

ATTACHMENT C

Stormwater Management Study



Tampa Electric Company

Big Bend Solar
Solar Photovoltaic (PV) System
6869 N US 41
Project No. 89390

Revision 2
April 2016

Stormwater Management Study

prepared for

**Tampa Electric Company
Big Bend Solar
Solar Photovoltaic (PV) System
6869 N US 41
Apollo Beach, FL 33601**

Project No. 89390

**Revision 2
April 2016**

prepared by

**Burns & McDonnell Consultants, Inc.
Kansas City, MO**

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Tampa Electric Company Stormwater Management Study Project No. 89390

EXECUTIVE SUMMARY

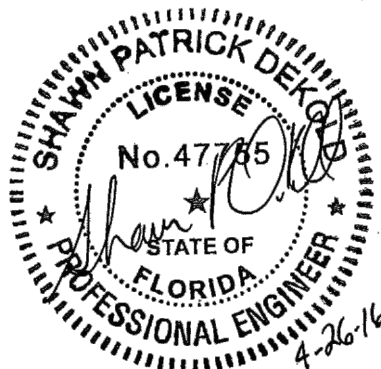
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Certification

I hereby certify, as a Professional Engineer in the state of Florida, that the information in this document was assembled under my direct personal charge. This report is not intended or represented to be suitable for reuse by the Tampa Electric Company or others without specific verification or adaptation by the Engineer.



Shawn DeKold, P.E.

Date:

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LIST OF ABBREVIATIONS

<u>Abbreviation</u>	<u>Term/Phrase/Name</u>
ac	acre
cf	cubic foot
cfs	cubic feet per second
cn	curve number
cp	channel protection
DC	direct current
elev	elevation
fps	feet per second
ft	foot
in	inch
MEP	military equipment parking
min.	minute, minimum
MW	megawat
SCS	Soil Conservation Service
TECO	Tampa Electric Company
TR-55	technical release 55
WQ	water quality
WQV	water quality volume
yr	year

1.0 Executive Summary

The purpose of this report is to analyze the effects that construction of the new Big Bend Solar Photovoltaic System for Tampa Electrical Company will have on predevelopment and post development stormwater. In accordance with the Hillsborough County Stormwater Technical Manual and the Southwest Florida Water Management District, the analysis will focus specifically the following:

- Storm Water Quantity
- Storm Water Quality

1.1 General Site Information

TECO proposes construction of a new 20 Megawatt (MW-DC) ground-mounted photovoltaic renewable energy facility on approximately 120 acres of open farmland at 6869 N US 41 Highway in Apollo Beach, Florida. The existing site is undeveloped and consists of open, agricultural grassed lands with sporadic outcropping of underbrush. A network of existing drainage ditches line the existing site. The proposed solar panels will be divided into six separate arrays. The array fields are spread across the open fields with a gravel entrance road that divides the array fields in the middle. Minimal grading is proposed for the site.

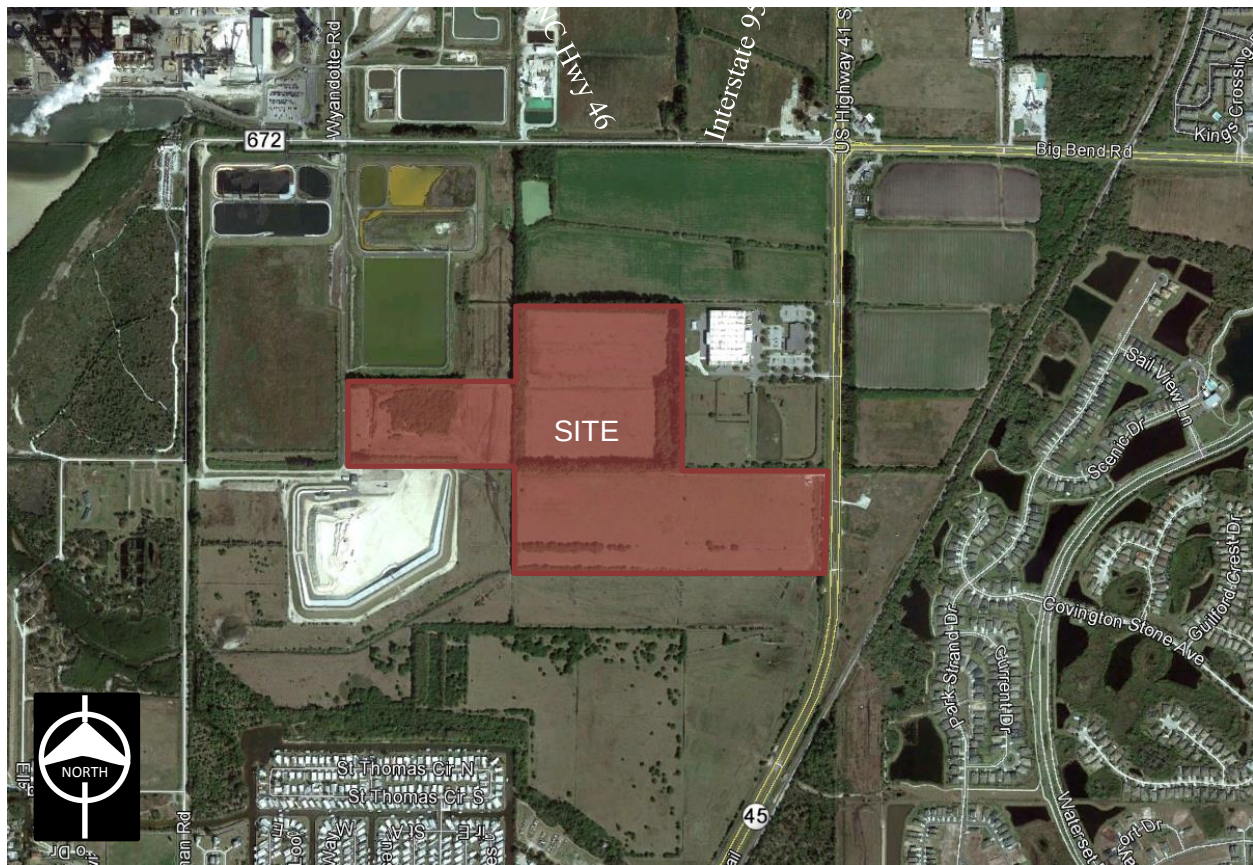


Figure 1-1: Aerial Photograph

(Source: Google Maps)

1.2 Design Methodology

Stormwater discharge rates for this report were computed utilizing the Soil Conservation Service (SCS) method modeled within Hydraflow Hydrographs computer software by Autodesk. The SCS method requires the following information:

- Drainage Area - the drainage area of each watershed was delineated from predevelopment and post-development topographic maps; as shown in Appendix D.
- Rainfall – the SCS method applicable to the State of Florida is based on a storm event that has a Type II time distribution. This distribution is used to distribute the 24-hour volume of rainfall for the different storm frequencies being analyzed.
- Runoff Factor – the SCS method utilizes the curve number (cn) which is based on land use, land treatment, soil types, and land slopes. See Appendix E for curve number calculations.

- Time of Concentration – the time of concentration for each watershed was computed utilizing the Technical Release 55 (TR-55). See Appendix D for travel paths and Appendix D for time of concentration calculations.

1.3 Stormwater Quantity Summary

The existing topographic data indicates that the project site has two main drainage basins, denoted as Basins A and B within this study. Basin A currently discharges into an existing wetland ditch that bisects the middle of the project site. Basin B discharges into another existing wetland ditch that parallels the southern property line. Both ditches remain on TECO property and ultimately discharge into Tampa Bay, approximately 1,400 feet to the west. The proposed project includes the installation of solar panels mounted on solar tracking racks, which will allow the solar panels to track the sun's movement through the sky. Only minimal grading will be required to crown the proposed maintenance access roads and provide roadside grassed drainage swales. The drainage swales are designed to provide water quality treatment which is discussed below in Section 1.4.

For the hydrologic model, only proposed impervious ground surfaces have been considered to have an impact on the curve number. This includes access roads and equipment pads. While the panels are impervious, the installed panels will not alter the hydrologic performance of the underlying pervious ground surface. In addition, though there is a decrease in the Manning's coefficient resulting in a faster sheet flow time of concentration, the overall flow path is lengthened due to the crowned roadways and roadside water quality swales; thereby creating a longer total time of concentration. Even though there is a modest increase in the impervious areas for the drainage basins, the post-development flows for each basin will match or are less than pre-developed flows due to no changes in the drainage area and a slight increase in the curve number and time of concentration.

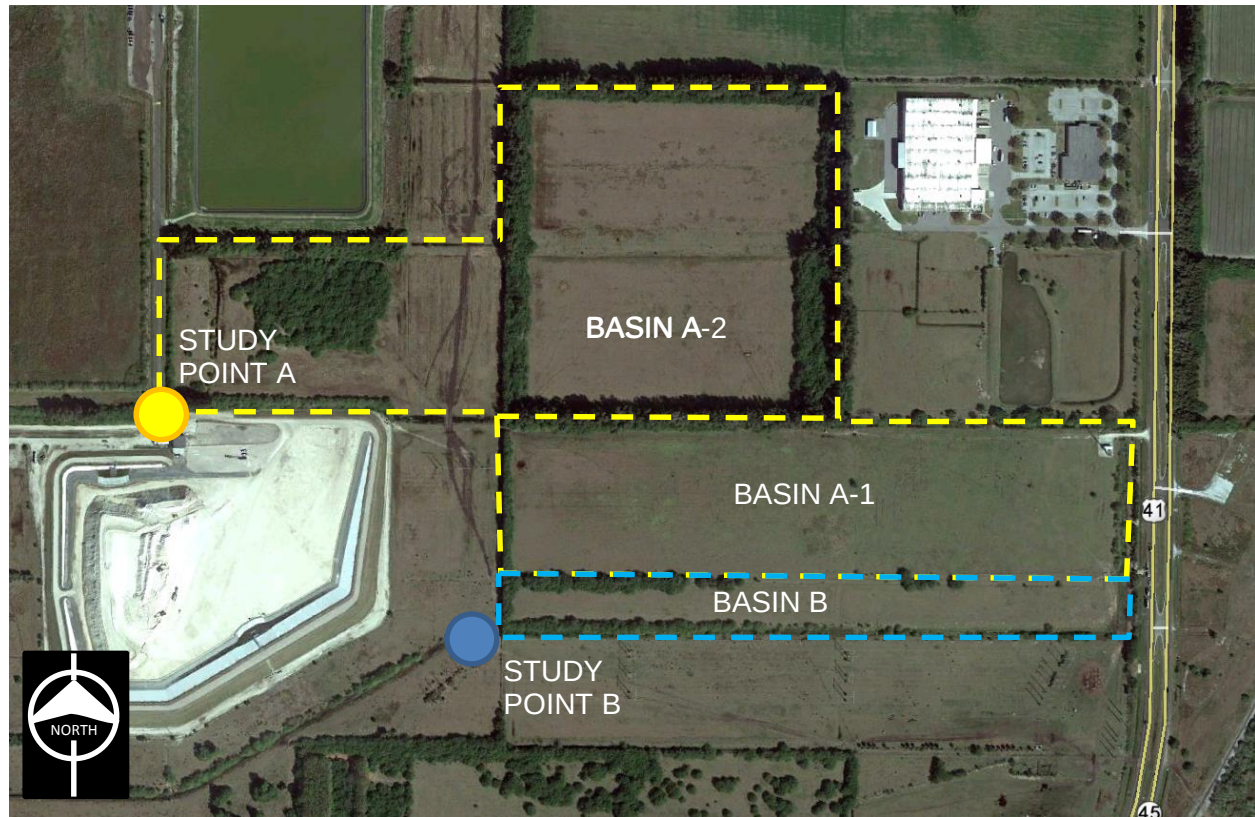


Figure 1-2: Drainage Basins

(Source: Google Maps)

**See topographic maps in Appendix D for basin delineations

Table 1-1: Site Drainage Basin Flow Summary

Storm Frequency	Basin A-1 Pre Developed (cfs)	Basin A-1 Post Developed (cfs)	Basin A-2 Pre Developed (cfs)	Basin A-2 Post Developed (cfs)	Basin B – Pre / Post Developed (cfs)
5-year	38.44	31.87	68.35	67.68	12.64
25-year	59.66	49.58	106.80	104.89	27.30
50-year	76.51	63.67	137.35	134.41	34.96
100-year	84.90	70.68	152.56	149.11	38.77

Table 1-2: Time of Concentration

Basin	Condition	Overland Flow (min.)	Shallow Concentrated Flow (min.)	Open Channel Flow (min.)	Total Tc (min.)
A-1	Pre	47.28	27.89	12.8	87.97
	Post	47.28	57.05	8.8	113.17
A-2	Pre	47.28	10.95	9.3	67.50
	Post	47.28	11.74	10.3	67.28
B	Pre	42.57	0	7.7	54.25
	Post	42.57	0	7.7	54.25

Table 1-3: Curve Number Summary

Basin	Condition	Area (ac)	Curve Number
A-1	Pre	39.2	89
	Post	39.2	89
A-2	Pre	59.8	88
	Post	59.8	89
B	Pre	13.6	89
	Post	13.6	89

1.4 Stormwater Quality Summary

As noted above, a roadside grassed swale system is designed for conveyance and infiltration of the stormwater runoff. The swales are designed to infiltrate the first 0.5 inches of rainfall through the permeable soils of the swale floor and side slopes. The total swale depth is 0.5' with 4:1 side slopes and a 2' flat bottom. The swales are cut into the existing terrain to minimize grading operations and follow the existing slope which averages 0.25% across the site. Earthen check dams are spaced every 200 feet to promote infiltration of the water quality treatment volume. Due to the typical section of the gravel roadways and drainage swales, the water quality swale design calculations are provided for a typical 200' section. A special calculation is provided for the asphalt entrance roadway from US 41. Additional geotechnical investigation including double ring infiltration tests and formal findings for the seasonal high water elevation (SHWE) are being performed and will be included in the next submittal. Infiltration rates and SHWE estimates shown are based on NRCS data tables. A majority of the site is Wabasso fine sand with a published seasonal high water of 6" to 18" below grade. However, the perimeter of the existing site is lined with channels and low ditches which are 3-4' below the open, upland field areas. These ditches tend to lower the water table in the upland areas. Therefore, the higher limit was utilized to estimate the SHWE until formal results are provided.

A summary of the water quality inputs and resulting calculations are shown in the table below. Detailed calculations area shown in Appendix G.

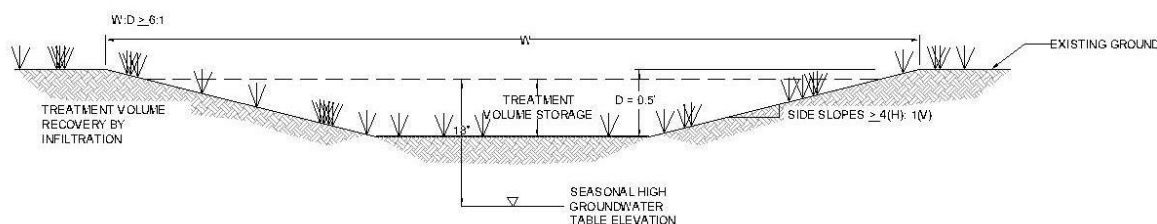


Figure 1-3: Swale Cross-Section

Table 1-4: Water Quality Summary

Basin	Depth to SHWE* (inch)	Saturated Vertical Hydraulic Conductivity (in/hr)	Recovery Time (hrs)	Water Quality Treatment Required (cf)	Water Quality Volume Infiltrated (cf)
Typical 200' Section Solar Farm Road (Eastside)*	6	0.8	36*	62.9	39.5*
Typical 200' Section Solar Farm Road	12	1.2	9	62.9	79.8
Entrance Road Swale 1	12	2	5	79.2	79.8
Entrance Road Swale 2	12	2	5	60.4	79.8

*Underdrain added to swale due to low infiltration rates and high seasonal high water table. Design recovery time set to 36 hours.

1.5 Culvert Analysis Summary

Several circular HDPE culverts are designed to convey surface water runoff through drainage channel driveway crossings. The culvert design takes into consideration several factors when determining the appropriate size, type, quantity, and configuration of the culverts including entrance/exit conditions, embankment shape, and tailwater conditions. The culverts are design to safely pass the peak flow from the 25-year storm event which is determined using the Rational Method in accordance with the Hillsborough County Stormwater Management Technical Manual. A roughness coefficient of 0.010 is used for HDPE pipes. A minimum culvert size of 15" is selected to reduce the risk of clogging while providing adequate cover over the pipes for the proposed driveway crossings. The tailwater elevation is expected to be below the culvert crown elevation at each culvert and therefore the culverts are designed assuming the hydraulic grade line elevation is at the crown elevation of the proposed culverts.

A summary of the culvert design inputs and resulting calculations are shown in the table below. Detailed calculations are shown in Appendix I.

Table 1-5: Culvert Design Summary

Name	25-yr Storm Peak Flow (cfs)	Maximum Velocity (ft/s)	Size (in)	Barrels	Slope (%)	Hw/D	Flow Regime
A2	2.29	3.90	15	1	0.25	0.71	Inlet Control
B2	57.11*	6.43	38x24	3	0.50	1.26	Outlet Control
C2	4.65	3.79	15	1	0.20	1.12	Inlet Control
D2	1.72	3.56	15	1	0.15	0.61	Inlet Control
E2	7.51	6.12	15	1	0.23	1.49	Inlet Control
F2	3.44	4.49	15	1	0.25	0.89	Inlet Control
G2	2.68	4.11	15	1	0.26	0.77	Inlet Control
H2	10.84	4.42	15	2	0.25	1.20	Inlet Control
J2	48.12	7.30	48	1	0.50	0.77	Inlet Control

*Flows for B2 are taken from the Hillsborough County EPSWMM Model, Stormwater Conduit C825050.

2.0 Construction Soil Erosion and Sediment Control

A detailed erosion and sediment control plan has been developed and is shown in the construction documents. During construction, measures will be taken to reduce erosion and manage sedimentation from disturbed surfaces. Minimal grading will be required to construct the solar panels and access roads. The following Best Management Practices will be employed:

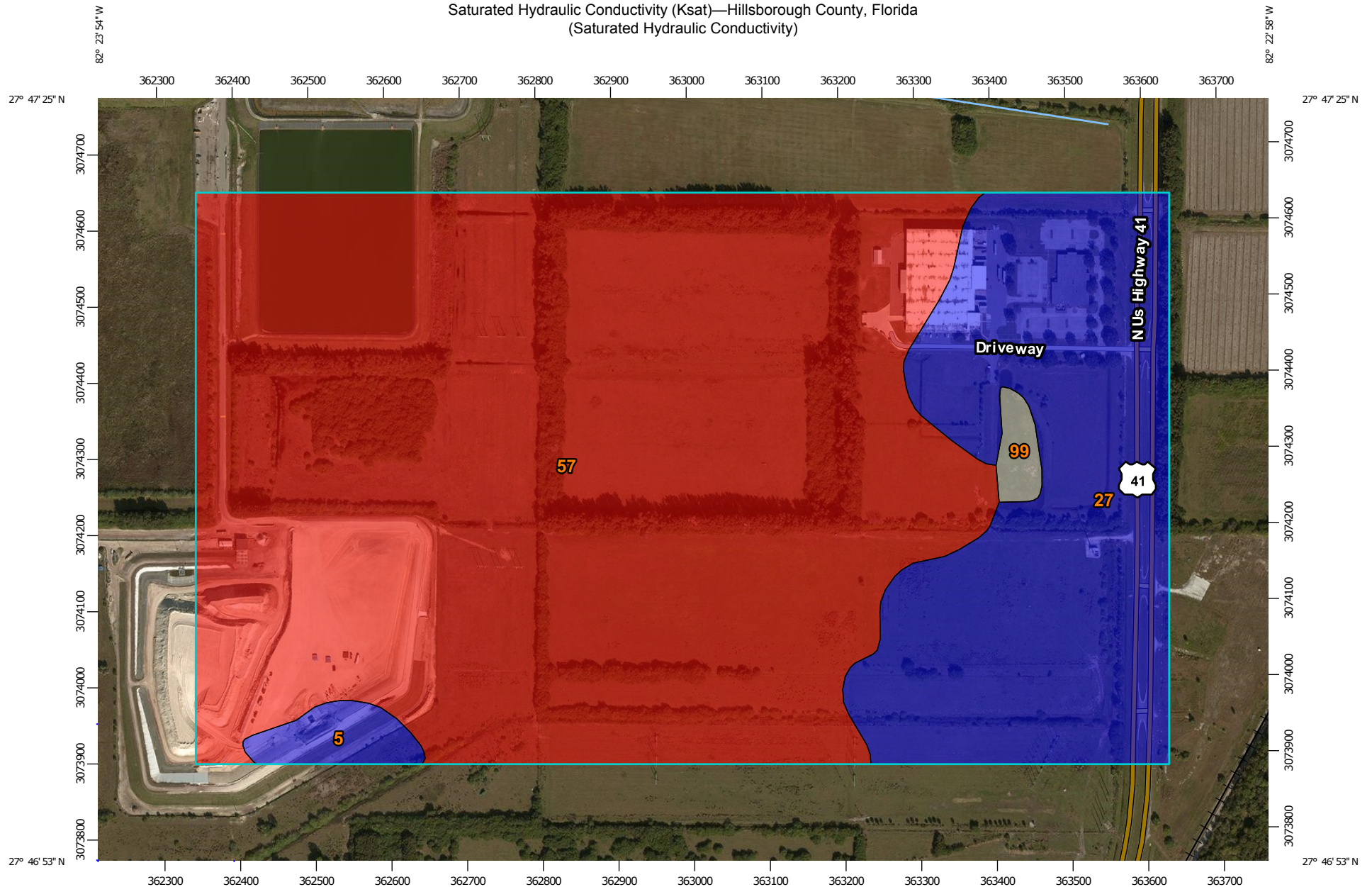
- Silt fence will be installed at the clearing limits and the down gradient perimeter of the disturbed portion of the site. Additional silt fence will be required around any top soil stock pile areas as needed;
- Construction entrances will be installed at the entrance from US Hwy 41 to prevent tracking sediment into local roads;
- Gravel check dams will be installed within the grassed drainage swale system; and
- Storm drainage outlet protection (rip-rap) will be installed at all culvert crossings.

APPENDIX A - FEMA FIRM MAP

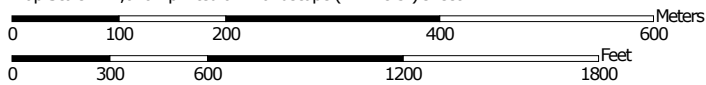
APPENDIX B - COUNTY FLOOD MAP

APPENDIX C - NRCS SOILS MAP

Saturated Hydraulic Conductivity (Ksat)—Hillsborough County, Florida
(Saturated Hydraulic Conductivity)



Map Scale: 1:7,070 if printed on A landscape (11" x 8.5") sheet.



Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 17N WGS84



Natural Resources
Conservation Service

Web Soil Survey
National Cooperative Soil Survey

3/8/2016
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Saturated Hydraulic Conductivity (Ksat)—Hillsborough County, Florida
(Saturated Hydraulic Conductivity)

MAP LEGEND

Area of Interest (AOI)

 Area of Interest (AOI)

Soils

Soil Rating Polygons

 ≤ 91.7400
 > 91.7400 and ≤ 92.0000
 Not rated or not available

Soil Rating Lines

 ≤ 91.7400
 > 91.7400 and ≤ 92.0000
 Not rated or not available

Soil Rating Points

 ≤ 91.7400
 > 91.7400 and ≤ 92.0000
 Not rated or not available

Water Features

 Streams and Canals

Transportation

 Rails
 Interstate Highways
 US Routes
 Major Roads
 Local Roads

Background

 Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:20,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: <http://websoilsurvey.nrcs.usda.gov>
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Hillsborough County, Florida
Survey Area Data: Version 14, Nov 19, 2015

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Dec 1, 2014—Jan 8, 2015

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Saturated Hydraulic Conductivity (Ksat)

Saturated Hydraulic Conductivity (Ksat)— Summary by Map Unit — Hillsborough County, Florida (FL057)				
Map unit symbol	Map unit name	Rating (micrometers per second)	Acres in AOI	Percent of AOI
5	Basinger, Holopaw, and Samsula soils, depressional	92.0000	3.6	1.5%
27	Malabar fine sand	92.0000	59.1	24.7%
57	Wabasso fine sand, 0 to 2 percent slopes	91.7400	175.2	73.1%
99	Water		1.8	0.7%
Totals for Area of Interest			239.6	100.0%

Description

Saturated hydraulic conductivity (Ksat) refers to the ease with which pores in a saturated soil transmit water. The estimates are expressed in terms of micrometers per second. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Saturated hydraulic conductivity is considered in the design of soil drainage systems and septic tank absorption fields.

For each soil layer, this attribute is actually recorded as three separate values in the database. A low value and a high value indicate the range of this attribute for the soil component. A "representative" value indicates the expected value of this attribute for the component. For this soil property, only the representative value is used.

The numeric Ksat values have been grouped according to standard Ksat class limits.

Rating Options

Units of Measure: micrometers per second

Aggregation Method: Dominant Component

Component Percent Cutoff: None Specified

Tie-break Rule: Fastest

Interpret Nulls as Zero: No

Layer Options (Horizon Aggregation Method): Surface Layer (Not applicable)

APPENDIX D - DRAINAGE BASIN MAP

APPENDIX E - SCS METHOD CALCULATION WORKSHEETS

Design Worksheet SCS Summary

Project Name: **Teco Big Bend Solar**

Basin **A-1 - Pre**

Basin Characteristics:

Total Area **39.2** ac. Elev (1) = **9.5**
Total Length **4370** L.F. Elev (2) = **2**

Average Slope = 0.002 ft./ft.

Curve Number Determination:

	CN value	Area	
Unimproved areas / Woods	83	1	Soil Group D
Pasture / Agriculture	89	37.98	Soil Group D
Impervious / Asphalt	98	0.22	Soil Group D
		39.2	Total Area (ac)
Weighted CN	89		

TR-55 - Time of Concentration Calculations:

Overland Flow:

Based on the following equation:

$$T = (0.42 (nL)^{0.8}) / (P(0.5)^*S^{0.4})$$

n = **0.13**

L = **300**

P = **4**

S = **0.002**

Where:

T = Travel time (min).

n = Manning roughness coefficient

L = Flow length

P = 2 yr Precipitation (4 in)

S = Land Slope (ft./ft.)

Time of Travel: 47.28 min.

Shallow Concentrated Flow:

Based on the following equations:

Where:

T = Travel time (min).

S = Land Slope (ft./ft.)

L = Flow length

Unpaved $T = L / (16.1345 * (S)^{0.5})$

Paved $T = L / (20.3282 * (S)^{0.5})$

L = **1350**

S = **0.0025**

L = **0**

Calculated Velocity = 0.81 ft/s
Time of Travel = 27.89 min.

Calculated Velocity = 1.02 ft/s
Time of Travel = 0.00 min.

Open Channel Flow:

Based on the following equations:

Where:

T = Travel time (min).

S = Land Slope (ft./ft.)

L = Flow length (ft)

A = Flow area (sf)

Pw = Wetted Perimeter (ft)

n = Manning roughness coefficient

$$T = L / [1.49 (A/Pw)^{0.67} (S)^{0.5}] / n$$

n = **0.03**

L = **2898**

A = **84**

Pw = **45.0**

S = **0.0025**

Calculated Velocity = 3.77 ft/s
Time of Travel: 12.8 min.

Calculated Slope = 0.002 ft./ft.

Overall Length = 4548 l.f.

Total Time of Concentration : 87.97 min.

Design Worksheet SCS Summary

Project Name: **Teco Big Bend Solar**

Basin **A-2 - Pre**

Basin Characteristics:

Total Area **59.8** ac. Elev (1) = **8.1**
Total Length **2930** L.F. Elev (2) = **2**

Average Slope = 0.002 ft./ft.

Curve Number Determination:

	CN value	Area	
Unimproved areas / Woods	83	8.5	Soil Group D
Pasture / Agriculture	89	51.13	Soil Group D
Impervious / Asphalt	98	0.17	Soil Group D
		59.8	Total Area (ac)
Weighted CN	88		

TR-55 - Time of Concentration Calculations:

Overland Flow:

Based on the following equation:

$$T = (0.42 (nL)^{0.8}) / (P^{0.5} S^{0.4})$$

n = **0.13**

L = **300**

P = **4**

S = **0.002**

Where:

T = Travel time (min).

n = Manning roughness coefficient

L = Flow length

P = 2 yr Precipitation (4 in)

S = Land Slope (ft./ft.)

Time of Travel: 47.28 min.

Shallow Concentrated Flow:

Based on the following equations:

Where:

T = Travel time (min).

S = Land Slope (ft./ft.)

L = Flow length

Unpaved $T = L / (16.1345 (S)^{0.5})$

Paved $T = L / (20.3282 (S)^{0.5})$

L = **530**

S = **0.0025**

L = **0**

Calculated Velocity = 0.81 ft/s
Time of Travel = 10.95 min.

Calculated Velocity = 1.02 ft/s
Time of Travel = 0.00 min.

Open Channel Flow:

Based on the following equations:

Where:

T = Travel time (min).

S = Land Slope (ft./ft.)

L = Flow length (ft)

A = Flow area (sf)

Pw = Wetted Perimeter (ft)

n = Manning roughness coefficient

$$T = L / [1.49 (A/Pw)^{0.67} (S)^{0.5}] / n$$

n = **0.03**

L = **2100**

A = **84**

Pw = **45.0**

S = **0.0025**

Calculated Velocity = 3.77 ft/s
Time of Travel: 9.3 min.

Calculated Slope = 0.002 ft./ft.
Overall Length = 2930 l.f.

Total Time of Concentration : 67.50 min.

Design Worksheet SCS Summary

Project Name: **Teco Big Bend Solar**

Basin **A-1 - Post**

Basin Characteristics:

Total Area **39.2** ac. Elev (1) = **9.5**
Total Length **4770** L.F. Elev (2) = **2**

Average Slope = 0.002 ft./ft.

Curve Number Determination:

	CN value	Area	
Unimproved areas / Woods	83	0	Soil Group D
Grassed / Pasture	89	37.01	Soil Group D
Asphalt Entrance	98	0.19	Soil Group D
Interconnection Station	85	0.5	Soil Group D
Gravel Roadway	91	1.5	Soil Group D
		39.2	Total Area (ac)
Weighted CN	89		

TR-55 - Time of Concentration Calculations:

Overland Flow:

Based on the following equation:

$$T = (0.42 (nL)^{0.8}) / (P(0.5)S^{0.4})$$

n = **0.13**

L = **300**

P = **4**

S = **0.002**

Where:

T = Travel time (min).

n = Manning roughness coefficient

L = Flow length

P = 2 yr Precipitation (4 in)

S = Land Slope (ft./ft.)

Time of Travel: 47.28 min.

Shallow Concentrated Flow:

Based on the following equations:

$$\text{Unpaved } T = L / (16.1345(S)^{0.5})$$

L = **2470**

S = **0.002**

Where:

T = Travel time (min).

S = Land Slope (ft./ft.)

L = Flow length

$$\text{Paved } T = L / (20.3282(S)^{0.5})$$

L = **0**

Calculated Velocity = 0.72 ft/s

Time of Travel = 57.05 min.

Calculated Velocity = 0.91 ft/s

Time of Travel = 0.00 min.

Open Channel Flow:

Based on the following equations:

$$T = L / [1.49 (A/Pw)^{0.67} (S)^{0.5}] / n$$

n = **0.03**

L = **2000**

A = **84**

Pw = **45.0**

S = **0.0025**

Where:

T = Travel time (min).

S = Land Slope (ft./ft.)

L = Flow length (ft)

A = Flow area (sf)

Pw = Wetted Perimeter (ft)

n = Manning roughness coefficient

Calculated Velocity = 3.77 ft/s

Time of Travel: 8.8 min.

Calculated Slope = 0.002 ft./ft.

Overall Length = 4770 l.f.

Total Time of Concentration : 113.17 min.

Design Worksheet SCS Summary

Project Name: **Teco Big Bend Solar**

Basin **A-2 - Post**

Basin Characteristics:

Total Area **59.8** ac. Elev (1) = **8.1**
Total Length **3063** L.F. Elev (2) = **2**

Average Slope = 0.002 ft./ft.

Curve Number Determination:

	CN value	Area	
Unimproved areas / Woods	83	0	Soil Group D
Grassed / Pasture	89	58.05	Soil Group D
Gravel Roadway	91	1.75	Soil Group D
Impervious / Asphalt	98	0	Soil Group D
		59.8	Total Area (ac)
Weighted CN	89		

TR-55 - Time of Concentration Calculations:

Overland Flow:

Based on the following equation:

$$T = (0.42 (nL)^{0.8}) / (P(0.5)^*S^{0.4})$$

n = **0.13**

L = **300**

P = **4**

S = **0.002**

Where:

T = Travel time (min).

n = Manning roughness coefficient

L = Flow length

P = 2 yr Precipitation (4 in)

S = Land Slope (ft./ft.)

Time of Travel: 47.28 min.

Shallow Concentrated Flow:

Based on the following equations:

$$\text{Unpaved } T = L / (16.1345 * (S)^{0.5})$$

L = **440**

S = **0.0015**

Where:

T = Travel time (min).

S = Land Slope (ft./ft.)

L = Flow length

$$\text{Paved } T = L / (20.3282 (S)^{0.5})$$

L = **0**

Calculated Velocity = 0.62 ft/s
Time of Travel = 11.74 min.

Calculated Velocity = 0.79 ft/s
Time of Travel = 0.00 min.

Open Channel Flow:

Based on the following equations:

$$T = L / [1.49 (A/Pw)^{0.67} (S)^{0.5}] / n$$

n = **0.03**

L = **2323**

A = **84**

Pw = **45.0**

S = **0.0025**

Where:

T = Travel time (min).

S = Land Slope (ft./ft.)

L = Flow length (ft)

A = Flow area (sf)

Pw = Wetted Perimeter (ft)

n = Manning roughness coefficient

Calculated Velocity = 3.77 ft/s
Time of Travel: 10.3 min.

Calculated Slope = 0.002 ft./ft.
Overall Length = 3063 l.f.

Total Time of Concentration : 69.28 min.

Design Worksheet SCS Summary

Project Name: **Teco Big Bend Solar**

Basin **B - Pre and Post**

Basin Characteristics:

Total Area **13.6** ac. Elev (1) = **9.5**
Total Length **2453** L.F. Elev (2) = **0**

Average Slope = 0.004 ft./ft.

Curve Number Determination:

	C value	Area	
Unimproved areas / Woods	83	0	Soil Group D
Pasture / Agriculture	89	13.6	Soil Group D
Grassed / Improved Area	75	0	Soil Group D
Gravel Roadway	91	0	Soil Group D
		13.6	Total Area (ac)
Weighted CN	89		

TR-55 - Time of Concentration Calculations:

Overland Flow:

Based on the following equation:

$$T = (0.42 (nL)^{0.8}) / (P(0.5)^*S^{0.4})$$

n = **0.13**

L = **300**

P = **4**

S = **0.0026**

Where:

T = Travel time (min).

n = Manning roughness coefficient

L = Flow length

P = 2 yr Precipitation (4 in)

S = Land Slope (ft./ft.)

Time of Travel: 42.57 min.

Shallow Concentrated Flow:

Based on the following equations:

$$\text{Unpaved } T = L / (16.1345 * (S)^{0.5})$$

L = **400**

S = **0.011**

Where:

T = Travel time (min).

S = Land Slope (ft./ft.)

L = Flow length

$$\text{Paved } T = L / (20.3282 (S)^{0.5})$$

L = **0**

Calculated Velocity = 1.69 ft/s
Time of Travel = 3.94 min.

Calculated Velocity = 2.13 ft/s
Time of Travel = 0.00 min.

Open Channel Flow:

Based on the following equations:

$$T = L / [1.49 (A/Pw)^{0.67} (S)^{0.5}] / n$$

n = **0.03**

L = **1753**

A = **84**

Pw = **45.0**

S = **0.0025**

Where:

T = Travel time (min).

S = Land Slope (ft./ft.)

L = Flow length (ft)

A = Flow area (sf)

Pw = Wetted Perimeter (ft)

n = Manning roughness coefficient

Calculated Velocity = 3.77 ft/s
Time of Travel: 7.7 min.

Calculated Slope = 0.004 ft./ft.
Overall Length = 2453 l.f.

Total Time of Concentration : 54.25 min.

