

## J.H. Campbell Generating Facility

### *Dry Ash Landfill Cell 6 Expansion - Run-On and Run-Off Control System Plan*

Pursuant to:

40 CFR 257.81

Submitted to:

**Consumers Energy Company**

1945 W. Parnall Road  
Jackson, Michigan USA 49201

Submitted by:

**Golder Associates Inc.**

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21451121

October 2021



## CERTIFICATION

### Professional Engineer Certification Statement [40 CFR 257.81(c)]

I hereby certify that, having reviewed the attached documentation and being familiar with the provisions of Title 40 of the Code of Federal Regulations Section 257.81 (40 CFR Part 257.81), I attest that this Run-on and Run-off Control System Plan is accurate and has been prepared in accordance with good engineering practices, including the consideration of applicable industry standards, and with the requirements of 40 CFR Part 257.81.

Golder Associates Inc.



10/11/2021

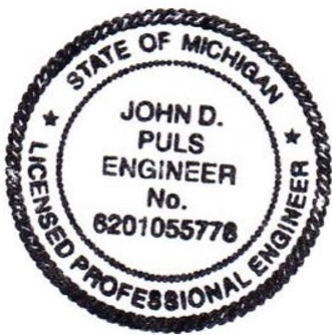
Date of Report Certification

John D. Puls, PE

Name

6201055778

Professional Engineer Certification Number



# Table of Contents

**1.0 INTRODUCTION ..... 1**

    1.1 Background ..... 1

    1.2 Purpose ..... 1

**2.0 RUN-ON AND RUN-OFF CONTROLS ..... 1**

    2.1 Run-on Control System ..... 1

    2.2 Run-off Control System ..... 2

**3.0 PLAN REVISION AND RECORDKEEPING ..... 3**

**4.0 REFERENCES ..... 4**

## TABLES

- Table 2.1.1 - 24-hour 25-year Storm Run-on Summary
- Table 2.2.1 - 24-hour 25-year Storm Run-off Summary

## FIGURES

- Figure 1 - Site Location Map
- Figure 2 - Probable Fill Progression Condition

## APPENDICES

### APPENDIX A

Rainfall Data

### APPENDIX B

Hydrologic and Hydraulic Model Output

## 1.0 INTRODUCTION

### 1.1 Background

J.H. Campbell Generating Facility (JH Campbell) is a coal-fired power generation facility located near West Olive, Michigan, as presented on Figure 1 – Site Location Map. The JH Campbell Dry Ash Landfill (Dry Ash Landfill) serves as the facility's primary disposal for dry ash and consists of six dual composite lined landfill cells and two leachate storage ponds. The Dry Ash Landfill utilizes a dual composite liner system with primary and secondary leachate collection layers between each composite liner. The total permitted capacity of the Dry Ash Landfill is 10,032,000 cubic yards (cy). As of March 25, 2021, approximately 5,331,095 cy of airspace was consumed per an airspace evaluation completed by Golder Associates Inc. (Golder).

### 1.2 Purpose

Per 40 CFR 257.81, the owner or operator of an existing or new Coal Combustion Residual (CCR) landfill or any lateral expansion of a CCR landfill must design, construct, operate, and maintain:

- A run-on control system to prevent flow onto the active portion of the CCR unit during the peak discharge from a 24-hour 25-year storm
- A run-off control system from the active portion of the CCR unit to collect and control at least the water volume resulting from a 24-hour 25-year storm

The JH Campbell Dry Ash Landfill Cell 6 Expansion is considered a lateral expansion of a CCR landfill; and therefore, is required to comply with 40 CFR 257.81.

## 2.0 RUN-ON AND RUN-OFF CONTROLS

To meet the requirements of 40 CFR 257.81(a), the run-on and run-off control system must prevent flow onto the active portion of the CCR unit during the peak discharge from a 24-hour 25-year storm and collect and control at least the water volume resulting from a 24-hour 25-year storm. The 24-hour 25-year storm depth is 4.97 inches, as provided in Appendix A – Rainfall Data. Run-off from the active portion of the CCR unit must be handled in accordance with the surface water requirements under 40 CFR 257.3-3.

The Run-on and Run-off Control System Plan was developed by assessing the 2018-2023 Dry Ash Landfill Cell Construction, Filling, and Final Cover Plan (Golder 2018) for a probable grading scenario that could be modeled with the 24-hour 25-year storm event to document certification pursuant to 40 CFR 257.81. The probable grading scenario is provided in Figure 2 – Probable Fill Progression Condition.

### 2.1 Run-on Control System

Run-on to the active portions of the Dry Ash Landfill is controlled using two methods. The first method is a perimeter berm around the landfill that creates a barrier that does not allow stormwater to enter the active areas. A drainage channel exists on the outboard slope of the perimeter berm that collects stormwater from the adjacent areas and directs it towards the site's National Pollutant Discharge Elimination System (NPDES) outfall in accordance with Permit No. MI0001422.

The second method is positive grading away from the active areas so that run-off from closed areas (non-contact water) is not diverted into the leachate collection system. The South Drainage Ditch collects stormwater from the South Drainage Watershed that includes closed portions of Cells 1 through 4 (50.18 acres). The South Drainage Ditch directs stormwater from closed portions of the landfill to the site's NPDES outfall.

The perimeter berm elevations and stormwater run-on were modeled using topography acquired as part of the airspace evaluation (Golder 2021). The model indicates that the 24-hour 25-year storm event (summarized in Table 2.1.1) will not run onto active portions of the landfill. Model outputs are provided in Appendix B – Hydraulic and Hydrologic Model Output, and approximate drainage patterns are provided on Figure 2.

**Table 2.1.1 - 24-hour 25-year Storm Run-on Summary**

Channel	24-hr, 25-yr Flow (cfs)	24-hr, 25-yr Flow Elevation (ft)	Perimeter Berm Elevation (ft)	24-hr, 25-yr Freeboard (ft)
South Drainage	186.78	606.1	631.9	25.8
West Drainage	66.68	608.0	615.4	7.4

Note: Elevations provided are in J.H. Campbell Plant Datum (NGVD29)

## 2.2 Run-off Control System

Run-off from active portions of the Dry Ash Landfill is controlled within the active landfill cells. Precipitation that comes in contact with CCR infiltrates within the unit and is collected in leachate pipes, where it is then pumped from a sump to catch basins and drained via gravity to the leachate holding ponds. The run-off control system was developed with two active area watersheds, as shown on Figure 2. Active Area 1 is 16.4 acres and has a west perimeter berm that ranges from elevation 619.2 to 624.0 feet NGVD29 and a south perimeter berm that extends to elevation 616.0 feet NGVD29. Active Area 2 is 11.5 acres and has a west perimeter berm that ranges from elevation 615.4 to 626.4 feet NGVD29 and a south perimeter berm that ranges from elevation 631.9 to 632.0 feet NGVD29.

Active Area 1 was modeled with topography that was acquired as part of the airspace evaluation (Golder 2021). Active Area 2 was modeled with probable grading conditions that were presented in 2018-2023 Dry Ash Landfill Cell Construction, Filling, and Final Cover Plan (Golder 2018). The volume of run-off from the 24-hour 25-year storm event in Active Area 1 and Active Area 2 is contained by the landfill perimeter berms. The run-off calculations are summarized in Table 2.2.1 and are presented in Appendix B – Hydraulic and Hydrologic Model Output.

**Table 2.2.1 - 24-hour 25-year Storm Run-off Summary**

Dry Ash Landfill Area	Volume of Run-off (Acre-feet)	Minimum Berm Elevation (NGVD29)	Peak Water Elevation (NGVD29)	Peak Outflow (cfs)
Active Area 1	3.785	616.0	615.7	0.3
Active Area 2	4.227	615.4	611.9	0.3

Note: Elevations provided are in J.H. Campbell Plant Datum (NGVD29)

### 3.0 PLAN REVISION AND RECORDKEEPING

Per 40 CFR 257.81(c)(2); “The owner or operator may amend the written run-on and run-off control system plan at any time provided the revised plan is placed in the facility’s operating record, as required by §257.105(g)(3). The owner or operator must amend the written run-on and run-off control system plan whenever there is a change in conditions that would substantially affect the written plan in effect.”

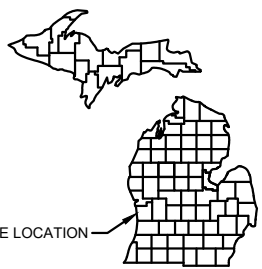
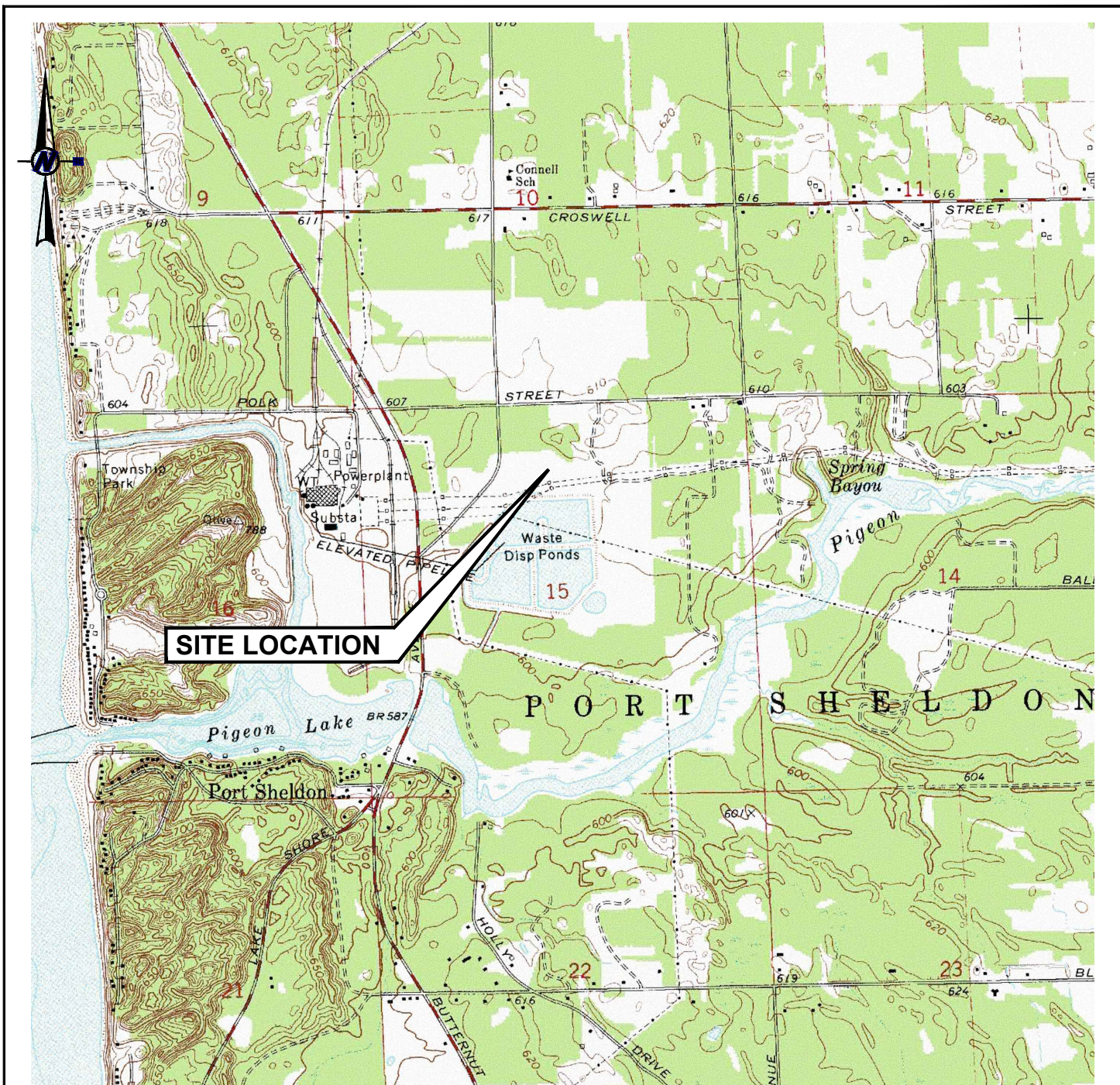
Per 40 CFR 257.81(c)(4); “The owner or operator of the CCR unit must prepare periodic run-on and run-off control system plans required by paragraph (c)(1) of this section every five years. The date of completing the initial plan is the basis for establishing the deadline to complete the first subsequent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

## 4.0 REFERENCES

- Golder Associates Inc. May 22, 2018. 2018-2023 Dry Ash Landfill Cell Construction, Filling, and Final Cover Plan.
- Golder Associates Inc. March 25, 2021. AutoCAD Civil 3D JHC Survey Data. Collected by drone and conventional GPS ground survey on March 25, 2021.
- Golder Associates Inc. July 13, 2021. Landfill Expansion Permit Application, J.H. Campbell Generating Facility – Dry Ash Landfill, Type III Expansion, Facility ID 395496, West Olive, Michigan.
- NOAA's National Weather Service. August 2014. Hydrometeorological Design Studies. Precipitation Frequency Data Server (PFDS). <http://hdsc.nws.noaa.gov/hdsc/pfds/>. (Appendix A).
- USEPA (US Environmental Protection Agency). 2015. Disposal of Coal Combustion Residuals from Electric Utilities; Final Rule. 40 CFR Part 257. Effective Date October 19, 2015.

