cfs

8.00' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 24.00'
Length= 72.2' Slope= 0.0144 '/'
Inlet Invert= 810.90', Outlet Invert= 809.86'

‡

Summary for Reach S1.4: Swale S1.4

Inflow Area = 14.938 ac, 0.00% Impervious, Inflow Depth = 1.72" for 25-yr, 24-hr event
Inflow = 35.12 cfs @ 12.16 hrs, Volume= 2.141 af
Outflow = 33.65 cfs @ 12.19 hrs, Volume= 2.141 af, Atten= 4%, Lag= 1.8 min
Routed to Reach S1.6 : Swale S1.6

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.73 fps, Min. Travel Time= 0.9 min
Avg. Velocity = 0.80 fps, Avg. Travel Time= 3.1 min

Peak Storage= 1,854 cf @ 12.18 hrs
Average Depth at Peak Storage= 1.03' , Surface Width= 16.27'
Bank-Full Depth= 2.00' Flow Area= 32.0 sf, Capacity= 126.50 cfs

8.00' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 24.00'
Length= 148.0' Slope= 0.0045 '/'
Inlet Invert= 809.60', Outlet Invert= 808.94'

‡

Summary for Reach S1.5: Swale S1.5

Inflow Area = 0.769 ac, 0.00% Impervious, Inflow Depth = 1.89" for 25-yr, 24-hr event
Inflow = 2.14 cfs @ 12.15 hrs, Volume= 0.121 af
Outflow = 1.95 cfs @ 12.23 hrs, Volume= 0.121 af, Atten= 9%, Lag= 4.7 min
Routed to Reach S1.6 : Swale S1.6

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.12 fps, Min. Travel Time= 2.7 min
Avg. Velocity = 0.32 fps, Avg. Travel Time= 9.2 min

Peak Storage= 316 cf @ 12.19 hrs
Average Depth at Peak Storage= 0.20' , Surface Width= 9.60'
Bank-Full Depth= 2.00' Flow Area= 32.0 sf, Capacity= 134.06 cfs

8.00' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 24.00'
Length= 179.7' Slope= 0.0050 '/'
Inlet Invert= 809.85', Outlet Invert= 808.95'

‡

Summary for Reach S1.6: Swale S1.6

Inflow Area = 17.290 ac, 0.00% Impervious, Inflow Depth = 1.73" for 25-yr, 24-hr event
Inflow = 39.20 cfs @ 12.19 hrs, Volume= 2.499 af
Outflow = 37.41 cfs @ 12.24 hrs, Volume= 2.499 af, Atten= 5%, Lag= 2.6 min
Routed to Link C5 : Culvert C5

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.05 fps, Min. Travel Time= 1.4 min
Avg. Velocity = 0.86 fps, Avg. Travel Time= 4.9 min

Peak Storage= 3,198 cf @ 12.21 hrs
Average Depth at Peak Storage= 1.04' , Surface Width= 16.34'
Bank-Full Depth= 2.00' Flow Area= 32.0 sf, Capacity= 139.68 cfs

8.00' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 24.00'
Length= 252.0' Slope= 0.0054 '/'
Inlet Invert= 808.94', Outlet Invert= 807.57'

‡

Summary for Reach S1.7: Swale S1.7

Inflow Area = 0.712 ac, 0.00% Impervious, Inflow Depth = 2.05" for 25-yr, 24-hr event
Inflow = 2.19 cfs @ 12.15 hrs, Volume= 0.122 af
Outflow = 1.99 cfs @ 12.21 hrs, Volume= 0.122 af, Atten= 9%, Lag= 3.8 min
Routed to Reach S1.6 : Swale S1.6

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.88 fps, Min. Travel Time= 2.2 min
Avg. Velocity = 0.56 fps, Avg. Travel Time= 7.3 min

Peak Storage= 265 cf @ 12.17 hrs
Average Depth at Peak Storage= 0.31' , Surface Width= 4.38'
Bank-Full Depth= 2.00' Flow Area= 17.0 sf, Capacity= 90.14 cfs

2.50' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 2.0 4.0 '/' Top Width= 14.50'
Length= 245.8' Slope= 0.0099 '/'
Inlet Invert= 810.00', Outlet Invert= 807.57'

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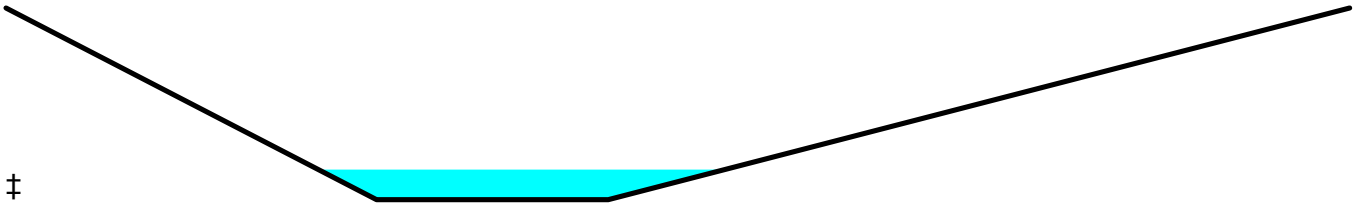

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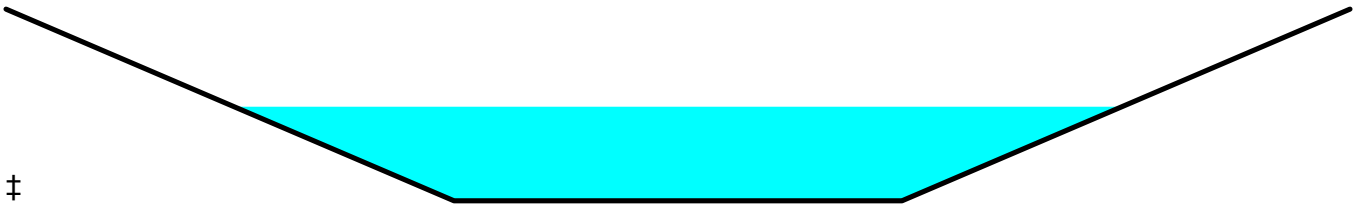
Summary for Reach S1.8: Swale S1.8

Inflow Area = 20.082 ac, 0.00% Impervious, Inflow Depth = 1.68" for 25-yr, 24-hr event
Inflow = 41.27 cfs @ 12.24 hrs, Volume= 2.805 af
Outflow = 39.57 cfs @ 12.30 hrs, Volume= 2.805 af, Atten= 4%, Lag= 3.7 min
Routed to Reach S2.1 : Swale S2.1

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.45 fps, Min. Travel Time= 2.0 min
Avg. Velocity = 0.95 fps, Avg. Travel Time= 7.4 min

Peak Storage= 4,932 cf @ 12.26 hrs
Average Depth at Peak Storage= 0.98' , Surface Width= 15.84'
Bank-Full Depth= 2.00' Flow Area= 32.0 sf, Capacity= 163.67 cfs

8.00' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 24.00'
Length= 422.0' Slope= 0.0075 '/'
Inlet Invert= 807.15', Outlet Invert= 804.00'



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Summary for Reach S2.1: Swale S2.1

Inflow Area = 22.196 ac, 0.00% Impervious, Inflow Depth = 1.53" for 25-yr, 24-hr event
Inflow = 39.58 cfs @ 12.30 hrs, Volume= 2.837 af
Outflow = 38.03 cfs @ 12.36 hrs, Volume= 2.837 af, Atten= 4%, Lag= 3.7 min
Routed to Reach S2.2 : Swale S2.2

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.17 fps, Min. Travel Time= 2.0 min
Avg. Velocity = 0.97 fps, Avg. Travel Time= 6.7 min

Peak Storage= 4,707 cf @ 12.33 hrs
Average Depth at Peak Storage= 1.31' , Surface Width= 14.48'
Bank-Full Depth= 2.00' Flow Area= 24.0 sf, Capacity= 97.05 cfs

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4.00' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 20.00'
Length= 389.0' Slope= 0.0054 '/'
Inlet Invert= 806.10', Outlet Invert= 804.00'

‡

Summary for Reach S2.2: Swale S2.2

Inflow Area = 39.450 ac, 0.00% Impervious, Inflow Depth = 1.69" for 25-yr, 24-hr event
Inflow = 65.64 cfs @ 12.31 hrs, Volume= 5.558 af
Outflow = 64.61 cfs @ 12.37 hrs, Volume= 5.558 af, Atten= 2%, Lag= 3.6 min
Routed to Reach S2.3 : Swale S2.3

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.33 fps, Min. Travel Time= 2.1 min
Avg. Velocity = 0.89 fps, Avg. Travel Time= 7.7 min

Peak Storage= 8,029 cf @ 12.33 hrs
Average Depth at Peak Storage= 1.29' , Surface Width= 20.31'
Bank-Full Depth= 2.00' Flow Area= 36.0 sf, Capacity= 152.61 cfs

10.00' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 26.00'
Length= 411.0' Slope= 0.0049 '/'
Inlet Invert= 804.00', Outlet Invert= 802.00'

‡

Summary for Reach S2.3: Swale S2.3

Inflow Area = 43.245 ac, 0.00% Impervious, Inflow Depth = 1.60" for 25-yr, 24-hr event
Inflow = 65.54 cfs @ 12.37 hrs, Volume= 5.750 af
Outflow = 64.79 cfs @ 12.40 hrs, Volume= 5.750 af, Atten= 1%, Lag= 1.9 min
Routed to Link C7 : Culvert C7

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 4.71 fps, Min. Travel Time= 1.1 min
Avg. Velocity = 1.26 fps, Avg. Travel Time= 4.0 min

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Peak Storage= 4,252 cf @ 12.38 hrs
Average Depth at Peak Storage= 0.99' , Surface Width= 17.93'
Bank-Full Depth= 2.00' Flow Area= 36.0 sf, Capacity= 249.72 cfs

10.00' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 26.00'
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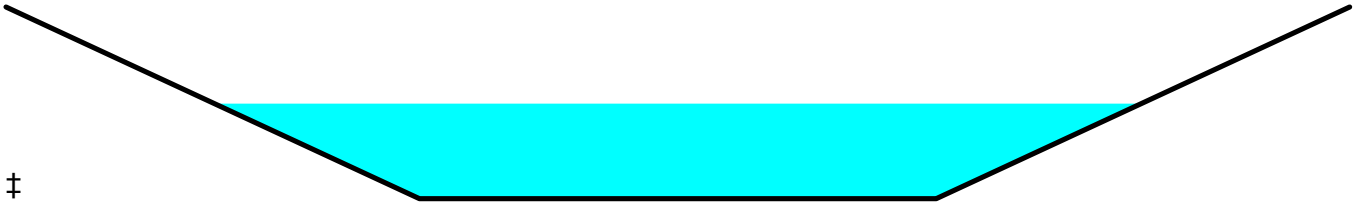
Inlet Invert= 802.00', Outlet Invert= 798.00'



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Summary for Reach S3.1: Swale S3.1

Inflow Area = 2.044 ac, 0.00% Impervious, Inflow Depth = 1.89" for 25-yr, 24-hr event
Inflow = 6.52 cfs @ 12.11 hrs, Volume= 0.322 af
Outflow = 5.46 cfs @ 12.21 hrs, Volume= 0.322 af, Atten= 16%, Lag= 5.9 min
Routed to Reach S3.2 : Swale S3.2

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.62 fps, Min. Travel Time= 3.7 min
Avg. Velocity = 0.42 fps, Avg. Travel Time= 14.2 min

Peak Storage= 1,242 cf @ 12.15 hrs
Average Depth at Peak Storage= 0.37' , Surface Width= 10.94'
Bank-Full Depth= 2.00' Flow Area= 32.0 sf, Capacity= 133.76 cfs

8.00' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 24.00'
Length= 357.0' Slope= 0.0050 '/'
Inlet Invert= 809.85', Outlet Invert= 808.07'

‡

Summary for Reach S3.2: Swale S3.2

Inflow Area = 8.141 ac, 0.00% Impervious, Inflow Depth = 1.90" for 25-yr, 24-hr event
Inflow = 22.25 cfs @ 12.12 hrs, Volume= 1.287 af
Outflow = 21.76 cfs @ 12.13 hrs, Volume= 1.287 af, Atten= 2%, Lag= 0.6 min
Routed to Reach S3.3 : Swale S3.3

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.48 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 0.66 fps, Avg. Travel Time= 0.9 min

Peak Storage= 299 cf @ 12.13 hrs
Average Depth at Peak Storage= 0.79' , Surface Width= 14.30'
Bank-Full Depth= 2.00' Flow Area= 32.0 sf, Capacity= 133.95 cfs

8.00' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 24.00'
Length= 34.0' Slope= 0.0050 '/'
Inlet Invert= 798.00', Outlet Invert= 797.83'

‡

Summary for Reach S3.3: Swale S3.3

Inflow Area = 8.141 ac, 0.00% Impervious, Inflow Depth = 1.90" for 25-yr, 24-hr event
Inflow = 21.76 cfs @ 12.13 hrs, Volume= 1.287 af
Outflow = 20.93 cfs @ 12.16 hrs, Volume= 1.287 af, Atten= 4%, Lag= 1.7 min
Routed to Link C6 : Culvert C6

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.48 fps, Min. Travel Time= 1.0 min
Avg. Velocity = 0.91 fps, Avg. Travel Time= 3.7 min

Peak Storage= 1,253 cf @ 12.14 hrs
Average Depth at Peak Storage= 0.60' , Surface Width= 12.82'
Bank-Full Depth= 2.00' Flow Area= 32.0 sf, Capacity= 215.99 cfs

8.00' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 24.00'
Length= 200.0' Slope= 0.0130 '/'
Inlet Invert= 808.00', Outlet Invert= 805.40'

‡

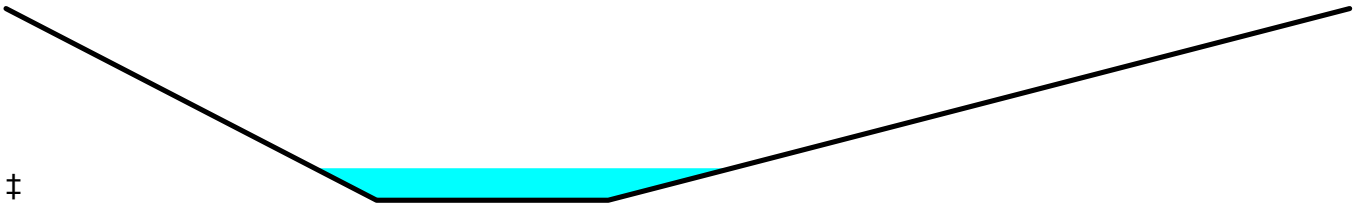
Summary for Reach S3.4: Swale S3.4

Inflow Area = 0.769 ac, 0.00% Impervious, Inflow Depth = 1.89" for 25-yr, 24-hr event
Inflow = 2.14 cfs @ 12.15 hrs, Volume= 0.121 af
Outflow = 1.94 cfs @ 12.24 hrs, Volume= 0.121 af, Atten= 9%, Lag= 5.0 min
Routed to Link C6 : Culvert C6

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.67 fps, Min. Travel Time= 2.8 min
Avg. Velocity = 0.50 fps, Avg. Travel Time= 9.5 min

Peak Storage= 332 cf @ 12.19 hrs
Average Depth at Peak Storage= 0.33' , Surface Width= 4.51'
Bank-Full Depth= 2.00' Flow Area= 17.0 sf, Capacity= 76.21 cfs

2.50' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 2.0 4.0 '/' Top Width= 14.50'
Length= 283.0' Slope= 0.0071 '/'
Inlet Invert= 810.00', Outlet Invert= 808.00'



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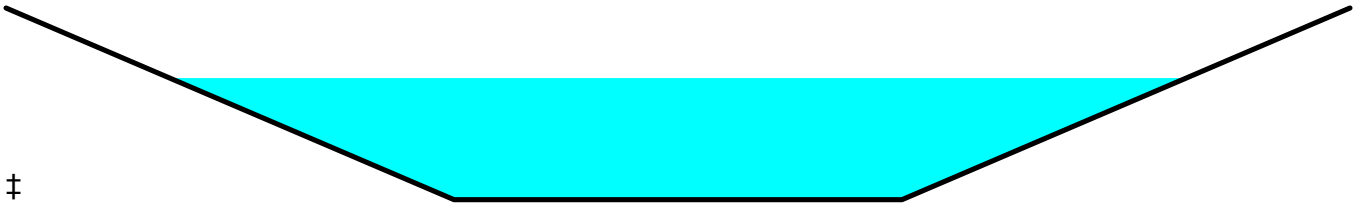
Summary for Reach S3.5: Swale S3.5

Inflow Area = 15.716 ac, 0.00% Impervious, Inflow Depth = 1.93" for 25-yr, 24-hr event
Inflow = 39.57 cfs @ 12.15 hrs, Volume= 2.531 af
Outflow = 36.85 cfs @ 12.23 hrs, Volume= 2.531 af, Atten= 7%, Lag= 4.3 min
Routed to Reach S2.2 : Swale S2.2

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.26 fps, Min. Travel Time= 2.3 min
Avg. Velocity = 0.60 fps, Avg. Travel Time= 8.9 min

Peak Storage= 5,280 cf @ 12.19 hrs
Average Depth at Peak Storage= 1.27' , Surface Width= 18.15'
Bank-Full Depth= 2.00' Flow Area= 32.0 sf, Capacity= 93.14 cfs

8.00' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 24.00'
Length= 318.5' Slope= 0.0024 '/'
Inlet Invert= 804.76', Outlet Invert= 803.99'



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Summary for Reach S4.1: Swale S4.1

Inflow Area = 1.364 ac, 0.00% Impervious, Inflow Depth = 1.28" for 25-yr, 24-hr event
Inflow = 2.74 cfs @ 12.10 hrs, Volume= 0.145 af
Outflow = 2.38 cfs @ 12.18 hrs, Volume= 0.145 af, Atten= 13%, Lag= 4.4 min
Routed to Reach S4.2 : Swale S4.2

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.62 fps, Min. Travel Time= 2.5 min
Avg. Velocity = 0.43 fps, Avg. Travel Time= 9.3 min

Peak Storage= 363 cf @ 12.14 hrs
Average Depth at Peak Storage= 0.14' , Surface Width= 11.01'
Bank-Full Depth= 1.00' Flow Area= 13.5 sf, Capacity= 70.22 cfs

10.00' x 1.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 3.0 '/' Top Width= 17.00'
Length= 240.0' Slope= 0.0153 '/'
Inlet Invert= 811.94', Outlet Invert= 808.26'

‡

Summary for Reach S4.2: Swale S4.2

Inflow Area = 3.174 ac, 0.00% Impervious, Inflow Depth = 1.41" for 25-yr, 24-hr event
Inflow = 6.29 cfs @ 12.15 hrs, Volume= 0.372 af
Outflow = 5.84 cfs @ 12.21 hrs, Volume= 0.372 af, Atten= 7%, Lag= 3.6 min
Routed to Reach S4.3 : Swale S4.3

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.12 fps, Min. Travel Time= 2.0 min
Avg. Velocity = 0.53 fps, Avg. Travel Time= 8.1 min

Peak Storage= 732 cf @ 12.17 hrs
Average Depth at Peak Storage= 0.26' , Surface Width= 11.81'
Bank-Full Depth= 1.00' Flow Area= 13.5 sf, Capacity= 63.88 cfs

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10.00' x 1.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 3.0 '/' Top Width= 17.00'
Length= 259.3' Slope= 0.0127 '/'
Inlet Invert= 808.26', Outlet Invert= 804.97'

‡

Summary for Reach S4.3: Swale S4.3

Inflow Area = 9.483 ac, 0.00% Impervious, Inflow Depth = 1.49" for 25-yr, 24-hr event
Inflow = 19.18 cfs @ 12.14 hrs, Volume= 1.179 af
Outflow = 17.09 cfs @ 12.24 hrs, Volume= 1.179 af, Atten= 11%, Lag= 5.7 min
Routed to Reach S4.4 : Swale S4.4

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.83 fps, Min. Travel Time= 3.3 min
Avg. Velocity = 0.46 fps, Avg. Travel Time= 13.1 min

Peak Storage= 3,406 cf @ 12.18 hrs
Average Depth at Peak Storage= 0.74' , Surface Width= 15.21'
Bank-Full Depth= 2.00' Flow Area= 34.0 sf, Capacity= 108.12 cfs

10.00' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 3.0 '/' Top Width= 24.00'
Length= 362.9' Slope= 0.0027 '/'
Inlet Invert= 804.97', Outlet Invert= 804.00'

‡

Summary for Reach S4.4: Swale S4.4

Inflow Area = 14.158 ac, 0.00% Impervious, Inflow Depth = 1.49" for 25-yr, 24-hr event
Inflow = 22.46 cfs @ 12.20 hrs, Volume= 1.757 af
Outflow = 21.52 cfs @ 12.31 hrs, Volume= 1.757 af, Atten= 4%, Lag= 6.4 min
Routed to Reach S4.5 : Swale S4.5

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.28 fps, Min. Travel Time= 3.6 min
Avg. Velocity = 0.58 fps, Avg. Travel Time= 14.2 min

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Peak Storage= 4,726 cf @ 12.25 hrs
Average Depth at Peak Storage= 0.75' , Surface Width= 15.28'
Bank-Full Depth= 2.00' Flow Area= 34.0 sf, Capacity= 132.85 cfs

10.00' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 3.0 '/' Top Width= 24.00'
Length= 495.6' Slope= 0.0040 '/'
Inlet Invert= 804.00', Outlet Invert= 802.00'

‡

Summary for Reach S4.5: Swale S4.5

Inflow Area = 16.268 ac, 0.00% Impervious, Inflow Depth = 1.43" for 25-yr, 24-hr event
Inflow = 22.64 cfs @ 12.30 hrs, Volume= 1.939 af
Outflow = 22.15 cfs @ 12.37 hrs, Volume= 1.939 af, Atten= 2%, Lag= 3.9 min
Routed to Reach S4.6 : Swale S4.6

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.08 fps, Min. Travel Time= 2.2 min
Avg. Velocity = 0.85 fps, Avg. Travel Time= 8.0 min

Peak Storage= 2,967 cf @ 12.33 hrs
Average Depth at Peak Storage= 0.60' , Surface Width= 14.18'
Bank-Full Depth= 3.00' Flow Area= 61.5 sf, Capacity= 465.89 cfs

10.00' x 3.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 3.0 '/' Top Width= 31.00'
Length= 411.1' Slope= 0.0097 '/'
Inlet Invert= 802.00', Outlet Invert= 798.00'

‡

Summary for Reach S4.6: Swale S4.6

Inflow Area = 64.606 ac, 0.00% Impervious, Inflow Depth = 1.53" for 25-yr, 24-hr event
Inflow = 89.26 cfs @ 12.39 hrs, Volume= 8.232 af
Outflow = 87.87 cfs @ 12.44 hrs, Volume= 8.232 af, Atten= 2%, Lag= 3.2 min
Routed to Pond Sed Pond : Sedimentation Basin

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 5.00 fps, Min. Travel Time= 1.8 min
Avg. Velocity = 1.37 fps, Avg. Travel Time= 6.5 min

Peak Storage= 9,534 cf @ 12.41 hrs
Average Depth at Peak Storage= 1.24' , Surface Width= 18.67'
Bank-Full Depth= 3.00' Flow Area= 61.5 sf, Capacity= 499.25 cfs

10.00' x 3.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 3.0 '/' Top Width= 31.00'
Length= 537.0' Slope= 0.0112 '/'
Inlet Invert= 798.00', Outlet Invert= 792.00'

‡

Summary for Reach S5.1: Swale S5.1

Inflow Area = 1.218 ac, 0.00% Impervious, Inflow Depth = 2.29" for 25-yr, 24-hr event
Inflow = 4.58 cfs @ 12.11 hrs, Volume= 0.233 af
Outflow = 3.89 cfs @ 12.21 hrs, Volume= 0.233 af, Atten= 15%, Lag= 6.0 min
Routed to Link C2 : Culvert C2

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.09 fps, Min. Travel Time= 3.8 min
Avg. Velocity = 0.57 fps, Avg. Travel Time= 14.0 min

Peak Storage= 926 cf @ 12.15 hrs
Average Depth at Peak Storage= 0.22' , Surface Width= 9.75'
Bank-Full Depth= 2.00' Flow Area= 32.0 sf, Capacity= 235.22 cfs

8.00' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 24.00'
Length= 478.0' Slope= 0.0154 '/'
Inlet Invert= 825.20', Outlet Invert= 817.83'

‡

Summary for Pond C8: Culvert C8

Inflow Area = 0.275 ac, 0.00% Impervious, Inflow Depth = 1.89" for 25-yr, 24-hr event
Inflow = 0.95 cfs @ 12.08 hrs, Volume= 0.043 af
Outflow = 0.96 cfs @ 12.08 hrs, Volume= 0.043 af, Atten= 0%, Lag= 0.1 min
Primary = 0.96 cfs @ 12.08 hrs, Volume= 0.043 af
Routed to Reach S4.1 : Swale S4.1

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 811.21' @ 12.08 hrs Surf.Area= 0.000 ac Storage= 0.000 af
Flood Elev= 819.00' Surf.Area= 0.000 ac Storage= 0.001 af

Plug-Flow detention time= 0.2 min calculated for 0.043 af (100% of inflow)
Center-of-Mass det. time= 0.2 min (830.2 - 830.0)

Volume	Invert	Avail.Storage	Storage Description
#1	810.70'	0.001 af	**3.00'D x 7.00'H Vertical Cone/Cylinder**

Device	Routing	Invert	Outlet Devices
#1	Primary	810.70'	**12.0" Round Culvert** L= 85.6' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 810.70' / 808.60' S= 0.0245 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=0.89 cfs @ 12.08 hrs HW=811.18' (Free Discharge)
↑**1=Culvert** (Inlet Controls 0.89 cfs @ 2.37 fps)

Summary for Pond N: North Infiltration Area

Inflow Area = 19.122 ac, 0.00% Impervious, Inflow Depth = 0.72" for 25-yr, 24-hr event
Inflow = 11.66 cfs @ 12.29 hrs, Volume= 1.151 af
Outflow = 1.38 cfs @ 13.97 hrs, Volume= 1.151 af, Atten= 88%, Lag= 100.5 min
Primary = 1.38 cfs @ 13.97 hrs, Volume= 1.151 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 803.86' @ 13.97 hrs Surf.Area= 16,535 sf Storage= 20,107 cf

Plug-Flow detention time= 176.3 min calculated for 1.150 af (100% of inflow)
Center-of-Mass det. time= 176.2 min (1,062.2 - 886.0)

Volume	Invert	Avail.Storage	Storage Description
#1	802.00'	256,569 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
802.00	5,140	0	0
804.00	17,424	22,564	22,564
806.00	32,191	49,615	72,179
808.00	46,130	78,321	150,500
810.00	59,939	106,069	256,569

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Device	Routing	Invert	Outlet Devices
#1	Primary	802.00'	**3.600 in/hr Exfiltration over Surface area**

Primary OutFlow Max=1.38 cfs @ 13.97 hrs HW=803.86' (Free Discharge)
1=Exfiltration (Exfiltration Controls 1.38 cfs)

Summary for Pond Sed Pond: Sedimentation Basin

Inflow Area = 71.936 ac, 2.10% Impervious, Inflow Depth = 1.49" for 25-yr, 24-hr event
Inflow = 89.59 cfs @ 12.44 hrs, Volume= 8.931 af
Outflow = 15.47 cfs @ 13.52 hrs, Volume= 8.931 af, Atten= 83%, Lag= 64.8 min
Discarded = 5.48 cfs @ 13.52 hrs, Volume= 6.100 af
Primary = 10.00 cfs @ 13.52 hrs, Volume= 2.831 af
Routed to Link Wetland : Wetland
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Routed to Link Wetland : Wetland
Tertiary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Routed to Link Wetland : Wetland

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 792.00' @ 13.52 hrs Surf.Area= 65,709 sf Storage= 164,114 cf
Flood Elev= 794.00' Surf.Area= 75,797 sf Storage= 304,443 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 185.0 min (1,047.1 - 862.1)

Volume	Invert	Avail.Storage	Storage Description
#1	789.00'	304,443 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
789.00	27,325	0	0
790.00	55,972	41,649	41,649
791.00	61,532	58,752	100,401
792.00	65,703	63,618	164,018
793.00	69,675	67,689	231,707
794.00	75,797	72,736	304,443

Device	Routing	Invert	Outlet Devices
#1	Primary	787.70'	**15.0" Round Culvert** L= 40.0' RCP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 787.70' / 787.50' S= 0.0050 '/' Cc= 0.900 n= 0.011 Concrete pipe, straight & clean, Flow Area= 1.23 sf
#2	Device 1	791.00'	**30.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Device 1	790.50'	**0.8" Vert. Orifice/Grate X 4.00** C= 0.600 Limited to weir flow at low heads
#4	Device 1	790.00'	**0.8" Vert. Orifice/Grate X 4.00** C= 0.600 Limited to weir flow at low heads
#5	Device 1	789.00'	**0.5" Vert. Orifice/Grate X 14.00 columns** X 6 rows with 6.0" cc spacing C= 0.600

Limited to weir flow at low heads

#6	Secondary	792.50'	**20.0' long x 10.0' breadth Broad-Crested Rectangular Weir**
			Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60
			Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64
#7	Tertiary	793.00'	**158.0' long x 10.0' breadth Broad-Crested Rectangular Weir**
			Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60
			Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64
#8	Discarded	789.00'	**3.600 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=5.48 cfs @ 13.52 hrs HW=792.00' (Free Discharge)
└**8=Exfiltration** (Exfiltration Controls 5.48 cfs)

Primary OutFlow Max=10.00 cfs @ 13.52 hrs HW=792.00' (Free Discharge)
└**1=Culvert** (Inlet Controls 10.00 cfs @ 8.15 fps)
  ├**2=Orifice/Grate** (Passes < 23.65 cfs potential flow)
  ├**3=Orifice/Grate** (Passes < 0.08 cfs potential flow)
  ├**4=Orifice/Grate** (Passes < 0.09 cfs potential flow)
  └**5=Orifice/Grate** (Passes < 0.70 cfs potential flow)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=789.00' (Free Discharge)
└**6=Broad-Crested Rectangular Weir**(Controls 0.00 cfs)

Tertiary OutFlow Max=0.00 cfs @ 0.00 hrs HW=789.00' (Free Discharge)
└**7=Broad-Crested Rectangular Weir**(Controls 0.00 cfs)

Summary for Link C1: Culvert C1

Inflow Area = 3.035 ac, 0.00% Impervious, Inflow Depth = 0.51" for 25-yr, 24-hr event
Inflow = 0.60 cfs @ 12.89 hrs, Volume= 0.128 af
Primary = 0.60 cfs @ 12.89 hrs, Volume= 0.128 af, Atten= 0%, Lag= 0.0 min
Routed to Reach RD2 : Roadside Ditch 2

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link C10: Culvert C10

Inflow Area = 1.185 ac, 0.00% Impervious, Inflow Depth = 1.59" for 25-yr, 24-hr event
Inflow = 2.76 cfs @ 12.18 hrs, Volume= 0.157 af
Primary = 2.76 cfs @ 12.18 hrs, Volume= 0.157 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S1.2 : Swale S1.2

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link C2: Culvert C2

Inflow Area = 3.377 ac, 0.00% Impervious, Inflow Depth = 2.29" for 25-yr, 24-hr event
Inflow = 10.95 cfs @ 12.20 hrs, Volume= 0.645 af
Primary = 10.95 cfs @ 12.20 hrs, Volume= 0.645 af, Atten= 0%, Lag= 0.0 min
Routed to Reach RD2 : Roadside Ditch 2

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

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Summary for Link C3: Culvert C3

Inflow Area = 11.287 ac, 0.00% Impervious, Inflow Depth = 1.80" for 25-yr, 24-hr event
Inflow = 28.58 cfs @ 12.17 hrs, Volume= 1.696 af
Primary = 28.58 cfs @ 12.17 hrs, Volume= 1.696 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S1.3 : Swale S1.3

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link C4: Culvert C4

Inflow Area = 14.199 ac, 0.00% Impervious, Inflow Depth = 1.76" for 25-yr, 24-hr event
Inflow = 34.14 cfs @ 12.16 hrs, Volume= 2.079 af
Primary = 34.14 cfs @ 12.16 hrs, Volume= 2.079 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S1.4 : Swale S1.4

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link C5: Culvert C5

Inflow Area = 17.290 ac, 0.00% Impervious, Inflow Depth = 1.73" for 25-yr, 24-hr event
Inflow = 37.41 cfs @ 12.24 hrs, Volume= 2.499 af
Primary = 37.41 cfs @ 12.24 hrs, Volume= 2.499 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S1.8 : Swale S1.8

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link C6: Culvert C6

Inflow Area = 11.990 ac, 0.00% Impervious, Inflow Depth = 1.90" for 25-yr, 24-hr event
Inflow = 30.67 cfs @ 12.15 hrs, Volume= 1.895 af
Primary = 30.67 cfs @ 12.15 hrs, Volume= 1.895 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S3.5 : Swale S3.5

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link C7: Culvert C7

Inflow Area = 46.337 ac, 0.00% Impervious, Inflow Depth = 1.62" for 25-yr, 24-hr event
Inflow = 67.17 cfs @ 12.39 hrs, Volume= 6.238 af
Primary = 67.17 cfs @ 12.39 hrs, Volume= 6.238 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S4.6 : Swale S4.6

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

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Summary for Link C9: Culvert C9

Inflow Area = 9.247 ac, 0.00% Impervious, Inflow Depth = 1.18" for 25-yr, 24-hr event
Inflow = 11.16 cfs @ 12.29 hrs, Volume= 0.913 af
Primary = 11.16 cfs @ 12.29 hrs, Volume= 0.913 af, Atten= 0%, Lag= 0.0 min
Routed to Pond N : North Infiltration Area

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link F10: Flume 10

Inflow Area = 0.275 ac, 0.00% Impervious, Inflow Depth = 1.89" for 25-yr, 24-hr event
Inflow = 0.95 cfs @ 12.08 hrs, Volume= 0.043 af
Primary = 0.95 cfs @ 12.08 hrs, Volume= 0.043 af, Atten= 0%, Lag= 0.0 min
Routed to Pond C8 : Culvert C8

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link F1A: Flume 1A

Inflow Area = 1.853 ac, 0.00% Impervious, Inflow Depth = 1.89" for 25-yr, 24-hr event
Inflow = 5.38 cfs @ 12.14 hrs, Volume= 0.292 af
Primary = 5.38 cfs @ 12.14 hrs, Volume= 0.292 af, Atten= 0%, Lag= 0.0 min
Routed to Link F1B : Flume 1B

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link F1B: Flume 1B

Inflow Area = 4.089 ac, 0.00% Impervious, Inflow Depth = 1.89" for 25-yr, 24-hr event
Inflow = 12.06 cfs @ 12.13 hrs, Volume= 0.645 af
Primary = 12.06 cfs @ 12.13 hrs, Volume= 0.645 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S4.3 : Swale S4.3

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link F2A: Flume 2A

Inflow Area = 0.636 ac, 0.00% Impervious, Inflow Depth = 1.89" for 25-yr, 24-hr event
Inflow = 1.98 cfs @ 12.11 hrs, Volume= 0.100 af
Primary = 1.98 cfs @ 12.11 hrs, Volume= 0.100 af, Atten= 0%, Lag= 0.0 min
Routed to Link F2B : Flume 2B

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

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Summary for Link F2B: Flume 2B

Inflow Area = 2.199 ac, 0.00% Impervious, Inflow Depth = 1.89" for 25-yr, 24-hr event
Inflow = 6.58 cfs @ 12.12 hrs, Volume= 0.347 af
Primary = 6.58 cfs @ 12.12 hrs, Volume= 0.347 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S4.4 : Swale S4.4

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link F3: Flume 3

Inflow Area = 0.427 ac, 0.00% Impervious, Inflow Depth = 1.89" for 25-yr, 24-hr event
Inflow = 1.38 cfs @ 12.10 hrs, Volume= 0.067 af
Primary = 1.38 cfs @ 12.10 hrs, Volume= 0.067 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S4.5 : Swale S4.5

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link F4A: Flume 4A

Inflow Area = 1.209 ac, 0.00% Impervious, Inflow Depth = 1.89" for 25-yr, 24-hr event
Inflow = 3.47 cfs @ 12.14 hrs, Volume= 0.191 af
Primary = 3.47 cfs @ 12.14 hrs, Volume= 0.191 af, Atten= 0%, Lag= 0.0 min
Routed to Link F4B : Flume 4B

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link F4B: Flume 4B

Inflow Area = 3.092 ac, 0.00% Impervious, Inflow Depth = 1.89" for 25-yr, 24-hr event
Inflow = 9.10 cfs @ 12.13 hrs, Volume= 0.488 af
Primary = 9.10 cfs @ 12.13 hrs, Volume= 0.488 af, Atten= 0%, Lag= 0.0 min
Routed to Link C7 : Culvert C7

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link F5A: Flume 5A

Inflow Area = 0.237 ac, 0.00% Impervious, Inflow Depth = 1.89" for 25-yr, 24-hr event
Inflow = 0.76 cfs @ 12.11 hrs, Volume= 0.037 af
Primary = 0.76 cfs @ 12.11 hrs, Volume= 0.037 af, Atten= 0%, Lag= 0.0 min
Routed to Link F5B : Flume 5B

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

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Summary for Link F5B: Flume 5B

Inflow Area = 0.712 ac, 0.00% Impervious, Inflow Depth = 1.89" for 25-yr, 24-hr event
Inflow = 2.23 cfs @ 12.11 hrs, Volume= 0.112 af
Primary = 2.23 cfs @ 12.11 hrs, Volume= 0.112 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S2.2 : Swale S2.2

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link F6A: Flume 6A

Inflow Area = 1.440 ac, 0.00% Impervious, Inflow Depth = 1.89" for 25-yr, 24-hr event
Inflow = 4.38 cfs @ 12.11 hrs, Volume= 0.227 af
Primary = 4.38 cfs @ 12.11 hrs, Volume= 0.227 af, Atten= 0%, Lag= 0.0 min
Routed to Link F6B : Flume 6B

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link F6B: Flume 6B

Inflow Area = 3.001 ac, 0.00% Impervious, Inflow Depth = 1.89" for 25-yr, 24-hr event
Inflow = 9.20 cfs @ 12.11 hrs, Volume= 0.473 af
Primary = 9.20 cfs @ 12.11 hrs, Volume= 0.473 af, Atten= 0%, Lag= 0.0 min
Routed to Link C6 : Culvert C6

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link F7A: Flume 7A

Inflow Area = 1.062 ac, 0.00% Impervious, Inflow Depth = 1.89" for 25-yr, 24-hr event
Inflow = 3.51 cfs @ 12.10 hrs, Volume= 0.167 af
Primary = 3.51 cfs @ 12.10 hrs, Volume= 0.167 af, Atten= 0%, Lag= 0.0 min
Routed to Link F7B : Flume 7B

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link F7B: Flume 7B

Inflow Area = 3.407 ac, 0.00% Impervious, Inflow Depth = 1.89" for 25-yr, 24-hr event
Inflow = 10.65 cfs @ 12.11 hrs, Volume= 0.537 af
Primary = 10.65 cfs @ 12.11 hrs, Volume= 0.537 af, Atten= 0%, Lag= 0.0 min
Routed to Link F7C : Flume 7C

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

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Summary for Link F7C: Flume 7C

Inflow Area = 5.640 ac, 0.00% Impervious, Inflow Depth = 1.89" for 25-yr, 24-hr event
Inflow = 17.47 cfs @ 12.11 hrs, Volume= 0.889 af
Primary = 17.47 cfs @ 12.11 hrs, Volume= 0.889 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S3.2 : Swale S3.2

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link F8A: Flume 8A

Inflow Area = 0.381 ac, 0.00% Impervious, Inflow Depth = 1.89" for 25-yr, 24-hr event
Inflow = 1.19 cfs @ 12.11 hrs, Volume= 0.060 af
Primary = 1.19 cfs @ 12.11 hrs, Volume= 0.060 af, Atten= 0%, Lag= 0.0 min
Routed to Link F8B : Flume 8B

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link F8B: Flume 8B

Inflow Area = 1.497 ac, 0.00% Impervious, Inflow Depth = 1.89" for 25-yr, 24-hr event
Inflow = 4.66 cfs @ 12.11 hrs, Volume= 0.236 af
Primary = 4.66 cfs @ 12.11 hrs, Volume= 0.236 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S1.3 : Swale S1.3

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link F9A: Flume 9A

Inflow Area = 2.445 ac, 0.00% Impervious, Inflow Depth = 1.89" for 25-yr, 24-hr event
Inflow = 6.88 cfs @ 12.15 hrs, Volume= 0.386 af
Primary = 6.88 cfs @ 12.15 hrs, Volume= 0.386 af, Atten= 0%, Lag= 0.0 min
Routed to Link F9B : Flume 9B

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link F9B: Flume 9B

Inflow Area = 5.540 ac, 0.00% Impervious, Inflow Depth = 1.89" for 25-yr, 24-hr event
Inflow = 15.84 cfs @ 12.14 hrs, Volume= 0.874 af
Primary = 15.84 cfs @ 12.14 hrs, Volume= 0.874 af, Atten= 0%, Lag= 0.0 min
Routed to Link F9C : Flume 9C

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

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Summary for Link F9C: Flume 9C

Inflow Area = 8.811 ac, 0.00% Impervious, Inflow Depth = 1.89" for 25-yr, 24-hr event
Inflow = 25.24 cfs @ 12.14 hrs, Volume= 1.389 af
Primary = 25.24 cfs @ 12.14 hrs, Volume= 1.389 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S1.2 : Swale S1.2

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link Wetland: Wetland

Inflow Area = 71.936 ac, 2.10% Impervious, Inflow Depth = 0.47" for 25-yr, 24-hr event
Inflow = 10.00 cfs @ 13.52 hrs, Volume= 2.831 af
Primary = 10.00 cfs @ 13.52 hrs, Volume= 2.831 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

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Time span=0.00-72.00 hrs, dt=0.05 hrs, 1441 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

SubcatchmentArea 1: Area 1 Runoff Area=1.296 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=364' Tc=6.7 min CN=69 Runoff=6.34 cfs 0.344 af

SubcatchmentArea 10: Area 10 Runoff Area=0.573 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=321' Tc=6.4 min CN=69 Runoff=2.83 cfs 0.152 af

SubcatchmentArea 11: Area 11 Runoff Area=1.872 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=796' Tc=7.6 min CN=69 Runoff=8.84 cfs 0.496 af

SubcatchmentArea 12: Area 12 Runoff Area=1.610 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=712' Tc=5.3 min CN=69 Runoff=8.11 cfs 0.427 af

SubcatchmentArea 13: Area 13 Runoff Area=0.626 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=333' Tc=4.5 min CN=69 Runoff=3.29 cfs 0.166 af

SubcatchmentArea 14: Area 14 Runoff Area=0.620 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=331' Tc=4.4 min CN=69 Runoff=3.27 cfs 0.164 af

SubcatchmentArea 15: Area 15 Runoff Area=0.943 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=464' Tc=5.9 min CN=69 Runoff=4.72 cfs 0.250 af

SubcatchmentArea 16: Area 16 Runoff Area=0.571 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=315' Tc=4.4 min CN=69 Runoff=3.01 cfs 0.151 af

SubcatchmentArea 17: Area 17 Runoff Area=0.990 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=424' Tc=4.7 min CN=69 Runoff=5.14 cfs 0.262 af

SubcatchmentArea 18: Area 18 Runoff Area=1.656 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=508' Tc=4.8 min CN=69 Runoff=8.56 cfs 0.439 af

SubcatchmentArea 19: Area 19 Runoff Area=0.689 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=286' Tc=4.3 min CN=69 Runoff=3.65 cfs 0.183 af

SubcatchmentArea 2: Area 2 Runoff Area=0.557 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=303' Tc=4.7 min CN=69 Runoff=2.89 cfs 0.148 af

SubcatchmentArea 20: Area 20 Runoff Area=0.381 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=306' Tc=4.3 min CN=69 Runoff=2.02 cfs 0.101 af

SubcatchmentArea 21: Area 21 Runoff Area=0.516 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=312' Tc=4.3 min CN=69 Runoff=2.74 cfs 0.137 af

SubcatchmentArea 22: Area 22 Runoff Area=2.579 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=1,146' Tc=6.4 min CN=69 Runoff=12.74 cfs 0.684 af

SubcatchmentArea 23: Area 23 Runoff Area=0.427 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=362' Tc=3.8 min CN=69 Runoff=2.33 cfs 0.113 af

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SubcatchmentArea 24: Area 24 Runoff Area=1.177 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=385' Tc=4.7 min CN=69 Runoff=6.11 cfs 0.312 af

SubcatchmentArea 25: Area 25 Runoff Area=0.682 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=349' Tc=4.5 min CN=69 Runoff=3.58 cfs 0.181 af

SubcatchmentArea 26: Area 26 Runoff Area=0.677 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=341' Tc=4.5 min CN=69 Runoff=3.56 cfs 0.179 af

SubcatchmentArea 27: Area 27 Runoff Area=2.594 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=1,357' Tc=6.9 min CN=69 Runoff=12.62 cfs 0.688 af

SubcatchmentArea 28: Area 28 Runoff Area=2.159 ac 0.00% Impervious Runoff Depth=3.69"
Flow Length=125' Slope=0.2500 '/' Tc=3.9 min CN=74 Runoff=13.48 cfs 0.663 af

SubcatchmentArea 29: Area 29 Runoff Area=0.616 ac 0.00% Impervious Runoff Depth=3.48"
Flow Length=109' Slope=0.2500 '/' Tc=3.8 min CN=72 Runoff=3.67 cfs 0.179 af

SubcatchmentArea 3: Area 3 Runoff Area=0.348 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=298' Tc=4.8 min CN=69 Runoff=1.80 cfs 0.092 af

SubcatchmentArea 30: Area 30 Runoff Area=0.149 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=211' Tc=1.2 min CN=69 Runoff=0.86 cfs 0.039 af

SubcatchmentArea 31: Area 31 Runoff Area=0.126 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=59' Slope=0.2500 '/' Tc=2.5 min CN=69 Runoff=0.74 cfs 0.033 af

SubcatchmentArea 32: Area 32 Runoff Area=0.457 ac 0.00% Impervious Runoff Depth=3.28"
Flow Length=122' Slope=0.2500 '/' Tc=3.9 min CN=70 Runoff=2.55 cfs 0.125 af

SubcatchmentArea 33: Area 33 Runoff Area=1.056 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=419' Tc=4.7 min CN=69 Runoff=5.48 cfs 0.280 af

SubcatchmentArea 34: Area 34 Runoff Area=0.434 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=374' Tc=4.5 min CN=69 Runoff=2.28 cfs 0.115 af

SubcatchmentArea 35: Area 35 Runoff Area=1.218 ac 0.00% Impervious Runoff Depth=3.69"
Flow Length=104' Tc=4.6 min CN=74 Runoff=7.33 cfs 0.374 af

SubcatchmentArea 36: Area 36 Runoff Area=1.185 ac 0.00% Impervious Runoff Depth=2.79"
Flow Length=106' Tc=4.1 min CN=65 Runoff=5.57 cfs 0.275 af

SubcatchmentArea 37: Area 37 Runoff Area=1.291 ac 0.00% Impervious Runoff Depth=2.50"
Flow Length=120' Slope=0.2500 '/' Tc=3.9 min CN=62 Runoff=5.48 cfs 0.269 af

SubcatchmentArea 38: Area 38 Runoff Area=0.795 ac 0.00% Impervious Runoff Depth=2.60"
Flow Length=155' Tc=4.3 min CN=63 Runoff=3.43 cfs 0.172 af

SubcatchmentArea 39: Area 39 Runoff Area=0.620 ac 0.00% Impervious Runoff Depth=1.96"
Flow Length=168' Tc=9.6 min CN=56 Runoff=1.57 cfs 0.101 af

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SubcatchmentArea 4: Area 4 Runoff Area=0.288 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=296' Tc=4.0 min CN=69 Runoff=1.55 cfs 0.076 af

SubcatchmentArea 40: Area 40 Runoff Area=0.739 ac 0.00% Impervious Runoff Depth=1.96"
Flow Length=141' Tc=7.2 min CN=56 Runoff=2.11 cfs 0.120 af

SubcatchmentArea 41a: Area 41a Runoff Area=0.871 ac 0.00% Impervious Runoff Depth=2.79"
Flow Length=144' Slope=0.0500 '/' Tc=7.8 min CN=65 Runoff=3.58 cfs 0.202 af

SubcatchmentArea 41b: Area 41b Runoff Area=0.712 ac 0.00% Impervious Runoff Depth=3.38"
Flow Length=102' Slope=0.0500 '/' Tc=7.3 min CN=71 Runoff=3.63 cfs 0.201 af

SubcatchmentArea 42: Area 42 Runoff Area=0.769 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=139' Slope=0.0500 '/' Tc=7.7 min CN=69 Runoff=3.63 cfs 0.204 af

SubcatchmentArea 43: Area 43 Runoff Area=2.792 ac 0.00% Impervious Runoff Depth=2.41"
Flow Length=419' Tc=14.7 min CN=61 Runoff=7.53 cfs 0.561 af

SubcatchmentArea 44: Area 44 Runoff Area=1.416 ac 0.00% Impervious Runoff Depth=0.63"
Flow Length=941' Slope=0.0260 '/' Tc=22.0 min CN=39 Runoff=0.43 cfs 0.074 af

SubcatchmentArea 45: Area 45 Runoff Area=2.044 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=138' Tc=4.0 min CN=69 Runoff=11.02 cfs 0.542 af

SubcatchmentArea 46: Area 46 Runoff Area=0.769 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=139' Slope=0.0500 '/' Tc=7.7 min CN=69 Runoff=3.63 cfs 0.204 af

SubcatchmentArea 47: Area 47 Runoff Area=0.079 ac 0.00% Impervious Runoff Depth=3.48"
Flow Length=143' Tc=5.1 min CN=72 Runoff=0.44 cfs 0.023 af

SubcatchmentArea 48: Area 48 Runoff Area=3.726 ac 0.00% Impervious Runoff Depth=3.38"
Flow Length=391' Tc=11.1 min CN=71 Runoff=16.26 cfs 1.050 af

SubcatchmentArea 49: Area 49 Runoff Area=0.698 ac 0.00% Impervious Runoff Depth=0.63"
Flow Length=100' Slope=0.0600 '/' Tc=6.8 min CN=39 Runoff=0.32 cfs 0.036 af

SubcatchmentArea 5: Area 5 Runoff Area=0.504 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=258' Tc=3.4 min CN=69 Runoff=2.81 cfs 0.134 af

SubcatchmentArea 50: Area 50 Runoff Area=0.223 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=296' Tc=3.7 min CN=69 Runoff=1.22 cfs 0.059 af

SubcatchmentArea 51: Area 51 Runoff Area=0.655 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=642' Tc=5.0 min CN=69 Runoff=3.35 cfs 0.174 af

SubcatchmentArea 52: Area 52 Runoff Area=0.237 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=348' Tc=4.0 min CN=69 Runoff=1.28 cfs 0.063 af

SubcatchmentArea 53: Area 53 Runoff Area=0.475 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=425' Tc=4.5 min CN=69 Runoff=2.50 cfs 0.126 af

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SubcatchmentArea 54: Area 54 Runoff Area=1.618 ac 0.00% Impervious Runoff Depth=2.23"
Flow Length=384' Tc=4.2 min CN=59 Runoff=5.93 cfs 0.300 af

SubcatchmentArea 55: Area 55 Runoff Area=0.826 ac 0.00% Impervious Runoff Depth=2.13"
Flow Length=126' Slope=0.2500 '/' Tc=3.9 min CN=58 Runoff=2.95 cfs 0.147 af

SubcatchmentArea 56: Area 56 Runoff Area=1.228 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=647' Tc=5.7 min CN=69 Runoff=6.17 cfs 0.325 af

SubcatchmentArea 57: Area 57 Runoff Area=1.089 ac 0.00% Impervious Runoff Depth=2.13"
Flow Length=158' Tc=4.3 min CN=58 Runoff=3.79 cfs 0.194 af

SubcatchmentArea 58: Area 58 Runoff Area=1.194 ac 0.00% Impervious Runoff Depth=2.23"
Flow Length=221' Tc=4.4 min CN=59 Runoff=4.33 cfs 0.221 af

SubcatchmentArea 59: Area 59 Runoff Area=2.220 ac 0.00% Impervious Runoff Depth=1.78"
Flow Length=240' Tc=4.6 min CN=54 Runoff=6.17 cfs 0.330 af

SubcatchmentArea 6: Area 6 Runoff Area=0.936 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=541' Tc=5.3 min CN=69 Runoff=4.72 cfs 0.248 af

SubcatchmentArea 60: Area 60 Runoff Area=2.476 ac 0.00% Impervious Runoff Depth=2.13"
Flow Length=263' Tc=4.7 min CN=58 Runoff=8.43 cfs 0.441 af

SubcatchmentArea 61: Area 61 Runoff Area=1.683 ac 0.00% Impervious Runoff Depth=1.70"
Flow Length=146' Slope=0.2345 '/' Tc=4.1 min CN=53 Runoff=4.54 cfs 0.238 af

SubcatchmentArea 62: Area 62 Runoff Area=2.001 ac 0.00% Impervious Runoff Depth=0.90"
Flow Length=318' Tc=20.8 min CN=43 Runoff=1.18 cfs 0.150 af

SubcatchmentArea 63: Area 63 Runoff Area=2.177 ac 0.00% Impervious Runoff Depth=0.63"
Flow Length=149' Tc=8.2 min CN=39 Runoff=0.97 cfs 0.114 af

SubcatchmentArea 64: Area 64 Runoff Area=0.594 ac 0.00% Impervious Runoff Depth=1.44"
Flow Length=147' Slope=0.0544 '/' Tc=7.6 min CN=50 Runoff=1.14 cfs 0.071 af

SubcatchmentArea 65: Area 65 Runoff Area=1.509 ac 100.00% Impervious Runoff Depth=6.35"
Tc=0.0 min CN=98 Runoff=14.43 cfs 0.799 af

SubcatchmentArea 66: Area 66 Runoff Area=5.227 ac 0.00% Impervious Runoff Depth=0.63"
Flow Length=701' Tc=7.9 min CN=39 Runoff=2.36 cfs 0.273 af

SubcatchmentArea 67: Area 67 Runoff Area=3.035 ac 0.00% Impervious Runoff Depth=1.20"
Flow Length=886' Slope=0.0068 '/' Tc=38.9 min CN=47 Runoff=1.99 cfs 0.304 af

SubcatchmentArea 68: Area 68 Runoff Area=0.251 ac 0.00% Impervious Runoff Depth=0.83"
Flow Length=52' Slope=0.1154 '/' Tc=3.1 min CN=42 Runoff=0.26 cfs 0.017 af

SubcatchmentArea 69: Area 69 Runoff Area=0.913 ac 0.00% Impervious Runoff Depth=1.13"
Flow Length=86' Slope=0.2326 '/' Tc=3.5 min CN=46 Runoff=1.50 cfs 0.086 af

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SubcatchmentArea 7: Area 7 Runoff Area=0.986 ac 0.00% Impervious Runoff Depth=3.18"
Flow Length=608' Tc=6.6 min CN=69 Runoff=4.85 cfs 0.261 af

SubcatchmentArea 70: Area 70 Runoff Area=1.671 ac 0.00% Impervious Runoff Depth=1.53"
Flow Length=126' Tc=4.0 min CN=51 Runoff=3.98 cfs 0.213 af

SubcatchmentArea 71: Area 71 Runoff Area=9.875 ac 0.00% Impervious Runoff Depth=0.83"
Flow Length=1,337' Tc=16.6 min CN=42 Runoff=5.65 cfs 0.684 af

SubcatchmentArea 8: Area 8 Runoff Area=35,545 sf 0.00% Impervious Runoff Depth=3.18"
Flow Length=348' Tc=3.6 min CN=69 Runoff=4.50 cfs 0.216 af

SubcatchmentArea 9: Area 9 Runoff Area=10,716 sf 0.00% Impervious Runoff Depth=3.18"
Flow Length=144' Tc=2.3 min CN=69 Runoff=1.44 cfs 0.065 af

Reach RD1: Roadside Ditch 1 Avg. Flow Depth=0.19' Max Vel=2.00 fps Inflow=1.99 cfs 0.304 af
n=0.030 L=440.6' S=0.0188 '/' Capacity=47.16 cfs Outflow=1.96 cfs 0.304 af

Reach RD2: Roadside Ditch 2 Avg. Flow Depth=0.52' Max Vel=3.14 fps Inflow=19.31 cfs 1.445 af
n=0.030 L=433.0' S=0.0162 '/' Capacity=72.77 cfs Outflow=17.96 cfs 1.445 af

Reach RD3: Roadside Ditch 3 Avg. Flow Depth=0.81' Max Vel=4.50 fps Inflow=13.48 cfs 0.663 af
n=0.030 L=821.0' S=0.0288 '/' Capacity=20.76 cfs Outflow=11.77 cfs 0.663 af

Reach RD4: Roadside Ditch 4 Avg. Flow Depth=0.24' Max Vel=1.52 fps Inflow=3.98 cfs 0.213 af
n=0.030 L=495.6' S=0.0090 '/' Capacity=54.26 cfs Outflow=2.99 cfs 0.213 af

Reach RD5: Roadside Ditch 5 Avg. Flow Depth=0.46' Max Vel=4.14 fps Inflow=3.67 cfs 0.179 af
n=0.030 L=288.0' S=0.0531 '/' Capacity=28.18 cfs Outflow=3.30 cfs 0.179 af

Reach S1.1: Swale S1.1 Avg. Flow Depth=0.21' Max Vel=2.87 fps Inflow=5.57 cfs 0.275 af
n=0.030 L=321.0' S=0.0319 '/' Capacity=338.34 cfs Outflow=4.95 cfs 0.275 af

Reach S1.2: Swale S1.2 Avg. Flow Depth=1.02' Max Vel=4.24 fps Inflow=52.19 cfs 2.880 af
n=0.030 L=202.8' S=0.0108 '/' Capacity=196.86 cfs Outflow=49.91 cfs 2.880 af

Reach S1.3: Swale S1.3 Avg. Flow Depth=1.03' Max Vel=4.92 fps Inflow=61.05 cfs 3.550 af
n=0.030 L=72.2' S=0.0144 '/' Capacity=227.36 cfs Outflow=60.33 cfs 3.550 af

Reach S1.4: Swale S1.4 Avg. Flow Depth=1.40' Max Vel=3.24 fps Inflow=62.44 cfs 3.671 af
n=0.030 L=148.0' S=0.0045 '/' Capacity=126.50 cfs Outflow=59.56 cfs 3.671 af

Reach S1.5: Swale S1.5 Avg. Flow Depth=0.27' Max Vel=1.35 fps Inflow=3.63 cfs 0.204 af
n=0.030 L=179.7' S=0.0050 '/' Capacity=134.06 cfs Outflow=3.33 cfs 0.204 af

Reach S1.6: Swale S1.6 Avg. Flow Depth=1.41' Max Vel=3.60 fps Inflow=69.21 cfs 4.277 af
n=0.030 L=252.0' S=0.0054 '/' Capacity=139.68 cfs Outflow=66.73 cfs 4.277 af

Reach S1.7: Swale S1.7 Avg. Flow Depth=0.41' Max Vel=2.20 fps Inflow=3.63 cfs 0.201 af
n=0.030 L=245.8' S=0.0099 '/' Capacity=90.14 cfs Outflow=3.32 cfs 0.201 af

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Reach S1.8: Swale S1.8 Avg. Flow Depth=1.33' Max Vel=4.09 fps Inflow=74.10 cfs 4.838 af
n=0.030 L=422.0' S=0.0075 '/' Capacity=163.67 cfs Outflow=70.85 cfs 4.838 af

Reach S2.1: Swale S2.1 Avg. Flow Depth=1.73' Max Vel=3.72 fps Inflow=71.34 cfs 4.949 af
n=0.030 L=389.0' S=0.0054 '/' Capacity=97.05 cfs Outflow=68.62 cfs 4.949 af

Reach S2.2: Swale S2.2 Avg. Flow Depth=1.77' Max Vel=3.96 fps Inflow=120.78 cfs 9.518 af
n=0.030 L=411.0' S=0.0049 '/' Capacity=152.61 cfs Outflow=118.35 cfs 9.518 af

Reach S2.3: Swale S2.3 Avg. Flow Depth=1.38' Max Vel=5.64 fps Inflow=120.84 cfs 9.932 af
n=0.030 L=307.0' S=0.0130 '/' Capacity=249.72 cfs Outflow=119.37 cfs 9.932 af

Reach S3.1: Swale S3.1 Avg. Flow Depth=0.50' Max Vel=1.94 fps Inflow=11.02 cfs 0.542 af
n=0.030 L=357.0' S=0.0050 '/' Capacity=133.76 cfs Outflow=9.75 cfs 0.542 af

Reach S3.2: Swale S3.2 Avg. Flow Depth=1.06' Max Vel=2.93 fps Inflow=38.61 cfs 2.162 af
n=0.030 L=34.0' S=0.0050 '/' Capacity=133.95 cfs Outflow=37.80 cfs 2.162 af

Reach S3.3: Swale S3.3 Avg. Flow Depth=0.82' Max Vel=4.12 fps Inflow=37.80 cfs 2.162 af
n=0.030 L=200.0' S=0.0130 '/' Capacity=215.99 cfs Outflow=36.67 cfs 2.162 af

Reach S3.4: Swale S3.4 Avg. Flow Depth=0.45' Max Vel=1.95 fps Inflow=3.63 cfs 0.204 af
n=0.030 L=283.0' S=0.0071 '/' Capacity=76.21 cfs Outflow=3.29 cfs 0.204 af

Reach S3.5: Swale S3.5 Avg. Flow Depth=1.68' Max Vel=2.63 fps Inflow=68.29 cfs 4.234 af
n=0.030 L=318.5' S=0.0024 '/' Capacity=93.14 cfs Outflow=64.19 cfs 4.234 af

Reach S4.1: Swale S4.1 Avg. Flow Depth=0.22' Max Vel=2.07 fps Inflow=5.28 cfs 0.267 af
n=0.030 L=240.0' S=0.0153 '/' Capacity=70.22 cfs Outflow=4.68 cfs 0.267 af

Reach S4.2: Swale S4.2 Avg. Flow Depth=0.38' Max Vel=2.70 fps Inflow=11.92 cfs 0.667 af
n=0.030 L=259.3' S=0.0127 '/' Capacity=63.88 cfs Outflow=11.06 cfs 0.667 af

Reach S4.3: Swale S4.3 Avg. Flow Depth=1.08' Max Vel=2.26 fps Inflow=36.14 cfs 2.080 af
n=0.030 L=362.9' S=0.0027 '/' Capacity=108.12 cfs Outflow=33.37 cfs 2.080 af

Reach S4.4: Swale S4.4 Avg. Flow Depth=1.11' Max Vel=2.82 fps Inflow=45.34 cfs 3.104 af
n=0.030 L=495.6' S=0.0040 '/' Capacity=132.85 cfs Outflow=43.47 cfs 3.104 af

Reach S4.5: Swale S4.5 Avg. Flow Depth=0.89' Max Vel=3.87 fps Inflow=45.91 cfs 3.454 af
n=0.030 L=411.1' S=0.0097 '/' Capacity=465.89 cfs Outflow=44.58 cfs 3.454 af

Reach S4.6: Swale S4.6 Avg. Flow Depth=1.74' Max Vel=6.02 fps Inflow=168.73 cfs 14.356 af
n=0.030 L=537.0' S=0.0112 '/' Capacity=499.25 cfs Outflow=165.72 cfs 14.356 af

Reach S5.1: Swale S5.1 Avg. Flow Depth=0.29' Max Vel=2.49 fps Inflow=7.33 cfs 0.374 af
n=0.030 L=478.0' S=0.0154 '/' Capacity=235.22 cfs Outflow=6.57 cfs 0.374 af

Pond C8: Culvert C8 Peak Elev=811.38' Storage=0.000 af Inflow=1.60 cfs 0.073 af
12.0" Round Culvert n=0.012 L=85.6' S=0.0245 '/' Outflow=1.60 cfs 0.073 af

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Pond N: North Infiltration Area Peak Elev=805.23' Storage=49,470 cf Inflow=26.07 cfs 2.341 af
Outflow=2.21 cfs 2.341 af

Pond Sed Pond: Sedimentation Basin Peak Elev=793.20' Storage=245,676 cf Inflow=169.96 cfs 15.500 af
3 af Primary=11.51 cfs 5.165 af Secondary=31.49 cfs 2.330 af Tertiary=34.88 cfs 0.772 af Outflow=83.78 cfs 15.500 af

Link C1: Culvert C1 Inflow=1.96 cfs 0.304 af
Primary=1.96 cfs 0.304 af

Link C10: Culvert C10 Inflow=4.95 cfs 0.275 af
Primary=4.95 cfs 0.275 af

Link C2: Culvert C2 Inflow=18.32 cfs 1.038 af
Primary=18.32 cfs 1.038 af

Link C3: Culvert C3 Inflow=49.91 cfs 2.880 af
Primary=49.91 cfs 2.880 af

Link C4: Culvert C4 Inflow=60.33 cfs 3.550 af
Primary=60.33 cfs 3.550 af

Link C5: Culvert C5 Inflow=66.73 cfs 4.277 af
Primary=66.73 cfs 4.277 af

Link C6: Culvert C6 Inflow=53.57 cfs 3.184 af
Primary=53.57 cfs 3.184 af

Link C7: Culvert C7 Inflow=123.92 cfs 10.752 af
Primary=123.92 cfs 10.752 af

Link C9: Culvert C9 Inflow=20.94 cfs 1.658 af
Primary=20.94 cfs 1.658 af

Link F10: Flume 10 Inflow=1.60 cfs 0.073 af
Primary=1.60 cfs 0.073 af

Link F1A: Flume 1A Inflow=9.08 cfs 0.491 af
Primary=9.08 cfs 0.491 af

Link F1B: Flume 1B Inflow=20.35 cfs 1.084 af
Primary=20.35 cfs 1.084 af

Link F2A: Flume 2A Inflow=3.34 cfs 0.169 af
Primary=3.34 cfs 0.169 af

Link F2B: Flume 2B Inflow=11.13 cfs 0.583 af
Primary=11.13 cfs 0.583 af

Link F3: Flume 3 Inflow=2.33 cfs 0.113 af
Primary=2.33 cfs 0.113 af

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Link F4A: Flume 4A Inflow=5.87 cfs 0.320 af
Primary=5.87 cfs 0.320 af

Link F4B: Flume 4B Inflow=15.35 cfs 0.820 af
Primary=15.35 cfs 0.820 af

Link F5A: Flume 5A Inflow=1.28 cfs 0.063 af
Primary=1.28 cfs 0.063 af

Link F5B: Flume 5B Inflow=3.77 cfs 0.189 af
Primary=3.77 cfs 0.189 af

Link F6A: Flume 6A Inflow=7.42 cfs 0.382 af
Primary=7.42 cfs 0.382 af

Link F6B: Flume 6B Inflow=15.57 cfs 0.795 af
Primary=15.57 cfs 0.795 af

Link F7A: Flume 7A Inflow=5.92 cfs 0.281 af
Primary=5.92 cfs 0.281 af

Link F7B: Flume 7B Inflow=18.00 cfs 0.903 af
Primary=18.00 cfs 0.903 af

Link F7C: Flume 7C Inflow=29.56 cfs 1.495 af
Primary=29.56 cfs 1.495 af

Link F8A: Flume 8A Inflow=2.02 cfs 0.101 af
Primary=2.02 cfs 0.101 af

Link F8B: Flume 8B Inflow=7.88 cfs 0.397 af
Primary=7.88 cfs 0.397 af

Link F9A: Flume 9A Inflow=11.65 cfs 0.648 af
Primary=11.65 cfs 0.648 af

Link F9B: Flume 9B Inflow=26.78 cfs 1.468 af
Primary=26.78 cfs 1.468 af

Link F9C: Flume 9C Inflow=42.66 cfs 2.335 af
Primary=42.66 cfs 2.335 af

Link Wetland: Wetland Inflow=77.88 cfs 8.267 af
Primary=77.88 cfs 8.267 af

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Summary for Subcatchment Area 1: Area 1

Runoff = 6.34 cfs @ 12.14 hrs, Volume= 0.344 af, Depth= 3.18"
Routed to Link F1A : Flume 1A

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
1.296	69	Pasture/grassland/range, Fair, HSG B
1.296		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.2	93	0.1000	0.30		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.5	7	0.2500	0.26		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.7	151	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.3	113	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
6.7	364	Total			

Summary for Subcatchment Area 10: Area 10

Runoff = 2.83 cfs @ 12.14 hrs, Volume= 0.152 af, Depth= 3.18"
Routed to Link F9A : Flume 9A

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.573	69	Pasture/grassland/range, Fair, HSG B
0.573		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.6	79	0.1000	0.29		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
1.1	21	0.2500	0.32		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.3	53	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.4	168	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
6.4	321	Total			

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Summary for Subcatchment Area 11: Area 11

Runoff = 8.84 cfs @ 12.15 hrs, Volume= 0.496 af, Depth= 3.18"
Routed to Link F9A : Flume 9A

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
1.872	69	Pasture/grassland/range, Fair, HSG B
1.872		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.4	96	0.1000	0.30		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.3	4	0.2500	0.23		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.4	90	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.5	606	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
7.6	796	Total			

Summary for Subcatchment Area 12: Area 12

Runoff = 8.11 cfs @ 12.12 hrs, Volume= 0.427 af, Depth= 3.18"
Routed to Link F1B : Flume 1B

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
1.610	69	Pasture/grassland/range, Fair, HSG B
1.610		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.1	31	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.4	581	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
5.3	712	Total			

Summary for Subcatchment Area 13: Area 13

Runoff = 3.29 cfs @ 12.11 hrs, Volume= 0.166 af, Depth= 3.18"
Routed to Link F1B : Flume 1B

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.626	69	Pasture/grassland/range, Fair, HSG B
0.626		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.2	50	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.5	183	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
4.5	333	Total			

Summary for Subcatchment Area 14: Area 14

Runoff = 3.27 cfs @ 12.11 hrs, Volume= 0.164 af, Depth= 3.18"
Routed to Link F2B : Flume 2B

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.620	69	Pasture/grassland/range, Fair, HSG B
0.620		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.2	50	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.4	181	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
4.4	331	Total			

Summary for Subcatchment Area 15: Area 15

Runoff = 4.72 cfs @ 12.13 hrs, Volume= 0.250 af, Depth= 3.18"
Routed to Link F2B : Flume 2B

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.943	69	Pasture/grassland/range, Fair, HSG B
0.943		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.7	100	0.1500	0.35		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.5	95	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.7	269	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
5.9	464	Total			

Summary for Subcatchment Area 16: Area 16

Runoff = 3.01 cfs @ 12.11 hrs, Volume= 0.151 af, Depth= 3.18"
Routed to Link F6B : Flume 6B

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.571	69	Pasture/grassland/range, Fair, HSG B
0.571		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.2	44	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.4	171	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
4.4	315	Total			

Summary for Subcatchment Area 17: Area 17

Runoff = 5.14 cfs @ 12.11 hrs, Volume= 0.262 af, Depth= 3.18"
Routed to Link F6B : Flume 6B

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.990	69	Pasture/grassland/range, Fair, HSG B
0.990		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.2	46	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.7	278	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
4.7	424	Total			

Summary for Subcatchment Area 18: Area 18

Runoff = 8.56 cfs @ 12.12 hrs, Volume= 0.439 af, Depth= 3.18"
Routed to Link F7B : Flume 7B

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
1.656	69	Pasture/grassland/range, Fair, HSG B
1.656		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	88	0.2045	0.39		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
1.0	420	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
4.8	508	Total			

Summary for Subcatchment Area 19: Area 19

Runoff = 3.65 cfs @ 12.11 hrs, Volume= 0.183 af, Depth= 3.18"
Routed to Link F7B : Flume 7B

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.689	69	Pasture/grassland/range, Fair, HSG B
0.689		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.2	50	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.3	136	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
4.3	286	Total			

Summary for Subcatchment Area 2: Area 2

Runoff = 2.89 cfs @ 12.11 hrs, Volume= 0.148 af, Depth= 3.18"
Routed to Link F1A : Flume 1A

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.557	69	Pasture/grassland/range, Fair, HSG B
0.557		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.2	100	0.1950	0.39		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.1	22	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.4	181	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
4.7	303	Total			

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Summary for Subcatchment Area 20: Area 20

Runoff = 2.02 cfs @ 12.11 hrs, Volume= 0.101 af, Depth= 3.18"
Routed to Link F8A : Flume 8A

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.381	69	Pasture/grassland/range, Fair, HSG B
0.381		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.0	7	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.5	199	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
4.3	306	Total			

Summary for Subcatchment Area 21: Area 21

Runoff = 2.74 cfs @ 12.11 hrs, Volume= 0.137 af, Depth= 3.18"
Routed to Link F9B : Flume 9B

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.516	69	Pasture/grassland/range, Fair, HSG B
0.516		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.0	7	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.5	205	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
4.3	312	Total			

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Summary for Subcatchment Area 22: Area 22

Runoff = 12.74 cfs @ 12.14 hrs, Volume= 0.684 af, Depth= 3.18"
Routed to Link F9B : Flume 9B

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
2.579	69	Pasture/grassland/range, Fair, HSG B
2.579		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.1	21	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
2.5	1,025	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
6.4	1,146	Total			

Summary for Subcatchment Area 23: Area 23

Runoff = 2.33 cfs @ 12.10 hrs, Volume= 0.113 af, Depth= 3.18"
Routed to Link F3 : Flume 3

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.427	69	Pasture/grassland/range, Fair, HSG B
0.427		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.9	70	0.2500	0.40		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.8	227	0.0200	4.80	23.38	**Trap/Vee/Rect Channel Flow, Existing Diversion Berm** Bot.W=0.00' D=1.18' Z= 4.0 & 3.0 '/' Top.W=8.26' n= 0.030 Earth, grassed & winding
0.1	65	0.2500	12.26	441.43	**Trap/Vee/Rect Channel Flow, Riprap Flume** Bot.W=12.00' D=2.00' Z= 3.0 '/' Top.W=24.00' n= 0.078 Riprap, 12-inch
3.8	362	Total			

Summary for Subcatchment Area 24: Area 24

Runoff = 6.11 cfs @ 12.11 hrs, Volume= 0.312 af, Depth= 3.18"
Routed to Link F7C : Flume 7C

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
1.177	69	Pasture/grassland/range, Fair, HSG B
1.177		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.3	60	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.6	225	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
4.7	385	Total			

Summary for Subcatchment Area 25: Area 25

Runoff = 3.58 cfs @ 12.11 hrs, Volume= 0.181 af, Depth= 3.18"
Routed to Link F8B : Flume 8B

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.682	69	Pasture/grassland/range, Fair, HSG B
0.682		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.2	50	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.5	199	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
4.5	349	Total			

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Summary for Subcatchment Area 26: Area 26

Runoff = 3.56 cfs @ 12.11 hrs, Volume= 0.179 af, Depth= 3.18"
Routed to Link F9C : Flume 9C

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.677	69	Pasture/grassland/range, Fair, HSG B
0.677		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.2	50	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.5	191	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
4.5	341	Total			

Summary for Subcatchment Area 27: Area 27

Runoff = 12.62 cfs @ 12.14 hrs, Volume= 0.688 af, Depth= 3.18"
Routed to Link F9C : Flume 9C

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
2.594	69	Pasture/grassland/range, Fair, HSG B
2.594		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	99	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
3.1	1,258	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
6.9	1,357	Total			

Summary for Subcatchment Area 28: Area 28

Runoff = 13.48 cfs @ 12.10 hrs, Volume= 0.663 af, Depth= 3.69"
Routed to Reach RD3 : Roadside Ditch 3

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
1.735	69	Pasture/grassland/range, Fair, HSG B
0.424	96	Gravel surface, HSG A
2.159	74	Weighted Average
2.159		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.1	25	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
3.9	125	Total			

Summary for Subcatchment Area 29: Area 29

Runoff = 3.67 cfs @ 12.10 hrs, Volume= 0.179 af, Depth= 3.48"
Routed to Reach RD5 : Roadside Ditch 5

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.543	69	Pasture/grassland/range, Fair, HSG B
0.073	96	Gravel surface, HSG A
0.616	72	Weighted Average
0.616		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.0	9	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
3.8	109	Total			

Summary for Subcatchment Area 3: Area 3

Runoff = 1.80 cfs @ 12.12 hrs, Volume= 0.092 af, Depth= 3.18"
Routed to Link F2A : Flume 2A

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.348	69	Pasture/grassland/range, Fair, HSG B
0.348		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.2	100	0.1950	0.39		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.2	36	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.4	162	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
4.8	298	Total			

Summary for Subcatchment Area 30: Area 30

Runoff = 0.86 cfs @ 12.07 hrs, Volume= 0.039 af, Depth= 3.18"
Routed to Link F10 : Flume 10

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.149	69	Pasture/grassland/range, Fair, HSG B
0.149		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.7	12	0.2500	0.28		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.5	199	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
1.2	211	Total			

Summary for Subcatchment Area 31: Area 31

Runoff = 0.74 cfs @ 12.09 hrs, Volume= 0.033 af, Depth= 3.18"
Routed to Link F10 : Flume 10

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.126	69	Pasture/grassland/range, Fair, HSG B
0.126		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.5	59	0.2500	0.39		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"

Summary for Subcatchment Area 32: Area 32

Runoff = 2.55 cfs @ 12.10 hrs, Volume= 0.125 af, Depth= 3.28"
Routed to Reach S3.2 : Swale S3.2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.435	69	Pasture/grassland/range, Fair, HSG B
0.022	96	Gravel surface, HSG A
0.457	70	Weighted Average
0.457		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.1	22	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
3.9	122	Total			

Summary for Subcatchment Area 33: Area 33

Runoff = 5.48 cfs @ 12.11 hrs, Volume= 0.280 af, Depth= 3.18"
Routed to Link F7C : Flume 7C

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

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Area (ac)	CN	Description
1.056	69	Pasture/grassland/range, Fair, HSG B
1.056		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.3	57	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.6	262	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
4.7	419	Total			

Summary for Subcatchment Area 34: Area 34

Runoff = 2.28 cfs @ 12.11 hrs, Volume= 0.115 af, Depth= 3.18"
Routed to Link F8B : Flume 8B

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.434	69	Pasture/grassland/range, Fair, HSG B
0.434		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.1	15	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.6	259	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
4.5	374	Total			

Summary for Subcatchment Area 35: Area 35

Runoff = 7.33 cfs @ 12.11 hrs, Volume= 0.374 af, Depth= 3.69"
Routed to Reach S5.1 : Swale S5.1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.986	69	Pasture/grassland/range, Fair, HSG B
0.232	96	Gravel surface, HSG A
1.218	74	Weighted Average
1.218		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.3	70	0.1736	0.35		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.6	20	0.0050	0.53		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.77"
0.7	10	0.1766	0.24		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.0	4	0.1766	2.94		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
4.6	104	Total			

Summary for Subcatchment Area 36: Area 36

Runoff = 5.57 cfs @ 12.11 hrs, Volume= 0.275 af, Depth= 2.79"
Routed to Reach S1.1 : Swale S1.1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.322	39	Pasture/grassland/range, Good, HSG A
0.696	69	Pasture/grassland/range, Fair, HSG B
0.167	96	Gravel surface, HSG A
1.185	65	Weighted Average
1.185		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.4	72	0.1736	0.35		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.6	20	0.0050	0.53		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.77"
0.1	14	0.1766	2.94		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
4.1	106	Total			

Summary for Subcatchment Area 37: Area 37

Runoff = 5.48 cfs @ 12.11 hrs, Volume= 0.269 af, Depth= 2.50"
Routed to Reach S1.2 : Swale S1.2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

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Area (ac)	CN	Description
0.415	39	Pasture/grassland/range, Good, HSG A
0.743	69	Pasture/grassland/range, Fair, HSG B
0.133	96	Gravel surface, HSG A
1.291	62	Weighted Average
1.291		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.1	20	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
3.9	120	Total			

Summary for Subcatchment Area 38: Area 38

Runoff = 3.43 cfs @ 12.11 hrs, Volume= 0.172 af, Depth= 2.60"
Routed to Reach S1.3 : Swale S1.3

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.263	39	Pasture/grassland/range, Good, HSG A
0.409	69	Pasture/grassland/range, Fair, HSG B
0.123	96	Gravel surface, HSG A
0.795	63	Weighted Average
0.795		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.1	14	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.2	17	0.0050	1.44		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.2	24	0.0833	2.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
4.3	155	Total			

Summary for Subcatchment Area 39: Area 39

Runoff = 1.57 cfs @ 12.18 hrs, Volume= 0.101 af, Depth= 1.96"
Routed to Reach S1.3 : Swale S1.3

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

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Area (ac)	CN	Description
0.317	39	Pasture/grassland/range, Good, HSG A
0.243	69	Pasture/grassland/range, Fair, HSG B
0.060	96	Gravel surface, HSG A
0.620	56	Weighted Average
0.620		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.2	81	0.0245	0.16		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
1.0	19	0.2500	0.31		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.1	29	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.2	20	0.0050	1.44		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.1	19	0.1053	2.27		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
9.6	168	Total			

Summary for Subcatchment Area 4: Area 4

Runoff = 1.55 cfs @ 12.10 hrs, Volume= 0.076 af, Depth= 3.18"
Routed to Link F2A : Flume 2A

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.288	69	Pasture/grassland/range, Fair, HSG B
0.288		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.4	49	0.0820	0.24		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.6	247	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
4.0	296	Total			

Summary for Subcatchment Area 40: Area 40

Runoff = 2.11 cfs @ 12.15 hrs, Volume= 0.120 af, Depth= 1.96"
Routed to Reach S1.4 : Swale S1.4

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

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Area (ac)	CN	Description
0.389	39	Pasture/grassland/range, Good, HSG A
0.270	69	Pasture/grassland/range, Fair, HSG B
0.080	96	Gravel surface, HSG A
0.739	56	Weighted Average
0.739		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.5	49	0.0408	0.18		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
2.1	47	0.2500	0.37		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.2	4	0.0050	0.39		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.77"
0.2	19	0.0050	1.44		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.2	22	0.1136	2.36		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
7.2	141	Total			

Summary for Subcatchment Area 41a: Area 41a

Runoff = 3.58 cfs @ 12.15 hrs, Volume= 0.202 af, Depth= 2.79"
Routed to Reach S1.6 : Swale S1.6

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.249	39	Pasture/grassland/range, Good, HSG A
0.489	69	Pasture/grassland/range, Fair, HSG B
0.133	96	Gravel surface, HSG A
0.871	65	Weighted Average
0.871		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.3	100	0.0500	0.23		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.5	44	0.0500	1.57		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
7.8	144	Total			

Summary for Subcatchment Area 41b: Area 41b

Runoff = 3.63 cfs @ 12.15 hrs, Volume= 0.201 af, Depth= 3.38"
Routed to Reach S1.7 : Swale S1.7

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.655	69	Pasture/grassland/range, Fair, HSG B
0.057	96	Gravel surface, HSG A
0.712	71	Weighted Average
0.712		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.3	100	0.0500	0.23		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.0	2	0.0500	1.57		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
7.3	102	Total			

Summary for Subcatchment Area 42: Area 42

Runoff = 3.63 cfs @ 12.15 hrs, Volume= 0.204 af, Depth= 3.18"
Routed to Reach S1.5 : Swale S1.5

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.769	69	Pasture/grassland/range, Fair, HSG B
0.769		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.3	100	0.0500	0.23		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.4	39	0.0500	1.57		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
7.7	139	Total			

Summary for Subcatchment Area 43: Area 43

Runoff = 7.53 cfs @ 12.24 hrs, Volume= 0.561 af, Depth= 2.41"
Routed to Reach S1.8 : Swale S1.8

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

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Area (ac)	CN	Description
0.797	39	Pasture/grassland/range, Good, HSG A
1.938	69	Pasture/grassland/range, Fair, HSG B
0.057	96	Gravel surface, HSG A
2.792	61	Weighted Average
2.792		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.3	100	0.0500	0.23		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
1.3	119	0.0500	1.57		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.1	22	0.1905	3.06		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
6.0	178	0.0050	0.49		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
14.7	419	Total			

Summary for Subcatchment Area 44: Area 44

Runoff = 0.43 cfs @ 12.47 hrs, Volume= 0.074 af, Depth= 0.63"
Routed to Reach S2.1 : Swale S2.1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
1.416	39	Pasture/grassland/range, Good, HSG A
1.416		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.5	100	0.0260	0.18		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
2.9	194	0.0260	1.13		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
9.6	647	0.0260	1.13		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
22.0	941	Total			

Summary for Subcatchment Area 45: Area 45

Runoff = 11.02 cfs @ 12.10 hrs, Volume= 0.542 af, Depth= 3.18"
Routed to Reach S3.1 : Swale S3.1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

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Area (ac)	CN	Description
2.044	69	Pasture/grassland/range, Fair, HSG B
2.044		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.2	38	0.2632	3.59		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
4.0	138	Total			

Summary for Subcatchment Area 46: Area 46

Runoff = 3.63 cfs @ 12.15 hrs, Volume= 0.204 af, Depth= 3.18"
Routed to Reach S3.4 : Swale S3.4

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.769	69	Pasture/grassland/range, Fair, HSG B
0.769		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.3	100	0.0500	0.23		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.4	39	0.0500	1.57		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
7.7	139	Total			

Summary for Subcatchment Area 47: Area 47

Runoff = 0.44 cfs @ 12.12 hrs, Volume= 0.023 af, Depth= 3.48"
Routed to Link C6 : Culvert C6

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.070	69	Pasture/grassland/range, Fair, HSG B
0.009	96	Gravel surface, HSG A
0.079	72	Weighted Average
0.079		100.00% Pervious Area

09/28/2023 - Classification: Internal - ECRM13153872

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.5	90	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
1.2	10	0.0500	0.14		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.1	10	0.0500	1.57		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.2	15	0.0050	1.44		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.1	18	0.1390	2.61		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
5.1	143	Total			

Summary for Subcatchment Area 48: Area 48

Runoff = 16.26 cfs @ 12.19 hrs, Volume= 1.050 af, Depth= 3.38"
Routed to Reach S3.5 : Swale S3.5

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
3.470	69	Pasture/grassland/range, Fair, HSG B
0.256	96	Gravel surface, HSG A
3.726	71	Weighted Average
3.726		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.3	100	0.0500	0.23		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.9	83	0.0500	1.57		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
2.9	208	0.0289	1.19		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
11.1	391	Total			

Summary for Subcatchment Area 49: Area 49

Runoff = 0.32 cfs @ 12.19 hrs, Volume= 0.036 af, Depth= 0.63"
Routed to Reach S2.1 : Swale S2.1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

09/28/2023 - Classification: Internal - ECRM13153872

Area (ac)	CN	Description
0.698	39	Pasture/grassland/range, Good, HSG A
0.698		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.8	100	0.0600	0.25		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"

Summary for Subcatchment Area 5: Area 5

Runoff = 2.81 cfs @ 12.10 hrs, Volume= 0.134 af, Depth= 3.18"
Routed to Link F6A : Flume 6A

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.504	69	Pasture/grassland/range, Fair, HSG B
0.504		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.9	72	0.2500	0.41		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.5	186	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Existing Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
3.4	258	Total			

Summary for Subcatchment Area 50: Area 50

Runoff = 1.22 cfs @ 12.10 hrs, Volume= 0.059 af, Depth= 3.18"
Routed to Link F4A : Flume 4A

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.223	69	Pasture/grassland/range, Fair, HSG B
0.223		100.00% Pervious Area

09/28/2023 - Classification: Internal - ECRM13153872

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.1	77	0.2500	0.41		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.5	157	0.0200	4.80	23.38	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.18' Z= 4.0 & 3.0 '/' Top.W=8.26' n= 0.030 Earth, grassed & winding
0.1	62	0.2500	12.26	441.43	**Trap/Vee/Rect Channel Flow, Riprap Flume** Bot.W=12.00' D=2.00' Z= 3.0 '/' Top.W=24.00' n= 0.078 Riprap, 12-inch
3.7	296	Total			

Summary for Subcatchment Area 51: Area 51

Runoff = 3.35 cfs @ 12.12 hrs, Volume= 0.174 af, Depth= 3.18"
Routed to Link F4B : Flume 4B

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.655	69	Pasture/grassland/range, Fair, HSG B
0.655		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.1	11	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.8	314	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Existing Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
0.3	217	0.2500	12.26	441.43	**Trap/Vee/Rect Channel Flow, Riprap Flume** Bot.W=12.00' D=2.00' Z= 3.0 '/' Top.W=24.00' n= 0.078 Riprap, 12-inch
5.0	642	Total			

Summary for Subcatchment Area 52: Area 52

Runoff = 1.28 cfs @ 12.10 hrs, Volume= 0.063 af, Depth= 3.18"
Routed to Link F5A : Flume 5A

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

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Area (ac)	CN	Description
0.237	69	Pasture/grassland/range, Fair, HSG B
0.237		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.3	83	0.2500	0.42		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.5	138	0.0200	4.80	23.38	**Trap/Vee/Rect Channel Flow, Existing Diversion Berm** Bot.W=0.00' D=1.18' Z= 4.0 & 3.0 '/' Top.W=8.26' n= 0.030 Earth, grassed & winding
0.2	127	0.2500	12.26	441.43	**Trap/Vee/Rect Channel Flow, Riprap Flume** Bot.W=12.00' D=2.00' Z= 3.0 '/' Top.W=24.00' n= 0.078 Riprap, 12-inch
4.0	348	Total			

Summary for Subcatchment Area 53: Area 53

Runoff = 2.50 cfs @ 12.11 hrs, Volume= 0.126 af, Depth= 3.18"
Routed to Link F5B : Flume 5B

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.475	69	Pasture/grassland/range, Fair, HSG B
0.475		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.5	90	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.8	219	0.0200	4.80	23.38	**Trap/Vee/Rect Channel Flow, Existing Diversion Berm** Bot.W=0.00' D=1.18' Z= 4.0 & 3.0 '/' Top.W=8.26' n= 0.030 Earth, grassed & winding
0.2	116	0.2500	12.26	441.43	**Trap/Vee/Rect Channel Flow, Riprap Flume** Bot.W=12.00' D=2.00' Z= 3.0 '/' Top.W=24.00' n= 0.078 Riprap, 12-inch
4.5	425	Total			

Summary for Subcatchment Area 54: Area 54

Runoff = 5.93 cfs @ 12.11 hrs, Volume= 0.300 af, Depth= 2.23"
Routed to Reach S2.3 : Swale S2.3

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

09/28/2023 - Classification: Internal - ECRM13153872

Area (ac)	CN	Description
1.079	69	Pasture/grassland/range, Fair, HSG B
0.539	39	Pasture/grassland/range, Good, HSG A
1.618	59	Weighted Average
1.618		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.1	77	0.2500	0.41		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.8	237	0.0200	4.80	23.38	**Trap/Vee/Rect Channel Flow, Existing Diversion Berm** Bot.W=0.00' D=1.18' Z= 4.0 & 3.0 '/' Top.W=8.26' n= 0.030 Earth, grassed & winding
0.3	70	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
4.2	384	Total			

Summary for Subcatchment Area 55: Area 55

Runoff = 2.95 cfs @ 12.11 hrs, Volume= 0.147 af, Depth= 2.13"
Routed to Reach S2.2 : Swale S2.2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.520	69	Pasture/grassland/range, Fair, HSG B
0.306	39	Pasture/grassland/range, Good, HSG A
0.826	58	Weighted Average
0.826		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.1	26	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
3.9	126	Total			

Summary for Subcatchment Area 56: Area 56

Runoff = 6.17 cfs @ 12.13 hrs, Volume= 0.325 af, Depth= 3.18"
Routed to Link F4B : Flume 4B

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

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Area (ac)	CN	Description
1.228	69	Pasture/grassland/range, Fair, HSG B
1.228		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.0	6	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.9	541	0.0200	4.80	23.38	**Trap/Vee/Rect Channel Flow, Existing Diversion Berm** Bot.W=0.00' D=1.18' Z= 4.0 & 3.0 '/' Top.W=8.26' n= 0.030 Earth, grassed & winding
5.7	647	Total			

Summary for Subcatchment Area 57: Area 57

Runoff = 3.79 cfs @ 12.11 hrs, Volume= 0.194 af, Depth= 2.13"
Routed to Reach S4.1 : Swale S4.1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.526	39	Pasture/grassland/range, Good, HSG A
0.405	69	Pasture/grassland/range, Fair, HSG B
0.158	96	Gravel surface, HSG A
1.089	58	Weighted Average
1.089		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.5	80	0.2000	0.38		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.2	20	0.0500	1.34		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.77"
0.1	10	0.0050	1.44		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.5	48	0.0625	1.75		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
4.3	158	Total			

Summary for Subcatchment Area 58: Area 58

Runoff = 4.33 cfs @ 12.11 hrs, Volume= 0.221 af, Depth= 2.23"
Routed to Reach S4.2 : Swale S4.2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

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Area (ac)	CN	Description
0.580	39	Pasture/grassland/range, Good, HSG A
0.433	69	Pasture/grassland/range, Fair, HSG B
0.181	96	Gravel surface, HSG B
1.194	59	Weighted Average
1.194		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.6	121	0.2314	3.37		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
4.4	221	Total			

Summary for Subcatchment Area 59: Area 59

Runoff = 6.17 cfs @ 12.12 hrs, Volume= 0.330 af, Depth= 1.78"
Routed to Reach S4.3 : Swale S4.3

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
1.134	39	Pasture/grassland/range, Good, HSG A
1.086	69	Pasture/grassland/range, Fair, HSG B
2.220	54	Weighted Average
2.220		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.8	140	0.1857	3.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
4.6	240	Total			

Summary for Subcatchment Area 6: Area 6

Runoff = 4.72 cfs @ 12.12 hrs, Volume= 0.248 af, Depth= 3.18"
Routed to Link F6A : Flume 6A

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.936	69	Pasture/grassland/range, Fair, HSG B
0.936		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.1	100	0.2070	0.40		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.2	46	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.0	395	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
5.3	541	Total			

Summary for Subcatchment Area 60: Area 60

Runoff = 8.43 cfs @ 12.12 hrs, Volume= 0.441 af, Depth= 2.13"
Routed to Reach S4.4 : Swale S4.4

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.939	39	Pasture/grassland/range, Good, HSG A
1.537	69	Pasture/grassland/range, Fair, HSG B
2.476	58	Weighted Average
2.476		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.9	163	0.1718	2.90		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
4.7	263	Total			

Summary for Subcatchment Area 61: Area 61

Runoff = 4.54 cfs @ 12.11 hrs, Volume= 0.238 af, Depth= 1.70"
Routed to Reach S4.5 : Swale S4.5

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.898	39	Pasture/grassland/range, Good, HSG A
0.785	69	Pasture/grassland/range, Fair, HSG B
1.683	53	Weighted Average
1.683		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.9	100	0.2345	0.42		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.2	46	0.2345	3.39		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
4.1	146	Total			

Summary for Subcatchment Area 62: Area 62

Runoff = 1.18 cfs @ 12.39 hrs, Volume= 0.150 af, Depth= 0.90"
Routed to Reach S4.6 : Swale S4.6

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
1.871	39	Pasture/grassland/range, Good, HSG A
0.000	96	Gravel surface, HSG A
0.130	96	Gravel surface, HSG A
2.001	43	Weighted Average
2.001		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.7	100	0.0074	0.11		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
4.7	169	0.0074	0.60		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.4	49	0.0800	1.98		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
20.8	318	Total			

Summary for Subcatchment Area 63: Area 63

Runoff = 0.97 cfs @ 12.21 hrs, Volume= 0.114 af, Depth= 0.63"
Routed to Reach S2.3 : Swale S2.3

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
2.177	39	Pasture/grassland/range, Good, HSG A
2.177		100.00% Pervious Area

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Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.4	66	0.0303	0.17		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
1.6	34	0.2500	0.35		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.2	49	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
8.2	149	Total			

Summary for Subcatchment Area 64: Area 64

Runoff = 1.14 cfs @ 12.16 hrs, Volume= 0.071 af, Depth= 1.44"
Routed to Pond Sed Pond : Sedimentation Basin

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.479	39	Pasture/grassland/range, Good, HSG A
0.115	96	Gravel surface, HSG A
0.594	50	Weighted Average
0.594		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.1	100	0.0544	0.24		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.5	47	0.0544	1.63		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
7.6	147	Total			

Summary for Subcatchment Area 65: Area 65

Runoff = 14.43 cfs @ 12.04 hrs, Volume= 0.799 af, Depth= 6.35"
Routed to Pond Sed Pond : Sedimentation Basin

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
1.509	98	Water Surface, HSG A
1.509		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry,**

Summary for Subcatchment Area 66: Area 66

Runoff = 2.36 cfs @ 12.21 hrs, Volume= 0.273 af, Depth= 0.63"
Routed to Pond Sed Pond : Sedimentation Basin

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
5.227	39	Pasture/grassland/range, Good, HSG A
5.227		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.5	75	0.0933	0.28		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
1.3	25	0.2500	0.33		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.0	10	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.8	381	0.0265	7.85	109.92	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=2.00' Z= 4.0 & 3.0 '/' Top.W=14.00' n= 0.030 Earth, grassed & winding
0.8	162	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.5	48	0.0500	1.57		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
7.9	701	Total			

Summary for Subcatchment Area 67: Area 67

Runoff = 1.99 cfs @ 12.64 hrs, Volume= 0.304 af, Depth= 1.20"
Routed to Reach RD1 : Roadside Ditch 1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
2.616	39	Pasture/grassland/range, Good, HSG A
0.039	69	Pasture/grassland/range, Fair, HSG B
0.380	96	Gravel surface, HSG A
3.035	47	Weighted Average
3.035		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
16.2	100	0.0068	0.10		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
22.7	786	0.0068	0.58		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
38.9	886	Total			

Summary for Subcatchment Area 68: Area 68

Runoff = 0.26 cfs @ 12.11 hrs, Volume= 0.017 af, Depth= 0.83"
Routed to Reach RD2 : Roadside Ditch 2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.227	39	Pasture/grassland/range, Good, HSG A
0.024	69	Pasture/grassland/range, Fair, HSG B
0.251	42	Weighted Average
0.251		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.1	52	0.1154	0.28		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"

Summary for Subcatchment Area 69: Area 69

Runoff = 1.50 cfs @ 12.11 hrs, Volume= 0.086 af, Depth= 1.13"
Routed to Reach RD2 : Roadside Ditch 2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.695	39	Pasture/grassland/range, Good, HSG A
0.218	69	Pasture/grassland/range, Fair, HSG B
0.913	46	Weighted Average
0.913		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.5	86	0.2326	0.41		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"

Summary for Subcatchment Area 7: Area 7

Runoff = 4.85 cfs @ 12.14 hrs, Volume= 0.261 af, Depth= 3.18"
Routed to Link F4A : Flume 4A

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
0.986	69	Pasture/grassland/range, Fair, HSG B
0.986		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.2	31	0.1000	0.24		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
2.8	69	0.2500	0.40		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.0	9	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.5	419	0.0200	4.80	23.38	**Trap/Vee/Rect Channel Flow, Existing Diversion Berm** Bot.W=0.00' D=1.18' Z= 4.0 & 3.0 '/' Top.W=8.26' n= 0.030 Earth, grassed & winding
0.1	80	0.2500	12.26	441.43	**Trap/Vee/Rect Channel Flow, Riprap Flume** Bot.W=12.00' D=2.00' Z= 3.0 '/' Top.W=24.00' n= 0.078 Riprap, 12-inch
6.6	608	Total			

Summary for Subcatchment Area 70: Area 70

Runoff = 3.98 cfs @ 12.11 hrs, Volume= 0.213 af, Depth= 1.53"
Routed to Reach RD4 : Roadside Ditch 4

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
1.016	39	Pasture/grassland/range, Good, HSG A
0.620	69	Pasture/grassland/range, Fair, HSG B
0.035	96	Gravel surface, HSG A
1.671	51	Weighted Average
1.671		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	100	0.2500	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.2	26	0.1538	2.75		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
4.0	126	Total			

Summary for Subcatchment Area 71: Area 71

Runoff = 5.65 cfs @ 12.32 hrs, Volume= 0.684 af, Depth= 0.83"
Routed to Pond N : North Infiltration Area

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (ac)	CN	Description
9.360	39	Pasture/grassland/range, Good, HSG A
0.515	96	Gravel surface, HSG A
9.875	42	Weighted Average
9.875		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.5	100	0.0200	0.16		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
1.7	100	0.0200	0.99		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
4.4	1,137	0.0193	4.31	32.30	**Trap/Vee/Rect Channel Flow, Roadside Ditch** Bot.W=0.00' D=1.00' Z= 5.0 & 10.0 '/' Top.W=15.00' n= 0.030
16.6	1,337	Total			

Summary for Subcatchment Area 8: Area 8

Runoff = 4.50 cfs @ 12.10 hrs, Volume= 0.216 af, Depth= 3.18"
Routed to Link F7A : Flume 7A

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (sf)	CN	Description
35,545	69	Pasture/grassland/range, Fair, HSG B
35,545		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.9	59	0.1695	0.33		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.7	289	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
3.6	348	Total			

Summary for Subcatchment Area 9: Area 9

Runoff = 1.44 cfs @ 12.09 hrs, Volume= 0.065 af, Depth= 3.18"
Routed to Link F7A : Flume 7A

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=6.59"

Area (sf)	CN	Description
10,716	69	Pasture/grassland/range, Fair, HSG B
10,716		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.1	48	0.2500	0.38		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.77"
0.2	96	0.0200	6.74	80.87	**Trap/Vee/Rect Channel Flow, Diversion Berm** Bot.W=0.00' D=2.00' Z= 4.0 & 2.0 '/' Top.W=12.00' n= 0.030 Earth, grassed & winding
2.3	144	Total			

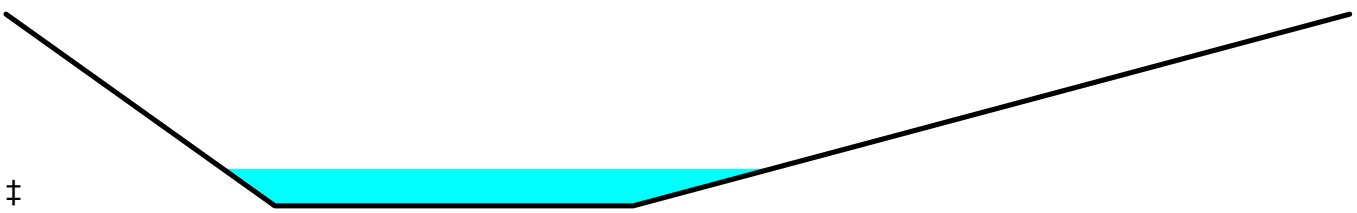
Summary for Reach RD1: Roadside Ditch 1

Inflow Area = 3.035 ac, 0.00% Impervious, Inflow Depth = 1.20" for 100-yr, 24-hr event
Inflow = 1.99 cfs @ 12.64 hrs, Volume= 0.304 af
Outflow = 1.96 cfs @ 12.74 hrs, Volume= 0.304 af, Atten= 1%, Lag= 6.5 min
Routed to Link C1 : Culvert C1

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.00 fps, Min. Travel Time= 3.7 min
Avg. Velocity = 0.80 fps, Avg. Travel Time= 9.2 min

Peak Storage= 434 cf @ 12.68 hrs
Average Depth at Peak Storage= 0.19' , Surface Width= 6.14'
Bank-Full Depth= 1.00' Flow Area= 9.5 sf, Capacity= 47.16 cfs

4.00' x 1.00' deep channel, n= 0.030
Side Slope Z-value= 3.0 8.0 '/' Top Width= 15.00'
Length= 440.6' Slope= 0.0188 '/'
Inlet Invert= 824.00', Outlet Invert= 815.70'



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Summary for Reach RD2: Roadside Ditch 2

Inflow Area = 7.576 ac, 0.00% Impervious, Inflow Depth = 2.29" for 100-yr, 24-hr event
Inflow = 19.31 cfs @ 12.19 hrs, Volume= 1.445 af
Outflow = 17.96 cfs @ 12.25 hrs, Volume= 1.445 af, Atten= 7%, Lag= 3.9 min
Routed to Link C9 : Culvert C9

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.14 fps, Min. Travel Time= 2.3 min
Avg. Velocity = 0.92 fps, Avg. Travel Time= 7.9 min

Peak Storage= 2,519 cf @ 12.21 hrs
Average Depth at Peak Storage= 0.52' , Surface Width= 16.40'
Bank-Full Depth= 1.00' Flow Area= 16.0 sf, Capacity= 72.77 cfs

6.00' x 1.00' deep channel, n= 0.030
Side Slope Z-value= 10.0 '/' Top Width= 26.00'
Length= 433.0' Slope= 0.0162 '/'
Inlet Invert= 814.55', Outlet Invert= 807.54'

‡

Summary for Reach RD3: Roadside Ditch 3

Inflow Area = 2.159 ac, 0.00% Impervious, Inflow Depth = 3.69" for 100-yr, 24-hr event
Inflow = 13.48 cfs @ 12.10 hrs, Volume= 0.663 af
Outflow = 11.77 cfs @ 12.19 hrs, Volume= 0.663 af, Atten= 13%, Lag= 5.2 min
Routed to Link C2 : Culvert C2

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 4.50 fps, Min. Travel Time= 3.0 min
Avg. Velocity = 1.47 fps, Avg. Travel Time= 9.3 min

Peak Storage= 2,151 cf @ 12.14 hrs
Average Depth at Peak Storage= 0.81' , Surface Width= 6.48'
Bank-Full Depth= 1.00' Flow Area= 4.0 sf, Capacity= 20.76 cfs

0.00' x 1.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 8.00'
Length= 821.0' Slope= 0.0288 '/'
Inlet Invert= 841.47', Outlet Invert= 817.83'

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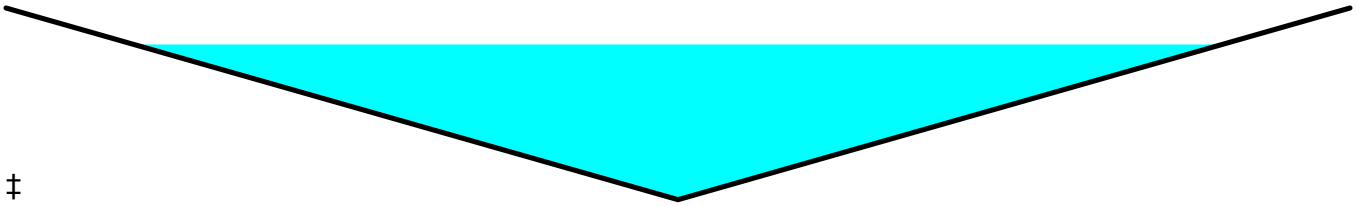

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Summary for Reach RD4: Roadside Ditch 4

Inflow Area = 1.671 ac, 0.00% Impervious, Inflow Depth = 1.53" for 100-yr, 24-hr event
Inflow = 3.98 cfs @ 12.11 hrs, Volume= 0.213 af
Outflow = 2.99 cfs @ 12.26 hrs, Volume= 0.213 af, Atten= 25%, Lag= 9.0 min
Routed to Link C9 : Culvert C9

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.52 fps, Min. Travel Time= 5.4 min
Avg. Velocity = 0.44 fps, Avg. Travel Time= 18.6 min

Peak Storage= 991 cf @ 12.17 hrs
Average Depth at Peak Storage= 0.24' , Surface Width= 10.77'
Bank-Full Depth= 1.00' Flow Area= 16.0 sf, Capacity= 54.26 cfs

6.00' x 1.00' deep channel, n= 0.030
Side Slope Z-value= 10.0 '/' Top Width= 26.00'
Length= 495.6' Slope= 0.0090 '/'
Inlet Invert= 812.00', Outlet Invert= 807.54'

‡

Summary for Reach RD5: Roadside Ditch 5

Inflow Area = 0.616 ac, 0.00% Impervious, Inflow Depth = 3.48" for 100-yr, 24-hr event
Inflow = 3.67 cfs @ 12.10 hrs, Volume= 0.179 af
Outflow = 3.30 cfs @ 12.14 hrs, Volume= 0.179 af, Atten= 10%, Lag= 2.2 min
Routed to Reach S4.2 : Swale S4.2

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 4.14 fps, Min. Travel Time= 1.2 min
Avg. Velocity = 1.52 fps, Avg. Travel Time= 3.2 min

Peak Storage= 238 cf @ 12.12 hrs
Average Depth at Peak Storage= 0.46' , Surface Width= 3.64'
Bank-Full Depth= 1.00' Flow Area= 4.0 sf, Capacity= 28.18 cfs

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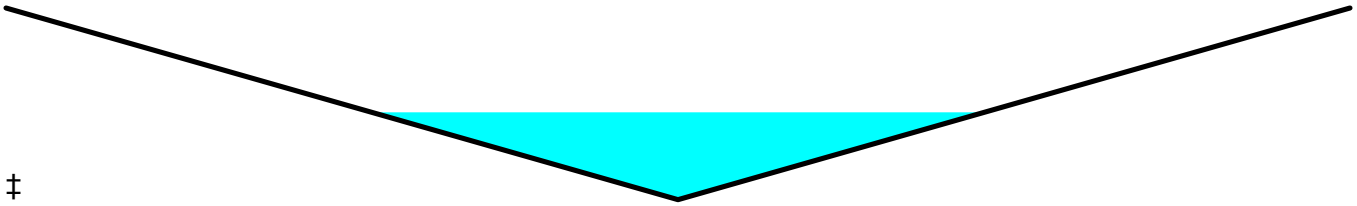
0.00' x 1.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 8.00'
Length= 288.0' Slope= 0.0531 '/'
Inlet Invert= 841.47', Outlet Invert= 826.18'



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Summary for Reach S1.1: Swale S1.1

Inflow Area = 1.185 ac, 0.00% Impervious, Inflow Depth = 2.79" for 100-yr, 24-hr event
Inflow = 5.57 cfs @ 12.11 hrs, Volume= 0.275 af
Outflow = 4.95 cfs @ 12.16 hrs, Volume= 0.275 af, Atten= 11%, Lag= 3.2 min
Routed to Link C10 : Culvert C10

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.87 fps, Min. Travel Time= 1.9 min
Avg. Velocity = 0.80 fps, Avg. Travel Time= 6.7 min

Peak Storage= 581 cf @ 12.13 hrs
Average Depth at Peak Storage= 0.21' , Surface Width= 9.64'
Bank-Full Depth= 2.00' Flow Area= 32.0 sf, Capacity= 338.34 cfs

8.00' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 24.00'
Length= 321.0' Slope= 0.0319 '/'
Inlet Invert= 825.20', Outlet Invert= 814.96'

‡

Summary for Reach S1.2: Swale S1.2

Inflow Area = 11.287 ac, 0.00% Impervious, Inflow Depth = 3.06" for 100-yr, 24-hr event
Inflow = 52.19 cfs @ 12.14 hrs, Volume= 2.880 af
Outflow = 49.91 cfs @ 12.16 hrs, Volume= 2.880 af, Atten= 4%, Lag= 1.2 min
Routed to Link C3 : Culvert C3

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 4.24 fps, Min. Travel Time= 0.8 min
Avg. Velocity = 1.15 fps, Avg. Travel Time= 2.9 min

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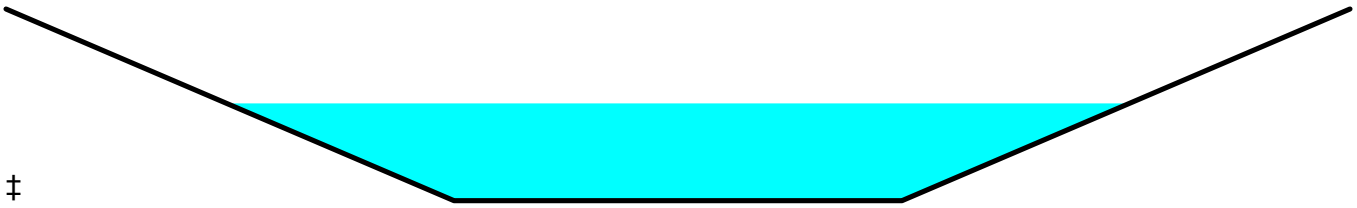
Peak Storage= 2,484 cf @ 12.15 hrs
Average Depth at Peak Storage= 1.02' , Surface Width= 16.13'
Bank-Full Depth= 2.00' Flow Area= 32.0 sf, Capacity= 196.86 cfs

8.00' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 24.00'
Length= 202.8' Slope= 0.0108 '/'
Inlet Invert= 813.36', Outlet Invert= 811.17'



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Summary for Reach S1.3: Swale S1.3

Inflow Area = 14.199 ac, 0.00% Impervious, Inflow Depth = 3.00" for 100-yr, 24-hr event
Inflow = 61.05 cfs @ 12.15 hrs, Volume= 3.550 af
Outflow = 60.33 cfs @ 12.15 hrs, Volume= 3.550 af, Atten= 1%, Lag= 0.4 min
Routed to Link C4 : Culvert C4

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 4.92 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 1.36 fps, Avg. Travel Time= 0.9 min

Peak Storage= 895 cf @ 12.15 hrs
Average Depth at Peak Storage= 1.03' , Surface Width= 16.20'
Bank-Full Depth= 2.00' Flow Area= 32.0 sf, Capacity= 227.36 cfs

8.00' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 24.00'
Length= 72.2' Slope= 0.0144 '/'
Inlet Invert= 810.90', Outlet Invert= 809.86'

‡

Summary for Reach S1.4: Swale S1.4

Inflow Area = 14.938 ac, 0.00% Impervious, Inflow Depth = 2.95" for 100-yr, 24-hr event
Inflow = 62.44 cfs @ 12.15 hrs, Volume= 3.671 af
Outflow = 59.56 cfs @ 12.18 hrs, Volume= 3.671 af, Atten= 5%, Lag= 1.4 min
Routed to Reach S1.6 : Swale S1.6

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.24 fps, Min. Travel Time= 0.8 min
Avg. Velocity = 0.92 fps, Avg. Travel Time= 2.7 min

Peak Storage= 2,814 cf @ 12.16 hrs
Average Depth at Peak Storage= 1.40' , Surface Width= 19.19'
Bank-Full Depth= 2.00' Flow Area= 32.0 sf, Capacity= 126.50 cfs

8.00' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 24.00'
Length= 148.0' Slope= 0.0045 '/'
Inlet Invert= 809.60', Outlet Invert= 808.94'

‡

Summary for Reach S1.5: Swale S1.5

Inflow Area = 0.769 ac, 0.00% Impervious, Inflow Depth = 3.18" for 100-yr, 24-hr event
Inflow = 3.63 cfs @ 12.15 hrs, Volume= 0.204 af
Outflow = 3.33 cfs @ 12.21 hrs, Volume= 0.204 af, Atten= 8%, Lag= 3.8 min
Routed to Reach S1.6 : Swale S1.6

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.35 fps, Min. Travel Time= 2.2 min
Avg. Velocity = 0.36 fps, Avg. Travel Time= 8.2 min

Peak Storage= 448 cf @ 12.18 hrs
Average Depth at Peak Storage= 0.27' , Surface Width= 10.19'
Bank-Full Depth= 2.00' Flow Area= 32.0 sf, Capacity= 134.06 cfs

8.00' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 24.00'
Length= 179.7' Slope= 0.0050 '/'
Inlet Invert= 809.85', Outlet Invert= 808.95'

‡

Summary for Reach S1.6: Swale S1.6

Inflow Area = 17.290 ac, 0.00% Impervious, Inflow Depth = 2.97" for 100-yr, 24-hr event
Inflow = 69.21 cfs @ 12.18 hrs, Volume= 4.277 af
Outflow = 66.73 cfs @ 12.21 hrs, Volume= 4.277 af, Atten= 4%, Lag= 2.1 min
Routed to Link C5 : Culvert C5

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.60 fps, Min. Travel Time= 1.2 min
Avg. Velocity = 0.98 fps, Avg. Travel Time= 4.3 min

Peak Storage= 4,825 cf @ 12.20 hrs
Average Depth at Peak Storage= 1.41' , Surface Width= 19.25'
Bank-Full Depth= 2.00' Flow Area= 32.0 sf, Capacity= 139.68 cfs

8.00' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 24.00'
Length= 252.0' Slope= 0.0054 '/'
Inlet Invert= 808.94', Outlet Invert= 807.57'

‡

Summary for Reach S1.7: Swale S1.7

Inflow Area = 0.712 ac, 0.00% Impervious, Inflow Depth = 3.38" for 100-yr, 24-hr event
Inflow = 3.63 cfs @ 12.15 hrs, Volume= 0.201 af
Outflow = 3.32 cfs @ 12.20 hrs, Volume= 0.201 af, Atten= 9%, Lag= 3.3 min
Routed to Reach S1.6 : Swale S1.6

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.20 fps, Min. Travel Time= 1.9 min
Avg. Velocity = 0.63 fps, Avg. Travel Time= 6.5 min

Peak Storage= 380 cf @ 12.17 hrs
Average Depth at Peak Storage= 0.41' , Surface Width= 4.98'
Bank-Full Depth= 2.00' Flow Area= 17.0 sf, Capacity= 90.14 cfs

2.50' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 2.0 4.0 '/' Top Width= 14.50'
Length= 245.8' Slope= 0.0099 '/'
Inlet Invert= 810.00', Outlet Invert= 807.57'

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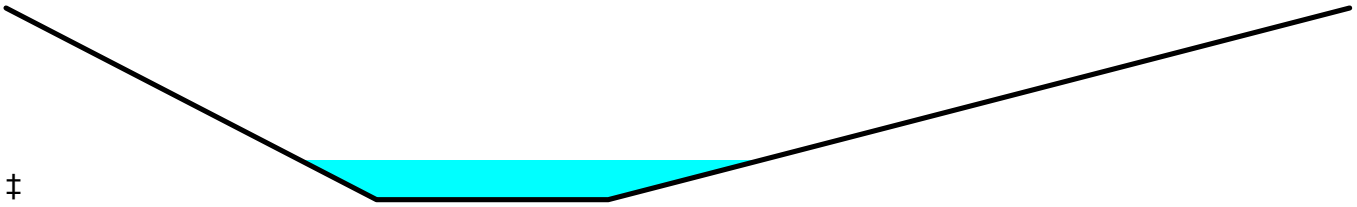

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Summary for Reach S1.8: Swale S1.8

Inflow Area = 20.082 ac, 0.00% Impervious, Inflow Depth = 2.89" for 100-yr, 24-hr event
Inflow = 74.10 cfs @ 12.22 hrs, Volume= 4.838 af
Outflow = 70.85 cfs @ 12.27 hrs, Volume= 4.838 af, Atten= 4%, Lag= 3.2 min
Routed to Reach S2.1 : Swale S2.1

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 4.09 fps, Min. Travel Time= 1.7 min
Avg. Velocity = 1.09 fps, Avg. Travel Time= 6.5 min

Peak Storage= 7,485 cf @ 12.24 hrs
Average Depth at Peak Storage= 1.33' , Surface Width= 18.65'
Bank-Full Depth= 2.00' Flow Area= 32.0 sf, Capacity= 163.67 cfs

8.00' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 24.00'
Length= 422.0' Slope= 0.0075 '/'
Inlet Invert= 807.15', Outlet Invert= 804.00'

‡

Summary for Reach S2.1: Swale S2.1

Inflow Area = 22.196 ac, 0.00% Impervious, Inflow Depth = 2.68" for 100-yr, 24-hr event
Inflow = 71.34 cfs @ 12.27 hrs, Volume= 4.949 af
Outflow = 68.62 cfs @ 12.32 hrs, Volume= 4.949 af, Atten= 4%, Lag= 3.2 min
Routed to Reach S2.2 : Swale S2.2

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.72 fps, Min. Travel Time= 1.7 min
Avg. Velocity = 1.10 fps, Avg. Travel Time= 5.9 min

Peak Storage= 7,331 cf @ 12.29 hrs
Average Depth at Peak Storage= 1.73' , Surface Width= 17.82'
Bank-Full Depth= 2.00' Flow Area= 24.0 sf, Capacity= 97.05 cfs

4.00' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 20.00'
Length= 389.0' Slope= 0.0054 '/'
Inlet Invert= 806.10', Outlet Invert= 804.00'

‡

Summary for Reach S2.2: Swale S2.2

Inflow Area = 39.450 ac, 0.00% Impervious, Inflow Depth = 2.90" for 100-yr, 24-hr event
Inflow = 120.78 cfs @ 12.27 hrs, Volume= 9.518 af
Outflow = 118.35 cfs @ 12.32 hrs, Volume= 9.518 af, Atten= 2%, Lag= 3.1 min
Routed to Reach S2.3 : Swale S2.3

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.96 fps, Min. Travel Time= 1.7 min
Avg. Velocity = 1.03 fps, Avg. Travel Time= 6.7 min

Peak Storage= 12,407 cf @ 12.29 hrs
Average Depth at Peak Storage= 1.77' , Surface Width= 24.15'
Bank-Full Depth= 2.00' Flow Area= 36.0 sf, Capacity= 152.61 cfs

10.00' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 26.00'
Length= 411.0' Slope= 0.0049 '/'
Inlet Invert= 804.00', Outlet Invert= 802.00'

‡

Summary for Reach S2.3: Swale S2.3

Inflow Area = 43.245 ac, 0.00% Impervious, Inflow Depth = 2.76" for 100-yr, 24-hr event
Inflow = 120.84 cfs @ 12.32 hrs, Volume= 9.932 af
Outflow = 119.37 cfs @ 12.35 hrs, Volume= 9.932 af, Atten= 1%, Lag= 1.7 min
Routed to Link C7 : Culvert C7

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 5.64 fps, Min. Travel Time= 0.9 min
Avg. Velocity = 1.45 fps, Avg. Travel Time= 3.5 min

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Peak Storage= 6,544 cf @ 12.33 hrs
Average Depth at Peak Storage= 1.38' , Surface Width= 21.00'
Bank-Full Depth= 2.00' Flow Area= 36.0 sf, Capacity= 249.72 cfs

10.00' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 26.00'
Length= 307.0' Slope= 0.0130 '/'
Inlet Invert= 802.00', Outlet Invert= 798.00'

‡

Summary for Reach S3.1: Swale S3.1

Inflow Area = 2.044 ac, 0.00% Impervious, Inflow Depth = 3.18" for 100-yr, 24-hr event
Inflow = 11.02 cfs @ 12.10 hrs, Volume= 0.542 af
Outflow = 9.75 cfs @ 12.19 hrs, Volume= 0.542 af, Atten= 12%, Lag= 5.2 min
Routed to Reach S3.2 : Swale S3.2

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.94 fps, Min. Travel Time= 3.1 min
Avg. Velocity = 0.48 fps, Avg. Travel Time= 12.5 min

Peak Storage= 1,797 cf @ 12.14 hrs
Average Depth at Peak Storage= 0.50' , Surface Width= 12.02'
Bank-Full Depth= 2.00' Flow Area= 32.0 sf, Capacity= 133.76 cfs

8.00' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 24.00'
Length= 357.0' Slope= 0.0050 '/'
Inlet Invert= 809.85', Outlet Invert= 808.07'

‡

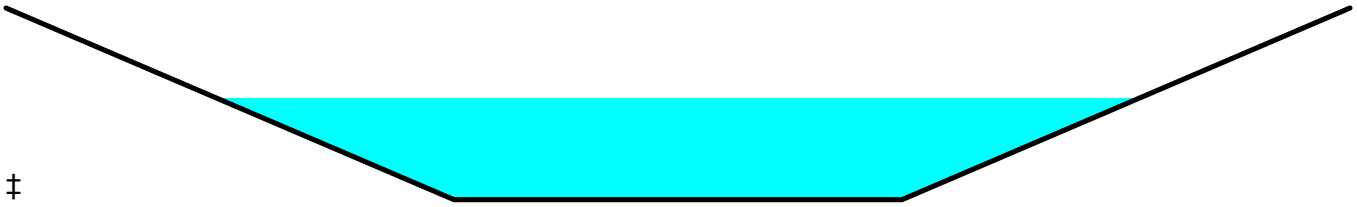
Summary for Reach S3.2: Swale S3.2

Inflow Area = 8.141 ac, 0.00% Impervious, Inflow Depth = 3.19" for 100-yr, 24-hr event
Inflow = 38.61 cfs @ 12.12 hrs, Volume= 2.162 af
Outflow = 37.80 cfs @ 12.13 hrs, Volume= 2.162 af, Atten= 2%, Lag= 0.5 min
Routed to Reach S3.3 : Swale S3.3

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.93 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 0.75 fps, Avg. Travel Time= 0.8 min

Peak Storage= 442 cf @ 12.12 hrs
Average Depth at Peak Storage= 1.06' , Surface Width= 16.50'
Bank-Full Depth= 2.00' Flow Area= 32.0 sf, Capacity= 133.95 cfs

8.00' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 24.00'
Length= 34.0' Slope= 0.0050 '/'
Inlet Invert= 798.00', Outlet Invert= 797.83'



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Summary for Reach S3.3: Swale S3.3

Inflow Area = 8.141 ac, 0.00% Impervious, Inflow Depth = 3.19" for 100-yr, 24-hr event
Inflow = 37.80 cfs @ 12.13 hrs, Volume= 2.162 af
Outflow = 36.67 cfs @ 12.15 hrs, Volume= 2.162 af, Atten= 3%, Lag= 1.5 min
Routed to Link C6 : Culvert C6

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 4.12 fps, Min. Travel Time= 0.8 min
Avg. Velocity = 1.04 fps, Avg. Travel Time= 3.2 min

Peak Storage= 1,839 cf @ 12.14 hrs
Average Depth at Peak Storage= 0.82' , Surface Width= 14.53'
Bank-Full Depth= 2.00' Flow Area= 32.0 sf, Capacity= 215.99 cfs

8.00' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 24.00'
Length= 200.0' Slope= 0.0130 '/'
Inlet Invert= 808.00', Outlet Invert= 805.40'

‡

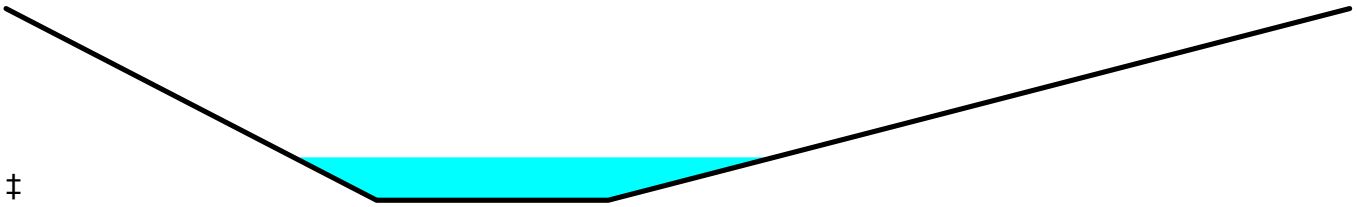
Summary for Reach S3.4: Swale S3.4

Inflow Area = 0.769 ac, 0.00% Impervious, Inflow Depth = 3.18" for 100-yr, 24-hr event
Inflow = 3.63 cfs @ 12.15 hrs, Volume= 0.204 af
Outflow = 3.29 cfs @ 12.22 hrs, Volume= 0.204 af, Atten= 9%, Lag= 4.3 min
Routed to Link C6 : Culvert C6

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.95 fps, Min. Travel Time= 2.4 min
Avg. Velocity = 0.57 fps, Avg. Travel Time= 8.3 min

Peak Storage= 487 cf @ 12.18 hrs
Average Depth at Peak Storage= 0.45' , Surface Width= 5.19'
Bank-Full Depth= 2.00' Flow Area= 17.0 sf, Capacity= 76.21 cfs

2.50' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 2.0 4.0 '/' Top Width= 14.50'
Length= 283.0' Slope= 0.0071 '/'
Inlet Invert= 810.00', Outlet Invert= 808.00'



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Summary for Reach S3.5: Swale S3.5

Inflow Area = 15.716 ac, 0.00% Impervious, Inflow Depth = 3.23" for 100-yr, 24-hr event
Inflow = 68.29 cfs @ 12.15 hrs, Volume= 4.234 af
Outflow = 64.19 cfs @ 12.21 hrs, Volume= 4.234 af, Atten= 6%, Lag= 3.7 min
Routed to Reach S2.2 : Swale S2.2

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.63 fps, Min. Travel Time= 2.0 min
Avg. Velocity = 0.68 fps, Avg. Travel Time= 7.8 min

Peak Storage= 7,904 cf @ 12.17 hrs
Average Depth at Peak Storage= 1.68' , Surface Width= 21.48'
Bank-Full Depth= 2.00' Flow Area= 32.0 sf, Capacity= 93.14 cfs

8.00' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 24.00'
Length= 318.5' Slope= 0.0024 '/'
Inlet Invert= 804.76', Outlet Invert= 803.99'

‡

Summary for Reach S4.1: Swale S4.1

Inflow Area = 1.364 ac, 0.00% Impervious, Inflow Depth = 2.35" for 100-yr, 24-hr event
Inflow = 5.28 cfs @ 12.10 hrs, Volume= 0.267 af
Outflow = 4.68 cfs @ 12.16 hrs, Volume= 0.267 af, Atten= 11%, Lag= 3.3 min
Routed to Reach S4.2 : Swale S4.2

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.07 fps, Min. Travel Time= 1.9 min
Avg. Velocity = 0.50 fps, Avg. Travel Time= 8.0 min

Peak Storage= 556 cf @ 12.12 hrs
Average Depth at Peak Storage= 0.22' , Surface Width= 11.51'
Bank-Full Depth= 1.00' Flow Area= 13.5 sf, Capacity= 70.22 cfs

10.00' x 1.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 3.0 '/' Top Width= 17.00'
Length= 240.0' Slope= 0.0153 '/'
Inlet Invert= 811.94', Outlet Invert= 808.26'

‡

Summary for Reach S4.2: Swale S4.2

Inflow Area = 3.174 ac, 0.00% Impervious, Inflow Depth = 2.52" for 100-yr, 24-hr event
Inflow = 11.92 cfs @ 12.14 hrs, Volume= 0.667 af
Outflow = 11.06 cfs @ 12.18 hrs, Volume= 0.667 af, Atten= 7%, Lag= 2.8 min
Routed to Reach S4.3 : Swale S4.3

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.70 fps, Min. Travel Time= 1.6 min
Avg. Velocity = 0.62 fps, Avg. Travel Time= 7.0 min

Peak Storage= 1,118 cf @ 12.15 hrs
Average Depth at Peak Storage= 0.38' , Surface Width= 12.66'
Bank-Full Depth= 1.00' Flow Area= 13.5 sf, Capacity= 63.88 cfs

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10.00' x 1.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 3.0 '/' Top Width= 17.00'
Length= 259.3' Slope= 0.0127 '/'
Inlet Invert= 808.26', Outlet Invert= 804.97'

‡

Summary for Reach S4.3: Swale S4.3

Inflow Area = 9.483 ac, 0.00% Impervious, Inflow Depth = 2.63" for 100-yr, 24-hr event
Inflow = 36.14 cfs @ 12.14 hrs, Volume= 2.080 af
Outflow = 33.37 cfs @ 12.21 hrs, Volume= 2.080 af, Atten= 8%, Lag= 4.5 min
Routed to Reach S4.4 : Swale S4.4

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.26 fps, Min. Travel Time= 2.7 min
Avg. Velocity = 0.54 fps, Avg. Travel Time= 11.3 min

Peak Storage= 5,406 cf @ 12.17 hrs
Average Depth at Peak Storage= 1.08' , Surface Width= 17.57'
Bank-Full Depth= 2.00' Flow Area= 34.0 sf, Capacity= 108.12 cfs

10.00' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 3.0 '/' Top Width= 24.00'
Length= 362.9' Slope= 0.0027 '/'
Inlet Invert= 804.97', Outlet Invert= 804.00'

‡

Summary for Reach S4.4: Swale S4.4

Inflow Area = 14.158 ac, 0.00% Impervious, Inflow Depth = 2.63" for 100-yr, 24-hr event
Inflow = 45.34 cfs @ 12.17 hrs, Volume= 3.104 af
Outflow = 43.47 cfs @ 12.26 hrs, Volume= 3.104 af, Atten= 4%, Lag= 5.4 min
Routed to Reach S4.5 : Swale S4.5

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.82 fps, Min. Travel Time= 2.9 min
Avg. Velocity = 0.67 fps, Avg. Travel Time= 12.3 min

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Peak Storage= 7,633 cf @ 12.21 hrs
Average Depth at Peak Storage= 1.11' , Surface Width= 17.77'
Bank-Full Depth= 2.00' Flow Area= 34.0 sf, Capacity= 132.85 cfs

10.00' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 3.0 '/' Top Width= 24.00'
Length= 495.6' Slope= 0.0040 '/'
Inlet Invert= 804.00', Outlet Invert= 802.00'

‡

Summary for Reach S4.5: Swale S4.5

Inflow Area = 16.268 ac, 0.00% Impervious, Inflow Depth = 2.55" for 100-yr, 24-hr event
Inflow = 45.91 cfs @ 12.26 hrs, Volume= 3.454 af
Outflow = 44.58 cfs @ 12.31 hrs, Volume= 3.454 af, Atten= 3%, Lag= 3.1 min
Routed to Reach S4.6 : Swale S4.6

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.87 fps, Min. Travel Time= 1.8 min
Avg. Velocity = 0.98 fps, Avg. Travel Time= 7.0 min

Peak Storage= 4,792 cf @ 12.28 hrs
Average Depth at Peak Storage= 0.89' , Surface Width= 16.22'
Bank-Full Depth= 3.00' Flow Area= 61.5 sf, Capacity= 465.89 cfs

10.00' x 3.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 3.0 '/' Top Width= 31.00'
Length= 411.1' Slope= 0.0097 '/'
Inlet Invert= 802.00', Outlet Invert= 798.00'

‡

Summary for Reach S4.6: Swale S4.6

Inflow Area = 64.606 ac, 0.00% Impervious, Inflow Depth = 2.67" for 100-yr, 24-hr event
Inflow = 168.73 cfs @ 12.33 hrs, Volume= 14.356 af
Outflow = 165.72 cfs @ 12.38 hrs, Volume= 14.356 af, Atten= 2%, Lag= 2.6 min
Routed to Pond Sed Pond : Sedimentation Basin

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 6.02 fps, Min. Travel Time= 1.5 min
Avg. Velocity = 1.58 fps, Avg. Travel Time= 5.7 min

Peak Storage= 14,984 cf @ 12.35 hrs
Average Depth at Peak Storage= 1.74' , Surface Width= 22.15'
Bank-Full Depth= 3.00' Flow Area= 61.5 sf, Capacity= 499.25 cfs

10.00' x 3.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 3.0 '/' Top Width= 31.00'
Length= 537.0' Slope= 0.0112 '/'
Inlet Invert= 798.00', Outlet Invert= 792.00'

‡

Summary for Reach S5.1: Swale S5.1

Inflow Area = 1.218 ac, 0.00% Impervious, Inflow Depth = 3.69" for 100-yr, 24-hr event
Inflow = 7.33 cfs @ 12.11 hrs, Volume= 0.374 af
Outflow = 6.57 cfs @ 12.20 hrs, Volume= 0.374 af, Atten= 10%, Lag= 5.2 min
Routed to Link C2 : Culvert C2

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.49 fps, Min. Travel Time= 3.2 min
Avg. Velocity = 0.63 fps, Avg. Travel Time= 12.7 min

Peak Storage= 1,277 cf @ 12.15 hrs
Average Depth at Peak Storage= 0.29' , Surface Width= 10.33'
Bank-Full Depth= 2.00' Flow Area= 32.0 sf, Capacity= 235.22 cfs

8.00' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 4.0 '/' Top Width= 24.00'
Length= 478.0' Slope= 0.0154 '/'
Inlet Invert= 825.20', Outlet Invert= 817.83'

‡

Summary for Pond C8: Culvert C8

Inflow Area = 0.275 ac, 0.00% Impervious, Inflow Depth = 3.18" for 100-yr, 24-hr event
Inflow = 1.60 cfs @ 12.08 hrs, Volume= 0.073 af
Outflow = 1.60 cfs @ 12.08 hrs, Volume= 0.073 af, Atten= 0%, Lag= 0.1 min
Primary = 1.60 cfs @ 12.08 hrs, Volume= 0.073 af
Routed to Reach S4.1 : Swale S4.1

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 811.38' @ 12.08 hrs Surf.Area= 0.000 ac Storage= 0.000 af
Flood Elev= 819.00' Surf.Area= 0.000 ac Storage= 0.001 af

Plug-Flow detention time= 0.2 min calculated for 0.073 af (100% of inflow)
Center-of-Mass det. time= 0.2 min (817.4 - 817.3)

Volume	Invert	Avail.Storage	Storage Description
#1	810.70'	0.001 af	**3.00'D x 7.00'H Vertical Cone/Cylinder**

Device	Routing	Invert	Outlet Devices
#1	Primary	810.70'	**12.0" Round Culvert** L= 85.6' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 810.70' / 808.60' S= 0.0245 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=1.49 cfs @ 12.08 hrs HW=811.35' (Free Discharge)
↑**1=Culvert** (Inlet Controls 1.49 cfs @ 2.75 fps)

Summary for Pond N: North Infiltration Area

Inflow Area = 19.122 ac, 0.00% Impervious, Inflow Depth = 1.47" for 100-yr, 24-hr event
Inflow = 26.07 cfs @ 12.26 hrs, Volume= 2.341 af
Outflow = 2.21 cfs @ 14.51 hrs, Volume= 2.341 af, Atten= 92%, Lag= 134.8 min
Primary = 2.21 cfs @ 14.51 hrs, Volume= 2.341 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 805.23' @ 14.51 hrs Surf.Area= 26,475 sf Storage= 49,470 cf

Plug-Flow detention time= 286.7 min calculated for 2.340 af (100% of inflow)
Center-of-Mass det. time= 286.7 min (1,155.0 - 868.3)

Volume	Invert	Avail.Storage	Storage Description
#1	802.00'	256,569 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
802.00	5,140	0	0
804.00	17,424	22,564	22,564
806.00	32,191	49,615	72,179
808.00	46,130	78,321	150,500
810.00	59,939	106,069	256,569

Device	Routing	Invert	Outlet Devices
#1	Primary	802.00'	**3.600 in/hr Exfiltration over Surface area**

Primary OutFlow Max=2.21 cfs @ 14.51 hrs HW=805.23' (Free Discharge)
↑—**1=Exfiltration** (Exfiltration Controls 2.21 cfs)

Summary for Pond Sed Pond: Sedimentation Basin

Inflow Area = 71.936 ac, 2.10% Impervious, Inflow Depth = 2.59" for 100-yr, 24-hr event
Inflow = 169.96 cfs @ 12.38 hrs, Volume= 15.500 af
Outflow = 83.78 cfs @ 12.65 hrs, Volume= 15.500 af, Atten= 51%, Lag= 16.6 min
Discarded = 5.91 cfs @ 12.65 hrs, Volume= 7.233 af
Primary = 11.51 cfs @ 12.65 hrs, Volume= 5.165 af
Routed to Link Wetland : Wetland
Secondary = 31.49 cfs @ 12.65 hrs, Volume= 2.330 af
Routed to Link Wetland : Wetland
Tertiary = 34.88 cfs @ 12.65 hrs, Volume= 0.772 af
Routed to Link Wetland : Wetland

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 793.20' @ 12.65 hrs Surf.Area= 70,892 sf Storage= 245,676 cf
Flood Elev= 794.00' Surf.Area= 75,797 sf Storage= 304,443 cf

Plug-Flow detention time= 158.5 min calculated for 15.489 af (100% of inflow)
Center-of-Mass det. time= 158.5 min (1,005.3 - 846.8)

Volume	Invert	Avail.Storage	Storage Description
#1	789.00'	304,443 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
789.00	27,325	0	0
790.00	55,972	41,649	41,649
791.00	61,532	58,752	100,401
792.00	65,703	63,618	164,018
793.00	69,675	67,689	231,707
794.00	75,797	72,736	304,443

Device	Routing	Invert	Outlet Devices
#1	Primary	787.70'	**15.0" Round Culvert** L= 40.0' RCP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 787.70' / 787.50' S= 0.0050 '/' Cc= 0.900 n= 0.011 Concrete pipe, straight & clean, Flow Area= 1.23 sf
#2	Device 1	791.00'	**30.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Device 1	790.50'	**0.8" Vert. Orifice/Grate X 4.00** C= 0.600 Limited to weir flow at low heads
#4	Device 1	790.00'	**0.8" Vert. Orifice/Grate X 4.00** C= 0.600 Limited to weir flow at low heads
#5	Device 1	789.00'	**0.5" Vert. Orifice/Grate X 14.00 columns** X 6 rows with 6.0" cc spacing C= 0.600

			Limited to weir flow at low heads
#6	Secondary	792.50'	**20.0' long x 10.0' breadth Broad-Crested Rectangular Weir**
			Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60
			Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64
#7	Tertiary	793.00'	**158.0' long x 10.0' breadth Broad-Crested Rectangular Weir**
			Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60
			Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64
#8	Discarded	789.00'	**3.600 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=5.91 cfs @ 12.65 hrs HW=793.20' (Free Discharge)
└**8=Exfiltration** (Exfiltration Controls 5.91 cfs)

Primary OutFlow Max=11.51 cfs @ 12.65 hrs HW=793.20' (Free Discharge)
└**1=Culvert** (Inlet Controls 11.51 cfs @ 9.38 fps)
  ├**2=Orifice/Grate** (Passes < 35.04 cfs potential flow)
  ├**3=Orifice/Grate** (Passes < 0.11 cfs potential flow)
  ├**4=Orifice/Grate** (Passes < 0.12 cfs potential flow)
  └**5=Orifice/Grate** (Passes < 0.93 cfs potential flow)

Secondary OutFlow Max=31.42 cfs @ 12.65 hrs HW=793.20' (Free Discharge)
└**6=Broad-Crested Rectangular Weir** (Weir Controls 31.42 cfs @ 2.25 fps)

Tertiary OutFlow Max=34.62 cfs @ 12.65 hrs HW=793.20' (Free Discharge)
└**7=Broad-Crested Rectangular Weir** (Weir Controls 34.62 cfs @ 1.11 fps)

Summary for Link C1: Culvert C1

Inflow Area = 3.035 ac, 0.00% Impervious, Inflow Depth = 1.20" for 100-yr, 24-hr event
Inflow = 1.96 cfs @ 12.74 hrs, Volume= 0.304 af
Primary = 1.96 cfs @ 12.74 hrs, Volume= 0.304 af, Atten= 0%, Lag= 0.0 min
Routed to Reach RD2 : Roadside Ditch 2

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link C10: Culvert C10

Inflow Area = 1.185 ac, 0.00% Impervious, Inflow Depth = 2.79" for 100-yr, 24-hr event
Inflow = 4.95 cfs @ 12.16 hrs, Volume= 0.275 af
Primary = 4.95 cfs @ 12.16 hrs, Volume= 0.275 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S1.2 : Swale S1.2

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link C2: Culvert C2

Inflow Area = 3.377 ac, 0.00% Impervious, Inflow Depth = 3.69" for 100-yr, 24-hr event
Inflow = 18.32 cfs @ 12.19 hrs, Volume= 1.038 af
Primary = 18.32 cfs @ 12.19 hrs, Volume= 1.038 af, Atten= 0%, Lag= 0.0 min
Routed to Reach RD2 : Roadside Ditch 2

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

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Summary for Link C3: Culvert C3

Inflow Area = 11.287 ac, 0.00% Impervious, Inflow Depth = 3.06" for 100-yr, 24-hr event
Inflow = 49.91 cfs @ 12.16 hrs, Volume= 2.880 af
Primary = 49.91 cfs @ 12.16 hrs, Volume= 2.880 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S1.3 : Swale S1.3

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link C4: Culvert C4

Inflow Area = 14.199 ac, 0.00% Impervious, Inflow Depth = 3.00" for 100-yr, 24-hr event
Inflow = 60.33 cfs @ 12.15 hrs, Volume= 3.550 af
Primary = 60.33 cfs @ 12.15 hrs, Volume= 3.550 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S1.4 : Swale S1.4

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link C5: Culvert C5

Inflow Area = 17.290 ac, 0.00% Impervious, Inflow Depth = 2.97" for 100-yr, 24-hr event
Inflow = 66.73 cfs @ 12.21 hrs, Volume= 4.277 af
Primary = 66.73 cfs @ 12.21 hrs, Volume= 4.277 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S1.8 : Swale S1.8

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link C6: Culvert C6

Inflow Area = 11.990 ac, 0.00% Impervious, Inflow Depth = 3.19" for 100-yr, 24-hr event
Inflow = 53.57 cfs @ 12.14 hrs, Volume= 3.184 af
Primary = 53.57 cfs @ 12.14 hrs, Volume= 3.184 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S3.5 : Swale S3.5

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link C7: Culvert C7

Inflow Area = 46.337 ac, 0.00% Impervious, Inflow Depth = 2.78" for 100-yr, 24-hr event
Inflow = 123.92 cfs @ 12.34 hrs, Volume= 10.752 af
Primary = 123.92 cfs @ 12.34 hrs, Volume= 10.752 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S4.6 : Swale S4.6

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

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Summary for Link C9: Culvert C9

Inflow Area = 9.247 ac, 0.00% Impervious, Inflow Depth = 2.15" for 100-yr, 24-hr event
Inflow = 20.94 cfs @ 12.26 hrs, Volume= 1.658 af
Primary = 20.94 cfs @ 12.26 hrs, Volume= 1.658 af, Atten= 0%, Lag= 0.0 min
Routed to Pond N : North Infiltration Area

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link F10: Flume 10

Inflow Area = 0.275 ac, 0.00% Impervious, Inflow Depth = 3.18" for 100-yr, 24-hr event
Inflow = 1.60 cfs @ 12.08 hrs, Volume= 0.073 af
Primary = 1.60 cfs @ 12.08 hrs, Volume= 0.073 af, Atten= 0%, Lag= 0.0 min
Routed to Pond C8 : Culvert C8

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link F1A: Flume 1A

Inflow Area = 1.853 ac, 0.00% Impervious, Inflow Depth = 3.18" for 100-yr, 24-hr event
Inflow = 9.08 cfs @ 12.13 hrs, Volume= 0.491 af
Primary = 9.08 cfs @ 12.13 hrs, Volume= 0.491 af, Atten= 0%, Lag= 0.0 min
Routed to Link F1B : Flume 1B

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link F1B: Flume 1B

Inflow Area = 4.089 ac, 0.00% Impervious, Inflow Depth = 3.18" for 100-yr, 24-hr event
Inflow = 20.35 cfs @ 12.13 hrs, Volume= 1.084 af
Primary = 20.35 cfs @ 12.13 hrs, Volume= 1.084 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S4.3 : Swale S4.3

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link F2A: Flume 2A

Inflow Area = 0.636 ac, 0.00% Impervious, Inflow Depth = 3.18" for 100-yr, 24-hr event
Inflow = 3.34 cfs @ 12.11 hrs, Volume= 0.169 af
Primary = 3.34 cfs @ 12.11 hrs, Volume= 0.169 af, Atten= 0%, Lag= 0.0 min
Routed to Link F2B : Flume 2B

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

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Summary for Link F2B: Flume 2B

Inflow Area = 2.199 ac, 0.00% Impervious, Inflow Depth = 3.18" for 100-yr, 24-hr event
Inflow = 11.13 cfs @ 12.12 hrs, Volume= 0.583 af
Primary = 11.13 cfs @ 12.12 hrs, Volume= 0.583 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S4.4 : Swale S4.4

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link F3: Flume 3

Inflow Area = 0.427 ac, 0.00% Impervious, Inflow Depth = 3.18" for 100-yr, 24-hr event
Inflow = 2.33 cfs @ 12.10 hrs, Volume= 0.113 af
Primary = 2.33 cfs @ 12.10 hrs, Volume= 0.113 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S4.5 : Swale S4.5

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link F4A: Flume 4A

Inflow Area = 1.209 ac, 0.00% Impervious, Inflow Depth = 3.18" for 100-yr, 24-hr event
Inflow = 5.87 cfs @ 12.13 hrs, Volume= 0.320 af
Primary = 5.87 cfs @ 12.13 hrs, Volume= 0.320 af, Atten= 0%, Lag= 0.0 min
Routed to Link F4B : Flume 4B

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link F4B: Flume 4B

Inflow Area = 3.092 ac, 0.00% Impervious, Inflow Depth = 3.18" for 100-yr, 24-hr event
Inflow = 15.35 cfs @ 12.13 hrs, Volume= 0.820 af
Primary = 15.35 cfs @ 12.13 hrs, Volume= 0.820 af, Atten= 0%, Lag= 0.0 min
Routed to Link C7 : Culvert C7

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link F5A: Flume 5A

Inflow Area = 0.237 ac, 0.00% Impervious, Inflow Depth = 3.18" for 100-yr, 24-hr event
Inflow = 1.28 cfs @ 12.10 hrs, Volume= 0.063 af
Primary = 1.28 cfs @ 12.10 hrs, Volume= 0.063 af, Atten= 0%, Lag= 0.0 min
Routed to Link F5B : Flume 5B

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

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Summary for Link F5B: Flume 5B

Inflow Area = 0.712 ac, 0.00% Impervious, Inflow Depth = 3.18" for 100-yr, 24-hr event
Inflow = 3.77 cfs @ 12.11 hrs, Volume= 0.189 af
Primary = 3.77 cfs @ 12.11 hrs, Volume= 0.189 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S2.2 : Swale S2.2

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link F6A: Flume 6A

Inflow Area = 1.440 ac, 0.00% Impervious, Inflow Depth = 3.18" for 100-yr, 24-hr event
Inflow = 7.42 cfs @ 12.11 hrs, Volume= 0.382 af
Primary = 7.42 cfs @ 12.11 hrs, Volume= 0.382 af, Atten= 0%, Lag= 0.0 min
Routed to Link F6B : Flume 6B

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link F6B: Flume 6B

Inflow Area = 3.001 ac, 0.00% Impervious, Inflow Depth = 3.18" for 100-yr, 24-hr event
Inflow = 15.57 cfs @ 12.11 hrs, Volume= 0.795 af
Primary = 15.57 cfs @ 12.11 hrs, Volume= 0.795 af, Atten= 0%, Lag= 0.0 min
Routed to Link C6 : Culvert C6

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link F7A: Flume 7A

Inflow Area = 1.062 ac, 0.00% Impervious, Inflow Depth = 3.18" for 100-yr, 24-hr event
Inflow = 5.92 cfs @ 12.10 hrs, Volume= 0.281 af
Primary = 5.92 cfs @ 12.10 hrs, Volume= 0.281 af, Atten= 0%, Lag= 0.0 min
Routed to Link F7B : Flume 7B

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link F7B: Flume 7B

Inflow Area = 3.407 ac, 0.00% Impervious, Inflow Depth = 3.18" for 100-yr, 24-hr event
Inflow = 18.00 cfs @ 12.11 hrs, Volume= 0.903 af
Primary = 18.00 cfs @ 12.11 hrs, Volume= 0.903 af, Atten= 0%, Lag= 0.0 min
Routed to Link F7C : Flume 7C

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

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Summary for Link F7C: Flume 7C

Inflow Area = 5.640 ac, 0.00% Impervious, Inflow Depth = 3.18" for 100-yr, 24-hr event
Inflow = 29.56 cfs @ 12.11 hrs, Volume= 1.495 af
Primary = 29.56 cfs @ 12.11 hrs, Volume= 1.495 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S3.2 : Swale S3.2

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link F8A: Flume 8A

Inflow Area = 0.381 ac, 0.00% Impervious, Inflow Depth = 3.18" for 100-yr, 24-hr event
Inflow = 2.02 cfs @ 12.11 hrs, Volume= 0.101 af
Primary = 2.02 cfs @ 12.11 hrs, Volume= 0.101 af, Atten= 0%, Lag= 0.0 min
Routed to Link F8B : Flume 8B

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link F8B: Flume 8B

Inflow Area = 1.497 ac, 0.00% Impervious, Inflow Depth = 3.18" for 100-yr, 24-hr event
Inflow = 7.88 cfs @ 12.11 hrs, Volume= 0.397 af
Primary = 7.88 cfs @ 12.11 hrs, Volume= 0.397 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S1.3 : Swale S1.3

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link F9A: Flume 9A

Inflow Area = 2.445 ac, 0.00% Impervious, Inflow Depth = 3.18" for 100-yr, 24-hr event
Inflow = 11.65 cfs @ 12.15 hrs, Volume= 0.648 af
Primary = 11.65 cfs @ 12.15 hrs, Volume= 0.648 af, Atten= 0%, Lag= 0.0 min
Routed to Link F9B : Flume 9B

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link F9B: Flume 9B

Inflow Area = 5.540 ac, 0.00% Impervious, Inflow Depth = 3.18" for 100-yr, 24-hr event
Inflow = 26.78 cfs @ 12.14 hrs, Volume= 1.468 af
Primary = 26.78 cfs @ 12.14 hrs, Volume= 1.468 af, Atten= 0%, Lag= 0.0 min
Routed to Link F9C : Flume 9C

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

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Summary for Link F9C: Flume 9C

Inflow Area = 8.811 ac, 0.00% Impervious, Inflow Depth = 3.18" for 100-yr, 24-hr event
Inflow = 42.66 cfs @ 12.14 hrs, Volume= 2.335 af
Primary = 42.66 cfs @ 12.14 hrs, Volume= 2.335 af, Atten= 0%, Lag= 0.0 min
Routed to Reach S1.2 : Swale S1.2

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link Wetland: Wetland

Inflow Area = 71.936 ac, 2.10% Impervious, Inflow Depth = 1.38" for 100-yr, 24-hr event
Inflow = 77.88 cfs @ 12.65 hrs, Volume= 8.267 af
Primary = 77.88 cfs @ 12.65 hrs, Volume= 8.267 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

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Swale Sizing

SCS ENGINEERS

		Sheet No:	1 of 3
		Calc. No.	
		Rev. No.	2
Job No. 25222260.00	Project: Columbia Energy Center MOD 12-13	By: SJL	Date: 8/28/23
Client: WPL	Subject: Swale Sizing	Chk'd: RJG	Date: 8/28/23

Purpose:

To size the proposed swales f to accommodate the 25-year, 24-hour storm event and determine required erosion matting.

References:

1. WisDOT Facilities Development Manual Chapter 13, Section 30-15 - Grass Lined Channels.
2. Design of Roadside Channels with Flexible Linings, HEC-15, USDOT FHWA.
3. HydroCAD Report: COL_Mod12-13_HydroCAD Report
4. Wisconsin Department of Natural Resources Conservation Practice Standard 1053 - Channel Erosion Mat.

Approach:

Use the HydroCAD Model results to obtain the peak flow during a 25-year, 24-hour storm event.

Use Grass Lined Channel Design WisDOT Spreadsheet, FDM 13-30 Attachment 15.2 (from Reference #1) to size the swale for each design swale cross section. The WisDOT spreadsheet incorporates the design guidelines and equations described in "Design of Roadside Channels with Flexible Linings", HEC-15, USDOT FHWA (Reference #2).

Confirm the swale is stable and has enough capacity for the design flow rate.

Use Standard 1053 (see Reference #4) to select appropriate erosion control mat based on shear stress and application.

Assumptions:

1. Swales geometry shown on the drawing set.
2. Assume the following parameters per Section 15.2 - Grass Lining Properties from Reference #1:
   - Vegetation Retardance Class = C for Swales
   - Vegetation Condition = Good
   - Vegetation Growth Form = Turf
3. Assume cohesive soil type with ASTM Soil Class SC and a Plasticity Index (PI) of 16.

Calculations:

From the HydroCAD Report, the 25-year, 24-hour peak discharge rates in the swales are

Swales:	25-year		25-year		25-year
Swale S1.1 =	3.1 cfs	**Swale S2.1 =**	39.6 cfs	**Swale S3.5 =**	39.6 cfs
Swale S1.2 =	30.3 cfs	**Swale S2.2 =**	65.6 cfs	**Swale S4.1 =**	2.7 cfs
Swale S1.3 =	34.7 cfs	**Swale S2.3 =**	65.5 cfs	**Swale S4.2 =**	6.3 cfs
Swale S1.4 =	35.1 cfs	**Swale S3.1 =**	6.5 cfs	**Swale S4.3 =**	19.2 cfs
Swale S1.5 =	2.1 cfs	**Swale S3.2 =**	22.3 cfs	**Swale S4.4 =**	22.5 cfs
Swale S1.6 =	39.2 cfs	**Swale S3.3 =**	21.8 cfs	**Swale S4.5 =**	22.6 cfs
Swale S1.7 =	2.2 cfs	**Swale S3.4 =**	2.1 cfs	**Swale S4.6 =**	89.3 cfs
Swale S1.8 =	41.3 cfs			**Swale S5.1 =**	4.6 cfs
Roadside Ditch 1 =	0.6 cfs	**Roadside Ditch 2 =**	11.2 cfs	**Roadside Ditch 3 =**	8.4 cfs
Roadside Ditch 4 =	1.5 cfs	**Roadside Ditch 5 =**	2.3 cfs		

Use the WisDOT Grass Swale Design Spreadsheet (Page 2) to determine the flow depth, velocity and shear stress in the swales.

Results:

The swales are adequately designed to accommodate the flows from the 25-year, 24-hour storm event.

The swales are stable at the design flow rates.

Use Class I, Type B erosion mat for all swales except Roadside Ditch 3 and 5 should be Class II, Type B if regraded.

Channel/Ditch Geometry	Swale S1.1 =	Swale S1.2 =	Swale S1.3 =	Swale S1.4 =	Swale S1.5 =	Swale S1.6 =	Swale S1.7 =	Swale S1.8 =	Swale S2.1 =	Swale S2.2 =	Swale S2.3 =	Swale S3.1 =	Swale S3.2 =	Swale S3.3 =	Swale S3.4 =	Swale S3.5 =	Swale S4.1 =	Swale S4.2 =	Swale S4.3 =	Swale S4.4 =	Swale S4.5 =	Swale S4.6 =	Swale S5.1 =	Roadside Ditch 1 =	Roadside Ditch 2 =	Roadside Ditch 3 =	Roadside Ditch 4 =	Roadside Ditch 5 =
Channel Slope, S_c (ft/ft)	0.0319	0.0108	0.0144	0.0045	0.0054	0.005	0.005	0.005	0.0054	0.0049	0.0130	0.0050	0.0050	0.0130	0.0071	0.0090	0.0153	0.0127	0.0027	0.0040	0.0097	0.0112	0.0154	0.0188	0.0162	0.0288	0.0090	0.0531
Channel Bottom Width, B (ft)	8	8	8	8	8	8	2.5	8	4	10	10	8	8	8	2.5	8	10	10	10	10	10	10	8	4	6	0	6	0
Channel Side Slope, z_1	4	4	4	4	4	4	2	4	4	4	4	4	4	4	2	4	4	4	4	4	4	4	4	3	10	4	10	4
Channel Side Slope, z_2	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3	3	3	3	3	3	4	8	10	4	10	4
Flow Depth, d (ft) Solve iteratively	0.25	1.14	1.08	1.73	0.45	1.73	0.75	1.77	2.00	2.02	1.37	0.78	1.36	0.91	0.65	1.38	0.29	0.47	1.52	1.38	0.97	1.70	0.41	0.20	0.63	0.90	0.33	0.49
Safety Factor, SF	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Vegetation/Soil Parameters																												
Vegetation Retardance Class	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
Vegetation Condition	good	good	good	good	good	good	good	good	good	good	good	good	good	good	good	good	good	good	good	good	good	good	good	good	good	good	good	good
Vegetation Growth Form	turf	turf	turf	turf	turf	turf	turf	turf	turf	turf	turf	turf	turf	turf	turf	turf	turf	turf	turf	turf	turf	turf	turf	turf	turf	turf	turf	turf
Soil Type	cohesive	cohesive	cohesive	cohesive	cohesive	cohesive	cohesive	cohesive	cohesive	cohesive	cohesive	cohesive	cohesive	cohesive	cohesive	cohesive	cohesive	cohesive	cohesive	cohesive	cohesive	cohesive	cohesive	cohesive	cohesive	cohesive	cohesive	cohesive
D_{75} (in) (Set at 0.00 for cohesive soils)																												
ASTM Soil Class	SC	SC	SC	SC	SC	SC	SC	SC	SC	SC	SC	SC	SC	SC	SC	SC	SC	SC	SC	SC	SC	SC	SC	SC	SC	SC	SC	SC
Plasticity Index, PI	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16
Results Summary																												
Design Q (ft^3/s)	3.1	30.3	34.7	35.1	2.1	39.2	2.2	41.3	39.6	65.6	65.5	6.5	22.3	21.8	2.1	39.6	2.7	6.3	19.2	22.5	22.6	89.3	4.6	0.6	11.2	8.4	1.5	2.3
1. Swales geometry shown on the drawing se	3.2	30.4	35.0	35.6	2.2	39.5	2.2	41.3	39.5	65.3	65.3	6.6	22.4	21.8	2.1	39.6	2.8	6.3	19.5	22.2	23.0	90.0	4.6	0.6	11.4	8.4	1.5	2.3
Difference Between Design & Calc. Flow (%)	1.0%	0.4%	0.8%	1.3%	1.4%	0.7%	-1.4%	0.2%	-0.3%	-0.6%	-0.3%	0.8%	0.9%	0.2%	-0.4%	0.0%	0.4%	0.4%	1.5%	-1.1%	1.8%	0.8%	-0.2%	-1.5%	1.2%	-0.2%	-1.7%	0.4%
Stable (Yes or No)	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Channel Parameters																												
Vegetation Height, h (ft)	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67
Grass Roughness Coefficient, C_k	0.238	0.238	0.238	0.238	0.238	0.238	0.238	0.238	0.238	0.238	0.238	0.238	0.238	0.238	0.238	0.238	0.238	0.238	0.238	0.238	0.238	0.238	0.238	0.238	0.238	0.238	0.238	0.238
Cover Factor, C_f	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Noncohesive Soil																												
Soil Grain Roughness, n_s	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016
Permissible Soil Shear Stress, τ_s (lb/ft^2)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Cohesive Soil																												
Porosity, e	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35
Soil Coefficient 1, c_1	1.0700	1.0700	1.0700	1.0700	1.0700	1.0700	1.0700	1.0700	1.0700	1.0700	1.0700	1.0700	1.0700	1.0700	1.0700	1.0700	1.0700	1.0700	1.0700	1.0700	1.0700	1.0700	1.0700	1.0700	1.0700	1.0700	1.0700	1.0700
Soil Coefficient 2, c_2	14.30	14.30	14.30	14.30	14.30	14.30	14.30	14.30	14.30	14.30	14.30	14.30	14.30	14.30	14.30	14.30	14.30	14.30	14.30	14.30	14.30	14.30	14.30	14.30	14.30	14.30	14.30	14.30
Soil Coefficient 3, c_3	47.700	47.700	47.700	47.700	47.700	47.700	47.700	47.700	47.700	47.700	47.700	47.700	47.700	47.700	47.700	47.700	47.700	47.700	47.700	47.700	47.700	47.700	47.700	47.700	47.700	47.700	47.700	47.700
Soil Coefficient 4, c_4	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42
Soil Coefficient 5, c_5	-0.61	-0.61	-0.61	-0.61	-0.61	-0.61	-0.61	-0.61	-0.61	-0.61	-0.61	-0.61	-0.61	-0.61	-0.61	-0.61	-0.61	-0.61	-0.61	-0.61	-0.61	-0.61	-0.61	-0.61	-0.61	-0.61	-0.61	-0.61
Soil Coefficient 6, c_6	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010
Permissible Soil Shear Stress, τ_s (lb/ft^2)	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080
Total Permissible Shear Stress, τ_s (lb/ft^2)	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080
Cross Sectional Area, A (ft^2)	2.250	14.318	13.306	25.812	4.410	25.812	3.563	26.692	24.000	36.522	21.208	8.674	18.278	10.592	2.893	18.658	3.194	5.473	23.286	20.465	12.993	27.115	3.952	0.989	7.749	3.240	3.069	0.960
Wetted Perimeter, P (ft)	10.06	17.40	16.91	22.27	11.71	22.27	7.27	22.60	20.49	26.66	21.30	14.43	19.21	15.50	6.63	19.38	12.11	13.42	21.07	20.05	17.07	22.39	11.38	6.19	18.66	7.42	12.63	4.04
Hydraulic Radius, R (ft)	0.224	0.823	0.787	1.159	0.377	1.159	0.490	1.181	1.171	1.370	0.996	0.601	0.951	0.683	0.436	0.963	0.264	0.408	1.105	1.021	0.761	1.211	0.347	0.160	0.415	0.437	0.243	0.238
Top Width, T (ft)	10.00	17.12	16.64	21.84	11.60	21.84	7.00	22.16	20.00	26.16	20.96	14.24	18.88	15.28	6.40	19.04	12.03	13.29	20.64	19.66	16.79	21.90	11.28	6.15	18.60	7.20	12.60	3.92
Hydraulic Depth, D (ft)	0.225	0.836	0.800	1.182	0.380	1.182	0.509	1.204	1.200	1.396	1.012	0.609	0.968	0.693	0.452	0.980	0.266	0.412	1.128	1.041	0.774	1.238	0.350	0.161	0.417	0.450	0.244	0.245
Froude Number (Q design)	0.520	0.409	0.518	0.224	0.141	0.248	0.150	0.249	0.264	0.267	0.540	0.171	0.220	0.436	0.193	0.377	0.295	0.317	0.139	0.187	0.355	0.526	0.344	0.267	0.400	0.683	0.174	0.838
Channel Shear Stress, τ_d (lb/ft^2)	0.45	0.55	0.71	0.33	0.13	0.36	0.15	0.37	0.39	0.42	0.81	0.19	0.30	0.55	0.19	0.54	0.25	0.32	0.19	0.25	0.46	0.85	0.33	0.19	0.42	0.78	0.14	0.79
Actual Sheer Stress, τ_d (lb/ft^2)	0.50	0.77	0.97	0.49	0.15	0.54	0.23	0.55	0.67	0.62	1.11	0.24	0.42	0.74	0.29	0.78	0.28	0.37	0.26	0.34	0.59	1.19	0.39	0.23	0.64	1.62	0.19	1.62
Mannings n	0.070	0.064	0.058	0.080	0.116	0.076	0.108	0.076	0.074	0.072	0.055	0.099	0.083	0.064	0.098	0.065	0.088	0.080	0.099	0.088	0.069	0.054	0.079	0.099	0.072	0.056	0.113	0.056
Average Velocity, V (ft/s)	1.39	2.12	2.61	1.36	0.49	1.52	0.61	1.55	1.65	1.80	3.09	0.75	1.22	2.05	0.74	2.12	0.86	1.15	0.82	1.10	1.74	3.29	1.16	0.62	1.45	2.60	0.50	2.34
Calculated Flow, Q (ft^3/s)	3.2	30.4	35.0	35.6	2.2	39.5	2.2	41.3	39.5	65.3	65.3	6.6	22.4	21.8	2.1	39.6	2.8	6.3	19.5	22.2	23.0	90.0	4.6	0.6	11.4	8.4	1.5	2.3
Difference Between Design & Calc. Flow (%)	1.0%	0.4%	0.8%	1.3%	1.4%	0.7%	-1.4%	0.2%	-0.3%	-0.6%	-0.3%	0.8%	0.9%	0.2%	-0.4%	0.0%	0.4%	0.4%	1.5%	-1.1%	1.8%	0.8%	-0.2%	-1.5%	1.2%	-0.2%	-1.7%	0.4%
Effective Shear on Soil Surface, τ_s (lb/ft^2)	0.003	0.005	0.007	0.002	0.000	0.002	0.001	0.002	0.003	0.003	0.009	0.001	0.002	0.005	0.001	0.005	0.001	0.001	0.001	0.001	0.003	0.010	0.002	0.001	0.003	0.013	0.000	0.013
Total Permissible Shear on Veg., $\tau_{s,veg}$ (lb/ft^2)	15.34	12.82	10.53	20.03	42.11	18.08	36.51	18.08	17.14	16.22	9.47	30.67	21.56	12.82	30.06	13.22	24.24	20.03	30.67	24.24	14.90	9.13	19.53	30.67	16.22	9.81	39.96	9.81
Stable (Y or N)	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

Source: Grass Lined Channel Design WisDOT Spreadsheet, FDM 13-30 Attachment 15.2

09/28/2023 - Classification: Internal - ECRM13153872

Channel Erosion Mat

(1053)

Wisconsin Department of Natural Resources
Conservation Practice Standard

To differentiate applications WisDOT organizes erosion mats into three classes of mats, which are further broken down into various Types.

A. **Class I**: A short-term duration (minimum of 6 months), light duty, organic ECRM with plastic or biodegradable netting.

   1. **Type A** – Only suitable for slope applications, not channel applications.

   2. **Type B** – Double netted product for use in channels where the calculated (design) shear stress is 1.5 lbs/ft^2 or less.

B. **Class II**: A long-term duration (three years or greater), organic ECRM.

   1. **Type A** – Jute fiber only for use in channels to reinforce sod.

   2. **Type B** – For use in channels where the calculated (design) shear stress is 2.0 lbs/ft^2 or less. Made with plastic or biodegradable mat.

   3. **Type C** – A woven mat of 100% organic material for use in channels where the calculated (design) shear stress is 2.0 lbs/ft^2 or less. Applicable for use in environmentally sensitive areas where plastic netting is inappropriate.

C. **Class III**: A permanent 100% synthetic ECRM or TRM. Class I, Type B erosion mat or Class II, Type B or C erosion mat must be placed over a soil filled TRM.

   1. **Type A** – An ECRM for use in channels where the calculated (design) shear stress of 2.0 lbs/ft^2 or less.

   2. **Type B** – A TRM for use in channels where the calculated (design) shear stress of 2.0 lbs/ft^2 or less.

   3. **Type C** – A TRM for use in channels where the calculated (design) shear stress of 3.5 lbs/ft^2 or less.

   4. **Type D** – A TRM for use in channels where the calculated (design) shear stress of 5.0 lbs/ft^2 or less.

09/28/2023 - Classification: Internal - ECRM13153872

Culvert Sizing

SCS ENGINEERS

		Sheet No:	1 of 21
		Calc. No.	
		Rev. No.	1
Job No. 25222260.00	Job: Columbia Energy Center MOD 12-13	By: SJL	Date: 8/28/23
Client: WPL	Subject: Culvert Sizing	Chk'd: RJG	Date: 8/28/23

Purpose:

To size the post closure culverts to accommodate the 25-year, 24-hour storm event.

References:

1. HY-8 7.40 Computer Model
2. HydroCAD Report: COL_Mod12-13_HydroCAD Report
3. Figure 1 - Final Grades (Module 13)

Approach:

1. Create culvert crossing in HY-8 and input data from Reference #2 and #3.
2. Adjust diameter size and number of culverts in model until design flow does not over top berm/road crossing.

Assumptions:

1. Assume the tailwater channel data is a based on discharge swale or rock chute geometry (Reference #2).
2. Culverts are circular, PE Pipe with smooth interior, and with square edge with headwall.
3. Culvert elevatons,lengths, and slopes based on Figure 1 (Reference #3).
4. Roadway data for crossing based on Figure 1 (Reference #3).
5. Discharge flows from HydroCAD report (Refence #2).

Calculations:

See attached HY-8 Model output reports for C1 through C10.

Results:

The culverts are adequately designed to accommodate the flows from the 25-year, 24-hour storm event.

Culvert	Dia. (ft)	# of Barrels	Upstream Invert (ft)	Downstream Invert (ft)	Slope (%)	Length (ft)
C1	2	1	815.70	814.55	2.22	52
C2	2	2	817.83	814.00	5.14	75
C3	2.5	2	811.17	810.90	0.54	50
C4	2.5	2	809.86	809.60	0.52	50
C5	2.5	2	807.57	807.15	0.87	49
C6	2	2	805.40	804.76	0.61	105
C7	3.5	2	796.64	796.34	0.50	60
C8	1	1	810.70	808.60	2.45	86
C9	2	1	807.54	806.81	0.73	100
C10	2	2	814.96	813.36	3.20	50

Culvert Data: Culvert C1

Site Data - Culvert C1

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 815.70 ft
Outlet Station: 51.88 ft
Outlet Elevation: 814.55 ft
Number of Barrels: 1

Culvert Data Summary - Culvert C1

Barrel Shape: Circular
Barrel Diameter: 2.00 ft
Barrel Material: Smooth HDPE
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge with Headwall
Inlet Depression: None

Table 2 - Culvert Summary Table: Culvert C1

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.60 cfs	0.60 cfs	816.05	0.35	0.0*	1-JS1t	0.18	0.27	1.06	0.29	0.36	1.23
0.74 cfs	0.74 cfs	816.09	0.39	0.0*	1-S2n	0.20	0.29	0.20	0.31	4.64	1.29
0.87 cfs	0.87 cfs	816.13	0.43	0.0*	1-JS1t	0.21	0.32	1.10	0.33	0.49	1.35
1.01 cfs	1.01 cfs	816.16	0.46	0.0*	1-JS1t	0.23	0.35	1.12	0.35	0.56	1.40
1.14 cfs	1.14 cfs	816.19	0.49	0.0*	1-JS1t	0.24	0.37	1.13	0.36	0.62	1.44
1.28 cfs	1.28 cfs	816.22	0.52	0.005	1-JS1t	0.26	0.39	1.15	0.38	0.69	1.48
1.42 cfs	1.42 cfs	816.25	0.55	0.021	1-JS1t	0.27	0.41	1.16	0.39	0.75	1.52
1.55 cfs	1.55 cfs	816.28	0.58	0.036	1-JS1t	0.28	0.43	1.18	0.41	0.81	1.55
1.69 cfs	1.69 cfs	816.30	0.60	0.050	1-JS1t	0.29	0.45	1.19	0.42	0.87	1.59
1.82 cfs	1.82 cfs	816.33	0.63	0.064	1-JS1t	0.30	0.47	1.20	0.43	0.92	1.62
1.96 cfs	1.96 cfs	816.35	0.65	0.078	1-JS1t	0.31	0.49	1.22	0.45	0.98	1.65

* Full Flow Headwater elevation is below inlet invert.

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 815.70 ft,
Outlet Elevation (invert): 814.55 ft
Culvert Length: 51.89 ft,
Culvert Slope: 0.0222

Tailwater Data for Crossing: Culvert C1

Table 3 - Downstream Channel Rating Curve (Crossing: Culvert C1)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
0.60	815.61	0.29	1.23	0.34	0.57
0.74	815.63	0.31	1.29	0.36	0.58
0.87	815.65	0.33	1.35	0.39	0.59

1.01	815.67	0.35	1.40	0.41	0.59
1.14	815.68	0.36	1.44	0.43	0.60
1.28	815.70	0.38	1.48	0.45	0.60
1.42	815.71	0.39	1.52	0.46	0.60
1.55	815.73	0.41	1.55	0.48	0.61
1.69	815.74	0.42	1.59	0.49	0.61
1.82	815.75	0.43	1.62	0.51	0.61
1.96	815.77	0.45	1.65	0.52	0.62

Tailwater Channel Data - Culvert C1

Tailwater Channel Option: Triangular Channel
Side Slope (H:V): 6.00 (_:1)
Channel Slope: 0.0188
Channel Manning's n: 0.0450
Channel Invert Elevation: 815.32 ft

Roadway Data for Crossing: Culvert C1

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 50.00 ft
Crest Elevation: 819.06 ft
Roadway Surface: Gravel
Roadway Top Width: 30.00 ft

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow
Minimum Flow: 0.60 cfs
Design Flow: 0.60 cfs
Maximum Flow: 1.96 cfs

Table 4 - Summary of Culvert Flows at Crossing: Culvert C1

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert C1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
816.05	0.60	0.60	0.00	1
816.09	0.74	0.74	0.00	1
816.13	0.87	0.87	0.00	1
816.16	1.01	1.01	0.00	1
816.19	1.14	1.14	0.00	1
816.22	1.28	1.28	0.00	1
816.25	1.42	1.42	0.00	1
816.28	1.55	1.55	0.00	1
816.30	1.69	1.69	0.00	1
816.33	1.82	1.82	0.00	1
816.35	1.96	1.96	0.00	1
819.06	22.61	22.61	0.00	Overtopping

Culvert Data: C2

Site Data - C2

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 817.83 ft
Outlet Station: 74.54 ft
Outlet Elevation: 814.00 ft
Number of Barrels: 2

Culvert Data Summary - C2

Barrel Shape: Circular
Barrel Diameter: 2.00 ft
Barrel Material: Smooth HDPE
Embedment: 0.00 in
Barrel Manning's n: 0.0120

Culvert Type: Straight
Inlet Configuration: Square Edge with Headwall
Inlet Depression: None

Table 3 - Culvert Summary Table: C2

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
10.95 cfs	10.95 cfs	818.96	1.13	0.593	1-JS1f	0.42	0.83	2.00	0.49	1.74	2.24
11.69 cfs	11.62 cfs	819.00	1.17	0.625	1-JS1f	0.44	0.85	2.00	0.51	1.85	2.29
12.42 cfs	11.95 cfs	819.02	1.19	0.649	1-JS1f	0.44	0.86	2.00	0.53	1.90	2.34
13.16 cfs	12.19 cfs	819.04	1.21	0.672	1-JS1f	0.45	0.87	2.00	0.54	1.94	2.38
13.90 cfs	12.40 cfs	819.05	1.22	0.693	1-JS1f	0.45	0.88	2.00	0.56	1.97	2.42
14.63 cfs	12.59 cfs	819.06	1.23	0.714	1-JS1f	0.45	0.89	2.00	0.58	2.00	2.46
15.37 cfs	12.77 cfs	819.07	1.24	0.734	1-JS1f	0.46	0.89	2.00	0.59	2.03	2.50
16.11 cfs	12.94 cfs	819.09	1.26	0.754	1-JS1f	0.46	0.90	2.00	0.61	2.06	2.54
16.85 cfs	13.10 cfs	819.10	1.27	0.773	1-JS1f	0.46	0.91	2.00	0.62	2.09	2.57
17.58 cfs	13.26 cfs	819.10	1.27	0.791	1-JS1f	0.47	0.91	2.00	0.64	2.11	2.61
18.32 cfs	13.41 cfs	819.11	1.28	0.810	1-JS1f	0.47	0.92	2.00	0.65	2.13	2.64

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 817.83 ft,
Outlet Elevation (invert): 814.00 ft
Culvert Length: 74.64 ft,
Culvert Slope: 0.0514

Tailwater Data for Crossing: Culvert C2

Table 5 - Downstream Channel Rating Curve (Crossing: Culvert C2)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
10.95	818.32	0.49	2.24	0.47	0.62
11.69	818.34	0.51	2.29	0.49	0.62
12.42	818.36	0.53	2.34	0.51	0.62

13.16	818.37	0.54	2.38	0.52	0.63
13.90	818.39	0.56	2.42	0.54	0.63
14.63	818.41	0.58	2.46	0.55	0.63
15.37	818.42	0.59	2.50	0.57	0.63
16.11	818.44	0.61	2.54	0.58	0.64
16.85	818.45	0.62	2.57	0.60	0.64
17.58	818.47	0.64	2.61	0.61	0.64
18.32	818.48	0.65	2.64	0.63	0.64

Tailwater Channel Data - Culvert C2

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 8.00 ft
Side Slope (H:V): 4.00 (_:1)
Channel Slope: 0.0154
Channel Manning's n: 0.0450
Channel Invert Elevation: 817.83 ft

Roadway Data for Crossing: Culvert C2

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 50.00 ft
Crest Elevation: 819.00 ft
Roadway Surface: Gravel
Roadway Top Width: 20.00 ft

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow
Minimum Flow: 10.95 cfs
Design Flow: 10.95 cfs
Maximum Flow: 18.32 cfs

Table 6 - Summary of Culvert Flows at Crossing: Culvert C2

Headwater Elevation (ft)	Total Discharge (cfs)	C2 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
818.96	10.95	10.95	0.00	1
819.00	11.69	11.62	0.01	13
819.02	12.42	11.95	0.43	6
819.04	13.16	12.19	0.93	5
819.05	13.90	12.40	1.48	5
819.06	14.63	12.59	2.01	4
819.07	15.37	12.77	2.58	4
819.09	16.11	12.94	3.15	4
819.10	16.85	13.10	3.73	4
819.10	17.58	13.26	4.32	4
819.11	18.32	13.41	4.91	4
819.00	11.61	11.61	0.00	Overtopping

Culvert Data: C3

Site Data - C3

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 811.17 ft
Outlet Station: 50.00 ft
Outlet Elevation: 810.90 ft
Number of Barrels: 2

Culvert Data Summary - C3

Barrel Shape: Circular
Barrel Diameter: 2.50 ft
Barrel Material: Smooth HDPE
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge with Headwall
Inlet Depression: None

Table 4 - Culvert Summary Table: C3

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
28.58 cfs	28.58 cfs	813.05	1.88	1.252	1-S2n	1.16	1.27	1.16	0.91	6.38	2.71
30.71 cfs	30.71 cfs	813.13	1.96	1.339	1-S2n	1.20	1.32	1.21	0.94	6.50	2.77
32.85 cfs	32.85 cfs	813.22	2.05	1.428	1-S2n	1.25	1.37	1.26	0.98	6.61	2.82
34.98 cfs	34.98 cfs	813.30	2.13	1.518	1-S2n	1.30	1.42	1.31	1.01	6.72	2.88
37.11 cfs	37.11 cfs	813.38	2.21	1.609	1-S2n	1.35	1.46	1.36	1.04	6.82	2.93
39.24 cfs	39.24 cfs	813.46	2.29	1.702	1-S2n	1.40	1.50	1.40	1.07	6.92	2.98
41.38 cfs	41.38 cfs	813.54	2.37	1.796	1-S2n	1.44	1.54	1.45	1.10	7.01	3.02
43.51 cfs	43.51 cfs	813.62	2.45	1.892	1-S2n	1.49	1.59	1.50	1.13	7.10	3.07
45.64 cfs	45.64 cfs	813.71	2.54	1.990	5-S2n	1.54	1.63	1.54	1.16	7.17	3.11
47.78 cfs	47.78 cfs	813.79	2.62	2.089	5-S2n	1.59	1.66	1.59	1.19	7.25	3.15
49.91 cfs	49.09 cfs	813.85	2.68	2.152	5-S2n	1.62	1.69	1.62	1.22	7.29	3.19

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 811.17 ft,
Outlet Elevation (invert): 810.90 ft
Culvert Length: 50.00 ft,
Culvert Slope: 0.0054

Tailwater Data for Crossing: Culvert C3

Table 7 - Downstream Channel Rating Curve (Crossing: Culvert C3)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
28.58	812.08	0.91	2.71	0.28	0.57
30.71	812.12	0.94	2.77	0.29	0.58
32.85	812.15	0.98	2.82	0.30	0.58

34.98	812.18	1.01	2.88	0.32	0.58
37.11	812.22	1.04	2.93	0.33	0.59
39.24	812.25	1.07	2.98	0.33	0.59
41.38	812.28	1.10	3.02	0.34	0.59
43.51	812.31	1.13	3.07	0.35	0.59
45.64	812.34	1.16	3.11	0.36	0.59
47.78	812.36	1.19	3.15	0.37	0.60
49.91	812.39	1.22	3.19	0.38	0.60

Tailwater Channel Data - Culvert C3

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 8.00 ft
Side Slope (H:V): 4.00 (_:1)
Channel Slope: 0.0050
Channel Manning's n: 0.0300
Channel Invert Elevation: 811.17 ft

Roadway Data for Crossing: Culvert C3

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 29.00 ft
Crest Elevation: 813.80 ft
Roadway Surface: Gravel
Roadway Top Width: 30.00 ft

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow
Minimum Flow: 28.58 cfs
Design Flow: 28.58 cfs
Maximum Flow: 49.91 cfs

Table 8 - Summary of Culvert Flows at Crossing: Culvert C3

Headwater Elevation (ft)	Total Discharge (cfs)	C3 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
813.05	28.58	28.58	0.00	1
813.13	30.71	30.71	0.00	1
813.22	32.85	32.85	0.00	1
813.30	34.98	34.98	0.00	1
813.38	37.11	37.11	0.00	1
813.46	39.24	39.24	0.00	1
813.54	41.38	41.38	0.00	1
813.62	43.51	43.51	0.00	1
813.71	45.64	45.64	0.00	1
813.79	47.78	47.78	0.00	1
813.85	49.91	49.09	0.77	7
813.80	47.90	47.90	0.00	Overtopping

Culvert Data: C4

Site Data - C4

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 809.86 ft
Outlet Station: 50.00 ft
Outlet Elevation: 809.60 ft
Number of Barrels: 2

Culvert Data Summary - C4

Barrel Shape: Circular
Barrel Diameter: 2.50 ft
Barrel Material: Smooth HDPE
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge with Headwall
Inlet Depression: None

Table 7 - Culvert Summary Table: C4

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
34.14 cfs	34.14 cfs	811.96	2.10	1.492	1-S2n	1.30	1.40	1.30	0.91	6.60	3.22
36.76 cfs	36.76 cfs	812.06	2.20	1.604	1-S2n	1.36	1.45	1.36	0.95	6.72	3.29
39.38 cfs	39.38 cfs	812.16	2.30	1.718	1-S2n	1.41	1.51	1.42	0.98	6.84	3.36
42.00 cfs	42.00 cfs	812.26	2.40	1.834	1-S2n	1.47	1.56	1.48	1.02	6.94	3.42
44.62 cfs	44.62 cfs	812.36	2.50	1.953	1-S2n	1.53	1.61	1.54	1.05	7.04	3.48
47.23 cfs	47.23 cfs	812.46	2.60	2.074	5-S2n	1.59	1.65	1.60	1.08	7.13	3.54
49.85 cfs	49.85 cfs	812.57	2.71	2.198	5-S2n	1.66	1.70	1.66	1.11	7.23	3.59
52.47 cfs	52.47 cfs	812.68	2.82	2.325	5-S2n	1.72	1.75	1.72	1.14	7.28	3.65
55.09 cfs	55.09 cfs	812.79	2.93	2.454	5-S2n	1.78	1.79	1.78	1.17	7.35	3.70
57.71 cfs	57.71 cfs	812.99	3.05	3.129	7-M2c	1.85	1.83	1.83	1.20	7.49	3.75
60.33 cfs	60.33 cfs	813.07	3.18	3.214	7-M2c	1.93	1.87	1.87	1.23	7.65	3.79

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 809.86 ft,
Outlet Elevation (invert): 809.60 ft
Culvert Length: 50.00 ft,
Culvert Slope: 0.0052

Tailwater Data for Crossing: Culvert C4

Table 13 - Downstream Channel Rating Curve (Crossing: Culvert C4)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
34.14	810.78	0.91	3.22	0.40	0.68
36.76	810.82	0.95	3.29	0.41	0.68
39.38	810.85	0.98	3.36	0.43	0.69

42.00	810.88	1.02	3.42	0.44	0.69
44.62	810.92	1.05	3.48	0.46	0.69
47.23	810.95	1.08	3.54	0.47	0.70
49.85	810.98	1.11	3.59	0.49	0.70
52.47	811.01	1.14	3.65	0.50	0.70
55.09	811.04	1.17	3.70	0.51	0.70
57.71	811.07	1.20	3.75	0.53	0.71
60.33	811.10	1.23	3.79	0.54	0.71

Tailwater Channel Data - Culvert C4

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 8.00 ft
Side Slope (H:V): 4.00 (_:1)
Channel Slope: 0.0070
Channel Manning's n: 0.0300
Channel Invert Elevation: 809.87 ft

Roadway Data for Crossing: Culvert C4

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 29.00 ft
Crest Elevation: 813.14 ft
Roadway Surface: Gravel
Roadway Top Width: 30.00 ft

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow
Minimum Flow: 34.14 cfs
Design Flow: 34.14 cfs
Maximum Flow: 60.33 cfs

Table 14 - Summary of Culvert Flows at Crossing: Culvert C4

Headwater Elevation (ft)	Total Discharge (cfs)	C4 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
811.96	34.14	34.14	0.00	1
812.06	36.76	36.76	0.00	1
812.16	39.38	39.38	0.00	1
812.26	42.00	42.00	0.00	1
812.36	44.62	44.62	0.00	1
812.46	47.23	47.23	0.00	1
812.57	49.85	49.85	0.00	1
812.68	52.47	52.47	0.00	1
812.79	55.09	55.09	0.00	1
812.99	57.71	57.71	0.00	1
813.07	60.33	60.33	0.00	1
813.14	62.28	62.28	0.00	Overtopping

Culvert Data: C5

Site Data - C5

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 807.57 ft
Outlet Station: 48.50 ft
Outlet Elevation: 807.15 ft
Number of Barrels: 2

Culvert Data Summary - C5

Barrel Shape: Circular
Barrel Diameter: 2.50 ft
Barrel Material: Smooth HDPE
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge with Headwall
Inlet Depression: None

Table 8 - Culvert Summary Table: C5

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
37.41 cfs	37.41 cfs	809.79	2.22	1.490	1-S2n	1.18	1.47	1.23	1.05	7.81	2.93
40.34 cfs	40.34 cfs	809.90	2.33	1.601	1-S2n	1.23	1.52	1.28	1.09	7.96	3.00
43.27 cfs	43.27 cfs	810.01	2.44	1.728	1-S2n	1.28	1.58	1.34	1.13	8.10	3.06
46.21 cfs	46.21 cfs	810.13	2.56	1.862	5-S2n	1.33	1.64	1.39	1.17	8.24	3.12
49.14 cfs	49.14 cfs	810.25	2.68	1.999	5-S2n	1.39	1.69	1.44	1.21	8.37	3.17
52.07 cfs	52.07 cfs	810.37	2.80	2.140	5-S2n	1.44	1.74	1.50	1.24	8.50	3.23
55.00 cfs	55.00 cfs	810.50	2.93	2.284	5-S2n	1.49	1.79	1.55	1.28	8.62	3.28
57.93 cfs	57.93 cfs	810.63	3.06	2.431	5-S2n	1.54	1.83	1.60	1.31	8.74	3.32
60.87 cfs	60.87 cfs	810.77	3.20	2.892	5-S2n	1.59	1.88	1.65	1.35	8.86	3.37
63.80 cfs	63.26 cfs	810.89	3.32	2.999	5-S2n	1.64	1.92	1.69	1.38	8.95	3.42
66.73 cfs	64.47 cfs	810.95	3.38	3.055	5-S2n	1.66	1.93	1.71	1.41	8.99	3.46

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 807.57 ft,
Outlet Elevation (invert): 807.15 ft
Culvert Length: 48.50 ft,
Culvert Slope: 0.0087

Tailwater Data for Crossing: Culvert C5

Table 15 - Downstream Channel Rating Curve (Crossing: Culvert C5)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
37.41	808.64	1.05	2.93	0.33	0.59
40.34	808.68	1.09	3.00	0.34	0.59
43.27	808.72	1.13	3.06	0.35	0.59

46.21	808.76	1.17	3.12	0.36	0.59
49.14	808.80	1.21	3.17	0.38	0.60
52.07	808.83	1.24	3.23	0.39	0.60
55.00	808.87	1.28	3.28	0.40	0.60
57.93	808.90	1.31	3.32	0.41	0.60
60.87	808.94	1.35	3.37	0.42	0.61
63.80	808.97	1.38	3.42	0.43	0.61
66.73	809.00	1.41	3.46	0.44	0.61

Tailwater Channel Data - Culvert C5

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 8.00 ft
Side Slope (H:V): 4.00 (_:1)
Channel Slope: 0.0050
Channel Manning's n: 0.0300
Channel Invert Elevation: 807.59 ft

Roadway Data for Crossing: Culvert C5

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 28.00 ft
Crest Elevation: 810.85 ft
Roadway Surface: Gravel
Roadway Top Width: 20.00 ft

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow
Minimum Flow: 37.41 cfs
Design Flow: 37.41 cfs
Maximum Flow: 66.73 cfs

Table 16 - Summary of Culvert Flows at Crossing: Culvert C5

Headwater Elevation (ft)	Total Discharge (cfs)	C5 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
809.79	37.41	37.41	0.00	1
809.90	40.34	40.34	0.00	1
810.01	43.27	43.27	0.00	1
810.13	46.21	46.21	0.00	1
810.25	49.14	49.14	0.00	1
810.37	52.07	52.07	0.00	1
810.50	55.00	55.00	0.00	1
810.63	57.93	57.93	0.00	1
810.77	60.87	60.87	0.00	1
810.89	63.80	63.26	0.50	11
810.95	66.73	64.47	2.22	7
810.85	62.53	62.53	0.00	Overtopping

Culvert Data: C6

Site Data - C6

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 805.40 ft
Outlet Station: 104.56 ft
Outlet Elevation: 804.76 ft
Number of Barrels: 2

Culvert Data Summary - C6

Barrel Shape: Circular
Barrel Diameter: 2.00 ft
Barrel Material: Smooth HDPE
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Mitered to Conform to Slope
Inlet Depression: None

Table 1 - Culvert Summary Table: C6

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
30.67 cfs	30.67 cfs	807.82	2.42	1.808	5-S2n	1.35	1.41	1.35	0.81	6.79	3.25
32.96 cfs	32.96 cfs	808.01	2.61	2.020	5-S2n	1.43	1.46	1.43	0.85	6.87	3.33
35.25 cfs	35.25 cfs	808.21	2.81	2.485	5-S2n	1.51	1.51	1.51	0.88	6.94	3.40
37.54 cfs	37.54 cfs	808.43	3.03	2.882	7-M2c	1.60	1.56	1.56	0.91	7.14	3.47
39.83 cfs	39.00 cfs	808.58	3.18	2.950	7-M2c	1.67	1.59	1.59	0.95	7.29	3.54
42.12 cfs	39.76 cfs	808.65	3.25	2.987	7-M2c	1.71	1.60	1.60	0.98	7.37	3.61
44.41 cfs	40.38 cfs	808.72	3.32	3.019	7-M2c	1.75	1.61	1.61	1.01	7.44	3.67
46.70 cfs	40.94 cfs	808.78	3.38	3.049	7-M2c	2.00	1.62	1.62	1.04	7.50	3.73
48.99 cfs	41.44 cfs	808.83	3.43	3.079	7-M2c	2.00	1.63	1.63	1.07	7.55	3.79
51.28 cfs	41.89 cfs	808.88	3.48	3.107	7-M2c	2.00	1.64	1.64	1.09	7.60	3.85
53.57 cfs	42.33 cfs	808.93	3.53	3.135	7-M2c	2.00	1.65	1.65	1.12	7.65	3.90

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 805.40 ft,
Outlet Elevation (invert): 804.76 ft
Culvert Length: 104.56 ft,
Culvert Slope: 0.0061

Tailwater Data for Crossing: Culvert C6

Table 1 - Downstream Channel Rating Curve (Crossing: Culvert C6)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
30.67	805.37	0.81	3.25	0.36	0.68
32.96	805.41	0.85	3.33	0.37	0.68
35.25	805.44	0.88	3.40	0.38	0.68

37.54	805.47	0.91	3.47	0.40	0.69
39.83	805.51	0.95	3.54	0.41	0.69
42.12	805.54	0.98	3.61	0.43	0.69
44.41	805.57	1.01	3.67	0.44	0.70
46.70	805.60	1.04	3.73	0.45	0.70
48.99	805.63	1.07	3.79	0.47	0.70
51.28	805.65	1.09	3.85	0.48	0.70
53.57	805.68	1.12	3.90	0.49	0.71

Tailwater Channel Data - Culvert C6

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 10.00 ft
Side Slope (H:V): 2.00 (_:1)
Channel Slope: 0.0070
Channel Manning's n: 0.0300
Channel Invert Elevation: 804.56 ft

Roadway Data for Crossing: Culvert C6

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 15.00 ft
Crest Elevation: 808.50 ft
Roadway Surface: Gravel
Roadway Top Width: 100.00 ft

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow
Minimum Flow: 30.67 cfs
Design Flow: 30.67 cfs
Maximum Flow: 53.57 cfs

Table 2 - Summary of Culvert Flows at Crossing: Culvert C6

Headwater Elevation (ft)	Total Discharge (cfs)	C6 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
807.82	30.67	30.67	0.00	1
808.01	32.96	32.96	0.00	1
808.21	35.25	35.25	0.00	1
808.43	37.54	37.54	0.00	1
808.58	39.83	39.00	0.81	10
808.65	42.12	39.76	2.34	7
808.72	44.41	40.38	4.01	6
808.78	46.70	40.94	5.75	6
808.83	48.99	41.44	7.55	6
808.88	51.28	41.89	9.37	5
808.93	53.57	42.33	11.23	5
808.50	38.24	38.24	0.00	Overtopping

Culvert Data: C7

Site Data - C7

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 796.64 ft
Outlet Station: 60.20 ft
Outlet Elevation: 796.34 ft
Number of Barrels: 2

Culvert Data Summary - C7

Barrel Shape: Circular
Barrel Diameter: 3.50 ft
Barrel Material: Corrugated Steel
Embedment: 0.00 in
Barrel Manning's n: 0.0240
Culvert Type: Straight
Inlet Configuration: Square Edge with Headwall
Inlet Depression: None

Table 5 - Culvert Summary Table: C7

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
67.17 cfs	67.17 cfs	799.52	2.60	2.880	2-M2c	2.53	1.79	1.79	1.08	6.76	4.34
72.84 cfs	72.84 cfs	799.66	2.73	3.024	2-M2c	2.71	1.87	1.87	1.13	6.95	4.44
78.52 cfs	78.52 cfs	799.81	2.86	3.167	2-M2c	2.93	1.95	1.95	1.18	7.14	4.54
84.19 cfs	84.19 cfs	799.95	3.00	3.310	2-M2c	3.50	2.02	2.02	1.22	7.32	4.64
89.87 cfs	89.87 cfs	800.09	3.13	3.452	2-M2c	3.50	2.09	2.09	1.26	7.50	4.72
95.55 cfs	95.55 cfs	800.23	3.26	3.595	7-M2c	3.50	2.16	2.16	1.31	7.67	4.81
101.22 cfs	101.22 cfs	800.38	3.40	3.739	7-M2c	3.50	2.22	2.22	1.35	7.85	4.89
106.90 cfs	106.90 cfs	800.53	3.54	3.886	7-M2c	3.50	2.29	2.29	1.38	8.02	4.97
112.57 cfs	112.57 cfs	800.68	3.68	4.037	7-M2c	3.50	2.35	2.35	1.42	8.20	5.04
118.25 cfs	118.25 cfs	800.83	3.83	4.194	7-M2c	3.50	2.41	2.41	1.46	8.37	5.11
123.92 cfs	123.92 cfs	801.00	3.98	4.360	7-M2c	3.50	2.47	2.47	1.50	8.55	5.18

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 796.64 ft,
Outlet Elevation (invert): 796.34 ft
Culvert Length: 60.20 ft,
Culvert Slope: 0.0050

Tailwater Data for Crossing: Culvert C7

Table 9 - Downstream Channel Rating Curve (Crossing: Culvert C7)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
67.17	796.68	1.08	4.34	0.67	0.84

72.84	796.73	1.13	4.44	0.70	0.84
78.52	796.78	1.18	4.54	0.73	0.85
84.19	796.82	1.22	4.64	0.76	0.85
89.87	796.86	1.26	4.72	0.79	0.86
95.55	796.91	1.31	4.81	0.81	0.86
101.22	796.95	1.35	4.89	0.84	0.86
106.90	796.98	1.38	4.97	0.86	0.87
112.57	797.02	1.42	5.04	0.89	0.87
118.25	797.06	1.46	5.11	0.91	0.87
123.92	797.10	1.50	5.18	0.93	0.88

Tailwater Channel Data - Culvert C7

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 10.00 ft
Side Slope (H:V): 4.00 (_:1)
Channel Slope: 0.0100
Channel Manning's n: 0.0300
Channel Invert Elevation: 795.60 ft

Roadway Data for Crossing: Culvert C7

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 50.00 ft
Crest Elevation: 802.50 ft
Roadway Surface: Gravel
Roadway Top Width: 60.00 ft

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow
Minimum Flow: 67.17 cfs
Design Flow: 67.17 cfs
Maximum Flow: 123.92 cfs

Table 10 - Summary of Culvert Flows at Crossing: Culvert C7

Headwater Elevation (ft)	Total Discharge (cfs)	C7 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
799.52	67.17	67.17	0.00	1
799.66	72.84	72.84	0.00	1
799.81	78.52	78.52	0.00	1
799.95	84.19	84.19	0.00	1
800.09	89.87	89.87	0.00	1
800.23	95.55	95.55	0.00	1
800.38	101.22	101.22	0.00	1
800.53	106.90	106.90	0.00	1
800.68	112.57	112.57	0.00	1
800.83	118.25	118.25	0.00	1
801.00	123.92	123.92	0.00	1
802.50	162.83	162.83	0.00	Overtopping

Culvert Data: C8

Site Data - C8

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 810.70 ft
Outlet Station: 85.60 ft
Outlet Elevation: 808.60 ft
Number of Barrels: 1

Culvert Data Summary - C8

Barrel Shape: Circular
Barrel Diameter: 1.00 ft
Barrel Material: Smooth HDPE
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge with Headwall
Inlet Depression: None

Table 9 - Culvert Summary Table: C8

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.96 cfs	0.96 cfs	811.27	0.57	0.534	1-JS1f	0.27	0.41	1.00	0.45	1.22	2.40
1.02 cfs	1.02 cfs	811.30	0.60	0.557	1-S2n	0.28	0.43	0.28	0.46	5.74	2.44
1.09 cfs	1.09 cfs	811.32	0.62	0.581	1-JS1f	0.29	0.44	1.00	0.47	1.39	2.47
1.15 cfs	1.15 cfs	811.34	0.64	0.605	1-JS1f	0.30	0.45	1.00	0.48	1.47	2.51
1.22 cfs	1.22 cfs	811.37	0.67	0.629	1-JS1f	0.30	0.47	1.00	0.49	1.55	2.54
1.28 cfs	1.28 cfs	811.39	0.69	0.653	1-JS1f	0.31	0.48	1.00	0.50	1.63	2.58
1.34 cfs	1.34 cfs	811.41	0.71	0.679	1-JS1f	0.32	0.49	1.00	0.51	1.71	2.61
1.41 cfs	1.41 cfs	811.43	0.73	0.704	1-JS1f	0.33	0.50	1.00	0.52	1.79	2.64
1.47 cfs	1.47 cfs	811.45	0.75	0.730	1-JS1f	0.34	0.51	1.00	0.53	1.87	2.67
1.54 cfs	1.54 cfs	811.54	0.77	0.840	1-S1f	0.34	0.53	1.00	0.53	1.96	2.70
1.60 cfs	1.60 cfs	811.55	0.79	0.849	1-S1f	0.35	0.54	1.00	0.54	2.04	2.72

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 810.70 ft,
Outlet Elevation (invert): 808.60 ft
Culvert Length: 85.63 ft,
Culvert Slope: 0.0245

Tailwater Data for Crossing: Culvert C8

Table 17 - Downstream Channel Rating Curve (Crossing: Culvert C8)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
0.96	811.15	0.45	2.40	0.56	0.89
1.02	811.16	0.46	2.44	0.57	0.90

1.09	811.17	0.47	2.47	0.59	0.90
1.15	811.18	0.48	2.51	0.60	0.90
1.22	811.19	0.49	2.54	0.61	0.91
1.28	811.20	0.50	2.58	0.62	0.91
1.34	811.21	0.51	2.61	0.63	0.91
1.41	811.22	0.52	2.64	0.64	0.91
1.47	811.23	0.53	2.67	0.66	0.92
1.54	811.23	0.53	2.70	0.67	0.92
1.60	811.24	0.54	2.72	0.68	0.92

Tailwater Channel Data - Culvert C8

Tailwater Channel Option: Triangular Channel
Side Slope (H:V): 2.00 (_:1)
Channel Slope: 0.0200
Channel Manning's n: 0.0300
Channel Invert Elevation: 822.00 ft

Roadway Data for Crossing: Culvert C8

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 10.00 ft
Crest Elevation: 822.00 ft
Roadway Surface: Gravel
Roadway Top Width: 25.00 ft

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow
Minimum Flow: 0.96 cfs
Design Flow: 0.96 cfs
Maximum Flow: 1.60 cfs

Table 18 - Summary of Culvert Flows at Crossing: Culvert C8b

Headwater Elevation (ft)	Total Discharge (cfs)	C8 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
811.27	0.96	0.96	0.00	1
811.30	1.02	1.02	0.00	1
811.32	1.09	1.09	0.00	1
811.34	1.15	1.15	0.00	1
811.37	1.22	1.22	0.00	1
811.39	1.28	1.28	0.00	1
811.41	1.34	1.34	0.00	1
811.43	1.41	1.41	0.00	1
811.45	1.47	1.47	0.00	1
811.54	1.54	1.54	0.00	1
811.55	1.60	1.60	0.00	1
822.00	10.37	10.37	0.00	Overtopping

Culvert Data: C9

Site Data - C9

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 807.54 ft
Outlet Station: 99.86 ft
Outlet Elevation: 806.81 ft
Number of Barrels: 1

Culvert Data Summary - C9

Barrel Shape: Circular
Barrel Diameter: 2.00 ft
Barrel Material: Corrugated Steel
Embedment: 0.00 in
Barrel Manning's n: 0.0240
Culvert Type: Straight
Inlet Configuration: Thin Edge Projecting
Inlet Depression: None

Table 6 - Culvert Summary Table: C9

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
11.16 cfs	11.16 cfs	809.67	1.98	2.134	7-M2c	1.79	1.20	1.20	0.27	5.68	3.11
12.14 cfs	12.14 cfs	809.83	2.11	2.287	7-M2c	2.00	1.25	1.25	0.29	5.87	3.21
13.12 cfs	13.12 cfs	810.01	2.24	2.473	7-M2c	2.00	1.30	1.30	0.30	6.05	3.30
14.09 cfs	14.09 cfs	810.31	2.39	2.772	7-M2c	2.00	1.35	1.35	0.31	6.24	3.39
15.07 cfs	15.07 cfs	810.63	2.54	3.090	7-M2c	2.00	1.40	1.40	0.33	6.42	3.47
16.05 cfs	16.05 cfs	810.97	2.70	3.425	7-M2c	2.00	1.44	1.44	0.34	6.61	3.55
17.03 cfs	17.03 cfs	811.32	2.87	3.777	7-M2c	2.00	1.49	1.49	0.35	6.80	3.62
18.01 cfs	18.01 cfs	811.69	3.05	4.147	7-M2c	2.00	1.53	1.53	0.36	6.99	3.69
18.98 cfs	18.98 cfs	812.04	3.24	4.503	7-M2c	2.00	1.57	1.57	0.37	7.19	3.76
19.96 cfs	19.96 cfs	812.44	3.44	4.896	7-M2c	2.00	1.60	1.60	0.38	7.39	3.83
20.94 cfs	20.94 cfs	812.85	3.65	5.310	7-M2c	2.00	1.64	1.64	0.40	7.60	3.90

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 807.54 ft,
Outlet Elevation (invert): 806.81 ft
Culvert Length: 99.86 ft,
Culvert Slope: 0.0073

Tailwater Data for Crossing: Culvert C9

Table 11 - Downstream Channel Rating Curve (Crossing: Culvert C9)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
11.16	807.71	0.27	3.11	0.96	1.09
12.14	807.73	0.29	3.21	1.01	1.10
13.12	807.74	0.30	3.30	1.05	1.11
14.09	807.75	0.31	3.39	1.10	1.11

15.07	807.77	0.33	3.47	1.14	1.12
16.05	807.78	0.34	3.55	1.18	1.13
17.03	807.79	0.35	3.62	1.23	1.13
18.01	807.80	0.36	3.69	1.27	1.14
18.98	807.81	0.37	3.76	1.31	1.14
19.96	807.82	0.38	3.83	1.34	1.15
20.94	807.84	0.40	3.90	1.38	1.15

Tailwater Channel Data - Culvert C9

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 12.00 ft
Side Slope (H:V): 4.00 (_:1)
Channel Slope: 0.0560
Channel Manning's n: 0.0450
Channel Invert Elevation: 807.44 ft

Roadway Data for Crossing: Culvert C9

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 50.00 ft
Crest Elevation: 812.87 ft
Roadway Surface: Paved
Roadway Top Width: 24.00 ft

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow
Minimum Flow: 11.16 cfs
Design Flow: 11.16 cfs
Maximum Flow: 20.94 cfs

Table 12 - Summary of Culvert Flows at Crossing: Culvert C9

Headwater Elevation (ft)	Total Discharge (cfs)	C9 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
809.67	11.16	11.16	0.00	1
809.83	12.14	12.14	0.00	1
810.01	13.12	13.12	0.00	1
810.31	14.09	14.09	0.00	1
810.63	15.07	15.07	0.00	1
810.97	16.05	16.05	0.00	1
811.32	17.03	17.03	0.00	1
811.69	18.01	18.01	0.00	1
812.04	18.98	18.98	0.00	1
812.44	19.96	19.96	0.00	1
812.85	20.94	20.94	0.00	1
812.87	21.00	21.00	0.00	Overtopping

Culvert Data: C10

Site Data - C10

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 814.96 ft
Outlet Station: 50.00 ft
Outlet Elevation: 813.36 ft
Number of Barrels: 2

Culvert Data Summary - C10

Barrel Shape: Circular
Barrel Diameter: 2.00 ft
Barrel Material: Smooth HDPE
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge with Headwall
Inlet Depression: None

Table 10 - Culvert Summary Table: C10

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
2.76 cfs	2.76 cfs	815.50	0.54	0.147	1-JS1t	0.24	0.41	1.74	0.14	0.48	2.29
2.98 cfs	2.98 cfs	815.52	0.56	0.154	1-JS1t	0.25	0.42	1.75	0.15	0.51	2.36
3.20 cfs	3.20 cfs	815.54	0.58	0.162	1-JS1t	0.26	0.44	1.75	0.15	0.55	2.42
3.42 cfs	3.42 cfs	815.56	0.60	0.169	1-JS1t	0.27	0.45	1.76	0.16	0.58	2.48
3.64 cfs	3.64 cfs	815.58	0.62	0.176	1-JS1t	0.28	0.47	1.77	0.17	0.62	2.54
3.85 cfs	3.85 cfs	815.60	0.64	0.183	1-JS1t	0.28	0.48	1.77	0.17	0.66	2.59
4.07 cfs	4.07 cfs	815.62	0.66	0.190	1-JS1t	0.29	0.50	1.78	0.18	0.69	2.64
4.29 cfs	4.29 cfs	815.64	0.68	0.197	1-JS1t	0.30	0.51	1.78	0.18	0.73	2.69
4.51 cfs	4.51 cfs	815.66	0.70	0.204	1-JS1t	0.31	0.52	1.79	0.19	0.76	2.74
4.73 cfs	4.73 cfs	815.68	0.72	0.211	1-JS1t	0.31	0.53	1.79	0.19	0.80	2.79
4.95 cfs	4.95 cfs	815.69	0.73	0.218	1-JS1t	0.32	0.55	1.80	0.20	0.83	2.84

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 814.96 ft,
Outlet Elevation (invert): 813.36 ft
Culvert Length: 50.03 ft,
Culvert Slope: 0.0320

Tailwater Data for Crossing: Culvert C10

Table 19 - Downstream Channel Rating Curve (Crossing: Culvert C10)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
2.76	815.10	0.14	2.29	0.28	1.11
2.98	815.11	0.15	2.36	0.29	1.12
3.20	815.11	0.15	2.42	0.31	1.13

3.42	815.12	0.16	2.48	0.32	1.13
3.64	815.13	0.17	2.54	0.33	1.14
3.85	815.13	0.17	2.59	0.34	1.15
4.07	815.14	0.18	2.64	0.35	1.15
4.29	815.14	0.18	2.69	0.36	1.16
4.51	815.15	0.19	2.74	0.38	1.16
4.73	815.15	0.19	2.79	0.39	1.17
4.95	815.16	0.20	2.84	0.40	1.17

Tailwater Channel Data - Culvert C10

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 8.00 ft
Side Slope (H:V): 4.00 (_:1)
Channel Slope: 0.0320
Channel Manning's n: 0.0300
Channel Invert Elevation: 814.96 ft

Roadway Data for Crossing: Culvert C10

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 10.00 ft
Crest Elevation: 818.00 ft
Roadway Surface: Gravel
Roadway Top Width: 25.00 ft

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow
Minimum Flow: 2.76 cfs
Design Flow: 2.76 cfs
Maximum Flow: 4.95 cfs

Table 20 - Summary of Culvert Flows at Crossing: Culvert C10

Headwater Elevation (ft)	Total Discharge (cfs)	C10 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
815.50	2.76	2.76	0.00	1
815.52	2.98	2.98	0.00	1
815.54	3.20	3.20	0.00	1
815.56	3.42	3.42	0.00	1
815.58	3.64	3.64	0.00	1
815.60	3.85	3.85	0.00	1
815.62	4.07	4.07	0.00	1
815.64	4.29	4.29	0.00	1
815.66	4.51	4.51	0.00	1
815.68	4.73	4.73	0.00	1
815.69	4.95	4.95	0.00	1
818.00	41.60	41.60	0.00	Overtopping

Diversion Berm Sizing

SCS ENGINEERS

		Sheet No:	1 of 3
		Calc. No.	
		Rev. No.	1
Job No. 25222260.00	Project: Columbia Energy Center MOD 12-13	By: RJG	Date: 8/11/23
Client: WPL	Subject: Diversion Berm Sizing	Chk'd: SJL	Date: 8/24/23

Purpose:

To size the post closure diversion berms on the final cover to accommodate the 25-year, 24-hour storm event.

References:

1. WisDOT Facilities Development Manual Chapter 13, Section 30-15 - Grass Lined Channels.
2. Design of Roadside Channels with Flexible Linings, HEC-15, USDOT FHWA.
3. HydroCAD Report: COL_Mod12-13_HydroCAD Report
4. Wisconsin Department of Natural Resources Conservation Practice Standard 1053 - Channel Erosion Mat.

Approach:

Use the Post Closure HydroCAD Model results to obtain the peak flow during a 25-year, 24-hour storm event along the diversion berms.

Use Grass Lined Channel Design WisDOT Spreadsheet, FDM 13-30 Attachment 15.2 (from Reference #1) to size the swale for each design swale cross section. The WisDOT spreadsheet incorporates the design guidelines and equations described in "Design of Roadside Channels with Flexible Linings", HEC-15, USDOT FHWA (Reference #2).

Confirm the swale is stable and has enough capacity for the design flow rate.

Assumptions:

1. Assume the channel geometry is a v-notch swale with one sideslope at 4:1 and one sideslope at 2:1 and a depth of 2.0 ft.
2. Assume 2.0% slope along the flowpath of the diversion swale.
3. Assume the following parameters per Section 15.2 - Grass Lining Properties from Reference #1:
   Vegetation Retardance Class = C for Swales
   Vegetation Condition = Good
   Vegetation Growth Form = Turf
4. Assume cohesive soil type with ASTM Soil Class SC and a Plasticity Index (PI) of 16.

Calculations:

From the HydroCAD Report, the peak flow rate along the diversion berms are as follows:

Areas			Areas			Areas			Areas		
1	3.75	cfs	10	1.68	cfs	18	5.06	cfs	26	2.10	cfs
2	1.71	cfs	11	5.22	cfs	19	2.16	cfs	27	7.46	cfs
3	1.06	cfs	12	4.83	cfs	20	1.19	cfs	30	1.34	cfs
4	0.92	cfs	13	1.94	cfs	21	1.62	cfs	33	3.24	cfs
5	1.66	cfs	14	1.93	cfs	22	7.54	cfs	34	1.35	cfs
6	2.81	cfs	15	2.80	cfs	23	1.38	cfs			
8	2.66	cfs	16	1.78	cfs	24	3.61	cfs			
9	0.86	cfs	17	3.04	cfs	25	2.12	cfs			

Use highest flow to confirm diversion berm functions.

Use the Grass Swale Design Spreadsheet (Page 2) to determine the flow depth, velocity and shear stress in the swales.

Results:

The diversion berms are adequately designed to accommodate the flows from the 25-year, 24-hour storm event.

The diversion berms are stable at the design flow rates. The design flow depth of 2.0 feet maintains at least 0.5 ft of freeboard during the 25-year, 24-hour storm event. Based on shear stress, use erosion mat Class I, Type B along the flow path of the diversion berms.

Channel/Ditch Geometry	*Area 22*
Channel Slope, S_o (ft/ft)	**0.02**
Channel Bottom Width, B (ft)	**0**
Channel Side Slope, z_1	**4**
Channel Side Slope, z_2	**2**
Flow Depth, d (ft) Solve iteratively	**1.07**
Safety Factor, SF	**1.0**
Vegetation/Soil Parameters	
Vegetation Retardance Class	**C**
Vegetation Condition	**good**
Vegetation Growth Form	**turf**
Soil Type	**cohesive**
D_{75} (in) (Set at 0.00 for cohesive soils)	
ASTM Soil Class	**SC**
Plasticity Index, PI	**16**
Results Summary	
Design Q (ft^3/s)	**7.5**
Calculated Q (ft^3/s)	7.5
Difference Between Design & Calc. Flow (%)	-0.2%
Stable (Yes or No)	**YES**
Channel Parameters	
Vegetation Height, h (ft)	0.67
Grass Roughness Coefficient, C_n	0.238
Cover Factor, C_f	0.90
Noncohesive Soil	
Soil Grain Roughness, n_s	0.016
Permissible Soil Shear Stress, τ_p (lb/ft^2)	N/A
Cohesive Soil	
Porosity, e	0.35
Soil Coefficient 1, c_1	1.0700
Soil Coefficient 2, c_2	14.30
Soil Coefficient 3, c_3	47.700
Soil Coefficient 4, c_4	1.42
Soil Coefficient 5, c_5	-0.61
Soil Coefficient 6, c_6	0.00010
Permissible Soil Shear Stress, τ_p (lb/ft^2)	0.080
Total Permissible Shear Stress, τ_p (lb/ft^2)	0.080
Cross Sectional Area, A (ft^2)	3.435
Wetted Perimeter, P (ft)	6.80
Hydraulic Radius, R (ft)	0.505
Top Width, T (ft)	6.42
Hydraulic Depth, D (ft)	0.535
Froude Number (Q design)	0.528
Channel Shear Stress, τ_o (lb/ft^2)	0.63
Actual Sheer Stress, τ_d (lb/ft^2)	1.34
Mannings n	0.061
Average Velocity, V (ft/s)	2.20
Calculated Flow, Q (ft^3/s)	7.5
Difference Between Design & Calc. Flow (%)	-0.2%
Effective Shear on Soil Surface, τ_e (lb/ft^2)	0.009
Total Permissible Shear on Veg., $\tau_{p,veg}$ (lb/ft^2)	11.65
Stable (Y or N)	YES

Source: Grass Lined Channel Design WisDOT Spreadsheet, FDM 13-30 Attachment 15.2

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Channel Erosion Mat

(1053)

Wisconsin Department of Natural Resources
Conservation Practice Standard

To differentiate applications WisDOT organizes erosion mats into three classes of mats, which are further broken down into various Types.

A. **Class I**: A short-term duration (minimum of 6 months), light duty, organic ECRM with plastic or biodegradable netting.

   1. **Type A** – Only suitable for slope applications, not channel applications.

   2. **Type B** – Double netted product for use in channels where the calculated (design) shear stress is 1.5 lbs/ft^2 or less.

B. **Class II**: A long-term duration (three years or greater), organic ECRM.

   1. **Type A** – Jute fiber only for use in channels to reinforce sod.

   2. **Type B** – For use in channels where the calculated (design) shear stress is 2.0 lbs/ft^2 or less. Made with plastic or biodegradable mat.

   3. **Type C** – A woven mat of 100% organic material for use in channels where the calculated (design) shear stress is 2.0 lbs/ft^2 or less. Applicable for use in environmentally sensitive areas where plastic netting is inappropriate.

C. **Class III**: A permanent 100% synthetic ECRM or TRM. Class I, Type B erosion mat or Class II, Type B or C erosion mat must be placed over a soil filled TRM.

   1. **Type A** – An ECRM for use in channels where the calculated (design) shear stress of 2.0 lbs/ft^2 or less.

   2. **Type B** – A TRM for use in channels where the calculated (design) shear stress of 2.0 lbs/ft^2 or less.

   3. **Type C** – A TRM for use in channels where the calculated (design) shear stress of 3.5 lbs/ft^2 or less.

   4. **Type D** – A TRM for use in channels where the calculated (design) shear stress of 5.0 lbs/ft^2 or less.

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SCS ENGINEERS

		Sheet No.	1 of 5
		Calc. No.	
		Rev. No.	
Job No. 25222260.00	Project: Columbia Energy Center MOD 12-13	By: RJG	Date: 8/11/23
Client: WPL	Subject: Diversion Berm Spacing Calculation	Chk'd: SJL	Date: 8/18/23

Purpose:

Determine the spacing between diversion berms on the landfill final cover, with the goal of maintaining ≤ 3 ton/acre of soil loss along the final cover.

References

1. "Predicting Rainfall Erosion Losses," USDA Agriculture Handbook Number 537, 1978. (Figure 1 on Sheet 2 and Tables 10 and 13 on Sheet 4).
2. Erosion and Sediment Control Handbook," Goldman, Jackson, & Bursztynsky, 1986. (Table 5.5 on Sheet 5).
3. Rainfed retention probabilities computed for different cropping tillage systems. Agricultural Water Management, A.W. Mills & G.W. Thomas, 1985. Table 5.10 on Sheet 3)
4. Colombia Energy Center POO Update Drawings

Approach:

Use the Universal Soil Loss Equation (USLE) to determine diversion berm spacing. Longest flow length is 555 feet.

USLE Equation: $A = R * K * LS * C * P$

where: A = Average annual soil loss, tons/acre
R = Rainfall and runoff erosivity index
K = Soil erodibility factor, tons/acre
LS = Slope length and steepness factor
C = Cover management factor
P = Practice factor

or $LS = \frac{A}{R \times K \times C \times P}$

Assumptions:

A =	3	tons/acre
R =	145	see Figure 1 on Sheet 2 (Reference #1)
K =	0.38	see Table 5.10 on Sheet 3 for Loamy Very Fine Sand (Reference #3)
C =	0.0064	see Table 10 on Sheet 4, assuming 90% cover (Reference #1)
P =	1.0	assume no support practice used

Calculation:

$$LS = \frac{A}{R \times K \times C \times P} = \frac{3}{145 \times 0.38 \times 0.0064 \times 1.0} = 8.51$$

From the LS Values Table (Sheet 5), based on the 4:1 final cover slope, the slope distance is between 200 and 250 feet.
Use linear interpolation between the LS values for 200 and 250 feet to determine the slope length value for the 4:1 slope.

Slope Length @ 200 ft LS= 8.33
Slope Length @ 250 ft LS= 9.31

Slope length for the calculate LS factor = 209 ft

Results:

The maximum distance between diversion berms along the final cover to maintain less than 3 tons/acre soil loss is 209 ft.

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SCS ENGINEERS

Sheet No.	2 of 5		
Calc. No.			
Rev. No.			
Job No. 25222260.00	Project: Columbia Energy Center MOD 12-13	By: RJG	Date: 8/11/23
Client: WPL	Subject: Diversion Berm Spacing Calculation	Chk'd: SJL	Date: 8/18/23

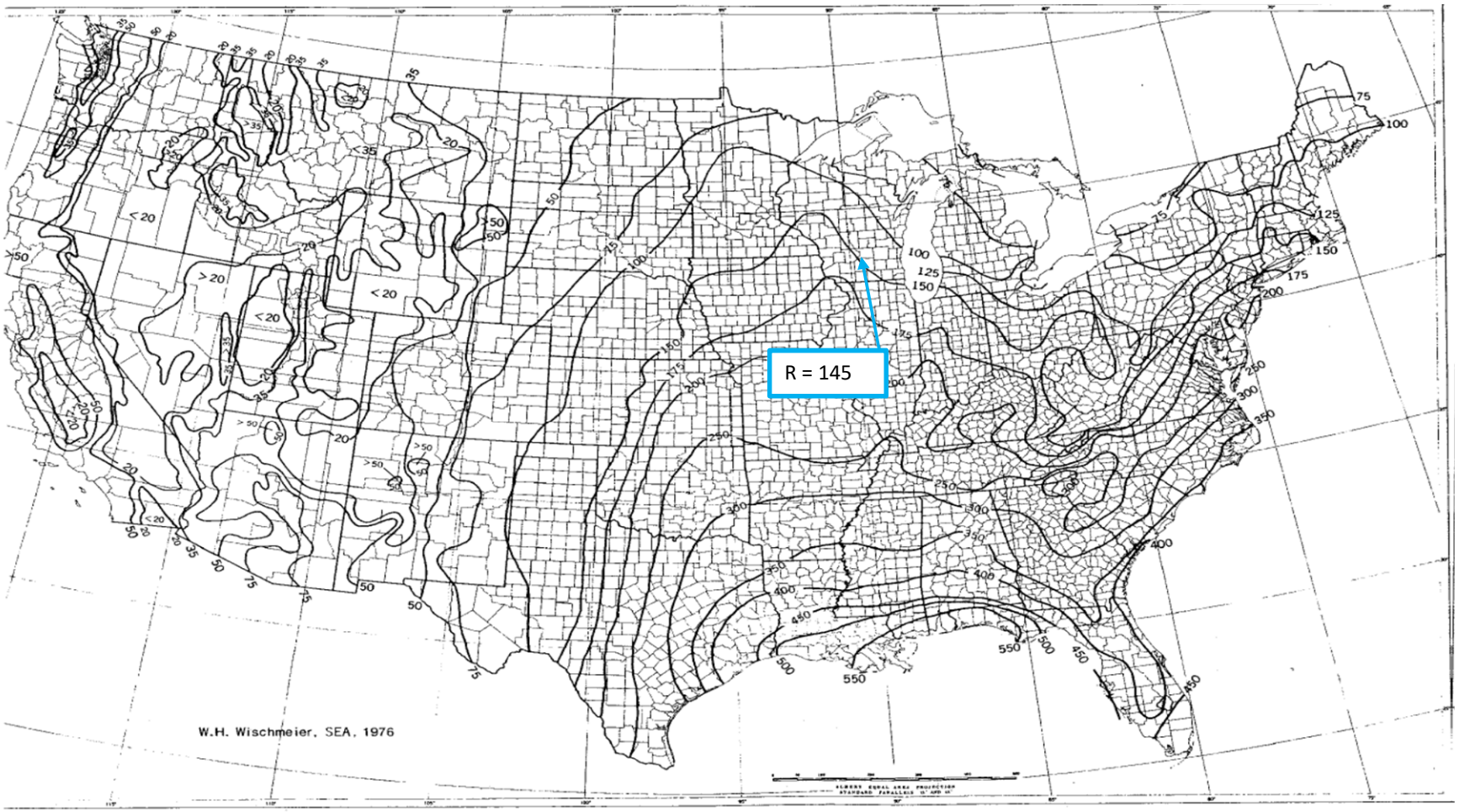

FIGURE 1.—Average annual values of the rainfall erosion index.

Source: "Predicting Rainfall Erosion Losses," USDA Agriculture Handbook Number 537, 1978.

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Table 5.10. Soil Erodibility Factor K_{fact} (after Stewart et al. 1975)[a]

	P_{om}(%)		
Textural Class	<0.5	2	4
Sand	0.05	0.03	0.02
Fine sand	0.16	0.14	0.10
Very finesand	0.42	0.36	0.28
Loamy sand	0.12	0.10	0.08
Loamy finesand	0.24	0.20	0.16
Loamy veryfine sand	0.44	0.38	0.30
Sandy loam	0.27	0.24	0.19
Fine sandyloam	0.35	0.30	0.24
Very fine sandy loam	0.47	0.41	0.33
Loam	0.38	0.34	0.29
Silt loam	0.48	0.42	0.33
Silt	0.60	0.52	0.42
Sandy clayloam	0.27	0.25	0.21
Clay loam	0.28	0.25	0.21
Silty clayloam	0.37	0.32	0.26
Sandy clay	0.14	0.13	0.12
Silty clay	0.25	0.23	0.19
Clay		0.13-0.2	

(a) The values shown are estimated averages of broad ranges of specific soil values. When a texture is near the border line of two texture classes, use the average of the two K_{fact} values. In addition, the values shown are commensurate with the English units used in the cited reference (and as used in the source-term module input files). To obtain analagous values in the metric units used in this report, the above values should be multiplied by 1.292.

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TABLE 10.—*Factor* **C** *for permanent pasture, range, and idle land*[1]

Vegetative canopy		Cover that contacts the soil surface						
Type and height[2]	Percent cover[3]	Type[4]	Percent ground cover 0	20	40	60	80	95
No appreciable canopy		G	0.45	0.20	0.10	0.042	0.013	0.003
		W	.45	.24	.15	.091	.043	.011
Tall weeds or short brush with average drop fall height of 20 in	25	G	.36	.17	.09	.038	.013	.003
		W	.36	.20	.13	.083	.041	.011
	50	G	.26	.13	.07	.035	.012	.003
		W	.26	.16	.11	.076	.039	.011
	75	G	.17	.10	.06	.032	.011	.003
		W	.17	.12	.09	.068	.038	.011
Appreciable brush or bushes, with average drop fall height of 6½ ft	25	G	.40	.18	.09	.040	.013	.003
		W	.40	.22	.14	.087	.042	.011
	50	G	.34	.16	.08	.038	.012	.003
		W	.34	.19	.13	.082	.041	.011
	75	G	.28	.14	.08	.036	.012	.003
		W	.28	.17	.12	.078	.040	.011
Trees, but no appreciable low brush. Average drop fall height of 13 ft	25	G	.42	.19	.10	.041	.013	.003
		W	.42	.23	.14	.089	.042	.011
	50	G	.39	.18	.09	.040	.013	.003
		W	.39	.21	.14	.087	.042	.011
	75	G	.36	.17	.09	.039	.012	.003
		W	.36	.20	.13	.084	.041	.011

[1] The listed **C** values assume that the vegetation and mulch are randomly distributed over the entire area.

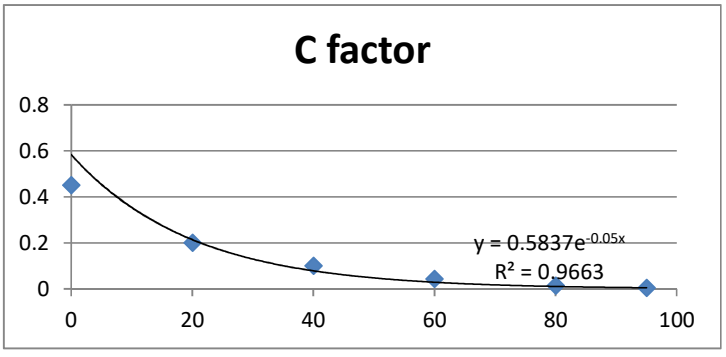
[2] Canopy height is measured as the average fall height of water drops falling from the canopy to the ground. Canopy effect is inversely proportional to drop fall height and is negligible if fall height exceeds 33 ft.

[3] Portion of total-area surface that would be hidden from view by canopy in a vertical projection (a bird's-eye view).

[4] G: cover at surface is grass, grasslike plants, decaying compacted duff, or litter at least 2 in deep.
W: cover at surface is mostly broadleaf herbaceous plants (as weeds with little lateral-root network near the surface) or undecayed residues or both.

Interpolated value
C = 0.0064

Source: "Predicting Rainfall Erosion Losses," USDA Agriculture Handbook Number 537, 1978.