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Hydrograph Return Period Recap

Hydrow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	-----	-----	38.44	-----	59.66	76.51	84.90	A-1 Pre
2	SCS Runoff	-----	-----	-----	-----	68.35	-----	106.80	137.35	152.56	A-2 Pre
3	SCS Runoff	-----	-----	-----	-----	31.87	-----	49.58	63.67	70.68	A-1 Post
4	SCS Runoff	-----	-----	-----	-----	67.68	-----	104.89	134.41	149.11	A-2 Post
6	Combine	1, 2,	-----	-----	-----	106.34	-----	165.78	213.00	236.51	POI A - Pre
7	Combine	3, 4,	-----	-----	-----	97.87	-----	151.85	194.70	216.03	POI A - Post
9	SCS Runoff	-----	-----	-----	-----	17.64	-----	27.30	34.96	38.77	Basin B - Pre & Post
Proj. file: Big Bend Solar.gpw										Saturday, 02 / 20 / 2016	

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	38.44	2	784	604,696	-----	-----	-----	A-1 Pre
2	SCS Runoff	68.35	2	768	901,427	-----	-----	-----	A-2 Pre
3	SCS Runoff	31.87	2	802	603,611	-----	-----	-----	A-1 Post
4	SCS Runoff	67.68	2	770	924,147	-----	-----	-----	A-2 Post
6	Combine	106.34	2	774	1,506,122	1, 2,	-----	-----	POI A - Pre
7	Combine	97.87	2	780	1,527,757	3, 4,	-----	-----	POI A - Post
9	SCS Runoff	17.64	2	760	210,641	-----	-----	-----	Basin B - Pre & Post
Big Bend Solar.gpw					Return Period: 5 Year			Saturday, 02 / 20 / 2016	

Hydrograph Report

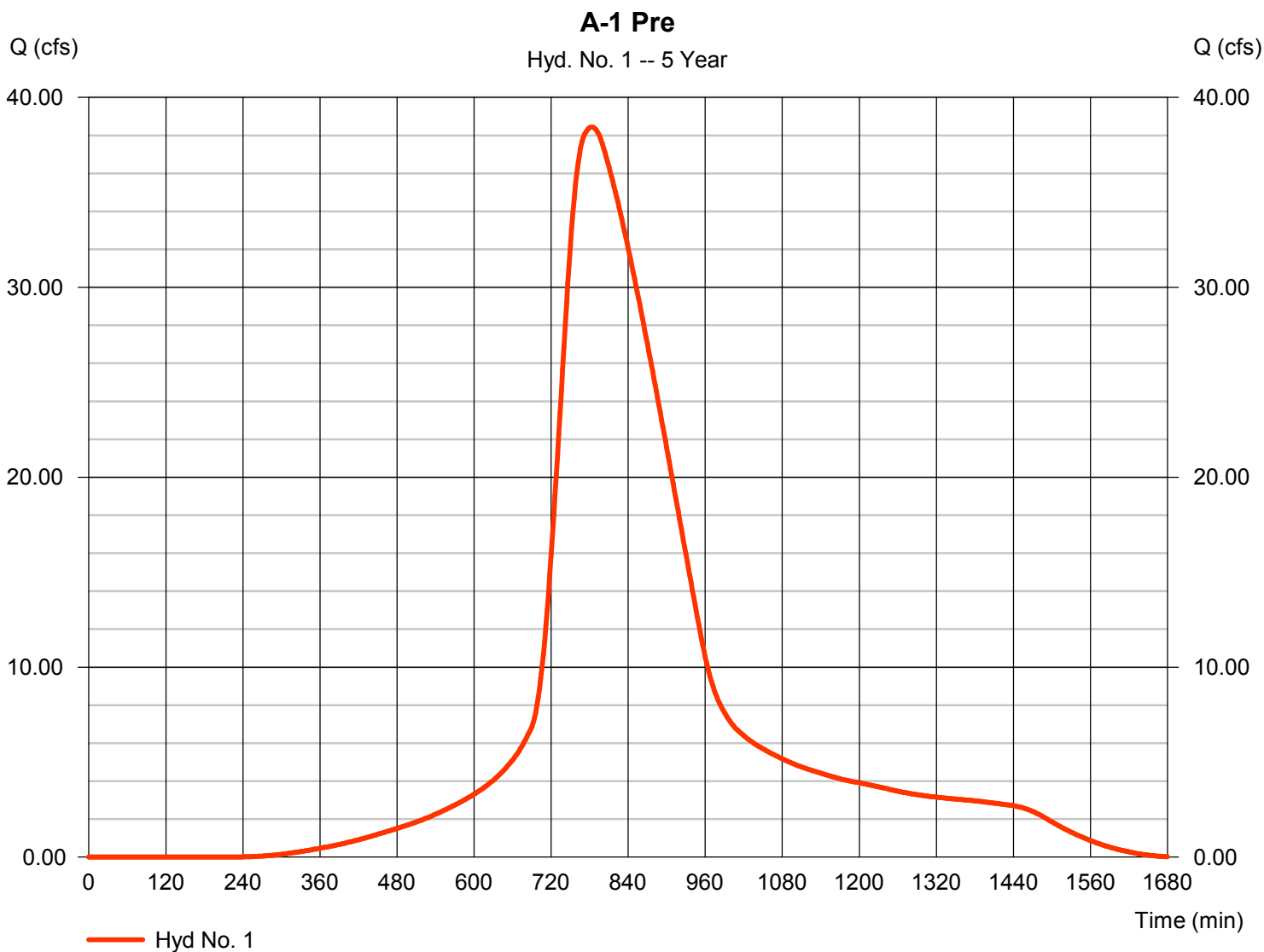
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Saturday, 02 / 20 / 2016

Hyd. No. 1

A-1 Pre

Hydrograph type	= SCS Runoff	Peak discharge	= 38.44 cfs
Storm frequency	= 5 yrs	Time to peak	= 784 min
Time interval	= 2 min	Hyd. volume	= 604,696 cuft
Drainage area	= 39.200 ac	Curve number	= 89
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 87.90 min
Total precip.	= 5.50 in	Distribution	= Type II FL
Storm duration	= 24 hrs	Shape factor	= 256

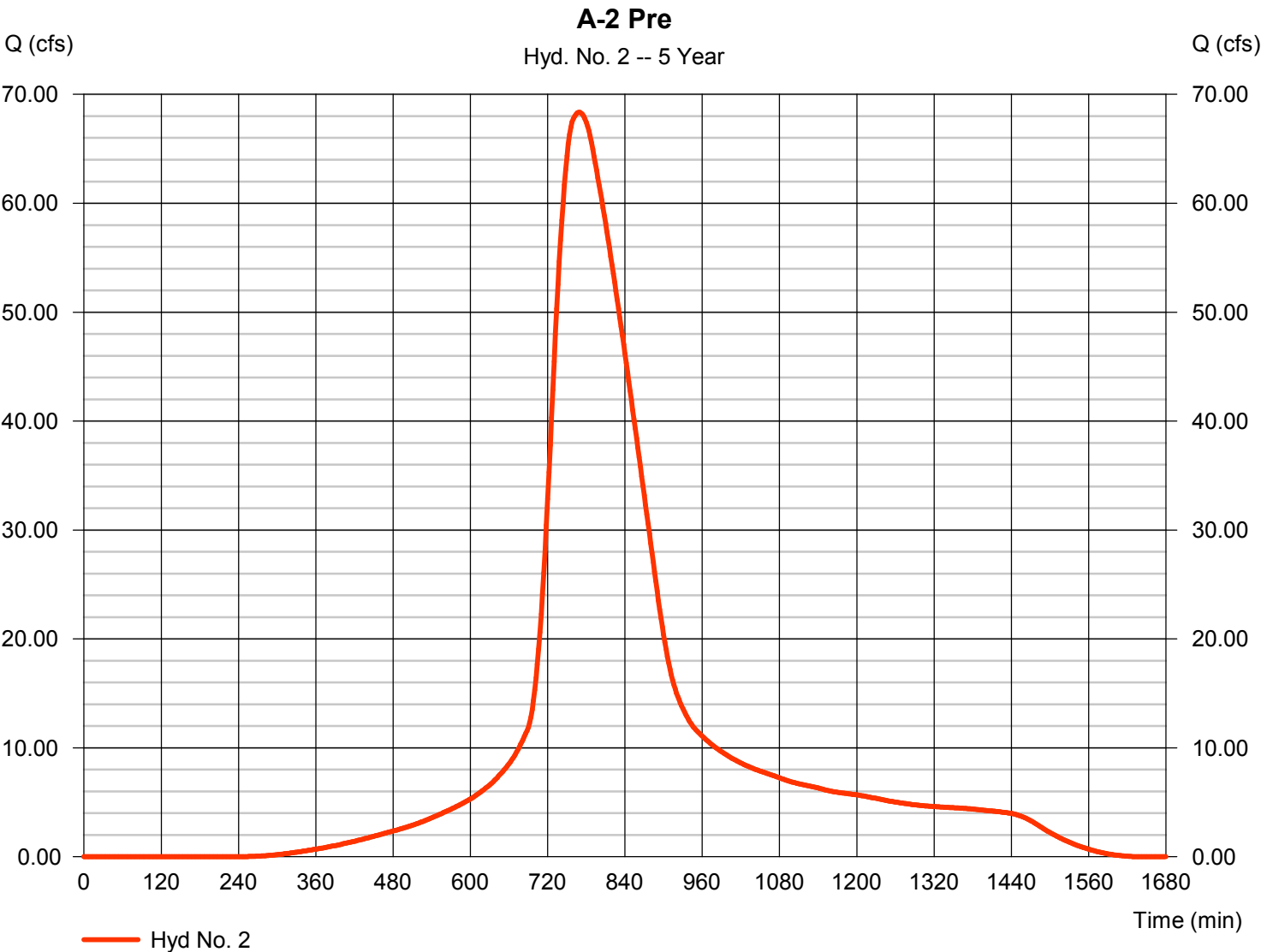


Hydrograph Report

Hyd. No. 2

A-2 Pre

Hydrograph type	= SCS Runoff	Peak discharge	= 68.35 cfs
Storm frequency	= 5 yrs	Time to peak	= 768 min
Time interval	= 2 min	Hyd. volume	= 901,427 cuft
Drainage area	= 59.800 ac	Curve number	= 88
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 67.50 min
Total precip.	= 5.50 in	Distribution	= Type II FL
Storm duration	= 24 hrs	Shape factor	= 256



Hydrograph Report

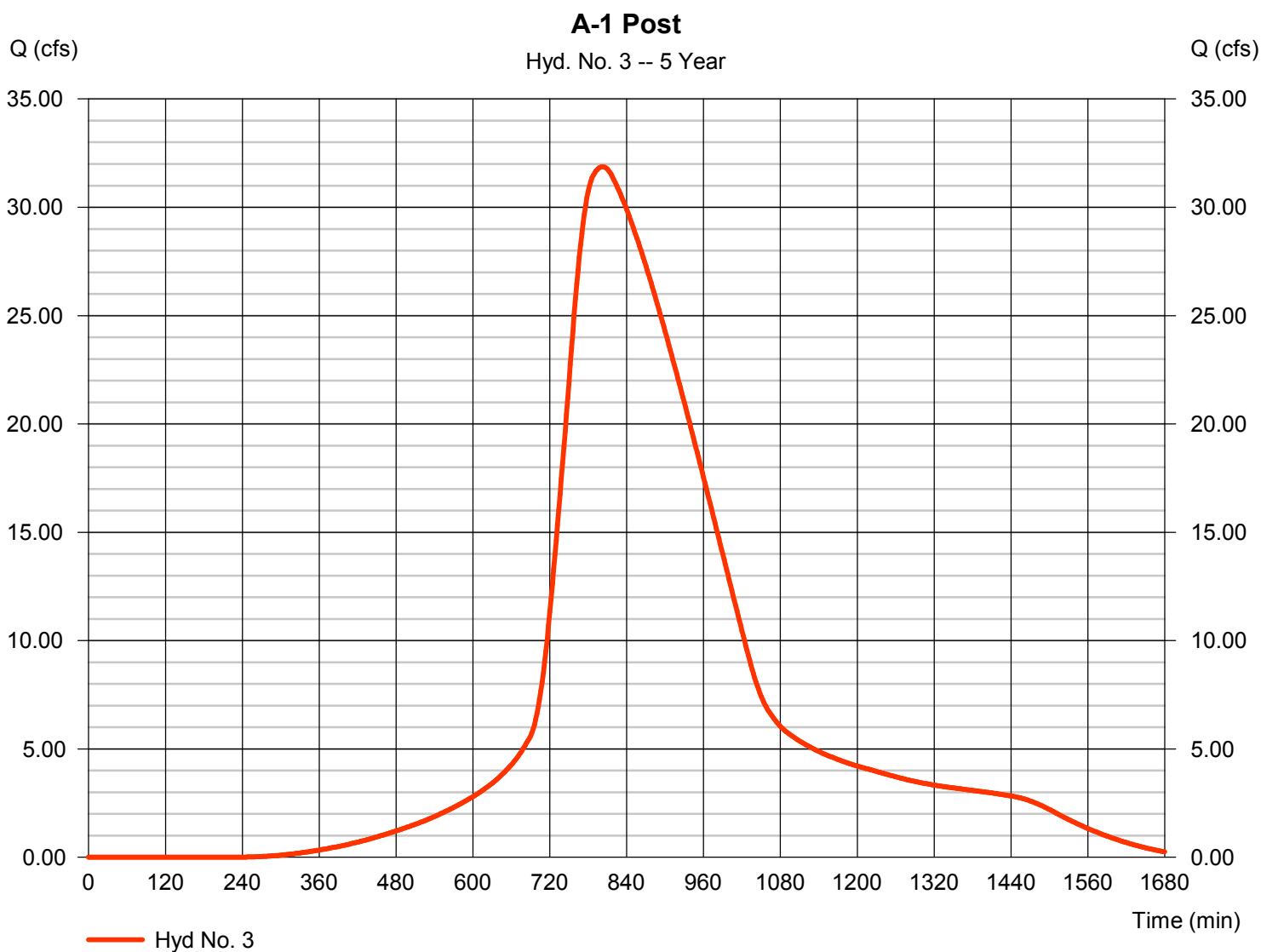
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Saturday, 02 / 20 / 2016

Hyd. No. 3

A-1 Post

Hydrograph type	= SCS Runoff	Peak discharge	= 31.87 cfs
Storm frequency	= 5 yrs	Time to peak	= 802 min
Time interval	= 2 min	Hyd. volume	= 603,611 cuft
Drainage area	= 39.200 ac	Curve number	= 89
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 113.00 min
Total precip.	= 5.50 in	Distribution	= Type II FL
Storm duration	= 24 hrs	Shape factor	= 256



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

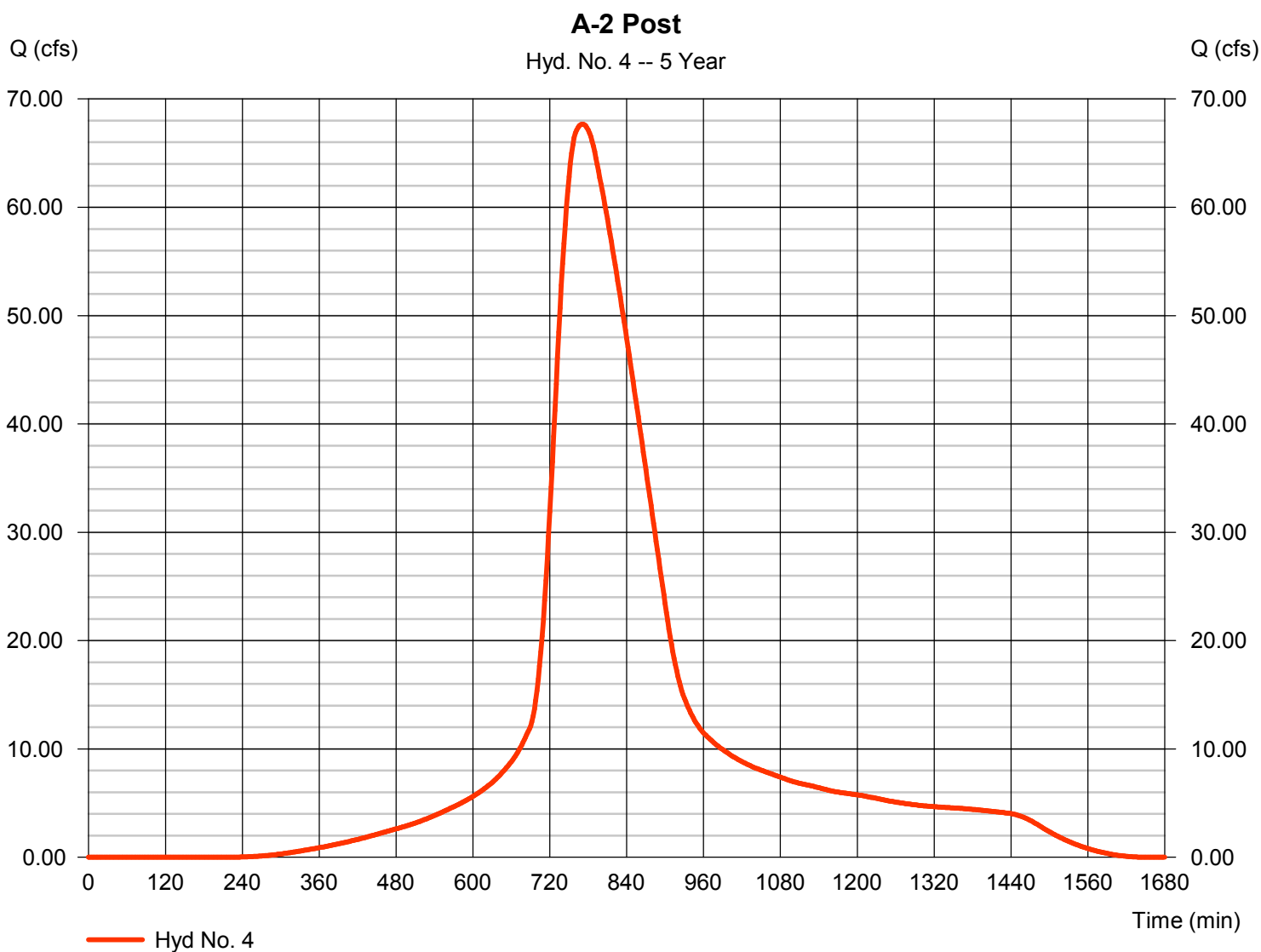
Saturday, 02 / 20 / 2016

Hyd. No. 4

A-2 Post

Hydrograph type = SCS Runoff
 Storm frequency = 5 yrs
 Time interval = 2 min
 Drainage area = 59.800 ac
 Basin Slope = 0.0 %
 Tc method = User
 Total precip. = 5.50 in
 Storm duration = 24 hrs

Peak discharge = 67.68 cfs
 Time to peak = 770 min
 Hyd. volume = 924,147 cuft
 Curve number = 89
 Hydraulic length = 0 ft
 Time of conc. (Tc) = 69.30 min
 Distribution = Type II FL
 Shape factor = 256



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

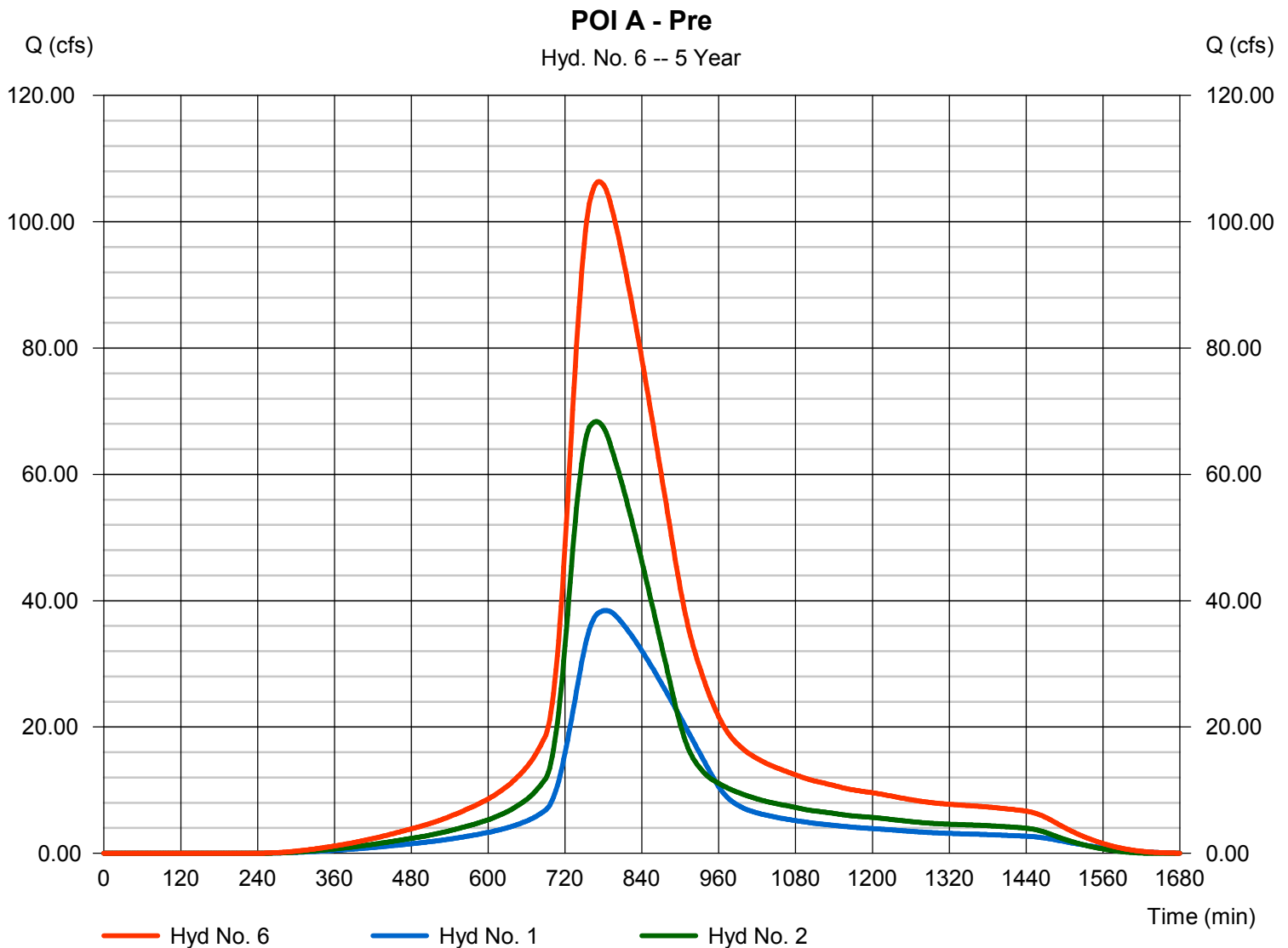
Saturday, 02 / 20 / 2016

Hyd. No. 6

POI A - Pre

Hydrograph type = Combine
Storm frequency = 5 yrs
Time interval = 2 min
Inflow hyds. = 1, 2

Peak discharge = 106.34 cfs
Time to peak = 774 min
Hyd. volume = 1,506,122 cuft
Contrib. drain. area = 99.000 ac

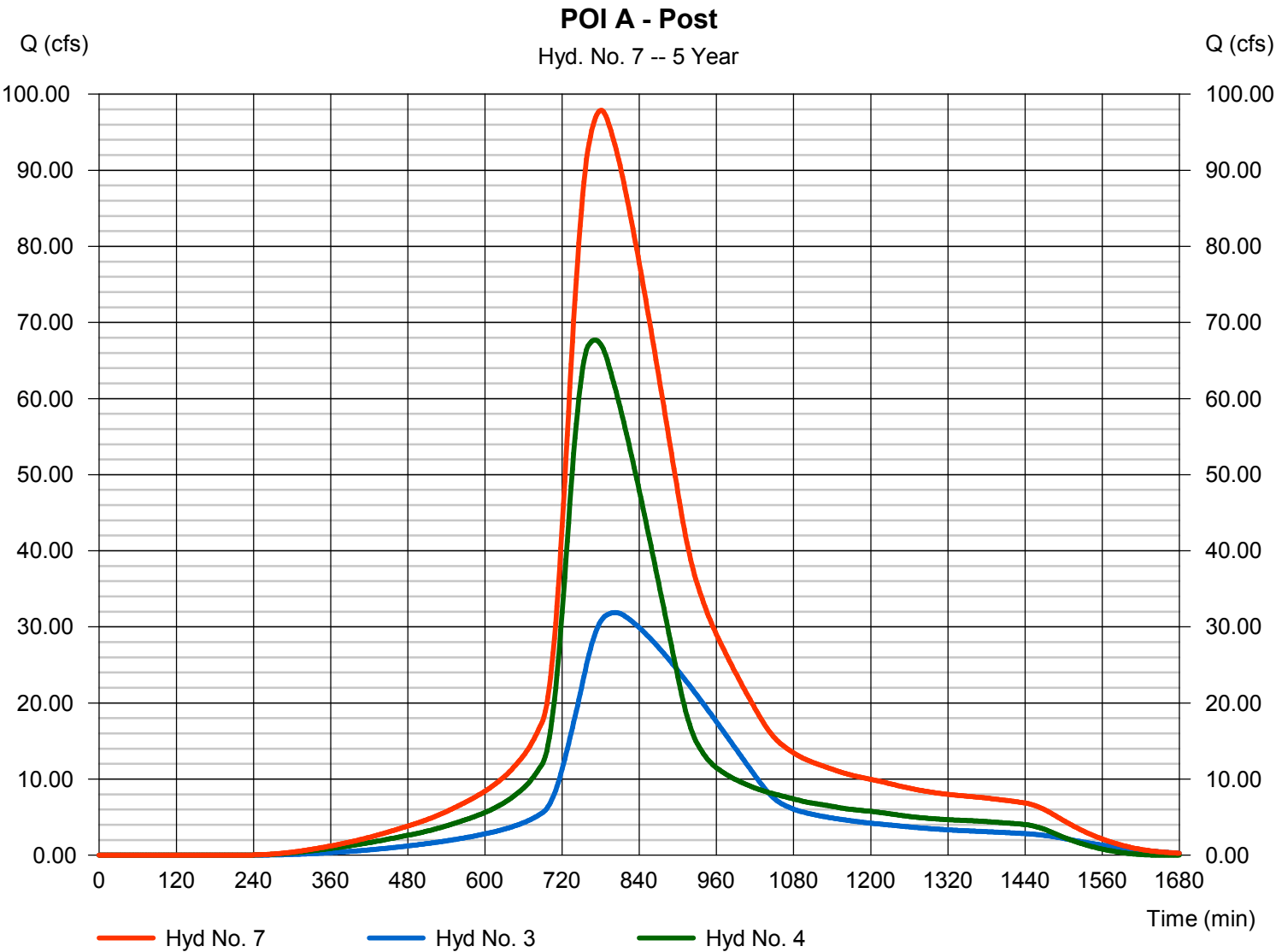


Hydrograph Report

Hyd. No. 7

POI A - Post

Hydrograph type	= Combine	Peak discharge	= 97.87 cfs
Storm frequency	= 5 yrs	Time to peak	= 780 min
Time interval	= 2 min	Hyd. volume	= 1,527,757 cuft
Inflow hyds.	= 3, 4	Contrib. drain. area	= 99.000 ac



Hydrograph Report

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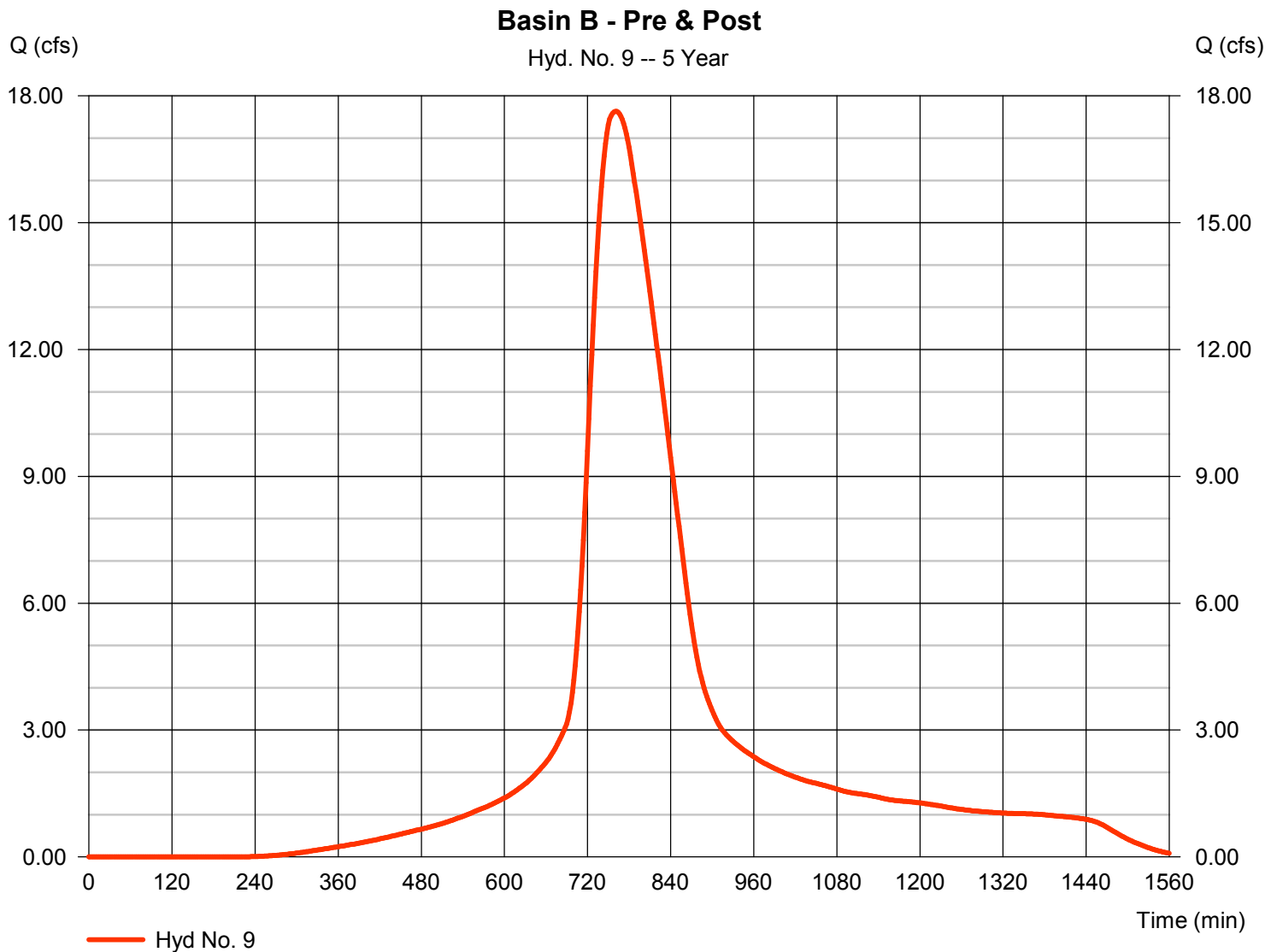
Saturday, 02 / 20 / 2016

Hyd. No. 9

Basin B - Pre & Post

Hydrograph type = SCS Runoff
 Storm frequency = 5 yrs
 Time interval = 2 min
 Drainage area = 13.600 ac
 Basin Slope = 0.0 %
 Tc method = User
 Total precip. = 5.50 in
 Storm duration = 24 hrs

Peak discharge = 17.64 cfs
 Time to peak = 760 min
 Hyd. volume = 210,641 cuft
 Curve number = 89
 Hydraulic length = 0 ft
 Time of conc. (Tc) = 54.25 min
 Distribution = Type II FL
 Shape factor = 256



Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	59.66	2	782	950,898	-----	-----	-----	A-1 Pre
2	SCS Runoff	106.80	2	768	1,428,137	-----	-----	-----	A-2 Pre
3	SCS Runoff	49.58	2	800	949,193	-----	-----	-----	A-1 Post
4	SCS Runoff	104.89	2	770	1,453,242	-----	-----	-----	A-2 Post
6	Combine	165.78	2	772	2,379,039	1, 2,	-----	-----	POI A - Pre
7	Combine	151.85	2	780	2,402,437	3, 4,	-----	-----	POI A - Post
9	SCS Runoff	27.30	2	760	331,237	-----	-----	-----	Basin B - Pre & Post
Big Bend Solar.gpw					Return Period: 25 Year			Saturday, 02 / 20 / 2016	

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

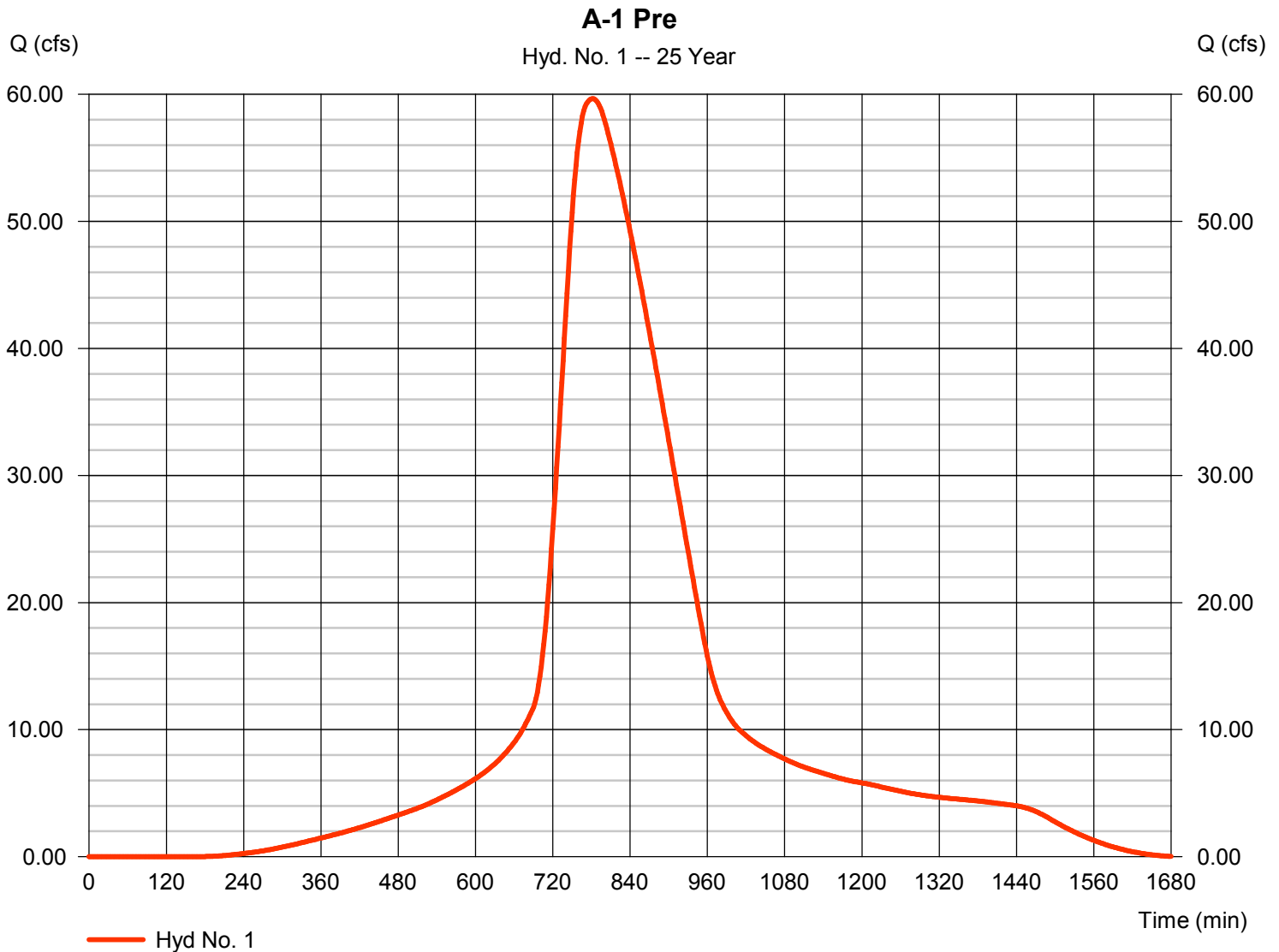
Saturday, 02 / 20 / 2016

Hyd. No. 1

A-1 Pre

Hydrograph type = SCS Runoff
 Storm frequency = 25 yrs
 Time interval = 2 min
 Drainage area = 39.200 ac
 Basin Slope = 0.0 %
 Tc method = User
 Total precip. = 8.00 in
 Storm duration = 24 hrs

Peak discharge = 59.66 cfs
 Time to peak = 782 min
 Hyd. volume = 950,898 cuft
 Curve number = 89
 Hydraulic length = 0 ft
 Time of conc. (Tc) = 87.90 min
 Distribution = Type II FL
 Shape factor = 256



Hydrograph Report

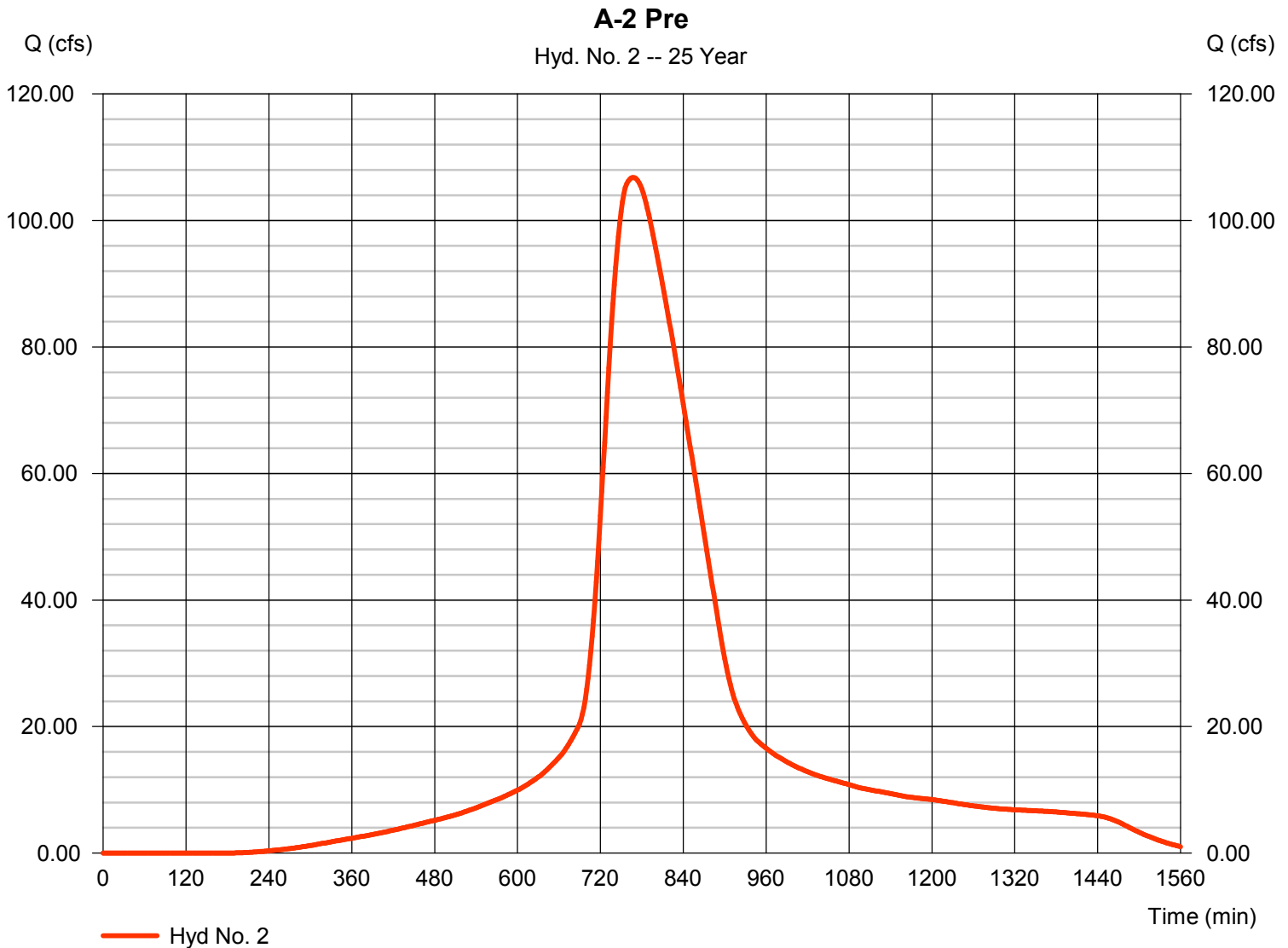
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Saturday, 02 / 20 / 2016

