Petersburg Generating Station

2021 CCR Landfill Run-On & Run-Off Control System Plan

Revision 0

October 6, 2021

Issue Purpose: Use

Project No.: 10572-140

55 East Monroe Street
Chicago, IL 60603-5780 USA
312-269-2000
www.sargentlundy.com

Sargent & Lundy

TABLE OF CONTENTS

1.0 PURPOSE

AES Indiana's Petersburg Generating Station ("Petersburg" or the "Station") has an existing coal combustion residual (CCR) landfill ("Petersburg Landfill") that is regulated by U.S. Environmental Protection Agency's "Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments," 40 CFR Part 257 Subpart D, also referred to herein as the "Federal CCR Rule." In accordance with 40 CFR 257.81(c)(1), this report documents the 2021 run-on and run-off control system plan for the Petersburg Landfill. The purpose of this plan is to document how the Petersburg Landfill's run-on and run-off control systems have been designed and constructed to meet the applicable requirements in 40 CFR 257.81. Pursuant to 40 CFR 257.81(c)(4), this plan was prepared within five years of the landfill's initial (2016) run-on and run-off control system plan.

2.0 ASSESSMENT

The inputs to the hydrologic and hydraulic analysis documented in the Petersburg Landfill's 2016 run-on and run-off control system plan were reviewed to determine if an updated analysis was warranted. Where no changes were noted for a given input, or where identified changes were determined to not impact the results and conclusions of the initial analysis, the previous evaluation of that input was considered to still be valid.

2.1 SUMMARY OF 2016 RUN-ON & RUN-OFF CONTROL SYSTEM PLAN

This section summarizes the Petersburg Landfill's run-on and run-off control systems and the hydrologic and hydraulic analyses of those systems as documented in the landfill's initial run-on and run-off control system plan. The 2016 plan was prepared by ATC Group Services LLC (ATC) and is included in its entirety as Appendix A to this 2021 plan. Pursuant to 40 CFR 257.81(a), the 2016 plan analyzed the landfill's run-on and run-off controls systems' abilities to manage stormwater during the 25-year, 24-hour storm event. Per the 2016 plan, the precipitation depth used in the hydrologic and hydraulic analyses to represent this design storm event was approximately 5.5 inches.

2.1.1 RUN-ON CONTROL SYSTEM

The 2016 plan analyzed the Peterburg Landfill's run-on control system by first evaluating the site's topography to understand the natural stormwater drainage paths. The 2016 plan concluded that the railroad embankment west of the landfill prevents run-on from the White River during the 100-year flood event since the embankment was determined to be higher than the river's 100-year flood elevation. The 2016 plan then evaluated the hydraulic capacity of the perimeter ditch around the Petersburg Landfill to verify it had the ability to manage stormwater run-on from areas around the landfill that did not otherwise flow into natural drainage features.

The perimeter ditch around the Petersburg Landfill is a trapezoidal channel with 3H:1V side slopes, a bottom width of 6.67 feet, and a depth of 4 feet. The ditch collects stormwater run-off from the landfill's riprap downcomers and, as previously mentioned, from adjacent areas downstream from the landfill that do not otherwise flow into natural drainage features. Stormwater in the ditch ultimately drains to one of three sedimentation basins: the Northwest Sedimentation Basin, West Sedimentation Basin, and East Sedimentation Pond. The Northwest and West Sedimentation Basins are existing basins, while the landfill's design plans called for the East Sedimentation Pond to be added to provide additional storage capacity for the landfill's final closure condition.

The 2016 hydrologic and hydraulic analysis for the Petersburg Landfill's run-on control system evaluated the hydraulic capacities of the perimeter ditch and the three sedimentation basins during interim and final cover conditions. Table 2-1 presents the maximum estimated flow rate in the perimeter ditch during the 25-year, 24-hour storm. Based on this result, the perimeter ditch can manage stormwater run-on from the Petersburg Landfill and adjacent areas during the design storm event because the estimated maximum flow rate is less than the ditch's hydraulic capacity. The 2016 hydrologic and hydraulic analysis also concluded that the Northwest, West, and East Sedimentation Basins had sufficient combined storage capacity to manage stormwater run-on and run-off during the 25-year, 24-hour storm event during both interim and final cover conditions. Therefore, the 2016 run-on and run-off control system plan concluded that the Petersburg Landfill was able to prevent flow onto the active portion of the landfill during the 25-year, 24-hour storm event in accordance with 40 CFR 257.81(a)(1).

Table 2-1 – Summary of 2016 Hydrologic and Hydraulic Analysis for Petersburg Landfill's Run-On Control System

Run-On Control Feature	Maximum Flow Rate (cfs)	Hydraulic Capacity (cfs)
Perimeter Ditch	31.64	394.7

2.1.2 RUN-OFF CONTROL SYSTEM

The Petersburg Landfill's run-off control system consists of a series of diversion berms and riprap downcomers along the slopes of the landfill, both of which direct rainfall into designated flow paths. The diversion berms prevent disturbance of CCR materials during storm events by directing stormwater into the landfill's riprap downcomers. The diversion berms are spaced approximately 60 feet horizontally from each other, and each berm is approximately 6-inches tall. The channels adjacent to the berms which drain to the aforementioned riprap downcomers have slopes of approximately 0.4% and have floors that are approximately 1.2-feet wide. The riprap downcomers ultimately convey stormwater into the perimeter ditch around the Petersburg Landfill, the hydraulic capacity of which was addressed in the analysis of the landfill's run-on control system (see Section 2.1.1).

The 2016 hydrologic and hydraulic analysis for the Petersburg Landfill's run-off control system evaluated the hydraulic capacities of the diversion berms and riprap downcomers during interim and final cover conditions. Table 2-2 presents the maximum flow depths determined for the diversion berms and riprap downcomers. Complete results are presented in Tables 1 and 2 in Appendix C of the 2016 plan (included as Appendix A to this 2021 plan). Based on these results, the Petersburg Landfill's run-off control system can manage rainfall during the design storm event because the estimated maximum flow depths are less than the heights of the diversion berms and riprap downcomers. Therefore, the 2016 run-on and run-off control system plan concluded that the Petersburg Landfill was able to maintain and control the run-off from the 25-year, 24-hour storm event in accordance with 40 CFR 257.81(a)(2).

Table 2-2 – Summary of 2016 Hydrologic and Hydraulic Analysis for Petersburg Landfill's Run-Off Control System

Run-Off Control Feature	Height (feet)	Max. Flow Depth (feet)	Freeboard (inches)
Diversion Berm Channel	0.5	0.31	2.28
Riprap Downcomer	1	0.47	6.36

2.2 CHANGES SINCE 2016 RUN-ON & RUN-OFF CONTROL SYSTEM PLAN

2.2.1 CHANGES IN DESIGN STORM EVENT

Per the National Oceanic and Atmospheric Administration's Atlas 14, "Point Precipitation Frequency Estimates," the precipitation depth for the 25-year, 24-hour storm event at the Petersburg site is approximately 5.5 inches, which is the same precipitation depth used in the 2016 run-on and run-off control system plan for the Petersburg Landfill. Therefore, no changes have been made to the 25-year, 24-hour storm event used in the 2016 hydrologic and hydraulic analyses of the Petersburg Landfill's run-on and run-off control systems that would require updating the 2016 analyses.

2.2.2 CHANGES IN ADJACENT TOPOGRAPHY

There have been no significant modifications to the topography adjacent to the Petersburg Landfill (mass excavations, mass fill operations, *etc*.) since the landfill's 2016 run-on and run-off control system plan was completed. Therefore, it is not necessary to modify the volume of stormwater considered in the 2016 hydrologic and hydraulic analysis to account for run-on from areas adjacent to the landfill that do not otherwise flow into natural drainage features.

2.2.3 CHANGES IN LANDFILL DESIGN & OPERATION

There have been no significant modifications to how the Station operates the Petersburg Landfill since its 2016 run-on and run-off control system plan was completed. However, AES Indiana submitted a minor permit modification to the Indiana Department of Environmental Management (IDEM) in early October 2017 that included proposed revisions to the landfill's final cover grades, final cover system, and stormwater management system. IDEM approved the proposed modifications to the Petersburg Landfill's design in September 2018. Therefore, these modifications are considered to be part of the current landfill design. Thus, the changes made to the landfill's final cover grades, final cover system, and stormwater management system are considered to be changes that have been made to the Petersburg Landfill's run-on and run-off control system design since the 2016 run-on and run-off control system plan was completed. It should be noted that these changes only impact the run-on and run-off control systems for the undeveloped, eastern portion of the Petersburg Landfill; the 2016 plan remains valid for the developed, western portion of the landfill.

2.3 MODIFIED STORMWATER MANAGEMENT SYSTEM ANALYSIS

Table 2-3 summarizes the changes made to the Petersburg Landfill design since the 2016 run-on and run-off control system plan was completed that impact the landfill's stormwater management system. In its application for a minor modification to the Petersburg Landfill's permit, AES Indiana included calculations prepared by ATC to demonstrate to IDEM that the proposed changes to the landfill's stormwater run-off control system could manage the 25-year, 24-hour storm event. These calculations are included in their entirety in Appendix B to this 2021 plan.

Table 2-3 – Modifications to Design of Petersburg Landfill's Stormwater Management System

Stormwater Management Feature	2016 Landfill Design	Post-2016 Landfill Design
Final Cover Grade	3H:1V Side Slopes to EL. 682 Feet	4H:1V Side Slopes to EL. 660 Feet 5% Side Slopes from EL. 660 Feet to Peak EL. 665 Feet
Final Cover System (Bottom to Top)	24-in. Compacted Soil 6-in. Vegetated Soil	Textured LLDPE Geomembrane Geocomposite Drainage Layer 30-in. Protective Soil 6-in. Vegetated Soil
Collection of Stormwater Run-Off from Eastern Portion of Landfill	Diversion Berms at 60-ft Horizontal Spacing → Riprap Downcomers → Perimeter Ditch → East Sedimentation Pond	Diversion Berms at 90-ft Horizontal Spacing → Downdrain Pipes → Perimeter Ditch → North and South Sedimentation Basins

Per Table 2-3 and Appendix B, the revised run-off control system for the future eastern portion of the Petersburg Landfill consists of a series of diversion berms that will direct stormwater into 18-in.-diameter downdrain pipes. The diversion berms will be spaced approximately 90 feet horizontally along the portion of the landfill sloped at 4H:1V; two diversion berms will be located along the peak of the landfill (5% side slope). On the 4H:1V side slopes, the channels adjacent to the berms will be V-shaped and sloped at approximately 2%. Meanwhile, the V-channels at the peak of the landfill will be sloped at approximately 1%. the 18-in.-diameter downdrain pipes will be installed in pairs and will receive stormwater run-off from drainage areas of 9 acres or less. Finally, the perimeter ditch along the eastern portion of the landfill that ultimately conveys stormwater to either one of the North or South Sedimentation Ponds will be a trapezoid channel similar to the perimeter ditch along the western portion, but with a bottom width and depth of 6 feet and 3 feet, respectively (compared to 6.67 feet and 4 feet on the west side of the landfill).

Table 2-4 summarizes the results from the hydrologic and hydraulic analyses conducted for the permitted modifications to the Petersburg Landfill's stormwater management system. Complete results which were submitted with the minor permit modification are presented in Appendix B to this 2021 plan. Based on these results the modified designs to the Petersburg Landfill's run-off control systems can manage rainfall during the design storm event because the estimated maximum inflow depths are less than the available storage depths in the diversion berm channels, downdrain pipes, and sedimentation basins. Accordingly, ATC concluded in the minor permit modification application for the Petersburg Landfill that the stormwater management system design modifications would be able to maintain and control the run-off from the 25-year, 24-hour storm event.

Table 2-4 – Summary of 2021 Hydrologic and Hydraulic Analysis for Petersburg Landfill's Run-Off Control System

Stormwater Management Feature	Inflow Depth (feet)	Storage Depth (feet)	Freeboard (feet)
Diversion Berm Channel on 4H:1V Side Slope	0.75	2.00	1.25
Diversion Berm Channel on 5% Side Slope	0.53	2.00	1.47
Downdrain Pipe	0.76	1.50	0.74
Perimeter Ditch	1.92	3.00	1.08
South Sedimentation Basin	6.65	9.00	2.35
North Sedimentation Basin	6.28	15.00	8.72

3.0 2021 RUN-ON & RUN-OFF CONTROL ASSESSMENT CONCLUSIONS

The 2016 run-on and run-off control plan for the Petersburg Landfill was reviewed and validated for compliance with the Federal CCR Rule's run-on and run-off control criteria for CCR landfills. Modifications to the stormwater management systems for the undeveloped eastern portion of the landfill are the only significant changes that have been made to the design or operation of the Petersburg Landfill since the 2016 plan was completed. The stormwater calculations submitted with the minor permit modification application to IDEM, which was ultimately approved by IDEM, were reviewed to verify compliance with the Federal CCR Rule's run-on and run-off control criteria for CCR landfills. Based on the results of these calculations, the modified stormwater management systems for the undeveloped eastern portion of the landfill were also determined to be capable of managing run-on and run-off from the 25-year, 24-hour storm event. Therefore, the Petersburg Landfill has been designed, constructed, operated, and maintained with run-on and run-off controls systems that can manage the 25-year, 24-hour storm event in accordance with 40 CFR 257.81(a).

4.0 CERTIFICATION

I certify that:

- This run-on and run-off control system plan was prepared by me or under my direct supervision.
- The work was conducted in accordance with the requirements of 40 CFR 257.81(c).
- I am a registered professional engineer under the laws of the State of Indiana.

Certified By: David E. Nielson Date: October 6, 2021

Seal:

APPENDIX A: 2016 PETERSBURG LANDFILL RUN-ON & RUN-OFF CONTROL SYSTEM PLAN

ATC

ENVIRONMENTAL • GEOTECHNICAL
BUILDING SCIENCES • MATERIALS TESTING

RUN-ON AND RUN-OFF CONTROL SYSTEM PLAN

TYPE III RESTRICTED WASTE LANDFILL
IPL PETERSBURG GENERATING STATION
6925 NORTH STATE ROAD 57
PETERSBURG, INDIANA 47567

ATC PROJECT NO. 170LF00266

OCTOBER 7, 2016

PREPARED FOR:

INDIANAPOLIS POWER & LIGHT COMPANY
6925 NORTH STATE ROAD 57
PETERSBURG, INDIANA 47567
ATTENTION: MR. ERWIN A. LEIDOLF

ENVIRONMENTAL • GEOTECHNICAL
BUILDING SCIENCES • MATERIALS TESTING

October 7, 2016

Mr. Erwin A. Leidolf
Senior Scientist
Indianapolis Power & Light Company
6925 North State Road 57
Petersburg, IN 47567

ATC Group Services LLC

7988 Centerpoint Dr.
Suite 100
Indianapolis, IN 46256

Phone **+1 317 849 4990**
Fax +1 317 849 4278

www.atcgroupservices.com

Re: **Run-on and Run-off Controls System Plan**
Type III Restricted Waste Landfill
IPL Petersburg Generating Station Landfill
Petersburg, IN 47567
ATC Project No. 170LF00266

Dear Mr. Leidolf:

ATC Group Services LLC (ATC) is pleased to present the following Run-On Run-Off Control System (ROROCS) Plan for the Indianapolis Power & Light Company (IPL) Petersburg Generating Station Type III Restricted Waste Landfill located at 6925 North State Road 57, Petersburg, IN 47567.

As required by 40 CFR 257.81, the owner or operator of a coal combustion residuals (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; and
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.

Contained here within is a summary report which demonstrates that the Petersburg Landfill design measures are compliant with the CCR Rule. We appreciate the opportunity to assist you with this project. If you have any questions concerning information contained in this letter, please do not hesitate to call the undersigned at 317.849.4990.

Sincerely,
ATC Group Services LLC

Charles Dewes

Charles Dewes, E.I., CFM
Project Engineer

Donald Bryenton

Donald Bryenton, P.E.
Principal Engineer

DONALD LEE BRYENTON
REGISTERED
No 17277
STATE OF
INDIANA
PROFESSIONAL ENGINEER

David Stelzer

David Stelzer, PhD., P.E.
Senior Project Engineer

Executive Summary

The IPL Petersburg Generating Station Landfill located at 6925 North State Road 57 in Petersburg, IN 47567, received a Solid Waste Land Disposal Facility Permit from Indiana Department of Environmental Management (IDEM) in 1983. The IDEM approved plans for this facility include a number of erosion control and runoff measures to contain design storm flow. Additional grading measures prevent run-on flow from entering the site.

The CCR Rule requires that all stormwater drainage structures, including channels, culverts, pipe systems, and detention basins be designed to convey the 25-year, 24-hour storm event. This report documents that the engineering structures for run-off and run-on control have been sized appropriately.

Table of Contents

Appendices

1 Introduction

This Run-On and Run-Off Control System (ROROCS) Plan was prepared for the existing IPL Petersburg Generating Station Type III Restricted Waste Landfill in accordance with 40 CFR 257.81 (Run-on and run-off controls for CCR landfills). This ROROCS Plan documents that the facility control systems have been designed and constructed to meet the CCR Rule following specified engineering calculations for the 24-hour, 25-year design storm. This ROROCS Plan must be placed in the facility's operating record as required by 40 CFR 257.105(g)(3).

2 Regulatory Requirements

2.1 Federal CCR Rule

As required by 40 CFR 257.81, the owner or operator of a coal combustion residuals (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; and

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.

Additional requirements of the CCR Rule state that the ROROCS Plan must be updated and submitted once every five years as long as the landfill continues to be active.

The permit application reviewed and approved by IDEM includes sedimentation and erosion control systems that meet these requirements.

2.2 Preamble to the Federal CCR Rule

The preamble to the federal CCR Rule provides additional description regarding the intent of the requirements. Regarding run-off control, the following quotation from the preamble is relevant.

> *The owner or operator must design, construct, operate, and maintain the CCR landfill in such a way that any runoff generated from at least a 24-hour, 25-year storm must be collected through hydraulic structures, such as drainage ditches, toe drains, swales, or other means, and controlled so as to not adversely affect the condition of the CCR landfill. EPA has promulgated these requirements to minimize the detention time of run-off on the CCR landfill and minimize infiltration into the CCR landfill, to dissipate storm water run-off velocity, and to minimize erosion of CCR landfill slopes. An additional concern with run-off from CCR landfills is the water quality of the run-off, which may collect suspended solids from the landfill slopes.*

A description of run-on and run-off control systems is included in the following sections of this report.

3 Design Methodology

3.1 Design Storm

The 24-hour, 25-year design storm is the mandatory protection standard for run-on and run-off control systems. The 25-year design storm rainfall amount was derived from the National Oceanic and Atmospheric Administration (NOAA) Atlas 14 data for Pike County, Indiana. The storm generates approximately 5.5 inches of precipitation for this location. The rainfall hyetograph for this storm event is included in Appendix A. All run-on and run-off control systems were designed for this capacity.

3.2 Rainfall Abstractions

Losses in rainfall volume are accounted for in abstractions (losses). The SCS Method was applied to calculate the correct curve number for the land use and soil types of the site. This curve number was then applied to calculate the losses and the actual runoff. SCS equations are below:

$S = 1000/CN - 10$ [Equation 1]

$I_a = 0.2{*}S$ [Equation 2]

Where:
S = potential maximum retention after runoff begins (in.);
CN = curve number; and
I_a = initial abstraction (in.)

The initial abstraction is a function of the land use conditions as represented by the composite curve number for the tributary drainage area. For example, the initial abstraction for run-off from CCR material having a curve number of 79 is calculated as follows:

$I_a = 200/79 - 2 = 0.53$ *inches*

3.3 Runoff and Routing Methodology

The EPA SWMM program Version 5.1 was used to generate the runoff flow, velocities, and flow depths for a typical set of run-on / run-off control measures under the highest drainage area loading situation. The EPA SWMM Model was developed by the Water Supply and Water Resources Division of the U.S. Environmental Protection Agency's National Risk Management Research Laboratory with assistance from the consulting firm of CDM Inc. under a Cooperative Research and Development Agreement (CRADA). The SWMM program emulates the NRCS TR55 Model. The infiltration calculations used SCS Curve Number method. The routing procedure used was the Kinematic Wave method for Unsteady Flow following a Type II SCS Unit Hydrograph. All erosion control measures were linked to drainage channels and reservoir areas using the EPA SWMM program. The simulation results are included in Appendix C.

4 Run-On Control

4.1 Topography

The site of the Petersburg Landfill is located directly adjacent to the White River at the Pike-Knox County border. The surrounding area is mostly flat with some rolling hills to the north and east of the landfill with the landfill itself as the highest feature. The landfill is protected from run-on flow by a perimeter road on the east and also by natural drainage relief. Runoff from higher topographic peaks routes around the landfill perimeter to join the White River.

4.2 Perimeter Railroad Embankment

The landfill is surrounded by a railroad embankment on the north and west sides. The railroad embankment height varies between 5 and 10 feet above natural grade. The railroad embankment is higher than the 100-Year Elevation of the White River. This prevents run-on flow from the White River entering the landfill (see Appendix B).

5 Run-Off Control

5.1 Erosion Control Measures

A series of diversion berms exist on the sloping faces of the developed portion of the landfill to gently direct runoff flow through the conveyance system. Additional berms will be added to the perimeter slopes as the remainder of the landfill is placed in operation. These berms prevent disturbance of the CCR materials during the design storm event. Terrace berms that are approximately twenty-four (24') feet wide convey flow to riprap downchutes. Terrace berms and downchute channels have adequate height to contain the calculated flow depth of the design storm.

5.2 Flow Conveyance and Capture Measures

Flow from diversion (terrace) berms is directed into riprap downchutes which feed into the perimeter ditch system. The encircling landfill ditch system is divided into several reaches. Some reaches flow to the (existing) Northwest and West Sedimentation Basins which will handle both the interim and final cover run-off flows. The West Sedimentation Basin outlets to an NPDES outfall area. Other perimeter ditch reaches will flow to the (future development) East Sedimentation Pond which will primarily handle final cover run-off flow. Future landfill development, ash pond closures, and other activities of the IPL Petersburg Generating Station which are unforeseen at this time may influence the planning and layout of run-on and run-off control measures. This plan will continue to be updated as future development occurs.

6 Conclusions

As required by 40 CFR 257.81, the IPL Petersburg Type III Restricted Waste Landfill run-on control system is designed to prevent flow onto the active portion of the CCR unit during the peak discharge from a 24-hour, 25-year storm, and the IPL Petersburg Type III Restricted Waste Landfill run-off control system is designed to collect and control at least the water volume resulting from a 24-hour, 25-year storm.

Appendices

Appendix A: Storm Water Control Plan Overview

Appendix B: Calculations for Run-On Control System

Section 1: Run-On Control System Summary

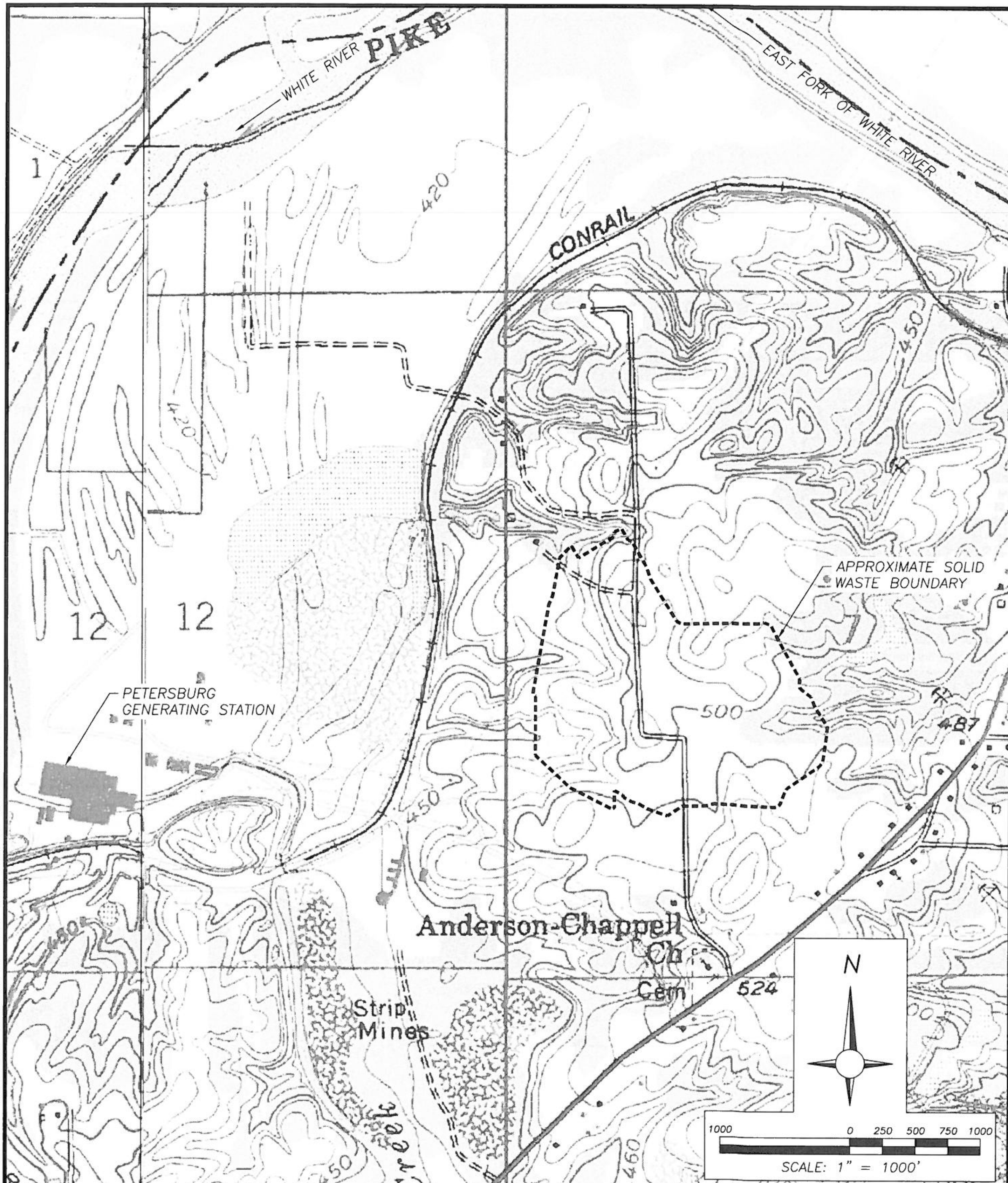
Appendix C: Calculations for Run-Off Control System

Run-Off Control System Interim and Final Cover Conditions Summary

Appendix D: References

Appendix E: Surface Water Control and Design Plan Sheets

Appendix A: Storm Water Control Plan Overview

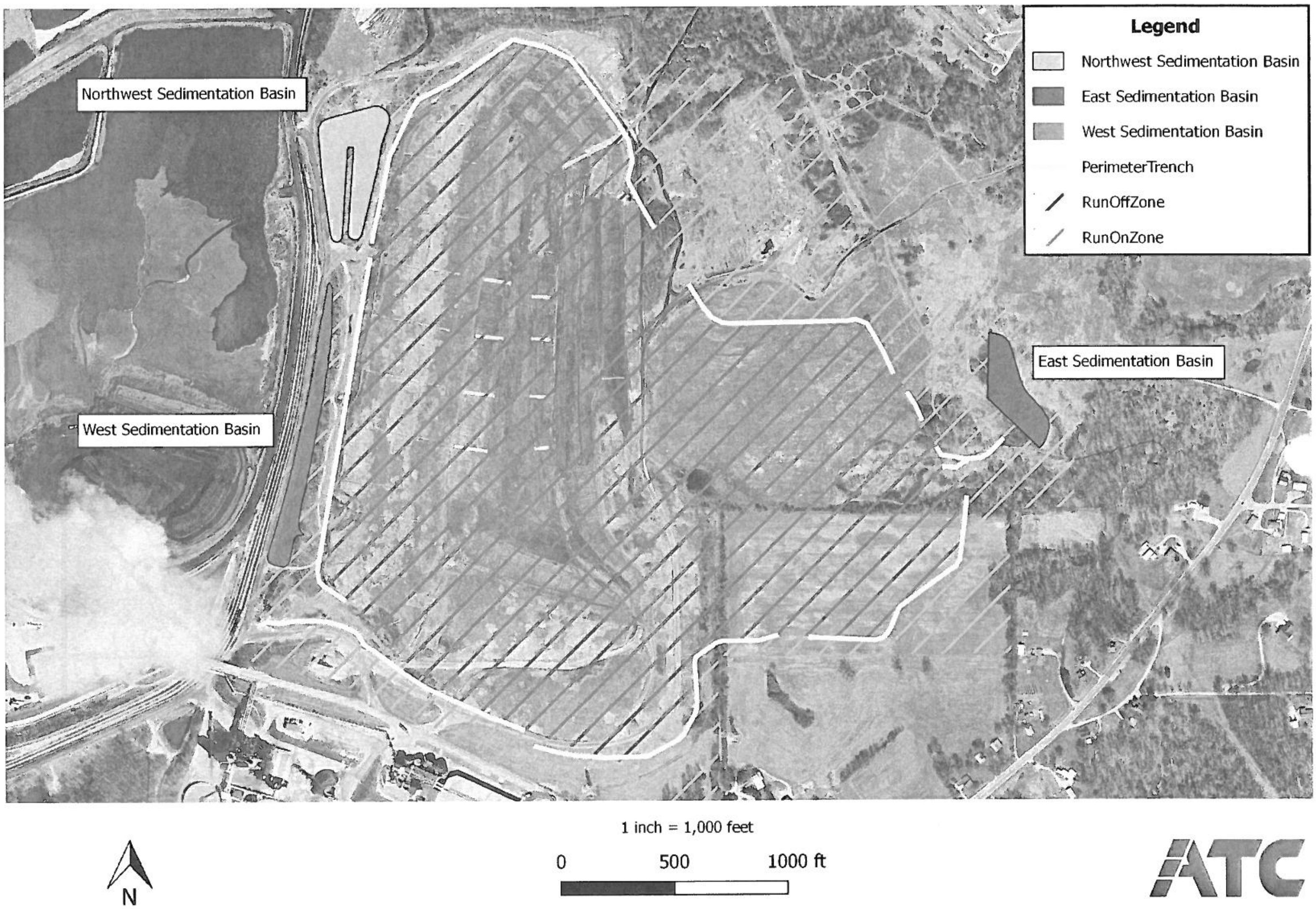


Project Number: 170LF00274		Drn. By: WS
Drawing File: SEE LOWER LEFT		Ckd. By: CD
Date: 9/16	Scale: AS SHOWN	App'd By:
ATC		Figure: 1

VICINITY MAP

IPL PETERSBURG GENERATING STATION
TYPE III RESTRICTED WASTE LANDFILL
PETERSBURG, INDIANA

H:\2016\IPL\PETERSBURG\170LF00274\CCR POST CLOSE\174LF00274-PGS-LANDFILL LIMITS.DWG, SITE


Legend
Northwest Sedimentation Basin
East Sedimentation Basin
West Sedimentation Basin
PerimeterTrench
RunOffZone
RunOnZone
Northwest Sedimentation Basin
West Sedimentation Basin
East Sedimentation Basin
1 inch = 1,000 feet
0
500
1000 ft
N

FLOW CONTROL STRUCTURE CONVEYANCE TABLE

FLOW CONTROL STRUCTURE	FLOW TYPE CONVEYED
Perimeter Channels	Run-On & Run-Off
Riprap Downchutes	Run-Off
Terrace Berms	Run-Off
Outlets to Retention Basins	Run-On & Run-Off
Retention Basins	Run-On & Run-Off

Appendix B: Calculations for Run-On Control System

Run-On Control System Summary

Run-On Control System

The objective of this calculation is to demonstrate that the perimeter stormwater controls for the IPL Petersburg Type III Restricted Waste Landfill have capacity to control run-on flow from the 24-hour, 25-year storm. According to EPA, run-on is defined as

"...Any liquid that drains over land onto any part of a CCR landfill or any lateral expansion of a CCR landfill. In surface water hydrology, run-on is a quantity of surface run-off, or excess rain, snowmelt, or other sources of water, which flows from an upstream catchment area onto a specific downstream location."

Although perimeter ditches and retention pond systems handle *both* run-on and run-off flow, the hydraulic capacities of these structures will be evaluated under this run-on section since the structures are located in the run-on producing zone of the landfill and adjoining area.

CALCULATION METHOD:

The capacity of the perimeter stormwater controls will be evaluated using the SCS method and Manning's equation.

DEFINITION OF VARIABLES

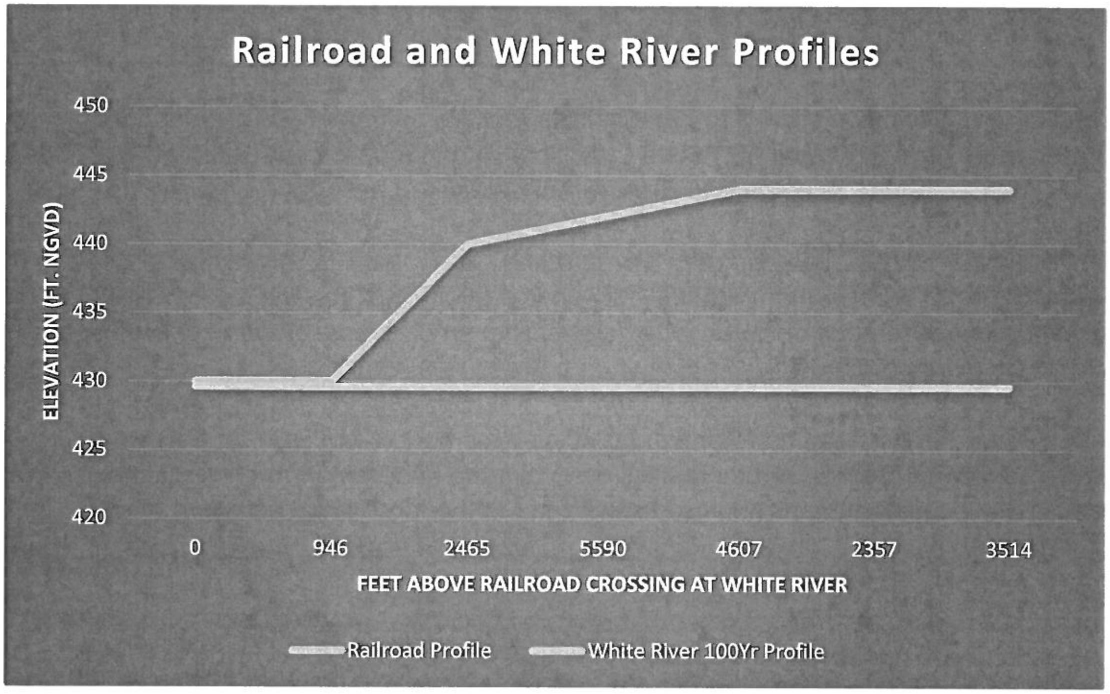
A = area;
CN = curve number;
Q = flow;
S = Channel Sideslope

CALCULATIONS

1.0 Perimeter Road

Drainage from the watersheds surrounding the Petersburg Landfill flows away from the landfill. Two principal watersheds which are UNT Lick Creek and UNT White River are shown on USGS Streamstats maps as dividing the landfill area in half with the landfill area as the highest local feature. This demonstrates that the landfill benefits from natural drainage relief and is protected from run-on flow of these smaller watersheds.

Further run-on flow protection from the larger White River watershed is provided by haul roads and the adjoining railroad embankment to the west of the landfill. The 100-year elevation of the White River was determined using Indiana Floodplain Information Portal (INFIP) as approximately 429.6 feet. A plot of the railroad embankment height versus the 100-year elevation of the White River is shown in the following figure:



At all locations along the elevation profile, the railroad embankment height is higher than the 100-year flood elevation. Therefore the landfill is insularly protected from run-on flow of the White River.

2.0 Perimeter Stormwater Channels

According to design plans perimeter ditches have 6.67'-foot channel bottoms with 3H:1V sideslopes. Perimeter ditches drain to sedimentation basins that are described in the following section.

The largest drainage area to any perimeter ditch segment was determined to be approximately 6 acres. EPA SWMM modeling results with max flow to a typical perimeter stormwater channel and capacity from manning's equation are summarized below:

EPA SWMM Max Flow (cfs)	Ditch Bottom (ft.)	Side Slope (xH:1V)	Ditch Height (ft.)	Capacity Channel (cfs)	Capacity> Max Flow?
31.64	6.67	3:1	4	394.7	YES

The ditch capacity is sufficient to handle stormwater flow from the landfill and adjacent areas.

3.0 Ponds

The combined run-on and run-off flow from the Petersburg Landfill is handled by a series of retention basins to the west of the landfill during the interim conditions. The west retention basins are the Northwest Sedimentation Basin and the West Sedimentation Basin. The Northwest Sedimentation Basin outlets to the West Sedimentation Basin before treatment and discharge to an NPDES outfall area.

For the final cover conditions an East Sedimentation Pond will add additional storage capacity. The storage volumes of individual basins were calculated and their approximate Stage-Storage curves are attached to this appendix for reference.

Combined storage available in the East, West, and Northwest Sedimentation basins is sufficient to handle the 25-year storm volume from the landfill and adjacent contributing areas during both interim and final cover conditions.

DISCUSSION:

The perimeter stormwater controls for the Petersburg Type III Restricted Waste Landfill have capacity to control both run-on and non-contact water run-off for the 24-Hour, 25-Year storm.

REFERENCES:

1. EPA SWMM v. 5.1 by Water Resources Division of the U.S. Environmental Protection Agency's National Risk Management Research Laboratory with assistance from the consulting firm of CDM, Inc.
2. StreamStats in Indiana. U.S. Geological Survey. <http://streamstats.usgs.gov/>.
3. United States Department of Agriculture, "Urban Hydrology for Small Watersheds", Technical Release 55, June 1986.
4. NOAA Atlas 14, Volume 2, Version 3. "Precipitation Frequency Data Server". G.M. Bonnin, D. Martin, B. Lin, T. Parzybok, M. Yekta, and D. Riley.
5. Indiana Floodplain Information Portal (INFIP). <http://dnrmaps.dnr.in.gov/appsphp/fdms/>.