= 90 % cover 0.0064

TABLE 5.5 LS Values* (10)

Slope ratio	Slope gradient s, %	LS values for following slope lengths l, ft (m)										LS values for following slope lengths l, ft (m)													
		10 (3.0)	20 (6.1)	30 (9.1)	40 (12.2)	50 (15.2)	60 (18.3)	70 (21.3)	80 (24.4)	90 (27.4)	100 (30.5)	150 (46)	200 (61)	250 (76)	300 (91)	350 (107)	400 (122)	450 (137)	500 (152)	600 (183)	700 (213)	800 (244)	900 (274)	1000 (305)
	0.5	0.06	0.07	0.07	0.08	0.08	0.09	0.09	0.09	0.09	0.10	0.10	0.11	0.11	0.12	0.12	0.13	0.13	0.13	0.14	0.14	0.14	0.15	0.15
100:1	1	0.08	0.09	0.10	0.10	0.11	0.11	0.12	0.12	0.12	0.12	0.14	0.14	0.15	0.16	0.16	0.16	0.17	0.17	0.18	0.18	0.19	0.19	0.20
	2	0.10	0.12	0.14	0.15	0.16	0.17	0.18	0.19	0.19	0.20	0.23	0.25	0.26	0.28	0.29	0.30	0.32	0.33	0.34	0.36	0.37	0.39	0.40
	3	0.14	0.18	0.20	0.22	0.23	0.25	0.26	0.27	0.28	0.29	0.32	0.35	0.38	0.40	0.42	0.43	0.45	0.46	0.49	0.51	0.54	0.55	0.57
	4	0.16	0.21	0.25	0.28	0.30	0.33	0.35	0.37	0.38	0.40	0.47	0.53	0.58	0.62	0.66	0.70	0.73	0.76	0.82	0.87	0.92	0.96	1.00
20:1	5	0.17	0.24	0.29	0.34	0.38	0.41	0.45	0.48	0.51	0.53	0.66	0.76	0.85	0.93	1.00	1.07	1.13	1.20	1.31	1.42	1.51	1.60	1.69
	6	0.21	0.30	0.37	0.43	0.48	0.52	0.56	0.60	0.64	0.67	0.82	0.95	1.06	1.16	1.26	1.34	1.43	1.50	1.65	1.78	1.90	2.02	2.13
	7	0.26	0.37	0.45	0.52	0.58	0.64	0.69	0.74	0.78	0.82	1.01	1.17	1.30	1.43	1.54	1.65	1.75	1.84	2.02	2.18	2.33	2.47	2.61
12½:1	8	0.31	0.44	0.54	0.63	0.70	0.77	0.83	0.89	0.94	0.99	1.21	1.40	1.57	1.72	1.85	1.98	2.10	2.22	2.43	2.62	2.80	2.97	3.13
	9	0.37	0.52	0.64	0.74	0.83	0.91	0.98	1.05	1.11	1.17	1.44	1.66	1.85	2.03	2.19	2.35	2.49	2.62	2.87	3.10	3.32	3.52	3.71
10:1	10	0.43	0.61	0.75	0.87	0.97	1.06	1.15	1.22	1.30	1.37	1.68	1.94	2.16	2.37	2.56	2.74	2.90	3.06	3.35	3.62	3.87	4.11	4.33
	11	0.50	0.71	0.86	1.00	1.12	1.22	1.32	1.41	1.50	1.58	1.93	2.23	2.50	2.74	2.95	3.16	3.35	3.53	3.87	4.18	4.47	4.74	4.99
8:1	12.5	0.61	0.86	1.05	1.22	1.36	1.49	1.61	1.72	1.82	1.92	2.35	2.72	3.04	3.33	3.59	3.84	4.08	4.30	4.71	5.08	5.43	5.76	6.08
	15	0.81	1.14	1.40	1.62	1.81	1.98	2.14	2.29	2.43	2.56	3.13	3.62	4.05	4.43	4.79	5.12	5.43	5.72	6.27	6.77	7.24	7.68	8.09
6:1	16.7	0.96	1.36	1.67	1.92	2.15	2.36	2.54	2.72	2.88	3.04	3.72	4.30	4.81	5.27	5.69	6.08	6.45	6.80	7.45	8.04	8.60	9.12	9.62
5:1	20	1.29	1.82	2.23	2.58	2.88	3.16	3.41	3.65	3.87	4.08	5.00	5.77	6.45	7.06	7.63	8.16	8.65	9.12	9.99	10.79	11.54	12.24	12.90
4½:1	22	1.51	2.13	2.61	3.02	3.37	3.69	3.99	4.27	4.53	4.77	5.84	6.75	7.54	8.26	8.92	9.54	10.12	10.67	11.68	12.62	13.49	14.31	15.08
4:1	25	1.86	2.63	3.23	3.73	4.16	4.56	4.93	5.27	5.59	5.89	7.21	8.33	9.31	10.20	11.02	11.78	12.49	13.17	14.43	15.58	16.66	17.67	18.63
	30	2.51	3.56	4.36	5.03	5.62	6.16	6.65	7.11	7.54	7.95	9.74	11.25	12.57	13.77	14.88	15.91	16.87	17.78	19.48	21.04	22.49	23.86	25.15
3:1	33.3	2.98	4.22	5.17	5.96	6.67	7.30	7.89	8.43	8.95	9.43	11.55	13.34	14.91	16.33	17.64	18.86	20.00	21.09	23.10	24.95	26.67	28.29	29.82
	35	3.23	4.57	5.60	6.46	7.23	7.92	8.55	9.14	9.70	10.22	12.52	14.46	16.16	17.70	19.12	20.44	21.68	22.86	25.04	27.04	28.91	30.67	32.32
2¾:1	40	4.00	5.66	6.93	8.00	8.95	9.80	10.59	11.32	12.00	12.65	15.50	17.89	20.01	21.91	23.67	25.30	26.84	28.29	30.99	33.48	35.79	37.96	40.01
	45	4.81	6.80	8.33	9.61	10.75	11.77	12.72	13.60	14.42	15.20	18.62	21.50	24.03	26.33	28.44	30.40	32.24	33.99	37.23	40.22	42.99	45.60	48.07
2:1	50	5.64	7.97	9.76	11.27	12.60	13.81	14.91	15.94	16.91	17.82	21.83	25.21	28.18	30.87	33.34	35.65	37.81	39.85	43.66	47.16	50.41	53.47	56.36
	55	6.48	9.16	11.22	12.96	14.48	15.87	17.14	18.32	19.43	20.48	25.09	28.97	32.39	35.48	38.32	40.97	43.45	45.80	50.18	54.20	57.94	61.45	64.78
1¾:1	57	6.82	9.64	11.80	13.63	15.24	16.69	18.03	19.28	20.45	21.55	26.40	30.48	34.08	37.33	40.32	43.10	45.72	48.19	52.79	57.02	60.96	64.66	68.15
	60	7.32	10.35	12.68	14.64	16.37	17.93	19.37	20.71	21.96	23.15	28.35	32.74	36.60	40.10	43.31	46.30	49.11	51.77	56.71	61.25	65.48	69.45	73.21
1½:1	66.7	8.44	11.93	14.61	16.88	18.87	20.67	22.32	23.87	25.31	26.68	32.68	37.74	42.19	46.22	49.92	53.37	56.60	59.66	65.36	70.60	75.47	80.05	84.38
	70	8.98	12.70	15.55	17.96	20.08	21.99	23.75	25.39	26.93	28.39	34.77	40.15	44.89	49.17	53.11	56.78	60.23	63.48	69.54	75.12	80.30	85.17	89.78
	75	9.78	13.83	16.94	19.56	21.87	23.95	25.87	27.66	29.34	30.92	37.87	43.73	48.89	53.56	57.85	61.85	65.60	69.15	75.75	81.82	87.46	92.77	97.79
1¼:1	80	10.55	14.93	18.28	21.11	23.60	25.85	27.93	29.85	31.66	33.38	40.88	47.20	52.77	57.81	62.44	66.75	70.80	74.63	81.76	88.31	94.41	100.13	105.55
	85	11.30	15.98	19.58	22.61	25.27	27.69	29.90	31.97	33.91	35.74	43.78	50.55	56.51	61.91	66.87	71.48	75.82	79.92	87.55	94.57	101.09	107.23	113.03
	90	12.02	17.00	20.82	24.04	26.88	29.44	31.80	34.00	36.06	38.01	46.55	53.76	60.10	65.84	71.11	76.02	80.63	84.99	93.11	100.57	107.51	114.03	120.20
	95	12.71	17.97	22.01	25.41	28.41	31.12	33.62	35.94	38.12	40.18	49.21	56.82	63.53	69.59	75.17	80.36	85.23	89.84	98.42	106.30	113.64	120.54	127.06
1:1	100	13.36	18.89	23.14	26.72	29.87	32.72	35.34	37.78	40.08	42.24	51.74	59.74	66.79	73.17	79.03	84.49	89.61	94.46	103.48	111.77	119.48	126.73	133.59

*Calculated from

$$LS = \left(\frac{65.41 \times s^2}{s^2 + 10{,}000} + \frac{4.56 \times s}{\sqrt{s^2 + 10{,}000}} + 0.065\right)\left(\frac{l}{72.5}\right)^m$$

LS = topographic factor
l = slope length, ft (m × 0.3048)
s = slope steepness,
m = exponent dependent upon slope steep
(0.2 for slopes < 1%, 0.3 for slopes 1 t
0.4 for slopes 3.5 to 4.5%, and
0.5 for slopes > 5%)

FROM "EROSION & SEDIMENT CONTROL HANDBOOK", Goldman, Jackson, + Bursztynsky, 1986

5.20

5.21

Source: Erosion and Sediment Control Handbook," Goldman, Jackson, & Bursztynsky, 1986.

09/28/2023 - Classification: Internal - ECRM13153872

Downslope Flume & Energy Dissipator Sizing

SCS ENGINEERS

		Sheet No:	1 of 4
		Calc. No.	
		Rev. No.	
Job No. 25222260.00	Project: Columbia Energy Center MOD 12-13	By: SJL	Date: 8/28/23
Client: WPL	Subject: Downslope Pipe and Inlet Sizing	Chk'd: RJG	Date: 8/28/23

Purpose:

To size the downslope pipe and inlet to accommodate the 25-year, 24-hour storm event.

References:

1. HydroCAD Report: COL_Mod12-13_HydroCAD Report

Approach:

Use the orifice equation to size the downslope pipe inlet. Size the inlet for the largest diversion berm flow rate and apply that inlet size to all downslope pipe inlets. Confirm the head (h) acting on the orifice will not overtop the diversion berm depth of 2.0 ft.

Use Manning's equation to size the downslope pipe based on the largest diversion berm flow rate. Confirm the pipe has capacity for the design flow under open channel flow conditions.

Assumptions:

1. Orifice coefficient = 0.63
2. Assume the orifice head (h) acts on the centerline of the inlet pipe.
3. Manning's n = 0.012 (For smooth walled HDPE pipe: http://www.engineeringtoolbox.com/mannings-roughness-d_799.html)
4. Size flumes under the vegetated cover condition.

From the HydroCAD Report (Reference 1) , the peak discharge to each downslope flume resulting from a 25-year, 24-hour storm is as follows*:

Flume 1		**Flume 2**		**Flume 3 Existing)**		**Flume 4 (Existing)**		**Flume 5 (Existing)**	
Area 1	3.75	Area 3	1.06						
Area 2	1.71	Area 4	0.92						
Area 12	4.83	Area 14	1.93						
Area 13	1.94	Area 15	2.80						
Total =	12.23		6.71		0		0		0

Flume 6		**Flume 7**		**Flume 8**		**Flume 9**		**Flume 10**	
Area 5	1.66	Area 8	2.66	Area 20	1.19	Area 10	1.68	Area 27	0.52
Area 6	2.81	Area 9	0.86	Area 25	2.12	Area 11	5.22	Area 28	0.44
Area 16	1.78	Area 18	5.06	Area 34	1.35	Area 21	1.62		
Area 17	3.04	Area 19	2.16			Area 22	7.54		
		Area 24	3.61			Area 26	2.10		
		Area 33	3.24			Area 27	7.46		
Total =	9.29	Total =	17.59	Total =	4.66	Total =	25.62	Total =	0.96

** Please note that the total flow rate at each flume calculated above may not reflect the flow rate shown in the HydroCAD Model due to the inflow to the flume occuring at different times during the storm event. The calculation above reflects the peak flow rate.*

Results:

Based on the inlet sizing calculation, an 18" diameter inlet will convey the stormwater runoff from the largest flow rate to a inlet (Area 22).

Based on the Manning's calculation for flow within the pipe, the 12" diameter downslope pipe will accommodate the design flow for Flumes 1 through 8 and Flume 10 under open channel flow conditions. Although the flow for the downslope pipes can be handled by 12" dia. pipes, for ease of construction, all downslope pipes will be 18" dia with the exception of Flume 10. Flume 10 will be constructed with a 12" dia pipe based on the drainage area and anticipated flow rate.

09/28/2023 - Classification: Internal - ECRM13153872

Calculations:

Size the downslope pipe inlet:

From the HydroCAD report (Reference #1), the maximum 25-year, 24-hour flow along a diversion berm is 7.54 cfs
in HydroCAD model). Area 27 Inlet

Orifice Equation: $Q = C * A * (2 * g * h)^{0.5}$

where: Q = flow rate (cfs) = 7.5 (From above)
C = orifice coefficient = 0.63 (See assumption #1)
A = orifice area (sf) = 1.77 (area of 18" diameter pipe) Actual Pipe Diameter = 18 inches
g = gravity (ft/sec^2)= 32
h = orifice head acting on centerline (ft)
$h = (Q/(C * A))^2/(2 * g)$ = 0.7 ft
Given Assumption #2, depth of flow along diversion berm = h + D/2/12 = 1.46 ft

The diversion swale depth of 2 ft is sufficient to prevent overtopping at the downslope pipe inlet locations. The depth of the diversion berm increases at the entrance of the down slope pipes due to mounding of the soil over the pipe.

Size the downslope flume pipe:

Use Manning's equation to size the downslope pipe.

Manning's Equation: Q = (1.49/n) x A x R^(2/3) x S^(1/2)
where: Q = Flow Rate, cfs
n = Manning's Roughness Coefficient
A = Flow Area, sf
R = Hydraulic Radius, ft (= A/P)
S = Channel Slope, ft/ft

For flow rates < 20 cfs, assume a 12" diameter downslope flume:

Use 17.59 cfs to Flume 7 to check sizing (max flow to a flume that is < 20 cfs)
Design Criteria
Pipe Diameter (in) = D = 12
Pipe Slope (ft/ft) = S = 0.25
Manning's Roughness Coefficient = n = 0.012
See Downslope Flume 7 pipe flow calculator on Sheet 3

For flow rates >20 cfs, try 18" diameter downslope flume:

Use 25.62 cfs to Flume 9 to check sizing (max flow to a flume that is < 20 cfs)
Design Criteria
Pipe Diameter (in) = D = 18
Pipe Slope (ft/ft) = S = 0.25
Manning's Roughness Coefficient = n = 0.012
See Downslope Flume 9 pipe flow calculator on Sheet 3

09/28/2023 - Classification: Internal - ECRM13153872

Calculations (Continued): **Flume 7** **17.59** 0

Manning Formula Uniform Pipe Flow at Given Slope and Depth

Inputs:

Pipe Diameter, d_o	12.00	in
Manning Roughness, n	0.0120	
Pressure slope (possibly equal to pipe slope), S_o	0.2500	slope
Percent of (or ratio to) full depth (100% or 1 if flowing full)	0.7500	fraction

Results:

Flow, Q	17.5969	ft^3/s
Velocity, v	27.8498	ft/s
Velocity head, hv	12.0541	ft
Flow Area, A	0.6319	ft^2
Wetted Perimeter, P	2.0944	ft
Hydraulic Radius	0.3017	ft
Top Width, T	0.8660	ft
Froude Number, F	5.84	
Shear Stress (tractive force), τ	11.7045	psf

Version 2.0 (20 June 2017)

HawsEDC Calculators

09/28/2023 - Classification: Internal - ECRM13153872

Calculations (Continued): **Flume 9** **25.62**

Manning Formula Uniform Pipe Flow at Given Slope and Depth

Inputs:

Pipe Diameter, d_o	18.00	in
Manning Roughness, n	0.0120	
Pressure slope (possibly equal to pipe slope), S_o	0.2500	slope
Percent of (or ratio to) full depth (100% or 1 if flowing full)	0.4705	fraction

Results:

Flow, Q	25.6240	ft^3/s
Velocity, v	31.3544	ft/s
Velocity head, hv	15.2789	ft
Flow Area, A	0.8172	ft^2
Wetted Perimeter, P	2.2676	ft
Hydraulic Radius	0.3604	ft
Top Width, T	1.4974	ft
Froude Number, F	7.60	
Shear Stress (tractive force), τ	11.0139	psf

Version 2.0 (20 June 2017)

HawsEDC Calculators

SCS ENGINEERS

Sheet No. 1 of 7			
Calc. No.			
Rev. No.			
Job No. 25222260.00	Project: Columbia Energy Center MOD 12-13	By: SJL	Date: 8/28/23
Client: WPL	Subject: Energy Dissipator Sizing	Chk'd: RJG	Date: 8/30/23

Purpose:

To size an energy dissipator structure and riprap apron at the outlet of the downslope flume pipes.

References:

1. "Hydraulic Design of Energy Dissipators for Culverts and Channels," HEC-14, Third Edition, July 2006, USDOT FHWA.
2. Downslope Pipe and Inlet Sizing calculation (for pipe size, flow rate, and pipe velocity).
3. HydroCAD Report: COL_Mod12-13_HydroCAD Report
4. Facilities Development Manual Chapter 13, Section 13-30 - Rock Riprap Lined Chutes.
5. WisDOT FDM Table 25.1

Approach:

Use the downslope pipe outlet velocity to size an energy dissipator structure (USBR Type VI Impact Basin) following the design approach outlined in Section 9.4 of Reference #1.

Use Rock Chute Data Spreadsheet, FDM 13-30-30 Attachment 30.1 (from Reference #5) to design the rock chute.

For construction purposes use the maximum flow to size all dissipators and riprap apron.

Assumptions:

1. Riprap specific gravity = 2.65
2. From the HydroCAD Report, the 25-year, 24-hour peak discharge to each downslope flume is as follows*:

Flume 1		**Flume 2**		**Flume 3 Existing)**		**Flume 4 (Existing)**		**Flume 5 (Existing)**	
Area 1	3.75	Area 3	1.06						
Area 2	1.71	Area 4	0.92						
Area 12	4.83	Area 14	1.93						
Area 13	1.94	Area 15	2.80						
Total =	12.23		6.71		0		0		0

Flume 6		**Flume 7**		**Flume 8**		**Flume 9**		**Flume 10**
Area 5	1.66	Area 8	2.66	Area 20	1.19	Area 10	1.68	This flume discharges directly into a concrete catch basin at the toe of slope, therefore, no energy dissipator is needed.
Area 6	2.81	Area 9	0.86	Area 25	2.12	Area 11	5.22	
Area 16	1.78	Area 18	5.06	Area 34	1.35	Area 21	1.62	
Area 17	3.04	Area 19	2.16			Area 22	7.54	
		Area 24	3.61			Area 26	2.10	
		Area 33	3.24			Area 27	7.46	
Total =	9.29	Total =	17.59	Total =	4.66	Total =	25.62	

** Please note that the total flow rate at each flume calculated above may not reflect the flow rate shown in the HydroCAD Model due to the inflow to the flume occuring at different times during the storm event. The calculation above reflects the peak flow rate.*

Using Figure 9.14 (See Sheet 4), enter the Froude Number and the Energy from Step 2 to determine the
from the downslope flume pipe and inlet sizing calculation.

Results:

The energy dissipator structures for the 18" dia. downslope flume pipes will consist of dissipator structures with widths (W_B) of 6 feet, with the remaining dimensions from Table 9.2 on Sheets 5 and 6.

Riprap at the Flume energy dissipator outlets will consist of WisDOT Select Crush Material (D50= 2.2 inches) (See Page 3).

The riprap apron footprint will be based on the energy dissipator width, the rock chute, and/or the outlet swale geometry (See Plan Set).

Calculations:

For 18" dia. downslope flume pipes

From Reference #2:

Flow rate (Q) = 25.6 cfs
Pipe velocity (V) = 31.4 ft/s
Flow area (A) = Q/V = 0.82 sf

Design procedure from pg. 9-40 of Reference #1:

Step 1: Compute the Equivalent Depth of Flow Entering Dissipator:

$Y_e = (A/2)^{1/2}$ where: Ye = Equivalent depth
A = Area (from above)

Y_e = 0.64 ft

Step 2: Compute the Froude Number and the energy at the end of the pipe:

$Fr = V/[(g*Y_e)^{1/2}]$ where: Fr = Froude Number
V = Velocity (from above)
g = Gravity constant (32.2 ft/sec^2)
Y_e = Equivalent depth (from Step 1 above)

Fr = 6.9

$H_o = Y_e+V^2/2g$ where: H_o = Energy at the end of the pipe
Y_e = Equivalent depth (from above)
V = Velocity (from above)
g = Gravity constant (32.2 ft/sec^2)

Ho = 15.9 ft

Step 3: Determine H_o/W_B and calculate the required width of the energy dissipator:

Using Figure 9.14 (See Sheet 4), enter the Froude Number and the Energy from Step 2 to determine the width of the energy dissipator.

From Figure 9.14, H_o/W_B = 2.70
$W_B = H_o/(H_o/W_B)$ W_B = 5.9 ft.
Use W_B = 6.0 ft.

Step 4: Obtain the remaining energy dissipator dimensions from Table 9.2 from Reference #1 (see Sheets 5 and 6)

Calculations:

Step 5: Determine the exit velocity from the energy dissiaptor structure and size the riprap apron at the structure outlet.

Use the relationship:

$H_B = Q/(W_B \times V_B) + V_B^2 / 2g = H_o \times (1-H_L/H_o)$

Where:

- Q = 25.6 cfs, flowrate
- W_B = 6.0 ft, width of energy dissipator
- g = 32.2 ft/s^2, gravity
- H_O 15.9 Energy at end of pipe
- H_L/H_O 76 %, Energy loss (From Figure 9.15 from Reference #1, see Sheet 3)
- V_B = Velocity at exit of dissipator (ft/s)
- HB = Energy at exit of dissipator (ft)

Calculate HB using the second part of the equation:

$H_B = H_o \times (1-H_L/H_o)$

H_B = 3.82 ft

Using trial and error, select values for V_B and use the first part of the equation to calculate H_B:

Try V_B = 1.105 ft/s H_B = 3.87 ft

Based on the energy dissipator structure exit velocity, calculate the riprap size at the dissipator outlet.

From Equation 10.6 from Reference #1:

$D_{50} = (0.692 / (S-1)) \times (V^2/2g)$

Where:

- S = 2.65 Specific gravity (See Assumption #1)
- V = 1.11 Velocity = V_B from above.
- D_{50} = riprap size

$D_{50\ Calc'd}$ = 0.008 feet

Round the calculated D_{50} up to the nearest IDOT standard riprap size:

$D_{50\ Design}$ = 0.18 feet Use = Select Crushed Material with geotextile Type R

Riprap Type	D_{50} (inches)	D_{50} (feet)	Riprap Thickness (in)	Geotextile Type
Select Crushed Material	2.2	0.18	5	Type R
Light Riprap	10	0.83	12	Type R
Medium Riprap	12.5	1.04	18	Type HR
Heavy Riprap	16	1.33	24	Type HR
Extra-Heavy Riprap	20	1.67	30	Type HR

from Reference 5

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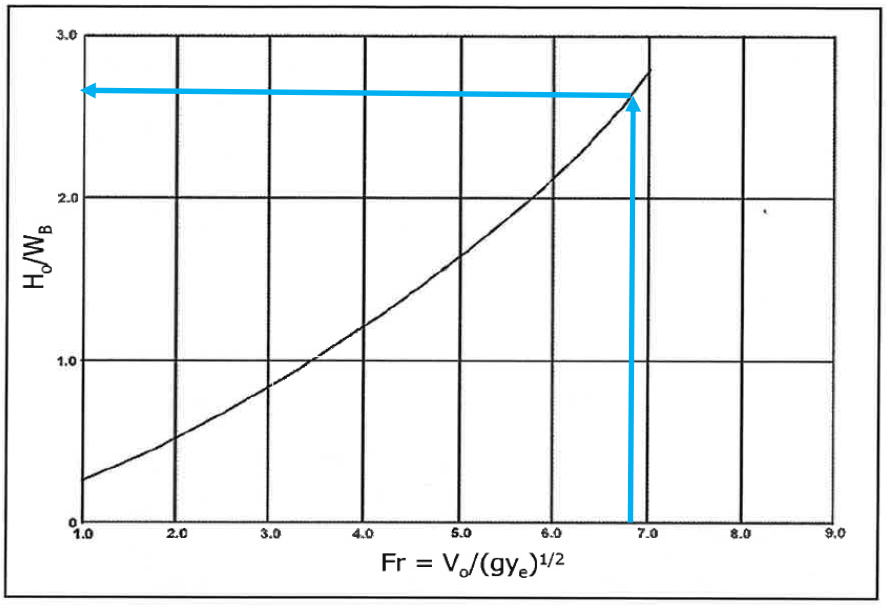


Figure 9.14. Design Curve for USBR Type VI Impact Basin

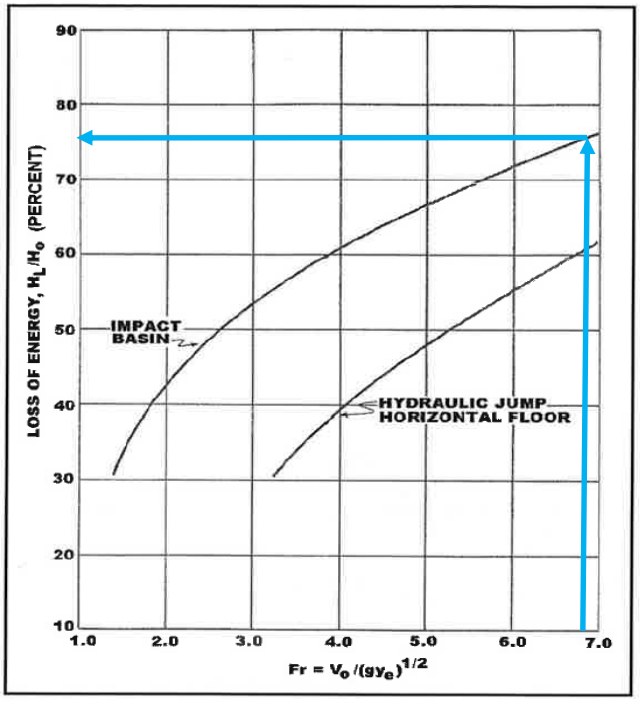


Figure 9.15. Energy Loss of USBR Type VI Impact Basin versus Hydraulic Jump

Table 9.2 (CU). USBR Type VI Impact Basin Dimensions (ft) (AASHTO, 2005)

W_B	h_1	h_2	h_3	h_4	L	L_1	L_2
4.	3.08	1.50	0.67	1.67	5.42	2.33	3.08
5.	3.83	1.92	0.83	2.08	6.67	2.92	3.83
6.	4.58	2.25	1.00	2.50	8.00	3.42	4.58
7.	5.42	2.58	1.17	2.92	9.42	4.00	5.42
8.	6.17	3.00	1.33	3.33	10.67	4.58	6.17
9.	6.92	3.42	1.50	3.75	12.00	5.17	6.92
10.	7.58	3.75	1.67	4.17	13.42	5.75	7.67
11.	8.42	4.17	1.83	4.58	14.58	6.33	8.42
12.	9.17	4.50	2.00	5.00	16.00	6.83	9.17
13.	10.17	4.92	2.17	5.42	17.33	7.42	10.00
14.	10.75	5.25	2.33	5.83	18.67	8.00	10.75
15.	11.50	5.58	2.50	6.25	20.00	8.50	11.50
16.	12.25	6.00	2.67	6.67	21.33	9.08	12.25
17.	13.00	6.33	2.83	7.08	21.50	9.67	13.00
18.	13.75	6.67	3.00	7.50	23.92	10.25	13.75
19.	14.58	7.08	3.17	7.92	25.33	10.83	14.58
20.	15.33	7.50	3.33	8.33	26.58	11.42	15.33

W_B	W_1	W_2	t_1	t_2	t_3	t_4	t_5
4.	0.33	1.08	0.50	0.50	0.50	0.50	0.25
5.	0.42	1.42	0.50	0.50	0.50	0.50	0.25
6.	0.50	1.67	0.50	0.50	0.50	0.50	0.25
7.	0.50	1.92	0.50	0.50	0.50	0.50	0.25
8.	0.58	2.17	0.50	0.58	0.58	0.50	0.25
9.	0.67	2.50	0.58	0.58	0.67	0.58	0.25
10.	0.75	2.75	0.67	0.67	0.75	0.67	0.25
11.	0.83	3.00	0.67	0.75	0.75	0.67	0.33
12.	0.92	3.00	0.67	0.83	0.83	0.75	0.33
13.	1.00	3.00	0.67	0.92	0.83	0.83	0.33
14.	1.08	3.00	0.67	1.00	0.92	0.92	0.42
15.	1.17	3.00	0.67	1.00	1.00	1.00	0.42
16.	1.25	3.00	0.75	1.00	1.00	1.00	0.50
17.	1.33	3.00	0.75	1.08	1.00	1.00	0.50
18.	1.33	3.00	0.75	1.08	1.08	1.08	0.58
19.	1.42	3.00	0.83	1.17	1.08	1.08	0.58
20.	1.50	3.00	0.83	1.17	1.17	1.17	0.67

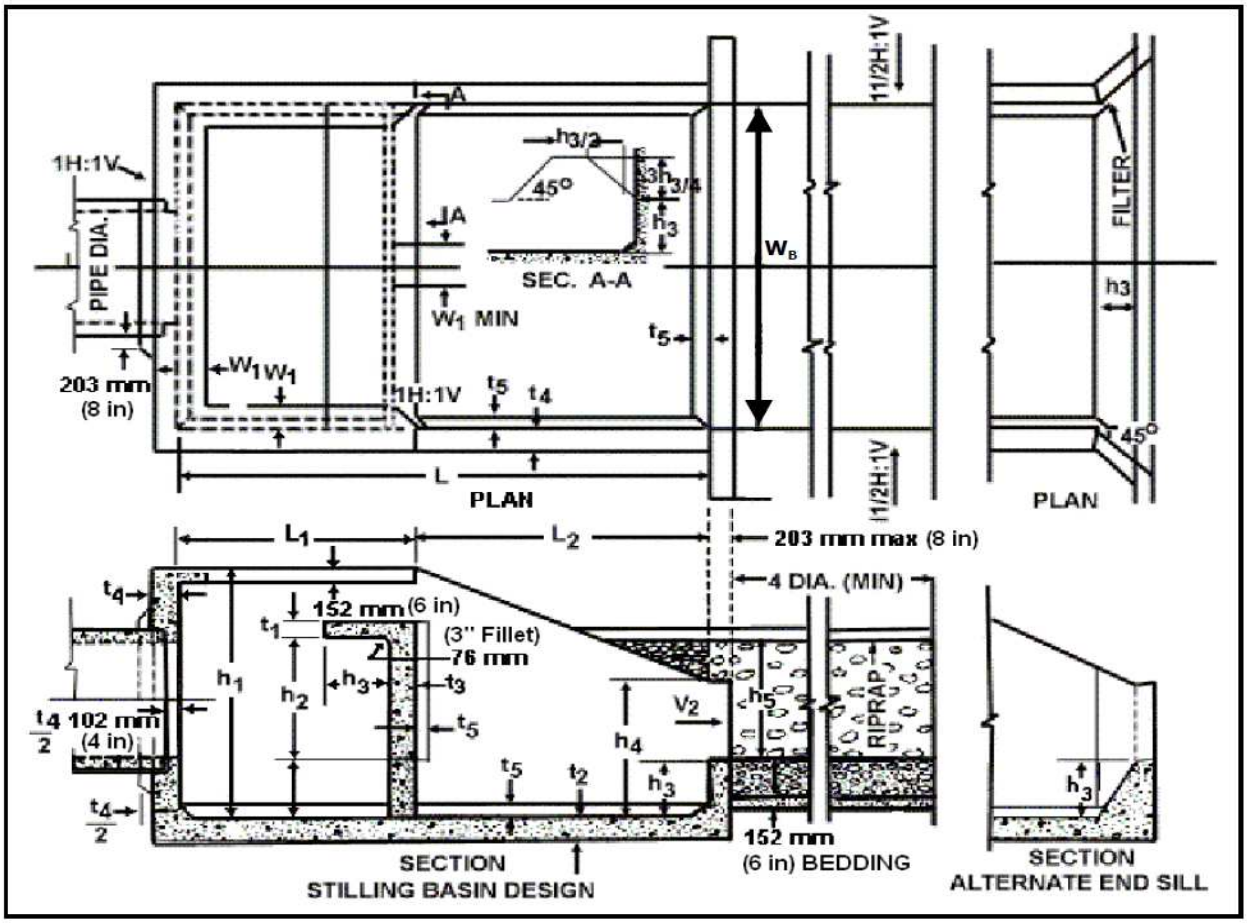


Figure 9.13. USBR Type VI Impact Basin

Calculations (Continued):

Downslope Flume 9 - Velocity Calculator (Q = 25.62 cfs)

Manning Formula Uniform Pipe Flow at Given Slope and Depth

Inputs:

Pipe Diameter, d_o	18	in
Manning Roughness, n	0.0120	
Pressure slope	0.2500	slope
Percent of (or ratio to) full depth (100% or 1 if flowing full)	0.4705	fraction

Results:

Flow, Q	25.6240	ft^3/s
Velocity, v	31.3544	ft/s
Velocity head, hv	183.3465	in
Flow Area, A	0.8172	ft^2
Wetted Perimeter, P	2.2676	ft
Hydraulic Radius	0.3604	ft
Top Width, T	1.4974	ft
Froude Number, F	7.60	
Shear Stress (tractive force), τ	11.0139	psf

Version 2.0 (20 June 2017)

HawsEDC Calculators

Rock Chute Sizing

SCS ENGINEERS

		Sheet No:	1 of 5
		Calc. No.	
		Rev. No.	
Job No. 25222260.00	Job: Columbia Energy Center MOD 12-13	By: SJL	Date: 8/28/23
Client: WPL	Subject: Rock Chute Sizing & Riprap Size	Chk'd: RJG	Date: 8/28/23

Purpose:

To size the rock chutes to accommodate the 25-year, 24-hour storm event.

References:

1. Rock Chute Design Data spreadsheet Version WI-April-2005, Based on Design of Rock Chutes by Robinson, Rice, Kadavy, ASAE, 1998.
2. HydroCAD Report: COL_Mod12-13_HydroCAD Report
3. Figure 1 - Final Grades (Module 13)
4. Stable 25.1 Typical Particle Sizes of Native Sands at 75 Percent Passing (D75) from WisDOT Facilities. Development Manual (FDM).

Approach:

1. Enter Inlet Channel data based on culvert apron or swale geometry Reference #2 and #3.
2. Enter Chute data based on slope from Reference #3, start the width, Bw equal to inlet channel Bw.
3. Enter Outlet Channel data based on Reference #3, start the width, Bw equal to inlet channel Bw.
4. Enter drainage area, apron elevations, flow (Q), and rainfall.
5. Adjust Bw for Chute and Outlet Channel until spreadsheet shows the rock chute "will" function adequately.
6. Determine rip rap classification based on D50 weight per Reference #4.

Assumptions:

1. Assume side slopes of chute and outlet channel are 2:1.
2. Assume Factor of Safey is 1.2.
3. n-value is based on proposed conditions at the channel.
4. Assume Outlet apron depth, d is 1.0 ft.
5. Freeboard is 1.0 ft.
6. Use 25-year, 24-hour storm event flow (Reference #2) for Q_{high} and Q_{low}.
7. Classification of riprap is based on weight (Reference #4).

Calculations:

See attached spreadsheet calcs for each rock chute.

Results:

The rock chutes are adequately designed to accommodate the flows from the 25-year, 24-hour storm event.

Rock Chute	Width (ft)	Thickness (in)	Apron Width (ft)	Apron Length (ft)	D_{50} (in)	WisDOT Rip Rap Classification
RC1	8	4	8	2	2	Select Crushed Material, Type R
RC2	6	12	6	7	5.9	Light Riprap Type R
RC3	6	8	6	5	3.8	Light Riprap Type R
RC4	6	9	6	6	3.8	Light Riprap, Type R

Rock Chute Design Data

(Version WI-April-2005, Based on Design of Rock Chutes by Robinson, Rice, Kadavy, ASAE, 1998)
Revised for WisDOT 9/2010

Project: COL - Mod 12-13 RC1 **County:** Columbia
Designer: SJL **Checked by:** RJG
Date: August 28, 2023 **Date:** 08/28/23

Input Geometry:

Upstream Channel		Chute			Downstream Channel	
Bottom Width =	0.0 ft.	Bottom Width =	8.0 ft.		Bottom Width =	8.0 ft.
Side slopes =	4.0 (m:1)	Factor of safety =	1.20 (SF)	1.2 Min	Side slopes =	2.0 (m:1)
Mannings n value =	0.030	Side slopes =	2.0 (z:1)	2.0:1 max.	Mannings n value =	0.045
Bed slope =	0.0600 ft./ft.	Bed slope =	0.1769 ft./ft	3.0:1 max.	Bed slope =	0.0050 ft./ft.
Note: Use procedures 13-30-15 or 13-30-25 for upstream and downstream Mannings n		Freeboard =	1.0 ft.			
		Outlet apron depth, d =	1.0 ft.		Base flow =	0.0 cfs

Flow and Elevation Data:

Apron elev. --- Inlet = 829.0 ft. ---- Outlet 806.0 ft. --- (H_{drop} = 22 ft.)

Degree of angularity = 1

Q_{high} = Runoff from design storm
Q_5 = Runoff from a 5-year,24-hour storm

1 --> 50% angular, 50% rounded
2 --> 100 % rounded

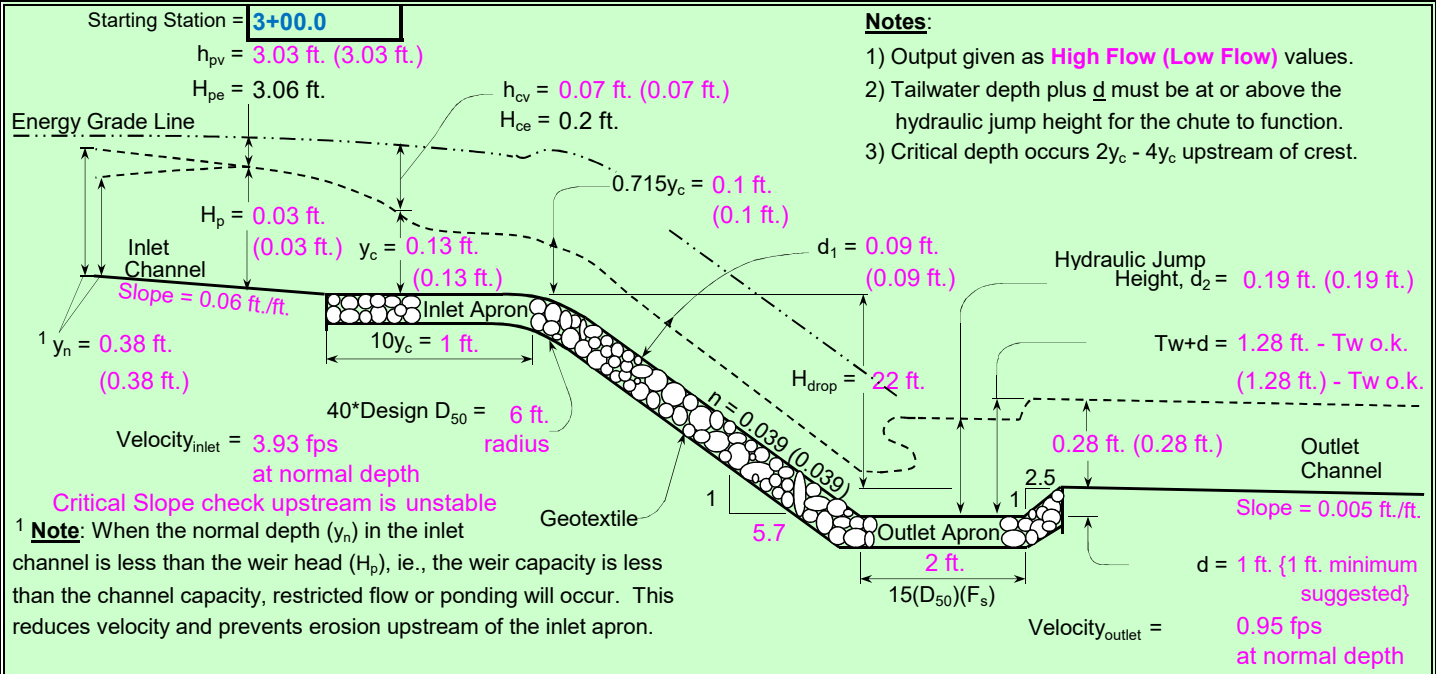
Q_{high} = 2.3 cfs High flow storm through chute → Tw (ft.) = Program
Q_{low} = 2.3 cfs Low flow storm through chute → Tw (ft.) = Program

Note: The total required capacity is routed through the chute (principal spillway) or in combination with an auxiliary spillway.

Input tailwater (Tw): 0.18 1.20

Profile and Cross Section (Output):

Starting Station = 3+00.0

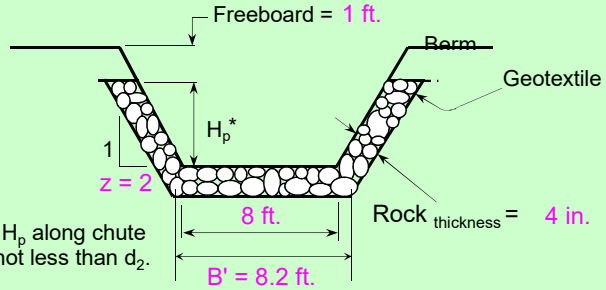


Notes:
1) Output given as **High Flow (Low Flow)** values.
2) Tailwater depth plus d must be at or above the hydraulic jump height for the chute to function.
3) Critical depth occurs 2y_c - 4y_c upstream of crest.

[1] **Note**: When the normal depth (y_n) in the inlet channel is less than the weir head (H_p), ie., the weir capacity is less than the channel capacity, restricted flow or ponding will occur. This reduces velocity and prevents erosion upstream of the inlet apron.

Profile Along Centerline of Chute

Typical Cross Section



* Use H_p along chute but not less than d_2.

	0.28 cfs/ft.	Equivalent unit discharge
SF =	1.20	Factor of safety (multiplier)
d_1 =	0.09 ft.	Normal depth in chute
n-value =	0.039	Manning's roughness coefficient
D_{50}(SF) =	2 in.	Minimum Design D_{50}*
2(D_{50})(SF) =	4 in.	Rock chute thickness
Tw + d =	1.28 ft.	Tailwater above outlet apron
d_2 =	0.19 ft.	Hydraulic jump height
*** The outlet	will	function adequately

High Flow Storm Information

Rock Chute Design Data

(Version WI-April-2005, Based on Design of Rock Chutes by Robinson, Rice, Kadavy, ASAE, 1998)
Revised for WisDOT 9/2010

Project: COL - Mod 12-13 RC2 **County:** Columbia
Designer: SJL **Checked by:** RJG
Date: August 28, 2023 **Date:** 08/28/23

Input Geometry:

Upstream Channel		Chute			Downstream Channel	
Bottom Width =	6.0 ft.	Bottom Width =	6.0 ft.		Bottom Width =	6.0 ft.
Side slopes =	1.0 (m:1)	Factor of safety =	1.20 (SF)	1.2 Min	Side slopes =	2.0 (m:1)
Mannings n value =	0.012	Side slopes =	2.0 (z:1) →	2.0:1 max.	Mannings n value =	0.045
Bed slope =	0.0001 ft./ft.	Bed slope =	0.2319 ft./ft →	3.0:1 max.	Bed slope =	0.0050 ft./ft.
Note: Use procedures 13-30-15 or 13-30-25 for upstream and downstream Mannings n		Freeboard =	1.0 ft. →			
		Outlet apron depth, d =	1.0 ft.		Base flow =	0.0 cfs

Flow and Elevation Data:

Apron elev. --- Inlet = 820.0 ft. ---- Outlet 804.0 ft. --- (H_{drop} = 15 ft.)

Degree of angularity = 1

Q_{high} = Runoff from design storm
Q_5 = Runoff from a 5-year,24-hour storm
1 --> 50% angular, 50% rounded
2 --> 100 % rounded

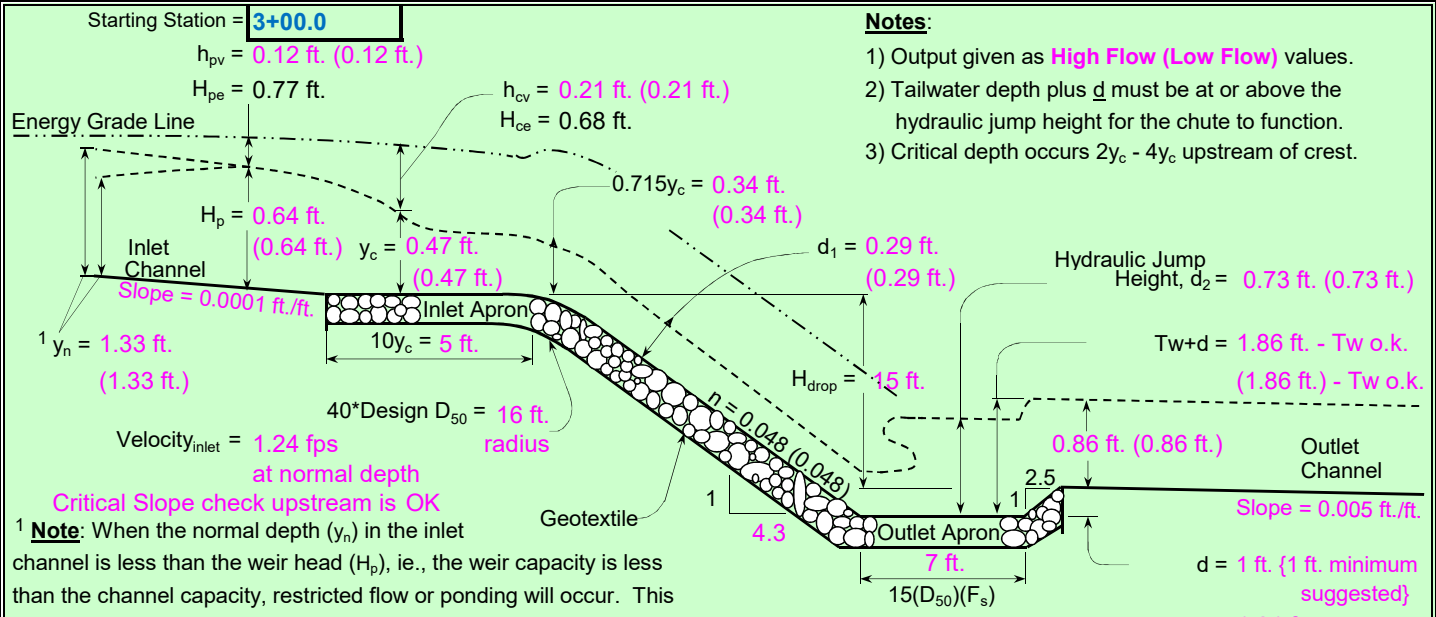
Q_{high} = 12.1 cfs High flow storm through chute → Tw (ft.) = Program
Q_{low} = 12.1 cfs Low flow storm through chute → Tw (ft.) = Program

Note: The total required capacity is routed through the chute (principal spillway) or in combination with an auxiliary spillway.

Input tailwater (Tw): 0.23 1.20

Profile and Cross Section (Output):

Starting Station = 3+00.0

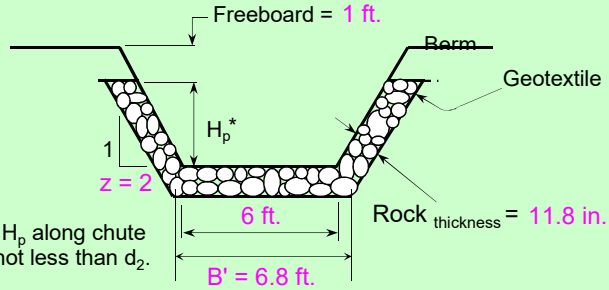


Notes:
1) Output given as **High Flow (Low Flow)** values.
2) Tailwater depth plus d must be at or above the hydraulic jump height for the chute to function.
3) Critical depth occurs 2y_c - 4y_c upstream of crest.

[1] **Note**: When the normal depth (y_n) in the inlet channel is less than the weir head (H_p), ie., the weir capacity is less than the channel capacity, restricted flow or ponding will occur. This reduces velocity and prevents erosion upstream of the inlet apron.

Profile Along Centerline of Chute

Typical Cross Section



* Use H_p along chute but not less than d_2.

	1.85 cfs/ft.	Equivalent unit discharge
SF =	1.20	Factor of safety (multiplier)
d_1 =	0.29 ft.	Normal depth in chute
n-value =	0.048	Manning's roughness coefficient
D_{50}(SF) =	5.9 in.	Minimum Design D_{50}*
2(D_{50})(SF) =	11.8 in.	Rock chute thickness
Tw + d =	1.86 ft.	Tailwater above outlet apron
d_2 =	0.73 ft.	Hydraulic jump height
*** The outlet	will	function adequately

High Flow Storm Information

Rock Chute Design Data

(Version WI-April-2005, Based on Design of Rock Chutes by Robinson, Rice, Kadavy, ASAE, 1998)
Revised for WisDOT 9/2010

Project: COL - Mod 12-13 RC3 **County:** Columbia
Designer: SJL **Checked by:** RJG
Date: August 28, 2023 **Date:** 08/28/23

Input Geometry:

Upstream Channel		Chute			Downstream Channel	
Bottom Width =	6.0 ft.	Bottom Width =	6.0 ft.		Bottom Width =	6.0 ft.
Side slopes =	1.0 (m:1)	Factor of safety =	1.20 (SF)	1.2 Min	Side slopes =	2.0 (m:1)
Mannings n value =	0.012	Side slopes =	2.0 (z:1) →	2.0:1 max.	Mannings n value =	0.045
Bed slope =	0.0001 ft./ft.	Bed slope =	0.1545 ft./ft →	3.0:1 max.	Bed slope =	0.0050 ft./ft.
Note: Use procedures 13-30-15 or 13-30-25 for upstream and downstream Mannings n		Freeboard =	1.0 ft. →			
		Outlet apron depth, d =	1.0 ft.		Base flow =	0.0 cfs

Flow and Elevation Data:

Apron elev. --- Inlet = 821.0 ft. ------ Outlet 804.0 ft. --- (H_{drop} = 16 ft.)

Degree of angularity = 1

Q_{high} = Runoff from design storm
Q_5 = Runoff from a 5-year,24-hour storm

1 --> 50% angular, 50% rounded
2 --> 100 % rounded

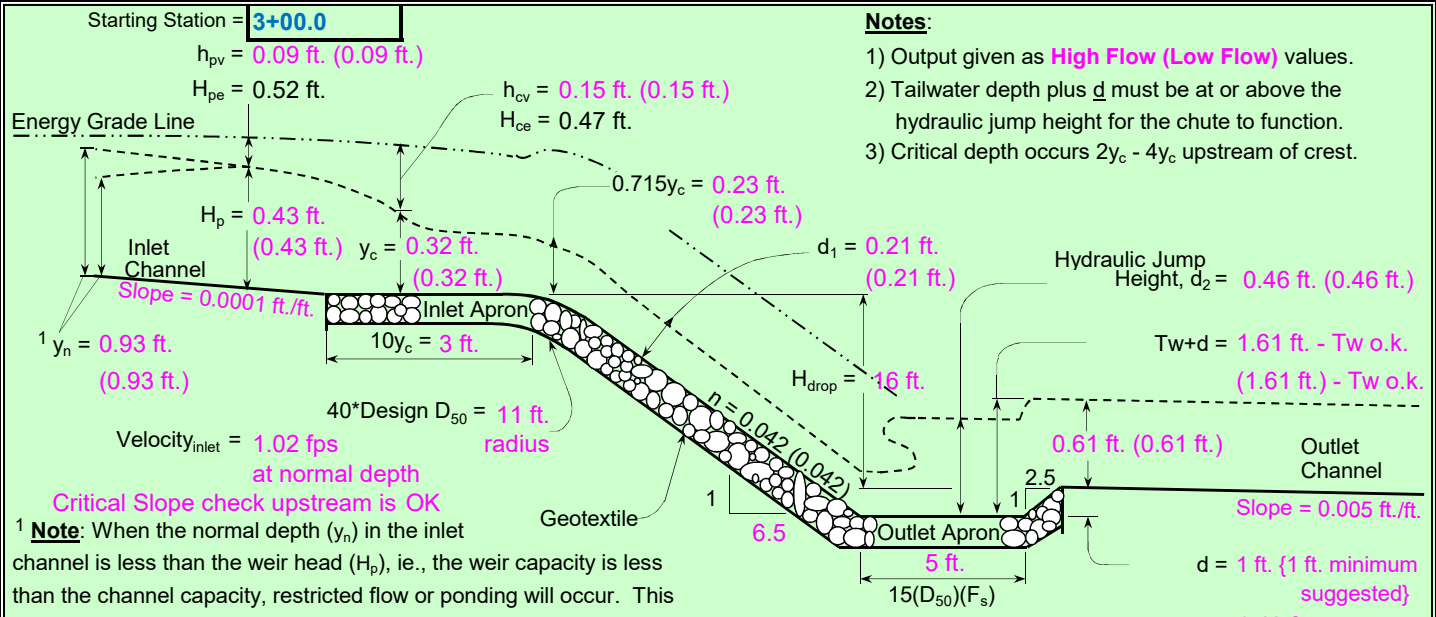
Q_{high} = 6.6 cfs High flow storm through chute → Tw (ft.) = Program
Q_{low} = 6.6 cfs Low flow storm through chute → Tw (ft.) = Program

Note: The total required capacity is routed through the chute (principal spillway) or in combination with an auxiliary spillway.

Input tailwater (Tw): 0.15 1.20

Profile and Cross Section (Output):

Starting Station = 3+00.0

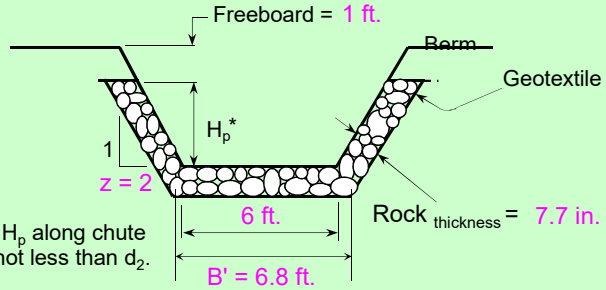


Notes:
1) Output given as **High Flow (Low Flow)** values.
2) Tailwater depth plus d must be at or above the hydraulic jump height for the chute to function.
3) Critical depth occurs 2y_c - 4y_c upstream of crest.

[1] **Note**: When the normal depth (y_n) in the inlet channel is less than the weir head (H_p), ie., the weir capacity is less than the channel capacity, restricted flow or ponding will occur. This reduces velocity and prevents erosion upstream of the inlet apron.

Profile Along Centerline of Chute

Typical Cross Section



* Use H_p along chute but not less than d_2.

	1.04 cfs/ft.	Equivalent unit discharge
SF =	1.20	Factor of safety (multiplier)
d_1 =	0.21 ft.	Normal depth in chute
n-value =	0.042	Manning's roughness coefficient
D_{50}(SF) =	3.8 in.	Minimum Design D_{50}*
2(D_{50})(SF) =	7.7 in.	Rock chute thickness
Tw + d =	1.61 ft.	Tailwater above outlet apron
d_2 =	0.46 ft.	Hydraulic jump height
*** The outlet	will	function adequately

High Flow Storm Information

Rock Chute Design Data

(Version WI-April-2005, Based on Design of Rock Chutes by Robinson, Rice, Kadavy, ASAE, 1998)
Revised for WisDOT 9/2010

Project: COL - Mod 12-13 RC4 **County:** Columbia
Designer: RJG **Checked by:** SJL
Date: August 28, 2023 **Date:** 08/28/23

Input Geometry:

Upstream Channel		Chute			Downstream Channel	
Bottom Width =	4.0 ft.	Bottom Width =	6.0 ft.		Bottom Width =	6.0 ft.
Side slopes =	4.0 (m:1)	Factor of safety =	1.20 (SF)	1.2 Min	Side slopes =	2.0 (m:1)
Mannings n value =	0.045	Side slopes =	2.0 (z:1) →	2.0:1 max.	Mannings n value =	0.045
Bed slope =	0.0288 ft./ft.	Bed slope =	0.2212 ft./ft →	3.0:1 max.	Bed slope =	0.0050 ft./ft.
Note: Use procedures 13-30-15 or 13-30-25 for upstream and downstream Mannings n		Freeboard =	1.0 ft. →			
		Outlet apron depth, d =	1.0 ft.		Base flow =	0.0 cfs

Flow and Elevation Data:

Apron elev. --- Inlet = 824.9 ft. ---- Outlet 817.6 ft. --- (H_{drop} = 6.3 ft.)

Degree of angularity = 1

Q_{high} = Runoff from design storm
Q_5 = Runoff from a 5-year,24-hour storm

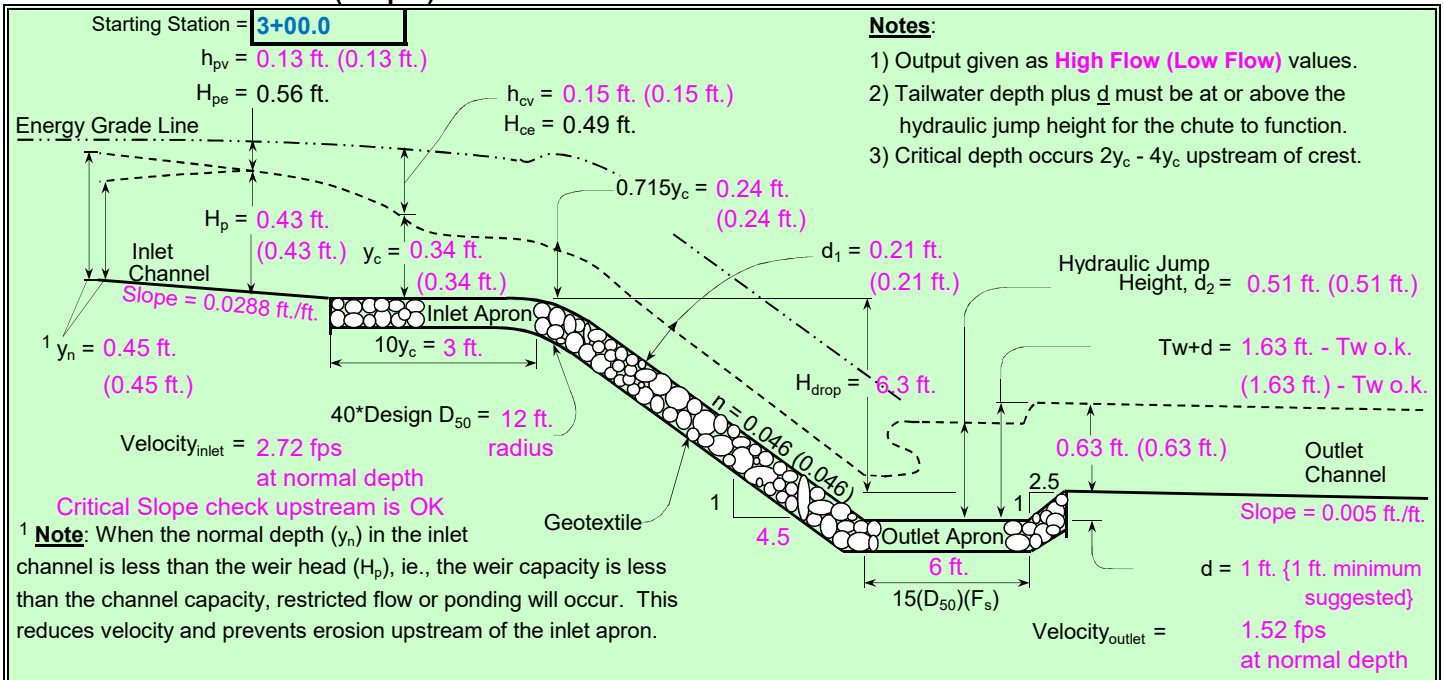
1 --> 50% angular, 50% rounded
2 --> 100 % rounded

Q_{high} = 7.0 cfs High flow storm through chute → Tw (ft.) = Program
Q_{low} = 7.0 cfs Low flow storm through chute → Tw (ft.) = Program

Note: The total required capacity is routed through the chute (principal spillway) or in combination with an auxiliary spillway.

Input tailwater (Tw): 0.22 1.20

Profile and Cross Section (Output):

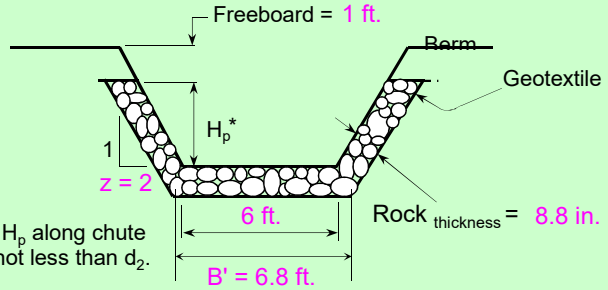


Notes:
1) Output given as **High Flow (Low Flow)** values.
2) Tailwater depth plus d must be at or above the hydraulic jump height for the chute to function.
3) Critical depth occurs 2y_c - 4y_c upstream of crest.

[1] **Note**: When the normal depth (y_n) in the inlet channel is less than the weir head (H_p), ie., the weir capacity is less than the channel capacity, restricted flow or ponding will occur. This reduces velocity and prevents erosion upstream of the inlet apron.

Profile Along Centerline of Chute

Typical Cross Section



* Use H_p along chute but not less than d_2.

	1.1 cfs/ft.	Equivalent unit discharge
SF =	1.20	Factor of safety (multiplier)
d_1 =	0.21 ft.	Normal depth in chute
n-value =	0.046	Manning's roughness coefficient
D_{50}(SF) =	4.4 in.	Minimum Design D_{50}*
2(D_{50})(SF) =	8.8 in.	Rock chute thickness
Tw + d =	1.63 ft.	Tailwater above outlet apron
d_2 =	0.51 ft.	Hydraulic jump height
*** The outlet	will	function adequately

High Flow Storm Information

Riprap Apron Sizing

SCS ENGINEERS

		Sheet No.	1 of 2
		Calc. No.	
		Rev. No.	2
Job No. 25222260.00	Job: Columbia Energy Center MOD 12-13	By: SJL	Date: 8/28/23
Client: WPL	Subject: Riprap Sizing at Culvert Outlet	Chk'd: RJG	Date: 8/28/23

Purpose:

To size the riprap apron dimensions at culvert C2, C3, C4, C5, C8, and C10 based on a 25-year, 24 hour storm event:

References:

1. "Energy Dissipators," Wisconsin Department of Transportation (WisDOT), Facilities Development Manual (FDM) 13-35-5.
2. HydroCAD Report: COL_Mod12-13_HydroCAD Report
3. "Rock Riprap Lined Channels," WisDOT FDM 13-30-25.
4. Culvert Sizing Calculation.
5. WisDOT FDM Chapter 13, Section 30 - Rock Riprap Lined Chutes

Approach:

Use the equations in Section 5.2 - Riprap Blanket of WisDOT FDM 13-35-5 (Energy Dissipators) to determine the average size of stone (d_{50}) and riprap apron length. Round up the calculated d_{50} to the nearest WisDOT standard riprap size.

Use WisDOT FDM 13-35 Attachment 5.2 to determine the width of the riprap apron for discharges to a flat area. For discharges to channels, extend riprap across the channel bottom and up the sides.

Assumptions:

Assume riprap apron thickness (T) is 2 * d_{50} to protect against washout and undercutting of the riprap.

Assume tailwater depth, TW = 0.40 * D_o

Assume max TW conditions for the riprap apron width.

Assume that when there are multiple culverts, the total discharge to the culverts is distributed evenly through each barrel.

Calculation:

From WisDOT Section 5.2 - Riprap Blanket:

$$d_{50}/D_o = 0.020\ (D_o/TW)\ (Q/D_o^{5/2})^{4/3}$$

$$L_{sp}/D_o = 1.7\ (Q/D_o^{5/2}) + 8$$

Or:

$$d_{50} = 0.02 \times (D_o/TW) \times (Q/D_o^{5/2})^{4/3} \times D_o$$

$$L_{sp} = (1.7\ (Q/D_o^{5/2}) + 8) \times D_o$$

where: D_o = Diameter or width of culvert (ft)

Q = Flow rate (cfs) (discharge rate through culvert, from Worst Case Condition HydroCAD Model (Reference #2))

TW = Tail water depth (ft)

d_{50} = Average size of stone (ft)

L_{sp} = Length of stone protection (Apron Length) (ft)

Location	Total Flow (Q, cfs)	Number of Pipes	D_o (ft)	Q (cfs)	TW (ft)	$d_{50\ calculated}$	$d_{50\ Design}$	L_{sp}
Culvert C2	10.95	2	2	5.5	0.80	0.10	0.18	19
Culvert C3	28.58	2	2.5	14.3	1.00	0.20	0.83	26
Culvert C4	34.14	2	2.5	17.1	1.00	0.26	0.83	27
Culvert C5	37.41	2	2.5	18.7	1.00	0.29	0.83	28
Culvert C8	0.96	1	1	1.0	0.40	0.05	0.18	10
Culvert 10	2.76	1	2	2.8	0.80	0.04	0.18	18

Results:

Below is a summary of the d_{50} , thickness (T), and configuration of the riprap apron. Also refer to WisDOT FDM Attachment 5.2 (Sheet 2) for details on apron layout. Use WisDOT Light Riprap at culvert discharge.

Location	d_{50} (in)*	T (in)	L_{sp} (ft)	W_{sp} (ft)	WisDOT Riprap sizes
Culvert C2	2.2	6	19	See Note 1	Select Crushed Material
Culvert C3	10.0	20	26	See Note 1	Light Riprap
Culvert C4	10.0	20	27	See Note 1	Light Riprap
Culvert C5	10.0	20	28	See Note 1	Light Riprap
Culvert C8	2.2	6	10	See Note 1	Select Crushed Material
Culvert 10	2.2	6	18	See Note 1	Select Crushed Material

1. For discharges to channels, place riprap along channel bottom and up side of channel.

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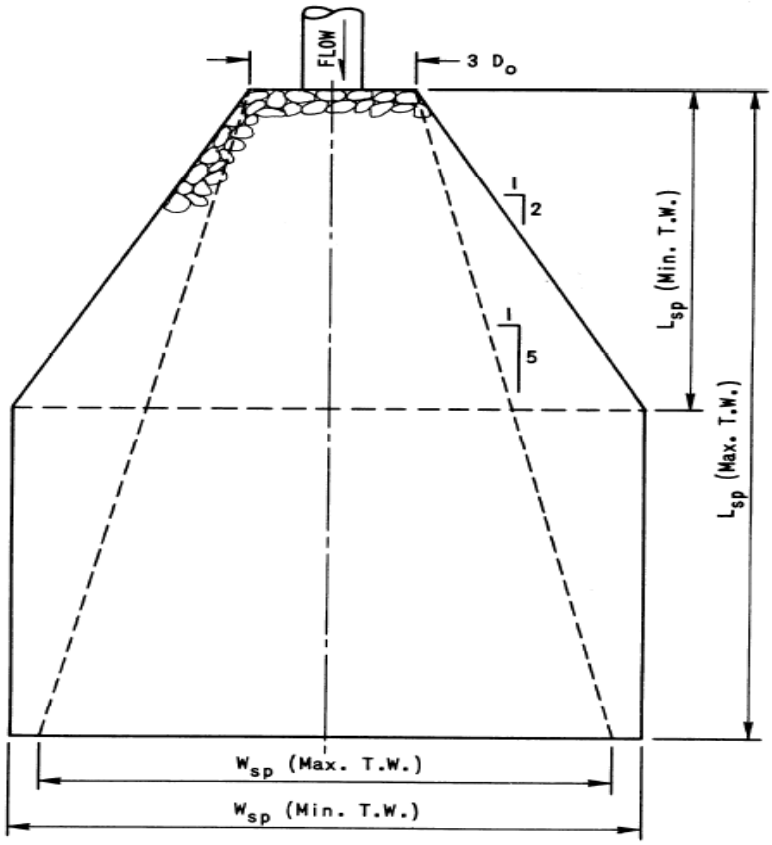
FDM 13-35 Attachment 5.2 Recommended Configuration of Riprap Blanket Subject to Maximum and Minimum Tail Waters



RECOMMENDED CONFIGURATION OF RIPRAP BLANKET SUBJECT TO MAXIMUM AND MINIMUM TAILWATERS

Source: Miscellaneous paper H-72-5, "Practical Guidance for Estimating and Controlling Erosion at Culvert Outlets", U.S. Army Engineer Waterways Experiment Station, May, 1972.

Table 25.1 Typical Particle Sizes of Native Sands at 75 Percent Passing (D_{75})

Riprap Type	D50 (inches)	D50 (feet)	Riprap Thickness (in)	Geotextile Type
Select Crushed Material	2.2	0.18	5	Type R
Light Riprap	10	0.83	12	Type R
Medium Riprap	12.5	1.04	18	Type HR
Heavy Riprap	16	1.33	24	Type HR
Extra-Heavy Riprap	20	1.67	30	Type HR

Source: Table 25.1 from WisDOT FDM.

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Appendix F

Closure Plan

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Closure Plan

Columbia Dry Ash Disposal Facility
Phase 1 Module 1
Phase 1 Module 2
Phase 1 Module 3
Phase 1 Module 4
Phase 1 Module 5
Phase 1 Module 6
Phase 2 Module 10
Phase 2 Module 11
Phase 2 Module 12
Phase 2 Module 13

Prepared for:

Wisconsin Power and Light Company
Columbia Energy Center
W8375 Murray Road
Pardeeville, Wisconsin 53954

SCS ENGINEERS

25222260.00 | September 1, 2023

2830 Dairy Drive
Madison, WI 53718-6751
608-224-2830

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2.0 Proposed Closure Plan Narrative 2
3.0 Final Cover System and Performance 3
4.0 Maximum Inventory of CCR 7
5.0 Largest Area of CCR Unit Requiring Final Cover 8
6.0 Schedule of Sequential Closure Activities 8
7.0 Completion of Closure Activities 8
8.0 Certification 9
9.0 Recordkeeping and Reporting 9

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Figure 1. Site Location Map
Figure 2. Closure Plan
Figure 3. Final Cover System

Appendices

Appendix A Stability Calculations
A1 Existing Final Cover Stability Calculations
A2 Future Module 1 Final Cover Stability Calculations
A3 Future Final Cover Stability Calculations
Appendix B Schedule

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PE CERTIFICATION

I, Phillip Gearing, hereby certify that I am a licensed professional engineer in the State of Wisconsin in accordance with the requirements of ch. A–E 4, Wis. Adm. Code; that this document has been prepared in accordance with the Rules of Professional Conduct in ch. A–E 8, Wis. Adm. Code; and that, to the best of my knowledge, all information contained in this document is correct and the document was prepared in compliance with all applicable requirements in chs. NR 500 to 538, Wis. Adm. Code.

Specifically,

- This Closure Plan was prepared by me or under my direct supervision and meets the requirements of 40 CFR 257.102(b) and NR 514.07(10)(c)

(signature) September 1, 2023 (date)

Phillip E. Gearing
(printed or typed name)

License number E-45115

My license renewal date is July 31, 2024.

Pages or sheets covered by this seal:

ALL

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1.0 INTRODUCTION AND PROJECT SUMMARY

On behalf of Wisconsin Power and Light Company (WPL), SCS Engineers (SCS) has prepared this Closure Plan for the Columbia (COL) Dry Ash Disposal Facility Phase 1, Modules 1 through 6 and Phase 2, Modules 10 through 13 as required by 40 Code of Federal Regulations (CFR) 257.102(b) and Wisconsin Administrative Code NR 514.07(10)(c), as stated below.

40 CFR 257.102(b) *"Written closure plan – (1) Content of the plan. The owner or operator of a CCR unit must prepare a written closure plan that describes the steps necessary to close the CCR unit at any point during the active life of the CCR unit consistent with recognized and generally accepted good engineering practices. The written closure plan must include, at a minimum, the information specified in paragraphs (b)(1)(i) through (vi) of this section."*

NR 517.07(10)(c) *"A written closure plan in accordance with the requirements under s. NR 514.06 (10) and all of the following: (1) A narrative description of how the CCR landfill will be closed, including a description of the steps necessary to close the CCR unit at any point during the active life of the CCR unit, consistent with recognized and generally accepted good engineering practices."*

The COL facility includes an active coal combustion residual (CCR) landfill, which currently consists of the following modules, located in Phase 1 and Phase 2 of the facility.

- **Phase 1, Module 1** – This module has received final cover over outer sideslope areas that will no longer receive additional CCR; intermediate cover has been placed over remaining areas. The final cover placed complies with the CCR Rule.
- **Phase 1, Module 2** – This module has received intermediate cover over a majority of the in-place CCR.
- **Phase 1, Module 3** – This module has received intermediate cover over a majority of the in-place CCR.
- **Phase 1, Module 4** – This module is currently being filled and also has received intermediate cover over areas of the in-place CCR.
- **Phase 1, Module 5** – This module is currently being filled and has received intermediate cover over areas of the in-place CCR.
- **Phase 1, Module 6** – This module is currently being filled and has received intermediate cover over areas of the in-place CCR.
- **Phase 2, Module 10** – This module is currently being filled.
- **Phase 2, Module 11** – This module is currently being filled.
- **Phase 2, Module 12** – This module is currently proposed for approval. The module will be constructed and filled following approval.
- **Phase 2, Module 13** – This module is currently proposed for approval. The module will be constructed and filled following approval.

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Phase 1, Modules 1 through 3 were previously described as separate existing CCR landfills although they are contiguous and are managed as a single landfill by the facility and by the Wisconsin Department of Natural Resources (WDNR, or "Department"). WPL has clarified in the operating record for the Columbia facility that Modules 1 Through 3 are one existing CCR landfill as defined in 40 CFR 257.53 of the federal CCR Rule. Phase 1, Modules 4 through 6 and Modules 10 and 11 are considered to be a new CCR landfill that initiated construction after October 19, 2015, and is therefore managed as a separate CCR unit under the CCR Rule even though they are contiguous to the existing CCR landfill (Modules 1 through 3). Phase 2, Modules 12 and 13 will be included in the new CCR landfill, if approved and constructed. Construction of additional modules beyond Modules 12 and 13 is not currently planned prior to retirement of the Columbia Energy Center, which is currently scheduled to occur no later than June 1, 2026.

Figure 1 shows the site location. **Figure 2** shows the closure areas. A detail of the final cover system is shown on **Figure 3**.

2.0 PROPOSED CLOSURE PLAN NARRATIVE

40 CFR 257.102(b)(1)(i) *"A narrative description of how the CCR unit will be closed in accordance with this section."*

NR 517.07(10)(c)(1) *"A narrative description of how the CCR landfill will be closed, including a description of the steps necessary to close the CCR unit at any point during the active life of the CCR unit, consistent with recognized and generally accepted good engineering practices."*

When CCR placement is completed in the CCR unit, or if early closure is required, the unit will be closed by covering the CCR with the final cover system described in **Section 3.0**. Prior to final cover system construction, the CCR surfaces will be graded and compacted to establish a firm subgrade for final cover construction. In addition, all required notifications will be submitted to the WDNR, and WPL will obtain all additional necessary permits (for example, general permit coverage for construction storm water management). WPL may also engage in procurement activities to secure services for installing the final cover system.

The timing for completion of CCR placement in the units that are addressed with this closure plan will depend on CCR generation and disposal rates. Future CCR unit development will also impact the timing of closure. Each of the existing CCR units is designed to receive additional CCR once adjacent units are constructed and overlay airspace is available for filling. Based on the current CCR units alone, if early closure of all units is required, final cover will be placed in the active landfill areas shown on **Figure 2**. A closure schedule is discussed in **Section 6.0** and presented in **Appendix B**.

The initiation of closure activities will commence no later than 30 days after the known final receipt of CCR as required by 40 CFR 257.102(e)(1) and NR 506.083(2)(a), or in accordance with 40 CFR 257.102(e)(2) and NR 506.083(2)(b).

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3.0 FINAL COVER SYSTEM AND PERFORMANCE

40 CFR 257.102(b)(1)(iii) *"If closure of the CCR unit will be accomplished by leaving CCR in place, a description of the final cover system, designed in accordance with paragraph (d) of this section, and the methods and procedures to be used to install the final cover. The closure plan must also discuss how the final cover system will achieve the performance standards specified in paragraph (d) of this section."*

40 CFR 257.102(d) *"Closure performance standard when leaving CCR in place."*

40 CFR 257.102(d)(1) *"The owner or operator of a CCR unit must ensure that, at a minimum, the CCR unit is closed in a manner that will:"*

> 40 CFR 257.102(d)(1)(i) "*Control, minimize or eliminate, to the maximum extent feasible, post-closure infiltration of liquids into the waste and releases of CCR, leachate, or contaminated run-off to the ground or surface waters or to the atmosphere;"*

NR 514.07(10)(c)(3) *"A demonstration, including a narrative discussion, of how final closure will meet the performance standards under s. NR 506.083(6)."*

NR 506.083(6) *"Closure performance standards when leaving CCR in place. An owner or operator of a CCR landfill shall ensure that, at a minimum the CCR landfill is closed in a manner that will achieve all of the following performance standards:"*

> NR 506.083(6)(a) *"Control, minimization or elimination, to the maximum extent feasible, of post-closure infiltration of liquids into the waste and of releases of CCR, leachate, or contaminated run-off to the ground or surface waters or to the atmosphere."*

The final cover system design will minimize or eliminate infiltration, as further described below.

> 40 CFR 257.102(d)(1)(ii) *"Preclude the probability of future impoundment of water, sediment, or slurry;"*
>
> NR 506.083(6)(b) *"Prevention of the impoundment of water, sediment or slurry."*

The final cover system will meet these criteria, as further described below.

> 40 CFR 257.102(d)(1)(iii) "*Include measures that provide for major slope stability to prevent the sloughing or movement of the final cover system during the closure and post-closure care period;"*
>
> NR 506.083(6)(c) *"Slope stability to prevent the sloughing or movement of the final cover system during the closure and long-term care period.*

The final cover system is designed to provide slope stability and to prevent sloughing or movement during the closure and post-closure care period. Stability of the final cover system was assessed as part of the WDNR landfill permitting process and is further addressed below.

> 40 CFR 257.102(d)(1)(iv) "*Minimize the need for further maintenance of the CCR unit; and"*
>
> NR 506.083(6)(d) *"Minimization of the need for long-term maintenance of the CCR landfill."*

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Maintenance of the final cover will be minimized by the establishment of vegetative cover and the erosion control systems, which are further described below.

> 40 CFR 257.102(d)(1)(v) *"Be completed in the shortest amount of time consistent with recognized and generally accepted good engineering practices."*
>
> NR 506.083(6)(e) *"Complete closure in the shortest amount of time consistent with recognized and generally accepted good engineering practices."*

All closure activities for the CCR units will be completed within 6 months, as stated in **Section 7.0** below.

40 CFR 257.102(d)(2) *"Drainage and stabilization of CCR surface impoundments."*

This does not apply to the COL CCR landfill units.

40 CFR 257.102(d)(3) *"Final cover system"*

NR 517.07(10)(c)(2) *"A description of the final cover system, designed in accordance with s. NR 504.07, and the methods and procedures to be used to install the final cover."*

The existing final cover system (see **Figure 3** for details) in place on part of Module 1 is as follows from the bottom up:

- 3-inch grading layer
- Geosynthetic clay liner (GCL)
- 40-millimeters (mil) linear low-density polyethylene (LLDPE) geomembrane
- 12 inches of drainage material
- 12 inches of rooting zone
- 6 inches of topsoil

Final cover designs have been developed to meet the requirements of NR 504.07 and are discussed in detail below.

The final cover system below will be extended to cover the remaining portion of Module 1 (see **Figure 3** for details). The future Module 1 final cover system consists of the following from the bottom up:

- 3-inch-thick grading layer
- 12-inch-thick capillary break/barrier soil
- 12-inch-thick clay barrier soil
- GCL
- 40-mil polyethylene geomembrane
- 12-inch-thick drainage layer (sand)
- 18-inch-thick rooting zone layer
- 6-inch-thick topsoil layer

These final cover systems meet and exceed the minimum requirements of 40 CFR 257.102(d)(3)(i)(A) through (D) and NR 504.12(4)(b)(1) through (4) as follows:

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- Per 257.102(d)(3)(i)(A) and NR 504.12(4)(b)(1), the permeability of the final cover system is less than or equal to the permeability of the bottom liner system and is less than $1x10^{-5}$ centimeters per second (cm/sec) required by the rule. The COL cover system contains a GCL with a permeability of $5x10^{-9}$ cm/sec. The geomembrane above the GCL makes the cover system even less permeable.

The bottom liner system for the existing CCR landfill in Module 1 is as follows:

- Phase 1, Module 1 South:
  - GCL.
  - 40-mil high density polyethylene (HDPE) geomembrane.
  - The layers of the liner system are less than the cover system layers; therefore, infiltration will be more than the cover system.

- Phase 1, Module 1 North:
  - 3 feet of compacted ash.
  - The liner here does not include a geomembrane, and therefore the infiltration through the cover system will be less than this base liner.

A final cover system will be installed in future remaining areas of final cover north of Module 1 (Phase 1, Modules 2, 3, 4, 5, and 6 and Phase 2, Modules 10, 11, 12, and 13) and consists of the following components, from bottom to top:

- 3-inch-thick grading layer
- 12-inch-thick capillary break/barrier soil
- 12-inch-thick clay barrier soil
- GCL
- 40-mil polyethylene geomembrane
- Geocomposite drainage layer
- 30-inch-thick rooting zone layer
- 6-inch-thick topsoil layer

This final cover meets and exceeds the minimum requirements of 40 CFR 257.102(d)(3)(i)(A) through (D) and NR 504.12(4)(b)(1) through (4) as follows:

- Per 257.102(d)(3)(ii)(A), 257.102(d)(3)(i)(A), and NR 504.12(4)(b)(1), the permeability of the final cover system is less than or equal to the permeability of the bottom liner system and is less than $1x10^{-5}$ centimeters per second (cm/sec) required by the rule. The COL cover system contains a GCL with a permeability of $5x10^{-9}$ cm/sec. The geomembrane above the GCL makes the cover system even less permeable.

The bottom liner system for the existing CCR landfill is as follows:

- Phase 1, Modules 2 and 3:
  - 2 feet of compacted clay
  - GCL
  - 60-mil HDPE geomembrane

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The bottom liner system for the new CCR landfill is as follows:

- Phase 1, Modules 4, 5, and 6 and Phase 2, Modules 10, 11, 12, and 13:
  - 2 feet of compacted clay
  - GCL
  - 60-mil HDPE geomembrane

Based on a comparison of the design slopes and drainage system components in the liner system and final cover system (described in greater detail below), the final cover system is at least equivalent in permeability when compared to the liner system in Phase 1, Modules 1, 2, 3, 4, 5, and 6 and Phase 2, Modules 10, 11, 12, and 13.

- Per 257.102(d)(3)(i)(B), the existing final cover system includes 2.5 feet of soil, which is greater than the 18 inches of earthen material required to minimize infiltration.

- Per 257.102(d)(3)(i)(B), the future Module 1 final cover system includes 5.0 feet of soil, which is greater than the 18 inches of earthen material required to minimize infiltration.

- Per 257.102(d)(3)(ii)(A) and 257.102(d)(3)(i)(B), the future final cover system north of Module 1 includes 5.0 feet of soil, which is greater than the 18 inches of earthen material required to minimize infiltration.

- Per NR 504.12(4)(b)(2), the proposed final cover contains a GCL infiltration layer. Water infiltrating the final cover will be contained in the drainage layers (sand and geocomposite), which will limit infiltration further through the final cover system. A soil barrier layer has been added below the final cover GCL.

- Per 257.102(d)(3)(i)(C) and NR 504.12(4)(b)(3), erosion of the existing final cover system is minimized with a vegetative support layer consisting of 12 inches of uncompacted rooting zone material and 6 inches of topsoil. This provides more than the required 6-inch thickness for plant growth.

- Per 257.102(d)(3)(i)(C) and NR 504.12(4)(b)(3), erosion of the future Module 1 final cover system is minimized with a vegetative support layer consisting of 18 inches of uncompacted rooting zone material and 6 inches of topsoil. This provides more than the required 6-inch thickness for plant growth.

- Per 257.102(d)(3)(ii)(B), 257.102(d)(3)(i)(C), and NR 504.12(4)(b)(3), erosion of the final cover system (north of Module 1) is minimized with a vegetative support layer consisting of 30 inches of uncompacted rooting zone material and 6 inches of topsoil. This provides more than the required 6-inch thickness for plant growth.

Also, the existing final cover system, the future Module 1 final cover system, and the final cover system north of Module 1 limits infiltration while promoting surface water run-off in a controlled manner to minimize erosion and promote stability. The surface layer of 18 inches (existing), 24 inches (future Module 1), or 36 inches (north of Module 1) of soil supports vegetation that assists with erosion control. Water that infiltrates will be collected by the 12-inch drainage layer (existing and future Module 1) or geocomposite drainage layer (north of Module 1) and will be routed to the perimeter drainage system.

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In addition, the surface has intermediate drainage swales to reduce the flow lengths down the final cover slope, also aiding in erosion control. Where needed, the intermediate drainage swales are connected to downslope channels to control storm water runoff and prevent erosion of the final cover.

- Per 257.102(d)(3)(i)(D) and NR 504.12(4)(b)(4), the design of the existing final cover system minimizes disruptions to the final cover system. Stability of the final cover system was assessed as part of the WDNR landfill permitting process. The stability calculations are included in **Appendix A1**.

- Per 257.102(d)(3)(i)(D) and NR 504.12(4)(b)(4), the design of the future Module 1 final cover system minimizes disruptions to the final cover system. Stability of the final cover system was assessed as part of the WDNR landfill permitting process. The stability calculations are included in **Appendix A2**.

- Per 257.102(d)(3)(ii)(C) and NR 504.12(4)(b)(4), the design of the final cover system north of Module 1 minimizes disruptions to the final cover system. Stability of the final cover system was assessed as part of the WDNR landfill permitting process. The stability calculations are included in **Appendix A3**.

The design of the final cover system accommodates settling and subsidence of the CCR fill below the cover. The CCR at COL is placed dry and is compacted in place. CCR continues to consolidate and gain strength as filling progresses prior to final cover placement. The final cover system is designed with a maximum slope of 25 percent (4 horizontal to 1 vertical). Because the final cover has a relatively large positive slope and the CCR has been gaining strength over time, the final cover is expected to easily accommodate the remaining relatively minor settlement potential of the CCR fill when fill placement ends and the landfill is closed.

Construction of each of the final cover systems will be performed per methods and procedures described in NR 504, NR 516, and the site-specific Construction Quality Assurance / Quality Control Plan. All final cover materials will be tested to confirm they meet the code requirements and project documents. Barrier soil, rooting zone, and topsoil layers will be checked for thickness. All areas will be restored after final cover is placed. Vegetation will be monitored and maintained. Construction activities will be documented by a licensed engineer.

4.0 MAXIMUM INVENTORY OF CCR

40 CFR 257.102(b)(1)(iv) *"An estimate of the maximum inventory of CCR ever on-site over the active life of the CCR unit."*

NR 514.07(10)(c)(4) *"An estimate of the maximum volume in cubic yards of CCR that will be disposed on−site over the active life of the CCR landfill."*

The following table reflects the estimated maximum volume of CCR disposed on-site at the COL facility.

Area	Maximum Capacity (cy)
Phase 1, Modules 1-6, Phase 2, Modules 10-13	3,630,075

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The estimated maximum inventory of CCR ever on-site over the active life of the CCR landfill units is based on the design capacity of the landfill. The maximum design capacity was submitted in the WDNR 2023 Plan of Operation Update, Addendum 2.

5.0 LARGEST AREA OF CCR UNIT REQUIRING FINAL COVER

40 CFR 257.102(b)(1)(v) *"An estimate of the largest area of the CCR unit ever requiring a final cover as required by paragraph (d) of this section at any time during the CCR unit's active life."*

NR 514.07(10)(c)(5) *"An estimate of the largest area of the CCR landfill that will require a final cover at any time during the CCR landfill's active life."*

The largest area of each CCR unit requiring final cover is the open area shown on **Figure 2**, with areas as follows:

Areas Requiring Final Cover (acres)	
Phase 1, Modules 1- 3	10.5
Phase 1, Modules 4-6	12.0
Phase 2, Modules 10-11	6.9
Phase 2, Modules 12-13	7.1
Total	**36.5**

6.0 SCHEDULE OF SEQUENTIAL CLOSURE ACTIVITIES

40 CFR 257.102(b)(1)(vi) *"A schedule for completing all activities necessary to satisfy the closure criteria in this section, including an estimate of the year in which all closure activities for the CCR unit will be completed."*

NR 514.07(10)(c)(6) *"A schedule for completion of all closure activities, including an estimate of the year in which all closure activities for the CCR landfill will be completed."*

CCR placement is anticipated to permanently end at this facility following retirement of the Columbia Generating Station by June 2026, as announced by WPL. Some CCR disposal activity may be necessary following retirement of Columbia as part of decommissioning efforts (for example, cleaning of ducts and other equipment that may contain CCR following retirement). Closure activities are expected to be complete by the end of 2027. The potential schedule for closure of the existing CCR modules was divided into two phases and is provided in **Appendix B**.

7.0 COMPLETION OF CLOSURE ACTIVITIES

40 CFR 257.102(f)(1) *"Except as provided for in paragraph (f)(2) of this section, the owner or operator must complete closure of the CCR unit:*

(i) For existing and new CCR landfills and any lateral expansion of a CCR landfill, within six months of commencing closure activities."

NR 506.083(3)(a) *"The owner or operator shall complete closure of the CCR landfill within 6 months of commencing closure activities."*

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As shown on the enclosed schedule, closure of each CCR unit will be completed within 6 months of commencing closure activities.

40 CFR 257.102(f)(3) *"Upon completion, the owner or operator of the CCR unit must obtain a certification from a qualified professional engineer verifying that closure has been completed in accordance with the closure plan specified in paragraph (b) of this section and the requirements of this section."*

NR 506.083(1)(b) *"Within 30 days following completion of closure of a CCR landfill under sub. (3), the owner or operator shall prepare and submit a notification of closure to the department and place a copy in the facility's operating record. The notification shall include the certification required under s. NR 516.04(3)(d)."*

A qualified licensed engineer will oversee the final cover construction. The engineer will verify final cover materials and methods and oversee material testing. At the end of construction, the engineer will provide a report summarizing and documenting construction and will certify compliance with the requirements.

8.0 CERTIFICATION

40 CFR 257.102(b)(4) "*The owner or operator of the CCR unit must obtain a written certification from a qualified professional engineer that the initial and any amendment of the written closure plan meets the requirement of this section."*

NR 500.05 *"Unless otherwise specified, all submittals for review and approval of any initial site report, feasibility report, plan of operation site investigation report, remedial action options report, construction documentation report, or closure plan, or any modifications to those plans, shall include all of the following:*

(4) CERTIFICATION. (a) The reports and plan sheets shall be under the seal of a licensed professional engineer."

Phillip Gearing, PE, a licensed professional engineer in the State of Wisconsin has overseen the preparation of this Closure Plan. A certification statement is provided on **page iii** of this plan.

40 CFR 257.102(d)(2)(iii) *"The owner or operator of the CCR unit must obtain a written certification from a qualified professional engineer that the design of the final cover system meets the requirement of this section."*

Phillip Gearing, PE, a licensed professional engineer in the State of Wisconsin has overseen the design of the final cover system and certifies that the design meets the requirements of 40 CFR 257.102(d). The certification statement is provided on **page iii** of this plan.

9.0 RECORDKEEPING AND REPORTING

40 CFR 257.102(b)(vi)(2)(iii) "*The owner or operator has completed the written closure plan when the plan including the certification required by paragraph (b)(4) of this section, has been placed in the facility's operating record as required by Section 257.105(i)(4)."*

NR 506.17(2)(e) *"The written operating record shall contain the plan of operation, plan modifications, construction documentation, department approvals, annual reports, inspection*

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records, monitoring and corrective action records, notifications to the department, and records of public comments received during any public comment period."

The Closure Plan will be placed in the facility's operating record and on Alliant Energy's CCR Rule Compliance Data and Information website.

Amendments to the written Closure Plan will be done when a new module is constructed, when there is a change in the operation of the CCR unit that affects the plan, or when unanticipated events warrant revision to the written Closure Plan as required by 40 CFR 257.102(b)(3) and NR 514.07(10)(c)(7).

WPL will provide notification as follows:

- Intent to initiate closure
- Closure completion
- Availability of the written Closure Plan and any amendments

All notifications will be placed in the facility's operating record and on the website per 40 CFR 257.105(i), 257.106(i), 257.107(i), and NR 506.17(2).

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Figures

1 Site Location Map
2 Closure Plan
3 Final Cover System

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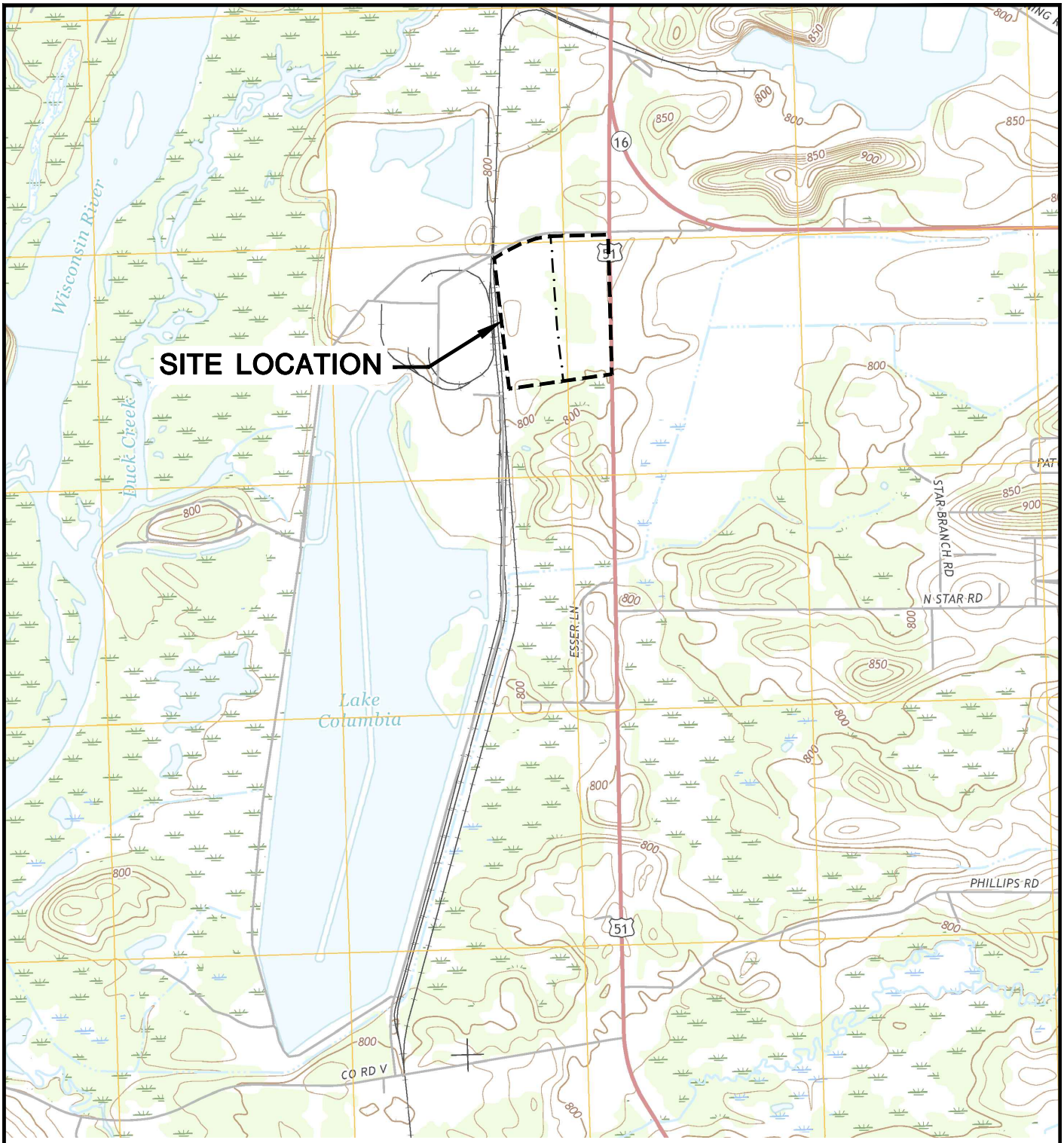

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POYNETTE QUADRANGLE
WISCONSIN–COLUMBIA CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)
2016
SCALE: 1" = 2,000'

CLIENT	WISCONSIN POWER AND LIGHT COLUMBIA ENERGY CENTER W8375 MURRAY ROAD PARDEEVILLE, WISCONSIN 53954	SITE	CLOSURE PLAN COLUMBIA DRY ASH DISPOSAL FACILITY TOWN OF PACIFIC, WISCONSIN

SITE LOCATION MAP

PROJECT NO.	25222260.00	DRAWN BY:	AHB
DRAWN:	08/09/2016	CHECKED BY:	RJG
REVISED:	12/28/2022	APPROVED BY:	PEG 01/31/23

ENGINEER

SCS ENGINEERS
2830 DAIRY DRIVE MADISON, WI 53718-6751
PHONE: (608) 224-2830

FIGURE 1

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09/28/2023 - Classification: Internal - ECRM13153872

LEGEND

- ASH DISPOSAL FACILITY LIMITS
- APPROVED LIMITS OF ASH FILL
- PHASE/MODULE LIMIT
- 810 EXISTING GRADE (5' CONTOUR)
- EXISTING GRADE (1' CONTOUR)
- PAVED ROAD
- UNPAVED ROAD
- RAILROAD TRACKS
- VEGETATION
- FENCE
- SWALE
- EDGE OF WATER
- APPROXIMATE LIMITS OF EXISTING LEACHATE/SURFACE WATER POND LINER
- CULVERT
- TRANSMISSION TOWER
- WATER SUPPLY WELL
- STAFF GAUGE
- WATER TABLE WELL
- PIEZOMETER
- SURFACE WATER SAMPLE LOCATION
- LYSIMETER
- ABANDONED WATER TABLE WELL
- ABANDONED PIEZOMETER
- BENCHMARK
- PROPOSED FINAL GRADE (2' CONTOUR)
- 820 PROPOSED FINAL GRADE (10' CONTOUR)
- ACTIVE LANDFILL AREA
- PROPOSED DIVERSION BERM
- PROPOSED DOWNSLOPE FLUME
- CLOSED AREA
- AREA TO BE CLOSED WITH FINAL COVER (SAND DRAINAGE LAYER)
- AREA TO BE CLOSED WITH FINAL COVER (GEOCOMPOSITE DRAINAGE LAYER)
- AREA OF LEACHATE/SURFACE WATER POND TO BE ABANDONED

NOTES:

1. BASE MAP CREATED FROM AERIAL SURVEY BY KBM, FLOWN DECEMBER 1, 2014, AND GROUND SURVEYS BY SCS ENGINEERS IN MAY 2019, DECEMBER 2020, NOVEMBER 2021, AND DECEMBER 2021, AND BY DRONE SURVEYS BY AMES IN NOVEMBER 2022, JANUARY 2023, AND JUNE 2023.
2. MONITORING WELL LOCATIONS AND ELEVATIONS SURVEYED BY WISCONSIN POWER AND LIGHT, INC. IN DECEMBER 1994, NOVEMBER 1996, APRIL 2003, AUGUST 2012, AND JANUARY 2016, AND BY SCS ENGINEERS IN MAY 2019.

N

200 0 200

SCALE: 1" = 200'

COAL PILE
WPDES POND
CLOSED LANDFILL
PHASE 1
MODULE 1
MODULE 2
MODULE 3
MODULE 4
MODULE 5
MODULE 6
PHASE 2
MODULE 10
MODULE 11
FUTURE MODULE 12
FUTURE MODULE 13
AREA TO BE GRADED TO DRAIN AFTER CLOSURE
PLANT ENTRANCE ROAD
C. M. ST. P. & P. RR.
U.S.H. 51
MW-311
MW-83
SG-4
MW-33AR
MW-33B
MW-34A
MW-34B
MW-88B
MW-88A
MW-85B
MW-302
MW-5R
LS-1
MW-310
MW-309
MW-92B
MW-92A
LS-3R
MW-91AR
MW-91B
MW-37B
MW-37A
MW-301
MW-312
MW-93B
MW-93A
MW-86
MW-84A
MW-84B
MW-17

CLOSURE PLAN

CLOSURE PLAN
COLUMBIA DRY ASH DISPOSAL FACILITY
TOWN OF PACIFIC, WISCONSIN

SITE

WISCONSIN POWER AND LIGHT
COLUMBIA ENERGY CENTER
W8375 MURRAY ROAD
PARDEEVILLE, WISCONSIN 53954

CLIENT

FIGURE 2

ENGINEER

SCS ENGINEERS
2830 DAIRY DRIVE MADISON, WI 53718-6751
PHONE: (608) 224-2830

PROJECT NO.	25222260.00
DRAWN:	11/30/2021
REVISED:	09/01/2023
DRAWN BY:	KP/MJT
CHECKED BY:	PEG
APPROVED BY:	PEG 09/01/23

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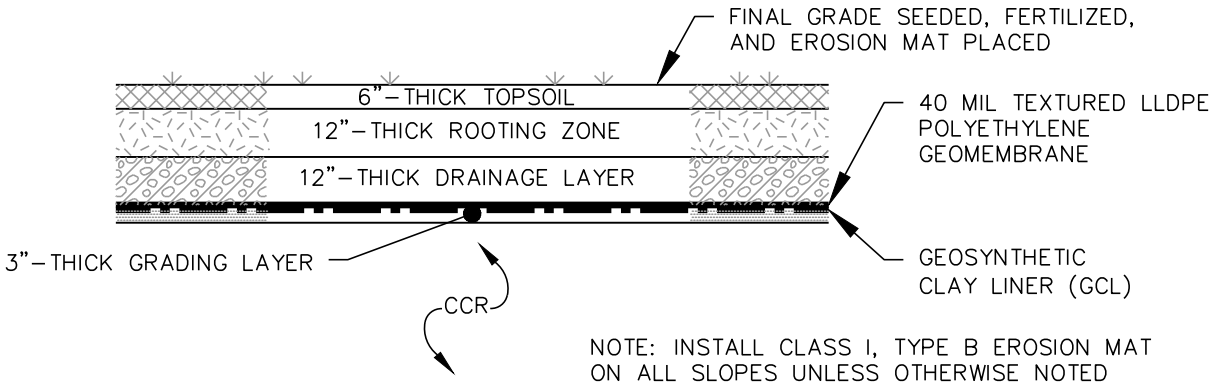
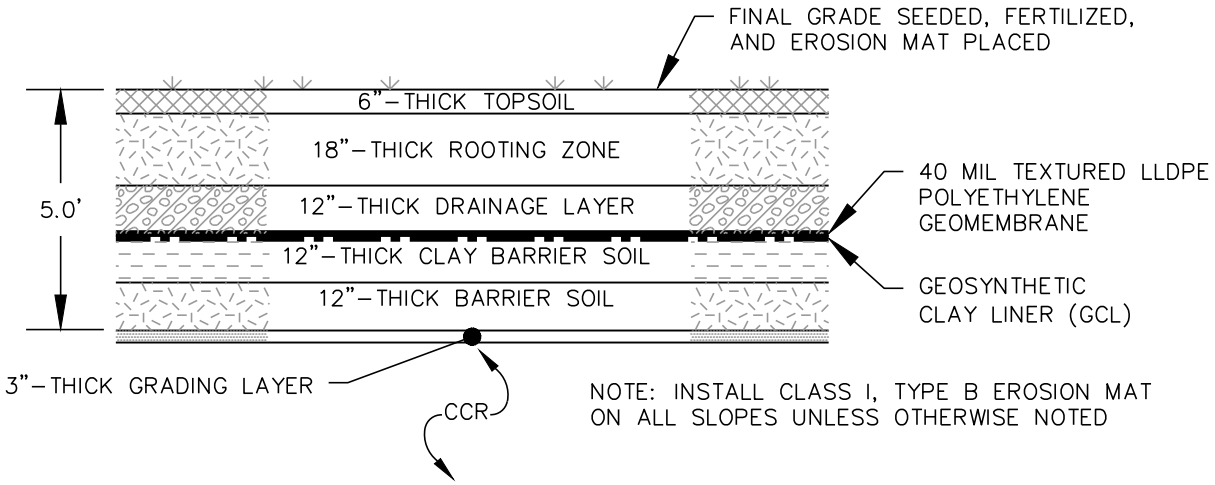


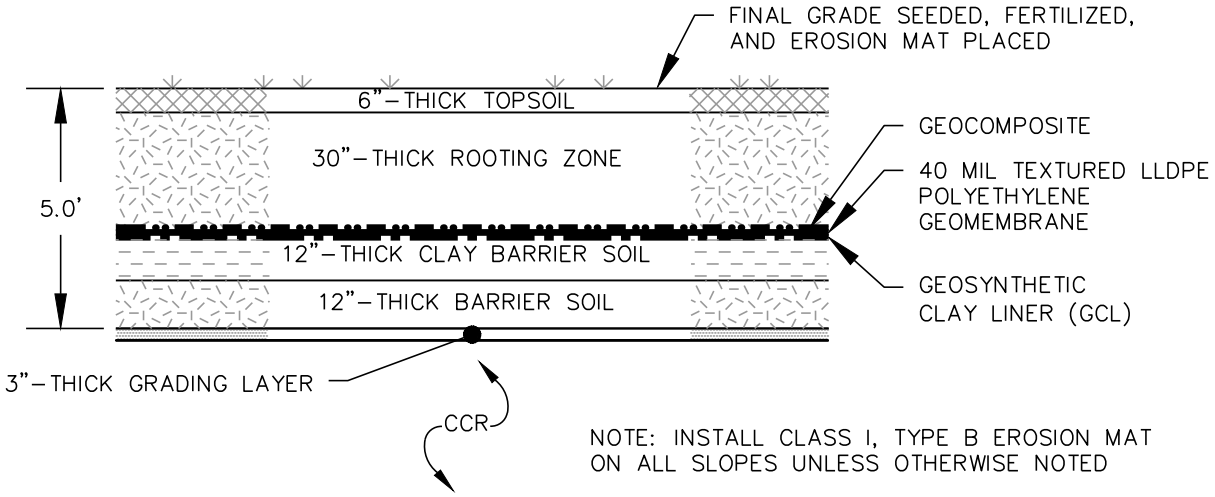
EXISTING FINAL COVER SYSTEM

SCALE: 1" = 4'



FINAL COVER SYSTEM (SAND DRAINAGE LAYER)

SCALE: 1" = 4'



FINAL COVER SYSTEM (GEOCOMPOSITE DRAINAGE LAYER)

SCALE: 1" = 4'

CLIENT	WISCONSIN POWER AND LIGHT COLUMBIA ENERGY CENTER W8375 MURRAY ROAD PARDEEVILLE, WISCONSIN 53954	SITE	CLOSURE PLAN COLUMBIA DRY ASH DISPOSAL FACILITY TOWN OF PACIFIC, WISCONSIN
			FINAL COVER SYSTEM

PROJECT NO.	25222260.00	DRAWN BY:	KP/MJT	ENGINEER	FIGURE
DRAWN:	08/17/2016	CHECKED BY:	PEG	SCS ENGINEERS 2830 DAIRY DRIVE MADISON, WI 53718-6751 PHONE: (608) 224-2830	3
REVISED:	08/18/2023	APPROVED BY:	PEG 09/01/2023		

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09/28/2023 - Classification: Internal - ECRM13153872

Appendix A

Stability Calculations

09/28/2023 - Classification: Internal - ECRM13153872

Appendix A1

Existing Final Cover Stability Calculations

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CIVIL & ENVIRONMENTAL ENGINEERING

Sheet No. 1			
Calc. No.			
Rev. No.			
Job No. 4071	Job: Columbia Ash Generation Landfill	By: PEG	Date 9/23/10
Client: Alliant	Subject: Liner Side Slope Drainage Layer Stability	Chk'd: DLN	Date 9/24/10

EVALUATION:

Evaluate the Phase 1 landfill liner side slope drainage layer for static veneer slope stability.

The side slope on the modules base runs at a 3:1 slope for an approximate maximum of 80 feet.

The following calculations evaluate the static veneer slope stability of the 3:1 slope.

REFERENCES:

1.) Koerner, Robert M. & Te-Yang Soong, Analysis and Design of Veneer Cover Soils, Geosynthetic Research Institute.

2.) U.S. Department of Transportation - Federal Highway Administration Recycled Materials, Coal Bottom Ash User's Guide

EQUATIONS:

$FS = (-b+(b^2-4*a*c)^{1/2})/(2*a)$

$a = (W_A-N_A*\cos\beta)*\cos\beta$

$b = -((W_A-N_A*\cos\beta)*\sin\beta*\tan\phi+(N_A*\tan\delta+C_a)*\sin\beta*\cos\beta+(C+W_P*\tan\phi)*\sin\beta)$

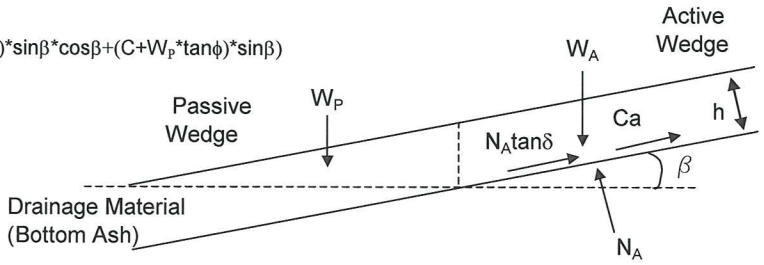
$c = (N_A*\tan\delta+C_a)*(\sin\beta)^2*\tan\phi$

$N_A = W_A*\cos\beta$

$W_A = \gamma*h^2*(L/h-1/\sin\beta-\tan\beta/2)$

$W_P = (\gamma*h^2)/\sin 2\beta)$

$C_a = c_a(L-h/\sin\beta)$



DEFINITIONS OF VARIABLES:

FS = Factor of Safety

a, b, & c = intermediate variables (= calculated variable)

N_A = Effective force normal to the failure plane of the active wedge (= calculated variable)

W_A = Total weight of active wedge (= calculated variable)

W_P = Total weight of passive wedge (= calculated variable)

β = Soil slope angle beneath the geomembrane (= 18.42 degrees or 0.322 radians based on liner slope of 3 to 1)

ϕ = Friction angle of the drainage layer material (= 35 degrees 0.611 radians based on Ref #2)

δ = Interface friction angle for liner system geosynthetics (to be determined)

c_a = Adhesion for liner system geosynthetics at active wedge (to be determined) , Variable

γ = Unit weight of the drainage layer material (= 135 pcf based on conservative wet density of bottom ash).

C = Cohesive force along the failure plane of the passive wedge (assumed 0 for drainage layer material)

C_a = Adhesive force of the active wedge for the liner system geosynthetics

h = Thickness of the drainage layer material(= 1.0 foot based on base design)

L = Length of slope measured along the geomembrane (= 80 feet based on base design)

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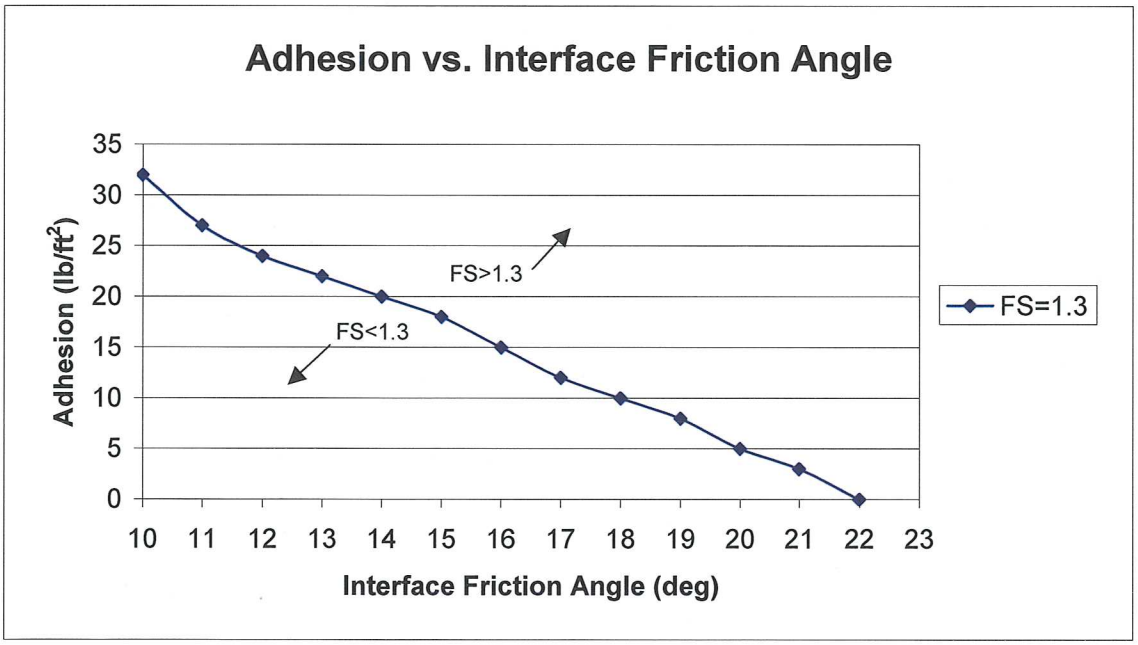
CALCULATIONS:

δ		c_a	W_A	W_P	N_A	C_a	a	b	c	FS
(deg)	(rad)	(lb/ft^2)	(lb/ft)	(lb/ft)	(lb/ft)	(lb/ft)	(lb/ft)	(lb/ft)	(lb/ft)	
10	0.175	32	10,350	225	9,820	2,459	981	-1,535	293	**1.3**
11	0.192	27	10,350	225	9,820	2,075	981	-1,473	279	**1.3**
12	0.209	24	10,350	225	9,820	1,844	981	-1,457	275	**1.3**
13	0.227	22	10,350	225	9,820	1,690	981	-1,465	277	**1.3**
14	0.244	20	10,350	225	9,820	1,537	981	-1,473	279	**1.3**
15	0.262	18	10,350	225	9,820	1,383	981	-1,482	281	**1.3**
16	0.279	15	10,350	225	9,820	1,153	981	-1,468	277	**1.3**
17	0.297	12	10,350	225	9,820	922	981	-1,455	274	**1.3**
18	0.314	10	10,350	225	9,820	768	981	-1,465	277	**1.3**
19	0.332	8	10,350	225	9,820	615	981	-1,477	279	**1.3**
20	0.349	5	10,350	225	9,820	384	981	-1,465	277	**1.3**
21	0.367	3	10,350	225	9,820	231	981	-1,478	280	**1.3**
22	0.384	0	10,350	225	9,820	0	981	-1,468	277	**1.3**



CONCLUSION:

The landfill liner side slope drainage layer was evaluated for static veneer slope stability along its longest slope. Calculations were performed to determine the minimum adhesion necessary for a range of interface friction angles to reach a FS of 1.3 or greater. Each interface friction angle and the coinciding adhesion was graphed in order to easily determine if a material interface is acceptable along the side slope.

09/28/2023 - Classification: Internal - ECRM13153872

BT SQUARED

Sheet No.	1 of 1		
Calc. No.			
Rev. No.			
Job No. 4071	Job: Columbia Ash Generation Landfill	By PEG	Date 9/27/10
Client: Alliant	Subject: GCL Internal Shear for Liner System	Chk'd DLN	Date 9/29/10

Purpose: Determine the maximum shear stress acting on a Geosynthetic Clay Liner (GCL) and the GCL internal shear strength required to provide a minimum slope stability safety factor (FS) of 1.5 for the liner system.

Approach: Use maximum shear stress formula and assumed values.

References: **Design of GCL Barrier for Final Cover Side Slope Applications**
Gregory N. Richardson, Ph.D., P.E. Geosynthetics '97 - 541

Calculation: The maximum shear stress acting on the GCL can be calculated as follows:

$$\tau_{act} = W_T \sin \beta$$

$$\beta = 18.4^{\circ}$$

$$W_T = \gamma * h$$

Where,

γ = Ash Unit Weight = 135 pcf

h = drainage layer thickness = 1 ft

$$W_T = 135 \text{ psf}$$

$$\tau_{act} = 42.6 \text{ psf}$$

$$FS = \frac{\tau_{resist}}{\tau_{act}} = 1.5$$

$$\tau_{resist} = FS * \tau_{act} = 1.5 * 42.6 = 64 \text{ psf}$$

Assumptions: 1. Slope angle, β=18.4° (3:1 horizontal/vertical liner side slope).
2. Ash unit weight, γ = 135 pcf

Conclusions: For a total weight of the leachate drainage layer of 135 psf and a slope angle of 3:1, the maximum shear stress will be 42.6 psf. A minimum GCL internal shear strength of 64 psf is required to provide a slope stability safety factor of 1.5.

09/28/2023 - Classification: Internal - ECRM13153872

Purpose: To determine the maximum length of slope that the final cover drainage layer (sand) can carry infiltrating water and remain stable.

Approach: Use the unit gradient method to determine the maximum slope length.

References:

1. Landfilldesign.com

2. "GRI-GC8, Determination of the Allowable Flow Rate of a Drainage Geocomposite". Geosynthetics Research Institute, 2001

3. "Beyond a factor-of-safety value, i.e., the probability of failure". GRI Newsletter/Report, Vol. 15, no. 3

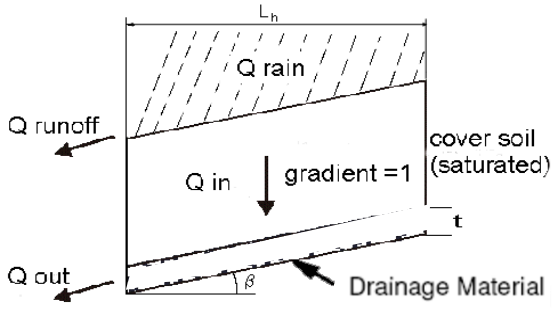
4. "Designing with Geosynthetics". R.M. Koerner, Prentice Hall Publishing Co., Englewood Cliffs, NJ, 1998

5. "Hydraulic Design of Geosynthetic and Granular Liquid Collection Layers". J. P. Giroud, J. G. Zornberg and A. Zhao, Geosynthetics International, Vol. 7, Nos 4-5

6. "Lateral Drainage Design update - part 2". G. N. Richardson, J. P. Giroud and A. Zhao, Geotechnical Fabrics Report, March 2002

7. HELP Model "User's Guide", Table 4: Default Soil, Waste, and Geosynthetic Characteristics

8. SCS Engineers, Plan of Operation Update, Dry Ash Disposal Facility, Columbia Energy Center, Final Grades (Modules 12 and 13) Plan Sheet, August 2023



With Darcy's Law:

$$Q = k \times i \times A$$

Inflow of water in the Drainage Material

$$Q_{in} = k_{veg} \times i \times A = k_{veg} \times 1 \times L_h \times 1$$

Outflow of water from the geocomposite at the toe of the slope

$$Q_{out} = k_{drain} \times i \times A = k_{drain} \times t \times \sin\beta$$

This results in a required k_{drain} of:

$$k_{drain} = \frac{k_{veg} \times L_h}{t \times \sin\beta} \times FS$$

09/28/2023 - Classification: Internal - ECRM13153872

Assumptions: 1. Soil hydraulic gradient *i* = 1.0.

2. Top soil will be clay. Soil permeability is 4.2 x 10^{-5} cm/sec for a CL clay from HELP model user's guide.

3. Drainage Layer hydraulic gradient = sinβ where β=14˚ (4:1 horizontal/vertical final cover slope).

4. Maximum horizontal final cover slope length from crest to toe drain is 371 feet as shown in Module 1 on the final grades plan sheet.

5. The minimum hydraulic conductivity ($k_{drain,ave}$) is 1.0 x 10^{-2} cm/s for the sand.

6. Cover drainage layer thickness t = 1 foot.

Calculation: Constants

L_h	=	Drainage pipe spacing or length of slope measured horizontally	=	See Below	
k_{veg}	=	Permeability of the vegetative supporting soil	=	0.000042	cm/sec
S	=	The liner's slope, **S** = tan **b**	=	25%	b = 14˚
FS_{slope}	=	Minimum factor of safety against sliding, for drainage layer/geomembrane interface	=	1.5	
$\delta_{req'd}$	=	Minimum interface friction angle = $\tan^{-1}$(FS*tan(b))	=	20.6	degrees

Determine the maximum slope length for the given minimum required drainage layer permeability

L_h (feet)	L_h (meter)	$k_{drain, req}$ (cm/s)	
30	9.1	7.69E-03	Design

Conclusions: The design has an intermediate pipe every 30 feet spaced evenly up the slope. The intermediate pipe spacing design with the sand material has a factor of safety of 1.95.

09/28/2023 - Classification: Internal - ECRM13153872

SCS ENGINEERS

Sheet No.	1 of 1		
Calc. No.			
Rev. No.			
Job No. 25220183.00	Job: Columbia Dry Ash Disposal Facility	By: MJT	Date: 04/25/22
Client: WPL	Subject: GCL Internal Shear on Final Cover	Chk'd: DLN	Date: 04/26/22

Purpose: Determine the maximum shear stress acting on a Geosynthetic Clay Liner (GCL) and the GCL internal shear strength required to provide a minimum slope stability safety factor (FS) of 1.5 for the final cover.

Approach: Use maximum shear stress formula and assumed values.

References: Design of GCL Barrier for Final Cover Side Slope Applications, Gregory N. Richardson, Ph.D., P.E., Geosynthetics '97-541

Calculation: The maximum shear stress acting on the GCL can be calculated as follows:

$$\tau_{act} = W_T \sin \beta$$

$$\beta = 14^{\circ}$$

$$W_T = \gamma \times h$$

Where: γ = Soil Unit Weight = 120 pcf

h = Cover Thickness = 2.5 ft

$$W_T = 300 \text{ psf}$$

$$\tau_{act} = 72.6 \text{ psf}$$

$$FS = \frac{\tau_{resist}}{\tau_{act}} = 1.5$$

$$\tau_{resist} = FS \times \tau_{act} = 1.5 \times 72.6 = 109 \text{ psf}$$

Assumptions: Slope angle, $\beta = 14^{\circ}$ (4:1 horizontal / vertical final cover slope)

Soil unit weight, $\gamma = 120$ pcf

Conclusion: For a total weight of the final cover system of 300 psf and a slope angle of 4:1, the maximum shear stress will be 72.6 psf. A minimum GCL internal shear strength of 109 psf is required to provide a slope stability safety factor of 1.5.

09/28/2023 - Classification: Internal - ECRM13153872

Appendix A2

Future Module 1 Final Cover Stability Calculations

09/28/2023 - Classification: Internal - ECRM13153872

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CIVIL & ENVIRONMENTAL ENGINEERING

Sheet No. 1			
Calc. No.			
Rev. No.			
Job No. 4071	Job: Columbia Ash Generation Landfill	By: PEG	Date 9/23/10
Client: Alliant	Subject: Liner Side Slope Drainage Layer Stability	Chk'd: DLN	Date 9/24/10

EVALUATION:

Evaluate the Phase 1 landfill liner side slope drainage layer for static veneer slope stability.

The side slope on the modules base runs at a 3:1 slope for an approximate maximum of 80 feet.

The following calculations evaluate the static veneer slope stability of the 3:1 slope.

REFERENCES:

1.) Koerner, Robert M. & Te-Yang Soong, Analysis and Design of Veneer Cover Soils, Geosynthetic Research Institute.

2.) U.S. Department of Transportation - Federal Highway Administration Recycled Materials, Coal Bottom Ash User's Guide

EQUATIONS:

$FS = (-b+(b^2-4*a*c)^{1/2})/(2*a)$

$a = (W_A-N_A*\cos\beta)*\cos\beta$

$b = -((W_A-N_A*\cos\beta)*\sin\beta*\tan\phi+(N_A*\tan\delta+C_a)*\sin\beta*\cos\beta+(C+W_P*\tan\phi)*\sin\beta)$

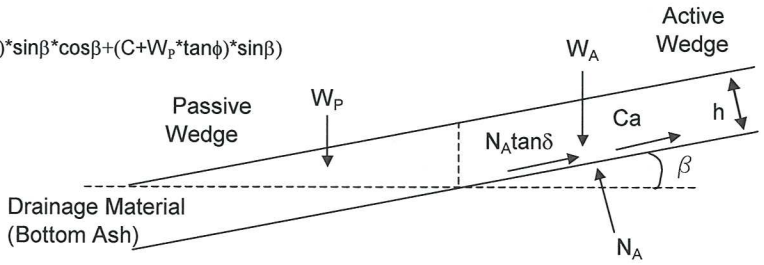
$c = (N_A*\tan\delta+C_a)*(\sin\beta)^2*\tan\phi$

$N_A = W_A*\cos\beta$

$W_A = \gamma*h^2*(L/h-1/\sin\beta-\tan\beta/2)$

$W_P = (\gamma*h^2)/\sin 2\beta)$

$C_a = c_a(L-h/\sin\beta)$



DEFINITIONS OF VARIABLES:

FS = Factor of Safety

a, b, & c = intermediate variables (= calculated variable)

N_A = Effective force normal to the failure plane of the active wedge (= calculated variable)

W_A = Total weight of active wedge (= calculated variable)

W_P = Total weight of passive wedge (= calculated variable)

β = Soil slope angle beneath the geomembrane (= 18.42 degrees or 0.322 radians based on liner slope of 3 to 1)

ϕ = Friction angle of the drainage layer material (= 35 degrees 0.611 radians based on Ref #2)

δ = Interface friction angle for liner system geosynthetics (to be determined)

c_a = Adhesion for liner system geosynthetics at active wedge (to be determined) , Variable

γ = Unit weight of the drainage layer material (= 135 pcf based on conservative wet density of bottom ash).

C = Cohesive force along the failure plane of the passive wedge (assumed 0 for drainage layer material)

C_a = Adhesive force of the active wedge for the liner system geosynthetics

h = Thickness of the drainage layer material(= 1.0 foot based on base design)

L = Length of slope measured along the geomembrane (= 80 feet based on base design)

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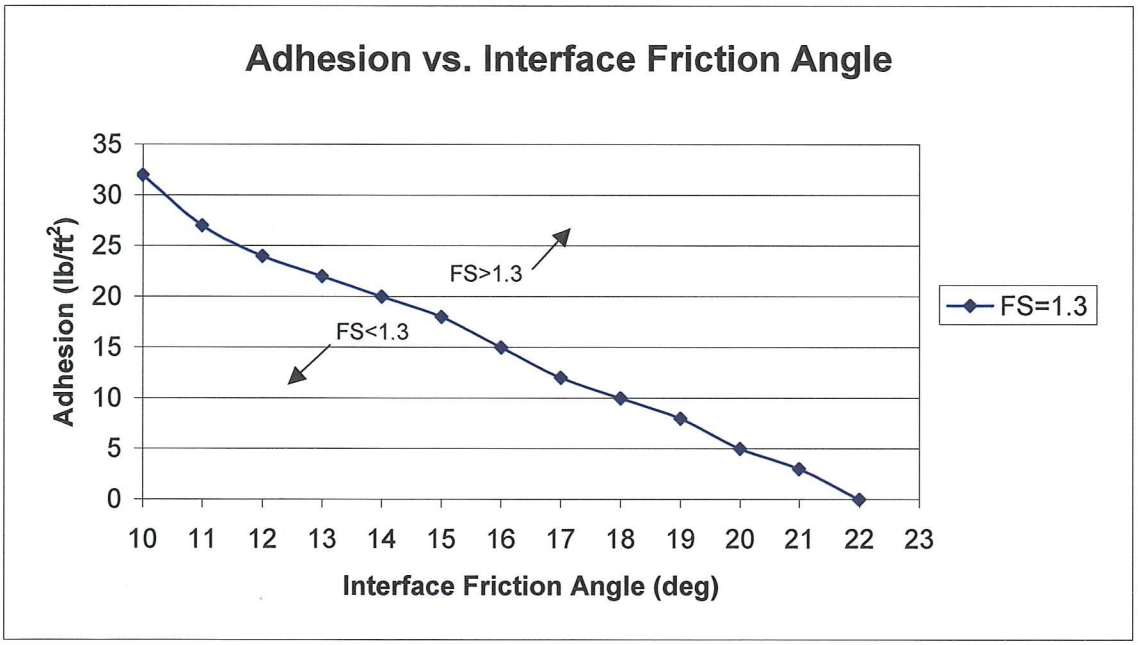
CALCULATIONS:

δ		c_a	W_A	W_P	N_A	C_a	a	b	c	FS
(deg)	(rad)	(lb/ft^2)	(lb/ft)	(lb/ft)	(lb/ft)	(lb/ft)	(lb/ft)	(lb/ft)	(lb/ft)	
10	0.175	32	10,350	225	9,820	2,459	981	-1,535	293	**1.3**
11	0.192	27	10,350	225	9,820	2,075	981	-1,473	279	**1.3**
12	0.209	24	10,350	225	9,820	1,844	981	-1,457	275	**1.3**
13	0.227	22	10,350	225	9,820	1,690	981	-1,465	277	**1.3**
14	0.244	20	10,350	225	9,820	1,537	981	-1,473	279	**1.3**
15	0.262	18	10,350	225	9,820	1,383	981	-1,482	281	**1.3**
16	0.279	15	10,350	225	9,820	1,153	981	-1,468	277	**1.3**
17	0.297	12	10,350	225	9,820	922	981	-1,455	274	**1.3**
18	0.314	10	10,350	225	9,820	768	981	-1,465	277	**1.3**
19	0.332	8	10,350	225	9,820	615	981	-1,477	279	**1.3**
20	0.349	5	10,350	225	9,820	384	981	-1,465	277	**1.3**
21	0.367	3	10,350	225	9,820	231	981	-1,478	280	**1.3**
22	0.384	0	10,350	225	9,820	0	981	-1,468	277	**1.3**



CONCLUSION:

The landfill liner side slope drainage layer was evaluated for static veneer slope stability along its longest slope. Calculations were performed to determine the minimum adhesion necessary for a range of interface friction angles to reach a FS of 1.3 or greater. Each interface friction angle and the coinciding adhesion was graphed in order to easily determine if a material interface is acceptable along the side slope.

09/28/2023 - Classification: Internal - ECRM13153872

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Sheet No.	1 of 1		
Calc. No.			
Rev. No.			
Job No. 4071	Job: Columbia Ash Generation Landfill	By PEG	Date 9/27/10
Client: Alliant	Subject: GCL Internal Shear for Liner System	Chk'd DLN	Date 9/29/10

Purpose: Determine the maximum shear stress acting on a Geosynthetic Clay Liner (GCL) and the GCL internal shear strength required to provide a minimum slope stability safety factor (FS) of 1.5 for the liner system.

Approach: Use maximum shear stress formula and assumed values.

References: **Design of GCL Barrier for Final Cover Side Slope Applications**
Gregory N. Richardson, Ph.D., P.E. Geosynthetics '97 - 541

Calculation: The maximum shear stress acting on the GCL can be calculated as follows:

$$\tau_{act} = W_T \sin \beta$$

$$\beta = 18.4^{\circ}$$

$$W_T = \gamma * h$$

Where,

γ = Ash Unit Weight = 135 pcf

h = drainage layer thickness = 1 ft

$$W_T = 135 \text{ psf}$$

$$\tau_{act} = 42.6 \text{ psf}$$

$$FS = \frac{\tau_{resist}}{\tau_{act}} = 1.5$$

$$\tau_{resist} = FS * \tau_{act} = 1.5 * 42.6 = 64 \text{ psf}$$

Assumptions: 1. Slope angle, β=18.4° (3:1 horizontal/vertical liner side slope).
2. Ash unit weight, γ = 135 pcf

Conclusions: For a total weight of the leachate drainage layer of 135 psf and a slope angle of 3:1, the maximum shear stress will be 42.6 psf. A minimum GCL internal shear strength of 64 psf is required to provide a slope stability safety factor of 1.5.

09/28/2023 - Classification: Internal - ECRM13153872

Purpose: To determine the maximum length of slope that the final cover drainage layer (sand) can carry infiltrating water and remain stable.

Approach: Use the unit gradient method to determine the maximum slope length.

References:

1. Landfilldesign.com

2. "GRI-GC8, Determination of the Allowable Flow Rate of a Drainage Geocomposite". Geosynthetics Research Institute, 2001

3. "Beyond a factor-of-safety value, i.e., the probability of failure". GRI Newsletter/Report, Vol. 15, no. 3

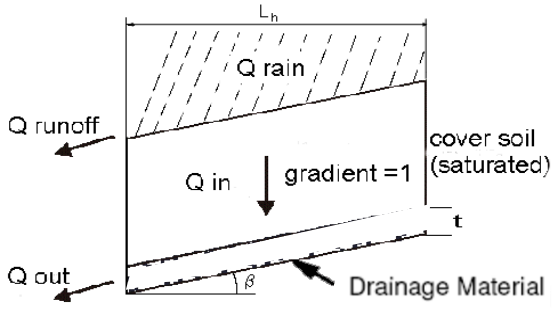
4. "Designing with Geosynthetics". R.M. Koerner, Prentice Hall Publishing Co., Englewood Cliffs, NJ, 1998

5. "Hydraulic Design of Geosynthetic and Granular Liquid Collection Layers". J. P. Giroud, J. G. Zornberg and A. Zhao, Geosynthetics International, Vol. 7, Nos 4-5

6. "Lateral Drainage Design update - part 2". G. N. Richardson, J. P. Giroud and A. Zhao, Geotechnical Fabrics Report, March 2002

7. HELP Model "User's Guide", Table 4: Default Soil, Waste, and Geosynthetic Characteristics

8. SCS Engineers, Plan of Operation Update, Dry Ash Disposal Facility, Columbia Energy Center, Final Grades (Modules 12 and 13) Plan Sheet, August 2023



With Darcy's Law:

$$Q = k \times i \times A$$

Inflow of water in the Drainage Material

$$Q_{in} = k_{veg} \times i \times A = k_{veg} \times 1 \times L_h \times 1$$

Outflow of water from the geocomposite at the toe of the slope

$$Q_{out} = k_{drain} \times i \times A = k_{drain} \times t \times \sin\beta$$

This results in a required k_{drain} of:

$$k_{drain} = \frac{k_{veg} \times L_h}{t \times \sin\beta} \times FS$$

09/28/2023 - Classification: Internal - ECRM13153872

Assumptions: 1. Soil hydraulic gradient *i* = 1.0.

2. Top soil will be clay. Soil permeability is 4.2 x 10^{-5} cm/sec for a CL clay from HELP model user's guide.

3. Drainage Layer hydraulic gradient = sinβ where β=14˚ (4:1 horizontal/vertical final cover slope).

4. Maximum horizontal final cover slope length from crest to toe drain is 371 feet as shown in Module 1 on the final grades plan sheet.

5. The minimum hydraulic conductivity ($k_{drain,ave}$) is 1.0 x 10^{-2} cm/s for the sand.

6. Cover drainage layer thickness t = 1 foot.

Calculation: Constants

L_h	=	Drainage pipe spacing or length of slope measured horizontally	=	See Below	
k_{veg}	=	Permeability of the vegetative supporting soil	=	0.000042	cm/sec
S	=	The liner's slope, **S** = tan **b**	=	25%	b = 14˚
FS_{slope}	=	Minimum factor of safety against sliding, for drainage layer/geomembrane interface	=	1.5	
$\delta_{req'd}$	=	Minimum interface friction angle = $\tan^{-1}$(FS*tan(b))	=	20.6	degrees

Determine the maximum slope length for the given minimum required drainage layer permeability

L_h (feet)	L_h (meter)	$k_{drain, req}$ (cm/s)	
30	9.1	7.69E-03	Design

Conclusions: The design has an intermediate pipe every 30 feet spaced evenly up the slope. The intermediate pipe spacing design with the sand material has a factor of safety of 1.95.

09/28/2023 - Classification: Internal - ECRM13153872

SCS ENGINEERS

		Sheet No.	1 of 1
		Calc. No.	
		Rev. No.	
Job No. 25222260.00	Job: Columbia Dry Ash Disposal Facility	By: MJT	Date: 07/18/23
Client: WPL	Subject: GCL Internal Shear on Final Cover	Chk'd: DLN	Date: 07/25/23

Purpose: Determine the maximum shear stress acting on a Geosynthetic Clay Liner (GCL) and the GCL internal shear strength required to provide a minimum slope stability safety factor (FS) of 1.5 for the final cover.

Approach: Use maximum shear stress formula and assumed values.

References: Design of GCL Barrier for Final Cover Side Slope Applications, Gregory N. Richardson, Ph.D., P.E., Geosynthetics '97-541

Calculation: The maximum shear stress acting on the GCL can be calculated as follows:

$$\tau_{act} = W_T \sin \beta$$

$$\beta = 14^{\circ}$$

$$W_T = \gamma \times h$$

Where: γ = Soil Unit Weight = 120 pcf

h = Cover Thickness = 3.0 ft

$$W_T = 360 \text{ psf}$$

$$\tau_{act} = 87.1 \text{ psf}$$

$$FS = \frac{\tau_{resist}}{\tau_{act}} = 1.5$$

$$\tau_{resist} = FS \times \tau_{act} = 1.5 \times 87.1 = 131 \text{ psf}$$

Assumptions: Slope angle, $\beta = 14^{\circ}$ (4:1 horizontal / vertical final cover slope)

Soil unit weight, $\gamma = 120$ pcf

Conclusion: For a total weight of the final cover system of 360 psf and a slope angle of 4:1, the maximum shear stress will be 87.1 psf. A minimum GCL internal shear strength of 131 psf is required to provide a slope stability safety factor of 1.5.

09/28/2023 - Classification: Internal - ECRM13153872

Appendix A3

Future Final Cover Stability Calculations

09/28/2023 - Classification: Internal - ECRM13153872

Purpose: Evaluate the Module 12 and 13 landfill liner side slope drainage layer for static veneer slope stability. The following calculations evaluate the static veneer slope stability of the 3:1 slope.

References: 1. Koerner, Robert M. & Te-Yang Soong, Analysis and Design of Veneer Cover Soils, Geosynthetic Research Institute.
2. U.S. Department of Transportation - Federal Highway Administration Recycled Materials, Coal Bottom Ash User's Guide

Calculation:

$$FS = (-b + (b^2 - 4 * a * c)^{1/2}) / (2 * a)$$

$$a = (W_A - N_A * \cos\beta) * \cos\beta$$

$$b = -((W_A - N_A * \cos\beta) * \sin\beta * \tan\phi + (N_A * \tan\delta + C_a) * \sin\beta * \cos\beta + (C + W_P * \tan\phi) * \sin\beta)$$

$$c = (N_A * \tan\delta + C_a) * (\sin\beta)^2 * \tan\phi$$

$$N_A = W_A * \cos\beta$$

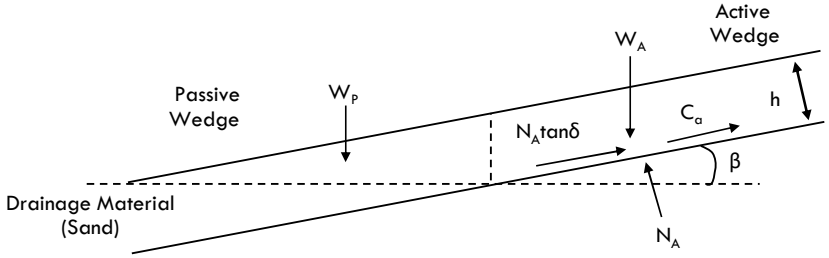
$$W_A = \gamma * h^2 * (L / h - 1 / \sin\beta - \tan\beta / 2)$$

$$W_P = (\gamma * h^2) / \sin 2\beta)$$

$$C_a = c_a (L - h / \sin\beta)$$

Where:

- FS = Factor of Safety
- a, b, & c = intermediate variables (calculated variable)
- N_A = Effective force normal to the failure plane of the active wedge (calculated variable)
- W_A = Total weight of active wedge (calculated variable)
- W_P = Total weight of passive wedge (calculated variable)
- β = Soil slope angle beneath the geomembrane = 18.421 degrees = 0.3215 radians, based on liner slope of 3 to 1
- ϕ = Friction angle of the sand drainage layer material = 30 degrees = 0.5236 radians, based on experience
- δ = Interface friction angle for liner system geosynthetics (to be determined)
- c_a = Adhesion for liner system geosynthetics at active wedge (to be determined), Variable
- γ = Unit weight of the drainage layer material = 125 pcf, based on conservative wet density of sand
- C = Cohesive force along the failure plane of the passive wedge, assumed = 0 for drainage layer material
- C_a = Adhesive force of the active wedge for the liner system geosynthetics
- h = Thickness of the drainage layer material = 1 foot, based on base design
- L = Length of slope measured along the geomembrane = 82 feet, based on base design

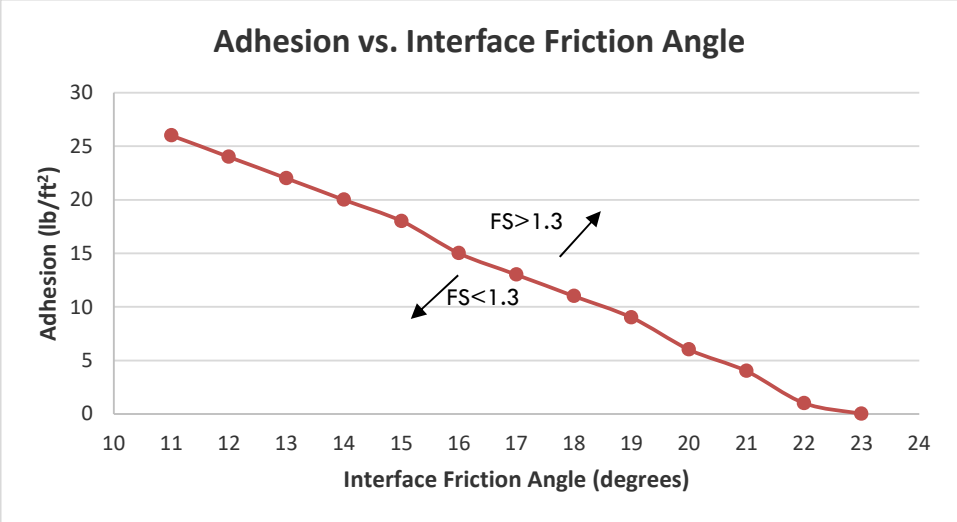


09/28/2023 - Classification: Internal - ECRM13153872

Calculation:

(cont.)

δ (deg)	δ (rad)	c_a (lb/ft^2)	W_A (lb/ft)	W_P (lb/ft)	N_A (lb/ft)	C_a (lb/ft)	a (lb/ft)	b (lb/ft)	c (lb/ft)	FS
11	0.192	26	9,834	208	9,330	2049.7	932	-1,375	223	1.3
12	0.2094	24	9,834	208	9,330	1,892	932	-1,379	223	1.3
13	0.2269	22	9,834	208	9,330	1,734	932	-1,383	224	1.3
14	0.2443	20	9,834	208	9,330	1,577	932	-1,387	225	1.3
15	0.2618	18	9,834	208	9,330	1,419	932	-1,392	226	1.3
16	0.2793	15	9,834	208	9,330	1,183	932	-1,374	222	1.3
17	0.2967	13	9,834	208	9,330	1,025	932	-1,380	224	1.3
18	0.3142	11	9,834	208	9,330	867	932	-1,386	225	1.3
19	0.3316	9	9,834	208	9,330	710	932	-1,393	226	1.3
20	0.3491	6	9,834	208	9,330	473	932	-1,377	223	1.3
21	0.3665	4	9,834	208	9,330	315	932	-1,385	225	1.3
22	0.384	1	9,834	208	9,330	79	932	-1,371	222	1.3
23	0.4014	0	9,834	208	9,330	0	932	-1,405	228	1.3



Conclusion: The landfill liner side slope drainage layer was evaluated for static veneer slope stability along its longest slope. Calculations were performed to determine the minimum adhesion necessary for a range of interface friction angles to reach a FS of 1.3 or greater. Each interface friction angle and the coinciding adhesion was graphed in order to easily determine if a material interface is acceptable along the side slope.

09/28/2023 - Classification: Internal - ECRM13153872

SCS ENGINEERS		Sheet No.	1 of 1
		Calc. No.	
		Rev. No.	
Job No. 25220183.00	Job: Columbia Dry Ash Disposal Facility	By: MJT	Date: 03/02/22
Client: WPL	Subject: GCL Internal Shear for Liner System	Chk'd: DLN	Date: 04/13/22

Purpose: Determine the maximum shear stress acting on a Geosynthetic Clay Liner (GCL) and the GCL internal shear strength required to provide a minimum slope stability safety factor (FS) of 1.5 for the liner system.

Approach: Use maximum shear stress formula and assumed values.

References: Design of GCL Barrier for Final Cover Side Slope Applications, Gregory N. Richardson, Ph.D., P.E., Geosynthetics '97-541

Calculation: The maximum shear stress acting on the GCL can be calculated as follows:

$$\tau_{act} = W_T \sin \beta$$

$$\beta = 18.4^{\circ}$$

$$W_T = \gamma \times h$$

Where: γ = Sand Unit Weight = 125 pcf

h = Drainage Layer Thickness = 1 ft

$$W_T = 125 \text{ psf}$$

$$\tau_{act} = 39.5 \text{ psf}$$

$$FS = \frac{\tau_{resist}}{\tau_{act}} = 1.5$$

$$\tau_{resist} = FS \times \tau_{act} = 1.5 \times 39.5 = 59 \text{ psf}$$

Assumptions: Slope angle, $\beta = 18.4^{\circ}$ (3:1 horizontal / vertical liner side slope

Sand unit weight, $\gamma = 125$ pcf

Conclusion: For a total weight of the leachate drainage layer of 125 psf and a slope angle of 3:1, the maximum shear stress will be 39.46 psf. A minimum GCL internal shear strength of 59.19 psf is required to provide a slope stability safety factor of 1.5.

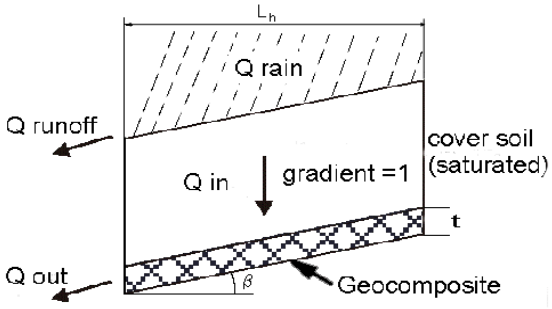
09/28/2023 - Classification: Internal - ECRM13153872

Purpose: To determine the maximum length of slope that the final cover drainage geocomposite can carry infiltrating water and remain stable. Also determine the recommended minimum friction angle for final cover side slope stability. Note: This calculation does not include the flow convergence areas where a separate calculation is required.

Approach: Use the unit gradient method to determine the maximum slope length.

References:

1. Landfilldesign.com - Lateral Drainage System - Single Slope, Unit Gradient Method
2. "GRI-GC8, Determination of the Allowable Flow Rate of a Drainage Geocomposite". Geosynthetics Research Institute, 2001.
3. "Beyond a factor-of-safety value, i.e., the probability of failure". GRI Newsletter/Report, Vol. 15, no. 3.
4. "Designing with Geosynthetics". R.M. Koerner, Prentice Hall Publishing Co., Englewood Cliffs, NJ, 1998.
5. "Hydraulic Design of Geosynthetic and Granular Liquid Collection Layers". J. P. Giroud, J. G. Zornberg and A. Zhao, Geosynthetics International, Vol. 7, Nos 4-5.
6. "Lateral Drainage Design update - part 2". G. N. Richardson, J. P. Giroud and A. Zhao, Geotechnical Fabrics Report, March 2002.
7. Giroud, Zornberg, and Zhao, 2000, "Hydraulic Design of Liquid Collection Layers", Geosynthetics International
8. SCS Engineers, Plan of Operation Update, Dry Ash Disposal Facility, Columbia Energy Center, Final Grades (Modules 12 and 13) Plan Sheet, August 2023
9. HELP Model "User's Guide" in conjunction with GRI report #19, pages 34-37 (Leachate Collection System)



With Darcy's law:

$$Q = k * i * A$$

Inflow of water in the geocomposite

$$Q_{in} = k_{veg} * i * A = k_{veg} * 1 * L_h * 1$$

Outflow of water from the geocomposite at the toe of the slope

$$Q_{out} = k_{comp} * i * A = k_{comp} * i * t * 1 = \theta_{required} * \sin\beta \quad = \theta * i * 1 \text{ where } \theta = k_{comp} * t$$

Inflow equals outflow (Factor of Safety = 1)

$$Q_{in} = Q_{out}$$

This results in a required transmissivity of the geocomposite of:

$$\theta_{required} = \frac{k_{veg} * L_h}{\sin\beta}$$

Which results in the ultimate transmissivity after multiplying by the Total Serviceability Factor (TSF)

$$\theta_{ultimate} = \theta_{required} * FS_d * RF_{in} * RF_{cr} * RF_{cc} * RF_{bc}$$

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Assumptions: 1. Soil hydraulic gradient i = 1.0.

2. Top soil will be clay. Soil permeability is 4.2 x 10^{-5} cm/sec for a CL clay from HELP model user's guide.

3. Geocomposite hydraulic gradient = sinβ where β=14˚ (4:1 horizontal/vertical final cover slope).

4. Factor of safety and transmissivity reduction factors are from recommended values in GRI report #19 (Leachate collection system example) and HELP model "Users Guide"

5. Maximum horizontal final cover slope length from crest to toe drain is 570 feet as shown on Final Grades (Modules 12 and 13) plan sheet. This includes 128' of 10:1 slope length at the peak.

Calculation: Constants

L_h	=	Drainage pipe spacing or length of slope measured horizontally	=	See Below	
k_{veg}	=	Permeability of the vegetative supporting soil	=	0.000042	cm/sec
S	=	The liner's slope, **S** = tan **b**	=	25%	b = 14 ˚
FS_{slope}	=	Minimum factor of safety against sliding, for soil/geocomposite or geocomposite/geomembrane interfaces	=	1.5	
$\delta_{req'd}$	=	Minimum interface friction angle = $\tan^{-1}$(FS*tan(b))	=	20.6	degrees
FS_d	=	Overall factor of safety for drainage	=	2.0	
RF_{in}	=	Intrusion Reduction Factor	=	1.1	
RF_{cr}	=	Creep Reduction Factor	=	1.2	
RF_{cc}	=	Chemical Clogging Reduction Factor	=	1.1	
RF_{bc}	=	Biological Clogging Reduction Factor	=	1.4	

Determine the maximum slope length for a given ultimate transmissivity

Θ_{ult} (m^2/sec)	L_h (meter)	L_h (feet)
1.00E-03	146.5	481

Determine the ultimate transmissivity based on a given slope length

L_h (feet)	L_h (meter)	Θ_{ult} (m^2/sec)	
570	173.7	1.19E-03	~ Total slope length
285	86.9	5.93E-04	~ 1/2 of total slope length
190	57.9	3.96E-04	~ 1/3 of total slope length

Conclusions: If no intermediate drainage outlets were constructed on the final cover, a minimum transmissivity of 1.19 x 10^{-3} m^2/sec would need to be obtained.

A minimum interface friction angle of 20.6 degrees between cover soil and geocomposite is required to achieve a minimum recommended final cover slope stability safety factor of 1.5.

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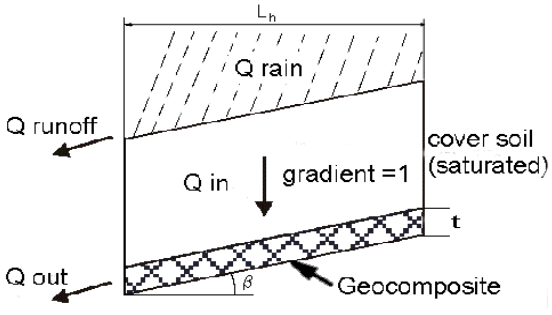
Purpose: To determine the maximum length of slopes that the final cover drainage geocomposite can carry infiltrating water and remain stable above the Final Cover Access Road.

Approach: Use the unit gradient method to determine the maximum slope length.

References:

1. Landfilldesign.com - Lateral Drainage System - Single Slope, Unit Gradient Method
2. "GRI-GC8, Determination of the Allowable Flow Rate of a Drainage Geocomposite". Geosynthetics Research Institute, 2001.
3. "Beyond a factor-of-safety value, i.e., the probability of failure". GRI Newsletter/Report, Vol. 15, no. 3.
4. "Designing with Geosynthetics". R.M. Koerner, Prentice Hall Publishing Co., Englewood Cliffs, NJ, 1998.
5. "Hydraulic Design of Geosynthetic and Granular Liquid Collection Layers". J. P. Giroud, J. G. Zornberg and A. Zhao, Geosynthetics International, Vol. 7, Nos 4-5.
6. "Lateral Drainage Design update - part 2". G. N. Richardson, J. P. Giroud and A. Zhao, Geotechnical Fabrics Report, March 2002.
7. Giroud, Zornberg, and Zhao, 2000, "Hydraulic Design of Liquid Collection Layers", Geosynthetics International
8. SCS Engineers, Plan of Operation Update, Dry Ash Disposal Facility, Columbia Energy Center, Final Grades (Module 12 and 13) Plan Sheet, August 2023
9. HELP Model "User's Guide", Table 1 - Default Low Density Soil Characteristics
10. Soong, T.Y. and Koerner, R.M. (1997), "The Design of Drainage Systems over Geosynthetically Lined Slopes", Geosynthetics Research Institute, Report #19.



With Darcy's law:

$$Q = k * i * A$$

Inflow of water in the geocomposite

$$Q_{in} = k_{veg} * i * A = k_{veg} * 1 * L_h * 1$$

Outflow of water from the geocomposite at the toe of the slope

$$Q_{out} = k_{comp} * i * A = k_{comp} * i * t * 1 = \theta_{required} * \sin\beta \quad = \theta * i * 1 \text{ where } \theta = k_{comp} * t$$

Inflow equals outflow (Factor of Safety = 1)

$$Q_{in} = Q_{out}$$

This results in a required transmissivity of the geocomposite of:

$$\theta_{required} = \frac{k_{veg} * L_h}{\sin\beta}$$

Which results in the ultimate transmissivity after multiplying by the Total Serviceability Factor (TSF)

$$\theta_{ultimate} = \theta_{required} * FS_d * RF_{in} * RF_{cr} * RF_{cc} * RF_{bc}$$

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4:1 final cover geocomposite slope above access road

Assumptions: 1. Soil hydraulic gradient i = 1.0.

2. Top soil will be clay. Soil permeability is 4.2 x 10^{-5} cm/sec for a CL clay from HELP model user's guide.

3. Geocomposite hydraulic gradient = sinβ where β=14˚ (4:1 horizontal/vertical final cover slope).

4. Factor of safety and transmissivity reduction factors are from recommended values in GRI report #19 (Leachate collection system example) and HELP model "Users Guide"

5. Maximum horizontal final cover slope length at 4:1 slope above the road is 495 feet as shown on Final Grades (Module 12 and 13) plan sheet. This includes 95' of 10:1 slope length at the peak.

Calculation: Constants

L_h	=	Drainage pipe spacing or length of slope measured horizontally	=	See Below		
k_{veg}	=	Permeability of the vegetative supporting soil	=	0.000042	cm/sec	
S	=	The liner's slope, **S** = tan **b**	=	25%	b =	14 ˚

FS_d	=	Overall factor of safety for drainage	=	2.0
RF_{in}	=	Intrusion Reduction Factor	=	1.1
RF_{cr}	=	Creep Reduction Factor	=	1.2
RF_{cc}	=	Chemical Clogging Reduction Factor	=	1.1
RF_{bc}	=	Biological Clogging Reduction Factor	=	1.4

Determine the ultimate transmissivity based on a given slope length

L_h (feet)	L_h (meter)	Θ_{ult} (m^2/sec)	
495	150.9	1.03E-03	~ Total slope length (4:1 slope above access road only)

Conclusion: If no intermediate drainage outlets were constructed on the final cover, above the Final Cover Access Road, a minimum transmissivity of 1.03 x 10^{-3} m^2/sec would need to be obtained.

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		Sheet No.	1 of 1
		Calc. No.	
		Rev. No.	
Job No. 25222260.00	Job: Columbia Dry Ash Disposal Facility	By: MJT	Date: 07/18/23
Client: WPL	Subject: GCL Internal Shear on Final Cover	Chk'd: DLN	Date: 07/25/23

Purpose: Determine the maximum shear stress acting on a Geosynthetic Clay Liner (GCL) and the GCL internal shear strength required to provide a minimum slope stability safety factor (FS) of 1.5 for the final cover.

Approach: Use maximum shear stress formula and assumed values.

References: Design of GCL Barrier for Final Cover Side Slope Applications, Gregory N. Richardson, Ph.D., P.E., Geosynthetics '97-541

Calculation: The maximum shear stress acting on the GCL can be calculated as follows:

$$\tau_{act} = W_T \sin \beta$$

$$\beta = 14^{\circ}$$

$$W_T = \gamma \times h$$

Where: γ = Soil Unit Weight = 120 pcf

h = Cover Thickness = 3.0 ft

$$W_T = 360 \text{ psf}$$

$$\tau_{act} = 87.1 \text{ psf}$$

$$FS = \frac{\tau_{resist}}{\tau_{act}} = 1.5$$

$$\tau_{resist} = FS \times \tau_{act} = 1.5 \times 87.1 = 131 \text{ psf}$$

Assumptions: Slope angle, $\beta = 14^{\circ}$ (4:1 horizontal / vertical final cover slope)

Soil unit weight, $\gamma = 120$ pcf

Conclusion: For a total weight of the final cover system of 360 psf and a slope angle of 4:1, the maximum shear stress will be 87.1 psf. A minimum GCL internal shear strength of 131 psf is required to provide a slope stability safety factor of 1.5.

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Appendix B

Schedule

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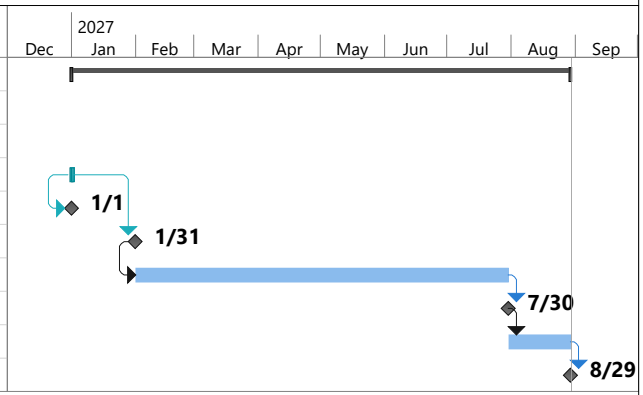
Closure Plan - Columbia Ash Disposal Facility

ID	Task Name	Duration	Start	Finish	Predec	Predecessors
1	**Closure of Columbia Ash Disposal Facility**	**241 days?**	**Fri 1/1/27**	**Sun 8/29/27**		
2	Closure of West Phase 1	180 days	Sat 6/1/24	Wed 11/27/24		
3	Closure of West Phase 1 Documentation	30 days	Thu 11/28/24	Fri 12/27/24		
4	Ash Filling Ceases	1 day	Fri 1/1/27	Fri 1/1/27		
5	Other Regulatory Permits - None	0 days	Fri 1/1/27	Fri 1/1/27	4SS	4SS
6	Notification of Intent to Close	0 days	Sun 1/31/27	Sun 1/31/27	4FS+3	4FS+30 days
7	Closure of Remaining Open Area	180 days	Mon 2/1/27	Fri 7/30/27	6SS	6SS
8	Notification of Closure Completion	0 days	Fri 7/30/27	Fri 7/30/27	7	7
9	Documentation of Closure	30 days	Sat 7/31/27	Sun 8/29/27	8	8
10	State Submittal of Documentation Report	0 days	Sun 8/29/27	Sun 8/29/27	9	9



Date: Fri 8/18/23

Task	Inactive Task	Manual Summary Rollup	External Milestone
Split	Inactive Milestone	Manual Summary	Deadline
Milestone	Inactive Summary	Start-only	Progress
Summary	Manual Task	Finish-only	Manual Progress
Project Summary	Duration-only	External Tasks	

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Appendix G

CCR Groundwater Monitoring System Plan

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CCR Groundwater Monitoring System Plan

Columbia Dry Ash Disposal Facility
Pardeeville, Wisconsin

Prepared for:

Wisconsin Power and Light Company
Columbia Energy Center
W8375 Murray Road
Pardeeville, Wisconsin 53954

SCS ENGINEERS

25222260.00 | September 1, 2023

2830 Dairy Drive
Madison, WI 53718-6751
608-224-2830

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3.0 Groundwater Monitoring Network Demonstration Under NR 514.045 (1)(h)....1
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4.1 Compliance With NR 507.15 (3)(a)....2
4.2 Compliance With NR 507.15 (3)(b)....3
4.3 Compliance With NR 507.15 (3)(c)....3
4.4 Compliance With NR 507.15 (3)(d)....4
4.5 Compliance With NR 507.15 (3)(e)....4

Figures

Figure 1. Site Location Map
Figure 2. Site Plan and Monitoring Wells

Attachments

Attachment A Regional Hydrogeologic Stratigraphy
Attachment B Monitoring Well Boring Logs
Attachment C Private Well Logs
Attachment D Site Groundwater Flow Maps
Attachment E Hydraulic Conductivity Test Results
Attachment F Monitoring Well Construction Documentation

I:\25222260.00\Deliverables\Plan Modification Addendum\Appendicies\G_CCR Groundwater Monitoring System Plan\230901_CCR Groundwater Monitoring System Plan_Final.docx

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1.0 INTRODUCTION

This Groundwater Monitoring System Plan establishes the coal combustion residual (CCR) groundwater monitoring system for the Columbia Dry Ash Disposal Facility (ADF), as required under NR 507.15(3). Specific requirements, responses to each requirement, and references to attached supporting documentation are included in Sections 3 and 4.

2.0 GROUNDWATER MONITORING NETWORK

The CCR groundwater monitoring system includes the following monitoring wells. Separate groups of downgradient monitoring wells are designated for each of the three groups of landfill modules. Two upgradient monitoring wells are designated as background wells for the entire ADF. All monitoring well locations are shown on Figure 2.

- Upgradient wells: MW-84A and MW-301
- Modules 1-3 (MOD 1-3) downgradient wells: MW-302, MW-33AR, MW-34A
- Modules 4-6 (MOD 4-6) downgradient wells: MW-309, MW-310, MW-311
- Modules 10-11 (MOD 10-11) downgradient wells: MW-313, MW-314, MW-315

3.0 GROUNDWATER MONITORING NETWORK DEMONSTRATION UNDER NR 514.045 (1)(H)

NR 514.045 (1)(h)

> *"A demonstration that the CCR groundwater monitoring system complies with the requirements under s. NR 507.15 (3), including documentation of the design, installation, and development of any CCR wells."*

The requirements of NR 50715(3)(a) through (e) are listed below, followed by a description of how each requirement is met by the monitoring system.

4.0 CCR GROUNDWATER MONITORING PLAN REQUIREMENTS UNDER NR 507.15 (3)

NR 507.15 (3)

> *"CCR LANDFILLS. In addition to the detection groundwater monitoring system required under s. NR 507.19, the owner or operator of a CCR landfill that accepts CCR on or after October 19, 2015, shall also submit a plan establishing a separate CCR groundwater monitoring system for the purpose of monitoring groundwater quality in the uppermost aquifer in accordance with this chapter. The plan shall be submitted with the plan of operation modification for initial permitting in accordance with s. NR 514.045 or in the feasibility report under ch. NR 512."*

This document establishes the CCR groundwater monitoring system for the Columbia ADF.

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4.1 COMPLIANCE WITH NR 507.15 (3)(A)

NR 507.15 (3)(a)

> *"The CCR groundwater monitoring system shall consist of a sufficient number of CCR wells, installed at appropriate locations and depths, as approved by the department, adequate to yield groundwater samples from the uppermost aquifer that accurately represent upgradient groundwater quality that has not been affected by leakage from a CCR landfill and downgradient groundwater quality passing the waste boundary of the CCR landfill. The downgradient monitoring wells shall be installed to ensure detection of groundwater contamination in the uppermost aquifer, including all known or suspected contaminant pathways."*

The uppermost aquifer unit at the site, as defined in NR 500.03(246m), is the surficial sand and gravel aquifer. A summary of the regional hydrogeologic stratigraphy is presented in **Attachment A**. Boring logs for monitoring wells in the CCR monitoring system, showing that the unconsolidated material at these well locations is primarily sand, are included in **Attachment B**. The thickness of unconsolidated deposits at the site varies from approximately 40 to 100 feet. A well construction record for one nearby private supply well that was apparently screened within the sand and gravel aquifer is included as the first log in **Attachment C**. Immediately underlying the surficial sand and gravel aquifer is the Cambrian-Ordovician sandstone aquifer. The three water supply wells at the site (HC-1, HC-2, and HC-3) all obtain water from the sandstone aquifer. The other nearby private wells are cased within the sandstone aquifer, based on the logs that SCS was able to locate through public records (**Attachment C**).

Groundwater elevation data from the site have historically shown that local groundwater flow within the unconsolidated formation is generally to the west, toward the Wisconsin River, but an area of outward radial flow has been present around the pond complex located to the northwest of the ADF. The two most recent groundwater flow maps, from April and October 2022, are included as **Attachment D**. The April 2022 flow map, showing a groundwater mound with radial outward flow around the Primary Ash Pond and Secondary Pond, is more typical of historical conditions around the pond complex. In October 2022, groundwater flow in the vicinity of the pond complex was affected by dewatering operations around the Secondary Pond related to pond closure. In the immediate area of the ADF, groundwater flow is generally to the northwest. This information was used to select background and downgradient monitoring well locations. The background wells (MW-84A and MW-301) are located to the southeast of the ADF, upgradient from the landfill.

The MOD 1-3 downgradient wells (MW-302, MW-33AR, and MW-34A) are located along the western edge of the landfill. The MOD 4-6 downgradient wells (MW-309, MW-310, and MW-311) are located along the northern edge of the landfill and to the northwest. The MOD 10-11 downgradient wells are located along the northern edge of Module 11. The understanding of groundwater flow at the site has changed since the installation of the CCR monitoring wells, due to additional information provided by the CCR monitoring wells at the northern edge of the landfill and other new wells to the northeast of the landfill. WPL would like to discuss with the Department the proper characterization of the groundwater monitoring network going forward, as one multi-unit network or as multiple separate networks.

The downgradient wells were installed as close as practicable to the CCR unit boundaries considering the site layout and obstructions. For the landfill wells, overhead power lines, a railroad right-of-way along the west side of the landfill, and steep grades in some areas restricted drilling locations immediately west and northwest of the ADF.

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4.2 COMPLIANCE WITH NR 507.15 (3)(B)

NR 507.15 (3)(b)

> *"The number, spacing, and depths of monitoring wells submitted to the department as part of the CCR groundwater monitoring system plan shall be determined based upon site-specific technical information that shall include thorough characterization of aquifer thickness, groundwater flow rate, and groundwater flow direction, including seasonal and temporal fluctuations in groundwater flow. The monitoring systems shall also take into account the saturated and unsaturated geologic units and fill materials overlying the uppermost aquifer, materials comprising the uppermost aquifer, and materials comprising the confining unit defining the lower boundary of the uppermost aquifer, including thicknesses, stratigraphy, lithology, hydraulic conductivities, porosities, and effective porosities."*

Regional information on the glacial deposits is included in **Attachment A**. Groundwater flow direction maps reflecting data collected in April and October 2022 are included in **Attachment D** and show little variation in flow direction across the ADF. Monitoring well boring logs showing site-specific geology are included in **Attachment B**. As shown on the logs, the sand and gravel aquifer unit is the uppermost geologic material at the site, and materials comprising the uppermost aquifer at each location are sand, silty sand, poorly graded sand, and/or poorly graded sand with gravel. Sandstone bedrock underlying the sand and gravel aquifer is shown on the boring logs for MW-33BR and MW-34B, located adjacent to MW-33AR and MW-34A (**Attachment B**). Hydraulic conductivity test results for monitoring wells installed for the CCR monitoring system are included in **Attachment E**. Additional geologic and hydrogeologic data are available in historic reports prepared for monitoring of the active and closed CCR landfills under the state monitoring program. Groundwater flow rates calculated using monitoring well hydraulic conductivity results for the wells installed for the CCR monitoring system and site potentiometric surface contours are approximately $2x10^{-3}$ to $8x10^{-2}$ feet/day.

The monitoring system takes into account the site-specific technical information listed above. As shown on the boring logs (**Attachment B**), all downgradient CCR monitoring wells are screened within the sand and gravel aquifer. Horizontal well spacing between the CCR monitoring wells is similar to or less than distance between monitoring wells in the pre-existing non-CCR monitoring program, which also monitors groundwater in the unconsolidated sand unit.

4.3 COMPLIANCE WITH NR 507.15 (3)(C)

NR 507.15 (3)(c)

> *"The CCR groundwater monitoring system plan shall include the minimum number of monitoring wells necessary to meet the performance standards specified under par. (a), based on the site-specific information specified under par. (b). The groundwater monitoring system plan shall contain all of the following:*
>
> *1. A minimum of one upgradient and 3 downgradient monitoring wells to be designated as CCR wells.*
>
> *2. Additional monitoring wells as necessary to accurately represent the background groundwater quality in the uppermost aquifer that has not been affected by leakage from the CCR landfill and the quality of groundwater passing the waste boundary of the CCR landfill."*

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The monitoring system at the site landfill includes two upgradient wells, three downgradient monitoring wells for MOD 1-3, three downgradient wells for MOD 4-6, and three downgradient wells for MOD 10-11. The well locations are shown on **Figure 2**.

4.4 COMPLIANCE WITH NR 507.15 (3)(D)

NR 507.15 (3)(d)

> *"Monitoring wells shall be designed and installed in accordance with s. NR 507.06 and regularly inspected in accordance with s. NR 507.13. All monitoring wells, piezometers, and other measuring, sampling, and analytical devices shall be operated and maintained so that the devices perform to the design specifications throughout the life of the monitoring program."*

Monitoring wells MW-301 through MW-305 were constructed in 2015, monitoring wells MW-309 through MW-311 were constructed in 2018, and monitoring wells MW-313 through MW-315 were constructed in 2022. These wells were constructed with a casing, screen, filter pack, and seal in accordance with the requirements of NR 141, Wis. Adm. Code. Monitoring wells MW-33AR, MW-34A, MW-84A, and M-4R were constructed between 1977 and 2003 to comply with the state-required groundwater sampling program. All of the wells have a bentonite seal in the annular space above the sampling depth. The length of the annular space seal for the pre-existing wells varies in accordance with the state monitoring well construction requirements in effect at the time of well construction. All of the pre-existing wells were included in the state-approved monitoring program. Monitoring well construction documentation is included in **Attachment F**.

Monitoring wells will be operated and maintained so that the devices perform to the design specifications throughout the life of the monitoring program.

4.5 COMPLIANCE WITH NR 507.15 (3)(E)

NR 507.15 (3)(e)

> *"The documentation of the design, installation, development, and decommissioning of any monitoring wells, piezometers, and other measurement, sampling, and analytical devices shall be performed in accordance with s. NR 507.14 and applicable requirements under ch. NR 141. This includes submission of all required forms to the department in the timeframes specified."*

Installation and development documentation for the existing CCR monitoring network wells are included in **Attachment F.** If additional monitoring wells are installed in the future, documentation will be performed and submitted as required by NR 507.15(3)(e).

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Figures

1 Site Location Map
2 Site Plan and Monitoring Wells

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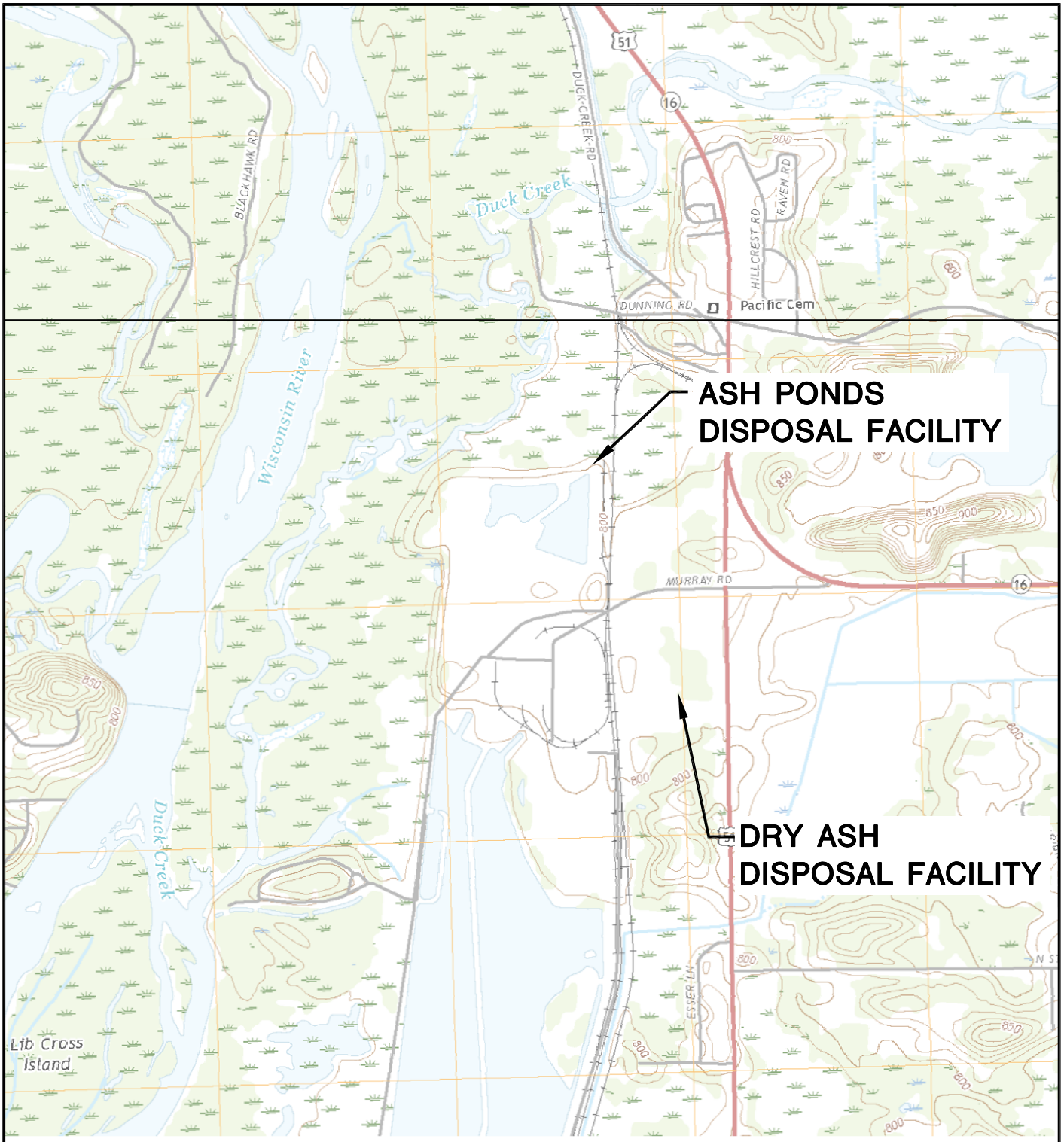

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POYNETTE QUADRANGLE
WISCONSIN–COLUMBIA CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)
2018
SCALE: 1" = 2,000'

CLIENT	SITE	
ALLIANT ENERGY COLUMBIA ENERGY CENTER W8375 MURRAY ROAD PARDEEVILLE, WI 53954	ALLIANT ENERGY COLUMBIA ENERGY CENTER PARDEEVILLE, WI	SITE LOCATION MAP

				ENGINEER		
PROJECT NO.	25220067.00	DRAWN BY:	BSS		SCS ENGINEERS 2830 DAIRY DRIVE MADISON, WI 53718–6751 PHONE: (608) 224–2830	FIGURE 1
DRAWN:	12/02/2019	CHECKED BY:	MDB			
REVISED:	01/10/2020	APPROVED BY:	TK 04/10/2020			

I:\25220067.00\Drawings\ASD Mod 1-3 LF\Site Location Map.dwg, 4/12/2020 7:05:09 PM

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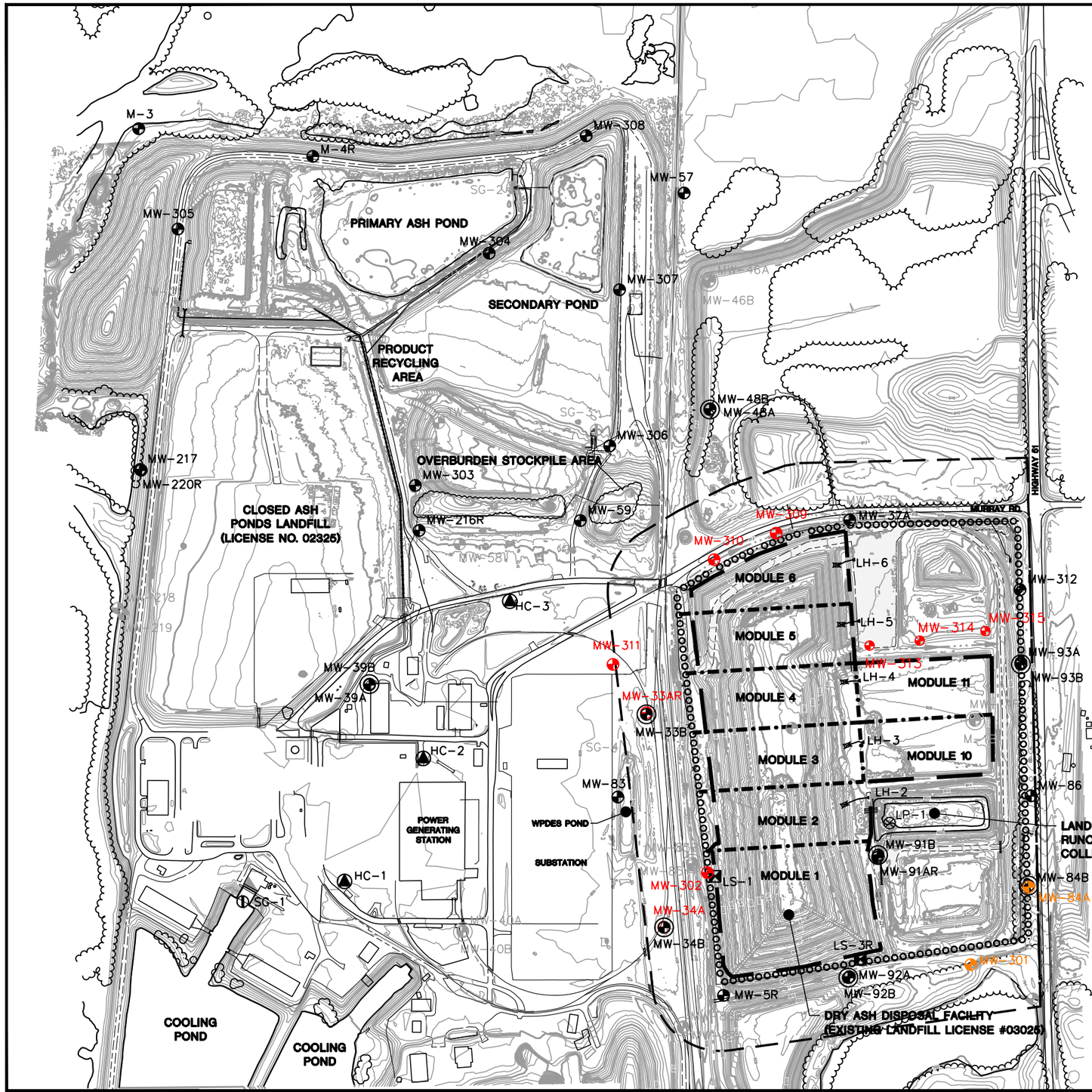


LEGEND

- EXISTING MAJOR CONTOUR (10' INTERVAL)
- EXISTING MINOR CONTOUR (2' CONTOUR)
- EXISTING FENCELINE
- EXISTING TRACKS
- EXISTING PAVED ROAD
- EXISTING UNPAVED ROAD
- EDGE OF WATER
- DRY ASH DISPOSAL FACILITY LIMITS
- LIMITS OF WASTE
- LINER PHASE/MODULE LIMITS
- DESIGN MANAGEMENT ZONE
- WATER SUPPLY WELL
- STAFF GAUGE
- NON-CCR WATER TABLE WELL
- NON-CCR PIEZOMETER
- CCR MONITORING WELL
- CCR BACKGROUND MONITORING WELL
- SURFACE WATER SAMPLE LOCATION
- LYSIMETER
- ABANDONED WATER TABLE WELL
- ABANDONED PIEZOMETER
- ABANDONED STAFF GAUGE
- LEACHATE HEADWELL

NOTES:

1. BASE MAP CREATED FROM AERIAL SURVEY BY KBM, FLOWN DECEMBER 1, 2014, AND GROUND SURVEYS BY SCS ENGINEERS IN MAY 2019, DECEMBER 2020, NOVEMBER 2021, AND DECEMBER 2021, AND BY DRONE SURVEY BY AMES IN NOVEMBER 2022, JANUARY 2023 AND JUNE 2023.
2. MONITORING WELL LOCATIONS AND ELEVATIONS SURVEYED BY WISCONSIN POWER AND LIGHT, INC. IN DECEMBER 1994, NOVEMBER 1996, APRIL 2003, AND JANUARY 2016, AND BY SCS ENGINEERS IN FEBRUARY 2018, APRIL 2022, AND JANUARY 2023.
3. SUPPLY WELL LOCATIONS ARE APPROXIMATE AND ASSUMED BASED ON JANUARY 2013 DRAWINGS BY TRC.
4. BACKGROUND MONITORING WELLS FOR THE DRY ASH FACILITY ARE: MW-301 AND MW-84A.
5. THIS DRAWING SHOWS ALL SITE MONITORING WELLS, INCLUDING WELLS THAT ARE NOT USED TO MONITOR THE DRY ASH DISPOSAL FACILITY, THE CLOSED ASH PONDS LANDFILL, ASH POND, AND/OR THE SECONDARY POND.

PROJECT NO.	25222260.00	DRAWN BY:	KP
DRAWN:	02/09/2023	CHECKED BY:	MDB
REVISED:	03/10/2023	APPROVED BY:	MDB 09/01/23

ENGINEER: SCS ENGINEERS
2830 DAIRY DRIVE MADISON, WI 53718-6751
PHONE: (608) 224-2830

CLIENT: ALLIANT ENERGY
COLUMBIA ENERGY CENTER
W8375 MURRAY ROAD
PARDEEVILLE, WI 53954

SITE: ALLIANT ENERGY
COLUMBIA ENERGY CENTER
COLUMBIA DRY ASH DISPOSAL FACILITY
PARDEEVILLE, WI

SITE PLAN AND MONITORING WELL LOCATIONS

FIGURE 2

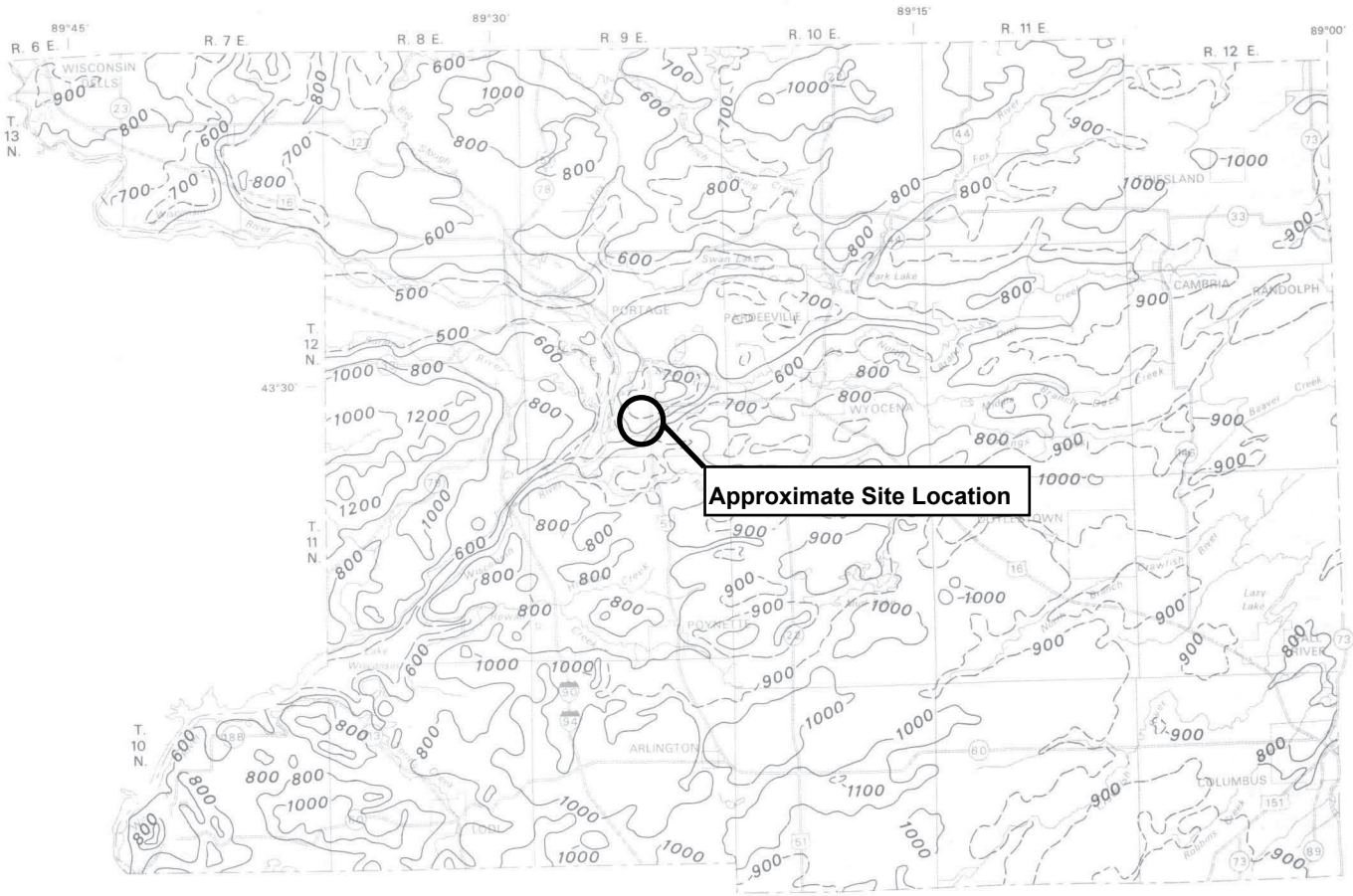
I:\25222260.00\Drawings\Site Plan and Monitoring Well Locations.dwg, 9/1/2023 12:23:49 PM

09/28/2023 - Classification: Internal - ECRM13153872

Attachment A

Regional Hydrogeologic Stratigraphy

09/28/2023 - Classification: Internal - ECRM13153872



0 2 4 6 8 10 MILES

0 2 4 6 8 10 KILOMETERS

EXPLANATION

600

Bedrock contour

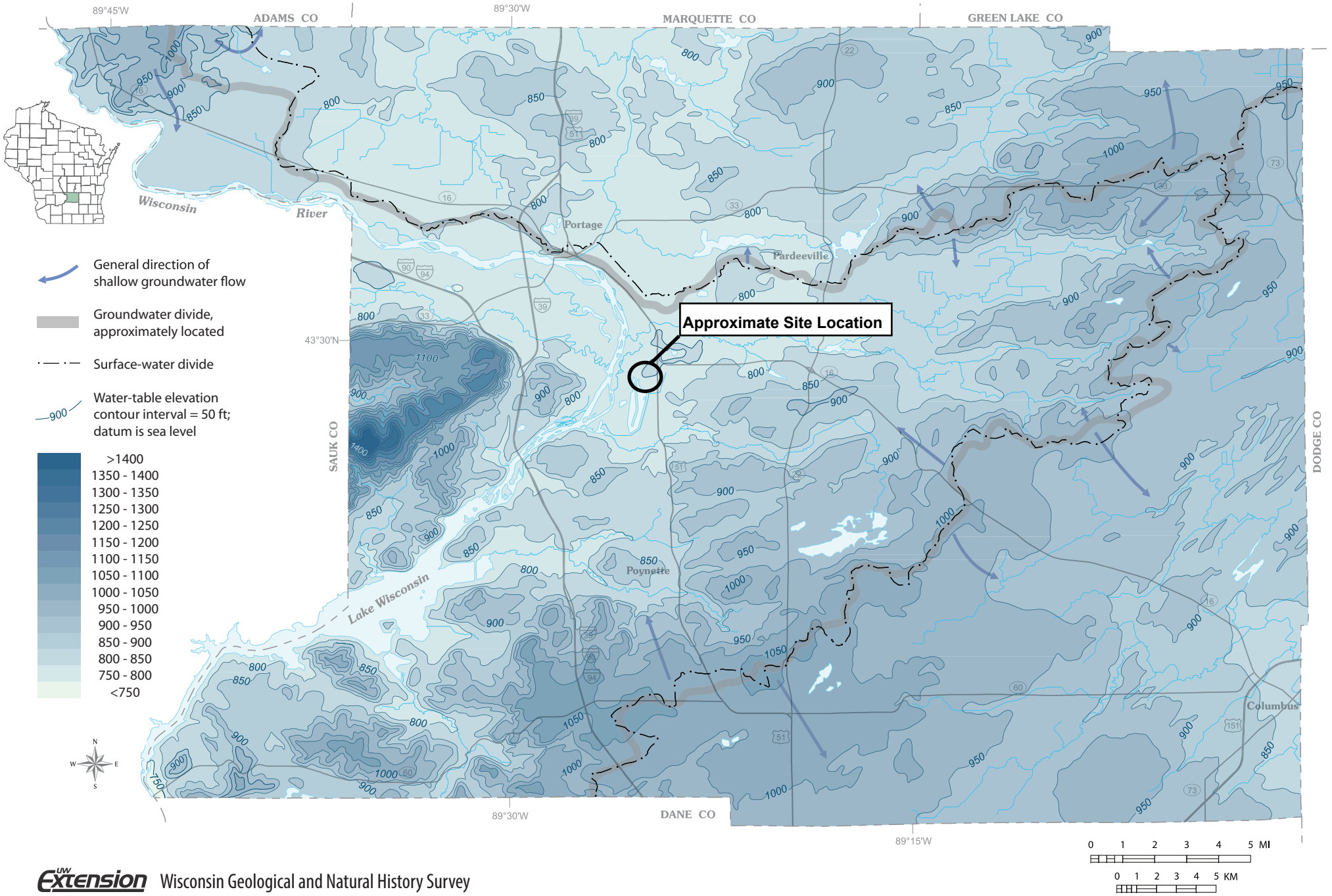
Shows altitude of bedrock surface. Contour interval 200 feet, with supplemental dashed 100 foot contours. Datum is mean sea level

Figure 3. Bedrock topography.

Source: Harr, C.A., L.C. Trotta, and R.G. Borman, "Ground-Water Resources and Geology of Columbia County, Wisconsin," University of Wisconisn-Extension Geological and Natural History Surevy Information Circular Number 37, 1978.

09/28/2023 - Classification: Internal - ECRM13153872

Generalized water-table elevation in Columbia County, Wisconsin



Wisconsin Geological and Natural History Survey

09/28/2023 Classification: Internal FORM#3153873

Source: Selkwood, Stephen R., Wisconsin Geologic and Natural History Survey, Water Table Elevation, Groundwater Resources of Columbia County Wisconsin,

Table COL-3. Regional Hydrogeologic Stratigraphy
Columbia Energy Center / SCS Engineers Project #25215053

Approximate Age	Hydrogeologic Unit	General Thickness (feet)	Name of Rock Unit*	Predominant Lithology
Quaternary (0-1 million years old)	Surficial Aquifer	0 to 300+	Holocene & Pleistocene Deposits	• Unconsolidated clay, silt, sand, gravel, cobbles, boulders, and organic matter
Ordovician (460 to 490 million years old)	Sandstone Aquifer	0 to 800+	Galena Decorah Platteville St. Peter Prairie du Chien	• Dolomite and shaley dolomite • Sandstone
Cambrian (490 to 500 million years old)			Trempeleau Franconia Galesville Eau Claire Mt. Simon	• Sandstone
Precambrian (more than 1 billion years old)	Used for domestic supply in some areas	--	Precambrian	• Igneous and metamorphic rocks

*This nomenclature and classification of rock units in this report are those of the Wisconsin Geological and Natural History Survey and do not necessarily coincide with those accepted by the U.S. Geological Survey.

Sources:

Harr, C.A., L.C. Trotta, and R.G. Borman, "Ground-Water Resources and Geology of Columbia County, Wisconsin," University of Wisconsin-Extension Geological and Natural History Survey Information Circular Number 37, 1978.

Wisconsin Geological and Natural History Survey, Bedrock Stratigraphic Units in Wisconsin, UW Extension Educational Series 51, ISSN: 1052-2115, 2011.

I:\25215053\Reports\Report 3 - Columbia\Tables\Table_2_Regional_Hydrogeologic_Stratigraphy.doc

09/28/2023 - Classification: Internal - ECRM13153872

Attachment B

Monitoring Well Boring Logs

09/28/2023 - Classification: Internal - ECRM13153872

State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION

Form 4400-122 Rev. 7-98

Route To: Watershed/Wastewater ☐ Waste Management ☒
Remediation/Redevelopment ☐ Other ☐

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Alliant Energy - Columbia	03025	MW-33AR

Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Ryan Fisher Boart Longyear	4/9/2003	4/9/2003	4 1/4" HSA

WI Unique Well No.	DNR Well ID No.	Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
PE223	138	MW-33AR	Feet MSL	805.4 Feet MSL	8.0 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☒
State Plane 542,663 N, 2,123,584 E S/C/N
NE 1/4 of SW 1/4 of Section 27, T 12 N, R 9 E
Lat ° ' "
Long ° ' "
Local Grid Location ☐ N ☐ E Feet ☐ S Feet ☐ W

Facility ID	County	County Code	Civil Town/City/ or Village
111049180	Columbia	11	Pacific

Sample Number and Type	Sample Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			2.5 5.0 7.5 10.0 12.5 15.0 17.5 20.0 22.5 25.0 27.5	**Blind drilled to 29 feet. See log of MW-33BR for lithology.**	SM									
				End of boring at 29 feet.										

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature RMA Firm RMT, Inc. Tel: Fax:

This form is authorized by Chapters 281, 283, 289, 291, 292, 293, 295, and 299, Wis. Stats. Completion of this form is mandatory. Failure to file this form may result in forfeiture of between $10 and $25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on this form is not intended to be be used for any other purpose. NOTE: See instructions for more information, including where the completed form should be sent.

WDNR_SBL_98 03024WDRY.GPJ WI_DNR98.GDT 7/18/03

09/28/2023 - Classification: Internal - ECRM13153872

State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION

Form 4400-122 Rev. 7-98

Route To: Watershed/Wastewater ☐ Waste Management ☒
Remediation/Redevelopment ☐ Other ☐

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
Alliant Energy - Columbia	03025	MW-33BR

Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Ryan Fisher Boart Longyear	4/8/2003	4/9/2003	4 1/4" HSA

WI Unique Well No.	DNR Well ID No.	Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
PE224	140	MW-33BR	785.3 Feet MSL	805.3 Feet MSL	8.0 inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☒
State Plane 542,660 N, 2,123,585 E S/C/N
NE 1/4 of SW 1/4 of Section 27, T 12 N, R 9 E
Lat ° ' "
Long ° ' "
Local Grid Location ☐ N ☐ E Feet ☐ S Feet ☐ W

Facility ID	County	County Code	Civil Town/City/ or Village
111049180	Columbia	11	Pacific

Sample Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
AUGER	60		1–15											
1 SS	24	4 4 4 4	5–6	**SILTY SAND (SM),** 85% fine to medium sand, 15% fines, nonplastic, 10YR 5/4 yellowish brown, no odor, moist.	SM									
2 SS	24	3 5 5 5	10–11											

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature Firm RMT, Inc. Tel: Fax:

This form is authorized by Chapters 281, 283, 289, 291, 292, 293, 295, and 299, Wis. Stats. Completion of this form is mandatory. Failure to file this form may result in forfeiture of between $10 and $25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on this form is not intended to be be used for any other purpose. NOTE: See instructions for more information, including where the completed form should be sent.

WDNR_SBL_98 03024WDRY.GPJ WI_DNR98.GDT 7/18/03

09/28/2023 - Classification: Internal - ECRM13153872

State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION SUPPLEMENT
Form 4400-122A

Boring Number MW-33BR Use only as an attachment to Form 4400-122.

Sample Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
3 SS	24	4 5 4 5	16											
			17											
			18											
			19											
4 SS	24	4 3 4 4	20	Same as above, but wet.			▼							
			21											
			22											
			23		SM									
			24											
5 SS	24	50/0	25	Hit a rock, auger through.										
			26											
			27											
			28											
			29											
6 SS	24	8 20 19 27	30	**SILTY SAND WITH GRAVEL (SM),** 70% fine to medium sand, 15% gravel, 15% fines, nonplastic, 10YR 4/3 brown, wet, dense.										
			31											
			32											
			33											
			34											
7 SS	24	10 17 19 24	35		SM									
			36											
			37											
			38											
			39											
			40											

WDNR_SBL_98 03024WDRY.GPJ WI_DNR98.GDT 7/18/03

09/28/2023 - Classification: Internal - ECRM13153872

State of Wisconsin
Department of Natural Resources

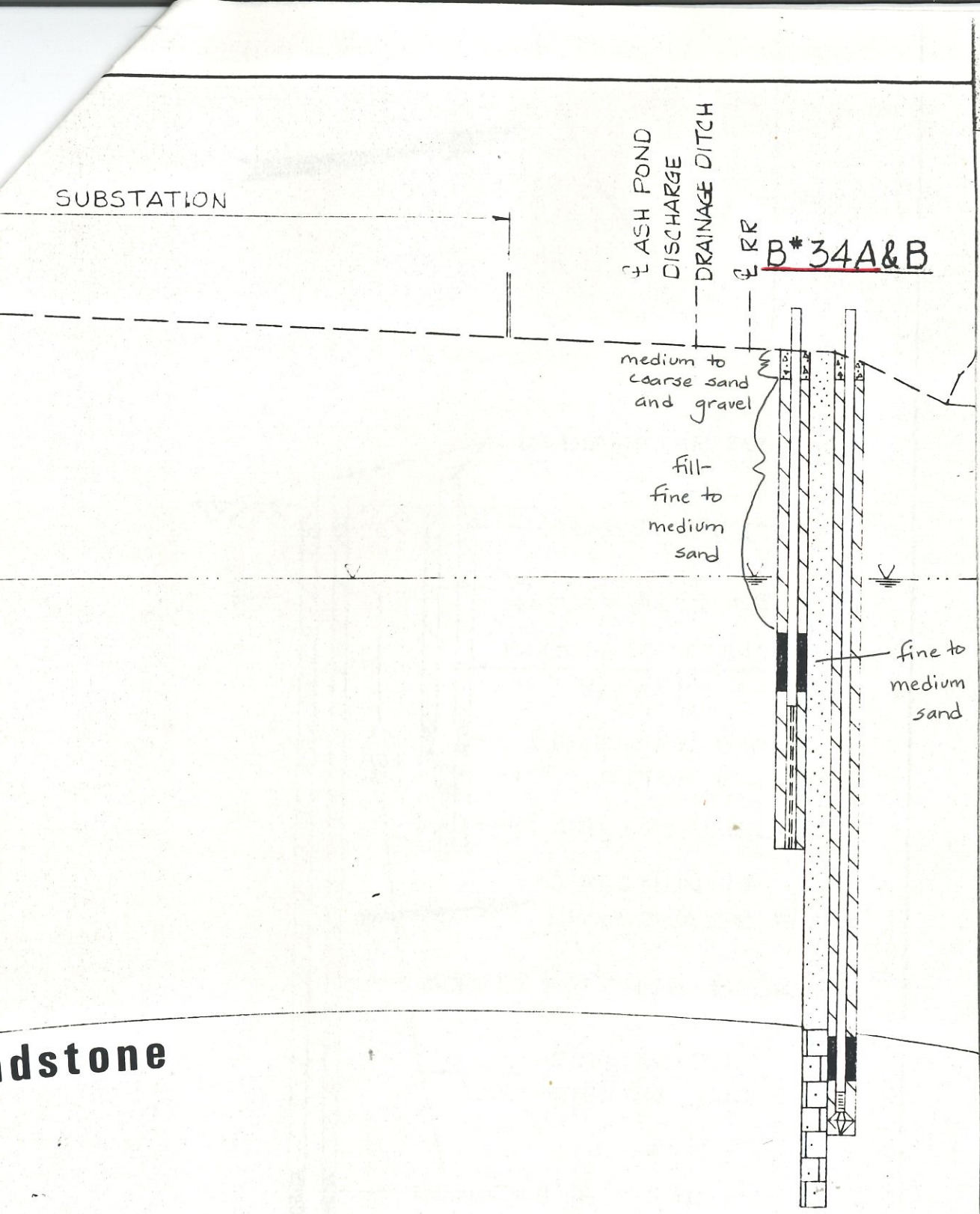
SOIL BORING LOG INFORMATION SUPPLEMENT
Form 4400-122A

Boring Number MW-33BR Use only as an attachment to Form 4400-122. Page 3 of 3

Sample Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
8 SS	24	18 20 28 39	41 42 43 44	Same as above.										
9 SS	24	27 50/2	45 46 47 48 49 50 51		SM									
10 SS	24	7 50/1	52 53 54 55 56	**WEATHERED SANDSTONE,** 95% poorly graded medium sand, 5% fines, white to brown, well sorted and rounded, poorly cemented.										
				End of boring at 56 feet.										

WDNR_SBL_98 03024WDRY.GPJ WI_DNR98.GDT 7/18/03

09/28/2023 - Classification: Internal - ECRM13153872



dstone

Scale:

Horizontal 1"=100'

Vertical 1"=10'

No legend available

Warzyn Engineering Inc.

Geologic Cross Sections

Drawing No. C7134-11

Date 1-20-78

09/28/2023 - Classification: Internal - ECRM13153872

DEPARTMENT OF NATURAL RESOURCES

SAMPLING POINT ID FORM
FORM 4400-40 REV. 6-79

FACILITY NAME: Wisconsin Power and Light Co. / Dry Ash

SAMPLING REQUIRED (✓ ONE): ☐ YES ☐ NO

POINT (✓ ONE): ☐ CAN BE SAMPLED ☐ CANNOT BE SAMPLED

COMMON NAME OF SAMPLING POINT: mw 34A

PREVIOUS COMMON NAME OF SAMPLING POINT:

FACILITY ID NO.:

POINT ID NO.:

TYPE OF POINT (✓ ONE)

1 (G) GROUND WATER
11 ☒ MONITOR WELL
12 ☐ PIEZOMETER
13 ☐ PRIVATE WELL
14 ☐ LYSIMETER
15 ☐ SPRING
16 ☐ RESISTIVITY PROBE

2 (L) LEACHATE
21 ☐ FLOW OR SEEP
22 ☐ POND
23 ☐ COLLECTION SYSTEM

3 (S) SURFACE WATER
31 ☐ UPSTREAM
32 ☐ MID-SITE
33 ☐ DOWNSTREAM
34 ☐ RUN-OFF
35 ☐ IMPOUNDED

POINT LOCATION
(+) ☒ E. (-) ☐ W. 2,155.200 FT.
(+) ☒ N. (-) ☐ S. 541.740 FT.
FROM ☒ GRIC ORIGIN ☐ BENCHMARK

DATE POINT ESTABLISHED: 09/28/77 (MON DAY YEAR)

6 COMMENTS ABOUT SAMPLING POINT:
Well depth - 30.6' Gradient from landfill- down gradient
Geologic formation of well screen- sand
Location of well seals/materials used- bentonite seal above well screen

WELL DESCRIPTION

PIPE DIAMETER: 2.00 INCHES

PIPE TOP ELEVATION: 806.00 FEET ☒ MSL ☐ SITE

GROUND SURFACE ELEVATION: 802.70 FEET ☒ MSL ☐ SITE

TYPE OF CASING (✓ ONE): ☒ 1 PLASTIC ☐ 2 STEEL

7 COMMENTS ABOUT REQUIRED SAMPLING:
Avg. vol. of water to be bailed:
Groundwater flow - westerly

REQUIRED SAMPLING (MG/L except as noted)

	NO.	PARAMETERS	MONTHS OF REQUIRED SAMPLING
■	00410	ALKALINITY (AS CA CO_3)	1-2-3-4-5-6-7-8-9-10-11-12
☐	00310	BOD (5 DAY)	1-2-3-4-5-6-7-8-9-10-11-12
☐	00916	CALCIUM	1-2-3-4-5-6-7-8-9-10-11-12
☐	00307	CHLORIDES	1-2-3-4-5-6-7-8-9-10-11-12
☐	00340	COD	1-2-3-4-5-6-7-8-9-10-11-12
■	00872	CONDUCTIVITY (SU)	1-2-3-4-5-6-7-8-9-10-11-12
☐	00277	COPPER (DISSOLVED)	1-2-3-4-5-6-7-8-9-10-11-12
■	00900	HARDNESS (AS CA CO_3)	1-2-3-4-5-6-7-8-9-10-11-12
■	01046	IRON (DISSOLVED)	1-2-3-4-5-6-7-8-9-10-11-12
☐	00348	MAGNESIUM	1-2-3-4-5-6-7-8-9-10-11-12
☐	00620	NITRATES (AS NO_3)	1-2-3-4-5-6-7-8-9-10-11-12
☐	00640	NITROGEN (TOTAL INOGRANIC N)	1-2-3-4-5-6-7-8-9-10-11-12
■	00400	PH (SU)	1-2-3-4-5-6-7-8-9-10-11-12
☐	00129	PHENOLS	1-2-3-4-5-6-7-8-9-10-11-12
■	00929	SODIUM	1-2-3-4-5-6-7-8-9-10-11-12
■	00945	SULFATES	1-2-3-4-5-6-7-8-9-10-11-12
☐	00360	TOTAL DIS. SOLIDS	1-2-3-4-5-6-7-8-9-10-11-12
■	00842	WATER ELEVATION (FT. MSL)	1-2-3-4-5-6-7-8-9-10-11-12
☐	00275	ZINC (DISSOLVED)	1-2-3-4-5-6-7-8-9-10-11-12

	NO.	PARAMETERS (OTHERS)	MONTHS
■	01022	Boron	1-2-3-4-5-6-7-8-9-10-11-12
■		Color	1-2-3-4-5-6-7-8-9-10-11-12
■		Odor	1-2-3-4-5-6-7-8-9-10-11-12
■		Turbidity	1-2-3-4-5-6-7-8-9-10-11-12
■	01002	Arsenic	1-2-3-4-5-6-7-8-9-10-11-12
■	01007	Barium	1-2-3-4-5-6-7-8-9-10-11-12
■	00312	Cadmium	1-2-3-4-5-6-7-8-9-10-11-12
■	00273	Chromium	1-2-3-4-5-6-7-8-9-10-11-12
■	00240	Lead	1-2-3-4-5-6-7-8-9-10-11-12
■	00126	Mercury	1-2-3-4-5-6-7-8-9-10-11-12
■	00270	Selenium	1-2-3-4-5-6-7-8-9-10-11-12
■	01077	Silver	1-2-3-4-5-6-7-8-9-10-11-12

09/28/2023 - Classification: Internal - ECRM13153872

WARZYN ENGINEERING INC

LOG OF TEST BORING

Project: Wisconsin Power & Light

Location: Columbia Generating Station

Boring No.: MW-84A
Surface Elevation: 813.4
Job No.: C 7134
Sheet: 1 of 1

1409 EMIL STREET • P.O. BOX 9538, MADISON, WIS. 53715 • TEL. (608) 257-4848

SAMPLE						VISUAL CLASSIFICATION and Remarks	SOIL PROPERTIES				
Recovery		Moisture									
No.	Type	↓	↓	N	Depth		q_u	W	LL	PL	D
						Dark Brown Silty SAND (SM)					
					5						
						Brown Fine to Medium SAND, Little Silt, Trace to Little Gravel and Boulders (SM)					
					10						
					15						
					20						
					25						
					30						
					35						
					40	End Boring at 37'					
						Well Installed at 37'					

WATER LEVEL OBSERVATIONS

While Drilling
Upon Completion of Drilling
Time After Drilling
Depth to Water
Depth to Cave In

GENERAL NOTES

Start: 10/5/83 Complete: 10/5/83
Crew Chief: JVS Rig: B-40
Drilling Method: ED 0-37'

09/28/2023 - Classification: Internal - ECRM13153872

State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION

Form 4400-122 Rev. 7-98

Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☐ Other ☐

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
WPL-Columbia SCS#: 25215135.00		MW-301

Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Kevin Durst Badger State Drilling	11/11/2015	11/11/2015	hollow stem auger

WI Unique Well No.	DNR Well ID No.	Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
VY701			Feet	803.69 Feet	8.5 in.

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☒
State Plane 541562.2 N, 2025001.0 E S/C/N
1/4 of 1/4 of Section 27, T 12 N, R 9 E
Lat ° ' "
Long ° ' "
Local Grid Location ☐ N ☐ E Feet ☐ S Feet ☐ W

Facility ID	County	County Code	Civil Town/City/ or Village
	Columbia	11	Portage

Sample Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Pocket Penetration (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
S1	21	7 6 9 10	1–2	SILTY SAND, yellowish brown (10YR 5/6), fine to medium grained.						M				
S2	20	6 7 9 10	3–4	Same as above except, 10YR 5/4 (top section), 10YR 3/6 (bottom section), trace gravel.						M				
S3	22	7 6 9 6	5–7	Same as above except, 10YR 3/4 (bottom), 10YR 5/4 (top), trace little roots and sticks, trace gravel.	SM					M				
S4	21	4 5 6 5	8–10	Same as above except, 10YR (top), 10YR 4/6 (bottom), trace clay at bottom.						M				
S5	18	2 2 4 5	11–12	Same as above except, fine to coarse grained sand, little gravel, trace clay in top half, 10YR 3/6.						M				
S6	20	2 3 3 3	13–15	Same as above except, 10YR 6/8.						M				

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature [signature] Firm SCS Engineers
2830 Dairy Drive Madison, WI 53711
Tel: (608) 224-2830
Fax:

This form is authorized by Chapters 281, 283, 289, 291, 292, 293, 295, and 299, Wis. Stats. Completion of this form is mandatory. Failure to file this form may result in forfeiture of between $10 and $25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on this form is not intended to be be used for any other purpose. NOTE: See instructions for more information, including where the completed form should be sent.

09/28/2023 - Classification: Internal - ECRM13153872

State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION SUPPLEMENT
Form 4400-122A

Boring Number MW-301 Use only as an attachment to Form 4400-122.

Sample Number and Type	Sample Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Pocket Penetration (tsf)	Soil Properties: Moisture Content	Soil Properties: Liquid Limit	Soil Properties: Plasticity Index	Soil Properties: P 200	RQD/ Comments
			16	SILTY SAND, yellowish brown (10YR 5/6), fine to medium grained.										
S7	20	5 4 4 3	17							M				
			18											
			19											
S8	20	2 4 4 5	20							W				
			21											
					SM									
S9	23	4 4 3 6	22							W				
			23											
			24	Same as above except, 10YR 6/4.										
S10	21	3 2 4 10	25							W				
			26											
			27											
			28											
				End of boring at 28 ft bgs.										

09/28/2023 - Classification: Internal - ECRM13153872

State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION

Form 4400-122 Rev. 7-98

Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☐ Other ☐

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
WPL-Columbia SCS#: 25215135.00		MW-302

Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Kevin Durst Badger State Drilling	11/11/2015	11/12/2015	hollow stem auger

WI Unique Well No.	DNR Well ID No.	Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
VY702			Feet	809.93 Feet	8.5 in.

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☒
State Pla 541964.7 N, 2123849 E S/C/N
1/4 of 1/4 of Section 27, T 12 N, R 9 E
Lat ° ' "
Long ° ' "
Local Grid Location ☐ N ☐ E Feet ☐ S Feet ☐ W

Facility ID	County	County Code	Civil Town/City/ or Village
	Columbia	11	Portage

Sample Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Pocket Penetration (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
S1	12	10 13 17 16	1–2	SILTY SAND, fine to medium grained, trace gravel, 10YR 5/6.						M				
S2	12	10 12 8 6	4–5	Same as above except, large gravel at bottom, trace to little gravel.						M				
S3	20	2 4 4 5	6–7	Same as above except, 10YR 4/6.	SM					M				
S4	23	3 3 4 5	9–10	Same as above except, 10YR 5/8.						M				
S5	20	3 3 3 4	11–12	Same as above except, 10YR 6/6.						M				
S6	20	3 4 4 7	14–15	POORLY GRADED SAND, 10YR 6/6.	SP					M				

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature for Zach Watson Firm SCS Engineers 2830 Dairy Drive Madison, WI 53711 Tel: (608) 224-2830 Fax:

This form is authorized by Chapters 281, 283, 289, 291, 292, 293, 295, and 299, Wis. Stats. Completion of this form is mandatory. Failure to file this form may result in forfeiture of between $10 and $25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on this form is not intended to be be used for any other purpose. NOTE: See instructions for more information, including where the completed form should be sent.

09/28/2023 - Classification: Internal - ECRM13153872

State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION SUPPLEMENT
Form 4400-122A

Boring Number MW-302 Use only as an attachment to Form 4400-122. Page 2 of 2

Sample Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Pocket Penetration (tsf)	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			16	POORLY GRADED SAND, light tan 10YR 8/3.										
S7	20	6 8 10 12	17							M				
			18											
			19		SP									
S8	20	5 6 8 8	20							M				
			21											
S9	19	3 3 3 2	22							M				
			23											
			24	SILTY SAND, 10YR 5/6.	SM									
S10	20	3 3 8 8	25	POORLY GRADED SAND, 10YR 8/3.						W				
			26	Same as above except, light tan 10YR 6/6.										
S11	23	5 9 12 12	27							W				
			28											
			29											
			30		SP									
			31											
			32											
			33											
			34											
			35	End of boring at 35 ft bgs.										

09/28/2023 - Classification: Internal - ECRM13153872

State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION
Form 4400-122 Rev. 7-98

Route To: Watershed/Wastewater ☐ Waste Management ☒
Remediation/Redevelopment ☐ Other ☐

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
WPL - Alliant Columbia Generating Station SCS#: 25217156.01		MW-309

Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Mark Crampton Badger State Drilling, Co.	2/13/2018	2/14/2018	hollow stem auger

WI Unique Well No.	DNR Well ID No.	Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
VR111		MW-309	26.7 Feet MSL	809.88 Feet MSL	8.5 in.

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☒
State Plane 543,448 N, 2,124,151 E S/C/N
NW 1/4 of SE 1/4 of Section 27, T 12 N, R 9 E
Lat ° ' "
Long ° ' "
Local Grid Location Feet ☐ N ☐ S Feet ☐ E ☐ W

Facility ID	County	County Code	Civil Town/City/ or Village
	Columbia	11	Town of Pacific

Sample Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Standard Penetration	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			1–8	Hydrovaced boring to 8.5 below ground surface; open hole.										
S1	20	11 14 18	9–10	POORLY GRADED SAND, fine to coarse, yellow, (10YR 7/6), rounded grains.					N/A	M				
S2	20	12 15 20 28	11–12	Same but with trace gravel.	SP				N/A	M				
S3	24	16 20 26	13–15	Same as above but with no gravel.					N/A	M				

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature

Firm SCS Engineers
2830 Dairy Drive Madison, WI 53711
Tel: (608) 224-2830
Fax:

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State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION SUPPLEMENT
Form 4400-122A

Boring Number MW-309 Use only as an attachment to Form 4400-122. Page 2 of 2

Sample Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Standard Penetration	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			16	POORLY GRADED SAND, fine to coarse, yellow, (10YR 7/6), rounded grains, trace silt.										
S4	22	11 17 32 41	17						N/A	M				
			18											
			19											
S5		22 29 36	20						N/A	M				
			21											
S6	24	18 20 28 36	22						N/A	M				
			23											
			24											
S7		18 24 32	25		SP				N/A	M				
			26											
S8	22	14 18 30 40	27						N/A	W				Depth to water at ~ 26 feet.
			28											
			29											
S9	22	22 32 34	30						N/A	W				
			31											
			32											
			33											
			34											
			35											
			36											
				End of Boring at 36.5 feet bgs.										

09/28/2023 - Classification: Internal - ECRM13153872

State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION

Form 4400-122 Rev. 7-98

Route To: Watershed/Wastewater ☐ Waste Management ☒
Remediation/Redevelopment ☐ Other ☐

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
WPL - Alliant Columbia Generating Station SCS#: 25217156.01		MW-310

Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Dave Cruise Badger State Drilling, Co.	2/13/2018	2/13/2018	hollow stem auger

WI Unique Well No.	DNR Well ID No.	Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
VR110		MW-310	27.9 Feet MSL	810.96 Feet MSL	8.5 in.

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☒
State Plane 543,332 N, 2,123,880 E S/C/N
NW 1/4 of SE 1/4 of Section 27, T 12 N, R 9 E
Lat ° ' "
Long ° ' "
Local Grid Location Feet ☐ N ☐ S Feet ☐ E ☐ W

Facility ID	County	County Code	Civil Town/City/ or Village
	Columbia	11	Town of Pacific

Sample Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Standard Penetration	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			1–8	Hydrovaced boring to 8 feet below ground surface; open hole.										
S1	18	4 6 8 8	9–10	POORLY GRADED SAND AND GRAVEL, fine to medium sand, coarse gravel, brownish yellow, (10YR 6/6), angular gravel, round sand.	SP				N/A	M				
S2	24	18 27 38 40	11–12	Same as above but trace gravel.					N/A	M				
S3	24	26 32 40 38	13–15						N/A	M				

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature	Firm	Tel:
	SCS Engineers 2830 Dairy Drive Madison, WI 53711	(608) 224-2830 Fax:

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State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION SUPPLEMENT
Form 4400-122A

Boring Number MW-310 Use only as an attachment to Form 4400-122. Page 2 of 2

Sample Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Standard Penetration	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			16	POORLY GRADED SAND AND GRAVEL, fine to medium sand, coarse gravel, brownish yellow, (10YR 6/6), angular gravel, round sand.										
S4	10	25 50/5	17						N/A	M				Tough drilling.
			18											
			19											
S5	24	38 60 50/4	20						N/A	M				
			21											
S6	12	38 50/5	22						N/A	M				
			23											
			24											
S7	24	32 46 50/4	25						N/A	M				
			26		SP									
S8	16	25 40 50/5	27						N/A	W				Depth to water at ~26 feet.
			28											
			29											
S9		32 25 50/5	30						N/A	W				
			31											
			32											
			33											
			34											
			35											
			36											
				End of Boring at 36.5 feet bgs.										

09/28/2023 - Classification: Internal - ECRM13153872

State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION

Form 4400-122 Rev. 7-98

Route To: Watershed/Wastewater ☐ Waste Management ☒
Remediation/Redevelopment ☐ Other ☐

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
WPL - Alliant Columbia Generating Station SCS#: 25217156.01		MW-311

Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Mark Crampton Badger State Drilling, Co.	2/14/2018	2/14/2018	hollow stem auger

WI Unique Well No.	DNR Well ID No.	Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
VR112		MW-311	23.5 Feet MSL	806.53 Feet MSL	8.5 in.

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☒
State Plane 542,874 N, 2,123,437 E S/C/N
NE 1/4 of SW 1/4 of Section 27, T 12 N, R 9 E
Lat ° ' "
Long ° ' "
Local Grid Location Feet ☐ N ☐ S Feet ☐ E ☐ W

Facility ID	County	County Code	Civil Town/City/ or Village
	Columbia	11	Town of Pacific

Sample Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Standard Penetration	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			1	Hydrovaced boring to 8 feet below ground surface; open hole.										
			2											
			3											
			4											
			5											
			6											
			7											
			8											
S1	24	12 16 20 24	9	POORLY GRADED SAND AND GRAVEL, fine to coarse sand, coarse gravel, yellow, (10YR 7/6), rounded sand, angular gravel.					N/A	M				
			10											
			11											
S2	24	17 27 30 38	12	Same as above but with trace silt.	SP				N/A	M				
			13											
			14											
S3	24	18 26 31	15						N/A	M				

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature	Firm	Tel: (608) 224-2830
	SCS Engineers 2830 Dairy Drive Madison, WI 53711	Fax:

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State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION SUPPLEMENT
Form 4400-122A

Boring Number MW-311 Use only as an attachment to Form 4400-122. Page 2 of 2

Sample Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Standard Penetration	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			16	POORLY GRADED SAND AND GRAVEL, fine to coarse sand, coarse gravel, yellow, (10YR 7/6), rounded sand, angular gravel, trace silt.										
S4	24	18 30 40 50/5	17						N/A	M				
			18											
			19											
S5	24	30 40 45	20						N/A	M				
			21											
S6	8	45 34 50/3	22						N/A	M+/W				
			23											
			24		SP									
S7	18	46 50/5	25						N/A	W				Depth to water at ~25 feet.
			26											
S8	20	46 54 54 50/4	27						N/A	W				
			28											
			29											
S9	24	25 38 50/5	30	Same as above but with thin silt seams.					N/A	W				
			31											
			32											
			33	End of Boring at 33 feet bgs.										

09/28/2023 - Classification: Internal - ECRM13153872

State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION

Form 4400-122 Rev. 7-98

Route To: Watershed/Wastewater ☐ Waste Management ☒
Remediation/Redevelopment ☐ Other ☐

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
WPL - Columbia Dry Ash Disposal Facility SCS#: 25220183.00	03025	B-313X

Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Adam Sweet Horizon Construction and Exploration	12/1/2022	12/1/2022	Geoprobe/HSA

WI Unique Well No.	DNR Well ID No.	Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
			Feet MSL	Feet MSL	2.0/8.25 in.

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☐
State Plane N, E S/C/N
NW 1/4 of NE 1/4 of Section 27, T 12 N, R 9 E
Lat ° ' "
Long ° ' "
Local Grid Location
Feet ☐ N ☐ S Feet ☐ E ☐ W

Facility ID	County	County Code	Civil Town/City/ or Village
111049180	Columbia	11	Town of Pacific

Sample Number and Type	Sample Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Standard Penetration	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			1	SILTY GRAVEL, fine to medium sand, fine to coarse gravel, tan, angular gravel (base course/fill).	GM									
			2	POORLY GRADED SAND, fine to medium, medium brown (7.5Y 5/4), trace angular fine to coarse gravel, trace silt, uniform (alluvium).										
S1	44		3							M				Geoprobed to 35 ft. Overdrilled with HSA to 27ft and hit refusal.
			4											
			5											
			6											
			7											
S2	47		8		SP					M				
			9											
			10											
			11											
			12											
S3	60		13							M				
			14											
			15											

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature	Firm		Tel:
	SCS Engineers	2830 Dairy Drive, Madison, WI 53718 608-224-3830	Fax:

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State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION SUPPLEMENT
Form 4400-122A

Boring Number B-313X Use only as an attachment to Form 4400-122.

Sample Number and Type	Sample Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Standard Penetration	Soil Properties: Moisture Content	Soil Properties: Liquid Limit	Soil Properties: Plasticity Index	Soil Properties: P 200	RQD/ Comments
S4	53		16–18							M				
S5	60		19–23							M				
			24–25		SP									
S6	30		26–27							M				Tough/hard drilling, only pushed 2.5 ft
S7	30		28–29							M				HSA refusal at approximately 27 ft; large boulder at depth
S8	60		30–33	Pulverized gravel at base of core.						M				Geoprobe refusal at 35 ft
			34–35	End of Borehole at 35 ft below ground surface. Abandoned borehole with 3/8" bentonite chips. Attempted monitoring wel MW-313 installation.										

09/28/2023 - Classification: Internal - ECRM13153872

State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION

Form 4400-122 Rev. 7-98

Route To: Watershed/Wastewater ☐ Waste Management ☒
Remediation/Redevelopment ☐ Other ☐

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
WPL - Columbia Dry Ash Disposal Facility SCS#: 25220183.00	03025	MW-313

Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Adam Sweet Horizon Construction and Exploration	12/19/2022	12/19/2022	rotosonic

WI Unique Well No.	DNR Well ID No.	Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
WC188		MW-313	Feet MSL	~817.80 Feet MSL	6.0 in.

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☒
State Plane 542,957 N, 2,124,559 E S/C/N
NW 1/4 of NE 1/4 of Section 27, T 12 N, R 9 E
Lat ° ' "
Long ° ' "
Local Grid Location Feet ☐ N ☐ S Feet ☐ E ☐ W

Facility ID	County	County Code	Civil Town/City/ or Village
111049180	Columbia	11	Town of Pacific

Sample Number and Type	Sample Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Standard Penetration	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			1–15	Blind drilled to 32 feet below ground surface. See boring log B-313X for lithology from 0-32 feet.										

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature Firm SCS Engineers 2830 Dairy Drive, Madison, WI 53718 Tel: 608-224-3830 Fax:

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State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION SUPPLEMENT
Form 4400-122A

Boring Number MW-313 Use only as an attachment to Form 4400-122.

Sample: Number and Type	Sample: Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID/FID	Soil Properties: Standard Penetration	Soil Properties: Moisture Content	Soil Properties: Liquid Limit	Soil Properties: Plasticity Index	Soil Properties: P 200	RQD/ Comments
			16											
			17											
			18											
			19											
			20											
			21											
			22											
			23											
			24											
			25											
			26											
			27											
			28											
			29											
			30											
			31											
			32	POORLY GRADED SAND, fine to medium, brown (7.5Y, 5/4), trace angular to sub-rounded fine to coarse gravel, trace silt, massive, (alluvium).										
			33											
			34											
			35											
			36		SP									
			37											
			38											
			39							W				Depth to water ~34-35 ft
			40											

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State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION SUPPLEMENT
Form 4400-122A

Boring Number MW-313 Use only as an attachment to Form 4400-122.

Sample									Soil Properties						
Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID/FID	Standard Penetration	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			41		SP									
			42											
			43											
			44											
			45	End of boring at 45 feet below ground surface. Installed monitoring well MW-313 at 43 feet.										

09/28/2023 - Classification: Internal - ECRM13153872

State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION

Form 4400-122 Rev. 7-98

Route To: Watershed/Wastewater ☐ Waste Management ☒
Remediation/Redevelopment ☐ Other ☐

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
WPL - Columbia Dry Ash Disposal Facility SCS#: 25220183.00	03025	MW-314

Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Adam Sweet Horizon Construction and Exploration	12/1/2022	12/1/2022	Geoprobe/HSA

WI Unique Well No.	DNR Well ID No.	Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
WC199		MW-314	Feet MSL	~819.07 Feet MSL	2.0/8.25 in.

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☒
State Plane 542,978 N, 2,124,778 E S/C/N
NW 1/4 of NE 1/4 of Section 27, T 12 N, R 9 E
Lat ° ' "
Long ° ' "
Local Grid Location Feet ☐ N ☐ S Feet ☐ E ☐ W

Facility ID	County	County Code	Civil Town/City/ or Village
111049180	Columbia	11	Town of Pacific

Sample Number and Type	Sample Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Standard Penetration	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
S1	36		1–6	POORLY GRADED SAND, fine to coarse, light brown (fill).	SP					M				Geoprobed to 45 ft, overdrilled with HSA to 45 ft
S2	36		6–11	POORLY GRADED SAND, fine to medium, light olive brown (2.5Y, 5/6), trace sub-rounded to sub-angular fine to coarse gravel (alluvium).	SP					M				
S3	32		11–15							M				

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature	Firm		Tel:
	SCS Engineers	2830 Dairy Drive, Madison, WI 53718 608-224-3830	Fax:

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State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION SUPPLEMENT
Form 4400-122A

Boring Number MW-314 Use only as an attachment to Form 4400-122.

Sample Number and Type	Sample Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID/FID	Soil Properties: Standard Penetration	Soil Properties: Moisture Content	Soil Properties: Liquid Limit	Soil Properties: Plasticity Index	Soil Properties: P 200	RQD/ Comments
S4	36		16–40		SP					M				
S5	55									M				
S6	60									M				
S7	60									M+				Measured water at approximately 34 ft in augers
S8	60									W				Depth to water ~36 ft

09/28/2023 - Classification: Internal - ECRM13153872

State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION SUPPLEMENT
Form 4400-122A

Boring Number MW-314 Use only as an attachment to Form 4400-122.

Sample									Soil Properties					
Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID/FID	Standard Penetration	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
S9	60		41 42 43 44 45		SP					W				
				End of borehole at 45 ft. Installed MW-314 to 43.5 ft.										

09/28/2023 - Classification: Internal - ECRM13153872

State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION

Form 4400-122 Rev. 7-98

Route To: Watershed/Wastewater ☐ Waste Management ☒
Remediation/Redevelopment ☐ Other ☐

Facility/Project Name	License/Permit/Monitoring Number	Boring Number
WPL - Columbia Dry Ash Disposal Facility SCS#: 25220183.00	03025	MW-315

Boring Drilled By: Name of crew chief (first, last) and Firm	Date Drilling Started	Date Drilling Completed	Drilling Method
Adam Sweet Horizon Construction and Exploration	12/1/2022	12/1/2022	Geoprobe/HSA

WI Unique Well No.	DNR Well ID No.	Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
PM289		MW-315	Feet MSL	~817.28 Feet MSL	2.0/8.25 in.

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☒
State Plane 543,020 N, 2,125,065 E S/C/N
NW 1/4 of NE 1/4 of Section 27, T 12 N, R 9 E
Lat ° ' "
Long ° ' "
Local Grid Location Feet ☐ N ☐ S Feet ☐ E ☐ W

Facility ID	County	County Code	Civil Town/City/ or Village
111049180	Columbia	11	Town of Pacific

Sample Number and Type	Sample Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Standard Penetration	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
S1	42		1–5	POORLY GRADED SAND, fine to medium sand, fine to coarse gravel, medium brown (fill).	SP					M				Geoprobed to 30 ft and hit refusal. Overdrilled to 45 ft with HSA.
S2	37		5–10	POORLY GRADED SAND, fine to medium sand, light brown (7.5YR, 6/4), with fine to coarse sub-rounded to sub-angular gravel, (alluvium).	SP					M				
S3	40		10–15							M				

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature	Firm		Tel:
	SCS Engineers	2830 Dairy Drive, Madison, WI 53718 608-224-3830	Fax:

This form is authorized by Chapters 281, 283, 289, 291, 292, 293, 295, and 299, Wis. Stats. Completion of this form is mandatory. Failure to file this form may result in forfeiture of between $10 and $25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on this form is not intended to be be used for any other purpose. NOTE: See instructions for more information, including where the completed form should be sent.

09/28/2023 - Classification: Internal - ECRM13153872

State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION SUPPLEMENT
Form 4400-122A

Boring Number MW-315 Use only as an attachment to Form 4400-122.

Sample Number and Type	Sample Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID/FID	Soil Properties: Standard Penetration	Soil Properties: Moisture Content	Soil Properties: Liquid Limit	Soil Properties: Plasticity Index	Soil Properties: P 200	RQD/ Comments
S4	60		16–20							M				
S5	60		21–25							M				
S6	27		26–30		SP					M				Sand got more compacted and continued to get more compacted.
S7	4		31–35							W				Attempt of split spoon sample at 34 ft and hit refutal. Depth to waterat ~ 34 ft.
			36–40											

09/28/2023 - Classification: Internal - ECRM13153872

State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION SUPPLEMENT
Form 4400-122A

Boring Number MW-315 Use only as an attachment to Form 4400-122.

Sample									Soil Properties					
Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth In Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	U S C S	Graphic Log	Well Diagram	PID/FID	Standard Penetration	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments
			41		SP									
			42											
			43											
			44											
			45	End of boring at 45 feet. Installed MW-315 to 43 feet.										

09/28/2023 - Classification: Internal - ECRM13153872

Attachment C

Private Well Logs

09/28/2023 - Classification: Internal - ECRM13153872

Wel. 6-30M (6-50)

WELL CONSTRUCTOR'S REPORT TO WISCONSIN STATE BOARD OF HEALTH

See Instructions on Reverse Side

1. County Columbia — Town ☒ Village ☐ City ☐ — Pacific (Check one and give name)

R9E

2. Location Pacific - Township T12N, Rec Sec 27-SE 1/4
Name of street and number of premise or Section, Town and Range numbers

RECEIVED FEB 6 1952 BUREAU SAN. ENG.

3. Owner ☐ or Agent ☐ Dennis Lovell
Name of individual, partnership or firm

4. Mail Address Box 233 Portage Wis.
Complete address required

5. From well to nearest: Building 30 ft; sewer [redacted] ft; drain 55 ft; septic tank 75 ft;
dry well or filter bed 55 ft; abandoned well — ft.

6. Well is intended to supply water for: Slaughter House

7. DRILLHOLE:

Dia. (in.)	From (ft.)	To (ft.)	Dia. (in.)	From (ft.)	To (ft.)

8. CASING AND LINER PIPE OR CURBING:

Dia. (in.)	Kind and Weight	From (ft.)	To (ft.)
4 in	Well Casing Steel	0'	47'

9. GROUT:

Kind	From (ft.)	To (ft.)
Cement top.	0"	10 inch

10. FORMATIONS:

Kind	From (ft.)	To (ft.)
Puddled Clay	0'	15'
Concret Stab.	15'	[redacted] 17'
Washed Sand	17'	35'
1/2 to 2" Washed Gravel	35	45'
(Old Dug well abt - alt 30" Dia.) D Lovell		

Construction of the well was completed on: January 25 1952

The well is terminated 24 inches ☒ above, below ☐ the permanent ground surface.

Was the well disinfected upon completion? Yes X No

Was the well sealed watertight upon completion? Yes X No

11. MISCELLANEOUS DATA:

Yield test: _____ Hrs. at _____ GPM.

Depth from surface to water-level: 42 ft.

Water-level when pumping: 43 ft.

Water sample was sent to the state laboratory at: Madison (City) on Feb. 4 1952

Signature Earl C Sanders — Registered Well Driller

Purdiville Wis RT 2 — Complete Mail Address

Please do not write in space below

Rec'd _____ No. _____

Ans'd _____

Interpretation _____

	10 ml	10 ml	10 ml	10 ml	10 ml
Gas—24 hrs.					
48 hrs.					
Confirm					
B. Coli					

Examiner _____

SEE OTHER SIDE

09/28/2023 - Classification: Internal - ECRM13153872

3471

WISCONSIN UNIQUE WELL NUMBER **BE363**

Source: SWAP PROJECT KEYED

State of Wi-Private Water Systems-DG/2
Department Of Natural Resources, Box 7921
Madison, WI 53707

Form 3300-77A
(Rev 02/02)bw

Depth **255** FT

Property Owner	WISCONSIN POWER & LIGHT CO	Telephone Number	- -
Mailing Address	PO BOX 98		
City	PORTAGE	State WI	Zip Code 53901
County of Well Location	11 COLUMBIA SC	Co Well Permit No W	Well Completion Date December 30, 1971

1. Well Location

T=Town C=City V=Village: **T** of PACIFIC

Fire#

Street Address or Road Name and Number

Subdivision Name | Lot# | Block #

Gov't Lot or **SW** 1/4 of **SW** 1/4 of

Section **27** T **12** N R **9** **E**

Well Constructor	EGERER GALLOWAY WELL CORP	License # 21	Facility ID (Public) 111021460
Address	CARMEN/STATE/N 3RD		Public Well Plan Approval#
City	MILWAUKEE	State WI / Zip Code 53213	Date Of Approval
Hicap Permanent Well #		Common Well #	Specific Capacity 12.5 gpm/ft

2. Well Type **1** (See item 12 below)

1=New 2=Replacement 3=Reconstruction

of previous unique well # _____ constructed in _____

Reason for replaced or reconstructed Well?

3. Well Serves **N** # of homes and or **INDUSTRIAL** (eg: barn, restaurant, church, school, industry, etc.)

M=Munic O=OTM N=NonCom P=Private Z=Other X=NonPot A=Anode L=Loop H=Drillhole

High Capacity: Well? N Property? N

1 1=Drilled 2=Driven Point 3=Jetted 4=Other

4. Is the well located upslope or sideslope and not downslope from any contamination sources, including those on neighboring properties? **N**

Well located in floodplain? **N**

Distance in feet from well to nearest: (including proposed)

1. Landfill
2. Building Overhang
3. 1=Septic 2= Holding Tank
4. Sewage Absorption Unit
5. Nonconforming Pit
6. Buried Home Heating Oil Tank
7. Buried Petroleum Tank
8. 1=Shoreline 2= Swimming Pool
9. Downspout/ Yard Hydrant
10. Privy
11. Foundation Drain to Clearwater
12. Foundation Drain to Sewer
13. Building Drain 1=Cast Iron or Plastic 2=Other
14. Building Sewer 1=Gravity 2=Pressure 1=Cast Iron or Plastic 2=Other
15. Collector Sewer: ___ units ___ in . diam.
16. Clearwater Sump
17. Wastewater Sump
18. Paved Animal Barn Pen
19. Animal Yard or Shelter
20. Silo
21. Barn Gutter
22. Manure Pipe 1=Gravity 2=Pressure 1=Cast iron or Plastic 2=Other
23. Other manure Storage
24. Ditch
25. Other NR 812 Waste Source

5. Drillhole Dimensions and Construction Method

Dia.(in.)	From (ft)	To (ft)
19.0	surface	132
15.0	132	255

Upper Enlarged Drillhole / Lower Open Bedrock

-- 1. Rotary - Mud Circulation
-- 2. Rotary - Air
-- 3. Rotary - Air and Foam
-- 4. Drill-Through Casing Hammer
-- 5. Reverse Rotary
X -- 6. Cable-tool Bit _ n. dia
-- 7. Temp. Outer Casing _ in. dia. _____ depth ft. Removed ?

Other

6. Casing Liner Screen Material, Weight, Specification / Manufacturer & Method of Assembly

Dia. (in.)		From (ft.)	To (ft.)
20.0	STEEL 3/8 WALL A53-B	surface	92
16.0	STEEL 3/8 WALL A53-B	0	132

Dia.(in.)	Screen type, material & slot size	From	To

7. Grout or Other Sealing Material

Method / Kind of Sealing Material	From (ft.)	To (ft.)	# Sacks Cement
NEAT CEMENT	surface	132.0	

Geology Codes	8. Geology Type, Caving/Noncaving, Color, Hardness, etc	From (ft.)	To (ft.)
__T_	GLACIAL DRIFT	0	88
__N_	SANDSTONE	88	255

9. Static Water Level

28.0 feet **B** ground surface (A=Above B=Below)

10. Pump Test

Pumping level **48.0** ft. below surface

Pumping at **250.0** GP **12.0** Hrs

11. Well Is: 24 in. A Grade (A=Above B=Below)

Developed? N

Disinfected? Y

Capped? Y

12. Did you notify the owner of the need to permanently abandon and fill all unused wells on this property? **N**

If no, explain

13. Initials of Well Constructor or Supervisory Driller GG Date Signed 12/30/71

Initials of Drill Rig Operator (Mandatory unless same as above) Date Signed

Additonal Comments?

