Run-On and Run-Off Control Plan Update – Phase 1, Modules 1 through 6

Columbia Dry Ash Disposal Facility
Columbia Energy Center
W8375 Murray Road
Pardeeville, Wisconsin 53954

Prepared for:

Columbia Energy Center
W8375 Murray Road
Pardeeville, Wisconsin 53954

SCS ENGINEERS

25221067.00 | December 9, 2021

2830 Dairy Drive
Madison, WI 53718-6751
608-224-2830

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PE CERTIFICATION

WISCONSIN
PHILLIP E. GEARING
E-45115
SUN PRAIRIE, WIS.
PROFESSIONAL ENGINEER

12/9/21

I, Phillip E. Gearing, hereby certify that this Run-On and Run-Off Control Plan Update meets the requirements of 40 CFR 257.81(c), was prepared by me or under my direct supervision, and that I am a duly licensed Professional Engineer under the laws of the State of Wisconsin.

December 9, 2021

(signature) (date)

Phillip E. Gearing

(printed or typed name)

License number ____E-45115____________

My license renewal date is __July 31, 2022___.

Pages or sheets covered by this seal:

Run-On and Run-Off Control Plan Update – Phase 1, Modules 1 through 6

Columbia Dry Ash Disposal Facility, Columbia Energy Center

W8375 Murray Road, Pardeeville, Wisconsin 53954

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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 Run-On and Run-Off Control Plan Update for the Columbia (COL) Dry Ash Disposal Facility in accordance with 40 CFR 257.81(c)(1) as follows.

<u>40 CFR 257.81(c)(4).</u> *"The owner or operator of the CCR unit must prepare periodic run-on and run-off control system plans required by paragraph (c)(1) of this section every five years. The date of completing the initial plan is the basis for establishing the deadline to complete the first subsequent plan. The owner or operator may complete any required plan prior to the required deadline provided the owner or operator places the completed plan into the facility's operating record within a reasonable amount of time. In all cases, the deadline for completing a subsequent plan is based on the date of completing the previous plan. For purposes of this paragraph (c)(4), the owner or operator has completed a periodic run-on and run-off control system plan when the plan has been placed in the facility's operating record as required by §257.105(g)(3)."*

The COL facility includes an active coal combustion residual (CCR) landfill, which currently consists of the following modules, all located in Phase 1 of the facility.

- **Phase 1, Module 1** – This module has received final cover over completed outer sideslope areas that will no longer receive additional CCR; intermediate cover has been placed over remaining areas.
- **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 was constructed in 2021 and is approved by Wisconsin Department of Natural Resources (WDNR) to receive CCR.
- **Phase 1, Module 6** – This module was constructed in 2021 and is approved by WDNR to receive CCR.

Modules 1-3 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 WDNR. WPL clarified that Modules 1-3 are one existing CCR landfill under the federal CCR Rule. Modules 4-6 are considered a new CCR landfill that initiated construction after October 19, 2015, and are therefore managed as a separate CCR unit under the CCR Rule even though they are contiguous to Modules 1-3.

Phase 2, Modules 7-13 are permitted with the WDNR, but have not been developed. If developed, the units will also be part of the new CCR landfill, as defined at 40 CFR 257.53.

This plan applies to Phase 1, Modules 1–6 only. Future CCR units are not discussed further herein. The initial Run-On and Run-Off Control Plan was completed in 2016, and an update was completed in 2018 prior to receipt of CCR in Phase 1, Module 4.

Figure 1 shows the site location. **Figure 2** shows the run-on and run-off drainage areas.

1.1 PERIODIC PLAN UPDATES

The following items have been updated in this plan prior to receipt of CCR in Phase 1, Modules 5 and 6:

- **Figure 2** – **Figure 2** has been updated to show topographic data for active landfill areas obtained during the most recent survey of the existing landfill in August 2021 and construction of Modules 5 and 6 in 2021. Additional intermediate cover has been placed in Module 3 and Module 4 reducing the area contributing run-off as contact water. Modules 5 and 6 include a temporary rain cover, which also reduces the area contributing run-off as contact water (refer to **Section 2.0**).

- **Storm Water Calculations** – Additional storm water calculations were completed for Modules 5 and 6 as described in **Section 2.0**.

- No other changes impacting the run-on and run-off controls have been identified with this update.

2.0 RUN-ON AND RUN-OFF CONTROL PLAN

<u>40 CFR 257.81(a).</u> *"The owner or operator of an existing or new CCR landfill or any lateral expansion of a CCR landfill must design, construct, operate, and maintain:*

(1) A run-on control system to prevent flow onto the active portion of the CCR unit during the peak discharge from a 24-hour, 25-year storm."

The entire facility has run-on and run-off control in place, as approved by the WDNR. Run-on is controlled by berms and swales around the perimeter of the landfill that divert storm water away from the landfill to a sedimentation basin.

(2) "A run-off control system from the active portion of the CCR unit to collect and control at least the water volume resulting from a 24-hour, 25-year storm."

Run-off from the active portions of the facility is handled as contact water and is collected by a leachate collection system and internal swales, which route the contact water run-off to a lined contact water basin. Module 4 and all module fills going forward will have intermediate cover added to reduce contact water that is directed to the contact pond. The contact water in the basin is used for dust control or other actions within the active landfill or, if needed, is transported with a water wagon to the Primary Ash Pond at the generating station where it may be discharged in accordance with a Wisconsin Pollutant Discharge Elimination System (WPDES) permit.

Run-off from areas outside existing CCR units and areas of the existing CCR units where final or intermediate cover is in place is diverted into the perimeter drainage swales, which drain to the South Sedimentation Basin. Intermediate swales/berms and downslope channels on the final cover help minimize erosion of the final cover and divert water to the perimeter drainage system, and ultimately to the on-site detention/ sedimentation basin. Per 40 CFR 257.81(b), this is consistent with the surface water requirements under 40 CFR 257.3-3.

In addition to these controls, a temporary rain cover will be installed to limit leachate and contact water production when needed. Storm water collected on the rain cover will be diverted to perimeter swales, and ultimately to the sedimentation basin. The rain cover will be removed in sections to accommodate waste placement. As the rain cover is removed, 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 rain cover and will anchor or ballast the rain cover at the new limits. When the rain cover has been fully removed, run-off will be controlled by the limits of the developed modules, and all water inside the lined waste limits will be managed as contact water.

2.1 DESIGN CRITERIA

The storm water features described above are designed to handle run-on and run-off from a 25-year, 24-hour storm event, as required by 40 CFR 257.81(a)(1) and (2). Storm water run-off calculations were updated in 2021. The calculations were performed assuming a 25-year, 24-hour precipitation depth of 4.91 inches, based on National Oceanic and Atmospheric Administration (NOAA) Atlas 14 precipitation data published in April 2013. The detention/sedimentation basin and associated basin outlet structures are designed to safely pass run-off from a 100-year, 24-hour storm event.

Table 1. Storm Water Updates

Year Conducted	Description of Update	Included in Appendix A
Run-On and Run-Off		
2000	Run-on calculations performed as part of the 2000 Plan of Operation Update; performed assuming 25-year, 24-hour precipitation depth of 4.7 inches, based on Technical Paper-40 (TP-40) precipitation data published in May 1961.	X
2010	Run-off calculations performed as part of the 2010 Plan of Operation Update; performed assuming 25-year, 24-hour precipitation depth of 4.7 inches, based on TP-40 precipitation data published in May 1961.	Superseded by Phase 1, Modules 5 & 6
2015	Update to leachate/surface water pond calculations; performed assuming 25-year, 24-hour precipitation depth of 4.9 inches, based on NOAA Atlas 14 precipitation data published in April 2013.	Superseded by Phase 1, Module 4
2016	Update to run-on to a ditch along the north end of Module 3; performed assuming 25-year, 24-hour precipitation depth of 4.9 inches, based on NOAA Atlas 14 precipitation data published in April 2013.	Superseded by Phase 1, Module 4
2016	Calculations to evaluate installation of a rain cover in Module 3; performed assuming 25-year, 24-hour precipitation depth of 4.9 inches, based on NOAA Atlas 14 precipitation data published in April 2013.	Superseded by Phase 1, Module 4
2017	Update to leachate/surface water pond calculations with consideration of Phase 1, Module 4 construction; performed assuming 25-year, 24-hour precipitation depth of 4.9 inches, based on NOAA Atlas 14 precipitation data published in April 2013.	Superseded by Phase 1, Modules 5 & 6
2018	Calculations to evaluate installation of a rain cover in Module 4; performed assuming 25-year, 24-hour precipitation depth of 4.9 inches, based on NOAA Atlas 14 precipitation data published in April 2013.	Superseded by Phase 1, Modules 5 & 6

Year Conducted	Description of Update	Included in Appendix A
Run-On and Run-Off		
2018	Calculations to size swales and culverts to divert run-on as part of construction of Module 4, performed assuming 25-year, 24-hour precipitation depth of 4.9 inches, based on NOAA Atlas 14 precipitation data published in April 2013.	Superseded by Phase 1, Modules 5 & 6
2021	Update to leachate/surface water pond calculations with consideration of Phase 1, Module 5 and 6 construction; performed assuming 25-year, 24-hour precipitation depth of 4.9 inches, based on NOAA Atlas 14 precipitation data published in April 2013.	X
2021	Calculations to size swales and culverts to divert run-on as part of construction of Module 5 and 6, performed assuming 25-year, 24-hour precipitation depth of 4.9 inches, based on NOAA Atlas 14 precipitation data published in April 2013.	X
2021	Calculations to confirm South Sedimentation Basin can handle storm water after construction of Module 5 and 6, performed assuming 25-year, 24-hour precipitation depth of 4.9 inches, based on NOAA Atlas 14 precipitation data published in April 2013.	X

2.2 DESIGN WITH CALCULATIONS

Storm water management design calculations are contained in **Appendix A.** As described in **Section 2.1**, the calculations from the 2000 Plan of Operation Update and the 2021 calculations describe the storm water management design and provide calculations showing that the run-on control system will prevent flow onto the active portion of the CCR units during the peak discharge from a 25-year, 24-hour storm. The 2021 calculations also describe the storm water management design and provide calculations showing that the run-off control system for the active portions of the CCR units will collect and control the water volume resulting from a 25-year, 24-hour storm. The calculations were performed by or overseen by a professional engineer licensed in the State of Wisconsin.

2.3 CONSTRUCTION

Existing storm water management features were constructed to site specifications with construction oversight directed by a professional engineer licensed in the State of Wisconsin. Construction documentation reports for the storm water management features were prepared, submitted to the WDNR, and approved by the WDNR.

3.0 CERTIFICATIONS

40 CFR 257.81(c)(5). "*The owner or operator must obtain a certification from a qualified professional engineer stating that the initial and periodic run-on and run-off control system plans meet the requirements of this section.*"

Phillip Gearing, PE, a licensed profession engineer in the State of Wisconsin, has overseen the preparation of this Run-On and Run-Off Control Plan. A certification statement is provided on **page iii** of this plan.

4.0 RECORDKEEPING AND PERIODIC UPDATES

<u>40 CFR 257.81(d).</u> *"The owner or operator of the CCR unit must comply with the recordkeeping requirements specified in section 257.105(g), the notification requirements specified in section 257.106(g), and the internet requirements specified in section 257.107(g)."*

This Run-On and Run-Off Control Plan, and all periodic plans, 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. Periodic plan updates will be completed at least every 5 years per 40 CFR 257.81(c)(4).

WPL will notify the State Director when this Run-On and Run-Off Control Plan, and all subsequent updates, are available in the facility's operating record and on the facility's website per 40 CFR 257.105(g), 257.106(g), and 257.107(g).

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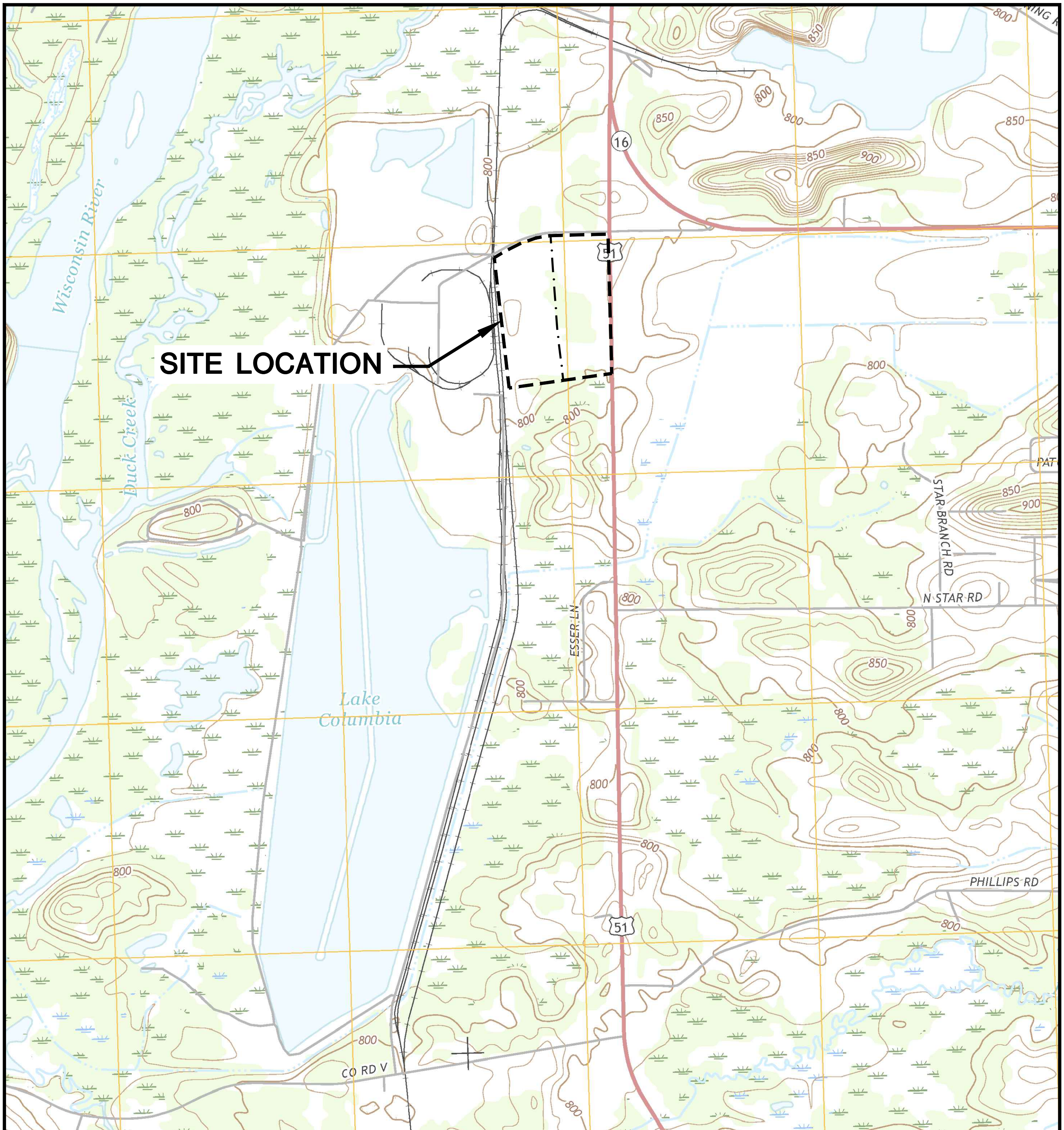
Figures



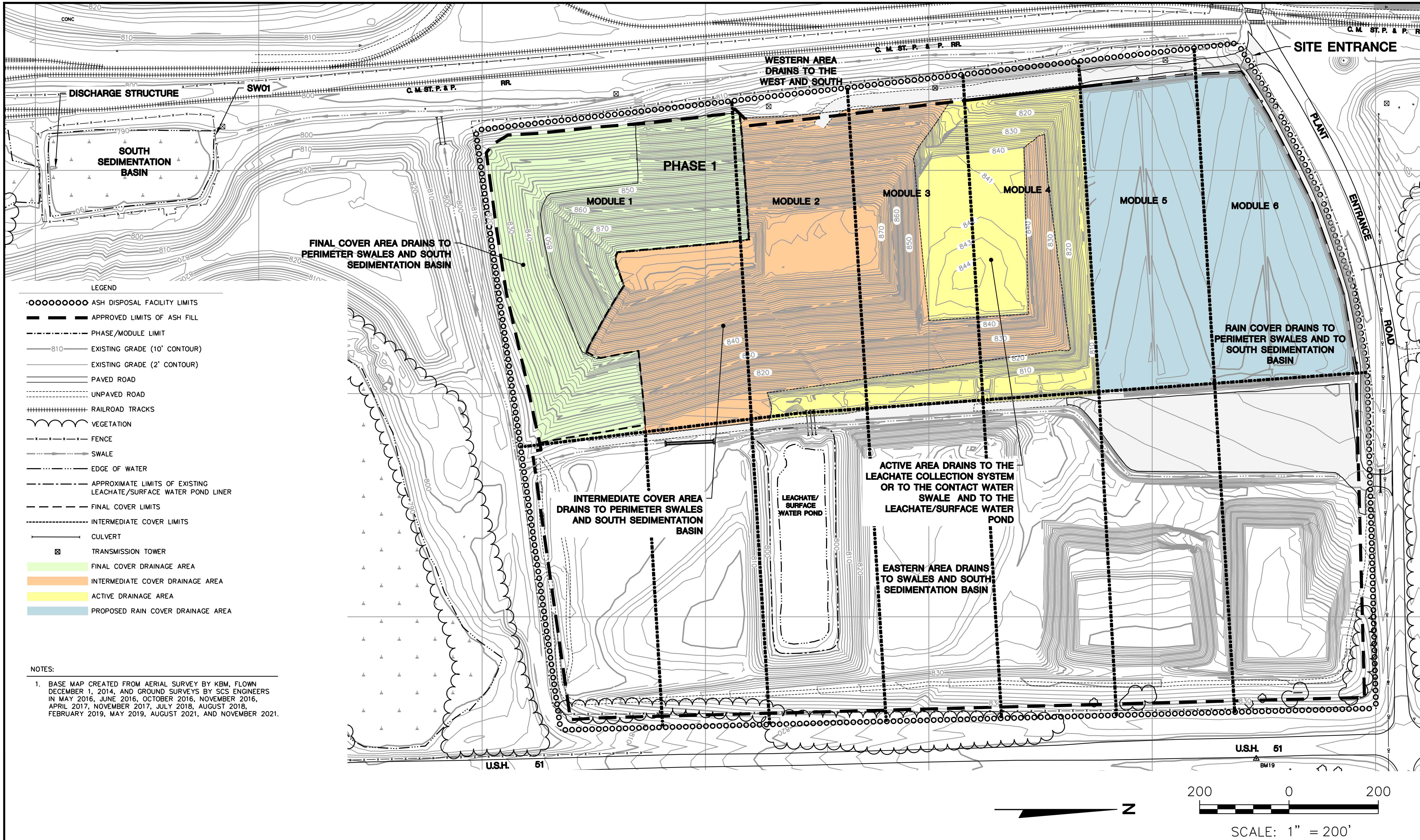
N

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	RUN–ON AND RUN–OFF CONTROL PLAN COLUMBIA DRY ASH DISPOSAL FACILITY TOWN OF PACIFIC, WISCONSIN
	SITE LOCATION MAP		

PROJECT NO.	25221067.00	DRAWN BY:	AHB/RJG	ENGINEER	SCS ENGINEERS 2830 DAIRY DRIVE MADISON, WI 53718–6751 PHONE: (608) 224–2830	FIGURE
DRAWN:	08/09/16	CHECKED BY:	PG			1
REVISED:	07/16/21	APPROVED BY:	PEG 12/09/21			

I:\25221067.00\Drawings\Runon Runoff Control Plan\1_Site Loc.dwg, 8/16/2021 10:40:42 AM



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DRAWN:	12/18/2017	CHECKED BY:	PEG
REVISED:	11/30/2021	APPROVED BY:	PEG 12/09/21

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

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

SITE: RUN-ON AND RUN-OFF CONTROL PLAN
COLUMBIA DRY ASH DISPOSAL FACILITY
TOWN OF PACIFIC, WISCONSIN

RUN-ON AND RUN-OFF CONTROL PLAN

FIGURE 2

I:\25221067.00\Drawings\Runon Runoff Control Plan\2_Runon-runoff control plan.dwg, 11/30/2021 4:07:02 PM

Appendix A

Storm Water Design Calculations

Appendix A1

2000 Plan of Operations Update

SURFACE WATER MANAGEMENT CALCULATIONS
COLUMBIA DRY ASH DISPOSAL FACILITY

PURPOSE:

The purpose of the surface water runoff calculations is to demonstrate that the surface water control features incorporated into the proposed design will collect and transfer surface water from the landfill in a controlled manner and will minimize erosion. The surface water runoff calculations were performed for the western half (Phase 1) of the landfill, which this 10-year Plan of Operation Update report addresses.

SITE GEOMETRY:

The surface water runoff from Phase 1 of the landfill will be routed to the existing South Sedimentation Basin. Diversion berms, downslope channels, and perimeter ditches are incorporated into the design to route the surface water to the southwestern corner of the landfill, where it is then routed to the South Sedimentation Basin. The South Sedimentation Basin was constructed during construction of Module 1 North. The south sedimentation pond discharges to a wetland area to the south of the pond.

METHODOLOGIES:

The following methods and procedures were used to demonstrate that the proposed surface water control features will collect and transfer surface water in controlled manner and minimize erosion potential:

<u>Hydrograph Generation</u>
Peak stormwater flows for the 25-year, 24-hour and 100-year, 24-hour storm events were calculated using the Quick TR-55 computer model developed by the National Resources Conservation Service (NRCS) (formerly known as the Soil Conservation Service (SCS)). The Quick TR-55 methods for computing hydrographs are based on the methodologies presented in the Urban Hydrology for Small Watersheds manual. The Quick TR-55 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 a particular storm event, contributing drainage areas, runoff curve numbers, and time of concentration.

SURFACE WATER MANAGEMENT CALCULATIONS (CONTINUED)
COLUMBIA DRY ASH DISPOSAL FACILITY

The time of concentration calculations combine overland flow time (i.e., sheet flow), shallow concentrated flow time, and channel flow time. Curve numbers for a specified drainage area were also calculated using the methodologies and tables presented in TR-55 (see **Reference** section at the end of this appendix).

Diversion Berm, Downslope Channels, and Perimeter Ditch Sizing

These control structures are sized to channel the peak storm runoff to the sedimentation basin while maintaining low enough velocities to limit the erosion potential. The proposed design allows storm water which comes into contact with the final cover to be routed by diversion berms and downslope channels to the perimeter ditches, which will then transport the water to the south sedimentation basin.

Diversion berm, downslope channels, and perimeter ditch locations and details are shown on the Plan Sheets. A portion of the perimeter ditch along the western side of the landfill was constructed as part of the construction of Module 1 North.

In conjunction with the graphical peak discharge methods as presented in TR-55, the Flowmaster computer modeling program was used to assist in the design of these control structures. This program allows the user to input the channel geometry, the slope of the channel, an estimated Manning's "n" value for the channel, and the peak flow in the channel. The program then determines the peak flow depth and the peak velocity for the given geometry of the control feature.

The diversion berms, downslope channels, and perimeter ditches were sized by calculating the peak flow each structure would have to manage in a worst-case design scenario (i.e., surface water runoff from the largest area of landfill final cover during the 25-year, 24-hour storm event). The drainage structure was modeled using the Flowmaster computer model to verify channel depth and velocity in the structure.

Sedimentation Pond Sizing

The sedimentation pond sizing process involved determining the proper ratio of surface area to flowrate that would allow a 15 micron particle size to settle out during a design storm event.

A table presented in the Erosion and Sediment Control Handbook (Goldman et al., 1986) provides the surface area-to-discharge ratios required to achieve settlement of the desired particle sizes (see the **Reference** section of this appendix).

The Pond Pack 6.0 computer program was used in conjunction with accepted formulas and engineering calculations to size the sedimentation basins. Calculations were performed to determine the performance of the basins as follows:

1. The inflow hydrograph for the basin was calculated as part of the hydrograph computations. The regulations require that sediment basins be sized for a 25-year, 6-hour storm event. Sediment basin calculations for the Alliant Columbia Ash Disposal Facility were based on the basin's peak discharge during the 25-year, 24-hour storm which equals or exceeds the basin inflow for average rainfall intensity of the 25-year, 6-hour storm.

2. Outlet structures were designed to provide the necessary detention of peak stormwater runoff from the final cover for the 25-year, 24-hour storm event.

3. The inflow hydrograph was routed through the sedimentation pond using the Pond Pack 6.0 program to determine the basin's peak water elevation and discharge during the 25-year, 24-hour storm.

4. The emergency spillways for the sedimentation basins were sized for the 100-year, 24-hour storm event.

ASSUMPTIONS:

Summarized below are some of the major assumptions and data used in the computations:

1. Due to the presence of a drainage layer in the proposed landfill final cover, the soil for the landfill area was modeled between a Type B and C soil to account for greater water infiltration

through the cover. The final cover was modeled as a grassland in good condition, which resulted in a runoff curve number of 67.5.

2. SCS Type II storm was selected according to SCS storm distribution maps for the United States.

3. A 2-year, 24-hour storm event in the vicinity of the facility equates to 2.7 inches according to figures provided in TR-55.

4. A 25-year, 24-hour storm event in the vicinity of the facility equates to 4.7 inches according to precipitation data provided in TR-55.

5. A 100-year, 24-hour storm event in the vicinity of the facility equates to 5.9 inches according to precipitation data provided in TR-55.

6. Grass-lined berms and channels were designed for a maximum velocity of 4 feet per second (fps).

7. A Manning's "n" value of 0.045 was used to model a grass-lined berm or channel, as provided by the parameters set in the Flowmaster model.

8. Depths of channels were designed to be a minimum of 1 foot, with a minimum freeboard of 0.5 foot. Depths of diversion berms were designated to be a minimum of 2 feet, with a minimum of 0.5 foot of freeboard.

9. A 15-micron particle was targeted to be settled out of the water column. The 15-micron particle is classified as a medium-fine silt by the AASHTO Soil Classification System.

SURFACE WATER MANAGEMENT CALCULATIONS (CONTINUED)
COLUMBIA DRY ASH DISPOSAL FACILITY

RESULTS:

Based on the results of the surface water runoff computations presented in this appendix, the proposed surface water control features will adequately handle the runoff from a 25-year, 24-hour storm event while minimizing erosion. The drainage features will be constructed as shown on the Plan Sheets.

All diversion berms and perimeter ditches will maintain greater than 0.5 foot of freeboard during the design storm event. The sedimentation basins will settle out particles 15 microns and larger in diameter and will dewater in no less than three days. The detailed calculations are included with this appendix.

I:\1370\Reports\surface water calcs writeup.wpd

Time of Concentration Calculations

Landfill Area (1/2)

::

TIME OF CONCENTRATION CALCULATOR

::

Landfill runoff to south basin

Segment #1: Tc: TR-55 Sheet
Description: final cover slope

Mannings n	.1900	
Hydraulic Length	60.00	ft
2yr, 24hr P	2.7000	in
Slope	.050000	ft/ft

Avg.Velocity .17 ft/sec

Segment #1 Time: .0989 hrs

Segment #2: Tc: TR-55 Sheet
Description: final cover slope

Mannings n	.1900	
Hydraulic Length	60.00	ft
2yr, 24hr P	2.7000	in
Slope	.250000	ft/ft

Avg.Velocity .32 ft/sec

Segment #2 Time: .0520 hrs

Segment #3: Tc: TR-55 Shallow
Description: diversion berm

Hydraulic Length	1530.00	ft
Slope	.020000	ft/ft
Unpaved		

Avg.Velocity 2.28 ft/sec

Segment #3 Time: .1863 hrs

Landfill Area (2/2)

Segment #4: Tc: TR-55 Channel
Description: perimeter ditch

Flow Area	32.0000	sq.ft
Wetted Perimeter	22.60	ft
Hydraulic Radius	1.42	ft
Slope	.006000	ft/ft
Mannings n	.0300	
Hydraulic Length	320.00	ft

Avg.Velocity 4.85 ft/sec

Segment #4 Time: .0183 hrs

Total Tc: .3555 hrs

File.... I:\1370\COLUMBIA.PPK
Title... Peripheral area to south basin (area outside of LF leading to basin)

::
TIME OF CONCENTRATION CALCULATOR
::

Peripheral area to south basin (area outside of LF leading to basin)

Segment #1: Tc: TR-55 Sheet
Description: flow into ditch

Mannings n	.1900	
Hydraulic Length	10.00	ft
2yr, 24hr P	2.7000	in
Slope	.330000	ft/ft

Avg.Velocity .25 ft/sec

Segment #1 Time: .0111 hrs

Segment #2: Tc: TR-55 Channel
Description: flow along perimeter ditch

Flow Area	22.0000	sq.ft
Wetted Perimeter	17.60	ft
Hydraulic Radius	1.25	ft
Slope	.006000	ft/ft
Mannings n	.0300	
Hydraulic Length	800.00	ft

Avg.Velocity 4.46 ft/sec

Segment #2 Time: .0498 hrs

Segment #3: Tc: TR-55 Channel
Description: flow along perimeter ditch

Flow Area	57.0000	sq.ft
Wetted Perimeter	29.00	ft
Hydraulic Radius	1.97	ft
Slope	.006000	ft/ft
Mannings n	.0300	
Hydraulic Length	1010.00	ft

Avg.Velocity 6.04 ft/sec

Segment #3 Time: .0465 hrs

Type.... Tc Calcs
Name.... PERIPH TO S BASI

West peripheral area leading to West perimeter ditch (z/z)

File.... I:\1370\COLUMBIA.PPK
Title... Peripheral area to south basin (area outside of LF leading to basin)

==========================
Total Tc: .1073 hrs
==========================

Type.... Tc Calcs
Name.... E PERIPHERAL

Northeast peripheral area leading to east perimeter ditch (1/1)

File.... I:\1370\COLUMBIA.PPK
Title... Eastern peripheral area (north of leachate basin) leading to east ditch

::

TIME OF CONCENTRATION CALCULATOR

::

Eastern peripheral area (north of leachate basin) leading to east ditch

---

Segment #1: Tc: TR-55 Sheet

Mannings n	.1900	
Hydraulic Length	40.00	ft
2yr, 24hr P	2.7000	in
Slope	.425000	ft/ft
Avg.Velocity	.37	ft/sec

Segment #1 Time: .0304 hrs

Segment #2: Tc: TR-55 Sheet

Mannings n	.1900	
Hydraulic Length	260.00	ft
2yr, 24hr P	2.7000	in
Slope	.023000	ft/ft
Avg.Velocity	.17	ft/sec

Segment #2 Time: .4362 hrs

Segment #3: Tc: TR-55 Shallow

Hydraulic Length	520.00	ft
Slope	.014000	ft/ft
Unpaved		
Avg.Velocity	1.91	ft/sec

Segment #3 Time: .0757 hrs

=========================

Total Tc: .5423 hrs

=========================

S/N: H0M0L0862791 BT 2, Inc
Pond Pack Ver: 8-01-98 (61) Compute Time: 14:58:36 Date: 08-29-2000

Southeast/South peripheral area leading to South perimeter ditch (1/2)

File.... I:\1370\COLUMBIA.PPK
Title... South peripheral area to south perimeter ditch

TIME OF CONCENTRATION CALCULATOR

South peripheral area to south perimeter ditch

Segment #1: Tc: TR-55 Sheet

Mannings n .1900
Hydraulic Length 300.00 ft
2yr, 24hr P 2.7000 in
Slope .010000 ft/ft

Avg.Velocity .12 ft/sec

Segment #1 Time: .6825 hrs

Segment #2: Tc: TR-55 Shallow

Hydraulic Length 110.00 ft
Slope .096000 ft/ft
Unpaved

Avg.Velocity 5.00 ft/sec

Segment #2 Time: .0061 hrs

Segment #3: Tc: TR-55 Shallow

Hydraulic Length 550.00 ft
Slope .022000 ft/ft
Unpaved

Avg.Velocity 2.39 ft/sec

Segment #3 Time: .0638 hrs

Type.... Tc Calcs
Name.... BASIN PERIPHERAL

Southeast/south peripheral area leading to south perimeter ditch (2/2)

File.... I:\1370\COLUMBIA.PPK
Title... South peripheral area to south perimeter ditch

Segment #4: Tc: TR-55 Channel
Description: flow along south perimeter ditch

Flow Area	100.0000	sq.ft
Wetted Perimeter	32.40	ft
Hydraulic Radius	3.09	ft
Slope	.012000	ft/ft
Mannings n	.0300	
Hydraulic Length	1030.00	ft

Avg.Velocity 11.53 ft/sec

Segment #4 Time: .0248 hrs

Total Tc: .7773 hrs

Equations used by PondPack to calculate Tc (1/2)

Tc Equations used...

==== SCS TR-55 Sheet Flow ====

```
Tc = (.007 * ((n * Lf)**0.8)) / ((P**.5) * (Sf**.4))

Where:  Tc = Time of concentration, hrs
        n  = Mannings n
        Lf = Flow length, ft
        P  = 2yr, 24hr Rain depth, inches
        Sf = Slope, ft/ft
```

==== SCS TR-55 Shallow Concentrated Flow ====

```
Unpaved surface:
V  = 16.1345 * (Sf**0.5)

Paved surface:
V  = 20.3282 * (Sf**0.5)

Tc = (Lf / V) / (3600sec/hr)

Where:  V  = Velocity, ft/sec
        Sf = Slope, ft/ft
        Tc = Time of concentration, hrs
        Lf = Flow length, ft
```

```
Type.... Tc Calcs
Name.... LF TO S BASIN

File.... I:\1370\Columbia.ppk
Title... Landfill runoff to south basin
```

Equations used by Pond Pack to Calculate Tc (2/2)

```
 ==== SCS Channel Flow ==============================================

      R  = Aq / Wp
      V  = (1.49 * (R**(2/3)) * (Sf**-0.5)) / n

      Tc = (Lf / V) / (3600sec/hr)

      Where:  R  = Hydraulic radius
              Aq = Flow area, sq.ft.
              Wp = Wetted perimeter, ft
              V  = Velocity, ft/sec
              Sf = Slope, ft/ft
              n  = Mannings n
              Tc = Time of concentration, hrs
              Lf = Flow length, ft
```

Hydrograph Generation

Type.... TR-55 Tabular Hyd.Input Data
Name.... TO SOUTH BASIN Tag: 25

To South Basin
25-yr, 24-hr Storm
(1/2)

File.... I:\1370\COLUMBIA.PPK
Title... Runoff to south basin
HYG Dir = I:\1370\
HYG file = S BASIN.HYG south basin 25

TR-55 TABULAR HYDROGRAPH METHOD
TYPE II Distribution
25yr, 24hr Rainfall Depth = 4.70 in

Total Area = 63.400 acres or .099063 sq.mi.
Peak Discharge = 69 cfs
WARNING: Drainage areas of two or more subareas differ by a factor of 5 or greater.

>>>> Input Parameters Used to Compute Hydrograph <<<<

Subarea Description	AREA (acres)	CN	Tc (hrs)	* Tt (hrs)	Precip. (in)	Runoff (in)	Ia/p input	Ia/p used
Landfill area	29.600	67.5	.4000	.0000	4.70	1.63	I.20	.20
W peripheral	4.600	67.5	.1000	.0000	4.70	1.63	I.20	.20
Basin area	1.800	98.0	.1000	.0000	4.70	4.46	I.01	.10
NE peripheral	13.700	67.5	.5000	.0000	4.70	1.63	I.20	.20
SE/S periphera	13.700	67.5	.7500	.0000	4.70	1.63	I.20	.20

* Travel time from subarea outfall to composite watershed outfall point.
I -- Subarea where user specified interpolation between Ia/p tables.

>>>> Computer Modifications of Input Parameters <<<<<

Subarea Description	Input Values Tc (hrs)	Input Values * Tt (hrs)	Rounded Values Tc (hrs)	Rounded Values * Tt (hrs)	Ia/p Interpolated (Yes/No)	Ia/p Messages
andfill area	.3600	.0000	.40	.00	Yes	--
peripheral	.1000	.0000	**	**	Yes	--
3asin area	.1000	.0000	**	**	No	Computed Ia/p < .1
E peripheral	.5400	.0000	.50	.00	Yes	--
E/S periphera	.7800	.0000	.75	.00	Yes	--

* Travel time from subarea outfall to composite watershed outfall point.
* Tc & Tt are available in the hydrograph tables.

S/N: H0M0L0862791 BT 2, Inc
Pond Pack Ver: 8-01-98 (61) Compute Time: 15:26:34 Date: 08-29-2000

Type.... TR-55 Tabular Hyd.Peaks
Name.... TO SOUTH BASIN Tag: 25

To South Basin
25-yr, 24-hr Storm
(2/2)

File.... I:\1370\COLUMBIA.PPK
Title... Runoff to south basin
HYG Dir = I:\1370\
HYG file = S BASIN.HYG south basin 25

TR-55 TABULAR HYDROGRAPH METHOD
TYPE II Distribution
25yr, 24hr Rainfall Depth = 4.70 in

>>>> Summary of Subarea Times to Peak <<<<

Subarea	Peak Discharge at Composite Outfall (cfs)	Time to Peak at Composite Outfall (hrs)
Landfill area	40	12.3
W peripheral	11	12.1
Basin area	13	12.1
NE peripheral	17	12.4
SE/S periphera	13	12.6
Composite Watershed	69	12.4

Type.... TR-55 Tabular Hyd.Input Data
Name.... TO SOUTH BASIN Tag: 100

To South Basin
100-yr, 24-hr

File.... I:\1370\COLUMBIA.PPK
Title... Runoff to south basin
HYG Dir = I:\1370\
HYG file = S BASIN.HYG south basin 100

TR-55 TABULAR HYDROGRAPH METHOD
TYPE II Distribution
100yr, 24hr Rainfall Depth = 5.90 in

Total Area = 63.400 acres or .099063 sq.mi.
Peak Discharge = 110 cfs
WARNING: Drainage areas of two or more subareas differ by a factor of 5 or greater.

>>>> Input Parameters Used to Compute Hydrograph <<<<

Subarea Description	AREA (acres)	CN	Tc (hrs)	* Tt (hrs)	Precip. (in)	Runoff (in)	Ia/p input	Ia/p used
Landfill area	29.600	67.5	.4000	.0000	5.90	2.50	I.16	.16
W peripheral	4.600	67.5	.1000	.0000	5.90	2.50	I.16	.16
Basin area	1.800	98.0	.1000	.0000	5.90	5.66	I.01	.10
E peripheral	13.700	67.5	.5000	.0000	5.90	2.50	I.16	.16
SE/S periphera	13.700	67.5	.7500	.0000	5.90	2.50	I.16	.16

* Travel time from subarea outfall to composite watershed outfall point.
I -- Subarea where user specified interpolation between Ia/p tables.

>>>> Computer Modifications of Input Parameters <<<<<

Subarea Description	Input Values Tc (hrs)	Input Values * Tt (hrs)	Rounded Values Tc (hrs)	Rounded Values * Tt (hrs)	Ia/p Interpolated (Yes/No)	Ia/p Messages
andfill area	.3600	.0000	.40	.00	Yes	--
W peripheral	.1000	.0000	**	**	Yes	--
Basin area	.1000	.0000	**	**	No	Computed Ia/p < .1
peripheral	.5400	.0000	.50	.00	Yes	--
E/S periphera	.7800	.0000	.75	.00	Yes	--

* Travel time from subarea outfall to composite watershed outfall point.
* Tc & Tt are available in the hydrograph tables.

S/N: H0M0L0862791 BT 2, Inc
Pond Pack Ver: 8-01-98 (61) Compute Time: 15:26:34 Date: 08-29-2000

Type.... TR-55 Tabular Hyd.Peaks
Name.... TO SOUTH BASIN Tag: 100

File.... I:\1370\COLUMBIA.PPK
Title... Runoff to south basin
HYG Dir = I:\1370\
HYG file = S BASIN.HYG south basin 100

TR-55 TABULAR HYDROGRAPH METHOD
TYPE II Distribution
100yr, 24hr Rainfall Depth = 5.90 in

>>>> Summary of Subarea Times to Peak <<<<

Subarea	Peak Discharge at Composite Outfall (cfs)	Time to Peak at Composite Outfall (hrs)
Landfill area	65	12.3
W peripheral	18	12.1
Basin area	16	12.1
NE peripheral	27	12.4
SE/S periphera	21	12.6
Composite Watershed	110	12.4

Diversion Berm, Downslope Swale, and Perimeter Ditch Sizing Calculations

Type.... Tc Calcs
Name.... WORSTCASE DIV BE

File.... I:\1370\COLUMBIA.PPK
Title... Tc for worst case diversion berm sizing calcs

::

TIME OF CONCENTRATION CALCULATOR

::

Tc for worst case diversion berm sizing calcs

Segment #1: Tc: TR-55 Sheet
Description: final cover slope - 25%

Mannings n	.1900	
Hydraulic Length	95.00	ft
2yr, 24hr P	2.7000	in
Slope	.250000	ft/ft
Avg.Velocity	.35	ft/sec

Segment #1 Time: .0751 hrs

Segment #2: Tc: TR-55 Shallow
Description: diversion berm

Hydraulic Length	2090.00	ft
Slope	.020000	ft/ft
Unpaved		
Avg.Velocity	2.28	ft/sec

Segment #2 Time: .2544 hrs

========================
Total Tc: .3295 hrs
========================

Worst-case diversion berm

Type.... TR-55 Tabular Hyd.Input Data
Name.... WORSTCASE DIV BE   Tag: 25

File.... I:\1370\COLUMBIA.PPK
Title... Hydrograph for worst-case diversion berm sizing calcs
HYG Dir = I:\1370\
HYG file = NONE STORED WORSTCASE DIV BE 25

TR-55 TABULAR HYDROGRAPH METHOD
TYPE II Distribution
25yr, 24hr Rainfall Depth = 4.70 in

Total Area = 4.600 acres or .007187 sq.mi.
Peak Discharge = 7 cfs

>>>> Input Parameters Used to Compute Hydrograph <<<<

Subarea Description	AREA (acres)	CN	Tc (hrs)	* Tt (hrs)	Precip. (in)	Runoff (in)	Ia/p input/used	
east side ph 1	4.600	67.5	.3000	.0000	4.70	1.63	I.20	.20

* Travel time from subarea outfall to composite watershed outfall point.
I -- Subarea where user specified interpolation between Ia/p tables.

>>>> Computer Modifications of Input Parameters <<<<<

Subarea Description	Input Values Tc (hrs)	Input Values * Tt (hrs)	Rounded Values Tc (hrs)	Rounded Values * Tt (hrs)	Ia/p Interpolated (Yes/No)	Ia/p Messages
east side ph 1	.3300	.0000	.30	.00	Yes	--

* Travel time from subarea outfall to composite watershed outfall point.

Worst-case diversion berm

Name.... WORSTCASE DIV BE Tag: 25

File.... I:\1370\COLUMBIA.PPK
Title... Hydrograph for worst-case diversion berm sizing calcs
HYG Dir = I:\1370\
HYG file = NONE STORED WORSTCASE DIV BE 25

TR-55 TABULAR HYDROGRAPH METHOD
TYPE II Distribution
25yr, 24hr Rainfall Depth = 4.70 in

>>>> Summary of Subarea Times to Peak <<<<

Subarea	Peak Discharge at Composite Outfall (cfs)	Time to Peak at Composite Outfall (hrs)
east side ph 1	7	12.2
Composite Watershed	7	12.2

Worksheet
Worksheet for Triangular Channel

Worst-case diversion berm

Project Description	
Worksheet	Triangular Channe
Flow Element	Triangular Channe
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.030	
Slope	020000	ft/ft
Left Side Slope	4.00	H : V
Right Side Slope	3.00	H : V
Discharge	7.00	cfs

Results		
Depth	0.75	ft
Flow Area	2.0	ft²
Wetted Perim	5.47	ft
Top Width	5.25	ft
Critical Depth	0.76	ft
Critical Slope	0.019122	ft/ft
Velocity	3.55	ft/s
Velocity Head	0.20	ft
Specific Energ	0.95	ft
Froude Numb	1.02	
Flow Type	Supercritical	

Worst-case downslope channel

Type.... Tc Calcs
Name.... WORST CASE FLUME

File.... I:\1370\COLUMBIA.PPK
Title... Tc for worst case downslope flume sizing calcs

::
TIME OF CONCENTRATION CALCULATOR
::

Tc for worst case downslope flume sizing calcs

Segment #1: Tc: TR-55 Sheet
Description: final cover slope - 5%

Mannings n	.1900	
Hydraulic Length	60.00	ft
2yr, 24hr P	2.7000	in
Slope	.050000	ft/ft

Avg.Velocity .17 ft/sec

Segment #1 Time: .0989 hrs

Segment #2: Tc: TR-55 Sheet
Description: final cover slope - 25%

Mannings n	.1900	
Hydraulic Length	60.00	ft
2yr, 24hr P	2.7000	in
Slope	.250000	ft/ft

Avg.Velocity .32 ft/sec

Segment #2 Time: .0520 hrs

Segment #3: Tc: TR-55 Shallow
Description: diversion berm

Hydraulic Length	1790.00	ft
Slope	.020000	ft/ft
Unpaved		

Avg.Velocity 2.28 ft/sec

Segment #3 Time: .2179 hrs

========================
Total Tc: .3688 hrs
========================

S/N: H0M0L0862791 BT 2, Inc
Pond Pack Ver: 8-01-98 (61) Compute Time: 14:37:11 Date: 08-29-2000

Worst-case downslope channel

Type.... TR-55 Tabular Hyd.Input Data
Name.... WORST CASE FLUME   Tag: 25

File.... I:\1370\COLUMBIA.PPK
Title... Hydrograph for worst-case downslope flume sizing calcs
HYG Dir = I:\1370\
HYG file = NONE STORED WORST CASE FLUME 25

TR-55 TABULAR HYDROGRAPH METHOD
TYPE II Distribution
25yr, 24hr Rainfall Depth = 4.70 in

Total Area = 7.500 acres or .011719 sq.mi.
Peak Discharge = 10 cfs

>>>> Input Parameters Used to Compute Hydrograph <<<<

Subarea Description	AREA (acres)	CN	Tc (hrs)	* Tt (hrs)	Precip. (in)	Runoff (in)	Ia/p input/used	
To SE flume	7.500	67.5	.4000	.0000	4.70	1.63	I.20	.20

* Travel time from subarea outfall to composite watershed outfall point.
I -- Subarea where user specified interpolation between Ia/p tables.

>>>> Computer Modifications of Input Parameters <<<<<

Subarea Description	Input Values Tc (hrs)	Input Values * Tt (hrs)	Rounded Values Tc (hrs)	Rounded Values * Tt (hrs)	Ia/p Interpolated (Yes/No)	Ia/p Messages
To SE flume	.3700	.0000	.40	.00	Yes	--

* Travel time from subarea outfall to composite watershed outfall point.

S/N: H0M0L0862791   BT 2, Inc
Pond Pack Ver: 8-01-98 (61)   Compute Time: 14:38:32   Date: 08-29-2000

Worst-case downslope channel

Type.... TR-55 Tabular Hyd.Peaks
Name.... WORST CASE FLUME   Tag: 25

File.... I:\1370\COLUMBIA.PPK
Title... Hydrograph for worst-case downslope flume sizing calcs
HYG Dir = I:\1370\
HYG file = NONE STORED WORST CASE FLUME 25

TR-55 TABULAR HYDROGRAPH METHOD
TYPE II Distribution
25yr, 24hr Rainfall Depth = 4.70 in

>>>> Summary of Subarea Times to Peak <<<<

Subarea	Peak Discharge at Composite Outfall (cfs)	Time to Peak at Composite Outfall (hrs)
To SE flume	10	12.3
Composite Watershed	10	12.3

Worksheet
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	downslope flume
Flow Element	Trapezoidal Cha
Method	Manning's Formi
Solve For	Channel Depth

Worst-case downslope channel (SW channel)

Input Data		
Mannings Coeffic	0.040	
Slope	200000	ft/ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	10.00	ft
Discharge	10.00	cfs

Results		
Depth	0.18	ft
Flow Area	1.9	ft²
Wetted Perim	11.16	ft
Top Width	11.10	ft
Critical Depth	0.30	ft
Critical Slope	0.035988	ft/ft
Velocity	5.17	ft/s
Velocity Head	0.41	ft
Specific Energ	0.60	ft
Froude Numb	2.18	
Flow Type	Supercritical	

Worksheet
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	worst-case west perimetei
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Worst-case west perimeter ditch

Input Data		
Mannings Coeffic	0.030	
Slope	006000	ft/ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	5.00	ft
Discharge	31.00	cfs

Results		
Depth	1.13	ft
Flow Area	9.5	ft²
Wetted Perim	12.17	ft
Top Width	11.80	ft
Critical Depth	0.88	ft
Critical Slope	0.015659	ft/ft
Velocity	3.26	ft/s
Velocity Head	0.16	ft
Specific Enerç	1.30	ft
Froude Numb	0.64	
Flow Type	Subcritical	

Worksheet
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	worst-case east perimeter
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Worst-case east perimeter ditch

Input Data		
Mannings Coeffic	0.030	
Slope	005000	ft/ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	10.00	ft
Discharge	57.00	cfs

Results		
Depth	1.23	ft
Flow Area	16.9	ft^2
Wetted Perim	17.79	ft
Top Width	17.39	ft
Critical Depth	0.91	ft
Critical Slope	0.014803	ft/ft
Velocity	3.38	ft/s
Velocity Head	0.18	ft
Specific Enerç	1.41	ft
Froude Numb	0.61	
Flow Type	Subcritical	

Worksheet
Worksheet for Trapezoidal Channel

Worst-case south perimeter ditch

Project Description	
Worksheet	worst case south perimetei
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.030	
Slope	012000	ft/ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	10.00	ft
Discharge	70.00	cfs

Results		
Depth	1.08	ft
Flow Area	14.4	ft²
Wetted Perim	16.85	ft
Top Width	16.50	ft
Critical Depth	1.03	ft
Critical Slope	0.014316	ft/ft
Velocity	4.88	ft/s
Velocity Head	0.37	ft
Specific Enerç	1.45	ft
Froude Numbı	0.92	
Flow Type	Subcritical	

Worksheet
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	ditch from SW corner of LF to S
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Ditch from SW corner of Landfill to South Basin

Input Data		
Mannings Coeffic	0.030	
Slope	006000	ft/ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	15.00	ft
Discharge	69.00	cfs

Results		
Depth	1.07	ft
Flow Area	19.4	ft²
Wetted Perim	21.74	ft
Top Width	21.40	ft
Critical Depth	0.82	ft
Critical Slope	0.014896	ft/ft
Velocity	3.56	ft/s
Velocity Head	0.20	ft
Specific Energ	1.26	ft
Froude Numb	0.66	
Flow Type	Subcritical	

Basin Volume Computations

Type.... Vol: Planimeter
Name.... SOUTH BASIN

File.... I:\1370\COLUMBIA.PPK
Title... south basin volume

POND VOLUME CALCULATIONS

Planimeter scale: 1.00 ft/in

Elevation (ft)	Planimeter (sq.in)	Area (acres)	A1+A2+sqr(A1*A2) (acres)	Volume (ac-ft)	Volume Sum (ac-ft)
789.00	62411.000	1.4328	.0000	.000	.000
790.00	68355.000	1.5692	4.5014	1.500	1.500
792.00	74865.000	1.7187	4.9301	3.287	4.787
794.00	82150.000	1.8859	5.4049	3.603	8.390

POND VOLUME EQUATIONS

* Incremental volume computed by the Conic Method for Reservoir Volumes.