Hyd. No. 2

A-2 Pre

Hydrograph type	= SCS Runoff	Peak discharge	= 106.80 cfs
Storm frequency	= 25 yrs	Time to peak	= 768 min
Time interval	= 2 min	Hyd. volume	= 1,428,137 cuft
Drainage area	= 59.800 ac	Curve number	= 88
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 67.50 min
Total precip.	= 8.00 in	Distribution	= Type II FL
Storm duration	= 24 hrs	Shape factor	= 256



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

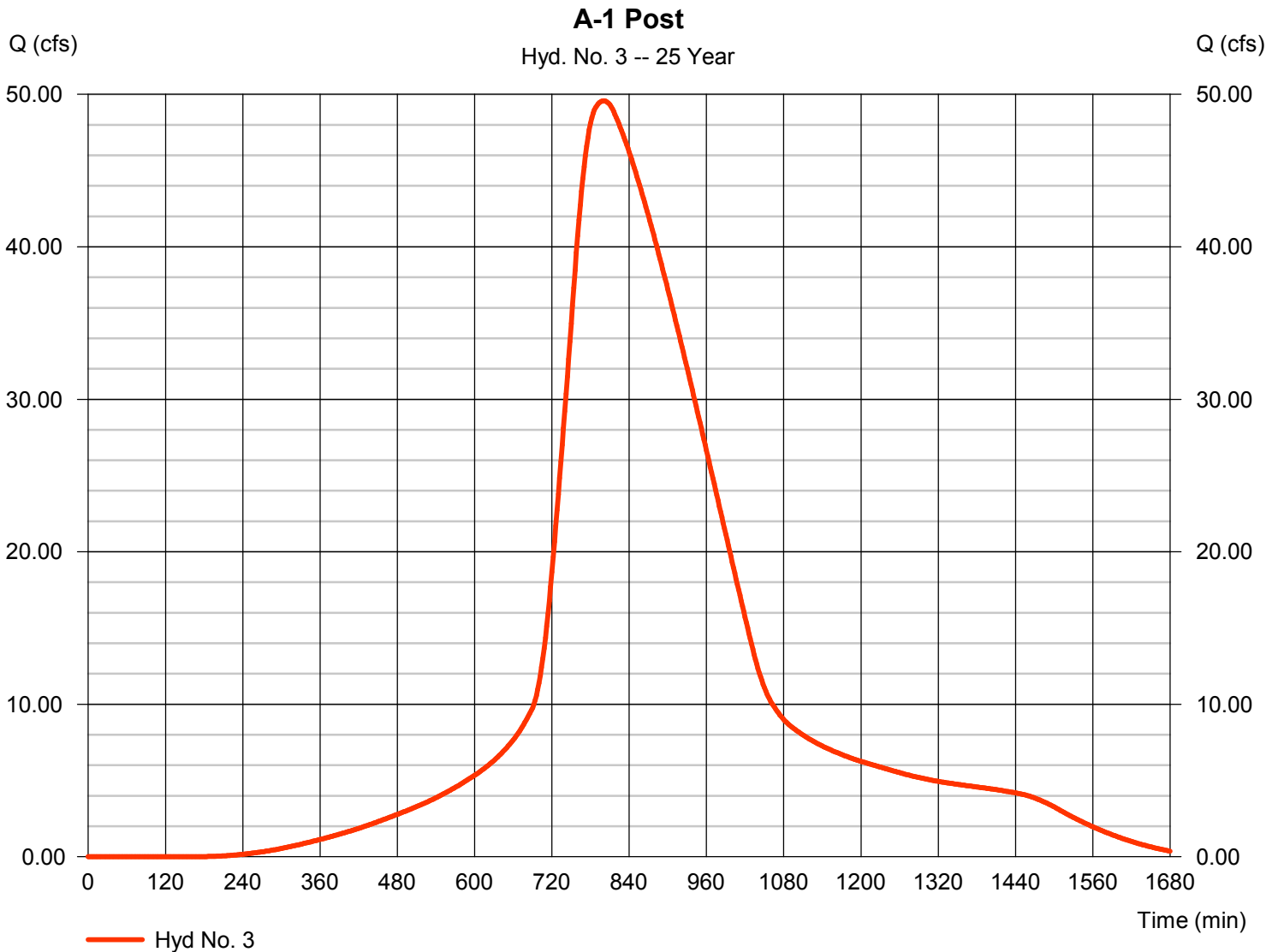
Saturday, 02 / 20 / 2016

Hyd. No. 3

A-1 Post

Hydrograph type = SCS Runoff
 Storm frequency = 25 yrs
 Time interval = 2 min
 Drainage area = 39.200 ac
 Basin Slope = 0.0 %
 Tc method = User
 Total precip. = 8.00 in
 Storm duration = 24 hrs

Peak discharge = 49.58 cfs
 Time to peak = 800 min
 Hyd. volume = 949,193 cuft
 Curve number = 89
 Hydraulic length = 0 ft
 Time of conc. (Tc) = 113.00 min
 Distribution = Type II FL
 Shape factor = 256



Hydrograph Report

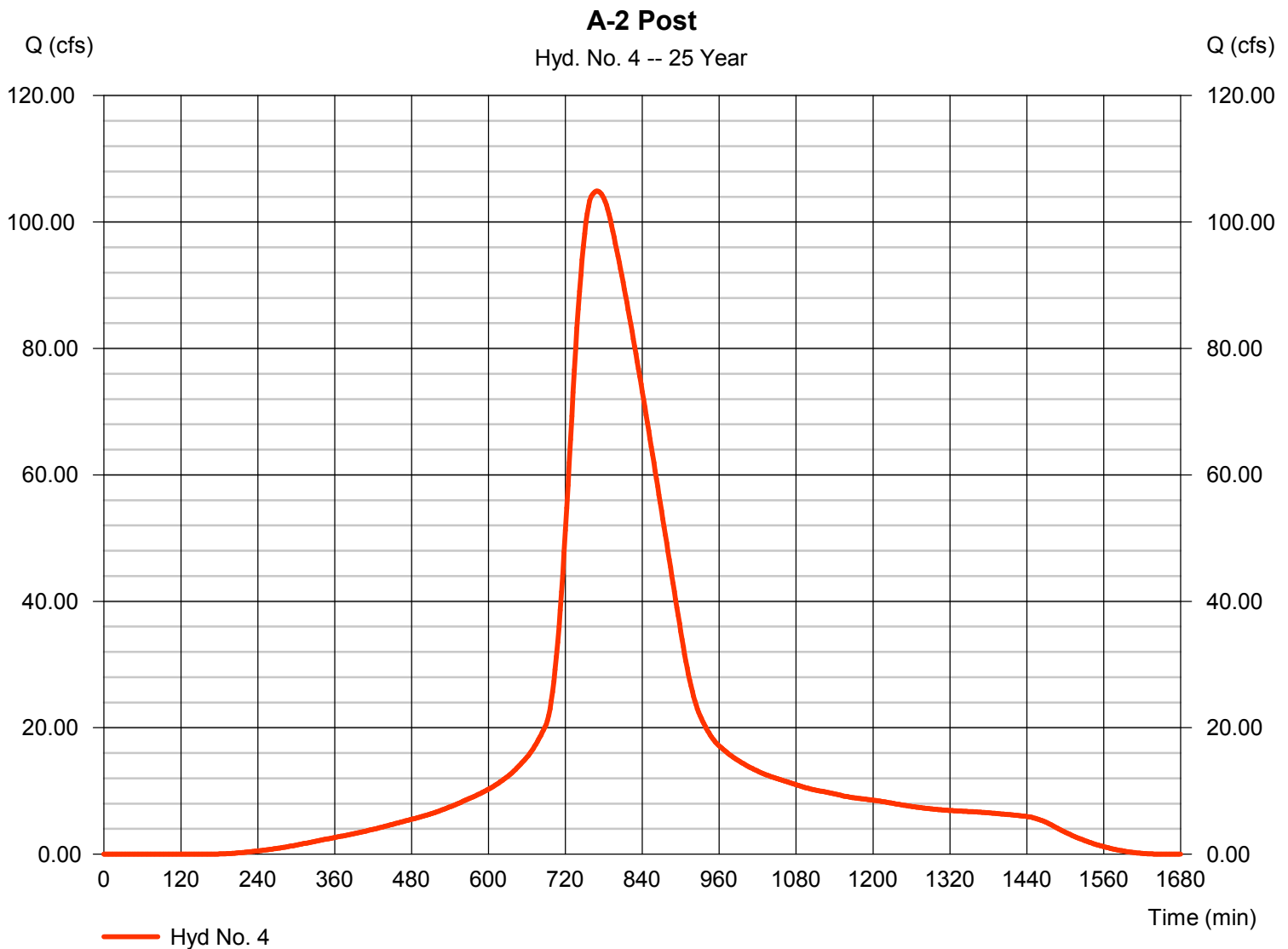
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Saturday, 02 / 20 / 2016

Hyd. No. 4

A-2 Post

Hydrograph type	= SCS Runoff	Peak discharge	= 104.89 cfs
Storm frequency	= 25 yrs	Time to peak	= 770 min
Time interval	= 2 min	Hyd. volume	= 1,453,242 cuft
Drainage area	= 59.800 ac	Curve number	= 89
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 69.30 min
Total precip.	= 8.00 in	Distribution	= Type II FL
Storm duration	= 24 hrs	Shape factor	= 256



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

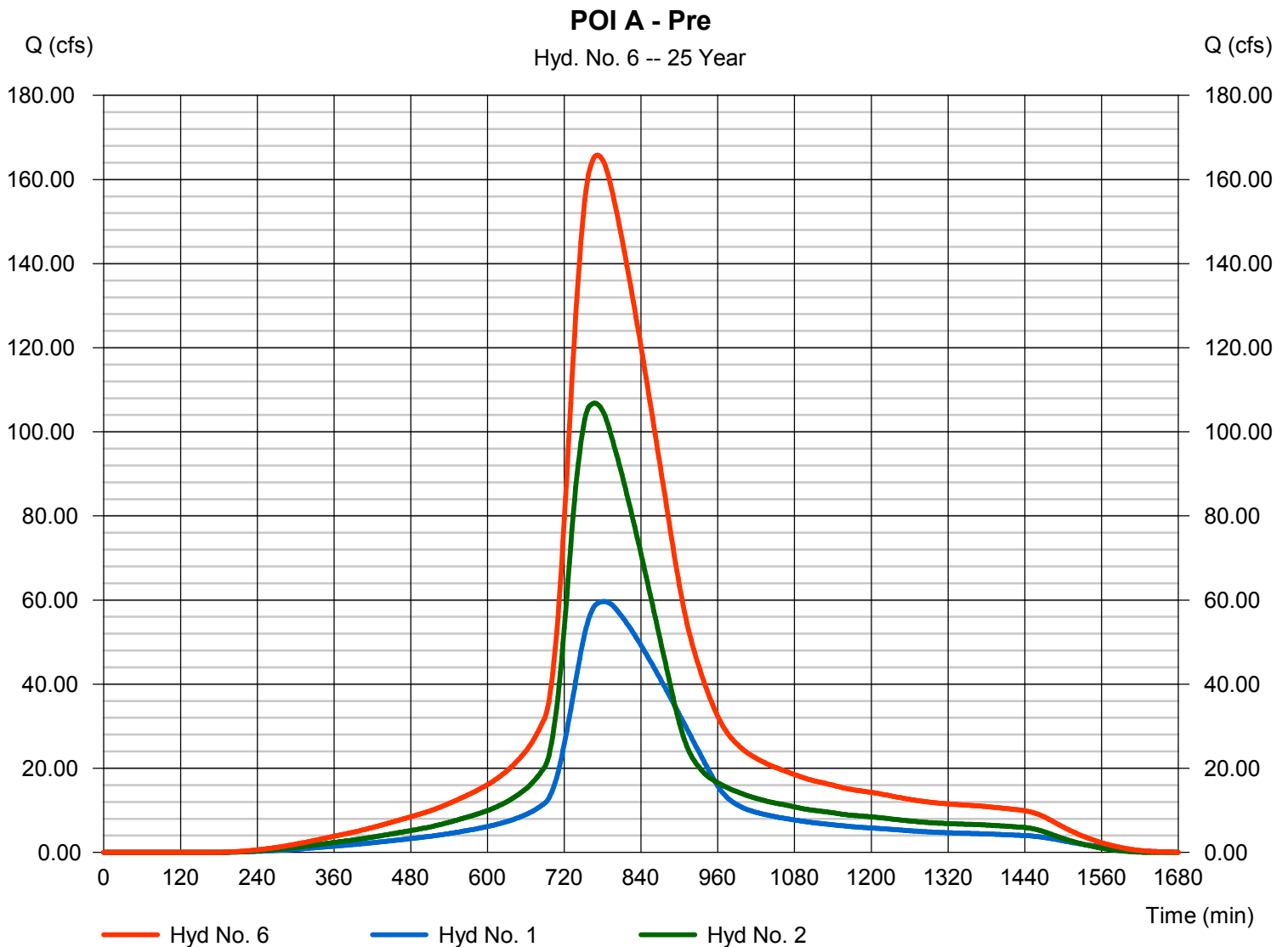
Saturday, 02 / 20 / 2016

Hyd. No. 6

POI A - Pre

Hydrograph type = Combine
Storm frequency = 25 yrs
Time interval = 2 min
Inflow hyds. = 1, 2

Peak discharge = 165.78 cfs
Time to peak = 772 min
Hyd. volume = 2,379,039 cuft
Contrib. drain. area = 99.000 ac



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

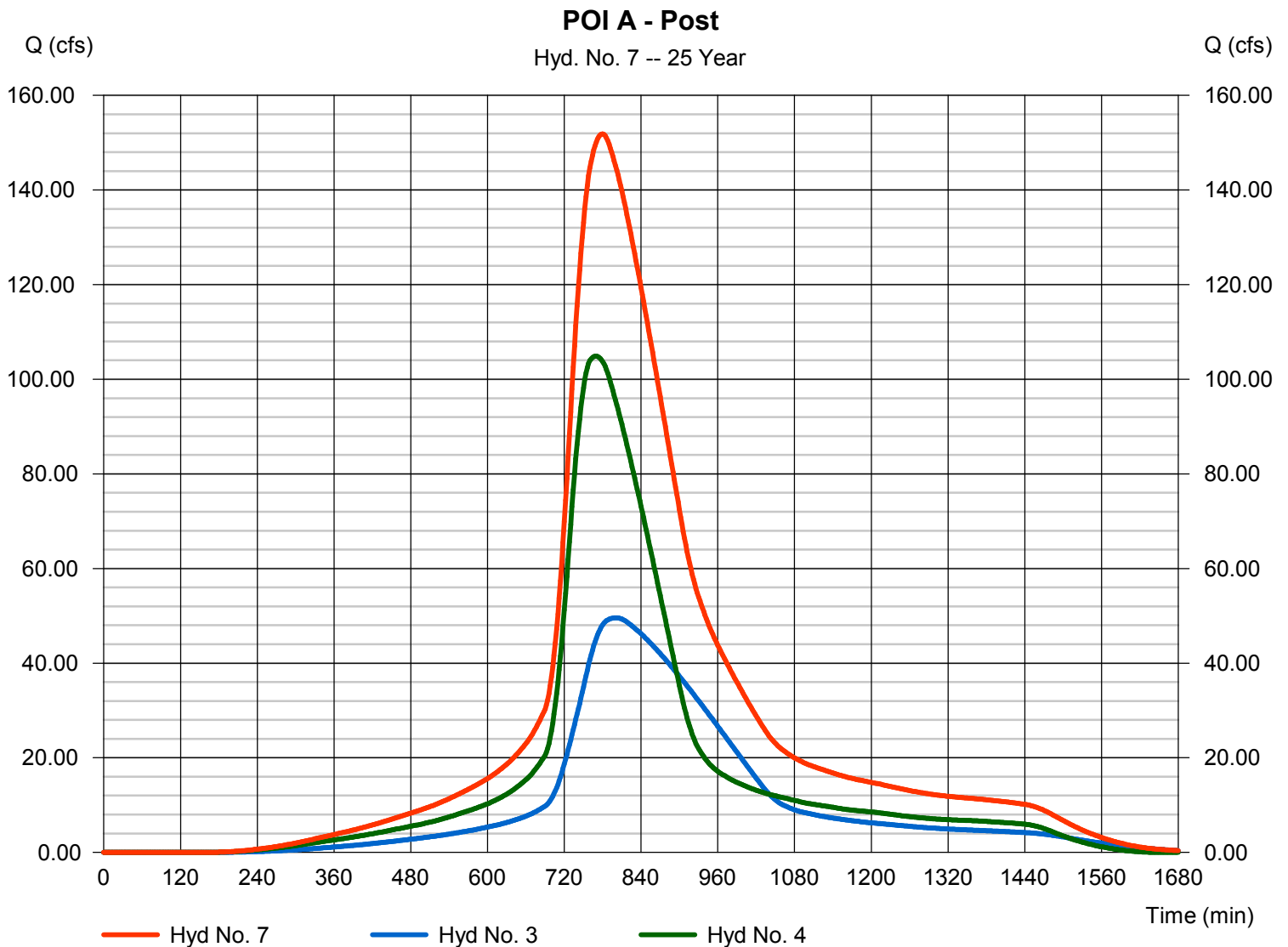
Saturday, 02 / 20 / 2016

Hyd. No. 7

POI A - Post

Hydrograph type = Combine
Storm frequency = 25 yrs
Time interval = 2 min
Inflow hyds. = 3, 4

Peak discharge = 151.85 cfs
Time to peak = 780 min
Hyd. volume = 2,402,437 cuft
Contrib. drain. area = 99.000 ac



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

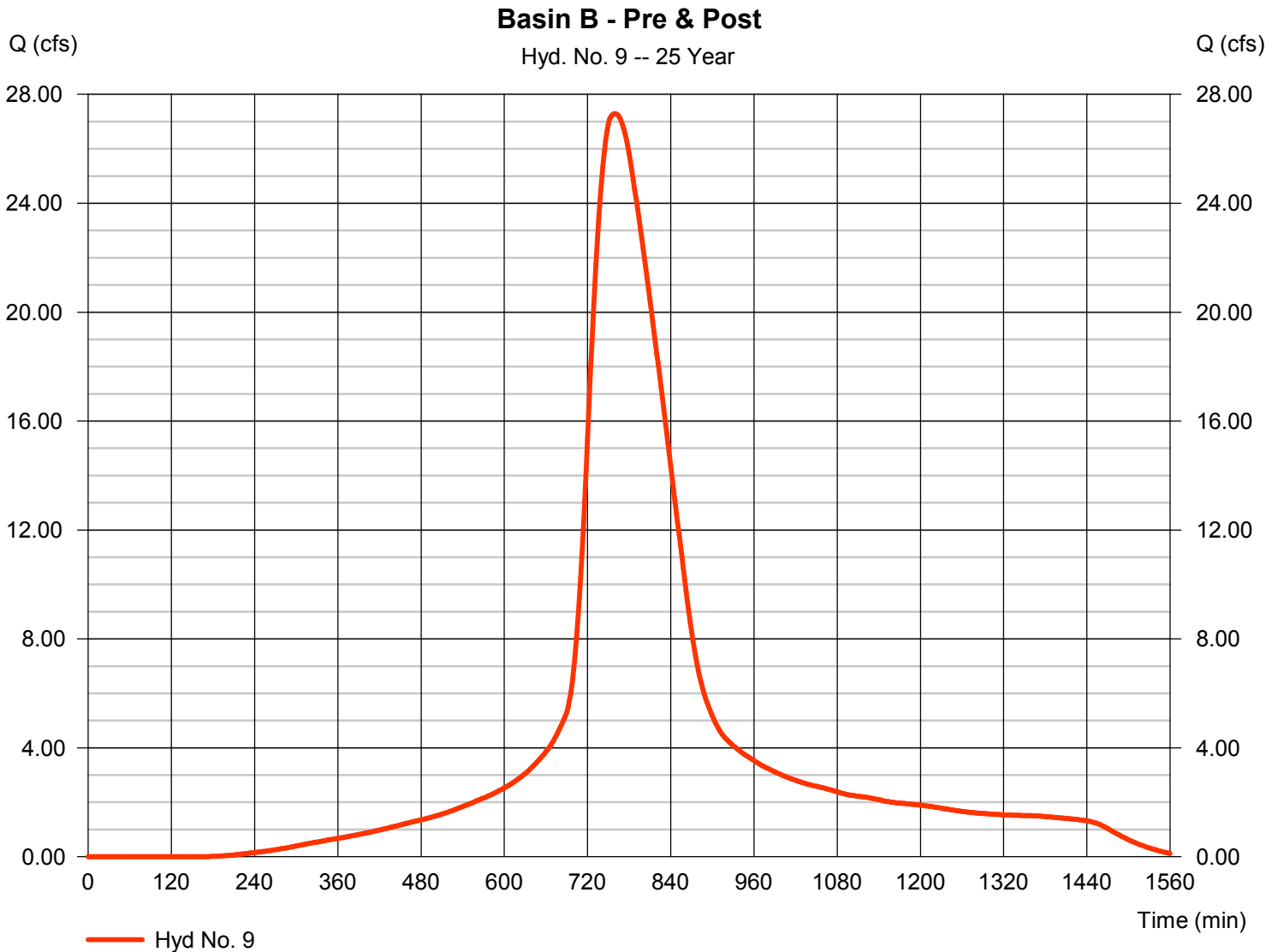
Saturday, 02 / 20 / 2016

Hyd. No. 9

Basin B - Pre & Post

Hydrograph type = SCS Runoff
 Storm frequency = 25 yrs
 Time interval = 2 min
 Drainage area = 13.600 ac
 Basin Slope = 0.0 %
 Tc method = User
 Total precip. = 8.00 in
 Storm duration = 24 hrs

Peak discharge = 27.30 cfs
 Time to peak = 760 min
 Hyd. volume = 331,237 cuft
 Curve number = 89
 Hydraulic length = 0 ft
 Time of conc. (Tc) = 54.25 min
 Distribution = Type II FL
 Shape factor = 256



Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	76.51	2	782	1,230,911	-----	-----	-----	A-1 Pre
2	SCS Runoff	137.35	2	766	1,854,983	-----	-----	-----	A-2 Pre
3	SCS Runoff	63.67	2	800	1,228,702	-----	-----	-----	A-1 Post
4	SCS Runoff	134.41	2	768	1,881,182	-----	-----	-----	A-2 Post
6	Combine	213.00	2	770	3,085,896	1, 2,	-----	-----	POI A - Pre
7	Combine	194.70	2	780	3,109,882	3, 4,	-----	-----	POI A - Post
9	SCS Runoff	34.96	2	758	428,777	-----	-----	-----	Basin B - Pre & Post
Big Bend Solar.gpw					Return Period: 50 Year			Saturday, 02 / 20 / 2016	

Hydrograph Report

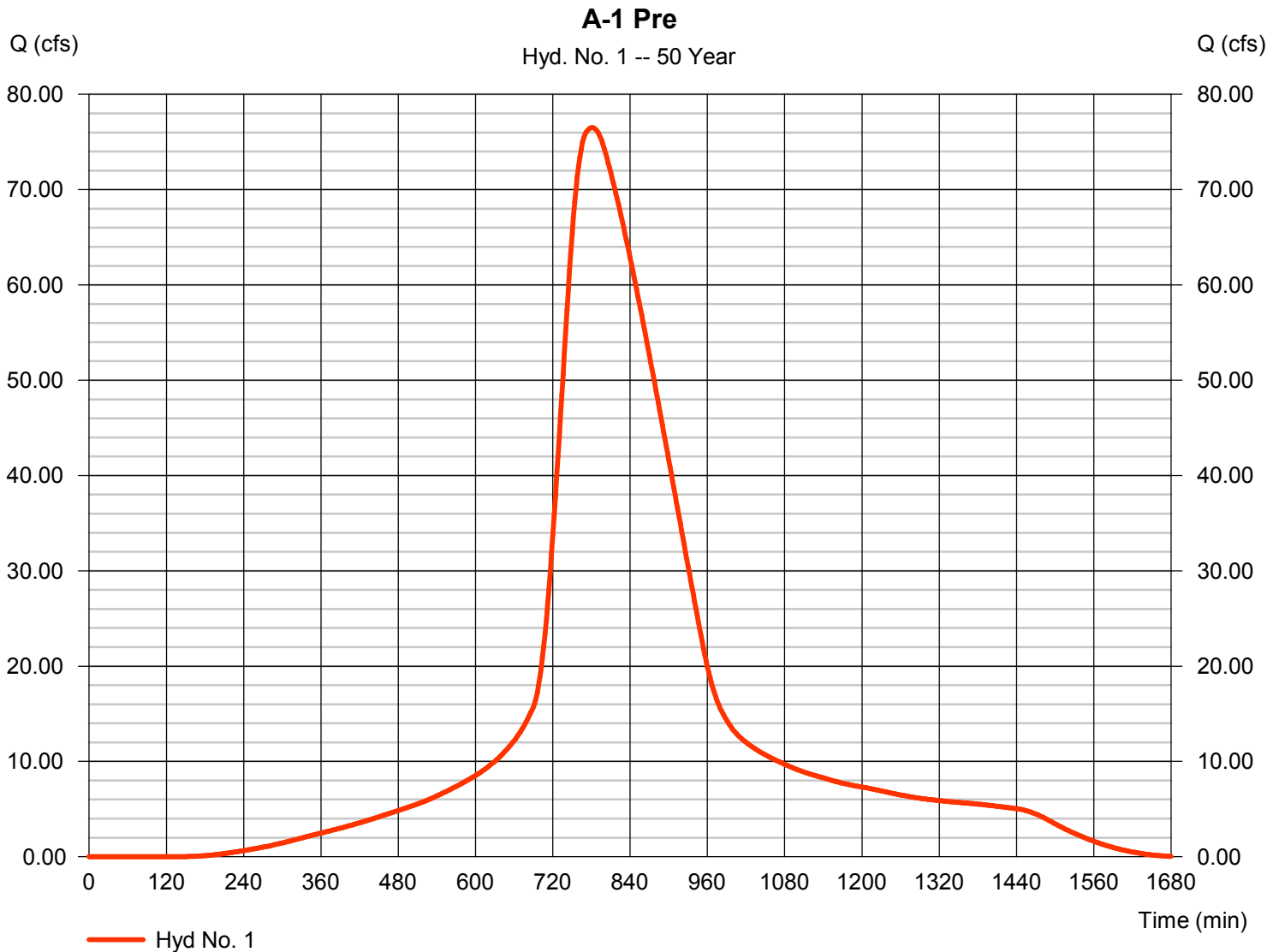
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Saturday, 02 / 20 / 2016

Hyd. No. 1

A-1 Pre

Hydrograph type	= SCS Runoff	Peak discharge	= 76.51 cfs
Storm frequency	= 50 yrs	Time to peak	= 782 min
Time interval	= 2 min	Hyd. volume	= 1,230,911 cuft
Drainage area	= 39.200 ac	Curve number	= 89
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 87.90 min
Total precip.	= 10.00 in	Distribution	= Type II FL
Storm duration	= 24 hrs	Shape factor	= 256



Hydrograph Report

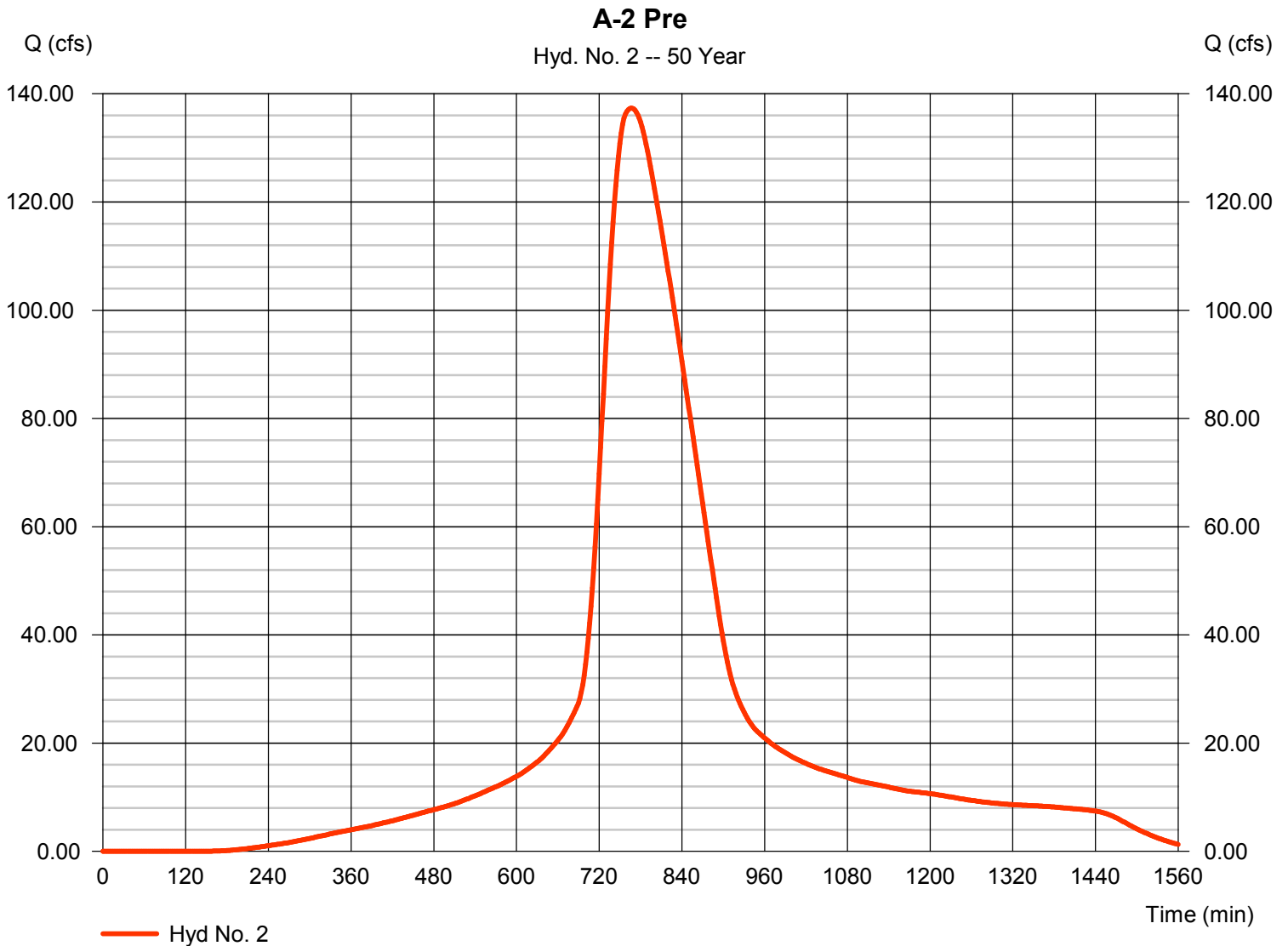
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Saturday, 02 / 20 / 2016

Hyd. No. 2

A-2 Pre

Hydrograph type	= SCS Runoff	Peak discharge	= 137.35 cfs
Storm frequency	= 50 yrs	Time to peak	= 766 min
Time interval	= 2 min	Hyd. volume	= 1,854,983 cuft
Drainage area	= 59.800 ac	Curve number	= 88
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 67.50 min
Total precip.	= 10.00 in	Distribution	= Type II FL
Storm duration	= 24 hrs	Shape factor	= 256



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Saturday, 02 / 20 / 2016

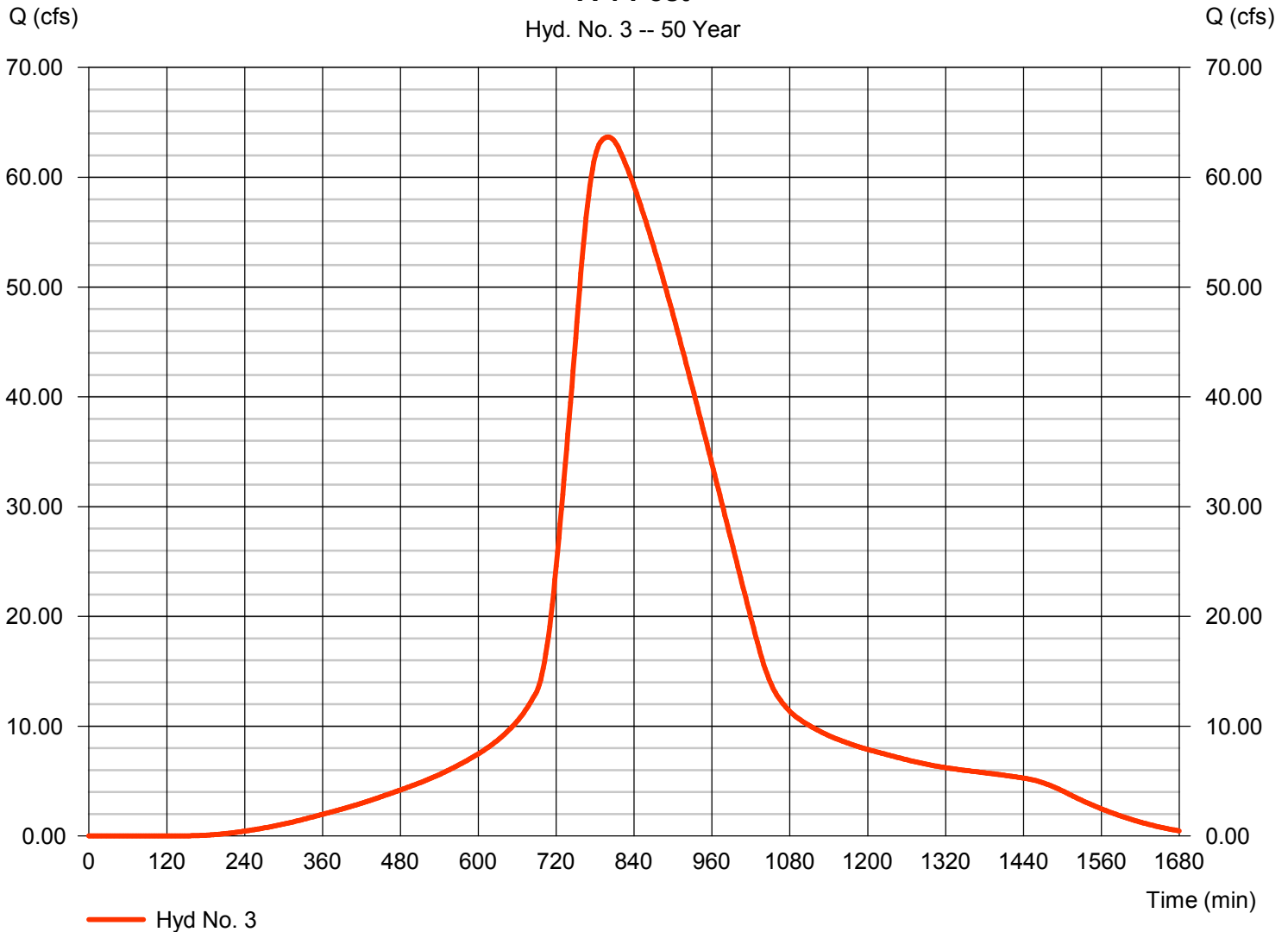
Hyd. No. 3

A-1 Post

Hydrograph type	= SCS Runoff	Peak discharge	= 63.67 cfs
Storm frequency	= 50 yrs	Time to peak	= 800 min
Time interval	= 2 min	Hyd. volume	= 1,228,702 cuft
Drainage area	= 39.200 ac	Curve number	= 89
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 113.00 min
Total precip.	= 10.00 in	Distribution	= Type II FL
Storm duration	= 24 hrs	Shape factor	= 256