## Figures

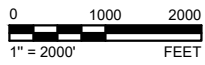




**MICHIGAN COUNTIES**  
NOT TO SCALE

**REFERENCE(S)**

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



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

CONSULTANT	YYYY-MM-DD	2018-11-08
	DESIGNED	HD
	PREPARED	DS
	REVIEWED	JP
	APPROVED	



PROJECT  
**J.H. CAMPBELL GENERATING FACILITY**  
 DRY ASH LANDFILL RUN-ON AND RUN-OFF CONTROL  
 SYSTEM PLAN

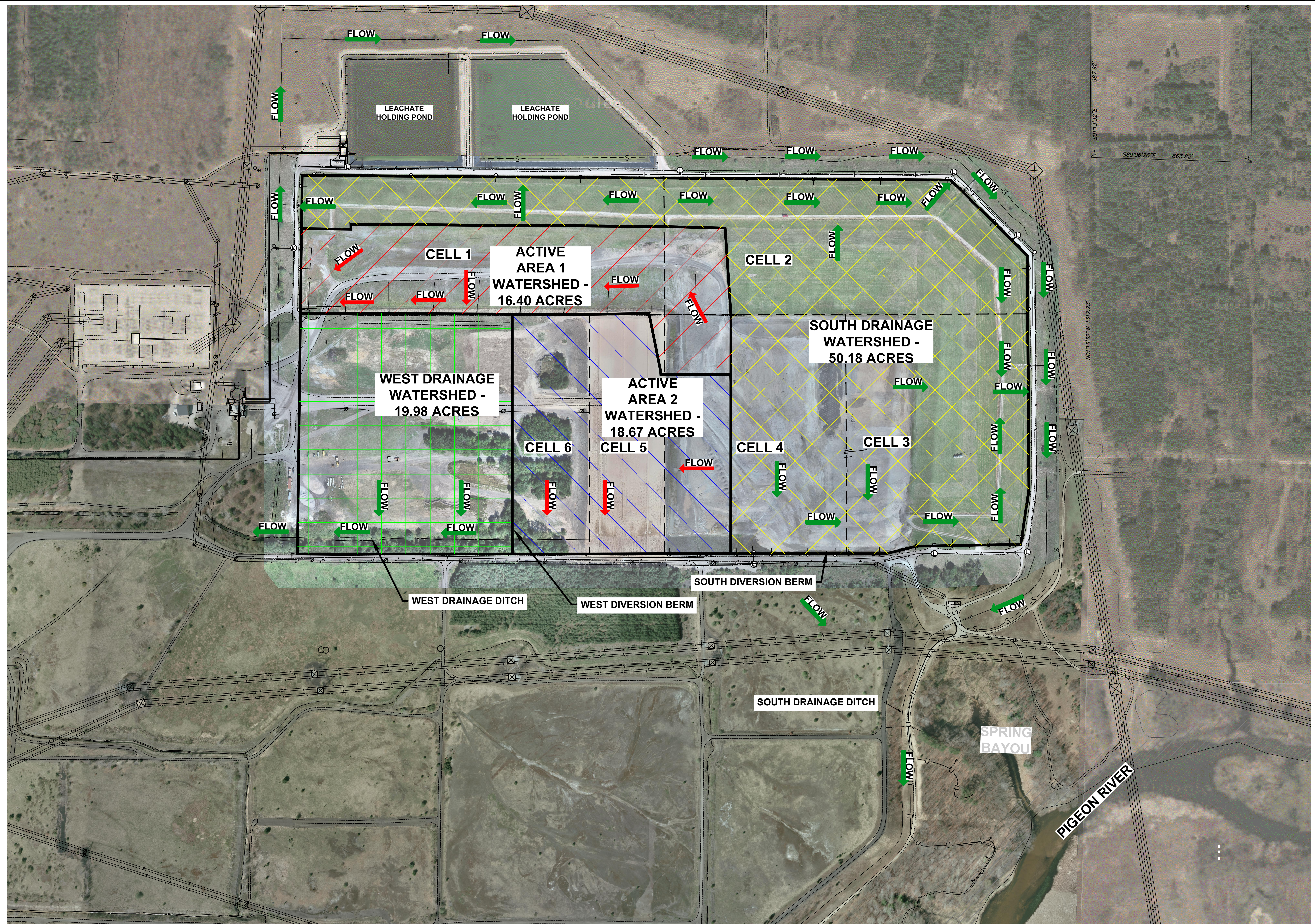
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**SITE LOCATION MAP**

PROJECT NO.  
 21451121

REV. \_\_\_\_\_  
 FIGURE **1**

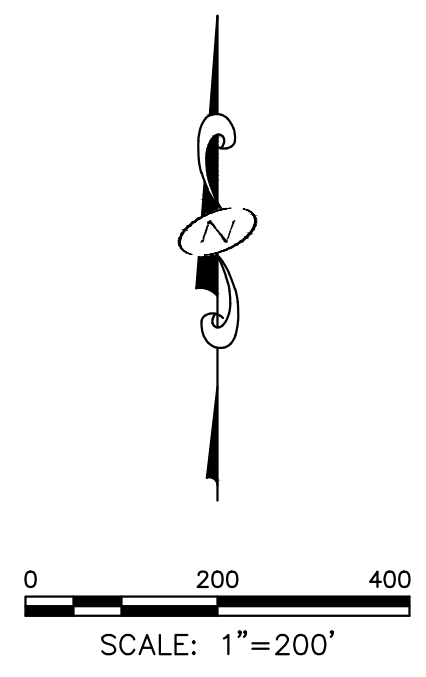
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**LEGEND**

- MONITORING WELL
- CONTACT WATER FLOW
- NON-CONTACT WATER FLOW
- SOUTH DRAINAGE WATERSHED
- ACTIVE AREA 1 WATERSHED
- ACTIVE AREA 2 WATERSHED
- WEST DRAINAGE WATERSHED



REFERENCE DRAWINGS	REV	DATE	DESCRIPTION	BY	CHK	APP	REV	DATE	DESCRIPTION	BY	CHK	APP
							C	08/06/2021	2021 UPDATE	DS	JH	JP
							B	12/05/2018	2018 UPDATE	DS	HD	JP
							A	10/6/2016	FILED IN OWNER'S OPERATING RECORD	AM	DS	JP



J.H. CAMPBELL ASH STORAGE FACILITY

**LANDFILL CLOSURE PLAN**  
PROBABLE FILL PROGRESSION CONDITIONS

SCALE 1" = 200'	DRAWING NO.	FIGURE	UNIT#
JOB 21451121		<b>2</b>	<b>C</b>

**APPENDIX A**

## Rainfall Data



**NOAA Atlas 14, Volume 8, Version 2**  
**Location name: West Olive, Michigan, USA\***  
**Latitude: 42.9147°, Longitude: -86.1836°**  
**Elevation: 609.22 ft\*\***  
 \* source: ESRI Maps  
 \*\* source: USGS



**POINT PRECIPITATION FREQUENCY ESTIMATES**

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

NOAA, National Weather Service, Silver Spring, Maryland

[PF\\_tabular](#) | [PF\\_graphical](#) | [Maps & aeriels](#)

