



Inflow Design Flood Control System Plan

J.H. CAMPBELL GENERATING FACILITY

BOTTOM ASH PONDS 1-2 INFLOW DESIGN FLOOD CONTROL SYSTEM PLAN

West Olive, Michigan

Pursuant to 40 CFR 257.82

Submitted To: Consumers Energy Company
1945 W. Parnall Road
Jackson, Michigan 49201

Submitted By: Golder Associates Inc.
15851 South US 27, Suite 50
Lansing, Michigan 48906

October 2016

1654923





CERTIFICATION

Professional Engineer Certification Statement [40 CFR 257.82(c)]

I hereby certify that, having reviewed the attached documentation and being familiar with the provisions of Title 40 of the Code of Federal Regulations Section 257.82 (40 CFR Part 257.82), I attest that this Inflow Design Flood Control System Plan is accurate and has been prepared in accordance with good engineering practices, including the consideration of applicable industry standards, and with the requirements of 40 CFR Part 257.82.

Golder Associates Inc.



Signature

October 14, 2016

Date of Report Certification

John D. Puls, PE

Name

6201055787

Professional Engineer Certification Number

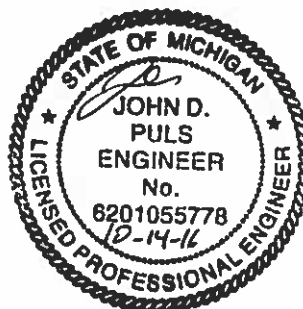




Table of Contents

CERTIFICATION..... C-1
Professional Engineer Certification Statement [40 CFR 257.82(c)]..... C-1
1.0 INTRODUCTION..... 1
1.1 Background 1
1.2 Purpose 1
2.0 FLOOD CONTROL SYSTEM 2
2.1 External Floodwater Protection 2
2.2 Internal Flood Control..... 3
3.0 PLAN REVISION AND RECORDKEEPING 4
4.0 REFERENCES..... 5

List of Tables

Table 2.2.1 Discharge Structure Summary
Table 2.2.2 Storm Flow Data

List of Figures

Figure 1 Site Location Map
Figure 2 Site Plan

List of Appendices

Appendix A FEMA Flood Elevation and Lake Michigan Normal Elevation
Appendix B Rainfall Data
Appendix C Hydrologic and Hydraulic Model Output



1.0 INTRODUCTION

1.1 Background

J.H. Campbell Generating Facility (JH Campbell) is a coal-fired power generation facility located near West Olive, Michigan as presented on Figure 1 – Site Location Map. Bottom ash is sluiced from the JH Campbell Unit 1-2 electrical generating unit to a pair of ponds, classified as Bottom Ash Ponds 1-2. An elevated trestle and pipe system hydraulically conveys bottom ash to the pond system. Bottom ash is removed via mechanical equipment from the ponds as required to maintain storage capacity. Water is discharged from the ponds via corrugated metal pipe (CMP) outflow pipes into an internal ditch that conveys the flow to an internal pond system and ultimately to the site's permitted National Pollutant Discharge Elimination System (NPDES) discharge. Additionally, a perimeter ditch (West Ditch) and associated culverts are located toward the western and southern toe of Bottom Ash Ponds 1-2. This flow in this ditch is covered under the site's NPDES permit and flows into the internal pond system and is ultimately discharged through the site's NPDES outfall.

1.2 Purpose

The purpose of the Inflow Design Flood Control System Plan (Plan) is to provide a basis for the certification required by 40 CFR 257.82 [Hydrologic and Hydraulic Capacity Requirements for Coal Combustion Residuals (CCR) Surface Impoundments]. Bottom Ash Ponds 1-2 have been rated a significant hazard potential as determined under 40 CFR 257.73(a)(2). 40 CFR 257.82(a) requires the owner or operator of the significant hazard potential CCR surface impoundment to design, construct, operate, and maintain an inflow flood control system as follows:

- Adequately manage the flow into the CCR unit during and following the peak discharge of the inflow of the 1000-year flood event
- Adequately manage the flow from the CCR unit to collect and control the peak discharge resulting from the 1000-year flood event
- Handle discharge from the CCR unit in accordance with the surface water requirements under 40 CFR 257.3-3



2.0 FLOOD CONTROL SYSTEM

To meet the requirements of 40 CFR 257.82(a), the flood control system must provide flood protection to the CCR unit during the inflow design flood (1000-year event) for two cases: 1) floodwater from outside the unit from the West Ditch and the Pigeon River; and 2) controlling internal water levels within the unit.

2.1 External Floodwater Protection

Bottom Ash Ponds 1-2 are surrounded by a perimeter berm that provides external flood water protection. Based on borings completed in 2015, the berm is generally constructed of ash over sand. Berms were constructed in continuous layers not exceeding eight inches compacted thickness that were compacted to a minimum 90 percent maximum dry density as determined by ASTM D1557-91, as documented in Sheet 11 of Drawing number 690-1976 (STS 1995). An access road travels the length of the perimeter berm.

Two potential inflow sources to Bottom Ash Ponds 1-2 were identified and evaluated; the West Ditch and the Pigeon River. The West Ditch parallels Bottom Ash Ponds 1-2 to the west and to the south. Given that the outer bank elevation of the West Ditch is approximately 605.00 feet (NGVD29) and the lowest perimeter berm elevation is 624.71 feet (NGVD29), overbank flow from the West Ditch during a 1000-year event would inundate areas to the west and south, away from Bottom Ash Ponds 1-2. Therefore, the West Ditch should not be an inflow source to Bottom Ash Ponds 1-2.

A publicly available 1000-year flood elevation for the Pigeon River has not been determined by Federal Emergency Management Agency (FEMA). As a result, Golder Associates Inc. (Golder) has estimated the 1000-year flood elevation by extrapolation of the FEMA data. The FEMA Flood Insurance Study (FIS) (FEMA 2013) reported the mouth of Pigeon River (Pigeon Lake) levels for the 10-, 50-, 100-, and 500-year recurrence intervals. The 100- and 500-year levels are 584.8 feet and 585.7 feet (NGVD29), respectively. Based on a logarithmic best fit curve extrapolation, the 1000-year Pigeon Lake level is approximately 586.2 feet (NGVD29). Based on FEMA Firm Map Numbers 26139C0195E and 26139C0190E, both Pigeon Lake and Pigeon River have 100-year flood elevations of 584.8 feet (NGVD29). FEMA elevations were converted from NAVD88 to NGVD29. Therefore, Golder has applied the extrapolated 1000-year level of Pigeon Lake to upstream areas of the Pigeon River that border Bottom Ash Ponds 1-2 to the south. The lowest elevation along the perimeter berm is 624.71 feet (NGVD29), which allows for 38.51 feet of freeboard during the 1000-year flood event. Therefore, the Pigeon River should not be an inflow source to Bottom Ash Ponds 1-2.



2.2 Internal Flood Control

The only inflow other than sluiced ash and low-volume miscellaneous wastewater will be precipitation directly falling on the ponds from a 1000-year 24-hour storm event of 11.2 inches, as provided in Appendix B - Rainfall Data. There are two discharge structures in the perimeter berm: one 24-inch CMP from Bottom Ash Ponds 1-2 North and one 24-inch CMP from Bottom Ash Ponds 1-2 South. Table 2.2.1 below provides a summary of the outflow structures as surveyed in May 2016.

Table 2.2.1 - Discharge Structure Summary

| Discharge Structure | Type | Size (Inches) | Length (Feet) | Upstream Invert (NGVD29) | Downstream Invert (NGVD29) | Slope (%) |
|---------------------|------|---------------|---------------|--------------------------|----------------------------|-----------|
| 24-inch | CMP | 24 | 78.49 | 619.08 | 618.36 | 0.92 |
| 24-inch | CMP | 24 | 59.89 | 618.78 | 617.72 | 1.77 |

Bottom Ash Ponds 1-2 were modeled as a two-pond network with water levels in each pond equal to that of the outfall pipe upstream invert elevation. Table 2.2.2 below provides a storm flow summary that indicates that Bottom Ash Ponds 1-2 are contained with a minimum 4.57 feet of freeboard (Bottom Ash Ponds 1-2 North), a peak discharge rate of 7.7 cubic feet per second (cfs) to Pond A during the design storm event (1000-year 24-hour). The modeled results indicate that:

- The inflow design flood control system adequately manages flow from the CCR unit to collect and control the peak discharge resulting from the inflow design flood (1000-year 24-hour storm event)

The hydrologic and hydraulic model output is provided in Appendix C - Hydrologic and Hydraulic Model Output. It should be noted that the pond elevations presented in Table 2.2.2 were used to assess the maximum storage pool loading condition pursuant to 40 CFR 257.73(e)(1)(i).

Table 2.2.2 – Storm Flow Data

| Area | Lowest Perimeter Berm Elevation (NGVD29) | Pond Elevation 1000-year 24-hour (NGVD29) | Peak Outflow (cfs) |
|----------------------------|--|---|--------------------|
| Bottom Ash Ponds 1-2 North | 624.71 | 620.14 | 5.2 |
| Bottom Ash Ponds 1-2 South | 624.71 | 619.32 | 2.5 |



3.0 PLAN REVISION AND RECORDKEEPING

Per 40 CFR 257.82(c)(2): “The owner or operator of the CCR unit may amend the written inflow design flood control system plan at any time provided the revised plan is placed in the facility's operating record as required by §257.105(g)(4). The owner or operator must amend the written inflow design flood control system plan whenever there is a change in conditions that would substantially affect the written plan in effect.”

Per 40 CFR 257.82(c)(4); “The owner or operator must prepare periodic inflow design flood control system plans required by paragraph (c)(1) of this section every five years. The date of completing the initial plan is the basis for establishing the deadline to complete the first periodic plan. The owner or operator may complete any required plan prior to the required deadline provided the owner or operator places the completed plan into the facility's operating record within a reasonable amount of time. In all cases, the deadline for completing a subsequent plan is based on the date of completing the previous plan. For purposes of this paragraph (c)(4), the owner or operator has completed an inflow design flood control system plan when the plan has been placed in the facility's operating record as required by §257.105(g)(4).”



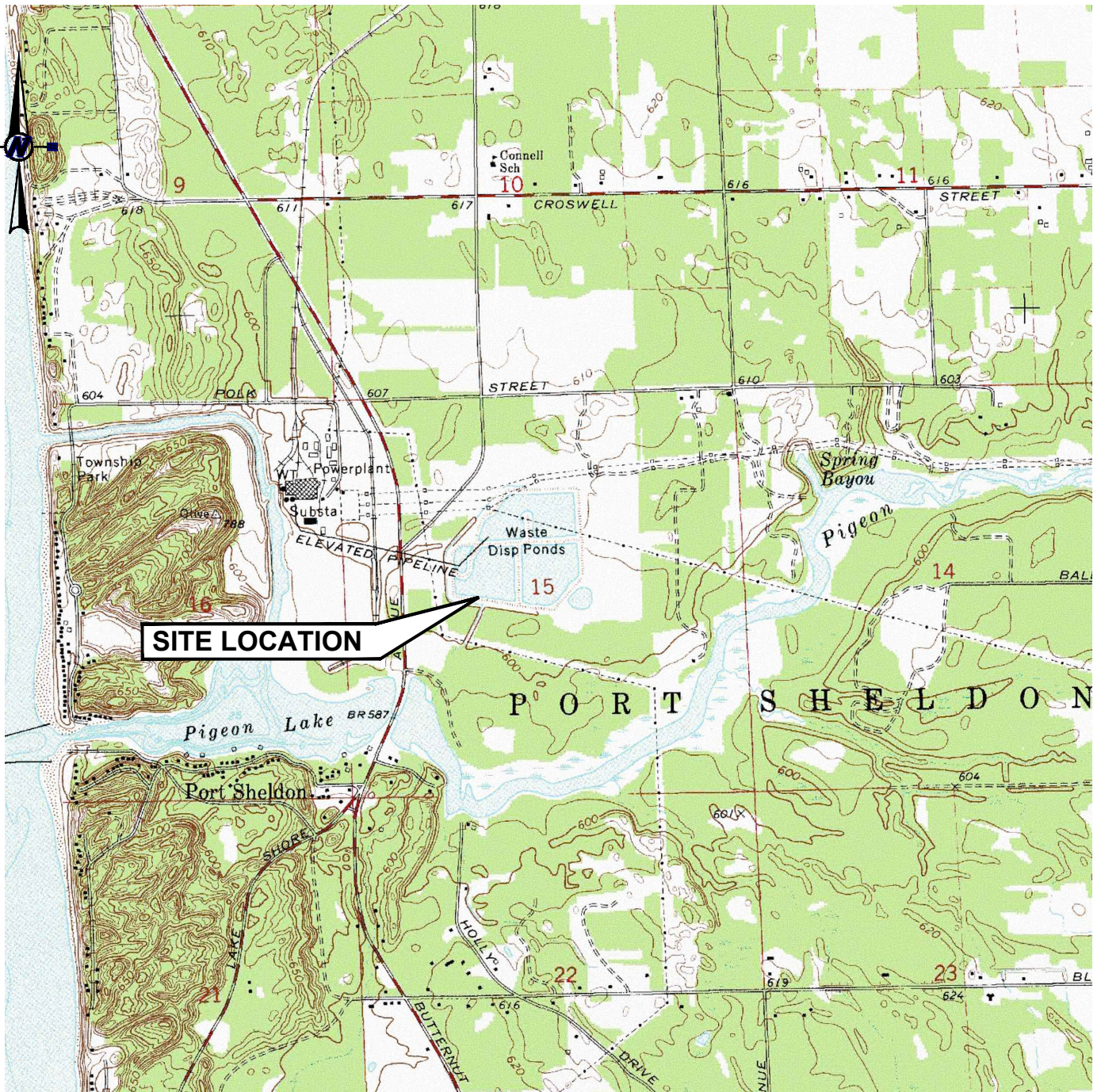
4.0 REFERENCES

FEMA (Federal Emergency Management Agency). 2013. Flood Insurance Study, Ottawa County, Michigan. Effective May 16, 2013. Flood Insurance Study Number 26139CV001B.

STS Consultants Ltd., Interior Dike Modification Bottom Ash Pond Repairs. Drawing number 690-1976. Sheet 11. October 10, 1995.

USEPA (US Environmental Protection Agency). 2015. Disposal of Coal Combustion Residuals from Electric Utilities; Final Rule. 40 CFR Part 257. Effective Date October 19, 2015.

FIGURES

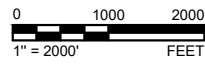


SITE LOCATION



REFERENCE(S)

1. BASE MAP TAKEN FROM 7.5 MINUTE U.S.G.S. QUADRANGLES OF PORT SHELDON MICHIGAN, DOWNLOADED FROM MICHIGAN DNR WEBSITE JUNE 2016.



CLIENT
CONSUMERS ENERGY COMPANY
 17000 CROSWELL ST.
 WEST OLIVE, MI 49460

PROJECT
J.H. CAMPBELL GENERATING FACILITY
BOTTOM ASH PONDS 1-2 INFLOW DESIGN
FLOOD CONTROL SYSTEM PLAN

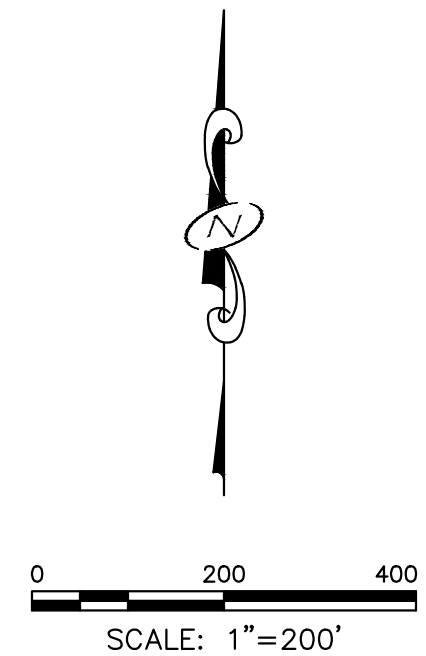
| | | |
|------------|------------|------------|
| CONSULTANT | YYYY-MM-DD | 2016-06-06 |
| | DESIGNED | BAL |
| | PREPARED | ARM |
| | REVIEWED | DJS |
| | APPROVED | MAB |

TITLE
SITE LOCATION MAP

PROJECT NO. 1654923 REV. # FIGURE 1



1b IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ANSI A



S:\Projects\094 - Collier Associates\016 Projects\094-16-004 - JH Campbell RCRA Ash Pond Closure\CAD\094-16-004-EXIST-HYDRO.dwg 10/7/2016 9:17 AM

| REFERENCE DRAWINGS | REV | DATE | DESCRIPTION | BY | CHK | APP | REV | DATE | DESCRIPTION | BY | CHK | APP |
|--------------------|-----|------|-------------|----|-----|-----|-----------|-----------------------------------|-------------|----|-----|-----|
| | | | | | | | 10/6/2016 | FILED IN OWNER'S OPERATING RECORD | | AM | DS | JP |



J.H. CAMPBELL ASH STORAGE FACILITY

EXISTING CONDITIONS
SITE PLAN

| | | | | |
|-------|-----------|-------------|--------|-------|
| SCALE | 1" = 200' | DRAWING NO. | FIGURE | UNIT# |
| JOB | 1654923 | | 2 | A |

APPENDIX A
FEMA FLOOD ELEVATION AND LAKE MICHIGAN NORMAL ELEVATION

NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The community map repository should be consulted for possible updated or additional flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevations (BFEs)** and/or **Floodways** have been determined, users are encouraged to consult the **Flood Profiles and Floodway Data and/or Summary of Stillwater Elevations** tables contained within the Flood Insurance Study (FIS) report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS report should be utilized in conjunction with the FIRM for purposes of construction and/or floodplain management.

Coastal Base Flood Elevations shown on this map apply only landward of 0.0' North American Vertical Datum of 1988 (NAVD 88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations table in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations table should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

Boundaries of the **Roadways** were computed at cross sections and interpolated between cross sections. The roadways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study report for this jurisdiction.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures**. Refer to Section 2.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures for this jurisdiction.

The projection used in the preparation of this map was Michigan State Plane South zone 8401 (FIPSZONE 2113). The horizontal datum was NAD83. Differences in datum, national projection or state plane zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

Flood elevations on this map are referenced to the North American Vertical Datum of 1988. These flood elevations must be compared to structure and ground elevations referenced to the same vertical datum. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at <http://www.ngs.noaa.gov/> or contact the National Geodetic Survey at the following address:

NGS Information Services
 NOAA, NGS012
 National Geodetic Survey
 5350 N. 26th St.
 Silver Spring, Maryland 20910-3282
 (301) 713-3242

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at (301) 713-3242 or visit its website at <http://www.ngs.noaa.gov/>.

Base Map information shown on this FIRM was derived from the Ottawa County, Michigan GIS Office from photography dated 2004.

This map reflects more detailed and up-to-date **stream channel configurations** than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables in the Flood Insurance Study report (which contains authoritative hydraulic data) may reflect stream channel distances that differ from what is shown on this map.

Corporate limits shown on this map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

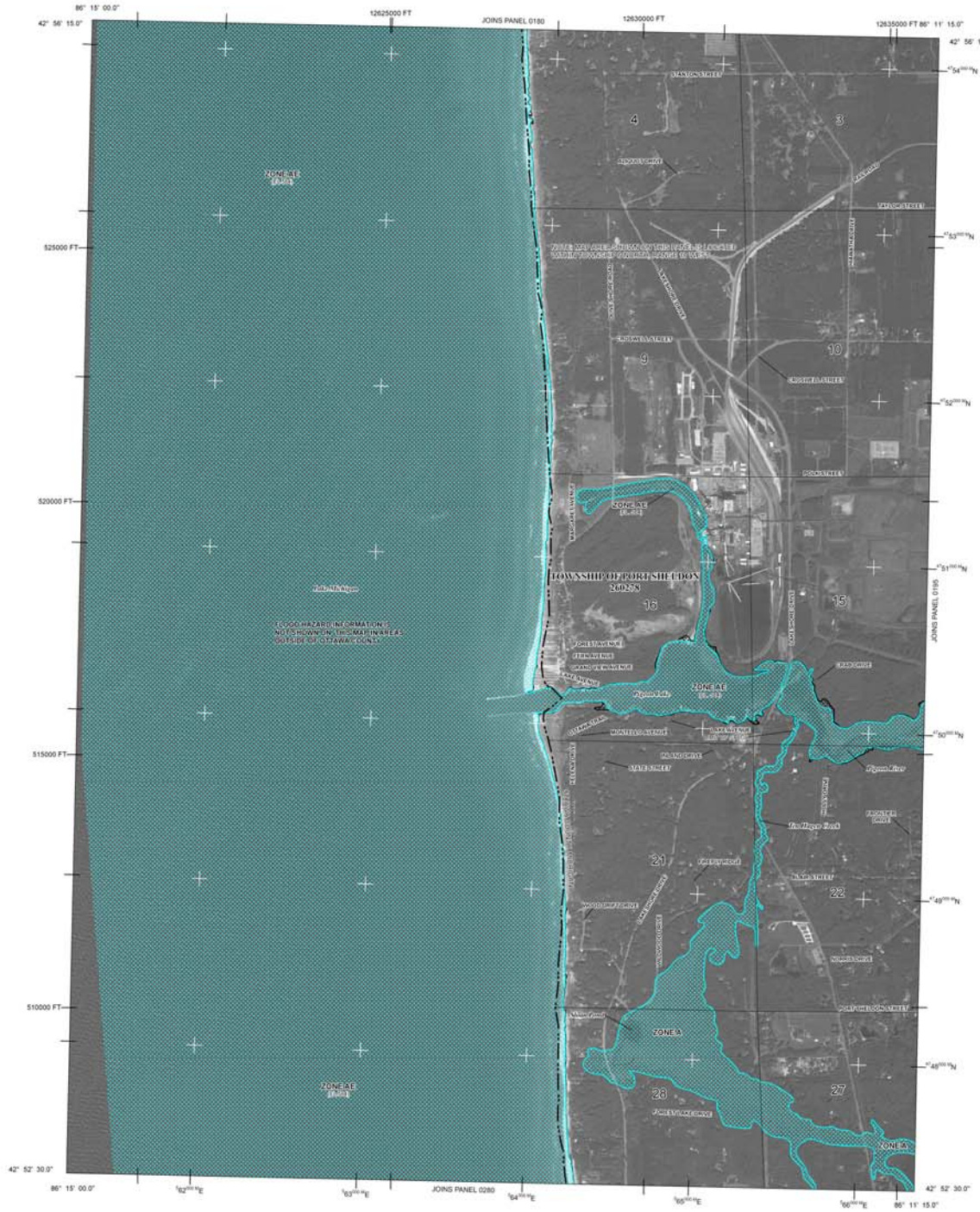
Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels, community map repository addresses, and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which each community is located.

For information on available products associated with this FIRM visit the **Map Service Center (MSC)** website at <http://www.fema.gov/business/mfc>. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. Many of these products can be ordered or obtained directly from the MSC website.

If you have **questions about this map**, how to order products, or the National Flood Insurance Program in general, please call the **FEMA Map Information Exchange (MIEX)** at 1-877-FEMA-MAP or visit the FEMA website at <http://www.fema.gov/business/mfc>.

The **profile base lines** depicted on this map represent the hydraulic modeling baselines that match the flood profiles in the FIS report. As a result of improved topographic data, the **profile base line** in some cases, may deviate significantly from the channel centerline or appear outside the SFHA.

PANEL INDEX



LEGEND

SPECIAL FLOOD HAZARD AREAS SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zone A, AE, AH, AO, AR, AR1, AR2, AR3, AR4, AR5, AR6, AR7, AR8, AR9, AR10, AR11, AR12, AR13, AR14, AR15, AR16, AR17, AR18, AR19, AR20, AR21, AR22, AR23, AR24, AR25, AR26, AR27, AR28, AR29, AR30, AR31, AR32, AR33, AR34, AR35, AR36, AR37, AR38, AR39, AR40, AR41, AR42, AR43, AR44, AR45, AR46, AR47, AR48, AR49, AR50, AR51, AR52, AR53, AR54, AR55, AR56, AR57, AR58, AR59, AR60, AR61, AR62, AR63, AR64, AR65, AR66, AR67, AR68, AR69, AR70, AR71, AR72, AR73, AR74, AR75, AR76, AR77, AR78, AR79, AR80, AR81, AR82, AR83, AR84, AR85, AR86, AR87, AR88, AR89, AR90, AR91, AR92, AR93, AR94, AR95, AR96, AR97, AR98, AR99, AR100.