Natural Resources Conservation Service
United States Department of Agriculture

Trapezoidal Channel Section

Participant: Indianapolis Power & Light Co.
Location: Petersburg
County: County, Indiana
Designer:
Date: 09/30/2016

Checker: C.P.D.
Date: 09/28/16

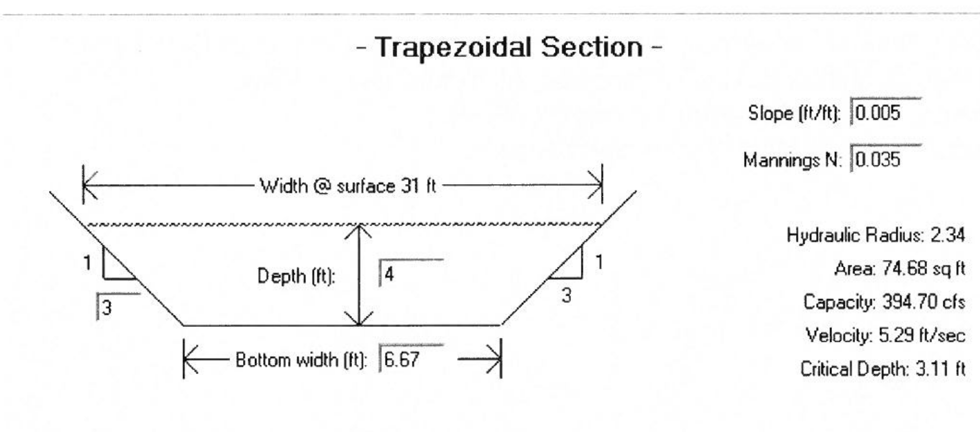
Hydraulics Formula, Version 2.2.1

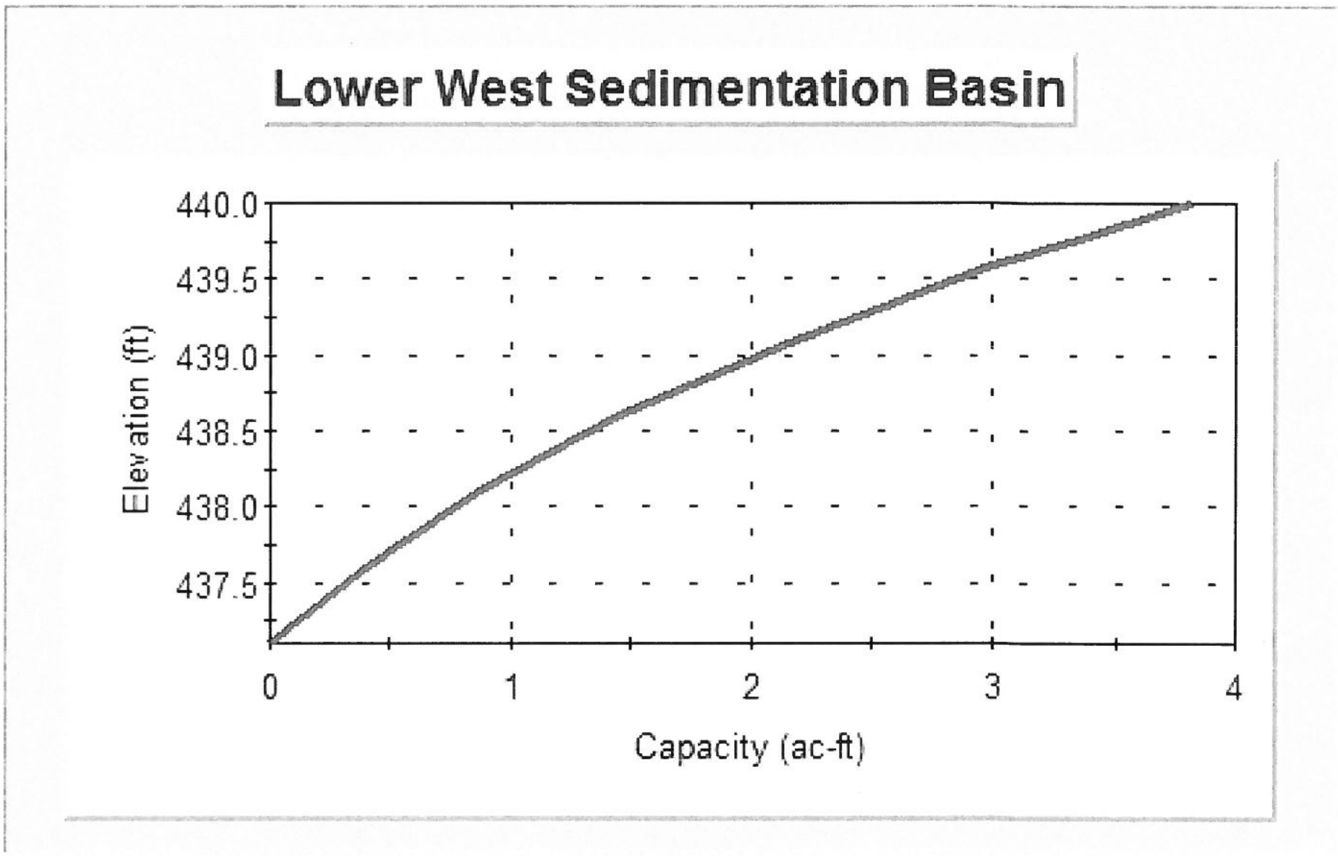
Perimeter Ditch

Slope: 0.005 ft/ft
'n' value: 0.035

Hydraulic Radius: 2.34
Area: 74.68 sq ft
Velocity: 5.29 ft/sec
Capacity: 394.70 cfs

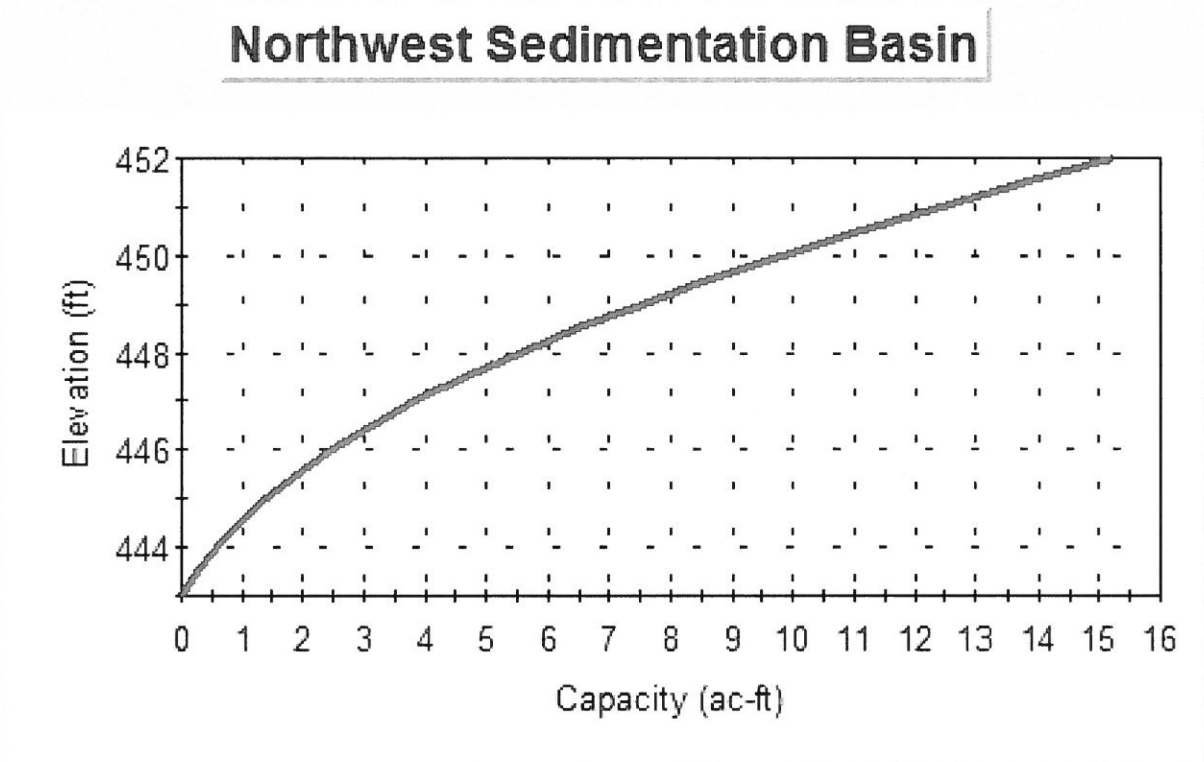
Sideslope: 3:1
Bottom Width: 6.67 ft
Depth of Flow: 4 ft.
Width @ surface 31 ft





Structure # 1

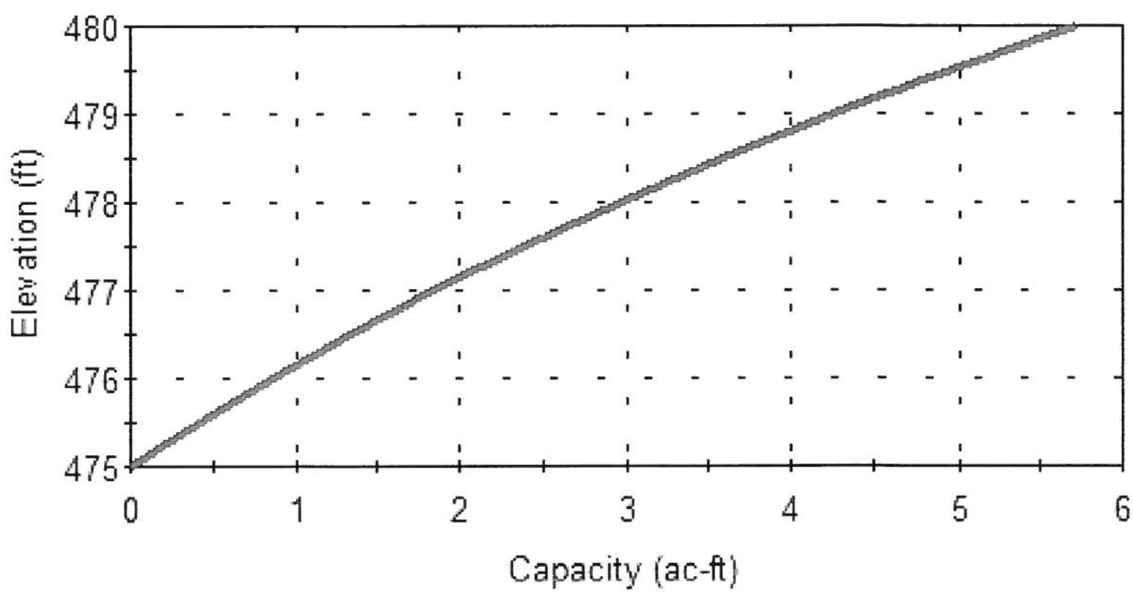
Elevation (ft)	Area (ac)	Capacity (ac-ft)
437.10	0.740	0.000
438.00	0.990	0.776
439.00	1.530	2.026
440.00	2.060	3.814



Structure # 1

Elevation (ft)	Area (ac)	Capacity (ac-ft)
443.00	0.500	0.000
444.00	0.700	0.597
445.00	0.940	1.414
446.00	1.220	2.491
447.00	1.520	3.858
448.00	1.840	5.536
449.00	2.150	7.529
450.00	2.470	9.837
451.00	2.790	12.465
452.00	2.790	15.255

East Sedimentation Basin



Structure # 1

Elevation (ft)	Area (ac)	Capacity (ac-ft)
475.00	0.820	0.000
476.00	0.910	0.865
477.00	1.050	1.844
478.00	1.210	2.973
479.00	1.370	4.262
480.00	1.540	5.716

Appendix C: Calculations for Run-Off Control System

Run-Off Control System Interim and Final Cover Conditions Summary

Run-Off Control System Interim and Final Cover Conditions Summary

The objective of this calculation is to evaluate the size of run-off control measures within the IPL Petersburg Type III Restricted Waste Landfill to provide capacity to control non-contract water run-off for the 24-Hour, 25-Year storm during interim and final cover conditions.

CALCULATION METHOD

The amount of rainfall for the 24-Hour, 25-Year storm event was taken from NOAA Atlas 14, Volume 2 [Ref. 4]. For the Petersburg, Indiana region, Atlas 14 yields a rainfall amount of approximately 5.5 inches.

Terrace-style diversion berm and riprap downchute designs were evaluated using EPA SWMM v. 5.1 modeling software [Ref. 1]. The EPA SWMM software uses the Soil Conservation Service (SCS) TR-55 [Ref. 3], Curve Number method for calculating runoff.

To demonstrate capacity of the interim and final cover storm water measures, a typical stormwater run-off control unit consisting of a downchute and adjoining terrace berms was modelled. The modelling simulation is for the stormwater run-off control unit of the Final Cover Grading Plan with the largest drainage area (highest loading condition). Deductive logic applies the calculated results from the highest loading condition to all other units with lesser loading conditions.

DEFINITION OF VARIABLES

A = area;
CN = curve number;
Q = flow;
S = Channel Sideslope

CALCULATIONS

1.0 Routing Procedure

After placement of the CCR to achieve a consistent grade across the landfill footprint, the landfill final closure area will be covered in protective soil and a vegetative layer. Several levels of terraces will be graded to act as diversion berms. Terraces will be spaced approximately sixty (60) feet apart from one another and will have a width of approximately twenty-four (24) feet. Individual terraces will convey run-off flow from the vegetated landfill cover areas to riprap downchute channels.

2.0 Hydraulic Performance of a Typical Terrace Diversion Berm

According to design plans terraces are 24 feet wide (topwidth) with 1.2-foot channel bottoms. Terrace berm channels are graded with a channel slope of 0.4% and drain to riprap downchutes.

The largest drainage area to any final cover terrace will be limited to approximately 0.6 acres. Flow to terraces of a typical stormwater run-off control unit are summarized in Table 1 below:

Table 1 – Terrace Berm Capacity

SWMM ID	Channel Slope {S}	Terrace Side Slope	Terrace Height (ft.)	Flow {Q} (cfs)	Flow Height (ft.)	Freeboard Inches
11	0.40%	3H:1V & 2%	0.5	1.5	0.21	3.48
12	0.40%	3H:1V & 2%	0.5	1.61	0.24	3.12
13	0.40%	3H:1V & 2%	0.5	1.75	0.27	2.76
14	0.40%	3H:1V & 2%	0.5	1.83	0.28	2.64
15	0.40%	3H:1V & 2%	0.5	1.9	0.29	2.52
16	0.40%	3H:1V & 2%	0.5	1.66	0.25	3
17	0.40%	3H:1V & 2%	0.5	1.61	0.23	3.24
18	0.40%	3H:1V & 2%	0.5	1.56	0.23	3.24
19	0.40%	3H:1V & 2%	0.5	1.53	0.21	3.48
20	0.40%	3H:1V & 2%	0.5	1.43	0.21	3.48
21	0.40%	3H:1V & 2%	0.5	2.16	0.3	2.4
22	0.40%	3H:1V & 2%	0.5	2.21	0.3	2.4
23	0.40%	3H:1V & 2%	0.5	2.26	0.3	2.4
24	0.40%	3H:1V & 2%	0.5	2.15	0.3	2.4
25	0.40%	3H:1V & 2%	0.5	2.41	0.31	2.28
26	0.40%	3H:1V & 2%	0.5	2.45	0.31	2.28
27	0.40%	3H:1V & 2%	0.5	2.49	0.31	2.28
28	0.40%	3H:1V & 2%	0.5	1.57	0.23	3.24
29	0.40%	3H:1V & 2%	0.5	1.45	0.2	3.6
30	0.40%	3H:1V & 2%	0.5	1.37	0.18	3.84

All terrace berms have positive freeboard indicating that sufficient design capacity exists.

3.0 Hydraulic Performance of a Typical Riprap Downchute

The trapezoidal riprap downchute channels have a 4-foot bottom width with 3H:1V sideslopes and 1 foot depth. All flows and velocities for a typical downchute under maximum loading were calculated using the EPA SWMM program [Ref. 1]. The resulting height of flow and capacity (freeboard) calculations are shown in Table 2 below:

Table 2 – Downchute Channel Capacity

SWMM ID	Channel Slope	Terrace Side Slope	Downchute Height (ft.)	Flow {Q} (cfs)	Flow Height (ft.)	Freeboard Inches
1	0.33	3H:1V	1	3.04	0.14	10.32
2	0.33	3H:1V	1	6.51	0.21	9.48
3	0.33	3H:1V	1	10.51	0.28	8.64
4	0.33	3H:1V	1	14.48	0.32	8.16
5	0.33	3H:1V	1	18.78	0.36	7.68
6	0.33	3H:1V	1	22.61	0.4	7.2
7	0.33	3H:1V	1	26.26	0.44	6.72
8	0.33	3H:1V	1	28.48	0.45	6.6
9	0.33	3H:1V	1	30.2	0.47	6.36
10	0.33	3H:1V	1	31.64	0.47	6.36

All channels have positive freeboard indicating that sufficient capacity exists.

DISCUSSION:

Run-off control measures for the IPL Petersburg Type III Restricted Waste Landfill have capacity to control non-contact water run-off for the 24-Hour, 25-Year storm event during interim and final cover conditions.

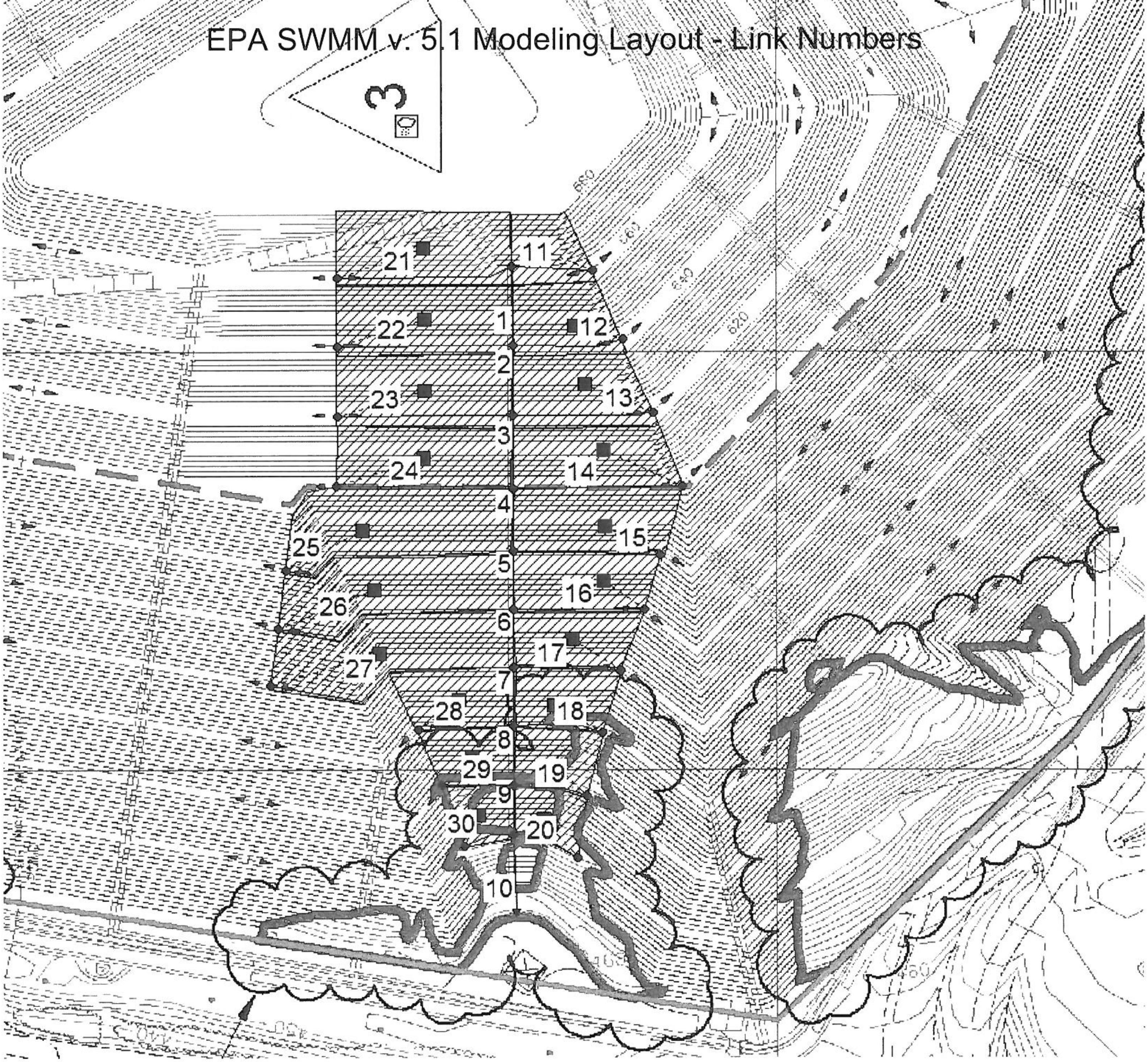
REFERENCES:

1. EPA SWMM v. 5.1 by Water Resources Division of the U.S. Environmental Protection Agency's National Risk Management Research Laboratory with assistance from the consulting firm of CDM, Inc.
2. StreamStats in Indiana. U.S. Geological Survey. <http://streamstats.usgs.gov/>.
3. United States Department of Agriculture, "Urban Hydrology for Small Watersheds", Technical Release 55, June 1986.
4. NOAA Atlas 14, Volume 2, Version 3. "Precipitation Frequency Data Server". G.M. Bonnin, D. Martin, B. Lin, T. Parzybok, M. Yekta, and D. Riley.
5. Indiana Floodplain Information Portal (INFIP). <http://dnrmaps.dnr.in.gov/appsphp/fdms/>.

Appendix D: References

REFERENCE NO.	DESCRIPTION
1	EPA SWMM Modeling
2	USGS Streamstats – Drainage Areas
3	USDA TR-55
4	NOAA Atlas 14 Rainfall
5	INFIP Report

Reference 1: EPA SWMM Modeling


EPA SWMM v. 5.1 Modeling Layout - Link Numbers
3
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30

EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.010)

IPL Petersburg Landfill - Downchute Routing Max Drainage Area 25Yr, 24Hr Storm

Element Count

Number of rain gages 1
Number of subcatchments ... 20
Number of nodes 31
Number of links 30
Number of pollutants 0
Number of land uses 0

Raingage Summary

Name	Data Source	Data Type	Recording Interval
1	25Year24Hour	CUMULATIVE	6 min.

Subcatchment Summary

Name	Area	Width	%Imperv	%Slope	Rain Gage	Outle
32	0.16	93.60	0.00	33.0000	1	3
33	0.23	131.20	0.00	33.0000	1	4
34	0.32	165.10	0.00	33.0000	1	5
35	0.34	205.30	0.00	33.0000	1	6
36	0.35	178.70	0.00	33.0000	1	7
37	0.26	156.00	0.00	33.0000	1	8
38	0.22	130.60	0.00	33.0000	1	15
39	0.20	112.50	0.00	33.0000	1	16
40	0.17	102.00	0.00	33.0000	1	20
41	0.16	78.90	0.00	33.0000	1	21
42	0.11	65.70	0.00	33.0000	1	31
43	0.15	81.50	0.00	33.0000	1	30
44	0.21	114.30	0.00	33.0000	1	29
45	0.48	306.50	0.00	33.0000	1	28
46	0.47	297.30	0.00	33.0000	1	27
47	0.46	282.70	0.00	33.0000	1	26
48	0.40	210.90	0.00	33.0000	1	25
49	0.42	209.10	0.00	33.0000	1	24
50	0.41	205.80	0.00	33.0000	1	23
51	0.40	209.70	0.00	33.0000	1	22

IPL Petersburg Landfill - Downchute Routing Max Drainage Area 25Yr, 24Hr Storm

```
************
Node Summary
************
                                              Invert      Max.    Ponded    External
Name                 Type                      Elev.     Depth      Area    Inflow
-------------------------------------------------------------------------------------
1                    JUNCTION                 660.00      1.00       0.0
3                    JUNCTION                 660.37      1.00       0.0
4                    JUNCTION                 640.52      1.00       0.0
5                    JUNCTION                 620.66      1.00       0.0
6                    JUNCTION                 600.82      1.00       0.0
7                    JUNCTION                 580.71      1.00       0.0
8                    JUNCTION                 560.62      1.00       0.0
9                    JUNCTION                 640.00      1.00       0.0
10                   JUNCTION                 620.00      1.00       0.0
11                   JUNCTION                 600.00      1.00       0.0
12                   JUNCTION                 580.00      1.00       0.0
13                   JUNCTION                 560.00      1.00       0.0
14                   JUNCTION                 540.00      1.00       0.0
15                   JUNCTION                 540.52      1.00       0.0
16                   JUNCTION                 520.45      1.00       0.0
17                   JUNCTION                 520.00      1.00       0.0
18                   JUNCTION                 500.00      1.00       0.0
19                   JUNCTION                 480.00      1.00       0.0
20                   JUNCTION                 500.41      1.00       0.0
21                   JUNCTION                 480.32      1.00       0.0
22                   JUNCTION                 660.82      1.00       0.0
23                   JUNCTION                 640.82      1.00       0.0
24                   JUNCTION                 620.84      1.00       0.0
25                   JUNCTION                 600.84      1.00       0.0
26                   JUNCTION                 581.13      1.00       0.0
27                   JUNCTION                 561.19      1.00       0.0
28                   JUNCTION                 541.23      1.00       0.0
29                   JUNCTION                 520.46      1.00       0.0
30                   JUNCTION                 500.33      1.00       0.0
31                   JUNCTION                 480.26      1.00       0.0
2                    OUTFALL                  460.00      1.00       0.0


************
Link Summary
************
Name             From Node        To Node          Type               Length    %Slope Roug
-------------------------------------------------------------------------------------------
1                1                9                CONDUIT              89.4   22.9531     0
2                9                10               CONDUIT              91.2   22.4770     0
3                10               11               CONDUIT              85.9   23.9408     0
4                11               12               CONDUIT              73.3   28.3613     0
5                12               13               CONDUIT              70.6   29.5386     0
6                13               14               CONDUIT              70.6   29.5386     0
7                14               17               CONDUIT              70.6   29.5386     0
8                17               18               CONDUIT              67.1   31.2256     0
9                18               19               CONDUIT              68.9   30.3337     0
```

10	19	2	CONDUIT	61.7	34.2650	0
11	3	1	CONDUIT	93.6	0.3953	0
12	4	9	CONDUIT	131.2	0.3963	0
13	5	10	CONDUIT	165.1	0.3998	0
14	6	11	CONDUIT	205.3	0.3994	0
15	7	12	CONDUIT	178.7	0.3973	0
16	8	13	CONDUIT	156.0	0.3974	0
17	15	14	CONDUIT	130.6	0.3982	0
18	16	17	CONDUIT	112.5	0.4000	0
19	20	18	CONDUIT	102.0	0.4020	0
20	21	19	CONDUIT	78.9	0.4056	0
21	22	1	CONDUIT	205.0	0.4000	0
22	23	9	CONDUIT	205.8	0.3984	0
23	24	10	CONDUIT	209.1	0.4017	0
24	25	11	CONDUIT	210.9	0.3983	0
25	26	12	CONDUIT	282.7	0.3997	0
26	27	13	CONDUIT	297.3	0.4003	0
27	28	14	CONDUIT	306.5	0.4013	0
28	29	17	CONDUIT	114.3	0.4025	0
29	30	18	CONDUIT	81.5	0.4049	0
30	31	19	CONDUIT	65.7	0.3957	0

****
Cross Section Summary
****

Conduit	Shape	Full Depth	Full Area	Hyd. Rad.	Max. Width	No. of Barrels	Full Flow
1	TRAPEZOIDAL	1.00	7.00	0.68	10.00	1	109.89
2	TRAPEZOIDAL	1.00	7.00	0.68	10.00	1	108.74
3	TRAPEZOIDAL	1.00	7.00	0.68	10.00	1	112.23
4	TRAPEZOIDAL	1.00	7.00	0.68	10.00	1	122.15
5	TRAPEZOIDAL	1.00	7.00	0.68	10.00	1	124.66
6	TRAPEZOIDAL	1.00	7.00	0.68	10.00	1	124.66
7	TRAPEZOIDAL	1.00	7.00	0.68	10.00	1	124.66
8	TRAPEZOIDAL	1.00	7.00	0.68	10.00	1	128.17
9	TRAPEZOIDAL	1.00	7.00	0.68	10.00	1	126.33
10	TRAPEZOIDAL	1.00	7.00	0.68	10.00	1	134.26
11	TRAPEZOIDAL	0.50	7.22	0.26	27.70	1	7.86
12	TRAPEZOIDAL	0.50	7.22	0.26	27.70	1	7.87
13	TRAPEZOIDAL	0.50	7.22	0.26	27.70	1	7.90
14	TRAPEZOIDAL	0.50	7.22	0.26	27.70	1	7.90
15	TRAPEZOIDAL	0.50	7.22	0.26	27.70	1	7.88
16	TRAPEZOIDAL	0.50	7.22	0.26	27.70	1	7.88
17	TRAPEZOIDAL	0.50	7.22	0.26	27.70	1	7.89
18	TRAPEZOIDAL	0.50	7.22	0.26	27.70	1	7.90
19	TRAPEZOIDAL	0.50	7.22	0.26	27.70	1	7.92
20	TRAPEZOIDAL	0.50	7.22	0.26	27.70	1	7.96
21	TRAPEZOIDAL	0.50	7.22	0.26	27.70	1	7.90
22	TRAPEZOIDAL	0.50	7.22	0.26	27.70	1	7.89
23	TRAPEZOIDAL	0.50	7.22	0.26	27.70	1	7.92
24	TRAPEZOIDAL	0.50	7.22	0.26	27.70	1	7.89

25	TRAPEZOIDAL	0.50	7.22	0.26	27.70	1	7.90
26	TRAPEZOIDAL	0.50	7.22	0.26	27.70	1	7.91
27	TRAPEZOIDAL	0.50	7.22	0.26	27.70	1	7.92
28	TRAPEZOIDAL	0.50	7.22	0.26	27.70	1	7.93
29	TRAPEZOIDAL	0.50	7.22	0.26	27.70	1	7.95
30	TRAPEZOIDAL	0.50	7.22	0.26	27.70	1	7.86

```
*********************************************************
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
*********************************************************

****************
Analysis Options
****************
Flow Units ............... CFS
Process Models:
  Rainfall/Runoff ........ YES
  RDII ................... NO
  Snowmelt ............... NO
  Groundwater ............ NO
  Flow Routing ........... YES
  Ponding Allowed ........ NO
  Water Quality .......... NO
Infiltration Method ...... CURVE_NUMBER
Flow Routing Method ...... KINWAVE
Starting Date ............ APR-08-2016 00:00:00
Ending Date .............. APR-09-2016 00:00:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 00:06:00
Wet Time Step ............ 00:06:00
Dry Time Step ............ 00:06:00
Routing Time Step ........ 30.00 sec


**************************        Volume         Depth
Runoff Quantity Continuity     acre-feet        inches
**************************     ---------       -------
Total Precipitation ......         2.755         5.584
Evaporation Loss .........         0.000         0.000
Infiltration Loss ........         0.888         1.801
Surface Runoff ...........         1.841         3.731
Final Storage ............         0.028         0.057
Continuity Error (%) .....        -0.096


**************************        Volume        Volume
Flow Routing Continuity        acre-feet      10^6 gal
**************************     ---------     ---------
Dry Weather Inflow .......         0.000         0.000
```

```
Wet Weather Inflow .......        1.839         0.599
Groundwater Inflow .......        0.000         0.000
RDII Inflow ..............        0.000         0.000
External Inflow ..........        0.000         0.000
External Outflow .........        1.954         0.637
Flooding Loss ............        0.007         0.002
Evaporation Loss .........        0.000         0.000
Exfiltration Loss ........        0.000         0.000
Initial Stored Volume ....        0.122         0.040
Final Stored Volume ......        0.008         0.003
Continuity Error (%) .....       -0.355


********************************
Highest Flow Instability Indexes
********************************
All links are stable.


*************************
Routing Time Step Summary
*************************
Minimum Time Step           :     30.00 sec
Average Time Step           :     30.00 sec
Maximum Time Step           :     30.00 sec
Percent in Steady State     :      0.00
Average Iterations per Step :      1.04
Percent Not Converging      :      0.00


***************************
Subcatchment Runoff Summary
***************************
```

Subcatchment	Total Precip in	Total Runon in	Total Evap in	Total Infil in	Total Runoff in	Total Runoff 10^6 gal
32	5.58	0.00	0.00	1.80	3.73	0.02
33	5.58	0.00	0.00	1.80	3.73	0.02
34	5.58	0.00	0.00	1.80	3.73	0.03
35	5.58	0.00	0.00	1.80	3.73	0.03
36	5.58	0.00	0.00	1.80	3.73	0.04
37	5.58	0.00	0.00	1.80	3.73	0.03
38	5.58	0.00	0.00	1.80	3.73	0.02
39	5.58	0.00	0.00	1.80	3.73	0.02
40	5.58	0.00	0.00	1.80	3.73	0.02
41	5.58	0.00	0.00	1.80	3.73	0.02
42	5.58	0.00	0.00	1.80	3.73	0.01
43	5.58	0.00	0.00	1.80	3.73	0.02
44	5.58	0.00	0.00	1.80	3.73	0.02
45	5.58	0.00	0.00	1.80	3.73	0.05

46	5.58	0.00	0.00	1.80	3.73	0.05
47	5.58	0.00	0.00	1.80	3.73	0.05
48	5.58	0.00	0.00	1.80	3.73	0.04
49	5.58	0.00	0.00	1.80	3.73	0.04
50	5.58	0.00	0.00	1.80	3.73	0.04
51	5.58	0.00	0.00	1.80	3.73	0.04

```
******************
Node Depth Summary
******************
```

Node	Type	Average Depth Feet	Maximum Depth Feet	Maximum HGL Feet	Time of Max Occurrence days	hr:min	Reported Max Depth Feet
1	JUNCTION	0.05	1.00	661.00	0	00:00	0.29
3	JUNCTION	0.03	0.21	660.58	0	12:00	0.21
4	JUNCTION	0.03	0.25	640.77	0	12:00	0.24
5	JUNCTION	0.04	0.28	620.94	0	12:00	0.28
6	JUNCTION	0.04	0.29	601.11	0	12:00	0.29
7	JUNCTION	0.04	0.29	581.00	0	12:00	0.29
8	JUNCTION	0.04	0.26	560.88	0	12:00	0.26
9	JUNCTION	0.05	1.00	641.00	0	00:00	0.30
10	JUNCTION	0.05	1.00	621.00	0	00:00	0.30
11	JUNCTION	0.05	1.00	601.00	0	00:00	0.31
12	JUNCTION	0.05	1.00	581.00	0	00:00	0.35
13	JUNCTION	0.05	1.00	561.00	0	00:00	0.39
14	JUNCTION	0.05	1.00	541.00	0	00:00	0.43
15	JUNCTION	0.03	0.24	540.76	0	12:00	0.24
16	JUNCTION	0.03	0.23	520.68	0	12:00	0.23
17	JUNCTION	0.04	1.00	521.00	0	00:00	0.44
18	JUNCTION	0.05	1.00	501.00	0	00:00	0.46
19	JUNCTION	0.05	1.00	481.00	0	00:00	0.46
20	JUNCTION	0.03	0.22	500.63	0	12:00	0.22
21	JUNCTION	0.03	0.21	480.53	0	12:00	0.21
22	JUNCTION	0.04	0.31	661.13	0	12:00	0.30
23	JUNCTION	0.05	0.31	641.13	0	12:00	0.31
24	JUNCTION	0.05	0.32	621.16	0	12:00	0.31
25	JUNCTION	0.04	0.31	601.15	0	12:00	0.30
26	JUNCTION	0.05	0.33	581.46	0	12:00	0.32
27	JUNCTION	0.05	0.33	561.52	0	12:00	0.32
28	JUNCTION	0.05	0.33	541.56	0	12:00	0.33
29	JUNCTION	0.03	0.24	520.70	0	12:00	0.23
30	JUNCTION	0.03	0.21	500.54	0	12:00	0.20
31	JUNCTION	0.02	0.18	480.44	0	12:00	0.18
2	OUTFALL	0.04	0.47	460.47	0	12:04	0.46

```
*******************
Node Inflow Summary
*******************
```

Node	Type	Maximum Lateral Inflow CFS	Maximum Total Inflow CFS	Time of Max Occurrence days hr:min	Lateral Inflow Volume 10^6 gal	Total Inflow Volume 10^6 gal
1	JUNCTION	0.00	3.22	0 00:00	0	0.0602
3	JUNCTION	0.94	0.94	0 12:00	0.0162	0.0162
4	JUNCTION	1.35	1.35	0 12:00	0.0233	0.0233
5	JUNCTION	1.88	1.88	0 12:00	0.0324	0.0324
6	JUNCTION	2.00	2.00	0 12:00	0.0344	0.0344
7	JUNCTION	2.06	2.06	0 12:00	0.0354	0.0354
8	JUNCTION	1.53	1.53	0 12:00	0.0263	0.0263
9	JUNCTION	0.00	6.51	0 12:03	0	0.129
10	JUNCTION	0.00	10.52	0 12:03	0	0.208
11	JUNCTION	0.00	14.49	0 12:03	0	0.288
12	JUNCTION	0.00	18.77	0 12:04	0	0.375
13	JUNCTION	0.00	22.61	0 12:04	0	0.454
14	JUNCTION	0.00	26.27	0 12:04	0	0.529
15	JUNCTION	1.29	1.29	0 12:00	0.0223	0.0223
16	JUNCTION	1.18	1.18	0 12:00	0.0202	0.0202
17	JUNCTION	0.00	28.48	0 12:04	0	0.573
18	JUNCTION	0.00	30.20	0 12:04	0	0.608
19	JUNCTION	0.00	31.64	0 12:04	0	0.637
20	JUNCTION	1.00	1.00	0 12:00	0.0172	0.0172
21	JUNCTION	0.94	0.94	0 12:00	0.0162	0.0162
22	JUNCTION	2.35	2.35	0 12:00	0.0405	0.0405
23	JUNCTION	2.41	2.41	0 12:00	0.0415	0.0415
24	JUNCTION	2.47	2.47	0 12:00	0.0425	0.0425
25	JUNCTION	2.35	2.35	0 12:00	0.0405	0.0405
26	JUNCTION	2.70	2.70	0 12:00	0.0466	0.0466
27	JUNCTION	2.76	2.76	0 12:00	0.0476	0.0476
28	JUNCTION	2.82	2.82	0 12:00	0.0486	0.0486
29	JUNCTION	1.23	1.23	0 12:00	0.0213	0.0213
30	JUNCTION	0.88	0.88	0 12:00	0.0152	0.0152
31	JUNCTION	0.65	0.65	0 12:00	0.0111	0.0111
2	OUTFALL	0.00	31.64	0 12:04	0	0.637

****
Node Surcharge Summary
****

Surcharging occurs when water rises above the top of the highest conduit.

Node	Type	Hours Surcharged	Max. Height Above Crown Feet	Min. Depth Below Rim Feet
1	JUNCTION	24.00	1.000	0.000
3	JUNCTION	24.00	0.214	0.786
4	JUNCTION	24.00	0.248	0.752

5	JUNCTION	24.00	0.283	0.717
6	JUNCTION	24.00	0.290	0.710
7	JUNCTION	24.00	0.294	0.706
8	JUNCTION	24.00	0.261	0.739
9	JUNCTION	24.00	1.000	0.000
10	JUNCTION	24.00	1.000	0.000
11	JUNCTION	24.00	1.000	0.000
12	JUNCTION	24.00	1.000	0.000
13	JUNCTION	24.00	1.000	0.000
14	JUNCTION	24.00	1.000	0.000
15	JUNCTION	24.00	0.244	0.756
16	JUNCTION	24.00	0.234	0.766
17	JUNCTION	24.00	1.000	0.000
18	JUNCTION	24.00	1.000	0.000
19	JUNCTION	24.00	1.000	0.000
20	JUNCTION	24.00	0.219	0.781
21	JUNCTION	24.00	0.213	0.787
22	JUNCTION	24.00	0.310	0.690
23	JUNCTION	24.00	0.313	0.687
24	JUNCTION	24.00	0.315	0.685
25	JUNCTION	24.00	0.310	0.690
26	JUNCTION	24.00	0.327	0.673
27	JUNCTION	24.00	0.330	0.670
28	JUNCTION	24.00	0.333	0.667
29	JUNCTION	24.00	0.238	0.762
30	JUNCTION	24.00	0.208	0.792
31	JUNCTION	24.00	0.183	0.817

****
Node Flooding Summary
****

Flooding refers to all water that overflows a node, whether it ponds or not.

