SCS ENGINEERS

Run-On and Run-Off Control Plan
Phase 1 Module 1
Phase 1 Module 2
Phase 1 Module 3

Columbia Dry Ash Disposal Facility

Prepared for:

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

Prepared by:

SCS ENGINEERS
2830 Dairy Drive
Madison, Wisconsin 53718-6751
(608) 224-2830

October 2016
File No. 25216112.00

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I:\25216112.00\Deliverables\Run-on_Run-off\Columbia Run-On and Run-Off Control Plan_FINAL.docx

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PE CERTIFICATION

I, Eric J. Nelson, hereby certify that this Run-On and Run-Off Control Plan 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.

(signature) 10/6/2016 (date)

ERIC J. NELSON

(printed or typed name)

License number E-37855-6

My license renewal date is 7/31/18.

Pages or sheets covered by this seal:
OCTOBER 2016 RUN-ON AND RUN-OFF CONTROL PLAN – WPL COLUMBIA DRY ASH DISPOSAL FACILITY

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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 for the Columbia (COL) Dry Ash Disposal Facility in accordance with 40 CFR 257.81(c) as follows.

40 CFR 257.81(c). *"Run-on and run-off control system plan – (1) Content of the plan. The owner or operator must prepare initial and periodic run-on and run-off control system plans for the CCR unit according to the timeframes specified in paragraphs (c)(3), and (4) of [section 257.81]. These plans must document how the run-on and run-off control systems have been designed and constructed to meet the applicable requirements of this section. Each plan must be supported by appropriate engineering calculations. The owner or operator has completed the initial run-on and run-off control system plan when the plan has been placed in the facility's operating record as required by section 257.105(g)(3)."*

The COL facility includes an active coal combustion residue (CCR) landfill, which currently consists of three CCR units, all located in Phase 1 of the facility:

- Phase 1, Module 1 - This unit has received some final cover over completed outer sideslope areas that will no longer receive additional CCR.
- Phase 1, Module 2 - This unit is currently being filled.
- Phase 1, Module 3 – Construction of this unit was recently completed and approved by the Wisconsin Department of Natural Resources (WDNR) to receive CCR.

Future CCR units (Phase 1 Modules 4-6 and Phase 2 Modules 7-13) are permitted with the WDNR, but have not been developed. When developed, the units will be new CCR landfills, as defined at 40 CFR 257.53.

This plan applies to Phase 1 Modules 1–3 only. Future CCR units are not discussed further herein.

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

2.0 RUN-ON AND RUN-OFF CONTROL PLAN

40 CFR 257.81(a). *"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. 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 through a Wisconsin Pollutant Discharge Elimination System (WPDES) permitted outfall.

Run-off from areas of the existing CCR units where final 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. These features 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 has been installed to limit leachate and contact water production in Module 3. Storm water collected on the rain cover is 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 Module 3 and all water inside the limits of Module 3 will be considered and handled as contract 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).

The storm water run-on calculations were performed in 2000 as part of the 2000 Plan of Operation Update, with an update to run-on to a ditch along the north end of Module 3 performed in 2016. The 2000 calculations were performed assuming a 25-year, 24-hour precipitation depth of 4.7 inches, based on Technical Paper-40 (TP-40) precipitation data published in May 1961. The 2016 update for the ditch north of Module 3 assumed a 25-year, 24-hour precipitation depth of 4.9 inches, based on NOAA Atlas 14 precipitation data published in April 2013.

The run-off calculations were performed in 2010 as part of the 2010 Plan of Operation Update. A subsequent update was made to the leachate/surface water pond calculations in 2015. Calculations to evaluate installation of a rain cover in Module 3 were also performed in 2016. The 2010 calculations were performed assuming a 25-year, 24-hour precipitation depth of 4.7 inches, based on TP-40 precipitation data published in May 1961. The 2015 and 2016

calculations assumed a 25-year, 24-hour precipitation depth of 4.9 inches, based on NOAA Atlas 14 precipitation data published in April 2013.

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 2016 update for the swale located north of Module 3 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 calculations from the 2010 Plan of Operation Update and subsequent update in 2015 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."*

Eric Nelson, 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.

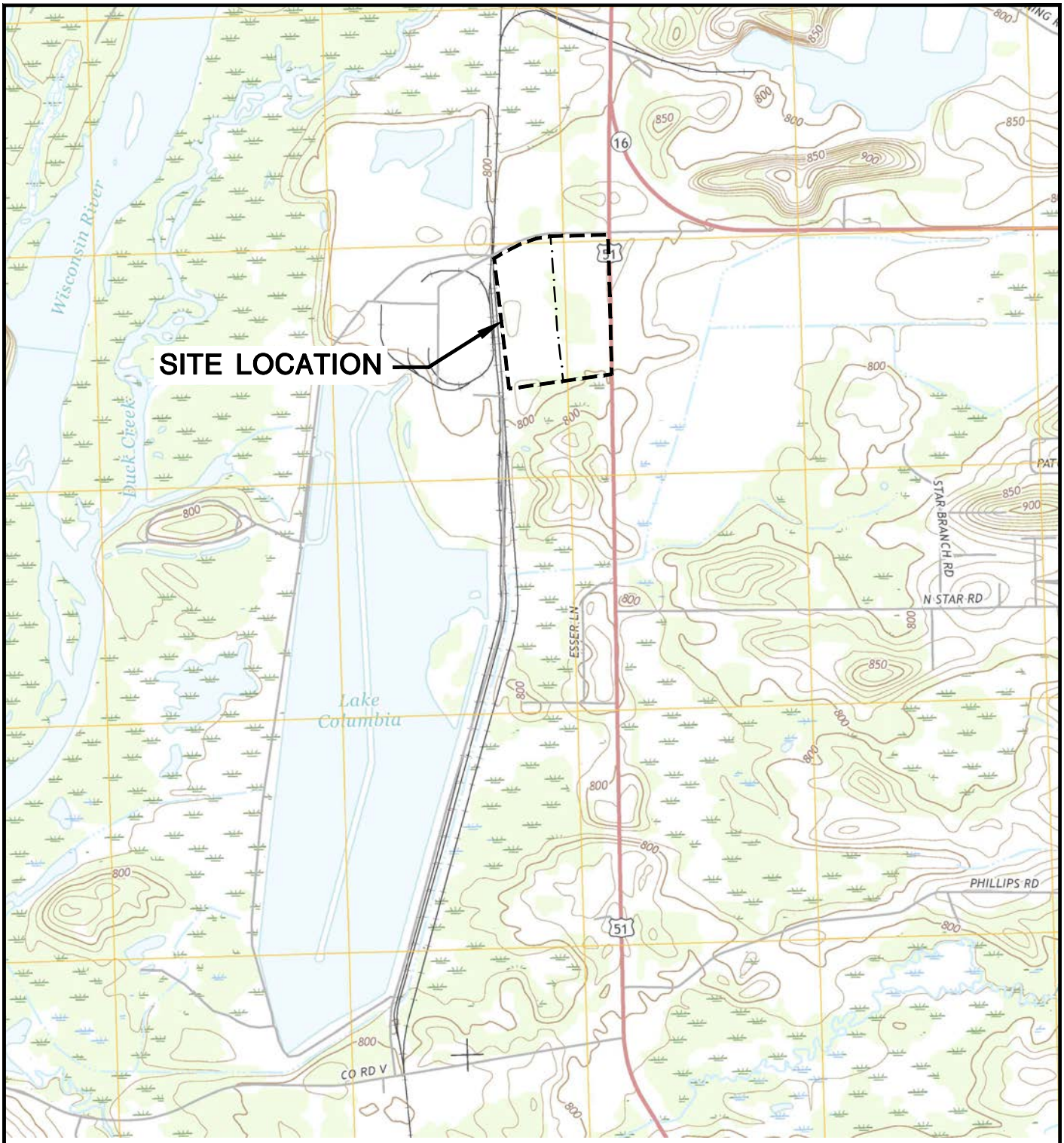
4.0 RECORDKEEPING AND PERIODIC UPDATES

40 CFR257.81(d). *"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 plans will be completed every 5 years per 40 CFR 257.81(c)(4).

Notification will be provided when this Run-On and Run-Off Control Plan, and all periodic plans, 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).

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

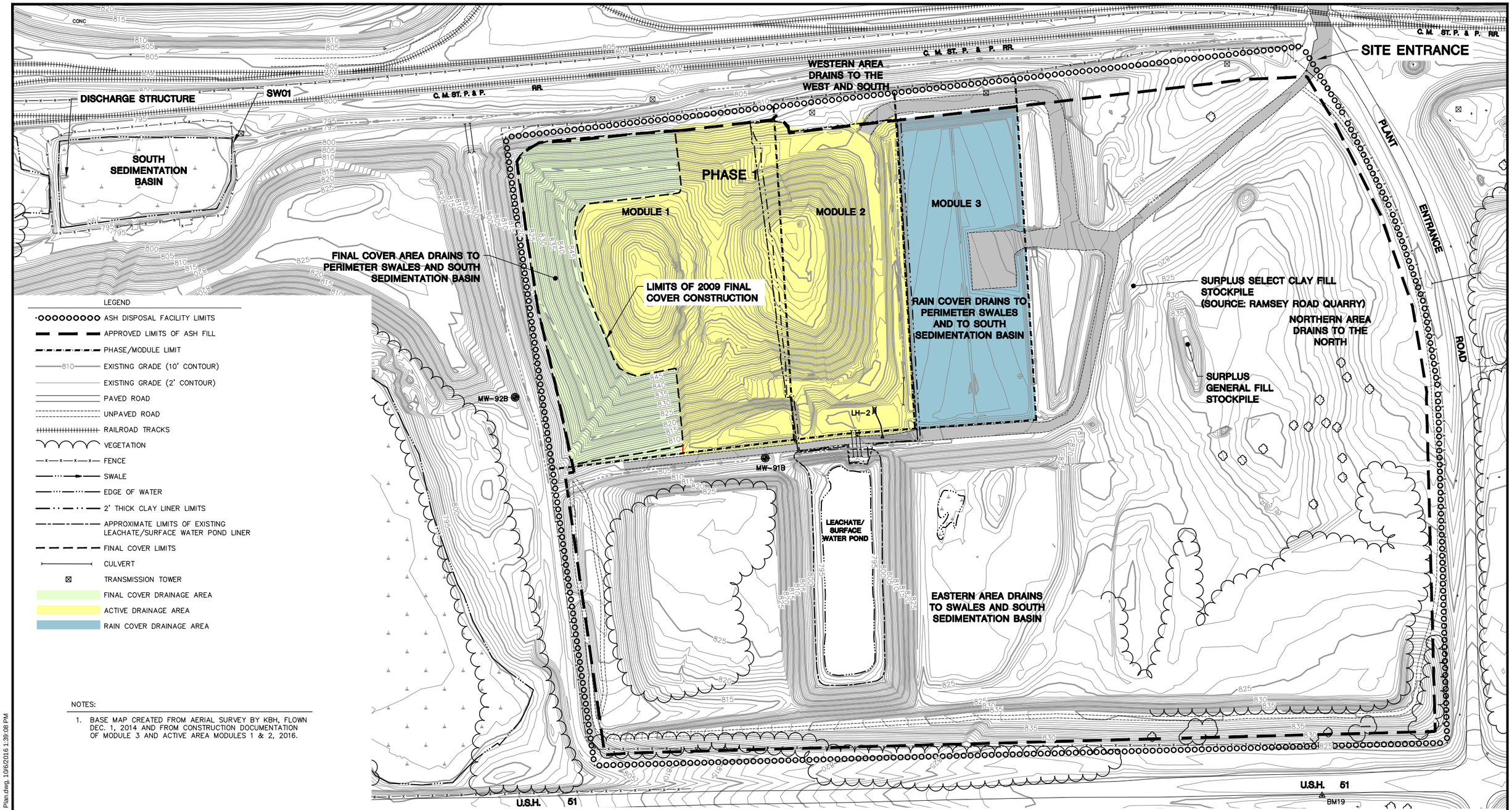
PROJECT NO.	25216112.00	DRAWN BY:	AHB
DRAWN:	08/09/16	CHECKED BY:	RJG
REVISED:	08/09/16	APPROVED BY:	EN 10/06/16

ENGINEER

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

FIGURE
1

I:\25216112.00\Drawings\Runoff Control\Site Loc.dwg, 10/6/2016 1:35:18 PM



NOTES:

1. BASE MAP CREATED FROM AERIAL SURVEY BY KBH, FLOWN DEC. 1, 2014 AND FROM CONSTRUCTION DOCUMENTATION OF MODULE 3 AND ACTIVE AREA MODULES 1 & 2, 2016.

PROJECT NO.	25216112.00	DRAWN BY:	KP
DRAWN:	08/09/16	CHECKED BY:	RJG
REVISED:	09/10/16	APPROVED BY:	EN 10/06/16

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:\25216112.00\Drawings\Runoff Control\Site Plan.dwg, 10/6/2016 1:39:08 PM

APPENDIX A

Storm Water Design Calculations

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:

Hydrograph Generation

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.

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

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

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

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

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
==========

West peripheral area leading to west perimeter ditch (1/2)

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

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 (2/2)

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

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

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

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

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

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

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/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)	* Tt (hrs)	Rounded Values Tc (hrs)	* Tt (hrs)	Ia/p Interpolated (Yes/No)	Ia/p Messages
andfill area	.3600	.0000	.40	.00	Yes	--
peripheral	.1000	.0000	**	**	Yes	--
Basin 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.

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

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

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

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

To South Basin
100-yr, 24-hr

Type.... TR-55 Tabular Hyd.Input Data
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

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)	* Tt (hrs)	Rounded Values Tc (hrs)	* 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.

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

Worst-case diversion Berm C1

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

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	Ia/p 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

Type.... TR-55 Tabular Hyd.Peaks
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	

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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
==========

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	Ia/p 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.

Worst-case downslope channel

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 Formı
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	

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Worksheet
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	worst-case west perimeter
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 Energ	1.30	ft
Froude Numb	0.64	
Flow Type	Subcritical	

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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	ft²
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 Energ	1.41	ft
Froude Numb	0.61	
Flow Type	Subcritical	

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Worksheet
Worksheet for Trapezoidal Channel

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

Worst-case south perimeter ditch

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 Energ	1.45	ft
Froude Numb	0.92	
Flow Type	Subcritical	

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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	

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Basin Volume Computations

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	

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;

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.						

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

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.				

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

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 discharge from basin
Peak Elevation	=	792.01 ft ← Peak water elevation		
Peak Storage	=	4.805 ac-ft		

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.

BT² inc.

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. MRH 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; whi
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

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

South Basin Outflow Hydrograph (2/7)

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					
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

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

South Basin Outflow Hydrograp (3/7)

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					
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

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 (4/7)

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					
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

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 (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

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

South Basin Outflow Hydrograph (6/7)

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					
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

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

South Basin Outflow Hydrograph (7/7)

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					
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 discharge from basin
Peak Elevation	= 793.29	ft ← Peak water elevation		
Peak Storage	= 7.080	ac-ft		

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
Dense grasses[2]	0.24
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
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.

[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.

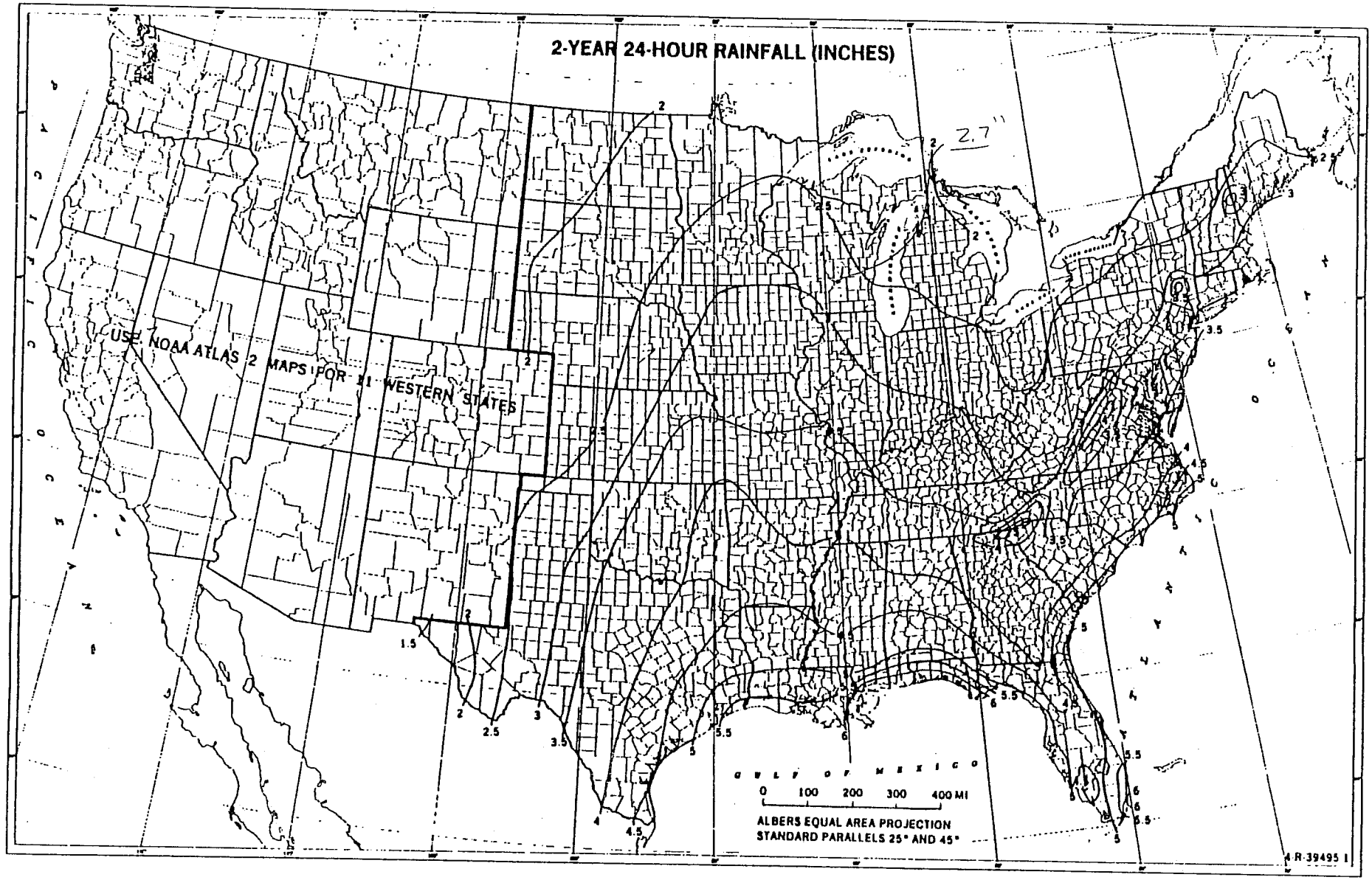


Figure B-3.—Two-year, 24-hour rainfall.

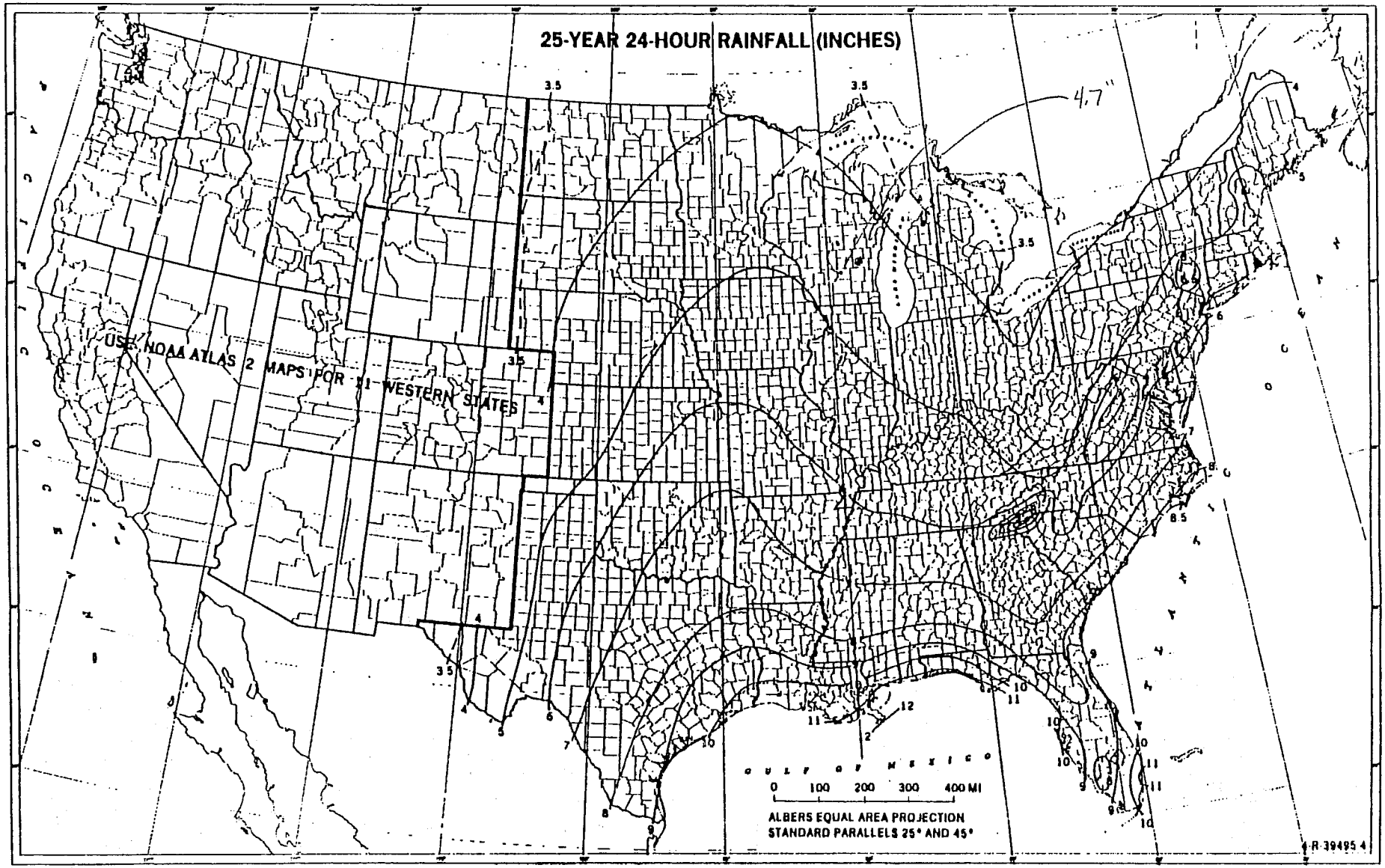


Figure B-6.—Twenty-five-year, 24-hour rainfall.

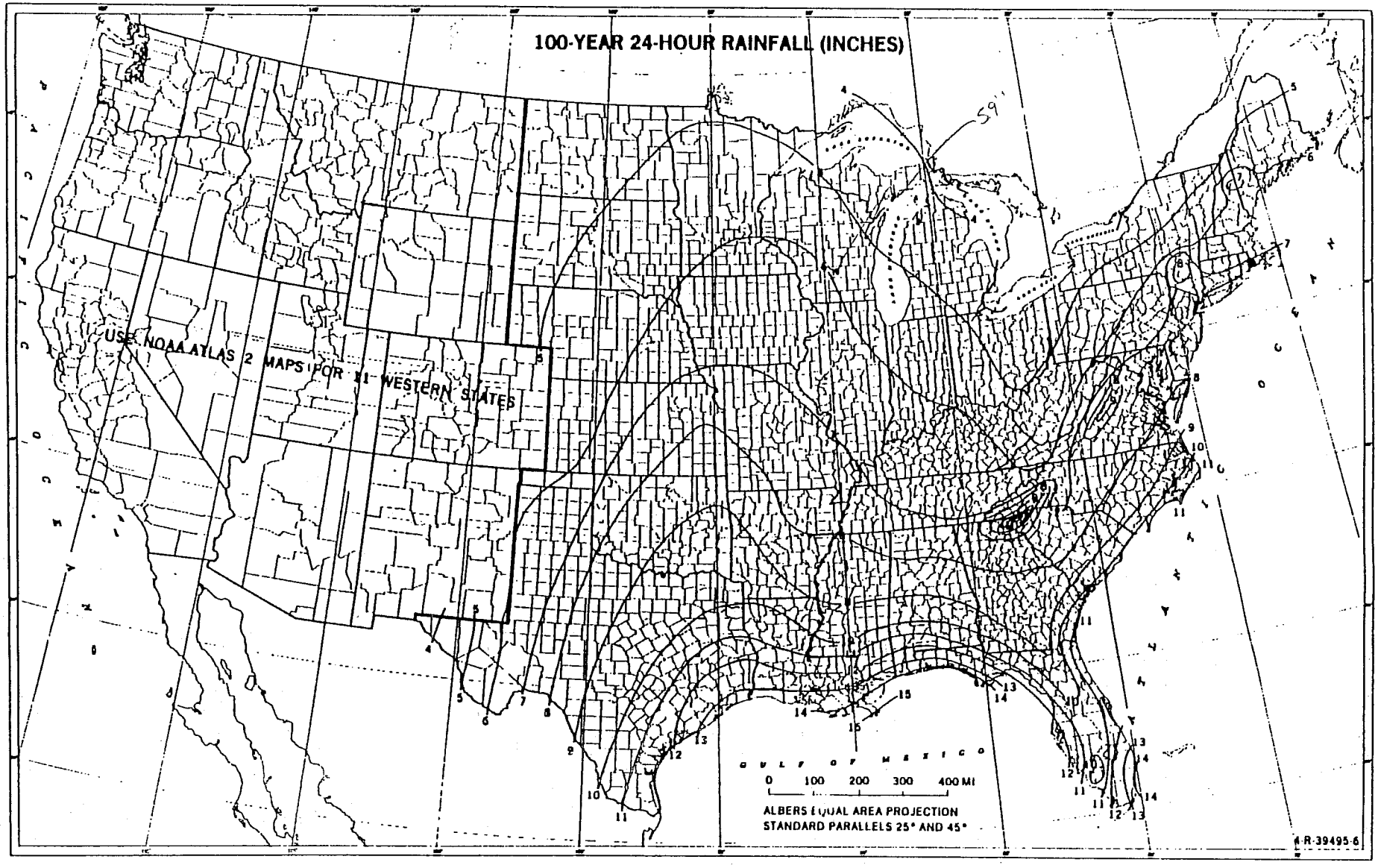


Figure B-8.—One-hundred-year, 24-hour rainfall.

TABLE 8.1 Surface Area Requirements of Sediment Traps and Basins

Particle size, mm		Settling velocity, ft/sec (m/sec)		Surface area requirements, ft^2 per ft^3/sec discharge	(m^2 per m^3/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

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 × 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:

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

297

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

PIPELINE

SWAMP ELEV. 827

W.L. 794.1

542,000 N

542,500 N

543,000 N

543,500 N

2,124,000 E

2,124,500 E

199,648 SF

West peripheral area

1,168,435 SF

121,578

LEGEND

PROPOSED LIMITS OF FILL	PAVED ROAD
APPROVED LIMITS OF FILL	UNPAVED ROAD
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'

N

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

EXISTING PHASE 1

PROPOSED PHASE 1

PROPOSED PHASE 2

PROPOSED PHASE 2

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

PLANT ENTRANCE ROAD

MODULE 1

MODULE 2

MODULE 3

MODULE 4

MODULE 5

MODULE 6

FINAL COVER SEE DETAIL (5/8)

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

SWAMP ELEV. 827

MW34A/B

MW85

MW30A/B

MW4

MW92A/B

MW91A/B

MW93A/B

MW16

LS32

542,000 N

542,500 N

543,000 N

543,500 N

2,124,000 E

2,124,500 E

A = 319,679 sf

A = 327,714 sf

A = 198,729 sf

1796' @ 2%

Worst-case downslope channel area

Worst-case diversion berm area

Areas determined by planimeter

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

60 0 60

SCALE: 1" = 60'

N

DRAFT

PROPOSED FINAL GRADES

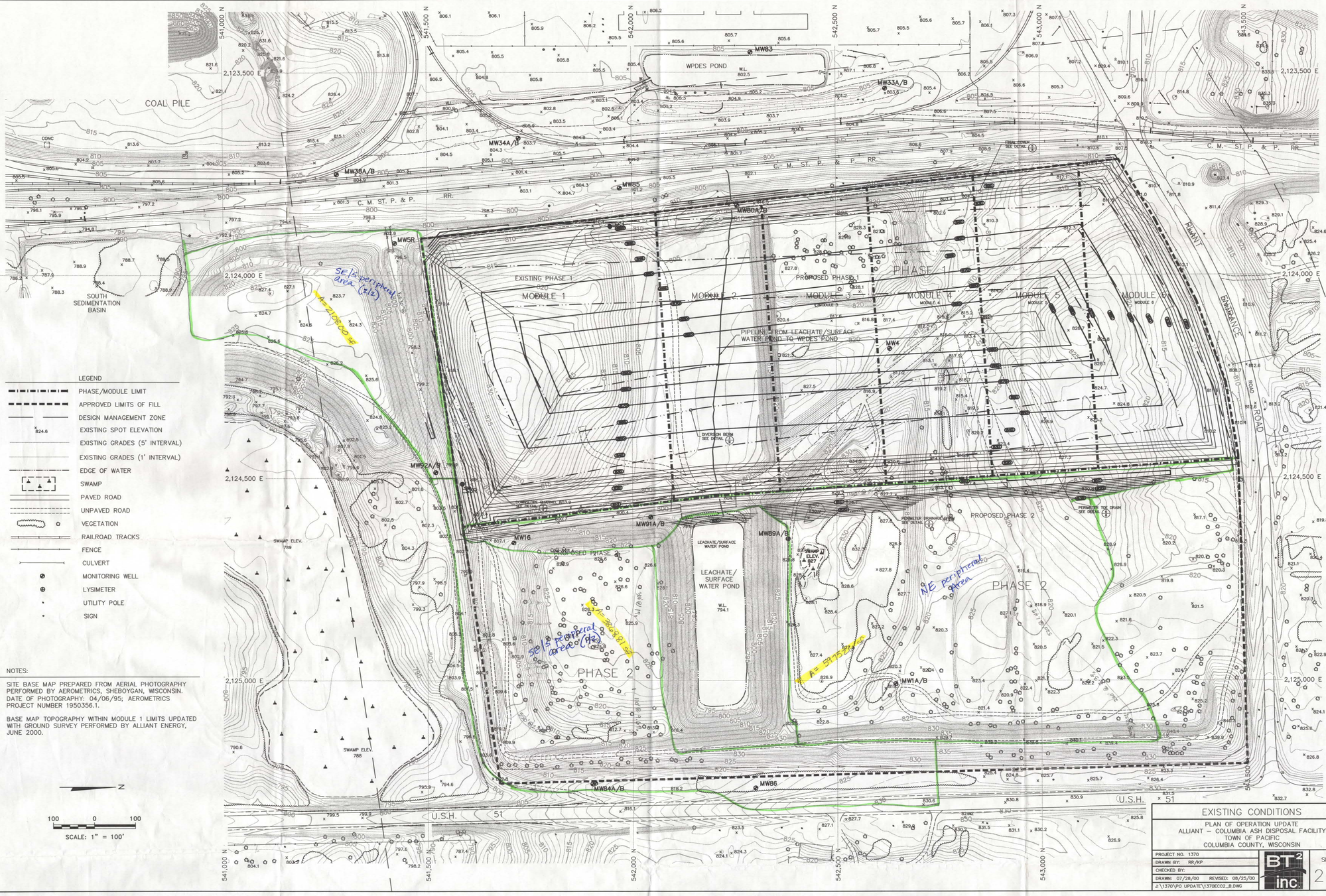
PLAN OF OPERATION UPDATE
ALLIANT – COLUMBIA ASH DISPOSAL FACILITY
TOWN OF PACIFIC
COLUMBIA COUNTY, WISCONSIN

PROJECT NO. 1370	
DRAWN BY: RR/KP	
CHECKED BY: MRH	
DRAWN: 07/28/00 REVISED: 09/25/00	
J:\1370\PO UPDATE\1370FG04.DWG	

BT² inc.