ZONE A No Base Flood Elevations determined.

ZONE AE Base Flood Elevations determined.

ZONE AH Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.

ZONE AO Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of shallow fan flooding, velocities also determined.

ZONE AR Area of special flood hazard formerly protected from the 1% annual chance flood event by a flood control system that was subsequently abandoned. Zone AR indicates that the former flood control system is being replaced to provide protection from the 1% annual chance of greater flood.

ZONE AR1-AR10 Area to be protected from 1% annual chance flood event by a Federal flood protection system under construction; no Base Flood Elevations determined.

ZONE V Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.

ZONE VE Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment to ensure the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or of average width less than 1 square mile; and areas protected by levees from the 1% annual chance of greater flood.

OTHER AREAS

ZONE D Areas determined to be outside of the 0.2% annual chance floodplain.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

1% annual chance floodplain boundary

0.2% annual chance floodplain boundary

Floodway boundary

Zone D boundary

CBRS and OPA boundary

Boundary Abutting Special Flood Hazard Areas of adjacent Base Flood Elevations, Flood depths or flood velocities

Base Flood Elevation line and value elevation in feet

Base Flood Elevation value where within zone elevation in feet

Referenced to the North American Vertical Datum of 1988

Cross section line

Thruway line

Bridge

Canal

Geographic coordinate referenced to the North American Datum of 1983 (NAD 83), Western Hemisphere

200-foot contour; Michigan State Plane South Coordinate System, 8401 zone (FIPSZONE 2113), Lambert Conformal Conic projection

Spot elevations (see explanation in Notes to Users section of this FIRM panel)

M1.5

MAP REPOSITORY

Refer to listing of Map Repositories on Map Index

EFFECTIVE DATE OF COUNTYWIDE FLOOD INSURANCE RATE MAP

December 16, 2011

EFFECTIVE DATES OF REVISIONS TO THIS PANEL

For community map revision history, prior to countywide mapping, refer to the Community Map History located in the Flood Insurance Study report for this jurisdiction. To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-658-6622.

MAP SCALE 1" = 1000'

500 FEET

0 1000 2000 FEET

300 0 300 METERS

NFIP

PANEL 0190E

FIRM

FLOOD INSURANCE RATE MAP

OTTAWA COUNTY, MICHIGAN

(ALL JURISDICTIONS)

PANEL 190 OF 425

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS

COMMUNITY NUMBER PANEL SUFFIX

PORT SHELDON TOWNSHIP OF 26077 0190 E

Note to User: The Map Number shown below should be used when placing map orders; the Community Number shown above should be used in insurance applications for the insured community.

MAP NUMBER

26139C0190E

EFFECTIVE DATE

DECEMBER 16, 2011

Federal Emergency Management Agency

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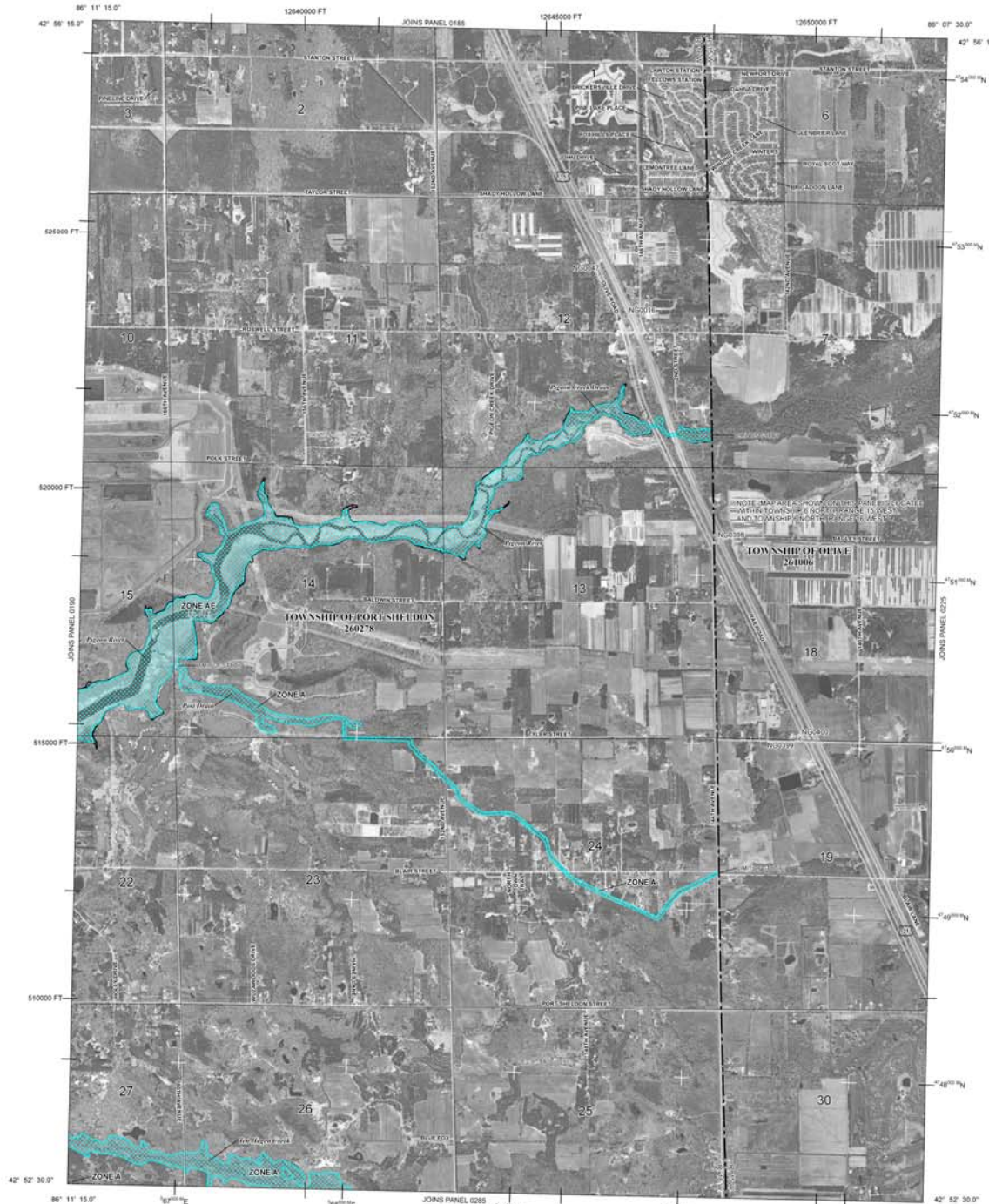
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The **profile base lines** depicted on this map represent the hydraulic modeling baselines that match the flood profiles in the FIS report. As a result of improved topographic data, the profile base line in some cases, may deviate significantly from the channel centerline or appear outside the SFHA.

PANEL INDEX



LEGEND

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ZONE A No Base Flood Elevations determined.
ZONE AE Base Flood Elevations determined.
ZONE AH Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined; For areas of shallow fan flooding, velocities also determined.
ZONE AO Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined; For areas of shallow fan flooding, velocities also determined.
ZONE AR Area of special flood hazard formerly protected from the 1% annual chance flood event by a flood control system that was subsequently abandoned. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
ZONE AV Area to be protected from 1% annual chance flood event by a Federal flood protection system under construction; no Base Flood Elevations determined.
ZONE V Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
ZONE VE Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance or greater flood.

OTHER AREAS

ZONE D Areas determined to be outside of the 0.2% annual chance floodplain. Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

- 1% annual chance floodplain boundary
- 0.2% annual chance floodplain boundary
- Floodway boundary
- Zone D boundary
- CBRS area boundary
- Boundary Abandoning Special Flood Hazard Areas of different Base Flood Elevations, Flood depths or flood velocities.
- Base Flood Elevation line and value elevation in feet* (E1, E2)
- Base Flood Elevation value where within zone elevation in feet* (E1, E2)

Referenced to the North American Vertical Datum of 1988.

Map Symbols:

- Cross section line
- Transit line
- Ridge
- Culvert
- Geoid
- Geoid coordinate referenced to the North American Datum of 1983 (NAD 83), UTM system hemispheres
- 100-year (average) recurrence interval gage station, zone AE
- 500-year (average) recurrence interval gage station, zone AV
- 500-year (average) recurrence interval gage station, zone AE
- 500-year (average) recurrence interval gage station, zone AV
- Beach area (see explanation in Notes to Users section of this FIRM panel)
- M1.5 River Mile

MAP REPOSITORY
 Refer to listing of Map Repositories on Map Index

EFFECTIVE DATE OF COURTYEAR FLOOD INSURANCE RATE MAP
 December 16, 2011

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

For community map revision history, prior to coordinate mapping, refer to the Community Map History located in the Flood Insurance Study report for this jurisdiction. To determine if flood insurance is available in a community, contact your insurance agent or call the National Flood Insurance Program at 1-800-658-6622.

MAP SCALE 1" = 1000'
 0 1000 2000 FEET
 0 300 600 METERS

NFIP
NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0195E

FIRM
FLOOD INSURANCE RATE MAP
OTTAWA COUNTY,
MICHIGAN
(ALL JURISDICTIONS)

PANEL 195 OF 425
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

| CONTAINS | SUBMER PANEL | SUFFIX |
|----------------------------|--------------|--------|
| COMMUNITY | 261000 | 0195 E |
| COUNTY, Township of | 261000 | 0195 E |
| FIRM REVISION, Township of | 261000 | 0195 E |

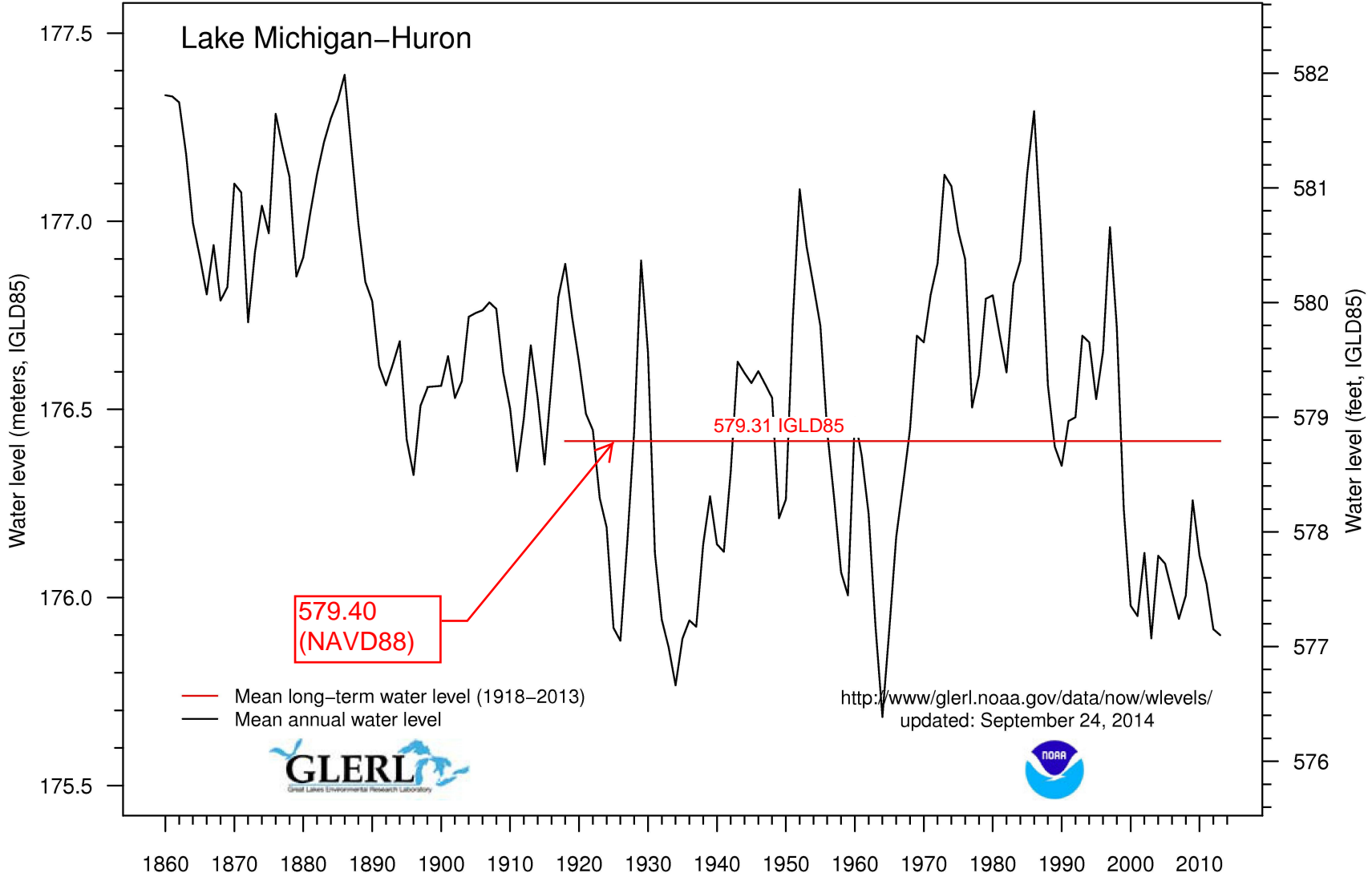
Note to User: The Map Number shown below should be used when placing map orders. The Community Number shown above should be used in insurance applications for the insured community.

MAP NUMBER
26139C0195E

EFFECTIVE DATE
DECEMBER 16, 2011

Federal Emergency Management Agency

Lake Michigan–Huron



FLOOD INSURANCE STUDY

VOLUME 1 OF 2



OTTAWA COUNTY, MICHIGAN (ALL JURISDICTIONS)

| Community Name | Community Number |
|---|------------------|
| Allendale, Charter Township of | 260490 |
| * Blendon, Township of | 261005 |
| Chester, Township of | 260829 |
| Coopersville, City of | 260491 |
| Crockery, Township of | 260981 |
| Ferrysburg, City of | 260184 |
| Georgetown, Charter Township of | 260589 |
| Grand Haven, City of | 260269 |
| Grand Haven, Charter Township of | 260270 |
| Holland, City of (Allegan and Ottawa Counties) | 260006 |
| Holland, Charter Township of | 260492 |
| Hudsonville, City of | 260493 |
| Jamestown, Charter Township of | 261001 |
| * Olive, Township of | 261006 |
| Park, Township of | 260185 |
| Polkton, Charter Township of | 260923 |
| Port Sheldon, Township of | 260278 |
| Robinson, Township of | 260913 |
| Spring Lake, Township of | 260281 |
| Spring Lake, Village of | 260282 |
| Tallmadge, Charter Township of | 260494 |
| Wright, Township of | 260495 |
| Zeeland, Charter Township of | 260932 |
| Zeeland, City of | 260983 |

* No Special Flood Hazard Areas identified



REVISED:
May 16, 2013



Federal Emergency Management Agency

FLOOD INSURANCE STUDY NUMBER
26139CV001B

TABLE 8 – Summary of Stillwater Elevations (*continued*)

| <u>Flooding Source and Location</u> | <u>Peak Elevation (feet NAVD88)</u> | | | |
|---|-------------------------------------|--------------------|--------------------|--------------------|
| | <u>10%</u> | <u>2%</u> | <u>1%</u> | <u>0.2%</u> |
| | <u>Annual</u> | <u>Annual</u> | <u>Annual</u> | <u>Annual</u> |
| | <u>Chance</u> | <u>Chance</u> | <u>Chance</u> | <u>Chance</u> |
| Lake Macatawa | | | | |
| Charter Township and City of Holland and Township of Park | 582.8 ¹ | 583.9 ¹ | 584.3 ¹ | 585.2 ¹ |
| Lake Michigan | | | | |
| Entire shoreline | 582.8 | 583.9 | 584.3 | 585.2 |
| Lloyd's Bayou | | | | |
| Township and Village of Spring Lake | 582.8 ¹ | 583.9 ¹ | 584.7 ² | 586.6 ² |
| Morning Dew Lake | | | | |
| Charter Township of Holland | * | * | 610.3 | * |
| Mill House Bayou | | | | |
| Charter Township of Grand Haven | 584.9 ² | 586.7 ² | 587.5 ² | 589.5 ² |
| Pigeon Lake | | | | |
| Township of Port Sheldon | 582.8 ¹ | 583.9 ¹ | 584.3 ¹ | 585.2 ¹ |
| Pottawattomie Bayou | | | | |
| Charter Township and City of Grand Haven | 584.4 ² | 586.3 ² | 587.1 ² | 589.1 ² |
| Rushmore Lake | | | | |
| Charter Township of Georgetown | * | * | 606.8 | * |
| Spring Lake | | | | |
| City of Ferrysburg and Township and Village of Spring Lake | 582.8 ¹ | 583.9 ¹ | 584.3 ¹ | 585.2 ¹ |
| Waterfront Lake | | | | |
| Charter Township of Georgetown | * | * | 606.7 | * |
| West Georgetown Shores Lake | | | | |
| Charter Township of Georgetown | * | * | 608.9 | * |

* Data not available

¹ Elevation controlled by peak flood elevation of Lake Michigan

² Elevation controlled by peak flood elevation of the Grand River

Hydrologic calculations were performed using approximate methods for each of the approximate-study streams listed in Section 1.2 to estimate the peak 1-percent-annual-chance flood discharges.

Discharges for the approximate-study streams studied as a part of Phase I were provided by MDEQ. No information regarding the hydrologic analyses performed to estimate the discharges for these streams was available for this study.

Discharges for the approximate-study stream studied as a part of Phase II were calculated by Stantec. Subbasins were delineated at various locations along each reach. The method of analysis used for each subbasin was selected based upon the contributing drainage area.

**APPENDIX B
RAINFALL DATA**



NOAA Atlas 14, Volume 8, Version 2
Location name: West Olive, Michigan, US*
Latitude: 42.9081°, Longitude: -86.1972°
Elevation: 606 ft*
 * source: Google Maps



POINT PRECIPITATION FREQUENCY ESTIMATES

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

NOAA, National Weather Service, Silver Spring, Maryland

[PF tabular](#) | [PF graphical](#) | [Maps & aerials](#)

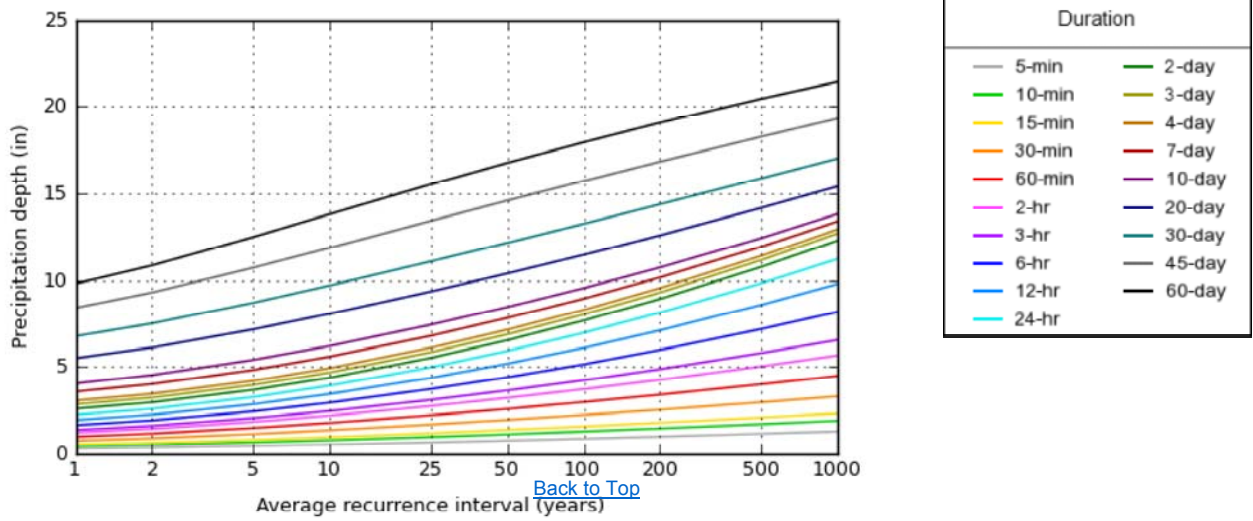
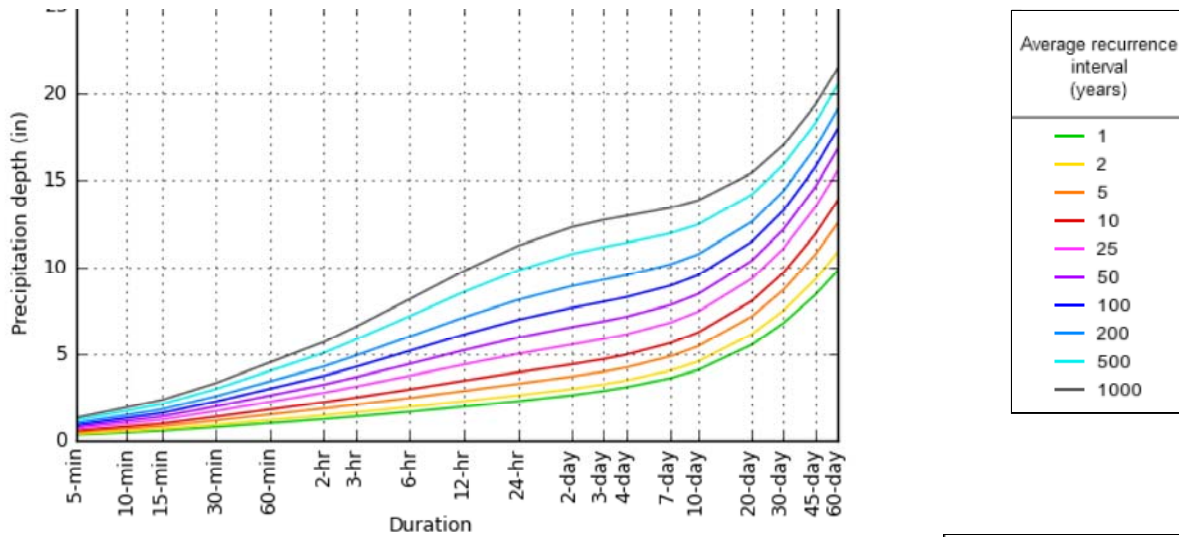
PF tabular

| PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)¹ | | | | | | | | | | |
|--|-------------------------------------|-------------------------------|-------------------------------|-------------------------------|-------------------------------|------------------------------|------------------------------|-----------------------------|-----------------------------|-----------------------------|
| Duration | Average recurrence interval (years) | | | | | | | | | |
| | 1 | 2 | 5 | 10 | 25 | 50 | 100 | 200 | 500 | 1000 |
| 5-min | 0.307 (0.251-0.382) | 0.362 (0.296-0.451) | 0.459 (0.373-0.572) | 0.544 (0.440-0.682) | 0.671 (0.526-0.877) | 0.776 (0.591-1.03) | 0.886 (0.650-1.20) | 1.01 (0.704-1.39) | 1.17 (0.786-1.66) | 1.30 (0.848-1.87) |
| 10-min | 0.450 (0.368-0.560) | 0.531 (0.433-0.661) | 0.671 (0.546-0.838) | 0.797 (0.644-0.999) | 0.982 (0.771-1.28) | 1.14 (0.866-1.50) | 1.30 (0.952-1.75) | 1.47 (1.03-2.04) | 1.71 (1.15-2.44) | 1.91 (1.24-2.74) |
| 15-min | 0.549 (0.449-0.683) | 0.647 (0.528-0.806) | 0.819 (0.666-1.02) | 0.972 (0.786-1.22) | 1.20 (0.940-1.57) | 1.39 (1.06-1.83) | 1.58 (1.16-2.14) | 1.79 (1.26-2.49) | 2.09 (1.40-2.97) | 2.33 (1.51-3.34) |
| 30-min | 0.768 (0.628-0.955) | 0.907 (0.741-1.13) | 1.15 (0.937-1.44) | 1.37 (1.11-1.72) | 1.69 (1.33-2.21) | 1.96 (1.49-2.59) | 2.24 (1.64-3.03) | 2.54 (1.78-3.52) | 2.96 (1.99-4.22) | 3.30 (2.15-4.74) |
| 60-min | 0.999 (0.817-1.24) | 1.18 (0.962-1.47) | 1.50 (1.22-1.87) | 1.79 (1.44-2.24) | 2.22 (1.75-2.92) | 2.59 (1.98-3.43) | 2.98 (2.19-4.03) | 3.40 (2.39-4.72) | 4.00 (2.69-5.69) | 4.48 (2.91-6.43) |
| 2-hr | 1.23 (1.01-1.52) | 1.45 (1.19-1.79) | 1.84 (1.51-2.28) | 2.20 (1.80-2.74) | 2.75 (2.18-3.58) | 3.21 (2.48-4.23) | 3.71 (2.75-4.99) | 4.26 (3.01-5.87) | 5.03 (3.41-7.11) | 5.66 (3.71-8.05) |
| 3-hr | 1.38 (1.14-1.69) | 1.62 (1.34-1.99) | 2.06 (1.70-2.53) | 2.47 (2.02-3.05) | 3.10 (2.48-4.03) | 3.64 (2.82-4.77) | 4.23 (3.15-5.67) | 4.87 (3.46-6.69) | 5.79 (3.94-8.16) | 6.54 (4.31-9.27) |
| 6-hr | 1.66 (1.38-2.01) | 1.93 (1.61-2.34) | 2.45 (2.03-2.98) | 2.94 (2.43-3.60) | 3.72 (3.01-4.81) | 4.40 (3.44-5.73) | 5.14 (3.87-6.86) | 5.97 (4.29-8.16) | 7.17 (4.93-10.0) | 8.15 (5.41-11.5) |
| 12-hr | 1.95 (1.64-2.34) | 2.26 (1.90-2.71) | 2.85 (2.39-3.44) | 3.44 (2.86-4.16) | 4.36 (3.56-5.61) | 5.18 (4.09-6.70) | 6.08 (4.62-8.05) | 7.09 (5.14-9.63) | 8.56 (5.94-11.9) | 9.78 (6.54-13.6) |
| 24-hr | 2.26 (1.91-2.68) | 2.60 (2.20-3.09) | 3.26 (2.75-3.89) | 3.92 (3.28-4.70) | 4.97 (4.09-6.34) | 5.91 (4.71-7.58) | 6.95 (5.32-9.12) | 8.11 (5.93-10.9) | 9.82 (6.87-13.6) | 11.2 (7.58-15.5) |
| 2-day | 2.60 (2.23-3.07) | 2.96 (2.53-3.49) | 3.67 (3.13-4.34) | 4.38 (3.70-5.20) | 5.51 (4.58-6.96) | 6.53 (5.24-8.29) | 7.65 (5.91-9.96) | 8.91 (6.57-11.9) | 10.8 (7.60-14.7) | 12.3 (8.37-16.9) |
| 3-day | 2.86 (2.45-3.34) | 3.23 (2.77-3.78) | 3.96 (3.38-4.65) | 4.68 (3.97-5.52) | 5.83 (4.86-7.31) | 6.86 (5.54-8.66) | 8.01 (6.21-10.4) | 9.29 (6.88-12.3) | 11.2 (7.91-15.2) | 12.7 (8.69-17.4) |
| 4-day | 3.06 (2.64-3.57) | 3.45 (2.97-4.02) | 4.20 (3.60-4.91) | 4.93 (4.20-5.79) | 6.09 (5.09-7.59) | 7.13 (5.77-8.95) | 8.27 (6.43-10.6) | 9.54 (7.09-12.6) | 11.4 (8.11-15.5) | 13.0 (8.88-17.6) |
| 7-day | 3.58 (3.10-4.13) | 4.01 (3.48-4.64) | 4.82 (4.16-5.59) | 5.59 (4.79-6.51) | 6.78 (5.68-8.31) | 7.80 (6.34-9.68) | 8.93 (6.98-11.3) | 10.2 (7.58-13.3) | 11.9 (8.54-16.0) | 13.4 (9.25-18.1) |
| 10-day | 4.05 (3.53-4.65) | 4.53 (3.94-5.21) | 5.40 (4.68-6.23) | 6.20 (5.34-7.18) | 7.41 (6.21-9.00) | 8.44 (6.87-10.4) | 9.54 (7.48-12.0) | 10.7 (8.04-13.9) | 12.4 (8.92-16.6) | 13.8 (9.59-18.6) |
| 20-day | 5.50 (4.83-6.25) | 6.11 (5.36-6.95) | 7.15 (6.25-8.16) | 8.05 (6.99-9.23) | 9.34 (7.85-11.1) | 10.4 (8.50-12.5) | 11.5 (9.04-14.2) | 12.6 (9.49-16.1) | 14.2 (10.2-18.6) | 15.4 (10.8-20.6) |
| 30-day | 6.76 (5.97-7.64) | 7.49 (6.61-8.47) | 8.69 (7.64-9.86) | 9.69 (8.47-11.1) | 11.1 (9.34-13.0) | 12.2 (10.0-14.6) | 13.3 (10.5-16.3) | 14.4 (10.9-18.2) | 15.9 (11.5-20.7) | 17.0 (12.0-22.6) |
| 45-day | 8.39 (7.45-9.43) | 9.29 (8.23-10.4) | 10.7 (9.47-12.1) | 11.9 (10.4-13.5) | 13.4 (11.3-15.6) | 14.6 (12.0-17.3) | 15.7 (12.5-19.1) | 16.8 (12.7-21.1) | 18.3 (13.2-23.6) | 19.3 (13.6-25.5) |
| 60-day | 9.80 (8.73-11.0) | 10.9 (9.66-12.2) | 12.5 (11.1-14.0) | 13.8 (12.2-15.6) | 15.5 (13.1-17.9) | 16.8 (13.8-19.7) | 17.9 (14.3-21.7) | 19.1 (14.5-23.8) | 20.4 (14.9-26.3) | 21.4 (15.2-28.2) |

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



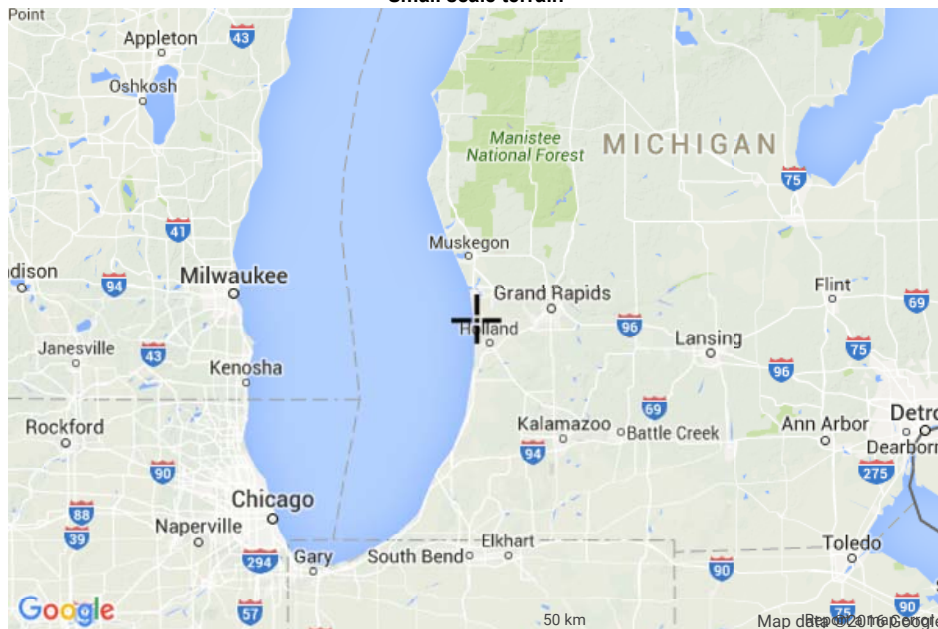
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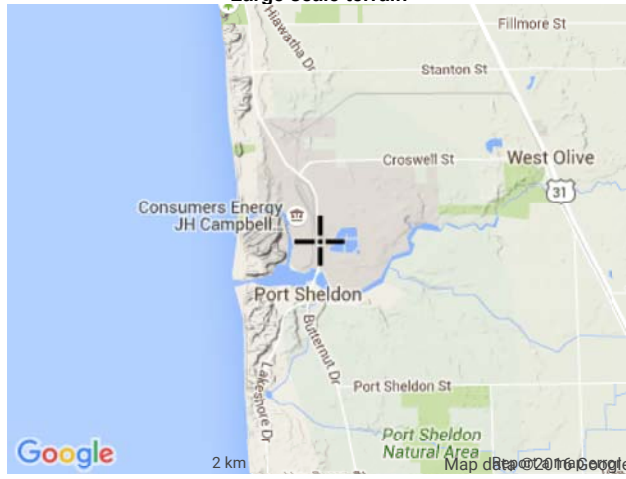
Maps & aeri

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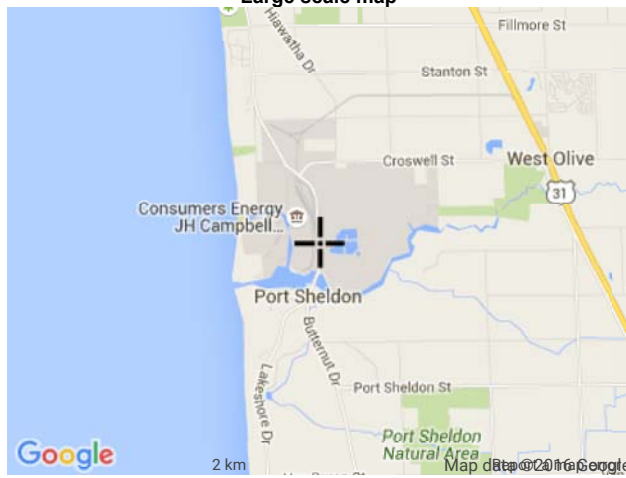
Small scale terrain



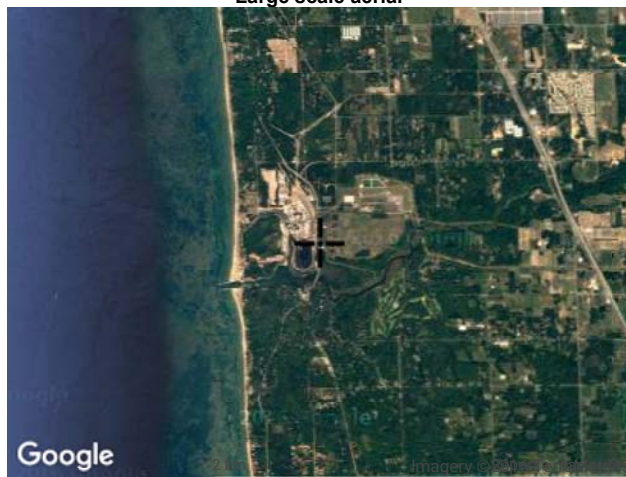
Large scale terrain



Large scale map



Large scale aerial



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Silver Spring, MD 20910

Questions?: HDSC.Questions@noaa.gov

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APPENDIX C
HYDROLOGIC AND HYDRAULIC MODEL OUTPUT

Project Description

File Name Campbell Units 1-3.SPF

Project Options

Flow Units CFS
 Elevation Type Depth
 Hydrology Method EPA SWMM
 EPA SWMM Infiltration Method Horton
 Link Routing Method Hydrodynamic
 Enable Overflow Ponding at Nodes YES
 Skip Steady State Analysis Time Periods NO

Analysis Options

Start Analysis On Jun 01, 2016 00:00:00
 End Analysis On Jun 04, 2016 00:00:00
 Start Reporting On Jun 01, 2016 00:00:00
 Antecedent Dry Days 0 days
 Runoff (Dry Weather) Time Step 0 01:00:00 days hh:mm:ss
 Runoff (Wet Weather) Time Step 0 00:05:00 days hh:mm:ss
 Reporting Time Step 0 00:05:00 days hh:mm:ss
 Routing Time Step 30 seconds

Number of Elements

| | Qty |
|------------------------------|-----|
| Rain Gages | 1 |
| Subbasins..... | 9 |
| Nodes..... | 21 |
| <i>Junctions</i> | 12 |
| <i>Outfalls</i> | 3 |
| <i>Flow Diversions</i> | 0 |
| <i>Inlets</i> | 0 |
| <i>Storage Nodes</i> | 6 |
| Links..... | 20 |
| <i>Channels</i> | 4 |
| <i>Pipes</i> | 14 |
| <i>Pumps</i> | 0 |
| <i>Orifices</i> | 1 |
| <i>Weirs</i> | 1 |
| <i>Outlets</i> | 0 |
| Pollutants | 0 |
| Land Uses | 0 |

Rainfall Details

| SN | Rain Gage ID | Data Source | Data Source ID | Rainfall Type | Rain Units | State | County | Return Period (years) | Rainfall Depth (inches) | Rainfall Distribution |
|----|--------------|-------------|----------------|---------------|------------|-------|--------|-----------------------|-------------------------|-----------------------|
| 1 | Rain Gage-01 | Time Series | TS-1000 | Cumulative | inches | | | | 11.20 | |

Subbasin Summary

| SN | Subbasin ID | Area | Impervious Area | Average Slope | Equivalent Width | Impervious Area Manning's Roughness | Pervious Area Manning's Roughness | Total Rainfall | Total Infiltration | Total Runoff | Total Runoff Volume | Peak Runoff | Time of Concentration |
|----|--------------|-------|-----------------|---------------|------------------|-------------------------------------|-----------------------------------|----------------|--------------------|--------------|---------------------|-------------|-----------------------|
| | | (ac) | (%) | (%) | (ft) | | | (in) | (in) | (in) | (ac-in) | (cfs) | (days hh:mm:ss) |
| 1 | Sub-100 | 8.85 | 25.00 | 0.5000 | 500.00 | 0.0150 | 0.1000 | 11.20 | 4.8600 | 6.34 | 56.12 | 73.21 | 0 01:11:18 |
| 2 | Sub-101 | 3.60 | 25.00 | 0.5000 | 500.00 | 0.0150 | 0.1000 | 11.20 | 4.7510 | 6.45 | 23.23 | 40.29 | 0 00:41:34 |
| 3 | Sub-102 | 1.70 | 25.00 | 0.5000 | 500.00 | 0.0150 | 0.1000 | 11.20 | 4.7090 | 6.50 | 11.05 | 22.47 | 0 00:26:30 |
| 4 | Sub-103 | 14.00 | 25.00 | 0.5000 | 500.00 | 0.0150 | 0.1000 | 11.20 | 4.9570 | 6.24 | 87.37 | 98.82 | 0 01:33:54 |
| 5 | Sub-Pond1-2N | 2.78 | 25.00 | 0.5000 | 500.00 | 0.0150 | 0.1000 | 11.20 | 4.7330 | 6.47 | 17.98 | 33.27 | 0 00:35:35 |
| 6 | Sub-Pond1-2S | 2.09 | 25.00 | 0.5000 | 500.00 | 0.0150 | 0.1000 | 11.20 | 4.7180 | 6.49 | 13.54 | 26.59 | 0 00:29:58 |
| 7 | Sub-Pond3N | 5.02 | 25.00 | 0.5000 | 500.00 | 0.0150 | 0.1000 | 11.20 | 4.7810 | 6.42 | 32.24 | 50.77 | 0 00:50:45 |
| 8 | Sub-Pond3S | 4.52 | 25.00 | 0.5000 | 500.00 | 0.0150 | 0.1000 | 11.20 | 4.7710 | 6.43 | 29.06 | 47.26 | 0 00:47:38 |
| 9 | Sub-PondA | 11.13 | 25.00 | 0.5000 | 500.00 | 0.0150 | 0.1000 | 11.20 | 4.9040 | 6.30 | 70.09 | 85.30 | 0 01:21:50 |

Node Summary

| SN | Element ID | Element Type | Invert Elevation | Ground/Rim (Max) Elevation | Initial Water Elevation | Surcharge Elevation | Ponded Area | Peak Inflow | Max HGL Elevation Attained | Max Surcharge Depth Attained | Min Freeboard Attained | Time of Peak Flooding Occurrence | Total Flooded Volume | Total Time Flooded |
|----|---------------|--------------|------------------|----------------------------|-------------------------|---------------------|--------------------|-------------|----------------------------|------------------------------|------------------------|----------------------------------|----------------------|--------------------|
| | | | (ft) | (ft) | (ft) | (ft) | (ft ²) | (cfs) | (ft) | (ft) | (ft) | (days hh:mm) | (ac-in) | (min) |
| 1 | Jun-10 | Junction | 619.90 | 631.46 | 0.00 | 0.00 | 0.00 | 7.93 | 623.61 | 0.00 | 7.85 | 0 00:00 | 0.00 | 0.00 |
| 2 | Jun-101 | Junction | 616.82 | 625.00 | 0.00 | 0.00 | 0.00 | 59.83 | 618.78 | 0.00 | 6.22 | 0 00:00 | 0.00 | 0.00 |
| 3 | Jun-103 | Junction | 618.16 | 632.32 | 0.00 | 0.00 | 0.00 | 84.35 | 632.32 | 0.00 | 0.00 | 0 12:01 | 0.03 | 0.00 |
| 4 | Jun-104 | Junction | 623.00 | 631.60 | 0.00 | 0.00 | 0.00 | 105.20 | 631.60 | 0.00 | 0.00 | 0 12:11 | 0.02 | 0.00 |
| 5 | Jun-105 | Junction | 628.00 | 633.20 | 0.00 | 0.00 | 0.00 | 98.76 | 630.98 | 0.00 | 2.22 | 0 00:00 | 0.00 | 0.00 |
| 6 | Jun-11 | Junction | 619.06 | 632.11 | 0.00 | 0.00 | 0.00 | 7.93 | 621.67 | 0.00 | 10.44 | 0 00:00 | 0.00 | 0.00 |
| 7 | Jun-12 | Junction | 608.50 | 610.50 | 0.00 | 0.00 | 0.00 | 14.53 | 609.30 | 0.00 | 1.20 | 0 00:00 | 0.00 | 0.00 |
| 8 | Jun-12N-Out | Junction | 618.36 | 631.07 | 0.00 | 6.00 | 0.00 | 47.66 | 620.40 | 0.00 | 10.67 | 0 00:00 | 0.00 | 0.00 |
| 9 | Jun-12S-Out | Junction | 617.72 | 624.87 | 0.00 | 0.00 | 0.00 | 23.17 | 619.10 | 0.00 | 5.77 | 0 00:00 | 0.00 | 0.00 |
| 10 | Jun-13 | Junction | 613.50 | 619.50 | 0.00 | 0.00 | 0.00 | 14.53 | 617.02 | 0.00 | 2.48 | 0 00:00 | 0.00 | 0.00 |
| 11 | Jun-3N-Out | Junction | 623.46 | 631.99 | 0.00 | 6.00 | 0.00 | 3.05 | 626.37 | 0.00 | 5.62 | 0 00:00 | 0.00 | 0.00 |
| 12 | Jun-3S-Out | Junction | 622.10 | 633.70 | 0.00 | 6.00 | 0.00 | 7.93 | 626.02 | 0.00 | 7.68 | 0 00:00 | 0.00 | 0.00 |
| 13 | Out-01 | Outfall | 589.75 | | | | | 44.78 | 591.04 | | | | | |
| 14 | Out-02 | Outfall | 602.00 | | | | | 0.00 | 602.00 | | | | | |
| 15 | Out-04 | Outfall | 596.80 | | | | | 14.53 | 597.54 | | | | | |
| 16 | Stor-100 | Storage Node | 625.00 | 632.00 | 625.93 | | 0.00 | 73.17 | 626.88 | | | | 0.00 | 0.00 |
| 17 | Stor-Pond1-2N | Storage Node | 604.00 | 626.00 | 619.08 | | 0.00 | 44.90 | 620.14 | | | | 0.00 | 0.00 |
| 18 | Stor-Pond1-2S | Storage Node | 600.00 | 626.00 | 618.78 | | 0.00 | 26.57 | 619.32 | | | | 0.00 | 0.00 |
| 19 | Stor-Pond3N | Storage Node | 604.00 | 632.00 | 625.34 | | 0.00 | 56.66 | 626.44 | | | | 0.00 | 0.00 |
| 20 | Stor-Pond3S | Storage Node | 604.00 | 632.00 | 624.66 | | 0.00 | 53.26 | 626.62 | | | | 0.00 | 0.00 |
| 21 | Stor-PondA | Storage Node | 600.00 | 626.00 | 615.50 | | 0.00 | 164.96 | 617.90 | | | | 0.00 | 0.00 |

Link Summary

| SN Element ID | Element Type | From (Inlet) Node | To (Outlet) Node | Length | Inlet Invert Elevation | Outlet Invert Elevation | Average Slope (%) | Diameter or Height (ft) | Manning's Roughness | Peak Flow (cfs) | Design Flow Capacity (cfs) | Peak Flow/Design Flow Ratio | Peak Flow Velocity (ft/sec) | Peak Flow Depth (ft) | Peak Flow Depth/Total Depth Ratio |
|------------------------|--------------|-------------------|------------------|---------|------------------------|-------------------------|-------------------|-------------------------|---------------------|-----------------|----------------------------|-----------------------------|-----------------------------|----------------------|-----------------------------------|
| 1 Link-17 | Pipe | Jun-10 | Jun-11 | 285.40 | 619.90 | 619.16 | 0.2600 | 1.500 | 0.0130 | 7.93 | 5.35 | 1.48 | 4.49 | 1.50 | 1.00 |
| 2 Link-18 | Pipe | Jun-11 | Jun-12N-Out | 192.01 | 619.06 | 619.03 | 0.0200 | 1.500 | 0.0130 | 7.93 | 1.31 | 6.04 | 4.89 | 1.43 | 0.96 |
| 3 Pipe-001 | Pipe | Jun-3N-Out | Jun-3S-Out | 658.20 | 623.46 | 622.08 | 0.2100 | 1.500 | 0.0130 | 3.05 | 4.77 | 0.64 | 1.78 | 1.50 | 1.00 |
| 4 Pipe-002 | Pipe | Jun-3S-Out | Jun-10 | 341.45 | 622.10 | 620.00 | 0.6200 | 1.500 | 0.0130 | 7.93 | 8.24 | 0.96 | 4.49 | 1.50 | 1.00 |
| 5 Pipe-Outfall01 | Pipe | Jun-101 | Out-01 | 173.41 | 617.37 | 589.75 | 15.9300 | 2.500 | 0.0250 | 44.78 | 85.12 | 0.53 | 16.54 | 1.32 | 0.54 |
| 6 Pipe-Pond12N-Outlet | Pipe | Stor-Pond1-2N | Jun-12N-Out | 78.49 | 619.08 | 618.36 | 0.9200 | 2.000 | 0.0250 | 5.28 | 11.27 | 0.47 | 2.80 | 1.45 | 0.74 |
| 7 Pipe-Pond12S-Outlet | Pipe | Stor-Pond1-2S | Jun-12S-Out | 59.89 | 618.78 | 617.72 | 1.7700 | 2.000 | 0.0250 | 2.46 | 15.65 | 0.16 | 3.57 | 0.89 | 0.45 |
| 8 Pipe-Pond3N-Outlet | Pipe | Stor-Pond3N | Jun-3N-Out | 109.20 | 625.34 | 623.56 | 1.6300 | 1.500 | 0.0130 | 3.05 | 13.41 | 0.23 | 3.83 | 1.30 | 0.87 |
| 9 Pipe-Pond3S-Outlet | Pipe | Stor-Pond3S | Jun-3S-Out | 119.51 | 624.66 | 622.08 | 2.1600 | 1.500 | 0.0130 | 6.03 | 15.37 | 0.39 | 4.77 | 1.50 | 1.00 |
| 10 Pipe-PondA-In1 | Pipe | Stor-100 | Stor-PondA | 99.23 | 625.93 | 614.05 | 11.9700 | 2.500 | 0.0250 | 22.57 | 73.80 | 0.31 | 6.25 | 1.72 | 0.69 |
| 11 Pipe-PondA-In2 | Pipe | Jun-103 | Stor-PondA | 100.72 | 618.16 | 615.82 | 2.3200 | 2.000 | 0.0130 | 55.57 | 34.48 | 1.61 | 17.69 | 2.00 | 1.00 |
| 12 Pipe-PondA-In3 | Pipe | Jun-101 | Stor-PondA | 640.00 | 616.82 | 615.14 | 0.2600 | 2.000 | 0.0130 | 11.84 | 11.59 | 1.02 | 4.16 | 1.72 | 0.86 |
| 13 Pipe-Pond-A-Outlet1 | Pipe | Jun-13 | Jun-12 | 345.00 | 613.50 | 608.50 | 1.4500 | 2.000 | 0.0250 | 14.53 | 14.16 | 1.03 | 6.35 | 1.40 | 0.70 |
| 14 Pipe-Pond-A-Outlet2 | Pipe | Jun-12 | Out-04 | 65.00 | 608.50 | 596.80 | 18.0000 | 2.000 | 0.0250 | 14.53 | 49.91 | 0.29 | 13.05 | 0.77 | 0.38 |
| 15 Ditch-001 | Channel | Jun-12N-Out | Jun-101 | 1154.00 | 618.36 | 616.82 | 0.1300 | 7.000 | 0.0350 | 39.54 | 462.65 | 0.09 | 2.02 | 1.98 | 0.28 |
| 16 Ditch-002 | Channel | Jun-12S-Out | Jun-101 | 558.30 | 617.72 | 616.82 | 0.1600 | 7.000 | 0.0350 | 21.24 | 508.49 | 0.04 | 1.46 | 1.65 | 0.24 |
| 17 Ditch-003 | Channel | Jun-105 | Jun-104 | 753.20 | 628.00 | 623.00 | 0.6600 | 5.000 | 0.0350 | 105.20 | 378.54 | 0.28 | 4.77 | 3.88 | 0.78 |
| 18 Ditch-004 | Channel | Jun-104 | Jun-103 | 504.30 | 623.00 | 618.16 | 0.9600 | 5.000 | 0.0350 | 84.35 | 455.15 | 0.19 | 3.48 | 5.00 | 1.00 |
| 19 Orifice-01 | Orifice | Stor-PondA | Jun-13 | | 600.00 | 613.50 | | 2.000 | | 14.53 | | | | | |
| 20 Weir-Pond1-2S | Weir | Out-02 | Stor-Pond1-2N | | 602.00 | 604.00 | | | | 0.00 | | | | | |