**PF tabular**

<b>PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)<sup>1</sup></b>										
<b>Duration</b>	<b>Average recurrence interval (years)</b>									
	<b>1</b>	<b>2</b>	<b>5</b>	<b>10</b>	<b>25</b>	<b>50</b>	<b>100</b>	<b>200</b>	<b>500</b>	<b>1000</b>
<b>5-min</b>	<b>0.307</b> (0.251-0.383)	<b>0.362</b> (0.295-0.451)	<b>0.458</b> (0.372-0.572)	<b>0.544</b> (0.439-0.682)	<b>0.670</b> (0.525-0.877)	<b>0.775</b> (0.590-1.02)	<b>0.885</b> (0.648-1.20)	<b>1.00</b> (0.702-1.39)	<b>1.17</b> (0.784-1.66)	<b>1.30</b> (0.845-1.87)
<b>10-min</b>	<b>0.450</b> (0.367-0.560)	<b>0.530</b> (0.432-0.661)	<b>0.671</b> (0.545-0.838)	<b>0.796</b> (0.642-0.999)	<b>0.981</b> (0.768-1.28)	<b>1.13</b> (0.863-1.50)	<b>1.30</b> (0.949-1.75)	<b>1.47</b> (1.03-2.04)	<b>1.71</b> (1.15-2.43)	<b>1.91</b> (1.24-2.73)
<b>15-min</b>	<b>0.548</b> (0.447-0.683)	<b>0.646</b> (0.527-0.806)	<b>0.818</b> (0.664-1.02)	<b>0.971</b> (0.783-1.22)	<b>1.20</b> (0.937-1.57)	<b>1.38</b> (1.05-1.83)	<b>1.58</b> (1.16-2.14)	<b>1.79</b> (1.25-2.48)	<b>2.09</b> (1.40-2.97)	<b>2.33</b> (1.51-3.33)
<b>30-min</b>	<b>0.767</b> (0.626-0.956)	<b>0.907</b> (0.739-1.13)	<b>1.15</b> (0.935-1.44)	<b>1.37</b> (1.10-1.72)	<b>1.69</b> (1.32-2.21)	<b>1.96</b> (1.49-2.59)	<b>2.24</b> (1.64-3.03)	<b>2.54</b> (1.78-3.52)	<b>2.96</b> (1.98-4.21)	<b>3.30</b> (2.14-4.73)
<b>60-min</b>	<b>0.999</b> (0.815-1.25)	<b>1.18</b> (0.960-1.47)	<b>1.50</b> (1.21-1.87)	<b>1.78</b> (1.44-2.24)	<b>2.22</b> (1.74-2.91)	<b>2.58</b> (1.97-3.42)	<b>2.97</b> (2.18-4.03)	<b>3.39</b> (2.38-4.71)	<b>3.99</b> (2.68-5.68)	<b>4.47</b> (2.90-6.41)
<b>2-hr</b>	<b>1.23</b> (1.01-1.52)	<b>1.45</b> (1.19-1.79)	<b>1.84</b> (1.51-2.28)	<b>2.20</b> (1.79-2.73)	<b>2.75</b> (2.17-3.58)	<b>3.21</b> (2.47-4.22)	<b>3.71</b> (2.74-4.98)	<b>4.25</b> (3.00-5.85)	<b>5.02</b> (3.39-7.09)	<b>5.64</b> (3.69-8.02)
<b>3-hr</b>	<b>1.38</b> (1.14-1.70)	<b>1.62</b> (1.34-1.99)	<b>2.06</b> (1.69-2.53)	<b>2.47</b> (2.01-3.05)	<b>3.09</b> (2.47-4.02)	<b>3.63</b> (2.81-4.76)	<b>4.22</b> (3.14-5.65)	<b>4.86</b> (3.45-6.67)	<b>5.77</b> (3.93-8.13)	<b>6.52</b> (4.29-9.24)
<b>6-hr</b>	<b>1.65</b> (1.38-2.01)	<b>1.93</b> (1.60-2.34)	<b>2.44</b> (2.03-2.98)	<b>2.94</b> (2.42-3.60)	<b>3.72</b> (3.00-4.81)	<b>4.39</b> (3.43-5.72)	<b>5.13</b> (3.86-6.84)	<b>5.96</b> (4.27-8.14)	<b>7.15</b> (4.91-10.0)	<b>8.13</b> (5.39-11.4)
<b>12-hr</b>	<b>1.95</b> (1.63-2.34)	<b>2.26</b> (1.89-2.71)	<b>2.85</b> (2.38-3.44)	<b>3.43</b> (2.85-4.16)	<b>4.36</b> (3.55-5.60)	<b>5.17</b> (4.08-6.70)	<b>6.08</b> (4.61-8.04)	<b>7.08</b> (5.13-9.61)	<b>8.55</b> (5.92-11.9)	<b>9.76</b> (6.52-13.6)
<b>24-hr</b>	<b>2.26</b> (1.91-2.68)	<b>2.60</b> (2.20-3.09)	<b>3.26</b> (2.75-3.89)	<b>3.91</b> (3.28-4.69)	<b>4.97</b> (4.09-6.33)	<b>5.90</b> (4.70-7.57)	<b>6.94</b> (5.31-9.11)	<b>8.10</b> (5.92-10.9)	<b>9.81</b> (6.86-13.5)	<b>11.2</b> (7.56-15.5)
<b>2-day</b>	<b>2.60</b> (2.22-3.06)	<b>2.96</b> (2.53-3.49)	<b>3.67</b> (3.12-4.34)	<b>4.37</b> (3.69-5.19)	<b>5.51</b> (4.57-6.95)	<b>6.52</b> (5.23-8.28)	<b>7.64</b> (5.90-9.94)	<b>8.91</b> (6.56-11.9)	<b>10.8</b> (7.58-14.7)	<b>12.3</b> (8.36-16.9)
<b>3-day</b>	<b>2.85</b> (2.45-3.34)	<b>3.22</b> (2.77-3.78)	<b>3.95</b> (3.38-4.64)	<b>4.67</b> (3.97-5.51)	<b>5.83</b> (4.86-7.30)	<b>6.86</b> (5.53-8.66)	<b>8.00</b> (6.20-10.3)	<b>9.28</b> (6.87-12.3)	<b>11.2</b> (7.90-15.2)	<b>12.7</b> (8.68-17.4)
<b>4-day</b>	<b>3.06</b> (2.64-3.57)	<b>3.45</b> (2.97-4.02)	<b>4.19</b> (3.60-4.90)	<b>4.92</b> (4.20-5.78)	<b>6.09</b> (5.09-7.58)	<b>7.12</b> (5.76-8.94)	<b>8.27</b> (6.43-10.6)	<b>9.54</b> (7.08-12.6)	<b>11.4</b> (8.10-15.5)	<b>12.9</b> (8.87-17.6)
<b>7-day</b>	<b>3.57</b> (3.10-4.13)	<b>4.01</b> (3.47-4.63)	<b>4.82</b> (4.16-5.58)	<b>5.58</b> (4.79-6.50)	<b>6.77</b> (5.67-8.30)	<b>7.79</b> (6.33-9.66)	<b>8.92</b> (6.97-11.3)	<b>10.2</b> (7.57-13.3)	<b>11.9</b> (8.52-16.0)	<b>13.4</b> (9.24-18.1)
<b>10-day</b>	<b>4.05</b> (3.53-4.65)	<b>4.53</b> (3.94-5.21)	<b>5.39</b> (4.68-6.22)	<b>6.19</b> (5.33-7.17)	<b>7.40</b> (6.20-8.98)	<b>8.42</b> (6.86-10.3)	<b>9.53</b> (7.47-12.0)	<b>10.7</b> (8.03-13.9)	<b>12.4</b> (8.91-16.6)	<b>13.8</b> (9.58-18.6)
<b>20-day</b>	<b>5.50</b> (4.84-6.25)	<b>6.11</b> (5.36-6.95)	<b>7.14</b> (6.25-8.15)	<b>8.04</b> (6.99-9.22)	<b>9.34</b> (7.85-11.1)	<b>10.4</b> (8.50-12.5)	<b>11.5</b> (9.04-14.2)	<b>12.6</b> (9.48-16.1)	<b>14.2</b> (10.2-18.6)	<b>15.4</b> (10.8-20.6)
<b>30-day</b>	<b>6.76</b> (5.97-7.63)	<b>7.49</b> (6.61-8.47)	<b>8.69</b> (7.64-9.85)	<b>9.69</b> (8.47-11.0)	<b>11.1</b> (9.34-13.0)	<b>12.2</b> (10.0-14.5)	<b>13.3</b> (10.5-16.3)	<b>14.4</b> (10.9-18.2)	<b>15.9</b> (11.5-20.7)	<b>17.0</b> (12.0-22.6)
<b>45-day</b>	<b>8.39</b> (7.45-9.41)	<b>9.28</b> (8.24-10.4)	<b>10.7</b> (9.48-12.1)	<b>11.9</b> (10.4-13.4)	<b>13.4</b> (11.3-15.6)	<b>14.6</b> (12.0-17.3)	<b>15.7</b> (12.5-19.1)	<b>16.8</b> (12.7-21.1)	<b>18.3</b> (13.2-23.6)	<b>19.3</b> (13.6-25.5)
<b>60-day</b>	<b>9.79</b> (8.74-10.9)	<b>10.8</b> (9.66-12.1)	<b>12.5</b> (11.1-14.0)	<b>13.8</b> (12.2-15.6)	<b>15.5</b> (13.1-17.9)	<b>16.7</b> (13.8-19.7)	<b>17.9</b> (14.3-21.7)	<b>19.0</b> (14.5-23.7)	<b>20.4</b> (14.9-26.3)	<b>21.4</b> (15.2-28.2)

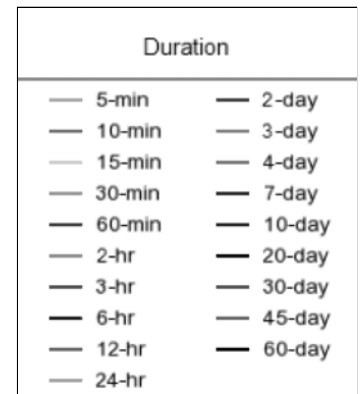
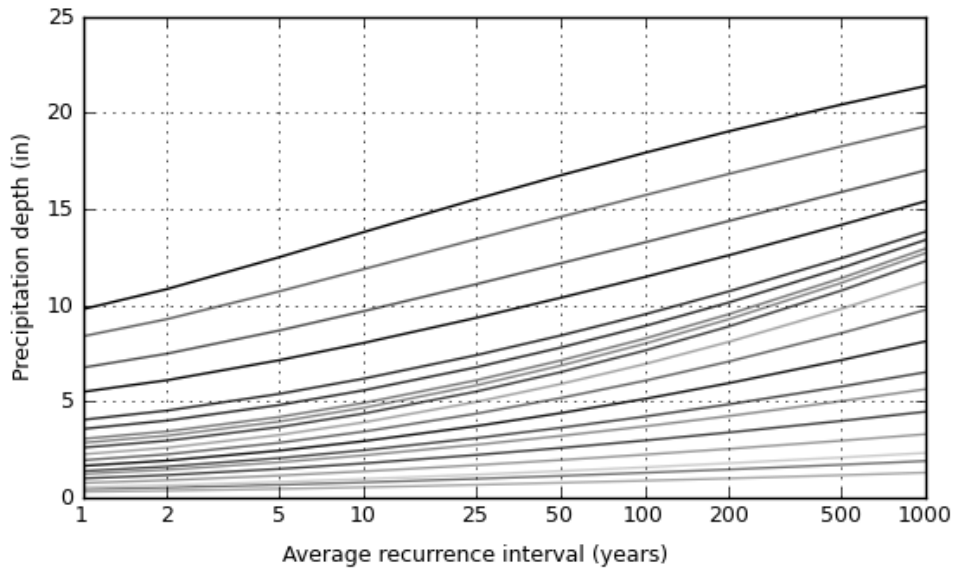
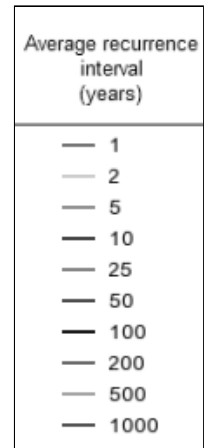
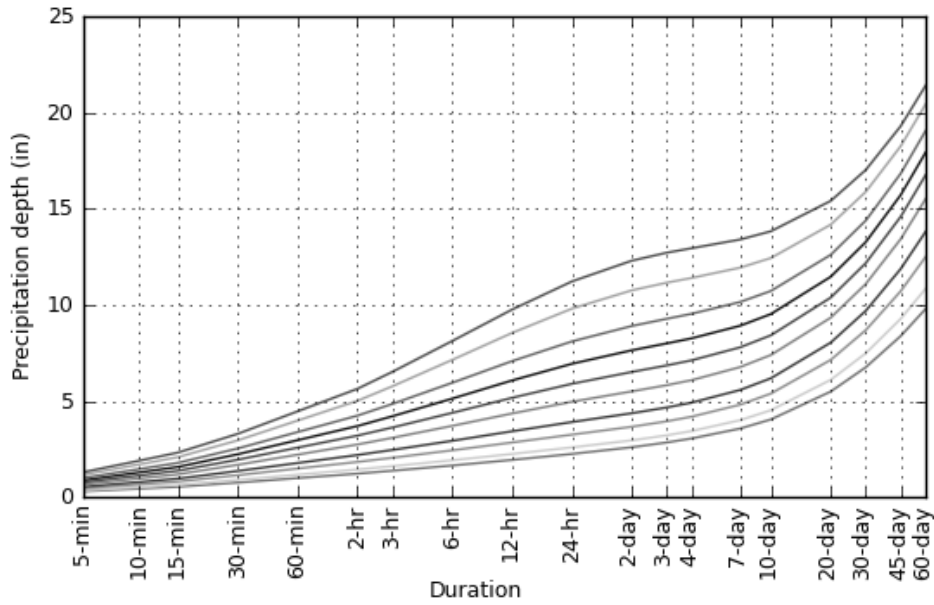
<sup>1</sup> Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS). Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values. Please refer to NOAA Atlas 14 document for more information.

[Back to Top](#)

**PF graphical**

PDS-based depth-duration-frequency (DDF) curves

Latitude: 42.9147°, Longitude: -86.1836°

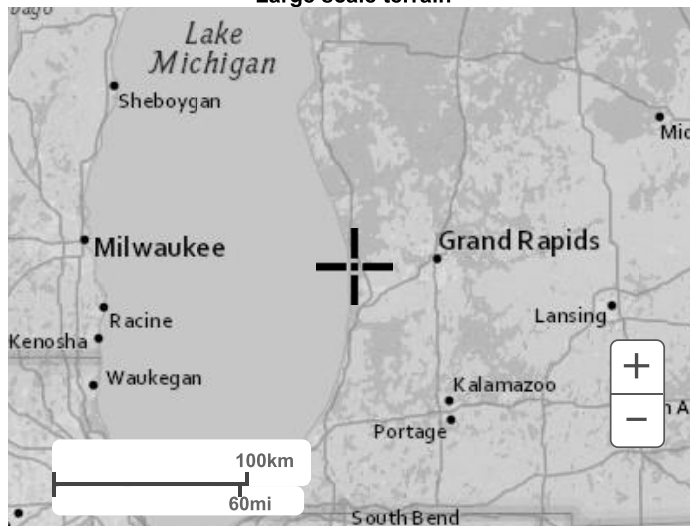


**Maps & aerials**

**Small scale terrain**



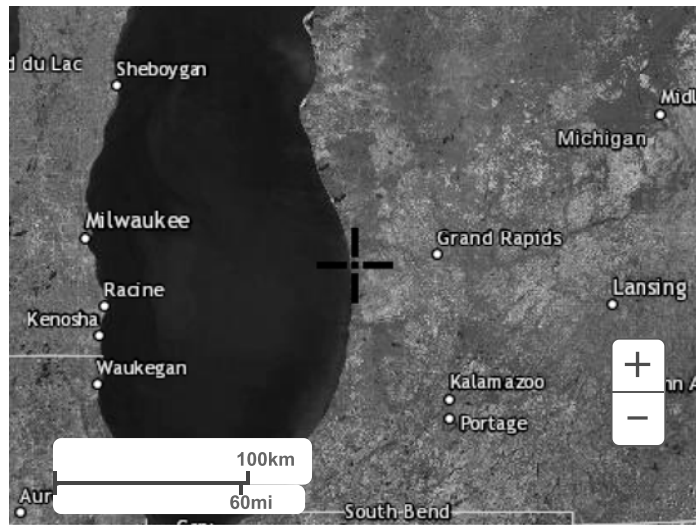
Large scale terrain



Large scale map



Large scale aerial



[Back to Top](#)