SHEET 4 OF 9

#1370 ON



LEGEND

- PHASE/MODULE LIMIT
- APPROVED LIMITS OF FILL
- DESIGN MANAGEMENT ZONE
- EXISTING SPOT ELEVATION (824.6)
- 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

SCS ENGINEERS					
		SHEET NO.	1 of 2		
Job No.	25215024	CALC. NO.			
Job:	Columbia Energy Center	REV. NO.			
Client	WPL	BY	BLP	DATE	6/9/15
Subject	Leachate/Surface Water Pond Evaluation	CHK'D.	MRH	DATE	6/9/15

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 during each remaining phase of development (Modules 3 – 6) in order to store the 25-year 24-hour storm at/below the top of the pond liner (elevation 796.97).
- The largest storm event the leachate/surface water pond can store during each remaining phase (Modules 3-6) of development with no additional intermediate/final cover installed, while maintaining the pond peak water elevation at/below the top of the liner (elevation 796.97).

Background:
During construction of Module 2, the top of the the leachate/surface water pond liner was determined to be at elevation 796.97, which is below the design elevation of 798. The Surface Water Runoff Capacity Evaluation, Leachate/Surface Water Pond calculations included in the 2010 Plan of Operation Update were based on the design elevation of 798.

Approach:
- Start with the HydroCAD storm water model from the 2010 Plan of Operation Update, and perform the following:
    - Review drainage areas based on latest topography (December 2014 aerial survey) and modify accordingly.
    - Update the pond stage-storage data based on as-built drawings. As-built contours were digitized into a CAD drawing, and the surface area of each contour measured in AutoCAD.
    - Set a standing water elevation in the pond at 6 inches off of the bottom (i.e., elevation 792.5).
    - Update Plan of Operation Update precipitation depths and distribution using NOAA Atlas 14 and associated hydrograph distributions developed for Wisconsin.
    - Run the HydroCAD model for the following scenarios with Module 3 constructed and active/open:
        - Model Run 1A: Modify the Module 1 open/active area draining to the pond until the maximum peak water elevation of 769.97 or less is obtained in the pond for a 25-year, 24-hour storm event.
        - Model Run 1B: Run the model at various precipitation depths to determine the maximum storm event the pond can store without additional intermediate/final cover.
    - Run the HydroCAD model for the following scenarios during Module 4 constructed and active/open:

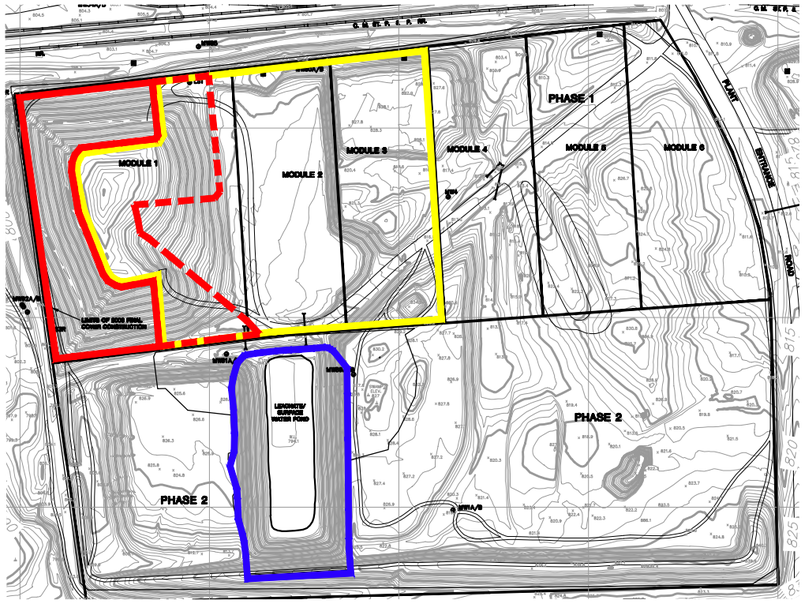
        - Model Run 2A: Modify the Module 2 open/active area draining to the pond until the maximum peak water elevation of 769.97 or less is obtained in the pond for a 25-year, 24-hour storm event.
        - Model Run 2B: Run the model at various precipitation depths to determine the maximum storm event the pond can store without additional intermediate/final cover.
    - Run the HydroCAD model for the following scenarios during Module 5 constructed and active/open:
        - Model Run 3A: Modify the Module 3 open/active area draining to the pond until the maximum peak water elevation of 769.97 or less is obtained in the pond for a 25-year, 24-hour storm event.
        - Model Run 3B: Run the model at various precipitation depths to determine the maximum storm event the pond can store without additional intermediate/final cover.
    - Run the HydroCAD model for the following scenarios during Module 6 constructed and active/open:
        - Model Run 4A: Modify the Module 4 open/active area draining to the pond until the maximum peak water elevation of 769.97 or less is obtained in the pond for a 25-year, 24-hour storm event.
        - Model Run 4B: Run the model at various precipitation depths to determine the maximum storm event the pond can store without additional intermediate/final cover.

Assumptions:

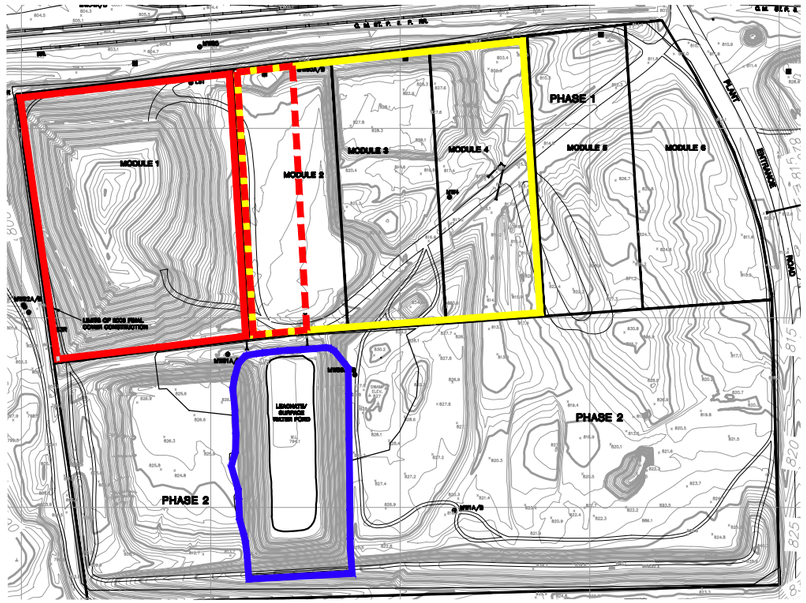
- See attached Figure 1 for approximate watersheds to the leachate/surface water pond. Modifications were made to the watersheds presented in the 2010 Plan of Operation Update to account for changes in topography and drainage patterns outside the limits of waste since the 2010 Plan of Operation Update.
- Active/open landfill areas were assumed to be impermeable (CN=98).
- Runoff from areas with intermediate or final cover will be routed to the sedimentation basin and are therefore not included in the runoff to the leachate/surface water pond.
- Three modules were assumed to be open at any stage of development.
- The bottom of the pond is at 792. The starting water level in the pond prior to the modeled storm event is 6 inches (elevation 792.5).

Results:

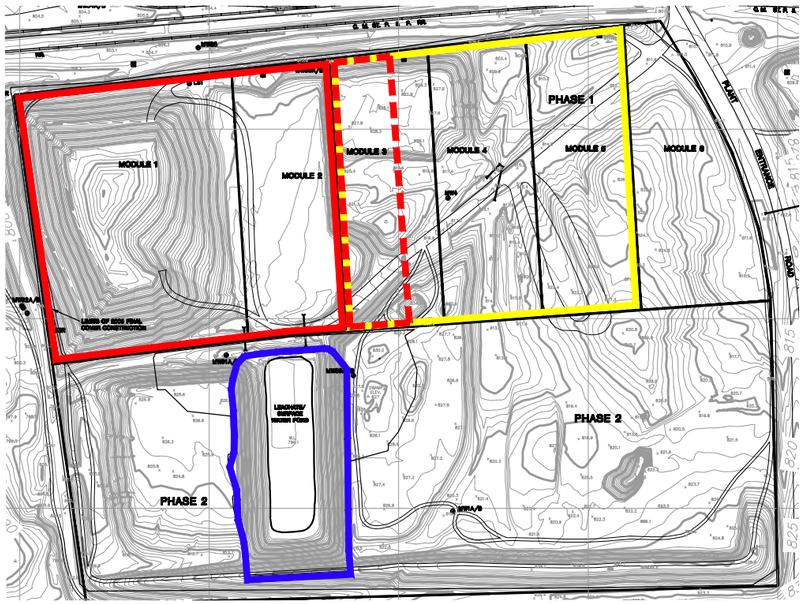
See attached summary table for each model run. See attached HydroCAD model results for detailed input/output for each of the above model runs.



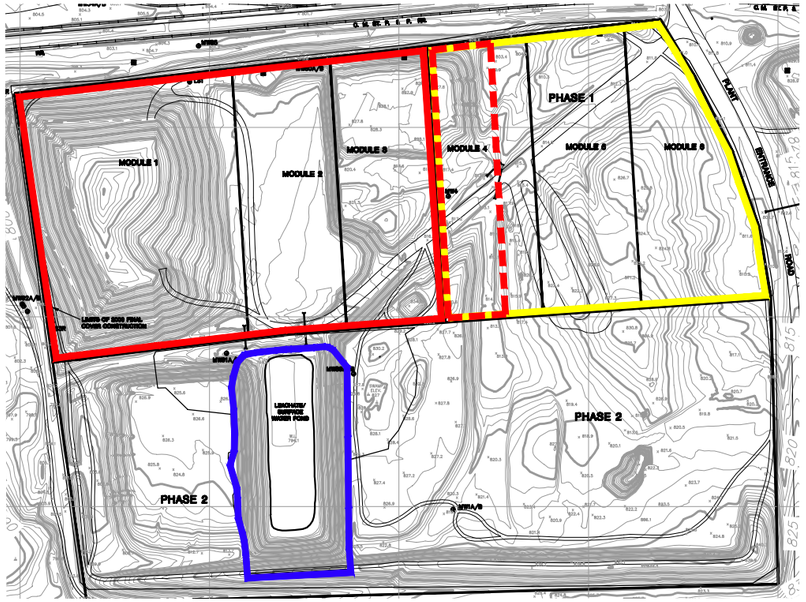
MODULE 3 CONSTRUCTED



MODULE 4 CONSTRUCTED



MODULE 5 CONSTRUCTED



MODULE 6 CONSTRUCTED

ADDITIONAL INTERMEDIATE/FINAL COVER AREA
FINAL COVER AREA
OPEN MODULE AREA (IMPERMEABLE)
WATERSHED/AREA OUTSIDE OF CONSTRUCTED MODULES

400 0 400

SCALE: 1" = 400'

N

PROJECT NO.	25214194	DRAWN BY:	PEG/JMO
DRAWN:	09/20/10	CHECKED BY:	BP
REVISED:	06/09/15	APPROVED BY:	

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

CLIENT: Wisconsin Power and Light Company

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

LEACHATE POND PLANNING

FIGURE 1

I:\25215024\Drawings\Leachate Pond Planning.dwg , 6/9/2015 6:00:42 PM

Leachate/Suface Water Pond Capacity Evaluation Summary
Columbia Energy Center

Module Summary

Module	Module Size (ac)
Module 1	9.00
1 (Currently Open/Active)	*5.31*
1 (Currently Closed)	*3.69*
Module 2	4.27
Module 3	4.33
Module 4	4.39
Module 5	4.46
Module 6	4.38

Evaluation Summary

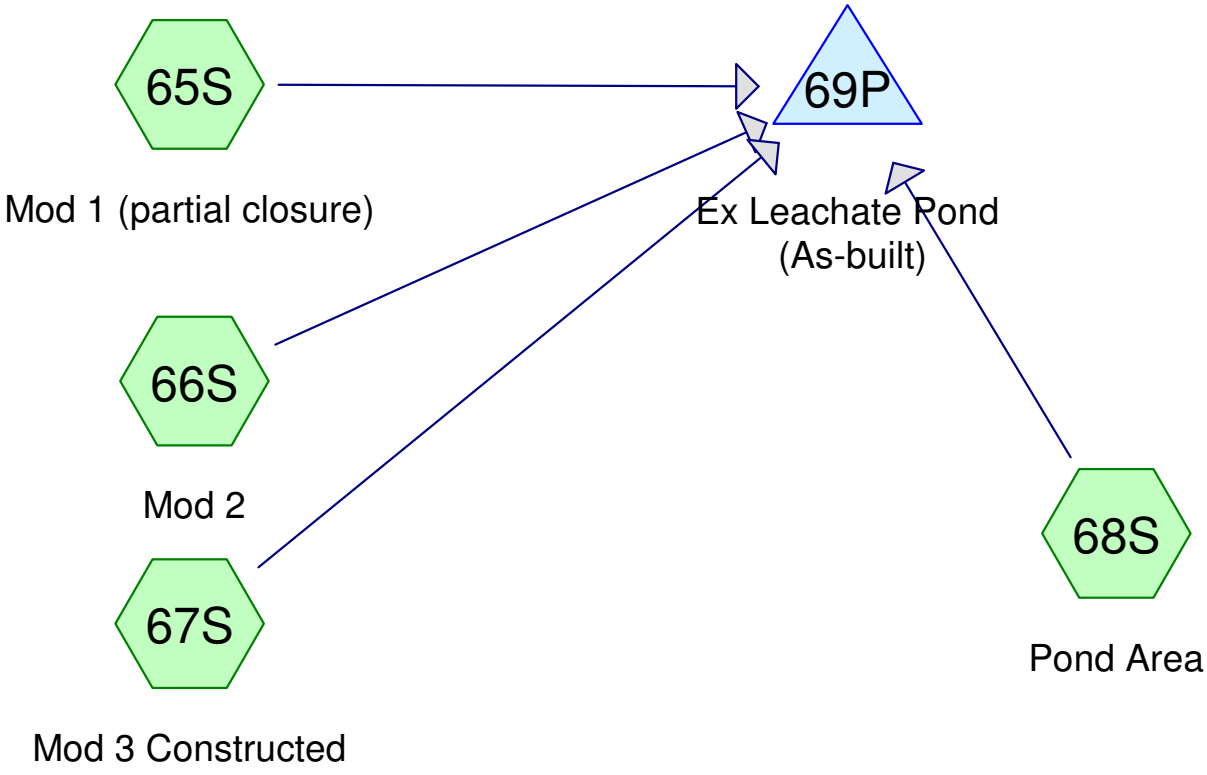
Description [1]	Modules Open/Active [4]	Total Area of Modules (see Module Summary table above)	Bottom of Pond [2]	Top of Pond (i.e.,Top of Liner/Maximum Allowable Water Elevation In Pond) [2]	Standing Water Elevation in Pond Prior to Start of Storm Event [2]	Peak Water Elevation (25-yr, 24-hr storm) [3]	Intermediate/Final Cover Area Required Within 3 Open/Active Modules to Maintain Maximum Allowable Pond Water Elevation [4,5]	Maximum Precipitation Depth Pond Can Accommodate Without Additional Intermediate/Final Cover while Maintainin Maximum Allowable Pond Water Elevation [6]
Mod 3 Constructed (Portion of Mod 1 is Currently Closed)	1, 2, 3	17.6	792	796.97	792.5	796.97	3.43 acres	4.0" (10-year event)
Mod 4 Constructed (Mod 1 Closed)	2, 3, 4	12.99	792	796.97	792.5	796.97	2.51 acres	4.21" (approximately 10-year event)
Mod 5 Constructed (Mods 1, 2 Closed)	3, 4, 5	13.18	792	796.97	792.5	796.97	2.70 acres	4.16" (approximately 10-year event)
Mod 6 Constructed (Mods 1, 2, 3 Closed)	4, 5, 6	13.23	792	796.97	792.5	796.97	2.75 acres	4.15" (approximately 10-year event)

Notes:

1. See attached Figure 1 for contributing watershed areas during each stage of development.
2. Bottom of pond elevation from Plan of Operation. Top of Pond from survey performed during Module 2 construction. Six inches of water assumed to be standing in pond prior to storm event.
3. Peak water elevation (25-year, 24-hour storm) from stormwater modelling results (attached).
4. Three modules were assumed to be open at any give stage of development.
5. Intermediate/Final cover area required determined by adjusting amount of open/active area until the maximum water elevation of 796.97 was obtained. Area reported is in addition to existing final cover area in Module 1.
6. Below is a summary of the precipitation depths associated with various design storm events:

   5-year, 24-hour storm event = 3.38"
   10-year, 24-hour storm event = 3.97"
   25-year, 24-hour storm event = 4.90"

Model Run 1A



Subcat Reach Pond Link

Time span=0.00-25.00 hrs, dt=0.01 hrs, 2501 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 65S: Mod 1 (partial closure) Runoff Area=1.880 ac 100.00% Impervious Runoff Depth=4.66"
Tc=15.0 min CN=98 Runoff=8.85 cfs 0.731 af

Subcatchment 66S: Mod 2 Runoff Area=4.270 ac 100.00% Impervious Runoff Depth=4.66"
Tc=15.0 min CN=98 Runoff=20.09 cfs 1.659 af

Subcatchment 67S: Mod 3 Constructed Runoff Area=4.330 ac 100.00% Impervious Runoff Depth=4.66"
Tc=20.0 min CN=98 Runoff=17.76 cfs 1.683 af

Subcatchment 68S: Pond Area Runoff Area=3.960 ac 100.00% Impervious Runoff Depth=4.66"
Tc=0.0 min CN=98 Runoff=28.03 cfs 1.539 af

Pond 69P: Ex Leachate Pond (As-built) Peak Elev=796.97' Storage=260,152 cf Inflow=55.31 cfs 5.612 af
Outflow=0.00 cfs 0.000 af

Total Runoff Area = 14.440 ac Runoff Volume = 5.612 af Average Runoff Depth = 4.66"
0.00% Pervious = 0.000 ac 100.00% Impervious = 14.440 ac

Summary for Subcatchment 65S: Mod 1 (partial closure)

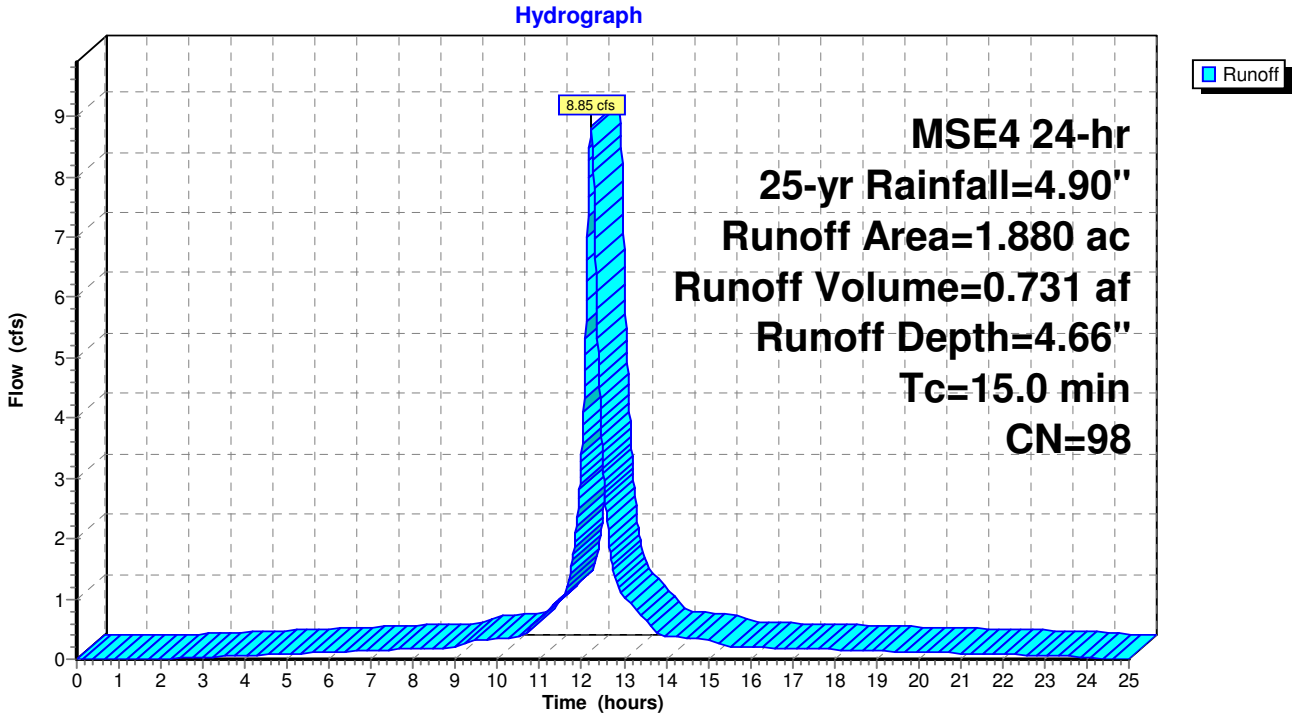
Runoff = 8.85 cfs @ 12.22 hrs, Volume= 0.731 af, Depth= 4.66"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.01 hrs
MSE4 24-hr 25-yr Rainfall=4.90"

	Area (ac)	CN	Description
*	1.880	98	Mod 1 no cover
	1.880		100.00% Impervious Area

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

Subcatchment 65S: Mod 1 (partial closure)



Summary for Subcatchment 66S: Mod 2

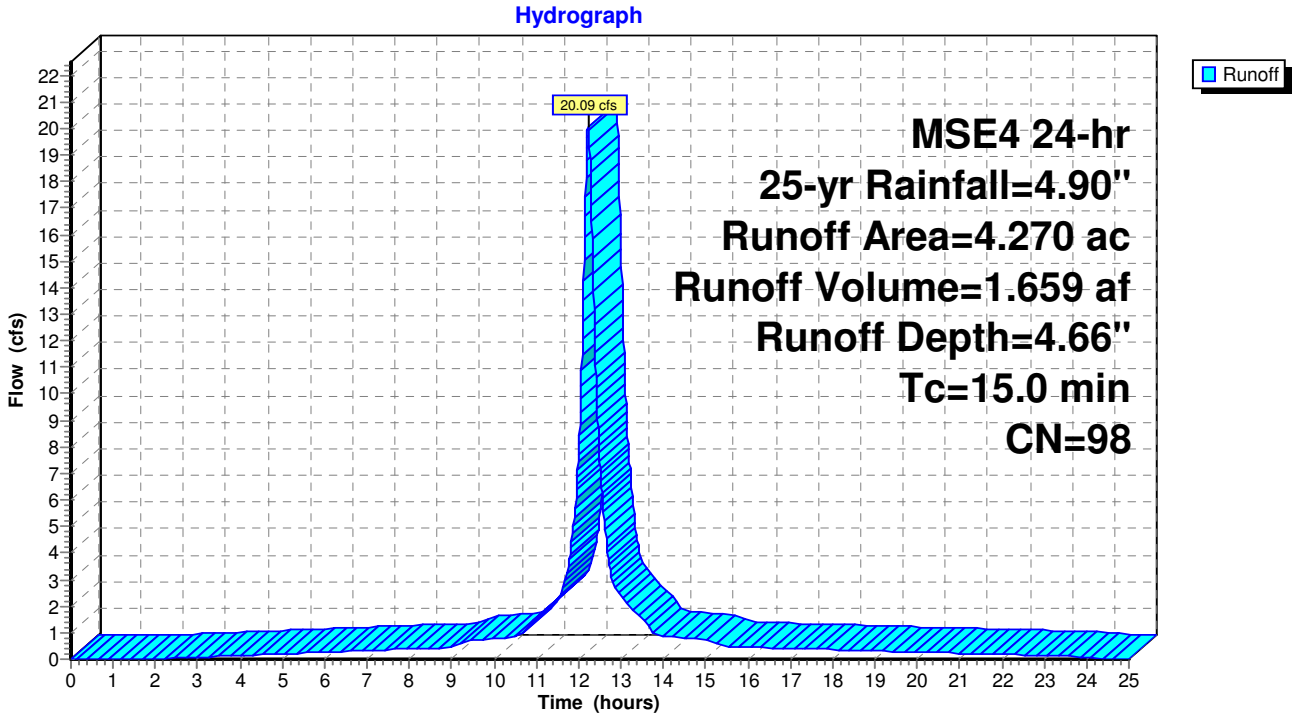
Runoff = 20.09 cfs @ 12.22 hrs, Volume= 1.659 af, Depth= 4.66"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.01 hrs
MSE4 24-hr 25-yr Rainfall=4.90"

	Area (ac)	CN	Description
*	4.270	98	Mod 2 final cover
	4.270		100.00% Impervious Area

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

Subcatchment 66S: Mod 2



Summary for Subcatchment 67S: Mod 3 Constructed

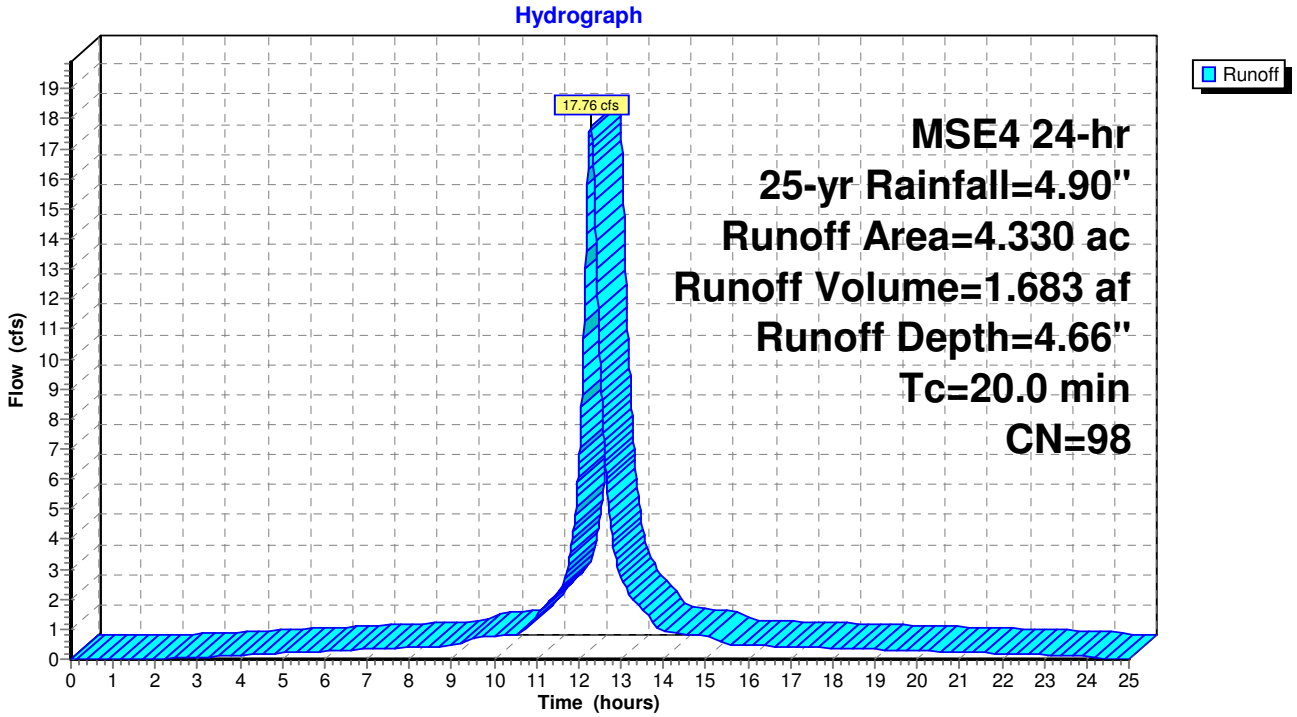
Runoff = 17.76 cfs @ 12.29 hrs, Volume= 1.683 af, Depth= 4.66"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.01 hrs
MSE4 24-hr 25-yr Rainfall=4.90"

	Area (ac)	CN	Description
*	4.330	98	Mod 3 no cover
	4.330		100.00% Impervious Area

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

Subcatchment 67S: Mod 3 Constructed



Summary for Subcatchment 68S: Pond Area

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

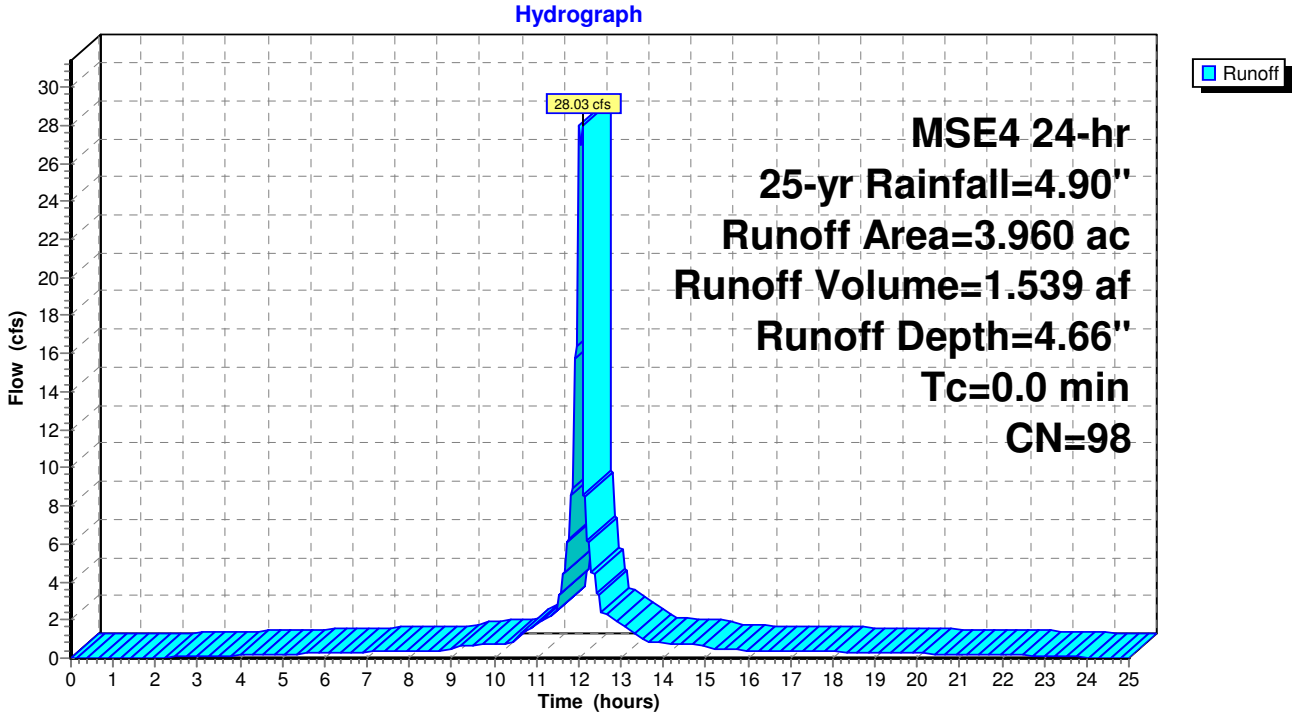
Runoff = 28.03 cfs @ 12.09 hrs, Volume= 1.539 af, Depth= 4.66"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.01 hrs
MSE4 24-hr 25-yr Rainfall=4.90"

	Area (ac)	CN	Description
*	3.960	98	
	3.960		100.00% Impervious Area

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

Subcatchment 68S: Pond Area



Summary for Pond 69P: Ex Leachate Pond (As-built)

Inflow Area = 14.440 ac,100.00% Impervious, Inflow Depth = 4.66" for 25-yr event
Inflow = 55.31 cfs @ 12.09 hrs, Volume= 5.612 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