Subbasin Hydrology

Subbasin : Sub-100

Input Data

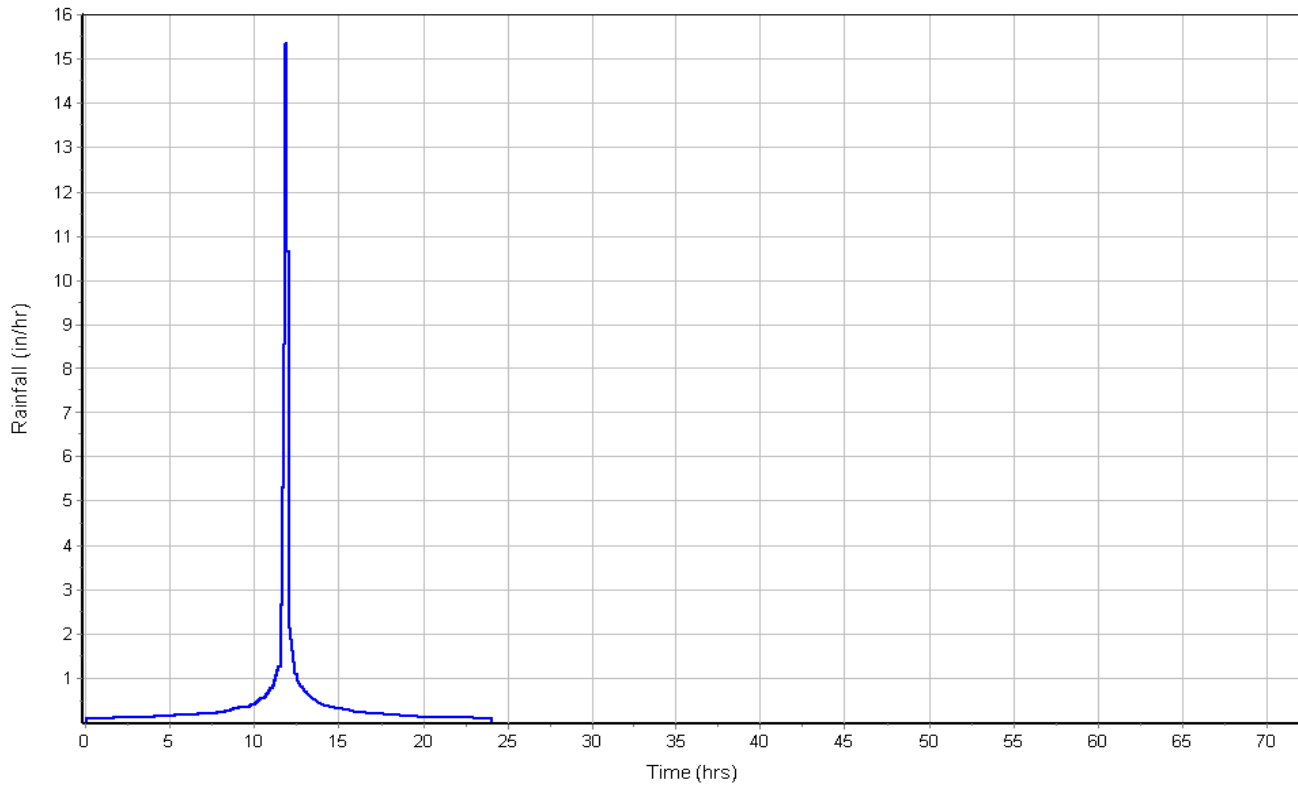
| | |
|-------------------------------------|--------------|
| Area (ac) | 8.85 |
| Impervious Area (%) | 25.00 |
| Max Infiltration Rate (in/hr) | 3.0000 |
| Min Infiltration Rate (in/hr) | 0.5000 |
| Drying Time (days) | 7.00 |
| Decay Constant (1/hrs) | 4.0000 |
| Max Volume (in) | 0.00 |
| Average Slope (%) | 0.5000 |
| Equivalent Width (ft) | 500.00 |
| Impervious Area | |
| <i>Manning's Roughness</i> | 0.0150 |
| Pervious Area | |
| <i>Manning's Roughness</i> | 0.1000 |
| Curb & Gutter Length (ft) | 0.00 |
| Rain Gage ID | Rain Gage-01 |

Subbasin Runoff Results

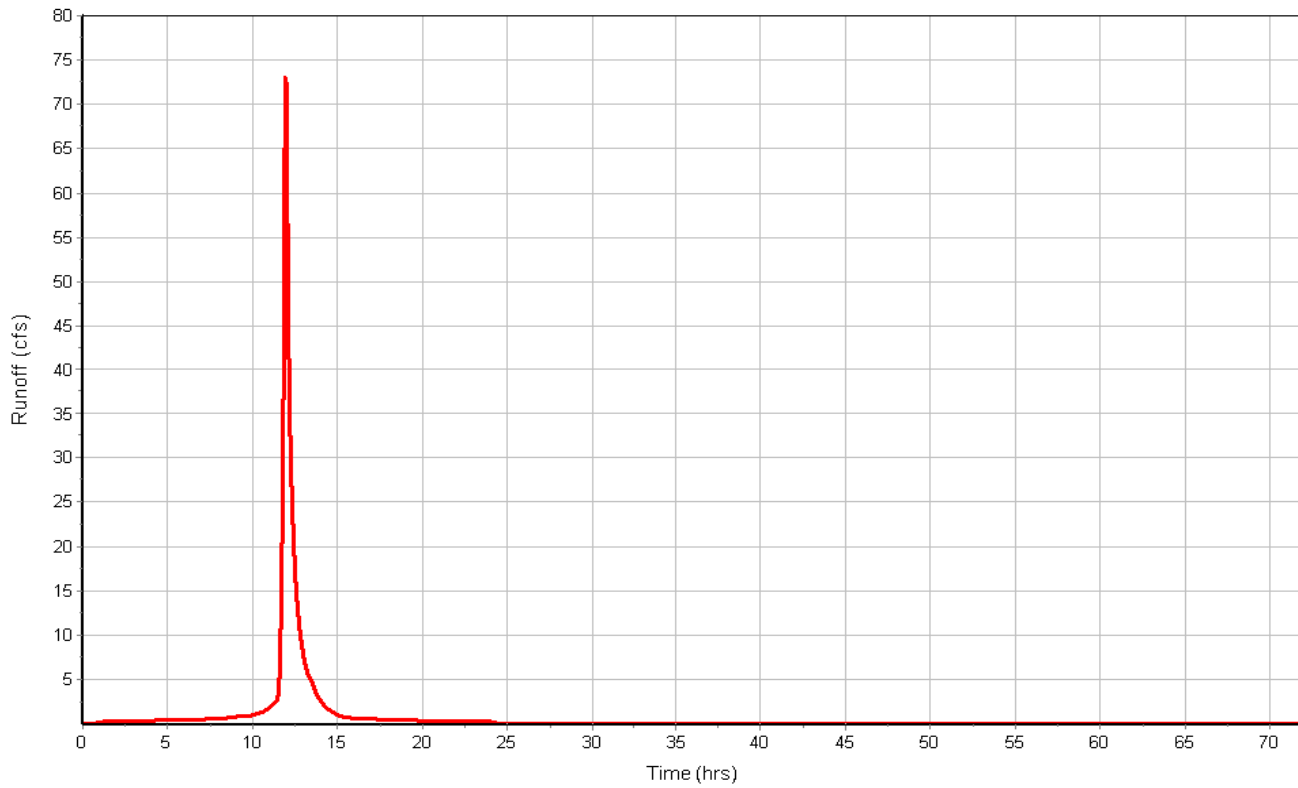
| | |
|---|------------|
| Total Rainfall (in) | 11.20 |
| Total Runon (in) | 0.00 |
| Total Evaporation (in) | 0.0000 |
| Total Infiltration (in) | 4.8600 |
| Total Runoff (in) | 6.34 |
| Peak Runoff (cfs) | 73.21 |
| Time of Concentration (days hh:mm:ss) | 0 01:11:18 |

Subbasin : Sub-100

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-101

Input Data

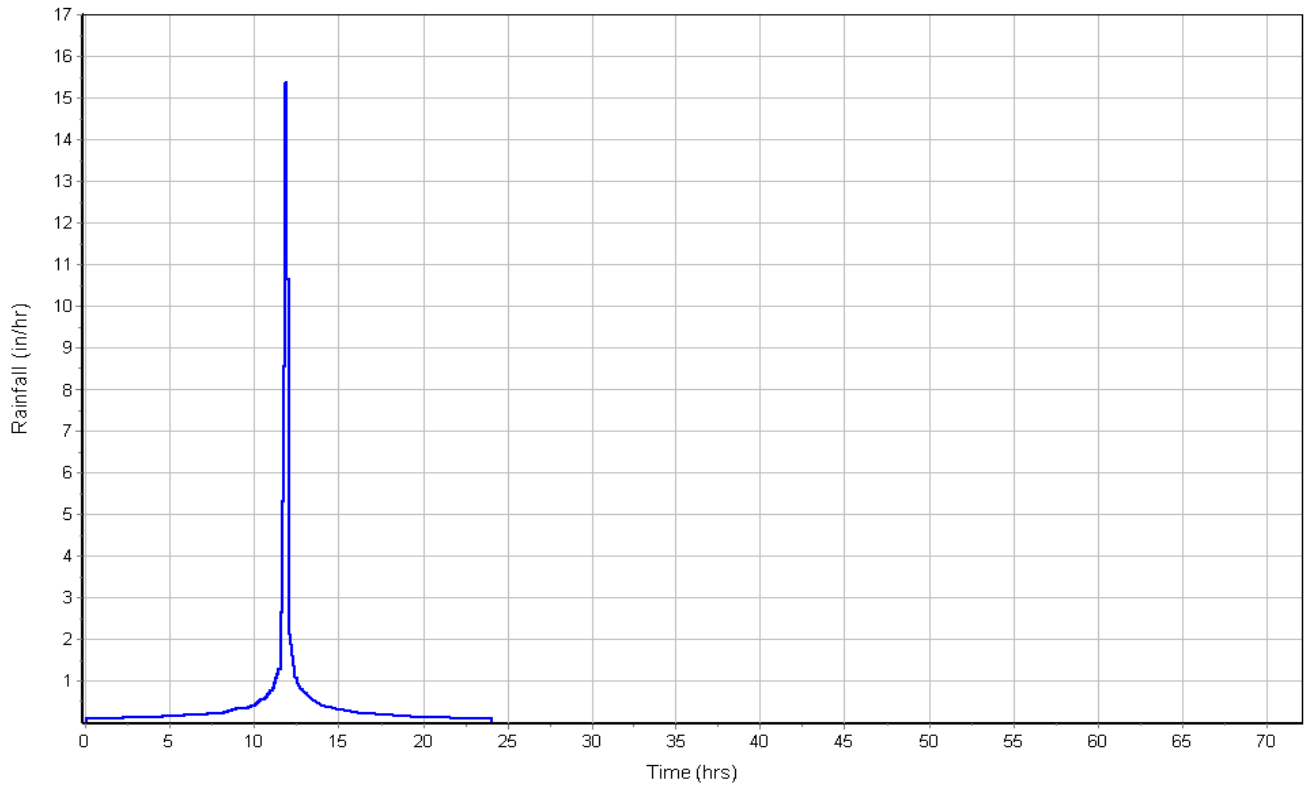
Area (ac) 3.60
Impervious Area (%) 25.00
Max Infiltration Rate (in/hr) 3.0000
Min Infiltration Rate (in/hr) 0.5000
Drying Time (days) 7.00
Decay Constant (1/hrs) 4.0000
Max Volume (in) 0.00
Average Slope (%) 0.5000
Equivalent Width (ft) 500.00
Impervious Area
 Manning's Roughness 0.0150
Pervious Area
 Manning's Roughness 0.1000
Curb & Gutter Length (ft) 0.00
Rain Gage ID Rain Gage-01

Subbasin Runoff Results

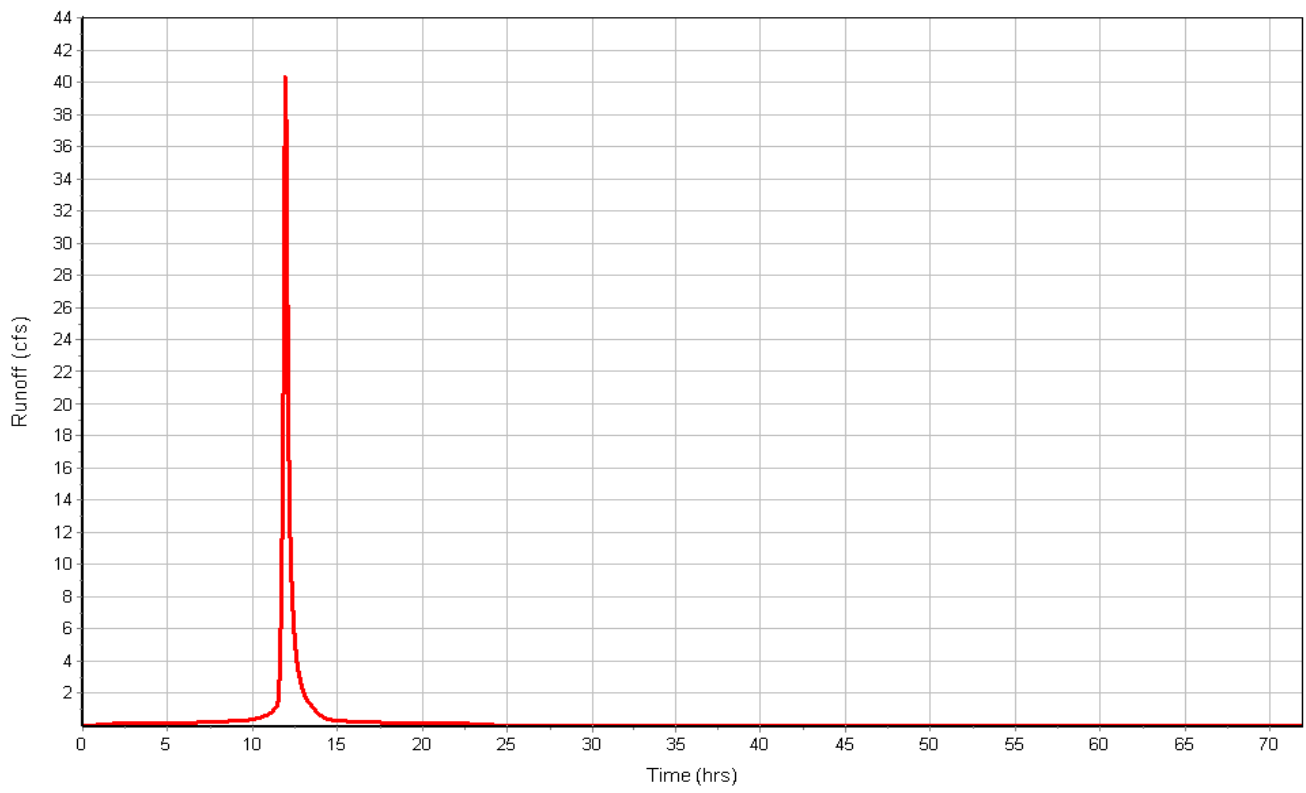
Total Rainfall (in) 11.20
Total Runon (in) 0.00
Total Evaporation (in) 0.0000
Total Infiltration (in) 4.7510
Total Runoff (in) 6.45
Peak Runoff (cfs) 40.29
Time of Concentration (days hh:mm:ss) 0 00:41:34

Subbasin : Sub-101

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-102

Input Data

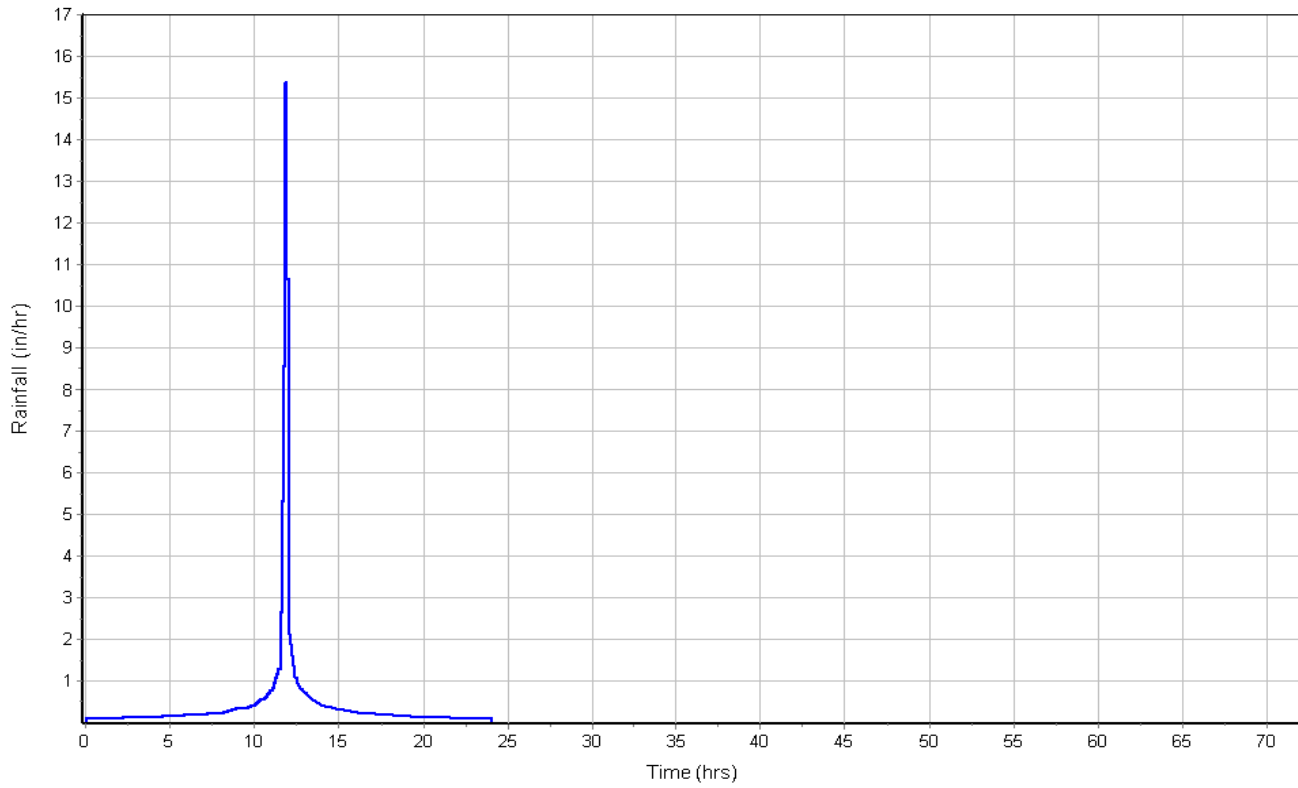
Area (ac) 1.70
Impervious Area (%) 25.00
Max Infiltration Rate (in/hr) 3.0000
Min Infiltration Rate (in/hr) 0.5000
Drying Time (days) 7.00
Decay Constant (1/hrs) 4.0000
Max Volume (in) 0.00
Average Slope (%) 0.5000
Equivalent Width (ft) 500.00
Impervious Area
 Manning's Roughness 0.0150
Pervious Area
 Manning's Roughness 0.1000
Curb & Gutter Length (ft) 0.00
Rain Gage ID Rain Gage-01

Subbasin Runoff Results

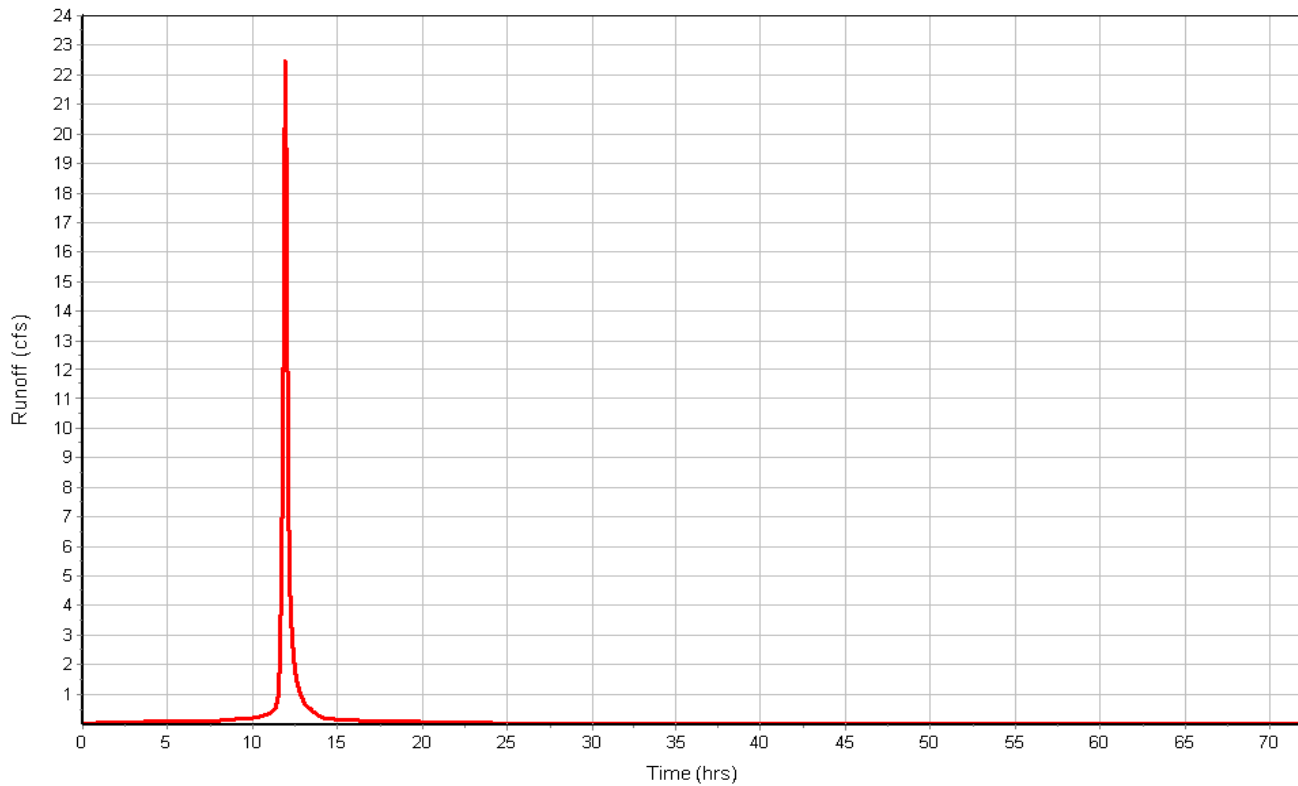
Total Rainfall (in) 11.20
Total Runon (in) 0.00
Total Evaporation (in) 0.0000
Total Infiltration (in) 4.7090
Total Runoff (in) 6.50
Peak Runoff (cfs) 22.47
Time of Concentration (days hh:mm:ss) 0 00:26:30