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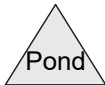
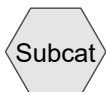
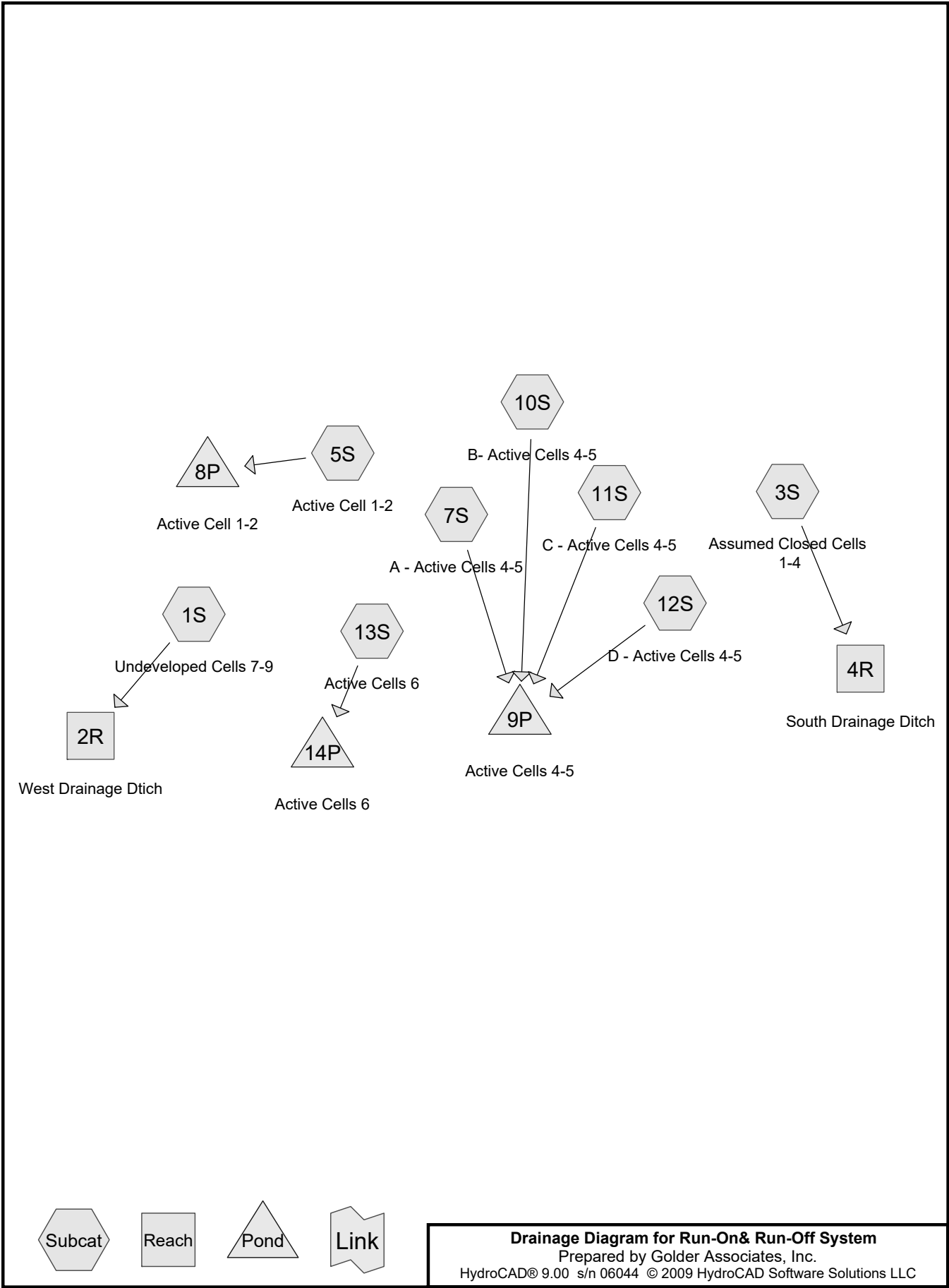
[US Department of Commerce](#)  
[National Oceanic and Atmospheric Administration](#)  
[National Weather Service](#)  
[National Water Center](#)  
1325 East West Highway  
Silver Spring, MD 20910  
Questions?: [HDSC.Questions@noaa.gov](mailto:HDSC.Questions@noaa.gov)

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**APPENDIX B**

**Hydrologic and Hydraulic Model  
Output**





**Drainage Diagram for Run-On & Run-Off System**  
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## Run-On& Run-Off System

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Page 2

### Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.300	77	sand (12S)
10.800	78	fly ash and sand (7S, 13S)
70.180	79	50-75% Grass cover, Fair, HSG C (1S, 3S)
23.950	79	fly ash (5S, 10S, 11S)
<b>105.230</b>		<b>TOTAL AREA</b>

## Run-On& Run-Off System

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Page 3

### Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
0.000	HSG B	
70.180	HSG C	1S, 3S
0.000	HSG D	
35.050	Other	5S, 7S, 10S, 11S, 12S, 13S
<b>105.230</b>		<b>TOTAL AREA</b>

# Run-On& Run-Off System

Type II 24-hr 25-yr 24-hr Rainfall=4.97"

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Page 4

Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points  
Runoff by SCS TR-20 method, UH=SCS  
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

**Subcatchment 1S: Undeveloped Cells 7-9** Runoff Area=20.000 ac 0.00% Impervious Runoff Depth>2.76"  
Flow Length=544' Slope=0.0200 '/' Tc=17.2 min CN=79 Runoff=66.68 cfs 4.607 af

**Subcatchment 3S: Assumed Closed Cells** Runoff Area=50.180 ac 0.00% Impervious Runoff Depth>2.77"  
Flow Length=948' Tc=13.7 min CN=79 Runoff=186.78 cfs 11.571 af

**Subcatchment 5S: Active Cell 1-2** Runoff Area=16.400 ac 0.00% Impervious Runoff Depth>2.77"  
Flow Length=1,671' Tc=10.3 min CN=79 Runoff=67.98 cfs 3.785 af

**Subcatchment 7S: A - Active Cells 4-5** Runoff Area=3.600 ac 0.00% Impervious Runoff Depth>2.68"  
Flow Length=1,158' Tc=4.4 min CN=78 Runoff=17.77 cfs 0.805 af

**Subcatchment 10S: B - Active Cells 4-5** Runoff Area=3.000 ac 0.00% Impervious Runoff Depth>2.77"  
Flow Length=672' Tc=5.5 min CN=79 Runoff=14.55 cfs 0.693 af

**Subcatchment 11S: C - Active Cells 4-5** Runoff Area=4.550 ac 0.00% Impervious Runoff Depth>2.77"  
Flow Length=1,120' Tc=6.0 min CN=79 Runoff=21.61 cfs 1.051 af

**Subcatchment 12S: D - Active Cells 4-5** Runoff Area=0.300 ac 0.00% Impervious Runoff Depth>2.60"  
Flow Length=165' Tc=1.9 min CN=77 Runoff=1.48 cfs 0.065 af

**Subcatchment 13S: Active Cells 6** Runoff Area=7.200 ac 0.00% Impervious Runoff Depth>2.69"  
Flow Length=240' Tc=1.1 min CN=78 Runoff=38.13 cfs 1.612 af

**Reach 2R: West Drainage Ditch** Avg. Depth=2.46' Max Vel=2.30 fps Inflow=66.68 cfs 4.607 af  
n=0.030 L=1,553.0' S=0.0013 '/' Capacity=77.01 cfs Outflow=50.07 cfs 4.544 af

**Reach 4R: South Drainage Ditch** Avg. Depth=2.12' Max Vel=4.10 fps Inflow=186.78 cfs 11.571 af  
n=0.030 L=4,956.0' S=0.0040 '/' Capacity=2,681.96 cfs Outflow=105.57 cfs 11.266 af

**Pond 8P: Active Cell 1-2** Peak Elev=615.74' Storage=3.397 af Inflow=67.98 cfs 3.785 af  
Outflow=0.30 cfs 0.387 af

**Pond 9P: Active Cells 4-5** Peak Elev=611.88' Storage=96,740 cf Inflow=54.98 cfs 2.615 af  
Outflow=0.32 cfs 0.393 af

**Pond 14P: Active Cells 6** Peak Elev=610.36' Storage=53,338 cf Inflow=38.13 cfs 1.612 af  
Outflow=0.32 cfs 0.387 af

**Total Runoff Area = 105.230 ac Runoff Volume = 24.190 af Average Runoff Depth = 2.76"**  
**100.00% Pervious = 105.230 ac 0.00% Impervious = 0.000 ac**

# Run-On& Run-Off System

Type II 24-hr 25-yr 24-hr Rainfall=4.97"

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Page 5

## Summary for Subcatchment 1S: Undeveloped Cells 7-9

Runoff = 66.68 cfs @ 12.10 hrs, Volume= 4.607 af, Depth> 2.76"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Type II 24-hr 25-yr 24-hr Rainfall=4.97"

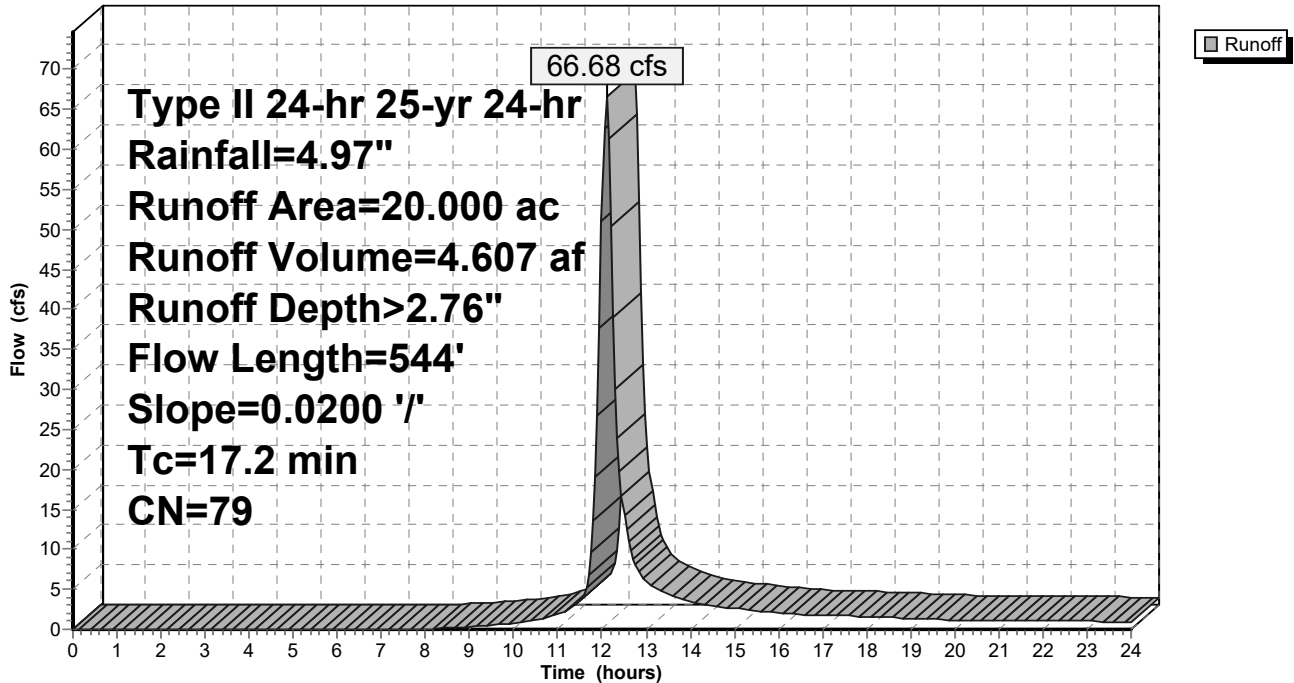
Area (ac)	CN	Description
20.000	79	50-75% Grass cover, Fair, HSG C
20.000		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.7	100	0.0200	0.17		Sheet Flow, Range n= 0.130 P2= 2.60"
7.5	444	0.0200	0.99		Shallow Concentrated Flow, Short Grass Pasture Kv= 7.0 fps
17.2	544	Total			