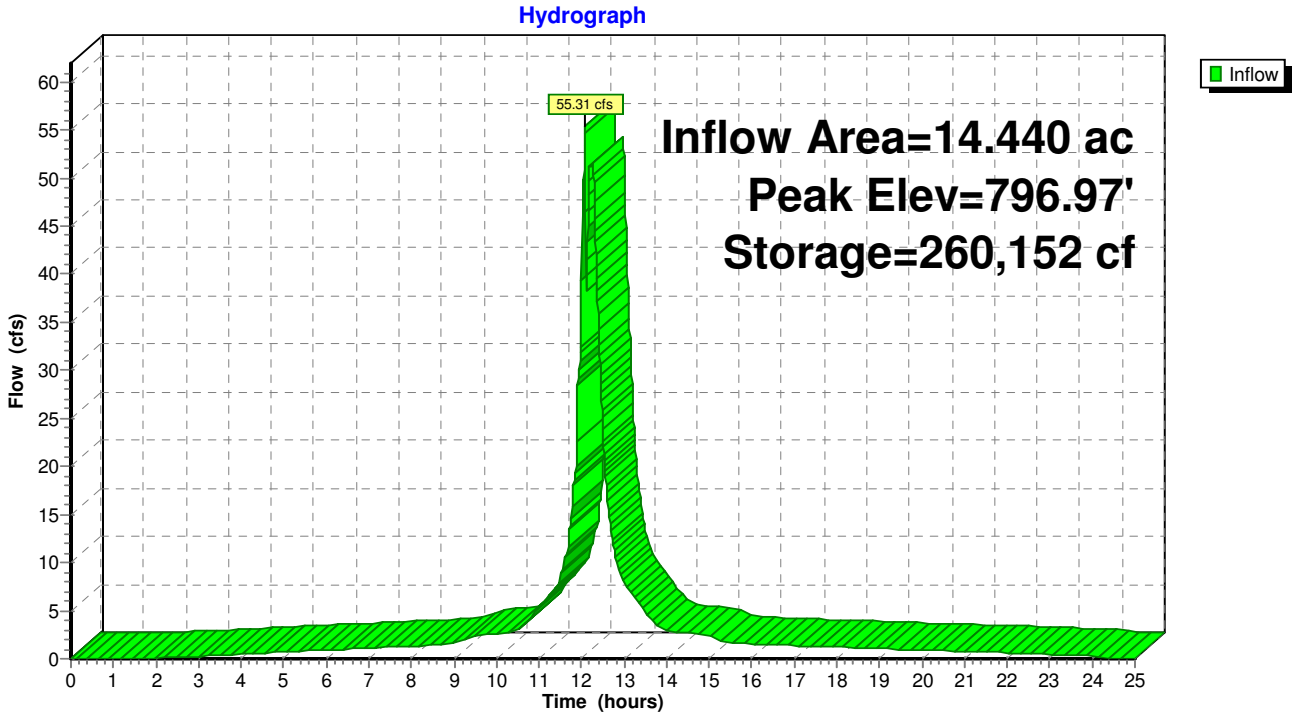
Routing by Stor-Ind method, Time Span= 0.00-25.00 hrs, dt= 0.01 hrs
Starting Elev= 792.50' Surf.Area= 34,630 sf Storage= 15,714 cf
Peak Elev= 796.97' @ 25.00 hrs Surf.Area= 65,516 sf Storage= 260,152 cf (244,438 cf above start)

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

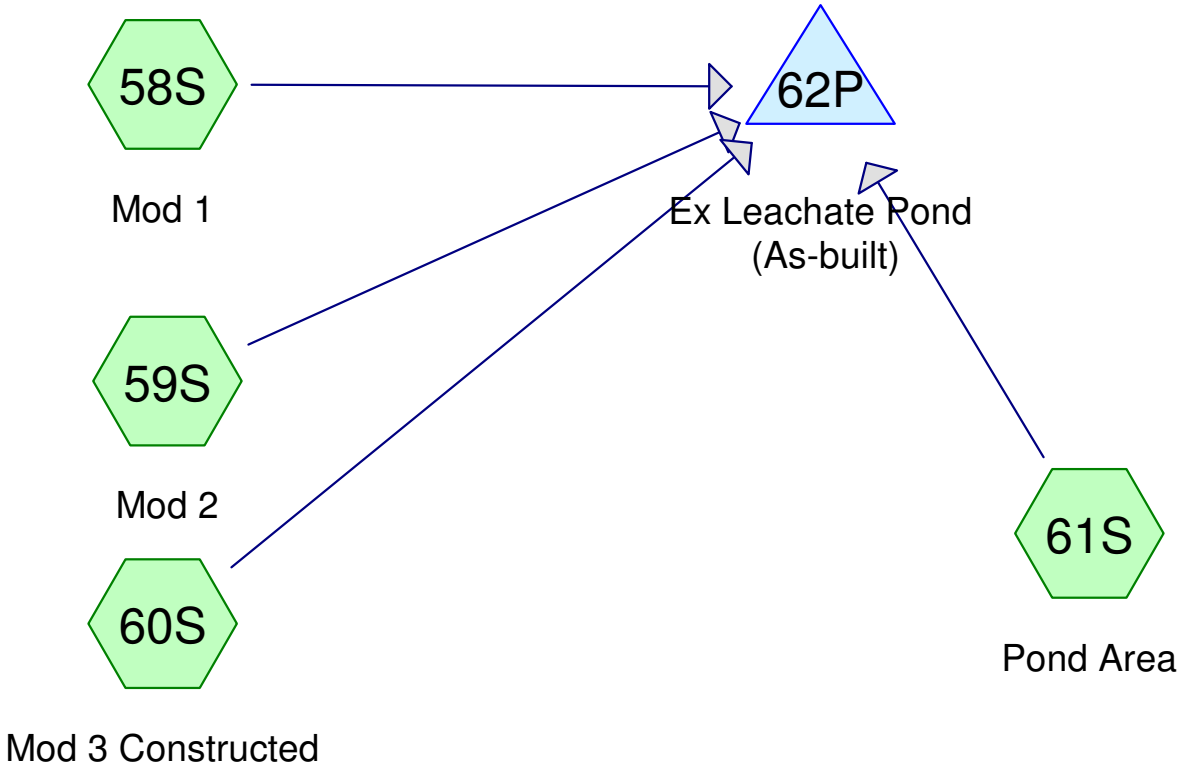
Volume	Invert	Avail.Storage	Storage Description
#1	792.00'	329,280 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
792.00	28,228	0	0
794.00	53,834	82,062	82,062
796.00	62,164	115,998	198,060
798.00	69,056	131,220	329,280

Pond 69P: Ex Leachate Pond (As-built)



Model Run 1B



Subcat Reach Pond Link

Time span=0.00-25.00 hrs, dt=0.01 hrs, 2501 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 58S: Mod 1 Runoff Area=5.310 ac 100.00% Impervious Runoff Depth=3.77"
Tc=15.0 min CN=98 Runoff=20.33 cfs 1.666 af

Subcatchment 59S: Mod 2 Runoff Area=4.270 ac 100.00% Impervious Runoff Depth=3.77"
Tc=15.0 min CN=98 Runoff=16.35 cfs 1.340 af

Subcatchment 60S: Mod 3 Constructed Runoff Area=4.330 ac 100.00% Impervious Runoff Depth=3.77"
Tc=20.0 min CN=98 Runoff=14.46 cfs 1.359 af

Subcatchment 61S: Pond Area Runoff Area=3.960 ac 100.00% Impervious Runoff Depth=3.77"
Tc=0.0 min CN=98 Runoff=22.83 cfs 1.242 af

Pond 62P: Ex Leachate Pond (As-built) Peak Elev=796.97' Storage=259,949 cf Inflow=55.25 cfs 5.607 af
Outflow=0.00 cfs 0.000 af

Total Runoff Area = 17.870 ac Runoff Volume = 5.607 af Average Runoff Depth = 3.77"
0.00% Pervious = 0.000 ac 100.00% Impervious = 17.870 ac

Summary for Subcatchment 58S: Mod 1

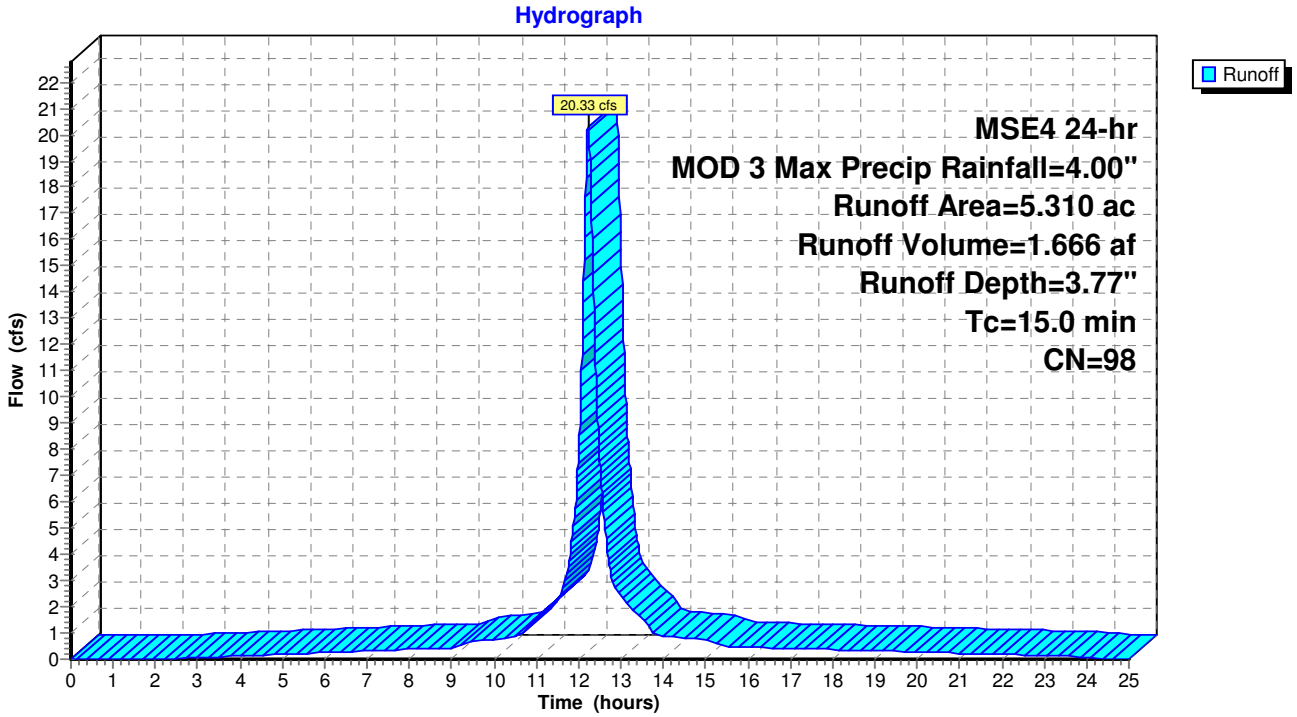
Runoff = 20.33 cfs @ 12.22 hrs, Volume= 1.666 af, Depth= 3.77"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.01 hrs
MSE4 24-hr MOD 3 Max Precip Rainfall=4.00"

	Area (ac)	CN	Description
*	5.310	98	Mod 1 no cover
	5.310		100.00% Impervious Area

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

Subcatchment 58S: Mod 1



Summary for Subcatchment 59S: Mod 2

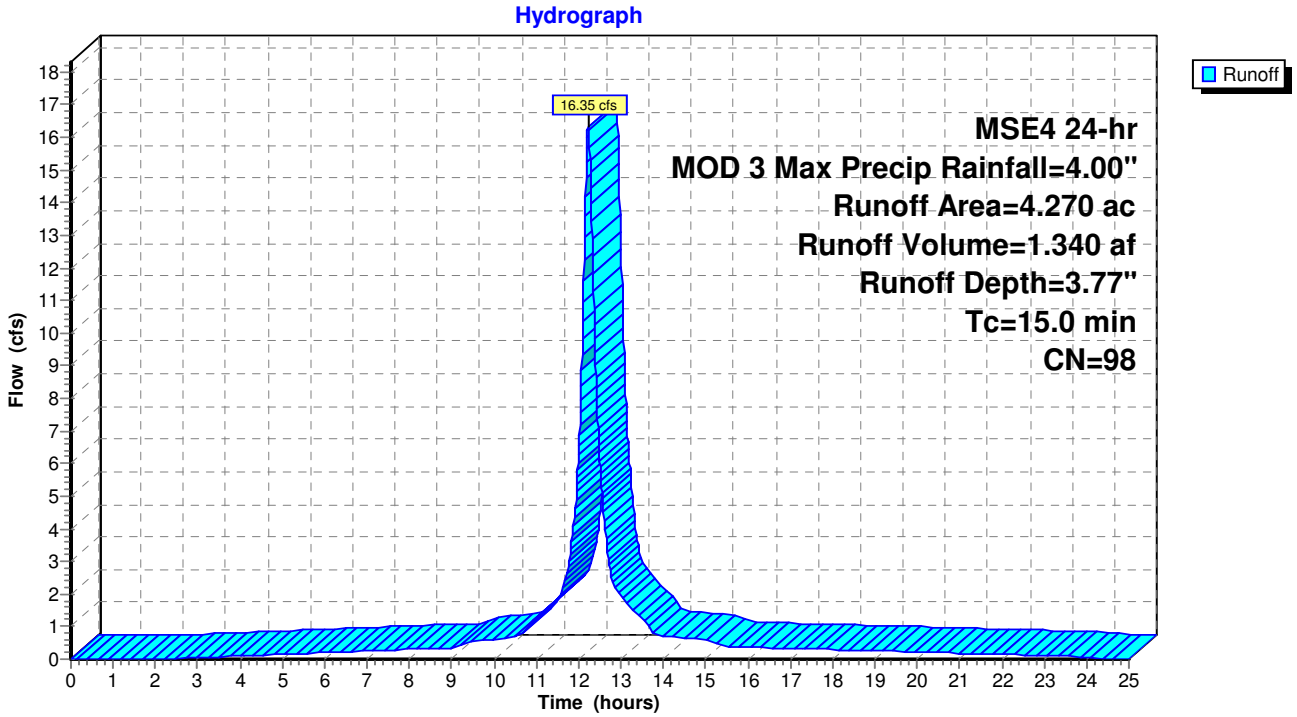
Runoff = 16.35 cfs @ 12.22 hrs, Volume= 1.340 af, Depth= 3.77"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.01 hrs
MSE4 24-hr MOD 3 Max Precip Rainfall=4.00"

	Area (ac)	CN	Description
*	4.270	98	Mod 2 final cover
	4.270		100.00% Impervious Area

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

Subcatchment 59S: Mod 2



Summary for Subcatchment 60S: Mod 3 Constructed

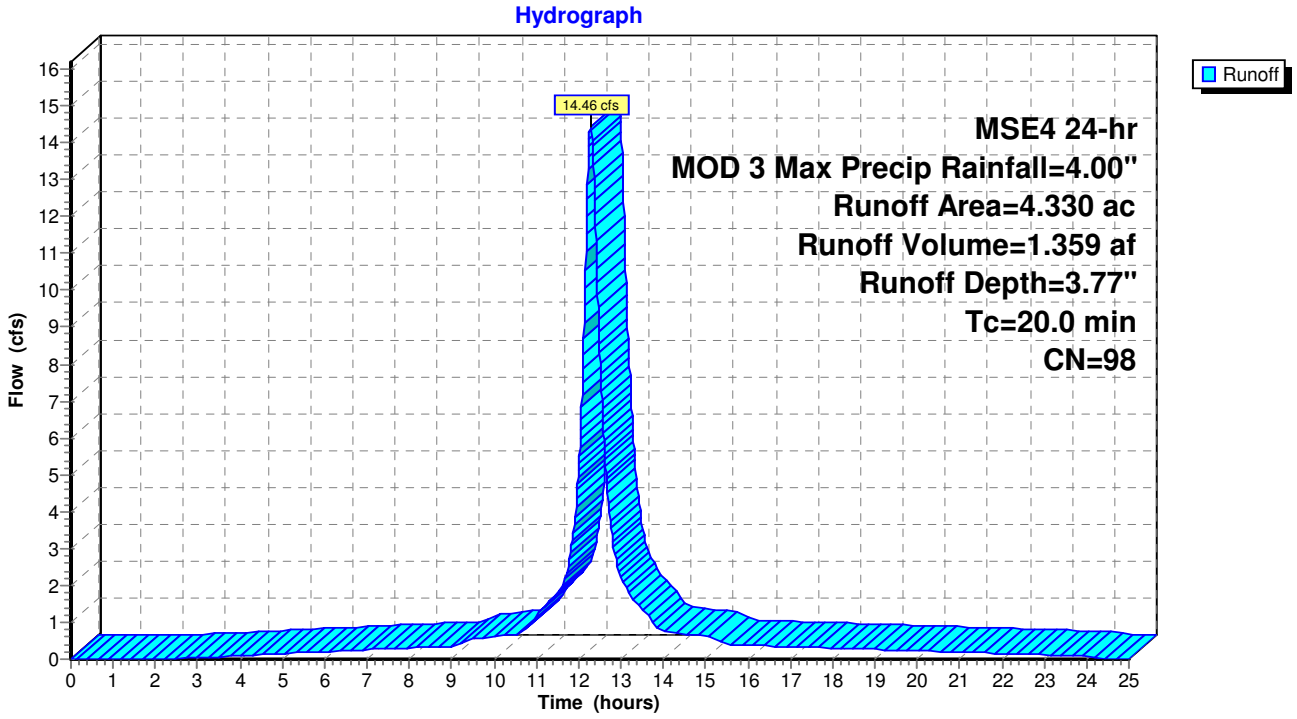
Runoff = 14.46 cfs @ 12.29 hrs, Volume= 1.359 af, Depth= 3.77"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.01 hrs
MSE4 24-hr MOD 3 Max Precip Rainfall=4.00"

	Area (ac)	CN	Description
*	4.330	98	Mod 3 no cover
	4.330		100.00% Impervious Area

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

Subcatchment 60S: Mod 3 Constructed



Summary for Subcatchment 61S: Pond Area

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

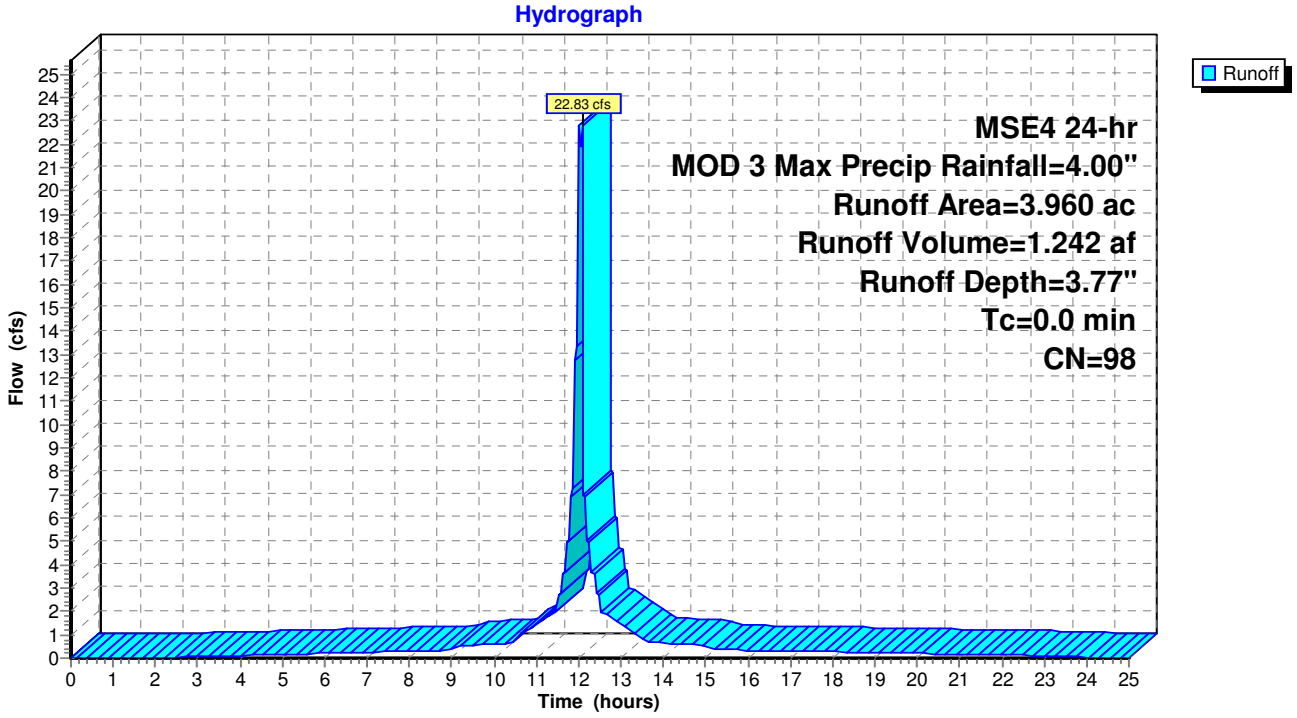
Runoff = 22.83 cfs @ 12.09 hrs, Volume= 1.242 af, Depth= 3.77"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.01 hrs
MSE4 24-hr MOD 3 Max Precip Rainfall=4.00"

	Area (ac)	CN	Description
*	3.960	98	
	3.960		100.00% Impervious Area

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

Subcatchment 61S: Pond Area



Summary for Pond 62P: Ex Leachate Pond (As-built)

Inflow Area = 17.870 ac,100.00% Impervious, Inflow Depth = 3.77" for MOD 3 Max Precip event
Inflow = 55.25 cfs @ 12.24 hrs, Volume= 5.607 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

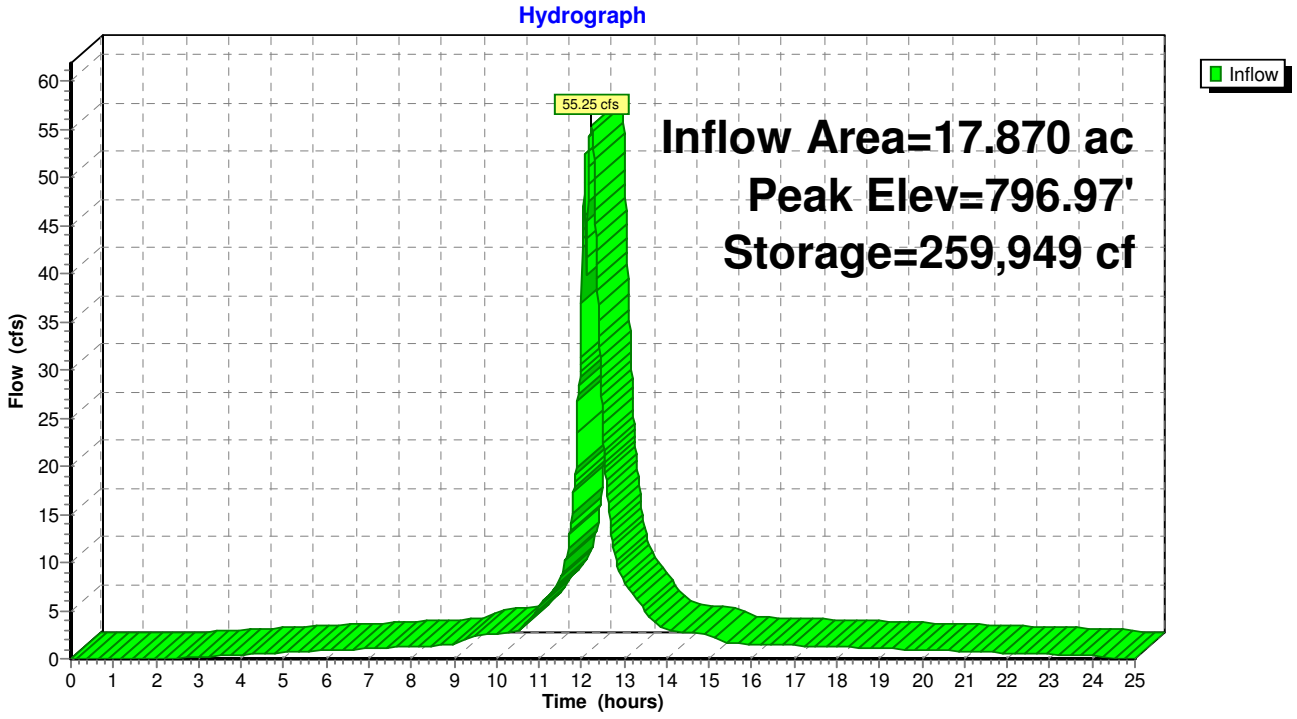
Routing by Stor-Ind method, Time Span= 0.00-25.00 hrs, dt= 0.01 hrs
Starting Elev= 792.50' Surf.Area= 34,630 sf Storage= 15,714 cf
Peak Elev= 796.97' @ 25.00 hrs Surf.Area= 65,505 sf Storage= 259,949 cf (244,234 cf above start)

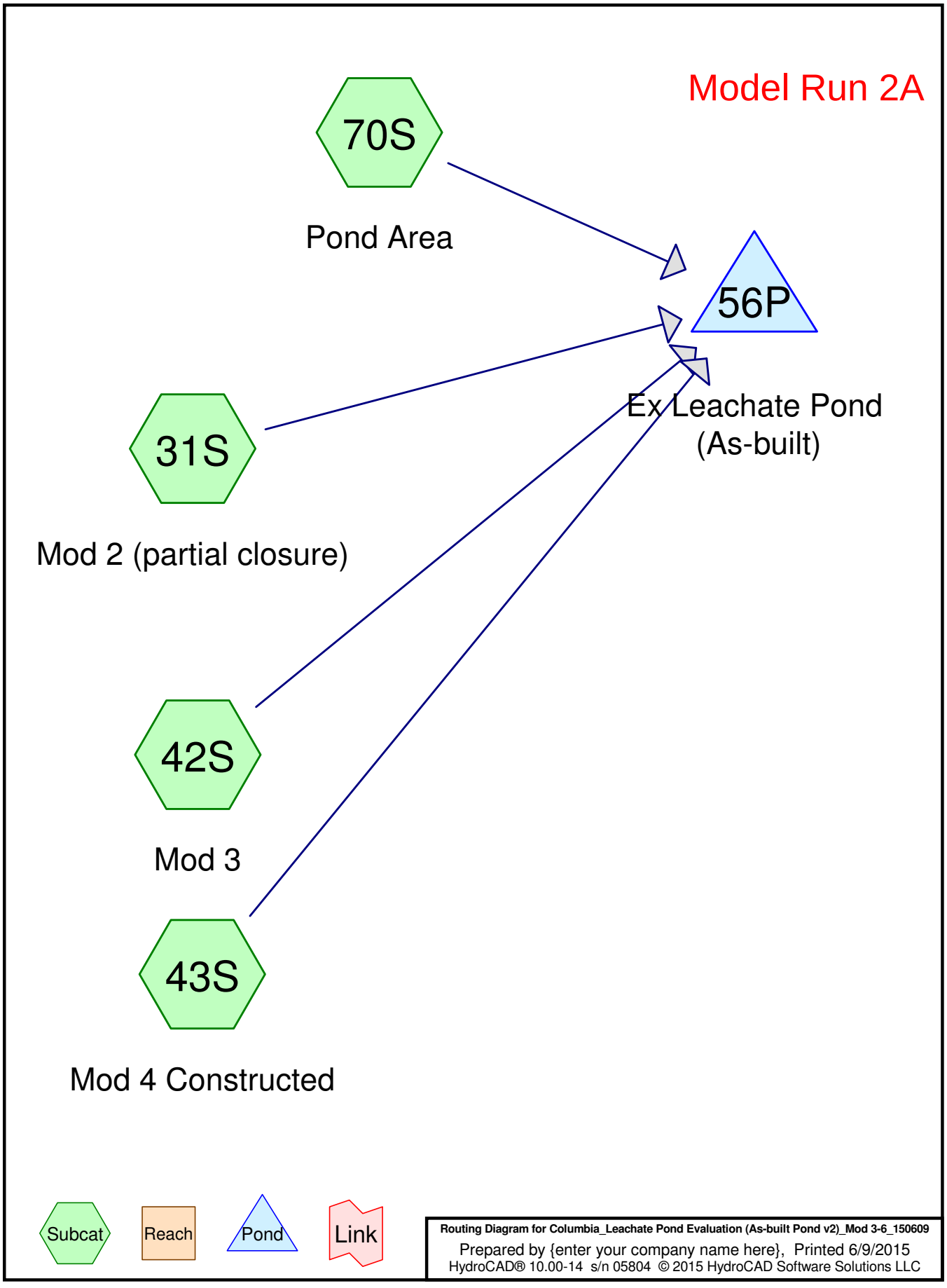
Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	792.00'	329,280 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
792.00	28,228	0	0
794.00	53,834	82,062	82,062
796.00	62,164	115,998	198,060
798.00	69,056	131,220	329,280

Pond 62P: Ex Leachate Pond (As-built)




Model Run 2A
70S
Pond Area
56P
Ex Leachate Pond
(As-built)
31S
Mod 2 (partial closure)
42S
Mod 3
43S
Mod 4 Constructed
Subcat
Reach
Pond
Link
Routing Diagram for Columbia_Leachate Pond Evaluation (As-built Pond v2)_Mod 3-6_150609
Prepared by {enter your company name here}, Printed 6/9/2015
HydroCAD® 10.00-14 s/n 05804 © 2015 HydroCAD Software Solutions LLC

Time span=0.00-25.00 hrs, dt=0.01 hrs, 2501 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 31S: Mod 2 (partial closure) Runoff Area=1.760 ac 100.00% Impervious Runoff Depth=4.66"
Tc=15.0 min CN=98 Runoff=8.28 cfs 0.684 af

Subcatchment 42S: Mod 3 Runoff Area=4.330 ac 100.00% Impervious Runoff Depth=4.66"
Tc=20.0 min CN=98 Runoff=17.76 cfs 1.683 af

Subcatchment 43S: Mod 4 Constructed Runoff Area=4.390 ac 100.00% Impervious Runoff Depth=4.66"
Tc=25.0 min CN=98 Runoff=16.12 cfs 1.706 af

Subcatchment 70S: Pond Area Runoff Area=3.960 ac 100.00% Impervious Runoff Depth=4.66"
Tc=0.0 min CN=98 Runoff=28.03 cfs 1.539 af

Pond 56P: Ex Leachate Pond (As-built) Peak Elev=796.97' Storage=260,152 cf Inflow=50.38 cfs 5.612 af
Outflow=0.00 cfs 0.000 af

Total Runoff Area = 14.440 ac Runoff Volume = 5.612 af Average Runoff Depth = 4.66"
0.00% Pervious = 0.000 ac 100.00% Impervious = 14.440 ac

Summary for Subcatchment 31S: Mod 2 (partial closure)