A-1 Post

Hyd. No. 3 -- 50 Year



Hydrograph Report

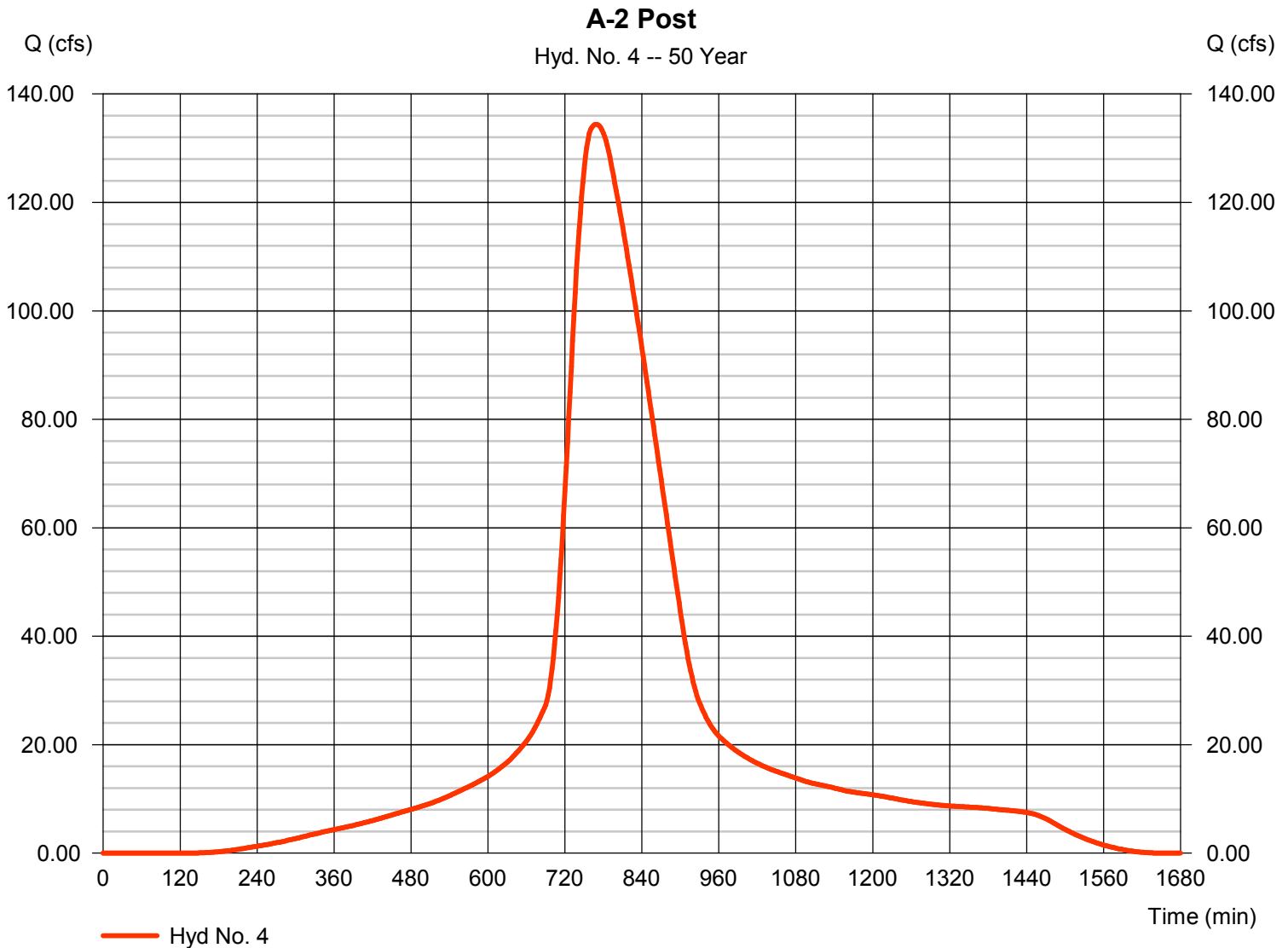
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Saturday, 02 / 20 / 2016

Hyd. No. 4

A-2 Post

Hydrograph type	= SCS Runoff	Peak discharge	= 134.41 cfs
Storm frequency	= 50 yrs	Time to peak	= 768 min
Time interval	= 2 min	Hyd. volume	= 1,881,182 cuft
Drainage area	= 59.800 ac	Curve number	= 89
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 69.30 min
Total precip.	= 10.00 in	Distribution	= Type II FL
Storm duration	= 24 hrs	Shape factor	= 256



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

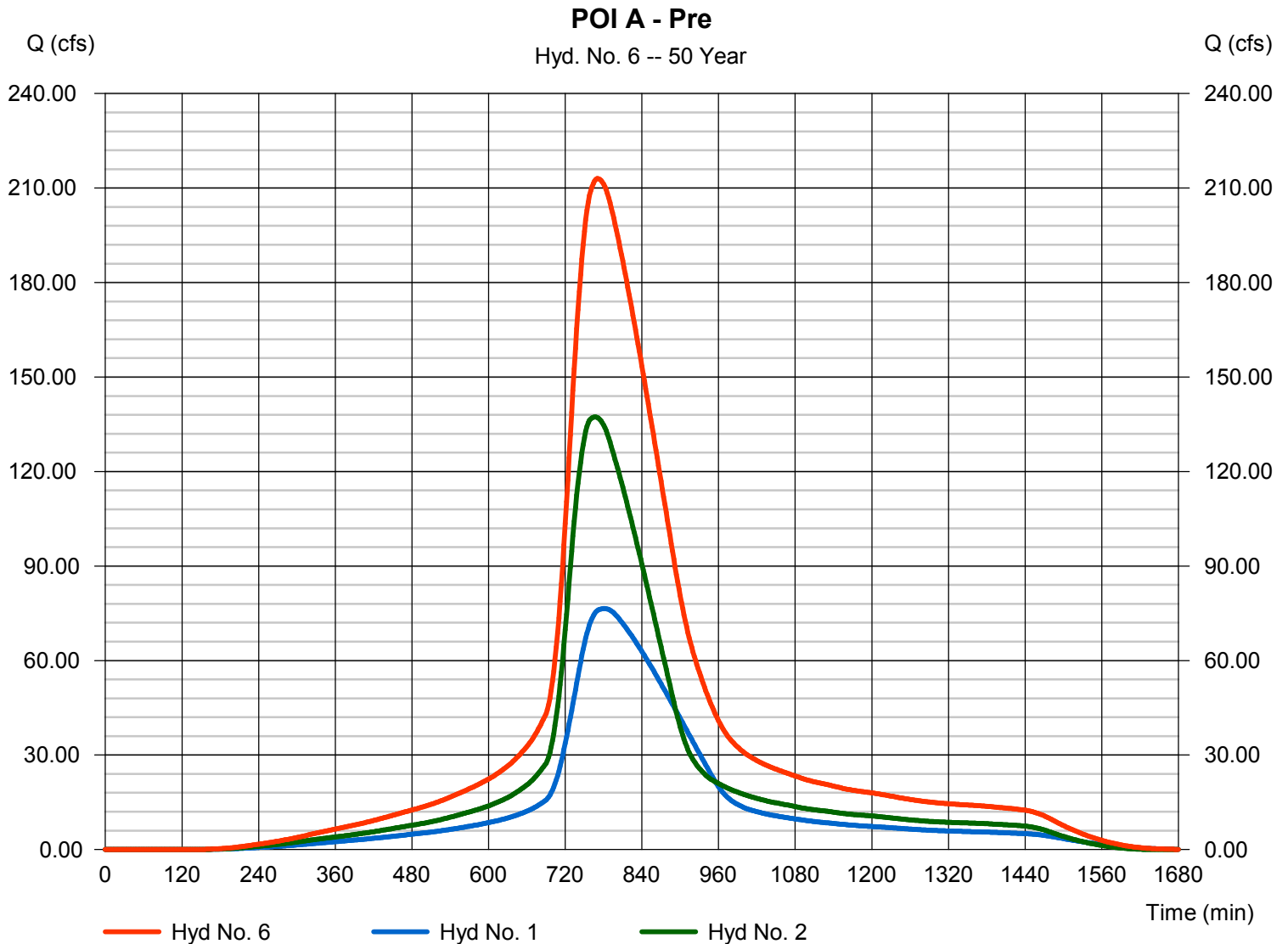
Saturday, 02 / 20 / 2016

Hyd. No. 6

POI A - Pre

Hydrograph type = Combine
 Storm frequency = 50 yrs
 Time interval = 2 min
 Inflow hyds. = 1, 2

Peak discharge = 213.00 cfs
 Time to peak = 770 min
 Hyd. volume = 3,085,896 cuft
 Contrib. drain. area = 99.000 ac



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

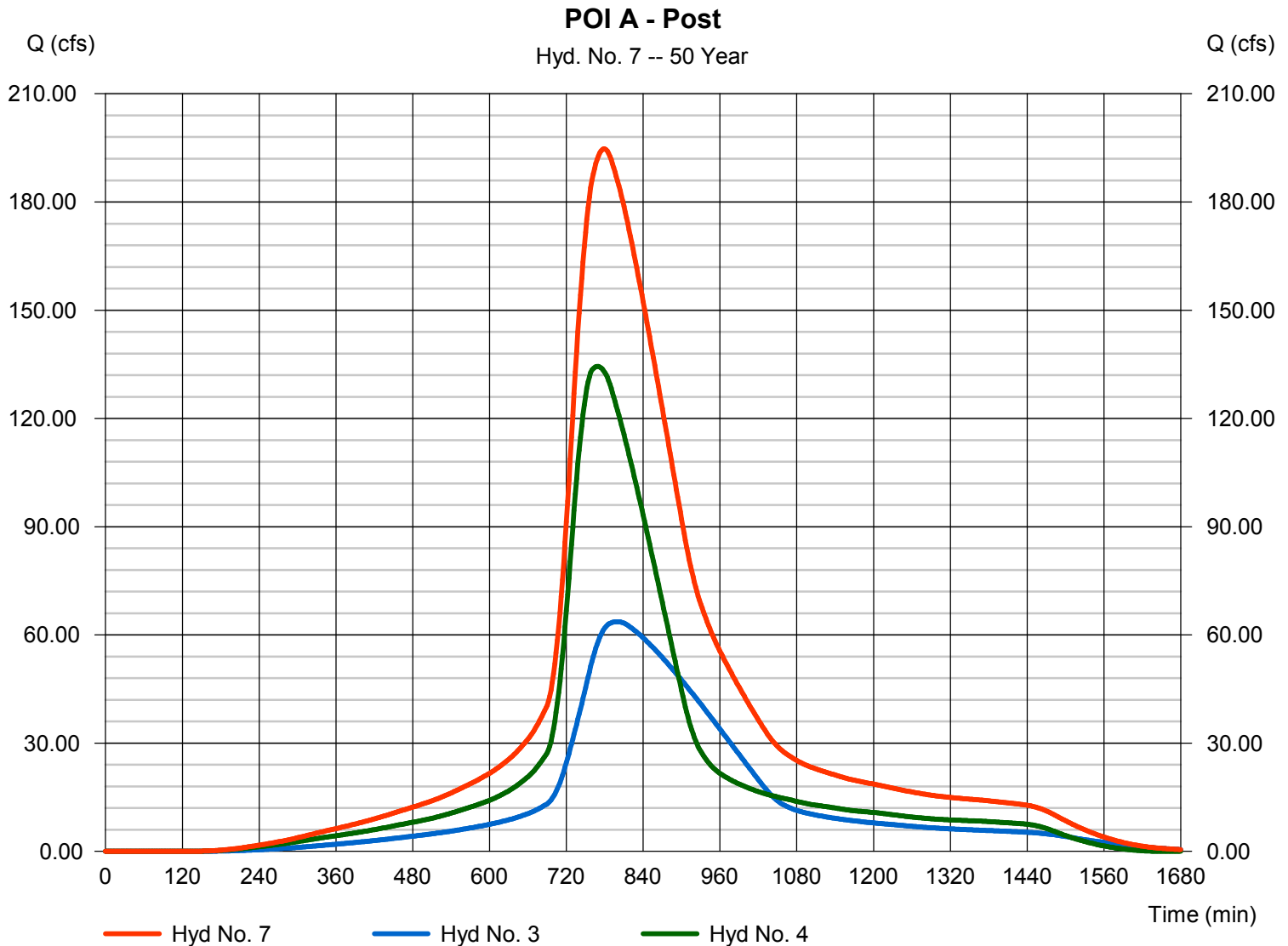
Saturday, 02 / 20 / 2016

Hyd. No. 7

POI A - Post

Hydrograph type = Combine
 Storm frequency = 50 yrs
 Time interval = 2 min
 Inflow hyds. = 3, 4

Peak discharge = 194.70 cfs
 Time to peak = 780 min
 Hyd. volume = 3,109,882 cuft
 Contrib. drain. area = 99.000 ac



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

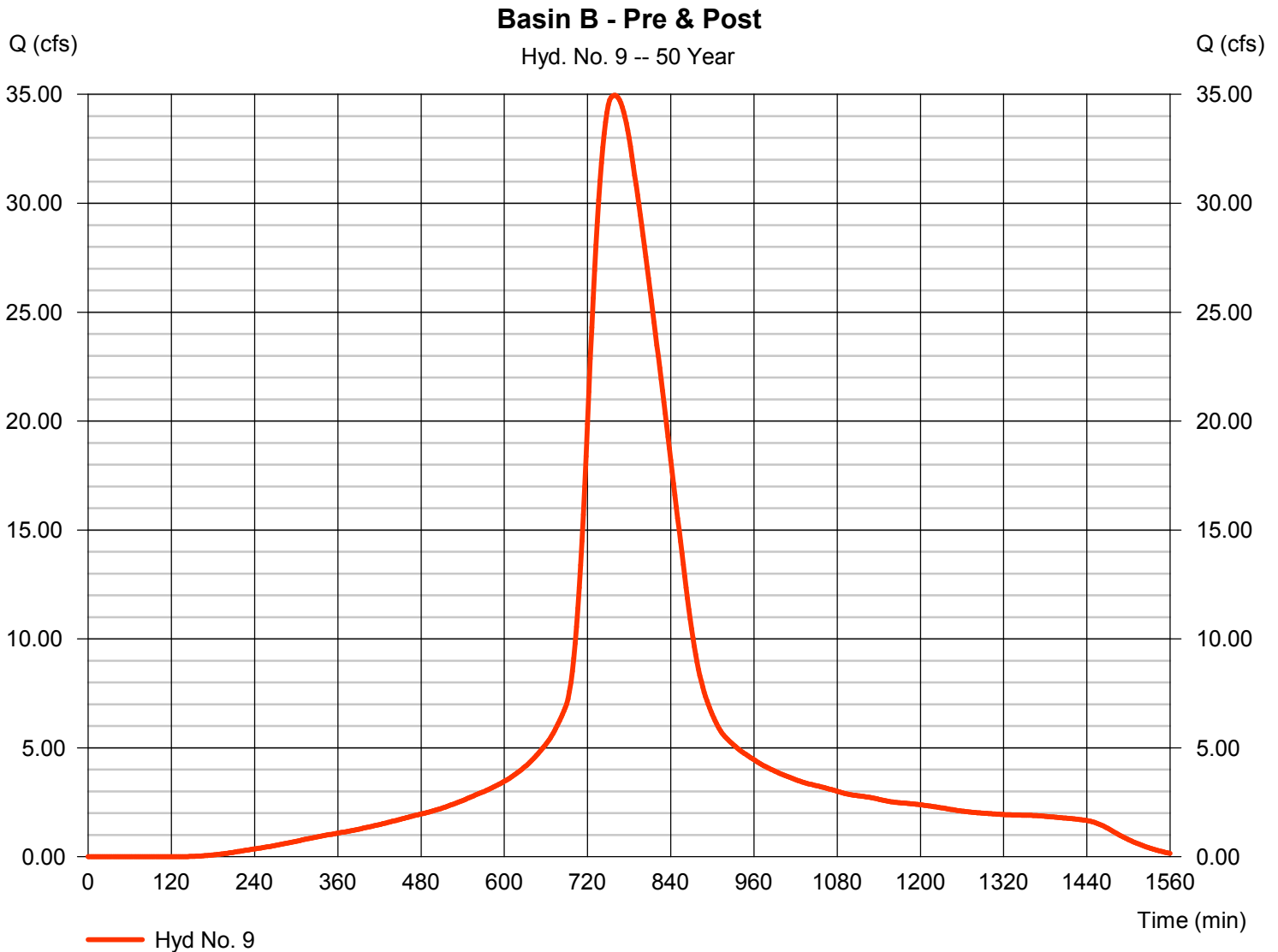
Saturday, 02 / 20 / 2016

Hyd. No. 9

Basin B - Pre & Post

Hydrograph type = SCS Runoff
 Storm frequency = 50 yrs
 Time interval = 2 min
 Drainage area = 13.600 ac
 Basin Slope = 0.0 %
 Tc method = User
 Total precip. = 10.00 in
 Storm duration = 24 hrs

Peak discharge = 34.96 cfs
 Time to peak = 758 min
 Hyd. volume = 428,777 cuft
 Curve number = 89
 Hydraulic length = 0 ft
 Time of conc. (Tc) = 54.25 min
 Distribution = Type II FL
 Shape factor = 256



Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	84.90	2	780	1,371,468	-----	-----	-----	A-1 Pre
2	SCS Runoff	152.56	2	766	2,069,403	-----	-----	-----	A-2 Pre
3	SCS Runoff	70.68	2	800	1,369,006	-----	-----	-----	A-1 Post
4	SCS Runoff	149.11	2	768	2,095,989	-----	-----	-----	A-2 Post
6	Combine	236.51	2	770	3,440,869	1, 2,	-----	-----	POI A - Pre
7	Combine	216.03	2	778	3,464,998	3, 4,	-----	-----	POI A - Post
9	SCS Runoff	38.77	2	758	477,738	-----	-----	-----	Basin B - Pre & Post
Big Bend Solar.gpw					Return Period: 100 Year			Saturday, 02 / 20 / 2016	

Hydrograph Report

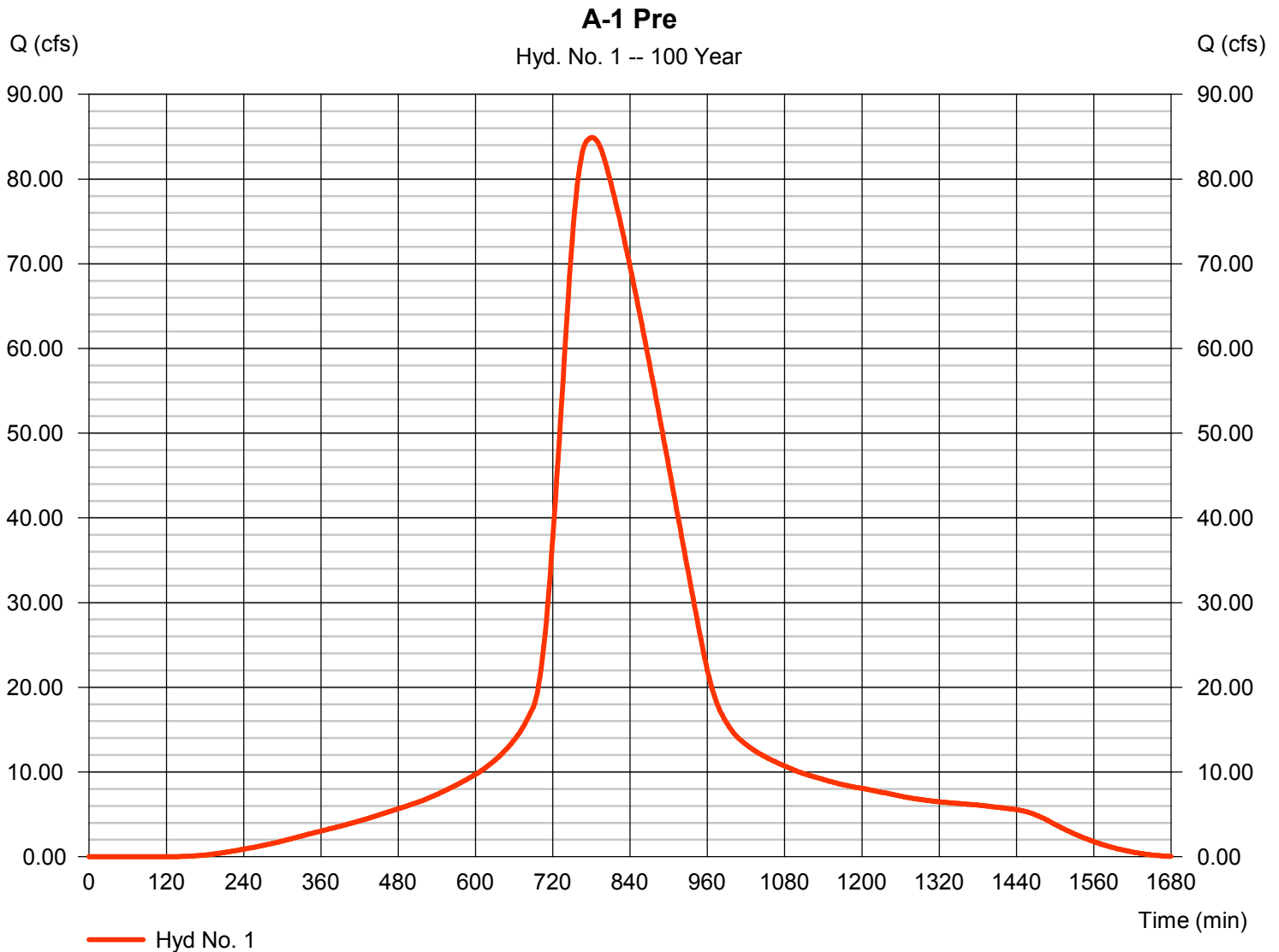
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Saturday, 02 / 20 / 2016

Hyd. No. 1

A-1 Pre

Hydrograph type	= SCS Runoff	Peak discharge	= 84.90 cfs
Storm frequency	= 100 yrs	Time to peak	= 780 min
Time interval	= 2 min	Hyd. volume	= 1,371,468 cuft
Drainage area	= 39.200 ac	Curve number	= 89
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 87.90 min
Total precip.	= 11.00 in	Distribution	= Type II FL
Storm duration	= 24 hrs	Shape factor	= 256



Hydrograph Report

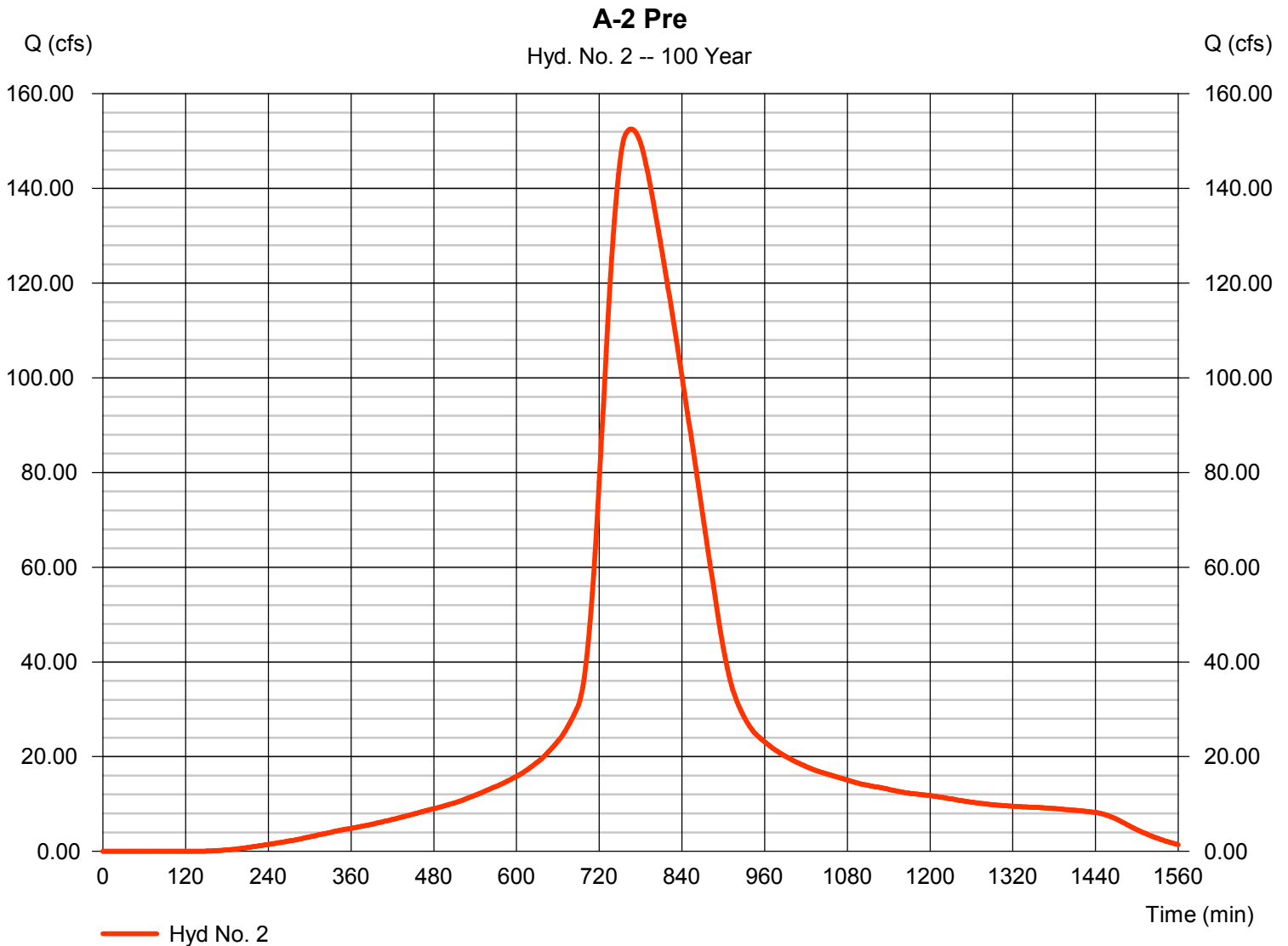
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Saturday, 02 / 20 / 2016

Hyd. No. 2

A-2 Pre

Hydrograph type	= SCS Runoff	Peak discharge	= 152.56 cfs
Storm frequency	= 100 yrs	Time to peak	= 766 min
Time interval	= 2 min	Hyd. volume	= 2,069,403 cuft
Drainage area	= 59.800 ac	Curve number	= 88
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 67.50 min
Total precip.	= 11.00 in	Distribution	= Type II FL
Storm duration	= 24 hrs	Shape factor	= 256



Hydrograph Report

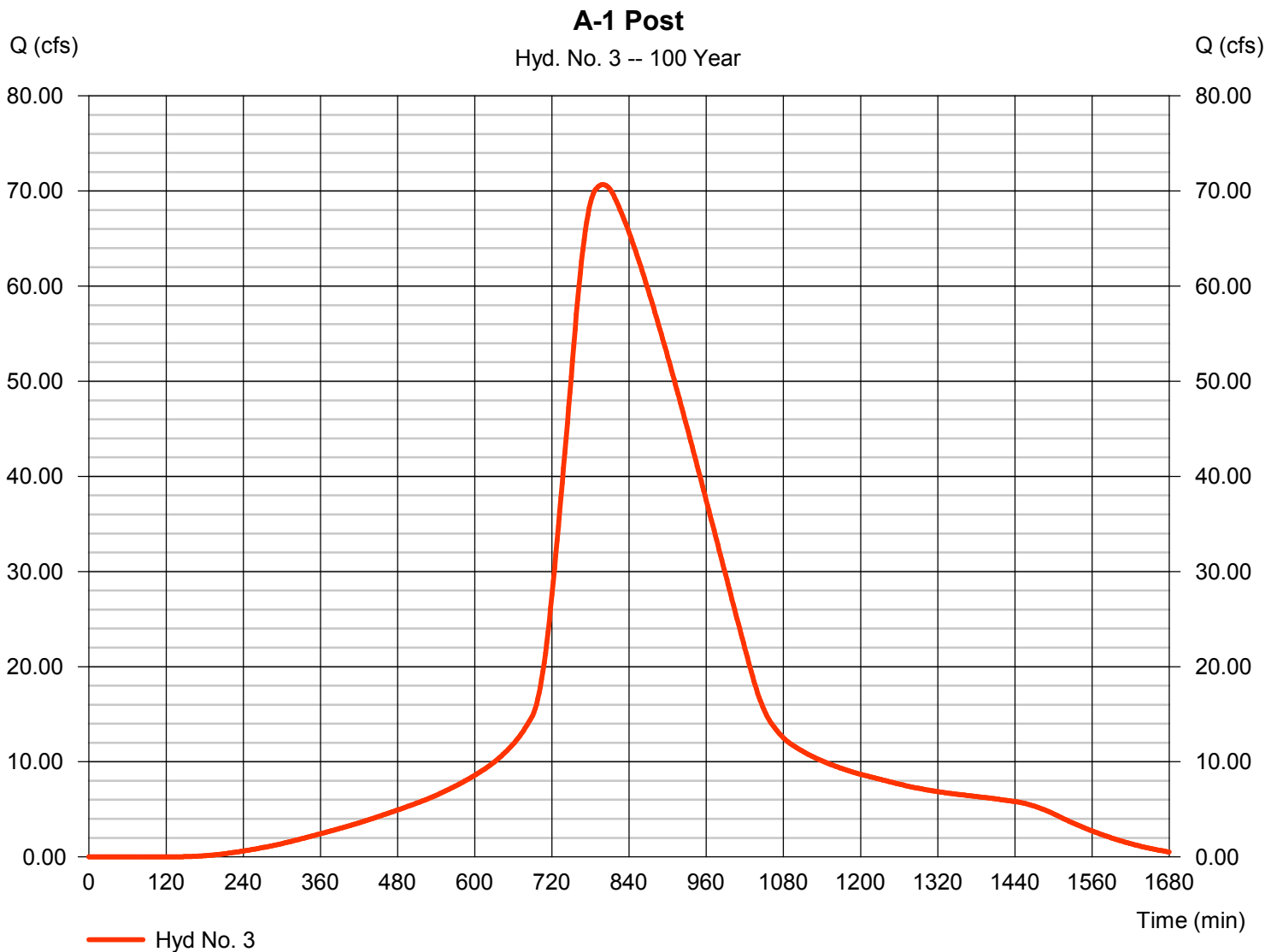
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Saturday, 02 / 20 / 2016

Hyd. No. 3

A-1 Post

Hydrograph type	= SCS Runoff	Peak discharge	= 70.68 cfs
Storm frequency	= 100 yrs	Time to peak	= 800 min
Time interval	= 2 min	Hyd. volume	= 1,369,006 cuft
Drainage area	= 39.200 ac	Curve number	= 89
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 113.00 min
Total precip.	= 11.00 in	Distribution	= Type II FL
Storm duration	= 24 hrs	Shape factor	= 256



Hydrograph Report

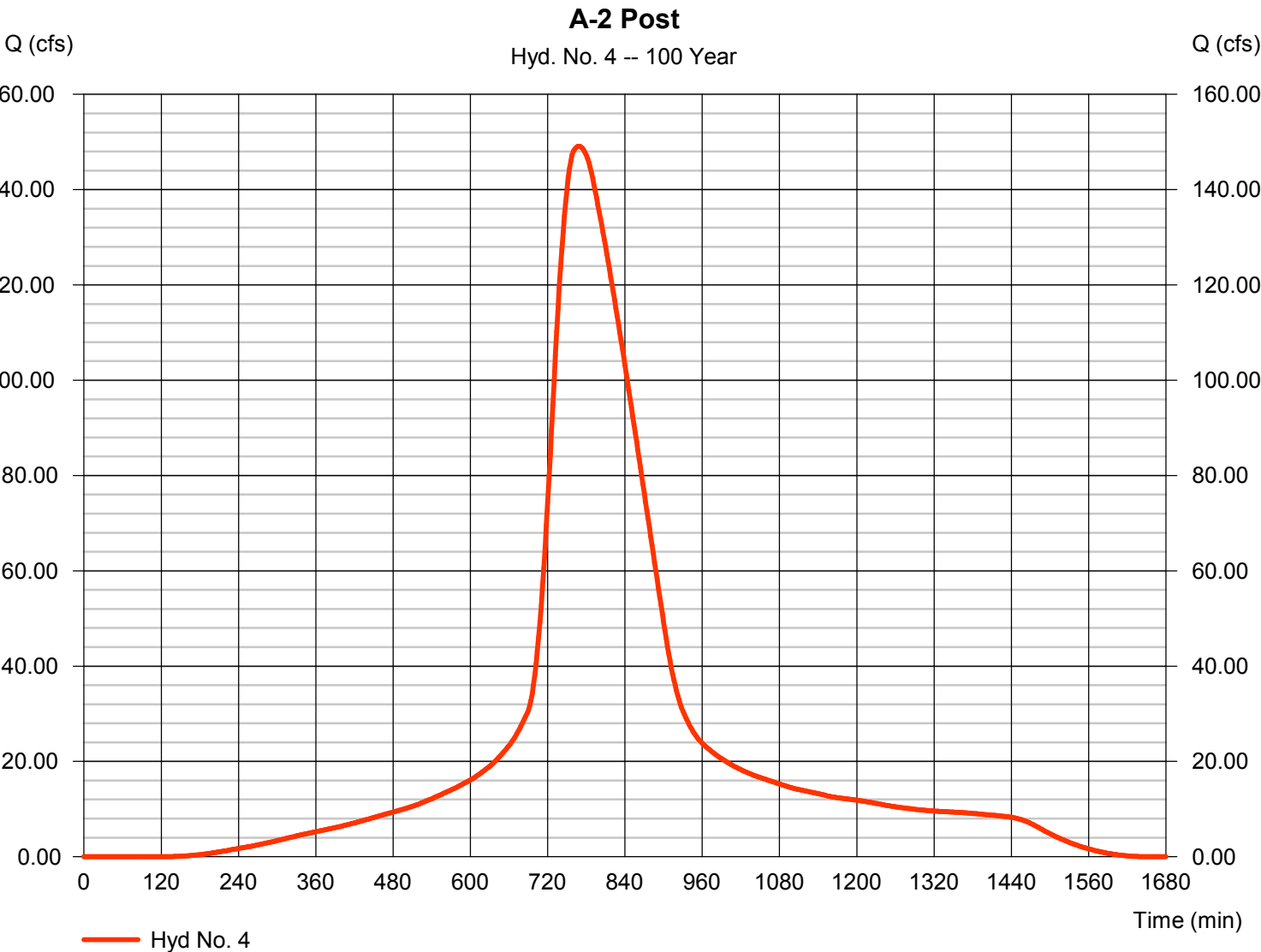
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Saturday, 02 / 20 / 2016

Hyd. No. 4

A-2 Post

Hydrograph type	= SCS Runoff	Peak discharge	= 149.11 cfs
Storm frequency	= 100 yrs	Time to peak	= 768 min
Time interval	= 2 min	Hyd. volume	= 2,095,989 cuft
Drainage area	= 59.800 ac	Curve number	= 89
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 69.30 min
Total precip.	= 11.00 in	Distribution	= Type II FL
Storm duration	= 24 hrs	Shape factor	= 256



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

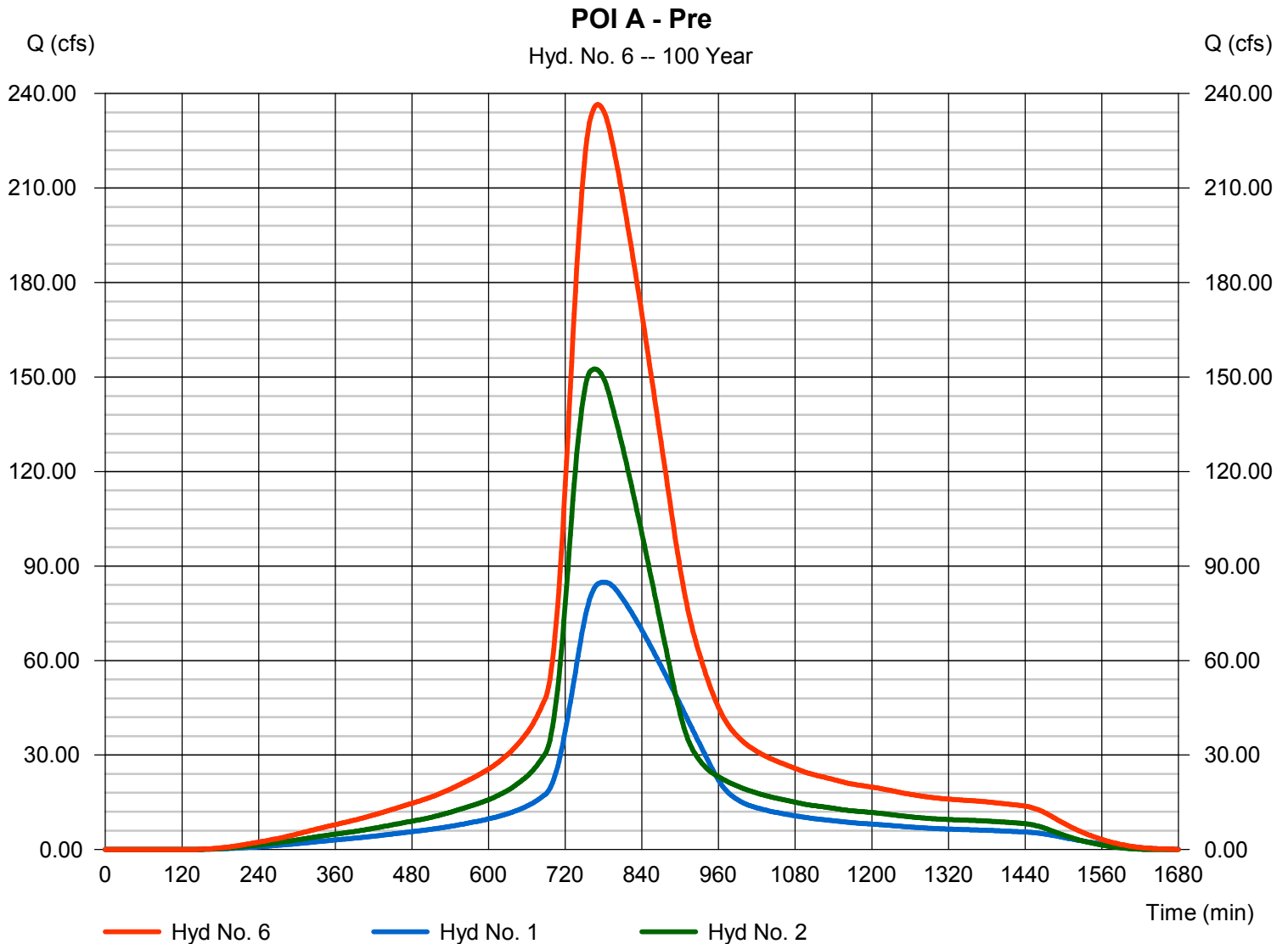
Saturday, 02 / 20 / 2016

Hyd. No. 6

POI A - Pre

Hydrograph type = Combine
 Storm frequency = 100 yrs
 Time interval = 2 min
 Inflow hyds. = 1, 2