Owner Sent Label? Y

Variance Issued?

More Geology?

Batch 777777777

09/28/2023 - Classification: Internal - ECRM13153872

DEC 2 0 1972

WELL CONSTRUCTOR'S REPORT *CORRECTED DEC. 14, 1972
FORM 3300-15

NOTE
WHITE COPY – DIVISION'S COPY
GREEN COPY – DRILLER'S COPY
YELLOW COPY – OWNER'S COPY

STATE OF WISCONSIN
DEPARTMENT OF NATURAL RESOURCES
Box 450
Madison, Wisconsin 53701

CO-214-G

1. COUNTY: Columbia

CHECK ONE: [X] Town [ ] Village [ ] City

NAME: Pacific

2. LOCATION – ¼ Section: SW-Sec. | Section: 27 | Township: 12N | Range: 9E

OR – Grid or street no. | Street name:

AND – If available subdivision name, lot & block no.:

3. OWNER AT TIME OF DRILLING: Wisconsin Power & Light Co. Well #2

ADDRESS: P. O. Box 192 Well No. 2

POST OFFICE: Madison, Wis. 53701

4. Distance in feet from well to nearest: (Record answer in appropriate block)

BUILDING	SANITARY SEWER C. I.	SANITARY SEWER TILE	FLOOR DRAIN C. I.	FLOOR DRAIN TILE	FOUNDATION DRAIN SEWER CONNECTED	FOUNDATION DRAIN INDEPENDENT	WASTE WATER DRAIN C. I.	WASTE WATER DRAIN TILE

CLEAR WATER DRAIN C. I.	CLEAR WATER DRAIN TILE	SEPTIC TANK	PRIVY	SEEPAGE PIT	ABSORPTION FIELD	BARN	SILO	ABANDONED WELL	SINK HOLE

OTHER POLLUTION SOURCES (Give description such as dump, quarry, drainage well, stream, pond, lake, etc.)
Site approved #3320

5. Well is intended to supply water for:
Industrial and Potable NORTH WELL P.W.#43224

6. DRILLHOLE

Dia. (in.)	From (ft.)	To (ft.)	Dia. (in.)	From (ft.)	To (ft.)
#19	Surface	152.5			
15	152.5	252.5			

7. CASING, LINER, CURBING, AND SCREEN

Dia. (in.)	Kind and Weight	From (ft.)	To (ft.)
20	Steel x 3/8"	Surface	110.5
	A-53-B		
16	Steel x 3/8"		152.5
	A-53-B		

8. GROUT OR OTHER SEALING MATERIAL

Kind	From (ft.)	To (ft.)
Neat Cement	Surface	152.5

9. FORMATIONS

Kind	From (ft.)	To (ft.)
Glacial Drift	Surface	102
Sandstone	102	252.5

10. TYPE OF DRILLING MACHINE USED
[X] Cable Tool [ ] Direct Rotary [ ] Reverse Rotary
[ ] Rotary – air w/drilling mud [ ] Rotary – hammer with drilling mud & air [ ] Jetting with [ ] Air [ ] Water

Well construction completed on April 12 1972

Well is terminated 24 inches [X] above [ ] below final grade

Well disinfected upon completion [X] Yes [ ] No

Well sealed watertight upon completion [X] Yes [ ] No

11. MISCELLANEOUS DATA
Yield test: 24 Hrs. at 1000 GPM

Depth from surface to normal water level 34 ft.

Depth to water level when pumping 100 ft.

Water sample sent to Will submit when pump is started. laboratory on: 19

Your opinion concerning other pollution hazards, information concerning difficulties encountered, and data relating to nearby wells, screens, seals, type of casing joints, method of finishing the well, amount of cement used in grouting, blasting, sub-surface pumprooms, access pits, etc., should be given on reverse side.

SIGNATURE: EGERER-GALLOWAY WELL CORP.
Geo. M. Galloway/EP Registered Well Driller

COMPLETE MAIL ADDRESS: 13640 W. Carmen Ave.
Menomonee Falls, WI
53051

Please do not write in space below

COLIFORM TEST RESULT	GAS – 24 HRS.	GAS – 48 HRS.	CONFIRMED	REMARKS

09/28/2023 - Classification: Internal - ECRM13153872

3468

WISCONSIN UNIQUE WELL NUMBER **GS873**

Source: SWAP PROJECT KEYED

State of Wi-Private Water Systems-DG/2
Department Of Natural Resources, Box 7921
Madison, WI 53707

Form 3300-77A
(Rev 02/02)bw

Depth **310** FT

Property Owner	WISCONSIN POWER & LIGHT	Telephone Number	- -
Mailing Address	PO BOX 98		
City	PORTAGE	State WI	Zip Code 53901
County of Well Location	11 COLUMBIA SC	Co Well Permit No W	Well Completion Date July 14, 1976

1. Well Location

T=Town C=City V=Village: **C** of PORTAGE

Fire#

Street Address or Road Name and Number

Subdivision Name | Lot# | Block #

Gov't Lot or **SW** 1/4 of **SW** 1/4 of

Section **27** T **12** N R **9** **E**

Well Constructor	MILAEGER WELL & PUMP	License # 82	Facility ID (Public) 111021460
Address	20950 ENTERPRISE AV		Public Well Plan Approval#
City	BROOKFIELD	State WI / Zip Code 53005	Date Of Approval
Hicap Permanent Well #	43225	Common Well #	Specific Capacity 10 gpm/ft

2. Well Type **1** (See item 12 below)

1=New 2=Replacement 3=Reconstruction

of previous unique well # _____ constructed in _____

Reason for replaced or reconstructed Well?

3. Well Serves **N** # of homes and or **GENERATING STATION** (eg: barn, restaurant, church, school, industry, etc.)

M=Munic O=OTM N=NonCom P=Private Z=Other X=NonPot A=Anode L=Loop H=Drillhole

High Capacity: Well? N Property? N

1 1=Drilled 2=Driven Point 3=Jetted 4=Other

4. Is the well located upslope or sideslope and not downslope from any contamination sources, including those on neighboring properties? **N**

Well located in floodplain? **N**

Distance in feet from well to nearest: (including proposed)

1. Landfill
2. Building Overhang
3. 1=Septic 2= Holding Tank
4. Sewage Absorption Unit
5. Nonconforming Pit
6. Buried Home Heating Oil Tank
7. Buried Petroleum Tank
8. 1=Shoreline 2= Swimming Pool
9. Downspout/ Yard Hydrant
10. Privy
11. Foundation Drain to Clearwater
12. Foundation Drain to Sewer
13. Building Drain 1=Cast Iron or Plastic 2=Other
14. Building Sewer 1=Gravity 2=Pressure 1=Cast Iron or Plastic 2=Other
15. Collector Sewer: ___ units ___ in . diam.
16. Clearwater Sump
17. Wastewater Sump
18. Paved Animal Barn Pen
19. Animal Yard or Shelter
20. Silo
21. Barn Gutter
22. Manure Pipe 1=Gravity 2=Pressure 1=Cast iron or Plastic 2=Other
23. Other manure Storage
24. Ditch
25. Other NR 812 Waste Source

5. Drillhole Dimensions and Construction Method

Dia.(in.)	From (ft)	To (ft)
20.0	surface	113
19.0	113	153
15.0	153	310

Upper Enlarged Drillhole / Lower Open Bedrock

-- 1. Rotary - Mud Circulation
-- 2. Rotary - Air
-- 3. Rotary - Air and Foam
-- 4. Drill-Through Casing Hammer
-- 5. Reverse Rotary
X -- 6. Cable-tool Bit _ n. dia
-- 7. Temp. Outer Casing _ in. dia. _____ depth ft. Removed ?

Other

6. Casing Liner Screen Material, Weight, Specification Manufacturer & Method of Assembly

Dia. (in.)		From (ft.)	To (ft.)
20.0	STEEL .375 ASTM 53-B 78#/FT	surface	113
16.0	STEEL .375 ASTM 53-B 62#/FT	113	310

Dia.(in.)	Screen type, material & slot size	From	To

7. Grout or Other Sealing Material

Method / Kind of Sealing Material	From (ft.)	To (ft.)	# Sacks Cement
NEAT CEMENT	surface	153.0	

8. Geology

Geology Codes	Type, Caving/Noncaving, Color, Hardness, etc	From (ft.)	To (ft.)
__T_	GLACIAL DRIFT	0	113
__N_	SANDSTONE	113	310

9. Static Water Level

25.0 feet **B** ground surface (A=Above B=Below)

10. Pump Test

Pumping level **50.0** ft. below surface

Pumping at **250.0** GP **12.0** Hrs

11. Well Is: 18 in. A Grade (A=Above B=Below)

Developed? N

Disinfected? Y

Capped? Y

12. Did you notify the owner of the need to permanently abandon and fill all unused wells on this property? **N**

If no, explain

13. Initials of Well Constructor or Supervisory Driller R Date Signed 7/14/76

Initials of Drill Rig Operator (Mandatory unless same as above) Date Signed

Additonal Comments?

Owner Sent Label? Y

Variance Issued?

More Geology?

Batch 777777777

WISCONSIN UNIQUE WELL NUMBER
Source: SWAP PROJECT KEYED **GO218**

State of Wi-Private Water Systems-DG/2
Department Of Natural Resources, Box 7921
Madison, WI 53707

Form 3300-77A
(Rev 02/02)bw

Depth **88** FT

Property Owner: **THURENALL, JOE** Telephone Number: 608 -742 -6775

Mailing Address: N6046 HWY 51

City: PORTAGE | State: WI | Zip Code: 53954

County of Well Location: 11 COLUMBIA SC | Co Well Permit No W | Well Completion Date: July 28, 1937

1. Well Location

T=Town C=City V=Village: **T** of PACIFIC | Fire#: N6046

Street Address or Road Name and Number: N6046 HWY 51

Subdivision Name | Lot# | Block #

Well Constructor: GEORGE REYNOLDS | License # | Facility ID (Public): 111035320

Address | Public Well Plan Approval#

City: PORTAGE | State: WI | Zip Code: 53954 | Date Of Approval

Hicap Permanent Well # | Common Well # | Specific Capacity: gpm/ft

Gov't Lot or **NE** 1/4 of **NE** 1/4 of

Section **27** T **12** N R **9** E

2. Well Type **1** (See item 12 below)

1=New 2=Replacement 3=Reconstruction

of previous unique well # _____ constructed in _____

Reason for replaced or reconstructed Well?

3. Well Serves **N** # of homes and or **TAVERN** (eg: barn, restaurant, church, school, industry, etc.)

M=Munic O=OTM N=NonCom P=Private Z=Other X=NonPot A=Anode L=Loop H=Drillhole

High Capacity: Well? N Property? N

1 1=Drilled 2=Driven Point 3=Jetted 4=Other

4. Is the well located upslope or sideslope and not downslope from any contamination sources, including those on neighboring properties? **N**

Well located in floodplain? **N**

Distance in feet from well to nearest: (including proposed)

1. Landfill
2. Building Overhang
3. 1=Septic 2= Holding Tank
4. Sewage Absorption Unit
5. Nonconforming Pit
6. Buried Home Heating Oil Tank
7. Buried Petroleum Tank
8. 1=Shoreline 2= Swimming Pool
9. Downspout/ Yard Hydrant
10. Privy
11. Foundation Drain to Clearwater
12. Foundation Drain to Sewer
13. Building Drain 1=Cast Iron or Plastic 2=Other
14. Building Sewer 1=Gravity 2=Pressure 1=Cast Iron or Plastic 2=Other
15. Collector Sewer: ___ units ___ in . diam.
16. Clearwater Sump
17. Wastewater Sump
18. Paved Animal Barn Pen
19. Animal Yard or Shelter
20. Silo
21. Barn Gutter
22. Manure Pipe 1=Gravity 2=Pressure 1=Cast iron or Plastic 2=Other
23. Other manure Storage
24. Ditch
25. Other NR 812 Waste Source

5. Drillhole Dimensions and Construction Method

Dia.(in.)	From (ft)	To (ft)
6.0	surface	88

Upper Enlarged Drillhole
-- 1. Rotary - Mud Circulation ----------
-- 2. Rotary - Air ----------
-- 3. Rotary - Air and Foam ----------
-- 4. Drill-Through Casing Hammer
-- 5. Reverse Rotary
-- 6. Cable-tool Bit _ n. dia ----------
-- 7. Temp. Outer Casing _ in. dia. _____ depth ft. Removed ?
Other

Lower Open Bedrock

6. Casing Liner Screen Material, Weight, Specification Manufacturer & Method of Assembly

Dia. (in.)		From (ft.)	To (ft.)
6.0	STEEL DRILLER'S SPEC PIPE	surface	50

Dia.(in.)	Screen type, material & slot size	From	To

7. Grout or Other Sealing Material

Method / Kind of Sealing Material	From (ft.)	To (ft.)	# Sacks Cement
	surface		

8. Geology

Geology Codes	Type, Caving/Noncaving, Color, Hardness, etc	From (ft.)	To (ft.)
__I_	TOPSOIL	0	24
IQN_	CAVING WHITE SANDSTONE	24	50
IHN_	SOLID WHITE SANDSTONE	50	88

9. Static Water Level
20.0 feet **B** ground surface A=Above B=Below

10. Pump Test
Pumping level **20.0** ft. below surface
Pumping at **10.0** GP M **2.0** Hrs

11. Well Is: 4 in. **B** Grade A=Above B=Below
Developed? N
Disinfected? Y
Capped? N

12. Did you notify the owner of the need to permanently abandon and fill all unused wells on this property? **N**
If no, explain

13. Initials of Well Constructor or Supervisory Driller GR Date Signed 9/11/37

Initials of Drill Rig Operator (Mandatory unless same as above) Date Signed

Additonal Comments?
Owner Sent Label? Y
Variance Issued?
More Geology?

Batch 777777777

WELL CONSTRUCTOR'S REPORT
FORM 3300-15

SEP 15 1975

NOTE
WHITE COPY – DIVISION'S COPY
GREEN COPY – DRILLER'S COPY
YELLOW COPY – OWNER'S COPY

STATE OF WISCONSIN
DEPARTMENT OF NATURAL RESOURCES
Box 450
Madison, Wisconsin 53701

1. COUNTY: Columbia
CHECK ONE: [x] Town [ ] Village [ ] City
NAME: Pacific

2. LOCATION – ¼ Section: NW | Section: 27 | Township: 12N | Range: 9E
OR – Grid or street no. | Street name
AND – If available subdivision name, lot & block no.

3. OWNER AT TIME OF DRILLING: Landsverk Const.
ADDRESS
POST OFFICE: Portage, Wis

4. Distance in feet from well to nearest: (Record answer in appropriate block)

BUILDING	SANITARY SEWER C. I.	SANITARY SEWER TILE	FLOOR DRAIN C. I.	FLOOR DRAIN TILE	FOUNDATION DRAIN SEWER CONNECTED	FOUNDATION DRAIN INDEPENDENT	WASTE WATER DRAIN C. I.	WASTE WATER DRAIN TILE
13								

CLEAR WATER DRAIN C. I.	CLEAR WATER DRAIN TILE	SEPTIC TANK	PRIVY	SEEPAGE PIT	ABSORPTION FIELD	BARN	SILO	ABANDONED WELL	SINK HOLE
		49			61				

OTHER POLLUTION SOURCES (Give description such as dump, quarry, drainage well, stream, pond, lake, etc.)

5. Well is intended to supply water for: Home

6. DRILLHOLE

Dia. (in.)	From (ft.)	To (ft.)	Dia. (in.)	From (ft.)	To (ft.)
8	Surface	54			
6	54	82			

7. CASING, LINER, CURBING, AND SCREEN

Dia. (in.)	Kind and Weight	From (ft.)	To (ft.)
6"	STD BLK Pipe	Surface	54
	.280 wall		
	18.97 WT		
	weld FTS		

8. GROUT OR OTHER SEALING MATERIAL

Kind	From (ft.)	To (ft.)
Mud & cuttings	Surface	54

9. FORMATIONS

Kind	From (ft.)	To (ft.)
Sand	Surface	18
Sandy clay	18	39
Sand	39	52
Sand Rock	52	82

10. TYPE OF DRILLING MACHINE USED
[ ] Cable Tool [ ] Direct Rotary [ ] Reverse Rotary
[ ] Rotary – air w/drilling mud [x] Rotary – hammer with drilling mud & air [ ] Jetting with [ ] Air [ ] Water

Well construction completed on 8-29 1975

Well is terminated 12 inches [x] above [ ] below final grade

Well disinfected upon completion [x] Yes [ ] No

Well sealed watertight upon completion [x] Yes [ ] No

11. MISCELLANEOUS DATA
Yield test: 2 Hrs. at 15 GPM
Depth from surface to normal water level 20 ft.
Depth to water level when pumping 65 ft.

Water sample sent to MADISON laboratory on: 8-29 1975

Your opinion concerning other pollution hazards, information concerning difficulties encountered, and data relating to nearby wells, screens, seals, type of casing joints, method of finishing the well, amount of cement used in grouting, blasting, sub-surface pumprooms, access pits, etc., should be given on reverse side.

SIGNATURE: Sam Vander Galien Jr. Registered Well Driller
COMPLETE MAIL ADDRESS: SAM'S ROTARY DRILLERS, ROUTE 1 - RANDOLPH, WISCONSIN 53956

Please do not write in space below

COLIFORM TEST RESULT	GAS – 24 HRS.	GAS – 48 HRS.	CONFIRMED	REMARKS
3474				

REV. 3-71

09/28/2023 - Classification: Internal - ECRM13153872

CO-611-U

WELL CONSTRUCTOR'S REPORT TO WISCONSIN STATE BOARD OF HEALTH

See Instructions on Reverse Side

CO-611-U

RECEIVED JUL 27 1950 BUREAU SAN. ENG.

1. County Columbia — Town ☒ Village ☐ City ☐ — pacific (Check one and give name)

2. Location N.W. 1/4 of S.W. 1/4 Sec. 27 T. 11 and 12 N. Rt. 9 E. T12N R9E
Name of street and number of premise or Section, Town and Range numbers

3. Owner ☒ or Agent ☐ William Murray
Name of individual, partnership or firm

4. Mail Address Pardeeville Wis. R. R. 2
Complete address required

5. From well to nearest: Building 3 ft; sewer ____ ft; drain ____ ft; septic tank 50 ft; dry well or filter bed 100 ft; abandoned well 80 ft.

6. Well is intended to supply water for: Home and farm

7. DRILLHOLE:

Dia. (in.)	From (ft.)	To (ft.)	Dia. (in.)	From (ft.)	To (ft.)
8	0	25	4	25	132

8. CASING AND LINER PIPE OR CURBING:

Dia. (in.)	Kind	From (ft.)	To (ft.)
4	Std. weight steel	0	97'4"

9. GROUT:

Kind	From (ft.)	To (ft.)
none		

10. FORMATIONS:

Kind	From (ft.)	To (ft.)
Clay	0	40
sand	40	65
soft sand rock	65	97'4"
sand rock solid	97'4"	132

11. MISCELLANEOUS DATA:

Yield test: 3 Hrs. at 6 GPM.

Depth from surface to water-level: 20 ft.

Water-level when pumping: 20 ft.

Water sample was sent to the state laboratory at: Madison (City) on July 19 1950

Construction of the well was completed on: July 18 1950

The well is terminated 8 inches ☒ above, below ☐ the permanent ground surface.

Was the well disinfected upon completion? Yes X No ____

Was the well sealed watertight upon completion? Yes X No ____

Signature Edward Malisch (Registered Well Driller) Portage Wis. R.R. 3 (Complete Mail Address)

Please do not write in space below

Rec'd JUL 21 1950 No. 10757

Ans'd

Interpretation Safe

	10 ml	10 ml	10 ml	10 ml	10 ml
Gas—24 hrs.					
48 hrs.					
Confirm					
B. Coli					

Examiner ____

09/28/2023 - Classification: Internal - ECRM13153872

3470

Vol. 6

WELL CONSTRUCTOR'S REPORT TO WISCONSIN STATE BOARD OF HEALTH

See Instructions on Reverse Side

1. County Columbia — Town ☑ / Village ☐ / City ☐ Pacific (Check one and give name)

2. Location Sec 27, Town 12 (T12N) Range 9E
Name of street and number of premise or Section, Town and Range numbers

3. Owner ☒ or Agent ☐ Dennis Lovell
Name of individual, partnership or firm

4. Mail Address Portage Wis - 302 - E. Pleasant St Portage Wis
Complete address required

5. From well to nearest: Building 20 ft; ~~sewer~~ None ft; ~~drain~~ None ft; septic tank 60 ft; dry well or filter bed 80 ft; abandoned well 5 ft.

6. Well is intended to supply water for: Slaughter House & Home

7. **DRILLHOLE:**

Dia. (in.)	From (ft.)	To (ft.)	Dia. (in.)	From (ft.)	To (ft.)
4	0	81			

8. **CASING AND LINER PIPE OR CURBING:**

Dia. (in.)	Kind and Weight	From (ft.)	To (ft.)
4	Drillers 10.89 per 100 ft	0	37

9. **GROUT:**

Kind	From (ft.)	To (ft.)
None		

10. **FORMATIONS:**

Kind	From (ft.)	To (ft.)
Sand	0	29
Soft Sandstone	29	37
Hardsandstone	37	81

11. **MISCELLANEOUS DATA:**

Yield test: 4 Hrs. at 5 GPM.

Depth from surface to water-level: 44 ft.

Water-level when pumping: 44 ft.

Water sample was sent to the state laboratory at: Madison City on Nov 3 1955

Construction of the well was completed on: Nov 1 1955

The well is terminated 8 inches ☒ above, below ☐ the permanent ground surface.

Was the well disinfected upon completion? Yes ✓ No

Was the well sealed watertight upon completion? Yes ✓ No

Signature George Buzzell
Registered Well Driller

503 E. Conant St. Portage Wis
Complete Mail Address

Please do not write in space below

Rec'd Nov 4 1955 No. 37985

Ans'd

Interpretation

SAFE

	10 ml	10 ml	10 ml	10 ml	10 ml
Gas—24 hrs.					
48 hrs.					
Confirm					
B. Coli	0				

Examiner

09/28/2023 - Classification: Internal - ECRM13153872

3465

Wel. 6-30M (6-50)

WELL CONSTRUCTOR'S REPORT TO WISCONSIN STATE BOARD OF HEALTH

See Instructions on Reverse Side

1. County COLUMBIA — Town ☐ Village ☐ City ☐ PACIFIC — Check one and give name

2. Location T 12 N R 9 E Sec. 27 Sec. 27 — Name of street and number of premise or Section, Town and Range numbers

RECEIVED NOV 20 1953 ENVIRONMENTAL SANITATION

3. Owner ☒ or Agent ☐ '51 DRIVE IN THEATRE — Name of individual, partnership or firm

4. Mail Address HIGH WAY 51 DRIVE IN THEATRE, PORTAGE, WIS — Complete address required

5. From well to nearest: Building 5 ft; sewer ____ ft; drain ____ ft; septic tank 75 ft; dry well or filter bed ____ ft; abandoned well ____ ft.

6. Well is intended to supply water for: THEATRE

7. DRILLHOLE:

Dia. (in.)	From (ft.)	To (ft.)	Dia. (in.)	From (ft.)	To (ft.)
6	0	105			

8. CASING AND LINER PIPE OR CURBING:

Dia. (in.)	Kind and Weight	From (ft.)	To (ft.)
6	SD. STEEL	0	76

9. GROUT:

Kind	From (ft.)	To (ft.)

10. FORMATIONS:

Kind	From (ft.)	To (ft.)
TOPSOIL	0	5
SAND	5	30
CLAY	30	63
SAND ROCK BR.	63	75
SAND ROCK, WH.	75	105

11. MISCELLANEOUS DATA:

Yield test: 4 Hrs. at 16 GPM.

Depth from surface to water-level: 28 ft.

Water-level when pumping: 28 ft.

Water sample was sent to the state laboratory at: MADISON City on 7/10 1952

Construction of the well was completed on: 6/24 1952

The well is terminated 6 inches ☒ above, below ☐ the permanent ground surface.

Was the well disinfected upon completion? Yes ✓ No ____

Was the well sealed watertight upon completion? Yes ✓ No ____

Signature GEO. REYNOLDS & SON Registered Well Driller

PORTAGE, WIS. Complete Mail Address

Please do not write in space below

Rec'd ____ No. ____

Ans'd ____

Interpretation ____

	10 ml	10 ml	10 ml	10 ml	10 ml
Gas—24 hrs.					
48 hrs.					
Confirm					
B. Coli					

Examiner ____

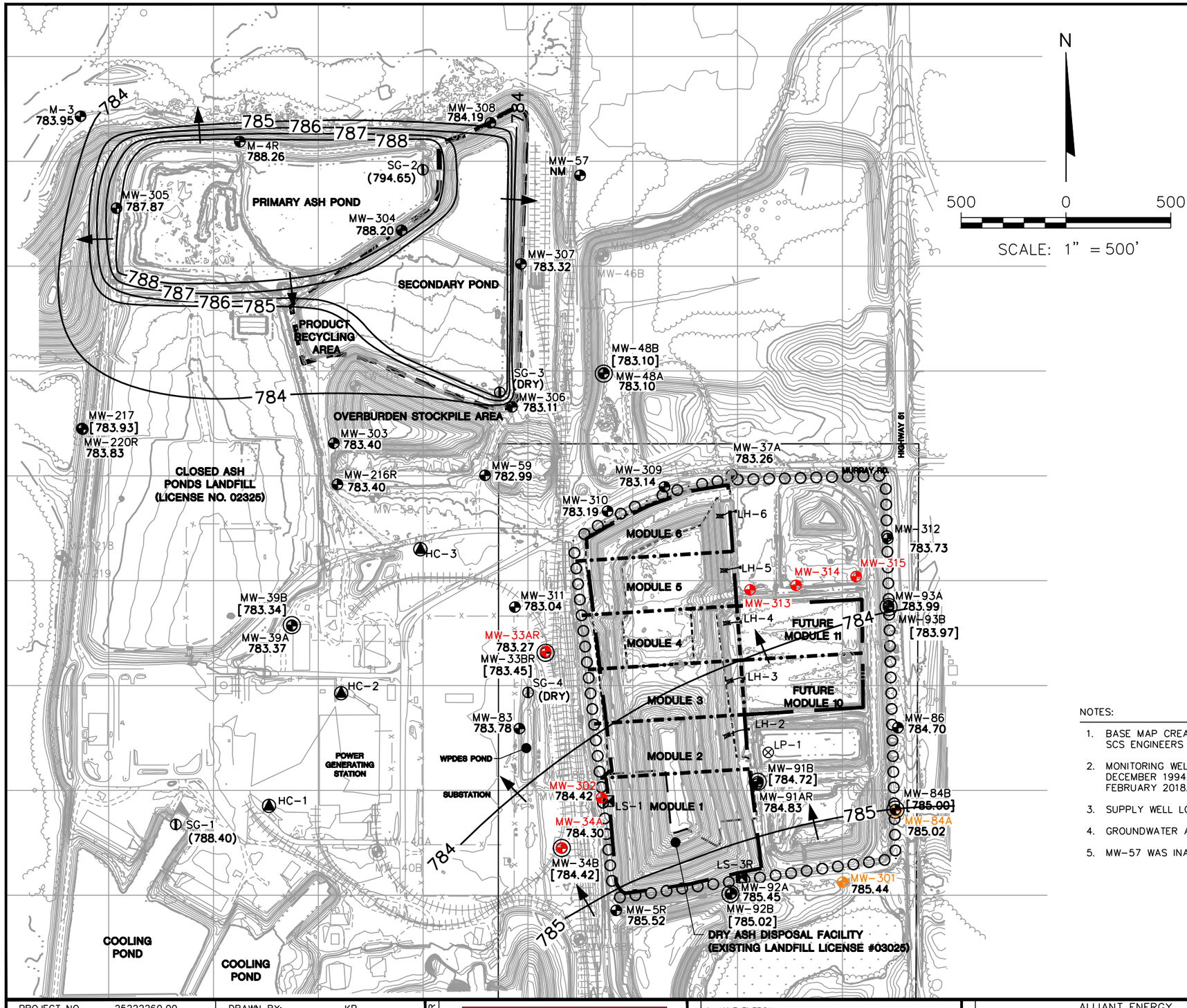
09/28/2023 - Classification: Internal - ECRM13153872

3464

Attachment D

Site Groundwater Flow Maps

09/28/2023 - Classification: Internal - ECRM13153872



LEGEND

- EXISTING MAJOR CONTOUR (10' INTERVAL)
- EXISTING MINOR CONTOUR (2' CONTOUR)
- EXISTING FENCELINE
- EXISTING TRACKS
- EXISTING PAVED ROAD
- EXISTING UNPAVED ROAD
- EDGE OF WATER
- DRY ASH DISPOSAL FACILITY LIMITS
- LIMITS OF WASTE
- LINER PHASE/MODULE LIMITS
- WATER SUPPLY WELL
- STAFF GAUGE
- NON-CCR WATER TABLE WELL
- NON-CCR PIEZOMETER
- CCR MONITORING WELL
- CCR BACKGROUND MONITORING WELL
- SURFACE WATER SAMPLE LOCATION
- LYSIMETER
- ABANDONED WATER TABLE WELL
- ABANDONED PIEZOMETER
- LEACHATE HEADWELL
- 787.62 WATER TABLE ELEVATION
- [788.87] POTENTIOMETRIC SURFACE ELEVATION (NOT CONTOURED)
- (795.20) SURFACE WATER ELEVATION (NOT CONTOURED)
- WATER TABLE CONTOUR
- APPROXIMATE GROUNDWATER FLOW DIRECTION

NOTES:

1. BASE MAP CREATED FROM AERIAL SURVEY BY KBM, FLOWN DECEMBER 1, 2014, AND GROUND SURVEY BY SCS ENGINEERS IN DECEMBER 2020, AND BY DRONE SURVEY BY AMES ON JANUARY 17, 2023.
2. MONITORING WELL LOCATIONS AND ELEVATIONS SURVEYED BY WISCONSIN POWER AND LIGHT, INC. IN DECEMBER 1994, NOVEMBER 1996, APRIL 2003, AND JANUARY 2016, AND BY SCS ENGINEERS IN FEBRUARY 2018, APRIL 2022, AND JANUARY 2023.
3. SUPPLY WELL LOCATIONS ARE APPROXIMATE AND ASSUMED BASED ON JANUARY 2013 DRAWINGS BY TRC.
4. GROUNDWATER AND SURFACE WATER ELEVATIONS WERE MEASURED ON APRIL 11-13, 2022.
5. MW-57 WAS INACCESSIBLE DURING THE APRIL 2022 EVENT DUE TO HIGH WATER.

PROJECT NO.	25222260.00	DRAWN BY:	KP
DRAWN:	02/06/2023	CHECKED BY:	
REVISED:	02/06/2023	APPROVED BY:	

ENGINEER: SCS ENGINEERS
2830 DAIRY DRIVE MADISON, WI 53718-6751
PHONE: (608) 224-2830

CLIENT: ALLIANT ENERGY
COLUMBIA ENERGY CENTER
W8375 MURRAY ROAD
PARDEEVILLE, WI 53954

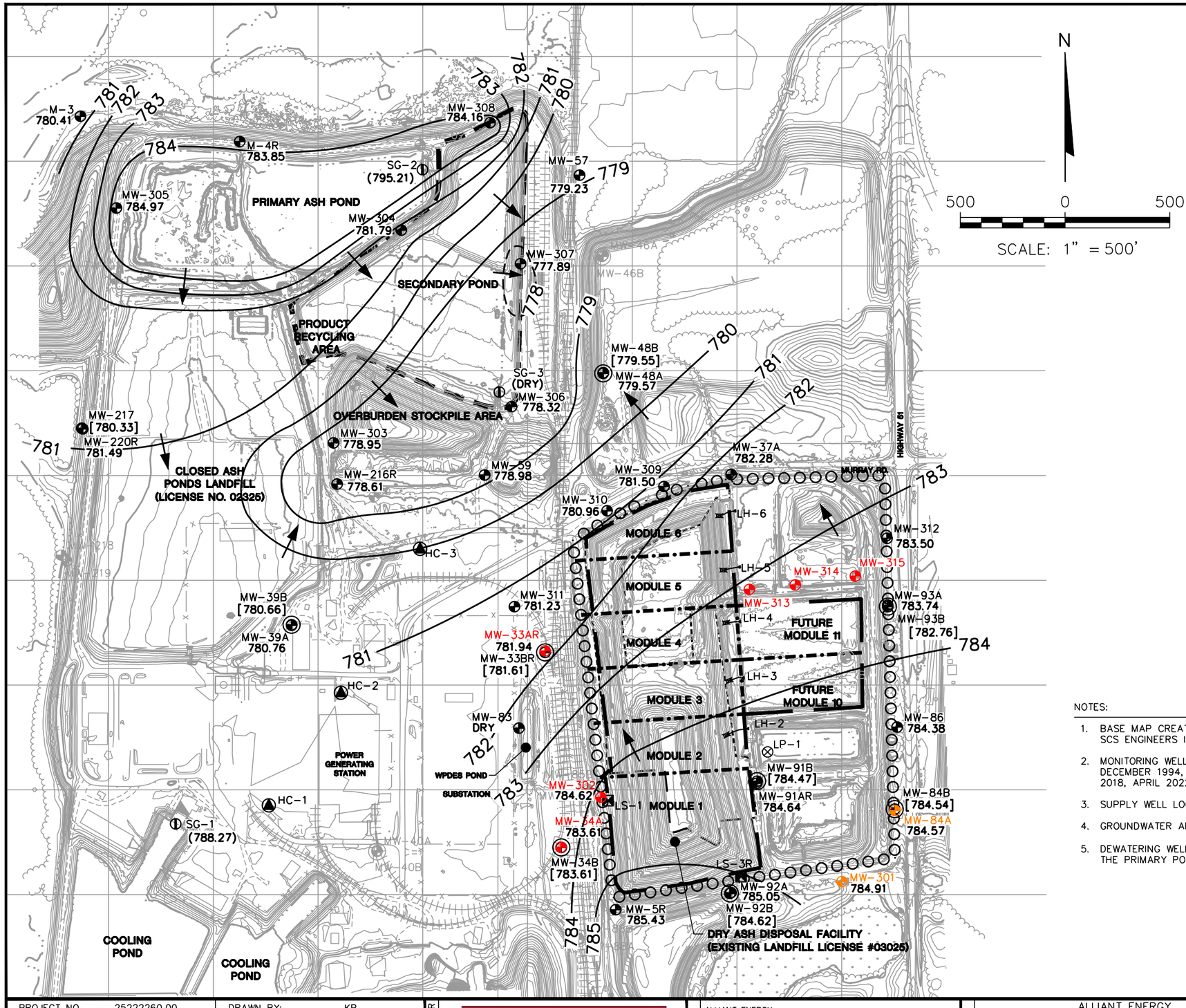
SITE: ALLIANT ENERGY
COLUMBIA ENERGY CENTER
COLUMBIA DRY ASH DISPOSAL FACILITY
PARDEEVILLE, WI

WATER TABLE MAP
APRIL 2022

FIGURE
3

I:\25222260.00\Drawings\Water Table Map-April 2022.dwg, 2/9/2023 3:52:38 PM

09/28/2023 - Classification: Internal - ECRM13153872



LEGEND

- EXISTING MAJOR CONTOUR (10' INTERVAL)
- EXISTING MINOR CONTOUR (2' CONTOUR)
- EXISTING FENCELINE
- EXISTING TRACKS
- EXISTING PAVED ROAD
- EXISTING UNPAVED ROAD
- EDGE OF WATER
- DRY ASH DISPOSAL FACILITY LIMITS
- LIMITS OF WASTE
- LINER PHASE/MODULE LIMITS
- WATER SUPPLY WELL
- STAFF GAUGE
- NON-CCR WATER TABLE WELL
- NON-CCR PIEZOMETER
- CCR MONITORING WELL
- CCR BACKGROUND MONITORING WELL
- SURFACE WATER SAMPLE LOCATION
- LYSIMETER
- ABANDONED WATER TABLE WELL
- ABANDONED PIEZOMETER
- LEACHATE HEADWELL
- 787.62 — WATER TABLE ELEVATION
- [788.87] — POTENTIOMETRIC SURFACE ELEVATION (NOT CONTOURED)
- (795.20) — SURFACE WATER ELEVATION (NOT CONTOURED)
- WATER TABLE CONTOUR
- APPROXIMATE GROUNDWATER FLOW DIRECTION

NOTES:

1. BASE MAP CREATED FROM AERIAL SURVEY BY KBM, FLOWN DECEMBER 1, 2014, AND GROUND SURVEY BY SCS ENGINEERS IN DECEMBER 2020, AND BY DRONE SURVEY BY AMES ON JANUARY 17, 2023.
2. MONITORING WELL LOCATIONS AND ELEVATIONS SURVEYED BY WISCONSIN POWER AND LIGHT, INC. IN DECEMBER 1994, NOVEMBER 1996, APRIL 2003, AND JANUARY 2016, AND BY SCS ENGINEERS IN FEBRUARY 2018, APRIL 2022, AND JANUARY 2023.
3. SUPPLY WELL LOCATIONS ARE APPROXIMATE AND ASSUMED BASED ON JANUARY 2013 DRAWINGS BY TRC.
4. GROUNDWATER AND SURFACE WATER ELEVATIONS WERE MEASURED ON OCTOBER 25–27, 2022.
5. DEWATERING WELLS (NOT SHOWN) AROUND THE SECONDARY POND WERE PUMPING AND DISCHARGING TO THE PRIMARY POND DURING THE OCTOBER 2022 SAMPLING EVENT.

PROJECT NO.	25222260.00	DRAWN BY:	KP
DRAWN:	02/09/2023	CHECKED BY:	
REVISED:	02/09/2023	APPROVED BY:	

ENGINEER: SCS ENGINEERS
2830 DAIRY DRIVE MADISON, WI 53718-6751
PHONE: (608) 224-2830

CLIENT: ALLIANT ENERGY
COLUMBIA ENERGY CENTER
W8375 MURRAY ROAD
PARDEEVILLE, WI 53954

SITE: ALLIANT ENERGY
COLUMBIA ENERGY CENTER
COLUMBIA DRY ASH DISPOSAL FACILITY
PARDEEVILLE, WI

WATER TABLE MAP
OCTOBER 2022

FIGURE
4

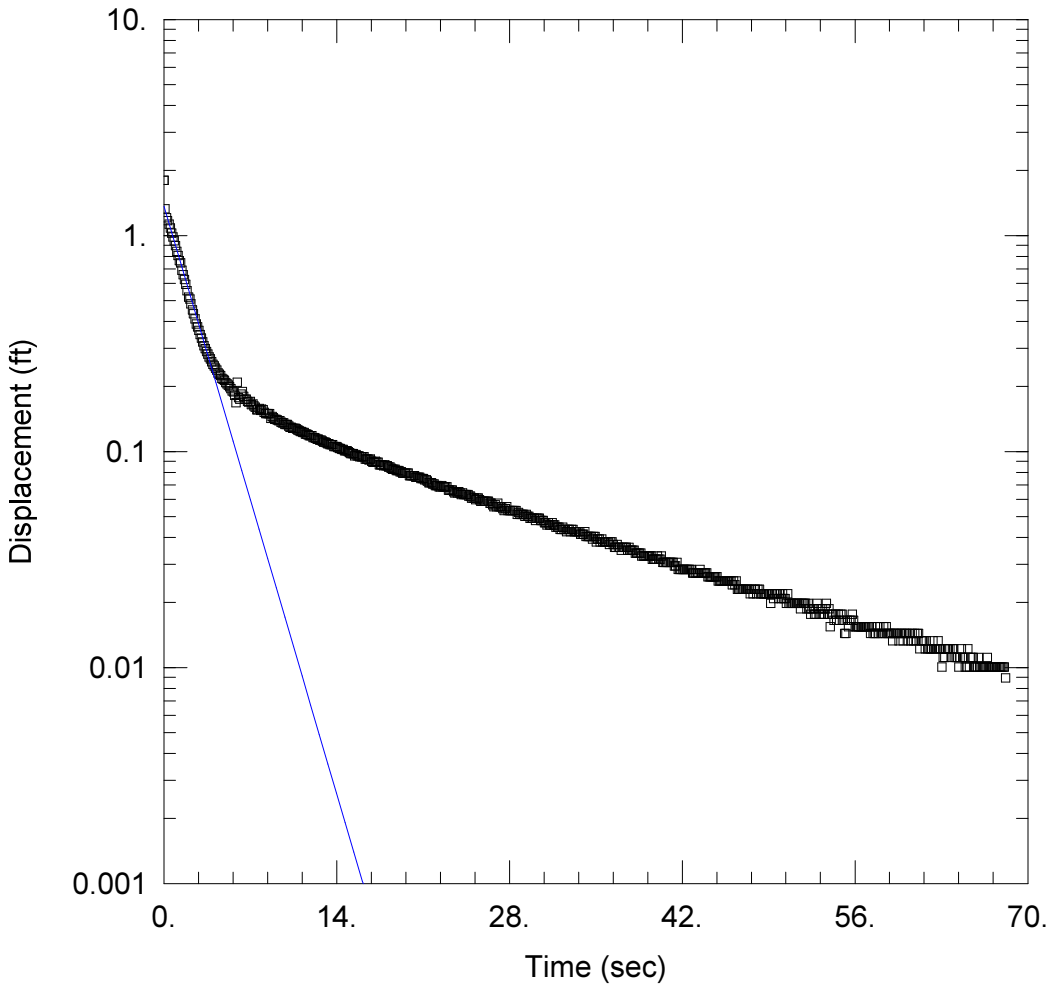
I:\25222260.00\Drawings\Water Table Map-October 2022.dwg, 2/9/2023 3:50:53 PM

09/28/2023 - Classification: Internal - ECRM13153872

Attachment E

Hydraulic Conductivity Test Results

09/28/2023 - Classification: Internal - ECRM13153872



WELL TEST ANALYSIS

Data Set: I:\25215135\Data\Hydraulic Conductivity Testing\COL Slug 160120\MW301.aqt
Date: 01/28/16 Time: 08:46:14

PROJECT INFORMATION

Company: SCS
Client: Alliant Energy - Columbia
Project: 25215135
Location: Portage, WI
Test Well: MW-301
Test Date: 12/20/2015

AQUIFER DATA

Saturated Thickness: 100. ft
Anisotropy Ratio (Kz/Kr): 1.

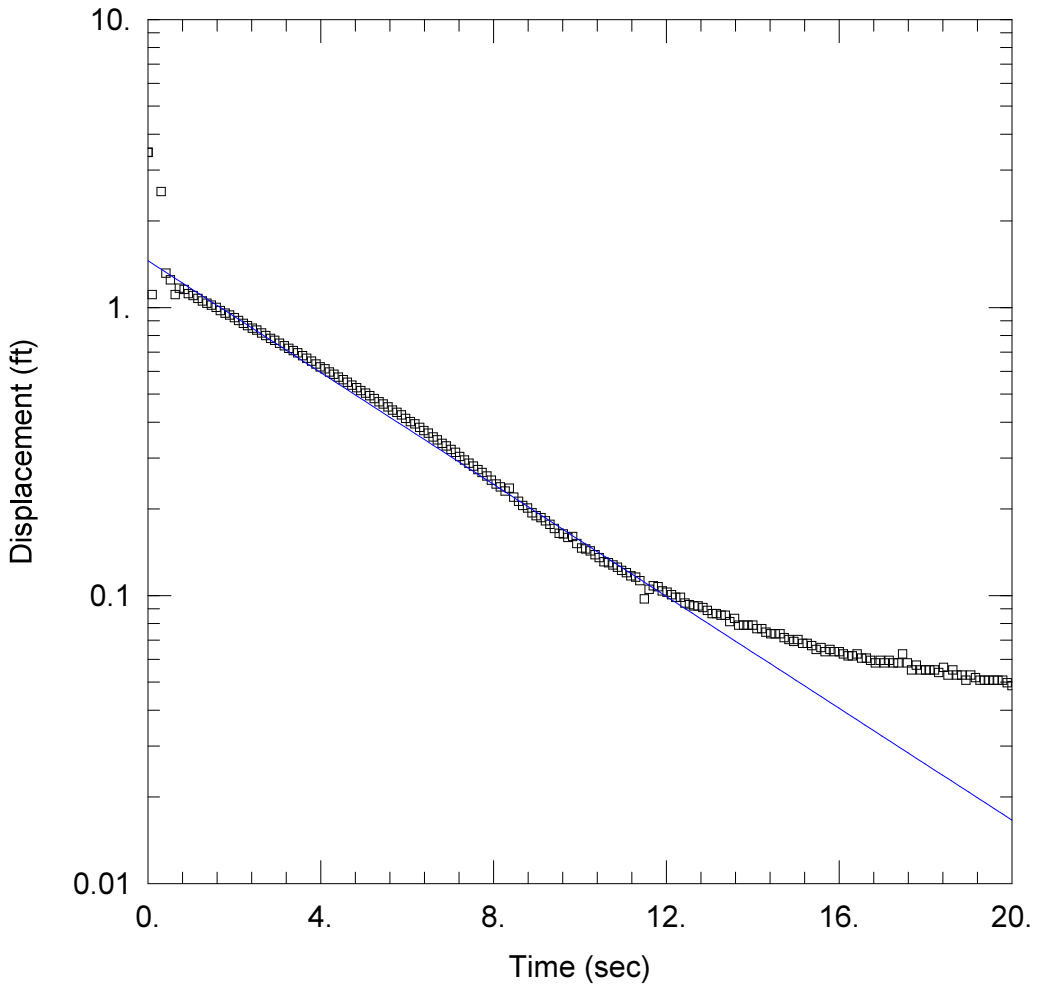
WELL DATA (MW-301 Slug Out)

Initial Displacement: 1.801 ft
Total Well Penetration Depth: 8.75 ft
Casing Radius: 0.09 ft
Static Water Column Height: 8.75 ft
Screen Length: 8.75 ft
Well Radius: 0.35 ft
Gravel Pack Porosity: 0.25

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K_z = 0.05542 cm/sec
y0 = 1.366 ft

09/28/2023 - Classification: Internal - ECRM13153872



MW-302 SLUG OUT

Data Set: I:\25215135\Data\Hydraulic Conductivity Testing\COL Slug 160120\MW302_Out.aqt
Date: 01/28/16 Time: 08:50:19

PROJECT INFORMATION

Company: SCS
Client: Alliant Energy - Columbia
Project: 25215135
Location: Portage, WI
Test Well: MW-302
Test Date: 12/20/2015

AQUIFER DATA

Saturated Thickness: 100. ft
Anisotropy Ratio (Kz/Kr): 1.

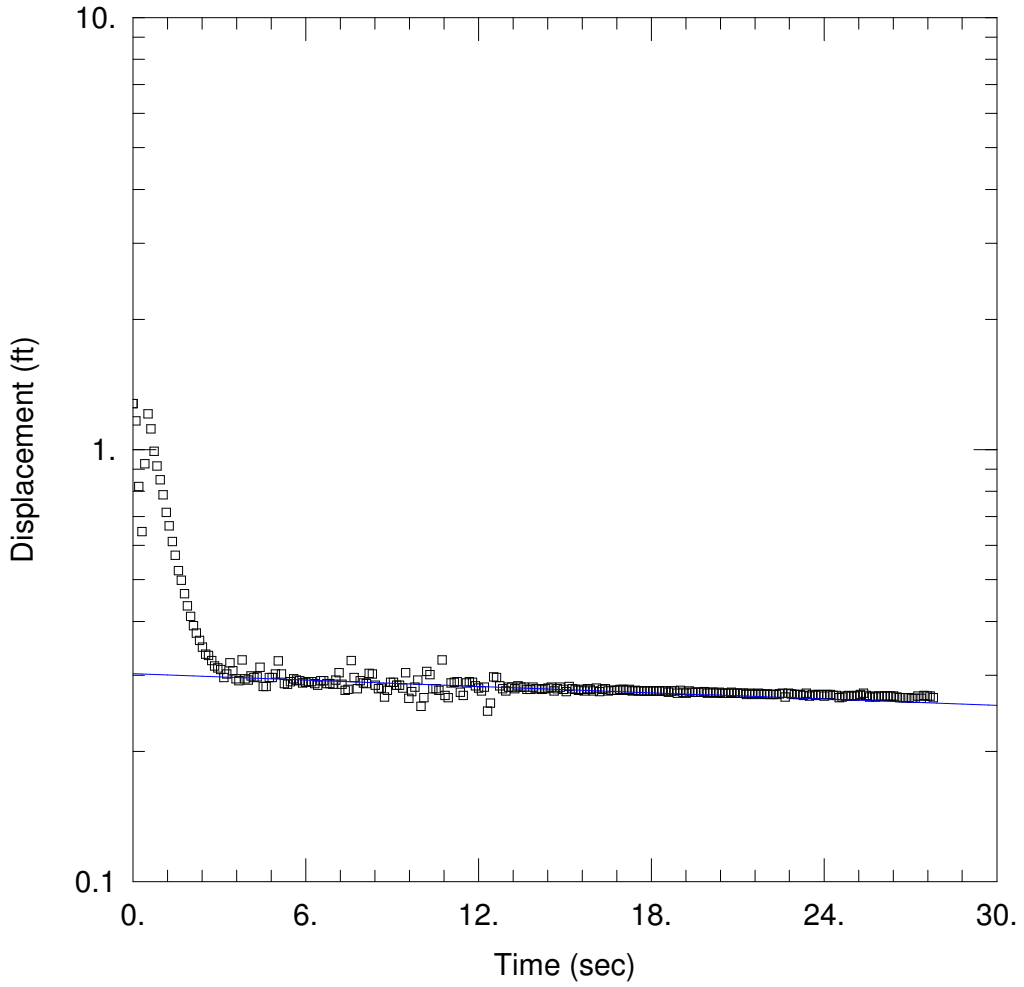
WELL DATA (MW-302 Slug Out)

Initial Displacement: 3.46 ft
Total Well Penetration Depth: 5.85 ft
Casing Radius: 0.09 ft
Static Water Column Height: 5.85 ft
Screen Length: 5.85 ft
Well Radius: 0.33 ft
Gravel Pack Porosity: 0.25

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K_z = 0.03217 cm/sec
y0 = 1.454 ft

09/28/2023 - Classification: Internal - ECRM13153872



WELL TEST ANALYSIS

Data Set: I:\25217156.00\Data and Calculations\Slug Test\180216\MW309.aqt
Date: 05/17/18 Time: 12:55:06

PROJECT INFORMATION

Company: SCS Engineers
Client: WPL-Columbia
Project: 25217156.01
Location: Pardeeville
Test Well: MW-309-Slug Out
Test Date: 2/16/2018

AQUIFER DATA

Saturated Thickness: 100. ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW-309)

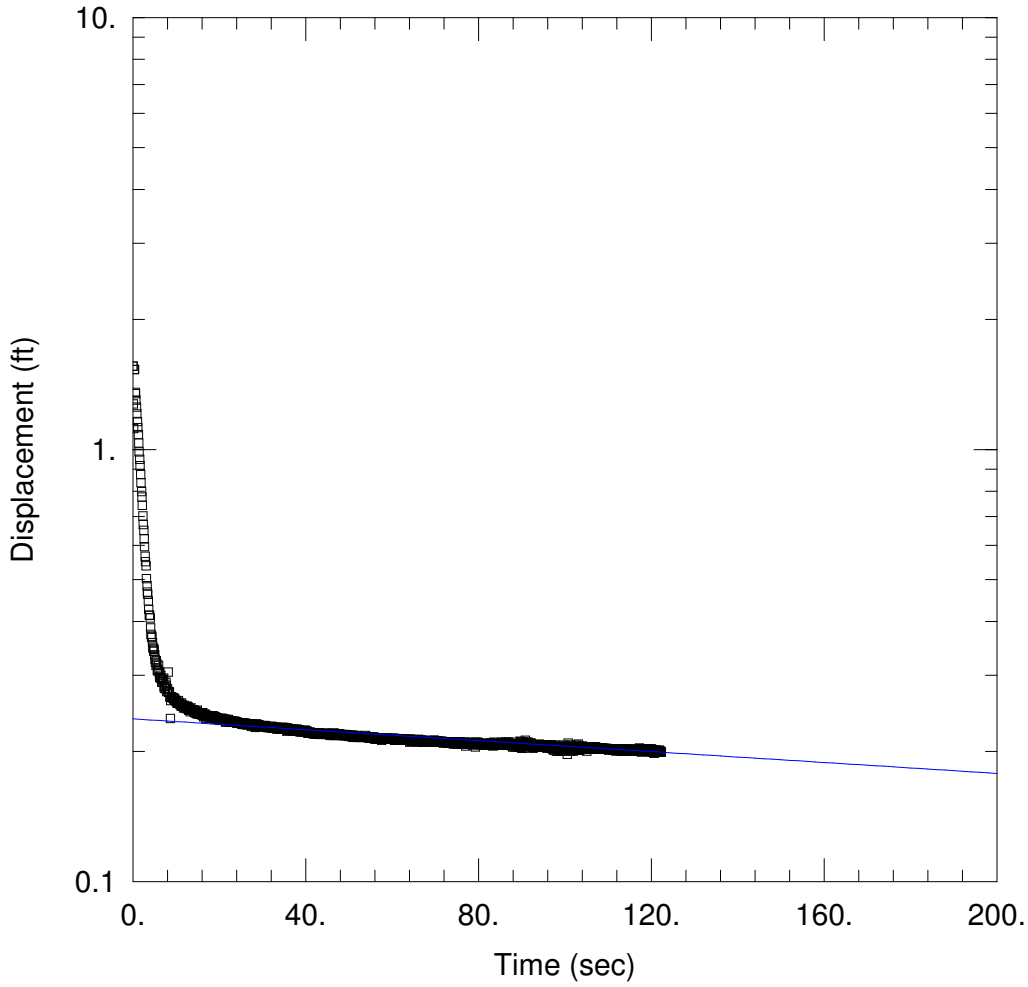
Initial Displacement: 1.277 ft
Total Well Penetration Depth: 9.97 ft
Casing Radius: 0.099 ft
Static Water Column Height: 7.6 ft
Screen Length: 7.6 ft
Well Radius: 0.35 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K_z = 0.0002122 cm/sec
y0 = 0.3025 ft

09/28/2023 - Classification: Internal - ECRM13153872



WELL TEST ANALYSIS

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Date: 05/17/18 Time: 12:55:52

PROJECT INFORMATION

Company: SCS Engineers
Client: WPL-Columbia
Project: 25217156.01
Location: Pardeeville, WI
Test Well: MW-310
Test Date: 2/16/2018

AQUIFER DATA

Saturated Thickness: 100. ft
Anisotropy Ratio (Kz/Kr): 1.

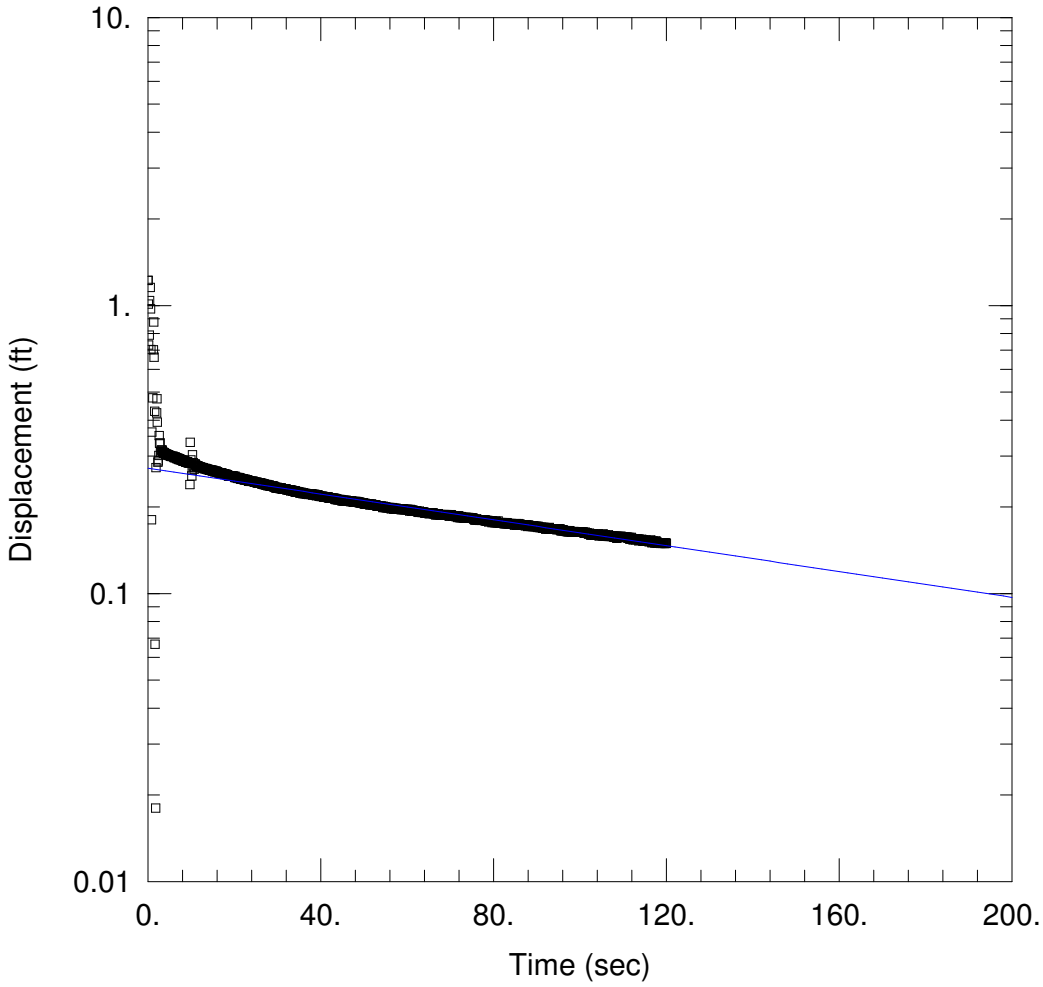
WELL DATA (MW-310)

Initial Displacement: 1.559 ft
Total Well Penetration Depth: 7.9 ft
Casing Radius: 0.09 ft
Static Water Column Height: 7.86 ft
Screen Length: 7.9 ft
Well Radius: 0.35 ft
Gravel Pack Porosity: 0.25

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K_z = 0.0001911 cm/sec
y0 = 0.238 ft

09/28/2023 - Classification: Internal - ECRM13153872



WELL TEST ANALYSIS

Data Set: I:\25217156.00\Data and Calculations\Slug Test\180216\MW311.aqt
Date: 05/17/18 Time: 12:56:06

PROJECT INFORMATION

Company: SCS Engineers
Client: WPL-Columbia
Project: 25217156.01
Location: Pardeeville, WI
Test Well: MW-311
Test Date: 2/16/2018

AQUIFER DATA

Saturated Thickness: 100. ft
Anisotropy Ratio (Kz/Kr): 1.

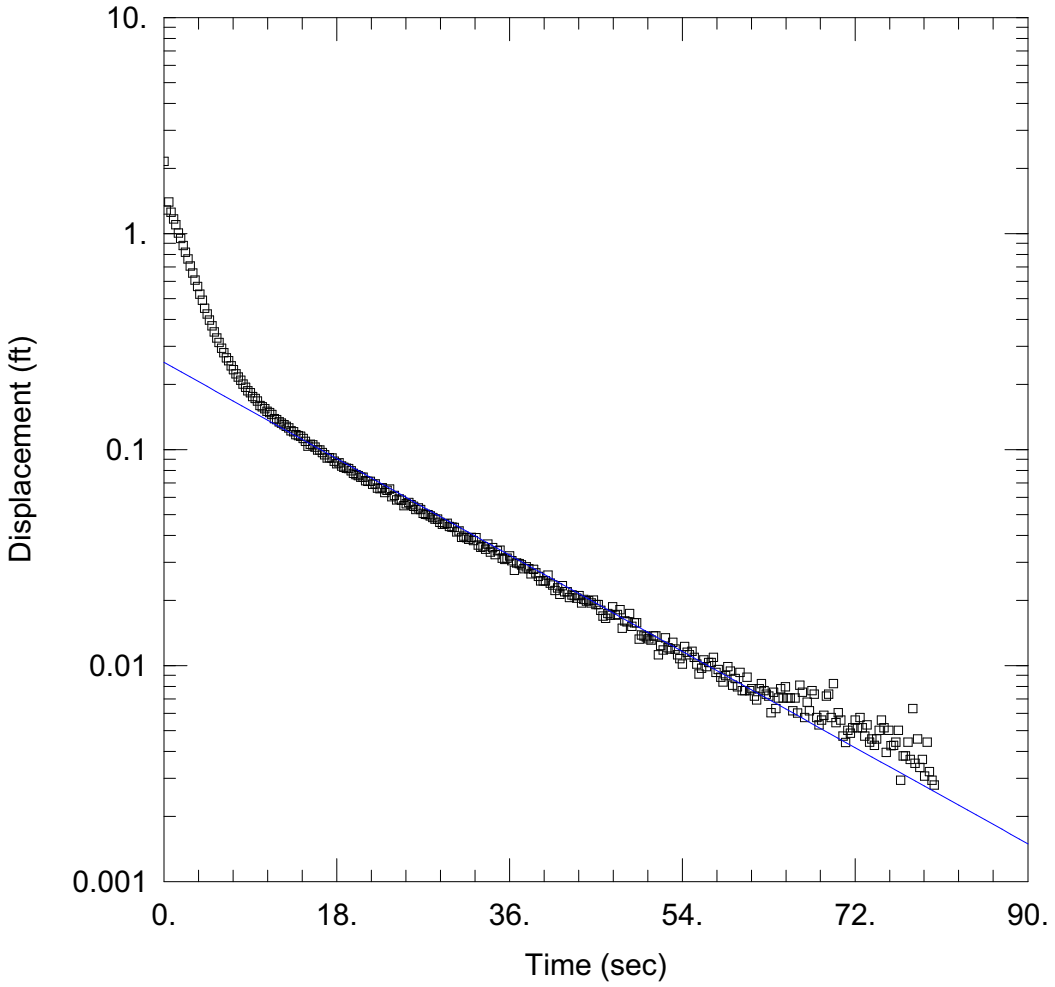
WELL DATA (MW-311)

Initial Displacement: 1.221 ft
Total Well Penetration Depth: 9.46 ft
Casing Radius: 0.09 ft
Static Water Column Height: 9.46 ft
Screen Length: 9.46 ft
Well Radius: 0.35 ft
Gravel Pack Porosity: 0.25

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K_z = 0.0006119 cm/sec
y0 = 0.2724 ft

09/28/2023 - Classification: Internal - ECRM13153872



WELL TEST ANALYSIS

Data Set: I:\25220183.00\Data and Calculations\K Tests\MW 313 314 315\MW313.aqt
Date: 01/24/23 Time: 22:13:07

PROJECT INFORMATION

Company: SCS Engineers
Client: Alliant
Project: 25220183.00
Location: WPL - Columbia
Test Well: MW-313
Test Date: 12/30/2022

AQUIFER DATA

Saturated Thickness: 100. ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW-313)

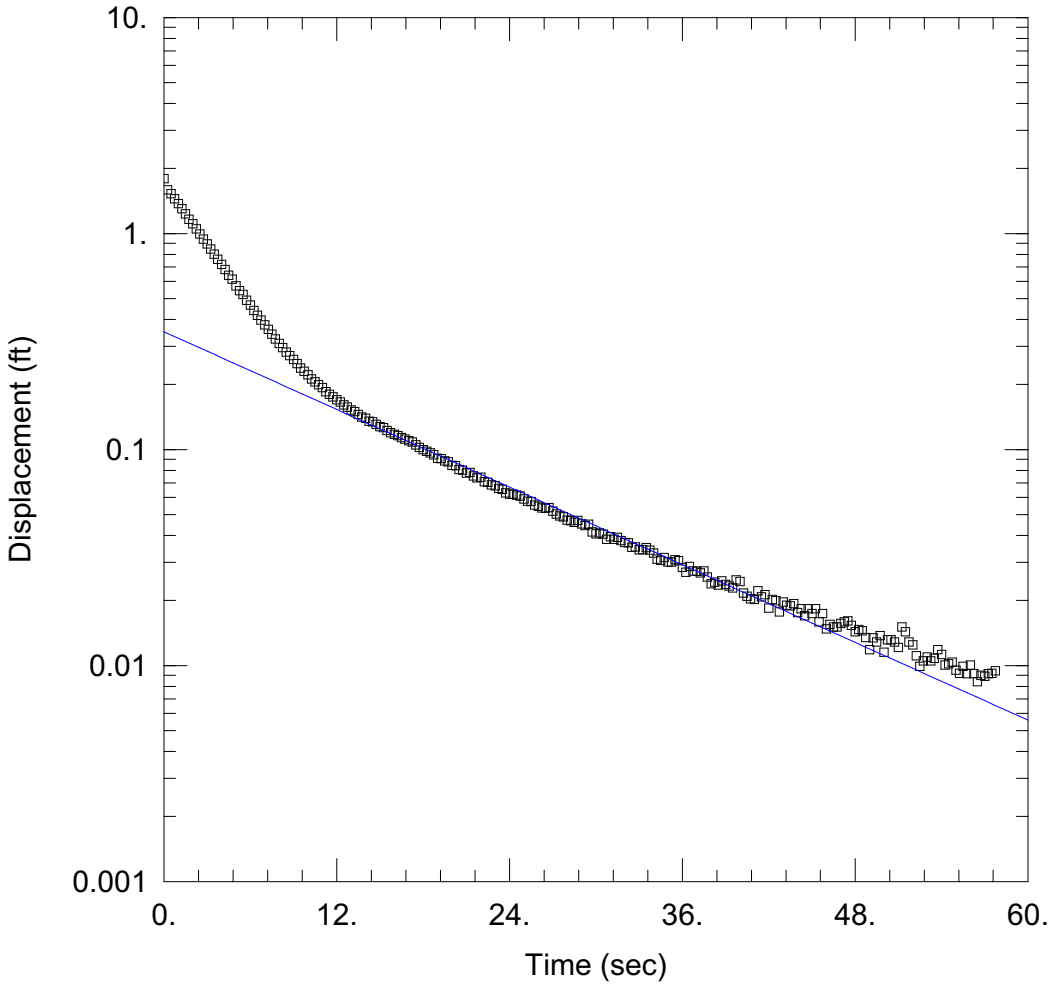
Initial Displacement: 2.16 ft
Total Well Penetration Depth: 8.75 ft
Casing Radius: 0.09 ft
Static Water Column Height: 8.75 ft
Screen Length: 8.75 ft
Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K_r = 0.001768 cm/sec
y0 = 0.2531 ft

09/28/2023 - Classification: Internal - ECRM13153872



WELL TEST ANALYSIS

Data Set: I:\25220183.00\Data and Calculations\K Tests\MW 313 314 315\MW314.aqt
Date: 01/24/23 Time: 22:12:57

PROJECT INFORMATION

Company: SCS Engineers
Client: Alliant
Project: 25220183.00
Location: WPL - Columbia
Test Well: MW-314
Test Date: 12/30/2022

AQUIFER DATA

Saturated Thickness: 100. ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW-314)

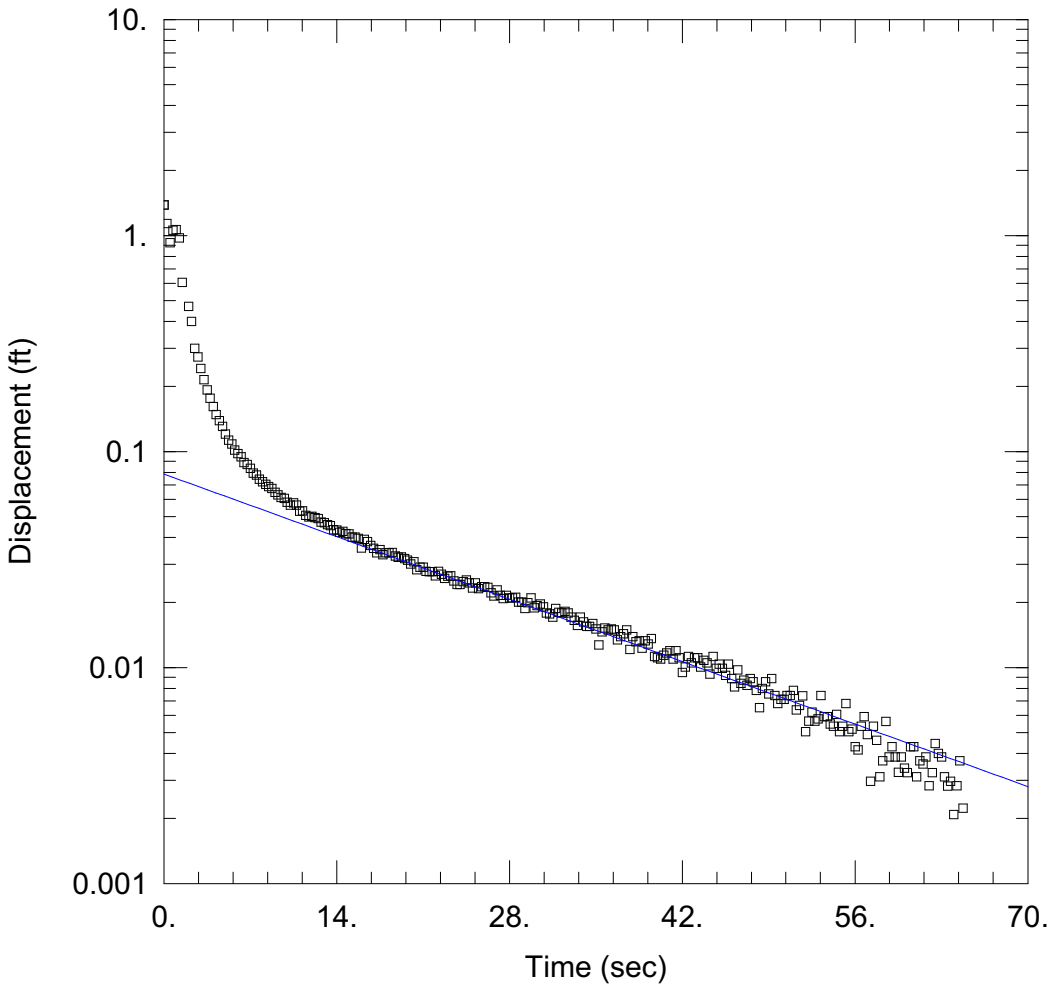
Initial Displacement: 1.797 ft
Total Well Penetration Depth: 6.55 ft
Casing Radius: 0.09 ft
Static Water Column Height: 6.55 ft
Screen Length: 6.55 ft
Well Radius: 0.35 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.002217 cm/sec
y0 = 0.3507 ft

09/28/2023 - Classification: Internal - ECRM13153872



WELL TEST ANALYSIS

Data Set: I:\25220183.00\Data and Calculations\K Tests\MW 313 314 315\MW315.aqt
Date: 01/24/23 Time: 22:03:09

PROJECT INFORMATION

Company: SCS Engineers
Client: Alliant
Project: 25220183.00
Location: WPL - Columbia
Test Well: MW-315
Test Date: 12/30/2022

AQUIFER DATA

Saturated Thickness: 100. ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW-315)

Initial Displacement: 1.385 ft
Total Well Penetration Depth: 9.27 ft
Casing Radius: 0.09 ft
Static Water Column Height: 9.27 ft
Screen Length: 9.27 ft
Well Radius: 0.35 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.001259 cm/sec
y0 = 0.07861 ft

09/28/2023 - Classification: Internal - ECRM13153872

Attachment F

Monitoring Well Construction Documentation

09/28/2023 - Classification: Internal - ECRM13153872

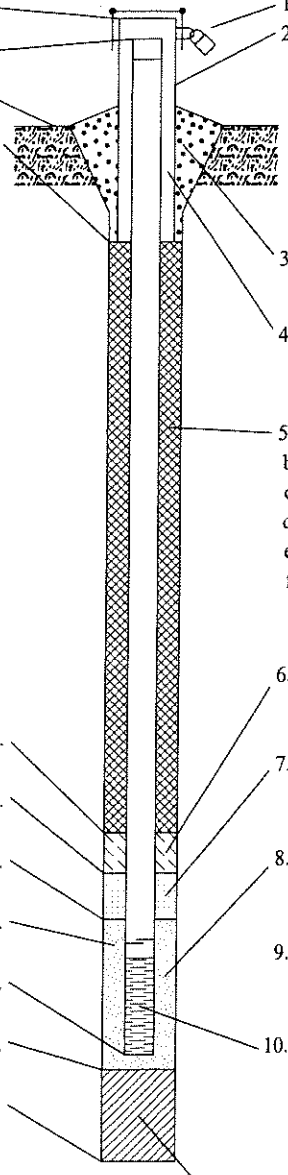
State of Wisconsin
Department of Natural Resources

Route To: Watershed/Wastewater ☐ Waste Management ☒ Remediation/Redevelopment ☐ Other ☐

MONITORING WELL CONSTRUCTION

Form 4400-113A Rev. 7-98

Facility/Project Name: Alliant Energy - Columbia	Local Grid Location of Well: ____ ft. ☐ N. ☐ S. ____ ft. ☐ E. ☐ W.	Well Name: MW-33AR
Facility License, Permit or Monitoring No.: 03025	Local Grid Origin ☐ (estimated: ☐) or Well Location ☒ Lat. ° ' " Long. ° ' " or	Wis. Unique Well No.: PE223 / DNR Well Number: 138
Facility ID: 111049180	St. Plane 542,663 ft. N, 2,123,584 ft. E. S/C/N	Date Well Installed: 04/09/2003
Type of Well: Well Code 71/dw	Section Location of Waste/Source: NE 1/4 of SW 1/4 of Sec. 27, T. 12 N, R. 9 ☒ E ☐ W	Well Installed By: (Person's Name and Firm) R. Fischer, Boart Longyear
Distance from Waste/Source: 500 ft. Enf. Stds. Apply ☐	Location of Well Relative to Waste/Source: u ☐ Upgradient s ☐ Sidegradient d ☒ Downgradient n ☐ Not Known	Gov. Lot Number:



A. Protective pipe, top elevation 808.09 ft. MSL

B. Well casing, top elevation 808.29 ft. MSL

C. Land surface elevation 805.4 ft. MSL

D. Surface seal, bottom 804.4 ft. MSL or 1.0 ft.

12. USCS classification of soil near screen:
GP ☐ GM ☐ GC ☐ GW ☐ SW ☐ SP ☐
SM ☒ SC ☐ ML ☐ MH ☐ CL ☐ CH ☐
Bedrock ☐

13. Sieve analysis attached? ☐ Yes ☒ No

14. Drilling method used: Rotary ☐ 5 0; Hollow Stem Auger ☒ 4 1; Other ☐

15. Drilling fluid used: Water ☐ 0 2 Air ☐ 0 1; Drilling Mud ☐ 0 3 None ☒ 9 9

16. Drilling additives used? ☐ Yes ☒ No

Describe ____

17. Source of water (attach analysis, if required): ____

E. Bentonite seal, top 794.4 ft. MSL or 11.0 ft.

F. Fine sand, top 789.4 ft. MSL or 16.0 ft.

G. Filter pack, top 788.4 ft. MSL or 17.0 ft.

H. Screen joint, top 787.4 ft. MSL or 18.0 ft.

I. Well bottom 777.4 ft. MSL or 28.0 ft.

J. Filter pack, bottom 776.4 ft. MSL or 29.0 ft.

K. Borehole, bottom 776.4 ft. MSL or 29.0 ft.

L. Borehole, diameter 8.0 in.

M. O.D. well casing 2.37 in.

N. I.D. well casing 2.06 in.

1. Cap and lock? ☒ Yes ☐ No
2. Protective cover pipe:
   a. Inside diameter: 4.0 in.
   b. Length: 7.0 ft.
   c. Material: Steel ☒ 0 4; Other ☐
   d. Additional protection? ☐ Yes ☒ No
   If yes, describe: ____
3. Surface seal: Bentonite ☒ 3 0; Concrete ☐ 0 1; Other ☐
4. Material between well casing and protective pipe: Bentonite ☒ 3 0; Other ☐
5. Annular space seal: a. Granular/Chipped Bentonite ☐ 3 3
   b. ____ Lbs/gal mud weight . . . Bentonite-sand slurry ☐ 3 5
   c. 10.5 Lbs/gal mud weight . . . Bentonite slurry ☒ 3 1
   d. ____ % Bentonite . . . Bentonite-cement grout ☐ 5 0
   e. 3.5 Ft^3 volume added for any of the above
   f. How installed: Tremie ☐ 0 1; Tremie pumped ☒ 0 2; Gravity ☐ 0 8
6. Bentonite seal: a. Bentonite granules ☒ 3 3
   b. ☐ 1/4 in. ☐ 3/8 in. ☐ 1/2 in. Bentonite chips ☐ 3 2
   c. ____ Other ☐
7. Fine sand material: Manufacturer, product name & mesh size
   a. #7 Badger
   b. Volume added 0.5 ft^3
8. Filter pack material: Manufacturer, product name & mesh size
   a. #40 Badger
   b. Volume added 4.5 ft^3
9. Well casing: Flush threaded PVC schedule 40 ☒ 2 3; Flush threaded PVC schedule 80 ☐ 2 4; Other ☐
10. Screen material: PVC
    a. Screen Type: Factory cut ☒ 1 1; Continuous slot ☐ 0 1; Other ☐
    b. Manufacturer Boart Longyear
    c. Slot size: 0.010 in.
    d. Slotted length: 10.0 ft.
11. Backfill material (below filter pack): None ☒ 1 4; Other ☐

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature	Firm	
[signature]	RMT, Inc.	Tel: Fax:

Please complete both Forms 4400-113A and 4400-113B and return them to the appropriate DNR office and bureau. Completion of these reports is required by chs. 160, 281, 283, 289, 291, 292, 293, 295, and 299, Wis. Stats., and ch. NR 141, Wis. Adm. Code. In accordance with chs. 281, 289, 291, 292, 293, 295, and 299, Wis. Stats., failure to file these forms may result in a forfeiture of between $10 and $25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on these forms is not intended to be used for any other purpose. NOTE: See the instructions for more information, including where the completed forms should be sent.

09/28/2023 - Classification: Internal - ECRM13153872

DEPARTMENT OF NATURAL RESOURCES

SAMPLING POINT ID FORM
FORM 4400-40 REV. 6-79

FACILITY NAME: Wisconsin Power and Light Co. / Dry Ash

SAMPLING REQUIRED (✓ ONE): ☐ YES ☐ NO

POINT (✓ ONE): ☐ CAN BE SAMPLED ☐ CANNOT BE SAMPLED

COMMON NAME OF SAMPLING POINT: mw 34A

PREVIOUS COMMON NAME OF SAMPLING POINT:

FACILITY ID NO.:

POINT ID NO.:

TYPE OF POINT (✓ ONE)

1 (G) GROUND WATER
11 ☒ MONITOR WELL
12 ☐ PIEZOMETER
13 ☐ PRIVATE WELL
14 ☐ LYSIMETER
15 ☐ SPRING
16 ☐ RESISTIVITY PROBE

2 (L) LEACHATE
21 ☐ FLOW OR SEEP
22 ☐ POND
23 ☐ COLLECTION SYSTEM

3 (S) SURFACE WATER
31 ☐ UPSTREAM
32 ☐ MID-SITE
33 ☐ DOWNSTREAM
34 ☐ RUN-OFF
35 ☐ IMPOUNDED

POINT LOCATION
(+) ☒ E. (-) ☐ W. 2,155.200 FT.
(+) ☒ N. (-) ☐ S. 541.740 FT.
FROM ☒ GRIC ORIGIN ☐ BENCHMARK

DATE POINT ESTABLISHED: 09/28/77 (MON DAY YEAR)

6 COMMENTS ABOUT SAMPLING POINT:
Well depth - 30.6' Gradient from landfill- down gradient
Geologic formation of well screen- sand
Location of well seals/materials used- bentonite seal above well screen

WELL DESCRIPTION

PIPE DIAMETER: 2.00 INCHES

PIPE TOP ELEVATION: 806.00 FEET ☒ MSL ☐ SITE

GROUND SURFACE ELEVATION: 802.70 FEET ☒ MSL ☐ SITE

TYPE OF CASING (✓ ONE): ☒ 1 PLASTIC ☐ 2 STEEL

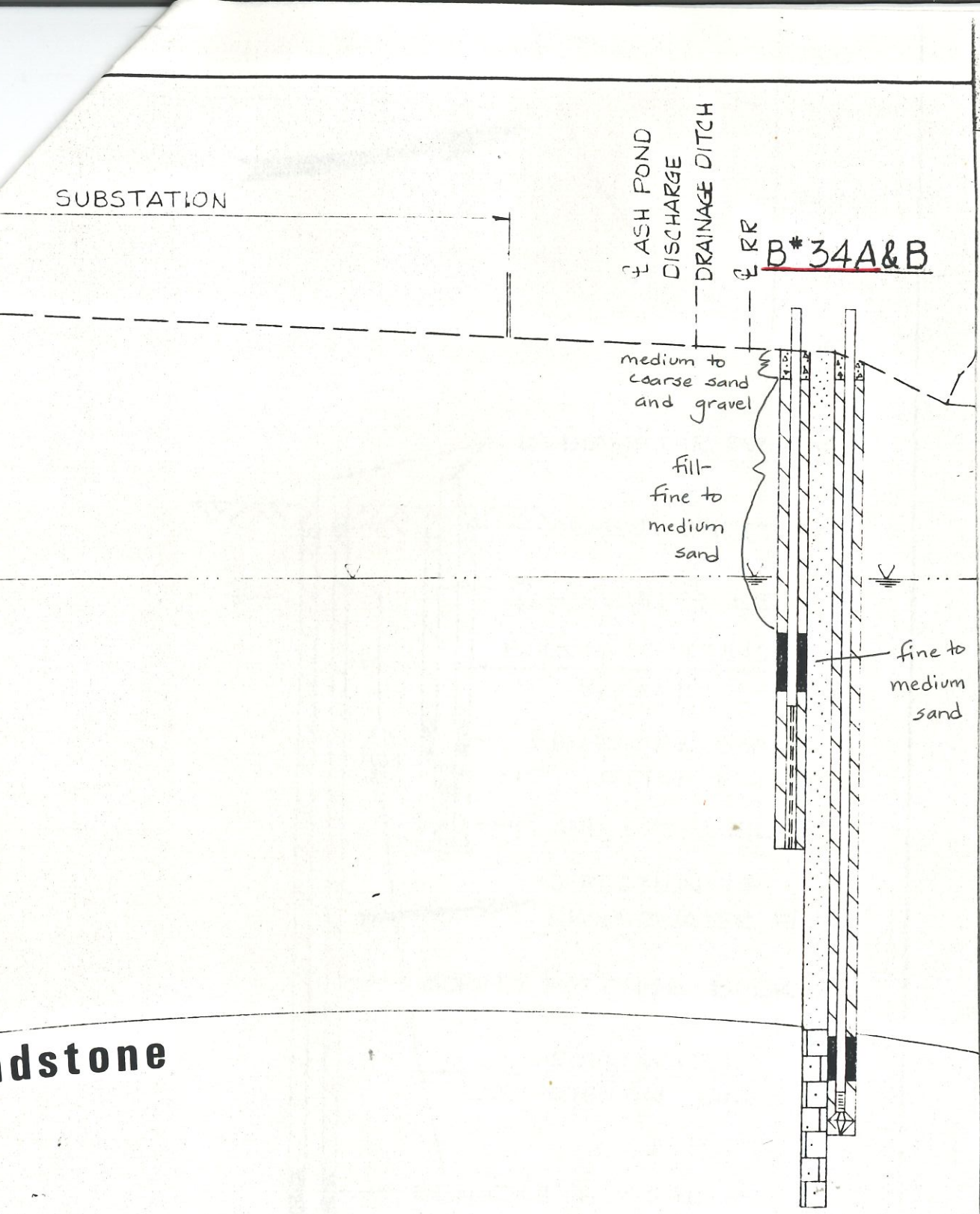
7 COMMENTS ABOUT REQUIRED SAMPLING:
Avg. vol. of water to be bailed:
Groundwater flow - westerly

REQUIRED SAMPLING (MG/L except as noted)

	NO.	PARAMETERS	MONTHS OF REQUIRED SAMPLING
■	00410	ALKALINITY (AS CA CO_3)	1-2-3-4-5-6-7-8-9-10-11-12
☐	00310	BOD (5 DAY)	1-2-3-4-5-6-7-8-9-10-11-12
☐	00916	CALCIUM	1-2-3-4-5-6-7-8-9-10-11-12
☐	00307	CHLORIDES	1-2-3-4-5-6-7-8-9-10-11-12
☐	00340	COD	1-2-3-4-5-6-7-8-9-10-11-12
■	00872	CONDUCTIVITY (SU)	1-2-3-4-5-6-7-8-9-10-11-12
☐	00277	COPPER (DISSOLVED)	1-2-3-4-5-6-7-8-9-10-11-12
■	00900	HARDNESS (AS CA CO_3)	1-2-3-4-5-6-7-8-9-10-11-12
■	01046	IRON (DISSOLVED)	1-2-3-4-5-6-7-8-9-10-11-12
☐	00348	MAGNESIUM	1-2-3-4-5-6-7-8-9-10-11-12
☐	00620	NITRATES (AS NO_3)	1-2-3-4-5-6-7-8-9-10-11-12
☐	00640	NITROGEN (TOTAL INOGRANIC N)	1-2-3-4-5-6-7-8-9-10-11-12
■	00400	PH (SU)	1-2-3-4-5-6-7-8-9-10-11-12
☐	00129	PHENOLS	1-2-3-4-5-6-7-8-9-10-11-12
■	00929	SODIUM	1-2-3-4-5-6-7-8-9-10-11-12
■	00945	SULFATES	1-2-3-4-5-6-7-8-9-10-11-12
☐	00360	TOTAL DIS. SOLIDS	1-2-3-4-5-6-7-8-9-10-11-12
■	00842	WATER ELEVATION (FT. MSL)	1-2-3-4-5-6-7-8-9-10-11-12
☐	00275	ZINC (DISSOLVED)	1-2-3-4-5-6-7-8-9-10-11-12

	NO.	PARAMETERS (OTHERS)	MONTHS
■	01022	Boron	1-2-3-4-5-6-7-8-9-10-11-12
■		Color	1-2-3-4-5-6-7-8-9-10-11-12
■		Odor	1-2-3-4-5-6-7-8-9-10-11-12
■		Turbidity	1-2-3-4-5-6-7-8-9-10-11-12
■	01002	Arsenic	1-2-3-4-5-6-7-8-9-10-11-12
■	01007	Barium	1-2-3-4-5-6-7-8-9-10-11-12
■	00312	Cadmium	1-2-3-4-5-6-7-8-9-10-11-12
■	00273	Chromium	1-2-3-4-5-6-7-8-9-10-11-12
■	00240	Lead	1-2-3-4-5-6-7-8-9-10-11-12
■	00126	Mercury	1-2-3-4-5-6-7-8-9-10-11-12
■	00270	Selenium	1-2-3-4-5-6-7-8-9-10-11-12
■	01077	Silver	1-2-3-4-5-6-7-8-9-10-11-12

09/28/2023 - Classification: Internal - ECRM13153872



dstone

Scale:

Horizontal 1"=100'

Vertical 1"=10'

No legend available

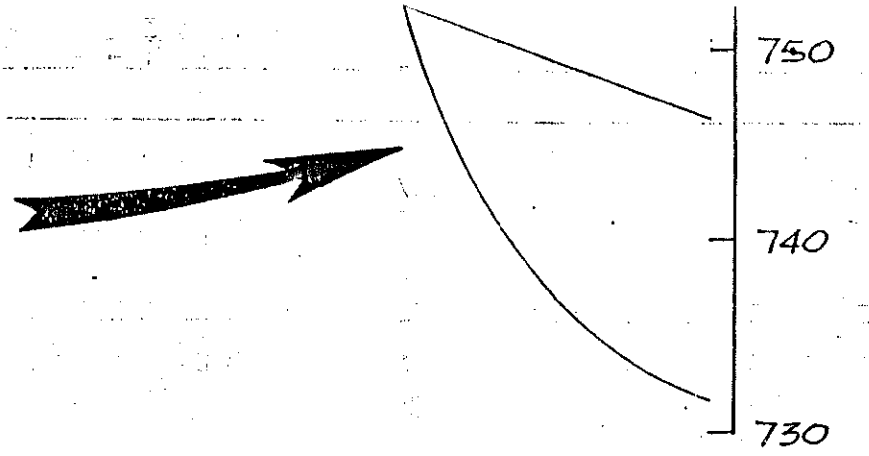
Warzyn Engineering Inc.

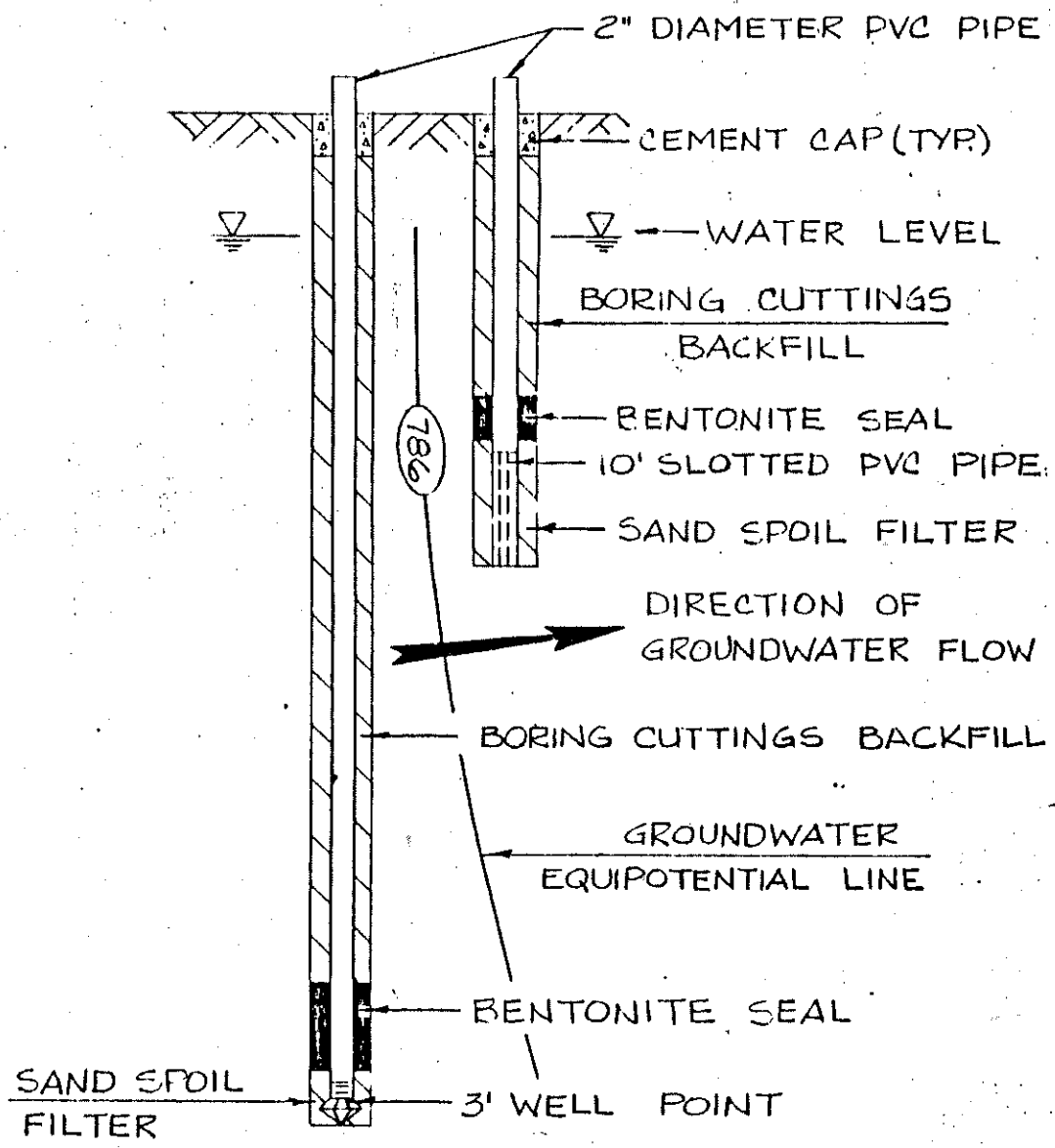
Geologic Cross Sections

Drawing No. C7134-11

Date 1-20-78

09/28/2023 - Classification: Internal - ECRM13153872





TYPICAL MONITORING WELL DETAIL

NOT TO SCALE

Date- 1-20-78 Drawing No. 7134-9

Warzyn Engineering Inc.

09/26/2023 - Classification: Internal - ECRM13153872

WELL DETAIL INFORMATION SHEET

JOB NO. C 7134

BORING NO. MW-84A

DATE 10/5/83

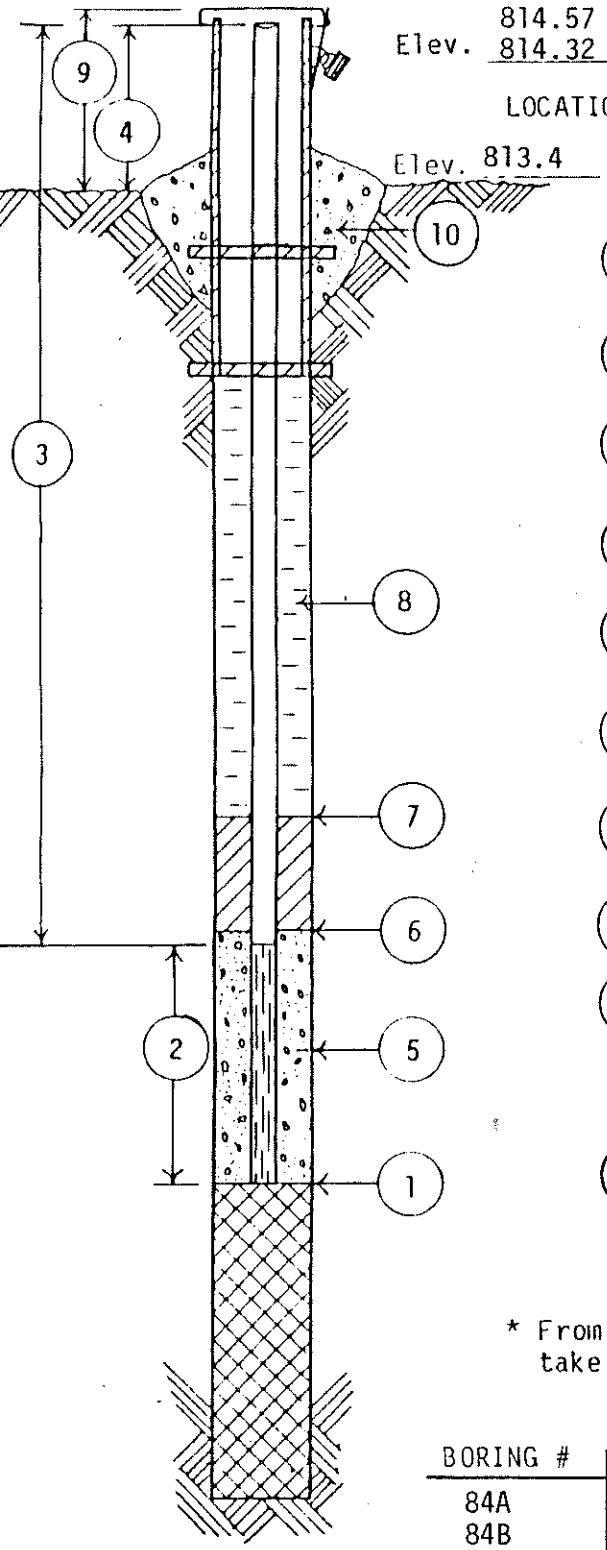
Elev. 814.57 Steel
814.32 PVC

CHIEF JS

LOCATION WP&L-Columbia Generating Station

Elev. 813.4

All depth measurements of well detail assumed to be from ground surface unless otherwise indicated.



(1) DEPTH TO BOTTOM OF BOREHOLE
37 FEET

(2) LENGTH OF WELL POINT, (WELL SCREEN,) OR SLOTTED PIPE 10 FEET

(3) TOTAL LENGTH OF SOLID PIPE 29 FEET @ 2 IN. DIAMETER

(4) HEIGHT OF WELL CASING ABOVE GROUND
2 FEET

(5) TYPE OF FILTER MATERIAL AROUND WELL POINT OR SLOTTED PIPE Flint Sand

(6) DEPTH OF LOWER OR BOTTOM SEAL
3 FEET

(7) DEPTH OF UPPER OR TOP SEAL
0 FEET

(8) TYPE OF BACKFILL Spoils (Sand)

(9) PROTECTIVE CASING (YES) NO

HEIGHT ABOVE GROUND 2'

LOCKING CAP (YES) NO

(10) CONCRETE CAP (YES) NO

WATER LEVEL CHECKS

* From top of casing, if protective casing higher take measurement from top of protective casing.

BORING #	DATE	TIME	DEPTH TO WATER	REMARKS
84A	10/7/83	3 days	21'	
84B	10/7/83	3 days	19'6"	

WARZYN ENGINEERING INC.

09/28/2023 Classification: Internal - ECRM13153872

SCS # 25215135

State of Wisconsin
Department of Natural Resources

Route to: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☐ Other ☐ _____

MONITORING WELL CONSTRUCTION
Form 4400-113A Rev. 7-98

Facility/Project Name: WPL-Columbia	Local Grid Location of Well: _____ ft. ☐ N. ☐ S. _____ ft. ☐ E. ☐ W.	Well Name: MW-301
Facility License, Permit or Monitoring No.	Local Grid Origin ☐ (estimated: ☐) or Well Location ☐ Lat. ° ' " Long. ° ' " or	Wis. Unique Well No.: VY701 / DNR Well ID No.: ____
Facility ID: ____	St. Plane 541562.2 ft. N, 2125001 ft. E. S/C/N	Date Well Installed: 11 / 11 / 2015 (m m d d y y y y)
Type of Well: Well Code 11 / MW	Section Location of Waste/Source: SW 1/4 of SE 1/4 of Sec. 27, T. 12 N, R. 9 ☒ E ☐ W	Well Installed By: Name (first, last) and Firm: Kevin Duerst / Badger State Drilling
Distance from Waste/Source: ____ ft. / Enf. Stds. Apply ☐	Location of Well Relative to Waste/Source: u ☐ Upgradient s ☐ Sidegradient d ☐ Downgradient n ☐ Not Known	Gov. Lot Number: ____

A. Protective pipe, top elevation 807.16 ft. MSL
B. Well casing, top elevation 806.89 ft. MSL
C. Land surface elevation 803.69 ft. MSL
D. Surface seal, bottom 791.69 ft. MSL or 12 ft.

12. USCS classification of soil near screen:
GP ☐ GM ☐ GC ☐ GW ☐ SW ☐ SP ☐
SM ☒ SC ☐ ML ☐ MH ☐ CL ☐ CH ☐
Bedrock ☐

13. Sieve analysis performed? ☐ Yes ☐ No

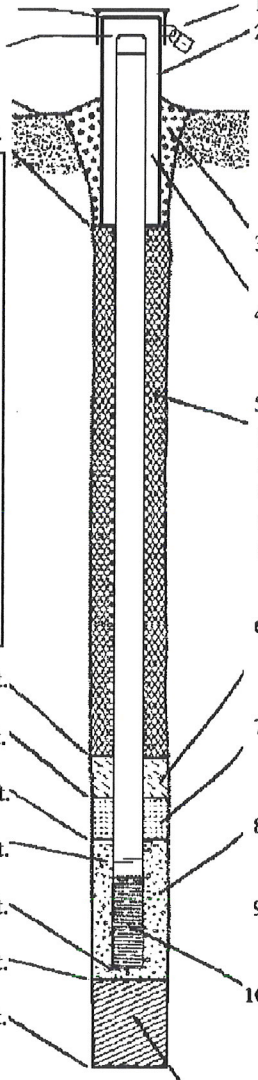
14. Drilling method used: Rotary ☐ 50 / Hollow Stem Auger ☒ 41 / Other ☐ ____

15. Drilling fluid used: Water ☐ 02 / Air ☐ 01 / Drilling Mud ☐ 03 / None ☒ 99

16. Drilling additives used? ☐ Yes ☒ No
Describe ____

17. Source of water (attach analysis, if required):
____

E. Bentonite seal, top 803.69 ft. MSL or 0 ft.
F. Fine sand, top 791.69 ft. MSL or 12 ft.
G. Filter pack, top 789.69 ft. MSL or 14 ft.
H. Screen joint, top 787.69 ft. MSL or 16 ft.
I. Well bottom 777.69 ft. MSL or 26 ft.
J. Filter pack, bottom 776.69 ft. MSL or 27 ft.
K. Borehole, bottom 775.69 ft. MSL or 28 ft.
L. Borehole, diameter 8.5 in.
M. O.D. well casing 2.4 in.
N. I.D. well casing 2.0 in.



1. Cap and lock? ☐ Yes ☒ No
2. Protective cover pipe:
a. Inside diameter: 6 in.
b. Length: 5 ft.
c. Material: Steel ☒ 04 / Other ☐ ____
d. Additional protection? ☒ Yes ☐ No
If yes, describe: bumper posts
3. Surface seal: Bentonite ☒ 30 / Concrete ☐ 01 / Other ☐ ____
4. Material between well casing and protective pipe: Bentonite ☒ 30 / Other ☐ ____
Bentonite to grade, sand above
5. Annular space seal: a. Granular/Chipped Bentonite ☐ 33
b. ____ Lbs/gal mud weight . . . Bentonite-sand slurry ☐ 35
c. ____ Lbs/gal mud weight . . . . . Bentonite slurry ☐ 31
d. ____ % Bentonite . . . . . Bentonite-cement grout ☐ 50
e. ____ Ft^3 volume added for any of the above
f. How installed: Tremie ☐ 01 / Tremie pumped ☐ 02 / Gravity ☐ 08
6. Bentonite seal: a. Bentonite granules ☐ 33
b. ☐ 1/4 in. ☒ 3/8 in. ☐ 1/2 in. Bentonite chips ☑ 32
c. 4 ft3 Other ☐ ____
7. Fine sand material: Manufacturer, product name & mesh size
a. RW Sidley Inc. #7 ☐
b. Volume added 0.5 ft^3
8. Filter pack material: Manufacturer, product name & mesh size
a. RW Sidley #5 ☐
b. Volume added 2 ft^3
9. Well casing: Flush threaded PVC schedule 40 ☒ 23 / Flush threaded PVC schedule 80 ☐ 24 / Other ☐ ____
10. Screen material: PVC
a. Screen type: Factory cut ☒ 11 / Continuous slot ☐ 01 / Other ☐ ____
b. Manufacturer Johnson
c. Slot size: 0.01 in.
d. Slotted length: 10 ft.
11. Backfill material (below filter pack): Native / None ☐ 14 / Other ☒ ____

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature: [signature] Firm: SCS ENGINEERS, 2830 Dairy Drive, Madison, WI 53718-6751

Please complete both Forms 4400-113A and 4400-113B and return them to the appropriate DNR office and bureau. Completion of these reports is required by chs. 160, 281, 283, 289, 291, 292, 293, 295, and 299, Wis. Stats., and ch. NR 141, Wis. Adm. Code. In accordance with chs. 281, 289, 291, 292, 293, 295, and 299, Wis. Stats., failure to file these forms may result in a forfeiture of between $10 and $25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on these forms is not intended to be used for any other purpose. NOTE: See the instructions for more information, including where the completed forms should be sent.

09/28/2023 - Classification: Internal - ECRM13153872

SCS # 25215135

State of Wisconsin
Department of Natural Resources

Route to: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☐ Other ☐

MONITORING WELL CONSTRUCTION
Form 4400-113A Rev. 7-98

Facility/Project Name: WPL-Columbia	Local Grid Location of Well: ____ ft. ☐N. ☐S. ____ ft. ☐E. ☐W.	Well Name: MW-302
Facility License, Permit or Monitoring No.	Local Grid Origin ☐ (estimated: ☐) or Well Location ☐ Lat. ° ' " Long. ° ' " or	Wis. Unique Well No.: VY702 / DNR Well ID No.:
Facility ID	St. Plane 541964.7 ft. N, 2123849 ft. E. S/C/N	Date Well Installed: 11 / 12 / 2015 (m m d d y y y y)
Type of Well: Well Code 11 / MW	Section Location of Waste/Source: SE 1/4 of SW 1/4 of Sec. 27, T. 12 N, R. 9 ☒E ☐W	Well Installed By: Name (first, last) and Firm: Kevin Duerst / Badger State Drilling
Distance from Waste/Source ____ ft. / Enf. Stds. Apply ☐	Location of Well Relative to Waste/Source: u ☐ Upgradient s ☐ Sidegradient d ☐ Downgradient n ☐ Not Known	Gov. Lot Number:

A. Protective pipe, top elevation 813.19 ft. MSL
B. Well casing, top elevation 813.00 ft. MSL
C. Land surface elevation 809.93 ft. MSL
D. Surface seal, bottom 793.53 ft. MSL or 16.4 ft.

12. USCS classification of soil near screen:
GP ☐ GM ☐ GC ☐ GW ☐ SW ☐ SP ☒
SM ☐ SC ☐ ML ☐ MH ☐ CL ☐ CH ☐
Bedrock ☐

13. Sieve analysis performed? ☐ Yes ☒ No

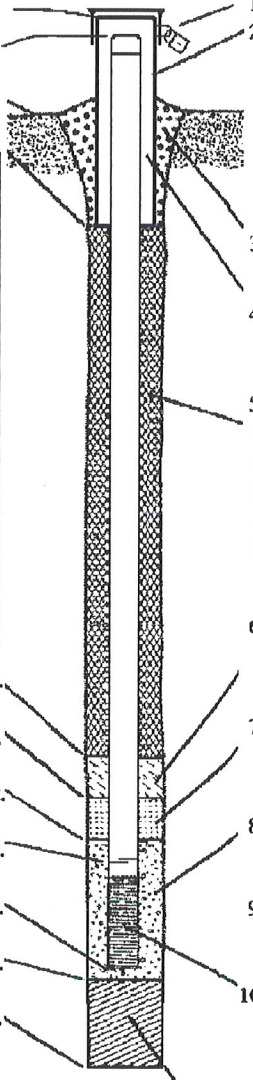
14. Drilling method used: Rotary ☐ 50 / Hollow Stem Auger ☒ 41 / Other ☐ ____

15. Drilling fluid used: Water ☐ 02 / Air ☐ 01 / Drilling Mud ☐ 03 / None ☒ 99

16. Drilling additives used? ☐ Yes ☒ No
Describe ____

17. Source of water (attach analysis, if required):

E. Bentonite seal, top 809.93 ft. MSL or 0 ft.
F. Fine sand, top 793.53 ft. MSL or 16.4 ft.
G. Filter pack, top 791.53 ft. MSL or 18.4 ft.
H. Screen joint, top 789.53 ft. MSL or 20.4 ft.
I. Well bottom 779.53 ft. MSL or 30.4 ft.
J. Filter pack, bottom 776.93 ft. MSL or 33 ft.
K. Borehole, bottom 776.93 ft. MSL or 33 ft.
L. Borehole, diameter 8.5 in.
M. O.D. well casing 2 3/8 in.
N. I.D. well casing 2 in.



1. Cap and lock? ☐ Yes ☒ No
2. Protective cover pipe:
a. Inside diameter: 6 in.
b. Length: 5 ft.
c. Material: steel — Steel ☐ 04 / Other ☐ ____
d. Additional protection? ☐ Yes ☐ No
If yes, describe: yes, bumper posts
3. Surface seal: Bentonite ☒ 30 / Concrete ☐ 01 / Other ☐ ____
4. Material between well casing and protective pipe: Bentonite to grade, sand above — Bentonite ☒ 30 / Other ☐ ____
5. Annular space seal: a. Granular/Chipped Bentonite ☐ 33
b. ____ Lbs/gal mud weight . . . Bentonite-sand slurry ☐ 35
c. ____ Lbs/gal mud weight . . . . . Bentonite slurry ☐ 31
d. ____ % Bentonite . . . . . Bentonite-cement grout ☐ 50
e. ____ Ft^3 volume added for any of the above
f. How installed: Tremie ☐ 01 / Tremie pumped ☐ 02 / Gravity ☐ 08
6. Bentonite seal: a. Bentonite granules ☐ 33
b. ☐ 1/4 in. ☒ 3/8 in. ☐ 1/2 in. Bentonite chips ☐ 32
c. 4.7 ft3 — Other ☐ ____
7. Fine sand material: Manufacturer, product name & mesh size
a. RW Sidley Inc. #7 ☐
b. Volume added 1 ft^3
8. Filter pack material: Manufacturer, product name & mesh size
a. RW Sidley #5 ☐
b. Volume added 2.5 ft^3
9. Well casing: Flush threaded PVC schedule 40 ☒ 23 / Flush threaded PVC schedule 80 ☐ 24 / Other ☐ ____
10. Screen material: PVC
a. Screen type: Factory cut ☒ 11 / Continuous slot ☐ 01 / Other ☐ ____
b. Manufacturer Johnson
c. Slot size: 0.01 in.
d. Slotted length: 10 ft.
11. Backfill material (below filter pack): Native — None ☐ 14 / Other ☒ ____

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature: for Zach Watson | Firm: SCS ENGINEERS, 2830 Dairy Drive, Madison, WI 53718-6751

Please complete both Forms 4400-113A and 4400-113B and return them to the appropriate DNR office and bureau. Completion of these reports is required by chs. 160, 281, 283, 289, 291, 292, 293, 295, and 299, Wis. Stats., and ch. NR 141, Wis. Adm. Code. In accordance with chs. 281, 289, 291, 292, 293, 295, and 299, Wis. Stats., failure to file these forms may result in a forfeiture of between $10 and $25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on these forms is not intended to be used for any other purpose. NOTE: See the instructions for more information, including where the completed forms should be sent.

09/28/2023 - Classification: Internal - ECRM13153872

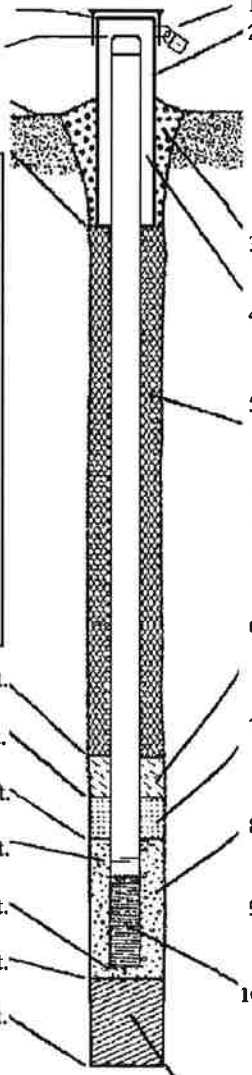
SCS # 25217156.01

State of Wisconsin
Department of Natural Resources

Route to: Watershed/Wastewater ☐ Waste Management ☒
Remediation/Redevelopment ☐ Other ☐

MONITORING WELL CONSTRUCTION
Form 4400-113A Rev. 7-98

Facility/Project Name: WPL-Columbia Generating Station	Local Grid Location of Well: ☒ N. ☐ S. 543447.673 ft. ☒ E. ☐ W. 2124151.113 ft.	Well Name: MW-309
Facility License, Permit or Monitoring No.	Local Grid Origin ☐ (estimated: ☐) or Well Location ☐ Lat. ° ' " Long. ° ' " or	Wis. Unique Well No.: VR111 DNR Well ID No.:
Facility ID	St. Plane ft. N, ft. E. S/C/N	Date Well Installed: 02 / 14 / 2018 (m m d d y y y y)
Type of Well: Well Code 11 / MW	Section Location of Waste/Source: NW 1/4 of SE 1/4 of Sec. 27, T. 12 N, R. 09 ☒ E ☐ W	Well Installed By: Name (first, last) and Firm: Mark Crampton; Badger State Drilling Co., Inc.
Distance from Waste/Source ft. Enf. Stds. Apply ☒	Location of Well Relative to Waste/Source: u ☐ Upgradient s ☐ Sidegradient d ☒ Downgradient n ☐ Not Known	Gov. Lot Number



A. Protective pipe, top elevation 813.59 ft. MSL
B. Well casing, top elevation 813.28 ft. MSL
C. Land surface elevation 809.88 ft. MSL
D. Surface seal, bottom 807.61 ft. MSL or 2.27 ft.

12. USCS classification of soil near screen:
GP ☐ GM ☐ GC ☐ GW ☐ SW ☐ SP ☒
SM ☐ SC ☐ ML ☐ MH ☐ CL ☐ CH ☐
Bedrock ☐

13. Sieve analysis performed? ☒ Yes ☐ No

14. Drilling method used: Rotary ☐ 50 Hollow Stem Auger ☒ 41 Other ☐

15. Drilling fluid used: Water ☐ 02 Air ☐ 01 Drilling Mud ☐ 03 None ☒ 99

16. Drilling additives used? ☐ Yes ☒ No

Describe --

17. Source of water (attach analysis, if required):
--

E. Bentonite seal, top 807.61 ft. MSL or 2.27 ft.
F. Fine sand, top 788.61 ft. MSL or 21.27 ft.
G. Filter pack, top 786.61 ft. MSL or 23.27 ft.
H. Screen joint, top 785.61 ft. MSL or 24.27 ft.
I. Well bottom 775.61 ft. MSL or 34.27 ft.
J. Filter pack, bottom 773.38 ft. MSL or 36.5 ft.
K. Borehole, bottom 773.38 ft. MSL or 36.5 ft.
L. Borehole, diameter 8.5 in.
M. O.D. well casing 2.38 in.
N. I.D. well casing 2.01 in.

1. Cap and lock? ☒ Yes ☐ No
2. Protective cover pipe:
a. Inside diameter: 6 in.
b. Length: 5 ft.
c. Material: Steel ☒ 04 Other ☐
d. Additional protection? ☐ Yes ☒ No
If yes, describe:
3. Surface seal: Bentonite ☒ 30 Concrete ☐ 01 Other ☐
4. Material between well casing and protective pipe: Bentonite ☐ 30 Other ☒
Filter Sand (#5)
5. Annular space seal: a. Granular/Chipped Bentonite ☒ 33
b. Lbs/gal mud weight . . . Bentonite-sand slurry ☐ 35
c. Lbs/gal mud weight . . . . . Bentonite slurry ☐ 31
d. % Bentonite . . . . . Bentonite-cement grout ☐ 50
e. 0.342 Ft^3 volume added for any of the above
f. How installed: Tremie ☐ 01 Tremie pumped ☐ 02 Gravity ☒ 08
6. Bentonite seal: a. Bentonite granules ☐ 33
b. ☐ 1/4 in. ☒ 3/8 in. ☐ 1/2 in. Bentonite chips ☒ 32
c. Other ☐
7. Fine sand material: Manufacturer, product name & mesh size
a. RW Sidley #7 (1 bag) ☒
b. Volume added ft^3
8. Filter pack material: Manufacturer, product name & mesh size
a. RW Sidley #5 (6 bags) ☒
b. Volume added ft^3
9. Well casing: Flush threaded PVC schedule 40 ☒ 23 Flush threaded PVC schedule 80 ☐ 24 Other ☐
10. Screen material: PVC
a. Screen type: Factory cut ☒ 11 Continuous slot ☐ 01 Other ☐
b. Manufacturer Monoflex
c. Slot size: 0.010 in.
d. Slotted length: 10 ft.
11. Backfill material (below filter pack): None ☒ 14 Other ☐

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature: [signature] Firm: SCS ENGINEERS, 2830 Dairy Drive, Madison, WI 53718

Please complete both Forms 4400-113A and 4400-113B and return them to the appropriate DNR office and bureau. Completion of these reports is required by chs. 160, 281, 283, 289, 291, 292, 293, 295, and 299, Wis. Stats., and ch. NR 141, Wis. Adm. Code. In accordance with chs. 281, 289, 291, 292, 293, 295, and 299, Wis. Stats., failure to file these forms may result in a forfeiture of between $10 and $25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on these forms is not intended to be used for any other purpose. NOTE: See the instructions for more information, including where the completed forms should be sent.

09/28/2023 - Classification: Internal - ECRM13153872

SCS # 25217156.01

State of Wisconsin
Department of Natural Resources

Route to: Watershed/Wastewater ☐ Waste Management ☒
Remediation/Redevelopment ☐ Other ☐

MONITORING WELL CONSTRUCTION
Form 4400-113A Rev. 7-98

Facility/Project Name: WPL-Columbia Generating Station	Local Grid Location of Well: ☒ N. ☐ S. 543331.971 ft. ☒ E. ☐ W. 2123879.85 ft.	Well Name: MW-310
Facility License, Permit or Monitoring No.	Local Grid Origin ☐ (estimated: ☐) or Well Location ☐ Lat. ° ' " Long. ° ' " or	Wis. Unique Well No.: VR110 / DNR Well ID No.
Facility ID	St. Plane ft. N, ft. E. S/C/N	Date Well Installed: 02 / 13 / 2018 (m m d d y y y y)
Type of Well: Well Code 11 / MW	Section Location of Waste/Source: NW 1/4 of SE 1/4 of Sec. 27, T. 12 N, R. 09 ☒ E ☐ W	Well Installed By: Name (first, last) and Firm: Dave Cruise / Badger State Drilling Co., Inc.
Distance from Waste/Source ft. / Enf. Stds. Apply ☒	Location of Well Relative to Waste/Source: u ☐ Upgradient s ☐ Sidegradient d ☒ Downgradient n ☐ Not Known	Gov. Lot Number

A. Protective pipe, top elevation 813.93 ft. MSL
B. Well casing, top elevation 813.62 ft. MSL
C. Land surface elevation 810.96 ft. MSL
D. Surface seal, bottom 809.21 ft. MSL or 1.75 ft.

12. USCS classification of soil near screen:
GP ☐ GM ☐ GC ☐ GW ☐ SW ☐ SP ☒
SM ☐ SC ☐ ML ☐ MH ☐ CL ☐ CH ☐
Bedrock ☐

13. Sieve analysis performed? ☒ Yes ☐ No

14. Drilling method used: Rotary ☐ 50 / Hollow Stem Auger ☒ 41 / Other ☐ ___

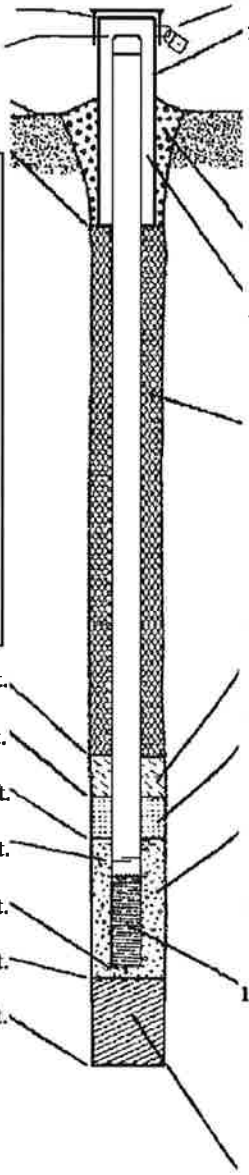
15. Drilling fluid used: Water ☐ 02 / Air ☐ 01 / Drilling Mud ☐ 03 / None ☒ 99

16. Drilling additives used? ☐ Yes ☒ No

Describe --

17. Source of water (attach analysis, if required):
--

E. Bentonite seal, top 809.21 ft. MSL or 1.75 ft.
F. Fine sand, top 789.21 ft. MSL or 21.75 ft.
G. Filter pack, top 787.21 ft. MSL or 23.75 ft.
H. Screen joint, top 785.21 ft. MSL or 25.75 ft.
I. Well bottom 775.21 ft. MSL or 35.75 ft.
J. Filter pack, bottom 774.46 ft. MSL or 36.5 ft.
K. Borehole, bottom 774.46 ft. MSL or 36.5 ft.
L. Borehole, diameter 8.5 in.
M. O.D. well casing 2.38 in.
N. I.D. well casing 2.01 in.



1. Cap and lock? ☒ Yes ☐ No
2. Protective cover pipe:
a. Inside diameter: 6 in.
b. Length: 5 ft.
c. Material: Steel ☒ 04 / Other ☐ ___
d. Additional protection? ☐ Yes ☒ No
If yes, describe:
3. Surface seal: Bentonite ☒ 30 / Concrete ☐ 01 / Other ☐ ___
4. Material between well casing and protective pipe: Bentonite ☐ 30 / Filter Sand (#5) / Other ☒ ___
5. Annular space seal: a. Granular/Chipped Bentonite ☒ 33
b. ___ Lbs/gal mud weight . . . Bentonite-sand slurry ☐ 35
c. ___ Lbs/gal mud weight . . . . . Bentonite slurry ☐ 31
d. ___ % Bentonite . . . . . Bentonite-cement grout ☐ 50
e. 0.369 Ft^3 volume added for any of the above
f. How installed: Tremie ☐ 01 / Tremie pumped ☐ 02 / Gravity ☒ 08
6. Bentonite seal: a. Bentonite granules ☐ 33
b. ☐ 1/4 in. ☒ 3/8 in. ☐ 1/2 in. Bentonite chips ☒ 32
c. ___ Other ☐ ___
7. Fine sand material: Manufacturer, product name & mesh size
a. RW Sidley #7 (1 bag) ☒
b. Volume added ___ ft^3
8. Filter pack material: Manufacturer, product name & mesh size
a. RW Sidley #5 (7 bags) ☒
b. Volume added ___ ft^3
9. Well casing: Flush threaded PVC schedule 40 ☒ 23 / Flush threaded PVC schedule 80 ☐ 24 / Other ☐ ___
10. Screen material: PVC
a. Screen type: Factory cut ☒ 11 / Continuous slot ☐ 01 / Other ☐ ___
b. Manufacturer Monoflex
c. Slot size: 0.010 in.
d. Slotted length: 10 ft.
11. Backfill material (below filter pack): None ☒ 14 / Other ☐ ___

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature | Firm: SCS ENGINEERS, 2830 Dairy Drive, Madison, WI 53718

Please complete both Forms 4400-113A and 4400-113B and return them to the appropriate DNR office and bureau. Completion of these reports is required by chs. 160, 281, 283, 289, 291, 292, 293, 295, and 299, Wis. Stats., and ch. NR 141, Wis. Adm. Code. In accordance with chs. 281, 289, 291, 292, 293, 295, and 299, Wis. Stats., failure to file these forms may result in a forfeiture of between $10 and $25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on these forms is not intended to be used for any other purpose. NOTE: See the instructions for more information, including where the completed forms should be sent.

09/28/2023 - Classification: Internal - ECRM13153872

SCS # 25217156.01

State of Wisconsin
Department of Natural Resources

Route to: Watershed/Wastewater ☐ Waste Management ☒
Remediation/Redevelopment ☐ Other ☐

MONITORING WELL CONSTRUCTION
Form 4400-113A Rev. 7-98

Facility/Project Name: WPL-Columbia Generating Station	Local Grid Location of Well: 542874.39 ft. ☒ N. ☐ S. 2123437.50 ft. ☒ E. ☐ W.	Well Name: MW-311
Facility License, Permit or Monitoring No.	Local Grid Origin ☐ (estimated: ☐) or Well Location ☐ Lat. ° ' " Long. ° ' " or	Wis. Unique Well No.: VR112 / DNR Well ID No.
Facility ID	St. Plane ft. N, ft. E. S/C/N	Date Well Installed: 02 / 14 / 2018 (m m d d y y y y)
Type of Well — Well Code 11 / MW	Section Location of Waste/Source: NE 1/4 of SW 1/4 of Sec. 27, T. 12 N, R. 09 ☒ E ☐ W	Well Installed By: Name (first, last) and Firm: Mark Crampton / Badger State Drilling Co., Inc.
Distance from Waste/Source ft. / Enf. Stds. Apply ☒	Location of Well Relative to Waste/Source: u ☐ Upgradient s ☐ Sidegradient d ☒ Downgradient n ☐ Not Known	Gov. Lot Number

A. Protective pipe, top elevation 810.05 ft. MSL
B. Well casing, top elevation 809.74 ft. MSL
C. Land surface elevation 806.53 ft. MSL
D. Surface seal, bottom 803.55 ft. MSL or 2.98 ft.

12. USCS classification of soil near screen:
GP ☐ GM ☐ GC ☐ GW ☐ SW ☐ SP ☒
SM ☐ SC ☐ ML ☐ MH ☐ CL ☐ CH ☐
Bedrock ☐

13. Sieve analysis performed? ☒ Yes ☐ No

14. Drilling method used: Rotary ☐ 50 / Hollow Stem Auger ☒ 41 / Other ☐

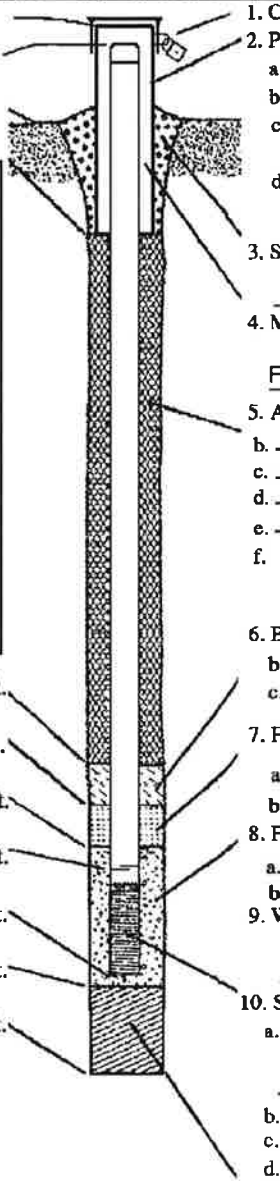
15. Drilling fluid used: Water ☐ 02 / Air ☐ 01 / Drilling Mud ☐ 03 / None ☒ 99

16. Drilling additives used? ☐ Yes ☒ No

Describe --

17. Source of water (attach analysis, if required):
--

E. Bentonite seal, top 803.55 ft. MSL or 2.98 ft.
F. Fine sand, top 787.55 ft. MSL or 18.98 ft.
G. Filter pack, top 785.55 ft. MSL or 20.98 ft.
H. Screen joint, top 783.55 ft. MSL or 22.98 ft.
I. Well bottom 773.55 ft. MSL or 32.98 ft.
J. Filter pack, bottom 773.53 ft. MSL or 33 ft.
K. Borehole, bottom 773.53 ft. MSL or 33 ft.
L. Borehole, diameter 8.5 in.
M. O.D. well casing 2.38 in.
N. I.D. well casing 2.01 in.



1. Cap and lock? ☒ Yes ☐ No
2. Protective cover pipe:
a. Inside diameter: 6 in.
b. Length: 5 ft.
c. Material: Steel ☒ 04 / Other ☐
d. Additional protection? ☐ Yes ☒ No
If yes, describe:
3. Surface seal: Bentonite ☒ 30 / Concrete ☐ 01 / Other ☐
4. Material between well casing and protective pipe: Bentonite ☐ 30 / Other ☒
Filter Sand (#5)
5. Annular space seal: a. Granular/Chipped Bentonite ☒ 33
b. ____ Lbs/gal mud weight . . . Bentonite-sand slurry ☐ 35
c. ____ Lbs/gal mud weight . . . . . Bentonite slurry ☐ 31
d. ____ % Bentonite . . . . . Bentonite-cement grout ☐ 50
e. 0.288 Ft³ volume added for any of the above
f. How installed: Tremie ☐ 01 / Tremie pumped ☐ 02 / Gravity ☒ 08
6. Bentonite seal: a. Bentonite granules ☐ 33
b. ☐ 1/4 in. ☒ 3/8 in. ☐ 1/2 in. Bentonite chips ☒ 32
c. ____ Other ☐
7. Fine sand material: Manufacturer, product name & mesh size
a. RW Sidley #7 (1 bag) ☒
b. Volume added ____ ft³
8. Filter pack material: Manufacturer, product name & mesh size
a. RW Sidley #5 (6 bags) ☒
b. Volume added ____ ft³
9. Well casing: Flush threaded PVC schedule 40 ☒ 23 / Flush threaded PVC schedule 80 ☐ 24 / Other ☐
10. Screen material: PVC
a. Screen type: Factory cut ☒ 11 / Continuous slot ☐ 01 / Other ☐
b. Manufacturer Monoflex
c. Slot size: 0.010 in.
d. Slotted length: 10 ft.
11. Backfill material (below filter pack): None ☒ 14 / Other ☐

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature: [signature] Firm: SCS ENGINEERS, 2830 Dairy Drive, Madison, WI 53718

Please complete both Forms 4400-113A and 4400-113B and return them to the appropriate DNR office and bureau. Completion of these reports is required by chs. 160, 281, 283, 289, 291, 292, 293, 295, and 299, Wis. Stats., and ch. NR 141, Wis. Adm. Code. In accordance with chs. 281, 289, 291, 292, 293, 295, and 299, Wis. Stats., failure to file these forms may result in a forfeiture of between $10 and $25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on these forms is not intended to be used for any other purpose. NOTE: See the instructions for more information, including where the completed forms should be sent.

09/28/2023 - Classification: Internal - ECRM13153872

SCS # 25220183.00

State of Wisconsin
Department of Natural Resources

Route to: Watershed/Wastewater ☐ Waste Management ☒
Remediation/Redevelopment ☐ Other ☐

MONITORING WELL CONSTRUCTION

Form 4400-113A Rev. 7-98

Facility/Project Name: WPL-Columbia Dry Ash Disposal Facility	Local Grid Location of Well: ___ ft. ☐N. ☐S. ___ ft. ☐E. ☐W.	Well Name: MW-313
Facility License, Permit or Monitoring No.: 03025	Local Grid Origin ☐ (estimated: ☐) or Well Location ☐ Lat. ___ ° ___ ' ___ " Long. ___ ° ___ ' ___ " or	Wis. Unique Well No.: WC188 / DNR Well ID No.: ___
Facility ID: 111049180	St. Plane 542956.598 ft. N, 2124559.041 ft. E. S/C/N	Date Well Installed: 12 / 019 / 2022 (m m d d y y y y)
Type of Well: Well Code 11 / MW	Section Location of Waste/Source: NW 1/4 of NE 1/4 of Sec. 27, T. 12 N, R. 09 ☒E ☐W	Well Installed By: Name (first, last) and Firm: Adam Sweet / Horizon Construction and Exploration
Distance from Waste/Source ___ ft. / Enf. Stds. Apply ☒	Location of Well Relative to Waste/Source: u ☐ Upgradient s ☐ Sidegradient d ☒ Downgradient n ☐ Not Known	Gov. Lot Number: ___

A. Protective pipe, top elevation ___ ft. MSL

B. Well casing, top elevation 820.30 ft. MSL

C. Land surface elevation ~817.80 ft. MSL

D. Surface seal, bottom ___ ft. MSL or ___ ft.

12. USCS classification of soil near screen:
GP ☐ GM ☐ GC ☐ GW ☐ SW ☐ SP ☒
SM ☐ SC ☐ ML ☐ MH ☐ CL ☐ CH ☐
Bedrock ☐

13. Sieve analysis performed? ☒ Yes ☐ No

14. Drilling method used: Rotary ☐ 50 / Hollow Stem Auger ☐ 41 / Other ☒ Rotosonic

15. Drilling fluid used: Water ☒ 02 / Air ☐ 01 / Drilling Mud ☐ 03 / None ☒ 99

16. Drilling additives used? ☐ Yes ☒ No
Describe NA

17. Source of water (attach analysis, if required):
Horizon's drilling shop

E. Bentonite seal, top ~817.80 ft. MSL or 0 ft.

F. Fine sand, top ~788.80 ft. MSL or 29 ft.

G. Filter pack, top ~786.80 ft. MSL or 31 ft.

H. Screen joint, top ~784.80 ft. MSL or 33 ft.

I. Well bottom ~774.80 ft. MSL or 43 ft.

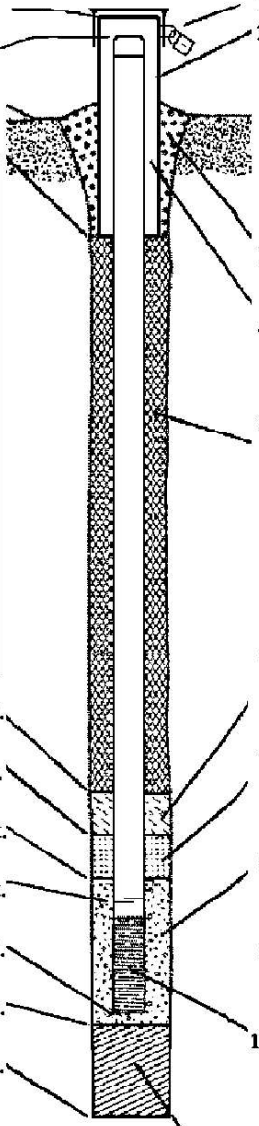
J. Filter pack, bottom ~772.80 ft. MSL or 45 ft.

K. Borehole, bottom ~772.80 ft. MSL or 45 ft.

L. Borehole, diameter 6.00 in.

M. O.D. well casing 2.31 in.

N. I.D. well casing 2.21 in.



1. Cap and lock? ☒ Yes ☐ No

2. Protective cover pipe:
a. Inside diameter: 4 in.
b. Length: 5 ft.
c. Material: Steel ☒ 04 / Other ☐
d. Additional protection? ☒ Yes ☐ No
If yes, describe: Three bollards

3. Surface seal: Bentonite ☒ 30 / Concrete ☐ 01 / Other ☐

4. Material between well casing and protective pipe: Bentonite ☒ 30 / Other ☒ Filter sand

5. Annular space seal: a. Granular/Chipped Bentonite ☒ 33
b. ___ Lbs/gal mud weight . . . Bentonite-sand slurry ☐ 35
c. ___ Lbs/gal mud weight . . . . . Bentonite slurry ☐ 31
d. ___ % Bentonite . . . . . Bentonite-cement grout ☐ 50
e. 5.22 Ft^3 volume added for any of the above
f. How installed: Tremie ☐ 01 / Tremie pumped ☐ 02 / Gravity ☒ 08

6. Bentonite seal: a. Bentonite granules ☐ 33
b. ☐ 1/4 in. ☒ 3/8 in. ☐ 1/2 in. Bentonite chips ☒ 32
c. ___ Other ☐

7. Fine sand material: Manufacturer, product name & mesh size
a. Red Flint #5 ☒
b. Volume added 0.36 ft^3

8. Filter pack material: Manufacturer, product name & mesh size
a. Red Flint #7 ☒
b. Volume added 2.52 ft^3

9. Well casing: Flush threaded PVC schedule 40 ☒ 23 / Flush threaded PVC schedule 80 ☐ 24 / Other ☐

10. Screen material: PVC
a. Screen type: Factory cut ☒ 11 / Continuous slot ☐ 01 / Other ☐
b. Manufacturer Monoflex
c. Slot size: 0.010 in.
d. Slotted length: 10 ft.

11. Backfill material (below filter pack): None ☐ 14 / Other ☒ SP- native, cave in

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature: Jackie Rennebohm | Firm: SCS ENGINEERS, 2830 Dairy Drive, Madison, WI 53718

Please complete both Forms 4400-113A and 4400-113B and return them to the appropriate DNR office and bureau. Completion of these reports is required by chs. 160, 281, 283, 289, 291, 292, 293, 295, and 299, Wis. Stats., and ch. NR 141, Wis. Adm. Code. In accordance with chs. 281, 289, 291, 292, 293, 295, and 299, Wis. Stats., failure to file these forms may result in a forfeiture of between $10 and $25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on these forms is not intended to be used for any other purpose. NOTE: See the instructions for more information, including where the completed forms should be sent.

09/28/2023 - Classification: Internal - ECRM13153872

SCS # 25220183.00

State of Wisconsin
Department of Natural Resources

Route to: Watershed/Wastewater ☐ Waste Management ☒
Remediation/Redevelopment ☐ Other ☐

MONITORING WELL CONSTRUCTION

Form 4400-113A Rev. 7-98

Facility/Project Name: WPL-Columbia Dry Ash Disposal Facility	Local Grid Location of Well: ___ ft. ☐N. ☐S. ___ ft. ☐E. ☐W.	Well Name: MW-314
Facility License, Permit or Monitoring No.: 03025	Local Grid Origin ☐ (estimated: ☐) or Well Location ☐ Lat. ___ ° ___ ' ___ " Long. ___ ° ___ ' ___ " or	Wis. Unique Well No.: WC199 / DNR Well ID No.: ___
Facility ID: 111049180	St. Plane 542978.081 ft. N, 2124778.237 ft. E. S/C/N	Date Well Installed: 12 / 01 / 2022 (m m d d y y y y)
Type of Well: Well Code 11 / MW	Section Location of Waste/Source: NW 1/4 of NE 1/4 of Sec. 27, T. 12 N, R. 09 ☒E ☐W	Well Installed By: Name (first, last) and Firm: Adam Sweet; Horizon Construction and Exploration
Distance from Waste/Source ___ ft. / Enf. Stds. Apply ☒	Location of Well Relative to Waste/Source: u ☐ Upgradient s ☐ Sidegradient d ☒ Downgradient n ☐ Not Known	Gov. Lot Number: ___

A. Protective pipe, top elevation ___ ft. MSL

B. Well casing, top elevation 821.57 ft. MSL

C. Land surface elevation ~819.07 ft. MSL

D. Surface seal, bottom ___ ft. MSL or ___ ft.

12. USCS classification of soil near screen:
GP ☐ GM ☐ GC ☐ GW ☐ SW ☐ SP ☒
SM ☐ SC ☐ ML ☐ MH ☐ CL ☐ CH ☐
Bedrock ☐

13. Sieve analysis performed? ☒ Yes ☐ No

14. Drilling method used: Rotary ☐ 50 / Hollow Stem Auger ☒ 41 / Other ☐ ___

15. Drilling fluid used: Water ☐ 02 / Air ☐ 01 / Drilling Mud ☐ 03 / None ☒ 99

16. Drilling additives used? ☐ Yes ☒ No

Describe NA

17. Source of water (attach analysis, if required):
NA

E. Bentonite seal, top ~819.07 ft. MSL or 0 ft.

F. Fine sand, top ~789.57 ft. MSL or 29.5 ft.

G. Filter pack, top ~787.57 ft. MSL or 31.5 ft.

H. Screen joint, top ~785.57 ft. MSL or 33.5 ft.

I. Well bottom ~775.57 ft. MSL or 43.5 ft.

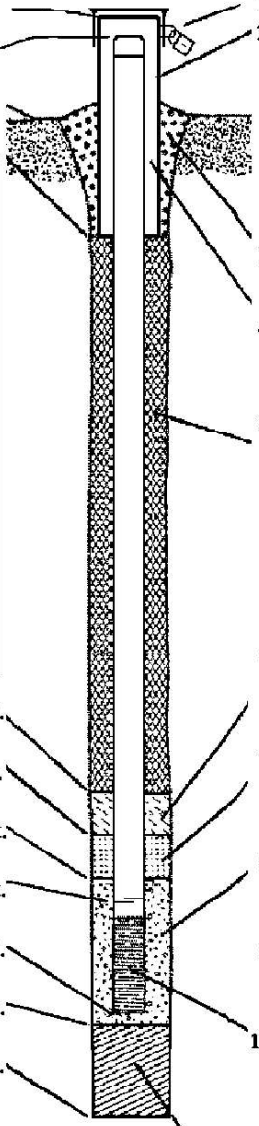
J. Filter pack, bottom ~775.57 ft. MSL or 43.5 ft.

K. Borehole, bottom ~774.07 ft. MSL or 45 ft.

L. Borehole, diameter 8.25 in.

M. O.D. well casing 2.31 in.

N. I.D. well casing 2.21 in.



1. Cap and lock? ☒ Yes ☐ No

2. Protective cover pipe:
a. Inside diameter: 4 in.
b. Length: 5 ft.
c. Material: Steel ☒ 04 / Other ☐ ___
d. Additional protection? ☒ Yes ☐ No
If yes, describe: Three bollards

3. Surface seal: Bentonite ☒ 30 / Concrete ☐ 01 / Other ☐ ___

4. Material between well casing and protective pipe: Bentonite ☒ 30 / Other ☒ ___
Filter sand

5. Annular space seal: a. Granular/Chipped Bentonite ☒ 33
b. ___ Lbs/gal mud weight . . . Bentonite-sand slurry ☐ 35
c. ___ Lbs/gal mud weight . . . . . Bentonite slurry ☐ 31
d. ___ % Bentonite . . . . . Bentonite-cement grout ☐ 50
e. 10.47 Ft^3 volume added for any of the above
f. How installed: Tremie ☐ 01 / Tremie pumped ☐ 02 / Gravity ☒ 08

6. Bentonite seal: a. Bentonite granules ☐ 33
b. ☐ 1/4 in. ☒ 3/8 in. ☐ 1/2 in. Bentonite chips ☒ 32
c. ___ Other ☐ ___

7. Fine sand material: Manufacturer, product name & mesh size
a. Red Flint #5 ☒
b. Volume added 0.71 ft^3

8. Filter pack material: Manufacturer, product name & mesh size
a. Red Flint #7 ☒
b. Volume added 4.26 ft^3

9. Well casing: Flush threaded PVC schedule 40 ☒ 23 / Flush threaded PVC schedule 80 ☐ 24 / Other ☐ ___

10. Screen material: PVC
a. Screen type: Factory cut ☒ 11 / Continuous slot ☐ 01 / Other ☐ ___
b. Manufacturer Monoflex
c. Slot size: 0.010 in.
d. Slotted length: 10 ft.

11. Backfill material (below filter pack): None ☐ 14 / Other ☒ ___
SP- native, cave in

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature	Firm
Jackie Rennebohm	SCS ENGINEERS, 2830 Dairy Drive, Madison, WI 53718

Please complete both Forms 4400-113A and 4400-113B and return them to the appropriate DNR office and bureau. Completion of these reports is required by chs. 160, 281, 283, 289, 291, 292, 293, 295, and 299, Wis. Stats., and ch. NR 141, Wis. Adm. Code. In accordance with chs. 281, 289, 291, 292, 293, 295, and 299, Wis. Stats., failure to file these forms may result in a forfeiture of between $10 and $25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on these forms is not intended to be used for any other purpose. NOTE: See the instructions for more information, including where the completed forms should be sent.

09/28/2023 - Classification: Internal - ECRM13153872

SCS # 25220183

State of Wisconsin
Department of Natural Resources

Route to: Watershed/Wastewater ☐ Waste Management ☒
Remediation/Redevelopment ☐ Other ☐

MONITORING WELL CONSTRUCTION
Form 4400-113A Rev. 7-98

Facility/Project Name WPL-Columbia Dry Ash Disposal Facility	**Local Grid Location of Well** ☐ ft. ☐ N. ☐ S. ☐ ft. ☐ E. ☐ W.	**Well Name** MW-315
Facility License, Permit or Monitoring No. 03025	**Local Grid Origin** ☐ (estimated: ☐) or **Well Location** ☐ Lat. ° ' " Long. ° ' " or	**Wis. Unique Well No.** PM289 — **DNR Well ID No.**
Facility ID 111049180	**St. Plane** 543019.956 ft. N, 2125065.014 ft. E. S/C/N	**Date Well Installed** 12 / 2 / 2022 (m m d d y y y y)
Type of Well Well Code 11 / MW	**Section Location of Waste/Source** NW 1/4 of NE 1/4 of Sec. 27, T. 12 N, R. 09 ☒ E ☐ W	**Well Installed By: Name (first, last) and Firm** Adam Sweet Horizon Construction and Exploration
Distance from Waste/ Source ft. — **Enf. Stds. Apply** ☒	**Location of Well Relative to Waste/Source** u ☐ Upgradient s ☐ Sidegradient d ☒ Downgradient n ☐ Not Known	**Gov. Lot Number**

A. Protective pipe, top elevation ft. MSL

B. Well casing, top elevation 819.78 ft. MSL

C. Land surface elevation ~817.28 ft. MSL

D. Surface seal, bottom ft. MSL or ft.

12. USCS classification of soil near screen:
GP ☐ GM ☐ GC ☐ GW ☐ SW ☐ SP ☒
SM ☐ SC ☐ ML ☐ MH ☐ CL ☐ CH ☐
Bedrock ☐

13. Sieve analysis performed? ☒ Yes ☐ No

14. Drilling method used: Rotary ☐ 50
Hollow Stem Auger ☒ 41
Other ☐

15. Drilling fluid used: Water ☐ 02 Air ☐ 01
Drilling Mud ☐ 03 None ☒ 99

16. Drilling additives used? ☐ Yes ☒ No
Describe NA

17. Source of water (attach analysis, if required):
NA

E. Bentonite seal, top ~817.28 ft. MSL or 0 ft.

F. Fine sand, top ~788.28 ft. MSL or 29 ft.

G. Filter pack, top ~786.28 ft. MSL or 31 ft.

H. Screen joint, top ~784.28 ft. MSL or 33 ft.

I. Well bottom ~774.28 ft. MSL or 43 ft.

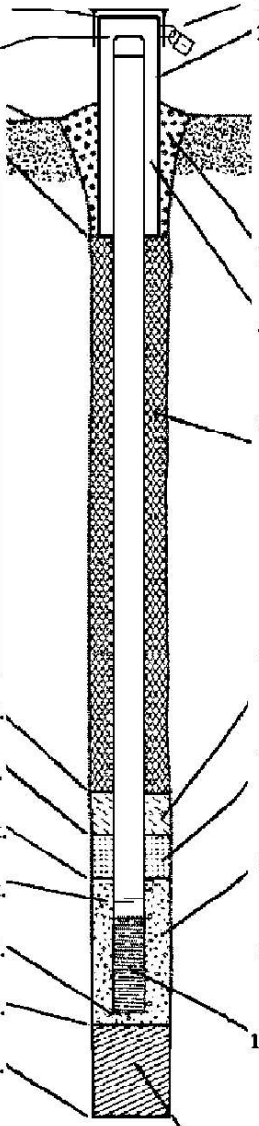
J. Filter pack, bottom ~772.28 ft. MSL or 45 ft.

K. Borehole, bottom ~772.28 ft. MSL or 45 ft.

L. Borehole, diameter 8.25 in.

M. O.D. well casing 2.31 in.

N. I.D. well casing 2.21 in.



1. Cap and lock? ☒ Yes ☐ No

2. Protective cover pipe:
a. Inside diameter: 4 in.
b. Length: 5 ft.
c. Material: Steel ☒ 04 Other ☐
d. Additional protection? ☒ Yes ☐ No
If yes, describe: three bollards

3. Surface seal: Bentonite ☒ 30 Concrete ☐ 01 Other ☐

4. Material between well casing and protective pipe:
Bentonite ☒ 30
Filter Sand — Other ☒

5. Annular space seal: a. Granular/Chipped Bentonite ☒ 33
b. ____ Lbs/gal mud weight . . . Bentonite-sand slurry ☐ 35
c. ____ Lbs/gal mud weight . . . . . Bentonite slurry ☐ 31
d. ____ % Bentonite . . . . . Bentonite-cement grout ☐ 50
e. 10.23 Ft^3 volume added for any of the above
f. How installed: Tremie ☐ 01 Tremie pumped ☐ 02 Gravity ☒ 08

6. Bentonite seal: a. Bentonite granules ☐ 33
b. ☐ 1/4 in. ☒ 3/8 in. ☐ 1/2 in. Bentonite chips ☒ 32
c. ____ Other ☐

7. Fine sand material: Manufacturer, product name & mesh size
a. Red Flint #5 ☒
b. Volume added 0.71 ft^3

8. Filter pack material: Manufacturer, product name & mesh size
a. Red Flint #7 ☒
b. Volume added 4.97 ft^3

9. Well casing: Flush threaded PVC schedule 40 ☒ 23
Flush threaded PVC schedule 80 ☐ 24
Other ☐

10. Screen material: PVC
a. Screen type: Factory cut ☒ 11 Continuous slot ☐ 01 Other ☐
b. Manufacturer Monoflex
c. Slot size: 0.010 in.
d. Slotted length: 10 ft.

11. Backfill material (below filter pack): None ☒ 14 Other ☐

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature	Firm
Jackie Rennebohm	SCS ENGINEERS, 2830 Dairy Drive, Madison, WI 53718

Please complete both Forms 4400-113A and 4400-113B and return them to the appropriate DNR office and bureau. Completion of these reports is required by chs. 160, 281, 283, 289, 291, 292, 293, 295, and 299, Wis. Stats., and ch. NR 141, Wis. Adm. Code. In accordance with chs. 281, 289, 291, 292, 293, 295, and 299, Wis. Stats., failure to file these forms may result in a forfeiture of between $10 and $25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on these forms is not intended to be used for any other purpose. NOTE: See the instructions for more information, including where the completed forms should be sent.

09/28/2023 - Classification: Internal - ECRM13153872

State of Wisconsin
Department of Natural Resources

MONITORING WELL DEVELOPMENT

Form 4400-113B Rev. 7-98

Route To: Watershed/Wastewater ☐ Waste Management ☒
Remediation/Redevelopment ☐ Other ☐

Facility/Project Name	County	Well Name
Alliant Energy - Columbia	Columbia	MW-33AR

Facility License, Permit or Monitoring Number	County Code	Wis. Unique Well Number	DNR Well Number
03025	11	PE223	138

1. Can this well be purged dry? ☒ Yes ☐ No

2. Well development method:

surged with bailer and bailed	☐	41
surged with bailer and pumped	☒	61
surged with block and bailed	☐	42
surged with block and pumped	☐	62
surged with block, bailed, and pumped	☐	70
compressed air	☐	20
bailed only	☐	10
pumped only	☐	51
pumped slowly	☐	50
other _____	☐	__

3. Time spent developing well 60 min.

4. Depth of well (from top of well casing) 31.3 ft.

5. Inside diameter of well 2.06 in.

6. Volume of water in filter pack and well casing 6.0 gal.

7. Volume of water removed from well 35.0 gal.

8. Volume of water added (if any) 0.0 gal.

9. Source of water added _____

10. Analysis performed on water added? ☐ Yes ☐ No
(If yes, attach results)

		Before Development	After Development
11. Depth to Water (from top of well casing)	a.	23.47 ft.	23.62 ft.
Date	b.	4/10/2003	4/10/2003
Time	c.	☒ a.m. 08:50 ☐ p.m.	☒ a.m. 11:50 ☐ p.m.
12. Sediment in well bottom		0.0 inches	0.0 inches
13. Water clarity		Clear ☐ 10 Turbid ☒ 15 (Describe) Opaque, brown	Clear ☐ 20 Turbid ☒ 25 (Describe) Slight, tan

Fill in if drilling fluids were used and well is at solid waste facility:

14. Total suspended solids		mg/l	72 mg/l
15. COD		mg/l	mg/l

16. Well developed by: Person's Name and Firm
Peter M. Chase
RMT, Inc.

17. Additional comments on development:
Pumped dry 3 times.

Facility Address or Owner/Responsible Party Address

Name: Peter M. Chase

Firm: RMT, Inc.

Street: 744 Heartland Tr.

City/State/Zip: Madison, WI 53717

I hereby certify that the above information is true and correct to the best of my knowledge.

Signature: PMC

Print Name: Peter M. Chase

Firm: RMT, Inc.

NOTE: See instructions for more information including a list of county codes and well type codes.

09/28/2023 - Classification: Internal - ECRM13153872

State of Wisconsin
Department of Natural Resources

MONITORING WELL DEVELOPMENT

Form 4400-113B Rev. 7-98

Route to: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☐ Other ☐ _____

Facility/Project Name	County Name	Well Name
Alliant-Columbia	Columbia	MW-301

Facility License, Permit or Monitoring Number	County Code	Wis. Unique Well Number	DNR Well ID Number
	11	VY701	

1. Can this well be purged dry? ☐ Yes ☒ No

2. Well development method

surged with bailer and bailed	☐ 41
surged with bailer and pumped	☒ 61
surged with block and bailed	☐ 42
surged with block and pumped	☐ 62
surged with block, bailed and pumped	☐ 70
compressed air	☐ 20
bailed only	☐ 10
pumped only	☐ 51
pumped slowly	☐ 50
Other _____	☐

3. Time spent developing well 120 min.

4. Depth of well (from top of well casisng) 29.4 ft.

5. Inside diameter of well 2.00 in.

6. Volume of water in filter pack and well casing 7.6 gal.

7. Volume of water removed from well 84.0 gal.

8. Volume of water added (if any) ____.__ gal.

9. Source of water added _____

10. Analysis performed on water added? (If yes, attach results) ☐ Yes ☒ No

	Before Development	After Development
11. Depth to Water (from top of well casing)	a. 21.72 ft.	21.77 ft.
Date	b. 12/02/2015 (m m d d y y y y)	12/02/2015
Time	c. 08:30 ☒ a.m. ☐ p.m.	10:30 ☒ a.m. ☐ p.m.
12. Sediment in well bottom	0.__ inches	0.__ inches
13. Water clarity	Clear ☐ 10 Turbid ☒ 15 (Describe)	Clear ☒ 20 Turbid ☐ 25 (Describe)
14. Total suspended solids	____.__ mg/l	____.__ mg/l
15. COD	____.__ mg/l	____.__ mg/l

Fill in if drilling fluids were used and well is at solid waste facility:

16. Well developed by: Name (first, last) and Firm
First Name: Gary Last Name: Sterkel
Firm: SCS ENGINEERS

17. Additional comments on development:

Name and Address of Facility Contact /Owner/Responsible Party
First Name: Nate Last Name: Sievers
Facility/Firm: Wisconsin Power and Light
Street: W8375 Murray Rd.
City/State/Zip: Pardeville, WI 53954

I hereby certify that the above information is true and correct to the best of my knowledge.
Signature: for Gary Sterkel
Print Name: Gary Sterkel
Firm: SCS ENGINEERS

NOTE: See instructions for more information including a list of county codes and well type codes.

09/28/2023 - Classification: Internal - ECRM13153872

State of Wisconsin
Department of Natural Resources

MONITORING WELL DEVELOPMENT

Form 4400-113B Rev. 7-98

Route to: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☐ Other ☐ _____

Facility/Project Name	County Name	Well Name
Alliant - Columbia	Columbia	MW-302

Facility License, Permit or Monitoring Number	County Code	Wis. Unique Well Number	DNR Well ID Number
	11	VY702	

1. Can this well be purged dry? ☐ Yes ☒ No

2. Well development method

surged with bailer and bailed	☐ 41
surged with bailer and pumped	☒ 61
surged with block and bailed	☐ 42
surged with block and pumped	☐ 62
surged with block, bailed and pumped	☐ 70
compressed air	☐ 20
bailed only	☐ 10
pumped only	☐ 51
pumped slowly	☐ 50
Other _____	☐

3. Time spent developing well 120 min.

4. Depth of well (from top of well casisng) 33.6 ft.

5. Inside diameter of well 2.00 in.

6. Volume of water in filter pack and well casing 5.4 gal.

7. Volume of water removed from well 60.0 gal.

8. Volume of water added (if any) ____.__ gal.

9. Source of water added _____

10. Analysis performed on water added? (If yes, attach results) ☐ Yes ☒ No

	Before Development	After Development
11. Depth to Water (from top of well casing)	a. 28.37 ft.	28.41 ft.
Date	b. 12/02/2015 (m m d d y y y y)	12/02/2015
Time	c. 02:00 ☐ a.m. ☒ p.m.	04:00 ☐ a.m. ☒ p.m.
12. Sediment in well bottom	0.__ inches	0.__ inches
13. Water clarity	Clear ☐ 10 Turbid ☒ 15 (Describe)	Clear ☒ 20 Turbid ☐ 25 (Describe)

Fill in if drilling fluids were used and well is at solid waste facility:

14. Total suspended solids	____.__ mg/l	____.__ mg/l
15. COD	____.__ mg/l	____.__ mg/l

16. Well developed by: Name (first, last) and Firm
First Name: Gary Last Name: Sterkel
Firm: SCS ENGINEERS

17. Additional comments on development:

Name and Address of Facility Contact /Owner/Responsible Party
First Name: Nate Last Name: Sievers
Facility/Firm: Wisconsin Power and Light
Street: W8375 Murray Rd.
City/State/Zip: Pardeeville, WI 53954

I hereby certify that the above information is true and correct to the best of my knowledge.
Signature: [signature] for G.S.
Print Name: Gary Sterkel
Firm: SCS ENGINEERS

NOTE: See instructions for more information including a list of county codes and well type codes.

09/28/2023 - Classification: Internal - ECRM13153872

SCS # 25217156.01

State of Wisconsin
Department of Natural Resources

MONITORING WELL DEVELOPMENT

Form 4400-113B Rev. 7-98

Route to: Watershed/Wastewater ☐ Waste Management ☒
Remediation/Redevelopment ☐ Other ☐ _____

Facility/Project Name	County Name	Well Name
WPL - Alliant Columbia Generating Station	Columbia	MW-309

Facility License, Permit or Monitoring Number	County Code	Wis. Unique Well Number	DNR Well ID Number
	11	VR111	

1. Can this well be purged dry? ☒ Yes ☐ No

2. Well development method

surged with bailer and bailed	☐ 41
surged with bailer and pumped	☒ 61
surged with block and bailed	☐ 42
surged with block and pumped	☐ 62
surged with block, bailed and pumped	☐ 70
compressed air	☐ 20
bailed only	☐ 10
pumped only	☐ 51
pumped slowly	☐ 50
Other _____	☐

3. Time spent developing well 75 min.

4. Depth of well (from top of well casisng) 37.67 ft.

5. Inside diameter of well 2.0 in.

6. Volume of water in filter pack and well casing 7.04 gal.

7. Volume of water removed from well 50.0 gal.

8. Volume of water added (if any) ---.- gal.

9. Source of water added _____

10. Analysis performed on water added? (If yes, attach results) ☐ Yes ☐ No

	Before Development	After Development
11. Depth to Water (from top of well casing) a.	30.07 ft.	32.29 ft.
Date b.	02/16/2018 (mm/dd/yyyy)	02/16/2018 (mm/dd/yyyy)
Time c.	12:47 ☐ a.m. ☒ p.m.	13:50 ☐ a.m. ☒ p.m.
12. Sediment in well bottom	---.- inches	---.- inches
13. Water clarity	Clear ☐ 10 Turbid ☒ 15	Clear ☒ 20 Turbid ☐ 25
(Describe)	Brown Silty	

Fill in if drilling fluids were used and well is at solid waste facility:

14. Total suspended solids	----.- mg/l	----.- mg/l
15. COD	----.- mg/l	----.- mg/l

16. Well developed by: Name (first, last) and Firm
First Name: Kyle Last Name: Kramer
Firm: SCS ENGINEERS, 2830 Dairy Drive, Madison, WI 53718

17. Additional comments on development:
Two cycles of well purging dry and recharging.

Name and Address of Facility Contact /Owner/Responsible Party
First Name: Nate Last Name: Sievers
Facility/Firm: Wisconsin Power and Light
Street: W8375 Murray Road
City/State/Zip: Pardeeville, Wisconsin 53954

I hereby certify that the above information is true and correct to the best of my knowledge.
Signature: Kyle Kramer
Print Name: Kyle Kramer
Firm: SCS ENGINEERS, 2830 Dairy Drive, Madison, WI 53718

NOTE: See instructions for more information including a list of county codes and well type codes.

09/28/2023 - Classification: Internal - ECRM13153872

SCS # 25217156.01

State of Wisconsin
Department of Natural Resources

MONITORING WELL DEVELOPMENT

Form 4400-113B Rev. 7-98

Route to: Watershed/Wastewater ☐ Waste Management ☒
Remediation/Redevelopment ☐ Other ☐ _____

Facility/Project Name	County Name	Well Name
WPL - Alliant Columbia Generating Station	Columbia	MW-310

Facility License, Permit or Monitoring Number	County Code	Wis. Unique Well Number	DNR Well ID Number
	11	VR110	

1. Can this well be purged dry? ☒ Yes ☐ No

2. Well development method

surged with bailer and bailed	☐ 41
surged with bailer and pumped	☒ 61
surged with block and bailed	☐ 42
surged with block and pumped	☐ 62
surged with block, bailed and pumped	☐ 70
compressed air	☐ 20
bailed only	☐ 10
pumped only	☐ 51
pumped slowly	☐ 50
Other _____	☐

3. Time spent developing well 171 min.

4. Depth of well (from top of well casisng) 38.41 ft.

5. Inside diameter of well 2.0 in.

6. Volume of water in filter pack and well casing 7.28 gal.

7. Volume of water removed from well 60.0 gal.

8. Volume of water added (if any) ---.- gal.

9. Source of water added _____

10. Analysis performed on water added? (If yes, attach results) ☐ Yes ☐ No

	Before Development	After Development
11. Depth to Water (from top of well casing)	a. 30.55 ft.	32.30 ft.
Date	b. 2/16/2018 (m m d d y y y y)	2/16/2018
Time	c. 9:45 ☒ a.m. ☐ p.m.	12:36 ☐ a.m. ☒ p.m.
12. Sediment in well bottom	---.- inches	---.- inches
13. Water clarity	Clear ☐ 10 Turbid ☒ 15	Clear ☒ 20 Turbid ☐ 25
(Describe)	brown silty	

Fill in if drilling fluids were used and well is at solid waste facility:

14. Total suspended solids	----.- mg/l	----.- mg/l
15. COD	----.- mg/l	----.- mg/l

16. Well developed by: Name (first, last) and Firm
First Name: Kyle Last Name: Kramer
Firm: SCS ENGINEERS, 2830 Dairy Drive, Madison, WI 53718

17. Additional comments on development:
Four cycles of well purging dry and recharging.

Name and Address of Facility Contact /Owner/Responsible Party
First Name: Nate Last Name: Sievers
Facility/Firm: Wisconsin Power and Light
Street: W8375 Murray Road
City/State/Zip: Pardeeville, Wisconsin 53954

I hereby certify that the above information is true and correct to the best of my knowledge.
Signature: [signature]
Print Name: Kyle Kramer
Firm: SCS ENGINEERS, 2830 Dairy Drive, Madison, WI 53718

NOTE: See instructions for more information including a list of county codes and well type codes.

09/28/2023 - Classification: Internal - ECRM13153872

SCS # 25217156.01

State of Wisconsin
Department of Natural Resources

MONITORING WELL DEVELOPMENT

Form 4400-113B Rev. 7-98

Route to: Watershed/Wastewater ☐ Waste Management ☒
Remediation/Redevelopment ☐ Other ☐ _____

Facility/Project Name	County Name	Well Name
WPL - Alliant Columbia Generating Station	Columbia	MW-311

Facility License, Permit or Monitoring Number	County Code	Wis. Unique Well Number	DNR Well ID Number
	11	VR112	

1. Can this well be purged dry? ☐ Yes ☒ No

2. Well development method

surged with bailer and bailed	☐	41
surged with bailer and pumped	☒	61
surged with block and bailed	☐	42
surged with block and pumped	☐	62
surged with block, bailed and pumped	☐	70
compressed air	☐	20
bailed only	☐	10
pumped only	☐	51
pumped slowly	☐	50
Other _____	☐	

3. Time spent developing well 168 min.

4. Depth of well (from top of well casisng) 36.19 ft.

5. Inside diameter of well 2.0 in.

6. Volume of water in filter pack and well casing 8.74 gal.

7. Volume of water removed from well 100.0 gal.

8. Volume of water added (if any) ---.- gal.

9. Source of water added _____

10. Analysis performed on water added? (If yes, attach results) ☐ Yes ☐ No

	Before Development	After Development
11. Depth to Water (from top of well casing)	a. 26.75 ft.	28.51 ft.
Date	b. 2/16/2018 (m m d d y y y y)	2/16/2018
Time	c. 2:00 ☐ a.m. ☒ p.m.	4:48 ☐ a.m. ☒ p.m.
12. Sediment in well bottom	---.- inches	---.- inches
13. Water clarity	Clear ☐ 10 Turbid ☒ 15	Clear ☒ 20 Turbid ☐ 25
(Describe)	brown, silly	

Fill in if drilling fluids were used and well is at solid waste facility:

14. Total suspended solids	----.- mg/l	----.- mg/l
15. COD	----.- mg/l	----.- mg/l

16. Well developed by: Name (first, last) and Firm
First Name: Kyle Last Name: Kramer
Firm: SCS ENGINEERS, 2830 Dairy Drive, Madison, WI 53718

17. Additional comments on development:

Name and Address of Facility Contact /Owner/Responsible Party
First Name: Nate Last Name: Sievers
Facility/Firm: Columbia Dry Ash & Ash Pond Disposal Facilities
Street: W8375 Murray Road
City/State/Zip: Pardeeville, Wisconsin 53954

I hereby certify that the above information is true and correct to the best of my knowledge.
Signature: Kyle Kramer
Print Name: Kyle Kramer
Firm: SCS ENGINEERS, 2830 Dairy Drive, Madison, WI 53718

NOTE: See instructions for more information including a list of county codes and well type codes.

09/28/2023 - Classification: Internal - ECRM13153872

SCS # 25220183.00

State of Wisconsin
Department of Natural Resources

MONITORING WELL DEVELOPMENT

Form 4400-113B Rev. 7-98

Route to: Watershed/Wastewater ☐ Waste Management ☒
Remediation/Redevelopment ☐ Other ☐ _____

Facility/Project Name	County Name	Well Name
WPL-Columbia Dry Ash Disposal Facility	Columbia	MW-313

Facility License, Permit or Monitoring Number	County Code	Wis. Unique Well Number	DNR Well ID Number
03025	11	WC188	

1. Can this well be purged dry? ☐ Yes ☒ No

2. Well development method

surged with bailer and bailed	☐ 41
surged with bailer and pumped	☒ 61
surged with block and bailed	☐ 42
surged with block and pumped	☐ 62
surged with block, bailed and pumped	☐ 70
compressed air	☐ 20
bailed only	☐ 10
pumped only	☐ 51
pumped slowly	☐ 50
Other _____	☐

3. Time spent developing well 45 min.

4. Depth of well (from top of well casisng) 46.18 ft.

5. Inside diameter of well 2.21 in.

6. Volume of water in filter pack and well casing 10.6 gal.

7. Volume of water removed from well 110.0 gal.

8. Volume of water added (if any) ____.__ gal.

9. Source of water added NA

10. Analysis performed on water added? (If yes, attach results) ☐ Yes ☐ No

	Before Development	After Development
11. Depth to Water (from top of well casing)	a. 37.34 ft.	37.43 ft.
Date	b. 12/30/2022 (m m d d y y y y)	12/30/2022
Time	c. 3:05 ☐ a.m. ☒ p.m.	3:50 ☐ a.m. ☒ p.m.
12. Sediment in well bottom	____.__ inches	____.__ inches
13. Water clarity	Clear ☒ 10 Turbid ☐ 15 (Describe) clear to light brown at start	Clear ☒ 20 Turbid ☐ 25 (Describe) clear

Fill in if drilling fluids were used and well is at solid waste facility:

14. Total suspended solids	____.__ mg/l	____.__ mg/l
15. COD	____.__ mg/l	____.__ mg/l

16. Well developed by: Name (first, last) and Firm
First Name: Adam Last Name: Watson
Firm: SCS ENGINEERS, 2830 Dairy Drive, Madison, WI 53718

17. Additional comments on development:
31 degrees F and cloudy
Purge rate= 5 gallons/ 2 minutes

Name and Address of Facility Contact /Owner/Responsible Party
First Name: _____ Last Name: _____
Facility/Firm: Wisconsin Power and Light Co. - Alliant Energy
Street: 1919 Alliant Energy Center Way
City/State/Zip: Madison, WI 53713

I hereby certify that the above information is true and correct to the best of my knowledge.
Signature:
Print Name: Adam Watson
Firm: SCS ENGINEERS, 2830 Dairy Drive, Madison, WI 53718

NOTE: See instructions for more information including a list of county codes and well type codes.

09/28/2023 - Classification: Internal - ECRM13153872

SCS # 25220183.00

State of Wisconsin
Department of Natural Resources

MONITORING WELL DEVELOPMENT

Form 4400-113B Rev. 7-98

Route to: Watershed/Wastewater ☐ Waste Management ☒
Remediation/Redevelopment ☐ Other ☐ _____

Facility/Project Name	County Name	Well Name
WPL-Columbia Dry Ash Disposal Facility	Columbia	MW-314

Facility License, Permit or Monitoring Number	County Code	Wis. Unique Well Number	DNR Well ID Number
03025	11	WC199	

1. Can this well be purged dry? ☐ Yes ☒ No

2. Well development method

surged with bailer and bailed	☐ 41
surged with bailer and pumped	☒ 61
surged with block and bailed	☐ 42
surged with block and pumped	☐ 62
surged with block, bailed and pumped	☐ 70
compressed air	☐ 20
bailed only	☐ 10
pumped only	☐ 51
pumped slowly	☐ 50
Other _____	☐

3. Time spent developing well 132 min.

4. Depth of well (from top of well casisng) 44.96 ft.

5. Inside diameter of well 2.31 in.

6. Volume of water in filter pack and well casing 10.4 gal.

7. Volume of water removed from well 120.0 gal.

8. Volume of water added (if any) ___.__ gal.

9. Source of water added NA

10. Analysis performed on water added? (If yes, attach results) ☐ Yes ☐ No

	Before Development	After Development
11. Depth to Water (from top of well casing)	a. 37.34 ft.	38.37 ft.
Date	b. 12/30/2022 (mm/dd/yyyy)	12/30/2022 (mm/dd/yyyy)
Time	c. 11:10 ☒ a.m. ☐ p.m.	1:22 ☐ a.m. ☒ p.m.
12. Sediment in well bottom	___.__ inches	___.__ inches
13. Water clarity	Clear ☒ 10 Turbid ☐ 15 (Describe) creamy brown at start	Clear ☒ 20 Turbid ☐ 25 (Describe) clear
14. Total suspended solids	____.__ mg/l	____.__ mg/l
15. COD	____.__ mg/l	____.__ mg/l

Fill in if drilling fluids were used and well is at solid waste facility:

16. Well developed by: Name (first, last) and Firm
First Name: Adam Last Name: Watson
Firm: SCS ENGINEERS, 2830 Dairy Drive, Madison, WI 53718

17. Additional comments on development:
31 degrees F and cloudy
Purge rate= 5.0 gallons/ 5 minutes

Name and Address of Facility Contact /Owner/Responsible Party
First Name: _____ Last Name: _____
Facility/Firm: Wisconsin Power and Light Co. - Alliant Energy
Street: 1919 Alliant Energy Center Way
City/State/Zip: Madison, WI 53713

I hereby certify that the above information is true and correct to the best of my knowledge.
Signature: [signature]
Print Name: Adam Watson
Firm: SCS ENGINEERS, 2830 Dairy Drive, Madison, WI 53718

NOTE: See instructions for more information including a list of county codes and well type codes.

09/28/2023 - Classification: Internal - ECRM13153872

SCS # 25220183.00

State of Wisconsin
Department of Natural Resources

MONITORING WELL DEVELOPMENT

Form 4400-113B Rev. 7-98

Route to: Watershed/Wastewater ☐ Waste Management ☒
Remediation/Redevelopment ☐ Other ☐ _____

Facility/Project Name	County Name	Well Name
WPL-Columbia Dry Ash Disposal Facility	Columbia	MW-315

Facility License, Permit or Monitoring Number	County Code	Wis. Unique Well Number	DNR Well ID Number
03025	11	PM289	

1. Can this well be purged dry? ☐ Yes ☒ No

2. Well development method

surged with bailer and bailed	☐ 41
surged with bailer and pumped	☒ 61
surged with block and bailed	☐ 42
surged with block and pumped	☐ 62
surged with block, bailed and pumped	☐ 70
compressed air	☐ 20
bailed only	☐ 10
pumped only	☐ 51
pumped slowly	☐ 50
Other _____	☐

3. Time spent developing well 120 min.

4. Depth of well (from top of well casisng) 45.61 ft.

5. Inside diameter of well 2.31 in.

6. Volume of water in filter pack and well casing 10.64 gal.

7. Volume of water removed from well 120.0 gal.

8. Volume of water added (if any) ____.__ gal.

9. Source of water added NA

10. Analysis performed on water added? (If yes, attach results) ☐ Yes ☐ No

	Before Development	After Development
11. Depth to Water (from top of well casing)	a. 36.34 ft.	36.34 ft.
Date	b. 12/30/2022 (m m d d y y y y)	12/30/2022
Time	c. 10:40 ☒ a.m. ☐ p.m.	12:40 ☐ a.m. ☒ p.m.
12. Sediment in well bottom	___.__ inches	___.__ inches
13. Water clarity	Clear ☒ 10 Turbid ☐ 15 (Describe) brown at start	Clear ☒ 20 Turbid ☐ 25 (Describe) clear
14. Total suspended solids	____.__ mg/l	____.__ mg/l
15. COD	____.__ mg/l	____.__ mg/l

Fill in if drilling fluids were used and well is at solid waste facility:

16. Well developed by: Name (first, last) and Firm
First Name: Adam Last Name: Watson
Firm: SCS ENGINEERS, 2830 Dairy Drive, Madison, WI 53718

17. Additional comments on development:
31 degrees F and cloudy
Purge rate= 1gallon/minute

Name and Address of Facility Contact /Owner/Responsible Party
First Name: _____ Last Name: _____
Facility/Firm: Wisconsin Power and Light Co. - Alliant Energy
Street: 1919 Alliant Energy Center Way
City/State/Zip: Madison, WI 53713

I hereby certify that the above information is true and correct to the best of my knowledge.
Signature: _____
Print Name: Adam Watson
Firm: SCS ENGINEERS, 2830 Dairy Drive, Madison, WI 53718

NOTE: See instructions for more information including a list of county codes and well type codes.

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Appendix H

Groundwater Sampling and Analysis Plan

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Groundwater Sampling and Analysis Plan

Columbia Energy Center
W8375 Murray Road
Pardeeville, Wisconsin 53954

Prepared for:
Wisconsin Power and Light Company

4902 N Biltmore Lane
Madison, Wisconsin 53707

SCS ENGINEERS

25222260.00 | September 1, 2023

2830 Dairy Drive
Madison, WI 53718-6751
608-224-2830

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Attachment A Example Chain of Custody

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1.0 INTRODUCTION

This Groundwater Sampling Plan (plan) summarizes groundwater sampling and analysis procedures for the Columbia Energy Center, a generating station with a coal combustion residuals (CCR) landfill and settling ponds located in Pardeeville, Wisconsin (**Figure 1**).

Groundwater sampling at this site is performed to satisfy sampling requirements at CCR wells under NR 514.045 and NR 507.15(3), and the site groundwater sampling program at non-CCR wells and other monitoring points that predates these rules. This plan was prepared in accordance with the requirements of NR 507.16. Samples will be obtained and analyzed in accordance with this plan and the requirements of NR 507.17.

Previously, groundwater sampling at this site has been performed to satisfy the requirements of both the Federal CCR Rule and the site's permit. The sampling program previously performed under the Federal CCR rule will continue under the requirements of NR 514.045 and NR 507.15(3), with the addition of select parameters and monitoring points required by NR 507.15(3) but not by the Federal CCR Rule. The sampling program previously performed under the site's permit will continue, with modifications as requested in the March 2023 Plan Modification Addendum 2.

2.0 SAMPLING EVENTS AND PARAMETERS

A list of the locations at which water level measurements and samples will be collected in compliance with the requirements under NR 514.15(3) and NR 507.15(3) (i.e., the CCR well network) is included in **Table 1.** A list of the locations at which water level measurements and samples will be collected in continuation of the site monitoring program that predated the requirements of NR 514.045 (i.e., the non-CCR well network) is included in **Table 2**. These tables include the parameters that may be analyzed at each sampling location. Sampling point locations are shown on **Figure 2**. All site groundwater monitoring points are shown on **Figure 2**, including several monitoring wells that are not associated with the Dry Ash Disposal Facility.

All groundwater samples collected under the NR 514.15(3) compliance sampling program are to be unfiltered (total analysis). Groundwater samples collected under the continuation of the site monitoring program that predated the requirements of NR 514.045 are to be filtered (dissolved analysis) or unfiltered (total analysis) as shown in **Table 2**.

In addition to the routine semiannual events, supplemental sampling events may be performed as follows:

- Retesting to evaluate a potential groundwater standard exceedance.
- Initial sampling of new monitoring wells added to the monitoring system.

Supplemental sampling events will typically include a subset of the parameters and wells shown in **Tables 1** and **2**.

The specific sampling and analysis requirements for each sampling event will be communicated to the sampling team and laboratory prior to the event.

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3.0 FIELD METHODS

3.1 WATER LEVEL MEASUREMENTS

Depth to water will be recorded at each monitoring well immediately prior to purging using an electronic water level measuring tape. These measurements should be taken from the top of the polyvinyl chloride (PVC) well casing. During each sampling event, depths to groundwater at all wells must be measured immediately prior to purging and within a period of time short enough to avoid temporal variations in groundwater flow which could preclude accurate determination of groundwater flow rate and direction.

3.2 FIELD PARAMETERS

Field parameters will be measured and recorded using the procedures in Sections 3.4.1.1 and 3.5.2. Different procedures are used for wells sampled using low-flow and non-low-flow methods.

Field pH, temperature, and specific conductance will be measured using a portable electronic meter. For samples collected using low-flow methods, field dissolved oxygen, oxidation/reduction potential, and turbidity will also be measured using a portable electronic meter. Meter calibration will be performed prior to field measurements according to the manufacturer's instructions and will be documented.

3.3 SAMPLING ORDER

Monitoring wells will be sampled in an order that allows for efficient collection of all samples to avoid effects from temporal variations in groundwater flow. Pumps used for purging and sample collection at CCR monitoring wells, and all bailers used for sample collection at non-CCR wells, are dedicated to specific wells, therefore sampling the wells in order from least- to most-impacted to avoid cross-contamination is not necessary.

3.4 WELL PURGING

Monitoring wells will be purged using either low-flow (CCR Wells) or non-low-flow (non-CCR wells) techniques as required by the applicable monitoring program. Supply wells will be purged with appropriate state-published techniques. Purging techniques are described below.

3.4.1 Monitoring Wells – Low-Flow Method

CCR monitoring wells will be sampled using low-flow sampling techniques, as documented in U.S. Environmental Protection Agency (U.S. EPA) publication EPA/540/S-95/504. All site CCR monitoring wells have dedicated WellWizard ™ sampling systems for this purpose. These dedicated pump systems will be used for well purging and for sample collection.

3.4.1.1 If Well Does Not Purge Dry

After the initial water level measurement, the well will be purged with a consistent flow of 1 liter per minute (L/min) or less. The water level should remain stable or stabilize during the purging. If the level does not stabilize and continues to drop, the flow rate will be reduced. If the level does not stabilize with a flow rate of 50 milliliters per minute (mL/min), the well will be purged according to the procedure in Section 3.4.1.2. The purge rate will be measured using a calibrated device and timer, and recorded.

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Purge water should be monitored until three consecutive readings, taken approximately 2 minutes or 0.5 well volumes apart, are stabilized within the provided ranges for the following parameters:

Parameter	Range
pH[1,2]	+/- 0.1 unit
Specific Conductance[1,2]	+/- 3%
Dissolved Oxygen[1,2]	+/- 10%
Oxidation/Reduction Potential[1,2]	+/- 10 millivolts
Temperature[2]	+/- 3%
Turbidity[1,2] (Required if collecting non-filtered metals samples. Recommended otherwise.)	+/- 10% for values greater than 5 NTU. If three turbidity values are less than 5 NTU, consider the values as stabilized.

References: (1): U.S. EPA Publication EPA/540/S-95/504 and (2): U.S. EPA Region 1 Low-Stress (Low-Flow) SOP, Revision Number 3, Revised January 19, 2010.

Measurements will be collected using a portable meter and recorded. All parameters except turbidity must be obtained using a flow-through cell. Samples for turbidity measurements will be obtained before water enters the flow-through cell.

Observations of sample odor and color will be recorded. Visual observations of turbidity may be recorded in addition to instrument readings.

Once the readings have stabilized, which indicates that stagnant water in the well has been replaced with formation water, the well will be ready for groundwater sampling from the discharge.

3.4.1.2 If Well Purges Dry

If a well purges dry where low-flow sampling is the intended sampling method, or if a stable water level cannot be achieved even with very low purge rates, the well will be purged dry using the dedicated pump. The well will then be allowed to recover sufficiently so that the required sample volume may be collected.

3.4.2 Monitoring Wells – Non-Low-Flow Sampling

Each non-CCR well sampled under the monitoring program shown in **Table 2** will be purged and sampled using a dedicated bailer. If a large purge volume is required at a well, a pump may be used to purge the well, and the dedicated bailer will be used for sample collection. If a well does not purge dry, four well volumes will be removed prior to sample collection and the sample will be collected at the completion of purging. If a well does purge dry, the well will be allowed to recover and sampled with a dedicated bailer.

3.4.3 Supply Wells

The site supply well will be purged according to the guidance in Section 3.4 of the Wisconsin Department of Natural Resources (WDNR) Groundwater Sampling Field Manual (PUBL-DG-038). The purge location will be as close to the well's pump as possible. If a sample cannot be collected before the water passes through a pressure tank or treatment system, this will be documented. Water will be run from the tap for a minimum of 2 minutes if the sample tap is before a pressure tank, or 5 minutes if the sample tap is after a pressure tank, prior to sample collection.

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3.5 SAMPLING PROTOCOL

3.5.1 General Sampling Procedures

Disposable chemical-resistant (e.g., nitrile) gloves will be worn during sampling and will be changed between sampling points.

All samples will be labeled with the sample ID (monitoring well number), site name, project number, time and date of collection, analytical parameters, preservative, and the initials of the sampler. The laboratory will provide instructions regarding the preservation techniques required for each analysis. The laboratory will provide any required temperature and/or trip blanks, and will provide water and sample containers for field blanks.

3.5.2 Sample Collection

3.5.2.1 Monitoring Wells – Low-Flow Method

After each well is determined to have stabilized (see Section 3.4.1.1), samples will be collected using the dedicated bladder pump. The pumping rate during sampling will not exceed the pumping rate during purging. Samples collected using low-flow methods will not be filtered.

3.5.2.2 Monitoring Wells – Low-Flow Method in Slow-Recovering Wells

At wells purged using the procedure described in Section 3.4.1.2, samples will be collected using the dedicated bladder pump after the well has recovered sufficiently for the required sample volume to be collected. The pumping rate during sampling will be set as low as practical in order to minimize sample turbidity. One set of the field parameters listed in Section 3.2.1.1 at the time of sample collection will be measured and recorded; stability is not required. Samples collected using low-flow methods will not be filtered.

3.5.2.3 Monitoring Wells – Non-Low-Flow Method

At wells purged using the procedures described in Section 3.4.2, samples will be collected using the dedicated bailer. Field pH, temperature, and specific conductance will be measured at the time of sample collection using an electronic meter. Qualitative descriptions of sample odor, color, and turbidity will also be recorded.

Laboratory samples for parameters that will be reported as dissolved (Table 2) will be field-filtered with a disposable 0.45 micron filter. Each filter will be used at a single well and then discarded.

3.5.2.4 Supply wells

Supply well samples will be collected from the sample tap after purging is complete. If a hose is used to direct purge water from an exterior tap, disconnect the hose and sample directly from the tap. Do not filter water supply well samples. Collect additional sample volume in a clean vessel for measurement of field parameters listed in Table 2.

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3.5.2.5 Leachate Monitoring Points

Leachate head readings in leachate headwells will be obtained from transducers installed in each headwell.

Leachate samples from the landfill surface water runoff/leachate collection pond (monitoring point LP-1) will be collected as grab samples using a dipper. Care will be taken to avoid inclusion of sediment in the sample. This sample will not be filtered. Collect additional sample volume in a clean vessel for measurement of field parameters listed in Table 1.

3.5.3 Quality Assurance and Quality Control

3.5.3.1 Field Blanks

One field blank sample will be collected during each sampling event using reagent grade water and sample containers provided by the laboratory. Field blanks at this site are collected for the purpose of assessing potential sample contamination from airborne particles. If applicable, the Field Blank bottles will be filled at the monitoring point where the risk of sample contamination from CCR handling activities appears to be the greatest (e.g., next to a monitoring well, adjacent to or downwind of an active CCR handling area). The location where the Field Blank bottles were filled will be recorded in the field notes. Field blank samples will not be filtered.

Dedicated equipment (bladder pump or bailer) is used for sample collection at all sampled monitoring wells, therefore rinsate and equipment blanks will not be collected.

3.5.3.2 Field Duplicates

One field duplicate per 10 or fewer samples will be collected for metals analysis.

Field duplicate samples will be collected and handled using the same procedures as the original samples. Each duplicate sample will be collected immediately after the associated original sample.

3.5.3.3 Trip Blanks

Trip blanks will not be collected, as volatile organic compounds, gasoline range organics, and petroleum volatile organic compounds are not included in the sampling program.

3.5.4 Sample Containers

Sample containers will be provided by the laboratory contractor for the sample analysis. Containers for samples that require chemical preservation will be pre-preserved by the laboratory. The required sample volume for each sampling point is determined by the analytical methods used. Fill all bottles provided by the laboratory for each sampling point. If sample volume is limited, consult with the laboratory project manager to determine whether all required analyses can be performed on a smaller volume of water for a specific sample. The laboratory will provide sample containers for the collection of quality control samples.

3.5.5 Sample Preservation

Samples will be preserved as required for the analytical methods being used. The laboratory will provide instructions and sample containers pre-filled with preservative chemicals, if required. All

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samples will be kept on ice from the time of collection until they are submitted to the laboratory, with the exception of samples to be analyzed only for radium 226 and/or radium 228, which may be stored and transported with or without ice per guidance from the laboratory. The laboratory will provide temperature blanks in the sample coolers, if required.

3.5.6 Sample Shipment

Samples for all parameters except radium will be packed in coolers with ice and will be shipped to the laboratory using a method that ensures delivery within required temperature limits. Radium samples do not require ice for shipping. Typically, samples will be shipped for next day delivery using a courier service or a shipping company (e.g., FedEx or UPS).

3.6 EQUIPMENT DECONTAMINATION

Equipment that is not dedicated to a single well (e.g., water level measurement tape or non-dedicated pump) will be decontaminated between monitoring points. Decontamination will consist of cleaning with water and nonphosphate detergent (i.e., Alconox™ or equivalent), followed by a double-rinse.

4.0 ANALYTICAL METHODS

Laboratory sample analysis will be performed using methods listed in Table 3. Other methods may be substituted provided the Limit of Detection of the new method is lower than the regulatory standard(s) to which the results will be compared.

4.1 ANALYTICAL QUALITY ASSURANCE/QUALITY CONTROL

Samples for laboratory analysis will be submitted only to a laboratory that is certified by the State of Wisconsin for the methods listed in Section 4.0. The laboratory will have established Quality Assurance/Quality Control (QA/QC) procedures that conform to industry standards.

5.0 DOCUMENTATION

5.1 FIELD DOCUMENTATION

Water levels, purge volumes, sample times, field parameters, and general well condition information will be recorded in the sampler's field book, on groundwater sampling log forms, or electronically.

5.2 CHAIN OF CUSTODY

Chain of Custody forms will be supplied by the laboratory and completed in the field by the sampler. An example Chain of Custody form is included in Attachment A. At a minimum, Chain of Custody forms will include:

- Sample IDs, date and time of sample collection, required analyses for each sample, and sample preservative (if applicable)
- Site name and project number
- Sampler's name and company
- Laboratory name and address
- Signature of person relinquishing samples for shipping

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Tables

1 Sampling Points and Parameters – NR 507.15(3) Groundwater Monitoring Program
2 Sampling Points and Parameters – License #3025 Non-CCR Well Groundwater Monitoring Program
3 Analytical Methods

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Table 1. NR 507.15(3) Groundwater Monitoring Program
CCR Monitoring Program
Wisconsin Power and Light - Columbia Ash Disposal Facility

Landfill Modules and Monitoring Points		Parameters - Detection Monitoring	Parameters - Assessment Monitoring (if required)	Frequency
Groundwater				
All Modules (Background Wells)	MW-84A MW-301	Alkalinity Boron Calcium Hardness Chloride Fluoride Sulfate TDS Field Conductivity Field pH Field Temperature Groundwater Elevation	Antimony Arsenic Barium Beryllium Cadmium Chromium Cobalt Copper Fluoride Lead Lithium Manganese Mercury Molybdenum Nitrate + Nitrite (as N) Selenium Silver Thallium Zinc Radium 226 and Radium 228, combined	Semiannual (April/October)
Modules 1-3	MW-302 MW-33AR MW-34A			
Modules 4-6	MW-309 MW-310 MW-311			
Modules 10-11	MW-313^ MW-314^ MW-315^			
Module 12 or Modules 12-13	Additional Wells as Installed			

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Table 1. NR 507.15(3) Groundwater Monitoring Program
CCR Monitoring Program
Wisconsin Power and Light - Columbia Ash Disposal Facility

Landfill Modules and Monitoring Points		Parameters - Detection Monitoring	Frequency
Leachate			
All Modules*	LP-1*	BOD_5	Semiannual (April/October)
		Field conductivity (at 25 deg C)	
All Modules*	Leachate Collection Tank*	Field pH	
		Alkalinity	
		Boron	
		Cadmium	
		Chloride	
		COD	
		Hardness	
		Iron	
		Lead	
		Manganese	
		Mercury	
		Selenium	
		Total suspended solids	
		Antimony	
		Beryllium	
		Cobalt	
		Fluoride	
		Lithium	
		Molybdenum	
		Radium 226 and 228, combined	
		Sulfate	
		Thallium	
		Semivolatile organic compound scan	Annual

^: MW-313, MW-314, and MW-315 will be abandoned prior to construction of Module 12.
*: At a later date, the leachate collection system will be converted to discharge all leachate to the Leachate Collection Tank.

Created by:	MDB	Date:	1/11/2023
Last revision by:	MDB	Date:	8/10/2023
Checked by:	ACW	Date:	8/17/2023

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Table 2. Non-CCR Well Groundwater Monitoring Program
Wisconsin Power and Light - Columbia Dry Ash Disposal Facility
License #3025

Monitoring Points	Parameters	Frequency	Revision from Prior Monitoring Program
Detection Groundwater Monitoring, Non-CCR Wells			
MW-33BR MW-34B MW-37A MW-83 MW-84B MW-86 MW-92A MW-92B MW-93A*	Groundwater elevation Field odor, color, and turbidity Field temperature, conductivity at 25° C, and pH Metals, dissolved (Arsenic, Boron, Molybdenum) Sulfate, dissolved Total Hardness, dissolved (mg/L as $CaCO_3$) Alkalinity, dissolved	Semiannual (April and October)	Remove: -Wells MW-91A and MW-91B -Chloride -Nitrite + Nitrate as N -Aluminum -Barium -Cadmium -Chromium -Mercury (October only) -Selenium
Water Supply Wells			
HC-1 HC-2 HC-3	Field odor, color, and turbidity Field temperature, conductivity at 25° C, and pH Nitrate + Nitrite as N, total Metals, total (Arsenic, Boron, Molybdenum) Sulfate, total Chloride, total Total Hardness (mg/L as $CaCO_3$) Alkalinity	Semiannual (April and October)	Remove: -Aluminum -Barium -Cadmium -Chromium -Selenium
Lysimeters			
LS-1 LS-3R	Field odor, color, and turbidity Field temperature, conductivity at 25° C, and pH Alkalinity Metals, total (Arsenic, Boron, Molybdenum) Total Hardness (mg/L as CaCO3) Chloride, total Chemical Oxygen Demadn (COD) Total Kjeldahl Nitrogen (TKN) Sulfate, total	Semiannual (April and October)	Remove: -Nitrite + Nitrate as N -Aluminum -Barium -Cadmium -Chromium -Mercury -Selenium Add: -COD -TKN
Leachate Head Wells			
LH-2, LH-3^, LH-4^, LH-5, LH-6, LH-10A, LH-10B^, LH-11A, LH-11B^	Leachate head	Monthly	

*MW-93A was installed in 2022, and is in baseline monitoring, including the collection of additional parameters.
^ LH-10A/B and LH-11A/B will replace LH-3 and LH-4 in the monitoring program.

Created by: MDB Date: 1/8/2015
Updated by: MDB Date: 8/10/2023
Checked by: ACW Date: 8/17/2023

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09/28/2023 - Classification: Internal - ECRM13153872

Table 3. Analytical Methods

Parameter Type	Analytical Method
Metals (except mercury)	EPA 6010 or 6020
Mercury	EPA 7470
Chloride, fluoride, sulfate	EPA 9056 or 300.0
Alkalinity	SM 2320B
Hardness	SM5340C
BOD5	SM 5210B
COD	EPA 410.4
Total Suspended Solids	SM 2540D
Total Dissolved Solids	SM 6540C
Nitrate + Nitrite (as N)	EPA 353.2
Radium 226	EPA 903.1
Radium 228	EPA 904.0

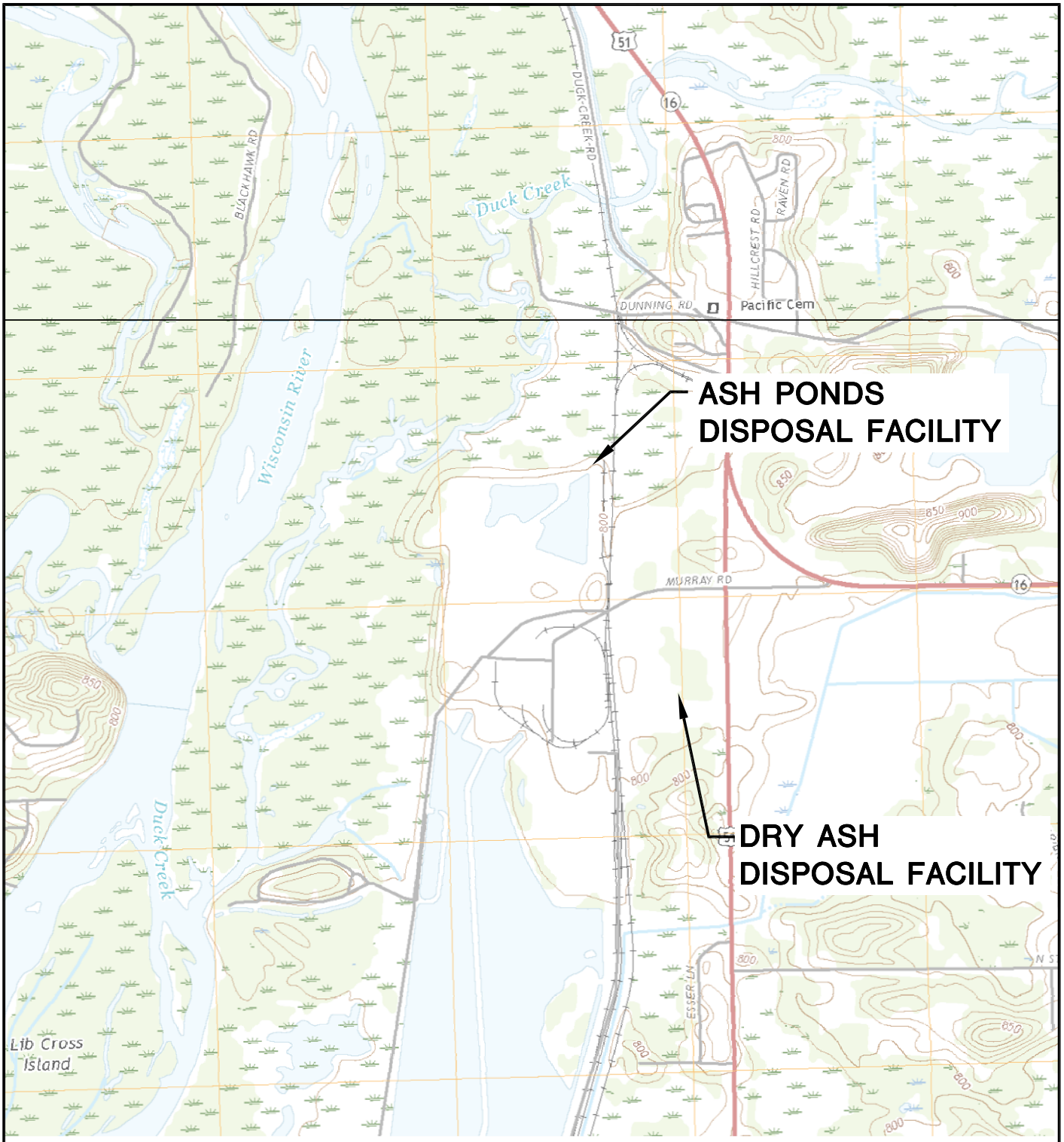
Note: Other methods may be substituted provided the Limit of Detection of the new method is lower than the regulatory standard(s) to which the results will be compared.

09/28/2023 - Classification: Internal - ECRM13153872

Figures

1 Site Location Map
2 Site Plan and Monitoring Well Locations

09/28/2023 - Classification: Internal - ECRM13153872



N

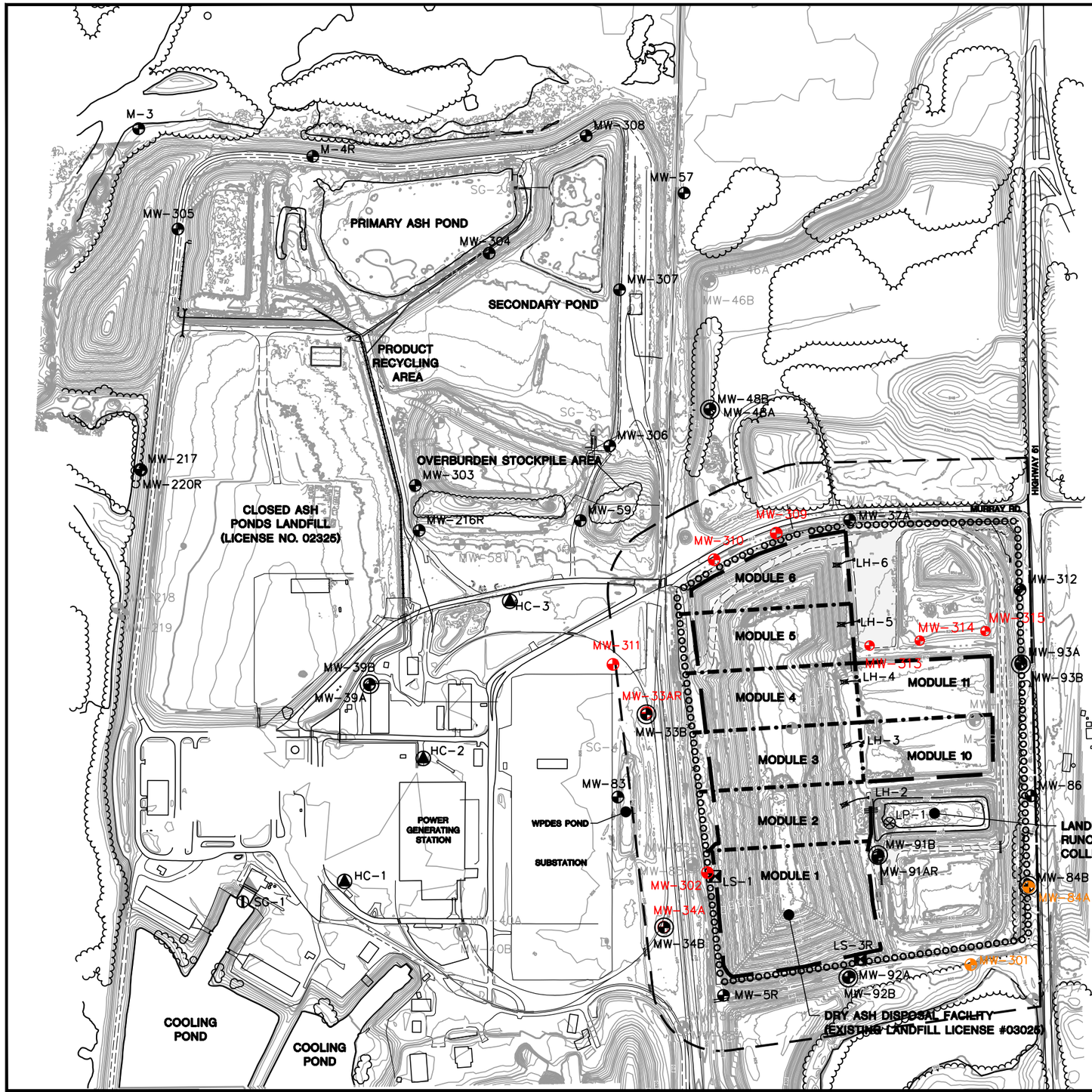
POYNETTE QUADRANGLE
WISCONSIN–COLUMBIA CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)
2018
SCALE: 1" = 2,000'

CLIENT	SITE	
ALLIANT ENERGY COLUMBIA ENERGY CENTER W8375 MURRAY ROAD PARDEEVILLE, WI 53954	ALLIANT ENERGY COLUMBIA ENERGY CENTER PARDEEVILLE, WI	SITE LOCATION MAP

				ENGINEER		
PROJECT NO.	25220067.00	DRAWN BY:	BSS		SCS ENGINEERS 2830 DAIRY DRIVE MADISON, WI 53718–6751 PHONE: (608) 224–2830	FIGURE 1
DRAWN:	12/02/2019	CHECKED BY:	MDB			
REVISED:	01/10/2020	APPROVED BY:	TK 04/10/2020			

I:\25220067.00\Drawings\ASD Mod 1-3 LF\Site Location Map.dwg, 4/12/2020 7:05:09 PM

09/28/2023 - Classification: Internal - ECRM13153872



LEGEND

- EXISTING MAJOR CONTOUR (10' INTERVAL)
- EXISTING MINOR CONTOUR (2' CONTOUR)
- EXISTING FENCELINE
- EXISTING TRACKS
- EXISTING PAVED ROAD
- EXISTING UNPAVED ROAD
- EDGE OF WATER
- DRY ASH DISPOSAL FACILITY LIMITS
- LIMITS OF WASTE
- LINER PHASE/MODULE LIMITS
- DESIGN MANAGEMENT ZONE
- WATER SUPPLY WELL
- STAFF GAUGE
- NON-CCR WATER TABLE WELL
- NON-CCR PIEZOMETER
- CCR MONITORING WELL
- CCR BACKGROUND MONITORING WELL
- SURFACE WATER SAMPLE LOCATION
- LYSIMETER
- ABANDONED WATER TABLE WELL
- ABANDONED PIEZOMETER
- ABANDONED STAFF GAUGE
- LEACHATE HEADWELL

NOTES:

1. BASE MAP CREATED FROM AERIAL SURVEY BY KBM, FLOWN DECEMBER 1, 2014, AND GROUND SURVEYS BY SCS ENGINEERS IN MAY 2019, DECEMBER 2020, NOVEMBER 2021, AND DECEMBER 2021, AND BY DRONE SURVEY BY AMES IN NOVEMBER 2022, JANUARY 2023 AND JUNE 2023.
2. MONITORING WELL LOCATIONS AND ELEVATIONS SURVEYED BY WISCONSIN POWER AND LIGHT, INC. IN DECEMBER 1994, NOVEMBER 1996, APRIL 2003, AND JANUARY 2016, AND BY SCS ENGINEERS IN FEBRUARY 2018, APRIL 2022, AND JANUARY 2023.
3. SUPPLY WELL LOCATIONS ARE APPROXIMATE AND ASSUMED BASED ON JANUARY 2013 DRAWINGS BY TRC.
4. BACKGROUND MONITORING WELLS FOR THE DRY ASH FACILITY ARE: MW-301 AND MW-84A.
5. THIS DRAWING SHOWS ALL SITE MONITORING WELLS, INCLUDING WELLS THAT ARE NOT USED TO MONITOR THE DRY ASH DISPOSAL FACILITY, THE CLOSED ASH PONDS LANDFILL, ASH POND, AND/OR THE SECONDARY POND.

PROJECT NO.	25222260.00	DRAWN BY:	KP
DRAWN:	02/09/2023	CHECKED BY:	MDB
REVISED:	03/10/2023	APPROVED BY:	MDB 09/01/23

ENGINEER: SCS ENGINEERS
2830 DAIRY DRIVE MADISON, WI 53718-6751
PHONE: (608) 224-2830

CLIENT: ALLIANT ENERGY
COLUMBIA ENERGY CENTER
W8375 MURRAY ROAD
PARDEEVILLE, WI 53954

SITE: ALLIANT ENERGY
COLUMBIA ENERGY CENTER
COLUMBIA DRY ASH DISPOSAL FACILITY
PARDEEVILLE, WI

SITE PLAN AND MONITORING WELL LOCATIONS

FIGURE 2

I:\25222260.00\Drawings\Site Plan and Monitoring Well Locations.dwg, 9/1/2023 12:23:49 PM

09/28/2023 - Classification: Internal - ECRM13153872

Attachment A

Example Chain of Custody

09/28/2023 - Classification: Internal - ECRM13153872

UPPER MIDWEST REGION
MN: 612-607-1700 WI: 920-469-2436

Pace Analytical®
www.pacelabs.com

CHAIN OF CUSTODY

(Please Print Clearly)	
Company Name:	SCS Engineers
Branch/Location:	Madison, WI
Project Contact:	Tom Karwoski
Phone:	(608) 224-2830
Project Number:	25221067.00
Project Name:	WPL-I43 GW Monitoring
Project State:	Wisconsin
Sampled By (Print):	
Sampled By (Sign):	
PO #:	Regulatory Program:

*Preservation Codes
A=None B=HCL C=H2SO4 D=HNO3 E=DI Water F=Methanol G=NaOH
H=Sodium Bisulfate Solution I=Sodium Thiosulfate J=Other

Quote #:	
Mail To Contact:	Tom Karwoski
Mail To Company:	SCS Engineers
Mail To Address:	2830 Dairy Drive Madison, WI 53718
Invoice To Contact:	Tom Karwoski
Invoice To Company:	SCS Engineers
Invoice To Address:	2830 Dairy Drive Madison, WI 53718
Invoice To Phone:	(608) 224-2830

Data Package Options (billable)
☐ EPA Level III
☐ EPA Level IV

MS/MSD
☐ On your sample (billable)
☐ NOT needed on your sample

Matrix Codes

A = Air	W = Water
B = Biota	DW = Drinking Water
C = Charcoal	GW = Ground Water
O = Oil	SW = Surface Water
S = Soil	WW = Waste Water
Sl = Sludge	WP = Wipe

PACE LAB #	CLIENT FIELD ID	COLLECTION DATE	COLLECTION TIME	MATRIX
	MW-302			GW
	MW-34A			GW
	MW-33AR			GW
	Field Blank			W

FILTERED? (YES/NO) — Y / N
PRESERVATION (CODE)* — Pick Letter
Analyses Requested

CLIENT COMMENTS	LAB COMMENTS (Lab Use Only)	Profile #

Rush Turnaround Time Requested - Prelims
(Rush TAT subject to approval/surcharge)
Date Needed:

Transmit Prelim Rush Results by (complete what you want):

Email #1:	
Email #2:	
Telephone:	
Fax:	

Samples on HOLD are subject to special pricing and release of liability

Relinquished By:	Date/Time:	Received By:	Date/Time:
Relinquished By:	Date/Time:	Received By:	Date/Time:
Relinquished By:	Date/Time:	Received By:	Date/Time:
Relinquished By:	Date/Time:	Received By:	Date/Time:
Relinquished By:	Date/Time:	Received By:	Date/Time:

PACE Project No.

Receipt Temp = °C

Sample Receipt pH OK / Adjusted

Cooler Custody Seal
Present / Not Present
Intact / Not Intact

Version 6.0 06/14/06

09/28/2023 - Classification: Internal - ECRM13153872

C019a(27Jun2006)

ORIGINAL

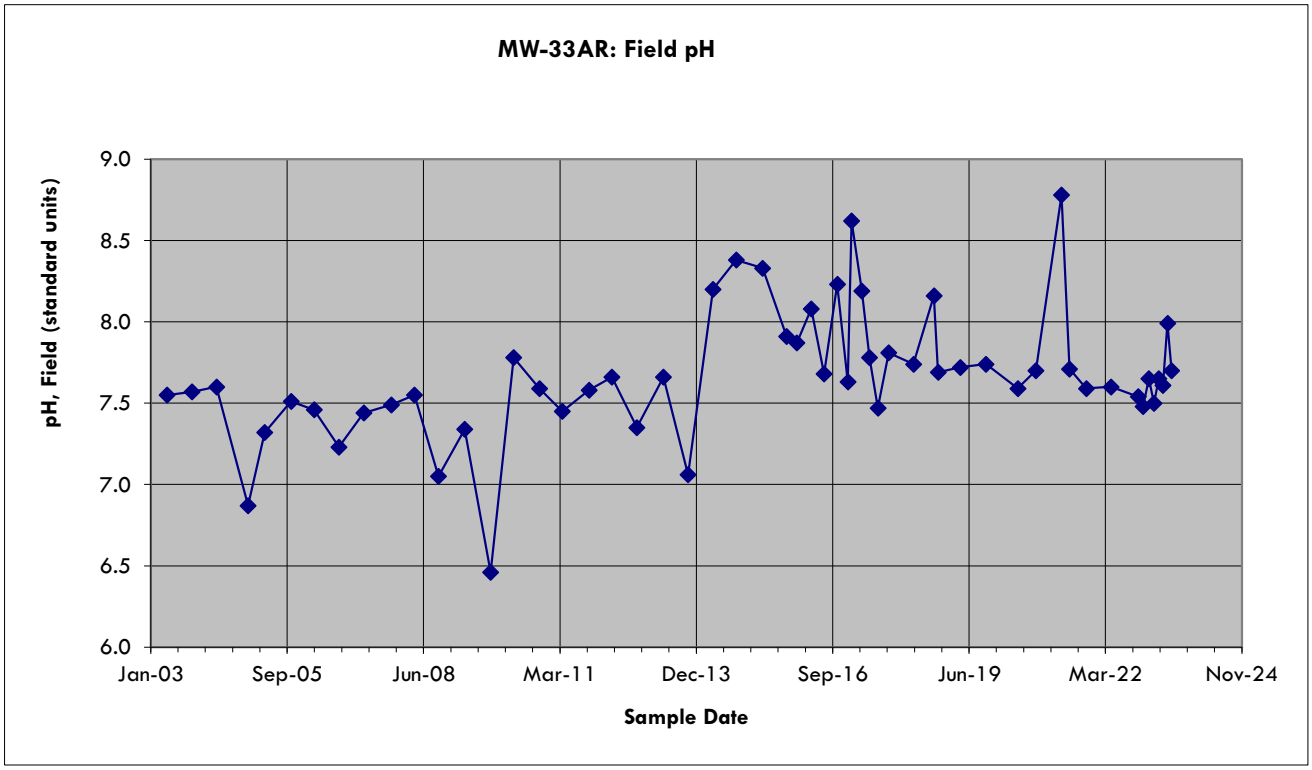
Appendix I

PAL and ACL Calculations

09/28/2023 - Classification: Internal - ECRM13153872

I.1 CCR Well PAL and ACL Calcs

09/28/2023 - Classification: Internal - ECRM13153872



Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-33AR	PH, FIELD (STANDARD UNITS)	01	7.55	4/29/2003	7.55	7.55	
MW-33AR	PH, FIELD (STANDARD UNITS)	01	7.57	10/30/2003	7.57	7.57	
MW-33AR	PH, FIELD (STANDARD UNITS)	01	7.6	4/27/2004	7.6	7.6	
MW-33AR	PH, FIELD (STANDARD UNITS)	01	6.87	12/14/2004	6.87	6.87	
MW-33AR	PH, FIELD (STANDARD UNITS)	01	7.32	4/15/2005	7.32	7.32	
MW-33AR	PH, FIELD (STANDARD UNITS)	01	7.51	10/26/2005	7.51	7.51	
MW-33AR	PH, FIELD (STANDARD UNITS)	01	7.46	4/13/2006	7.46	7.46	
MW-33AR	PH, FIELD (STANDARD UNITS)	01	7.23	10/12/2006	7.23	7.23	
MW-33AR	PH, FIELD (STANDARD UNITS)	01	7.44	4/11/2007	7.44	7.44	
MW-33AR	PH, FIELD (STANDARD UNITS)	01	7.49	10/31/2007	7.49	7.49	
MW-33AR	PH, FIELD (STANDARD UNITS)	01	7.55	4/17/2008	7.55	7.55	
MW-33AR	PH, FIELD (STANDARD UNITS)	01	7.05	10/10/2008	7.05	7.05	
MW-33AR	PH, FIELD (STANDARD UNITS)	01	7.34	4/21/2009	7.34	7.34	
MW-33AR	PH, FIELD (STANDARD UNITS)	01	6.46	10/27/2009	6.46	6.46	
MW-33AR	PH, FIELD (STANDARD UNITS)	01	7.78	4/14/2010	7.78	7.78	
MW-33AR	PH, FIELD (STANDARD UNITS)	01	7.59	10/20/2010	7.59	7.59	
MW-33AR	PH, FIELD (STANDARD UNITS)	01	7.45	4/6/2011	7.45	7.45	
MW-33AR	PH, FIELD (STANDARD UNITS)	01	7.58	10/20/2011	7.58	7.58	
MW-33AR	PH, FIELD (STANDARD UNITS)	01	7.66	4/4/2012	7.66	7.66	
MW-33AR	PH, FIELD (STANDARD UNITS)	01	7.35	10/4/2012	7.35	7.35	
MW-33AR	PH, FIELD (STANDARD UNITS)	01	7.66	4/17/2013	7.66	7.66	
MW-33AR	PH, FIELD (STANDARD UNITS)	01	7.06	10/14/2013	7.06	7.06	
MW-33AR	PH, FIELD (STANDARD UNITS)	01	8.2	4/16/2014	8.2	8.2	
MW-33AR	PH, FIELD (STANDARD UNITS)	01	8.38	10/2/2014	8.38	8.38	
MW-33AR	PH, FIELD (STANDARD UNITS)	01	8.33	4/14/2015	8.33	8.33	
MW-33AR	PH, FIELD (STANDARD UNITS)	01	7.91	10/7/2015	7.91	7.91	
MW-33AR	PH, FIELD (STANDARD UNITS)	01	7.87	12/21/2015	7.87	7.87	
MW-33AR	PH, FIELD (STANDARD UNITS)	01	8.08	4/5/2016	8.08	8.08	
MW-33AR	PH, FIELD (STANDARD UNITS)	01	7.68	7/7/2016	7.68	7.68	
MW-33AR	PH, FIELD (STANDARD UNITS)	01	8.23	10/13/2016	8.23	8.23	
MW-33AR	PH, FIELD (STANDARD UNITS)	01	7.63	12/29/2016	7.63	7.63	
MW-33AR	PH, FIELD (STANDARD UNITS)	01	8.62	1/25/2017	8.62	8.62	
MW-33AR	PH, FIELD (STANDARD UNITS)	01	8.19	4/11/2017	8.19	8.19	
MW-33AR	PH, FIELD (STANDARD UNITS)	01	7.78	6/6/2017	7.78	7.78	
MW-33AR	PH, FIELD (STANDARD UNITS)	01	7.47	8/7/2017	7.47	7.47	
MW-33AR	PH, FIELD (STANDARD UNITS)	01	7.81	10/24/2017	7.81	7.81	

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Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-33AR	PH, FIELD (STANDARD UNITS)	01	7.74	4/24/2018	7.74	7.74	
MW-33AR	PH, FIELD (STANDARD UNITS)	01	8.16	9/21/2018	8.16	8.16	
MW-33AR	PH, FIELD (STANDARD UNITS)	01	7.69	10/22/2018	7.69	7.69	
MW-33AR	PH, FIELD (STANDARD UNITS)	01	7.72	4/2/2019	7.72	7.72	
MW-33AR	PH, FIELD (STANDARD UNITS)	01	7.74	10/8/2019	7.74	7.74	
MW-33AR	PH, FIELD (STANDARD UNITS)	01	7.59	5/28/2020	7.59	7.59	
MW-33AR	PH, FIELD (STANDARD UNITS)	01	7.7	10/8/2020	7.7	7.7	
MW-33AR	PH, FIELD (STANDARD UNITS)	01	8.78	4/13/2021	8.78	8.78	
MW-33AR	PH, FIELD (STANDARD UNITS)	01	7.71	6/11/2021	7.71	7.71	
MW-33AR	PH, FIELD (STANDARD UNITS)	01	7.59	10/12/2021	7.59	7.59	
MW-33AR	PH, FIELD (STANDARD UNITS)	01	7.6	4/12/2022	7.6	7.6	
MW-33AR	PH, FIELD (STANDARD UNITS)	01	7.54	10/27/2022	7.54	7.54	
MW-33AR	PH, FIELD (STANDARD UNITS)	01	7.48	12/2/2022	7.48	7.48	
MW-33AR	PH, FIELD (STANDARD UNITS)	01	7.65	1/13/2023	7.65	7.65	
MW-33AR	PH, FIELD (STANDARD UNITS)	01	7.5	2/21/2023	7.5	7.5	
MW-33AR	PH, FIELD (STANDARD UNITS)	01	7.65	3/28/2023	7.65	7.65	
MW-33AR	PH, FIELD (STANDARD UNITS)	01	7.61	4/27/2023	7.61	7.61	
MW-33AR	PH, FIELD (STANDARD UNITS)	01	7.99	5/31/2023	7.99	7.99	
MW-33AR	PH, FIELD (STANDARD UNITS)	01	7.7	6/30/2023	7.7	7.7	
Calculations							
Count						55	
Mean						7.67	
PAL Limit (NR 140.20(2)(a)						+/- 1	
Upper PAL, Calculated						8.67	
Lower PAL, Calculated						6.67	
Upper PAL, Rounded						8.7	
Lower PAL, Rounded						6.6	

Duplicate Data Not Used for Calculations							

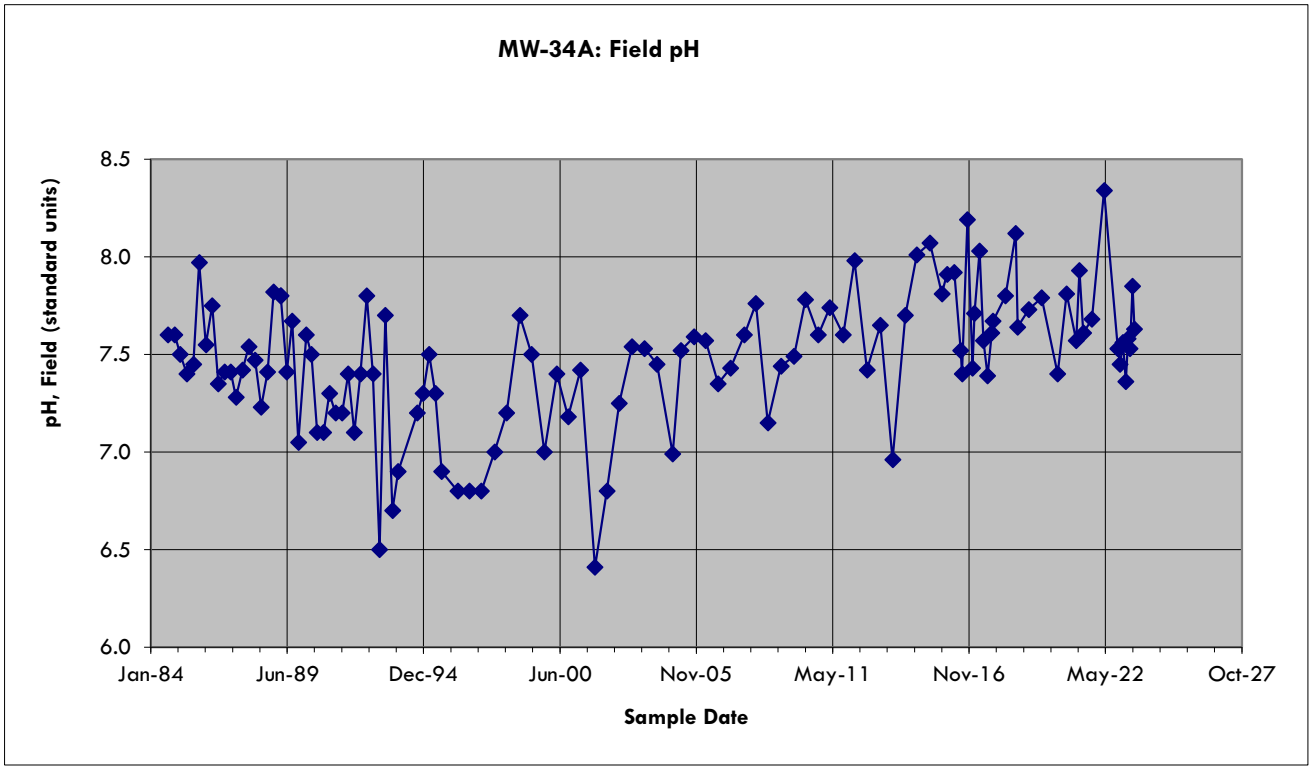
Note: Data through 10/2015 downloaded from GEMS, 12/2015 - 10/2022 downloaded from ChemPoint, later data from PacePort

J = Result is an estimated value below the laboratory's limit of quantitation.

P = Did not meet required preservation and/or hold time.

B = Compound detected in blank.

M = Failed method QC check.



Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.6	9/7/1984	7.6		
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.6	12/17/1984	7.6		
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.5	3/7/1985	7.5		
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.4	6/14/1985	7.4		
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.45	9/18/1985	7.45		
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.97	12/12/1985	7.97		
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.55	3/21/1986	7.55		
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.75	6/20/1986	7.75		
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.35	9/18/1986	7.35		
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.41	12/19/1986	7.41		
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.41	3/20/1987	7.41		
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.28	6/5/1987	7.28		
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.42	9/9/1987	7.42		
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.54	12/9/1987	7.54		
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.47	3/10/1988	7.47		
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.23	6/7/1988	7.23		
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.41	9/9/1988	7.41		
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.82	12/7/1988	7.82		
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.8	3/21/1989	7.8		
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.8	3/22/1989	7.8		
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.41	6/16/1989	7.41		
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.67	9/6/1989	7.67		
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.05	12/5/1989	7.05		
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.6	3/29/1990	7.6		
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.5	6/14/1990	7.5		
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.1	9/5/1990	7.1		
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.1	12/10/1990	7.1		
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.3	3/5/1991	7.3		
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.2	6/3/1991	7.2		
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.2	9/6/1991	7.2		
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.4	12/4/1991	7.4		
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.1	3/3/1992	7.1		
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.4	6/2/1992	7.4		
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.8	9/1/1992	7.8		
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.4	12/2/1992	7.4		
MW-34A	PH, FIELD (STANDARD UNITS)	01	6.5	3/10/1993	6.5		

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Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.7	6/2/1993	7.7		
MW-34A	PH, FIELD (STANDARD UNITS)	01	6.7	9/14/1993	6.7		
MW-34A	PH, FIELD (STANDARD UNITS)	01	6.9	12/7/1993	6.9		
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.2	9/13/1994	7.2		
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.3	12/6/1994	7.3		
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.5	3/7/1995	7.5		
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.3	6/6/1995	7.3		
MW-34A	PH, FIELD (STANDARD UNITS)	01	6.9	9/6/1995	6.9		
MW-34A	PH, FIELD (STANDARD UNITS)	01	6.8	4/30/1996	6.8		
MW-34A	PH, FIELD (STANDARD UNITS)	01	6.8	10/16/1996	6.8		
MW-34A	PH, FIELD (STANDARD UNITS)	01	6.8	4/8/1997	6.8		
MW-34A	PH, FIELD (STANDARD UNITS)	01	7	10/20/1997	7		
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.2	4/14/1998	7.2		
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.7	10/27/1998	7.7		
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.5	4/16/1999	7.5		
MW-34A	PH, FIELD (STANDARD UNITS)	01	7	10/21/1999	7		
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.4	4/20/2000	7.4		
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.18	10/4/2000	7.18		
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.42	4/3/2001	7.42		
MW-34A	PH, FIELD (STANDARD UNITS)	01	6.41	10/30/2001	6.41		
MW-34A	PH, FIELD (STANDARD UNITS)	01	6.8	4/25/2002	6.8		
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.25	10/24/2002	7.25		
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.54	4/29/2003	7.54	7.54	Using last 20 years of data for PAL calculation
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.53	10/29/2003	7.53	7.53	
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.45	4/27/2004	7.45	7.45	
MW-34A	PH, FIELD (STANDARD UNITS)	01	6.99	12/14/2004	6.99	6.99	
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.52	4/15/2005	7.52	7.52	
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.59	10/26/2005	7.59	7.59	
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.57	4/13/2006	7.57	7.57	
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.35	10/12/2006	7.35	7.35	
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.43	4/11/2007	7.43	7.43	
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.6	10/31/2007	7.6	7.6	
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.76	4/17/2008	7.76	7.76	
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.15	10/10/2008	7.15	7.15	
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.44	4/21/2009	7.44	7.44	
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.49	10/27/2009	7.49	7.49	
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.78	4/14/2010	7.78	7.78	
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.6	10/20/2010	7.6	7.6	
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.74	4/6/2011	7.74	7.74	
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.6	10/20/2011	7.6	7.6	
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.98	4/4/2012	7.98	7.98	
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.42	10/4/2012	7.42	7.42	
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.65	4/16/2013	7.65	7.65	
MW-34A	PH, FIELD (STANDARD UNITS)	01	6.96	10/14/2013	6.96	6.96	
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.7	4/16/2014	7.7	7.7	
MW-34A	PH, FIELD (STANDARD UNITS)	01	8.01	10/2/2014	8.01	8.01	
MW-34A	PH, FIELD (STANDARD UNITS)	01	8.07	4/14/2015	8.07	8.07	
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.81	10/7/2015	7.81	7.81	
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.91	12/21/2015	7.91	7.91	
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.92	4/5/2016	7.92	7.92	
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.52	7/7/2016	7.52	7.52	
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.4	7/28/2016	7.4	7.4	
MW-34A	PH, FIELD (STANDARD UNITS)	01	8.19	10/13/2016	8.19	8.19	
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.43	12/29/2016	7.43	7.43	
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.71	1/25/2017	7.71	7.71	
MW-34A	PH, FIELD (STANDARD UNITS)	01	8.03	4/11/2017	8.03	8.03	
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.57	6/6/2017	7.57	7.57	
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.39	8/7/2017	7.39	7.39	
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.61	10/4/2017	7.61	7.61	
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.67	10/24/2017	7.67	7.67	
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.8	4/24/2018	7.8	7.8	
MW-34A	PH, FIELD (STANDARD UNITS)	01	8.12	9/21/2018	8.12	8.12	
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.64	10/22/2018	7.64	7.64	
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.73	4/2/2019	7.73	7.73	

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.79	10/8/2019	7.79	7.79	
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.4	5/28/2020	7.4	7.4	
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.81	10/8/2020	7.81	7.81	
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.57	2/25/2021	7.57	7.57	
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.93	4/13/2021	7.93	7.93	
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.61	6/11/2021	7.61	7.61	
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.68	10/12/2021	7.68	7.68	
MW-34A	PH, FIELD (STANDARD UNITS)	01	8.34	4/12/2022	8.34	8.34	
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.53	10/27/2022	7.53	7.53	
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.45	12/2/2022	7.45	7.45	
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.56	1/13/2023	7.56	7.56	
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.36	2/21/2023	7.36	7.36	
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.58	3/27/2023	7.58	7.58	
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.53	4/26/2023	7.53	7.53	
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.85	5/31/2023	7.85	7.85	
MW-34A	PH, FIELD (STANDARD UNITS)	01	7.63	6/30/2023	7.63	7.63	
Calculations							
Count						58	
Mean						7.64	
PAL Limit (NR 140.20(2)(a)						+/- 1	
Upper PAL, Calculated						8.64	
Lower PAL, Calculated						6.64	
Upper PAL, Rounded						8.7	
Lower PAL, Rounded						6.6	

Duplicate Data Not Used for Calculations							

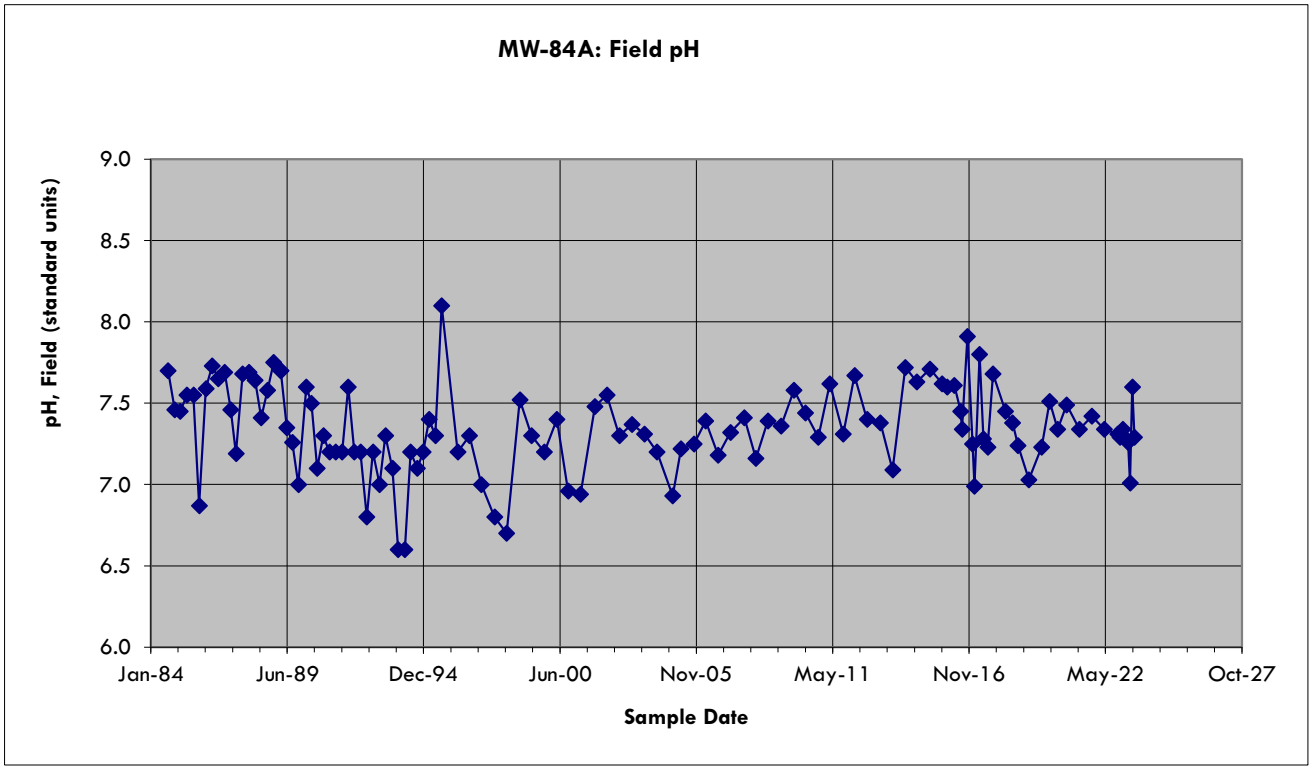
Note: Data through 10/2015 downloaded from GEMS, 12/2015 - 10/2022 downloaded from ChemPoint, later data from PacePort

J = Result is an estimated value below the laboratory's limit of quantitation.

P = Did not meet required preservation and/or hold time.

B = Compound detected in blank.

M = Failed method QC check.