Subbasin : Sub-102

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-103

Input Data

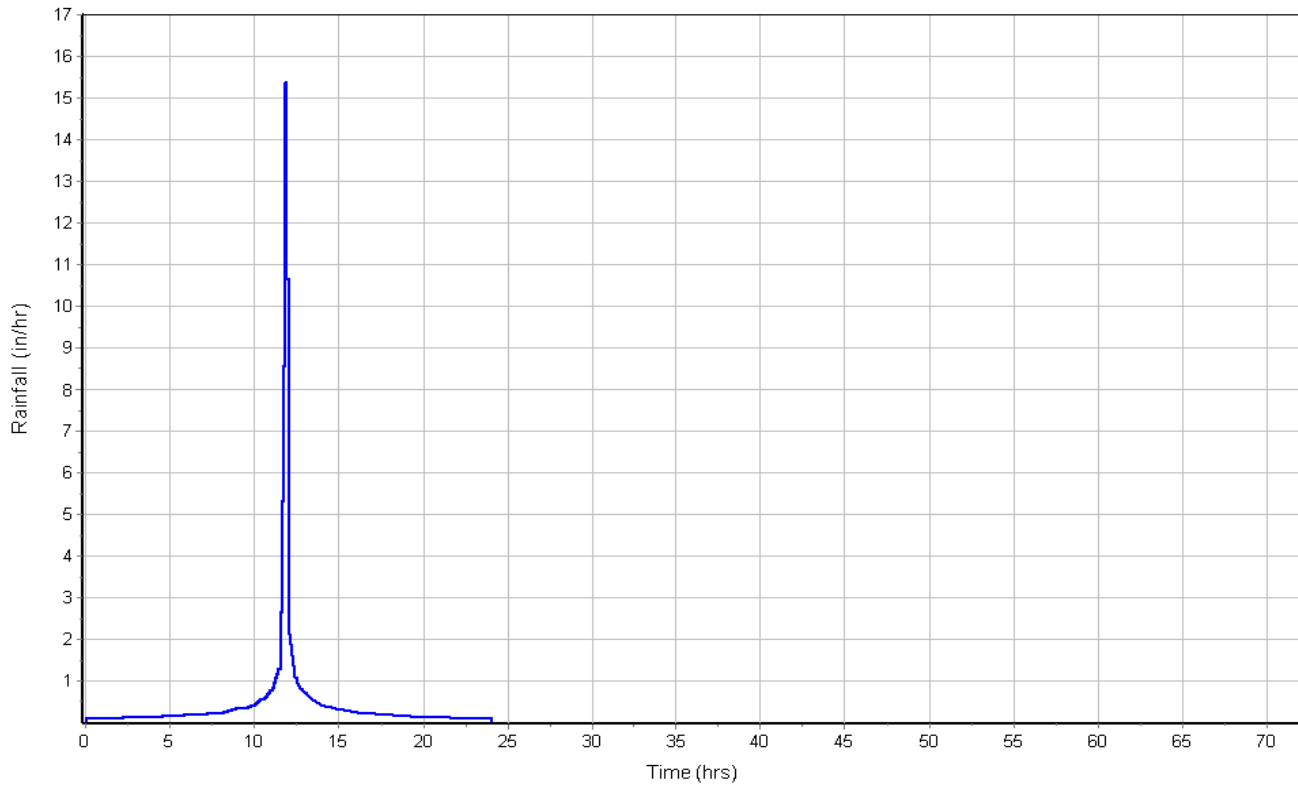
Area (ac) 14.00
Impervious Area (%) 25.00
Max Infiltration Rate (in/hr) 3.0000
Min Infiltration Rate (in/hr) 0.5000
Drying Time (days) 7.00
Decay Constant (1/hrs) 4.0000
Max Volume (in) 0.00
Average Slope (%) 0.5000
Equivalent Width (ft) 500.00
Impervious Area
 Manning's Roughness 0.0150
Pervious Area
 Manning's Roughness 0.1000
Curb & Gutter Length (ft) 0.00
Rain Gage ID Rain Gage-01

Subbasin Runoff Results

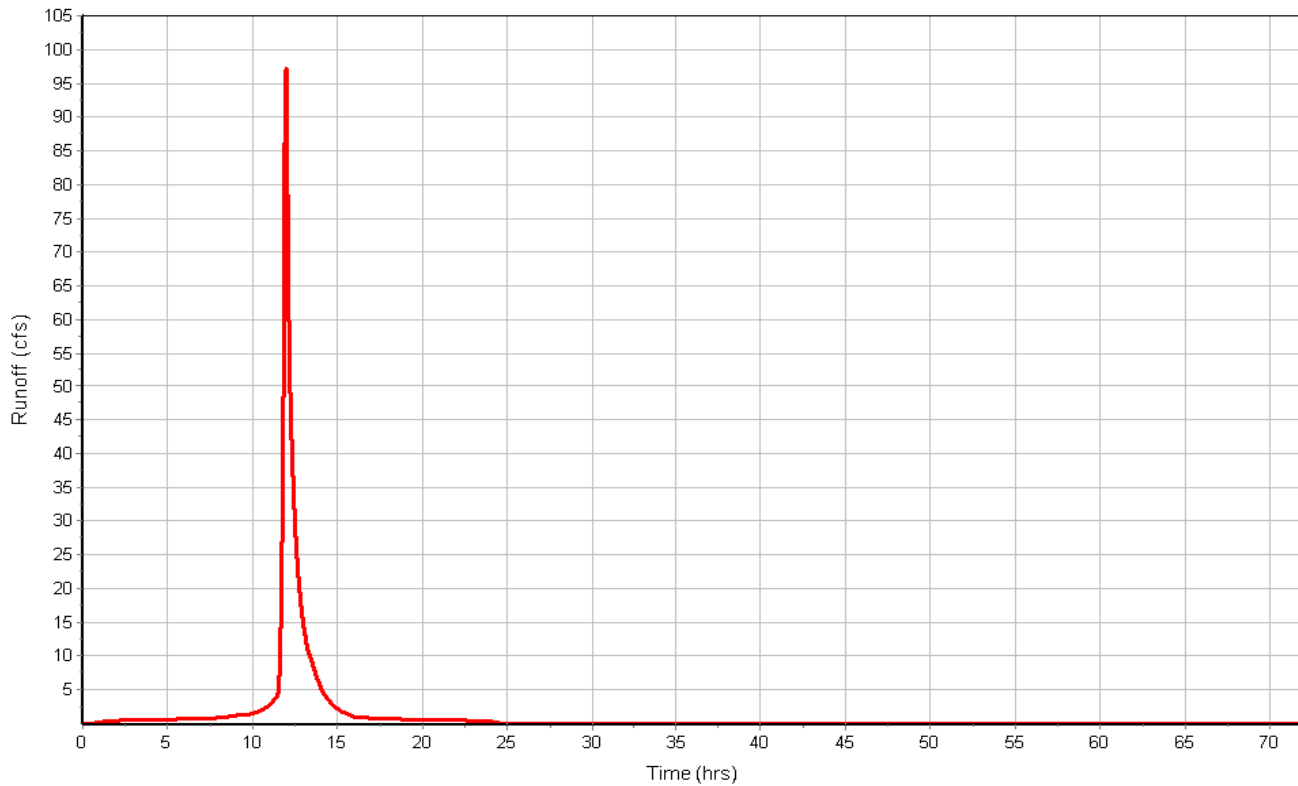
Total Rainfall (in) 11.20
Total Runon (in) 0.00
Total Evaporation (in) 0.0000
Total Infiltration (in) 4.9570
Total Runoff (in) 6.24
Peak Runoff (cfs) 98.82
Time of Concentration (days hh:mm:ss) 0 01:33:54

Subbasin : Sub-103

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-Pond1-2N

Input Data

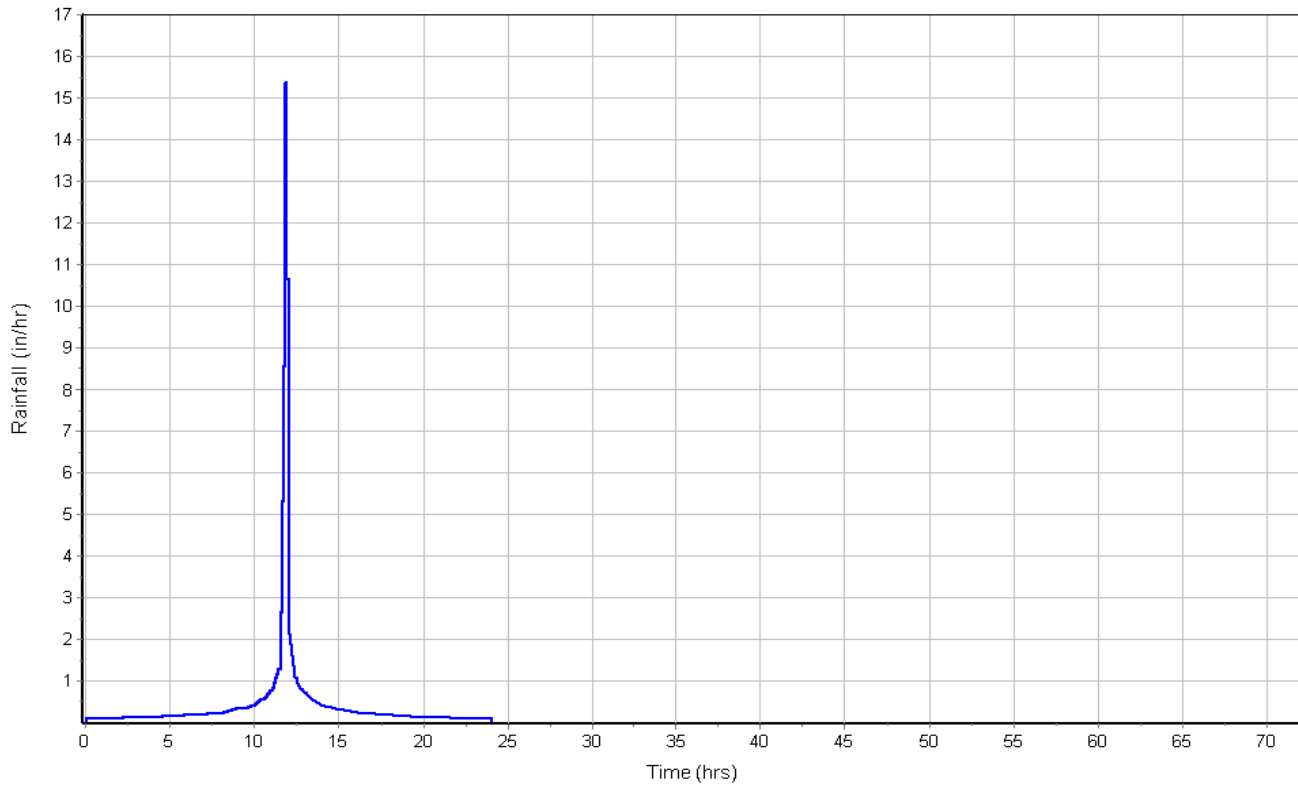
Area (ac) 2.78
Impervious Area (%) 25.00
Max Infiltration Rate (in/hr) 3.0000
Min Infiltration Rate (in/hr) 0.5000
Drying Time (days) 7.00
Decay Constant (1/hrs) 4.0000
Max Volume (in) 0.00
Average Slope (%) 0.5000
Equivalent Width (ft) 500.00
Impervious Area
 Manning's Roughness 0.0150
Pervious Area
 Manning's Roughness 0.1000
Curb & Gutter Length (ft) 0.00
Rain Gage ID Rain Gage-01

Subbasin Runoff Results

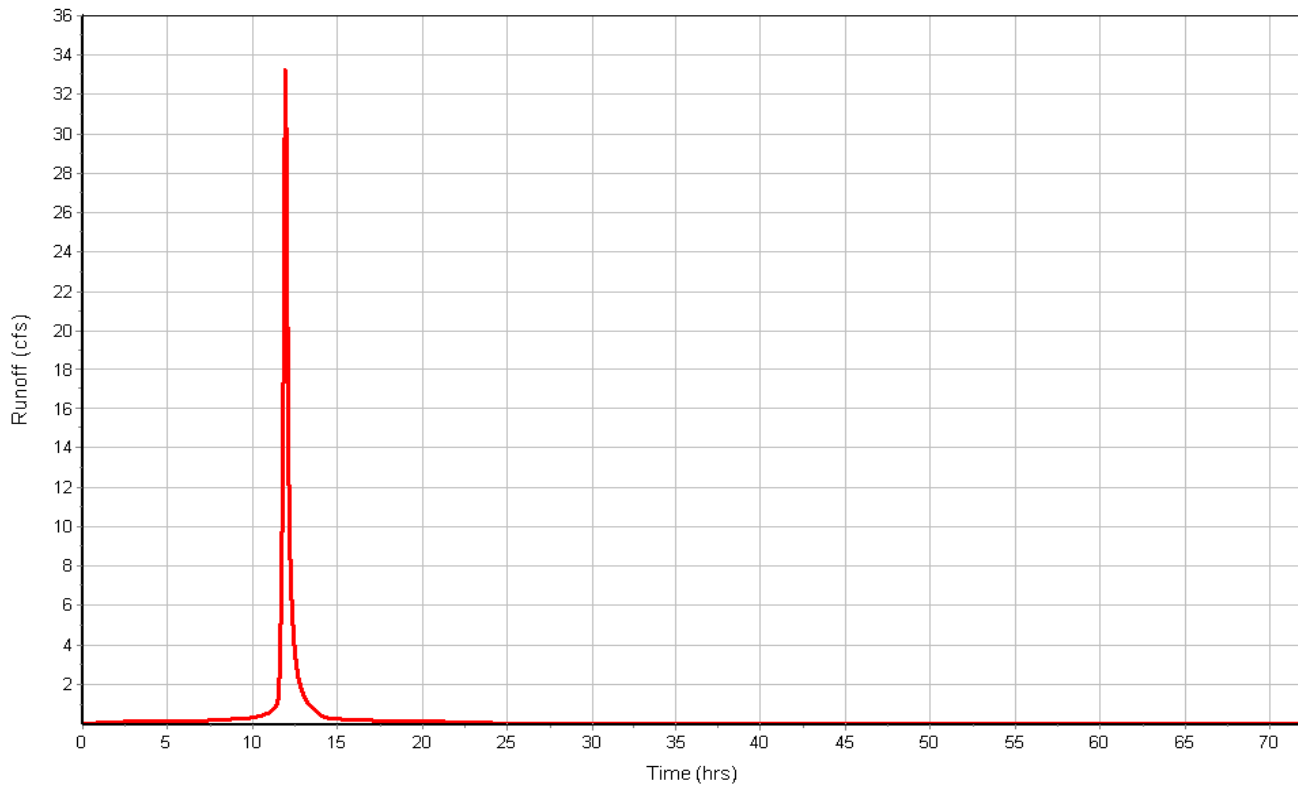
Total Rainfall (in) 11.20
Total Runon (in) 0.00
Total Evaporation (in) 0.0000
Total Infiltration (in) 4.7330
Total Runoff (in) 6.47
Peak Runoff (cfs) 33.27
Time of Concentration (days hh:mm:ss) 0 00:35:35

Subbasin : Sub-Pond1-2N

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-Pond1-2S

Input Data

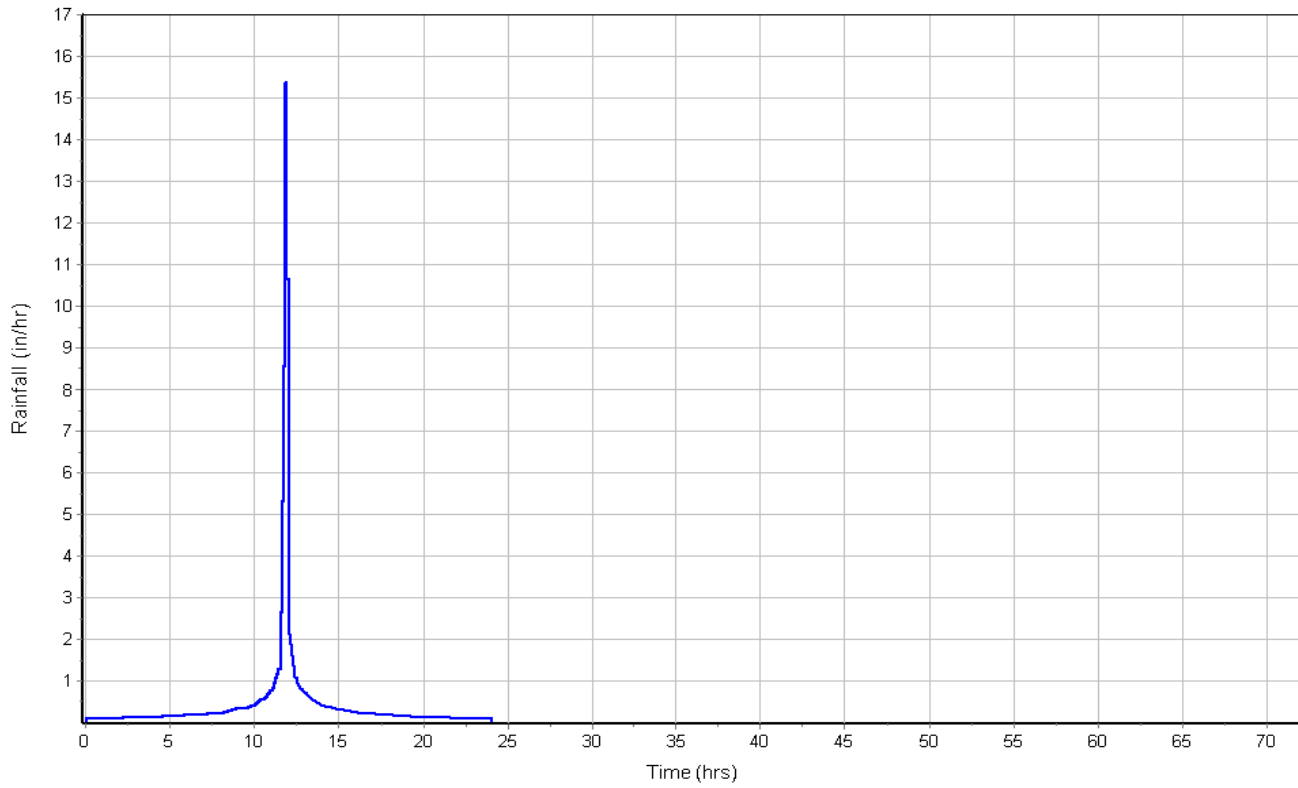
Area (ac) 2.09
Impervious Area (%) 25.00
Max Infiltration Rate (in/hr) 3.0000
Min Infiltration Rate (in/hr) 0.5000
Drying Time (days) 7.00
Decay Constant (1/hrs) 4.0000
Max Volume (in) 0.00
Average Slope (%) 0.5000
Equivalent Width (ft) 500.00
Impervious Area
 Manning's Roughness 0.0150
Pervious Area
 Manning's Roughness 0.1000
Curb & Gutter Length (ft) 0.00
Rain Gage ID Rain Gage-01

Subbasin Runoff Results

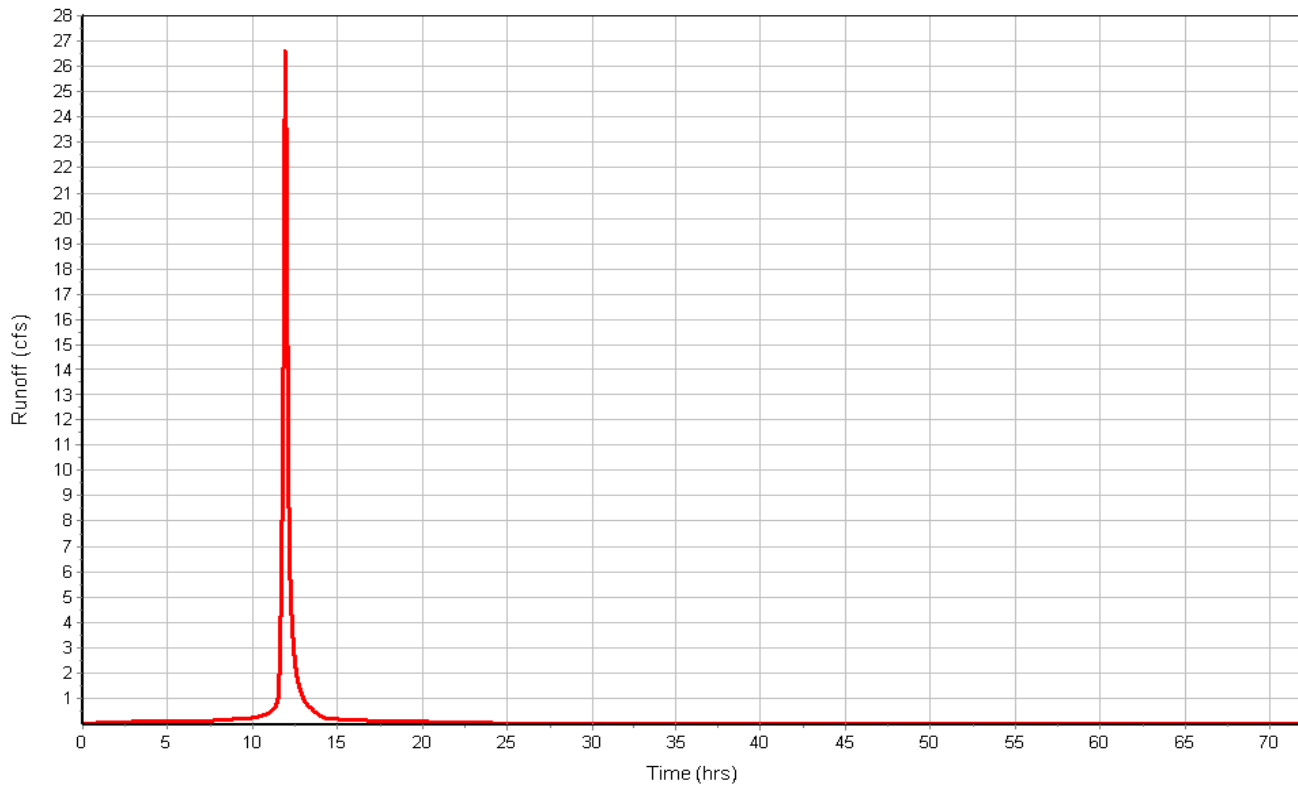
Total Rainfall (in) 11.20
Total Runon (in) 0.00
Total Evaporation (in) 0.0000
Total Infiltration (in) 4.7180
Total Runoff (in) 6.49
Peak Runoff (cfs) 26.59
Time of Concentration (days hh:mm:ss) 0 00:29:58