Peak discharge = 236.51 cfs
 Time to peak = 770 min
 Hyd. volume = 3,440,869 cuft
 Contrib. drain. area = 99.000 ac



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

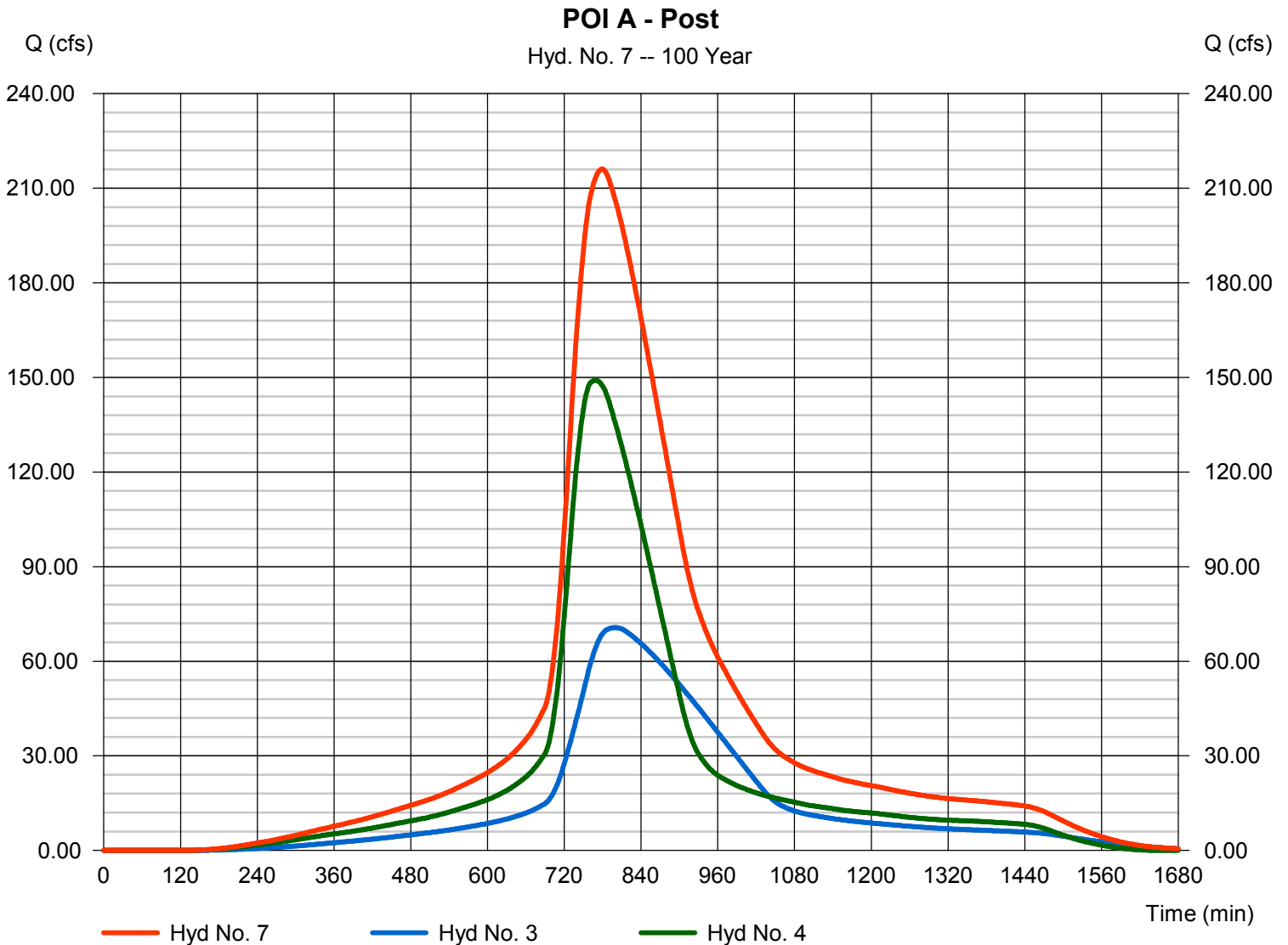
Saturday, 02 / 20 / 2016

Hyd. No. 7

POI A - Post

Hydrograph type = Combine
 Storm frequency = 100 yrs
 Time interval = 2 min
 Inflow hyds. = 3, 4

Peak discharge = 216.03 cfs
 Time to peak = 778 min
 Hyd. volume = 3,464,998 cuft
 Contrib. drain. area = 99.000 ac



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

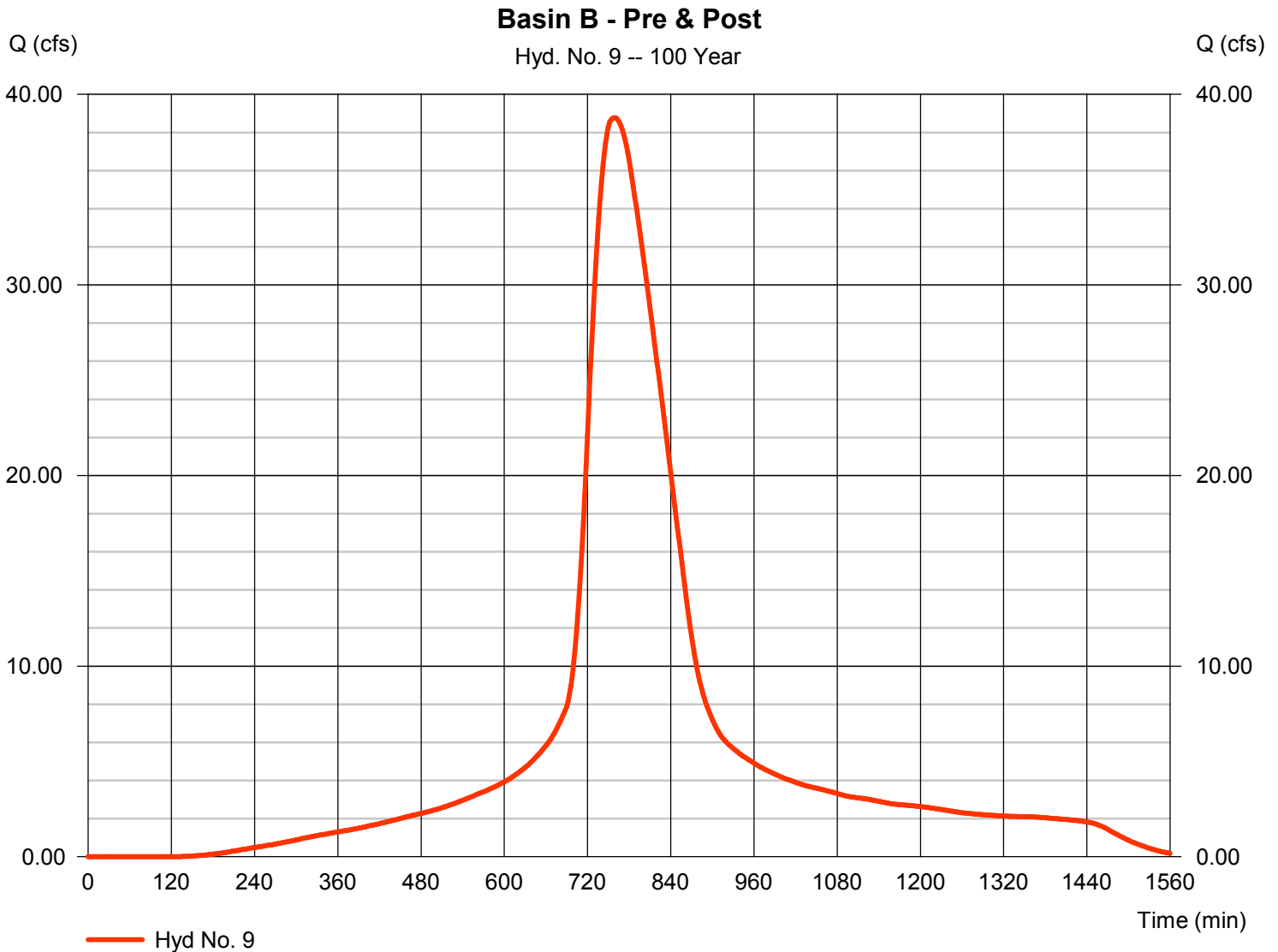
Saturday, 02 / 20 / 2016

Hyd. No. 9

Basin B - Pre & Post

Hydrograph type = SCS Runoff
 Storm frequency = 100 yrs
 Time interval = 2 min
 Drainage area = 13.600 ac
 Basin Slope = 0.0 %
 Tc method = User
 Total precip. = 11.00 in
 Storm duration = 24 hrs

Peak discharge = 38.77 cfs
 Time to peak = 758 min
 Hyd. volume = 477,738 cuft
 Curve number = 89
 Hydraulic length = 0 ft
 Time of conc. (Tc) = 54.25 min
 Distribution = Type II FL
 Shape factor = 256



Precip. file name: C:\Hydro\Hillsborough County FL SCS 24 hr.pcp

APPENDIX G – GRASSED SWALE DESIGN WORKSHEETS

Design Worksheet Grassed Swale Design

Project Name: **Teco Big Bend Solar**
Basin: **Entrance Grassed Swale #1**

Basin Information: Drainage Disturbed Area: **2000** Sq. Ft. 0.05 Ac.
 Impervious Area: **2000** Sq. Ft. 0.05 Ac.
 Percent Impervious: 100.00 %

WQ Volume Required: $WQ_v = [P \cdot R_v \cdot A] / 12$ Where: $P = 0.5$ inches
WQ_v = 79.2 CF

Water Quality Peak Flow: $Q_{wv} = P(0.05 + 0.009 \cdot \%Imp)$
 $Q_{wv} = 0.475$ inches

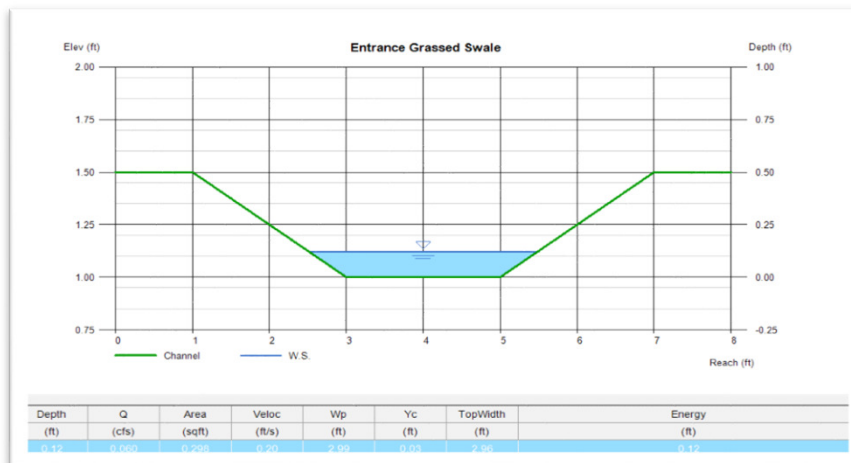
$CN = 1000 / [10 + 5P + 10Q - 10(Q^2 + 1.25 \cdot Q \cdot P)^{0.5}]$
CN = 100

From Table 4-1, TR-55 Where: $T_c = 5$ min. See attached
 $I_a = 0.040$ in. 0.083 hr.
 $I_a/P = 0.080$ If $I_a/P < 0.1$ use $I_a/P = 0.1$
 If $I_a/P > 0.5$ use $I_a/P = 0.5$

From Fig. 4-II, TR-55
 $q_u = 1000$ csm/in.

$Q_{wq} = q_u \cdot (X_{ac} / 640 \text{ ac/mi}^2) \cdot WQ_v$
0.03 cfs

Channel Design: Characteristics: $n = 0.077$ Bermuda Grass
 (See attached worksheet) $S = 0.0026$ ft/ft
 $D = 0.08$ ft
 $V = 0.16$ ft/sec
 $WP = 2.66$ ft
 $A = 0.11$ sf



Design Worksheet Grassed Swale Design

Project Name: **Teco Big Bend Solar**
 Basin: **Entrance Grassed Swale #1 (Continued)**

Swale Stage / Storage	Elevation	Area	
	5	392	Assumed Datum - BTM Swale Elev. 5
	5.5	1200	

					Inc.	
Stage	Elevation	Inc. Area	Storage	Total Storage		
0	5	392	0	0		
0.05	5.05	472.8	21.62	21.62		
0.1	5.1	553.6	25.66	47.28		
0.15	5.15	634.4	29.7	76.98		
0.2	5.2	715.2	33.74	110.72		
0.25	5.25	796	37.78	148.5		
0.3	5.3	876.8	41.82	190.32		
0.35	5.35	957.6	45.86	236.18		
0.4	5.4	1038.4	49.9	286.08		
0.45	5.45	1119.2	53.94	340.02		
0.5	5.5	1200	57.98	398		

h_v = Stage 1
 Treatment Vol.
 h_v = 0.15

Design Infiltration:

$$I_d = K_{vu} / FS$$

Where: I_d = Design Infiltration rate (ft/hr)
 K_{vu} = Unsaturated vertical hydraulic conductivity (ft/hr) = $2/3 K_{vs}$
 K_{vs} = Saturated vertical hydraulic conductivity (ft/hr)
 FS = Factor of Safety (2)

$K_{vs} = 2$ in/hr
 $K_{vu} = 1.33$ in/hr
 $K_{vu} = 0.11$ ft/hr
 $I_d = 0.06$ ft/hr

Unsaturated Vertical Flow Analysis:

$V_u = A_b * f * h_b$
 $A_b = WP * \text{Swale Length}$
 $A_b = 266$ sf
 $h_b = 1$ ft
 $V_u = 79.8$ cf

Where: V_u = Volume of water required to saturate the soil below grade, cf
 A_b = Infiltration Area, sf
 h_b = Height of swale above water table, ft
 f = Fillable porosity (0.3)

$h_u = f * h_b$
 $f = 0.3$
 $h_b = 1$
 $h_u = 0.3$

Where: h_u = Height of water to saturate soil
 f = Fillable porosity (0.3)
 h_b = Height of swale above water table, ft

$$V_u > WQv \quad \text{or} \quad h_u > h_v$$

therefore infiltration will occur entirely under vertical unsaturated flow conditions

Recovery Time:

$$t_{sat} = (f * h_b) / I_d$$

$t_{sat} = 5.40$ hours

Design Worksheet Grassed Swale Design

Project Name: **Teco Big Bend Solar**
Basin: **Entrance Grassed Swale #2**

Basin Information: Drainage Disturbed Area: **2000** Sq. Ft. 0.05 Ac.
 Impervious Area: **1500** Sq. Ft. 0.03 Ac.
 Percent Impervious: 75.00 %

WQ Volume Required: $WQ_v = [P \cdot R_v \cdot A] / 12$ Where: $P = 0.5$ inches
WQ_v = 60.4 CF

Water Quality Peak Flow: $Q_{wv} = P(0.05 + 0.009 \cdot \%Imp)$
 $Q_{wv} = 0.363$ inches

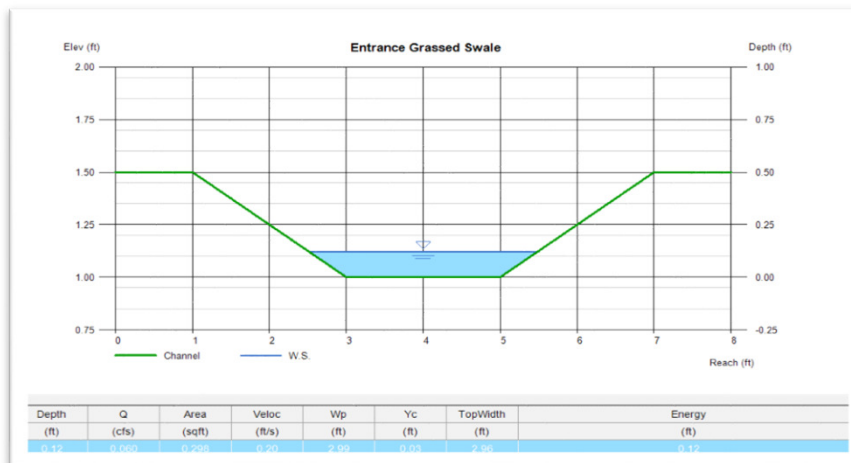
$CN = 1000 / [10 + 5P + 10Q - 10(Q^2 + 1.25 \cdot Q \cdot P)^{0.5}]$
CN = 99

From Table 4-1, TR-55 Where: $T_c = 5$ min. See attached
 $I_a = 0.040$ in. 0.083 hr.
 $I_a/P = 0.080$ If $I_a/P < 0.1$ use $I_a/P = 0.1$
 If $I_a/P > 0.5$ use $I_a/P = 0.5$

From Fig. 4-II, TR-55
 $q_u = 1000$ csm/in.

$Q_{wq} = q_u \cdot (X_{ac} / 640 \text{ ac/mi}^2) \cdot WQ_v$
0.03 cfs

Channel Design: Characteristics: $n = 0.077$ Bermuda Grass
 (See attached worksheet) $S = 0.0026$ ft/ft
 $D = 0.08$ ft
 $V = 0.16$ ft/sec
 $WP = 2.66$ ft
 $A = 0.11$ sf



Design Worksheet Grassed Swale Design

Project Name: **Teco Big Bend Solar**
 Basin: **Entrance Grassed Swale #2 (Continued)**

Swale Stage / Storage	Elevation	Area	
	5	392	Assumed Datum - BTM Swale Elev. 5
	5.5	1200	

			Inc.		
	Stage	Elevation	Inc. Area	Storage	Total Storage
	0	5	392	0	0
	0.05	5.05	472.8	21.62	21.62
	0.1	5.1	553.6	25.66	47.28
	0.15	5.15	634.4	29.7	76.98
	0.2	5.2	715.2	33.74	110.72
	0.25	5.25	796	37.78	148.5
	0.3	5.3	876.8	41.82	190.32
	0.35	5.35	957.6	45.86	236.18
	0.4	5.4	1038.4	49.9	286.08
	0.45	5.45	1119.2	53.94	340.02
	0.5	5.5	1200	57.98	398

h_v = Stage 1
 Treatment Vol.
 h_v = 0.12

Design Infiltration:

$$I_d = K_{vu} / FS$$

Where: I_d = Design Infiltration rate (ft/hr)
 K_{vu} = Unsaturated vertical hydraulic conductivity (ft/hr) = $2/3 K_{vs}$
 K_{vs} = Saturated vertical hydraulic conductivity (ft/hr)
 FS = Factor of Safety (2)

K_{vs} = 2 in/hr
 K_{vu} = 1.33 in/hr
 K_{vu} = 0.11 ft/hr
 I_d = 0.06 ft/hr

Unsaturated Vertical Flow Analysis:

$V_u = A_b * f * h_b$
 A_b = WP * Swale Length
 A_b = 266 sf
 h_b = 1 ft
 V_u = 79.8 cf

Where: V_u = Volume of water required to saturate the soil below grade, cf
 A_b = Infiltration Area, sf
 h_b = Height of swale above water table, ft
 f = Fillable porosity (0.3)

$h_u = f * h_b$
 f = 0.3
 h_b = 1
 h_u = 0.3

Where: h_u = Height of water to saturate soil
 f = Fillable porosity (0.3)
 h_b = Height of swale above water table, ft

$$V_u > WQ_v \quad \text{or} \quad h_u > h_v$$

therefore infiltration will occur entirely under vertical unsaturated flow conditions

Recovery Time:

$$t_{sat} = (f * h_b) / I_d$$

t_{sat} = 5.40 hours

Design Worksheet Grassed Swale Design

Project Name: **Teco Big Bend Solar**
Basin: **Roadway Grassed Swale**

Basin Information: Drainage Disturbed Area: **3200** Sq. Ft. 0.07 Ac. 200-ft section of road
 Impervious Area: **1500** Sq. Ft. 0.03 Ac. 7.5 feet gravel road x 200 ft
 Percent Impervious: 46.88 % length

WQ Volume Required: $WQ_v = [P \cdot R_v \cdot A] / 12$ Where: P = 0.5 inches
 WQ_v = 62.9 CF

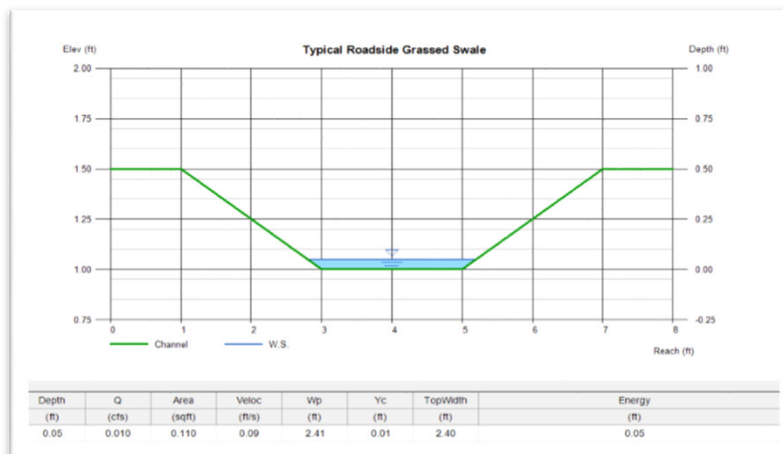
Water Quality Peak Flow: $Q_{wv} = P(0.05 + 0.009 \cdot \%Imp)$
 $Q_{wv} = 0.236$ inches
 $CN = 1000 / [10 + 5P + 10Q - 10(Q^2 + 1.25 \cdot Q \cdot P)^{0.5}]$
 CN = 97

From Table 4-1, TR-55 Where: T_c = 5 min. See attached
 I_a = **0.040** in. 0.083 hr.
 I_a/P = 0.080 If I_a/P < 0.1 use I_a/P = 0.1
 If I_a/P > 0.5 use I_a/P = 0.5

From Fig. 4-II, TR-55
 q_u = **1000** csm/in.

$Q_{wq} = q_u \cdot (X_{ac} / 640 \text{ ac/mi}^2) \cdot WQ_v$
 0.03 cfs

Channel Design: Characteristics: n = **0.077** Bermuda Grass
 (See attached worksheet) S = **0.0026** ft/ft
 D = **0.08** ft
 V = **0.16** ft/sec
 WP = **2.66** ft
 A = **0.11** sf



Design Worksheet Grassed Swale Design

Project Name: **Teco Big Bend Solar**
 Basin: **Roadway Grassed Swale (Continued)**

Swale Stage / Storage	Elevation	Area	
	5	392	Assumed Datum - BTM Swale Elev. 5
	5.5	1200	

					Inc.	
Stage	Elevation	Inc. Area	Storage	Total Storage		
0	5	392	0	0		
0.05	5.05	472.8	21.62	21.62		
0.1	5.1	553.6	25.66	47.28		
0.15	5.15	634.4	29.7	76.98		
0.2	5.2	715.2	33.74	110.72		
0.25	5.25	796	37.78	148.5		
0.3	5.3	876.8	41.82	190.32		
0.35	5.35	957.6	45.86	236.18		
0.4	5.4	1038.4	49.9	286.08		
0.45	5.45	1119.2	53.94	340.02		
0.5	5.5	1200	57.98	398		

h_v = Stage 1
 Treatment Vol.
 h_v = 0.12

Design Infiltration:

$$I_d = K_{vu} / FS$$

Where: I_d = Design Infiltration rate (ft/hr)
 K_{vu} = Unsaturated vertical hydraulic conductivity (ft/hr) = $2/3 K_{vs}$
 K_{vs} = Saturated vertical hydraulic conductivity (ft/hr)
 FS = Factor of Safety (2)

K_{vs} = 1.2 in/hr
 K_{vu} = 0.80 in/hr
 K_{vu} = 0.07 ft/hr
 I_d = 0.03 ft/hr

Unsaturated Vertical Flow Analysis:

$V_u = A_b * f * h_b$
 A_b = WP * Swale Length
 A_b = 266 sf
 h_b = 1 ft
 V_u = 79.8 cf

Where: V_u = Volume of water required to saturate the soil below grade, cf
 A_b = Infiltration Area, sf
 h_b = Height of swale above water table, ft
 f = Fillable porosity (0.3)

$h_u = f * h_b$
 f = 0.3
 h_b = 1
 h_u = 0.3

Where: h_u = Height of water to saturate soil
 f = Fillable porosity (0.3)
 h_b = Height of swale above water table, ft

$$V_u > WQ_v \quad \text{or} \quad h_u > h_v$$

therefore infiltration will occur entirely under vertical unsaturated flow conditions

Recovery Time:

$$t_{sat} = (f * h_b) / I_d$$

t_{sat} = 9.00 hours

Design Worksheet Grassed Swale Design

Project Name: **Teco Big Bend Solar**
Basin: **Roadway Grassed Swale with underdrain**

Basin Information: Drainage Disturbed Area: **3200** Sq. Ft. 0.07 Ac. 200-ft section of road
 Impervious Area: **1500** Sq. Ft. 0.03 Ac. 7.5 feet gravel road x 200 ft length
 Percent Impervious: 46.88 %

WQ Volume Required: $WQ_v = [P \cdot R_v \cdot A] / 12$ Where: $P = 0.5$ inches
WQv = 62.9 CF

Water Quality Peak Flow: $Q_{wv} = P(0.05 + 0.009 \cdot \%Imp)$
 $Q_{wv} = 0.236$ inches

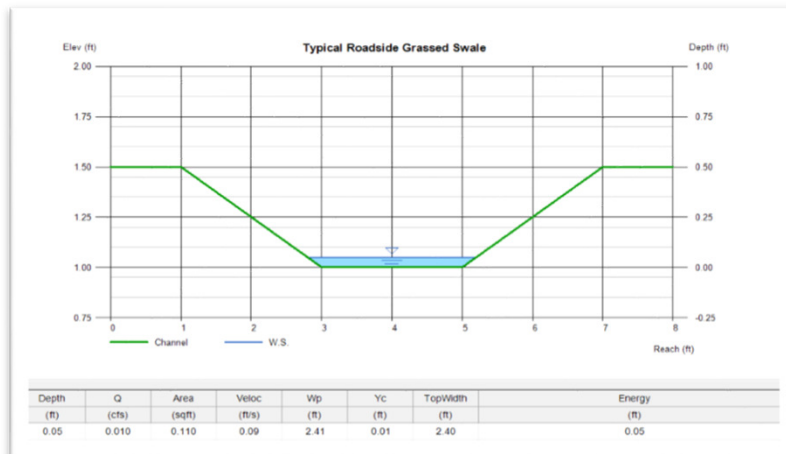
$CN = 1000 / [10 + 5P + 10Q - 10(Q^2 + 1.25 \cdot Q \cdot P)^{0.5}]$
 $CN = 97$

From Table 4-1, TR-55 Where: $T_c = 5$ min. See attached
 $I_a = 0.040$ in. 0.083 hr.
 $I_a/P = 0.080$ If $I_a/P < 0.1$ use $I_a/P = 0.1$
 If $I_a/P > 0.5$ use $I_a/P = 0.5$

From Fig. 4-II, TR-55
 $q_u = 1000$ csm/in.

$Q_{wq} = q_u \cdot (X_{ac} / 640 \text{ ac/mi}^2) \cdot WQ_v$
 0.03 cfs

Channel Design: Characteristics: $n = 0.077$ Bermuda Grass
 (See attached worksheet) $S = 0.0026$ ft/ft
 $D = 0.08$ ft
 $V = 0.16$ ft/sec
 $WP = 2.66$ ft
 $A = 0.11$ sf



Design Worksheet Grassed Swale Design

Project Name: **Teco Big Bend Solar**
 Basin: **Roadway Grassed Swale with underdrain (Continued)**

Swale Stage / Storage	Elevation	Area	
	5	392	Assumed Datum - BTM Swale Elev. 5
	5.5	1200	

			Inc.		
	Stage	Elevation	Inc. Area	Storage	Total Storage
	0	5	392	0	0
	0.05	5.05	472.8	21.62	21.62
	0.1	5.1	553.6	25.66	47.28
	0.15	5.15	634.4	29.7	76.98
	0.2	5.2	715.2	33.74	110.72
	0.25	5.25	796	37.78	148.5
	0.3	5.3	876.8	41.82	190.32
	0.35	5.35	957.6	45.86	236.18
	0.4	5.4	1038.4	49.9	286.08
	0.45	5.45	1119.2	53.94	340.02
	0.5	5.5	1200	57.98	398

h_v = Stage 1
 Treatment Vol.
 h_v = 0.12

Design Infiltration:

$$I_d = K_{vu} / FS$$

Where: I_d = Design Infiltration rate (ft/hr)
 K_{vu} = Unsaturated vertical hydraulic conductivity (ft/hr) = $2/3 K_{vs}$
 K_{vs} = Saturated vertical hydraulic conductivity (ft/hr)
 FS = Factor of Safety (2)

K_{vs} = 0.8 in/hr
 K_{vu} = 0.53 in/hr
 K_{vu} = 0.04 ft/hr
 I_d = 0.02 ft/hr

Unsaturated Vertical Flow Analysis:

$V_u = A_b * f * h_b$
 A_b = WP * Swale Length
 A_b = 266 sf
 h_b = 0.5 ft
 V_u = 39.9 cf

Where: V_u = Volume of water required to saturate the soil below grade, cf
 A_b = Infiltration Area, sf
 h_b = Height of swale above water table, ft
 f = Fillable porosity (0.3)

$h_u = f * h_b$
 f = 0.3
 h_b = 0.5
 h_u = 0.15

Where: h_u = Height of water to saturate soil
 f = Fillable porosity (0.3)
 h_b = Height of swale above water table, ft

$V_u < WQ_v$ or $h_u > h_v$
 therefore underdrain system provided (see next sheet)

Design Worksheet Grassed Swale Design

Project Name: **Teco Big Bend Solar**
 Basin: **Roadway Grassed Swale with underdrain (Continued)**

Treatment Volume Elev.= 5.00 ft
 Underdrain Elev.= 2.42 ft
 r= 0.50 ft
 d= 3.08 ft
 D= 6.17 ft
 a= 3.08 ft
 c= 1.00 ft
 m= 2.08 ft
 t= 36.00 hrs

q= c/t
 q= 0.03 ft/hr
 q= 0.33 in/hr

Min. S = 34.00 ft

Provided S = 25.00 ft

Average Length of Lateral, L:= 360 ft
 Average Flow per Lateral, Qr:= 0.07 cfs

Lateral Slope:= 0.20 %
 Lateral Mannings:= 0.015

4" Pipe Capacity:= 0.074 cfs
 6" Pipe Capacity:= 0.220 cfs

Header Pipe Flow, Qt= 0.14 cfs

Where:

d = Depth to underdrain from
 D= Depth to impervious layer (2*d)
 a= Height of drain above imp. Layer
 c= Depth from natural ground to water table after draw down
 m= Height of water table above drain
 t= Recovery time (72 hrs / FS)
 q= Drainage coefficient
 S= Min. Drain Spacing required
 Qr = Relief Drain Discharge
 L = Length of Drain
 CF = Conversion Factor (43200)

$$S = \sqrt{\frac{4 K (m^2 + 2 a m)}{q}}$$

$$Q_r = \frac{q S \left(L + \frac{S}{2} \right)}{CF}$$

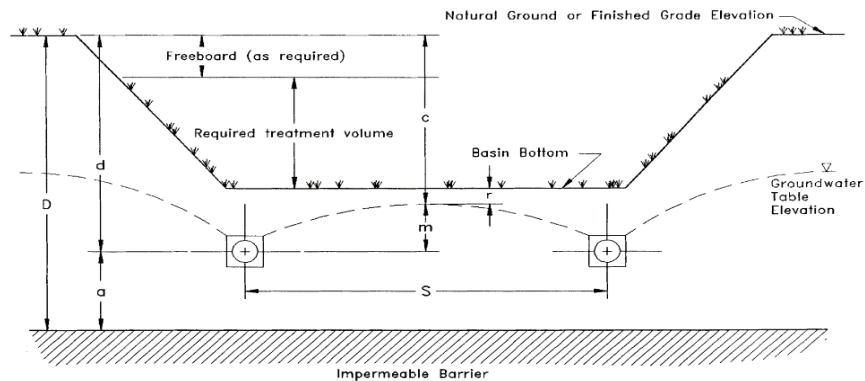


Figure 27-5, From Applicants Handbook

Figure 27-5, From Applicants Handbook

Design Worksheet Grassed Swale Design

Project Name: **Teco Big Bend Solar**
Basin: **Eastside Substation Grassed Swale**

Basin Information: Drainage Disturbed Area: **12625** Sq. Ft. 0.29 Ac.
 Impervious Area: **521** Sq. Ft. 0.01 Ac.
 Percent Impervious: 4.13 %

WQ Volume Required: $WQ_v = [P \cdot R_v \cdot A] / 12$ Where: $P =$ 0.5 inches
WQ_v = 45.8 CF

Water Quality Peak Flow: $Q_{wv} = P(0.05 + 0.009 \cdot \%Imp)$
 $Q_{wv} =$ 0.044 inches

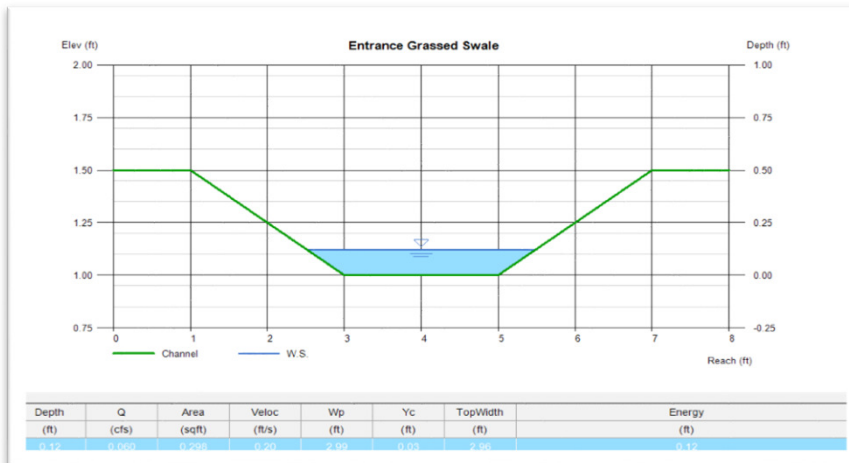
$CN = 1000 / [10 + 5P + 10Q - 10(Q^2 + 1.25 \cdot Q \cdot P)^{0.5}]$
CN = 89

From Table 4-1, TR-55 Where: $T_c =$ 5 min. See attached
 $I_a =$ **0.040** in. 0.083 hr.
 $I_a/P =$ 0.080 If $I_a/P < 0.1$ use $I_a/P = 0.1$
 If $I_a/P > 0.5$ use $I_a/P = 0.5$

From Fig. 4-II, TR-55
 $q_u =$ **1000** csm/in.

$Q_{wq} = q_u \cdot (X_{ac} / 640 \text{ ac/mi}^2) \cdot WQ_v$
0.02 cfs

Channel Design: Characteristics: $n =$ **0.077** Bermuda Grass
 (See attached worksheet) $S =$ **0.0026** ft/ft
 $D =$ **0.08** ft
 $V =$ **0.16** ft/sec
 $WP =$ **2.66** ft
 $A =$ **0.11** sf



Design Worksheet Grassed Swale Design

Project Name: **Teco Big Bend Solar**
Basin: **Eastside Substation Grassed Swale (Continued)**

Swale Stage / Storage	Elevation	Area	
	5	392	Assumed Datum - BTM Swale Elev. 5
	5.5	1200	

					Inc.	
Stage	Elevation	Inc. Area	Storage	Total Storage		
0	5	392	0	0		
0.05	5.05	472.8	21.62	21.62		
0.1	5.1	553.6	25.66	47.28		
0.15	5.15	634.4	29.7	76.98		
0.2	5.2	715.2	33.74	110.72		
0.25	5.25	796	37.78	148.5		
0.3	5.3	876.8	41.82	190.32		
0.35	5.35	957.6	45.86	236.18		
0.4	5.4	1038.4	49.9	286.08		
0.45	5.45	1119.2	53.94	340.02		
0.5	5.5	1200	57.98	398		

h_v = Stage 1
Treatment Vol.
 h_v = 0.10

Design Infiltration:

$$I_d = K_{vu} / FS$$

Where: I_d = Design Infiltration rate (ft/hr)
 K_{vu} = Unsaturated vertical hydraulic conductivity (ft/hr) = $2/3 K_{vs}$
 K_{vs} = Saturated vertical hydraulic conductivity (ft/hr)
FS = Factor of Safety (2)

K_{vs} = 2 in/hr
 K_{vu} = 1.33 in/hr
 K_{vu} = 0.11 ft/hr
 I_d = 0.06 ft/hr

Unsaturated Vertical Flow Analysis:

$V_u = A_b * f * h_b$
 A_b = WP * Swale Length
 A_b = 266 sf
 h_b = 1 ft
 V_u = 79.8 cf

Where: V_u = Volume of water required to saturate the soil below grade, cf
 A_b = Infiltration Area, sf
 h_b = Height of swale above water table, ft

 f = Fillable porosity (0.3)

$h_u = f * h_b$
 f = 0.3
 h_b = 1
 h_u = 0.3

Where: h_u = Height of water to saturate soil
 f = Fillable porosity (0.3)
 h_b = Height of swale above water table, ft

$$V_u > WQ_v \quad \text{or} \quad h_u > h_v$$

therefore infiltration will occur entirely under vertical unsaturated flow conditions

Recovery Time:

$$t_{sat} = (f * h_b) / I_d$$

t_{sat} = 5.40 hours

APPENDIX H - GEOTECHNICAL REPORT

March 23, 2016

Burns & McDonnell
2600 N. Central Ave, Suite 1500
Phoenix, Arizona 85004



Attn: Mr. Jason S. Hope, SE
Structural Department Manager, Energy
Office: 480.337.6540
Cell: 480.363.2278
Email: jhope@burnsmcd.com

Re: Double Ring Infiltration Evaluation
TECO Solar Project
Big Bend Power Station
Apollo Beach, Florida
Terracon Project Number: H4165002

Dear Mr. Hope:

Terracon Consultants, Inc. (Terracon) has performed five double ring infiltration (DRI) tests for the above project.