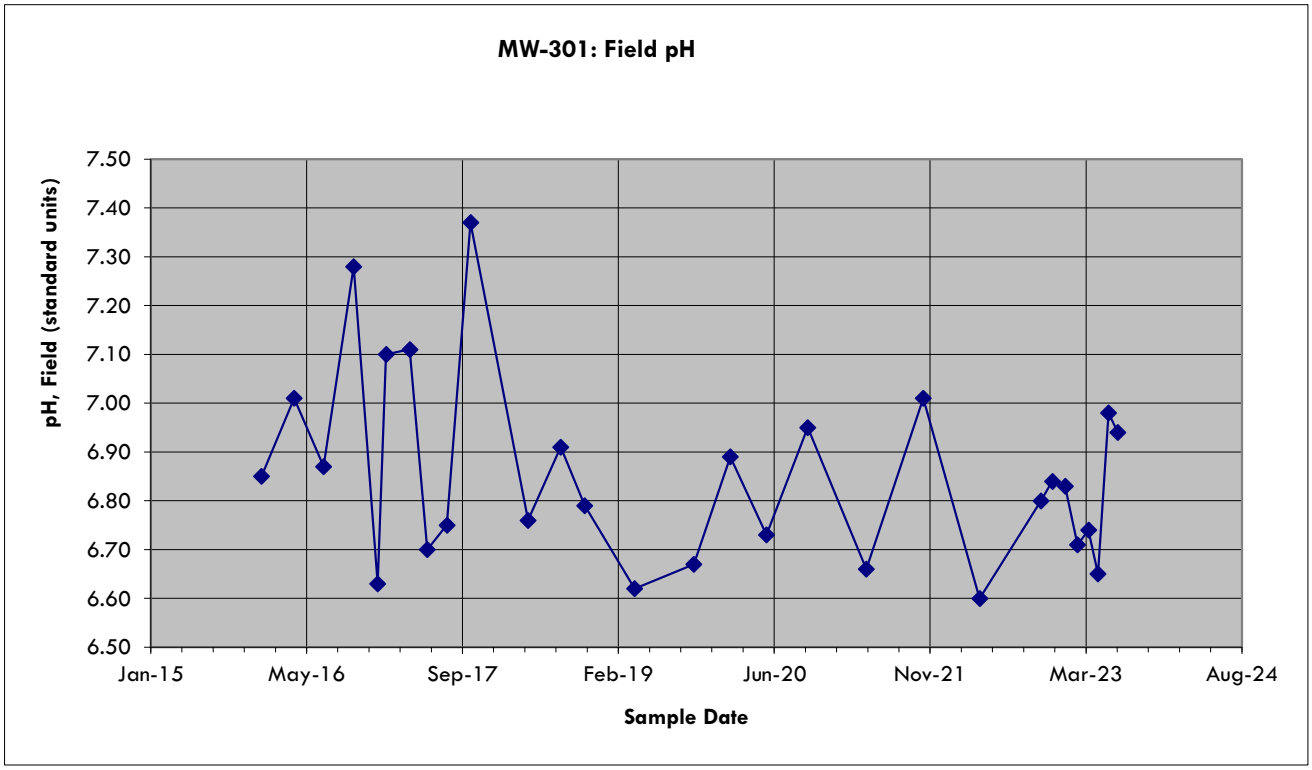


Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.70	9/7/1984	7.70	7.70	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.46	12/17/1984	7.46	7.46	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.45	3/7/1985	7.45	7.45	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.55	6/14/1985	7.55	7.55	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.55	9/18/1985	7.55	7.55	
MW-84A	PH, FIELD (STANDARD UNITS)	01	6.87	12/12/1985	6.87	6.87	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.59	3/21/1986	7.59	7.59	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.73	6/20/1986	7.73	7.73	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.65	9/18/1986	7.65	7.65	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.69	12/19/1986	7.69	7.69	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.46	3/20/1987	7.46	7.46	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.19	6/5/1987	7.19	7.19	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.68	9/9/1987	7.68	7.68	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.69	12/9/1987	7.69	7.69	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.64	3/10/1988	7.64	7.64	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.41	6/7/1988	7.41	7.41	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.58	9/9/1988	7.58	7.58	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.75	12/7/1988	7.75	7.75	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.70	3/21/1989	7.70	7.70	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.70	3/22/1989	7.70	7.70	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.35	6/16/1989	7.35	7.35	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.26	9/7/1989	7.26	7.26	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.00	12/6/1989	7.00	7.00	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.60	3/29/1990	7.60	7.60	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.50	6/14/1990	7.50	7.50	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.10	9/6/1990	7.10	7.10	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.30	12/7/1990	7.30	7.30	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.20	3/6/1991	7.20	7.20	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.20	6/3/1991	7.20	7.20	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.20	9/6/1991	7.20	7.20	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.60	12/5/1991	7.60	7.60	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.20	3/2/1992	7.20	7.20	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.20	6/2/1992	7.20	7.20	
MW-84A	PH, FIELD (STANDARD UNITS)	01	6.80	9/2/1992	6.80	6.80	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.20	12/2/1992	7.20	7.20	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.00	3/10/1993	7.00	7.00	

09/28/2023 - Classification: Internal - ECRM13153872

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.30	6/3/1993	7.30	7.30	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.10	9/14/1993	7.10	7.10	
MW-84A	PH, FIELD (STANDARD UNITS)	01	6.60	12/7/1993	6.60	6.60	
MW-84A	PH, FIELD (STANDARD UNITS)	01	6.60	3/15/1994	6.60	6.60	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.20	6/7/1994	7.20	7.20	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.10	9/13/1994	7.10	7.10	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.20	12/6/1994	7.20	7.20	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.40	3/7/1995	7.40	7.40	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.30	6/5/1995	7.30	7.30	
MW-84A	PH, FIELD (STANDARD UNITS)	01	8.10	9/5/1995	8.10	8.10	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.20	4/29/1996	7.20	7.20	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.30	10/17/1996	7.30	7.30	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.00	4/8/1997	7.00	7.00	
MW-84A	PH, FIELD (STANDARD UNITS)	01	6.80	10/20/1997	6.80	6.80	
MW-84A	PH, FIELD (STANDARD UNITS)	01	6.70	4/14/1998	6.70	6.70	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.52	10/27/1998	7.52	7.52	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.30	4/16/1999	7.30	7.30	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.20	10/21/1999	7.20	7.20	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.40	4/20/2000	7.40	7.40	
MW-84A	PH, FIELD (STANDARD UNITS)	01	6.96	10/4/2000	6.96	6.96	
MW-84A	PH, FIELD (STANDARD UNITS)	01	6.94	4/3/2001	6.94	6.94	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.48	10/30/2001	7.48	7.48	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.55	4/25/2002	7.55	7.55	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.30	10/25/2002	7.30	7.30	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.37	4/28/2003	7.37	7.37	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.31	10/29/2003	7.31	7.31	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.20	4/27/2004	7.20	7.20	
MW-84A	PH, FIELD (STANDARD UNITS)	01	6.93	12/14/2004	6.93	6.93	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.22	4/14/2005	7.22	7.22	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.25	10/26/2005	7.25	7.25	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.39	4/13/2006	7.39	7.39	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.18	10/12/2006	7.18	7.18	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.32	4/10/2007	7.32	7.32	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.41	10/30/2007	7.41	7.41	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.16	4/17/2008	7.16	7.16	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.39	10/10/2008	7.39	7.39	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.36	4/22/2009	7.36	7.36	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.58	10/27/2009	7.58	7.58	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.44	4/14/2010	7.44	7.44	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.29	10/20/2010	7.29	7.29	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.62	4/6/2011	7.62	7.62	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.31	10/21/2011	7.31	7.31	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.67	4/4/2012	7.67	7.67	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.40	10/4/2012	7.40	7.40	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.38	4/17/2013	7.38	7.38	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.09	10/14/2013	7.09	7.09	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.72	4/17/2014	7.72	7.72	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.63	10/2/2014	7.63	7.63	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.71	4/13/2015	7.71	7.71	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.62	10/8/2015	7.62	7.62	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.60	12/22/2015	7.60	7.60	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.61	4/5/2016	7.61	7.61	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.45	7/8/2016	7.45	7.45	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.34	7/28/2016	7.34	7.34	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.91	10/13/2016	7.91	7.91	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.25	12/29/2016	7.25	7.25	
MW-84A	PH, FIELD (STANDARD UNITS)	01	6.99	1/25/2017	6.99	6.99	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.80	4/11/2017	7.80	7.80	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.28	6/6/2017	7.28	7.28	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.23	8/8/2017	7.23	7.23	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.68	10/24/2017	7.68	7.68	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.45	4/25/2018	7.45	7.45	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.38	8/8/2018	7.38	7.38	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.24	10/24/2018	7.24	7.24	

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.03	4/3/2019	7.03	7.03	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.23	10/9/2019	7.23	7.23	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.51	2/3/2020	7.51	7.51	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.34	5/29/2020	7.34	7.34	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.49	10/8/2020	7.49	7.49	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.34	4/14/2021	7.34	7.34	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.42	10/14/2021	7.42	7.42	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.34	4/13/2022	7.34	7.34	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.31	10/27/2022	7.31	7.31	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.29	12/2/2022	7.29	7.29	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.34	1/12/2023	7.34	7.34	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.28	2/21/2023	7.28	7.28	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.26	3/28/2023	7.26	7.26	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.01	4/27/2023	7.01	7.01	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.60	5/30/2023	7.60	7.60	
MW-84A	PH, FIELD (STANDARD UNITS)	01	7.29	6/29/2023	7.29	7.29	
Calculations							
Count						116	
Mean						7.35	
PAL Limit (NR 140.20(2)(a)						+/- 1	
Upper PAL, Calculated						8.35	
Lower PAL, Calculated						6.35	
Upper PAL, Rounded						8.4	
Lower PAL, Rounded						6.3	



Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-301	PH, FIELD (STANDARD UNITS)	01	6.85	12/22/2015	6.85	6.85	
MW-301	PH, FIELD (STANDARD UNITS)	01	7.01	4/5/2016	7.01	7.01	
MW-301	PH, FIELD (STANDARD UNITS)	01	6.87	7/8/2016	6.87	6.87	
MW-301	PH, FIELD (STANDARD UNITS)	01	7.28	10/13/2016	7.28	7.28	
MW-301	PH, FIELD (STANDARD UNITS)	01	6.63	12/29/2016	6.63	6.63	
MW-301	PH, FIELD (STANDARD UNITS)	01	7.10	1/25/2017	7.10	7.10	
MW-301	PH, FIELD (STANDARD UNITS)	01	7.11	4/11/2017	7.11	7.11	
MW-301	PH, FIELD (STANDARD UNITS)	01	6.70	6/6/2017	6.70	6.70	
MW-301	PH, FIELD (STANDARD UNITS)	01	6.75	8/8/2017	6.75	6.75	
MW-301	PH, FIELD (STANDARD UNITS)	01	7.37	10/23/2017	7.37	7.37	
MW-301	PH, FIELD (STANDARD UNITS)	01	6.76	4/25/2018	6.76	6.76	
MW-301	PH, FIELD (STANDARD UNITS)	01	6.91	8/8/2018	6.91	6.91	
MW-301	PH, FIELD (STANDARD UNITS)	01	6.79	10/24/2018	6.79	6.79	
MW-301	PH, FIELD (STANDARD UNITS)	01	6.62	4/2/2019	6.62	6.62	
MW-301	PH, FIELD (STANDARD UNITS)	01	6.67	10/9/2019	6.67	6.67	
MW-301	PH, FIELD (STANDARD UNITS)	01	6.89	2/3/2020	6.89	6.89	
MW-301	PH, FIELD (STANDARD UNITS)	01	6.73	5/29/2020	6.73	6.73	
MW-301	PH, FIELD (STANDARD UNITS)	01	6.95	10/8/2020	6.95	6.95	
MW-301	PH, FIELD (STANDARD UNITS)	01	6.66	4/14/2021	6.66	6.66	
MW-301	PH, FIELD (STANDARD UNITS)	01	7.01	10/14/2021	7.01	7.01	
MW-301	PH, FIELD (STANDARD UNITS)	01	6.60	4/13/2022	6.60	6.60	
MW-301	PH, FIELD (STANDARD UNITS)	01	6.80	10/27/2022	6.80	6.80	
MW-301	PH, FIELD (STANDARD UNITS)	01	6.84	12/2/2022	6.84	6.84	
MW-301	PH, FIELD (STANDARD UNITS)	01	6.83	1/12/2023	6.83	6.83	
MW-301	PH, FIELD (STANDARD UNITS)	01	6.71	2/21/2023	6.71	6.71	
MW-301	PH, FIELD (STANDARD UNITS)	01	6.74	3/28/2023	6.74	6.74	
MW-301	PH, FIELD (STANDARD UNITS)	01	6.65	4/27/2023	6.65	6.65	
MW-301	PH, FIELD (STANDARD UNITS)	01	6.98	5/31/2023	6.98	6.98	
MW-301	PH, FIELD (STANDARD UNITS)	01	6.94	6/30/2023	6.94	6.94	
Calculations							
Count						29	
Mean						6.85	
PAL Limit (NR 140.20(2)(a)						+/- 1	
Upper PAL, Calculated						7.85	
Lower PAL, Calculated						5.85	

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
Upper PAL, Rounded						7.9	
Lower PAL, Rounded						5.8	

Duplicate Data Not Used for Calculations							

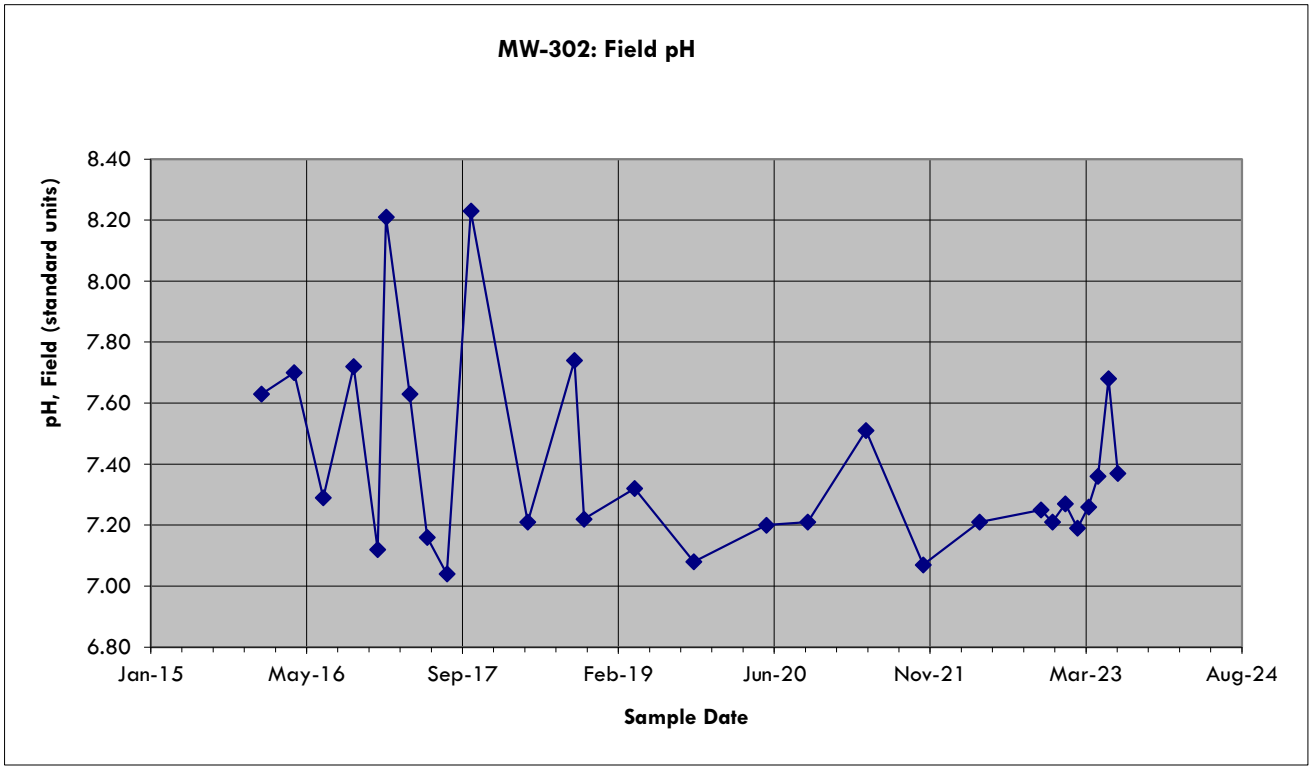
Note: Data through October 2022 downloaded from ChemPoint, later data from PacePort

J = Result is an estimated value below the laboratory's limit of quantitation.

P = Did not meet required preservation and/or hold time.

B = Compound detected in blank.

M = Failed method QC check.

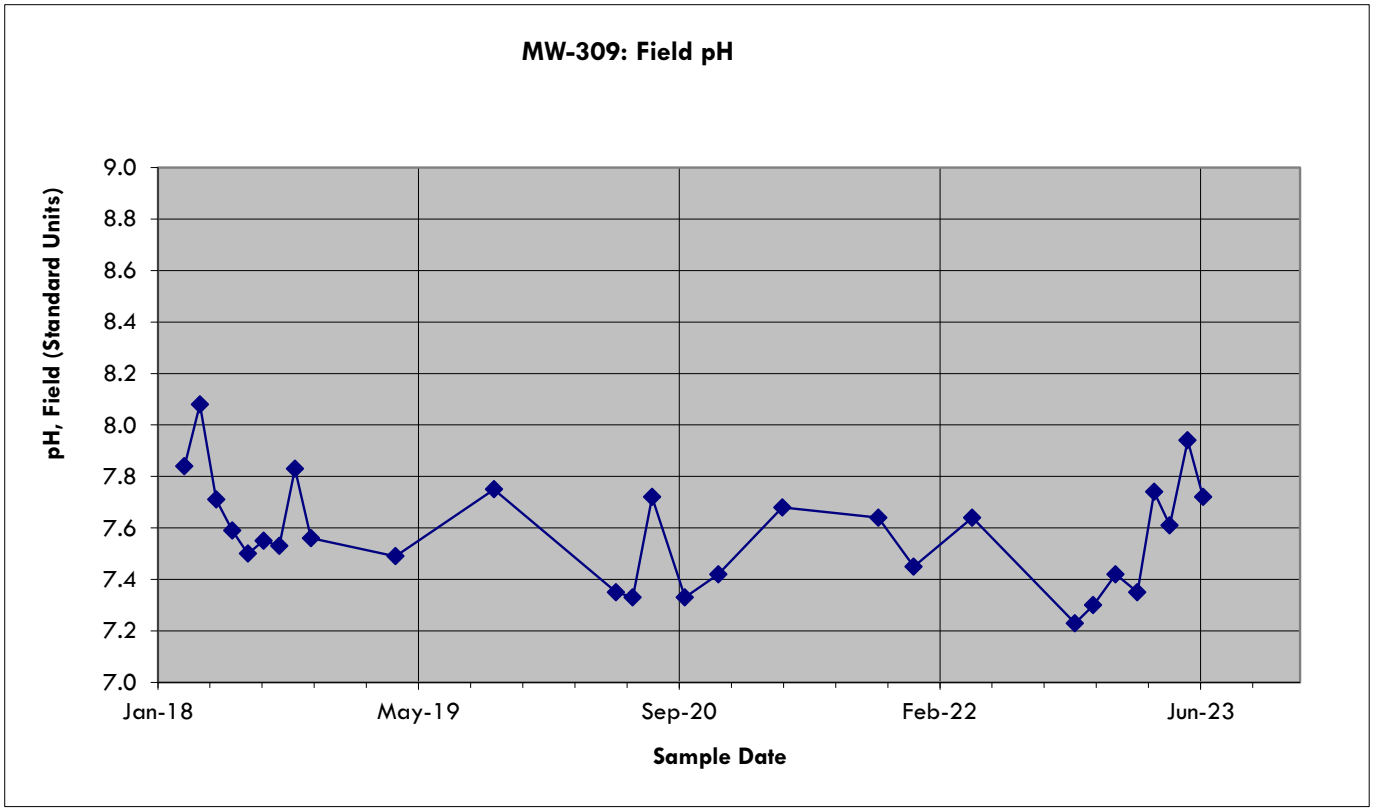


Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-302	PH, FIELD (STANDARD UNITS)	01	7.63	12/22/2015	7.63	7.63	
MW-302	PH, FIELD (STANDARD UNITS)	01	7.7	4/5/2016	7.7	7.7	
MW-302	PH, FIELD (STANDARD UNITS)	01	7.29	7/7/2016	7.29	7.29	
MW-302	PH, FIELD (STANDARD UNITS)	01	7.72	10/13/2016	7.72	7.72	
MW-302	PH, FIELD (STANDARD UNITS)	01	7.12	12/29/2016	7.12	7.12	
MW-302	PH, FIELD (STANDARD UNITS)	01	8.21	1/25/2017	8.21	8.21	
MW-302	PH, FIELD (STANDARD UNITS)	01	7.63	4/11/2017	7.63	7.63	
MW-302	PH, FIELD (STANDARD UNITS)	01	7.16	6/6/2017	7.16	7.16	
MW-302	PH, FIELD (STANDARD UNITS)	01	7.04	8/8/2017	7.04	7.04	
MW-302	PH, FIELD (STANDARD UNITS)	01	8.23	10/24/2017	8.23	8.23	
MW-302	PH, FIELD (STANDARD UNITS)	01	7.21	4/24/2018	7.21	7.21	
MW-302	PH, FIELD (STANDARD UNITS)	01	7.74	9/21/2018	7.74	7.74	
MW-302	PH, FIELD (STANDARD UNITS)	01	7.22	10/22/2018	7.22	7.22	
MW-302	PH, FIELD (STANDARD UNITS)	01	7.32	4/2/2019	7.32	7.32	
MW-302	PH, FIELD (STANDARD UNITS)	01	7.08	10/9/2019	7.08	7.08	
MW-302	PH, FIELD (STANDARD UNITS)	01	7.2	5/29/2020	7.2	7.2	
MW-302	PH, FIELD (STANDARD UNITS)	01	7.21	10/8/2020	7.21	7.21	
MW-302	PH, FIELD (STANDARD UNITS)	01	7.51	4/13/2021	7.51	7.51	
MW-302	PH, FIELD (STANDARD UNITS)	01	7.07	10/14/2021	7.07	7.07	
MW-302	PH, FIELD (STANDARD UNITS)	01	7.21	4/12/2022	7.21	7.21	
MW-302	PH, FIELD (STANDARD UNITS)	01	7.25	10/27/2022	7.25	7.25	
MW-302	PH, FIELD (STANDARD UNITS)	01	7.21	12/2/2022	7.21	7.21	
MW-302	PH, FIELD (STANDARD UNITS)	01	7.27	1/13/2023	7.27	7.27	
MW-302	PH, FIELD (STANDARD UNITS)	01	7.19	2/21/2023	7.19	7.19	
MW-302	PH, FIELD (STANDARD UNITS)	01	7.26	3/28/2023	7.26	7.26	
MW-302	PH, FIELD (STANDARD UNITS)	01	7.36	4/27/2023	7.36	7.36	
MW-302	PH, FIELD (STANDARD UNITS)	01	7.68	5/31/2023	7.68	7.68	
MW-302	PH, FIELD (STANDARD UNITS)	01	7.37	6/30/2023	7.37	7.37	
Calculations							
Count						28	
Mean						7.40	
PAL Limit (NR 140.20(2)(a)						+/- 1	
Upper PAL, Calculated						8.40	
Lower PAL, Calculated						6.40	
Upper PAL, Rounded						8.4	

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
Lower PAL, Rounded						6.3	

Duplicate Data Not Used for Calculations							

Note: Data through October 2022 downloaded from ChemPoint, later data from PacePort
J = Result is an estimated value below the laboratory's limit of quantitation.
P = Did not meet required preservation and/or hold time.
B = Compound detected in blank.
M = Failed method QC check.



Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-309	PH, FIELD (STANDARD UNITS)	01	7.84	2/21/2018	7.84	7.84	
MW-309	PH, FIELD (STANDARD UNITS)	01	8.08	3/23/2018	8.08	8.08	
MW-309	PH, FIELD (STANDARD UNITS)	01	7.71	4/23/2018	7.71	7.71	
MW-309	PH, FIELD (STANDARD UNITS)	01	7.59	5/24/2018	7.59	7.59	
MW-309	PH, FIELD (STANDARD UNITS)	01	7.5	6/23/2018	7.5	7.5	
MW-309	PH, FIELD (STANDARD UNITS)	01	7.55	7/23/2018	7.55	7.55	
MW-309	PH, FIELD (STANDARD UNITS)	01	7.53	8/22/2018	7.53	7.53	
MW-309	PH, FIELD (STANDARD UNITS)	01	7.83	9/21/2018	7.83	7.83	
MW-309	PH, FIELD (STANDARD UNITS)	01	7.56	10/22/2018	7.56	7.56	
MW-309	PH, FIELD (STANDARD UNITS)	01	7.49	4/2/2019	7.49	7.49	
MW-309	PH, FIELD (STANDARD UNITS)	01	7.75	10/8/2019	7.75	7.75	
MW-309	PH, FIELD (STANDARD UNITS)	01	7.35	5/29/2020	7.35	7.35	
MW-309	PH, FIELD (STANDARD UNITS)	01	7.33	6/30/2020	7.33	7.33	
MW-309	PH, FIELD (STANDARD UNITS)	01	7.72	8/6/2020	7.72	7.72	
MW-309	PH, FIELD (STANDARD UNITS)	01	7.33	10/8/2020	7.33	7.33	
MW-309	PH, FIELD (STANDARD UNITS)	01	7.42	12/11/2020	7.42	7.42	
MW-309	PH, FIELD (STANDARD UNITS)	01	7.68	4/13/2021	7.68	7.68	
MW-309	PH, FIELD (STANDARD UNITS)	01	7.64	10/14/2021	7.64	7.64	
MW-309	PH, FIELD (STANDARD UNITS)	01	7.45	12/21/2021	7.45	7.45	
MW-309	PH, FIELD (STANDARD UNITS)	01	7.64	4/12/2022	7.64	7.64	
MW-309	PH, FIELD (STANDARD UNITS)	01	7.23	10/26/2022	7.23	7.23	
MW-309	PH, FIELD (STANDARD UNITS)	01	7.3	11/30/2022	7.3	7.3	
MW-309	PH, FIELD (STANDARD UNITS)	01	7.42	1/12/2023	7.42	7.42	
MW-309	PH, FIELD (STANDARD UNITS)	01	7.35	2/23/2023	7.35	7.35	
MW-309	PH, FIELD (STANDARD UNITS)	01	7.74	3/27/2023	7.74	7.74	
MW-309	PH, FIELD (STANDARD UNITS)	01	7.61	4/26/2023	7.61	7.61	
MW-309	PH, FIELD (STANDARD UNITS)	01	7.94	5/30/2023	7.94	7.94	
MW-309	PH, FIELD (STANDARD UNITS)	01	7.72	6/29/2023	7.72	7.72	
Calculations							
Count						28	
Mean						7.58	
PAL Limit (NR 140.20(2)(a)						+/- 1	

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
Upper PAL, Calculated						8.58	
Lower PAL, Calculated						6.58	
Upper PAL, Rounded						8.6	
Lower PAL, Rounded						6.5	

Duplicate Data Not Used for Calculations							

Note:

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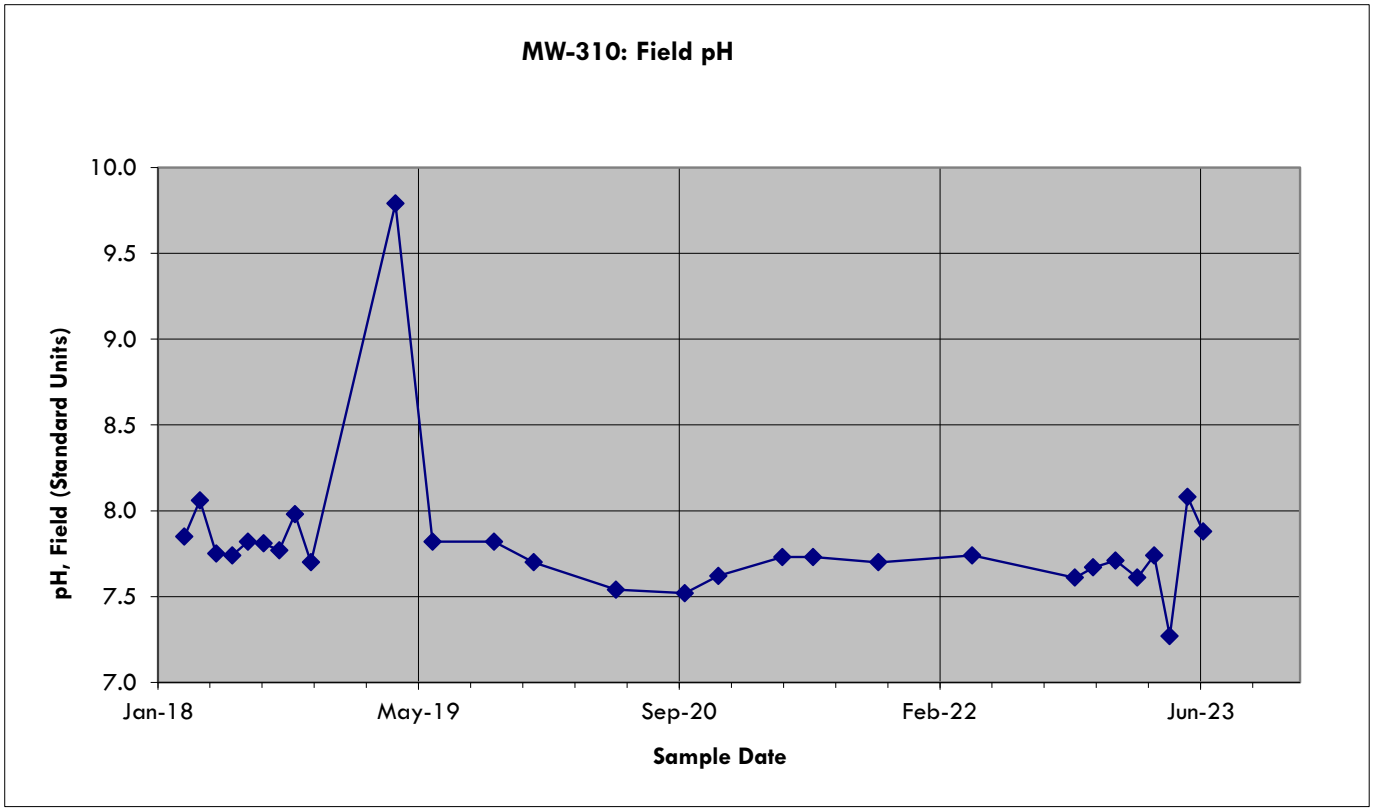
B = Compound detected in blank.

M = Failed method QC check.



Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-310	PH, FIELD (STANDARD UNITS)	01	7.85	2/21/2018	7.85	7.85	
MW-310	PH, FIELD (STANDARD UNITS)	01	8.06	3/23/2018	8.06	8.06	
MW-310	PH, FIELD (STANDARD UNITS)	01	7.75	4/23/2018	7.75	7.75	
MW-310	PH, FIELD (STANDARD UNITS)	01	7.74	5/24/2018	7.74	7.74	
MW-310	PH, FIELD (STANDARD UNITS)	01	7.82	6/23/2018	7.82	7.82	
MW-310	PH, FIELD (STANDARD UNITS)	01	7.81	7/23/2018	7.81	7.81	
MW-310	PH, FIELD (STANDARD UNITS)	01	7.77	8/22/2018	7.77	7.77	
MW-310	PH, FIELD (STANDARD UNITS)	01	7.98	9/21/2018	7.98	7.98	
MW-310	PH, FIELD (STANDARD UNITS)	01	7.70	10/22/2018	7.70	7.70	
MW-310	PH, FIELD (STANDARD UNITS)	01	9.79	4/2/2019	9.79		outlier
MW-310	PH, FIELD (STANDARD UNITS)	01	7.82	6/12/2019	7.82	7.82	
MW-310	PH, FIELD (STANDARD UNITS)	01	7.82	10/8/2019	7.82	7.82	
MW-310	PH, FIELD (STANDARD UNITS)	01	7.70	12/23/2019	7.70	7.70	
MW-310	PH, FIELD (STANDARD UNITS)	01	7.54	5/29/2020	7.54	7.54	
MW-310	PH, FIELD (STANDARD UNITS)	01	7.52	10/8/2020	7.52	7.52	
MW-310	PH, FIELD (STANDARD UNITS)	01	7.62	12/11/2020	7.62	7.62	
MW-310	PH, FIELD (STANDARD UNITS)	01	7.73	4/13/2021	7.73	7.73	
MW-311	PH, FIELD (STANDARD UNITS)	02	7.73	6/11/2021	7.73	7.73	
MW-310	PH, FIELD (STANDARD UNITS)	01	7.70	10/14/2021	7.70	7.70	
MW-310	PH, FIELD (STANDARD UNITS)	01	7.74	4/12/2022	7.74	7.74	
MW-310	PH, FIELD (STANDARD UNITS)	01	7.61	10/26/2022	7.61	7.61	
MW-310	PH, FIELD (STANDARD UNITS)	01	7.67	11/30/2022	7.67	7.67	
MW-310	PH, FIELD (STANDARD UNITS)	01	7.71	1/12/2023	7.71	7.71	
MW-310	PH, FIELD (STANDARD UNITS)	01	7.61	2/23/2023	7.61	7.61	
MW-310	PH, FIELD (STANDARD UNITS)	01	7.74	3/27/2023	7.74	7.74	
MW-310	PH, FIELD (STANDARD UNITS)	01	7.27	4/26/2023	7.27	7.27	
MW-310	PH, FIELD (STANDARD UNITS)	01	8.08	5/30/2023	8.08	8.08	
MW-310	PH, FIELD (STANDARD UNITS)	01	7.88	6/29/2023	7.88	7.88	
Calculations							
Count						27	
Mean						7.74	

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
PAL Limit (NR 140.20(2)(a)						+/- 1	
Upper PAL, Calculated						8.74	
Lower PAL, Calculated						6.74	
Upper PAL, Rounded						8.8	
Lower PAL, Rounded						6.7	

Duplicate Data Not Used for Calculations							

Note:

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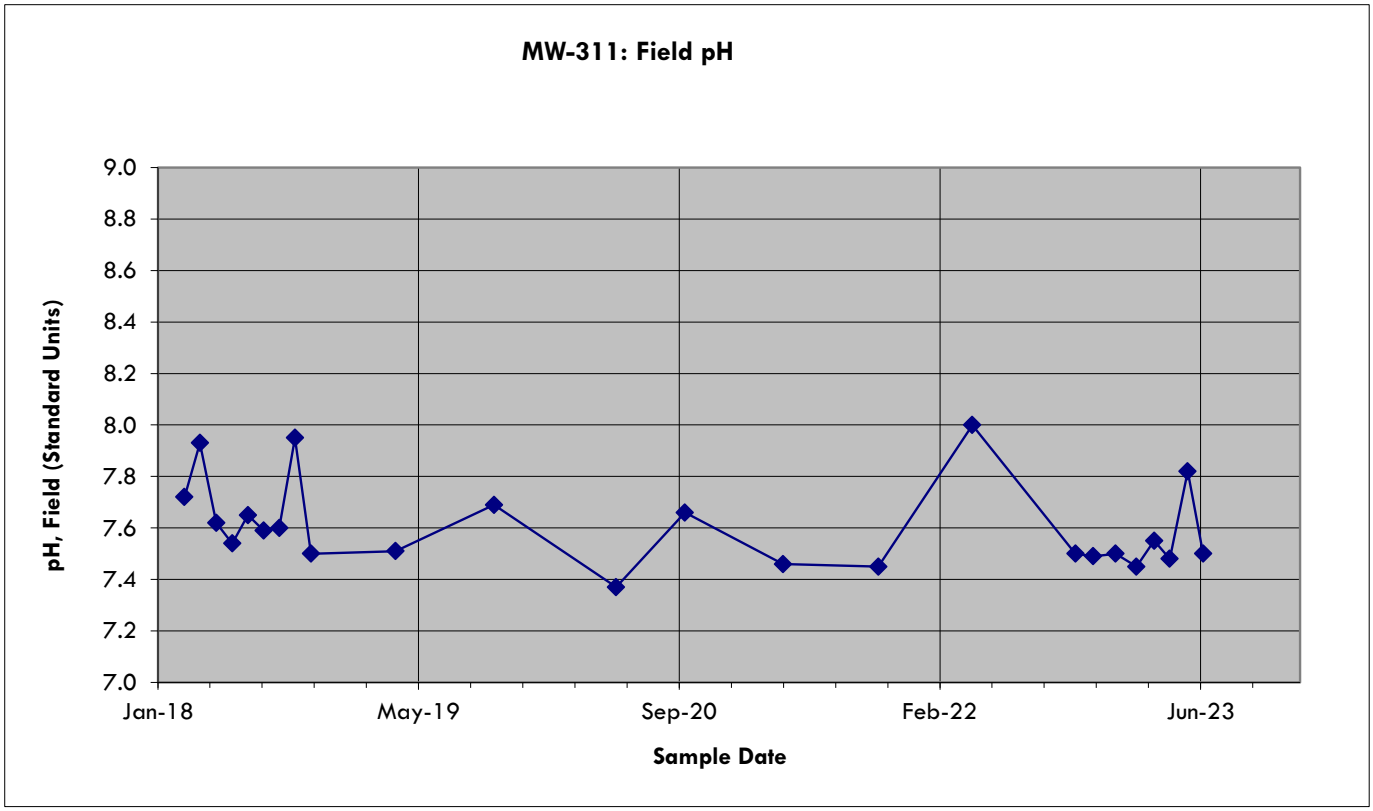
B = Compound detected in blank.

M = Failed method QC check.



Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-311	PH, FIELD (STANDARD UNITS)	01	7.72	2/21/2018	7.72	7.72	
MW-311	PH, FIELD (STANDARD UNITS)	01	7.93	3/23/2018	7.93	7.93	
MW-311	PH, FIELD (STANDARD UNITS)	01	7.62	4/23/2018	7.62	7.62	
MW-311	PH, FIELD (STANDARD UNITS)	01	7.54	5/24/2018	7.54	7.54	
MW-311	PH, FIELD (STANDARD UNITS)	01	7.65	6/23/2018	7.65	7.65	
MW-311	PH, FIELD (STANDARD UNITS)	01	7.59	7/23/2018	7.59	7.59	
MW-311	PH, FIELD (STANDARD UNITS)	01	7.60	8/22/2018	7.60	7.60	
MW-311	PH, FIELD (STANDARD UNITS)	01	7.95	9/21/2018	7.95	7.95	
MW-311	PH, FIELD (STANDARD UNITS)	01	7.50	10/22/2018	7.50	7.50	
MW-311	PH, FIELD (STANDARD UNITS)	01	7.51	4/2/2019	7.51	7.51	
MW-311	PH, FIELD (STANDARD UNITS)	01	7.69	10/8/2019	7.69	7.69	
MW-311	PH, FIELD (STANDARD UNITS)	01	7.37	5/29/2020	7.37	7.37	
MW-311	PH, FIELD (STANDARD UNITS)	01	7.66	10/8/2020	7.66	7.66	
MW-311	PH, FIELD (STANDARD UNITS)	01	7.46	4/14/2021	7.46	7.46	
MW-311	PH, FIELD (STANDARD UNITS)	01	7.45	10/14/2021	7.45	7.45	
MW-311	PH, FIELD (STANDARD UNITS)	01	8.00	4/12/2022	8.00	8.00	
MW-311	PH, FIELD (STANDARD UNITS)	01	7.50	10/27/2022	7.50	7.50	
MW-311	PH, FIELD (STANDARD UNITS)	01	7.49	11/30/2022	7.49	7.49	
MW-311	PH, FIELD (STANDARD UNITS)	01	7.50	1/12/2023	7.50	7.50	
MW-311	PH, FIELD (STANDARD UNITS)	01	7.45	2/21/2023	7.45	7.45	
MW-311	PH, FIELD (STANDARD UNITS)	01	7.55	3/27/2023	7.55	7.55	
MW-311	PH, FIELD (STANDARD UNITS)	01	7.48	4/26/2023	7.48	7.48	
MW-311	PH, FIELD (STANDARD UNITS)	01	7.82	5/30/2023	7.82	7.82	
MW-311	PH, FIELD (STANDARD UNITS)	01	7.50	6/29/2023	7.50	7.50	
Calculations							
Count						24	
Mean						7.61	
PAL Limit (NR 140.20(2)(a)						+/- 1	
Upper PAL, Calculated						8.61	
Lower PAL, Calculated						6.61	
Upper PAL, Rounded						8.7	
Lower PAL, Rounded						6.6	

09/28/2023 - Classification: Internal - ECRM13153872

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes

Duplicate Data Not Used for Calculations							

Note:

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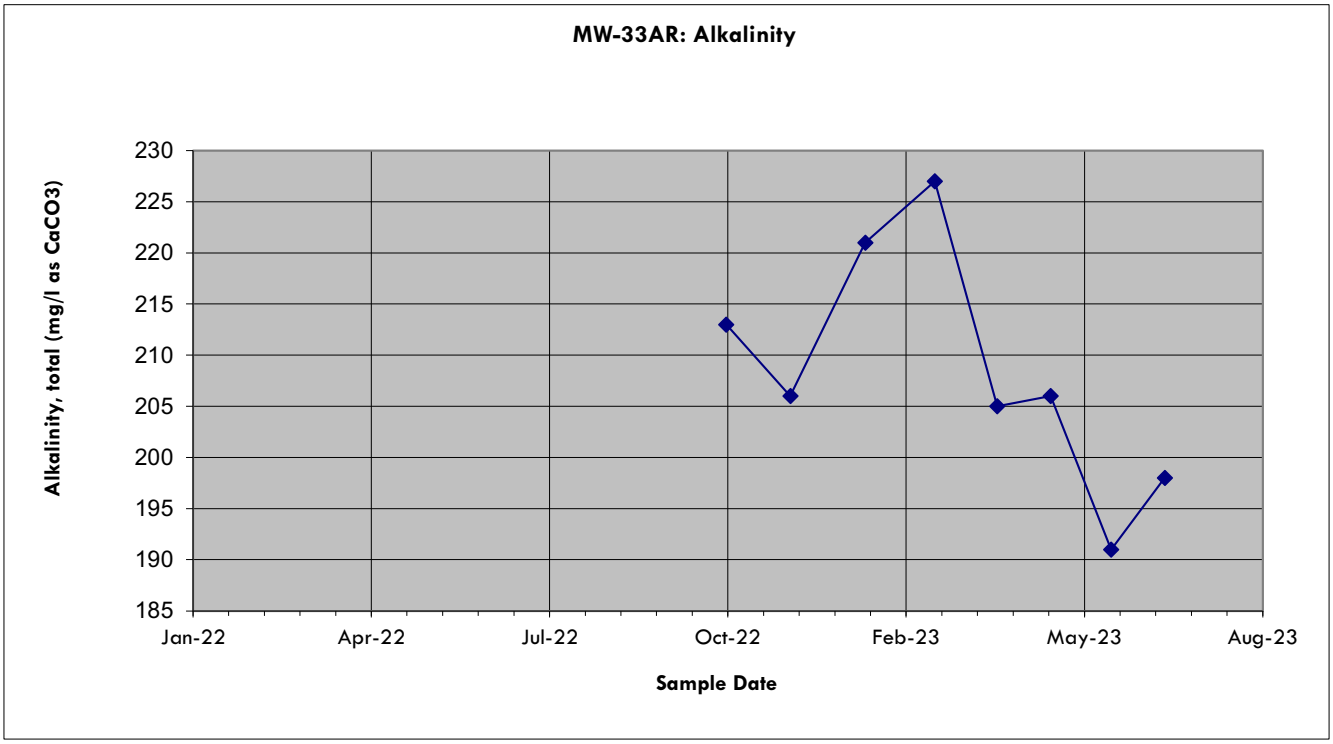
P = Did not meet required preservation and/or hold time.

B = Compound detected in blank.

M = Failed method QC check.



Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-33AR	Alkalinity, Total as CaCO3	01	213	10/27/2022	213	213	
MW-33AR	Alkalinity, Total as CaCO3	01	206	12/2/2022	206	206	
MW-33AR	Alkalinity, Total as CaCO3	01	221	1/13/2023	221	221	
MW-33AR	Alkalinity, Total as CaCO3	01	227	2/21/2023	227	227	
MW-33AR	Alkalinity, Total as CaCO3	01	205	3/28/2023	205	205	
MW-33AR	Alkalinity, Total as CaCO3	01	206	4/27/2023	206	206	
MW-33AR	Alkalinity, Total as CaCO3	01	191	5/31/2023	191	191	
MW-33AR	Alkalinity, Total as CaCO3	01	198	6/30/2023	198	198	
Calculations							
Count						8	
Mean						208.38	
Std Dev						11.71	
3 X SD (PAL)						35.13	
Min Increase (PAL)						100	
PAL, Calculated						308.38	
PAL, Rounded						310	

Duplicate Data Not Used for Calculations							

Notes: Data downloaded from PacePort

J = Result is an estimated value below the laboratory's limit of quantitation.

P = Did not meet required preservation and/or hold time.

B = Compound detected in blank.

M = Failed method QC check.

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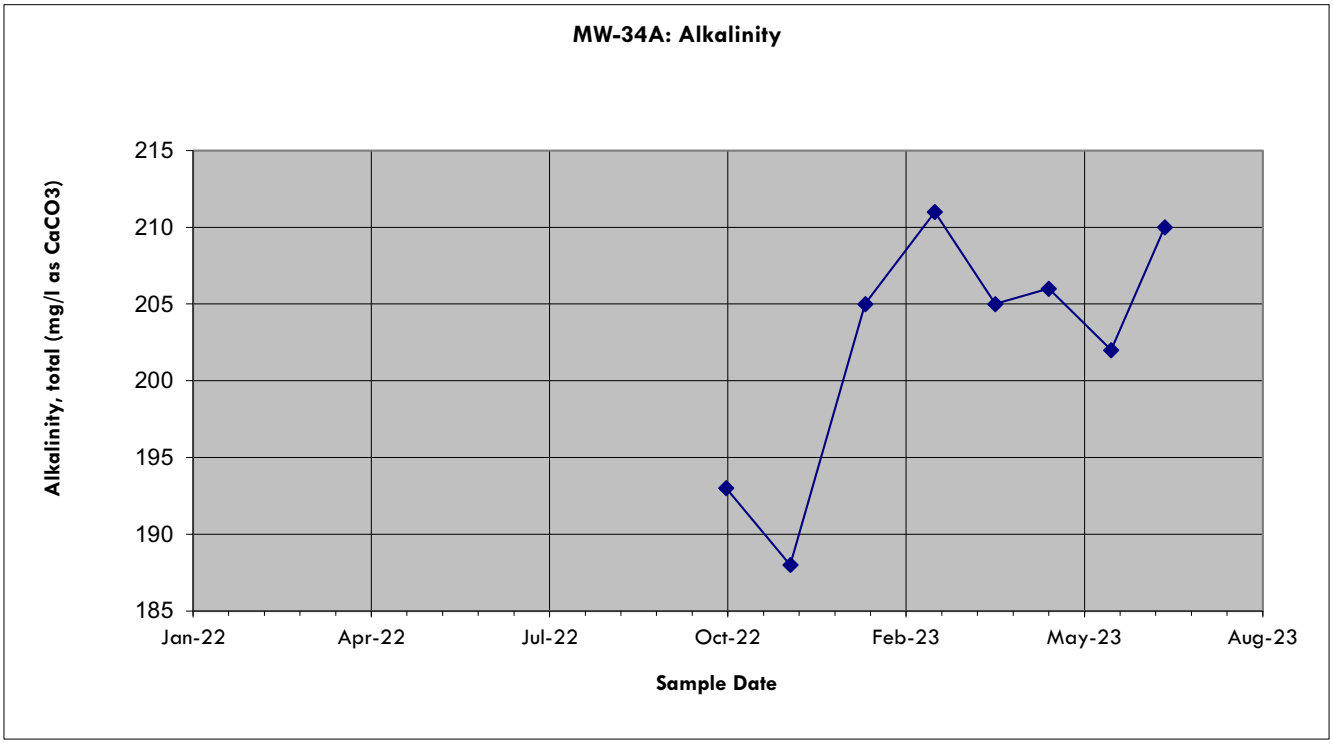
09/28/2023 - Classification: Internal - ECRM13153872



Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-34A	Alkalinity, Total as CaCO3	01	193	10/27/2022	193	193	
MW-34A	Alkalinity, Total as CaCO3	01	188	12/2/2022	188	188	
MW-34A	Alkalinity, Total as CaCO3	01	205	1/13/2023	205	205	
MW-34A	Alkalinity, Total as CaCO3	01	211	2/21/2023	211	211	
MW-34A	Alkalinity, Total as CaCO3	01	205	3/27/2023	205	205	
MW-34A	Alkalinity, Total as CaCO3	01	206	4/26/2023	206	206	
MW-34A	Alkalinity, Total as CaCO3	01	202	5/31/2023	202	202	
MW-34A	Alkalinity, Total as CaCO3	01	210	6/30/2023	210	210	
Calculations							
Count						8	
Mean						202.50	
Std Dev						8.05	
3 X SD (PAL)						24.16	
Min Increase (PAL)						100	
PAL, Calculated						302.50	
PAL, Rounded						310	

Duplicate Data Not Used for Calculations							

Notes: Data downloaded from PacePort

J = Result is an estimated value below the laboratory's limit of quantitation.

P = Did not meet required preservation and/or hold time.

B = Compound detected in blank.

M = Failed method QC check.

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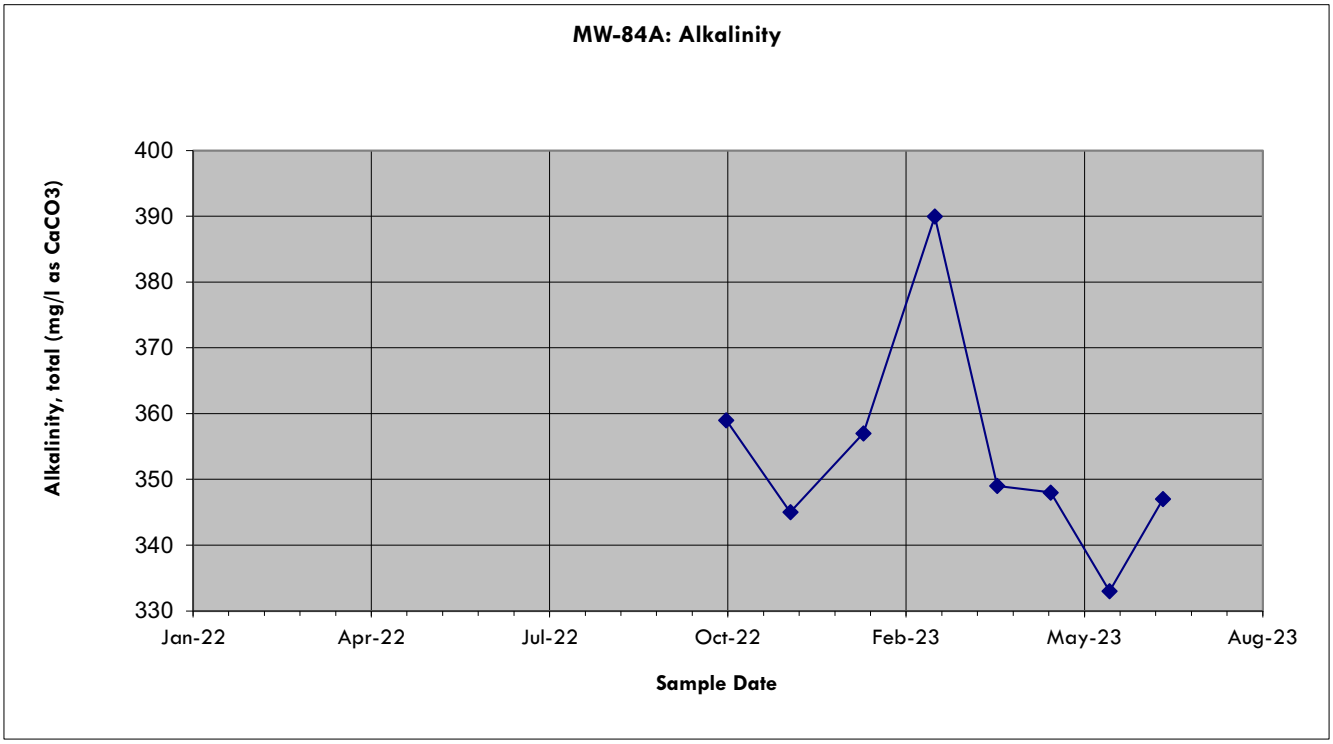

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-84A	Alkalinity, Total as CaCO3	01	359	10/27/2022	359	359	
MW-84A	Alkalinity, Total as CaCO3	01	345	12/2/2022	345	345	
MW-84A	Alkalinity, Total as CaCO3	01	357	1/12/2023	357	357	
MW-84A	Alkalinity, Total as CaCO3	01	390	2/21/2023	390	390	
MW-84A	Alkalinity, Total as CaCO3	01	349	3/28/2023	349	349	
MW-84A	Alkalinity, Total as CaCO3	01	348	4/27/2023	348	348	
MW-84A	Alkalinity, Total as CaCO3	01	333	5/30/2023	333	333	
MW-84A	Alkalinity, Total as CaCO3	01	347	6/29/2023	347	347	
Calculations							
Count						8	
Mean						353.50	
Std Dev						16.73	
3 X SD (PAL)						50.20	
Min Increase (PAL)						100	
PAL, Calculated						453.50	
PAL, Rounded						460	

Duplicate Data Not Used for Calculations							

Notes: Data downloaded from PacePort

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P = Did not meet required preservation and/or hold time.

B = Compound detected in blank.

M = Failed method QC check.

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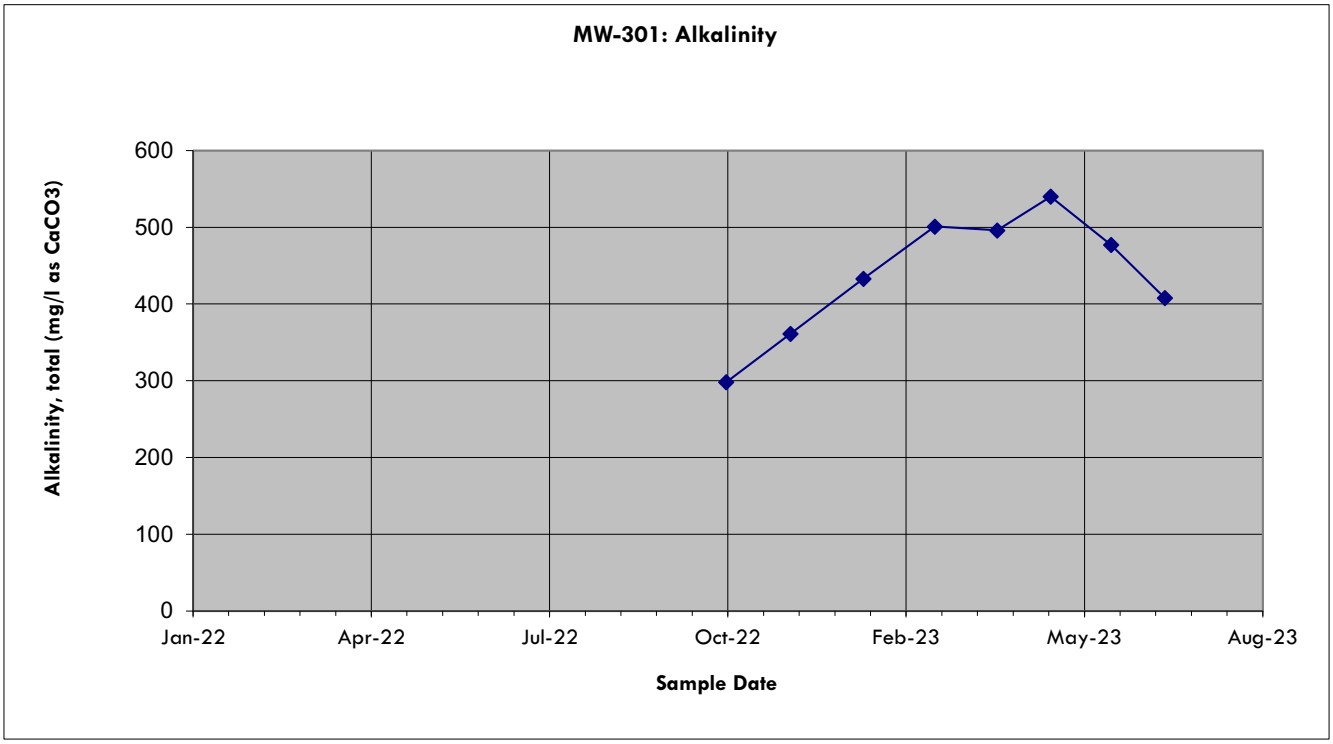

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-301	Alkalinity, Total as CaCO3	01	298	10/27/2022	298	298	
MW-301	Alkalinity, Total as CaCO3	01	361	12/2/2022	361	361	
MW-301	Alkalinity, Total as CaCO3	01	433	1/12/2023	433	433	
MW-301	Alkalinity, Total as CaCO3	01	501	2/21/2023	501	501	
MW-301	Alkalinity, Total as CaCO3	01	496	3/28/2023	496	496	
MW-301	Alkalinity, Total as CaCO3	01	540	4/27/2023	540	540	
MW-301	Alkalinity, Total as CaCO3	01	477	5/31/2023	477	477	
MW-301	Alkalinity, Total as CaCO3	01	408	6/30/2023	408	408	
Calculations							
Count						8	
Mean						439.25	
Std Dev						80.80	
3 X SD (PAL)						242.40	
Min Increase (PAL)						100	
PAL, Calculated						681.65	
PAL, Rounded						690	

Duplicate Data Not Used for Calculations							

Notes: Data downloaded from PacePort

J = Result is an estimated value below the laboratory's limit of quantitation.

P = Did not meet required preservation and/or hold time.

B = Compound detected in blank.

M = Failed method QC check.

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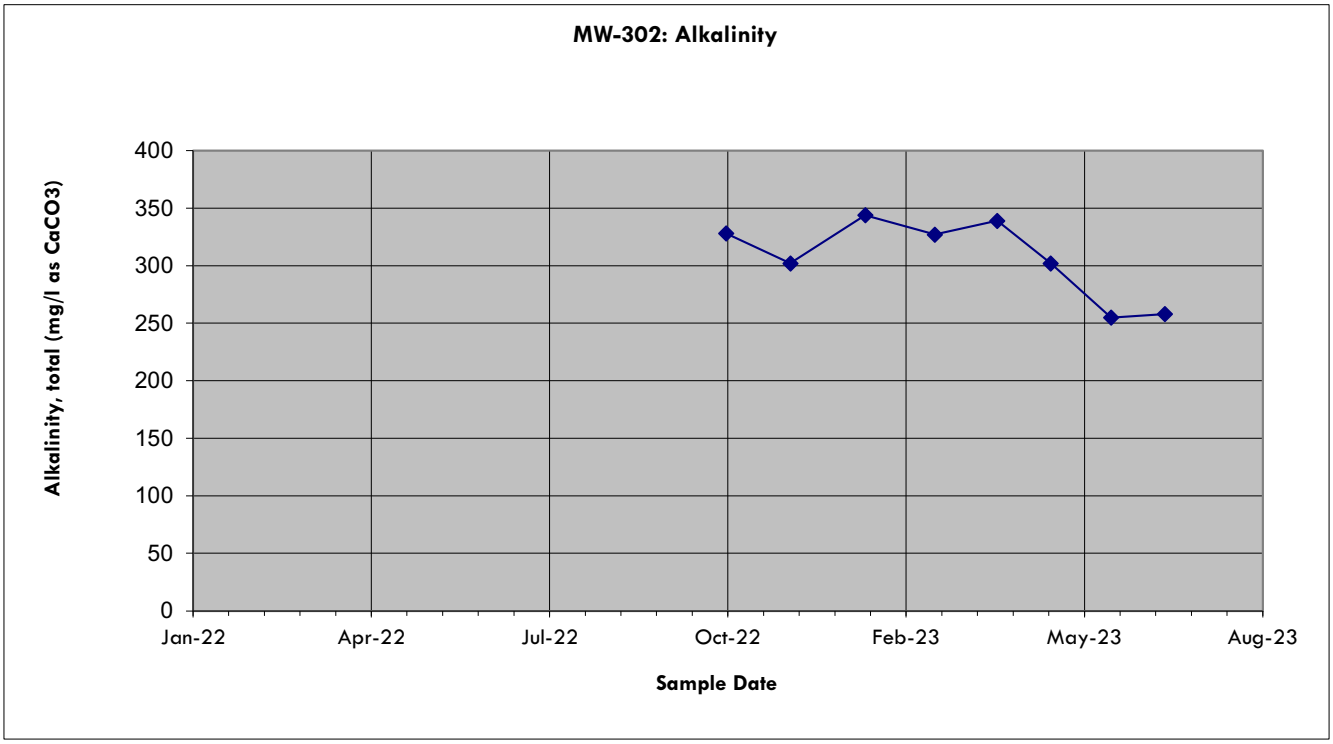


Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-302	Alkalinity, Total as CaCO3	01	328	10/27/2022	328	328	
MW-302	Alkalinity, Total as CaCO3	01	302	12/2/2022	302	302	
MW-302	Alkalinity, Total as CaCO3	01	344	1/13/2023	344	344	
MW-302	Alkalinity, Total as CaCO3	01	327	2/21/2023	327	327	
MW-302	Alkalinity, Total as CaCO3	01	339	3/28/2023	339	339	
MW-302	Alkalinity, Total as CaCO3	01	302	4/27/2023	302	302	
MW-302	Alkalinity, Total as CaCO3	01	255	5/31/2023	255	255	
MW-302	Alkalinity, Total as CaCO3	01	258	6/30/2023	258	258	
Calculations							
Count						8	
Mean						306.88	
Std Dev						34.62	
3 X SD (PAL)						103.85	
Min Increase (PAL)						100	
PAL, Calculated						410.73	
PAL, Rounded						420	

Duplicate Data Not Used for Calculations							

Notes: Data downloaded from PacePort

J = Result is an estimated value below the laboratory's limit of quantitation.

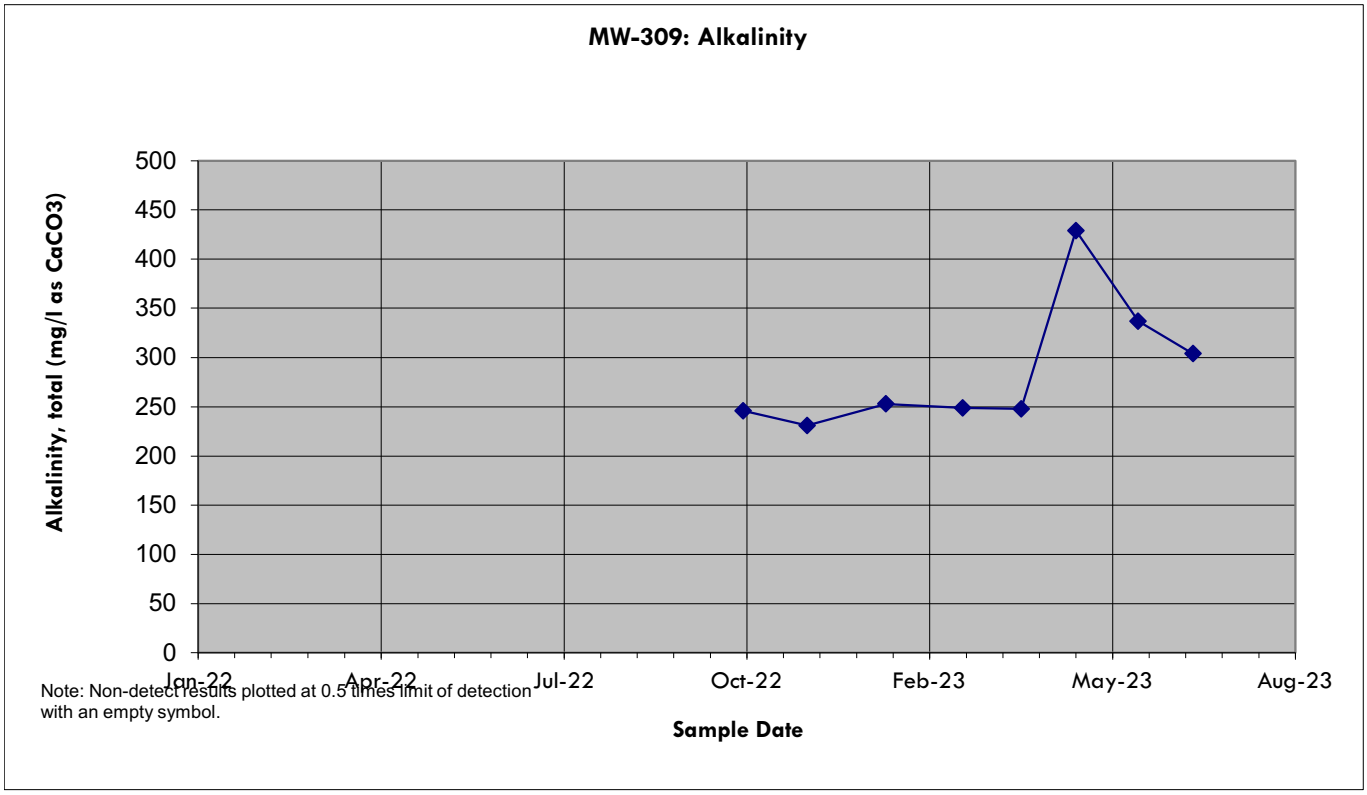
P = Did not meet required preservation and/or hold time.

B = Compound detected in blank.

M = Failed method QC check.

I:\25222260.00\Data and Calculations\Groundwater PALs ACLs\[PAL Calculations_CCR Wells Combined.xls]MW-302_Alk_PAL

09/28/2023 - Classification: Internal - ECRM13153872



Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-309	ALKALINITY, TOTAL (MG/L AS CACO3)	01	246	10/26/2022	246	246	
MW-309	ALKALINITY, TOTAL (MG/L AS CACO3)	01	231	11/30/2022	231	231	
MW-309	ALKALINITY, TOTAL (MG/L AS CACO3)	01	253	1/12/2023	253	253	
MW-309	ALKALINITY, TOTAL (MG/L AS CACO3)	01	249	2/23/2023	249	249	
MW-309	ALKALINITY, TOTAL (MG/L AS CACO3)	01	248	3/27/2023	248	248	
MW-309	ALKALINITY, TOTAL (MG/L AS CACO3)	01	429	4/26/2023	429	429	
MW-309	ALKALINITY, TOTAL (MG/L AS CACO3)	01	337	5/30/2023	337	337	
MW-309	ALKALINITY, TOTAL (MG/L AS CACO3)	01	304	6/29/2023	304	304	
Calculations							
Count						8	
Mean						287.13	
Std Dev						67.50	
3 X SD (PAL)						202.49	
Min Increase (PAL)						100	
PAL, Calculated						489.62	
PAL, Rounded						490	

Duplicate Data Not Used for Calculations							

Notes:

J = Result is an estimated value below the laboratory's limit of quantitation.

P = Did not meet required preservation and/or hold time.

B = Compound detected in blank.

M = Failed method QC check.

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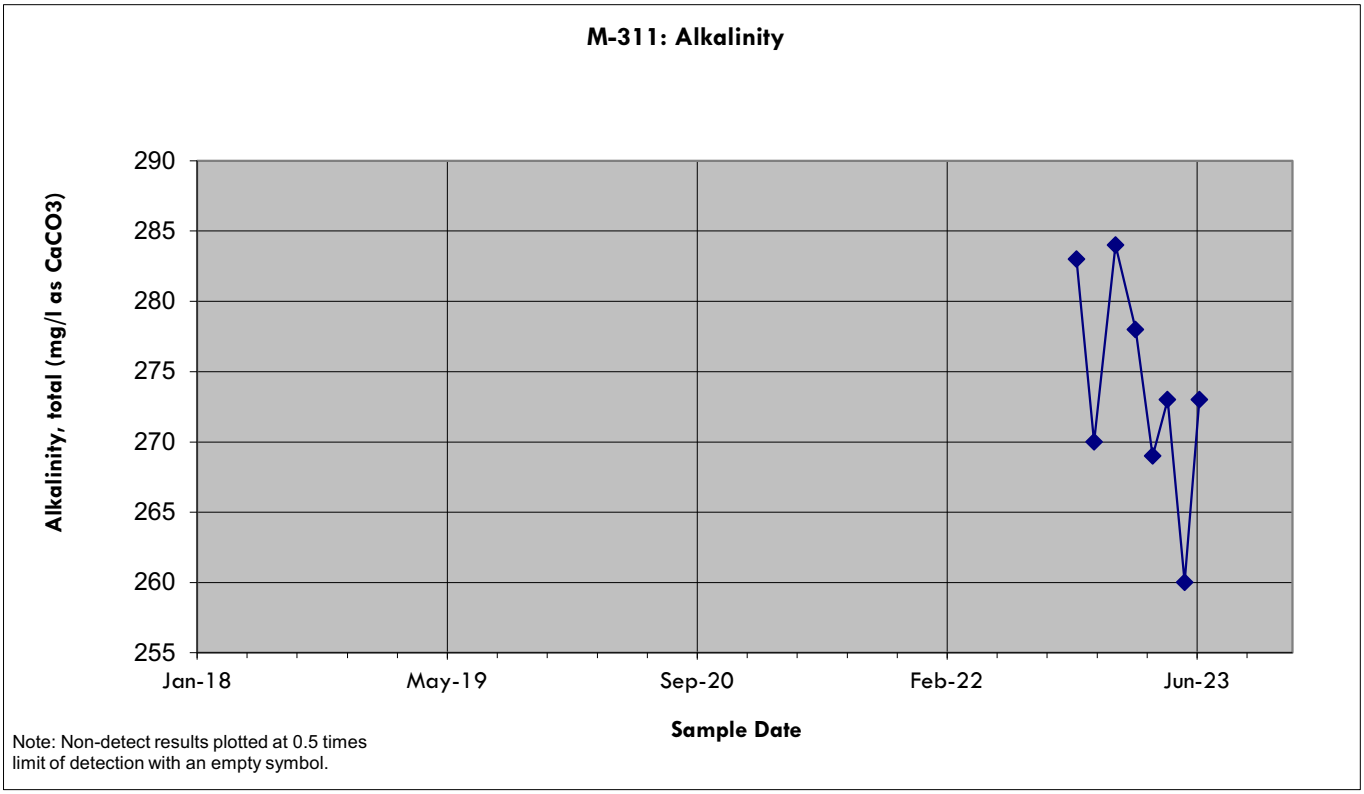
09/28/2023 - Classification: Internal - ECRM13153872



Note: Non-detect results plotted at 0.5 times limit of detection with an empty symbol.

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
M-311	ALKALINITY, TOTAL (MG/L AS CACO3)	01	283	10/26/2022	283	283	
M-311	ALKALINITY, TOTAL (MG/L AS CACO3)	01	270	11/30/2022	270	270	
M-311	ALKALINITY, TOTAL (MG/L AS CACO3)	01	284	1/12/2023	284	284	
M-311	ALKALINITY, TOTAL (MG/L AS CACO3)	01	278	2/21/2023	278	278	
M-311	ALKALINITY, TOTAL (MG/L AS CACO3)	01	269	3/27/2023	269	269	
M-311	ALKALINITY, TOTAL (MG/L AS CACO3)	01	273	4/26/2023	273	273	
M-311	ALKALINITY, TOTAL (MG/L AS CACO3)	01	260	5/30/2023	260	260	
M-311	ALKALINITY, TOTAL (MG/L AS CACO3)	01	273	6/29/2023	273	273	
Calculations							
Count						8	
Mean						273.75	
Std Dev						7.89	
3 X SD (PAL)						23.66	
Min Increase (PAL)						100	
PAL, Calculated						373.75	
PAL, Rounded						380	

Duplicate Data Not Used for Calculations							

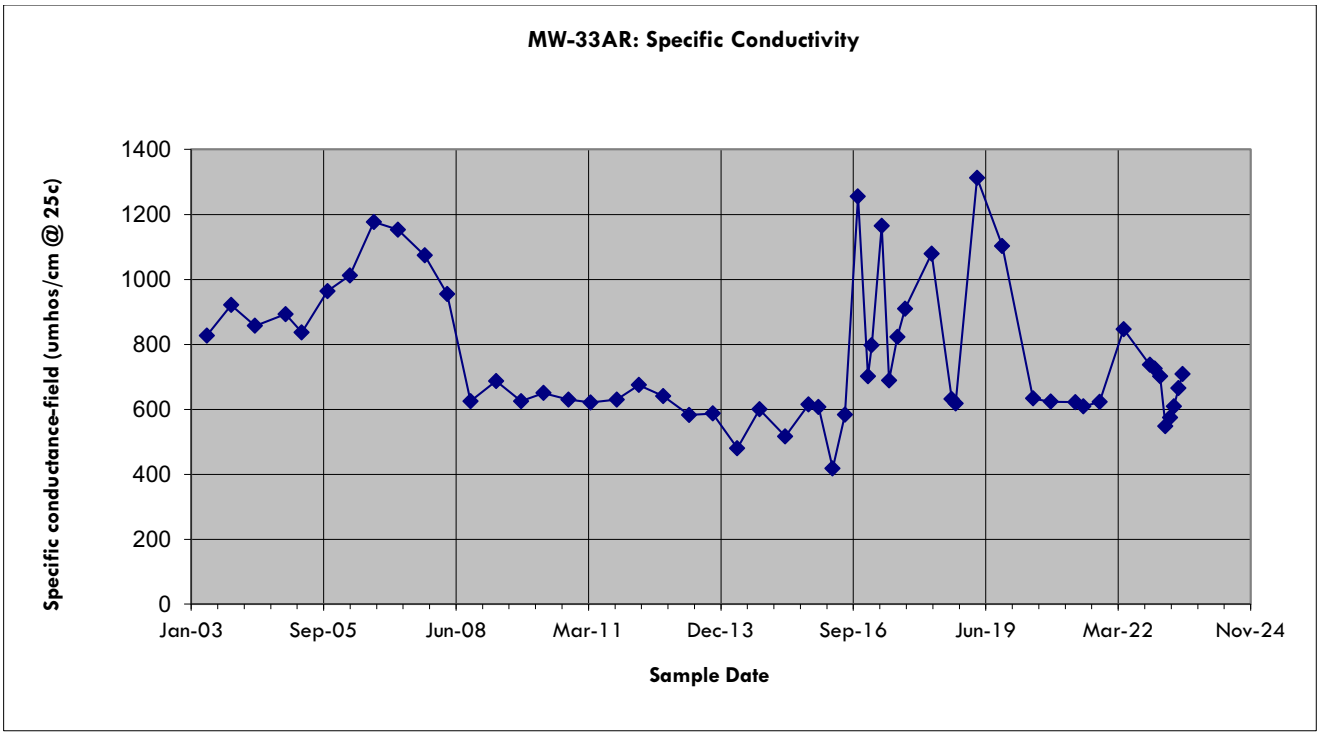
Calculated by: RM, 7/21/2023
Checked by:

Notes:

J = Result is an estimated value below the laboratory's limit of quantitation.
P = Did not meet required preservation and/or hold time.
B = Compound detected in blank.
M = Failed method QC check.

I:\25222260.00\Data and Calculations\Groundwater PALs ACLs\[PAL Calculations_CCR Wells Combined.xls]M311_Alk_PAL

09/28/2023 - Classification: Internal - ECRM13153872



Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-33AR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	827	4/29/2003	827	827	
MW-33AR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	921	10/30/2003	921	921	
MW-33AR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	857	4/27/2004	857	857	
MW-33AR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	893	12/14/2004	893	893	
MW-33AR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	837	4/15/2005	837	837	
MW-33AR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	964	10/26/2005	964	964	
MW-33AR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1012	4/13/2006	1012	1012	
MW-33AR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1177	10/12/2006	1177	1177	
MW-33AR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1153	4/11/2007	1153	1153	
MW-33AR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1074	10/31/2007	1074	1074	
MW-33AR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	955	4/17/2008	955	955	
MW-33AR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	625	10/10/2008	625	625	
MW-33AR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	687	4/21/2009	687	687	
MW-33AR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	625	10/27/2009	625	625	
MW-33AR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	650	4/14/2010	650	650	
MW-33AR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	630	10/20/2010	630	630	
MW-33AR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	621	4/6/2011	621	621	
MW-33AR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	630	10/20/2011	630	630	
MW-33AR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	675	4/4/2012	675	675	
MW-33AR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	641	10/4/2012	641	641	
MW-33AR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	583	4/17/2013	583	583	
MW-33AR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	587	10/14/2013	587	587	
MW-33AR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	480	4/16/2014	480	480	
MW-33AR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	600	10/2/2014	600	600	
MW-33AR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	517	4/14/2015	517	517	
MW-33AR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	615	10/7/2015	615	615	
MW-33AR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	607	12/21/2015	607	607	
MW-33AR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	417.6	4/5/2016	417.6	417.6	
MW-33AR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	583.4	7/7/2016	583.4	583.4	
MW-33AR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1255	10/13/2016	1255		*
MW-33AR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	702	12/29/2016	702	702	
MW-33AR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	797	1/25/2017	797	797	
MW-33AR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1165	4/11/2017	1165		*
MW-33AR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	689	6/6/2017	689	689	
MW-33AR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	823	8/7/2017	823	823	
MW-33AR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	910	10/4/2017	910	910	
MW-33AR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1079	4/24/2018	1079	1079	
MW-33AR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	632	9/21/2018	632	632	
MW-33AR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	618.4	10/22/2018	618.4	618.4	
MW-33AR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1312	4/2/2019	1312	1312	

09/28/2023 - Classification: Internal - ECRM13153872

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-33AR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1103	10/8/2019	1103	1103	
MW-33AR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	633.4	5/28/2020	633.4	633.4	
MW-33AR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	623.5	10/8/2020	623.5	623.5	
MW-33AR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	622	4/13/2021	622	622	
MW-33AR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	609	6/11/2021	609	609	
MW-33AR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	623.2	10/12/2021	623.2	623.2	
MW-33AR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	847	4/12/2022	847	847	
MW-33AR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	737	10/27/2022	737	737	
MW-33AR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	725	12/2/2022	725	725	
MW-33AR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	702	1/13/2023	702	702	
MW-33AR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	547.8	2/21/2023	547.8	547.8	
MW-33AR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	574.5	3/28/2023	574.5	574.5	
MW-33AR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	609.3	4/27/2023	609.3	609.3	
MW-33AR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	665	5/31/2023	665	665	
MW-33AR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	709	6/30/2023	709	709	
Calculations							
Count						53	
Mean						742.21	
Std Dev						195.17	
3 X SD (PAL)						585.51	
Min Increase (PAL)						200	
PAL, Calculated						1327.72	
PAL, Rounded						1,400	

Duplicate Data Not Used for Calculations							

Notes: Data for all events through October 2022 downloaded from GEMS

*: Readings from October 2016 and April 2017 not included in calculations due to an apparent meter issue.

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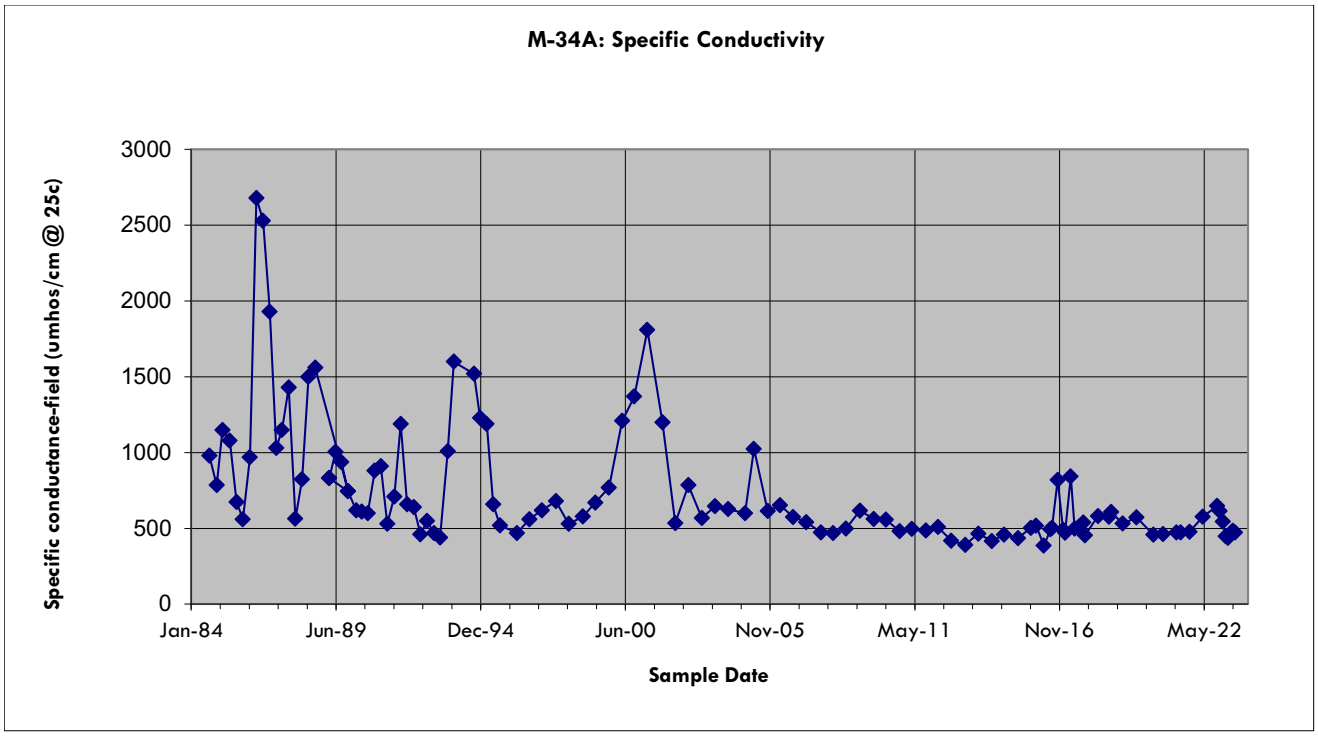

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	980	9/7/1984	980		
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	785	12/17/1984	785		
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1150	3/7/1985	1150		
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1080	6/14/1985	1080		
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	675	9/18/1985	675		
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	560	12/12/1985	560		
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	970	3/21/1986	970		
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	2680	6/20/1986	2680		
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	2530	9/18/1986	2530		
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1930	12/19/1986	1930		
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1030	3/20/1987	1030		
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1150	6/5/1987	1150		
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1430	9/9/1987	1430		
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	565	12/9/1987	565		
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	825	3/10/1988	825		
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1500	6/7/1988	1500		
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1560	9/9/1988	1560		
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	745	12/7/1989	745		
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	832	3/21/1989	832		
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	832	3/22/1989	832		
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1005	6/16/1989	1005		
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	937	9/6/1989	937		
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	746	12/5/1989	746		
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	620	3/29/1990	620		
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	610	6/14/1990	610		
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	600	9/5/1990	600		
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	880	12/10/1990	880		
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	910	3/5/1991	910		
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	530	6/3/1991	530		
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	710	9/6/1991	710		
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1190	12/4/1991	1190		
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	660	3/3/1992	660		
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	640	6/2/1992	640		
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	460	9/1/1992	460		
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	550	12/2/1992	550		
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	470	3/10/1993	470		
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	440	6/2/1993	440		
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1010	9/14/1993	1010		
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1600	12/7/1993	1600		

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1520	9/13/1994	1520		
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1230	12/6/1994	1230		
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1190	3/7/1995	1190		
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	660	6/6/1995	660		
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	520	9/6/1995	520		
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	470	4/30/1996	470		
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	560	10/16/1996	560		
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	620	4/8/1997	620		
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	680	10/20/1997	680		
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	530	4/14/1998	530		
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	580	10/27/1998	580		
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	670	4/16/1999	670		
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	770	10/21/1999	770		
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1210	4/20/2000	1210		
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1370	10/4/2000	1370		
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1809	4/3/2001	1809		
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1199	10/30/2001	1199		
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	535	4/25/2002	535		
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	785	10/24/2002	785		
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	569	4/29/2003	569	569	Using last 20 years of data for PAL calculation
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	647	10/29/2003	647	647	
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	627	4/27/2004	627	627	
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	601	12/14/2004	601	601	
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1025	4/15/2005	1025	1025	
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	614	10/26/2005	614	614	
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	652	4/13/2006	652	652	
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	575	10/12/2006	575	575	
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	541	4/11/2007	541	541	
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	473	10/31/2007	473	473	
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	470	4/17/2008	470	470	
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	499	10/10/2008	499	499	
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	617	4/21/2009	617	617	
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	562	10/27/2009	562	562	
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	559	4/14/2010	559	559	
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	483	10/20/2010	483	483	
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	496	4/6/2011	496	496	
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	487	10/20/2011	487	487	
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	509	4/4/2012	509	509	
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	419	10/4/2012	419	419	
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	391	4/16/2013	391	391	
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	466	10/14/2013	466	466	
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	417	4/16/2014	417	417	
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	459	10/2/2014	459	459	
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	436	4/14/2015	436	436	
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	504	10/7/2015	504	504	
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	517	12/21/2015	517	517	
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	386.9	4/5/2016	386.9	386.9	
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	494.3	7/7/2016	494.3	494.3	
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	503.6	7/28/2016	503.6	503.6	
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	819	10/13/2016	819		*
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	490	12/29/2016	490	490	
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	470.9	1/25/2017	470.9	470.9	
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	843	4/11/2017	843		*
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	499.1	6/6/2017	499.1	499.1	
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	510.6	8/7/2017	510.6	510.6	
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	539.5	10/4/2017	539.5	539.5	
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	454	10/24/2017	454	454	
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	581.4	4/24/2018	581.4	581.4	
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	578	9/21/2018	578	578	
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	607.7	10/22/2018	607.7	607.7	
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	531.7	4/2/2019	531.7	531.7	
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	573	10/8/2019	573	573	
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	459	5/29/2020	459	459	
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	464	10/8/2020	464	464	
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	472.6	4/13/2021	472.6	472.6	
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	472.7	6/11/2021	472.7	472.7	
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	478.1	10/12/2021	478.1	478.1	

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	577	4/12/2022	577	577	
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	648	10/27/2022	648	648	
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	614.3	12/2/2022	614.3	614.3	
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	545.7	1/13/2023	545.7	545.7	
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	447.9	2/21/2023	447.9	447.9	
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	438.7	3/27/2023	438.7	438.7	
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	465.8	4/26/2023	465.8	465.8	
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	483.5	5/31/2023	483.5	483.5	
MW34A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	474.3	6/30/2023	474.3	474.3	
Calculations							
Count						55	
Mean						525.04	
Std Dev						96.01	
3 X SD (PAL)						288.02	
Min Increase (PAL)						200	
PAL, Calculated						813.06	
PAL, Rounded						820	

Duplicate Data Not Used for Calculations							

Note: Data downloaded from GEMS

*: Readings from October 2016 and April 2017 not included in calculations due to an apparent meter issue.

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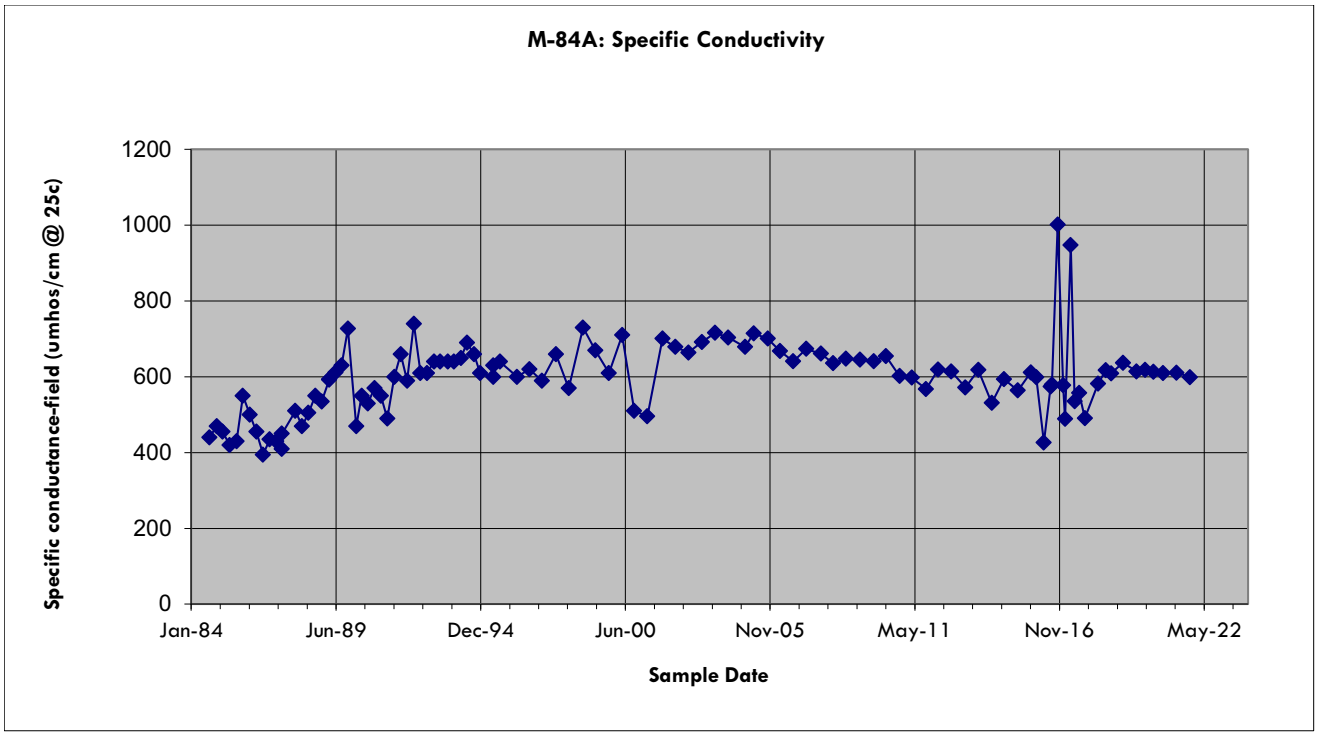

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	440	9/7/1984	440	440	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	470	12/17/1984	470	470	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	455	3/7/1985	455	455	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	420	6/14/1985	420	420	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	430	9/18/1985	430	430	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	550	12/12/1985	550	550	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	500	3/21/1986	500	500	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	455	6/20/1986	455	455	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	395	9/18/1986	395	395	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	435	12/19/1986	435	435	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	430	3/20/1987	430	430	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	410	6/5/1987	410	410	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	450	6/6/1987	450	450	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	510	12/9/1987	510	510	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	470	3/10/1988	470	470	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	505	6/7/1988	505	505	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	550	9/9/1988	550	550	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	535	12/7/1988	535	535	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	593	3/21/1989	593	593	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	593	3/22/1989	593	593	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	612	6/16/1989	612	612	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	630	9/7/1989	630	630	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	727	12/6/1989	727	727	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	470	3/29/1990	470	470	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	550	6/14/1990	550	550	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	530	9/6/1990	530	530	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	570	12/7/1990	570	570	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	550	3/6/1991	550	550	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	490	6/3/1991	490	490	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	600	9/6/1991	600	600	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	660	12/5/1991	660	660	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	590	3/2/1992	590	590	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	740	6/2/1992	740	740	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	610	9/2/1992	610	610	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	610	12/2/1992	610	610	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	640	3/10/1993	640	640	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	640	6/3/1993	640	640	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	640	9/14/1993	640	640	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	640	12/7/1993	640	640	

09/28/2023 - Classification: Internal - ECRM13153872

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	650	3/15/1994	650	650	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	690	6/7/1994	690	690	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	660	9/13/1994	660	660	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	610	12/6/1994	610	610	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	600	6/5/1995	600	600	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	630	6/5/1995	630	630	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	640	9/5/1995	640	640	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	600	4/29/1996	600	600	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	620	10/17/1996	620	620	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	590	4/8/1997	590	590	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	660	10/20/1997	660	660	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	570	4/14/1998	570	570	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	730	10/27/1998	730	730	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	670	4/16/1999	670	670	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	610	10/21/1999	610	610	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	710	4/20/2000	710	710	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	510	10/4/2000	510	510	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	496	4/3/2001	496	496	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	701	10/30/2001	701	701	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	679	4/25/2002	679	679	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	664	10/25/2002	664	664	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	692	4/28/2003	692	692	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	716	10/29/2003	716	716	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	704	4/27/2004	704	704	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	679	12/14/2004	679	679	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	715	4/14/2005	715	715	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	701	10/26/2005	701	701	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	668	4/13/2006	668	668	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	641	10/12/2006	641	641	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	674	4/10/2007	674	674	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	661	10/30/2007	661	661	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	636	4/17/2008	636	636	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	648	10/10/2008	648	648	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	645	4/22/2009	645	645	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	641	10/27/2009	641	641	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	655	4/14/2010	655	655	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	602	10/20/2010	602	602	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	598	4/6/2011	598	598	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	568	10/21/2011	568	568	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	619	4/4/2012	619	619	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	614	10/4/2012	614	614	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	572	4/17/2013	572	572	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	618	10/14/2013	618	618	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	531	4/17/2014	531	531	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	594	10/2/2014	594	594	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	564	4/13/2015	564	564	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	612	10/8/2015	612	612	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	599	12/22/2015	599	599	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	427	4/5/2016	427	427	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	574.8	7/8/2016	574.8	574.8	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	579.3	7/28/2016	579.3	579.3	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1002	10/13/2016	1002		*
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	578.2	12/29/2016	578.2	578.2	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	489	1/25/2017	489	489	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	948	4/11/2017	948		*
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	535.3	6/6/2017	535.3	535.3	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	557.2	8/8/2017	557.2	557.2	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	491	10/24/2017	491	491	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	581.7	4/25/2018	581.7	581.7	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	617.1	8/8/2018	617.1	617.1	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	609	10/24/2018	609	609	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	637.2	4/3/2019	637.2	637.2	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	614.1	10/9/2019	614.1	614.1	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	618.4	2/3/2020	618.4	618.4	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	613.7	5/29/2020	613.7	613.7	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	610.1	10/8/2020	610.1	610.1	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	610.9	4/14/2021	610.9	610.9	

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	598.9	10/14/2021	598.9	598.9	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	600	4/13/2022	600	600	
MW84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	585.2	10/27/2022	585.2	585.2	
MW-84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	595.4	12/2/2022	595.4	595.4	
MW-84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	582.9	1/12/2023	582.9	582.9	
MW-84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	516.1	2/21/2023	516.1	516.1	
MW-84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	578.4	3/28/2023	578.4	578.4	
MW-84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	556.6	4/27/2023	556.6	556.6	
MW-84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	507.9	5/30/2023	507.9	507.9	
MW-84A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	580	6/29/2023	580	580	
Calculations							
Count						114	
Mean						587.70	
Std Dev						78.79	
3 X SD (PAL)						236.38	
Min Increase (PAL)						200	
PAL, Calculated						824.07	
PAL, Rounded						830	

Duplicate Data Not Used for Calculations							

Note: Data for all events through October 2022 downloaded from GEMS

*: Readings from October 2016 and April 2017 not included in calculations due to an apparent meter issue.

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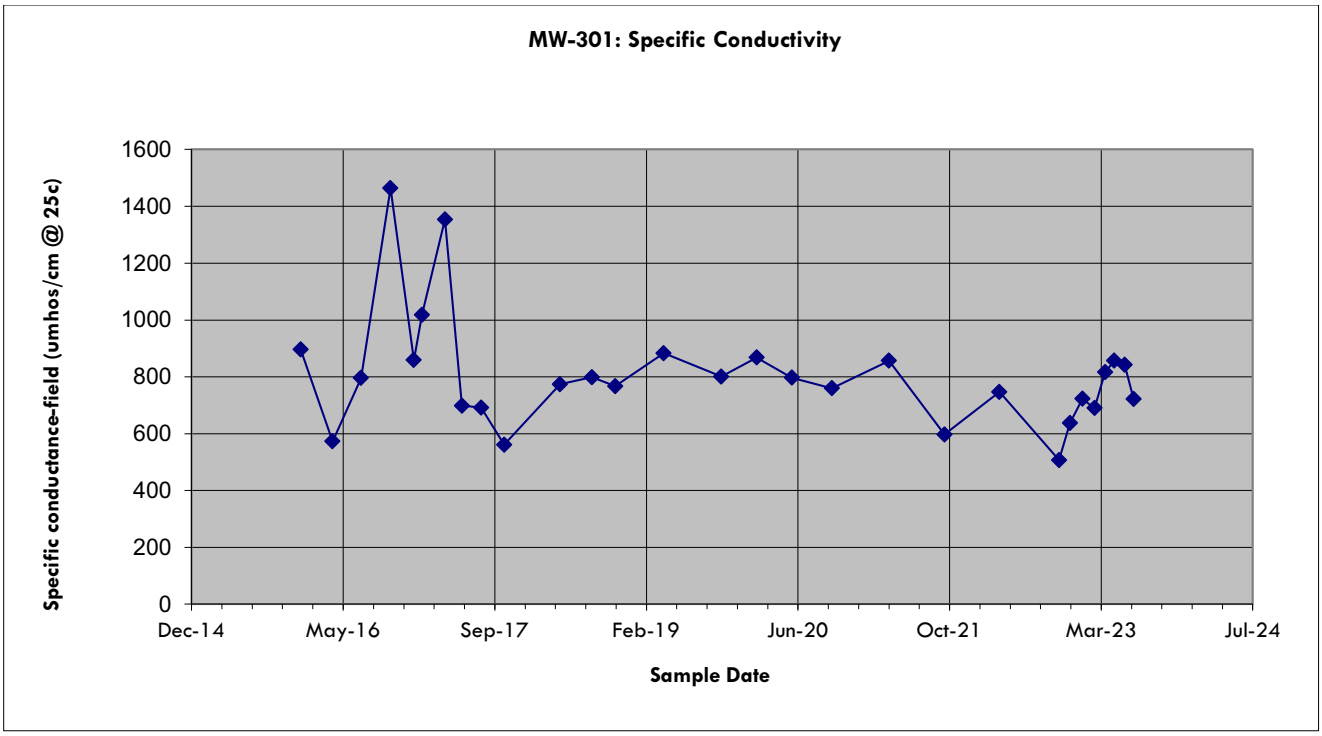

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-301	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	897	12/22/2015	897	897	
MW-301	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	573	4/5/2016	573	573	
MW-301	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	796	7/8/2016	796	796	
MW-301	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1464	10/13/2016	1464		*
MW-301	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	859	12/29/2016	859	859	
MW-301	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1018	1/25/2017	1018	1018	
MW-301	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1354	4/11/2017	1354		*
MW-301	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	698.4	6/6/2017	698.4	698.4	
MW-301	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	691.7	8/8/2017	691.7	691.7	
MW-301	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	561	10/23/2017	561	561	
MW-301	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	774	4/25/2018	774	774	
MW-301	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	799	8/8/2018	799	799	
MW-301	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	767	10/24/2018	767	767	
MW-301	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	883	4/2/2019	883	883	
MW-301	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	801	10/9/2019	801	801	
MW-301	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	868	2/3/2020	868	868	
MW-301	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	797	5/29/2020	797	797	
MW-301	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	760	10/8/2020	760	760	
MW-301	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	857	4/14/2021	857	857	
MW-301	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	597.2	10/14/2021	597.2	597.2	
MW-301	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	747	4/13/2022	747	747	
MW-301	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	507.5	10/27/2022	507.5	507.5	
MW-301	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	637.3	12/2/2022	637.3	637.3	
MW-301	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	723	1/12/2023	723	723	
MW-301	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	690	2/21/2023	690	690	
MW-301	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	817	3/28/2023	817	817	
MW-301	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	857	4/27/2023	857	857	
MW-301	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	843	5/31/2023	843	843	
MW-301	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	722	6/30/2023	722	722	
Calculations							
Count						27	
Mean						760.78	
Std Dev						116.55	
3 X SD (PAL)						349.66	
Min Increase (PAL)						200	
PAL, Calculated						1110.44	
PAL, Rounded						1,200	

09/28/2023 - Classification: Internal - ECRM13153872

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
Duplicate Data Not Used for Calculations							

Note: Data from Chempoint and PacePort

*: Readings from October 2016 and April 2017 not included in calculations due to an apparent meter issue.

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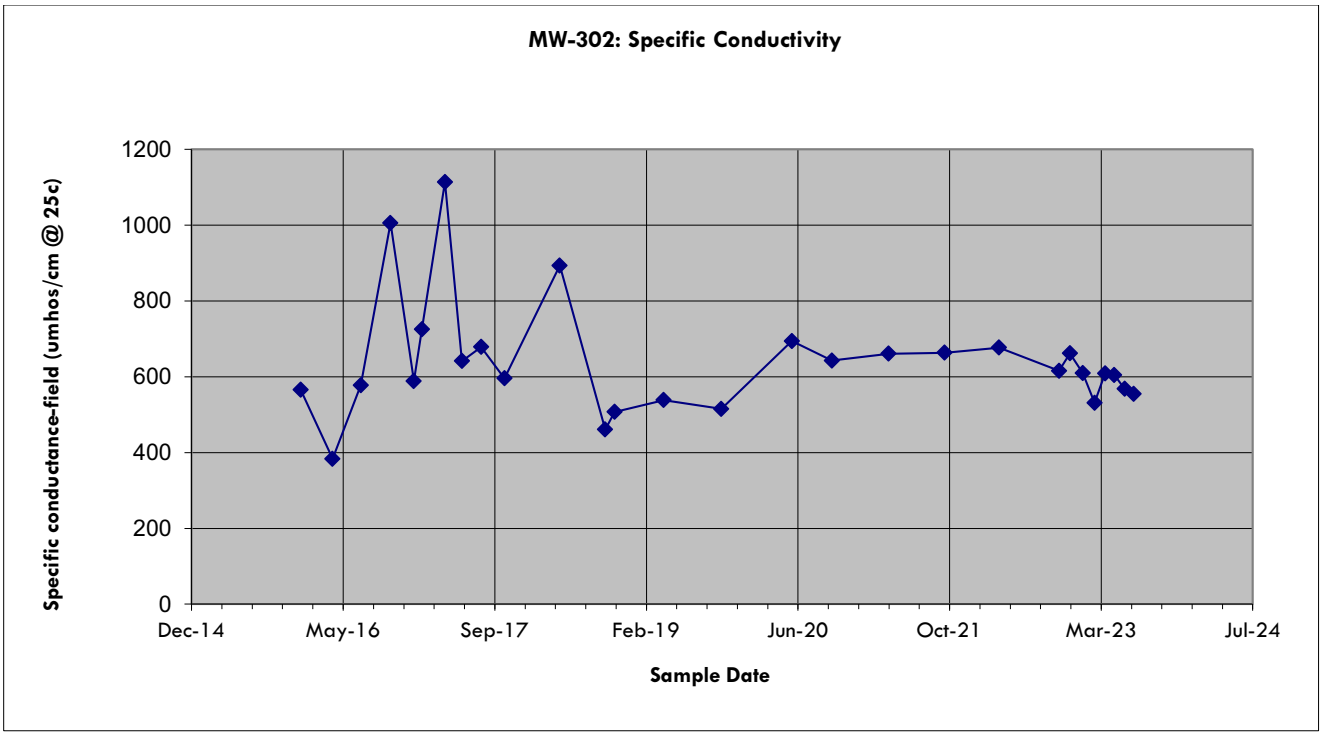


Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-302	Field Specific Conductivity	01	566	12/22/2015	566	566	
MW-302	Field Specific Conductivity	01	383.6	4/5/2016	383.6	383.6	
MW-302	Field Specific Conductivity	01	578	7/7/2016	578	578	
MW-302	Field Specific Conductivity	01	1006	10/13/2016	1006		*
MW-302	Field Specific Conductivity	01	588.9	12/29/2016	588.9	588.9	
MW-302	Field Specific Conductivity	01	726	1/25/2017	726	726	
MW-302	Field Specific Conductivity	01	1114	4/11/2017	1114		*
MW-302	Field Specific Conductivity	01	641.8	6/6/2017	641.8	641.8	
MW-302	Field Specific Conductivity	01	679	8/8/2017	679	679	
MW-302	Field Specific Conductivity	01	596	10/24/2017	596	596	
MW-302	Field Specific Conductivity	01	894	4/24/2018	894	894	
MW-302	Field Specific Conductivity	01	461	9/21/2018	461	461	
MW-302	Field Specific Conductivity	01	507.6	10/22/2018	507.6	507.6	
MW-302	Field Specific Conductivity	01	538.6	4/2/2019	538.6	538.6	
MW-302	Field Specific Conductivity	01	515.4	10/9/2019	515.4	515.4	
MW-302	Field Specific Conductivity	01	694.7	5/29/2020	694.7	694.7	
MW-302	Field Specific Conductivity	01	643.1	10/8/2020	643.1	643.1	
MW-302	Field Specific Conductivity	01	661.3	4/13/2021	661.3	661.3	
MW-302	Field Specific Conductivity	01	663.7	10/14/2021	663.7	663.7	
MW-302	Field Specific Conductivity	01	677.1	4/12/2022	677.1	677.1	
MW-302	Field Specific Conductivity	01	616.1	10/27/2022	616.1	616.1	
MW-302	Field Specific Conductivity	01	662	12/2/2022	662	662	
MW-302	Field Specific Conductivity	01	610.1	1/13/2023	610.1	610.1	
MW-302	Field Specific Conductivity	01	531.8	2/21/2023	531.8	531.8	
MW-302	Field Specific Conductivity	01	609.4	3/28/2023	609.4	609.4	
MW-302	Field Specific Conductivity	01	605.2	4/27/2023	605.2	605.2	
MW-302	Field Specific Conductivity	01	568.3	5/31/2023	568.3	568.3	
MW-302	Field Specific Conductivity	01	555.3	6/30/2023	555.3	555.3	
Calculations							
Count						26	
Mean						606.69	
Std Dev						96.56	
3 X SD (PAL)						289.68	
Min Increase (PAL)						200	
PAL, Calculated						896.37	
PAL, Rounded						900	

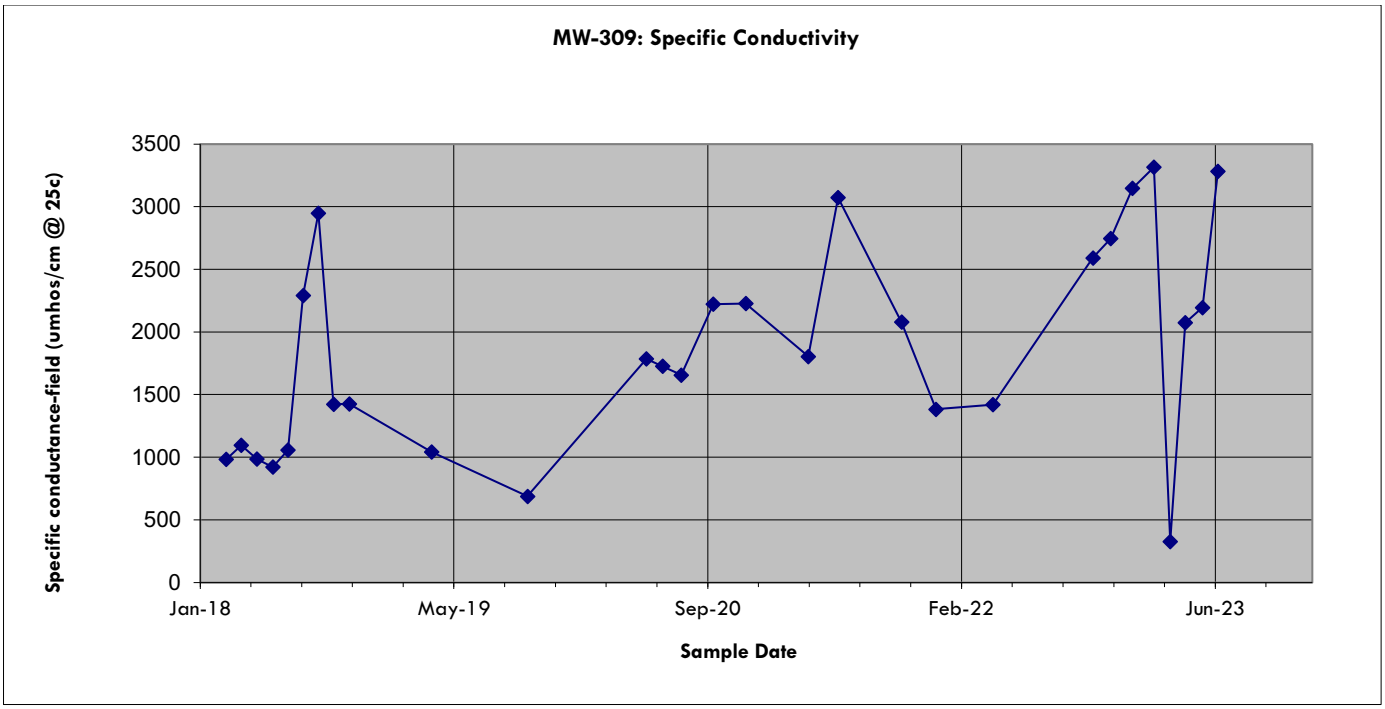
Duplicate Data Not Used for Calculations

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes

Note: Data from PacePort

*: Readings from October 2016 and April 2017 not included in calculations due to an apparent meter issue.

I:\25222260.00\Data and Calculations\Groundwater PALs ACLs\[PAL Calculations_CCR Wells Combined.xls]MW-302_Cond_PAL



Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-309	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	983	2/21/2018	983	983	
MW-309	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1094	3/23/2018	1094	1094	
MW-309	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	985	4/23/2018	985	985	
MW-309	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	921	5/24/2018	921	921	
MW-309	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1057	6/23/2018	1057	1057	
MW-309	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	2290	7/23/2018	2290	2290	
MW-309	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	2948	8/22/2018	2948	2948	
MW-309	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1423	9/21/2018	1423	1423	
MW-309	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1424	10/22/2018	1424	1424	
MW-309	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1041	4/2/2019	1041	1041	
MW-309	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	687	10/8/2019	687	687	
MW-309	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1785	5/29/2020	1785	1785	
MW-309	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1726	6/30/2020	1726	1726	
MW-309	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1656	8/6/2020	1656	1656	
MW-309	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	2222	10/8/2020	2222	2222	
MW-309	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	2227	12/11/2020	2227	2227	
MW-309	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1804	4/13/2021	1804	1804	
MW-309	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	3072	6/11/2021	3072	3072	
MW-309	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	2079	10/14/2021	2079	2079	
MW-309	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1382	12/21/2021	1382	1382	
MW-309	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1420	4/12/2022	1420	1420	
MW-309	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	2,591	10/26/2022	2591	2591	
MW-309	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	2746	11/30/2022	2746	2746	
MW-309	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	3147	1/12/2023	3147	3147	
MW-309	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	3316	2/23/2023	3316	3316	
MW-309	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	326.7	3/27/2023	326.7		outlier
MW-309	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	2073	4/26/2023	2073	2073	
MW-309	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	2195	5/30/2023	2195	2195	
MW-309	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	3282	6/29/2023	3282	3282	

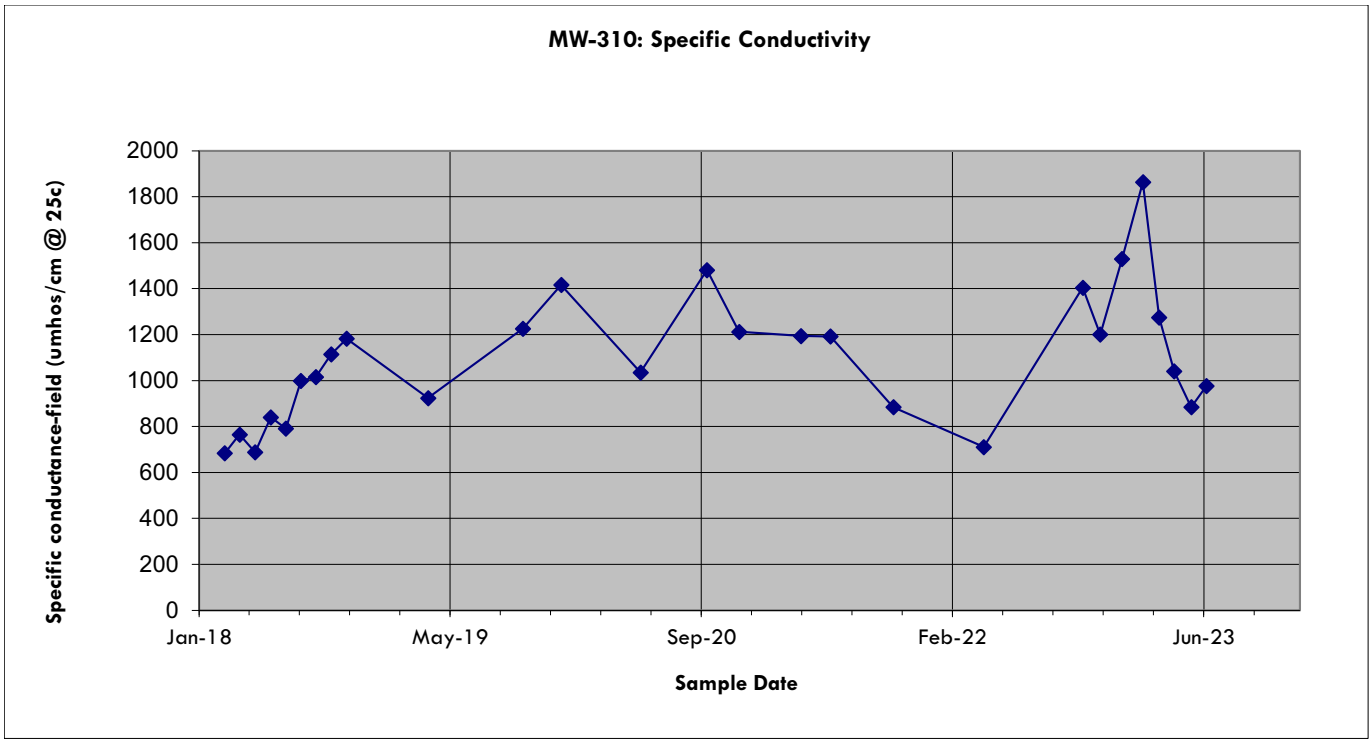
Calculations		
Count	28	
Mean	1,913.43	
Std Dev	791.46	
3 X SD (PAL)	2,374.37	
Min Increase (PAL)	200	
PAL, Calculated	4,287.80	
PAL, Rounded	4,300	

Duplicate Data Not Used for Calculations							

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes

Note:

I:\25222260.00\Data and Calculations\Groundwater PALs ACLs\[PAL Calculations_CCR Wells Combined.xls]MW309_Cond_PAL



Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-310	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	684	2/21/2018	684	684	
MW-310	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	765	3/23/2018	765	765	
MW-310	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	688	4/23/2018	688	688	
MW-310	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	840	5/24/2018	840	840	
MW-310	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	791	6/23/2018	791	791	
MW-310	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	998	7/23/2018	998	998	
MW-310	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1016	8/22/2018	1016	1016	
MW-310	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1114	9/21/2018	1114	1114	
MW-310	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1182	10/22/2018	1182	1182	
MW-310	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	924	4/2/2019	924	924	
MW-310	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1226	10/8/2019	1226	1226	
MW-310	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1416	12/23/2019	1416	1416	
MW-310	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1035	5/29/2020	1035	1035	
MW-310	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1481	10/8/2020	1481	1481	
MW-310	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1212	12/11/2020	1212	1212	
MW-310	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1194	4/13/2021	1194	1194	
MW-310	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1192	6/11/2021	1192	1192	
MW-310	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	884	10/14/2021	884	884	
MW-310	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	711	4/12/2022	711	711	
MW-310	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1,404	10/26/2022	1404	1404	
MW-310	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1200	11/30/2022	1200	1200	
MW-310	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1529	1/12/2023	1529	1529	
MW-310	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1863	2/23/2023	1863	1863	
MW-310	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1275	3/27/2023	1275	1275	
MW-310	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1040	4/26/2023	1040	1040	
MW-310	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	884	5/30/2023	884	884	
MW-310	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	977	6/29/2023	977	977	
Calculations							
Count						27	
Mean						1093.52	
Std Dev						286.22	
3 X SD (PAL)						858.65	
Min Increase (PAL)						200	
PAL, Calculated						1952.17	
PAL, Rounded						2000	

Duplicate Data Not Used for Calculations

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes

Note:

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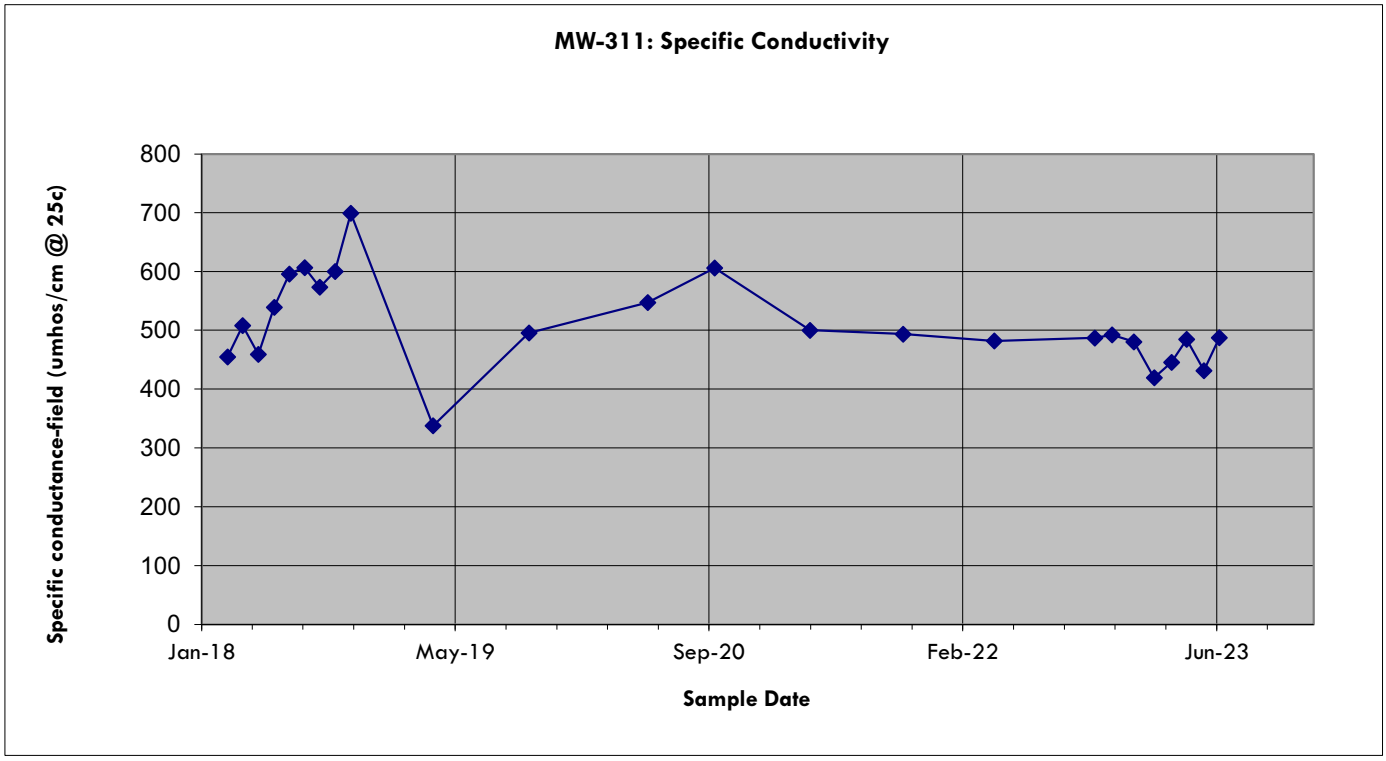

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-311	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	455	2/21/2018	455	455	
MW-311	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	508.1	3/23/2018	508.1	508.1	
MW-311	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	459.1	4/23/2018	459.1	459.1	
MW-311	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	539	5/24/2018	539	539	
MW-311	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	596	6/23/2018	596	596	
MW-311	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	606.8	7/23/2018	606.8	606.8	
MW-311	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	573.2	8/22/2018	573.2	573.2	
MW-311	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	600	9/21/2018	600	600	
MW-311	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	699	10/22/2018	699	699	
MW-311	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	337.8	4/2/2019	337.8	337.8	
MW-311	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	495.6	10/8/2019	495.6	495.6	
MW-311	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	547.2	5/29/2020	547.2	547.2	
MW-311	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	606.1	10/8/2020	606.1	606.1	
MW-311	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	500.2	4/14/2021	500.2	500.2	
MW-311	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	493.5	10/14/2021	493.5	493.5	
MW-311	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	482	4/12/2022	482	482	
MW-311	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	487	10/27/2022	487	487	
MW-311	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	492.2	11/30/2022	492.2	492.2	
MW-311	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	480.5	1/12/2023	480.5	480.5	
MW-311	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	419.2	2/21/2023	419.2	419.2	
MW-311	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	445.5	3/27/2023	445.5	445.5	
MW-311	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	484.7	4/26/2023	484.7	484.7	
MW-311	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	431.6	5/30/2023	431.6	431.6	
MW-311	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	487.2	6/29/2023	487.2	487.2	
Calculations							
Count						24	
Mean						509.44	
Std Dev						76.36	
3 X SD (PAL)						229.07	
Min Increase (PAL)						200	
PAL, Calculated						738.50	
PAL, Rounded						740	

Duplicate Data Not Used for Calculations							

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes

Note:

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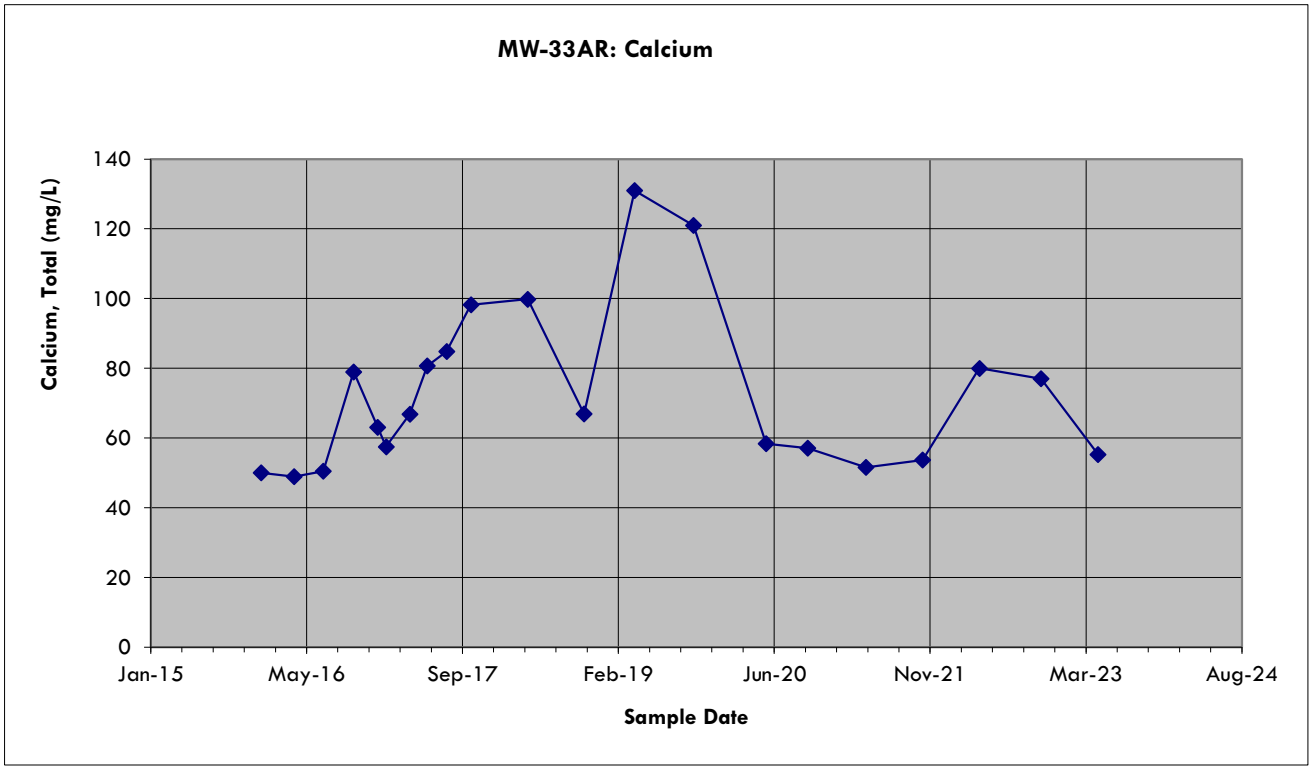


Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-33AR	CALCIUM, TOTAL (MG/L CA)	01	50	12/21/2015	50	50	
MW-33AR	CALCIUM, TOTAL (MG/L CA)	01	48.9	4/5/2016	48.9	48.9	
MW-33AR	CALCIUM, TOTAL (MG/L CA)	01	50.5	7/7/2016	50.5	50.5	
MW-33AR	CALCIUM, TOTAL (MG/L CA)	01	79	10/13/2016	79	79	
MW-33AR	CALCIUM, TOTAL (MG/L CA)	01	63.1	12/29/2016	63.1	63.1	
MW-33AR	CALCIUM, TOTAL (MG/L CA)	01	57.5	1/25/2017	57.5	57.5	
MW-33AR	CALCIUM, TOTAL (MG/L CA)	01	66.8	4/11/2017	66.8	66.8	
MW-33AR	CALCIUM, TOTAL (MG/L CA)	01	80.7	6/6/2017	80.7	80.7	
MW-33AR	CALCIUM, TOTAL (MG/L CA)	01	84.8	8/7/2017	84.8	84.8	
MW-33AR	CALCIUM, TOTAL (MG/L CA)	01	98.2	10/24/2017	98.2	98.2	
MW-33AR	CALCIUM, TOTAL (MG/L CA)	01	99.8	4/24/2018	99.8	99.8	
MW-33AR	CALCIUM, TOTAL (MG/L CA)	01	66.9	10/22/2018	66.9	66.9	
MW-33AR	CALCIUM, TOTAL (MG/L CA)	01	131	4/2/2019	131	131	
MW-33AR	CALCIUM, TOTAL (MG/L CA)	01	121	10/8/2019	121	121	
MW-33AR	CALCIUM, TOTAL (MG/L CA)	01	58.4	5/28/2020	58.4	58.4	
MW-33AR	CALCIUM, TOTAL (MG/L CA)	01	57.1	10/8/2020	57.1	57.1	
MW-33AR	CALCIUM, TOTAL (MG/L CA)	01	51.6	4/13/2021	51.6	51.6	
MW-33AR	CALCIUM, TOTAL (MG/L CA)	01	53.7	10/12/2021	53.7	53.7	
MW-33AR	CALCIUM, TOTAL (MG/L CA)	01	80	4/12/2022	80	80	
MW-33AR	CALCIUM, TOTAL (MG/L CA)	01	77	10/27/2022	77	77	
MW-33AR	CALCIUM, TOTAL (MG/L CA)	01	55.3	4/27/2023	55.3	55.3	
Calculations							
Count						21	
Mean						72.92	
Std Dev						23.41	
3 X SD (PAL)						70.23	
Min Increase (PAL)						25	
PAL, Calculated						143.15	
PAL, Rounded						150	

Duplicate Data Not Used for Calculations							

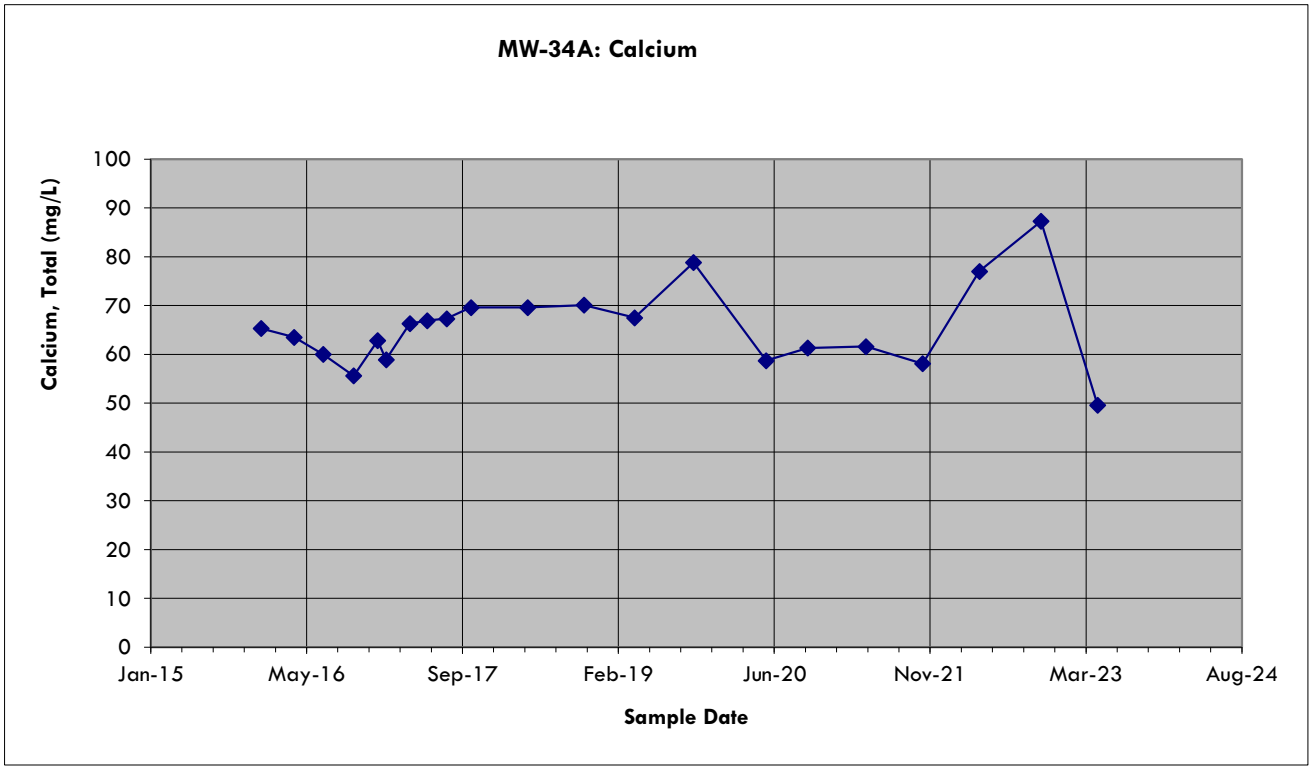
Note: Data downloaded from ChemPoint
J = Result is an estimated value below the laboratory's limit of quantitation.
P = Did not meet required preservation and/or hold time.

09/28/2023 - Classification: Internal - ECRM13153872

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes

B = Compound detected in blank.

M = Failed method QC check.



Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-34A	CALCIUM, TOTAL (MG/L CA)	01	65.3	12/21/2015	65.3	65.3	
MW-34A	CALCIUM, TOTAL (MG/L CA)	01	63.5	4/5/2016	63.5	63.5	
MW-34A	CALCIUM, TOTAL (MG/L CA)	01	60	7/7/2016	60	60	
MW-34A	CALCIUM, TOTAL (MG/L CA)	01	55.6	10/13/2016	55.6	55.6	
MW-34A	CALCIUM, TOTAL (MG/L CA)	01	62.8	12/29/2016	62.8	62.8	
MW-34A	CALCIUM, TOTAL (MG/L CA)	01	58.9	1/25/2017	58.9	58.9	
MW-34A	CALCIUM, TOTAL (MG/L CA)	01	66.3	4/11/2017	66.3	66.3	
MW-34A	CALCIUM, TOTAL (MG/L CA)	01	66.9	6/6/2017	66.9	66.9	
MW-34A	CALCIUM, TOTAL (MG/L CA)	01	67.3	8/7/2017	67.3	67.3	
MW-34A	CALCIUM, TOTAL (MG/L CA)	01	69.6	10/24/2017	69.6	69.6	
MW-34A	CALCIUM, TOTAL (MG/L CA)	01	69.6	4/24/2018	69.6	69.6	
MW-34A	CALCIUM, TOTAL (MG/L CA)	01	70.1	10/22/2018	70.1	70.1	
MW-34A	CALCIUM, TOTAL (MG/L CA)	01	67.5	4/2/2019	67.5	67.5	
MW-34A	CALCIUM, TOTAL (MG/L CA)	01	78.8	10/8/2019	78.8	78.8	
MW-34A	CALCIUM, TOTAL (MG/L CA)	01	58.7	5/28/2020	58.7	58.7	
MW-34A	CALCIUM, TOTAL (MG/L CA)	01	61.3	10/8/2020	61.3	61.3	
MW-34A	CALCIUM, TOTAL (MG/L CA)	01	61.6	4/13/2021	61.6	61.6	
MW-34A	CALCIUM, TOTAL (MG/L CA)	01	58.1	10/12/2021	58.1	58.1	
MW-34A	CALCIUM, TOTAL (MG/L CA)	01	77	4/12/2022	77	77	
MW-34A	CALCIUM, TOTAL (MG/L CA)	01	87.3	10/27/2022	87.3	87.3	
MW-34A	CALCIUM, TOTAL (MG/L CA)	01	49.6	4/26/2023	49.6	49.6	
Calculations							
Count						21	
Mean						65.51	
Std Dev						8.42	
3 X SD (PAL)						25.27	
Min Increase (PAL)						25	
PAL, Calculated						90.78	
PAL, Rounded						91	

Duplicate Data Not Used for Calculations							
MW-34A	Calcium	02	65.2	12/21/2015	65.2	65.2	

Note: Data downloaded from ChemPoint
J = Result is an estimated value below the laboratory's limit of quantitation.
P = Did not meet required preservation and/or hold time.

09/28/2023 - Classification: Internal - ECRM13153872

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes

B = Compound detected in blank.

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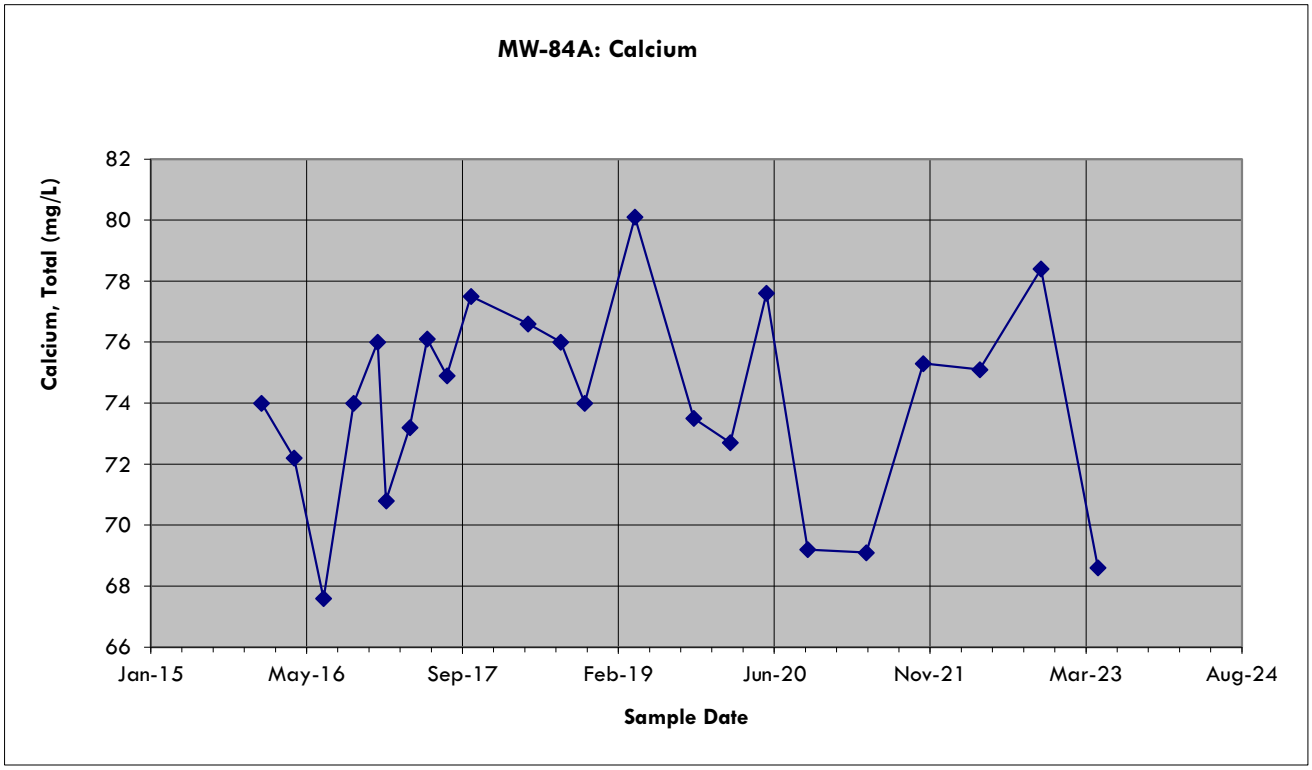


Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-84A	CALCIUM, TOTAL (MG/L CA)	01	74	12/22/2015	74	74	
MW-84A	CALCIUM, TOTAL (MG/L CA)	01	72.2	4/5/2016	72.2	72.2	
MW-84A	CALCIUM, TOTAL (MG/L CA)	01	67.6	7/8/2016	67.6	67.6	
MW-84A	CALCIUM, TOTAL (MG/L CA)	01	74	10/13/2016	74	74	
MW-84A	CALCIUM, TOTAL (MG/L CA)	01	76	12/29/2016	76	76	
MW-84A	CALCIUM, TOTAL (MG/L CA)	01	70.8	1/25/2017	70.8	70.8	
MW-84A	CALCIUM, TOTAL (MG/L CA)	01	73.2	4/11/2017	73.2	73.2	
MW-84A	CALCIUM, TOTAL (MG/L CA)	01	76.1	6/6/2017	76.1	76.1	
MW-84A	CALCIUM, TOTAL (MG/L CA)	01	74.9	8/8/2017	74.9	74.9	
MW-84A	CALCIUM, TOTAL (MG/L CA)	01	77.5	10/24/2017	77.5	77.5	
MW-84A	CALCIUM, TOTAL (MG/L CA)	01	76.6	4/25/2018	76.6	76.6	
MW-84A	CALCIUM, TOTAL (MG/L CA)	01	76	8/8/2018	76	76	
MW-84A	CALCIUM, TOTAL (MG/L CA)	01	74	10/24/2018	74	74	
MW-84A	CALCIUM, TOTAL (MG/L CA)	01	80.1	4/3/2019	80.1	80.1	
MW-84A	CALCIUM, TOTAL (MG/L CA)	01	73.5	10/9/2019	73.5	73.5	
MW-84A	CALCIUM, TOTAL (MG/L CA)	01	72.7	2/3/2020	72.7	72.7	
MW-84A	CALCIUM, TOTAL (MG/L CA)	01	77.6	5/29/2020	77.6	77.6	
MW-84A	CALCIUM, TOTAL (MG/L CA)	01	69.2	10/8/2020	69.2	69.2	
MW-84A	CALCIUM, TOTAL (MG/L CA)	01	69.1	4/14/2021	69.1	69.1	
MW-84A	CALCIUM, TOTAL (MG/L CA)	01	75.3	10/14/2021	75.3	75.3	
MW-84A	CALCIUM, TOTAL (MG/L CA)	01	75.1	4/13/2022	75.1	75.1	
MW-84A	CALCIUM, TOTAL (MG/L CA)	01	78.4	10/27/2022	78.4	78.4	
MW-84A	CALCIUM, TOTAL (MG/L CA)	01	68.6	4/27/2023	68.6	68.6	
Calculations							
Count						23	
Mean						74.02	
Std Dev						3.29	
3 X SD (PAL)						9.86	
Min Increase (PAL)						25	
PAL, Calculated						99.02	
PAL, Rounded						100	

Duplicate Data Not Used for Calculations							

Note: Data downloaded from ChemPoint

09/28/2023 - Classification: Internal - ECRM13153872

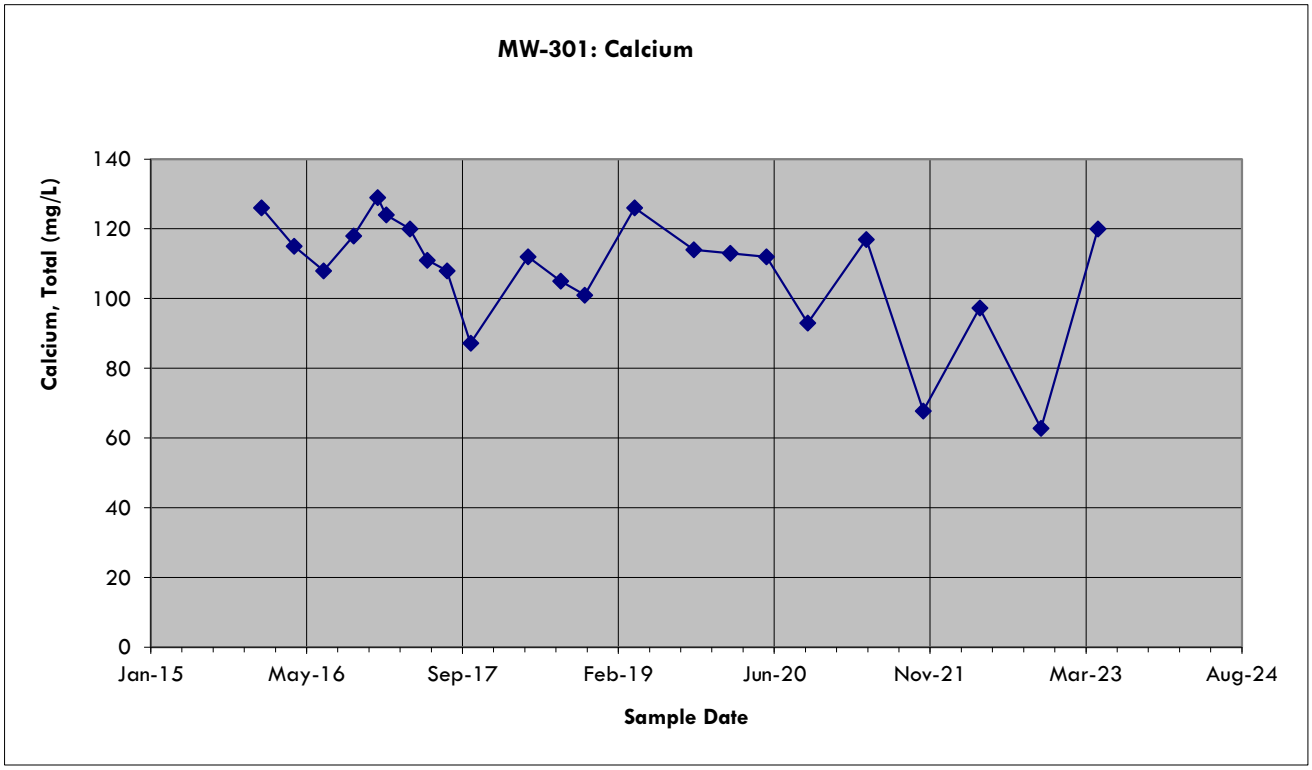
Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes

J = Result is an estimated value below the laboratory's limit of quantitation.

P = Did not meet required preservation and/or hold time.

B = Compound detected in blank.

M = Failed method QC check.



Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-301	CALCIUM, TOTAL (MG/L CA)	01	126	12/22/2015	126	126	
MW-301	CALCIUM, TOTAL (MG/L CA)	01	115	4/5/2016	115	115	
MW-301	CALCIUM, TOTAL (MG/L CA)	01	108	7/8/2016	108	108	
MW-301	CALCIUM, TOTAL (MG/L CA)	01	118	10/13/2016	118	118	
MW-301	CALCIUM, TOTAL (MG/L CA)	01	129	12/29/2016	129	129	
MW-301	CALCIUM, TOTAL (MG/L CA)	01	124	1/25/2017	124	124	
MW-301	CALCIUM, TOTAL (MG/L CA)	01	120	4/11/2017	120	120	
MW-301	CALCIUM, TOTAL (MG/L CA)	01	111	6/6/2017	111	111	
MW-301	CALCIUM, TOTAL (MG/L CA)	01	108	8/8/2017	108	108	
MW-301	CALCIUM, TOTAL (MG/L CA)	01	87.2	10/23/2017	87.2	87.2	
MW-301	CALCIUM, TOTAL (MG/L CA)	01	112	4/25/2018	112	112	
MW-301	CALCIUM, TOTAL (MG/L CA)	01	105	8/8/2018	105	105	
MW-301	CALCIUM, TOTAL (MG/L CA)	01	101	10/24/2018	101	101	
MW-301	CALCIUM, TOTAL (MG/L CA)	01	126	4/2/2019	126	126	
MW-301	CALCIUM, TOTAL (MG/L CA)	01	114	10/9/2019	114	114	
MW-301	CALCIUM, TOTAL (MG/L CA)	01	113	2/3/2020	113	113	
MW-301	CALCIUM, TOTAL (MG/L CA)	01	112	5/29/2020	112	112	
MW-301	CALCIUM, TOTAL (MG/L CA)	01	93	10/8/2020	93	93	
MW-301	CALCIUM, TOTAL (MG/L CA)	01	117	4/14/2021	117	117	
MW-301	CALCIUM, TOTAL (MG/L CA)	01	67.8	10/14/2021	67.8	67.8	
MW-301	CALCIUM, TOTAL (MG/L CA)	01	97.3	4/13/2022	97.3	97.3	
MW-301	CALCIUM, TOTAL (MG/L CA)	01	62.8	10/27/2022	62.8	62.8	
MW-301	CALCIUM, TOTAL (MG/L CA)	01	120	4/27/2023	120	120	
Calculations							
Count						23	
Mean						108.13	
Std Dev						17.13	
3 X SD (PAL)						51.38	
Min Increase (PAL)						25	
PAL, Calculated						159.52	
PAL, Rounded						160	

Duplicate Data Not Used for Calculations							

Note: Data downloaded from ChemPoint

09/28/2023 - Classification: Internal - ECRM13153872

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes

J = Result is an estimated value below the laboratory's limit of quantitation.

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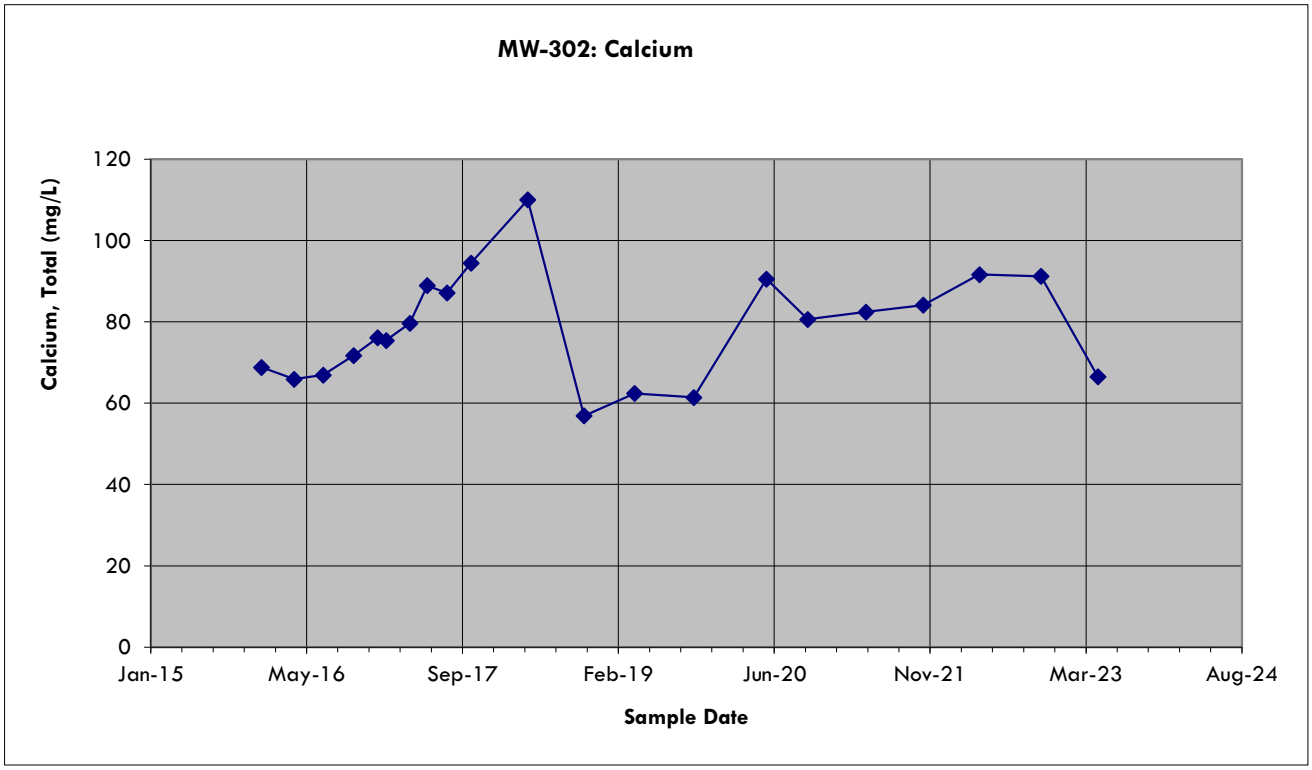

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-302	CALCIUM, TOTAL (MG/L CA)	01	68.8	12/22/2015	68.8	68.8	
MW-302	CALCIUM, TOTAL (MG/L CA)	01	65.9	4/5/2016	65.9	65.9	
MW-302	CALCIUM, TOTAL (MG/L CA)	01	66.9	7/7/2016	66.9	66.9	
MW-302	CALCIUM, TOTAL (MG/L CA)	01	71.7	10/13/2016	71.7	71.7	
MW-302	CALCIUM, TOTAL (MG/L CA)	01	76.1	12/29/2016	76.1	76.1	
MW-302	CALCIUM, TOTAL (MG/L CA)	01	75.4	1/25/2017	75.4	75.4	
MW-302	CALCIUM, TOTAL (MG/L CA)	01	79.6	4/11/2017	79.6	79.6	
MW-302	CALCIUM, TOTAL (MG/L CA)	01	88.9	6/6/2017	88.9	88.9	
MW-302	CALCIUM, TOTAL (MG/L CA)	01	87.1	8/8/2017	87.1	87.1	
MW-302	CALCIUM, TOTAL (MG/L CA)	01	94.4	10/24/2017	94.4	94.4	
MW-302	CALCIUM, TOTAL (MG/L CA)	01	110	4/24/2018	110	110	
MW-302	CALCIUM, TOTAL (MG/L CA)	01	56.9	10/22/2018	56.9	56.9	
MW-302	CALCIUM, TOTAL (MG/L CA)	01	62.4	4/2/2019	62.4	62.4	
MW-302	CALCIUM, TOTAL (MG/L CA)	01	61.4	10/9/2019	61.4	61.4	
MW-302	CALCIUM, TOTAL (MG/L CA)	01	90.5	5/29/2020	90.5	90.5	
MW-302	CALCIUM, TOTAL (MG/L CA)	01	80.6	10/8/2020	80.6	80.6	
MW-302	CALCIUM, TOTAL (MG/L CA)	01	82.4	4/13/2021	82.4	82.4	
MW-302	CALCIUM, TOTAL (MG/L CA)	01	84.1	10/14/2021	84.1	84.1	
MW-302	CALCIUM, TOTAL (MG/L CA)	01	91.6	4/12/2022	91.6	91.6	
MW-302	CALCIUM, TOTAL (MG/L CA)	01	91.2	10/27/2022	91.2	91.2	
MW-302	CALCIUM, TOTAL (MG/L CA)	01	66.5	4/27/2023	66.5	66.5	
Calculations							
Count						21	
Mean						78.69	
Std Dev						13.35	
3 X SD (PAL)						40.06	
Min Increase (PAL)						25	
PAL, Calculated						118.75	
PAL, Rounded						120	

Duplicate Data Not Used for Calculations							

Note: Data downloaded from ChemPoint
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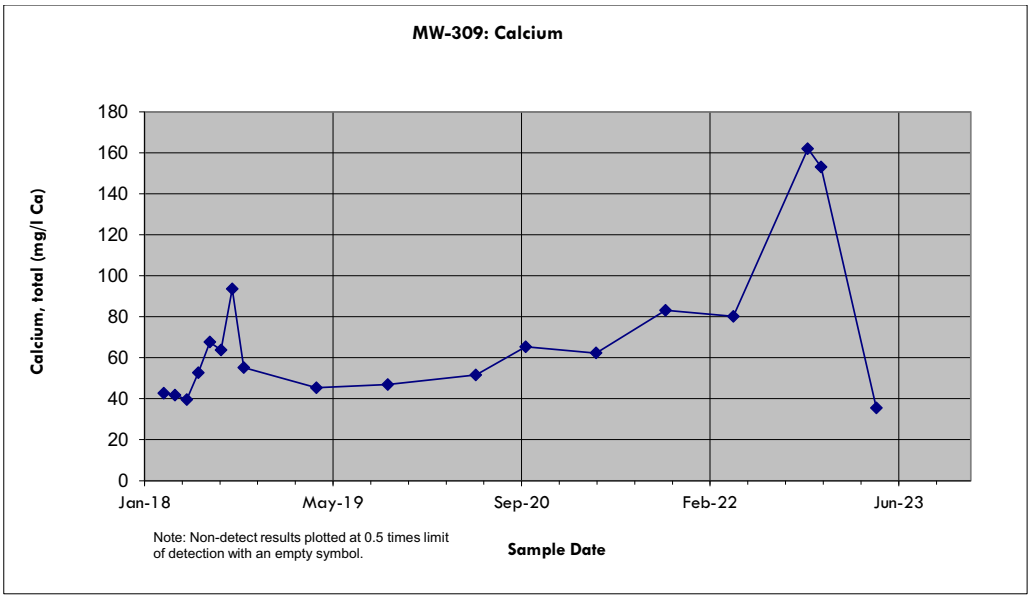
09/28/2023 - Classification: Internal - ECRM13153872

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes

B = Compound detected in blank.

M = Failed method QC check.



Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-309	CALCIUM, TOTAL (MG/L CA)	01	42.7	2/21/2018	42.7	42.7	M
MW-309	CALCIUM, TOTAL (MG/L CA)	01	41.8	3/23/2018	41.8	41.8	
MW-309	CALCIUM, TOTAL (MG/L CA)	01	39.6	4/23/2018	39.6	39.6	
MW-309	CALCIUM, TOTAL (MG/L CA)	01	52.7	5/24/2018	52.7	52.7	
MW-309	CALCIUM, TOTAL (MG/L CA)	01	67.6	6/23/2018	67.6	67.6	
MW-309	CALCIUM, TOTAL (MG/L CA)	01	63.8	7/23/2018	63.8	63.8	
MW-309	CALCIUM, TOTAL (MG/L CA)	01	93.6	8/22/2018	93.6	93.6	
MW-309	CALCIUM, TOTAL (MG/L CA)	01	55.2	9/21/2018	55.2	55.2	
MW-309	CALCIUM, TOTAL (MG/L CA)	01	45.3	4/2/2019	45.3	45.3	
MW-309	CALCIUM, TOTAL (MG/L CA)	01	46.9	10/8/2019	46.9	46.9	
MW-309	CALCIUM, TOTAL (MG/L CA)	01	51.6	5/29/2020	51.6	51.6	
MW-309	CALCIUM, TOTAL (MG/L CA)	01	65.3	10/8/2020	65.3	65.3	
MW-309	CALCIUM, TOTAL (MG/L CA)	01	62.3	4/13/2021	62.3	62.3	
MW-309	CALCIUM, TOTAL (MG/L CA)	01	83.1	10/14/2021	83.1	83.1	
MW-309	CALCIUM, TOTAL (MG/L CA)	01	80.2	4/12/2022	80.2	80.2	
MW-309	CALCIUM, TOTAL (MG/L CA)	01	162	10/26/2022	162	162	
MW-309	CALCIUM, TOTAL (MG/L CA)	01	153	11/30/2022	153	153	
MW-309	CALCIUM, TOTAL (MG/L CA)	01	35.5	4/26/2023	35.5	35.5	
Calculations							
Count						18	
Mean						69.01	
Std Dev						35.93	
3 X SD (PAL)						107.80	
Min Increase (PAL)						25	
PAL, Calculated						176.81	
PAL, Rounded						180	

Duplicate Data Not Used for Calculations							

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M = Failed method QC check.

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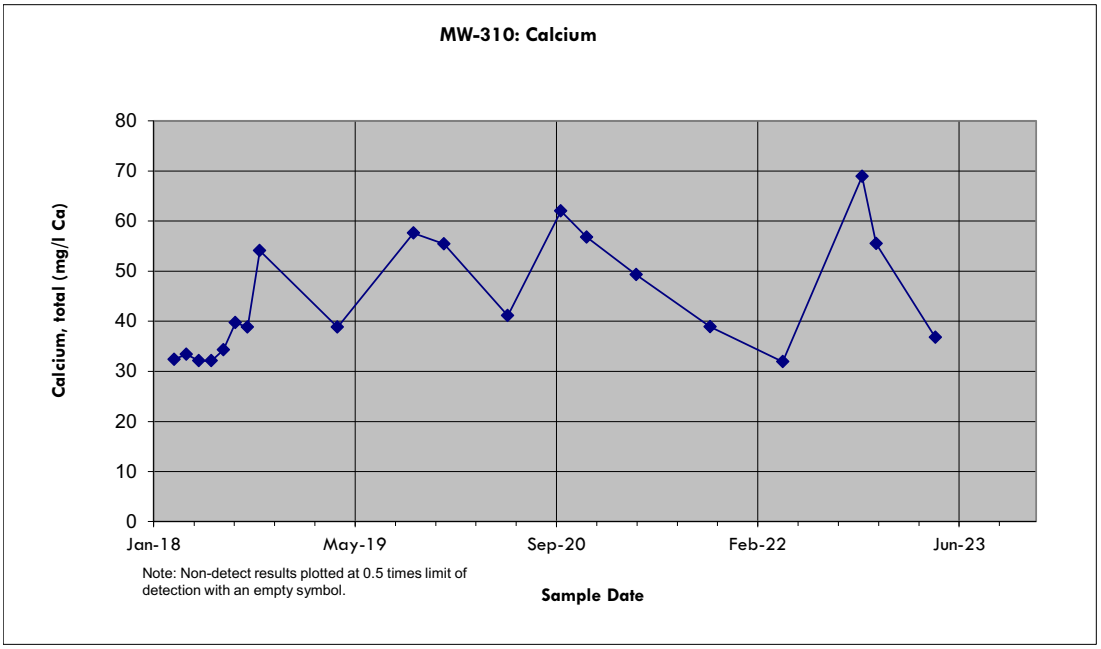

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-310	CALCIUM, TOTAL (MG/L CA)	01	32.4	2/21/2018	32.4	32.4	
MW-310	CALCIUM, TOTAL (MG/L CA)	01	33.4	3/23/2018	33.4	33.4	
MW-310	CALCIUM, TOTAL (MG/L CA)	01	32.1	4/23/2018	32.1	32.1	
MW-310	CALCIUM, TOTAL (MG/L CA)	01	32.1	5/24/2018	32.1	32.1	
MW-310	CALCIUM, TOTAL (MG/L CA)	01	34.3	6/23/2018	34.3	34.3	
MW-310	CALCIUM, TOTAL (MG/L CA)	01	39.7	7/23/2018	39.7	39.7	
MW-310	CALCIUM, TOTAL (MG/L CA)	01	38.8	8/22/2018	38.8	38.8	
MW-310	CALCIUM, TOTAL (MG/L CA)	01	54.1	9/21/2018	54.1	54.1	
MW-310	CALCIUM, TOTAL (MG/L CA)	01	38.8	4/2/2019	38.8	38.8	
MW-310	CALCIUM, TOTAL (MG/L CA)	01	57.6	10/8/2019	57.6	57.6	
MW-310	CALCIUM, TOTAL (MG/L CA)	01	55.4	12/23/2019	55.4	55.4	M
MW-310	CALCIUM, TOTAL (MG/L CA)	01	41.1	5/29/2020	41.1	41.1	
MW-310	CALCIUM, TOTAL (MG/L CA)	01	62	10/8/2020	62	62	
MW-310	CALCIUM, TOTAL (MG/L CA)	01	56.8	12/11/2020	56.8	56.8	
MW-310	CALCIUM, TOTAL (MG/L CA)	01	49.3	4/13/2021	49.3	49.3	
MW-310	CALCIUM, TOTAL (MG/L CA)	01	38.9	10/14/2021	38.9	38.9	
MW-310	CALCIUM, TOTAL (MG/L CA)	01	31.9	4/12/2022	31.9	31.9	
MW-310	CALCIUM, TOTAL (MG/L CA)	01	68.9	10/26/2022	68.9	68.9	
MW-310	CALCIUM, TOTAL (MG/L CA)	01	55.5	11/30/2022	55.5	55.5	
MW-310	CALCIUM, TOTAL (MG/L CA)	01	36.8	4/26/2023	36.8	36.8	
Calculations							
Count						20	
Mean						44.50	
Std Dev						11.72	
3 X SD (PAL)						35.16	
Min Increase (PAL)						25	
PAL, Calculated						79.65	
PAL, Rounded						80	

32400	32.4
33400	33.4
32100	32.1
32100	32.1
34300	34.3
39700	39.7
38800	38.8
54100	54.1

Duplicate Data Not Used for Calculations

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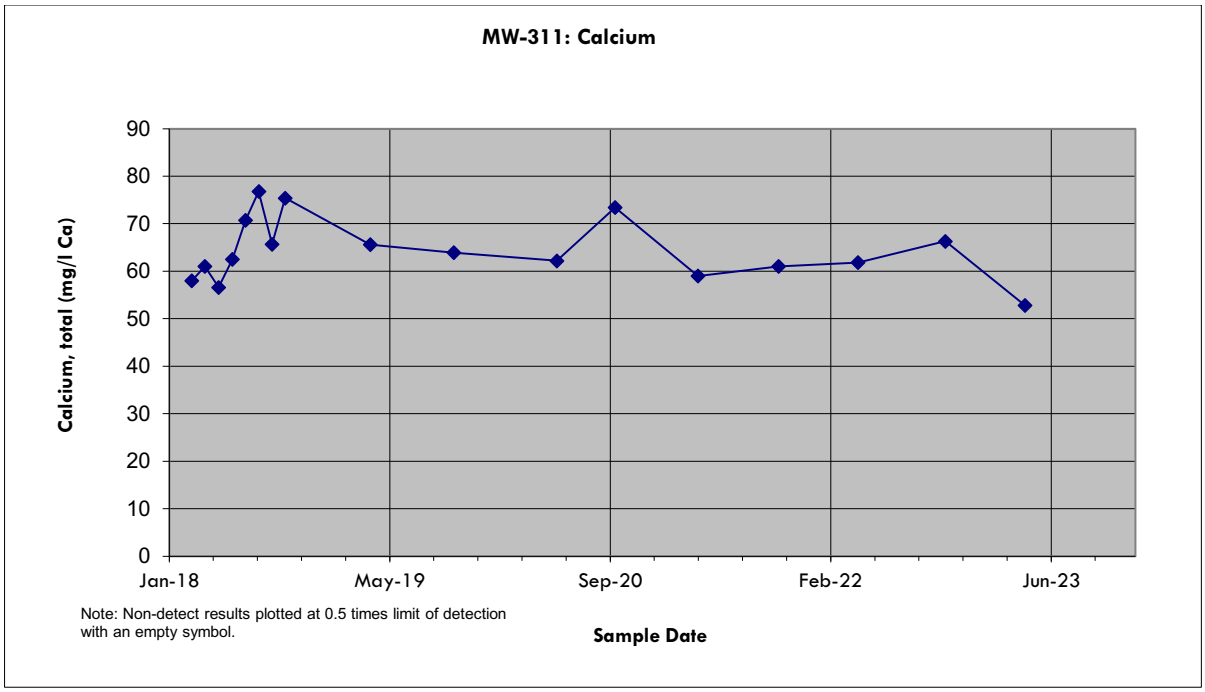

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-311	CALCIUM, TOTAL (MG/L CA)	01	58	2/21/2018	58	58	
MW-311	CALCIUM, TOTAL (MG/L CA)	01	61	3/23/2018	61	61	
MW-311	CALCIUM, TOTAL (MG/L CA)	01	56.6	4/23/2018	56.6	56.6	
MW-311	CALCIUM, TOTAL (MG/L CA)	01	62.5	5/24/2018	62.5	62.5	
MW-311	CALCIUM, TOTAL (MG/L CA)	01	70.7	6/23/2018	70.7	70.7	
MW-311	CALCIUM, TOTAL (MG/L CA)	01	76.8	7/23/2018	76.8	76.8	
MW-311	CALCIUM, TOTAL (MG/L CA)	01	65.7	8/22/2018	65.7	65.7	M
MW-311	CALCIUM, TOTAL (MG/L CA)	01	75.4	9/21/2018	75.4	75.4	
MW-311	CALCIUM, TOTAL (MG/L CA)	01	65.6	4/2/2019	65.6	65.6	
MW-311	CALCIUM, TOTAL (MG/L CA)	01	63.9	10/8/2019	63.9	63.9	
MW-311	CALCIUM, TOTAL (MG/L CA)	01	62.2	5/29/2020	62.2	62.2	
MW-311	CALCIUM, TOTAL (MG/L CA)	01	73.4	10/8/2020	73.4	73.4	
MW-311	CALCIUM, TOTAL (MG/L CA)	01	59	4/14/2021	59	59	
MW-311	CALCIUM, TOTAL (MG/L CA)	01	61	10/14/2021	61	61	
MW-311	CALCIUM, TOTAL (MG/L CA)	01	61.8	4/12/2022	61.8	61.8	
MW-311	CALCIUM, TOTAL (MG/L CA)	01	66.3	10/27/2022	66.3	66.3	
MW-311	CALCIUM, TOTAL (MG/L CA)	01	52.8	4/26/2023	52.8	52.8	
Calculations							
Count						17	
Mean						64.28	
Std Dev						6.64	
3 X SD (PAL)						19.93	
Min Increase (PAL)						25	
PAL, Calculated						89.28	
PAL, Rounded						90	

Duplicate Data Not Used for Calculations							

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M = Failed method QC check.

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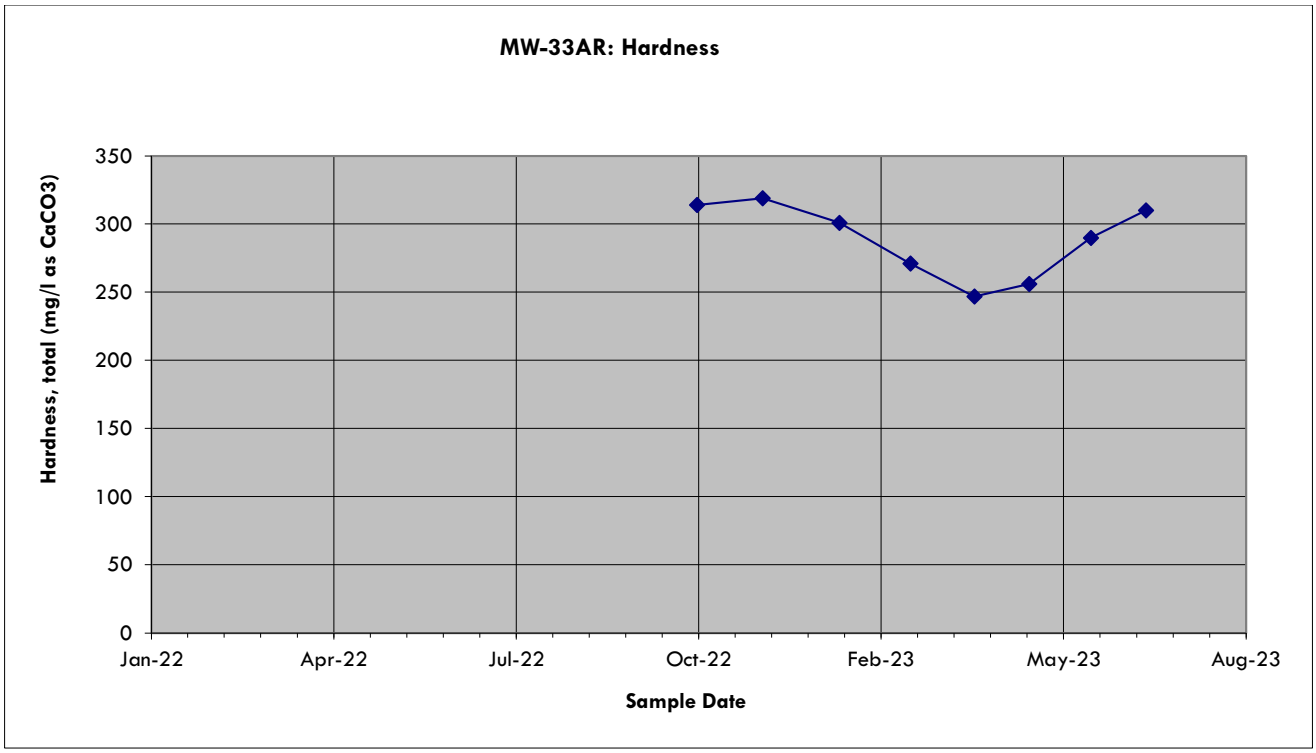

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-33AR	HARDNESS, TOTAL (MG/L AS CACO3)	01	314	10/27/2022	314	314	
MW-33AR	HARDNESS, TOTAL (MG/L AS CACO3)	01	319	12/2/2022	319	319	
MW-33AR	HARDNESS, TOTAL (MG/L AS CACO3)	01	301	1/13/2023	301	301	
MW-33AR	HARDNESS, TOTAL (MG/L AS CACO3)	01	271	2/21/2023	271	271	
MW-33AR	HARDNESS, TOTAL (MG/L AS CACO3)	01	247	3/28/2023	247	247	
MW-33AR	HARDNESS, TOTAL (MG/L AS CACO3)	01	256	4/27/2023	256	256	
MW-33AR	HARDNESS, TOTAL (MG/L AS CACO3)	01	290	5/31/2023	290	290	
MW-33AR	HARDNESS, TOTAL (MG/L AS CACO3)	01	310	6/30/2023	310	310	
Calculations							
Count						8	
Mean						288.50	
Std Dev						27.48	
3 X SD (PAL)						82.44	
Min Increase (PAL)						100	
PAL, Calculated						388.50	
PAL, Rounded						390	

Duplicate Data Not Used for Calculations							

Note:

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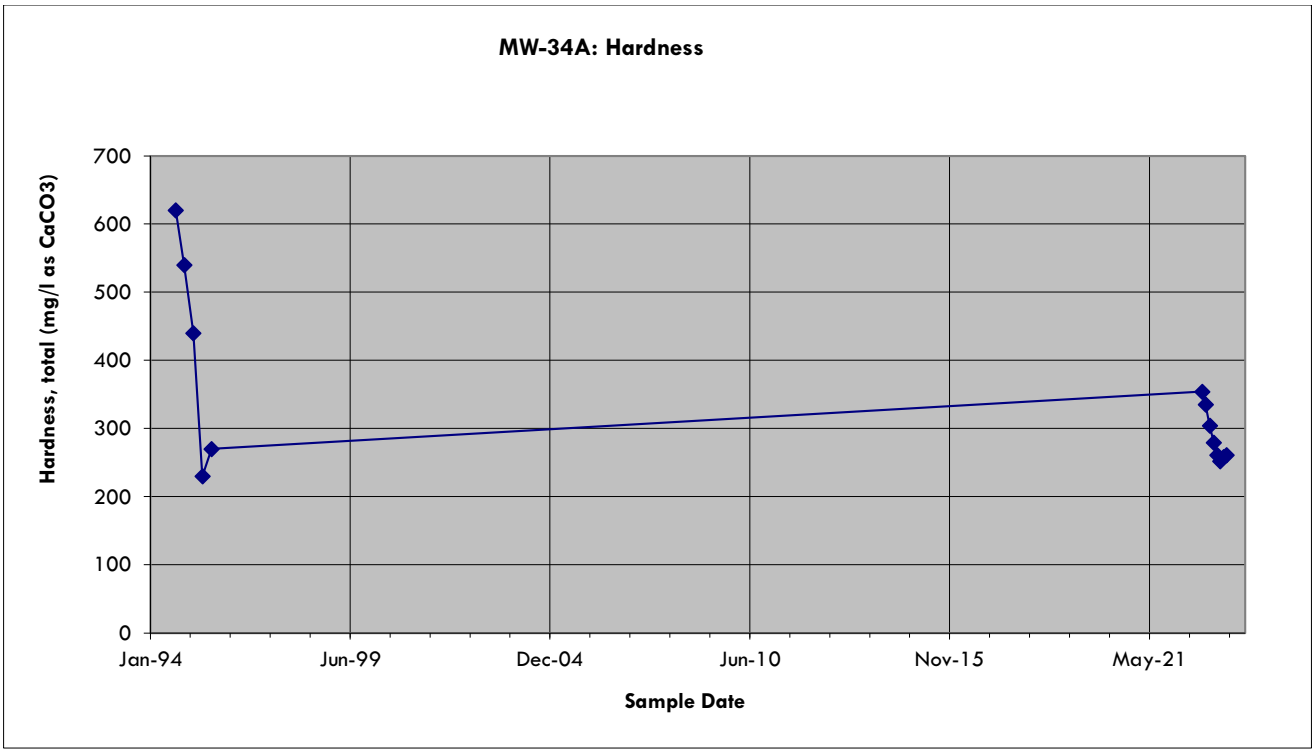


Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW34A	HARDNESS, TOTAL (MG/L AS CACO3)	01	620	9/13/1994	620		
MW34A	HARDNESS, TOTAL (MG/L AS CACO3)	01	540	12/6/1994	540		
MW34A	HARDNESS, TOTAL (MG/L AS CACO3)	01	440	3/7/1995	440		
MW34A	HARDNESS, TOTAL (MG/L AS CACO3)	01	230	6/6/1995	230		
MW34A	HARDNESS, TOTAL (MG/L AS CACO3)	01	270	9/6/1995	270		
MW34A	HARDNESS, TOTAL (MG/L AS CACO3)	01	354	10/27/2022	354	354	Using last 20 years of data for PAL calculation
MW34A	HARDNESS, TOTAL (MG/L AS CACO3)	01	335	12/2/2022	335	335	
MW34A	HARDNESS, TOTAL (MG/L AS CACO3)	01	304	1/13/2023	304	304	
MW34A	HARDNESS, TOTAL (MG/L AS CACO3)	01	279	2/21/2023	279	279	
MW34A	HARDNESS, TOTAL (MG/L AS CACO3)	01	261	3/27/2023	261	261	
MW34A	HARDNESS, TOTAL (MG/L AS CACO3)	01	252	4/26/2023	252	252	
MW34A	HARDNESS, TOTAL (MG/L AS CACO3)	01	258	5/31/2023	258	258	
MW34A	HARDNESS, TOTAL (MG/L AS CACO3)	01	261	6/30/2023	261	261	
Calculations							
Count						8	
Mean						288.00	
Std Dev						38.83	
3 X SD (PAL)						116.50	
Min Increase (PAL)						100	
PAL, Calculated						404.50	
PAL, Rounded						410	

Duplicate Data Not Used for Calculations							

Note: 1994-1995 data from GEMS; 2022-2023 data from PacePort

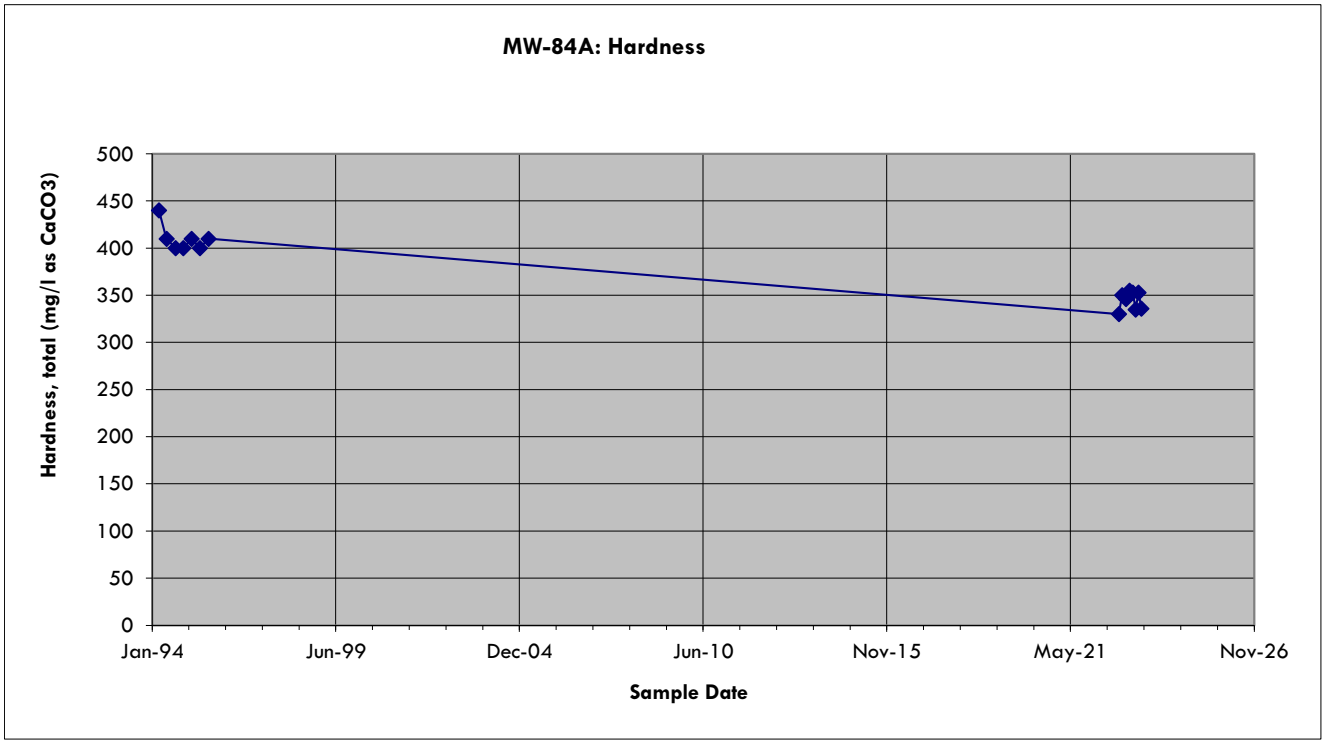
J = Result is an estimated value below the laboratory's limit of quantitation.

P = Did not meet required preservation and/or hold time.

B = Compound detected in blank.

M = Failed method QC check.

09/28/2023 - Classification: Internal - ECRM13153872

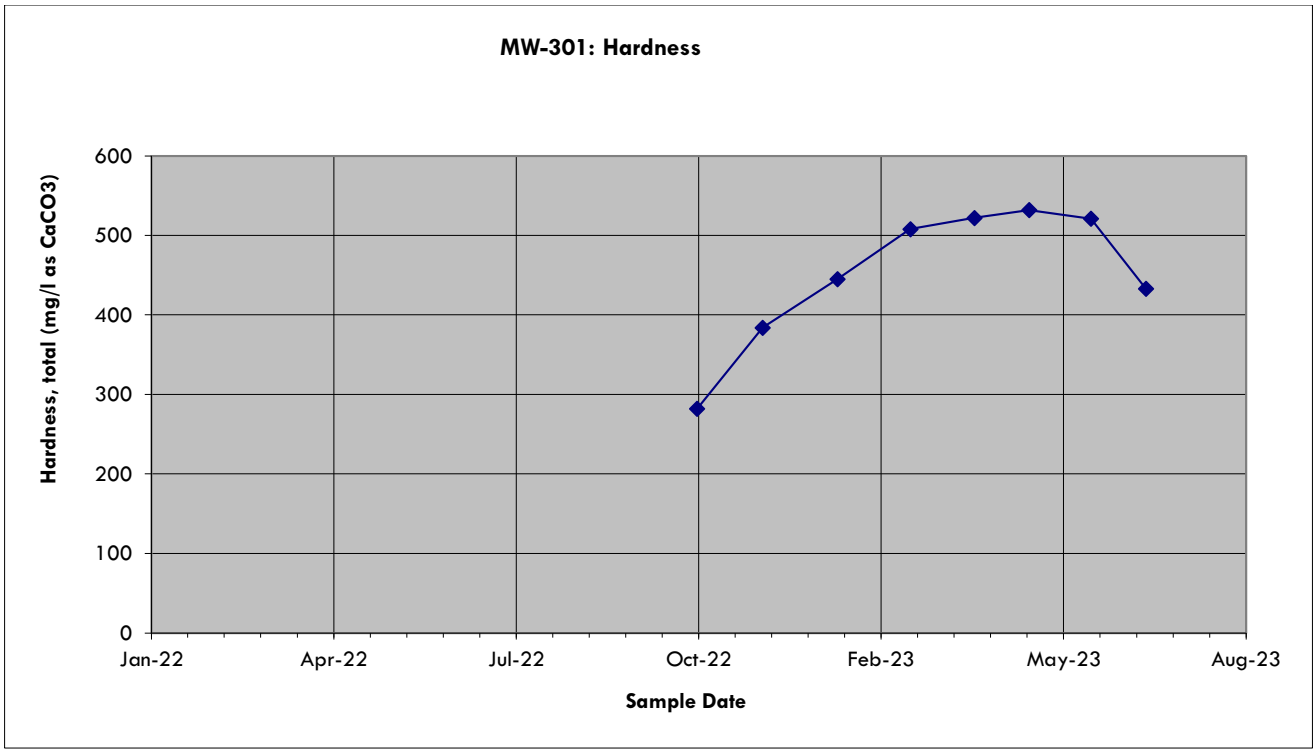


Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW84A	HARDNESS, TOTAL (MG/L AS CACO3)	01	440	3/15/1994	440	440	
MW84A	HARDNESS, TOTAL (MG/L AS CACO3)	01	410	6/7/1994	410	410	
MW84A	HARDNESS, TOTAL (MG/L AS CACO3)	01	400	9/13/1994	400	400	
MW84A	HARDNESS, TOTAL (MG/L AS CACO3)	01	400	12/6/1994	400	400	
MW84A	HARDNESS, TOTAL (MG/L AS CACO3)	01	410	3/7/1995	410	410	
MW84A	HARDNESS, TOTAL (MG/L AS CACO3)	01	400	6/5/1995	400	400	
MW84A	HARDNESS, TOTAL (MG/L AS CACO3)	01	410	9/5/1995	410	410	
MW-84A	HARDNESS, TOTAL (MG/L AS CACO3)	01	330	10/27/2022	330	330	
MW-84A	HARDNESS, TOTAL (MG/L AS CACO3)	01	350	12/2/2022	350	350	
MW-84A	HARDNESS, TOTAL (MG/L AS CACO3)	01	346	1/12/2023	346	346	
MW-84A	HARDNESS, TOTAL (MG/L AS CACO3)	01	355	2/21/2023	355	355	
MW-84A	HARDNESS, TOTAL (MG/L AS CACO3)	01	353	3/28/2023	353	353	
MW-84A	HARDNESS, TOTAL (MG/L AS CACO3)	01	335	4/27/2023	335	335	
MW-84A	HARDNESS, TOTAL (MG/L AS CACO3)	01	353	5/30/2023	353	353	
MW-84A	HARDNESS, TOTAL (MG/L AS CACO3)	01	336	6/29/2023	336	336	
Calculations							
Count						15	
Mean						375.20	
Std Dev						35.61	
3 X SD (PAL)						106.83	
Min Increase (PAL)						100	
PAL, Calculated						482.03	
PAL, Rounded						490	

Duplicate Data Not Used for Calculations							

Note: 1994 and 1995 dota downloaded from GEMS; 2022 & 2023 data from PacePort
J = Result is an estimated value below the laboratory's limit of quantitation.
P = Did not meet required preservation and/or hold time.
B = Compound detected in blank.
M = Failed method QC check.

09/28/2023 - Classification: Internal - ECRM13153872



Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-301	HARDNESS, TOTAL (MG/L AS CACO3)	01	282	10/27/2022	282	282	
MW-301	HARDNESS, TOTAL (MG/L AS CACO3)	01	384	12/2/2022	384	384	
MW-301	HARDNESS, TOTAL (MG/L AS CACO3)	01	445	1/12/2023	445	445	
MW-301	HARDNESS, TOTAL (MG/L AS CACO3)	01	508	2/21/2023	508	508	
MW-301	HARDNESS, TOTAL (MG/L AS CACO3)	01	522	3/28/2023	522	522	
MW-301	HARDNESS, TOTAL (MG/L AS CACO3)	01	532	4/27/2023	532	532	
MW-301	HARDNESS, TOTAL (MG/L AS CACO3)	01	521	5/31/2023	521	521	
MW-301	HARDNESS, TOTAL (MG/L AS CACO3)	01	433	6/30/2023	433	433	
Calculations							
Count						8	
Mean						453.38	
Std Dev						87.11	
3 X SD (PAL)						261.33	
Min Increase (PAL)						100	
PAL, Calculated						714.70	
PAL, Rounded						720	

Duplicate Data Not Used for Calculations							

Note: Data downloaded from PacePort

J = Result is an estimated value below the laboratory's limit of quantitation.

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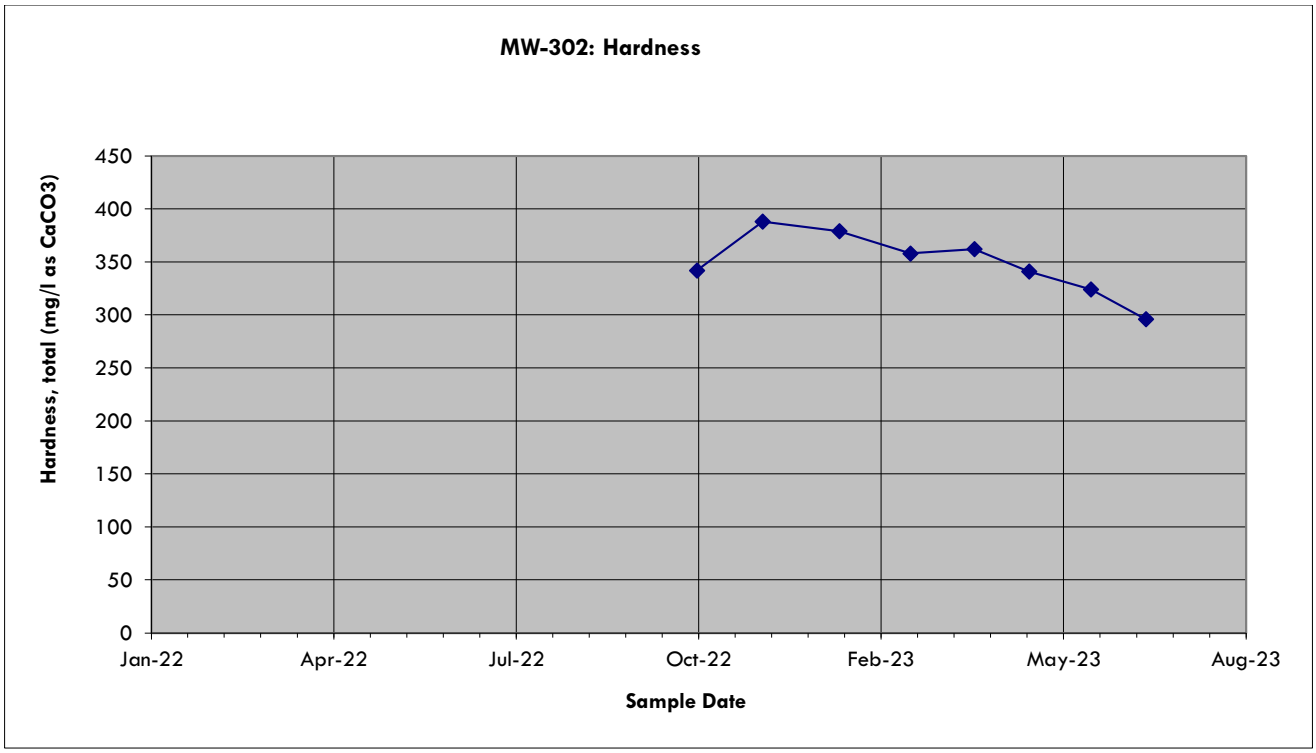
B = Compound detected in blank.

M = Failed method QC check.



Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-302	HARDNESS, TOTAL (MG/L AS CACO3)	01	342	10/27/2022	342	342	
MW-302	HARDNESS, TOTAL (MG/L AS CACO3)	01	388	12/2/2022	388	388	
MW-302	Total Hardness by 2340B	01	379	1/13/2023	379	379	
MW-302	Total Hardness by 2340B	01	358	2/21/2023	358	358	
MW-302	Total Hardness by 2340B	01	362	3/28/2023	362	362	
MW-302	Total Hardness by 2340B	01	341	4/27/2023	341	341	
MW-302	Total Hardness by 2340B	01	324	5/31/2023	324	324	
MW-302	Total Hardness by 2340B	01	296	6/30/2023	296	296	
Calculations							
Count						8	
Mean						348.75	
Std Dev						29.80	
3 X SD (PAL)						89.41	
Min Increase (PAL)						100	
PAL, Calculated						448.75	
PAL, Rounded						450	

Duplicate Data Not Used for Calculations							

Note: Data downloaded from PacePort
J = Result is an estimated value below the laboratory's limit of quantitation.
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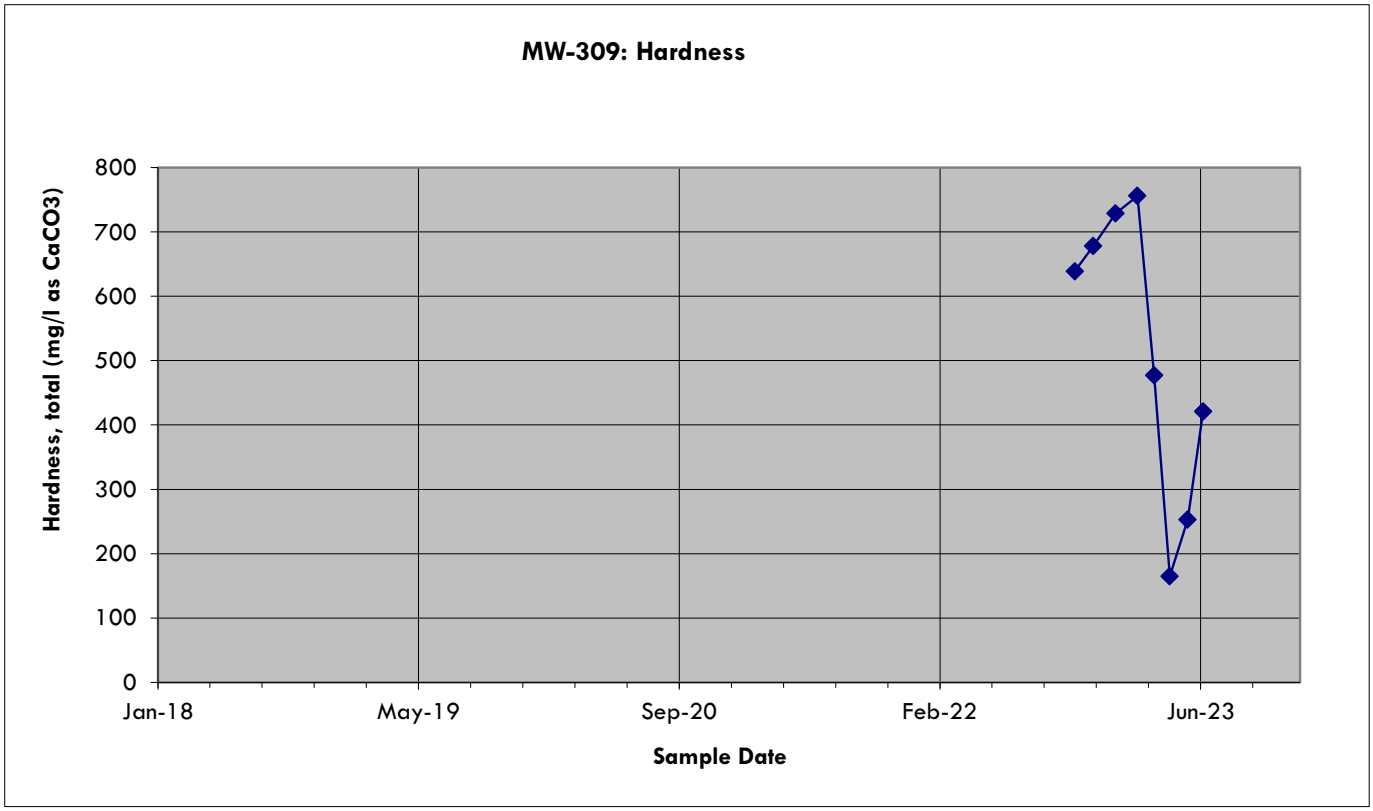
B = Compound detected in blank.
M = Failed method QC check.

09/28/2023 - Classification: Internal - ECRM13153872



Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-309	HARDNESS, TOTAL (MG/L AS CACO3)	01	639	10/26/2022	639	639	
MW-309	HARDNESS, TOTAL (MG/L AS CACO3)	01	678	11/30/2022	678	678	
MW-309	HARDNESS, TOTAL (MG/L AS CACO3)	01	729	1/12/2023	729	729	
MW-309	HARDNESS, TOTAL (MG/L AS CACO3)	01	756	2/23/2023	756	756	
MW-309	HARDNESS, TOTAL (MG/L AS CACO3)	01	477	3/27/2023	477	477	
MW-309	HARDNESS, TOTAL (MG/L AS CACO3)	01	165	4/26/2023	165	165	
MW-309	HARDNESS, TOTAL (MG/L AS CACO3)	01	253	5/30/2023	253	253	
MW-309	HARDNESS, TOTAL (MG/L AS CACO3)	01	421	6/29/2023	421	421	
Calculations							
Count						8	
Mean						514.75	
Std Dev						222.73	
3 X SD (PAL)						668.18	
Min Increase (PAL)						100	
PAL, Calculated						1182.93	
PAL, Rounded						1,200	

Duplicate Data Not Used for Calculations							

Note:

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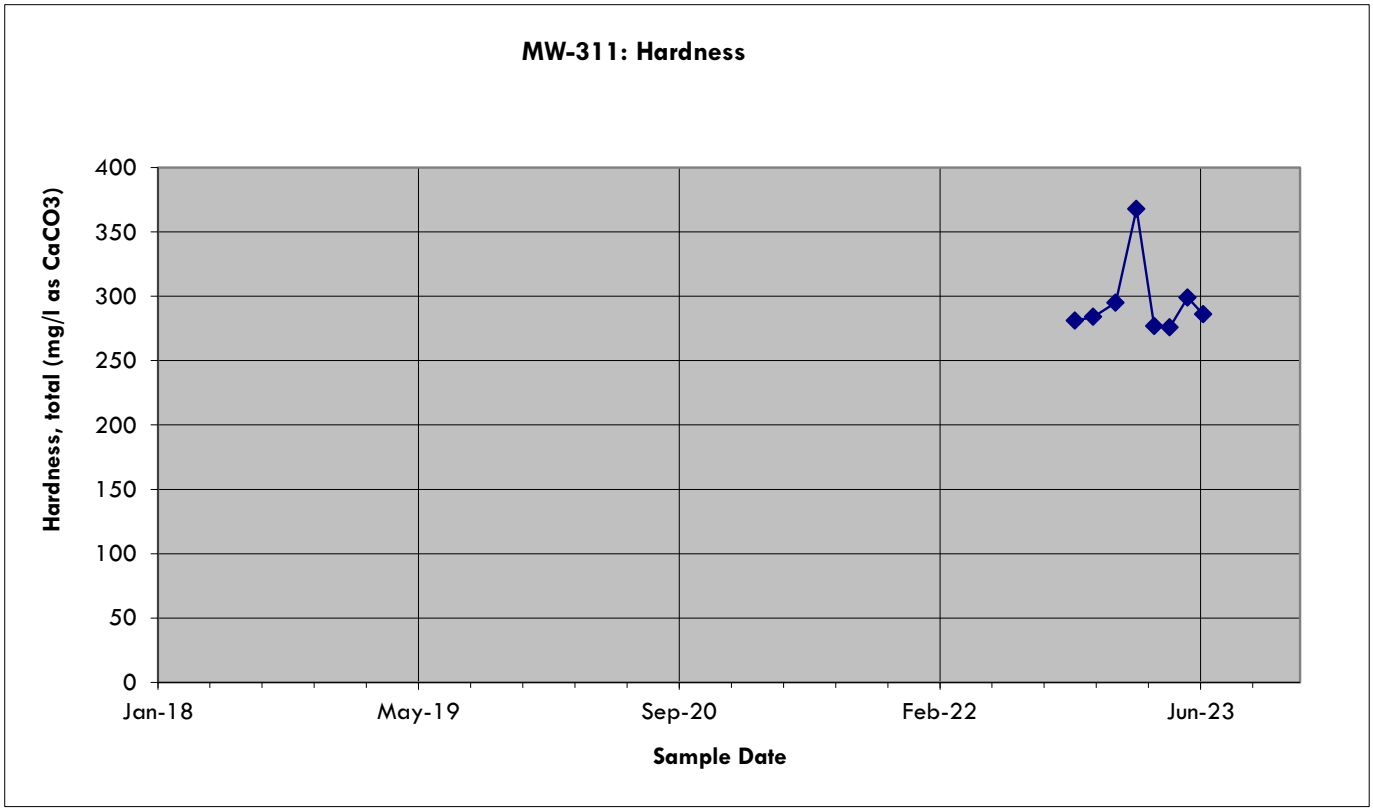
P = Did not meet required preservation and/or hold time.

B = Compound detected in blank.

M = Failed method QC check.



Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-311	HARDNESS, TOTAL (MG/L AS CACO3)	01	281	10/26/2022	281	281	
MW-311	HARDNESS, TOTAL (MG/L AS CACO3)	01	284	11/30/2022	284	284	
MW-311	HARDNESS, TOTAL (MG/L AS CACO3)	01	295	1/12/2023	295	295	
MW-311	HARDNESS, TOTAL (MG/L AS CACO3)	01	368	2/21/2023	368	368	
MW-311	HARDNESS, TOTAL (MG/L AS CACO3)	01	277	3/27/2023	277	277	
MW-311	HARDNESS, TOTAL (MG/L AS CACO3)	01	276	4/26/2023	276	276	
MW-311	HARDNESS, TOTAL (MG/L AS CACO3)	01	299	5/30/2023	299	299	
MW-311	HARDNESS, TOTAL (MG/L AS CACO3)	01	286	6/29/2023	286	286	
Calculations							
Count						8	
Mean						295.75	
Std Dev						30.29	
3 X SD (PAL)						90.88	
Min Increase (PAL)						100	
PAL, Calculated						395.75	
PAL, Rounded						400	

Duplicate Data Not Used for Calculations							

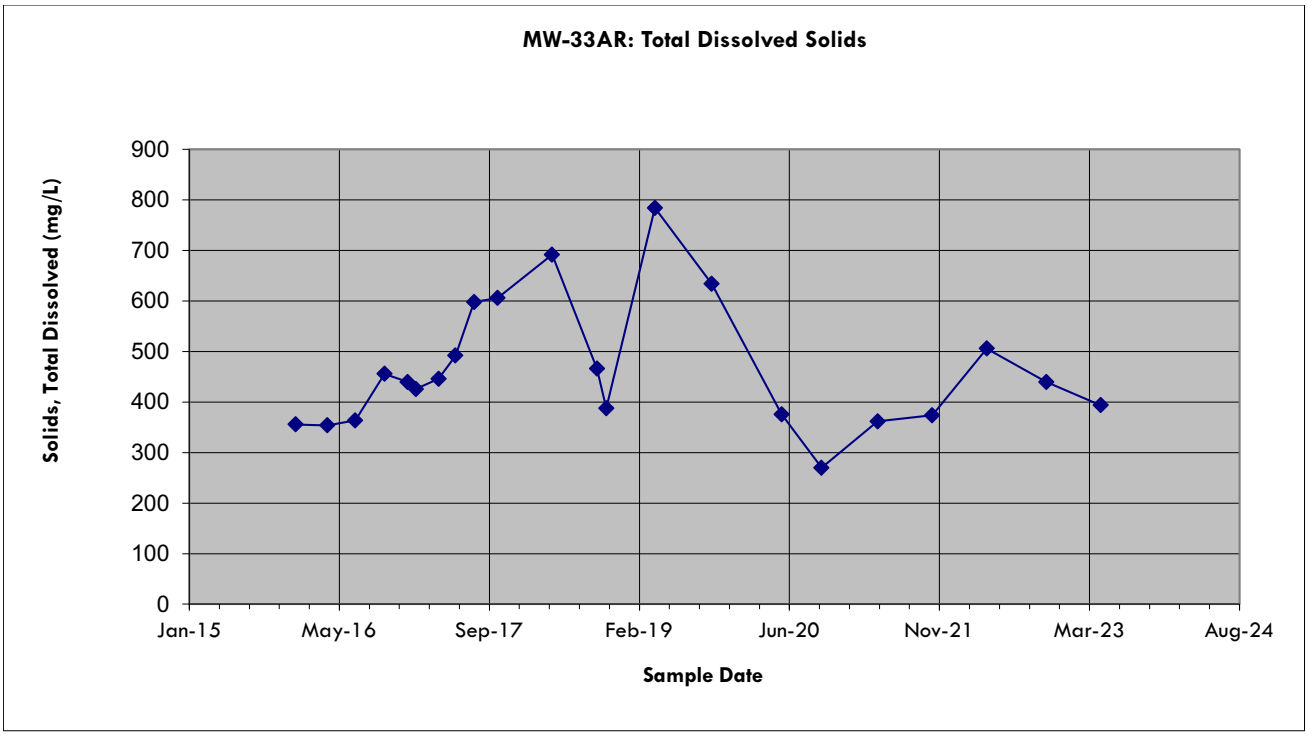
Note:

J = Result is an estimated value below the laboratory's limit of quantitation.

P = Did not meet required preservation and/or hold time.

B = Compound detected in blank.

M = Failed method QC check.



Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-33AR	SOLIDS, TOTAL DISSOLVED (MG/L)	01	356	12/21/2015	356	356	
MW-33AR	SOLIDS, TOTAL DISSOLVED (MG/L)	01	354	4/5/2016	354	354	
MW-33AR	SOLIDS, TOTAL DISSOLVED (MG/L)	01	364	7/7/2016	364	364	
MW-33AR	SOLIDS, TOTAL DISSOLVED (MG/L)	01	456	10/13/2016	456	456	
MW-33AR	SOLIDS, TOTAL DISSOLVED (MG/L)	01	440	12/29/2016	440	440	
MW-33AR	SOLIDS, TOTAL DISSOLVED (MG/L)	01	426	1/25/2017	426	426	
MW-33AR	SOLIDS, TOTAL DISSOLVED (MG/L)	01	446	4/11/2017	446	446	
MW-33AR	SOLIDS, TOTAL DISSOLVED (MG/L)	01	492	6/6/2017	492	492	
MW-33AR	SOLIDS, TOTAL DISSOLVED (MG/L)	01	598	8/7/2017	598	598	
MW-33AR	SOLIDS, TOTAL DISSOLVED (MG/L)	01	606	10/24/2017	606	606	
MW-33AR	SOLIDS, TOTAL DISSOLVED (MG/L)	01	692	4/24/2018	692	692	
MW-33AR	SOLIDS, TOTAL DISSOLVED (MG/L)	01	466	9/21/2018	466	466	
MW-33AR	SOLIDS, TOTAL DISSOLVED (MG/L)	01	388	10/22/2018	388	388	
MW-33AR	SOLIDS, TOTAL DISSOLVED (MG/L)	01	784	4/2/2019	784	784	
MW-33AR	SOLIDS, TOTAL DISSOLVED (MG/L)	01	634	10/8/2019	634	634	
MW-33AR	SOLIDS, TOTAL DISSOLVED (MG/L)	01	376	5/28/2020	376	376	
MW-33AR	SOLIDS, TOTAL DISSOLVED (MG/L)	01	270	10/8/2020	270	270	
MW-33AR	SOLIDS, TOTAL DISSOLVED (MG/L)	01	362	4/13/2021	362	362	
MW-33AR	SOLIDS, TOTAL DISSOLVED (MG/L)	01	374	10/12/2021	374	374	
MW-33AR	SOLIDS, TOTAL DISSOLVED (MG/L)	01	506	4/12/2022	506	506	
MW-33AR	SOLIDS, TOTAL DISSOLVED (MG/L)	01	440	10/27/2022	440	440	
MW-33AR	SOLIDS, TOTAL DISSOLVED (MG/L)	01	394	4/27/2023	394	394	
Calculations							
Count						22	
Mean						464.73	
Std Dev						126.35	
3 X SD (PAL)						379.05	
Min Increase (PAL)						200	
PAL, Calculated						843.78	
PAL, Rounded						850	

Duplicate Data Not Used for Calculations							

Note: Data downloaded from ChemPoint

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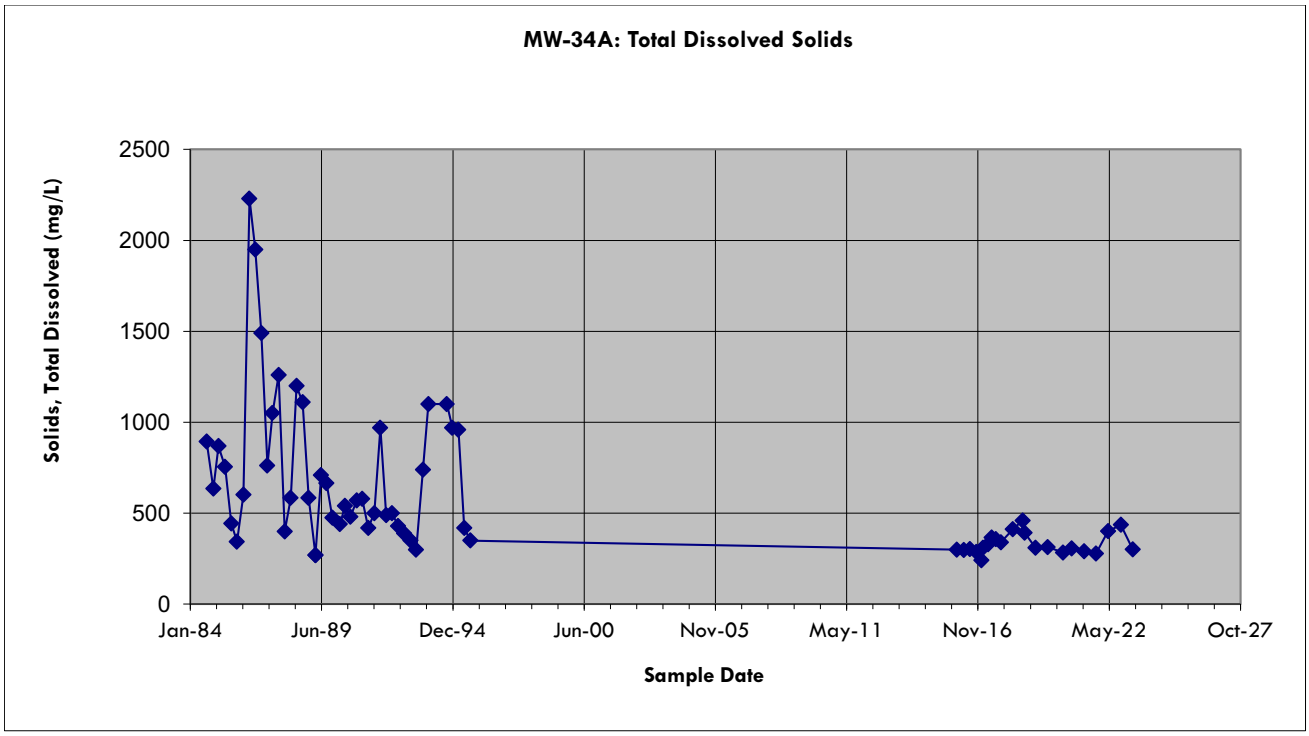
09/28/2023 - Classification: Internal - ECRM13153872



Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-34A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	895	9/7/1984	895		
MW-34A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	635	12/17/1984	635		
MW-34A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	869	3/7/1985	869		
MW-34A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	755	6/14/1985	755		
MW-34A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	444	9/18/1985	444		
MW-34A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	344	12/12/1985	344		
MW-34A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	602	3/21/1986	602		
MW-34A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	2230	6/20/1986	2230		
MW-34A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	1950	9/18/1986	1950		
MW-34A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	1490	12/19/1986	1490		
MW-34A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	763	3/20/1987	763		
MW-34A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	1050	6/5/1987	1050		
MW-34A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	1260	9/9/1987	1260		
MW-34A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	400	12/9/1987	400		
MW-34A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	584	3/10/1988	584		
MW-34A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	1200	6/7/1988	1200		
MW-34A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	1110	9/9/1988	1110		
MW-34A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	584	12/7/1988	584		
MW-34A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	270	3/21/1989	270		
MW-34A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	270	3/22/1989	270		
MW-34A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	710	6/16/1989	710		
MW-34A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	665	9/6/1989	665		
MW-34A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	475	12/5/1989	475		
MW-34A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	440	3/29/1990	440		
MW-34A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	540	6/14/1990	540		
MW-34A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	480	9/5/1990	480		
MW-34A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	570	12/10/1990	570		
MW-34A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	580	3/5/1991	580		
MW-34A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	420	6/3/1991	420		
MW-34A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	500	9/6/1991	500		
MW-34A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	970	12/4/1991	970		
MW-34A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	490	3/3/1992	490		
MW-34A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	500	6/2/1992	500		
MW-34A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	430	9/1/1992	430		
MW-34A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	390	12/2/1992	390		
MW-34A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	350	3/10/1993	350		
MW-34A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	300	6/2/1993	300		
MW-34A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	740	9/14/1993	740		
MW-34A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	1100	12/7/1993	1100		

09/28/2023 - Classification: Internal - ECRM13153872

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-34A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	1100	9/13/1994	1100		
MW-34A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	970	12/6/1994	970		
MW-34A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	960	3/7/1995	960		
MW-34A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	420	6/6/1995	420		
MW-34A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	350	9/6/1995	350		
MW-34A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	300	12/21/2015	300	300	Using last
MW-34A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	298	4/5/2016	298	298	20 years of
MW-34A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	304	7/7/2016	304	304	data for
MW-34A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	288	10/13/2016	288	288	PAL
MW-34A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	242	12/29/2016	242	242	calculation
MW-34A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	310	1/25/2017	310	310	
MW-34A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	330	4/11/2017	330	330	
MW-34A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	366	6/6/2017	366	366	
MW-34A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	358	8/7/2017	358	358	
MW-34A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	340	10/24/2017	340	340	
MW-34A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	412	4/24/2018	412	412	
MW-34A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	460	9/21/2018	460	460	
MW-34A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	392	10/22/2018	392	392	
MW-34A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	310	4/2/2019	310	310	
MW-34A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	314	10/8/2019	314	314	
MW-34A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	284	5/28/2020	284	284	
MW-34A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	306	10/8/2020	306	306	
MW-34A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	290	4/13/2021	290	290	
MW-34A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	278	10/12/2021	278	278	
MW-34A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	402	4/12/2022	402	402	
MW-34A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	436	10/27/2022	436	436	
MW-34A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	302	4/26/2023	302	302	
Calculations							
Count						22	
Mean						332.82	
Std Dev						56.42	
3 X SD (PAL)						169.25	
Min Increase (PAL)						200	
PAL, Calculated						532.82	
PAL, Rounded						540	

Duplicate Data Not Used for Calculations							
MW-34A	Total Dissolved Solids	02	324	12/21/2015	324	324	

Note: Data downloaded from ChemPoint

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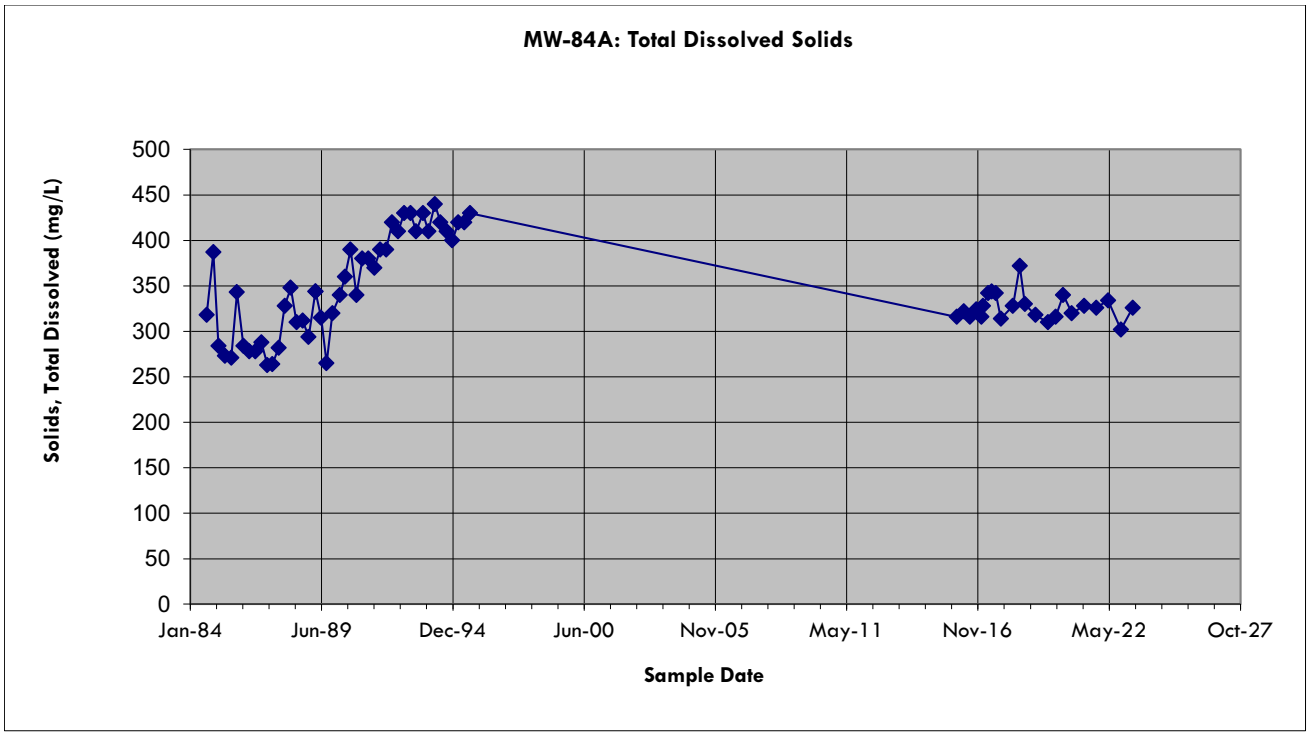

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-84A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	318	9/7/1984	318	318	
MW-84A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	387	12/17/1984	387	387	
MW-84A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	284	3/7/1985	284	284	
MW-84A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	273	6/14/1985	273	273	
MW-84A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	271	9/18/1985	271	271	
MW-84A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	343	12/12/1985	343	343	
MW-84A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	284	3/21/1986	284	284	
MW-84A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	278	6/20/1986	278	278	
MW-84A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	278	9/18/1986	278	278	
MW-84A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	288	12/19/1986	288	288	
MW-84A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	263	3/20/1987	263	263	
MW-84A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	264	6/5/1987	264	264	
MW-84A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	282	9/9/1987	282	282	
MW-84A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	328	12/9/1987	328	328	
MW-84A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	348	3/10/1988	348	348	
MW-84A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	310	6/7/1988	310	310	
MW-84A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	312	9/9/1988	312	312	
MW-84A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	294	12/7/1988	294	294	
MW-84A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	344	3/21/1989	344	344	
MW-84A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	344	3/22/1989	344	344	
MW-84A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	315	6/16/1989	315	315	
MW-84A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	265	9/7/1989	265	265	
MW-84A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	320	12/6/1989	320	320	
MW-84A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	340	3/29/1990	340	340	
MW-84A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	360	6/14/1990	360	360	
MW-84A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	390	9/6/1990	390	390	
MW-84A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	340	12/7/1990	340	340	
MW-84A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	380	3/6/1991	380	380	
MW-84A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	380	6/3/1991	380	380	
MW-84A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	370	9/6/1991	370	370	
MW-84A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	390	12/5/1991	390	390	
MW-84A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	390	3/2/1992	390	390	
MW-84A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	420	6/2/1992	420	420	
MW-84A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	410	9/2/1992	410	410	
MW-84A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	430	12/2/1992	430	430	
MW-84A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	430	3/10/1993	430	430	
MW-84A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	410	6/3/1993	410	410	
MW-84A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	430	9/14/1993	430	430	
MW-84A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	410	12/7/1993	410	410	

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-84A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	440	3/15/1994	440	440	
MW-84A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	420	6/7/1994	420	420	
MW-84A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	410	9/13/1994	410	410	
MW-84A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	400	12/6/1994	400	400	
MW-84A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	420	3/7/1995	420	420	
MW-84A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	420	6/5/1995	420	420	
MW-84A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	430	9/5/1995	430	430	
MW-84A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	316	12/22/2015	316	316	
MW-84A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	322	4/5/2016	322	322	
MW-84A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	316	7/8/2016	316	316	
MW-84A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	324	10/13/2016	324	324	
MW-84A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	316	12/29/2016	316	316	
MW-84A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	328	1/25/2017	328	328	
MW-84A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	342	4/11/2017	342	342	
MW-84A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	344	6/6/2017	344	344	
MW-84A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	342	8/8/2017	342	342	
MW-84A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	314	10/24/2017	314	314	
MW-84A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	328	4/25/2018	328	328	
MW-84A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	372	8/8/2018	372	372	
MW-84A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	330	10/24/2018	330	330	
MW-84A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	318	4/3/2019	318	318	
MW-84A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	310	10/9/2019	310	310	
MW-84A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	316	2/3/2020	316	316	
MW-84A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	340	5/29/2020	340	340	
MW-84A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	320	10/8/2020	320	320	
MW-84A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	328	4/14/2021	328	328	
MW-84A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	326	10/14/2021	326	326	
MW-84A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	334	4/13/2022	334	334	
MW-84A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	302	10/27/2022	302	302	
MW-84A	SOLIDS, TOTAL DISSOLVED (MG/L)	01	326	4/27/2023	326	326	
Calculations							
Count						69	
Mean						343.87	
Std Dev						49.31	
3 X SD (PAL)						147.93	
Min Increase (PAL)						200	
PAL, Calculated						543.87	
PAL, Rounded						550	

Duplicate Data Not Used for Calculations							

Note: Data downloaded from ChemPoint

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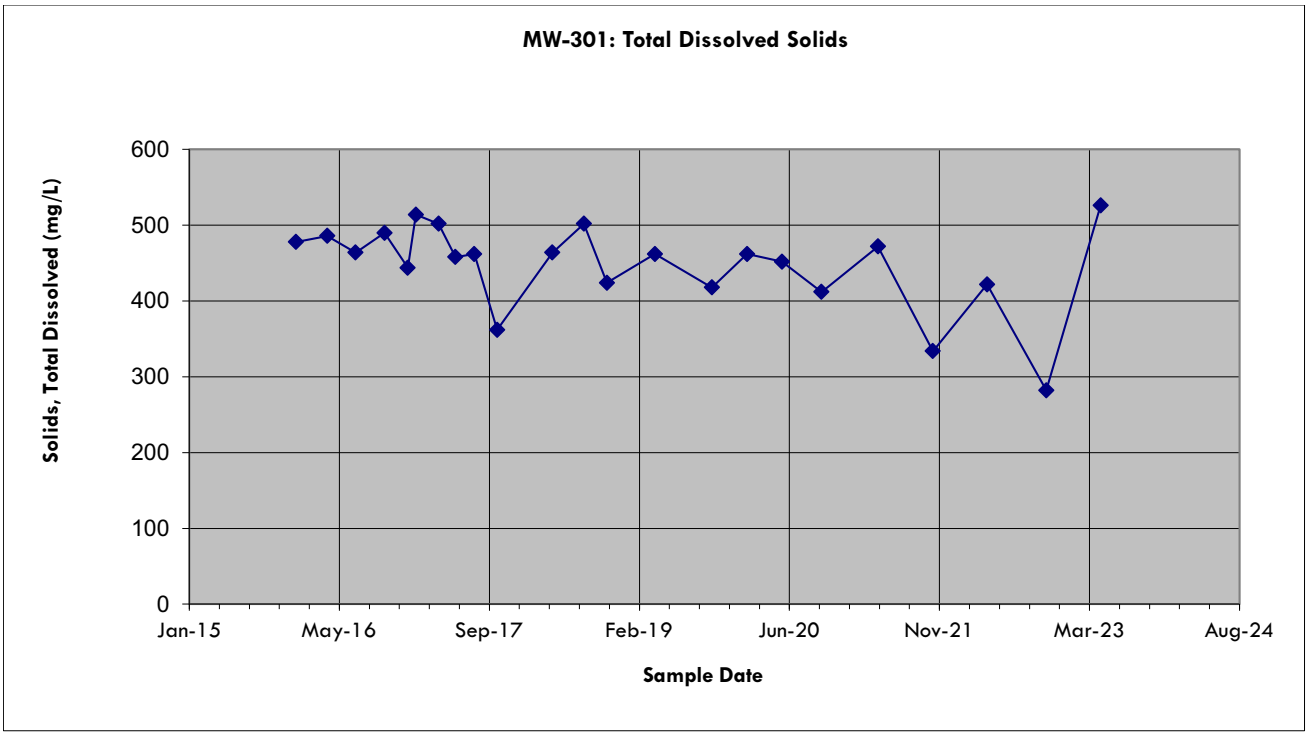

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-301	SOLIDS, TOTAL DISSOLVED (MG/L)	01	478	12/22/2015	478	478	
MW-301	SOLIDS, TOTAL DISSOLVED (MG/L)	01	486	4/5/2016	486	486	
MW-301	SOLIDS, TOTAL DISSOLVED (MG/L)	01	464	7/8/2016	464	464	
MW-301	SOLIDS, TOTAL DISSOLVED (MG/L)	01	490	10/13/2016	490	490	
MW-301	SOLIDS, TOTAL DISSOLVED (MG/L)	01	444	12/29/2016	444	444	
MW-301	SOLIDS, TOTAL DISSOLVED (MG/L)	01	514	1/25/2017	514	514	
MW-301	SOLIDS, TOTAL DISSOLVED (MG/L)	01	502	4/11/2017	502	502	
MW-301	SOLIDS, TOTAL DISSOLVED (MG/L)	01	458	6/6/2017	458	458	
MW-301	SOLIDS, TOTAL DISSOLVED (MG/L)	01	462	8/8/2017	462	462	
MW-301	SOLIDS, TOTAL DISSOLVED (MG/L)	01	362	10/23/2017	362	362	
MW-301	SOLIDS, TOTAL DISSOLVED (MG/L)	01	464	4/25/2018	464	464	
MW-301	SOLIDS, TOTAL DISSOLVED (MG/L)	01	502	8/8/2018	502	502	
MW-301	SOLIDS, TOTAL DISSOLVED (MG/L)	01	424	10/24/2018	424	424	
MW-301	SOLIDS, TOTAL DISSOLVED (MG/L)	01	462	4/2/2019	462	462	
MW-301	SOLIDS, TOTAL DISSOLVED (MG/L)	01	418	10/9/2019	418	418	
MW-301	SOLIDS, TOTAL DISSOLVED (MG/L)	01	462	2/3/2020	462	462	
MW-301	SOLIDS, TOTAL DISSOLVED (MG/L)	01	452	5/29/2020	452	452	
MW-301	SOLIDS, TOTAL DISSOLVED (MG/L)	01	412	10/8/2020	412	412	
MW-301	SOLIDS, TOTAL DISSOLVED (MG/L)	01	472	4/14/2021	472	472	
MW-301	SOLIDS, TOTAL DISSOLVED (MG/L)	01	334	10/14/2021	334	334	
MW-301	SOLIDS, TOTAL DISSOLVED (MG/L)	01	422	4/13/2022	422	422	
MW-301	SOLIDS, TOTAL DISSOLVED (MG/L)	01	282	10/27/2022	282	282	
MW-301	SOLIDS, TOTAL DISSOLVED (MG/L)	01	526	4/27/2023	526	526	
Calculations							
Count						23	
Mean						447.48	
Std Dev						57.83	
3 X SD (PAL)						173.49	
Min Increase (PAL)						200	
PAL, Calculated						647.48	
PAL, Rounded						650	

Duplicate Data Not Used for Calculations							

Note: Data downloaded from ChemPoint

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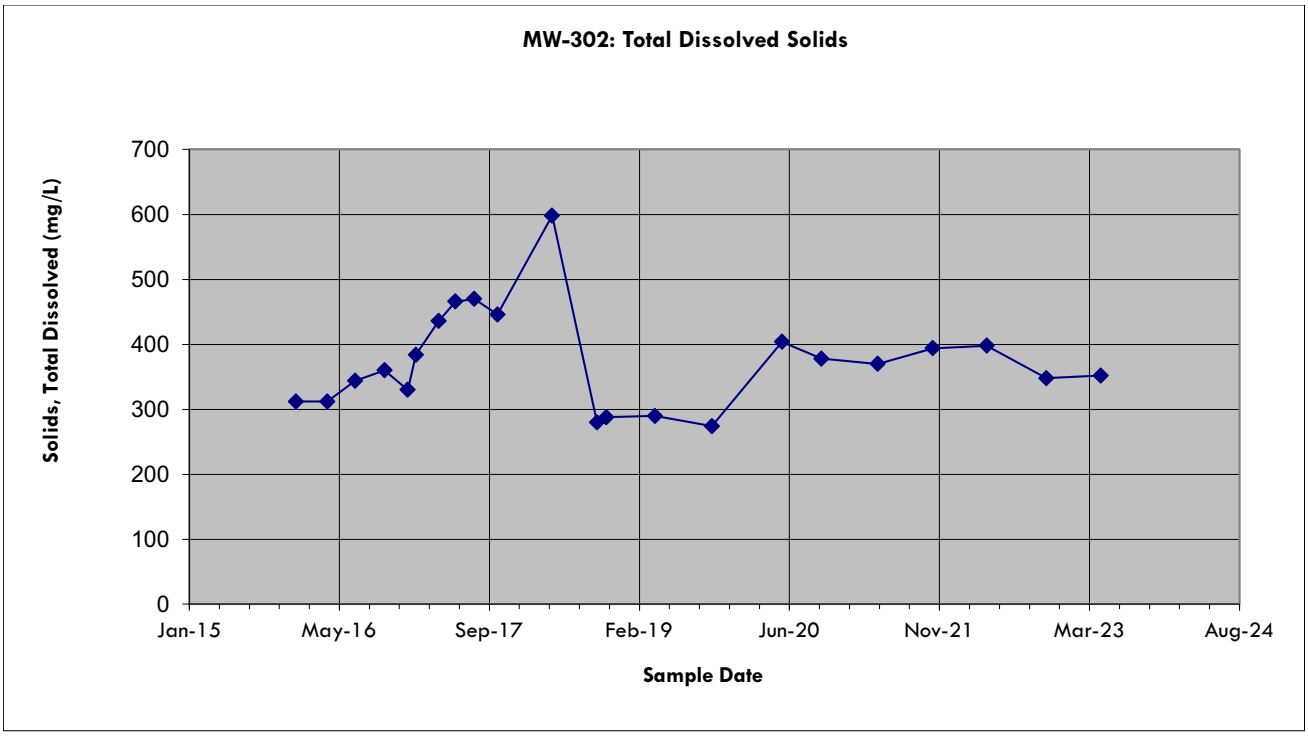

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-302	SOLIDS, TOTAL DISSOLVED (MG/L)	01	312	12/22/2015	312	312	
MW-302	SOLIDS, TOTAL DISSOLVED (MG/L)	01	312	4/5/2016	312	312	
MW-302	SOLIDS, TOTAL DISSOLVED (MG/L)	01	344	7/7/2016	344	344	
MW-302	SOLIDS, TOTAL DISSOLVED (MG/L)	01	360	10/13/2016	360	360	
MW-302	SOLIDS, TOTAL DISSOLVED (MG/L)	01	330	12/29/2016	330	330	
MW-302	SOLIDS, TOTAL DISSOLVED (MG/L)	01	384	1/25/2017	384	384	
MW-302	SOLIDS, TOTAL DISSOLVED (MG/L)	01	436	4/11/2017	436	436	
MW-302	SOLIDS, TOTAL DISSOLVED (MG/L)	01	466	6/6/2017	466	466	
MW-302	SOLIDS, TOTAL DISSOLVED (MG/L)	01	470	8/8/2017	470	470	
MW-302	SOLIDS, TOTAL DISSOLVED (MG/L)	01	446	10/24/2017	446	446	
MW-302	SOLIDS, TOTAL DISSOLVED (MG/L)	01	598	4/24/2018	598	598	
MW-302	SOLIDS, TOTAL DISSOLVED (MG/L)	01	280	9/21/2018	280	280	
MW-302	SOLIDS, TOTAL DISSOLVED (MG/L)	01	288	10/22/2018	288	288	
MW-302	SOLIDS, TOTAL DISSOLVED (MG/L)	01	290	4/2/2019	290	290	
MW-302	SOLIDS, TOTAL DISSOLVED (MG/L)	01	274	10/9/2019	274	274	
MW-302	SOLIDS, TOTAL DISSOLVED (MG/L)	01	404	5/29/2020	404	404	
MW-302	SOLIDS, TOTAL DISSOLVED (MG/L)	01	378	10/8/2020	378	378	
MW-302	SOLIDS, TOTAL DISSOLVED (MG/L)	01	370	4/13/2021	370	370	
MW-302	SOLIDS, TOTAL DISSOLVED (MG/L)	01	394	10/14/2021	394	394	
MW-302	SOLIDS, TOTAL DISSOLVED (MG/L)	01	398	4/12/2022	398	398	
MW-302	SOLIDS, TOTAL DISSOLVED (MG/L)	01	348	10/27/2022	348	348	
MW-302	SOLIDS, TOTAL DISSOLVED (MG/L)	01	352	4/27/2023	352	352	
Calculations							
Count						22	
Mean						374.27	
Std Dev						76.86	
3 X SD (PAL)						230.58	
Min Increase (PAL)						200	
PAL, Calculated						604.85	
PAL, Rounded						610	

Duplicate Data Not Used for Calculations							

Note: Data downloaded from ChemPoint

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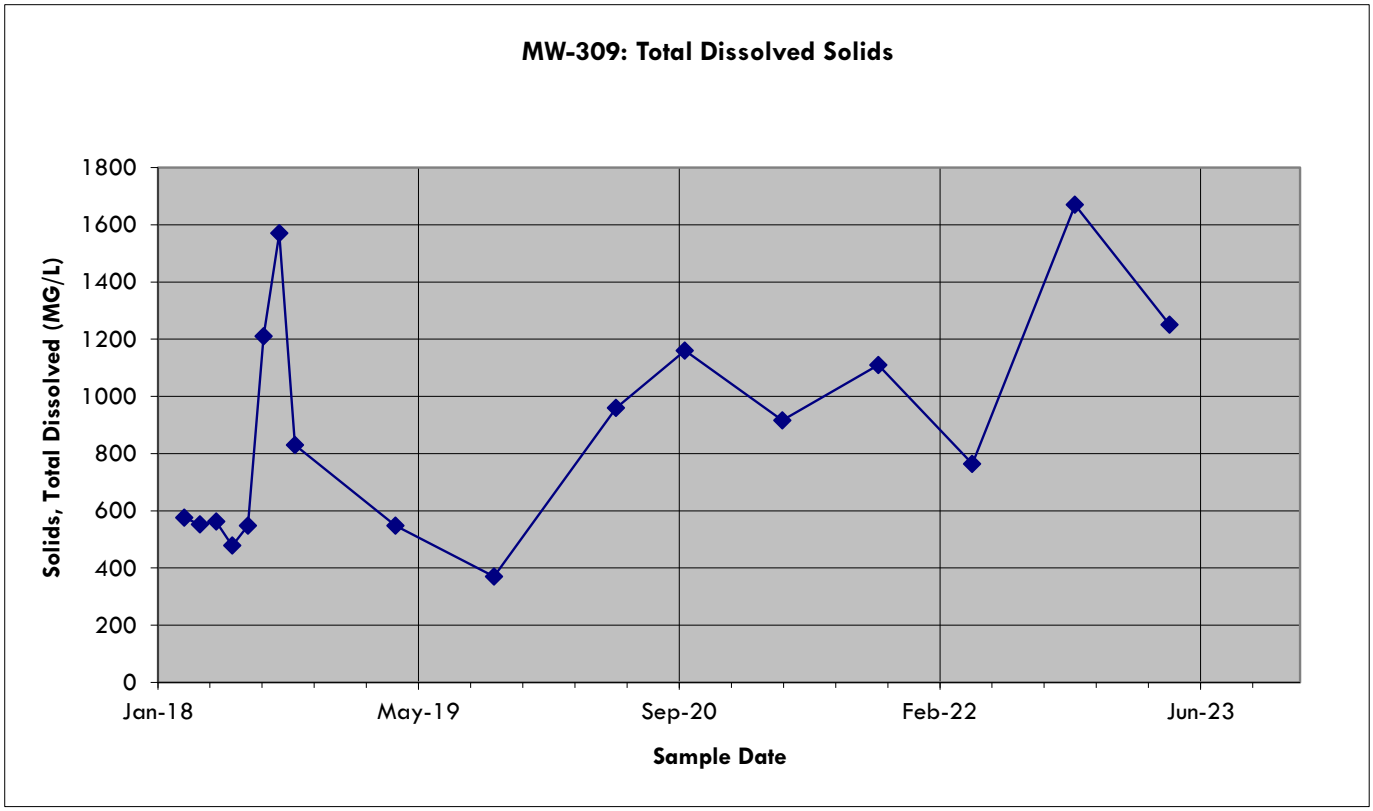
09/28/2023 - Classification: Internal - ECRM13153872



Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-309	SOLIDS, TOTAL DISSOLVED (MG/L)	01	576	2/21/2018	576	576	
MW-309	SOLIDS, TOTAL DISSOLVED (MG/L)	01	552	3/23/2018	552	552	
MW-309	SOLIDS, TOTAL DISSOLVED (MG/L)	01	562	4/23/2018	562	562	
MW-309	SOLIDS, TOTAL DISSOLVED (MG/L)	01	478	5/24/2018	478	478	
MW-309	SOLIDS, TOTAL DISSOLVED (MG/L)	01	548	6/23/2018	548	548	
MW-309	SOLIDS, TOTAL DISSOLVED (MG/L)	01	1210	7/23/2018	1210	1210	
MW-309	SOLIDS, TOTAL DISSOLVED (MG/L)	01	1570	8/22/2018	1570	1570	
MW-309	SOLIDS, TOTAL DISSOLVED (MG/L)	01	830	9/21/2018	830	830	
MW-309	SOLIDS, TOTAL DISSOLVED (MG/L)	01	548	4/2/2019	548	548	
MW-309	SOLIDS, TOTAL DISSOLVED (MG/L)	01	370	10/8/2019	370	370	
MW-309	SOLIDS, TOTAL DISSOLVED (MG/L)	01	960	5/29/2020	960	960	
MW-309	SOLIDS, TOTAL DISSOLVED (MG/L)	01	1160	10/8/2020	1160	1160	
MW-309	SOLIDS, TOTAL DISSOLVED (MG/L)	01	916	4/13/2021	916	916	
MW-309	SOLIDS, TOTAL DISSOLVED (MG/L)	01	1110	10/14/2021	1110	1110	
MW-309	SOLIDS, TOTAL DISSOLVED (MG/L)	01	764	4/12/2022	764	764	
MW-309	SOLIDS, TOTAL DISSOLVED (MG/L)	01	1670	10/26/2022	1670	1670	
MW-309	SOLIDS, TOTAL DISSOLVED (MG/L)	01	1250	4/26/2023	1250	1250	
Calculations							
Count						17	
Mean						886.71	
Std Dev						390.79	
3 X SD (PAL)						1172.37	
Min Increase (PAL)						200	
PAL, Calculated						2059.07	
PAL, Rounded						2,100	

Duplicate Data Not Used for Calculations							

Note:

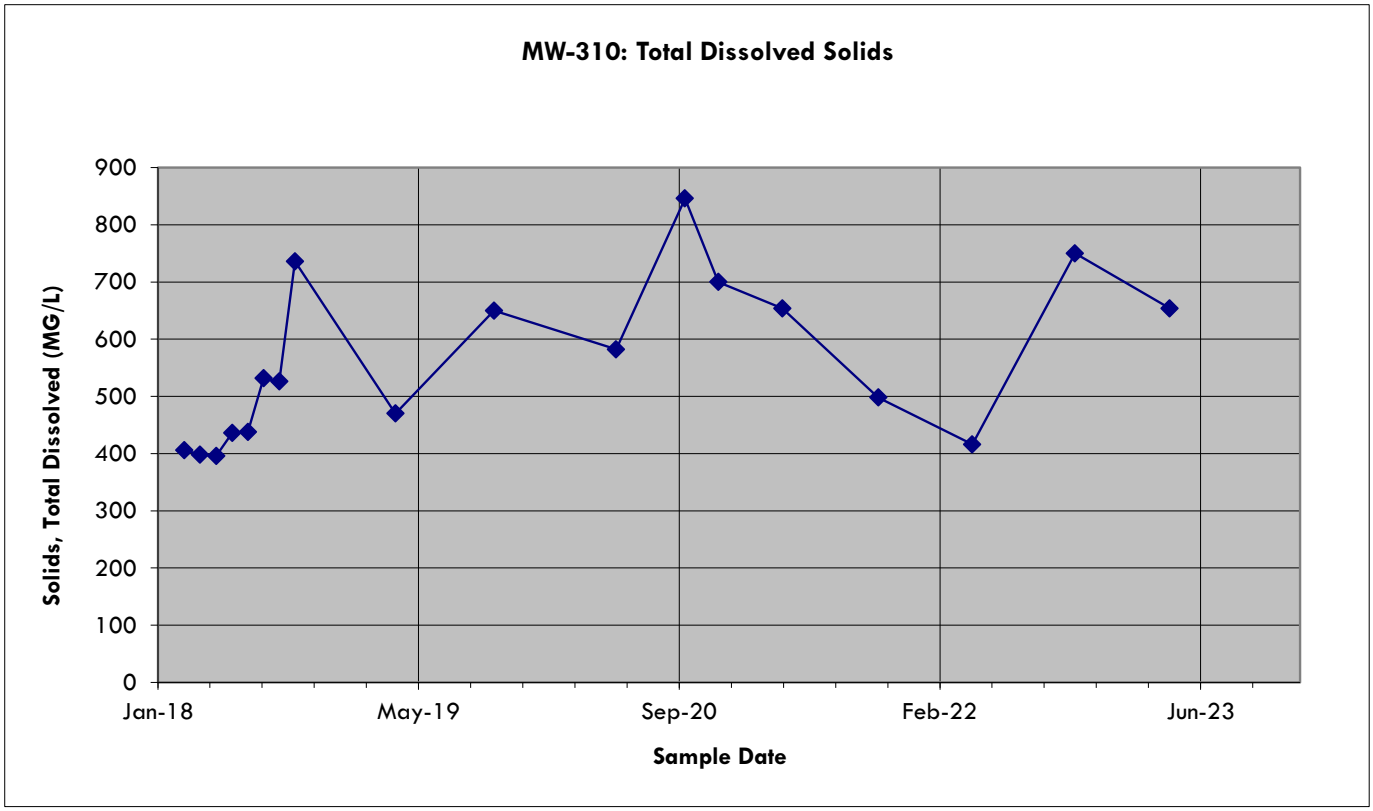
J = Result is an estimated value below the laboratory's limit of quantitation.

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes

P = Did not meet required preservation and/or hold time.

B = Compound detected in blank.

M = Failed method QC check.



Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-310	SOLIDS, TOTAL DISSOLVED (MG/L)	01	406	2/21/2018	406	406	
MW-310	SOLIDS, TOTAL DISSOLVED (MG/L)	01	398	3/23/2018	398	398	
MW-310	SOLIDS, TOTAL DISSOLVED (MG/L)	01	396	4/23/2018	396	396	
MW-310	SOLIDS, TOTAL DISSOLVED (MG/L)	01	436	5/24/2018	436	436	
MW-310	SOLIDS, TOTAL DISSOLVED (MG/L)	01	438	6/23/2018	438	438	
MW-310	SOLIDS, TOTAL DISSOLVED (MG/L)	01	532	7/23/2018	532	532	
MW-310	SOLIDS, TOTAL DISSOLVED (MG/L)	01	526	8/22/2018	526	526	
MW-310	SOLIDS, TOTAL DISSOLVED (MG/L)	01	736	9/21/2018	736	736	
MW-310	SOLIDS, TOTAL DISSOLVED (MG/L)	01	470	4/2/2019	470	470	
MW-310	SOLIDS, TOTAL DISSOLVED (MG/L)	01	650	10/8/2019	650	650	
MW-310	SOLIDS, TOTAL DISSOLVED (MG/L)	01	582	5/29/2020	582	582	
MW-310	SOLIDS, TOTAL DISSOLVED (MG/L)	01	846	10/8/2020	846	846	
MW-310	SOLIDS, TOTAL DISSOLVED (MG/L)	01	700	12/11/2020	700	700	
MW-310	SOLIDS, TOTAL DISSOLVED (MG/L)	01	654	4/13/2021	654	654	
MW-310	SOLIDS, TOTAL DISSOLVED (MG/L)	01	498	10/14/2021	498	498	
MW-310	SOLIDS, TOTAL DISSOLVED (MG/L)	01	416	4/12/2022	416	416	
MW-310	SOLIDS, TOTAL DISSOLVED (MG/L)	01	750	10/26/2022	750	750	
MW-310	SOLIDS, TOTAL DISSOLVED (MG/L)	01	654	4/26/2023	654	654	
Calculations							
Count						18	
Mean						560.44	
Std Dev						140.68	
3 X SD (PAL)						422.05	
Min Increase (PAL)						200	
PAL, Calculated						982.49	
PAL, Rounded						990	

Duplicate Data Not Used for Calculations							

Note:

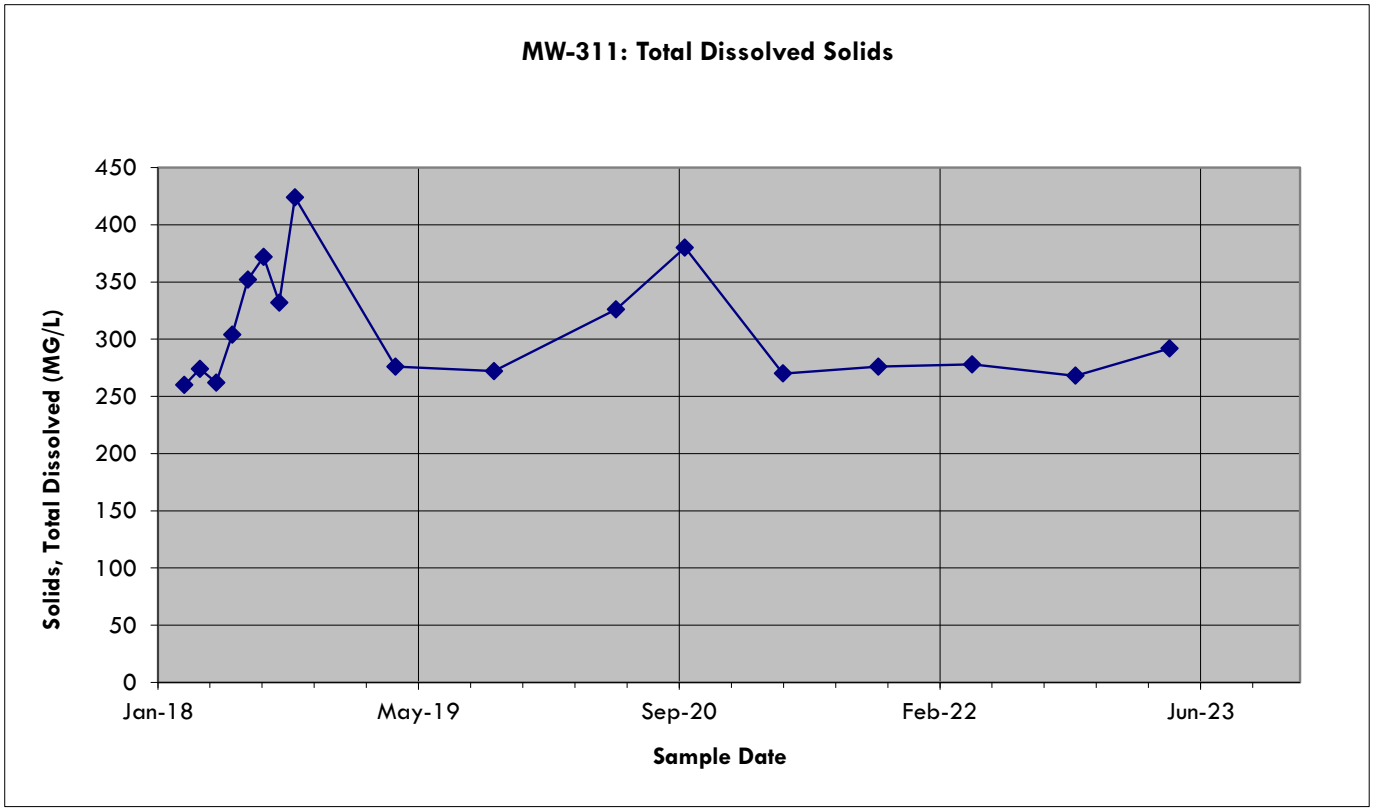
Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes

J = Result is an estimated value below the laboratory's limit of quantitation.

P = Did not meet required preservation and/or hold time.

B = Compound detected in blank.

M = Failed method QC check.



Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-311	SOLIDS, TOTAL DISSOLVED (MG/L)	01	260	2/21/2018	260	260	
MW-311	SOLIDS, TOTAL DISSOLVED (MG/L)	01	274	3/23/2018	274	274	
MW-311	SOLIDS, TOTAL DISSOLVED (MG/L)	01	262	4/23/2018	262	262	
MW-311	SOLIDS, TOTAL DISSOLVED (MG/L)	01	304	5/24/2018	304	304	
MW-311	SOLIDS, TOTAL DISSOLVED (MG/L)	01	352	6/23/2018	352	352	
MW-311	SOLIDS, TOTAL DISSOLVED (MG/L)	01	372	7/23/2018	372	372	
MW-311	SOLIDS, TOTAL DISSOLVED (MG/L)	01	332	8/22/2018	332	332	
MW-311	SOLIDS, TOTAL DISSOLVED (MG/L)	01	424	9/21/2018	424	424	
MW-311	SOLIDS, TOTAL DISSOLVED (MG/L)	01	276	4/2/2019	276	276	
MW-311	SOLIDS, TOTAL DISSOLVED (MG/L)	01	272	10/8/2019	272	272	
MW-311	SOLIDS, TOTAL DISSOLVED (MG/L)	01	326	5/29/2020	326	326	
MW-311	SOLIDS, TOTAL DISSOLVED (MG/L)	01	380	10/8/2020	380	380	
MW-311	SOLIDS, TOTAL DISSOLVED (MG/L)	01	270	4/14/2021	270	270	
MW-311	SOLIDS, TOTAL DISSOLVED (MG/L)	01	276	10/14/2021	276	276	
MW-311	SOLIDS, TOTAL DISSOLVED (MG/L)	01	278	4/12/2022	278	278	
MW-311	SOLIDS, TOTAL DISSOLVED (MG/L)	01	268	10/27/2022	268	268	
MW-311	SOLIDS, TOTAL DISSOLVED (MG/L)	01	292	4/26/2023	292	292	
Calculations							
Count						17	
Mean						306.94	
Std Dev						49.17	
3 X SD (PAL)						147.52	
Min Increase (PAL)						200	
PAL, Calculated						506.94	
PAL, Rounded						510	

Duplicate Data Not Used for Calculations							

Note:

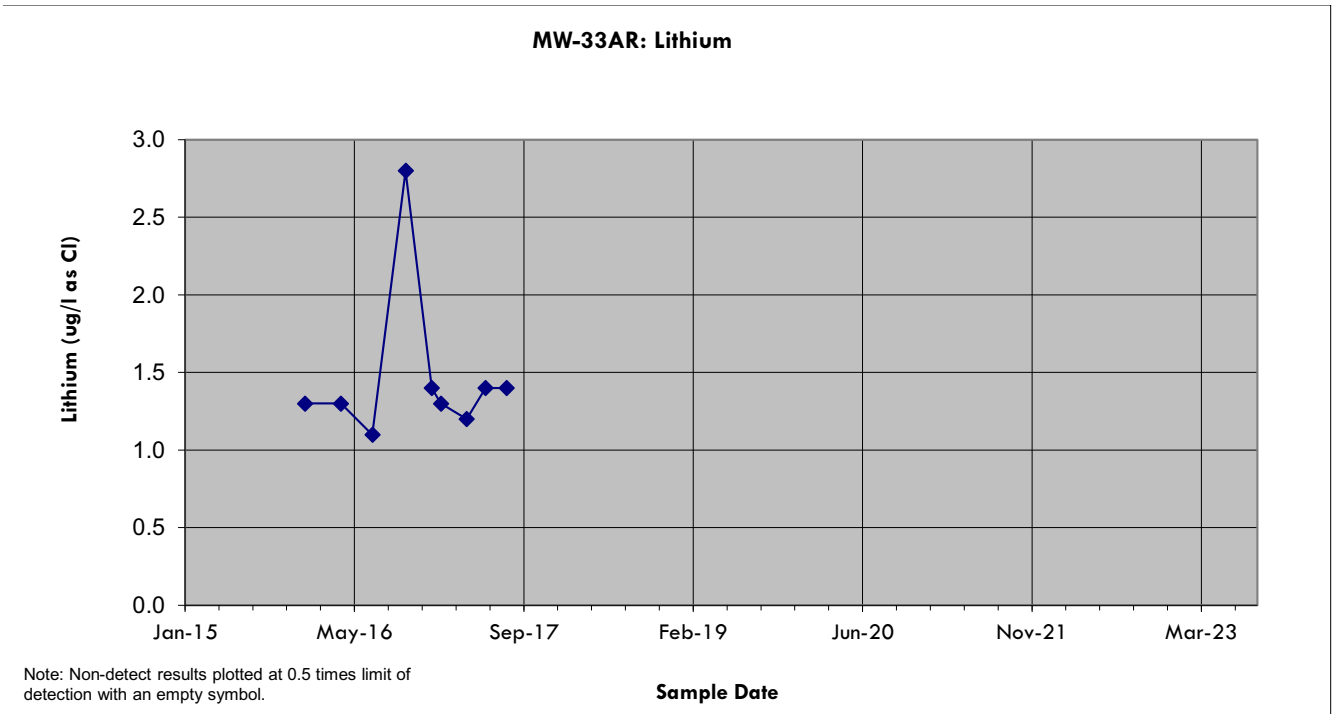
J = Result is an estimated value below the laboratory's limit of quantitation.

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes

P = Did not meet required preservation and/or hold time.

B = Compound detected in blank.

M = Failed method QC check.



Note: Non-detect results plotted at 0.5 times limit of detection with an empty symbol.

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-33AR	Lithium, Total (ug/L)	01	1.3	12/21/2015	1.3	1.3	
MW-33AR	Lithium, Total (ug/L)	01	1.3	4/5/2016	1.3	1.3	
MW-33AR	Lithium, Total (ug/L)	01	1.1	7/7/2016	1.1	1.1	
MW-33AR	Lithium, Total (ug/L)	01	2.8	10/13/2016	2.8	2.8	
MW-33AR	Lithium, Total (ug/L)	01	1.4	12/29/2016	1.4	1.4	
MW-33AR	Lithium, Total (ug/L)	01	1.3	1/25/2017	1.3	1.3	
MW-33AR	Lithium, Total (ug/L)	01	1.2	4/11/2017	1.2	1.2	
MW-33AR	Lithium, Total (ug/L)	01	1.4	6/6/2017	1.4	1.4	
MW-33AR	Lithium, Total (ug/L)	01	1.4	8/7/2017	1.4	1.4	
Calculations							
Count						9	
Mean						1.5	
Std Dev						0.51	
3 X SD (PAL)						1.5	
PAL, Calculated						3.0	
PAL, Rounded						3.0	

Duplicate Data Not Used for Calculations							

Note: Current PAL = 125 mg/l; ES = 250 mg/l; data downloaded from ChemPoint
J = Result is an estimated value below the laboratory's limit of quantitation.
P = Did not meet required preservation and/or hold time.
B = Compound detected in blank.
M = Failed method QC check.

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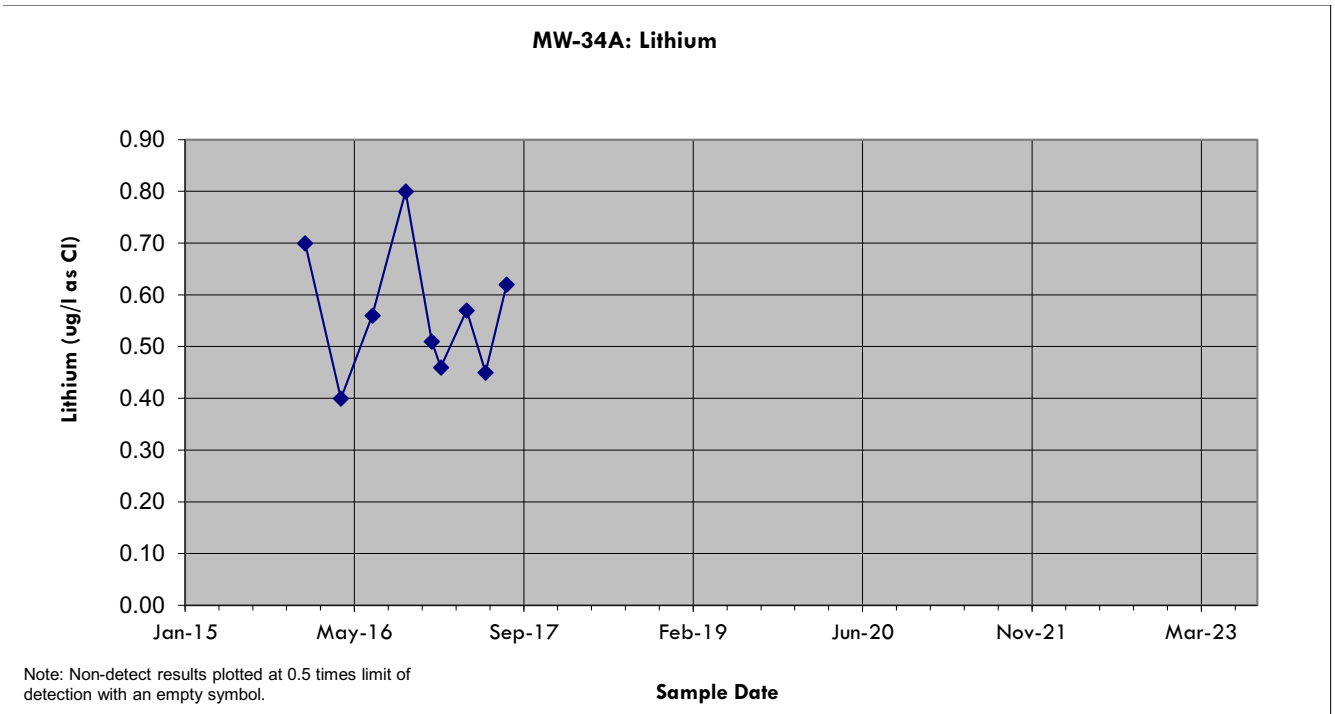
09/28/2023 - Classification: Internal - ECRM13153872



Note: Non-detect results plotted at 0.5 times limit of detection with an empty symbol.

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-34A	Lithium, Total (ug/L)	01	0.7	12/21/2015	0.7	0.7	J
MW-34A	Lithium, Total (ug/L)	01	0.4	4/5/2016	0.4	0.4	J
MW-34A	Lithium, Total (ug/L)	01	0.56	7/7/2016	0.56	0.56	J
MW-34A	Lithium, Total (ug/L)	01	0.8	10/13/2016	0.8	0.8	J
MW-34A	Lithium, Total (ug/L)	01	0.51	12/29/2016	0.51	0.51	J
MW-34A	Lithium, Total (ug/L)	01	0.46	1/25/2017	0.46	0.46	J
MW-34A	Lithium, Total (ug/L)	01	0.57	4/11/2017	0.57	0.57	J
MW-34A	Lithium, Total (ug/L)	01	0.45	6/6/2017	0.45	0.45	J
MW-34A	Lithium, Total (ug/L)	01	0.62	8/7/2017	0.62	0.62	J
Calculations							
Count						9	
Mean						0.56	
Std Dev						0.13	
3 X SD (PAL)						0.38	
PAL, Calculated						0.95	
PAL, Rounded						1.0	

Duplicate Data Not Used for Calculations							
MW-34A	Lithium, Total (ug/L)	02	0.64	12/21/2015	0.64	0.64	J

Note: Current PAL = 125 mg/l; ES = 250 mg/l; data downloaded from ChemPoint
J = Result is an estimated value below the laboratory's limit of quantitation.
P = Did not meet required preservation and/or hold time.
B = Compound detected in blank.
M = Failed method QC check.

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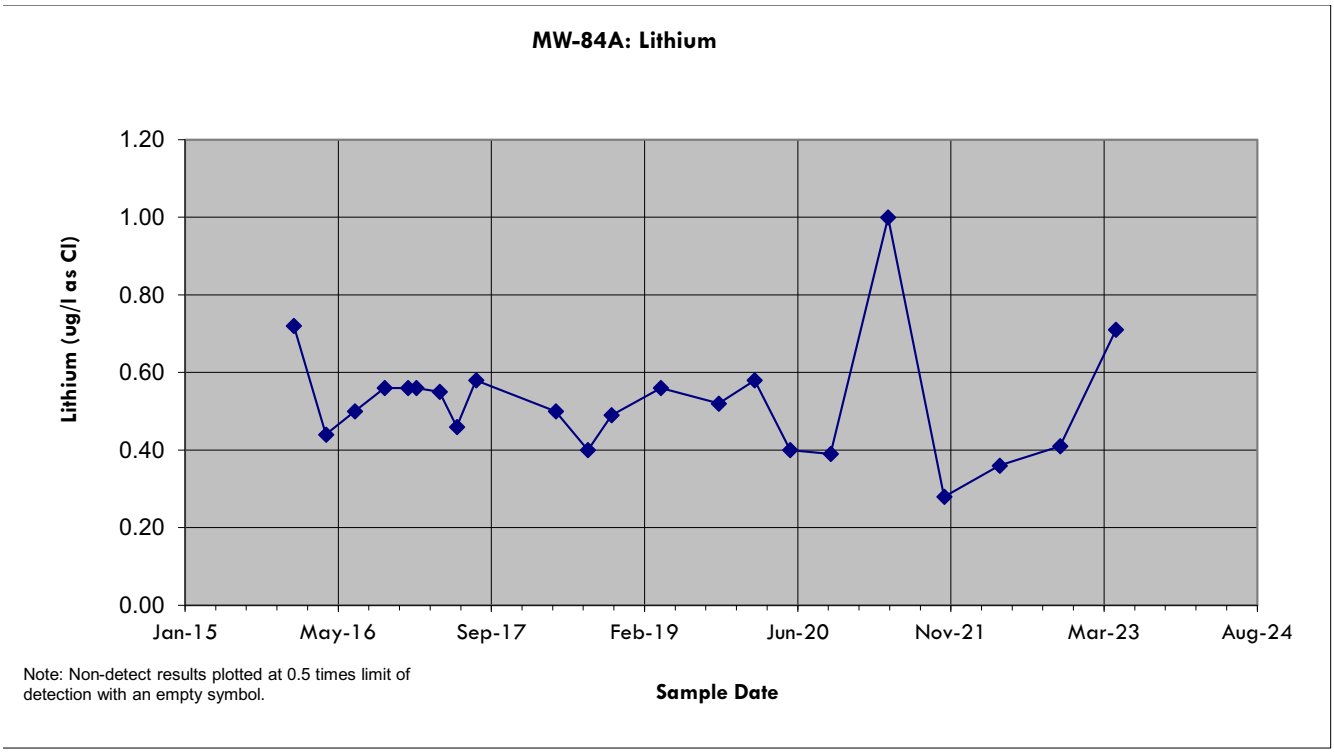
09/28/2023 - Classification: Internal - ECRM13153872



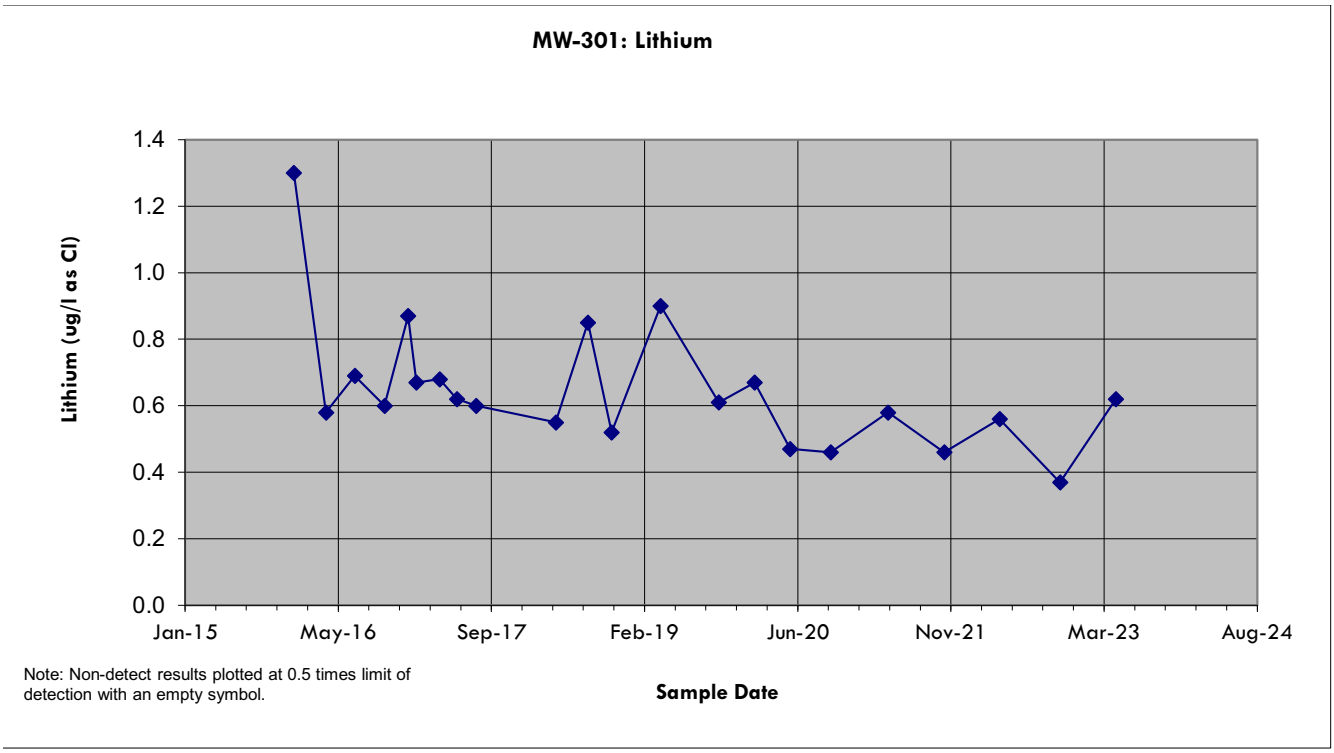
Note: Non-detect results plotted at 0.5 times limit of detection with an empty symbol.

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-84A	Lithium, Total (ug/L)	01	0.72	12/22/2015	0.72	0.72	J
MW-84A	Lithium, Total (ug/L)	01	0.44	4/5/2016	0.44	0.44	J
MW-84A	Lithium, Total (ug/L)	01	0.5	7/8/2016	0.5	0.5	J
MW-84A	Lithium, Total (ug/L)	01	0.56	10/13/2016	0.56	0.56	J
MW-84A	Lithium, Total (ug/L)	01	0.56	12/29/2016	0.56	0.56	J
MW-84A	Lithium, Total (ug/L)	01	0.56	1/25/2017	0.56	0.56	J
MW-84A	Lithium, Total (ug/L)	01	0.55	4/11/2017	0.55	0.55	J
MW-84A	Lithium, Total (ug/L)	01	0.46	6/6/2017	0.46	0.46	J
MW-84A	Lithium, Total (ug/L)	01	0.58	8/8/2017	0.58	0.58	J
MW-84A	Lithium, Total (ug/L)	01	0.5	4/25/2018	0.5	0.5	J
MW-84A	Lithium, Total (ug/L)	01	0.4	8/8/2018	0.4	0.4	J
MW-84A	Lithium, Total (ug/L)	01	0.49	10/24/2018	0.49	0.49	J
MW-84A	Lithium, Total (ug/L)	01	0.56	4/3/2019	0.56	0.56	J
MW-84A	Lithium, Total (ug/L)	01	0.52	10/9/2019	0.52	0.52	J
MW-84A	Lithium, Total (ug/L)	01	0.58	2/3/2020	0.58	0.58	J
MW-84A	Lithium, Total (ug/L)	01	0.4	5/29/2020	0.4	0.4	J
MW-84A	Lithium, Total (ug/L)	01	0.39	10/8/2020	0.39	0.39	J
MW-84A	Lithium, Total (ug/L)	01	1	4/14/2021	1	1	
MW-84A	Lithium, Total (ug/L)	01	0.28	10/14/2021	0.28	0.28	J
MW-84A	Lithium, Total (ug/L)	01	0.36	4/13/2022	0.36	0.36	J
MW-84A	Lithium, Total (ug/L)	01	0.41	10/27/2022	0.41	0.41	J
MW-84A	Lithium, Total (ug/L)	01	0.71	4/27/2023	0.71	0.71	J
Calculations							
Count						22	
Mean						0.52	
Std Dev						0.15	
3 X SD (PAL)						0.45	
PAL, Calculated						0.97	
PAL, Rounded						1.0	

Duplicate Data Not Used for Calculations							

Note: Current PAL = 125 mg/l; ES = 250 mg/l; data downloaded from ChemPoint
J = Result is an estimated value below the laboratory's limit of quantitation.
P = Did not meet required preservation and/or hold time.
B = Compound detected in blank.
M = Failed method QC check.

09/28/2023 - Classification: Internal - ECRM13153872



Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-301	Lithium, Total (ug/L)	01	1.3	12/22/2015	1.3	1.3	
MW-301	Lithium, Total (ug/L)	01	0.58	4/5/2016	0.58	0.58	J
MW-301	Lithium, Total (ug/L)	01	0.69	7/8/2016	0.69	0.69	J
MW-301	Lithium, Total (ug/L)	01	0.6	10/13/2016	0.6	0.6	J
MW-301	Lithium, Total (ug/L)	01	0.87	12/29/2016	0.87	0.87	J
MW-301	Lithium, Total (ug/L)	01	0.67	1/25/2017	0.67	0.67	J
MW-301	Lithium, Total (ug/L)	01	0.68	4/11/2017	0.68	0.68	J
MW-301	Lithium, Total (ug/L)	01	0.62	6/6/2017	0.62	0.62	J
MW-301	Lithium, Total (ug/L)	01	0.6	8/8/2017	0.6	0.6	J
MW-301	Lithium, Total (ug/L)	01	0.55	4/25/2018	0.55	0.55	J
MW-301	Lithium, Total (ug/L)	01	0.85	8/8/2018	0.85	0.85	J
MW-301	Lithium, Total (ug/L)	01	0.52	10/24/2018	0.52	0.52	J
MW-301	Lithium, Total (ug/L)	01	0.9	4/2/2019	0.9	0.9	J
MW-301	Lithium, Total (ug/L)	01	0.61	10/9/2019	0.61	0.61	J
MW-301	Lithium, Total (ug/L)	01	0.67	2/3/2020	0.67	0.67	J
MW-301	Lithium, Total (ug/L)	01	0.47	5/29/2020	0.47	0.47	J
MW-301	Lithium, Total (ug/L)	01	0.46	10/8/2020	0.46	0.46	J
MW-301	Lithium, Total (ug/L)	01	0.58	4/14/2021	0.58	0.58	J
MW-301	Lithium, Total (ug/L)	01	0.46	10/14/2021	0.46	0.46	J
MW-301	Lithium, Total (ug/L)	01	0.56	4/13/2022	0.56	0.56	J
MW-301	Lithium, Total (ug/L)	01	0.37	10/27/2022	0.37	0.37	J
MW-301	Lithium, Total (ug/L)	01	0.62	4/27/2023	0.62	0.62	J
Calculations							
Count						22	
Mean						0.65	
Std Dev						0.20	
3 X SD (PAL)						0.59	
PAL, Calculated						1.24	
PAL, Rounded						1.3	

Duplicate Data Not Used for Calculations							

Note: Current PAL = 125 mg/l; ES = 250 mg/l; data downloaded from ChemPoint
J = Result is an estimated value below the laboratory's limit of quantitation.
P = Did not meet required preservation and/or hold time.
B = Compound detected in blank.

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Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes

M = Failed method QC check.

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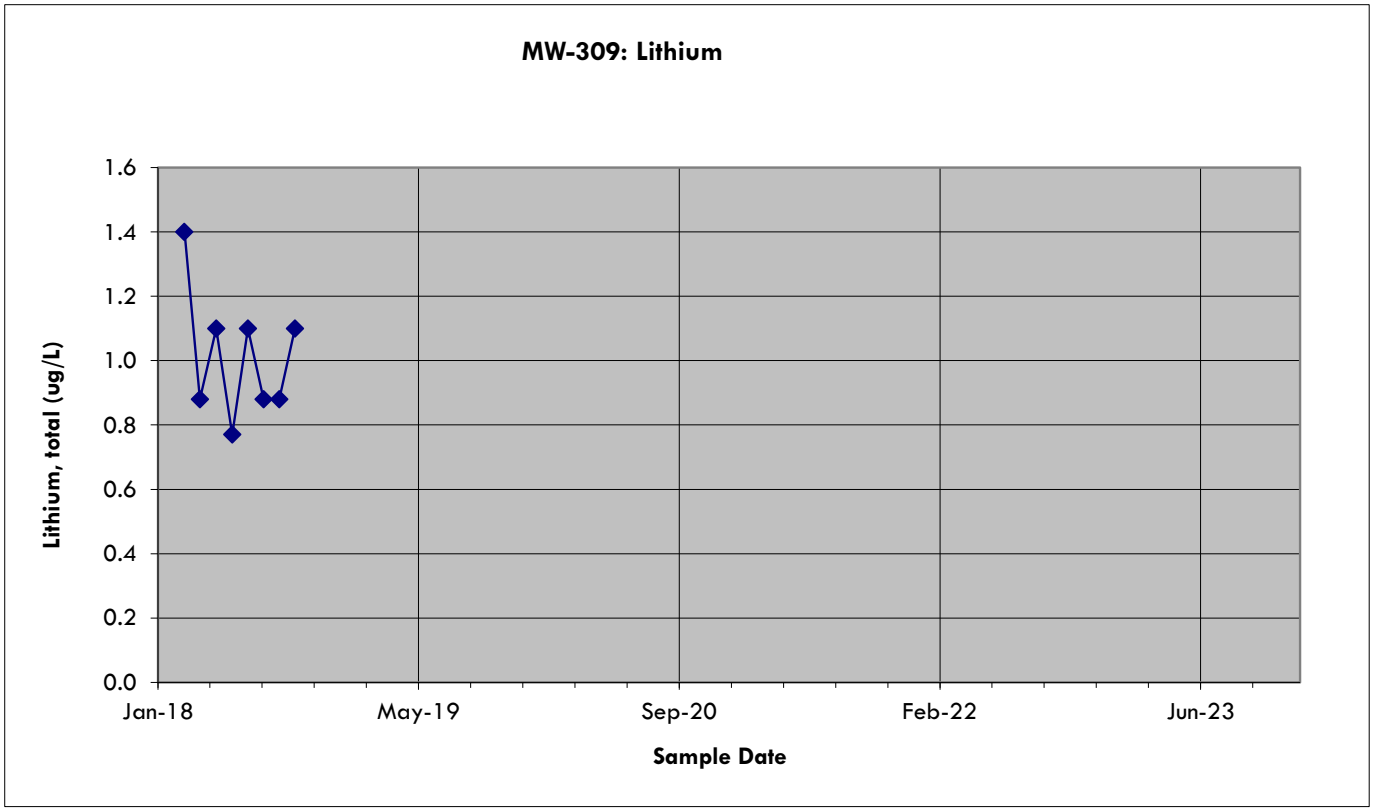


Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-309	LITHIUM, TOTAL (UG/L)	01	1.4	2/21/2018	1.4	1.4	
MW-309	LITHIUM, TOTAL (UG/L)	01	0.88	3/23/2018	0.88	0.88	J
MW-309	LITHIUM, TOTAL (UG/L)	01	1.1	4/23/2018	1.1	1.1	
MW-309	LITHIUM, TOTAL (UG/L)	01	0.77	5/24/2018	0.77	0.77	J
MW-309	LITHIUM, TOTAL (UG/L)	01	1.1	6/23/2018	1.1	1.1	
MW-309	LITHIUM, TOTAL (UG/L)	01	0.88	7/23/2018	0.88	0.88	J
MW-309	LITHIUM, TOTAL (UG/L)	01	1.1	8/22/2018	0.88	0.88	
MW-309	LITHIUM, TOTAL (UG/L)	01	0.76	9/21/2018	1.1	1.1	J
Calculations							
Count						8	
Mean						1.01	
Std Dev						0.20	
3 X SD (PAL)						0.60	
Min Increase (PAL)						N/A	
PAL, Calculated						1.62	
PAL, Rounded						1.7	

Duplicate Data Not Used for Calculations							

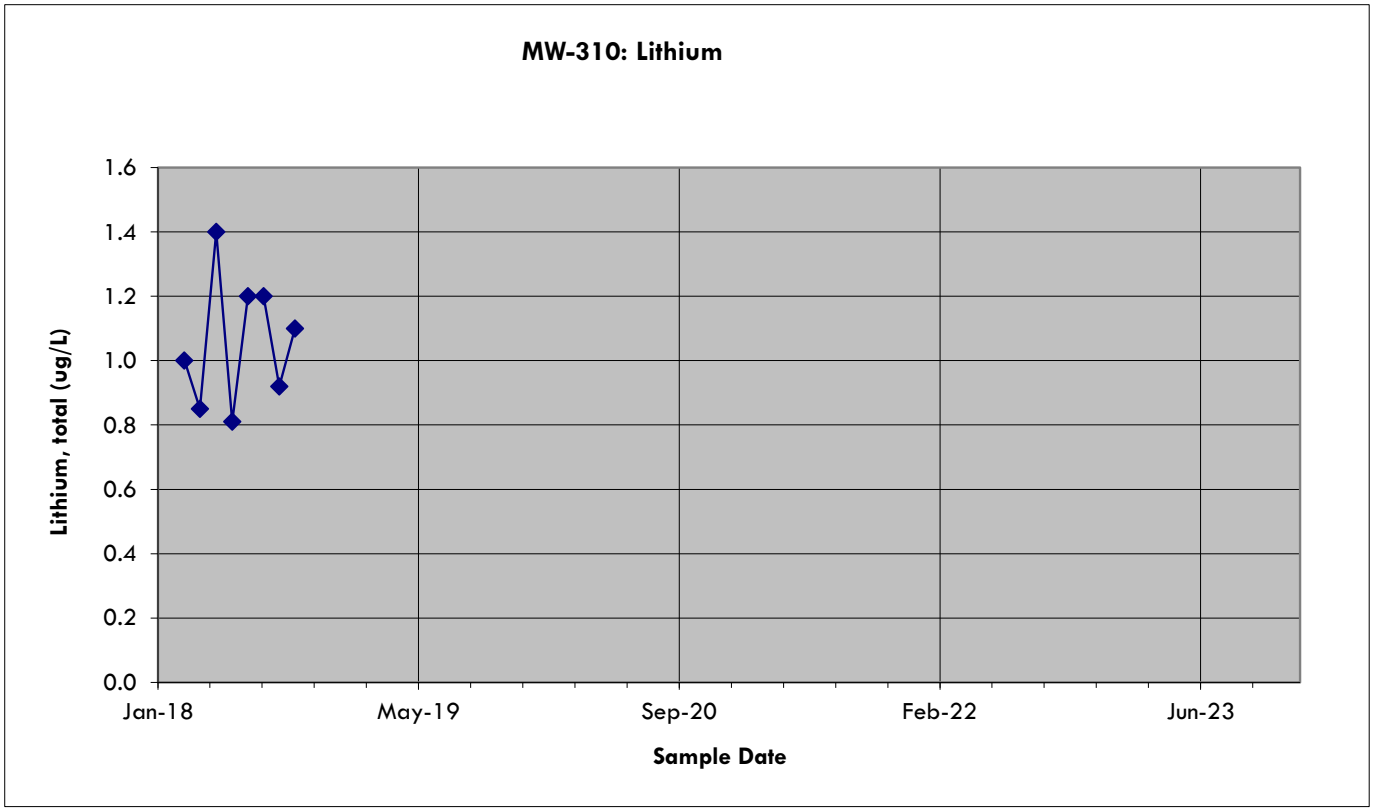
Note:

J = Result is an estimated value below the laboratory's limit of quantitation.

P = Did not meet required preservation and/or hold time.

B = Compound detected in blank.

M = Failed method QC check.



Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-310	LITHIUM, TOTAL (UG/L)	01	1.0	2/21/2018	1.0	1.0	
MW-310	LITHIUM, TOTAL (UG/L)	01	0.85	3/23/2018	0.85	0.85	J
MW-310	LITHIUM, TOTAL (UG/L)	01	1.40	4/23/2018	1.40	1.40	
MW-310	LITHIUM, TOTAL (UG/L)	01	0.81	5/24/2018	0.81	0.81	J
MW-310	LITHIUM, TOTAL (UG/L)	01	1.20	6/23/2018	1.20	1.20	
MW-310	LITHIUM, TOTAL (UG/L)	01	1.20	7/23/2018	1.20	1.20	
MW-310	LITHIUM, TOTAL (UG/L)	01	0.92	8/22/2018	0.92	0.92	J
MW-310	LITHIUM, TOTAL (UG/L)	01	1.10	9/21/2018	1.10	1.10	
Calculations							
Count						8	
Mean						1.06	
Std Dev						0.20	
3 X SD (PAL)						0.61	
Min Increase (PAL)						N/A	
PAL, Calculated						1.67	
PAL, Rounded						1.7	

Duplicate Data Not Used for Calculations							

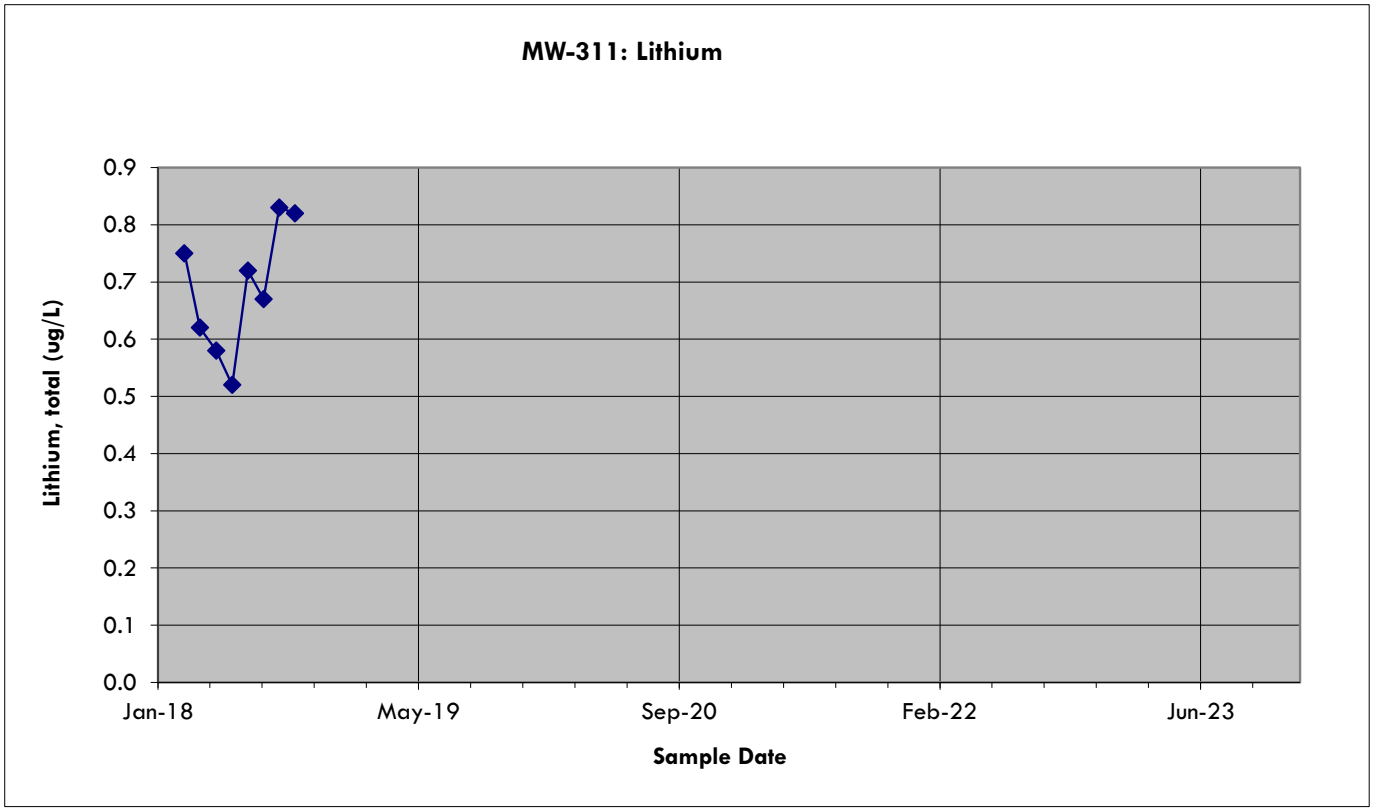
Note:

J = Result is an estimated value below the laboratory's limit of quantitation.

P = Did not meet required preservation and/or hold time.

B = Compound detected in blank.

M = Failed method QC check.



Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-311	LITHIUM, TOTAL (UG/L)	01	0.75	2/21/2018	0.75	0.75	J
MW-311	LITHIUM, TOTAL (UG/L)	01	0.62	3/23/2018	0.62	0.62	J
MW-311	LITHIUM, TOTAL (UG/L)	01	0.58	4/23/2018	0.58	0.58	J
MW-311	LITHIUM, TOTAL (UG/L)	01	0.52	5/24/2018	0.52	0.52	J
MW-311	LITHIUM, TOTAL (UG/L)	01	0.72	6/23/2018	0.72	0.72	J
MW-311	LITHIUM, TOTAL (UG/L)	01	0.67	7/23/2018	0.67	0.67	J
MW-311	LITHIUM, TOTAL (UG/L)	01	0.83	8/22/2018	0.83	0.83	J
MW-311	LITHIUM, TOTAL (UG/L)	01	0.82	9/21/2018	0.82	0.82	J
Calculations							
Count						8	
Mean						0.69	
Std Dev						0.11	
3 X SD (PAL)						0.34	
Min Increase (PAL)						N/A	
PAL, Calculated						1.02	
PAL, Rounded						1.1	

Duplicate Data Not Used for Calculations							

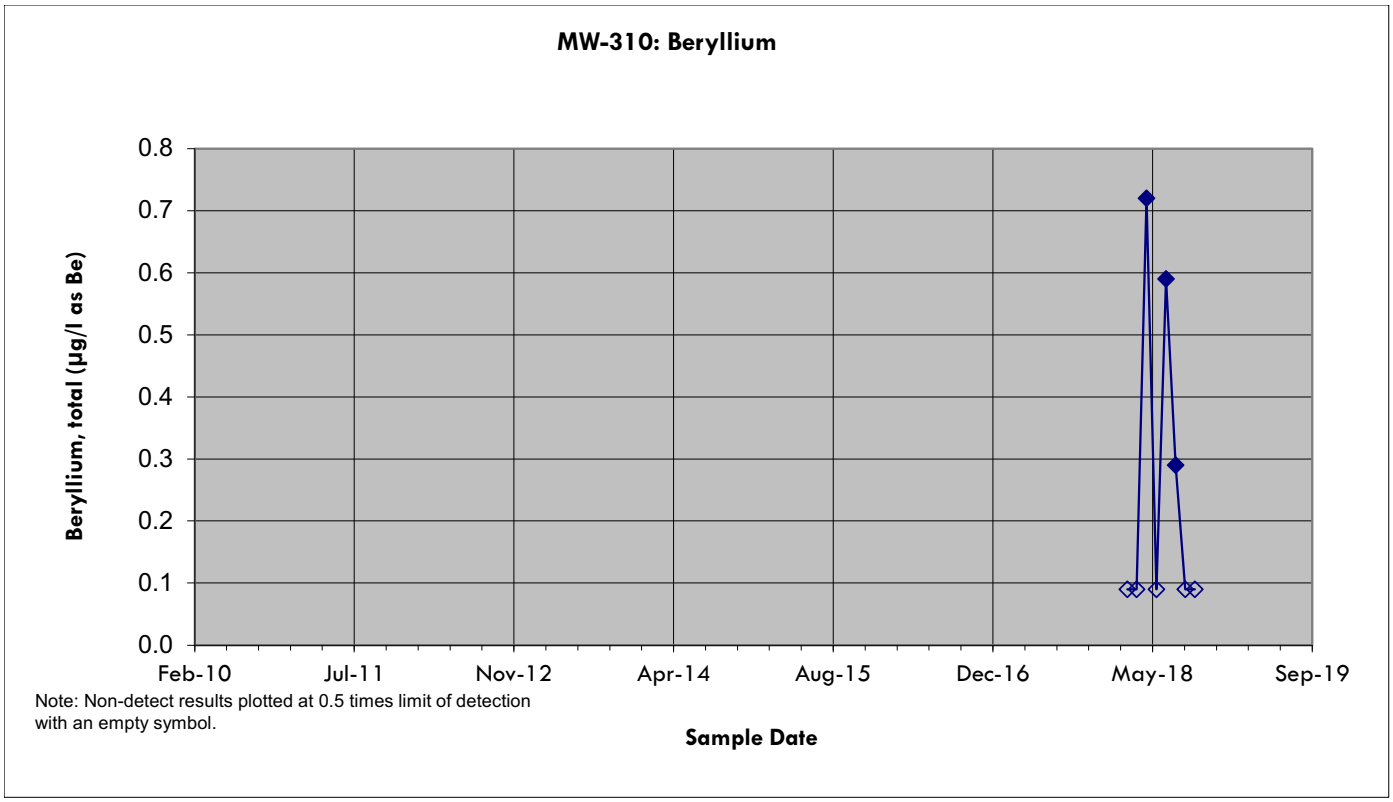
Note:

J = Result is an estimated value below the laboratory's limit of quantitation.

P = Did not meet required preservation and/or hold time.

B = Compound detected in blank.

M = Failed method QC check.



Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-310	BERYLLIUM, TOTAL (UG/L B)	01	<0.18	2/21/2018	0.09	0.09	
MW-310	BERYLLIUM, TOTAL (UG/L B)	01	<0.18	3/23/2018	0.09	0.09	
MW-310	BERYLLIUM, TOTAL (UG/L B)	01	0.72	4/23/2018	0.72	0.72	J
MW-310	BERYLLIUM, TOTAL (UG/L B)	01	<0.18	5/24/2018	0.09	0.09	
MW-310	BERYLLIUM, TOTAL (UG/L B)	01	0.59	6/23/2018	0.59	0.59	J
MW-310	BERYLLIUM, TOTAL (UG/L B)	01	0.29	7/23/2018	0.29	0.29	J
MW-310	BERYLLIUM, TOTAL (UG/L B)	01	<0.18	8/22/2018	0.09	0.09	
MW-310	BERYLLIUM, TOTAL (UG/L B)	01	<0.18	9/21/2018	0.09	0.09	
Calculations							
Count						8	
Mean						0.26	
Std Dev						0.26	
2 X SD (ACL)						0.52	
ACL, Calculated						0.77	
ACL, Rounded						0.78	

Duplicate Data Not Used for Calculations							

Note: Current PAL = 0.4 ug/l; ES = 4 ug/l

J = Result is an estimated value below the laboratory's limit of quantitation.

P = Did not meet required preservation and/or hold time.

B = Compound detected in blank.

M = Failed method QC check.

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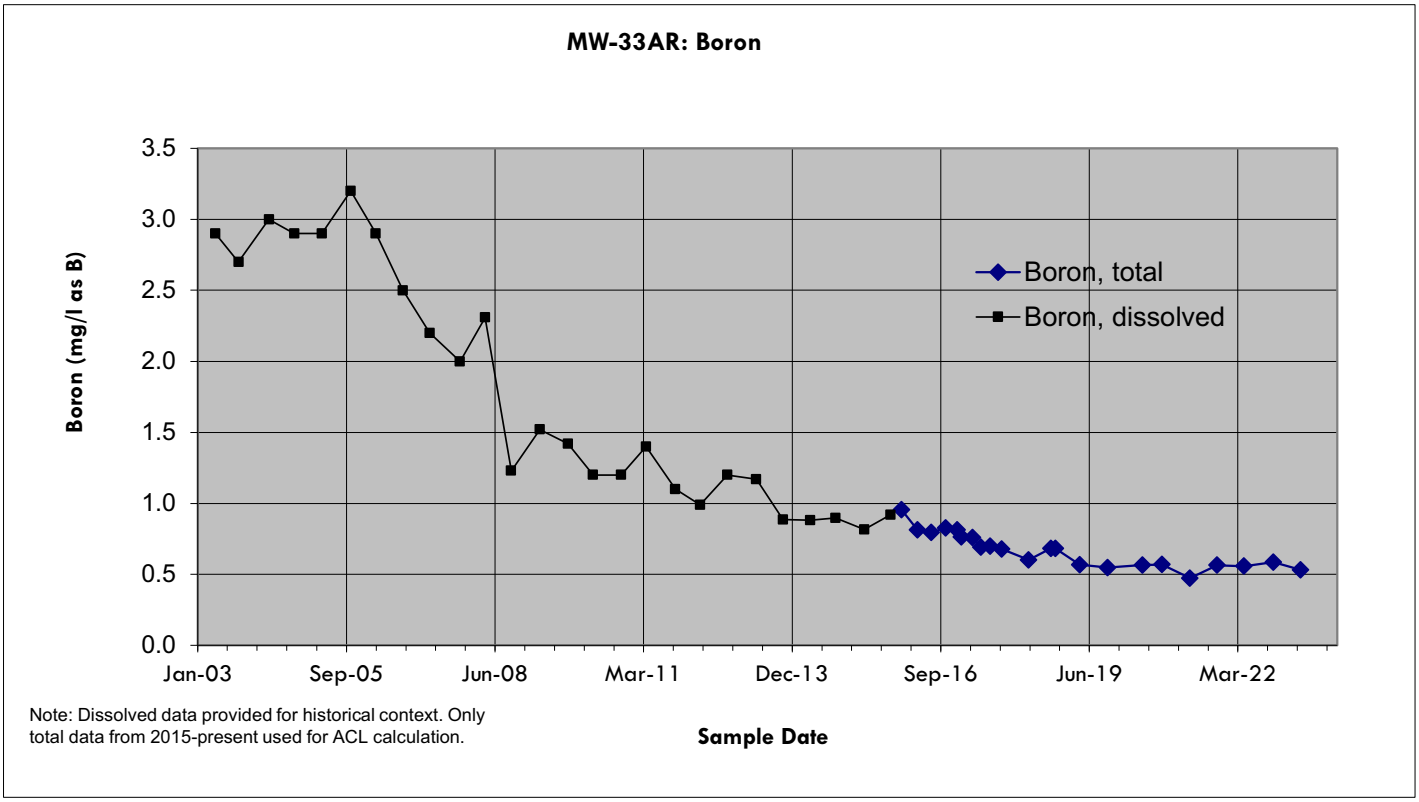

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-33AR	BORON, DISSOLVED (MG/L B)	01	2.9	4/29/2003	2.9		
MW-33AR	BORON, DISSOLVED (MG/L B)	01	2.7	10/3/2003	2.7		
MW-33AR	BORON, DISSOLVED (MG/L B)	01	3	4/24/2004	3		
MW-33AR	BORON, DISSOLVED (MG/L B)	01	2.9	10/12/2004	2.9		
MW-33AR	BORON, DISSOLVED (MG/L B)	01	2.9	4/15/2005	2.9		
MW-33AR	BORON, DISSOLVED (MG/L B)	01	3.2	10/26/2005	3.2		
MW-33AR	BORON, DISSOLVED (MG/L B)	01	2.9	4/13/2006	2.9		
MW-33AR	BORON, DISSOLVED (MG/L B)	01	2.5	10/12/2006	2.5		
MW-33AR	BORON, DISSOLVED (MG/L B)	01	2.2	4/11/2007	2.2		
MW-33AR	BORON, DISSOLVED (MG/L B)	01	2	10/31/2007	2		
MW-33AR	BORON, DISSOLVED (MG/L B)	01	2.31	4/17/2008	2.31		
MW-33AR	BORON, DISSOLVED (MG/L B)	01	1.23	10/10/2008	1.23		
MW-33AR	BORON, DISSOLVED (MG/L B)	01	1.52	4/21/2009	1.52		
MW-33AR	BORON, DISSOLVED (MG/L B)	01	1.42	10/27/2009	1.42		
MW-33AR	BORON, DISSOLVED (MG/L B)	01	1.2	4/14/2010	1.2		
MW-33AR	BORON, DISSOLVED (MG/L B)	01	1.2	10/20/2010	1.2		
MW-33AR	BORON, DISSOLVED (MG/L B)	01	1.4	4/6/2011	1.4		
MW-33AR	BORON, DISSOLVED (MG/L B)	01	1.1	10/20/2011	1.1		
MW-33AR	BORON, DISSOLVED (MG/L B)	01	0.99	4/4/2012	0.99		
MW-33AR	BORON, DISSOLVED (MG/L B)	01	1.2	10/4/2012	1.2		
MW-33AR	BORON, DISSOLVED (MG/L B)	01	1.17	4/17/2013	1.17		
MW-33AR	BORON, DISSOLVED (MG/L B)	01	0.886	10/14/2013	0.886		
MW-33AR	BORON, DISSOLVED (MG/L B)	01	0.881	4/16/2014	0.881		
MW-33AR	BORON, DISSOLVED (MG/L B)	01	0.897	10/2/2014	0.897		
MW-33AR	BORON, DISSOLVED (MG/L B)	01	0.815	4/14/2015	0.815		
MW-33AR	BORON, DISSOLVED (MG/L B)	01	0.92	10/7/2015	0.92		
MW-33AR	BORON, TOTAL (MG/L B)	01	0.954	12/21/2015	0.954	0.954	
MW-33AR	BORON, TOTAL (MG/L B)	01	0.813	4/5/2016	0.813	0.813	
MW-33AR	BORON, TOTAL (MG/L B)	01	0.794	7/7/2016	0.794	0.794	
MW-33AR	BORON, TOTAL (MG/L B)	01	0.827	10/13/2016	0.827	0.827	
MW-33AR	BORON, TOTAL (MG/L B)	01	0.812	12/29/2016	0.812	0.812	
MW-33AR	BORON, TOTAL (MG/L B)	01	0.763	1/25/2017	0.763	0.763	
MW-33AR	BORON, TOTAL (MG/L B)	01	0.76	4/11/2017	0.76	0.76	
MW-33AR	BORON, TOTAL (MG/L B)	01	0.692	6/6/2017	0.692	0.692	
MW-33AR	BORON, TOTAL (MG/L B)	01	0.697	8/7/2017	0.697	0.697	

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Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-33AR	BORON, TOTAL (MG/L B)	01	0.678	10/24/2017	0.678	0.678	
MW-33AR	BORON, TOTAL (MG/L B)	01	0.601	4/24/2018	0.601	0.601	
MW-33AR	BORON, TOTAL (MG/L B)	01	0.683	9/21/2018	0.683	0.683	
MW-33AR	BORON, TOTAL (MG/L B)	01	0.682	10/22/2018	0.682	0.682	
MW-33AR	BORON, TOTAL (MG/L B)	01	0.568	4/2/2019	0.568	0.568	
MW-33AR	BORON, TOTAL (MG/L B)	01	0.548	10/8/2019	0.548	0.548	
MW-33AR	BORON, TOTAL (MG/L B)	01	0.566	5/28/2020	0.566	0.566	
MW-33AR	BORON, TOTAL (MG/L B)	01	0.569	10/8/2020	0.569	0.569	
MW-33AR	BORON, TOTAL (MG/L B)	01	0.473	4/13/2021	0.473	0.473	
MW-33AR	BORON, TOTAL (MG/L B)	01	0.564	10/12/2021	0.564	0.564	
MW-33AR	BORON, TOTAL (MG/L B)	01	0.558	4/12/2022	0.558	0.558	
MW-33AR	BORON, TOTAL (MG/L B)	01	0.586	10/27/2022	0.586	0.586	
MW-33AR	BORON, TOTAL (MG/L B)	01	0.532	4/27/2023	0.532	0.532	
Calculations							
Count						22	
Mean						0.67	
Std Dev						0.12	
2 X SD (ACL)						0.25	
ACL, Calculated						0.92	
ACL, Rounded						0.92	

Duplicate Data Not Used for Calculations							

Note: Current PAL = 0.2 mg/l; ES = 1 mg/l, Data through 10/2015 downloaded from GEMS

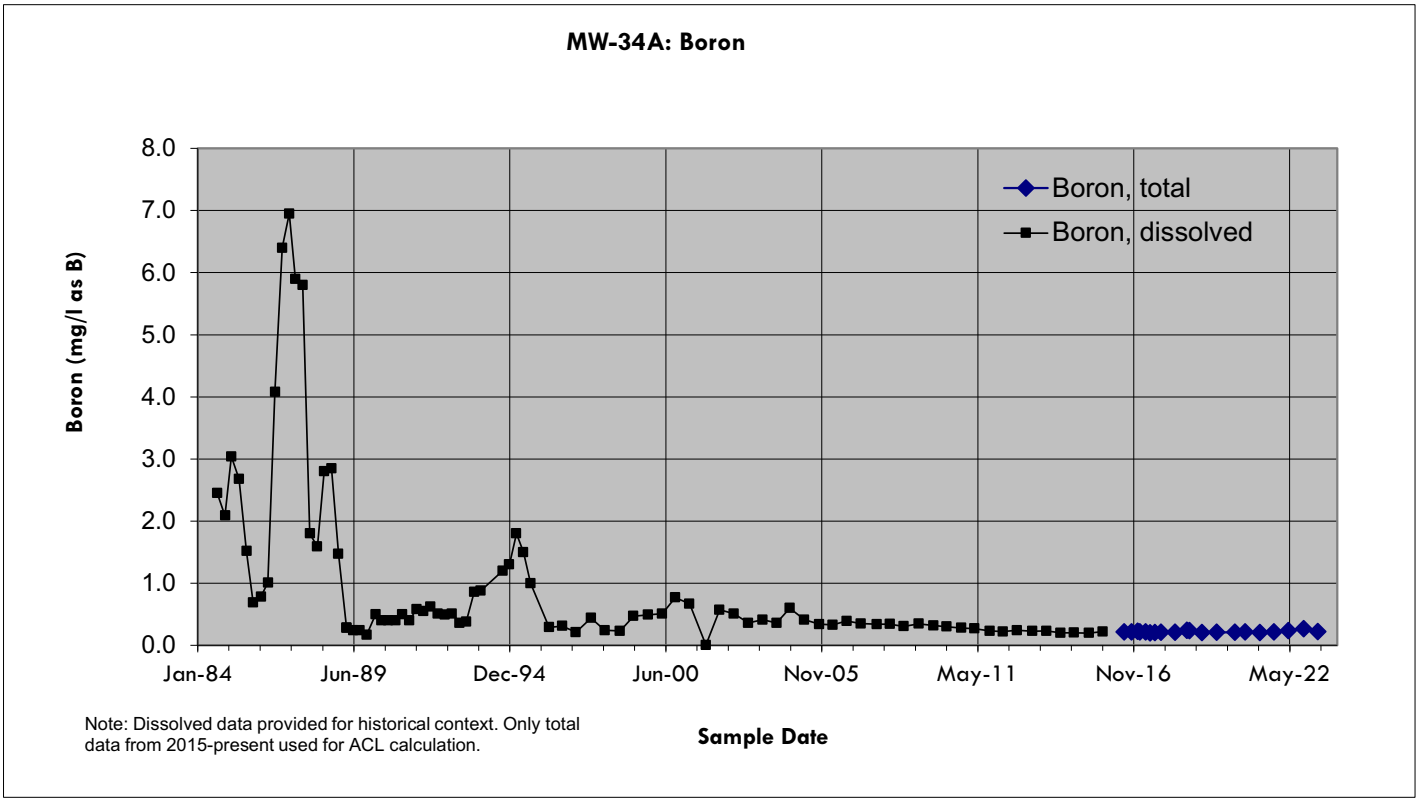
J = Result is an estimated value below the laboratory's limit of quantitation.

P = Did not meet required preservation and/or hold time.

B = Compound detected in blank.

M = Failed method QC check.

I:\25222260.00\Data and Calculations\Groundwater PALs ACLs\[ACL Calculations_CCR Wells_Combined.xlsx]MW-33AR_B_ACL



Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW34A	BORON, DISSOLVED (MG/L B)	01	2.45	9/7/1984	2.45		
MW34A	BORON, DISSOLVED (MG/L B)	01	2.09	12/17/1984	2.09		
MW34A	BORON, DISSOLVED (MG/L B)	01	3.04	3/7/1985	3.04		
MW34A	BORON, DISSOLVED (MG/L B)	01	2.68	6/14/1985	2.68		
MW34A	BORON, DISSOLVED (MG/L B)	01	1.52	9/18/1985	1.52		
MW34A	BORON, DISSOLVED (MG/L B)	01	0.69	12/12/1985	0.69		
MW34A	BORON, DISSOLVED (MG/L B)	01	0.78	3/21/1986	0.78		
MW34A	BORON, DISSOLVED (MG/L B)	01	1.01	6/20/1986	1.01		
MW34A	BORON, DISSOLVED (MG/L B)	01	4.08	9/18/1986	4.08		
MW34A	BORON, DISSOLVED (MG/L B)	01	6.4	12/19/1986	6.4		
MW34A	BORON, DISSOLVED (MG/L B)	01	6.95	3/20/1987	6.95		
MW34A	BORON, DISSOLVED (MG/L B)	01	5.9	6/5/1987	5.9		
MW34A	BORON, DISSOLVED (MG/L B)	01	5.8	9/9/1987	5.8		
MW34A	BORON, DISSOLVED (MG/L B)	01	1.8	12/9/1987	1.8		
MW34A	BORON, DISSOLVED (MG/L B)	01	1.59	3/10/1988	1.59		
MW34A	BORON, DISSOLVED (MG/L B)	01	2.8	6/7/1988	2.8		
MW34A	BORON, DISSOLVED (MG/L B)	01	2.85	9/9/1988	2.85		
MW34A	BORON, DISSOLVED (MG/L B)	01	1.47	12/7/1988	1.47		
MW34A	BORON, DISSOLVED (MG/L B)	01	0.28	3/21/1989	0.28		
MW34A	BORON, DISSOLVED (MG/L B)	01	0.28	3/22/1989	0.28		
MW34A	BORON, DISSOLVED (MG/L B)	01	0.24	6/16/1989	0.24		
MW34A	BORON, DISSOLVED (MG/L B)	01	0.24	9/6/1989	0.24		
MW34A	BORON, DISSOLVED (MG/L B)	01	0.17	12/5/1989	0.17		
MW34A	BORON, DISSOLVED (MG/L B)	01	0.5	3/29/1990	0.5		
MW34A	BORON, DISSOLVED (MG/L B)	01	0.4	6/14/1990	0.4		
MW34A	BORON, DISSOLVED (MG/L B)	01	0.4	9/5/1990	0.4		
MW34A	BORON, DISSOLVED (MG/L B)	01	0.4	12/10/1990	0.4		
MW34A	BORON, DISSOLVED (MG/L B)	01	0.5	3/5/1991	0.5		
MW34A	BORON, DISSOLVED (MG/L B)	01	0.4	6/3/1991	0.4		
MW34A	BORON, DISSOLVED (MG/L B)	01	0.58	9/6/1991	0.58		
MW34A	BORON, DISSOLVED (MG/L B)	01	0.55	12/4/1991	0.55		
MW34A	BORON, DISSOLVED (MG/L B)	01	0.62	3/3/1992	0.62		
MW34A	BORON, DISSOLVED (MG/L B)	01	0.51	6/2/1992	0.51		
MW34A	BORON, DISSOLVED (MG/L B)	01	0.49	9/1/1992	0.49		
MW34A	BORON, DISSOLVED (MG/L B)	01	0.51	12/2/1992	0.51		

09/28/2023 - Classification: Internal - ECRM13153872

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW34A	BORON, DISSOLVED (MG/L B)	01	0.36	3/10/1993	0.36		
MW34A	BORON, DISSOLVED (MG/L B)	01	0.38	6/2/1993	0.38		
MW34A	BORON, DISSOLVED (MG/L B)	01	0.86	9/14/1993	0.86		
MW34A	BORON, DISSOLVED (MG/L B)	01	0.88	12/7/1993	0.88		
MW34A	BORON, DISSOLVED (MG/L B)	01	1.2	9/13/1994	1.2		
MW34A	BORON, DISSOLVED (MG/L B)	01	1.3	12/6/1994	1.3		
MW34A	BORON, DISSOLVED (MG/L B)	01	1.8	3/7/1995	1.8		
MW34A	BORON, DISSOLVED (MG/L B)	01	1.5	6/6/1995	1.5		
MW34A	BORON, DISSOLVED (MG/L B)	01	1	9/6/1995	1		
MW34A	BORON, DISSOLVED (MG/L B)	01	0.29	4/30/1996	0.29		
MW34A	BORON, DISSOLVED (MG/L B)	01	0.31	10/16/1996	0.31		
MW34A	BORON, DISSOLVED (MG/L B)	01	0.21	4/8/1997	0.21		
MW34A	BORON, DISSOLVED (MG/L B)	01	0.44	10/20/1997	0.44		
MW34A	BORON, DISSOLVED (MG/L B)	01	0.24	4/14/1998	0.24		
MW34A	BORON, DISSOLVED (MG/L B)	01	0.23	10/27/1998	0.23		
MW34A	BORON, DISSOLVED (MG/L B)	01	0.47	4/16/1999	0.47		
MW34A	BORON, DISSOLVED (MG/L B)	01	0.49	10/21/1999	0.49		
MW34A	BORON, DISSOLVED (MG/L B)	01	0.51	4/20/2000	0.51		
MW34A	BORON, DISSOLVED (MG/L B)	01	0.77	10/4/2000	0.77		
MW34A	BORON, DISSOLVED (MG/L B)	01	0.67	4/3/2001	0.67		
MW34A	BORON, DISSOLVED (MG/L B)	01	0.0038	10/31/2001	0.0038		
MW34A	BORON, DISSOLVED (MG/L B)	01	0.57	4/25/2002	0.57		
MW34A	BORON, DISSOLVED (MG/L B)	01	0.51	10/24/2002	0.51		
MW34A	BORON, DISSOLVED (MG/L B)	01	0.36	4/29/2003	0.36		
MW34A	BORON, DISSOLVED (MG/L B)	01	0.41	10/29/2003	0.41		
MW34A	BORON, DISSOLVED (MG/L B)	01	0.36	4/27/2004	0.36		
MW34A	BORON, DISSOLVED (MG/L B)	01	0.6	10/12/2004	0.6		
MW34A	BORON, DISSOLVED (MG/L B)	01	0.41	4/15/2005	0.41		
MW34A	BORON, DISSOLVED (MG/L B)	01	0.34	10/26/2005	0.34		
MW34A	BORON, DISSOLVED (MG/L B)	01	0.33	4/13/2006	0.33		
MW34A	BORON, DISSOLVED (MG/L B)	01	0.39	10/12/2006	0.39		
MW34A	BORON, DISSOLVED (MG/L B)	01	0.35	4/11/2007	0.35		
MW34A	BORON, DISSOLVED (MG/L B)	01	0.34	10/31/2007	0.34		
MW34A	BORON, DISSOLVED (MG/L B)	01	0.342	4/17/2008	0.342		
MW34A	BORON, DISSOLVED (MG/L B)	01	0.305	10/10/2008	0.305		
MW34A	BORON, DISSOLVED (MG/L B)	01	0.347	4/21/2009	0.347		
MW34A	BORON, DISSOLVED (MG/L B)	01	0.318	10/27/2009	0.318		
MW34A	BORON, DISSOLVED (MG/L B)	01	0.3	4/14/2010	0.3		
MW34A	BORON, DISSOLVED (MG/L B)	01	0.28	10/20/2010	0.28		
MW34A	BORON, DISSOLVED (MG/L B)	01	0.27	4/6/2011	0.27		
MW34A	BORON, DISSOLVED (MG/L B)	01	0.23	10/20/2011	0.23		
MW34A	BORON, DISSOLVED (MG/L B)	01	0.22	4/4/2012	0.22		
MW34A	BORON, DISSOLVED (MG/L B)	01	0.24	10/4/2012	0.24		
MW34A	BORON, DISSOLVED (MG/L B)	01	0.228	4/16/2013	0.228		
MW34A	BORON, DISSOLVED (MG/L B)	01	0.23	10/14/2013	0.23		
MW34A	BORON, DISSOLVED (MG/L B)	01	0.201	4/16/2014	0.201		
MW34A	BORON, DISSOLVED (MG/L B)	01	0.203	10/2/2014	0.203		
MW34A	BORON, DISSOLVED (MG/L B)	01	0.197	4/14/2015	0.197		
MW34A	BORON, DISSOLVED (MG/L B)	01	0.221	10/7/2015	0.221		
MW34A	BORON, TOTAL (MG/L B)	01	0.216	7/7/2016	0.216	0.216	
MW34A	BORON, TOTAL (MG/L B)	01	0.212	10/13/2016	0.212	0.212	
MW34A	BORON, TOTAL (MG/L B)	01	0.224	12/29/2016	0.224	0.224	
MW34A	BORON, TOTAL (MG/L B)	01	0.214	1/25/2017	0.214	0.214	
MW34A	BORON, TOTAL (MG/L B)	01	0.214	4/11/2017	0.214	0.214	
MW34A	BORON, TOTAL (MG/L B)	01	0.201	6/6/2017	0.201	0.201	
MW34A	BORON, TOTAL (MG/L B)	01	0.205	8/7/2017	0.205	0.205	
MW34A	BORON, TOTAL (MG/L B)	01	0.208	10/24/2017	0.208	0.208	
MW34A	BORON, TOTAL (MG/L B)	01	0.209	4/24/2018	0.209	0.209	
MW34A	BORON, TOTAL (MG/L B)	01	0.241	9/21/2018	0.241	0.241	
MW34A	BORON, TOTAL (MG/L B)	01	0.233	10/22/2018	0.233	0.233	
MW34A	BORON, TOTAL (MG/L B)	01	0.204	4/2/2019	0.204	0.204	
MW34A	BORON, TOTAL (MG/L B)	01	0.207	10/8/2019	0.207	0.207	
MW34A	BORON, TOTAL (MG/L B)	01	0.21	5/28/2020	0.21	0.21	

09/28/2023 - Classification: Internal - ECRM13153872

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW34A	BORON, TOTAL (MG/L B)	01	0.213	10/8/2020	0.213	0.213	
MW34A	BORON, TOTAL (MG/L B)	01	0.203	4/13/2021	0.203	0.203	
MW34A	BORON, TOTAL (MG/L B)	01	0.212	10/12/2021	0.212	0.212	
MW34A	BORON, TOTAL (MG/L B)	01	0.237	4/12/2022	0.237	0.237	
MW34A	BORON, TOTAL (MG/L B)	01	0.264	10/27/2022	0.264	0.264	
MW34A	BORON, TOTAL (MG/L B)	01	0.22	4/26/2023	0.22	0.22	
Calculations							
Count						20	
Mean						0.22	
Std Dev						0.02	
2 X SD (ACL)						0.03	
ACL, Calculated						0.25	
ACL, Rounded						0.25	

Duplicate Data Not Used for Calculations							

Note: Current PAL = 0.2 mg/l; ES = 1 mg/l, Data through 10/2015 downloaded from GEMS

J = Result is an estimated value below the laboratory's limit of quantitation.

P = Did not meet required preservation and/or hold time.

B = Compound detected in blank.

M = Failed method QC check.

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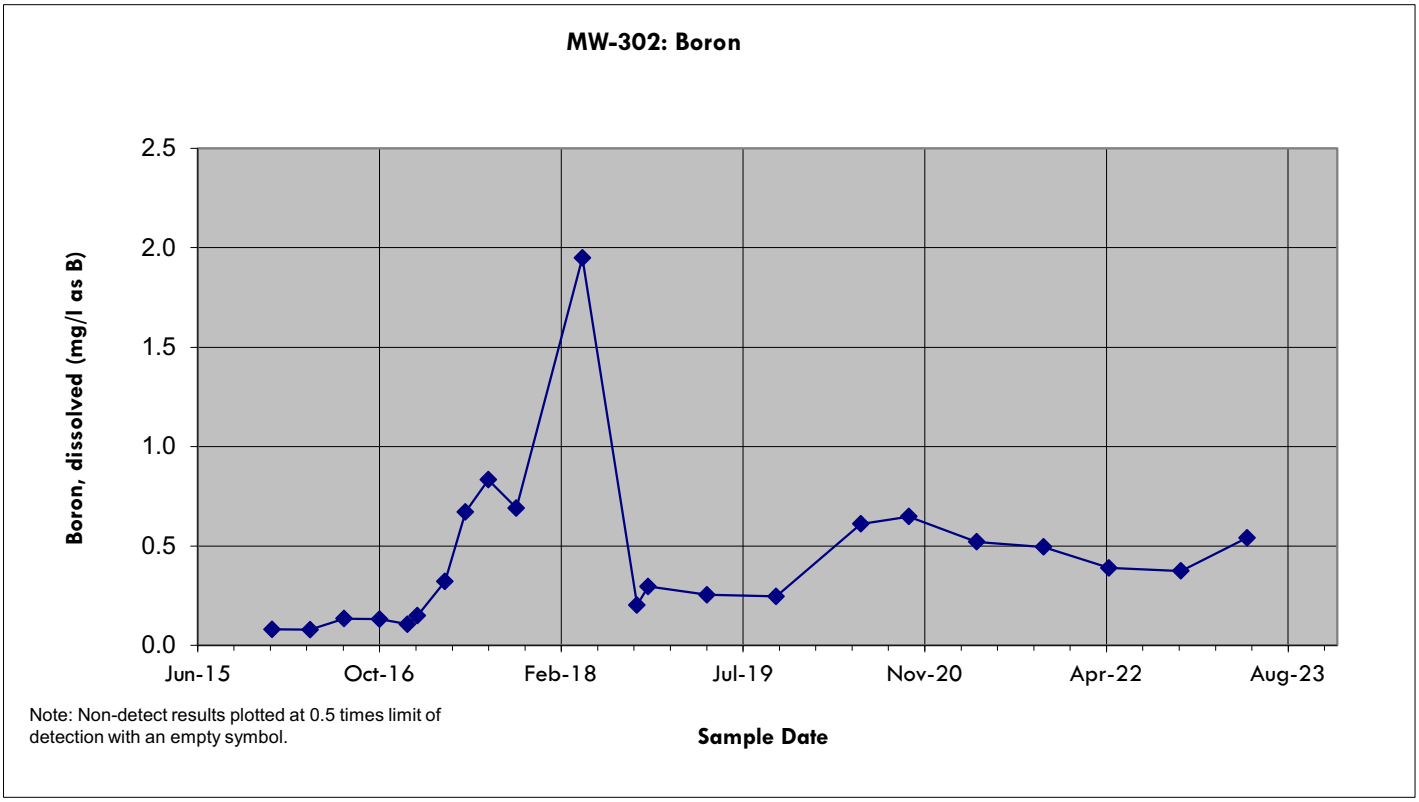

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-302	BORON, TOTAL (MG/L B)	01	0.08	12/22/2015	0.08	0.08	
MW-302	BORON, TOTAL (MG/L B)	01	0.0788	4/5/2016	0.0788	0.0788	
MW-302	BORON, TOTAL (MG/L B)	01	0.134	7/7/2016	0.134	0.134	
MW-302	BORON, TOTAL (MG/L B)	01	0.132	10/13/2016	0.132	0.132	
MW-302	BORON, TOTAL (MG/L B)	01	0.106	12/29/2016	0.106	0.106	
MW-302	BORON, TOTAL (MG/L B)	01	0.149	1/25/2017	0.149	0.149	
MW-302	BORON, TOTAL (MG/L B)	01	0.322	4/11/2017	0.322	0.322	
MW-302	BORON, TOTAL (MG/L B)	01	0.671	6/6/2017	0.671	0.671	
MW-302	BORON, TOTAL (MG/L B)	01	0.833	8/8/2017	0.833	0.833	
MW-302	BORON, TOTAL (MG/L B)	01	0.691	10/24/2017	0.691	0.691	
MW-302	BORON, TOTAL (MG/L B)	01	1.95	4/24/2018	1.95	1.95	
MW-302	BORON, TOTAL (MG/L B)	01	0.203	9/21/2018	0.203	0.203	
MW-302	BORON, TOTAL (MG/L B)	01	0.296	10/22/2018	0.296	0.296	
MW-302	BORON, TOTAL (MG/L B)	01	0.254	4/2/2019	0.254	0.254	
MW-302	BORON, TOTAL (MG/L B)	01	0.246	10/9/2019	0.246	0.246	
MW-302	BORON, TOTAL (MG/L B)	01	0.611	5/29/2020	0.611	0.611	
MW-302	BORON, TOTAL (MG/L B)	01	0.648	10/8/2020	0.648	0.648	
MW-302	BORON, TOTAL (MG/L B)	01	0.521	4/13/2021	0.521	0.521	
MW-302	BORON, TOTAL (MG/L B)	01	0.495	10/14/2021	0.495	0.495	
MW-302	BORON, TOTAL (MG/L B)	01	0.389	4/12/2022	0.389	0.389	
MW-302	BORON, TOTAL (MG/L B)	01	0.374	10/27/2022	0.374	0.374	
MW-302	BORON, TOTAL (MG/L B)	01	0.541	4/27/2023	0.541	0.541	
Calculations							
Count						22	
Mean						0.44	
Std Dev						0.41	
2 X SD (ACL)						0.81	
ACL, Calculated						1.25	
ACL, Rounded						1.3	

Duplicate Data Not Used for Calculations							

Note: Current PAL = 0.2 mg/l; ES = 1 mg/l, data downloaded from ChemPoint
J = Result is an estimated value below the laboratory's limit of quantitation.

09/28/2023 - Classification: Internal - ECRM13153872

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes

P = Did not meet required preservation and/or hold time.

B = Compound detected in blank.

M = Failed method QC check.

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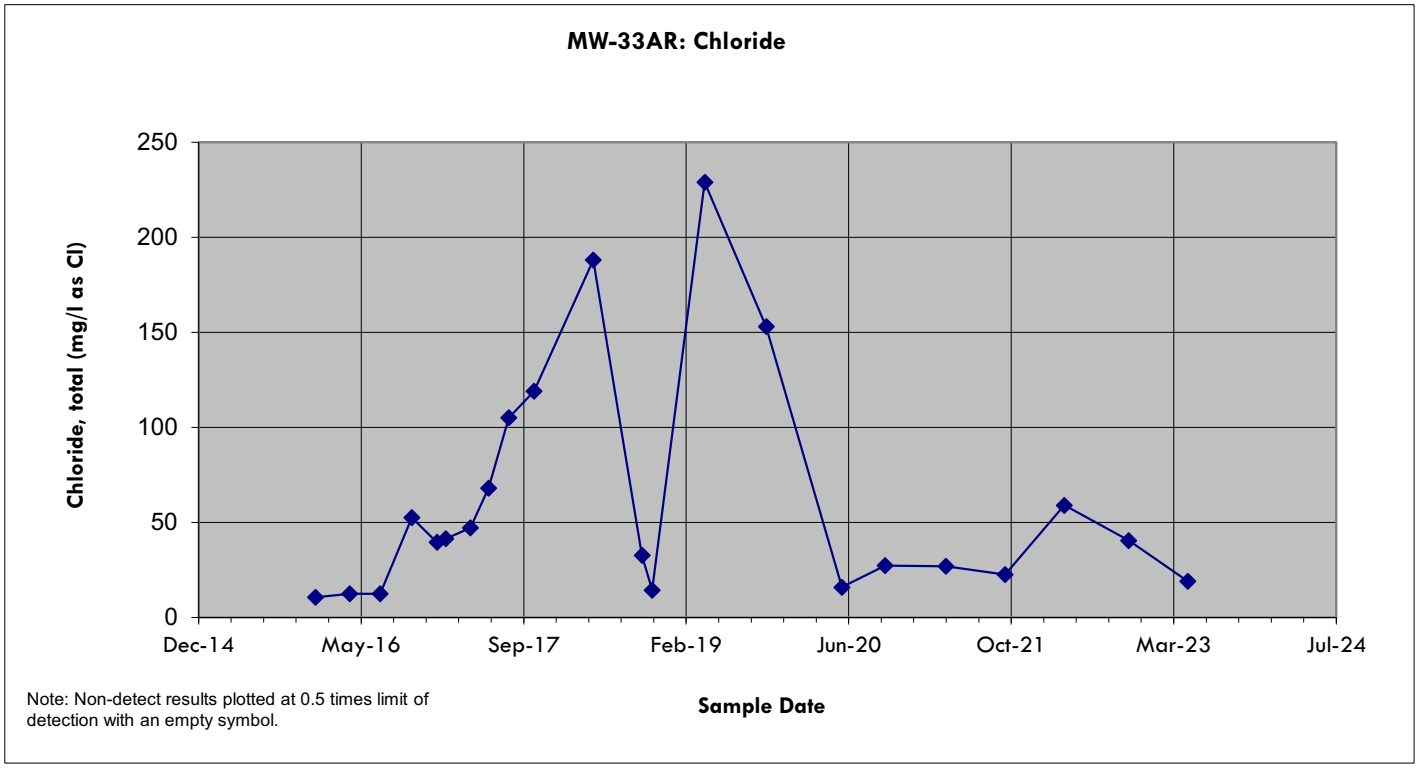

Note: Non-detect results plotted at 0.5 times limit of detection with an empty symbol.

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-33AR	CHLORIDE, TOTAL (MG/L CL)	01	10.6	12/21/2015	10.6	10.6	
MW-33AR	CHLORIDE, TOTAL (MG/L CL)	01	12.5	4/5/2016	12.5	12.5	
MW-33AR	CHLORIDE, TOTAL (MG/L CL)	01	12.5	7/7/2016	12.5	12.5	
MW-33AR	CHLORIDE, TOTAL (MG/L CL)	01	52.5	10/13/2016	52.5	52.5	
MW-33AR	CHLORIDE, TOTAL (MG/L CL)	01	39.6	12/29/2016	39.6	39.6	
MW-33AR	CHLORIDE, TOTAL (MG/L CL)	01	41.4	1/25/2017	41.4	41.4	
MW-33AR	CHLORIDE, TOTAL (MG/L CL)	01	47.1	4/11/2017	47.1	47.1	
MW-33AR	CHLORIDE, TOTAL (MG/L CL)	01	68.1	6/6/2017	68.1	68.1	
MW-33AR	CHLORIDE, TOTAL (MG/L CL)	01	105	8/7/2017	105	105	
MW-33AR	CHLORIDE, TOTAL (MG/L CL)	01	119	10/24/2017	119	119	
MW-33AR	CHLORIDE, TOTAL (MG/L CL)	01	188	4/24/2018	188	188	
MW-33AR	CHLORIDE, TOTAL (MG/L CL)	01	32.6	9/21/2018	32.6	32.6	
MW-33AR	CHLORIDE, TOTAL (MG/L CL)	01	14.4	10/22/2018	14.4	14.4	
MW-33AR	CHLORIDE, TOTAL (MG/L CL)	01	229	4/2/2019	229	229	
MW-33AR	CHLORIDE, TOTAL (MG/L CL)	01	153	10/8/2019	153	153	
MW-33AR	CHLORIDE, TOTAL (MG/L CL)	01	15.9	5/28/2020	15.9	15.9	
MW-33AR	CHLORIDE, TOTAL (MG/L CL)	01	27.3	10/8/2020	27.3	27.3	
MW-33AR	CHLORIDE, TOTAL (MG/L CL)	01	26.9	4/13/2021	26.9	26.9	
MW-33AR	CHLORIDE, TOTAL (MG/L CL)	01	22.6	10/12/2021	22.6	22.6	
MW-33AR	CHLORIDE, TOTAL (MG/L CL)	01	59	4/12/2022	59	59	
MW-33AR	CHLORIDE, TOTAL (MG/L CL)	01	40.5	10/27/2022	40.5	40.5	
MW-33AR	CHLORIDE, TOTAL (MG/L CL)	01	19	4/27/2023	19	19	
Calculations							
Count						22	
Mean						60.75	
Std Dev						59.35	
2 X SD (ACL)						118.70	
ACL, Calculated						179.45	
ACL, Rounded						180	

Duplicate Data Not Used for Calculations							

Note: Current PAL = 125 mg/l; ES = 250 mg/l; Data downloaded from ChemPoint
J = Result is an estimated value below the laboratory's limit of quantitation.
P = Did not meet required preservation and/or hold time.
B = Compound detected in blank.
M = Failed method QC check.

09/28/2023 - Classification: Internal - ECRM13153872

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes

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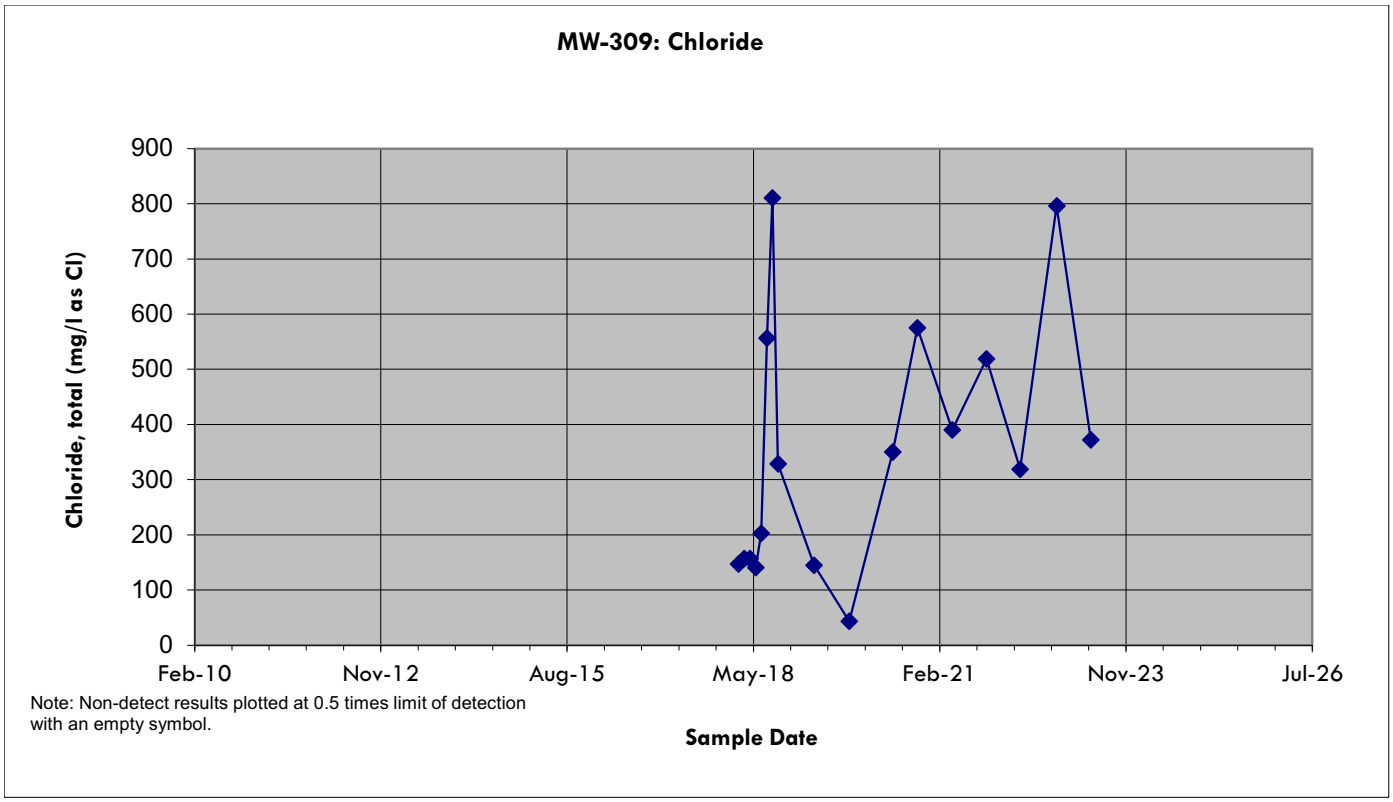

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-309	CHLORIDE, TOTAL (MG/L CI)	01	147	2/21/2018	147	147	
MW-309	CHLORIDE, TOTAL (MG/L CI)	01	157	3/23/2018	157	157	
MW-310	CHLORIDE, TOTAL (MG/L CI)	01	157	4/23/2018	157	157	
MW-311	CHLORIDE, TOTAL (MG/L CI)	01	141	5/24/2018	141	141	
MW-312	CHLORIDE, TOTAL (MG/L CI)	01	203	6/23/2018	203	203	
MW-313	CHLORIDE, TOTAL (MG/L CI)	01	557	7/23/2018	557	557	
MW-314	CHLORIDE, TOTAL (MG/L CI)	01	811	8/22/2018	811	811	
MW-315	CHLORIDE, TOTAL (MG/L CI)	01	329	9/21/2018	329	329	
MW-316	CHLORIDE, TOTAL (MG/L CI)	01	145	4/2/2019	145	145	
MW-317	CHLORIDE, TOTAL (MG/L CI)	01	43.2	10/8/2019	43.2	43.2	
MW-318	CHLORIDE, TOTAL (MG/L CI)	01	350	5/29/2020	350	350	
MW-319	CHLORIDE, TOTAL (MG/L CI)	01	575	10/8/2020	575	575	
MW-320	CHLORIDE, TOTAL (MG/L CI)	01	390	4/13/2021	390	390	
MW-321	CHLORIDE, TOTAL (MG/L CI)	01	519	10/14/2021	519	519	
MW-322	CHLORIDE, TOTAL (MG/L CI)	01	319	4/12/2022	319	319	
MW-309	CHLORIDE, TOTAL (MG/L CI)	01	796	10/26/2022	796	796	
MW-309	CHLORIDE, TOTAL (MG/L CI)	01	372	4/26/2023	372	372	
Calculations							
Count						17	
Mean						353.60	
Std Dev						231.01	
2 X SD (ACL)						462.03	
ACL, Calculated						815.63	
ACL, Rounded						820	

Duplicate Data Not Used for Calculations							

Note: Current PAL = 125 mg/l; ES = 250 mg/l

J = Result is an estimated value below the laboratory's limit of quantitation.

P = Did not meet required preservation and/or hold time.

B = Compound detected in blank.

M = Failed method QC check.

09/28/2023 - Classification: Internal - ECRM13153872

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes

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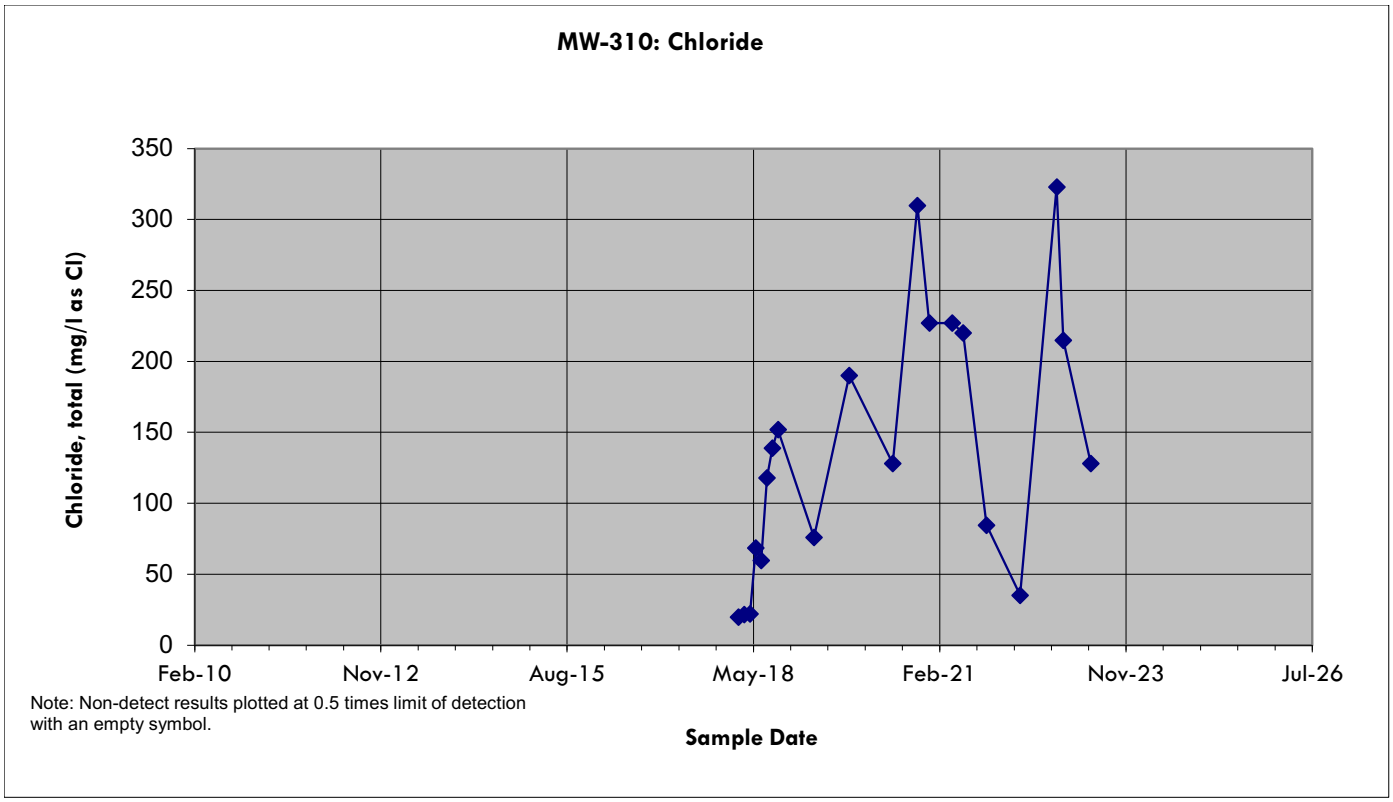

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-310	CHLORIDE, TOTAL (MG/L Cl)	01	19.8	2/21/2018	19.8	19.8	
MW-310	CHLORIDE, TOTAL (MG/L Cl)	01	21.7	3/23/2018	21.7	21.7	
MW-310	CHLORIDE, TOTAL (MG/L Cl)	01	22.1	4/23/2018	22.1	22.1	
MW-310	CHLORIDE, TOTAL (MG/L Cl)	01	68.6	5/24/2018	68.6	68.6	
MW-310	CHLORIDE, TOTAL (MG/L Cl)	01	59.8	6/23/2018	59.8	59.8	
MW-310	CHLORIDE, TOTAL (MG/L Cl)	01	118	7/23/2018	118	118	
MW-310	CHLORIDE, TOTAL (MG/L Cl)	01	139	8/22/2018	139	139	
MW-310	CHLORIDE, TOTAL (MG/L Cl)	01	152	9/21/2018	152	152	
MW-310	CHLORIDE, TOTAL (MG/L Cl)	01	76	4/2/2019	76	76	
MW-310	CHLORIDE, TOTAL (MG/L Cl)	01	190	10/8/2019	190	190	
MW-310	CHLORIDE, TOTAL (MG/L Cl)	01	128	5/29/2020	128	128	
MW-310	CHLORIDE, TOTAL (MG/L Cl)	01	310	10/8/2020	310	310	
MW-310	CHLORIDE, TOTAL (MG/L Cl)	01	227	12/11/2020	227	227	
MW-310	CHLORIDE, TOTAL (MG/L Cl)	01	227	4/13/2021	227	227	
MW-310	CHLORIDE, TOTAL (MG/L Cl)	01	220	6/11/2021	220	220	
MW-310	CHLORIDE, TOTAL (MG/L Cl)	01	84.6	10/14/2021	84.6	84.6	
MW-310	CHLORIDE, TOTAL (MG/L Cl)	01	35.2	4/12/2022	35.2	35.2	
MW-310	CHLORIDE, TOTAL (MG/L Cl)	01	323	10/26/2022	323	323	
MW-310	CHLORIDE, TOTAL (MG/L Cl)	01	215	11/30/2022	215	215	
MW-310	CHLORIDE, TOTAL (MG/L Cl)	01	128	4/26/2023	128	128	
Calculations							
Count						20	
Mean						138.24	
Std Dev						93.17	
2 X SD (ACL)						186.34	
ACL, Calculated						324.58	
ACL, Rounded						330	

Duplicate Data Not Used for Calculations							

Note: Current PAL = 125 mg/l; ES = 250 mg/l

J = Result is an estimated value below the laboratory's limit of quantitation.

P = Did not meet required preservation and/or hold time.

09/28/2023 - Classification: Internal - ECRM13153872

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes

B = Compound detected in blank.

M = Failed method QC check.

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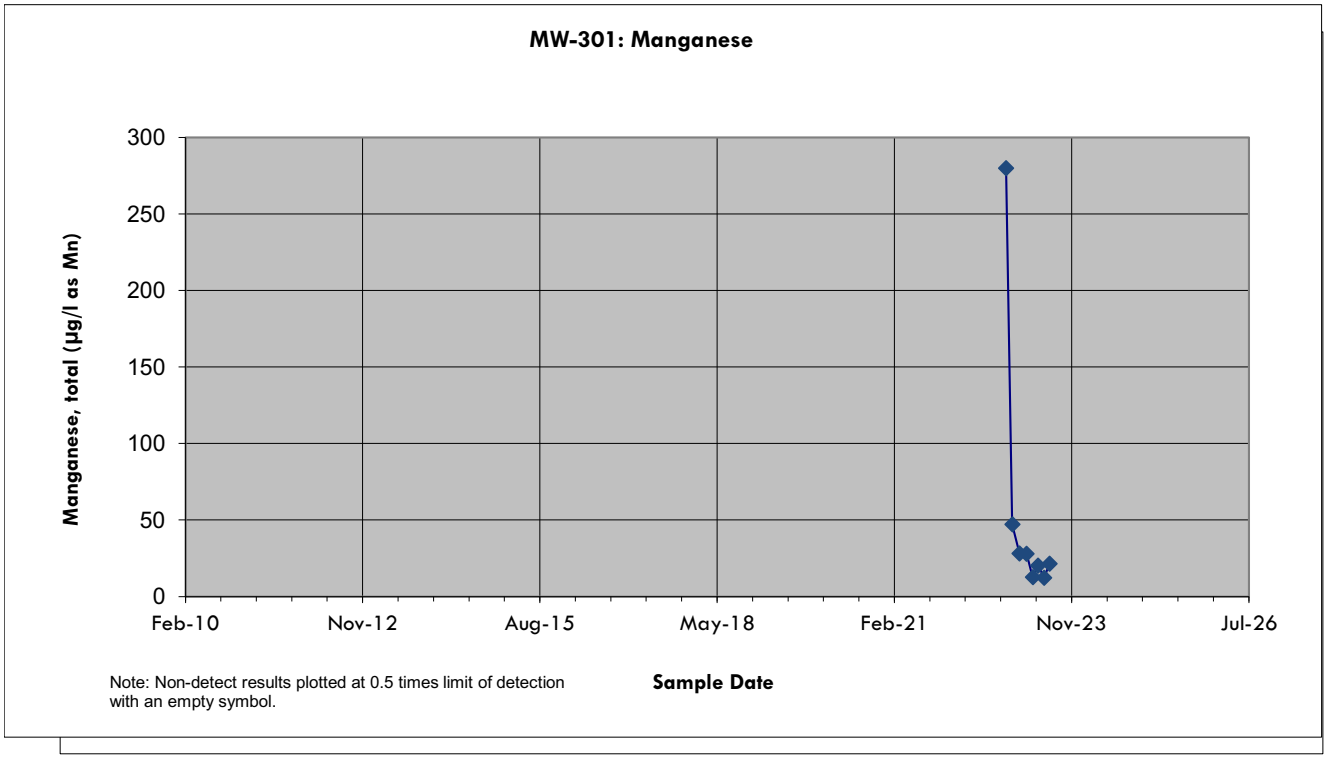

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-301	MANGANESE, TOTAL (UG/L MN)	01	280	10/27/2022	280		outlier
MW-301	MANGANESE, TOTAL (UG/L MN)	01	47.2	12/2/2022	47.2	47.2	
MW-301	MANGANESE, TOTAL (UG/L MN)	01	28.1	1/12/2023	28.1	28.1	
MW-301	MANGANESE, TOTAL (UG/L MN)	01	28	2/21/2023	28	28	
MW-301	MANGANESE, TOTAL (UG/L MN)	01	12.7	3/28/2023	12.7	12.7	
MW-301	MANGANESE, TOTAL (UG/L MN)	01	20.3	4/27/2023	20.3	20.3	
MW-301	MANGANESE, TOTAL (UG/L MN)	01	12.3	5/31/2023	12.3	12.3	
MW-301	MANGANESE, TOTAL (UG/L MN)	01	21.5	6/30/2023	21.5	21.5	
Calculations							
Count						7	
Mean						24.30	
Std Dev						11.94	
2 X SD (ACL)						23.87	
ACL, Calculated						48.17	
ACL, Rounded						48	

Duplicate Data Not Used for Calculations							

Note: Current Public Welfare PAL = 25 ug/l; ES = 50 ug/l

J = Result is an estimated value below the laboratory's limit of quantitation.

P = Did not meet required preservation and/or hold time.

B = Compound detected in blank.

M = Failed method QC check.

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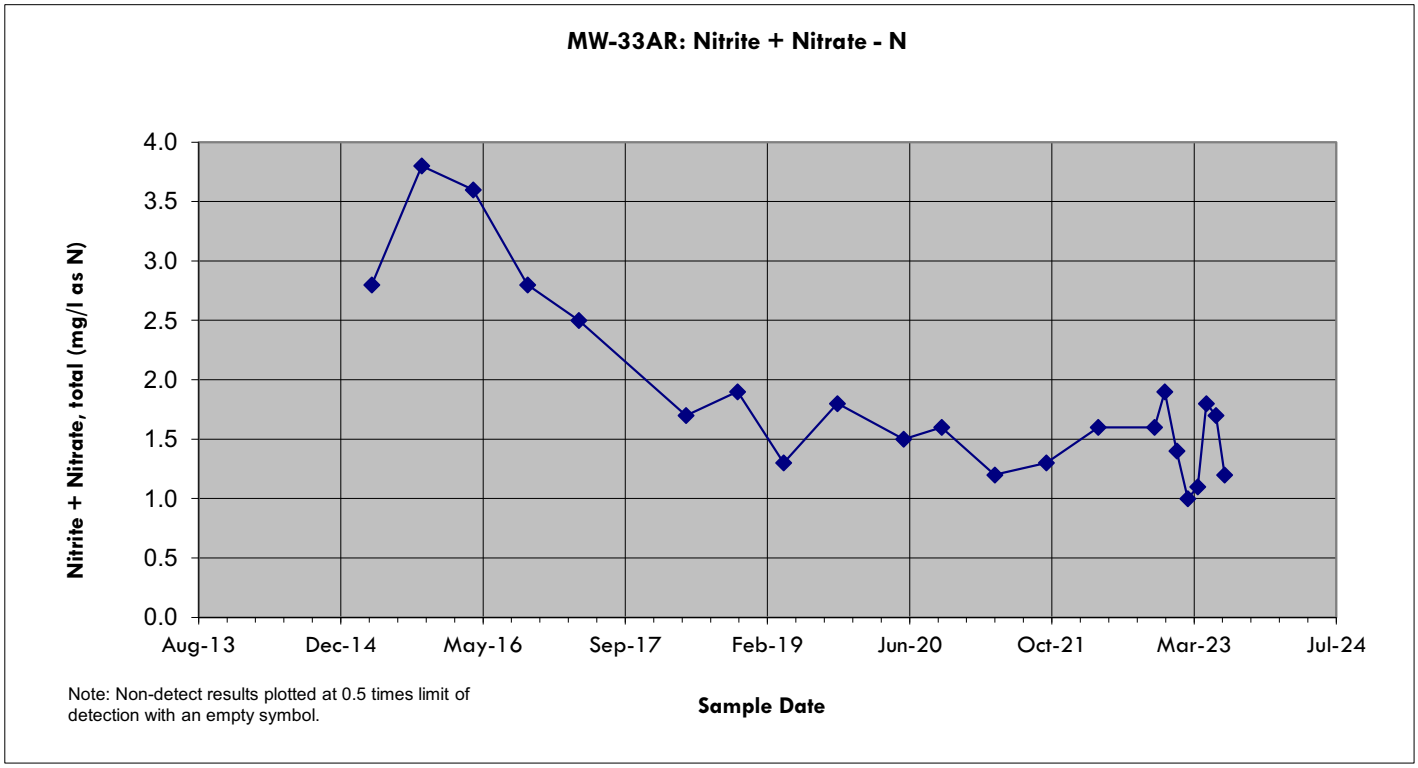
09/28/2023 - Classification: Internal - ECRM13153872



Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-33AR	NITRITE PLUS NITRATE, TOTAL 1 DET. (MG/L AS N)	01	2.8	4/14/2015	2.8	2.8	
MW-33AR	NITRITE PLUS NITRATE, TOTAL 1 DET. (MG/L AS N)	01	3.8	10/7/2015	3.8	3.8	
MW-33AR	NITRITE PLUS NITRATE, TOTAL 1 DET. (MG/L AS N)	01	3.6	4/5/2016	3.6	3.6	
MW-33AR	NITRITE PLUS NITRATE, TOTAL 1 DET. (MG/L AS N)	01	2.8	10/13/2016	2.8	2.8	
MW-33AR	NITRITE PLUS NITRATE, TOTAL 1 DET. (MG/L AS N)	01	2.5	4/11/2017	2.5	2.5	
MW-33AR	NITRITE PLUS NITRATE, TOTAL 1 DET. (MG/L AS N)	01	1.7	4/24/2018	1.7	1.7	
MW-33AR	NITRITE PLUS NITRATE, TOTAL 1 DET. (MG/L AS N)	01	1.9	10/22/2018	1.9	1.9	
MW-33AR	NITRITE PLUS NITRATE, TOTAL 1 DET. (MG/L AS N)	01	1.3	4/2/2019	1.3	1.3	
MW-33AR	NITRITE PLUS NITRATE, TOTAL 1 DET. (MG/L AS N)	01	1.8	10/8/2019	1.8	1.8	
MW-33AR	NITRITE PLUS NITRATE, TOTAL 1 DET. (MG/L AS N)	01	1.5	5/28/2020	1.5	1.5	
MW-33AR	NITRITE PLUS NITRATE, TOTAL 1 DET. (MG/L AS N)	01	1.6	10/8/2020	1.6	1.6	
MW-33AR	NITRITE PLUS NITRATE, TOTAL 1 DET. (MG/L AS N)	01	1.2	4/13/2021	1.2	1.2	
MW-33AR	NITRITE PLUS NITRATE, TOTAL 1 DET. (MG/L AS N)	01	1.3	10/12/2021	1.3	1.3	
MW-33AR	NITRITE PLUS NITRATE, TOTAL 1 DET. (MG/L AS N)	01	1.6	4/12/2022	1.6	1.6	
MW-33AR	NITRITE PLUS NITRATE, TOTAL 1 DET. (MG/L AS N)	01	1.6	10/27/2022	1.6	1.6	
MW-33AR	NITRITE PLUS NITRATE, TOTAL 1 DET. (MG/L AS N)	01	1.9	12/2/2022	1.9	1.9	
MW-33AR	NITRITE PLUS NITRATE, TOTAL 1 DET. (MG/L AS N)	01	1.4	1/13/2023	1.4	1.4	
MW-33AR	NITRITE PLUS NITRATE, TOTAL 1 DET. (MG/L AS N)	01	1	2/21/2023	1	1	
MW-33AR	NITRITE PLUS NITRATE, TOTAL 1 DET. (MG/L AS N)	01	1.1	3/28/2023	1.1	1.1	
MW-33AR	NITRITE PLUS NITRATE, TOTAL 1 DET. (MG/L AS N)	01	1.8	4/27/2023	1.8	1.8	
MW-33AR	NITRITE PLUS NITRATE, TOTAL 1 DET. (MG/L AS N)	01	1.7	5/31/2023	1.7	1.7	
MW-33AR	NITRITE PLUS NITRATE, TOTAL 1 DET. (MG/L AS N)	01	1.2	6/30/2023	1.2	1.2	
Calculations							
Count						22	
Mean						1.87	
Std Dev						0.75	
2 X SD (ACL)						1.50	
ACL, Calculated						3.37	
ACL, Rounded						3.4	

Duplicate Data Not Used for Calculations							

Note: Current PAL = 125 mg/l; ES = 250 mg/l; Data downloaded from ChemPoint
J = Result is an estimated value below the laboratory's limit of quantitation.
P = Did not meet required preservation and/or hold time.
B = Compound detected in blank.

09/28/2023 - Classification: Internal - ECRM13153872

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes

M = Failed method QC check.

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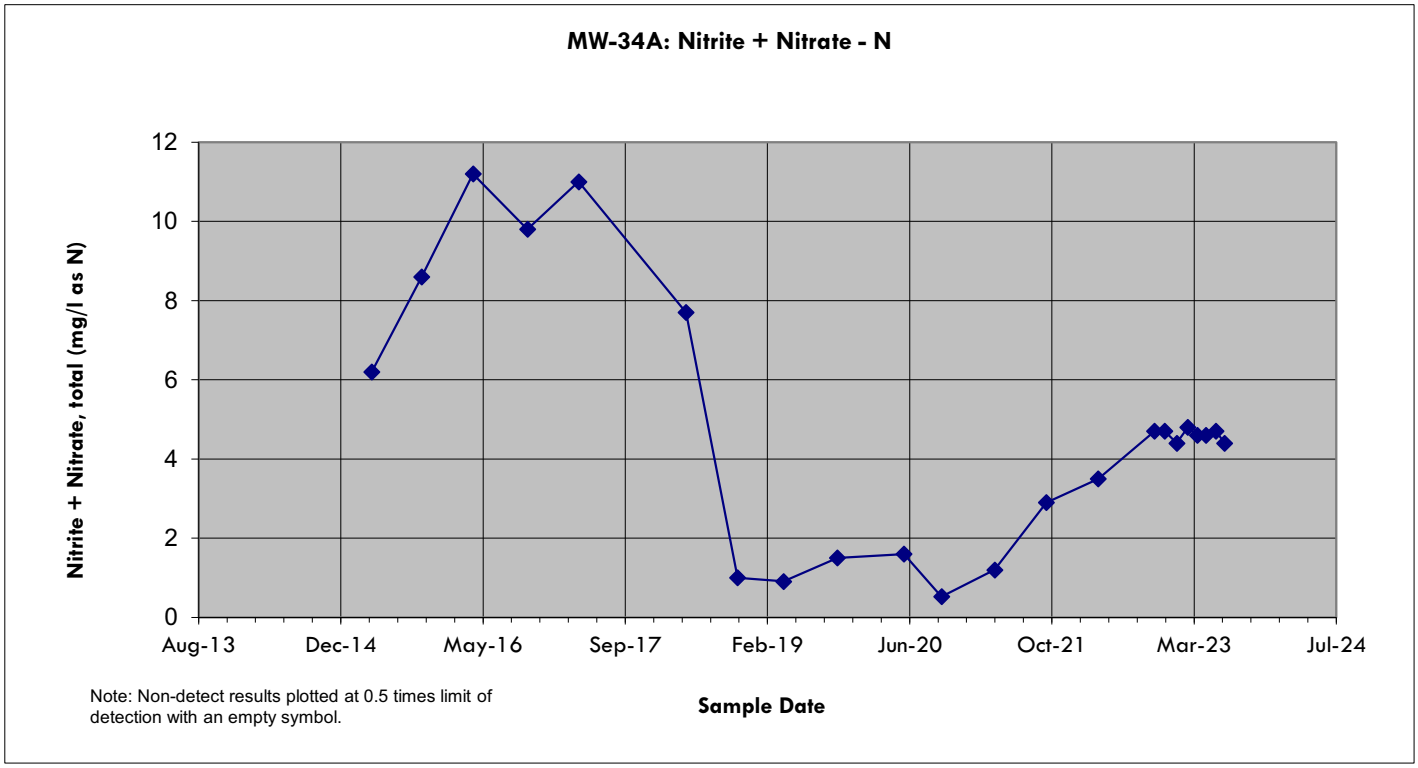

Note: Non-detect results plotted at 0.5 times limit of detection with an empty symbol.

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-34A	NITRITE PLUS NITRATE, TOTAL 1 DET. (MG/L AS N)	01	6.2	4/14/2015	6.2	6.2	
MW-34A	NITRITE PLUS NITRATE, TOTAL 1 DET. (MG/L AS N)	01	8.6	10/7/2015	8.6	8.6	
MW-34A	NITRITE PLUS NITRATE, TOTAL 1 DET. (MG/L AS N)	01	11.2	4/5/2016	11.2	11.2	
MW-34A	NITRITE PLUS NITRATE, TOTAL 1 DET. (MG/L AS N)	01	9.8	10/13/2016	9.8	9.8	
MW-34A	NITRITE PLUS NITRATE, TOTAL 1 DET. (MG/L AS N)	01	11	4/11/2017	11	11	
MW-34A	NITRITE PLUS NITRATE, TOTAL 1 DET. (MG/L AS N)	01	7.7	4/24/2018	7.7	7.7	
MW-34A	NITRITE PLUS NITRATE, TOTAL 1 DET. (MG/L AS N)	01	1	10/22/2018	1	1	
MW-34A	NITRITE PLUS NITRATE, TOTAL 1 DET. (MG/L AS N)	01	0.91	4/2/2019	0.91	0.91	
MW-34A	NITRITE PLUS NITRATE, TOTAL 1 DET. (MG/L AS N)	01	1.5	10/8/2019	1.5	1.5	
MW-34A	NITRITE PLUS NITRATE, TOTAL 1 DET. (MG/L AS N)	01	1.6	5/29/2020	1.6	1.6	
MW-34A	NITRITE PLUS NITRATE, TOTAL 1 DET. (MG/L AS N)	01	0.53	10/8/2020	0.53	0.53	
MW-34A	NITRITE PLUS NITRATE, TOTAL 1 DET. (MG/L AS N)	01	1.2	4/13/2021	1.2	1.2	
MW-34A	NITRITE PLUS NITRATE, TOTAL 1 DET. (MG/L AS N)	01	2.9	10/12/2021	2.9	2.9	
MW-34A	NITRITE PLUS NITRATE, TOTAL 1 DET. (MG/L AS N)	01	3.5	4/12/2022	3.5	3.5	
MW-34A	NITRITE PLUS NITRATE, TOTAL 1 DET. (MG/L AS N)	01	4.7	10/27/2022	4.7	4.7	
MW-34A	NITRITE PLUS NITRATE, TOTAL 1 DET. (MG/L AS N)	01	4.7	12/2/2022	4.7	4.7	
MW-34A	NITRITE PLUS NITRATE, TOTAL 1 DET. (MG/L AS N)	01	4.4	1/13/2023	4.4	4.4	
MW-34A	NITRITE PLUS NITRATE, TOTAL 1 DET. (MG/L AS N)	01	4.8	2/21/2023	4.8	4.8	
MW-34A	NITRITE PLUS NITRATE, TOTAL 1 DET. (MG/L AS N)	01	4.6	3/27/2023	4.6	4.6	
MW-34A	NITRITE PLUS NITRATE, TOTAL 1 DET. (MG/L AS N)	01	4.6	4/26/2023	4.6	4.6	
MW-34A	NITRITE PLUS NITRATE, TOTAL 1 DET. (MG/L AS N)	01	4.7	5/31/2023	4.7	4.7	
MW-34A	NITRITE PLUS NITRATE, TOTAL 1 DET. (MG/L AS N)	01	4.4	6/30/2023	4.4	4.4	
Calculations							
Count						22	
Mean						4.75	
Std Dev						3.14	
2 X SD (ACL)						6.28	
ACL, Calculated						11.03	
ACL, Rounded						12	

Duplicate Data Not Used for Calculations							
MW-34A	NITRITE PLUS NITRATE, TOTAL 1 DET. (MG/L AS N)	02	4.8	10/27/2022	4.8	4.8	
MW-34A	NITRITE PLUS NITRATE, TOTAL 1 DET. (MG/L AS N)	02	4.5	4/26/2023	4.5	4.5	

Note: Current PAL = 125 mg/l; ES = 250 mg/l; Data downloaded from ChemPoint
J = Result is an estimated value below the laboratory's limit of quantitation.
P = Did not meet required preservation and/or hold time.

09/28/2023 - Classification: Internal - ECRM13153872

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes

B = Compound detected in blank.

M = Failed method QC check.

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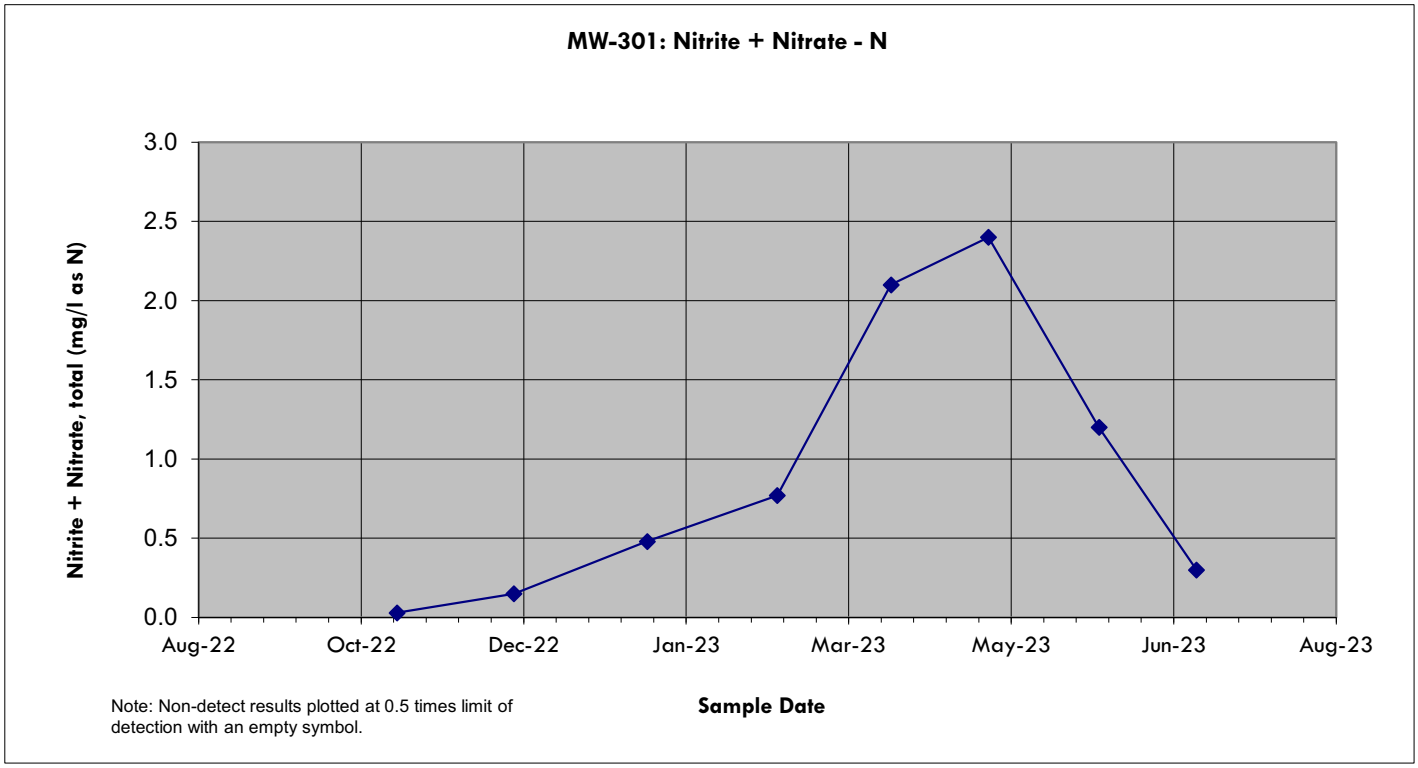

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-33AR	NITRITE PLUS NITRATE, TOTAL 1 DET. (MG/L AS N)	01	<0.059	10/27/2022	0.0295	0.0295	
MW-33AR	NITRITE PLUS NITRATE, TOTAL 1 DET. (MG/L AS N)	01	0.15	12/2/2022	0.15	0.15	J
MW-33AR	NITRITE PLUS NITRATE, TOTAL 1 DET. (MG/L AS N)	01	0.48	1/12/2023	0.48	0.48	
MW-33AR	NITRITE PLUS NITRATE, TOTAL 1 DET. (MG/L AS N)	01	0.77	2/21/2023	0.77	0.77	
MW-33AR	NITRITE PLUS NITRATE, TOTAL 1 DET. (MG/L AS N)	01	2.1	3/28/2023	2.1	2.1	
MW-33AR	NITRITE PLUS NITRATE, TOTAL 1 DET. (MG/L AS N)	01	2.4	4/27/2023	2.4	2.4	
MW-33AR	NITRITE PLUS NITRATE, TOTAL 1 DET. (MG/L AS N)	01	1.2	5/31/2023	1.2	1.2	
MW-33AR	NITRITE PLUS NITRATE, TOTAL 1 DET. (MG/L AS N)	01	0.3	6/30/2023	0.3	0.3	
Calculations							
Count						8	
Mean						0.93	
Std Dev						0.84	
2 X SD (ACL)						1.68	
ACL, Calculated						2.61	
ACL, Rounded						2.7	

Duplicate Data Not Used for Calculations							

Note: Current PAL = 125 mg/l; ES = 250 mg/l; Data downloaded from ChemPoint
J = Result is an estimated value below the laboratory's limit of quantitation.
P = Did not meet required preservation and/or hold time.
B = Compound detected in blank.
M = Failed method QC check.

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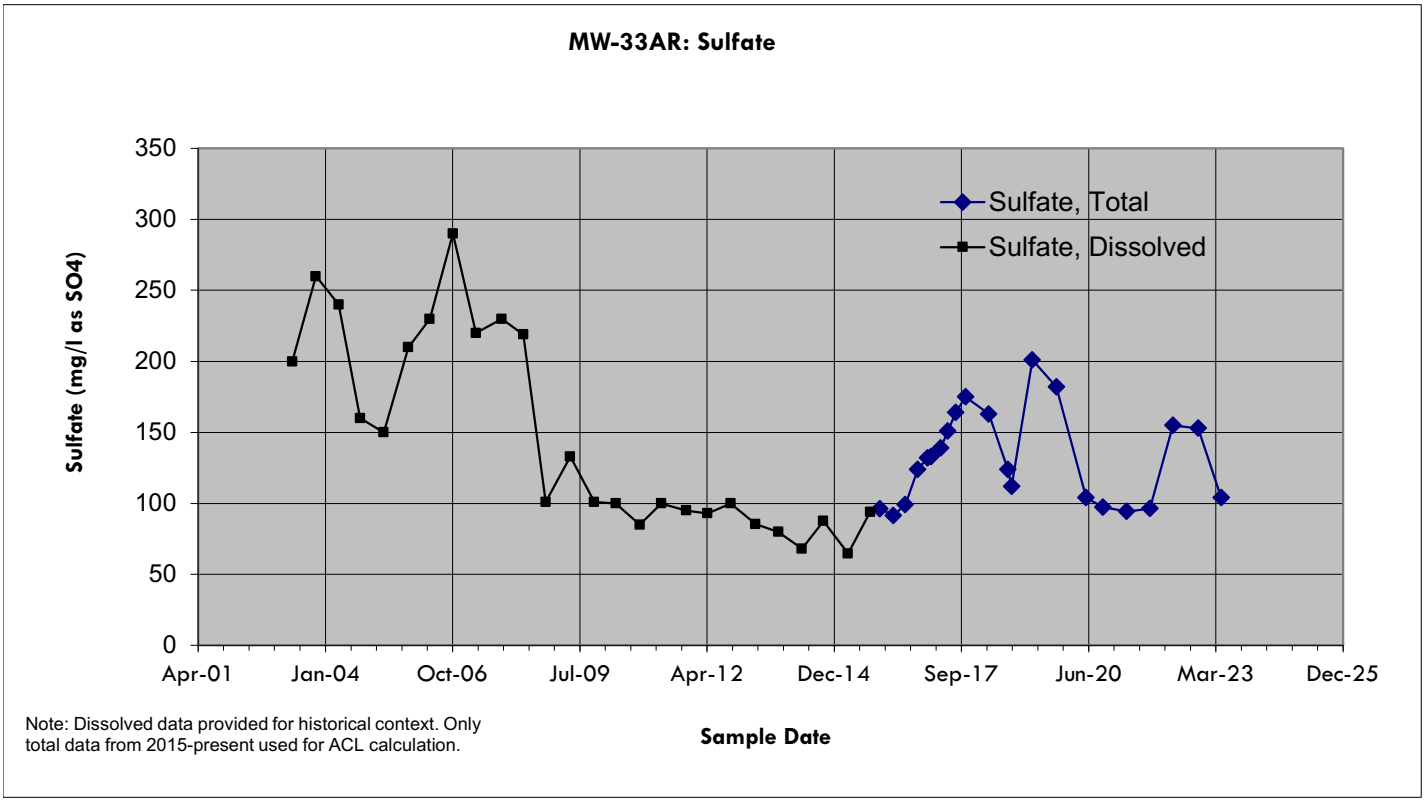

Note: Dissolved data provided for historical context. Only total data from 2015-present used for ACL calculation.

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-33AR	SULFATE, DISSOLVED (MG/L SO4)	01	200	4/29/2003	200		
MW-33AR	SULFATE, DISSOLVED (MG/L SO4)	01	260	10/30/2003	260		
MW-33AR	SULFATE, DISSOLVED (MG/L SO4)	01	240	4/27/2004	240		
MW-33AR	SULFATE, DISSOLVED (MG/L SO4)	01	160	10/12/2004	160		
MW-33AR	SULFATE, DISSOLVED (MG/L SO4)	01	150	4/15/2005	150		
MW-33AR	SULFATE, DISSOLVED (MG/L SO4)	01	210	10/26/2005	210		
MW-33AR	SULFATE, DISSOLVED (MG/L SO4)	01	230	4/13/2006	230		
MW-33AR	SULFATE, DISSOLVED (MG/L SO4)	01	290	10/12/2006	290		
MW-33AR	SULFATE, DISSOLVED (MG/L SO4)	01	220	4/11/2007	220		
MW-33AR	SULFATE, DISSOLVED (MG/L SO4)	01	230	10/31/2007	230		
MW-33AR	SULFATE, DISSOLVED (MG/L SO4)	01	219	4/17/2008	219		
MW-33AR	SULFATE, DISSOLVED (MG/L SO4)	01	101	10/10/2008	101		
MW-33AR	SULFATE, DISSOLVED (MG/L SO4)	01	133	4/21/2009	133		
MW-33AR	SULFATE, DISSOLVED (MG/L SO4)	01	101	10/27/2009	101		
MW-33AR	SULFATE, DISSOLVED (MG/L SO4)	01	100	4/14/2010	100		
MW-33AR	SULFATE, DISSOLVED (MG/L SO4)	01	85	10/20/2010	85		
MW-33AR	SULFATE, DISSOLVED (MG/L SO4)	01	100	4/6/2011	100		
MW-33AR	SULFATE, DISSOLVED (MG/L SO4)	01	95	10/20/2011	95		
MW-33AR	SULFATE, DISSOLVED (MG/L SO4)	01	93	4/4/2012	93		
MW-33AR	SULFATE, DISSOLVED (MG/L SO4)	01	100	10/4/2012	100		
MW-33AR	SULFATE, DISSOLVED (MG/L SO4)	01	85.4	4/17/2013	85.4		
MW-33AR	SULFATE, TOTAL (MG/L SO4)	01	79.9	10/14/2013	79.9		
MW-33AR	SULFATE, DISSOLVED (MG/L SO4)	01	68.1	4/16/2014	68.1		
MW-33AR	SULFATE, DISSOLVED (MG/L SO4)	01	87.6	10/2/2014	87.6		
MW-33AR	SULFATE, DISSOLVED (MG/L SO4)	01	64.7	4/14/2015	64.7		
MW-33AR	SULFATE, DISSOLVED (MG/L SO4)	01	94	10/7/2015	94		
MW-33AR	SULFATE, TOTAL (MG/L SO4)	01	96.2	12/21/2015	96.2	96.2	
MW-33AR	SULFATE, TOTAL (MG/L SO4)	01	91.5	4/5/2016	91.5	91.5	
MW-33AR	SULFATE, TOTAL (MG/L SO4)	01	99.2	7/7/2016	99.2	99.2	
MW-33AR	SULFATE, TOTAL (MG/L SO4)	01	124	10/13/2016	124	124	
MW-33AR	SULFATE, TOTAL (MG/L SO4)	01	132	12/29/2016	132	132	
MW-33AR	SULFATE, TOTAL (MG/L SO4)	01	133	1/25/2017	133	133	
MW-33AR	SULFATE, TOTAL (MG/L SO4)	01	139	4/11/2017	139	139	
MW-33AR	SULFATE, TOTAL (MG/L SO4)	01	151	6/6/2017	151	151	
MW-33AR	SULFATE, TOTAL (MG/L SO4)	01	164	8/7/2017	164	164	

09/28/2023 - Classification: Internal - ECRM13153872

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-33AR	SULFATE, TOTAL (MG/L SO4)	01	175	10/24/2017	175	175	
MW-33AR	SULFATE, TOTAL (MG/L SO4)	01	163	4/24/2018	163	163	
MW-33AR	SULFATE, TOTAL (MG/L SO4)	01	124	9/21/2018	124	124	
MW-33AR	SULFATE, TOTAL (MG/L SO4)	01	112	10/22/2018	112	112	
MW-33AR	SULFATE, TOTAL (MG/L SO4)	01	201	4/2/2019	201	201	
MW-33AR	SULFATE, TOTAL (MG/L SO4)	01	182	10/8/2019	182	182	
MW-33AR	SULFATE, TOTAL (MG/L SO4)	01	104	5/28/2020	104	104	
MW-33AR	SULFATE, TOTAL (MG/L SO4)	01	97.4	10/8/2020	97.4	97.4	
MW-33AR	SULFATE, TOTAL (MG/L SO4)	01	94.3	4/13/2021	94.3	94.3	
MW-33AR	SULFATE, TOTAL (MG/L SO4)	01	96.4	10/12/2021	96.4	96.4	
MW-33AR	SULFATE, TOTAL (MG/L SO4)	01	155	4/12/2022	155	155	
MW-33AR	SULFATE, TOTAL (MG/L SO4)	01	153	10/27/2022	153	153	
MW-33AR	SULFATE, TOTAL (MG/L SO4)	01	104	4/27/2023	104	104	
Calculations							
Count						22	
Mean						131.41	
Std Dev						32.69	
2 X SD (ACL)						65.39	
ACL, Calculated						196.80	
ACL, Rounded						200	

Duplicate Data Not Used for Calculations							

Note: Current PAL = 125 mg/l; ES = 250 mg/l; Data through 10/2015 from GEMS, later data from Chempoint

J = Result is an estimated value below the laboratory's limit of quantitation.

P = Did not meet required preservation and/or hold time.

B = Compound detected in blank.

M = Failed method QC check.

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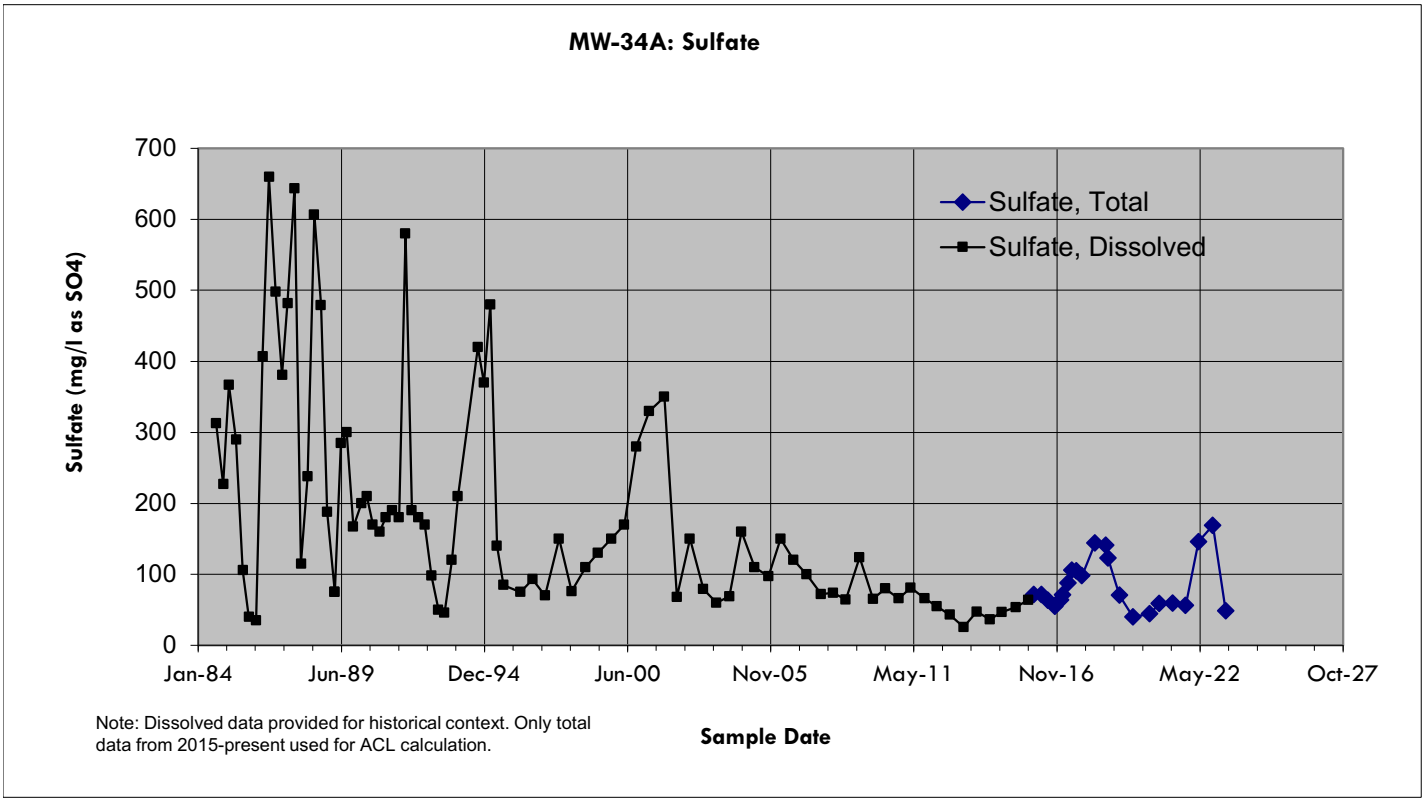

Note: Dissolved data provided for historical context. Only total data from 2015-present used for ACL calculation.

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-34A	SULFATE, DISSOLVED (MG/L SO4)	01	313	9/7/1984	313		
MW-34A	SULFATE, DISSOLVED (MG/L SO4)	01	227	12/17/1984	227		
MW-34A	SULFATE, DISSOLVED (MG/L SO4)	01	367	3/7/1985	367		
MW-34A	SULFATE, DISSOLVED (MG/L SO4)	01	290	6/14/1985	290		
MW-34A	SULFATE, DISSOLVED (MG/L SO4)	01	106	9/18/1985	106		
MW-34A	SULFATE, DISSOLVED (MG/L SO4)	01	40	12/12/1985	40		
MW-34A	SULFATE, DISSOLVED (MG/L SO4)	01	35	3/21/1986	35		
MW-34A	SULFATE, DISSOLVED (MG/L SO4)	01	407	6/20/1986	407		
MW-34A	SULFATE, DISSOLVED (MG/L SO4)	01	660	9/18/1986	660		
MW-34A	SULFATE, DISSOLVED (MG/L SO4)	01	498	12/19/1986	498		
MW-34A	SULFATE, DISSOLVED (MG/L SO4)	01	381	3/20/1987	381		
MW-34A	SULFATE, DISSOLVED (MG/L SO4)	01	482	6/5/1987	482		
MW-34A	SULFATE, DISSOLVED (MG/L SO4)	01	644	9/9/1987	644		
MW-34A	SULFATE, DISSOLVED (MG/L SO4)	01	115	12/9/1987	115		
MW-34A	SULFATE, DISSOLVED (MG/L SO4)	01	238	3/10/1988	238		
MW-34A	SULFATE, DISSOLVED (MG/L SO4)	01	607	6/7/1988	607		
MW-34A	SULFATE, DISSOLVED (MG/L SO4)	01	479	9/9/1988	479		
MW-34A	SULFATE, DISSOLVED (MG/L SO4)	01	188	12/7/1988	188		
MW-34A	SULFATE, DISSOLVED (MG/L SO4)	01	75	3/21/1989	75		
MW-34A	SULFATE, DISSOLVED (MG/L SO4)	01	75	3/22/1989	75		
MW-34A	SULFATE, DISSOLVED (MG/L SO4)	01	285	6/16/1989	285		
MW-34A	SULFATE, TOTAL (MG/L SO4)	01	300	9/6/1989	300		
MW-34A	SULFATE, DISSOLVED (MG/L SO4)	01	167	12/5/1989	167		
MW-34A	SULFATE, DISSOLVED (MG/L SO4)	01	200	3/29/1990	200		
MW-34A	SULFATE, DISSOLVED (MG/L SO4)	01	210	6/14/1990	210		
MW-34A	SULFATE, DISSOLVED (MG/L SO4)	01	170	9/5/1990	170		
MW-34A	SULFATE, DISSOLVED (MG/L SO4)	01	160	12/10/1990	160		
MW-34A	SULFATE, DISSOLVED (MG/L SO4)	01	180	3/5/1991	180		
MW-34A	SULFATE, DISSOLVED (MG/L SO4)	01	190	6/3/1991	190		
MW-34A	SULFATE, DISSOLVED (MG/L SO4)	01	180	9/6/1991	180		
MW-34A	SULFATE, DISSOLVED (MG/L SO4)	01	580	12/4/1991	580		
MW-34A	SULFATE, DISSOLVED (MG/L SO4)	01	190	3/3/1992	190		
MW-34A	SULFATE, DISSOLVED (MG/L SO4)	01	180	6/2/1992	180		
MW-34A	SULFATE, DISSOLVED (MG/L SO4)	01	170	9/1/1992	170		
MW-34A	SULFATE, DISSOLVED (MG/L SO4)	01	98	12/2/1992	98		

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Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-34A	SULFATE, DISSOLVED (MG/L SO4)	01	50	3/10/1993	50		
MW-34A	SULFATE, DISSOLVED (MG/L SO4)	01	46	6/2/1993	46		
MW-34A	SULFATE, DISSOLVED (MG/L SO4)	01	120	9/14/1993	120		
MW-34A	SULFATE, DISSOLVED (MG/L SO4)	01	210	12/7/1993	210		
MW-34A	SULFATE, DISSOLVED (MG/L SO4)	01	420	9/13/1994	420		
MW-34A	SULFATE, DISSOLVED (MG/L SO4)	01	370	12/6/1994	370		
MW-34A	SULFATE, DISSOLVED (MG/L SO4)	01	480	3/7/1995	480		
MW-34A	SULFATE, DISSOLVED (MG/L SO4)	01	140	6/6/1995	140		
MW-34A	SULFATE, DISSOLVED (MG/L SO4)	01	85	9/6/1995	85		
MW-34A	SULFATE, DISSOLVED (MG/L SO4)	01	75	4/30/1996	75		
MW-34A	SULFATE, DISSOLVED (MG/L SO4)	01	93	10/16/1996	93		
MW-34A	SULFATE, DISSOLVED (MG/L SO4)	01	70	4/8/1997	70		
MW-34A	SULFATE, DISSOLVED (MG/L SO4)	01	150	10/20/1997	150		
MW-34A	SULFATE, DISSOLVED (MG/L SO4)	01	76	4/14/1998	76		
MW-34A	SULFATE, DISSOLVED (MG/L SO4)	01	110	10/27/1998	110		
MW-34A	SULFATE, DISSOLVED (MG/L SO4)	01	130	4/16/1999	130		B
MW-34A	SULFATE, DISSOLVED (MG/L SO4)	01	150	10/21/1999	150		
MW-34A	SULFATE, DISSOLVED (MG/L SO4)	01	170	4/20/2000	170		
MW-34A	SULFATE, DISSOLVED (MG/L SO4)	01	280	10/4/2000	280		
MW-34A	SULFATE, DISSOLVED (MG/L SO4)	01	330	4/3/2001	330		
MW-34A	SULFATE, DISSOLVED (MG/L SO4)	01	350	10/30/2001	350		
MW-34A	SULFATE, DISSOLVED (MG/L SO4)	01	68	4/25/2002	68		
MW-34A	SULFATE, DISSOLVED (MG/L SO4)	01	150	10/24/2002	150		
MW-34A	SULFATE, DISSOLVED (MG/L SO4)	01	79	4/29/2003	79		
MW-34A	SULFATE, DISSOLVED (MG/L SO4)	01	60	10/29/2003	60		
MW-34A	SULFATE, DISSOLVED (MG/L SO4)	01	69	4/27/2004	69		
MW-34A	SULFATE, DISSOLVED (MG/L SO4)	01	160	10/12/2004	160		
MW-34A	SULFATE, DISSOLVED (MG/L SO4)	01	110	4/15/2005	110		
MW-34A	SULFATE, DISSOLVED (MG/L SO4)	01	97	10/26/2005	97		
MW-34A	SULFATE, DISSOLVED (MG/L SO4)	01	150	4/13/2006	150		
MW-34A	SULFATE, DISSOLVED (MG/L SO4)	01	120	10/12/2006	120		
MW-34A	SULFATE, DISSOLVED (MG/L SO4)	01	100	4/11/2007	100		
MW-34A	SULFATE, DISSOLVED (MG/L SO4)	01	72	10/31/2007	72		
MW-34A	SULFATE, DISSOLVED (MG/L SO4)	01	73.9	4/17/2008	73.9		
MW-34A	SULFATE, DISSOLVED (MG/L SO4)	01	64.4	10/10/2008	64.4		
MW-34A	SULFATE, DISSOLVED (MG/L SO4)	01	124	4/21/2009	124		
MW-34A	SULFATE, DISSOLVED (MG/L SO4)	01	65.2	10/27/2009	65.2		
MW-34A	SULFATE, DISSOLVED (MG/L SO4)	01	80	4/14/2010	80		
MW-34A	SULFATE, DISSOLVED (MG/L SO4)	01	66	10/20/2010	66		
MW-34A	SULFATE, DISSOLVED (MG/L SO4)	01	81	4/6/2011	81		
MW-34A	SULFATE, DISSOLVED (MG/L SO4)	01	66	10/20/2011	66		
MW-34A	SULFATE, DISSOLVED (MG/L SO4)	01	55	4/4/2012	55		
MW-34A	SULFATE, DISSOLVED (MG/L SO4)	01	43	10/4/2012	43		
MW-34A	SULFATE, DISSOLVED (MG/L SO4)	01	25.7	4/16/2013	25.7		
MW-34A	SULFATE, TOTAL (MG/L SO4)	01	47.2	10/14/2013	47.2		
MW-34A	SULFATE, DISSOLVED (MG/L SO4)	01	36.4	4/16/2014	36.4		
MW-34A	SULFATE, DISSOLVED (MG/L SO4)	01	46.7	10/2/2014	46.7		
MW-34A	SULFATE, DISSOLVED (MG/L SO4)	01	53.6	4/14/2015	53.6		
MW-34A	SULFATE, DISSOLVED (MG/L SO4)	01	64	10/7/2015	64		
MW-33AR	SULFATE, TOTAL (MG/L SO4)	00	69.9	12/21/2015	69.9	69.9	
MW-33AR	SULFATE, TOTAL (MG/L SO4)	01	71.3	12/21/2015	71.3	71.3	
MW-33AR	SULFATE, TOTAL (MG/L SO4)	01	71.6	4/5/2016	71.6	71.6	
MW-33AR	SULFATE, TOTAL (MG/L SO4)	01	63.4	7/7/2016	63.4	63.4	
MW-33AR	SULFATE, TOTAL (MG/L SO4)	01	54.8	10/13/2016	54.8	54.8	
MW-33AR	SULFATE, TOTAL (MG/L SO4)	01	63.9	12/29/2016	63.9	63.9	
MW-33AR	SULFATE, TOTAL (MG/L SO4)	01	71.2	1/25/2017	71.2	71.2	
MW-33AR	SULFATE, TOTAL (MG/L SO4)	01	87.6	4/11/2017	87.6	87.6	
MW-33AR	SULFATE, TOTAL (MG/L SO4)	01	106	6/6/2017	106	106	
MW-33AR	SULFATE, TOTAL (MG/L SO4)	01	105	8/7/2017	105	105	
MW-33AR	SULFATE, TOTAL (MG/L SO4)	01	98	10/24/2017	98	98	
MW-33AR	SULFATE, TOTAL (MG/L SO4)	01	144	4/24/2018	144	144	
MW-33AR	SULFATE, TOTAL (MG/L SO4)	01	141	9/21/2018	141	141	
MW-33AR	SULFATE, TOTAL (MG/L SO4)	01	123	10/22/2018	123	123	

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Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-33AR	SULFATE, TOTAL (MG/L SO4)	01	70.4	4/2/2019	70.4	70.4	
MW-33AR	SULFATE, TOTAL (MG/L SO4)	01	39.8	10/8/2019	39.8	39.8	
MW-33AR	SULFATE, TOTAL (MG/L SO4)	01	44.4	5/28/2020	44.4	44.4	
MW-33AR	SULFATE, TOTAL (MG/L SO4)	01	58.7	10/8/2020	58.7	58.7	
MW-33AR	SULFATE, TOTAL (MG/L SO4)	01	59.3	4/13/2021	59.3	59.3	
MW-33AR	SULFATE, TOTAL (MG/L SO4)	01	56.1	10/12/2021	56.1	56.1	
MW-33AR	SULFATE, TOTAL (MG/L SO4)	01	146	4/12/2022	146	146	
MW-33AR	SULFATE, TOTAL (MG/L SO4)	01	169	10/27/2022	169	169	
MW-33AR	SULFATE, TOTAL (MG/L SO4)	01	48.4	4/26/2023	48.4	48.4	
Calculations							
Count						23	
Mean						85.34	
Std Dev						36.86	
2 X SD (ACL)						73.72	
ACL, Calculated						159.06	
ACL, Rounded						160	

Duplicate Data Not Used for Calculations							

Note: Current PAL = 125 mg/l; ES = 250 mg/l; Data through 10/2015 from GEMS, later data from Chempoint

J = Result is an estimated value below the laboratory's limit of quantitation.

P = Did not meet required preservation and/or hold time.

B = Compound detected in blank.

M = Failed method QC check.

QC1 = GEMS Quality Control Flag 1. Concentration of parameter in associated method, field, or trip blank exceeds highest of: limit of detection, 5% of PAL, or 10 % of sample concentration.

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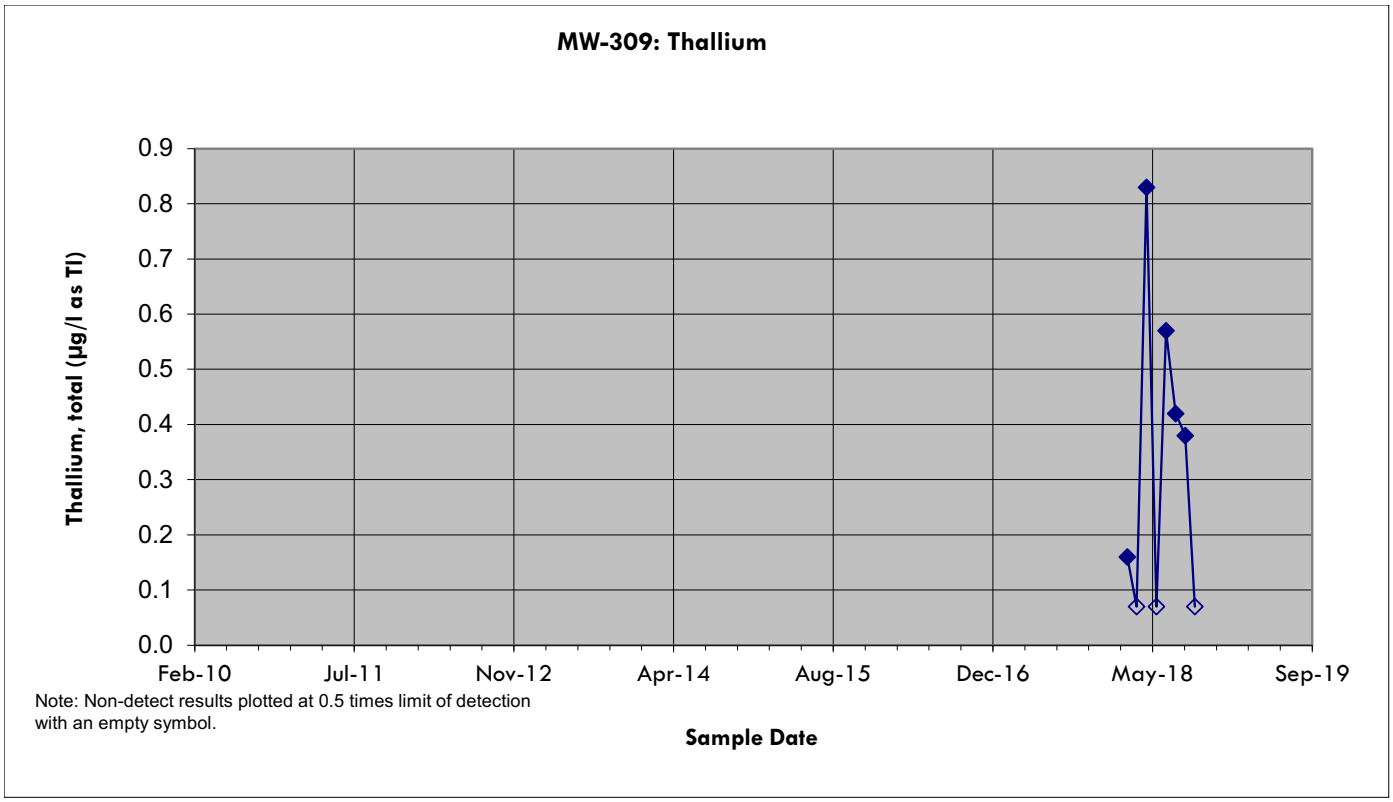

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-309	THALLIUM, TOTAL (UG/L TL)	01	0.16	2/21/2018	0.16	0.16	J
MW-309	THALLIUM, TOTAL (UG/L TL)	01	<0.14	3/23/2018	0.07	0.07	
MW-309	THALLIUM, TOTAL (UG/L TL)	01	0.83	4/23/2018	0.83	0.83	J
MW-309	THALLIUM, TOTAL (UG/L TL)	01	<0.14	5/24/2018	0.07	0.07	
MW-309	THALLIUM, TOTAL (UG/L TL)	01	0.57	6/23/2018	0.57	0.57	J
MW-309	THALLIUM, TOTAL (UG/L TL)	01	0.42	7/23/2018	0.42	0.42	J
MW-309	THALLIUM, TOTAL (UG/L TL)	01	0.38	8/22/2018	0.38	0.38	J
MW-309	THALLIUM, TOTAL (UG/L TL)	01	<0.14	9/21/2018	0.07	0.07	
Calculations							
Count						8	
Mean						0.32	
Std Dev						0.28	
2 X SD (ACL)						0.56	
ACL, Calculated						0.88	
ACL, Rounded						0.89	

Duplicate Data Not Used for Calculations							

Note: Current PAL = 0.4 ug/l; ES = 2 ug/l

J = Result is an estimated value below the laboratory's limit of quantitation.

P = Did not meet required preservation and/or hold time.

B = Compound detected in blank.

M = Failed method QC check.

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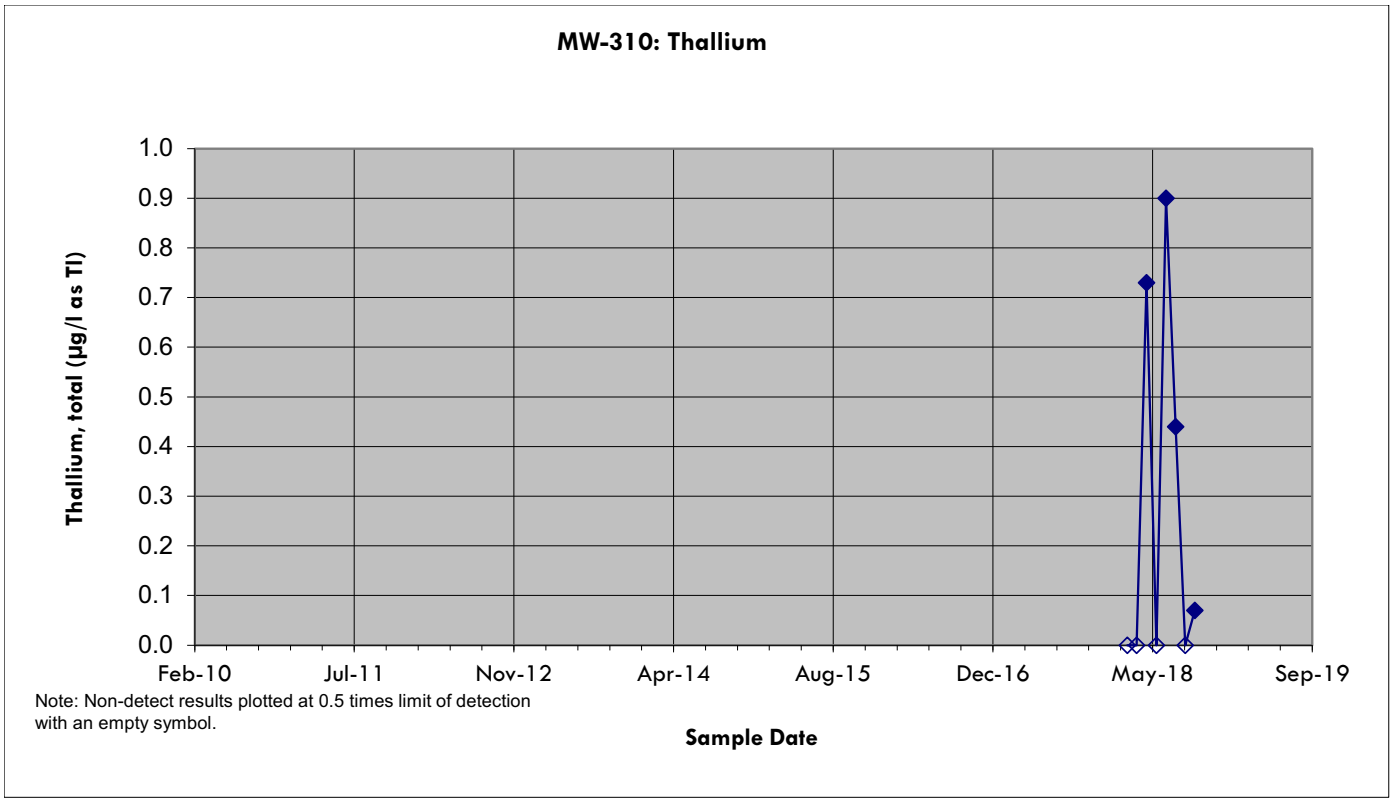

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-310	THALLIUM, TOTAL (UG/L TL)	01	<0.14	2/21/2018	<0.14	<0.14	
MW-310	THALLIUM, TOTAL (UG/L TL)	01	<0.14	3/23/2018	<0.14	<0.14	
MW-310	THALLIUM, TOTAL (UG/L TL)	01	0.73	4/23/2018	0.73	0.73	J
MW-310	THALLIUM, TOTAL (UG/L TL)	01	<0.14	5/24/2018	<0.14	<0.14	
MW-310	THALLIUM, TOTAL (UG/L TL)	01	0.9	6/23/2018	0.9	0.9	J
MW-310	THALLIUM, TOTAL (UG/L TL)	01	0.44	7/23/2018	0.44	0.44	J
MW-310	THALLIUM, TOTAL (UG/L TL)	01	<0.14	8/22/2018	<0.14	<0.14	
MW-310	THALLIUM, TOTAL (UG/L TL)	01	0.27	9/21/2018	0.07	0.07	J
Calculations							
Count						4	
Mean						0.54	
Std Dev						0.36	
2 X SD (ACL)						0.73	
ACL, Calculated						1.26	
ACL, Rounded						1.3	

Duplicate Data Not Used for Calculations							

Note: Current PAL = 0.4 ug/l; ES = 2 ug/l

J = Result is an estimated value below the laboratory's limit of quantitation.

P = Did not meet required preservation and/or hold time.

B = Compound detected in blank.

M = Failed method QC check.

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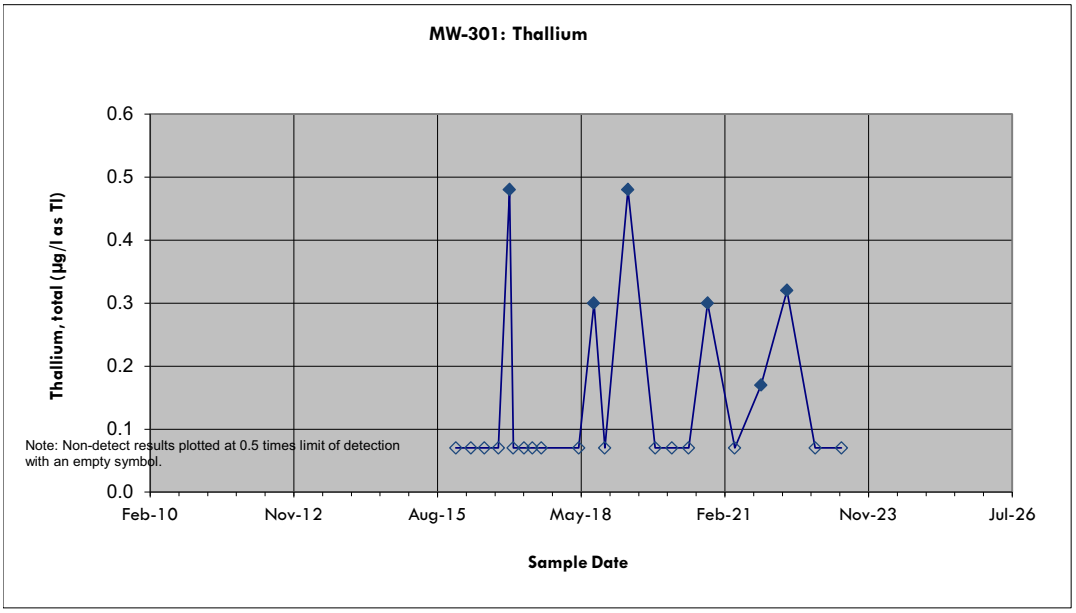
09/28/2023 - Classification: Internal - ECRM13153872



Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-301	THALLIUM, TOTAL (UG/L TL)	01	<0.14	12/22/2015	0.07	0.07	
MW-301	THALLIUM, TOTAL (UG/L TL)	01	<0.14	4/5/2016	0.07	0.07	
MW-301	THALLIUM, TOTAL (UG/L TL)	01	<0.14	7/8/2016	0.07	0.07	
MW-301	THALLIUM, TOTAL (UG/L TL)	01	<0.14	10/13/2016	0.07	0.07	
MW-301	THALLIUM, TOTAL (UG/L TL)	01	0.48	12/29/2016	0.48	0.48	J
MW-301	THALLIUM, TOTAL (UG/L TL)	01	<0.14	1/25/2017	0.07	0.07	
MW-301	THALLIUM, TOTAL (UG/L TL)	01	<0.14	4/11/2017	0.07	0.07	
MW-301	THALLIUM, TOTAL (UG/L TL)	01	<0.14	6/6/2017	0.07	0.07	
MW-301	THALLIUM, TOTAL (UG/L TL)	01	<0.14	8/8/2017	0.07	0.07	
MW-301	THALLIUM, TOTAL (UG/L TL)	01	<0.14	4/25/2018	0.07	0.07	
MW-301	THALLIUM, TOTAL (UG/L TL)	01	0.3	8/8/2018	0.3	0.3	J
MW-301	THALLIUM, TOTAL (UG/L TL)	01	<0.14	10/24/2018	0.07	0.07	
MW-301	THALLIUM, TOTAL (UG/L TL)	01	0.48	4/2/2019	0.48	0.48	J
MW-301	THALLIUM, TOTAL (UG/L TL)	01	<0.14	10/9/2019	0.07	0.07	
MW-301	THALLIUM, TOTAL (UG/L TL)	01	<0.14	2/3/2020	0.07	0.07	
MW-301	THALLIUM, TOTAL (UG/L TL)	01	<0.14	5/29/2020	0.07	0.07	
MW-301	THALLIUM, TOTAL (UG/L TL)	01	0.3	10/8/2020	0.3	0.3	J
MW-301	THALLIUM, TOTAL (UG/L TL)	01	<0.14	4/14/2021	0.07	0.07	
MW-301	THALLIUM, TOTAL (UG/L TL)	01	0.17	10/14/2021	0.17	0.17	J
MW-301	THALLIUM, TOTAL (UG/L TL)	01	0.32	4/13/2022	0.32	0.32	J
MW-301	THALLIUM, TOTAL (UG/L TL)	01	<0.14	10/27/2022	0.07	0.07	
MW-301	THALLIUM, TOTAL (UG/L TL)	01	<0.14	4/27/2023	0.07	0.07	
Calculations							
Count						22	
Mean						0.14	
Std Dev						0.14	
2 X SD (ACL)						0.27	
ACL, Calculated						0.42	
ACL, Rounded						0.42	

All detects <LOQ, so no ACL?

Duplicate Data Not Used for Calculations							

Note: Current PAL = 0.4 ug/l; ES = 4 ug/l
J = Result is an estimated value below the laboratory's limit of quantitation.
P = Did not meet required preservation and/or hold time.
B = Compound detected in blank.
M = Failed method QC check.

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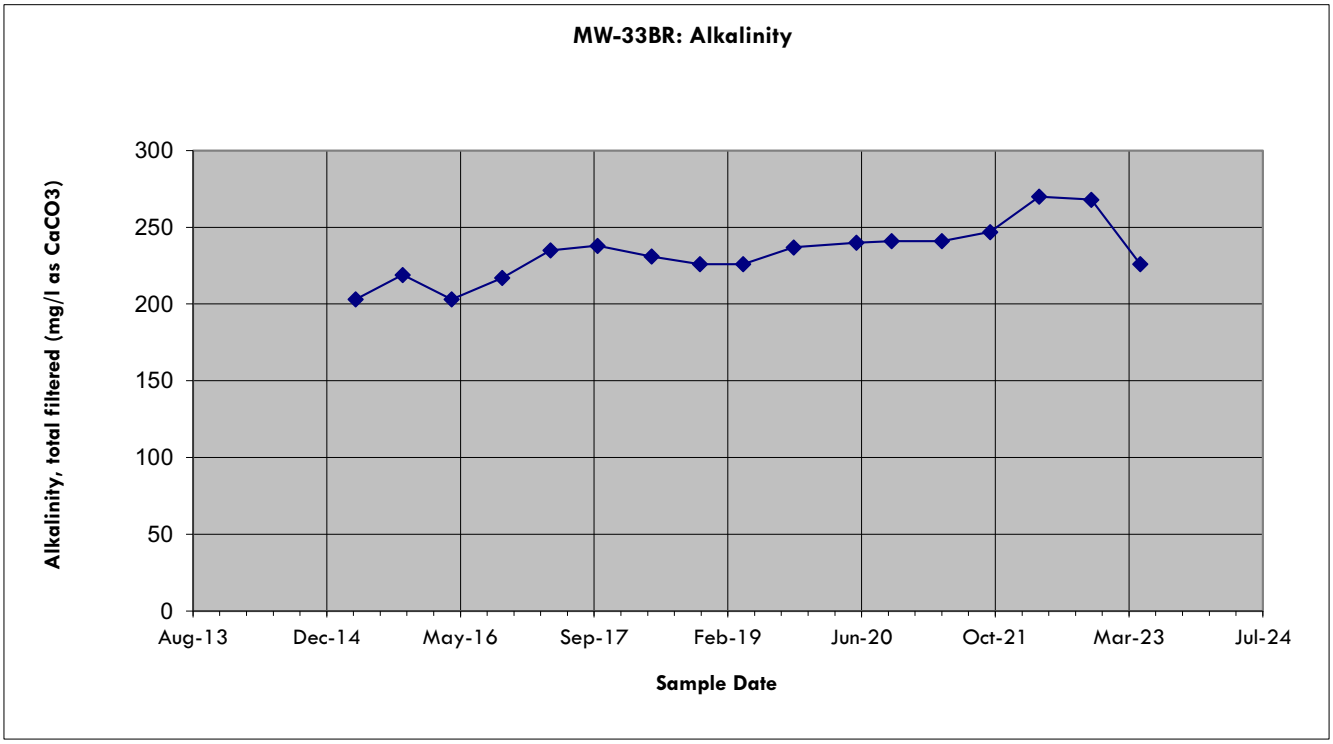
09/28/2023 - Classification: Internal - ECRM13153872

I.2 Non-CCR Well PAL and ACL Calcs

09/28/2023 - Classification: Internal - ECRM13153872



Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-33BR	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	203	4/13/2015	203	203	
MW-33BR	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	219	10/7/2015	219	219	
MW-33BR	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	203	4/7/2016	203	203	
MW-33BR	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	217	10/13/2016	217	217	
MW-33BR	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	235	4/11/2017	235	235	
MW-33BR	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	238	10/4/2017	238	238	
MW-33BR	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	231	4/24/2018	231	231	
MW-33BR	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	226	10/22/2018	226	226	
MW-33BR	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	226	4/2/2019	226	226	
MW-33BR	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	237	10/8/2019	237	237	
MW-33BR	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	240	5/29/2020	240	240	
MW-33BR	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	241	10/8/2020	241	241	
MW-33BR	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	241	4/14/2021	241	241	
MW-33BR	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	247	10/12/2021	247	247	
MW-33BR	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	270	4/13/2022	270	270	
MW-33BR	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	268	10/25/2022	268	268	
MW-33BR	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	226	4/26/2023	226	226	
Calculations							
Count						17	
Mean						233.41	
Std Dev						18.39	
3 X SD (PAL)						55.18	
Min Increase (PAL)						100	
PAL, Calculated						333.41	
PAL, Rounded						340	

Duplicate Data Not Used for Calculations							

Notes: Data downloaded from GEMS

J = Result is an estimated value below the laboratory's limit of quantitation.

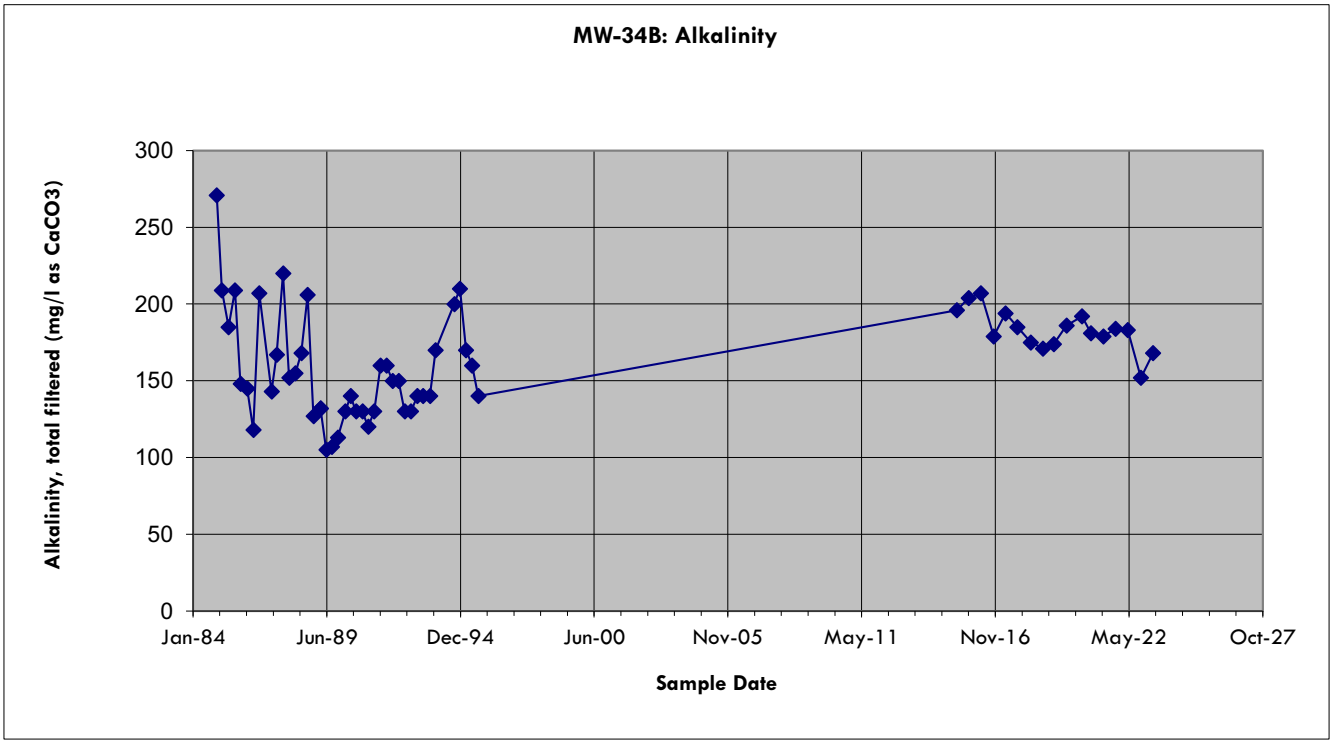
P = Did not meet required preservation and/or hold time.

B = Compound detected in blank.

M = Failed method QC check.

I:\25222260.00\Data and Calculations\Groundwater PALs ACLs\[PAL Calculations_Non CCR Wells.xlsx]MW-33BR_Alk_PAL

09/28/2023 - Classification: Internal - ECRM13153872



Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-34B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	271	12/17/1984	271		
MW-34B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	209	3/7/1985	209		
MW-34B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	185	6/14/1985	185		
MW-34B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	209	9/18/1985	209		
MW-34B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	148	12/12/1985	148		
MW-34B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	145	3/21/1986	145		
MW-34B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	118	6/20/1986	118		
MW-34B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	207	9/18/1986	207		
MW-34B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	143	3/20/1987	143		
MW-34B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	167	6/5/1987	167		
MW-34B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	220	9/9/1987	220		
MW-34B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	152	12/9/1987	152		
MW-34B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	155	3/10/1988	155		
MW-34B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	168	6/7/1988	168		
MW-34B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	206	9/9/1988	206		
MW-34B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	127	12/7/1988	127		
MW-34B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	132	3/21/1989	132		
MW-34B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	132	3/22/1989	132		
MW-34B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	105	6/16/1989	105		
MW-34B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	107	9/6/1989	107		
MW-34B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	113	12/5/1989	113		
MW-34B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	130	3/29/1990	130		
MW-34B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	140	6/14/1990	140		
MW-34B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	130	9/5/1990	130		
MW-34B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	130	12/10/1990	130		
MW-34B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	120	3/5/1991	120		
MW-34B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	130	6/3/1991	130		
MW-34B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	160	9/6/1991	160		
MW-34B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	160	12/4/1991	160		
MW-34B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	150	3/3/1992	150		
MW-34B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	150	6/2/1992	150		
MW-34B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	130	9/1/1992	130		
MW-34B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	130	12/2/1992	130		
MW-34B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	140	3/10/1993	140		
MW-34B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	140	6/2/1993	140		
MW-34B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	140	9/14/1993	140		
MW-34B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	170	12/7/1993	170		
MW-34B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	200	9/13/1994	200		
MW-34B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	210	12/6/1994	210		
MW-34B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	170	3/7/1995	170		

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Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-34B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	160	6/6/1995	160		
MW-34B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	140	9/6/1995	140		
MW-34B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	196	4/13/2015	196	196	
MW-34B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	204	10/7/2015	204	204	
MW-34B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	207	4/7/2016	207	207	
MW-34B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	179	10/13/2016	179	179	
MW-34B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	194	4/11/2017	194	194	
MW-34B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	185	10/4/2017	185	185	
MW-34B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	175	4/24/2018	175	175	
MW-34B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	171	10/22/2018	171	171	
MW-34B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	174	4/2/2019	174	174	
MW-34B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	186	10/8/2019	186	186	
MW-34B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	192	5/29/2020	192	192	
MW-34B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	181	10/8/2020	181	181	
MW-34B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	179	4/14/2021	179	179	
MW-34B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	184	10/12/2021	184	184	
MW-34B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	183	4/13/2022	183	183	
MW-34B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	152	10/25/2022	152	152	
MW-34B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	168	4/26/2023	168	168	
Calculations							
Count						17	
Mean						182.94	
Std Dev						13.49	
3 X SD (PAL)						40.48	
Min Increase (PAL)						100	
PAL, Calculated						282.94	
PAL, Rounded						290	

Duplicate Data Not Used for Calculations							

Notes: Data downloaded from GEMS

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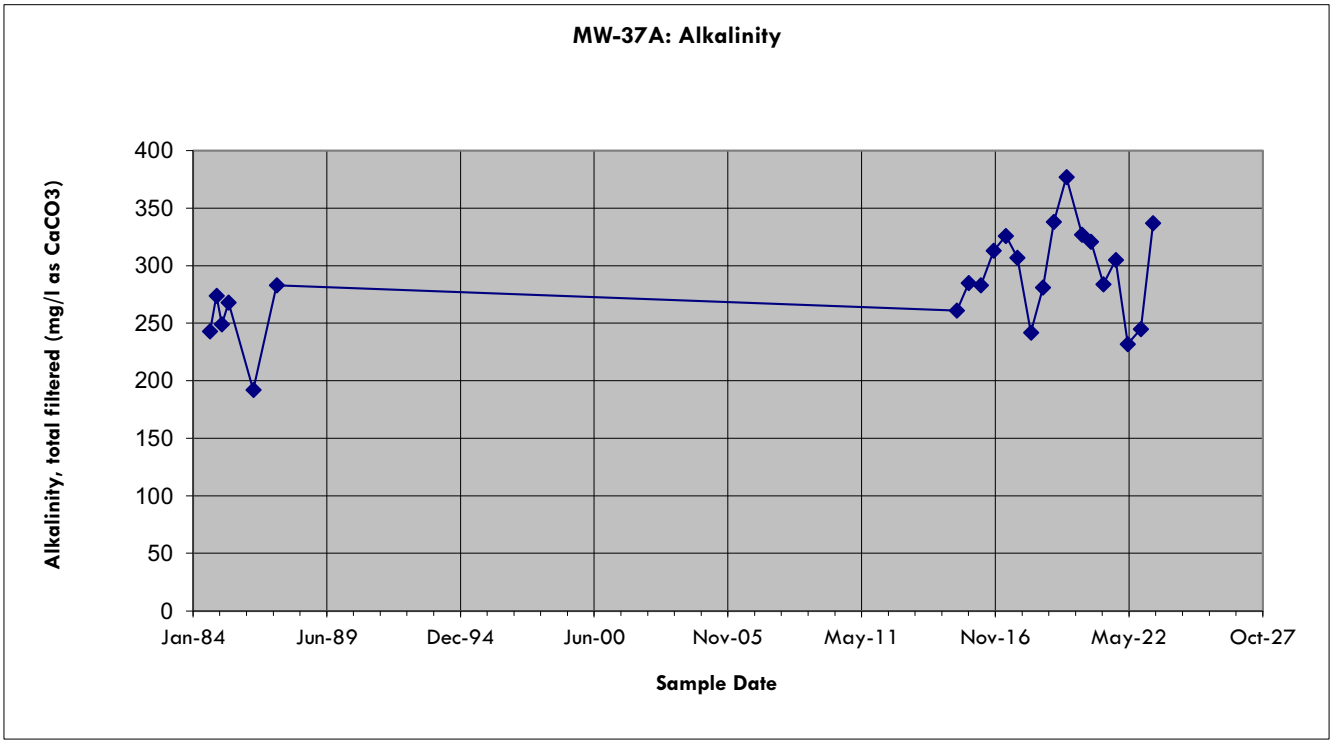

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-37A	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	243	9/7/1984	243		
MW-37A	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	274	12/17/1984	274		
MW-37A	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	249	3/7/1985	249		
MW-37A	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	268	6/14/1985	268		
MW-37A	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	192	6/20/1986	192		
MW-37A	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	283	6/5/1987	283		
MW-37A	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	261	4/14/2015	261	261	Using data from within the last 20 years for PAL calculation
MW-37A	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	285	10/8/2015	285	285	
MW-37A	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	283	4/7/2016	283	283	
MW-37A	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	313	10/13/2016	313	313	
MW-37A	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	326	4/13/2017	326	326	
MW-37A	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	307	10/5/2017	307	307	
MW-37A	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	242	4/25/2018	242	242	
MW-37A	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	281	10/23/2018	281	281	
MW-37A	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	338	4/3/2019	338	338	
MW-37A	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	377	10/9/2019	377	377	
MW-37A	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	327	5/29/2020	327	327	
MW-37A	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	321	10/8/2020	321	321	
MW-37A	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	284	4/14/2021	284	284	
MW-37A	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	305	10/14/2021	305	305	
MW-37A	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	232	4/13/2022	232	232	
MW-37A	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	245	10/25/2022	245	245	
MW-37A	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	337	4/24/2023	337	337	
Calculations							
Count						17	
Mean						297.88	
Std Dev						39.07	
3 X SD (PAL)						117.20	
Min Increase (PAL)						100	
PAL, Calculated						415.08	
PAL, Rounded						420	

Duplicate Data Not Used for Calculations							

Notes: Data downloaded from GEMS

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M = Failed method QC check.

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Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes

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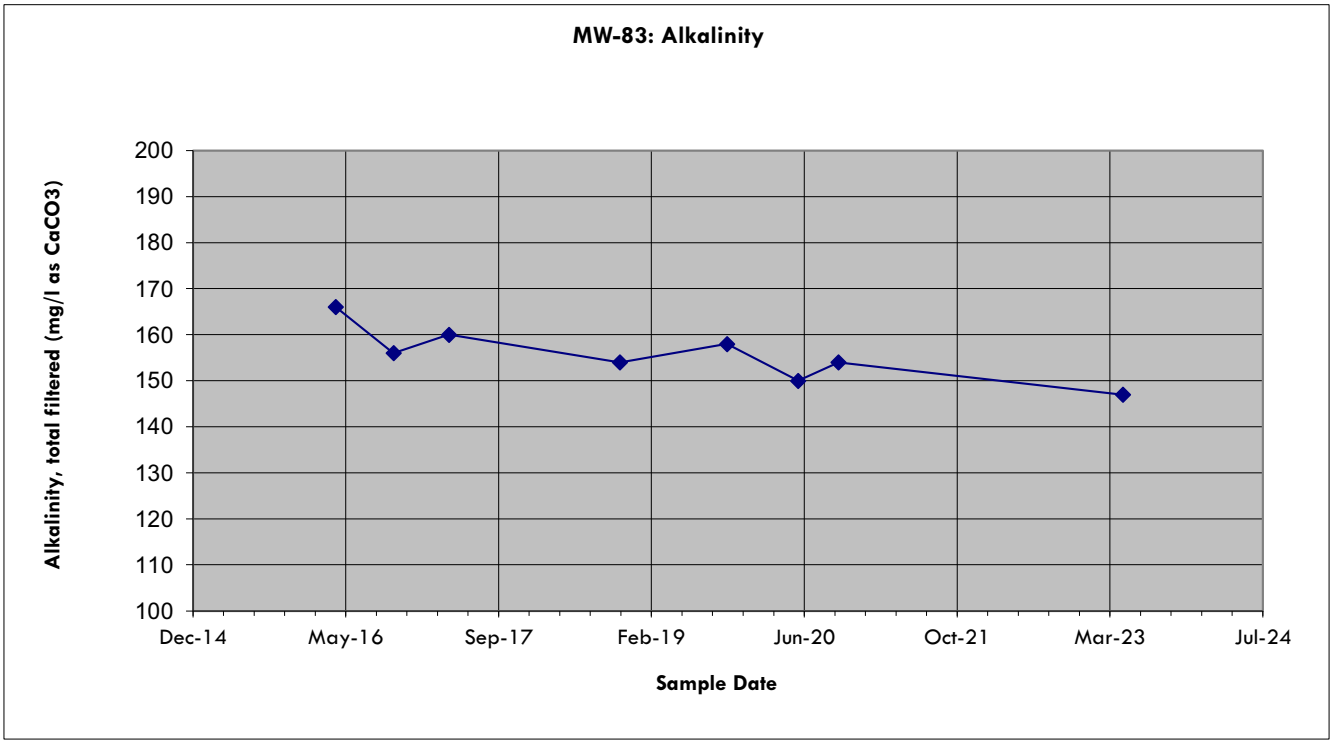

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-83	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	166	4/7/2016	166	166	
MW-83	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	156	10/13/2016	156	156	
MW-83	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	160	4/12/2017	160	160	
MW-83	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	154	10/24/2018	154	154	
MW-83	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	158	10/9/2019	158	158	
MW-83	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	150	5/29/2020	150	150	
MW-83	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	154	10/8/2020	154	154	
MW-83	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	147	4/27/2023	147	147	
Calculations							
Count						8	
Mean						155.63	
Std Dev						5.90	
3 X SD (PAL)						17.71	
Min Increase (PAL)						100	
PAL, Calculated						255.63	
PAL, Rounded						260	

Duplicate Data Not Used for Calculations							

Notes: Data downloaded from GEMS

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P = Did not meet required preservation and/or hold time.

B = Compound detected in blank.

M = Failed method QC check.

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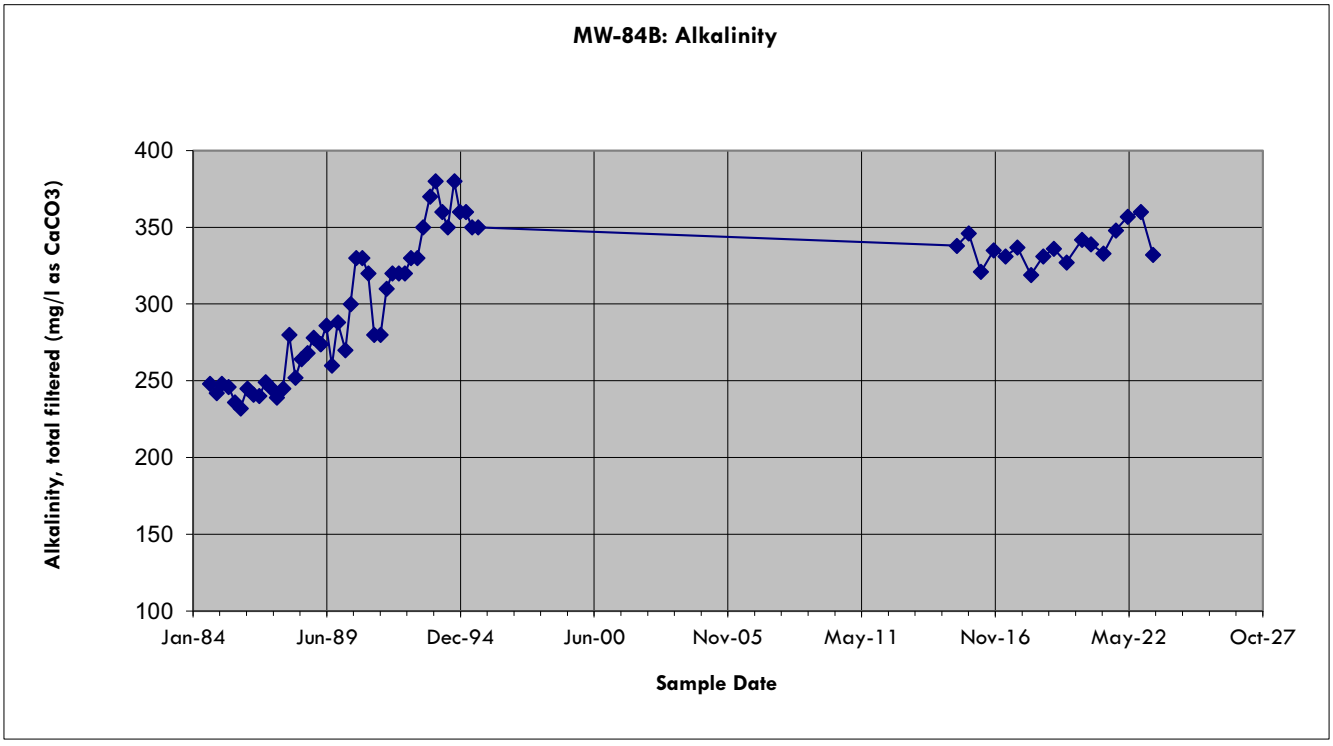
09/28/2023 - Classification: Internal - ECRM13153872



Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-84B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	248	9/7/1984	248		
MW-84B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	242	12/17/1984	242		
MW-84B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	248	3/7/1985	248		
MW-84B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	246	6/14/1985	246		
MW-84B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	236	9/18/1985	236		
MW-84B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	232	12/12/1985	232		
MW-84B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	245	3/21/1986	245		
MW-84B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	241	6/20/1986	241		
MW-84B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	240	9/18/1986	240		
MW-84B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	249	12/19/1986	249		
MW-84B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	245	3/20/1987	245		
MW-84B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	239	6/5/1987	239		
MW-84B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	245	9/9/1987	245		
MW-84B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	280	12/9/1987	280		
MW-84B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	252	3/10/1988	252		
MW-84B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	264	6/7/1988	264		
MW-84B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	268	9/9/1988	268		
MW-84B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	278	12/7/1988	278		
MW-84B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	274	3/21/1989	274		
MW-84B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	274	3/22/1989	274		
MW-84B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	286	6/16/1989	286		
MW-84B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	260	9/7/1989	260		
MW-84B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	288	12/6/1989	288		
MW-84B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	270	3/29/1990	270		
MW-84B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	300	6/14/1990	300		
MW-84B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	330	9/5/1990	330		
MW-84B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	330	12/7/1990	330		
MW-84B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	320	3/6/1991	320		
MW-84B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	280	6/3/1991	280		
MW-84B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	280	9/6/1991	280		
MW-84B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	310	12/5/1991	310		
MW-84B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	320	3/2/1992	320		
MW-84B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	320	6/2/1992	320		
MW-84B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	320	9/2/1992	320		
MW-84B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	330	12/2/1992	330		
MW-84B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	330	3/10/1993	330		
MW-84B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	350	6/3/1993	350		
MW-84B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	370	9/14/1993	370		
MW-84B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	380	12/7/1993	380		
MW-84B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	360	3/15/1994	360		

09/28/2023 - Classification: Internal - ECRM13153872

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-84B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	350	6/7/1994	350		
MW-84B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	380	9/13/1994	380		
MW-84B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	360	12/6/1994	360		
MW-84B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	360	3/7/1995	360		
MW-84B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	350	6/5/1995	350		
MW-84B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	350	9/5/1995	350		
MW-84B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	338	4/13/2015	338	338	Using data from within the last 20 years for PAL calculation
MW-84B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	346	10/8/2015	346	346	
MW-84B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	321	4/7/2016	321	321	
MW-84B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	335	10/13/2016	335	335	
MW-84B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	331	4/11/2017	331	331	
MW-84B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	337	10/5/2017	337	337	
MW-84B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	319	4/25/2018	319	319	
MW-84B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	331	10/24/2018	331	331	
MW-84B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	336	4/3/2019	336	336	M
MW-84B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	327	10/9/2019	327	327	M
MW-84B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	342	5/29/2020	342	342	
MW-84B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	339	10/9/2020	339	339	
MW-84B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	333	4/15/2021	333	333	
MW-84B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	348	10/14/2021	348	348	
MW-84B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	357	4/13/2022	357	357	
MW-84B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	360	10/25/2022	360	360	
MW-84B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	332	4/25/2023	332	332	
Calculations							
Count						17	
Mean						337.18	
Std Dev						11.06	
3 X SD (PAL)						33.19	
Min Increase (PAL)						100	
PAL, Calculated						437.18	
PAL, Rounded						440	

Duplicate Data Not Used for Calculations							

Notes: Data downloaded from GEMS

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M = Failed method QC check.

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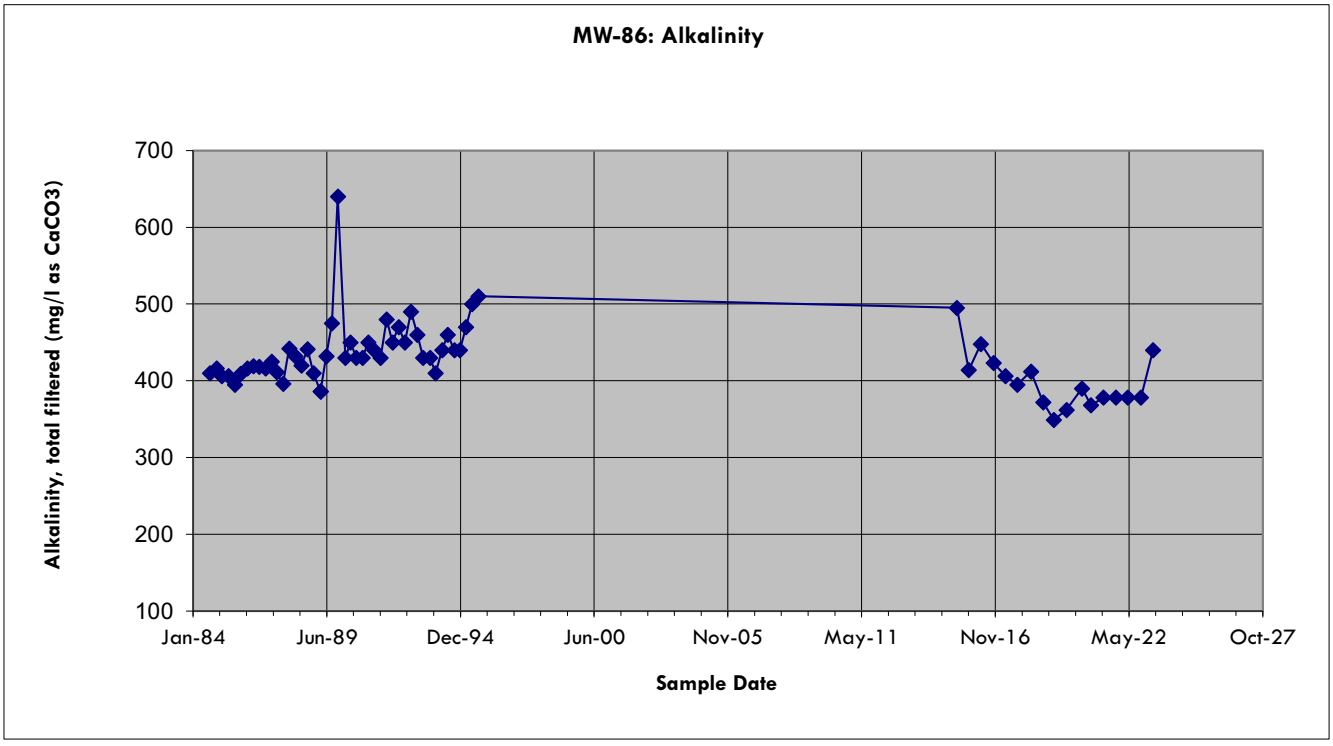

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-86	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	410	9/7/1984	410		
MW-86	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	416	12/17/1984	416		
MW-86	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	406	3/7/1985	406		
MW-86	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	406	6/14/1985	406		
MW-86	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	395	9/18/1985	395		
MW-86	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	409	12/12/1985	409		
MW-86	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	416	3/21/1986	416		
MW-86	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	419	6/20/1986	419		
MW-86	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	418	9/18/1986	418		
MW-86	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	416	12/19/1986	416		
MW-86	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	425	3/20/1987	425		
MW-86	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	411	6/5/1987	411		
MW-86	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	396	9/9/1987	396		
MW-86	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	442	12/9/1987	442		
MW-86	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	432	3/10/1988	432		
MW-86	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	420	6/7/1988	420		
MW-86	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	441	9/9/1988	441		
MW-86	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	410	12/7/1988	410		
MW-86	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	386	3/21/1989	386		
MW-86	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	386	3/22/1989	386		
MW-86	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	432	6/16/1989	432		
MW-86	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	475	9/7/1989	475		
MW-86	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	640	12/6/1989	640		
MW-86	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	430	3/29/1990	430		
MW-86	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	450	6/13/1990	450		
MW-86	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	430	9/7/1990	430		
MW-86	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	430	12/11/1990	430		
MW-86	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	450	3/6/1991	450		
MW-86	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	440	6/3/1991	440		
MW-86	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	430	9/6/1991	430		
MW-86	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	480	12/5/1991	480		
MW-86	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	450	3/3/1992	450		
MW-86	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	470	6/2/1992	470		
MW-86	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	450	9/2/1992	450		
MW-86	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	490	12/2/1992	490		
MW-86	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	460	3/10/1993	460		
MW-86	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	430	6/2/1993	430		
MW-86	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	430	9/14/1993	430		
MW-86	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	410	12/7/1993	410		
MW-86	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	440	3/15/1994	440		

09/28/2023 - Classification: Internal - ECRM13153872

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-86	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	460	6/7/1994	460		
MW-86	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	440	9/13/1994	440		
MW-86	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	440	12/6/1994	440		
MW-86	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	470	3/7/1995	470		
MW-86	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	500	6/5/1995	500		
MW-86	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	510	9/6/1995	510		
MW-86	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	495	4/14/2015	495	495	Using data from within the last 20 years for PAL calculation
MW-86	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	414	10/8/2015	414	414	
MW-86	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	448	4/7/2016	448	448	
MW-86	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	423	10/13/2016	423	423	
MW-86	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	406	4/11/2017	406	406	
MW-86	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	395	10/5/2017	395	395	
MW-86	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	412	4/25/2018	412	412	
MW-86	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	372	10/24/2018	372	372	
MW-86	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	349	4/3/2019	349	349	M
MW-86	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	362	10/9/2019	362	362	M
MW-86	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	390	5/29/2020	390	390	
MW-86	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	368	10/9/2020	368	368	
MW-86	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	378	4/15/2021	378	378	
MW-86	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	378	10/14/2021	378	378	
MW-86	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	378	4/13/2022	378	378	
MW-86	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	378	10/25/2022	378	378	
MW-86	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	440	4/24/2023	440	440	

Count	17	
Mean	399.18	
Std Dev	36.86	
3 X SD (PAL)	110.57	
Min Increase (PAL)	100	
PAL, Calculated	509.75	
PAL, Rounded	510	

Duplicate Data Not Used for Calculations							

Notes: Data downloaded from GEMS

J = Result is an estimated value below the laboratory's limit of quantitation.

P = Did not meet required preservation and/or hold time.

B = Compound detected in blank.

M = Failed method QC check.

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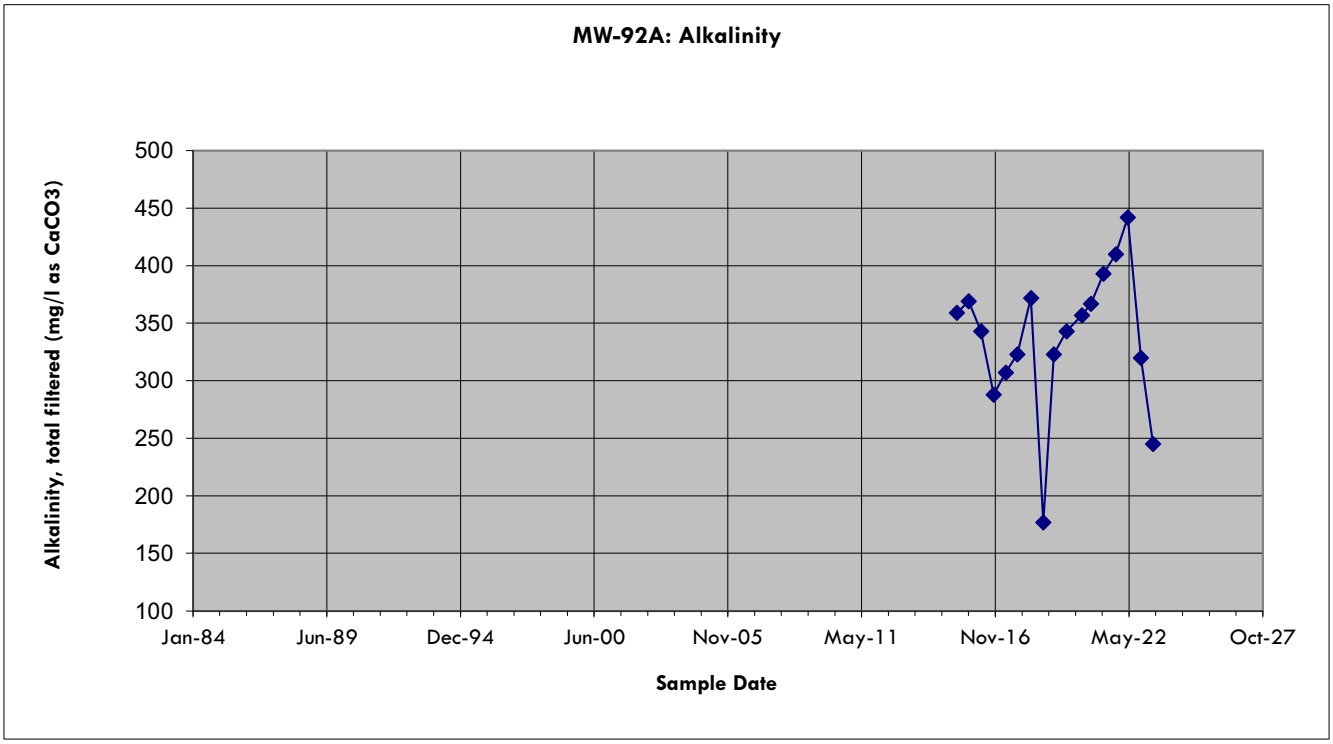

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-92A	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	359	4/13/2015	359	359	
MW-92A	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	369	10/8/2015	369	369	
MW-92A	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	343	4/8/2016	343	343	
MW-92A	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	288	10/13/2016	288	288	
MW-92A	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	307	4/12/2017	307	307	
MW-92A	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	323	10/5/2017	323	323	
MW-92A	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	372	4/25/2018	372	372	
MW-92A	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	177	10/25/2018	177	177	
MW-92A	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	323	4/3/2019	323	323	
MW-92A	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	343	10/9/2019	343	343	
MW-92A	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	357	5/29/2020	357	357	
MW-92A	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	367	10/9/2020	367	367	
MW-92A	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	393	4/15/2021	393	393	
MW-92A	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	410	10/14/2021	410	410	
MW-92A	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	442	4/13/2022	442	442	
MW-92A	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	320	10/25/2022	320	320	
MW-92A	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	245	4/24/2023	245	245	

Count	17	
Mean	337.53	
Std Dev	62.07	
3 X SD (PAL)	186.20	
Min Increase (PAL)	100	
PAL, Calculated	523.73	
PAL, Rounded	530	

Duplicate Data Not Used for Calculations							

Notes: Data downloaded from GEMS

J = Result is an estimated value below the laboratory's limit of quantitation.

P = Did not meet required preservation and/or hold time.

B = Compound detected in blank.

M = Failed method QC check.

QC3 = sample failed the quality control standards specified by the analyticalmethod or the requirements of NR 149.48

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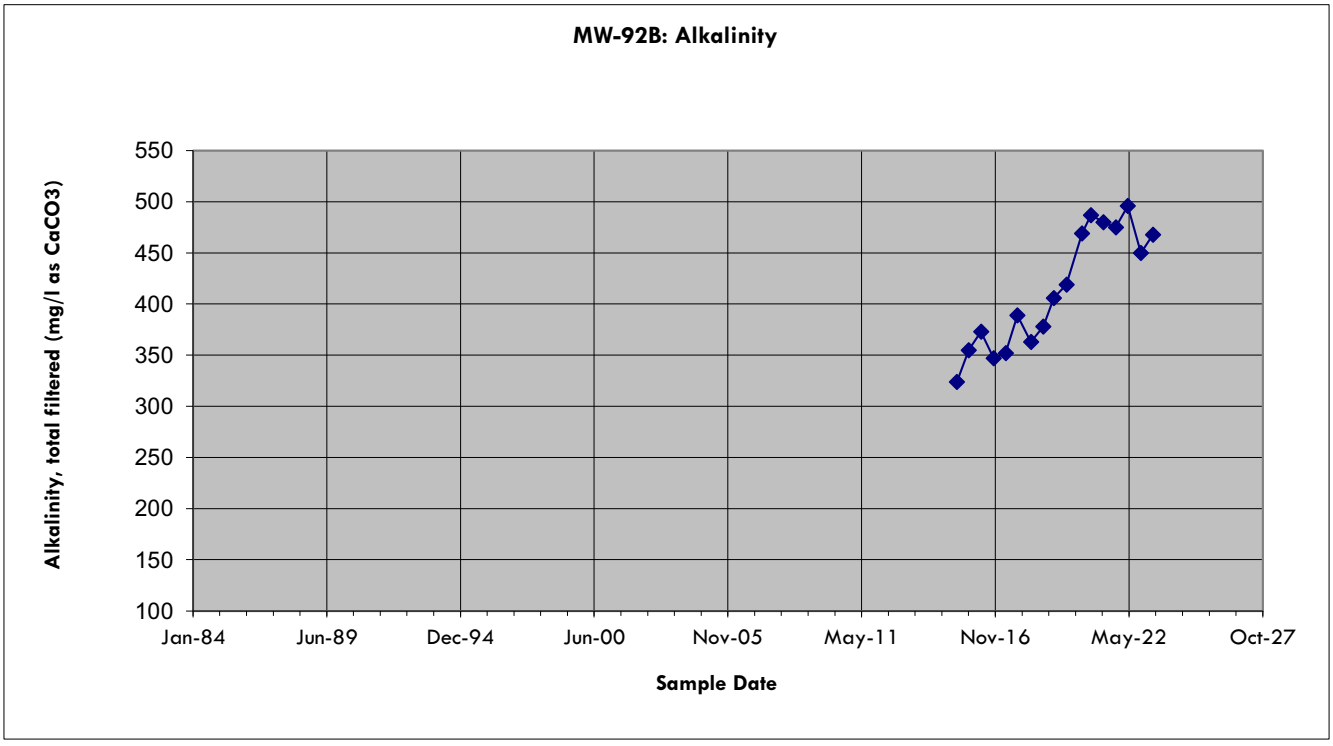
09/28/2023 - Classification: Internal - ECRM13153872



Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-92B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	324	4/13/2015	324	324	
MW-92B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	355	10/8/2015	355	355	
MW-92B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	373	4/8/2016	373	373	
MW-92B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	347	10/13/2016	347	347	
MW-92B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	352	4/12/2017	352	352	
MW-92B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	389	10/5/2017	389	389	
MW-92B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	363	4/25/2018	363	363	
MW-92B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	378	10/25/2018	378	378	
MW-92B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	406	4/3/2019	406	406	
MW-92B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	419	10/9/2019	419	419	
MW-92B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	469	5/29/2020	469	469	M
MW-92B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	487	10/9/2020	487	487	
MW-92B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	480	4/15/2021	480	480	
MW-92B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	475	10/14/2021	475	475	
MW-92B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	496	4/13/2022	496	496	
MW-92B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	450	10/25/2022	450	450	
MW-92B	ALKALINITY, TOTAL FILTERED (MG/L AS CACO3)	01	468	4/24/2023	468	468	

Count	17	
Mean	413.59	
Std Dev	57.86	
3 X SD (PAL)	173.59	
Min Increase (PAL)	100	
PAL, Calculated	587.18	
PAL, Rounded	590	

Duplicate Data Not Used for Calculations							

Notes: Data downloaded from GEMS

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P = Did not meet required preservation and/or hold time.

B = Compound detected in blank.

M = Failed method QC check.

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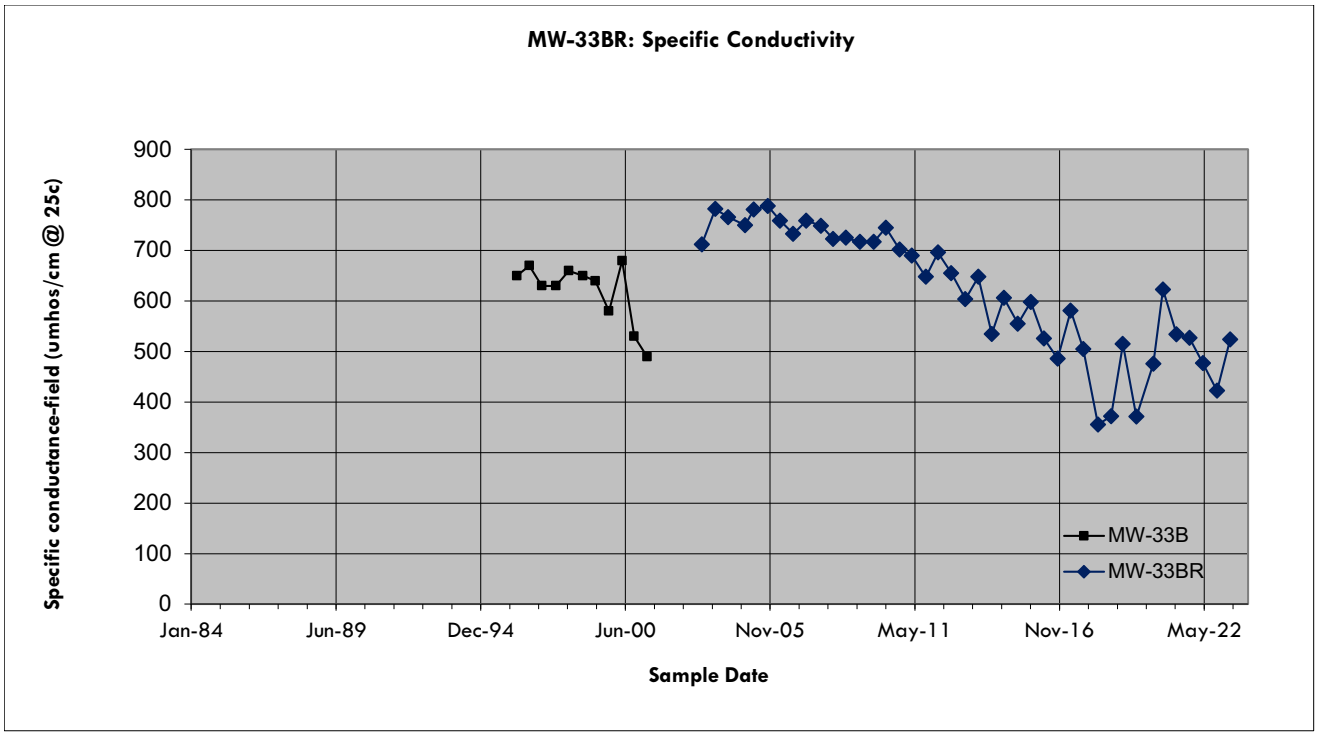
09/28/2023 - Classification: Internal - ECRM13153872



Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-33B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	650	4/30/1996	650		
MW-33B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	670	10/16/1996	670		
MW-33B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	630	4/8/1997	630		
MW-33B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	630	10/20/1997	630		
MW-33B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	660	4/14/1998	660		
MW-33B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	650	10/27/1998	650		
MW-33B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	640	4/16/1999	640		
MW-33B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	580	10/21/1999	580		
MW-33B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	680	4/20/2000	680		
MW-33B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	530	10/4/2000	530		
MW-33B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	490	4/3/2001	490		
MW-33BR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	712	4/29/2003	712	712	
MW-33BR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	782	10/30/2003	782	782	
MW-33BR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	766	4/27/2004	766	766	
MW-33BR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	750	12/14/2004	750	750	
MW-33BR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	781	4/15/2005	781	781	
MW-33BR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	788	10/26/2005	788	788	
MW-33BR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	759	4/13/2006	759	759	
MW-33BR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	733	10/12/2006	733	733	
MW-33BR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	759	4/11/2007	759	759	
MW-33BR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	749	10/31/2007	749	749	
MW-33BR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	723	4/17/2008	723	723	
MW-33BR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	725	10/10/2008	725	725	
MW-33BR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	717	4/21/2009	717	717	
MW-33BR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	717	10/27/2009	717	717	
MW-33BR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	745	4/14/2010	745	745	
MW-33BR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	702	10/20/2010	702	702	
MW-33BR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	690	4/6/2011	690	690	
MW-33BR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	648	10/20/2011	648	648	
MW-33BR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	696	4/4/2012	696	696	
MW-33BR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	655	10/4/2012	655	655	
MW-33BR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	604	4/17/2013	604	604	
MW-33BR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	648	10/14/2013	648	648	
MW-33BR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	535	4/16/2014	535	535	
MW-33BR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	606	10/2/2014	606	606	
MW-33BR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	555	4/13/2015	555	555	
MW-33BR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	598	10/7/2015	598	598	
MW-33BR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	526	4/7/2016	526	526	
MW-33BR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	486	10/13/2016	486	486	
MW-33BR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	580.9	4/11/2017	580.9	580.9	
MW-33BR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	505	10/4/2017	505	505	

09/28/2023 - Classification: Internal - ECRM13153872

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-33BR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	355.5	4/24/2018	355.5	355.5	
MW-33BR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	372	10/22/2018	372	372	
MW-33BR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	515	4/2/2019	515	515	
MW-33BR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	371	10/8/2019	371	371	
MW-33BR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	476	5/29/2020	476	476	
MW-33BR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	623	10/8/2020	623	623	
MW-33BR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	534	4/14/2021	534	534	
MW-33BR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	527	10/12/2021	527	527	
MW-33BR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	477	4/13/2022	477	477	
MW-33BR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	422.4	10/25/2022	422.4	422.4	
MW-33BR	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	524.1	4/26/2023	524.1	524.1	
Calculations							
Count						41	
Mean						620.44	
Std Dev						126.02	
3 X SD (PAL)						378.07	
Min Increase (PAL)						200	
PAL, Calculated						998.51	
PAL, Rounded						1000	

Duplicate Data Not Used for Calculations							

Note: Data for all events through October 2022 downloaded from GEMS

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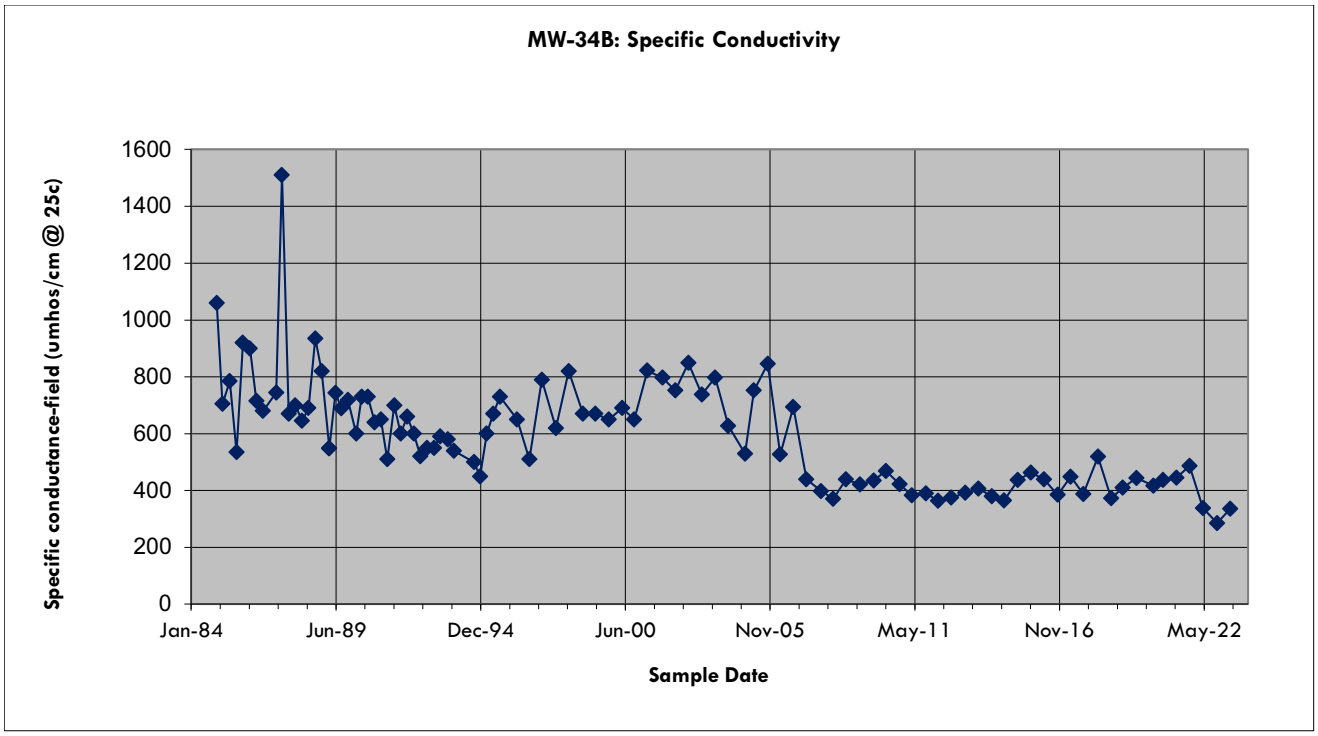

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1060	12/17/1984	1060		
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	705	3/7/1985	705		
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	785	6/14/1985	785		
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	535	9/18/1985	535		
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	920	12/12/1985	920		
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	900	3/21/1986	900		
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	715	6/20/1986	715		
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	680	9/18/1986	680		
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	745	3/20/1987	745		
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1510	6/5/1987	1510		
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	670	9/9/1987	670		
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	700	12/9/1987	700		
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	645	3/10/1988	645		
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	690	6/7/1988	690		
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	935	9/9/1988	935		
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	820	12/7/1988	820		
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	549	3/21/1989	549		
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	549	3/22/1989	549		
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	743	6/16/1989	743		
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	689	9/6/1989	689		
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	719	12/5/1989	719		
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	600	3/29/1990	600		
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	730	6/14/1990	730		
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	730	9/5/1990	730		
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	640	12/10/1990	640		
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	650	3/5/1991	650		
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	510	6/3/1991	510		
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	700	9/6/1991	700		
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	600	12/4/1991	600		
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	660	3/3/1992	660		
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	600	6/2/1992	600		
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	520	9/1/1992	520		
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	550	12/2/1992	550		
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	550	3/10/1993	550		
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	590	6/2/1993	590		
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	580	9/14/1993	580		
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	540	12/7/1993	540		
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	500	9/13/1994	500		
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	450	12/6/1994	450		
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	600	3/7/1995	600		
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	670	6/6/1995	670		

09/28/2023 - Classification: Internal - ECRM13153872

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	730	9/6/1995	730		
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	650	4/30/1996	650		
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	510	10/16/1996	510		
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	790	4/8/1997	790		
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	620	10/20/1997	620		
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	820	4/14/1998	820		
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	670	10/27/1998	670		
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	670	4/16/1999	670		
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	650	10/21/1999	650		
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	690	4/20/2000	690		
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	650	10/4/2000	650		
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	822	4/3/2001	822		
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	797	10/30/2001	797		
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	752	4/25/2002	752		
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	849	10/24/2002	849		
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	738	4/29/2003	738	738	Using data from within the last 20 years for PAL calculation
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	798	10/29/2003	798	798	
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	628	4/27/2004	628	628	
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	530	12/14/2004	530	530	
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	752	4/15/2005	752	752	
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	846	10/26/2005	846	846	
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	527	4/13/2006	527	527	
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	694	10/12/2006	694	694	
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	440	4/11/2007	440	440	
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	398	10/31/2007	398	398	
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	371	4/17/2008	371	371	
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	440	10/10/2008	440	440	
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	421	4/21/2009	421	421	
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	435	10/27/2009	435	435	
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	469	4/14/2010	469	469	
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	423	10/20/2010	423	423	
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	383	4/6/2011	383	383	
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	390	10/20/2011	390	390	
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	364	4/4/2012	364	364	
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	375	10/4/2012	375	375	
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	392	4/16/2013	392	392	
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	407	10/14/2013	407	407	
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	380	4/16/2014	380	380	
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	365	10/2/2014	365	365	
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	437	4/13/2015	437	437	
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	463	10/7/2015	463	463	
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	440	4/7/2016	440	440	
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	385	10/13/2016	385	385	
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	448.9	4/11/2017	448.9	448.9	
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	388	10/4/2017	388	388	
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	519	4/24/2018	519	519	
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	373	10/22/2018	373	373	
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	410	4/2/2019	410	410	
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	444	10/8/2019	444	444	
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	417	5/29/2020	417	417	
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	437	10/8/2020	437	437	
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	445	4/14/2021	445	445	
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	487	10/12/2021	487	487	
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	338	4/13/2022	338	338	
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	285.5	10/25/2022	285.5	285.5	
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	335.4	4/26/2023	335.4	335.4	
Calculations							
Count						41	
Mean						463.87	
Std Dev						129.78	
3 X SD (PAL)						389.34	
Min Increase (PAL)						200	
PAL, Calculated						853.21	
PAL, Rounded						900	

Duplicate Data Not Used for Calculations							

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes

Note: Data downloaded from GEMS

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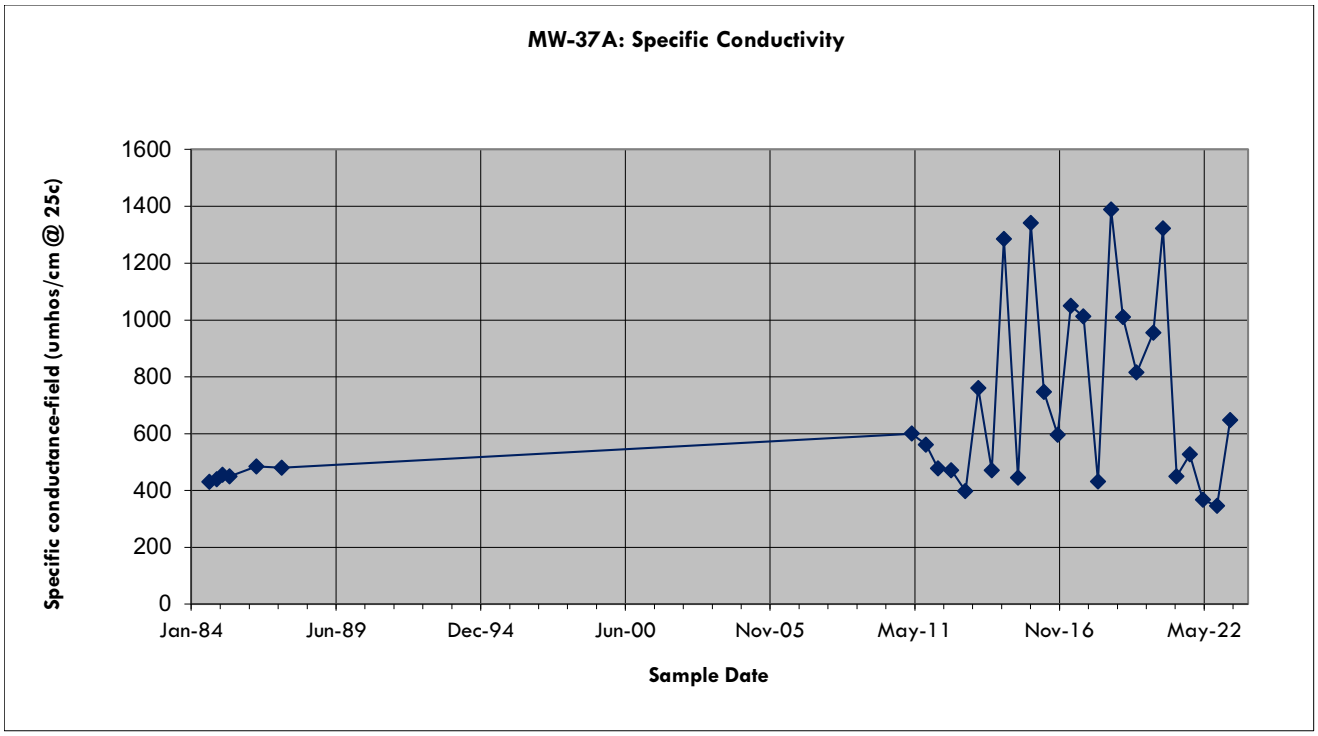

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	430	9/7/1984	430		
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	440	12/17/1984	440		
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	455	3/7/1985	455		
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	450	6/14/1985	450		
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	485	6/20/1986	485		
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	480	6/5/1987	480		
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	600	4/6/2011	600	600	Using data from within the last 20 years for PAL calculation
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	561	10/21/2011	561	561	
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	478	4/4/2012	478	478	
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	471	10/4/2012	471	471	
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	398	4/17/2013	398	398	
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	760	10/14/2013	760	760	
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	471	4/17/2014	471	471	
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1285	10/2/2014	1285	1285	
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	445	4/14/2015	445	445	
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1341	10/8/2015	1341	1341	
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	747	4/7/2016	747	747	
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	596	10/13/2016	596	596	
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1050	4/13/2017	1050	1050	
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1012	10/5/2017	1012	1012	
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	431.6	4/25/2018	431.6	431.6	
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1389	10/23/2018	1389	1389	
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1010	4/3/2019	1010	1010	
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	815	10/9/2019	815	815	
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	955	5/29/2020	955	955	
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1322	10/8/2020	1322	1322	
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	450	4/14/2021	450	450	
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	527	10/14/2021	527	527	
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	367	4/13/2022	367	367	
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	346.3	10/25/2022	346.3	346.3	
MW-34B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	648	4/24/2023	648	648	
Calculations							
Count						25	
Mean						739.04	
Std Dev						337.29	
3 X SD (PAL)						1011.86	
Min Increase (PAL)						200	
PAL, Calculated						1750.90	
PAL, Rounded						1800	

09/28/2023 - Classification: Internal - ECRM13153872

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
Duplicate Data Not Used for Calculations							

Note: Data downloaded from GEMS

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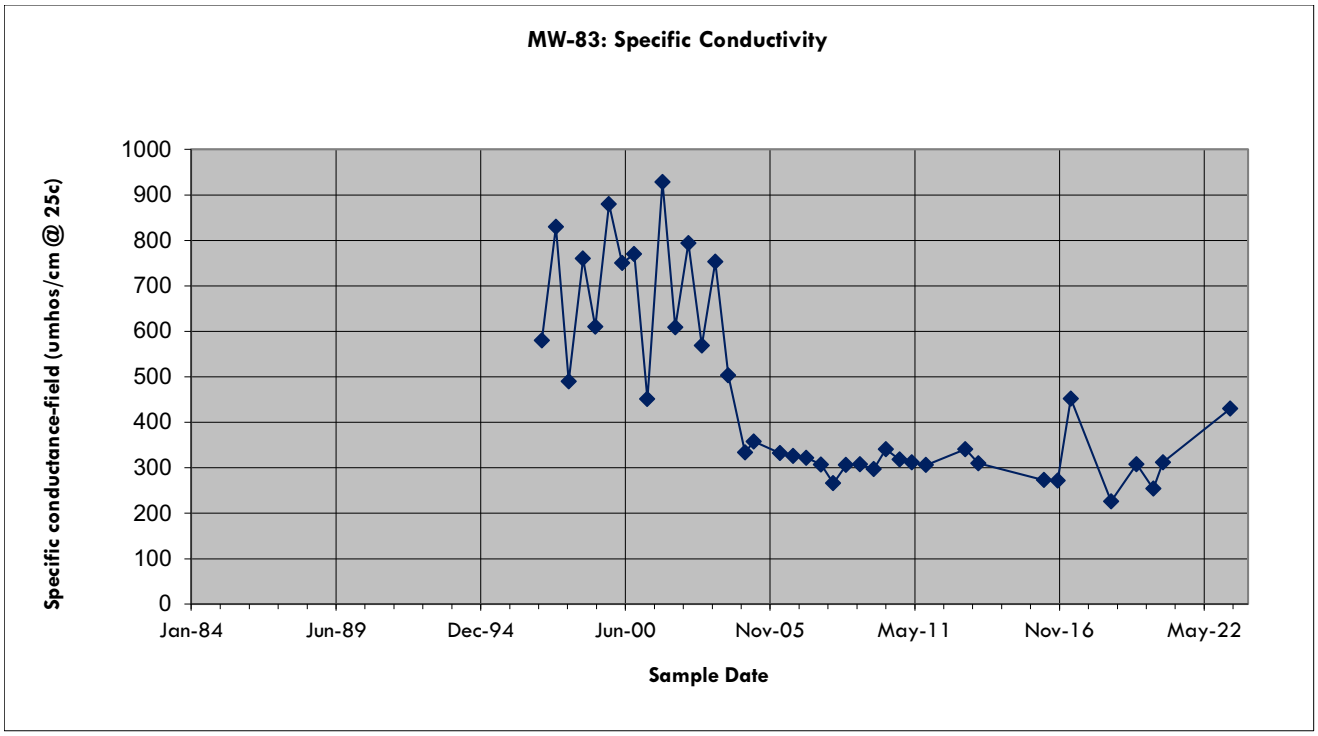

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-83	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	580	4/8/1997	580		
MW-83	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	830	10/20/1997	830		
MW-83	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	490	4/14/1998	490		
MW-83	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	760	10/27/1998	760		
MW-83	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	610	4/16/1999	610		
MW-83	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	880	10/21/1999	880		
MW-83	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	750	4/20/2000	750		
MW-83	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	770	10/4/2000	770		
MW-83	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	451	4/3/2001	451		
MW-83	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	928	10/30/2001	928		
MW-83	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	609	4/25/2002	609		
MW-83	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	794	10/24/2002	794		
MW-83	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	569	4/29/2003	569	569	Using data from within the last 20 years for PAL calculation
MW-83	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	753	10/30/2003	753	753	
MW-83	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	503	4/27/2004	503	503	
MW-83	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	334	12/14/2004	334	334	
MW-83	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	358	4/15/2005	358	358	
MW-83	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	332	4/13/2006	332	332	
MW-83	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	326	10/12/2006	326	326	
MW-83	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	322	4/11/2007	322	322	
MW-83	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	307	10/31/2007	307	307	
MW-83	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	266	4/17/2008	266	266	
MW-83	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	306	10/10/2008	306	306	
MW-83	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	308	4/21/2009	308	308	
MW-83	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	297	10/27/2009	297	297	
MW-83	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	341	4/15/2010	341	341	
MW-83	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	318	10/20/2010	318	318	
MW-83	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	312	4/6/2011	312	312	
MW-83	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	306	10/21/2011	306	306	
MW-83	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	341	4/17/2013	341	341	
MW-83	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	310	10/14/2013	310	310	
MW-83	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	273	4/7/2016	273	273	
MW-83	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	272	10/13/2016	272	272	
MW-83	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	452.3	4/12/2017	452.3	452.3	
MW-83	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	226	10/24/2018	226	226	
MW-83	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	308	10/9/2019	308	308	
MW-83	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	254	5/29/2020	254	254	
MW-83	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	312	10/8/2020	312	312	
MW-83	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	430	4/27/2023	430	430	
Calculations							
Count						27	

09/28/2023 - Classification: Internal - ECRM13153872

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
Mean						349.49	
Std Dev						109.90	
3 X SD (PAL)						329.70	
Min Increase (PAL)						200	
PAL, Calculated						679.20	
PAL, Rounded						700	

Duplicate Data Not Used for Calculations							

Note: Data downloaded from GEMS

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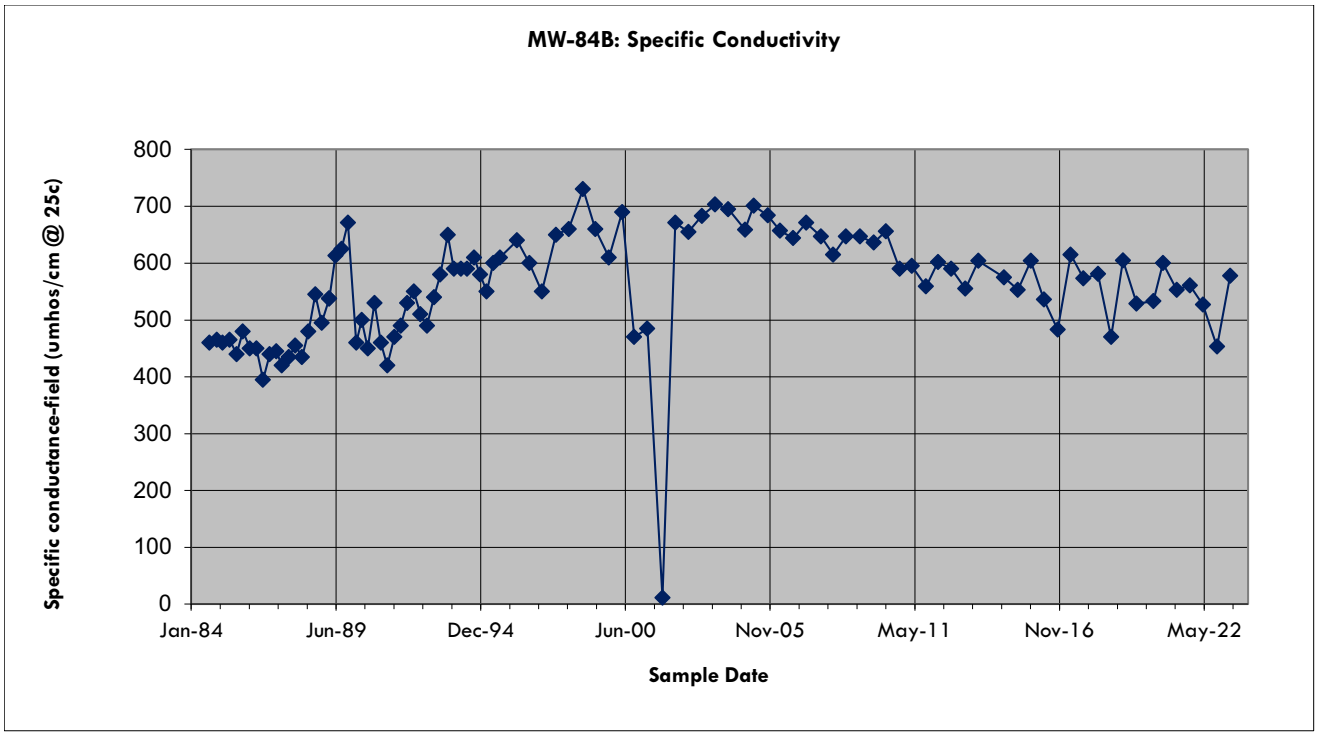


Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	460	9/7/1984	460		
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	465	12/17/1984	465		
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	460	3/7/1985	460		
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	465	6/14/1985	465		
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	440	9/18/1985	440		
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	480	12/12/1985	480		
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	450	3/21/1986	450		
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	450	6/20/1986	450		
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	395	9/18/1986	395		
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	440	12/19/1986	440		
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	445	3/20/1987	445		
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	420	6/5/1987	420		
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	435	9/9/1987	435		
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	455	12/9/1987	455		
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	435	3/10/1988	435		
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	480	6/7/1988	480		
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	545	9/9/1988	545		
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	495	12/7/1988	495		
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	538	3/21/1989	538		
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	538	3/22/1989	538		
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	613	6/16/1989	613		
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	625	9/7/1989	625		
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	671	12/6/1989	671		
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	460	3/29/1990	460		
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	500	6/14/1990	500		
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	450	9/5/1990	450		
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	530	12/7/1990	530		
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	460	3/6/1991	460		
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	420	6/3/1991	420		
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	470	9/6/1991	470		
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	490	12/5/1991	490		
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	530	3/2/1992	530		
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	550	6/2/1992	550		
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	510	9/2/1992	510		
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	490	12/2/1992	490		
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	540	3/10/1993	540		
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	580	6/3/1993	580		
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	650	9/14/1993	650		
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	590	12/7/1993	590		
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	590	3/15/1994	590		
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	590	6/7/1994	590		

09/28/2023 - Classification: Internal - ECRM13153872

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	610	9/13/1994	610		
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	580	12/6/1994	580		
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	550	3/7/1995	550		
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	600	6/5/1995	600		
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	610	9/5/1995	610		
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	640	4/29/1996	640		
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	600	10/17/1996	600		
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	550	4/8/1997	550		
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	650	10/20/1997	650		
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	660	4/14/1998	660		
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	730	10/27/1998	730		
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	660	4/16/1999	660		
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	610	10/21/1999	610		
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	690	4/20/2000	690		
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	470	10/4/2000	470		
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	485	4/3/2001	485		
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	11.2	10/30/2001	11.2		outlier
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	671	4/25/2002	671		
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	655	10/25/2002	655		
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	683	4/28/2003	683	683	Using data from within the last 20 years for PAL calculation
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	703	10/29/2003	703	703	
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	695	4/27/2004	695	695	
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	659	12/14/2004	659	659	
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	701	4/14/2005	701	701	
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	684	10/26/2005	684	684	
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	657	4/13/2006	657	657	
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	644	10/12/2006	644	644	
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	671	4/10/2007	671	671	
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	647	10/30/2007	647	647	
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	615	4/17/2008	615	615	
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	647	10/10/2008	647	647	
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	647	4/22/2009	647	647	
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	636	10/27/2009	636	636	
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	656	4/14/2010	656	656	
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	590	10/20/2010	590	590	
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	595	4/6/2011	595	595	
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	559	10/21/2011	559	559	
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	602	4/4/2012	602	602	
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	590	10/4/2012	590	590	
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	555	4/17/2013	555	555	
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	604	10/14/2013	604	604	
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	575	10/2/2014	575	575	
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	553	4/13/2015	553	553	
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	604	10/8/2015	604	604	
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	536	4/7/2016	536	536	
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	483	10/13/2016	483	483	
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	615	4/11/2017	615	615	
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	573	10/5/2017	573	573	
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	581	4/25/2018	581	581	
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	470	10/24/2018	470	470	
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	605	4/3/2019	605	605	
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	529	10/9/2019	529	529	
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	533	5/29/2020	533	533	
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	600	10/9/2020	600	600	
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	553	4/15/2021	553	553	
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	561	10/14/2021	561	561	
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	527	4/13/2022	527	527	
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	453.1	10/25/2022	453.1	453.1	
MW-84B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	577.7	4/25/2023	577.7	577.7	
Calculations							
Count						40	
Mean						599.22	
Std Dev						62.48	
3 X SD (PAL)						187.44	
Min Increase (PAL)						200	
PAL, Calculated						799.22	
PAL, Rounded						800	

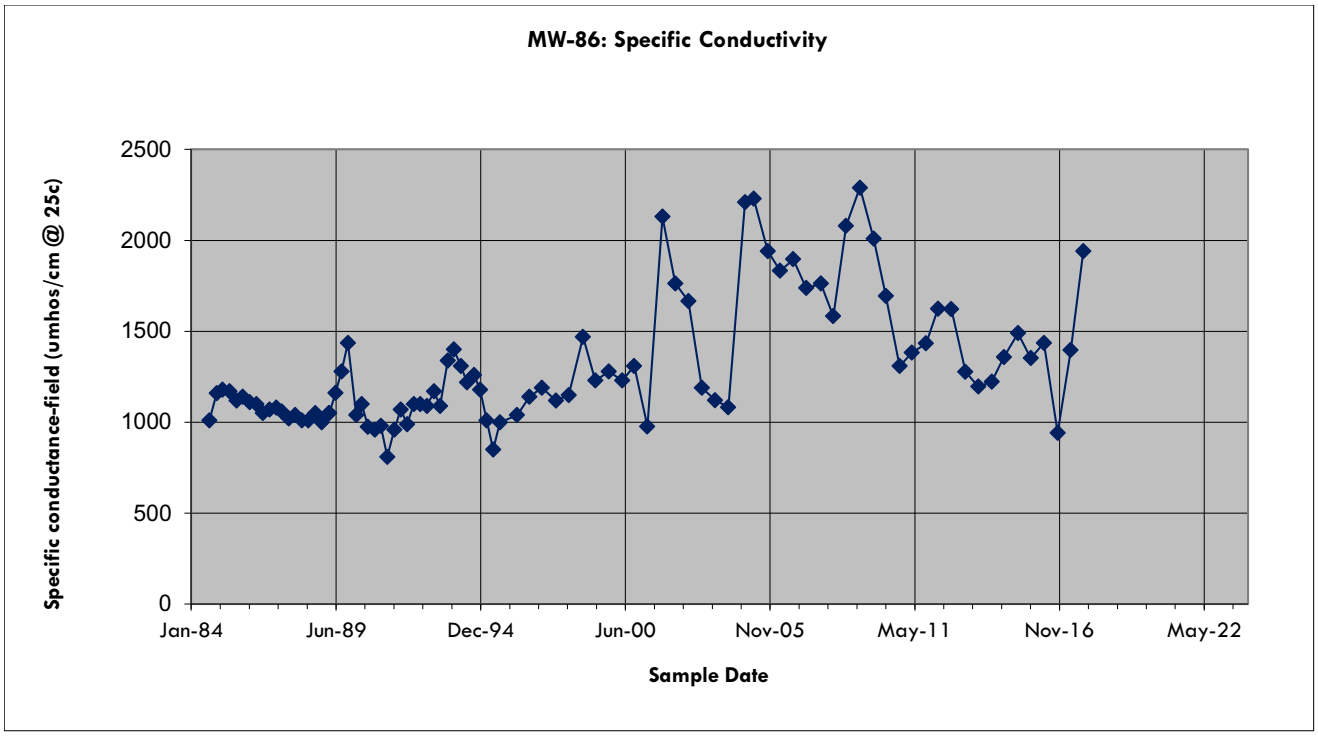
Duplicate Data Not Used for Calculations

09/28/2023 - Classification: Internal - ECRM13153872

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes

Note: Data downloaded from GEMS

I:\25222260.00\Data and Calculations\Groundwater PALs ACLs\[PAL Calculations_Non CCR Wells.xlsx]MW-84B_Cond_PAL



Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1010	9/7/1984	1010		
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1160	12/17/1984	1160		
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1180	3/7/1985	1180		
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1170	6/14/1985	1170		
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1120	9/18/1985	1120		
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1140	12/12/1985	1140		
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1110	3/21/1986	1110		
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1100	6/20/1986	1100		
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1050	9/18/1986	1050		
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1070	12/19/1986	1070		
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1080	3/20/1987	1080		
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1060	6/5/1987	1060		
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1020	9/9/1987	1020		
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1040	12/9/1987	1040		
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1010	3/10/1988	1010		
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1010	6/7/1988	1010		
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1050	9/9/1988	1050		
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1000	12/7/1988	1000		
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1050	3/21/1989	1050		
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1050	3/22/1989	1050		
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1161	6/16/1989	1161		
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1280	9/7/1989	1280		
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1436	12/6/1989	1436		
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1040	3/29/1990	1040		
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1100	6/13/1990	1100		
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	976	9/7/1990	976		
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	960	12/11/1990	960		
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	980	3/6/1991	980		
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	810	6/3/1991	810		
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	960	9/6/1991	960		
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1070	12/5/1991	1070		
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	990	3/3/1992	990		
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1100	6/2/1992	1100		
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1100	9/2/1992	1100		
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1090	12/2/1992	1090		
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1170	3/10/1993	1170		
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1090	6/2/1993	1090		
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1340	9/14/1993	1340		
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1400	12/7/1993	1400		
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1310	3/15/1994	1310		
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1220	6/7/1994	1220		

09/28/2023 - Classification: Internal - ECRM13153872

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1260	9/13/1994	1260		
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1180	12/6/1994	1180		
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1010	3/7/1995	1010		
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	850	6/5/1995	850		
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1000	9/6/1995	1000		
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1040	4/29/1996	1040		
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1140	10/17/1996	1140		
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1190	4/8/1997	1190		
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1120	10/20/1997	1120		
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1150	4/14/1998	1150		
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1470	10/27/1998	1470		
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1230	4/16/1999	1230		
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1280	10/21/1999	1280		
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1230	4/20/2000	1230		
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1310	10/4/2000	1310		
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	977	4/3/2001	977		
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	2130	10/30/2001	2130		
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1764	4/25/2002	1764		
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1667	10/25/2002	1667		
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1190	4/28/2003	1190	1190	Using data from within the last 20 years for PAL calculation
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1121	10/28/2003	1121	1121	
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1083	4/27/2004	1083	1083	
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	2210	12/14/2004	2210	2210	
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	2230	4/14/2005	2230	2230	
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1941	10/26/2005	1941	1941	
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1833	4/13/2006	1833	1833	
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1896	10/12/2006	1896	1896	
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1738	4/10/2007	1738	1738	
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1763	10/30/2007	1763	1763	
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1583	4/17/2008	1583	1583	
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	2080	10/10/2008	2080	2080	
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	2290	4/22/2009	2290	2290	
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	2010	10/27/2009	2010	2010	
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1695	4/14/2010	1695	1695	
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1309	10/20/2010	1309	1309	
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1383	4/6/2011	1383	1383	
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1434	10/21/2011	1434	1434	
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1625	4/4/2012	1625	1625	
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1622	10/4/2012	1622	1622	
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1278	4/17/2013	1278	1278	
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1196	10/14/2013	1196	1196	
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1223	4/17/2014	1223	1223	
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1359	10/2/2014	1359	1359	
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1490	4/14/2015	1490	1490	
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1353	10/8/2015	1353	1353	
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1436	4/7/2016	1436	1436	
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	942	10/13/2016	942	942	
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1397	4/11/2017	1397	1397	
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1940	10/5/2017	1940	1940	
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1624	4/25/2018	1624	1624	
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1108	10/24/2018	1108	1108	
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1600	4/3/2019	1600	1600	
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1678	10/9/2019	1678	1678	
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1638	5/29/2020	1638	1638	
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1752	10/9/2020	1752	1752	
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1547	4/15/2021	1547	1547	
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1765	10/14/2021	1765	1765	
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1833	4/13/2022	1833	1833	
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1585	10/25/2022	1585	1585	
MW-86	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	1742	4/24/2023	1742	1742	
Calculations							
Count						41	
Mean						1598.10	
Std Dev						328.51	
3 X SD (PAL)						985.52	
Min Increase (PAL)						200	
PAL, Calculated						2583.62	
PAL, Rounded						2600	

09/28/2023 - Classification: Internal - ECRM13153872

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
Duplicate Data Not Used for Calculations							

Note: Data downloaded from GEMS

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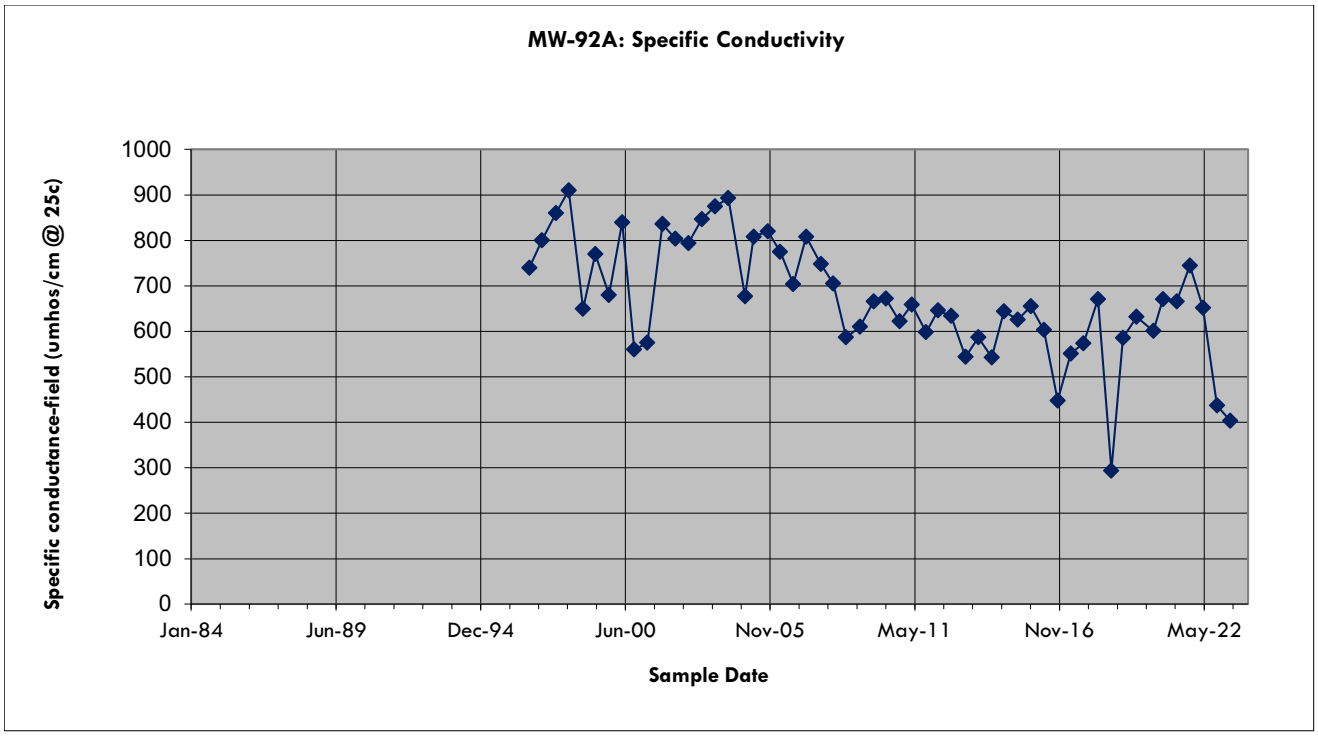


Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-92A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	740	10/16/1996	740		
MW-92A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	800	4/8/1997	800		
MW-92A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	860	10/20/1997	860		
MW-92A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	910	4/14/1998	910		
MW-92A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	650	10/27/1998	650		
MW-92A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	770	4/16/1999	770		
MW-92A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	680	10/21/1999	680		
MW-92A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	840	4/20/2000	840		
MW-92A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	560	10/4/2000	560		
MW-92A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	575	4/3/2001	575		
MW-92A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	836	10/30/2001	836		
MW-92A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	804	4/25/2002	804		
MW-92A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	794	10/25/2002	794		
MW-92A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	847	4/28/2003	847	847	Using data from within the last 20 years for PAL calculation
MW-92A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	875	10/29/2003	875	875	
MW-92A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	893	4/27/2004	893	893	
MW-92A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	677	12/14/2004	677	677	
MW-92A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	808	4/14/2005	808	808	
MW-92A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	820	10/26/2005	820	820	
MW-92A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	775	4/13/2006	775	775	
MW-92A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	704	10/12/2006	704	704	
MW-92A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	808	4/10/2007	808	808	
MW-92A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	748	10/30/2007	748	748	
MW-92A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	705	4/17/2008	705	705	
MW-92A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	587	10/10/2008	587	587	
MW-92A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	610	4/22/2009	610	610	
MW-92A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	666	10/27/2009	666	666	
MW-92A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	672	4/14/2010	672	672	
MW-92A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	622	10/20/2010	622	622	
MW-92A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	659	4/6/2011	659	659	
MW-92A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	598	10/21/2011	598	598	
MW-92A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	646	4/4/2012	646	646	
MW-92A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	634	10/3/2012	634	634	
MW-92A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	544	4/18/2013	544	544	
MW-92A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	587	10/14/2013	587	587	
MW-92A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	543	4/17/2014	543	543	
MW-92A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	644	10/2/2014	644	644	
MW-92A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	626	4/13/2015	626	626	
MW-92A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	655	10/8/2015	655	655	
MW-92A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	603	4/8/2016	603	603	
MW-92A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	448	10/13/2016	448	448	

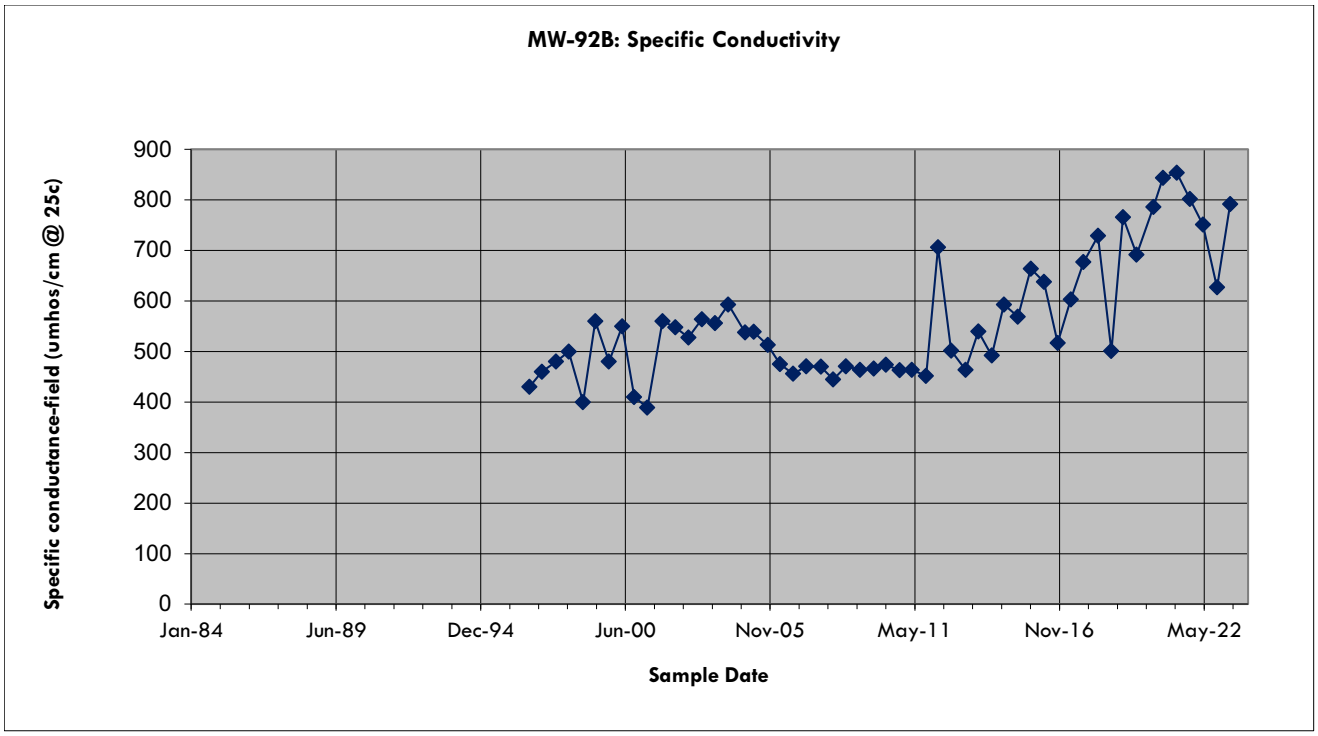
09/28/2023 - Classification: Internal - ECRM13153872

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-92A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	551.4	4/12/2017	551.4	551.4	
MW-92A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	574	10/5/2017	574	574	
MW-92A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	671	4/25/2018	671	671	
MW-92A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	294	10/25/2018	294	294	
MW-92A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	586	4/3/2019	586	586	
MW-92A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	632	10/9/2019	632	632	
MW-92A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	601	5/29/2020	601	601	
MW-92A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	671	10/9/2020	671	671	
MW-92A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	666	4/15/2021	666	666	
MW-92A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	745	10/14/2021	745	745	
MW-92A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	652	4/13/2022	652	652	
MW-92A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	436.9	10/25/2022	436.9	436.9	
MW-92A	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	403.6	4/24/2023	403.6	403.6	
Calculations							
Count						41	
Mean						646.05	
Std Dev						122.92	
3 X SD (PAL)						368.76	
Min Increase (PAL)						200	
PAL, Calculated						1014.81	
PAL, Rounded						1100	

Duplicate Data Not Used for Calculations							

Note: Data downloaded from GEMS

I:\25222260.00\Data and Calculations\Groundwater PALs ACLs\[PAL Calculations_Non CCR Wells.xlsx]MW-92A_Cond_PAL



Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-92B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	430	10/16/1996	430		
MW-92B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	460	4/8/1997	460		
MW-92B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	480	10/20/1997	480		
MW-92B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	500	4/14/1998	500		
MW-92B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	400	10/27/1998	400		
MW-92B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	560	4/16/1999	560		
MW-92B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	480	10/21/1999	480		
MW-92B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	550	4/20/2000	550		
MW-92B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	410	10/4/2000	410		
MW-92B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	389	4/3/2001	389		
MW-92B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	560	10/30/2001	560		
MW-92B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	548	4/25/2002	548		
MW-92B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	528	10/25/2002	528		
MW-92B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	564	4/28/2003	564	564	Using data from within the last 20 years for PAL calculation
MW-92B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	556	10/29/2003	556	556	
MW-92B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	593	4/27/2004	593	593	
MW-92B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	538	12/14/2004	538	538	
MW-92B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	539	4/14/2005	539	539	
MW-92B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	513	10/26/2005	513	513	
MW-92B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	475	4/13/2006	475	475	
MW-92B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	456	10/12/2006	456	456	
MW-92B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	471	4/10/2007	471	471	
MW-92B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	470	10/30/2007	470	470	
MW-92B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	445	4/17/2008	445	445	
MW-92B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	471	10/10/2008	471	471	
MW-92B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	464	4/22/2009	464	464	
MW-92B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	466	10/27/2009	466	466	
MW-92B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	474	4/14/2010	474	474	
MW-92B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	463	10/20/2010	463	463	
MW-92B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	464	4/6/2011	464	464	
MW-92B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	452	10/21/2011	452	452	
MW-92B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	706	4/4/2012	706	706	
MW-92B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	502	10/3/2012	502	502	
MW-92B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	464	4/18/2013	464	464	
MW-92B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	540	10/14/2013	540	540	
MW-92B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	492	4/17/2014	492	492	
MW-92B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	593	10/2/2014	593	593	
MW-92B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	569	4/13/2015	569	569	
MW-92B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	664	10/8/2015	664	664	
MW-92B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	638	4/8/2016	638	638	
MW-92B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	517	10/13/2016	517	517	

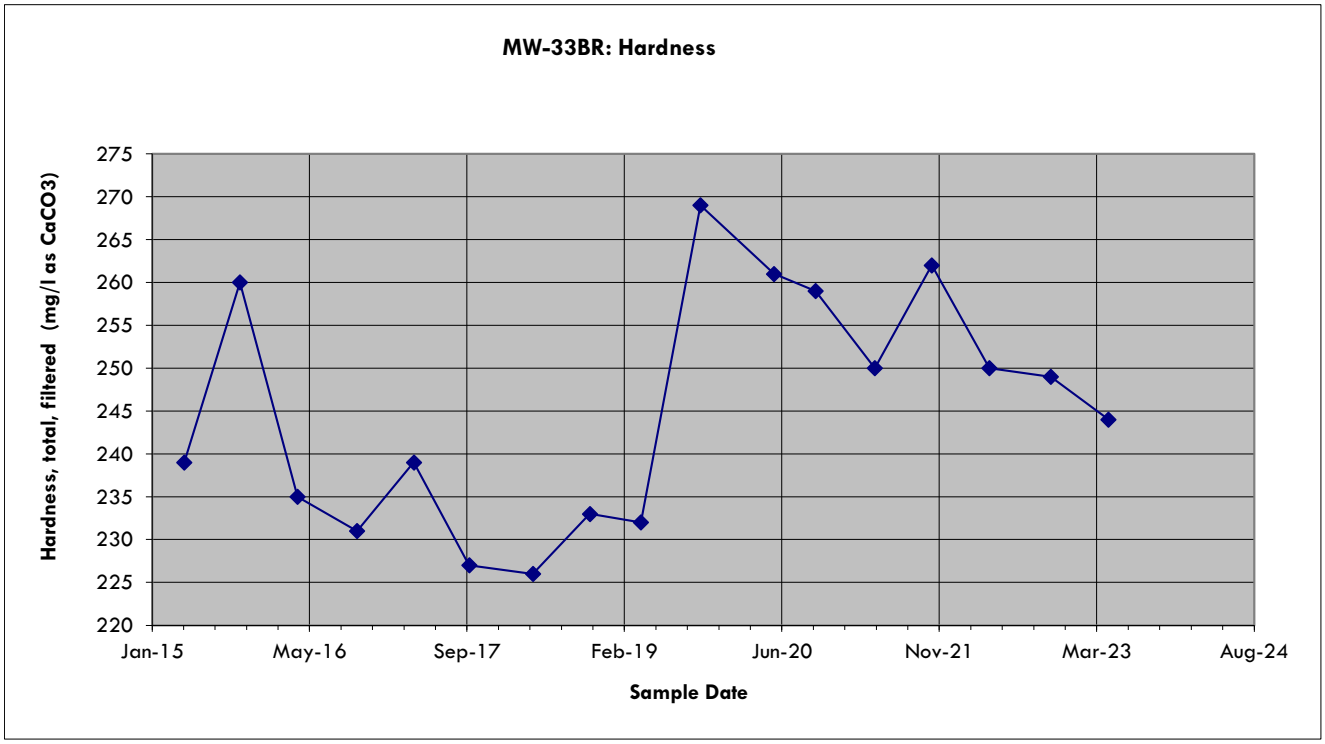
09/28/2023 - Classification: Internal - ECRM13153872

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-92B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	603.3	4/12/2017	603.3	603.3	
MW-92B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	677	10/5/2017	677	677	
MW-92B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	729	4/25/2018	729	729	
MW-92B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	501	10/25/2018	501	501	
MW-92B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	766	4/3/2019	766	766	
MW-92B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	692	10/9/2019	692	692	
MW-92B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	786	5/29/2020	786	786	
MW-92B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	844	10/9/2020	844	844	
MW-92B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	854	4/15/2021	854	854	
MW-92B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	802	10/14/2021	802	802	
MW-92B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	751	4/13/2022	751	751	
MW-92B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	627	10/25/2022	627	627	
MW-92B	SPECIFIC CONDUCTANCE, FIELD (UMHO/CM @ 25C)	01	792	4/24/2023	792	792	
Calculations							
Count						41	
Mean						584.96	
Std Dev						125.25	
3 X SD (PAL)						375.75	
Min Increase (PAL)						200	
PAL, Calculated						960.71	
PAL, Rounded						970	

Duplicate Data Not Used for Calculations							

Note: Data downloaded from GEMS

I:\25222260.00\Data and Calculations\Groundwater PALs ACLs\[PAL Calculations_Non CCR Wells.xlsx]MW-92B_Cond_PAL



Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-33BR	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	239	4/13/2015	239	239	
MW-33BR	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	260	10/7/2015	260	260	
MW-33BR	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	235	4/7/2016	235	235	
MW-33BR	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	231	10/13/2016	231	231	
MW-33BR	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	239	4/11/2017	239	239	
MW-33BR	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	227	10/4/2017	227	227	
MW-33BR	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	226	4/24/2018	226	226	
MW-33BR	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	233	10/22/2018	233	233	
MW-33BR	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	232	4/2/2019	232	232	
MW-33BR	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	269	10/8/2019	269	269	
MW-33BR	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	261	5/29/2020	261	261	
MW-33BR	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	259	10/8/2020	259	259	
MW-33BR	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	250	4/14/2021	250	250	
MW-33BR	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	262	10/12/2021	262	262	
MW-33BR	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	250	4/13/2022	250	250	
MW-33BR	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	249	10/25/2022	249	249	
MW-33BR	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	244	4/26/2023	244	244	
Calculations							
Count						17	
Mean						245.06	
Std Dev						13.64	
3 X SD (PAL)						40.91	
Min Increase (PAL)						100	
PAL, Calculated						345.06	
PAL, Rounded						350	

Duplicate Data Not Used for Calculations							

Note: Data downloaded from GEMS

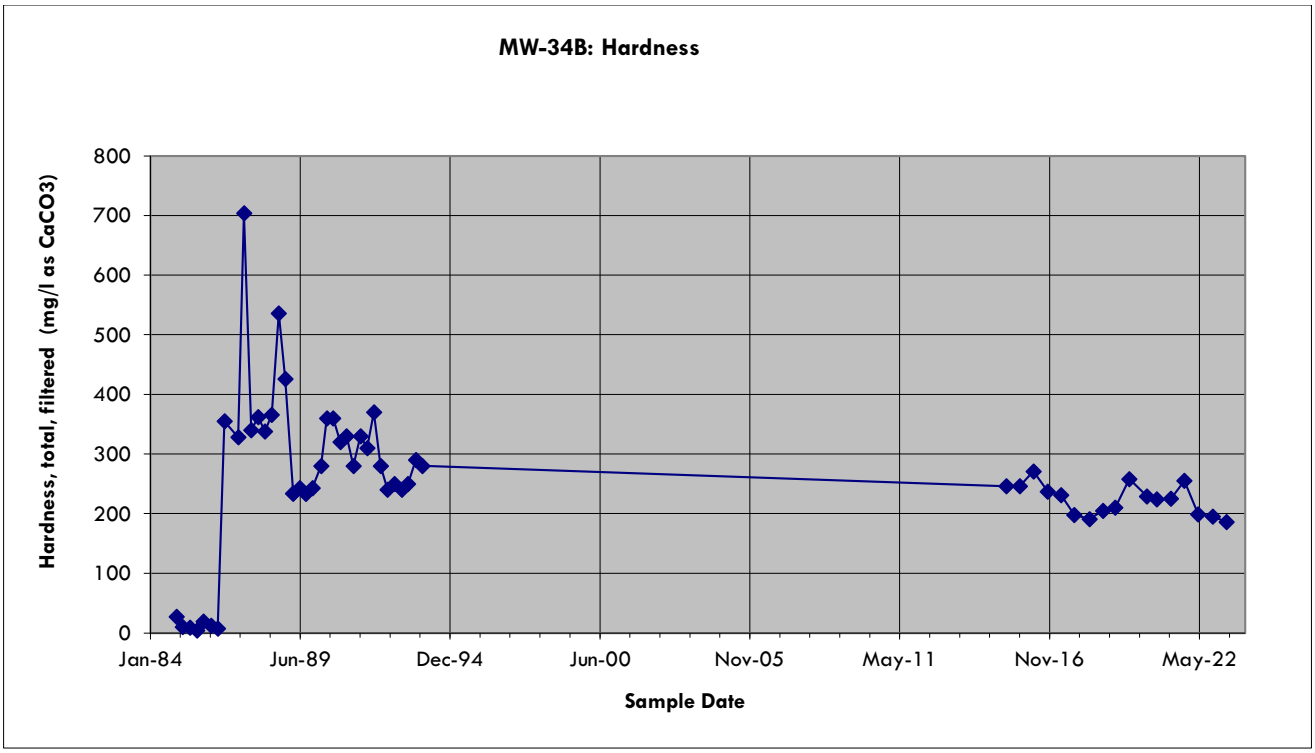
J = Result is an estimated value below the laboratory's limit of quantitation.