Subbasin : Sub-Pond1-2S

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-Pond3N

Input Data

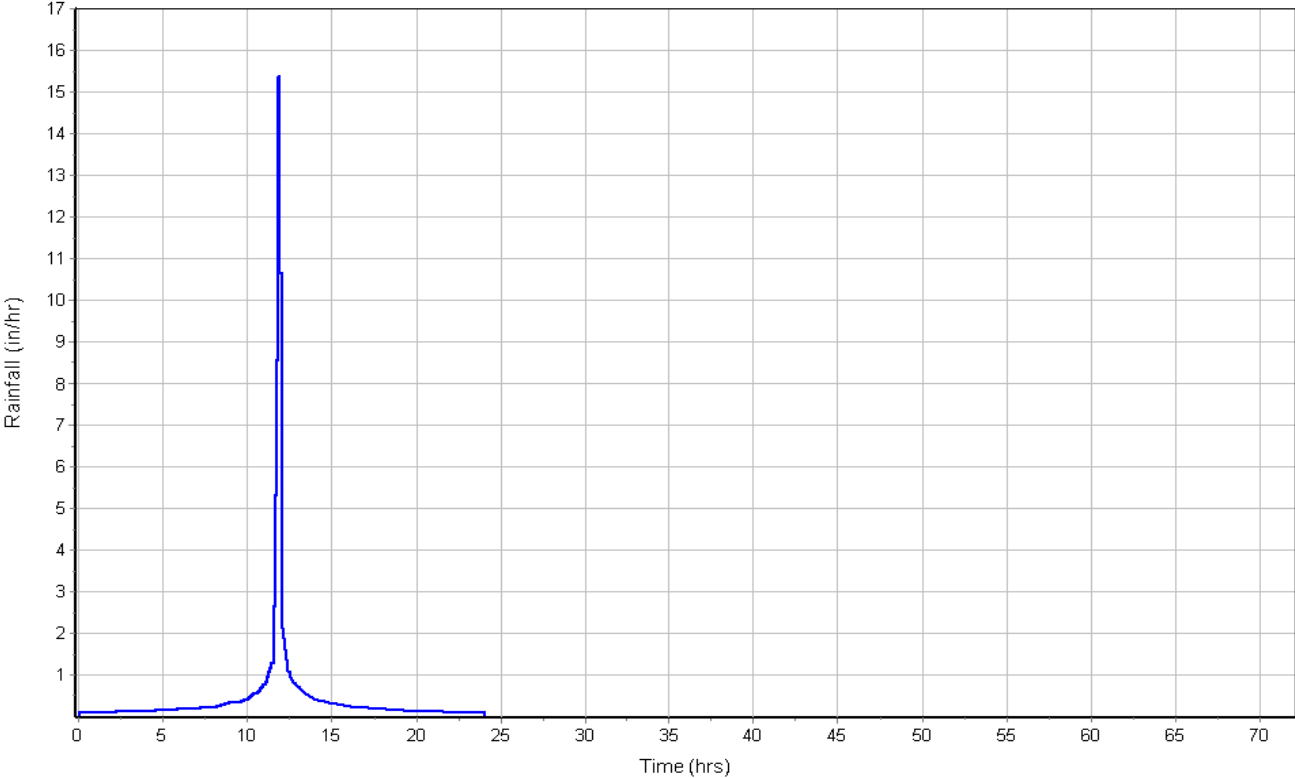
Area (ac) 5.02
Impervious Area (%) 25.00
Max Infiltration Rate (in/hr) 3.0000
Min Infiltration Rate (in/hr) 0.5000
Drying Time (days) 7.00
Decay Constant (1/hrs) 4.0000
Max Volume (in) 0.00
Average Slope (%) 0.5000
Equivalent Width (ft) 500.00
Impervious Area
 Manning's Roughness 0.0150
Pervious Area
 Manning's Roughness 0.1000
Curb & Gutter Length (ft) 0.00
Rain Gage ID Rain Gage-01

Subbasin Runoff Results

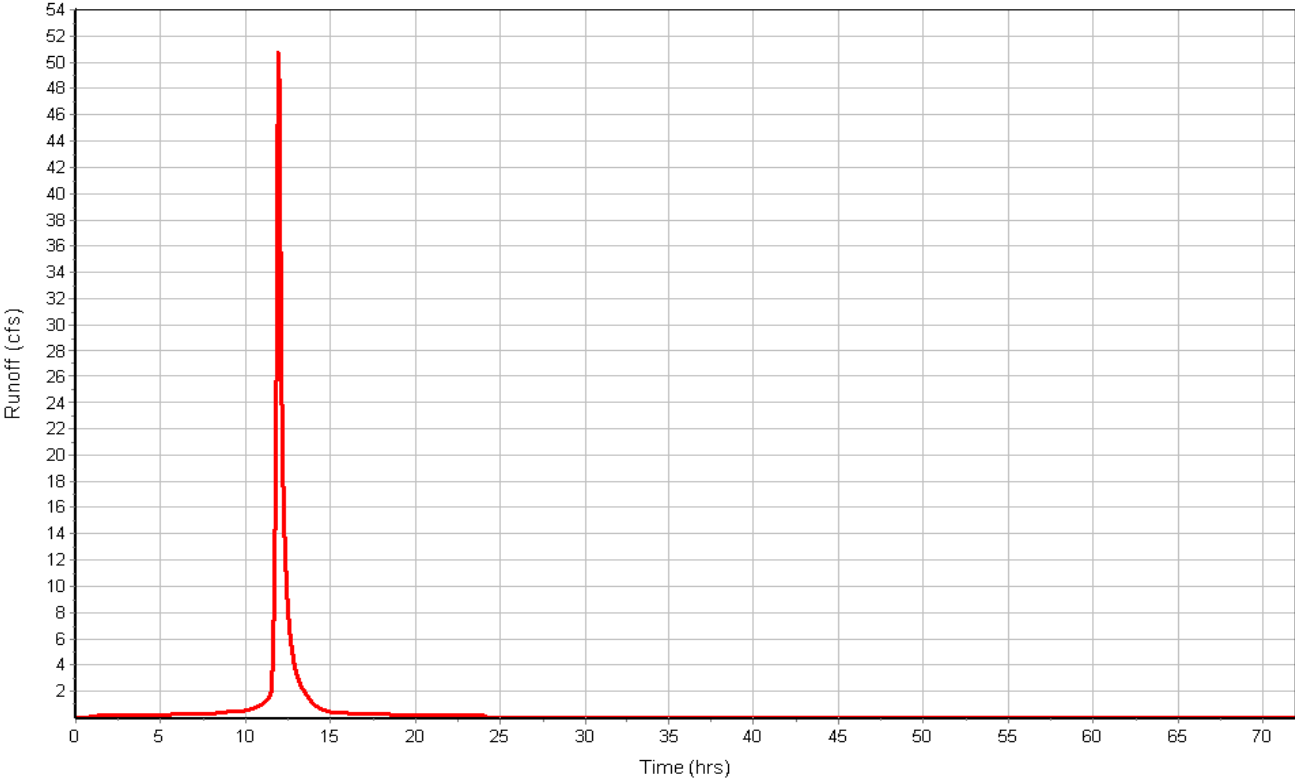
Total Rainfall (in) 11.20
Total Runon (in) 0.00
Total Evaporation (in) 0.0000
Total Infiltration (in) 4.7810
Total Runoff (in) 6.42
Peak Runoff (cfs) 50.77
Time of Concentration (days hh:mm:ss) 0 00:50:45

Subbasin : Sub-Pond3N

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-Pond3S

Input Data

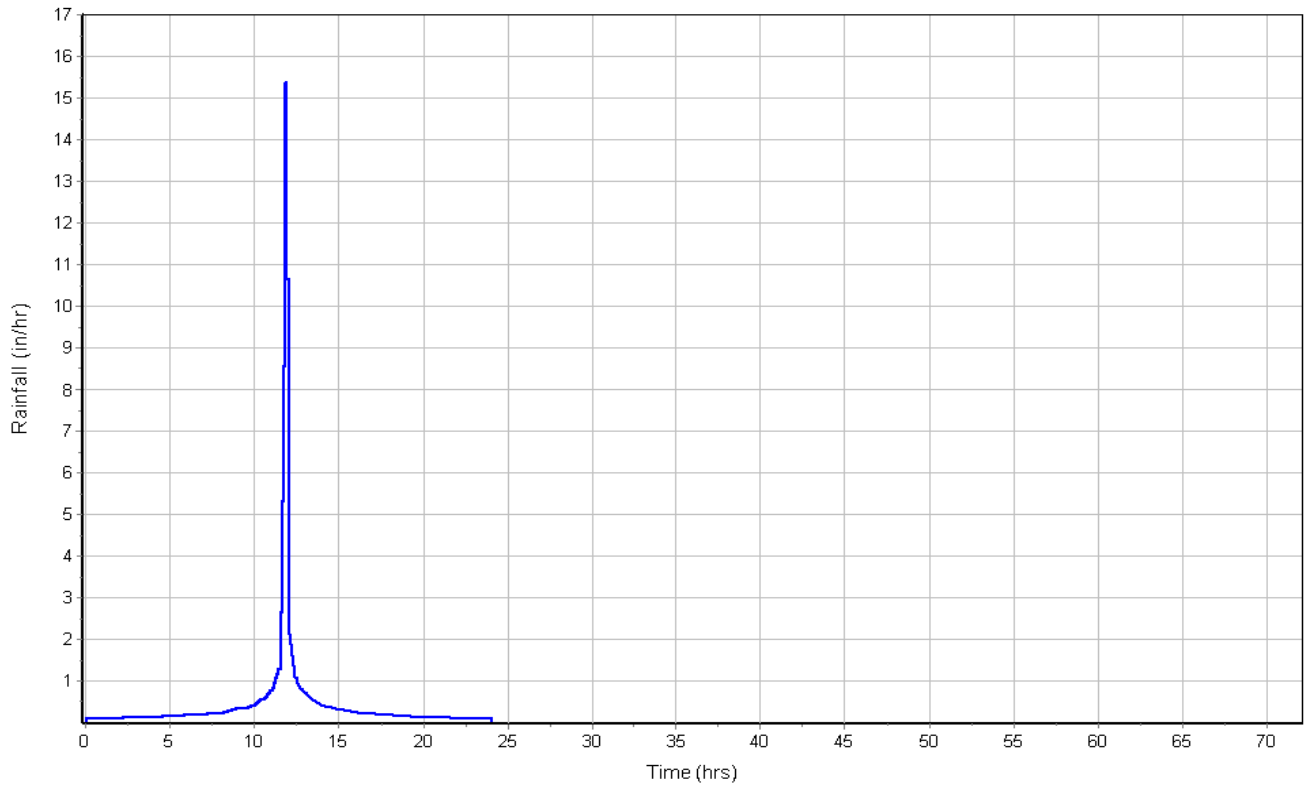
Area (ac) 4.52
Impervious Area (%) 25.00
Max Infiltration Rate (in/hr) 3.0000
Min Infiltration Rate (in/hr) 0.5000
Drying Time (days) 7.00
Decay Constant (1/hrs) 4.0000
Max Volume (in) 0.00
Average Slope (%) 0.5000
Equivalent Width (ft) 500.00
Impervious Area
 Manning's Roughness 0.0150
Pervious Area
 Manning's Roughness 0.1000
Curb & Gutter Length (ft) 0.00
Rain Gage ID Rain Gage-01

Subbasin Runoff Results

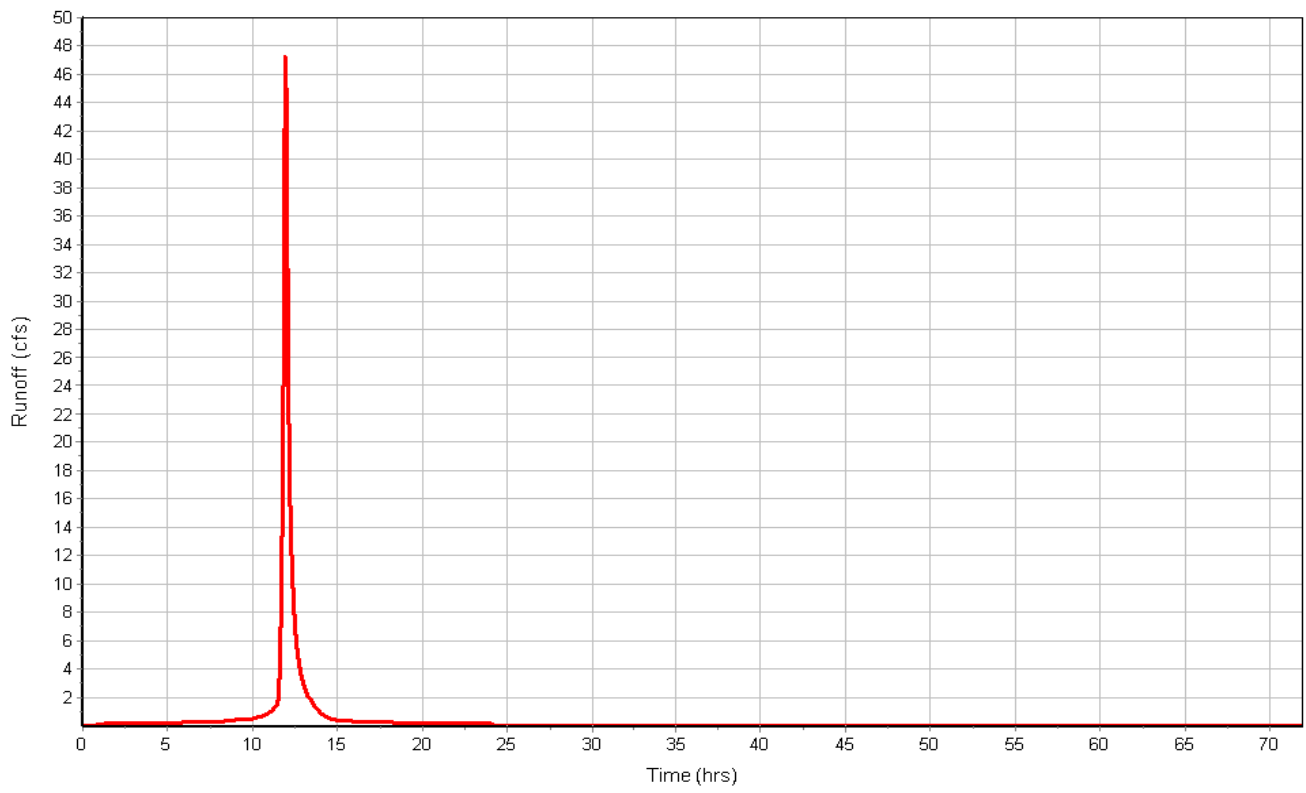
Total Rainfall (in) 11.20
Total Runon (in) 0.00
Total Evaporation (in) 0.0000
Total Infiltration (in) 4.7710
Total Runoff (in) 6.43
Peak Runoff (cfs) 47.26
Time of Concentration (days hh:mm:ss) 0 00:47:38

Subbasin : Sub-Pond3S

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-PondA

Input Data

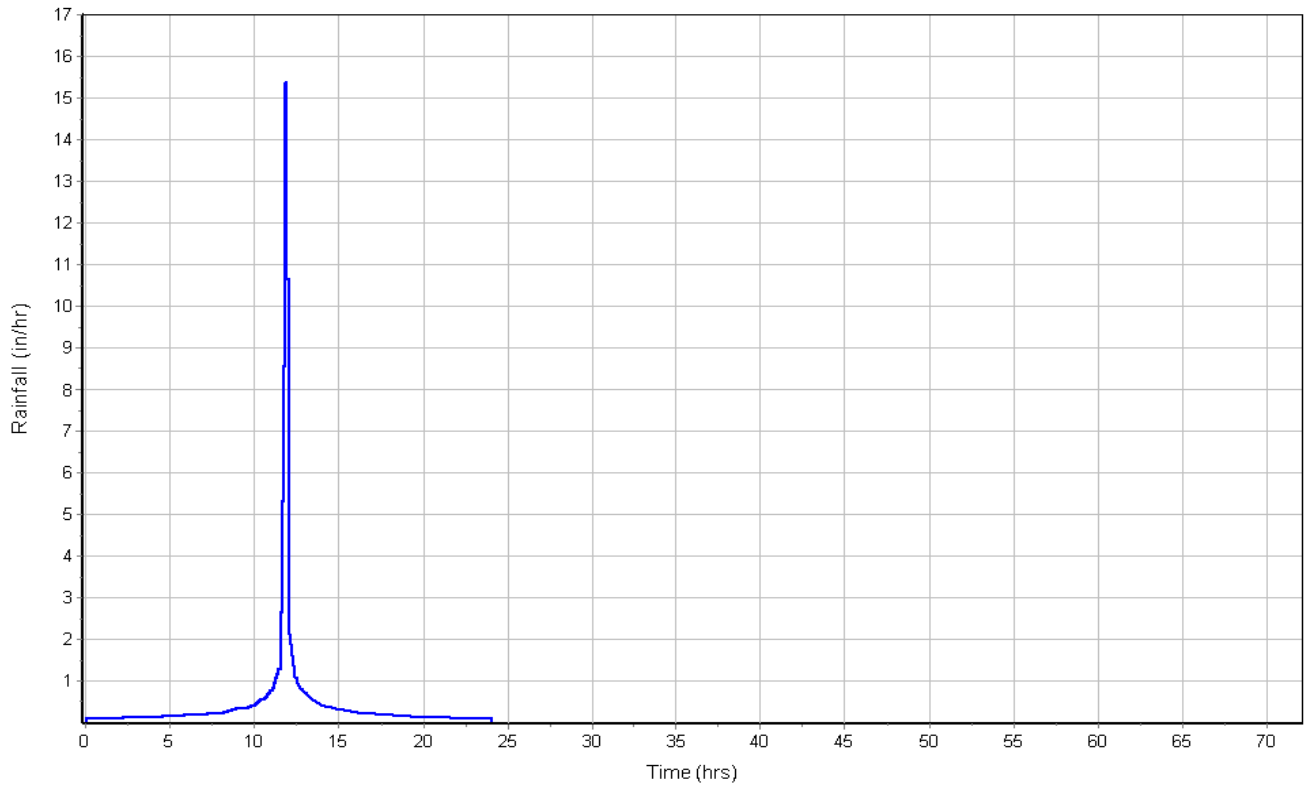
Area (ac) 11.13
Impervious Area (%) 25.00
Max Infiltration Rate (in/hr) 3.0000
Min Infiltration Rate (in/hr) 0.5000
Drying Time (days) 7.00
Decay Constant (1/hrs) 4.0000
Max Volume (in) 0.00
Average Slope (%) 0.5000
Equivalent Width (ft) 500.00
Impervious Area
 Manning's Roughness 0.0150
Pervious Area
 Manning's Roughness 0.1000
Curb & Gutter Length (ft) 0.00
Rain Gage ID Rain Gage-01

Subbasin Runoff Results

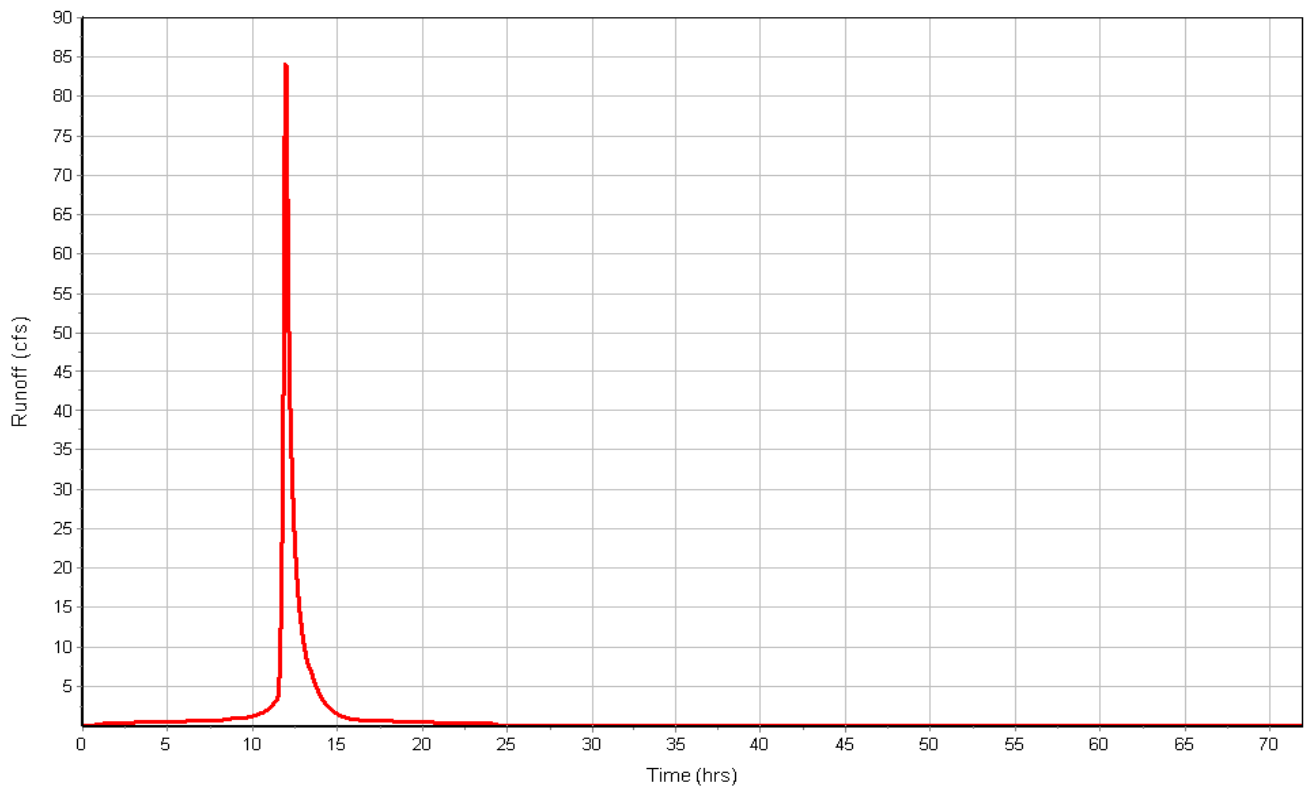
Total Rainfall (in) 11.20
Total Runon (in) 0.00
Total Evaporation (in) 0.0000
Total Infiltration (in) 4.9040
Total Runoff (in) 6.30
Peak Runoff (cfs) 85.30
Time of Concentration (days hh:mm:ss) 0 01:21:50

Subbasin : Sub-PondA

Rainfall Intensity Graph



Runoff Hydrograph



Junction Input

| SN Element ID | Invert Elevation (ft) | Ground/Rim (Max) Elevation (ft) | Ground/Rim (Max) Offset (ft) | Initial Water Elevation (ft) | Initial Water Depth (ft) | Surcharge Elevation (ft) | Surcharge Depth (ft) | Ponded Area (ft ²) | Minimum Pipe Cover (ft) |
|---------------|-----------------------|---------------------------------|------------------------------|------------------------------|--------------------------|--------------------------|----------------------|--------------------------------|-------------------------|
| 1 Jun-10 | 619.90 | 631.46 | 11.56 | 0.00 | -619.90 | 0.00 | -631.46 | 0.00 | 0.00 |
| 2 Jun-101 | 616.82 | 625.00 | 8.18 | 0.00 | -616.82 | 0.00 | -625.00 | 0.00 | 0.00 |
| 3 Jun-103 | 618.16 | 632.32 | 14.16 | 0.00 | -618.16 | 0.00 | -632.32 | 0.00 | 0.00 |
| 4 Jun-104 | 623.00 | 631.60 | 8.60 | 0.00 | -623.00 | 0.00 | -631.60 | 0.00 | 0.00 |
| 5 Jun-105 | 628.00 | 633.20 | 5.20 | 0.00 | -628.00 | 0.00 | -633.20 | 0.00 | 0.00 |
| 6 Jun-11 | 619.06 | 632.11 | 13.05 | 0.00 | -619.06 | 0.00 | -632.11 | 0.00 | 0.00 |
| 7 Jun-12 | 608.50 | 610.50 | 2.00 | 0.00 | -608.50 | 0.00 | -610.50 | 0.00 | 0.00 |
| 8 Jun-12N-Out | 618.36 | 631.07 | 12.71 | 0.00 | -618.36 | 6.00 | -625.07 | 0.00 | 0.00 |
| 9 Jun-12S-Out | 617.72 | 624.87 | 7.15 | 0.00 | -617.72 | 0.00 | -624.87 | 0.00 | 0.00 |
| 10 Jun-13 | 613.50 | 619.50 | 6.00 | 0.00 | -613.50 | 0.00 | -619.50 | 0.00 | 0.00 |
| 11 Jun-3N-Out | 623.46 | 631.99 | 8.53 | 0.00 | -623.46 | 6.00 | -625.99 | 0.00 | 0.00 |
| 12 Jun-3S-Out | 622.10 | 633.70 | 11.60 | 0.00 | -622.10 | 6.00 | -627.70 | 0.00 | 0.00 |

