Appendix C

Run-on and Run-off Control System Plan

Omaha Public Power District
North Omaha Generating Station
Ash Disposal Area

September 2019

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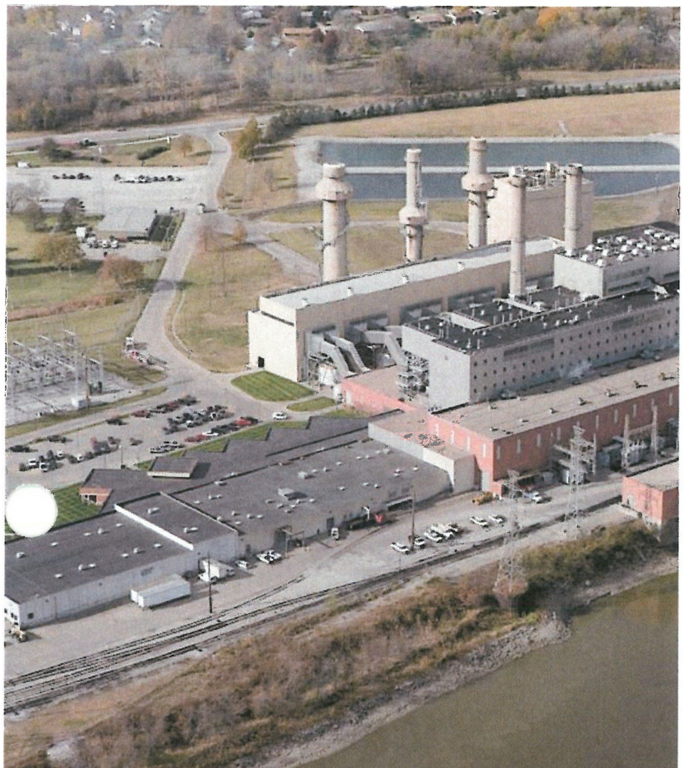

North Omaha Ash Disposal Area

Run-on and Run-off Control System Plan

Omaha Public Power District

North Omaha Station

Omaha, Nebraska

November 21, 2019

Rev January 7, 2020

OPPD North Omaha Ash Disposal Area
Run-On and Run-Off Control System Plan

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Appendices

OPPD North Omaha Ash Disposal Area
Run-On and Run-Off Control System Plan

Professional Engineer Certification

"I hereby certify that this Run-on and Run-off Control System Plan for the CCR landfill known as the North Omaha Ash Disposal Area at the North Omaha Generating Station, owned and operated by the Omaha Public Power District, meets the requirements of the Coal Combustion Residual Rule 40 CFR 257.81. I am a duly licensed independent Professional Engineer under the laws of the State of Nebraska."

Print Name: Garrett M. Williams

Signature:

Date: 1/7/20

License #: E-15124

I. Introduction

A. Purpose

On April 17, 2015 the U.S. Environmental Protection Agency (EPA) published the final rule for the regulation and management of coal combustion residuals (CCR) under the Resource Conservation and Recovery Act (RCRA). Section 40 CFR 257.81 requires that an owner or operator of a CCR landfill 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. As a result, this plan is being updated concurrently with the 2019 Title 132 permit renewal application. The plan must document how the control systems have been designed and constructed to meet the applicable requirements of the CCR rule, supported by appropriate engineering calculations. In accordance with the CCR rule 40 CFR 257.81, the intent of stormwater management is to 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; and
- A run-off control system from the active portion of the CCR unit to collect and control at least the water volume resulting from a 24-hour, 25-year storm. Run-off from the active portion of the CCR unit must be handled in accordance with the surface water requirements under 40 CFR 257.3-3.

B. Facility Background

OPPD has a five-unit, fossil fuel-fired generating plant at the North Omaha Station (Station) in Omaha, Nebraska, along the west shore of the Missouri River. Recently Units 1-3 were retired from coal operations; Units 4 and 5 were retrofitted for air pollution control equipment and are still operating. The need for CCR disposal capacity is anticipated to continue to at least year 2023. This Station has an existing CCR landfill (the North Omaha Ash Disposal Area) that is permitted under the current NDEE Title 132 regulations for fossil fuel combustion ash disposal area (Permit No. NE0054739, Facility ID 59763). Under the CCR rule, the North Omaha Ash Disposal Area is an existing CCR landfill since it has and will receive CCR both before and after October 19, 2015 – the effective date of the CCR rule. The North Omaha Ash Disposal Area is an unlined CCR landfill with an active area of approximately 13 acres.

The NDEE Title 132 permit for the North Omaha Ash Disposal Area includes an operations plan which describes the routine maintenance activities for the site drainage system. The permit also includes descriptions, calculations and figures of run-on and run-off control system features. This plan checks, expands and confirms compliance with the CCR rule for run-on and run-off controls from the active areas of the North Omaha Ash Disposal Area.

II. Run-On Control System

The run-on control system for the North Omaha Ash Disposal Area consists of perimeter ditches, access roads and grading sloped away from the ash disposal area to prevent and minimize stormwater run-on to the active portion of the CCR landfill. As shown on Figure 1 in Appendix A, potential run-on does not reach the CCR and is diverted around the North Omaha Ash Disposal Area. There is a contributing area of approximately 1.7 acres west of the adjacent public road, John J Pershing Drive, with off-site run-on draining into the west perimeter ditch at the western toe of slope for the North Omaha Ash Disposal Area. Currently this drainage is flowing south and becomes combined with the run-off from the active CCR landfill area. Improvements will be completed in the future which will re-direct this run-on towards the north stormwater inlet, along with other stormwater run-off that does not come into contact with the active CCR area. Calculation of the run-on volume is contained in Appendix A and the west perimeter ditch sizing is contained in Appendix B. Grading and improved perimeter ditches will continue to intercept, divert and prevent potential storm water run-on to the CCR landfill.