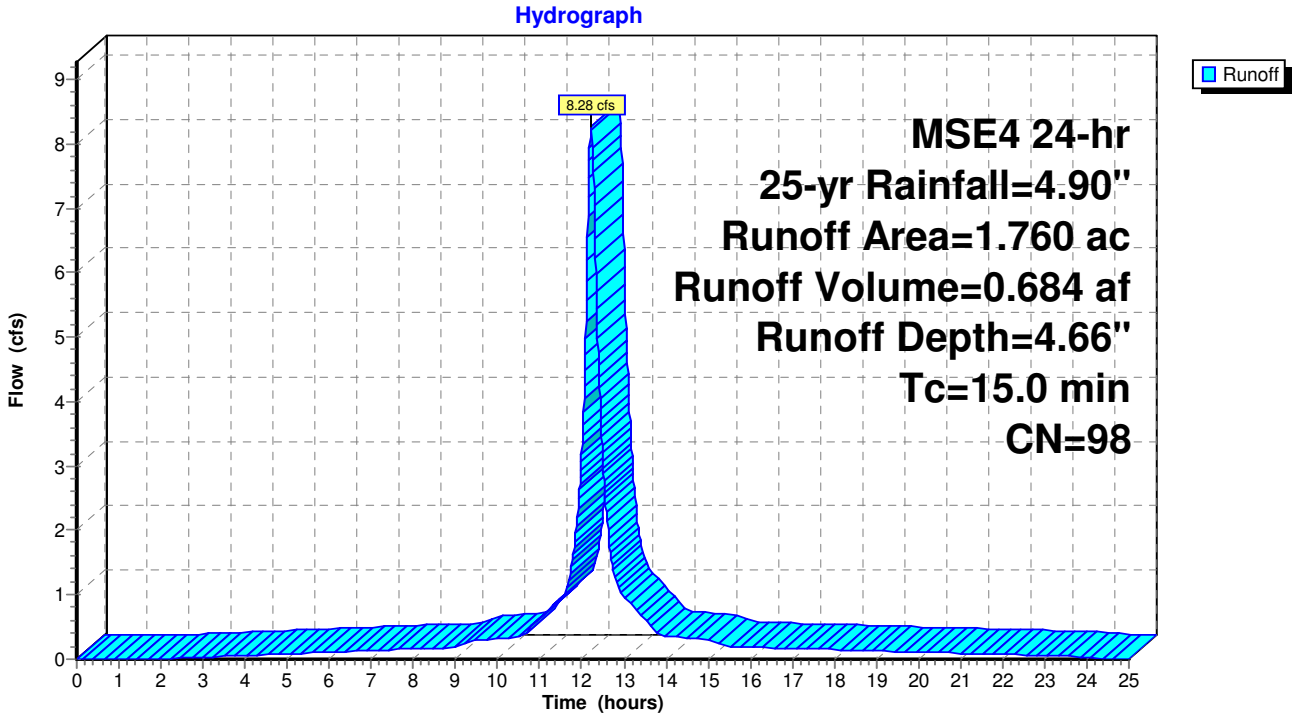
Runoff = 8.28 cfs @ 12.22 hrs, Volume= 0.684 af, Depth= 4.66"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.01 hrs
MSE4 24-hr 25-yr Rainfall=4.90"

	Area (ac)	CN	Description
*	1.760	98	Mod 2 final cover
	1.760		100.00% Impervious Area

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

Subcatchment 31S: Mod 2 (partial closure)



Summary for Subcatchment 42S: Mod 3

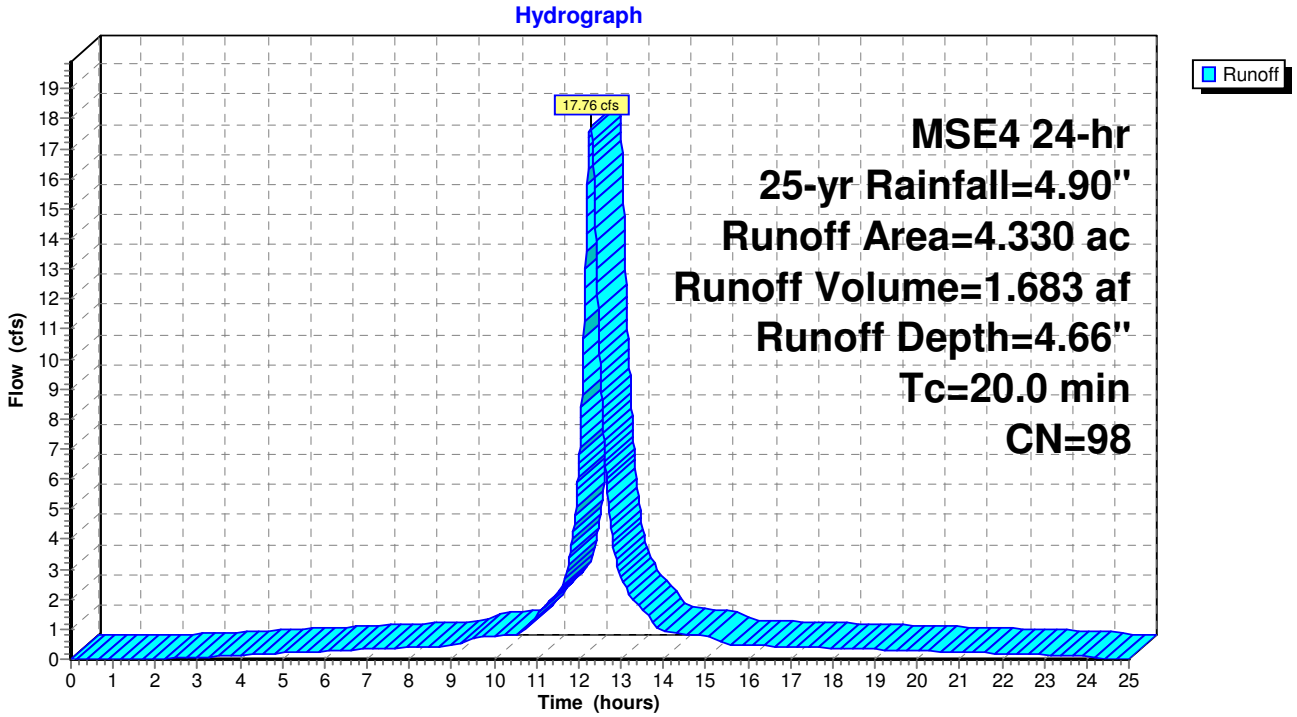
Runoff = 17.76 cfs @ 12.29 hrs, Volume= 1.683 af, Depth= 4.66"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.01 hrs
MSE4 24-hr 25-yr Rainfall=4.90"

	Area (ac)	CN	Description
*	4.330	98	Mod 3
	4.330		100.00% Impervious Area

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

Subcatchment 42S: Mod 3



Summary for Subcatchment 43S: Mod 4 Constructed

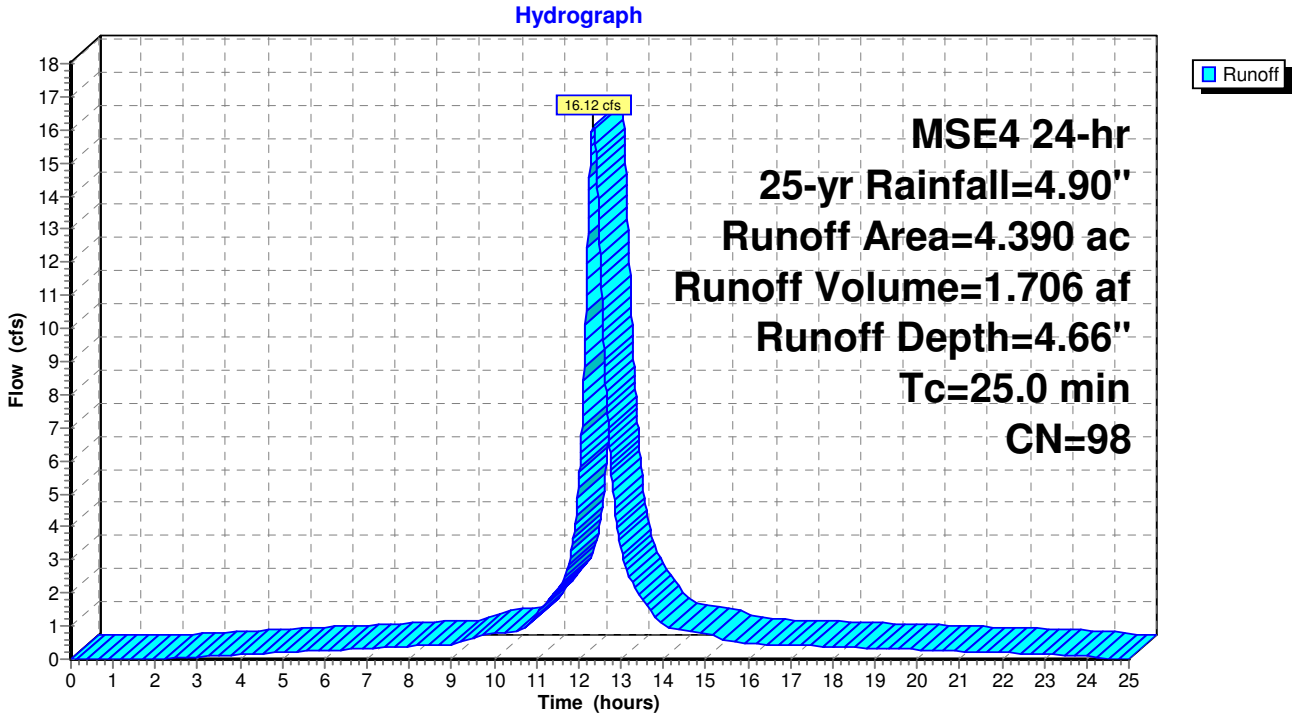
Runoff = 16.12 cfs @ 12.34 hrs, Volume= 1.706 af, Depth= 4.66"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.01 hrs
MSE4 24-hr 25-yr Rainfall=4.90"

	Area (ac)	CN	Description
*	4.390	98	Mod 4 no cover
	4.390		100.00% Impervious Area

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

Subcatchment 43S: Mod 4 Constructed



Summary for Subcatchment 70S: Pond Area

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

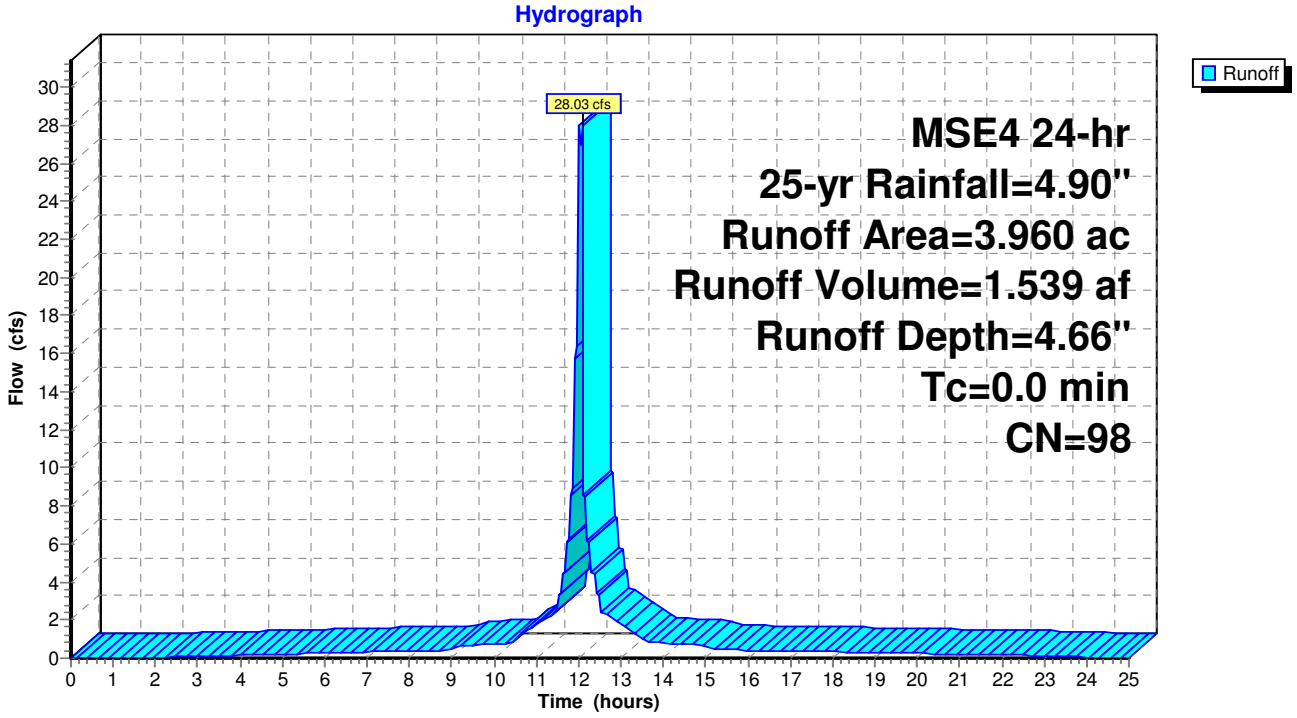
Runoff = 28.03 cfs @ 12.09 hrs, Volume= 1.539 af, Depth= 4.66"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.01 hrs
MSE4 24-hr 25-yr Rainfall=4.90"

	Area (ac)	CN	Description
*	3.960	98	
	3.960		100.00% Impervious Area

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

Subcatchment 70S: Pond Area



Summary for Pond 56P: Ex Leachate Pond (As-built)

Inflow Area = 14.440 ac,100.00% Impervious, Inflow Depth = 4.66" for 25-yr event
Inflow = 50.38 cfs @ 12.09 hrs, Volume= 5.612 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

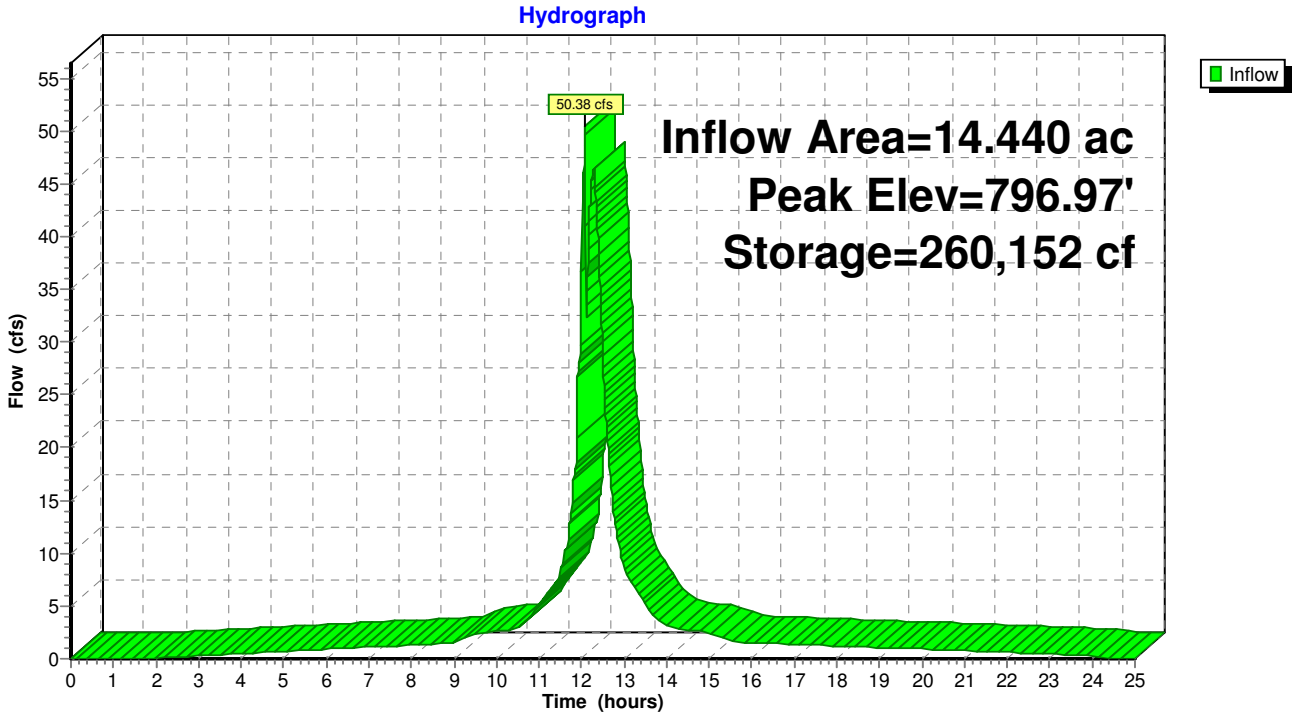
Routing by Stor-Ind method, Time Span= 0.00-25.00 hrs, dt= 0.01 hrs
Starting Elev= 792.50' Surf.Area= 34,630 sf Storage= 15,714 cf
Peak Elev= 796.97' @ 25.00 hrs Surf.Area= 65,516 sf Storage= 260,152 cf (244,438 cf above start)

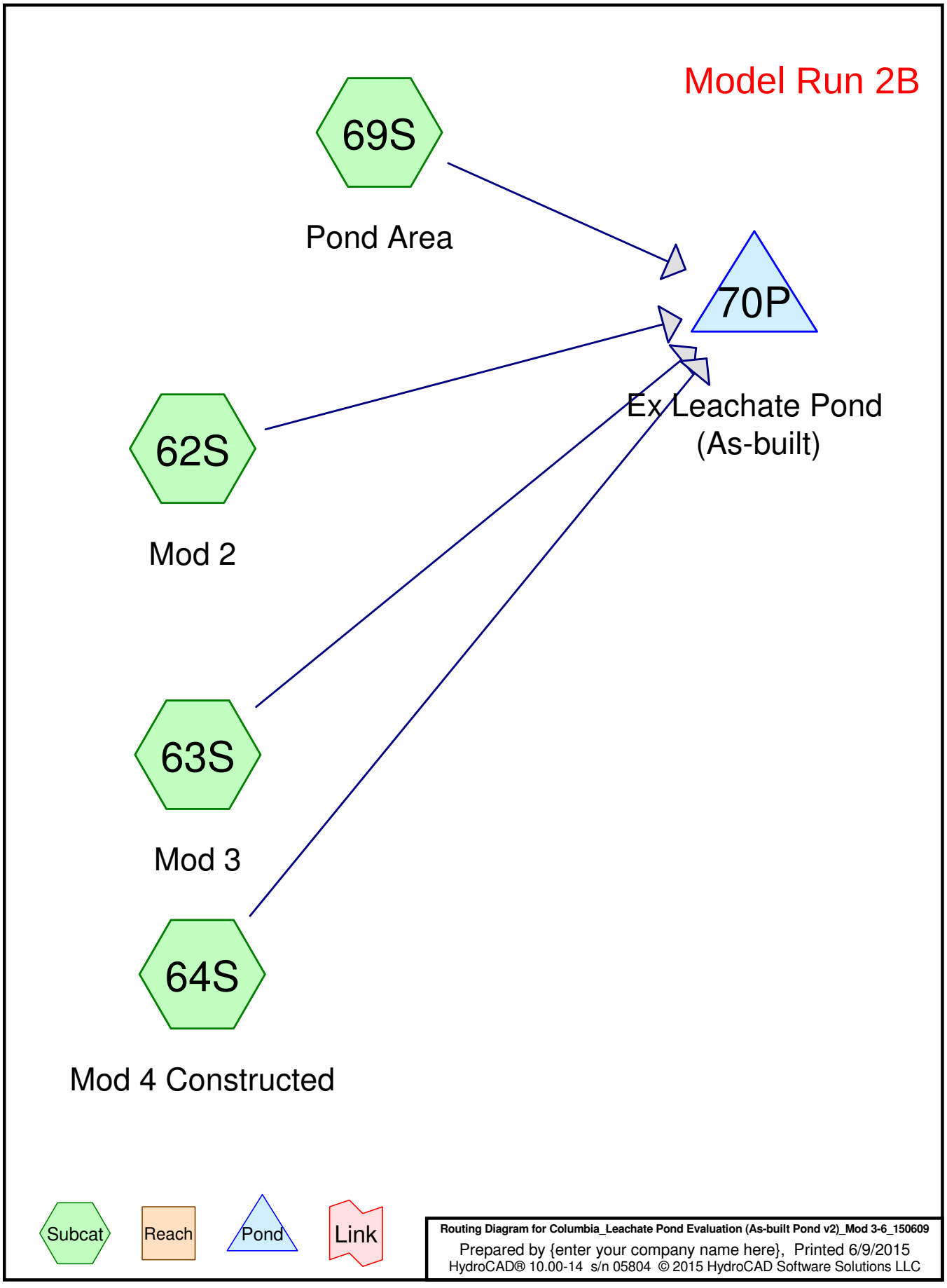
Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	792.00'	329,280 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
792.00	28,228	0	0
794.00	53,834	82,062	82,062
796.00	62,164	115,998	198,060
798.00	69,056	131,220	329,280

Pond 56P: Ex Leachate Pond (As-built)





Routing Diagram for Columbia_Leachate Pond Evaluation (As-built Pond v2)_Mod 3-6_150609

Prepared by {enter your company name here}, Printed 6/9/2015

Time span=0.00-25.00 hrs, dt=0.01 hrs, 2501 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 62S: Mod 2 Runoff Area=4.270 ac 100.00% Impervious Runoff Depth=3.97"
Tc=15.0 min CN=98 Runoff=17.22 cfs 1.414 af

Subcatchment 63S: Mod 3 Runoff Area=4.330 ac 100.00% Impervious Runoff Depth=3.97"
Tc=20.0 min CN=98 Runoff=15.23 cfs 1.434 af

Subcatchment 64S: Mod 4 Constructed Runoff Area=4.390 ac 100.00% Impervious Runoff Depth=3.97"
Tc=25.0 min CN=98 Runoff=13.82 cfs 1.454 af

Subcatchment 69S: Pond Area Runoff Area=3.960 ac 100.00% Impervious Runoff Depth=3.97"
Tc=0.0 min CN=98 Runoff=24.05 cfs 1.312 af

Pond 70P: Ex Leachate Pond (As-built) Peak Elev=796.97' Storage=260,266 cf Inflow=49.37 cfs 5.614 af
Outflow=0.00 cfs 0.000 af

Total Runoff Area = 16.950 ac Runoff Volume = 5.614 af Average Runoff Depth = 3.97"
0.00% Pervious = 0.000 ac 100.00% Impervious = 16.950 ac

Summary for Subcatchment 62S: Mod 2

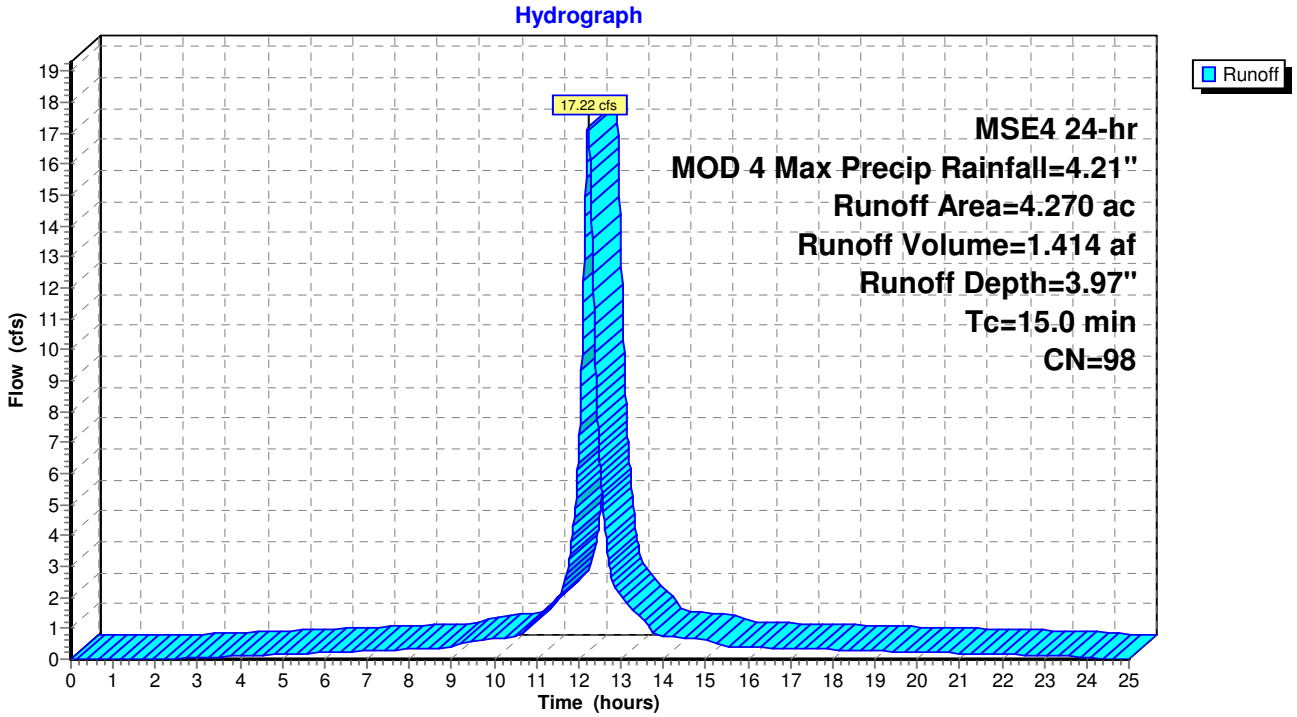
Runoff = 17.22 cfs @ 12.22 hrs, Volume= 1.414 af, Depth= 3.97"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.01 hrs
MSE4 24-hr MOD 4 Max Precip Rainfall=4.21"

	Area (ac)	CN	Description
*	4.270	98	Mod 2 final cover
	4.270		100.00% Impervious Area

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

Subcatchment 62S: Mod 2



Summary for Subcatchment 63S: Mod 3

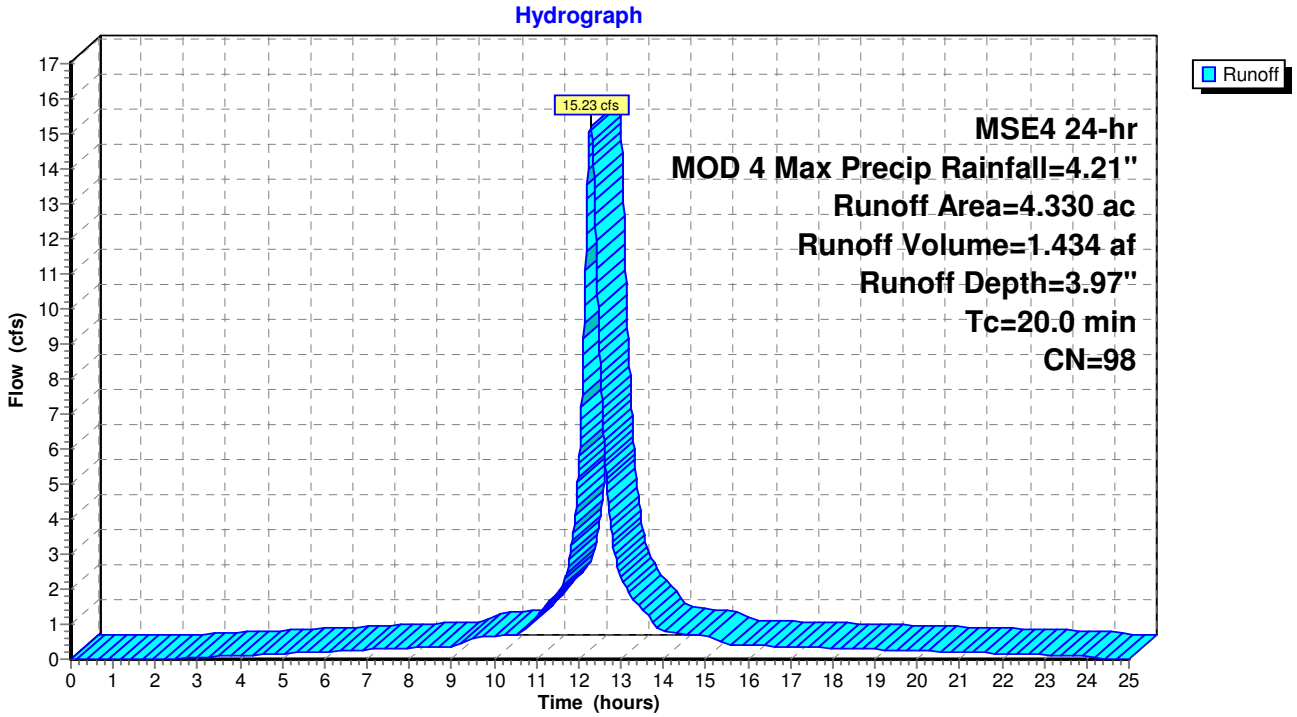
Runoff = 15.23 cfs @ 12.29 hrs, Volume= 1.434 af, Depth= 3.97"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.01 hrs
MSE4 24-hr MOD 4 Max Precip Rainfall=4.21"

	Area (ac)	CN	Description
*	4.330	98	Mod 3
	4.330		100.00% Impervious Area

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

Subcatchment 63S: Mod 3



Summary for Subcatchment 64S: Mod 4 Constructed

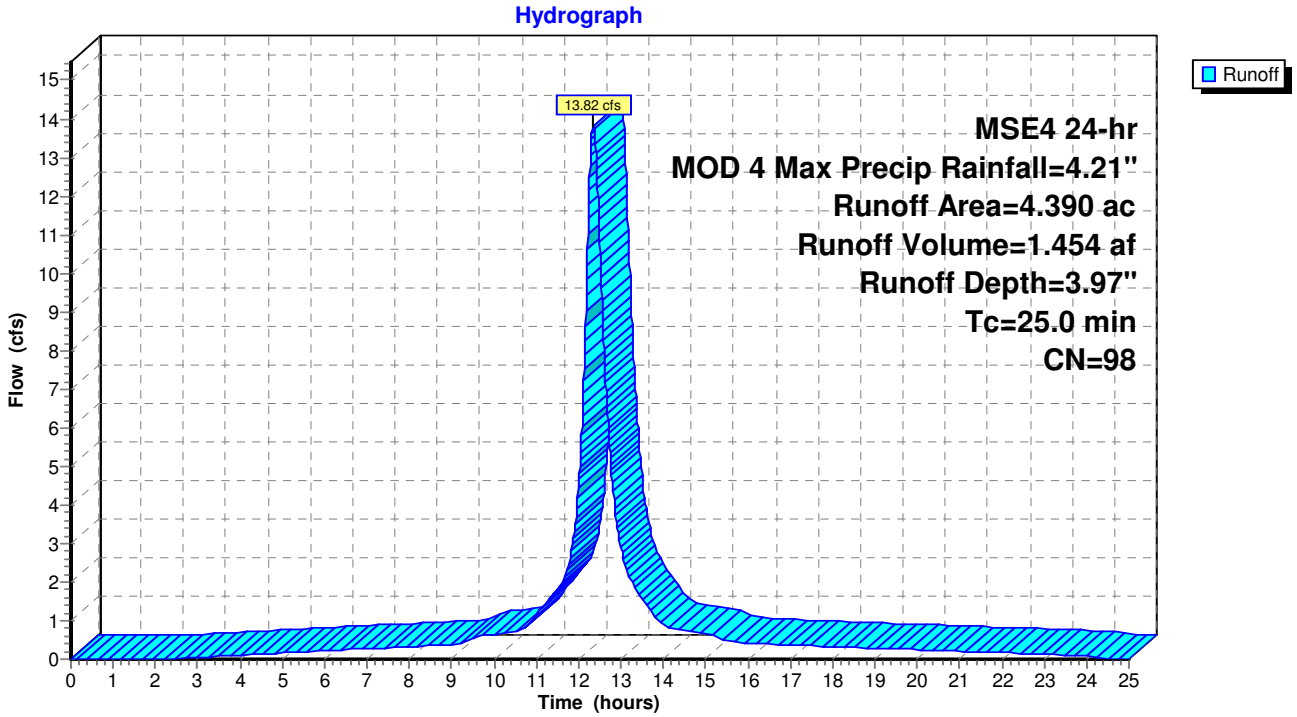
Runoff = 13.82 cfs @ 12.34 hrs, Volume= 1.454 af, Depth= 3.97"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.01 hrs
MSE4 24-hr MOD 4 Max Precip Rainfall=4.21"

	Area (ac)	CN	Description
*	4.390	98	Mod 4 no cover
	4.390		100.00% Impervious Area