Junction Results

| SN Element ID | Peak Inflow | Peak Lateral Inflow | Max HGL Elevation Attained | Max HGL Depth Attained | Max Surcharge Depth Attained | Min Freeboard Attained | Average HGL Elevation Attained | Average HGL Depth Attained | Time of Max HGL Occurrence | Time of Peak Flooding Occurrence | Total Flooded Volume | Total Time Flooded |
|---------------|-------------|---------------------|----------------------------|------------------------|------------------------------|------------------------|--------------------------------|----------------------------|----------------------------|----------------------------------|----------------------|--------------------|
| | (cfs) | (cfs) | (ft) | (ft) | (ft) | (ft) | (ft) | (ft) | (days hh:mm) | (days hh:mm) | (ac-in) | (min) |
| 1 Jun-10 | 7.93 | 0.00 | 623.61 | 3.71 | 0.00 | 7.85 | 623.36 | 3.46 | 2 21:00 | 0 00:00 | 0.00 | 0.00 |
| 2 Jun-101 | 59.83 | 0.00 | 618.78 | 1.96 | 0.00 | 6.22 | 617.77 | 0.95 | 0 12:07 | 0 00:00 | 0.00 | 0.00 |
| 3 Jun-103 | 84.35 | 0.00 | 632.32 | 14.16 | 0.00 | 0.00 | 618.39 | 0.23 | 0 12:01 | 0 12:01 | 0.03 | 0.00 |
| 4 Jun-104 | 105.20 | 0.00 | 631.60 | 8.60 | 0.00 | 0.00 | 623.17 | 0.17 | 0 12:11 | 0 12:11 | 0.02 | 0.00 |
| 5 Jun-105 | 98.76 | 98.76 | 630.98 | 2.98 | 0.00 | 2.22 | 628.14 | 0.14 | 0 12:01 | 0 00:00 | 0.00 | 0.00 |
| 6 Jun-11 | 7.93 | 0.00 | 621.67 | 2.61 | 0.00 | 10.44 | 621.56 | 2.50 | 2 21:00 | 0 00:00 | 0.00 | 0.00 |
| 7 Jun-12 | 14.53 | 0.00 | 609.30 | 0.80 | 0.00 | 1.20 | 609.24 | 0.74 | 0 15:27 | 0 00:00 | 0.00 | 0.00 |
| 8 Jun-12N-Out | 47.66 | 40.28 | 620.40 | 2.04 | 0.00 | 10.67 | 619.23 | 0.87 | 0 12:04 | 0 00:00 | 0.00 | 0.00 |
| 9 Jun-12S-Out | 23.17 | 22.45 | 619.10 | 1.38 | 0.00 | 5.77 | 617.80 | 0.08 | 0 12:06 | 0 00:00 | 0.00 | 0.00 |
| 10 Jun-13 | 14.53 | 0.00 | 617.02 | 3.52 | 0.00 | 2.48 | 616.09 | 2.59 | 0 15:27 | 0 00:00 | 0.00 | 0.00 |
| 11 Jun-3N-Out | 3.05 | 0.00 | 626.37 | 2.91 | 0.00 | 5.62 | 625.98 | 2.52 | 2 21:00 | 0 00:00 | 0.00 | 0.00 |
| 12 Jun-3S-Out | 7.93 | 0.00 | 626.02 | 3.92 | 0.00 | 7.68 | 625.63 | 3.53 | 2 21:00 | 0 00:00 | 0.00 | 0.00 |

Channel Input

| SN Element ID | Length (ft) | Inlet Invert Elevation (ft) | Inlet Invert Offset (ft) | Outlet Invert Elevation (ft) | Outlet Invert Offset (ft) | Total Drop (ft) | Average Slope (%) | Shape | Height (ft) | Width (ft) | Manning's Roughness | Entrance Losses | Exit/Bend Losses | Additional Losses | Initial Flow (cfs) | Flap Gate |
|---------------|-------------|-----------------------------|--------------------------|------------------------------|---------------------------|-----------------|-------------------|-------------|-------------|------------|---------------------|-----------------|------------------|-------------------|--------------------|-----------|
| 1 Ditch-001 | 1154.00 | 618.36 | 0.00 | 616.82 | 0.00 | 1.54 | 0.1300 | Trapezoidal | 7.000 | 28.000 | 0.0350 | 0.0000 | 0.0000 | 0.0000 | 0.00 | No |
| 2 Ditch-002 | 558.30 | 617.72 | 0.00 | 616.82 | 0.00 | 0.90 | 0.1600 | Trapezoidal | 7.000 | 28.000 | 0.0350 | 0.0000 | 0.0000 | 0.0000 | 0.00 | No |
| 3 Ditch-003 | 753.20 | 628.00 | 0.00 | 623.00 | 0.00 | 5.00 | 0.6600 | Trapezoidal | 5.000 | 22.000 | 0.0350 | 0.0000 | 0.0000 | 0.0000 | 0.00 | No |
| 4 Ditch-004 | 504.30 | 623.00 | 0.00 | 618.16 | 0.00 | 4.84 | 0.9600 | Trapezoidal | 5.000 | 22.000 | 0.0350 | 0.0000 | 0.0000 | 0.0000 | 0.00 | No |

Channel Results

| SN Element ID | Peak Flow | Time of Peak Flow Occurrence | Design Flow Capacity | Peak Flow/Design Flow Ratio | Peak Flow Velocity | Travel Time | Peak Flow Depth | Peak Flow Depth/Total Depth Ratio | Total Time Surcharged | Froude Number | Reported Condition |
|---------------|-----------|------------------------------|----------------------|-----------------------------|--------------------|-------------|-----------------|-----------------------------------|-----------------------|---------------|--------------------|
| | (cfs) | (days hh:mm) | (cfs) | | (ft/sec) | (min) | (ft) | | (min) | | |
| 1 Ditch-001 | 39.54 | 0 12:06 | 462.65 | 0.09 | 2.02 | 9.52 | 1.98 | 0.28 | 0.00 | 0.23 | |
| 2 Ditch-002 | 21.24 | 0 12:01 | 508.49 | 0.04 | 1.46 | 6.37 | 1.65 | 0.24 | 0.00 | 0.01 | |
| 3 Ditch-003 | 105.20 | 0 12:02 | 378.54 | 0.28 | 4.77 | 2.63 | 3.88 | 0.78 | 0.00 | 0.26 | |
| 4 Ditch-004 | 84.35 | 0 12:01 | 455.15 | 0.19 | 3.48 | 2.42 | 5.00 | 1.00 | 19.00 | 0.32 | |

Pipe Input

| SN Element ID | Length (ft) | Inlet Invert Elevation (ft) | Inlet Invert Offset (ft) | Outlet Invert Elevation (ft) | Outlet Invert Offset (ft) | Total Drop (ft) | Average Slope (%) | Pipe Shape | Pipe Diameter or Height (ft) | Pipe Width (ft) | Manning's Roughness | Entrance Losses | Exit/Bend Losses | Additional Losses | Initial Flow (cfs) | Flap Gate |
|------------------------|-------------|-----------------------------|--------------------------|------------------------------|---------------------------|-----------------|-------------------|------------|------------------------------|-----------------|---------------------|-----------------|------------------|-------------------|--------------------|-----------|
| 1 Link-17 | 285.40 | 619.90 | 0.00 | 619.16 | 0.10 | 0.74 | 0.2600 | CIRCULAR | 1.500 | 1.500 | 0.0130 | 0.5000 | 0.5000 | 0.0000 | 0.00 | No |
| 2 Link-18 | 192.01 | 619.06 | 0.00 | 619.03 | 0.67 | 0.03 | 0.0200 | CIRCULAR | 1.500 | 1.500 | 0.0130 | 0.5000 | 0.5000 | 0.0000 | 0.00 | No |
| 3 Pipe-001 | 658.20 | 623.46 | 0.00 | 622.08 | -0.02 | 1.38 | 0.2100 | CIRCULAR | 1.500 | 1.500 | 0.0130 | 0.5000 | 1.0000 | 0.0000 | 0.00 | No |
| 4 Pipe-002 | 341.45 | 622.10 | 0.00 | 620.00 | 0.10 | 2.10 | 0.6200 | CIRCULAR | 1.500 | 1.500 | 0.0130 | 0.5000 | 1.0000 | 0.0000 | 0.00 | No |
| 5 Pipe-Outfall01 | 173.41 | 617.37 | 0.55 | 589.75 | 0.00 | 27.62 | 15.9300 | CIRCULAR | 2.500 | 2.500 | 0.0250 | 0.5000 | 1.0000 | 0.0000 | 0.00 | No |
| 6 Pipe-Pond12N-Outlet | 78.49 | 619.08 | 15.08 | 618.36 | 0.00 | 0.72 | 0.9200 | CIRCULAR | 2.000 | 2.000 | 0.0250 | 0.5000 | 1.0000 | 0.0000 | 0.00 | No |
| 7 Pipe-Pond12S-Outlet | 59.89 | 618.78 | 18.78 | 617.72 | 0.00 | 1.06 | 1.7700 | CIRCULAR | 2.000 | 2.000 | 0.0250 | 0.5000 | 1.0000 | 0.0000 | 0.00 | No |
| 8 Pipe-Pond3N-Outlet | 109.20 | 625.34 | 21.34 | 623.56 | 0.10 | 1.78 | 1.6300 | CIRCULAR | 1.500 | 1.500 | 0.0130 | 0.5000 | 1.0000 | 0.0000 | 0.00 | No |
| 9 Pipe-Pond3S-Outlet | 119.51 | 624.66 | 20.66 | 622.08 | -0.02 | 2.58 | 2.1600 | CIRCULAR | 1.500 | 1.500 | 0.0130 | 0.5000 | 1.0000 | 0.0000 | 0.00 | No |
| 10 Pipe-PondA-In1 | 99.23 | 625.93 | 0.93 | 614.05 | 14.05 | 11.88 | 11.9700 | CIRCULAR | 2.500 | 2.500 | 0.0250 | 0.5000 | 1.0000 | 0.0000 | 0.00 | No |
| 11 Pipe-PondA-In2 | 100.72 | 618.16 | 0.00 | 615.82 | 15.82 | 2.34 | 2.3200 | CIRCULAR | 2.000 | 2.000 | 0.0130 | 0.5000 | 1.0000 | 0.0000 | 0.00 | No |
| 12 Pipe-PondA-In3 | 640.00 | 616.82 | 0.00 | 615.14 | 15.14 | 1.68 | 0.2600 | CIRCULAR | 2.000 | 2.000 | 0.0130 | 0.5000 | 1.0000 | 0.0000 | 0.00 | No |
| 13 Pipe-Pond-A-Outlet1 | 345.00 | 613.50 | 0.00 | 608.50 | 0.00 | 5.00 | 1.4500 | CIRCULAR | 2.000 | 2.000 | 0.0250 | 0.5000 | 0.5000 | 0.0000 | 0.00 | No |
| 14 Pipe-Pond-A-Outlet2 | 65.00 | 608.50 | 0.00 | 596.80 | 0.00 | 11.70 | 18.0000 | CIRCULAR | 2.000 | 2.000 | 0.0250 | 0.5000 | 0.5000 | 0.0000 | 0.00 | No |

Pipe Results

| SN Element ID | Peak Flow | Time of Peak Flow Occurrence | Design Flow Capacity | Peak Flow/ Design Flow Ratio | Peak Flow Velocity | Travel Time | Peak Flow Depth | Peak Flow Depth/ Total Depth Ratio | Total Time Surcharged | Froude Number |
|------------------------|-----------|------------------------------|----------------------|------------------------------|--------------------|-------------|-----------------|------------------------------------|-----------------------|---------------|
| | (cfs) | (days hh:mm) | (cfs) | | (ft/sec) | (min) | (ft) | | (min) | |
| 1 Link-17 | 7.93 | 2 21:00 | 5.35 | 1.48 | 4.49 | 1.06 | 1.50 | 1.00 | 4031.00 | 0.01 |
| 2 Link-18 | 7.93 | 2 21:00 | 1.31 | 6.04 | 4.89 | 0.65 | 1.43 | 0.96 | 0.00 | 0.67 |
| 3 Pipe-001 | 3.05 | 0 13:00 | 4.77 | 0.64 | 1.78 | 6.16 | 1.50 | 1.00 | 3657.00 | 0.02 |
| 4 Pipe-002 | 7.93 | 2 21:00 | 8.24 | 0.96 | 4.49 | 1.27 | 1.50 | 1.00 | 3938.00 | 0.03 |
| 5 Pipe-Outfall01 | 44.78 | 0 12:07 | 85.12 | 0.53 | 16.54 | 0.17 | 1.32 | 0.54 | 0.00 | 3.02 |
| 6 Pipe-Pond12N-Outlet | 5.28 | 0 12:03 | 11.27 | 0.47 | 2.80 | 0.47 | 1.45 | 0.74 | 0.00 | 0.30 |
| 7 Pipe-Pond12S-Outlet | 2.46 | 0 12:25 | 15.65 | 0.16 | 3.57 | 0.28 | 0.89 | 0.45 | 0.00 | 1.15 |
| 8 Pipe-Pond3N-Outlet | 3.05 | 0 12:58 | 13.41 | 0.23 | 3.83 | 0.48 | 1.30 | 0.87 | 0.00 | 0.29 |
| 9 Pipe-Pond3S-Outlet | 6.03 | 2 18:00 | 15.37 | 0.39 | 4.77 | 0.42 | 1.50 | 1.00 | 3199.00 | 0.12 |
| 10 Pipe-PondA-In1 | 22.57 | 0 12:28 | 73.80 | 0.31 | 6.25 | 0.26 | 1.72 | 0.69 | 0.00 | 0.04 |
| 11 Pipe-PondA-In2 | 55.57 | 0 12:11 | 34.48 | 1.61 | 17.69 | 0.09 | 2.00 | 1.00 | 59.00 | 0.25 |
| 12 Pipe-PondA-In3 | 11.84 | 0 12:08 | 11.59 | 1.02 | 4.16 | 2.56 | 1.72 | 0.86 | 0.00 | 0.38 |
| 13 Pipe-PondA-Outlet1 | 14.53 | 0 15:27 | 14.16 | 1.03 | 6.35 | 0.91 | 1.40 | 0.70 | 0.00 | 0.96 |
| 14 Pipe-Pond-A-Outlet2 | 14.53 | 0 15:27 | 49.91 | 0.29 | 13.05 | 0.08 | 0.77 | 0.38 | 0.00 | 3.06 |

Storage Nodes

Storage Node : Stor-100

Input Data

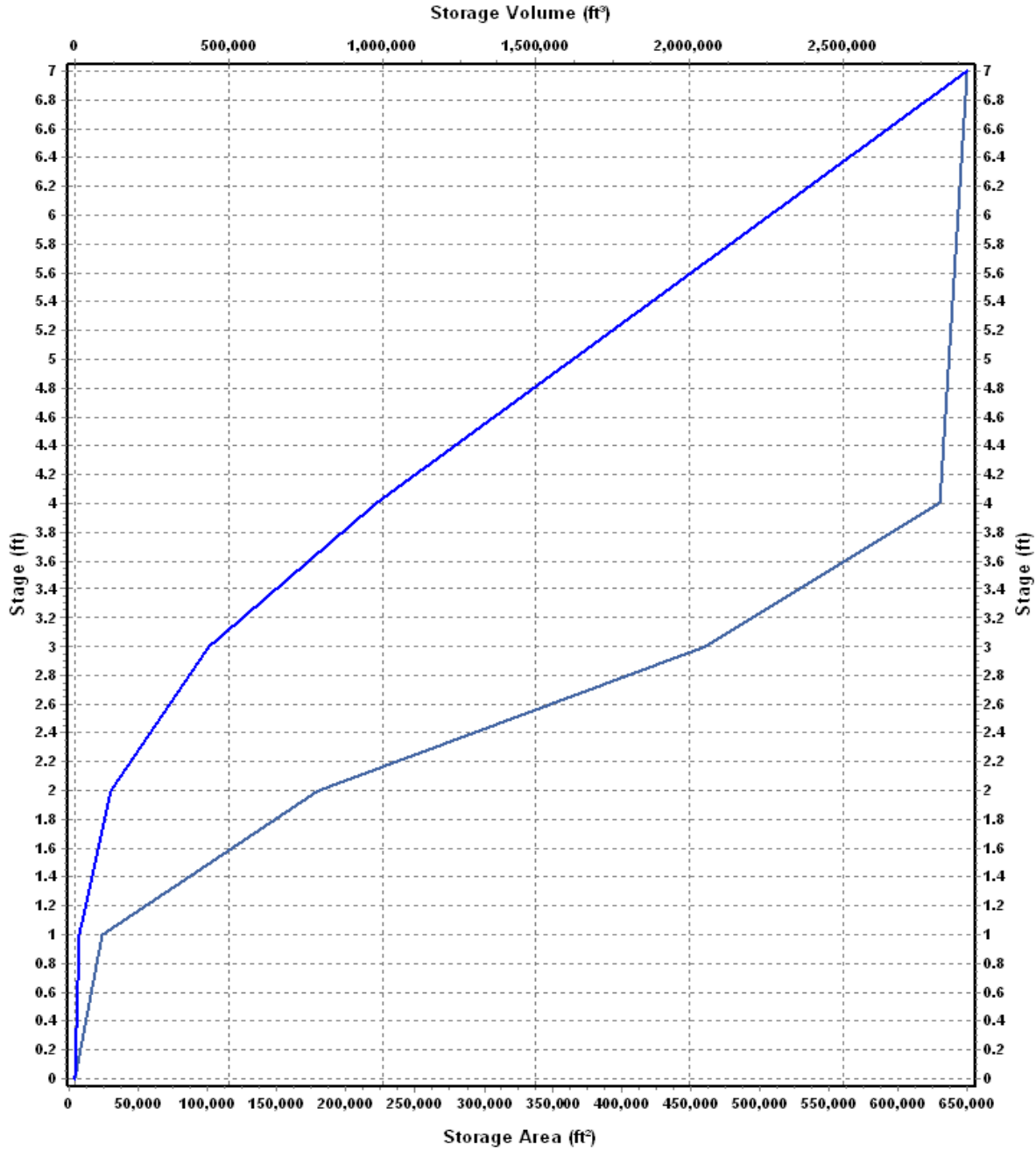
Invert Elevation (ft) 625.00
Max (Rim) Elevation (ft) 632.00
Max (Rim) Offset (ft) 7.00
Initial Water Elevation (ft) 625.93
Initial Water Depth (ft) 0.93
Ponded Area (ft²) 0.00
Evaporation Loss 0.00

Storage Area Volume Curves

Storage Curve : Storage-100

| Stage | Storage Area | Storage Volume |
|-------|--------------------|--------------------|
| (ft) | (ft ²) | (ft ³) |
| 0 | 4000 | 0.000 |
| 1 | 24000 | 14000.00 |
| 2 | 180000 | 116000.00 |
| 3 | 460000 | 436000.00 |
| 4 | 630000 | 981000.00 |
| 7 | 650000 | 2901000.00 |

Storage Area Volume Curves



— Storage Area — Storage Volume

Storage Node : Stor-100 (continued)

Output Summary Results

| | |
|---|---------|
| Peak Inflow (cfs) | 73.17 |
| Peak Lateral Inflow (cfs) | 73.17 |
| Peak Outflow (cfs) | 22.57 |
| Peak Exfiltration Flow Rate (cfm) | 0.00 |
| Max HGL Elevation Attained (ft) | 626.88 |
| Max HGL Depth Attained (ft) | 1.88 |
| Average HGL Elevation Attained (ft) | 626.02 |
| Average HGL Depth Attained (ft) | 1.02 |
| Time of Max HGL Occurrence (days hh:mm) | 0 12:28 |
| Total Exfiltration Volume (1000-ft ³) | 0.000 |
| Total Flooded Volume (ac-in) | 0 |
| Total Time Flooded (min) | 0 |
| Total Retention Time (sec) | 0.00 |

Storage Node : Stor-Pond1-2N

Input Data

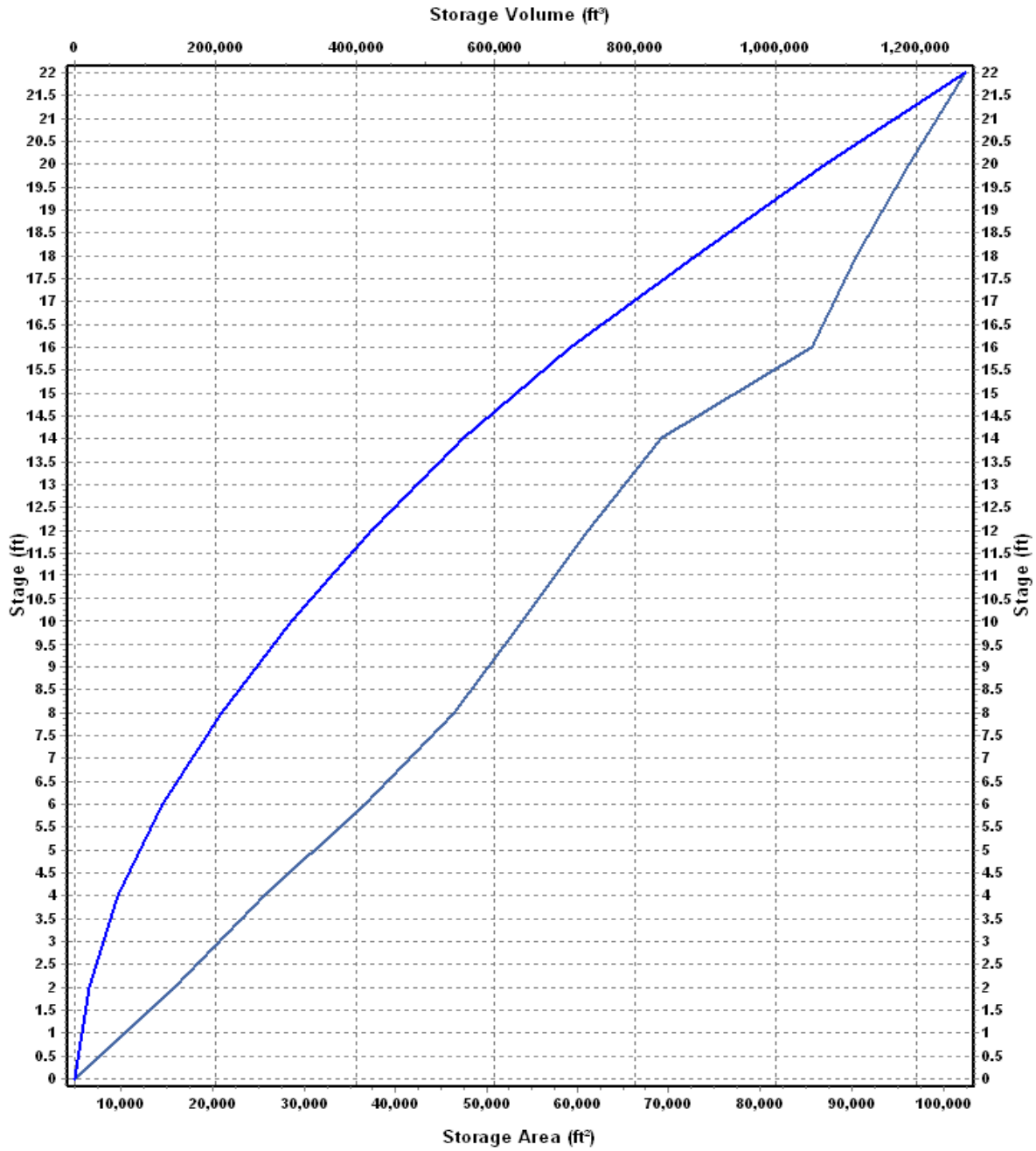
Invert Elevation (ft) 604.00
Max (Rim) Elevation (ft) 626.00
Max (Rim) Offset (ft) 22.00
Initial Water Elevation (ft) 619.08
Initial Water Depth (ft) 15.08
Ponded Area (ft²) 0.00
Evaporation Loss 0.00

Storage Area Volume Curves

Storage Curve : Storage-Pond12N

| Stage (ft) | Storage Area (ft ²) | Storage Volume (ft ³) |
|---------------|---------------------------------------|---|
| 0 | 4955.10 | 0.000 |
| 2 | 15820.19 | 20775.29 |
| 4 | 25676.42 | 62271.90 |
| 6 | 36648.10 | 124596.42 |
| 8 | 46410.19 | 207654.71 |
| 10 | 53887.47 | 307952.37 |
| 12 | 61209.12 | 423048.96 |
| 14 | 69122.69 | 553380.77 |
| 16 | 85688.98 | 708192.44 |
| 18 | 90544.27 | 884425.69 |
| 20 | 96239.46 | 1071209.42 |
| 22 | 102428.12 | 1269877.00 |

Storage Area Volume Curves



— Storage Area — Storage Volume

Storage Node : Stor-Pond1-2N (continued)

Output Summary Results

| | |
|---|---------|
| Peak Inflow (cfs) | 44.90 |
| Peak Lateral Inflow (cfs) | 40.36 |
| Peak Outflow (cfs) | 5.21 |
| Peak Exfiltration Flow Rate (cfm) | 0.00 |
| Max HGL Elevation Attained (ft) | 620.14 |
| Max HGL Depth Attained (ft) | 16.14 |
| Average HGL Elevation Attained (ft) | 619.49 |
| Average HGL Depth Attained (ft) | 15.49 |
| Time of Max HGL Occurrence (days hh:mm) | 0 12:28 |
| Total Exfiltration Volume (1000-ft³) | 0.000 |
| Total Flooded Volume (ac-in) | 0 |
| Total Time Flooded (min) | 0 |
| Total Retention Time (sec) | 0.00 |