Volume = (1/3) * (EL2-EL1) * (Area1 + Area2 + sq.rt.(Area1*Area2))

where: EL1, EL2 = Lower and upper elevations of the increment
Area1,Area2 = Areas computed for EL1, EL2, respectively
Volume = Incremental volume between EL1 and EL2

Outlet Structure Data

Type.... Outlet Input Data
Name.... SOUTH BASIN2

File.... I:\1370\COLUMBIA.PPK
Title... south basin outlet structure

REQUESTED POND WS ELEVATIONS:

Min. Elev.= 789.50 ft
Increment = 1.00 ft
Max. Elev.= 794.00 ft

****
OUTLET CONNECTIVITY
****

---> Forward Flow Only (UpStream to DnStream)
<--- Reverse Flow Only (DnStream to UpStream)
<---> Forward and Reverse Both Allowed

Structure	No.		Outfall	E1, ft	E2, ft
Weir-Rectangular	e1	--->	TW	793.000	794.000
Stand Pipe	s1	--->	c1	791.000	794.000
Orifice-Circular	o1	--->	c1	789.500	794.000
Culvert-Circular	c1	--->	TW	789.000	794.000
TW SETUP, DS Channel					

File.... I:\1370\COLUMBIA.PPK
Title... south basin outlet structure

OUTLET STRUCTURE INPUT DATA

```
Structure ID        = e1
Structure Type      = Weir-Rectangular
------------------------------------
# of Openings       =         1
Crest Elev.         =    793.00 ft
Weir Length         =     10.00 ft
Weir Coeff.         =  3.300000

Weir TW effects       (Use adjustment equation)


Structure ID        = s1
Structure Type      = Stand Pipe
------------------------------------
# of Openings       =         1
Invert Elev.        =    791.00 ft
Diameter            =    2.5000 ft
Orifice Area        =    4.9087 sq.ft
Orifice Coeff.      =      .600
Weir Length         =      7.85 ft
Weir Coeff.         =     3.300
K, Submerged        =      .000
K, Reverse          =     1.000
Kb,Barrel           =   .000000  (per ft of full flow)
Barrel Length       =       .00 ft
Mannings n          =     .0000


Structure ID        = o1
Structure Type      = Orifice-Circular
------------------------------------
# of Openings       =        72
Invert Elev.        =    789.50 ft
Diameter            =     .0400 ft
Orifice Coeff.      =      .600
```

```
Type.... Outlet Input Data
Name.... SOUTH BASIN2

File.... I:\1370\COLUMBIA.PPK
Title... south basin outlet structure

              OUTLET STRUCTURE INPUT DATA


              Structure ID       = c1
              Structure Type     = Culvert-Circular
              ------------------------------------
              No. Barrels        =        1
              Barrel Diameter    =    1.2500 ft
              Upstream Invert    =    789.00 ft
              Dnstream Invert    =    788.50 ft
              Horiz. Length      =     50.00 ft
              Barrel Length      =     50.00 ft
              Barrel Slope       =    .01000 ft/ft

              OUTLET CONTROL DATA...
              Mannings n         =     .0130
              Ke                 =     .9000  (forward entrance loss)
              Kb                 =   .023225  (per ft of full flow)
              Kr                 =     .9000  (reverse entrance loss)
              HW Convergence     =      .001  +/- ft

              INLET CONTROL DATA...
              Equation form      =         1
              Inlet Control K    =     .0340
              Inlet Control M    =    1.5000
              Inlet Control c    =    .05530
              Inlet Control Y    =     .5400
              T1 ratio (HW/D)    =     1.258
              T2 ratio (HW/D)    =     1.420
              Slope Factor       =     -.500

 Use unsubmerged inlet control Form 1 equ. below T1 elev.
 Use   submerged inlet control Form 1 equ. above T2 elev.

 In transition zone between unsubmerged and submerged inlet control,
 interpolate between flows at T1 & T2...
 At T1 Elev =   790.57 ft   ---> Flow =     4.80 cfs
 At T2 Elev =   790.77 ft   ---> Flow =     5.49 cfs


              Structure ID       = TW
              Structure Type     = TW SETUP, DS Channel
              ------------------------------------
              FREE OUTFALL CONDITIONS SPECIFIED

              CONVERGENCE TOLERANCES...
              Maximum Iterations=    30
              Min. TW tolerance =    .01 ft
              Max. TW tolerance =    .01 ft
              Min. HW tolerance =    .01 ft
              Max. HW tolerance =    .01 ft
```

File.... I:\1370\COLUMBIA.PPK
Title... south basin outlet structure

RATING TABLE FOR ONE OUTLET TYPE

Structure ID = e1 (Weir-Rectangular)

Upstream ID = (Pond Water Surface)
DNstream ID = TW (Pond Outfall)

WS Elev, Device Q		Tail Water		Notes
WS Elev. ft	Q cfs	TW Elev ft	Converge +/-ft	Computation Messages
789.50	.00	Free Outfall		WS below an invert; no flow.
790.50	.00	Free Outfall		WS below an invert; no flow.
791.00	.00	Free Outfall		WS below an invert; no flow.
791.50	.00	Free Outfall		WS below an invert; no flow.
792.50	.00	Free Outfall		WS below an invert; no flow.
793.00	.00	Free Outfall		WS below an invert; no flow.
793.50	11.67	Free Outfall		H=.50; Htw=.00; Qfree=11.67;
794.00	33.00	Free Outfall		H=1.00; Htw=.00; Qfree=33.00;

Type.... Individual Outlet Curves
Name.... SOUTH BASIN2

File.... I:\1370\COLUMBIA.PPK
Title... south basin outlet structure

RATING TABLE FOR ONE OUTLET TYPE

Structure ID = s1 (Stand Pipe)

Upstream ID = (Pond Water Surface)
DNstream ID = c1 (Culvert-Circular)

Pond WS. Elev. ft	Device Q cfs	(into) HW HGL ft	Converge DS HGL ft	Next DS HGL ft	DS HGL Error +/-ft	Q SUM Error +/-cfs	DS Chan. TW ft	TW Error +/-ft
789.50	.00	...	...	...	...	...	Free Outfall	
	WS below an invert; no flow.							
790.50	.00	...	...	...	...	...	Free Outfall	
	WS below an invert; no flow.							
791.00	.00	...	...	...	...	...	Free Outfall	
	WS below an invert; no flow.							
791.50	7.06	791.50	791.50	791.50	.000	.000	Free Outfall	
	DS HGL+Loss > crest: Flow set to Downstream outlet.							
792.50	8.78	792.50	792.50	792.50	.000	.000	Free Outfall	
	DS HGL+Loss > crest: Flow set to Downstream outlet.							
793.00	9.52	793.00	793.00	793.00	.000	.000	Free Outfall	
	DS HGL+Loss > crest: Flow set to Downstream outlet.							
793.50	10.21	793.50	793.50	793.50	.000	.000	Free Outfall	
	DS HGL+Loss > crest: Flow set to Downstream outlet.							
794.00	10.86	794.00	794.00	794.00	.000	.000	Free Outfall	
	DS HGL+Loss > crest: Flow set to Downstream outlet.							

RATING TABLE FOR ONE OUTLET TYPE

Structure ID = o1 (Orifice-Circular)

Upstream ID = (Pond Water Surface)
DNstream ID = c1 (Culvert-Circular)

NUMBER OF OPENINGS = 72
EACH FLOW = SUM OF OPENINGS x FLOW FOR ONE OPENING

Pond WS. Elev. ft	Device Q cfs	(into) HW HGL ft	Converge DS HGL ft	Next DS HGL ft	DS HGL Error +/-ft	Q SUM Error +/-cfs	DS Chan. TW ft	TW Error +/-ft
789.50	.00	...	...	...	...	...	Free Outfall	
	WS below an invert; no flow.							
790.50	.43	790.50	Free	789.42	.000	.000	Free Outfall	
	H =.98							
791.00	.53	791.00	Free	789.47	.000	.000	Free Outfall	
	H =1.48							
791.50	.00	791.50	791.50	791.50	.000	.000	Free Outfall	
				Full riser flow. Q=0 this opening.				
792.50	.00	792.50	792.50	792.50	.000	.000	Free Outfall	
				Full riser flow. Q=0 this opening.				
793.00	.00	793.00	793.00	793.00	.000	.000	Free Outfall	
				Full riser flow. Q=0 this opening.				
793.50	.00	793.50	793.50	793.50	.000	.000	Free Outfall	
				Full riser flow. Q=0 this opening.				
794.00	.00	794.00	794.00	794.00	.000	.000	Free Outfall	
				Full riser flow. Q=0 this opening.				

File.... I:\1370\COLUMBIA.PPK
Title... south basin outlet structure

RATING TABLE FOR ONE OUTLET TYPE

Structure ID = c1 (Culvert-Circular)

Mannings open channel maximum capacity: 6.95 cfs
UPstream ID's= s1, o1
DNstream ID = TW (Pond Outfall)

Pond WS. Elev. ft	Device Q cfs	(into) HW HGL ft	Converge DS HGL ft	Next DS HGL ft	DS HGL Error +/-ft	Q SUM Error +/-cfs	DS Chan. TW ft	TW Error +/-ft
789.50	.00	789.00	Free	Free	.000	.000	Free	Outfall
790.50	.43	789.42	Free	Free	.000	.000	Free	Outfall
		CRIT.DEPTH	CONTROL	Vh= .089ft	Dcr=	.255ft	CRIT.DEPTH	
791.00	.53	789.47	Free	Free	.000	.000	Free	Outfall
		CRIT.DEPTH	CONTROL	Vh= .100ft	Dcr=	.283ft	CRIT.DEPTH	
791.50	7.06	791.50	Free	Free	.000	.000	Free	Outfall
		INLET CONTROL...		Submerged:	HW =2.50			
792.50	8.78	792.50	Free	Free	.000	.000	Free	Outfall
		INLET CONTROL...		Submerged:	HW =3.50			
793.00	9.52	793.00	Free	Free	.000	.000	Free	Outfall
		INLET CONTROL...		Submerged:	HW =4.00			
793.50	10.21	793.50	Free	Free	.000	.000	Free	Outfall
		INLET CONTROL...		Submerged:	HW =4.50			
794.00	10.86	794.00	Free	Free	.000	.000	Free	Outfall
		INLET CONTROL...		Submerged:	HW =5.00			

Pond Routing Summary

Name.... SOUTH BASIN2 Tag: 25

South Basin
25-yr, 24-hr Storm

File.... I:\1370\COLUMBIA.PPK
Title... routing of hydrograph through south basin

LEVEL POOL ROUTING SUMMARY

```
HYG Dir              = I:\1370\
Inflow  HYG file = SBASIN.HYG - south basin      25
Outflow HYG file = NONE STORED - SOUTH BASIN2 OUT 25

Pond Node   Data = south basin
Pond Volume Data = south basin
Pond Outlet Data = south basin2

No Infiltration

INITIAL CONDITIONS
---------------------------------
Starting WS Elev    =  789.00 ft
Starting Volume     =     .000 ac-ft
Starting Outflow    =      .00 cfs
Starting Infiltr.   =      .00 cfs
Starting Total Qout=      .00 cfs
Time Increment      =    .1000 hrs


INFLOW/OUTFLOW HYDROGRAPH SUMMARY
====================================================
Peak Inflow      =    69.00 cfs    at   12.4000 hrs
Peak Outflow     =     7.94 cfs    at   14.1000 hrs
----------------------------------------------------
Peak Elevation   =   792.01 ft
Peak Storage =        4.805 ac-ft
====================================================
```

Peak discharge from basin

Peak water elevation

```
MASS BALANCE (ac-ft)
-------------------------
+ Initial Vol    =        .000
+ HYG Vol IN     =       8.872
- Infiltration =          .000
- HYG Vol OUT    =       8.101
- Retained Vol =          .769
                    ----------
Unrouted Vol =         -.001 ac-ft   (.016% of Inflow Volume)


WARNING: Inflow hydrograph truncated on left side.
WARNING: Outflow hydrograph truncated on right side.
```

			Sheet No.
			Calc. No.
			Rev. No.
Job No. 1370	Job Columbia Plan of Op Update		By BLP Date 8/23/00
Client Alliant	Subject Basin Calcs		Chk'd. MKH Date 8-31-00

Basin Particle Size Settling Capability

Basin required to settle out ≥ 15 micron (0.015 mm) particle for a 25-yr, 24-hr Storm event.

From calculations, peak discharge from basin is 7.94 cfs and peak water elevation is 792.0 ft. The corresponding surface area of the basin at elevation 792.0 is 74,865 sf (see Basin Volume Computations Sectio

The surface area to discharge ratio is therefore

$$\frac{74,865 \text{ sf}}{7.94 \text{ cfs}} = 9,429 \text{ sf/cfs}$$

From the Erosion and Sediment Control Handbook, the required surface area to discharge ratio to settle out a 15 micron particle is 3,125 sf/cfs.

9,429 cfs/sf > 3,125 sf/cfs, therefore the basin is adequately sized to settle out a 15 micron particle

```
Type.... Pond Routed HYG (total out)
Name.... SOUTH BASIN2        Tag:     25

File.... I:\1370\COLUMBIA.PPK
Title... routing of hydrograph through south basin
```

South Basin
Outflow Hydrograph
(1/7)

```
POND ROUTED TOTAL OUTFLOW HYG...
HYG file =
HYG ID   = SOUTH BASIN2 OUT
HYG Tag  =     25
---------------------------------------
Peak Discharge =         7.94 cfs
Time to Peak   =      14.1000 hrs
HYG Volume     =        8.101 ac-ft
---------------------------------------

WARNING: Hydrograph truncated on right side.
```

Basin dewatering time -
Begin discharge: 12.2
End discharge: 113.8 sa
Total discharge time: 101.6
or 4.2 days, whic
is greater than the
required minimum
of 3 days

HYDROGRAPH ORDINATES (cfs)
Output Time increment = .1000 hrs
Time on left represents time for first value in each row.

Time hrs					
11.0000	.00	.00	.00	.00	.00
11.5000	.00	.00	.00	.00	.00
12.0000	.00	.00	.10 Begin discharge	.24	.39
12.5000	.48	.92	3.82	6.00	7.14
13.0000	7.31	7.44	7.55	7.64	7.72
13.5000	7.78	7.83	7.87	7.90	7.92
14.0000	7.93	7.94	7.94	7.94	7.93
14.5000	7.92	7.91	7.90	7.89	7.87
15.0000	7.84	7.82	7.80	7.77	7.75
15.5000	7.73	7.71	7.68	7.66	7.63
16.0000	7.60	7.57	7.54	7.51	7.48
16.5000	7.45	7.42	7.40	7.37	7.34
17.0000	7.31	7.28	7.26	7.23	7.20
17.5000	7.18	7.15	7.13	7.10	7.08
18.0000	6.96	6.77	6.60	6.44	6.28
18.5000	6.14	6.00	5.88	5.76	5.65
19.0000	5.55	5.45	5.36	5.27	5.19
19.5000	5.12	5.01	4.89	4.77	4.66
20.0000	4.55	4.46	4.36	4.28	4.20
20.5000	4.12	4.05	3.99	3.92	3.87
21.0000	3.81	3.76	3.71	3.67	3.63
21.5000	3.59	3.55	3.51	3.48	3.45
22.0000	3.42	3.40	3.37	3.35	3.33
22.5000	3.31	3.29	3.24	3.16	3.09
23.0000	3.02	2.95	2.89	2.84	2.78
23.5000	2.74	2.69	2.65	2.61	2.57
24.0000	2.53	2.47	2.37	2.29	2.21
24.5000	2.13	2.06	1.99	1.93	1.87
25.0000	1.82	1.77	1.72	1.67	1.60

Type.... Pond Routed HYG (total out)
Name.... SOUTH BASIN2 Tag: 25

South Basin
Outflow Hydrograph
(2/7)

File.... I:\1370\COLUMBIA.PPK
Title... routing of hydrograph through south basin

WARNING: Hydrograph truncated on right side.

HYDROGRAPH ORDINATES (cfs)
Output Time increment = .1000 hrs
Time on left represents time for first value in each row.

Time hrs					
25.5000	1.50	1.40	1.32	1.23	1.15
26.0000	1.08	1.01	.95	.89	.83
26.5000	.78	.73	.69	.64	.60
27.0000	.56	.53	.53	.53	.53
27.5000	.53	.53	.53	.53	.53
28.0000	.53	.52	.52	.52	.52
28.5000	.52	.52	.52	.52	.52
29.0000	.52	.52	.52	.52	.52
29.5000	.52	.52	.52	.52	.52
30.0000	.51	.51	.51	.51	.51
30.5000	.51	.51	.51	.51	.51
31.0000	.51	.51	.51	.51	.51
31.5000	.51	.51	.51	.51	.50
32.0000	.50	.50	.50	.50	.50
32.5000	.50	.50	.50	.50	.50
33.0000	.50	.50	.50	.50	.50
33.5000	.50	.50	.50	.50	.49
34.0000	.49	.49	.49	.49	.49
34.5000	.49	.49	.49	.49	.49
35.0000	.49	.49	.49	.49	.49
35.5000	.49	.49	.49	.49	.48
36.0000	.48	.48	.48	.48	.48
36.5000	.48	.48	.48	.48	.48
37.0000	.48	.48	.48	.48	.48
37.5000	.48	.48	.48	.48	.48
38.0000	.47	.47	.47	.47	.47
38.5000	.47	.47	.47	.47	.47
39.0000	.47	.47	.47	.47	.47
39.5000	.47	.47	.47	.47	.47
40.0000	.47	.46	.46	.46	.46
40.5000	.46	.46	.46	.46	.46
41.0000	.46	.46	.46	.46	.46
41.5000	.46	.46	.46	.46	.46
42.0000	.46	.46	.46	.45	.45
42.5000	.45	.45	.45	.45	.45
43.0000	.45	.45	.45	.45	.45
43.5000	.45	.45	.45	.45	.45
44.0000	.45	.45	.45	.45	.45
44.5000	.44	.44	.44	.44	.44
45.0000	.44	.44	.44	.44	.44
45.5000	.44	.44	.44	.44	.44
46.0000	.44	.44	.44	.44	.44
46.5000	.44	.44	.44	.43	.43

Type.... Pond Routed HYG (total out)
Name.... SOUTH BASIN2 Tag: 25

South Basin
Outflow Hydrograp
(3/7)

File.... I:\1370\COLUMBIA.PPK
Title... routing of hydrograph through south basin

WARNING: Hydrograph truncated on right side.

HYDROGRAPH ORDINATES (cfs)
Output Time increment = .1000 hrs
Time on left represents time for first value in each row.

Time hrs					
47.0000	.43	.43	.43	.43	.43
47.5000	.43	.43	.43	.43	.43
48.0000	.43	.43	.43	.42	.42
48.5000	.42	.42	.42	.42	.42
49.0000	.42	.42	.42	.41	.41
49.5000	.41	.41	.41	.41	.41
50.0000	.41	.41	.41	.41	.40
50.5000	.40	.40	.40	.40	.40
51.0000	.40	.40	.40	.40	.40
51.5000	.39	.39	.39	.39	.39
52.0000	.39	.39	.39	.39	.39
52.5000	.39	.38	.38	.38	.38
53.0000	.38	.38	.38	.38	.38
53.5000	.38	.38	.38	.37	.37
54.0000	.37	.37	.37	.37	.37
54.5000	.37	.37	.37	.37	.37
55.0000	.36	.36	.36	.36	.36
55.5000	.36	.36	.36	.36	.36
56.0000	.36	.36	.35	.35	.35
56.5000	.35	.35	.35	.35	.35
57.0000	.35	.35	.35	.35	.34
57.5000	.34	.34	.34	.34	.34
58.0000	.34	.34	.34	.34	.34
58.5000	.34	.34	.33	.33	.33
59.0000	.33	.33	.33	.33	.33
59.5000	.33	.33	.33	.33	.33
60.0000	.33	.32	.32	.32	.32
60.5000	.32	.32	.32	.32	.32
61.0000	.32	.32	.32	.32	.31
61.5000	.31	.31	.31	.31	.31
62.0000	.31	.31	.31	.31	.31
62.5000	.31	.31	.31	.30	.30
63.0000	.30	.30	.30	.30	.30
63.5000	.30	.30	.30	.30	.30
64.0000	.30	.30	.30	.29	.29
64.5000	.29	.29	.29	.29	.29
65.0000	.29	.29	.29	.29	.29
65.5000	.29	.29	.29	.28	.28
66.0000	.28	.28	.28	.28	.28
66.5000	.28	.28	.28	.28	.28
67.0000	.28	.28	.28	.28	.27
67.5000	.27	.27	.27	.27	.27
68.0000	.27	.27	.27	.27	.27

South Basin
Outflow Hydrograp
(4/7)

File.... I:\1370\COLUMBIA.PPK
Title... routing of hydrograph through south basin

WARNING: Hydrograph truncated on right side.

HYDROGRAPH ORDINATES (cfs)
Output Time increment = .1000 hrs
Time on left represents time for first value in each row.

Time hrs					
68.5000	.27	.27	.27	.27	.27
69.0000	.26	.26	.26	.26	.26
69.5000	.26	.26	.26	.26	.26
70.0000	.26	.26	.26	.26	.26
70.5000	.26	.26	.25	.25	.25
71.0000	.25	.25	.25	.25	.25
71.5000	.25	.25	.25	.25	.25
72.0000	.25	.25	.25	.25	.24
72.5000	.24	.24	.24	.24	.24
73.0000	.24	.24	.24	.24	.24
73.5000	.24	.24	.24	.24	.24
74.0000	.24	.24	.24	.23	.23
74.5000	.23	.23	.23	.23	.23
75.0000	.23	.23	.23	.23	.23
75.5000	.23	.23	.23	.23	.23
76.0000	.23	.23	.22	.22	.22
76.5000	.22	.22	.22	.22	.22
77.0000	.22	.22	.22	.22	.22
77.5000	.22	.22	.22	.22	.22
78.0000	.22	.22	.21	.21	.21
78.5000	.21	.21	.21	.21	.21
79.0000	.21	.21	.21	.21	.21
79.5000	.21	.21	.21	.21	.21
80.0000	.21	.21	.20	.20	.20
80.5000	.20	.20	.20	.20	.20
81.0000	.20	.20	.20	.20	.20
81.5000	.20	.20	.20	.20	.20
82.0000	.20	.20	.20	.20	.19
82.5000	.19	.19	.19	.19	.19
83.0000	.19	.19	.19	.19	.19
83.5000	.19	.19	.19	.19	.19
84.0000	.19	.19	.19	.19	.19
84.5000	.19	.19	.18	.18	.18
85.0000	.18	.18	.18	.18	.18
85.5000	.18	.18	.18	.18	.18
86.0000	.18	.18	.18	.18	.18
86.5000	.18	.18	.18	.18	.18
87.0000	.18	.18	.17	.17	.17
87.5000	.17	.17	.17	.17	.17
88.0000	.17	.17	.17	.17	.17
88.5000	.17	.17	.17	.17	.17
89.0000	.17	.17	.17	.17	.17
89.5000	.17	.17	.17	.16	.16

Name.... SOUTH BASIN2 Tag: 25

File.... I:\1370\COLUMBIA.PPK
Title... routing of hydrograph through south basin

South Basin Outflow Hydrograph (5/7)

WARNING: Hydrograph truncated on right side.

HYDROGRAPH ORDINATES (cfs)
Output Time increment = .1000 hrs
Time on left represents time for first value in each row.

Time hrs					
90.0000	.16	.16	.16	.16	.16
90.5000	.16	.16	.16	.16	.16
91.0000	.16	.16	.16	.16	.16
91.5000	.16	.16	.16	.16	.16
92.0000	.16	.16	.16	.16	.16
92.5000	.15	.15	.15	.15	.15
93.0000	.15	.15	.15	.15	.15
93.5000	.15	.15	.15	.15	.15
94.0000	.15	.15	.15	.15	.15
94.5000	.15	.15	.15	.15	.15
95.0000	.15	.15	.15	.15	.14
95.5000	.14	.14	.14	.14	.14
96.0000	.14	.14	.14	.14	.14
96.5000	.14	.14	.14	.14	.14
97.0000	.14	.14	.14	.14	.14
97.5000	.14	.14	.14	.14	.14
98.0000	.14	.14	.14	.14	.14
98.5000	.14	.13	.13	.13	.13
99.0000	.13	.13	.13	.13	.13
99.5000	.13	.13	.13	.13	.13
100.0000	.13	.13	.13	.13	.13
100.5000	.13	.13	.13	.13	.13
101.0000	.13	.13	.13	.13	.13
101.5000	.13	.13	.13	.13	.12
102.0000	.12	.12	.12	.12	.12
102.5000	.12	.12	.12	.12	.12
103.0000	.12	.12	.12	.12	.12
103.5000	.12	.12	.12	.12	.12
104.0000	.12	.12	.12	.12	.12
104.5000	.12	.12	.12	.12	.12
105.0000	.12	.12	.12	.12	.12
105.5000	.12	.11	.11	.11	.11
106.0000	.11	.11	.11	.11	.11
106.5000	.11	.11	.11	.11	.11
107.0000	.11	.11	.11	.11	.11
107.5000	.11	.11	.11	.11	.11
108.0000	.11	.11	.11	.11	.11
108.5000	.11	.11	.11	.11	.11
109.0000	.11	.11	.11	.11	.11
109.5000	.11	.10	.10	.10	.10
110.0000	.10	.10	.10	.10	.10
110.5000	.10	.10	.10	.10	.10
111.0000	.10	.10	.10	.10	.10

Type.... Pond Routed HYG (total out)
Name.... SOUTH BASIN2 Tag: 25

South Basin Outflow Hydrograph (6/7)

File.... I:\1370\COLUMBIA.PPK
Title... routing of hydrograph through south basin

WARNING: Hydrograph truncated on right side.

HYDROGRAPH ORDINATES (cfs)
Output Time increment = .1000 hrs
Time on left represents time for first value in each row.

Time hrs					
111.5000	.10	.10	.10	.10	.10
112.0000	.10	.10	.10	.10	.10
112.5000	.10	.10	.10	.10	.10
113.0000	.10	.10	.10	.10	.10
113.5000	.10	.10	.10	.10 End discharge	.09
114.0000	.09	.09	.09	.09	.09
114.5000	.09	.09	.09	.09	.09
115.0000	.09	.09	.09	.09	.09
115.5000	.09	.09	.09	.09	.09
116.0000	.09	.09	.09	.09	.09
116.5000	.09	.09	.09	.09	.09
117.0000	.09	.09	.09	.09	.09
117.5000	.09	.09	.09	.09	.09
118.0000	.09	.09	.09	.09	.09
118.5000	.09	.09	.09	.08	.08
119.0000	.08	.08	.08	.08	.08
119.5000	.08	.08	.08	.08	.08
120.0000	.08	.08	.08	.08	.08
120.5000	.08	.08	.08	.08	.08
121.0000	.08	.08	.08	.08	.08
121.5000	.08	.08	.08	.08	.08
122.0000	.08	.08	.08	.08	.08
122.5000	.08	.08	.08	.08	.08
123.0000	.08	.08	.08	.08	.08
123.5000	.08	.08	.08	.08	.08
124.0000	.08	.08	.08	.07	.07
124.5000	.07	.07	.07	.07	.07
125.0000	.07	.07	.07	.07	.07
125.5000	.07	.07	.07	.07	.07
126.0000	.07	.07	.07	.07	.07
126.5000	.07	.07	.07	.07	.07
127.0000	.07	.07	.07	.07	.07
127.5000	.07	.07	.07	.07	.07
128.0000	.07	.07	.07	.07	.07
128.5000	.07	.07	.07	.07	.07
129.0000	.07	.07	.07	.07	.07
129.5000	.07	.07	.07	.07	.07
130.0000	.07	.07	.07	.07	.07
130.5000	.07	.06	.06	.06	.06
131.0000	.06	.06	.06	.06	.06
131.5000	.06	.06	.06	.06	.06
132.0000	.06	.06	.06	.06	.06
132.5000	.06	.06	.06	.06	.06

Type.... Pond Routed HYG (total out)
Name.... SOUTH BASIN2 Tag: 25

South Basin
Outflow Hydrograp
(7/7)

File.... I:\1370\COLUMBIA.PPK
Title... routing of hydrograph through south basin

WARNING: Hydrograph truncated on right side.

HYDROGRAPH ORDINATES (cfs)
Output Time increment = .1000 hrs
Time on left represents time for first value in each row.

Time hrs					
133.0000	.06	.06	.06	.06	.06
133.5000	.06	.06	.06	.06	.06
134.0000	.06	.06	.06	.06	.06
134.5000	.06	.06	.06	.06	.06
135.0000	.06	.06	.06	.06	.06
135.5000	.06	.06	.06	.06	.06
136.0000	.06	.06	.06	.06	.06
136.5000	.06	.06	.06	.06	.06
137.0000	.06	.06	.06	.06	.06
137.5000	.06	.06	.06	.06	.05
138.0000	.05	.05	.05	.05	.05
138.5000	.05	.05	.05	.05	.05
139.0000	.05	.05	.05	.05	.05
139.5000	.05	.05	.05	.05	.05
140.0000	.05	.05	.05	.05	.05
140.5000	.05	.05	.05	.05	.05
141.0000	.05	.05	.05	.05	.05
141.5000	.05	.05	.05	.05	.05
142.0000	.05	.05	.05	.05	.05
142.5000	.05	.05	.05	.05	.05
143.0000	.05	.05	.05	.05	.05
143.5000	.05	.05	.05	.05	.05
144.0000	.05	.05	.05	.05	.05
144.5000	.05	.05	.05	.05	.05
145.0000	.05	.05	.05	.05	.05
145.5000	.05	.05	.05	.05	.05
146.0000	.05	.05	.05	.05	.05
146.5000	.05	.05	.04	.04	.04
147.0000	.04	.04	.04	.04	.04
147.5000	.04	.04	.04	.04	.04
148.0000	.04	.04	.04	.04	.04
148.5000	.04	.04	.04	.04	.04
149.0000	.04	.04	.04	.04	.04
149.5000	.04	.04	.04	.04	.04
150.0000	.04	.04	.04	.04	.04
150.5000	.04	.04	.04	.04	.04
151.0000	.04	.04	.04	.04	.04
151.5000	.04	.04	.04	.04	.04
152.0000	.04	.04	.04	.04	.04
152.5000	.04	.04	.04	.04	.04
153.0000	.04	.04	.04	.04	.04
153.5000	.04	.04	.04	.04	.04
154.0000	.04	.04	.04	.04	.04

File.... I:\1370\COLUMBIA.PPK
Title... routing of hydrograph through south basin

South Basin
100-yr, 24-hr Storm

LEVEL POOL ROUTING SUMMARY

```
HYG Dir            = I:\1370\
Inflow  HYG file = SBASIN.HYG - south basin       100
Outflow HYG file = NONE STORED - SOUTH BASIN2 OUT 100

Pond Node   Data = south basin
Pond Volume Data = south basin
Pond Outlet Data = south basin2

No Infiltration

INITIAL CONDITIONS
----------------------------------
Starting WS Elev    =  789.00 ft
Starting Volume     =    .000 ac-ft
Starting Outflow    =     .00 cfs
Starting Infiltr.   =     .00 cfs
Starting Total Qout=      .00 cfs
Time Increment      =   .1000 hrs


INFLOW/OUTFLOW HYDROGRAPH SUMMARY
=====================================================
Peak Inflow       =   110.00 cfs    at   12.4000 hrs
Peak Outflow      =    16.79 cfs    at   13.7000 hrs
-----------------------------------------------------
Peak Elevation    =   793.29 ft
Peak Storage =         7.080 ac-ft
=====================================================
```

Peak discharge from basin

Peak water elevation

```
MASS BALANCE (ac-ft)
--------------------------
+ Initial Vol   =       .000
+ HYG Vol IN    =     13.207
- Infiltration =        .000
- HYG Vol OUT   =     12.435
- Retained Vol =        .770
                 ----------
  Unrouted Vol =       -.001 ac-ft  (.011% of Inflow Volume)


WARNING: Inflow hydrograph truncated on left side.
WARNING: Outflow hydrograph truncated on right side.
```

References

Sheet flow

Sheet flow is flow over plane surfaces. It usually occurs in the headwater of streams. With sheet flow, the friction value (Manning's n) is an effective roughness coefficient that includes the effect of raindrop impact; drag over the plane surface; obstacles such as litter, crop ridges, and rocks; and erosion and transportation of sediment. These n values are for very shallow flow depths of about 0.1 foot or so. Table 3-1 gives Manning's n values for sheet flow for various surface conditions.

For sheet flow of less than 300 feet, use Manning's kinematic solution (Overton and Meadows 1976) to compute T_t:

$$T_t = \frac{0.007\,(nL)^{0.8}}{(P_2)^{0.5}\,s^{0.4}} \qquad \text{[Eq. 3-3]}$$

Table 3-1.—Roughness coefficients (Manning's n) for sheet flow

Surface description	n[1]	
Smooth surfaces (concrete, asphalt, gravel, or bare soil)	0.011	
Fallow (no residue)	0.05	
Cultivated soils:		
Residue cover ≤20%	0.06	
Residue cover >20%	0.17	
Grass:		
Short grass prairie	0.15	Ave =
Dense grasses[2]	0.24	0.19
Bermudagrass	0.41	
Range (natural)	0.13	
Woods:[3]		
Light underbrush	0.40	
Dense underbrush	0.80	

[1]The n values are a composite of information compiled by Engman (1986).
[2]Includes species such as weeping lovegrass, bluegrass, buffalo grass, blue grama grass, and native grass mixtures.
[3]When selecting n, consider cover to a height of about 0.1 ft. This is the only part of the plant cover that will obstruct sheet flow.

where

T_t = travel time (hr),
n = Manning's roughness coefficient (table 3-1),
L = flow length (ft),
P_2 = 2-year, 24-hour rainfall (in), and
s = slope of hydraulic grade line (land slope, ft/ft).

This simplified form of the Manning's kinematic solution is based on the following: (1) shallow steady uniform flow, (2) constant intensity of rainfall excess (that part of a rain available for runoff), (3) rainfall duration of 24 hours, and (4) minor effect of infiltration on travel time. Rainfall depth can be obtained from appendix B.

Shallow concentrated flow

After a maximum of 300 feet, sheet flow usually becomes shallow concentrated flow. The average velocity for this flow can be determined from figure 3-1, in which average velocity is a function of watercourse slope and type of channel. For slopes less than 0.005 ft/ft, use equations given in appendix F for figure 3-1. Tillage can affect the direction of shallow concentrated flow. Flow may not always be directly down the watershed slope if tillage runs across the slope.

After determining average velocity in figure 3-1, use equation 3-1 to estimate travel time for the shallow concentrated flow segment.

Open channels

Open channels are assumed to begin where surveyed cross section information has been obtained, where channels are visible on aerial photographs, or where blue lines (indicating streams) appear on United States Geological Survey (USGS) quadrangle sheets. Manning's equation or water surface profile information can be used to estimate average flow velocity. Average flow velocity is usually determined for bank-full elevation.

Table 2-2c.—Runoff curve numbers for other agricultural lands[1]

Cover description		Curve numbers for hydrologic soil group—			
Cover type	Hydrologic condition	A	B	C	D
Pasture, grassland, or range—continuous forage for grazing.[2]	Poor	68	79	86	89
	Fair	49	69	79	84
	Good	39	61	74	80
				Ave=67.5	
Meadow—continuous grass, protected from grazing and generally mowed for hay.	—	30	58	71	78
Brush—brush-weed-grass mixture with brush the major element.[3]	Poor	48	67	77	83
	Fair	35	56	70	77
	Good	[4]30	48	65	73
Woods—grass combination (orchard or tree farm).[5]	Poor	57	73	82	86
	Fair	43	65	76	82
	Good	32	58	72	79
Woods.[6]	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	[4]30	55	70	77
Farmsteads—buildings, lanes, driveways, and surrounding lots.	—	59	74	82	86

[1]Average runoff condition, and $I_a = 0.2S$.

[2]*Poor:* <50% ground cover or heavily grazed with no mulch.
Fair: 50 to 75% ground cover and not heavily grazed.
Good: >75% ground cover and lightly or only occasionally grazed.

0.6

[3]*Poor:* <50% ground cover.
Fair: 50 to 75% ground cover.
Good: >75% ground cover.

[4]Actual curve number is less than 30; use CN = 30 for runoff computations.

[5]CN's shown were computed for areas with 50% woods and 50% grass (pasture) cover. Other combinations of conditions may be computed from the CN's for woods and pasture.

[6]*Poor:* Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning.
Fair: Woods are grazed but not burned, and some forest litter covers the soil.
Good: Woods are protected from grazing, and litter and brush adequately cover the soil.

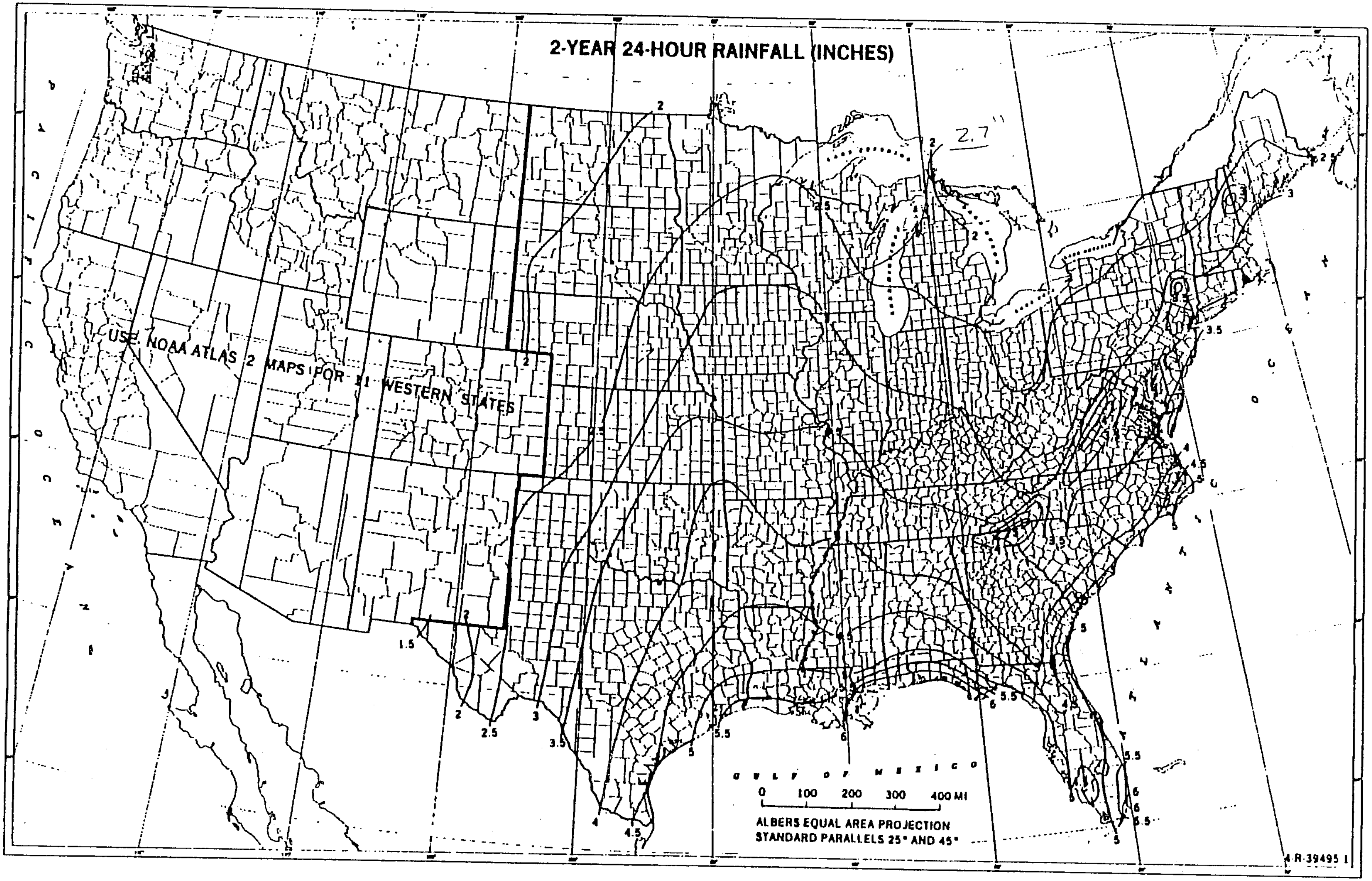

Figure B-3.—Two-year, 24-hour rainfall.

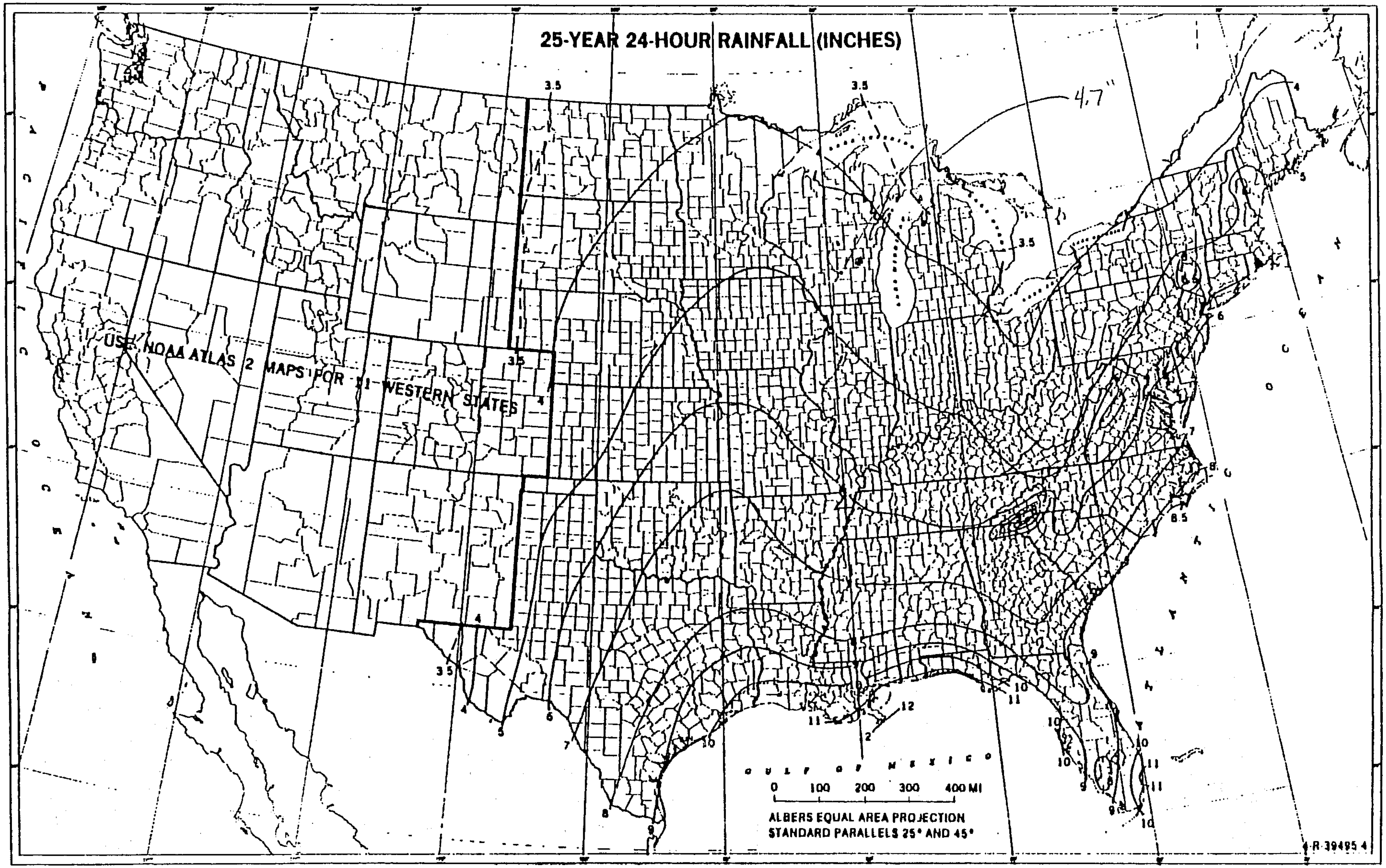

Figure B-6.—Twenty-five-year, 24-hour rainfall.

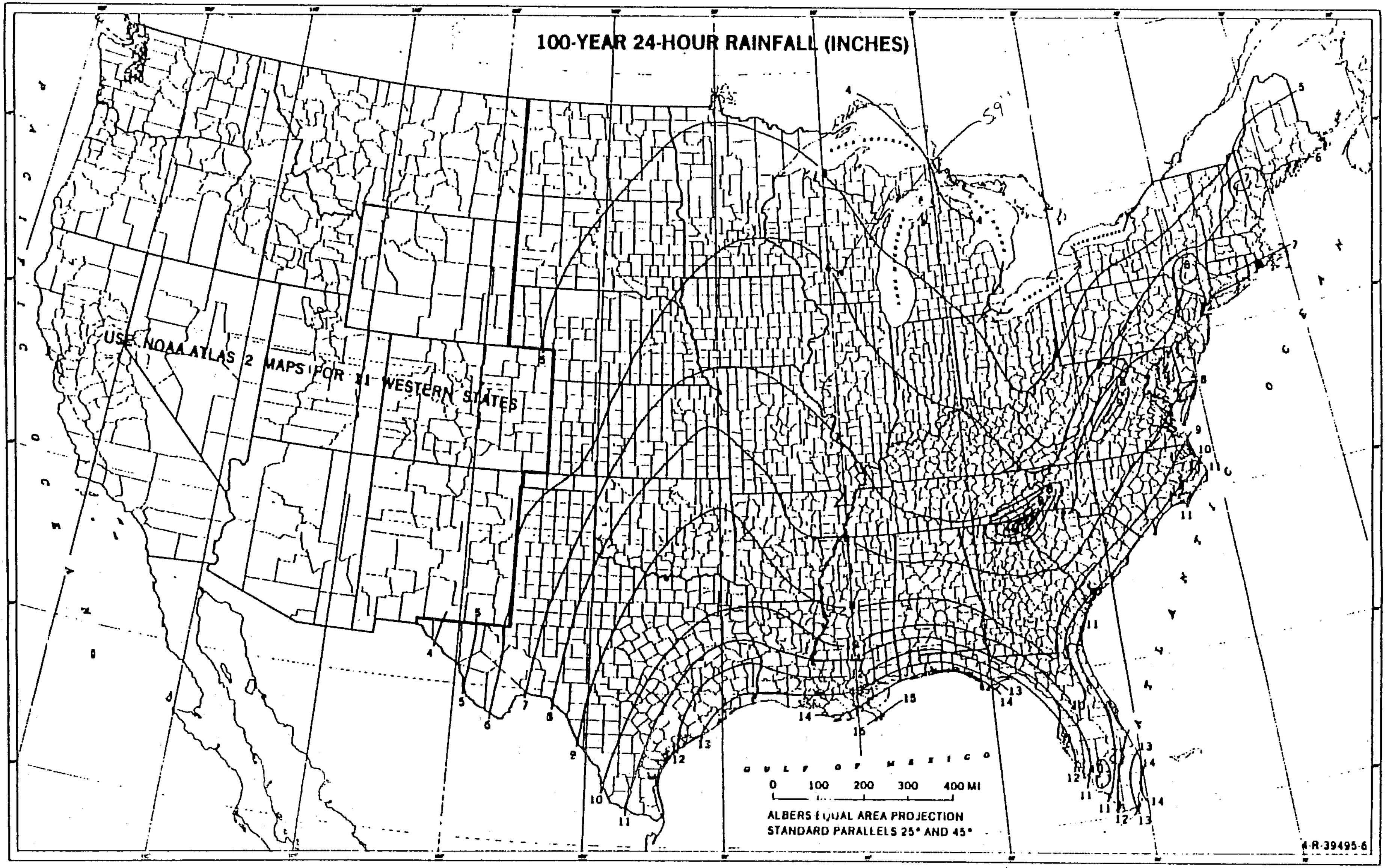

Figure B-8.—One-hundred-year, 24-hour rainfall.

TABLE 8.1 Surface Area Requirements of Sediment Traps and Basins

Particle size, mm	Settling velocity, ft/sec (m/sec)	Surface area requirements, ft² per ft³/sec discharge	(m² per m³/sec discharge)
0.5 (coarse sand)	0.19 (0.058)	6.3	(20.7)
0.2 (medium sand)	0.067 (0.020)	17.9	(58.7)
0.1 (fine sand)	0.023 (0.0070)	52.2	(171.0)
0.05 (coarse silt)	0.0062 (0.0019)	193.6	(635.0)
0.02 (medium silt)	0.00096 (0.00029)	1,250.0	(4,101.0)
0.01 (fine silt)	0.00024 (0.000073)	5,000.0	(16,404.0)
0.005 (clay)	0.00006 (0.000018)	20,000.0	(65,617.0)

0.015

Ave = 3,125 SF/cfs

weight composed of particles in the 0.01- to 0.02-mm range. A surface area 4 times larger would be needed to capture 5 percent more of this soil.

A balance between the cost-effectiveness of a certain basin size and the desire to capture fine particles must be achieved. It is desirable to capture the very small soil particles (clays and fine silts) because they cause turbidity and other water quality problems. However, Table 8.1 shows that a basin would have to be very large to capture particles smaller than 0.02 mm, particularly clay particles 0.005 mm and smaller. Because of the high cost of trapping very small particles, the authors recommend 0.02 as the design particle size for sediment basins except in areas with coarse soils, where a larger design particle may be used. The 0.02-mm particle is classified as a medium silt by the AASHTO soil classification system.

8.2d Basin Discharge Rate

The peak discharge, calculated by the rational or another approved method, is used to size the basin riser. During any major storm, a sediment basin should fill with water to the top of its riser and then discharge at the rate of inflow to the basin. A sediment basin is not designed with a large water storage volume as is a reservoir. If the inflow exceeds the design peak flow used to size the riser, the overflow should discharge down an emergency spillway.

8.2e Design Runoff Rate

In the equation for surface area of a sediment basin, the discharge rate Q is a variable to be chosen by the designer. The above discussion of basin discharge rate shows that the discharge rate is, to a large extent, equal to the inflow. The riser is sized to handle the peak inflow to the basin. The authors suggest determining the surface area by the *average runoff of a 10-year, 6-hr storm* instead

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of the peak flow. A substantial savings in size, and therefore cost, is obtained, and basin efficiency is not significantly decreased.

Consider a basin designed to capture the 0.02-mm particle at the average runoff rate. The average rainfall per hour is 17 percent of the total rainfall in a 6-hr storm (Sec. 4.1f). On a site with soils with a moderately high clay content, under ideal settling conditions this basin would retain about 62 percent of the eroded soil (i.e., 62 percent of the soil, by weight, is composed of 0.02-mm or larger particles).