## Subcatchment 1S: Undeveloped Cells 7-9

Hydrograph



# Run-On& Run-Off System

Type II 24-hr 25-yr 24-hr Rainfall=4.97"

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Page 6

## Summary for Subcatchment 3S: Assumed Closed Cells 1-4

Runoff = 186.78 cfs @ 12.06 hrs, Volume= 11.571 af, Depth> 2.77"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs  
Type II 24-hr 25-yr 24-hr Rainfall=4.97"

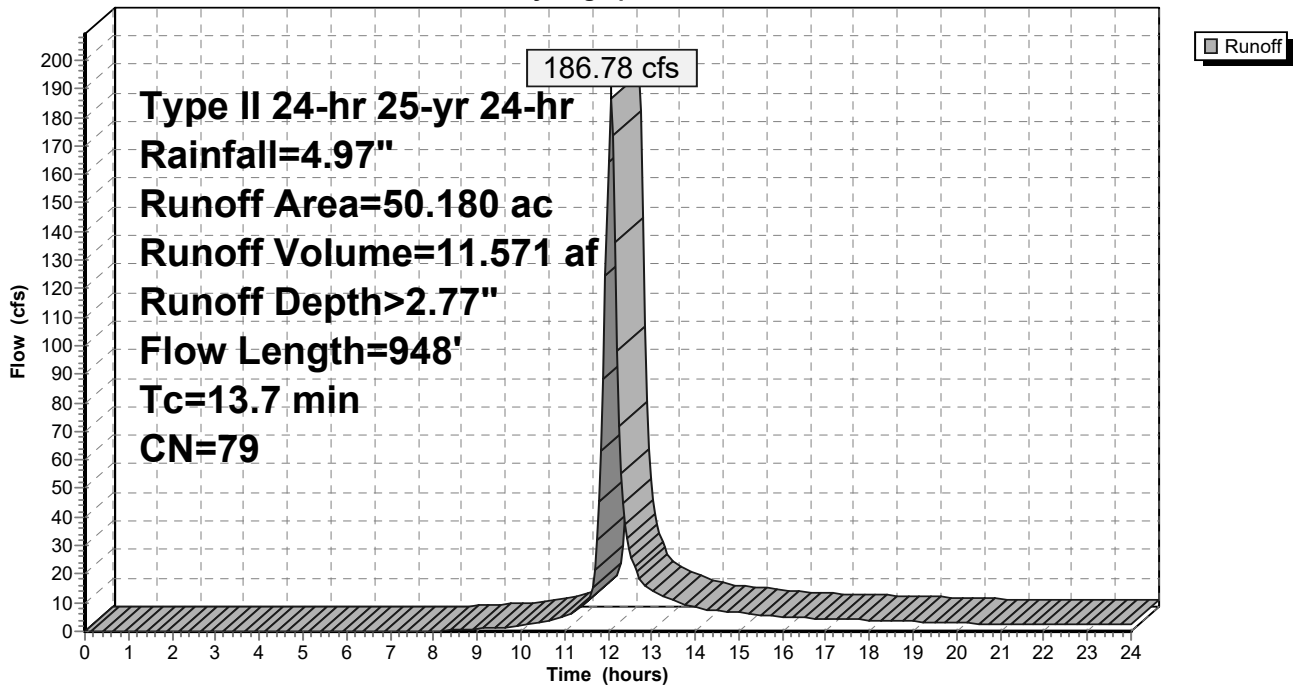
Area (ac)	CN	Description
50.180	79	50-75% Grass cover, Fair, HSG C
50.180		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.7	100	0.0200	0.17		Sheet Flow, Range n= 0.130 P2= 2.60"
4.0	848	0.2500	3.50		Shallow Concentrated Flow, Short Grass Pasture Kv= 7.0 fps
13.7	948	Total			

## Subcatchment 3S: Assumed Closed Cells 1-4

Hydrograph



# Run-On& Run-Off System

Type II 24-hr 25-yr 24-hr Rainfall=4.97"

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Page 7

## Summary for Subcatchment 5S: Active Cell 1-2

Runoff = 67.98 cfs @ 12.02 hrs, Volume= 3.785 af, Depth> 2.77"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs  
 Type II 24-hr 25-yr 24-hr Rainfall=4.97"

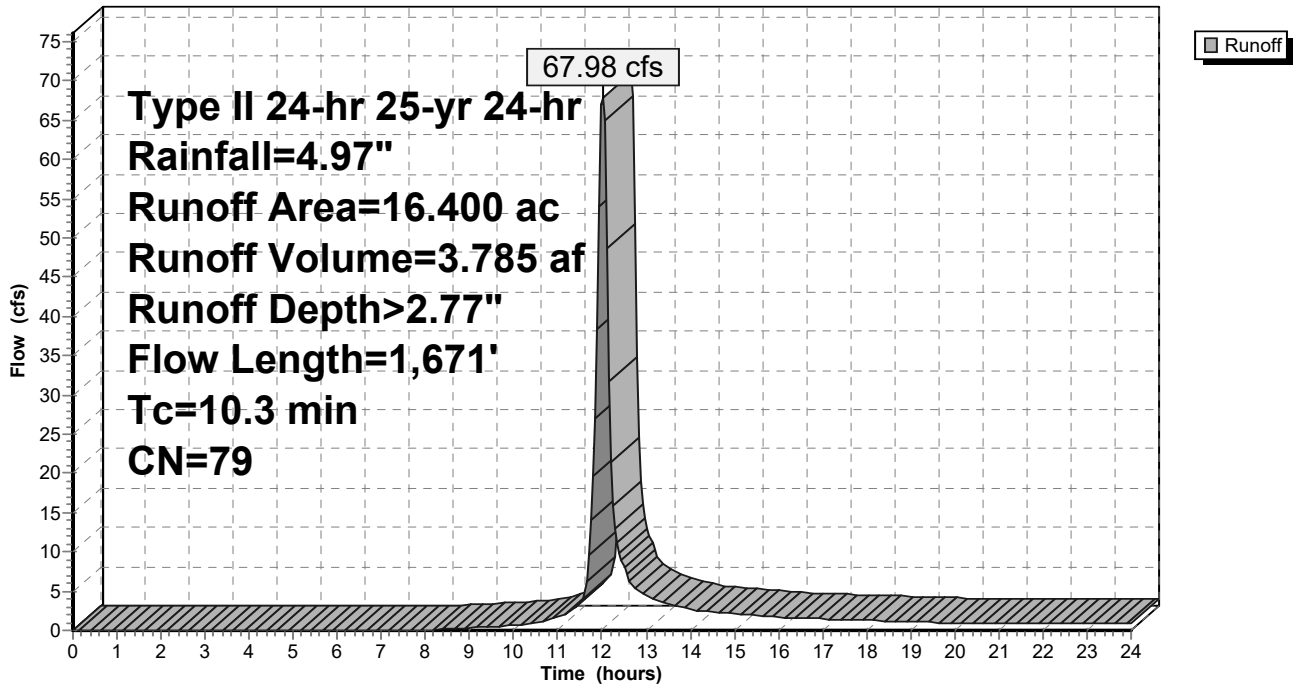
Area (ac)	CN	Description
* 16.400	79	fly ash
16.400		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.6	100	0.2500	1.01		<b>Sheet Flow,</b> Fallow n= 0.050 P2= 2.60"
0.2	100	0.2500	8.05		<b>Shallow Concentrated Flow,</b> Unpaved Kv= 16.1 fps
8.5	1,471	0.0200	2.87		<b>Shallow Concentrated Flow,</b> Paved Kv= 20.3 fps
10.3	1,671	Total			

## Subcatchment 5S: Active Cell 1-2

Hydrograph



# Run-On& Run-Off System

Type II 24-hr 25-yr 24-hr Rainfall=4.97"

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Page 8

## Summary for Subcatchment 7S: A - Active Cells 4-5

Runoff = 17.77 cfs @ 11.95 hrs, Volume= 0.805 af, Depth> 2.68"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs  
 Type II 24-hr 25-yr 24-hr Rainfall=4.97"

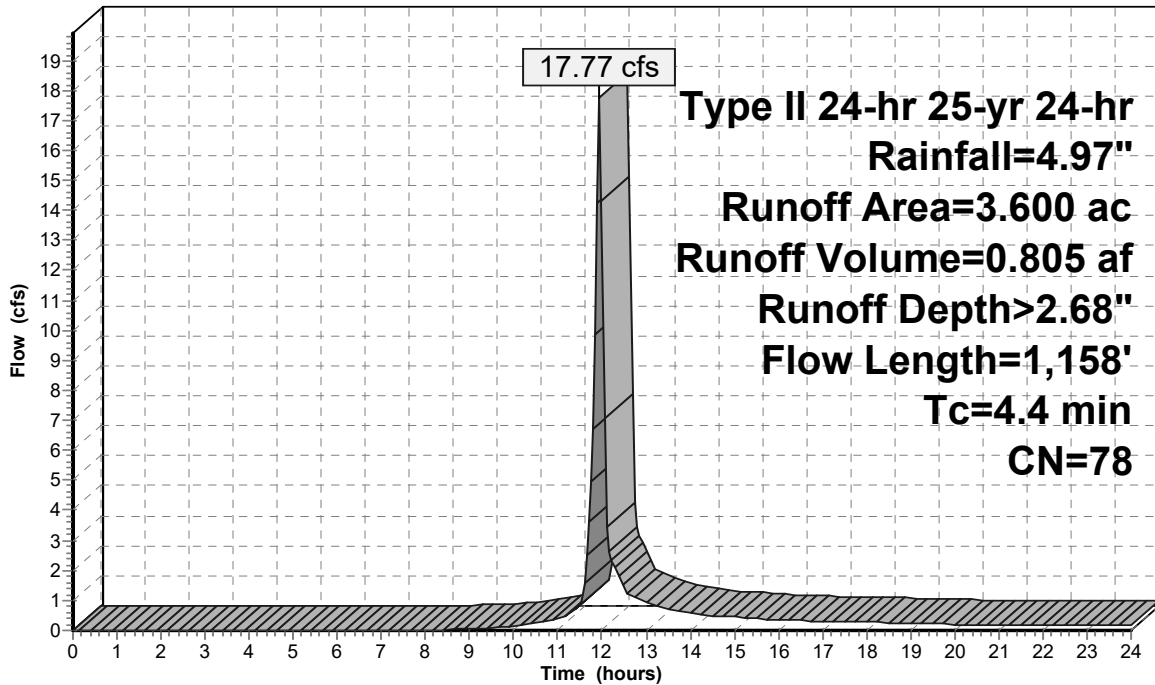
Area (ac)	CN	Description
* 3.600	78	fly ash and sand
3.600		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.6	160	0.3330	4.20		<b>Sheet Flow,</b> Smooth surfaces n= 0.011 P2= 2.60"
0.5	80	0.0250	2.55		<b>Shallow Concentrated Flow,</b> Unpaved Kv= 16.1 fps
3.1	850	0.0150	4.59	1.60	<b>Pipe Channel,</b> 8.0" Round Area= 0.3 sf Perim= 2.1' r= 0.17' n= 0.012
0.2	68	0.0150	4.59	1.60	<b>Pipe Channel,</b> 8.0" Round Area= 0.3 sf Perim= 2.1' r= 0.17' n= 0.012
4.4	1,158	Total			

## Subcatchment 7S: A - Active Cells 4-5

Hydrograph





# Run-On& Run-Off System

Type II 24-hr 25-yr 24-hr Rainfall=4.97"

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Page 9

## Summary for Subcatchment 10S: B- Active Cells 4-5

Runoff = 14.55 cfs @ 11.96 hrs, Volume= 0.693 af, Depth> 2.77"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs  
 Type II 24-hr 25-yr 24-hr Rainfall=4.97"