Five double ring infiltration tests, DRI-1 through DRI-5, were conducted in the locations selected by Burns & McDonnell across the site as shown on the attached site plan. The results of the tests are summarized in the following table:

Test Location	Area Function	Infiltration Rate (in/hr)
DRI-1	Stormwater	2.0
DRI-2	Stormwater	2.2
DRI-3	Stormwater	0.8
DRI-4	Stormwater	1.6
DRI-5	Stormwater	1.2

A copy of the field test results is included following this letter.

Hand auger borings conducted along with the DRI tests were observed during drilling for the presence and level of groundwater. Groundwater was observed at depths ranging from 0.5 to 2.9 feet in the borings.

It should be recognized that fluctuations of the groundwater table will occur due to seasonal variations in the amount of rainfall, runoff and other factors not evident at the time the boring was performed. In addition, perched water can develop within higher permeability soils



Terracon Consultants, Inc. 504 E. Tyler Street Tampa,, Florida 33602
P [813] 221 0050 F [813] 221 0051 terracon.com

Geotechnical



Environmental



Construction Materials



Facilities

Groundwater Level Evaluation

TECO Solar Project ■ Apollo Beach, Florida
March 23, 2016 ■ Terracon Project No. H4165002



overlying less permeable soils. Therefore, groundwater levels during construction or at other times in the future may be higher or lower than the levels indicated on the boring logs.

We estimate that the seasonal high groundwater level will be within 12 inches of the ground surface. Our estimate of the seasonal groundwater conditions are based on the USDA Soil Survey, available survey data, the encountered soil types, recent weather conditions, and the encountered water levels.

These seasonal water table estimates do not represent the temporary rise in water table that occurs immediately during a significant storm event, including adjacent to other stormwater management facilities. This is different from static groundwater levels in wet ponds and/or drainage canals which can affect the design water levels of new, nearby ponds. The seasonal high water table may vary from normal when affected by extreme weather changes, localized or regional flooding, karst activity, future grading, drainage improvements, or other construction that may occur on or around the site following the date of this report.

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning this report, or if we may be of further service, please contact us.

Sincerely,

Terracon Consultants, Inc.

Certificate of Authorization Number 8830

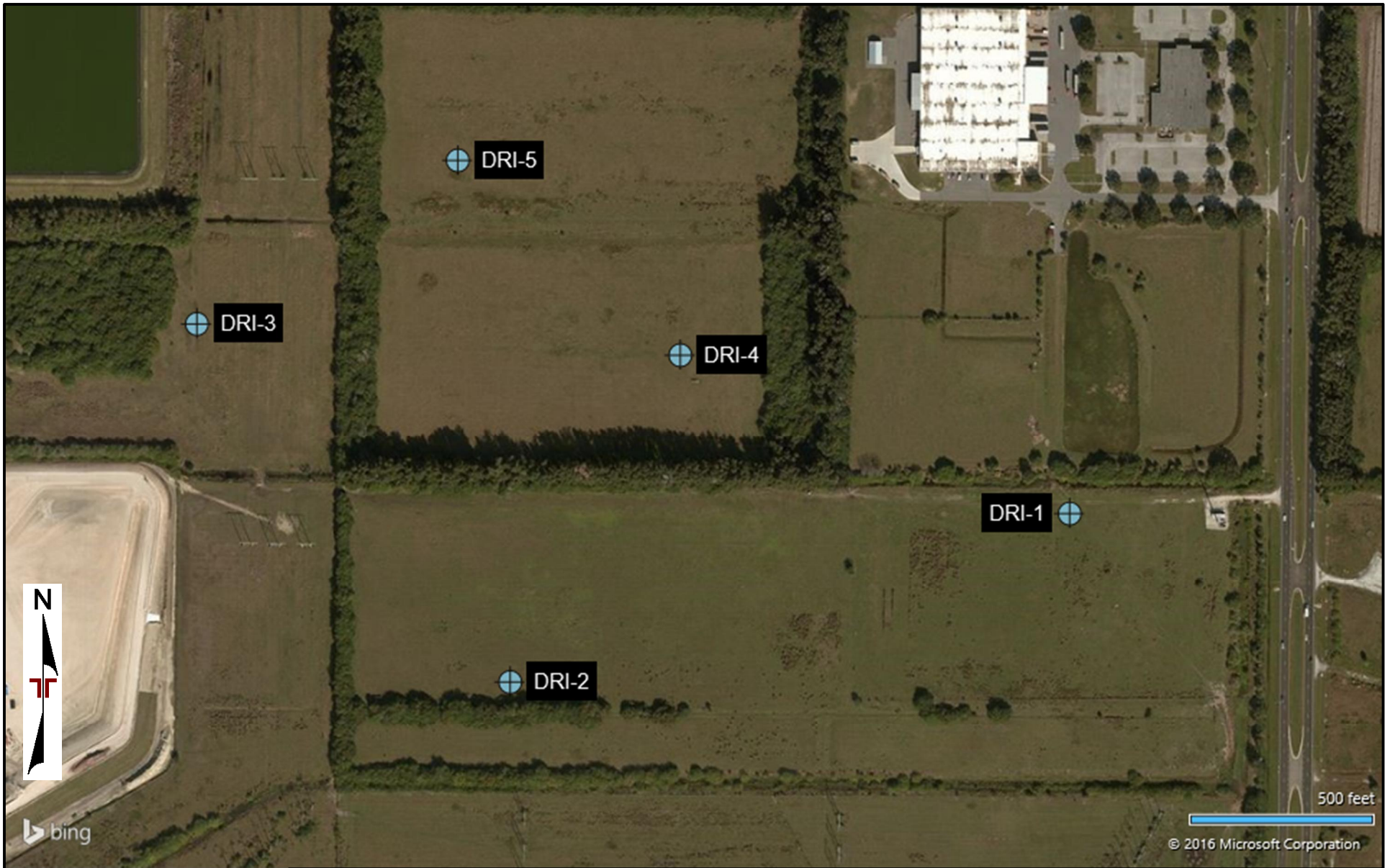
A handwritten signature in blue ink, appearing to read "Caleb Hodnett", written over the printed name.

Caleb Hodnett, E.I.

Geotechnical Project Manager



Attachments: Exploration Plan
DRI Test Results



AERIAL PHOTOGRAPHY PROVIDED BY
MICROSOFT BING MAPS

DIAGRAM IS FOR GENERAL LOCATION ONLY,
AND IS NOT INTENDED FOR CONSTRUCTION
PURPOSES

Project Manager:	SCK
Drawn by:	CJH
Checked by:	SCK
Approved by:	SCK

Project No.	H4165002
Scale:	AS SHOWN
File Name:	CAD
Date:	3/23/2016

Terracon
504 E Tyler St
Tampa, FL 33602-3408

EXPLORATION PLAN

TECO Solar Project
US 41
Apollo Beach, FL

Exhibit

A-1

Double Ring Infiltration Test

PROJECT: TECO Solar Project
 PROJECT LOCATION: US 41 and Big Bend Road, Apollo Beach, FL
 TEST LOCATION: DRI-1 as per plan
 DATE OF TEST: 3/15/2016
 DEPTH OF TEST: 1 feet
 DEPTH TO WATER TABLE: 2 feet 2 inches

TEST RESULTS:

TEST TIME	INFLTRATION RATE (Inches/Hour)
0:10 min	2.5
0:10 min	1.2
0:10 min	2.5
0:10 min	1.2
0:10 min	2.5
0:10 min	1.2
Average 1st Hour	1.8
0:15 min	2.5
0:15 min	1.6
0:15 min	2.5
0:15 min	1.6
Average 2nd Hour	2.0
0:30 min	2.0
0:30 min	2.0
Average 3rd Hour	2.0

INFILTRATION RATE: 2.0 Inches Per Hour

SOIIL PROFILE:	Depth (Ft.)	Soil Description
	0 - 0.5'	Gray fine sand
	0.5' - 1.5'	Light brown fine sand
	1.5' - 2'	Dark brown/brown fine sand
	2' - 4'	Light brown fine sand

Terracon Project No.: H4165002

Double Ring Infiltration Test

PROJECT: TECO Solar Project
 PROJECT LOCATION: US 41 and Big Bend Road, Apollo Beach, FL
 TEST LOCATION: DRI-2 as per plan
 DATE OF TEST: 3/15/2016
 DEPTH OF TEST: 1 feet
 DEPTH TO WATER TABLE: 2 feet 2 inches

TEST RESULTS:

TEST TIME	INFLITRATION RATE (Inches/Hour)
0:10 min	2.5
0:10 min	2.5
0:10 min	2.5
0:10 min	3.7
0:10 min	2.5
0:10 min	2.5
Average 1st Hour	2.7
0:15 min	2.5
0:15 min	2.5
0:15 min	2.5
0:15 min	2.5
Average 2nd Hour	2.5
0:30 min	2.5
0:30 min	2.0
Average 3rd Hour	2.2

INFILTRATION RATE: 2.2 Inches Per Hour

SOIIL PROFILE:	Depth (Ft.)	Soil Description
	0 - 1'	Gray fine sand
	1' - 2'	Brown/light brown fine sand
	2' - 3'	Gray clay with hardpan

Terracon Project No.: H4165002

Double Ring Infiltration Test

PROJECT: TECO Solar Project
 PROJECT LOCATION: US 41 and Big Bend Road, Apollo Beach, FL
 TEST LOCATION: DRI-3 as per plan
 DATE OF TEST: 3/16/2016
 DEPTH OF TEST: 3 inches
 DEPTH TO WATER TABLE: 6 inches

TEST RESULTS:

TEST TIME	INFILTRATION RATE (Inches/Hour)
0:10 min	1.2
0:10 min	0.0
0:10 min	0.0
0:10 min	2.5
0:10 min	1.2
0:10 min	0.0
Average 1st Hour	0.8
0:15 min	0.8
0:15 min	0.8
0:15 min	0.8
0:15 min	0.8
Average 2nd Hour	0.8
0:30 min	0.8
0:30 min	0.8
Average 3rd Hour	0.8

INFILTRATION RATE: 0.8 Inches Per Hour

SOIL PROFILE:	Depth (Ft.)	Soil Description
	0 - 1'	Gray fine sand

Terracon Project No.: H4165002

Double Ring Infiltration Test

PROJECT: TECO Solar Project
 PROJECT LOCATION: US 41 and Big Bend Road, Apollo Beach, FL
 TEST LOCATION: DRI-4 as per plan
 DATE OF TEST: 3/17/2016
 DEPTH OF TEST: 3 inches
 DEPTH TO WATER TABLE: 6 inches

TEST RESULTS:

TEST TIME	INFILTRATION RATE (Inches/Hour)
0:10 min	1.2
0:10 min	1.2
0:10 min	2.5
0:10 min	1.2
0:10 min	1.2
0:10 min	2.5
Average 1st Hour	1.6
0:15 min	1.6
0:15 min	1.6
0:15 min	1.6
0:15 min	1.6
Average 2nd Hour	1.6
0:30 min	1.6
0:30 min	1.6
Average 3rd Hour	1.6

INFILTRATION RATE: 1.6 Inches Per Hour

SOIL PROFILE:	Depth (Ft.)	Soil Description
	0 - 1'	Gray fine sand
	1' - 1.5'	Light brown fine sand
	1.5' - 3'	Brown fine sand

Terracon Project No.: H4165002

Double Ring Infiltration Test

PROJECT: TECO Solar Project
 PROJECT LOCATION: US 41 and Big Bend Road, Apollo Beach, FL
 TEST LOCATION: DRI-5 as per plan
 DATE OF TEST: 3/17/2016
 DEPTH OF TEST: 3 inches
 DEPTH TO WATER TABLE: 6 inches

TEST RESULTS:

TEST TIME	INFLTRATION RATE (Inches/Hour)
0:10 min	2.5
0:10 min	1.2
0:10 min	0.0
0:10 min	2.5
0:10 min	0.0
0:10 min	1.2
Average 1st Hour	1.2
0:15 min	1.6
0:15 min	1.6
0:15 min	1.6
0:15 min	1.6
Average 2nd Hour	1.6
0:30 min	1.6
0:30 min	1.2
Average 3rd Hour	1.4
0:30 min	1.2
0:30 min	1.2
Average 4th Hour	1.2

INFILTRATION RATE: 1.2 Inches Per Hour

SOIL PROFILE:	Depth (Ft.)	Soil Description

**Report of Geotechnical Services
TECO Solar Project
Apollo Beach, Florida
S&ME Project No. 1484-15-017**



Prepared for:
Tampa Electric Company
P.O. Box 111
Tampa, FL 33601-0111

Prepared by:
S&ME, Inc.
111 Kelsey Lane, Ste E
Tampa, FL 33619

July 16, 2015



July 16, 2015

Tampa Electric Company
P.O. Box 111
Tampa, FL 33601-0111

Attention: Mr. Joshua Alston, E.I.

Reference: **Report of Geotechnical Services**
TECO Solar Project
Apollo Beach, Florida
S&ME Project No. 1484-15-017
Florida Certificate of Authorization No. 6712

Dear Mr. Alston:

S&ME, Inc. (S&ME) has completed our geotechnical engineering services for the proposed solar power generating facility near Tampa Electric Company's Big Bend Power Station in Apollo Beach, Florida. Our services were provided pursuant to S&ME Proposal Nos. 14-1500460 and 14-1500460A dated June 19, 2015 and June 30, 2015, respectively. Our services were authorized with the issuance of Tampa Electric Company Work Order No. 2551065-05 dated June 30, 2015 and Change Order No. 1 dated July 1, 2015.

The purpose of our services was to explore the subsurface conditions at the subject site pertinent to site preparation and foundation support. The following report presents our geotechnical findings and recommendations.

S&ME appreciates the opportunity to be of service to Tampa Electric Company. Please contact us if you have any questions.

Sincerely,

S&ME, Inc.

Graham T. Zoeller, P.E.
Project Engineer
Florida License No. 79426



Philip J. Erbland, P.E.
Senior Engineer
Florida License No. 52621

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Appendix I – Additional Figures

Appendix II – Laboratory Test Results

Appendix III – Field and Laboratory Test Procedures

1.0 Introduction

1.1 Purpose

The purpose of our services was to explore the subsurface conditions at the subject site pertinent to site preparation and foundation support, to determine the general engineering characteristics of the materials encountered, and to provide to the design engineers information to aid in their design.

1.2 Project Information

We understand that Tampa Electric Company (TEC) plans to construct a solar power generating facility near its Big Bend Power Station. The facility will include solar panels, inverters, transformers and a substation. The solar panels will be mounted on driven steel piers (such as W6 or W8 members). Current plans require that these piles be driven to a depth of approximately 10 feet below finished grades. Multiple skids containing an inverter and transformer will be placed throughout the site, the locations of which are currently unknown, with loads on the order of 2 to 4 kips. The skids will be raised on a steel structure supported by a shallow foundation system. The substation will be built onsite, off US 41 near the existing telephone tower. The substation will include a larger transformer with a reported weight of 125 kips supported on a mat foundation 12 feet by 20 feet in plan size. No stormwater ponds are expected to be constructed.

1.3 Scope of Study and Report Format

This exploration included a site reconnaissance, field exploration, laboratory testing, and a geotechnical engineering analysis. The following sections of this report present a discussion of the details surrounding the field exploration, laboratory testing programs, site conditions, and our corresponding conclusions and recommendations. Figures are provided in Appendix I and laboratory test results are provided in Appendix II. The field and laboratory testing procedures are presented in Appendix III.

2.0 Site Information

2.1 Site Reconnaissance

The subject property is located south of Big Bend Road and is bounded to the west by Dickman Road and the east by US 41 in Apollo Beach, Florida. The location of the site is depicted on the Site Location Plan (Figure 1 in Appendix I). Based on information provided by TEC, the subject property is approximately 154 acres in size. At the time of our exploration, the eastern portion of the site was in use as cattle rangeland while the western portion consisted of the power line/utility easement and overgrown, undeveloped areas. Numerous drainage ditches crossed the property (some with standing water). There was also a heavily overgrown area near the north center of the site that was unable to be observed.

2.2 Site History

Based on a review of historical aerial photography dating back to 1938, the subject site was undeveloped rangeland from 1938 to sometime before 1965. By 1965, the northern half of the site was used for farming of row crops. By 1976, it appears that most of the row crops are gone and the site is likely used as cattle rangeland. At some time between 1976 and 1984 construction was started on the south gypsum holding area and the ditch along the south side of the site was constructed. By 1991 construction of the south gypsum area was completed. No significant changes were noted between 1991 and 2015.

2.3 Soil Survey Information

The Soil Survey of Hillsborough County, Florida, prepared by the U.S. Department of Agriculture Natural Resource Conservation Service (formerly the Soil Conservation Service) was reviewed for the preparation of this report. Borings S-1 to S-2 and S-4 to S-8 are in an area identified as Wabasso fine sand. Wabasso fine sand is poorly drained with a published seasonal high water table of $\frac{1}{2}$ to $1\frac{1}{2}$ feet below the ground surface. The area around boring S-3 is mapped as Basinger, Holopaw, and Samsula soils, depressional. These soil types are typically very poorly drained with a published seasonal high water table at the ground surface. Borings S-9 and B-1 to B-3 are in an area mapped as Malabar fine sand. Malabar fine sand is poorly drained with a published seasonal high water table of 0 to 1 feet below the ground surface.

3.0 Exploration and Testing Programs

3.1 Field Exploration

Our field exploration included locating utilities in the proposed boring locations using Ground Penetrating Radar (GPR) and electromagnetic techniques. The GPR and electromagnetic surveys were performed by Cardno under contract to S&ME on June 30, 2015. A copy of the survey results are presented in Appendix I. No utility conflicts were noted or observed in the field. After the utility scanning was complete, TEC revised the locations of borings B-1 and B-2 and as such these boring locations were not scanned for utilities prior to drilling.

Our field exploration consisted of the following:

- Nine (9) Standard Penetration Test (SPT) borings to a depth of 15 feet to evaluate the soils in the footprint of the proposed solar array;
- Three (3) Standard Penetration Test (SPT) borings to a depth of 50 feet to evaluate the soils in the footprint of the proposed substation; and,
- One (1) bulk soil sample obtained near the ground surface in the substation area for Limerock Bearing Ratio testing.

The test locations and depths were selected by S&ME. The boring locations were initially located in the field by S&ME personnel using a handheld GPS unit and were survey located by SurvTech Solutions, Inc. after the conclusion of the field exploration. The obtained coordinates are presented on the boring logs. The field testing was performed between July 1, 2015 and July 2, 2015. The approximate boring locations are shown on the Field Test Location Plan (Figure 2) in Appendix I.

SPT sampling began at the ground surface in all of the borings except for borings B-1 and B-2. The upper 4 feet of these borings were advanced using a hand auger to check for buried utilities. The soil test borings were advanced using rotary wash methods. Sampling of the soils was accomplished using the SPT procedure (ASTM D1586). Rock coring was attempted in boring B-3 in general accordance with ASTM D2113. However, the soil conditions were not conducive to coring and very poor recovery was obtained. Therefore, no additional coring was attempted. The deep borings were grouted upon completion using bentonite chips in accordance with Water Management District requirements while the shallow borings were backfilled with native materials.

Our initial scope included soil resistivity testing using the Wenner Four-Electrode method in the substation area. However, this item was deleted from the scope of services by TEC prior to mobilization.

The field exploration results are presented in Appendix I and the procedures used are described in Appendix III.

3.2 Laboratory Test Program

Representative soil samples and cores obtained during our field sampling operation were packaged and transferred to our office for evaluation by a geotechnical engineer in order to confirm the field descriptions of the various soil strata. Laboratory testing was performed on selected samples as deemed necessary to aid in soil classification and to further define the engineering properties of the soils. The laboratory tests performed consisted of percent fines analyses, corrosion series testing, and Limerock Bearing Ratio (LBR) testing.

4.0 Subsurface Conditions

4.1 Subsurface Conditions

The borings generally encountered interbedded layers of very loose to medium dense sandy soils with varying amounts of silt and clay from the ground surface to a depth of approximately 12 to 22 feet below the ground surface. Borings S-1 to S-6, and S-8 and S-9 were terminated in this material at a depth of 15 feet. The sandy soils between 2 and 6 feet below the ground surface in borings S-1, S-2, and S-4 to S-9 contained a significant amount of shell and cemented sand nodules. A four-foot-thick interbedded layer of firm sandy clay was encountered at a depth of approximately 8 feet in boring S-4. Stiff to very hard clayey soils were encountered beneath the sand strata to the termination depth of 15 feet in boring S-7 and to the termination depth of 50 feet in borings B-1 to B-3.

The above subsurface description is of a highly generalized nature to highlight the major subsurface stratification features and material characteristics. The boring logs included in Appendix I should be reviewed for specific information at individual boring locations. The depth and thickness of the subsurface strata indicated on the soil profiles were generalized from and interpolated between test locations. The transition between materials will be more or less gradual than indicated and may be abrupt. Information on actual subsurface conditions exists only at the specific boring locations and is relevant to the time the exploration was performed. Variations may occur and should be expected between boring locations. The samples that were not altered by laboratory testing will be retained for 60 days from the date of this report and then will be discarded.

4.2 Subsurface Water

Subsurface water was encountered at a depth of approximately 3½ to 4 feet at the time of our exploration. Subsurface water levels may fluctuate due to seasonal changes in precipitation amounts or with construction activity in the area. The subsurface water information presented in this report was collected at the time of our exploration.

4.3 Laboratory Test Results

Percent fines analyses, corrosion series tests, and a LBR test were performed on selected soil samples. The laboratory classification results are presented on the soil boring logs presented in Appendix I at the depth of the individually tested soil samples while the corrosion and LBR results are presented in Appendix II.

4.3.1 Percent Fines Analyses

Six soil samples were selected for determination of percentage of fine-grained material using the test procedures outlined in ASTM D1140. The results of these tests are useful in evaluating soil suitability and densification methods.

4.3.2 Corrosion Series

Corrosion tests consisted of pH, resistivity, chlorides, and sulfates. Samples were taken from borings B-1 and S-1. The pH of the samples was determined in accordance with Florida Department of Transportation (FDOT) laboratory test method FM 5-550. The resistivity of the samples was determined in accordance with FDOT laboratory test method FM 5-551. The concentrations of chlorides and sulfates were determined using FDOT laboratory test methods FM 5-552 and FM 5-553, respectively. Based on the results, the sample tested from boring B-1 was moderately aggressive to steel and concrete. The sample tested from boring S-1 was found to be extremely aggressive to steel and moderately aggressive to concrete. A summary of the corrosion series testing results can be found in Appendix II.

4.3.3 Limerock Bearing Ratio (LBR) Test

One (1) LBR test was performed in accordance with FDOT laboratory test method FM 5-515. The LBR test included a Modified Proctor test from the existing subgrade soils at location R-1. The test showed that the material has a LBR value of 28. The LBR data is presented in Appendix II.

5.0 Conclusions and Recommendations

5.1 General

The conclusions and recommendations presented in this report are based on the preceding project information and the results of this exploration. Actual subsurface conditions may vary between or away from the soil boring locations. If it becomes apparent during construction that the conditions encountered vary substantially from those presented herein, this office should be notified at once. At that time, the conditions can be evaluated and the recommendations of this report modified, in written form, if necessary.

During review of these recommendations, it should be kept in mind that, as with any previously developed site, unexpected subsurface conditions may be encountered. These conditions could include such things as undiscovered fill deposits, remnants of previous development, or buried debris. These variable conditions can normally be handled during construction by field engineering evaluation.

5.2 Site Geotechnical Considerations

Based on our evaluation and analyses, these soils will be capable of supporting the anticipated structural loads on the proposed shallow and deep foundation systems previously presented after the completion of the recommended site preparation program presented herein. The recommended site preparation program involves the densification the subgrade foundation surfaces to compress loose surface soils, as well as subgrade soils disturbed by other site preparation procedures, thereby creating a more uniform and less yielding soil mass. The above-created conditions will promote uniform settlement of the structure, thereby reducing the incidence and magnitude of differential settlement.

5.3 Shallow Foundation Design Considerations

Assuming our site preparation recommendations are followed as recommended in Section 5.5, the proposed transformer structure may be supported on a shallow foundation system. Based on the provided 12 foot by 20 foot transformer pad supporting a load of 125 kips, post-construction settlement potential should be on the order of 1¼ inches or less. Other ancillary soil-supported pad foundations (up to 10 feet by 10 feet) should be designed for maximum allowable bearing pressure 900 psf. Post-construction settlement potential based on this bearing pressure should be on the order of 1¼ inch or less.

Foundations should bear at least 18 inches below the finished exterior grades to develop the design bearing pressure. Isolated column footings should be a minimum of 24 inches wide, regardless of the resulting bearing pressure. This recommendation is made to help prevent a "localized" or "punching" shear failure condition, which could exist with very narrow footings.

The soils in the foundation excavation bottoms should be compacted to densities equivalent to at least 95 percent of the Modified Proctor (ASTM D1557) maximum dry density. Due to limited access in smaller individual excavations, compaction of sandy bearing level soils (if loosened by the excavation process) can probably be best achieved by making several passes with a relatively lightweight, walk-behind vibratory sled or roller.

All foundation excavation bottoms should be evaluated by a representative of the Geotechnical Engineer prior to backfilling and prior to reinforcing steel and concrete placement. This evaluation will help determine if individual footings are directly underlain by suitable bearing material. Any loose material should be properly compacted or undercut and replaced with well-compacted fill or crushed aggregate such as No. 57 stone. If practical, concrete placement should be completed the same day as the footing excavation.

5.4 Deep Foundation Design Considerations

Based on information provided, we understand some items may be supported on driven pipe foundations. The following table presents soil properties for use in deep foundation design:



Table 5-1 – Deep Foundation Design Parameters for Solar Panels

Boring	Layer	Depth (feet)	Soil Type	Cohesion (psf)	Friction Angle (ϕ)	Unit Weight (pcf)	$k^{(1)}$ (pci)	E_{50}
S-1	1	0 – 2	Sand	0	29	108	15	0
	2	2 – 8	Sand	0	31	112	39	0
	3	8 – 12	Sand	0	28	107	12	0
	4	12 – 15	Sand	0	31	111	33	0
S-2	1	0 – 2	Sand	0	31	111	33	0
	2	2 – 6	Sand	0	36	123	94	0
	3	6 – 12	Sand	0	30	109	24	0
	4	12 – 15	Sand	0	31	112	39	0
S-3	1	0 – 3	Sand	0	30	109	24	0
	2	3 – 6	Sand	0	28	106	6	0
	3	6 – 12	Sand	0	30	111	30	0
	4	12 – 15	Sand	0	35	120	79	0
S-4	1	0 – 2	Sand	0	29	108	18	0
	2	2 – 8	Sand	0	31	111	33	0
	3	8 – 12	Clay	750	0	109	100	0.01
	4	12 – 15	Sand	0	34	118	67	0
S-5	1	0 – 2	Sand	0	29	108	18	0
	2	2 – 4	Sand	0	34	117	61	0
	3	4 – 8	Sand	0	29	108	15	0
	4	8 – 11	Sand	0	32	114	48	0
	5	11 – 15	Sand	0	29	108	15	0
S-6	1	0 – 8	Sand	0	29	109	21	0
	2	8 – 12	Sand	0	32	114	45	0
	3	12 – 15	Sand	0	28	107	12	0
S-7	1	0 – 2	Sand	0	28	107	12	0
	2	2 – 8	Sand	0	32	113	42	0
	3	8 – 12	Sand	0	29	108	15	0
	4	12 – 15	Clay	2250	0	116	1000	0.005
S-8	1	0 – 2	Sand	0	28	107	12	0
	2	2 – 6	Sand	0	31	111	33	0
	3	6 – 12	Sand	0	29	108	18	0
	4	12 – 15	Sand	0	34	117	64	0

Boring	Layer	Depth (feet)	Soil Type	Cohesion (psf)	Friction Angle (ϕ)	Unit Weight (pcf)	$k^{(1)}$ (pci)	E_{50}
S-9	1	0 – 4	Sand	0	30	109	24	0
	2	4 – 6	Sand	0	29	108	15	0
	3	6 – 12	Sand	0	32	113	42	0
	4	12 – 15	Sand	0	29	108	15	0

(1) k - lateral modulus of subgrade reaction

Table 5-2 – Deep Foundation Design Parameters for Substation Structures

Boring	Layer	Depth (feet)	Soil Type	Cohesion (psf)	Friction Angle (ϕ)	Unit Weight (pcf)	$k^{(1)}$ (pci)	E_{50}
B-1 to B-3	1	0 – 2	Sand	0	29	108	15	0
	2	2 – 12	Sand	0	30	111	30	0
	3	12 – 17	Silty Sand	0	28	107	12	0
	4	17 – 22	Sandy Clay	1875	0	114	500	0.007
	5	22 – 50	Clay	5000	0	135	2000	0.004

(1) k - lateral modulus of subgrade reaction

A factor of safety of 3.0 should be used to establish an allowable foundation capacity assuming a load test will not be performed at the site. We recommend the upper 4 feet of depth be neglected in the side frictional resistance calculations due to the potential disturbance of the upper soils during the construction process. The water table should be modeled at the existing ground surface and the effective unit weight of soil and concrete should be used for design below this depth to account for the fluctuation of the subsurface water level.

5.5 Site Preparation Recommendations

5.5.1 Demolition/Stripping

Site preparation should begin with the removal of all unsuitable surface materials. This will include clearing and grubbing all vegetation, stripping organic-laden topsoil, and undercutting any unsuitable surface materials from proposed construction areas. As a minimum, it is recommended that the clearing operations extend at least 5 feet beyond the perimeter of development area. Strippings, debris and organic soils should be disposed in accordance with the owner's instructions.

Stumps and taproots should be completely removed from within proposed building areas, and voids created should be cleaned and backfilled with well-compacted structural fill as defined in Section 5.5.4. Any holes larger than 3 feet in diameter, resulting from the removal of any object or material, should be ramped to allow compaction of the bottom and sides with mechanical equipment prior to filling.

Provisions should then be made to relocate any interfering utility lines within the construction area to appropriate locations. In this regard, it should be noted that if abandoned underground pipes are not properly removed or plugged, they may serve as conduits for subsurface erosion, which may subsequently result in excessive settlements.

In conjunction with demolition and backfilling operations, it may be necessary to establish positive temporary groundwater and surface water control measures to improve construction trafficability and facilitate drying of the surface soils to allow acceptable compaction. The groundwater level should be lowered at least 1 foot beneath the surface of any excavations made during construction and 2 feet below the surface of any vibratory compaction operations.

5.5.2 Evaluation of Exposed Subgrade Soils

Following stripping operations, the exposed subgrade should be evaluated by the Geotechnical Engineer. At the Engineer's discretion, this evaluation may include proofrolling with a heavily loaded tandem-axle dump truck or similar rubber-tired equipment under the observation of the geotechnical engineer. Unstable areas should be scarified, the moisture content brought closer to optimum, and re-compacted in place, or the areas may be undercut as recommended by the Geotechnical Engineer. In general, the extent and depth of any undercutting will depend heavily upon final grades, the climatic conditions during construction, the aggressiveness of the earthwork schedule, site drainage, and the grading contractor's experience, equipment, means, and methods.

5.5.3 Surface Soil Compaction

Following surface stripping and ground modification activities, the exposed soils should be compacted with overlapping passes of a vibratory drum roller with a drum diameter of at least 30 inches. Densities equivalent to at least 95 percent of the Modified Proctor maximum dry density should be uniformly obtained to a depth of at least 12 inches below the compacted surface. Regardless of the degree of compaction achieved, a minimum of eight (8) complete overlapping coverages should be made in the building pad areas with the compaction equipment to help increase the density and improve the uniformity of the underlying sandy soils. The roller coverage should be divided evenly into two (2) perpendicular directions.

5.5.4 Structural Fill/Backfill

Structural fill/backfill materials should consist of cohesionless sandy soil containing no more than 12-percent fines (material passing the No. 200 sieve) by weight (Unified Soil Classification of SP or SP-SM) and having a maximum dry density of at least 95 pounds per cubic foot (pcf) as determined by a laboratory Modified Proctor compaction test (ASTM D1557). The soil should be relatively free of organics (less than 2.5%), deleterious matter, and elongated or flat particles susceptible to degradation.

Structural fill should be placed and compacted in loose lift thicknesses appropriate for the compaction equipment being used. For vibratory drum rollers at least 30 inches in diameter, the maximum loose lift thickness should be no greater than 12 inches in thickness. All material being used as soil fill should be tested and approved by the Geotechnical Engineer before being placed.

Structural fill/backfill should be compacted until densities of at least 95 percent of the Modified Proctor maximum dry density are uniformly obtained in the lift being compacted.

5.5.5 Use of On-Site Materials as Structural Fill

Soils meeting the requirements for structural fill as discussed above are preferred for use as structural fill beneath foundation elements. It is our opinion that the upper sands encountered in the top 2 are suitable for reuse as structural fill with proper moisture control. The soils encountered below this depth typically had a high percentage of shell to a depth of approximately 6 feet and are also acceptable as fill material. However, some of the borings had interbedded layers of clayey sand and clay with a fines content exceeding 12 percent. These soils, if encountered, will likely be difficult to place and compact given the higher fines content and moisture sensitivity of this material. Therefore, these materials are not acceptable for use as structural fill and should be placed in non-structural areas or removed from the site.

5.5.6 Excavations

The soil boring data indicates excavation (if required) will primarily extend through very loose to medium dense, sandy soils. The subsurface water level, if encountered, should be maintained at least 1 foot below the bottom of excavations to mitigate bottom instability and at least 2 feet below the surface where vibratory compaction operations are being performed.

Groundwater control measures should be anticipated prior to initiating any excavations deeper than about 1 foot below existing grades at the site. Water can likely be controlled at the site by pumping from sumps located in perimeter ditches or pits located away from potential foundation bearing areas. The designer of the dewatering system should address the effects on surrounding structures in the design.

All excavations should be sloped or shored in accordance with local, state, and federal regulations, including OSHA (29CFR Part 1926) excavation trench safety standards. The contractor is solely responsible for site safety. This information is provided only as a service and under no circumstances should S&ME be assumed to be responsible for construction site safety.

5.6 Slab Design and Construction

Soil-supported slabs are acceptable at the site provided that our site preparation and fill/backfill recommendations are followed. A subgrade modulus (k) of 180 pounds per cubic inch (pci), based on the 12-inch-diameter plate load test, is appropriate for design of the slabs. This modulus value should be appropriately reduced when designing the slab thickness to accommodate wide area loads. Detailed settlement analyses for the slab should be performed if it will be subjected to large, wide area loads.

Suitable granular material should be used as backfill materials for utility trenches located beneath slab areas. The backfill should be placed and compacted in accordance with the recommendations discussed in Sections 5.5.3 and 5.5.4. Also, the slab should be designed with proper joints to keep stresses within the appropriate limits, achieve adequate load transfer across joints, and reduce the potential for irregular crack formation.

The performance of concrete slabs is also affected by the concrete mix that is used. A relatively high water-cement ratio of the concrete can cause aesthetic disruptions, such as unsightly slab curling and

shrinkage cracking. We recommend a concrete mix design be selected with a water–cement ratio not exceeding 0.45. In addition, we recommend water curing for the first 3 days to minimize cracking and curling.

5.7 Pavement Recommendations

We have not been provided with detailed traffic loading information at this time and minimum pavement section layer thicknesses have been provided in the following sections based on our experience with similar facilities. If the facility will be subject to significant truck vehicle traffic then it will be necessary to perform a detailed pavement design considering the desired pavement design life, terminal serviceability, and expected traffic loading.

5.7.1 Flexible Pavement Recommendations

We recommend using a layered pavement section consisting of a compacted soil subgrade, a graded aggregate base course (compacted Florida Limerock, crushed concrete, or equivalent), and an asphaltic concrete surface course. The asphaltic concrete surface course should consist of Superpave mix (such as SP-9.5).

The asphaltic concrete mix should be a current Florida Department of Transportation (FDOT)-approved design. Samples of the materials delivered to the project should be tested to verify that the aggregate gradation and asphalt content satisfies the mix design requirements. The asphalt should be compacted to FDOT specifications. After placement and field compaction, the wearing surface should be cored to evaluate material thickness and to perform laboratory density tests. Cores should be obtained at a frequency of at least one (1) core per 3,000 square feet of placed pavement or a minimum of two (2) cores per day's production.

Because detailed traffic loading information is currently unavailable, we have generalized our pavement recommendations into two groups. The group descriptions and the recommended component thicknesses are presented in the following table. The component layer thicknesses below are based on a structural number analysis with the following estimated daily traffic volume for a 15-year pavement design life.