If the surface area of this basin were instead designed for the peak flow, it would be roughly 3 times larger. According to data from the U.S. Bureau of Reclamation (10), 25 percent of the total rainfall in a 6-hr storm falls in a ½-hr period (Fig. 4.2). Since the rainfall intensity i value is in units of inches (or millimeters) per hour, the peak flow can be calculated by using an i value of 50 percent of the 6-hr total. Since basin surface area is directly proportional to the discharge rate ($A = 1.2Q/V_s$) and the peak discharge rate in a 6-hr storm is 2.9 times the average rate ($50\% = 2.9 \times 17\%$), the surface area sized for the peak flow would be about 3 times the surface area sized for the average flow. The basin sized for the peak flow would capture, during most of the storm except the peak, particles with approximately one-third the settling velocity of the design particle. Since the 0.02-mm particle settles at 0.00096 ft/sec (0.00029 m/sec), particles with a settling velocity of 0.00032 ft/sec (0.000098 m/sec) would then be captured. These are approximately 0.01-mm particles.

Suppose a basin on a site with clayey soils were sized by using the peak runoff rate. For the purpose of illustration, suppose the soil composition were typical of the San Francisco Bay Area as in the preceding example (62 percent of particles, by weight, greater than 0.02 mm and 5 percent, by weight, from 0.01 to 0.02 mm). A basin with a large surface area based on the peak runoff would capture the 0.01- to 0.02-mm particles as well as particles greater than 0.02 mm, or 67 percent of the eroded material. The basin efficiency would be increased 8 percent (5/62) by tripling the surface area. Thus it is generally much more cost-effective to size a basin by using the average runoff rather than the peak, and basin efficiency will not be significantly lower.

8.2f Settling Depth

If a basin is too shallow, water flowing rapidly through the basin may resuspend settled particles and decrease efficiency of capture. A similar problem occurs in grit-settling chambers at sewage treatment plants, where velocity must be controlled to prevent particle resuspension. An equation that describes scour in a grit chamber (2) is:

$$V_{scour} = \frac{1.486}{n} \times \left[r^{1/6} \times k(S_s - 1) \times \frac{d}{304.8} \right]^{1/2}$$

Source: Goldman, S.J., et al. 1986. Erosion and Sediment Control Handbook. New York. McGraw-Hill. 1986.

LEGEND

— — —	PROPOSED LIMITS OF FILL		PAVED ROAD
- - - -	APPROVED LIMITS OF FILL		UNPAVED ROAD
824.6	EXISTING SPOT ELEVATION		VEGETATION
	EXISTING GRADES (5' INTERVAL)		RAILROAD TRACKS
	EXISTING GRADES (1' INTERVAL)		FENCE
	EDGE OF WATER		CULVERT

Areas obtained from AutoCADD

60 0 60

SCALE: 1" = 60'

Z

PROPOSED FINAL GRADES

PLAN OF OPERATION UPDATE
ALLIANT – COLUMBIA ASH DISPOSAL FACILITY
TOWN OF PACIFIC
COLUMBIA COUNTY, WISCONSIN

PROJECT NO. 1370	
DRAWN BY: RR/KP	
CHECKED BY: MRH	
DRAWN: 07/28/00 REVISED: 08/16/00	
J:\1370\PO UPDATE\1370FG04.DWG	

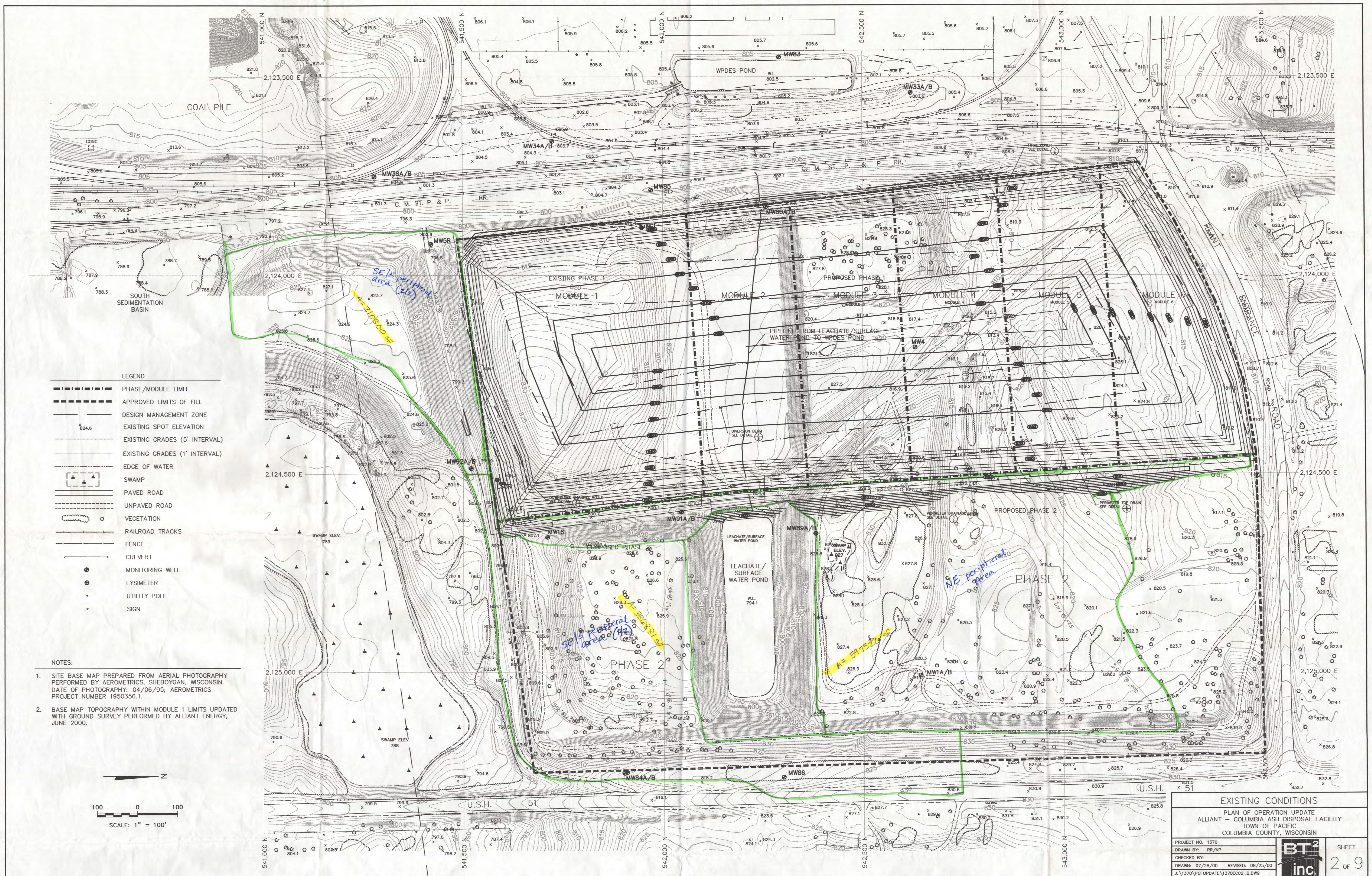
BT² inc.

SHEET 4 OF 8

#1370 ON


C. M. ST. P. & P. RR.
FINAL COVER SEE DETAIL 5/8
EXISTING PHASE 1
PROPOSED PHASE 1
MODULE 1
MODULE 2
MODULE 3
MODULE 4
MODULE 5
MODULE 6
A= 319679 sf
A= 327714 sf
A= 198872 sf
1790' @ 2%
Worst-case downslope channel area
Worst-case diversion berm area
DIVERSION BERM SEE DETAIL 1/9
DOWNSLOPE CHANNEL SEE DETAIL 2/9
PERIMETER DRAINAGE DITCH SEE DETAIL 3/9
PERIMETER TOE DRAIN SEE DETAIL 6/8
LEACHATE/SURFACE WATER POND
PROPOSED PHASE 2
PROPOSED PHASE 2
PLANT ENTRANCE ROAD
MW34A/B
MW85
MW30A/B
MW4
MW92A/B
MW91A/B
MW89A/B
MW16
LS32
542,000 N
542,500 N
543,000 N
543,500 N
2,124,000 E
2,124,500 E
LEGEND
PHASE/MODULE LIMIT
APPROVED LIMITS OF FILL
EXISTING SPOT ELEVATION
EXISTING GRADES (5' INTERVAL)
EXISTING GRADES (1' INTERVAL)
EDGE OF WATER
PAVED ROAD
UNPAVED ROAD
VEGETATION
RAILROAD TRACKS
FENCE
CULVERT
PROPOSED FINAL GRADES (5' INTERVAL)
PROPOSED FINAL GRADES (1' INTERVAL)
PROPOSED DIVERSION BERM
PROPOSED DOWNSLOPE CHANNEL
DRAINAGE DITCH
Areas determined by planimeter
SCALE: 1" = 60'
DRAFT
PROPOSED FINAL GRADES
PLAN OF OPERATION UPDATE
ALLIANT – COLUMBIA ASH DISPOSAL FACILITY
TOWN OF PACIFIC
COLUMBIA COUNTY, WISCONSIN
PROJECT NO. 1370
DRAWN BY: RR/KP
CHECKED BY: MRH
DRAWN: 07/28/00 REVISED: 08/25/00
J:\1370\PO UPDATE\1370FG04.DWG
BT² inc.
SHEET 4 OF 9

#1370 ON


COAL PILE
WPDES POND
C. M. ST. P. & P. RR.
SOUTH SEDIMENTATION BASIN
EXISTING PHASE 1
PROPOSED PHASE 1
PHASE 1
MODULE 1
MODULE 2
MODULE 3
MODULE 4
MODULE 5
MODULE 6
PIPELINE FROM LEACHATE/SURFACE WATER POND TO WPDES POND
LEACHATE/SURFACE WATER POND
PROPOSED PHASE 2
PHASE 2
SWAMP ELEV. 789
SWAMP ELEV. 788
U.S.H. 51
SE 1/5 peripheral area (1/2)
SE 1/5 peripheral area (1/2)
NE peripheral area
MW5R
MW4
MW1A/B
MW16
MW83
MW33A/B
MW34A/B
MW35A/B
MW85
MW86
MW84A/B
MW89A/B
MW91A/B
MW92A/B
LEGEND
PHASE/MODULE LIMIT
APPROVED LIMITS OF FILL
DESIGN MANAGEMENT ZONE
EXISTING SPOT ELEVATION
EXISTING GRADES (5' INTERVAL)
EXISTING GRADES (1' INTERVAL)
EDGE OF WATER
SWAMP
PAVED ROAD
UNPAVED ROAD
VEGETATION
RAILROAD TRACKS
FENCE
CULVERT
MONITORING WELL
LYSIMETER
UTILITY POLE
SIGN
NOTES:
1. SITE BASE MAP PREPARED FROM AERIAL PHOTOGRAPHY PERFORMED BY AEROMETRICS, SHEBOYGAN, WISCONSIN. DATE OF PHOTOGRAPHY: 04/06/95; AEROMETRICS PROJECT NUMBER 1950356.1.
2. BASE MAP TOPOGRAPHY WITHIN MODULE 1 LIMITS UPDATED WITH GROUND SURVEY PERFORMED BY ALLIANT ENERGY, JUNE 2000.
N
100 0 100
SCALE: 1" = 100'
EXISTING CONDITIONS
PLAN OF OPERATION UPDATE
ALLIANT – COLUMBIA ASH DISPOSAL FACILITY
TOWN OF PACIFIC
COLUMBIA COUNTY, WISCONSIN
PROJECT NO. 1370
DRAWN BY: RR/KP
CHECKED BY:
DRAWN: 07/28/00 REVISED: 08/25/00
J:\1370\PO UPDATE\1370EC02_B.DWG
BT2 inc.
SHEET 2 OF 9

#1370 ON

Appendix A2

Leachate/Surface Water Pond Capacity Evaluation

March 10, 2021
File No. 25220183.00

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

Subject: Leachate/Surface Water Pond Capacity Evaluation
Dry Ash Disposal Facility – Columbia Energy Center
License #3025
Town of Pacific, Columbia County, Wisconsin

Dear Ms. Bekta:

On behalf of Wisconsin Power and Light Company (WPL), SCS Engineers (SCS) has prepared this leachate/surface water pond (pond) capacity evaluation in preparation for Phase 1, Module 5 (Module 5) and Module 6 (Module 6) liner construction at the dry ash disposal facility located at the Columbia Energy Center (Columbia) in the Town of Pacific, Wisconsin. This evaluation has been prepared in accordance with Condition No. 1 of the Rain Cover System Plan of Operation Approval Modification issued by Wisconsin Department of Natural Resources (WDNR) on June 6, 2018 (**Attachment A**). Construction of Module 5 and Module 6 is expected to begin in mid-2021 and be completed by the end of 2021.

POND CAPACITY EVALUATION

A pond capacity evaluation was performed using storm water modeling. The evaluation demonstrates that the pond can accommodate a 25-year, 24-hour storm with up to 6.54 acres of open landfill area without overtopping. The model write-up and results are included in **Attachment B**. Based on this conclusion, WPL plans to manage pond levels using a similar approach implemented during construction and operation of Phase 1, Module 4 (Module 4). WPL proposes to use a rain cover in Module 5 and Module 6 to offset the required intermediate/final cover area necessary.

The evaluation was performed to determine the amount of open/contributing area in Modules 2, 3, 4, 5, and 6 that can be accommodated in the pond below the maximum lined pond limits (i.e., to elevation 796.97). The following scenarios were evaluated:

- Scenario 1 – 50 percent of Module 5 open (partially active); Module 6 and remaining 50 percent of Module 5 covered with a rain cover (**Figure 1, Attachment B**).
- Scenario 2 – 100 percent of Module 5 open (fully active); Module 6 covered with a rain cover (**Figure 2, Attachment B**).
- Scenario 3 – 50 percent of Module 6 open (partially active) (**Figure 3, Attachment B**).
- Scenario 4 – 100 percent of Module 6 open (fully active) (**Figure 4, Attachment B**).

Figures 1 through **4** show the resulting general area requiring intermediate/final cover to achieve open landfill area for the scenarios modeled. The actual location of cover placement may vary depending on coal combustion residual (CCR) grades, but the required additional intermediate/final cover area will be met.

POND MANAGEMENT PLAN

While Module 5 and Module 6 are constructed and completed, water levels in the pond will be managed as outlined below:

During Construction of Module 5 and Module 6, Through Installation of a Rain Cover Over a Frost Protection Layer

- **Intermediate/final cover in Module 3 and Module 4.**
  - Areas with existing intermediate/final cover will continue to be routed to the South Sedimentation Basin, reducing the volume discharging to the pond.
  - Intermediate cover will be placed on portions of Modules 3 and 4 if final waste grades are reached.

- **Water level management in the pond.**
  - The pond will be pumped dry and maintained by the site or Module 5 and Module 6 liner construction contractor:
    - At the start of Module 5 and Module 6 construction;
    - Following rain events during Module 5 and Module 6 construction; and
    - Following rain events during placement of the frost protection layer in Module 5 and Module 6.

    Note: During frost protection placement, there will be more than 6.54 acres of open landfill space; however, the pond will be able to accommodate a 10-year 24-hour storm (assuming a starting elevation of 6 inches of water in the pond). This transition period will last approximately 6 weeks or less and consist of the placement of approximately 50,000 cubic yards of frost protection material.

- **Installation of a rain cover in Module 5 and Module 6.**
  - A rain cover will be installed after the frost protection layer is placed in Module 5 and Module 6.
  - The rain cover will allow clean storm water to be diverted away from the leachate/contact water collection system prior to additional filling operations, reducing the volume discharging to the pond.

During Subsequent Filling in Module 5

Filling in Module 5, beyond the frost protection layer, is expected to begin in early 2022. When filling commences, water levels will be managed as follows:

- **Transition of disposal operations into Module 5.**
  - WPL will remove a portion of the Module 5 rain cover only large enough to accommodate the transition of disposal operations in Module 5.

- To the extent possible, in advance of the transition and during the transition, WPL may begin placing intermediate cover with internal resources in areas of Modules 3 and 4 where final or interim waste grades have been achieved.
- WPL will continue installation of intermediate cover or begin the procurement of external resources (i.e., engineering and contractor assistance) to install final cover in Modules 3 and 4 once the transition of disposal operations into Module 5 is complete. WPL intends to monitor waste grades in Modules 3 and 4 using regular airspace surveys and GPS equipment to predict the timing of the transition as accurately as possible.
- During the transition of disposal operations into Module 5, there may be more than 6.54 acres of open landfill space; however, the pond will be able to accommodate at least a 10-year 24-hour storm (assuming a starting elevation of 6 inches of water in the pond). The duration of this transition period will be as short as possible. The required timing of the transition in relation to the construction season may affect the duration of the transition.

- **Placement of additional intermediate/final cover in Modules 3 and 4.**
  - Following the complete transition of disposal operations into Module 5, WPL will focus on achieving the 6.54 acres of open landfill (if not already obtained) by placing additional intermediate/final cover in Modules 3 and 4 as described in the Pond Capacity Evaluation section above.
  - To maintain a maximum open area of 6.54 acres, WPL will place intermediate/final cover over a currently active area in Modules 3 and 4 that is equal to the area of the Module 5 rain cover they will remove. For example, 1.98 acres of intermediate/final cover will need to be installed if 50 percent of the rain cover were removed, and 4.03 acres of intermediate/final cover will need to be installed if 100 percent of the rain cover were removed.

- **Water level management in the pond and staged removal of rain cover.**
  - The rain cover may be removed in sections during additional waste filling, allowing portions of storm water in Module 5 to continue to be diverted from the pond.
  - Water levels will be managed by pumping to specified maximum starting elevations prior to the start of anticipated storm events. Operating level figures are attached to the pond evaluation in **Attachment B** for open scenarios of 50 percent and 100 percent of Module 5. Operating levels will be updated for actual removal areas.

During Subsequent Filling in Module 6

Filling in Module 6, beyond the frost protection layer, is expected to begin in 2023. When filling commences, water levels will be managed as follows:

- **Transition of disposal operations into Module 6.**
  - WPL will remove a portion of the Module 6 rain cover only large enough to accommodate the transition of disposal operations in Module 6.
  - To the extent possible, in advance of the transition and during the transition, WPL may begin placing intermediate cover with internal resources in areas of Modules 4 and 5 where final or interim waste grades have been achieved.

- WPL will continue installation of intermediate cover or begin the procurement of external resources (i.e., engineering and contractor assistance) to install final cover in Modules 4 and 5 once the transition of disposal operations into Module 6 is complete. WPL intends to monitor waste grades in Modules 4 and 5 using regular airspace surveys to predict the timing of the transition as accurately as possible.
- During the transition of disposal operations into Module 6, there may be more than 6.54 acres of open landfill space; however, the pond will be able to accommodate at least a 10-year 24-hour storm (assuming a starting elevation of 6 inches of water in the pond). The duration of this transition period will be as short as possible. The required timing of the transition in relation to the construction season may affect the duration of the transition.

- **Placement of additional intermediate/final cover in Modules 4 and 5.**
  - Following the complete transition of disposal operations into Module 6, WPL will focus on achieving the 6.54 acres of open landfill by placing additional intermediate/final cover in Modules 4 and 5 as described in the Pond Capacity Evaluation section above.
  - To maintain a maximum open area of 6.54 acres, WPL will place intermediate/final cover over a currently active area in Modules 4 and 5 that is equal to the area of the Module 6 rain cover they will remove. For example, 6.07 acres of intermediate/final cover will need to be installed if 50 percent of the rain cover were removed, and 7.97 acres of intermediate/final cover will need to be installed if 100 percent of the rain cover were removed. NOTE: The total areas of coverage are measured from current 2021 intermediate/final cover areas.

- **Water level management in the pond and staged removal of rain cover.**
  - The rain cover may be removed in sections during additional waste filling, allowing portions of storm water in Module 6 to continue to be diverted from the pond.
  - Water levels will be managed by pumping to specified maximum starting elevations prior to the start of anticipated storm events. Operating level figures are attached to the pond evaluation in **Attachment B** for open scenarios of 50 percent and 100 percent of Module 6. Operating levels will be updated for actual removal areas.

PLAN MODIFICATION

A Plan of Operation Approval Modification (Plan Modification) to install a rain cover in Module 4 and future modules was provided on April 17, 2018, and approved on June 6, 2018 (**Attachment A**). The Plan Modification addressed installation, maintenance, and removal requirements for the rain cover. A preconstruction report will be submitted at a later date including geosynthetics material for Module 5 and Module 6 construction.

If you have any questions regarding the contents of this letter, please contact Jeff Maxted at 608.458.3853 or Phil Gearing at 608.216.7324.

Sincerely,

Phillip E. Gearing, PE	Mark R. Huber, PE
Project Manager	Project Director
SCS Engineers	SCS Engineers

RJG/AJR_jsn/PEG/MRH

cc: Jeff Maxted, Alliant Energy
Brian Clepper, WPL – Columbia Energy Center

Encl. Attachment A – WDNR Correspondence
Attachment B – Leachate/Surface Water Pond Capacity Evaluation

I:\25220183.00\Correspondence\Agency\Leachate Pond Capacity Evaluation\2021 Leachate Pond Capacity Evaluation\210310_Bekta_Columbia Leachate Pond Capacity Evaluation_FINAL.docx

Attachment A

WDNR Correspondence

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

Scott Walker, Governor
Daniel L. Meyer, Secretary
Telephone 608-266-2621
Toll Free 1-888-936-7463
TTY Access via relay - 711

WISCONSIN
DEPT. OF NATURAL RESOURCES

June 6, 2018

File Ref: FID 111049180
Columbia County
Approval

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

Subject: Rain Cover System, Plan of Operation Approval Modification, Dry Ash Disposal Facility, Columbia Energy Center License #3025

Dear Mr. Maxted:

The requested modification to your plan of operation for a rain cover system has been reviewed and approved. Please include the attached approval in the written operating record for the landfill as specified in s. NR 506.17, Wis. Adm. Code.

The proposed modification includes the installation and operation of a proposed rain cover system above the completed liner and leachate collection system at the Wisconsin Power and Light Company (WPL) Columbia dry ash disposal facility. The rain cover will allow WPL to divert clean storm water away from the leachate collection system. Diverting clean storm water will minimize the volume of leachate that is collected in the leachate/surface water pond.

If you have any questions regarding this letter, please contact Ann Bekta at ann.bekta@wisconsin.gov or (608)743-4845.

Sincerely,

Cynthia Moore

Cynthia Moore
Waste and Materials Management Program Supervisor
South Central Region

c: Ann Bekta – DNR JSC
Adam Hogan – DNR SCR
Valerie Joosten – DNR NER
Eric Nelson – ENelson@scsengineers.com
Nate Sievers - NathanielSievers@alliantenergy.com

PROJECT SUMMARY
COLUMBIA DRY ASH DISPOSAL LANDFILL

Background

During the construction of Phase 1, Module 2 it was discovered that the peak liner elevation of the existing leachate/surface water pond was at approximately 797 MSL instead of the design elevation of 798. Because of this, the new maximum allowable pond water level was set at 796.97 MSL. In the 2010 Plan of Operation Update the peak water elevation in the pond from a 25-year, 24-hour storm event when Module 3 is operating is 797.17 MSL, which is above the maximum allowable pond water level. Condition 1 of the Department's February 13, 2012 Phase 1, Module 2 liner construction documentation approval required an evaluation of the leachate/surface water pond capacity. The evaluation contained recommendations for a leachate management plan during Phase 1, Module 3 operation. Additional recommendations were discussed in a June 10, 2016 letter. It was determined that a combination of additional final and intermediate cover in Phase 1, Modules 1 and 2 and a rain cover system would maintain the pond water level below the maximum allowable level of 796.9 MSL.

Because the rain cover system for Phase 1, Module 3 was effective in keeping the levels of the pond below the maximum allowable level, WPL proposes to use the system in future modules.

Rain Cover System

WPL is proposing to use rain covers to divert clean storm water away from the leachate collection system in newly constructed landfill cells at the Columbia Energy Center (Columbia) dry ash disposal facility. WPL will install rain covers over new liner and leachate collection systems or coal combustion residual (CCR) frost protection material, and the rain covers will remain in place until removal is needed to facilitate waste placement operations.

The rain covers will prevent storm water contact with leachate drainage layer material and frost protection material, which may both consist of CCR. The rain covers will collect clean, non-contact storm water that would otherwise be managed as leachate with the leachate collection system and allow WPL to divert that water to the perimeter drainage system.

The rain cover will be installed over the leachate drainage layer material, or frost protection layer, and anchored in a trench or with sand bags at the limits of the rain cover area. The rain cover will consist of a 12-mil polyethylene scrim reinforced polyethylene geomembrane. The 12-mil scrim reinforced polyethylene geomembrane material will be stitched together. A ballast system consisting of sandbags and rope installed on a grid over the scrim material will be used to protect the barrier layer from wind damage. The sand bag and rope ballast system will be installed on a grid over the scrim material. Sandbags will be installed on a 10-foot by 5-foot grid with ropes tied to the bags along the north-south lines. Sandbags used in the ballast system will be filled with a sand material and will not contain bottom ash.

When used, the rain cover will be terminated at a berm. The perimeter berms or temporary berms constructed within the limits of each module will be used to provide storm water containment. A berm will be constructed along the tie in or existing delineation berm between adjacent modules (i.e., existing and newly constructed). This berm will be constructed by grading the waste or general fill material in the existing module. The berm between adjacent modules is required to keep clean storm water on the rain cover and leachate off the rain cover. If interior berms are constructed for containment, the height will be determined based on storm water calculations to be performed prior to construction of each module. The berm between adjacent modules will be at least 4 feet high, but will be no higher than the exterior perimeter berms. Outlets from the rain cover area will also be sized based on storm water calculations performed for each module where a rain cover is installed.

Non-contact storm water that accumulates on top of a rain cover will gravity drain or be pumped into the perimeter drainage swales. The perimeter drainage swales drain to the sedimentation basin located to the south of the landfill. Water collected on the rain cover will be visually inspected for evidence of leachate or contact water and other impacts before it is pumped into the perimeter drainage system. Evidence of leachate or contact water impacts may include a discoloration of the water, an accumulation of coal combustion residuals (CCR) at the collection point or signs of erosion along the limits of the rain cover where it abuts the active disposal area. The rain cover limits, including the berm and anchoring, will be inspected after all significant precipitation events (>0.5 inches) to ensure that leachate or contact water has not run onto the rain cover. In the event that leachate or contact water runs onto the rain cover, all water collected on the rain cover will be managed as leachate and hauled to the ash pond for disposal or used for dust control within the landfill limits of waste.

No CCR material will be placed on top of the rain cover. The rain cover will be removed in sections as filling operations proceed in each module. The rain cover will be cut at the limits of the operating area for CCR disposal and a new berm will be constructed at the rain cover limits to maintain flow to a new collection point. When removed, rain cover materials may be stored for reuse in future installations. The removed material may also be used for future repairs depending on the condition of material. Rain cover materials in poor condition after removal will be disposed offsite.

An updated Construction Quality Assurance (CQA) Plan that incorporates the rain cover will be included with the geosynthetics preconstruction report for future module construction. For future modules, the preconstruction report will also contain the storm water calculations performed to determine if a rain cover is needed. If a rain cover is required, the preconstruction report will contain the rain cover product identification, material properties, and installation recommendations from the manufacturer.

The installed limits of the rain cover will 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.

BEFORE THE
STATE OF WISCONSIN

DEPARTMENT OF NATURAL RESOURCES
PLAN OF OPERATION APPROVAL MODIFICATION
FOR THE WISCONSIN POWER AND LIGHT (WPL)
COLUMBIA DRY ASH DISPOSAL LANDFILL (#03025)

FINDINGS OF FACT

The Department finds:

1. Wisconsin Power and Light (WPL) owns and operates a non-hazardous solid waste disposal facility located in Section 27, T12N, R9W, Town of Pacific, Columbia County, Wisconsin.

2. The Department conditionally approved a plan of operation for the facility on June 30, 1983. The plan of operation was updated on November 2, 2000 and January 28, 2011.

3. On April 19, 2018, Alliant Energy, on behalf of WPL, submitted a plan modification request to the Department for a rain cover system. The correct plan review fee of $1,650 was received by the Department on June 5, 2018.

4. The information submitted in connection with the modification request includes a report prepared by SCS Engineers, entitled "Plan Modification Rain Cover, Dry Ash Disposal Facility, Columbia Energy Center, Town of Pacific, Wisconsin" dated April 17, 2018 and was received by the Department on April 19, 2018.

5. Additional documents considered in connection with the modification request include documents supporting the following approvals:

   a. The Department's June 30, 1983 plan of operation approval.

   b. The Department's November 2, 2000 plan of operation update approval.

   c. The Department's January 28, 2011 plan of operation update approval.

   d. Alliant's February 24, 2016 leachate/surface water pond capacity evaluation.

   e. Alliant's June 10, 2016 letter containing additional information regarding the leachate/surface water pond capacity evaluation.

   f. The Department's July 1, 2016 plan of operation approval modification for a rain cover system.

   g. The Department files for the Columbia Energy Center Landfill #3025.

6. If the special conditions set forth below are complied with, the proposal will meet the requirements of chs. NR 500-538, Wis. Adm. Code.

CONCLUSIONS OF LAW

1. The Department has authority under s. 289.30(6), Stats., to modify a plan of operation approval if the modification would not inhibit compliance with the applicable portions of chs. NR 500-538, Wis. Adm. Code.

2. The Department has authority to approve a plan of operation approval modification with special conditions if the conditions are needed to ensure compliance with chs. NR 500-538, Wis. Adm. Code.

3. The conditions of this approval are needed to ensure compliance with chs. NR 500-538, Wis. Adm. Code.

4. In accordance with the foregoing, the Department has the authority under s. 289.30, Stats., to issue the following conditional plan of operation approval modification.

PLAN OF OPERATION MODIFICATION APPROVAL

The Department hereby approves the proposed modification to the plan of operation for the Wisconsin Power and Light Columbia Dry Ash Landfill to allow the use of a rain cover system, subject to chs. NR 500- 538, Wis. Adm. Code and the following:

1. For future modules, the preconstruction report shall contain the storm water calculations performed to determine if a rain cover is needed or not.

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.

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.

The Department retains the right to require the submittal of additional information or to modify this approval at any time if, in the Department's opinion, further modifications are necessary. Unless specifically stated, the conditions of this approval modification do not supersede or replace any previous conditions of approval for this facility.

NOTICE OF APPEAL RIGHTS

If you believe you have a right to challenge this decision made by the Department, you should know that Wisconsin statutes and administrative codes establish time periods and requirements for reviewing Department decisions.

To seek judicial review of the Department's decision, sections 227.52 and 227.53, Stats., establish criteria for filing a petition for judicial review. You have 30 days after the decision is mailed or otherwise served by the Department to file your petition with the appropriate circuit court and serve the petition on the Department. The petition shall name the Department of Natural Resources as the respondent.

Dated: June 6, 2018

DEPARTMENT OF NATURAL RESOURCES
For the Secretary

Cynthia Moore

Cynthia Moore
Waste and Materials Management Program
South Central Region

Ann Bekta

Ann M. Bekta, P.E.
Waste Management Engineer
South Central Region

Attachment B

Leachate/Surface Water Pond Capacity Evaluation

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 amount of intermediate/final cover area required with Module 5 and 6 constructed 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 intermediate/final cover 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, 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 that produced a chart of maximum leachate/surface water pond starting elevations vs. rainfall storage capacity.
- Portions of Modules 1, 2, and 3 currently have final or intermediate cover in place (see **Figure 1**).

Approach:

- Use the previously developed HydroCAD storm water model from Module 4 construction to model the below three scenarios.
  1. Scenario 1 –Assume a rain cover is in place over 50% of Module 5 and 100% of Module 6, resulting in the remaining 50% of Module 5 contributing to the leachate/surface water pond.
  2. Scenario 2 – Assume all of Module 5 is contributing to the leachate/surface water pond, while Module 6 is still under the rain cover.
  3. Scenario 3 – Assume a rain cover is in place over 50% of Module 6, resulting in 50% of Module 6 contributing to the leachate/surface water pond.
  4. Scenario 4 – Assume all of Module 6 is contributing to the leachate/surface water pond

Assumptions:

- Ash 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. Scenario 1 - with 50% of Module 5 contributing to the leachate/storm water pond:
   - The maximum allowable contributing area of landfill to the leachate/surface water pond is 4.47 acres for the leachate/surface water pond to accommodate the runoff from a 25-year, 24-hour storm without overtopping.
   - The remainder of landfill (1.98 acres) would need to be closed/covered with final or intermediate cover and routed away from the pond.
   - **Figure 1** shows a conceptual 1.98 acres of additional cover, 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.

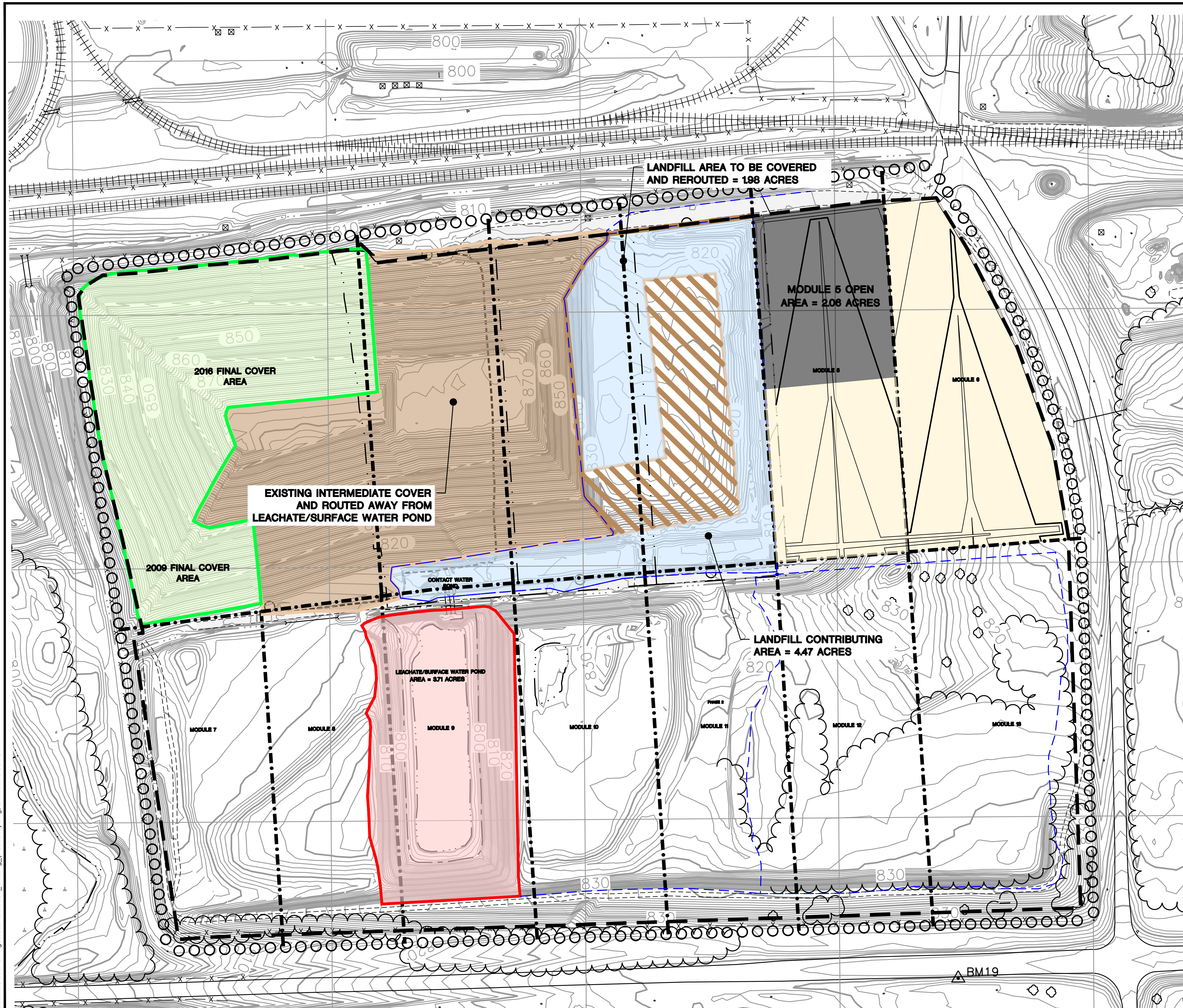
2. Scenario 2 - with 100% of Module 5 contributing to the leachate/storm water pond:
   - The maximum allowable contributing area of landfill to the leachate/surface water pond is 2.42 acres for the leachate/surface water pond to accommodate the runoff from a 25-year, 24-hour storm without overtopping.
   - The remainder of landfill (4.03 acres) would need to be closed/covered with final or intermediate cover and routed away from the pond.
   - **Figure 2** shows a conceptual 4.03 acres of additional cover, 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.

3. Scenario 3 - with 50% of Module 6 contributing to the leachate/storm water pond:
   - The maximum allowable contributing area of landfill to the leachate/surface water pond is 4.64 acres for the leachate/surface water pond to accommodate the runoff from a 25-year, 24-hour storm without overtopping.
   - The remainder of landfill (6.07 acres) would need to be closed/covered with final or intermediate cover and routed away from the pond.
   - **Figure 3** shows a conceptual 6.07 acres of additional cover, and **Figure 3a** shows the various operating levels of the leachate/surface water pond to accommodate the various storm events with the additional cover in place.

4. Scenario 4 - with 100% of Module 6 contributing to the leachate/storm water pond:
   - The maximum allowable contributing area of landfill to the leachate/surface water pond is 2.74 acres for the leachate/surface water pond to accommodate the runoff from a 25-year, 24-hour storm without overtopping.
   - The remainder of landfill (7.97 acres) would need to be closed/covered with final or intermediate cover and routed away from the pond.

- **Figure 4** shows a conceptual 7.97 acres of additional cover, and **Figure 4a** 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 each scenario and storm event modeled are attached.



LEGEND

- DRY ASH DISPOSAL FACILITY LIMITS
- APPROVED LIMITS OF WASTE
- PROPOSED MODULE LIMIT
- EXISTING GRADE (2' CONTOUR)
- 690 EXISTING GRADE (10' CONTOUR)
- EDGE OF WATER (APPROXIMATE)
- EXISTING FINAL COVER AREA
- EXISTING INTERMEDIATE COVER AND ROUTED AWAY FROM POND
- LEACHATE/SURFACE WATER POND CONTRIBUTING AREA
- LANDFILL CONTRIBUTING AREA
- MODULE 5 CONTRIBUTING AREA
- AREA TO BE COVERED/REROUTED
- MODULE 5 AND 6 COVERED WITH RAIN COVER

N

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SCALE: 1" = 200'

LEACHATE/SURFACE WATER POND EVALUATION SCENARIO 1

FIGURE 1

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

ENGINEER

COLUMBIA ENERGY CENTER
W8375 MURRAY ROAD
PARDEEVILLE, WISCONSIN 53954

SITE

DRAWN BY: RJG
CHECKED BY: PG
APPROVED BY:

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

CLIENT LOGO IF AVAILABLE

CLIENT

PROJECT NO. 25220183.00
DRAWN: 02/11/21
REVISED: 03/01/21

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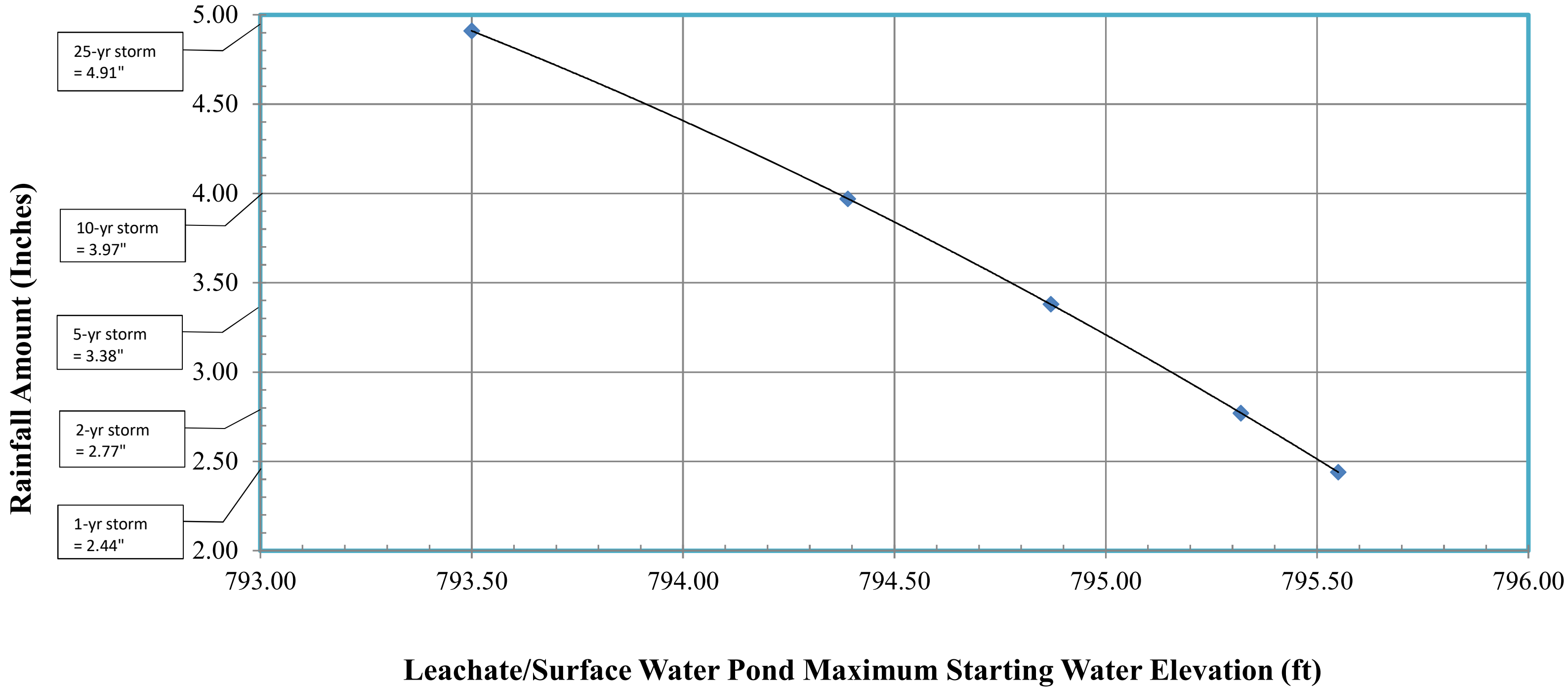
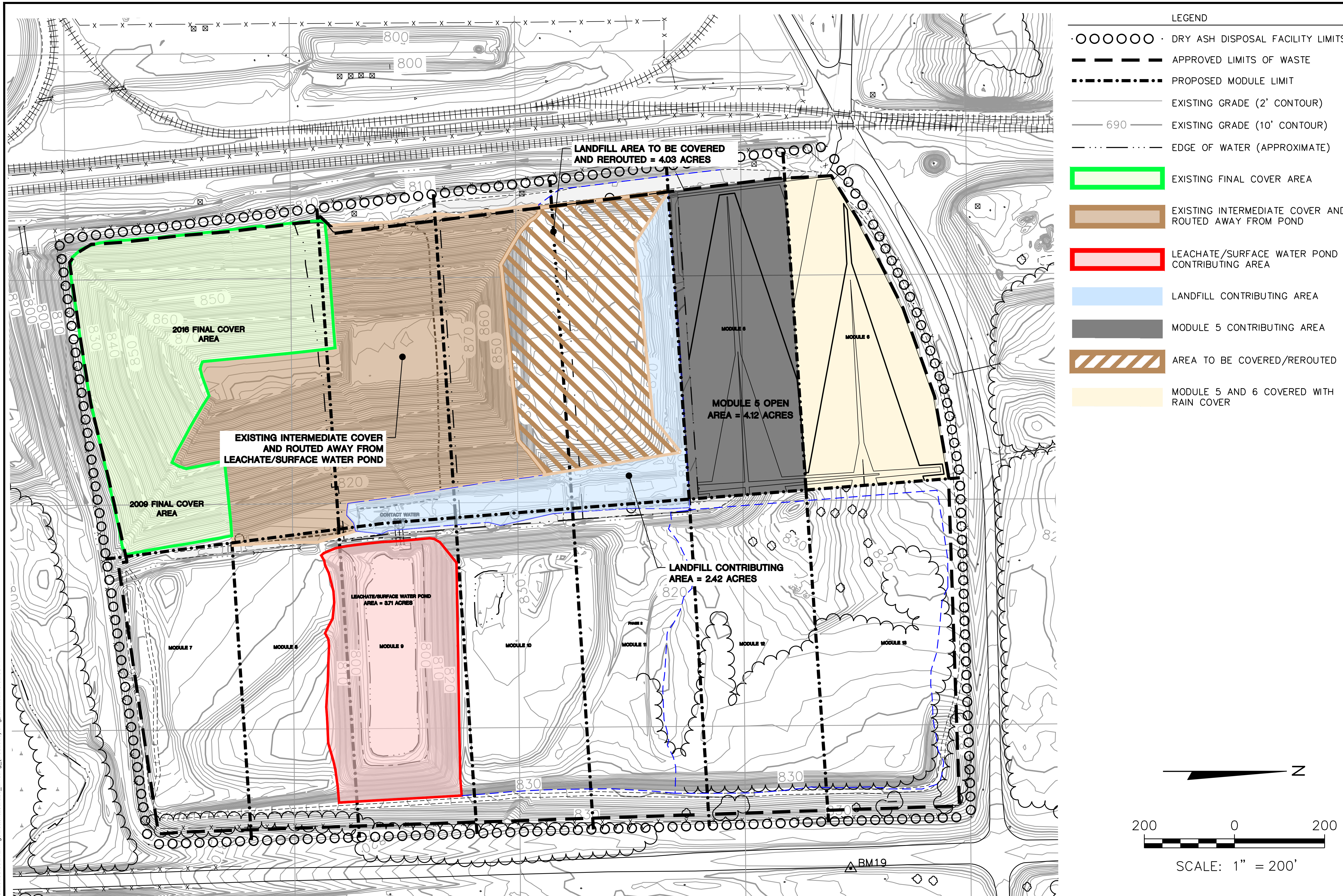
Figure 1A
Columbia Energy Center
Scenario 1 - Module 5 50% Open
Leachate/Surface Water Pond Maximum Starting Water Elevation



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 (refer to Leachate/Surface Water Pond Evaluation figure dated 11/28/17):
   - Mod 5 open area = 50% of module = 2.06 acres.
   - Landfill open area = 4.47 acres (previously open/contributing area [6.45 acres] - required closure/rerouted area [1.98 acres]).
   - Leachate/Surface Water Pond Area, 3.71 acres.



LEACHATE/SURFACE WATER POND EVALUATION
SCENARIO 2

FIGURE 2

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

ENGINEER

COLUMBIA ENERGY CENTER
W8375 MURRAY ROAD
PARDEEVILLE, WISCONSIN 53954

SITE

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

CLIENT LOGO IF AVAILABLE

CLIENT

PROJECT NO.	25220183.00	DRAWN BY:	RJG
DRAWN:	02/11/21	CHECKED BY:	PG
REVISED:	03/01/21	APPROVED BY:	

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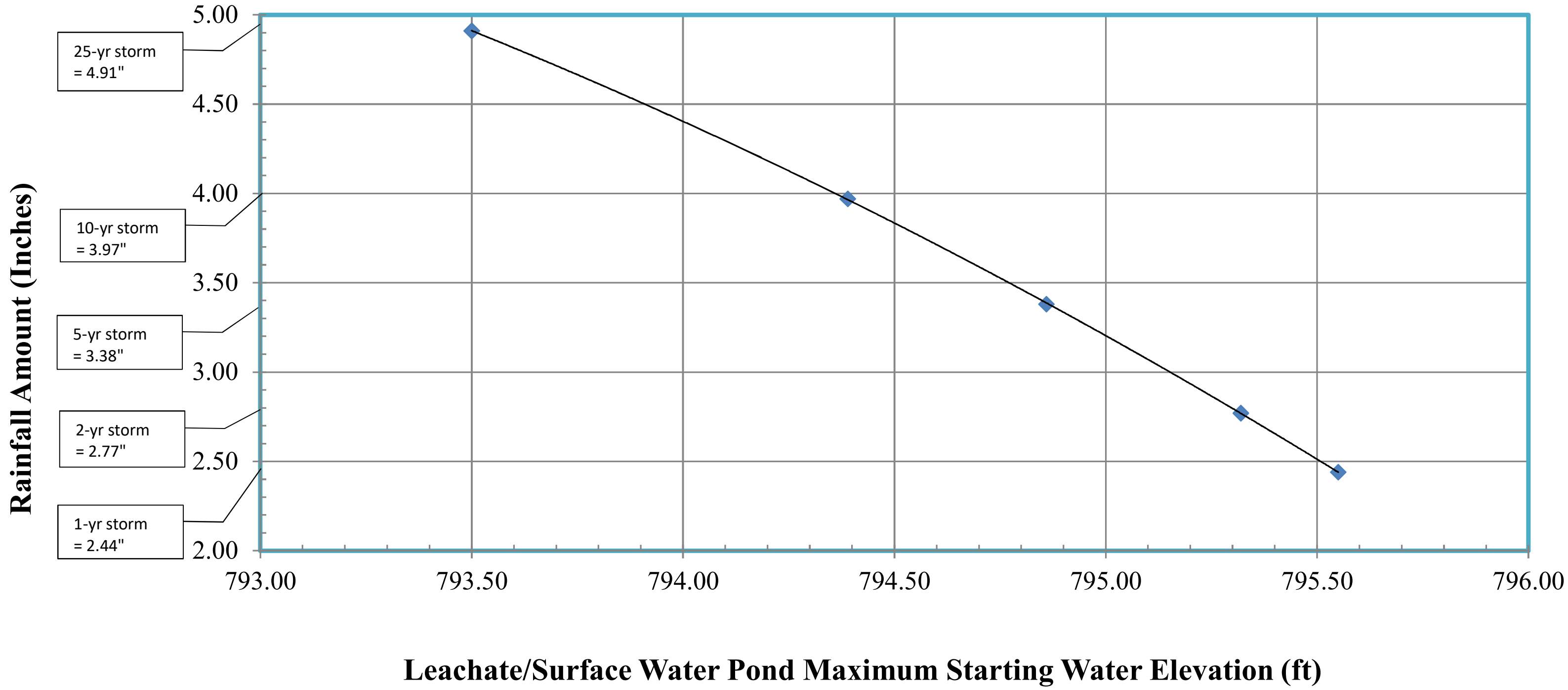
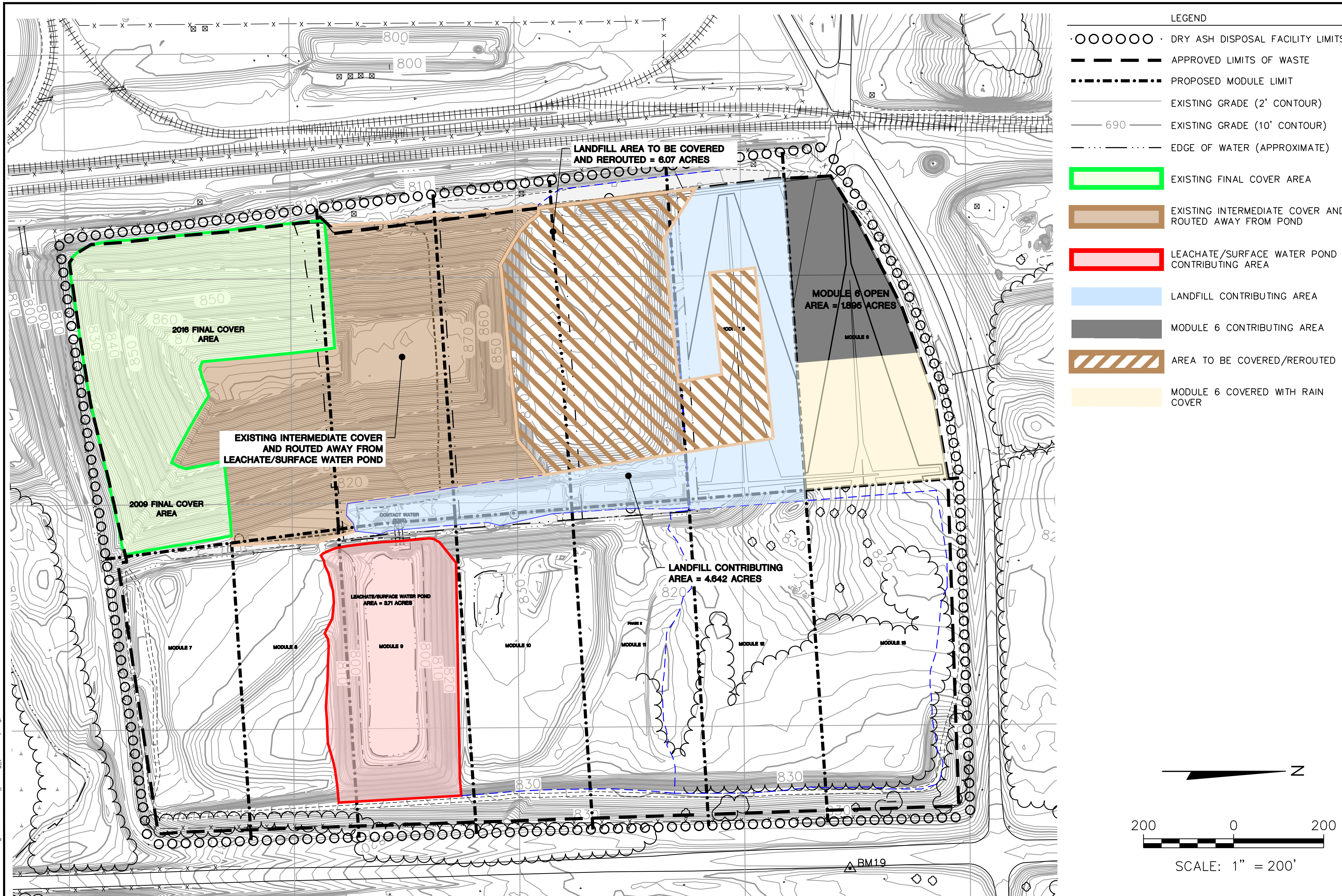
Figure 2A
Columbia Energy Center
Scenario 2 - Module 5 100% Open
Leachate/Surface Water Pond Maximum Starting Water Elevation



<u>Notes/Assumptions:</u>

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 (refer to Leachate/Surface Water Pond Evaluation figure dated 11/2/17):
   - Mod 5 open area = 100% of module = 4.12 acres.
   - Landfill open area = 2.42 acres (previously open/contributing area [6.45 acres] -require closure/rerouted area [4.03 acres]).
   - Leachate/Surface Water Pond Area, 3.71 acres.