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

Subcatchment 64S: Mod 4 Constructed



Summary for Subcatchment 69S: Pond Area

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

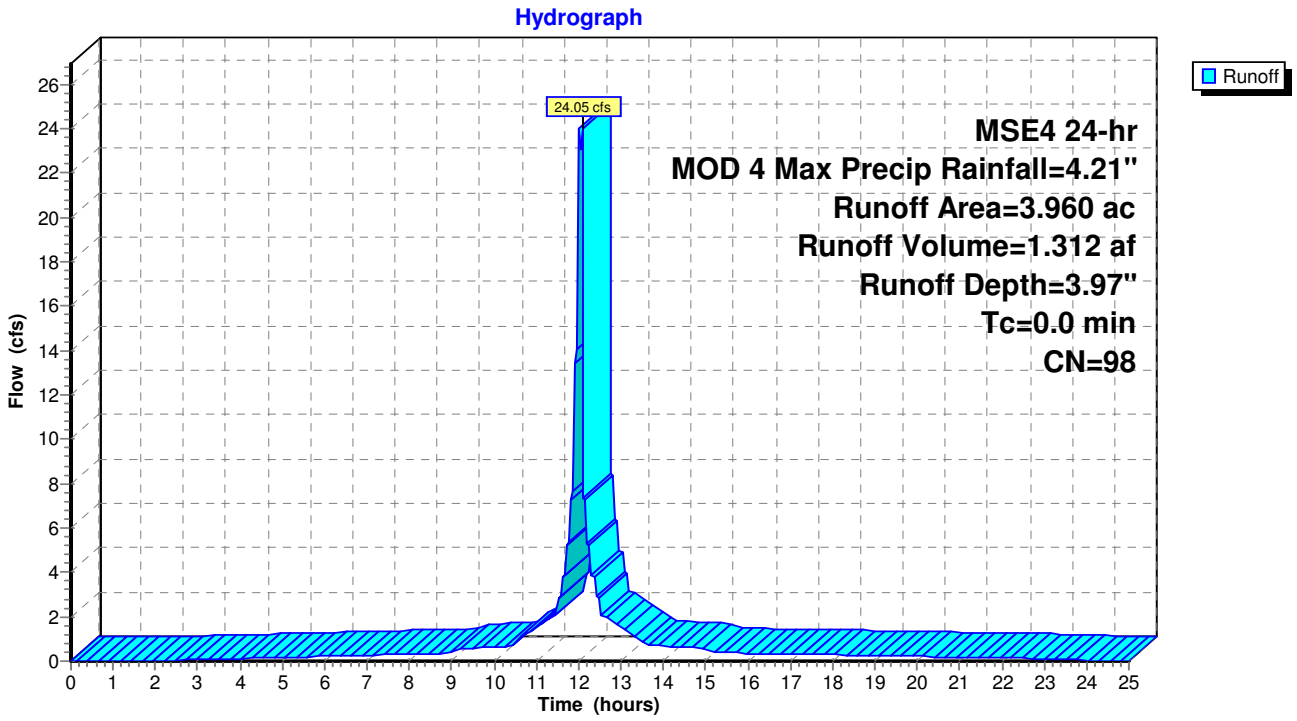
Runoff = 24.05 cfs @ 12.09 hrs, Volume= 1.312 af, Depth= 3.97"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.01 hrs
MSE4 24-hr MOD 4 Max Precip Rainfall=4.21"

	Area (ac)	CN	Description
*	3.960	98	
	3.960		100.00% Impervious Area

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

Subcatchment 69S: Pond Area



Summary for Pond 70P: Ex Leachate Pond (As-built)

Inflow Area = 16.950 ac,100.00% Impervious, Inflow Depth = 3.97" for MOD 4 Max Precip event
Inflow = 49.37 cfs @ 12.27 hrs, Volume= 5.614 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

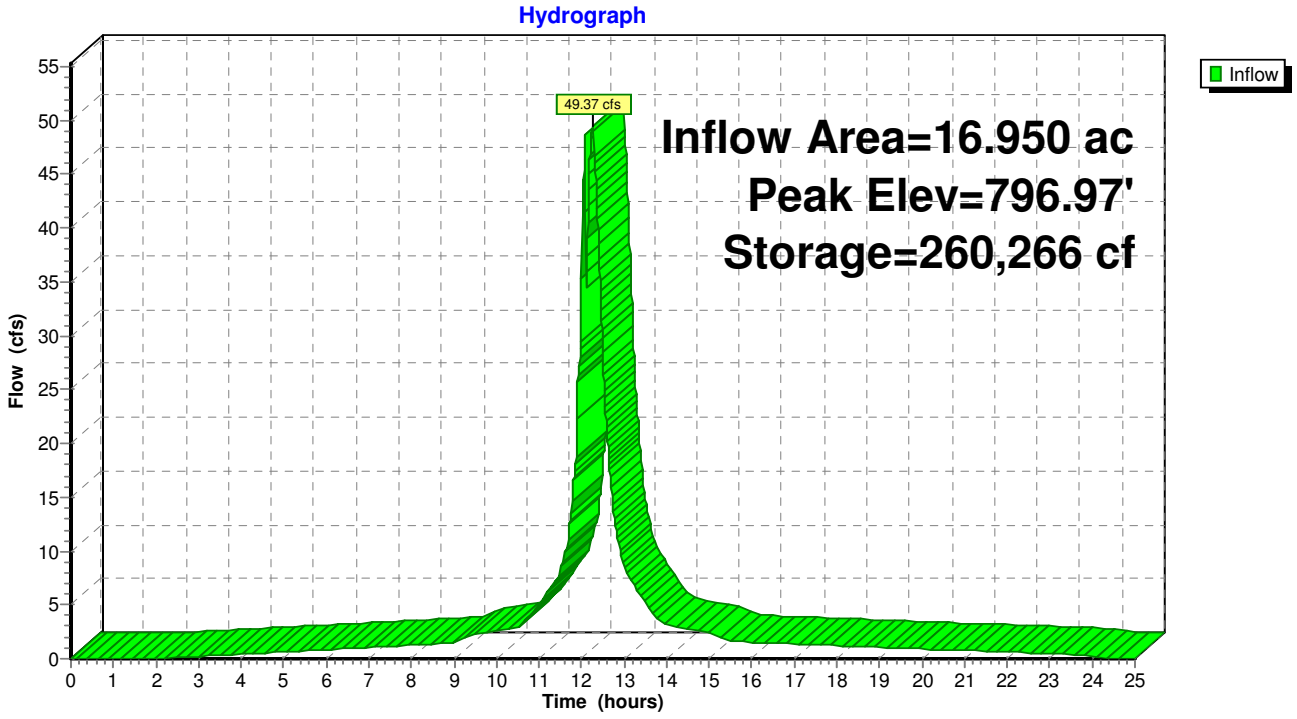
Routing by Stor-Ind method, Time Span= 0.00-25.00 hrs, dt= 0.01 hrs
Starting Elev= 792.50' Surf.Area= 34,630 sf Storage= 15,714 cf
Peak Elev= 796.97' @ 25.00 hrs Surf.Area= 65,522 sf Storage= 260,266 cf (244,552 cf above start)

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

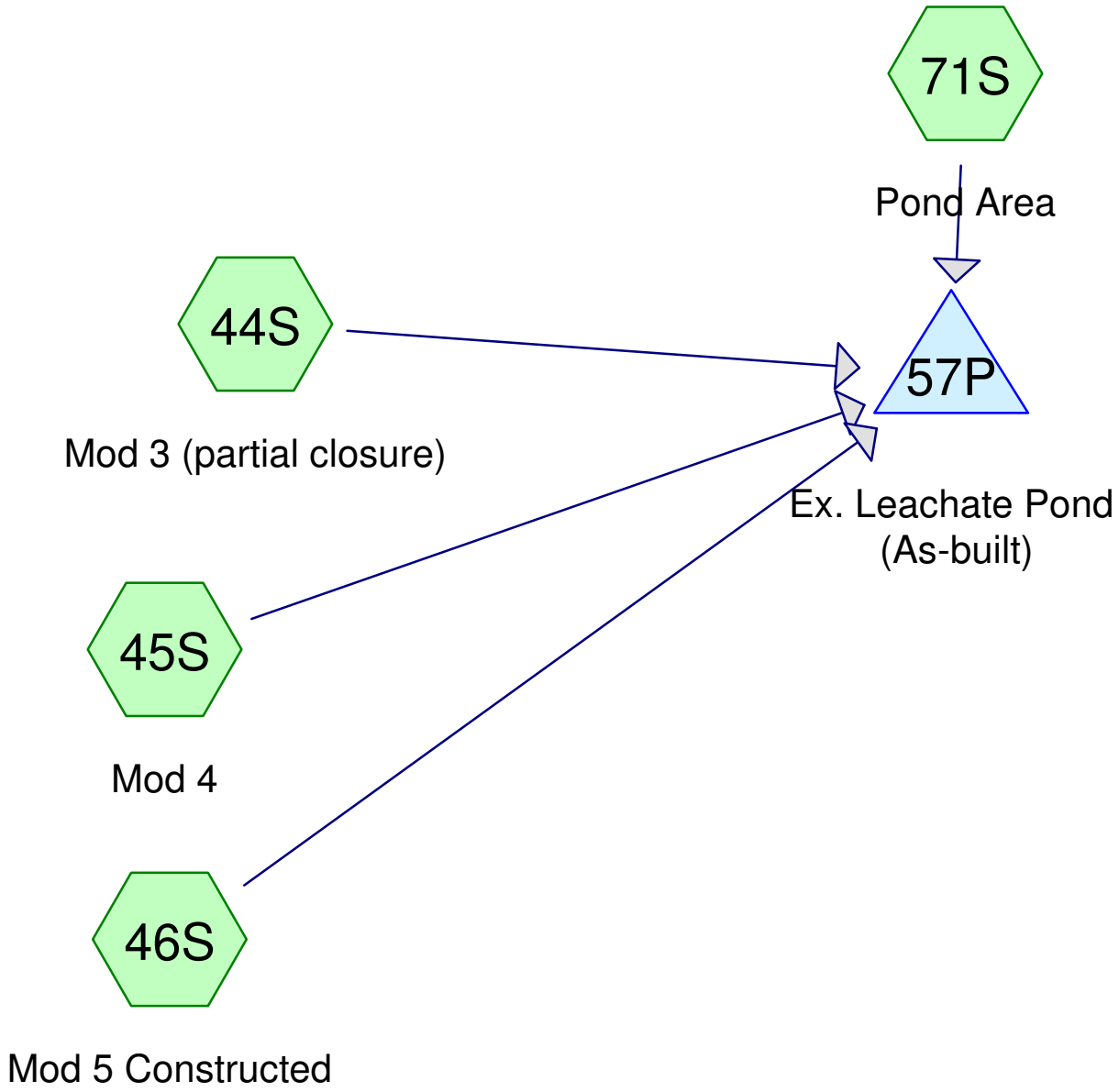
Volume	Invert	Avail.Storage	Storage Description
#1	792.00'	329,280 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
792.00	28,228	0	0
794.00	53,834	82,062	82,062
796.00	62,164	115,998	198,060
798.00	69,056	131,220	329,280

Pond 70P: Ex Leachate Pond (As-built)



Model Run 3A



Subcat Reach Pond Link

Time span=0.00-25.00 hrs, dt=0.01 hrs, 2501 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 44S: Mod 3 (partial closure) Runoff Area=1.630 ac 100.00% Impervious Runoff Depth=4.66"
Tc=20.0 min CN=98 Runoff=6.69 cfs 0.633 af

Subcatchment 45S: Mod 4 Runoff Area=4.390 ac 100.00% Impervious Runoff Depth=4.66"
Tc=25.0 min CN=98 Runoff=16.12 cfs 1.706 af

Subcatchment 46S: Mod 5 Constructed Runoff Area=4.460 ac 100.00% Impervious Runoff Depth>4.66"
Tc=30.0 min CN=98 Runoff=14.86 cfs 1.733 af

Subcatchment 71S: Pond Area Runoff Area=3.960 ac 100.00% Impervious Runoff Depth=4.66"
Tc=0.0 min CN=98 Runoff=28.03 cfs 1.539 af

Pond 57P: Ex. Leachate Pond (As-built) Peak Elev=796.97' Storage=260,150 cf Inflow=45.90 cfs 5.611 af
Outflow=0.00 cfs 0.000 af

Total Runoff Area = 14.440 ac Runoff Volume = 5.611 af Average Runoff Depth = 4.66"
0.00% Pervious = 0.000 ac 100.00% Impervious = 14.440 ac

Summary for Subcatchment 44S: Mod 3 (partial closure)

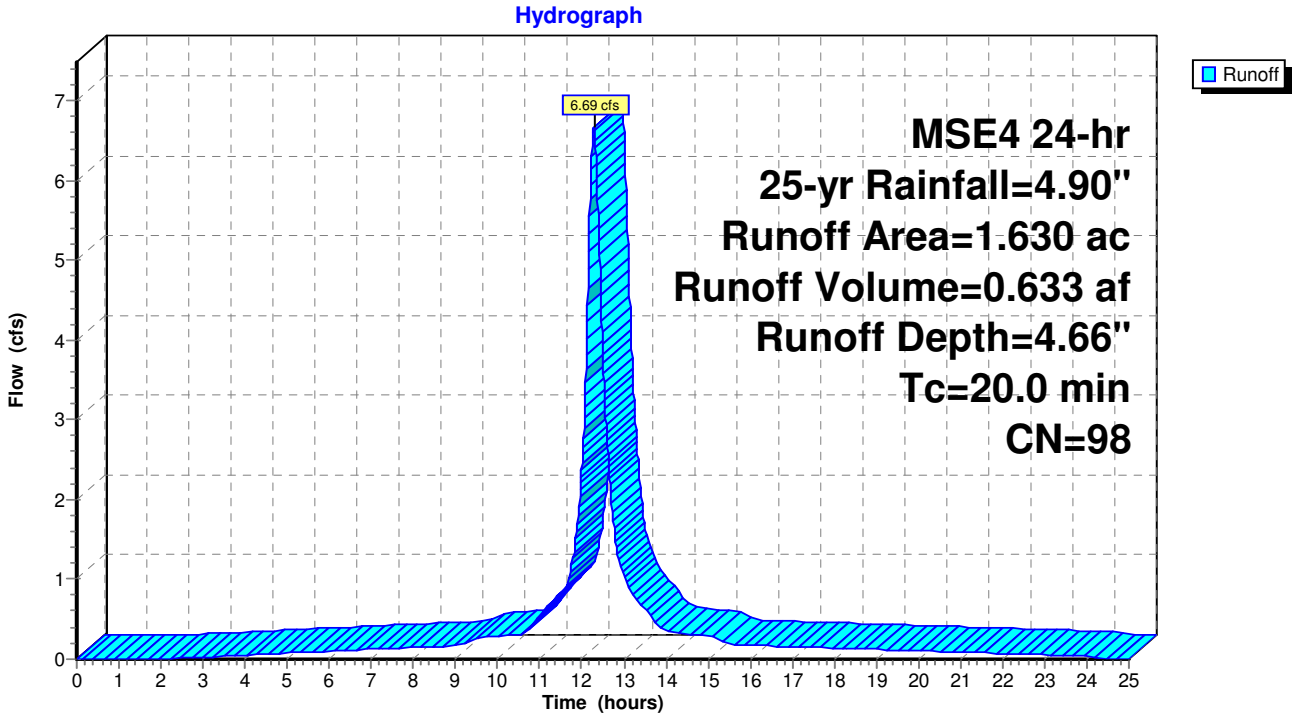
Runoff = 6.69 cfs @ 12.29 hrs, Volume= 0.633 af, Depth= 4.66"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.01 hrs
MSE4 24-hr 25-yr Rainfall=4.90"

	Area (ac)	CN	Description
*	1.630	98	Mod 3
	1.630		100.00% Impervious Area

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

Subcatchment 44S: Mod 3 (partial closure)



Summary for Subcatchment 45S: Mod 4

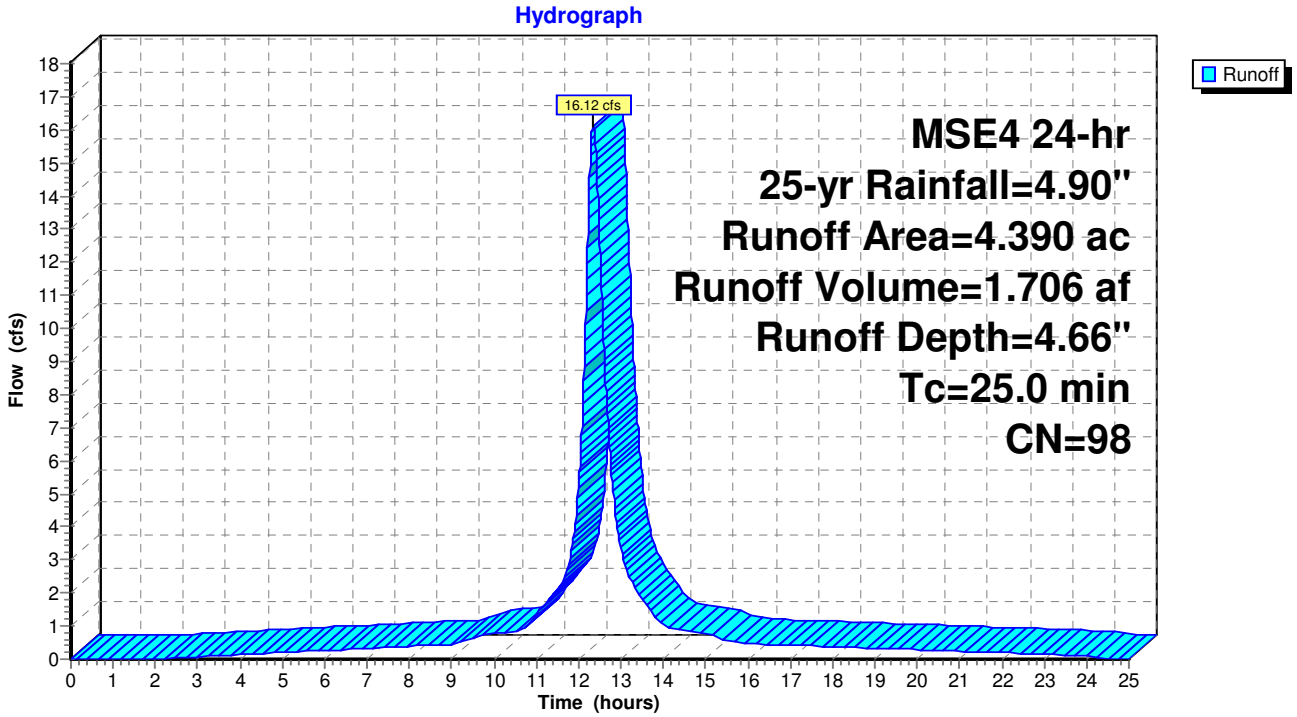
Runoff = 16.12 cfs @ 12.34 hrs, Volume= 1.706 af, Depth= 4.66"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.01 hrs
MSE4 24-hr 25-yr Rainfall=4.90"

	Area (ac)	CN	Description
*	4.390	98	Mod 4
	4.390		100.00% Impervious Area

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

Subcatchment 45S: Mod 4



Summary for Subcatchment 46S: Mod 5 Constructed

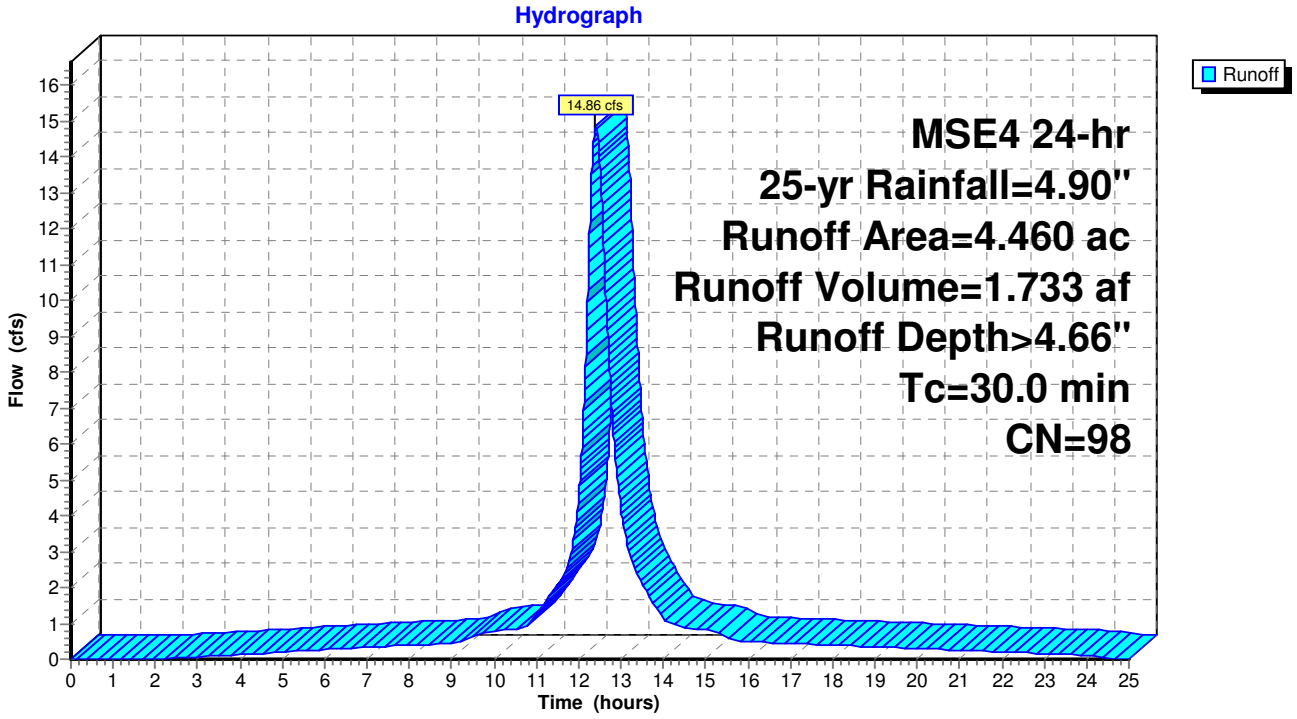
Runoff = 14.86 cfs @ 12.40 hrs, Volume= 1.733 af, Depth> 4.66"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.01 hrs
MSE4 24-hr 25-yr Rainfall=4.90"

	Area (ac)	CN	Description
*	4.460	98	Mod 5 no cover
	4.460		100.00% Impervious Area

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

Subcatchment 46S: Mod 5 Constructed



Summary for Subcatchment 71S: Pond Area

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

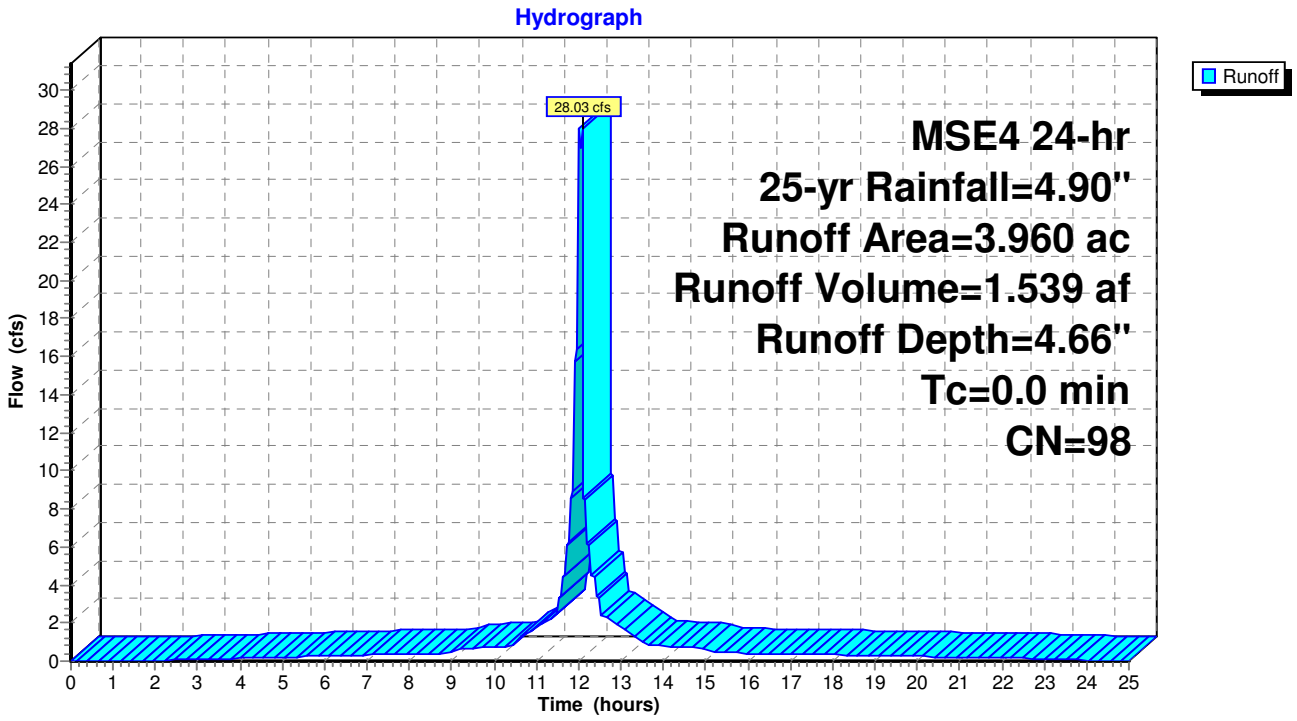
Runoff = 28.03 cfs @ 12.09 hrs, Volume= 1.539 af, Depth= 4.66"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.01 hrs
MSE4 24-hr 25-yr Rainfall=4.90"

	Area (ac)	CN	Description
*	3.960	98	
	3.960		100.00% Impervious Area

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

Subcatchment 71S: Pond Area



Summary for Pond 57P: Ex. Leachate Pond (As-built)

Inflow Area = 14.440 ac,100.00% Impervious, Inflow Depth = 4.66" for 25-yr event
Inflow = 45.90 cfs @ 12.09 hrs, Volume= 5.611 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

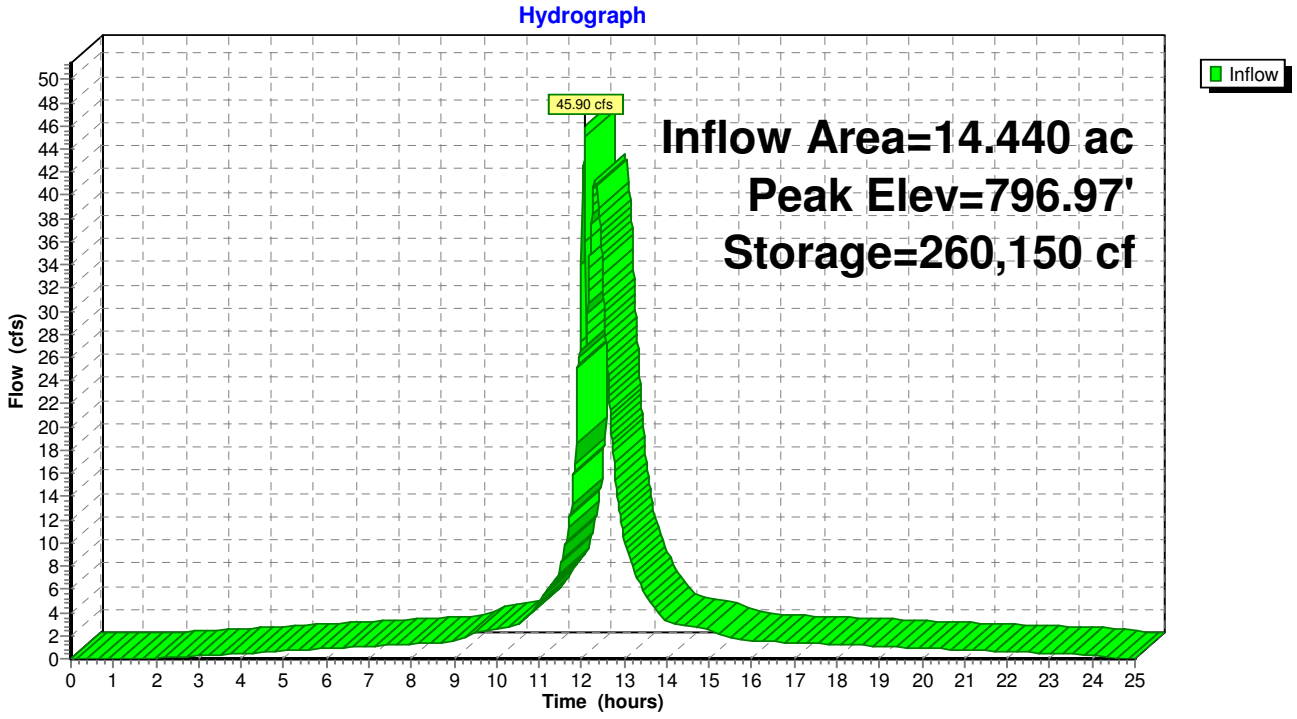
Routing by Stor-Ind method, Time Span= 0.00-25.00 hrs, dt= 0.01 hrs
Starting Elev= 792.50' Surf.Area= 34,630 sf Storage= 15,714 cf
Peak Elev= 796.97' @ 25.00 hrs Surf.Area= 65,516 sf Storage= 260,150 cf (244,436 cf above start)

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

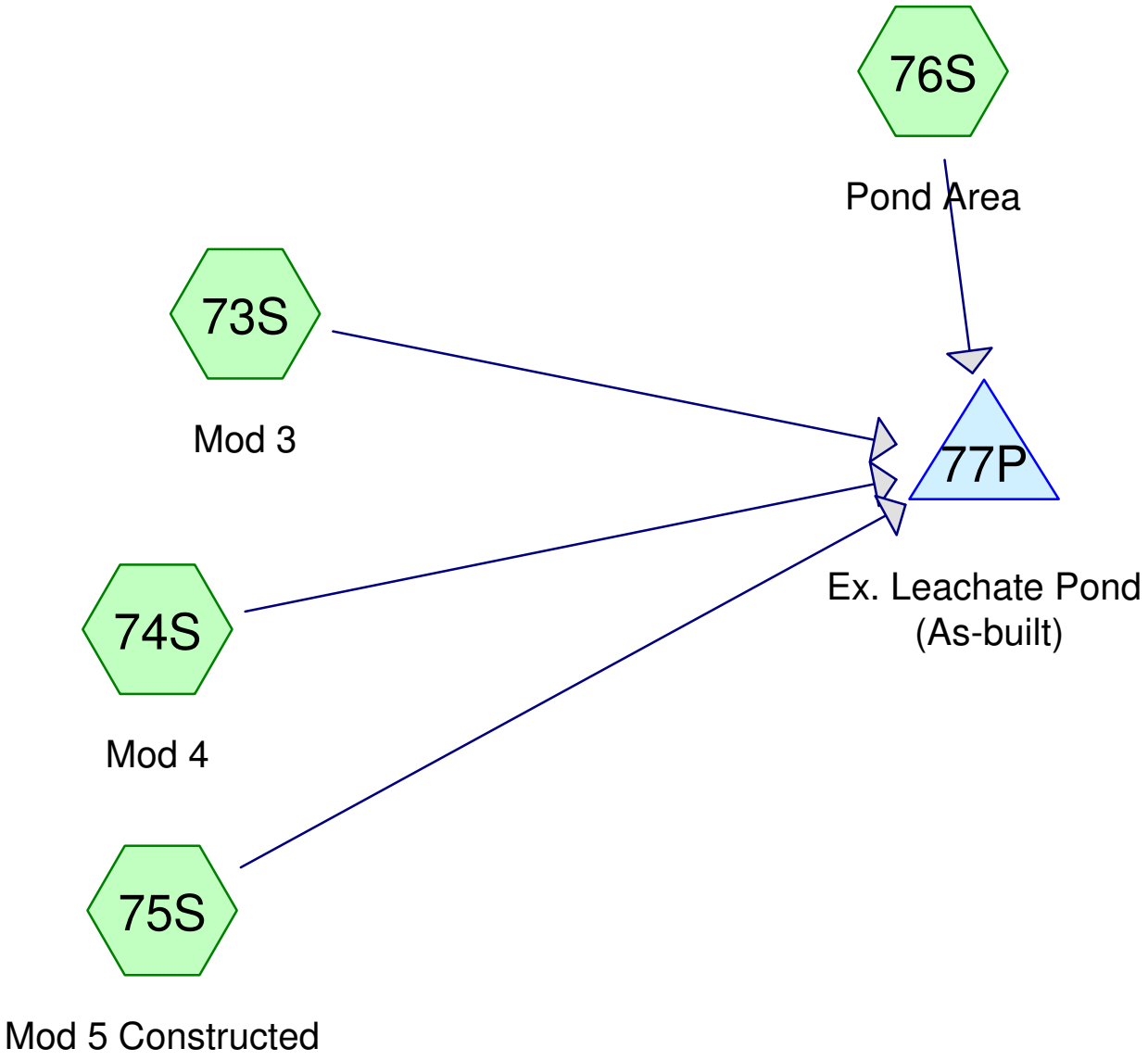
Volume	Invert	Avail.Storage	Storage Description
#1	792.00'	329,280 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
792.00	28,228	0	0
794.00	53,834	82,062	82,062
796.00	62,164	115,998	198,060
798.00	69,056	131,220	329,280