P = Did not meet required preservation and/or hold time.

B = Compound detected in blank.

M = Failed method QC check.

09/28/2023 - Classification: Internal - ECRM13153872



Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-34B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	27	12/17/1984	27		
MW-34B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	10	3/7/1985	10		
MW-34B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	9	6/14/1985	9		
MW-34B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	4	9/18/1985	4		
MW-34B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	19	12/12/1985	19		
MW-34B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	12	3/21/1986	12		
MW-34B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	7	6/20/1986	7		
MW-34B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	355	9/18/1986	355		
MW-34B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	328	3/20/1987	328		
MW-34B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	704	6/5/1987	704		
MW-34B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	340	9/9/1987	340		
MW-34B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	362	12/9/1987	362		
MW-34B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	338	3/10/1988	338		
MW-34B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	366	6/7/1988	366		
MW-34B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	536	9/9/1988	536		
MW-34B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	426	12/7/1988	426		
MW-34B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	234	3/21/1989	234		
MW-34B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	234	3/22/1989	234		
MW-34B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	243	6/16/1989	243		
MW-34B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	233	9/6/1989	233		
MW-34B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	243	12/5/1989	243		
MW-34B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	280	3/29/1990	280		
MW-34B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	360	6/14/1990	360		
MW-34B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	360	9/5/1990	360		
MW-34B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	320	12/10/1990	320		
MW-34B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	330	3/5/1991	330		
MW-34B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	280	6/3/1991	280		
MW-34B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	330	9/6/1991	330		
MW-34B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	310	12/4/1991	310		
MW-34B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	370	3/3/1992	370		
MW-34B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	280	6/2/1992	280		
MW-34B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	240	9/1/1992	240		
MW-34B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	250	12/2/1992	250		
MW-34B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	240	3/10/1993	240		
MW-34B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	250	6/2/1993	250		
MW-34B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	290	9/14/1993	290		
MW-34B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	280	12/7/1993	280		
MW-34B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	246	4/13/2015	246	246	Using data
MW-34B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	246	10/7/2015	246	246	from within

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-34B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	271	4/7/2016	271	271	the last 20 years for PAL calculation
MW-34B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	237	10/13/2016	237	237	
MW-34B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	231	4/11/2017	231	231	
MW-34B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	198	10/4/2017	198	198	
MW-34B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	191	4/24/2018	191	191	
MW-34B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	205	10/22/2018	205	205	
MW-34B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	210	4/2/2019	210	210	
MW-34B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	258	10/8/2019	258	258	
MW-34B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	229	5/29/2020	229	229	
MW-34B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	224	10/8/2020	224	224	
MW-34B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	225	4/14/2021	225	225	
MW-34B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	255	10/12/2021	255	255	
MW-34B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	199	4/13/2022	199	199	
MW-34B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	195	10/25/2022	195	195	
MW-34B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	186	4/26/2023	186	186	
Calculations							
Count						17	
Mean						223.88	
Std Dev						24.83	
3 X SD (PAL)						74.48	
Min Increase (PAL)						100	
PAL, Calculated						323.88	
PAL, Rounded						330	

Duplicate Data Not Used for Calculations							

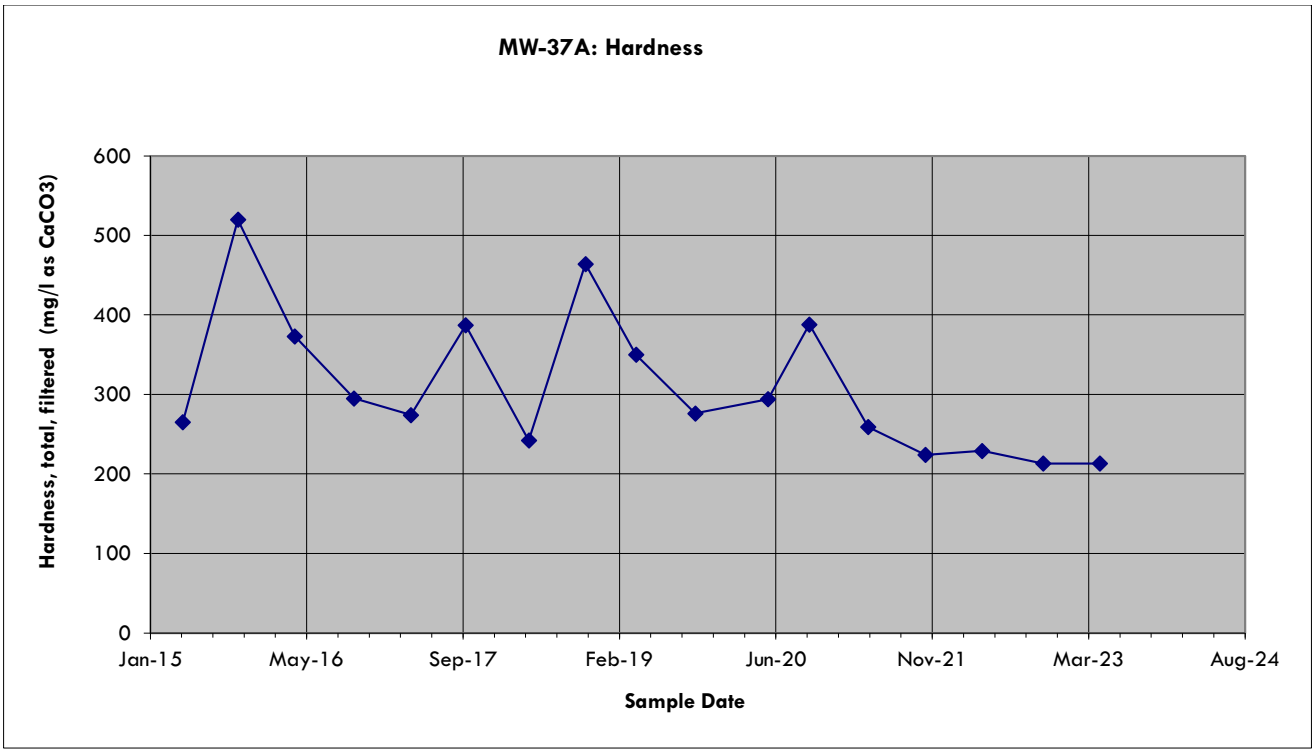
Note: Data downloaded from GEMS

J = Result is an estimated value below the laboratory's limit of quantitation.

P = Did not meet required preservation and/or hold time.

B = Compound detected in blank.

M = Failed method QC check.

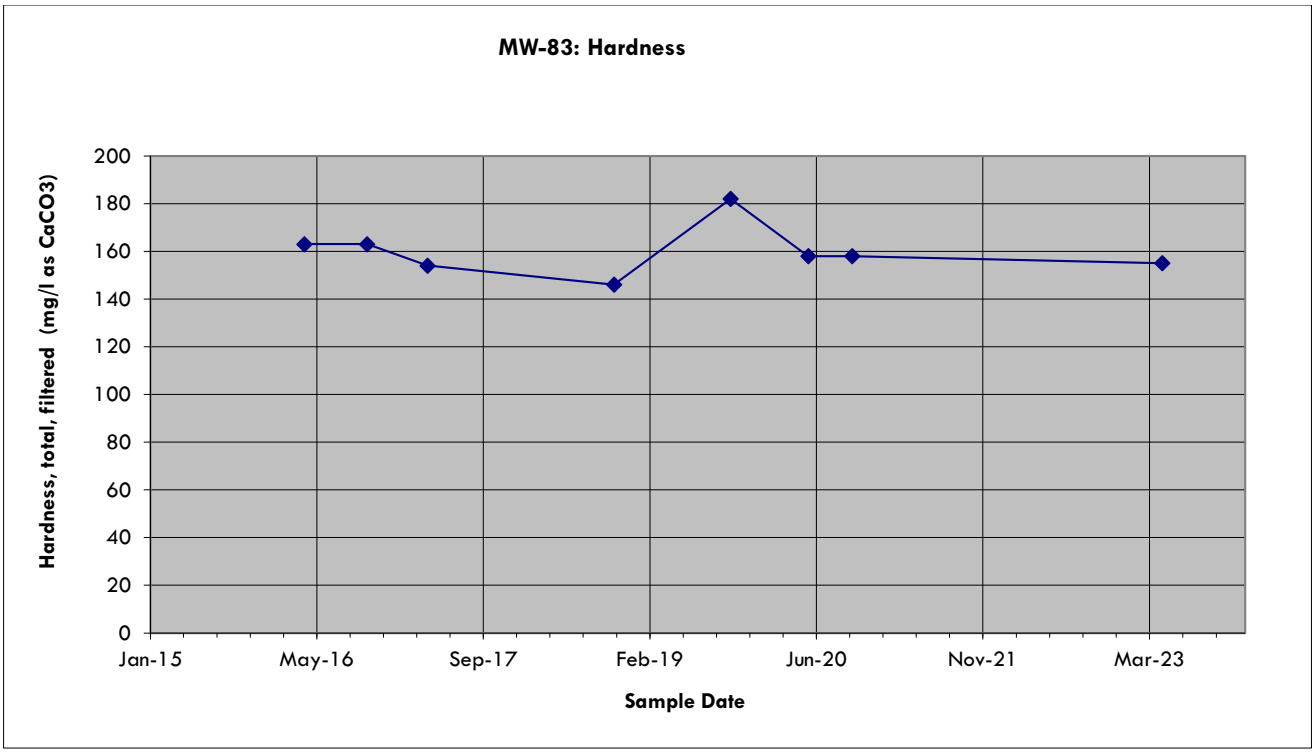


Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-37A	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	265	4/14/2015	265	265	
MW-37A	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	520	10/8/2015	520	520	
MW-37A	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	373	4/7/2016	373	373	
MW-37A	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	295	10/13/2016	295	295	
MW-37A	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	274	4/13/2017	274	274	
MW-37A	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	387	10/5/2017	387	387	
MW-37A	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	242	4/25/2018	242	242	
MW-37A	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	464	10/23/2018	464	464	
MW-37A	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	350	4/3/2019	350	350	
MW-37A	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	276	10/9/2019	276	276	
MW-37A	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	294	5/29/2020	294	294	
MW-37A	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	388	10/8/2020	388	388	
MW-37A	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	259	4/14/2021	259	259	
MW-37A	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	224	10/14/2021	224	224	
MW-37A	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	229	4/13/2022	229	229	
MW-37A	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	213	10/25/2022	213	213	
MW-37A	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	220	4/24/2023	213	213	
Calculations							
Count						17	
Mean						309.76	
Std Dev						90.26	
3 X SD (PAL)						270.79	
Min Increase (PAL)						100	
PAL, Calculated						580.55	
PAL, Rounded						590	

Duplicate Data Not Used for Calculations							

Note: Data downloaded from GEMS
J = Result is an estimated value below the laboratory's limit of quantitation.
P = Did not meet required preservation and/or hold time.
B = Compound detected in blank.
M = Failed method QC check.

09/28/2023 - Classification: Internal - ECRM13153872



Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-83	HARDNESS, TOTAL (MG/L AS CACO3)	01	163	4/7/2016	163	163	
MW-83	HARDNESS, TOTAL (MG/L AS CACO3)	01	163	10/13/2016	163	163	
MW-83	HARDNESS, TOTAL (MG/L AS CACO3)	01	154	4/12/2017	154	154	
MW-83	HARDNESS, TOTAL (MG/L AS CACO3)	01	146	10/24/2018	146	146	
MW-83	HARDNESS, TOTAL (MG/L AS CACO3)	01	182	10/9/2019	182	182	
MW-83	HARDNESS, TOTAL (MG/L AS CACO3)	01	158	5/29/2020	158	158	
MW-83	HARDNESS, TOTAL (MG/L AS CACO3)	01	158	10/8/2020	158	158	
MW-83	HARDNESS, TOTAL (MG/L AS CACO3)	01	155	4/27/2023	155	155	
Calculations							
Count						8	
Mean						159.88	
Std Dev						10.47	
3 X SD (PAL)						31.40	
Min Increase (PAL)						100	
PAL, Calculated						259.88	
PAL, Rounded						260	

Duplicate Data Not Used for Calculations							

Note: Data downloaded from GEMS
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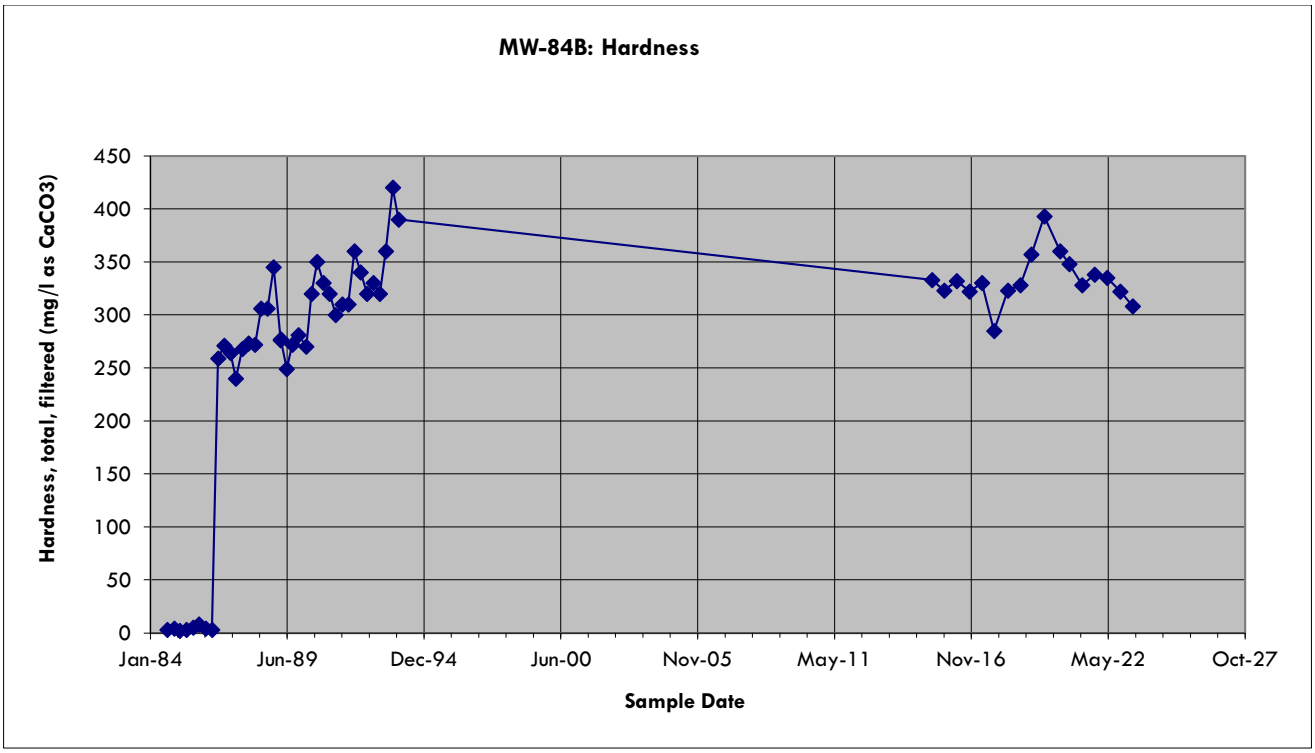
P = Did not meet required preservation and/or hold time.
B = Compound detected in blank.
M = Failed method QC check.



Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-84B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	3	9/7/1984	3		
MW-84B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	4	12/17/1984	4		
MW-84B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	2	3/7/1985	2		
MW-84B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	3	6/14/1985	3		
MW-84B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	5	9/18/1985	5		
MW-84B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	8	12/12/1985	8		
MW-84B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	4	3/21/1986	4		
MW-84B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	3	6/20/1986	3		
MW-84B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	259	9/18/1986	259		
MW-84B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	271	12/19/1986	271		
MW-84B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	264	3/20/1987	264		
MW-84B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	240	6/5/1987	240		
MW-84B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	268	9/9/1987	268		
MW-84B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	273	12/9/1987	273		
MW-84B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	272	3/10/1988	272		
MW-84B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	306	6/7/1988	306		
MW-84B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	306	9/9/1988	306		
MW-84B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	345	12/7/1988	345		
MW-84B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	276	3/21/1989	276		
MW-84B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	277	3/22/1989	277		
MW-84B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	249	6/16/1989	249		
MW-84B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	272	9/7/1989	272		
MW-84B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	281	12/6/1989	281		
MW-84B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	270	3/29/1990	270		
MW-84B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	320	6/14/1990	320		
MW-84B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	350	9/5/1990	350		
MW-84B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	330	12/7/1990	330		
MW-84B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	320	3/6/1991	320		
MW-84B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	300	6/3/1991	300		
MW-84B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	310	9/6/1991	310		
MW-84B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	310	12/5/1991	310		
MW-84B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	360	3/2/1992	360		
MW-84B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	340	6/2/1992	340		
MW-84B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	320	9/2/1992	320		
MW-84B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	330	12/2/1992	330		
MW-84B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	320	3/10/1993	320		
MW-84B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	360	6/3/1993	360		
MW-84B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	420	9/14/1993	420		
MW-84B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	390	12/7/1993	390		

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-84B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	333	4/13/2015	333	333	Using data from within the last 20 years for PAL calculation
MW-84B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	323	10/8/2015	323	323	
MW-84B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	332	4/7/2016	332	332	
MW-84B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	322	10/13/2016	322	322	
MW-84B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	330	4/11/2017	330	330	
MW-84B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	285	10/5/2017	285	285	
MW-84B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	323	4/25/2018	323	323	
MW-84B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	328	10/24/2018	328	328	
MW-84B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	357	4/3/2019	357	357	
MW-84B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	393	10/9/2019	393	393	
MW-84B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	360	5/29/2020	360	360	
MW-84B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	348	10/9/2020	348	348	
MW-84B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	328	4/15/2021	328	328	
MW-84B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	338	10/14/2021	338	338	
MW-84B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	335	4/13/2022	335	335	
MW-84B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	322	10/25/2022	322	322	
MW-84B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	308	4/25/2023	308	308	
Calculations							
Count						17	
Mean						333.24	
Std Dev						23.17	
3 X SD (PAL)						69.51	
Min Increase (PAL)						100	
PAL, Calculated						433.24	
PAL, Rounded						440	

Duplicate Data Not Used for Calculations							

Note: Data downloaded from GEMS

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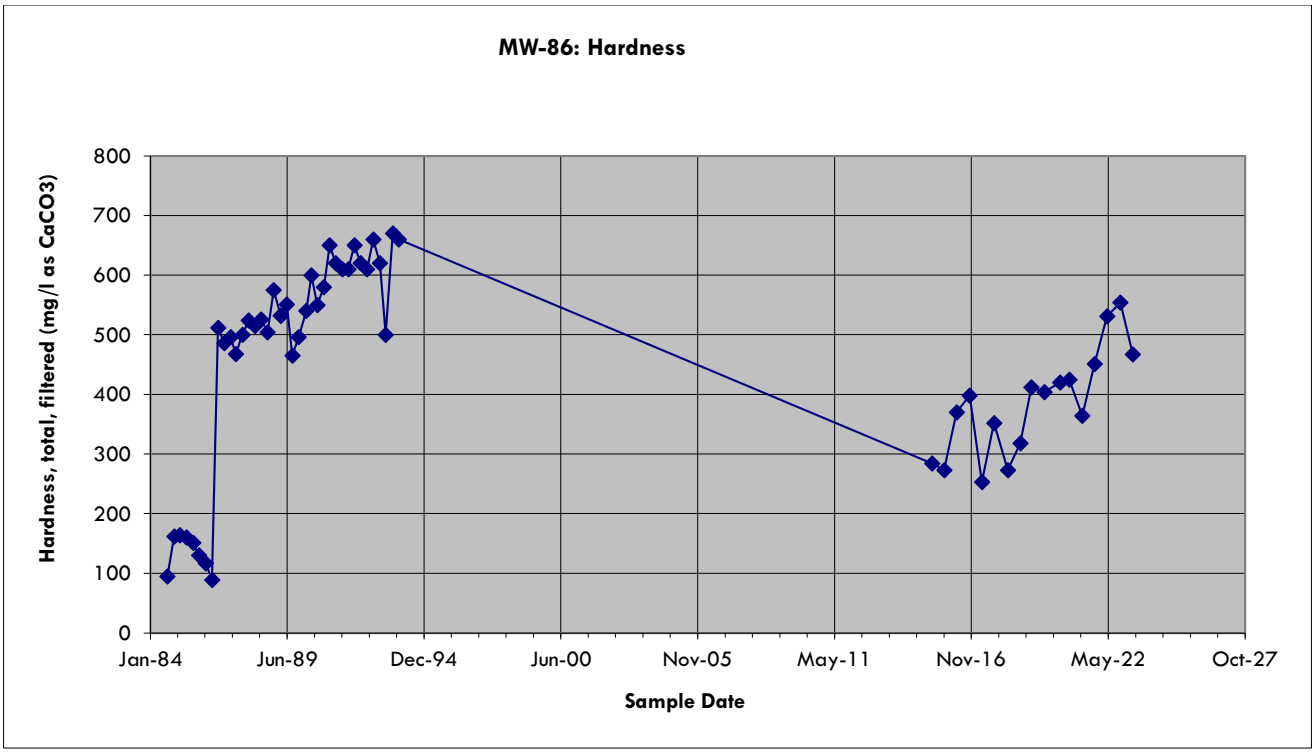
B = Compound detected in blank.

M = Failed method QC check.



Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-86	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	95	9/7/1984	95		
MW-86	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	162	12/17/1984	162		
MW-86	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	164	3/7/1985	164		
MW-86	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	160	6/14/1985	160		
MW-86	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	151	9/18/1985	151		
MW-86	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	130	12/12/1985	130		
MW-86	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	117	3/21/1986	117		
MW-86	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	89	6/20/1986	89		
MW-86	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	512	9/18/1986	512		
MW-86	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	486	12/19/1986	486		
MW-86	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	496	3/20/1987	496		
MW-86	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	468	6/5/1987	468		
MW-86	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	500	9/9/1987	500		
MW-86	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	524	12/9/1987	524		
MW-86	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	515	3/10/1988	515		
MW-86	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	526	6/7/1988	526		
MW-86	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	504	9/9/1988	504		
MW-86	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	575	12/7/1988	575		
MW-86	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	532	3/21/1989	532		
MW-86	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	532	3/22/1989	532		
MW-86	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	551	6/16/1989	551		
MW-86	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	465	9/7/1989	465		
MW-86	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	496	12/6/1989	496		
MW-86	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	540	3/29/1990	540		
MW-86	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	600	6/13/1990	600		
MW-86	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	550	9/7/1990	550		
MW-86	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	580	12/11/1990	580		
MW-86	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	650	3/6/1991	650		
MW-86	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	620	6/3/1991	620		
MW-86	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	610	9/6/1991	610		
MW-86	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	610	12/5/1991	610		
MW-86	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	650	3/3/1992	650		
MW-86	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	620	6/2/1992	620		
MW-86	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	610	9/2/1992	610		
MW-86	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	660	12/2/1992	660		
MW-86	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	620	3/10/1993	620		
MW-86	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	500	6/2/1993	500		
MW-86	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	670	9/14/1993	670		
MW-86	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	660	12/7/1993	660		

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-86	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	284	4/14/2015	284	284	Using data from within the last 20 years for PAL calculation
MW-86	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	273	10/8/2015	273	273	
MW-86	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	370	4/7/2016	370	370	
MW-86	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	398	10/13/2016	398	398	
MW-86	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	253	4/11/2017	253	253	
MW-86	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	352	10/5/2017	352	352	
MW-86	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	273	4/25/2018	273	273	
MW-86	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	318	10/24/2018	318	318	
MW-86	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	412	4/3/2019	412	412	
MW-86	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	404	10/9/2019	404	404	
MW-86	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	420	5/29/2020	420	420	
MW-86	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	425	10/9/2020	425	425	
MW-86	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	364	4/15/2021	364	364	
MW-86	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	451	10/14/2021	451	451	
MW-86	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	531	4/13/2022	531	531	
MW-86	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	554	10/25/2022	554	554	
MW-86	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	467	4/24/2023	467	467	
Calculations							
Count						17	
Mean						385.24	
Std Dev						88.03	
3 X SD (PAL)						264.10	
Min Increase (PAL)						100	
PAL, Calculated						649.33	
PAL, Rounded						650	

Duplicate Data Not Used for Calculations							

Note: Data downloaded from GEMS

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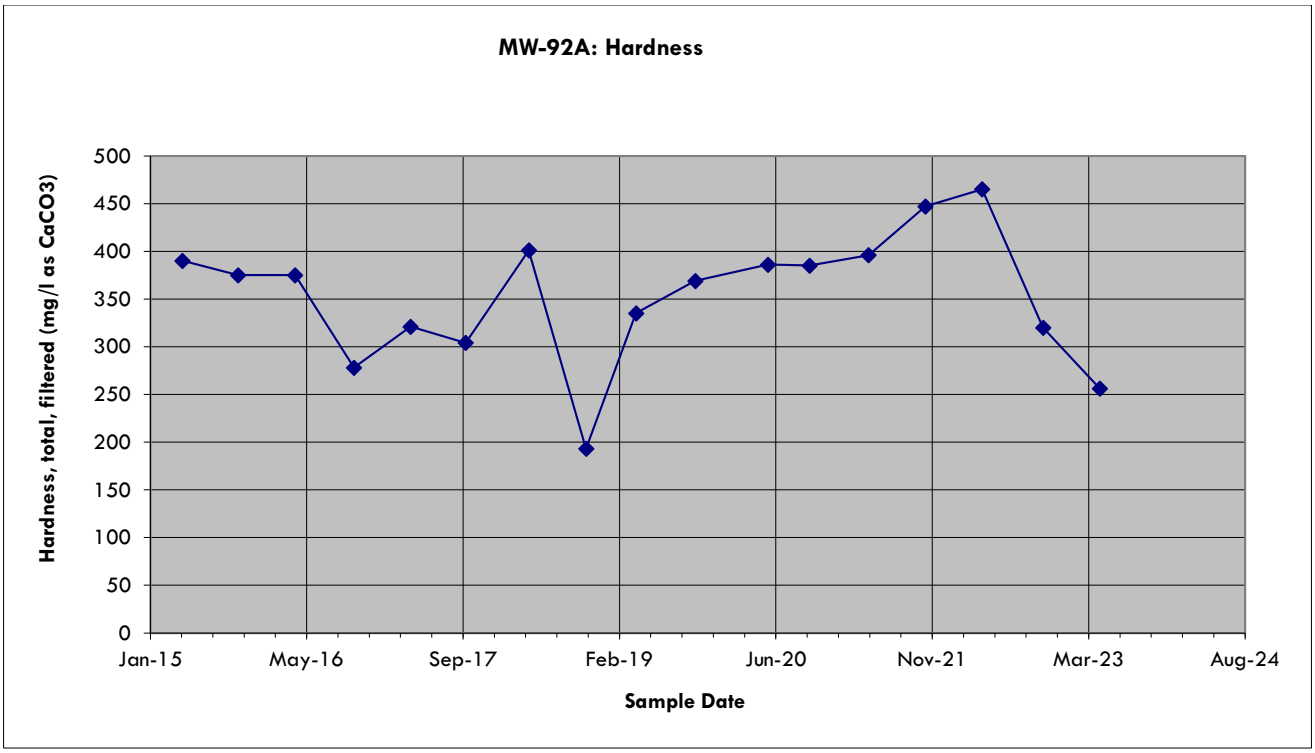

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-92A	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	390	4/13/2015	390	390	
MW-92A	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	375	10/8/2015	375	375	
MW-92A	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	375	4/8/2016	375	375	
MW-92A	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	278	10/13/2016	278	278	
MW-92A	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	321	4/12/2017	321	321	
MW-92A	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	304	10/5/2017	304	304	
MW-92A	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	401	4/25/2018	401	401	
MW-92A	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	193	10/25/2018	193	193	
MW-92A	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	335	4/3/2019	335	335	
MW-92A	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	369	10/9/2019	369	369	
MW-92A	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	386	5/29/2020	386	386	
MW-92A	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	385	10/9/2020	385	385	
MW-92A	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	396	4/15/2021	396	396	
MW-92A	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	447	10/14/2021	447	447	
MW-92A	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	465	4/13/2022	465	465	
MW-92A	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	320	10/25/2022	320	320	
MW-92A	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	256	4/24/2023	256	256	
Calculations							
Count						17	
Mean						352.71	
Std Dev						68.79	
3 X SD (PAL)						206.37	
Min Increase (PAL)						100	
PAL, Calculated						559.07	
PAL, Rounded						560	

Duplicate Data Not Used for Calculations							

Note: Data downloaded from GEMS

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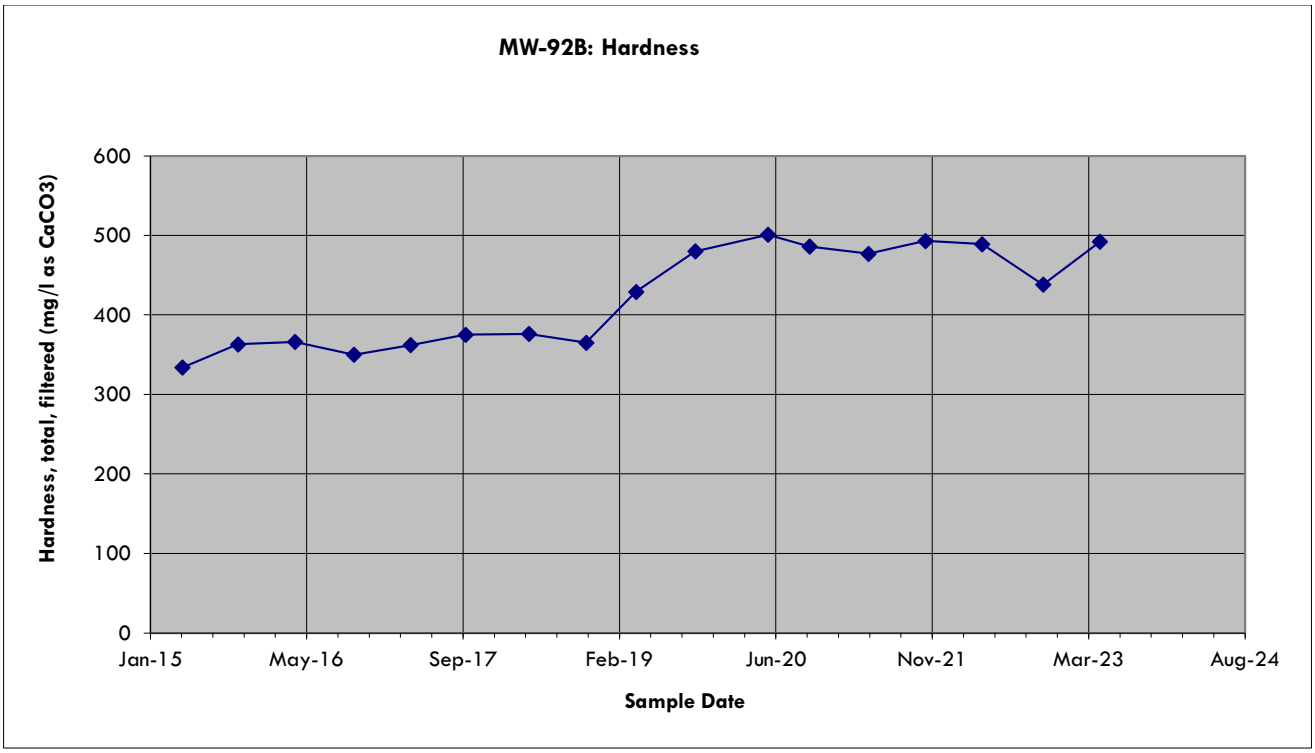
B = Compound detected in blank.

M = Failed method QC check.



Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-92B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	334	4/13/2015	334	334	
MW-92B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	363	10/8/2015	363	363	
MW-92B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	366	4/8/2016	366	366	
MW-92B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	350	10/13/2016	350	350	
MW-92B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	362	4/12/2017	362	362	
MW-92B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	375	10/5/2017	375	375	
MW-92B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	376	4/25/2018	376	376	
MW-92B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	365	10/25/2018	365	365	
MW-92B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	429	4/3/2019	429	429	
MW-92B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	480	10/9/2019	480	480	
MW-92B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	501	5/29/2020	501	501	
MW-92B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	486	10/9/2020	486	486	
MW-92B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	477	4/15/2021	477	477	
MW-92B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	493	10/14/2021	493	493	
MW-92B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	489	4/13/2022	489	489	
MW-92B	HARDNESS, TOTAL, FILTERED (MG/L AS CACO3)	01	438	10/25/2022	438	438	
MW-92B	Hardness, Total, Filtered (Mg/L As Caco3)	01	492	4/24/2023	492	492	
Calculations							
Count						17	
Mean						422.12	
Std Dev						62.34	
3 X SD (PAL)						187.02	
Min Increase (PAL)						100	
PAL, Calculated						609.14	
PAL, Rounded						610	

Duplicate Data Not Used for Calculations							

Note: Data downloaded from GEMS

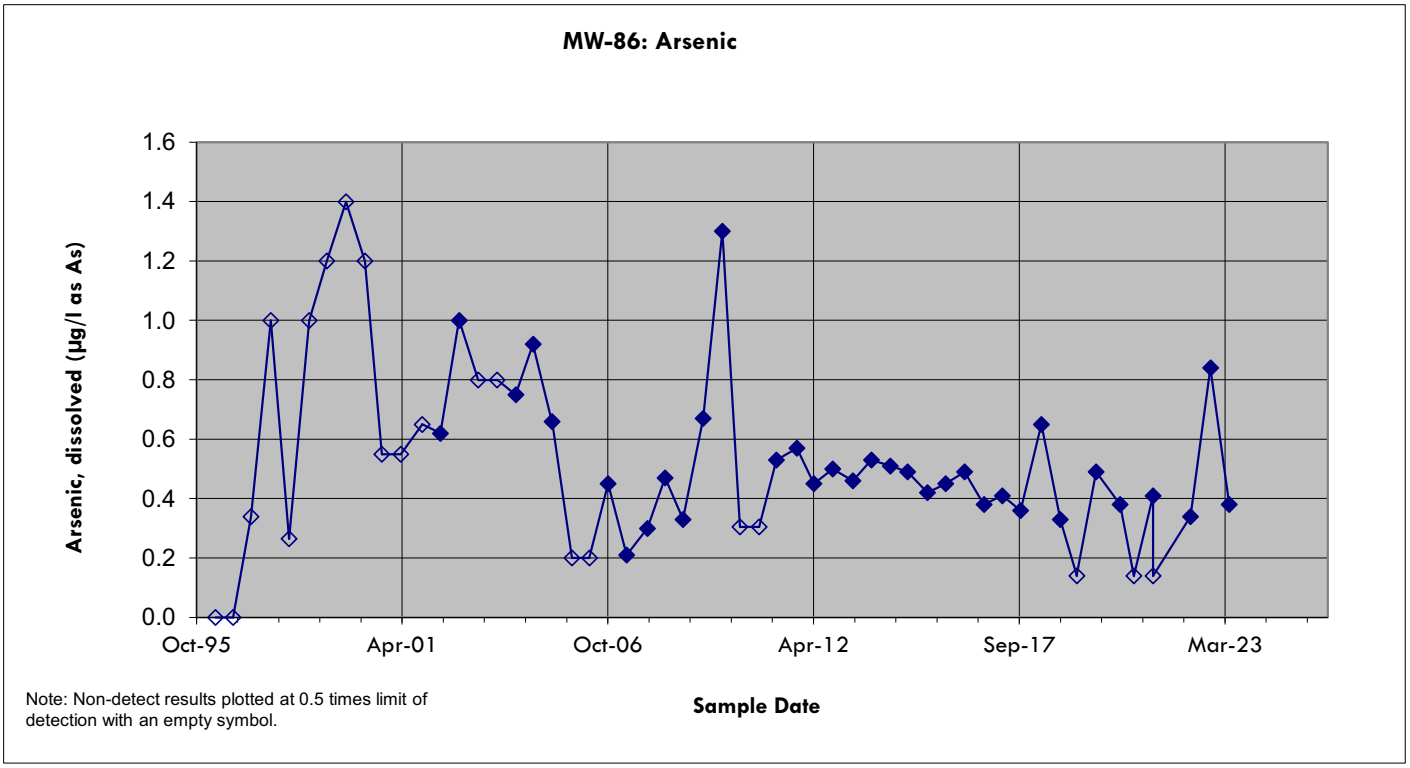
J = Result is an estimated value below the laboratory's limit of quantitation.

P = Did not meet required preservation and/or hold time.

B = Compound detected in blank.

M = Failed method QC check.

09/28/2023 - Classification: Internal - ECRM13153872



Note: Non-detect results plotted at 0.5 times limit of detection with an empty symbol.

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-86	ARSENIC, DISSOLVED (µG/L As)	01	<0	4/29/1996	0		
MW-86	ARSENIC, DISSOLVED (µG/L As)	01	<0	10/17/1996	0		
MW-86	ARSENIC, DISSOLVED (µG/L As)	01	<0.68	4/8/1997	0.34	0.34	
MW-86	ARSENIC, DISSOLVED (µG/L As)	01	<2	10/20/1997	1	1	
MW-86	ARSENIC, DISSOLVED (µG/L As)	01	<0.53	4/14/1998	0.265	0.265	
MW-86	ARSENIC, DISSOLVED (µG/L As)	01	<2	10/27/1998	1	1	
MW-86	ARSENIC, DISSOLVED (µG/L As)	01	<2.4	4/16/1999	1.2	1.2	
MW-86	ARSENIC, DISSOLVED (µG/L As)	01	<2.8	10/21/1999	1.4	1.4	
MW-86	ARSENIC, DISSOLVED (µG/L As)	01	<2.4	4/20/2000	1.2	1.2	
MW-86	ARSENIC, DISSOLVED (µG/L As)	01	<1.1	10/4/2000	0.55	0.55	
MW-86	ARSENIC, DISSOLVED (µG/L As)	01	<1.1	4/3/2001	0.55	0.55	
MW-86	ARSENIC, DISSOLVED (µG/L As)	01	<1.3	10/30/2001	0.65	0.65	
MW-86	ARSENIC, DISSOLVED (µG/L As)	01	0.62	4/25/2002	0.62	0.62	J
MW-86	ARSENIC, DISSOLVED (µG/L As)	01	1	10/25/2002	1	1	
MW-86	ARSENIC, DISSOLVED (µG/L As)	01	<1.6	4/28/2003	0.8	0.8	
MW-86	ARSENIC, DISSOLVED (µG/L As)	01	<1.6	10/28/2003	0.8	0.8	
MW-86	ARSENIC, DISSOLVED (µG/L As)	01	0.75	4/27/2004	0.75	0.75	J
MW-86	ARSENIC, DISSOLVED (µG/L As)	01	0.92	10/12/2004	0.92	0.92	
MW-86	ARSENIC, DISSOLVED (µG/L As)	01	0.66	4/14/2005	0.66	0.66	J
MW-86	ARSENIC, DISSOLVED (µG/L As)	01	<0.4	10/26/2005	0.2	0.2	
MW-86	ARSENIC, DISSOLVED (µG/L As)	01	<0.4	4/13/2006	0.2	0.2	
MW-86	ARSENIC, DISSOLVED (µG/L As)	01	0.45	10/12/2006	0.45	0.45	
MW-86	ARSENIC, DISSOLVED (µG/L As)	01	0.21	4/10/2007	0.21	0.21	J
MW-86	ARSENIC, DISSOLVED (µG/L As)	01	0.3	10/30/2007	0.3	0.3	J
MW-86	ARSENIC, DISSOLVED (µG/L As)	01	0.47	4/17/2008	0.47	0.47	J
MW-86	ARSENIC, DISSOLVED (µG/L As)	01	0.33	10/10/2008	0.33	0.33	J
MW-86	ARSENIC, DISSOLVED (µG/L As)	01	0.67	4/22/2009	0.67	0.67	J
MW-86	ARSENIC, DISSOLVED (µG/L As)	01	1.3	10/27/2009	1.3	1.3	
MW-86	ARSENIC, DISSOLVED (µG/L As)	01	<0.61	4/14/2010	0.305	0.305	
MW-86	ARSENIC, DISSOLVED (µG/L As)	01	<0.61	10/20/2010	0.305	0.305	
MW-86	ARSENIC, DISSOLVED (µG/L As)	01	0.53	4/6/2011	0.53	0.53	J
MW-86	ARSENIC, DISSOLVED (µG/L As)	01	0.57	10/21/2011	0.57	0.57	J
MW-86	ARSENIC, DISSOLVED (µG/L As)	01	0.45	4/4/2012	0.45	0.45	J
MW-86	ARSENIC, DISSOLVED (µG/L As)	01	0.5	10/4/2012	0.5	0.5	J
MW-86	ARSENIC, DISSOLVED (µG/L As)	01	0.46	4/17/2013	0.46	0.46	J
MW-86	ARSENIC, DISSOLVED (µG/L As)	01	0.53	10/14/2013	0.53	0.53	J
MW-86	ARSENIC, DISSOLVED (µG/L As)	01	0.51	4/17/2014	0.51	0.51	J
MW-86	ARSENIC, DISSOLVED (µG/L As)	01	0.49	10/2/2014	0.49	0.49	J

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Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-86	ARSENIC, DISSOLVED (µG/L As)	01	0.42	4/14/2015	0.42	0.42	J
MW-86	ARSENIC, DISSOLVED (µG/L As)	01	0.45	10/8/2015	0.45	0.45	
MW-86	ARSENIC, DISSOLVED (µG/L As)	01	0.49	4/7/2016	0.49	0.49	J
MW-86	ARSENIC, DISSOLVED (µG/L As)	01	0.38	10/13/2016	0.38	0.38	J
MW-86	ARSENIC, DISSOLVED (µG/L As)	01	0.41	4/11/2017	0.41	0.41	J
MW-86	ARSENIC, DISSOLVED (µG/L As)	01	0.36	10/5/2017	0.36	0.36	J
MW-86	ARSENIC, DISSOLVED (µG/L As)	01	0.65	4/25/2018	0.65	0.65	J
MW-86	ARSENIC, DISSOLVED (µG/L As)	01	0.33	10/24/2018	0.33	0.33	J
MW-86	ARSENIC, DISSOLVED (µG/L As)	01	<0.28	4/3/2019	0.14	0.14	
MW-86	ARSENIC, DISSOLVED (µG/L As)	01	0.49	10/9/2019	0.49	0.49	J
MW-86	ARSENIC, DISSOLVED (µG/L As)	01	0.38	5/29/2020	0.38	0.38	J
MW-86	ARSENIC, DISSOLVED (µG/L As)	01	<0.28	10/9/2020	0.14	0.14	
MW-86	ARSENIC, DISSOLVED (µG/L As)	01	0.41	4/15/2021	0.41	0.41	J
MW-86	ARSENIC, DISSOLVED (µG/L As)	01	<0.28	4/15/2021	0.14	0.14	
MW-86	ARSENIC, DISSOLVED (µG/L As)	01	0.34	4/13/2022	0.34	0.34	J
MW-86	ARSENIC, DISSOLVED (µG/L As)	01	0.84	10/25/2022	0.84	0.84	J
MW-86	ARSENIC, DISSOLVED (µG/L As)	01	0.38	4/24/2023	0.38	0.38	J
Calculations							
Count						53	
Mean						0.55	
Std Dev						0.30	
2 X SD (ACL)						0.60	
ACL, Calculated						1.15	
ACL, Rounded						1.2	

Duplicate Data Not Used for Calculations							

Note: Current PAL = 1 µg/l; ES = 10 µg/l

Data downlaoded from GEMS

J = Result is an estimated value below the laboratory's limit of quantitation.

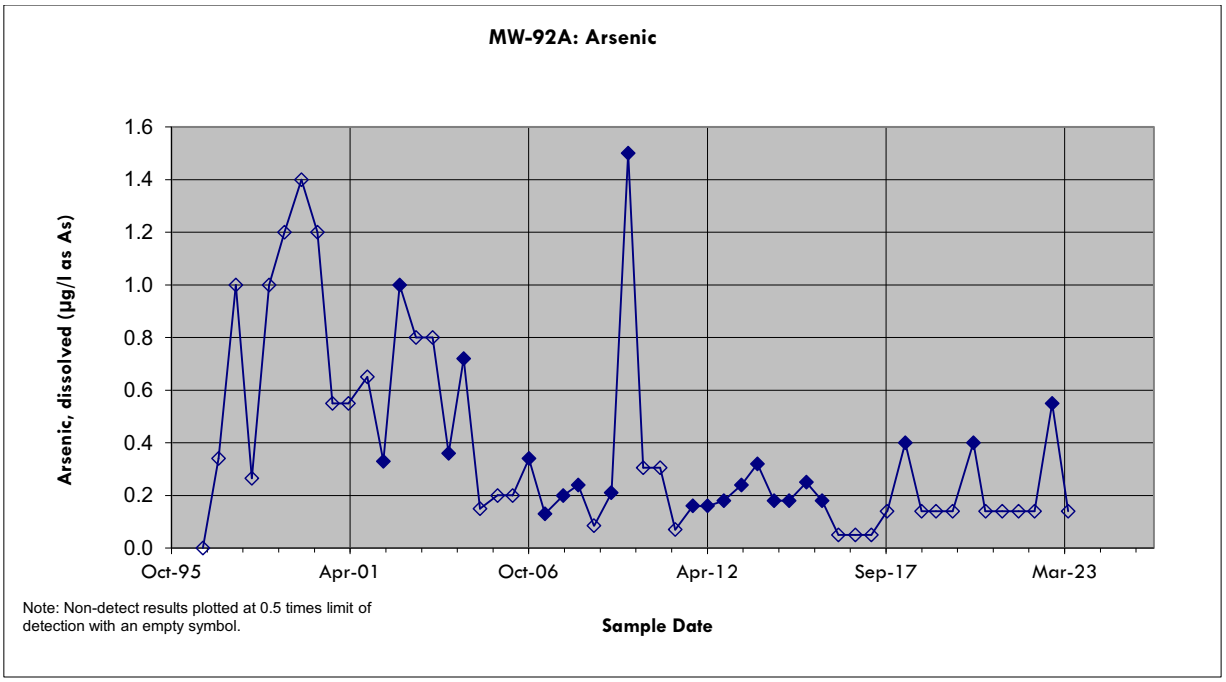
P = Did not meet required preservation and/or hold time.

B = Compound detected in blank.

M = Failed method QC check.

I:\25222260.00\Data and Calculations\Groundwater PALs ACLs\[ACL Calculations_Non CCR Wells.xls]MW86_As_ACL

09/28/2023 - Classification: Internal - ECRM13153872



Note: Non-detect results plotted at 0.5 times limit of detection with an empty symbol.

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-92A	ARSENIC, DISSOLVED (µG/L As)	01	<0	10/16/1996	0		
MW-92A	ARSENIC, DISSOLVED (µG/L As)	01	<0.68	4/8/1997	0.34	0.34	
MW-92A	ARSENIC, DISSOLVED (µG/L As)	01	<2	10/20/1997	1	1	
MW-92A	ARSENIC, DISSOLVED (µG/L As)	01	<0.53	4/14/1998	0.265	0.265	
MW-92A	ARSENIC, DISSOLVED (µG/L As)	01	<2	10/27/1998	1	1	
MW-92A	ARSENIC, DISSOLVED (µG/L As)	01	<2.4	4/16/1999	1.2	1.2	
MW-92A	ARSENIC, DISSOLVED (µG/L As)	01	<2.8	10/21/1999	1.4	1.4	
MW-92A	ARSENIC, DISSOLVED (µG/L As)	01	<2.4	4/20/2000	1.2	1.2	
MW-92A	ARSENIC, DISSOLVED (µG/L As)	01	<1.1	10/4/2000	0.55	0.55	
MW-92A	ARSENIC, DISSOLVED (µG/L As)	01	<1.1	4/3/2001	0.55	0.55	
MW-92A	ARSENIC, DISSOLVED (µG/L As)	01	<1.3	10/30/2001	0.65	0.65	
MW-92A	ARSENIC, DISSOLVED (µG/L As)	01	0.33	4/25/2002	0.33	0.33	J
MW-92A	ARSENIC, DISSOLVED (µG/L As)	01	1	10/25/2002	1	1	
MW-92A	ARSENIC, DISSOLVED (µG/L As)	01	<1.6	4/28/2003	0.8	0.8	
MW-92A	ARSENIC, DISSOLVED (µG/L As)	01	<1.6	10/29/2003	0.8	0.8	
MW-92A	ARSENIC, DISSOLVED (µG/L As)	01	0.36	4/27/2004	0.36	0.36	J
MW-92A	ARSENIC, DISSOLVED (µG/L As)	01	0.72	10/12/2004	0.72	0.72	
MW-92A	ARSENIC, DISSOLVED (µG/L As)	01	<0.3	4/14/2005	0.15	0.15	
MW-92A	ARSENIC, DISSOLVED (µG/L As)	01	<0.4	10/26/2005	0.2	0.2	
MW-92A	ARSENIC, DISSOLVED (µG/L As)	01	<0.4	4/13/2006	0.2	0.2	
MW-92A	ARSENIC, DISSOLVED (µG/L As)	01	0.34	10/12/2006	0.34	0.34	J
MW-92A	ARSENIC, DISSOLVED (µG/L As)	01	0.13	4/10/2007	0.13	0.13	J
MW-92A	ARSENIC, DISSOLVED (µG/L As)	01	0.2	10/30/2007	0.2	0.2	J
MW-92A	ARSENIC, DISSOLVED (µG/L As)	01	0.24	4/17/2008	0.24	0.24	J
MW-92A	ARSENIC, DISSOLVED (µG/L As)	01	<0.17	10/10/2008	0.085	0.085	
MW-92A	ARSENIC, DISSOLVED (µG/L As)	01	0.21	4/22/2009	0.21	0.21	J
MW-92A	ARSENIC, DISSOLVED (µG/L As)	01	1.5	10/27/2009	1.5	1.5	
MW-92A	ARSENIC, DISSOLVED (µG/L As)	01	<0.61	4/14/2010	0.305	0.305	
MW-92A	ARSENIC, DISSOLVED (µG/L As)	01	<0.61	10/20/2010	0.305	0.305	
MW-92A	ARSENIC, DISSOLVED (µG/L As)	01	<0.14	4/6/2011	0.07	0.07	
MW-92A	ARSENIC, DISSOLVED (µG/L As)	01	0.16	10/21/2011	0.16	0.16	J
MW-92A	ARSENIC, DISSOLVED (µG/L As)	01	0.16	4/4/2012	0.16	0.16	J
MW-92A	ARSENIC, DISSOLVED (µG/L As)	01	0.18	10/3/2012	0.18	0.18	J
MW-92A	ARSENIC, DISSOLVED (µG/L As)	01	0.24	4/18/2013	0.24	0.24	J
MW-92A	ARSENIC, DISSOLVED (µG/L As)	01	0.32	10/14/2013	0.32	0.32	J
MW-92A	ARSENIC, DISSOLVED (µG/L As)	01	0.18	4/17/2014	0.18	0.18	J
MW-92A	ARSENIC, DISSOLVED (µG/L As)	01	0.18	10/2/2014	0.18	0.18	J
MW-92A	ARSENIC, DISSOLVED (µG/L As)	01	0.25	4/13/2015	0.25	0.25	J
MW-92A	ARSENIC, DISSOLVED (µG/L As)	01	0.18	10/8/2015	0.18	0.18	J
MW-92A	ARSENIC, DISSOLVED (µG/L As)	01	<0.1	4/8/2016	0.05	0.05	
MW-92A	ARSENIC, DISSOLVED (µG/L As)	01	<0.1	10/13/2016	0.05	0.05	
MW-92A	ARSENIC, DISSOLVED (µG/L As)	01	<0.1	4/12/2017	0.05	0.05	
MW-92A	ARSENIC, DISSOLVED (µG/L As)	01	<0.28	10/5/2017	0.14	0.14	
MW-92A	ARSENIC, DISSOLVED (µG/L As)	01	0.4	4/25/2018	0.4	0.4	J
MW-92A	ARSENIC, DISSOLVED (µG/L As)	01	<0.28	10/25/2018	0.14	0.14	
MW-92A	ARSENIC, DISSOLVED (µG/L As)	01	<0.28	4/3/2019	0.14	0.14	

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-92A	ARSENIC, DISSOLVED (µG/L As)	01	<0.28	10/9/2019	0.14	0.14	
MW-92A	ARSENIC, DISSOLVED (µG/L As)	01	0.4	5/29/2020	0.4	0.4	J
MW-92A	ARSENIC, DISSOLVED (µG/L As)	01	<0.28	10/9/2020	0.14	0.14	
MW-92A	ARSENIC, DISSOLVED (µG/L As)	01	<0.28	4/15/2021	0.14	0.14	
MW-92A	ARSENIC, DISSOLVED (µG/L As)	01	<0.28	10/14/2021	0.14	0.14	
MW-92A	ARSENIC, DISSOLVED (µG/L As)	01	<0.28	4/13/2022	0.14	0.14	
MW-92A	ARSENIC, DISSOLVED (µG/L As)	01	0.55	10/25/2022	0.55	0.55	J
MW-92A	ARSENIC, DISSOLVED (µG/L As)	01	<0.28	4/24/2023	0.14	0.14	
Calculations							
Count						53	
Mean						0.39	
Std Dev						0.37	
2 X SD (ACL)						0.74	
ACL, Calculated						1.13	
ACL, Rounded						1.2	

Duplicate Data Not Used for Calculations							

Note: Current PAL = 1 µg/l; ES = 10 µg/l

J = Result is an estimated value below the laboratory's limit of quantitation.

P = Did not meet required preservation and/or hold time.

B = Compound detected in blank.

M = Failed method QC check.

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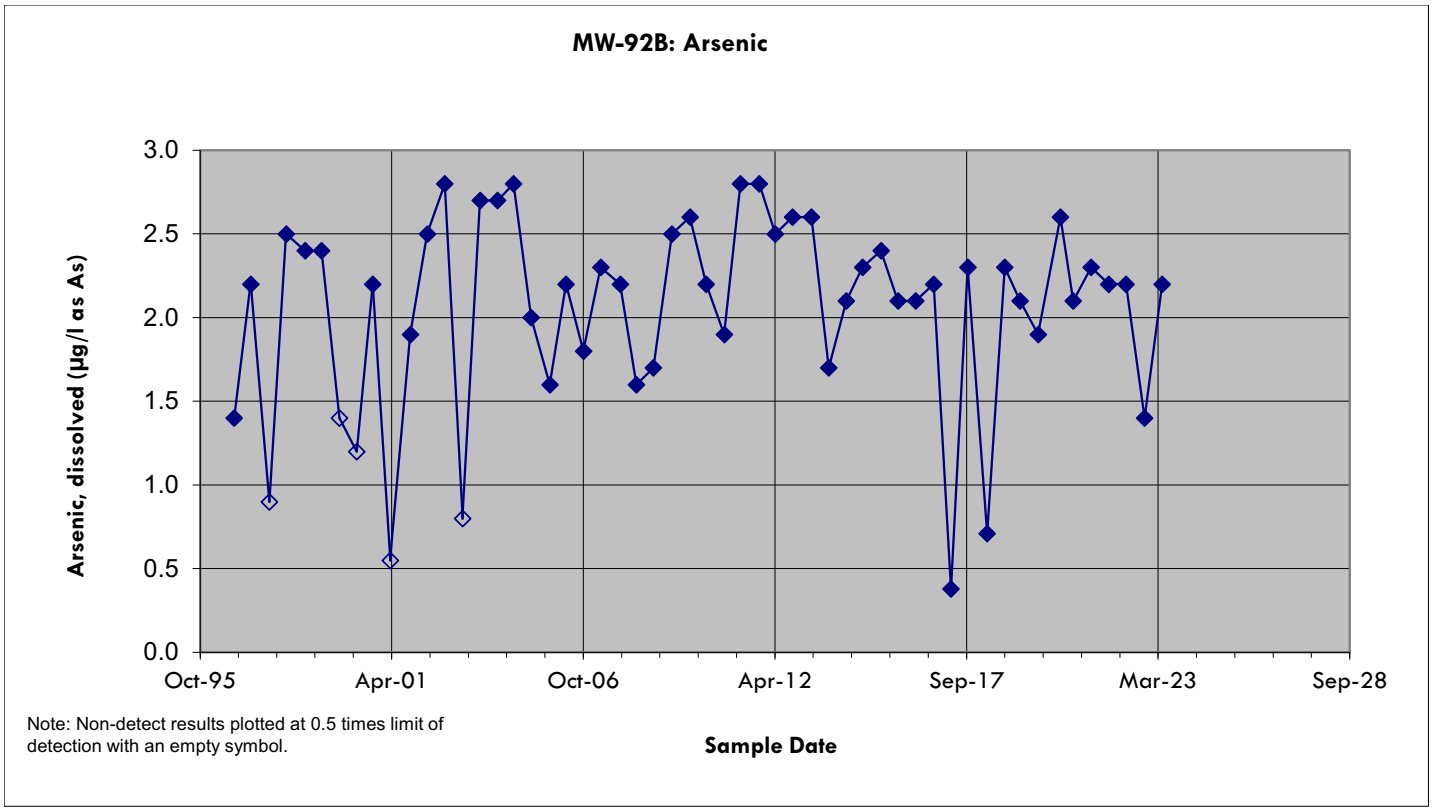
09/28/2023 - Classification: Internal - ECRM13153872



Note: Non-detect results plotted at 0.5 times limit of detection with an empty symbol.

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-92B	ARSENIC, DISSOLVED (µG/L As)	01	1.4	10/16/1996	1.4	1.4	
MW-92B	ARSENIC, DISSOLVED (µG/L As)	01	2.2	4/8/1997	2.2	2.2	
MW-92B	ARSENIC, DISSOLVED (µG/L As)	01	<1.8	10/20/1997	0.9	0.9	
MW-92B	ARSENIC, DISSOLVED (µG/L As)	01	2.5	4/14/1998	2.5	2.5	
MW-92B	ARSENIC, DISSOLVED (µG/L As)	01	2.4	10/27/1998	2.4	2.4	J
MW-92B	ARSENIC, DISSOLVED (µG/L As)	01	2.4	4/16/1999	2.4	2.4	J
MW-92B	ARSENIC, DISSOLVED (µG/L As)	01	<2.8	10/21/1999	1.4	1.4	
MW-92B	ARSENIC, DISSOLVED (µG/L As)	01	<2.4	4/20/2000	1.2	1.2	
MW-92B	ARSENIC, DISSOLVED (µG/L As)	01	2.2	10/4/2000	2.2	2.2	J
MW-92B	ARSENIC, DISSOLVED (µG/L As)	01	<1.1	4/3/2001	0.55	0.55	
MW-92B	ARSENIC, DISSOLVED (µG/L As)	01	1.9	10/30/2001	1.9	1.9	J
MW-92B	ARSENIC, DISSOLVED (µG/L As)	01	2.5	4/25/2002	2.5	2.5	
MW-92B	ARSENIC, DISSOLVED (µG/L As)	01	2.8	10/25/2002	2.8	2.8	
MW-92B	ARSENIC, DISSOLVED (µG/L As)	01	<1.6	4/28/2003	0.8	0.8	
MW-92B	ARSENIC, DISSOLVED (µG/L As)	01	2.7	10/29/2003	2.7	2.7	J
MW-92B	ARSENIC, DISSOLVED (µG/L As)	01	2.7	4/27/2004	2.7	2.7	
MW-92B	ARSENIC, DISSOLVED (µG/L As)	01	2.8	10/12/2004	2.8	2.8	
MW-92B	ARSENIC, DISSOLVED (µG/L As)	01	2	4/14/2005	2	2	
MW-92B	ARSENIC, DISSOLVED (µG/L As)	01	1.6	10/26/2005	1.6	1.6	
MW-92B	ARSENIC, DISSOLVED (µG/L As)	01	2.2	4/13/2006	2.2	2.2	
MW-92B	ARSENIC, DISSOLVED (µG/L As)	01	1.8	10/12/2006	1.8	1.8	
MW-92B	ARSENIC, DISSOLVED (µG/L As)	01	2.3	4/10/2007	2.3	2.3	
MW-92B	ARSENIC, DISSOLVED (µG/L As)	01	2.2	10/30/2007	2.2	2.2	
MW-92B	ARSENIC, DISSOLVED (µG/L As)	01	1.6	4/17/2008	1.6	1.6	
MW-92B	ARSENIC, DISSOLVED (µG/L As)	01	1.7	10/10/2008	1.7	1.7	
MW-92B	ARSENIC, DISSOLVED (µG/L As)	01	2.5	4/22/2009	2.5	2.5	
MW-92B	ARSENIC, DISSOLVED (µG/L As)	01	2.6	10/27/2009	2.6	2.6	
MW-92B	ARSENIC, DISSOLVED (µG/L As)	01	2.2	4/14/2010	2.2	2.2	
MW-92B	ARSENIC, DISSOLVED (µG/L As)	01	1.9	10/20/2010	1.9	1.9	J
MW-92B	ARSENIC, DISSOLVED (µG/L As)	01	2.8	4/6/2011	2.8	2.8	
MW-92B	ARSENIC, DISSOLVED (µG/L As)	01	2.8	10/21/2011	2.8	2.8	
MW-92B	ARSENIC, DISSOLVED (µG/L As)	01	2.5	4/4/2012	2.5	2.5	
MW-92B	ARSENIC, DISSOLVED (µG/L As)	01	2.6	10/3/2012	2.6	2.6	
MW-92B	ARSENIC, DISSOLVED (µG/L As)	01	2.6	4/18/2013	2.6	2.6	

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Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-92B	ARSENIC, DISSOLVED (µG/L As)	01	1.7	10/14/2013	1.7	1.7	
MW-92B	ARSENIC, DISSOLVED (µG/L As)	01	2.1	4/17/2014	2.1	2.1	
MW-92B	ARSENIC, DISSOLVED (µG/L As)	01	2.3	10/2/2014	2.3	2.3	
MW-92B	ARSENIC, DISSOLVED (µG/L As)	01	2.4	4/13/2015	2.4	2.4	
MW-92B	ARSENIC, DISSOLVED (µG/L As)	01	2.1	10/8/2015	2.1	2.1	
MW-92B	ARSENIC, DISSOLVED (µG/L As)	01	2.1	4/8/2016	2.1	2.1	
MW-92B	ARSENIC, DISSOLVED (µG/L As)	01	2.2	10/13/2016	2.2	2.2	
MW-92B	ARSENIC, DISSOLVED (µG/L As)	01	0.38	4/12/2017	0.38	0.38	J
MW-92B	ARSENIC, DISSOLVED (µG/L As)	01	2.3	10/5/2017	2.3	2.3	
MW-92B	ARSENIC, DISSOLVED (µG/L As)	01	0.71	4/25/2018	0.71	0.71	J
MW-92B	ARSENIC, DISSOLVED (µG/L As)	01	2.3	10/25/2018	2.3	2.3	
MW-92B	ARSENIC, DISSOLVED (µG/L As)	01	2.1	4/3/2019	2.1	2.1	
MW-92B	ARSENIC, DISSOLVED (µG/L As)	01	1.9	10/9/2019	1.9	1.9	
MW-92B	ARSENIC, DISSOLVED (µG/L As)	01	2.6	5/29/2020	2.6	2.6	
MW-92B	ARSENIC, DISSOLVED (µG/L As)	01	2.1	10/9/2020	2.1	2.1	
MW-92B	ARSENIC, DISSOLVED (µG/L As)	01	2.3	4/15/2021	2.3	2.3	
MW-92B	ARSENIC, DISSOLVED (µG/L As)	01	2.2	10/14/2021	2.2	2.2	
MW-92B	ARSENIC, DISSOLVED (µG/L As)	01	2.2	4/13/2022	2.2	2.2	
MW-92B	ARSENIC, DISSOLVED (µG/L As)	01	1.4	10/25/2022	1.4	1.4	
MW-92B	ARSENIC, DISSOLVED (µG/L As)	01	2.2	4/24/2023	2.2	2.2	
Calculations							
Count						54	
Mean						2.05	
Std Dev						0.59	
2 X SD (ACL)						1.18	
ACL, Calculated						3.23	
ACL, Rounded						3.3	

Duplicate Data Not Used for Calculations							

Note: Current PAL = 1 µg/l; ES = 10 µg/l

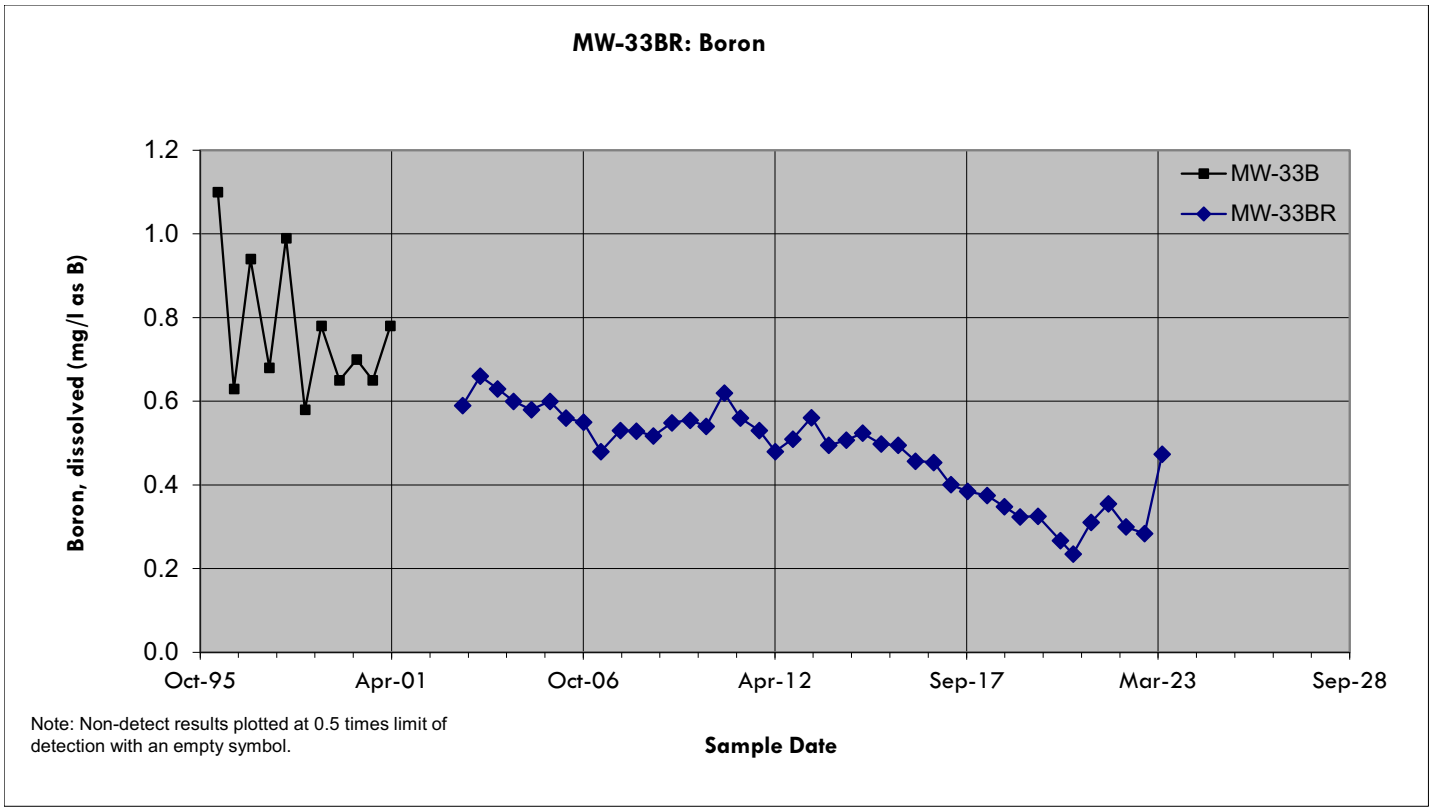
J = Result is an estimated value below the laboratory's limit of quantitation.

P = Did not meet required preservation and/or hold time.

B = Compound detected in blank.

M = Failed method QC check.

I:\25222260.00\Data and Calculations\Groundwater PALs ACLs\[ACL Calculations_Non CCR Wells.xls]MW92B_As_ACL



Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-33B	BORON, DISSOLVED (MG/L B)	01	1.1	4/30/1996	1.1		
MW-33B	BORON, DISSOLVED (MG/L B)	01	0.63	10/16/1996	0.63		
MW-33B	BORON, DISSOLVED (MG/L B)	01	0.94	4/8/1997	0.94		
MW-33B	BORON, DISSOLVED (MG/L B)	01	0.68	10/20/1997	0.68		
MW-33B	BORON, DISSOLVED (MG/L B)	01	0.99	4/14/1998	0.99		
MW-33B	BORON, DISSOLVED (MG/L B)	01	0.58	10/27/1998	0.58		
MW-33B	BORON, DISSOLVED (MG/L B)	01	0.78	4/16/1999	0.78		
MW-33B	BORON, DISSOLVED (MG/L B)	01	0.65	10/21/1999	0.65		
MW-33B	BORON, DISSOLVED (MG/L B)	01	0.7	4/20/2000	0.7		
MW-33B	BORON, DISSOLVED (MG/L B)	01	0.65	10/4/2000	0.65		
MW-33B	BORON, DISSOLVED (MG/L B)	01	0.78	4/3/2001	0.78		
MW-33BR	BORON, DISSOLVED (MG/L B)	01	0.59	4/29/2003	0.59	0.59	
MW-33BR	BORON, DISSOLVED (MG/L B)	01	0.66	10/30/2003	0.66	0.66	
MW-33BR	BORON, DISSOLVED (MG/L B)	01	0.63	4/27/2004	0.63	0.63	
MW-33BR	BORON, DISSOLVED (MG/L B)	01	0.6	10/12/2004	0.6	0.6	
MW-33BR	BORON, DISSOLVED (MG/L B)	01	0.58	4/15/2005	0.58	0.58	
MW-33BR	BORON, DISSOLVED (MG/L B)	01	0.6	10/26/2005	0.6	0.6	
MW-33BR	BORON, DISSOLVED (MG/L B)	01	0.56	4/13/2006	0.56	0.56	
MW-33BR	BORON, DISSOLVED (MG/L B)	01	0.55	10/12/2006	0.55	0.55	
MW-33BR	BORON, DISSOLVED (MG/L B)	01	0.48	4/11/2007	0.48	0.48	
MW-33BR	BORON, DISSOLVED (MG/L B)	01	0.53	10/31/2007	0.53	0.53	
MW-33BR	BORON, DISSOLVED (MG/L B)	01	0.529	4/17/2008	0.529	0.529	
MW-33BR	BORON, DISSOLVED (MG/L B)	01	0.517	10/10/2008	0.517	0.517	
MW-33BR	BORON, DISSOLVED (MG/L B)	01	0.549	4/21/2009	0.549	0.549	
MW-33BR	BORON, DISSOLVED (MG/L B)	01	0.555	10/27/2009	0.555	0.555	
MW-33BR	BORON, DISSOLVED (MG/L B)	01	0.54	4/14/2010	0.54	0.54	J
MW-33BR	BORON, DISSOLVED (MG/L B)	01	0.62	10/20/2010	0.62	0.62	
MW-33BR	BORON, DISSOLVED (MG/L B)	01	0.56	4/6/2011	0.56	0.56	
MW-33BR	BORON, DISSOLVED (MG/L B)	01	0.53	10/20/2011	0.53	0.53	
MW-33BR	BORON, DISSOLVED (MG/L B)	01	0.48	4/4/2012	0.48	0.48	
MW-33BR	BORON, DISSOLVED (MG/L B)	01	0.51	10/4/2012	0.51	0.51	
MW-33BR	BORON, DISSOLVED (MG/L B)	01	0.561	4/17/2013	0.561	0.561	
MW-33BR	BORON, DISSOLVED (MG/L B)	01	0.495	10/14/2013	0.495	0.495	
MW-33BR	BORON, DISSOLVED (MG/L B)	01	0.507	4/16/2014	0.507	0.507	

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Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-33BR	BORON, DISSOLVED (MG/L B)	01	0.524	10/2/2014	0.524	0.524	
MW-33BR	BORON, DISSOLVED (MG/L B)	01	0.498	4/13/2015	0.498	0.498	
MW-33BR	BORON, DISSOLVED (MG/L B)	01	0.495	10/7/2015	0.495	0.495	
MW-33BR	BORON, DISSOLVED (MG/L B)	01	0.457	4/7/2016	0.457	0.457	
MW-33BR	BORON, DISSOLVED (MG/L B)	01	0.454	10/13/2016	0.454	0.454	
MW-33BR	BORON, DISSOLVED (MG/L B)	01	0.401	4/11/2017	0.401	0.401	
MW-33BR	BORON, DISSOLVED (MG/L B)	01	0.385	10/4/2017	0.385	0.385	
MW-33BR	BORON, DISSOLVED (MG/L B)	01	0.375	4/24/2018	0.375	0.375	
MW-33BR	BORON, DISSOLVED (MG/L B)	01	0.348	10/22/2018	0.348	0.348	
MW-33BR	BORON, DISSOLVED (MG/L B)	01	0.324	4/2/2019	0.324	0.324	
MW-33BR	BORON, DISSOLVED (MG/L B)	01	0.325	10/8/2019	0.325	0.325	
MW-33BR	BORON, DISSOLVED (MG/L B)	01	0.267	5/29/2020	0.267	0.267	
MW-33BR	BORON, DISSOLVED (MG/L B)	01	0.235	10/8/2020	0.235	0.235	
MW-33BR	BORON, DISSOLVED (MG/L B)	01	0.311	4/14/2021	0.311	0.311	
MW-33BR	BORON, DISSOLVED (MG/L B)	01	0.355	10/12/2021	0.355	0.355	
MW-33BR	BORON, DISSOLVED (MG/L B)	01	0.3	4/13/2022	0.3	0.3	
MW-33BR	BORON, DISSOLVED (MG/L B)	01	0.284	10/25/2022	0.284	0.284	
MW-33BR	BORON, DISSOLVED (MG/L B)	01	0.474	4/26/2023	0.474	0.474	
Calculations							
Count						41	
Mean						0.48	
Std Dev						0.11	
2 X SD (ACL)						0.22	
ACL, Calculated						0.70	
ACL, Rounded						0.70	

Duplicate Data Not Used for Calculations							

Note: Current PAL = 0.2 mg/l; ES = 1 mg/l

J = Result is an estimated value below the laboratory's limit of quantitation.

P = Did not meet required preservation and/or hold time.

B = Compound detected in blank.

M = Failed method QC check.

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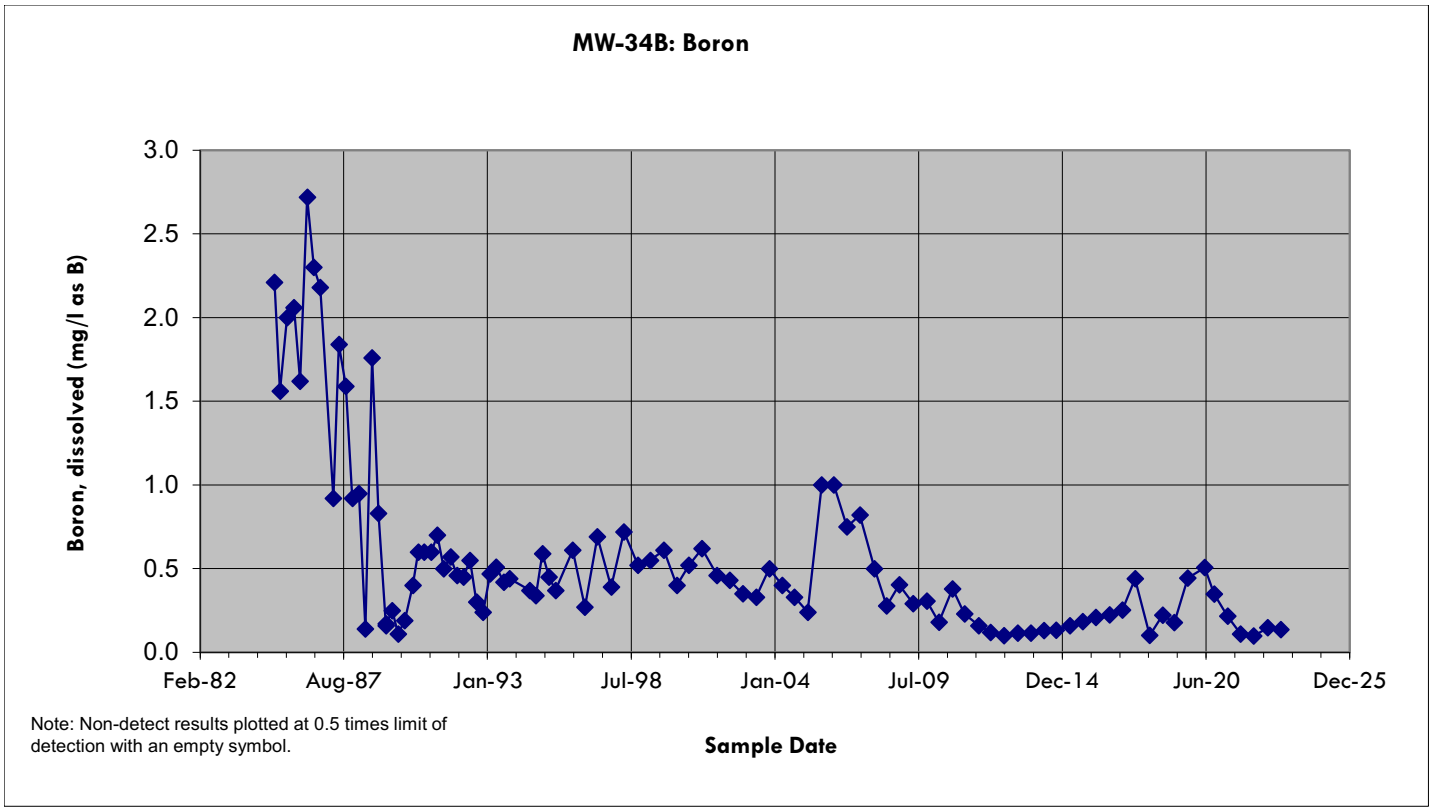

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-34B	BORON, DISSOLVED (MG/L B)	01	2.21	12/17/1984	2.21		
MW-34B	BORON, DISSOLVED (MG/L B)	01	1.56	3/7/1985	1.56		
MW-34B	BORON, DISSOLVED (MG/L B)	01	2	6/14/1985	2		
MW-34B	BORON, DISSOLVED (MG/L B)	01	2.06	9/18/1985	2.06		
MW-34B	BORON, DISSOLVED (MG/L B)	01	1.62	12/12/1985	1.62		
MW-34B	BORON, DISSOLVED (MG/L B)	01	2.72	3/21/1986	2.72		
MW-34B	BORON, DISSOLVED (MG/L B)	01	2.3	6/20/1986	2.3		
MW-34B	BORON, DISSOLVED (MG/L B)	01	2.18	9/18/1986	2.18		
MW-34B	BORON, DISSOLVED (MG/L B)	01	0.92	3/20/1987	0.92		
MW-34B	BORON, DISSOLVED (MG/L B)	01	1.84	6/5/1987	1.84		
MW-34B	BORON, DISSOLVED (MG/L B)	01	1.59	9/9/1987	1.59		
MW-34B	BORON, DISSOLVED (MG/L B)	01	0.92	12/9/1987	0.92		
MW-34B	BORON, DISSOLVED (MG/L B)	01	0.95	3/10/1988	0.95		
MW-34B	BORON, DISSOLVED (MG/L B)	01	0.14	6/7/1988	0.14		
MW-34B	BORON, DISSOLVED (MG/L B)	01	1.76	9/9/1988	1.76		
MW-34B	BORON, DISSOLVED (MG/L B)	01	0.83	12/7/1988	0.83		
MW-34B	BORON, DISSOLVED (MG/L B)	01	0.16	3/21/1989	0.16		
MW-34B	BORON, DISSOLVED (MG/L B)	01	0.17	3/22/1989	0.17		
MW-34B	BORON, DISSOLVED (MG/L B)	01	0.25	6/16/1989	0.25		
MW-34B	BORON, DISSOLVED (MG/L B)	01	0.11	9/6/1989	0.11		
MW-34B	BORON, DISSOLVED (MG/L B)	01	0.19	12/5/1989	0.19		
MW-34B	BORON, DISSOLVED (MG/L B)	01	0.4	3/29/1990	0.4		
MW-34B	BORON, DISSOLVED (MG/L B)	01	0.6	6/14/1990	0.6		
MW-34B	BORON, DISSOLVED (MG/L B)	01	0.6	9/5/1990	0.6		
MW-34B	BORON, DISSOLVED (MG/L B)	01	0.6	12/10/1990	0.6		
MW-34B	BORON, DISSOLVED (MG/L B)	01	0.7	3/5/1991	0.7		
MW-34B	BORON, DISSOLVED (MG/L B)	01	0.5	6/3/1991	0.5		
MW-34B	BORON, DISSOLVED (MG/L B)	01	0.57	9/6/1991	0.57		
MW-34B	BORON, DISSOLVED (MG/L B)	01	0.46	12/4/1991	0.46		
MW-34B	BORON, DISSOLVED (MG/L B)	01	0.45	3/3/1992	0.45		
MW-34B	BORON, DISSOLVED (MG/L B)	01	0.55	6/2/1992	0.55		
MW-34B	BORON, DISSOLVED (MG/L B)	01	0.3	9/1/1992	0.3		
MW-34B	BORON, DISSOLVED (MG/L B)	01	0.24	12/2/1992	0.24		
MW-34B	BORON, DISSOLVED (MG/L B)	01	0.47	3/10/1993	0.47		

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Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-34B	BORON, DISSOLVED (MG/L B)	01	0.51	6/2/1993	0.51		
MW-34B	BORON, DISSOLVED (MG/L B)	01	0.42	9/14/1993	0.42		
MW-34B	BORON, DISSOLVED (MG/L B)	01	0.44	12/7/1993	0.44		
MW-34B	BORON, DISSOLVED (MG/L B)	01	0.37	9/13/1994	0.37		
MW-34B	BORON, DISSOLVED (MG/L B)	01	0.34	12/6/1994	0.34		
MW-34B	BORON, DISSOLVED (MG/L B)	01	0.59	3/7/1995	0.59		
MW-34B	BORON, DISSOLVED (MG/L B)	01	0.45	6/6/1995	0.45		
MW-34B	BORON, DISSOLVED (MG/L B)	01	0.37	9/6/1995	0.37		
MW-34B	BORON, DISSOLVED (MG/L B)	01	0.61	4/30/1996	0.61		
MW-34B	BORON, DISSOLVED (MG/L B)	01	0.27	10/16/1996	0.27		
MW-34B	BORON, DISSOLVED (MG/L B)	01	0.69	4/8/1997	0.69		
MW-34B	BORON, DISSOLVED (MG/L B)	01	0.39	10/20/1997	0.39		
MW-34B	BORON, DISSOLVED (MG/L B)	01	0.72	4/14/1998	0.72		
MW-34B	BORON, DISSOLVED (MG/L B)	01	0.52	10/27/1998	0.52		
MW-34B	BORON, DISSOLVED (MG/L B)	01	0.55	4/16/1999	0.55		
MW-34B	BORON, DISSOLVED (MG/L B)	01	0.61	10/21/1999	0.61		
MW-34B	BORON, DISSOLVED (MG/L B)	01	0.4	4/20/2000	0.4		
MW-34B	BORON, DISSOLVED (MG/L B)	01	0.52	10/4/2000	0.52		
MW-34B	BORON, DISSOLVED (MG/L B)	01	0.62	4/3/2001	0.62		
MW-34B	BORON, DISSOLVED (MG/L B)	01	0.46	10/30/2001	0.46		
MW-34B	BORON, DISSOLVED (MG/L B)	01	0.43	4/25/2002	0.43		
MW-34B	BORON, DISSOLVED (MG/L B)	01	0.35	10/24/2002	0.35		
MW-34B	BORON, DISSOLVED (MG/L B)	01	0.33	4/29/2003	0.33	0.33	Using data from within the last 20 years for PAL calculation
MW-34B	BORON, DISSOLVED (MG/L B)	01	0.5	10/29/2003	0.5	0.5	
MW-34B	BORON, DISSOLVED (MG/L B)	01	0.4	4/27/2004	0.4	0.4	
MW-34B	BORON, DISSOLVED (MG/L B)	01	0.33	10/12/2004	0.33	0.33	
MW-34B	BORON, DISSOLVED (MG/L B)	01	0.24	4/15/2005	0.24	0.24	
MW-34B	BORON, DISSOLVED (MG/L B)	01	1	10/26/2005	1	1	
MW-34B	BORON, DISSOLVED (MG/L B)	01	1	4/13/2006	1	1	
MW-34B	BORON, DISSOLVED (MG/L B)	01	0.75	10/12/2006	0.75	0.75	
MW-34B	BORON, DISSOLVED (MG/L B)	01	0.82	4/11/2007	0.82	0.82	
MW-34B	BORON, DISSOLVED (MG/L B)	01	0.5	10/31/2007	0.5	0.5	
MW-34B	BORON, DISSOLVED (MG/L B)	01	0.278	4/17/2008	0.278	0.278	
MW-34B	BORON, DISSOLVED (MG/L B)	01	0.404	10/10/2008	0.404	0.404	
MW-34B	BORON, DISSOLVED (MG/L B)	01	0.291	4/21/2009	0.291	0.291	
MW-34B	BORON, DISSOLVED (MG/L B)	01	0.307	10/27/2009	0.307	0.307	
MW-34B	BORON, DISSOLVED (MG/L B)	01	0.18	4/14/2010	0.18	0.18	J,B
MW-34B	BORON, DISSOLVED (MG/L B)	01	0.38	10/20/2010	0.38	0.38	
MW-34B	BORON, DISSOLVED (MG/L B)	01	0.23	4/6/2011	0.23	0.23	B
MW-34B	BORON, DISSOLVED (MG/L B)	01	0.16	10/20/2011	0.16	0.16	
MW-34B	BORON, DISSOLVED (MG/L B)	01	0.12	4/4/2012	0.12	0.12	
MW-34B	BORON, DISSOLVED (MG/L B)	01	0.1	10/4/2012	0.1	0.1	
MW-34B	BORON, DISSOLVED (MG/L B)	01	0.116	4/16/2013	0.116	0.116	
MW-34B	BORON, DISSOLVED (MG/L B)	01	0.116	10/14/2013	0.116	0.116	
MW-34B	BORON, DISSOLVED (MG/L B)	01	0.131	4/16/2014	0.131	0.131	
MW-34B	BORON, DISSOLVED (MG/L B)	01	0.132	10/2/2014	0.132	0.132	
MW-34B	BORON, DISSOLVED (MG/L B)	01	0.159	4/13/2015	0.159	0.159	
MW-34B	BORON, DISSOLVED (MG/L B)	01	0.184	10/7/2015	0.184	0.184	
MW-34B	BORON, DISSOLVED (MG/L B)	01	0.209	4/7/2016	0.209	0.209	
MW-34B	BORON, DISSOLVED (MG/L B)	01	0.224	10/13/2016	0.224	0.224	
MW-34B	BORON, DISSOLVED (MG/L B)	01	0.254	4/11/2017	0.254	0.254	
MW-34B	BORON, DISSOLVED (MG/L B)	01	0.44	10/4/2017	0.44	0.44	
MW-34B	BORON, DISSOLVED (MG/L B)	01	0.102	4/24/2018	0.102	0.102	
MW-34B	BORON, DISSOLVED (MG/L B)	01	0.222	10/22/2018	0.222	0.222	
MW-34B	BORON, DISSOLVED (MG/L B)	01	0.178	4/2/2019	0.178	0.178	
MW-34B	BORON, DISSOLVED (MG/L B)	01	0.444	10/8/2019	0.444	0.444	
MW-34B	BORON, DISSOLVED (MG/L B)	01	0.507	5/29/2020	0.507	0.507	
MW-34B	BORON, DISSOLVED (MG/L B)	01	0.349	10/8/2020	0.349	0.349	
MW-34B	BORON, DISSOLVED (MG/L B)	01	0.216	4/14/2021	0.216	0.216	
MW-34B	BORON, DISSOLVED (MG/L B)	01	0.11	10/12/2021	0.11	0.11	
MW-34B	BORON, DISSOLVED (MG/L B)	01	0.0981	4/13/2022	0.0981	0.0981	
MW-34B	BORON, DISSOLVED (MG/L B)	01	0.148	10/25/2022	0.148	0.148	

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Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-34B	BORON, DISSOLVED (MG/L B)	01	0.136	4/26/2023	0.136	0.136	
Calculations							
Count						41	
Mean						0.31	
Std Dev						0.23	
2 X SD (ACL)						0.46	
ACL, Calculated						0.77	
ACL, Rounded						0.78	

Duplicate Data Not Used for Calculations							

Note: Current PAL = 0.2 mg/l; ES = 1 mg/l

J = Result is an estimated value below the laboratory's limit of quantitation.

P = Did not meet required preservation and/or hold time.

B = Compound detected in blank.

M = Failed method QC check.

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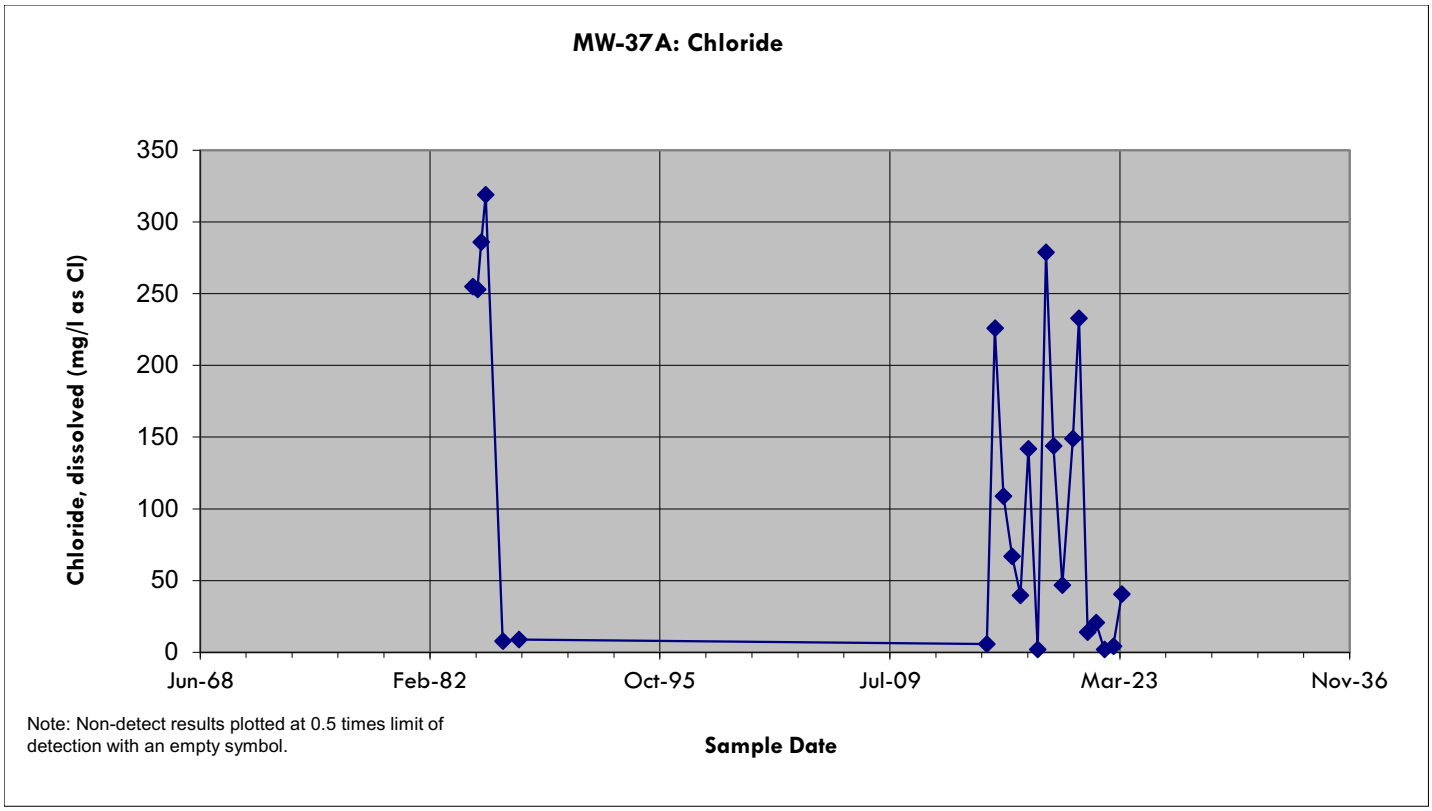

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-37A	CHLORIDE, TOTAL OR DISSOLVED IN WTR SMPL (MG/L CL)	01	255	9/7/1984	255		
MW-37A	CHLORIDE, TOTAL OR DISSOLVED IN WTR SMPL (MG/L CL)	01	253	12/17/1984	253		
MW-37A	CHLORIDE, TOTAL OR DISSOLVED IN WTR SMPL (MG/L CL)	01	286	3/7/1985	286		
MW-37A	CHLORIDE, TOTAL OR DISSOLVED IN WTR SMPL (MG/L CL)	01	319	6/14/1985	319		
MW-37A	CHLORIDE, TOTAL OR DISSOLVED IN WTR SMPL (MG/L CL)	01	8	6/20/1986	8		
MW-37A	CHLORIDE, TOTAL OR DISSOLVED IN WTR SMPL (MG/L CL)	01	9	6/5/1987	9		
MW-37A	CHLORIDE, DISSOLVED (MG/L CI)	01	5.8	4/14/2015	5.8	5.8	Using data from within the last 20 years for PAL calculation
MW-37A	CHLORIDE, DISSOLVED (MG/L CI)	01	226	10/8/2015	226	226	
MW-37A	CHLORIDE, DISSOLVED (MG/L CI)	01	109	4/7/2016	109	109	
MW-37A	CHLORIDE, DISSOLVED (MG/L CI)	01	67.1	10/13/2016	67.1	67.1	
MW-37A	CHLORIDE, DISSOLVED (MG/L CI)	01	39.9	4/13/2017	39.9	39.9	
MW-37A	CHLORIDE, DISSOLVED (MG/L CI)	01	142	10/5/2017	142	142	
MW-37A	CHLORIDE, DISSOLVED (MG/L CI)	01	2.2	4/25/2018	2.2	2.2	
MW-37A	CHLORIDE, DISSOLVED (MG/L CI)	01	279	10/23/2018	279	279	
MW-37A	CHLORIDE, DISSOLVED (MG/L CI)	01	144	4/3/2019	144	144	
MW-37A	CHLORIDE, DISSOLVED (MG/L CI)	01	47	10/9/2019	47	47	
MW-37A	CHLORIDE, DISSOLVED (MG/L CI)	01	149	5/29/2020	149	149	
MW-37A	CHLORIDE, DISSOLVED (MG/L CI)	01	233	10/8/2020	233	233	
MW-37A	CHLORIDE, DISSOLVED (MG/L CI)	01	14.1	4/14/2021	14.1	14.1	
MW-37A	CHLORIDE, DISSOLVED (MG/L CI)	01	20.8	10/14/2021	20.8	20.8	
MW-37A	CHLORIDE, DISSOLVED (MG/L CI)	01	2	4/13/2022	2	2	
MW-37A	CHLORIDE, DISSOLVED (MG/L CI)	01	4.4	10/25/2022	4.4	4.4	
MW-37A	CHLORIDE, DISSOLVED (MG/L CI)	01	40.7	4/24/2023	40.7	40.7	
Calculations							
Count						17	
Mean						89.76	
Std Dev						90.78	
2 X SD (ACL)						181.56	
ACL, Calculated						271.33	
ACL, Rounded						280	

Duplicate Data Not Used for Calculations							

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes

Note: Current PAL = 125 mg/l; ES = 250 mg/l

J = Result is an estimated value below the laboratory's limit of quantitation.

P = Did not meet required preservation and/or hold time.

B = Compound detected in blank.

M = Failed method QC check.

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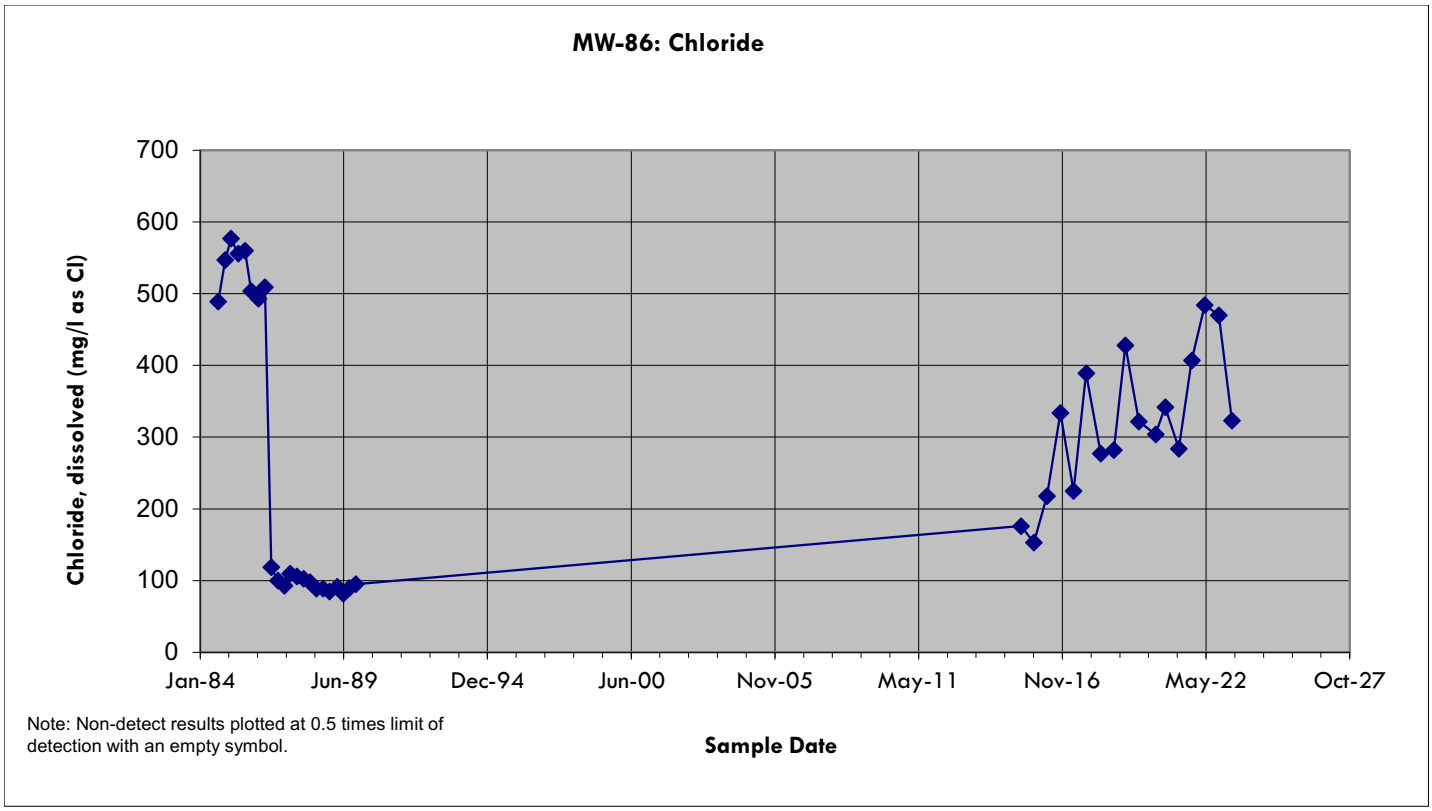

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-86	CHLORIDE, TOTAL OR DISSOLVED IN WTR SMPL (MG/L CL)	01	489	9/7/1984	489	489	
MW-86	CHLORIDE, TOTAL OR DISSOLVED IN WTR SMPL (MG/L CL)	01	547	12/17/1984	547	547	
MW-86	CHLORIDE, TOTAL OR DISSOLVED IN WTR SMPL (MG/L CL)	01	577	3/7/1985	577	577	
MW-86	CHLORIDE, TOTAL OR DISSOLVED IN WTR SMPL (MG/L CL)	01	556	6/14/1985	556	556	
MW-86	CHLORIDE, TOTAL OR DISSOLVED IN WTR SMPL (MG/L CL)	01	560	9/18/1985	560	560	
MW-86	CHLORIDE, TOTAL OR DISSOLVED IN WTR SMPL (MG/L CL)	01	504	12/12/1985	504	504	
MW-86	CHLORIDE, TOTAL OR DISSOLVED IN WTR SMPL (MG/L CL)	01	493	3/21/1986	493	493	
MW-86	CHLORIDE, TOTAL OR DISSOLVED IN WTR SMPL (MG/L CL)	01	509	6/20/1986	509	509	
MW-86	CHLORIDE, TOTAL OR DISSOLVED IN WTR SMPL (MG/L CL)	01	119	9/18/1986	119	119	
MW-86	CHLORIDE, TOTAL OR DISSOLVED IN WTR SMPL (MG/L CL)	01	100	12/19/1986	100	100	
MW-86	CHLORIDE, TOTAL OR DISSOLVED IN WTR SMPL (MG/L CL)	01	93	3/20/1987	93	93	
MW-86	CHLORIDE, TOTAL OR DISSOLVED IN WTR SMPL (MG/L CL)	01	110	6/5/1987	110	110	
MW-86	CHLORIDE, TOTAL OR DISSOLVED IN WTR SMPL (MG/L CL)	01	106	9/9/1987	106	106	
MW-86	CHLORIDE, TOTAL OR DISSOLVED IN WTR SMPL (MG/L CL)	01	103	12/9/1987	103	103	
MW-86	CHLORIDE, TOTAL OR DISSOLVED IN WTR SMPL (MG/L CL)	01	98	3/10/1988	98	98	
MW-86	CHLORIDE, TOTAL OR DISSOLVED IN WTR SMPL (MG/L CL)	01	89	6/7/1988	89	89	
MW-86	CHLORIDE, TOTAL OR DISSOLVED IN WTR SMPL (MG/L CL)	01	89	9/9/1988	89	89	
MW-86	CHLORIDE, TOTAL OR DISSOLVED IN WTR SMPL (MG/L CL)	01	85	12/7/1988	85	85	
MW-86	CHLORIDE, TOTAL OR DISSOLVED IN WTR SMPL (MG/L CL)	01	91	3/21/1989	91	91	
MW-86	CHLORIDE, TOTAL OR DISSOLVED IN WTR SMPL (MG/L CL)	01	91	3/22/1989	91	91	
MW-86	CHLORIDE, TOTAL OR DISSOLVED IN WTR SMPL (MG/L CL)	01	82	6/16/1989	82	82	
MW-86	CHLORIDE, TOTAL OR DISSOLVED IN WTR SMPL (MG/L CL)	01	90	9/7/1989	90	90	
MW-86	CHLORIDE, TOTAL OR DISSOLVED IN WTR SMPL (MG/L CL)	01	95	12/6/1989	95	95	
MW-86	CHLORIDE, DISSOLVED (MG/L CI)	01	176	4/14/2015	176	176	
MW-86	CHLORIDE, DISSOLVED (MG/L CI)	01	153	10/8/2015	153	153	
MW-86	CHLORIDE, DISSOLVED (MG/L CI)	01	218	4/7/2016	218	218	
MW-86	CHLORIDE, DISSOLVED (MG/L CI)	01	334	10/13/2016	334	334	
MW-86	CHLORIDE, DISSOLVED (MG/L CI)	01	225	4/11/2017	225	225	
MW-86	CHLORIDE, DISSOLVED (MG/L CI)	01	389	10/5/2017	389	389	
MW-86	CHLORIDE, DISSOLVED (MG/L CI)	01	277	4/25/2018	277	277	
MW-86	CHLORIDE, DISSOLVED (MG/L CI)	01	282	10/24/2018	282	282	
MW-86	CHLORIDE, DISSOLVED (MG/L CI)	01	428	4/3/2019	428	428	
MW-86	CHLORIDE, DISSOLVED (MG/L CI)	01	322	10/9/2019	322	322	
MW-86	CHLORIDE, DISSOLVED (MG/L CI)	01	304	5/29/2020	304	304	

09/28/2023 - Classification: Internal - ECRM13153872

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-86	CHLORIDE, DISSOLVED (MG/L CI)	01	342	10/9/2020	342	342	
MW-86	CHLORIDE, DISSOLVED (MG/L CI)	01	284	4/15/2021	284	284	
MW-86	CHLORIDE, DISSOLVED (MG/L CI)	01	407	10/14/2021	407	407	M
MW-86	CHLORIDE, DISSOLVED (MG/L CI)	01	484	4/13/2022	484	484	
MW-86	CHLORIDE, DISSOLVED (MG/L CI)	01	470	10/25/2022	470	470	M
MW-86	CHLORIDE, DISSOLVED (MG/L CI)	01	323	4/24/2023	323	323	
Calculations							
Count						40	
Mean						277.35	
Std Dev						174.44	
2 X SD (ACL)						348.88	
ACL, Calculated						626.23	
ACL, Rounded						630	

Duplicate Data Not Used for Calculations							

Note: Current PAL = 125 mg/l; ES = 250 mg/l

J = Result is an estimated value below the laboratory's limit of quantitation.

P = Did not meet required preservation and/or hold time.

B = Compound detected in blank.

M = Failed method QC check.

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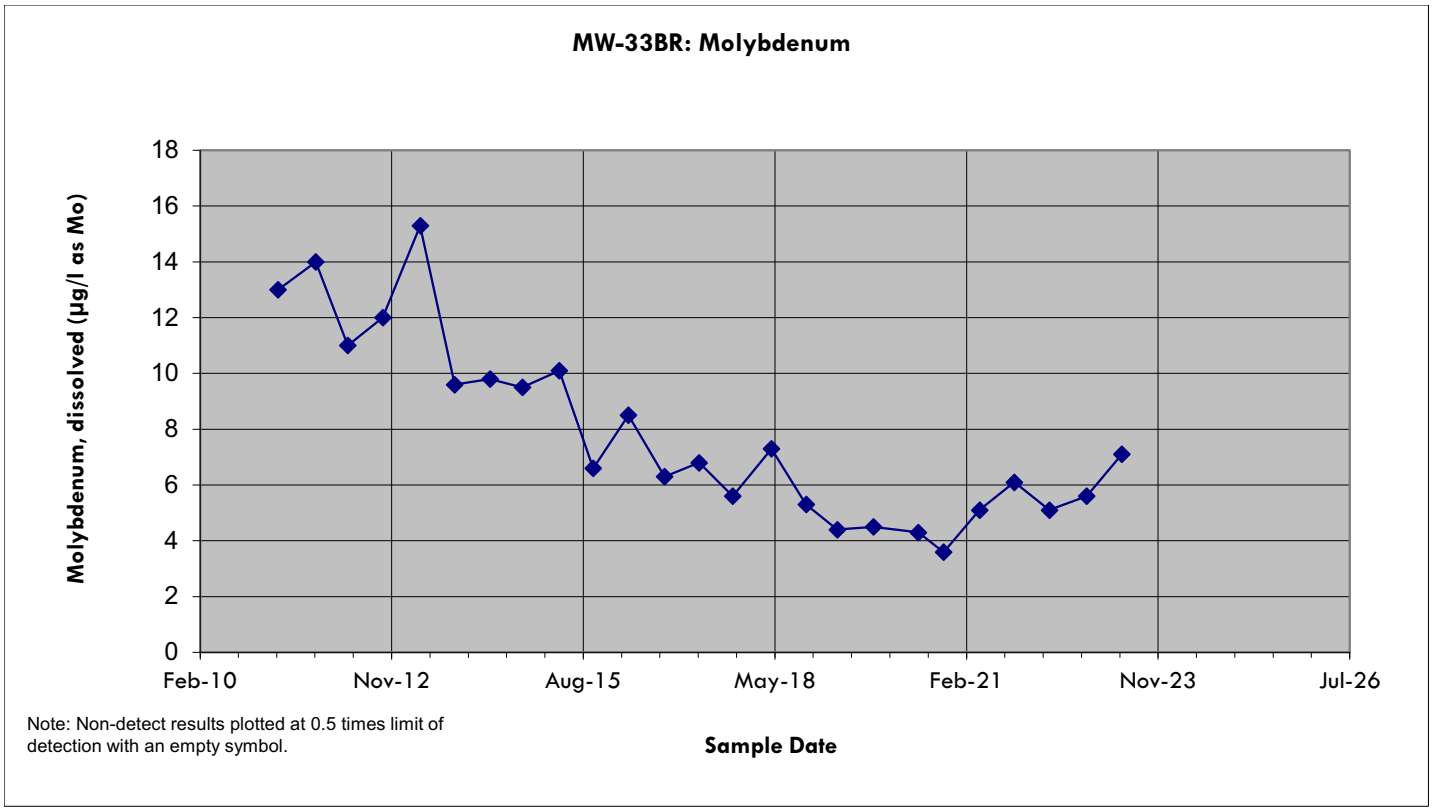

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-33BR	MOLYBDENUM, DISSOLVED (µG/L Mo)	01	13	4/6/2011	13	13	
MW-33BR	MOLYBDENUM, DISSOLVED (µG/L Mo)	01	14	10/20/2011	14	14	
MW-33BR	MOLYBDENUM, DISSOLVED (µG/L Mo)	01	11	4/4/2012	11	11	
MW-33BR	MOLYBDENUM, DISSOLVED (µG/L Mo)	01	12	10/4/2012	12	12	
MW-33BR	MOLYBDENUM, DISSOLVED (µG/L Mo)	01	15.3	4/17/2013	15.3	15.3	
MW-33BR	MOLYBDENUM, DISSOLVED (µG/L Mo)	01	9.6	10/14/2013	9.6	9.6	
MW-33BR	MOLYBDENUM, DISSOLVED (µG/L Mo)	01	9.8	4/16/2014	9.8	9.8	
MW-33BR	MOLYBDENUM, DISSOLVED (µG/L Mo)	01	9.5	10/2/2014	9.5	9.5	
MW-33BR	MOLYBDENUM, DISSOLVED (µG/L Mo)	01	10.1	4/13/2015	10.1	10.1	
MW-33BR	MOLYBDENUM, DISSOLVED (µG/L Mo)	01	6.6	10/7/2015	6.6	6.6	
MW-33BR	MOLYBDENUM, DISSOLVED (µG/L Mo)	01	8.5	4/7/2016	8.5	8.5	
MW-33BR	MOLYBDENUM, DISSOLVED (µG/L Mo)	01	6.3	10/13/2016	6.3	6.3	
MW-33BR	MOLYBDENUM, DISSOLVED (µG/L Mo)	01	6.8	4/11/2017	6.8	6.8	
MW-33BR	MOLYBDENUM, DISSOLVED (µG/L Mo)	01	5.6	10/4/2017	5.6	5.6	
MW-33BR	MOLYBDENUM, DISSOLVED (µG/L Mo)	01	7.3	4/24/2018	7.3	7.3	
MW-33BR	MOLYBDENUM, DISSOLVED (µG/L Mo)	01	5.3	10/22/2018	5.3	5.3	
MW-33BR	MOLYBDENUM, DISSOLVED (µG/L Mo)	01	4.4	4/2/2019	4.4	4.4	
MW-33BR	MOLYBDENUM, DISSOLVED (µG/L Mo)	01	4.5	10/8/2019	4.5	4.5	
MW-33BR	MOLYBDENUM, DISSOLVED (µG/L Mo)	01	4.3	5/29/2020	4.3	4.3	
MW-33BR	MOLYBDENUM, DISSOLVED (µG/L Mo)	01	3.6	10/8/2020	3.6	3.6	
MW-33BR	MOLYBDENUM, DISSOLVED (µG/L Mo)	01	5.1	4/14/2021	5.1	5.1	
MW-33BR	MOLYBDENUM, DISSOLVED (µG/L Mo)	01	6.1	10/12/2021	6.1	6.1	
MW-33BR	MOLYBDENUM, DISSOLVED (µG/L Mo)	01	5.1	4/13/2022	5.1	5.1	
MW-33BR	MOLYBDENUM, DISSOLVED (µG/L Mo)	01	5.6	10/25/2022	5.6	5.6	
MW-33BR	MOLYBDENUM, DISSOLVED (µG/L Mo)	01	7.1	4/26/2023	7.1	7.1	
Calculations							
Count						25	
Mean						7.86	
Std Dev						3.27	
2 X SD (ACL)						6.54	
ACL, Calculated						14.40	
ACL, Rounded						15	

Duplicate Data Not Used for Calculations

09/28/2023 - Classification: Internal - ECRM13153872

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes

Note: Current PAL = 8 µg/l; ES = 40 µg/l
J = Result is an estimated value below the laboratory's limit of quantitation.
P = Did not meet required preservation and/or hold time.
B = Compound detected in blank.
M = Failed method QC check.

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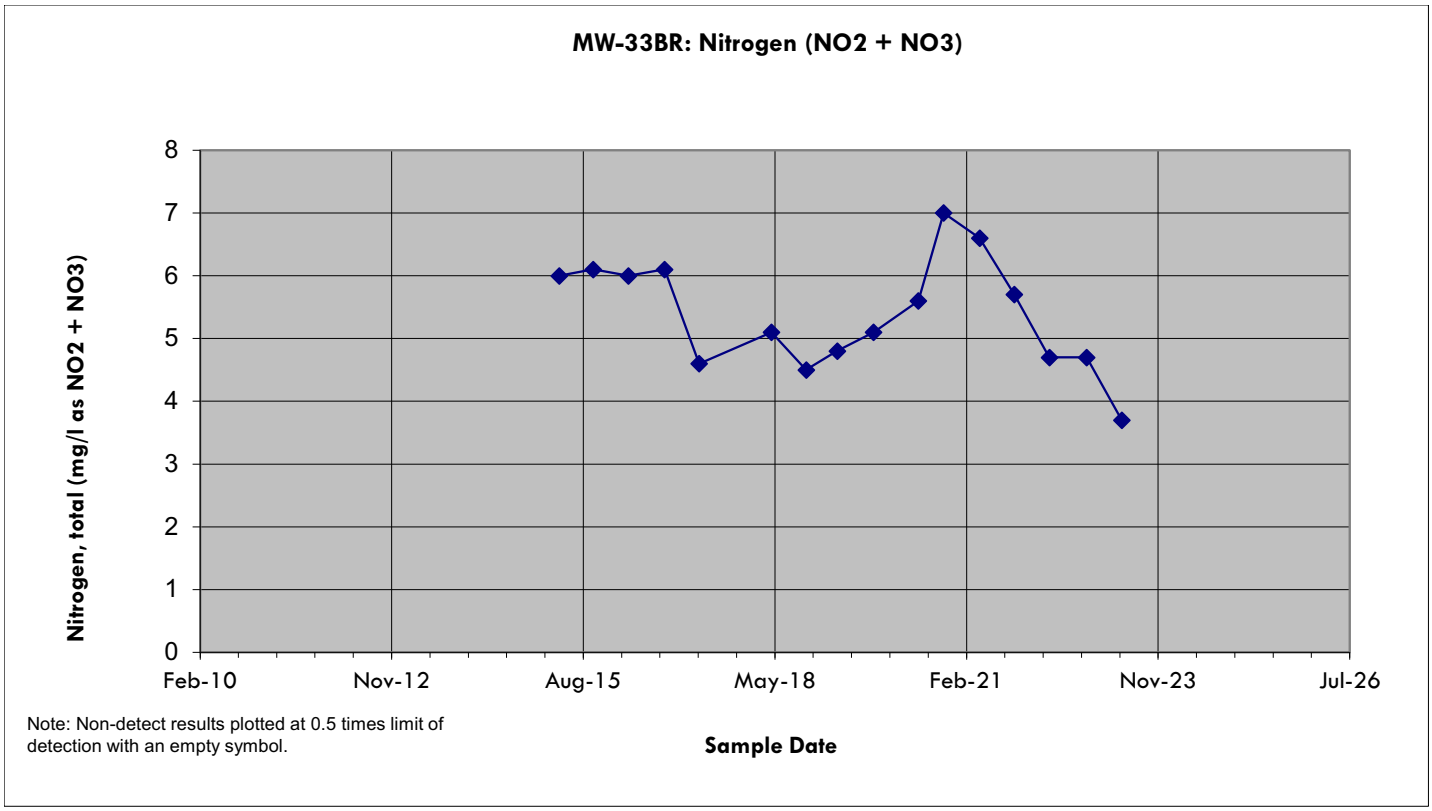


Note: Non-detect results plotted at 0.5 times limit of detection with an empty symbol.

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-33BR	NITROGEN, TOTAL (MG/L NO2+NO3)	01	6	4/13/2015	6	6	
MW-33BR	NITROGEN, TOTAL (MG/L NO2+NO3)	01	6.1	10/7/2015	6.1	6.1	M
MW-33BR	NITROGEN, TOTAL (MG/L NO2+NO3)	01	6	4/7/2016	6	6	
MW-33BR	NITROGEN, TOTAL (MG/L NO2+NO3)	01	6.1	10/13/2016	6.1	6.1	
MW-33BR	NITROGEN, TOTAL (MG/L NO2+NO3)	01	4.6	4/11/2017	4.6	4.6	
MW-33BR	NITROGEN, TOTAL (MG/L NO2+NO3)	01	5.1	4/24/2018	5.1	5.1	
MW-33BR	NITROGEN, TOTAL (MG/L NO2+NO3)	01	4.5	10/22/2018	4.5	4.5	
MW-33BR	NITROGEN, TOTAL (MG/L NO2+NO3)	01	4.8	4/2/2019	4.8	4.8	
MW-33BR	NITROGEN, TOTAL (MG/L NO2+NO3)	01	5.1	10/8/2019	5.1	5.1	
MW-33BR	NITROGEN, TOTAL (MG/L NO2+NO3)	01	5.6	5/29/2020	5.6	5.6	
MW-33BR	NITROGEN, TOTAL (MG/L NO2+NO3)	01	7	10/8/2020	7	7	
MW-33BR	NITROGEN, TOTAL (MG/L NO2+NO3)	01	6.6	4/14/2021	6.6	6.6	
MW-33BR	NITROGEN, TOTAL (MG/L NO2+NO3)	01	5.7	10/12/2021	5.7	5.7	
MW-33BR	NITROGEN, TOTAL (MG/L NO2+NO3)	01	4.7	4/13/2022	4.7	4.7	
MW-33BR	NITROGEN, TOTAL (MG/L NO2+NO3)	01	4.7	10/25/2022	4.7	4.7	
MW-33BR	NITROGEN, TOTAL (MG/L NO2+NO3)	01	3.7	4/26/2023	3.7	3.7	
Calculations							
Count						16	
Mean						5.39	
Std Dev						0.88	
2 X SD (ACL)						1.77	
ACL, Calculated						7.16	
ACL, Rounded						7.2	

Duplicate Data Not Used for Calculations							

Note: Current PAL = 2 mg/l; ES = 10 mg/l

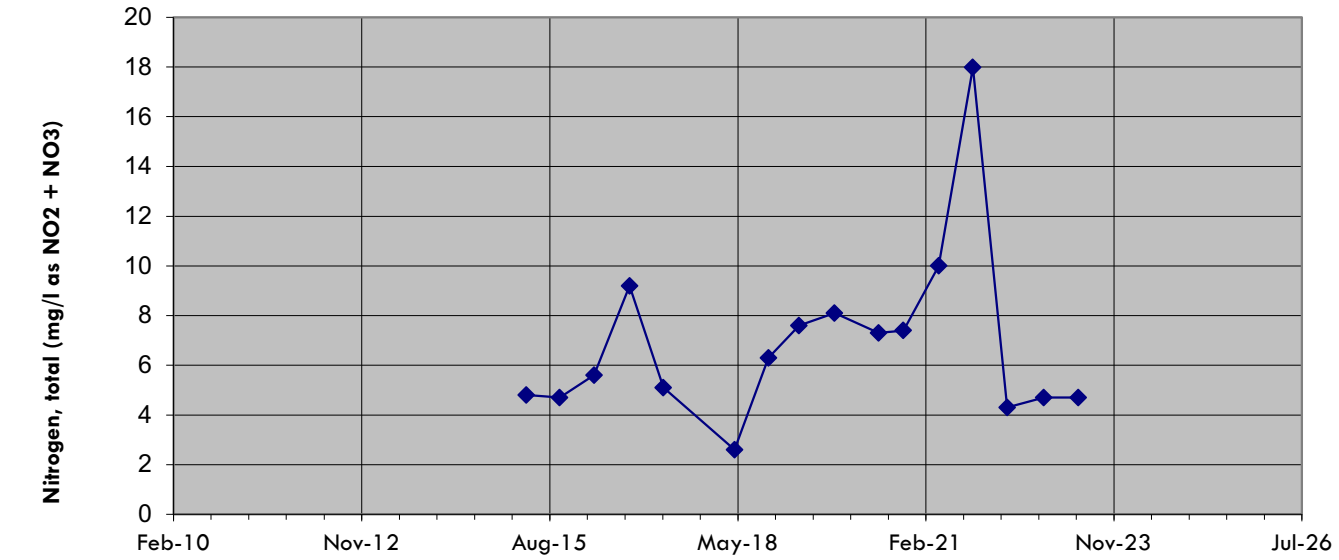
J = Result is an estimated value below the laboratory's limit of quantitation.

P = Did not meet required preservation and/or hold time.

B = Compound detected in blank.

M = Failed method QC check.

09/28/2023 - Classification: Internal - ECRM13153872



Note: Non-detect results plotted at 0.5 times limit of detection with an empty symbol.

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-34B	NITROGEN, TOTAL (MG/L NO2+NO3)	01	4.8	4/13/2015	4.8	4.8	
MW-34B	NITROGEN, TOTAL (MG/L NO2+NO3)	01	4.7	10/7/2015	4.7	4.7	
MW-34B	NITROGEN, TOTAL (MG/L NO2+NO3)	01	5.6	4/7/2016	5.6	5.6	
MW-34B	NITROGEN, TOTAL (MG/L NO2+NO3)	01	9.2	10/13/2016	9.2	9.2	
MW-34B	NITROGEN, TOTAL (MG/L NO2+NO3)	01	5.1	4/11/2017	5.1	5.1	
MW-34B	NITROGEN, TOTAL (MG/L NO2+NO3)	01	2.6	4/24/2018	2.6	2.6	
MW-34B	NITROGEN, TOTAL (MG/L NO2+NO3)	01	6.3	10/22/2018	6.3	6.3	
MW-34B	NITROGEN, TOTAL (MG/L NO2+NO3)	01	7.6	4/2/2019	7.6	7.6	
MW-34B	NITROGEN, TOTAL (MG/L NO2+NO3)	01	8.1	10/8/2019	8.1	8.1	
MW-34B	NITROGEN, TOTAL (MG/L NO2+NO3)	01	7.3	5/29/2020	7.3	7.3	
MW-34B	NITROGEN, TOTAL (MG/L NO2+NO3)	01	7.4	10/8/2020	7.4	7.4	
MW-34B	NITROGEN, TOTAL (MG/L NO2+NO3)	01	10	4/14/2021	10	10	
MW-34B	NITROGEN, TOTAL (MG/L NO2+NO3)	01	18	10/12/2021	18	18	
MW-34B	NITROGEN, TOTAL (MG/L NO2+NO3)	01	4.3	4/13/2022	4.3	4.3	
MW-34B	NITROGEN, TOTAL (MG/L NO2+NO3)	01	4.7	10/25/2022	4.7	4.7	
MW-34B	NITROGEN, TOTAL (MG/L NO2+NO3)	01	4.7	4/26/2023	4.7	4.7	
Calculations							
Count						16	
Mean						6.90	
Std Dev						3.56	
2 X SD (ACL)						7.12	
ACL, Calculated						14.02	
ACL, Rounded						15	

Duplicate Data Not Used for Calculations							

Note: Current PAL = 2 mg/l; ES = 10 mg/l

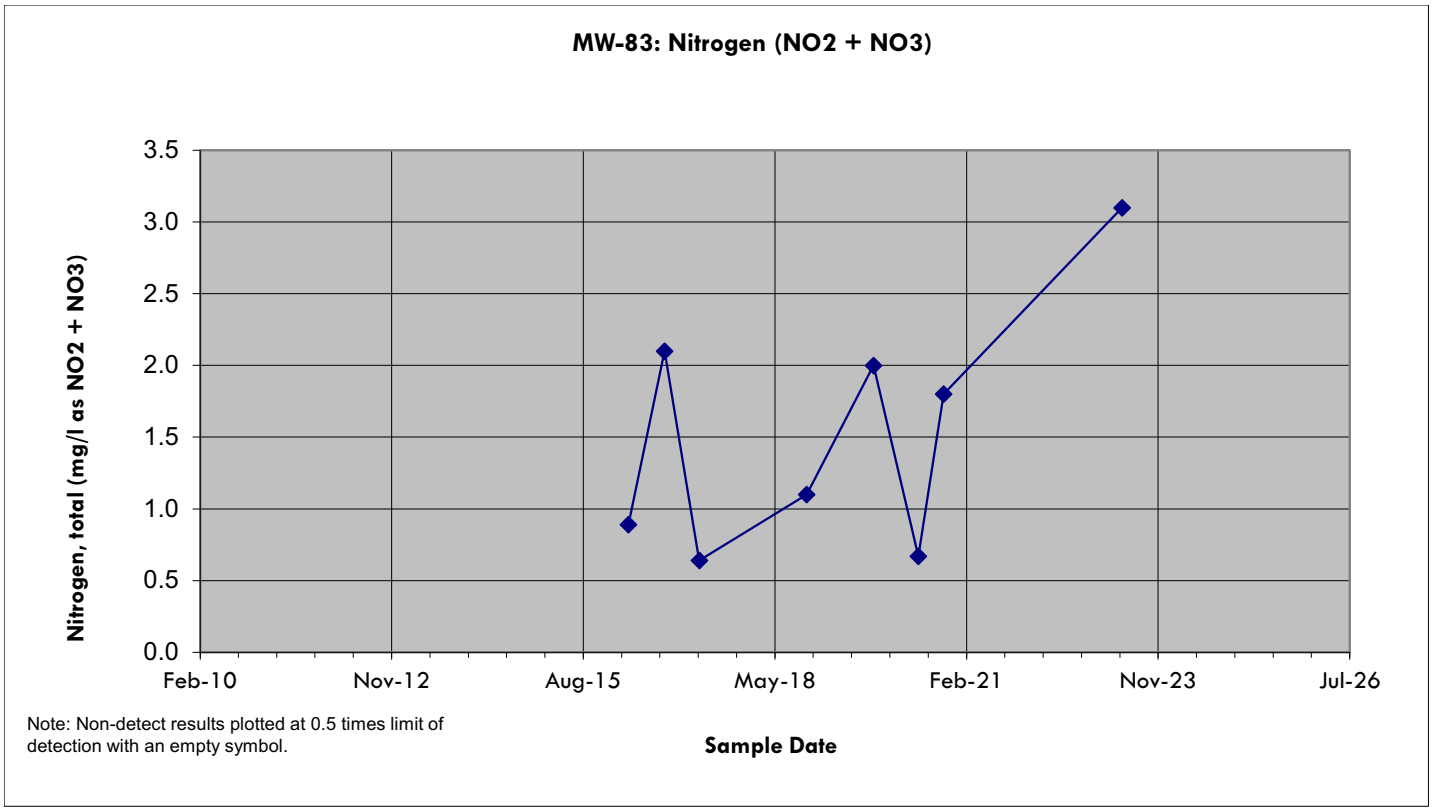
J = Result is an estimated value below the laboratory's limit of quantitation.

P = Did not meet required preservation and/or hold time.

B = Compound detected in blank.

M = Failed method QC check.

09/28/2023 - Classification: Internal - ECRM13153872



Note: Non-detect results plotted at 0.5 times limit of detection with an empty symbol.

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-83	NITROGEN, TOTAL (MG/L NO2+NO3)	01	0.89	4/7/2016	0.89	0.89	
MW-83	NITROGEN, TOTAL (MG/L NO2+NO3)	01	2.1	10/13/2016	2.1	2.1	
MW-83	NITROGEN, TOTAL (MG/L NO2+NO3)	01	0.64	4/12/2017	0.64	0.64	
MW-83	NITROGEN, TOTAL (MG/L NO2+NO3)	01	1.1	10/24/2018	1.1	1.1	
MW-83	NITROGEN, TOTAL (MG/L NO2+NO3)	01	2	10/9/2019	2	2	
MW-83	NITROGEN, TOTAL (MG/L NO2+NO3)	01	0.67	5/29/2020	0.67	0.67	
MW-83	NITROGEN, TOTAL (MG/L NO2+NO3)	01	1.8	10/8/2020	1.8	1.8	
MW-83	NITROGEN, TOTAL (MG/L NO2+NO3)	01	3.1	4/27/2023	3.1	3.1	
Calculations							
Count						8	
Mean						1.54	
Std Dev						0.86	
2 X SD (ACL)						1.73	
ACL, Calculated						3.26	
ACL, Rounded						3.3	

Duplicate Data Not Used for Calculations							

Note: Current PAL = 2 mg/l; ES = 10 mg/l

J = Result is an estimated value below the laboratory's limit of quantitation.

P = Did not meet required preservation and/or hold time.

B = Compound detected in blank.

M = Failed method QC check.

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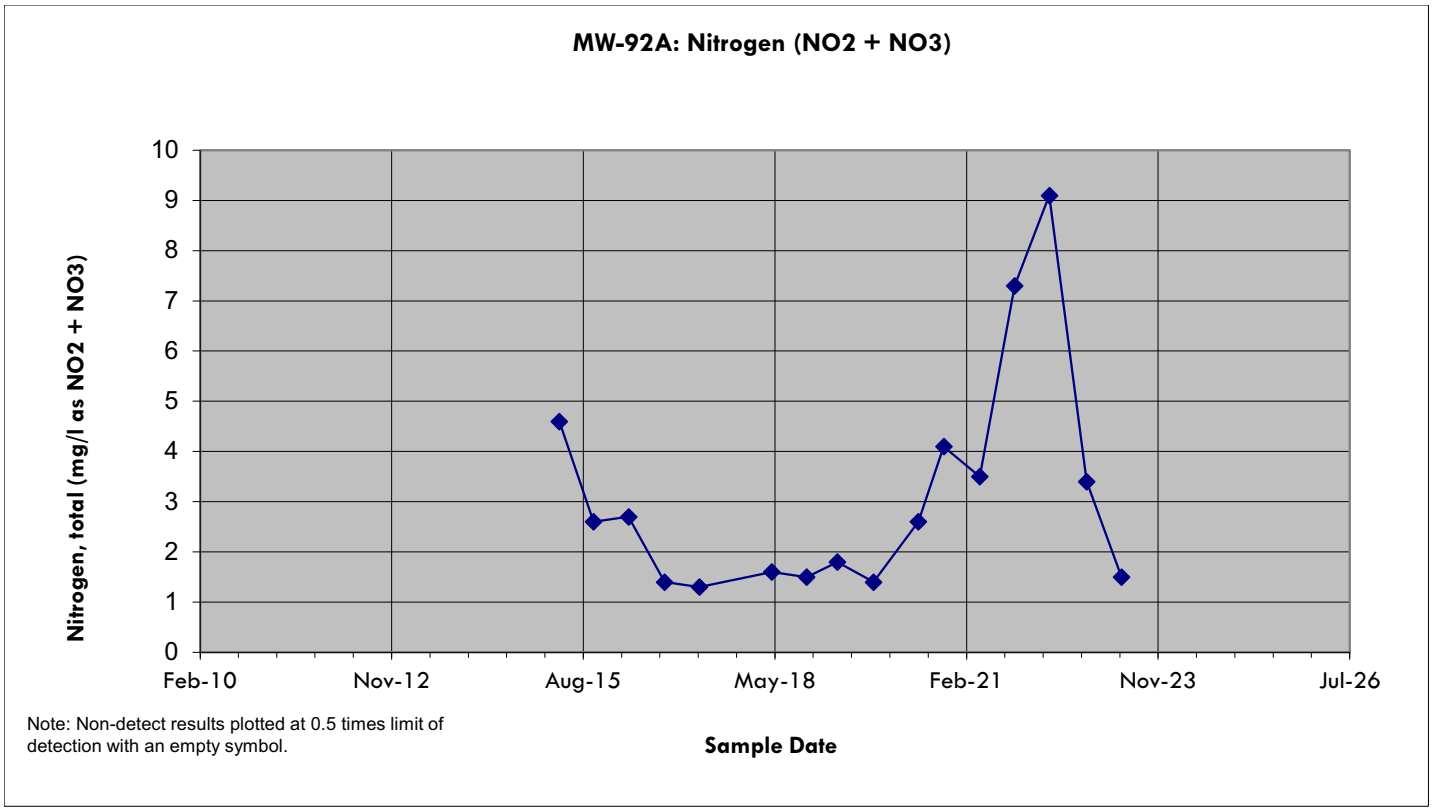
09/28/2023 - Classification: Internal - ECRM13153872



Note: Non-detect results plotted at 0.5 times limit of detection with an empty symbol.

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-92A	NITROGEN, TOTAL (MG/L NO2+NO3)	01	4.6	4/13/2015	4.6	4.6	
MW-92A	NITROGEN, TOTAL (MG/L NO2+NO3)	01	2.6	10/8/2015	2.6	2.6	M
MW-92A	NITROGEN, TOTAL (MG/L NO2+NO3)	01	2.7	4/8/2016	2.7	2.7	
MW-92A	NITROGEN, TOTAL (MG/L NO2+NO3)	01	1.4	10/13/2016	1.4	1.4	
MW-92A	NITROGEN, TOTAL (MG/L NO2+NO3)	01	1.3	4/12/2017	1.3	1.3	
MW-92A	NITROGEN, TOTAL (MG/L NO2+NO3)	01	1.6	4/25/2018	1.6	1.6	
MW-92A	NITROGEN, TOTAL (MG/L NO2+NO3)	01	1.5	10/25/2018	1.5	1.5	
MW-92A	NITROGEN, TOTAL (MG/L NO2+NO3)	01	1.8	4/3/2019	1.8	1.8	
MW-92A	NITROGEN, TOTAL (MG/L NO2+NO3)	01	1.4	10/9/2019	1.4	1.4	
MW-92A	NITROGEN, TOTAL (MG/L NO2+NO3)	01	2.6	5/29/2020	2.6	2.6	
MW-92A	NITROGEN, TOTAL (MG/L NO2+NO3)	01	4.1	10/9/2020	4.1	4.1	
MW-92A	NITROGEN, TOTAL (MG/L NO2+NO3)	01	3.5	4/15/2021	3.5	3.5	
MW-92A	NITROGEN, TOTAL (MG/L NO2+NO3)	01	7.3	10/14/2021	7.3	7.3	
MW-92A	NITROGEN, TOTAL (MG/L NO2+NO3)	01	9.1	4/13/2022	9.1	9.1	
MW-92A	NITROGEN, TOTAL (MG/L NO2+NO3)	01	3.4	10/25/2022	3.4	3.4	
MW-92A	NITROGEN, TOTAL (MG/L NO2+NO3)	01	1.5	4/24/2023	1.5	1.5	
Calculations							
Count						16	
Mean						3.15	
Std Dev						2.25	
2 X SD (ACL)						4.50	
ACL, Calculated						7.65	
ACL, Rounded						7.7	

Duplicate Data Not Used for Calculations							

Note: Current PAL = 2 mg/l; ES = 10 mg/l

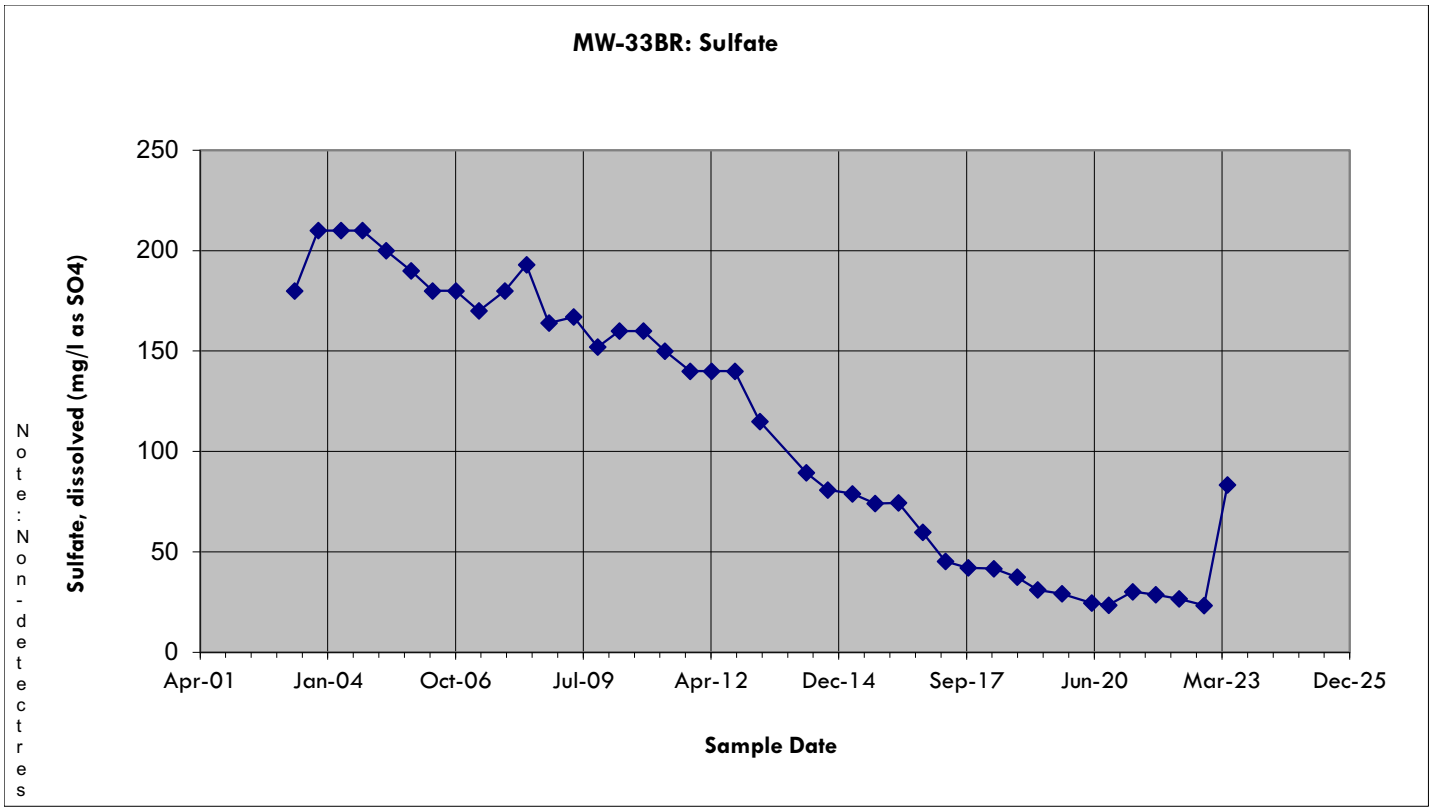
J = Result is an estimated value below the laboratory's limit of quantitation.

P = Did not meet required preservation and/or hold time.

B = Compound detected in blank.

M = Failed method QC check.

09/28/2023 - Classification: Internal - ECRM13153872



Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-33BR	SULFATE, DISSOLVED (MG/L SO4)	01	180	4/29/2003	180	180	
MW-33BR	SULFATE, DISSOLVED (MG/L SO4)	01	210	10/30/2003	210	210	
MW-33BR	SULFATE, DISSOLVED (MG/L SO4)	01	210	4/27/2004	210	210	
MW-33BR	SULFATE, DISSOLVED (MG/L SO4)	01	210	10/12/2004	210	210	
MW-33BR	SULFATE, DISSOLVED (MG/L SO4)	01	200	4/15/2005	200	200	
MW-33BR	SULFATE, DISSOLVED (MG/L SO4)	01	190	10/26/2005	190	190	
MW-33BR	SULFATE, DISSOLVED (MG/L SO4)	01	180	4/13/2006	180	180	
MW-33BR	SULFATE, DISSOLVED (MG/L SO4)	01	180	10/12/2006	180	180	
MW-33BR	SULFATE, DISSOLVED (MG/L SO4)	01	170	4/11/2007	170	170	
MW-33BR	SULFATE, DISSOLVED (MG/L SO4)	01	180	10/31/2007	180	180	
MW-33BR	SULFATE, DISSOLVED (MG/L SO4)	01	193	4/17/2008	193	193	
MW-33BR	SULFATE, DISSOLVED (MG/L SO4)	01	164	10/10/2008	164	164	
MW-33BR	SULFATE, DISSOLVED (MG/L SO4)	01	167	4/21/2009	167	167	
MW-33BR	SULFATE, DISSOLVED (MG/L SO4)	01	152	10/27/2009	152	152	
MW-33BR	SULFATE, DISSOLVED (MG/L SO4)	01	160	4/14/2010	160	160	
MW-33BR	SULFATE, DISSOLVED (MG/L SO4)	01	160	10/20/2010	160	160	
MW-33BR	SULFATE, DISSOLVED (MG/L SO4)	01	150	4/6/2011	150	150	
MW-33BR	SULFATE, DISSOLVED (MG/L SO4)	01	140	10/20/2011	140	140	
MW-33BR	SULFATE, DISSOLVED (MG/L SO4)	01	140	4/4/2012	140	140	
MW-33BR	SULFATE, DISSOLVED (MG/L SO4)	01	140	10/4/2012	140	140	
MW-33BR	SULFATE, DISSOLVED (MG/L SO4)	01	115	4/17/2013	115	115	
MW-33BR	SULFATE, DISSOLVED (MG/L SO4)	01	89.4	4/16/2014	89.4	89.4	
MW-33BR	SULFATE, DISSOLVED (MG/L SO4)	01	80.9	10/2/2014	80.9	80.9	
MW-33BR	SULFATE, DISSOLVED (MG/L SO4)	01	79	4/13/2015	79	79	
MW-33BR	SULFATE, DISSOLVED (MG/L SO4)	01	74.1	10/7/2015	74.1	74.1	
MW-33BR	SULFATE, DISSOLVED (MG/L SO4)	01	74.4	4/7/2016	74.4	74.4	
MW-33BR	SULFATE, DISSOLVED (MG/L SO4)	01	59.8	10/13/2016	59.8	59.8	
MW-33BR	SULFATE, DISSOLVED (MG/L SO4)	01	45.3	4/11/2017	45.3	45.3	
MW-33BR	SULFATE, DISSOLVED (MG/L SO4)	01	42.1	10/4/2017	42.1	42.1	
MW-33BR	SULFATE, DISSOLVED (MG/L SO4)	01	41.7	4/24/2018	41.7	41.7	
MW-33BR	SULFATE, DISSOLVED (MG/L SO4)	01	37.5	10/22/2018	37.5	37.5	
MW-33BR	SULFATE, DISSOLVED (MG/L SO4)	01	31.1	4/2/2019	31.1	31.1	
MW-33BR	SULFATE, DISSOLVED (MG/L SO4)	01	29.2	10/8/2019	29.2	29.2	
MW-33BR	SULFATE, DISSOLVED (MG/L SO4)	01	24.6	5/29/2020	24.6	24.6	

09/28/2023 - Classification: Internal - ECRM1315387

Point Name	Parameter	Mult Sample ID	Report Value	Sample Date	Graph Value	Calculation Value	Notes
MW-33BR	SULFATE, DISSOLVED (MG/L SO4)	01	23.5	10/8/2020	23.5	23.5	M
MW-33BR	SULFATE, DISSOLVED (MG/L SO4)	01	30.2	4/14/2021	30.2	30.2	
MW-33BR	SULFATE, DISSOLVED (MG/L SO4)	01	28.7	10/12/2021	28.7	28.7	
MW-33BR	SULFATE, DISSOLVED (MG/L SO4)	01	26.6	4/13/2022	26.6	26.6	
MW-33BR	SULFATE, DISSOLVED (MG/L SO4)	01	23.4	10/25/2022	23.4	23.4	
MW-33BR	SULFATE, DISSOLVED (MG/L SO4)	01	83.4	4/26/2023	83.4	83.4	
Calculations							
Count						40	
Mean						112.90	
Std Dev						66.64	
2 X SD (ACL)						133.28	
ACL, Calculated						246.18	
ACL, Rounded						250	

Duplicate Data Not Used for Calculations							

Note: Current PAL = 125 mg/l; ES = 250 mg/l

J = Result is an estimated value below the laboratory's limit of quantitation.

P = Did not meet required preservation and/or hold time.

B = Compound detected in blank.

M = Failed method QC check.

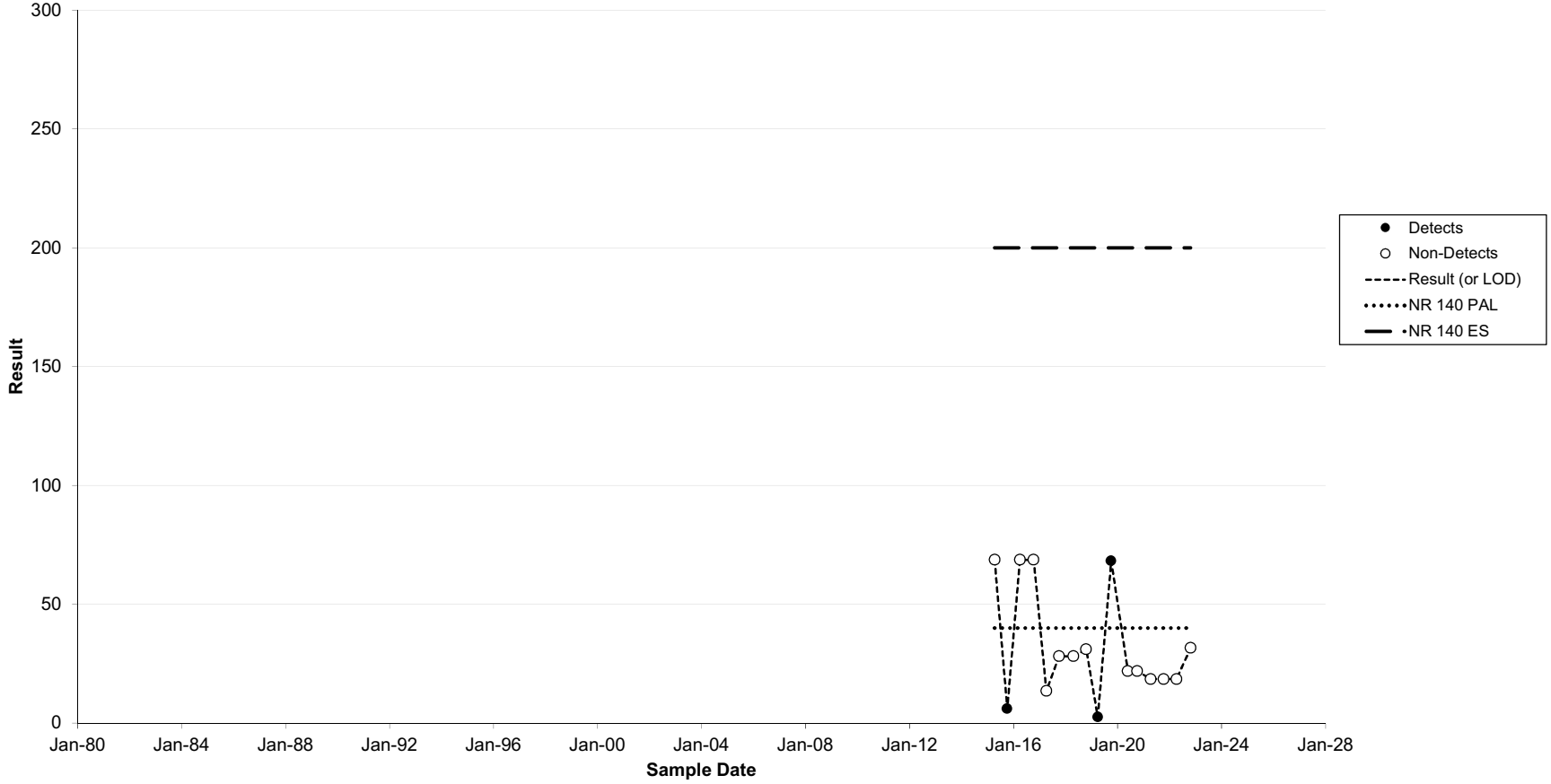
I:\25222260.00\Data and Calculations\Groundwater PALs ACLs\[ACL Calculations_Non CCR Wells.xls]MW33BR_SO4_ACL

Appendix J

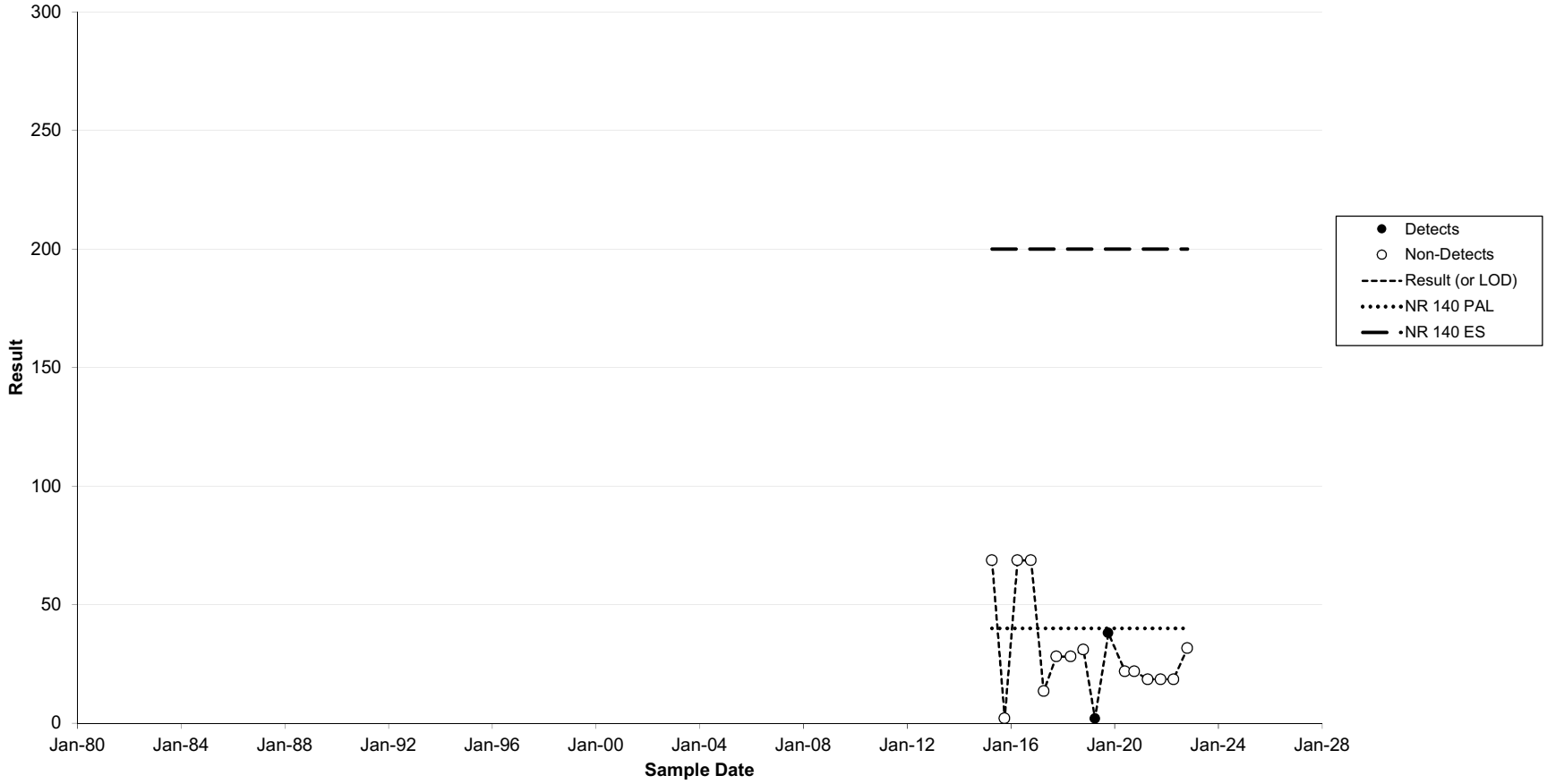
Historical Groundwater Results Graphs

09/28/2023 - Classification: Internal - ECRM13153872

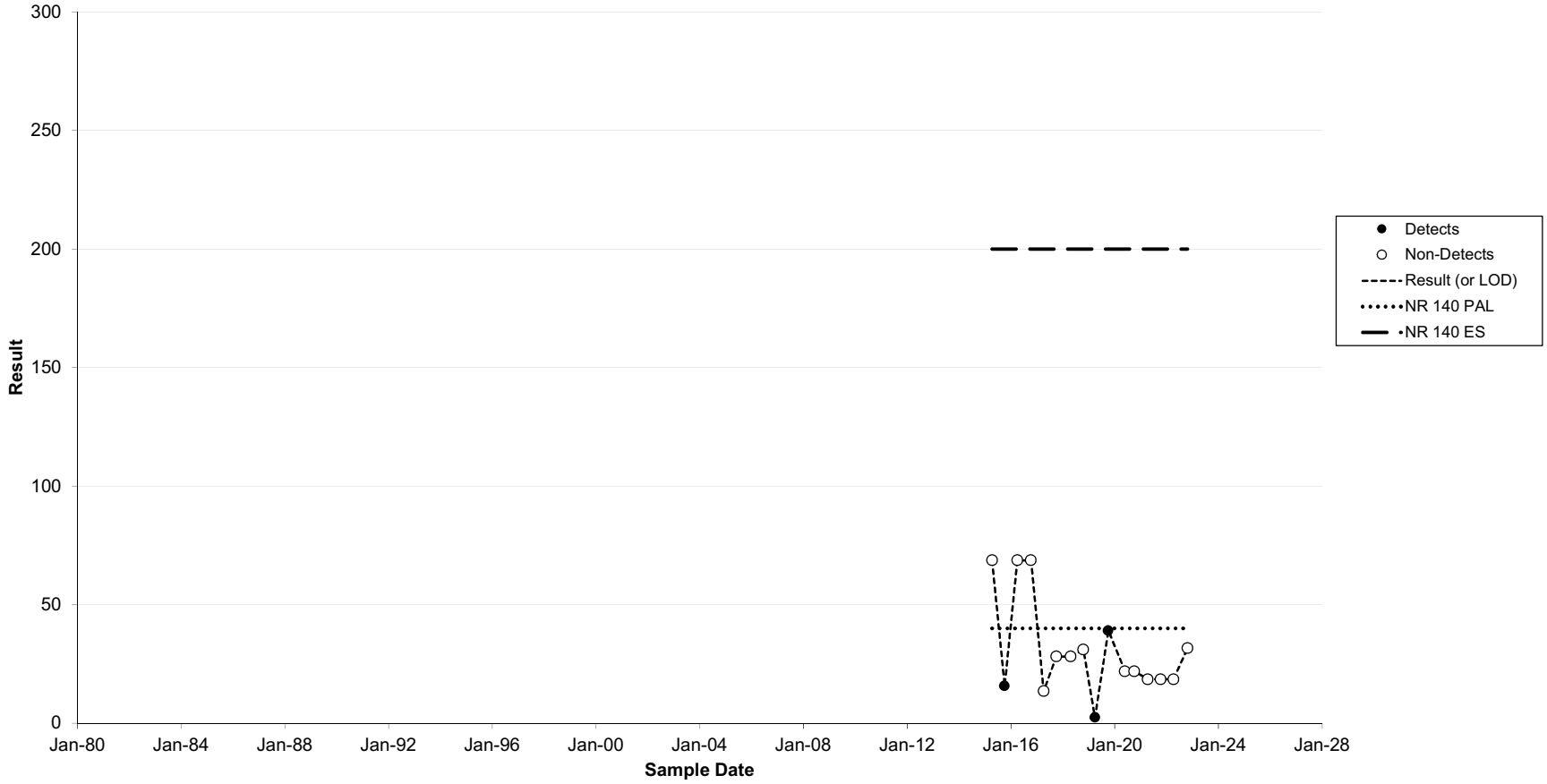
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-33AR - Aluminum, dissolved (ug/l as Al)



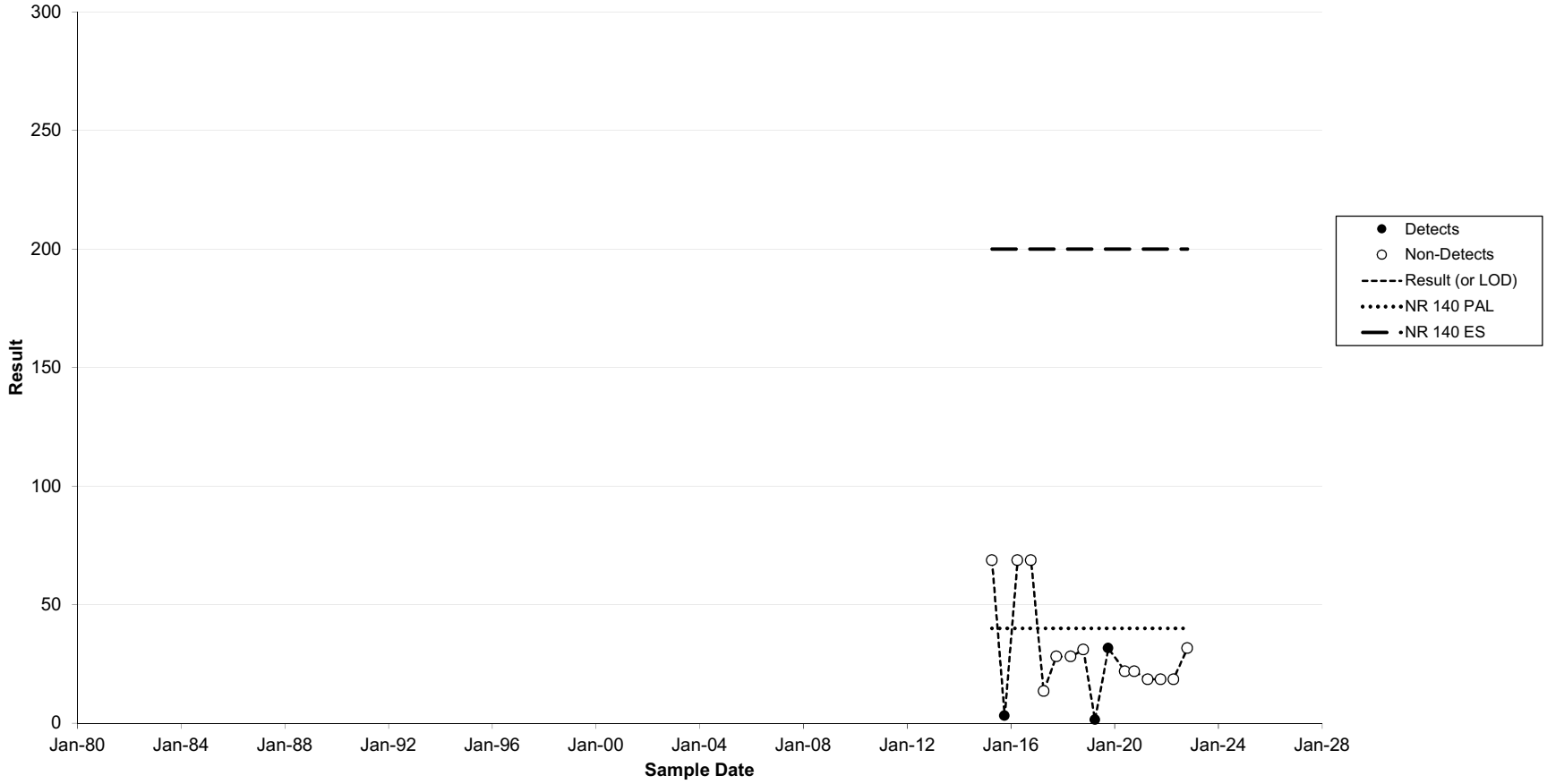
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-33BR - Aluminum, dissolved (ug/l as Al)



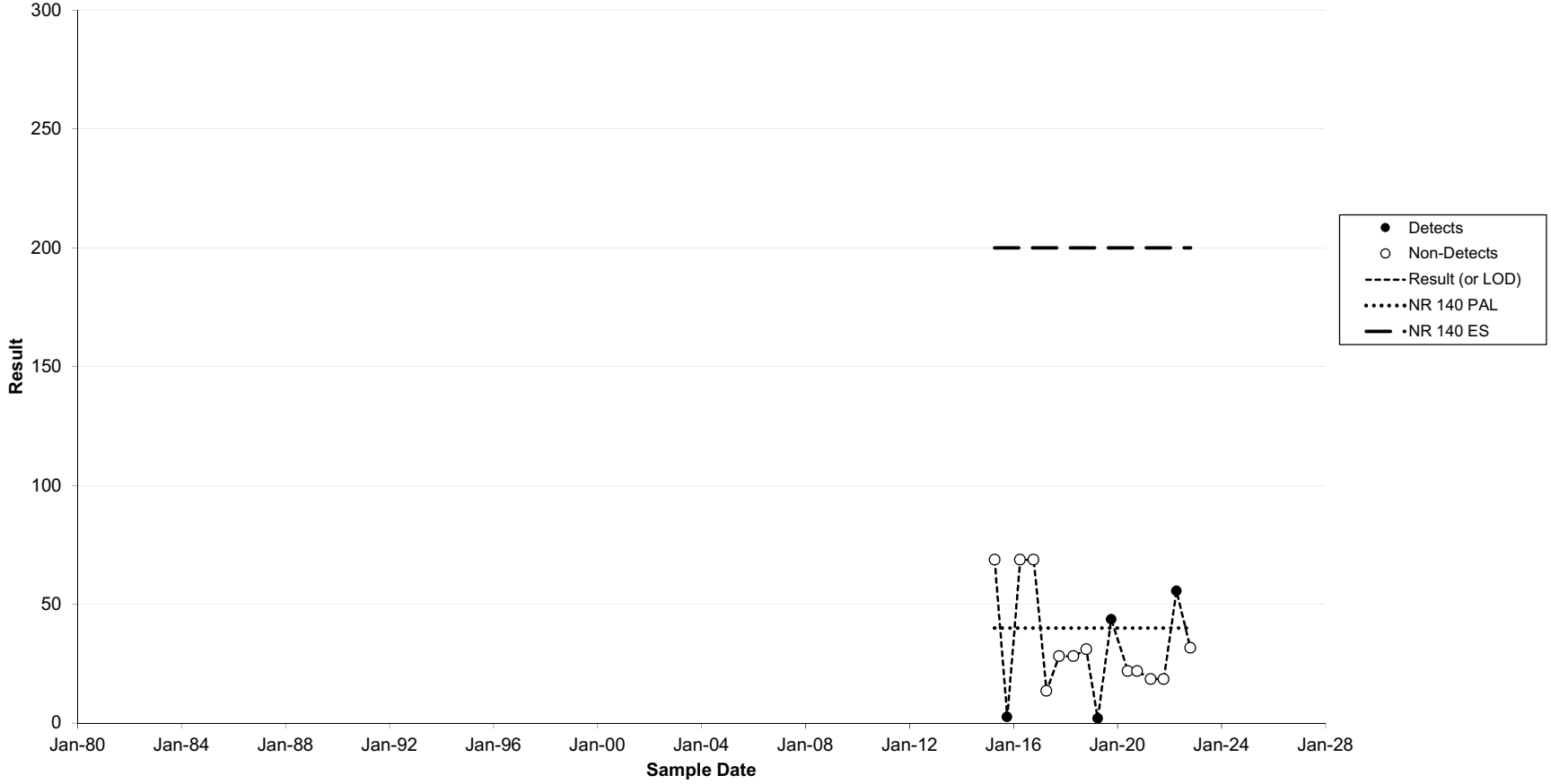
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW34A - Aluminum, dissolved (ug/l as Al)



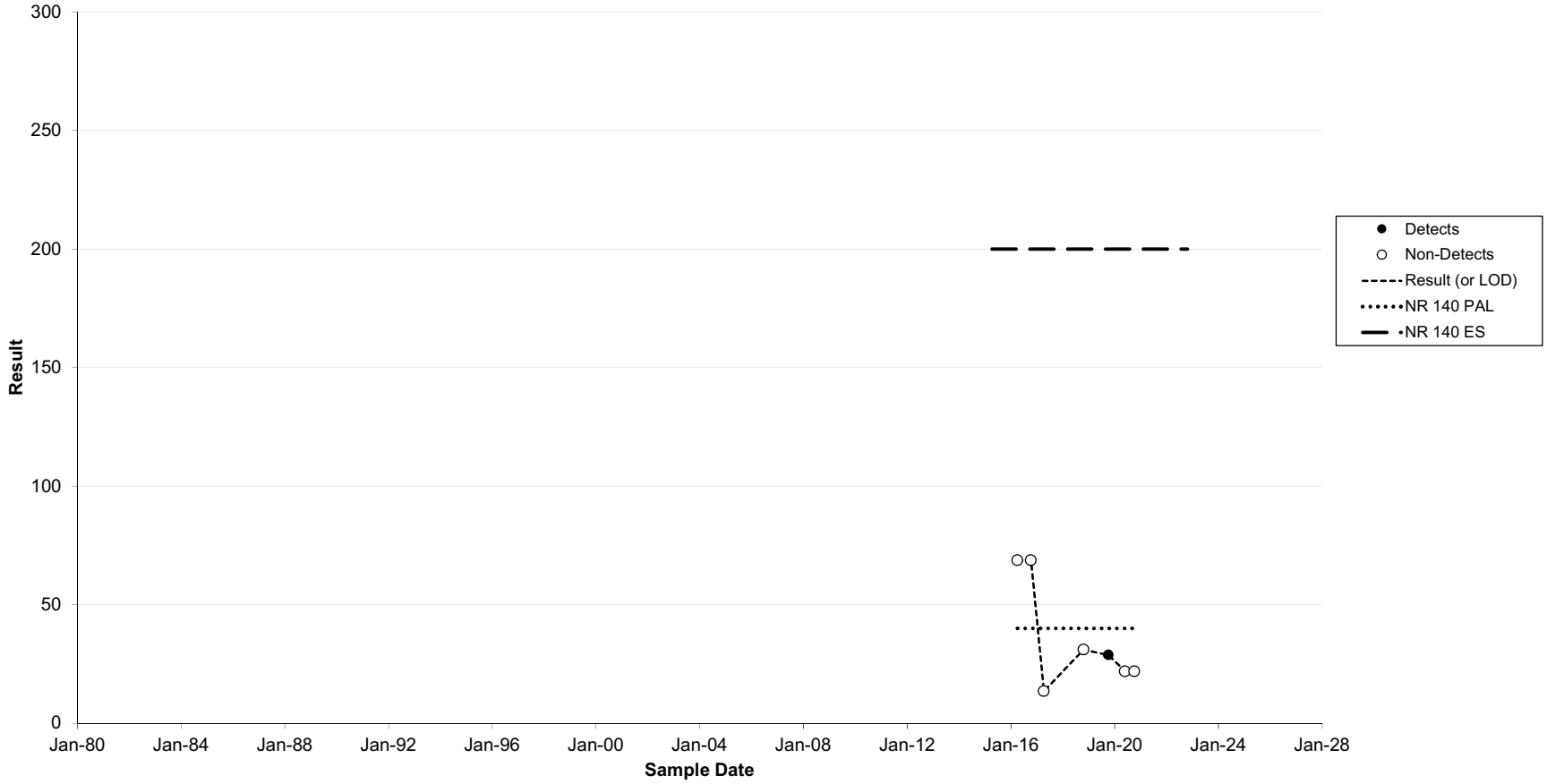
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW34B - Aluminum, dissolved (ug/l as Al)



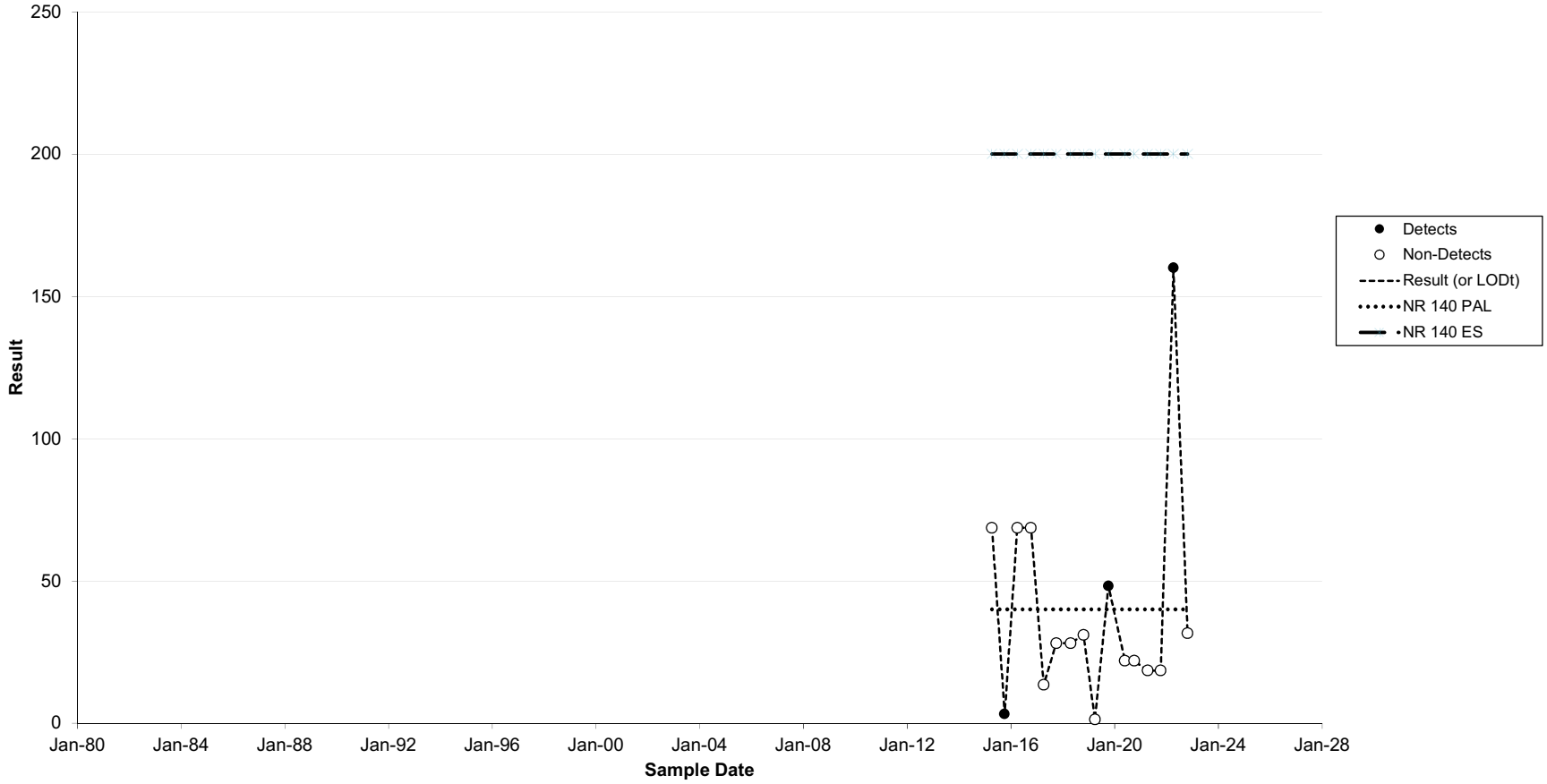
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW37A - Aluminum, dissolved (ug/l as Al)



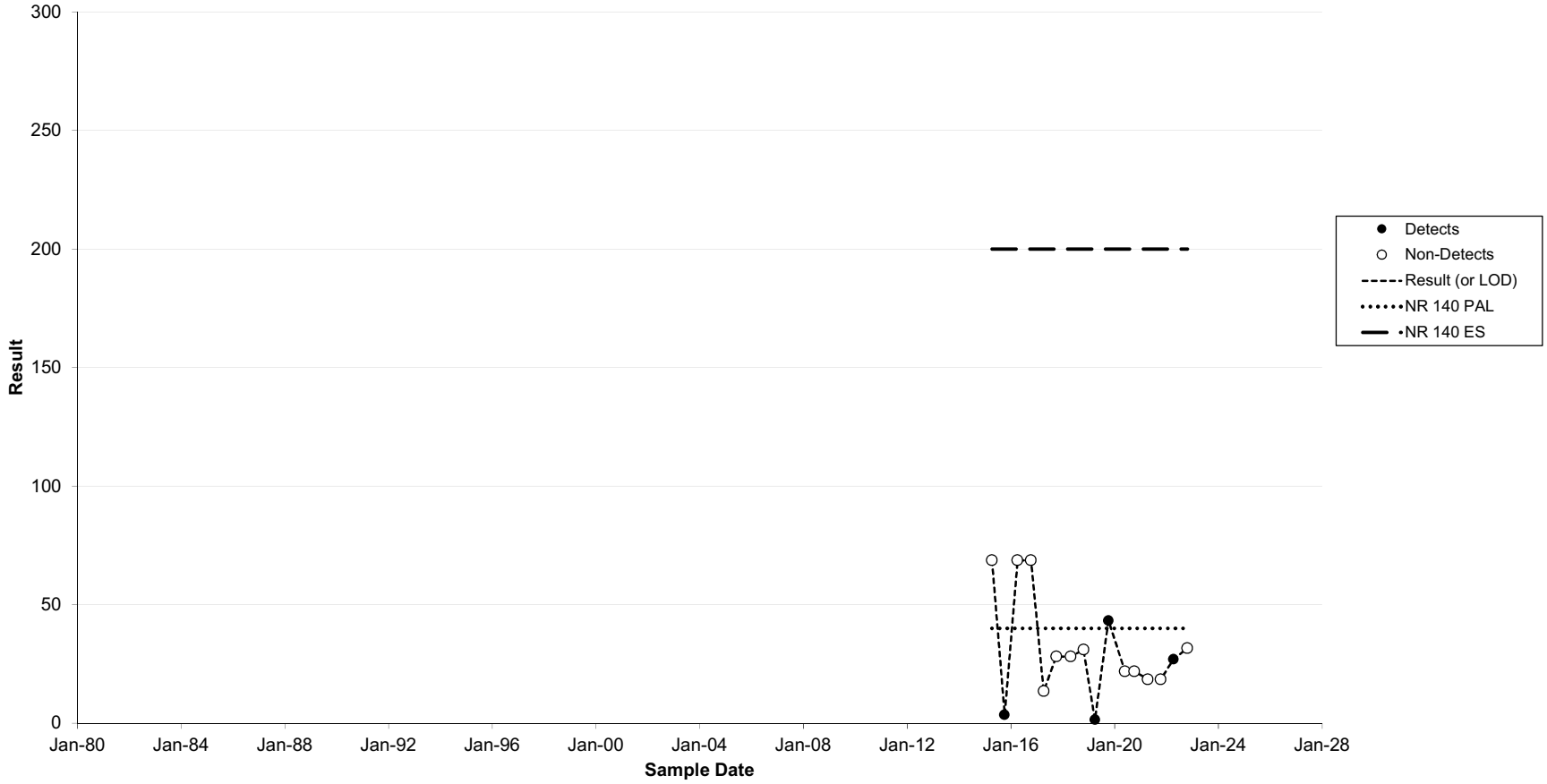
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-83 - Aluminum, dissolved (ug/l as Al)



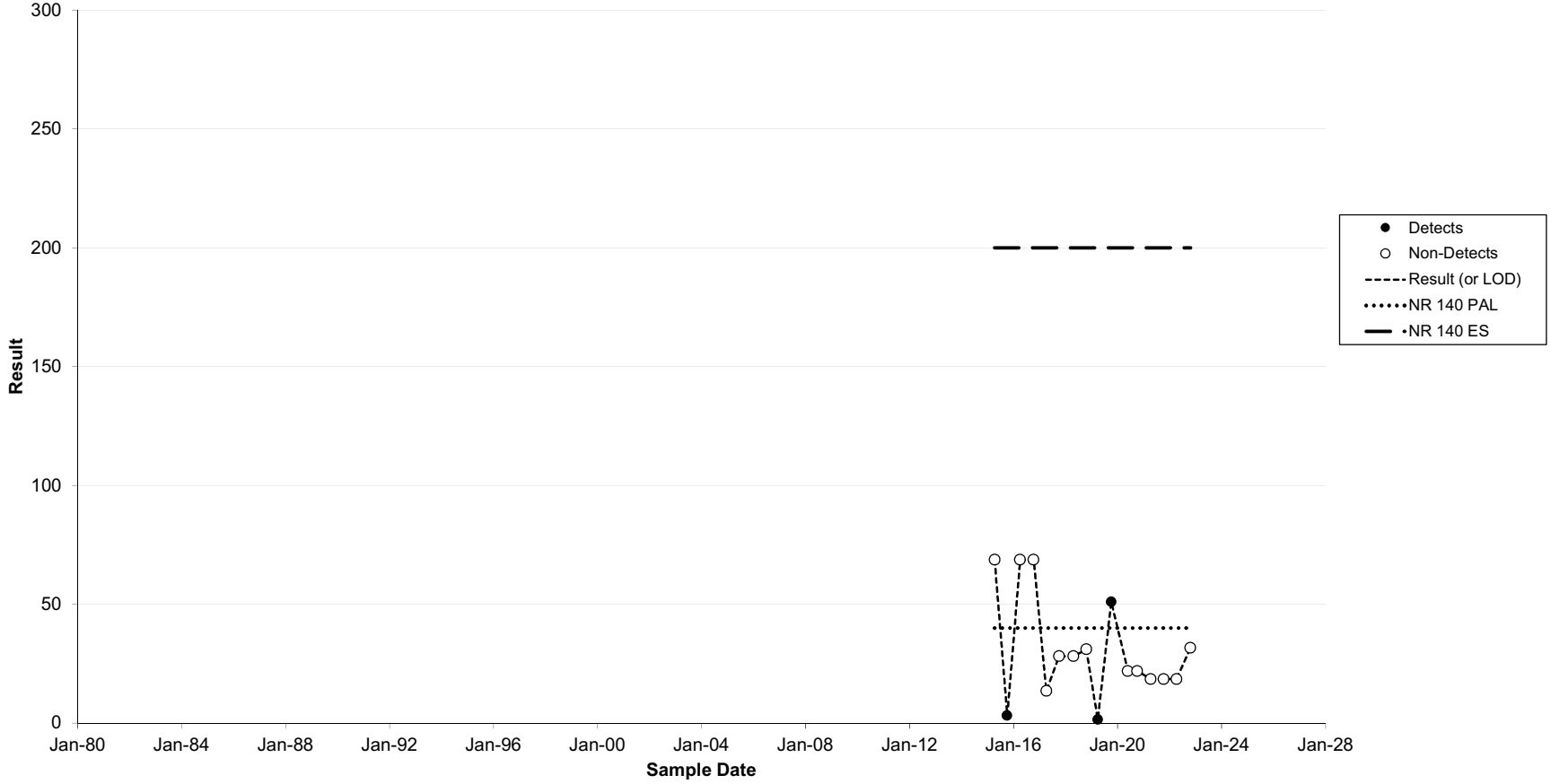
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW84A - Aluminum, dissolved (ug/l as Al)



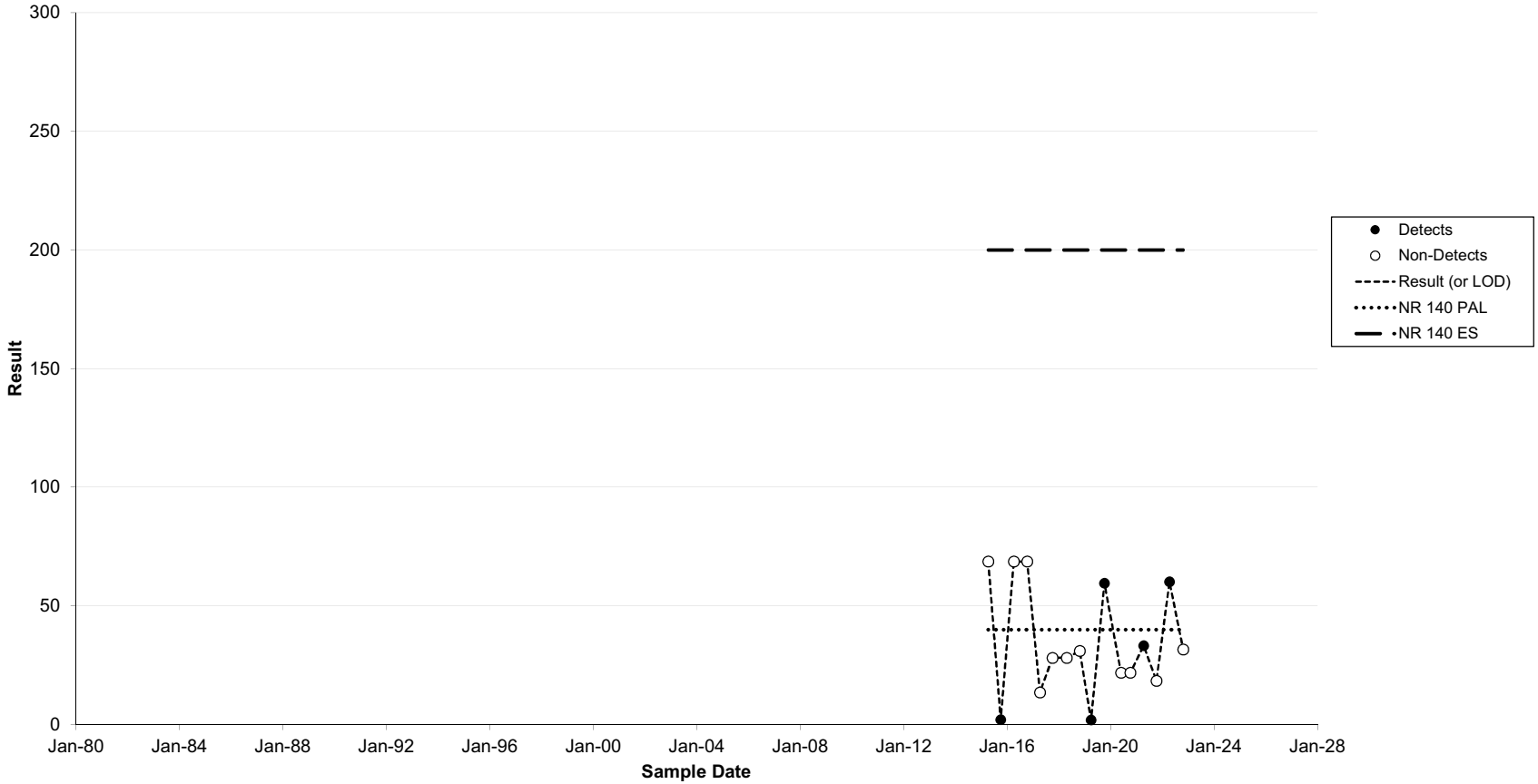
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW84B - Aluminum, dissolved (ug/l as Al)



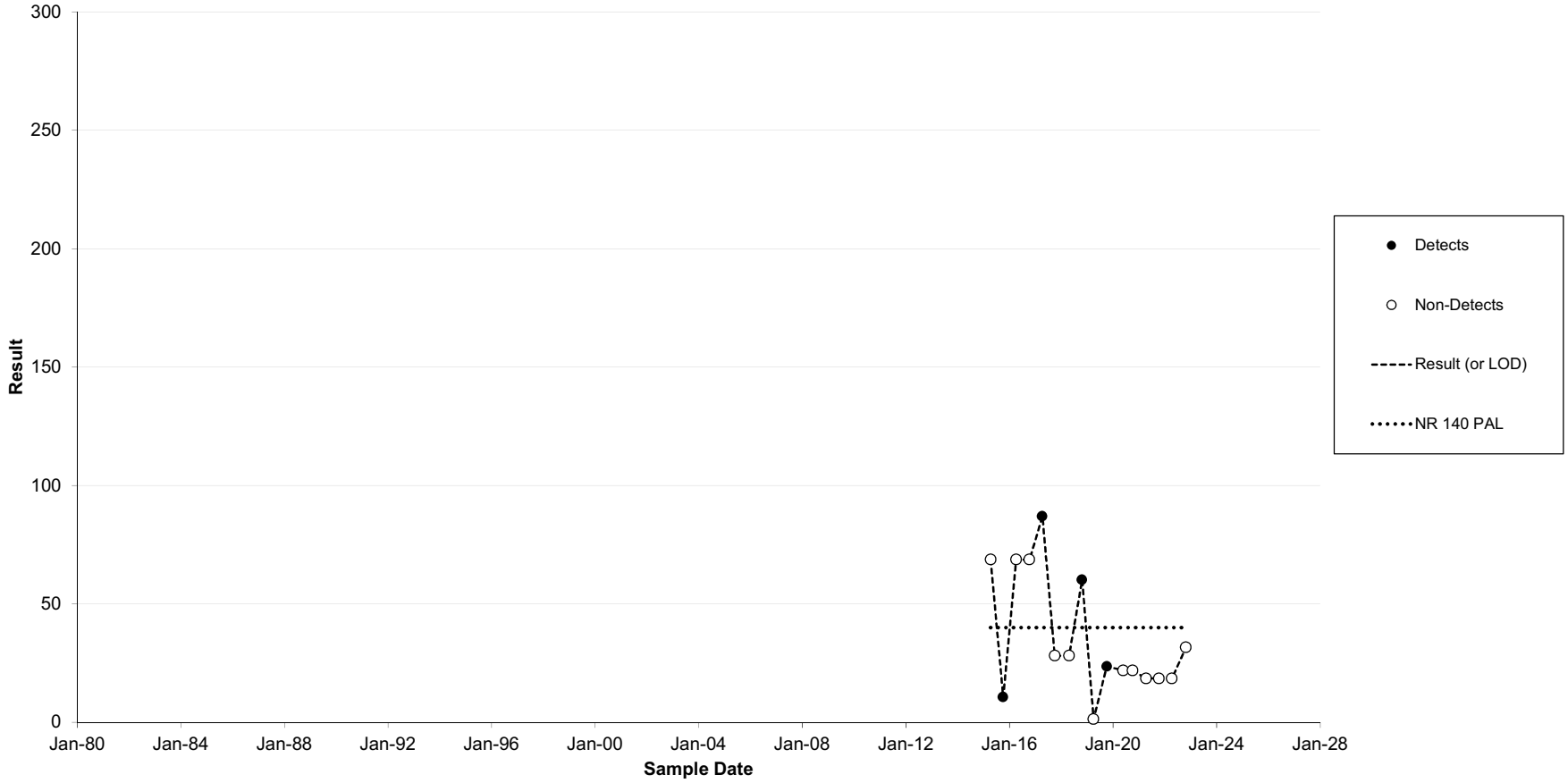
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW86 - Aluminum, dissolved (ug/l as Al)



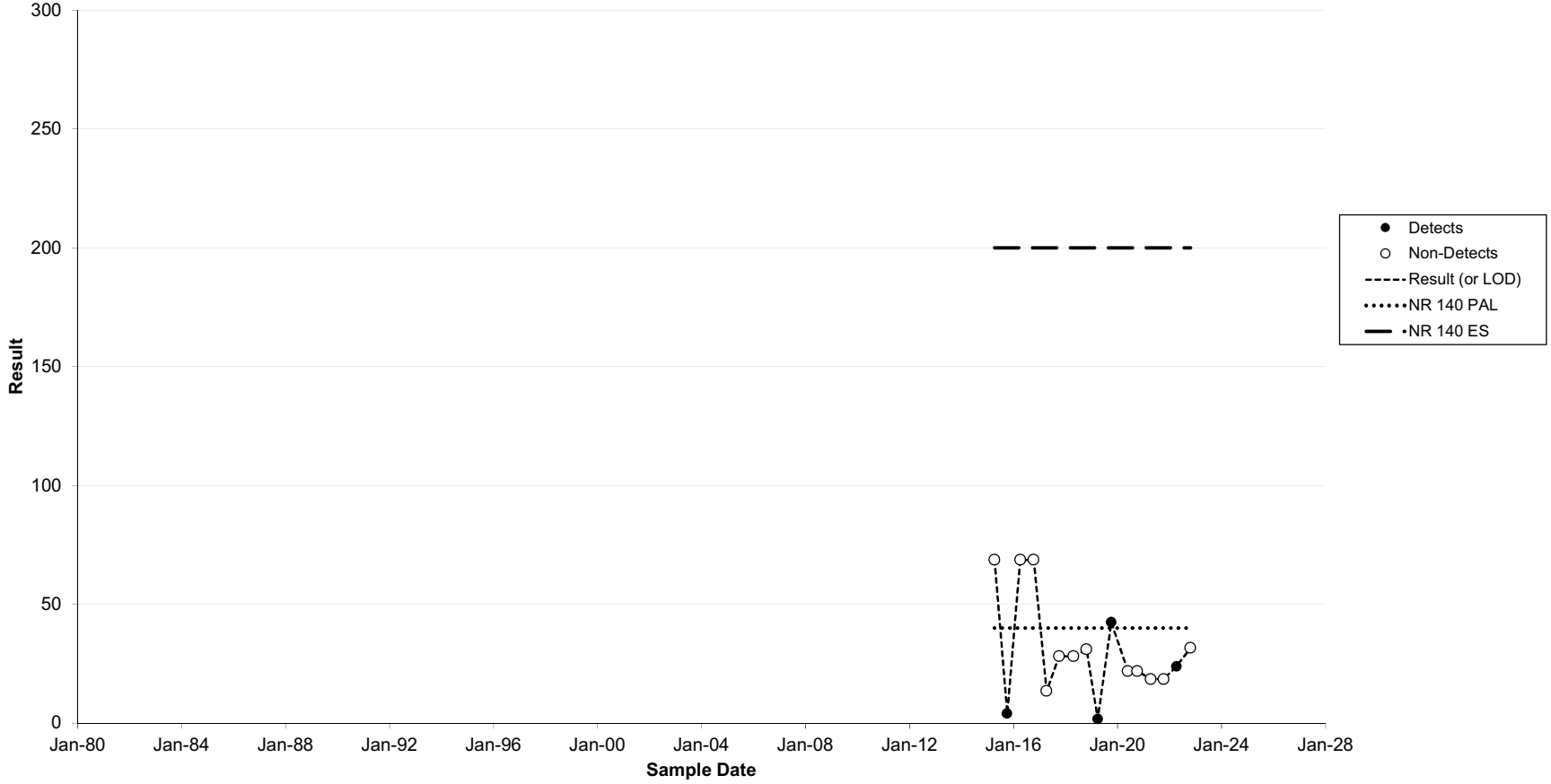
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-91AR - Aluminum, dissolved (ug/l as Al)



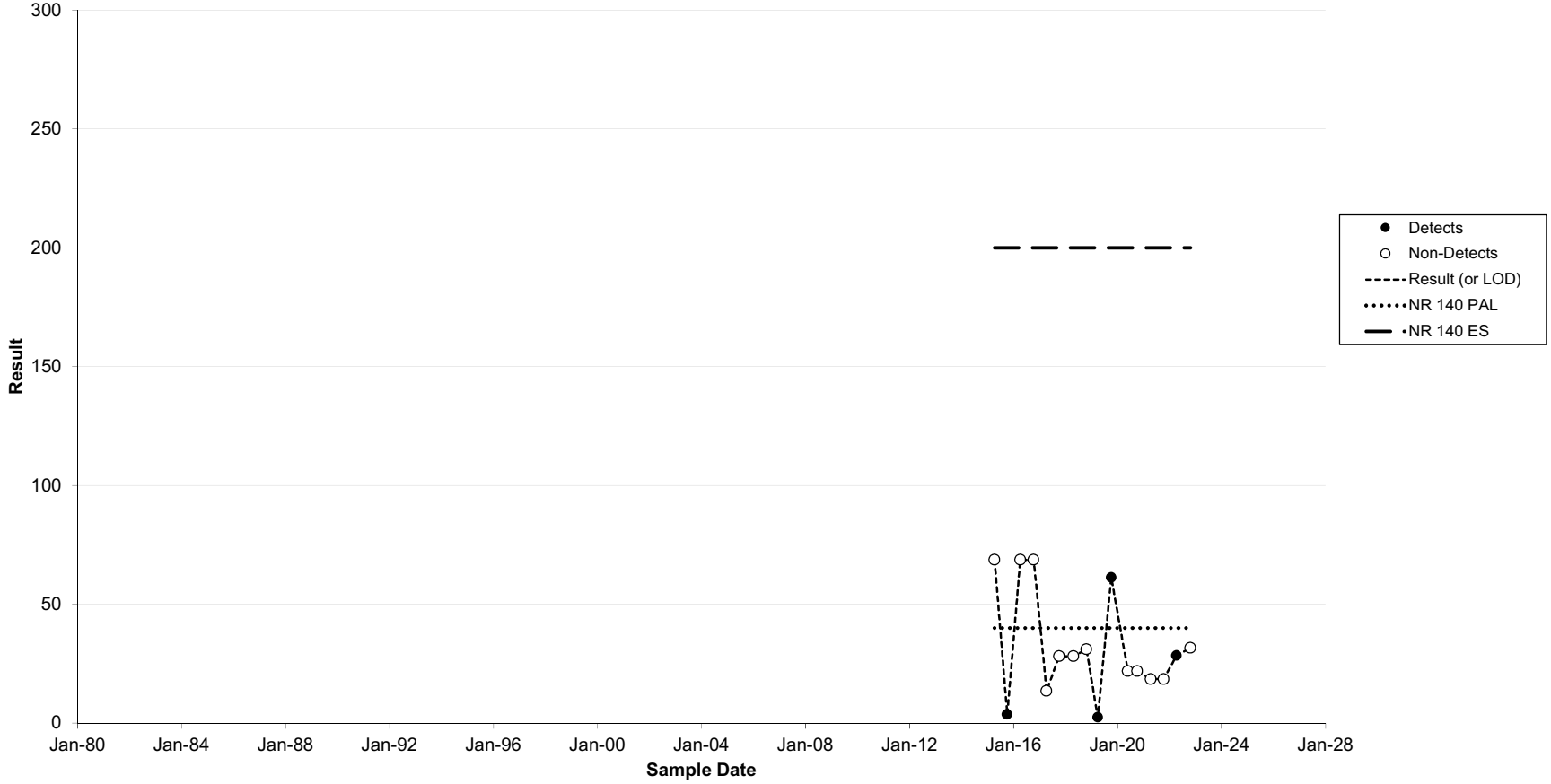
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
HC-3 - Aluminum, total (ug/l as Al)



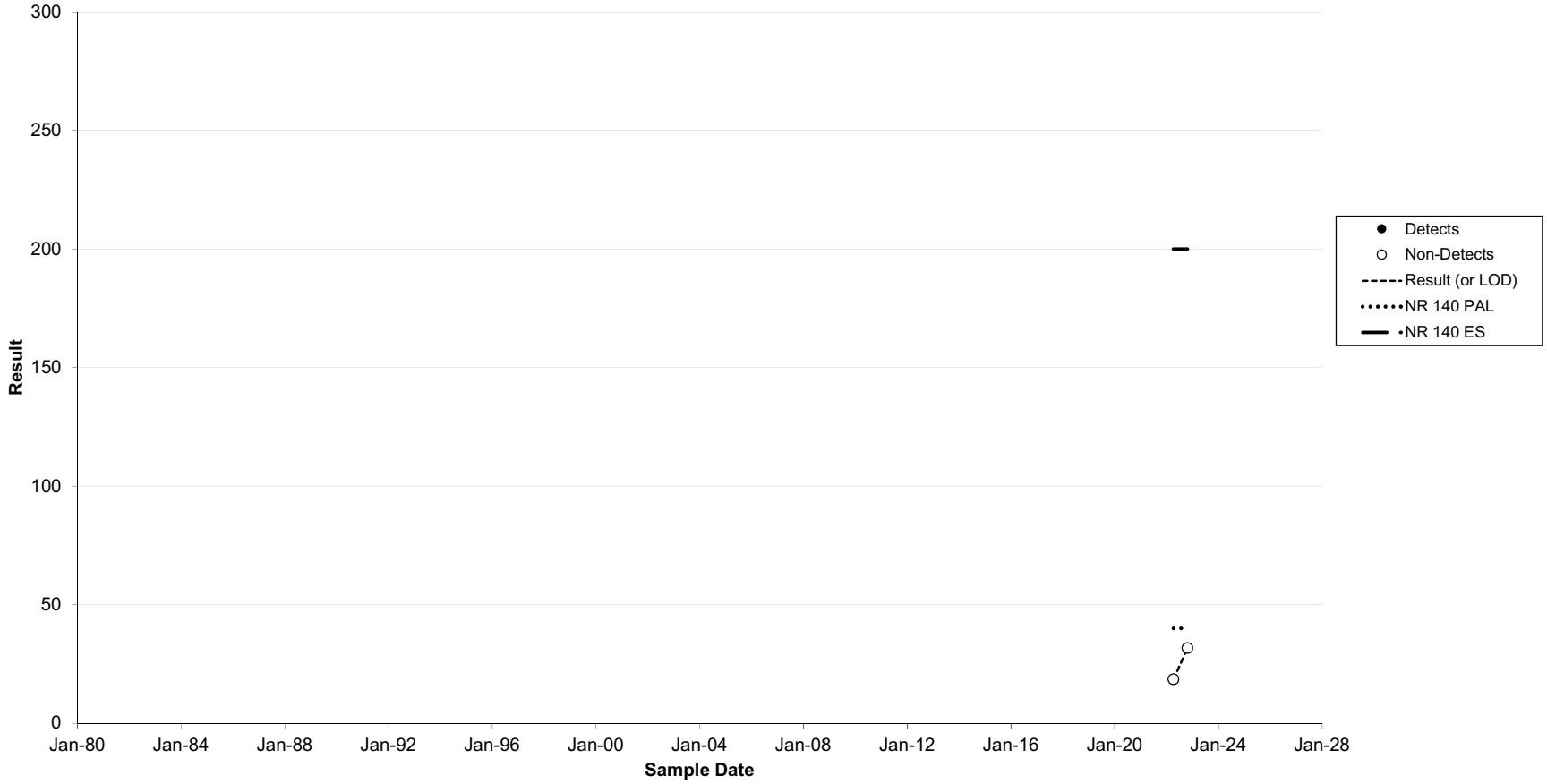
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-92A - Aluminum, dissolved (ug/l as Al)



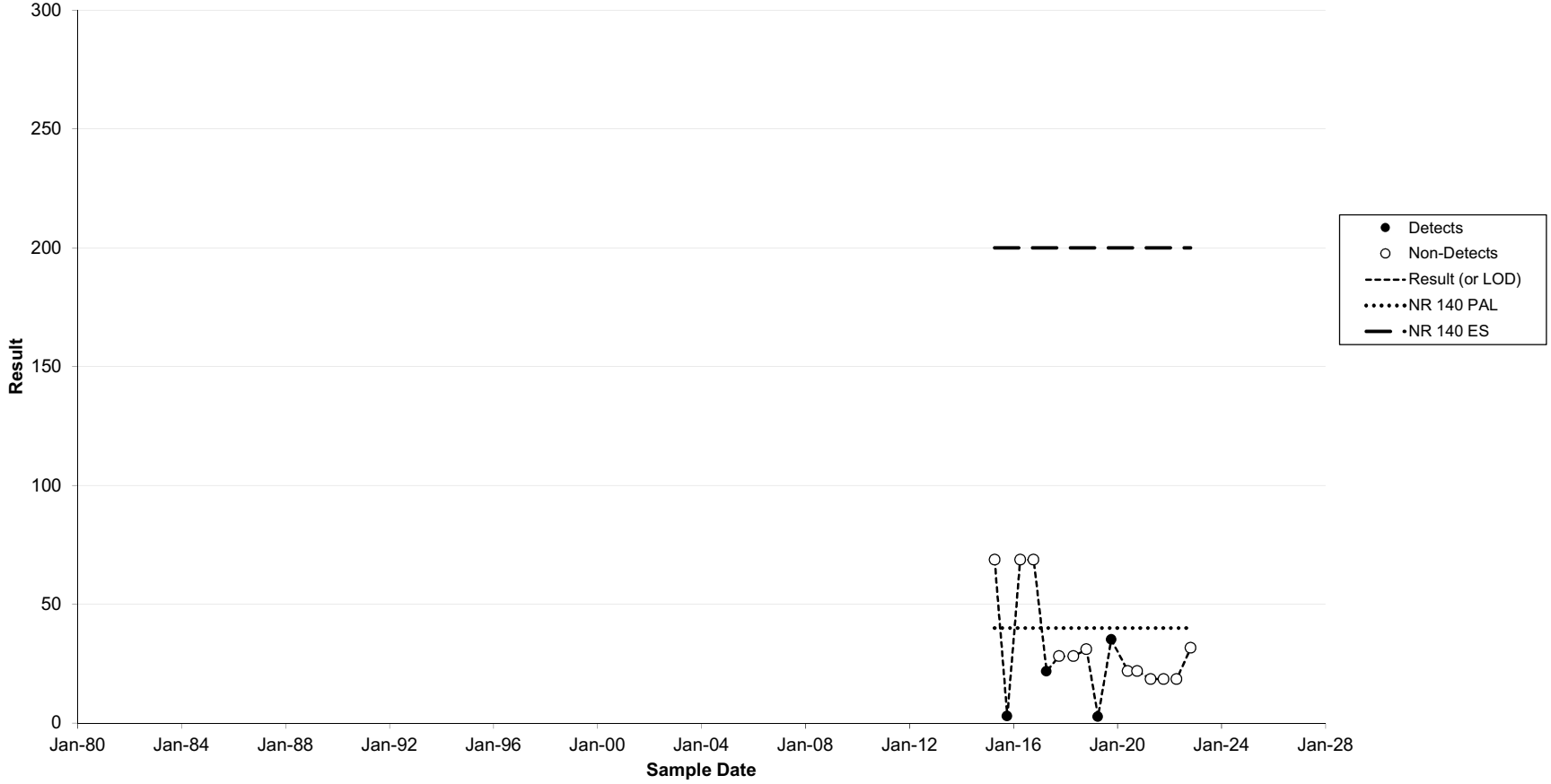
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-92B - Aluminum, dissolved (ug/l as Al)



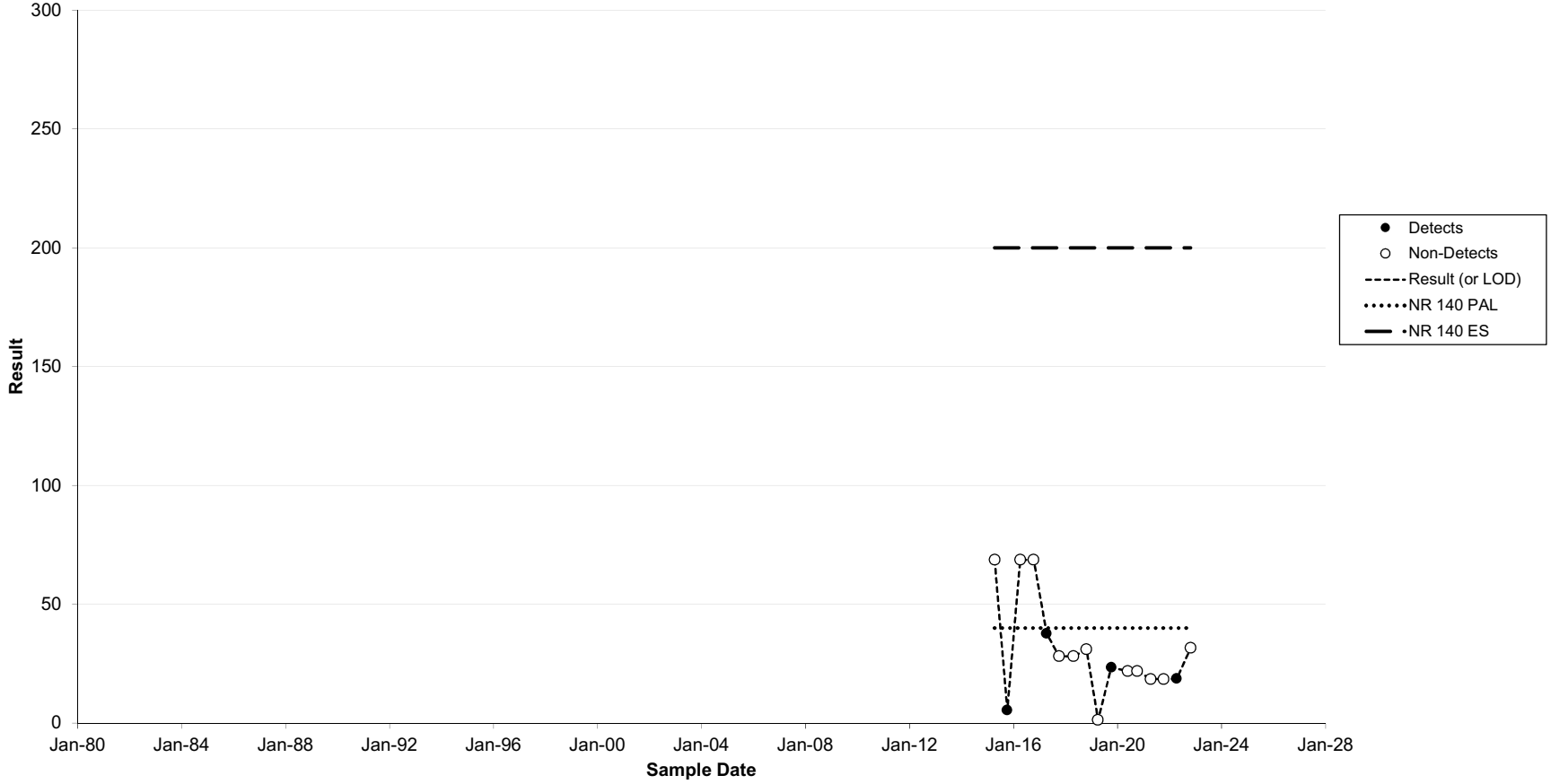
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-93A - Aluminum, dissolved (ug/l as Al)



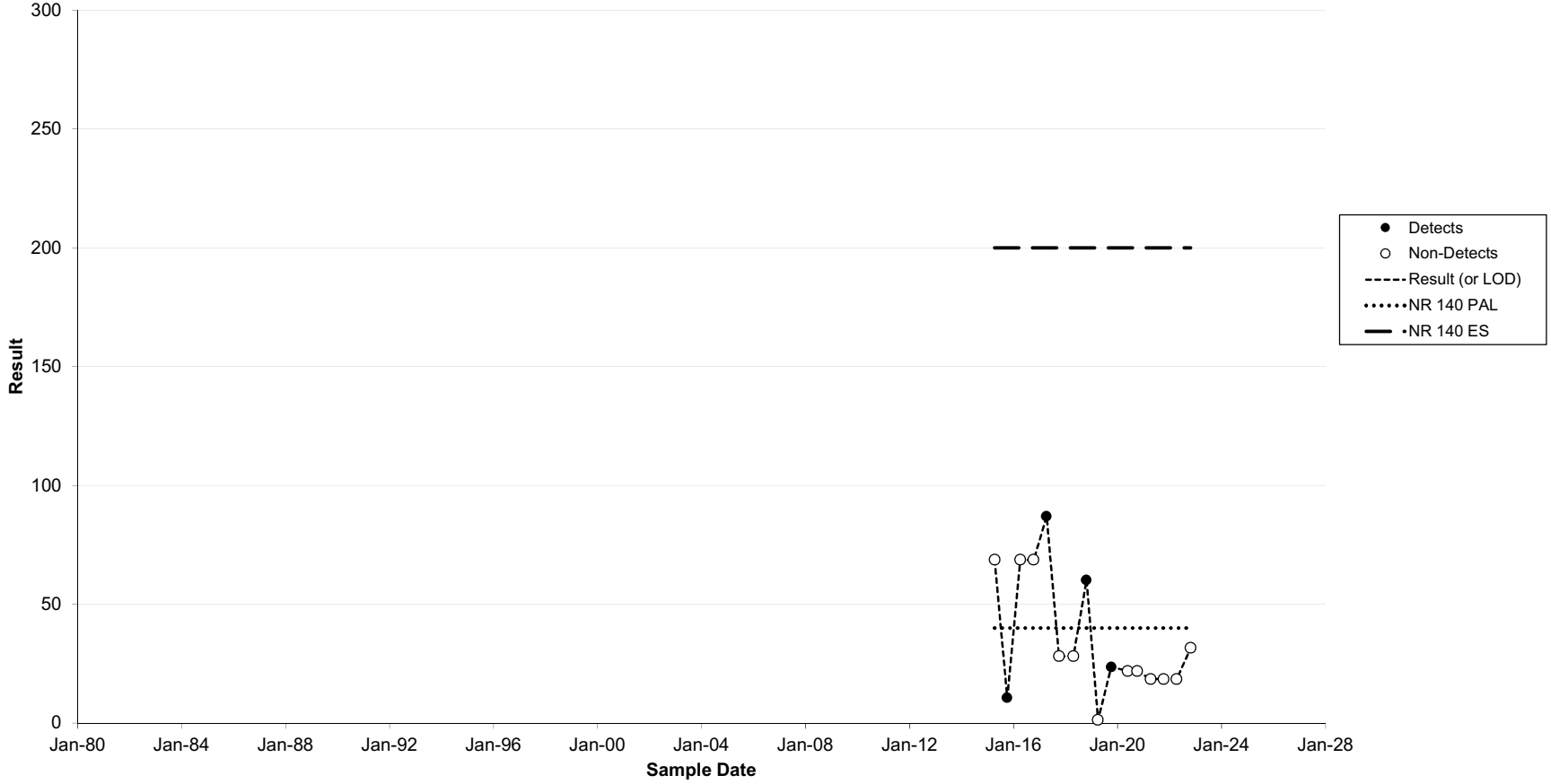
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
HC-1 - Aluminum, total (ug/l as Al)