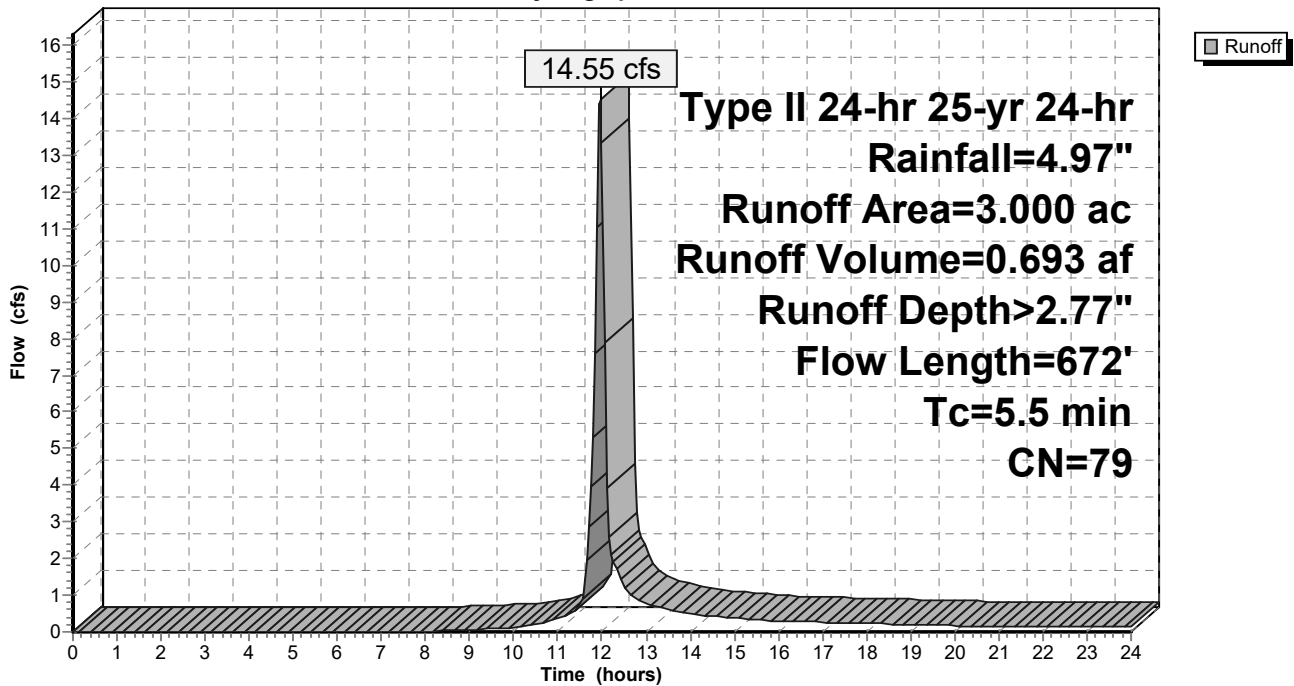
Area (ac)	CN	Description
* 3.000	79	fly ash
3.000		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.7	244	0.0200	1.48		<b>Sheet Flow,</b> Smooth surfaces n= 0.011 P2= 2.60"
2.8	428	0.0150	2.51	0.87	<b>Pipe Channel,</b> 8.0" Round Area= 0.3 sf Perim= 2.1' r= 0.17' n= 0.022 Earth, clean & straight
5.5	672	Total			

## Subcatchment 10S: B- Active Cells 4-5

Hydrograph



# Run-On& Run-Off System

Type II 24-hr 25-yr 24-hr Rainfall=4.97"

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## Summary for Subcatchment 11S: C - Active Cells 4-5

Runoff = 21.61 cfs @ 11.97 hrs, Volume= 1.051 af, Depth> 2.77"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs  
 Type II 24-hr 25-yr 24-hr Rainfall=4.97"

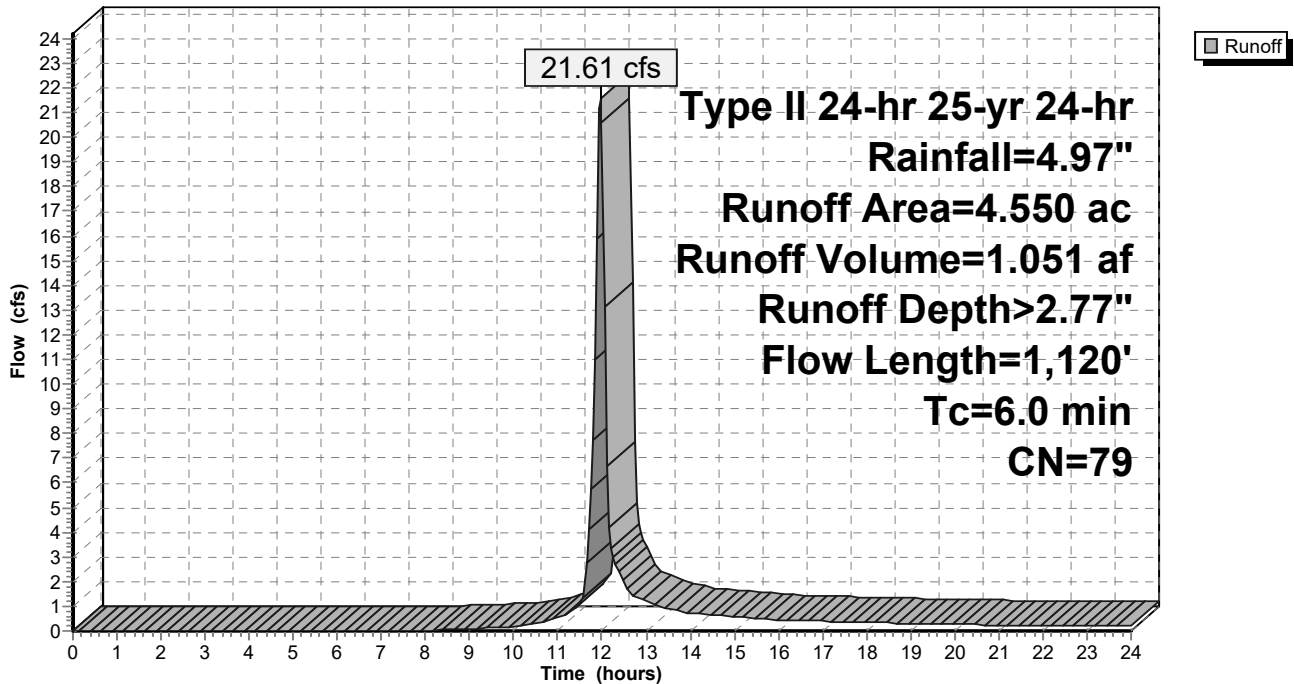
Area (ac)	CN	Description
* 4.550	79	fly ash
4.550		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.2	300	0.0200	1.54		<b>Sheet Flow,</b> Smooth surfaces n= 0.011 P2= 2.60"
1.1	191	0.0200	2.87		<b>Shallow Concentrated Flow,</b> Paved Kv= 20.3 fps
0.3	203	0.2500	10.15		<b>Shallow Concentrated Flow,</b> Paved Kv= 20.3 fps
1.4	426	0.0120	4.93	1.72	<b>Pipe Channel,</b> 8.0" Round Area= 0.3 sf Perim= 2.1' r= 0.17' n= 0.010 PVC, smooth interior
6.0	1,120	Total			

## Subcatchment 11S: C - Active Cells 4-5

Hydrograph



# Run-On& Run-Off System

Type II 24-hr 25-yr 24-hr Rainfall=4.97"

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Page 11

## Summary for Subcatchment 12S: D - Active Cells 4-5

Runoff = 1.48 cfs @ 11.92 hrs, Volume= 0.065 af, Depth> 2.60"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs  
Type II 24-hr 25-yr 24-hr Rainfall=4.97"

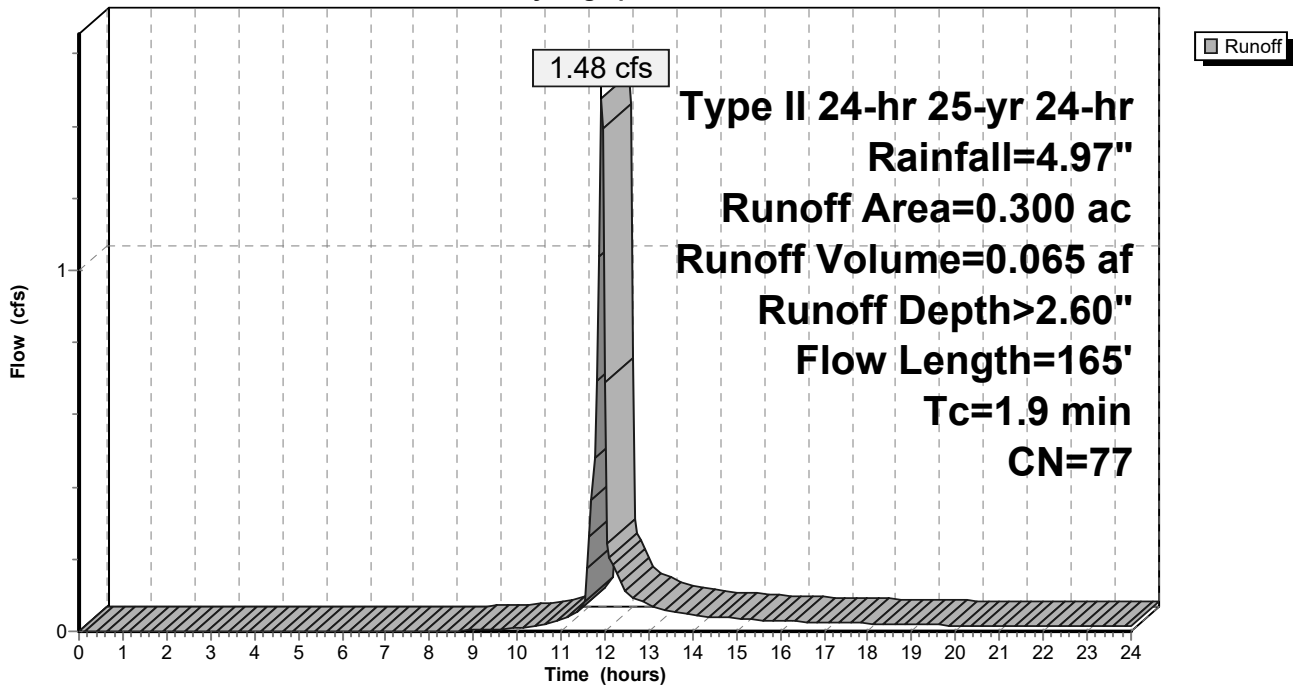
Area (ac)	CN	Description
* 0.300	77	sand
0.300		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.1	72	0.3330	1.07		<b>Sheet Flow,</b> Fallow n= 0.050 P2= 2.60"
0.8	93	0.0150	1.97		<b>Shallow Concentrated Flow,</b> Unpaved Kv= 16.1 fps
1.9	165	Total			

## Subcatchment 12S: D - Active Cells 4-5

Hydrograph



# Run-On& Run-Off System

Type II 24-hr 25-yr 24-hr Rainfall=4.97"

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## Summary for Subcatchment 13S: Active Cells 6

Runoff = 38.13 cfs @ 11.90 hrs, Volume= 1.612 af, Depth> 2.69"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs  
 Type II 24-hr 25-yr 24-hr Rainfall=4.97"