Node	Hours Flooded	Maximum Rate CFS	Time of Max Occurrence days hr:min	Total Flood Volume 10^6 gal	Maximum Ponded Volume 1000 ft3
1	0.01	0.50	0 00:00	0.000	0.000
9	0.01	1.00	0 00:00	0.000	0.000
10	0.01	1.00	0 00:00	0.000	0.000
11	0.01	1.00	0 00:00	0.000	0.000
12	0.01	1.00	0 00:00	0.000	0.000
13	0.01	1.00	0 00:00	0.000	0.000
14	0.01	1.00	0 00:00	0.000	0.000
17	0.01	1.00	0 00:00	0.000	0.000
18	0.01	1.00	0 00:00	0.000	0.000
19	0.01	1.00	0 00:00	0.000	0.000

****

Outfall Loading Summary
****

Outfall Node	Flow Freq Pcnt	Avg Flow CFS	Max Flow CFS	Total Volume 10^6 gal
2	85.38	1.15	31.64	0.637
System	85.38	1.15	31.64	0.637

****
Link Flow Summary
****

Link	Type	Maximum |Flow| CFS	Time of Max Occurrence days	hr:min	Maximum |Veloc| ft/sec	Max/ Full Flow	Max/ Full Depth
1	CONDUIT	3.04	0	12:03	5.40	0.03	0.14
2	CONDUIT	6.51	0	12:03	6.55	0.06	0.21
3	CONDUIT	10.51	0	12:03	7.86	0.09	0.28
4	CONDUIT	14.48	0	12:04	9.24	0.12	0.32
5	CONDUIT	18.78	0	12:04	10.18	0.15	0.36
6	CONDUIT	22.61	0	12:04	10.80	0.18	0.40
7	CONDUIT	26.26	0	12:04	11.31	0.21	0.44
8	CONDUIT	28.48	0	12:04	11.82	0.22	0.45
9	CONDUIT	30.20	0	12:04	11.92	0.24	0.47
10	CONDUIT	31.64	0	12:04	12.61	0.24	0.47
11	CONDUIT	1.50	0	00:00	2.50	0.19	0.42
12	CONDUIT	1.61	0	00:00	2.55	0.20	0.48
13	CONDUIT	1.75	0	12:03	2.59	0.22	0.55
14	CONDUIT	1.83	0	12:04	2.61	0.23	0.56
15	CONDUIT	1.90	0	12:03	2.60	0.24	0.57
16	CONDUIT	1.66	0	00:00	2.58	0.21	0.50
17	CONDUIT	1.61	0	00:00	2.56	0.20	0.47
18	CONDUIT	1.56	0	00:00	2.54	0.20	0.46
19	CONDUIT	1.53	0	00:00	2.53	0.19	0.43
20	CONDUIT	1.43	0	00:00	2.49	0.18	0.42
21	CONDUIT	2.16	0	12:03	2.62	0.27	0.60
22	CONDUIT	2.21	0	12:03	2.61	0.28	0.60
23	CONDUIT	2.26	0	12:03	2.62	0.29	0.61
24	CONDUIT	2.15	0	12:04	2.61	0.27	0.60
25	CONDUIT	2.41	0	12:04	2.64	0.30	0.62
26	CONDUIT	2.45	0	12:05	2.65	0.31	0.62
27	CONDUIT	2.49	0	12:05	2.65	0.31	0.63
28	CONDUIT	1.57	0	00:00	2.55	0.20	0.46
29	CONDUIT	1.45	0	00:00	2.49	0.18	0.41
30	CONDUIT	1.37	0	00:00	2.43	0.17	0.36

```
*************************
Conduit Surcharge Summary
*************************

No conduits were surcharged.


Analysis begun on:  Wed Sep 28 14:38:59 2016
Analysis ended on:  Wed Sep 28 14:38:59 2016
Total elapsed time: < 1 sec
```

IPL Petersburg Landfill - Downchute Routing Max Drainage Area 25Yr, 24Hr Storm

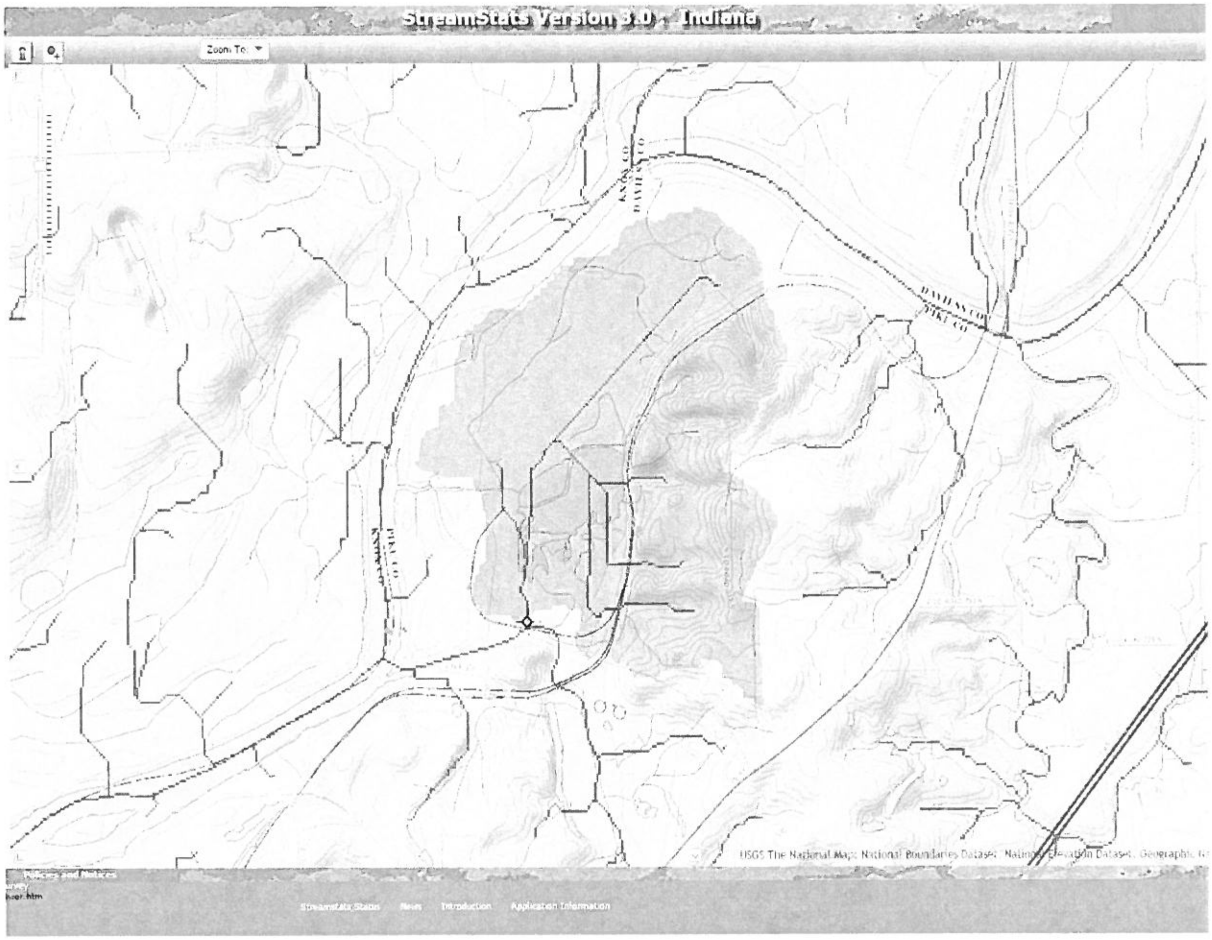
Link Flow Summary

Link	Type	Maximum |Flow| CFS	Day of Maximum Flow	Hour of Maximum Flow	Maximum |Velocity| ft/sec	Max / Full Flow	Max / Full Depth
1	CONDUIT	3.04	0	12:03	5.40	0.03	0.14
2	CONDUIT	6.51	0	12:03	6.55	0.06	0.21
3	CONDUIT	10.51	0	12:03	7.86	0.09	0.28
4	CONDUIT	14.48	0	12:04	9.24	0.12	0.32
5	CONDUIT	18.78	0	12:04	10.18	0.15	0.36
6	CONDUIT	22.61	0	12:04	10.80	0.18	0.40
7	CONDUIT	26.26	0	12:04	11.31	0.21	0.44
8	CONDUIT	28.48	0	12:04	11.82	0.22	0.45
9	CONDUIT	30.20	0	12:04	11.92	0.24	0.47
10	CONDUIT	31.64	0	12:04	12.61	0.24	0.47
11	CONDUIT	1.50	0	00:00	2.50	0.19	0.42
12	CONDUIT	1.61	0	00:00	2.55	0.20	0.48
13	CONDUIT	1.75	0	12:03	2.59	0.22	0.55
14	CONDUIT	1.83	0	12:04	2.61	0.23	0.56

IPL Petersburg Landfill - Downchute Routing Max Drainage Area 25Yr, 24Hr Storm

Link	Type	Maximum |Flow| CFS	Day of Maximum Flow	Hour of Maximum Flow	Maximum |Velocity| ft/sec	Max / Full Flow	Max / Full Depth
15	CONDUIT	1.90	0	12:03	2.60	0.24	0.57
16	CONDUIT	1.66	0	00:00	2.58	0.21	0.50
17	CONDUIT	1.61	0	00:00	2.56	0.20	0.47
18	CONDUIT	1.56	0	00:00	2.54	0.20	0.46
19	CONDUIT	1.53	0	00:00	2.53	0.19	0.43
20	CONDUIT	1.43	0	00:00	2.49	0.18	0.42
21	CONDUIT	2.16	0	12:03	2.62	0.27	0.60
22	CONDUIT	2.21	0	12:03	2.61	0.28	0.60
23	CONDUIT	2.26	0	12:03	2.62	0.29	0.61
24	CONDUIT	2.15	0	12:04	2.61	0.27	0.60
25	CONDUIT	2.41	0	12:04	2.64	0.30	0.62
26	CONDUIT	2.45	0	12:05	2.65	0.31	0.62
27	CONDUIT	2.49	0	12:05	2.65	0.31	0.63
28	CONDUIT	1.57	0	00:00	2.55	0.20	0.46
29	CONDUIT	1.45	0	00:00	2.49	0.18	0.41
30	CONDUIT	1.37	0	00:00	2.43	0.17	0.36

Reference 2: USGS Streamstats Drainage Areas



StreamStats Version 3.0 - Indiana
Zoom To
KNOX CO
DAVIESS CO
DAVIESS CO
PIKE CO
PIKE CO
KNOX CO
USGS The National Map: National Boundaries Dataset, National Elevation Dataset, Geographic
Policies and Notices
StreamStats Status
News
Introduction
Application Information


StreamStats Version 3.0 : Indiana
Zoom To:
KNOX CO
DAVIESS CO
PIKE CO
USGS The National Map: National Boundaries Dataset, National Elev
Streamstats Status
News
Introduction
Application Information

Reference 3: USDA TR-55 Calculations

USDA

United States
Department of
Agriculture

Natural Resources Conservation Service

Conservation Engineering Division

Technical
Release 55

June 1986

Urban Hydrology for Small Watersheds

TR-55

Chapter 2 Estimating Runoff

SCS runoff curve number method

The SCS Runoff Curve Number (CN) method is described in detail in NEH-4 (SCS 1985). The SCS runoff equation is

$$Q = \frac{\left(P - I_a\right)^2}{\left(P - I_a\right) + S} \qquad \text{[eq. 2-1]}$$

where

Q = runoff (in)
P = rainfall (in)
S = potential maximum retention after runoff begins (in) and
I_a = initial abstraction (in)

Initial abstraction (I_a) is all losses before runoff begins. It includes water retained in surface depressions, water intercepted by vegetation, evaporation, and infiltration. I_a is highly variable but generally is correlated with soil and cover parameters. Through studies of many small agricultural watersheds, I_a was found to be approximated by the following empirical equation:

$$I_a = 0.2S \qquad \text{[eq. 2-2]}$$

By removing I_a as an independent parameter, this approximation allows use of a combination of S and P to produce a unique runoff amount. Substituting equation 2-2 into equation 2-1 gives:

$$Q = \frac{(P - 0.2S)^2}{(P + 0.8S)} \qquad \text{[eq. 2-3]}$$

S is related to the soil and cover conditions of the watershed through the CN. CN has a range of 0 to 100, and S is related to CN by:

$$S = \frac{1000}{CN} - 10 \qquad \text{[eq. 2-4]}$$

Figure 2-1 and table 2-1 solve equations 2-3 and 2-4 for a range of CN's and rainfall.

Factors considered in determining runoff curve numbers

The major factors that determine CN are the hydrologic soil group (HSG), cover type, treatment, hydrologic condition, and antecedent runoff condition (ARC). Another factor considered is whether impervious areas outlet directly to the drainage system (connected) or whether the flow spreads over pervious areas before entering the drainage system (unconnected). Figure 2-2 is provided to aid in selecting the appropriate figure or table for determining curve numbers.

CN's in table 2-2 (*a* to *d*) represent average antecedent runoff condition for urban, cultivated agricultural, other agricultural, and arid and semiarid rangeland uses. Table 2-2 assumes impervious areas are directly connected. The following sections explain how to determine CN's and how to modify them for urban conditions.

Hydrologic soil groups

Infiltration rates of soils vary widely and are affected by subsurface permeability as well as surface intake rates. Soils are classified into four HSG's (A, B, C, and D) according to their minimum infiltration rate, which is obtained for bare soil after prolonged wetting. Appendix A defines the four groups and provides a list of most of the soils in the United States and their group classification. The soils in the area of interest may be identified from a soil survey report, which can be obtained from local SCS offices or soil and water conservation district offices.

Most urban areas are only partially covered by impervious surfaces: the soil remains an important factor in runoff estimates. Urbanization has a greater effect on runoff in watersheds with soils having high infiltration rates (sands and gravels) than in watersheds predominantly of silts and clays, which generally have low infiltration rates.

Any disturbance of a soil profile can significantly change its infiltration characteristics. With urbanization, native soil profiles may be mixed or removed or fill material from other areas may be introduced. Therefore, a method based on soil texture is given in appendix A for determining the HSG classification for disturbed soils.

Manning's equation is:

$$V = \frac{1.49 r^{\frac{2}{3}} s^{\frac{1}{2}}}{n} \qquad \text{[eq. 3-4]}$$

where:

V = average velocity (ft/s)
r = hydraulic radius (ft) and is equal to a/p_w
a = cross sectional flow area (ft^2)
p_w = wetted perimeter (ft)
s = slope of the hydraulic grade line (channel slope, ft/ft)
n = Manning's roughness coefficient for open channel flow.

Manning's n values for open channel flow can be obtained from standard textbooks such as Chow (1959) or Linsley et al. (1982). After average velocity is computed using equation 3-4, T_t for the channel segment can be estimated using equation 3-1.

Reservoirs or lakes

Sometimes it is necessary to estimate the velocity of flow through a reservoir or lake at the outlet of a watershed. This travel time is normally very small and can be assumed as zero.

Limitations

- Manning's kinematic solution should not be used for sheet flow longer than 300 feet. Equation 3-3 was developed for use with the four standard rainfall intensity-duration relationships.

- In watersheds with storm sewers, carefully identify the appropriate hydraulic flow path to estimate T_c. Storm sewers generally handle only a small portion of a large event. The rest of the peak flow travels by streets, lawns, and so on, to the outlet. Consult a standard hydraulics textbook to determine average velocity in pipes for either pressure or nonpressure flow.

- The minimum T_c used in TR-55 is 0.1 hour.

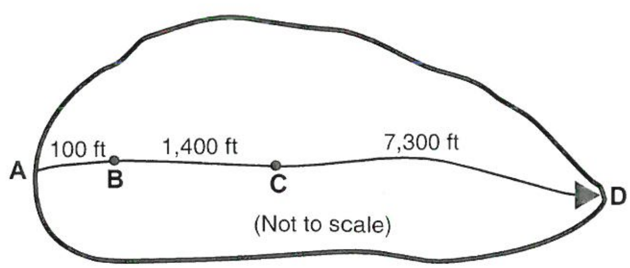
- A culvert or bridge can act as a reservoir outlet if there is significant storage behind it. The procedures in TR-55 can be used to determine the peak flow upstream of the culvert. Detailed storage routing procedures should be used to determine the outflow through the culvert.

Example 3-1

The sketch below shows a watershed in Dyer County, northwestern Tennessee. The problem is to compute T_c at the outlet of the watershed (point D). The 2-year 24-hour rainfall depth is 3.6 inches. All three types of flow occur from the hydraulically most distant point (A) to the point of interest (D). To compute T_c, first determine T_t for each segment from the following information:

Segment AB: Sheet flow; dense grass; slope (s) = 0.01 ft/ft; and length (L) = 100 ft. Segment BC: Shallow concentrated flow; unpaved; s = 0.01 ft/ft; and L = 1,400 ft. Segment CD: Channel flow; Manning's n = .05; flow area (a) = 27 ft^2; wetted perimeter (p_w) = 28.2 ft; s = 0.005 ft/ft; and L = 7,300 ft.

See figure 3-2 for the computations made on worksheet 3.



Reference 4: NOAA Atlas 14 Rainfall

NOAA Atlas 14, Volume 2, Version 3
Location name: Petersburg, Indiana, USA*
Latitude: 38.5303°, Longitude: -87.2396°
Elevation: 561.3 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

G.M. Bonnin, D. Martin, B. Lin, T. Parzybok, M.Yekta, and D. Riley

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	**0.394** (0.362-0.431)	**0.467** (0.429-0.511)	**0.554** (0.509-0.606)	**0.624** (0.570-0.681)	**0.713** (0.649-0.777)	**0.783** (0.710-0.852)	**0.851** (0.768-0.926)	**0.923** (0.827-1.00)	**1.02** (0.906-1.11)	**1.09** (0.964-1.19)
10-min	**0.613** (0.563-0.669)	**0.729** (0.670-0.798)	**0.861** (0.791-0.941)	**0.963** (0.880-1.05)	**1.09** (0.993-1.19)	**1.19** (1.08-1.29)	**1.28** (1.16-1.39)	**1.38** (1.24-1.50)	**1.50** (1.33-1.63)	**1.59** (1.40-1.73)
15-min	**0.751** (0.690-0.820)	**0.891** (0.819-0.976)	**1.06** (0.971-1.16)	**1.19** (1.08-1.29)	**1.35** (1.23-1.47)	**1.47** (1.33-1.60)	**1.59** (1.44-1.73)	**1.71** (1.54-1.86)	**1.87** (1.66-2.03)	**1.98** (1.75-2.16)
30-min	**0.993** (0.913-1.08)	**1.19** (1.10-1.31)	**1.45** (1.33-1.58)	**1.65** (1.50-1.79)	**1.90** (1.73-2.07)	**2.10** (1.90-2.29)	**2.30** (2.07-2.50)	**2.50** (2.24-2.72)	**2.77** (2.46-3.01)	**2.97** (2.63-3.24)
60-min	**1.21** (1.11-1.32)	**1.46** (1.34-1.60)	**1.82** (1.67-1.99)	**2.09** (1.91-2.28)	**2.47** (2.25-2.69)	**2.77** (2.51-3.01)	**3.07** (2.77-3.34)	**3.39** (3.04-3.69)	**3.83** (3.40-4.17)	**4.18** (3.69-4.55)
2-hr	**1.45** (1.32-1.58)	**1.75** (1.60-1.92)	**2.20** (2.01-2.40)	**2.55** (2.33-2.78)	**3.04** (2.76-3.31)	**3.44** (3.10-3.74)	**3.85** (3.46-4.19)	**4.29** (3.84-4.67)	**4.90** (4.35-5.33)	**5.38** (4.75-5.86)
3-hr	**1.54** (1.42-1.68)	**1.86** (1.71-2.04)	**2.34** (2.14-2.55)	**2.73** (2.49-2.97)	**3.27** (2.97-3.56)	**3.72** (3.36-4.04)	**4.19** (3.77-4.55)	**4.69** (4.19-5.09)	**5.40** (4.78-5.85)	**5.98** (5.25-6.48)
6-hr	**1.87** (1.72-2.05)	**2.25** (2.07-2.47)	**2.82** (2.58-3.09)	**3.28** (3.00-3.59)	**3.94** (3.58-4.30)	**4.48** (4.05-4.88)	**5.05** (4.54-5.50)	**5.66** (5.05-6.15)	**6.52** (5.76-7.09)	**7.22** (6.32-7.85)
12-hr	**2.21** (2.04-2.42)	**2.67** (2.45-2.92)	**3.31** (3.04-3.62)	**3.84** (3.51-4.18)	**4.58** (4.17-4.98)	**5.18** (4.71-5.63)	**5.81** (5.26-6.31)	**6.48** (5.83-7.04)	**7.42** (6.61-8.06)	**8.17** (7.23-8.88)
24-hr	**2.63** (2.46-2.83)	**3.17** (2.96-3.40)	**3.95** (3.68-4.24)	**4.58** (4.26-4.92)	**5.49** (5.05-5.93)	**6.24** (5.68-6.79)	**7.04** (6.32-7.73)	**7.89** (6.98-8.78)	**9.12** (7.86-10.4)	**10.1** (8.54-11.7)
2-day	**3.14** (2.93-3.37)	**3.77** (3.51-4.05)	**4.66** (4.33-5.01)	**5.39** (4.99-5.81)	**6.43** (5.88-7.00)	**7.29** (6.60-8.00)	**8.20** (7.32-9.13)	**9.18** (8.04-10.4)	**10.6** (9.02-12.3)	**11.7** (9.77-14.0)
3-day	**3.36** (3.13-3.60)	**4.03** (3.75-4.33)	**4.97** (4.62-5.35)	**5.75** (5.33-6.20)	**6.85** (6.27-7.45)	**7.76** (7.03-8.51)	**8.72** (7.79-9.70)	**9.75** (8.56-11.0)	**11.2** (9.60-13.0)	**12.4** (10.4-14.7)
4-day	**3.58** (3.33-3.84)	**4.29** (4.00-4.61)	**5.29** (4.92-5.69)	**6.11** (5.66-6.59)	**7.28** (6.67-7.91)	**8.23** (7.47-9.03)	**9.25** (8.27-10.3)	**10.3** (9.09-11.6)	**11.9** (10.2-13.7)	**13.1** (11.0-15.5)
7-day	**4.18** (3.90-4.48)	**5.00** (4.67-5.37)	**6.14** (5.70-6.61)	**7.06** (6.53-7.64)	**8.37** (7.65-9.13)	**9.44** (8.54-10.4)	**10.6** (9.44-11.8)	**11.8** (10.3-13.4)	**13.5** (11.5-15.8)	**14.9** (12.4-17.8)
10-day	**4.73** (4.43-5.07)	**5.66** (5.30-6.07)	**6.93** (6.46-7.45)	**7.96** (7.38-8.59)	**9.40** (8.62-10.2)	**10.6** (9.59-11.6)	**11.8** (10.6-13.1)	**13.1** (11.5-14.8)	**14.9** (12.8-17.3)	**16.4** (13.8-19.5)
20-day	**6.51** (6.12-6.92)	**7.74** (7.28-8.24)	**9.28** (8.70-9.89)	**10.5** (9.79-11.2)	**12.2** (11.3-13.1)	**13.4** (12.3-14.6)	**14.8** (13.4-16.2)	**16.1** (14.4-17.9)	**17.9** (15.8-20.4)	**19.3** (16.8-22.4)
30-day	**8.02** (7.57-8.49)	**9.47** (8.95-10.0)	**11.2** (10.5-11.9)	**12.5** (11.7-13.3)	**14.3** (13.3-15.3)	**15.7** (14.5-16.9)	**17.0** (15.6-18.6)	**18.4** (16.7-20.3)	**20.2** (18.0-22.8)	**21.6** (19.0-24.8)
45-day	**10.1** (9.54-10.7)	**11.9** (11.2-12.6)	**13.9** (13.1-14.7)	**15.5** (14.5-16.4)	**17.5** (16.4-18.7)	**19.1** (17.7-20.5)	**20.6** (19.0-22.4)	**22.2** (20.2-24.3)	**24.2** (21.7-26.9)	**25.7** (22.8-29.1)
60-day	**12.0** (11.4-12.7)	**14.1** (13.4-14.9)	**16.5** (15.6-17.4)	**18.2** (17.2-19.3)	**20.5** (19.2-21.8)	**22.3** (20.7-23.8)	**23.9** (22.1-25.8)	**25.6** (23.4-27.9)	**27.7** (25.0-30.6)	**29.2** (26.1-32.7)

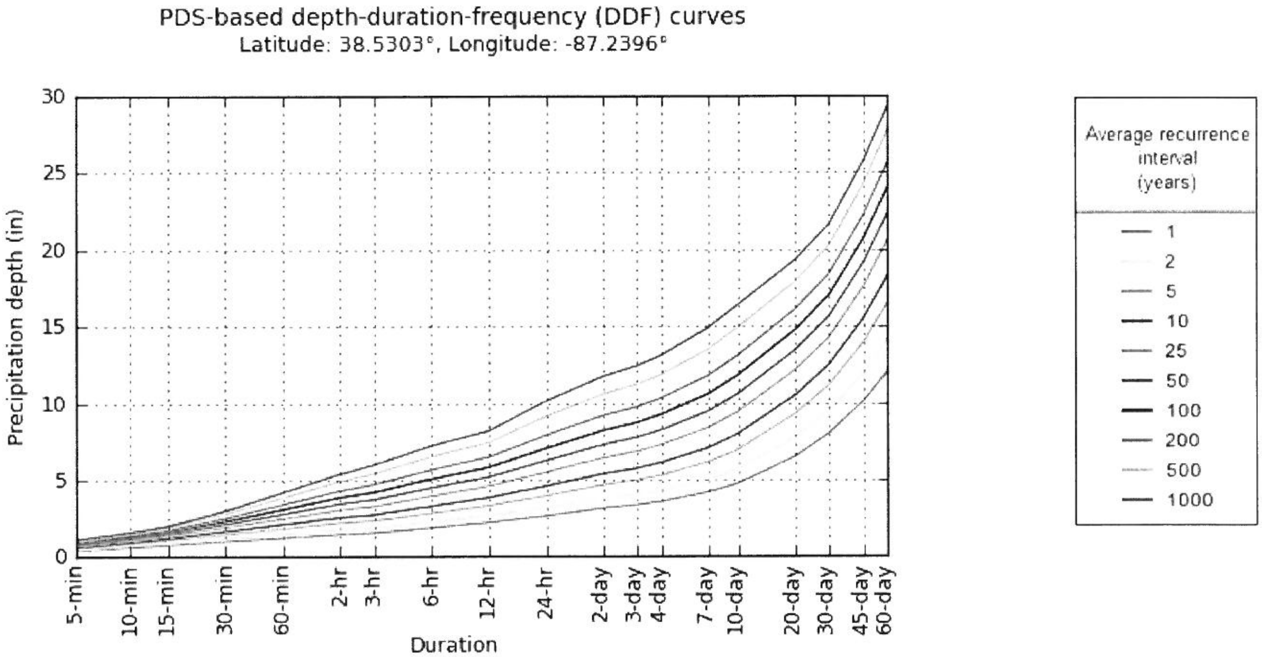
[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

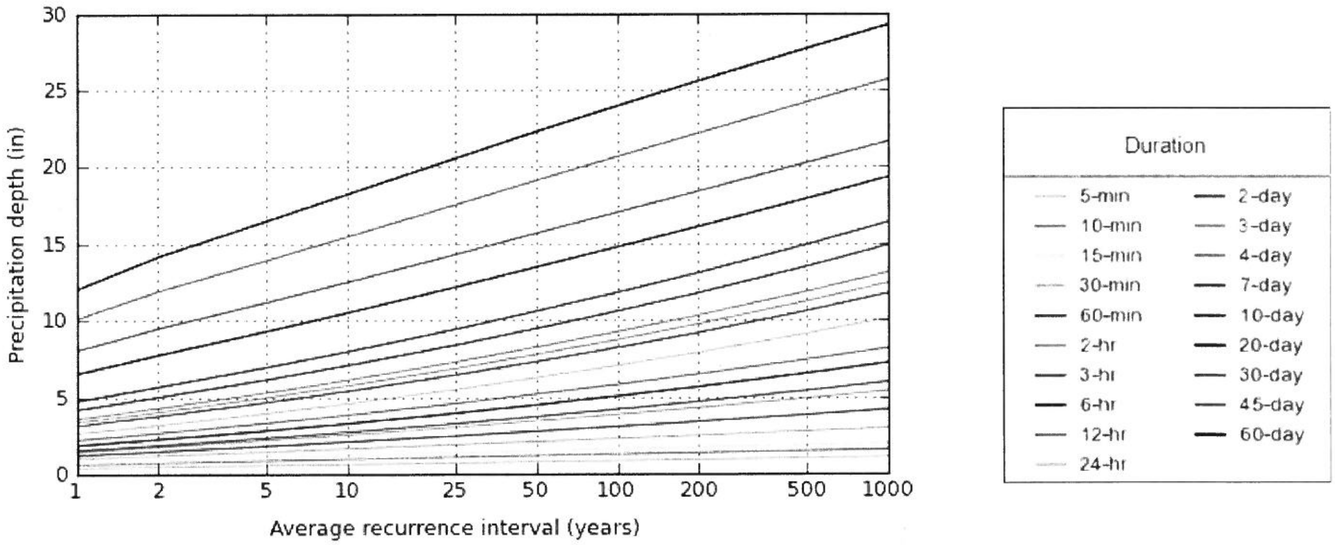
Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper 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.

Back to Top

PF graphical



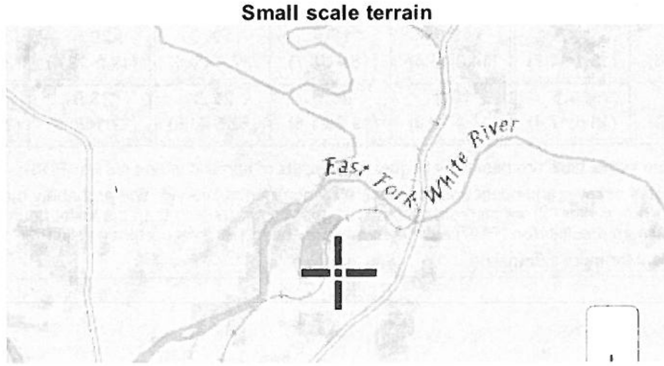


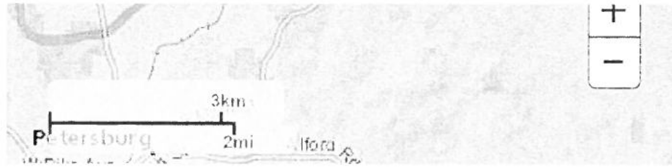
NOAA Atlas 14, Volume 2, Version 3 Created (GMT): Wed Sep 28 19:33:34 2016

Back to Top

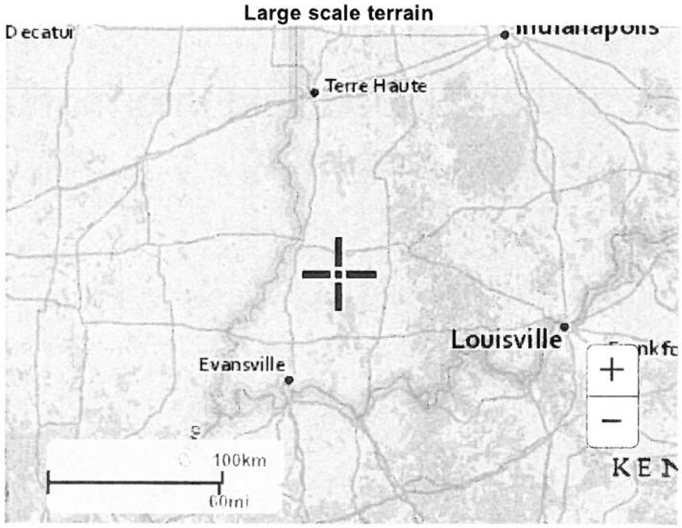
Maps & aerials

Small scale terrain

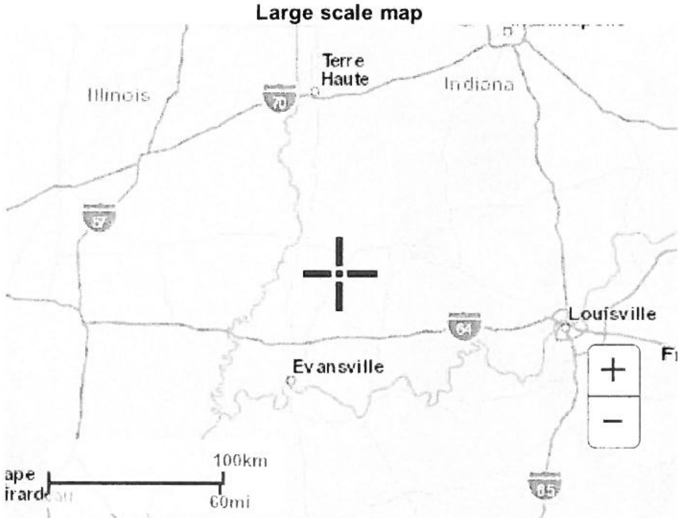




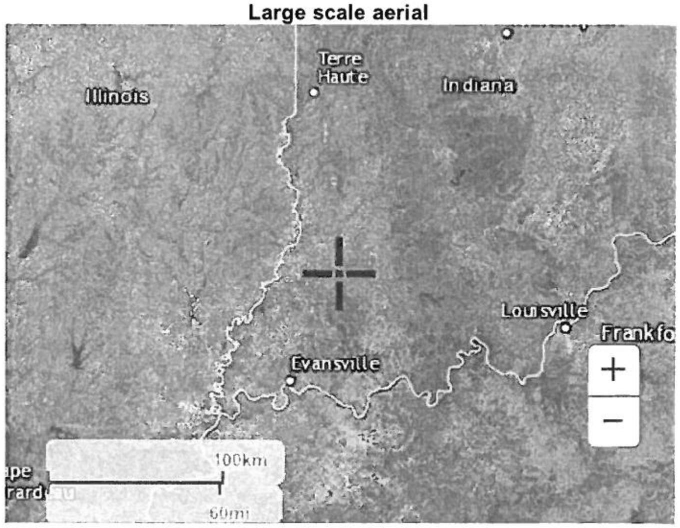
Large scale terrain



Large scale map



Large scale aerial



Back to Top

Reference 5: Indiana Floodplain Information Portal (INFIP) Report

DNR

Indiana Floodplain Information Portal Report

Point of Interest

Effective Flood Zone:
A
Preliminary Flood Zone:
N/A
Best Available Flood Zone:
A
Approximate Flood Elevation:
429.6ft NAVD88
Source:
Zone A Model Delineation
Nearest Stream:
WHITE RIVER

Map Legend

Point of Interest
Nearest Point on Stream

Effective Flood Zone

0.2% Annual Chance Flood Hazard
1% Annual Chance Flood Hazard - Zone A (Approximate Study)
1% Annual Chance Flood Hazard - Zone AE (Detailed Study)
1% Annual Chance Flood Hazard - Floodway
1% Annual Chance Flood Hazard - Zone AH
1% Annual Chance Flood Hazard - Zone AO
Zone X - Protected by Levee

Site Map with Effective Flood Zone

Approximate scale 1:24,000

Disclaimer

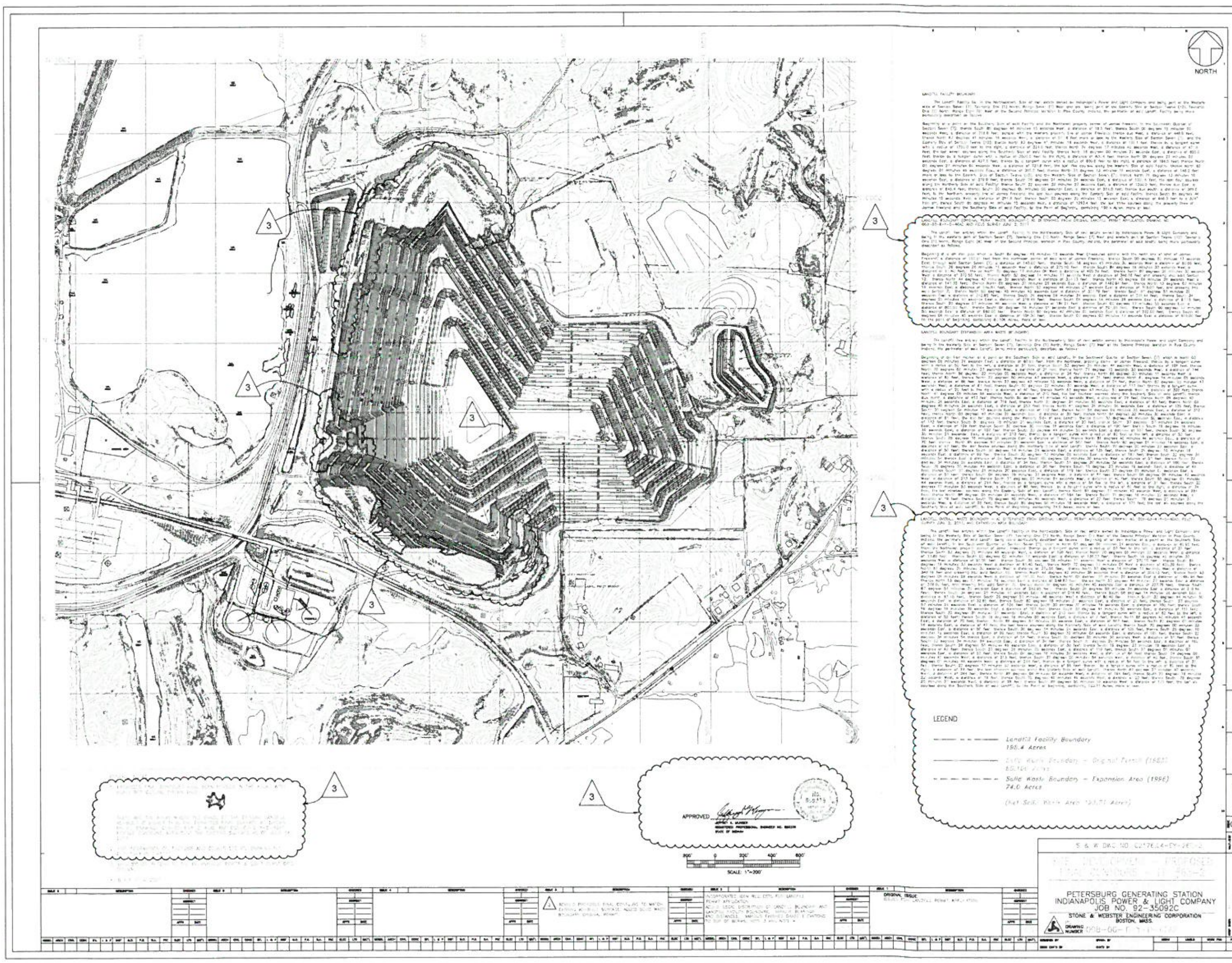
This data is a digital representation of the former paper Flood Insurance Rate Maps (FIRMs) for counties that have completed the Map Modernization Initiative. The data on counties derived from the official FEMA digital products (DFIRM) represent official FEMA designations of the Special Flood Hazard Areas. This data can be used for official National Flood Insurance Program (NFIP) purposes in accordance with the FEMA Mitigation Directorate Policy document tiled "Use of Digital Flood Hazard Data" dated November 29, 2007. For the non-modernized counties, the Effective is enhanced by the addition of the floodplain data from digitized paper copies of the FIRMs and the information should be considered advisory only. For these non-modernized counties, the paper maps are the official FEMA documents for regulatory and insurance purposes. Once the NFHL is official, the Effective is updated with the newly published information. For the status of counties published by FEMA please see http://www.floodmaps.fema.gov/NFHL/status.shtml.