Light duty:	Auto parking areas; light panel and pickup trucks; 10,000 18-kip equivalent axle loads for a 15-year design life.
Heavy duty:	Driveways; delivery vehicles and semi-trucks; 50,000 18-kip equivalent axle loads for a 15-year design life.

Table 5-3 – Flexible Pavement Component Recommendations

Layer	Minimum Thickness – Light Duty	Minimum Thickness – Heavy Duty
Asphaltic Concrete (SP-9.5)	1.5 inches	2 inches
Limerock or Crushed Concrete base course compacted to at least 98 percent of the Modified Proctor (ASTM D1557) to yield a min. LBR = 100	6 inches	8 inches
Sub-base compacted to at least 98 percent of the Modified Proctor (ASTM D1557) to yield a min. LBR = 40	12 inches	12 inches

Based on our testing, the site soils did not yield a Limerock Bearing Ratio (LBR) value of 40. Therefore, they should be stabilized to obtain a minimum LBR value of 40. In the areas receiving high traffic loads from service trucks, we recommend increasing the asphaltic concrete thickness to a minimum of 2 inches and the base course to 8 inches. A minimum of 18 to 24 inches should be maintained between the bottom of the base course and the seasonal high water level.

5.7.2 Rigid Pavement Recommendations

Areas of the site where heavy vehicle loads with sharp turning movements are anticipated may require the use of rigid pavement. For these areas, we recommend a concrete pavement. The concrete should have a minimum flexural strength of 500 pounds per square inch (psi) at 28 days when tested in accordance with ASTM C-78. Based on our experience, a minimal thickness of 5 inches should be utilized for standard duty applications and a minimal thickness of 6 inches should be utilized for heavy-duty applications. We recommend a reinforcing steel mat, preferably #4 bars, spaced at 16 inches on center. However, the steel reinforcement within the concrete pavement should be designed by the Civil Engineer.

The subgrade should be prepared to achieve a minimum LBR of 20 as mixed and pulverized to a depth of 12 inches below the concrete base elevation. The subgrade soils should be compacted to a minimum density of 98 percent of the Modified Proctor maximum dry density (ASTM D-1557). It is suggested that a rigid pavement be utilized in areas in which service trucks load, backup, and turn.

Concrete should be reinforced with welded wire fabric or reinforcing bars to assist in controlling cracking from drying shrinkage and thermal changes. Sawed or formed control joints should be included. Saw cuts should not cut through the welded wire fabric or reinforcing steel and dowels should be utilized at formed and/or cold joints.

5.7.3 Pavement Drainage Considerations

One of the most critical influences on the pavement performance in Florida is the relationship between the pavement subgrade and the seasonal high groundwater level. Many roadways and parking areas have been destroyed as a result of deterioration of the base and the base/surface course bond. Regardless of the type of base selected, we recommend that the seasonal high groundwater level and the bottom of the base course be separated by at least 18 to 24 inches, depending on base type. Limerock

base should have a minimum separation of 24 inches from the seasonal high ground water table while crushed concrete should have a minimum of 18 inches separation.

According to the FDOT design standards, a minimum of 18 inches separation is required between the bottom of the base course and any clayey material. Our experience has shown that this value results in acceptable pavement performance and is the recommended minimum value. Based on the provided site grade, the existing site soils meet this guideline; however, if areas of cut are planned in pavement areas, undercutting and replacement with structural fill may be required.

5.8 Guidelines for Construction Observation and Testing

A representative number of in-place field density tests should be performed in the compacted existing soils and in each lift of structural fill or backfill to confirm that the required degree of compaction has been obtained. In-place density tests should also be performed at representative locations in the bearing level soils in the footing excavation bottoms. Field density tests should be performed at a frequency of not less than one (1) test per 2,500 square feet per lift in the structure areas, or at a minimum of two (2) test locations, whichever is greater. For compacted fill placed beneath pavements, field density tests should be performed at a frequency of not less than one (1) test per 5,000 square feet per lift, or at a minimum of two (2) tests per lift, whichever is greater. In addition, we recommend that at least one (1) density test be performed for every 100 feet of soil-supported wall footing, one (1) density test for each soil-supported column footing, and one (1) density test per lift for every 200 linear feet of utility trenches.

6.0 Limitations

This report has been prepared in accordance with generally accepted geotechnical engineering practice for specific application to this project. The conclusions and recommendations contained in this report are based upon applicable standards of our practice in this geographic area at the time this report was prepared. No other representation or warranty either express or implied, is made.

We relied on project information given to us to develop our conclusions and recommendations. If project information described in this report is not accurate, or if it changes during project development, we should be notified of the changes so that we can modify our recommendations based on this additional information if necessary.

Our conclusions and recommendations are based on limited data from a field exploration program. Subsurface conditions can vary widely between explored areas. Some variations may not become evident until construction. If conditions are encountered which appear different than those described in our report, we should be notified. This report should not be construed to represent subsurface conditions for the entire site.



Unless specifically noted otherwise, our field exploration program did not include an assessment of regulatory compliance, environmental conditions or pollutants or presence of any biological materials (mold, fungi, and bacteria). If there is a concern about these items, other studies should be performed. S&ME can provide a proposal and perform these services if requested. S&ME should be provided the opportunity to review the final plans and specifications to confirm that earthwork, foundation, and other recommendations are properly interpreted and implemented. The recommendations in this report are contingent on S&ME's review of final plans and specifications followed by observation and monitoring of earthwork and foundation construction activities.

Appendices

Appendix I – Additional Figures

Figure 1 - Site Location Plan

Figure 2 - Field Test Location Plan

SUE Figure

Legend to Soil Classification and Symbols

Soil Boring Logs



PHILIP J. ERBLAND, P.E.
LICENSE NO. 52621

TECO SOLAR PROJECT

DATE
7-15-15

JOB NO.
1484-15-017

FIGURE
1



111 Kelsey Lane, Suite E Tampa, Florida 33619 813-623-6646
Florida Certificate of Authorization No. 6012

SITE LOCATION PLAN

BIG BEND POWER STATION
APOLLO BEACH, FLORIDA



LEGEND

- APPROXIMATE LOCATION OF SPT BORING
- ⊕ APPROXIMATE LOCATION OF LBR SAMPLE

APPROXIMATE SCALE
0 400 FT.



TECO SOLAR PROJECT



111 Kelsey Lane, Suite E Tampa, Florida 33619 813-623-6646
Florida Certificate of Authorization No. 6112

DATE
7-15-15

JOB NO.
1484-15-017

FIGURE
2

FIELD TEST LOCATION PLAN

BIG BEND POWER STATION
APOLLO BEACH, FLORIDA

* NOTE:
PHILIP ERBLAND HAD MOVED BORE
LOCATIONS S-4 & S-5.

M. ALBANESE 6-30-15



LEGEND:
UNK UNKNOWN
BE BURIED ELECTRIC

NOTE:
ALL UNKNOWN UTILITIES ARE NON-TONEABLE. UTILITIES WERE LOCATED VIA GPR OR
HAND-PROBING WITH AIR LANCE. CARDNO IS UNABLE TO DETERMINE UTILITY TYPE
WITHOUT FURTHER INVESTIGATION AND CAUTIONS THAT UTILITY MAY BE IN SERVICE.

Aerial: 1"=200'
Sketch: NTS

M. ALBANESE 6-30-15
TECO Solar Project
Sheet 1

LEGEND TO SOIL CLASSIFICATION AND SYMBOLS

ATTACHMENT 2 GG-124-15

SOIL TYPES

(Shown in Graphic Log)



Fill



Asphalt



Concrete



Topsoil



Gravel



Sand



Silt



Clay



Organic



Silty Sand



Clayey Sand



Sandy Silt



Clayey Silt



Sandy Clay



Silty Clay



Limestone

WATER LEVELS

(Shown in Water Level Column)

▽ = Water Level At Termination of Boring

▼ = Water Level Taken After 24 Hours

HC = Hole Cave

CONSISTENCY OF COHESIVE SOILS

CONSISTENCY

Very Soft

Soft

Firm

Stiff

Very Stiff

Hard

STD. PENETRATION RESISTANCE BLOWS/FOOT

0 to 2

2 to 4

4 to 8

8 to 15

15 to 30

30 to Over 50

RELATIVE DENSITY OF COHESIONLESS SOILS

RELATIVE DENSITY

Very Loose

Loose

Medium Dense

Dense

Very Dense

STD. PENETRATION RESISTANCE BLOWS/FOOT

0 to 4

4 to 10

10 to 30

30 to 50

Over 50

SAMPLER TYPES

(Shown in Samples Column)



Shelby Tube



Split Spoon



Rock Core



No Recovery

TERMS

Standard Penetration Resistance - The Number of Blows of 140 lb. Hammer Falling 30 in. Required to Drive 1.4 in. I.D. Split Spoon Sampler 1 Foot as Specified in ASTM D-1586.

REC - Total Length of Rock Recovered in the Core Barrel Divided by the Total Length of the Core Run Times 100%.

RQD - Total Length of Sound Rock Segments Recovered that are Longer Than or Equal to 4" (mechanical breaks excluded) Divided by the Total Length of the Core Run Times 100%.



PROJECT: TECO Solar Project Apollo Beach, Florida S&ME Project No. 1484-15-017				BORING LOG ATTACHMENT 2 LOG-124-15 B-1										
DATE DRILLED: 7/2/15		ELEVATION: 8.9 feet		NOTES: -Horizontal coordinates reference plant datum, elevations reference NAVD88 -Set 20 feet of HW Casing										
DRILL RIG: Mud Bug		BORING DEPTH: 50.0 ft												
DRILLER: R. Swint, Sr.		WATER LEVEL: 4 ft ATD												
HAMMER TYPE: Safety		LOGGED BY: R. Swint												
SAMPLING METHOD: Split Spoon				NORTHING: -428		EASTING: 9752.9								
DRILLING METHOD: Mud Rotary														
DEPTH (feet)	GRAPHIC LOG	MATERIAL DESCRIPTION	WATER LEVEL	ELEVATION (feet)	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT / CORE DATA			STANDARD PENETRATION TEST DATA (blows/ft)				N VALUE
							1st 6in / RUN #	2nd 6in / REC	3rd 6in / RQD	/ REMARKS 10 20 30 60 80				
		<u>SLIGHTLY SILTY SAND (SP-SM)</u> gray, fine - - - Light brown - - - Dark brown			HA									
					HA									
5		<u>SAND (SP)</u> loose, pale brown, fine - - - Medium dense - - - Loose		3.9	SS-1		2	4	4					8
					SS-2		2	4	7					11
					SS-3		2	4	5					9
10				-1.1										
		<u>SLIGHTLY CLAYEY SAND (SP-SC)</u> very loose, dark gray, fine			SS-4		1	2	1					3
15				-6.1										
		<u>SANDY CLAY (CL)</u> stiff, pale gray, trace phosphate nodules			SS-5		1	4	11					15
20				-11.1										
		<u>CEMENTED CLAY (CL)</u> hard, pale gray, trace phosphate nodules			SS-6		21	39	50/4					50/4
25				-16.1										
					SS-7		19	24	15					39

NOTES:

- THIS LOG IS ONLY A PORTION OF A REPORT PREPARED FOR THE NAMED PROJECT AND MUST ONLY BE USED TOGETHER WITH THAT REPORT.
- BORING, SAMPLING AND PENETRATION TEST DATA IN GENERAL ACCORDANCE WITH ASTM D-1586.
- STRATIFICATION AND GROUNDWATER DEPTHS ARE NOT EXACT.
- WATER LEVEL IS AT TIME OF EXPLORATION AND WILL VARY.



PROJECT: TECO Solar Project Apollo Beach, Florida S&ME Project No. 1484-15-017				BORING LOG ATTACHMENT 2 LOG-124-15 B-1					
DATE DRILLED: 7/2/15		ELEVATION: 8.9 feet		NOTES: -Horizontal coordinates reference plant datum, elevations reference NAVD88 -Set 20 feet of HW Casing					
DRILL RIG: Mud Bug		BORING DEPTH: 50.0 ft							
DRILLER: R. Swint, Sr.		WATER LEVEL: 4 ft ATD							
HAMMER TYPE: Safety		LOGGED BY: R. Swint							
SAMPLING METHOD: Split Spoon				NORTHING: -428		EASTING: 9752.9			
DRILLING METHOD: Mud Rotary									
DEPTH (feet)	GRAPHIC LOG	MATERIAL DESCRIPTION	WATER LEVEL	ELEVATION (feet)	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT / CORE DATA	STANDARD PENETRATION TEST DATA (blows/ft) / REMARKS	N VALUE
							1st 6in / RUN # 2nd 6in / REC 3rd 6in / RQD	10 20 30 60 80	
35		CEMENTED CLAY (CL) hard, pale gray, trace phosphate nodules <i>(continued)</i> --- Trace cemented sand nodules		-26.1	SS-8		36 50/3		50/3
40			-31.1	SS-9		50/4		50/4	
45		CLAY (CL) hard, gray, with cemented sand nodules	-36.1	SS-10		17 50/6		50/6	
50		INDURATED CLAY (CL) hard, olive	-41.1	SS-11		15 35 50/6		50/6	
		Boring terminated at 50 ft Backfilled with bentonite chips upon completion Target Depth							

NOTES:

1. THIS LOG IS ONLY A PORTION OF A REPORT PREPARED FOR THE NAMED PROJECT AND MUST ONLY BE USED TOGETHER WITH THAT REPORT.
2. BORING, SAMPLING AND PENETRATION TEST DATA IN GENERAL ACCORDANCE WITH ASTM D-1586.
3. STRATIFICATION AND GROUNDWATER DEPTHS ARE NOT EXACT.
4. WATER LEVEL IS AT TIME OF EXPLORATION AND WILL VARY.



PROJECT: TECO Solar Project Apollo Beach, Florida S&ME Project No. 1484-15-017				BORING LOG ATTACHMENT 2 LOG-124-15 B-2											
DATE DRILLED: 7/2/15			ELEVATION: 9 feet						NOTES: -Horizontal coordinates reference plant datum, elevations reference NAVD88 -Set 22 feet of HW Casing						
DRILL RIG: Mud Bug			BORING DEPTH: 50.0 ft												
DRILLER: R. Swint, Sr.			WATER LEVEL: 4 ft ATD												
HAMMER TYPE: Safety			LOGGED BY: R. Swint												
SAMPLING METHOD: Split Spoon								NORTHING: -543.8			EASTING: 9818.9				
DRILLING METHOD: Mud Rotary															
DEPTH (feet)	GRAPHIC LOG	MATERIAL DESCRIPTION	WATER LEVEL	ELEVATION (feet)	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT / CORE DATA			STANDARD PENETRATION TEST DATA (blows/ft) /REMARKS				N VALUE	
							1st 6in / RUN #	2nd 6in / REC	3rd 6in / RQD	10	20	30	60/80		
		<u>SLIGHTLY SILTY SAND (SP-SM)</u> gray, fine --- Light brown --- Dark brown			HA										
					HA										
5		<u>SAND (SP)</u> loose, pale brown, fine --- Medium dense		4.0	SS-1		2	4	6					10	
					SS-2		3	5	7					12	
					SS-3		3	5	7					12	
10				-1.0											
		<u>SLIGHTLY SILTY SAND (SP-SM)</u> medium dense, dark gray, trace clayey nodules, fine			SS-4		3	5	6					11	
15				-6.0											
		<u>SAND (SP)</u> medium dense, gray, fine			SS-5		3	9	13					22	
20				-11.0											
		<u>CEMENTED CLAY (CL)</u> hard, pale gray, trace cemented sand nodules			SS-6		4	50/5						50/5	
25				-16.0											
					SS-7		14	50/4						50/4	

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3. STRATIFICATION AND GROUNDWATER DEPTHS ARE NOT EXACT.
4. WATER LEVEL IS AT TIME OF EXPLORATION AND WILL VARY.



PROJECT: TECO Solar Project Apollo Beach, Florida S&ME Project No. 1484-15-017				BORING LOG ATTACHMENT 2 OG-124-15 B-2					
DATE DRILLED: 7/2/15		ELEVATION: 9 feet		NOTES: -Horizontal coordinates reference plant datum, elevations reference NAVD88 -Set 22 feet of HW Casing					
DRILL RIG: Mud Bug		BORING DEPTH: 50.0 ft							
DRILLER: R. Swint, Sr.		WATER LEVEL: 4 ft ATD							
HAMMER TYPE: Safety		LOGGED BY: R. Swint							
SAMPLING METHOD: Split Spoon				NORTHING: -543.8		EASTING: 9818.9			
DRILLING METHOD: Mud Rotary									
DEPTH (feet)	GRAPHIC LOG	MATERIAL DESCRIPTION	WATER LEVEL	ELEVATION (feet)	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT / CORE DATA	STANDARD PENETRATION TEST DATA (blows/ft) / REMARKS	N VALUE
							1st 6in / RUN # 2nd 6in / REC 3rd 6in / RQD	10 20 30 60 80	
35		CEMENTED CLAY (CL) hard, pale gray, trace cemented sand nodules (continued)							
		--- Trace phosphate nodules		-26.0	SS-8	50/5			50/5
		--- With cemented sand nodules							
40				-31.0	SS-9	50/4			50/4
45		CLAY (CL) hard, gray, trace phosphate nodules		-36.0	SS-10	36 32 36			68
50		SANDY CLAY (CL) very stiff, gray, with cemented sand nodules		-41.0	SS-11	46 11 16			27
		Boring terminated at 50 ft Backfilled with bentonite chips upon completion Target Depth							

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PROJECT: TECO Solar Project Apollo Beach, Florida S&ME Project No. 1484-15-017				BORING LOG ATTACHMENT 2 CG-124-15 B-3					
DATE DRILLED: 7/2/15		ELEVATION: 9 feet		NOTES: -Horizontal coordinates reference plant datum, elevations reference NAVD88 -Set 20 feet of HW Casing					
DRILL RIG: CME 45-B		BORING DEPTH: 50.0 ft							
DRILLER: R. Swint, Sr.		WATER LEVEL: 3.5 ft ATD							
HAMMER TYPE: Auto		LOGGED BY: R. Swint							
SAMPLING METHOD: Split Spoon						NORTHING: -423.3		EASTING: 9901.9	
DRILLING METHOD: Mud Rotary									

DEPTH (feet)	GRAPHIC LOG	MATERIAL DESCRIPTION	WATER LEVEL	ELEVATION (feet)	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT / CORE DATA			STANDARD PENETRATION TEST DATA (blows/ft) / REMARKS					N VALUE	
							1st 6in / RUN #	2nd 6in / REC	3rd 6in / RQD	10	20	30	60	80		
		SLIGHTLY SILTY SAND (SP-SM) very loose, gray, fine --- Light brown, trace roots --- Medium dense, pale reddish yellow, no roots			SS-1		1	1	2							3
					SS-2		5	8	8							16
5		SAND (SP) loose, gray, fine		4.0	SS-3		2	4	4							8
					SS-4		2	3	4							7
10		SLIGHTLY SILTY SAND (SP-SM) medium dense, brown, fine		-1.0	SS-5		3	5	7							12
15		SILTY SAND (SM) very loose, dark gray, fine		-6.0	SS-6		3	1	1							2
20		SANDY CLAY (CL) stiff, gray, trace phosphate nodules		-11.0	SS-7		1	4	7							11
25		CEMENTED CLAY (CL) hard, pale gray, trace phosphate nodules		-16.0	SS-8		12	16	22							38
					SS-9		49	50/6								50/6

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PROJECT: TECO Solar Project Apollo Beach, Florida S&ME Project No. 1484-15-017				BORING LOG ATTACHMENT 2 CG-124-15 B-3					
DATE DRILLED: 7/2/15		ELEVATION: 9 feet		NOTES: -Horizontal coordinates reference plant datum, elevations reference NAVD88 -Set 20 feet of HW Casing					
DRILL RIG: CME 45-B		BORING DEPTH: 50.0 ft							
DRILLER: R. Swint, Sr.		WATER LEVEL: 3.5 ft ATD							
HAMMER TYPE: Auto		LOGGED BY: R. Swint							
SAMPLING METHOD: Split Spoon				NORTHING: -423.3		EASTING: 9901.9			
DRILLING METHOD: Mud Rotary									
DEPTH (feet)	GRAPHIC LOG	MATERIAL DESCRIPTION	WATER LEVEL	ELEVATION (feet)	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT / CORE DATA	STANDARD PENETRATION TEST DATA (blows/ft) / REMARKS	N VALUE
							1st 6in / RUN # 2nd 6in / REC 3rd 6in / RQD	10 20 30 60 80	
35		CEMENTED CLAY (CL) hard, pale gray, trace phosphate nodules <i>(continued)</i> --- With cemented sand nodules		-26.0	SS-10	5	50/4		50/4
40			-31.0	RC-1		10% 0%			
45			-36.0	SS-11	20	32	50/5		50/5
			-36.0	SS-12	41	50/3		50/3	
50		SANDY CLAY (CL) hard, pale olive, trace phosphate nodules Boring terminated at 50 ft Backfilled with bentonite chips upon completion Target Depth	-41.0	SS-13	25	50/6		50/6	

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PROJECT: TECO Solar Project Apollo Beach, Florida S&ME Project No. 1484-15-017				BORING LOG ATTACHMENT 3 LOG-124-15 3-1										
DATE DRILLED: 7/1/15			ELEVATION: 3.8 feet				NOTES: -Horizontal coordinates reference plant datum, elevations reference NAVD88							
DRILL RIG: CME 45-B			BORING DEPTH: 15.0 ft											
DRILLER: R. Swint, Sr.			WATER LEVEL: 3.6 ft ATD											
HAMMER TYPE: Auto			LOGGED BY: R. Swint											
SAMPLING METHOD: Split Spoon							NORTHING: -1119.8		EASTING: 5331.7					
DRILLING METHOD: Mud Rotary														
DEPTH (feet)	GRAPHIC LOG	MATERIAL DESCRIPTION	WATER LEVEL	ELEVATION (feet)	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT / CORE DATA			STANDARD PENETRATION TEST DATA (blows/ft) / REMARKS				N VALUE
							1st 6in / RUN #	2nd 6in / REC	3rd 6in / RQD	10	20	30	60	80
		SLIGHTLY SILTY SAND (SP-SM) very loose, gray, trace organics, fine --- Pale brown			SS-1		1	1	2					3
		SLIGHTLY CLAYEY SAND (SP-SC) medium dense, pale yellow, with shell fragments, fine --- Loose, pale brown, trace shell fragments			SS-2		3	6	6					12
5				-1.2	SS-3		6	4	4					8
					SS-4		3	4	6					10
10				-6.2	SS-5		2	1	1					2
		--- With silt seams			SS-6		2	3	5					8
15		Boring terminated at 15 ft Backfilled with cuttings upon completion Target Depth		-11.2										

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PROJECT: TECO Solar Project Apollo Beach, Florida S&ME Project No. 1484-15-017				BORING LOG ATTACHMENT LOG-124-15 S-2					
DATE DRILLED: 7/1/15		ELEVATION: 5.1 feet			NOTES: -Horizontal coorindates reference plant datum, elevations reference NAVD88 %200 = Percent passing a #200 sieve				
DRILL RIG: CME 45-B		BORING DEPTH: 15.0 ft							
DRILLER: R. Swint, Sr.		WATER LEVEL: 3.8 ft ATD							
HAMMER TYPE: Auto		LOGGED BY: R. Swint							
SAMPLING METHOD: Split Spoon					NORTHING: -75.4		EASTING: 6513.2		
DRILLING METHOD: Mud Rotary									
DEPTH (feet)	GRAPHIC LOG	MATERIAL DESCRIPTION	WATER LEVEL	ELEVATION (feet)	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT / CORE DATA 1st 6in / RUN # 2nd 6in / REC 3rd 6in / RQD	STANDARD PENETRATION TEST DATA (blows/ft) / REMARKS 10 20 30 60 80	N VALUE
5		<u>SLIGHTLY SILTY SAND (SP-SM)</u> loose, gray, fine --- Pale brown --- Dense --- Medium dense, pale brown, with shell fragments, with cemented sand nodules			SS-1		1 2 6		8
				SS-2		13 10 21	31		
		0.1		SS-3		11 12 9	21		
				SS-4		1 2 2	4		
		10		SS-5		4 4 4	8		
15		<u>SAND (SP)</u> loose, fine				SS-6			6 6 4
		Boring terminated at 15 ft Backfilled with cuttings upon completion Target Depth		-9.9					

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PROJECT: TECO Solar Project Apollo Beach, Florida S&ME Project No. 1484-15-017				BORING LOG ATTACHMENT 3 LOG-124-15 S-3					
DATE DRILLED: 7/1/15		ELEVATION: 4.9 feet			NOTES: -Horizontal coordinates reference plant datum, elevations reference NAVD88				
DRILL RIG: CME 45-B		BORING DEPTH: 15.0 ft							
DRILLER: R. Swint, Sr.		WATER LEVEL: 3.8 ft ATD							
HAMMER TYPE: Auto		LOGGED BY: R. Swint							
SAMPLING METHOD: Split Spoon					NORTHING: -1495.8		EASTING: 6634.6		
DRILLING METHOD: Mud Rotary									
DEPTH (feet)	GRAPHIC LOG	MATERIAL DESCRIPTION	WATER LEVEL	ELEVATION (feet)	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT / CORE DATA 1st 6in / RUN # 2nd 6in / REC 3rd 6in / RQD	STANDARD PENETRATION TEST DATA (blows/ft) / REMARKS 10 20 30 60 80	N VALUE
		<u>SLIGHTLY SILTY SAND (SP-SM)</u> very loose to loose, gray, fine			SS-1		1 1 2		3
		<u>CLAYEY SAND (SC)</u> loose, dark gray, trace roots, fine --- Very loose			SS-2		6 6 2		8
5				-0.1	SS-3		1 0 1		1
		<u>SLIGHTLY SILTY SAND (SP-SM)</u> loose, gray			SS-4		1 3 5		8
10				-5.1	SS-5		3 3 4		7
		<u>SAND (SP)</u> medium dense, gray, trace clay nodules, fine							
15		Boring terminated at 15 ft Backfilled with cuttings upon completion Target Depth		-10.1	SS-6		6 8 12		20

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PROJECT: TECO Solar Project Apollo Beach, Florida S&ME Project No. 1484-15-017				BORING LOG ATTACHMENT 3 LOG-124-15 S-4								
DATE DRILLED: 7/1/15		ELEVATION: 6.3 feet			NOTES: -Horizontal coordinates reference plant datum, elevations reference NAVD88 %200 = Percent passing a #200 sieve							
DRILL RIG: CME 45-B		BORING DEPTH: 15.0 ft										
DRILLER: R. Swint, Sr.		WATER LEVEL: 3.5 ft ATD										
HAMMER TYPE: Auto		LOGGED BY: R. Swint										
SAMPLING METHOD: Split Spoon					NORTHING: -694		EASTING: 7773.6					
DRILLING METHOD: Mud Rotary												
DEPTH (feet)	GRAPHIC LOG	MATERIAL DESCRIPTION	WATER LEVEL	ELEVATION (feet)	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT / CORE DATA 1st 6in / RUN # 2nd 6in / REC 3rd 6in / RQD	STANDARD PENETRATION TEST DATA (blows/ft) / REMARKS 1020306080				N VALUE
5		SLIGHTLY SILTY SAND (SP-SM) very loose, brown, fine - - - Reddish brown - - - Loose, light brown, with shell fragments, with cemented sand nodules		1.3	SS-1		122			4		
					SS-2		654			9		
					SS-3		455			10		
					SS-4		223			5		
10		SAND (SP) loose, light gray, fine				SS-5			123		5	
		SANDY CLAY (CL) firm, gray, %200 = 66%			-3.7							
		CLAYEY SAND (SC) medium dense, gray, %200 = 49%										
15		Boring terminated at 15 ft Backfilled with cuttings upon completion Target Depth		-8.7	SS-6		5710			17		

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PROJECT: TECO Solar Project Apollo Beach, Florida S&ME Project No. 1484-15-017				BORING LOG ATTACHMENT 3 CG-124-15 S-5										
DATE DRILLED: 7/1/15		ELEVATION: 5.1 feet		NOTES: -Horizontal coordinates reference plant datum, elevations reference NAVD88 %200 = Percent passing a #200 sieve										
DRILL RIG: CME 45-B		BORING DEPTH: 15.0 ft												
DRILLER: R. Swint, Sr.		WATER LEVEL: 3.4 ft ATD												
HAMMER TYPE: Auto		LOGGED BY: R. Swint												
SAMPLING METHOD: Split Spoon						NORTHING: 53.7		EASTING: 7077.7						
DRILLING METHOD: Mud Rotary														
DEPTH (feet)	GRAPHIC LOG	MATERIAL DESCRIPTION	WATER LEVEL	ELEVATION (feet)	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT / CORE DATA			STANDARD PENETRATION TEST DATA (blows/ft) / REMARKS				N VALUE
							1st 6in / RUN #	2nd 6in / REC	3rd 6in / RQD	10	20	30	60 80	
		SLIGHTLY SILTY SAND (SP-SM) very loose, dark gray, fine			SS-1		1	1	3					4
		--- Medium dense, brown			SS-2		7	8	7					15
5		--- With shell fragments, with cemented sand nodules			SS-3		3	2	3					5
		--- Loose, trace shell fragments, no cemented sand nodules		0.1	SS-4		1	1	1					2
		CLAYEY SAND (SC) very loose, trace shell fragments, trace shell fragments, fine, %200 = 16%			SS-5		2	5	7					12
10		SAND (SP) medium dense, gray, fine		-4.9										
		--- Very loose			SS-6		1	2	1					3
15		Boring terminated at 15 ft Backfilled with cuttings upon completion Target Depth		-9.9										

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PROJECT: TECO Solar Project Apollo Beach, Florida S&ME Project No. 1484-15-017				BORING LOG ATTACHMENT LOG-124-15 S-6					
DATE DRILLED: 7/1/15		ELEVATION: 6.5 feet			NOTES: -Horizontal coordinates reference plant datum, elevations reference NAVD88 %200 = Percent passing a #200 sieve				
DRILL RIG: CME 45-B		BORING DEPTH: 15.0 ft							
DRILLER: R. Swint, Sr.		WATER LEVEL: 3.5 ft ATD							
HAMMER TYPE: Auto		LOGGED BY: R. Swint							
SAMPLING METHOD: Split Spoon					NORTHING: 663.6		EASTING: 8193.5		
DRILLING METHOD: Mud Rotary									
DEPTH (feet)	GRAPHIC LOG	MATERIAL DESCRIPTION	WATER LEVEL	ELEVATION (feet)	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT / CORE DATA 1st 6in / RUN # 2nd 6in / REC 3rd 6in / RQD	STANDARD PENETRATION TEST DATA (blows/ft) / REMARKS 10 20 30 60 80	N VALUE
		SLIGHTLY SILTY SAND (SP-SM) very loose, gray, fine --- Pale brown			SS-1		1 2 2		4
		CLAYEY SAND (SC) loose, reddish brown, fine, %200 = 20%			SS-2		3 6 3		9
5		SLIGHTLY SILTY SAND (SP-SM) loose, brown, with shell fragments, with cemented sand nodules, fine		1.5	SS-3		4 3 2		5
		NO RECOVERY			SS-4		3 3 3		6
10		SAND (SP) medium dense, pale gray, fine		-3.5	SS-5		3 5 6		11
		SLIGHTLY SILTY SAND (SP-SM) very loose, dark gray, fine							
15		Boring terminated at 15 ft Backfilled with cuttings upon completion Target Depth		-8.5	SS-6		1 0 2		2

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PROJECT: TECO Solar Project Apollo Beach, Florida S&ME Project No. 1484-15-017				BORING LOG ATTACHMENT LOG-124-15 3-9					
DATE DRILLED: 7/1/15		ELEVATION: 7.3 feet			NOTES: -Horizontal coordinates reference plant datum, elevations reference NAVD88				
DRILL RIG: CME 45-B		BORING DEPTH: 15.0 ft							
DRILLER: R. Swint, Sr.		WATER LEVEL: 3.5 ft ATD							
HAMMER TYPE: Auto		LOGGED BY: R. Swint							
SAMPLING METHOD: Split Spoon					NORTHING: -705.7		EASTING: 8558.7		
DRILLING METHOD: Mud Rotary									
DEPTH (feet)	GRAPHIC LOG	MATERIAL DESCRIPTION	WATER LEVEL	ELEVATION (feet)	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT / CORE DATA 1st 6in / RUN # 2nd 6in / REC 3rd 6in / RQD	STANDARD PENETRATION TEST DATA (blows/ft) / REMARKS 10 20 30 60 80	N VALUE
		<u>SLIGHTLY SILTY SAND (SP-SM)</u> very loose, gray, trace roots, fine --- Brown			SS-1		1 1 2		3
		<u>CLAYEY SAND (SC)</u> medium dense, yellowish brown, fine			SS-2		2 10 7		17
5		<u>SLIGHTLY SILTY SAND (SP-SM)</u> medium dense, yellowish brown, with shell fragments, fine		2.3	SS-3		4 5 5		10
		<u>SAND (SP)</u> loose, pale brown, trace shell fragments			SS-4		2 3 4		7
10		<u>SLIGHTLY SILTY SAND (SP-SM)</u> very loose, dark gray		-2.7	SS-5		1 1 2		3
		<u>CLAY (CL)</u> stiff, pale gray							
15		Boring terminated at 15 ft Backfilled with cuttings upon completion Target Depth		-7.7	SS-6		4 5 9		14

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PROJECT: TECO Solar Project Apollo Beach, Florida S&ME Project No. 1484-15-017				BORING LOG ATTACHMENT 3 LOG-124-15 S-8												
DATE DRILLED: 7/1/15		ELEVATION: 6.4 feet		NOTES: -Horizontal coordinates reference plant datum, elevations reference NAVD88												
DRILL RIG: CME 45-B		BORING DEPTH: 15.0 ft														
DRILLER: R. Swint, Sr.		WATER LEVEL: 3.5 ft ATD														
HAMMER TYPE: Auto		LOGGED BY: R. Swint														
SAMPLING METHOD: Split Spoon						NORTHING: 18.5		EASTING: 8168.7								
DRILLING METHOD: Mud Rotary																
DEPTH (feet)	GRAPHIC LOG	MATERIAL DESCRIPTION	WATER LEVEL	ELEVATION (feet)	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT / CORE DATA			STANDARD PENETRATION TEST DATA (blows/ft) / REMARKS				N VALUE		
							1st 6in / RUN #	2nd 6in / REC	3rd 6in / RQD	10	20	30	60 80			
5		SLIGHTLY SILTY SAND (SP-SM) very loose, brown, trace roots, fine			SS-1		1	1	2						3	
		--- Loose, pale yellow, with shell fragments			SS-2		2	3	6							9
		--- No shell fragments			SS-3		3	4	3							7
		--- Very loose			SS-4		1	2	2							4
		--- Gray			SS-5		2	2	2							4
10																
15		--- Medium dense, dark gray			SS-6	3	7	9						16		
		Boring terminated at 15 ft Backfilled with cuttings upon completion Target Depth														

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PROJECT: TECO Solar Project Apollo Beach, Florida S&ME Project No. 1484-15-017				BORING LOG ATTACHMENT 3 LOG-124-15 S-9					
DATE DRILLED: 7/1/15		ELEVATION: 8.3 feet			NOTES: -Horizontal coorindates reference plant datum, elevations reference NAVD88 %200 = Percent passing a #200 sieve				
DRILL RIG: CME 45-B		BORING DEPTH: 15.0 ft							
DRILLER: R. Swint, Sr.		WATER LEVEL: 4 ft ATD							
HAMMER TYPE: Auto		LOGGED BY: R. Swint							
SAMPLING METHOD: Split Spoon					NORTHING: -703.2		EASTING: 9326.4		
DRILLING METHOD: Mud Rotary									
DEPTH (feet)	GRAPHIC LOG	MATERIAL DESCRIPTION	WATER LEVEL	ELEVATION (feet)	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT / CORE DATA 1st 6in / RUN # 2nd 6in / REC 3rd 6in / RQD	STANDARD PENETRATION TEST DATA (blows/ft) / REMARKS 1020306080	N VALUE
5		<u>SLIGHTLY SILTY SAND (SP-SM)</u> loose, brown, trace roots, fine - - - Yellowish brown - - - With shell fragments - - - Very loose, gray, no shell fragments			SS-1		223		5
				SS-2		443	7		
				SS-3		112	3		
				<u>SAND (SP)</u> loose, gray, fine	SS-4		346		10
10				<u>SLIGHTLY SILTY SAND (SP-SM)</u> loose, dark brown	SS-5		355		10
15		- - - Very loose, dark gray, fine, %200 = 9%		SS-6		212	3		
		Boring terminated at 15 ft Backfilled with cuttings upon completion Target Depth		-6.7					

NOTES:

1. THIS LOG IS ONLY A PORTION OF A REPORT PREPARED FOR THE NAMED PROJECT AND MUST ONLY BE USED TOGETHER WITH THAT REPORT.
2. BORING, SAMPLING AND PENETRATION TEST DATA IN GENERAL ACCORDANCE WITH ASTM D-1586.
3. STRATIFICATION AND GROUNDWATER DEPTHS ARE NOT EXACT.
4. WATER LEVEL IS AT TIME OF EXPLORATION AND WILL VARY.