LEACHATE/SURFACE WATER POND EVALUATION
SCENARIO 3

FIGURE 3

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

ENGINEER

COLUMBIA ENERGY CENTER
W8375 MURRAY ROAD
PARDEEVILLE, WISCONSIN 53954

SITE

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

CLIENT

CLIENT LOGO IF AVAILABLE

PROJECT NO.	25220183.00	DRAWN BY:	RJG
DRAWN:	02/11/21	CHECKED BY:	PG
REVISED:	03/01/21	APPROVED BY:	

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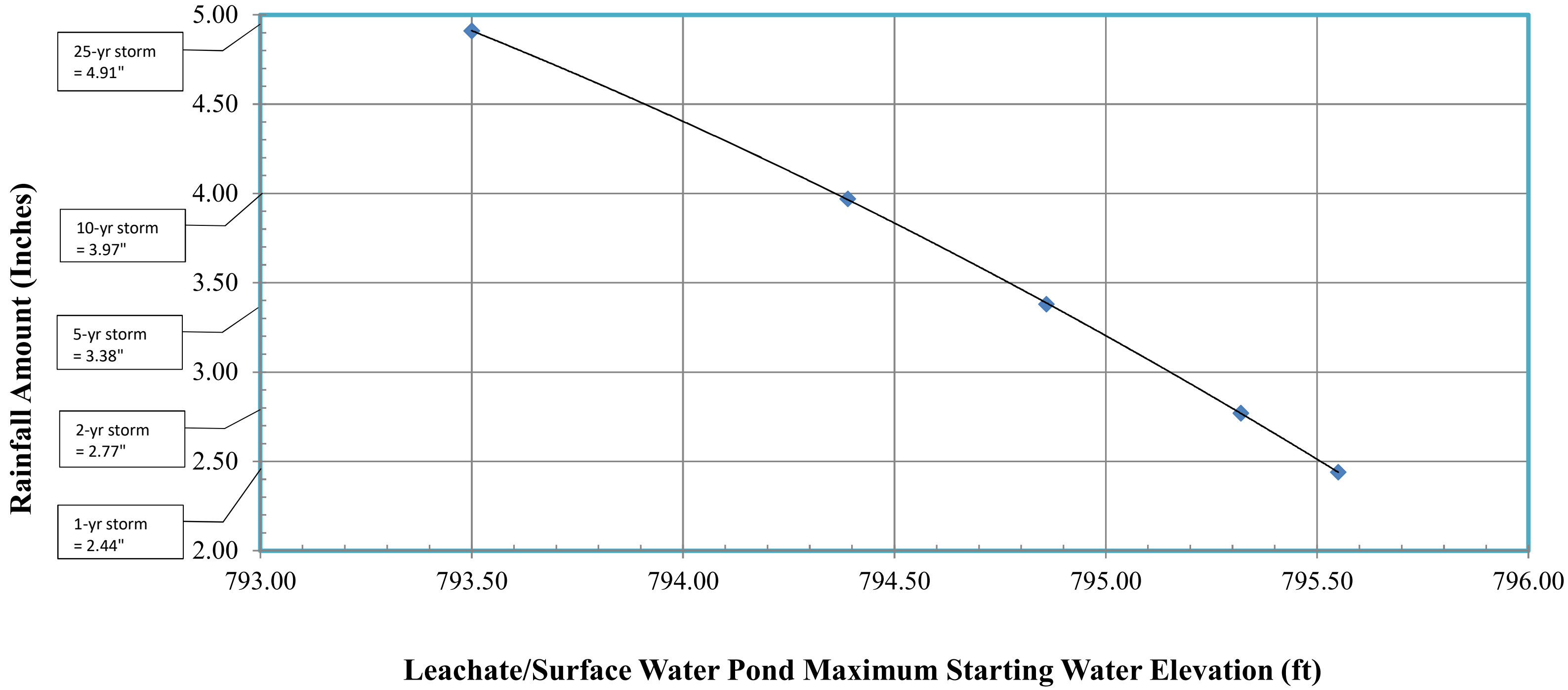
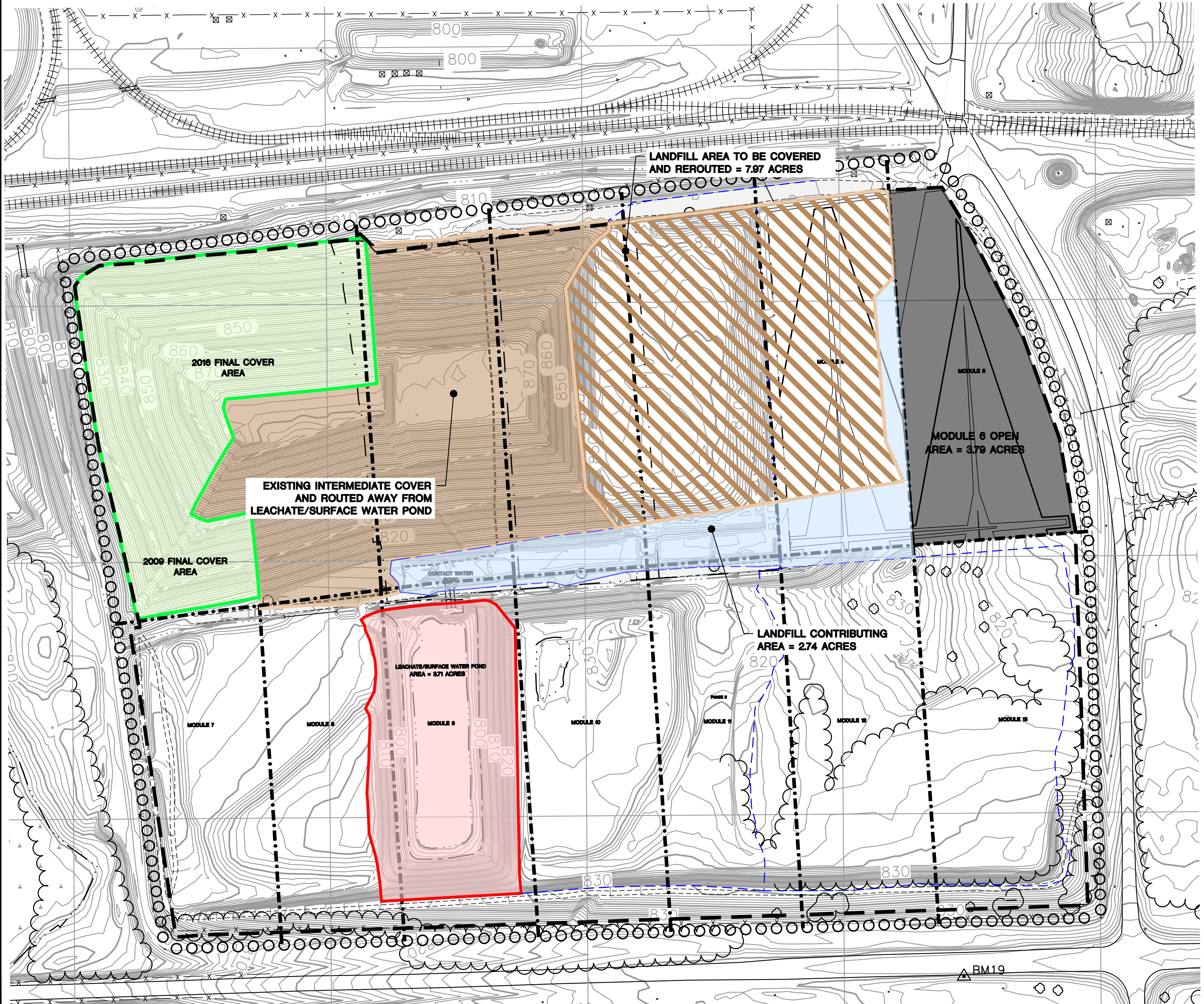
Figure 3A
Columbia Energy Center
Scenario 3 - Module 6 50% Open
Leachate/Surface Water Pond Maximum Starting Water Elevation



<u>Notes/Assumptions:</u>
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 (refer to Leachate/Surface Water Pond Evaluation figure dated 11/2/17):
   - Mod 6 open area = 50% of module = 1.895 acres.
   - Landfill open area = 4.64 acres (previously open/contributing area and Mod 5 [10.71 acres] -require closure/rerouted area [6.07 acres]).
   - Leachate/Surface Water Pond Area, 3.71 acres.



LEGEND

- DRY ASH DISPOSAL FACILITY LIMITS
- APPROVED LIMITS OF WASTE
- PROPOSED MODULE LIMIT
- EXISTING GRADE (2' CONTOUR)
- 690 EXISTING GRADE (10' CONTOUR)
- EDGE OF WATER (APPROXIMATE)
- EXISTING FINAL COVER AREA
- EXISTING INTERMEDIATE COVER AND ROUTED AWAY FROM POND
- LEACHATE/SURFACE WATER POND CONTRIBUTING AREA
- LANDFILL CONTRIBUTING AREA
- MODULE 6 CONTRIBUTING AREA
- AREA TO BE COVERED/REROUTED

N

200 0 200

SCALE: 1" = 200'

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LEACHATE/SURFACE WATER POND EVALUATION SCENARIO 4

COLUMBIA ENERGY CENTER
W8375 MURRAY ROAD
PARDEEVILLE, WISCONSIN 53954

SITE

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

CLIENT LOGO IF AVAILABLE

CLIENT

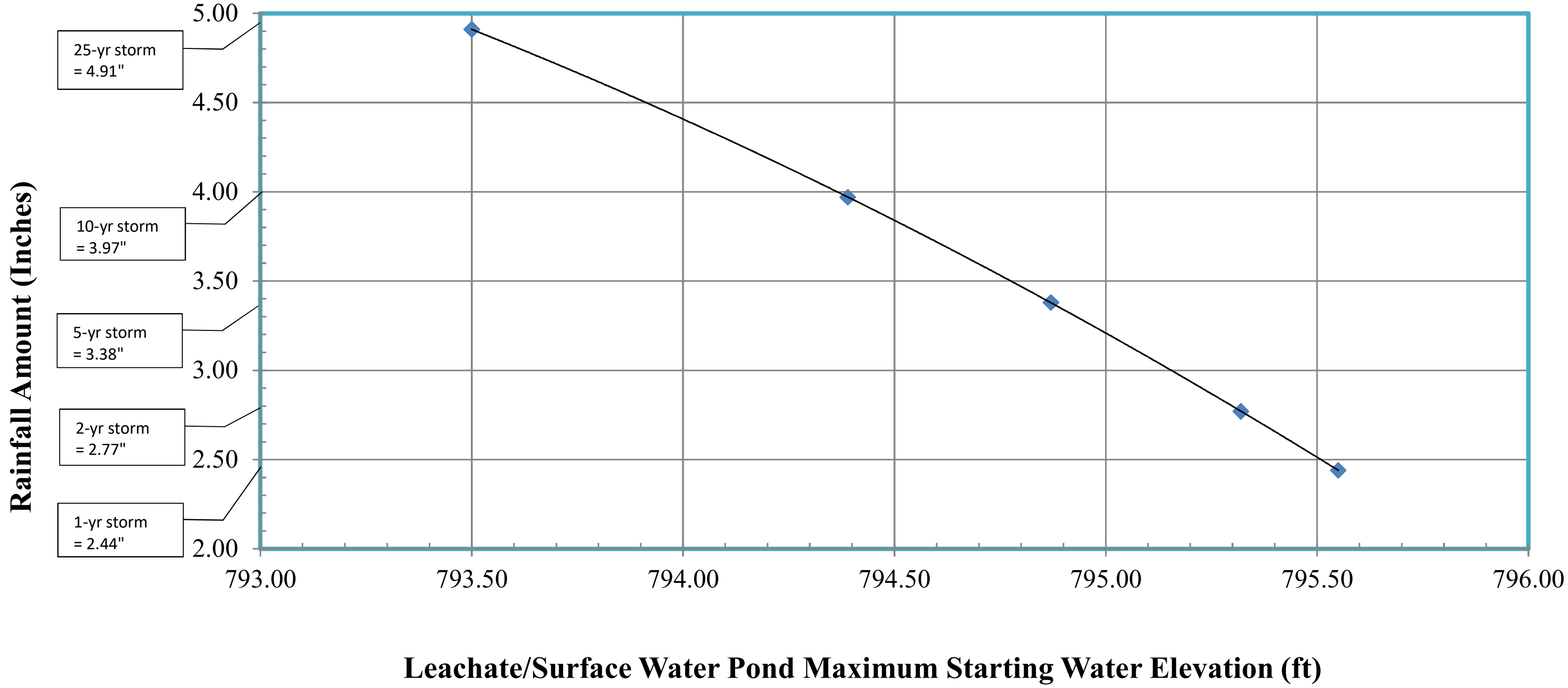
SCS ENGINEERS
2830 DAIRY DRIVE MADISON, WI 53718-6751
PHONE: (608) 224-2830

ENGINEER

PROJECT NO.	25220183.00	DRAWN BY:	RJG
DRAWN:	02/17/21	CHECKED BY:	PG
REVISED:	03/01/21	APPROVED BY:	

FIGURE 4

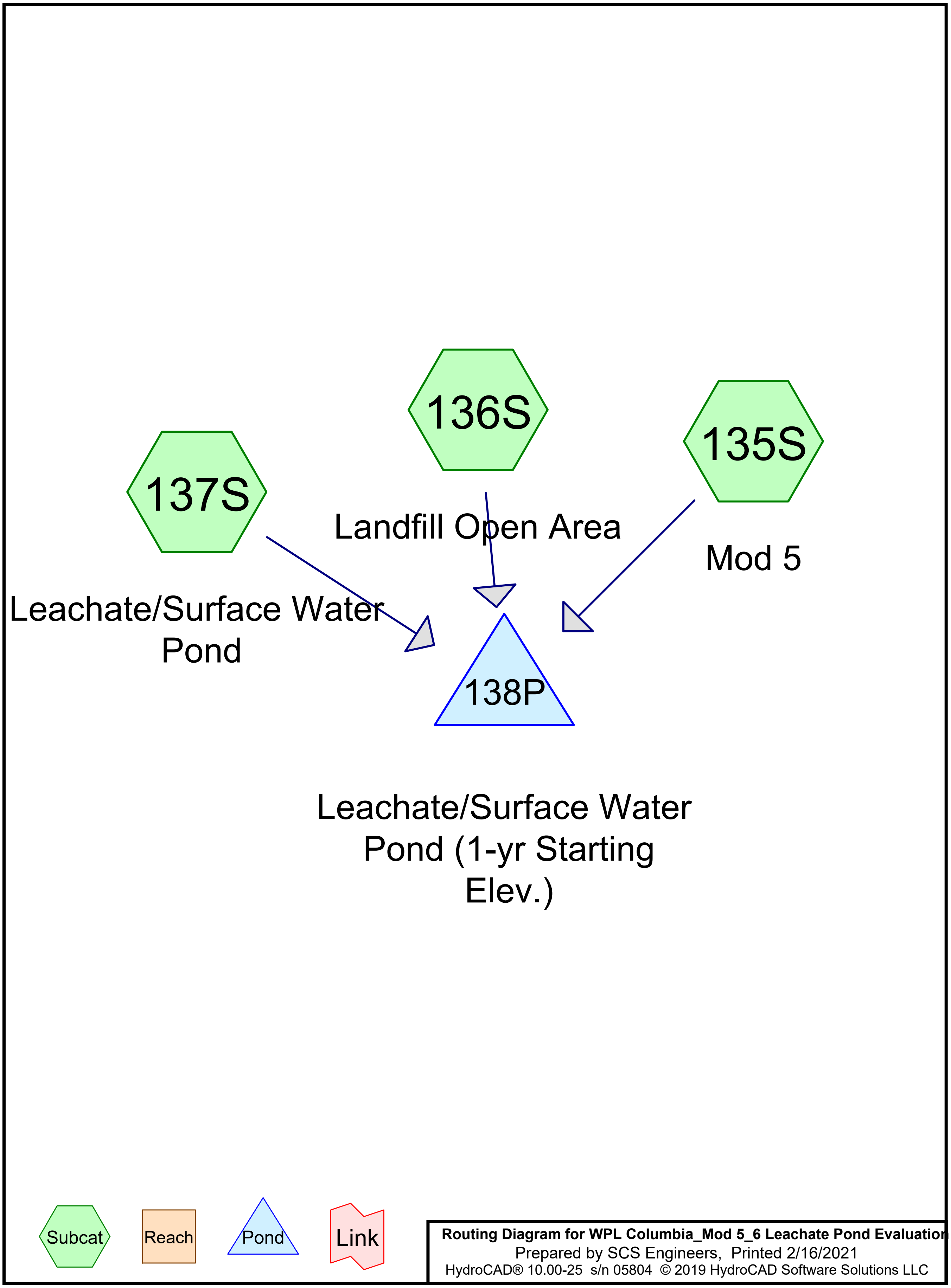
Figure 4A
Columbia Energy Center
Scenario 3 - Module 6 50% Open
Leachate/Surface Water Pond Maximum Starting Water Elevation



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 (refer to Leachate/Surface Water Pond Evaluation figure dated 11/2/17):
   - Mod 6 open area = 100% of module = 3.79 acres.
   - Landfill open area = 2.74 acres (previously open/contributing area and Mod 5 [10.71 acres] -require closure/rerouted area [7.97 acres]).
   - Leachate/Surface Water Pond Area, 3.71 acres.

Scenario 1


136S
135S
137S
Landfill Open Area
Mod 5
Leachate/Surface Water Pond
138P
Leachate/Surface Water Pond (1-yr Starting Elev.)
Subcat
Reach
Pond
Link
Routing Diagram for WPL Columbia_Mod 5_6 Leachate Pond Evaluation
Prepared by SCS Engineers, Printed 2/16/2021
HydroCAD® 10.00-25 s/n 05804 © 2019 HydroCAD Software Solutions LLC

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

Subcatchment 135S: Mod 5 Runoff Area=2.060 ac 100.00% Impervious Runoff Depth=2.21"
Tc=20.0 min CN=98 Runoff=4.11 cfs 0.380 af

Subcatchment 136S: Landfill Open Area Runoff Area=4.470 ac 100.00% Impervious Runoff Depth=2.21"
Tc=20.0 min CN=98 Runoff=8.91 cfs 0.824 af

Subcatchment 137S: Leachate/Surface Runoff Area=3.710 ac 100.00% Impervious Runoff Depth=2.21"
Tc=0.0 min CN=98 Runoff=12.92 cfs 0.684 af

Pond 138P: Leachate/Surface Water Peak Elev=796.97' Storage=197,576 cf Inflow=18.52 cfs 1.887 af
Outflow=0.00 cfs 0.000 af

Total Runoff Area = 10.240 ac Runoff Volume = 1.887 af Average Runoff Depth = 2.21"
0.00% Pervious = 0.000 ac 100.00% Impervious = 10.240 ac

Summary for Subcatchment 135S: Mod 5

Runoff = 4.11 cfs @ 12.29 hrs, Volume= 0.380 af, Depth= 2.21"

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
*	2.060	98	Ash
	2.060		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 136S: Landfill Open Area

Runoff = 8.91 cfs @ 12.29 hrs, Volume= 0.824 af, Depth= 2.21"

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
*	4.470	98	Mod 4 Allowable Open Area
	4.470		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 137S: Leachate/Surface Water Pond

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 12.92 cfs @ 12.04 hrs, Volume= 0.684 af, Depth= 2.21"

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
*	3.710	98	Leachate Surface Water Pond
	3.710		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry,**

Summary for Pond 138P: Leachate/Surface Water Pond (1-yr Starting Elev.)

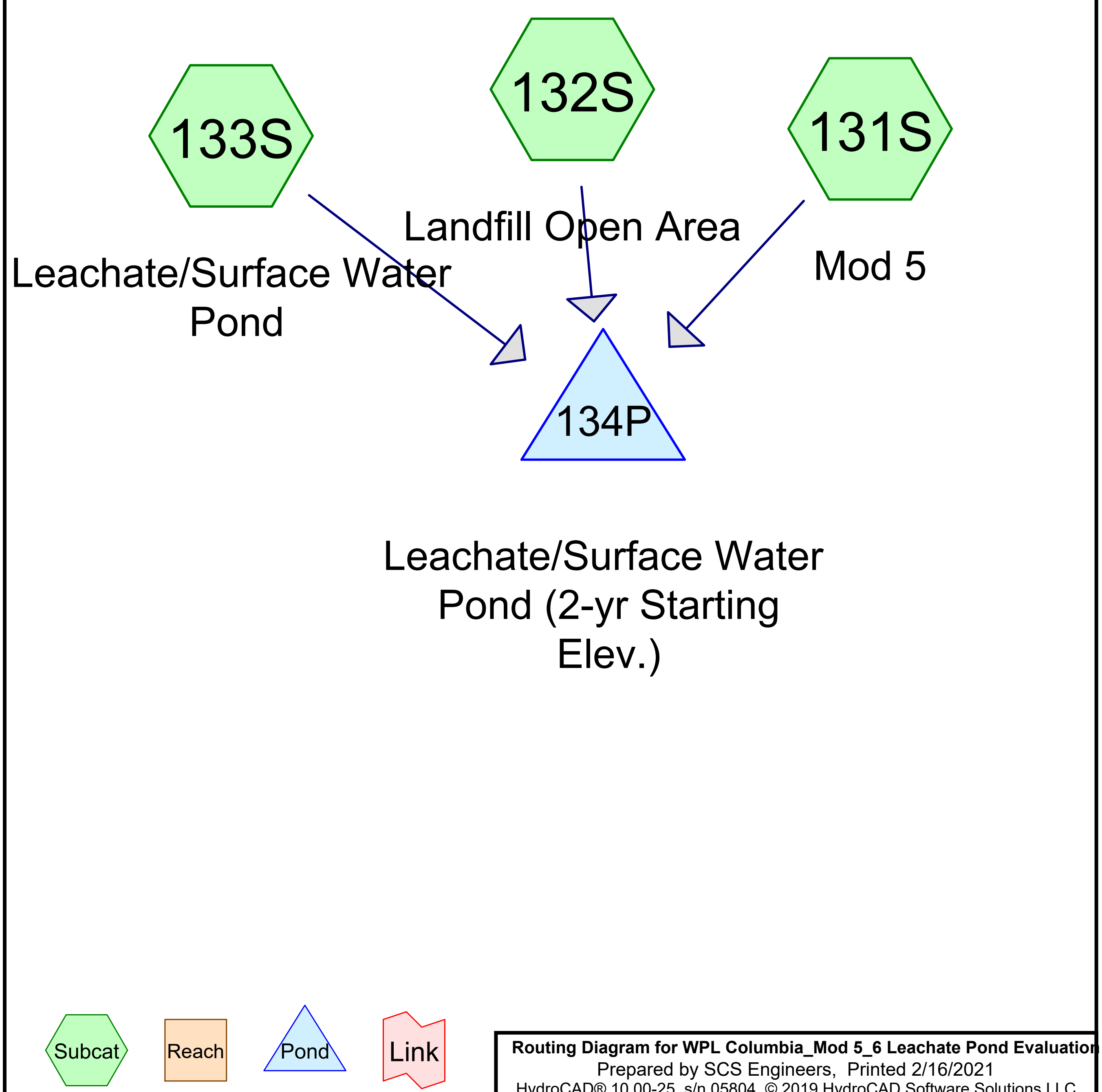
Inflow Area = 10.240 ac,100.00% Impervious, Inflow Depth = 2.21" for 1-yr, 24-hr storm event
Inflow = 18.52 cfs @ 12.05 hrs, Volume= 1.887 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
Starting Elev= 795.55' Surf.Area= 53,339 sf Storage= 115,388 cf
Peak Elev= 796.97' @ 25.15 hrs Surf.Area= 61,582 sf Storage= 197,576 cf (82,188 cf above start)
Flood Elev= 796.97' Surf.Area= 61,588 sf Storage= 197,647 cf (82,260 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'	263,654 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



Routing Diagram for WPL Columbia_Mod 5_6 Leachate Pond Evaluation
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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

Subcatchment 131S: Mod 5 Runoff Area=2.060 ac 100.00% Impervious Runoff Depth=2.54"
Tc=20.0 min CN=98 Runoff=4.69 cfs 0.436 af

Subcatchment 132S: Landfill Open Area Runoff Area=4.470 ac 100.00% Impervious Runoff Depth=2.54"
Tc=20.0 min CN=98 Runoff=10.17 cfs 0.946 af

Subcatchment 133S: Leachate/Surface Runoff Area=3.710 ac 100.00% Impervious Runoff Depth=2.54"
Tc=0.0 min CN=98 Runoff=14.73 cfs 0.785 af

Pond 134P: Leachate/Surface Water Peak Elev=796.97' Storage=197,716 cf Inflow=21.13 cfs 2.167 af
Outflow=0.00 cfs 0.000 af

Total Runoff Area = 10.240 ac Runoff Volume = 2.167 af Average Runoff Depth = 2.54"
0.00% Pervious = 0.000 ac 100.00% Impervious = 10.240 ac

Summary for Subcatchment 131S: Mod 5

Runoff = 4.69 cfs @ 12.29 hrs, Volume= 0.436 af, Depth= 2.54"

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
*	2.060	98	Ash
	2.060		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 132S: Landfill Open Area

Runoff = 10.17 cfs @ 12.29 hrs, Volume= 0.946 af, Depth= 2.54"

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
*	4.470	98	Mod 4 Allowable Open Area
	4.470		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 133S: Leachate/Surface Water Pond

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 14.73 cfs @ 12.04 hrs, Volume= 0.785 af, Depth= 2.54"

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
*	3.710	98	Leachate Surface Water Pond
	3.710		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry,**

Summary for Pond 134P: Leachate/Surface Water Pond (2-yr Starting Elev.)

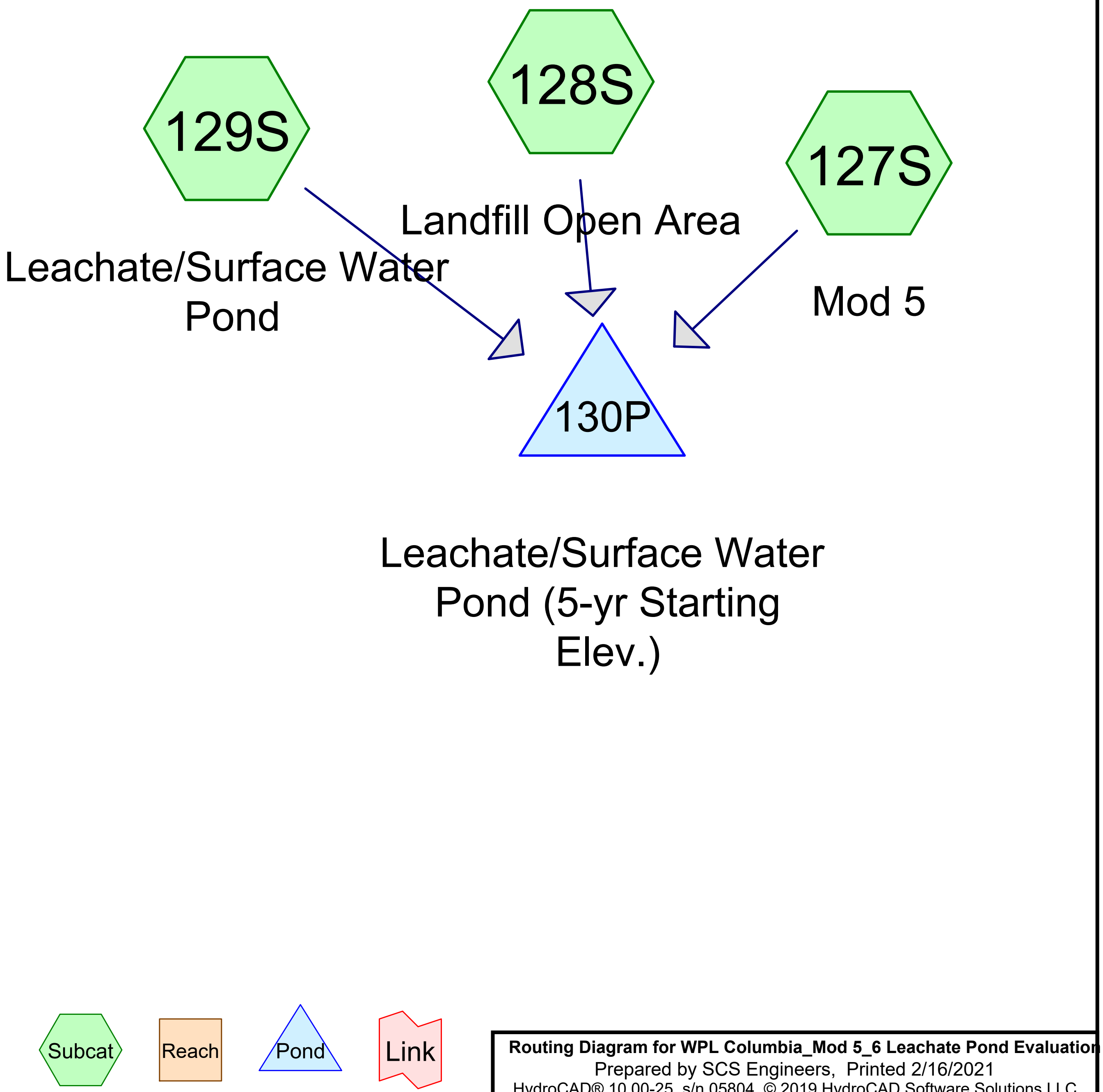
Inflow Area = 10.240 ac,100.00% Impervious, Inflow Depth = 2.54" for 2-yr, 24-hr storm event
Inflow = 21.13 cfs @ 12.05 hrs, Volume= 2.167 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
Starting Elev= 795.32' Surf.Area= 51,527 sf Storage= 103,328 cf
Peak Elev= 796.97' @ 25.15 hrs Surf.Area= 61,593 sf Storage= 197,716 cf (94,388 cf above start)
Flood Elev= 796.97' Surf.Area= 61,588 sf Storage= 197,647 cf (94,319 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'	263,654 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



Routing Diagram for WPL Columbia_Mod 5_6 Leachate Pond Evaluation
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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

Subcatchment 127S: Mod 5 Runoff Area=2.060 ac 100.00% Impervious Runoff Depth=3.15"
Tc=20.0 min CN=98 Runoff=5.75 cfs 0.540 af

Subcatchment 128S: Landfill Open Area Runoff Area=4.470 ac 100.00% Impervious Runoff Depth=3.15"
Tc=20.0 min CN=98 Runoff=12.48 cfs 1.172 af

Subcatchment 129S: Leachate/Surface Runoff Area=3.710 ac 100.00% Impervious Runoff Depth=3.15"
Tc=0.0 min CN=98 Runoff=18.06 cfs 0.973 af

Pond 130P: Leachate/Surface Water Peak Elev=796.97' Storage=197,910 cf Inflow=25.94 cfs 2.685 af
Outflow=0.00 cfs 0.000 af

Total Runoff Area = 10.240 ac Runoff Volume = 2.685 af Average Runoff Depth = 3.15"
0.00% Pervious = 0.000 ac 100.00% Impervious = 10.240 ac

Summary for Subcatchment 127S: Mod 5

Runoff = 5.75 cfs @ 12.29 hrs, Volume= 0.540 af, Depth= 3.15"

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
*	2.060	98	Ash
	2.060		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 128S: Landfill Open Area

Runoff = 12.48 cfs @ 12.29 hrs, Volume= 1.172 af, Depth= 3.15"

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
*	4.470	98	Mod 4 Allowable Open Area
	4.470		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 129S: Leachate/Surface Water Pond

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 18.06 cfs @ 12.04 hrs, Volume= 0.973 af, Depth= 3.15"

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
*	3.710	98	Leachate Surface Water Pond
	3.710		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry,**

Summary for Pond 130P: Leachate/Surface Water Pond (5-yr Starting Elev.)

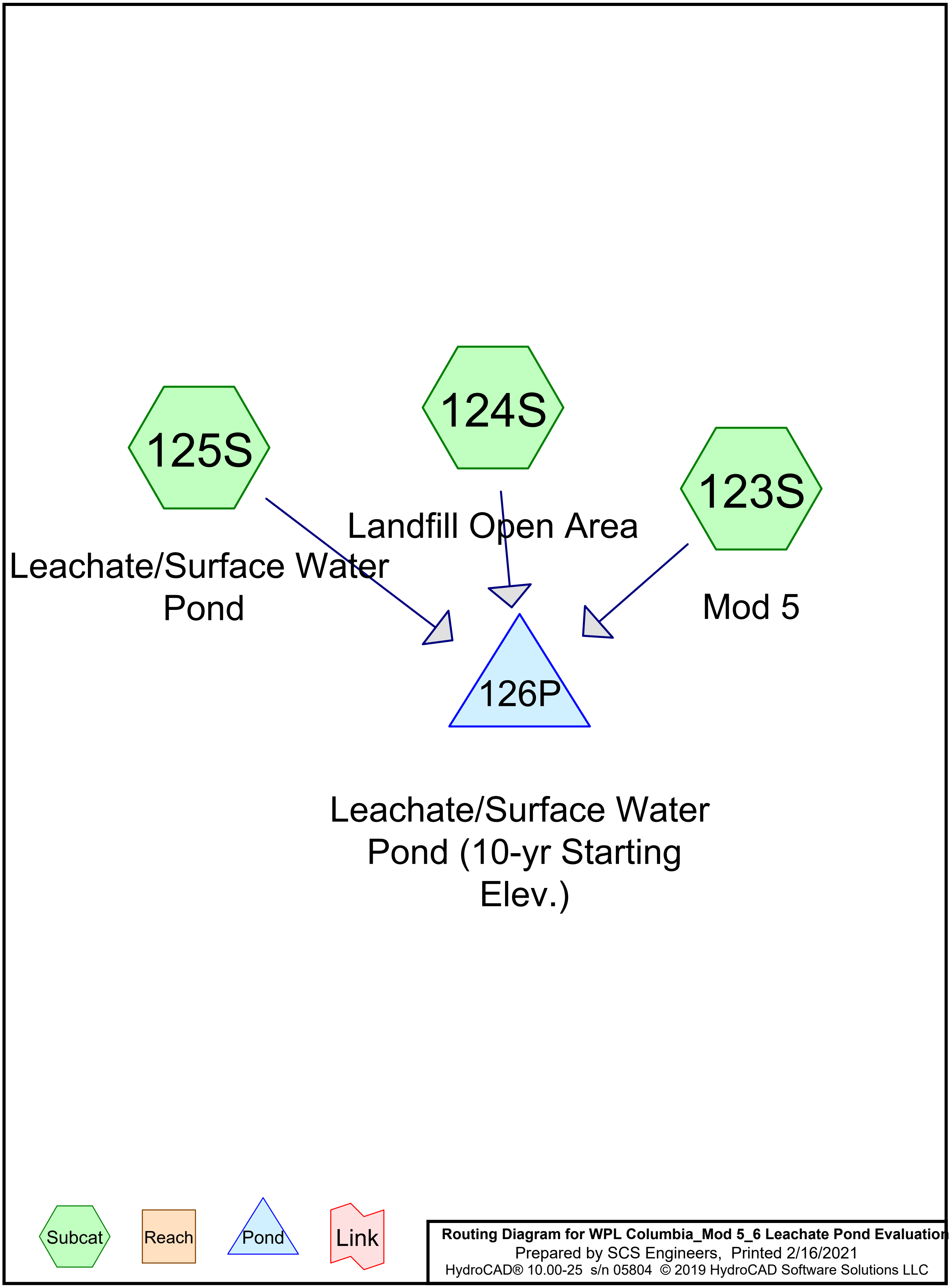
Inflow Area = 10.240 ac,100.00% Impervious, Inflow Depth = 3.15" for 5-yr, 24-hr storm event
Inflow = 25.94 cfs @ 12.05 hrs, Volume= 2.685 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
Starting Elev= 794.87' Surf.Area= 47,981 sf Storage= 80,939 cf
Peak Elev= 796.97' @ 25.15 hrs Surf.Area= 61,608 sf Storage= 197,910 cf (116,972 cf above start)
Flood Elev= 796.97' Surf.Area= 61,588 sf Storage= 197,647 cf (116,709 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'	263,654 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



Routing Diagram for WPL Columbia_Mod 5_6 Leachate Pond Evaluation
Prepared by SCS Engineers, Printed 2/16/2021
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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

Subcatchment 123S: Mod 5	Runoff Area=2.060 ac 100.00% Impervious Runoff Depth=3.74" Tc=20.0 min CN=98 Runoff=6.78 cfs 0.641 af
Subcatchment 124S: Landfill Open Area	Runoff Area=4.470 ac 100.00% Impervious Runoff Depth=3.74" Tc=20.0 min CN=98 Runoff=14.70 cfs 1.391 af
Subcatchment 125S: Leachate/Surface	Runoff Area=3.710 ac 100.00% Impervious Runoff Depth=3.74" Tc=0.0 min CN=98 Runoff=21.27 cfs 1.155 af
Pond 126P: Leachate/Surface Water	Peak Elev=796.97' Storage=197,655 cf Inflow=30.59 cfs 3.187 af Outflow=0.00 cfs 0.000 af

Total Runoff Area = 10.240 ac Runoff Volume = 3.187 af Average Runoff Depth = 3.74"
0.00% Pervious = 0.000 ac 100.00% Impervious = 10.240 ac

Summary for Subcatchment 123S: Mod 5

Runoff = 6.78 cfs @ 12.29 hrs, Volume= 0.641 af, Depth= 3.74"

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
*	2.060	98	Ash
	2.060		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 124S: Landfill Open Area

Runoff = 14.70 cfs @ 12.29 hrs, Volume= 1.391 af, Depth= 3.74"

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
*	4.470	98	Mod 4 Allowable Open Area
	4.470		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 125S: Leachate/Surface Water Pond

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 21.27 cfs @ 12.04 hrs, Volume= 1.155 af, Depth= 3.74"

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
*	3.710	98	Leachate Surface Water Pond
	3.710		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry,**

Summary for Pond 126P: Leachate/Surface Water Pond (10-yr Starting Elev.)

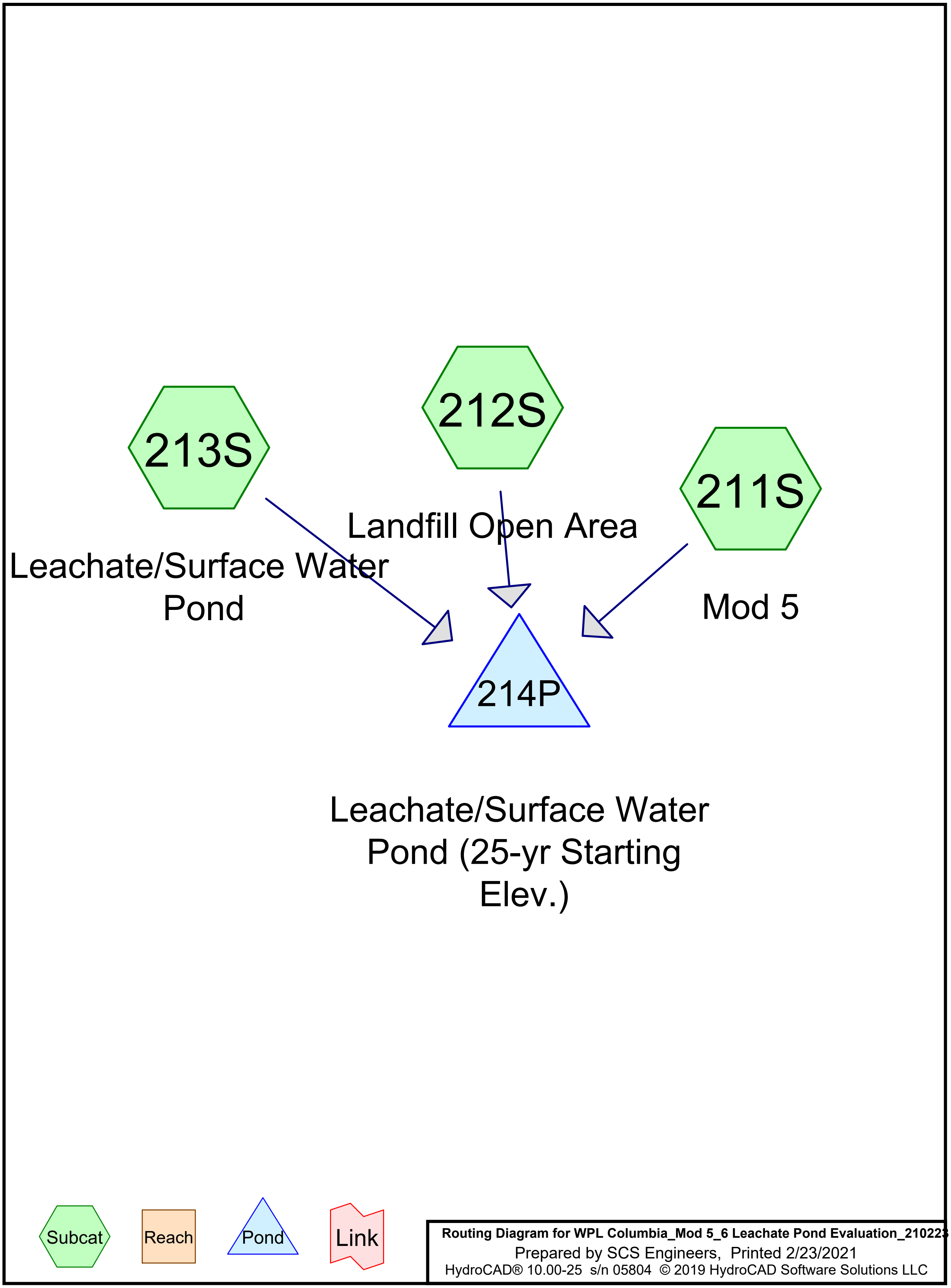
Inflow Area = 10.240 ac,100.00% Impervious, Inflow Depth = 3.74" for 10-yr, 24-hr storm event
Inflow = 30.59 cfs @ 12.05 hrs, Volume= 3.187 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
Starting Elev= 794.39' Surf.Area= 44,199 sf Storage= 58,815 cf
Peak Elev= 796.97' @ 25.15 hrs Surf.Area= 61,588 sf Storage= 197,655 cf (138,840 cf above start)
Flood Elev= 796.97' Surf.Area= 61,588 sf Storage= 197,647 cf (138,832 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'	263,654 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



Routing Diagram for WPL Columbia_Mod 5_6 Leachate Pond Evaluation_210223
Prepared by SCS Engineers, Printed 2/23/2021
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Summary for Pond 214P: Leachate/Surface Water Pond (25-yr Starting Elev.)

Inflow Area = 10.240 ac,100.00% Impervious, Inflow Depth = 4.67" for 25-yr, 24-hr storm event
Inflow = 37.96 cfs @ 12.05 hrs, Volume= 3.988 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= 793.50' Surf.Area= 31,107 sf Storage= 24,119 cf
Peak Elev= 796.97' @ 25.15 hrs Surf.Area= 61,602 sf Storage= 197,830 cf (173,712 cf above start)
Flood Elev= 796.97' Surf.Area= 61,588 sf Storage= 197,647 cf (173,529 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'	263,654 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

Summary for Subcatchment 211S: Mod 5

Runoff = 8.41 cfs @ 12.28 hrs, Volume= 0.802 af, Depth= 4.67"

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
*	2.060	98	Ash
	2.060		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 212S: Landfill Open Area

Runoff = 18.24 cfs @ 12.28 hrs, Volume= 1.741 af, Depth= 4.67"

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
*	4.470	98	Mod 4 Allowable Open Area
	4.470		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 213S: Leachate/Surface Water Pond

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

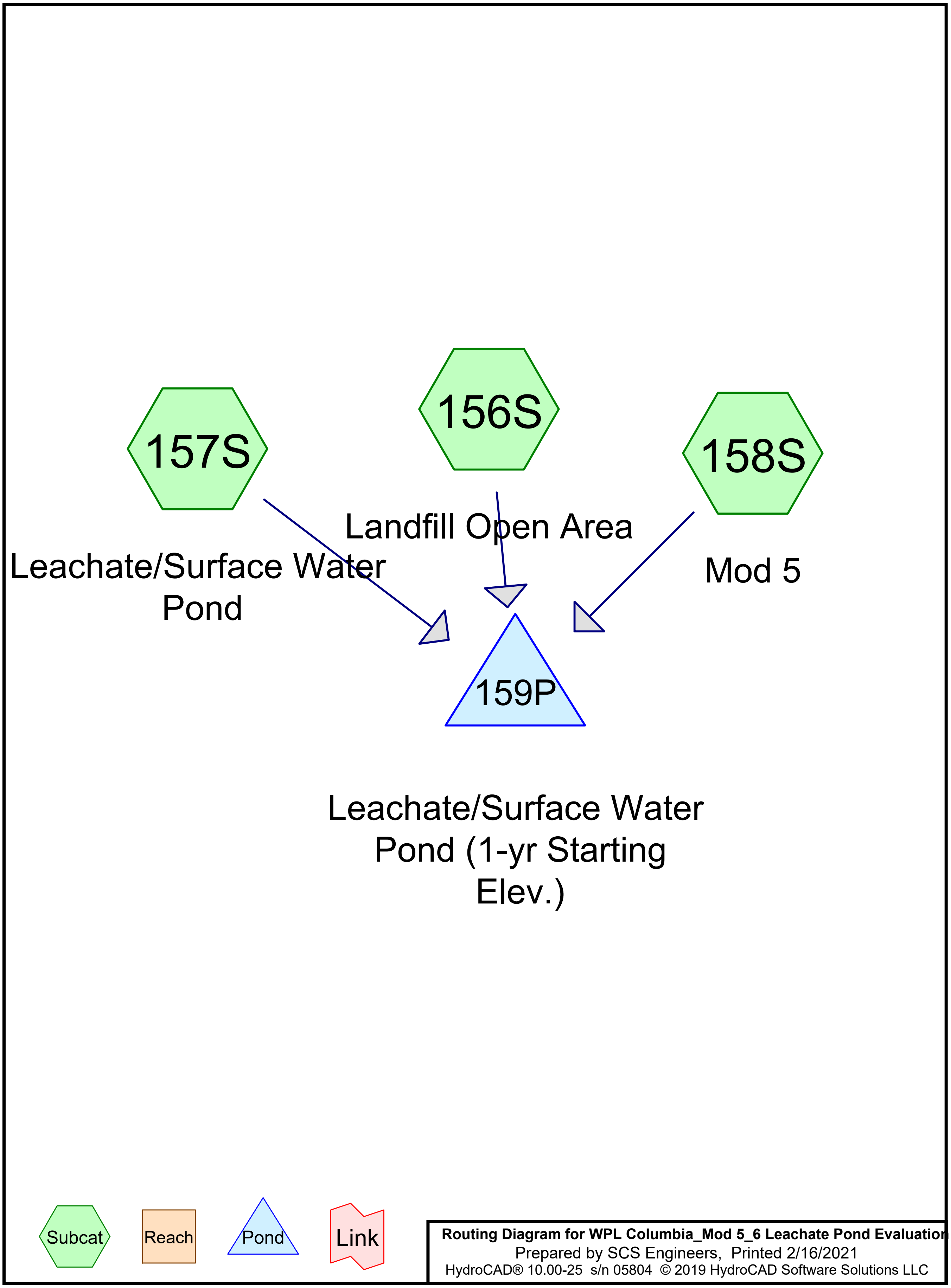
Runoff = 26.38 cfs @ 12.04 hrs, Volume= 1.445 af, Depth= 4.67"

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
*	3.710	98	Leachate Surface Water Pond
	3.710		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry,**

Scenario 2


157S
156S
158S
Landfill Open Area
Leachate/Surface Water
Pond
Mod 5
159P
Leachate/Surface Water
Pond (1-yr Starting
Elev.)
Subcat
Reach
Pond
Link
Routing Diagram for WPL Columbia_Mod 5_6 Leachate Pond Evaluation
Prepared by SCS Engineers, Printed 2/16/2021
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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

Subcatchment 156S: Landfill Open Area Runoff Area=2.417 ac 100.00% Impervious Runoff Depth=2.21"
Tc=20.0 min CN=98 Runoff=4.82 cfs 0.445 af

Subcatchment 157S: Leachate/Surface Runoff Area=3.710 ac 100.00% Impervious Runoff Depth=2.21"
Tc=0.0 min CN=98 Runoff=12.92 cfs 0.684 af

Subcatchment 158S: Mod 5 Runoff Area=4.120 ac 100.00% Impervious Runoff Depth=2.21"
Tc=20.0 min CN=98 Runoff=8.22 cfs 0.759 af

Pond 159P: Leachate/Surface Water Peak Elev=796.97' Storage=197,632 cf Inflow=18.52 cfs 1.888 af
Outflow=0.00 cfs 0.000 af

Total Runoff Area = 10.247 ac Runoff Volume = 1.888 af Average Runoff Depth = 2.21"
0.00% Pervious = 0.000 ac 100.00% Impervious = 10.247 ac

Summary for Subcatchment 156S: Landfill Open Area

Runoff = 4.82 cfs @ 12.29 hrs, Volume= 0.445 af, Depth= 2.21"

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
*	2.417	98	Mod 4 Allowable Open Area
	2.417		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 157S: Leachate/Surface Water Pond

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 12.92 cfs @ 12.04 hrs, Volume= 0.684 af, Depth= 2.21"

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
*	3.710	98	Leachate Surface Water Pond
	3.710		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry,**

Summary for Subcatchment 158S: Mod 5

Runoff = 8.22 cfs @ 12.29 hrs, Volume= 0.759 af, Depth= 2.21"

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
*	4.120	98	Ash
	4.120		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.0					**Direct Entry, Estimated**

Summary for Pond 159P: Leachate/Surface Water Pond (1-yr Starting Elev.)