Generated on Thursday September 29th 2016 at 10:21:25am

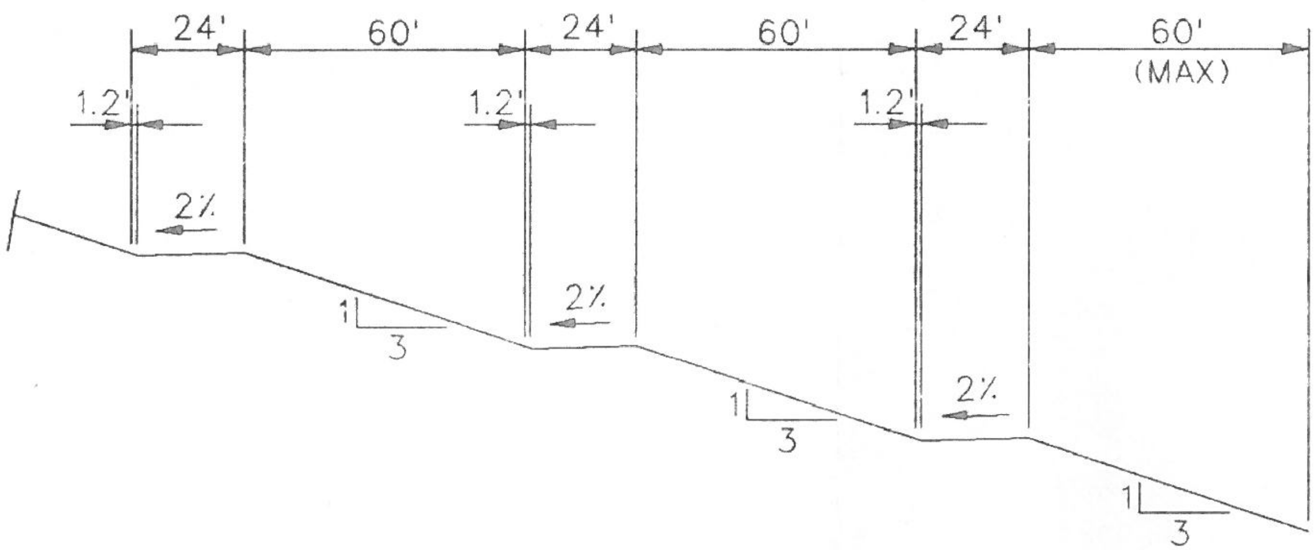
Appendix E: Surface Water Control and Design Plan Sheets

SHEET NO.	DESCRIPTION
*IPL 008-00-6-Y-D-42AF	Final Cover Conditions - Surface Water Control Plan
*Detail 1-1	Terrace Channel Design
*Detail 5-5	Riprap Downchute Channel Design
*Detail 6-6	Downchute Channel Profile

*Plan sheets from previously approved Indiana Department of Environmental Management (IDEM) Restricted Waste Type III Landfill application



NORTH
LEGEND
Landfill Facility Boundary
198.4 Acres
Solid Waste Boundary – Expansion Area (1996)
74.0 Acres
APPROVED
SCALE: 1"=200'
ORIGINAL ISSUE
PETERSBURG GENERATING STATION
INDIANAPOLIS POWER & LIGHT COMPANY
JOB NO. 92-35092C
STONE & WEBSTER ENGINEERING CORPORATION
BOSTON, MASS.
DRAWING NUMBER



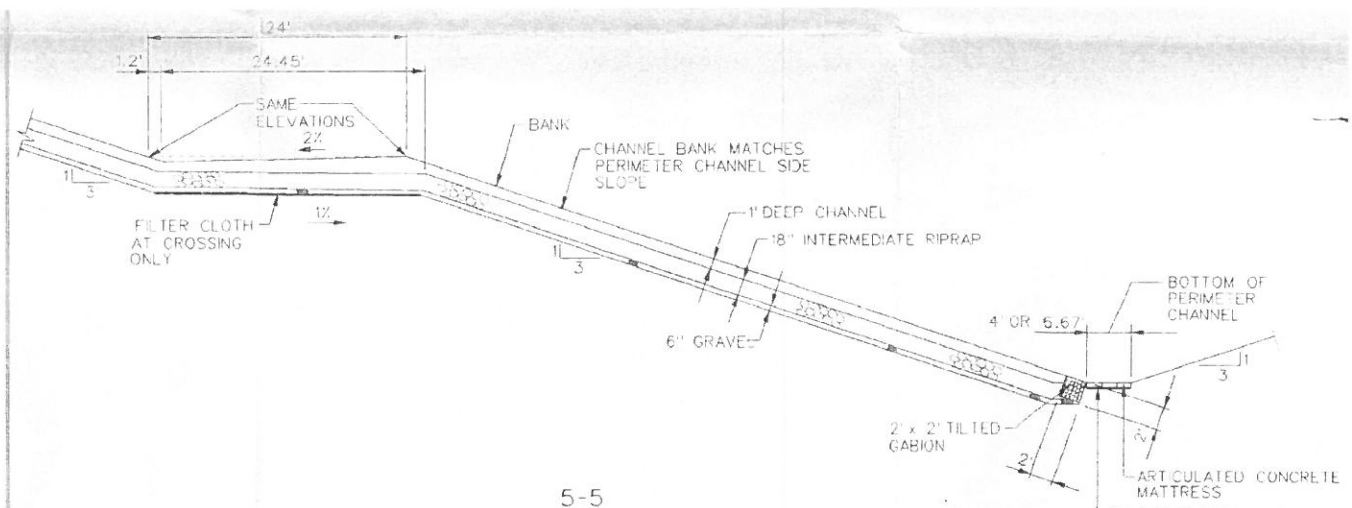
1-1
SCALE: 1"=40'

IPL PETERSBURG GENERATING STATION
TYPE III RESTRICTED WASTE LANDFILL

DETAIL 1-1 FROM IPL DRAWING NO. 008-00-6-Y-D-42AG
BY STONE & WEBSTER ENGINEERING CORPORATION

Project Number: 170LF00266		Drn. By: WS
Drawing File: SEE LOWER LEFT		Ckd. By: CD
Date: 9/16	Scale: AS SHOWN	App'd By:
ATC		Figure: 1

H:\2016\IPL\IPL ROROCS PLAN (170LF00266)\170LF00266-DETAILS-SCAN.DWG, DETAIL 1-1

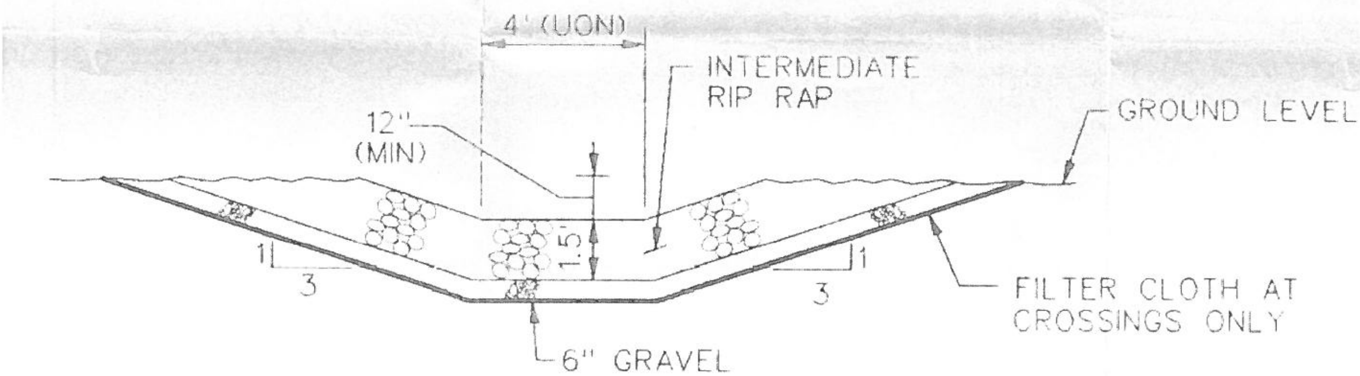


5-5
(B-3)
SCALE: 1"=8'

H:\2016\IPL\IPL RORocs PLAN (170LF00266)\170LF00266-DETAILS-SCAN.DWG, DETAIL 5-5

IPL PETERSBURG GENERATING STATION
TYPE III RESTRICTED WASTE LANDFILL
DETAIL 5-5 FROM IPL DRAWING NO. 008-00-6-Y-D-42AG
BY STONE & WEBSTER ENGINEERING CORPORATION

Project Number: 170LF00266
Drawing File: SEE LOWER LEFT
Drn. By: WS
Ckd. By: CD
App'd By:
Ckd. Date:
ATC
Date: 9/16
Scale: AS SHOWN
Figure: 2



6-6
(D-4)
SCALE: 1"=4'

IPL PETERSBURG GENERATING STATION
TYPE III RESTRICTED WASTE LANDFILL

DETAIL 6–6 FROM IPL DRAWING NO. 008–00–6–Y–D–42AG
BY STONE & WEBSTER ENGINEERING CORPORATION

Project Number: 170LF00266		Drn. By: WS
Drawing File: SEE LOWER LEFT		Ckd. By: CD
Date: 9/16	Scale: AS SHOWN	App'd By:
ATC		Figure: 3

H:\2016\IPL\IPL ROROCS PLAN (170LF00266)\170LF00266–DETAILS–SCAN.DWG, DETAIL 6–6

APPENDIX B: EXCERPT FROM 2017 PETERSBURG LANDFILL MINOR PERMIT MODIFICATION APPLICATION

Section 3 – Stormwater Runoff and Final Cover Soil Loss Calculations

STORM WATER RUNOFF CALCULATIONS

The erosion and stormwater control structures described in this section have been designed, as required, to limit soil erosion to less than 5 tons-per-acre-per-year and adequately convey the 25year/24hour storm event (5.50", attached). The 100yr/24hr storm event (7.07") was also used to check for structure overtopping. Soil erosion estimates are attached in a separate calculations section.

Flows were determined using the HydroCAD model developed by HydroCAD Software Solutions LLC using drainage area, elevation change across the drainage area, flow path length, and soil cover characteristics. Outputs from representative models are attached at the end of this section.

The following document describes different types of final cover subdrainage situations: areas with diversion berms that drain into catch basins that are drained by pipe downdrains, and areas that drain into riprap downdrains.

Side-slope diversion-berm channels, top-of-landfill diversion-berm channels, and downdrain pipes were individually input into the HydroCAD computer models, using the worst-case conditions with the largest drainage areas, to show that these components could adequately convey their portions of a 25-year/24-hour storm. These worst-case models are discussed below:

- **Side-slope diversion-berm channels** lie on the 4H:1V-sloped, grass-covered, final cover sideslopes. The 90-ft-horizontal spaces between channels are based on erosion control calculations provided in the "Final Cover Soil Loss Estimates" section of this minor permit modification application. These channels have 2% slopes, are v-shaped with 4H:1V and 3H:1V sideslopes, and are up to 600 ft in length. An attached HydroCAD output (#1) shows that the 2%-sloped berm conveys the 25-year/24-hour storm (6.6 cfs at a velocity of 3.5 fps and a flow depth of 0.8 feet from 1.2 acres). Flow from each sideslope berm enters an 18-inch-diameter drop-inlet pipe that is drained into an 18-inch-diamater downdrain pipe.

- **Top-of-landfill diversion-berm channels.** At these locations, two diversion berms are paired to enter a single downdrain pipe. Each berm has a slope of about 1%, a v-shape with 3H:1V and 50H:1V sideslopes, and a length of up to 600 ft along the outer edge of the 5%-sloped portion of the final cover. The attached HydroCAD output (#2) shows that a 1%-slope berm easily conveys a 25-year/24-hour storm flow (12 cfs at a velocity of 1.4 fps and a flow depth of 0.5 feet from 3.0 acres). Flow from each top-of-landfill channel enters an 18-inch-diameter, drop-inlet pipe that is drained into an 18-inch-diameter downdrain pipe.

- **Pairs of 18-inch-diameter downdrain pipes** will be placed to serve drainage areas of 9 acres or less. Output #3 shows that a drainage area of 4.5 acres (flow into one pipe) produces a 25-year/24-hour peak runoff of about 26 cfs that can flow within a single 18-inch-diameter pipe at about one-half full when the pipe is placed on a 25% slope. Output #4 shows that a drainage area of 4.5 acres (flow into one pipe) produces a 100-year/24-hour peak runoff of about 37 cfs that can flow within a single 18-inch-diameter pipe at about two-thirds full when the pipe is placed on a 25% slope. The locations of these 18-inch-pipe pairs are shown on the surface-water drainage plan.

Drainage from the southeastern and southwestern portions of the expansion area are routed to the South Sedimentation Basin. Output #5 (based on a 25-year/24-hour rainfall event) and Output #6 (based on a 100-yr/24-hour rainfall even) are attached and show that:

- The southeastern portion of the expansion area produces a 25-year/24-hour storm-runoff flow of 94 cfs that is carried, at a depth of about 1.9 feet and a velocity of 4.0 fps by a 6-ft-bottom perimeter channel along the east and south sides of the landfill. This flow joins the southwestern portion of the South Drainage Area that produces a 25-year/24-hour storm-runoff flow of 88 cfs. Together, these flows pond over a 72-inch-diameter drop inlet that drains at a peak elevation of 505.4 into a 54-inch-diameter culvert that drains into the South Sedimentation Pond. The 25-yr/24-hour flow fills the South Sedimentation Pond to a maximum level at EL 497.6 (2.4 feet below the EL 500 crest) and drains at a maximum flow of 10.8 cfs through an 18-inch-diameter culvert that drains into the existing site drainage system that in turn flows out through the landfill's existing holding pond.

- The 100-yr/24-hour flow fills the South Sedimentation Pond to a maximum level at EL 499.4 (0.6 feet below the EL 500 crest) and drains at a maximum flow of 12.3 cfs through an 18-inch-diameter culvert and 12.5 cfs through an 24-inch-diameter overflow culvert into the existing site drainage system that in turn flows out through the landfill's existing holding pond.

Drainage from the northeastern and northwestern portions of the expansion area are routed to the North Sedimentation Basin. Output #7 (based on a 25-year/24-hour rainfall event) and Output #8 (based on a 100-yr/24-hour rainfall even) are attached and show that:

- The northeastern portion of the expansion area produces a 25-year/24-hour storm-runoff flow of 69.9 cfs that is carried, at a depth of about 1.7 feet and a velocity of 3.8 fps by a 6-ft-bottom perimeter channel along the south side of the landfill. This flow joins the northwestern portion of the expansion area that produces a 25-year/24-hour storm-runoff flow of 66.9 cfs. These flows join together, pond over a 72-inch-diameter drop inlet that drains into a 54-inch-diameter culvert, and then drain into the North Sedimentation Pond. The 25-yr/24-hour flow fills the North Sedimentation Pond to a maximum level at EL 502.2 (7.8 feet below the EL 510 crest) and drains at a maximum flow of 4.9 cfs through an 18-inch-diameter culvert that drains into the existing site drainage system that in turn flows out through the landfill's existing holding pond.

- The 100-yr/24-hour flow fills the North Sedimentation Pond to a maximum level at EL 504.4 (5.6 feet below the EL 510 crest) and drains at a maximum flow of 8.7 cfs through an 18-inch-diameter culvert and 0 cfs through an 24-inch-diameter emergency overflow culvert that both drain into the existing site drainage system that in turn flows out through the landfill's existing holding pond.

North and South Sedimentation Basins' sediment storage volume are determined by using a rate of 0.3 inches of sediment per year for an average drainage-area slope of 5% during a period of 3 years.

The following equation will be used for the North sedimentation basin:

Sediment depth in basin = (drainage area) (0.3"/year) (3 years) / (basin area)
Sed. Basin sediment-storage depth = (38.0 acres) (0.3") (3) / (1.5 acres) = 23 inches
Sed. Basin permanent pool @ EL 491 minus 23 inches = EL 489.1

The following equation will be used for the South sedimentation basin:

Sediment depth in basin = (drainage area) (0.3"/year) (3 years) / (basin area)
Sed. Basin sediment-storage depth =(41.9 acres)(0.3")(3) / (1.8 acres)= 21 inches
Sed. Basin permanent pool @ EL 504 minus 21 inches = EL 502.2

Documentation

NOAA Atlas 14, Volume 2, Version 3
Location name: Petersburg, Indiana, US*
Latitude: 38.5165°, Longitude: -87.2624°
Elevation: 465ft*
* source: Google Maps

POINT PRECIPITATION FREQUENCY ESTIMATES

G.M. Bonnin, D. Martin, B. Lin, T. Parzybok, M.Yekta, and D. Riley

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	0.394 (0.362–0.431)	0.467 (0.429–0.511)	0.554 (0.509–0.606)	0.624 (0.570–0.681)	0.713 (0.649–0.777)	0.783 (0.709–0.852)	0.851 (0.767–0.926)	0.923 (0.827–1.00)	1.02 (0.906–1.11)	1.09 (0.964–1.19)
10-min	0.613 (0.563–0.669)	0.729 (0.670–0.798)	0.861 (0.791–0.942)	0.963 (0.880–1.05)	1.09 (0.993–1.19)	1.19 (1.08–1.29)	1.28 (1.16–1.39)	1.38 (1.24–1.50)	1.50 (1.33–1.63)	1.59 (1.40–1.73)
15-min	0.751 (0.690–0.820)	0.892 (0.819–0.976)	1.06 (0.971–1.16)	1.19 (1.08–1.29)	1.35 (1.23–1.47)	1.47 (1.33–1.60)	1.59 (1.44–1.73)	1.71 (1.54–1.86)	1.87 (1.66–2.03)	1.98 (1.75–2.16)
30-min	0.993 (0.913–1.09)	1.19 (1.10–1.31)	1.45 (1.33–1.58)	1.65 (1.50–1.80)	1.90 (1.73–2.07)	2.10 (1.90–2.29)	2.30 (2.07–2.50)	2.50 (2.24–2.72)	2.77 (2.46–3.01)	2.97 (2.63–3.24)
60-min	1.21 (1.12–1.33)	1.46 (1.35–1.60)	1.82 (1.67–1.99)	2.09 (1.91–2.29)	2.47 (2.25–2.69)	2.77 (2.51–3.01)	3.07 (2.77–3.34)	3.39 (3.04–3.69)	3.83 (3.41–4.16)	4.18 (3.69–4.54)
2-hr	1.45 (1.32–1.58)	1.75 (1.60–1.92)	2.20 (2.01–2.40)	2.55 (2.33–2.79)	3.04 (2.76–3.31)	3.44 (3.11–3.74)	3.86 (3.47–4.20)	4.30 (3.85–4.67)	4.90 (4.35–5.33)	5.39 (4.75–5.87)
3-hr	1.54 (1.42–1.68)	1.86 (1.71–2.04)	2.34 (2.14–2.56)	2.73 (2.49–2.97)	3.27 (2.97–3.56)	3.72 (3.36–4.04)	4.19 (3.77–4.55)	4.70 (4.19–5.09)	5.41 (4.78–5.86)	5.99 (5.26–6.48)
6-hr	1.87 (1.72–2.05)	2.26 (2.07–2.48)	2.82 (2.58–3.09)	3.28 (3.00–3.60)	3.94 (3.58–4.30)	4.48 (4.05–4.88)	5.05 (4.54–5.50)	5.66 (5.06–6.16)	6.52 (5.76–7.09)	7.22 (6.33–7.85)
12-hr	2.21 (2.03–2.42)	2.67 (2.45–2.92)	3.31 (3.04–3.62)	3.84 (3.51–4.19)	4.58 (4.18–4.98)	5.18 (4.71–5.63)	5.82 (5.26–6.31)	6.48 (5.83–7.04)	7.43 (6.62–8.06)	8.18 (7.24–8.89)
24-hr	2.63 (2.46–2.83)	3.16 (2.95–3.40)	3.95 (3.68–4.23)	4.58 (4.26–4.92)	5.50 (5.06–5.94)	6.26 (5.69–6.82)	7.07 (6.33–7.78)	7.93 (6.99–8.85)	9.18 (7.88–10.5)	10.2 (8.58–11.8)
2-day	3.14 (2.93–3.37)	3.76 (3.51–4.04)	4.66 (4.33–5.00)	5.39 (4.99–5.82)	6.44 (5.89–7.02)	7.31 (6.61–8.04)	8.24 (7.34–9.19)	9.24 (8.06–10.5)	10.7 (9.05–12.5)	11.9 (9.81–14.2)
3-day	3.36 (3.13–3.60)	4.02 (3.75–4.32)	4.97 (4.62–5.34)	5.75 (5.33–6.21)	6.86 (6.28–7.47)	7.78 (7.04–8.55)	8.76 (7.81–9.77)	9.80 (8.59–11.1)	11.3 (9.63–13.2)	12.5 (10.4–15.0)
4-day	3.57 (3.33–3.83)	4.28 (3.99–4.60)	5.29 (4.92–5.69)	6.12 (5.66–6.60)	7.29 (6.67–7.93)	8.26 (7.48–9.07)	9.28 (8.29–10.3)	10.4 (9.11–11.7)	11.9 (10.2–13.9)	13.2 (11.1–15.7)
7-day	4.17 (3.89–4.47)	4.99 (4.66–5.36)	6.13 (5.69–6.60)	7.06 (6.52–7.65)	8.39 (7.66–9.16)	9.47 (8.55–10.5)	10.6 (9.46–11.9)	11.9 (10.4–13.5)	13.6 (11.6–16.0)	15.0 (12.5–18.1)
10-day	4.72 (4.42–5.06)	5.65 (5.28–6.06)	6.93 (6.45–7.45)	7.97 (7.37–8.60)	9.42 (8.63–10.3)	10.6 (9.61–11.7)	11.9 (10.6–13.3)	13.2 (11.6–15.0)	15.0 (12.9–17.6)	16.6 (13.8–19.8)
20-day	6.50 (6.12–6.91)	7.73 (7.27–8.23)	9.28 (8.69–9.89)	10.5 (9.79–11.2)	12.2 (11.3–13.1)	13.5 (12.3–14.7)	14.8 (13.4–16.3)	16.2 (14.5–18.1)	18.0 (15.8–20.6)	19.4 (16.8–22.7)
30-day	8.00 (7.56–8.48)	9.46 (8.94–10.0)	11.2 (10.5–11.8)	12.5 (11.7–13.3)	14.3 (13.3–15.3)	15.7 (14.5–17.0)	17.1 (15.6–18.7)	18.5 (16.7–20.5)	20.3 (18.0–23.0)	21.8 (19.1–25.0)
45-day	10.1 (9.52–10.6)	11.9 (11.2–12.6)	13.9 (13.1–14.7)	15.5 (14.5–16.4)	17.5 (16.4–18.7)	19.1 (17.7–20.6)	20.7 (19.0–22.5)	22.2 (20.2–24.5)	24.3 (21.8–27.1)	25.8 (22.8–29.3)
60-day	12.0 (11.4–12.6)	14.1 (13.4–14.9)	16.4 (15.5–17.4)	18.2 (17.2–19.3)	20.5 (19.2–21.9)	22.3 (20.8–23.9)	24.0 (22.2–25.9)	25.7 (23.5–28.0)	27.8 (25.1–30.8)	29.4 (26.2–33.0)

[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.

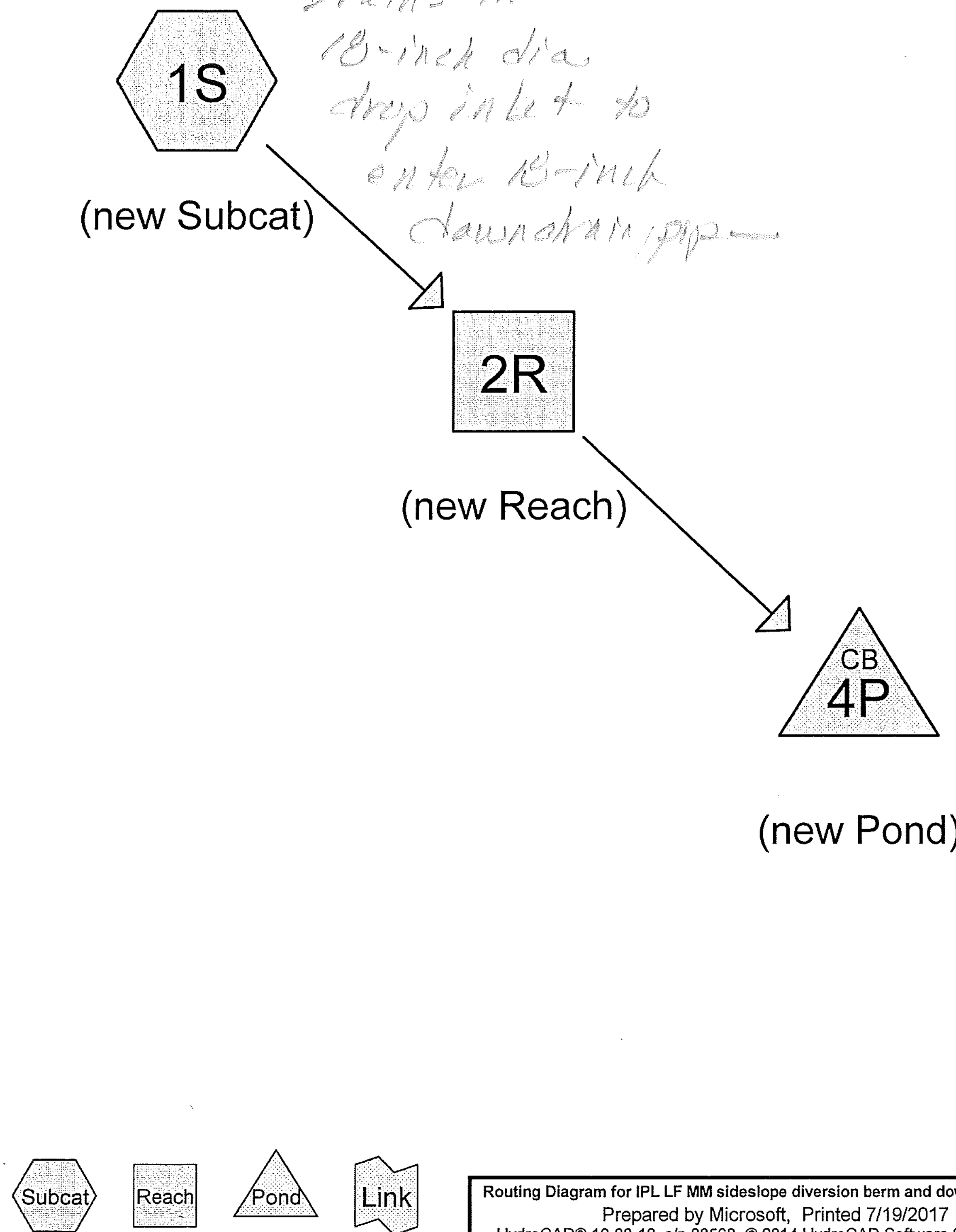
Please refer to NOAA Atlas 14 document for more information.

Back to Top

PF graphical

Output # 1

Diversion Berm
Drains into
18-inch dia
drop inlet to
enter 18-inch
downdrain pipe



Routing Diagram for IPL LF MM sideslope diversion berm and downdrain 7.19.17
Prepared by Microsoft, Printed 7/19/2017
HydroCAD® 10.00-12 s/n 08568 © 2014 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
1.240	80	>75% Grass cover, Good, HSG D (1S)
1.240	**80**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
0.000	HSG B	
0.000	HSG C	
1.240	HSG D	1S
0.000	Other	
1.240		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	0.000	0.000	1.240	0.000	1.240	>75% Grass cover, Good	1S
0.000	**0.000**	**0.000**	**1.240**	**0.000**	**1.240**	**TOTAL AREA**	

Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 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 1S: (new Subcat) Runoff Area=1.240 ac 0.00% Impervious Runoff Depth>3.10"
Flow Length=90' Slope=0.2500 '/' Tc=4.8 min CN=80 Runoff=7.38 cfs 0.320 af

Reach 2R: (new Reach) Avg. Flow Depth=0.75' Max Vel=3.52 fps Inflow=7.38 cfs 0.320 af
n=0.030 L=500.0' S=0.0200 '/' Capacity=95.49 cfs Outflow=6.63 cfs 0.319 af

Pond 4P: (new Pond) Peak Elev=590.59' Inflow=6.63 cfs 0.319 af
Outflow=6.63 cfs 0.319 af

Total Runoff Area = 1.240 ac Runoff Volume = 0.320 af Average Runoff Depth = 3.10"
100.00% Pervious = 1.240 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment 1S: (new Subcat)

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

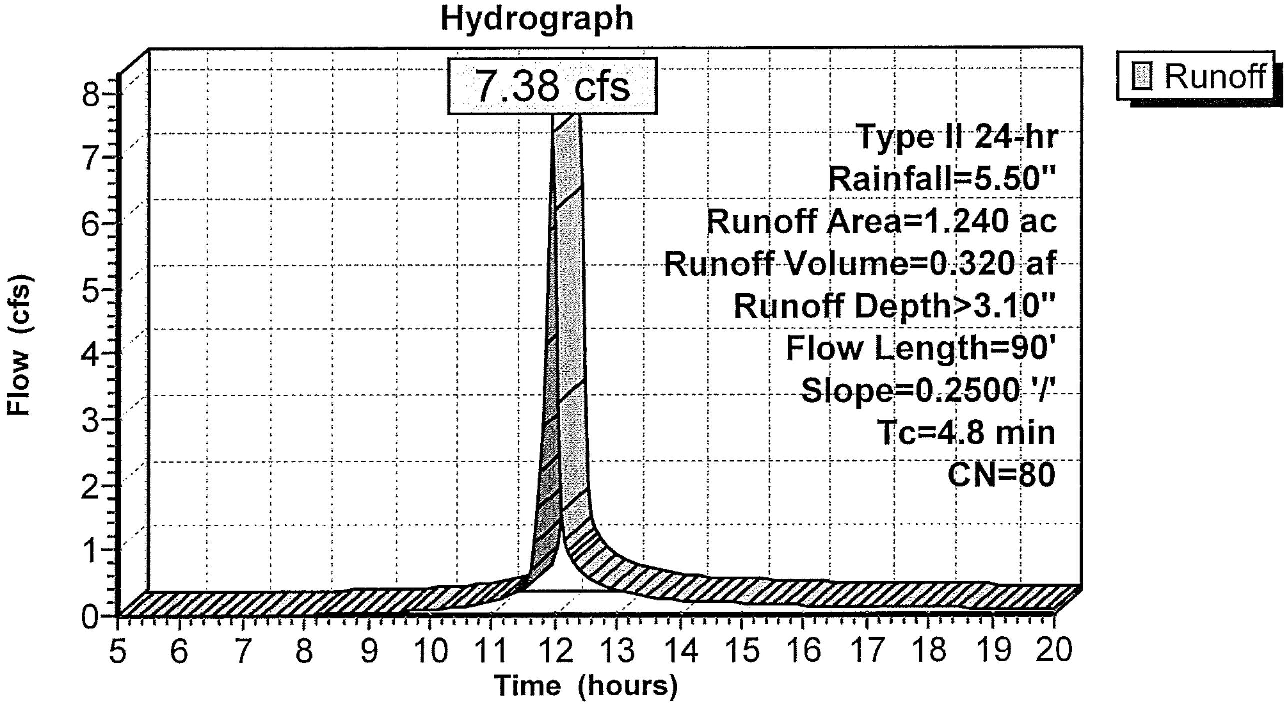
Runoff = 7.38 cfs @ 11.95 hrs, Volume= 0.320 af, Depth> 3.10"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr Rainfall=5.50"

Area (ac)	CN	Description
1.240	80	>75% Grass cover, Good, HSG D
1.240		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.8	90	0.2500	0.31		**Sheet Flow, 90** Grass: Dense n= 0.240 P2= 3.16"

Subcatchment 1S: (new Subcat)



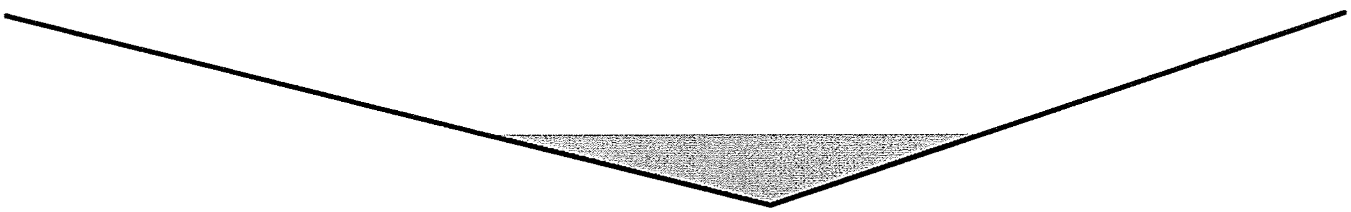
Summary for Reach 2R: (new Reach)

Inflow Area = 1.240 ac, 0.00% Impervious, Inflow Depth > 3.10"
Inflow = 7.38 cfs @ 11.95 hrs, Volume= 0.320 af
Outflow = 6.63 cfs @ 12.02 hrs, Volume= 0.319 af, Atten= 10%, Lag= 4.1 min

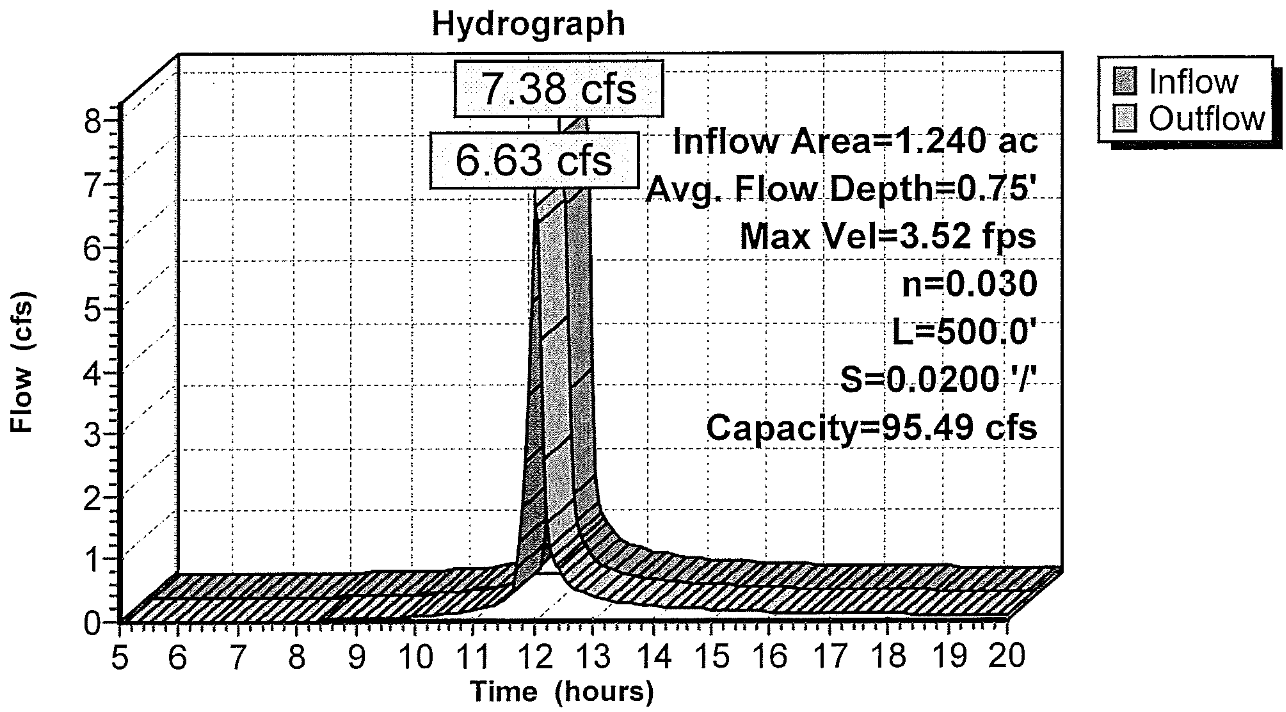
Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.52 fps, Min. Travel Time= 2.4 min
Avg. Velocity = 1.32 fps, Avg. Travel Time= 6.3 min

Peak Storage= 975 cf @ 11.98 hrs
Average Depth at Peak Storage= 0.75'
Bank-Full Depth= 2.00' Flow Area= 14.0 sf, Capacity= 95.49 cfs

0.00' x 2.00' deep channel, n= 0.030 Earth, dense weeds
Side Slope Z-value= 4.0 3.0 '/' Top Width= 14.00'
Length= 500.0' Slope= 0.0200 '/'
Inlet Invert= 600.00', Outlet Invert= 590.00'



Reach 2R: (new Reach)



Summary for Pond 4P: (new Pond)

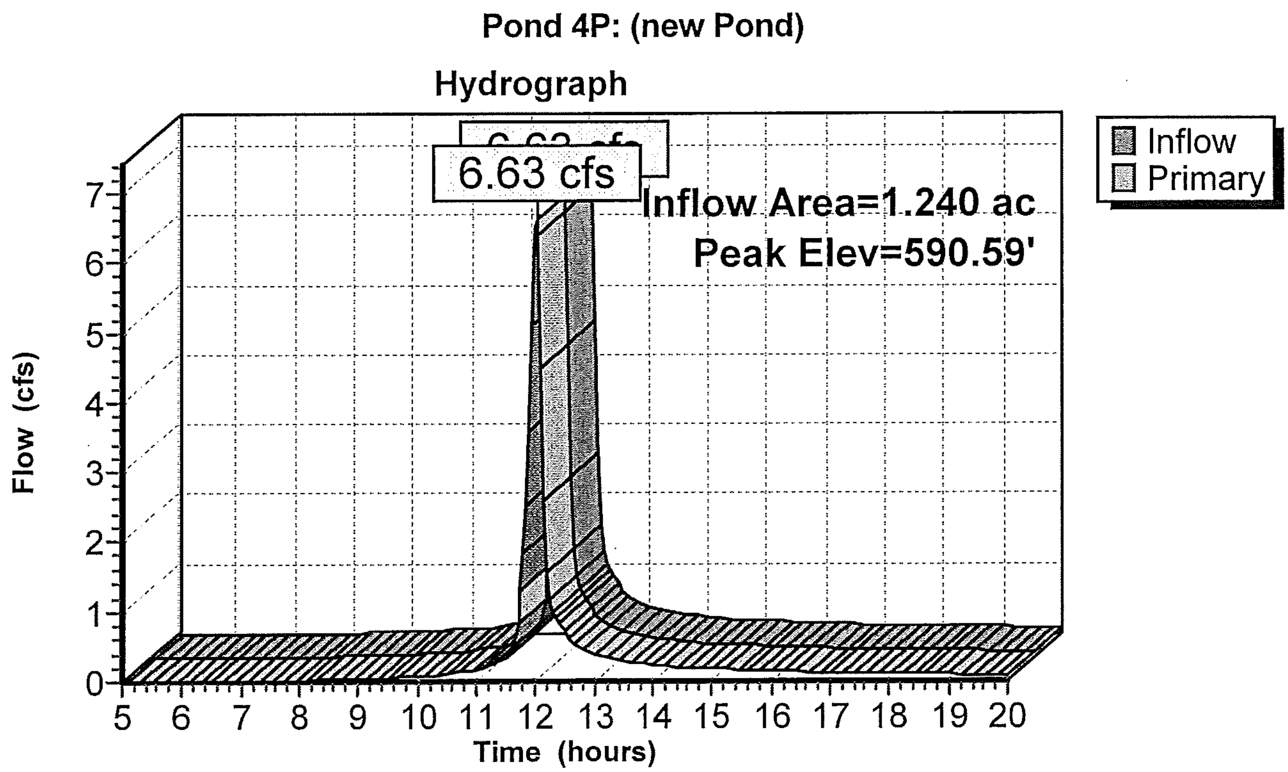
[57] Hint: Peaked at 590.59' (Flood elevation advised)
[61] Hint: Exceeded Reach 2R outlet invert by 0.58' @ 12.00 hrs

Inflow Area =	1.240 ac,	0.00% Impervious,	Inflow Depth > 3.09"	
Inflow =	6.63 cfs @	12.02 hrs, Volume=	0.319 af	
Outflow =	6.63 cfs @	12.02 hrs, Volume=	0.319 af,	Atten= 0%, Lag= 0.0 min
Primary =	6.63 cfs @	12.02 hrs, Volume=	0.319 af	

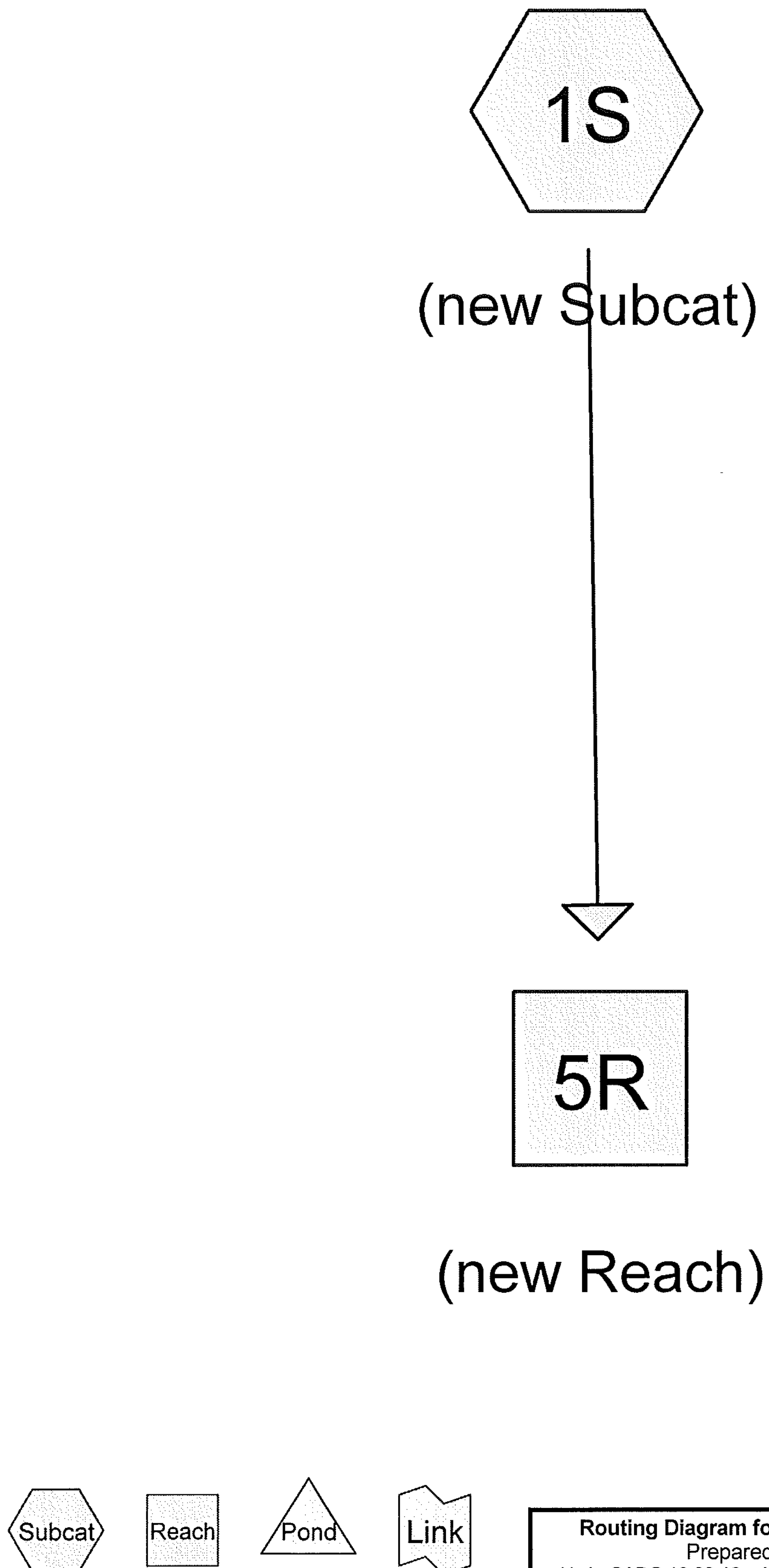
Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 590.59' @ 12.02 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	590.00'	**18.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=6.45 cfs @ 12.02 hrs HW=590.57' (Free Discharge)
└─**1=Orifice/Grate** (Orifice Controls 6.45 cfs @ 3.65 fps)



Output #3
Downdrain Pipe
Drains 4.5 acres
at one-half
full during
a 25yr/24yr
rainstorm