Appendix II – Laboratory Test Results

Summary of Corrosion Testing Results

Limerock Bearing Ratio Test Report



Summary of Corrosion Testing Results

**TECO Solar Project
Apollo Beach, Florida
S&ME Project No. 1484-15-017**

Boring No.	Depth Range, Feet		pH (FM 5-550)	Resistivity (ohm-cm) (FM 5-551)	Chlorides (ppm) (FM 5-552)	Sulfates (ppm) (FM 5-553)	Environmental Classification (Soil)*	
	From	To					Steel	Concrete
B-1	4	6	7.0	5,000	30	27.8	Moderately Aggressive	Moderately Aggressive
S-1	4	6	7.9	1,000	135	402.1	Extremely Aggressive	Moderately Aggressive

*As per FDOT Structures Design Guidelines, Table 1.1

LIMEROCK BEARING RATIO TEST REPORT FM 5-515



S&ME, Inc. Tampa, 111 Kelsey Lane, Suite E / Florida 33619/ p 813-623-6646 fax 813-623-3795
Florida Certificate of Authorization No. 6712

PROJECT: TECO Solar Project

REPORT DATE: July 13, 2015

CLIENT : TECO

JOB NO: 1484-15-017

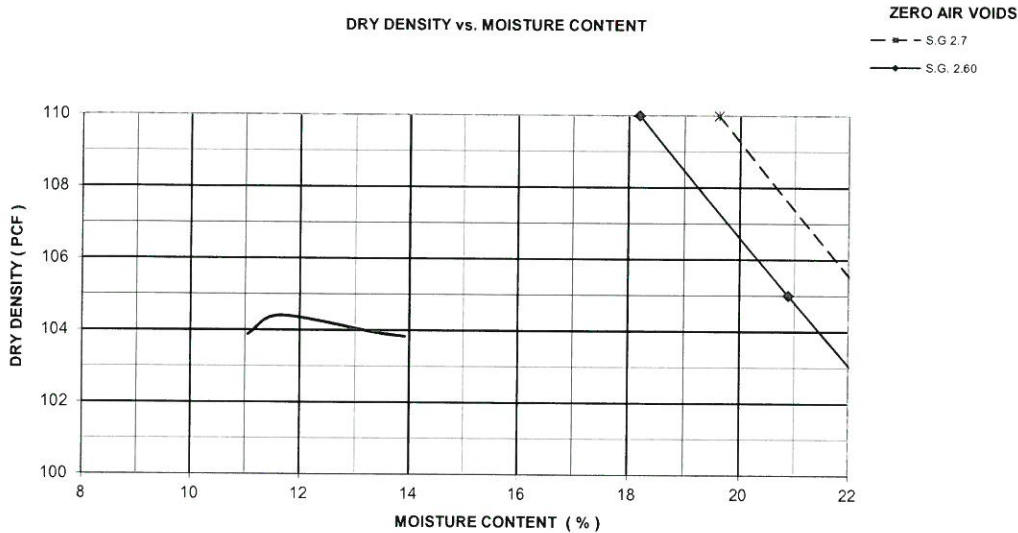
COPIES: TECO

LBR SAMPLE NO: L1

REPORT NO: NA

SAMPLE LOCATION: R1	DATE SAMPLED: 7/2/2015
SOIL DESCRIPTION: Brown sand	SAMPLED BY: G. Zoeller

DRY DENSITY vs. MOISTURE CONTENT



DATE COMPACTED: 7/8/2015

DATE PENETRATED: 7/10/2015

TESTED BY: A. Lawrence

ANTICIPATED USE OF SOIL: Subgrade

SURCHARGE: 20 lb

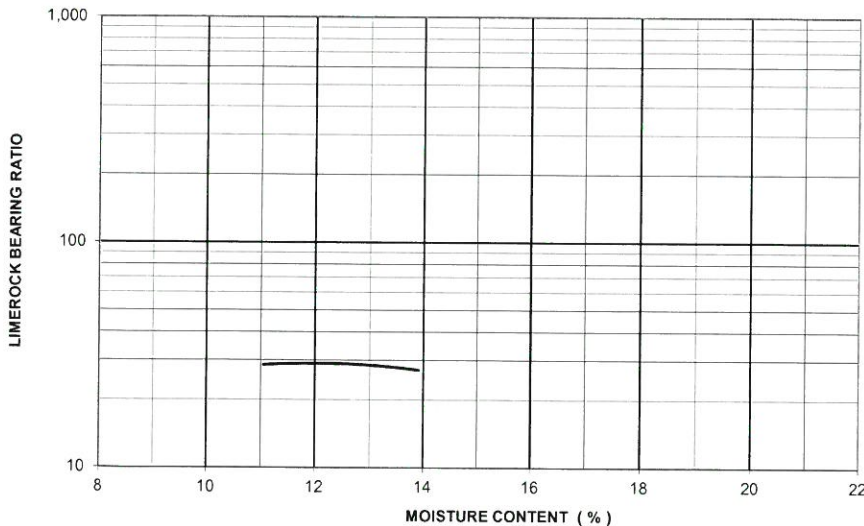
AASHTO CLASSIFICATION *: -

USCS CLASSIFICATION *: -

* classifications based on visual methods

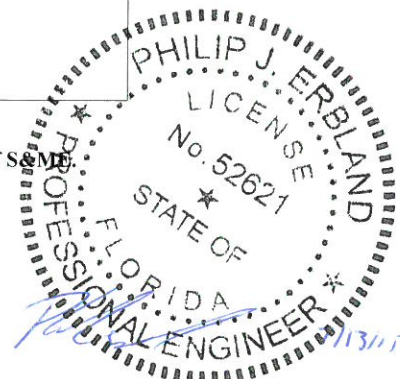
MAXIMUM DRY DENSITY (pcf):
104.4OPT. MOISTURE CONTENT (%):
11.6

LIMEROCK BEARING RATIO vs. MOISTURE CONTENT

LIMEROCK BEARING RATIO (LBR):
28MINIMUM REQUIRED LBR:
NA

Sampling performed as outlined in practice ASTM D75 (AASHTO T2)

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Appendix III – Field and Laboratory Test Procedures

FIELD AND LABORATORY TEST PROCEDURES

Soil Test Boring Procedures (ASTM D1586)

The borings were advanced by a rotary drilling process which utilized a viscous bentonite drilling fluid to flush the cuttings and stabilize the hole. At regular intervals, the drilling tools were withdrawn and soil samples obtained with a standard 1 $\frac{3}{8}$ -inch inside diameter, 2-inch outside diameter, split tube sampler in general accordance with ASTM D1586.

The sampler was initially seated 6 inches to penetrate any loose cuttings then driven an additional foot to 1 $\frac{1}{2}$ feet with blows of a 140-pound hammer falling 30 inches. The number of hammer blows required to drive the sampler the foot increment after the 6-inch seating blows was recorded and is designated as the standard penetration resistance, N-value. Penetration resistance is an index to the soil's strength and density.

The samples were classified in the field by an engineering technician as they were obtained. Representative portions of each soil sample were then sealed in containers and transported to our laboratory. The samples were examined by a geotechnical engineer to visually check the field classification. Boring data, including sampling intervals, penetration resistance N-values, soil classifications, and groundwater level are presented on the Soil Profiles.

Rock Coring (ASTM D2113)

Once competent limestone was encountered, an HWG-size core barrel was used to obtain nominal 3-inch-diameter core samples. Coring was completed in 5 foot-long runs. Recovered cores were photographed, placed in core boxes, and transported to our laboratory. The samples were examined by a geotechnical engineer to visually check the field classification. Core data, including recovery and RQD, are presented on the Soil Profiles. Coring was performed in general accordance with ASTM D2113.

Hand Auger Boring Procedures (ASTM D1452)

The hand auger borings are performed in general accordance with ASTM D1452. A 6-inch-long bucket is manually advanced into the soil in approximate 6-inch intervals. The soil is removed from the auger hole at each interval and the samples were classified in the field by an engineering technician as they were obtained. Representative portions of each soil sample were then sealed in containers and transported to our laboratory. The samples were examined by a geotechnical engineer to visually check the field classification.

Determination of Soils Finer than No. 200 Sieve (ASTM D1140)

The clay and silt content of granular soils affects their physical properties such as strength, compressibility, and permeability. Selected samples were tested to determine the percent, by weight, of soil particles finer than the No. 200 sieve (silt and clay size particles). Soil particles finer than 75 microns were flushed through a No. 200 sieve using water. The coarse materials retained on the No. 200 sieve were dried to obtain their dry weight. The dry weight of materials retained on the No. 200 sieve was compared to the dry weight of the total test specimen. The difference in weight, expressed as a percentage of the pre-wash weight, is designated as the percentage of "fines" (silt and clay size particles).

Environmental Classification (FM 5-550 to 5-553)

Environmental corrosion tests were conducted in for this project. Environmental corrosion tests were conducted in accordance with FDOT test designations FM 5-550, FM 5-551, FM 5-552, and FM 5-553. The environmental corrosion tests are used to measure soil parameters such as pH, resistivity, and sulfate and chloride content.

Limerock Bearing Ratio Test (FM 5-515)

The LBR test was performed in accordance with FDOT test designation FM 5-515 including a Modified Proctor test. The LBR test is a measure of the bearing capacity of a soil. The test consists of measuring the load required to cause a standard circular plunger to penetrate a specimen at a specified rate. The LBR is the load in psi required to force the plunger into the soil 0.1 inch expressed as a percentage of the load in psi required to force the same plunger the same depth into a standard sample of crushed limerock which is 800 psi.

APPENDIX I – CULVERT ANALYSIS WORKSHEETS

Culvert Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc.

Thursday, Feb 18 2016

Culvert A2

Invert Elev Dn (ft) = 5.58
Pipe Length (ft) = 55.00
Slope (%) = 0.25
Invert Elev Up (ft) = 5.72
Rise (in) = 15.0
Shape = Circular
Span (in) = 15.0
No. Barrels = 1
n-Value = 0.010
Culvert Type = Circular Culvert
Culvert Entrance = Smooth tapered inlet throat
Coeff. K,M,c,Y,k = 0.534, 0.555, 0.0196, 0.9, 0.2

Embankment

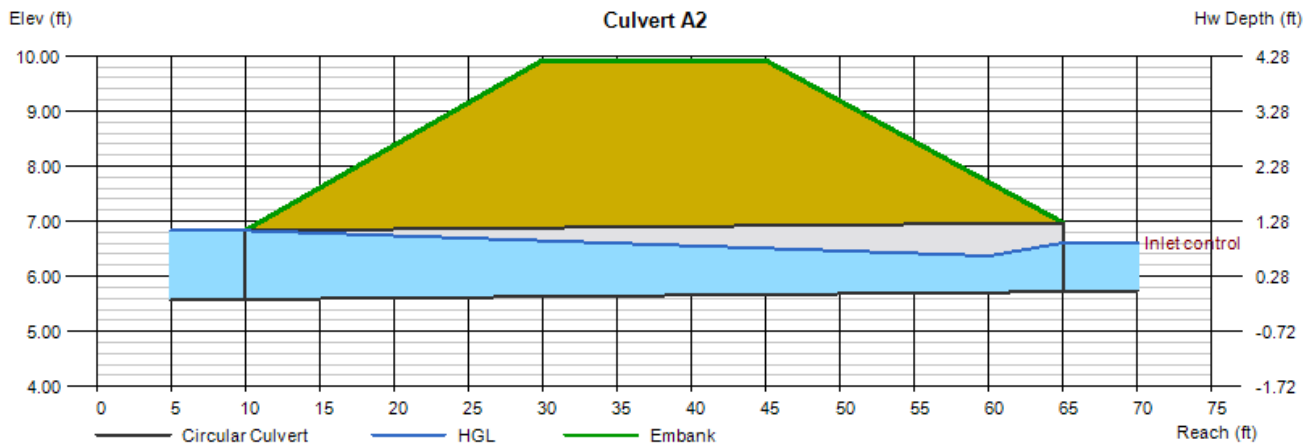
Top Elevation (ft) = 9.92
Top Width (ft) = 15.00
Crest Width (ft) = 30.00

Calculations

Qmin (cfs) = 0.00
Qmax (cfs) = 2.29
Tailwater Elev (ft) = Crown

Highlighted

Qtotal (cfs) = 2.29
Qpipe (cfs) = 2.29
Qovertop (cfs) = 0.00
Veloc Dn (ft/s) = 1.87
Veloc Up (ft/s) = 3.90
HGL Dn (ft) = 6.83
HGL Up (ft) = 6.32
Hw Elev (ft) = 6.61
Hw/D (ft) = 0.71
Flow Regime = Inlet Control



Culvert Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc.

Friday, Mar 4 2016

Culvert B2

Invert Elev Dn (ft) = 4.83
Pipe Length (ft) = 31.50
Slope (%) = 0.51
Invert Elev Up (ft) = 4.99
Rise (in) = 24.0
Shape = Elliptical
Span (in) = 38.0
No. Barrels = 3
n-Value = 0.010
Culvert Type = Horizontal Ellipse Concrete
Culvert Entrance = Square edge w/headwall (H)
Coeff. K,M,c,Y,k = 0.01, 2, 0.0398, 0.67, 0.5

Embankment

Top Elevation (ft) = 8.25
Top Width (ft) = 15.00
Crest Width (ft) = 30.00

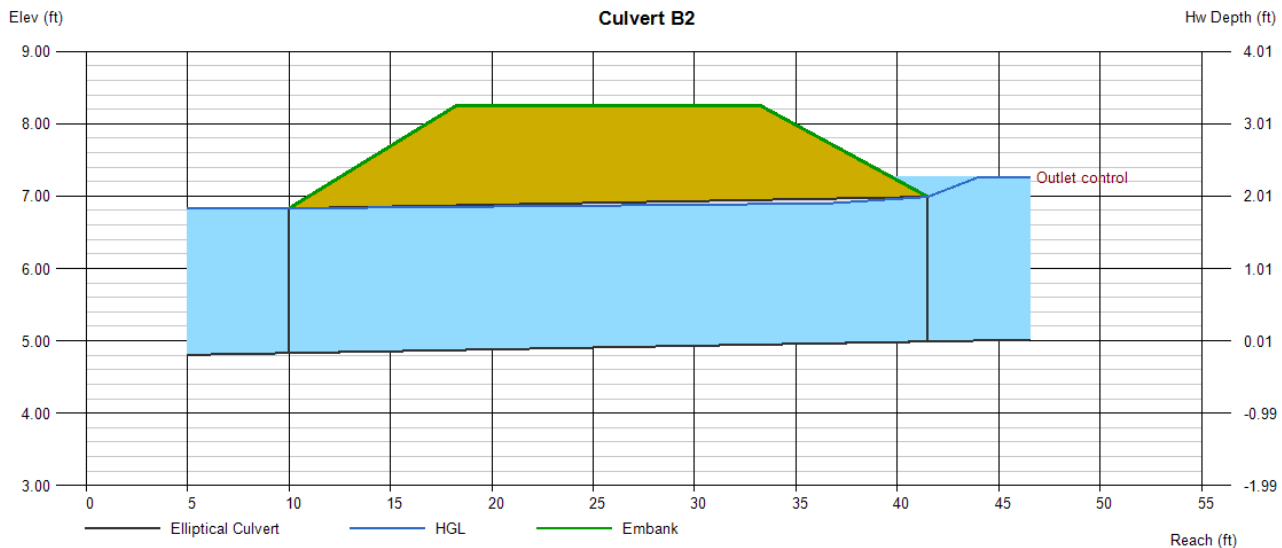
Calculations

Qmin (cfs) = 0.00
Qmax (cfs) = 57.11
Tailwater Elev (ft) = Crown

Highlighted

Qtotal (cfs) = 57.11
Qpipe (cfs) = 57.11
Qovertop (cfs) = 0.00
Veloc Dn (ft/s) = 3.83
Veloc Up (ft/s) = 3.89
HGL Dn (ft) = 6.83
HGL Up (ft) = 6.91
Hw Elev (ft) = 7.26
Hw/D (ft) = 1.14
Flow Regime = Outlet Control

25 YEAR
STORM
FROM
EPSWMM
MODEL



Culvert Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc.

Thursday, Feb 18 2016

Culvert C2

Invert Elev Dn (ft) = 7.05
Pipe Length (ft) = 35.00
Slope (%) = 0.20
Invert Elev Up (ft) = 7.12
Rise (in) = 15.0
Shape = Circular
Span (in) = 15.0
No. Barrels = 1
n-Value = 0.010
Culvert Type = Circular Culvert
Culvert Entrance = Smooth tapered inlet throat
Coeff. K,M,c,Y,k = 0.534, 0.555, 0.0196, 0.9, 0.2

Embankment

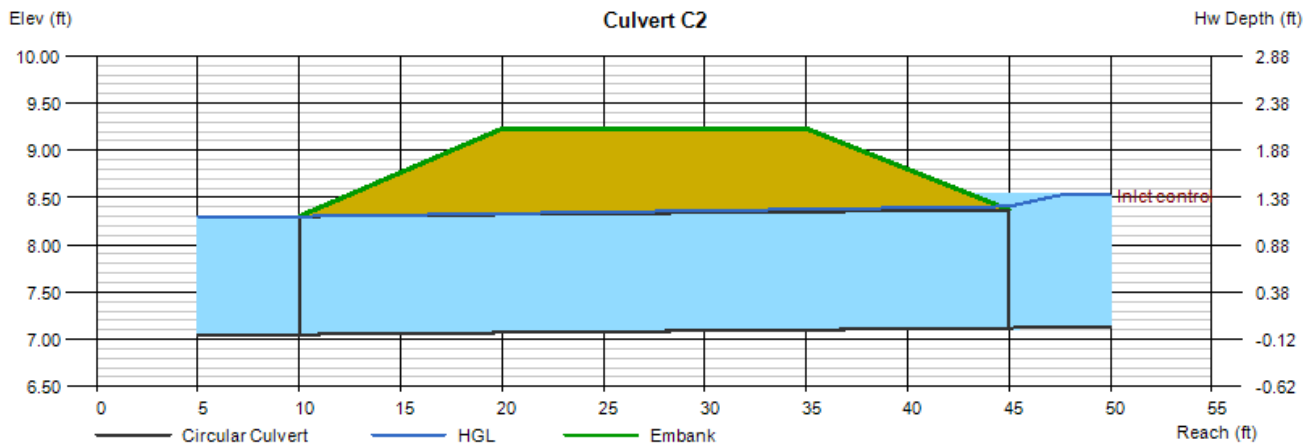
Top Elevation (ft) = 9.23
Top Width (ft) = 15.00
Crest Width (ft) = 30.00

Calculations

Qmin (cfs) = 0.00
Qmax (cfs) = 4.65
Tailwater Elev (ft) = Crown

Highlighted

Qtotal (cfs) = 4.65
Qpipe (cfs) = 4.65
Qovertop (cfs) = 0.00
Veloc Dn (ft/s) = 3.79
Veloc Up (ft/s) = 3.79
HGL Dn (ft) = 8.30
HGL Up (ft) = 8.41
Hw Elev (ft) = 8.53
Hw/D (ft) = 1.12
Flow Regime = Inlet Control



Culvert Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc.

Thursday, Feb 18 2016

Culvert D2

Invert Elev Dn (ft) = 5.87
Pipe Length (ft) = 34.00
Slope (%) = 0.15
Invert Elev Up (ft) = 5.92
Rise (in) = 15.0
Shape = Circular
Span (in) = 15.0
No. Barrels = 1
n-Value = 0.010
Culvert Type = Circular Culvert
Culvert Entrance = Smooth tapered inlet throat
Coeff. K,M,c,Y,k = 0.534, 0.555, 0.0196, 0.9, 0.2

Embankment

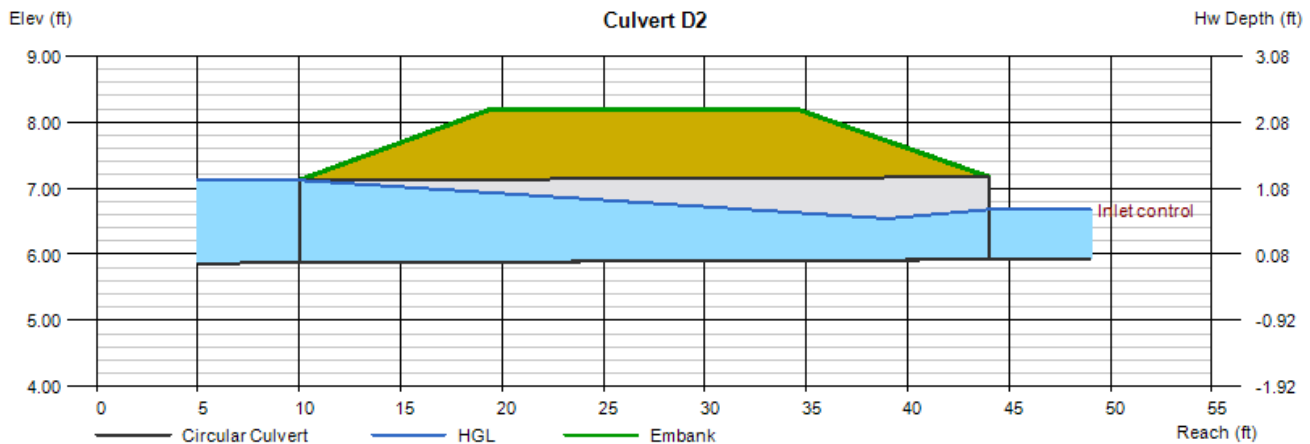
Top Elevation (ft) = 8.20
Top Width (ft) = 15.00
Crest Width (ft) = 30.00

Calculations

Qmin (cfs) = 0.00
Qmax (cfs) = 1.72
Tailwater Elev (ft) = Crown

Highlighted

Qtotal (cfs) = 1.72
Qpipe (cfs) = 1.72
Qovertop (cfs) = 0.00
Veloc Dn (ft/s) = 1.40
Veloc Up (ft/s) = 3.56
HGL Dn (ft) = 7.12
HGL Up (ft) = 6.44
Hw Elev (ft) = 6.68
Hw/D (ft) = 0.61
Flow Regime = Inlet Control



Culvert Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc.

Thursday, Feb 18 2016

Culvert E2

Invert Elev Dn (ft) = 5.41
Pipe Length (ft) = 26.00
Slope (%) = 0.23
Invert Elev Up (ft) = 5.47
Rise (in) = 15.0
Shape = Circular
Span (in) = 15.0
No. Barrels = 1
n-Value = 0.010
Culvert Type = Circular Culvert
Culvert Entrance = Smooth tapered inlet throat
Coeff. K,M,c,Y,k = 0.534, 0.555, 0.0196, 0.9, 0.2

Embankment

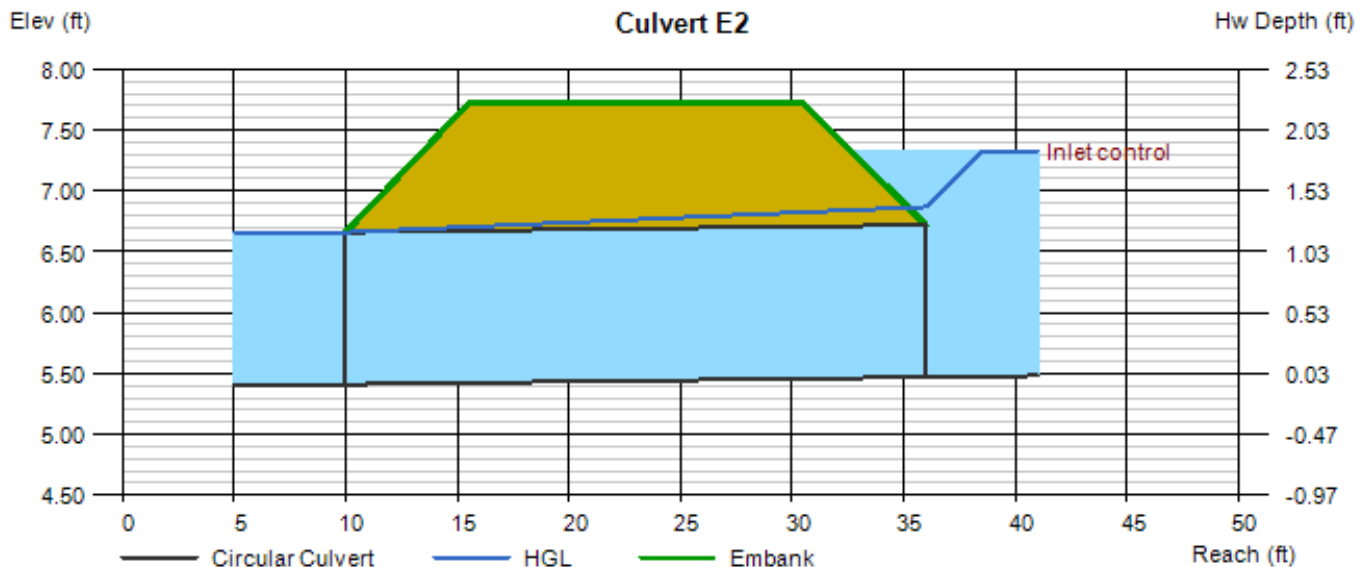
Top Elevation (ft) = 7.72
Top Width (ft) = 15.00
Crest Width (ft) = 30.00

Calculations

Qmin (cfs) = 0.00
Qmax (cfs) = 7.51
Tailwater Elev (ft) = Crown

Highlighted

Qtotal (cfs) = 7.51
Qpipe (cfs) = 7.51
Qovertop (cfs) = 0.00
Veloc Dn (ft/s) = 6.12
Veloc Up (ft/s) = 6.12
HGL Dn (ft) = 6.66
HGL Up (ft) = 6.87
Hw Elev (ft) = 7.33
Hw/D (ft) = 1.49
Flow Regime = Inlet Control



Culvert Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc.

Thursday, Feb 18 2016

Culvert F2

Invert Elev Dn (ft) = 6.00
Pipe Length (ft) = 24.00
Slope (%) = 0.25
Invert Elev Up (ft) = 6.06
Rise (in) = 15.0
Shape = Circular
Span (in) = 15.0
No. Barrels = 1
n-Value = 0.010
Culvert Type = Circular Culvert
Culvert Entrance = Smooth tapered inlet throat
Coeff. K,M,c,Y,k = 0.534, 0.555, 0.0196, 0.9, 0.2

Embankment

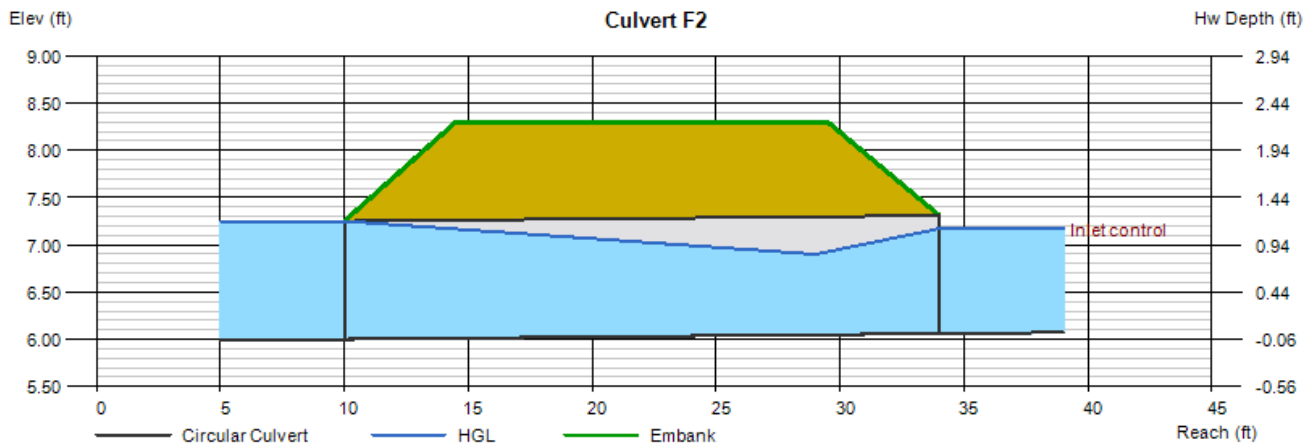
Top Elevation (ft) = 8.30
Top Width (ft) = 15.00
Crest Width (ft) = 30.00

Calculations

Qmin (cfs) = 0.00
Qmax (cfs) = 3.44
Tailwater Elev (ft) = Crown

Highlighted

Qtotal (cfs) = 3.44
Qpipe (cfs) = 3.44
Qovertop (cfs) = 0.00
Veloc Dn (ft/s) = 2.80
Veloc Up (ft/s) = 4.49
HGL Dn (ft) = 7.25
HGL Up (ft) = 6.81
Hw Elev (ft) = 7.17
Hw/D (ft) = 0.89
Flow Regime = Inlet Control



Culvert Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc.

Thursday, Feb 18 2016

Culvert G2

Invert Elev Dn (ft) = 6.02
Pipe Length (ft) = 23.00
Slope (%) = 0.26
Invert Elev Up (ft) = 6.08
Rise (in) = 15.0
Shape = Circular
Span (in) = 15.0
No. Barrels = 1
n-Value = 0.010
Culvert Type = Circular Culvert
Culvert Entrance = Smooth tapered inlet throat
Coeff. K,M,c,Y,k = 0.534, 0.555, 0.0196, 0.9, 0.2

Embankment

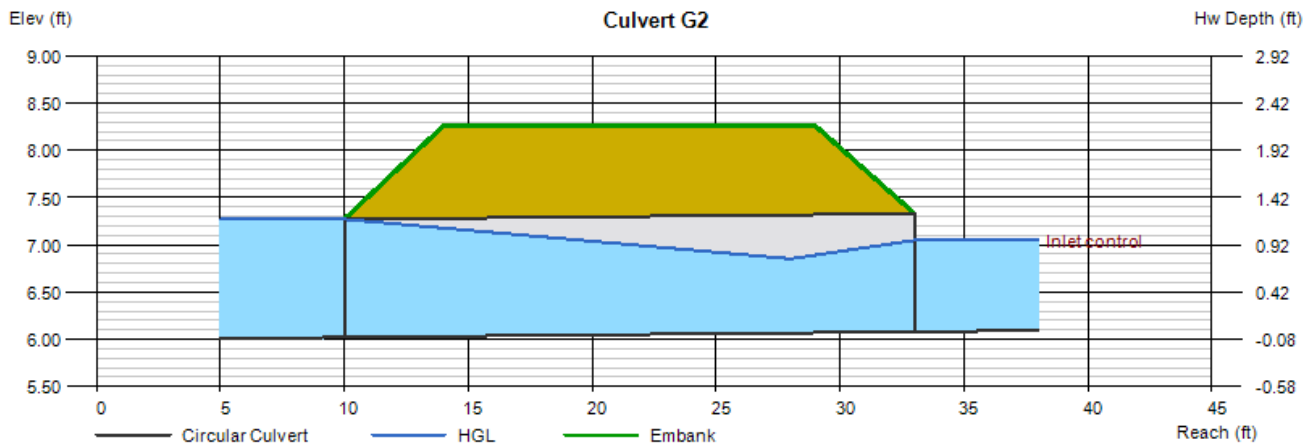
Top Elevation (ft) = 8.26
Top Width (ft) = 15.00
Crest Width (ft) = 30.00

Calculations

Qmin (cfs) = 0.00
Qmax (cfs) = 2.68
Tailwater Elev (ft) = Crown

Highlighted

Qtotal (cfs) = 2.68
Qpipe (cfs) = 2.68
Qovertop (cfs) = 0.00
Veloc Dn (ft/s) = 2.18
Veloc Up (ft/s) = 4.11
HGL Dn (ft) = 7.27
HGL Up (ft) = 6.74
Hw Elev (ft) = 7.05
Hw/D (ft) = 0.77
Flow Regime = Inlet Control



Culvert Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc.

Thursday, Feb 18 2016

Culvert H2

Invert Elev Dn (ft) = 5.40
Pipe Length (ft) = 19.00
Slope (%) = 0.21
Invert Elev Up (ft) = 5.44
Rise (in) = 15.0
Shape = Circular
Span (in) = 15.0
No. Barrels = 2
n-Value = 0.010
Culvert Type = Circular Culvert
Culvert Entrance = Smooth tapered inlet throat
Coeff. K,M,c,Y,k = 0.534, 0.555, 0.0196, 0.9, 0.2

Embankment

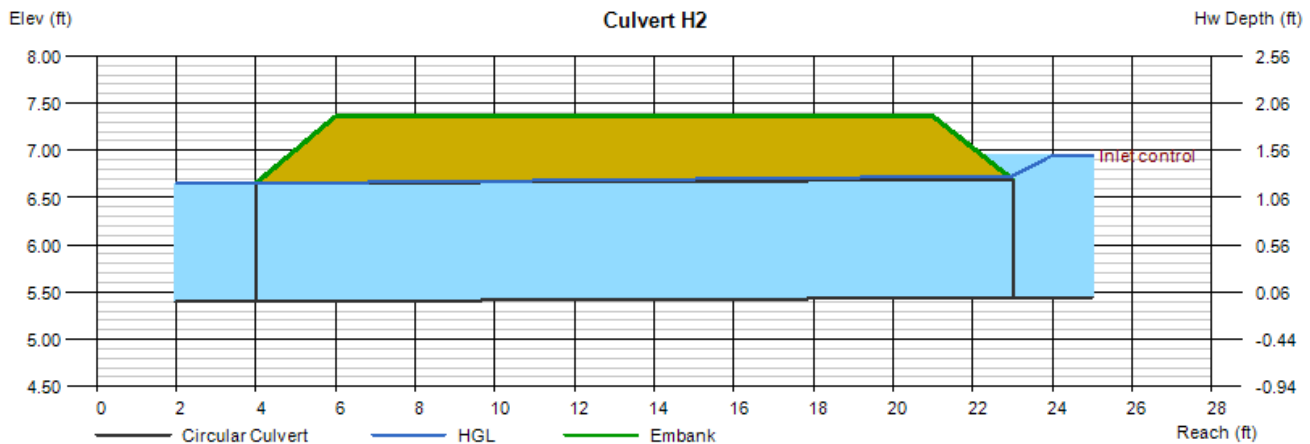
Top Elevation (ft) = 7.36
Top Width (ft) = 15.00
Crest Width (ft) = 30.00

Calculations

Qmin (cfs) = 0.00
Qmax (cfs) = 10.84
Tailwater Elev (ft) = Crown

Highlighted

Qtotal (cfs) = 10.84
Qpipe (cfs) = 10.84
Qovertop (cfs) = 0.00
Veloc Dn (ft/s) = 4.42
Veloc Up (ft/s) = 4.42
HGL Dn (ft) = 6.65
HGL Up (ft) = 6.73
Hw Elev (ft) = 6.95
Hw/D (ft) = 1.20
Flow Regime = Inlet Control



Culvert Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc.

Thursday, Feb 11 2016

Culvert J2

Invert Elev Dn (ft) = 4.39
Pipe Length (ft) = 34.00
Slope (%) = 0.50
Invert Elev Up (ft) = 4.56
Rise (in) = 48.0
Shape = Circular
Span (in) = 48.0
No. Barrels = 1
n-Value = 0.010
Culvert Type = Circular Culvert
Culvert Entrance = Smooth tapered inlet throat
Coeff. K,M,c,Y,k = 0.534, 0.555, 0.0196, 0.9, 0.2

Embankment

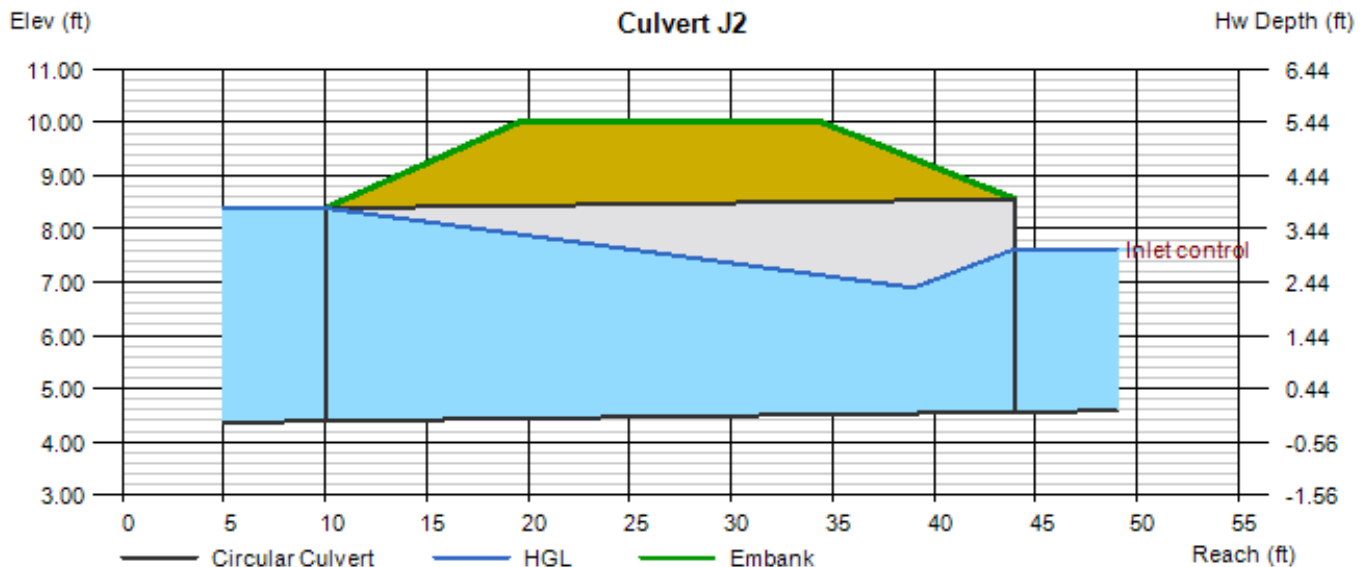
Top Elevation (ft) = 10.00
Top Width (ft) = 15.00
Crest Width (ft) = 30.00

Calculations

Qmin (cfs) = 0.00
Qmax (cfs) = 48.12
Tailwater Elev (ft) = Crown

Highlighted

Qtotal (cfs) = 48.12
Qpipe (cfs) = 48.12
Qovertop (cfs) = 0.00
Veloc Dn (ft/s) = 3.83
Veloc Up (ft/s) = 7.30
HGL Dn (ft) = 8.39
HGL Up (ft) = 6.64
Hw Elev (ft) = 7.62
Hw/D (ft) = 0.77
Flow Regime = Inlet Control





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