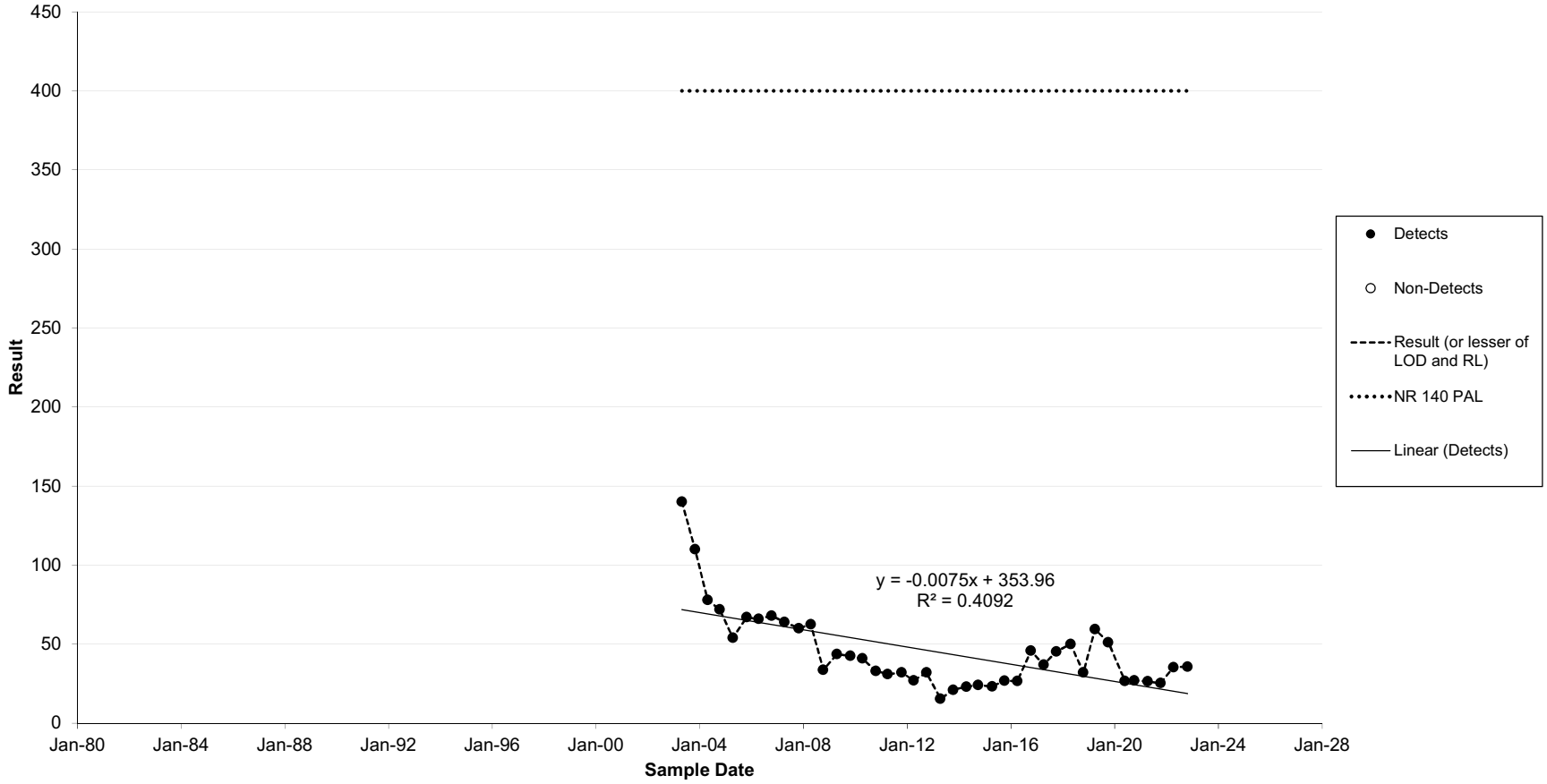
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
HC-2 - Aluminum, total (ug/l as Al)



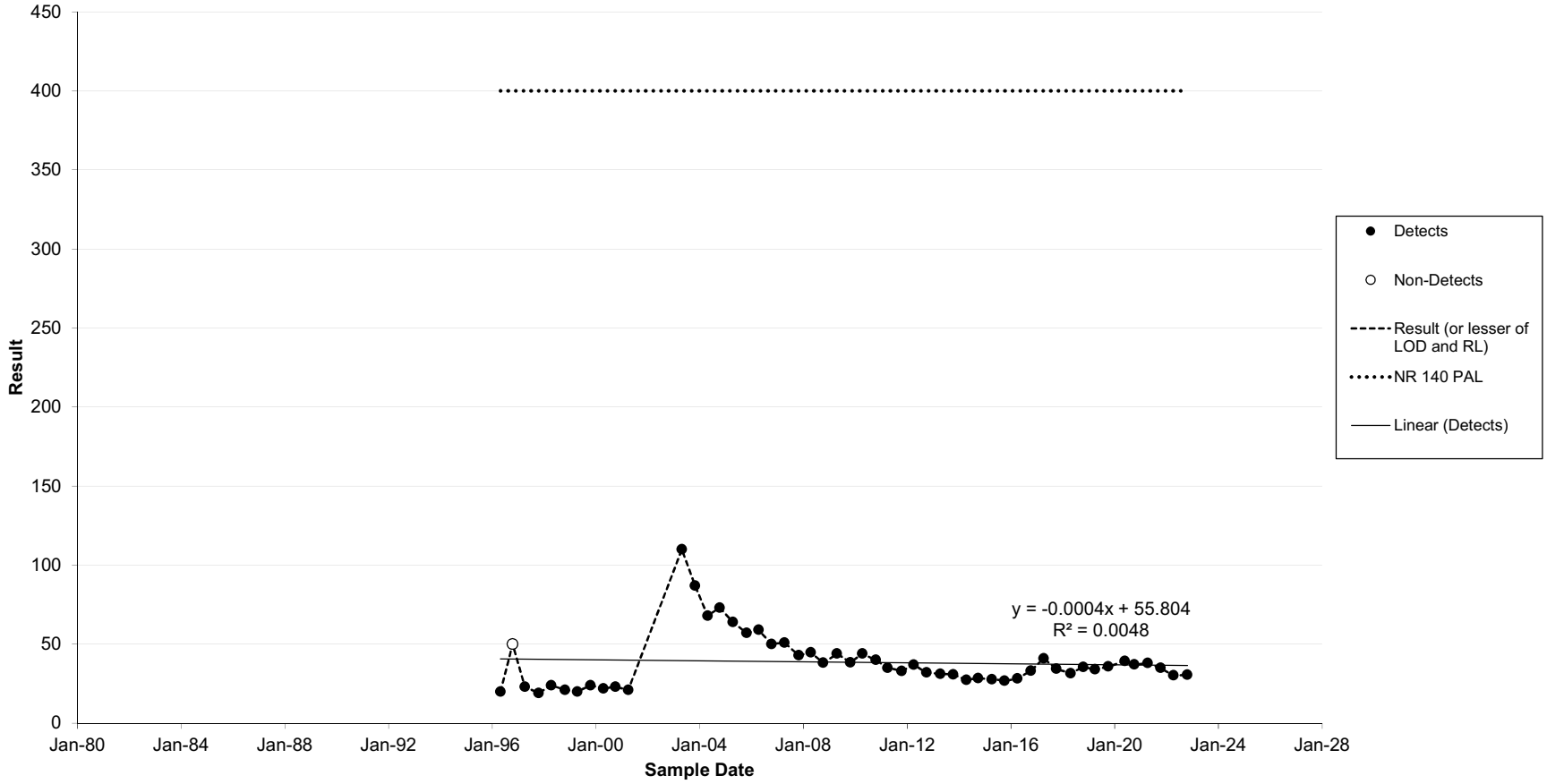
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
HC-3 - Aluminum, total (ug/l as Al)



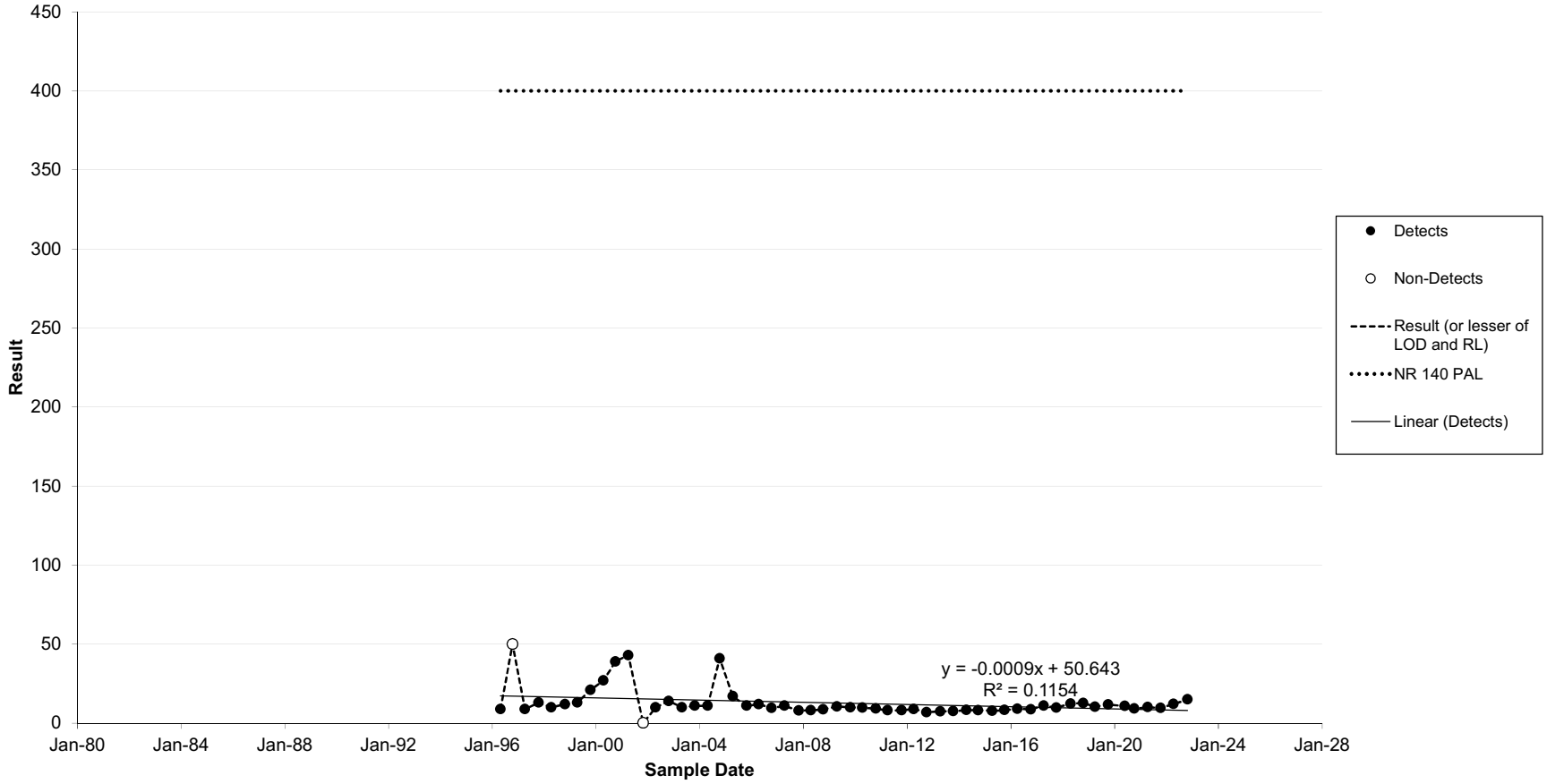
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-33AR - Barium, dissolved (ug/l as Ba)



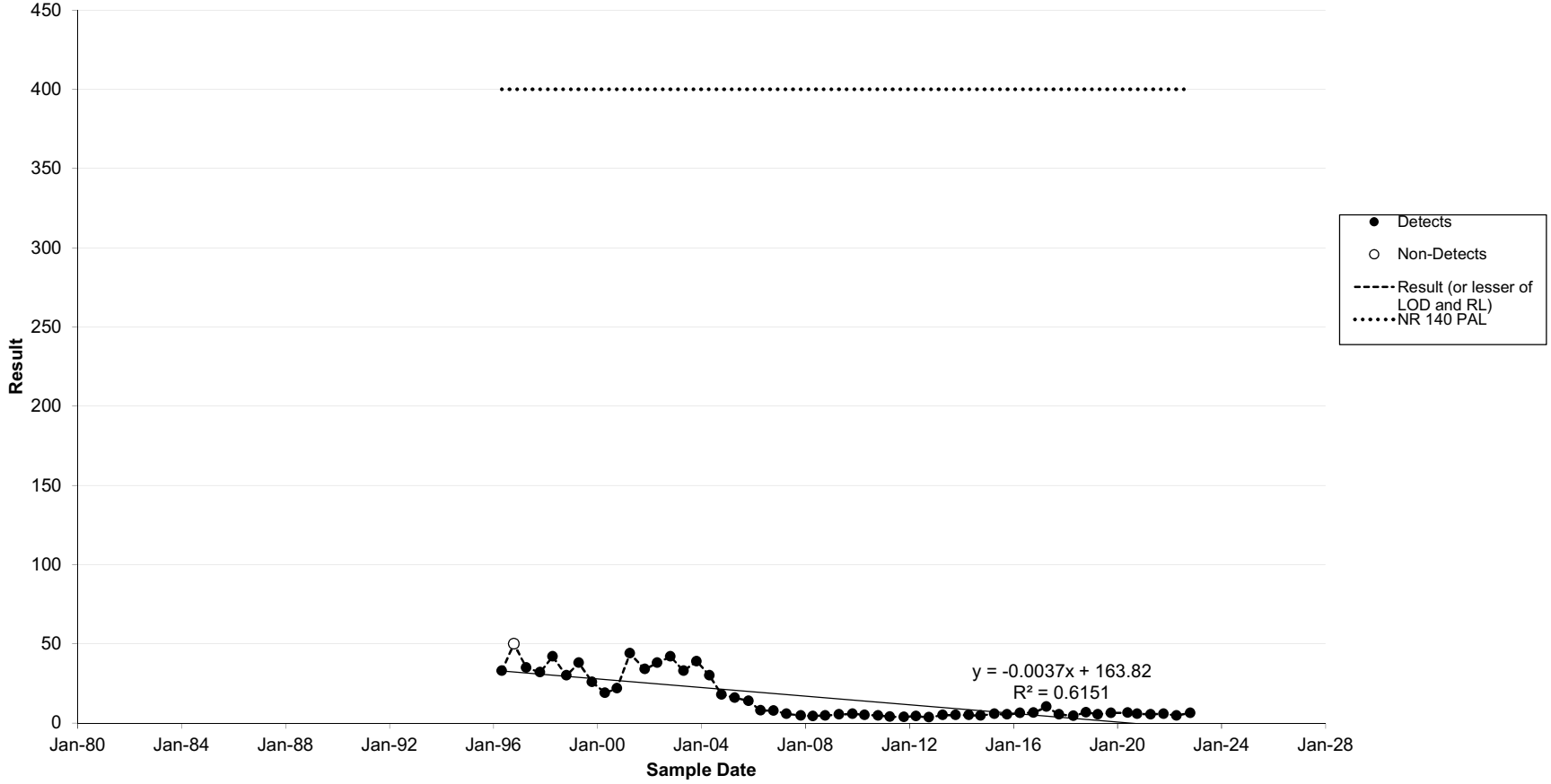
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-33B - Barium, dissolved (ug/l as Ba)



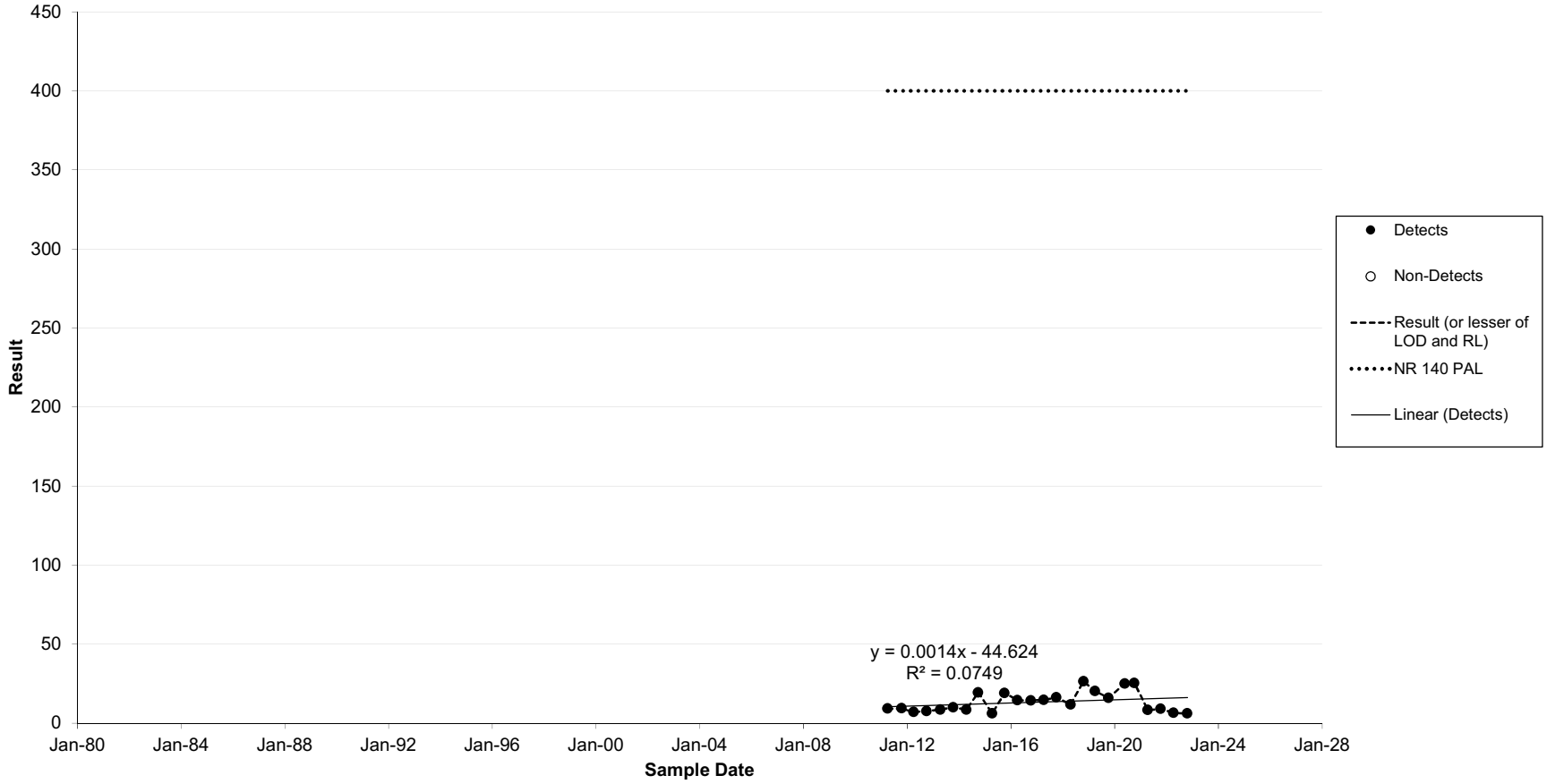
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-34A - Barium, dissolved (ug/l as Ba)



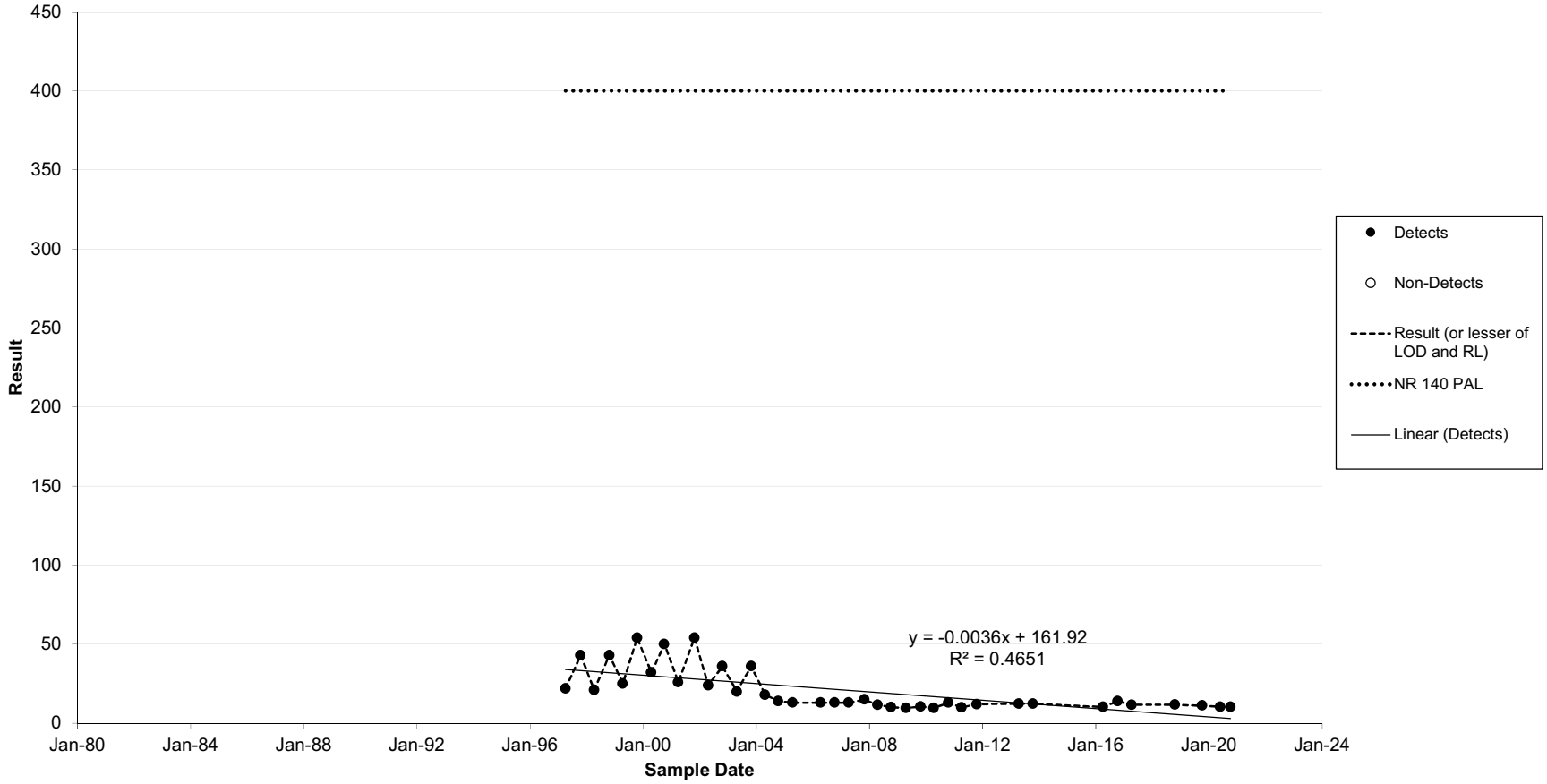
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-34B - Barium, dissolved (ug/l as Ba)



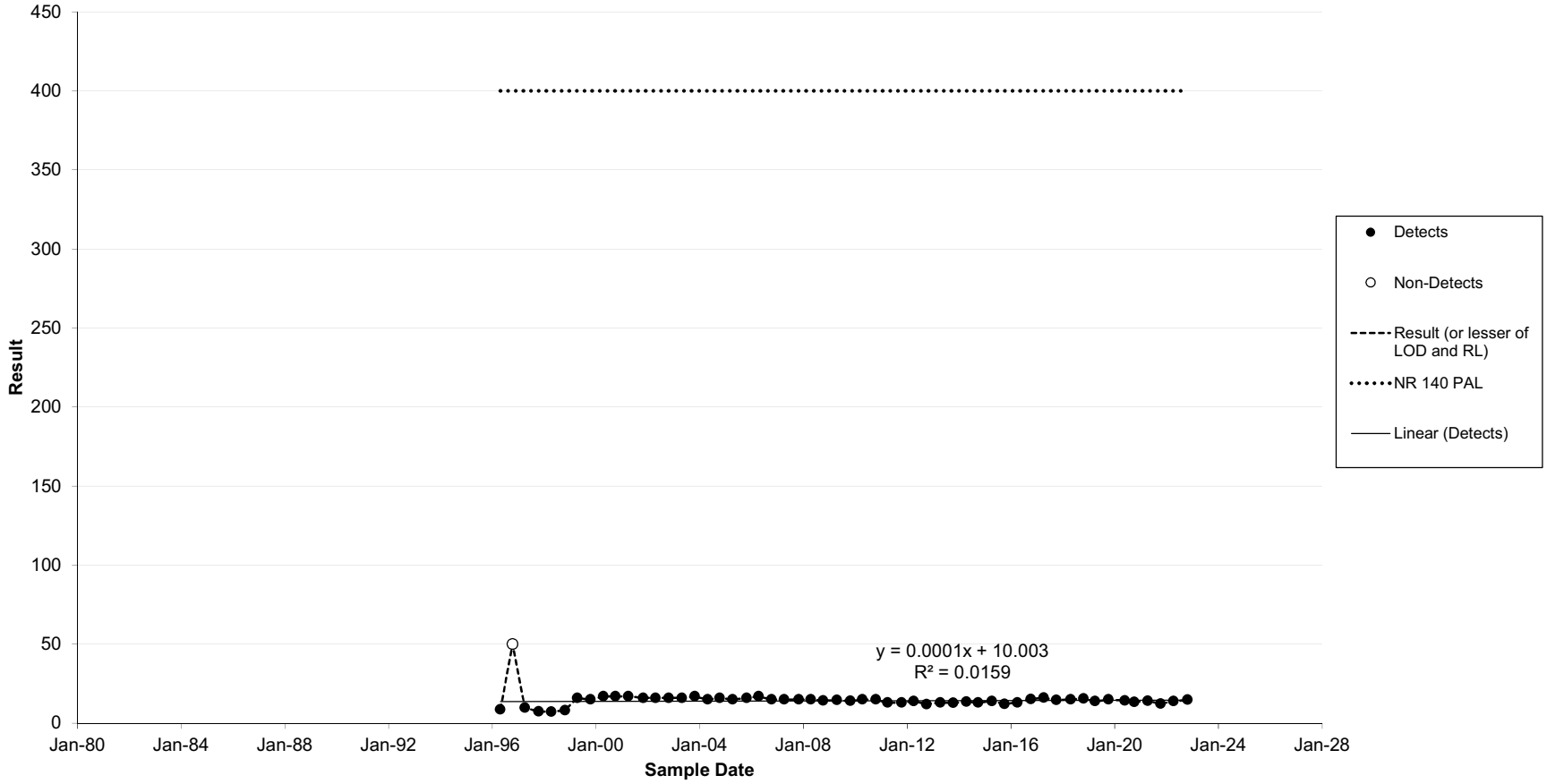
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-37A - Barium, dissolved (ug/l as Ba)



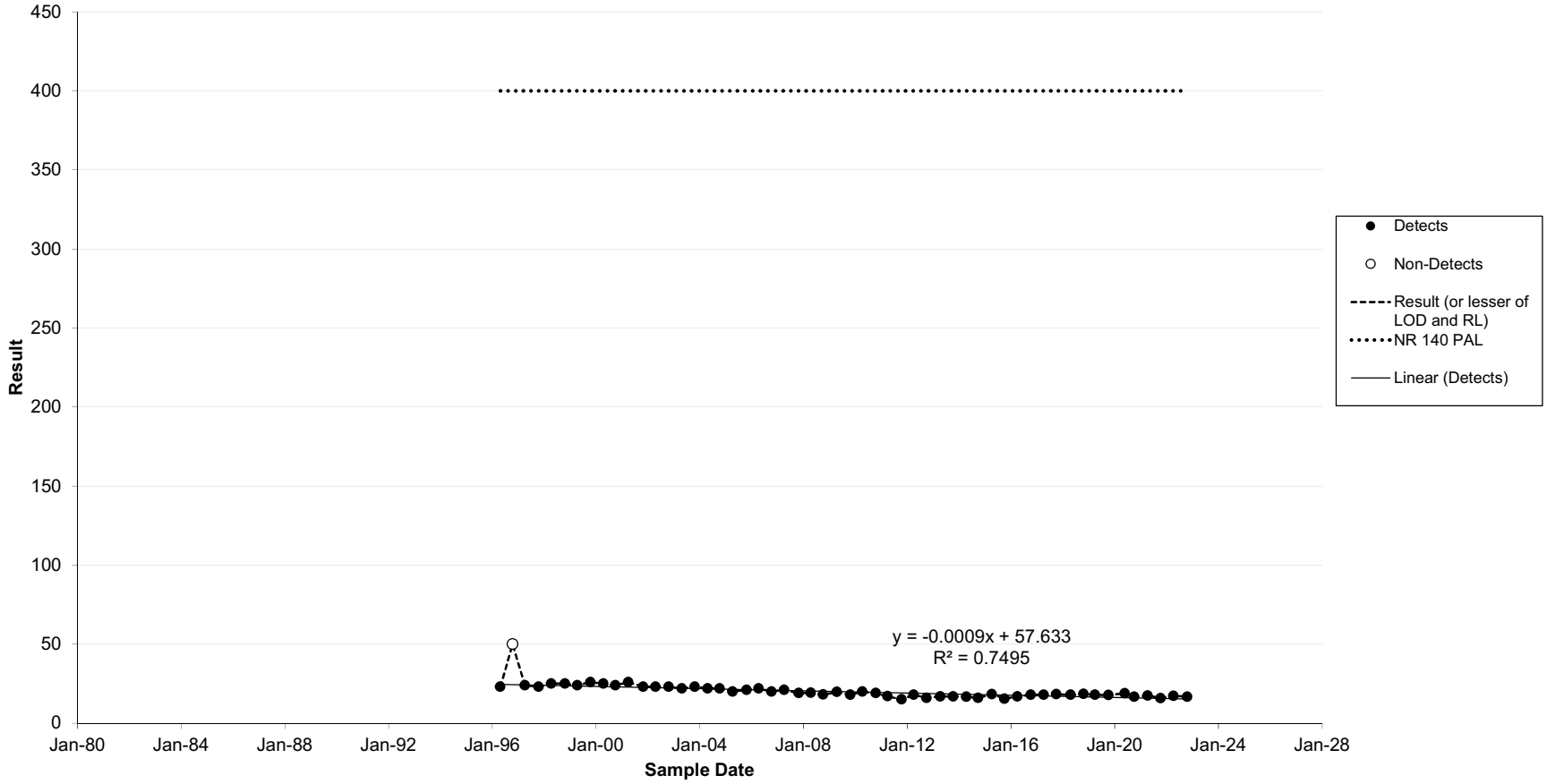
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-83 - Barium, dissolved (ug/l as Ba)



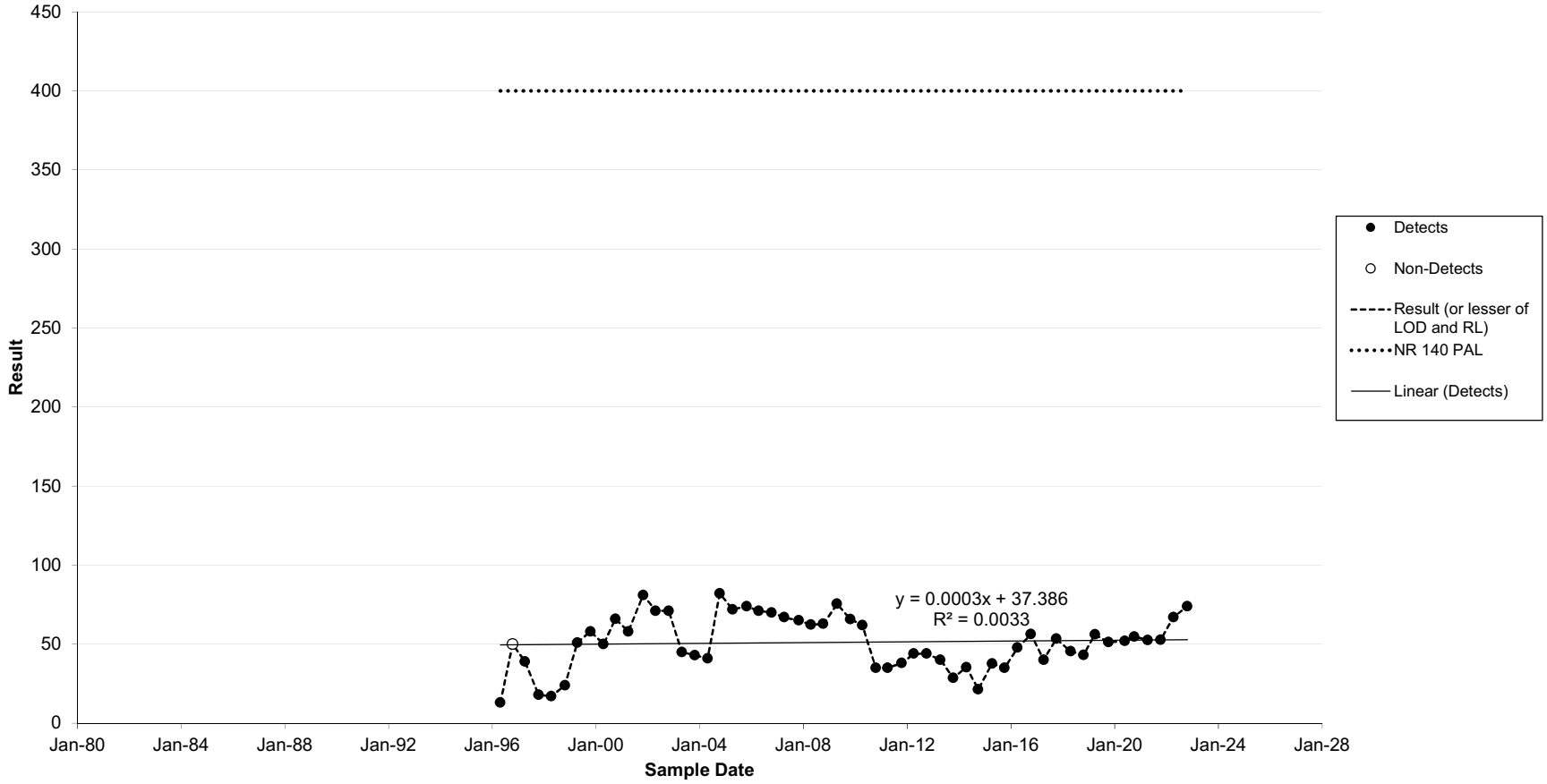
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-84A - Barium, dissolved (ug/l as Ba)



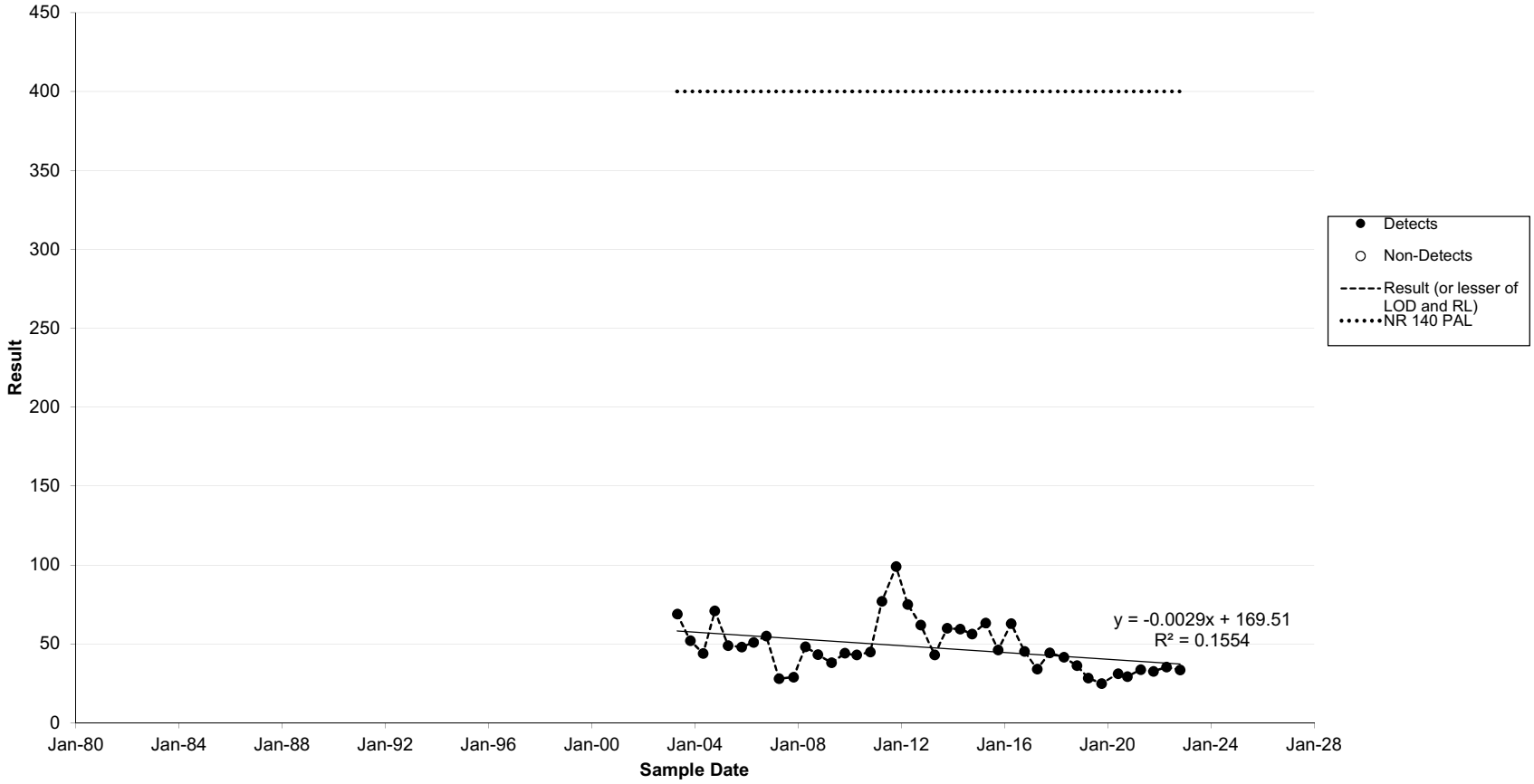
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-84B - Barium, dissolved (ug/l as Ba)



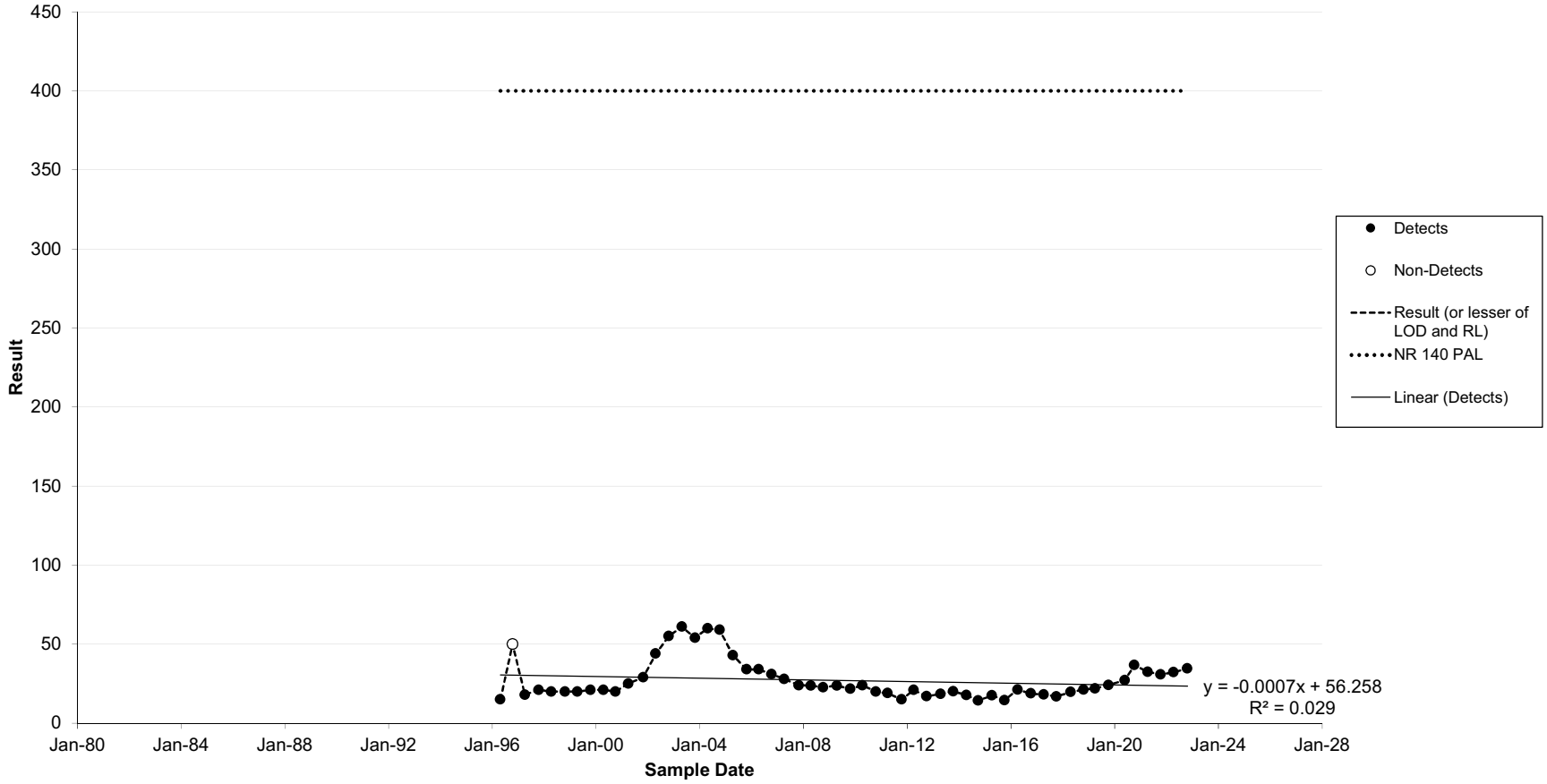
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-86 - Barium, dissolved (ug/l as Ba)



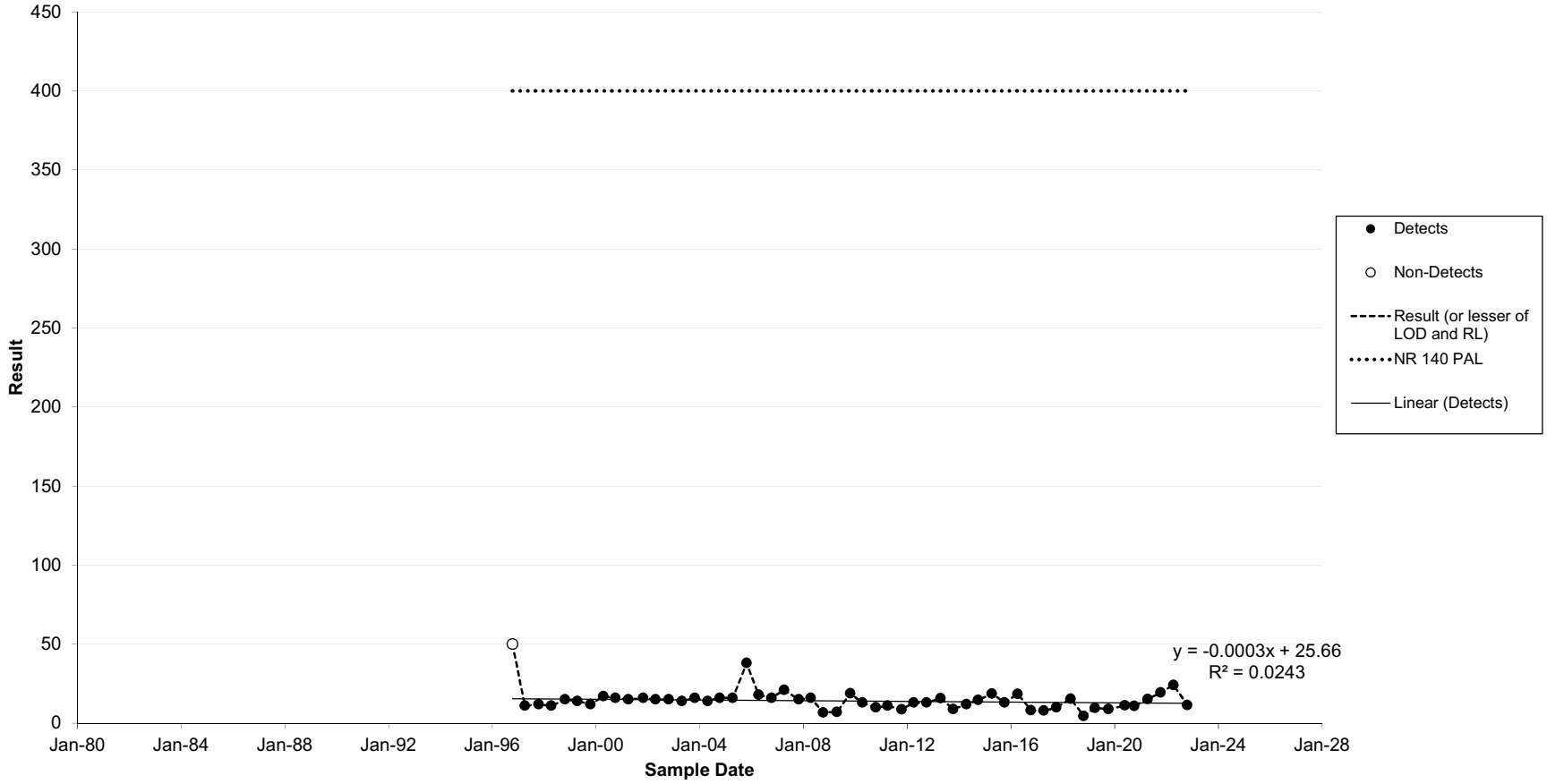
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-91AR - Barium, dissolved (ug/l as Ba)



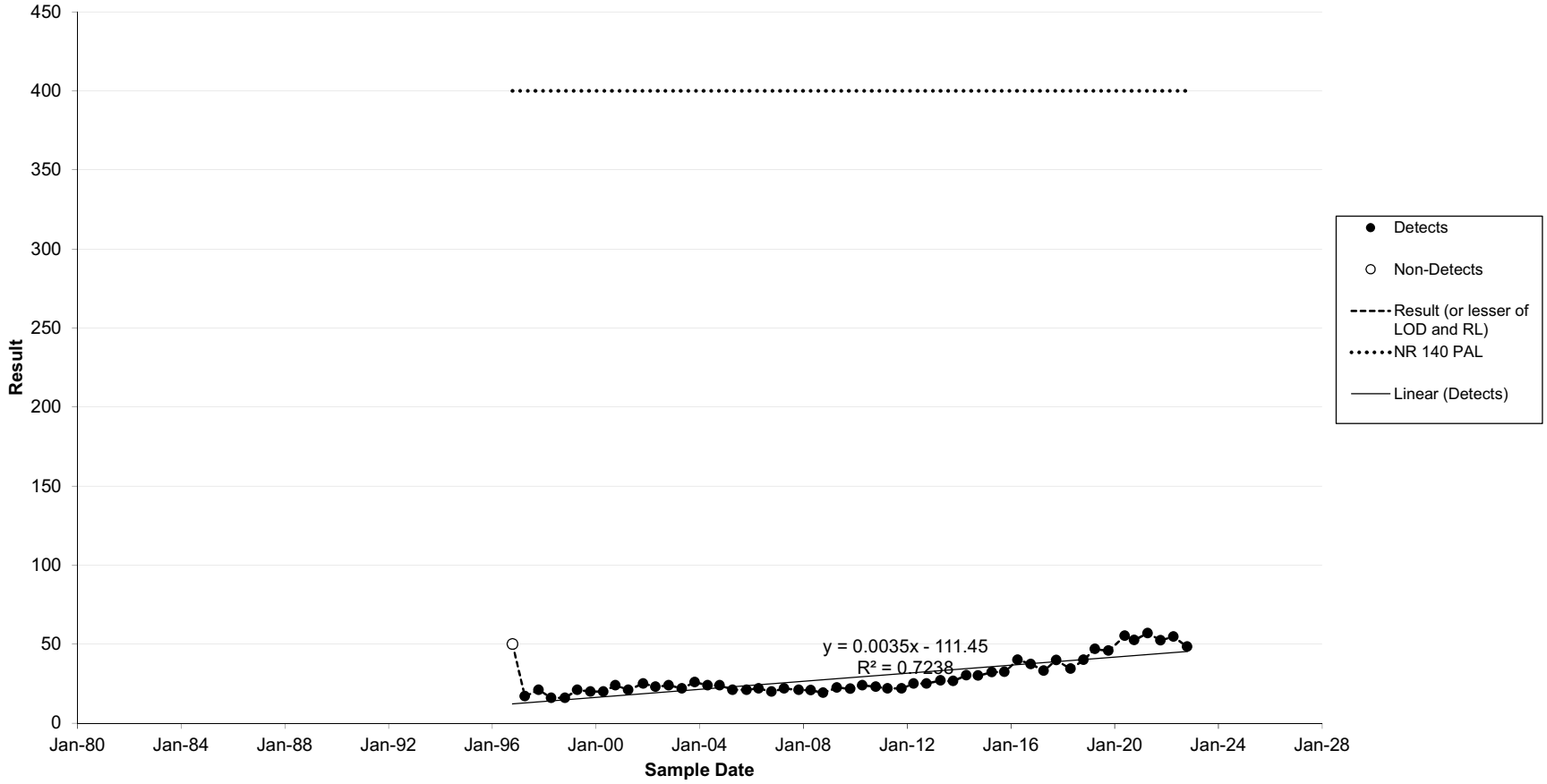
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-91B - Barium, dissolved (ug/l as Ba)



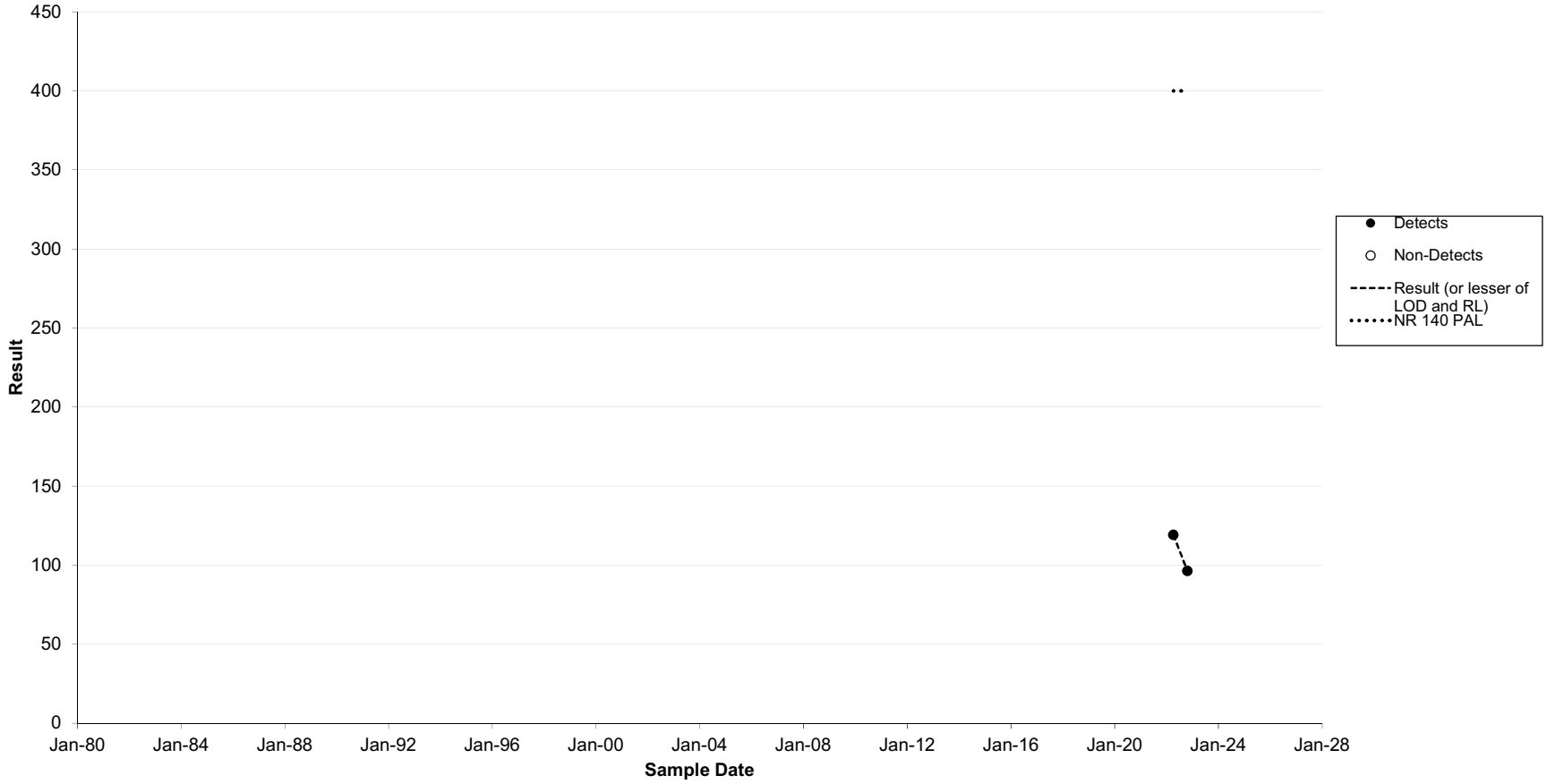
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-92A - Barium, dissolved (ug/l as Ba)



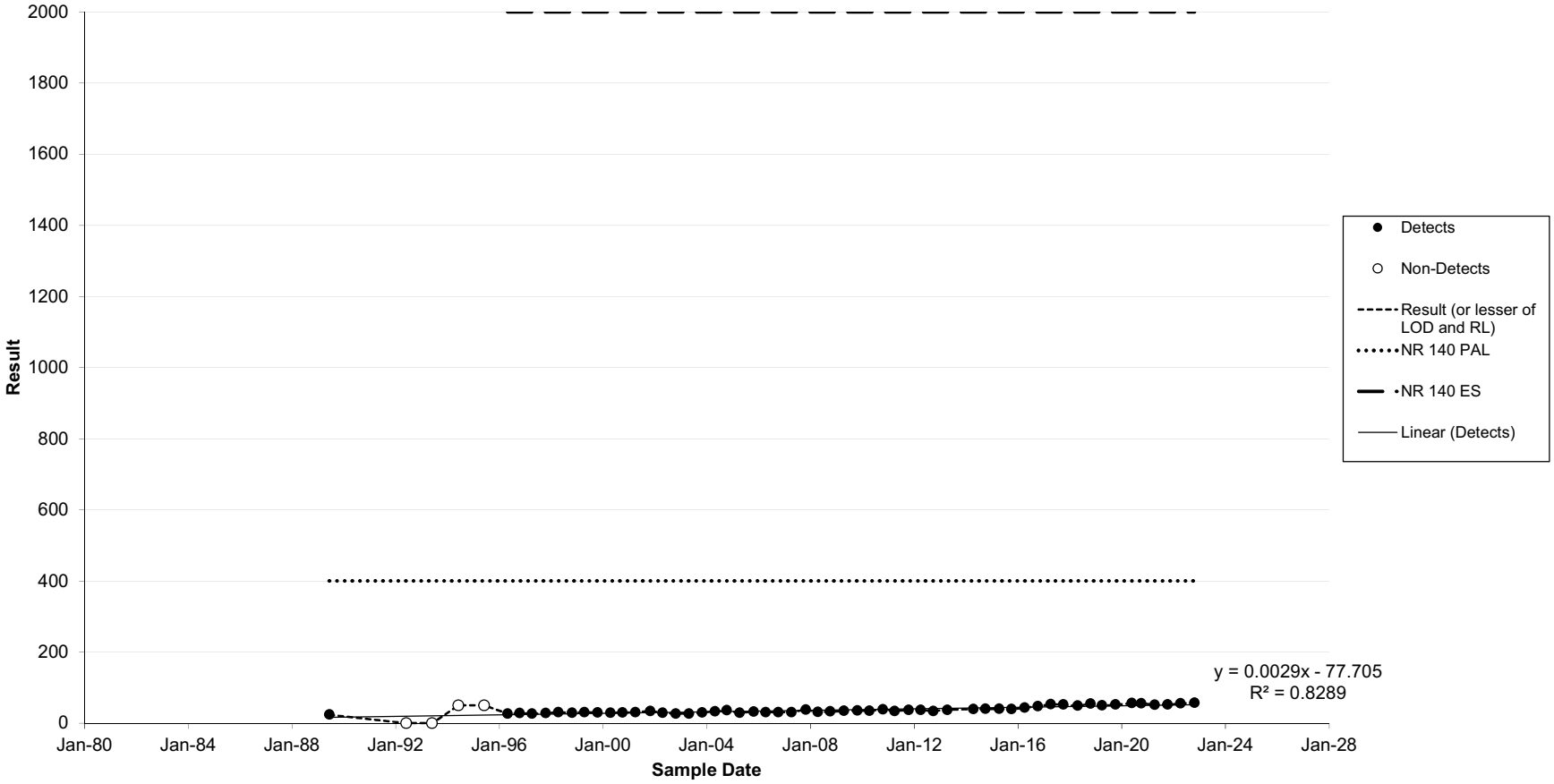
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-92B - Barium, dissolved (ug/l as Ba)



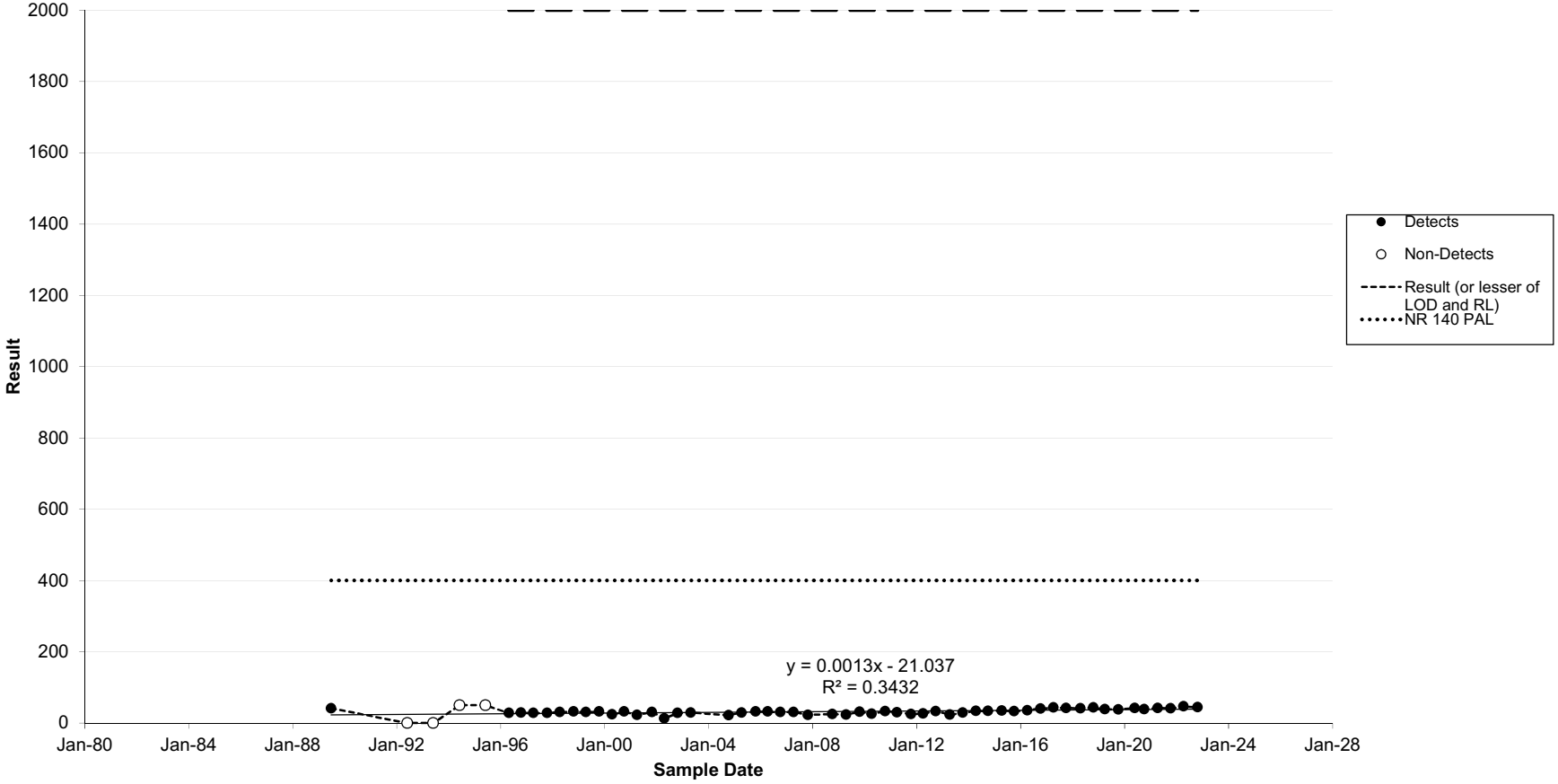
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-93A - Barium, dissolved (ug/l as Ba)



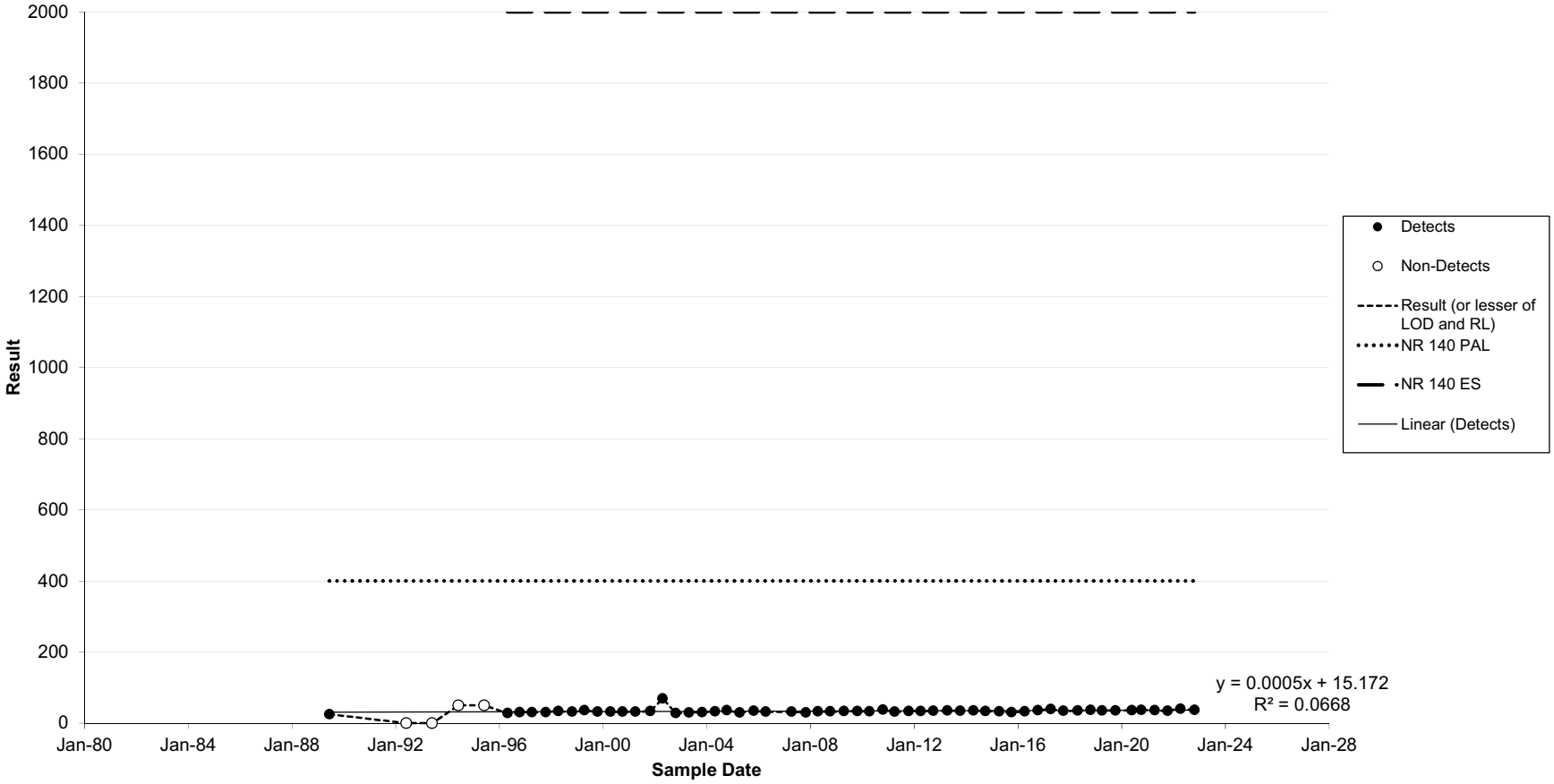
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
HC-1 - Barium, total (ug/l Ba)



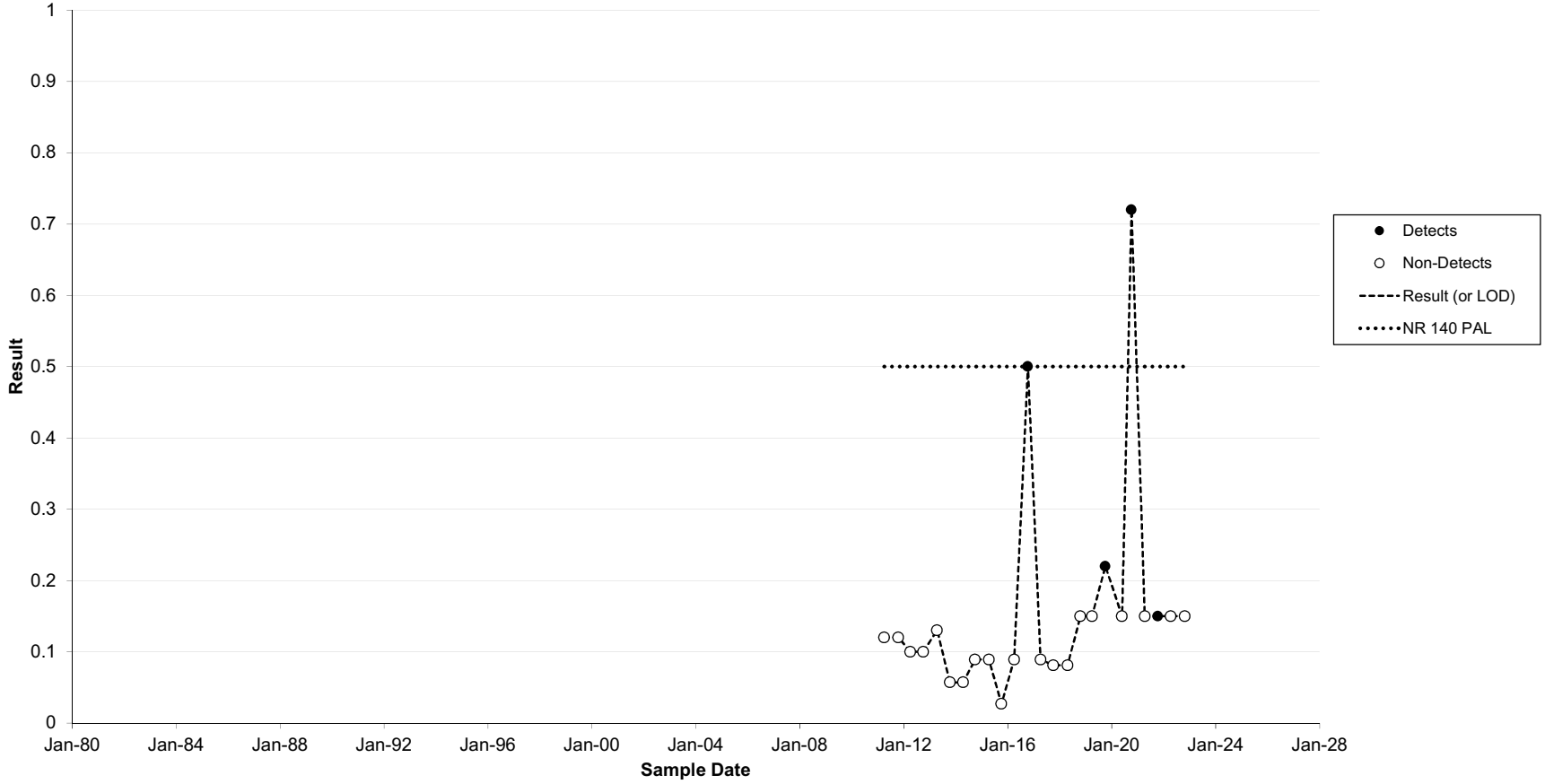
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
HC-2 - Barium, total (ug/l Ba)



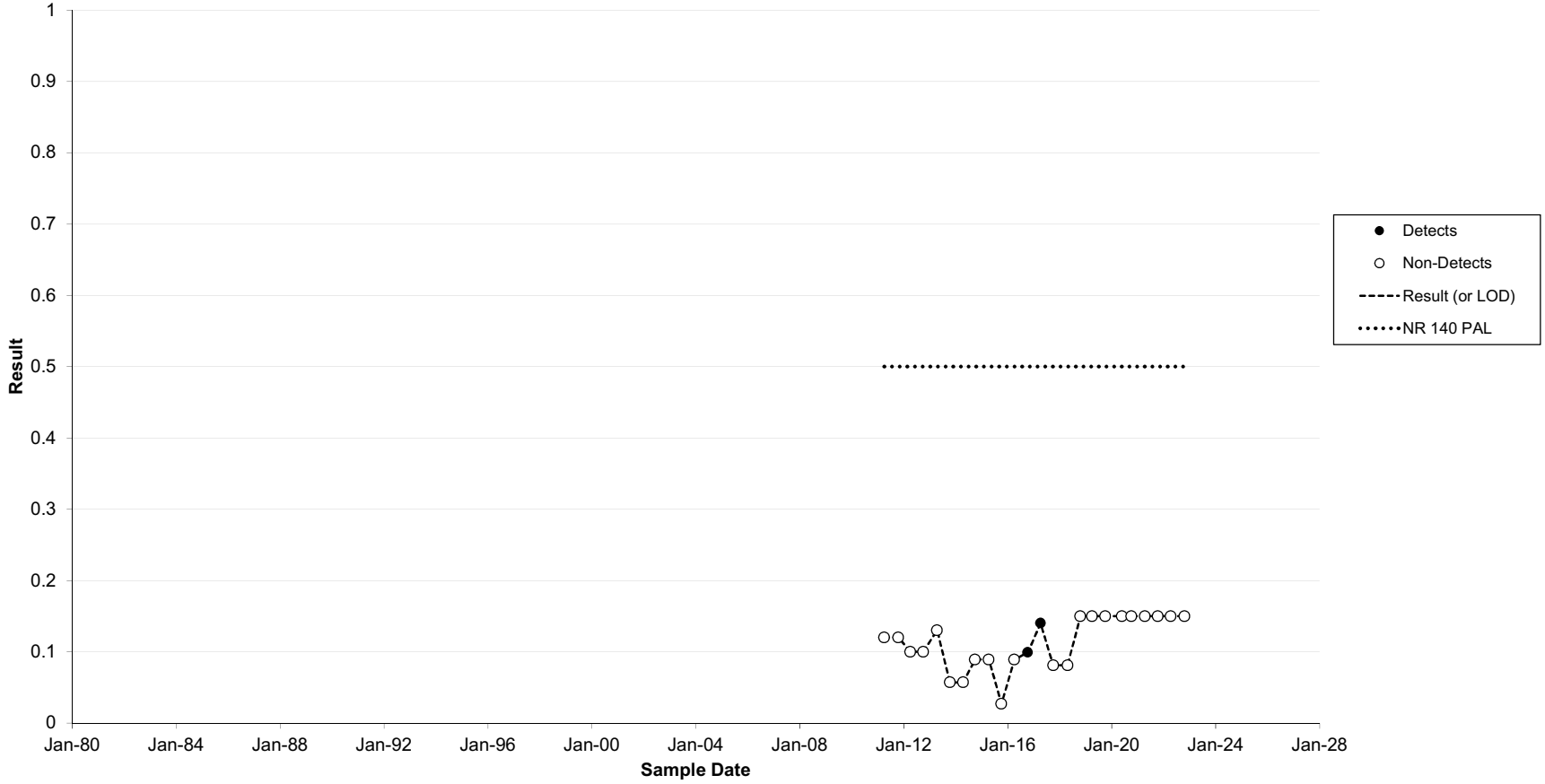
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
HC-3 - Barium, total (ug/l Ba)



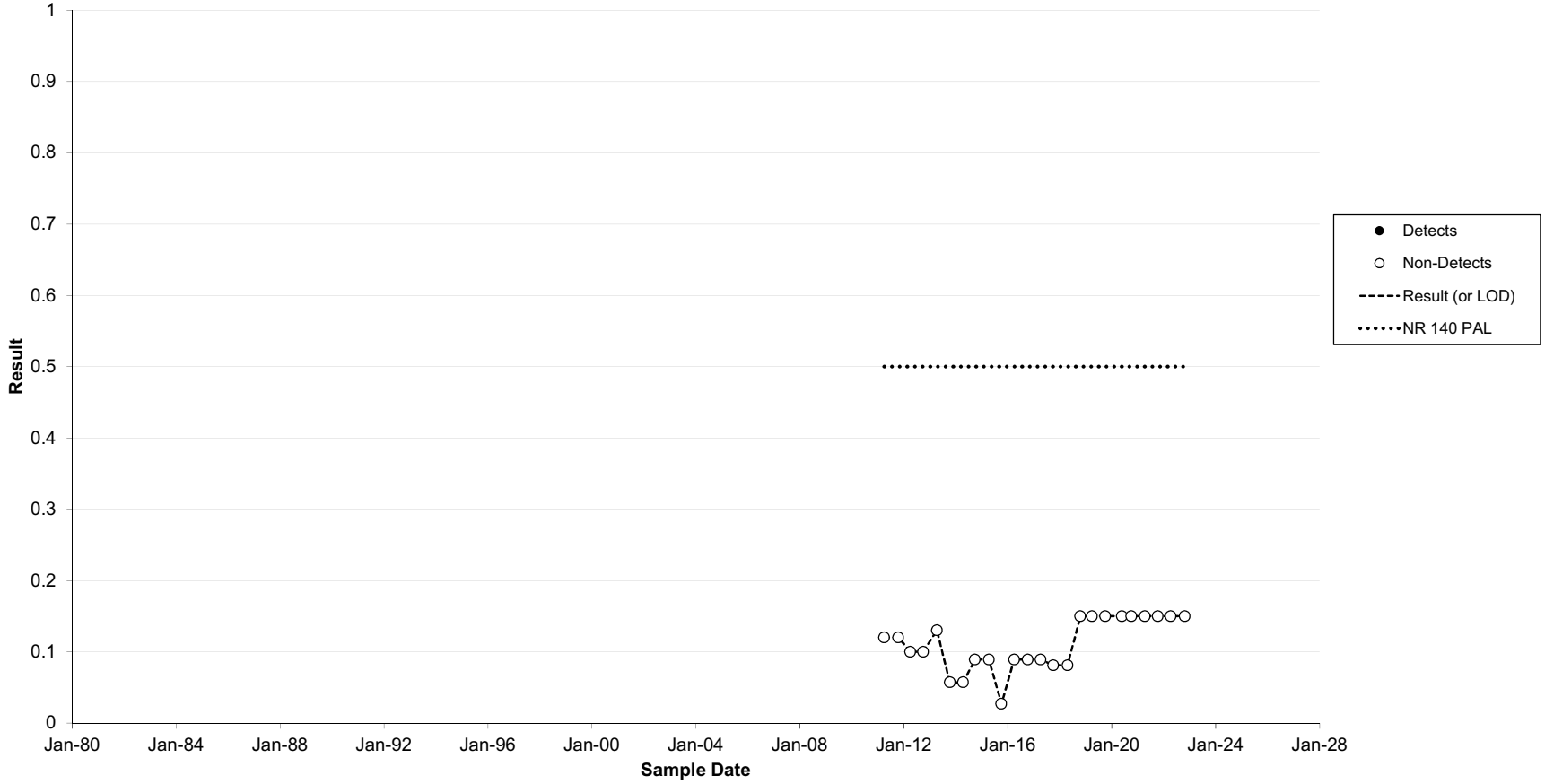
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-33AR - Cadmium, dissolved (ug/l as Cd)



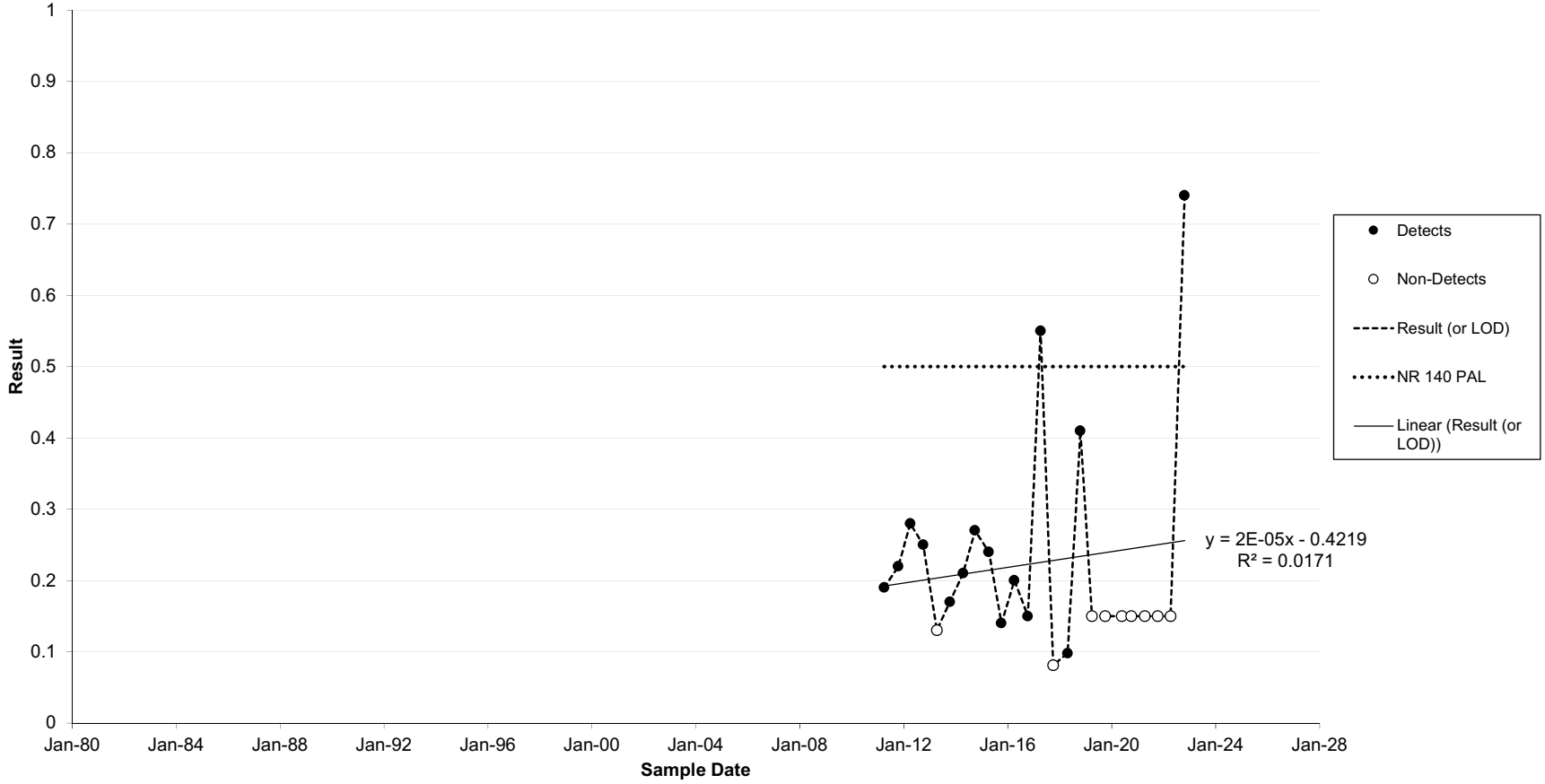
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-33BR - Cadmium, dissolved (ug/l as Cd)



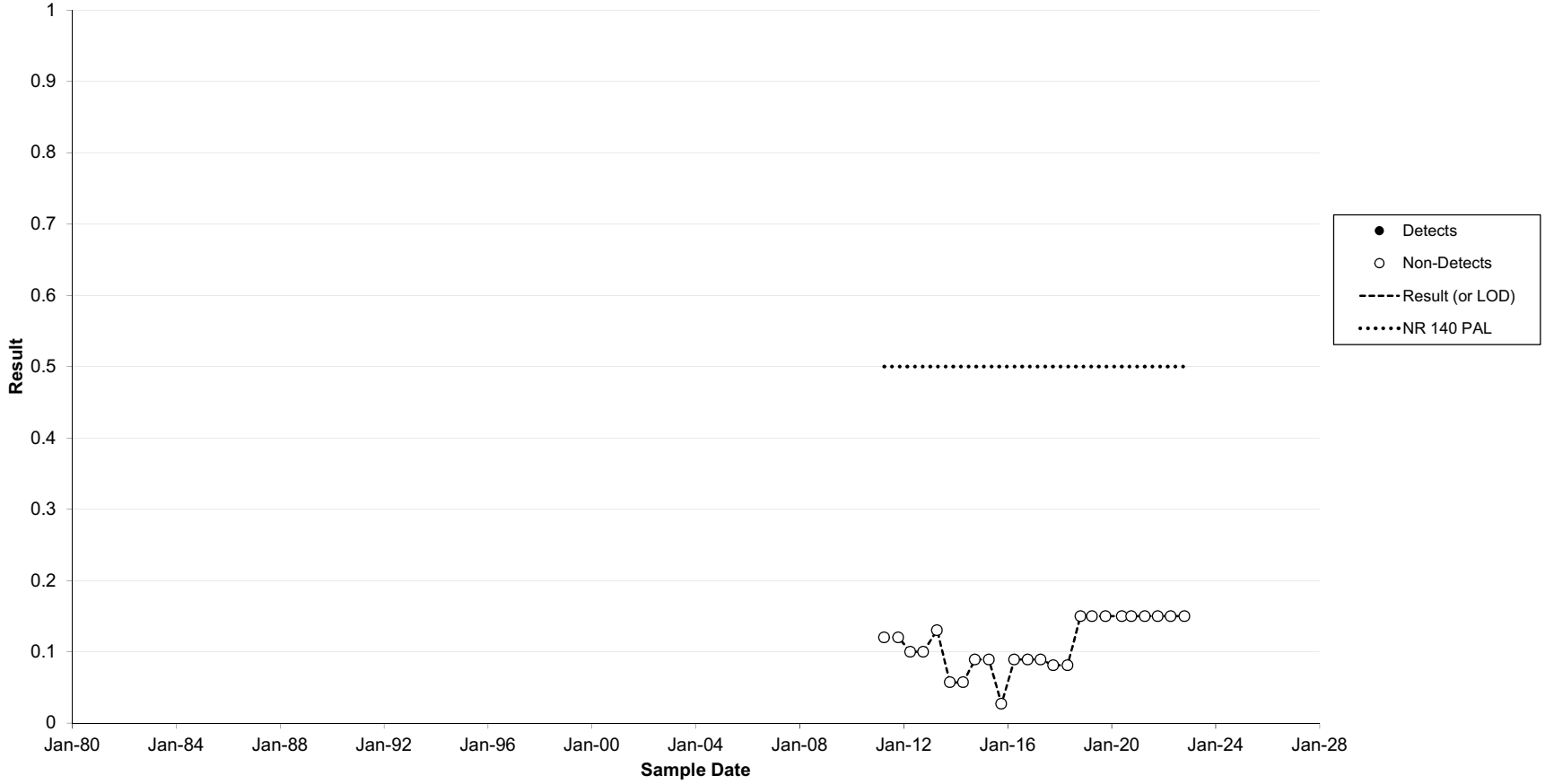
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-34A - Cadmium, dissolved (ug/l as Cd)



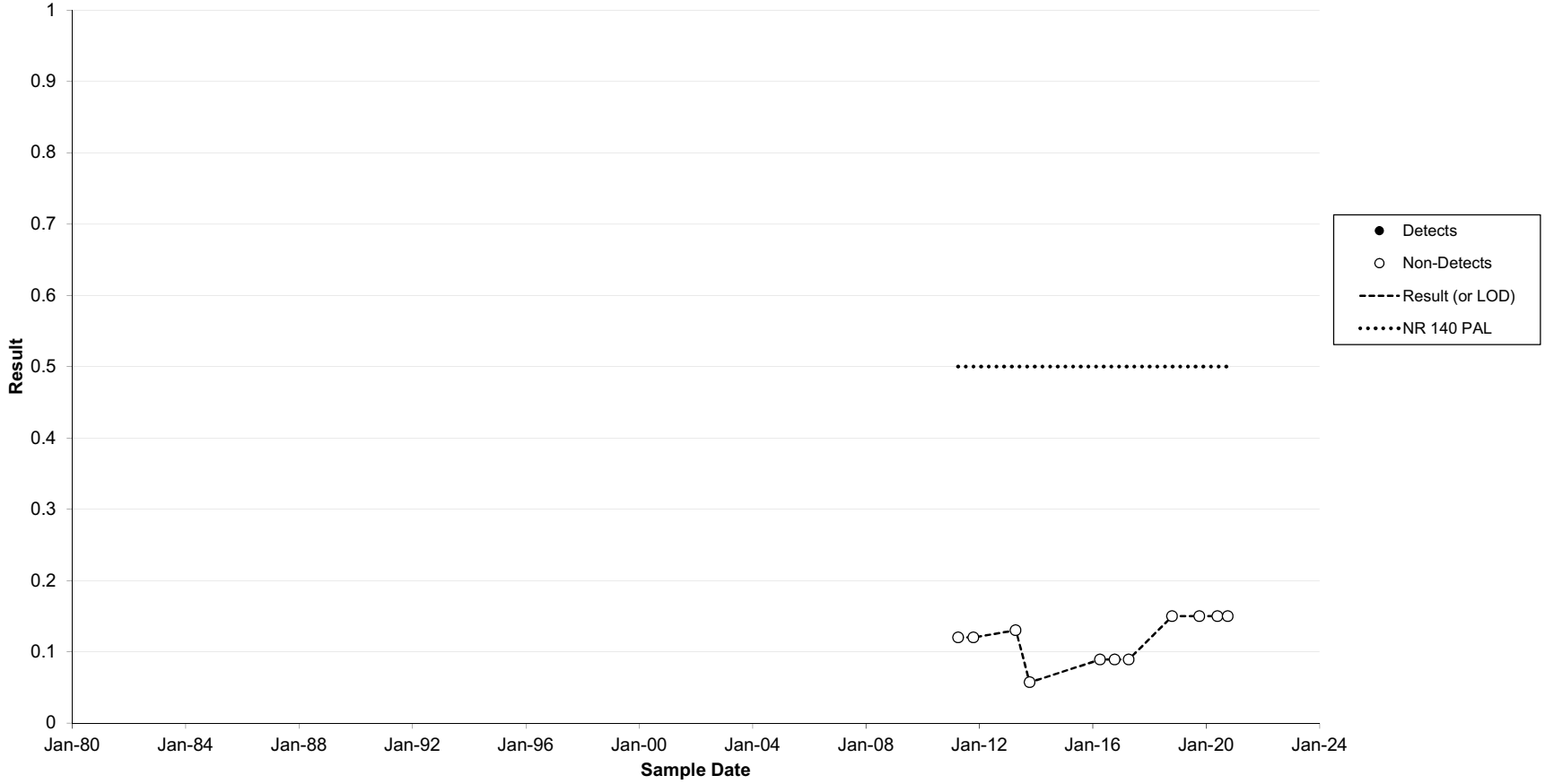
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-34B - Cadmium, dissolved (ug/l as Cd)



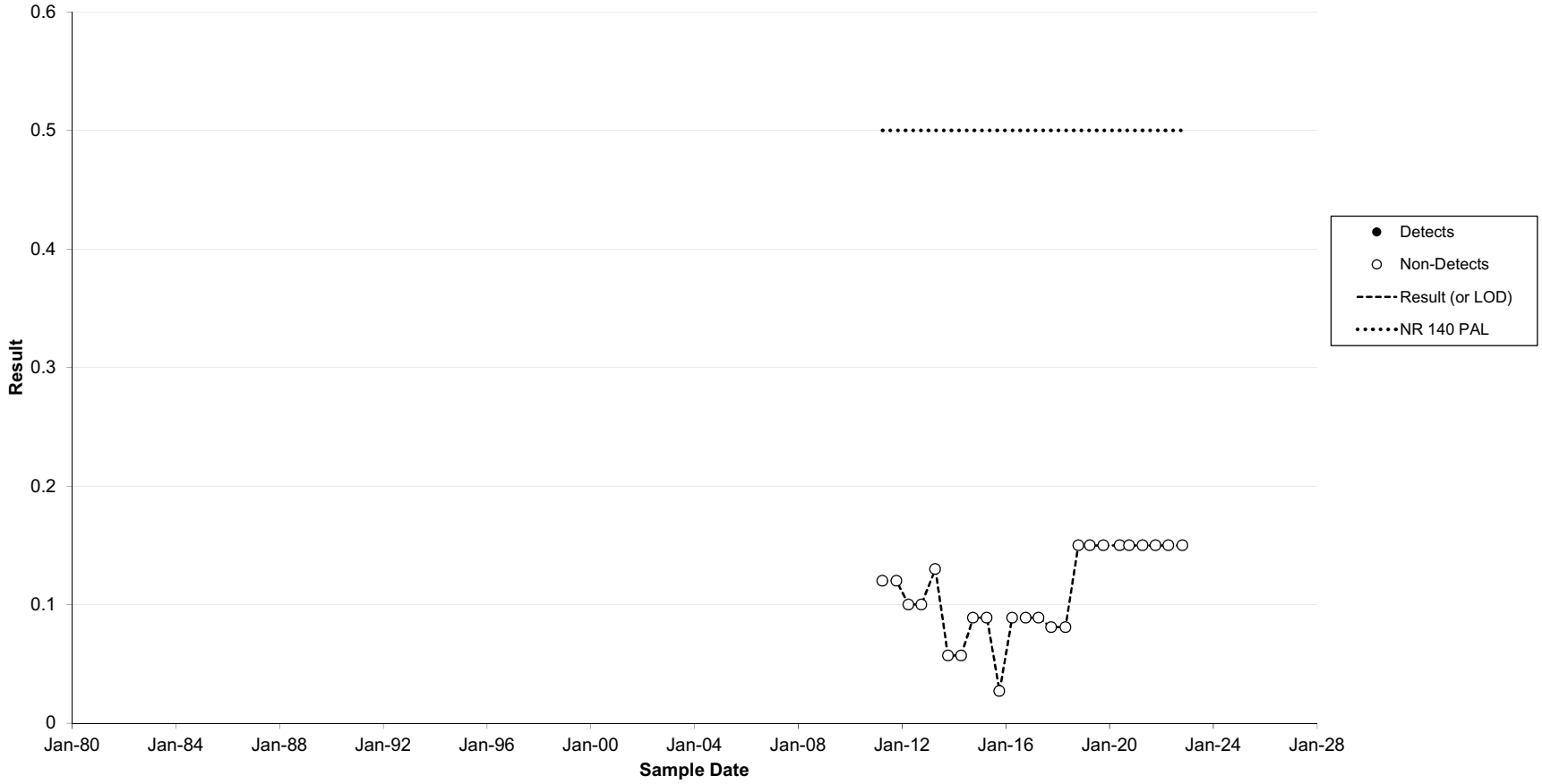
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-37A - Cadmium, dissolved (ug/l as Cd)



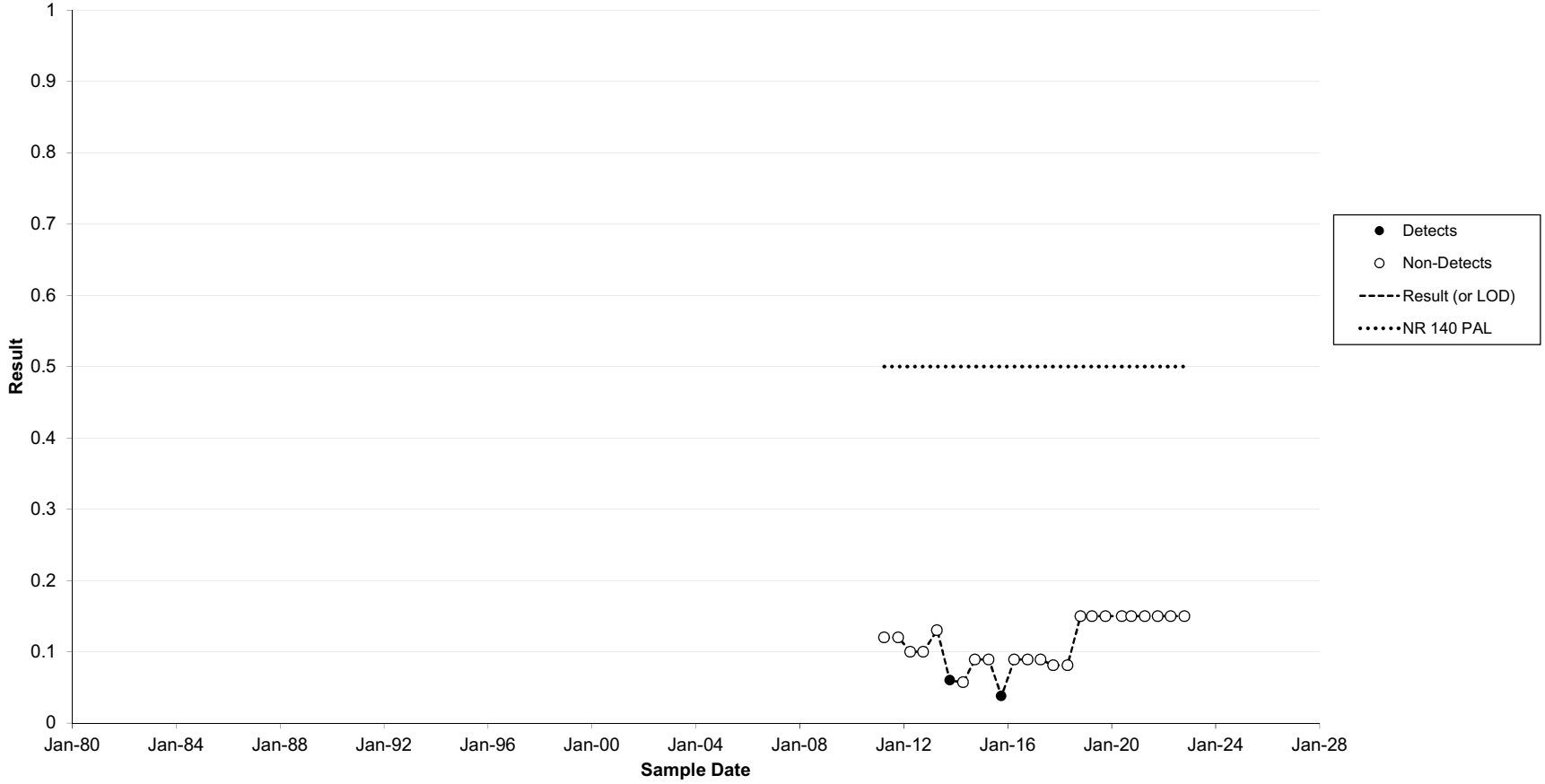
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-83 - Cadmium, dissolved (ug/l as Cd)



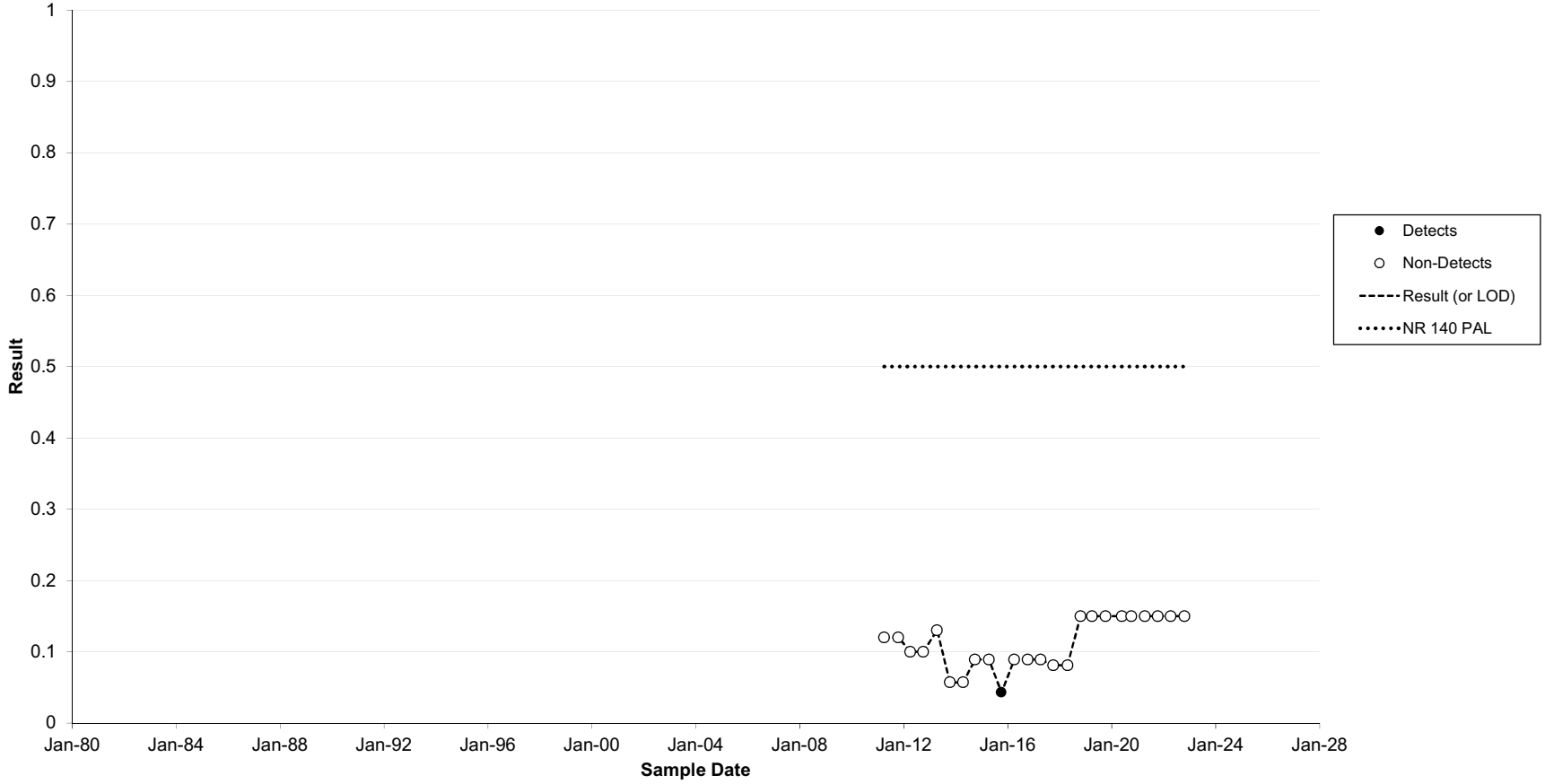
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-84A - Cadmium, dissolved (ug/l as Cd)



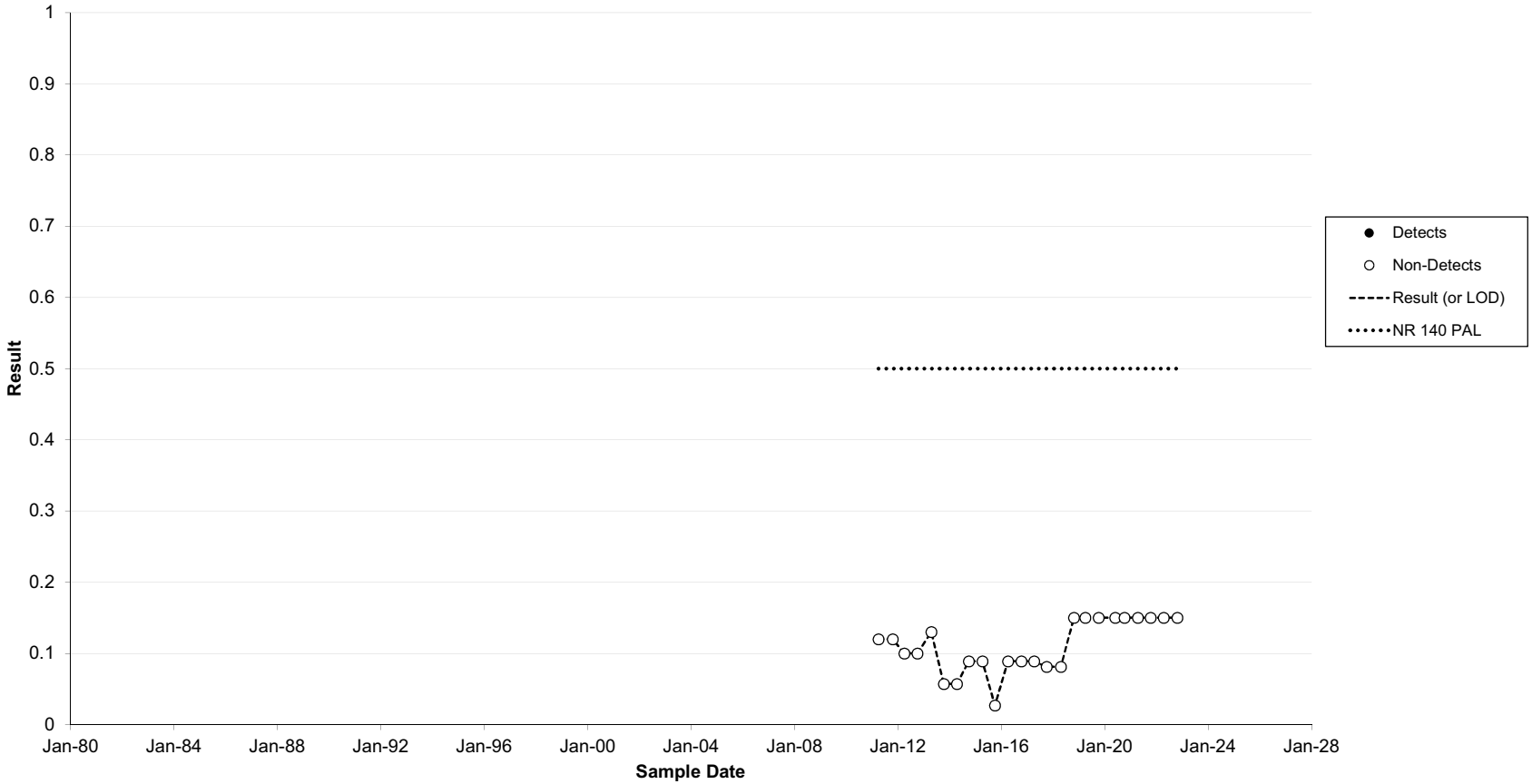
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-84B - Cadmium, dissolved (ug/l as Cd)



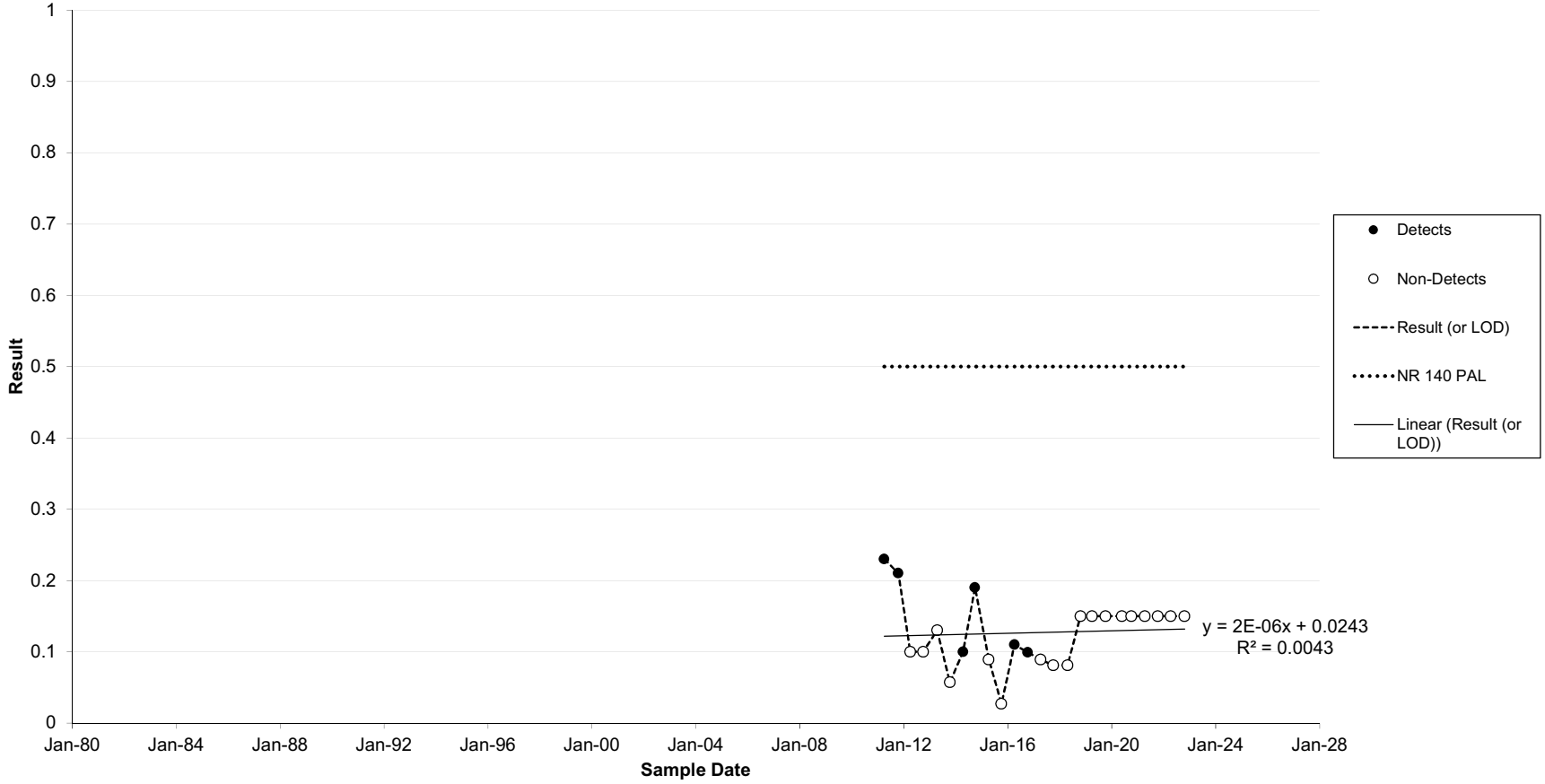
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-86 - Cadmium, dissolved (ug/l as Cd)



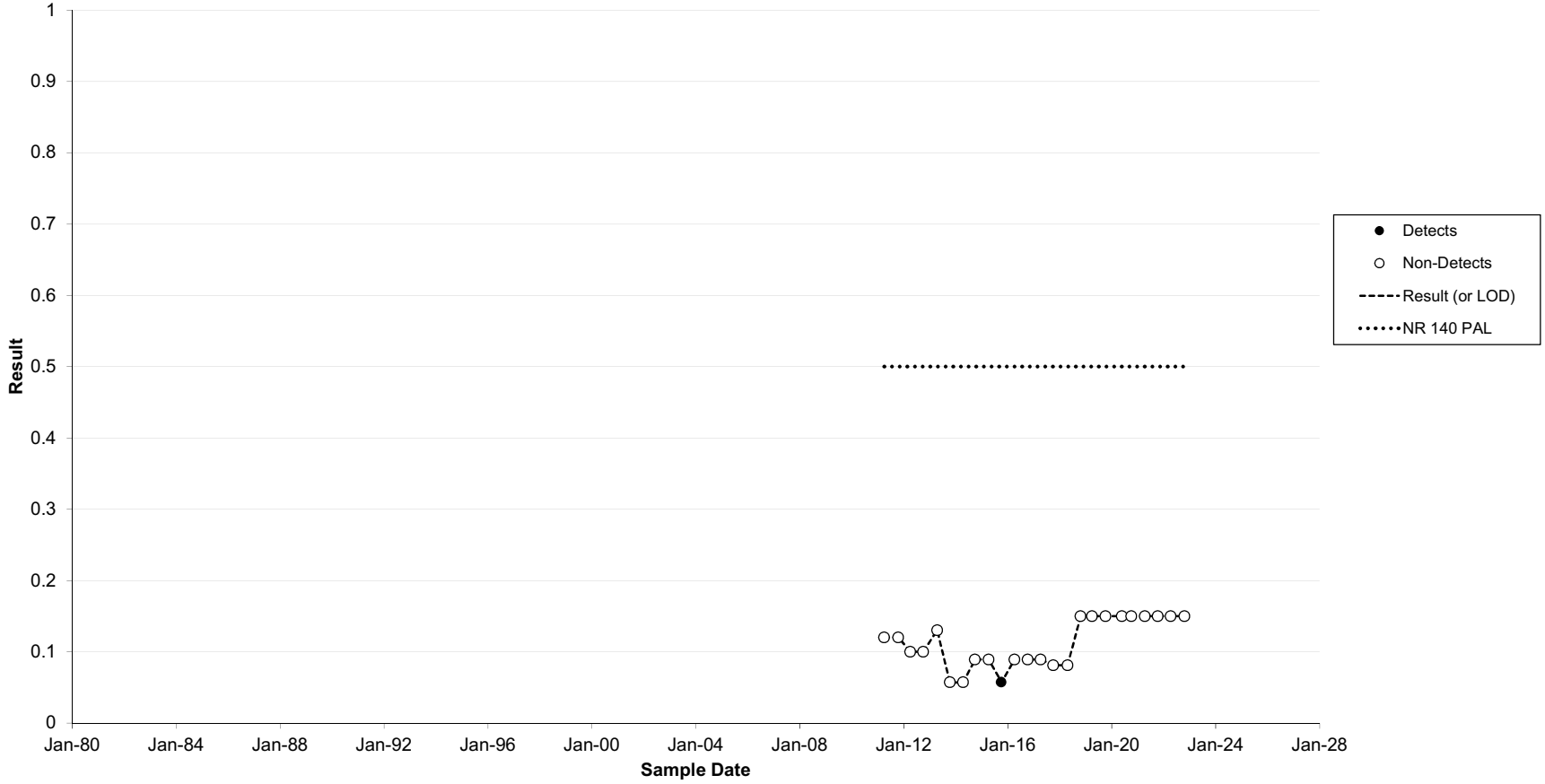
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-91AR - Cadmium, dissolved (ug/l as Cd)



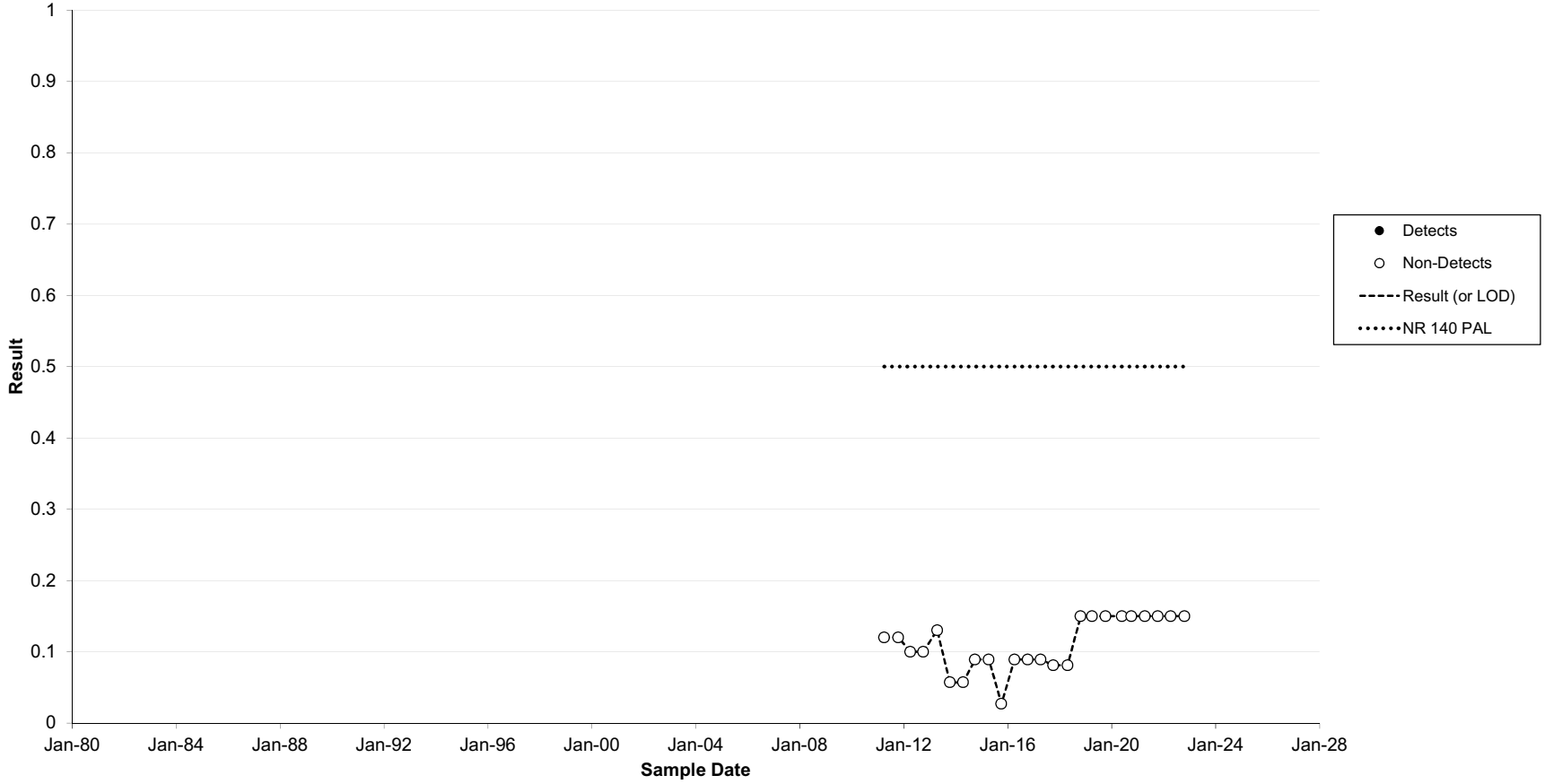
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-91B - Cadmium, dissolved (ug/l as Cd)



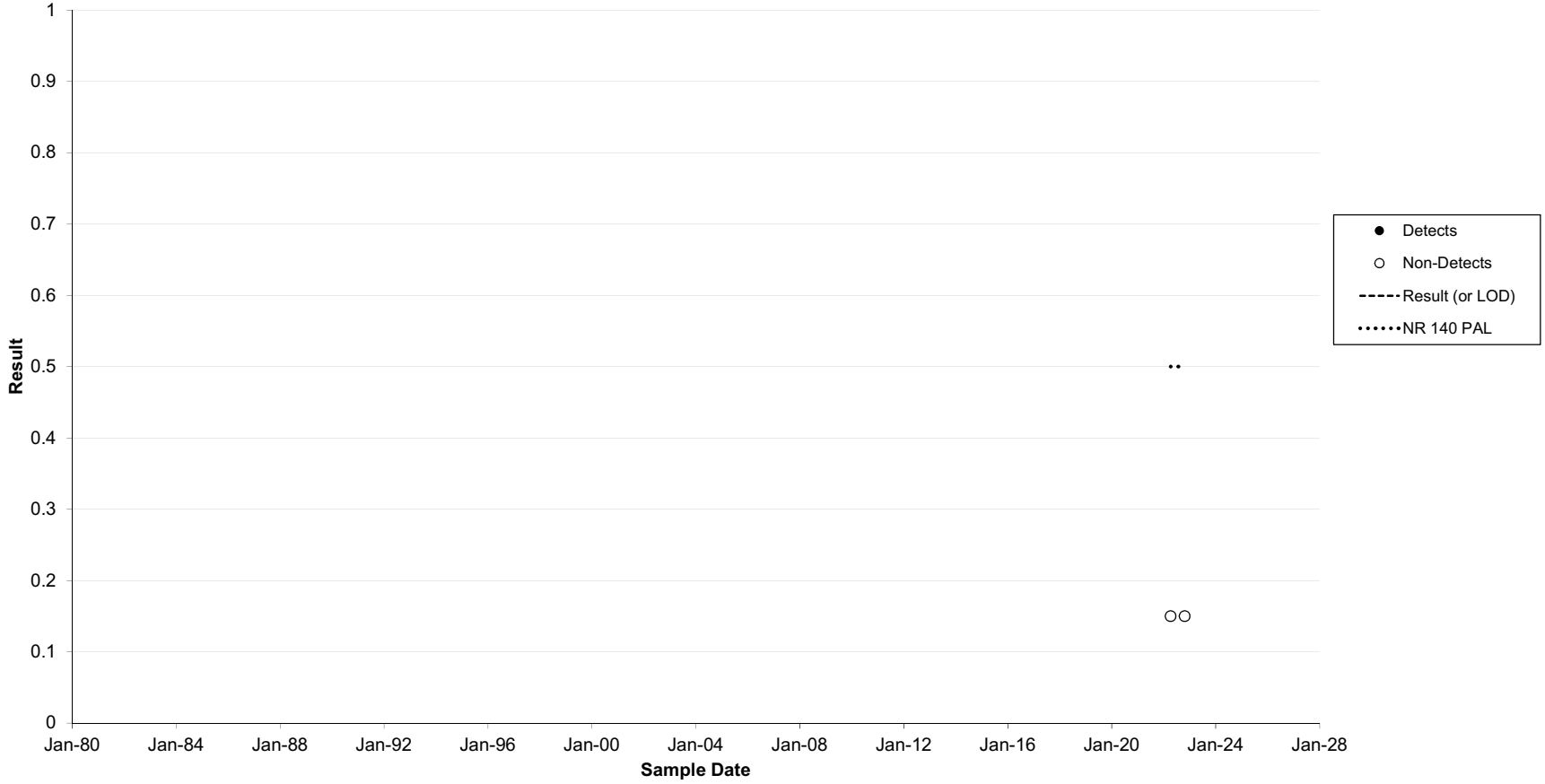
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-92A - Cadmium, dissolved (ug/l as Cd)



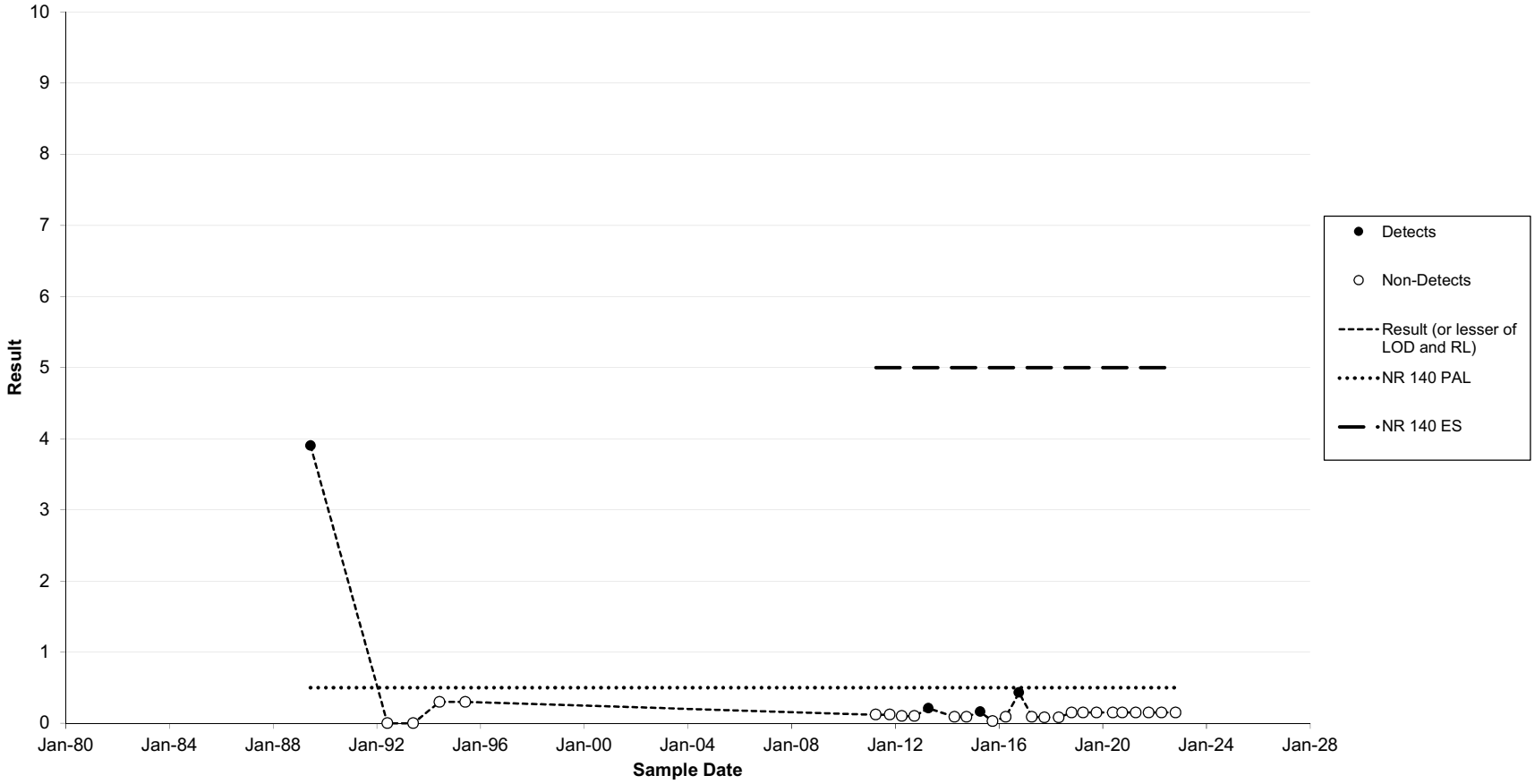
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-92B - Cadmium, dissolved (ug/l as Cd)



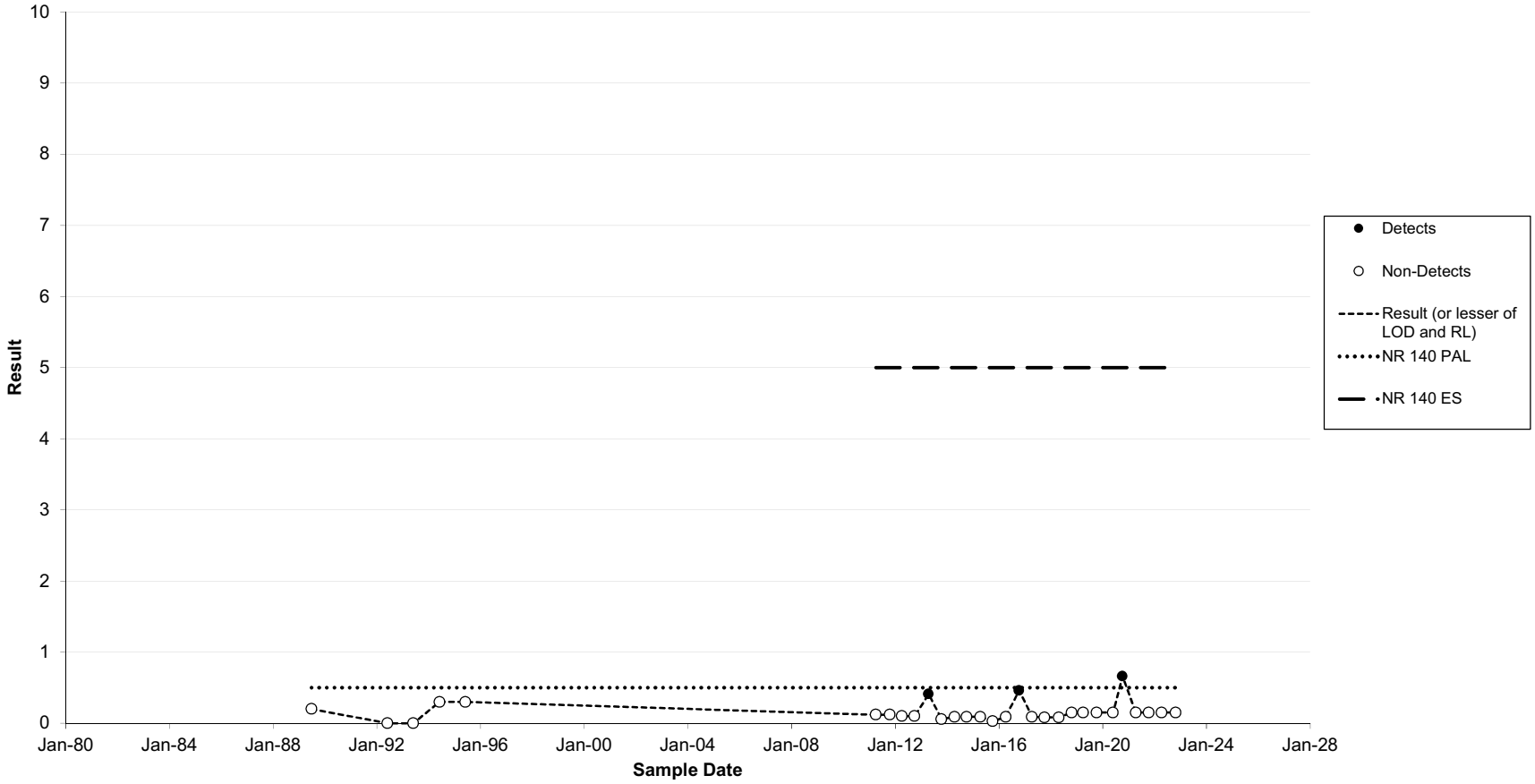
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-93A - Cadmium, dissolved (ug/l as Cd)



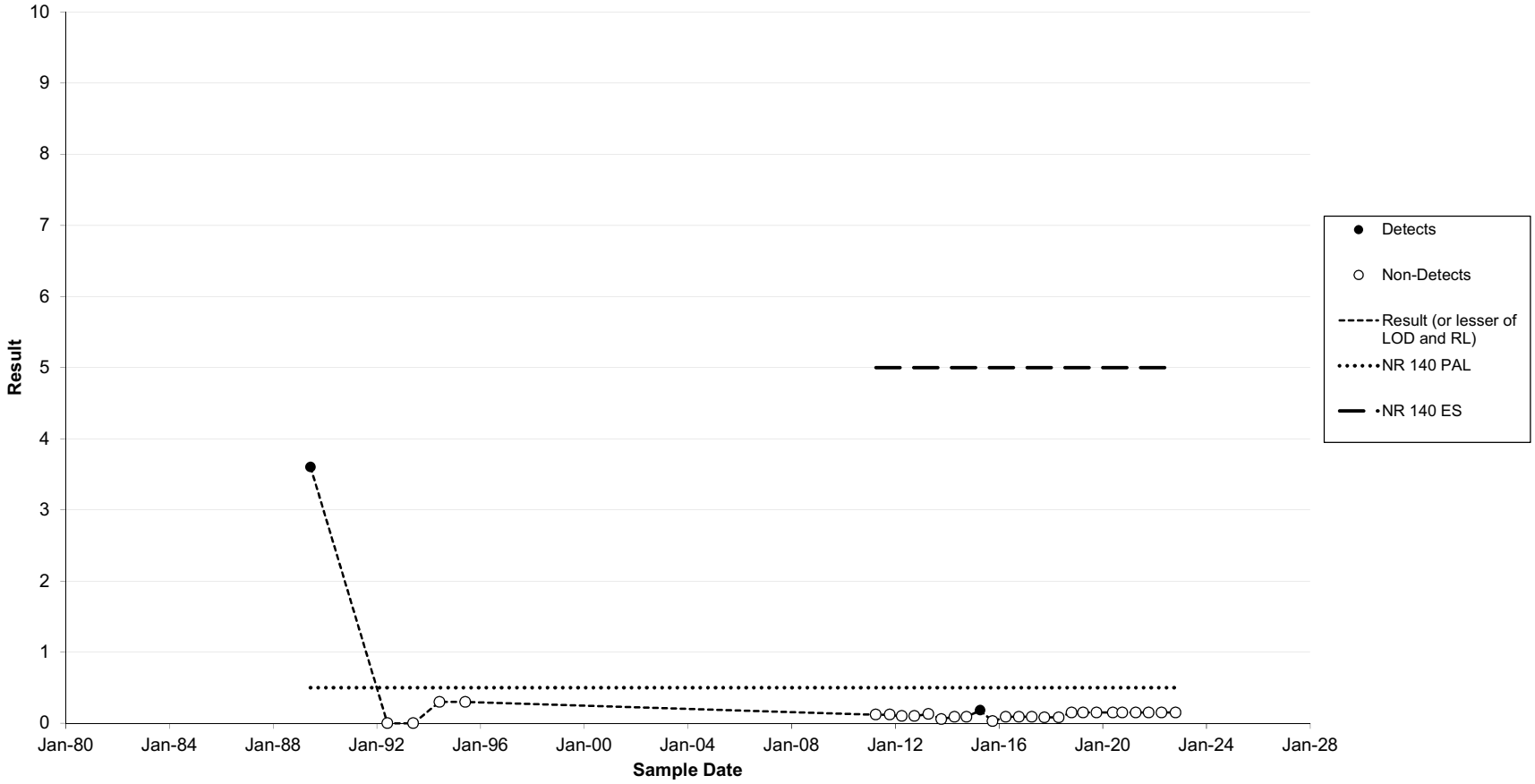
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
HC-1 - Cadmium, total (ug/l as Cd)



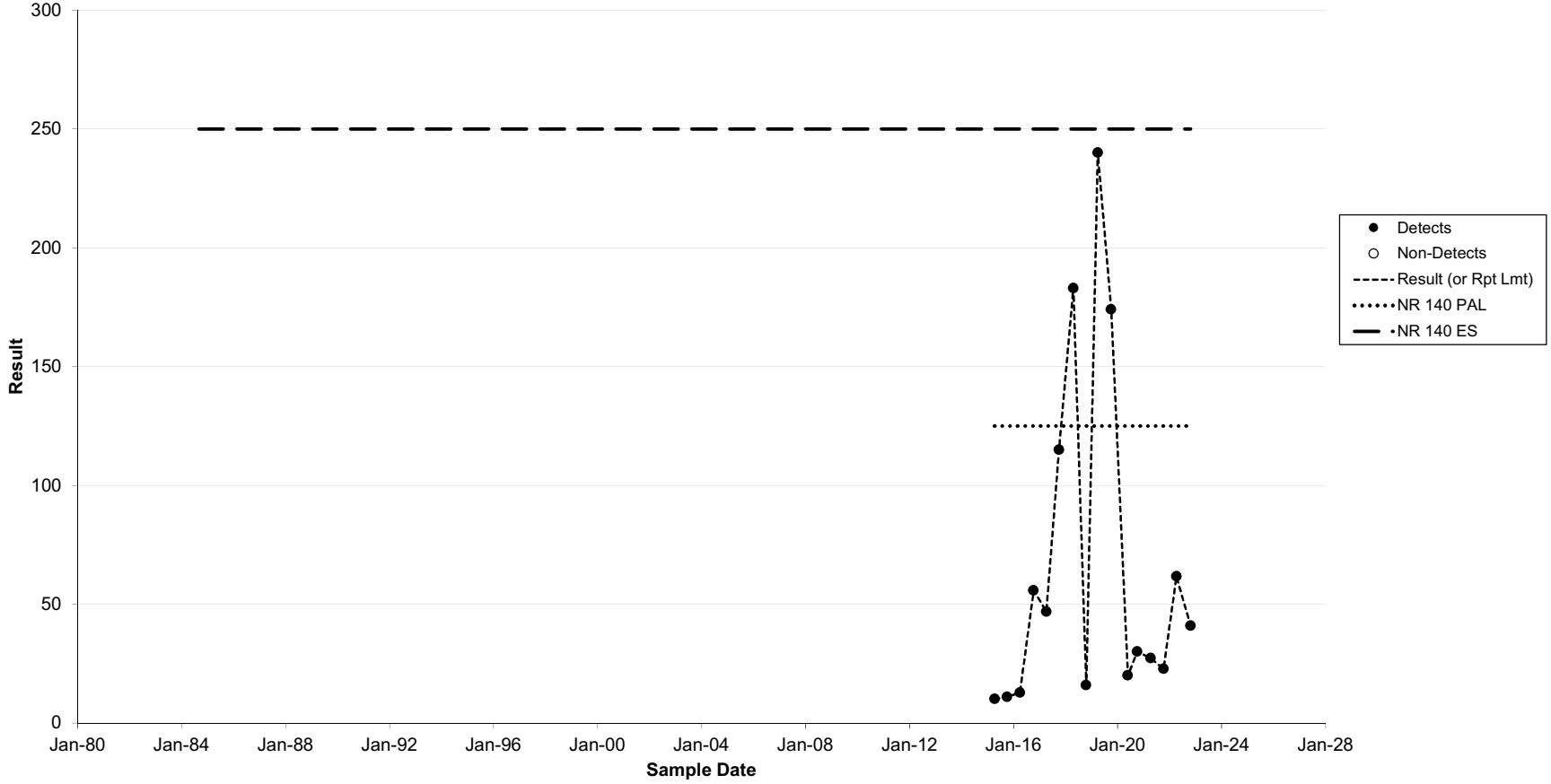
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
HC-2 - Cadmium, total (ug/l as Cd)



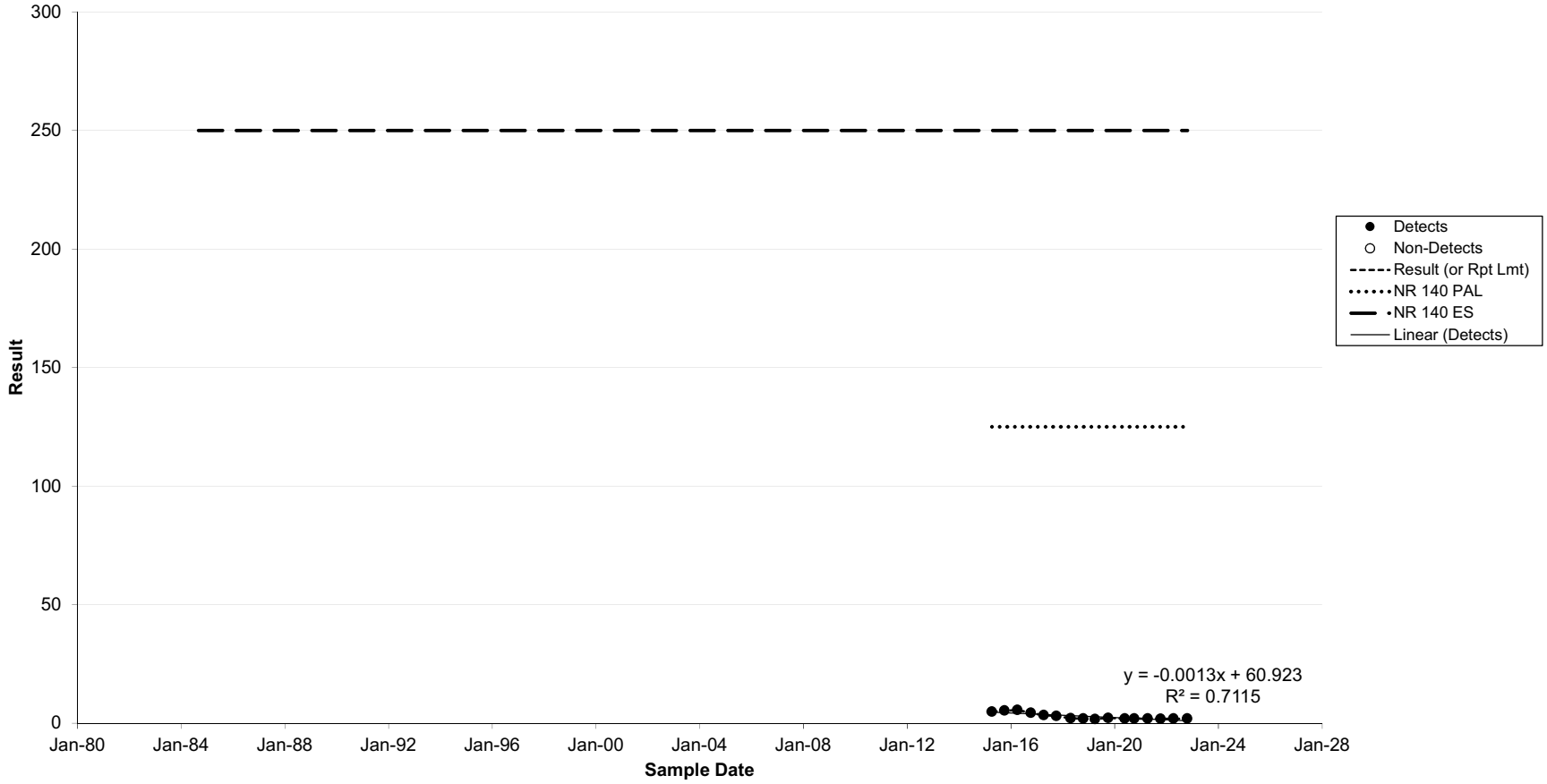
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
HC-3 - Cadmium, total (ug/l as Cd)



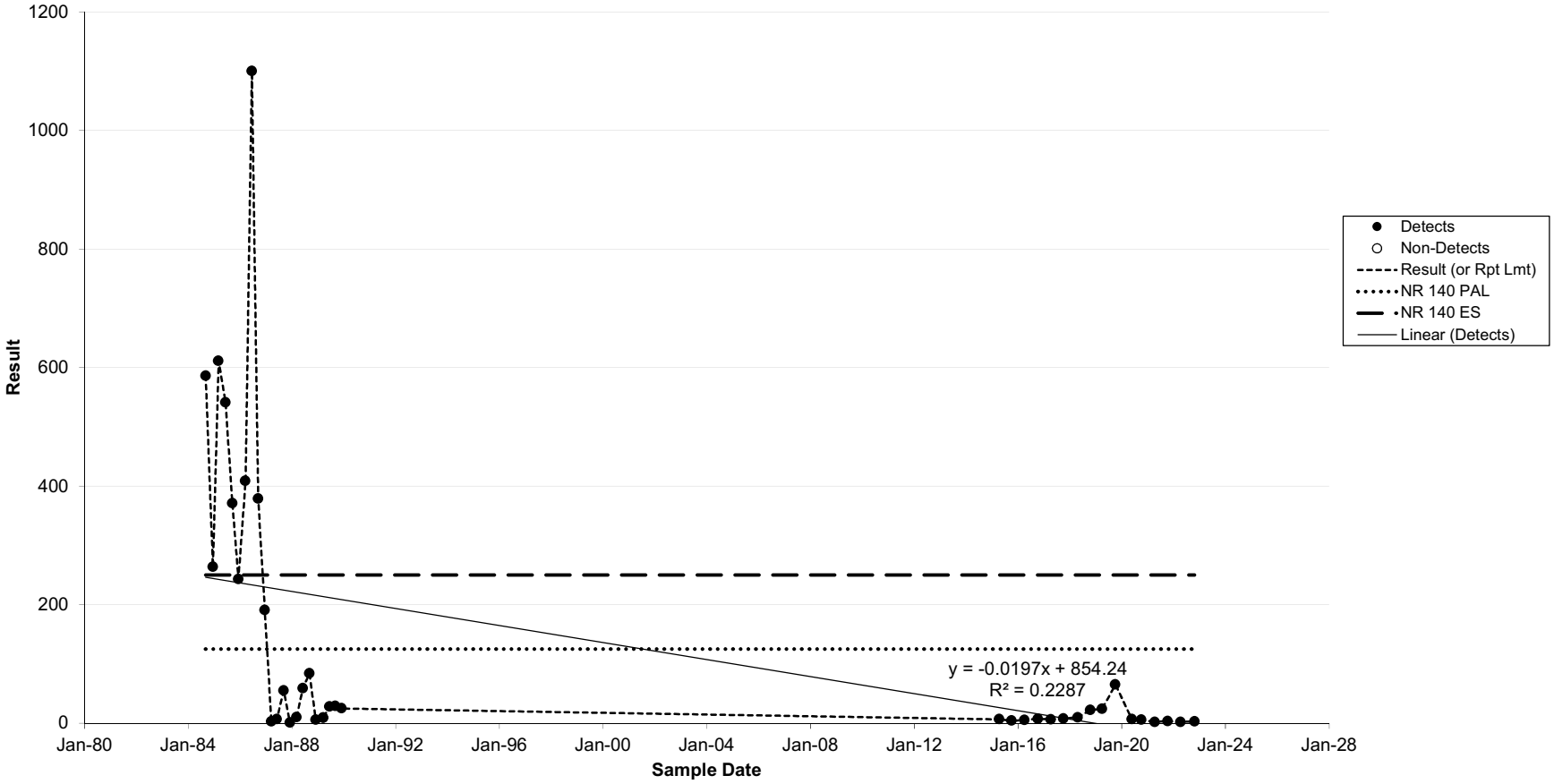
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-33AR - Chloride, dissolved (mg/l as Cl)



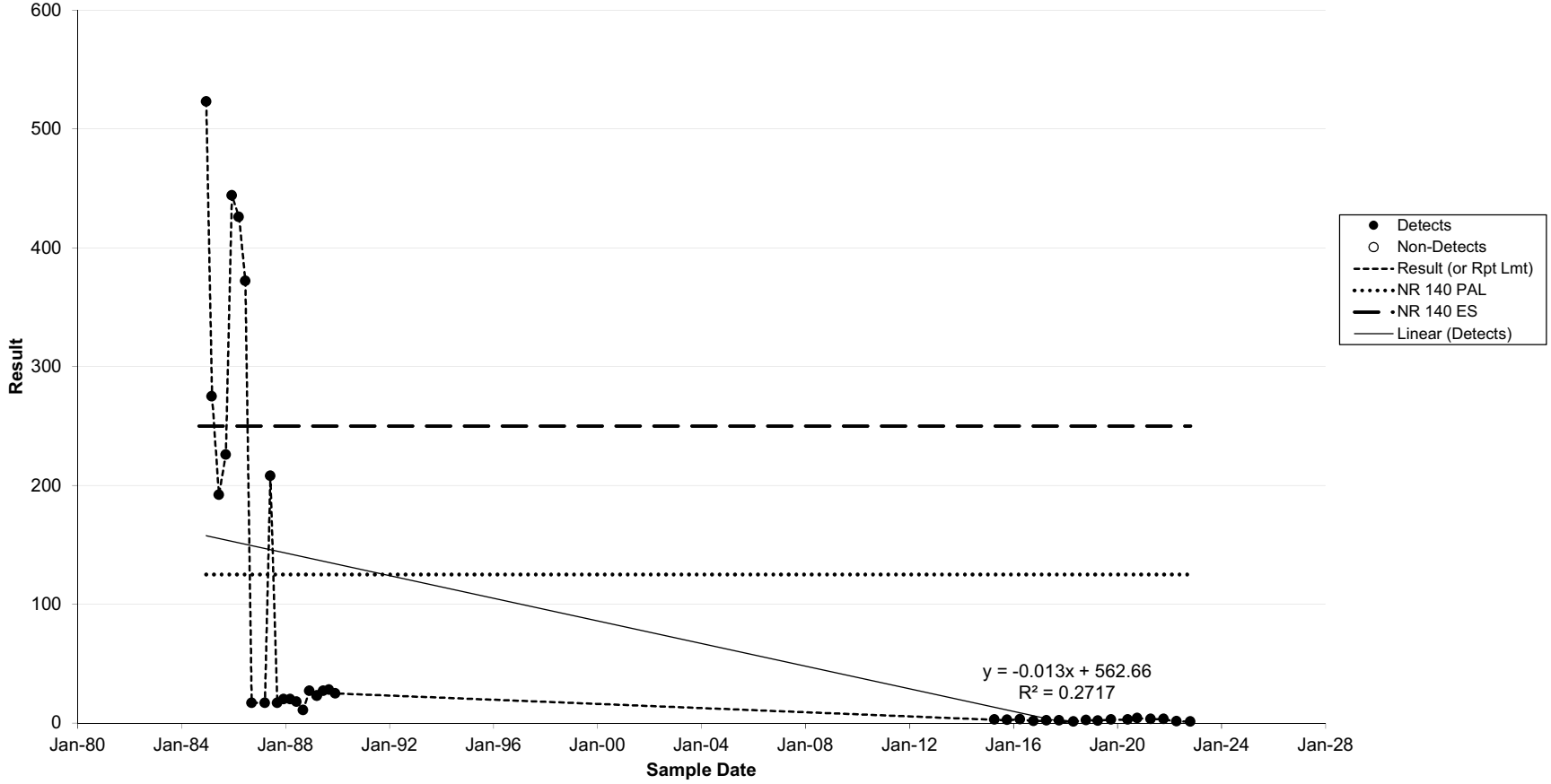
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-33BR - Chloride, dissolved (mg/l as Cl)



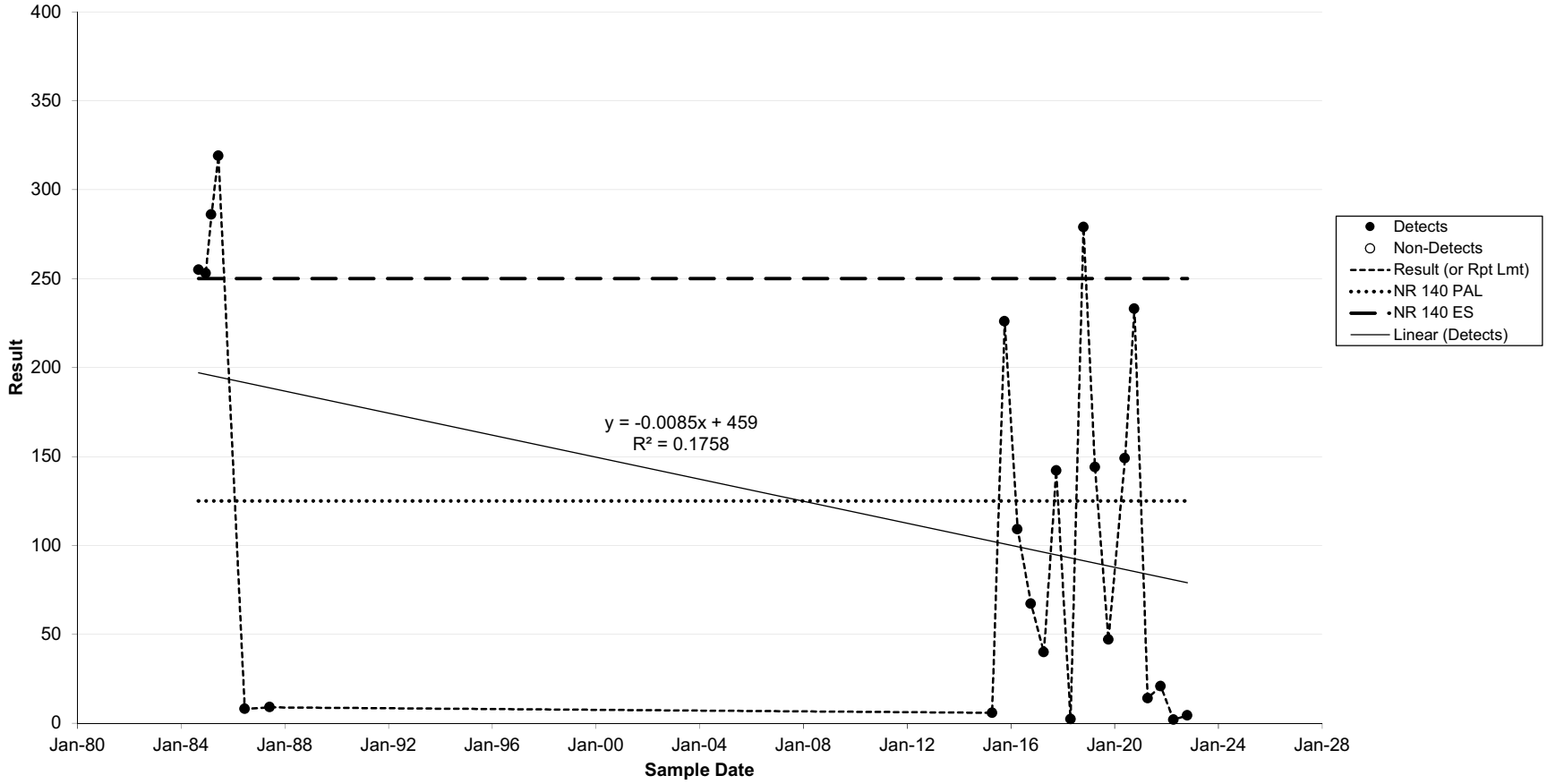
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-34A - Chloride, total (mg/l as Cl)



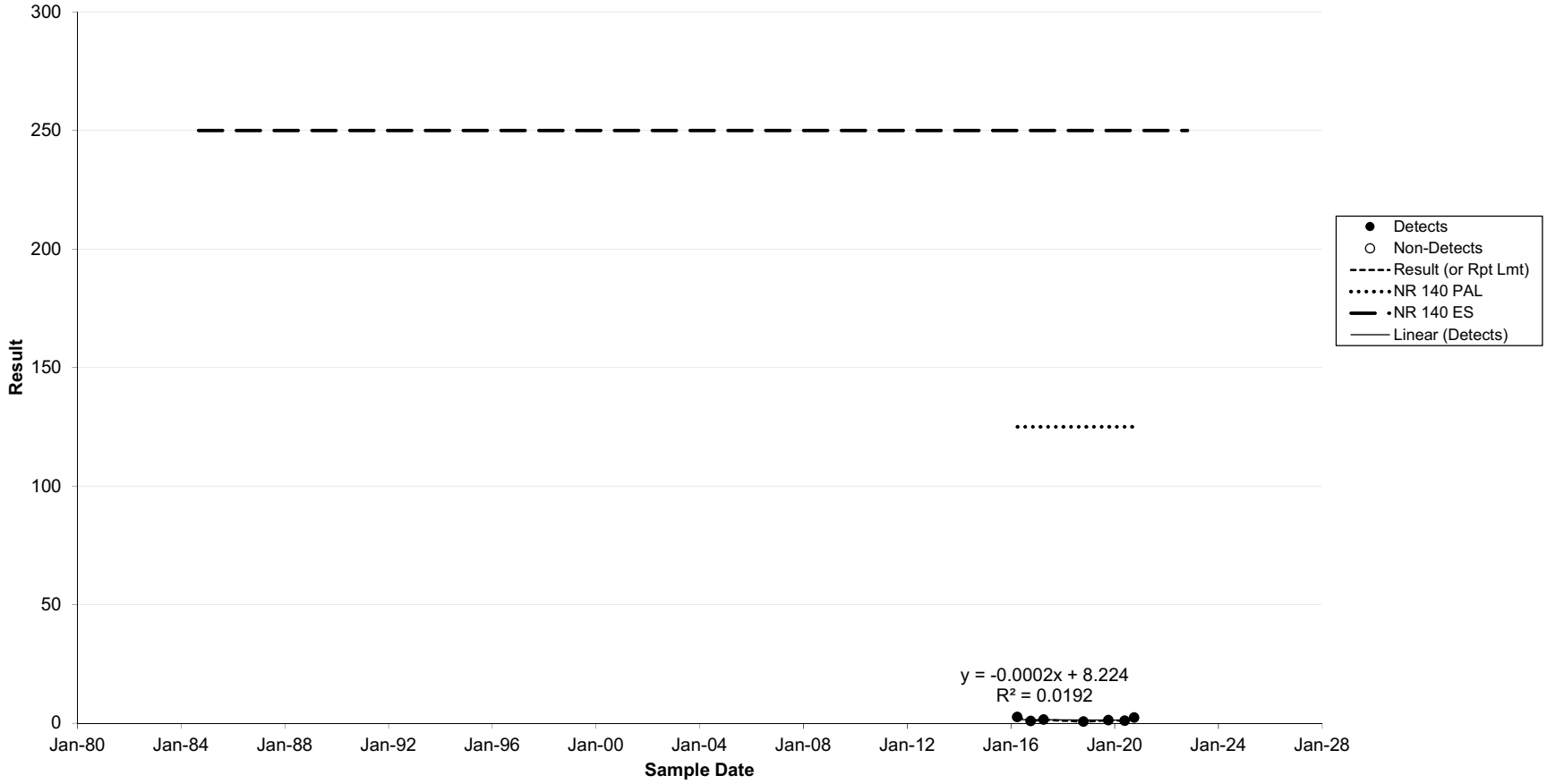
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-34B - Chloride, total (mg/l as Cl)



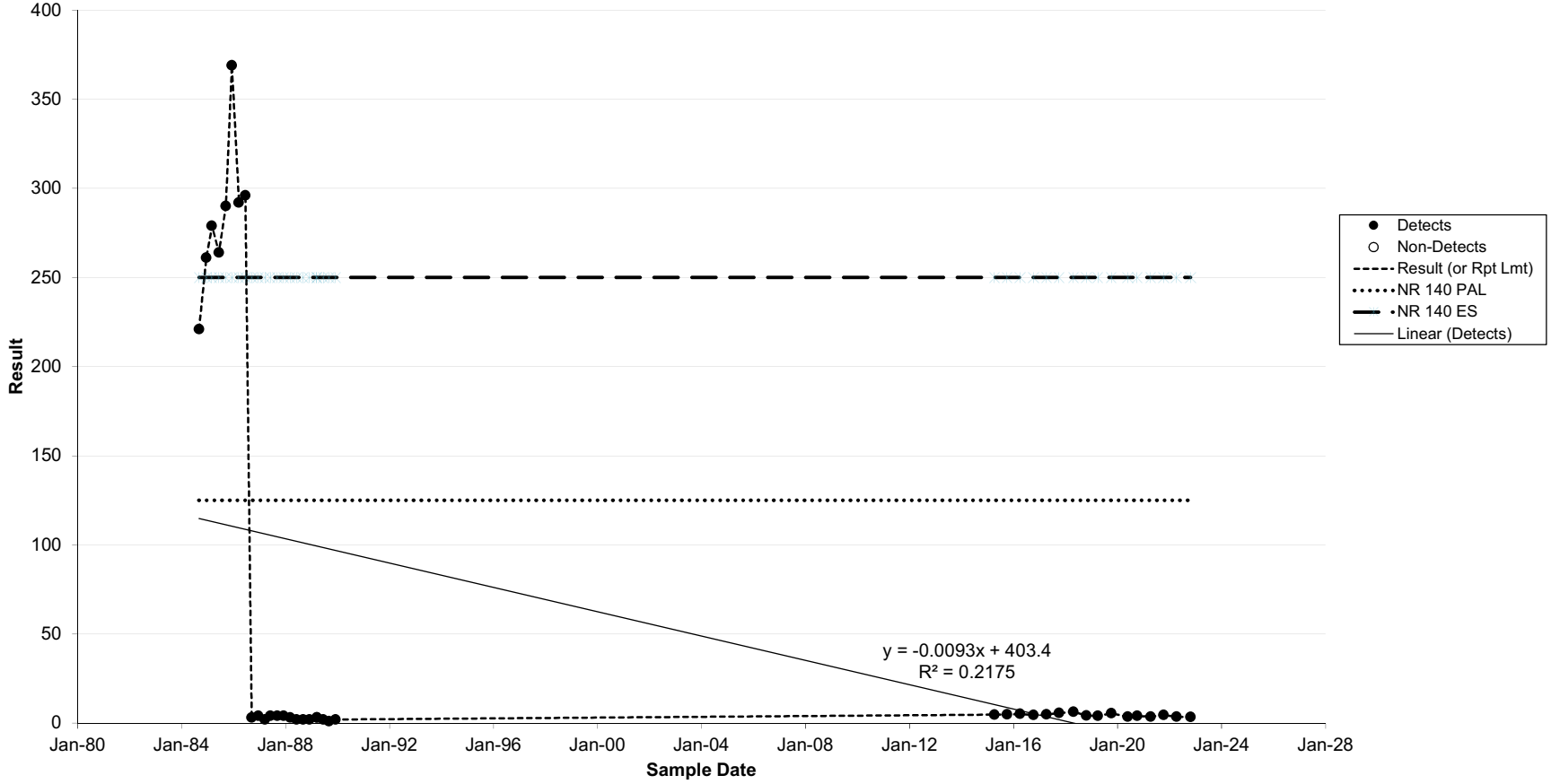
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW37A - Chloride, dissolved (mg/l as Cl)



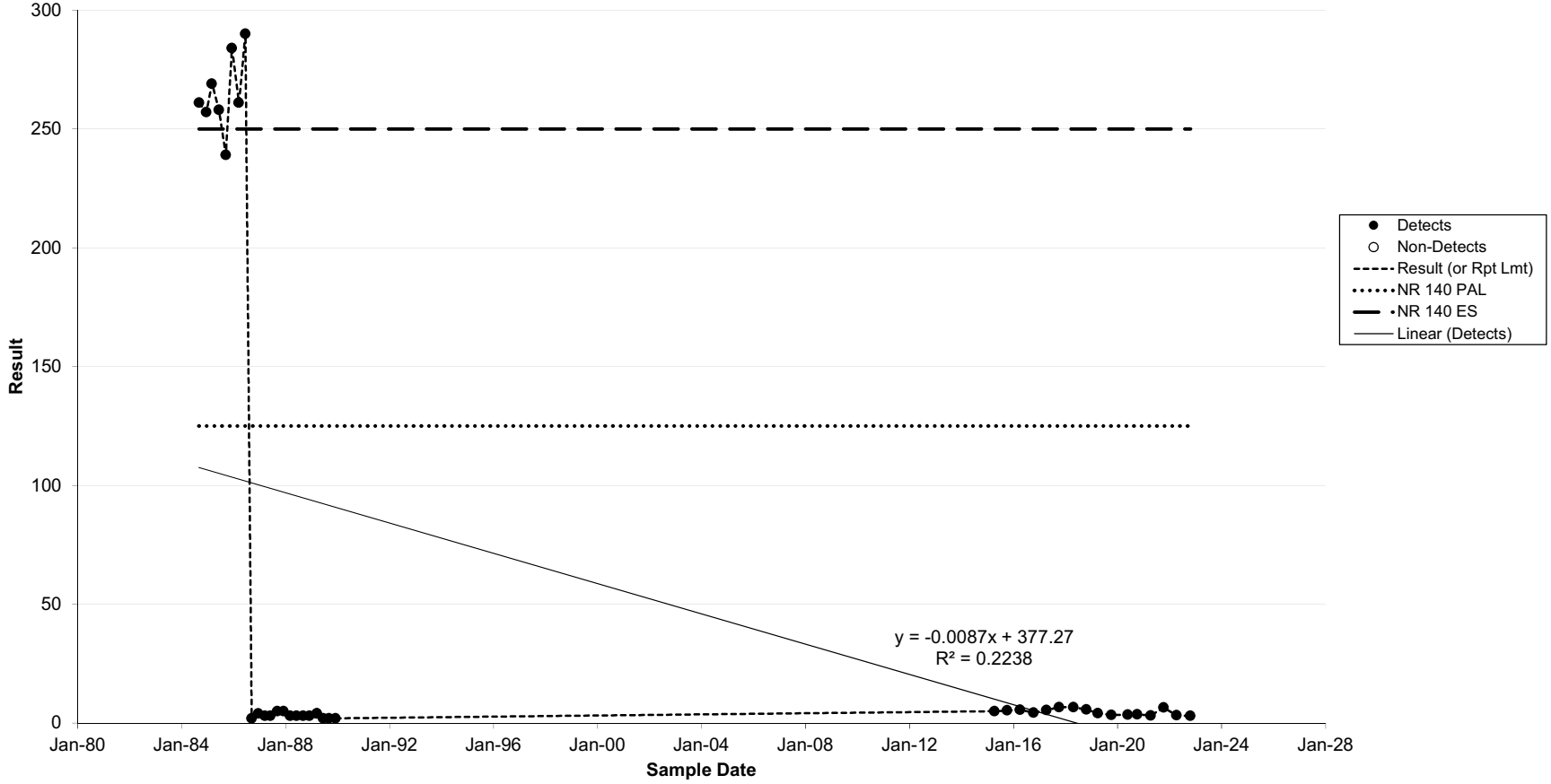
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-83 - Chloride, dissolved (mg/l as Cl)



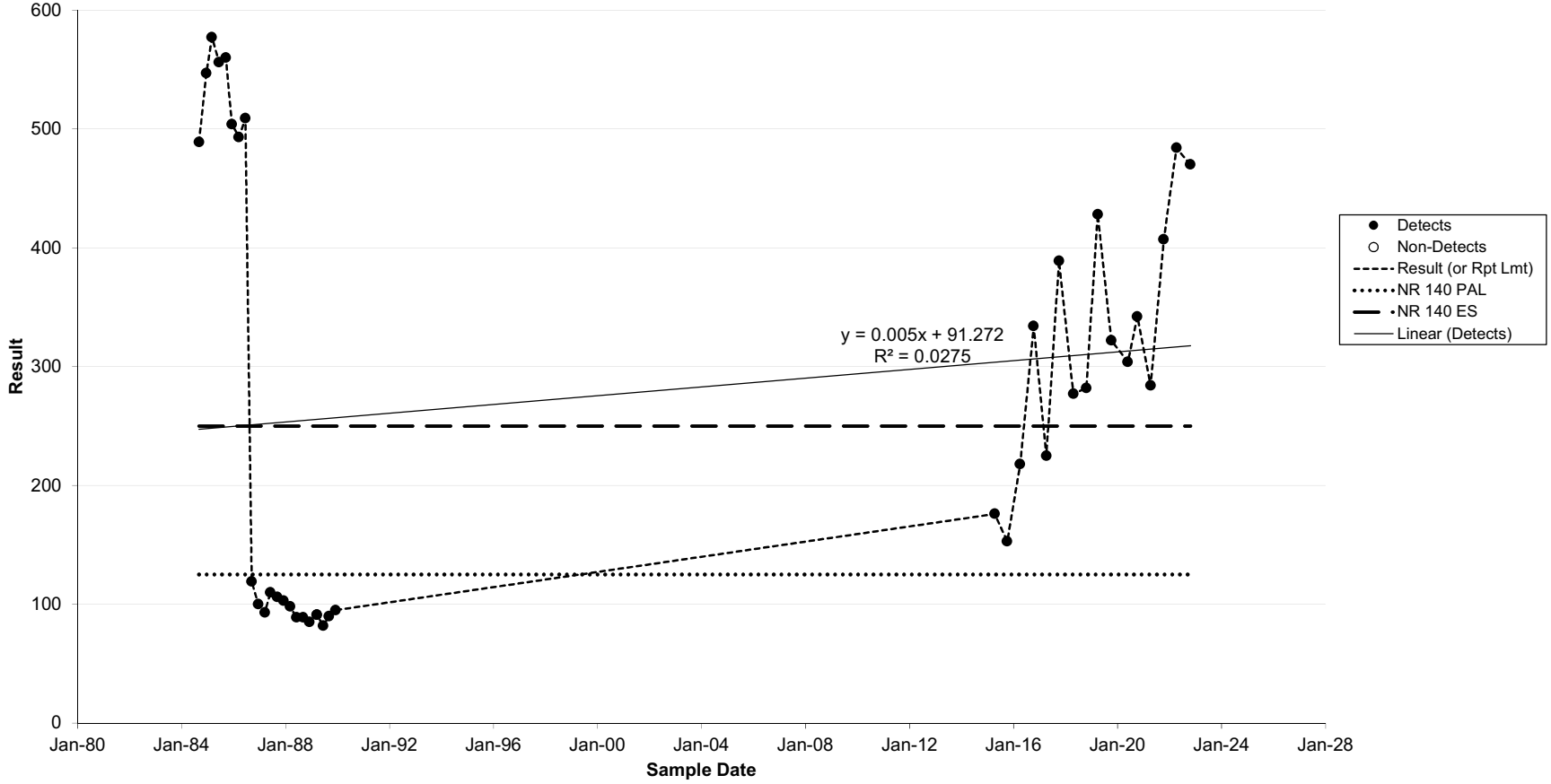
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-84A - Chloride, total (mg/l as Cl)



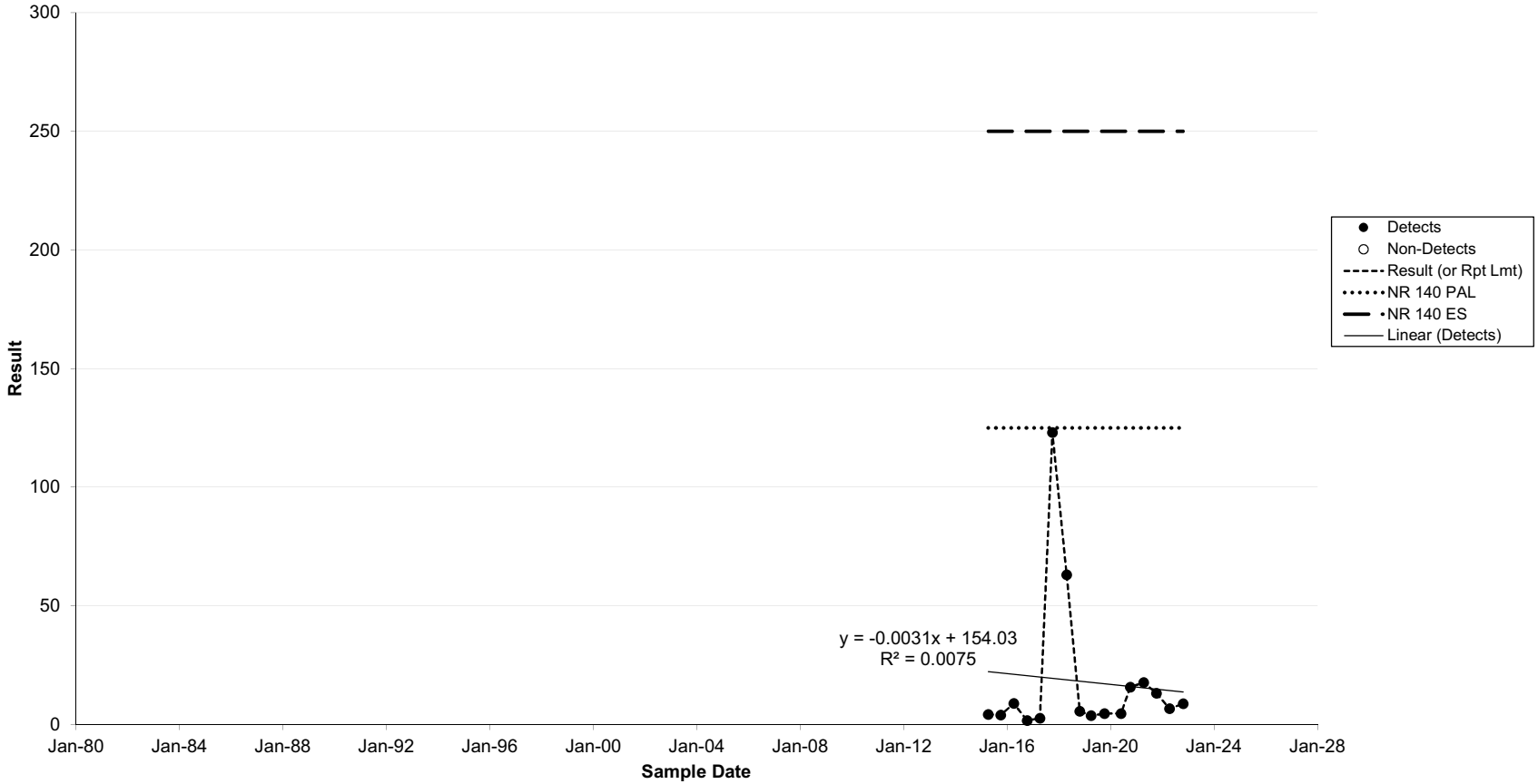
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-84B - Chloride, total (mg/l as Cl)



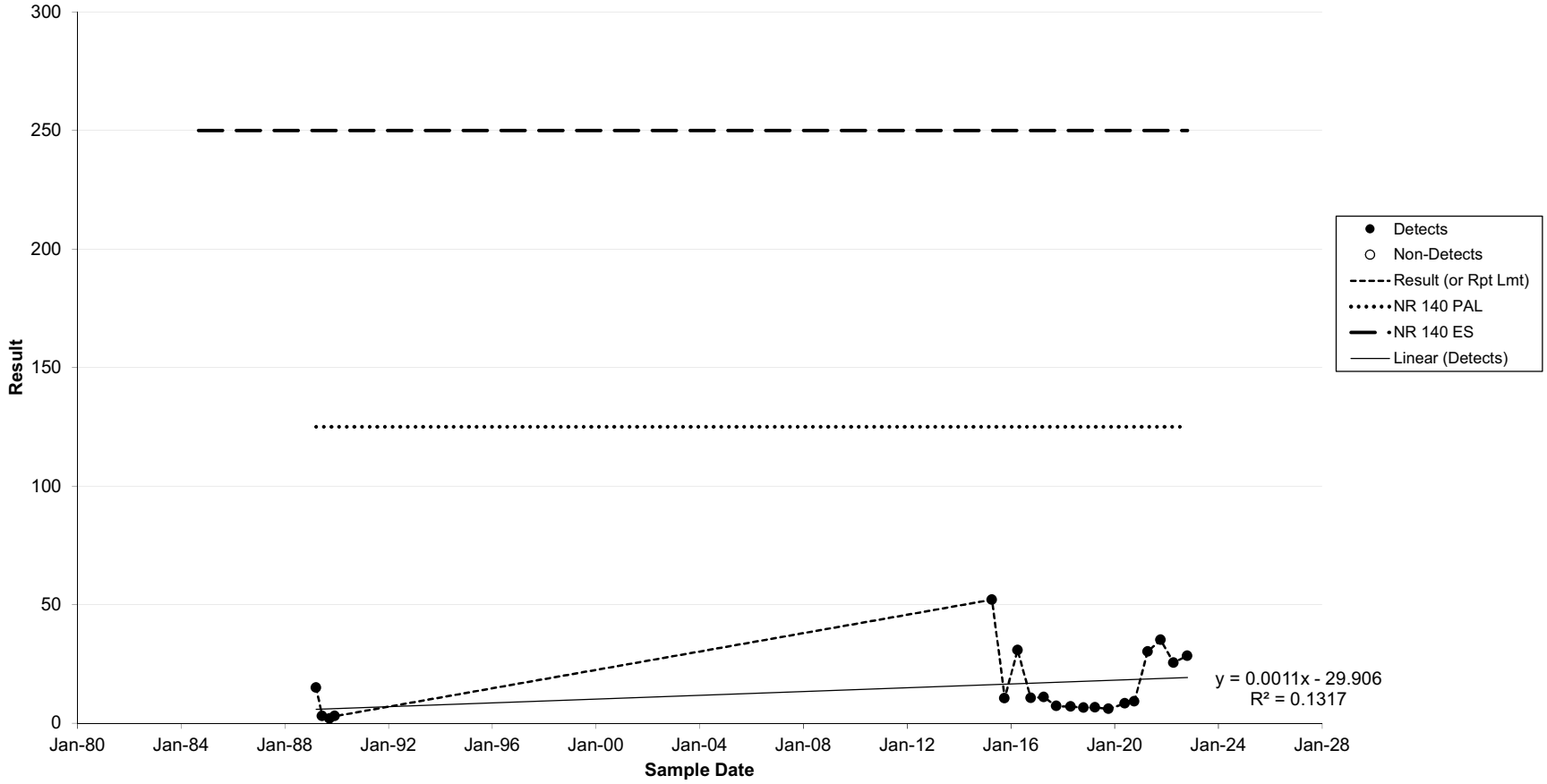
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-86 - Chloride, total (mg/l as Cl)



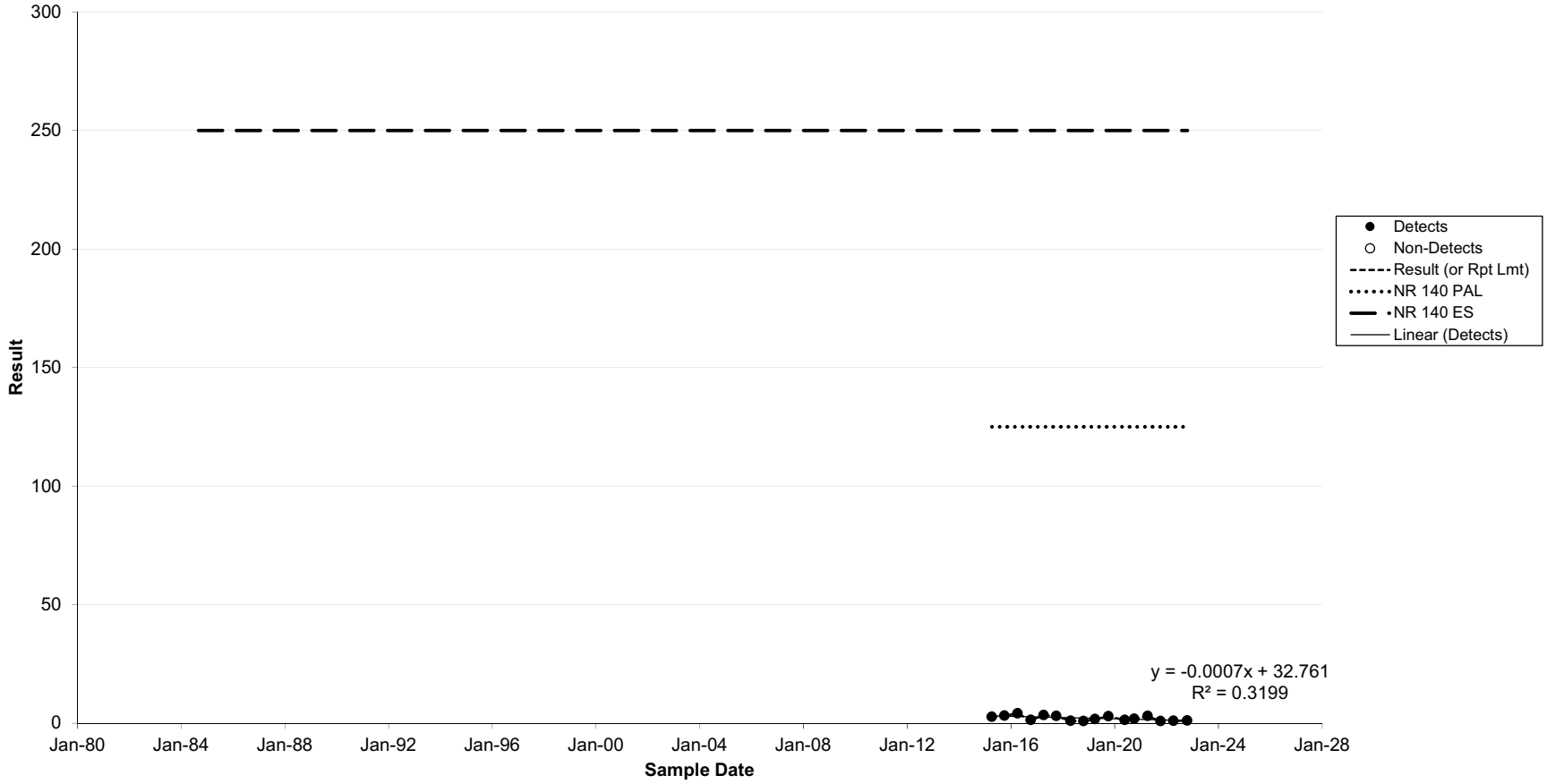
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-91AR - Chloride, dissolved (mg/l as Cl)



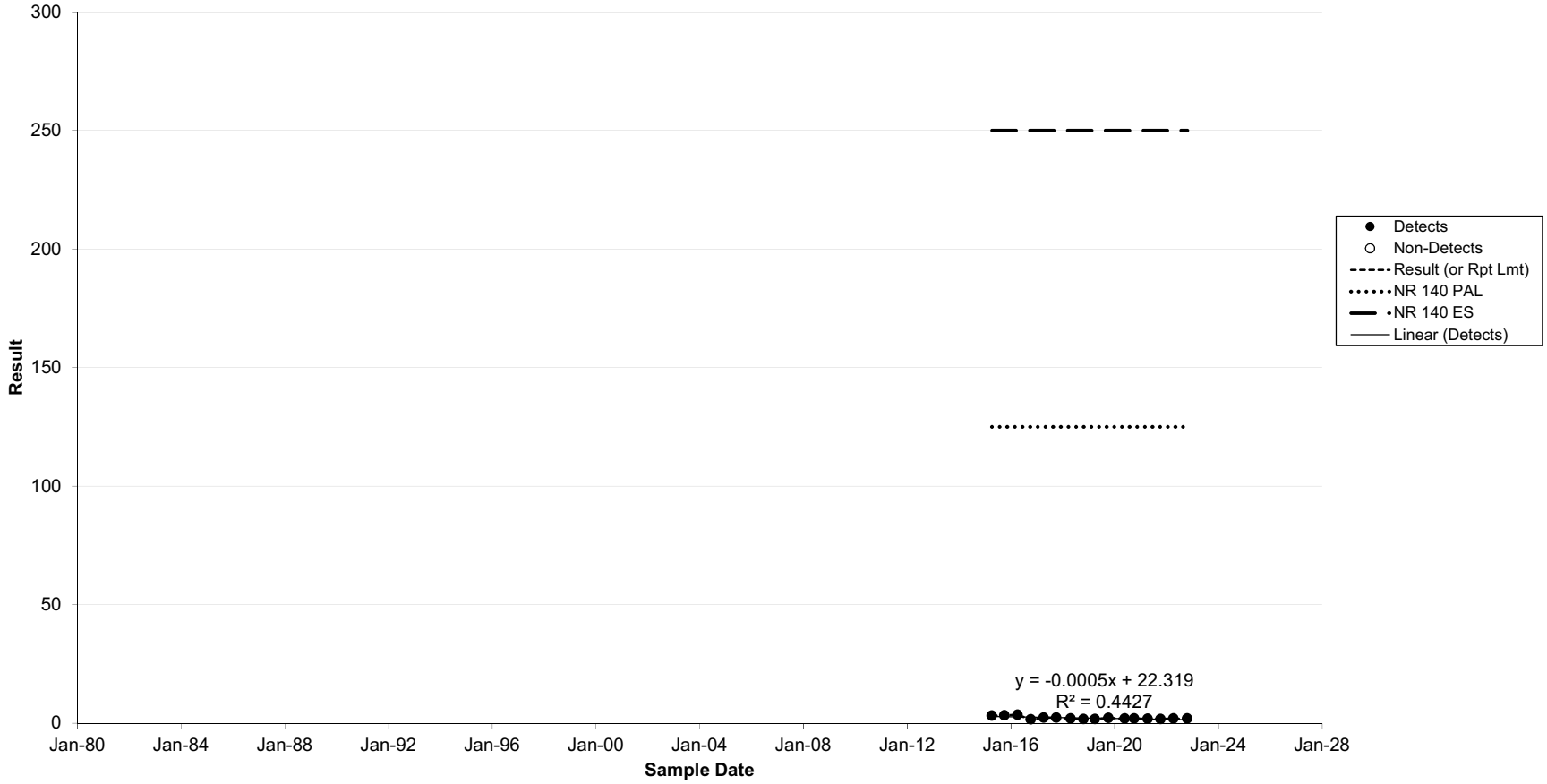
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-91B - Chloride, dissolved (mg/l as Cl)



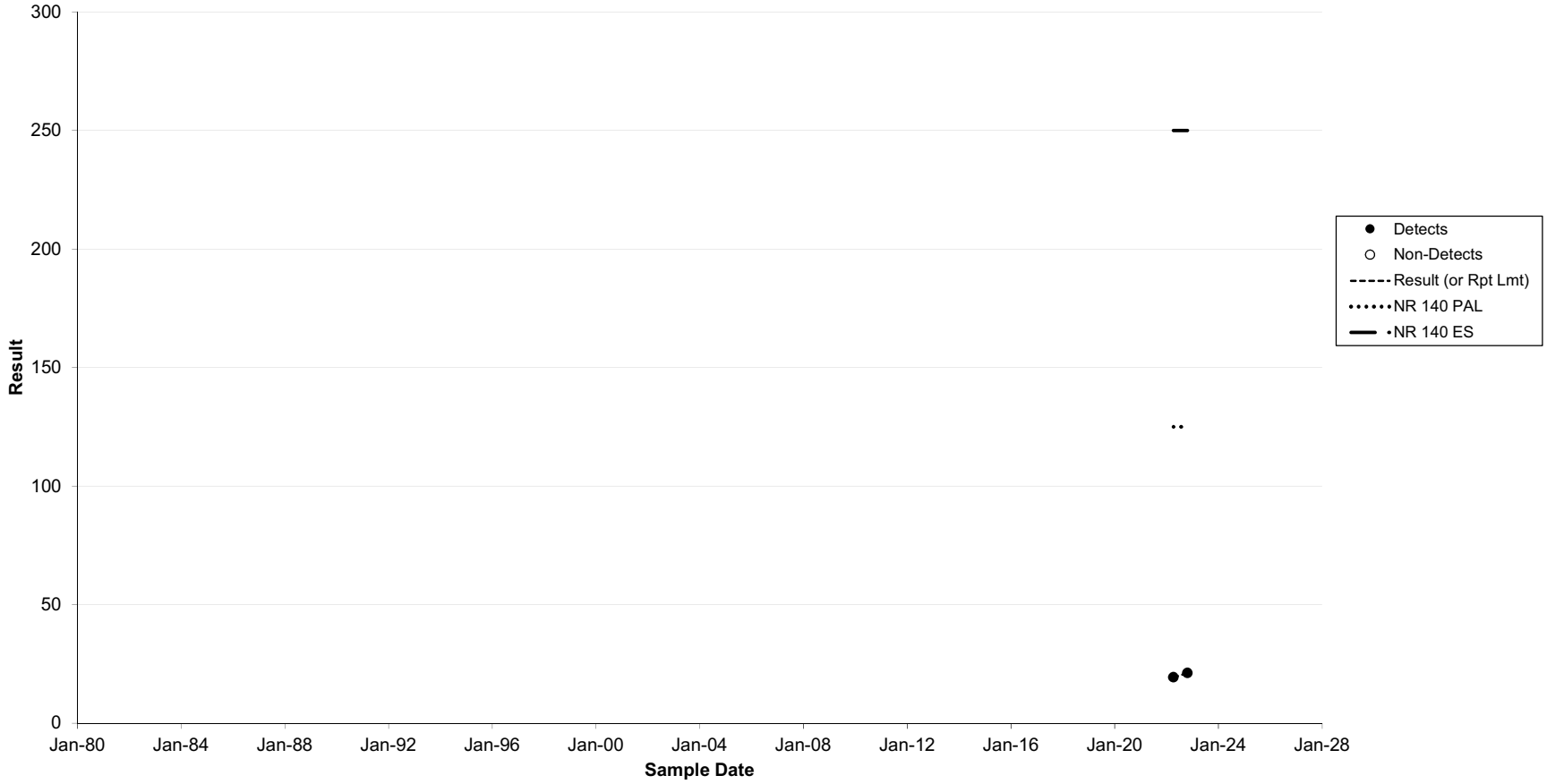
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-92A - Chloride, dissolved (mg/l as Cl)



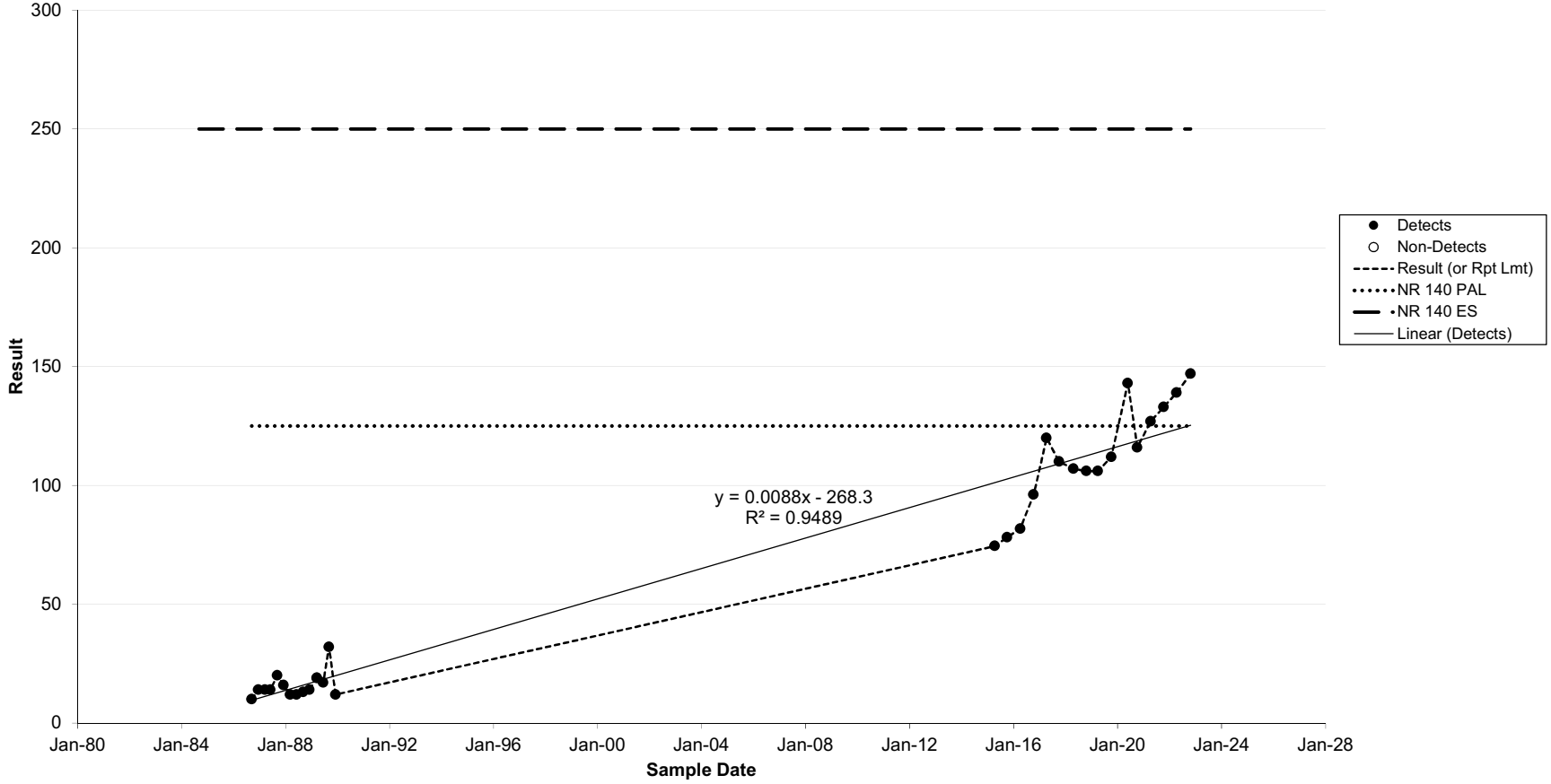
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-92B - Chloride, dissolved (mg/l as Cl)



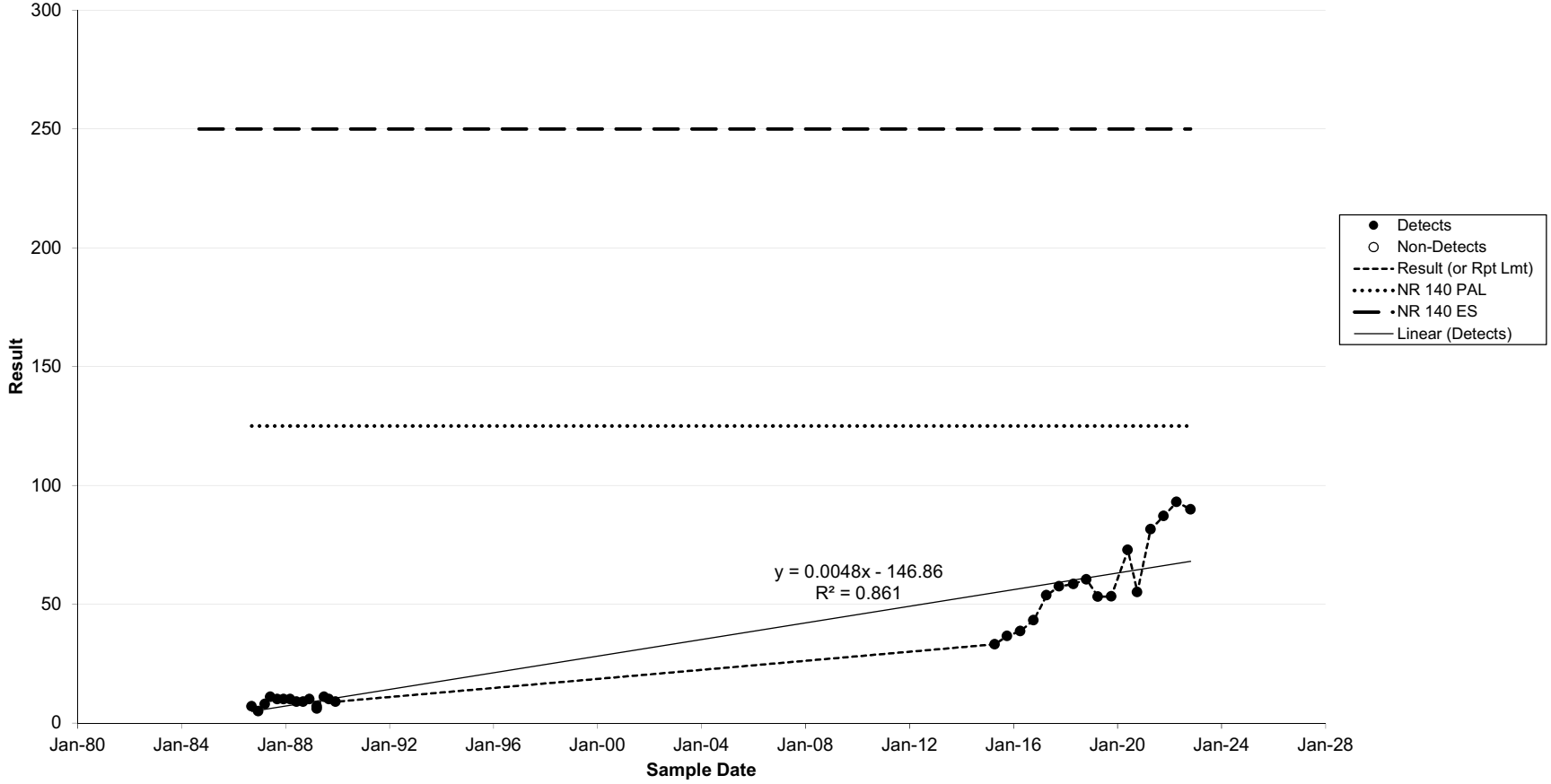
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-93A - Chloride, dissolved (mg/l as Cl)



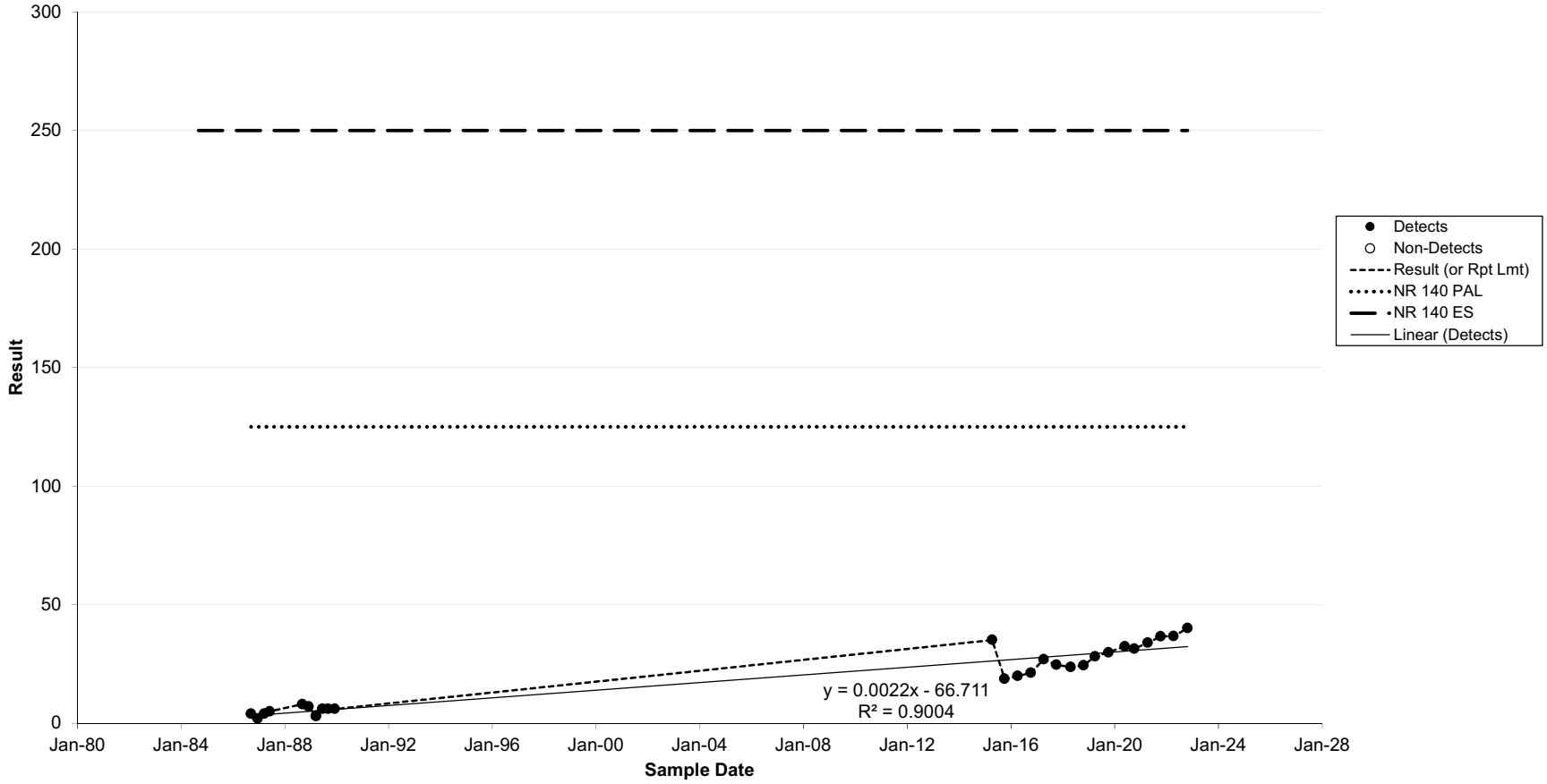
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
HC-1 - Chloride, total (mg/l as Cl)



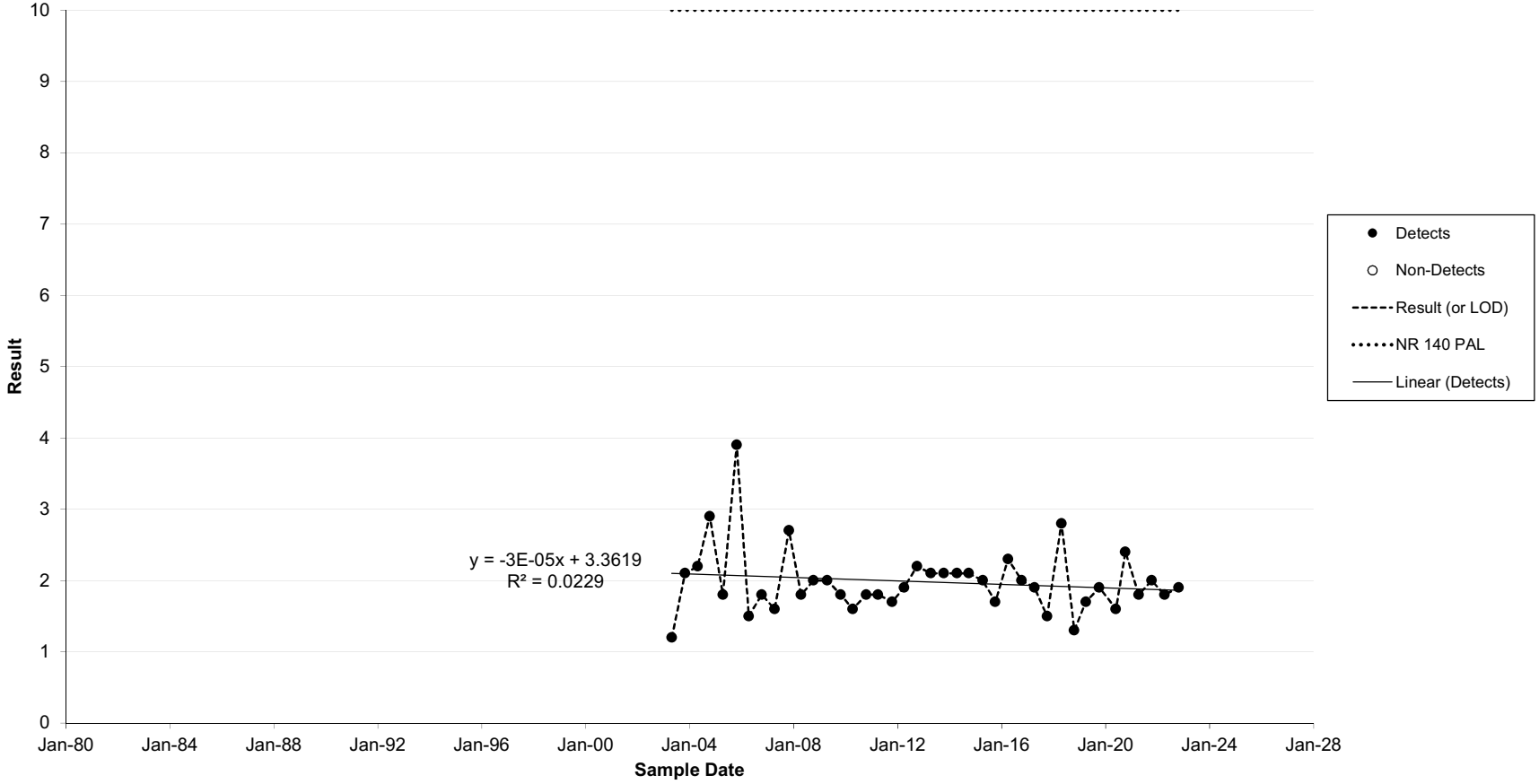
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
HC-2 - Chloride, total (mg/l as Cl)



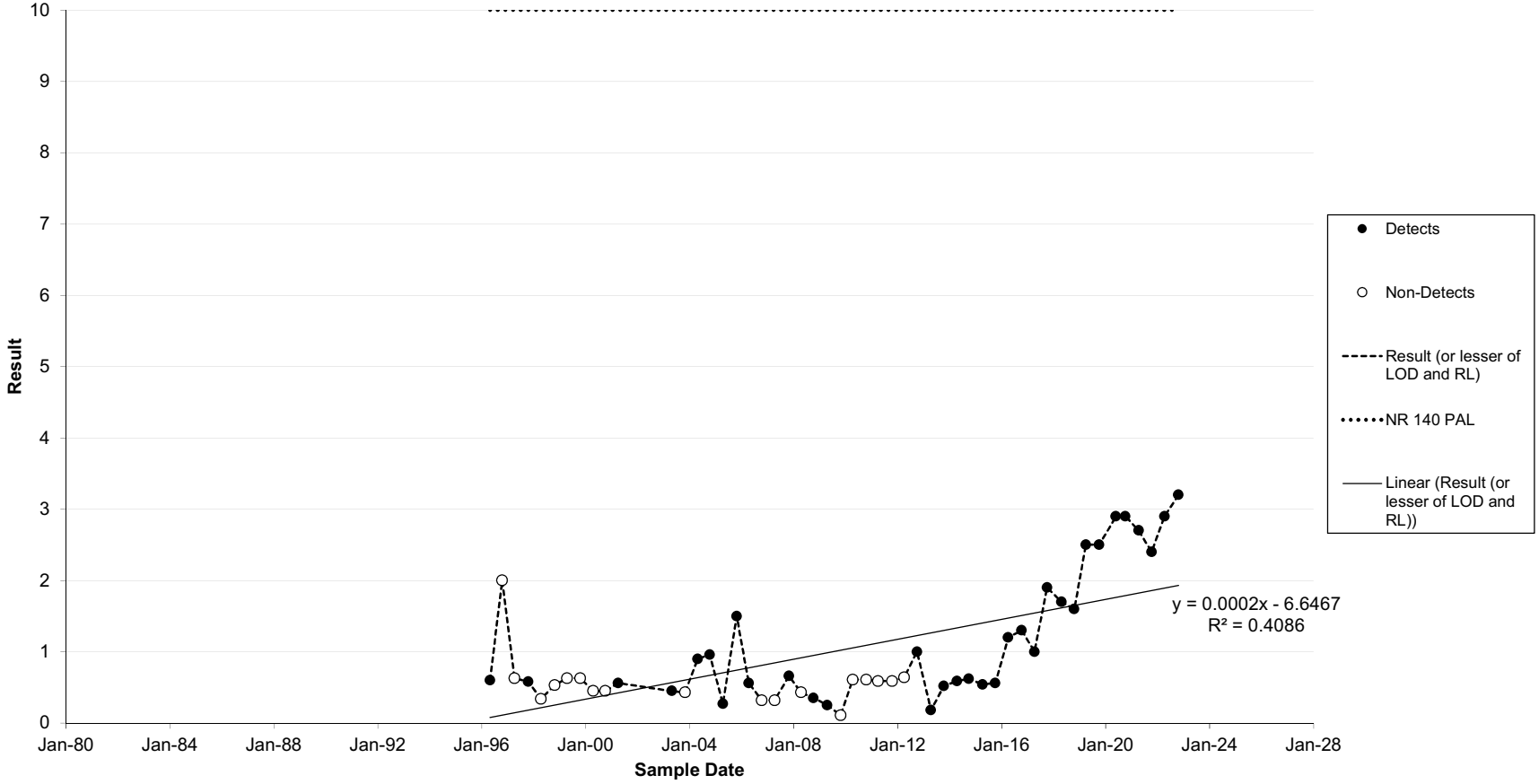
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
HC-3 - Chloride, total (mg/l as Cl)



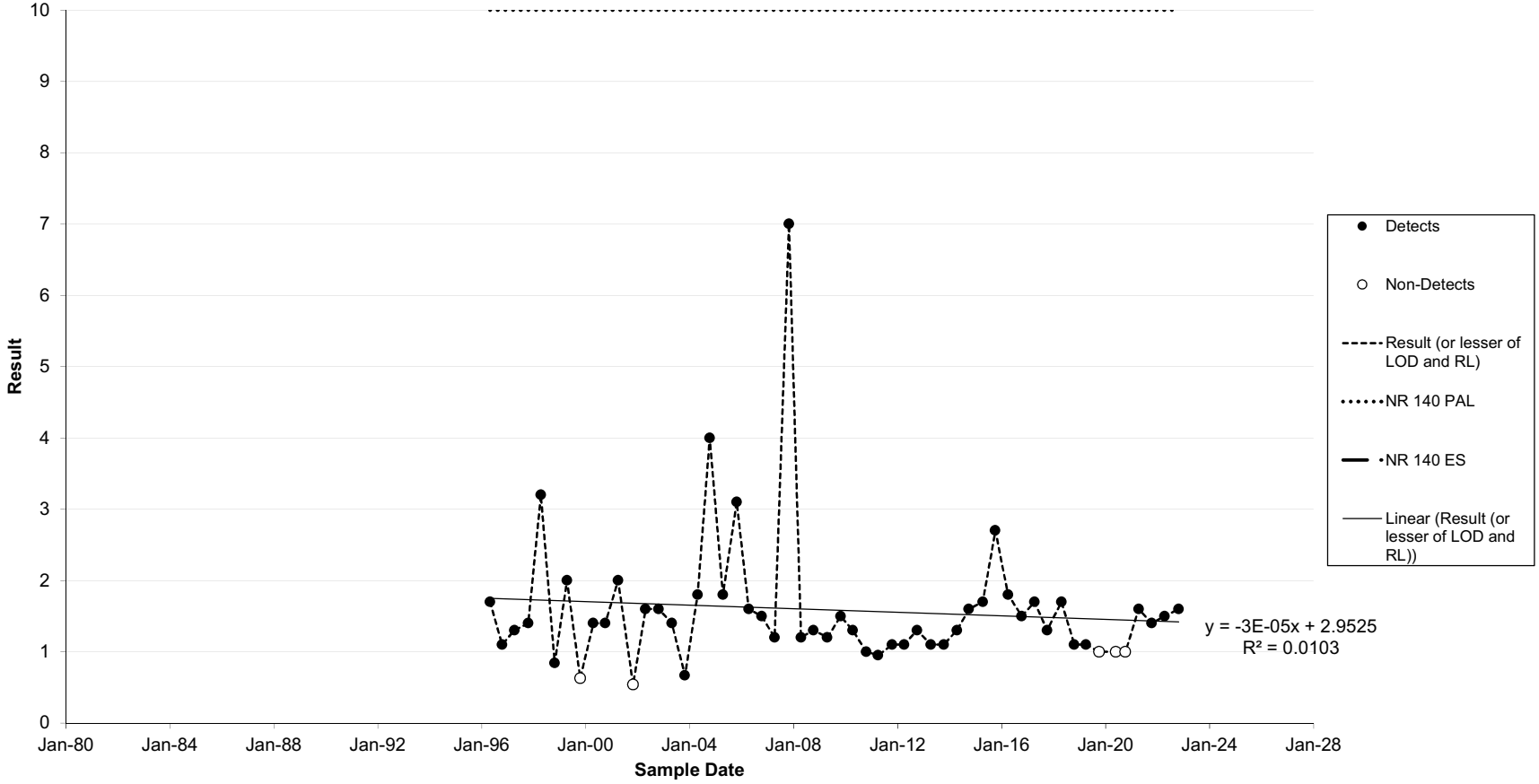
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-33AR - Chromium, dissolved (ug/l as Cr)



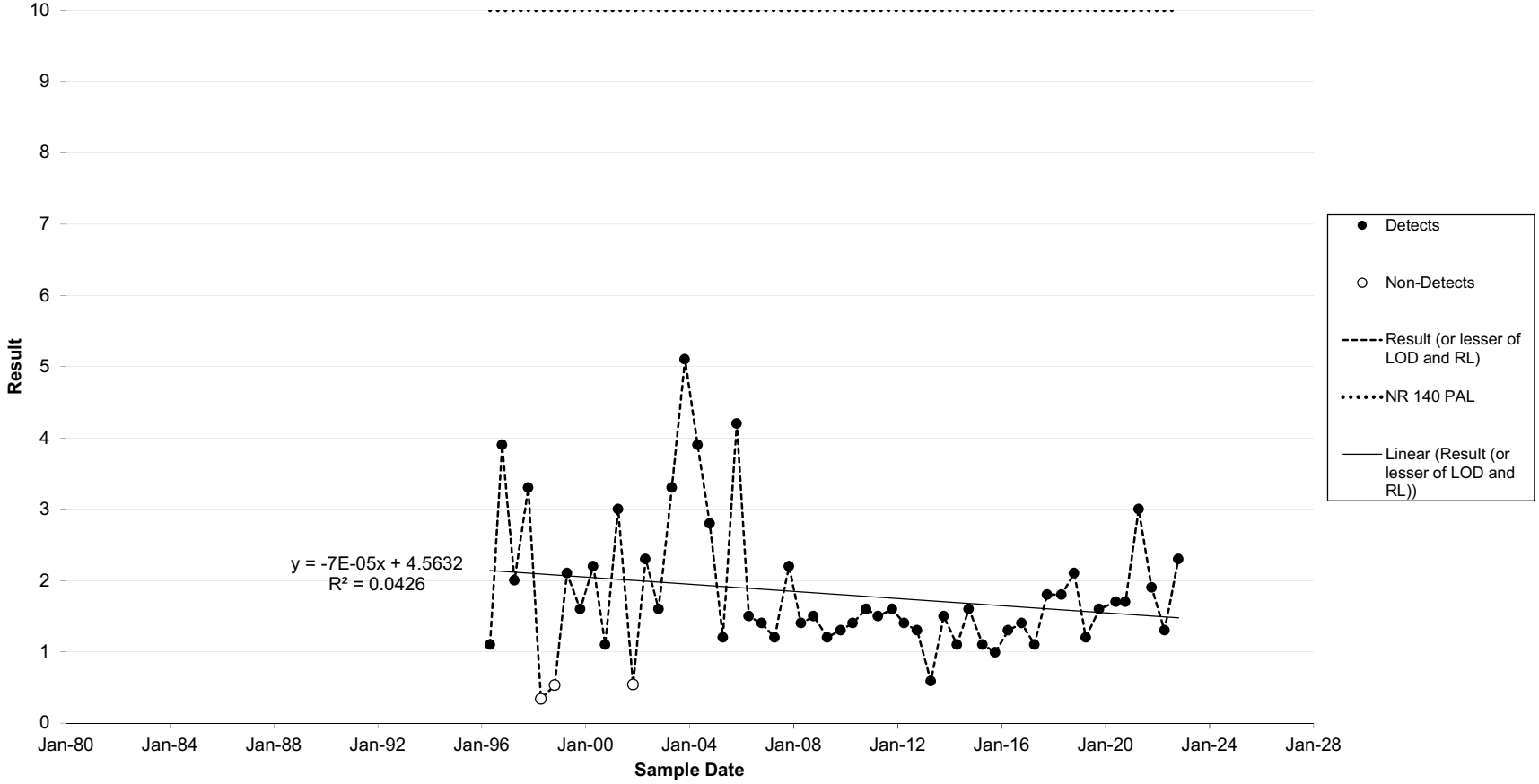
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-33B - Chromium, dissolved (ug/l as Cr)



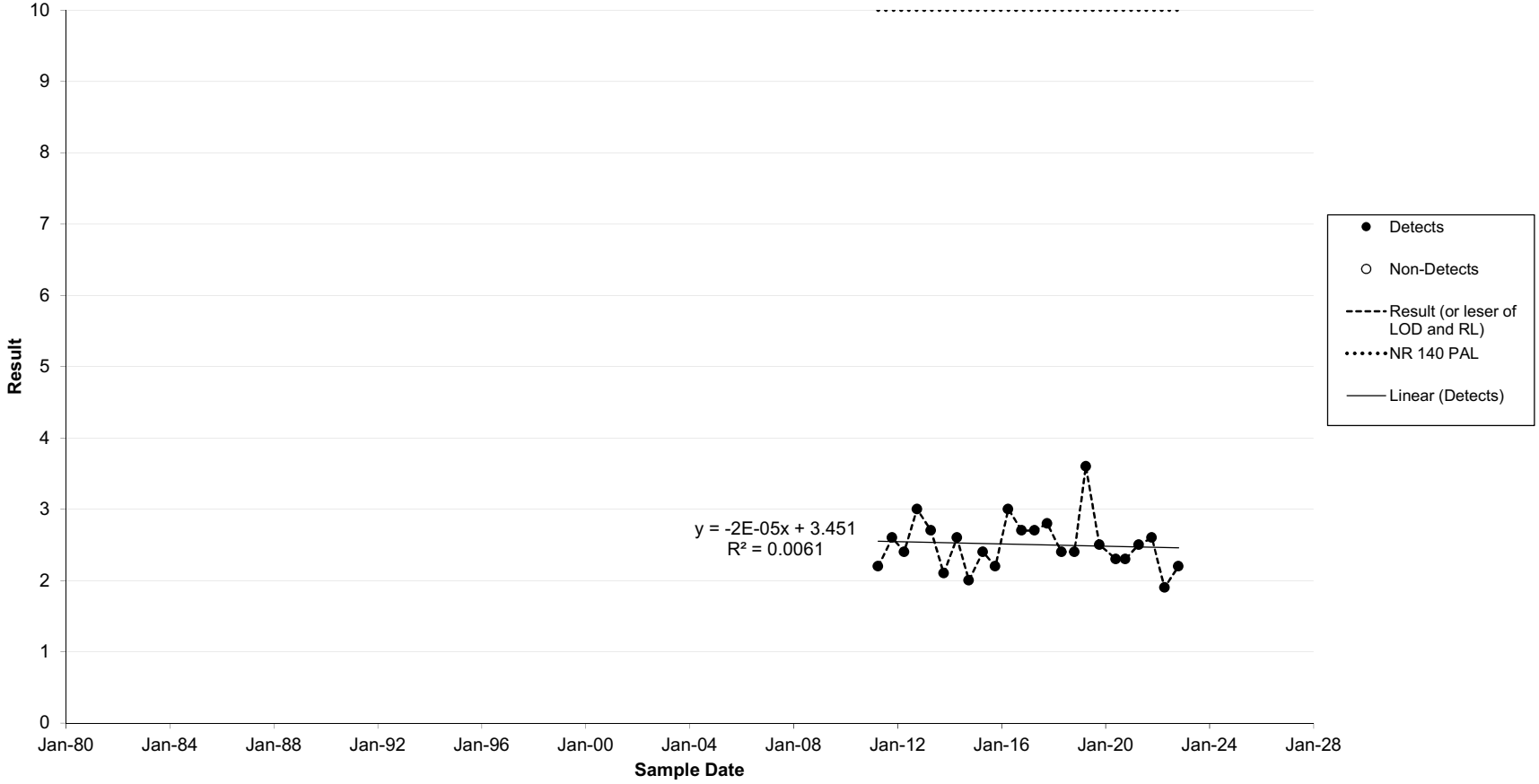
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-34A - Chromium, dissolved (ug/l as Cr)



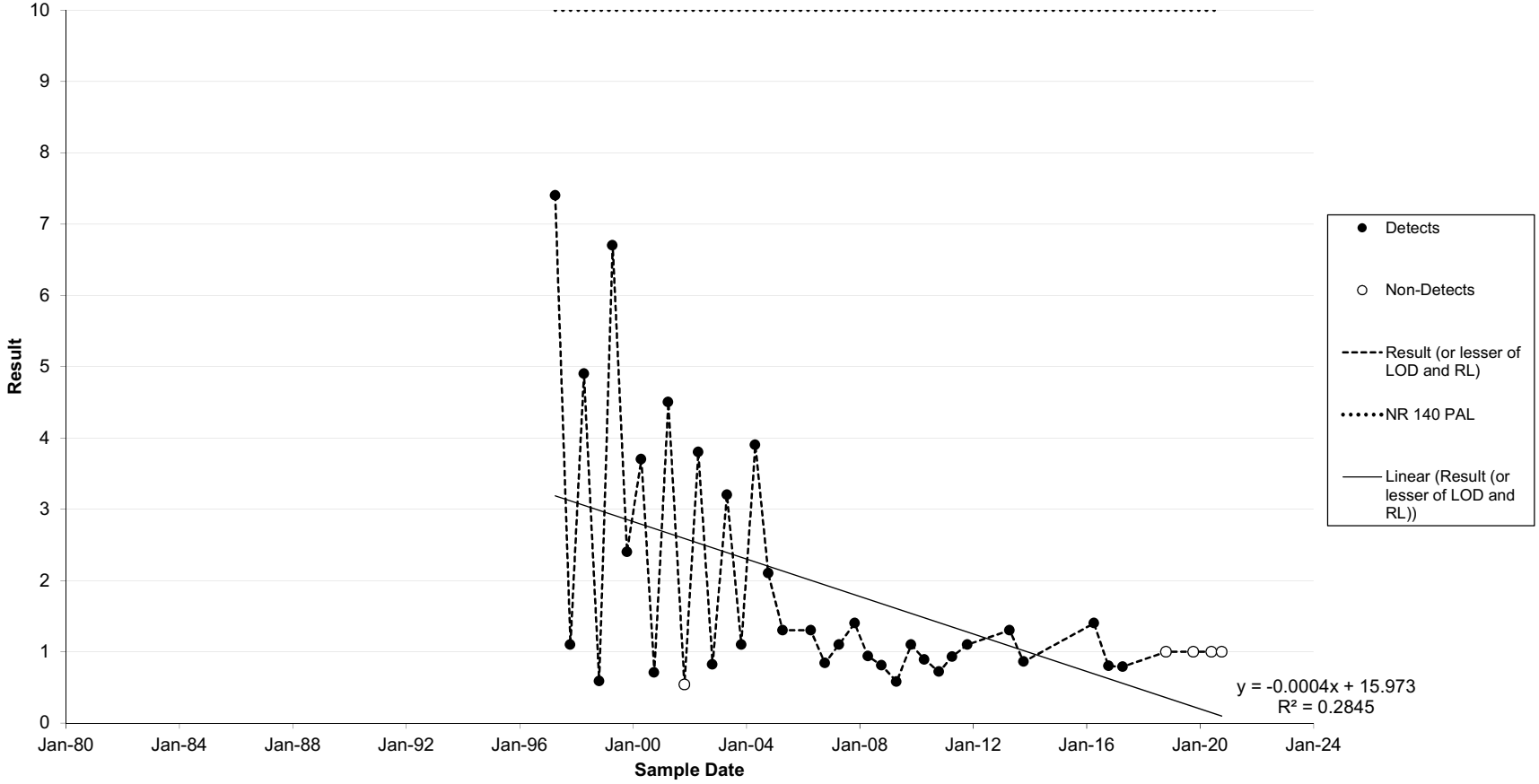
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-34B - Chromium, dissolved (ug/l as Cr)



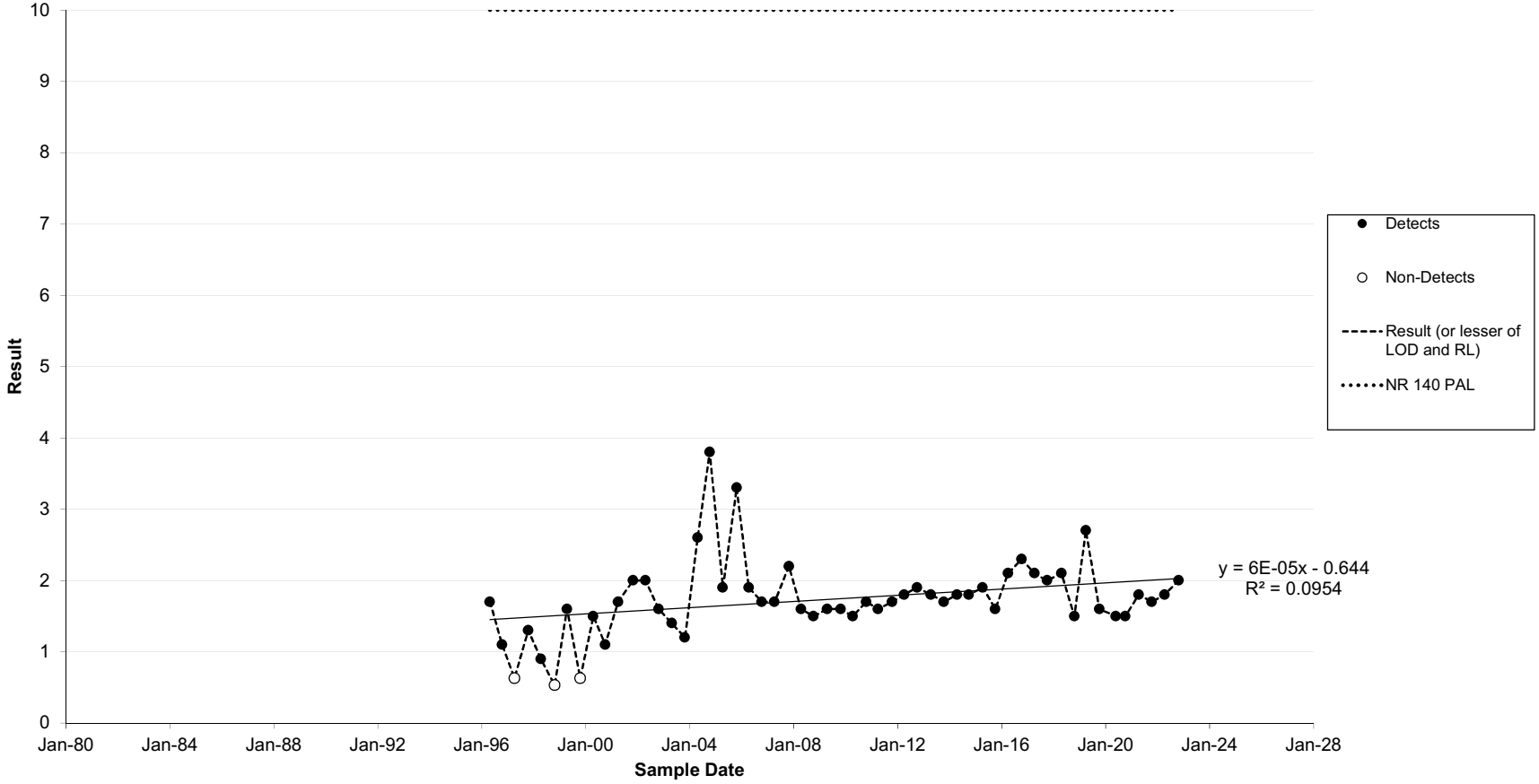
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-37A - Chromium, dissolved (ug/l as Cr)



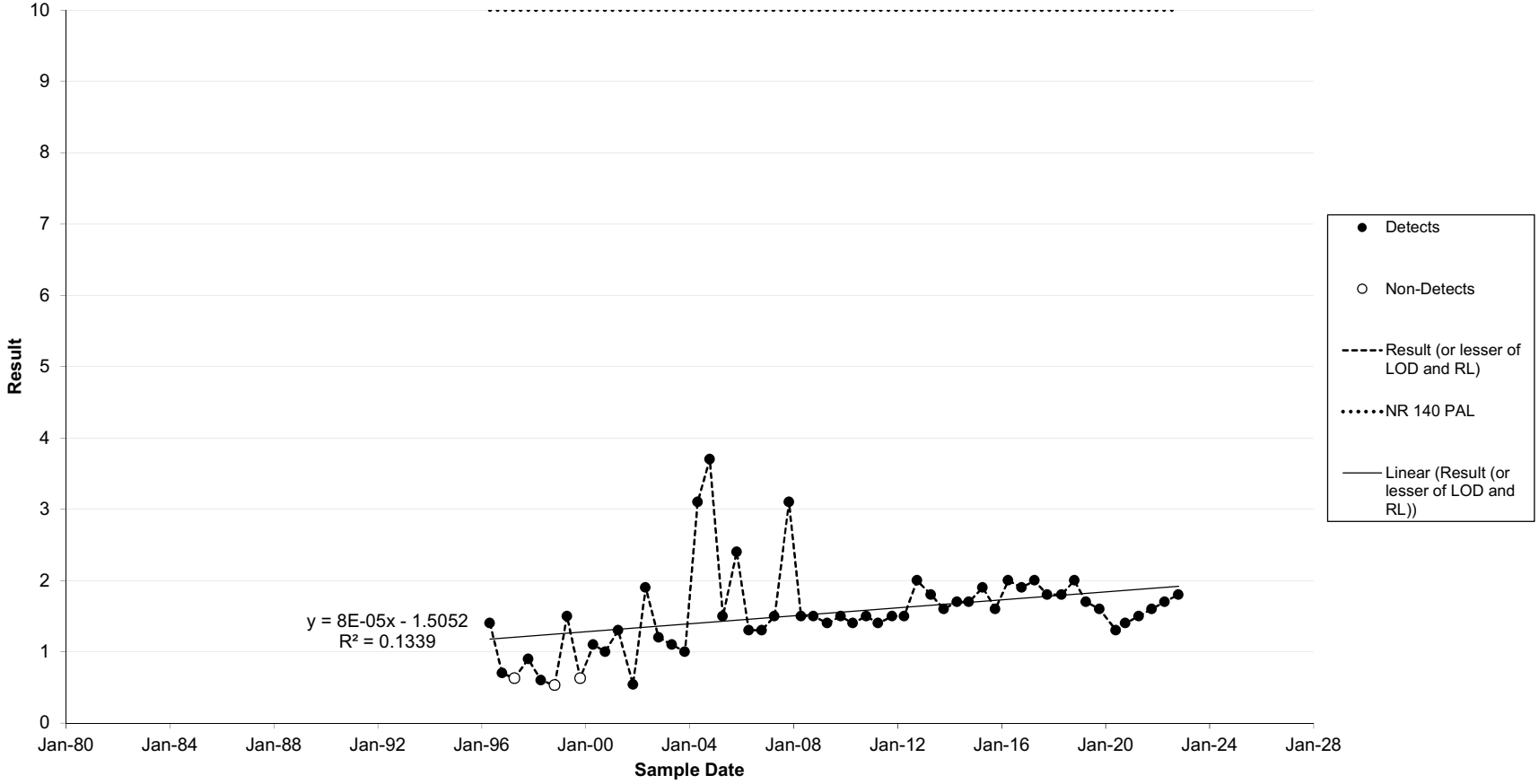
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-83 - Chromium, dissolved (ug/l as Cr)



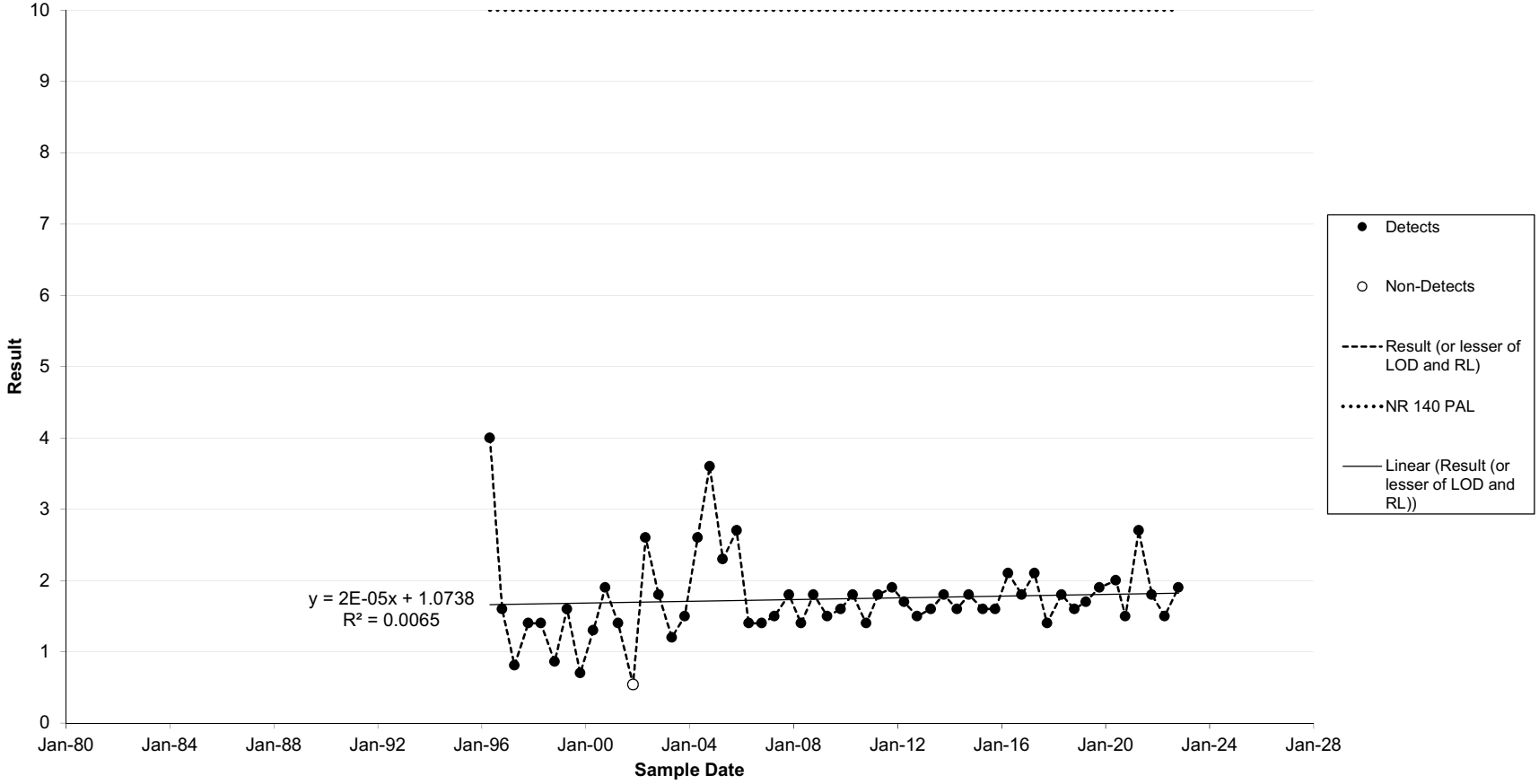
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-84A - Chromium, dissolved (ug/l as Cr)



Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-84B - Chromium, dissolved (ug/l as Cr)

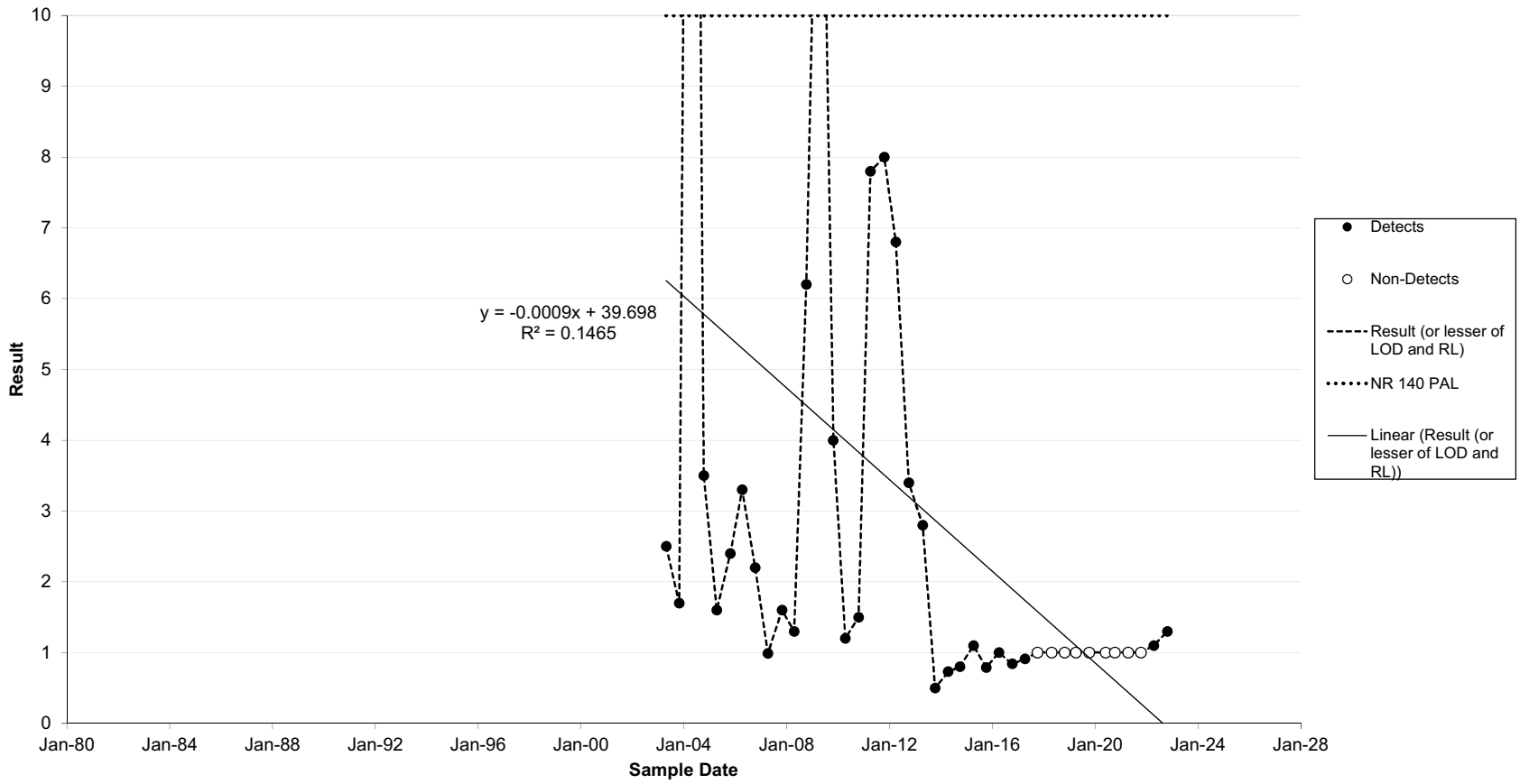


Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-86 - Chromium, dissolved (ug/l as Cr)