Routing Diagram for IPL LF MM sideslope downdrain 7.19.17
Prepared by Microsoft, Printed 8/2/2017
HydroCAD® 10.00-12 s/n 08568 © 2014 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
4.500	80	>75% Grass cover, Good, HSG D (1S)
4.500	**80**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
0.000	HSG B	
0.000	HSG C	
4.500	HSG D	1S
0.000	Other	
4.500		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	0.000	0.000	4.500	0.000	4.500	>75% Grass cover, Good	1S
0.000	**0.000**	**0.000**	**4.500**	**0.000**	**4.500**	**TOTAL AREA**	

Pipe Listing (all nodes)

Line#	Node Number	In-Invert (feet)	Out-Invert (feet)	Length (feet)	Slope (ft/ft)	n	Diam/Width (inches)	Height (inches)	Inside-Fill (inches)
1	5R	600.00	500.00	400.0	0.2500	0.013	18.0	0.0	0.0

Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 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 1S: (new Subcat) Runoff Area=4.500 ac 0.00% Impervious Runoff Depth>3.10"
Flow Length=90' Slope=0.2500 '/' Tc=4.8 min CN=80 Runoff=26.80 cfs 1.161 af

Reach 5R: (new Reach) Avg. Flow Depth=0.76' Max Vel=29.80 fps Inflow=26.80 cfs 1.161 af
18.0" Round Pipe n=0.013 L=400.0' S=0.2500 '/' Capacity=52.52 cfs Outflow=26.25 cfs 1.161 af

Total Runoff Area = 4.500 ac Runoff Volume = 1.161 af Average Runoff Depth = 3.10"
100.00% Pervious = 4.500 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment 1S: (new Subcat)

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

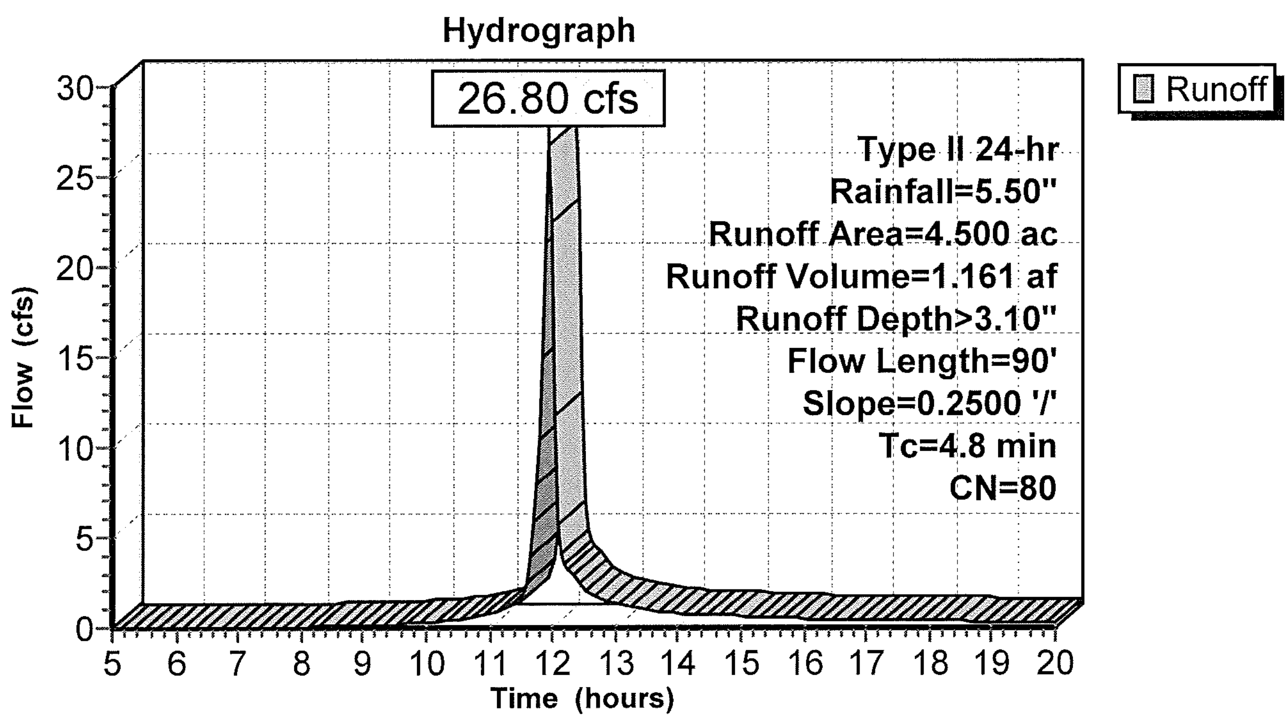
Runoff = 26.80 cfs @ 11.95 hrs, Volume= 1.161 af, Depth> 3.10"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr Rainfall=5.50"

Area (ac)	CN	Description
4.500	80	>75% Grass cover, Good, HSG D
4.500		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.8	90	0.2500	0.31		**Sheet Flow, 90** Grass: Dense n= 0.240 P2= 3.16"

Subcatchment 1S: (new Subcat)



Summary for Reach 5R: (new Reach)

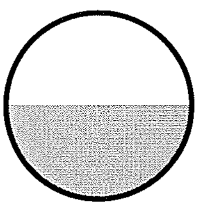
[52] Hint: Inlet/Outlet conditions not evaluated

Inflow Area = 4.500 ac, 0.00% Impervious, Inflow Depth > 3.10"
Inflow = 26.80 cfs @ 11.95 hrs, Volume= 1.161 af
Outflow = 26.25 cfs @ 11.96 hrs, Volume= 1.161 af, Atten= 2%, Lag= 0.3 min

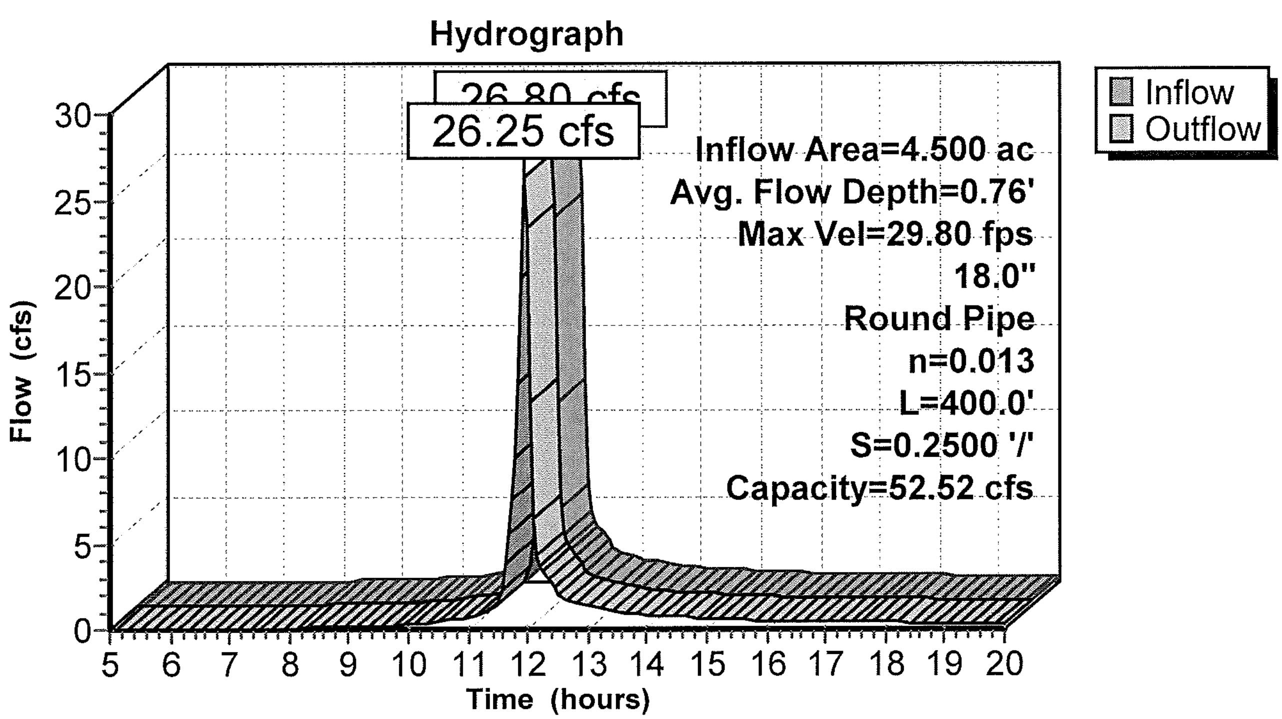
Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 29.80 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 9.50 fps, Avg. Travel Time= 0.7 min

Peak Storage= 357 cf @ 11.96 hrs
Average Depth at Peak Storage= 0.76'
Bank-Full Depth= 1.50' Flow Area= 1.8 sf, Capacity= 52.52 cfs

18.0" Round Pipe
n= 0.013 Corrugated PE, smooth interior
Length= 400.0' Slope= 0.2500 '/'
Inlet Invert= 600.00', Outlet Invert= 500.00'



Reach 5R: (new Reach)



HYDROCALC HYDRAULICS

File Structures View Options Help

Circular Char

Flow Rate:	26	cfs
Bottom Slope:	0.25	ft/ft
Manning's N-Value:	0.013 Select	
Diameter:	1.5	ft

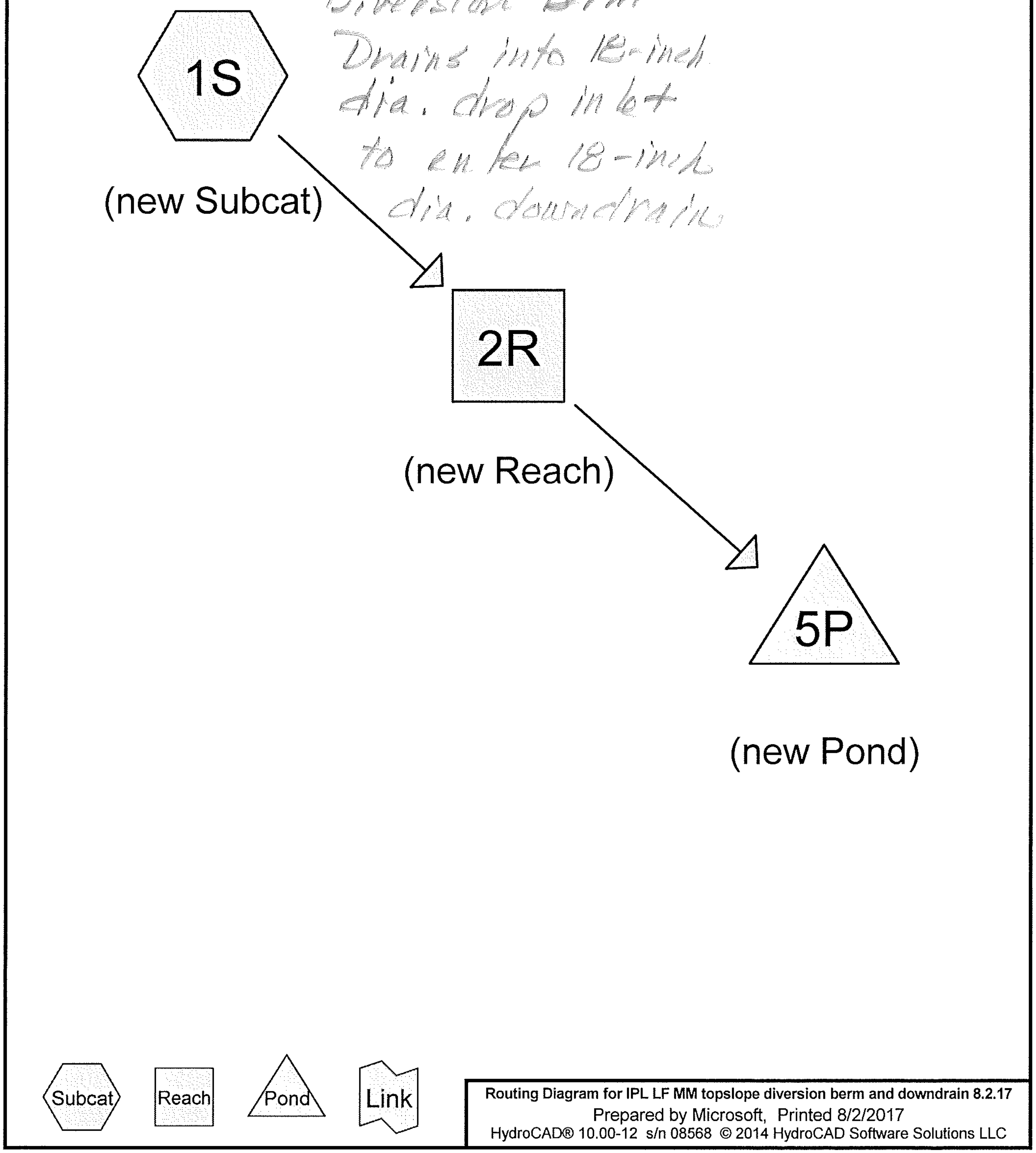
Normal Depth:	0.75	ft
Flow Velocity:	29.65	fps
Froude Number:	6.835	
Velocity Head:	13.66	ft
Energy Head:	14.40	ft
Cross-Sectional Area of Flow:	0.88	sq ft
Top Width of Flow:	1.50	ft

Critical Depth | Normal Depth | Rating Curve | Water Surface Profile

-1.7E+38 to 1.7E+38

Output #2

Top of Landfill
Diversion Berm
Drains into 12-inch
dia. drop inlet
to enter 18-inch
dia. downdrain



Routing Diagram for IPL LF MM topslope diversion berm and downdrain 8.2.17
Prepared by Microsoft, Printed 8/2/2017
HydroCAD® 10.00-12 s/n 08568 © 2014 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
3.000	80	>75% Grass cover, Good, HSG D (1S)
3.000	**80**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
0.000	HSG B	
0.000	HSG C	
3.000	HSG D	1S
0.000	Other	
3.000		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	0.000	0.000	3.000	0.000	3.000	>75% Grass cover, Good	1S
0.000	**0.000**	**0.000**	**3.000**	**0.000**	**3.000**	**TOTAL AREA**	

Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 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 1S: (new Subcat) Runoff Area=3.000 ac 0.00% Impervious Runoff Depth>3.08"
Flow Length=200' Slope=0.0500 '/' Tc=17.3 min CN=80 Runoff=11.95 cfs 0.771 af

Reach 2R: (new Reach) Avg. Flow Depth=0.53' Max Vel=1.44 fps Inflow=11.95 cfs 0.771 af
n=0.030 L=500.0' S=0.0050 '/' Capacity=370.47 cfs Outflow=10.62 cfs 0.765 af

Pond 5P: (new Pond) Peak Elev=590.48' Storage=0.031 af Inflow=10.62 cfs 0.765 af
Outflow=10.23 cfs 0.764 af

Total Runoff Area = 3.000 ac Runoff Volume = 0.771 af Average Runoff Depth = 3.08"
100.00% Pervious = 3.000 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment 1S: (new Subcat)

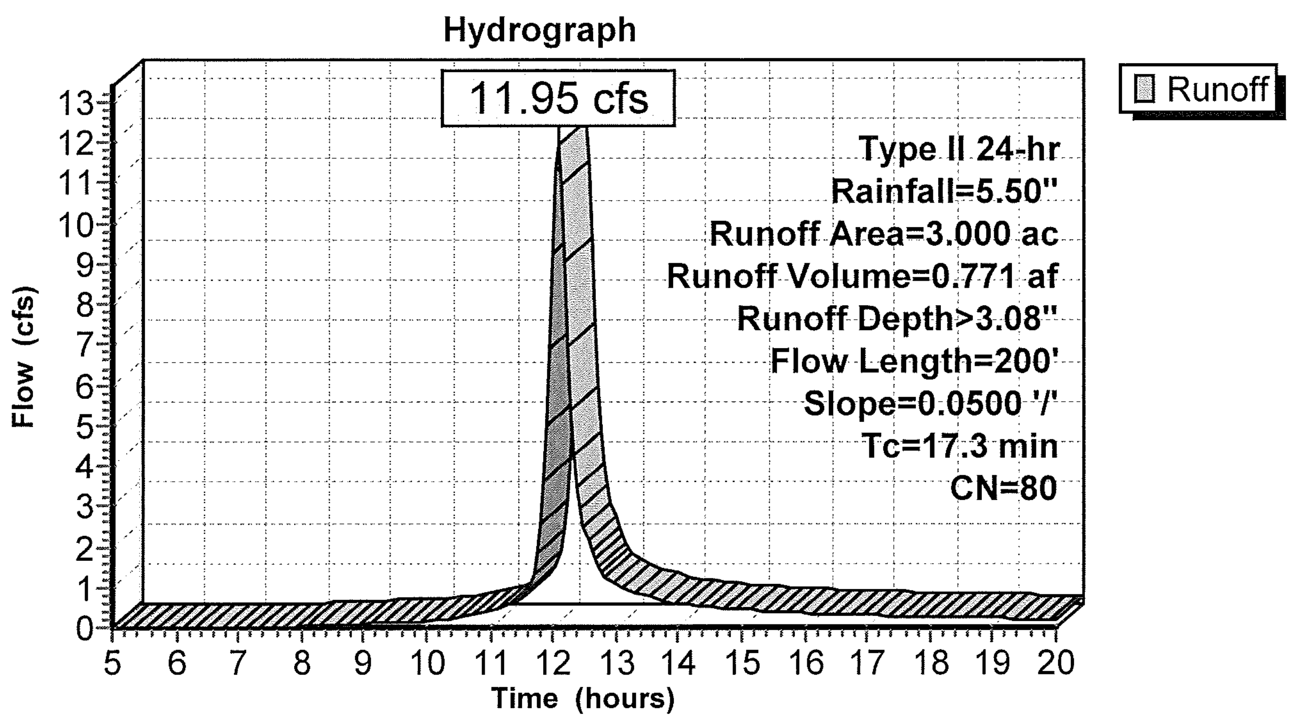
Runoff = 11.95 cfs @ 12.10 hrs, Volume= 0.771 af, Depth> 3.08"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr Rainfall=5.50"

Area (ac)	CN	Description
3.000	80	>75% Grass cover, Good, HSG D
3.000		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
17.3	200	0.0500	0.19		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.16"

Subcatchment 1S: (new Subcat)



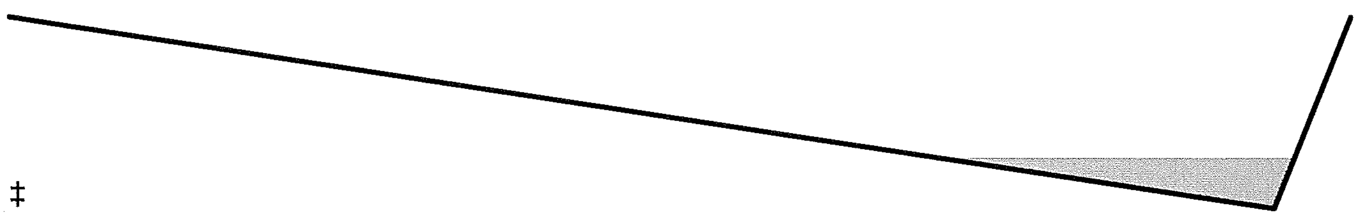
Summary for Reach 2R: (new Reach)

Inflow Area = 3.000 ac, 0.00% Impervious, Inflow Depth > 3.08"
Inflow = 11.95 cfs @ 12.10 hrs, Volume= 0.771 af
Outflow = 10.62 cfs @ 12.26 hrs, Volume= 0.765 af, Atten= 11%, Lag= 9.8 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.44 fps, Min. Travel Time= 5.8 min
Avg. Velocity = 0.60 fps, Avg. Travel Time= 13.9 min

Peak Storage= 3,702 cf @ 12.16 hrs
Average Depth at Peak Storage= 0.53'
Bank-Full Depth= 2.00' Flow Area= 106.0 sf, Capacity= 370.47 cfs

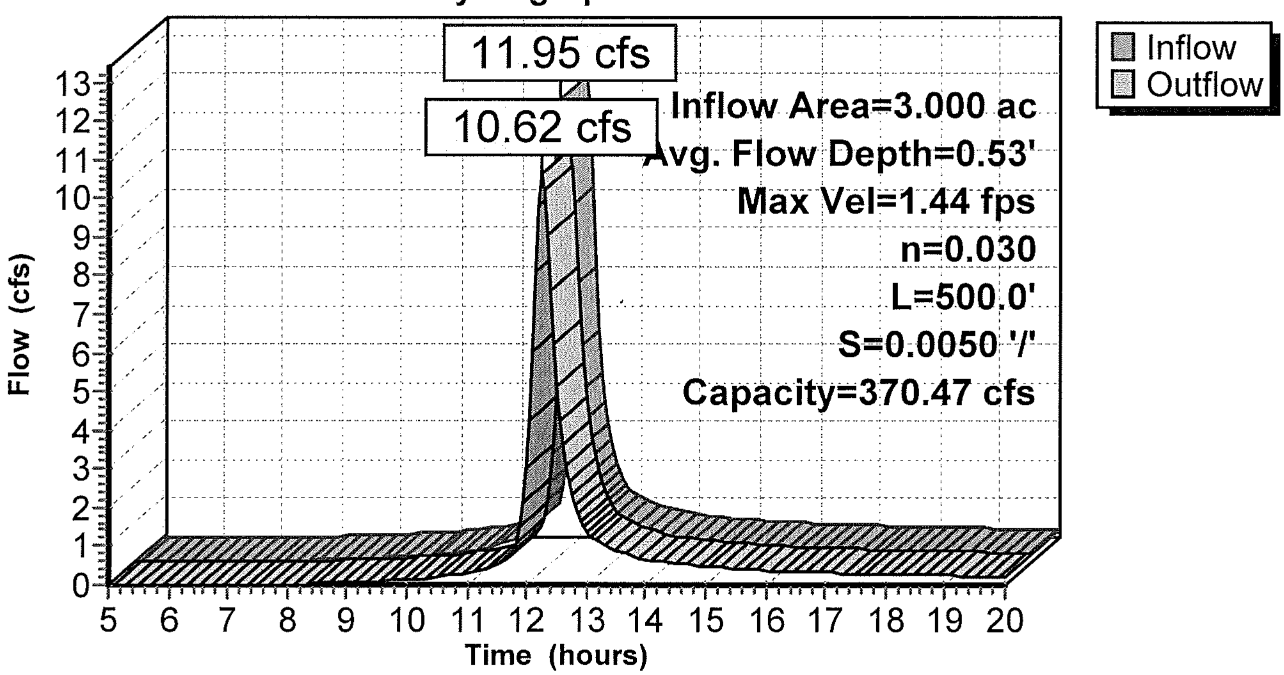
0.00' x 2.00' deep channel, n= 0.030 Earth, dense weeds
Side Slope Z-value= 50.0 3.0 '/' Top Width= 106.00'
Length= 500.0' Slope= 0.0050 '/'
Inlet Invert= 600.00', Outlet Invert= 597.50'



‡

Reach 2R: (new Reach)

Hydrograph



Summary for Pond 5P: (new Pond)

Inflow Area =	3.000 ac,	0.00% Impervious,	Inflow Depth >	3.06"	
Inflow =	10.62 cfs @	12.26 hrs,	Volume=	0.765 af	
Outflow =	10.23 cfs @	12.30 hrs,	Volume=	0.764 af,	Atten= 4%, Lag= 2.6 min
Primary =	10.23 cfs @	12.30 hrs,	Volume=	0.764 af	

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 590.48' @ 12.30 hrs Surf.Area= 0.118 ac Storage= 0.031 af

Plug-Flow detention time= 1.8 min calculated for 0.762 af (100% of inflow)
Center-of-Mass det. time= 1.6 min (798.2 - 796.6)

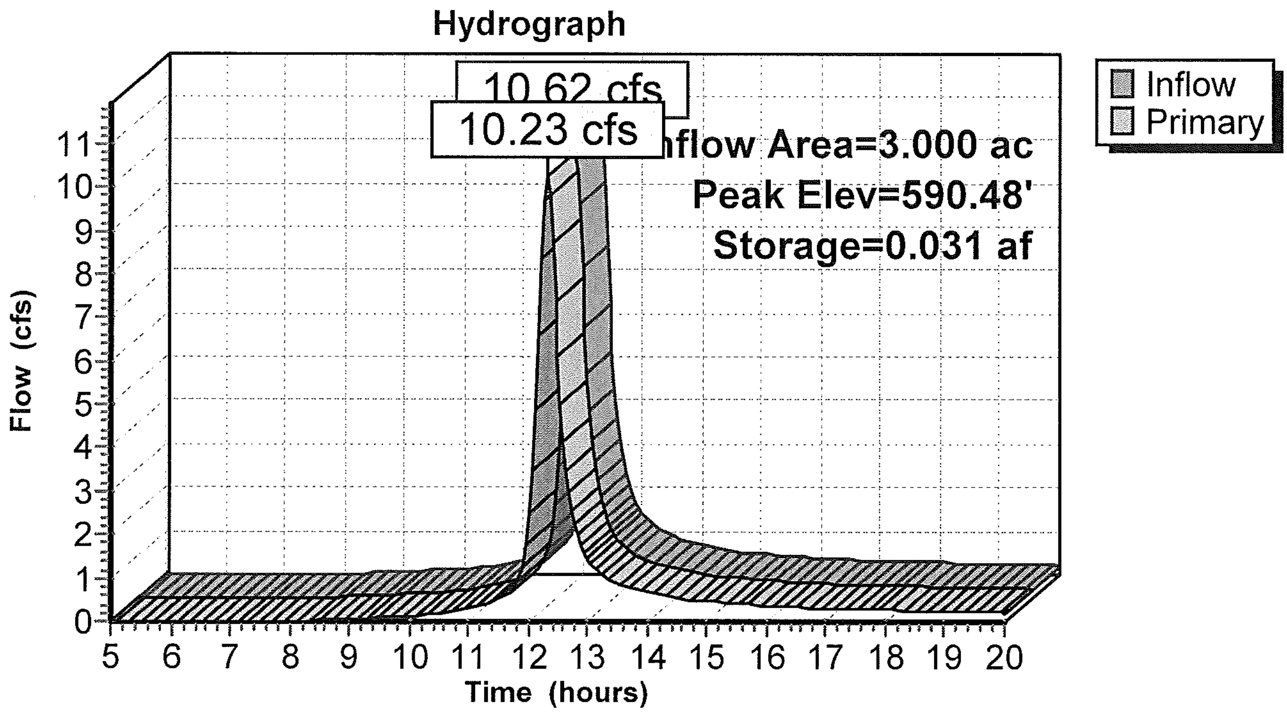
Volume	Invert	Avail.Storage	Storage Description
#1	590.00'	0.470 af	**Custom Stage Data (Prismatic)** Listed below (Recalc)

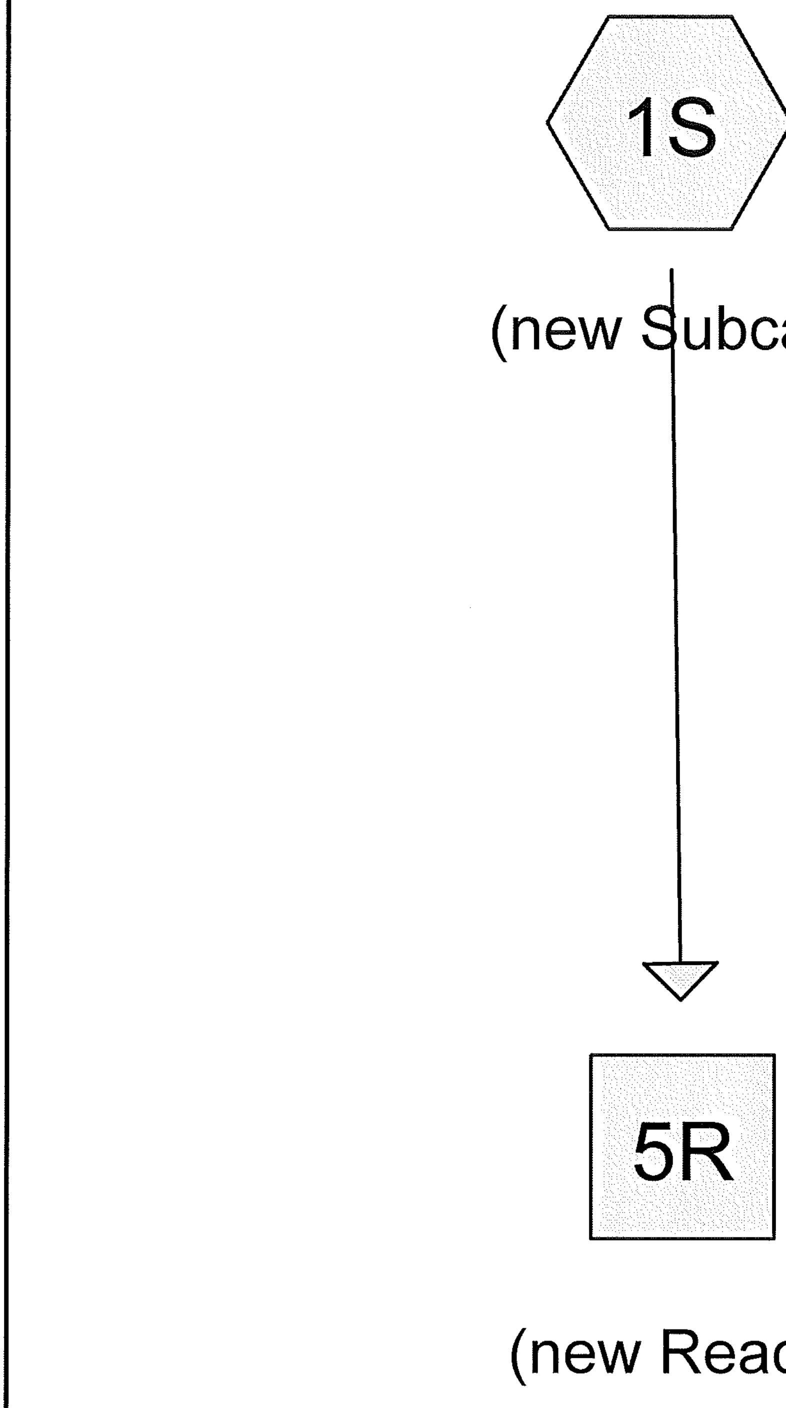
Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
590.00	0.010	0.000	0.000
592.00	0.460	0.470	0.470

Device	Routing	Invert	Outlet Devices
#1	Primary	590.00'	**18.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#2	Primary	590.00'	**18.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=10.21 cfs @ 12.30 hrs HW=590.48' (Free Discharge)
—**1=Orifice/Grate** (Weir Controls 5.10 cfs @ 2.26 fps)
—**2=Orifice/Grate** (Weir Controls 5.10 cfs @ 2.26 fps)

Pond 5P: (new Pond)





Output #4

Downdrain Pipe Drains 4.5 acres at two-thirds full during a 100yr/24hr. rainstorm.

Routing Diagram for IPL LF MM sideslope downdrain 7.19.17
Prepared by Microsoft, Printed 8/2/2017
HydroCAD® 10.00-12 s/n 08568 © 2014 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
4.500	80	>75% Grass cover, Good, HSG D (1S)
4.500	**80**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
0.000	HSG B	
0.000	HSG C	
4.500	HSG D	1S
0.000	Other	
4.500		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	0.000	0.000	4.500	0.000	4.500	>75% Grass cover, Good	1S
0.000	**0.000**	**0.000**	**4.500**	**0.000**	**4.500**	**TOTAL AREA**	

Pipe Listing (all nodes)

Line#	Node Number	In-Invert (feet)	Out-Invert (feet)	Length (feet)	Slope (ft/ft)	n	Diam/Width (inches)	Height (inches)	Inside-Fill (inches)
1	5R	600.00	500.00	400.0	0.2500	0.013	18.0	0.0	0.0

Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 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 1S: (new Subcat) Runoff Area=4.500 ac 0.00% Impervious Runoff Depth>4.44"
Flow Length=90' Slope=0.2500 '/' Tc=4.8 min CN=80 Runoff=37.63 cfs 1.666 af

Reach 5R: (new Reach) Avg. Flow Depth=0.93' Max Vel=32.26 fps Inflow=37.63 cfs 1.666 af
18.0" Round Pipe n=0.013 L=400.0' S=0.2500 '/' Capacity=52.52 cfs Outflow=36.92 cfs 1.665 af

Total Runoff Area = 4.500 ac Runoff Volume = 1.666 af Average Runoff Depth = 4.44"
100.00% Pervious = 4.500 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment 1S: (new Subcat)

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

Runoff = 37.63 cfs @ 11.95 hrs, Volume= 1.666 af, Depth> 4.44"

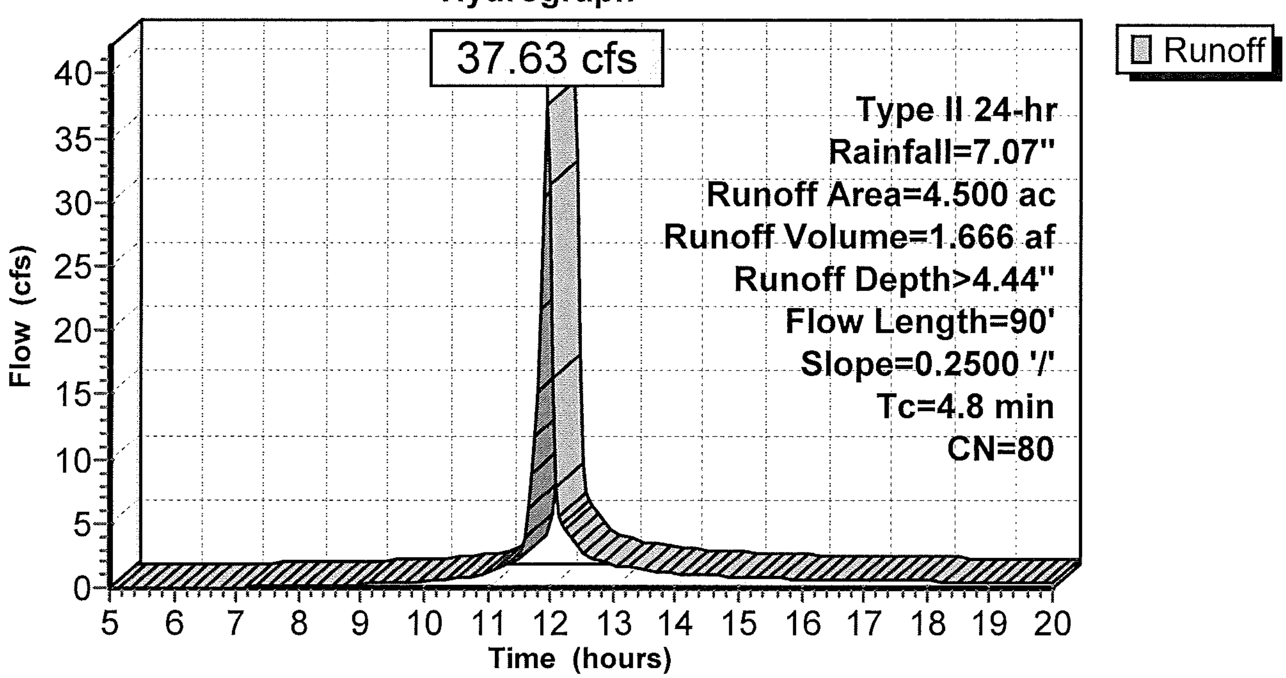
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr Rainfall=7.07"

Area (ac)	CN	Description
4.500	80	>75% Grass cover, Good, HSG D
4.500		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.8	90	0.2500	0.31		**Sheet Flow, 90** Grass: Dense n= 0.240 P2= 3.16"

Subcatchment 1S: (new Subcat)

Hydrograph



Summary for Reach 5R: (new Reach)

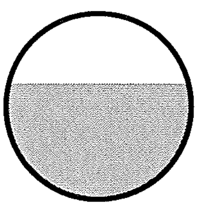
[52] Hint: Inlet/Outlet conditions not evaluated

Inflow Area = 4.500 ac, 0.00% Impervious, Inflow Depth > 4.44"
Inflow = 37.63 cfs @ 11.95 hrs, Volume= 1.666 af
Outflow = 36.92 cfs @ 11.96 hrs, Volume= 1.665 af, Atten= 2%, Lag= 0.3 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 32.26 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 10.25 fps, Avg. Travel Time= 0.7 min

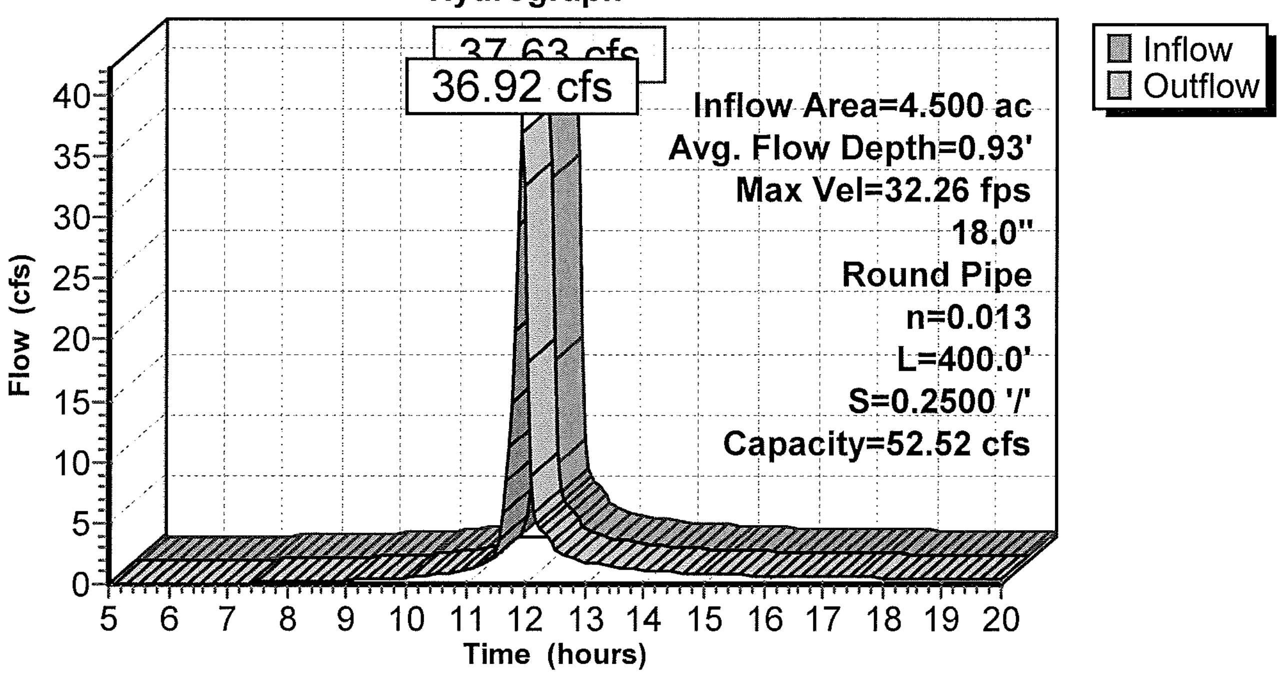
Peak Storage= 463 cf @ 11.95 hrs
Average Depth at Peak Storage= 0.93'
Bank-Full Depth= 1.50' Flow Area= 1.8 sf, Capacity= 52.52 cfs