Pond 57P: Ex. Leachate Pond (As-built)



Model Run 3B



Subcat Reach Pond Link

Time span=0.00-25.00 hrs, dt=0.01 hrs, 2501 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 73S: Mod 3 Runoff Area=4.330 ac 100.00% Impervious Runoff Depth=3.92"
Tc=20.0 min CN=98 Runoff=15.04 cfs 1.416 af

Subcatchment 74S: Mod 4 Runoff Area=4.390 ac 100.00% Impervious Runoff Depth=3.92"
Tc=25.0 min CN=98 Runoff=13.65 cfs 1.436 af

Subcatchment 75S: Mod 5 Constructed Runoff Area=4.460 ac 100.00% Impervious Runoff Depth>3.92"
Tc=30.0 min CN=98 Runoff=12.59 cfs 1.459 af

Subcatchment 76S: Pond Area Runoff Area=3.960 ac 100.00% Impervious Runoff Depth=3.92"
Tc=0.0 min CN=98 Runoff=23.76 cfs 1.295 af

Pond 77P: Ex. Leachate Pond (As-built) Peak Elev=796.97' Storage=259,902 cf Inflow=44.31 cfs 5.606 af
Outflow=0.00 cfs 0.000 af

Total Runoff Area = 17.140 ac Runoff Volume = 5.606 af Average Runoff Depth = 3.92"
0.00% Pervious = 0.000 ac 100.00% Impervious = 17.140 ac

Summary for Subcatchment 73S: Mod 3

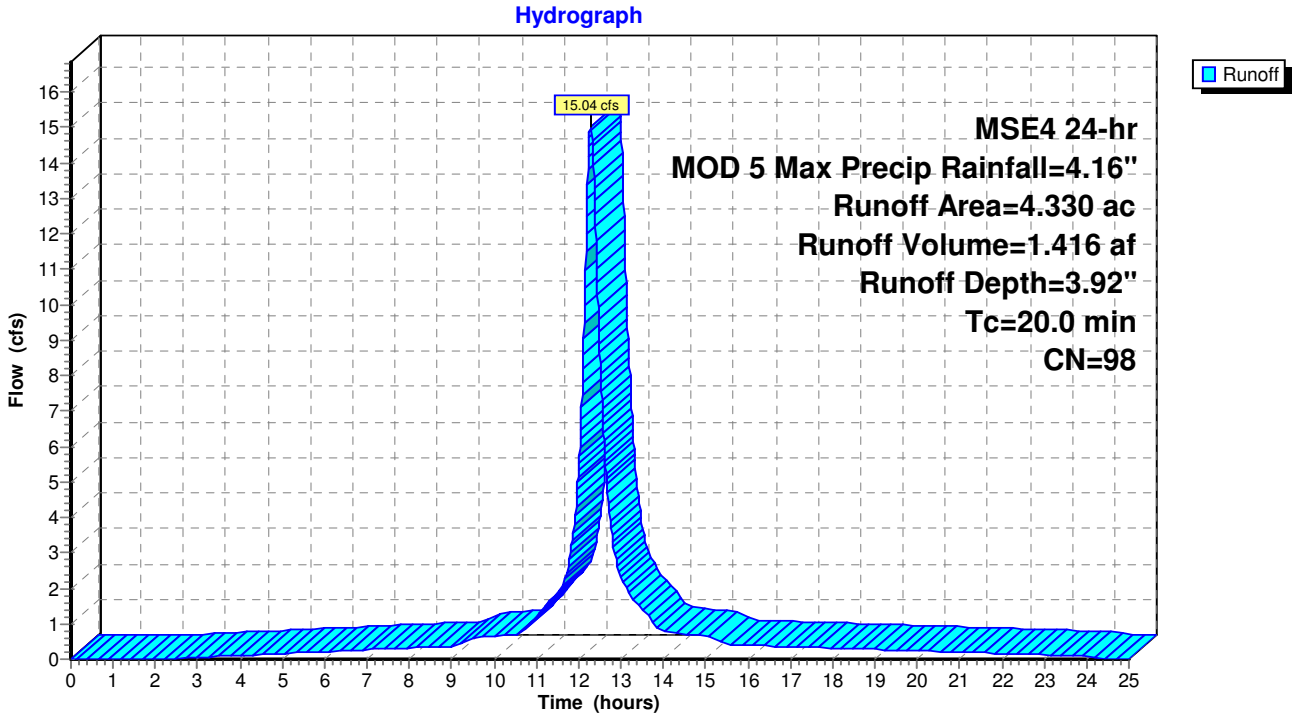
Runoff = 15.04 cfs @ 12.29 hrs, Volume= 1.416 af, Depth= 3.92"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.01 hrs
MSE4 24-hr MOD 5 Max Precip Rainfall=4.16"

	Area (ac)	CN	Description
*	4.330	98	Mod 3
	4.330		100.00% Impervious Area

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

Subcatchment 73S: Mod 3



Summary for Subcatchment 74S: Mod 4

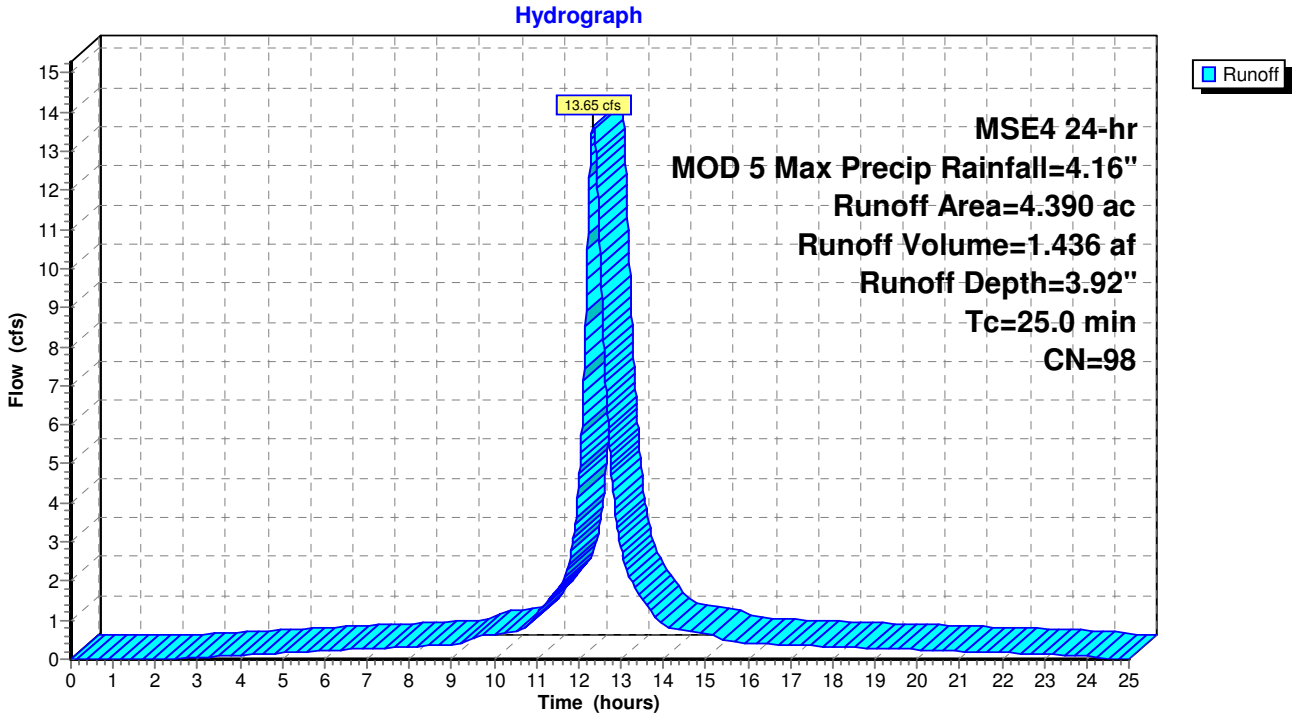
Runoff = 13.65 cfs @ 12.34 hrs, Volume= 1.436 af, Depth= 3.92"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.01 hrs
MSE4 24-hr MOD 5 Max Precip Rainfall=4.16"

	Area (ac)	CN	Description
*	4.390	98	Mod 4
	4.390		100.00% Impervious Area

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

Subcatchment 74S: Mod 4



Summary for Subcatchment 75S: Mod 5 Constructed

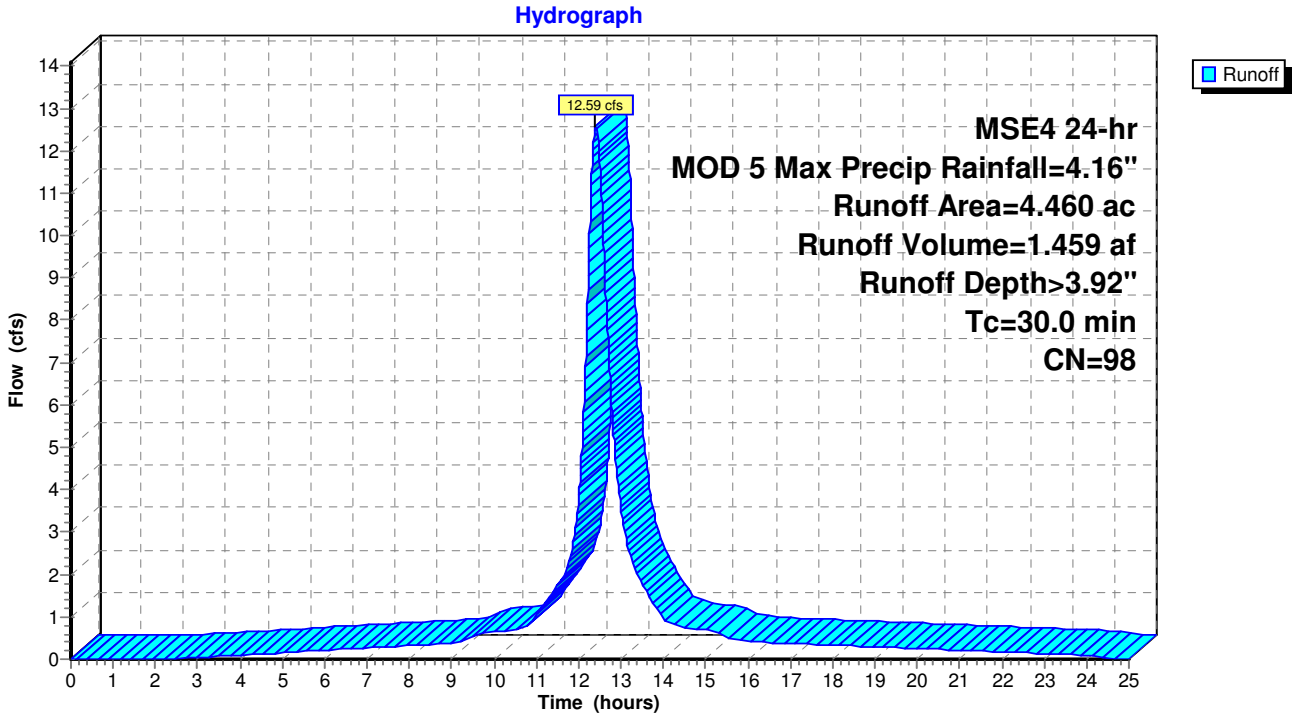
Runoff = 12.59 cfs @ 12.40 hrs, Volume= 1.459 af, Depth> 3.92"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.01 hrs
MSE4 24-hr MOD 5 Max Precip Rainfall=4.16"

	Area (ac)	CN	Description
*	4.460	98	Mod 5 no cover
	4.460		100.00% Impervious Area

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

Subcatchment 75S: Mod 5 Constructed



Summary for Subcatchment 76S: Pond Area

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

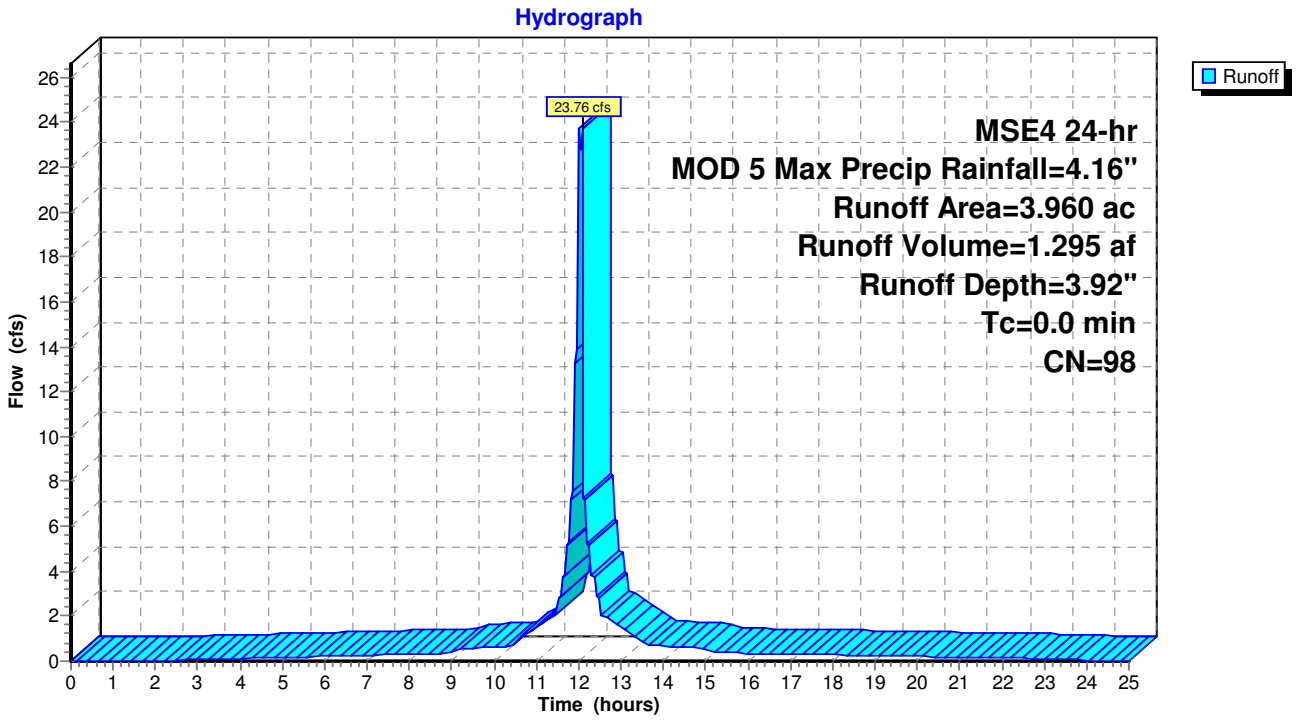
Runoff = 23.76 cfs @ 12.09 hrs, Volume= 1.295 af, Depth= 3.92"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.01 hrs
MSE4 24-hr MOD 5 Max Precip Rainfall=4.16"

	Area (ac)	CN	Description
*	3.960	98	
	3.960		100.00% Impervious Area

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

Subcatchment 76S: Pond Area



Summary for Pond 77P: Ex. Leachate Pond (As-built)

Inflow Area = 17.140 ac,100.00% Impervious, Inflow Depth = 3.92" for MOD 5 Max Precip event
Inflow = 44.31 cfs @ 12.29 hrs, Volume= 5.606 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

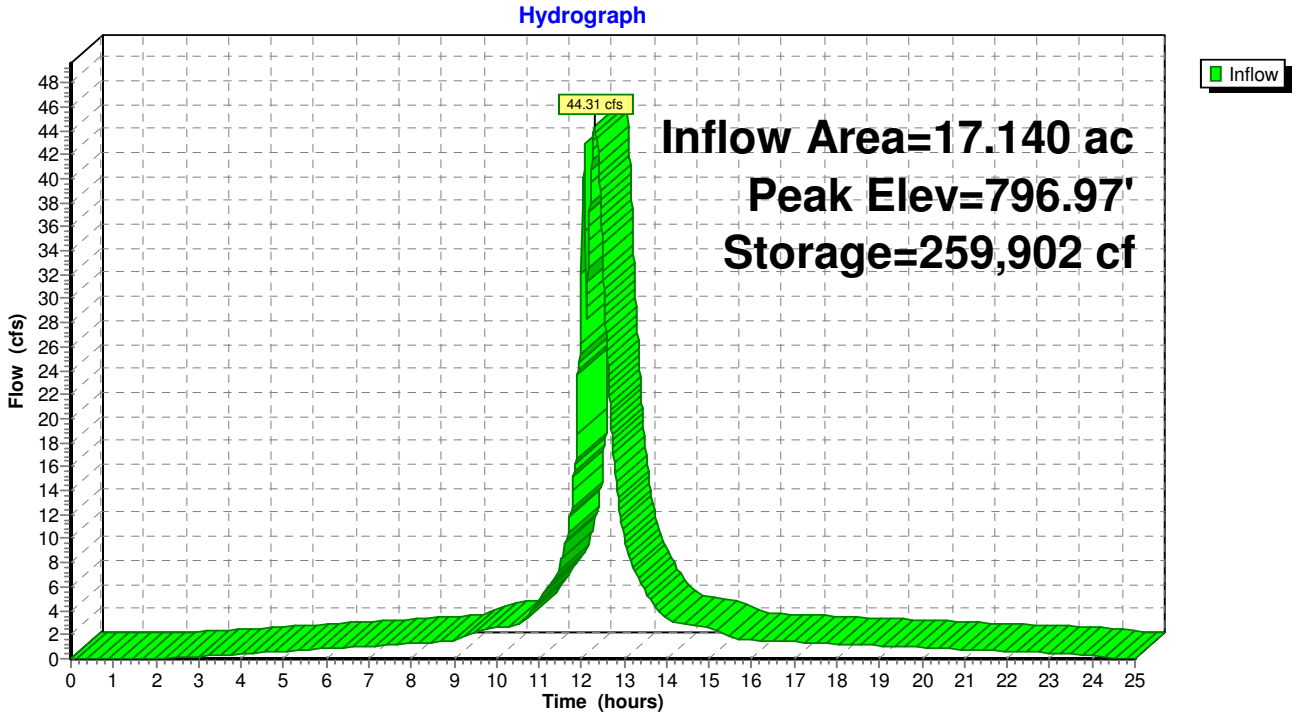
Routing by Stor-Ind method, Time Span= 0.00-25.00 hrs, dt= 0.01 hrs
Starting Elev= 792.50' Surf.Area= 34,630 sf Storage= 15,714 cf
Peak Elev= 796.97' @ 25.00 hrs Surf.Area= 65,502 sf Storage= 259,902 cf (244,187 cf above start)

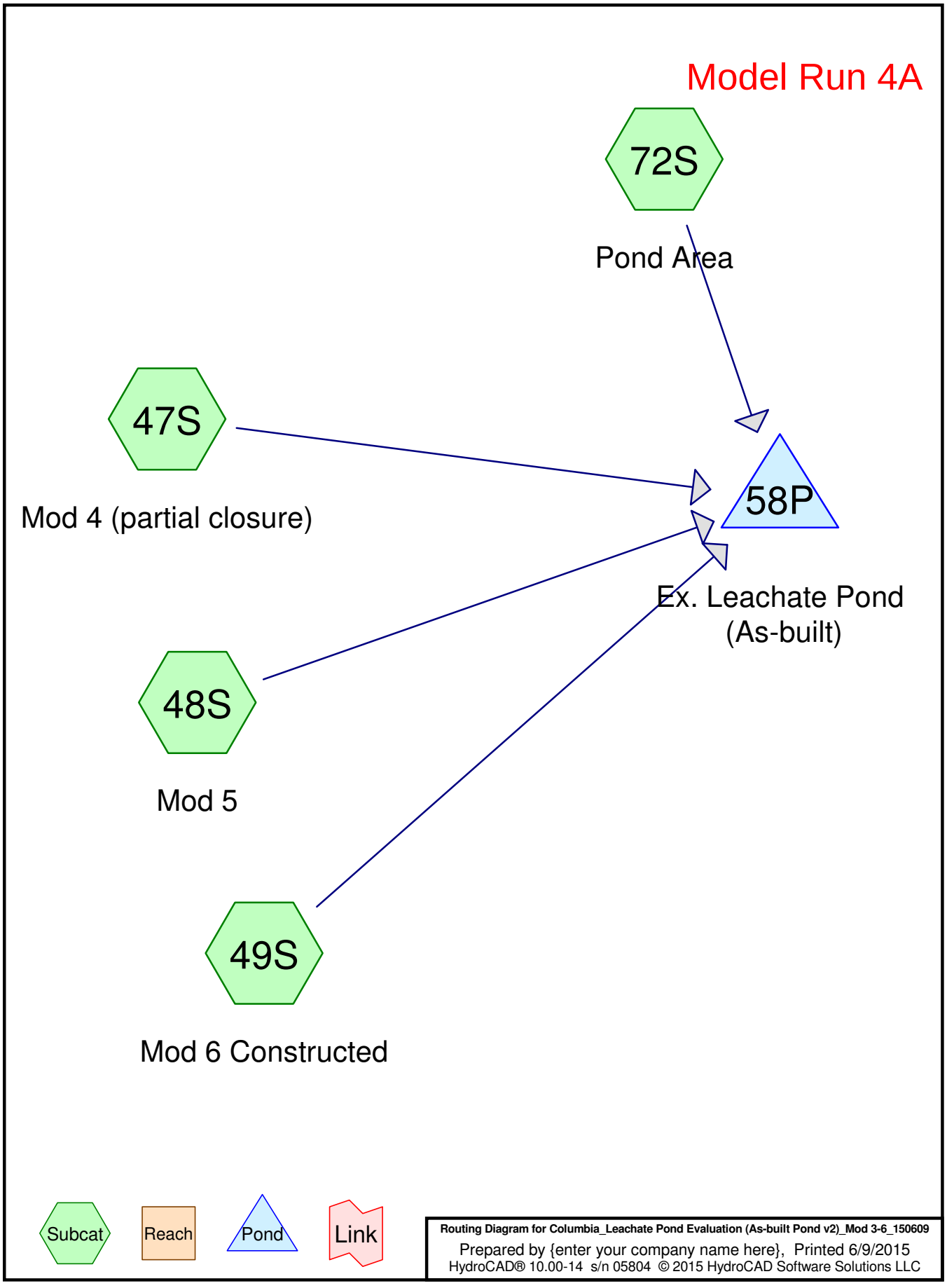
Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	792.00'	329,280 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
792.00	28,228	0	0
794.00	53,834	82,062	82,062
796.00	62,164	115,998	198,060
798.00	69,056	131,220	329,280

Pond 77P: Ex. Leachate Pond (As-built)





Routing Diagram for Columbia_Leachate Pond Evaluation (As-built Pond v2)_Mod 3-6_150609

Prepared by {enter your company name here}, Printed 6/9/2015

Time span=0.00-25.00 hrs, dt=0.01 hrs, 2501 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 47S: Mod 4 (partial closure) Runoff Area=1.640 ac 100.00% Impervious Runoff Depth=4.66"
Tc=25.0 min CN=98 Runoff=6.02 cfs 0.637 af

Subcatchment 48S: Mod 5 Runoff Area=4.460 ac 100.00% Impervious Runoff Depth>4.66"
Tc=30.0 min CN=98 Runoff=14.86 cfs 1.733 af

Subcatchment 49S: Mod 6 Constructed Runoff Area=4.380 ac 100.00% Impervious Runoff Depth>4.66"
Tc=35.0 min CN=98 Runoff=13.45 cfs 1.702 af

Subcatchment 72S: Pond Area Runoff Area=3.960 ac 100.00% Impervious Runoff Depth=4.66"
Tc=0.0 min CN=98 Runoff=28.03 cfs 1.539 af

Pond 58P: Ex. Leachate Pond (As-built) Peak Elev=796.97' Storage=260,146 cf Inflow=42.93 cfs 5.611 af
Outflow=0.00 cfs 0.000 af

Total Runoff Area = 14.440 ac Runoff Volume = 5.611 af Average Runoff Depth = 4.66"
0.00% Pervious = 0.000 ac 100.00% Impervious = 14.440 ac

Summary for Subcatchment 47S: Mod 4 (partial closure)

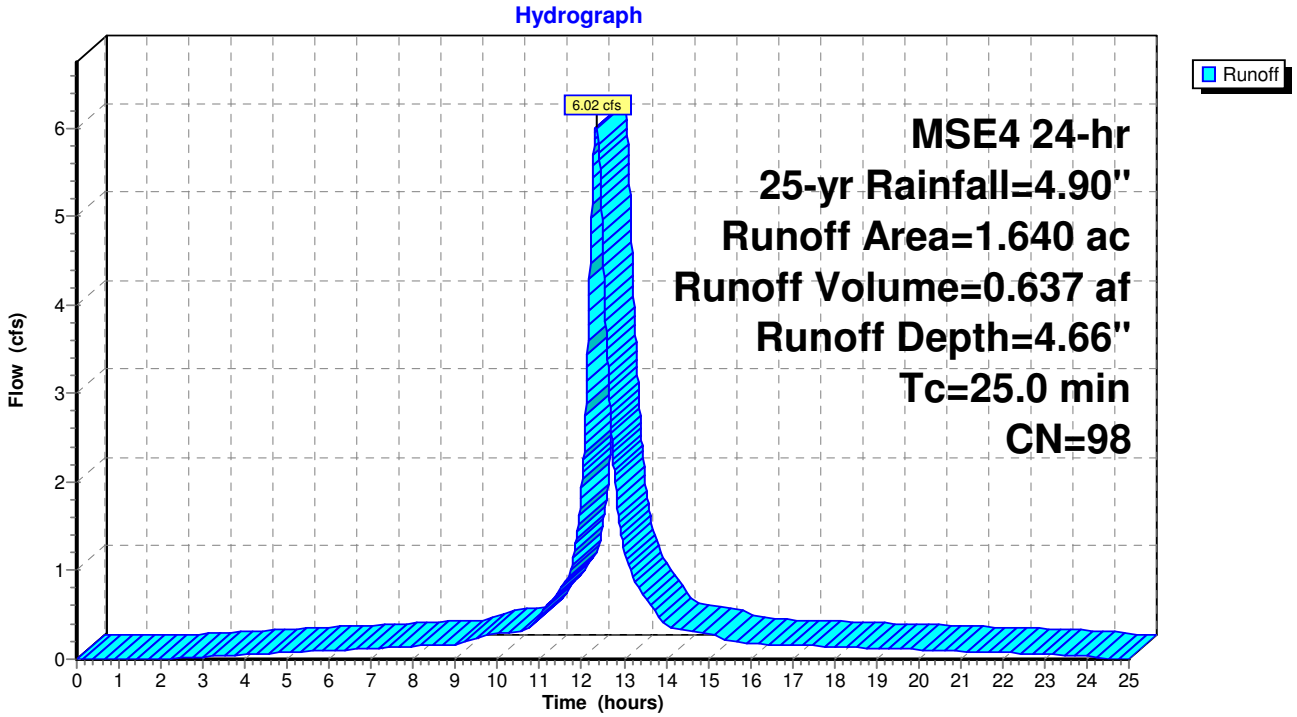
Runoff = 6.02 cfs @ 12.34 hrs, Volume= 0.637 af, Depth= 4.66"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.01 hrs
MSE4 24-hr 25-yr Rainfall=4.90"

	Area (ac)	CN	Description
*	1.640	98	Mod 4
	1.640		100.00% Impervious Area

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

Subcatchment 47S: Mod 4 (partial closure)



Summary for Subcatchment 48S: Mod 5

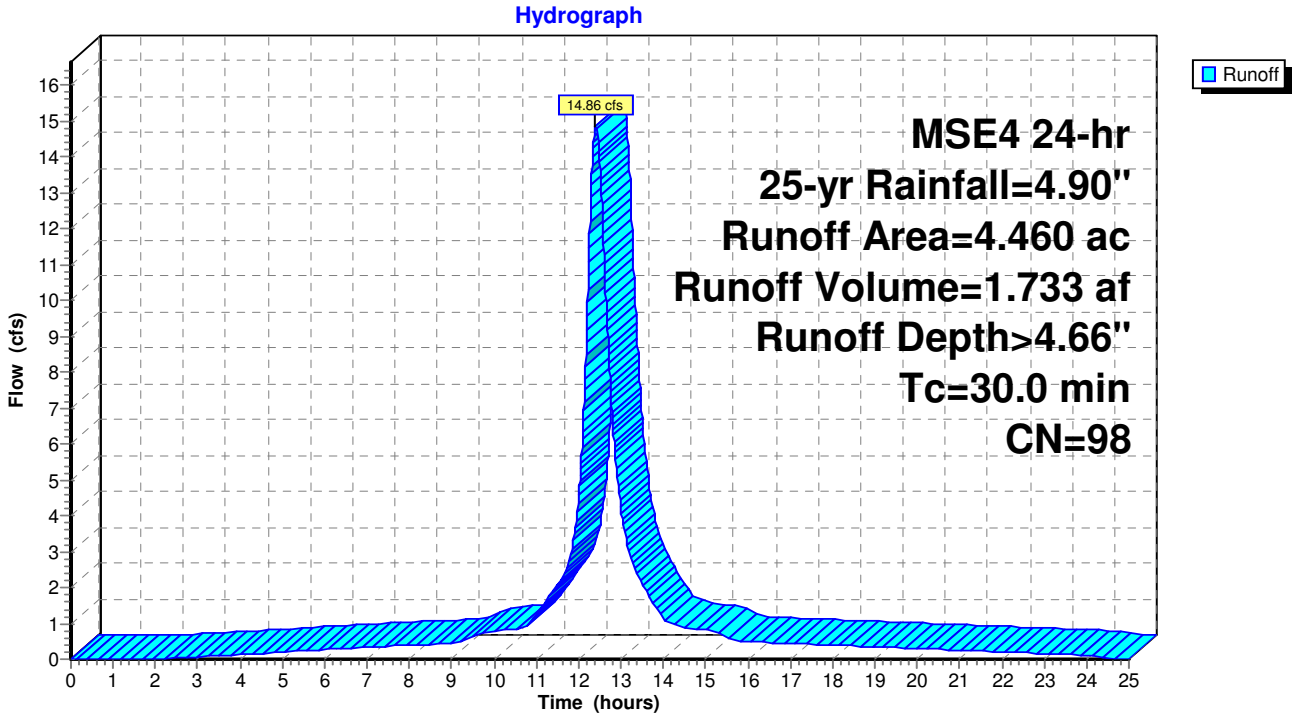
Runoff = 14.86 cfs @ 12.40 hrs, Volume= 1.733 af, Depth> 4.66"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.01 hrs
MSE4 24-hr 25-yr Rainfall=4.90"