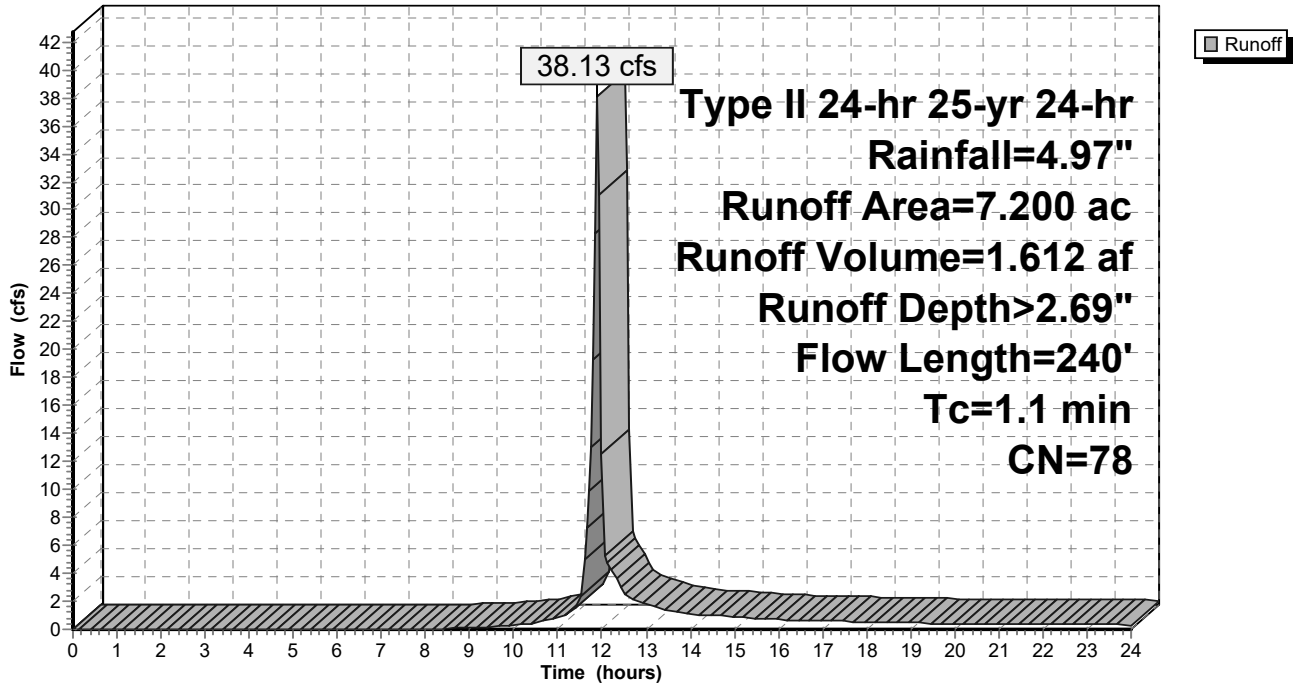
Area (ac)	CN	Description
* 7.200	78	fly ash and sand
7.200		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.6	160	0.3330	4.20		<b>Sheet Flow,</b> Smooth surfaces n= 0.011 P2= 2.60"
0.5	80	0.0250	2.55		<b>Shallow Concentrated Flow,</b> Unpaved Kv= 16.1 fps
1.1	240	Total			

## Subcatchment 13S: Active Cells 6

Hydrograph



# Run-On& Run-Off System

Type II 24-hr 25-yr 24-hr Rainfall=4.97"

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Page 13

## Summary for Reach 2R: West Drainage Ditch

Inflow Area = 20.000 ac, 0.00% Impervious, Inflow Depth > 2.76" for 25-yr 24-hr event  
Inflow = 66.68 cfs @ 12.10 hrs, Volume= 4.607 af  
Outflow = 50.07 cfs @ 12.39 hrs, Volume= 4.544 af, Atten= 25%, Lag= 17.8 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs  
Max. Velocity= 2.30 fps, Min. Travel Time= 11.2 min  
Avg. Velocity = 0.86 fps, Avg. Travel Time= 30.3 min

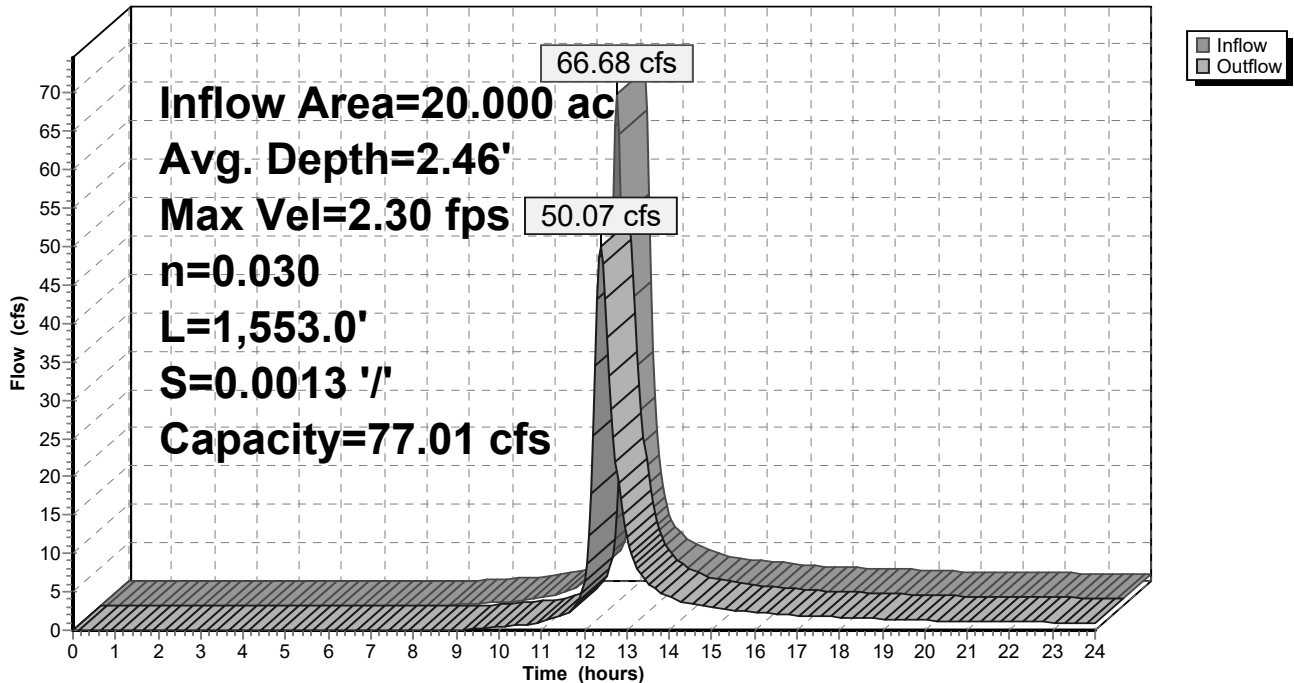
Peak Storage= 34,063 cf @ 12.20 hrs, Average Depth at Peak Storage= 2.46'  
Bank-Full Depth= 3.00', Capacity at Bank-Full= 77.01 cfs

4.00' x 3.00' deep channel, n= 0.030 Earth, grassed & winding  
Side Slope Z-value= 2.0 '/' Top Width= 16.00'  
Length= 1,553.0' Slope= 0.0013 '/'  
Inlet Invert= 605.52', Outlet Invert= 603.50'



## Reach 2R: West Drainage Ditch

Hydrograph



# Run-On& Run-Off System

Type II 24-hr 25-yr 24-hr Rainfall=4.97"

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Page 14

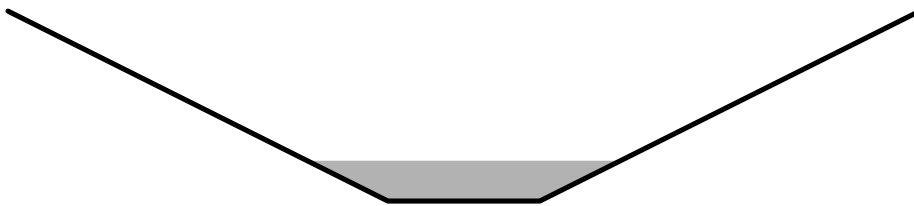
## Summary for Reach 4R: South Drainage Ditch

Inflow Area = 50.180 ac, 0.00% Impervious, Inflow Depth > 2.77" for 25-yr 24-hr event  
Inflow = 186.78 cfs @ 12.06 hrs, Volume= 11.571 af  
Outflow = 105.57 cfs @ 12.53 hrs, Volume= 11.266 af, Atten= 43%, Lag= 28.5 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs  
Max. Velocity= 4.10 fps, Min. Travel Time= 20.2 min  
Avg. Velocity = 1.49 fps, Avg. Travel Time= 55.5 min

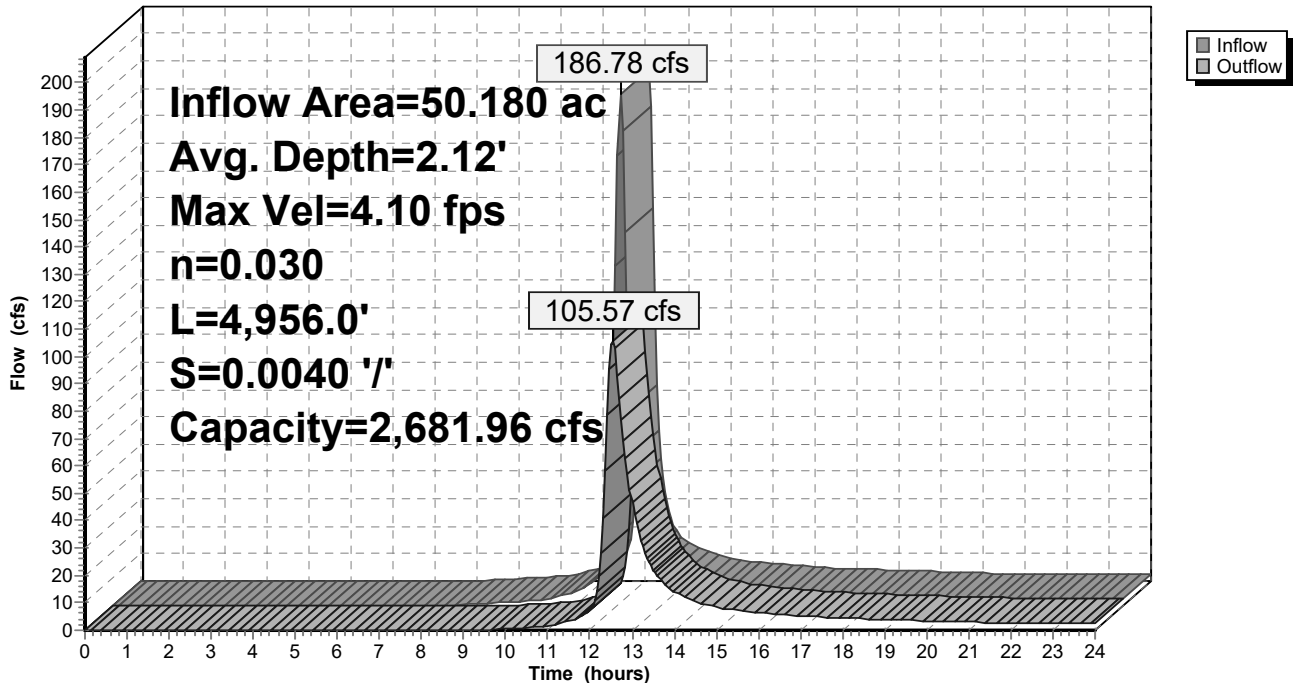
Peak Storage= 128,661 cf @ 12.19 hrs, Average Depth at Peak Storage= 2.12'  
Bank-Full Depth= 10.00', Capacity at Bank-Full= 2,681.96 cfs

8.00' x 10.00' deep channel, n= 0.030 Earth, grassed & winding  
Side Slope Z-value= 2.0 '/' Top Width= 48.00'  
Length= 4,956.0' Slope= 0.0040 '/'  
Inlet Invert= 610.00', Outlet Invert= 590.00'



## Reach 4R: South Drainage Ditch

Hydrograph



# Run-On& Run-Off System

Type II 24-hr 25-yr 24-hr Rainfall=4.97"

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Page 15

## Summary for Pond 8P: Active Cell 1-2

Inflow Area = 16.400 ac, 0.00% Impervious, Inflow Depth > 2.77" for 25-yr 24-hr event  
Inflow = 67.98 cfs @ 12.02 hrs, Volume= 3.785 af  
Outflow = 0.30 cfs @ 9.05 hrs, Volume= 0.387 af, Atten= 100%, Lag= 0.0 min  
Primary = 0.30 cfs @ 9.05 hrs, Volume= 0.387 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs  
Peak Elev= 615.74' @ 24.00 hrs Surf.Area= 1.360 ac Storage= 3.397 af

Plug-Flow detention time= 313.6 min calculated for 0.386 af (10% of inflow)  
Center-of-Mass det. time= 149.3 min ( 973.4 - 824.2 )

Volume	Invert	Avail.Storage	Storage Description
#1	610.00'	3.761 af	<b>Custom Stage Data (Prismatic)</b> Listed below (Recalc)
Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
610.00	0.009	0.000	0.000
611.00	0.105	0.057	0.057
612.00	0.381	0.243	0.300
613.00	0.596	0.488	0.788
614.00	0.832	0.714	1.502
615.00	1.121	0.976	2.479
616.00	1.444	1.282	3.761

Device	Routing	Invert	Outlet Devices
#1	Primary	610.00'	<b>0.30 cfs Exfiltration when above 610.00'</b>