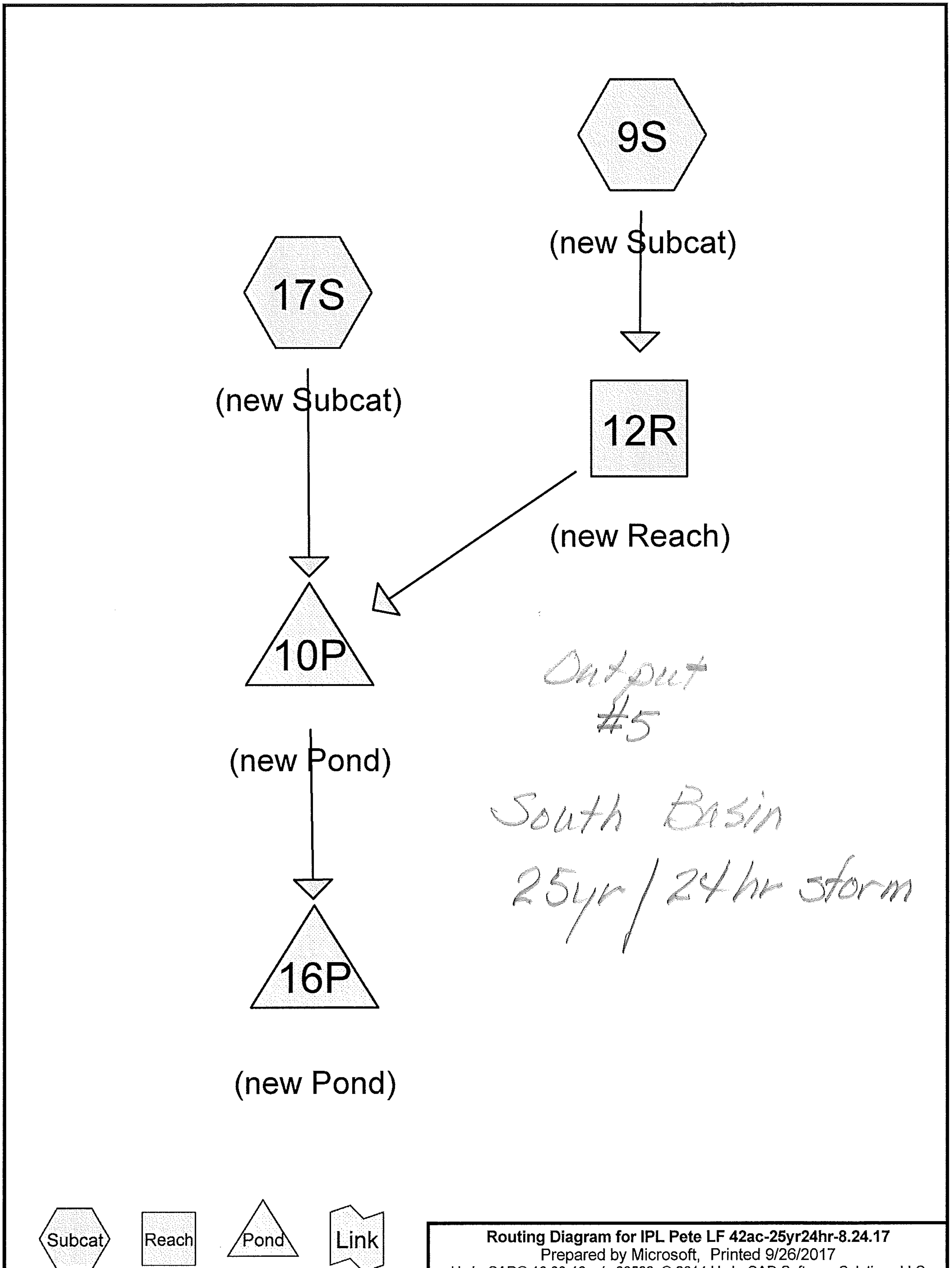
18.0" Round Pipe
n= 0.013 Corrugated PE, smooth interior
Length= 400.0' Slope= 0.2500 '/'
Inlet Invert= 600.00', Outlet Invert= 500.00'



Reach 5R: (new Reach)

Hydrograph





Routing Diagram for IPL Pete LF 42ac-25yr24hr-8.24.17
Prepared by Microsoft, Printed 9/26/2017
HydroCAD® 10.00-12 s/n 08568 © 2014 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
44.600	85	(9S, 17S)
44.600	**85**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
0.000	HSG B	
0.000	HSG C	
0.000	HSG D	
44.600	Other	9S, 17S
44.600		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	0.000	0.000	0.000	44.600	44.600		9S, 17S
0.000	**0.000**	**0.000**	**0.000**	**44.600**	**44.600**	**TOTAL AREA**	

Pipe Listing (all nodes)

Line#	Node Number	In-Invert (feet)	Out-Invert (feet)	Length (feet)	Slope (ft/ft)	n	Diam/Width (inches)	Height (inches)	Inside-Fill (inches)
1	10P	496.00	493.00	700.0	0.0043	0.020	54.0	0.0	0.0
2	16P	491.00	490.00	200.0	0.0050	0.020	18.0	0.0	0.0
3	16P	497.30	490.00	75.0	0.0973	0.020	24.0	0.0	0.0

Time span=5.00-100.00 hrs, dt=0.05 hrs, 1901 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 9S: (new Subcat) Runoff Area=32.000 ac 0.00% Impervious Runoff Depth=3.83"
Flow Length=3,000' Slope=0.0333 '/' Tc=35.6 min CN=85 Runoff=94.33 cfs 10.221 af

Subcatchment 17S: (new Subcat) Runoff Area=12.600 ac 0.00% Impervious Runoff Depth=3.83"
Flow Length=600' Slope=0.2500 '/' Tc=3.6 min CN=85 Runoff=87.75 cfs 4.025 af

Reach 12R: (new Reach) Avg. Flow Depth=1.92' Max Vel=4.05 fps Inflow=94.33 cfs 10.221 af
n=0.030 L=1,200.0' S=0.0050 '/' Capacity=233.39 cfs Outflow=91.32 cfs 10.221 af

Pond 10P: (new Pond) Peak Elev=505.42' Storage=0.058 af Inflow=106.45 cfs 14.246 af
Outflow=104.53 cfs 14.246 af

Pond 16P: (new Pond) Peak Elev=497.65' Storage=8.403 af Inflow=104.53 cfs 14.246 af
Outflow=11.40 cfs 14.170 af

Total Runoff Area = 44.600 ac Runoff Volume = 14.246 af Average Runoff Depth = 3.83"
100.00% Pervious = 44.600 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment 9S: (new Subcat)

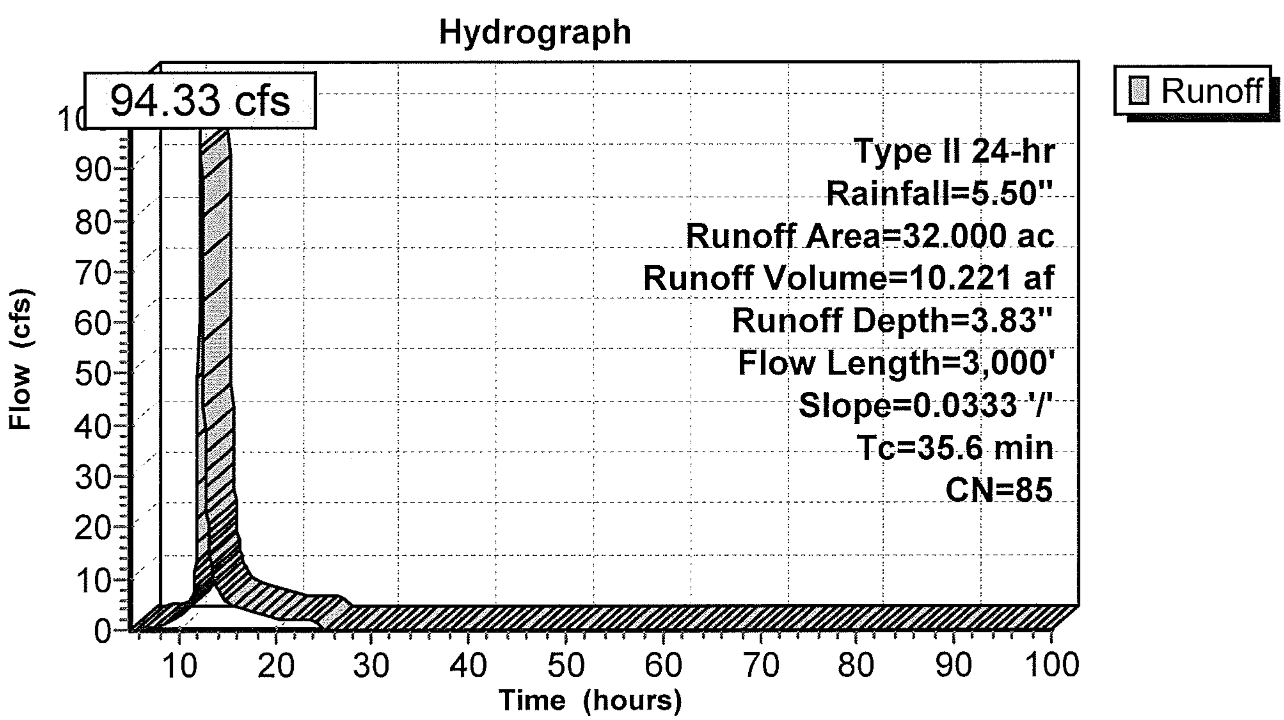
Runoff = 94.33 cfs @ 12.30 hrs, Volume= 10.221 af, Depth= 3.83"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-100.00 hrs, dt= 0.05 hrs
Type II 24-hr Rainfall=5.50"

	Area (ac)	CN	Description
*	32.000	85	
	32.000		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
35.6	3,000	0.0333	1.41		**Lag/CN Method,**

Subcatchment 9S: (new Subcat)



Summary for Subcatchment 17S: (new Subcat)

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

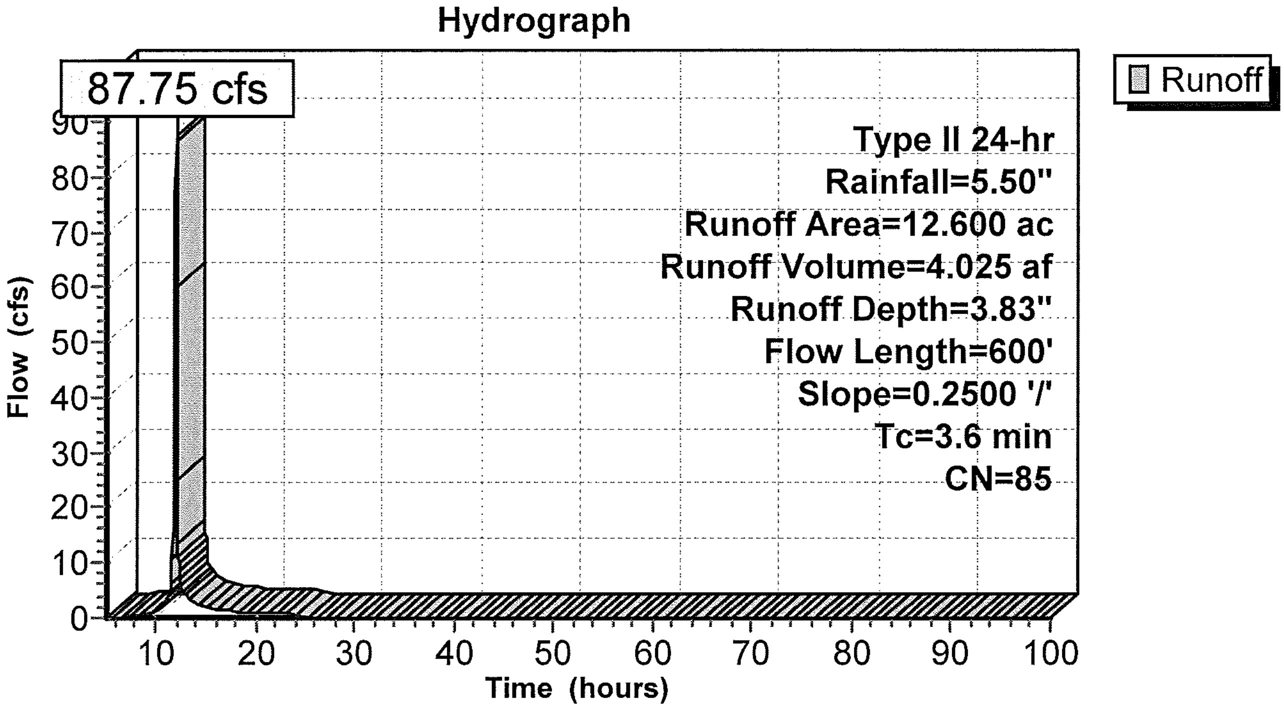
Runoff = 87.75 cfs @ 11.94 hrs, Volume= 4.025 af, Depth= 3.83"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-100.00 hrs, dt= 0.05 hrs
Type II 24-hr Rainfall=5.50"

	Area (ac)	CN	Description
*	12.600	85	
	12.600		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	600	0.2500	2.79		**Lag/CN Method,**

Subcatchment 17S: (new Subcat)



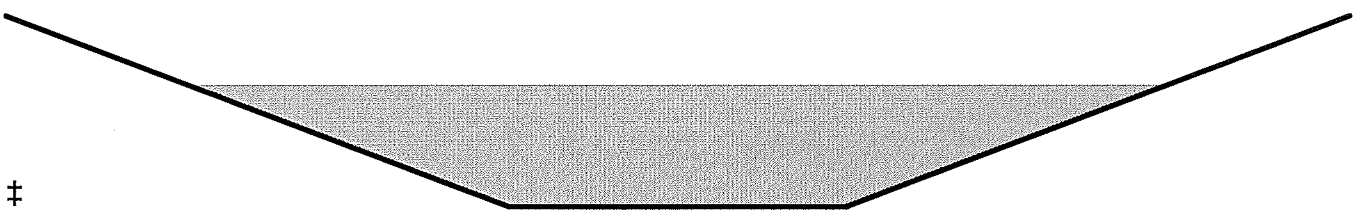
Summary for Reach 12R: (new Reach)

Inflow Area = 32.000 ac, 0.00% Impervious, Inflow Depth = 3.83"
Inflow = 94.33 cfs @ 12.30 hrs, Volume= 10.221 af
Outflow = 91.32 cfs @ 12.37 hrs, Volume= 10.221 af, Atten= 3%, Lag= 3.9 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-100.00 hrs, dt= 0.05 hrs
Max. Velocity= 4.05 fps, Min. Travel Time= 4.9 min
Avg. Velocity = 1.12 fps, Avg. Travel Time= 17.8 min

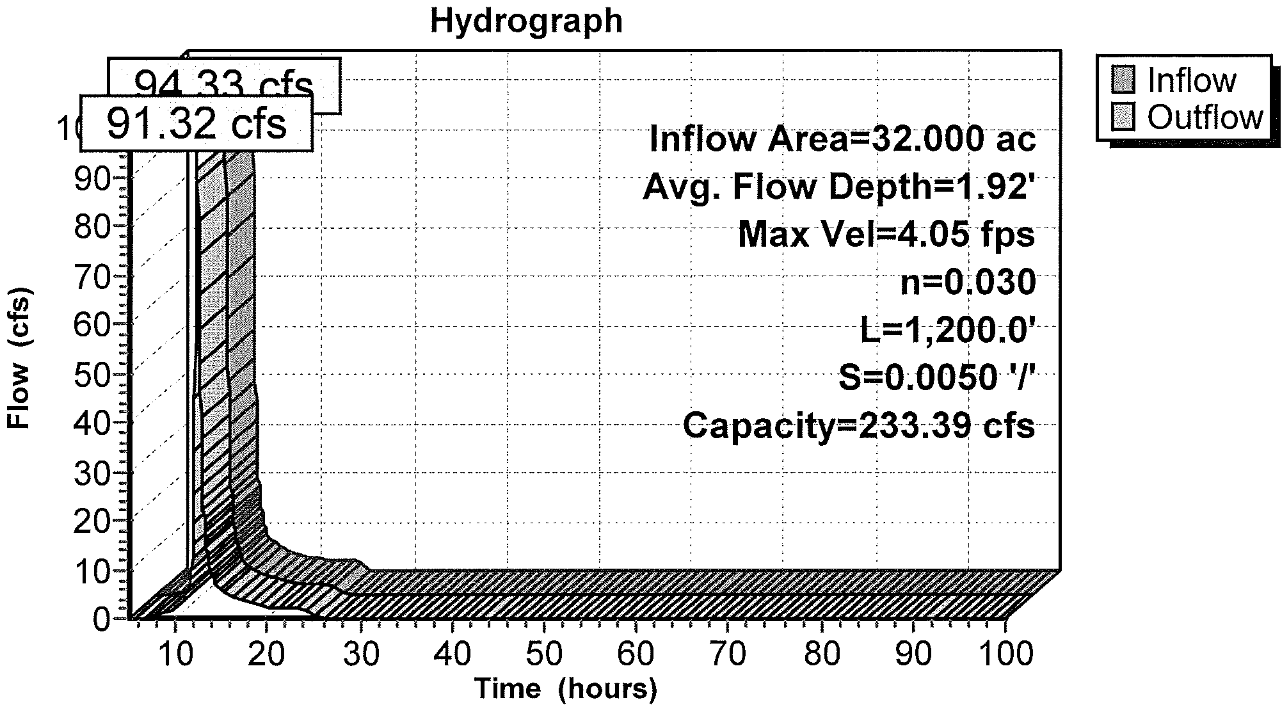
Peak Storage= 27,056 cf @ 12.37 hrs
Average Depth at Peak Storage= 1.92'
Bank-Full Depth= 3.00' Flow Area= 45.0 sf, Capacity= 233.39 cfs

6.00' x 3.00' deep channel, n= 0.030 Earth, dense weeds
Side Slope Z-value= 3.0 '/' Top Width= 24.00'
Length= 1,200.0' Slope= 0.0050 '/'
Inlet Invert= 514.00', Outlet Invert= 508.00'



‡

Reach 12R: (new Reach)



Summary for Pond 10P: (new Pond)

[58] Hint: Peaked 525.42' above defined flood level

Inflow Area = 44.600 ac, 0.00% Impervious, Inflow Depth = 3.83"
Inflow = 106.45 cfs @ 11.95 hrs, Volume= 14.246 af
Outflow = 104.53 cfs @ 11.95 hrs, Volume= 14.246 af, Atten= 2%, Lag= 0.5 min
Primary = 104.53 cfs @ 11.95 hrs, Volume= 14.246 af

Routing by Dyn-Stor-Ind method, Time Span= 5.00-100.00 hrs, dt= 0.05 hrs
Peak Elev= 505.42' @ 11.95 hrs Surf.Area= 0.079 ac Storage= 0.058 af
Flood Elev= -20.00' Surf.Area= 0.000 ac Storage= 0.000 af

Plug-Flow detention time= 0.3 min calculated for 14.238 af (100% of inflow)
Center-of-Mass det. time= 0.3 min (826.6 - 826.3)

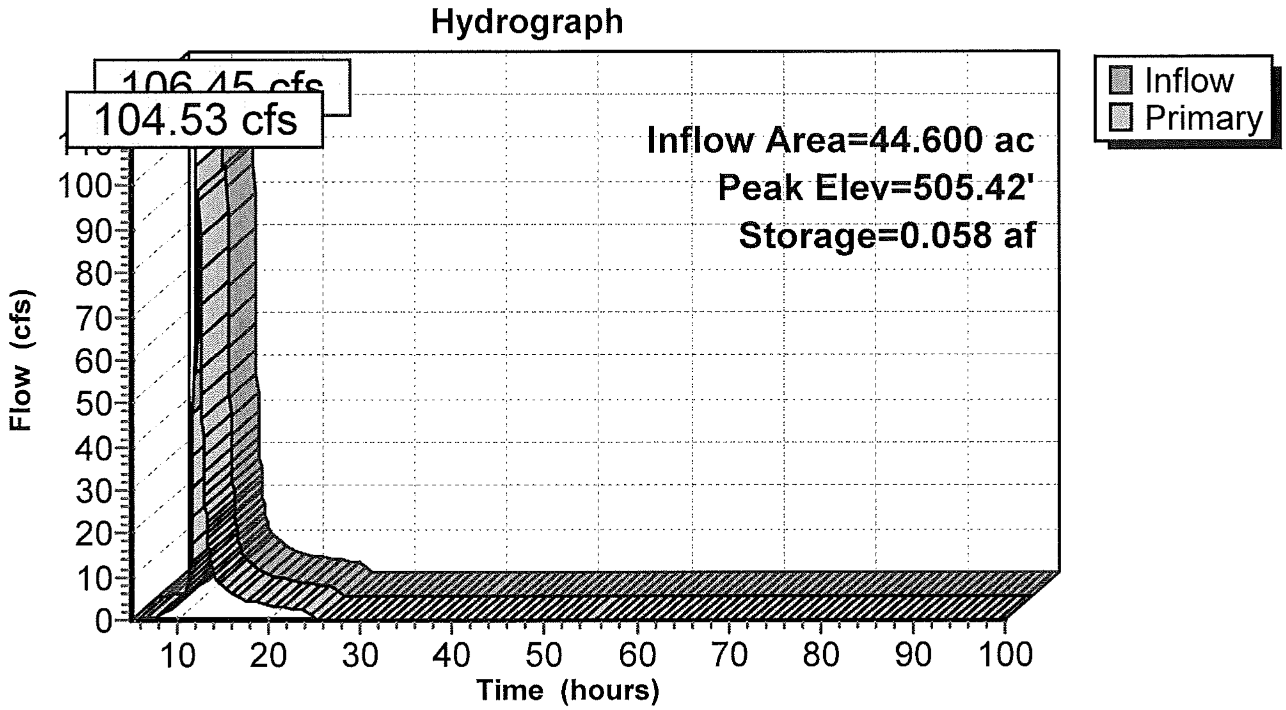
Volume	Invert	Avail.Storage	Storage Description
#1	504.00'	0.250 af	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
504.00	0.002	0.000	0.000
507.00	0.165	0.250	0.250

Device	Routing	Invert	Outlet Devices
#1	Device 2	504.00'	**72.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#2	Primary	496.00'	**54.0" Round Culvert** L= 700.0' Ke= 0.700 Inlet / Outlet Invert= 496.00' / 493.00' S= 0.0043 '/' Cc= 0.900 n= 0.020 Corrugated PE, corrugated interior, Flow Area= 15.90 sf

Primary OutFlow Max=103.44 cfs @ 11.95 hrs HW=505.41' TW=493.25' (Dynamic Tailwater)
↑—**2=Culvert** (Passes 103.44 cfs of 121.68 cfs potential flow)
↑—**1=Orifice/Grate** (Weir Controls 103.44 cfs @ 3.89 fps)

Pond 10P: (new Pond)



Summary for Pond 16P: (new Pond)

Inflow Area = 44.600 ac, 0.00% Impervious, Inflow Depth = 3.83"
Inflow = 104.53 cfs @ 11.95 hrs, Volume= 14.246 af
Outflow = 11.40 cfs @ 13.95 hrs, Volume= 14.170 af, Atten= 89%, Lag= 119.6 min
Primary = 11.40 cfs @ 13.95 hrs, Volume= 14.170 af

Routing by Dyn-Stor-Ind method, Time Span= 5.00-100.00 hrs, dt= 0.05 hrs
Peak Elev= 497.65' @ 13.95 hrs Surf.Area= 1.478 ac Storage= 8.403 af

Plug-Flow detention time= 455.0 min calculated for 14.163 af (99% of inflow)
Center-of-Mass det. time= 453.5 min (1,280.1 - 826.6)

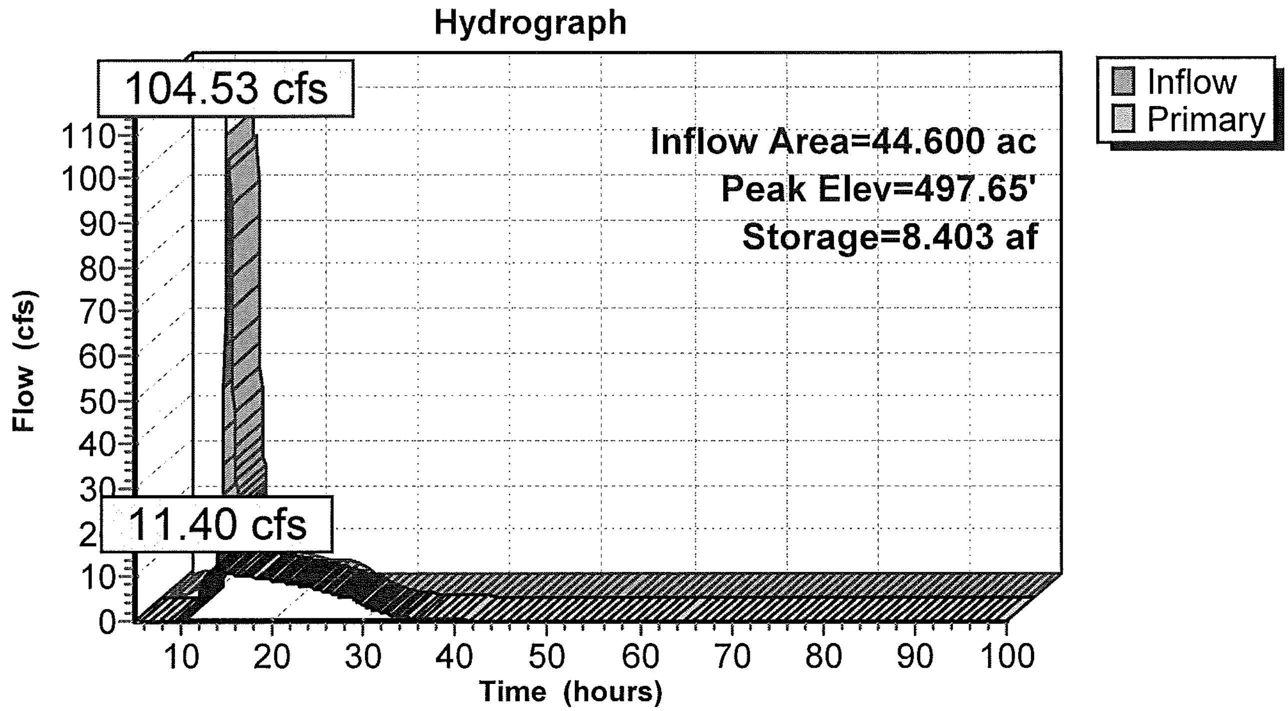
Volume	Invert	Avail.Storage	Storage Description
#1	491.00'	12.060 af	**Custom Stage Data (Prismatic)** Listed below (Recalc)

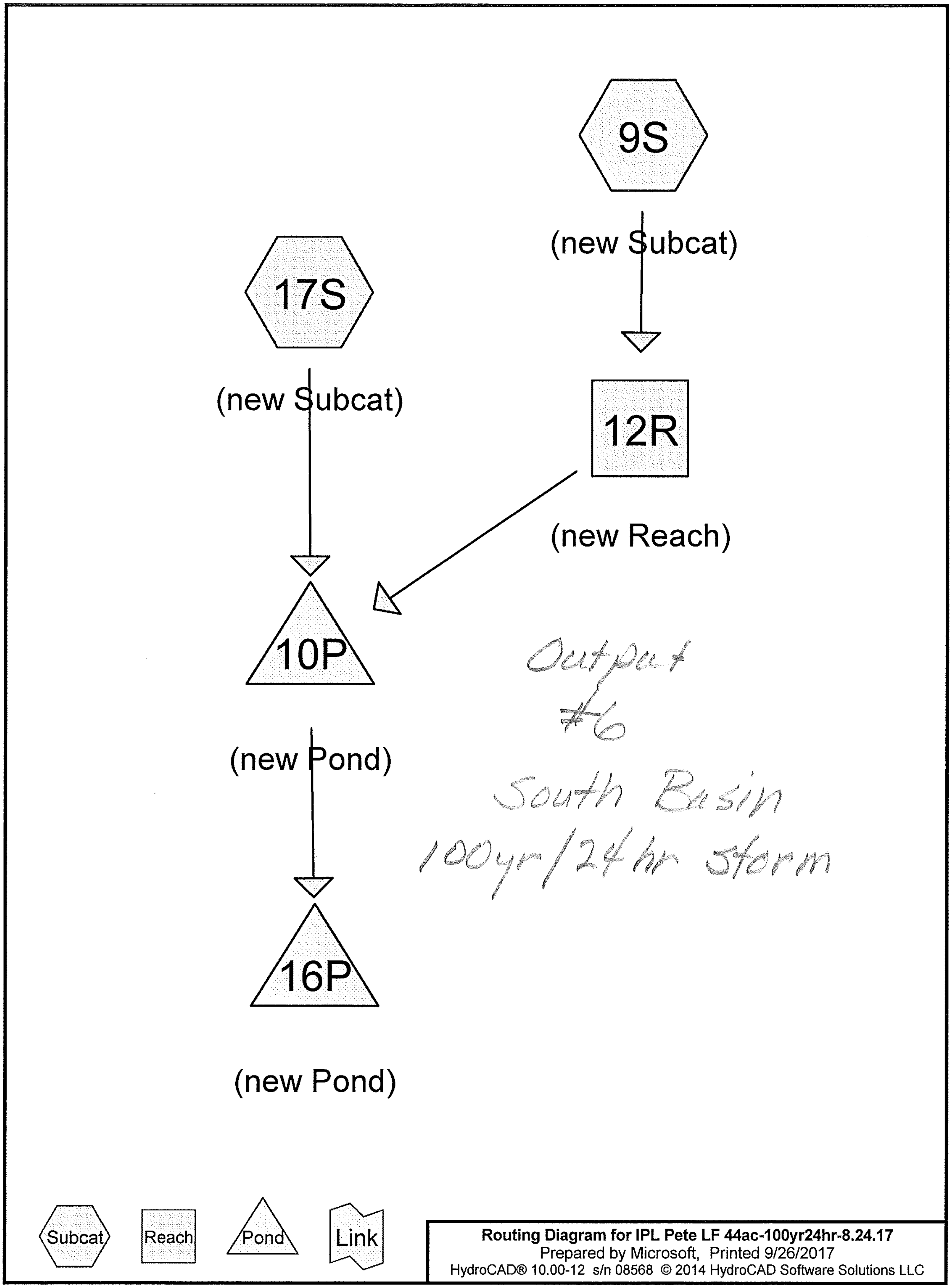
Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
491.00	1.050	0.000	0.000
500.00	1.630	12.060	12.060

Device	Routing	Invert	Outlet Devices
#1	Primary	491.00'	**18.0" Round Culvert** L= 200.0' Ke= 0.900 Inlet / Outlet Invert= 491.00' / 490.00' S= 0.0050 '/' Cc= 0.900 n= 0.020 Corrugated PE, corrugated interior, Flow Area= 1.77 sf
#2	Primary	497.30'	**24.0" Round Culvert** L= 75.0' Ke= 0.900 Inlet / Outlet Invert= 497.30' / 490.00' S= 0.0973 '/' Cc= 0.900 n= 0.020 Corrugated PE, corrugated interior, Flow Area= 3.14 sf

Primary OutFlow Max=11.40 cfs @ 13.95 hrs HW=497.65' (Free Discharge)
├─**1=Culvert** (Barrel Controls 10.82 cfs @ 6.12 fps)
└─**2=Culvert** (Inlet Controls 0.58 cfs @ 1.58 fps)

Pond 16P: (new Pond)





Routing Diagram for IPL Pete LF 44ac-100yr24hr-8.24.17
Prepared by Microsoft, Printed 9/26/2017
HydroCAD® 10.00-12 s/n 08568 © 2014 HydroCAD Software Solutions LLC

Area Listing (all nodes)

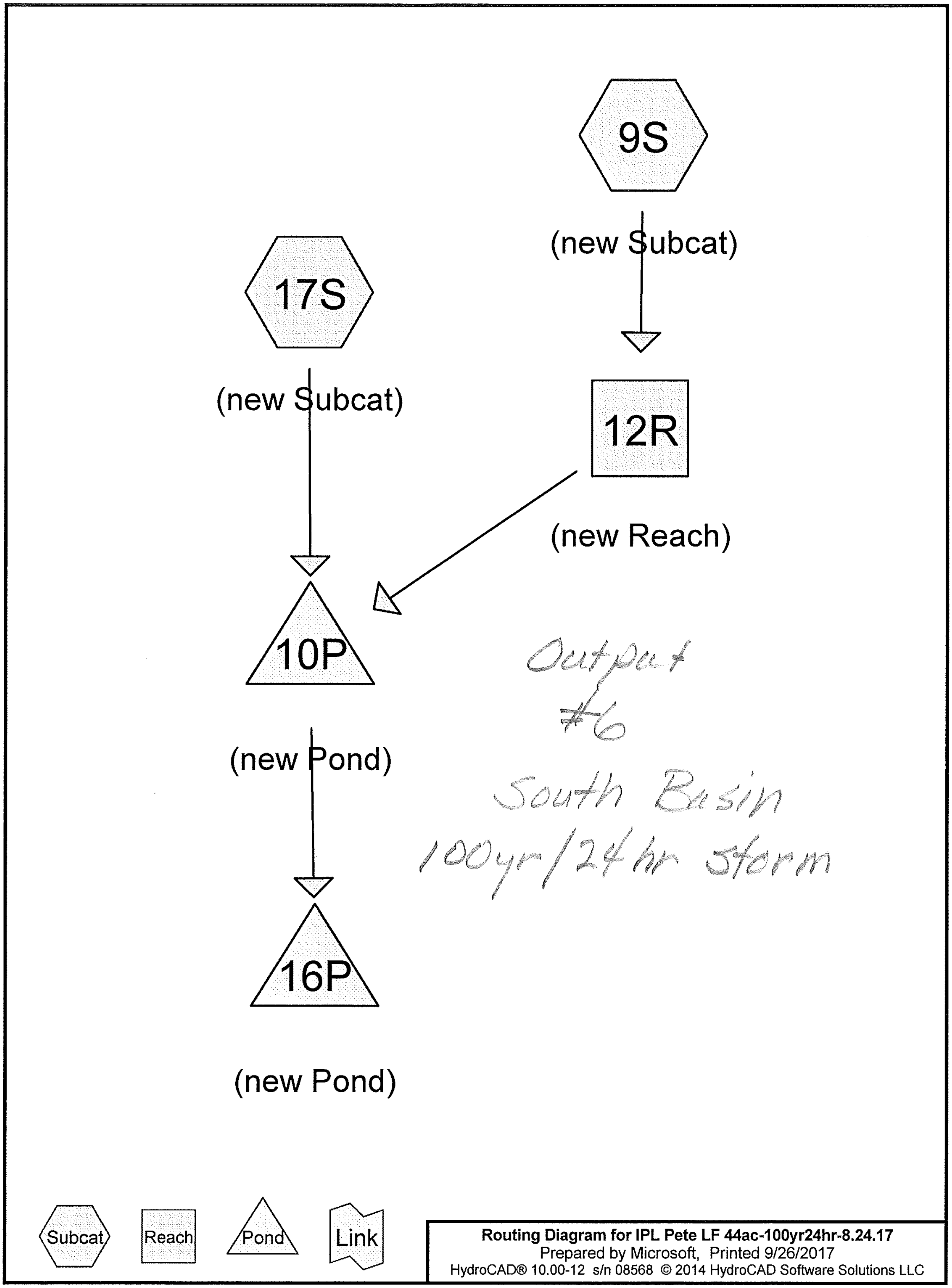
Area (acres)	CN	Description (subcatchment-numbers)
44.600	85	(9S, 17S)
44.600	**85**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
0.000	HSG B	
0.000	HSG C	
0.000	HSG D	
44.600	Other	9S, 17S
44.600		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	0.000	0.000	0.000	44.600	44.600		9S, 17S
0.000	**0.000**	**0.000**	**0.000**	**44.600**	**44.600**	**TOTAL AREA**	



Output
#6
South Basin
100yr/24hr storm

Routing Diagram for IPL Pete LF 44ac-100yr24hr-8.24.17
Prepared by Microsoft, Printed 9/26/2017
HydroCAD® 10.00-12 s/n 08568 © 2014 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
44.600	85	(9S, 17S)
44.600	**85**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
0.000	HSG B	
0.000	HSG C	
0.000	HSG D	
44.600	Other	9S, 17S
44.600		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	0.000	0.000	0.000	44.600	44.600		9S, 17S
0.000	**0.000**	**0.000**	**0.000**	**44.600**	**44.600**	**TOTAL AREA**	

Pipe Listing (all nodes)

Line#	Node Number	In-Invert (feet)	Out-Invert (feet)	Length (feet)	Slope (ft/ft)	n	Diam/Width (inches)	Height (inches)	Inside-Fill (inches)
1	10P	496.00	493.00	700.0	0.0043	0.020	54.0	0.0	0.0
2	16P	491.00	490.00	200.0	0.0050	0.020	18.0	0.0	0.0
3	16P	497.30	490.00	75.0	0.0973	0.020	24.0	0.0	0.0

Time span=5.00-100.00 hrs, dt=0.05 hrs, 1901 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 9S: (new Subcat) Runoff Area=32.000 ac 0.00% Impervious Runoff Depth>5.32"
Flow Length=3,000' Slope=0.0333 '/' Tc=35.6 min CN=85 Runoff=129.69 cfs 14.183 af

Subcatchment 17S: (new Subcat) Runoff Area=12.600 ac 0.00% Impervious Runoff Depth>5.32"
Flow Length=600' Slope=0.2500 '/' Tc=3.6 min CN=85 Runoff=119.23 cfs 5.582 af

Reach 12R: (new Reach) Avg. Flow Depth=2.24' Max Vel=4.41 fps Inflow=129.69 cfs 14.183 af
n=0.030 L=1,200.0' S=0.0050 '/' Capacity=233.39 cfs Outflow=126.14 cfs 14.183 af

Pond 10P: (new Pond) Peak Elev=506.52' Storage=0.178 af Inflow=146.99 cfs 19.765 af
Outflow=129.92 cfs 19.765 af

Pond 16P: (new Pond) Peak Elev=499.40' Storage=11.088 af Inflow=129.92 cfs 19.765 af
Outflow=24.77 cfs 19.688 af

Total Runoff Area = 44.600 ac Runoff Volume = 19.765 af Average Runoff Depth = 5.32"
100.00% Pervious = 44.600 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment 9S: (new Subcat)

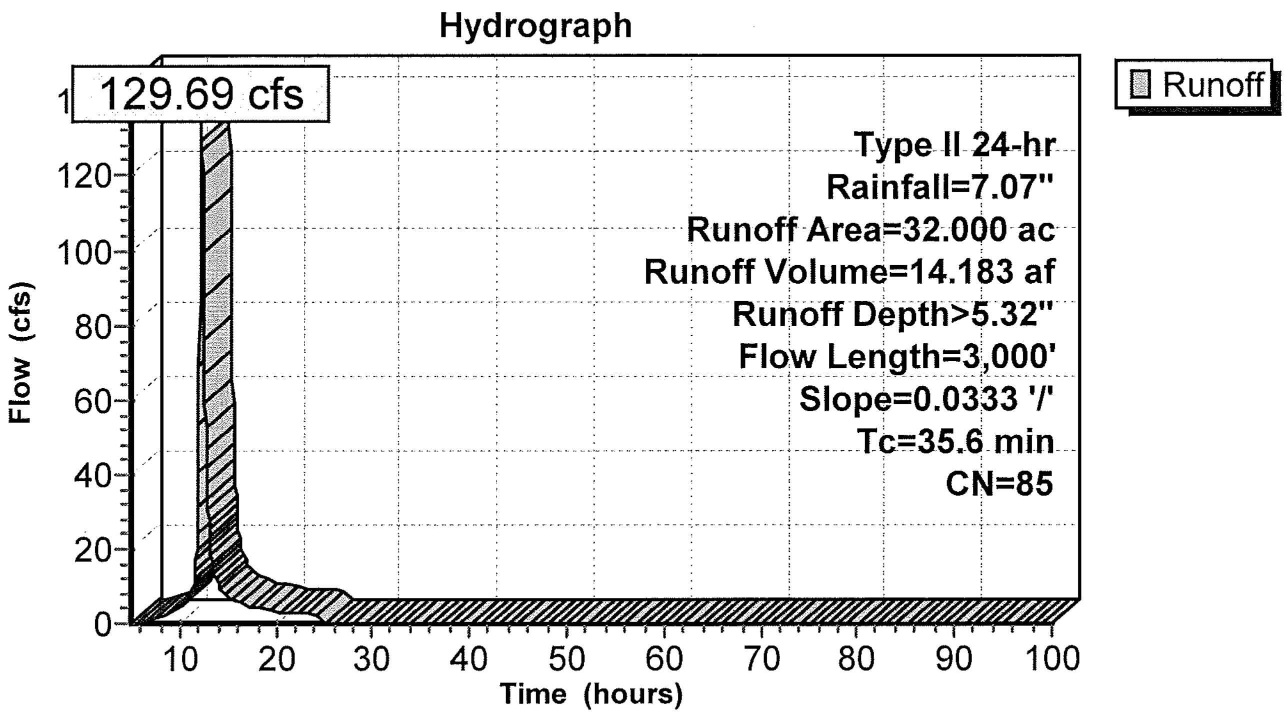
Runoff = 129.69 cfs @ 12.30 hrs, Volume= 14.183 af, Depth> 5.32"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-100.00 hrs, dt= 0.05 hrs
Type II 24-hr Rainfall=7.07"

	Area (ac)	CN	Description
*	32.000	85	
	32.000		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
35.6	3,000	0.0333	1.41		**Lag/CN Method,**

Subcatchment 9S: (new Subcat)



Summary for Subcatchment 17S: (new Subcat)