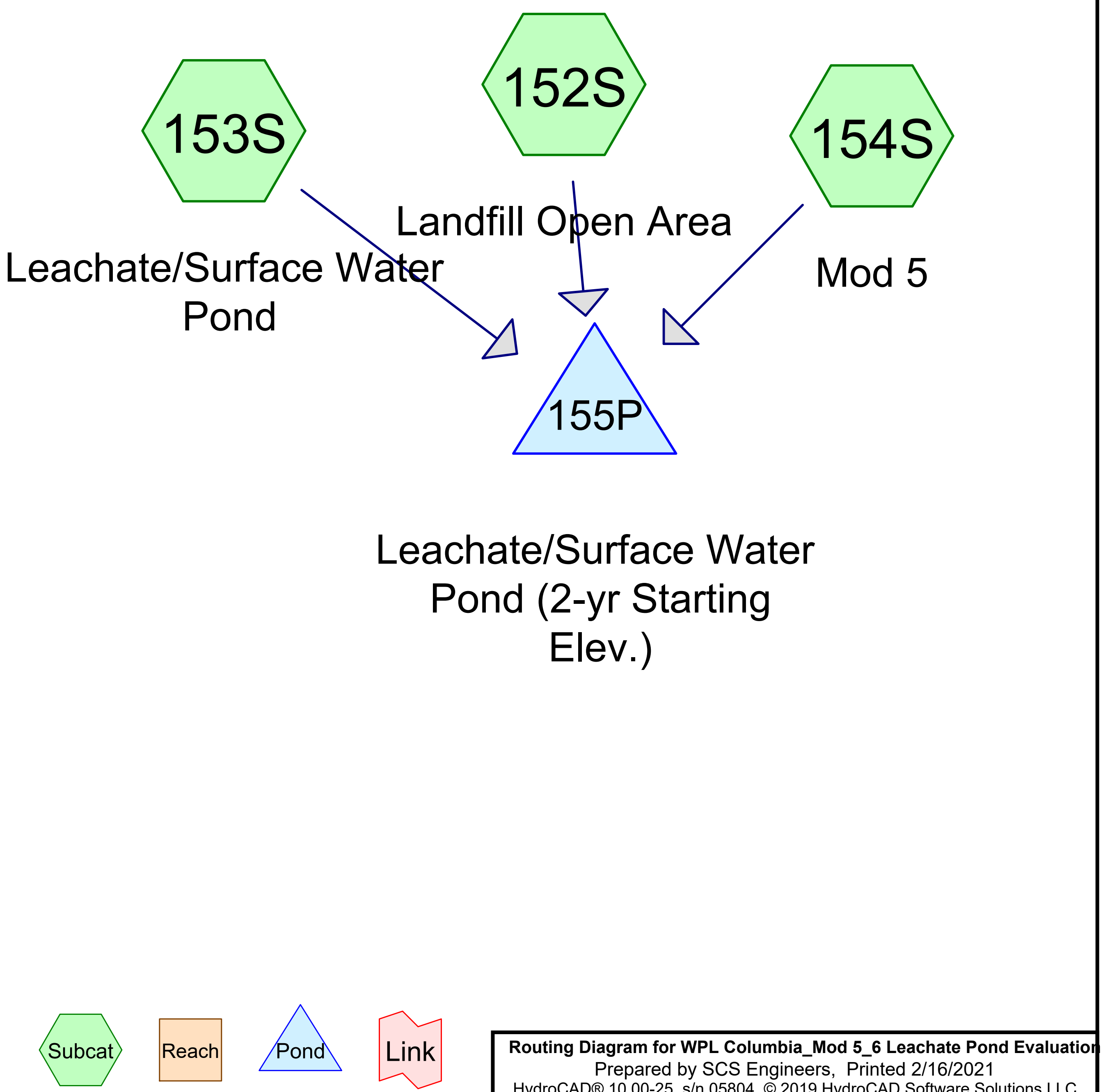
Inflow Area = 10.247 ac,100.00% Impervious, Inflow Depth = 2.21" for 1-yr, 24-hr storm event
Inflow = 18.52 cfs @ 12.05 hrs, Volume= 1.888 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
Starting Elev= 795.55' Surf.Area= 53,339 sf Storage= 115,388 cf
Peak Elev= 796.97' @ 25.15 hrs Surf.Area= 61,586 sf Storage= 197,632 cf (82,244 cf above start)
Flood Elev= 796.97' Surf.Area= 61,588 sf Storage= 197,647 cf (82,260 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'	263,654 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



Routing Diagram for WPL Columbia_Mod 5_6 Leachate Pond Evaluation
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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

Subcatchment 152S: Landfill Open Area Runoff Area=2.417 ac 100.00% Impervious Runoff Depth=2.54"
Tc=20.0 min CN=98 Runoff=5.50 cfs 0.511 af

Subcatchment 153S: Leachate/Surface Runoff Area=3.710 ac 100.00% Impervious Runoff Depth=2.54"
Tc=0.0 min CN=98 Runoff=14.73 cfs 0.785 af

Subcatchment 154S: Mod 5 Runoff Area=4.120 ac 100.00% Impervious Runoff Depth=2.54"
Tc=20.0 min CN=98 Runoff=9.37 cfs 0.872 af

Pond 155P: Leachate/Surface Water Peak Elev=796.97' Storage=197,780 cf Inflow=21.14 cfs 2.168 af
Outflow=0.00 cfs 0.000 af

Total Runoff Area = 10.247 ac Runoff Volume = 2.168 af Average Runoff Depth = 2.54"
0.00% Pervious = 0.000 ac 100.00% Impervious = 10.247 ac

Summary for Subcatchment 152S: Landfill Open Area

Runoff = 5.50 cfs @ 12.29 hrs, Volume= 0.511 af, Depth= 2.54"

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
*	2.417	98	Mod 4 Allowable Open Area
	2.417		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 153S: Leachate/Surface Water Pond

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 14.73 cfs @ 12.04 hrs, Volume= 0.785 af, Depth= 2.54"

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
*	3.710	98	Leachate Surface Water Pond
	3.710		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry,**

Summary for Subcatchment 154S: Mod 5

Runoff = 9.37 cfs @ 12.29 hrs, Volume= 0.872 af, Depth= 2.54"

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
*	4.120	98	Ash
	4.120		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.0					**Direct Entry, Estimated**

Summary for Pond 155P: Leachate/Surface Water Pond (2-yr Starting Elev.)

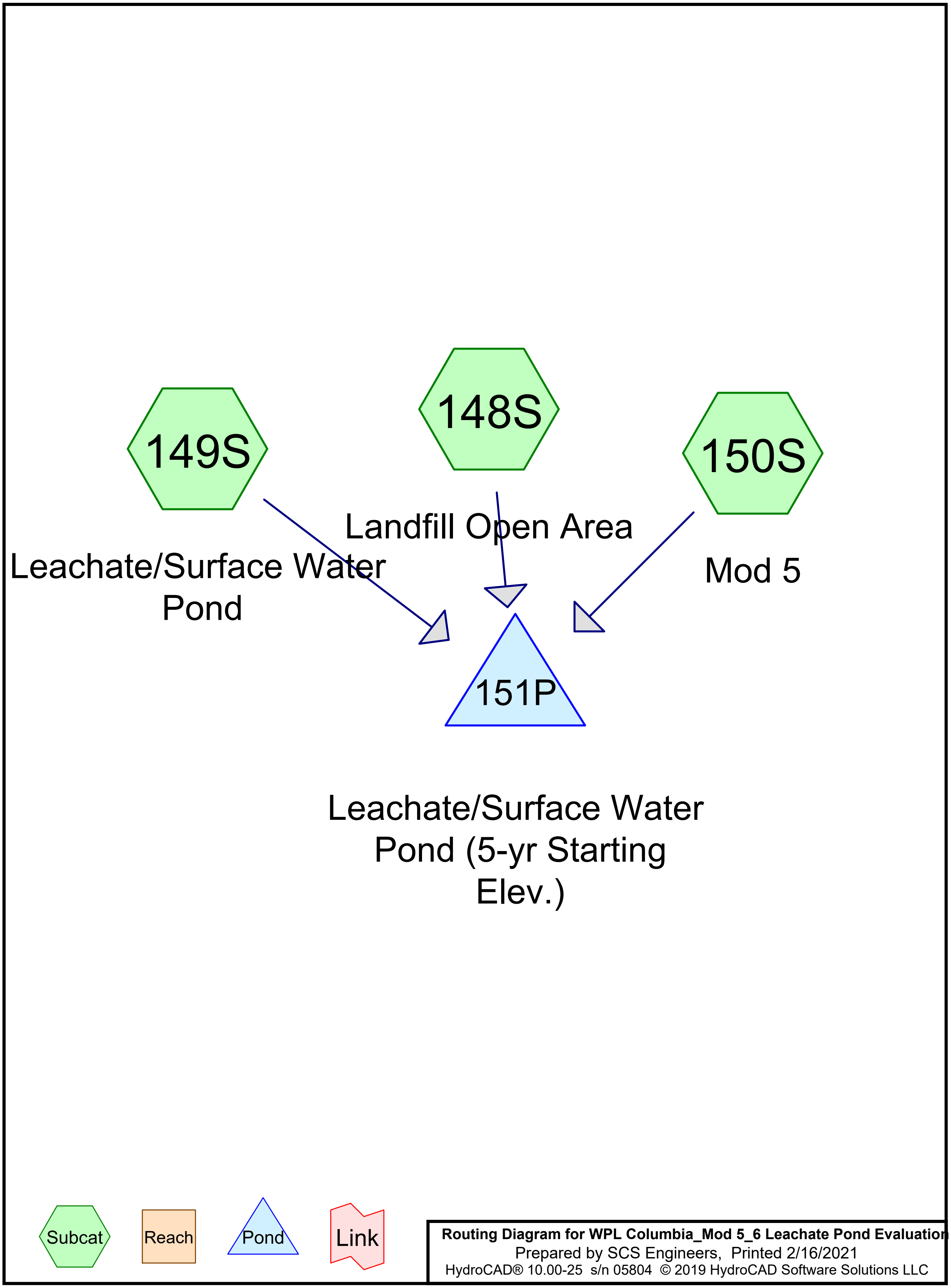
Inflow Area = 10.247 ac,100.00% Impervious, Inflow Depth = 2.54" for 2-yr, 24-hr storm event
Inflow = 21.14 cfs @ 12.05 hrs, Volume= 2.168 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
Starting Elev= 795.32' Surf.Area= 51,527 sf Storage= 103,328 cf
Peak Elev= 796.97' @ 25.15 hrs Surf.Area= 61,598 sf Storage= 197,780 cf (94,452 cf above start)
Flood Elev= 796.97' Surf.Area= 61,588 sf Storage= 197,647 cf (94,319 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'	263,654 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


149S
Leachate/Surface Water Pond
148S
Landfill Open Area
150S
Mod 5
151P
Leachate/Surface Water Pond (5-yr Starting Elev.)
Subcat
Reach
Pond
Link
Routing Diagram for WPL Columbia_Mod 5_6 Leachate Pond Evaluation
Prepared by SCS Engineers, Printed 2/16/2021
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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

Subcatchment 148S: Landfill Open Area Runoff Area=2.417 ac 100.00% Impervious Runoff Depth=3.15"
Tc=20.0 min CN=98 Runoff=6.75 cfs 0.634 af

Subcatchment 149S: Leachate/Surface Runoff Area=3.710 ac 100.00% Impervious Runoff Depth=3.15"
Tc=0.0 min CN=98 Runoff=18.06 cfs 0.973 af

Subcatchment 150S: Mod 5 Runoff Area=4.120 ac 100.00% Impervious Runoff Depth=3.15"
Tc=20.0 min CN=98 Runoff=11.50 cfs 1.080 af

Pond 151P: Leachate/Surface Water Peak Elev=796.97' Storage=197,510 cf Inflow=25.95 cfs 2.687 af
Outflow=0.00 cfs 0.000 af

Total Runoff Area = 10.247 ac Runoff Volume = 2.687 af Average Runoff Depth = 3.15"
0.00% Pervious = 0.000 ac 100.00% Impervious = 10.247 ac

Summary for Subcatchment 148S: Landfill Open Area

Runoff = 6.75 cfs @ 12.29 hrs, Volume= 0.634 af, Depth= 3.15"

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
*	2.417	98	Mod 4 Allowable Open Area
	2.417		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 149S: Leachate/Surface Water Pond

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 18.06 cfs @ 12.04 hrs, Volume= 0.973 af, Depth= 3.15"

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
*	3.710	98	Leachate Surface Water Pond
	3.710		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry,**

Summary for Subcatchment 150S: Mod 5

Runoff = 11.50 cfs @ 12.29 hrs, Volume= 1.080 af, Depth= 3.15"

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
*	4.120	98	Ash
	4.120		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.0					**Direct Entry, Estimated**

Summary for Pond 151P: Leachate/Surface Water Pond (5-yr Starting Elev.)

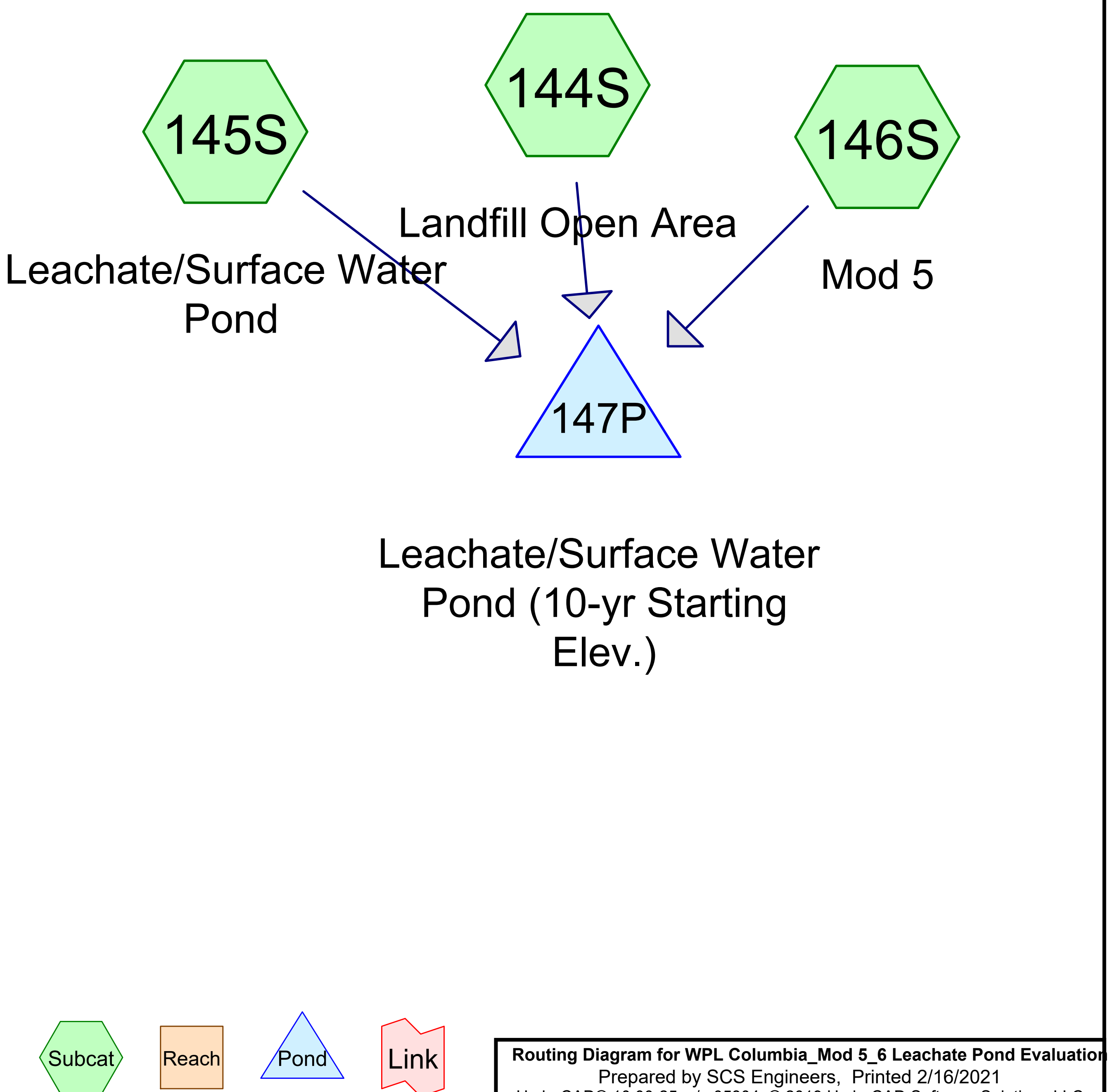
Inflow Area = 10.247 ac,100.00% Impervious, Inflow Depth = 3.15" for 5-yr, 24-hr storm event
Inflow = 25.95 cfs @ 12.05 hrs, Volume= 2.687 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
Starting Elev= 794.86' Surf.Area= 47,902 sf Storage= 80,459 cf
Peak Elev= 796.97' @ 25.15 hrs Surf.Area= 61,577 sf Storage= 197,510 cf (117,051 cf above start)
Flood Elev= 796.97' Surf.Area= 61,588 sf Storage= 197,647 cf (117,188 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'	263,654 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



Routing Diagram for WPL Columbia_Mod 5_6 Leachate Pond Evaluation
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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

Subcatchment 144S: Landfill Open Area Runoff Area=2.417 ac 100.00% Impervious Runoff Depth=3.74"
Tc=20.0 min CN=98 Runoff=7.95 cfs 0.752 af

Subcatchment 145S: Leachate/Surface Runoff Area=3.710 ac 100.00% Impervious Runoff Depth=3.74"
Tc=0.0 min CN=98 Runoff=21.27 cfs 1.155 af

Subcatchment 146S: Mod 5 Runoff Area=4.120 ac 100.00% Impervious Runoff Depth=3.74"
Tc=20.0 min CN=98 Runoff=13.55 cfs 1.282 af

Pond 147P: Leachate/Surface Water Peak Elev=796.97' Storage=197,750 cf Inflow=30.60 cfs 3.190 af
Outflow=0.00 cfs 0.000 af

Total Runoff Area = 10.247 ac Runoff Volume = 3.190 af Average Runoff Depth = 3.74"
0.00% Pervious = 0.000 ac 100.00% Impervious = 10.247 ac

Summary for Subcatchment 144S: Landfill Open Area

Runoff = 7.95 cfs @ 12.29 hrs, Volume= 0.752 af, Depth= 3.74"

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
*	2.417	98	Mod 4 Allowable Open Area
	2.417		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 145S: Leachate/Surface Water Pond

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 21.27 cfs @ 12.04 hrs, Volume= 1.155 af, Depth= 3.74"

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
*	3.710	98	Leachate Surface Water Pond
	3.710		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry,**

Summary for Subcatchment 146S: Mod 5

Runoff = 13.55 cfs @ 12.29 hrs, Volume= 1.282 af, Depth= 3.74"

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
*	4.120	98	Ash
	4.120		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.0					**Direct Entry, Estimated**

Summary for Pond 147P: Leachate/Surface Water Pond (10-yr Starting Elev.)

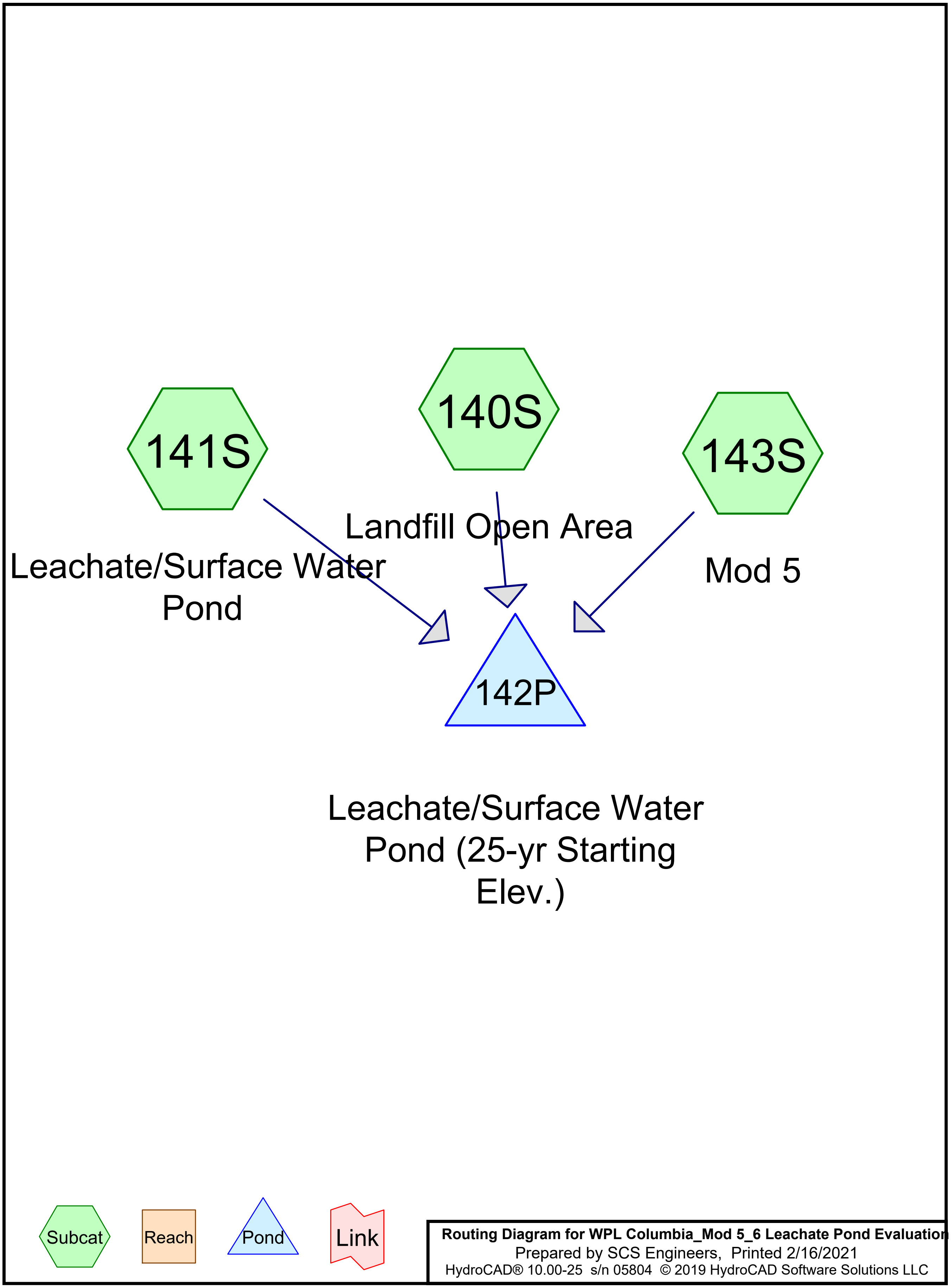
Inflow Area = 10.247 ac,100.00% Impervious, Inflow Depth = 3.74" for 10-yr, 24-hr storm event
Inflow = 30.60 cfs @ 12.05 hrs, Volume= 3.190 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
Starting Elev= 794.39' Surf.Area= 44,199 sf Storage= 58,815 cf
Peak Elev= 796.97' @ 25.15 hrs Surf.Area= 61,596 sf Storage= 197,750 cf (138,935 cf above start)
Flood Elev= 796.97' Surf.Area= 61,588 sf Storage= 197,647 cf (138,832 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'	263,654 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


141S
Leachate/Surface Water Pond
140S
Landfill Open Area
143S
Mod 5
142P
Leachate/Surface Water Pond (25-yr Starting Elev.)
Subcat
Reach
Pond
Link
Routing Diagram for WPL Columbia_Mod 5_6 Leachate Pond Evaluation
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Summary for Pond 142P: Leachate/Surface Water Pond (25-yr Starting Elev.)

Inflow Area = 10.247 ac,100.00% Impervious, Inflow Depth = 4.67" for 25-yr, 24-hr storm event
Inflow = 37.97 cfs @ 12.05 hrs, Volume= 3.991 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= 793.50' Surf.Area= 31,107 sf Storage= 24,119 cf
Peak Elev= 796.97' @ 25.15 hrs Surf.Area= 61,611 sf Storage= 197,949 cf (173,831 cf above start)
Flood Elev= 796.97' Surf.Area= 61,588 sf Storage= 197,647 cf (173,529 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'	263,654 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

Summary for Subcatchment 140S: Landfill Open Area

Runoff = 9.86 cfs @ 12.28 hrs, Volume= 0.941 af, Depth= 4.67"

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
*	2.417	98	Mod 4 Allowable Open Area
	2.417		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 141S: Leachate/Surface Water Pond

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 26.38 cfs @ 12.04 hrs, Volume= 1.445 af, Depth= 4.67"

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
*	3.710	98	Leachate Surface Water Pond
	3.710		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry,**

Summary for Subcatchment 143S: Mod 5

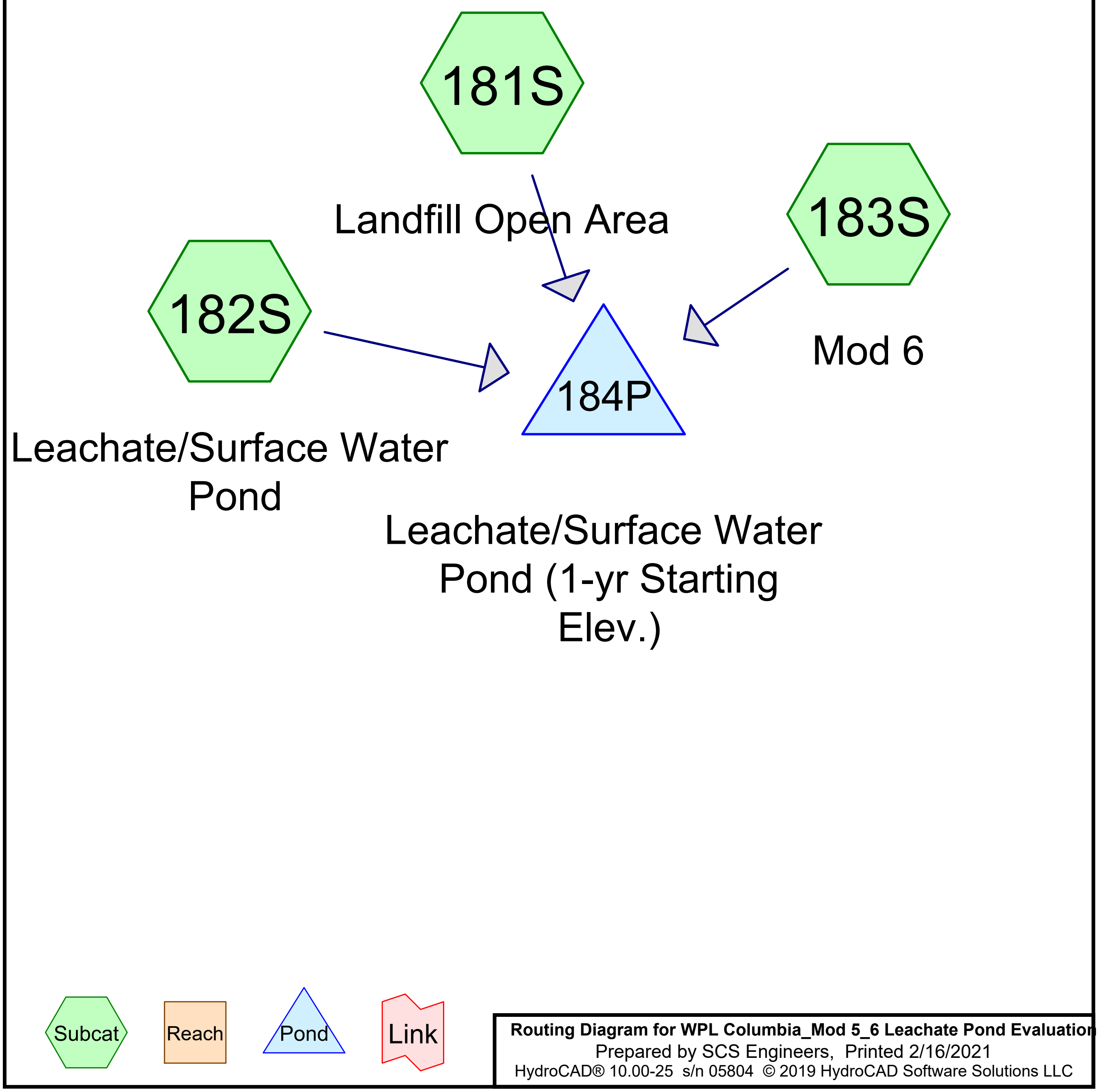
Runoff = 16.82 cfs @ 12.28 hrs, Volume= 1.605 af, Depth= 4.67"

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
*	4.120	98	Ash
	4.120		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.0					**Direct Entry, Estimated**

Scenario 3



Routing Diagram for WPL Columbia_Mod 5_6 Leachate Pond Evaluation
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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

Subcatchment 181S: Landfill Open Area Runoff Area=4.642 ac 100.00% Impervious Runoff Depth=2.21"
Tc=20.0 min CN=98 Runoff=9.26 cfs 0.855 af

Subcatchment 182S: Leachate/Surface Runoff Area=3.710 ac 100.00% Impervious Runoff Depth=2.21"
Tc=0.0 min CN=98 Runoff=12.92 cfs 0.684 af

Subcatchment 183S: Mod 6 Runoff Area=1.895 ac 100.00% Impervious Runoff Depth=2.21"
Tc=20.0 min CN=98 Runoff=3.78 cfs 0.349 af

Pond 184P: Leachate/Surface Water Peak Elev=796.97' Storage=197,632 cf Inflow=18.52 cfs 1.888 af
Outflow=0.00 cfs 0.000 af

Total Runoff Area = 10.247 ac Runoff Volume = 1.888 af Average Runoff Depth = 2.21"
0.00% Pervious = 0.000 ac 100.00% Impervious = 10.247 ac

Summary for Subcatchment 181S: Landfill Open Area

Runoff = 9.26 cfs @ 12.29 hrs, Volume= 0.855 af, Depth= 2.21"

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
*	4.642	98	Mod 4 Allowable Open Area
	4.642		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 182S: Leachate/Surface Water Pond

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 12.92 cfs @ 12.04 hrs, Volume= 0.684 af, Depth= 2.21"

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
*	3.710	98	Leachate Surface Water Pond
	3.710		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry,**

Summary for Subcatchment 183S: Mod 6

Runoff = 3.78 cfs @ 12.29 hrs, Volume= 0.349 af, Depth= 2.21"

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
*	1.895	98	Ash
	1.895		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.0					**Direct Entry, Estimated**

Summary for Pond 184P: Leachate/Surface Water Pond (1-yr Starting Elev.)

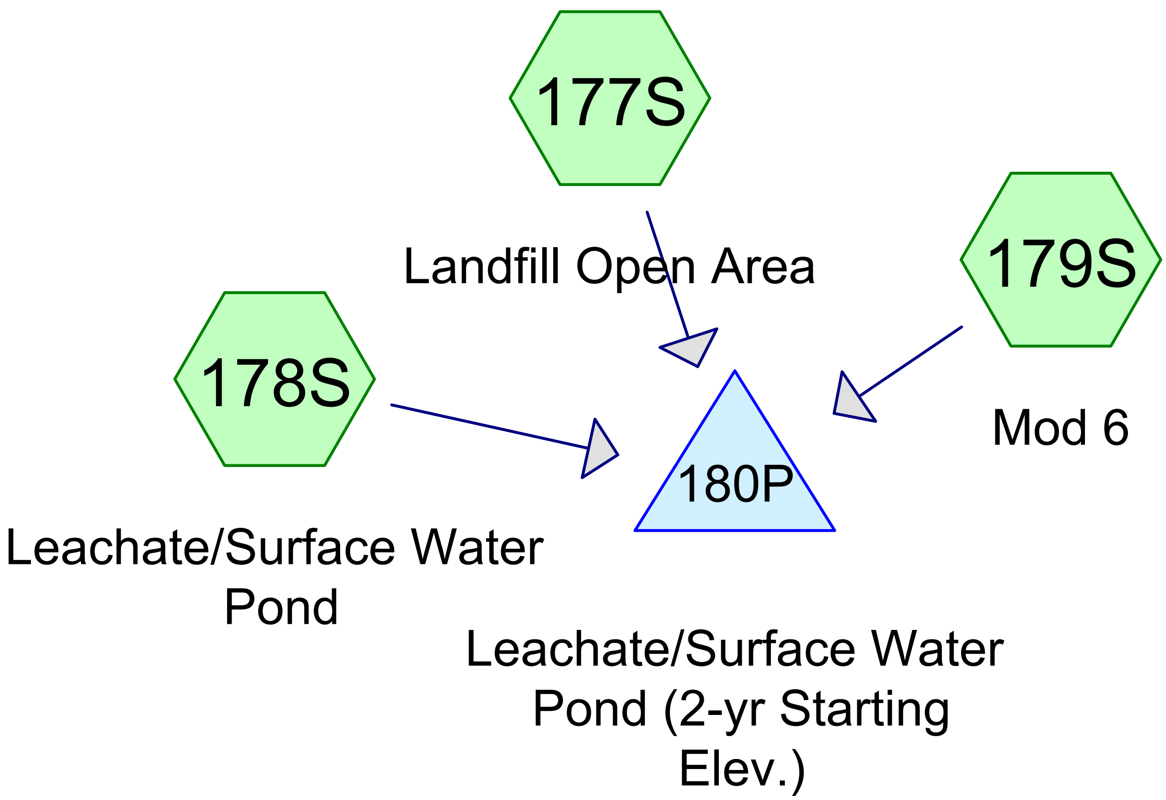
Inflow Area = 10.247 ac,100.00% Impervious, Inflow Depth = 2.21" for 1-yr, 24-hr storm event
Inflow = 18.52 cfs @ 12.05 hrs, Volume= 1.888 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

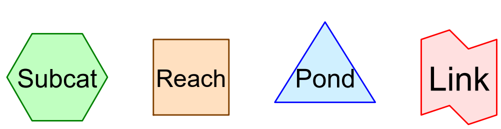
Routing by Stor-Ind method, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
Starting Elev= 795.55' Surf.Area= 53,339 sf Storage= 115,388 cf
Peak Elev= 796.97' @ 25.15 hrs Surf.Area= 61,586 sf Storage= 197,632 cf (82,244 cf above start)
Flood Elev= 796.97' Surf.Area= 61,588 sf Storage= 197,647 cf (82,260 cf above 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'	263,654 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





Routing Diagram for WPL Columbia_Mod 5_6 Leachate Pond Evaluation
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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

Subcatchment 177S: Landfill Open Area Runoff Area=4.642 ac 100.00% Impervious Runoff Depth=2.54"
Tc=20.0 min CN=98 Runoff=10.56 cfs 0.982 af

Subcatchment 178S: Leachate/Surface Runoff Area=3.710 ac 100.00% Impervious Runoff Depth=2.54"
Tc=0.0 min CN=98 Runoff=14.73 cfs 0.785 af

Subcatchment 179S: Mod 6 Runoff Area=1.895 ac 100.00% Impervious Runoff Depth=2.54"
Tc=20.0 min CN=98 Runoff=4.31 cfs 0.401 af

Pond 180P: Leachate/Surface Water Peak Elev=796.97' Storage=197,780 cf Inflow=21.14 cfs 2.168 af
Outflow=0.00 cfs 0.000 af

Total Runoff Area = 10.247 ac Runoff Volume = 2.168 af Average Runoff Depth = 2.54"
0.00% Pervious = 0.000 ac 100.00% Impervious = 10.247 ac

Summary for Subcatchment 177S: Landfill Open Area

Runoff = 10.56 cfs @ 12.29 hrs, Volume= 0.982 af, Depth= 2.54"

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
*	4.642	98	Mod 4 Allowable Open Area
	4.642		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 178S: Leachate/Surface Water Pond

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 14.73 cfs @ 12.04 hrs, Volume= 0.785 af, Depth= 2.54"

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
*	3.710	98	Leachate Surface Water Pond
	3.710		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry,**

Summary for Subcatchment 179S: Mod 6

Runoff = 4.31 cfs @ 12.29 hrs, Volume= 0.401 af, Depth= 2.54"

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
*	1.895	98	Ash
	1.895		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.0					**Direct Entry, Estimated**

Summary for Pond 180P: Leachate/Surface Water Pond (2-yr Starting Elev.)

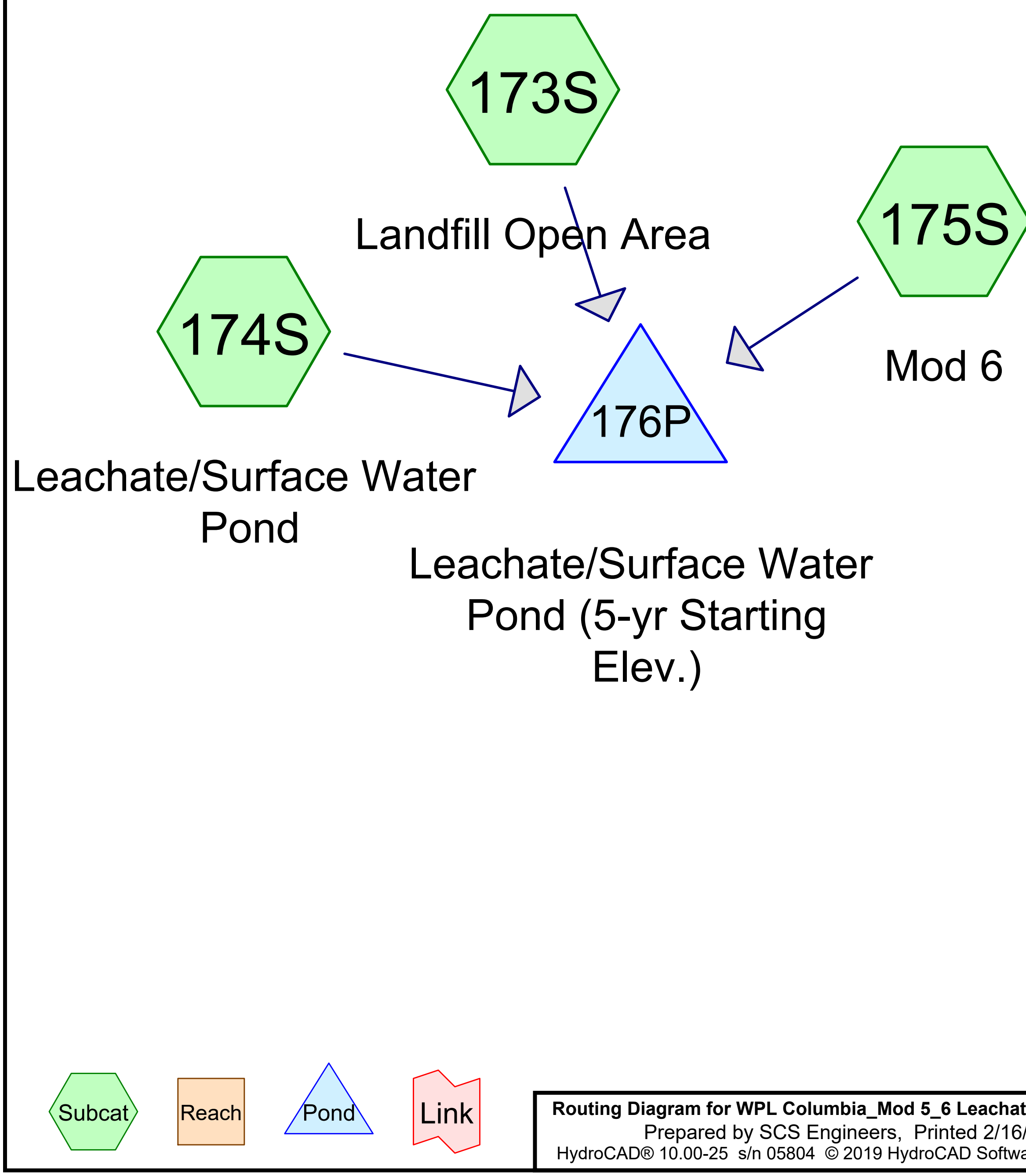
Inflow Area = 10.247 ac,100.00% Impervious, Inflow Depth = 2.54" for 2-yr, 24-hr storm event
Inflow = 21.14 cfs @ 12.05 hrs, Volume= 2.168 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
Starting Elev= 795.32' Surf.Area= 51,527 sf Storage= 103,328 cf
Peak Elev= 796.97' @ 25.15 hrs Surf.Area= 61,598 sf Storage= 197,780 cf (94,452 cf above start)
Flood Elev= 796.97' Surf.Area= 61,588 sf Storage= 197,647 cf (94,319 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'	263,654 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



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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

Subcatchment 173S: Landfill Open Area Runoff Area=4.642 ac 100.00% Impervious Runoff Depth=3.15"
Tc=20.0 min CN=98 Runoff=12.96 cfs 1.217 af

Subcatchment 174S: Leachate/Surface Runoff Area=3.710 ac 100.00% Impervious Runoff Depth=3.15"
Tc=0.0 min CN=98 Runoff=18.06 cfs 0.973 af

Subcatchment 175S: Mod 6 Runoff Area=1.895 ac 100.00% Impervious Runoff Depth=3.15"
Tc=20.0 min CN=98 Runoff=5.29 cfs 0.497 af

Pond 176P: Leachate/Surface Water Peak Elev=796.97' Storage=197,510 cf Inflow=25.95 cfs 2.687 af
Outflow=0.00 cfs 0.000 af

Total Runoff Area = 10.247 ac Runoff Volume = 2.687 af Average Runoff Depth = 3.15"
0.00% Pervious = 0.000 ac 100.00% Impervious = 10.247 ac

Summary for Subcatchment 173S: Landfill Open Area

Runoff = 12.96 cfs @ 12.29 hrs, Volume= 1.217 af, Depth= 3.15"

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
*	4.642	98	Mod 4 Allowable Open Area
	4.642		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 174S: Leachate/Surface Water Pond

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 18.06 cfs @ 12.04 hrs, Volume= 0.973 af, Depth= 3.15"

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
*	3.710	98	Leachate Surface Water Pond
	3.710		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry,**

Summary for Subcatchment 175S: Mod 6

Runoff = 5.29 cfs @ 12.29 hrs, Volume= 0.497 af, Depth= 3.15"

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
*	1.895	98	Ash
	1.895		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.0					**Direct Entry, Estimated**

Summary for Pond 176P: Leachate/Surface Water Pond (5-yr Starting Elev.)

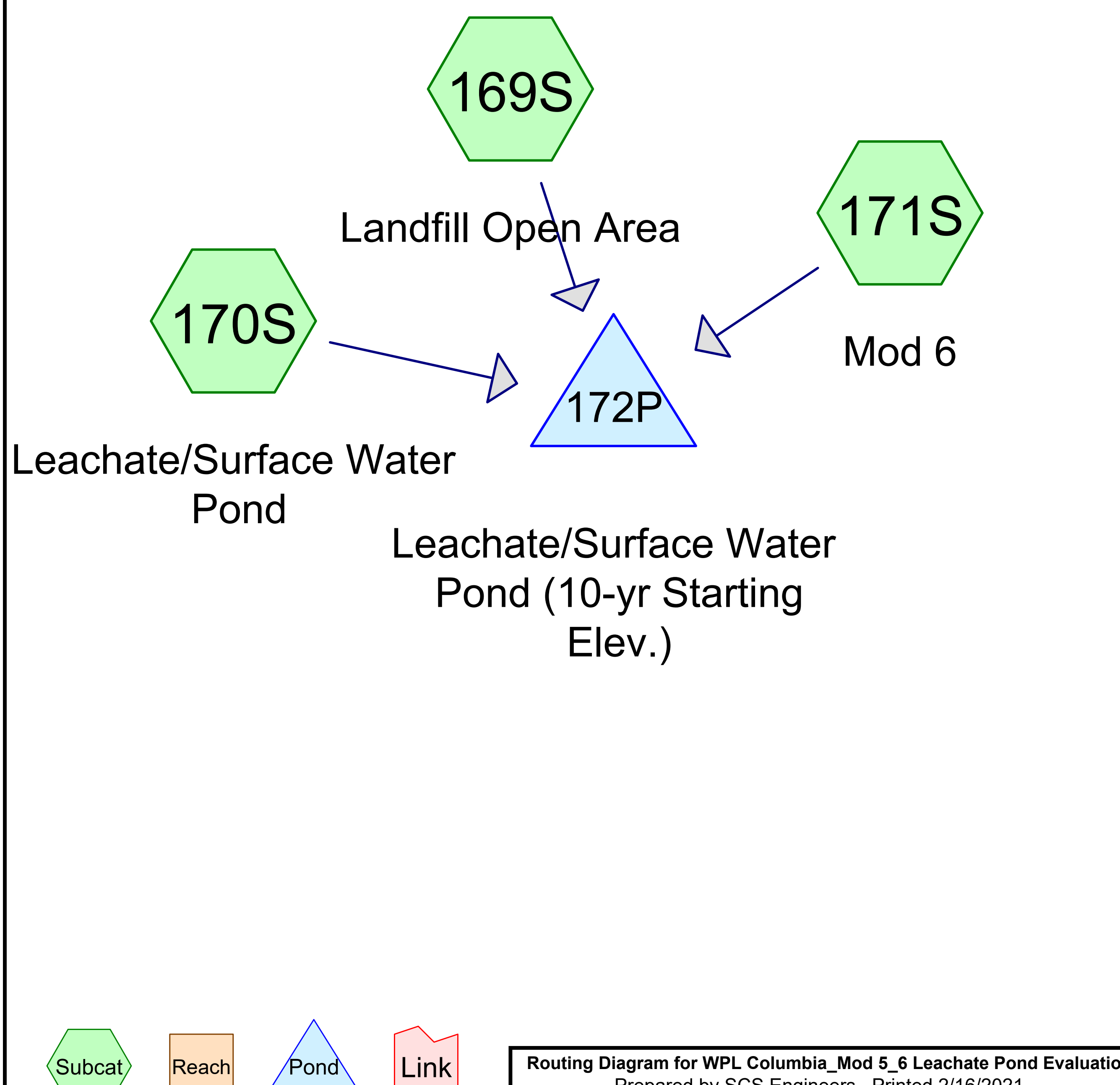
Inflow Area = 10.247 ac,100.00% Impervious, Inflow Depth = 3.15" for 5-yr, 24-hr storm event
Inflow = 25.95 cfs @ 12.05 hrs, Volume= 2.687 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
Starting Elev= 794.86' Surf.Area= 47,902 sf Storage= 80,459 cf
Peak Elev= 796.97' @ 25.15 hrs Surf.Area= 61,577 sf Storage= 197,510 cf (117,051 cf above start)
Flood Elev= 796.97' Surf.Area= 61,588 sf Storage= 197,647 cf (117,188 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'	263,654 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



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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

Subcatchment 169S: Landfill Open Area Runoff Area=4.642 ac 100.00% Impervious Runoff Depth=3.74"
Tc=20.0 min CN=98 Runoff=15.27 cfs 1.445 af

Subcatchment 170S: Leachate/Surface Runoff Area=3.710 ac 100.00% Impervious Runoff Depth=3.74"
Tc=0.0 min CN=98 Runoff=21.27 cfs 1.155 af

Subcatchment 171S: Mod 6 Runoff Area=1.895 ac 100.00% Impervious Runoff Depth=3.74"
Tc=20.0 min CN=98 Runoff=6.23 cfs 0.590 af

Pond 172P: Leachate/Surface Water Peak Elev=796.97' Storage=197,750 cf Inflow=30.60 cfs 3.190 af
Outflow=0.00 cfs 0.000 af

Total Runoff Area = 10.247 ac Runoff Volume = 3.190 af Average Runoff Depth = 3.74"
0.00% Pervious = 0.000 ac 100.00% Impervious = 10.247 ac

Summary for Subcatchment 169S: Landfill Open Area

Runoff = 15.27 cfs @ 12.29 hrs, Volume= 1.445 af, Depth= 3.74"

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
*	4.642	98	Mod 4 Allowable Open Area
	4.642		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 170S: Leachate/Surface Water Pond

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 21.27 cfs @ 12.04 hrs, Volume= 1.155 af, Depth= 3.74"

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
*	3.710	98	Leachate Surface Water Pond
	3.710		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry,**

Summary for Subcatchment 171S: Mod 6

Runoff = 6.23 cfs @ 12.29 hrs, Volume= 0.590 af, Depth= 3.74"

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
*	1.895	98	Ash
	1.895		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.0					**Direct Entry, Estimated**

Summary for Pond 172P: Leachate/Surface Water Pond (10-yr Starting Elev.)