	Area (ac)	CN	Description
*	4.460	98	Mod 5
	4.460		100.00% Impervious Area

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

Subcatchment 48S: Mod 5



Summary for Subcatchment 49S: Mod 6 Constructed

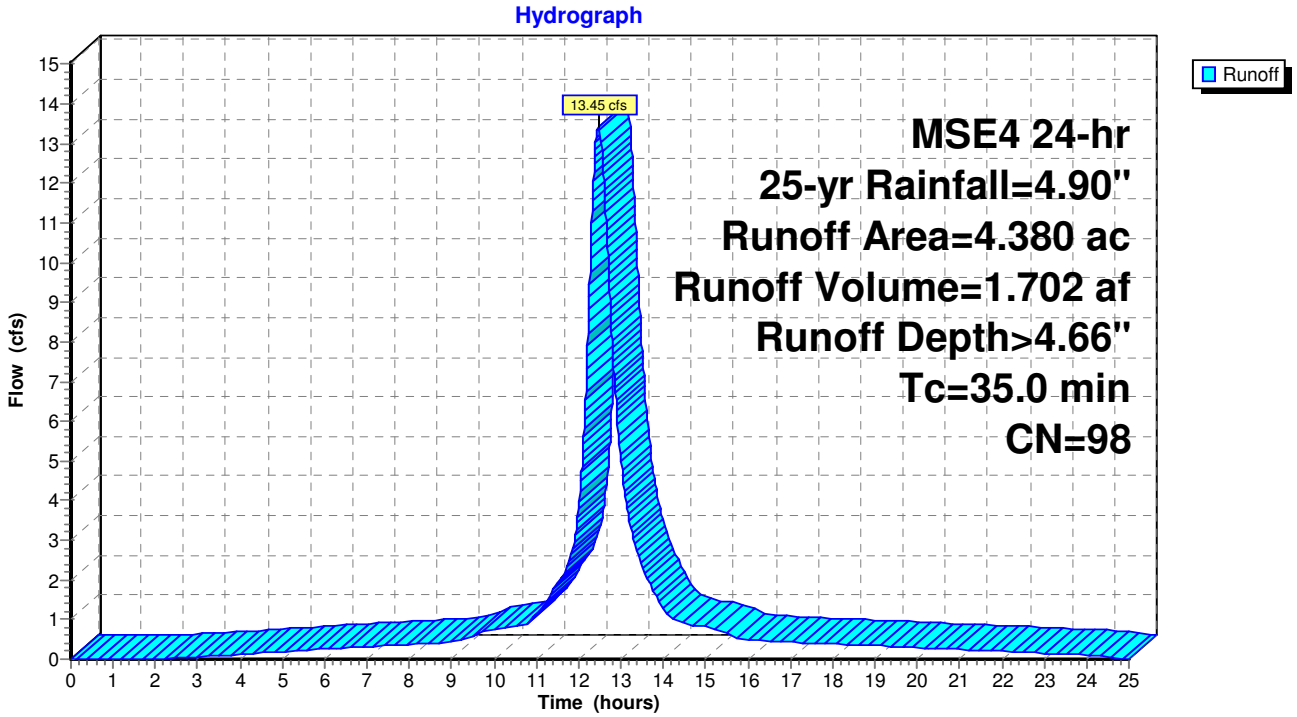
Runoff = 13.45 cfs @ 12.48 hrs, Volume= 1.702 af, Depth> 4.66"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.01 hrs
MSE4 24-hr 25-yr Rainfall=4.90"

	Area (ac)	CN	Description
*	4.380	98	Mod 6 no cover
	4.380		100.00% Impervious Area

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

Subcatchment 49S: Mod 6 Constructed



Summary for Subcatchment 72S: Pond Area

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

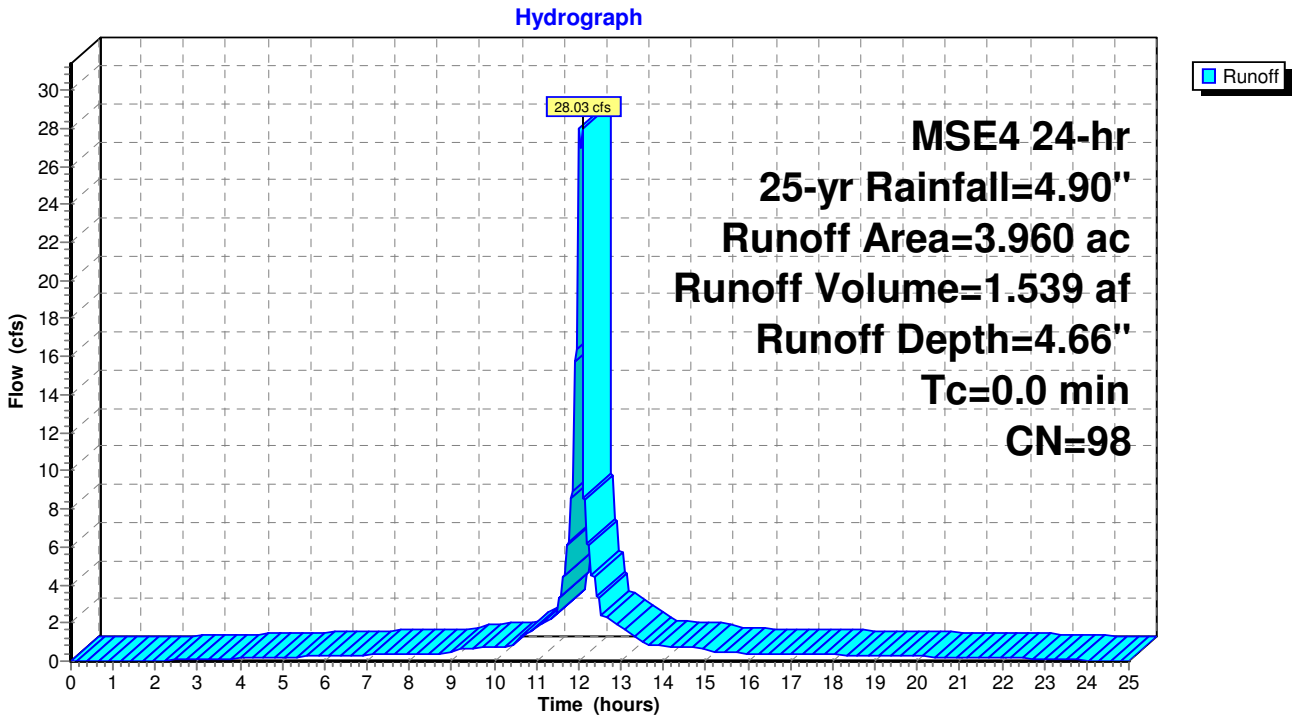
Runoff = 28.03 cfs @ 12.09 hrs, Volume= 1.539 af, Depth= 4.66"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.01 hrs
MSE4 24-hr 25-yr Rainfall=4.90"

	Area (ac)	CN	Description
*	3.960	98	
	3.960		100.00% Impervious Area

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

Subcatchment 72S: Pond Area



Summary for Pond 58P: Ex. Leachate Pond (As-built)

Inflow Area = 14.440 ac,100.00% Impervious, Inflow Depth > 4.66" for 25-yr event
Inflow = 42.93 cfs @ 12.09 hrs, Volume= 5.611 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

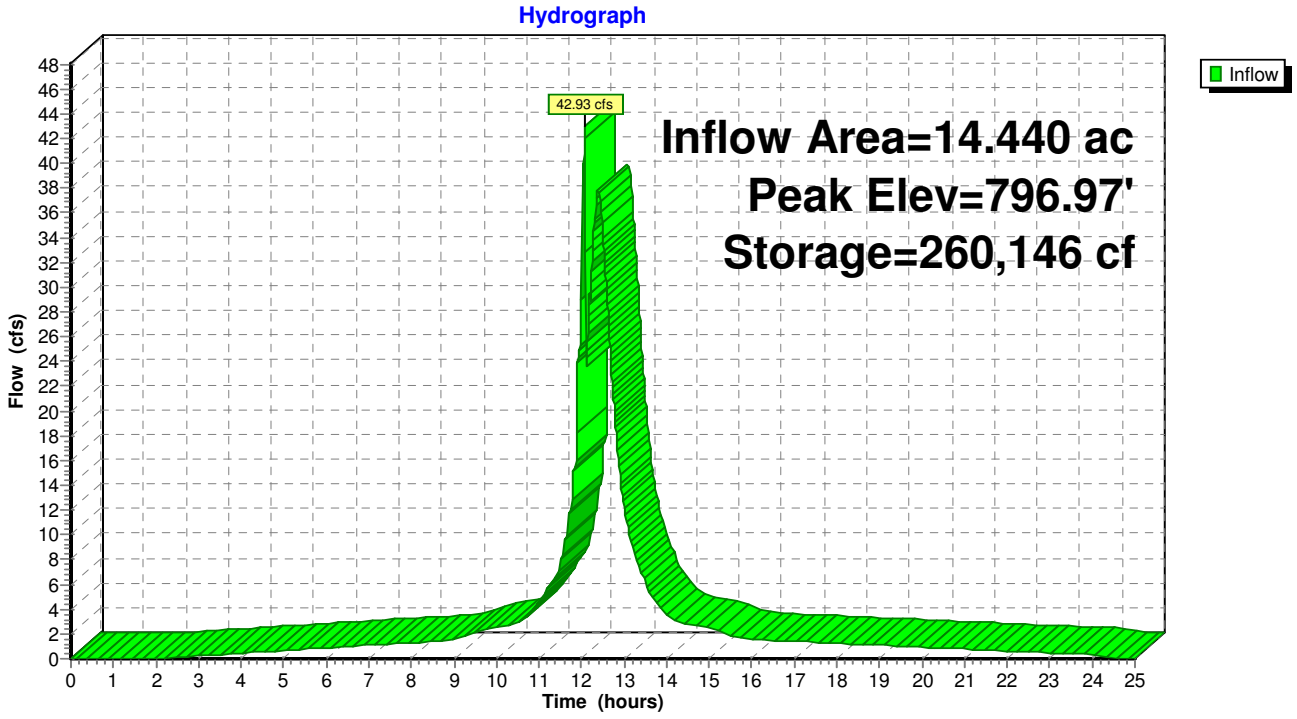
Routing by Stor-Ind method, Time Span= 0.00-25.00 hrs, dt= 0.01 hrs
Starting Elev= 792.50' Surf.Area= 34,630 sf Storage= 15,714 cf
Peak Elev= 796.97' @ 25.00 hrs Surf.Area= 65,515 sf Storage= 260,146 cf (244,432 cf above start)

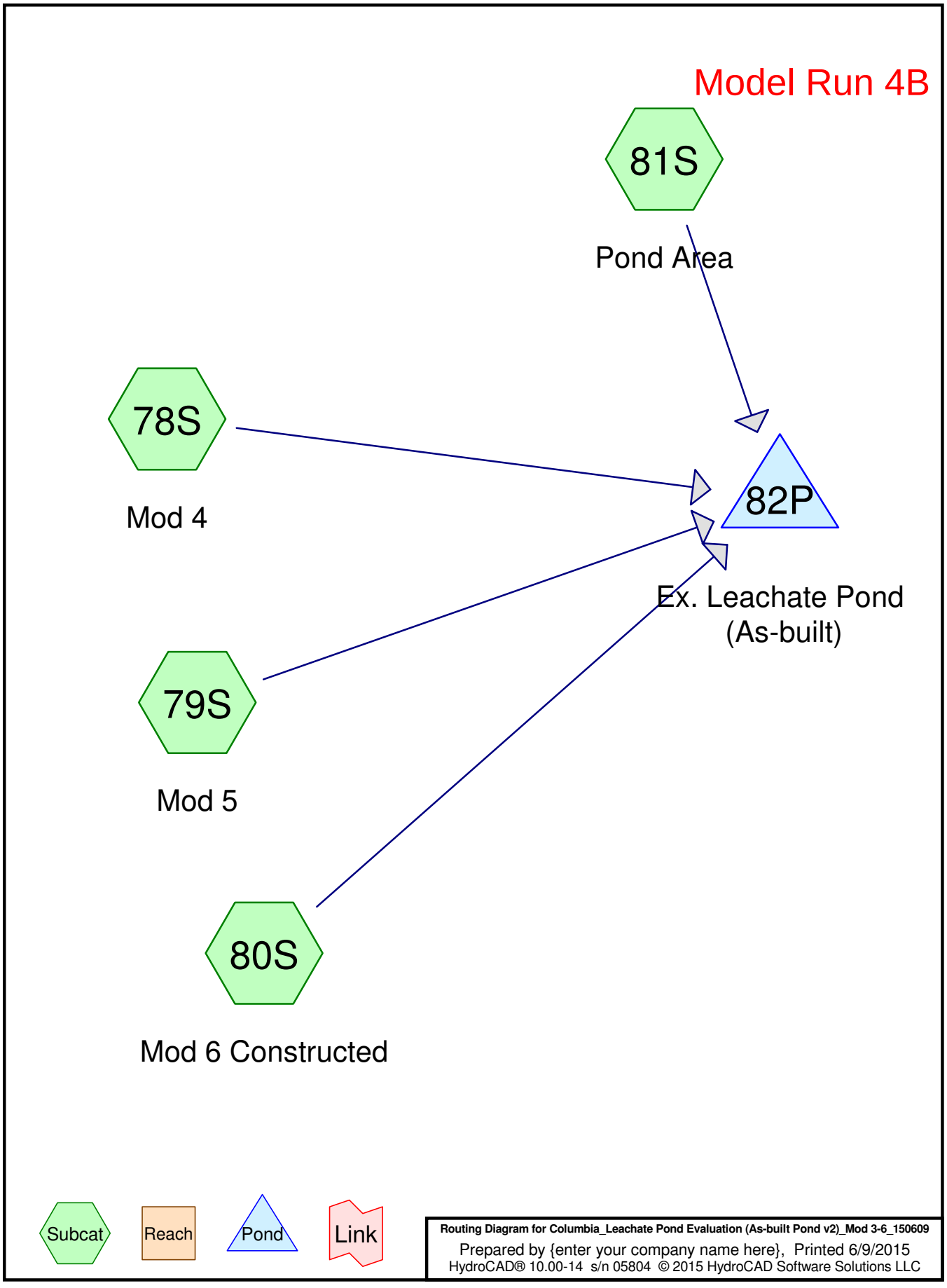
Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	792.00'	329,280 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
792.00	28,228	0	0
794.00	53,834	82,062	82,062
796.00	62,164	115,998	198,060
798.00	69,056	131,220	329,280

Pond 58P: Ex. Leachate Pond (As-built)





Routing Diagram for Columbia_Leachate Pond Evaluation (As-built Pond v2)_Mod 3-6_150609

Prepared by {enter your company name here}, Printed 6/9/2015

Time span=0.00-25.00 hrs, dt=0.01 hrs, 2501 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 78S: Mod 4 Runoff Area=4.390 ac 100.00% Impervious Runoff Depth=3.91"
Tc=25.0 min CN=98 Runoff=13.62 cfs 1.432 af

Subcatchment 79S: Mod 5 Runoff Area=4.460 ac 100.00% Impervious Runoff Depth>3.91"
Tc=30.0 min CN=98 Runoff=12.56 cfs 1.455 af

Subcatchment 80S: Mod 6 Constructed Runoff Area=4.380 ac 100.00% Impervious Runoff Depth>3.91"
Tc=35.0 min CN=98 Runoff=11.36 cfs 1.429 af

Subcatchment 81S: Pond Area Runoff Area=3.960 ac 100.00% Impervious Runoff Depth=3.91"
Tc=0.0 min CN=98 Runoff=23.70 cfs 1.292 af

Pond 82P: Ex. Leachate Pond (As-built) Peak Elev=796.97' Storage=259,988 cf Inflow=40.45 cfs 5.608 af
Outflow=0.00 cfs 0.000 af

Total Runoff Area = 17.190 ac Runoff Volume = 5.608 af Average Runoff Depth = 3.91"
0.00% Pervious = 0.000 ac 100.00% Impervious = 17.190 ac

Summary for Subcatchment 78S: Mod 4

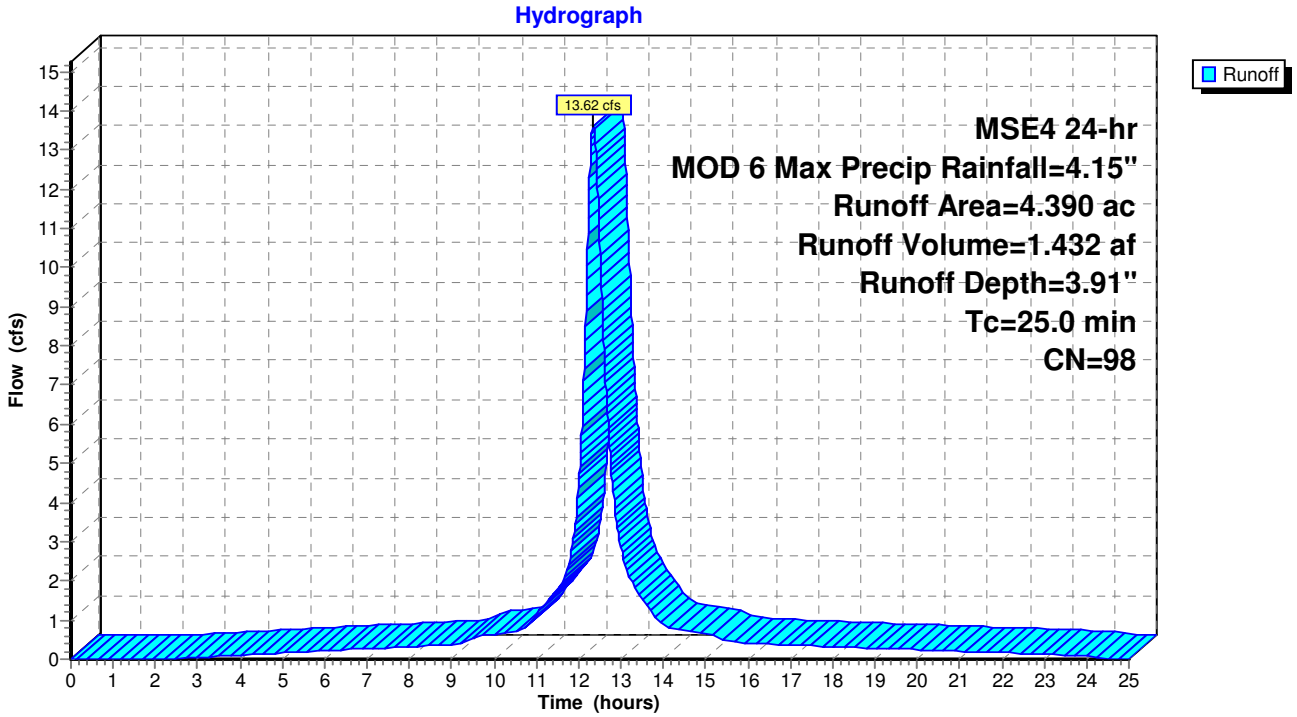
Runoff = 13.62 cfs @ 12.34 hrs, Volume= 1.432 af, Depth= 3.91"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.01 hrs
MSE4 24-hr MOD 6 Max Precip Rainfall=4.15"

	Area (ac)	CN	Description
*	4.390	98	Mod 4
	4.390		100.00% Impervious Area

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

Subcatchment 78S: Mod 4



Summary for Subcatchment 79S: Mod 5

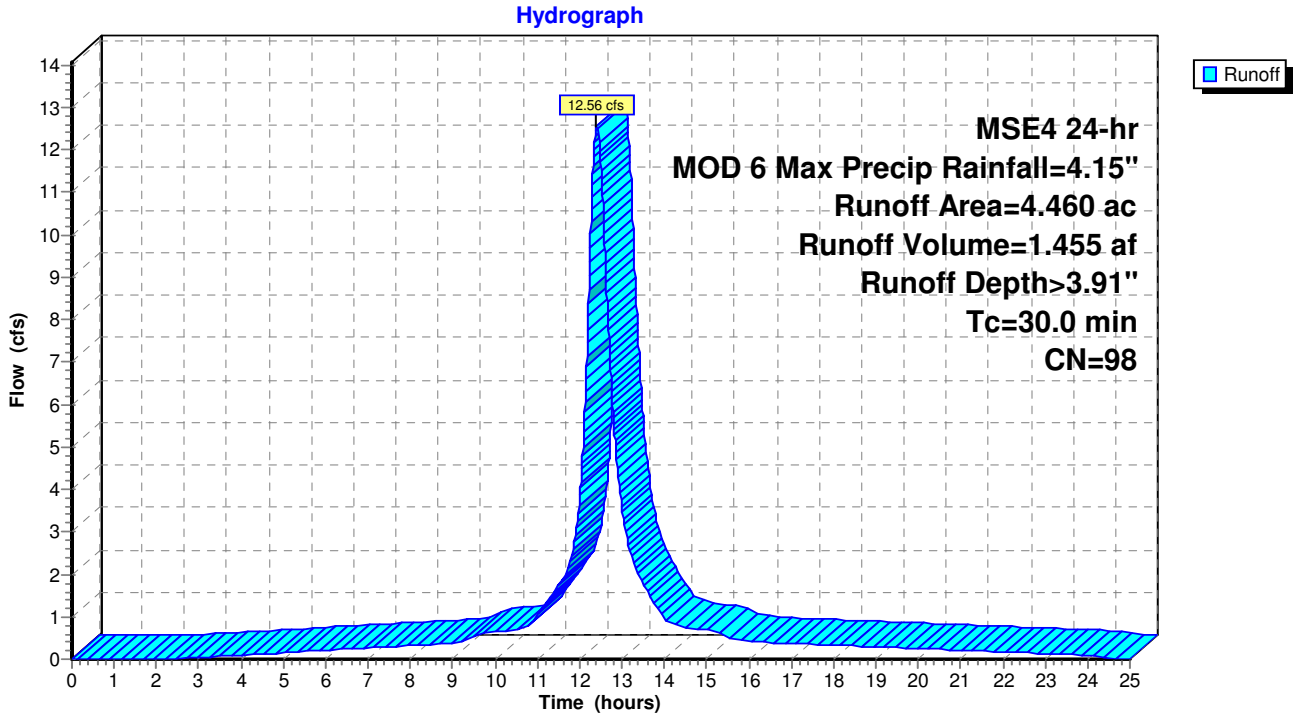
Runoff = 12.56 cfs @ 12.40 hrs, Volume= 1.455 af, Depth> 3.91"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.01 hrs
MSE4 24-hr MOD 6 Max Precip Rainfall=4.15"

	Area (ac)	CN	Description
*	4.460	98	Mod 5
	4.460		100.00% Impervious Area

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

Subcatchment 79S: Mod 5



Summary for Subcatchment 80S: Mod 6 Constructed

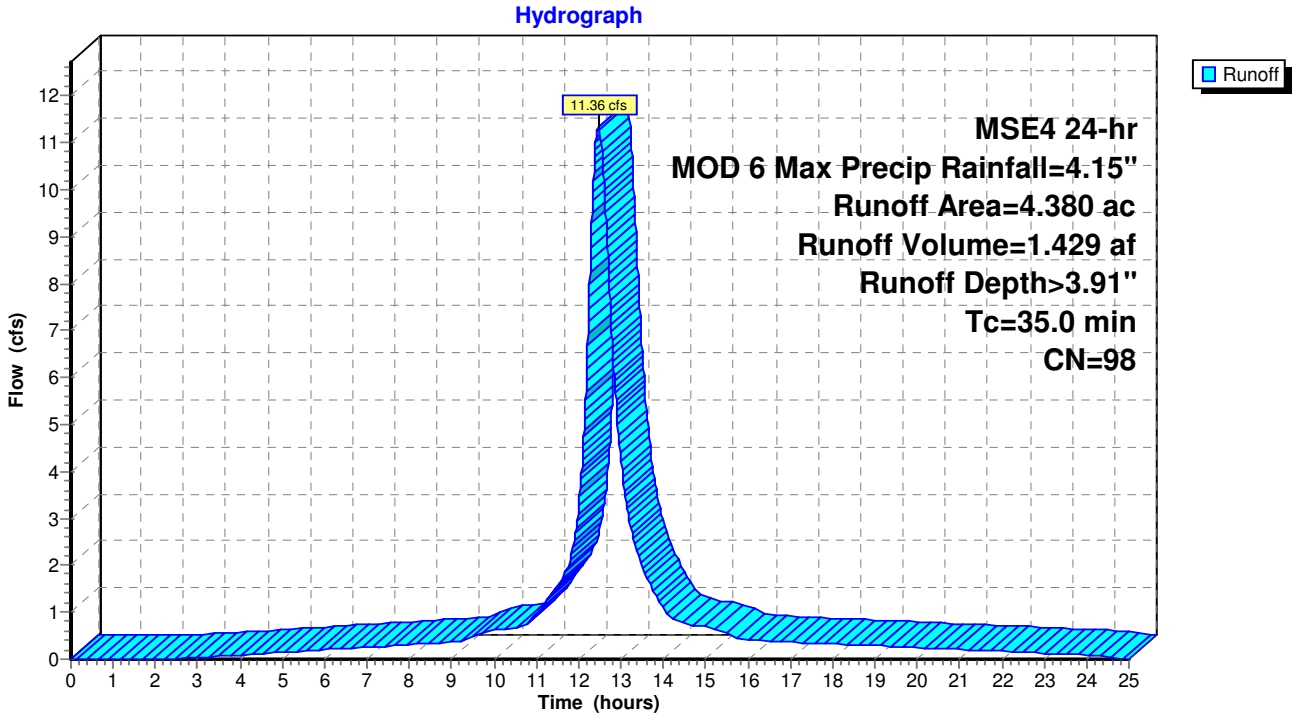
Runoff = 11.36 cfs @ 12.48 hrs, Volume= 1.429 af, Depth> 3.91"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.01 hrs
MSE4 24-hr MOD 6 Max Precip Rainfall=4.15"

	Area (ac)	CN	Description
*	4.380	98	Mod 6 no cover
	4.380		100.00% Impervious Area

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

Subcatchment 80S: Mod 6 Constructed



Summary for Subcatchment 81S: Pond Area

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

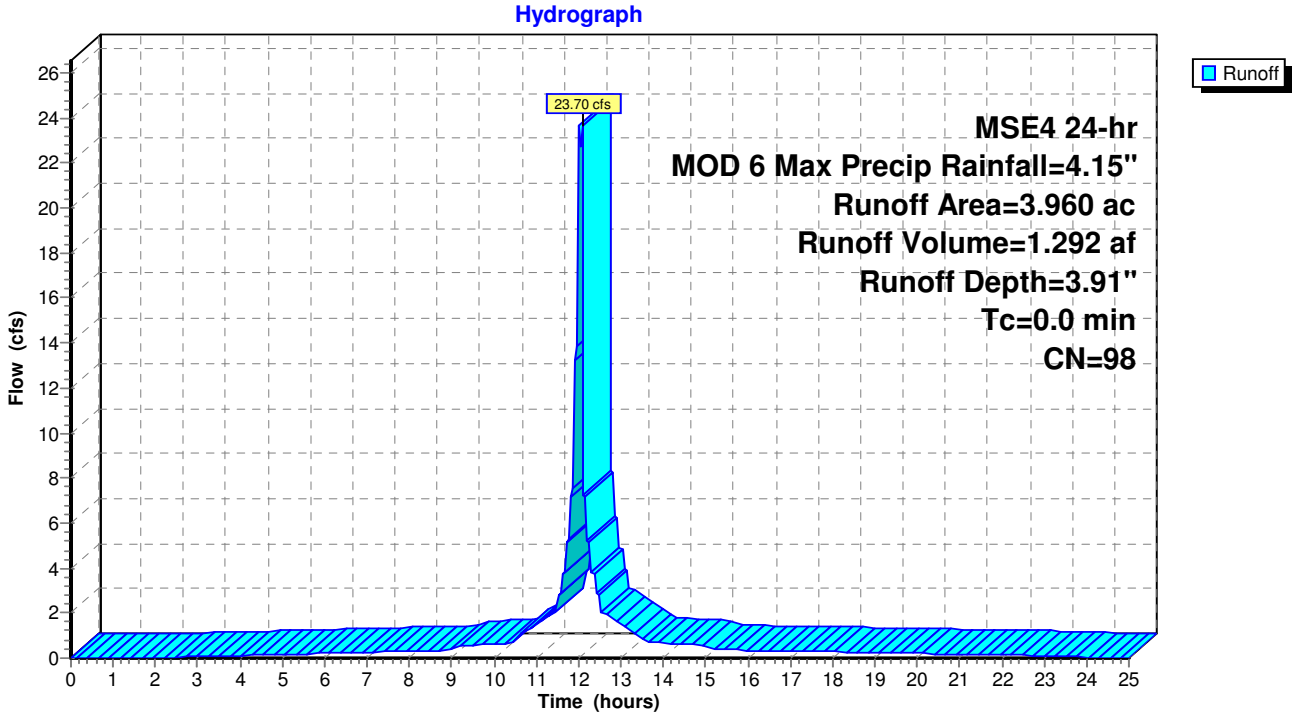
Runoff = 23.70 cfs @ 12.09 hrs, Volume= 1.292 af, Depth= 3.91"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.01 hrs
MSE4 24-hr MOD 6 Max Precip Rainfall=4.15"

	Area (ac)	CN	Description
*	3.960	98	
	3.960		100.00% Impervious Area

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

Subcatchment 81S: Pond Area



Summary for Pond 82P: Ex. Leachate Pond (As-built)

Inflow Area = 17.190 ac,100.00% Impervious, Inflow Depth > 3.91" for MOD 6 Max Precip event
Inflow = 40.45 cfs @ 12.39 hrs, Volume= 5.608 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

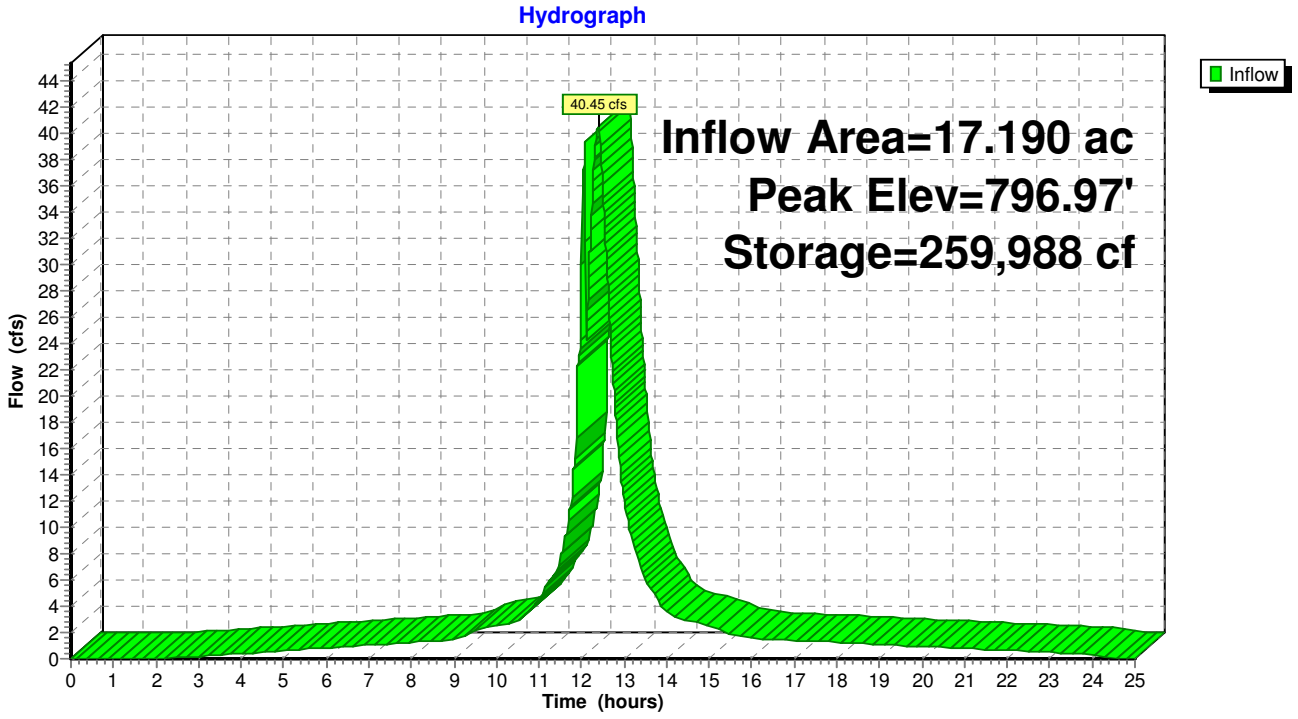
Routing by Stor-Ind method, Time Span= 0.00-25.00 hrs, dt= 0.01 hrs
Starting Elev= 792.50' Surf.Area= 34,630 sf Storage= 15,714 cf
Peak Elev= 796.97' @ 25.00 hrs Surf.Area= 65,507 sf Storage= 259,988 cf (244,273 cf above start)

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'	329,280 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
792.00	28,228	0	0
794.00	53,834	82,062	82,062
796.00	62,164	115,998	198,060
798.00	69,056	131,220	329,280

Pond 82P: Ex. Leachate Pond (As-built)



Storm Water Management Calculations – Ditch North of Module 3

Purpose:
The purpose of the storm water runoff calculations is to demonstrate that the proposed ditch north of Module 3 is adequately sized to divert run-on from the 25-year, 24-hour storm event around Module 3.