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

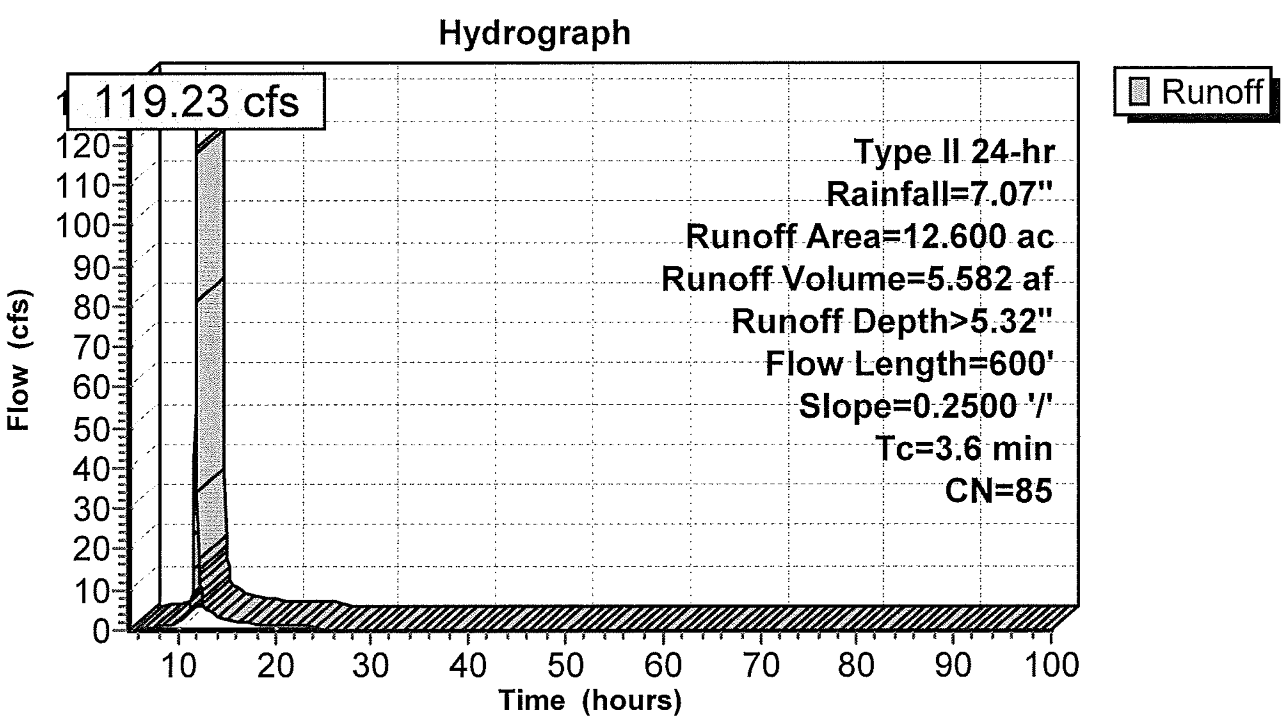
Runoff = 119.23 cfs @ 11.94 hrs, Volume= 5.582 af, Depth> 5.32"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-100.00 hrs, dt= 0.05 hrs
Type II 24-hr Rainfall=7.07"

	Area (ac)	CN	Description
*	12.600	85	
	12.600		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	600	0.2500	2.79		**Lag/CN Method,**

Subcatchment 17S: (new Subcat)



Summary for Reach 12R: (new Reach)

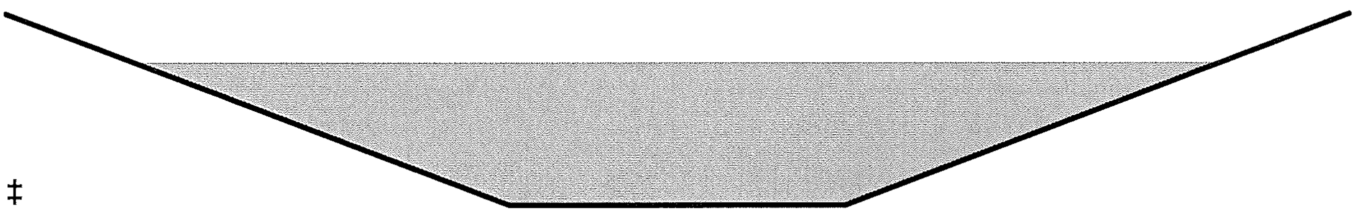
[82] Warning: Early inflow requires earlier time span

Inflow Area = 32.000 ac, 0.00% Impervious, Inflow Depth > 5.32"
Inflow = 129.69 cfs @ 12.30 hrs, Volume= 14.183 af
Outflow = 126.14 cfs @ 12.36 hrs, Volume= 14.183 af, Atten= 3%, Lag= 3.6 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-100.00 hrs, dt= 0.05 hrs
Max. Velocity= 4.41 fps, Min. Travel Time= 4.5 min
Avg. Velocity = 1.25 fps, Avg. Travel Time= 16.0 min

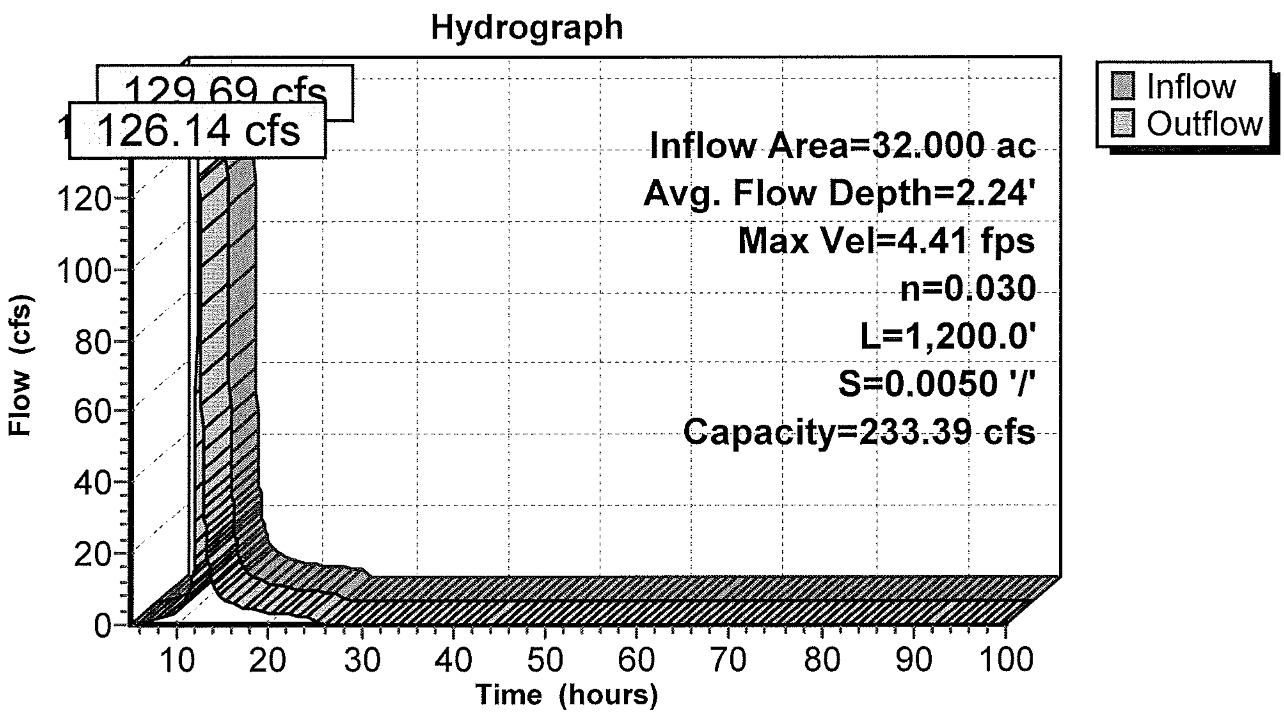
Peak Storage= 34,288 cf @ 12.36 hrs
Average Depth at Peak Storage= 2.24'
Bank-Full Depth= 3.00' Flow Area= 45.0 sf, Capacity= 233.39 cfs

6.00' x 3.00' deep channel, n= 0.030 Earth, dense weeds
Side Slope Z-value= 3.0 '/' Top Width= 24.00'
Length= 1,200.0' Slope= 0.0050 '/'
Inlet Invert= 514.00', Outlet Invert= 508.00'



‡

Reach 12R: (new Reach)



Summary for Pond 10P: (new Pond)

[58] Hint: Peaked 526.52' above defined flood level

Inflow Area = 44.600 ac, 0.00% Impervious, Inflow Depth > 5.32"
Inflow = 146.99 cfs @ 11.95 hrs, Volume= 19.765 af
Outflow = 129.92 cfs @ 12.44 hrs, Volume= 19.765 af, Atten= 12%, Lag= 29.5 min
Primary = 129.92 cfs @ 12.44 hrs, Volume= 19.765 af

Routing by Dyn-Stor-Ind method, Time Span= 5.00-100.00 hrs, dt= 0.05 hrs
Peak Elev= 506.52' @ 12.44 hrs Surf.Area= 0.139 ac Storage= 0.178 af
Flood Elev= -20.00' Surf.Area= 0.000 ac Storage= 0.000 af

Plug-Flow detention time= 0.4 min calculated for 19.754 af (100% of inflow)
Center-of-Mass det. time= 0.4 min (817.1 - 816.7)

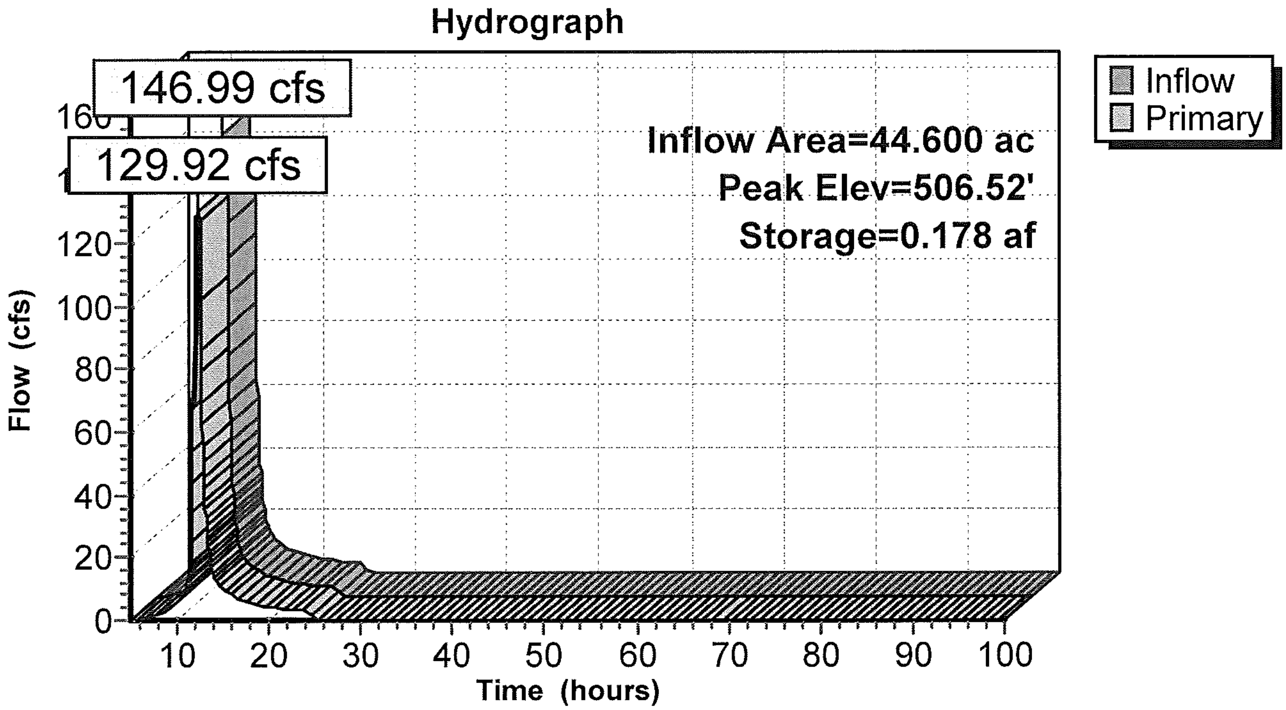
Volume	Invert	Avail.Storage	Storage Description
#1	504.00'	0.250 af	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
504.00	0.002	0.000	0.000
507.00	0.165	0.250	0.250

Device	Routing	Invert	Outlet Devices
#1	Device 2	504.00'	**72.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#2	Primary	496.00'	**54.0" Round Culvert** L= 700.0' Ke= 0.700 Inlet / Outlet Invert= 496.00' / 493.00' S= 0.0043 '/' Cc= 0.900 n= 0.020 Corrugated PE, corrugated interior, Flow Area= 15.90 sf

Primary OutFlow Max=129.76 cfs @ 12.44 hrs HW=506.50' TW=497.31' (Dynamic Tailwater)
↑—**2=Culvert** (Barrel Controls 129.76 cfs @ 8.16 fps)
↑—**1=Orifice/Grate** (Passes 129.76 cfs of 215.16 cfs potential flow)

Pond 10P: (new Pond)



Summary for Pond 16P: (new Pond)

Inflow Area = 44.600 ac, 0.00% Impervious, Inflow Depth > 5.32"
Inflow = 129.92 cfs @ 12.44 hrs, Volume= 19.765 af
Outflow = 24.77 cfs @ 13.36 hrs, Volume= 19.688 af, Atten= 81%, Lag= 55.3 min
Primary = 24.77 cfs @ 13.36 hrs, Volume= 19.688 af

Routing by Dyn-Stor-Ind method, Time Span= 5.00-100.00 hrs, dt= 0.05 hrs
Peak Elev= 499.40' @ 13.36 hrs Surf.Area= 1.591 ac Storage= 11.088 af

Plug-Flow detention time= 421.0 min calculated for 19.687 af (100% of inflow)
Center-of-Mass det. time= 418.3 min (1,235.3 - 817.1)

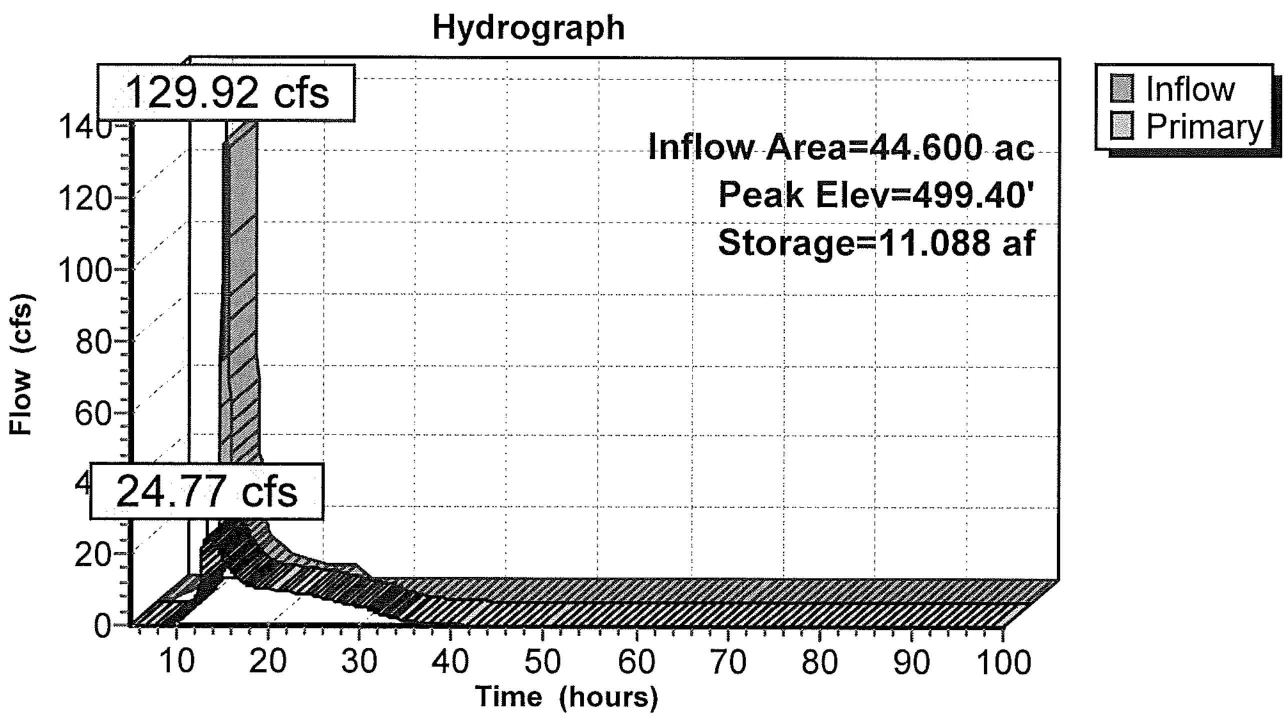
Volume	Invert	Avail.Storage	Storage Description
#1	491.00'	12.060 af	**Custom Stage Data (Prismatic)** Listed below (Recalc)

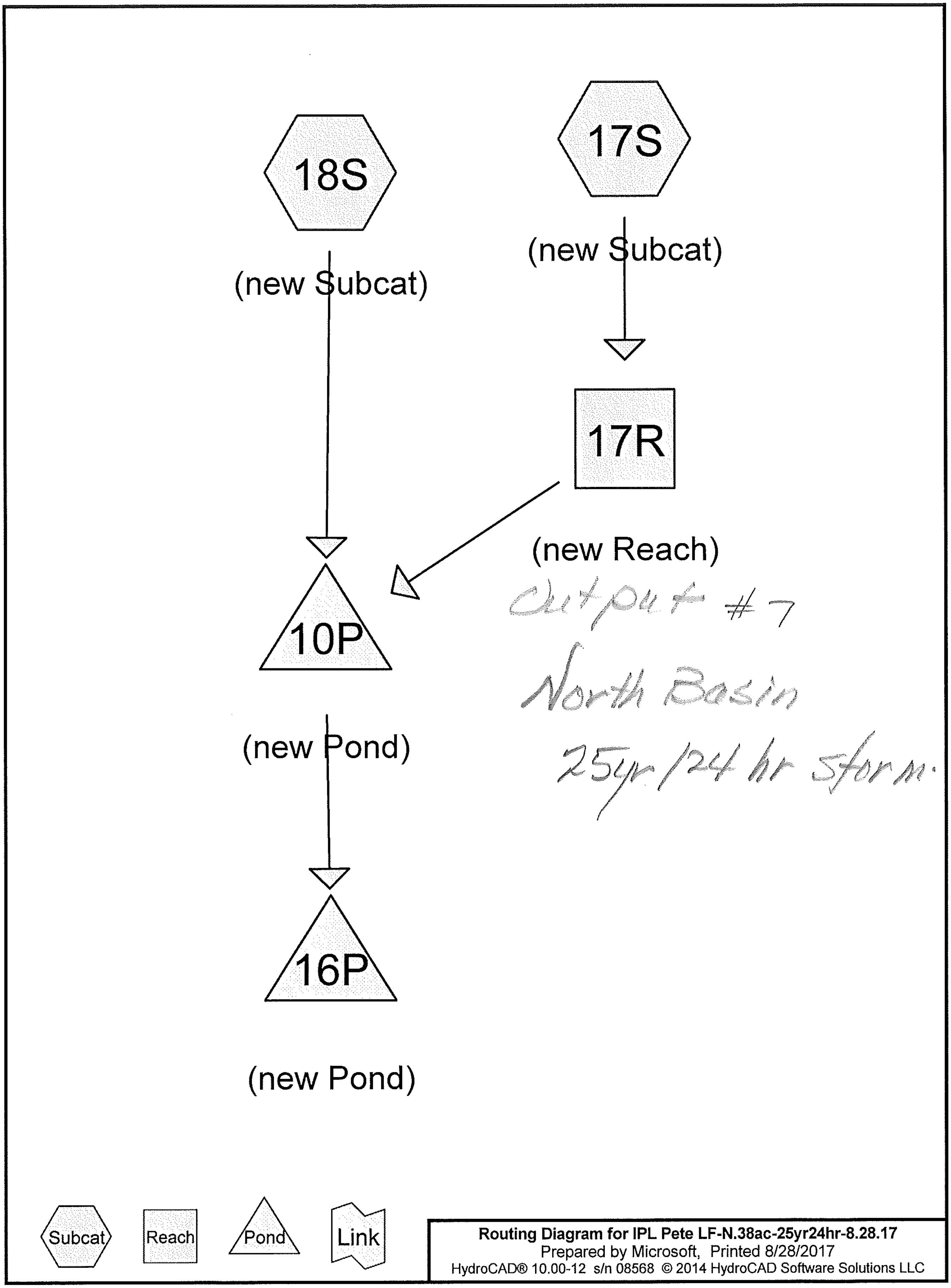
Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
491.00	1.050	0.000	0.000
500.00	1.630	12.060	12.060

Device	Routing	Invert	Outlet Devices
#1	Primary	491.00'	**18.0" Round Culvert** L= 200.0' Ke= 0.900 Inlet / Outlet Invert= 491.00' / 490.00' S= 0.0050 '/' Cc= 0.900 n= 0.020 Corrugated PE, corrugated interior, Flow Area= 1.77 sf
#2	Primary	497.30'	**24.0" Round Culvert** L= 75.0' Ke= 0.900 Inlet / Outlet Invert= 497.30' / 490.00' S= 0.0973 '/' Cc= 0.900 n= 0.020 Corrugated PE, corrugated interior, Flow Area= 3.14 sf

Primary OutFlow Max=24.77 cfs @ 13.36 hrs HW=499.40' (Free Discharge)
1=Culvert (Barrel Controls 12.26 cfs @ 6.94 fps)
2=Culvert (Inlet Controls 12.50 cfs @ 3.98 fps)

Pond 16P: (new Pond)




18S
(new Subcat)
17S
(new Subcat)
17R
(new Reach)
10P
(new Pond)
16P
(new Pond)
Output #7
North Basin
25yr/24 hr storm.
Subcat
Reach
Pond
Link
Routing Diagram for IPL Pete LF-N.38ac-25yr24hr-8.28.17
Prepared by Microsoft, Printed 8/28/2017
HydroCAD® 10.00-12 s/n 08568 © 2014 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
38.000	80	(17S, 18S)
38.000	**80**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
0.000	HSG B	
0.000	HSG C	
0.000	HSG D	
38.000	Other	17S, 18S
38.000		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	0.000	0.000	0.000	38.000	38.000		17S, 18S
0.000	**0.000**	**0.000**	**0.000**	**38.000**	**38.000**	**TOTAL AREA**	

Pipe Listing (all nodes)

Line#	Node Number	In-Invert (feet)	Out-Invert (feet)	Length (feet)	Slope (ft/ft)	n	Diam/Width (inches)	Height (inches)	Inside-Fill (inches)
1	10P	501.00	500.00	120.0	0.0083	0.020	54.0	0.0	0.0
2	16P	500.00	498.00	160.0	0.0125	0.020	18.0	0.0	0.0
3	16P	507.00	498.00	80.0	0.1125	0.020	24.0	0.0	0.0

Time span=5.00-100.00 hrs, dt=0.05 hrs, 1901 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 17S: (new Subcat) Runoff Area=20.000 ac 0.00% Impervious Runoff Depth=3.33"
Flow Length=1,500' Slope=0.0500 '/' Tc=19.7 min CN=80 Runoff=74.35 cfs 5.556 af

Subcatchment 18S: (new Subcat) Runoff Area=18.000 ac 0.00% Impervious Runoff Depth=3.33"
Flow Length=1,500' Slope=0.0500 '/' Tc=19.7 min CN=80 Runoff=66.91 cfs 5.000 af

Reach 17R: (new Reach) Avg. Flow Depth=1.68' Max Vel=3.75 fps Inflow=74.35 cfs 5.556 af
n=0.030 L=1,000.0' S=0.0050 '/' Capacity=233.39 cfs Outflow=69.88 cfs 5.556 af

Pond 10P: (new Pond) Peak Elev=509.68' Storage=0.061 af Inflow=134.63 cfs 10.556 af
Outflow=134.54 cfs 10.556 af

Pond 16P: (new Pond) Peak Elev=501.28' Storage=7.480 af Inflow=134.54 cfs 10.556 af
Outflow=4.87 cfs 4.964 af

Total Runoff Area = 38.000 ac Runoff Volume = 10.556 af Average Runoff Depth = 3.33"
100.00% Pervious = 38.000 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment 17S: (new Subcat)

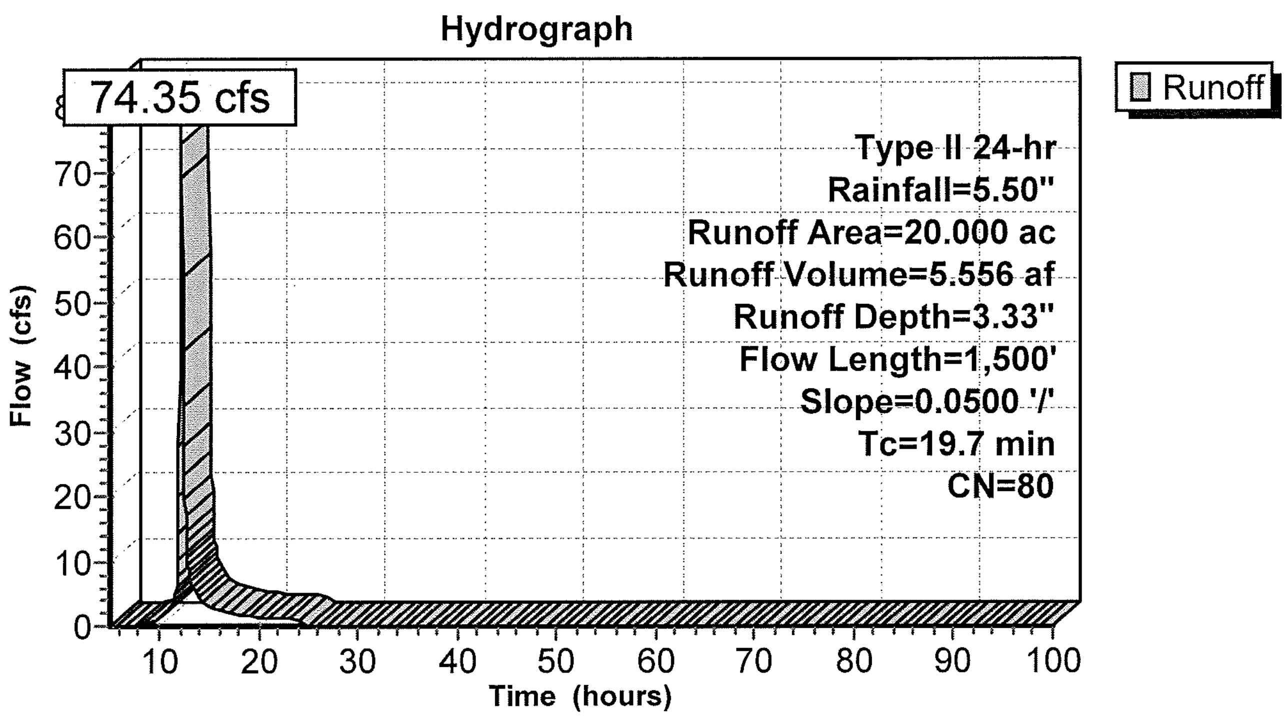
Runoff = 74.35 cfs @ 12.12 hrs, Volume= 5.556 af, Depth= 3.33"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-100.00 hrs, dt= 0.05 hrs
Type II 24-hr Rainfall=5.50"

	Area (ac)	CN	Description
*	20.000	80	
	20.000		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
19.7	1,500	0.0500	1.27		**Lag/CN Method,**

Subcatchment 17S: (new Subcat)



Summary for Subcatchment 18S: (new Subcat)

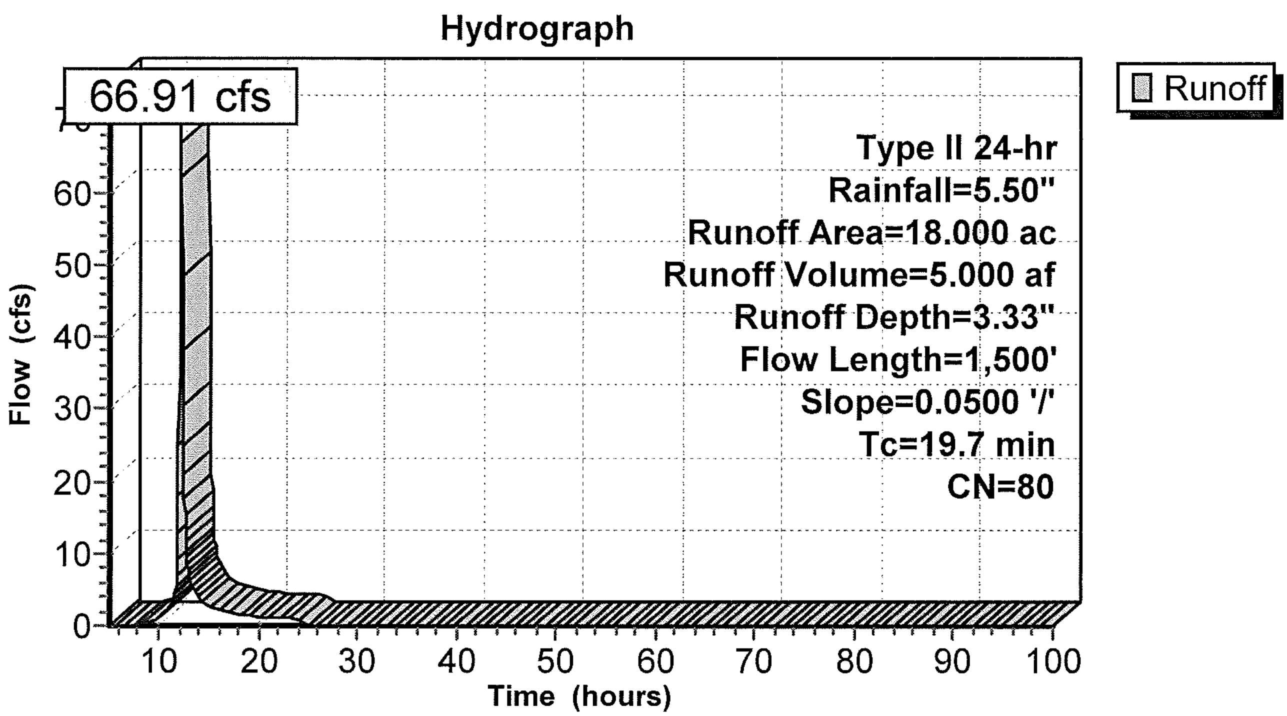
Runoff = 66.91 cfs @ 12.12 hrs, Volume= 5.000 af, Depth= 3.33"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-100.00 hrs, dt= 0.05 hrs
Type II 24-hr Rainfall=5.50"

	Area (ac)	CN	Description
*	18.000	80	
	18.000		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
19.7	1,500	0.0500	1.27		**Lag/CN Method,**

Subcatchment 18S: (new Subcat)



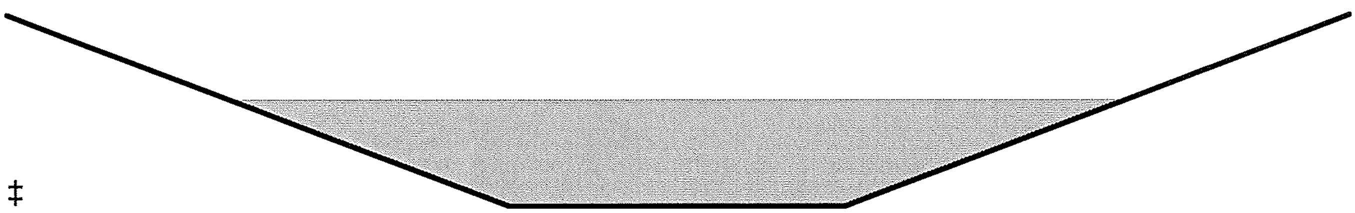
Summary for Reach 17R: (new Reach)

Inflow Area = 20.000 ac, 0.00% Impervious, Inflow Depth = 3.33"
Inflow = 74.35 cfs @ 12.12 hrs, Volume= 5.556 af
Outflow = 69.88 cfs @ 12.17 hrs, Volume= 5.556 af, Atten= 6%, Lag= 3.2 min

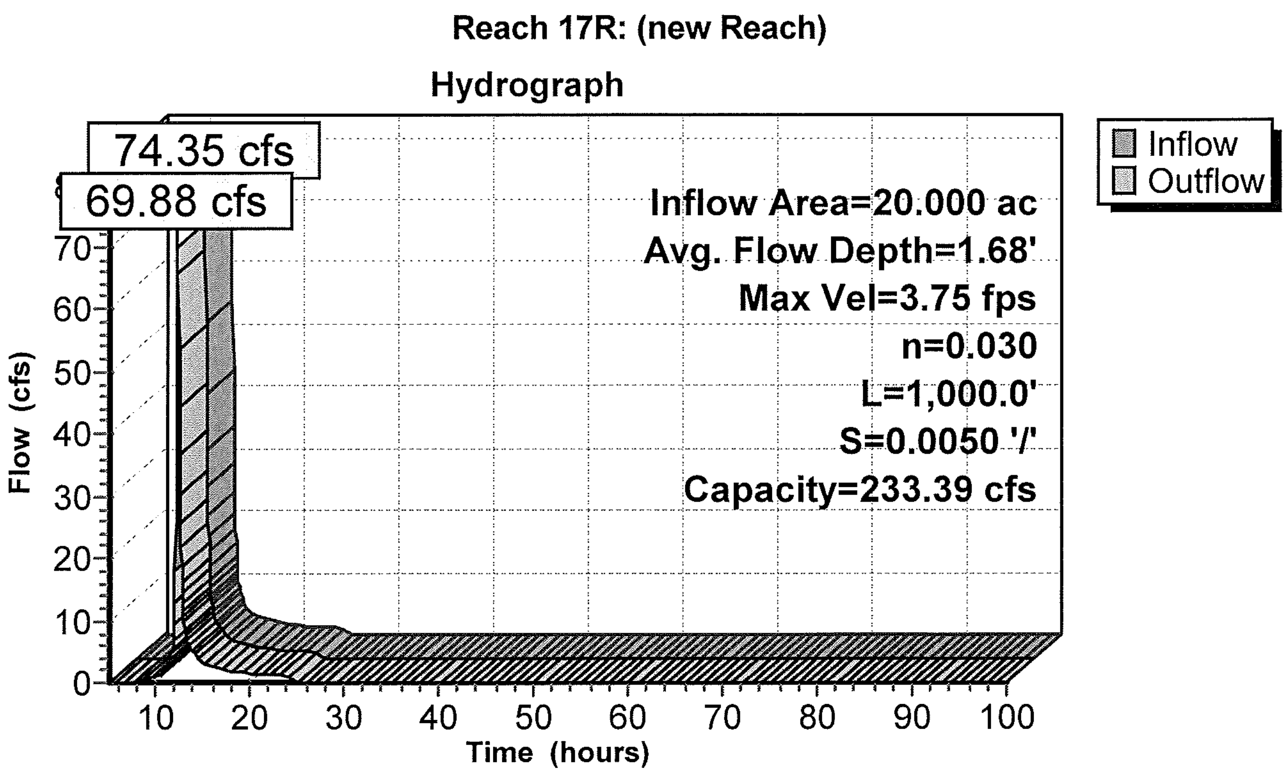
Routing by Dyn-Stor-Ind method, Time Span= 5.00-100.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.75 fps, Min. Travel Time= 4.4 min
Avg. Velocity = 0.98 fps, Avg. Travel Time= 16.9 min

Peak Storage= 18,550 cf @ 12.17 hrs
Average Depth at Peak Storage= 1.68'
Bank-Full Depth= 3.00' Flow Area= 45.0 sf, Capacity= 233.39 cfs

6.00' x 3.00' deep channel, n= 0.030 Earth, dense weeds
Side Slope Z-value= 3.0 '/' Top Width= 24.00'
Length= 1,000.0' Slope= 0.0050 '/'
Inlet Invert= 5.00', Outlet Invert= 0.00'



‡



Summary for Pond 10P: (new Pond)

[58] Hint: Peaked 529.68' above defined flood level
[63] Warning: Exceeded Reach 17R INLET depth by 503.03' @ 12.10 hrs

Inflow Area = 38.000 ac, 0.00% Impervious, Inflow Depth = 3.33"
Inflow = 134.63 cfs @ 12.15 hrs, Volume= 10.556 af
Outflow = 134.54 cfs @ 12.16 hrs, Volume= 10.556 af, Atten= 0%, Lag= 0.4 min
Primary = 134.54 cfs @ 12.16 hrs, Volume= 10.556 af

Routing by Dyn-Stor-Ind method, Time Span= 5.00-100.00 hrs, dt= 0.05 hrs
Peak Elev= 509.68' @ 12.16 hrs Surf.Area= 0.071 ac Storage= 0.061 af
Flood Elev= -20.00' Surf.Area= 0.000 ac Storage= 0.000 af

Plug-Flow detention time= 0.2 min calculated for 10.550 af (100% of inflow)
Center-of-Mass det. time= 0.2 min (832.2 - 832.0)

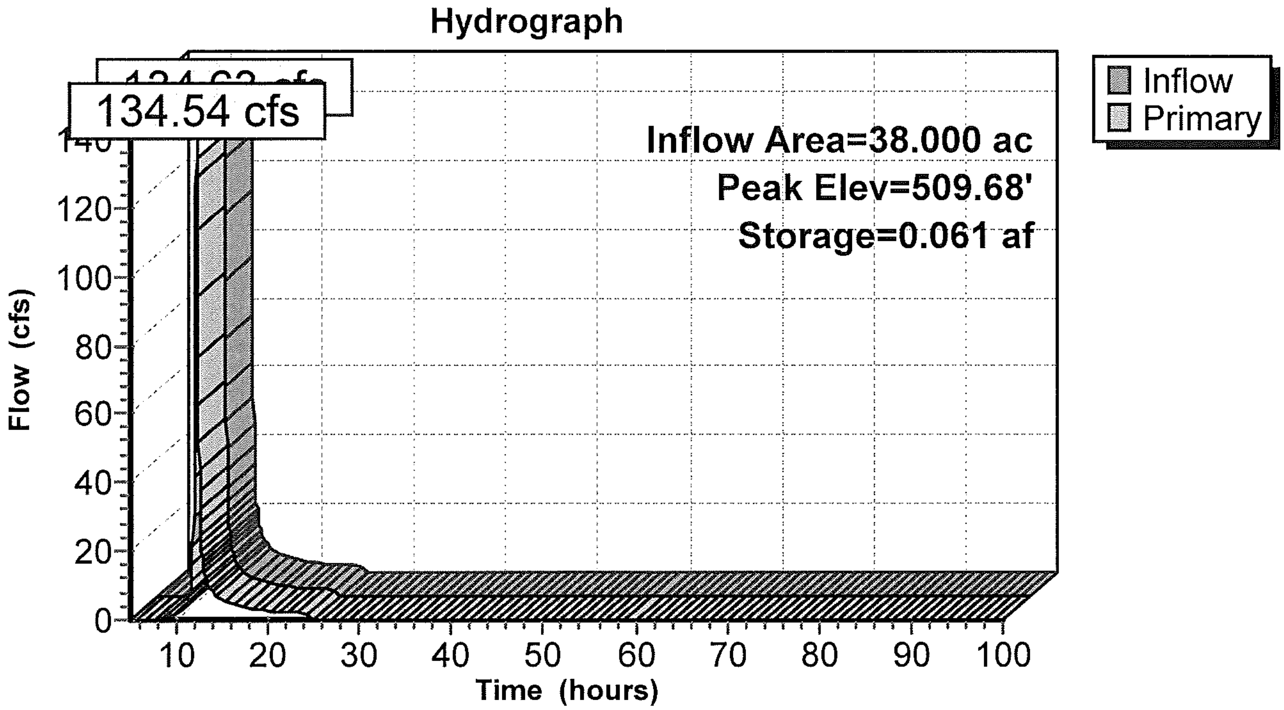
Volume	Invert	Avail.Storage	Storage Description
#1	508.00'	0.334 af	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
508.00	0.002	0.000	0.000
512.00	0.165	0.334	0.334

Device	Routing	Invert	Outlet Devices
#1	Device 2	508.00'	**72.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#2	Primary	501.00'	**54.0" Round Culvert** L= 120.0' Ke= 0.700 Inlet / Outlet Invert= 501.00' / 500.00' S= 0.0083 '/' Cc= 0.900 n= 0.020 Corrugated PE, corrugated interior, Flow Area= 15.90 sf

Primary OutFlow Max=133.77 cfs @ 12.16 hrs HW=509.68' TW=498.30' (Dynamic Tailwater)
└─**2=Culvert** (Passes 133.77 cfs of 170.49 cfs potential flow)
  └─**1=Orifice/Grate** (Weir Controls 133.77 cfs @ 4.23 fps)

Pond 10P: (new Pond)



Summary for Pond 16P: (new Pond)

Inflow Area = 38.000 ac, 0.00% Impervious, Inflow Depth = 3.33"
Inflow = 134.54 cfs @ 12.16 hrs, Volume= 10.556 af
Outflow = 4.87 cfs @ 15.84 hrs, Volume= 4.964 af, Atten= 96%, Lag= 221.1 min
Primary = 4.87 cfs @ 15.84 hrs, Volume= 4.964 af

Routing by Dyn-Stor-Ind method, Time Span= 5.00-100.00 hrs, dt= 0.05 hrs
Peak Elev= 501.28' @ 15.84 hrs Surf.Area= 1.602 ac Storage= 7.480 af