**Primary OutFlow** Max=0.30 cfs @ 9.05 hrs HW=610.06' (Free Discharge)  
↑1=Exfiltration (Exfiltration Controls 0.30 cfs)

**Run-On& Run-Off System**

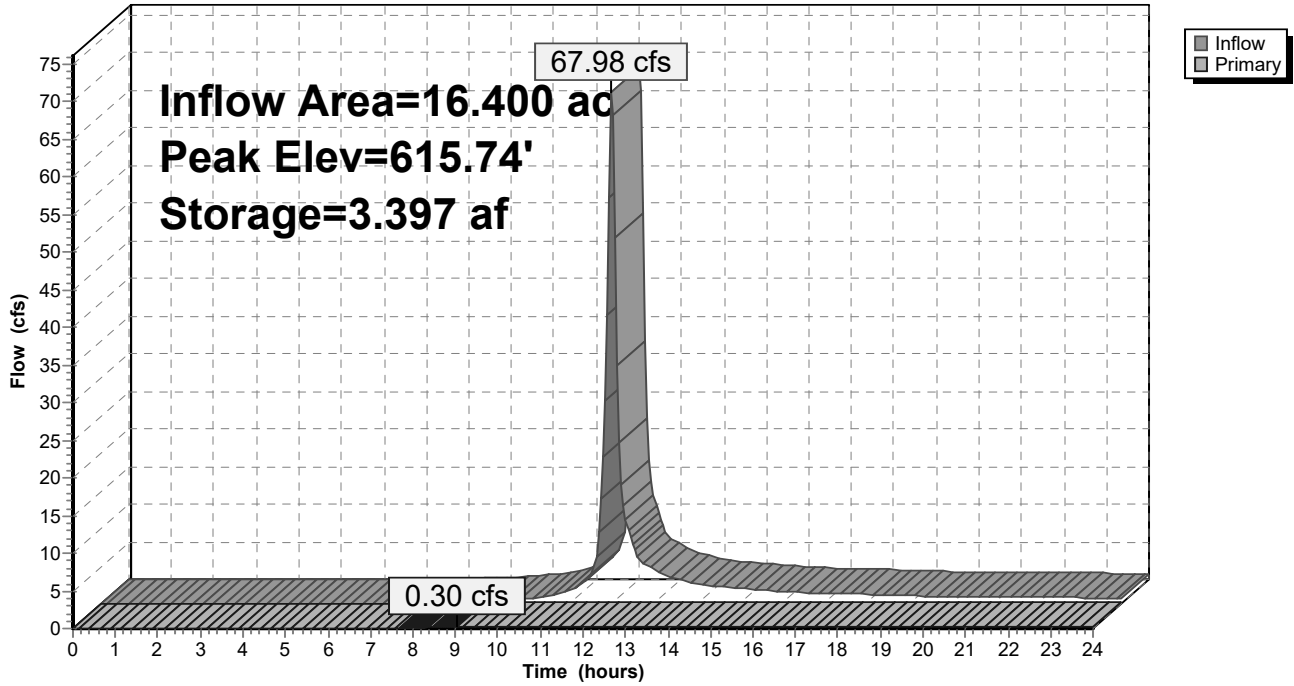
Type II 24-hr 25-yr 24-hr Rainfall=4.97"

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**Pond 8P: Active Cell 1-2**

Hydrograph





# Run-On& Run-Off System

Type II 24-hr 25-yr 24-hr Rainfall=4.97"

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Page 17

## Summary for Pond 9P: Active Cells 4-5

Inflow Area = 11.450 ac, 0.00% Impervious, Inflow Depth > 2.74" for 25-yr 24-hr event  
Inflow = 54.98 cfs @ 11.96 hrs, Volume= 2.615 af  
Outflow = 0.32 cfs @ 10.00 hrs, Volume= 0.393 af, Atten= 99%, Lag= 0.0 min  
Primary = 0.32 cfs @ 10.00 hrs, Volume= 0.393 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs  
Peak Elev= 611.88' @ 24.00 hrs Surf.Area= 63,620 sf Storage= 96,740 cf

Plug-Flow detention time= 322.1 min calculated for 0.393 af (15% of inflow)  
Center-of-Mass det. time= 173.2 min ( 994.5 - 821.3 )

Volume	Invert	Avail.Storage	Storage Description
#1	609.00'	273,255 cf	<b>Custom Stage Data (Prismatic)</b> Listed below
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
609.00	0	0	0
610.00	23,929	11,965	11,965
612.00	66,061	89,990	101,955
614.00	105,239	171,300	273,255

Device	Routing	Invert	Outlet Devices
#1	Primary	609.00'	<b>0.32 cfs Exfiltration when above 609.00'</b>

**Primary OutFlow** Max=0.32 cfs @ 10.00 hrs HW=609.05' (Free Discharge)  
↑1=Exfiltration (Exfiltration Controls 0.32 cfs)

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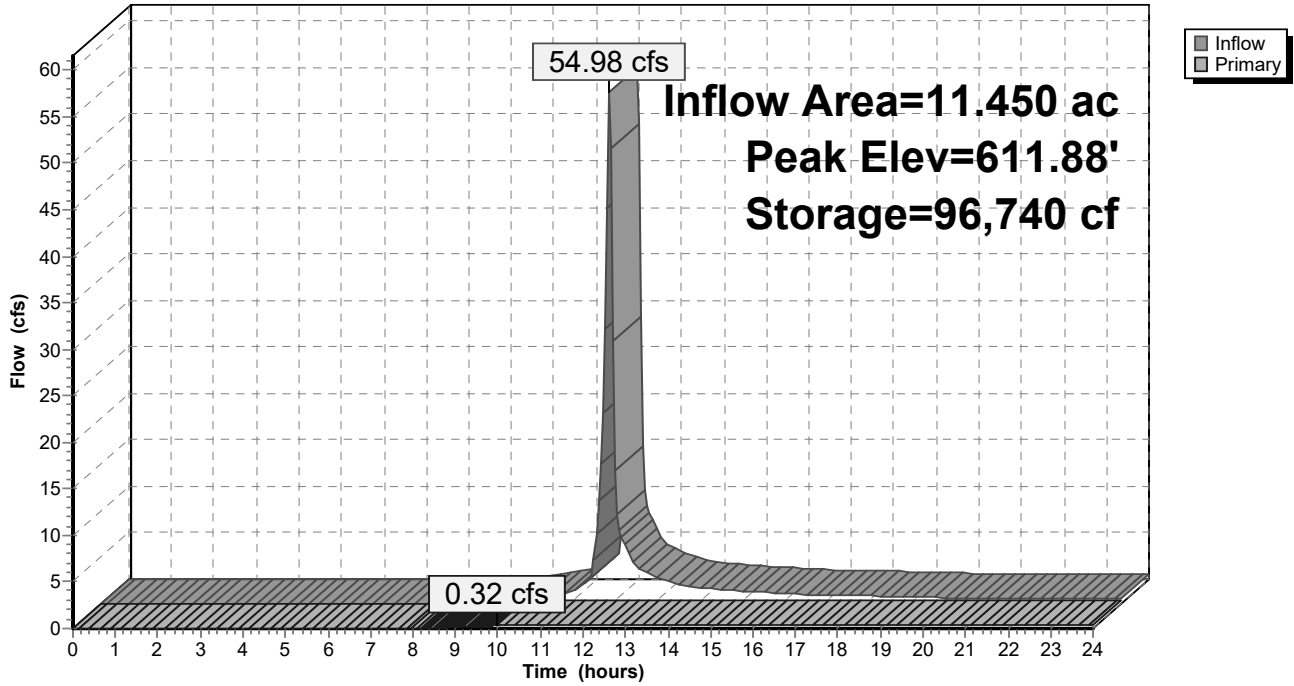
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Page 18

## Pond 9P: Active Cells 4-5

Hydrograph



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Page 19

## Summary for Pond 14P: Active Cells 6

Inflow Area = 7.200 ac, 0.00% Impervious, Inflow Depth > 2.69" for 25-yr 24-hr event  
 Inflow = 38.13 cfs @ 11.90 hrs, Volume= 1.612 af  
 Outflow = 0.32 cfs @ 10.30 hrs, Volume= 0.387 af, Atten= 99%, Lag= 0.0 min  
 Primary = 0.32 cfs @ 10.30 hrs, Volume= 0.387 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs  
 Peak Elev= 610.36' @ 23.95 hrs Surf.Area= 36,213 sf Storage= 53,338 cf

Plug-Flow detention time= 315.1 min calculated for 0.387 af (24% of inflow)  
 Center-of-Mass det. time= 181.4 min ( 1,001.1 - 819.7 )

Volume	Invert	Avail.Storage	Storage Description
#1	606.00'	209,676 cf	<b>Custom Stage Data (Prismatic)</b> Listed below
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
606.00	2,488	0	0
607.00	3,400	2,944	2,944
608.00	5,903	4,652	7,596
609.00	13,966	9,935	17,530
610.00	30,005	21,986	39,516
611.00	47,384	38,695	78,210
612.00	65,627	56,506	134,716
613.00	84,293	74,960	209,676

Device	Routing	Invert	Outlet Devices
#1	Primary	606.00'	<b>0.32 cfs Exfiltration when above 606.00'</b>

**Primary OutFlow** Max=0.32 cfs @ 10.30 hrs HW=606.07' (Free Discharge)  
 ↑1=Exfiltration (Exfiltration Controls 0.32 cfs)

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Type II 24-hr 25-yr 24-hr Rainfall=4.97"

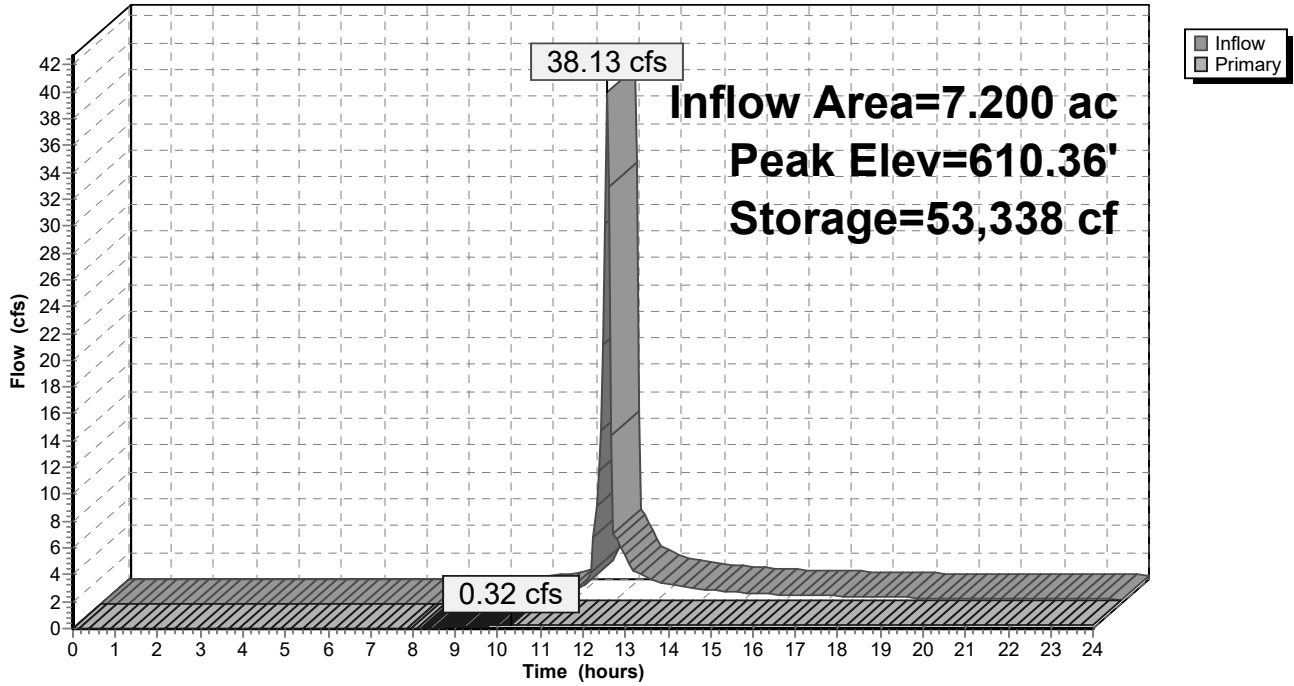
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Page 20

## Pond 14P: Active Cells 6

Hydrograph





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