Approach:
Hydrograph Generation
To properly size the ditch, a runoff hydrograph for the 25-year, 24-hour storm event was developed. HydroCAD was used to generate the hydrograph 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 event, contributing drainage areas, runoff curve numbers, time of concentration, and travel time.

The contributing watershed is shown on **Figure 1**.

Ditch Sizing
The ditch, located just north of the Module 3 limits, was sized for the 25-year, 24-hour storm event using the Manning's equation to determine the depth of flow and stability in the ditch based on the ditch geometry and peak flow in the ditch (as determined by the Hydrograph Generation calculation). The Wisconsin DOT Grass Lined Swale spreadsheet was used to evaluate the flow depth in the ditch and ditch stability.

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

Cover Type	CN
Grass areas	49 – Grass cover in fair condition, hydrologic soil group A
Gravel access road	96 – Compacted gravel surface

- The NOAA Atlas 14 precipitation depth of 4.91 inches and storm distribution MSE4 was used.
- Other assumptions are included with the calculations attached to this calculation.

Results:
The ditch north of Module 3 will accommodate runoff from the 25-year, 24-hour storm event without overtopping. The ditch provides over 0.5 foot of freeboard.

Figure 1

2,123,800 E | 2,123,900 E | 2,124,000 E | 2,124,100 E | 2,124,200 E | 2,124,300 E | 2,124,400 E | 2,124,500 E | 2,124,600 E

542,800 N | 542,700 N | 542,600 N | 542,500 N | 542,400 N | 542,300 N

N 000°01'12" E

DRAINAGE AREA 1

DRAINAGE AREA 2

RUN-ON DIVERSION DITCH

FUTURE MODULE 4

MODULE 3-MODULE 4 DELINEATION BERM SEE DETAIL

MODULE 3

EXISTING MODULE 2

MODULE 2

MODULE 4

SURFACE WATER

LEGEND

- DRAINAGE AREA BOUNDARY
- PROPOSED FLOW PATH
- PHASE/MODULE LIMIT
- 825 EXISTING GRADES (5' CONTOUR)
- 821 EXISTING GRADES (1' CONTOUR)
- DRAINAGE AREA 1
- DRAINAGE AREA 2
- 806 AS-BUILT GRADE (1' CONTOUR)
- 805 AS-BUILT GRADE (5' CONTOUR)
- CULVERT
- DRY ASH DISPOSAL FACILITY LIMITS
- SWALE/PERIMETER DITCH
- NEW ACCESS ROAD
- EXISTING ACCESS ROAD

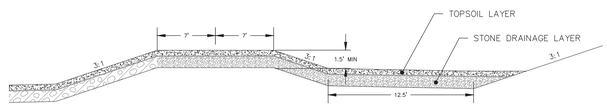
NOTES

1. CONTOURS WITHIN MODULE 3 LIMITS REPRESENT TOP OF LEACHATE DRAINAGE LAYER. GRADES OUTSIDE MODULE LIMITS REPRESENT FINISHED PERIMETER GRADES.

N

60 0 60

SCALE: 1" = 60'



TYPICAL DELINEATION BERM CROSS SECTION

SCALE: NTS

K:\25214194\GIS\mxd\Form Drainage Area Calc.dwg, 8/5/2016 12:14:13 PM

DRAWN BY:	KF/ES
CHECKED BY:	EN
APPROVED BY:	
PROJECT NO.	25214194
DRAWN:	09/08/16
REVISED:	09/09/16

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: CONSTRUCTION DOCUMENTATION MODULE 3 LINER
COLUMBIA DRY ASH DISPOSAL FACILITY
TOWN OF PACIFIC, WISCONSIN

DRAINAGE AREAS

SHEET 1 of 1

Hydrograph Generation

- 25-year, 24-hour Storm Event

Subcat Reach Pond Link

Routing Diagram for Storm Water Ditch at Mod 3 Limit
Prepared by {enter your company name here}, Printed 9/9/2016

Summary for Subcatchment 30S: Drainage Area 2

Runoff = 5.44 cfs @ 12.45 hrs, Volume= 0.753 af, Depth> 0.65"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

	Area (ac)	CN	Description
	13.420	49	50-75% Grass cover, Fair, HSG A
*	0.431	96	Gravel
	13.851	50	Weighted Average
	13.851		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.6	45	0.3300	0.28		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.78"
8.4	55	0.0270	0.11		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.78"
4.6	245	0.0160	0.89		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
8.6	535	0.0220	1.04		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
24.2	880	Total			

Summary for Subcatchment 31S: Drainage Area 1

Runoff = 1.27 cfs @ 12.13 hrs, Volume= 0.071 af, Depth> 0.82"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=4.91"

	Area (ac)	CN	Description
	0.953	49	50-75% Grass cover, Fair, HSG A
*	0.087	96	Gravel
	1.040	53	Weighted Average
	1.040		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.9	34	0.0600	0.20		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.78"
1.5	27	0.1850	0.30		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.78"
4.4	61	Total			

Ditch Sizing Calculation

Lining Type: Vegetation

Project ID:	**25214194**
Location:	**Columbia**
Designer/Checker:	**ES/BLP**
Date:	

	25-yr, 24-hr	25-yr, 24-hr
Channel/Ditch Geometry	***Drainage Area 1 Portion***	***Drainage Area 2 Portion***
Channel Slope, S_o (ft/ft)	**0.005**	**0.005**
Channel Bottom Width, B (ft)	**12.5**	**12.5**
Channel Side Slope, z_1	**3**	**3**
Channel Side Slope, z_2	**3**	**3**
Flow Depth, d (ft) Solve iteratively	**0.30**	**0.59**
Safety Factor, SF	**1.0**	**1.0**
Vegetation/Soil Parameters		
Vegetation Retardance Class	**C**	**C**
Vegetation Condition	**good**	**good**
Vegetation Growth Form	**turf**	**turf**
Soil Type	**noncohesive**	**noncohesive**
D_{75} (in) (Set at 0.00 for cohesive soils)		
ASTM Soil Class	**SC**	**SC**
Plasticity Index, PI	**16**	**16**
Results Summary		
Design Q (ft^3/s)	**1.3**	**5.4**
Calculated Q (ft^3/s)	1.3	5.5
Difference Between Design & Calc. Flow (%)	1.9%	1.0%
Stable (Yes or No)	**YES**	**YES**
Channel Parameters		
Vegetation Height, h (ft)	0.67	0.67
Grass Roughness Coefficient, C_n	0.238	0.238
Cover Factor, C_f	0.90	0.90
Noncohesive Soil		
Soil Grain Roughness, n_s	0.016	0.016
Permissible Soil Shear Stress, τ_p (lb/ft^2)	0.020	0.020
Cohesive Soil		
Porosity, e	0.35	0.35
Soil Coefficient 1, c_1	1.0700	1.0700
Soil Coefficient 2, c_2	14.30	14.30
Soil Coefficient 3, c_3	47.700	47.700
Soil Coefficient 4, c_4	1.42	1.42
Soil Coefficient 5, c_5	-0.61	-0.61
Soil Coefficient 6, c_6	0.00010	0.00010
Permissible Soil Shear Stress, τ_p (lb/ft^2)	N/A	N/A
Total Permissible Shear Stress, τ_p (lb/ft^2)	0.020	0.020
Cross Sectional Area, A (ft^2)	3.991	8.419
Wetted Perimeter, P (ft)	14.38	16.23
Hydraulic Radius, R (ft)	0.277	0.519
Top Width, T (ft)	14.29	16.04
Hydraulic Depth, D (ft)	0.279	0.525
Froude Number (Q design)	0.111	0.158
Channel Shear Stress, τ_o (lb/ft^2)	0.09	0.16
Actual Sheer Stress, τ_d (lb/ft^2)	0.09	0.18
Mannings n	0.135	0.105
Average Velocity, V (ft/s)	0.33	0.64
Calculated Flow, Q (ft^3/s)	1.3	5.5
Difference Between Design & Calc. Flow (%)	1.9%	1.0%
Effective Shear on Soil Surface, τ_e (lb/ft^2)	0.000	0.000
Total Permissible Shear on Veg., $\tau_{p,veg}$ (lb/ft^2)	14.24	8.61
Stable (Y or N)	YES	YES

SCS ENGINEERS

Sheet No.
Calc. No.
Rev. No.

Job No. 25214194 Job Alliant - Columbia By KRG Date 6/17/16

Client Alliant Subject Stormwater Storage on Rain Cover Chk'd BP Date 6/20/16

Purpose:

To evaluate the ability of Module 3 to contain runoff from various storm events up to the 100-yr, 24-hr storm with the raincover in place.

Method:

Use HydroCAD to model the storm events, with the module area set up as a pond.

Assumptions:

* Total drainage area = 4.12 acres
* The runoff courve number (CN) = 100
* There will be a berm around the outside of the module to contain water within the module.
* There will be a drainage notch in the southwest corner to allow stormwater to overflow into a drainage area that goes to the leachate basin. Notch assumed to be 5 ft wide at El. 808.
* The starting water elevation in the Module before the start fo the rain event is 806.0.
* The capacity of the Module is based on as-built contours of the top of the leachate drainage layer (see Figure 1).
* Use NOAA Atlas 14 precipitation data, with storm distribution MSE 4.
* Model runoff from the 1-yr, 2-yr, 5-yr, 10-yr, 25-yr, 50-yr and 100-year, 24-hour storm events.

Results:

With a starting water elevatin of 806.0, the module is able to contain the runoff from all the storms up to the 100-yr, 24-hr storm event without overtopping.

2,123,800 E | 2,123,900 E | 2,124,000 E | 2,124,100 E | 2,124,200 E | 2,124,300 E | 2,124,400 E | 2,124,500 E | 2,124,600 E

542,600 N | 542,500 N | 542,400 N | 542,300 N

ACCESS ROAD

FUTURE MODULE 4

BOTTOM ASH OPERATING PAD

LIMITS OF MODULE 3 RAIN COVER (APPROX. 179,675 SF)

MODULE 3

CLEAN STORM WATER COLLECTION/PUMPING LOCATIONS

MODULE 2-MODULE 3 LINER TIE-IN

EXISTING MODULE 2

LEGEND

- DRY ASH DISPOSAL FACILITY LIMITS
- APPROVED LIMITS OF ASH FILL
- PHASE/MODULE LIMIT
- EXISTING 2' THICK CLAY LINER LIMITS
- × 824.6 EXISTING SPOT ELEVATION
- 825 EXISTING GRADES (5' INTERVAL)
- 821 EXISTING GRADES (1' INTERVAL)
- 806 AS-BUILT DRAINAGE LAYER GRADES (1' CONTOUR)
- 805 AS-BUILT DRAINAGE LAYER GRADES (5' CONTOUR)
- 806 PROPOSED GRADE (1' CONTOUR)
- 805 PROPOSED (5' CONTOUR)
- PROPOSED 2' THICK CLAY LINER LIMITS
- PROPOSED RAIN COVER LIMITS

NOTES

1. SEE SHEET 2 FOR BASE MAP NOTES.
2. PROPOSED CONTINUOUS CONTOURS WITHIN MODULE 3 LIMITS REPRESENT TOP OF DRAINAGE LAYER.
3. MODULE 2 BASE GRADES TAKEN FROM JANUARY 19, 2012, PHASE 1, MODULE 2 CONSTRUCTION DOCUMENTATION REPORT PREPARED BY SCS ENGINEERS. BASE GRADES REPRESENT TOP OF COMPACTED CLAY LINER.

60 0 60

SCALE: 1" = 60'

MODULE 3 RAIN COVER AND BOTTOM ASH PAD

FIGURE 1

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

ENGINEER

KP | PG

2015 MODULE 3 LINER PLAN MOD
COLUMBIA DRY ASH DISPOSAL FACILITY
TOWN OF PACIFIC, WISCONSIN

SITE

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

CLIENT

Wisconsin Power and Light Company

PROJECT NO.	25214194.01
DRAWN:	06/16/16
REVISED:	06/16/16
DRAWN BY:	
CHECKED BY:	
APPROVED BY:	

I:\25214194\Drawings\Rain Flap Stormwater Calc.dwg, 6/20/2016 1:40:44 PM

Mod 3

Storage on Rain Cover

Subcat Reach Pond Link

Routing Diagram for Rain Cover
Prepared by SCS Engineers, Printed 6/20/2016

Summary for Subcatchment 1S: Mod 3

[49] Hint: Tc<2dt may require smaller dt

Runoff = 14.64 cfs @ 12.06 hrs, Volume= 0.838 af, Depth= 2.44"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-26.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 1-yr Rainfall=2.44"

	Area (ac)	CN	Description
*	4.120	100	Impervious Rain Cover
	4.120		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.1	25	0.3300	2.98		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.78"
0.7	115	0.0200	2.87		**Shallow Concentrated Flow, Flow across cell** Paved Kv= 20.3 fps
0.8	140	Total			

Summary for Pond 2P: Storage on Rain Cover

Inflow Area = 4.120 ac,100.00% Impervious, Inflow Depth = 2.44" for 1-yr event
Inflow = 14.64 cfs @ 12.06 hrs, Volume= 0.838 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-26.00 hrs, dt= 0.05 hrs
Starting Elev= 806.00' Surf.Area= 20,423 sf Storage= 10,322 cf
Peak Elev= 806.92' @ 24.10 hrs Surf.Area= 59,211 sf Storage= 46,811 cf (36,489 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	805.00'	271,226 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
805.00	221	0	0
806.00	20,423	10,322	10,322
807.00	62,749	41,586	51,908
808.00	114,149	88,449	140,357
809.00	147,589	130,869	271,226

Device	Routing	Invert	Outlet Devices
#1	Primary	808.00'	**5.0' long x 3.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 Coef. (English) 2.44 2.58 2.68 2.67 2.65 2.64 2.64 2.68 2.68 2.72 2.81 2.92 2.97 3.07 3.32

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=806.00' (Free Discharge)
↑—**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Subcatchment 1S: Mod 3

[49] Hint: Tc<2dt may require smaller dt

Runoff = 16.68 cfs @ 12.06 hrs, Volume= 0.954 af, Depth= 2.78"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-26.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 2-yr Rainfall=2.78"

	Area (ac)	CN	Description
*	4.120	100	Impervious Rain Cover
	4.120		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.1	25	0.3300	2.98		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.78"
0.7	115	0.0200	2.87		**Shallow Concentrated Flow, Flow across cell** Paved Kv= 20.3 fps
0.8	140	Total			

Summary for Pond 2P: Storage on Rain Cover

Inflow Area = 4.120 ac,100.00% Impervious, Inflow Depth = 2.78" for 2-yr event
Inflow = 16.68 cfs @ 12.06 hrs, Volume= 0.954 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-26.00 hrs, dt= 0.05 hrs
Starting Elev= 806.00' Surf.Area= 20,423 sf Storage= 10,322 cf
Peak Elev= 807.00' @ 24.10 hrs Surf.Area= 62,743 sf Storage= 51,898 cf (41,576 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	805.00'	271,226 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
805.00	221	0	0
806.00	20,423	10,322	10,322
807.00	62,749	41,586	51,908
808.00	114,149	88,449	140,357
809.00	147,589	130,869	271,226

Device	Routing	Invert	Outlet Devices
#1	Primary	808.00'	**5.0' long x 3.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 Coef. (English) 2.44 2.58 2.68 2.67 2.65 2.64 2.64 2.68 2.68 2.72 2.81 2.92 2.97 3.07 3.32

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=806.00' (Free Discharge)
↑—**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Subcatchment 1S: Mod 3

[49] Hint: Tc<2dt may require smaller dt

Runoff = 20.40 cfs @ 12.06 hrs, Volume= 1.167 af, Depth= 3.40"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-26.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 5-yr Rainfall=3.40"

	Area (ac)	CN	Description
*	4.120	100	Impervious Rain Cover
	4.120		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.1	25	0.3300	2.98		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.78"
0.7	115	0.0200	2.87		**Shallow Concentrated Flow, Flow across cell** Paved Kv= 20.3 fps
0.8	140	Total			

Summary for Pond 2P: Storage on Rain Cover

Inflow Area = 4.120 ac,100.00% Impervious, Inflow Depth = 3.40" for 5-yr event
Inflow = 20.40 cfs @ 12.06 hrs, Volume= 1.167 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-26.00 hrs, dt= 0.05 hrs
Starting Elev= 806.00' Surf.Area= 20,423 sf Storage= 10,322 cf
Peak Elev= 807.14' @ 24.10 hrs Surf.Area= 69,919 sf Storage= 61,161 cf (50,839 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	805.00'	271,226 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
805.00	221	0	0
806.00	20,423	10,322	10,322
807.00	62,749	41,586	51,908
808.00	114,149	88,449	140,357
809.00	147,589	130,869	271,226

Device	Routing	Invert	Outlet Devices
#1	Primary	808.00'	**5.0' long x 3.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 Coef. (English) 2.44 2.58 2.68 2.67 2.65 2.64 2.64 2.68 2.68 2.72 2.81 2.92 2.97 3.07 3.32

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=806.00' (Free Discharge)
1=Broad-Crested Rectangular Weir (Controls 0.00 cfs)

Summary for Subcatchment 1S: Mod 3

[49] Hint: Tc<2dt may require smaller dt

Runoff = 23.94 cfs @ 12.06 hrs, Volume= 1.370 af, Depth= 3.99"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-26.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 10-yr Rainfall=3.99"

	Area (ac)	CN	Description
*	4.120	100	Impervious Rain Cover
	4.120		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.1	25	0.3300	2.98		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.78"
0.7	115	0.0200	2.87		**Shallow Concentrated Flow, Flow across cell** Paved Kv= 20.3 fps
0.8	140	Total			

Summary for Pond 2P: Storage on Rain Cover

Inflow Area = 4.120 ac,100.00% Impervious, Inflow Depth = 3.99" for 10-yr event
Inflow = 23.94 cfs @ 12.06 hrs, Volume= 1.370 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-26.00 hrs, dt= 0.05 hrs
Starting Elev= 806.00' Surf.Area= 20,423 sf Storage= 10,322 cf
Peak Elev= 807.26' @ 24.10 hrs Surf.Area= 76,130 sf Storage= 69,985 cf (59,663 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	805.00'	271,226 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
805.00	221	0	0
806.00	20,423	10,322	10,322
807.00	62,749	41,586	51,908
808.00	114,149	88,449	140,357
809.00	147,589	130,869	271,226

Device	Routing	Invert	Outlet Devices
#1	Primary	808.00'	**5.0' long x 3.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 Coef. (English) 2.44 2.58 2.68 2.67 2.65 2.64 2.64 2.68 2.68 2.72 2.81 2.92 2.97 3.07 3.32

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=806.00' (Free Discharge)
↑—**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Subcatchment 1S: Mod 3

[49] Hint: Tc<2dt may require smaller dt

Runoff = 29.46 cfs @ 12.06 hrs, Volume= 1.686 af, Depth= 4.91"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-26.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr Rainfall=4.91"

	Area (ac)	CN	Description
*	4.120	100	Impervious Rain Cover
	4.120		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.1	25	0.3300	2.98		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.78"
0.7	115	0.0200	2.87		**Shallow Concentrated Flow, Flow across cell** Paved Kv= 20.3 fps
0.8	140	Total			

Summary for Pond 2P: Storage on Rain Cover

Inflow Area = 4.120 ac,100.00% Impervious, Inflow Depth = 4.91" for 25-yr event
Inflow = 29.46 cfs @ 12.06 hrs, Volume= 1.686 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-26.00 hrs, dt= 0.05 hrs
Starting Elev= 806.00' Surf.Area= 20,423 sf Storage= 10,322 cf
Peak Elev= 807.43' @ 24.10 hrs Surf.Area= 84,915 sf Storage= 83,747 cf (73,425 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	805.00'	271,226 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
805.00	221	0	0
806.00	20,423	10,322	10,322
807.00	62,749	41,586	51,908
808.00	114,149	88,449	140,357
809.00	147,589	130,869	271,226

Device	Routing	Invert	Outlet Devices
#1	Primary	808.00'	**5.0' long x 3.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 Coef. (English) 2.44 2.58 2.68 2.67 2.65 2.64 2.64 2.68 2.68 2.72 2.81 2.92 2.97 3.07 3.32

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=806.00' (Free Discharge)
↑—**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Subcatchment 1S: Mod 3

[49] Hint: Tc<2dt may require smaller dt

Runoff = 34.25 cfs @ 12.06 hrs, Volume= 1.960 af, Depth= 5.71"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-26.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 50-yr Rainfall=5.71"

	Area (ac)	CN	Description
*	4.120	100	Impervious Rain Cover
	4.120		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.1	25	0.3300	2.98		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.78"
0.7	115	0.0200	2.87		**Shallow Concentrated Flow, Flow across cell** Paved Kv= 20.3 fps
0.8	140	Total			

Summary for Pond 2P: Storage on Rain Cover

Inflow Area = 4.120 ac,100.00% Impervious, Inflow Depth = 5.71" for 50-yr event
Inflow = 34.25 cfs @ 12.06 hrs, Volume= 1.960 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-26.00 hrs, dt= 0.05 hrs
Starting Elev= 806.00' Surf.Area= 20,423 sf Storage= 10,322 cf
Peak Elev= 807.57' @ 24.10 hrs Surf.Area= 91,873 sf Storage= 95,713 cf (85,391 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	805.00'	271,226 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
805.00	221	0	0
806.00	20,423	10,322	10,322
807.00	62,749	41,586	51,908
808.00	114,149	88,449	140,357
809.00	147,589	130,869	271,226

Device	Routing	Invert	Outlet Devices
#1	Primary	808.00'	**5.0' long x 3.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 Coef. (English) 2.44 2.58 2.68 2.67 2.65 2.64 2.64 2.68 2.68 2.72 2.81 2.92 2.97 3.07 3.32

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=806.00' (Free Discharge)
↑—**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Subcatchment 1S: Mod 3

[49] Hint: Tc<2dt may require smaller dt

Runoff = 39.53 cfs @ 12.06 hrs, Volume= 2.263 af, Depth= 6.59"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-26.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr Rainfall=6.59"

	Area (ac)	CN	Description
*	4.120	100	Impervious Rain Cover
	4.120		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.1	25	0.3300	2.98		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.78"
0.7	115	0.0200	2.87		**Shallow Concentrated Flow, Flow across cell** Paved Kv= 20.3 fps
0.8	140	Total			

Summary for Pond 2P: Storage on Rain Cover

Inflow Area = 4.120 ac,100.00% Impervious, Inflow Depth = 6.59" for 100-yr event
Inflow = 39.53 cfs @ 12.06 hrs, Volume= 2.263 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-26.00 hrs, dt= 0.05 hrs
Starting Elev= 806.00' Surf.Area= 20,423 sf Storage= 10,322 cf
Peak Elev= 807.70' @ 24.10 hrs Surf.Area= 98,960 sf Storage= 108,870 cf (98,548 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	805.00'	271,226 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
805.00	221	0	0
806.00	20,423	10,322	10,322
807.00	62,749	41,586	51,908
808.00	114,149	88,449	140,357
809.00	147,589	130,869	271,226

Device	Routing	Invert	Outlet Devices
#1	Primary	808.00'	**5.0' long x 3.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 Coef. (English) 2.44 2.58 2.68 2.67 2.65 2.64 2.64 2.68 2.68 2.72 2.81 2.92 2.97 3.07 3.32

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=806.00' (Free Discharge)
↑—**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

NOAA Atlas 14, Volume 8, Version 2
Location name: Pardeeville, Wisconsin, US*
Latitude: 43.4868°, Longitude: -89.4128°
Elevation: 811 ft*
* source: Google Maps

MSE4

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Deborah Martin, Sandra Pavlovic, Ishani Roy, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Michael Yekta, Geoffery Bonnin

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.367 (0.318–0.433)	0.416 (0.361–0.492)	0.504 (0.435–0.596)	0.581 (0.499–0.690)	0.696 (0.580–0.857)	0.791 (0.642–0.983)	0.891 (0.697–1.13)	0.998 (0.746–1.30)	1.15 (0.824–1.53)	1.27 (0.882–1.70)
10-min	0.537 (0.466–0.634)	0.610 (0.528–0.720)	0.737 (0.637–0.873)	0.851 (0.730–1.01)	1.02 (0.849–1.26)	1.16 (0.939–1.44)	1.30 (1.02–1.66)	1.46 (1.09–1.90)	1.68 (1.21–2.24)	1.86 (1.29–2.49)
15-min	0.655 (0.568–0.773)	0.744 (0.644–0.878)	0.899 (0.776–1.06)	1.04 (0.891–1.23)	1.24 (1.04–1.53)	1.41 (1.15–1.76)	1.59 (1.24–2.02)	1.78 (1.33–2.32)	2.05 (1.47–2.73)	2.27 (1.58–3.04)
30-min	0.908 (0.788–1.07)	1.03 (0.894–1.22)	1.25 (1.08–1.48)	1.44 (1.24–1.71)	1.73 (1.44–2.13)	1.97 (1.60–2.45)	2.22 (1.73–2.82)	2.49 (1.86–3.23)	2.87 (2.06–3.81)	3.17 (2.20–4.25)
60-min	1.15 (1.00–1.36)	1.33 (1.15–1.57)	1.63 (1.41–1.93)	1.91 (1.64–2.26)	2.32 (1.94–2.87)	2.66 (2.16–3.32)	3.03 (2.37–3.85)	3.42 (2.56–4.45)	3.98 (2.86–5.30)	4.43 (3.08–5.94)
2-hr	1.40 (1.22–1.64)	1.62 (1.41–1.90)	2.01 (1.75–2.36)	2.37 (2.05–2.79)	2.91 (2.44–3.57)	3.36 (2.75–4.16)	3.84 (3.03–4.85)	4.36 (3.29–5.64)	5.10 (3.68–6.74)	5.69 (3.99–7.58)
3-hr	1.54 (1.35–1.80)	1.80 (1.57–2.10)	2.25 (1.97–2.64)	2.67 (2.32–3.14)	3.31 (2.79–4.05)	3.84 (3.16–4.75)	4.42 (3.50–5.57)	5.05 (3.82–6.51)	5.94 (4.31–7.83)	6.66 (4.68–8.83)
6-hr	1.82 (1.61–2.11)	2.11 (1.86–2.44)	2.64 (2.31–3.06)	3.13 (2.73–3.65)	3.90 (3.32–4.76)	4.55 (3.77–5.60)	5.27 (4.21–6.61)	6.06 (4.62–7.77)	7.18 (5.26–9.43)	8.11 (5.75–10.7)
12-hr	2.14 (1.90–2.46)	2.43 (2.15–2.79)	2.98 (2.63–3.43)	3.51 (3.08–4.05)	4.34 (3.74–5.28)	5.07 (4.24–6.21)	5.88 (4.73–7.33)	6.77 (5.21–8.64)	8.06 (5.95–10.5)	9.13 (6.52–11.9)
24-hr	2.44 (2.18–2.78)	2.78 (2.47–3.16)	3.40 (3.02–3.88)	3.99 (3.52–4.58)	4.91 (4.25–5.91)	5.71 (4.80–6.93)	6.59 (5.34–8.15)	7.56 (5.86–9.56)	8.96 (6.66–11.6)	10.1 (7.27–13.1)
2-day	2.73 (2.46–3.09)	3.18 (2.85–3.60)	3.97 (3.55–4.50)	4.69 (4.16–5.33)	5.76 (4.99–6.83)	6.66 (5.61–7.97)	7.62 (6.19–9.31)	8.65 (6.73–10.8)	10.1 (7.56–13.0)	11.3 (8.18–14.6)
3-day	3.01 (2.71–3.38)	3.48 (3.14–3.92)	4.32 (3.88–4.88)	5.08 (4.53–5.75)	6.20 (5.38–7.31)	7.13 (6.03–8.48)	8.12 (6.62–9.87)	9.18 (7.17–11.4)	10.7 (8.00–13.6)	11.9 (8.64–15.2)
4-day	3.25 (2.94–3.65)	3.75 (3.38–4.20)	4.61 (4.15–5.18)	5.38 (4.81–6.07)	6.53 (5.68–7.66)	7.48 (6.34–8.86)	8.48 (6.94–10.3)	9.56 (7.49–11.9)	11.1 (8.34–14.1)	12.3 (8.97–15.7)
7-day	3.89 (3.53–4.33)	4.42 (4.01–4.93)	5.36 (4.85–5.99)	6.19 (5.56–6.94)	7.41 (6.48–8.63)	8.42 (7.17–9.90)	9.48 (7.79–11.4)	10.6 (8.36–13.1)	12.2 (9.23–15.4)	13.5 (9.89–17.1)
10-day	4.45 (4.05–4.93)	5.03 (4.58–5.59)	6.04 (5.48–6.72)	6.93 (6.25–7.74)	8.22 (7.20–9.51)	9.28 (7.93–10.8)	10.4 (8.56–12.4)	11.6 (9.13–14.1)	13.2 (10.0–16.5)	14.5 (10.7–18.4)
20-day	6.08 (5.58–6.69)	6.83 (6.25–7.51)	8.07 (7.37–8.90)	9.13 (8.29–10.1)	10.6 (9.34–12.1)	11.8 (10.1–13.6)	13.0 (10.8–15.4)	14.3 (11.3–17.3)	16.0 (12.2–19.8)	17.3 (12.8–21.8)
30-day	7.47 (6.88–8.18)	8.38 (7.70–9.18)	9.86 (9.03–10.8)	11.1 (10.1–12.2)	12.8 (11.2–14.4)	14.1 (12.1–16.1)	15.4 (12.8–18.0)	16.7 (13.3–20.1)	18.4 (14.1–22.7)	19.8 (14.7–24.8)
45-day	9.27 (8.57–10.1)	10.4 (9.60–11.3)	12.2 (11.2–13.4)	13.7 (12.5–15.0)	15.7 (13.8–17.6)	17.1 (14.8–19.5)	18.6 (15.5–21.6)	20.0 (16.0–23.8)	21.8 (16.7–26.7)	23.1 (17.3–28.9)
60-day	10.8 (10.0–11.7)	12.2 (11.3–13.2)	14.3 (13.2–15.6)	16.0 (14.7–17.5)	18.2 (16.1–20.3)	19.9 (17.2–22.5)	21.4 (17.9–24.8)	22.9 (18.4–27.2)	24.8 (19.1–30.3)	26.1 (19.7–32.5)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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PF graphical