Plug-Flow detention time= 629.0 min calculated for 4.964 af (47% of inflow)
Center-of-Mass det. time= 509.1 min (1,341.3 - 832.2)

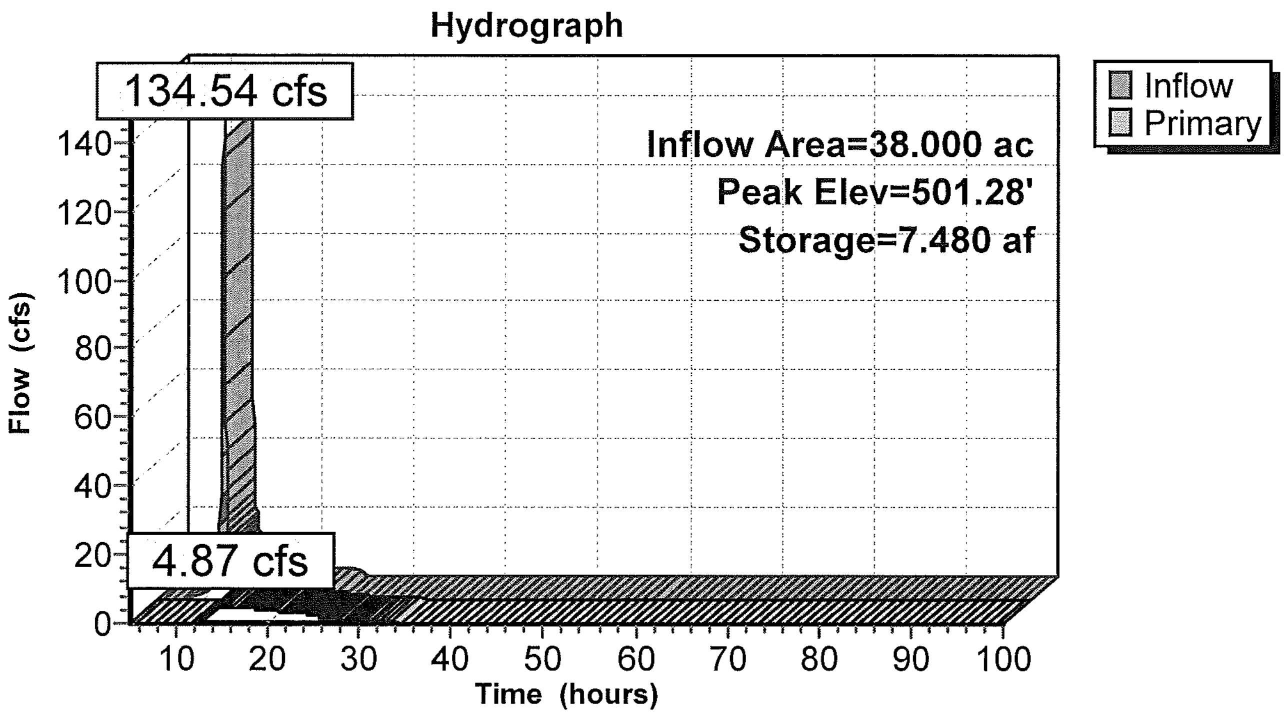
Volume	Invert	Avail.Storage	Storage Description
#1	495.00'	24.500 af	**Custom Stage Data (Prismatic)** Listed below (Recalc)

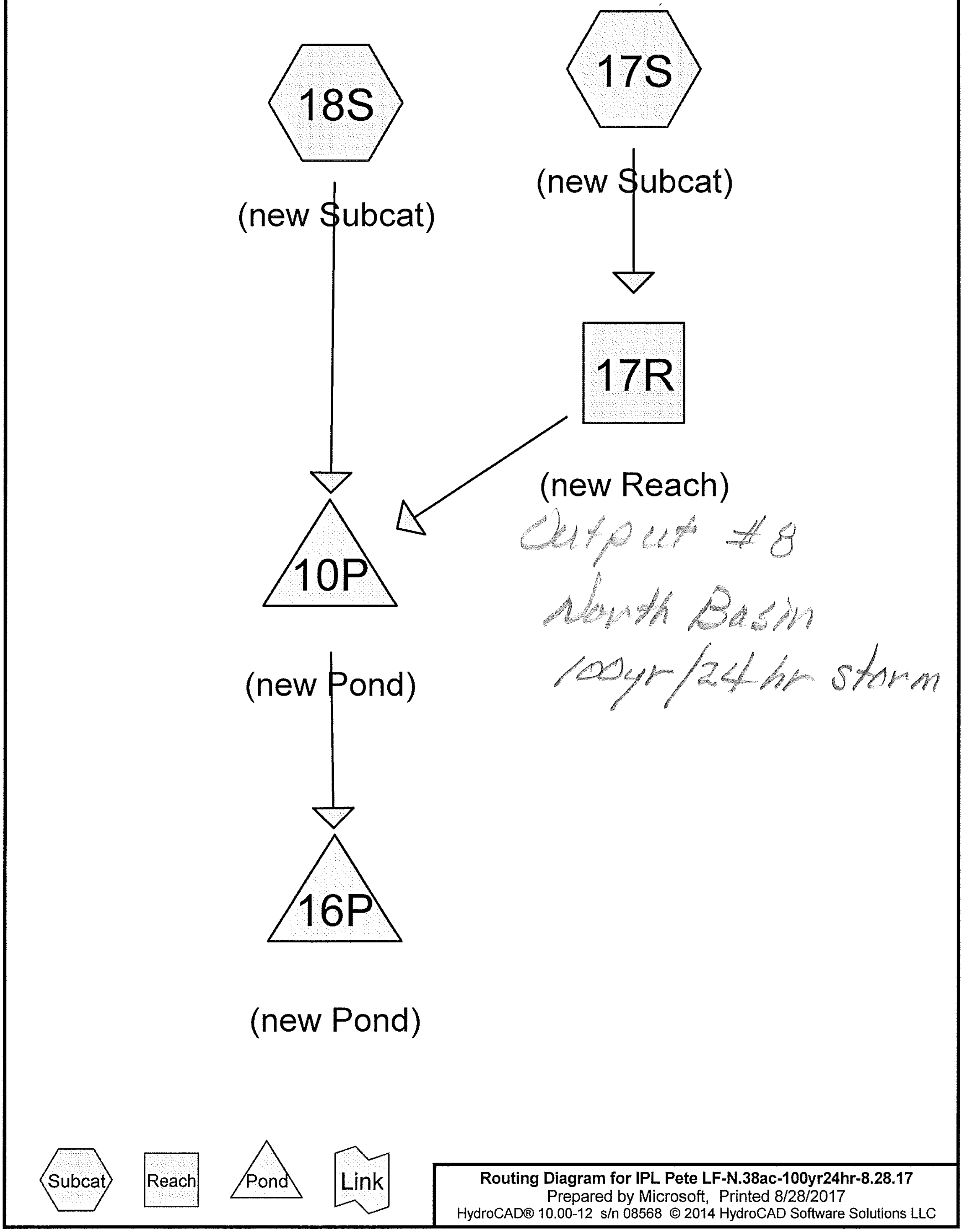
Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
495.00	0.700	0.000	0.000
500.00	1.500	5.500	5.500
510.00	2.300	19.000	24.500

Device	Routing	Invert	Outlet Devices
#1	Primary	500.00'	**18.0" Round Culvert** L= 160.0' Ke= 0.900 Inlet / Outlet Invert= 500.00' / 498.00' S= 0.0125 '/' Cc= 0.900 n= 0.020 Corrugated PE, corrugated interior, Flow Area= 1.77 sf
#2	Primary	507.00'	**24.0" Round Culvert** L= 80.0' Ke= 0.900 Inlet / Outlet Invert= 507.00' / 498.00' S= 0.1125 '/' Cc= 0.900 n= 0.020 Corrugated PE, corrugated interior, Flow Area= 3.14 sf

Primary OutFlow Max=4.87 cfs @ 15.84 hrs HW=501.28' (Free Discharge)
1=Culvert (Inlet Controls 4.87 cfs @ 3.04 fps)
2=Culvert (Controls 0.00 cfs)

Pond 16P: (new Pond)





Output #8
North Basin
100yr/24hr storm

Routing Diagram for IPL Pete LF-N.38ac-100yr24hr-8.28.17
Prepared by Microsoft, Printed 8/28/2017
HydroCAD® 10.00-12 s/n 08568 © 2014 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
38.000	80	(17S, 18S)
38.000	**80**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
0.000	HSG B	
0.000	HSG C	
0.000	HSG D	
38.000	Other	17S, 18S
38.000		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	0.000	0.000	0.000	38.000	38.000		17S, 18S
0.000	**0.000**	**0.000**	**0.000**	**38.000**	**38.000**	**TOTAL AREA**	

Pipe Listing (all nodes)

Line#	Node Number	In-Invert (feet)	Out-Invert (feet)	Length (feet)	Slope (ft/ft)	n	Diam/Width (inches)	Height (inches)	Inside-Fill (inches)
1	10P	501.00	500.00	120.0	0.0083	0.020	54.0	0.0	0.0
2	16P	500.00	498.00	160.0	0.0125	0.020	18.0	0.0	0.0
3	16P	507.00	498.00	80.0	0.1125	0.020	24.0	0.0	0.0

Time span=5.00-100.00 hrs, dt=0.05 hrs, 1901 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 17S: (new Subcat) Runoff Area=20.000 ac 0.00% Impervious Runoff Depth=4.76"
Flow Length=1,500' Slope=0.0500 '/' Tc=19.7 min CN=80 Runoff=105.37 cfs 7.932 af

Subcatchment 18S: (new Subcat) Runoff Area=18.000 ac 0.00% Impervious Runoff Depth=4.76"
Flow Length=1,500' Slope=0.0500 '/' Tc=19.7 min CN=80 Runoff=94.83 cfs 7.139 af

Reach 17R: (new Reach) Avg. Flow Depth=2.01' Max Vel=4.14 fps Inflow=105.37 cfs 7.932 af
n=0.030 L=1,000.0' S=0.0050 '/' Capacity=233.39 cfs Outflow=100.02 cfs 7.932 af

Pond 10P: (new Pond) Peak Elev=510.66' Storage=0.150 af Inflow=192.18 cfs 15.070 af
Outflow=183.98 cfs 15.070 af

Pond 16P: (new Pond) Peak Elev=502.78' Storage=9.986 af Inflow=183.98 cfs 15.070 af
Outflow=8.65 cfs 9.477 af

Total Runoff Area = 38.000 ac Runoff Volume = 15.070 af Average Runoff Depth = 4.76"
100.00% Pervious = 38.000 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment 17S: (new Subcat)

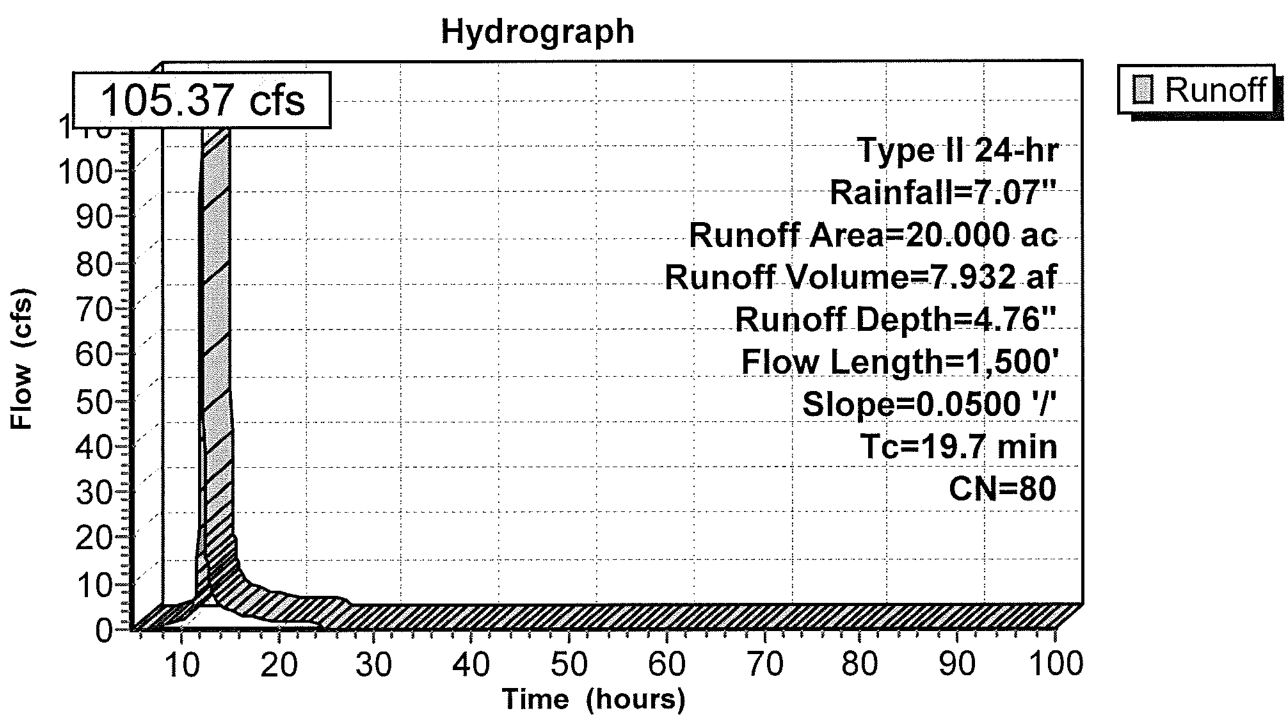
Runoff = 105.37 cfs @ 12.12 hrs, Volume= 7.932 af, Depth= 4.76"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-100.00 hrs, dt= 0.05 hrs
Type II 24-hr Rainfall=7.07"

	Area (ac)	CN	Description
*	20.000	80	
	20.000		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
19.7	1,500	0.0500	1.27		**Lag/CN Method,**

Subcatchment 17S: (new Subcat)



Summary for Subcatchment 18S: (new Subcat)

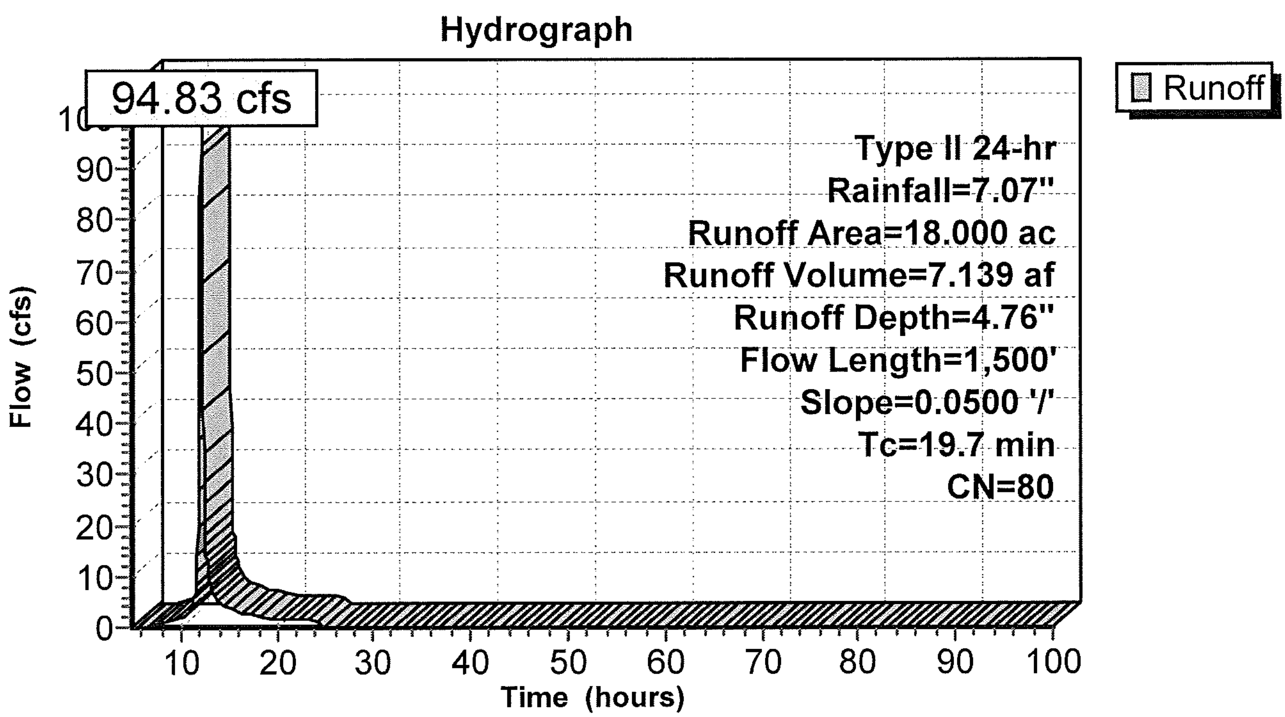
Runoff = 94.83 cfs @ 12.12 hrs, Volume= 7.139 af, Depth= 4.76"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-100.00 hrs, dt= 0.05 hrs
Type II 24-hr Rainfall=7.07"

	Area (ac)	CN	Description
*	18.000	80	
	18.000		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
19.7	1,500	0.0500	1.27		**Lag/CN Method,**

Subcatchment 18S: (new Subcat)



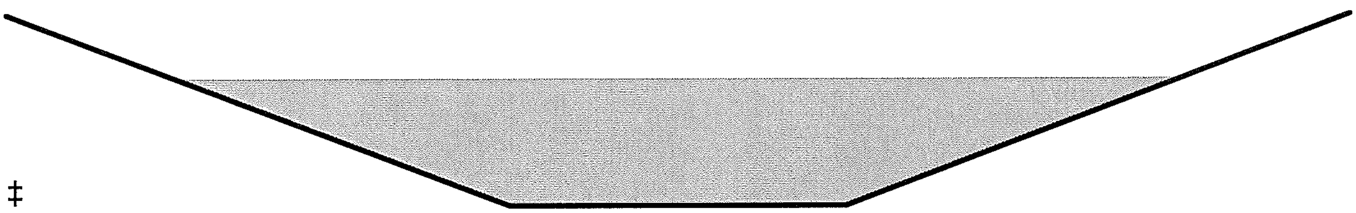
Summary for Reach 17R: (new Reach)

Inflow Area = 20.000 ac, 0.00% Impervious, Inflow Depth = 4.76"
Inflow = 105.37 cfs @ 12.12 hrs, Volume= 7.932 af
Outflow = 100.02 cfs @ 12.17 hrs, Volume= 7.932 af, Atten= 5%, Lag= 3.0 min

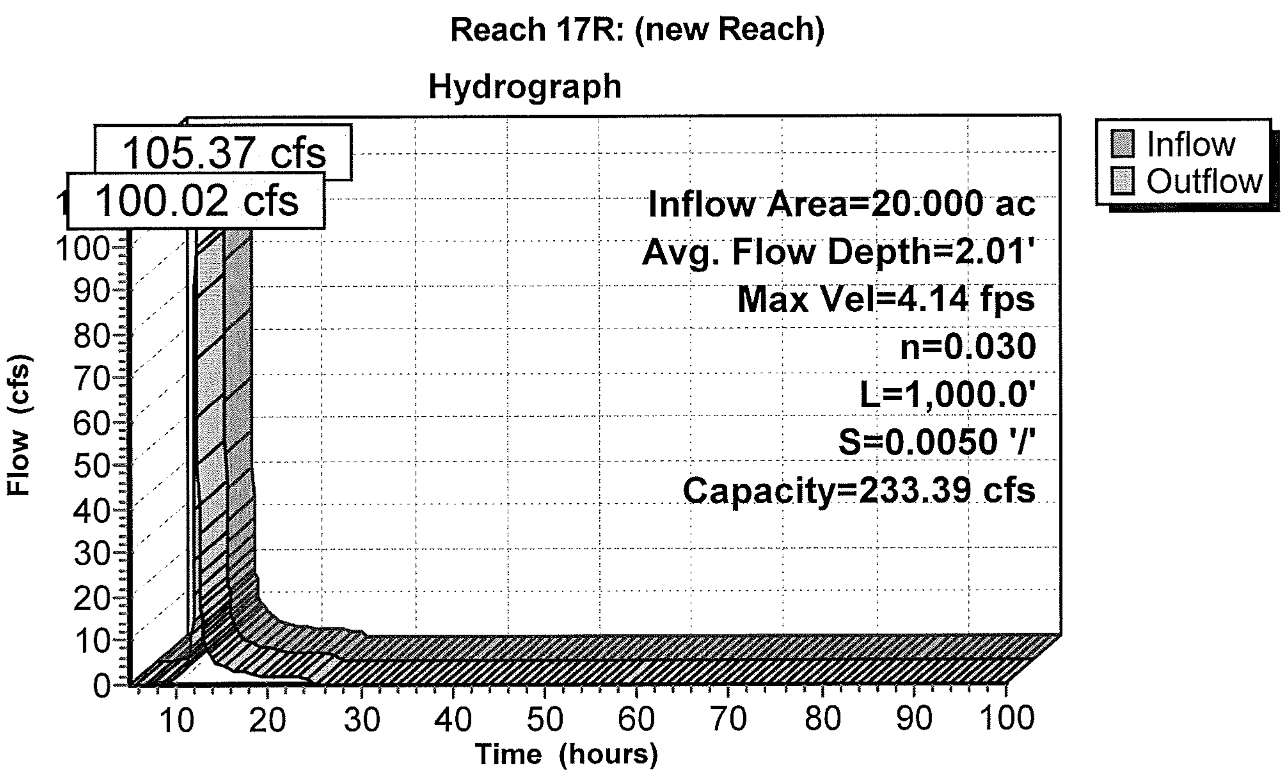
Routing by Dyn-Stor-Ind method, Time Span= 5.00-100.00 hrs, dt= 0.05 hrs
Max. Velocity= 4.14 fps, Min. Travel Time= 4.0 min
Avg. Velocity = 1.08 fps, Avg. Travel Time= 15.4 min

Peak Storage= 24,102 cf @ 12.17 hrs
Average Depth at Peak Storage= 2.01'
Bank-Full Depth= 3.00' Flow Area= 45.0 sf, Capacity= 233.39 cfs

6.00' x 3.00' deep channel, n= 0.030 Earth, dense weeds
Side Slope Z-value= 3.0 '/' Top Width= 24.00'
Length= 1,000.0' Slope= 0.0050 '/'
Inlet Invert= 5.00', Outlet Invert= 0.00'



‡



Summary for Pond 10P: (new Pond)

[58] Hint: Peaked 530.66' above defined flood level
[63] Warning: Exceeded Reach 17R INLET depth by 503.65' @ 12.20 hrs

Inflow Area = 38.000 ac, 0.00% Impervious, Inflow Depth = 4.76"
Inflow = 192.18 cfs @ 12.14 hrs, Volume= 15.070 af
Outflow = 183.98 cfs @ 12.18 hrs, Volume= 15.070 af, Atten= 4%, Lag= 2.4 min
Primary = 183.98 cfs @ 12.18 hrs, Volume= 15.070 af

Routing by Dyn-Stor-Ind method, Time Span= 5.00-100.00 hrs, dt= 0.05 hrs
Peak Elev= 510.66' @ 12.19 hrs Surf.Area= 0.111 ac Storage= 0.150 af
Flood Elev= -20.00' Surf.Area= 0.000 ac Storage= 0.000 af

Plug-Flow detention time= 0.3 min calculated for 15.063 af (100% of inflow)
Center-of-Mass det. time= 0.3 min (821.7 - 821.4)

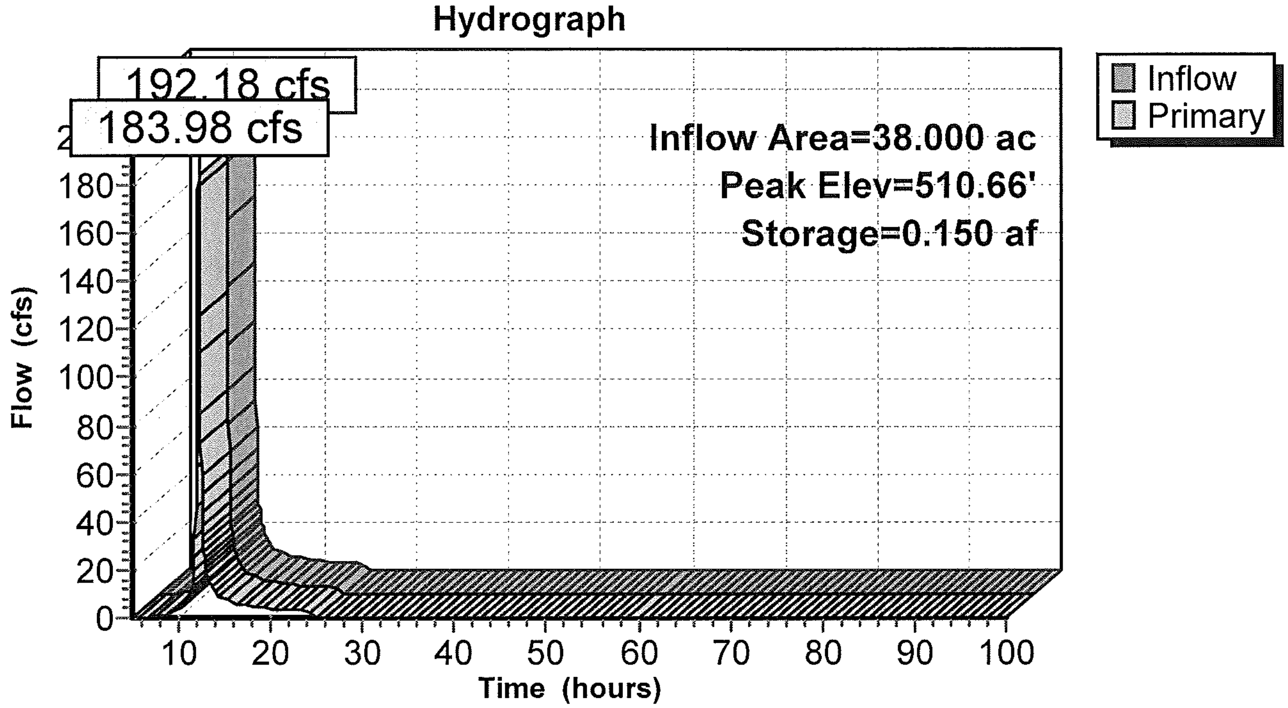
Volume	Invert	Avail.Storage	Storage Description
#1	508.00'	0.334 af	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
508.00	0.002	0.000	0.000
512.00	0.165	0.334	0.334

Device	Routing	Invert	Outlet Devices
#1	Device 2	508.00'	**72.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#2	Primary	501.00'	**54.0" Round Culvert** L= 120.0' Ke= 0.700 Inlet / Outlet Invert= 501.00' / 500.00' S= 0.0083 '/' Cc= 0.900 n= 0.020 Corrugated PE, corrugated interior, Flow Area= 15.90 sf

Primary OutFlow Max=183.13 cfs @ 12.18 hrs HW=510.60' TW=499.93' (Dynamic Tailwater)
↑—**2=Culvert** (Inlet Controls 183.13 cfs @ 11.51 fps)
↑—**1=Orifice/Grate** (Passes 183.13 cfs of 219.32 cfs potential flow)

Pond 10P: (new Pond)



Summary for Pond 16P: (new Pond)

Inflow Area = 38.000 ac, 0.00% Impervious, Inflow Depth = 4.76"
Inflow = 183.98 cfs @ 12.18 hrs, Volume= 15.070 af
Outflow = 8.65 cfs @ 14.60 hrs, Volume= 9.477 af, Atten= 95%, Lag= 145.0 min
Primary = 8.65 cfs @ 14.60 hrs, Volume= 9.477 af

Routing by Dyn-Stor-Ind method, Time Span= 5.00-100.00 hrs, dt= 0.05 hrs
Peak Elev= 502.78' @ 14.60 hrs Surf.Area= 1.723 ac Storage= 9.986 af

Plug-Flow detention time= 541.6 min calculated for 9.477 af (63% of inflow)
Center-of-Mass det. time= 435.1 min (1,256.8 - 821.7)

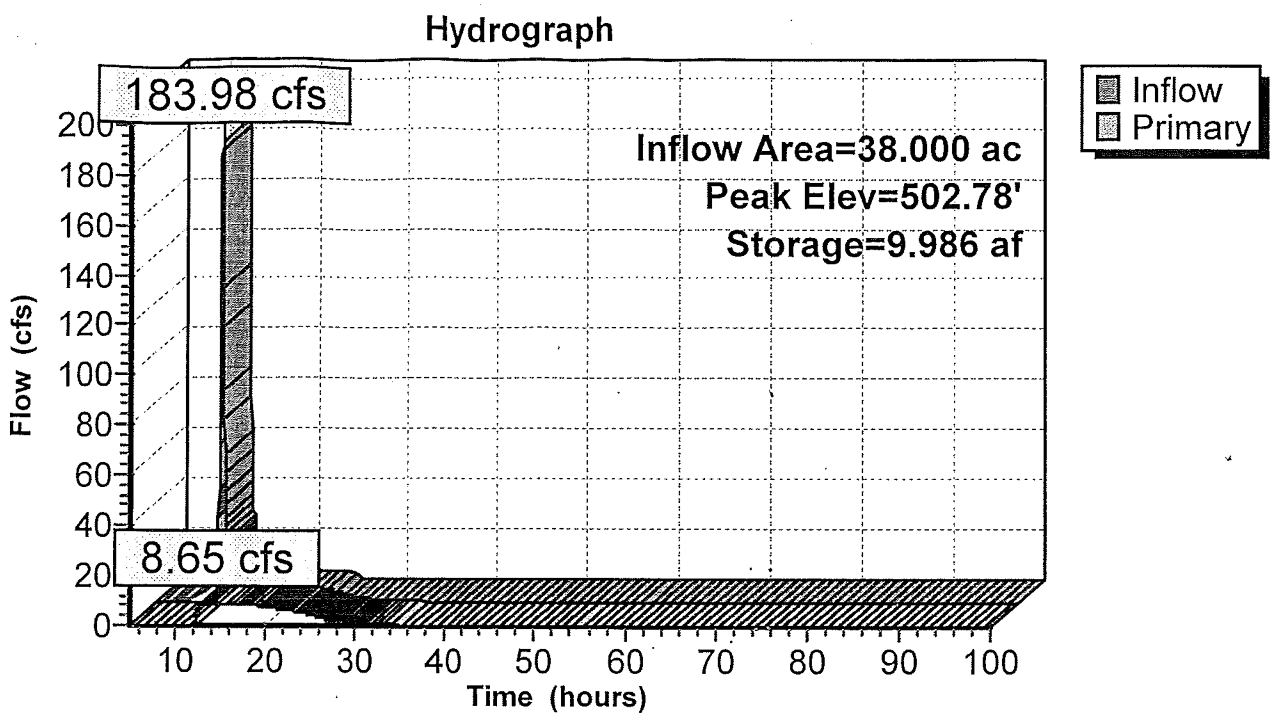
Volume	Invert	Avail.Storage	Storage Description
#1	495.00'	24.500 af	**Custom Stage Data (Prismatic)** Listed below (Recalc)

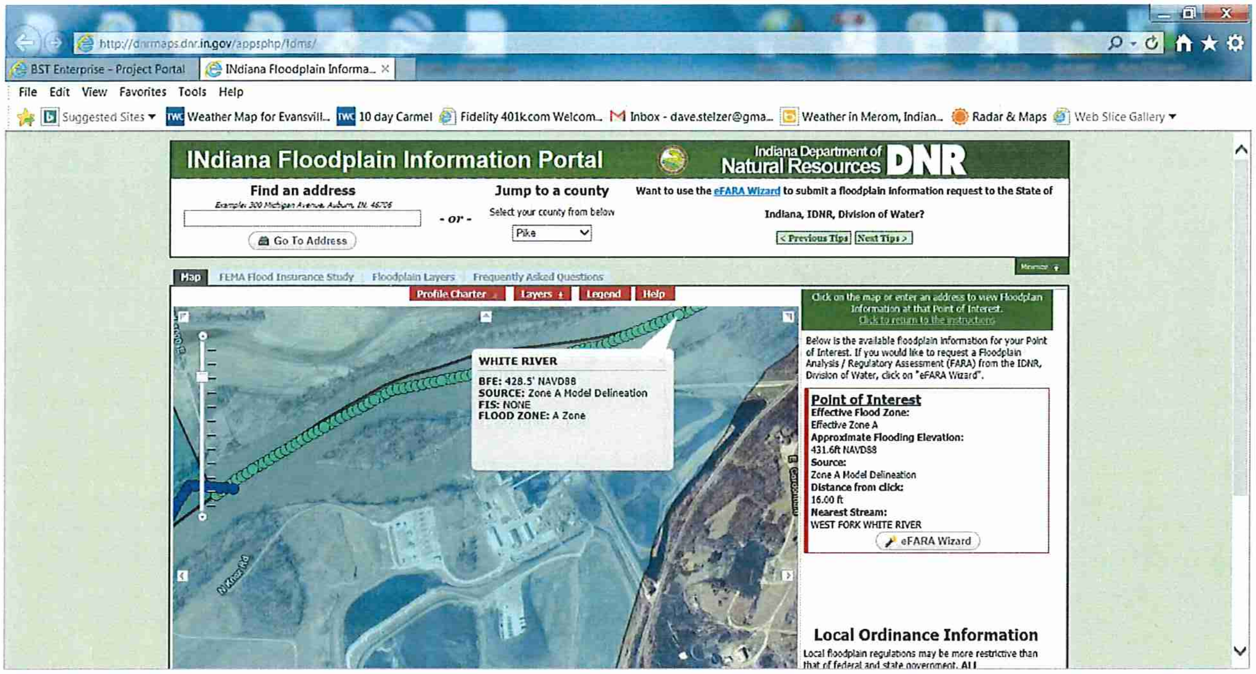
Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
495.00	0.700	0.000	0.000
500.00	1.500	5.500	5.500
510.00	2.300	19.000	24.500

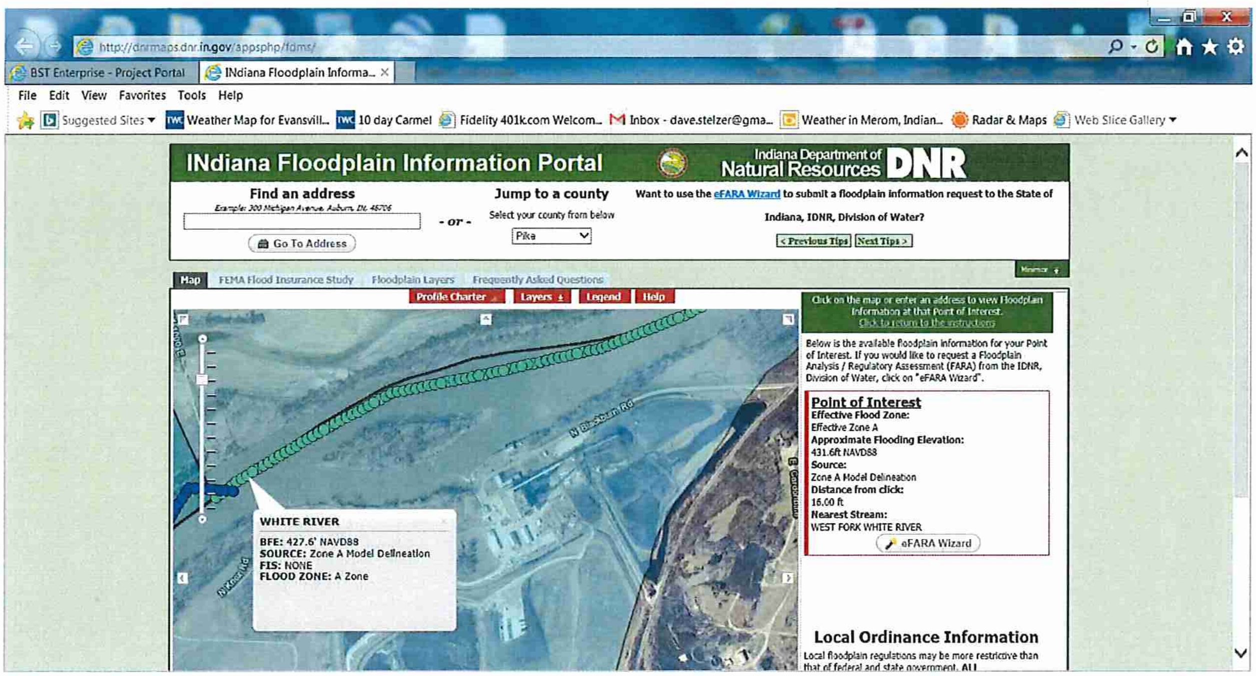
Device	Routing	Invert	Outlet Devices
#1	Primary	500.00'	**18.0" Round Culvert** L= 160.0' Ke= 0.900 Inlet / Outlet Invert= 500.00' / 498.00' S= 0.0125 '/' Cc= 0.900 n= 0.020 Corrugated PE, corrugated interior, Flow Area= 1.77 sf
#2	Primary	507.00'	**24.0" Round Culvert** L= 80.0' Ke= 0.900 Inlet / Outlet Invert= 507.00' / 498.00' S= 0.1125 '/' Cc= 0.900 n= 0.020 Corrugated PE, corrugated interior, Flow Area= 3.14 sf

Primary OutFlow Max=8.65 cfs @ 14.60 hrs HW=502.78' (Free Discharge)
├─**1=Culvert** (Barrel Controls 8.65 cfs @ 4.89 fps)
└─**2=Culvert** (Controls 0.00 cfs)

Pond 16P: (new Pond)




http://dnrmaps.dnr.in.gov/appsphp/fdms/
BST Enterprise - Project Portal
INdiana Floodplain Informa...
File Edit View Favorites Tools Help
Suggested Sites
Weather Map for Evansvill...
10 day Carmel
Fidelity 401k.com Welcom...
Inbox - dave.stelzer@gma...
Weather in Merom, Indian...
Radar & Maps
Web Slice Gallery
INdiana Floodplain Information Portal
Indiana Department of Natural Resources DNR
Find an address
Example: 300 Michigan Avenue, Auburn, IN 46706
Go To Address
- or -
Jump to a county
Select your county from below
Pike
Want to use the eFARA Wizard to submit a floodplain information request to the State of Indiana, IDNR, Division of Water?
< Previous Tips
Next Tips >
Map
FEMA Flood Insurance Study
Floodplain Layers
Frequently Asked Questions
Profile Charter
Layers
Legend
Help
WHITE RIVER
BFE: 428.5' NAVD88
SOURCE: Zone A Model Delineation
FIS: NONE
FLOOD ZONE: A Zone
N Knox Rd
Click on the map or enter an address to view Floodplain Information at that Point of Interest.
Click to return to the instructions
Below is the available floodplain information for your Point of Interest. If you would like to request a Floodplain Analysis / Regulatory Assessment (FARA) from the IDNR, Division of Water, click on "eFARA Wizard".
Point of Interest
Effective Flood Zone:
Effective Zone A
Approximate Flooding Elevation:
431.6ft NAVD88
Source:
Zone A Model Delineation
Distance from click:
16.00 ft
Nearest Stream:
WEST FORK WHITE RIVER
eFARA Wizard
Local Ordinance Information
Local floodplain regulations may be more restrictive than that of federal and state government. All


http://dnrmaps.dnr.in.gov/appsphp/fdms/
BST Enterprise - Project Portal
INdiana Floodplain Informa...
File Edit View Favorites Tools Help
Suggested Sites
Weather Map for Evansvill...
10 day Carmel
Fidelity 401k.com Welcom...
Inbox - dave.stelzer@gma...
Weather in Merom, Indian...
Radar & Maps
Web Slice Gallery
INdiana Floodplain Information Portal
Indiana Department of Natural Resources DNR
Find an address
Example: 300 Michigan Avenue, Auburn, IN 46706
Go To Address
- or -
Jump to a county
Select your county from below
Pike
Want to use the eFARA Wizard to submit a floodplain information request to the State of Indiana, IDNR, Division of Water?
< Previous Tips
Next Tips >
Map
FEMA Flood Insurance Study
Floodplain Layers
Frequently Asked Questions
Profile Charter
Layers
Legend
Help
N Blackburn Rd
WHITE RIVER
BFE: 427.6' NAVD88
SOURCE: Zone A Model Delineation
FIS: NONE
FLOOD ZONE: A Zone
N Knox Rd
Click on the map or enter an address to view Floodplain Information at that Point of Interest.
Click to return to the instructions
Below is the available floodplain information for your Point of Interest. If you would like to request a Floodplain Analysis / Regulatory Assessment (FARA) from the IDNR, Division of Water, click on "eFARA Wizard".
Point of Interest
Effective Flood Zone:
Effective Zone A
Approximate Flooding Elevation:
431.6ft NAVD88
Source:
Zone A Model Delineation
Distance from click:
16.00 ft
Nearest Stream:
WEST FORK WHITE RIVER
eFARA Wizard
Local Ordinance Information
Local floodplain regulations may be more restrictive than that of federal and state government. All