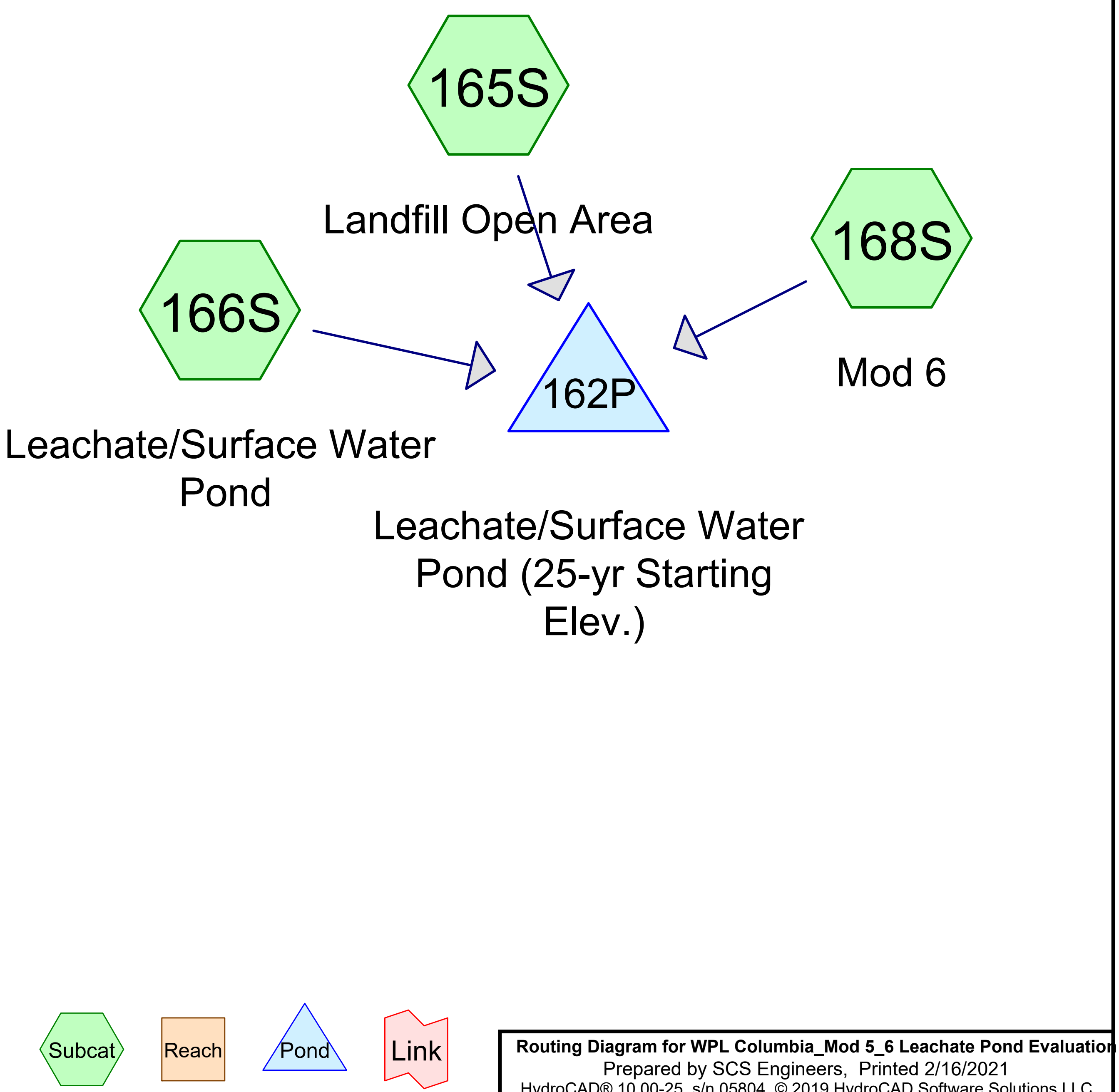
Inflow Area = 10.247 ac,100.00% Impervious, Inflow Depth = 3.74" for 10-yr, 24-hr storm event
Inflow = 30.60 cfs @ 12.05 hrs, Volume= 3.190 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
Starting Elev= 794.39' Surf.Area= 44,199 sf Storage= 58,815 cf
Peak Elev= 796.97' @ 25.15 hrs Surf.Area= 61,596 sf Storage= 197,750 cf (138,935 cf above start)
Flood Elev= 796.97' Surf.Area= 61,588 sf Storage= 197,647 cf (138,832 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'	263,654 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



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Summary for Pond 162P: Leachate/Surface Water Pond (25-yr Starting Elev.)

Inflow Area = 10.247 ac,100.00% Impervious, Inflow Depth = 4.67" for 25-yr, 24-hr storm event
Inflow = 37.97 cfs @ 12.05 hrs, Volume= 3.991 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= 793.50' Surf.Area= 31,107 sf Storage= 24,119 cf
Peak Elev= 796.97' @ 25.15 hrs Surf.Area= 61,611 sf Storage= 197,949 cf (173,831 cf above start)
Flood Elev= 796.97' Surf.Area= 61,588 sf Storage= 197,647 cf (173,529 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'	263,654 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

Summary for Subcatchment 165S: Landfill Open Area

Runoff = 18.95 cfs @ 12.28 hrs, Volume= 1.808 af, Depth= 4.67"

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
*	4.642	98	Mod 4 Allowable Open Area
	4.642		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 166S: Leachate/Surface Water Pond

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 26.38 cfs @ 12.04 hrs, Volume= 1.445 af, Depth= 4.67"

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
*	3.710	98	Leachate Surface Water Pond
	3.710		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry,**

Summary for Subcatchment 168S: Mod 6

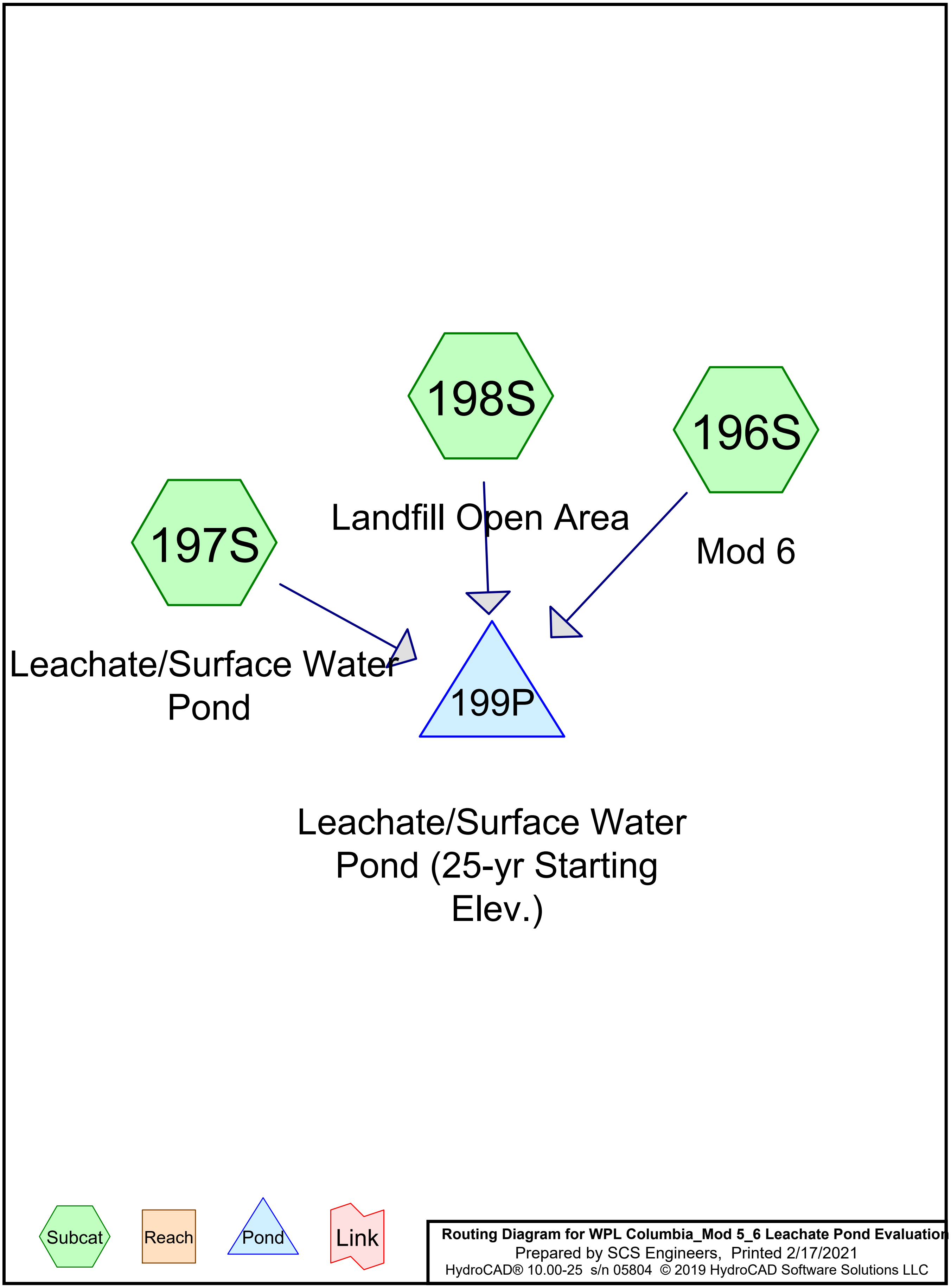
Runoff = 7.73 cfs @ 12.28 hrs, Volume= 0.738 af, Depth= 4.67"

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
*	1.895	98	Ash
	1.895		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.0					**Direct Entry, Estimated**

Scenario 4


198S
196S
197S
Landfill Open Area
Mod 6
Leachate/Surface Water Pond
199P
Leachate/Surface Water Pond (25-yr Starting Elev.)
Subcat
Reach
Pond
Link
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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

Subcatchment 196S: Mod 6 Runoff Area=3.790 ac 100.00% Impervious Runoff Depth=2.21"
Tc=20.0 min CN=98 Runoff=7.56 cfs 0.698 af

Subcatchment 197S: Leachate/Surface Runoff Area=3.710 ac 100.00% Impervious Runoff Depth=2.21"
Tc=0.0 min CN=98 Runoff=12.92 cfs 0.684 af

Subcatchment 198S: Landfill Open Area Runoff Area=2.740 ac 100.00% Impervious Runoff Depth=2.21"
Tc=20.0 min CN=98 Runoff=5.46 cfs 0.505 af

Pond 199P: Leachate/Surface Water Peak Elev=796.97' Storage=197,576 cf Inflow=18.52 cfs 1.887 af
Outflow=0.00 cfs 0.000 af

Total Runoff Area = 10.240 ac Runoff Volume = 1.887 af Average Runoff Depth = 2.21"
0.00% Pervious = 0.000 ac 100.00% Impervious = 10.240 ac

Summary for Subcatchment 196S: Mod 6

Runoff = 7.56 cfs @ 12.29 hrs, Volume= 0.698 af, Depth= 2.21"

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
*	3.790	98	Ash
	3.790		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 197S: Leachate/Surface Water Pond

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 12.92 cfs @ 12.04 hrs, Volume= 0.684 af, Depth= 2.21"

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
*	3.710	98	Leachate Surface Water Pond
	3.710		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry,**

Summary for Subcatchment 198S: Landfill Open Area

Runoff = 5.46 cfs @ 12.29 hrs, Volume= 0.505 af, Depth= 2.21"

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
*	2.740	98	Allowable Open Area
	2.740		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.0					**Direct Entry, Estimated**

Summary for Pond 199P: Leachate/Surface Water Pond (25-yr Starting Elev.)

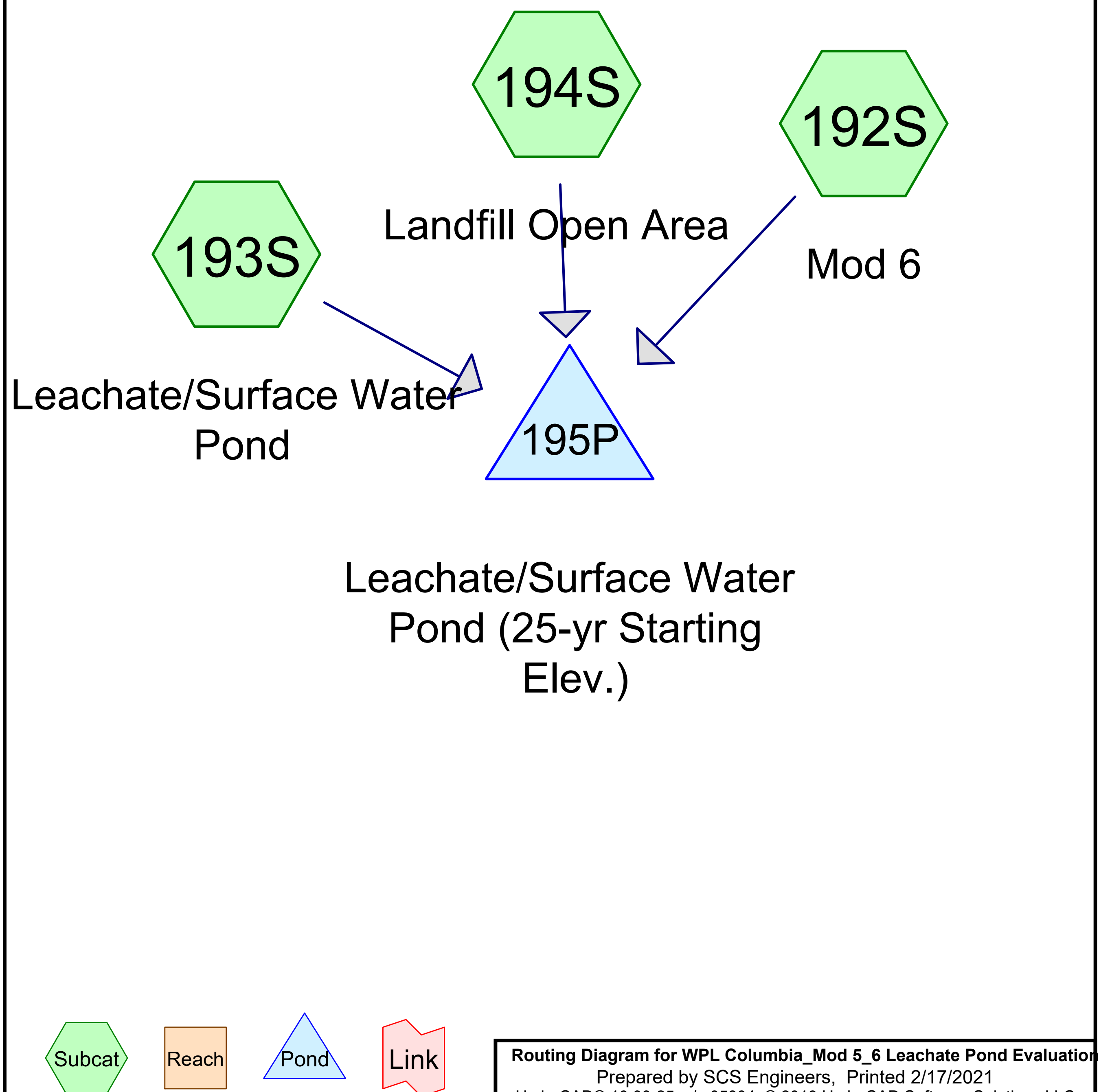
Inflow Area = 10.240 ac,100.00% Impervious, Inflow Depth = 2.21" for 1-yr, 24-hr storm event
Inflow = 18.52 cfs @ 12.05 hrs, Volume= 1.887 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
Starting Elev= 795.55' Surf.Area= 53,339 sf Storage= 115,388 cf
Peak Elev= 796.97' @ 25.15 hrs Surf.Area= 61,582 sf Storage= 197,576 cf (82,188 cf above start)
Flood Elev= 796.97' Surf.Area= 61,588 sf Storage= 197,647 cf (82,260 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'	263,654 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



Routing Diagram for WPL Columbia_Mod 5_6 Leachate Pond Evaluation
Prepared by SCS Engineers, Printed 2/17/2021
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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

Subcatchment 192S: Mod 6 Runoff Area=3.790 ac 100.00% Impervious Runoff Depth=2.54"
Tc=20.0 min CN=98 Runoff=8.62 cfs 0.802 af

Subcatchment 193S: Leachate/Surface Runoff Area=3.710 ac 100.00% Impervious Runoff Depth=2.54"
Tc=0.0 min CN=98 Runoff=14.73 cfs 0.785 af

Subcatchment 194S: Landfill Open Area Runoff Area=2.740 ac 100.00% Impervious Runoff Depth=2.54"
Tc=20.0 min CN=98 Runoff=6.23 cfs 0.580 af

Pond 195P: Leachate/Surface Water Peak Elev=796.97' Storage=197,716 cf Inflow=21.13 cfs 2.167 af
Outflow=0.00 cfs 0.000 af

Total Runoff Area = 10.240 ac Runoff Volume = 2.167 af Average Runoff Depth = 2.54"
0.00% Pervious = 0.000 ac 100.00% Impervious = 10.240 ac

Summary for Subcatchment 192S: Mod 6

Runoff = 8.62 cfs @ 12.29 hrs, Volume= 0.802 af, Depth= 2.54"

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
*	3.790	98	Ash
	3.790		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 193S: Leachate/Surface Water Pond

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 14.73 cfs @ 12.04 hrs, Volume= 0.785 af, Depth= 2.54"

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
*	3.710	98	Leachate Surface Water Pond
	3.710		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry,**

Summary for Subcatchment 194S: Landfill Open Area

Runoff = 6.23 cfs @ 12.29 hrs, Volume= 0.580 af, Depth= 2.54"

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
*	2.740	98	Allowable Open Area
	2.740		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.0					**Direct Entry, Estimated**

Summary for Pond 195P: Leachate/Surface Water Pond (25-yr Starting Elev.)

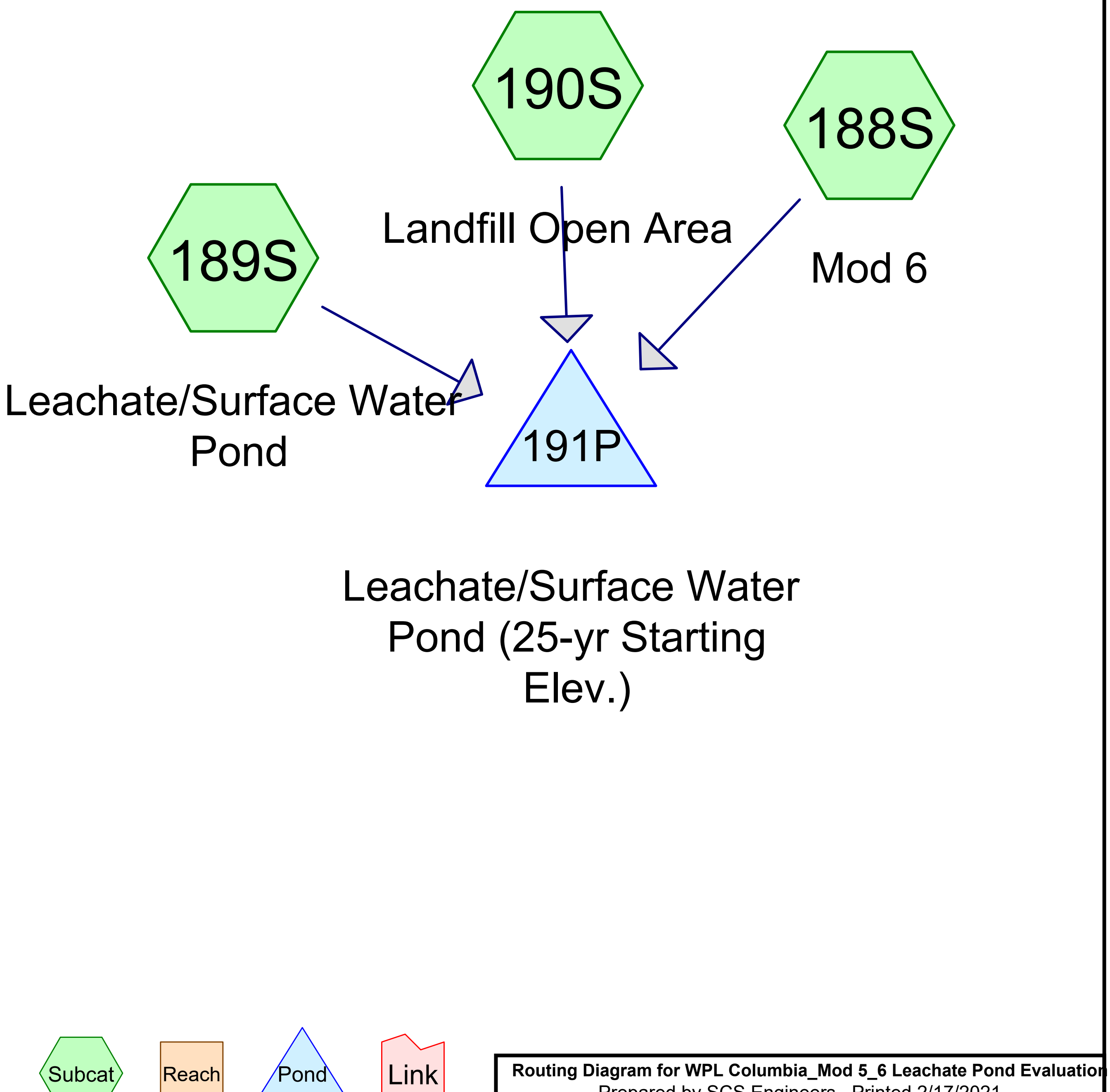
Inflow Area = 10.240 ac,100.00% Impervious, Inflow Depth = 2.54" for 2-yr, 24-hr storm event
Inflow = 21.13 cfs @ 12.05 hrs, Volume= 2.167 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
Starting Elev= 795.32' Surf.Area= 51,527 sf Storage= 103,328 cf
Peak Elev= 796.97' @ 25.15 hrs Surf.Area= 61,593 sf Storage= 197,716 cf (94,388 cf above start)
Flood Elev= 796.97' Surf.Area= 61,588 sf Storage= 197,647 cf (94,319 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'	263,654 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



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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

Subcatchment 188S: Mod 6 Runoff Area=3.790 ac 100.00% Impervious Runoff Depth=3.15"
Tc=20.0 min CN=98 Runoff=10.58 cfs 0.994 af

Subcatchment 189S: Leachate/Surface Runoff Area=3.710 ac 100.00% Impervious Runoff Depth=3.15"
Tc=0.0 min CN=98 Runoff=18.06 cfs 0.973 af

Subcatchment 190S: Landfill Open Area Runoff Area=2.740 ac 100.00% Impervious Runoff Depth=3.15"
Tc=20.0 min CN=98 Runoff=7.65 cfs 0.719 af

Pond 191P: Leachate/Surface Water Peak Elev=796.97' Storage=197,910 cf Inflow=25.94 cfs 2.685 af
Outflow=0.00 cfs 0.000 af

Total Runoff Area = 10.240 ac Runoff Volume = 2.685 af Average Runoff Depth = 3.15"
0.00% Pervious = 0.000 ac 100.00% Impervious = 10.240 ac

Summary for Subcatchment 188S: Mod 6

Runoff = 10.58 cfs @ 12.29 hrs, Volume= 0.994 af, Depth= 3.15"

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
*	3.790	98	Ash
	3.790		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 189S: Leachate/Surface Water Pond

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 18.06 cfs @ 12.04 hrs, Volume= 0.973 af, Depth= 3.15"

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
*	3.710	98	Leachate Surface Water Pond
	3.710		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry,**

Summary for Subcatchment 190S: Landfill Open Area

Runoff = 7.65 cfs @ 12.29 hrs, Volume= 0.719 af, Depth= 3.15"

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
*	2.740	98	Allowable Open Area
	2.740		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.0					**Direct Entry, Estimated**

Summary for Pond 191P: Leachate/Surface Water Pond (25-yr Starting Elev.)

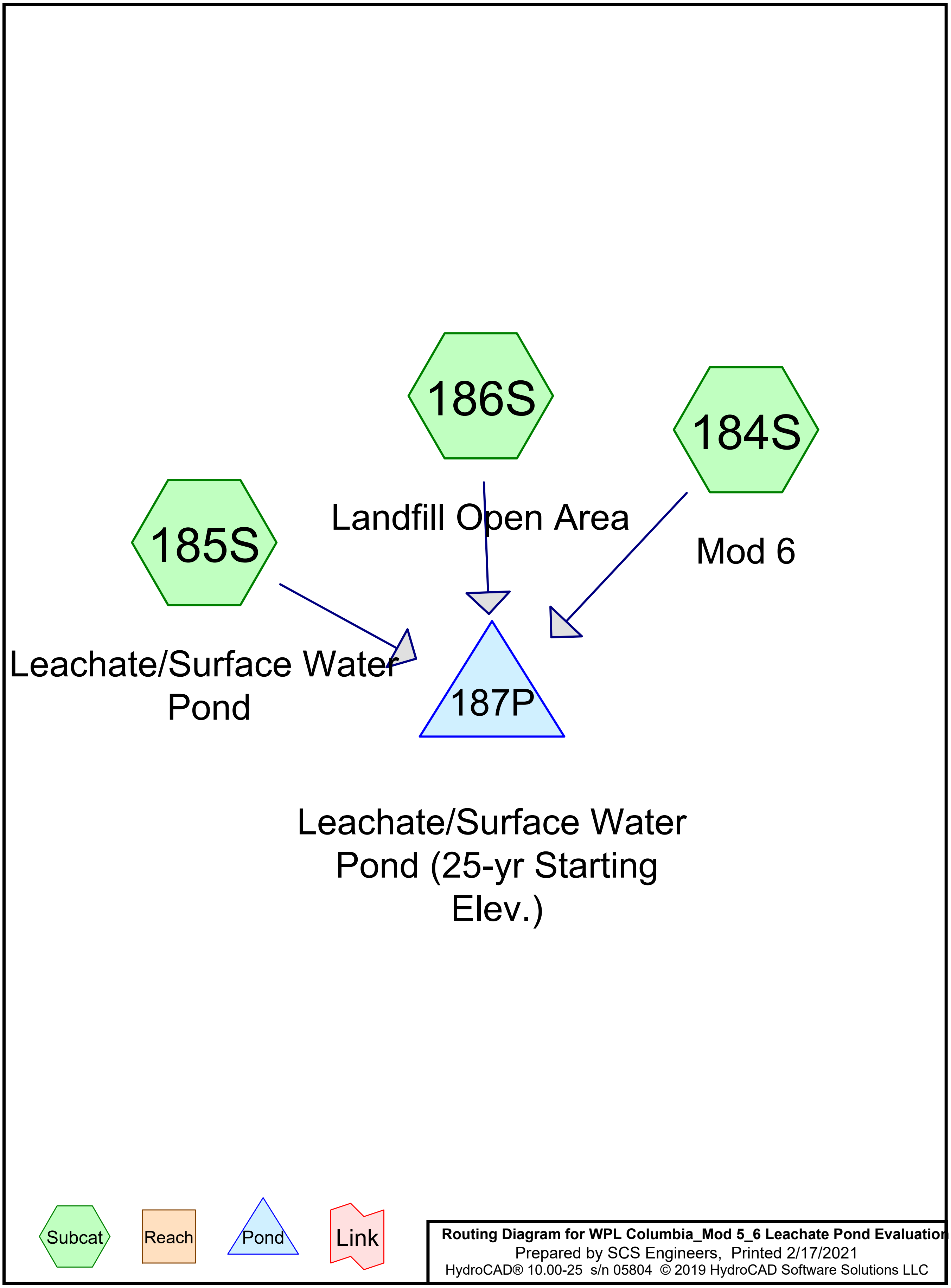
Inflow Area = 10.240 ac,100.00% Impervious, Inflow Depth = 3.15" for 5-yr, 24-hr storm event
Inflow = 25.94 cfs @ 12.05 hrs, Volume= 2.685 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
Starting Elev= 794.87' Surf.Area= 47,981 sf Storage= 80,939 cf
Peak Elev= 796.97' @ 25.15 hrs Surf.Area= 61,608 sf Storage= 197,910 cf (116,972 cf above start)
Flood Elev= 796.97' Surf.Area= 61,588 sf Storage= 197,647 cf (116,709 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'	263,654 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


186S
184S
Landfill Open Area
185S
Mod 6
Leachate/Surface Water Pond
187P
Leachate/Surface Water Pond (25-yr Starting Elev.)
Subcat
Reach
Pond
Link
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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

Subcatchment 184S: Mod 6 Runoff Area=3.790 ac 100.00% Impervious Runoff Depth=3.74"
Tc=20.0 min CN=98 Runoff=12.47 cfs 1.180 af

Subcatchment 185S: Leachate/Surface Runoff Area=3.710 ac 100.00% Impervious Runoff Depth=3.74"
Tc=0.0 min CN=98 Runoff=21.27 cfs 1.155 af

Subcatchment 186S: Landfill Open Area Runoff Area=2.740 ac 100.00% Impervious Runoff Depth=3.74"
Tc=20.0 min CN=98 Runoff=9.01 cfs 0.853 af

Pond 187P: Leachate/Surface Water Peak Elev=796.97' Storage=197,655 cf Inflow=30.59 cfs 3.187 af
Outflow=0.00 cfs 0.000 af

Total Runoff Area = 10.240 ac Runoff Volume = 3.187 af Average Runoff Depth = 3.74"
0.00% Pervious = 0.000 ac 100.00% Impervious = 10.240 ac

Summary for Subcatchment 184S: Mod 6

Runoff = 12.47 cfs @ 12.29 hrs, Volume= 1.180 af, Depth= 3.74"

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
*	3.790	98	Ash
	3.790		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 185S: Leachate/Surface Water Pond

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 21.27 cfs @ 12.04 hrs, Volume= 1.155 af, Depth= 3.74"

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
*	3.710	98	Leachate Surface Water Pond
	3.710		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry,**

Summary for Subcatchment 186S: Landfill Open Area

Runoff = 9.01 cfs @ 12.29 hrs, Volume= 0.853 af, Depth= 3.74"

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
*	2.740	98	Allowable Open Area
	2.740		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.0					**Direct Entry, Estimated**

Summary for Pond 187P: Leachate/Surface Water Pond (25-yr Starting Elev.)

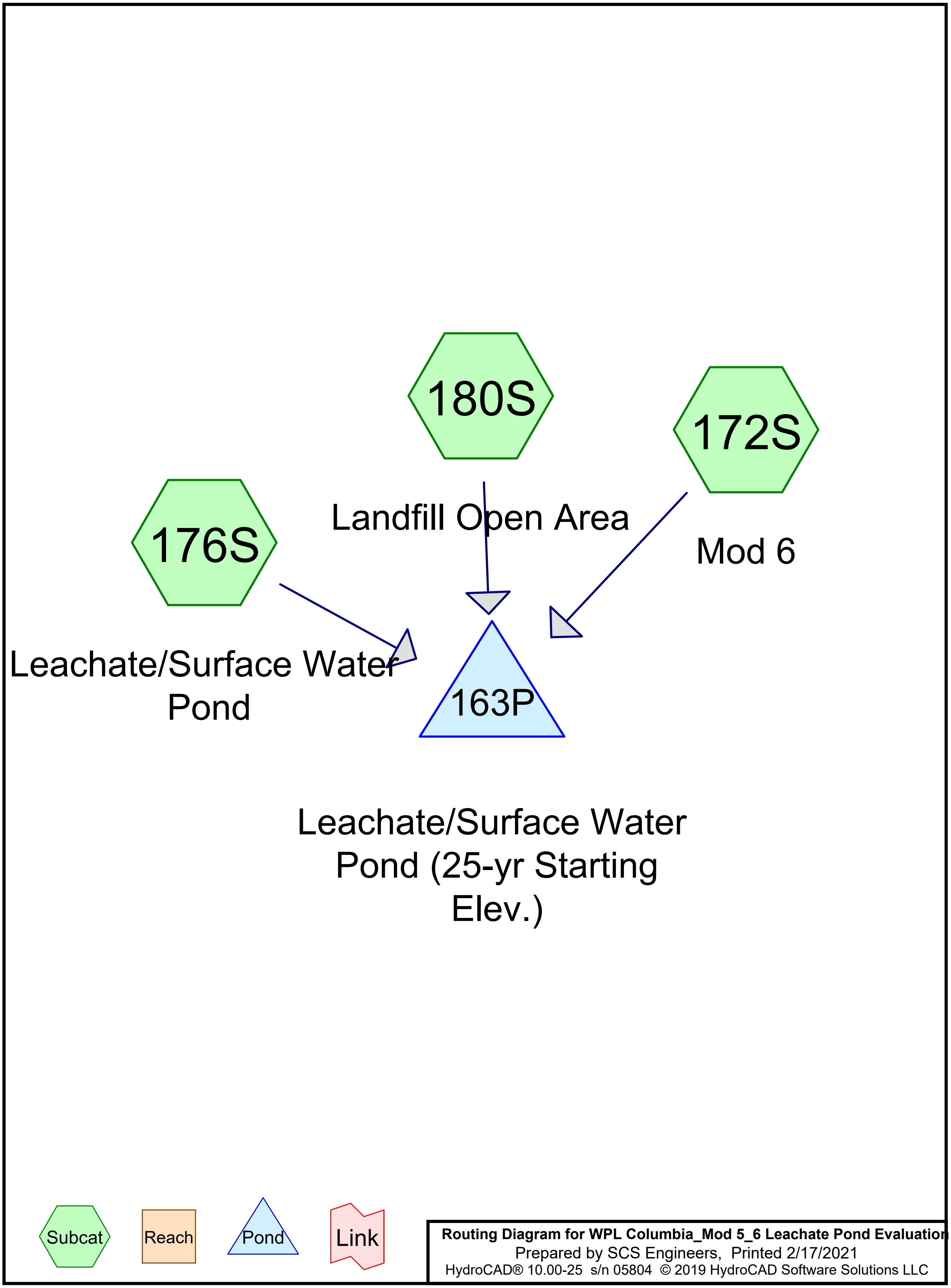
Inflow Area = 10.240 ac,100.00% Impervious, Inflow Depth = 3.74" for 10-yr, 24-hr storm event
Inflow = 30.59 cfs @ 12.05 hrs, Volume= 3.187 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
Starting Elev= 794.39' Surf.Area= 44,199 sf Storage= 58,815 cf
Peak Elev= 796.97' @ 25.15 hrs Surf.Area= 61,588 sf Storage= 197,655 cf (138,840 cf above start)
Flood Elev= 796.97' Surf.Area= 61,588 sf Storage= 197,647 cf (138,832 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'	263,654 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


180S
172S
176S
Landfill Open Area
Mod 6
Leachate/Surface Water Pond
163P
Leachate/Surface Water Pond (25-yr Starting Elev.)
Subcat
Reach
Pond
Link
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Summary for Pond 163P: Leachate/Surface Water Pond (25-yr Starting Elev.)

Inflow Area = 10.240 ac,100.00% Impervious, Inflow Depth = 4.67" for 25-yr, 24-hr storm event
Inflow = 37.96 cfs @ 12.05 hrs, Volume= 3.988 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= 793.50' Surf.Area= 31,107 sf Storage= 24,119 cf
Peak Elev= 796.97' @ 25.15 hrs Surf.Area= 61,602 sf Storage= 197,830 cf (173,712 cf above start)
Flood Elev= 796.97' Surf.Area= 61,588 sf Storage= 197,647 cf (173,529 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'	263,654 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

Summary for Subcatchment 172S: Mod 6

Runoff = 15.47 cfs @ 12.28 hrs, Volume= 1.476 af, Depth= 4.67"

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
*	3.790	98	Ash
	3.790		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 176S: Leachate/Surface Water Pond

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 26.38 cfs @ 12.04 hrs, Volume= 1.445 af, Depth= 4.67"

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
*	3.710	98	Leachate Surface Water Pond
	3.710		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry,**

Summary for Subcatchment 180S: Landfill Open Area

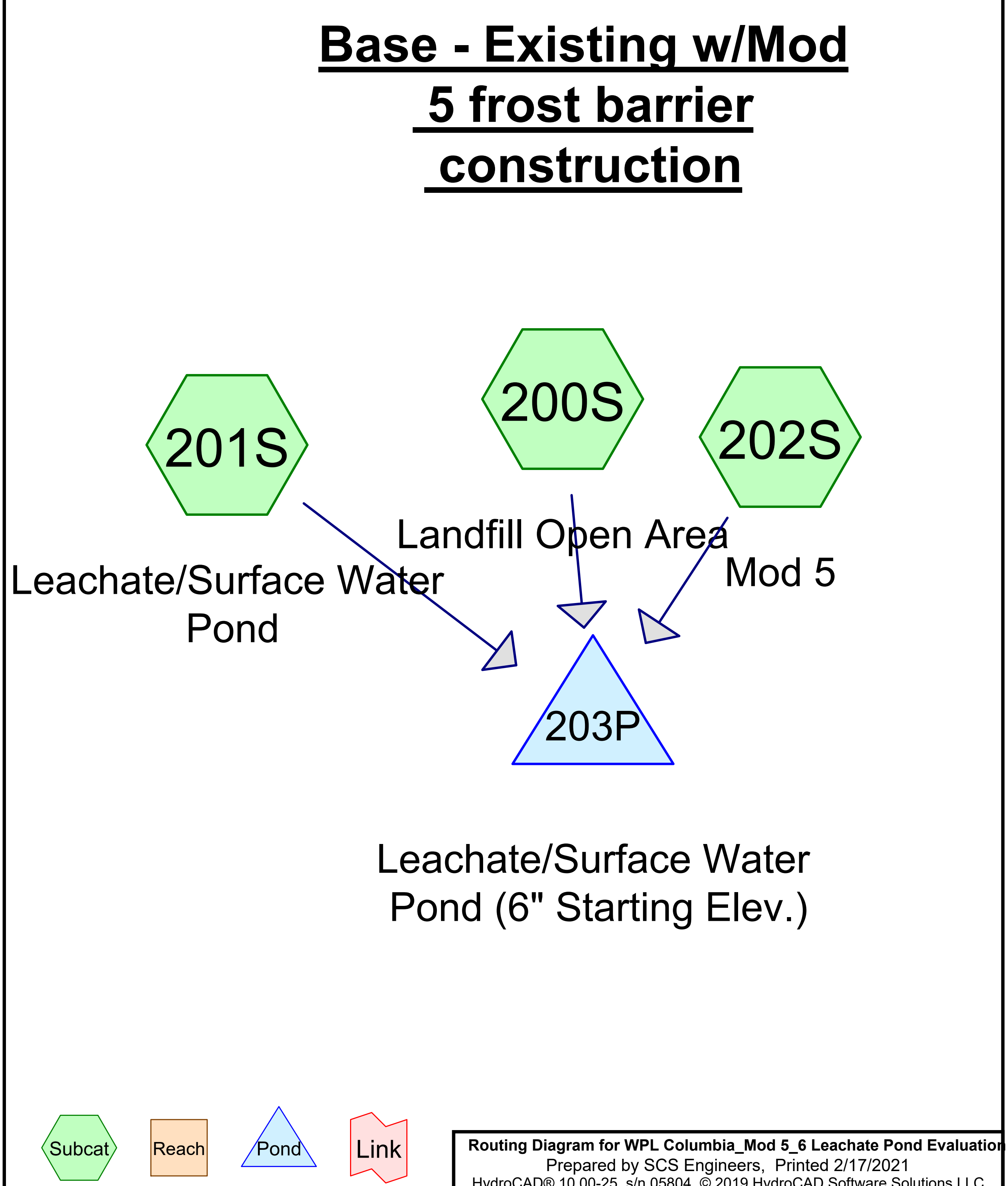
Runoff = 11.18 cfs @ 12.28 hrs, Volume= 1.067 af, Depth= 4.67"

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
*	2.740	98	Allowable Open Area
	2.740		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.0					**Direct Entry, Estimated**

Frost Protection Placement



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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

Subcatchment 200S: Landfill Open Area Runoff Area=6.450 ac 100.00% Impervious Runoff Depth=3.74"
Tc=20.0 min CN=98 Runoff=21.22 cfs 2.008 af

Subcatchment 201S: Leachate/Surface Runoff Area=3.710 ac 100.00% Impervious Runoff Depth=3.74"
Tc=0.0 min CN=98 Runoff=21.27 cfs 1.155 af

Subcatchment 202S: Mod 5 Runoff Area=4.120 ac 100.00% Impervious Runoff Depth=3.74"
Tc=20.0 min CN=98 Runoff=13.55 cfs 1.282 af

Pond 203P: Leachate/Surface Water Peak Elev=796.95' Storage=196,646 cf Inflow=39.08 cfs 4.445 af
Outflow=0.00 cfs 0.000 af

Total Runoff Area = 14.280 ac Runoff Volume = 4.445 af Average Runoff Depth = 3.74"
0.00% Pervious = 0.000 ac 100.00% Impervious = 14.280 ac

Summary for Subcatchment 200S: Landfill Open Area

Runoff = 21.22 cfs @ 12.29 hrs, Volume= 2.008 af, Depth= 3.74"

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
*	6.450	98	Mod 4 Open
	6.450		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 201S: Leachate/Surface Water Pond

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 21.27 cfs @ 12.04 hrs, Volume= 1.155 af, Depth= 3.74"

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
*	3.710	98	Leachate Surface Water Pond
	3.710		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry,**

Summary for Subcatchment 202S: Mod 5

Runoff = 13.55 cfs @ 12.29 hrs, Volume= 1.282 af, Depth= 3.74"

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
*	4.120	98	Ash
	4.120		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.0					**Direct Entry, Estimated**

Summary for Pond 203P: Leachate/Surface Water Pond (6" Starting Elev.)

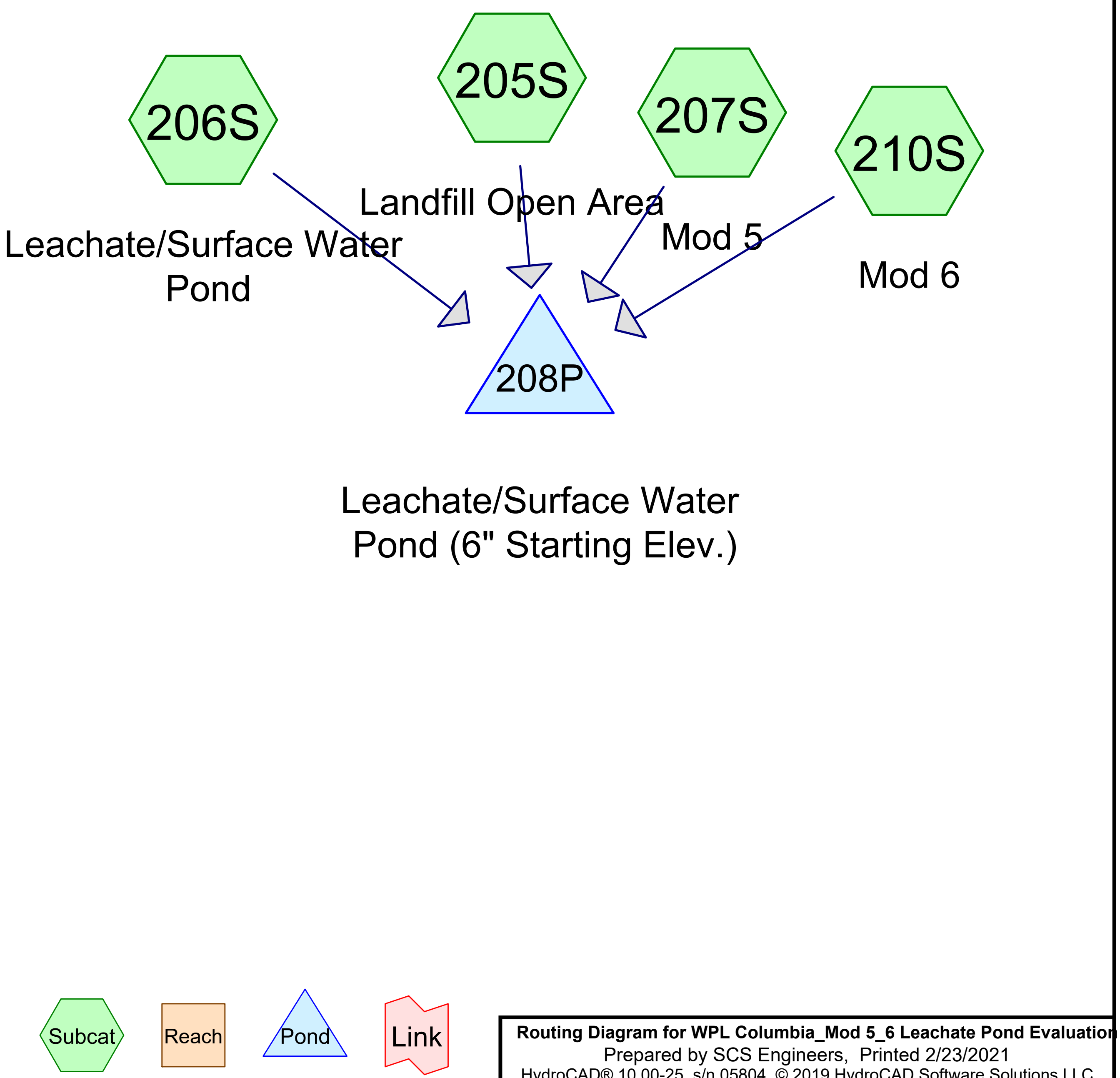
Inflow Area = 14.280 ac,100.00% Impervious, Inflow Depth = 3.74" for 10-yr, 24-hr storm event
Inflow = 39.08 cfs @ 12.27 hrs, Volume= 4.445 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

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= 796.95' @ 25.15 hrs Surf.Area= 61,509 sf Storage= 196,646 cf (193,616 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'	263,654 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



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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

Subcatchment 205S: Landfill Open Area Runoff Area=6.450 ac 100.00% Impervious Runoff Depth=3.74"
Tc=20.0 min CN=98 Runoff=21.22 cfs 2.008 af

Subcatchment 206S: Leachate/Surface Runoff Area=3.710 ac 100.00% Impervious Runoff Depth=3.74"
Tc=0.0 min CN=98 Runoff=21.27 cfs 1.155 af

Subcatchment 207S: Mod 5 Runoff Area=4.120 ac 100.00% Impervious Runoff Depth=3.74"
Tc=20.0 min CN=98 Runoff=13.55 cfs 1.282 af

Subcatchment 210S: Mod 6 Runoff Area=3.790 ac 100.00% Impervious Runoff Depth=3.74"
Tc=20.0 min CN=98 Runoff=12.47 cfs 1.180 af

Pond 208P: Leachate/Surface Water Peak Elev=797.76' Storage=248,035 cf Inflow=51.51 cfs 5.625 af
Outflow=0.00 cfs 0.000 af

Total Runoff Area = 18.070 ac Runoff Volume = 5.625 af Average Runoff Depth = 3.74"
0.00% Pervious = 0.000 ac 100.00% Impervious = 18.070 ac

Summary for Subcatchment 205S: Landfill Open Area

Runoff = 21.22 cfs @ 12.29 hrs, Volume= 2.008 af, Depth= 3.74"

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
*	6.450	98	Mod 4 Open
	6.450		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 206S: Leachate/Surface Water Pond

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 21.27 cfs @ 12.04 hrs, Volume= 1.155 af, Depth= 3.74"

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
*	3.710	98	Leachate Surface Water Pond
	3.710		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry,**

Summary for Subcatchment 207S: Mod 5

Runoff = 13.55 cfs @ 12.29 hrs, Volume= 1.282 af, Depth= 3.74"

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
*	4.120	98	Ash
	4.120		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 210S: Mod 6

Runoff = 12.47 cfs @ 12.29 hrs, Volume= 1.180 af, Depth= 3.74"

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
*	3.790	98	Ash
	3.790		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.0					**Direct Entry, Estimated**

Summary for Pond 208P: Leachate/Surface Water Pond (6" Starting Elev.)

[58] Hint: Peaked 0.79' above defined flood level

Inflow Area = 18.070 ac,100.00% Impervious, Inflow Depth = 3.74" for 10-yr, 24-hr storm event
Inflow = 51.51 cfs @ 12.28 hrs, Volume= 5.625 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= 797.76' @ 25.15 hrs Surf.Area= 65,434 sf Storage= 248,035 cf (245,005 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'	263,654 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

Appendix A3

2021 Module 5 and Module 6 Design

Storm Water Management Calculations

Purpose:
The purpose of the storm water runoff calculations is to demonstrate that the proposed storm water management features included with the proposed Module 5 and 6 construction can accommodate and safely convey the runoff from a 25-year, 24-hour storm event during post construction conditions.

Items addressed in these calculations:

- Swales (Laydown Swale (Swale 1), East Existing Swale (Swale 2), Existing Swale (Swale 3))
- Culverts (C1, C2, C3, C4)
- Discharge Apron (C2, C4)

The proposed storm water management conditions are shown on **Figure 1**.

The calculations support the design of the following proposed storm water management features:

Feature	Purpose	Design Method
Swales	Convey storm water runoff from adjacent areas to Culvert C2 and offsite during post construction conditions	HydroCAD runoff modeling and Swale Calculation
C1 Culvert	Convey storm water from off the rain cover and through the East Existing Swale (Swale 2) during post construction conditions	HydroCAD runoff modeling and HY-8 Culvert Model
C2 Culvert	Convey storm water under access road/entrance into future Mod 7 and 8 through the East Swale during post construction conditions	HydroCAD runoff modeling and HY-8 Culvert Model
C3 Culvert	Convey contact water in the contact water trench from Mod 5 and 6 when Mod 5 and 6 is completely open for CCR placement	HydroCAD runoff modeling and HY-8 Culvert Model
C4 Culvert	Convey storm water under proposed access road entrance in existing swale along plant entrance road during post construction conditions	HydroCAD runoff modeling and HY-8 Culvert Model
Discharge Aprons	Erosion protection from culvert discharge at Culvert C2 and C4	HydroCAD runoff modeling and Apron Calculation

Approach:
<u>Hydrograph Generation</u>
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 spreadsheet based on Manning's equation was used to determine the depth of flow and velocity in the swales based on 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.

Culvert Riprap 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 sizing was used to size the riprap discharge apron.

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).
- Runoff curve numbers were based on tables presented in Urban Hydrology for Small Watersheds, and were assumed as follows:

Cover Type	CN
Final Cover	69 – Pasture/grassland/range in good condition, hydrologic soil group (HSG) C/B (assumed mid value between each soil group)
Woods/Grass Combination	58 – Woods/grass combination in good condition, hydrologic soil group (HSG) B
Meadow	58 – Meadow, non-grazed, HSG B
Rain Cover	98 – Rain Cover (plastic smooth material)
Pavement	92 – Paved roads w/open ditches, 50% impervious HSG C
Gravel	96 – Gravel Surface, HSG C
Coal Combustion Residuals (CCR)	96 – assumed for CCR materials in the landfill

- Type B soil group for non-disturbed areas outside the landfill.
- Other assumptions are included with the calculations attached.

Results:

Hydrograph Generation

The hydrograph modeling results for the 25-year, 24-hour storm events are included in the Post Construction Conditions Hydrograph Generation section.

SCS ENGINEERS

				SHEET NO.	3 of 3		
				CALC. NO.			
				REV. NO.			
Job No.	25220183.00	Job	Columbia Mod 5/6 Construction	BY	RJG	DATE	3/9/21
Client	WPL	Subject	Storm Water Management	CHK'D.	BP	DATE	12/1/21

Swale Sizing

The proposed swales will be constructed as shown on the Drawings. The swales have the capacity to safely convey the 25-year, 24-hour storm events and maintain a minimum 0.5 foot of freeboard. Refer to the Swale Sizing section.