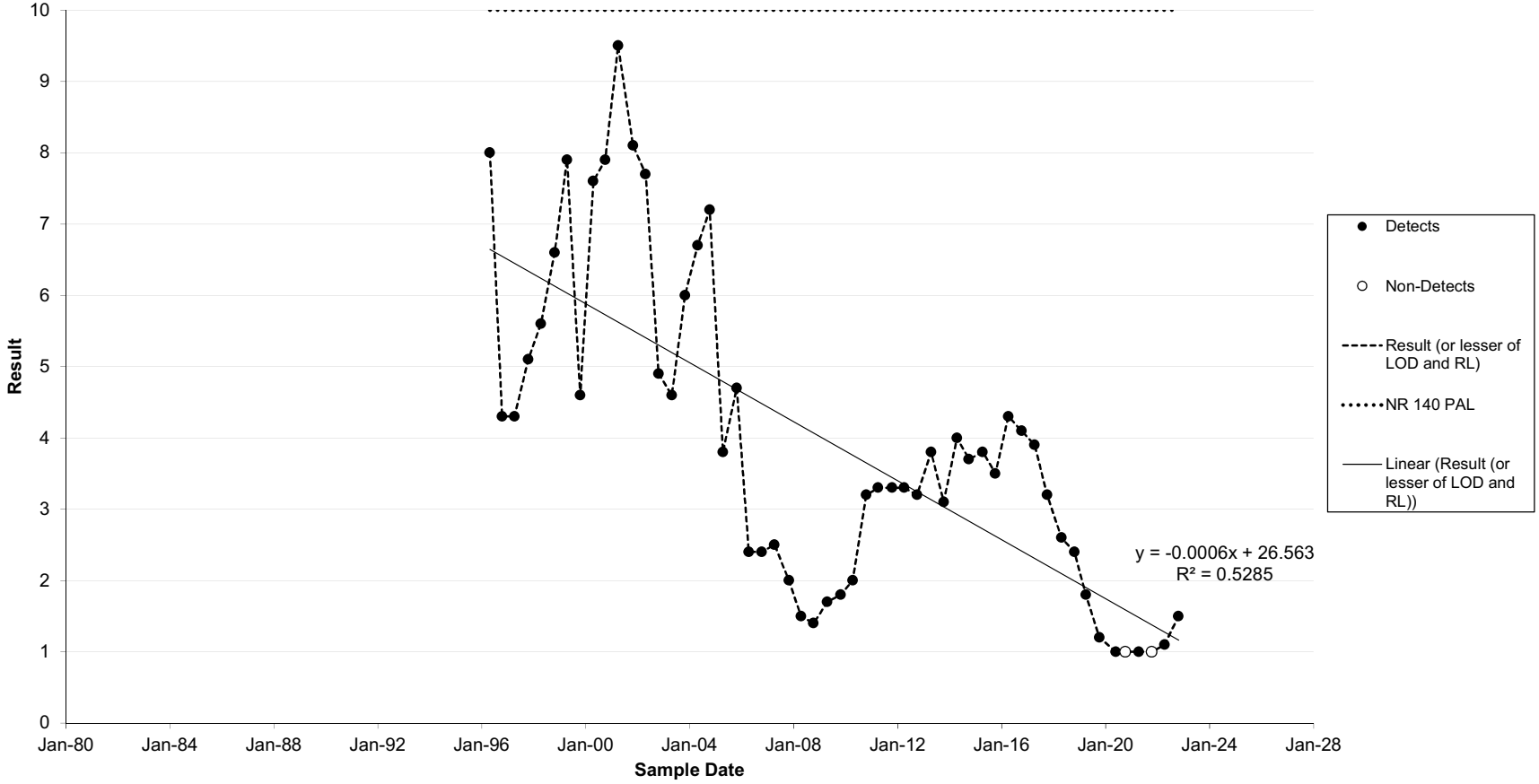


09/28/2023 - Classification: Internal - ECRM13153872

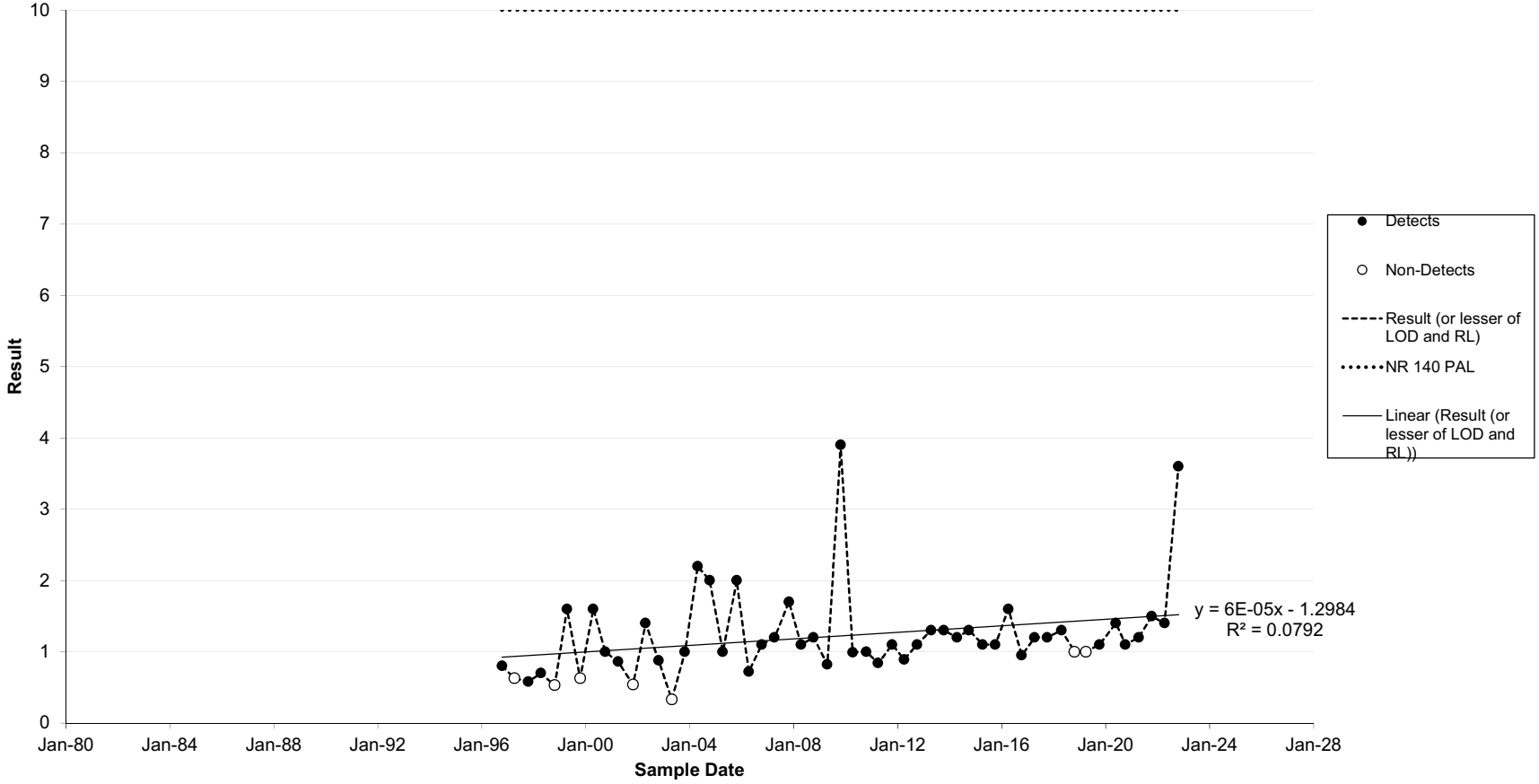
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-91AR - Chromium, dissolved (ug/l as Cr)



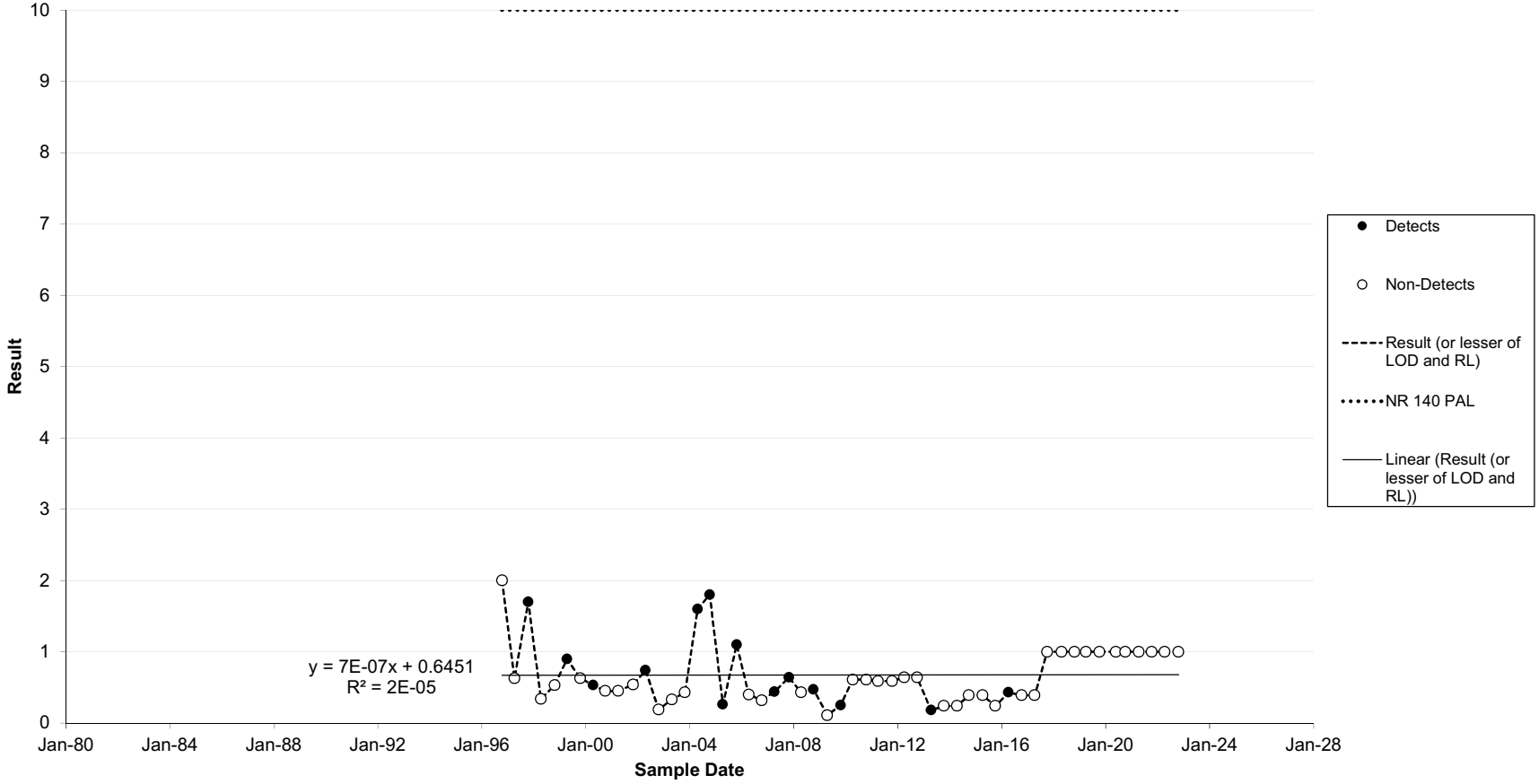
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-91B - Chromium, dissolved (ug/l as Cr)



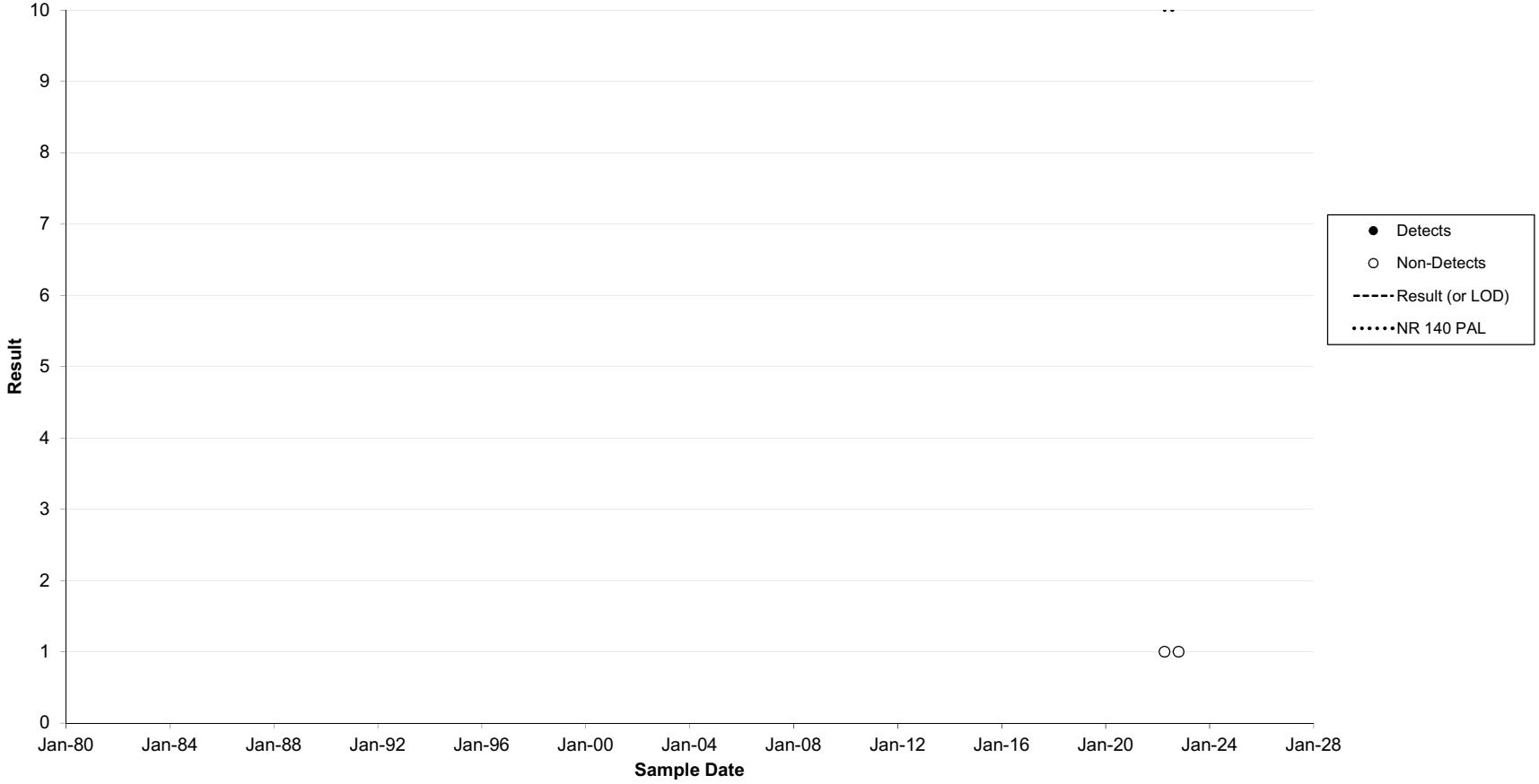
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-92A - Chromium, dissolved (ug/l as Cr)



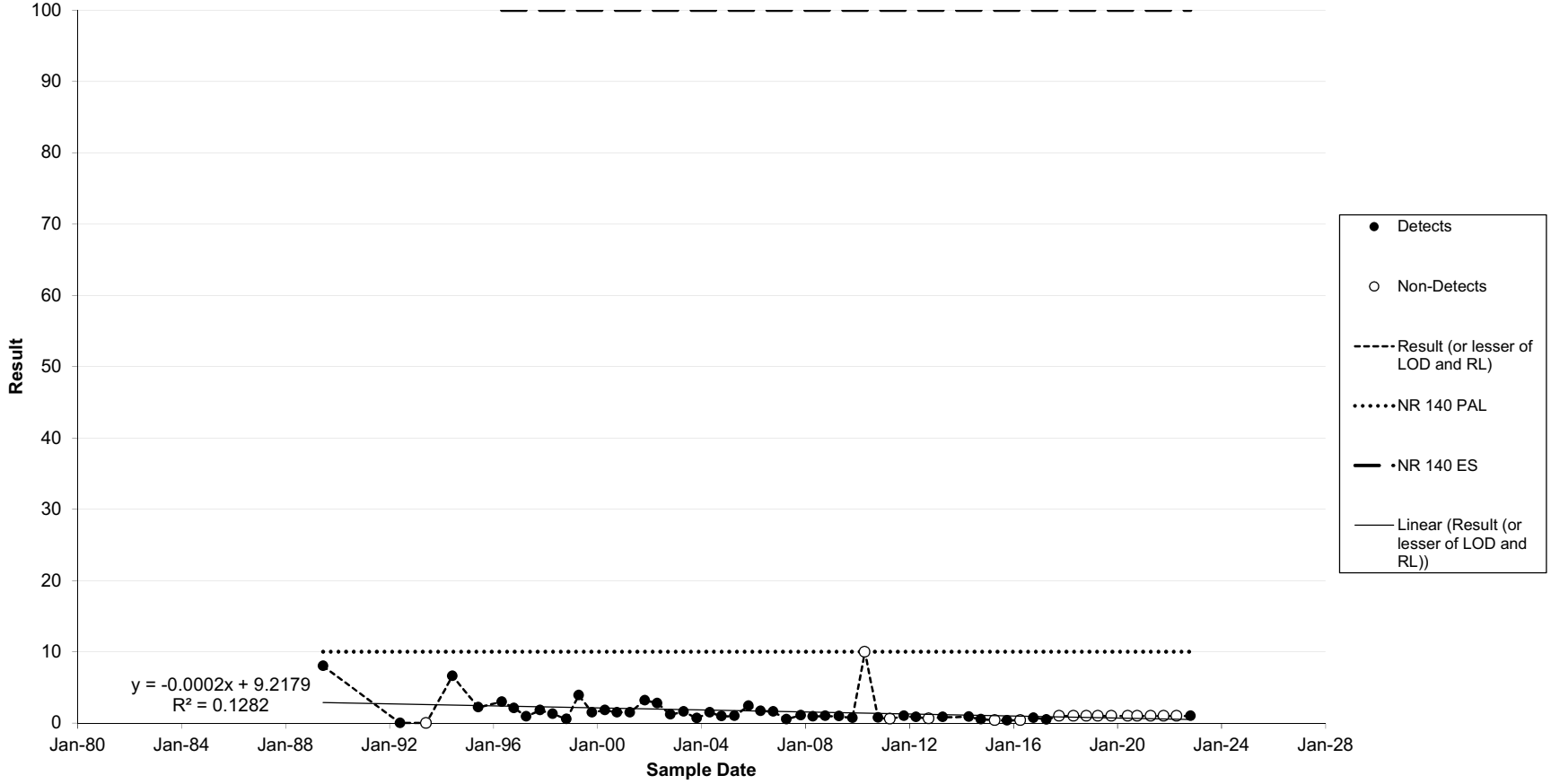
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-92B - Chromium, dissolved (ug/l as Cr)



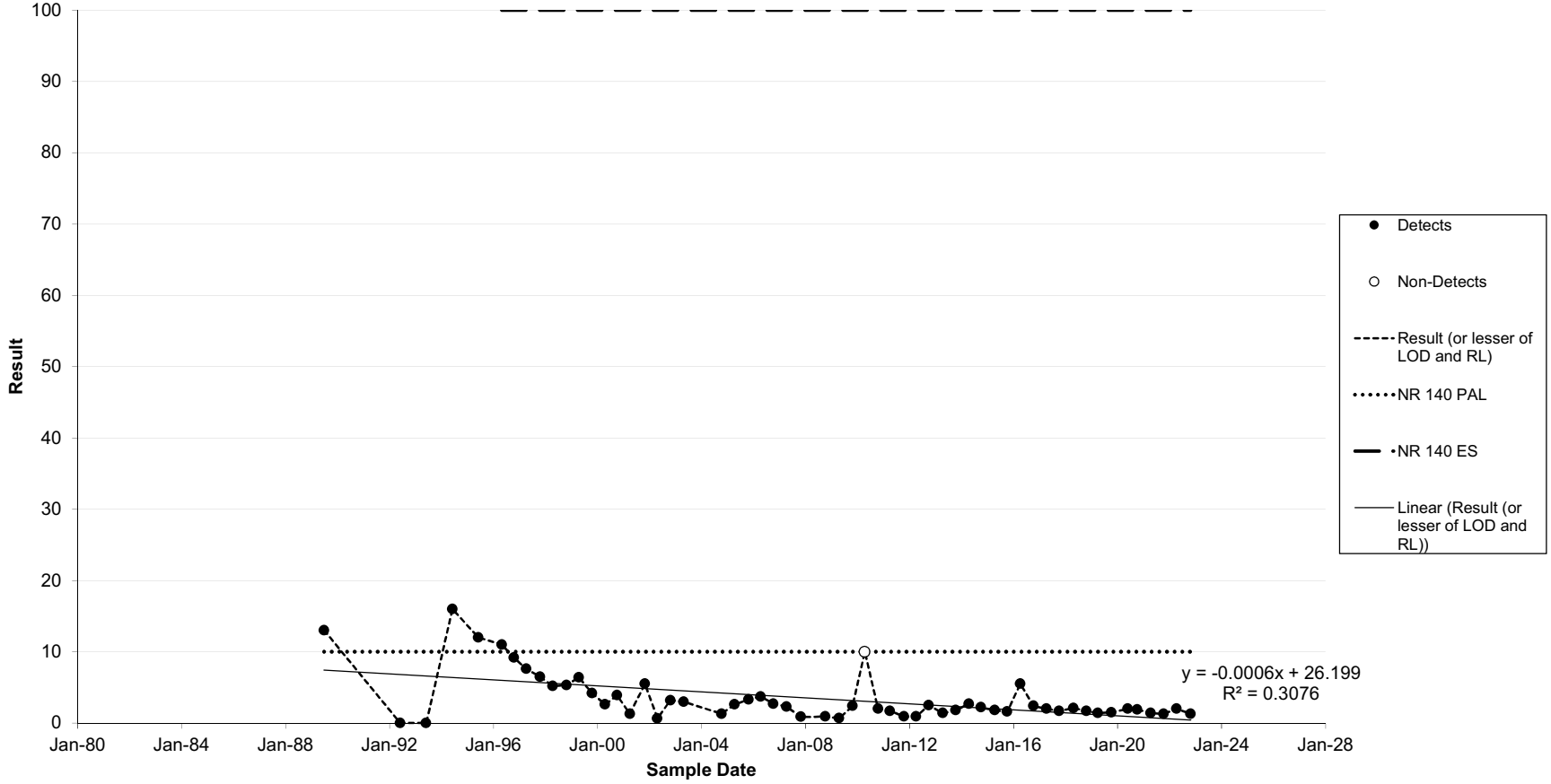
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-93A - Chromium, dissolved (ug/l as Cr)



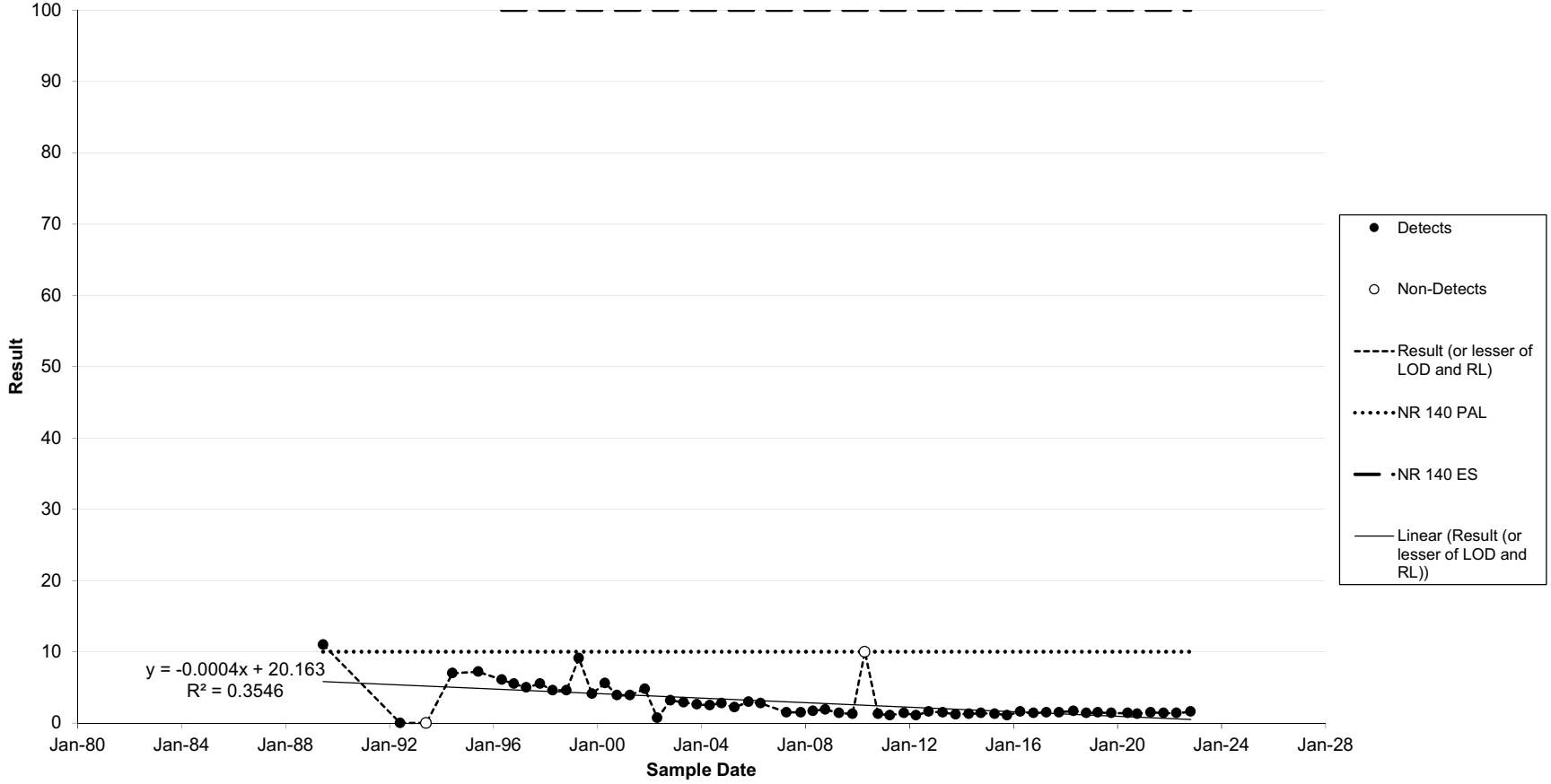
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
HC-1 - Chromium, total (ug/l Cr)



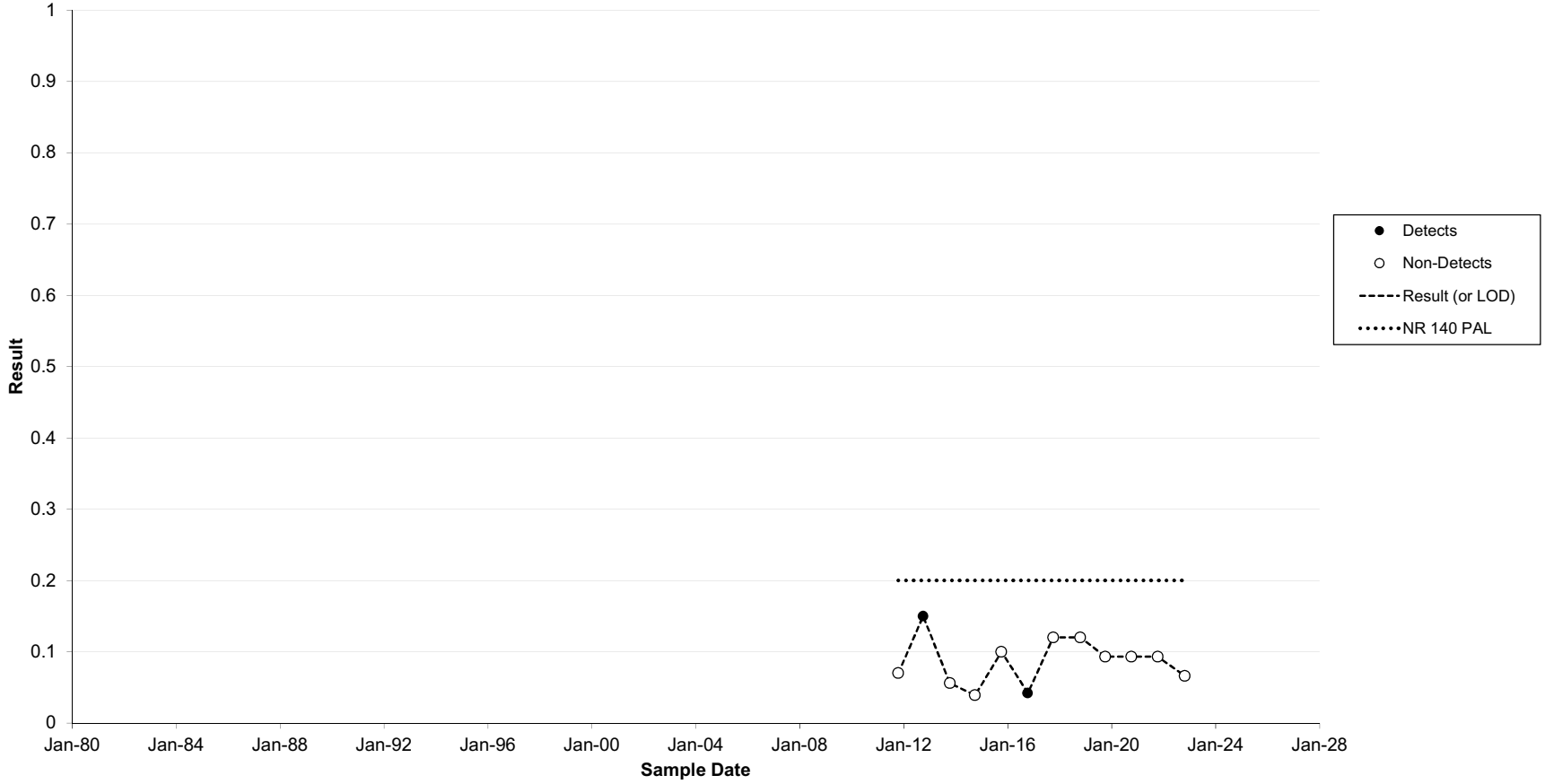
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
HC-2 - Chromium, total (ug/l Cr)



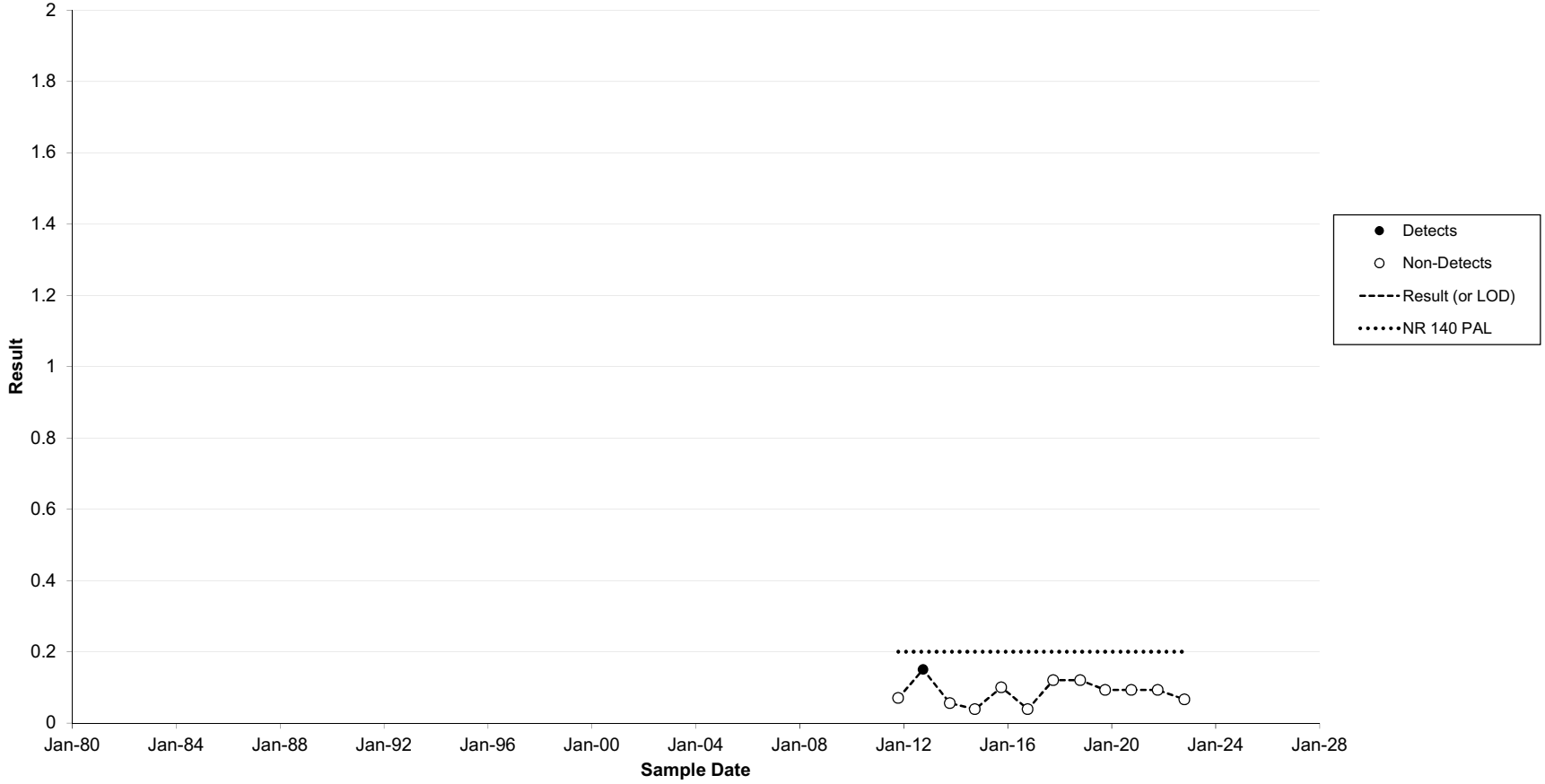
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
HC-3 - Chromium, total (ug/l Cr)



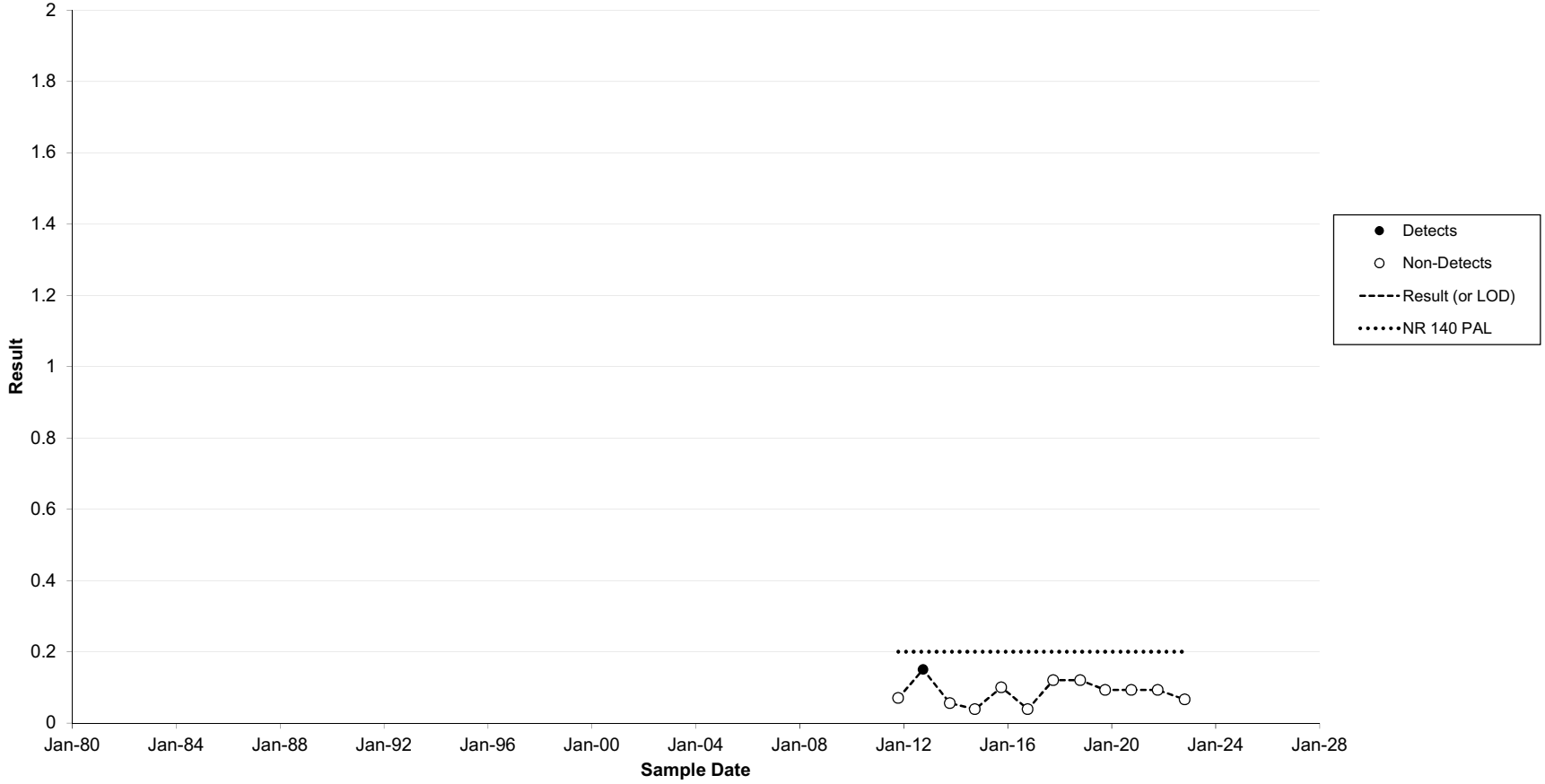
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-33AR - Mercury, dissolved (ug/l as Hg)



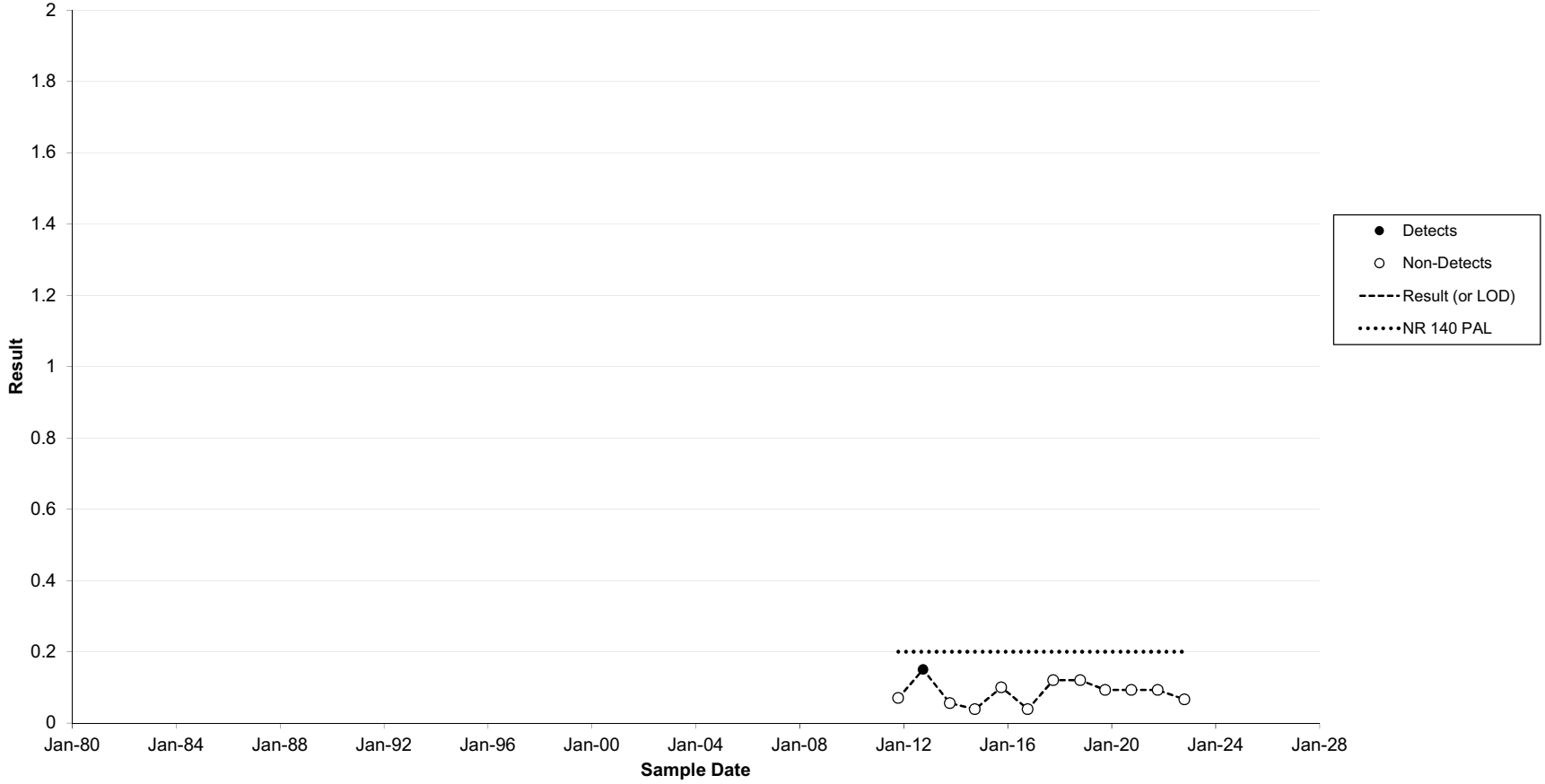
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-33BR - Mercury, dissolved (ug/l as Hg)



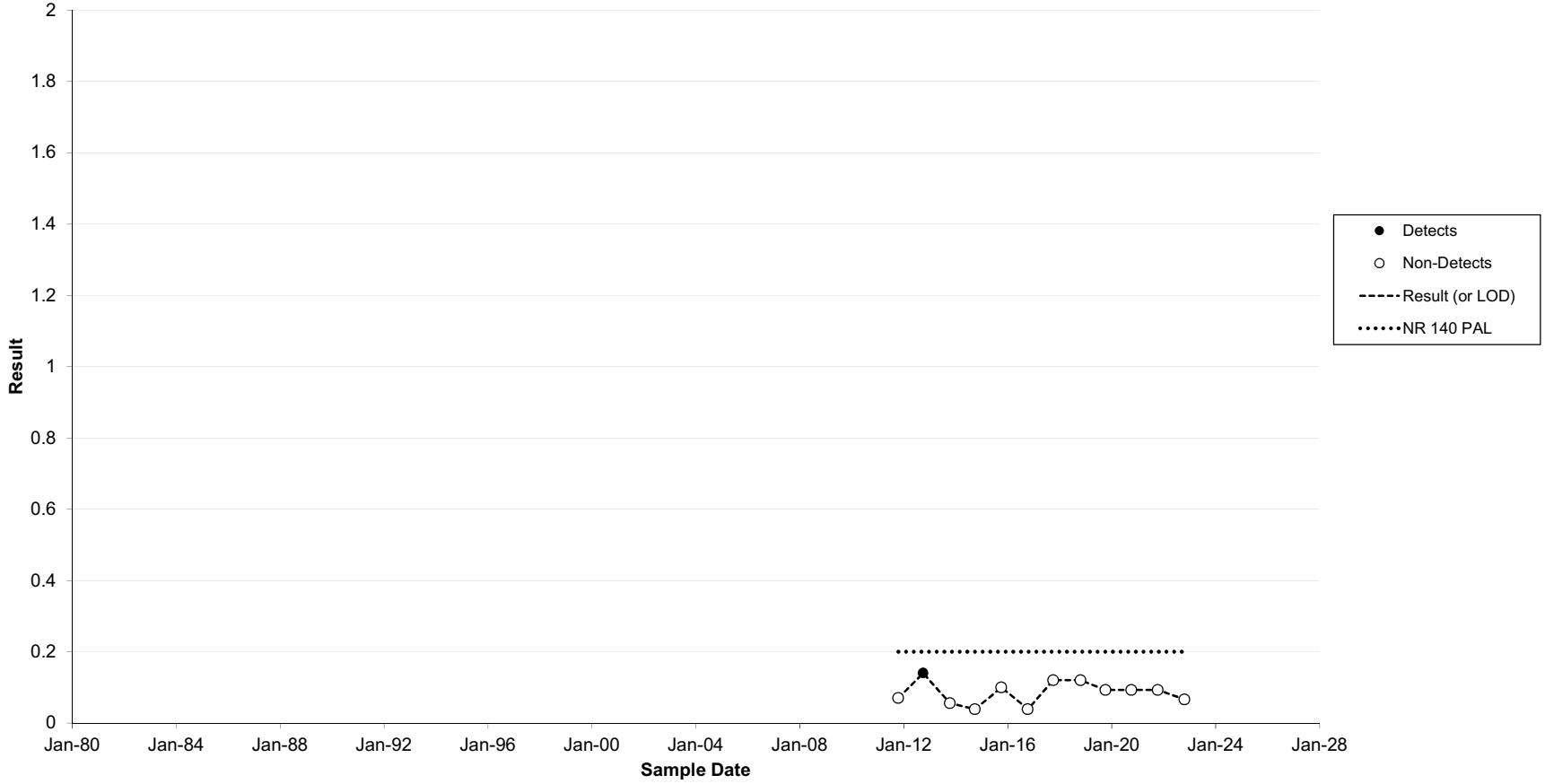
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-34A - Mercury, dissolved (ug/l as Hg)



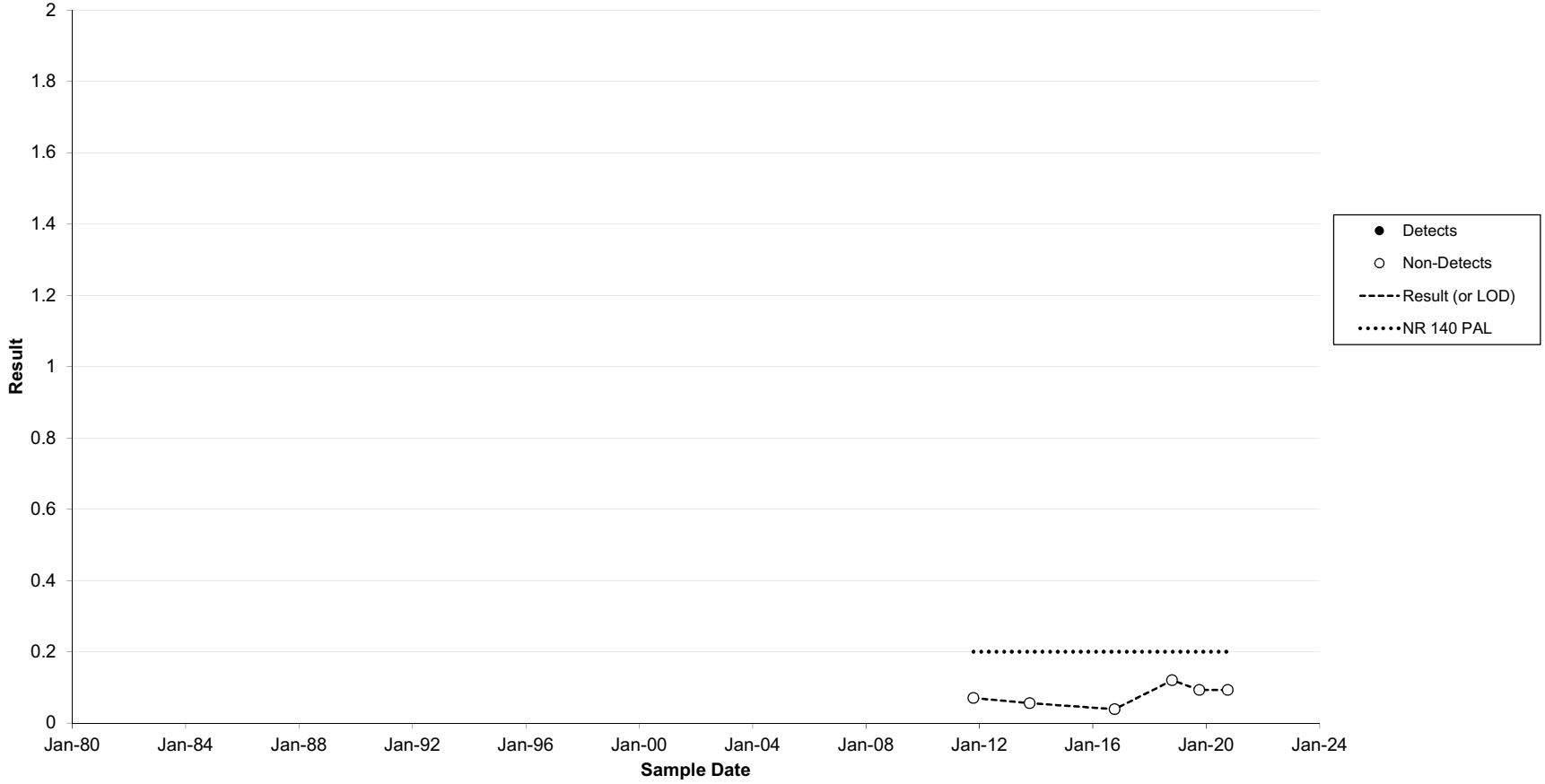
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-34B - Mercury, dissolved (ug/l as Hg)



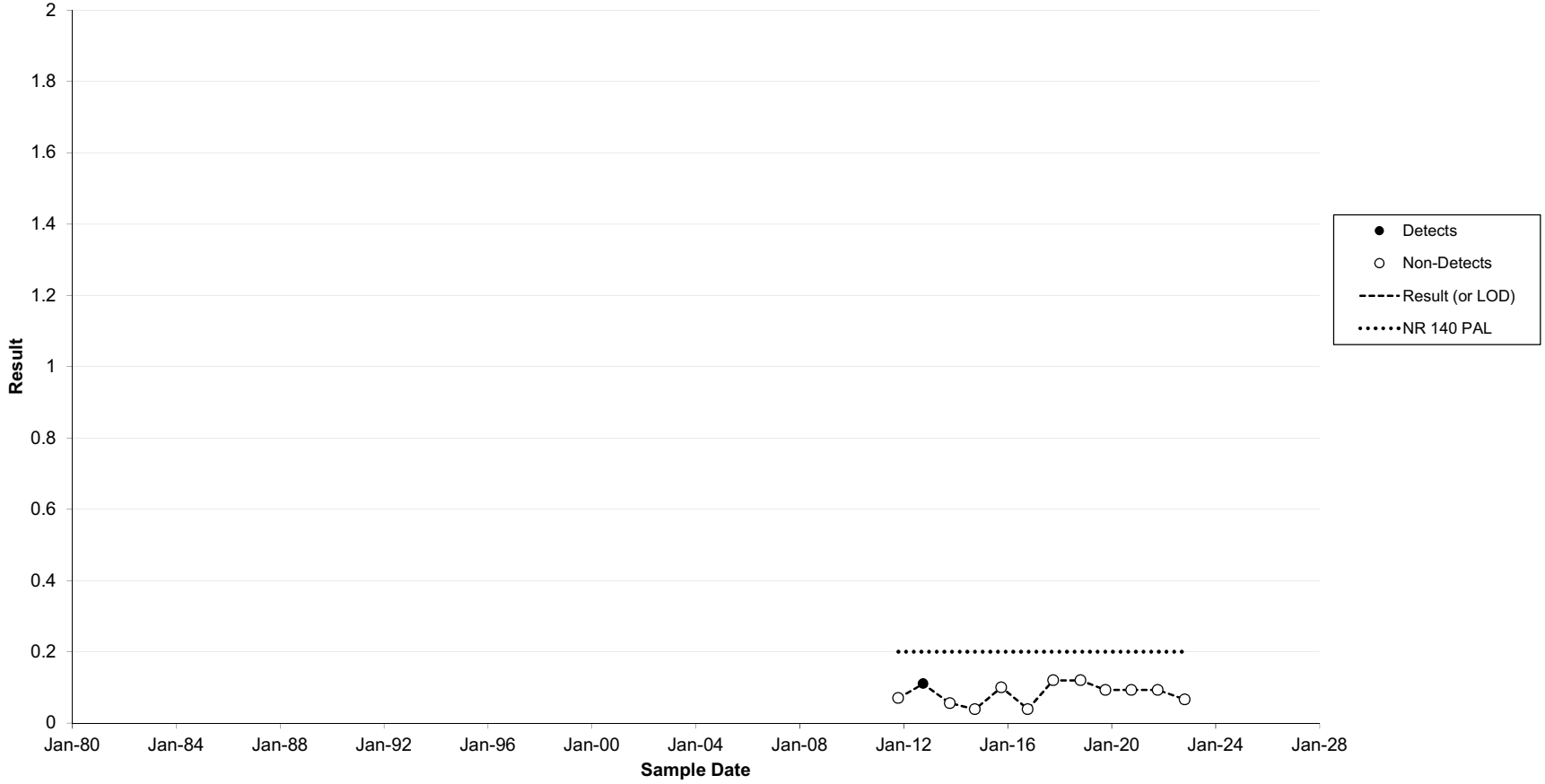
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW37A - Mercury, dissolved (ug/l as Hg)



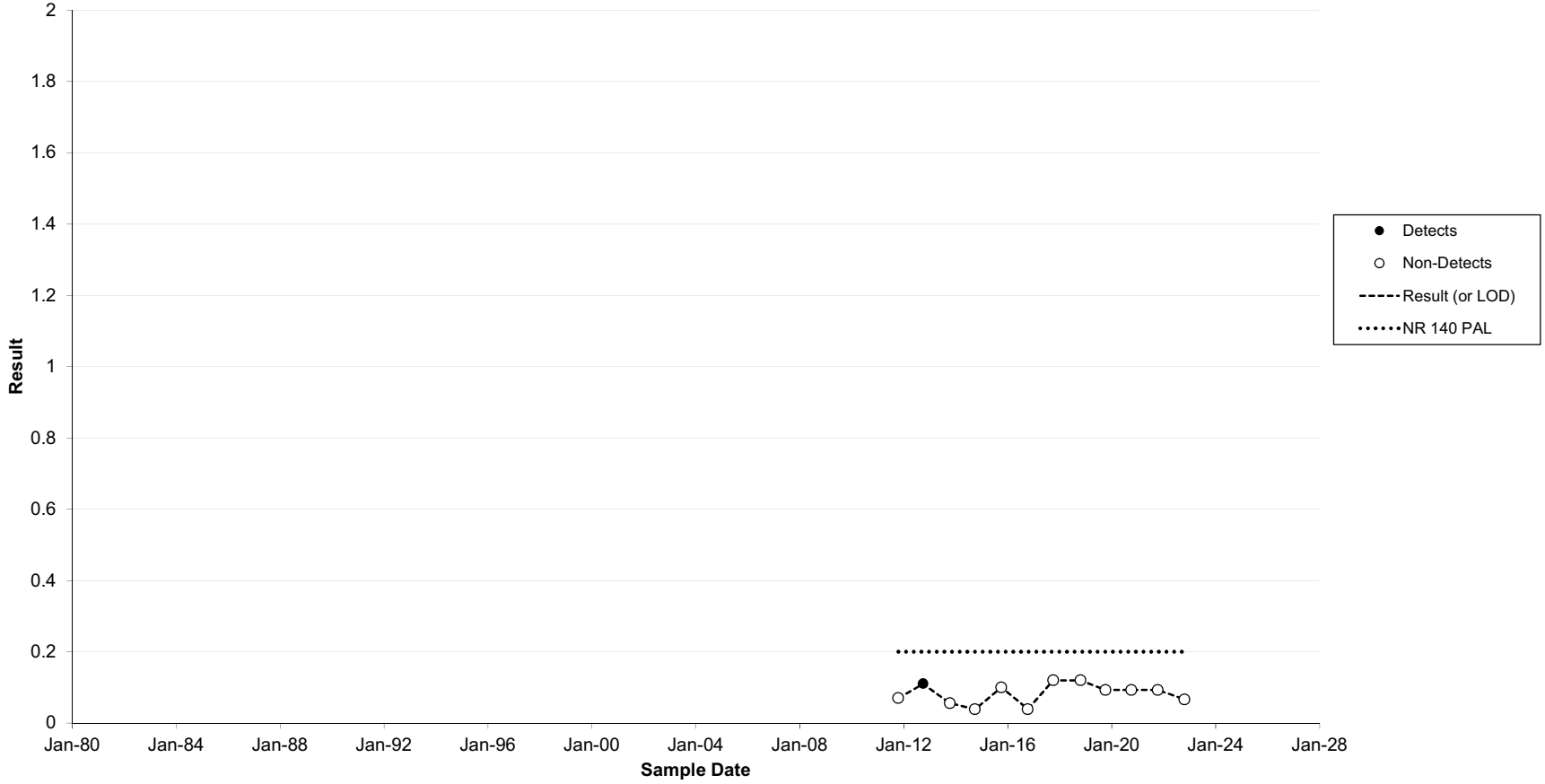
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-83 - Mercury, dissolved (ug/l as Hg)



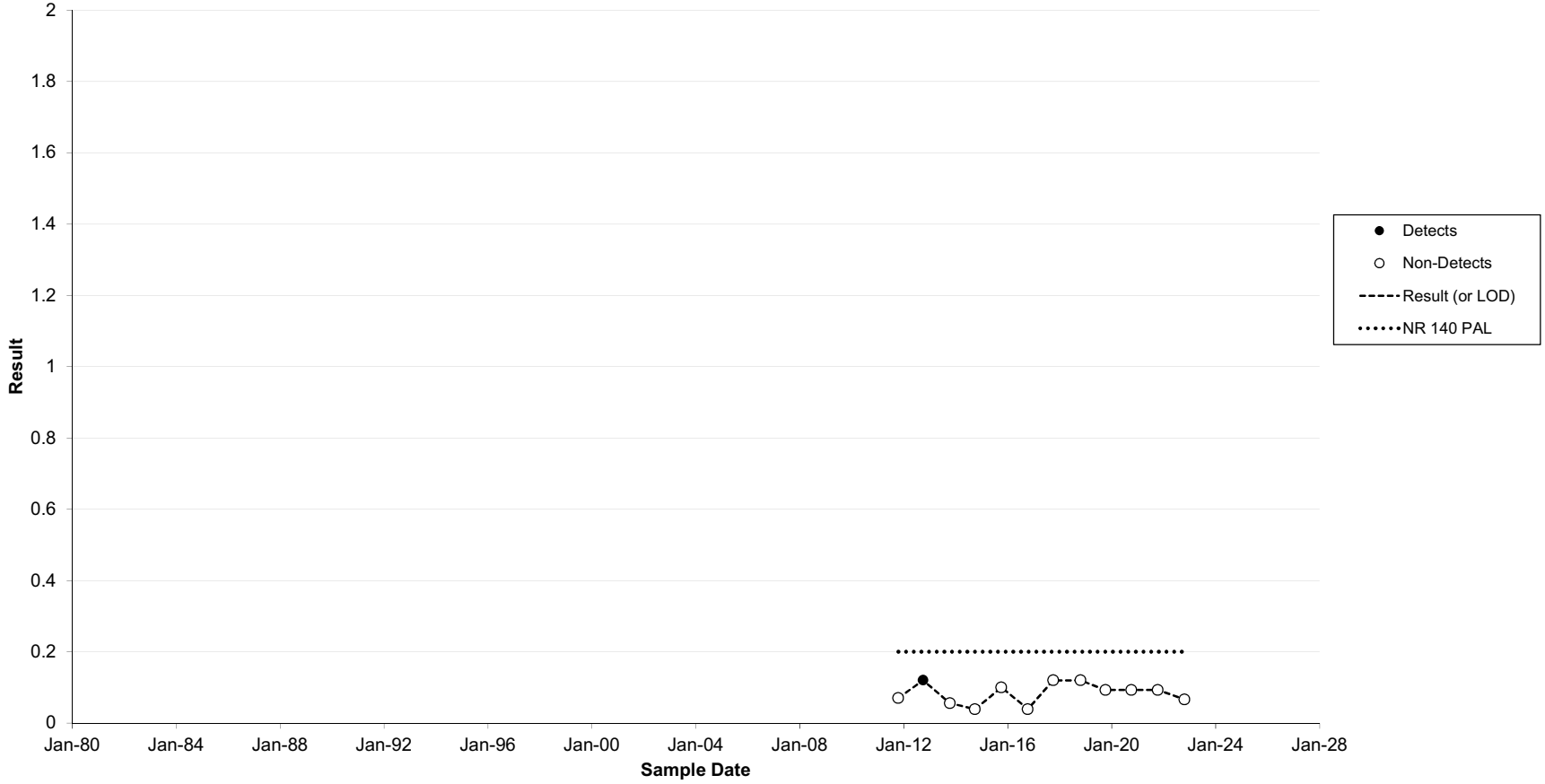
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW84A - Mercury, dissolved (ug/l as Hg)



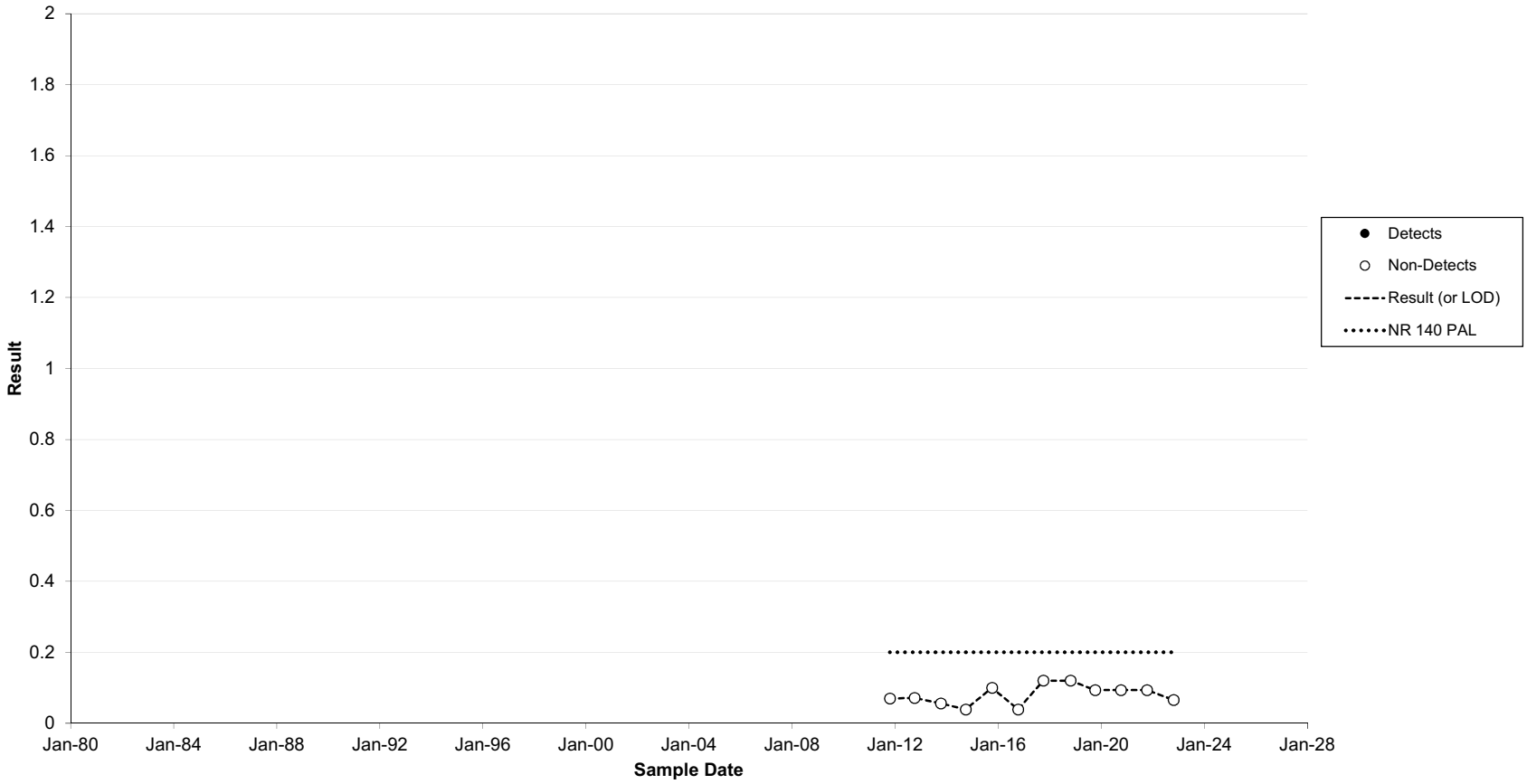
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW84B - Mercury, dissolved (ug/l as Hg)



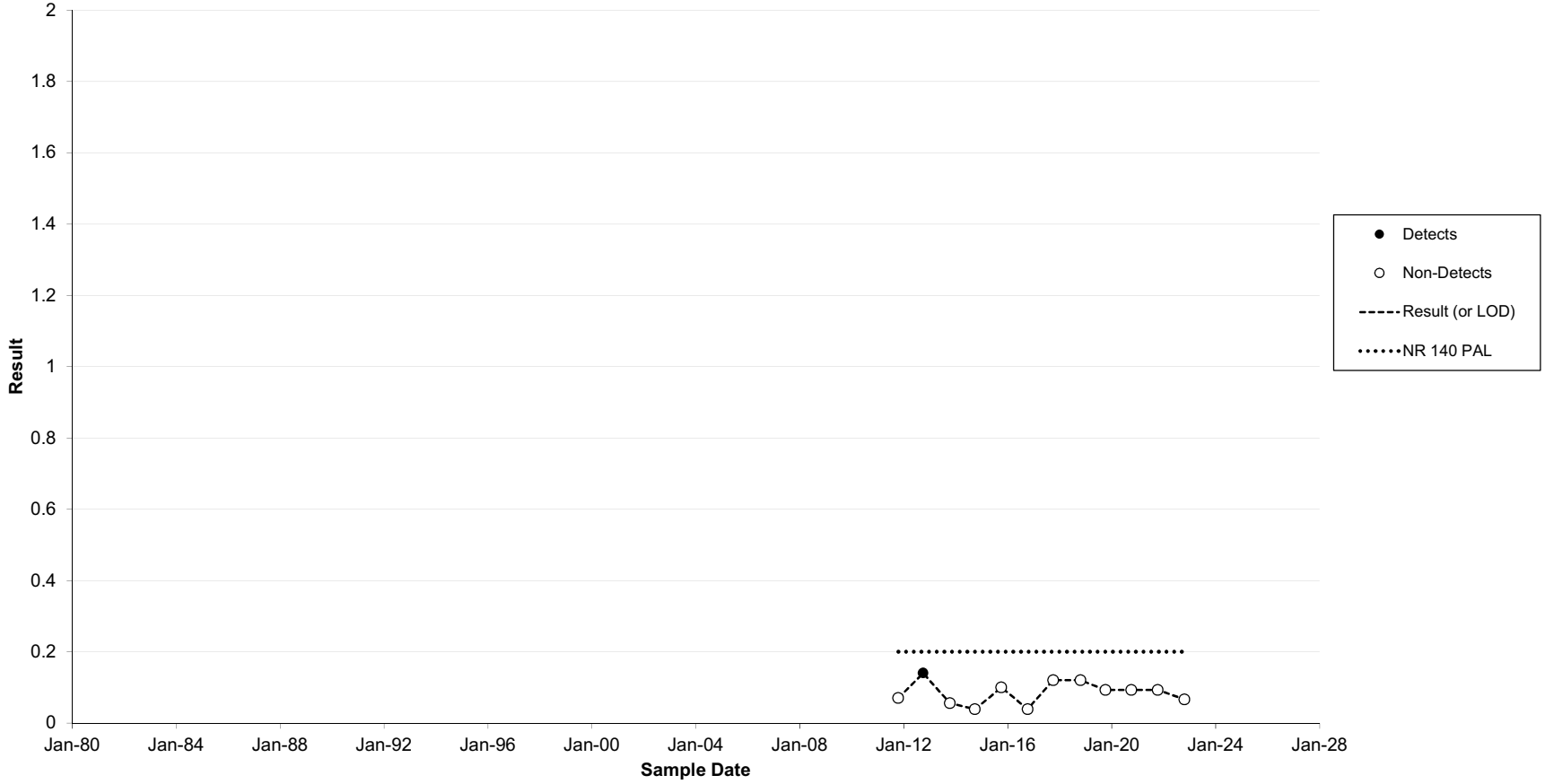
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW86 - Mercury, dissolved (ug/l as Hg)



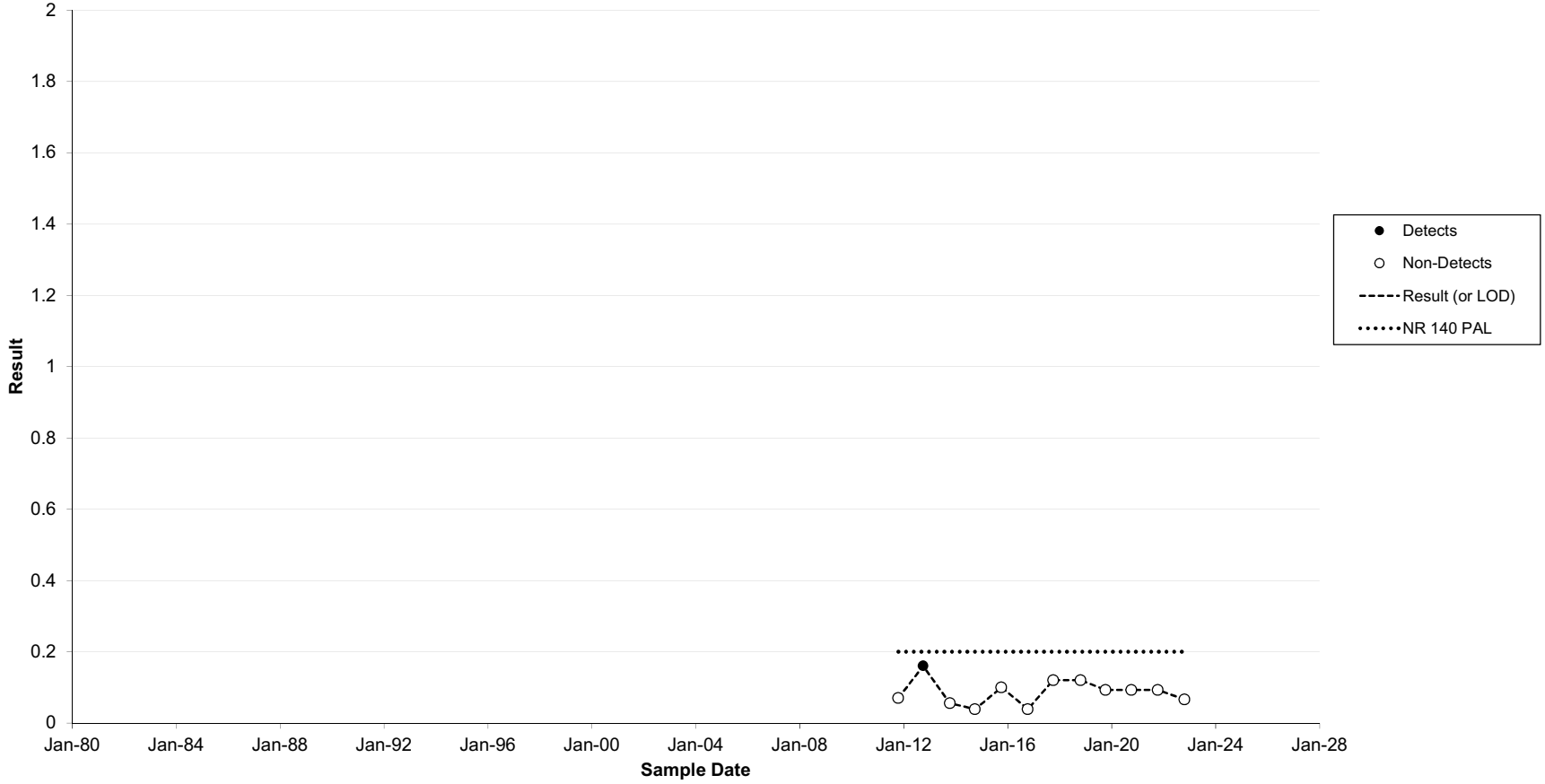
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-91AR - Mercury, dissolved (ug/l as Hg)



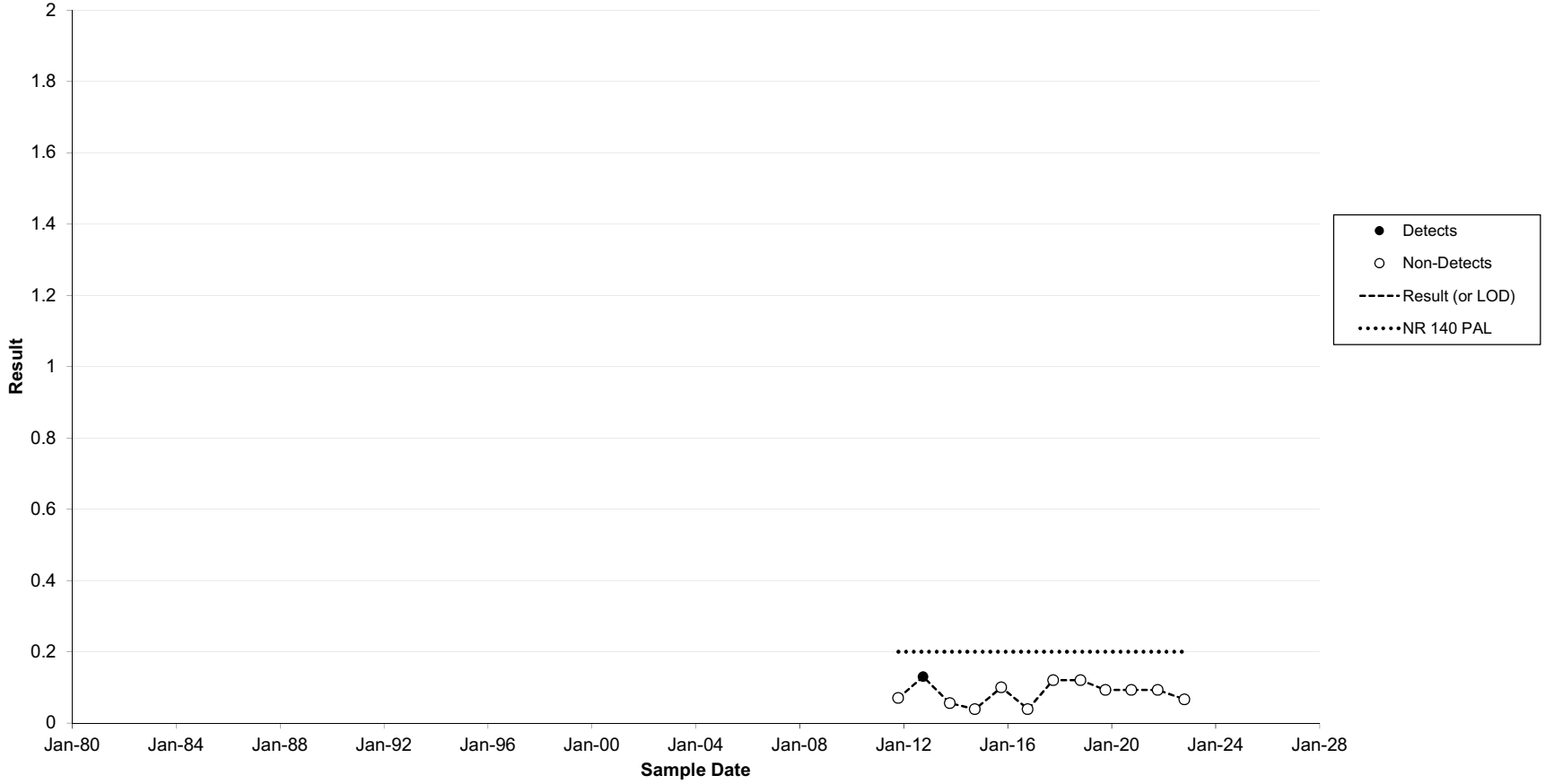
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-91B - Mercury, dissolved (ug/l as Hg)



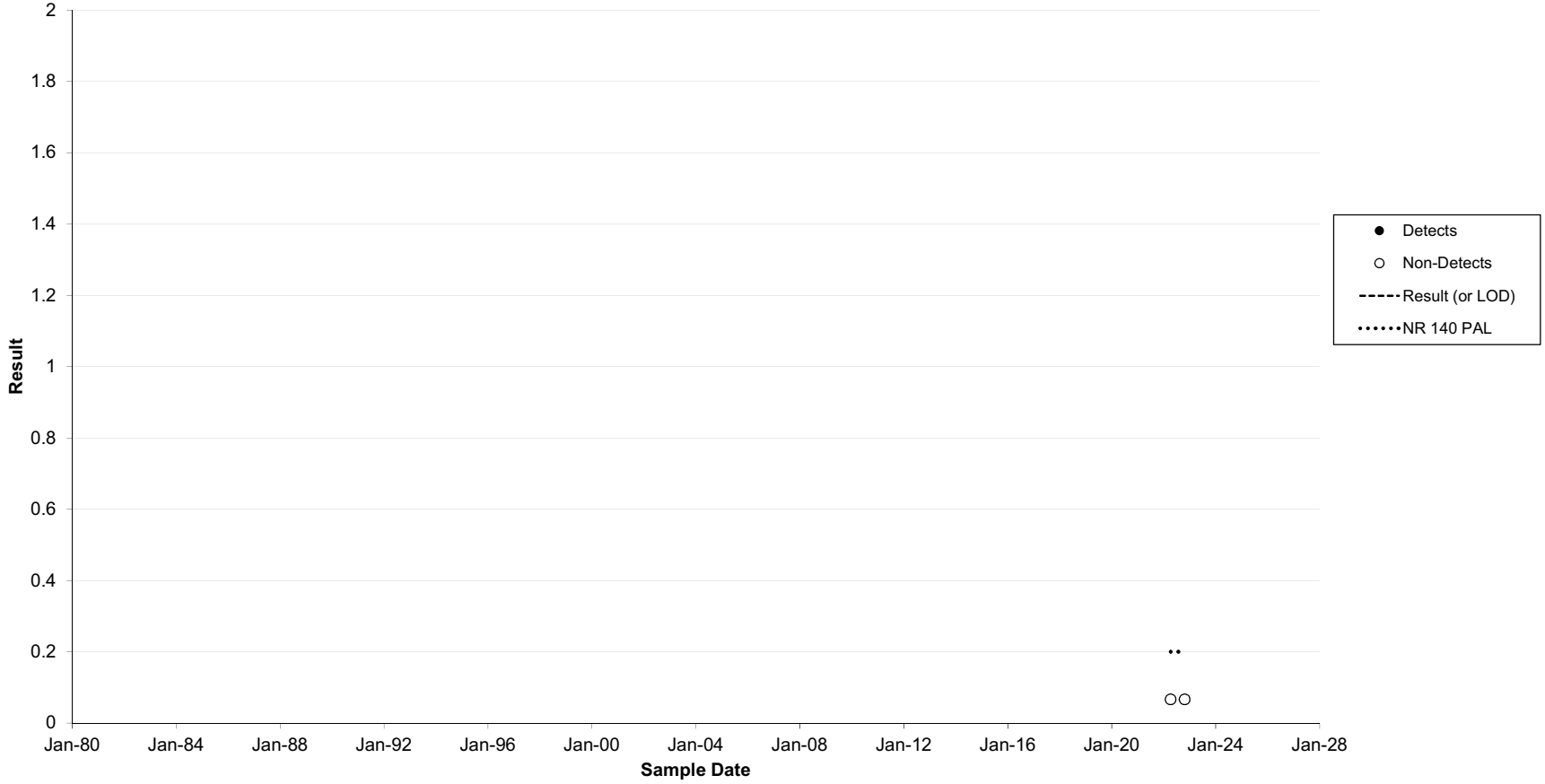
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-92A - Mercury, dissolved (ug/l as Hg)



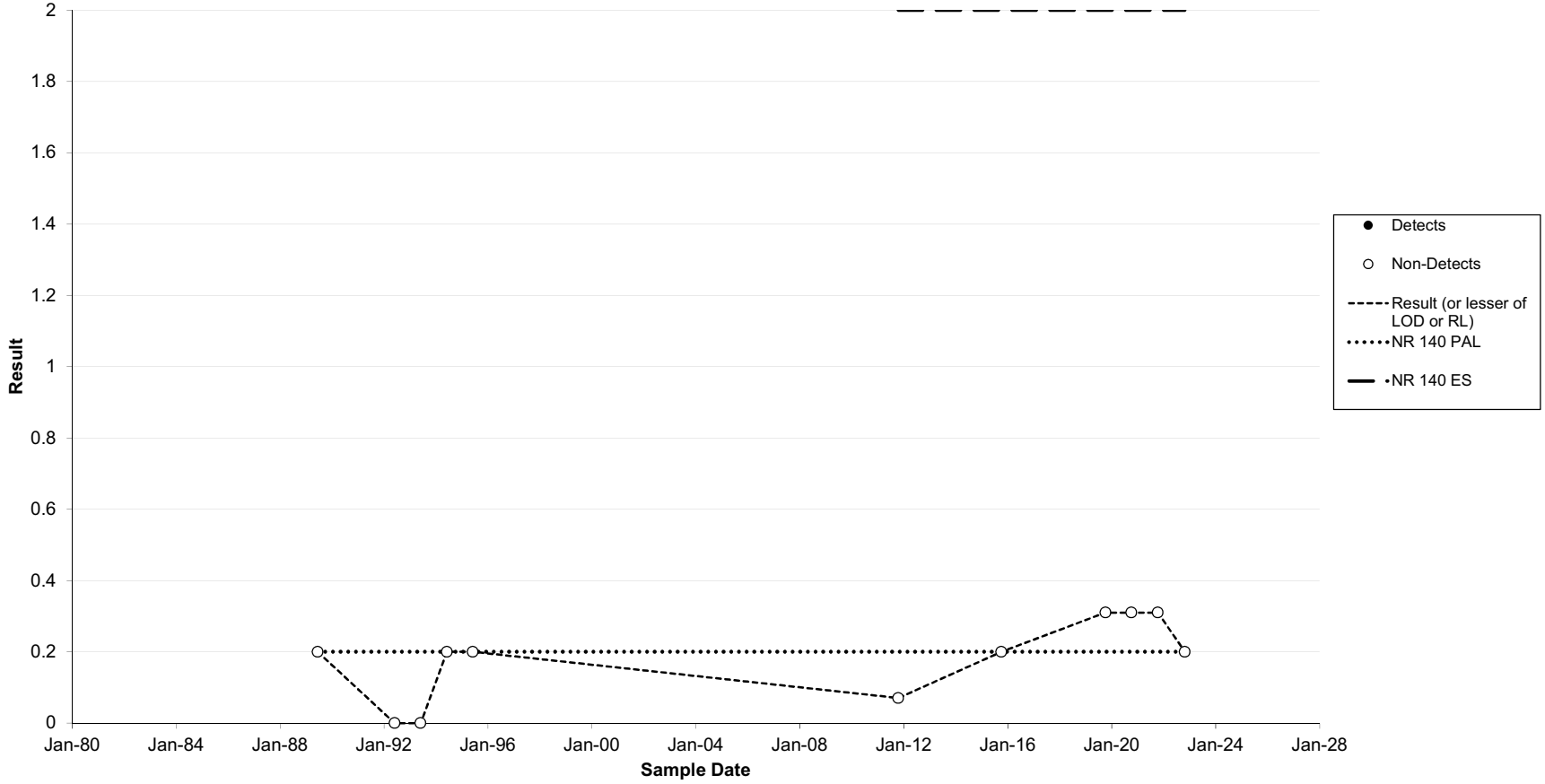
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-92B - Mercury, dissolved (ug/l as Hg)



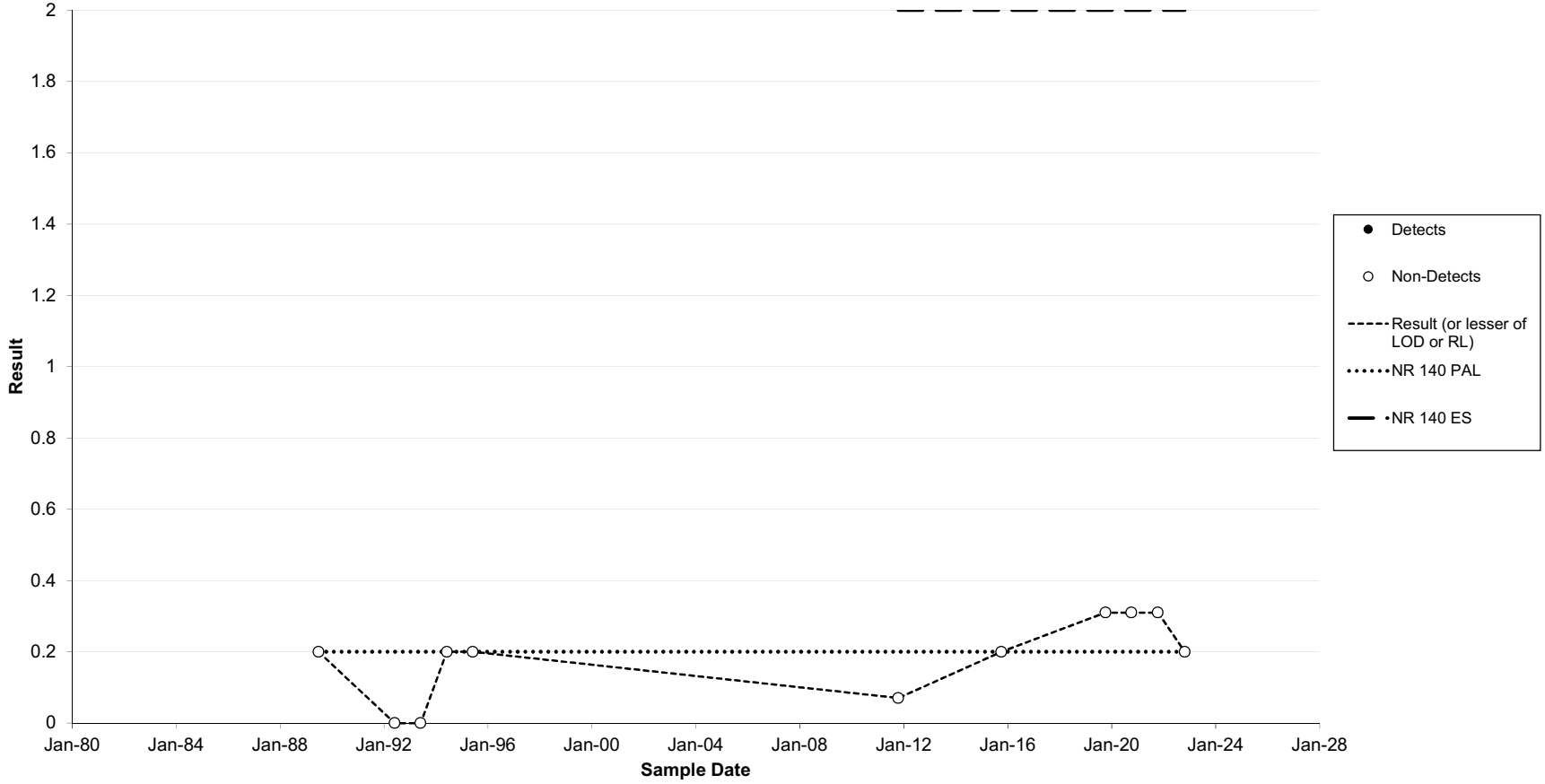
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-93A - Mercury, total (ug/l Hg)



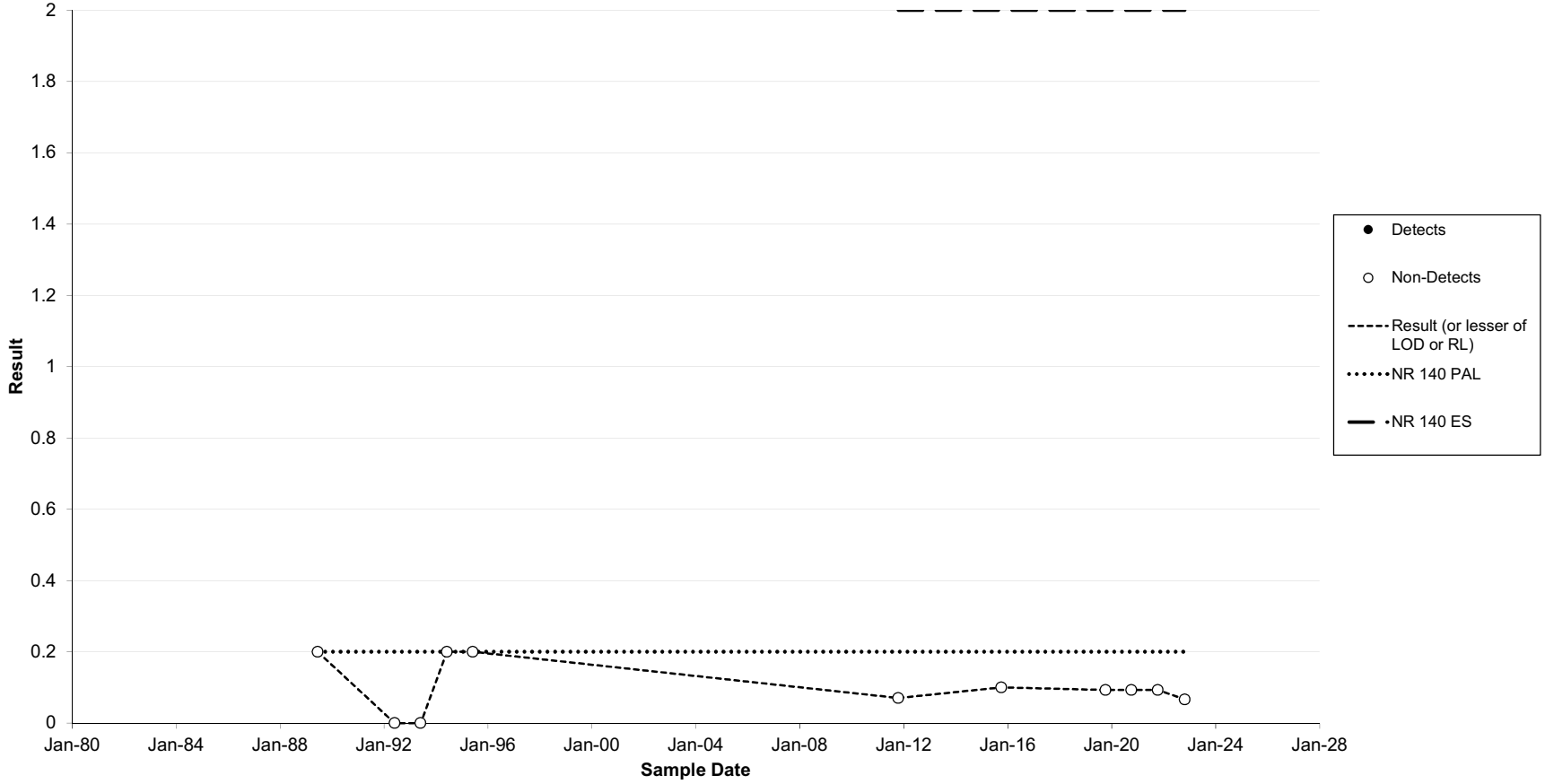
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
HC-1 - Mercury, total (ug/l Hg)



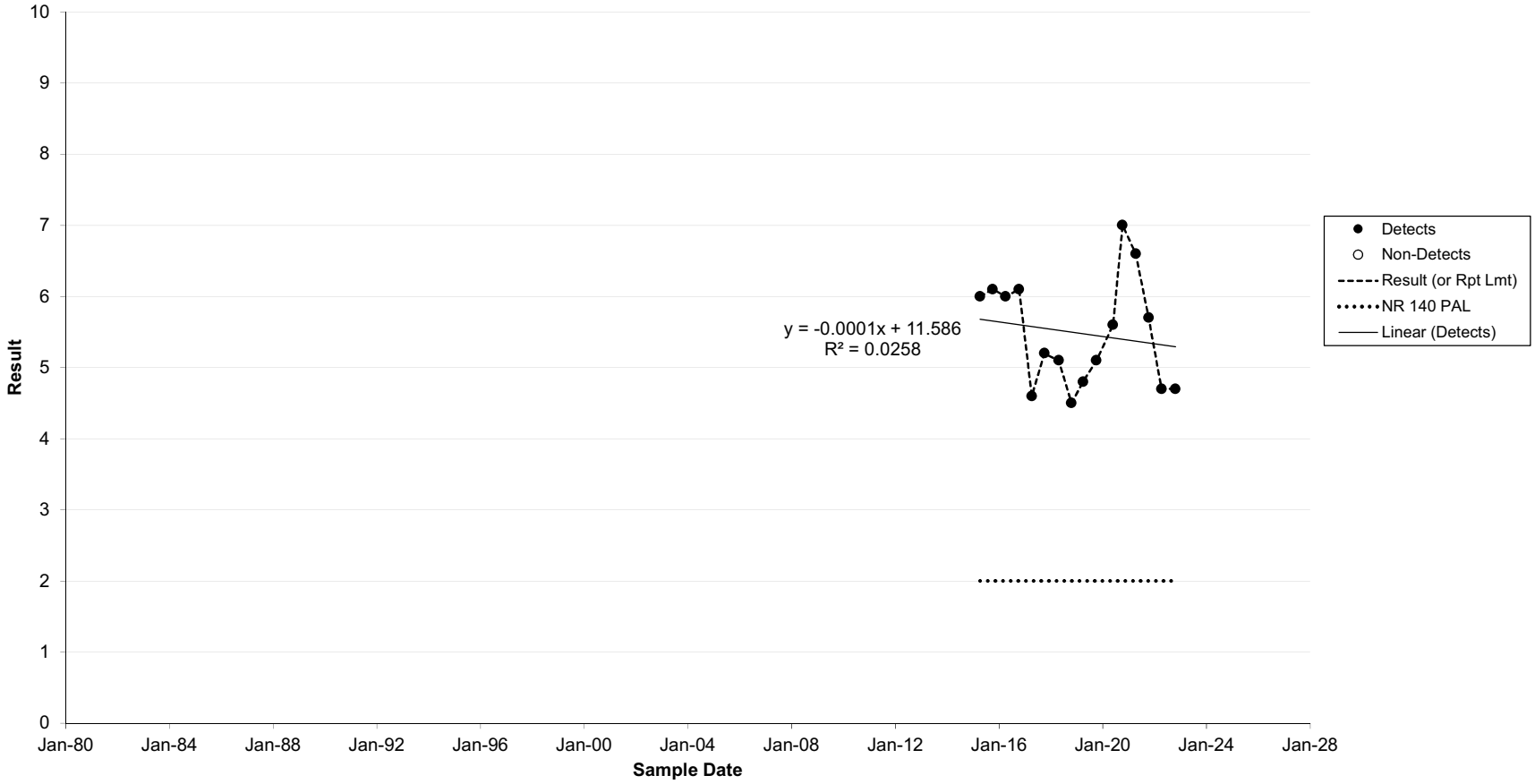
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
HC-2 - Mercury, total (ug/l Hg)



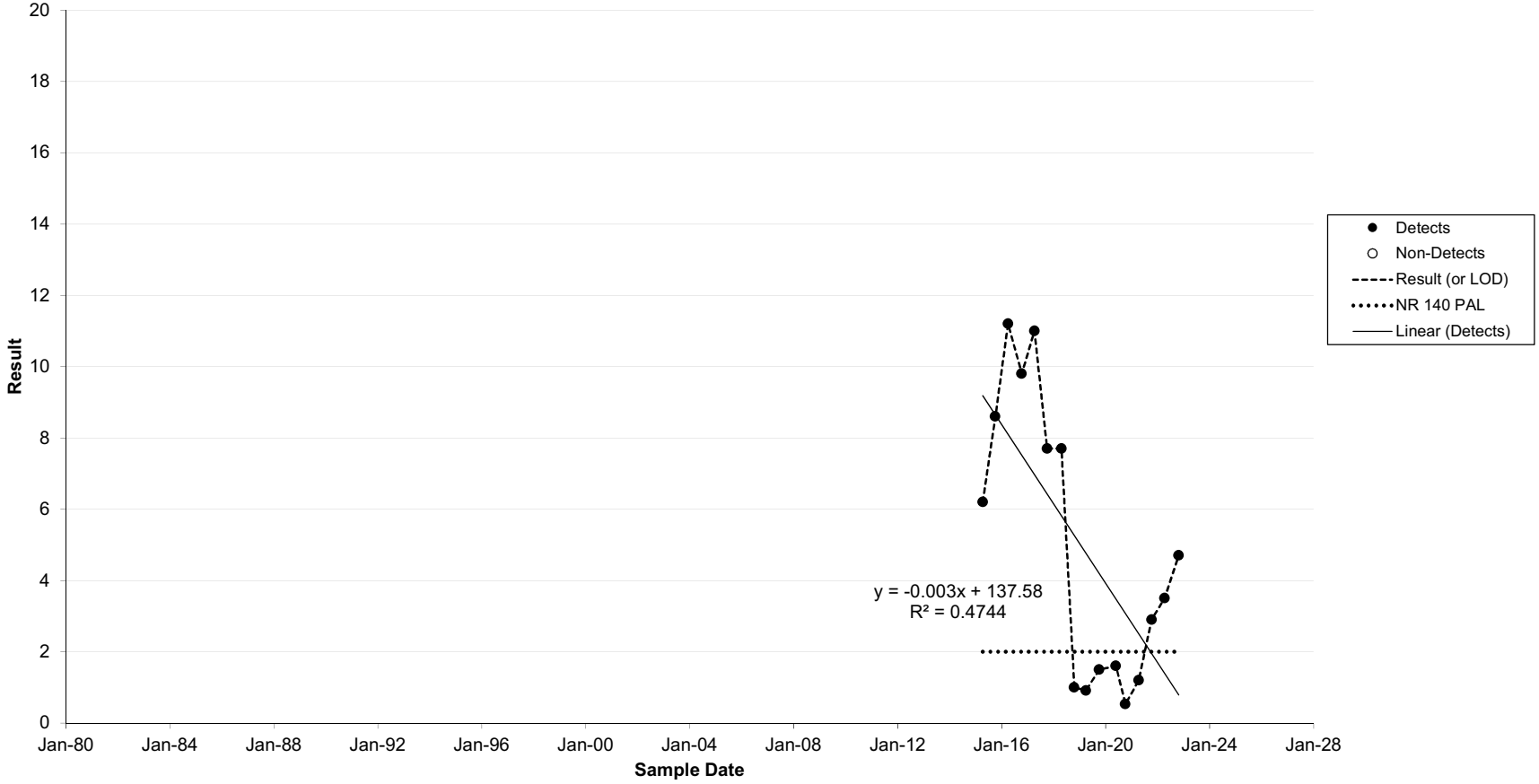
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
HC-3 - Mercury, total (ug/l Hg)



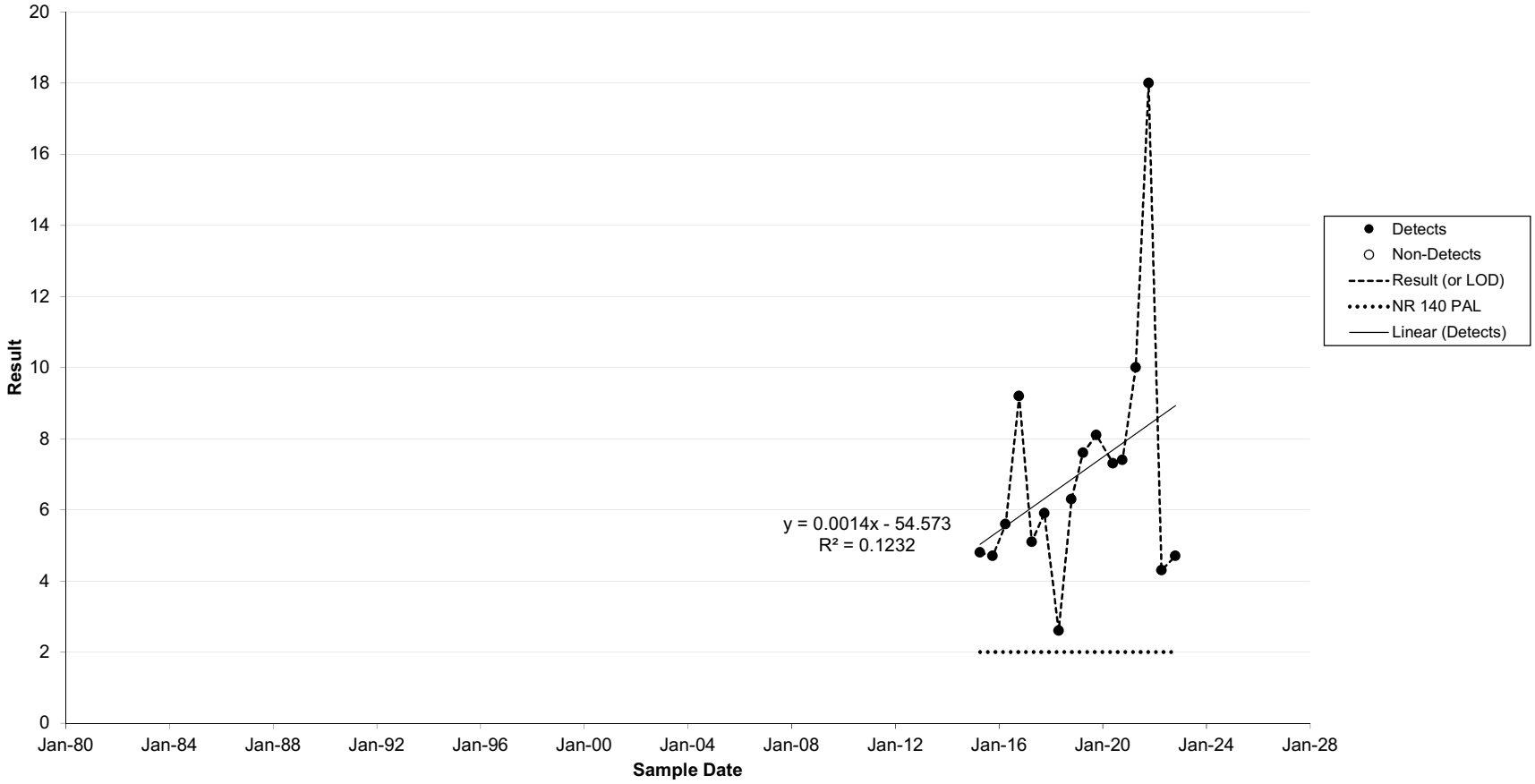
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-33BR - Nitrite + Nitrate as N



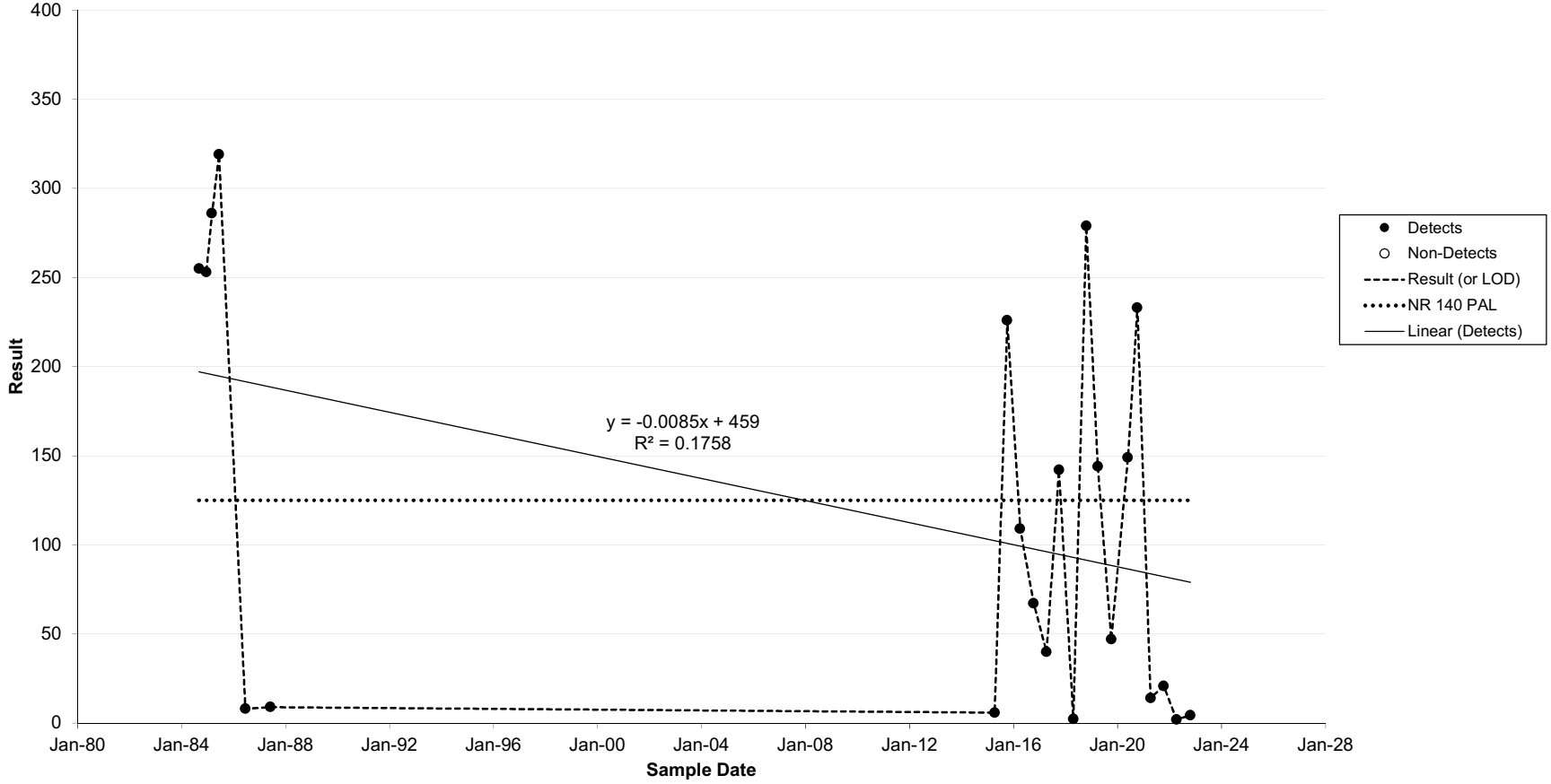
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW34A - Nitrite + Nitrate as N, mg/L



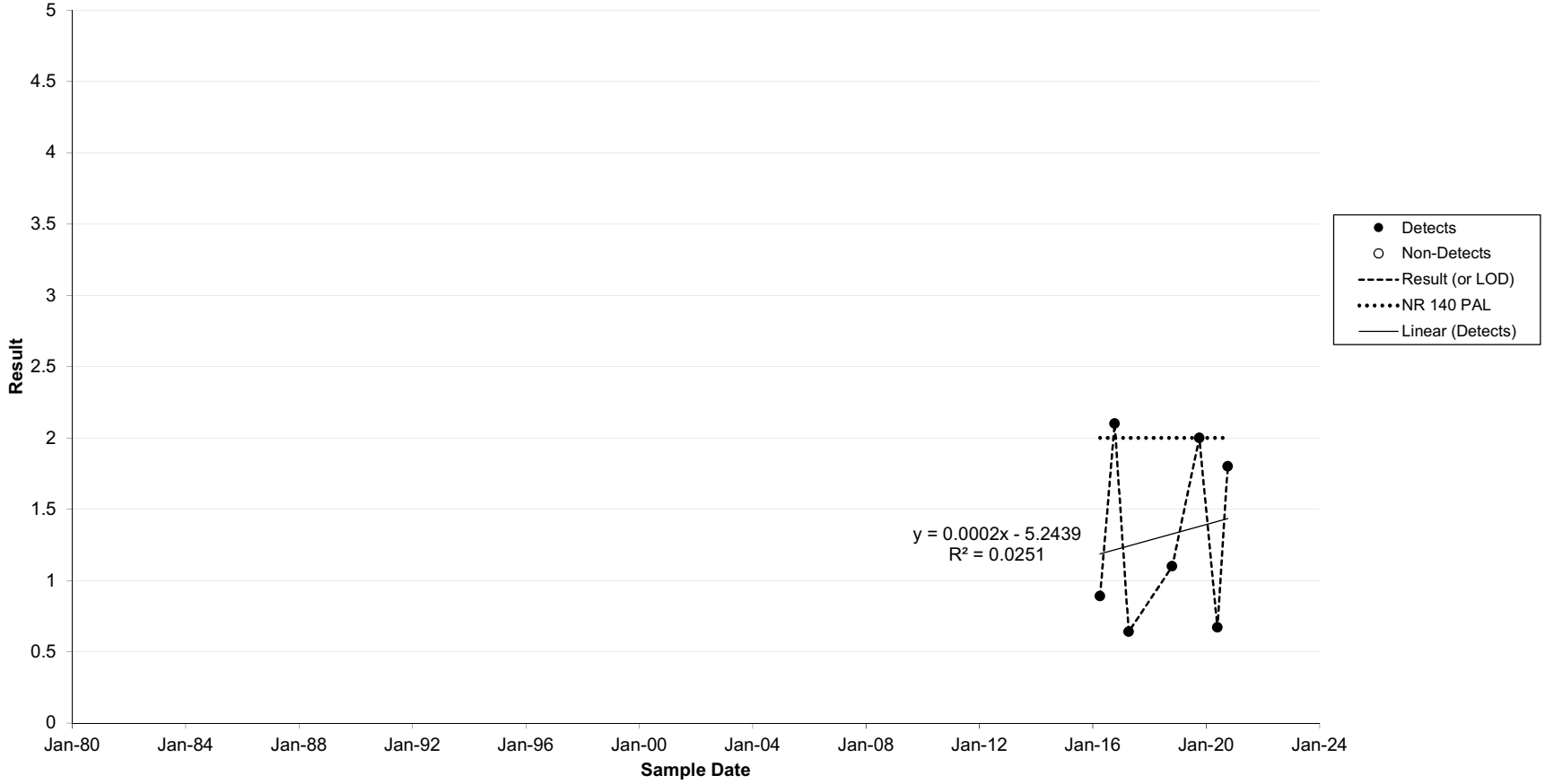
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW34B - Nitrite + Nitrate as N, mg/L



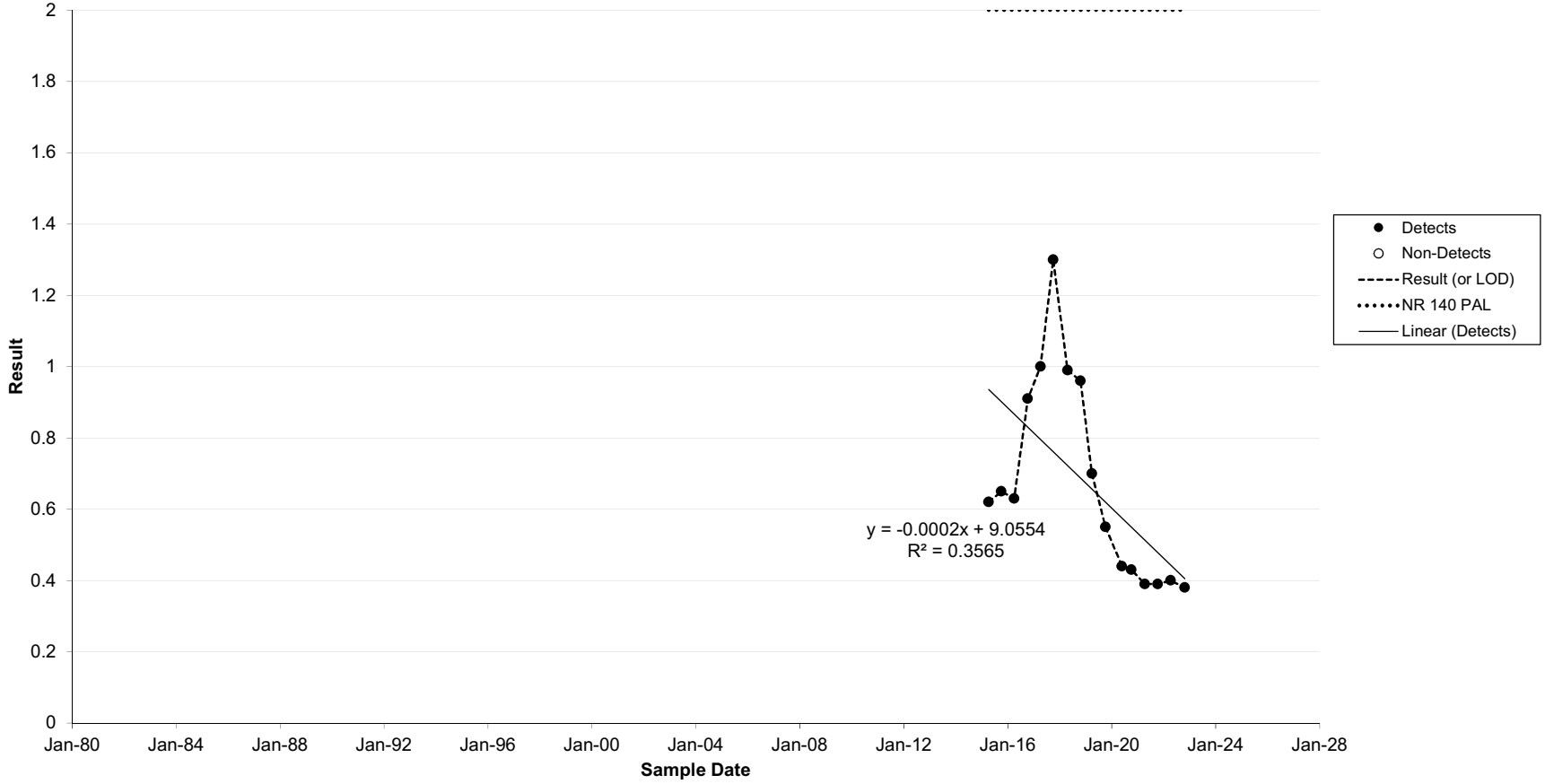
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW37A - Nitrite + Nitrate as N, mg/L



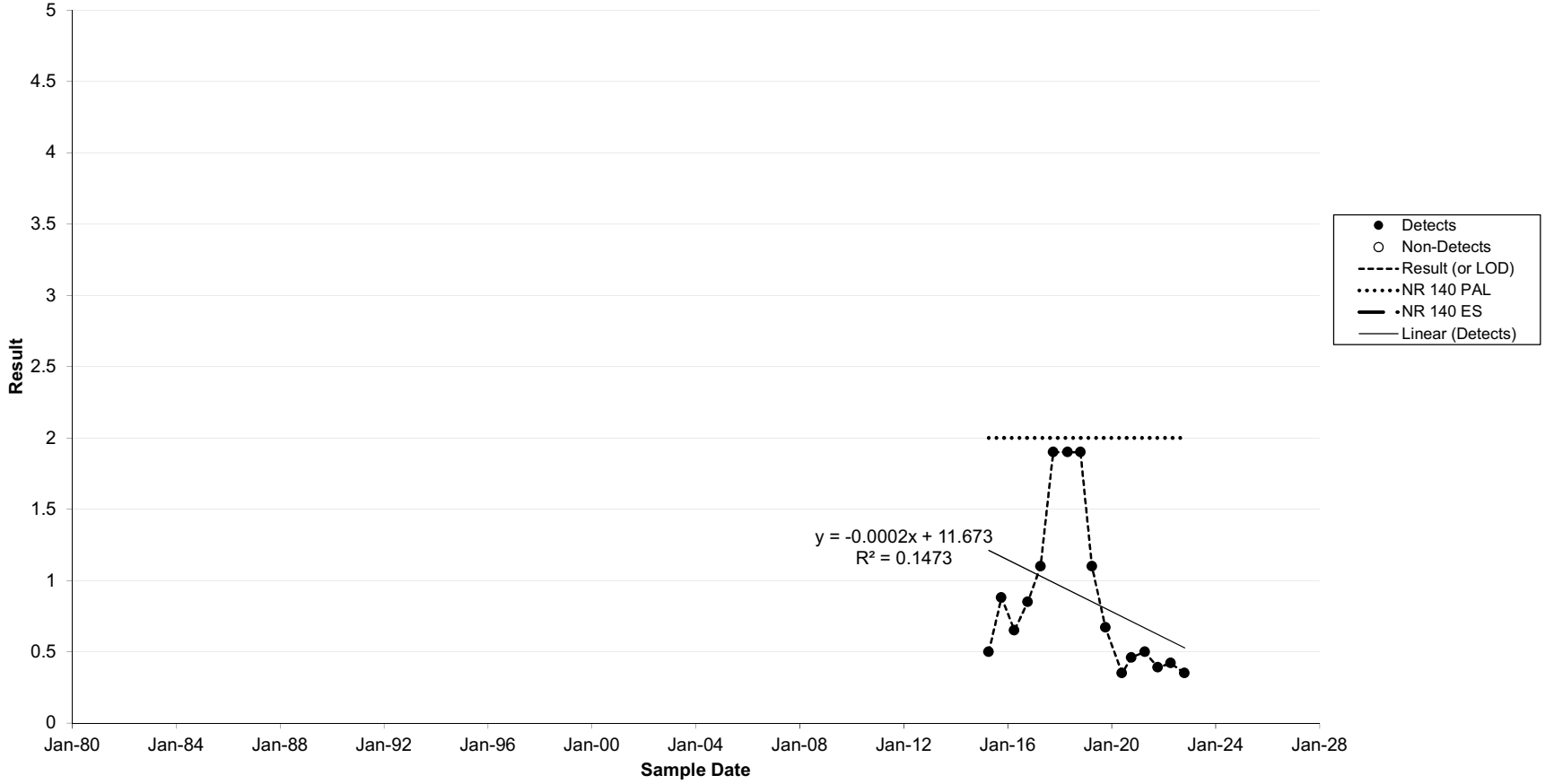
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-83 - Nitrite + Nitrate as N, mg/L



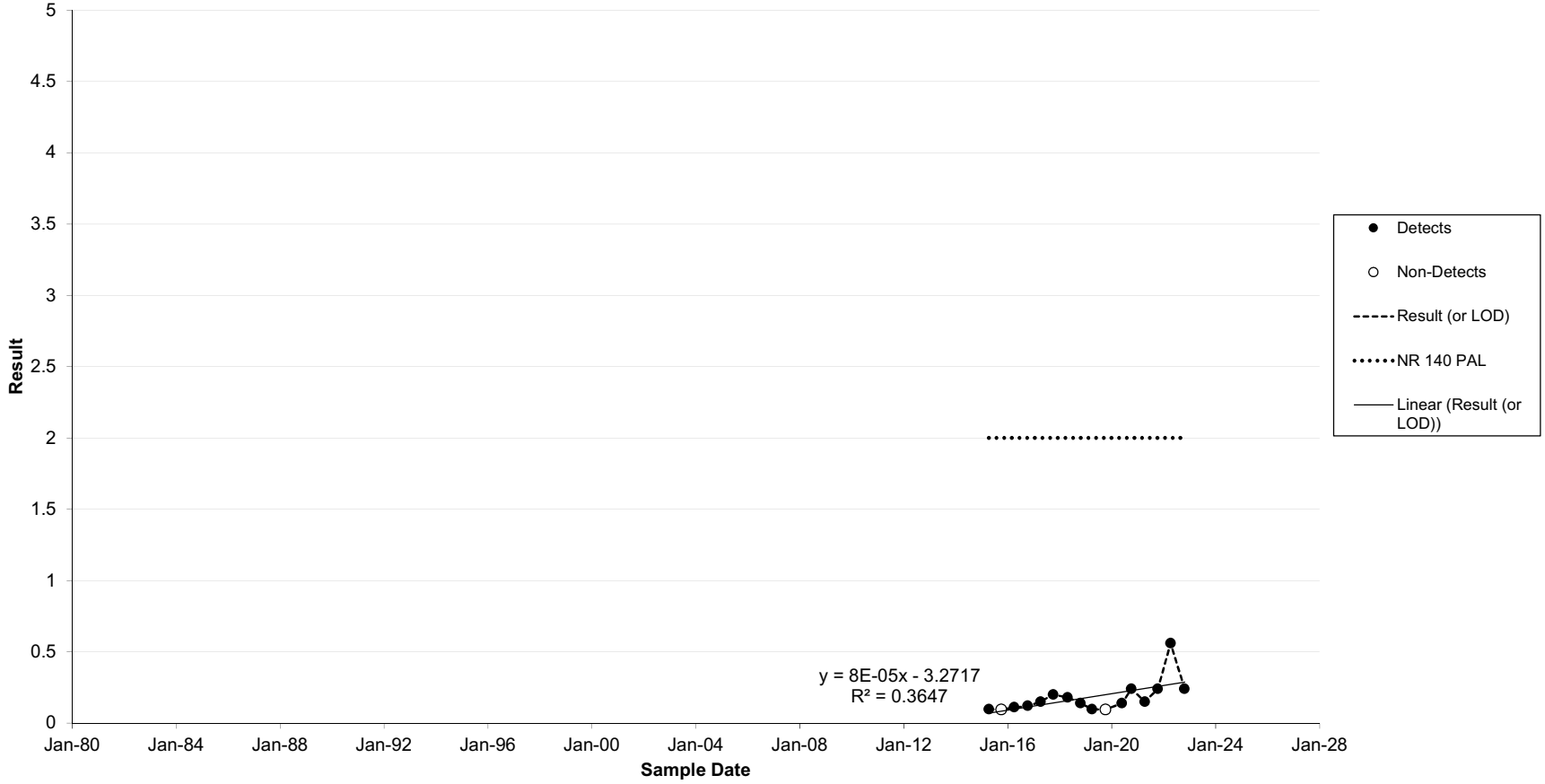
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW84A - Nitrite + Nitrate as N, mg/L



Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW84B - Nitrite + Nitrate as N, mg/L

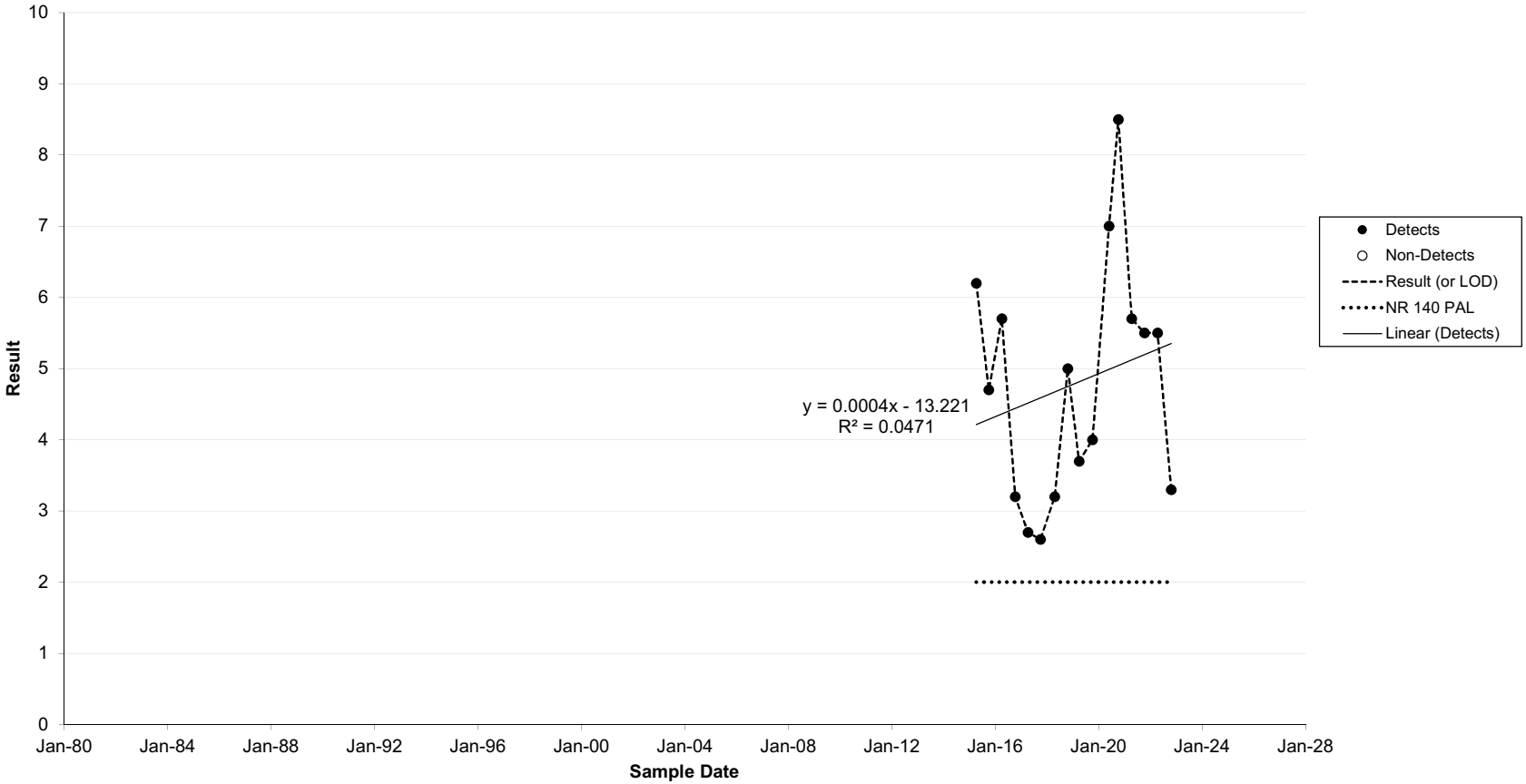


Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW86 - Nitrite + Nitrate as N, mg/L

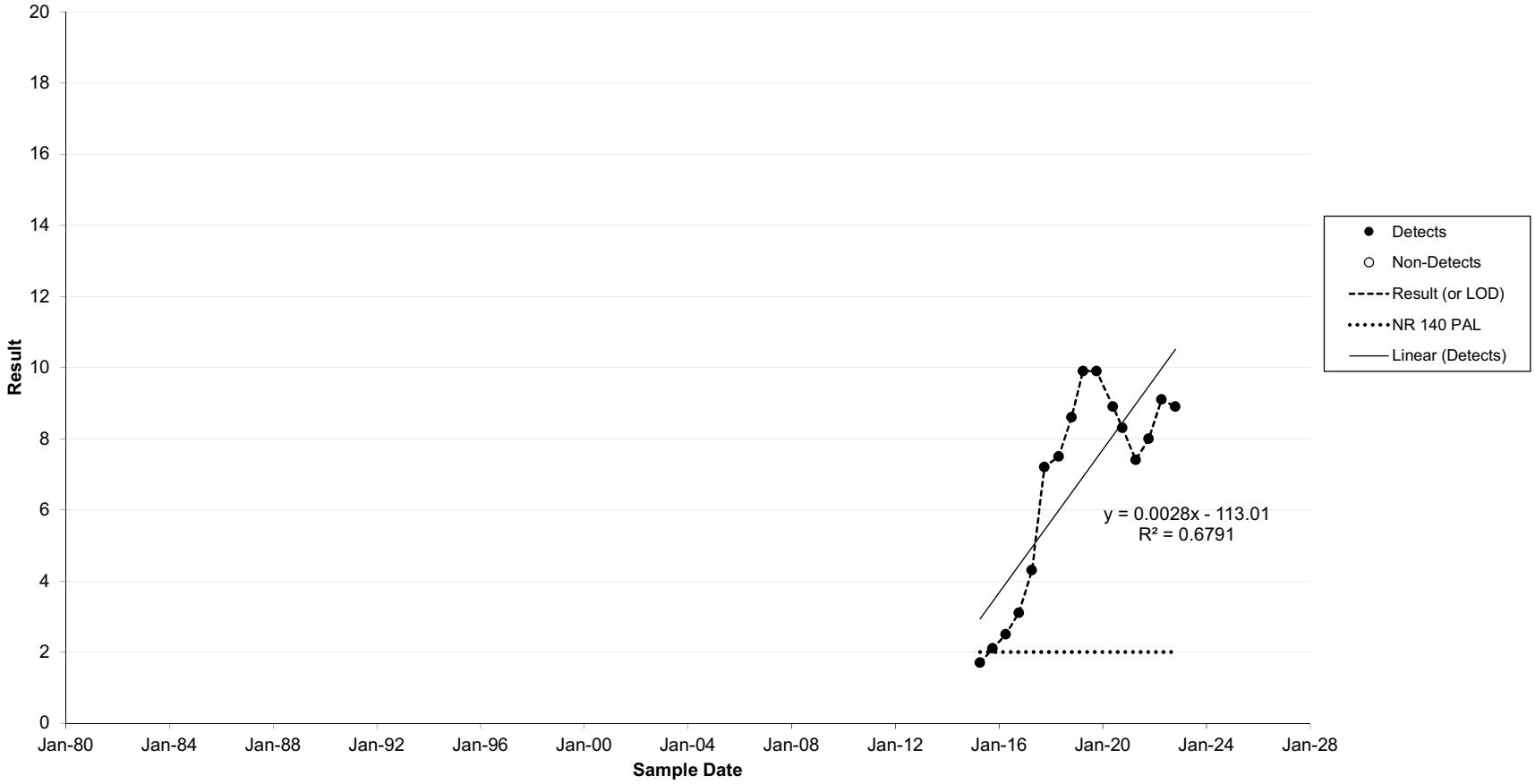


09/28/2023 - Classification: Internal - ECRM13153872

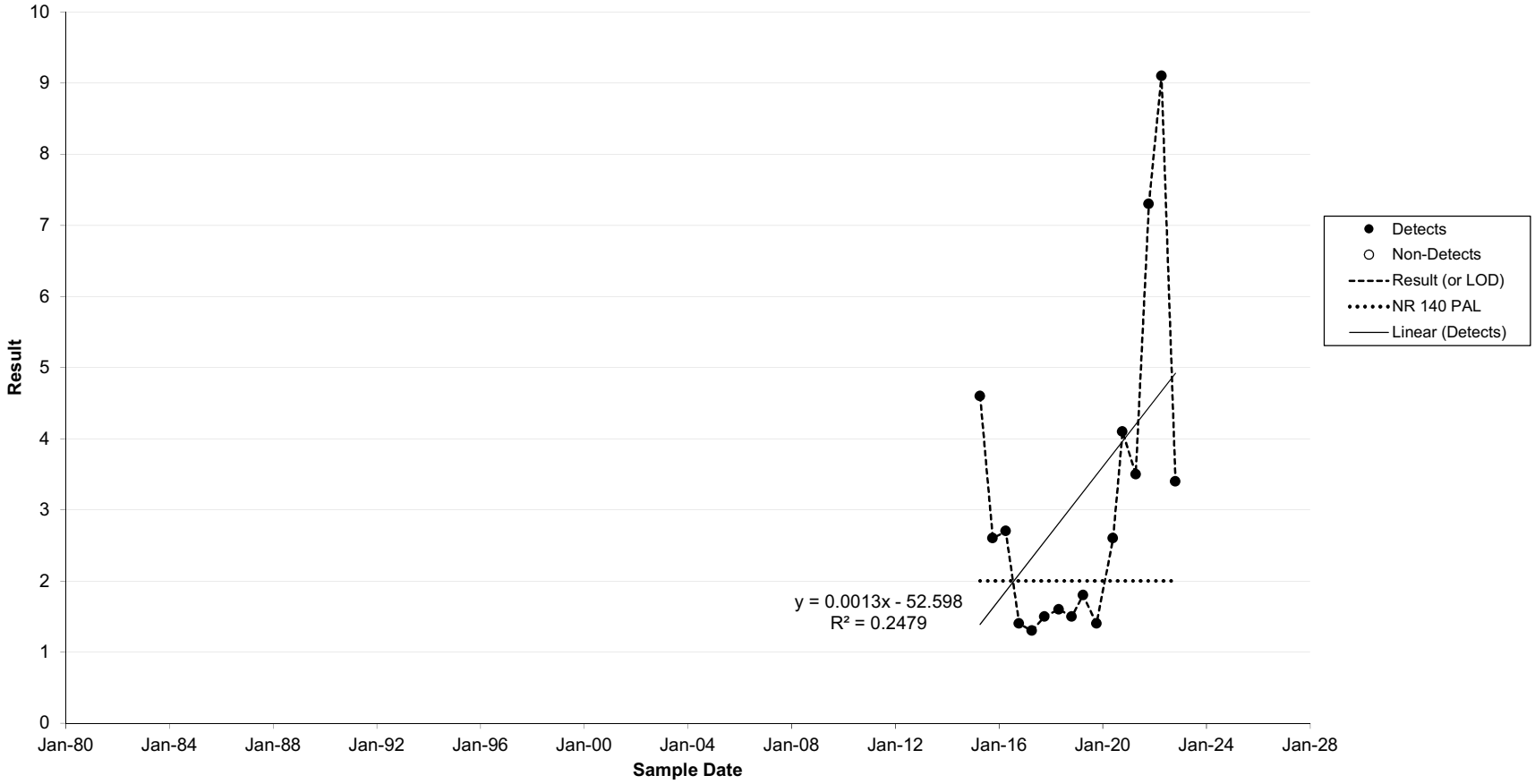
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-91AR - Nitrite + Nitrate as N, mg/L



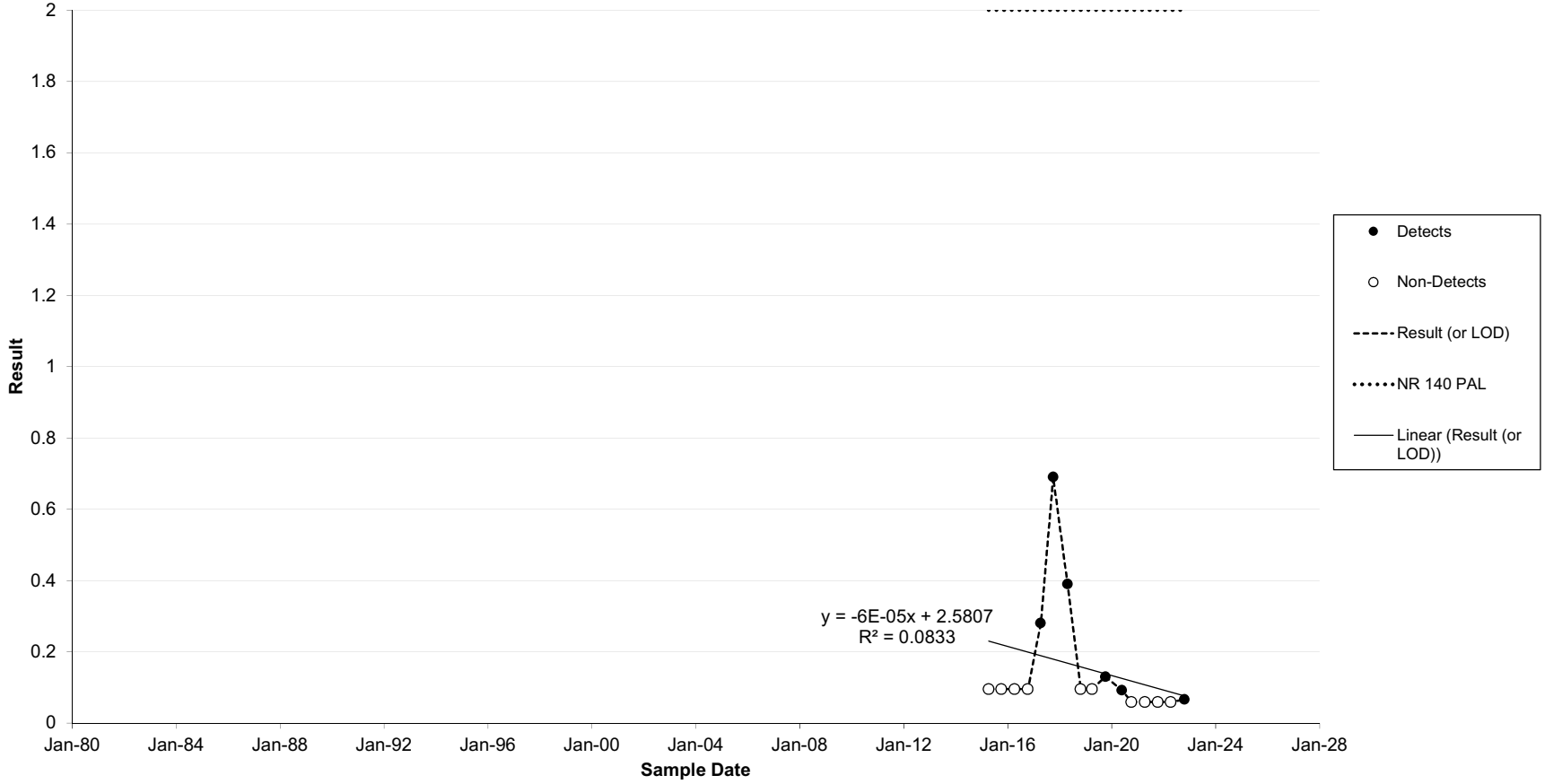
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-91B - Nitrite + Nitrate as N, mg/L



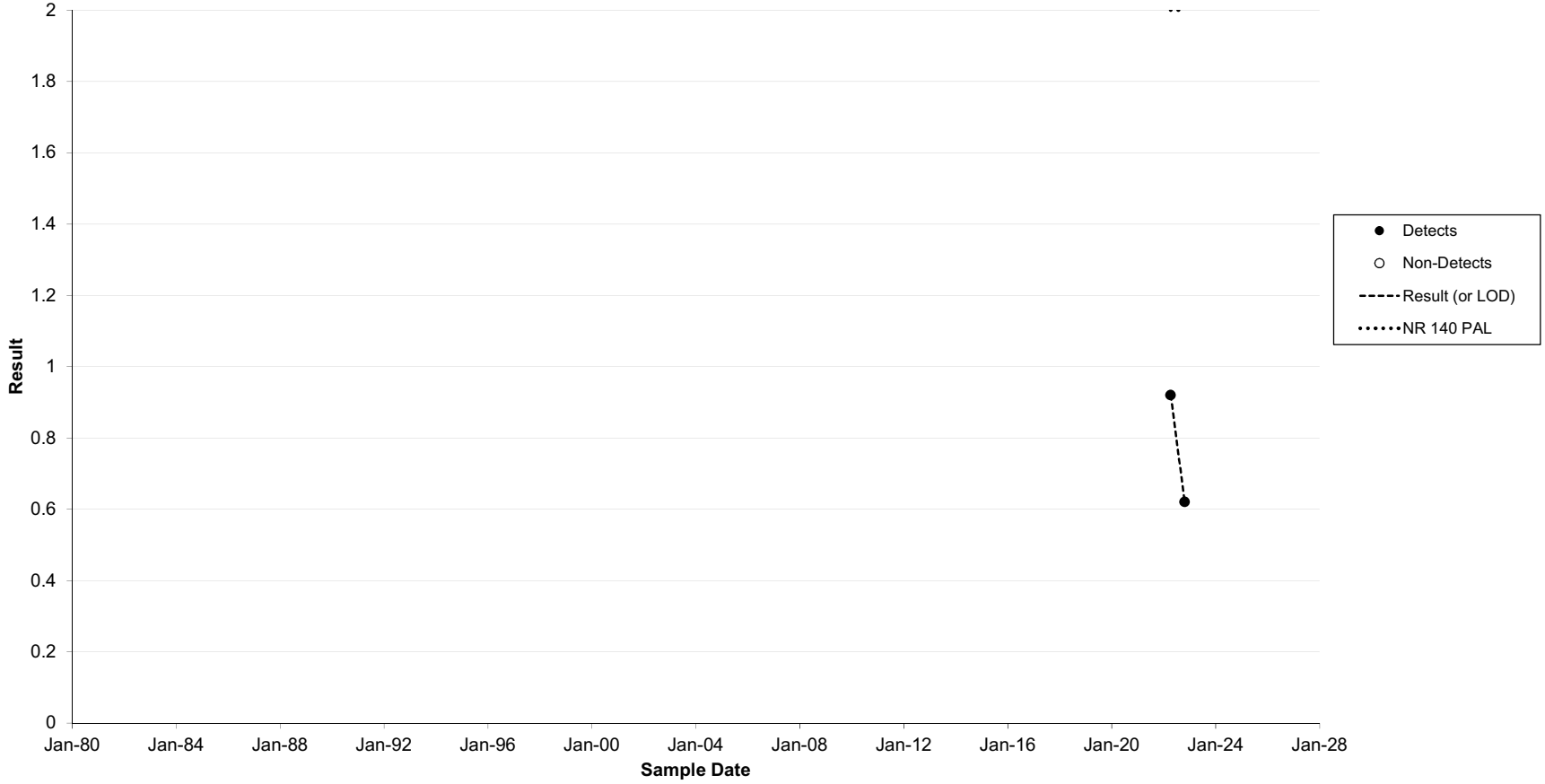
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-92A - Nitrite + Nitrate as N, mg/L



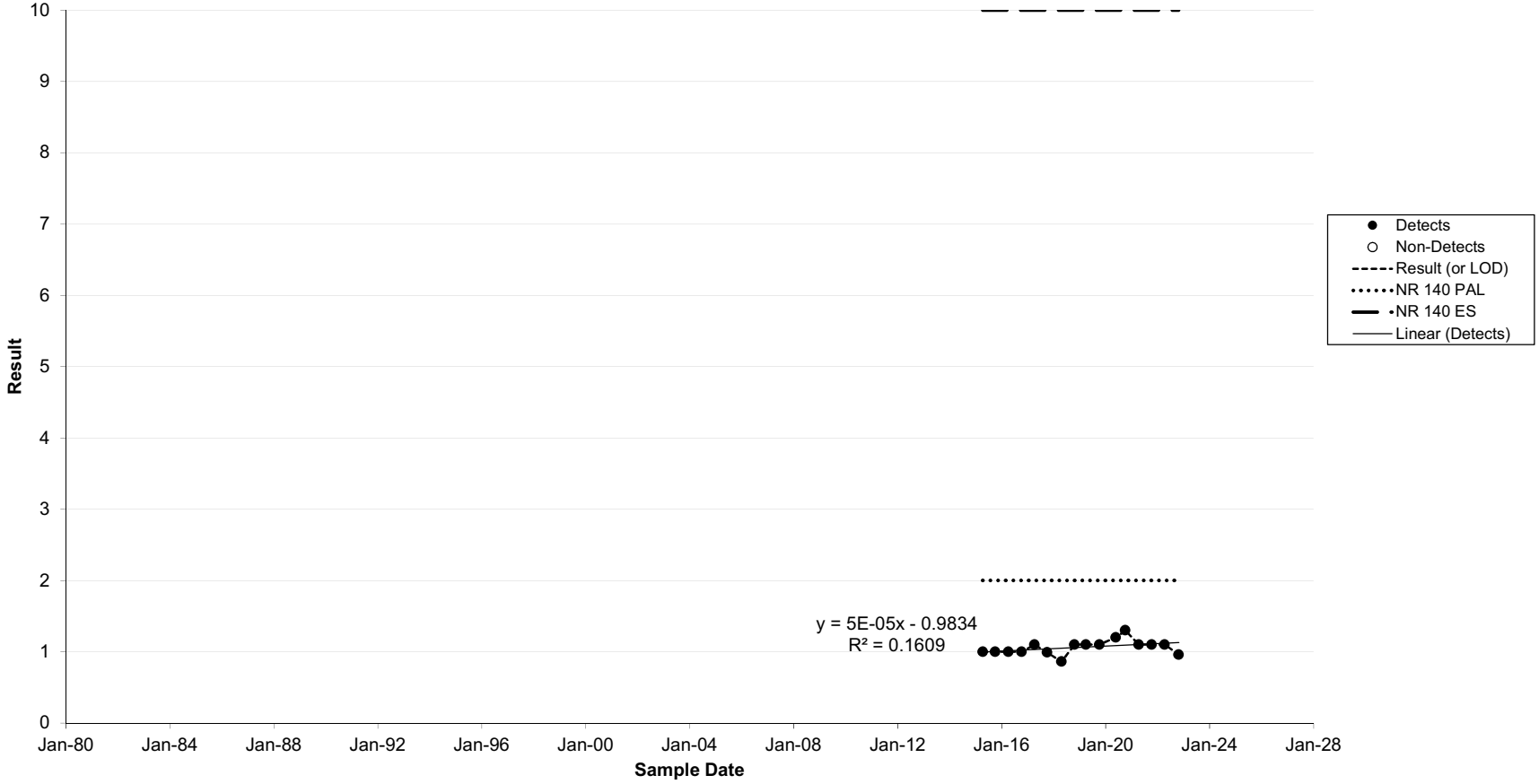
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-92B - Nitrite + Nitrate as N, mg/L



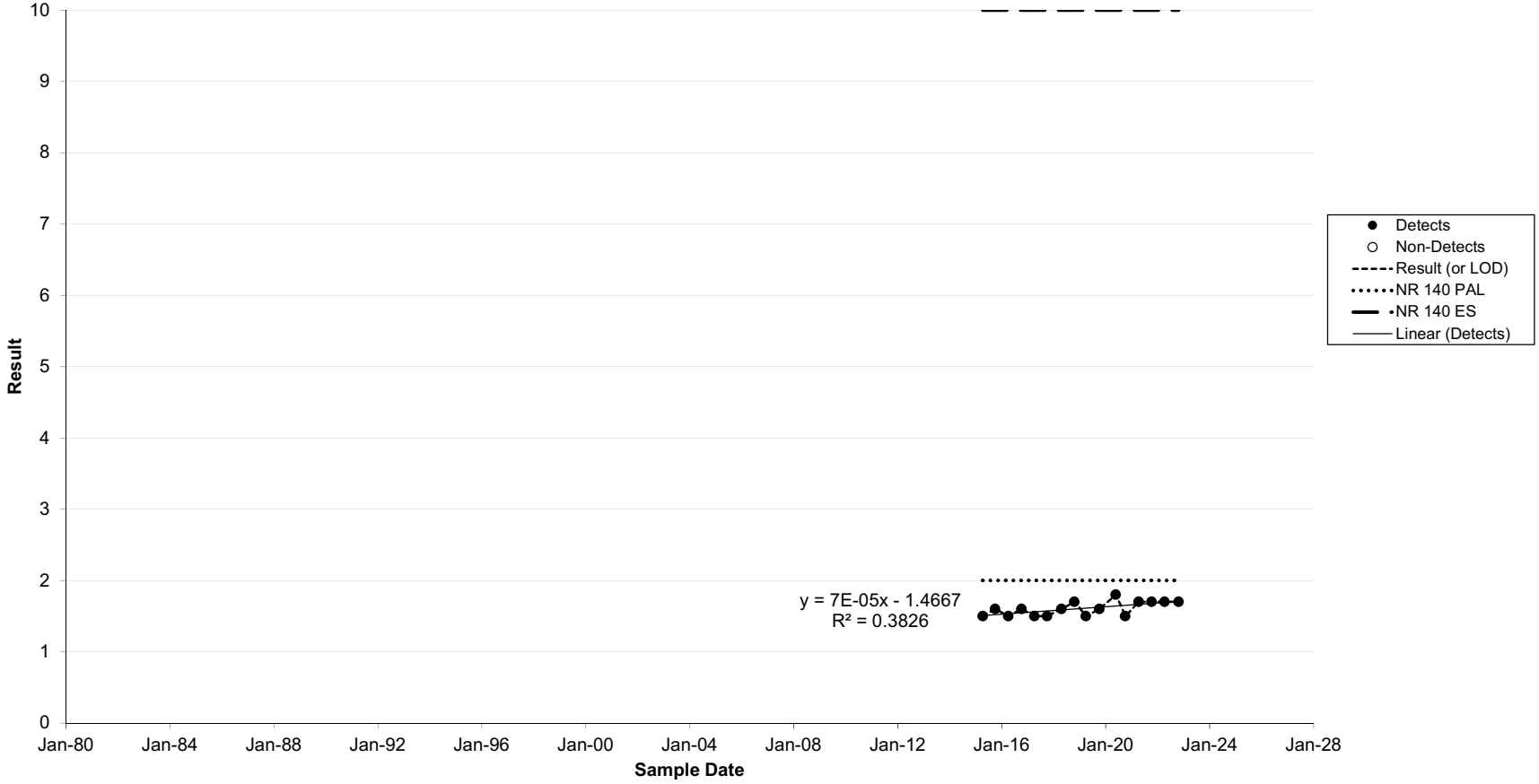
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-93A - Nitrite + Nitrate as N, mg/L



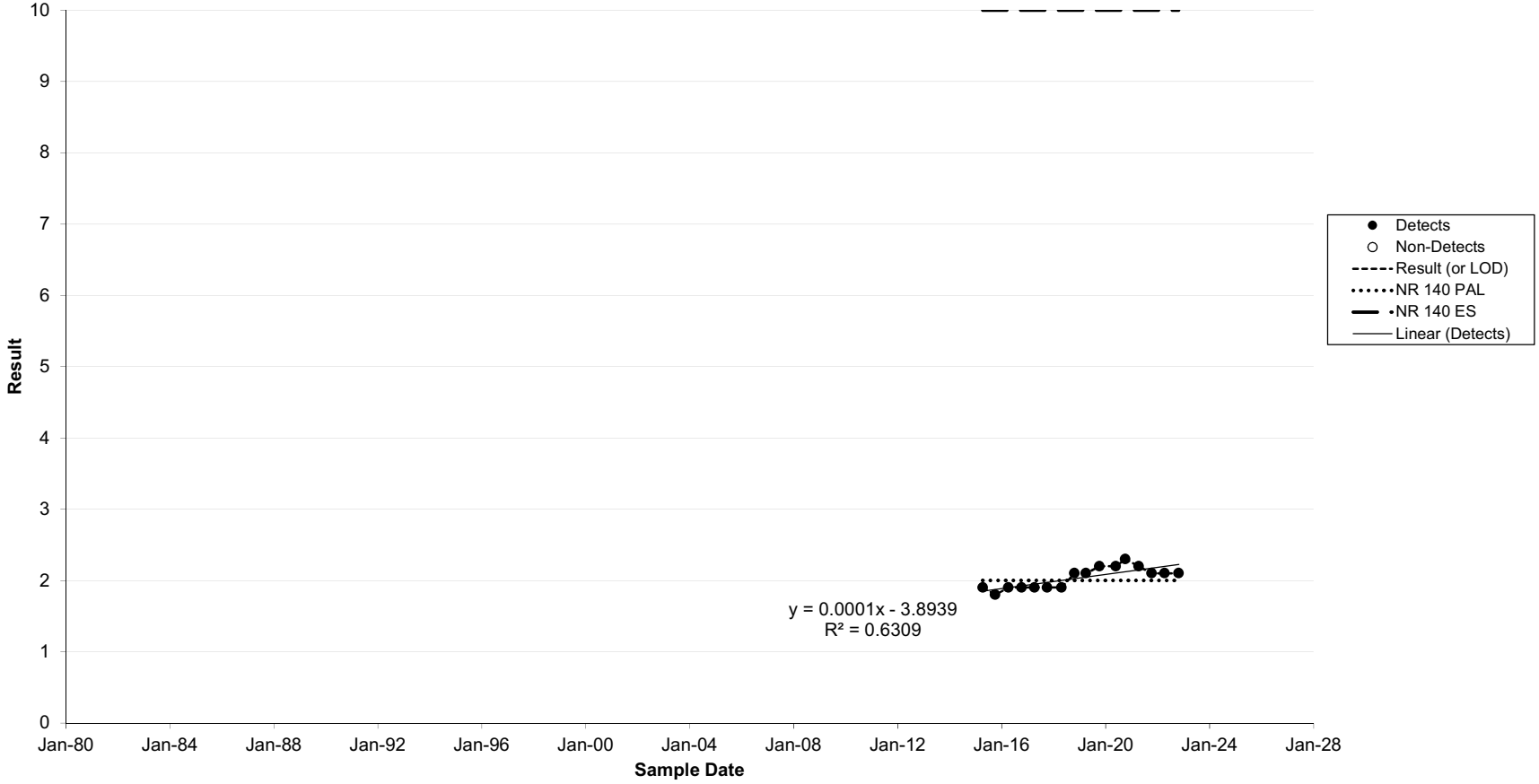
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
HC-1 - Nitrite + Nitrate as N, mg/L



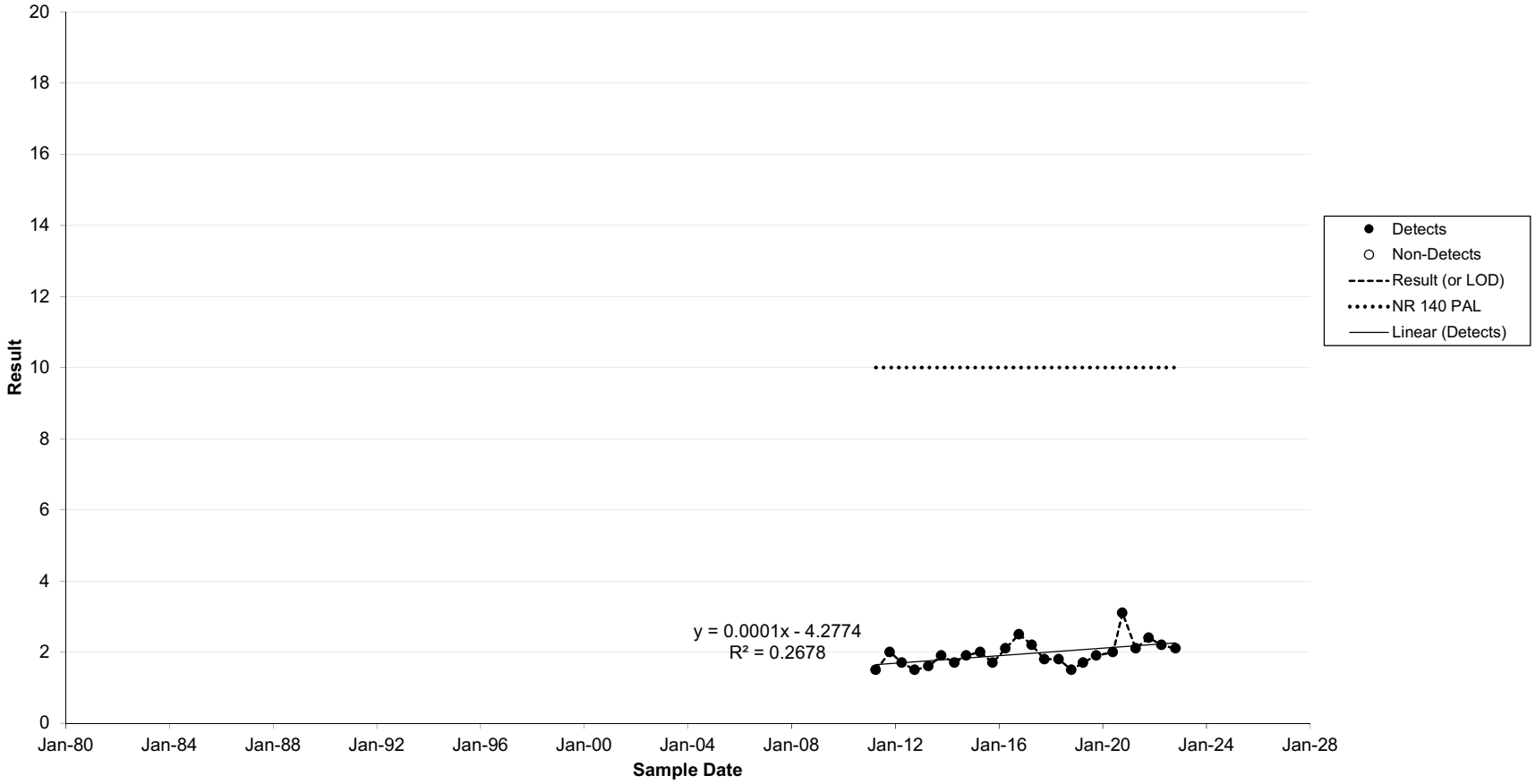
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
HC-2 - Nitrite + Nitrate as N, mg/L



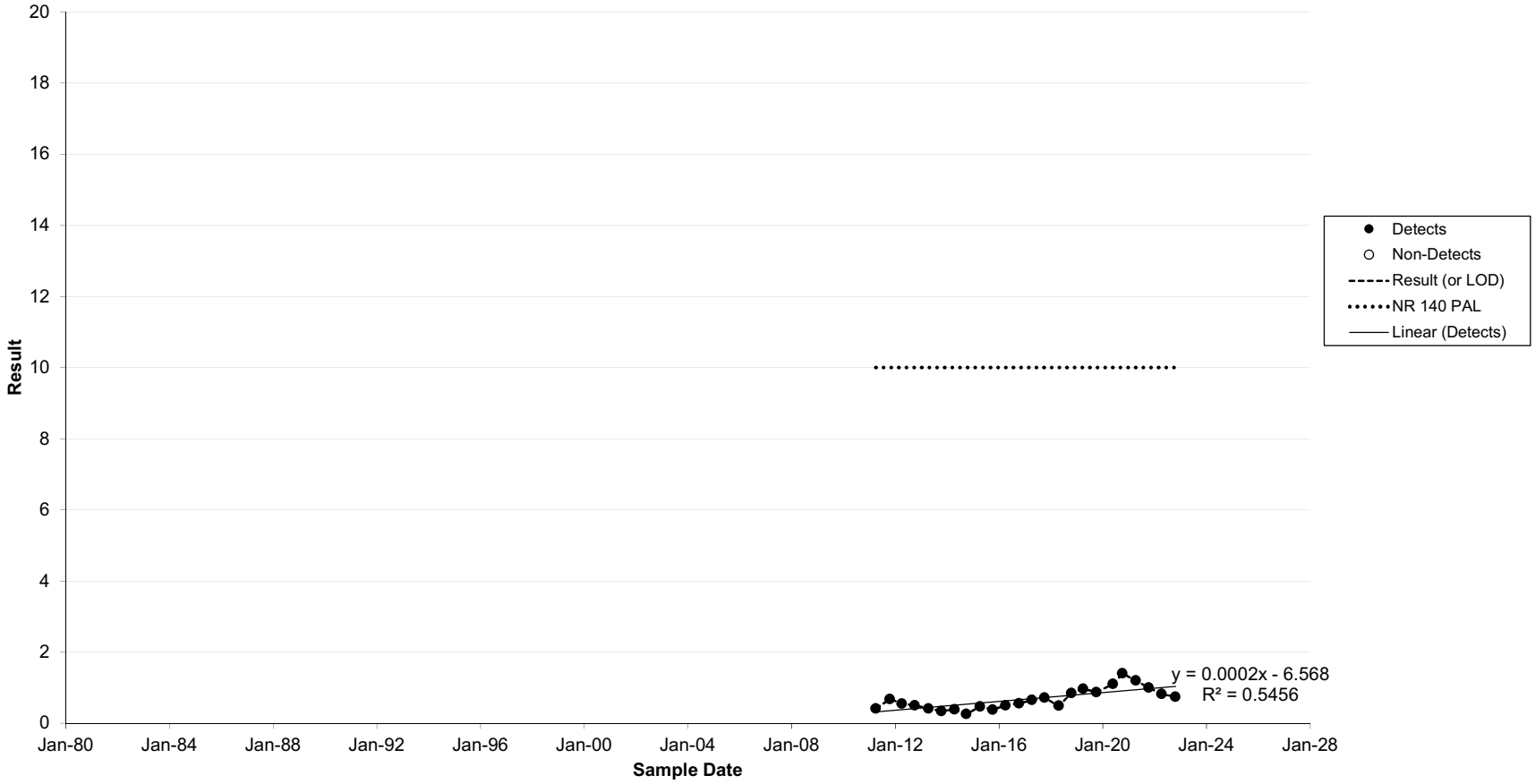
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
HC-3 - Nitrite + Nitrate as N, mg/L



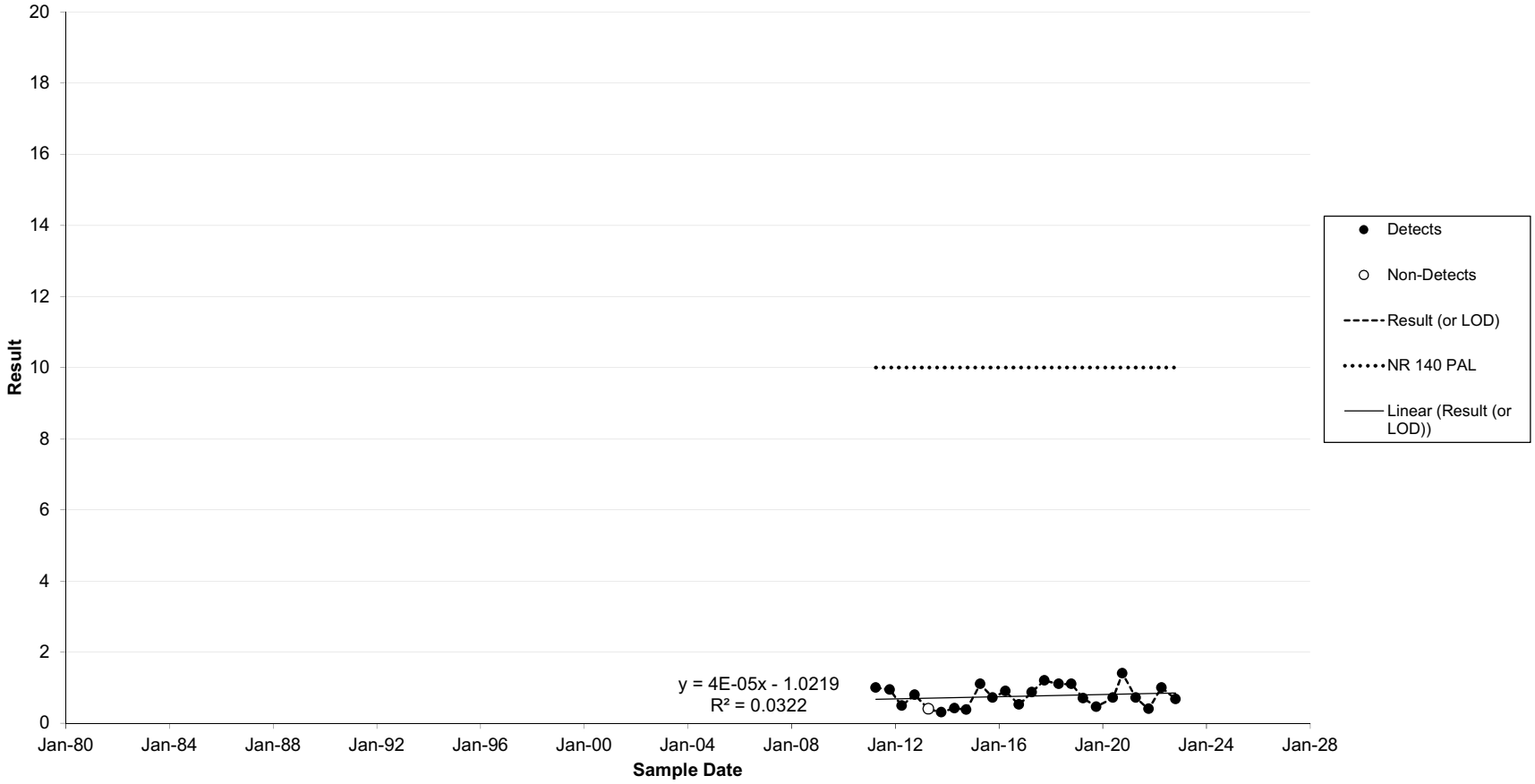
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-33AR - Selenium, dissolved (ug/l as Se)



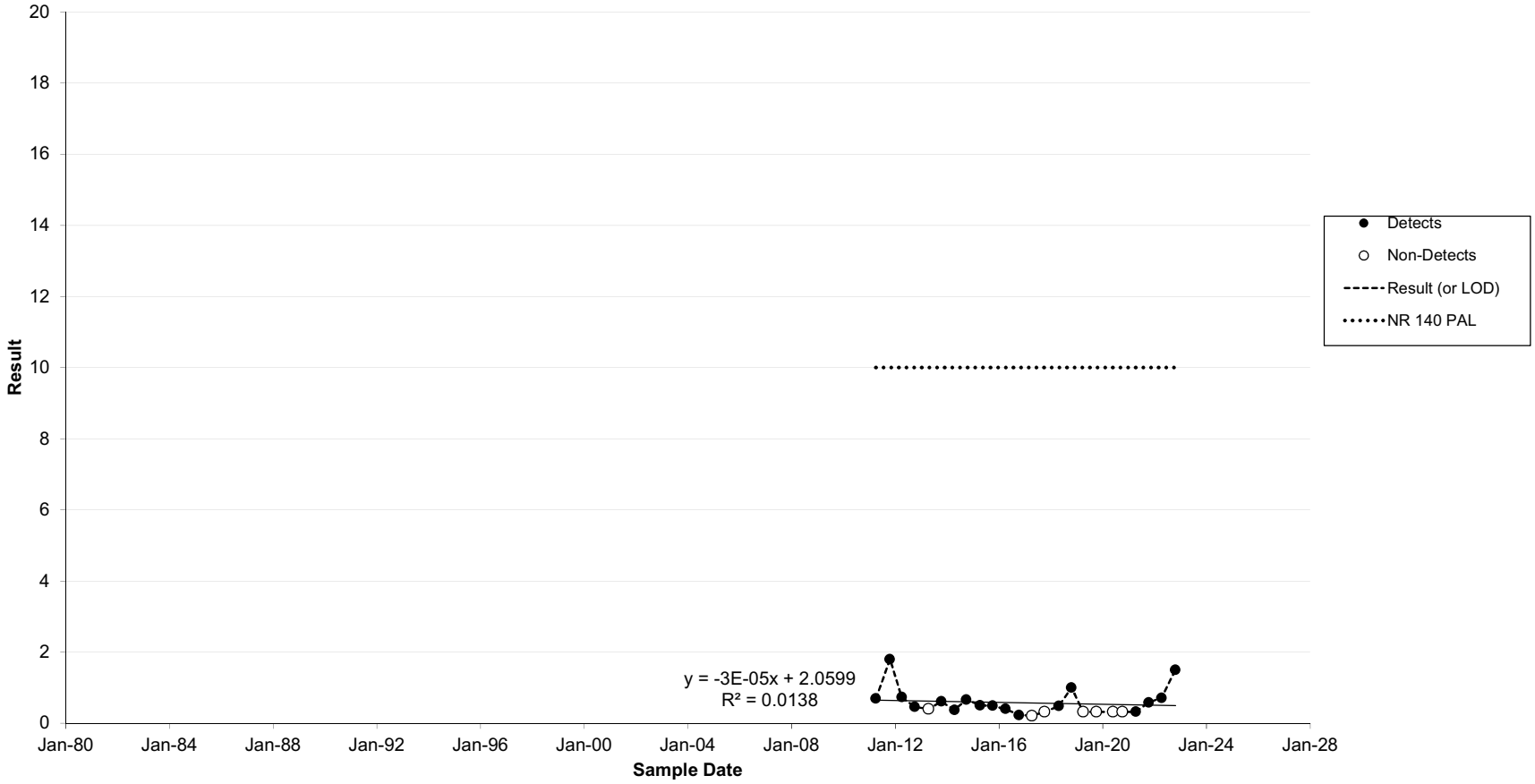
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-33BR - Selenium, dissolved (ug/l as Se)



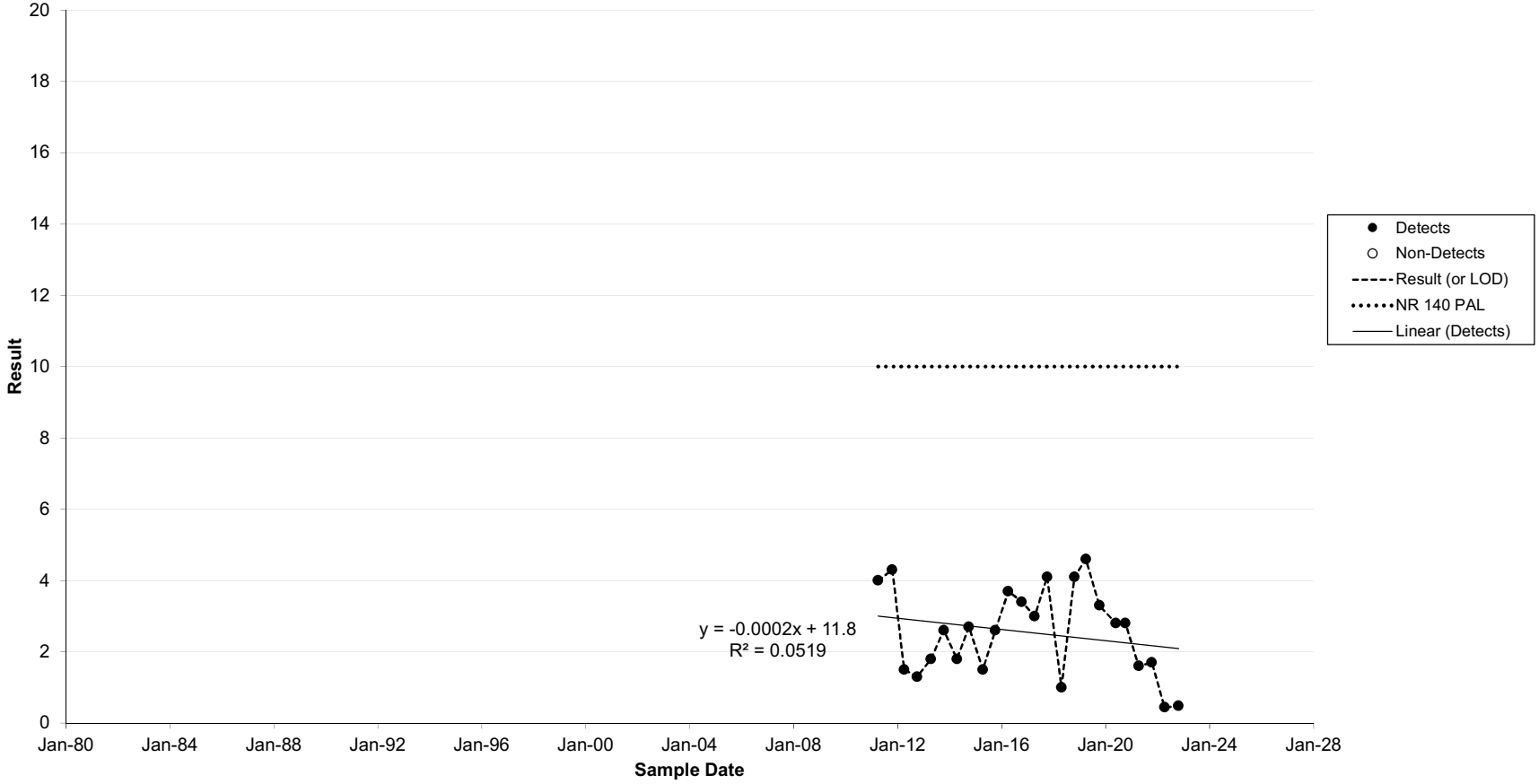
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-34A - Selenium, dissolved (ug/l as Se)



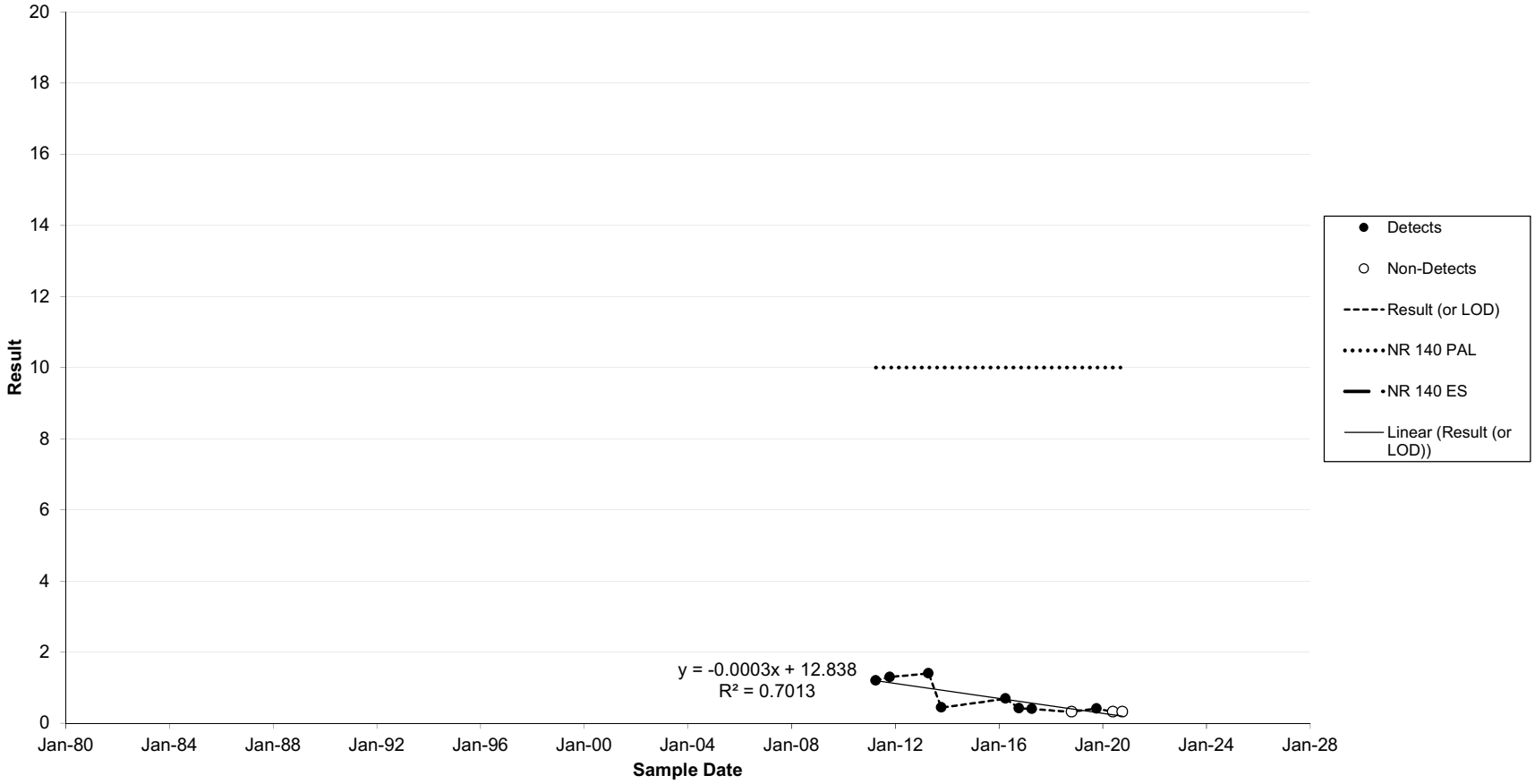
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-34B - Selenium, dissolved (ug/l as Se)



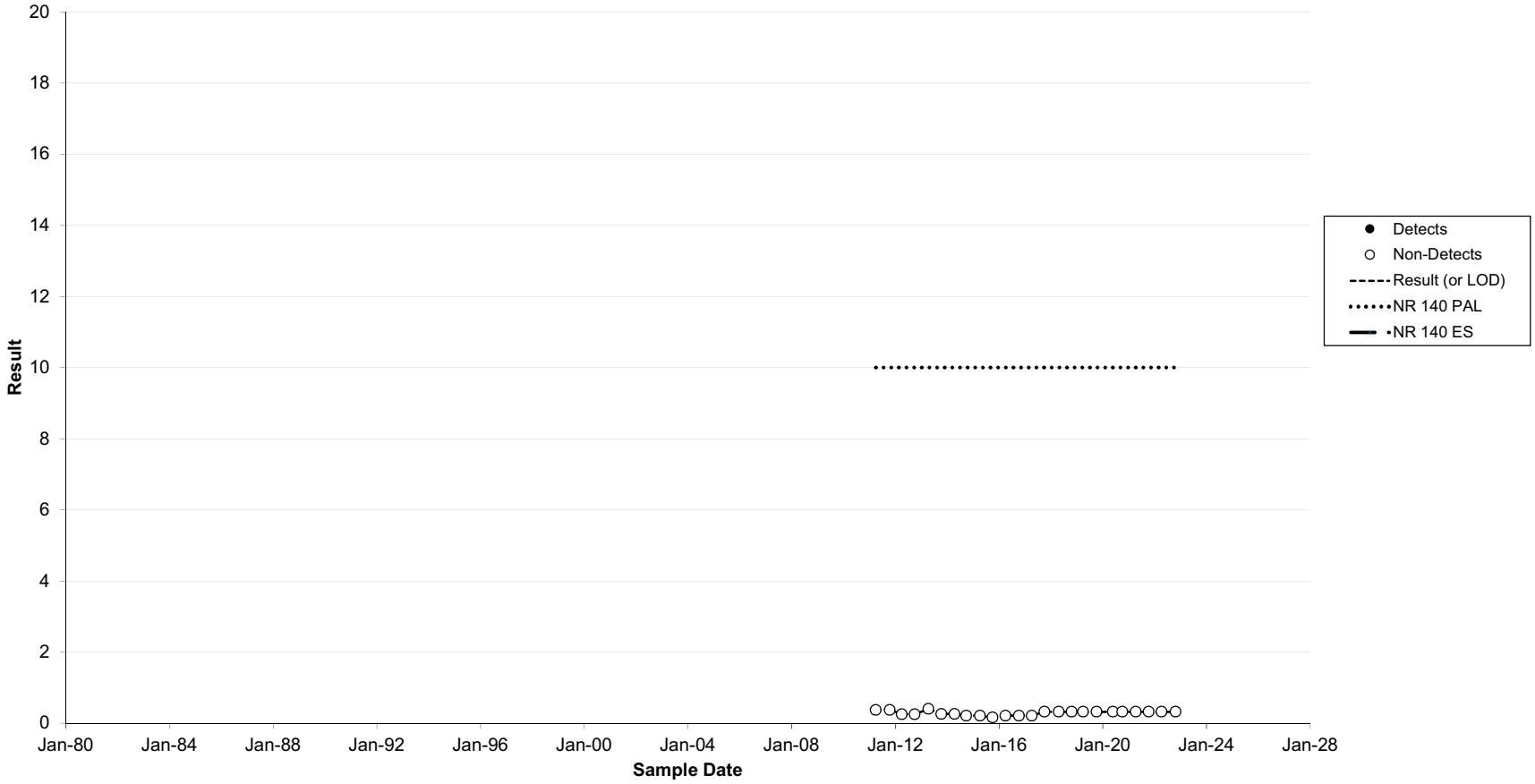
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-37A - Selenium, dissolved (ug/l as Se)



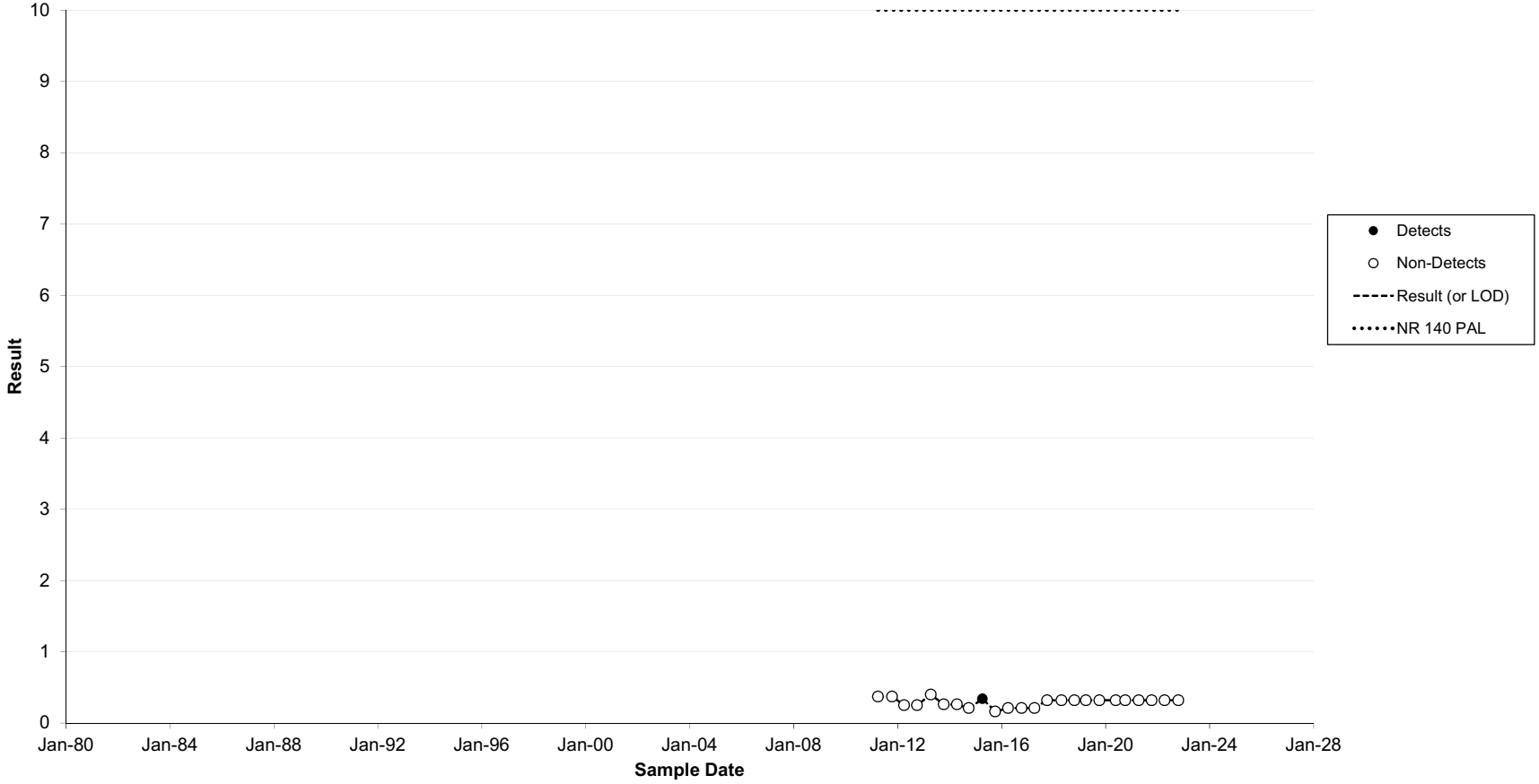
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-83 - Selenium, dissolved (ug/l as Se)



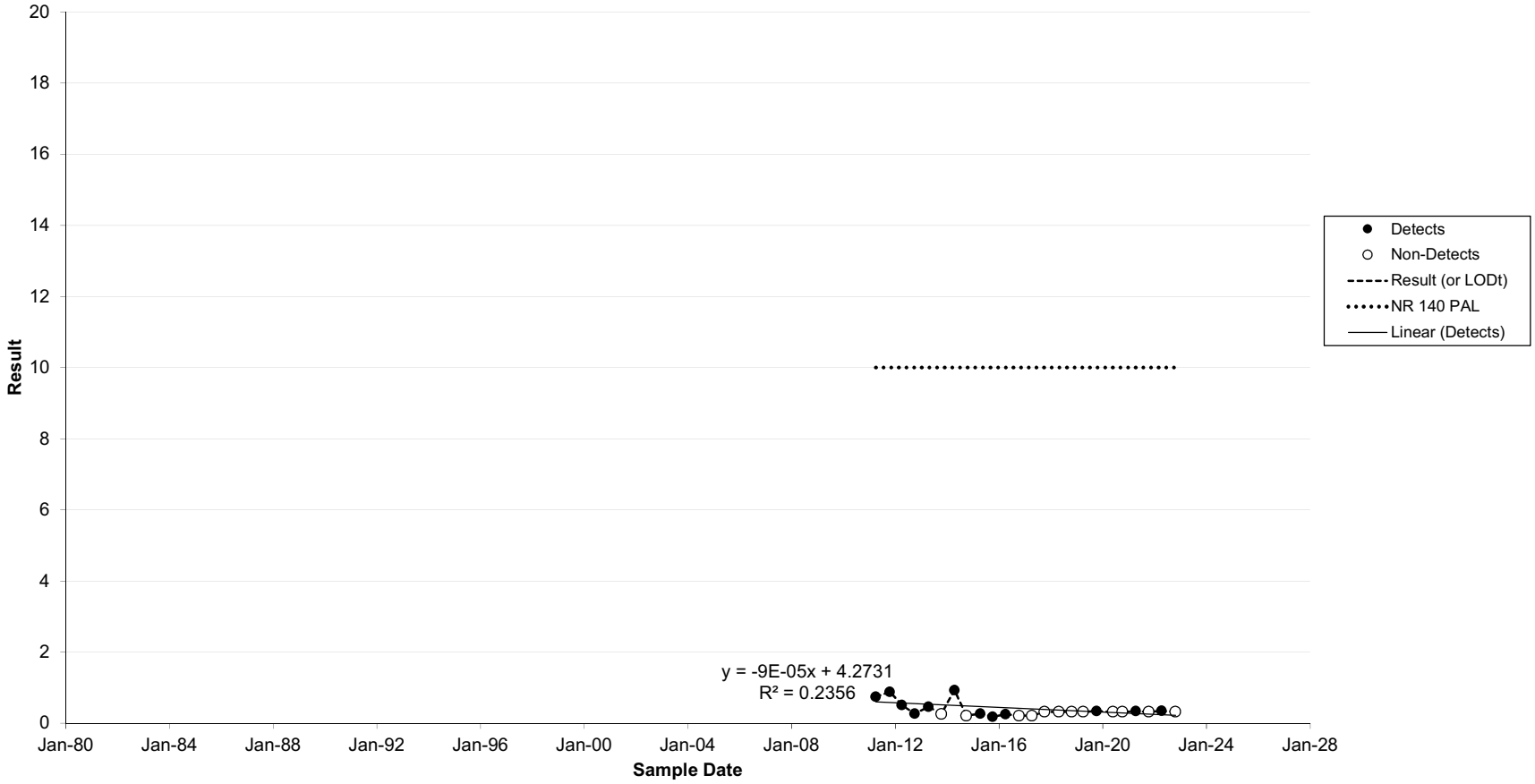
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-84A - Selenium, dissolved (ug/l as Se)



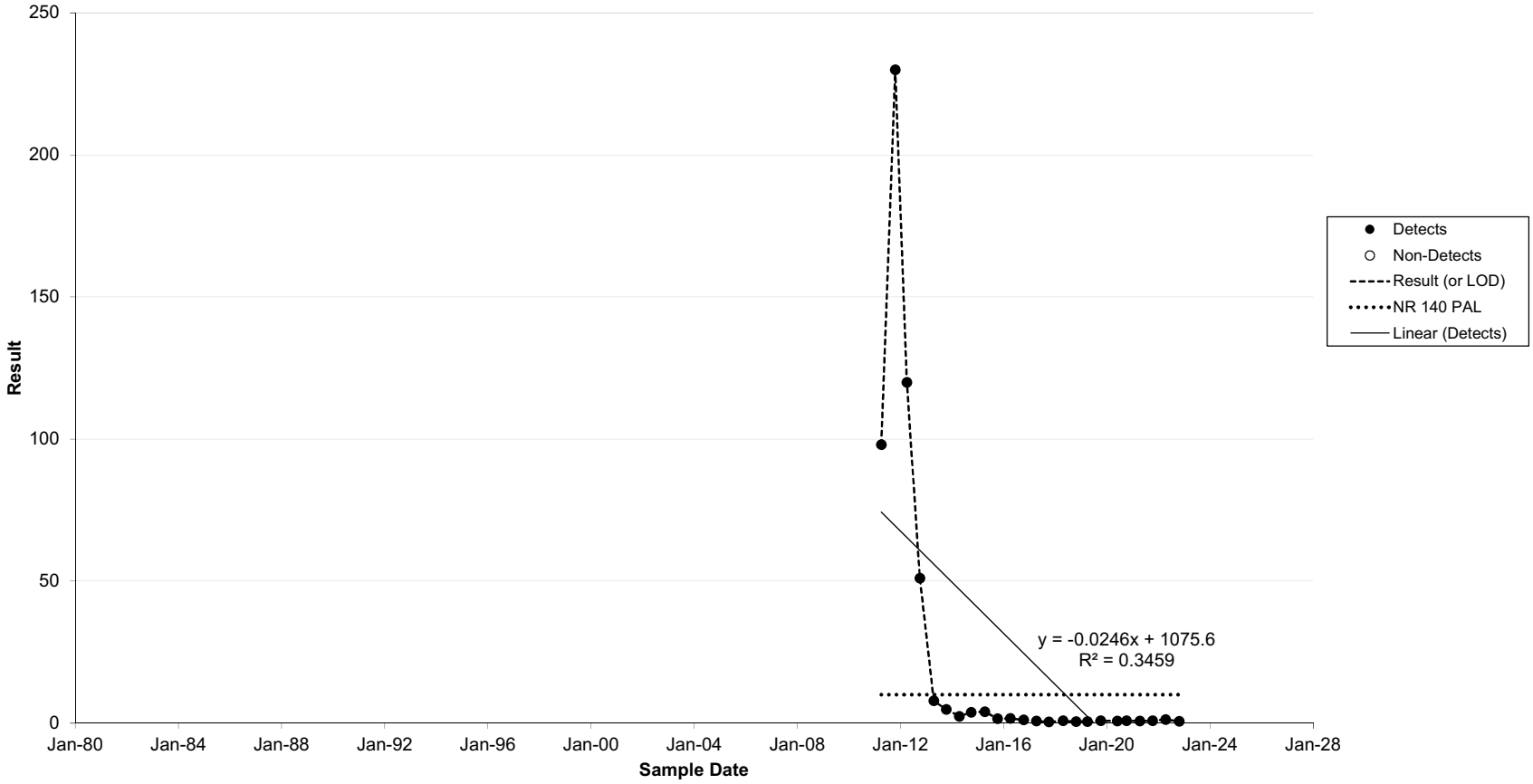
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-84B - Selenium, dissolved (ug/l as Se)



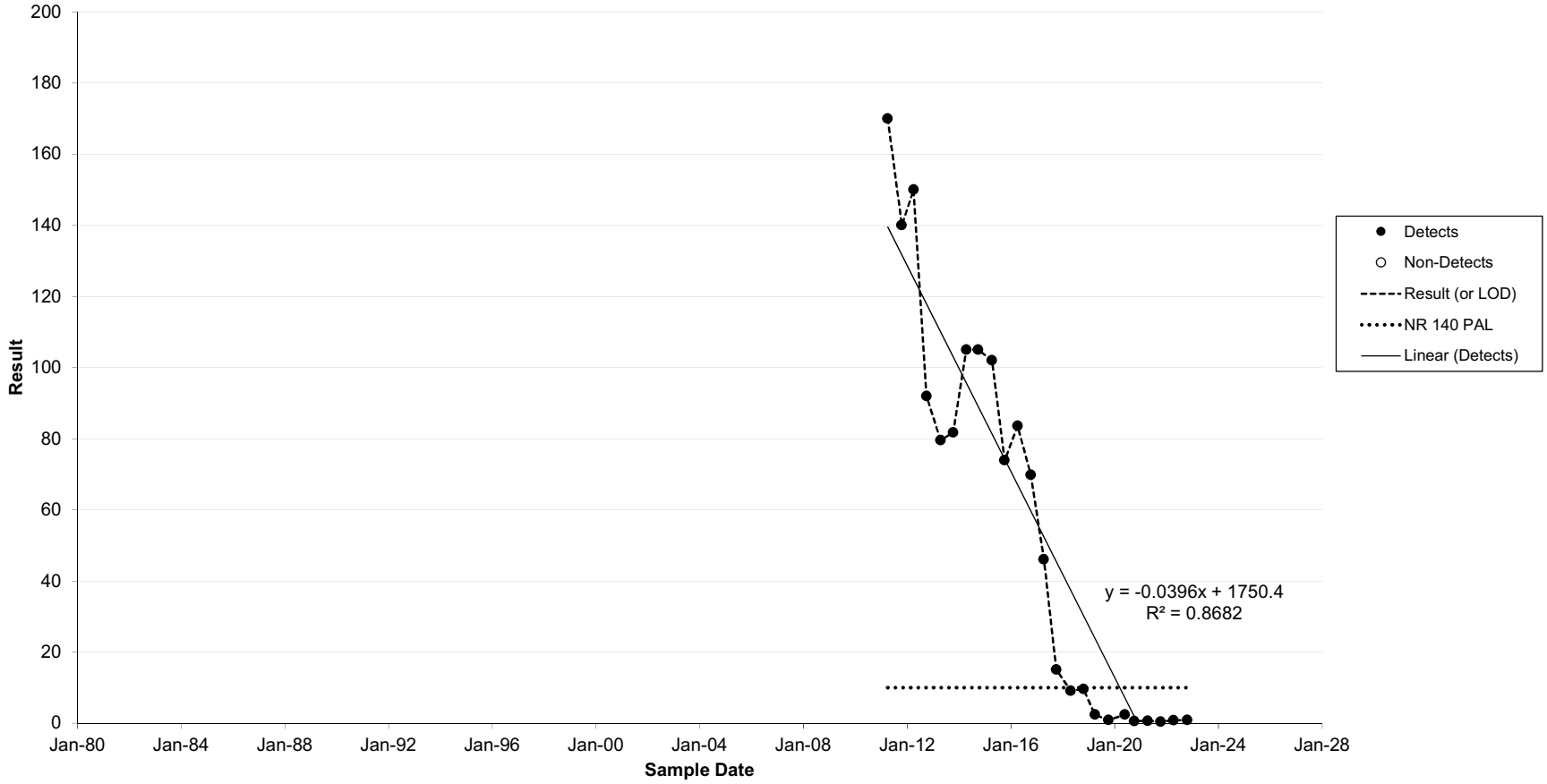
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-86 - Selenium, dissolved (ug/l as Se)



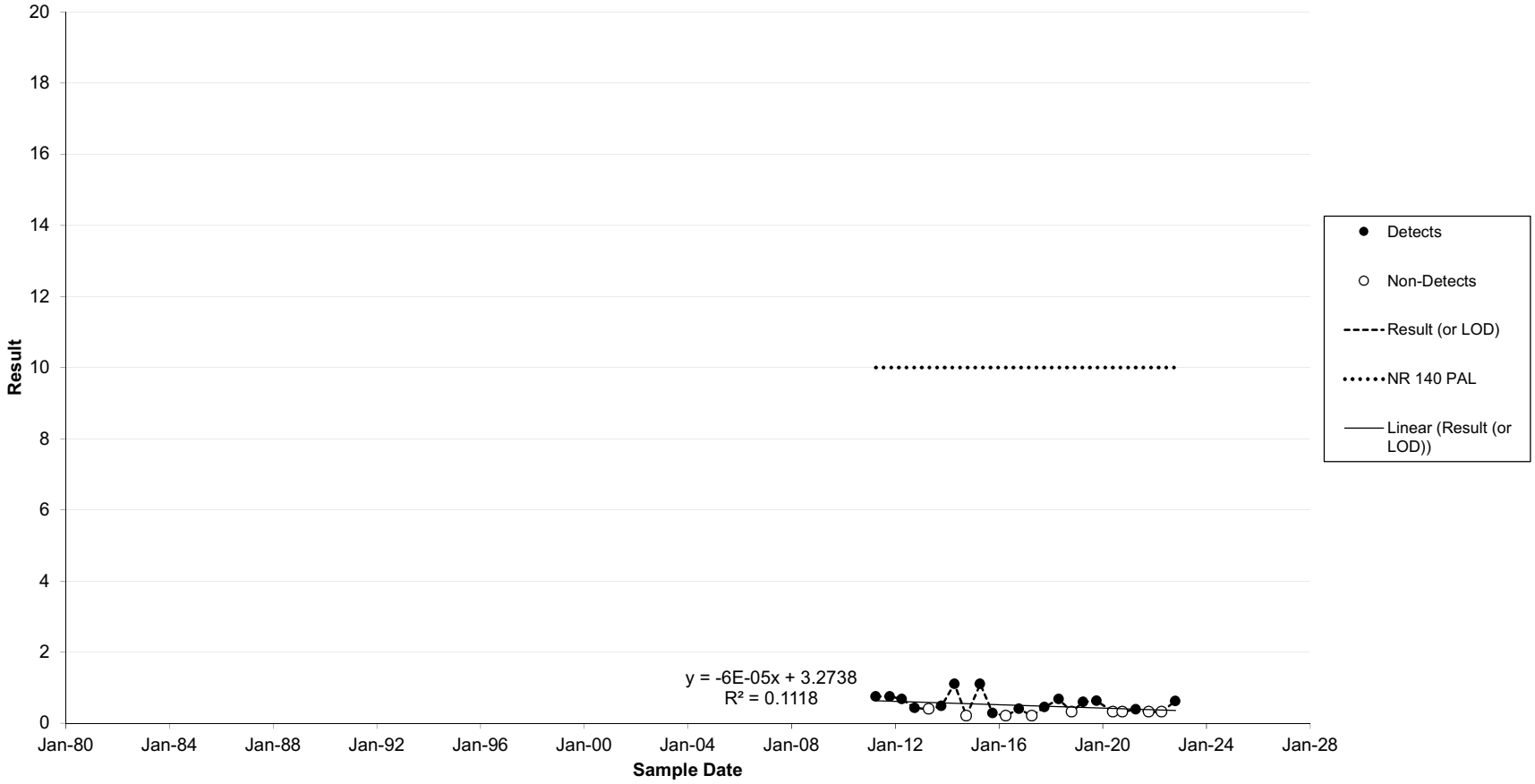
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-91AR - Selenium, dissolved (ug/l as Se)



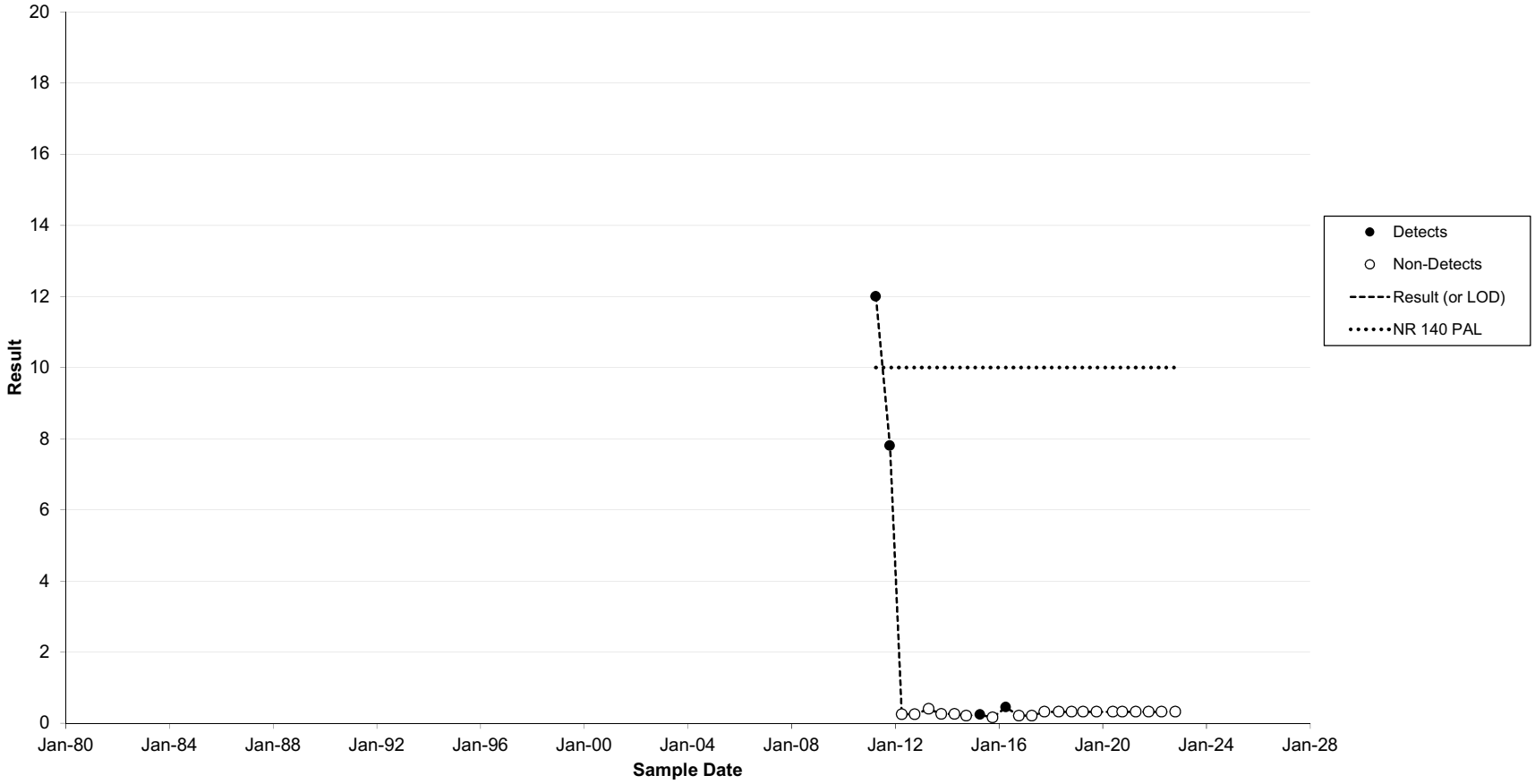
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-91B - Selenium, dissolved (ug/l as Se)



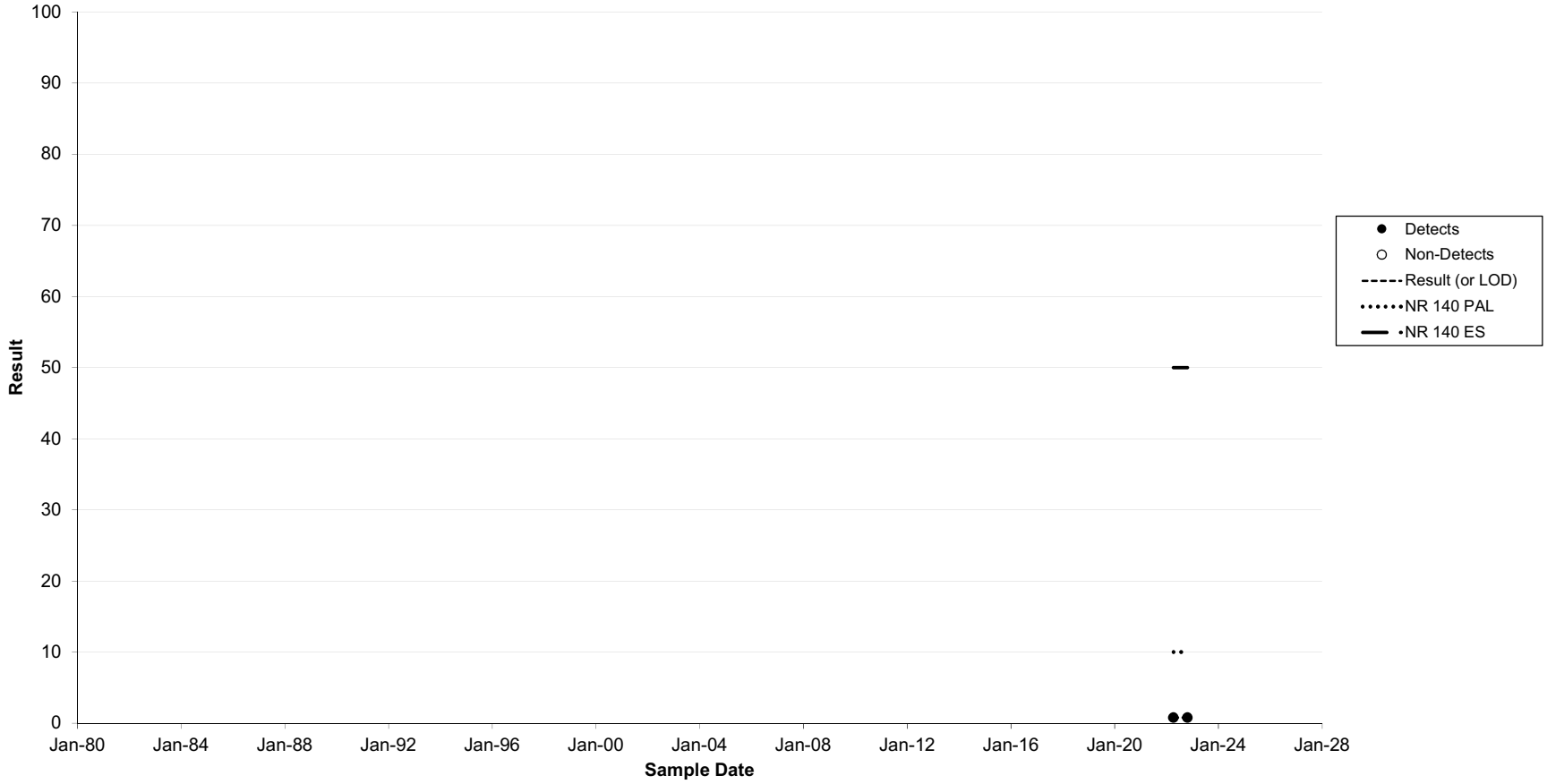
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-92A - Selenium, dissolved (ug/l as Se)



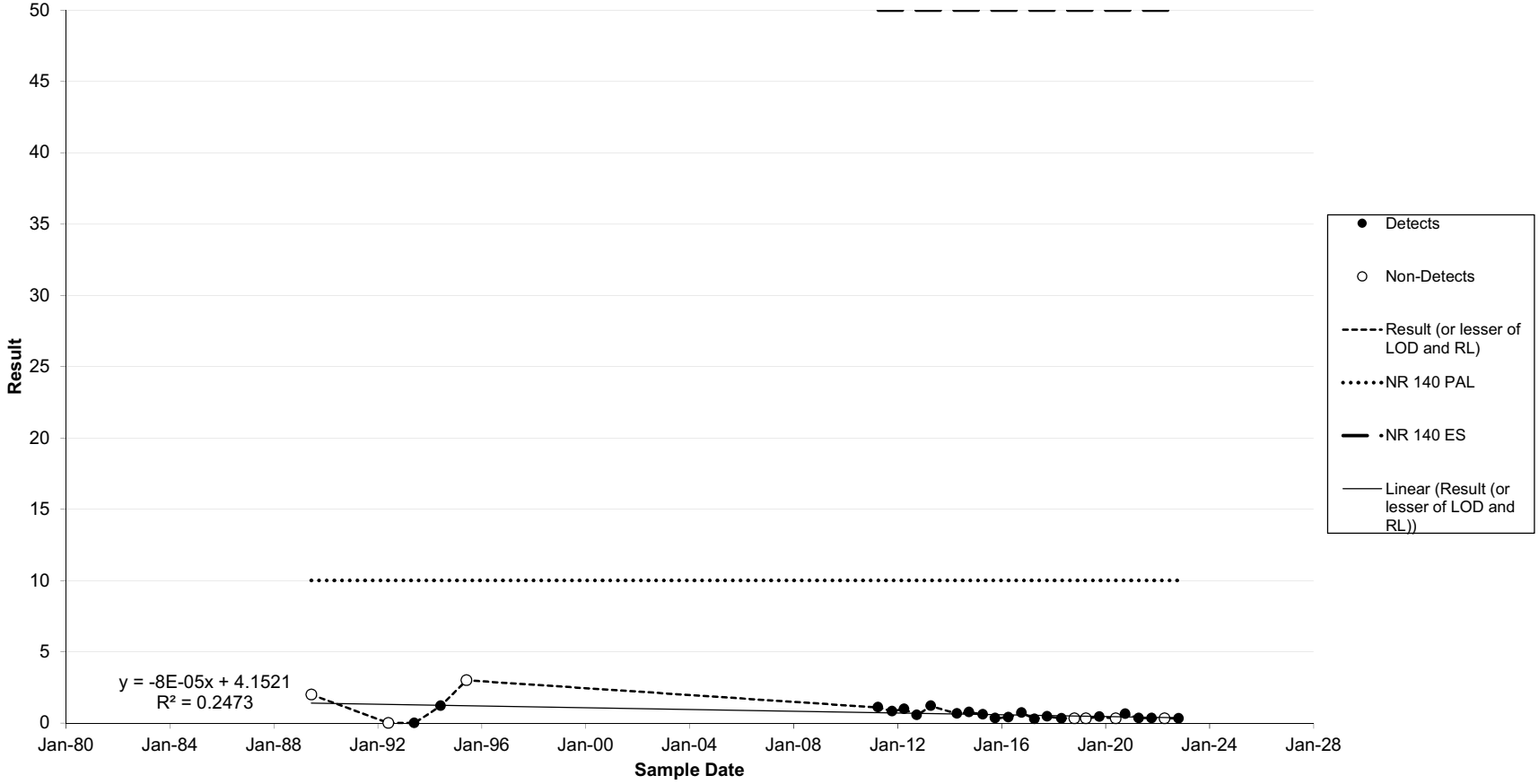
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-92B - Selenium, dissolved (ug/l as Se)



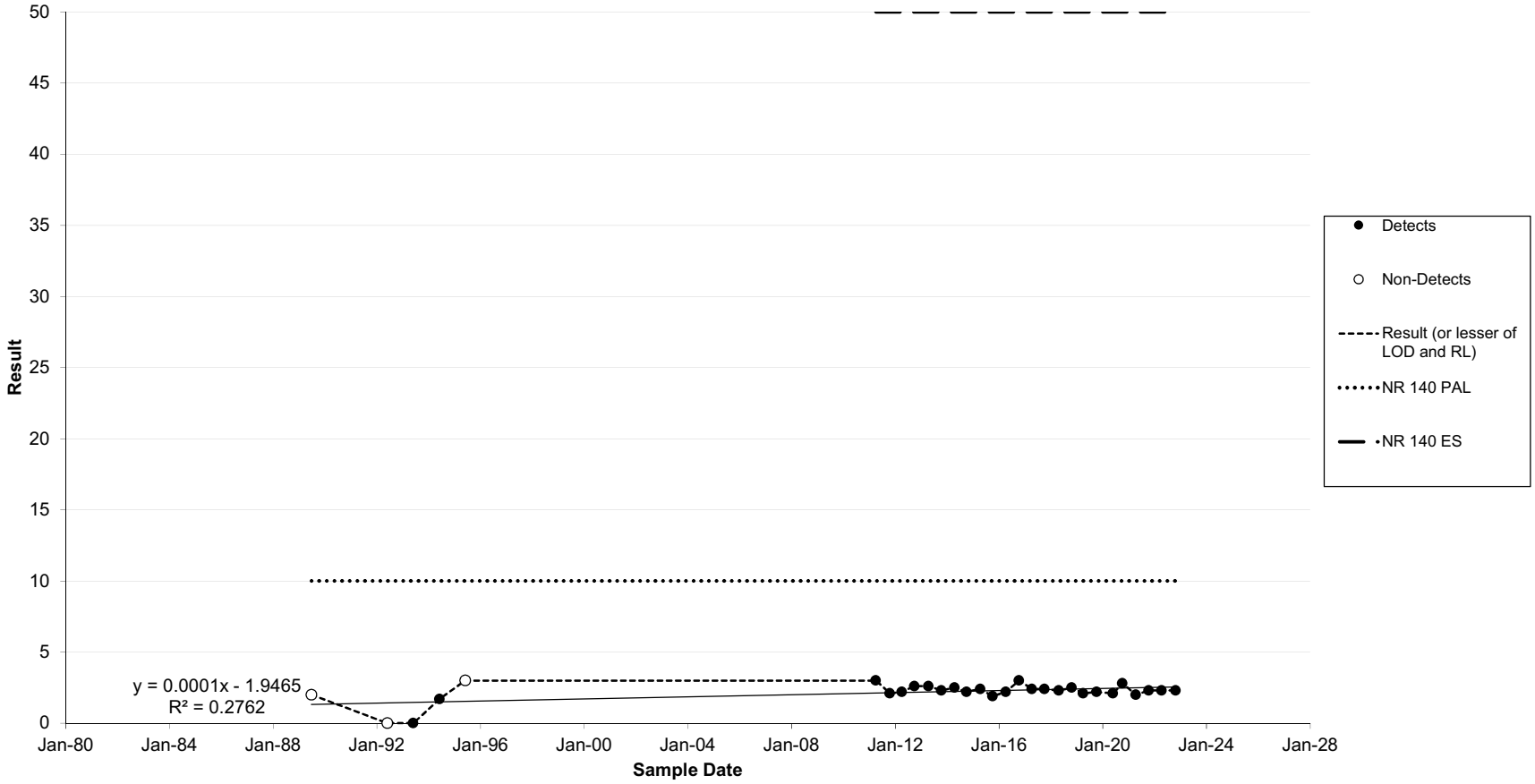
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
MW-93A - Selenium, dissolved (ug/l as Se)



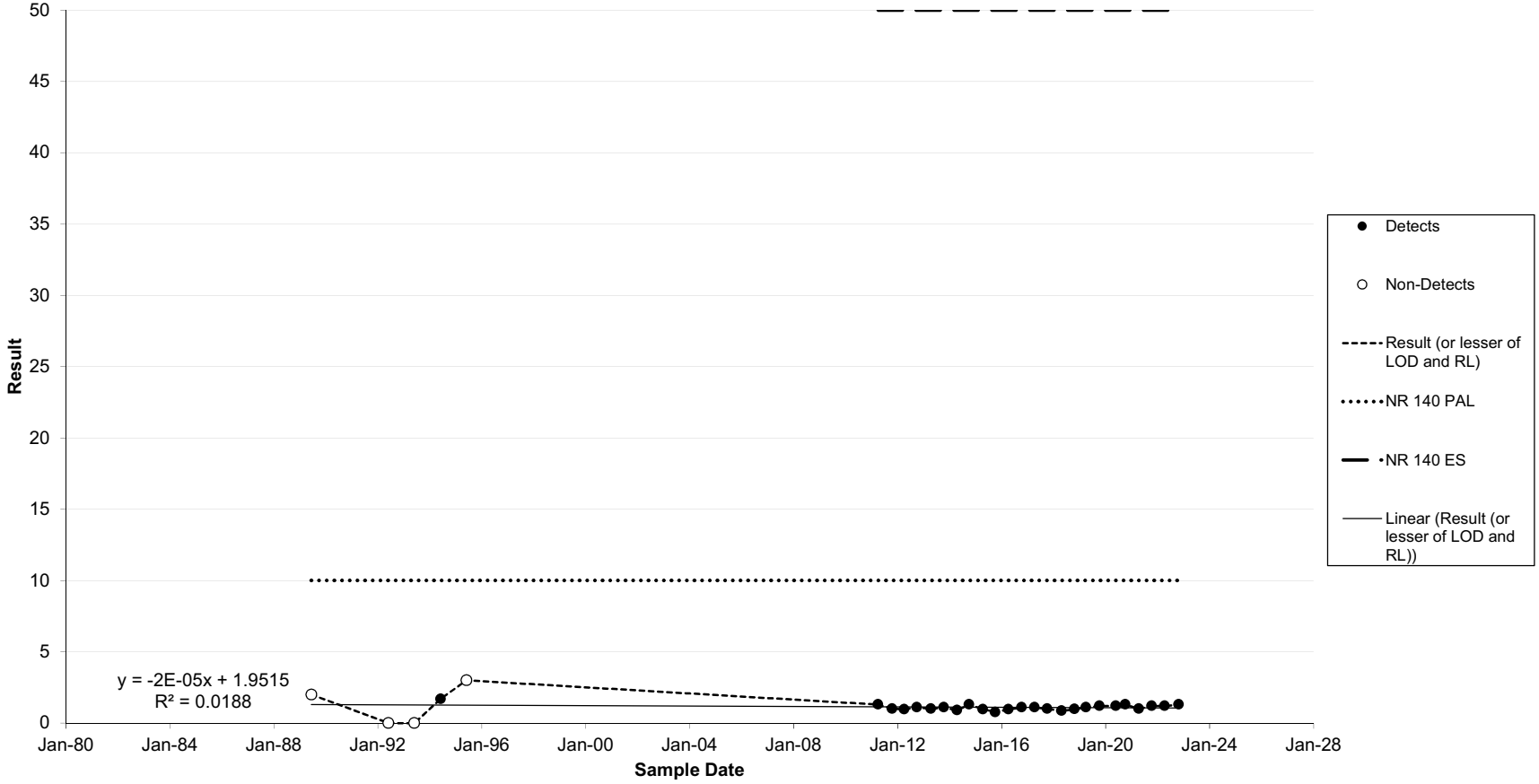
Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
HC-1 - Selenium, total (ug/l as Se)



Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
HC-2 - Selenium, total (ug/l as Se)



Wisconsin Power & Light Company
Columbia Dry Ash Disposal Facility
HC-3 - Selenium, total (ug/l as Se)



Appendix K

Long Term Care Plan

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Post-Closure Care Plan

Columbia Dry Ash Disposal Facility
Phase 1 Module 1
Phase 1 Module 2
Phase 1 Module 3
Phase 1 Module 4
Phase 1 Module 5
Phase 1 Module 6
Phase 2 Module 10
Phase 2 Module 11
Phase 2 Module 12
Phase 2 Module 13

Prepared for:

Wisconsin Power and Light Company
Columbia Energy Center
W8375 Murray Road
Pardeeville, Wisconsin 53954

SCS ENGINEERS

25222260.00 | September 1, 2023

2830 Dairy Drive
Madison, WI 53718-6751
608-224-2830

09/28/2023 - Classification: Internal - ECRM13153872

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PE Certification iii
1.0 **Introduction and Project Summary** 1
2.0 **Monitoring and Maintenance Activities** 2
2.1 Final Cover Maintenance 2
2.2 Leachate Collection and Removal System Maintenance 3
2.3 Groundwater Monitoring and System Maintenance 3
3.0 **Post-Closure Period Contacts** 3
4.0 **Post-Closure Period Site Use** 4
5.0 **Certifications** 4
6.0 **Recordkeeping and Reporting** 4

Figures

Figure 1. Site Location Map
Figure 2. Post-Closure Care Plan

I:\25222260.00\Deliverables\Post Closure Care Plan_08 August 2023 Long Term Care Plan\230901_COL Landfill_Post-Closure Care Plan Amendment_Final.docx

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PE CERTIFICATION

I, Phillip Gearing, hereby certify that I am a licensed professional engineer in the State of Wisconsin in accordance with the requirements of ch. A–E 4, Wis. Adm. Code; that this document has been prepared in accordance with the Rules of Professional Conduct in ch. A–E 8, Wis. Adm. Code; and that, to the best of my knowledge, all information contained in this document is correct and the document was prepared in compliance with all applicable requirements in chs. NR 500 to 538, Wis. Adm. Code.

Specifically,

- This Post-Closure Care Plan was prepared by me or under my direct supervision and meets the requirements of 40 CFR 257.104(d) and NR 514.07(10)(d)

(signature) September 1, 2023 (date)

Phillip E. Gearing
(printed or typed name)

License number E-45115

My license renewal date is July 31, 2024.

Pages or sheets covered by this seal:

ALL

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1.0 INTRODUCTION AND PROJECT SUMMARY

On behalf of Wisconsin Power and Light Company (WPL), SCS Engineers (SCS) has prepared this Post-Closure Care Plan for the Columbia (COL) Dry Ash Disposal Facility Phase 1, Modules 1 through 6 and Phase 2, Modules 10 through 13 as required by 40 Code of Federal Regulations (CFR) 257.104 and Wisconsin Administrative Code NR 514.07(10)(d), as stated below.

40 CFR 257.104(d). *"Written post-closure plan – (1) Content of the plan. The owner or operator of a CCR unit must prepare a written post-closure plan that includes, as a minimum, the information specified in paragraphs (d)(1)(i) through (iii) of this section."*

NR 517.07 (10)(d). *"A written long–term care plan that addresses all of the following: 1. A description of the monitoring and maintenance activities and the frequency at which those activities will be performed. The activities shall include, at a minimum, all of the following:"*

The COL facility includes an active coal combustion residual (CCR) landfill, which currently consists of the following modules, located in Phase 1 and Phase 2 of the facility.

- **Phase 1, Module 1** – This module has received final cover over outer sideslope areas that will no longer receive additional CCR; intermediate cover has been placed over remaining areas. The final cover placed complies with the CCR Rule.
- **Phase 1, Module 2** – This module has received intermediate cover over a majority of the in-place CCR.
- **Phase 1, Module 3** – This module has received intermediate cover over a majority of the in-place CCR.
- **Phase 1, Module 4** – This module is currently being filled.
- **Phase 1, Module 5** – This module is currently being filled.
- **Phase 1, Module 6** – This module is currently being filled.
- **Phase 2, Module 10** – This module is currently being filled.
- **Phase 2, Module 11** – This module is currently being filled.
- **Phase 2, Module 12** – This module is currently proposed for approval. The module will be constructed and filled following approval.
- **Phase 2, Module 13** – This module is currently proposed for approval. The module will be constructed and filled following approval.

Phase 1, Modules 1 through 3 were previously described as separate existing CCR landfills although they are contiguous and are managed as a single landfill by the facility and by the Wisconsin Department of Natural Resources (WDNR). WPL has clarified in the operating record for the Columbia facility that Modules 1 through 3 are one existing CCR landfill as defined in 40 CFR 257.53 of the federal CCR Rule. Phase 1, Modules 4 through 6 and Modules 10 and 11 are considered to be a new CCR landfill that initiated construction after October 19, 2015, and is therefore managed as a

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separate CCR unit under the CCR Rule even though they are contiguous to the existing CCR landfill (Modules 1 through 3). Phase 2, Modules 12 and 13 will be included in the new CCR landfill, if approved and constructed. Construction of additional modules beyond Modules 12 and 13 is not currently planned prior to retirement of the Columbia Energy Center, which is currently scheduled to occur no later than June 1, 2026.

The site location is shown on **Figure 1**. **Figure 2** shows proposed final cover grades and monitoring locations.

Phase 1, Module 1 has been partially closed with a final cover as described in the Closure Plan for the existing CCR landfill. The remaining open areas of this module will be closed when CCR materials reach final waste grades, as described in the Plan of Operations approved by the WDNR. The future final cover system is planned to differ from the existing final cover system, as explained in the Closure Plan. Following the closure of the CCR units at COL, WPL will conduct post-closure care in accordance with 40 CFR 257.104(b) for the required 30 years and with NR 514.07(10)(d) for the required 40 years per NR 506.084(2).

2.0 MONITORING AND MAINTENANCE ACTIVITIES

40 CFR 257.104(d)(1)(i). *"A description of the monitoring and maintenance activities required in paragraph (b) of this section for the CCR unit, and the frequency at which these activities will be performed."*

NR 514.07(10)(d)(1). *"A description of the monitoring and maintenance activities and the frequency at which those activities will be performed."*

Monitoring and Maintenance Activities	Frequency
Mowing	Semi-Annually
Inspections by Owner/Operator	Quarterly
Repair to Final Cover for Erosion Concerns	As needed, determined by inspection
Sedimentation Basin Cleaning	As needed, determined by inspection
Leachate Collection Line Cleaning	Annually
Environmental Monitoring (groundwater, leachate)	Semi-Annually

The owner/operator will perform quarterly inspections of the landfill surface, leachate control system, and groundwater monitoring systems. If issues are noticed during the inspection, action will be taken to remedy the situation. Eroded areas will be repaired and reseeded. Repairs or replacement will be performed on the groundwater monitoring system as needed.

2.1 FINAL COVER MAINTENANCE

Mowing will be performed semi-annually during the growing season unless additional mowing is required in response to the vegetation growth rate. During quarterly inspections, if eroded areas are noted, WPL will repair and reseed the area.

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2.2 LEACHATE COLLECTION AND REMOVAL SYSTEM MAINTENANCE

The leachate collection and removal system for the existing CCR landfill and existing / future units will be maintained to meet state requirements including leachate collection line cleaning, leachate collection video inspection, and any needed repairs to the existing system. Leachate collection video inspection will occur at 5-year intervals, following the annual pipe cleaning required by NR 506.07(5)(c). The video camera inspection will extend a minimum of 300 feet onto the base grades of each leachate collection line.

Phase 1, Module 4 was constructed and opened in 2018. Module 4 is a new CCR landfill as defined in 40 CFR 257.53. Phase 1, Modules 5 and 6 were constructed in 2021. Phase 2, Modules 10 and 11 began construction in 2022. These modules are defined as lateral expansions of the new CCR landfill. Phase 1, Modules 4, 5, and 6 and Phase 2, Modules 10 and 11 are in compliance with the requirements of 40 CFR 257.70, as demonstrated in the Liner and Leachate Collection System Design Compliance Demonstrations. Phase 1, Modules 4, 5, and 6 and Phase 2, Modules 10 and 11 are in compliance with the requirements of NR 504.12, as demonstrated in the Plan of Operation Modification Request WDNR CCR Code Update Report. The proposed Phase 2, Modules 12 and 13 will be in compliance with the requirements of NR 504.12, as well.

2.3 GROUNDWATER MONITORING AND SYSTEM MAINTENANCE

CCR wells, as defined by NR 500.03(26y) and approved by the Department, will be maintained and sampled semi-annually for the parameters listed in Appendix III to Part 257 and listed in Appendix I, Table 1A to NR 507, and in accordance with 40 CFR 257.90-98 and NR 507.15 (3).

Non-CCR monitoring wells at the site will be maintained and sampled as approved by the Department in writing.

Sampling and analysis will be conducted in accordance with the Groundwater Sampling and Analysis Plan.

3.0 POST-CLOSURE PERIOD CONTACTS

40 CFR 257.104(d)(1)(ii). *"The name, address, telephone number, and email address of the person or office to contact about the facility during the post-closure period."*

NR 514.07(10)(d)(2). *"The name, address, telephone number, and email address of the person or office to contact about the facility during long–term care."*

Currently, the contact information for COL during the post-closure/long-term care period is as follows:

Columbia Energy Center
Attn: Plant Manager
W8375 Murray Road
Pardeeville, WI 53954
(608) 742-0711
CCRProgram@alliantenergy.com

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4.0 POST-CLOSURE PERIOD SITE USE

40 CFR 257.104(d)(1)(iii). *"A description of the planned uses of the property during the post-closure period. Post-closure use of the property shall not disturb the integrity of the final cover, liner(s), or any other component of the containment system or the function of the monitoring systems unless necessary to comply with the requirements of the subpart…"*

NR 514.07(10)(d)(3). *"A description of the planned uses of the property during long−term care. Post−closure uses may not disturb the integrity of the final cover, liner, or any other component of the landfill, or the function of the monitoring systems unless approved in writing by the department…."*

The final use of the COL Dry Ash Disposal Facility will be privately owned green space. With this use, there will be no disturbance of the final cover or any other landfill-related components.

5.0 CERTIFICATIONS

40 CFR 257.104(d)(4). *"The owner or operator of the CCR unit must obtain a written certification from a qualified professional engineer that the initial and any amendment of the written post-closure plan meets the requirements of this section."*

NR 500.05. *"Unless otherwise specified, all submittals for review and approval of any initial site report, feasibility report, plan of operation site investigation report, remedial action options report, construction documentation report, or closure plan, or any modifications to those plans, shall include all of the following:*

(4) CERTIFICATION. (a) The reports and plan sheets shall be under the seal of a licensed professional engineer."

Phillip Gearing, PE, a licensed profession engineer in the State of Wisconsin, has overseen the preparation of this Post-Closure Care Plan. A certification statement is provided on **page iii** of this plan.

6.0 RECORDKEEPING AND REPORTING

40 CFR 257.104(b)(2)(iii). "*The owner or operator has completed the written post-closure plan when the plan including the certification required by paragraph (d)(4) of this section, has been placed in the facility's operating record as required by Section 257.105(i)(4)."*

NR 506.17(2)(e). *"The written operating record shall contain the plan of operation, plan modifications, construction documentation, department approvals, annual reports, inspection records, monitoring and corrective action records, notifications to the department, and records of public comments received during any public comment period."*

The Post-Closure Care Plan will be placed in the facility's operating record and on Alliant Energy's CCR Rule Compliance Data and Information website, as will all amendments.

WPL will amend the Post-Closure Care Plan if there is a change in operation of the CCR unit that affects the written Post-Closure Care Plan or, if after post-closure activities have started, unexpected events cause a revision of the plan.

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WPL will provide notification of completion of the post-closure care no later than 60 days following the completion of the post-closure care period. The notification will include certification by a qualified professional engineer verifying that post-closure care has been completed in accordance with the plan. The notification will be placed in the facility's operating record and on the website.

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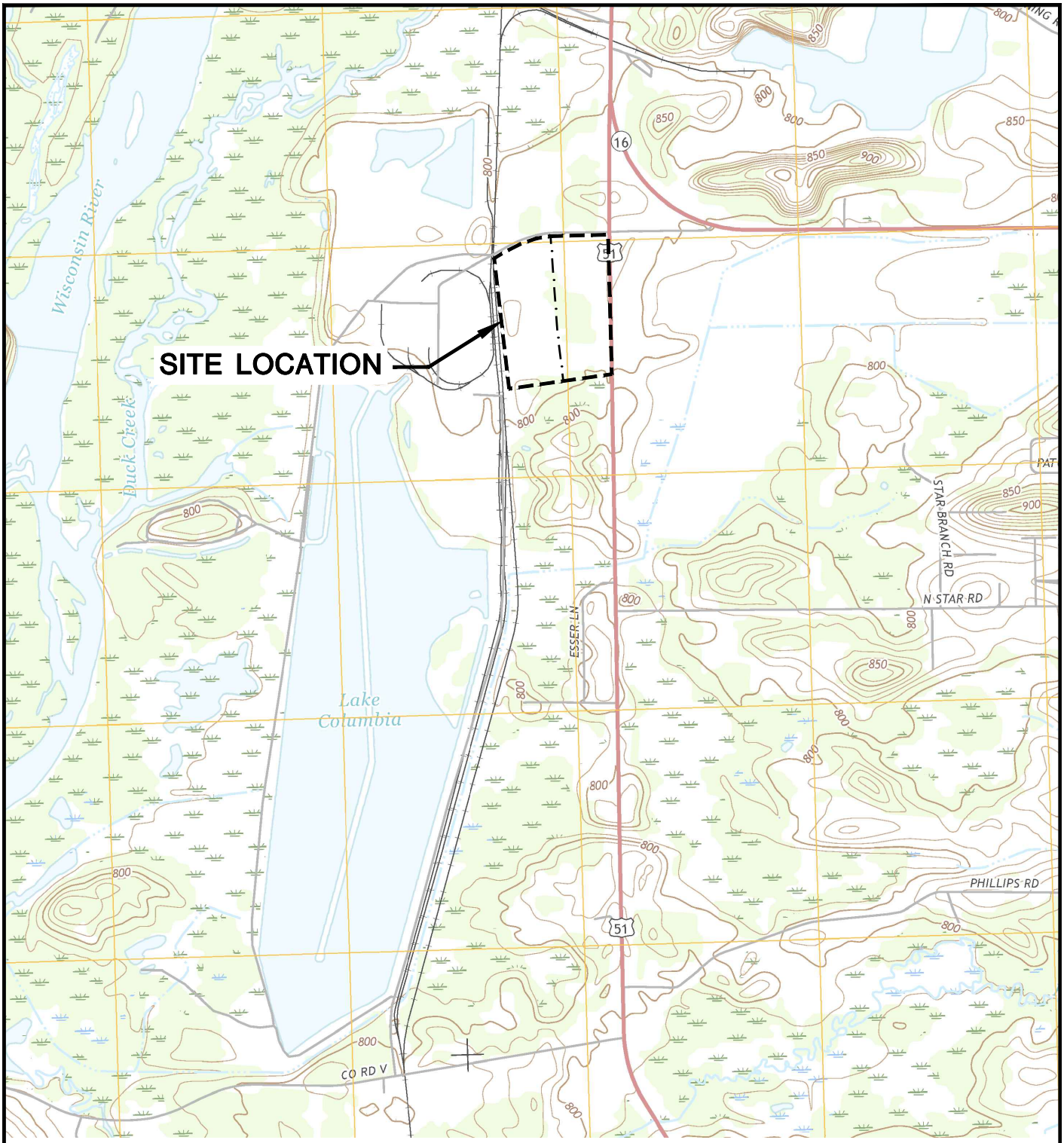
Figures

1 Site Location Map
2 Post-Closure Care Plan



N

POYNETTE QUADRANGLE
WISCONSIN–COLUMBIA CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)
2016
SCALE: 1" = 2,000'

CLIENT	WISCONSIN POWER AND LIGHT COLUMBIA ENERGY CENTER W8375 MURRAY ROAD PARDEEVILLE, WISCONSIN 53954	SITE	POST CLOSURE CARE PLAN COLUMBIA DRY ASH DISPOSAL FACILITY TOWN OF PACIFIC, WISCONSIN

SITE LOCATION MAP

PROJECT NO.	25222260.00	DRAWN BY:	AHB
DRAWN:	08/09/2016	CHECKED BY:	RJG
REVISED:	12/28/2022	APPROVED BY:	PEG 01/31/23

ENGINEER
SCS ENGINEERS
2830 DAIRY DRIVE MADISON, WI 53718-6751
PHONE: (608) 224-2830

FIGURE 1

I:\25222260.00\Drawings\Post Closure\1_Site Location.dwg, 1/31/2023 2:38:58 PM

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LEGEND

- ASH DISPOSAL FACILITY LIMITS
- APPROVED LIMITS OF ASH FILL
- PHASE/MODULE LIMIT
- 810 EXISTING GRADE (10' CONTOUR)
- EXISTING GRADE (2' CONTOUR)
- PAVED ROAD
- UNPAVED ROAD
- RAILROAD TRACKS
- VEGETATION
- FENCE
- SWALE
- EDGE OF WATER
- APPROXIMATE LIMITS OF EXISTING LEACHATE/SURFACE WATER POND LINER
- CULVERT
- TRANSMISSION TOWER
- WATER SUPPLY WELL
- WATER TABLE WELL
- PIEZOMETER
- SURFACE WATER SAMPLE LOCATION
- LYSIMETER
- LEACHATE HEADWELL
- BENCHMARK
- 820 PROPOSED FINAL GRADES (10' CONTOUR)
- PROPOSED FINAL GRADES (2' CONTOUR)
- PROPOSED MODULE 13 MONITORING WELL

NOTES:

1. BASE MAP CREATED FROM AERIAL SURVEY BY KBM, FLOWN DECEMBER 1, 2014, AND GROUND SURVEYS BY SCS ENGINEERS IN MAY 2019, DECEMBER 2020, NOVEMBER 2021, AND DECEMBER 2021, AND BY DRONE SURVEYS BY AMES IN NOVEMBER 2022, JANUARY 2023, AND JUNE 2023.
2. MONITORING WELL LOCATIONS AND ELEVATIONS SURVEYED BY WISCONSIN POWER AND LIGHT, INC. IN DECEMBER 1994, NOVEMBER 1996, APRIL 2003, AUGUST 2012, AND JANUARY 2016, AND BY SCS ENGINEERS IN MAY 2019.

N

400 0 400

SCALE: 1" = 400'

CLOSED PRIMARY ASH POND
CLOSED SECONDARY ASH POND
CLOSED ASH PONDS LANDFILL (LICENSE NO. 02325)
ASH EXPANSION AREA (LICENSE NO. 02325)
HIGHWAY 51
MURRAY RD.
POWER GENERATING STATION
WPDES POND
SUBSTATION
COOLING POND
COOLING POND
LANDFILL SURFACE WATER RUNOFF/ LEACHATE COLLECTION POND TO BE ABANDONED
AREA TO BE GRADED TO DRAIN AFTER CLOSURE
EXISTING LANDFILL (LICENSE #03025)

MW-309 MW-37A MW-310 MW-311 MW-33AR MW-33BR MW-83 MW-302 MW-34A MW-34B MW-5R MW-92B MW-92A MW-301 MW-91AR MW-91B MW-84B MW-84A MW-86 MW-312 MW-93A MW-93B

LH-13B LH-13A LH-12B LH-12A LH-11B LH-11A LH-10B LH-10A LH-2 LP-1 LS-3R

HC-1 HC-2 HC-3

POST-CLOSURE CARE PLAN
COLUMBIA DRY ASH DISPOSAL FACILITY
TOWN OF PACIFIC, WISCONSIN

SITE

WISCONSIN POWER AND LIGHT
COLUMBIA ENERGY CENTER
W8375 MURRAY ROAD
PARDEEVILLE, WISCONSIN 53954

CLIENT

FIGURE 2

SCS ENGINEERS
2830 DAIRY DRIVE MADISON, WI 53718-6751
PHONE: (608) 224-2830

ENGINEER

DRAWN BY:	BJM/KP
CHECKED BY:	PEG
APPROVED BY:	PEG 09/01/23
PROJECT NO.	25222260.00
DRAWN:	12/18/2017
REVISED:	9/1/2023

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