Storage Node : Stor-Pond1-2S

Input Data

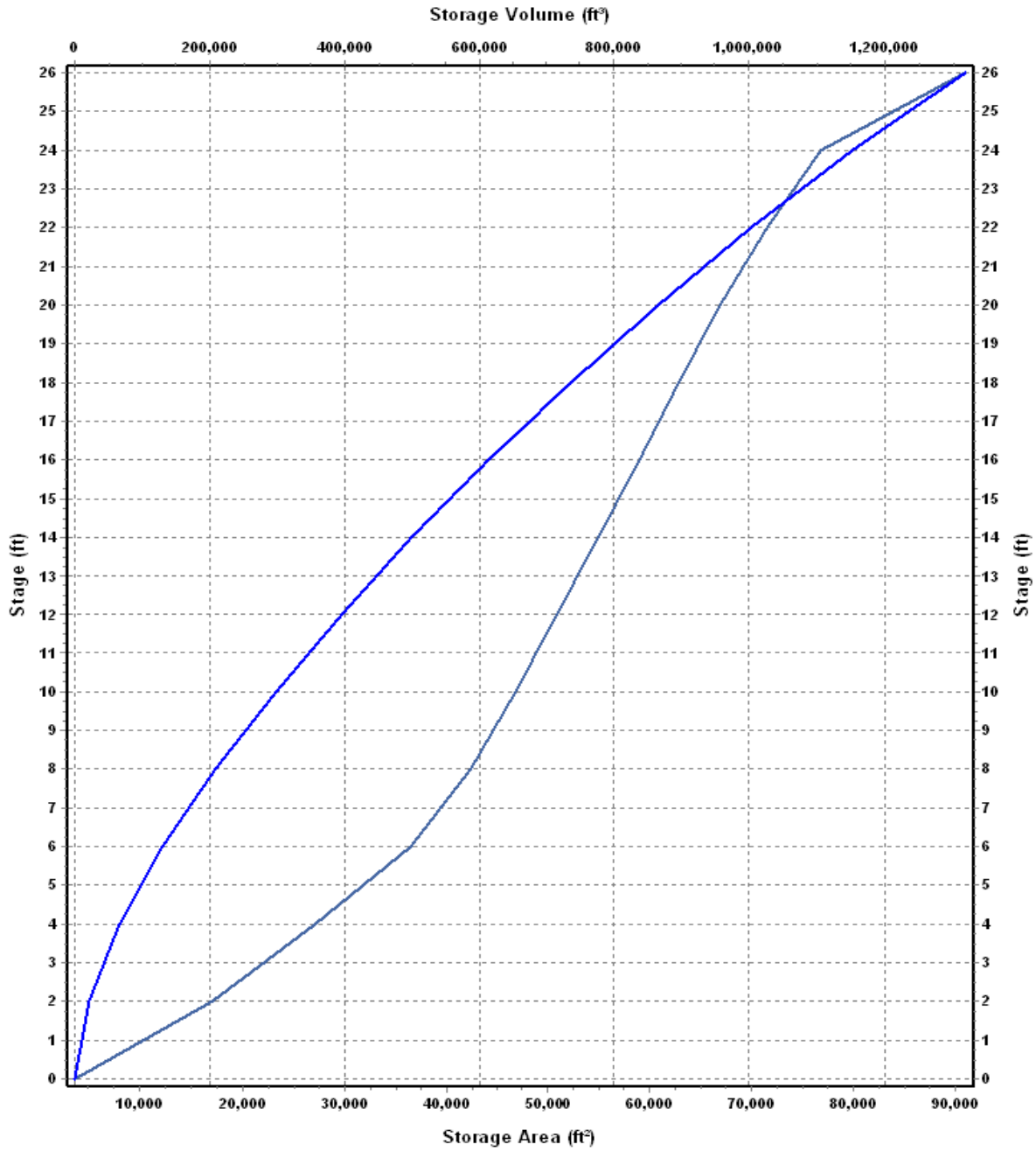
Invert Elevation (ft) 600.00
Max (Rim) Elevation (ft) 626.00
Max (Rim) Offset (ft) 26.00
Initial Water Elevation (ft) 618.78
Initial Water Depth (ft) 18.78
Ponded Area (ft²) 0.00
Evaporation Loss 0.00

Storage Area Volume Curves

Storage Curve : Storage-Pond12S

| Stage (ft) | Storage Area (ft ²) | Storage Volume (ft ³) |
|---------------|---------------------------------------|---|
| 0 | 3604.98 | 0.000 |
| 2 | 17159.40 | 20764.38 |
| 4 | 27121.01 | 65044.79 |
| 6 | 36533.37 | 128699.17 |
| 8 | 42427.01 | 207659.55 |
| 10 | 46794.54 | 296881.10 |
| 12 | 50912.71 | 394588.35 |
| 14 | 54856.85 | 500357.91 |
| 16 | 58996.35 | 614211.11 |
| 18 | 62792.91 | 736000.37 |
| 20 | 66866.07 | 865659.35 |
| 22 | 71514.01 | 1004039.43 |
| 24 | 76770.32 | 1152323.76 |
| 26 | 90921.00 | 1320015.08 |

Storage Area Volume Curves



— Storage Area — Storage Volume

Storage Node : Stor-Pond1-2S (continued)

Output Summary Results

| | |
|---|---------|
| Peak Inflow (cfs) | 26.57 |
| Peak Lateral Inflow (cfs) | 26.57 |
| Peak Outflow (cfs) | 2.46 |
| Peak Exfiltration Flow Rate (cfm) | 0.00 |
| Max HGL Elevation Attained (ft) | 619.32 |
| Max HGL Depth Attained (ft) | 19.32 |
| Average HGL Elevation Attained (ft) | 618.9 |
| Average HGL Depth Attained (ft) | 18.90 |
| Time of Max HGL Occurrence (days hh:mm) | 0 12:38 |
| Total Exfiltration Volume (1000-ft³) | 0.000 |
| Total Flooded Volume (ac-in) | 0 |
| Total Time Flooded (min) | 0 |
| Total Retention Time (sec) | 0.00 |

Storage Node : Stor-Pond3N

Input Data

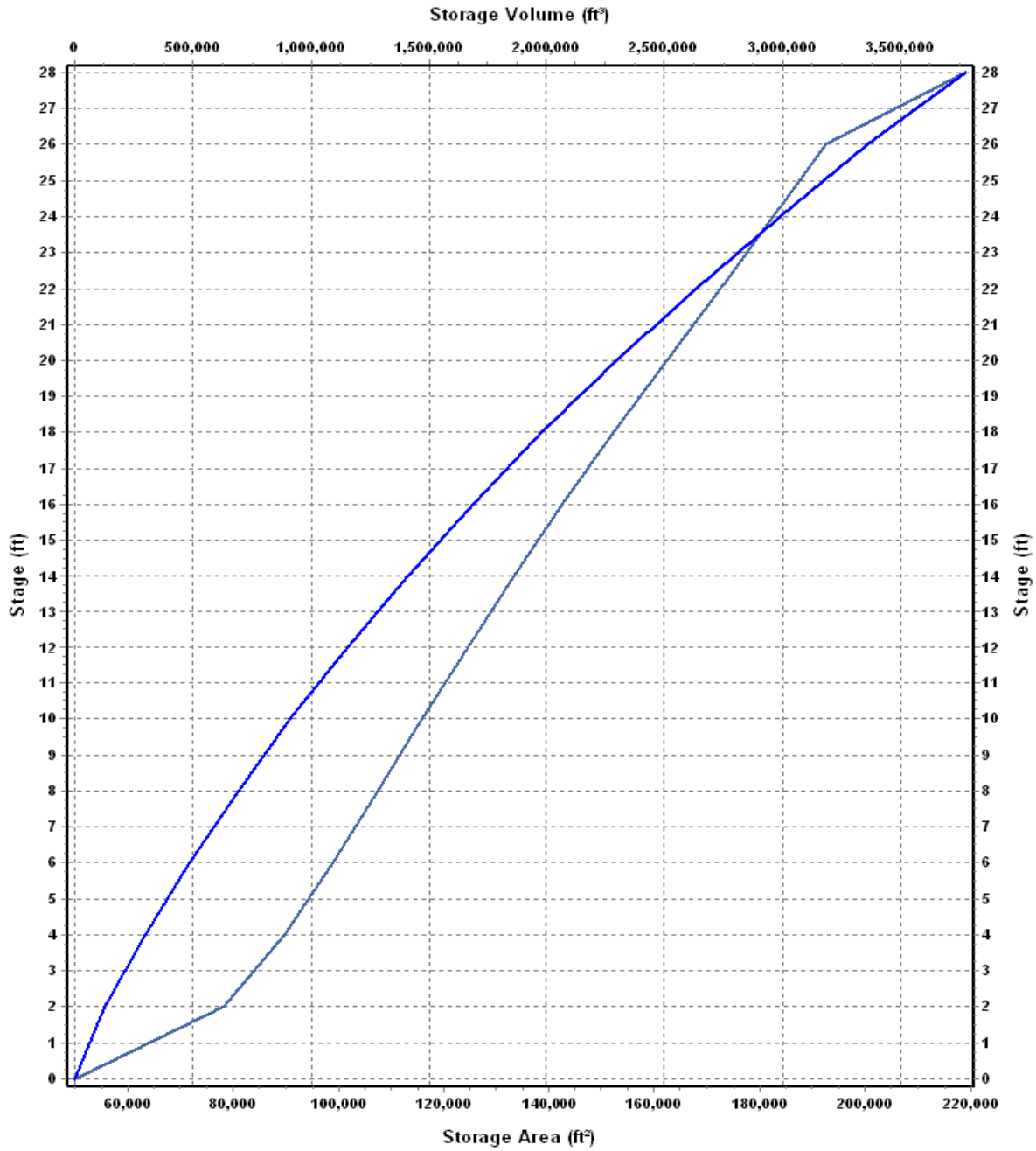
Invert Elevation (ft) 604.00
Max (Rim) Elevation (ft) 632.00
Max (Rim) Offset (ft) 28.00
Initial Water Elevation (ft) 625.34
Initial Water Depth (ft) 21.34
Ponded Area (ft²) 0.00
Evaporation Loss 0.00

Storage Area Volume Curves

Storage Curve : Storage-Pond3N

| Stage (ft) | Storage Area (ft ²) | Storage Volume (ft ³) |
|---------------|---------------------------------------|---|
| 0 | 49967.95 | 0.000 |
| 2 | 78356.09 | 128324.04 |
| 4 | 89739.44 | 296419.57 |
| 6 | 98856.66 | 485015.67 |
| 8 | 107309.16 | 691181.49 |
| 10 | 115789.97 | 914280.62 |
| 12 | 124461.94 | 1154532.53 |
| 14 | 133313.10 | 1412307.57 |
| 16 | 142403.76 | 1688024.43 |
| 18 | 152229.55 | 1982657.74 |
| 20 | 162328.39 | 2297215.68 |
| 22 | 172534.85 | 2632078.92 |
| 24 | 182457.24 | 2987071.01 |
| 26 | 192696.07 | 3362224.32 |
| 28 | 218974.00 | 3773894.39 |

Storage Area Volume Curves



— Storage Area — Storage Volume

Storage Node : Stor-Pond3N (continued)

Output Summary Results

| | |
|---|---------|
| Peak Inflow (cfs) | 56.66 |
| Peak Lateral Inflow (cfs) | 56.66 |
| Peak Outflow (cfs) | 3.05 |
| Peak Exfiltration Flow Rate (cfm) | 0.00 |
| Max HGL Elevation Attained (ft) | 626.44 |
| Max HGL Depth Attained (ft) | 22.44 |
| Average HGL Elevation Attained (ft) | 626.2 |
| Average HGL Depth Attained (ft) | 22.20 |
| Time of Max HGL Occurrence (days hh:mm) | 2 21:00 |
| Total Exfiltration Volume (1000-ft ³) | 0.000 |
| Total Flooded Volume (ac-in) | 0 |
| Total Time Flooded (min) | 0 |
| Total Retention Time (sec) | 0.00 |

Storage Node : Stor-Pond3S

Input Data

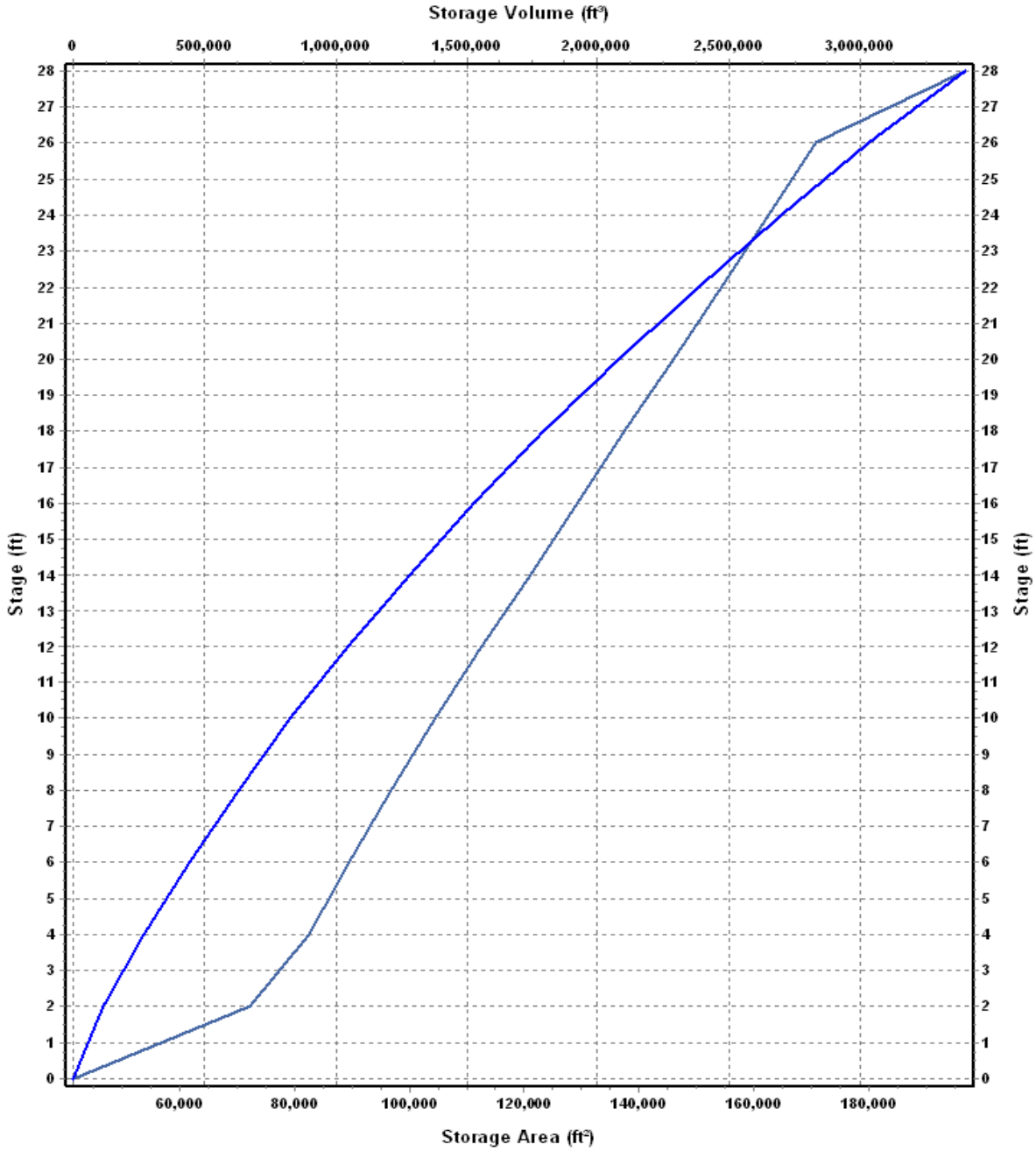
Invert Elevation (ft) 604.00
Max (Rim) Elevation (ft) 632.00
Max (Rim) Offset (ft) 28.00
Initial Water Elevation (ft) 624.66
Initial Water Depth (ft) 20.66
Ponded Area (ft²) 0.00
Evaporation Loss 0.00

Storage Area Volume Curves

Storage Curve : Storage-Pond3S

| Stage (ft) | Storage Area (ft ²) | Storage Volume (ft ³) |
|---------------|---------------------------------------|---|
| 0 | 41626.09 | 0.000 |
| 2 | 72438.46 | 114064.55 |
| 4 | 82587.06 | 269090.07 |
| 6 | 89505.89 | 441183.02 |
| 8 | 96741.54 | 627430.45 |
| 10 | 104521.74 | 828693.73 |
| 12 | 112486.68 | 1045702.15 |
| 14 | 120990.09 | 1279178.92 |
| 16 | 129285.30 | 1529454.31 |
| 18 | 137679.45 | 1796419.06 |
| 20 | 146088.97 | 2080187.48 |
| 22 | 154269.17 | 2380545.62 |
| 24 | 162544.34 | 2697359.13 |
| 26 | 170930.02 | 3030833.49 |
| 28 | 196791.00 | 3398554.51 |

Storage Area Volume Curves



— Storage Area — Storage Volume

Storage Node : Stor-Pond3S (continued)

Output Summary Results

| | |
|---|---------|
| Peak Inflow (cfs) | 53.26 |
| Peak Lateral Inflow (cfs) | 53.26 |
| Peak Outflow (cfs) | 6.03 |
| Peak Exfiltration Flow Rate (cfm) | 0.00 |
| Max HGL Elevation Attained (ft) | 626.62 |
| Max HGL Depth Attained (ft) | 22.62 |
| Average HGL Elevation Attained (ft) | 626.29 |
| Average HGL Depth Attained (ft) | 22.29 |
| Time of Max HGL Occurrence (days hh:mm) | 3 00:00 |
| Total Exfiltration Volume (1000-ft³) | 0.000 |
| Total Flooded Volume (ac-in) | 0 |
| Total Time Flooded (min) | 0 |
| Total Retention Time (sec) | 0.00 |

Storage Node : Stor-PondA

Input Data

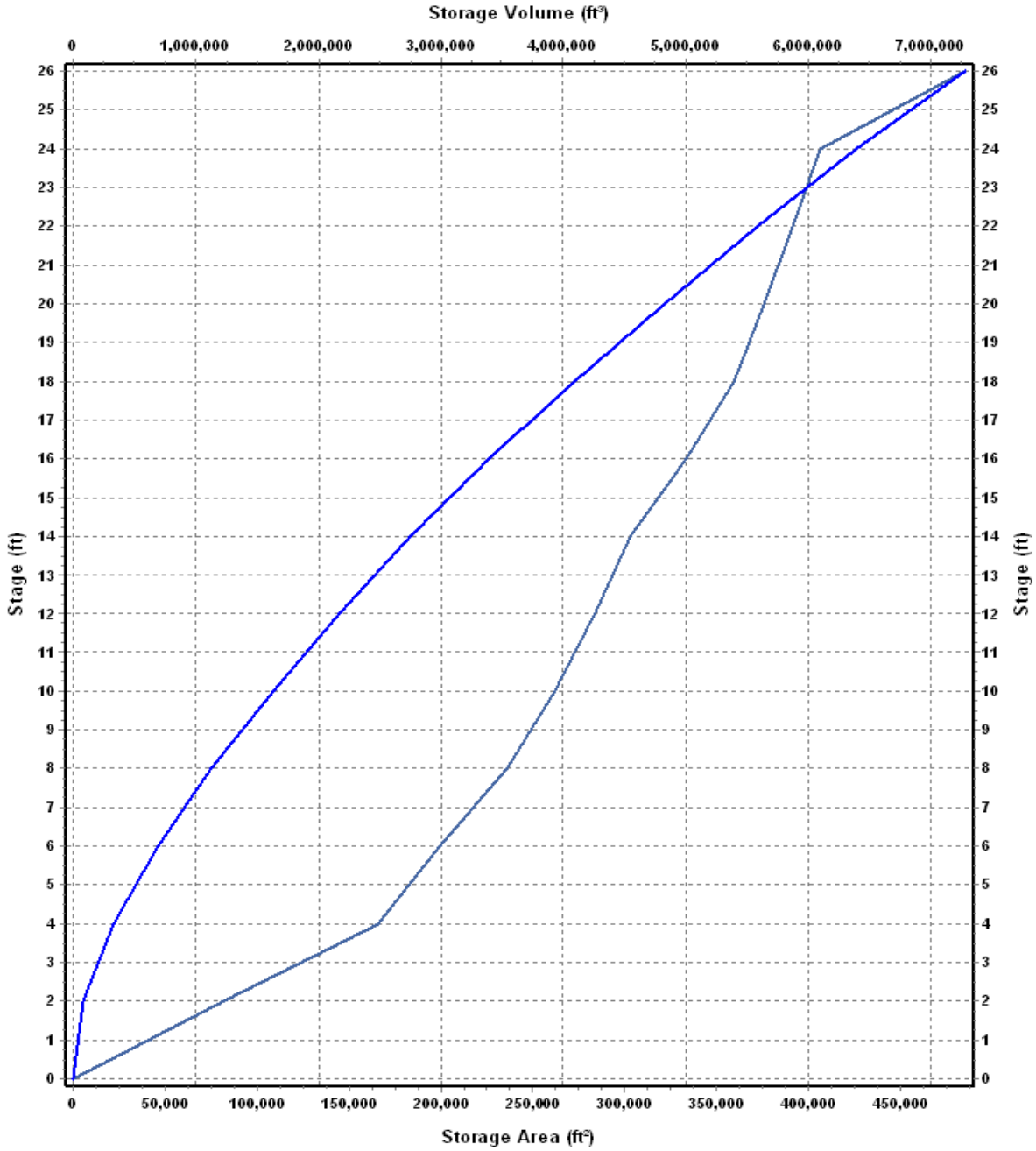
Invert Elevation (ft) 600.00
Max (Rim) Elevation (ft) 626.00
Max (Rim) Offset (ft) 26.00
Initial Water Elevation (ft) 615.50
Initial Water Depth (ft) 15.50
Ponded Area (ft²) 0.00
Evaporation Loss 0.00

Storage Area Volume Curves

Storage Curve : Storage-PondA

| Stage (ft) | Storage Area (ft ²) | Storage Volume (ft ³) |
|---------------|---------------------------------------|---|
| 0 | 169 | 0.000 |
| 2 | 82304 | 82473.00 |
| 4 | 165720 | 330497.00 |
| 6 | 199134 | 695351.00 |
| 8 | 235912 | 1130397.00 |
| 10 | 262021 | 1628330.00 |
| 12 | 283586 | 2173937.00 |
| 14 | 302913 | 2760436.00 |
| 16 | 333408 | 3396757.00 |
| 18 | 359569 | 4089734.00 |
| 20 | 375557 | 4824860.00 |
| 22 | 391075 | 5591492.00 |
| 24 | 406267 | 6388834.00 |
| 26 | 484900 | 7280001.00 |

Storage Area Volume Curves



— Storage Area — Storage Volume

Storage Node : Stor-PondA (continued)

Outflow Orifices

| SN Element ID | Orifice Type | Orifice Shape | Flap Gate | Circular Orifice Diameter (ft) | Rectangular Orifice Height (ft) | Rectangular Orifice Width (ft) | Orifice Invert Elevation (ft) | Orifice Coefficient |
|---------------|--------------|---------------|-----------|--------------------------------|---------------------------------|--------------------------------|-------------------------------|---------------------|
| 1 Orifice-01 | Bottom | CIRCULAR | No | 2.00 | | | 615.50 | 0.61 |

Output Summary Results

| | |
|---|---------|
| Peak Inflow (cfs) | 164.96 |
| Peak Lateral Inflow (cfs) | 91.27 |
| Peak Outflow (cfs) | 14.53 |
| Peak Exfiltration Flow Rate (cfm) | 0.00 |
| Max HGL Elevation Attained (ft) | 617.9 |
| Max HGL Depth Attained (ft) | 17.90 |
| Average HGL Elevation Attained (ft) | 616.94 |
| Average HGL Depth Attained (ft) | 16.94 |
| Time of Max HGL Occurrence (days hh:mm) | 0 15:26 |
| Total Exfiltration Volume (1000-ft ³) | 0.000 |
| Total Flooded Volume (ac-in) | 0 |
| Total Time Flooded (min) | 0 |
| Total Retention Time (sec) | 0.00 |

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solutions@golder.com
www.golder.com

Golder Associates Inc.
15851 South U.S. 27, Suite 50
Lansing, MI 48906 USA
Tel: (517) 482-2262
Fax: (517) 482-2460



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