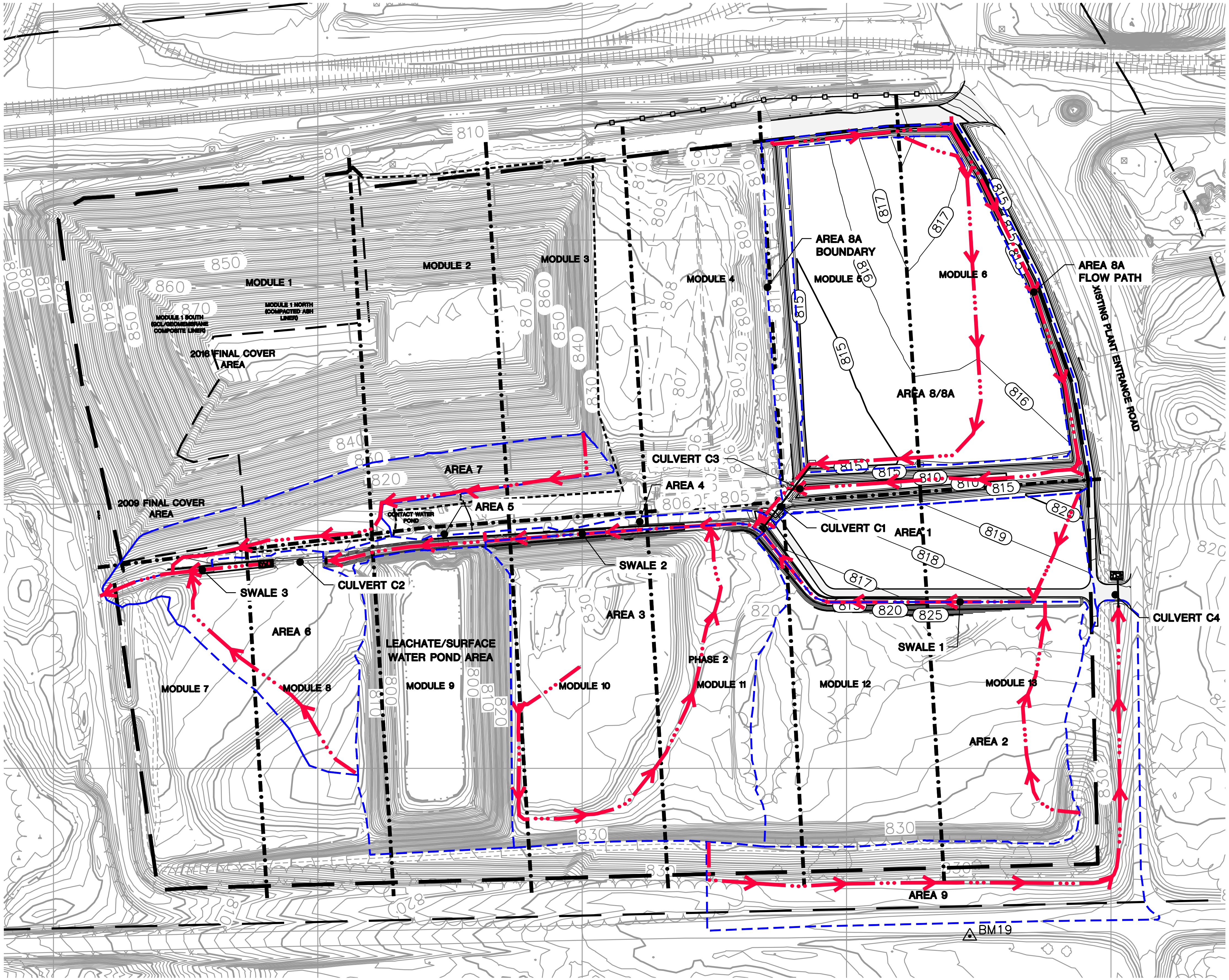
Appropriate erosion control product was selected based on the velocities and shear stress in the swales. Refer to the Swale Sizing section for the evaluation.

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.

Culvert Riprap 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 the Culvert Riprap Apron Sizing for design calculations.



LEGEND

- PROPOSED MODULE LIMIT
- PROPOSED ASH LIMIT
- EXISTING GRADE (1' CONTOUR)
- 690 EXISTING GRADE (5' CONTOUR)
- PROPOSED GRADE (1' CONTOUR)
- PROPOSED GRADE (5' CONTOUR)
- EDGE OF WATER (APPROXIMATE)
- DRAINAGE DIVIDE
- FLOW PATH

N

200 0 200

SCALE: 1" = 200'

PROJECT NO.	25220183.00	DRAWN BY:	MT
DRAWN:	02/11/21	CHECKED BY:	RJG
REVISED:	04/13/21	APPROVED BY:	

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

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

SITE: COLUMBIA ENERGY CENTER, W8375 MURRAY ROAD, PARDEEVILLE, WISCONSIN 53954

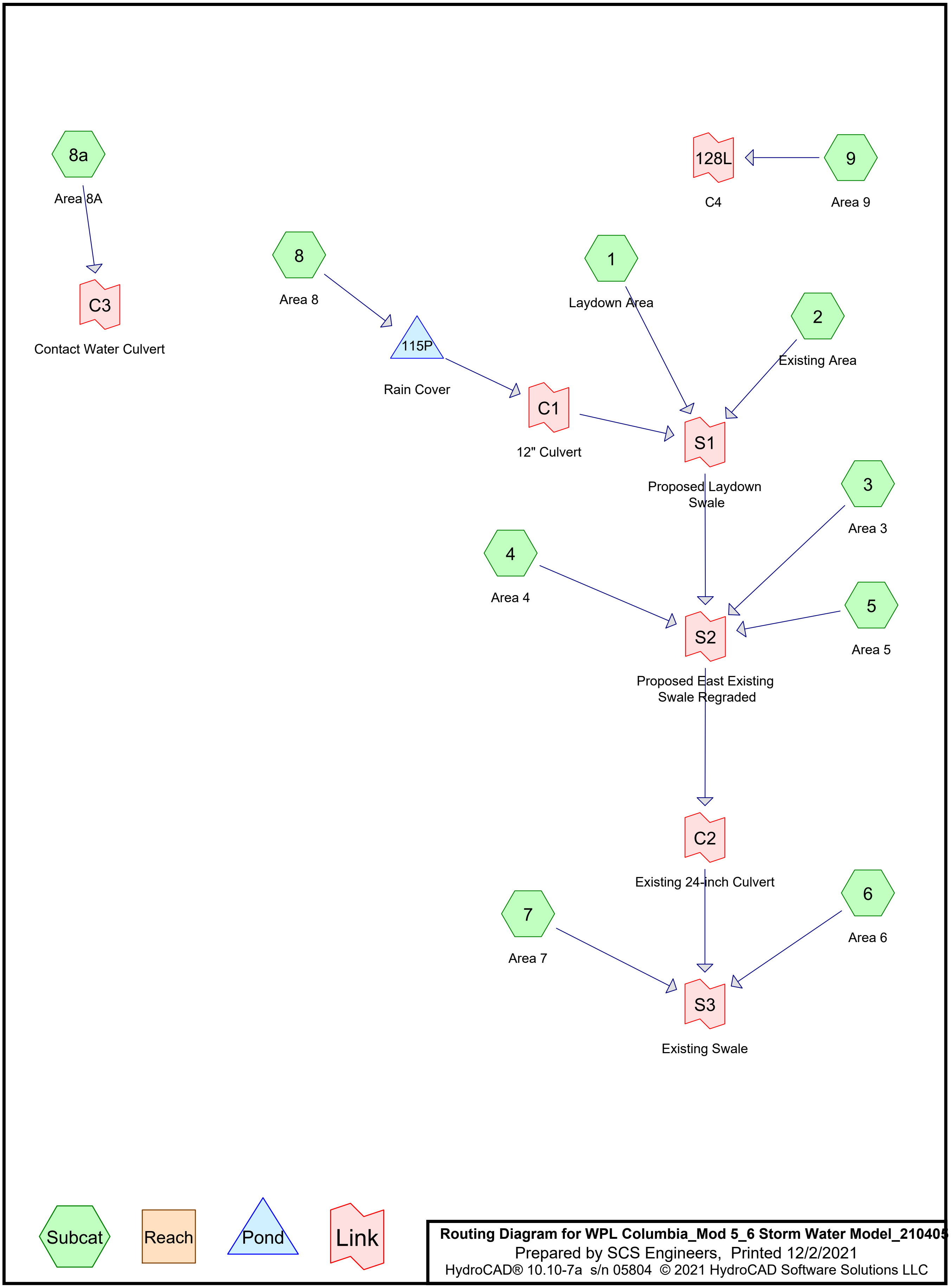
MODULE 5 AND 6 CONSTRUCTION
POST CONSTRUCTION STORM WATER

FIGURE 1

I:\25220183.00\Drawings\Stormwater Landfill\Stormwater_Mod 5-6 Rain Cover.dwg, 12/2/2021 1:57:29 PM

Post Construction Conditions Hydrograph Generation

- 25-year, 24-hour Storm Event



Routing Diagram for WPL Columbia_Mod 5_6 Storm Water Model_210405
Prepared by SCS Engineers, Printed 12/2/2021
HydroCAD® 10.10-7a s/n 05804 © 2021 HydroCAD Software Solutions LLC

Time span=0.00-100.00 hrs, dt=0.05 hrs, 2001 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 1: Laydown Area Runoff Area=107,493 sf 0.00% Impervious Runoff Depth=4.11"
Flow Length=1,631' Tc=6.7 min CN=93 Runoff=14.24 cfs 0.845 af

Subcatchment 2: Existing Area Runoff Area=276,222 sf 0.00% Impervious Runoff Depth=1.12"
Flow Length=1,900' Tc=19.0 min CN=58 Runoff=6.31 cfs 0.592 af

Subcatchment 3: Area 3 Runoff Area=283,569 sf 0.00% Impervious Runoff Depth=1.12"
Flow Length=1,862' Tc=19.1 min CN=58 Runoff=6.45 cfs 0.607 af

Subcatchment 4: Area 4 Runoff Area=11,656 sf 0.00% Impervious Runoff Depth=3.19"
Flow Length=865' Tc=3.8 min CN=84 Runoff=1.43 cfs 0.071 af

Subcatchment 5: Area 5 Runoff Area=9,522 sf 0.00% Impervious Runoff Depth=1.74"
Flow Length=320' Tc=1.8 min CN=67 Runoff=0.71 cfs 0.032 af

Subcatchment 6: Area 6 Runoff Area=101,675 sf 0.00% Impervious Runoff Depth=1.97"
Flow Length=698' Tc=21.3 min CN=70 Runoff=4.34 cfs 0.383 af

Subcatchment 7: Area 7 Runoff Area=90,039 sf 0.00% Impervious Runoff Depth=1.97"
Flow Length=1,075' Tc=31.8 min CN=70 Runoff=3.09 cfs 0.339 af

Subcatchment 8: Area 8 Runoff Area=267,532 sf 100.00% Impervious Runoff Depth=4.67"
Flow Length=967' Slope=0.0043 '/' Tc=13.3 min CN=98 Runoff=30.00 cfs 2.392 af

Subcatchment 8a: Area 8A Runoff Area=364,708 sf 0.00% Impervious Runoff Depth=4.44"
Flow Length=1,615' Tc=6.1 min CN=96 Runoff=50.83 cfs 3.100 af

Subcatchment 9: Area 9 Runoff Area=179,489 sf 6.85% Impervious Runoff Depth=1.45"
Flow Length=1,352' Tc=8.9 min CN=63 Runoff=8.02 cfs 0.499 af

Pond 115P: Rain Cover Peak Elev=815.54' Storage=43,946 cf Inflow=30.00 cfs 2.392 af
12.0" Round Culvert n=0.013 L=147.3' S=0.0068 '/' Outflow=3.52 cfs 2.392 af

Link 128L: C4 Inflow=8.02 cfs 0.499 af
Primary=8.02 cfs 0.499 af

Link C1: 12" Culvert Inflow=3.52 cfs 2.392 af
Primary=3.52 cfs 2.392 af

Link C2: Existing 24-inch Culvert Inflow=24.62 cfs 4.539 af
Primary=24.62 cfs 4.539 af

Link C3: Contact Water Culvert Inflow=50.83 cfs 3.100 af
Primary=50.83 cfs 3.100 af

Link S1: Proposed Laydown Swale Inflow=20.15 cfs 3.829 af
Primary=20.15 cfs 3.829 af

Link S2: Proposed East Existing Swale Regraded
Inflow=24.62 cfs 4.539 af
Primary=24.62 cfs 4.539 af

Link S3: Existing Swale
Inflow=28.21 cfs 5.261 af
Primary=28.21 cfs 5.261 af

Summary for Subcatchment 1: Laydown Area

Runoff = 14.24 cfs @ 12.14 hrs, Volume= 0.845 af, Depth= 4.11"
Routed to Link S1 : Proposed Laydown Swale

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-100.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr storm Rainfall=4.91"

Area (sf)	CN	Description
7,146	58	Meadow, non-grazed, HSG B
100,347	96	Gravel surface, HSG C
107,493	93	Weighted Average
107,493		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.6	100	0.0118	1.04		**Sheet Flow, sheet across laydown area** Smooth surfaces n= 0.011 P2= 2.78"
1.1	112	0.0118	1.75		**Shallow Concentrated Flow, flow across laydown area and acce** Unpaved Kv= 16.1 fps
0.1	11	0.2182	3.27		**Shallow Concentrated Flow, Slope into Swale** Short Grass Pasture Kv= 7.0 fps
1.2	573	0.0076	8.13	585.12	**Trap/Vee/Rect Channel Flow,** Bot.W=10.00' D=4.00' Z= 2.0 '/' Top.W=26.00' n= 0.030 Earth, grassed & winding
0.1	21	0.0076	5.60	156.89	**Trap/Vee/Rect Channel Flow,** Bot.W=10.00' D=2.00' Z= 2.0 '/' Top.W=18.00' n= 0.030 Earth, grassed & winding
1.6	511	0.0073	5.49	153.76	**Trap/Vee/Rect Channel Flow,** Bot.W=10.00' D=2.00' Z= 2.0 '/' Top.W=18.00' n= 0.030 Earth, grassed & winding
1.0	303	0.0067	5.03	171.18	**Trap/Vee/Rect Channel Flow,** Bot.W=10.00' D=2.00' Z= 4.0 & 3.0 '/' Top.W=24.00' n= 0.030 Earth, grassed & winding
6.7	1,631	Total			

Summary for Subcatchment 2: Existing Area

Runoff = 6.31 cfs @ 12.32 hrs, Volume= 0.592 af, Depth= 1.12"
Routed to Link S1 : Proposed Laydown Swale

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-100.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr storm Rainfall=4.91"

Area (sf)	CN	Description
13,491	58	Meadow, non-grazed, HSG B
857	96	Gravel surface, HSG C
261,874	58	Woods/grass comb., Good, HSG B
276,222	58	Weighted Average
276,222		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.4	55	0.2364	0.38		**Sheet Flow, Sheet** Grass: Short n= 0.150 P2= 2.78"
5.8	45	0.0179	0.13		**Sheet Flow, Sheet** Grass: Short n= 0.150 P2= 2.78"
6.2	347	0.0179	0.94		**Shallow Concentrated Flow, Shallow** Short Grass Pasture Kv= 7.0 fps
0.1	25	0.1720	2.90		**Shallow Concentrated Flow, Slope into Swale** Short Grass Pasture Kv= 7.0 fps
1.8	593	0.0076	5.60	156.89	**Trap/Vee/Rect Channel Flow,** Bot.W=10.00' D=2.00' Z= 2.0 '/' Top.W=18.00' n= 0.030 Earth, grassed & winding
0.1	21	0.0076	5.60	156.89	**Trap/Vee/Rect Channel Flow,** Bot.W=10.00' D=2.00' Z= 2.0 '/' Top.W=18.00' n= 0.030 Earth, grassed & winding
1.6	511	0.0073	5.49	153.76	**Trap/Vee/Rect Channel Flow,** Bot.W=10.00' D=2.00' Z= 2.0 '/' Top.W=18.00' n= 0.030 Earth, grassed & winding
1.0	303	0.0067	5.03	171.18	**Trap/Vee/Rect Channel Flow,** Bot.W=10.00' D=2.00' Z= 3.0 & 4.0 '/' Top.W=24.00' n= 0.030 Earth, grassed & winding
19.0	1,900	Total			

Summary for Subcatchment 3: Area 3

Runoff = 6.45 cfs @ 12.32 hrs, Volume= 0.607 af, Depth= 1.12"
Routed to Link S2 : Proposed East Existing Swale Regraded

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-100.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr storm Rainfall=4.91"

Area (sf)	CN	Description
283,569	58	Woods/grass comb., Good, HSG B
283,569		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.2	100	0.0217	0.16		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.78"
0.6	38	0.0217	1.03		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
2.9	759	0.0105	4.32	125.30	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=2.00' Z= 5.0 & 9.5 '/' Top.W=29.00' n= 0.035 Earth, dense weeds
3.0	234	0.0350	1.31		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.4	428	0.0067	5.26	147.30	**Trap/Vee/Rect Channel Flow,** Bot.W=10.00' D=2.00' Z= 2.0 '/' Top.W=18.00' n= 0.030 Earth, grassed & winding
1.0	303	0.0067	5.03	171.18	**Trap/Vee/Rect Channel Flow,** Bot.W=10.00' D=2.00' Z= 3.0 & 4.0 '/' Top.W=24.00' n= 0.030 Earth, grassed & winding
19.1	1,862	Total			

Summary for Subcatchment 4: Area 4

[49] Hint: Tc<2dt may require smaller dt

Runoff = 1.43 cfs @ 12.10 hrs, Volume= 0.071 af, Depth= 3.19"
Routed to Link S2 : Proposed East Existing Swale Regraded

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-100.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr storm Rainfall=4.91"

	Area (sf)	CN	Description
	6,339	96	Gravel surface, HSG C
*	5,317	69	>75% Grass cover, Good, HSG C
	11,656	84	Weighted Average
	11,656		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.4	36	0.0639	1.66		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.78"
0.8	15	0.2867	0.31		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.78"
1.6	511	0.0073	5.49	153.76	**Trap/Vee/Rect Channel Flow,** Bot.W=10.00' D=2.00' Z= 2.0 '/' Top.W=18.00' n= 0.030 Earth, grassed & winding
1.0	303	0.0067	5.03	171.18	**Trap/Vee/Rect Channel Flow,** Bot.W=10.00' D=2.00' Z= 3.0 & 4.0 '/' Top.W=24.00' n= 0.030 Earth, grassed & winding
3.8	865	Total			

Summary for Subcatchment 5: Area 5

[49] Hint: Tc<2dt may require smaller dt

Runoff = 0.71 cfs @ 12.08 hrs, Volume= 0.032 af, Depth= 1.74"
Routed to Link S2 : Proposed East Existing Swale Regraded

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-100.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr storm Rainfall=4.91"

Area (sf)	CN	Description
2,284	96	Gravel surface, HSG C
7,238	58	Meadow, non-grazed, HSG B
9,522	67	Weighted Average
9,522		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.3	9	0.0050	0.45		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.78"
0.5	8	0.2537	0.26		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.78"
1.0	303	0.0067	5.03	171.18	**Trap/Vee/Rect Channel Flow,** Bot.W=10.00' D=2.00' Z= 3.0 & 4.0 '/' Top.W=24.00' n= 0.030 Earth, grassed & winding
1.8	320	Total			

Summary for Subcatchment 6: Area 6

Runoff = 4.34 cfs @ 12.32 hrs, Volume= 0.383 af, Depth= 1.97"
Routed to Link S3 : Existing Swale

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-100.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr storm Rainfall=4.91"

	Area (sf)	CN	Description
*	99,711	69	>75% Grass cover, Good, HSG C
	1,964	96	Gravel surface, HSG C
	101,675	70	Weighted Average
	101,675		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.1	100	0.0283	0.18		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.78"
0.8	59	0.0283	1.18		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.2	35	0.1714	2.90		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
4.7	240	0.0146	0.85		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.2	72	0.0208	1.01		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.1	13	0.2154	3.25		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
5.2	179	0.0067	0.57		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
21.3	698	Total			

Summary for Subcatchment 7: Area 7

Runoff = 3.09 cfs @ 12.47 hrs, Volume= 0.339 af, Depth= 1.97"
Routed to Link S3 : Existing Swale

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-100.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr storm Rainfall=4.91"

	Area (sf)	CN	Description
*	86,044	69	>75% Grass cover, Good, HSG C
	3,995	96	Gravel surface, HSG C
	90,039	70	Weighted Average
	90,039		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.2	80	0.2500	0.42		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.78"
3.1	20	0.0165	0.11		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.78"
6.9	373	0.0165	0.90		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.6	53	0.0377	1.36		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
13.6	365	0.0041	0.45		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.2	31	0.0323	2.89		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.0	8	0.2537	3.53		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
4.2	145	0.0067	0.57		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
31.8	1,075	Total			

Summary for Subcatchment 8: Area 8

Runoff = 30.00 cfs @ 12.21 hrs, Volume= 2.392 af, Depth= 4.67"
Routed to Pond 115P : Rain Cover

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-100.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr storm Rainfall=4.91"

	Area (sf)	CN	Description
*	267,532	98	Rain Cover
	267,532		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.4	100	0.0043	0.69		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.78"
10.9	867	0.0043	1.33		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
13.3	967	Total			

Summary for Subcatchment 8a: Area 8A

[47] Hint: Peak is 100124% of capacity of segment #4

Runoff = 50.83 cfs @ 12.13 hrs, Volume= 3.100 af, Depth= 4.44"
Routed to Link C3 : Contact Water Culvert

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-100.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr storm Rainfall=4.91"

	Area (sf)	CN	Description
*	364,708	96	open CCR
	364,708		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.1	9	0.3333	2.44		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.78"
3.9	1,036	0.0047	4.47	53.65	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=2.00' Z= 3.0 '/' Top.W=12.00' n= 0.022 Earth, clean & straight
1.6	540	0.0056	5.55	99.88	**Trap/Vee/Rect Channel Flow,** Bot.W=3.00' D=2.00' Z= 3.0 '/' Top.W=15.00' n= 0.022 Earth, clean & straight
0.5	30	0.0033	1.03	0.05	**Pipe Channel,** 3.0" Round Area= 0.0 sf Perim= 0.8' r= 0.06' n= 0.013 Corrugated PE, smooth interior
6.1	1,615	Total			

Summary for Subcatchment 9: Area 9

Runoff = 8.02 cfs @ 12.17 hrs, Volume= 0.499 af, Depth= 1.45"
Routed to Link 128L : C4

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-100.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr storm Rainfall=4.91"

Area (sf)	CN	Description
154,913	58	Woods/grass comb., Good, HSG B
24,576	92	Paved roads w/open ditches, 50% imp, HSG C
179,489	63	Weighted Average
167,201		93.15% Pervious Area
12,288		6.85% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.4	72	0.1806	0.36		**Sheet Flow, Sheet** Grass: Short n= 0.150 P2= 2.78"
4.8	925	0.0043	3.22	83.79	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=2.00' Z= 6.0 & 7.0 '/' Top.W=26.00' n= 0.030 Earth, grassed & winding
0.7	355	0.0197	8.00	325.06	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=2.50' Z= 8.0 & 5.0 '/' Top.W=32.50' n= 0.030 Earth, grassed & winding
8.9	1,352	Total			

Summary for Pond 115P: Rain Cover

Inflow Area = 6.142 ac,100.00% Impervious, Inflow Depth = 4.67" for 25-yr, 24-hr storm event
Inflow = 30.00 cfs @ 12.21 hrs, Volume= 2.392 af
Outflow = 3.52 cfs @ 12.92 hrs, Volume= 2.392 af, Atten= 88%, Lag= 42.5 min
Primary = 3.52 cfs @ 12.92 hrs, Volume= 2.392 af
Routed to Link C1 : 12" Culvert

Routing by Dyn-Stor-Ind method, Time Span= 0.00-100.00 hrs, dt= 0.05 hrs
Peak Elev= 815.54' @ 12.92 hrs Surf.Area= 76,209 sf Storage= 43,946 cf

Plug-Flow detention time= 104.9 min calculated for 2.391 af (100% of inflow)
Center-of-Mass det. time= 104.9 min (858.4 - 753.5)

Volume	Invert	Avail.Storage	Storage Description
#1	813.50'	92,479 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
813.50	1	0	0
814.50	8,879	4,440	4,440
815.00	33,357	10,559	14,999
815.50	71,848	26,301	41,300
816.00	132,867	51,179	92,479

Device	Routing	Invert	Outlet Devices
#1	Primary	813.50'	**12.0" Round Culvert** L= 147.3' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 813.50' / 812.50' S= 0.0068 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=3.52 cfs @ 12.92 hrs HW=815.54' TW=0.00' (Dynamic Tailwater)
└─**1=Culvert** (Barrel Controls 3.52 cfs @ 4.48 fps)

Summary for Link 128L: C4

Inflow Area = 4.121 ac, 6.85% Impervious, Inflow Depth = 1.45" for 25-yr, 24-hr storm event
Inflow = 8.02 cfs @ 12.17 hrs, Volume= 0.499 af
Primary = 8.02 cfs @ 12.17 hrs, Volume= 0.499 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-100.00 hrs, dt= 0.05 hrs

Summary for Link C1: 12" Culvert

Inflow Area = 6.142 ac,100.00% Impervious, Inflow Depth = 4.67" for 25-yr, 24-hr storm event
Inflow = 3.52 cfs @ 12.92 hrs, Volume= 2.392 af
Primary = 3.52 cfs @ 12.92 hrs, Volume= 2.392 af, Atten= 0%, Lag= 0.0 min
Routed to Link S1 : Proposed Laydown Swale

Primary outflow = Inflow, Time Span= 0.00-100.00 hrs, dt= 0.05 hrs

Summary for Link C2: Existing 24-inch Culvert

Inflow Area = 21.947 ac, 27.98% Impervious, Inflow Depth = 2.48" for 25-yr, 24-hr storm event
Inflow = 24.62 cfs @ 12.16 hrs, Volume= 4.539 af
Primary = 24.62 cfs @ 12.16 hrs, Volume= 4.539 af, Atten= 0%, Lag= 0.0 min
Routed to Link S3 : Existing Swale

Primary outflow = Inflow, Time Span= 0.00-100.00 hrs, dt= 0.05 hrs

Summary for Link C3: Contact Water Culvert

Inflow Area = 8.373 ac, 0.00% Impervious, Inflow Depth = 4.44" for 25-yr, 24-hr storm event
Inflow = 50.83 cfs @ 12.13 hrs, Volume= 3.100 af
Primary = 50.83 cfs @ 12.13 hrs, Volume= 3.100 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-100.00 hrs, dt= 0.05 hrs

Summary for Link S1: Proposed Laydown Swale

Inflow Area = 14.951 ac, 41.08% Impervious, Inflow Depth = 3.07" for 25-yr, 24-hr storm event
Inflow = 20.15 cfs @ 12.15 hrs, Volume= 3.829 af
Primary = 20.15 cfs @ 12.15 hrs, Volume= 3.829 af, Atten= 0%, Lag= 0.0 min
Routed to Link S2 : Proposed East Existing Swale Regraded

Primary outflow = Inflow, Time Span= 0.00-100.00 hrs, dt= 0.05 hrs

Summary for Link S2: Proposed East Existing Swale Regraded

Inflow Area = 21.947 ac, 27.98% Impervious, Inflow Depth = 2.48" for 25-yr, 24-hr storm event
Inflow = 24.62 cfs @ 12.16 hrs, Volume= 4.539 af
Primary = 24.62 cfs @ 12.16 hrs, Volume= 4.539 af, Atten= 0%, Lag= 0.0 min
Routed to Link C2 : Existing 24-inch Culvert

Primary outflow = Inflow, Time Span= 0.00-100.00 hrs, dt= 0.05 hrs

Summary for Link S3: Existing Swale

Inflow Area = 26.348 ac, 23.31% Impervious, Inflow Depth = 2.40" for 25-yr, 24-hr storm event
Inflow = 28.21 cfs @ 12.29 hrs, Volume= 5.261 af
Primary = 28.21 cfs @ 12.29 hrs, Volume= 5.261 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-100.00 hrs, dt= 0.05 hrs

TABLE OF CONTENTS

Swale Sizing

SCS ENGINEERS

		Sheet No:	1 of 2
		Calc. No.	
		Rev. No.	0
Job No. 25220183.00	Job: Columbia Energy Center	By: RJG	Date: 3/11/21
Client: WPL	Subject: Swale Sizing	Chk'd: BP	Date: 12/1/21

Purpose:

To size the proposed swale along Mod 5 and 6 laydown area to accommodate the 25-year, 24-hour storm event and determine required rolled erosion control product. To confirm capacity of existing swale with addition of Mod 5/6 rain cover and the proposed Mod 5 and 6 swale.

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_MOD5_6 Post Construction
4. Table 7E-5.01: Typical Rolled Erosion Control Product Properties and Uses, Iowa SUDAS Design and Specifications Manual.

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 Table 7E-5.01 (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
Swale S1 =	20.2 cfs
Swale S2 =	24.6 cfs
Swale S3 =	28.2 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.

 SCS ENGINEERS

Sheet No:	2 of 2		
Calc. No.			
Rev. No.			
By: RJG		Date: 3/11/21	
Chk'd: BP		Date: 12/1/21	

Job No. 25220183.00 Job: Columbia Energy Center
Client: WPL Subject: Swale Sizing

	25-yr	25-yr	25-yr
Channel/Ditch Geometry	**Swale 1**	**Swale 2**	**Swale 3**
Channel Slope, S_o (ft/ft)	**0.0076**	**0.0073**	**0.0067**
Channel Bottom Width, B (ft)	**10**	**10**	**10**
Channel Side Slope, z_1	**2**	**2**	**3**
Channel Side Slope, z_2	**2**	**2**	**4**
Flow Depth, d (ft) Solve iteratively	**1.05**	**1.17**	**1.25**
Safety Factor, SF	**1.0**	**1.0**	**1.0**
Vegetation/Soil Parameters			
Vegetation Retardance Class	**C**	**C**	**C**
Vegetation Condition	**good**	**good**	**good**
Vegetation Growth Form	**turf**	**turf**	**turf**
Soil Type	**cohesive**	**cohesive**	**cohesive**
D_{75} (in) (Set at 0.00 for cohesive soils)			
ASTM Soil Class	**SC**	**SC**	**SC**
Plasticity Index, PI	**16**	**16**	**16**
Results Summary			
Design Q (ft^3/s)	**20.2**	**24.6**	**28.2**
1. Swales geometry shown on the drawing set.	20.5	25.0	28.4
Difference Between Design & Calc. Flow (%)	1.8%	1.5%	0.8%
Stable (Yes or No)	**YES**	**YES**	**YES**
Channel Parameters			
Vegetation Height, h (ft)	0.67	0.67	0.67
Grass Roughness Coefficient, C_n	0.238	0.238	0.238
Cover Factor, C_f	0.90	0.90	0.90
Noncohesive Soil			
Soil Grain Roughness, n_s	0.016	0.016	0.016
Permissible Soil Shear Stress, τ_p (lb/ft^2)	N/A	N/A	N/A
Cohesive Soil			
Porosity, e	0.35	0.35	0.35
Soil Coefficient 1, c_1	1.0700	1.0700	1.0700
Soil Coefficient 2, c_2	14.30	14.30	14.30
Soil Coefficient 3, c_3	47.700	47.700	47.700
Soil Coefficient 4, c_4	1.42	1.42	1.42
Soil Coefficient 5, c_5	-0.61	-0.61	-0.61
Soil Coefficient 6, c_6	0.00010	0.00010	0.00010
Permissible Soil Shear Stress, τ_p (lb/ft^2)	0.080	0.080	0.080
Total Permissible Shear Stress, τ_p (lb/ft^2)	0.080	0.080	0.080
Cross Sectional Area, A (ft^2)	12.705	14.438	17.969
Wetted Perimeter, P (ft)	14.70	15.23	19.11
Hydraulic Radius, R (ft)	0.865	0.948	0.940
Top Width, T (ft)	14.20	14.68	18.75
Hydraulic Depth, D (ft)	0.895	0.984	0.958
Froude Number (Q design)	0.301	0.307	0.285
Channel Shear Stress, τ_o (lb/ft^2)	0.41	0.43	0.39
Actual Sheer Stress, τ_d (lb/ft^2)	0.50	0.53	0.52
Mannings n	0.073	0.071	0.074
Average Velocity, V (ft/s)	1.59	1.71	1.57
Calculated Flow, Q (ft^3/s)	20.5	25.0	28.4
Difference Between Design & Calc. Flow (%)	1.8%	1.5%	0.8%
Effective Shear on Soil Surface, τ_e (lb/ft^2)	0.002	0.003	0.002
Total Permissible Shear on Veg., $\tau_{p,veg}$ (lb/ft^2)	16.68	15.78	17.14
Stable (Y or N)	YES	YES	YES

Source: Grass Lined Channel Design WisDOT Spreadsheet, FDM 13-30 Attachment 15.2

Culvert Sizing

HY-8 Culvert Analysis Report – C1

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 3.52 cfs

Design Flow: 3.52 cfs

Maximum Flow: 3.52 cfs

Site Data - C1

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 813.50 ft

Outlet Station: 147.34 ft

Outlet Elevation: 812.50 ft

Number of Barrels: 1

Culvert Data Summary - C1

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: Thin Edge Projecting

Inlet Depression: NONE

Tailwater Channel Data - Culvert C1 Rain Cover

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 10.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0160

Channel Manning's n: 0.0450

Channel Invert Elevation: 813.00 ft

Roadway Data for Crossing: Culvert C1 Rain Cover

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 30.00 ft

Crest Elevation: 816.00 ft

Roadway Surface: Gravel

Roadway Top Width: 80.00 ft

Table 1 - Summary of Culvert Flows at Crossing: Culvert C1 Rain Cover

Headwater Elevation (ft)	Total Discharge (cfs)	C1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
815.21	3.52	3.52	0.00	1
815.22	3.54	3.54	0.00	1
815.24	3.56	3.56	0.00	1
815.25	3.58	3.58	0.00	1
815.26	3.60	3.60	0.00	1
815.27	3.62	3.62	0.00	1
815.28	3.63	3.63	0.00	1
815.31	3.65	3.65	0.00	1
815.34	3.67	3.67	0.00	1
815.36	3.69	3.69	0.00	1
815.39	3.71	3.71	0.00	1
816.00	4.19	4.19	0.00	Overtopping

Table 2 - Culvert Summary Table: 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)
3.52	3.52	815.21	1.713	1.593	7-M2c	1.000	0.798	0.798	0.225	5.236	1.494
3.54	3.54	815.22	1.725	1.627	7-M2c	1.000	0.800	0.800	0.226	5.251	1.498
3.56	3.56	815.24	1.736	1.662	7-M2c	1.000	0.802	0.802	0.227	5.267	1.501
3.58	3.58	815.25	1.748	1.694	7-M2c	1.000	0.804	0.804	0.228	5.283	1.503
3.60	3.60	815.26	1.759	1.729	7-M2c	1.000	0.806	0.806	0.228	5.299	1.506
3.62	3.62	815.27	1.771	1.752	7-M2c	1.000	0.808	0.808	0.229	5.315	1.510
3.63	3.63	815.28	1.783	1.784	7-M2c	1.000	0.810	0.810	0.230	5.331	1.512
3.65	3.65	815.31	1.794	1.811	7-M2c	1.000	0.812	0.812	0.230	5.347	1.516
3.67	3.67	815.34	1.806	1.837	7-M2c	1.000	0.814	0.814	0.231	5.363	1.519
3.69	3.69	815.36	1.818	1.862	7-M2c	1.000	0.816	0.816	0.232	5.379	1.521
3.71	3.71	815.39	1.830	1.887	7-M2c	1.000	0.818	0.818	0.233	5.396	1.525

****

Straight Culvert

Inlet Elevation (invert): 813.50 ft,   Outlet Elevation (invert): 812.50 ft

Culvert Length: 147.34 ft,   Culvert Slope: 0.0068

****

HY-8 Culvert Analysis Report – C2

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 24.62 cfs

Design Flow: 24.62 cfs

Maximum Flow: 24.62 cfs

Site Data - C2

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 805.42 ft

Outlet Station: 100.00 ft

Outlet Elevation: 804.75 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

Tailwater Channel Data - Culvert C2

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: 0.0450

Channel Invert Elevation: 804.56 ft

Roadway Data for Crossing: Culvert C2

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

Table 1 - Summary of Culvert Flows at Crossing: Culvert C2

Headwater Elevation (ft)	Total Discharge (cfs)	C2 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
807.37	24.62	24.62	0.00	1
807.37	24.62	24.62	0.00	1
807.37	24.62	24.62	0.00	1
807.37	24.62	24.62	0.00	1
807.37	24.62	24.62	0.00	1
807.37	24.62	24.62	0.00	1
807.37	24.62	24.62	0.00	1
807.37	24.62	24.62	0.00	1
807.37	24.62	24.62	0.00	1
807.37	24.62	24.62	0.00	1
807.37	24.62	24.62	0.00	1
808.50	41.78	41.78	0.00	Overtopping

Table 2 - 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)
24.62	24.62	807.37	1.947	0.045	1-S2n	1.028	1.259	1.134	0.905	5.966	2.303
24.62	24.62	807.37	1.947	1.197	1-S2n	1.028	1.259	1.134	0.905	5.966	2.303
24.62	24.62	807.37	1.947	1.197	1-S2n	1.028	1.259	1.134	0.905	5.966	2.303
24.62	24.62	807.37	1.947	1.197	1-S2n	1.028	1.259	1.134	0.905	5.966	2.303
24.62	24.62	807.37	1.947	1.197	1-S2n	1.028	1.259	1.134	0.905	5.966	2.303
24.62	24.62	807.37	1.947	1.197	1-S2n	1.028	1.259	1.134	0.905	5.966	2.303
24.62	24.62	807.37	1.947	1.197	1-S2n	1.028	1.259	1.134	0.905	5.966	2.303
24.62	24.62	807.37	1.947	1.197	1-S2n	1.028	1.259	1.134	0.905	5.966	2.303
24.62	24.62	807.37	1.947	1.197	1-S2n	1.028	1.259	1.134	0.905	5.966	2.303
24.62	24.62	807.37	1.947	1.197	1-S2n	1.028	1.259	1.134	0.905	5.966	2.303
24.62	24.62	807.37	1.947	1.197	1-S2n	1.028	1.259	1.134	0.905	5.966	2.303

****

Straight Culvert

Inlet Elevation (invert): 805.42 ft, Outlet Elevation (invert): 804.75 ft

Culvert Length: 100.00 ft, Culvert Slope: 0.0067

****

HY-8 Culvert Analysis Report – C3

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 50.83 cfs

Design Flow: 50.83 cfs

Maximum Flow: 50.83 cfs

Site Data - Culvert C3

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 808.09 ft

Outlet Station: 75.00 ft

Outlet Elevation: 807.71 ft

Number of Barrels: 1

Culvert Data Summary - Culvert C3

Barrel Shape: Circular

Barrel Diameter: 3.00 ft

Barrel Material: Smooth HDPE

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Thin Edge Projecting

Inlet Depression: NONE

Tailwater Channel Data - Culvert C3

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 3.00 ft

Side Slope (H:V): 3.00 (_:1)

Channel Slope: 0.0050

Channel Manning's n: 0.0020

Channel Invert Elevation: 808.90 ft

Roadway Data for Crossing: Culvert C3

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 20.00 ft

Crest Elevation: 816.00 ft

Roadway Surface: Gravel

Roadway Top Width: 35.00 ft

Table 1 - Summary of Culvert Flows at Crossing: Culvert C3

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert C3 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
812.79	50.83	50.83	0.00	1
812.98	52.63	52.63	0.00	1
813.18	54.43	54.43	0.00	1
813.39	56.22	56.22	0.00	1
813.61	58.02	58.02	0.00	1
813.83	59.82	59.82	0.00	1
814.06	61.62	61.62	0.00	1
814.31	63.42	63.42	0.00	1
814.56	65.21	65.21	0.00	1
814.82	67.01	67.01	0.00	1
815.08	68.81	68.81	0.00	1
816.00	74.56	74.56	0.00	Overtopping

Table 2 - Culvert Summary Table: Culvert 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)
50.83	50.83	812.79	4.698	1.266	5-S2n	2.209	2.317	2.312	0.456	7.984	25.521
52.63	52.63	812.98	4.891	4.565	7-M2c	3.000	2.355	2.355	0.465	8.840	25.780
54.43	54.43	813.18	5.092	4.673	7-M2c	3.000	2.393	2.393	0.473	9.005	26.035
56.22	56.22	813.39	5.300	4.788	7-M2c	3.000	2.429	2.429	0.481	9.172	26.288
58.02	58.02	813.61	5.517	4.910	7-M2c	3.000	2.463	2.463	0.489	9.342	26.531
59.82	59.82	813.83	5.742	5.041	7-M2c	3.000	2.496	2.496	0.497	9.516	26.767
61.62	61.62	814.06	5.975	5.183	7-M2c	3.000	2.528	2.528	0.505	9.693	26.996
63.42	63.42	814.31	6.217	5.337	7-M2c	3.000	2.559	2.559	0.513	9.874	27.225
65.21	65.21	814.56	6.467	5.524	7-M2c	3.000	2.588	2.588	0.521	10.059	27.448
67.01	67.01	814.82	6.726	5.713	7-M2c	3.000	2.615	2.615	0.528	10.248	27.658
68.81	68.81	815.08	6.994	5.912	7-M2c	3.000	2.641	2.641	0.536	10.441	27.870

****

Straight Culvert

Inlet Elevation (invert): 808.09 ft, Outlet Elevation (invert): 807.71 ft

Culvert Length: 75.00 ft, Culvert Slope: 0.0051

****

HY-8 Culvert Analysis Report – C4

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 8.02 cfs

Design Flow: 8.02 cfs

Maximum Flow: 8.02 cfs

Site Data - Culvert C4

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 816.30 ft

Outlet Station: 48.69 ft

Outlet Elevation: 815.32 ft

Number of Barrels: 2

Culvert Data Summary - Culvert C4

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

Tailwater Channel Data - Culvert C4

Tailwater Channel Option: Triangular Channel

Side Slope (H:V): 6.00 (_:1)

Channel Slope: 0.0300

Channel Manning's n: 0.0450

Channel Invert Elevation: 815.32 ft

Roadway Data for Crossing: Culvert C4

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

Table 1 - Summary of Culvert Flows at Crossing: Culvert C4

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert C4 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
817.99	8.02	8.02	0.00	1
817.99	8.02	8.02	0.00	1
817.99	8.02	8.02	0.00	1
817.99	8.02	8.02	0.00	1
817.99	8.02	8.02	0.00	1
817.99	8.02	8.02	0.00	1
817.99	8.02	8.02	0.00	1
817.99	8.02	8.02	0.00	1
817.99	8.02	8.02	0.00	1
817.99	8.02	8.02	0.00	1
817.99	8.02	8.02	0.00	1
819.06	11.42	11.42	0.00	Overtopping

Table 2 - Culvert Summary Table: Culvert 1

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)
8.02	8.02	817.99	1.688	0.0*	5-S2n	0.578	0.846	0.648	0.692	6.689	2.793
8.02	8.02	817.99	1.688	1.073	5-S2n	0.578	0.846	0.648	0.692	6.689	2.793
8.02	8.02	817.99	1.688	1.073	5-S2n	0.578	0.846	0.648	0.692	6.689	2.793
8.02	8.02	817.99	1.688	1.073	5-S2n	0.578	0.846	0.648	0.692	6.689	2.793
8.02	8.02	817.99	1.688	1.073	5-S2n	0.578	0.846	0.648	0.692	6.689	2.793
8.02	8.02	817.99	1.688	1.073	5-S2n	0.578	0.846	0.648	0.692	6.689	2.793
8.02	8.02	817.99	1.688	1.073	5-S2n	0.578	0.846	0.648	0.692	6.689	2.793
8.02	8.02	817.99	1.688	1.073	5-S2n	0.578	0.846	0.648	0.692	6.689	2.793
8.02	8.02	817.99	1.688	1.073	5-S2n	0.578	0.846	0.648	0.692	6.689	2.793
8.02	8.02	817.99	1.688	1.073	5-S2n	0.578	0.846	0.648	0.692	6.689	2.793
8.02	8.02	817.99	1.688	1.073	5-S2n	0.578	0.846	0.648	0.692	6.689	2.793

* Full Flow Headwater elevation is below inlet invert.

****

Straight Culvert

Inlet Elevation (invert): 816.30 ft, Outlet Elevation (invert): 815.32 ft

Culvert Length: 48.70 ft, Culvert Slope: 0.0201

****

Culvert Discharge Apron Sizing

Job No. 25220183.00	Job: Columbia Energy Center Mod 5 and 6 Construction	By: RJG	Date: 03/12/21
Client: WPL	Subject: Riprap Sizing at Culvert Outlet	Chk'd: BP	Date: 12/2/21

Purpose:

To size the riprap apron dimensions at culvert C2 and C4 based on a 25-year, 24 hour storm event:

- Culvert 2 (the discharge end of the culverts in the Proposed East Swale)
- Culvert 4 (the discharge end of the culvert in the existing entrance road south ditch)

References:

1. "Energy Dissipators," Wisconsin Department of Transportation (WisDOT), Facilities Development Manual (FDM) 13-35-5.
2. Post Construction Condition HydroCAD Model.
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	24.62	2	2	12.3	0.80	0.28	0.83	23
Culvert C4	8.02	2	1	4.0	0.40	0.32	0.83	15

Results:

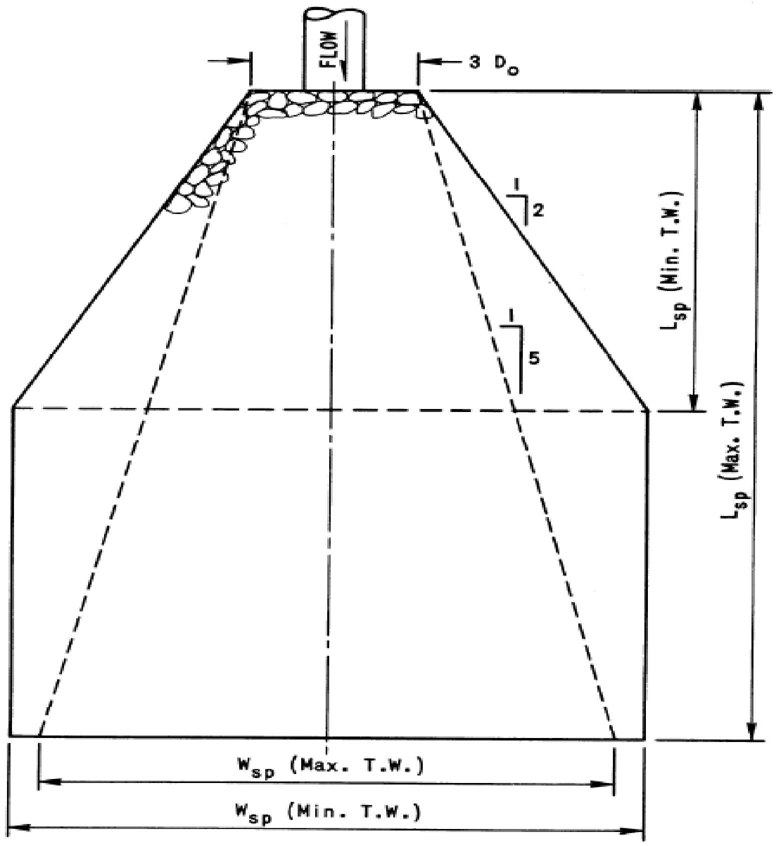
Below is a summary of the d_{50} , thickness (T), and configuration of the riprap apron. Also refer to WisDOT FDM Attachment 5.2 (Sheet 2) for details on apron layout. Use WisDOT Light Riprap at culvert discharge.

Location	d_{50} (in)*	T (in)	L_{sp} (ft)	W_{sp} (ft)
Culvert C2	10.0	20	23	See Note 1
Culvert C4	10.0	20	15	See Note 1

1. For discharges to channels, place riprap along channel bottom and up side of channel.

*Per Table 25.1 on Sheet 2 for standard WisDOT riprap sizes use Light Riprap.

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.

Appendix A4

2021 South Sediment Basin Check

Storm Water Management Calculations

Purpose:
The purpose of the storm water runoff calculations is to demonstrate that the existing storm water sedimentation basin can accommodate and safely convey the runoff from a 25-year, 24-hour storm event during post construction conditions from Module 5 and 6 construction.

Items addressed in these calculations:

- Sedimentation Basin

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
Sedimentation Basin	To safely handle 25-year, 24-hour storm event without overtopping the 100-year, 24-hour emergency spillway.	HydroCAD runoff modeling

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.

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. HydroCAD was used to model the runoff flow through the basin outfall (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).

- 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) C/B (assumed mid value between each soil group)
Woods/Grass Combination	58 – Woods/grass combination in good condition, hydrologic soil group (HSG) B
Meadow	58 – Meadow, non-grazed, HSG B
Rain Cover	98 – Rain Cover (plastic smooth material)
Pavement	92 – Paved roads w/open ditches, 50% impervious HSG C
Gravel	96 – Gravel Surface, HSG C
Coal Combustion Residuals (CCR)	96 – assumed for CCR materials in the landfill

- Type B soil group for non-disturbed areas outside the landfill.
- Other assumptions are included with the calculations attached to this appendix.

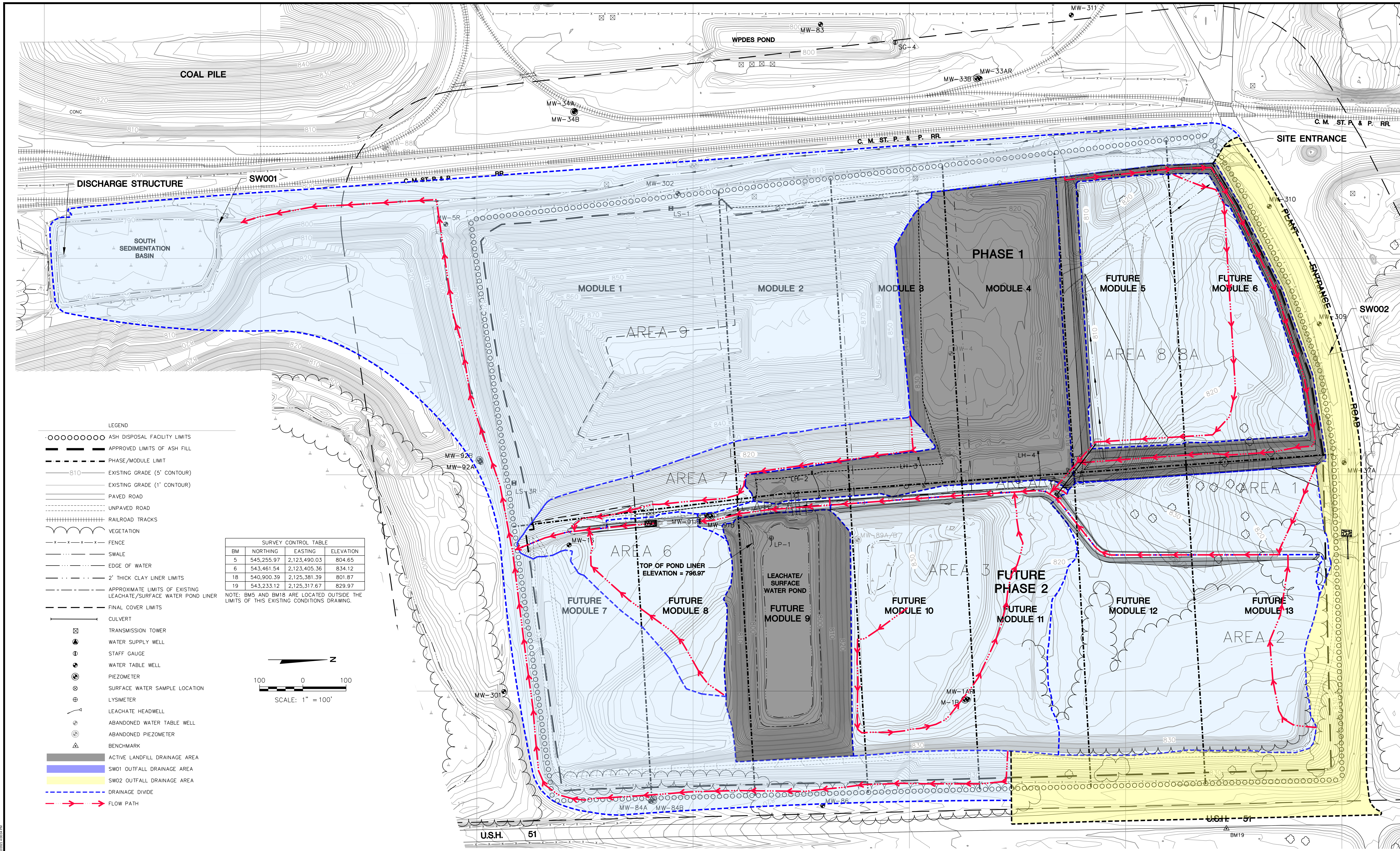
Results:

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.

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. Refer to the Basin Sizing section.



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.	25220183.00	DRAWN BY:	RJG
DRAWN:	07/13/16	CHECKED BY:	MT
REVISED:	12/02/21	APPROVED BY:	BP 12/02/21

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

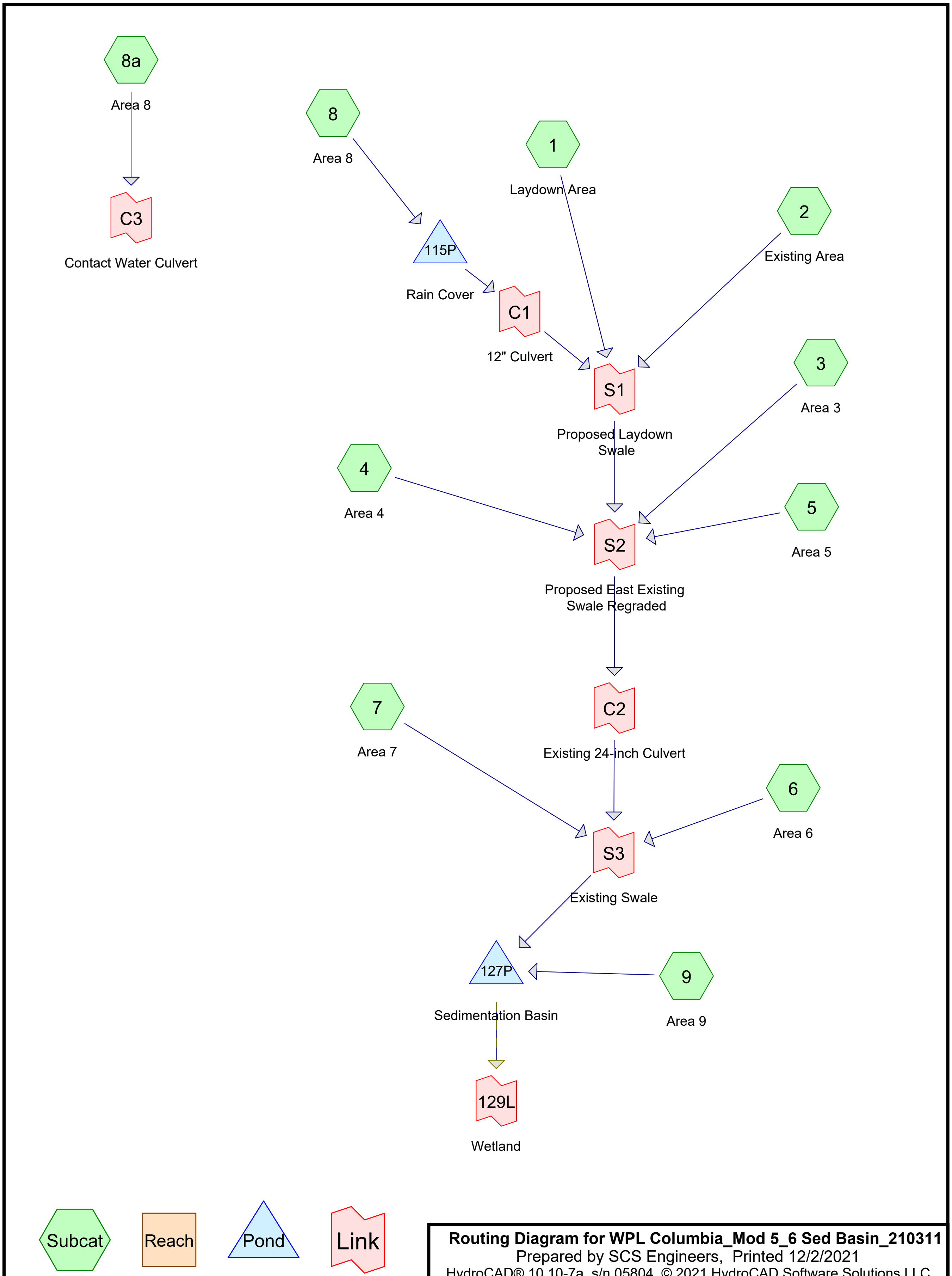
SITE
STORM WATER POLLUTION PREVENTION PLAN
COLUMBIA DRY ASH DISPOSAL FACILITY
TOWN OF PACIFIC, WISCONSIN

DRAINAGE AREAS AND OUFALLS

FIGURE 3

Post Construction Conditions Hydrograph Generation

- 25-year, 24-hour Storm Event
- 100-year, 24-hour Storm Event



Routing Diagram for WPL Columbia_Mod 5_6 Sed Basin_210311
Prepared by SCS Engineers, Printed 12/2/2021
HydroCAD® 10.10-7a s/n 05804 © 2021 HydroCAD Software Solutions LLC

Time span=0.00-100.00 hrs, dt=0.05 hrs, 2001 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 1: Laydown Area Runoff Area=107,493 sf 0.00% Impervious Runoff Depth=4.11"
Flow Length=1,631' Tc=6.7 min CN=93 Runoff=14.24 cfs 0.845 af

Subcatchment 2: Existing Area Runoff Area=276,222 sf 0.00% Impervious Runoff Depth=1.12"
Flow Length=1,900' Tc=19.0 min CN=58 Runoff=6.31 cfs 0.592 af

Subcatchment 3: Area 3 Runoff Area=283,569 sf 0.00% Impervious Runoff Depth=1.12"
Flow Length=1,862' Tc=19.1 min CN=58 Runoff=6.45 cfs 0.607 af

Subcatchment 4: Area 4 Runoff Area=11,656 sf 0.00% Impervious Runoff Depth=3.19"
Flow Length=865' Tc=3.8 min CN=84 Runoff=1.43 cfs 0.071 af

Subcatchment 5: Area 5 Runoff Area=9,522 sf 0.00% Impervious Runoff Depth=1.74"
Flow Length=320' Tc=1.8 min CN=67 Runoff=0.71 cfs 0.032 af

Subcatchment 6: Area 6 Runoff Area=101,675 sf 0.00% Impervious Runoff Depth=1.97"
Flow Length=698' Tc=21.3 min CN=70 Runoff=4.34 cfs 0.383 af

Subcatchment 7: Area 7 Runoff Area=90,039 sf 0.00% Impervious Runoff Depth=1.97"
Flow Length=1,075' Tc=31.8 min CN=70 Runoff=3.09 cfs 0.339 af

Subcatchment 8: Area 8 Runoff Area=267,532 sf 100.00% Impervious Runoff Depth=4.67"
Flow Length=967' Slope=0.0043 '/' Tc=13.3 min CN=98 Runoff=30.00 cfs 2.392 af

Subcatchment 8a: Area 8 Runoff Area=364,708 sf 0.00% Impervious Runoff Depth=4.44"
Flow Length=1,615' Tc=6.1 min CN=96 Runoff=50.83 cfs 3.100 af

Subcatchment 9: Area 9 Runoff Area=1,407,983 sf 0.00% Impervious Runoff Depth=1.12"
Flow Length=2,983' Tc=17.9 min CN=58 Runoff=33.05 cfs 3.016 af

Pond 115P: Rain Cover Peak Elev=815.54' Storage=43,946 cf Inflow=30.00 cfs 2.392 af
12.0" Round Culvert n=0.013 L=147.3' S=0.0068 '/' Outflow=3.52 cfs 2.392 af

Pond 127P: Sedimentation Basin Peak Elev=791.42' Storage=126,389 cf Inflow=61.21 cfs 8.277 af
s 6.453 af Primary=7.57 cfs 1.828 af Secondary=0.00 cfs 0.000 af Tertiary=0.00 cfs 0.000 af Outflow=12.84 cfs 8.281 af

Link 129L: Wetland Inflow=7.57 cfs 1.828 af
Primary=7.57 cfs 1.828 af

Link C1: 12" Culvert Inflow=3.52 cfs 2.392 af
Primary=3.52 cfs 2.392 af

Link C2: Existing 24-inch Culvert Inflow=24.62 cfs 4.539 af
Primary=24.62 cfs 4.539 af

Link C3: Contact Water Culvert Inflow=50.83 cfs 3.100 af
Primary=50.83 cfs 3.100 af

Link S1: Proposed Laydown Swale	Inflow=20.15 cfs 3.829 af Primary=20.15 cfs 3.829 af
Link S2: Proposed East Existing Swale Regraded	Inflow=24.62 cfs 4.539 af Primary=24.62 cfs 4.539 af
Link S3: Existing Swale	Inflow=28.21 cfs 5.261 af Primary=28.21 cfs 5.261 af

Summary for Subcatchment 1: Laydown Area

Runoff = 14.24 cfs @ 12.14 hrs, Volume= 0.845 af, Depth= 4.11"
Routed to Link S1 : Proposed Laydown Swale

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-100.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr storm Rainfall=4.91"

Area (sf)	CN	Description
7,146	58	Meadow, non-grazed, HSG B
100,347	96	Gravel surface, HSG C
107,493	93	Weighted Average
107,493		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.6	100	0.0118	1.04		**Sheet Flow, sheet across laydown area** Smooth surfaces n= 0.011 P2= 2.78"
1.1	112	0.0118	1.75		**Shallow Concentrated Flow, flow across laydown area and acce** Unpaved Kv= 16.1 fps
0.1	11	0.2182	3.27		**Shallow Concentrated Flow, Slope into Swale** Short Grass Pasture Kv= 7.0 fps
1.2	573	0.0076	8.13	585.12	**Trap/Vee/Rect Channel Flow,** Bot.W=10.00' D=4.00' Z= 2.0 '/' Top.W=26.00' n= 0.030 Earth, grassed & winding
0.1	21	0.0076	5.60	156.89	**Trap/Vee/Rect Channel Flow,** Bot.W=10.00' D=2.00' Z= 2.0 '/' Top.W=18.00' n= 0.030 Earth, grassed & winding
1.6	511	0.0073	5.49	153.76	**Trap/Vee/Rect Channel Flow,** Bot.W=10.00' D=2.00' Z= 2.0 '/' Top.W=18.00' n= 0.030 Earth, grassed & winding
1.0	303	0.0067	5.03	171.18	**Trap/Vee/Rect Channel Flow,** Bot.W=10.00' D=2.00' Z= 4.0 & 3.0 '/' Top.W=24.00' n= 0.030 Earth, grassed & winding
6.7	1,631	Total			

Summary for Subcatchment 2: Existing Area

Runoff = 6.31 cfs @ 12.32 hrs, Volume= 0.592 af, Depth= 1.12"
Routed to Link S1 : Proposed Laydown Swale

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-100.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr storm Rainfall=4.91"

Area (sf)	CN	Description
13,491	58	Meadow, non-grazed, HSG B
857	96	Gravel surface, HSG C
261,874	58	Woods/grass comb., Good, HSG B
276,222	58	Weighted Average
276,222		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.4	55	0.2364	0.38		**Sheet Flow, Sheet** Grass: Short n= 0.150 P2= 2.78"
5.8	45	0.0179	0.13		**Sheet Flow, Sheet** Grass: Short n= 0.150 P2= 2.78"
6.2	347	0.0179	0.94		**Shallow Concentrated Flow, Shallow** Short Grass Pasture Kv= 7.0 fps
0.1	25	0.1720	2.90		**Shallow Concentrated Flow, Slope into Swale** Short Grass Pasture Kv= 7.0 fps
1.8	593	0.0076	5.60	156.89	**Trap/Vee/Rect Channel Flow,** Bot.W=10.00' D=2.00' Z= 2.0 '/' Top.W=18.00' n= 0.030 Earth, grassed & winding
0.1	21	0.0076	5.60	156.89	**Trap/Vee/Rect Channel Flow,** Bot.W=10.00' D=2.00' Z= 2.0 '/' Top.W=18.00' n= 0.030 Earth, grassed & winding
1.6	511	0.0073	5.49	153.76	**Trap/Vee/Rect Channel Flow,** Bot.W=10.00' D=2.00' Z= 2.0 '/' Top.W=18.00' n= 0.030 Earth, grassed & winding
1.0	303	0.0067	5.03	171.18	**Trap/Vee/Rect Channel Flow,** Bot.W=10.00' D=2.00' Z= 3.0 & 4.0 '/' Top.W=24.00' n= 0.030 Earth, grassed & winding
19.0	1,900	Total			

Summary for Subcatchment 3: Area 3

Runoff = 6.45 cfs @ 12.32 hrs, Volume= 0.607 af, Depth= 1.12"
Routed to Link S2 : Proposed East Existing Swale Regraded

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-100.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr storm Rainfall=4.91"

Area (sf)	CN	Description
283,569	58	Woods/grass comb., Good, HSG B
283,569		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.2	100	0.0217	0.16		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.78"
0.6	38	0.0217	1.03		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
2.9	759	0.0105	4.32	125.30	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=2.00' Z= 5.0 & 9.5 '/' Top.W=29.00' n= 0.035 Earth, dense weeds
3.0	234	0.0350	1.31		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.4	428	0.0067	5.26	147.30	**Trap/Vee/Rect Channel Flow,** Bot.W=10.00' D=2.00' Z= 2.0 '/' Top.W=18.00' n= 0.030 Earth, grassed & winding
1.0	303	0.0067	5.03	171.18	**Trap/Vee/Rect Channel Flow,** Bot.W=10.00' D=2.00' Z= 3.0 & 4.0 '/' Top.W=24.00' n= 0.030 Earth, grassed & winding
19.1	1,862	Total			

Summary for Subcatchment 4: Area 4

[49] Hint: Tc<2dt may require smaller dt

Runoff = 1.43 cfs @ 12.10 hrs, Volume= 0.071 af, Depth= 3.19"
Routed to Link S2 : Proposed East Existing Swale Regraded

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-100.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr storm Rainfall=4.91"

	Area (sf)	CN	Description
	6,339	96	Gravel surface, HSG C
*	5,317	69	>75% Grass cover, Good, HSG C
	11,656	84	Weighted Average
	11,656		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.4	36	0.0639	1.66		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.78"
0.8	15	0.2867	0.31		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.78"
1.6	511	0.0073	5.49	153.76	**Trap/Vee/Rect Channel Flow,** Bot.W=10.00' D=2.00' Z= 2.0 '/' Top.W=18.00' n= 0.030 Earth, grassed & winding
1.0	303	0.0067	5.03	171.18	**Trap/Vee/Rect Channel Flow,** Bot.W=10.00' D=2.00' Z= 3.0 & 4.0 '/' Top.W=24.00' n= 0.030 Earth, grassed & winding
3.8	865	Total			

Summary for Subcatchment 5: Area 5

[49] Hint: Tc<2dt may require smaller dt

Runoff = 0.71 cfs @ 12.08 hrs, Volume= 0.032 af, Depth= 1.74"
Routed to Link S2 : Proposed East Existing Swale Regraded

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-100.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr storm Rainfall=4.91"

Area (sf)	CN	Description
2,284	96	Gravel surface, HSG C
7,238	58	Meadow, non-grazed, HSG B
9,522	67	Weighted Average
9,522		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.3	9	0.0050	0.45		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.78"
0.5	8	0.2537	0.26		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.78"
1.0	303	0.0067	5.03	171.18	**Trap/Vee/Rect Channel Flow,** Bot.W=10.00' D=2.00' Z= 3.0 & 4.0 '/' Top.W=24.00' n= 0.030 Earth, grassed & winding
1.8	320	Total			

Summary for Subcatchment 6: Area 6

Runoff = 4.34 cfs @ 12.32 hrs, Volume= 0.383 af, Depth= 1.97"
Routed to Link S3 : Existing Swale

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-100.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr storm Rainfall=4.91"

	Area (sf)	CN	Description
*	99,711	69	>75% Grass cover, Good, HSG C
	1,964	96	Gravel surface, HSG C
	101,675	70	Weighted Average
	101,675		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.1	100	0.0283	0.18		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.78"
0.8	59	0.0283	1.18		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.2	35	0.1714	2.90		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
4.7	240	0.0146	0.85		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.2	72	0.0208	1.01		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.1	13	0.2154	3.25		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
5.2	179	0.0067	0.57		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
21.3	698	Total			

Summary for Subcatchment 7: Area 7

Runoff = 3.09 cfs @ 12.47 hrs, Volume= 0.339 af, Depth= 1.97"
Routed to Link S3 : Existing Swale

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-100.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr storm Rainfall=4.91"

	Area (sf)	CN	Description
*	86,044	69	>75% Grass cover, Good, HSG C
	3,995	96	Gravel surface, HSG C
	90,039	70	Weighted Average
	90,039		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.2	80	0.2500	0.42		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.78"
3.1	20	0.0165	0.11		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.78"
6.9	373	0.0165	0.90		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.6	53	0.0377	1.36		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
13.6	365	0.0041	0.45		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.2	31	0.0323	2.89		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.0	8	0.2537	3.53		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
4.2	145	0.0067	0.57		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
31.8	1,075	Total			

Summary for Subcatchment 8: Area 8

Runoff = 30.00 cfs @ 12.21 hrs, Volume= 2.392 af, Depth= 4.67"
Routed to Pond 115P : Rain Cover

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-100.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr storm Rainfall=4.91"

	Area (sf)	CN	Description
*	267,532	98	Rain Cover
	267,532		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.4	100	0.0043	0.69		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.78"
10.9	867	0.0043	1.33		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
13.3	967	Total			

Summary for Subcatchment 8a: Area 8

[47] Hint: Peak is 100124% of capacity of segment #4

Runoff = 50.83 cfs @ 12.13 hrs, Volume= 3.100 af, Depth= 4.44"
Routed to Link C3 : Contact Water Culvert

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-100.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr storm Rainfall=4.91"

	Area (sf)	CN	Description
*	364,708	96	open CCR
	364,708		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.1	9	0.3333	2.44		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.78"
3.9	1,036	0.0047	4.47	53.65	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=2.00' Z= 3.0 '/' Top.W=12.00' n= 0.022 Earth, clean & straight
1.6	540	0.0056	5.55	99.88	**Trap/Vee/Rect Channel Flow,** Bot.W=3.00' D=2.00' Z= 3.0 '/' Top.W=15.00' n= 0.022 Earth, clean & straight
0.5	30	0.0033	1.03	0.05	**Pipe Channel,** 3.0" Round Area= 0.0 sf Perim= 0.8' r= 0.06' n= 0.013 Corrugated PE, smooth interior
6.1	1,615	Total			

Summary for Subcatchment 9: Area 9

[47] Hint: Peak is 24557% of capacity of segment #6

Runoff = 33.05 cfs @ 12.30 hrs, Volume= 3.016 af, Depth= 1.12"
Routed to Pond 127P : Sedimentation Basin

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-100.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr storm Rainfall=4.91"

Area (sf)	CN	Description
1,407,983	58	Woods/grass comb., Good, HSG B
1,407,983		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.1	70	0.0186	0.14		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.78"
1.7	626	0.0160	6.18	123.62	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=2.00' Z= 4.0 & 6.0 '/' Top.W=20.00' n= 0.030 Earth, grassed & winding
0.6	413	0.0339	11.43	457.38	**Trap/Vee/Rect Channel Flow,** Bot.W=12.00' D=2.00' Z= 4.0 '/' Top.W=28.00' n= 0.030 Earth, grassed & winding
2.7	585	0.0034	3.67	139.35	**Trap/Vee/Rect Channel Flow,** Bot.W=12.00' D=2.00' Z= 3.5 '/' Top.W=26.00' n= 0.030 Earth, grassed & winding
2.8	756	0.0053	4.55	177.41	**Trap/Vee/Rect Channel Flow,** Bot.W=12.00' D=2.00' Z= 3.5 & 4.0 '/' Top.W=27.00' n= 0.030 Earth, grassed & winding
0.6	60	0.0050	1.54	0.13	**Pipe Channel,** 4.0" Round Area= 0.1 sf Perim= 1.0' r= 0.08' n= 0.013 Corrugated PE, smooth interior
0.1	16	0.1187	2.41		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.3	457	0.0083	5.72	177.39	**Trap/Vee/Rect Channel Flow,** Bot.W=10.00' D=2.00' Z= 2.5 & 3.0 '/' Top.W=21.00' n= 0.030 Earth, grassed & winding
17.9	2,983	Total			

Summary for Pond 115P: Rain Cover

Inflow Area = 6.142 ac,100.00% Impervious, Inflow Depth = 4.67" for 25-yr, 24-hr storm event
Inflow = 30.00 cfs @ 12.21 hrs, Volume= 2.392 af
Outflow = 3.52 cfs @ 12.92 hrs, Volume= 2.392 af, Atten= 88%, Lag= 42.5 min
Primary = 3.52 cfs @ 12.92 hrs, Volume= 2.392 af
Routed to Link C1 : 12" Culvert

Routing by Dyn-Stor-Ind method, Time Span= 0.00-100.00 hrs, dt= 0.05 hrs
Peak Elev= 815.54' @ 12.92 hrs Surf.Area= 76,209 sf Storage= 43,946 cf

Plug-Flow detention time= 104.9 min calculated for 2.391 af (100% of inflow)
Center-of-Mass det. time= 104.9 min (858.4 - 753.5)

Volume	Invert	Avail.Storage	Storage Description
#1	813.50'	92,479 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
813.50	1	0	0
814.50	8,879	4,440	4,440
815.00	33,357	10,559	14,999
815.50	71,848	26,301	41,300
816.00	132,867	51,179	92,479

Device	Routing	Invert	Outlet Devices
#1	Primary	813.50'	**12.0" Round Culvert** L= 147.3' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 813.50' / 812.50' S= 0.0068 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=3.52 cfs @ 12.92 hrs HW=815.54' TW=0.00' (Dynamic Tailwater)
└─**1=Culvert** (Barrel Controls 3.52 cfs @ 4.48 fps)

Summary for Pond 127P: Sedimentation Basin

Inflow Area = 58.671 ac, 10.47% Impervious, Inflow Depth = 1.69" for 25-yr, 24-hr storm event
Inflow = 61.21 cfs @ 12.30 hrs, Volume= 8.277 af
Outflow = 12.84 cfs @ 13.55 hrs, Volume= 8.281 af, Atten= 79%, Lag= 75.1 min
Discarded = 5.27 cfs @ 13.55 hrs, Volume= 6.453 af
Primary = 7.57 cfs @ 13.55 hrs, Volume= 1.828 af
Routed to Link 129L : Wetland
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Routed to Link 129L : Wetland
Tertiary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Routed to Link 129L : Wetland

Routing by Dyn-Stor-Ind method, Time Span= 0.00-100.00 hrs, dt= 0.05 hrs
Peak Elev= 791.42' @ 13.55 hrs Surf.Area= 63,269 sf Storage= 126,389 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 190.4 min (1,046.1 - 855.8)

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=5.27 cfs @ 13.55 hrs HW=791.42' (Free Discharge)
└─**8=Exfiltration** (Exfiltration Controls 5.27 cfs)

Primary OutFlow Max=7.57 cfs @ 13.55 hrs HW=791.42' TW=0.00' (Dynamic Tailwater)
└─**1=Culvert** (Passes 7.57 cfs of 9.17 cfs potential flow)
  ├─**2=Orifice/Grate** (Weir Controls 6.90 cfs @ 2.11 fps)
  ├─**3=Orifice/Grate** (Orifice Controls 0.06 cfs @ 4.52 fps)
  ├─**4=Orifice/Grate** (Orifice Controls 0.08 cfs @ 5.66 fps)
  └─**5=Orifice/Grate** (Orifice Controls 0.52 cfs @ 5.47 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=789.00' TW=0.00' (Dynamic Tailwater)
└─**6=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Tertiary OutFlow Max=0.00 cfs @ 0.00 hrs HW=789.00' TW=0.00' (Dynamic Tailwater)
└─**7=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Link 129L: Wetland

Inflow Area = 58.671 ac, 10.47% Impervious, Inflow Depth = 0.37" for 25-yr, 24-hr storm event
Inflow = 7.57 cfs @ 13.55 hrs, Volume= 1.828 af
Primary = 7.57 cfs @ 13.55 hrs, Volume= 1.828 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-100.00 hrs, dt= 0.05 hrs

Summary for Link C1: 12" Culvert

Inflow Area = 6.142 ac,100.00% Impervious, Inflow Depth = 4.67" for 25-yr, 24-hr storm event
Inflow = 3.52 cfs @ 12.92 hrs, Volume= 2.392 af
Primary = 3.52 cfs @ 12.92 hrs, Volume= 2.392 af, Atten= 0%, Lag= 0.0 min
Routed to Link S1 : Proposed Laydown Swale

Primary outflow = Inflow, Time Span= 0.00-100.00 hrs, dt= 0.05 hrs

Summary for Link C2: Existing 24-inch Culvert

Inflow Area = 21.947 ac, 27.98% Impervious, Inflow Depth = 2.48" for 25-yr, 24-hr storm event
Inflow = 24.62 cfs @ 12.16 hrs, Volume= 4.539 af
Primary = 24.62 cfs @ 12.16 hrs, Volume= 4.539 af, Atten= 0%, Lag= 0.0 min
Routed to Link S3 : Existing Swale

Primary outflow = Inflow, Time Span= 0.00-100.00 hrs, dt= 0.05 hrs

Summary for Link C3: Contact Water Culvert

Inflow Area = 8.373 ac, 0.00% Impervious, Inflow Depth = 4.44" for 25-yr, 24-hr storm event
Inflow = 50.83 cfs @ 12.13 hrs, Volume= 3.100 af
Primary = 50.83 cfs @ 12.13 hrs, Volume= 3.100 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-100.00 hrs, dt= 0.05 hrs

Summary for Link S1: Proposed Laydown Swale

Inflow Area = 14.951 ac, 41.08% Impervious, Inflow Depth = 3.07" for 25-yr, 24-hr storm event
Inflow = 20.15 cfs @ 12.15 hrs, Volume= 3.829 af
Primary = 20.15 cfs @ 12.15 hrs, Volume= 3.829 af, Atten= 0%, Lag= 0.0 min
Routed to Link S2 : Proposed East Existing Swale Regraded

Primary outflow = Inflow, Time Span= 0.00-100.00 hrs, dt= 0.05 hrs

Summary for Link S2: Proposed East Existing Swale Regraded

Inflow Area = 21.947 ac, 27.98% Impervious, Inflow Depth = 2.48" for 25-yr, 24-hr storm event
Inflow = 24.62 cfs @ 12.16 hrs, Volume= 4.539 af
Primary = 24.62 cfs @ 12.16 hrs, Volume= 4.539 af, Atten= 0%, Lag= 0.0 min
Routed to Link C2 : Existing 24-inch Culvert

Primary outflow = Inflow, Time Span= 0.00-100.00 hrs, dt= 0.05 hrs

Summary for Link S3: Existing Swale

Inflow Area = 26.348 ac, 23.31% Impervious, Inflow Depth = 2.40" for 25-yr, 24-hr storm event
Inflow = 28.21 cfs @ 12.29 hrs, Volume= 5.261 af
Primary = 28.21 cfs @ 12.29 hrs, Volume= 5.261 af, Atten= 0%, Lag= 0.0 min
Routed to Pond 127P : Sedimentation Basin

Primary outflow = Inflow, Time Span= 0.00-100.00 hrs, dt= 0.05 hrs

Time span=0.00-100.00 hrs, dt=0.05 hrs, 2001 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 1: Laydown Area Runoff Area=107,493 sf 0.00% Impervious Runoff Depth=5.77"
Flow Length=1,631' Tc=6.7 min CN=93 Runoff=19.56 cfs 1.186 af

Subcatchment 2: Existing Area Runoff Area=276,222 sf 0.00% Impervious Runoff Depth=2.13"
Flow Length=1,900' Tc=19.0 min CN=58 Runoff=13.15 cfs 1.128 af

Subcatchment 3: Area 3 Runoff Area=283,569 sf 0.00% Impervious Runoff Depth=2.13"
Flow Length=1,862' Tc=19.1 min CN=58 Runoff=13.46 cfs 1.158 af

Subcatchment 4: Area 4 Runoff Area=11,656 sf 0.00% Impervious Runoff Depth=4.75"
Flow Length=865' Tc=3.8 min CN=84 Runoff=2.09 cfs 0.106 af

Subcatchment 5: Area 5 Runoff Area=9,522 sf 0.00% Impervious Runoff Depth=2.98"
Flow Length=320' Tc=1.8 min CN=67 Runoff=1.22 cfs 0.054 af

Subcatchment 6: Area 6 Runoff Area=101,675 sf 0.00% Impervious Runoff Depth=3.28"
Flow Length=698' Tc=21.3 min CN=70 Runoff=7.35 cfs 0.638 af

Subcatchment 7: Area 7 Runoff Area=90,039 sf 0.00% Impervious Runoff Depth=3.28"
Flow Length=1,075' Tc=31.8 min CN=70 Runoff=5.24 cfs 0.565 af

Subcatchment 8: Area 8 Runoff Area=267,532 sf 100.00% Impervious Runoff Depth=6.35"
Flow Length=967' Slope=0.0043 '/' Tc=13.3 min CN=98 Runoff=40.37 cfs 3.251 af

Subcatchment 8a: Area 8 Runoff Area=364,708 sf 0.00% Impervious Runoff Depth=6.12"
Flow Length=1,615' Tc=6.1 min CN=96 Runoff=68.81 cfs 4.267 af

Subcatchment 9: Area 9 Runoff Area=1,407,983 sf 0.00% Impervious Runoff Depth=2.13"
Flow Length=2,983' Tc=17.9 min CN=58 Runoff=68.88 cfs 5.751 af

Pond 115P: Rain Cover Peak Elev=815.77' Storage=64,644 cf Inflow=40.37 cfs 3.251 af
12.0" Round Culvert n=0.013 L=147.3' S=0.0068 '/' Outflow=3.71 cfs 3.251 af

Pond 127P: Sedimentation Basin Peak Elev=792.80' Storage=217,850 cf Inflow=118.19 cfs 13.837 af
7.682 af Primary=11.03 cfs 5.486 af Secondary=8.30 cfs 0.673 af Tertiary=0.00 cfs 0.000 af Outflow=25.07 cfs 13.840 af

Link 129L: Wetland Inflow=19.33 cfs 6.159 af
Primary=19.33 cfs 6.159 af

Link C1: 12" Culvert Inflow=3.71 cfs 3.251 af
Primary=3.71 cfs 3.251 af

Link C2: Existing 24-inch Culvert Inflow=40.21 cfs 6.883 af
Primary=40.21 cfs 6.883 af

Link C3: Contact Water Culvert Inflow=68.81 cfs 4.267 af
Primary=68.81 cfs 4.267 af

Link S1: Proposed Laydown Swale Inflow=30.07 cfs 5.564 af
Primary=30.07 cfs 5.564 af

Link S2: Proposed East Existing Swale Regraded Inflow=40.21 cfs 6.883 af
Primary=40.21 cfs 6.883 af

Link S3: Existing Swale Inflow=49.32 cfs 8.086 af
Primary=49.32 cfs 8.086 af

Summary for Subcatchment 1: Laydown Area

Runoff = 19.56 cfs @ 12.14 hrs, Volume= 1.186 af, Depth= 5.77"
Routed to Link S1 : Proposed Laydown Swale

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-100.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr storm Rainfall=6.59"

Area (sf)	CN	Description
7,146	58	Meadow, non-grazed, HSG B
100,347	96	Gravel surface, HSG C
107,493	93	Weighted Average
107,493		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.6	100	0.0118	1.04		**Sheet Flow, sheet across laydown area** Smooth surfaces n= 0.011 P2= 2.78"
1.1	112	0.0118	1.75		**Shallow Concentrated Flow, flow across laydown area and acce** Unpaved Kv= 16.1 fps
0.1	11	0.2182	3.27		**Shallow Concentrated Flow, Slope into Swale** Short Grass Pasture Kv= 7.0 fps
1.2	573	0.0076	8.13	585.12	**Trap/Vee/Rect Channel Flow,** Bot.W=10.00' D=4.00' Z= 2.0 '/' Top.W=26.00' n= 0.030 Earth, grassed & winding
0.1	21	0.0076	5.60	156.89	**Trap/Vee/Rect Channel Flow,** Bot.W=10.00' D=2.00' Z= 2.0 '/' Top.W=18.00' n= 0.030 Earth, grassed & winding
1.6	511	0.0073	5.49	153.76	**Trap/Vee/Rect Channel Flow,** Bot.W=10.00' D=2.00' Z= 2.0 '/' Top.W=18.00' n= 0.030 Earth, grassed & winding
1.0	303	0.0067	5.03	171.18	**Trap/Vee/Rect Channel Flow,** Bot.W=10.00' D=2.00' Z= 4.0 & 3.0 '/' Top.W=24.00' n= 0.030 Earth, grassed & winding
6.7	1,631	Total			

Summary for Subcatchment 2: Existing Area

Runoff = 13.15 cfs @ 12.30 hrs, Volume= 1.128 af, Depth= 2.13"
Routed to Link S1 : Proposed Laydown Swale

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-100.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr storm Rainfall=6.59"

Area (sf)	CN	Description
13,491	58	Meadow, non-grazed, HSG B
857	96	Gravel surface, HSG C
261,874	58	Woods/grass comb., Good, HSG B
276,222	58	Weighted Average
276,222		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.4	55	0.2364	0.38		**Sheet Flow, Sheet** Grass: Short n= 0.150 P2= 2.78"
5.8	45	0.0179	0.13		**Sheet Flow, Sheet** Grass: Short n= 0.150 P2= 2.78"
6.2	347	0.0179	0.94		**Shallow Concentrated Flow, Shallow** Short Grass Pasture Kv= 7.0 fps
0.1	25	0.1720	2.90		**Shallow Concentrated Flow, Slope into Swale** Short Grass Pasture Kv= 7.0 fps
1.8	593	0.0076	5.60	156.89	**Trap/Vee/Rect Channel Flow,** Bot.W=10.00' D=2.00' Z= 2.0 '/' Top.W=18.00' n= 0.030 Earth, grassed & winding
0.1	21	0.0076	5.60	156.89	**Trap/Vee/Rect Channel Flow,** Bot.W=10.00' D=2.00' Z= 2.0 '/' Top.W=18.00' n= 0.030 Earth, grassed & winding
1.6	511	0.0073	5.49	153.76	**Trap/Vee/Rect Channel Flow,** Bot.W=10.00' D=2.00' Z= 2.0 '/' Top.W=18.00' n= 0.030 Earth, grassed & winding
1.0	303	0.0067	5.03	171.18	**Trap/Vee/Rect Channel Flow,** Bot.W=10.00' D=2.00' Z= 3.0 & 4.0 '/' Top.W=24.00' n= 0.030 Earth, grassed & winding
19.0	1,900	Total			

Summary for Subcatchment 3: Area 3

Runoff = 13.46 cfs @ 12.30 hrs, Volume= 1.158 af, Depth= 2.13"
Routed to Link S2 : Proposed East Existing Swale Regraded

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-100.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr storm Rainfall=6.59"

Area (sf)	CN	Description
283,569	58	Woods/grass comb., Good, HSG B
283,569		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.2	100	0.0217	0.16		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.78"
0.6	38	0.0217	1.03		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
2.9	759	0.0105	4.32	125.30	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=2.00' Z= 5.0 & 9.5 '/' Top.W=29.00' n= 0.035 Earth, dense weeds
3.0	234	0.0350	1.31		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.4	428	0.0067	5.26	147.30	**Trap/Vee/Rect Channel Flow,** Bot.W=10.00' D=2.00' Z= 2.0 '/' Top.W=18.00' n= 0.030 Earth, grassed & winding
1.0	303	0.0067	5.03	171.18	**Trap/Vee/Rect Channel Flow,** Bot.W=10.00' D=2.00' Z= 3.0 & 4.0 '/' Top.W=24.00' n= 0.030 Earth, grassed & winding
19.1	1,862	Total			

Summary for Subcatchment 4: Area 4

[49] Hint: Tc<2dt may require smaller dt

Runoff = 2.09 cfs @ 12.10 hrs, Volume= 0.106 af, Depth= 4.75"
Routed to Link S2 : Proposed East Existing Swale Regraded

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-100.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr storm Rainfall=6.59"

	Area (sf)	CN	Description
	6,339	96	Gravel surface, HSG C
*	5,317	69	>75% Grass cover, Good, HSG C
	11,656	84	Weighted Average
	11,656		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.4	36	0.0639	1.66		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.78"
0.8	15	0.2867	0.31		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.78"
1.6	511	0.0073	5.49	153.76	**Trap/Vee/Rect Channel Flow,** Bot.W=10.00' D=2.00' Z= 2.0 '/' Top.W=18.00' n= 0.030 Earth, grassed & winding
1.0	303	0.0067	5.03	171.18	**Trap/Vee/Rect Channel Flow,** Bot.W=10.00' D=2.00' Z= 3.0 & 4.0 '/' Top.W=24.00' n= 0.030 Earth, grassed & winding
3.8	865	Total			

Summary for Subcatchment 5: Area 5

[49] Hint: Tc<2dt may require smaller dt

Runoff = 1.22 cfs @ 12.08 hrs, Volume= 0.054 af, Depth= 2.98"
Routed to Link S2 : Proposed East Existing Swale Regraded

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-100.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr storm Rainfall=6.59"

Area (sf)	CN	Description
2,284	96	Gravel surface, HSG C
7,238	58	Meadow, non-grazed, HSG B
9,522	67	Weighted Average
9,522		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.3	9	0.0050	0.45		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.78"
0.5	8	0.2537	0.26		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.78"
1.0	303	0.0067	5.03	171.18	**Trap/Vee/Rect Channel Flow,** Bot.W=10.00' D=2.00' Z= 3.0 & 4.0 '/' Top.W=24.00' n= 0.030 Earth, grassed & winding
1.8	320	Total			

Summary for Subcatchment 6: Area 6

Runoff = 7.35 cfs @ 12.32 hrs, Volume= 0.638 af, Depth= 3.28"
Routed to Link S3 : Existing Swale

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-100.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr storm Rainfall=6.59"

	Area (sf)	CN	Description
*	99,711	69	>75% Grass cover, Good, HSG C
	1,964	96	Gravel surface, HSG C
	101,675	70	Weighted Average
	101,675		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.1	100	0.0283	0.18		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.78"
0.8	59	0.0283	1.18		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.2	35	0.1714	2.90		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
4.7	240	0.0146	0.85		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.2	72	0.0208	1.01		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.1	13	0.2154	3.25		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
5.2	179	0.0067	0.57		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
21.3	698	Total			

Summary for Subcatchment 7: Area 7

Runoff = 5.24 cfs @ 12.46 hrs, Volume= 0.565 af, Depth= 3.28"
Routed to Link S3 : Existing Swale

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-100.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr storm Rainfall=6.59"

	Area (sf)	CN	Description
*	86,044	69	>75% Grass cover, Good, HSG C
	3,995	96	Gravel surface, HSG C
	90,039	70	Weighted Average
	90,039		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.2	80	0.2500	0.42		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.78"
3.1	20	0.0165	0.11		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.78"
6.9	373	0.0165	0.90		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.6	53	0.0377	1.36		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
13.6	365	0.0041	0.45		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.2	31	0.0323	2.89		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.0	8	0.2537	3.53		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
4.2	145	0.0067	0.57		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
31.8	1,075	Total			

Summary for Subcatchment 8: Area 8

Runoff = 40.37 cfs @ 12.21 hrs, Volume= 3.251 af, Depth= 6.35"
Routed to Pond 115P : Rain Cover

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-100.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr storm Rainfall=6.59"

	Area (sf)	CN	Description
*	267,532	98	Rain Cover
	267,532		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.4	100	0.0043	0.69		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.78"
10.9	867	0.0043	1.33		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
13.3	967	Total			

Summary for Subcatchment 8a: Area 8

[47] Hint: Peak is 128% of capacity of segment #2
[47] Hint: Peak is 135543% of capacity of segment #4

Runoff = 68.81 cfs @ 12.13 hrs, Volume= 4.267 af, Depth= 6.12"
Routed to Link C3 : Contact Water Culvert

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-100.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr storm Rainfall=6.59"

	Area (sf)	CN	Description
*	364,708	96	open CCR
	364,708		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.1	9	0.3333	2.44		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.78"
3.9	1,036	0.0047	4.47	53.65	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=2.00' Z= 3.0 '/' Top.W=12.00' n= 0.022 Earth, clean & straight
1.6	540	0.0056	5.55	99.88	**Trap/Vee/Rect Channel Flow,** Bot.W=3.00' D=2.00' Z= 3.0 '/' Top.W=15.00' n= 0.022 Earth, clean & straight
0.5	30	0.0033	1.03	0.05	**Pipe Channel,** 3.0" Round Area= 0.0 sf Perim= 0.8' r= 0.06' n= 0.013 Corrugated PE, smooth interior
6.1	1,615	Total			

Summary for Subcatchment 9: Area 9

[47] Hint: Peak is 51182% of capacity of segment #6

Runoff = 68.88 cfs @ 12.29 hrs, Volume= 5.751 af, Depth= 2.13"
Routed to Pond 127P : Sedimentation Basin

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-100.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr storm Rainfall=6.59"

Area (sf)	CN	Description
1,407,983	58	Woods/grass comb., Good, HSG B
1,407,983		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.1	70	0.0186	0.14		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.78"
1.7	626	0.0160	6.18	123.62	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=2.00' Z= 4.0 & 6.0 '/' Top.W=20.00' n= 0.030 Earth, grassed & winding
0.6	413	0.0339	11.43	457.38	**Trap/Vee/Rect Channel Flow,** Bot.W=12.00' D=2.00' Z= 4.0 '/' Top.W=28.00' n= 0.030 Earth, grassed & winding
2.7	585	0.0034	3.67	139.35	**Trap/Vee/Rect Channel Flow,** Bot.W=12.00' D=2.00' Z= 3.5 '/' Top.W=26.00' n= 0.030 Earth, grassed & winding
2.8	756	0.0053	4.55	177.41	**Trap/Vee/Rect Channel Flow,** Bot.W=12.00' D=2.00' Z= 3.5 & 4.0 '/' Top.W=27.00' n= 0.030 Earth, grassed & winding
0.6	60	0.0050	1.54	0.13	**Pipe Channel,** 4.0" Round Area= 0.1 sf Perim= 1.0' r= 0.08' n= 0.013 Corrugated PE, smooth interior
0.1	16	0.1187	2.41		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.3	457	0.0083	5.72	177.39	**Trap/Vee/Rect Channel Flow,** Bot.W=10.00' D=2.00' Z= 2.5 & 3.0 '/' Top.W=21.00' n= 0.030 Earth, grassed & winding
17.9	2,983	Total			

Summary for Pond 115P: Rain Cover

Inflow Area = 6.142 ac,100.00% Impervious, Inflow Depth = 6.35" for 100-yr, 24-hr storm event
Inflow = 40.37 cfs @ 12.21 hrs, Volume= 3.251 af
Outflow = 3.71 cfs @ 13.23 hrs, Volume= 3.251 af, Atten= 91%, Lag= 61.2 min
Primary = 3.71 cfs @ 13.23 hrs, Volume= 3.251 af
Routed to Link C1 : 12" Culvert

Routing by Dyn-Stor-Ind method, Time Span= 0.00-100.00 hrs, dt= 0.05 hrs
Peak Elev= 815.77' @ 13.23 hrs Surf.Area= 104,211 sf Storage= 64,644 cf

Plug-Flow detention time= 148.2 min calculated for 3.249 af (100% of inflow)
Center-of-Mass det. time= 148.2 min (897.6 - 749.5)

Volume	Invert	Avail.Storage	Storage Description
#1	813.50'	92,479 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
813.50	1	0	0
814.50	8,879	4,440	4,440
815.00	33,357	10,559	14,999
815.50	71,848	26,301	41,300
816.00	132,867	51,179	92,479

Device	Routing	Invert	Outlet Devices
#1	Primary	813.50'	**12.0" Round Culvert** L= 147.3' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 813.50' / 812.50' S= 0.0068 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=3.71 cfs @ 13.23 hrs HW=815.77' TW=0.00' (Dynamic Tailwater)
└─**1=Culvert** (Barrel Controls 3.71 cfs @ 4.73 fps)

Summary for Pond 127P: Sedimentation Basin

Inflow Area = 58.671 ac, 10.47% Impervious, Inflow Depth = 2.83" for 100-yr, 24-hr storm event
Inflow = 118.19 cfs @ 12.29 hrs, Volume= 13.837 af
Outflow = 25.07 cfs @ 13.17 hrs, Volume= 13.840 af, Atten= 79%, Lag= 53.2 min
Discarded = 5.74 cfs @ 13.17 hrs, Volume= 7.682 af
Primary = 11.03 cfs @ 13.17 hrs, Volume= 5.486 af
Routed to Link 129L : Wetland
Secondary = 8.30 cfs @ 13.17 hrs, Volume= 0.673 af
Routed to Link 129L : Wetland
Tertiary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Routed to Link 129L : Wetland

Routing by Dyn-Stor-Ind method, Time Span= 0.00-100.00 hrs, dt= 0.05 hrs
Peak Elev= 792.80' @ 13.17 hrs Surf.Area= 68,880 sf Storage= 217,850 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 176.7 min (1,031.7 - 855.0)

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=5.74 cfs @ 13.17 hrs HW=792.80' (Free Discharge)
└─**8=Exfiltration** (Exfiltration Controls 5.74 cfs)

Primary OutFlow Max=11.03 cfs @ 13.17 hrs HW=792.80' TW=0.00' (Dynamic Tailwater)
└─**1=Culvert** (Inlet Controls 11.03 cfs @ 8.99 fps)
  ├─**2=Orifice/Grate** (Passes < 31.71 cfs potential flow)
  ├─**3=Orifice/Grate** (Passes < 0.10 cfs potential flow)
  ├─**4=Orifice/Grate** (Passes < 0.11 cfs potential flow)
  └─**5=Orifice/Grate** (Passes < 0.86 cfs potential flow)

Secondary OutFlow Max=8.28 cfs @ 13.17 hrs HW=792.80' TW=0.00' (Dynamic Tailwater)
└─**6=Broad-Crested Rectangular Weir** (Weir Controls 8.28 cfs @ 1.38 fps)

Tertiary OutFlow Max=0.00 cfs @ 0.00 hrs HW=789.00' TW=0.00' (Dynamic Tailwater)
└─**7=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Link 129L: Wetland

Inflow Area = 58.671 ac, 10.47% Impervious, Inflow Depth = 1.26" for 100-yr, 24-hr storm event
Inflow = 19.33 cfs @ 13.17 hrs, Volume= 6.159 af
Primary = 19.33 cfs @ 13.17 hrs, Volume= 6.159 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-100.00 hrs, dt= 0.05 hrs

Summary for Link C1: 12" Culvert

Inflow Area = 6.142 ac,100.00% Impervious, Inflow Depth = 6.35" for 100-yr, 24-hr storm event
Inflow = 3.71 cfs @ 13.23 hrs, Volume= 3.251 af
Primary = 3.71 cfs @ 13.23 hrs, Volume= 3.251 af, Atten= 0%, Lag= 0.0 min
Routed to Link S1 : Proposed Laydown Swale

Primary outflow = Inflow, Time Span= 0.00-100.00 hrs, dt= 0.05 hrs

Summary for Link C2: Existing 24-inch Culvert

Inflow Area = 21.947 ac, 27.98% Impervious, Inflow Depth = 3.76" for 100-yr, 24-hr storm event
Inflow = 40.21 cfs @ 12.17 hrs, Volume= 6.883 af
Primary = 40.21 cfs @ 12.17 hrs, Volume= 6.883 af, Atten= 0%, Lag= 0.0 min
Routed to Link S3 : Existing Swale

Primary outflow = Inflow, Time Span= 0.00-100.00 hrs, dt= 0.05 hrs

Summary for Link C3: Contact Water Culvert

Inflow Area = 8.373 ac, 0.00% Impervious, Inflow Depth = 6.12" for 100-yr, 24-hr storm event
Inflow = 68.81 cfs @ 12.13 hrs, Volume= 4.267 af
Primary = 68.81 cfs @ 12.13 hrs, Volume= 4.267 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-100.00 hrs, dt= 0.05 hrs

Summary for Link S1: Proposed Laydown Swale

Inflow Area = 14.951 ac, 41.08% Impervious, Inflow Depth = 4.47" for 100-yr, 24-hr storm event
Inflow = 30.07 cfs @ 12.16 hrs, Volume= 5.564 af
Primary = 30.07 cfs @ 12.16 hrs, Volume= 5.564 af, Atten= 0%, Lag= 0.0 min
Routed to Link S2 : Proposed East Existing Swale Regraded

Primary outflow = Inflow, Time Span= 0.00-100.00 hrs, dt= 0.05 hrs

Summary for Link S2: Proposed East Existing Swale Regraded

Inflow Area = 21.947 ac, 27.98% Impervious, Inflow Depth = 3.76" for 100-yr, 24-hr storm event
Inflow = 40.21 cfs @ 12.17 hrs, Volume= 6.883 af
Primary = 40.21 cfs @ 12.17 hrs, Volume= 6.883 af, Atten= 0%, Lag= 0.0 min
Routed to Link C2 : Existing 24-inch Culvert

Primary outflow = Inflow, Time Span= 0.00-100.00 hrs, dt= 0.05 hrs

Summary for Link S3: Existing Swale

Inflow Area = 26.348 ac, 23.31% Impervious, Inflow Depth = 3.68" for 100-yr, 24-hr storm event
Inflow = 49.32 cfs @ 12.28 hrs, Volume= 8.086 af
Primary = 49.32 cfs @ 12.28 hrs, Volume= 8.086 af, Atten= 0%, Lag= 0.0 min
Routed to Pond 127P : Sedimentation Basin

Primary outflow = Inflow, Time Span= 0.00-100.00 hrs, dt= 0.05 hrs