III. Run-Off Control System

Before modifications were made to the stormwater control system in 2017, the run-off control system for the North Omaha Ash Disposal Area consisted of directing the majority of the run-off from the active CCR landfill to the existing onsite coal pile run-off pond and the remainder to the North Pond, located at the north end of the landfill. The modifications in 2017 rerouted all run-off from the active CCR landfill to a central drainage ditch which discharges to the existing Ash Landfill Drainage Pond (previously described as the West Process Water Pond).

The contributing volume of runoff was modeled for a 25-year, 24-hour storm event. The rainfall depths were obtained from NOAA Atlas 14. The results of the hydrologic modeling, with the current drainage areas schematic, are found in Appendix A.

The results of the hydrologic modeling, included in Appendix A, indicate approximately 48,845 cubic feet (CF) of non-contact stormwater will flow to the north. This consists of 8,875 CF of runon from the treeline west of the closed west side slope, 26,530 CF along the east side slope and 13,440 CF along the closed west slope flowing toward the north. The modeling also indicates approximately 210,970 CF of run-off flow that would be directed to the Ash Landfill Drainage Pond. This includes 37,660 CF of direct infiltration, 10,790 CF from the ash building roof, 18,594 CF from area closed area southwest of active area, 117,725 CF from active area, 19,780 CF from John J Pershing Drive run-on, and 6,415 from closed west slope flowing south.

The following drainage controls improvements were completed in 2017 to more effectively manage the run-off from the North Omaha Ash Disposal Area:

- The north, west and east sideslopes of the North Omaha Ash Disposal Area were closed and covered with a final cover system. Most of the run-off from these areas is directed to the north. Only stormwater run-off that has not been in direct contact with CCR will be directed to the north stormwater inlet for management as clean stormwater. Run-off volumes during the 25-year, 24-hour storm are provided in Appendix A.

- Run-off controls for the final cover system are described in the NDEE Title 132 permit application and are not part of the CCR Rule requirement for this plan.
- The North Pond is no longer required for management of CCR run-off. The pond was retained for temporary sediment control, while vegetation on final cover system is established. The pond may be filled in at a later date and the area graded for the storm water to enter the storm sewer located immediately east.

- Perimeter ditches were improved and constructed along the west and east sides of the North Omaha Ash Disposal Area. Ditch sizing calculations and figures are contained in Appendix B.
  - An east perimeter ditch was constructed at the toe of the CCR landfill to collect and convey most of the run-off from covered Phase 2 sideslopes to the north. Perimeter ditch sizing calculations are included in Appendix B.
  - The west perimeter ditch was improved to collect and convey as much of the run-off from the covered Phase 1 sideslopes to the north. The high point of the ditch is located immediately south of the outlet bringing the off-site run-on from the area west of John J Pershing Drive onto the site, which is currently routed to the Ash Landfill Drainage Pond. A portion of run-off from closed west slope is directed to the Ash Landfill Drainage Pond. The ditch ties in to the existing, natural ditch which has an approximate slope of 7.5%. Perimeter ditch sizing calculations are included in Appendix B.
- Run-off from the active portion of the North Omaha Ash Disposal Area is directed towards a central channel that extends south from the landfill to the Ash Landfill Drainage Pond on the Station property. Run-off volumes from the active portion during the 25-year, 24-hour storm are provided in Appendix C.
  - The active CCR fill within the North Omaha Ash Disposal Area has been and will further be graded to facilitate surface water run-off from the active portion of the CCR landfill towards the interior channels.
  - A channel located at the south-central end of the CCR landfill (starting near existing ash building) collects and conveys run-off from the active portion of the CCR landfill south directly into the Ash Landfill Drainage Pond. Channel sizing calculations are included in Appendix C.
  - Three 30-inch reinforced concrete culverts capable of providing sufficient capacity and strength were installed under the service road to convey flow from the proposed interior channel south into the Ash Landfill Drainage Pond while preventing flow over the roadway. Culvert sizing calculations are included in Appendix C.
  - The Ash Landfill Drainage Pond has approximately 931,700 CF of available storage from bottom elevation 987 to elevation 999; when maintaining 2 feet of freeboard the available capacity is 732,000 CF. The areas of the CCR landfill directed to the Ash Landfill Drainage Pond produce approximately 128,515 CF of run-off during the 25-year, 24-hour storm event. An additional 82,455 CF of stormwater runoff that does not come into contact with the active CCR area also drains to or directly falls in the pond. At this contribution of approximately 210,970 CF run-off to the Ash Landfill

Drainage Pond, process water levels within the pond should be maintained at elevation 994.7 or lower.

- Run-off from the closed sideslopes in the area to the southeast of the ash building is directed to the north pond.

The majority of stormwater run-off from the covered areas of the North Omaha Ash Disposal Area will be collected, controlled and conveyed north via perimeter ditches for management in accordance with the existing surface water requirements in the Station's stormwater pollution prevention plan (SWPPP).

Stormwater run-off from the active CCR area generated from the 25-year, 24-hour storm (and lesser storms) will be collected, controlled and conveyed south to the existing Ash Landfill Drainage Pond direct via the central drainage channel. This run-off will be managed in accordance with requirements of the Station's industrial NPDES permit.

Calculations, figures and management of stormwater run-off from the North Omaha Ash Disposal Area are contained in Appendices A, B, and C of this plan.

Appendix A
Stormwater Drainage Areas and Hydraflow Report

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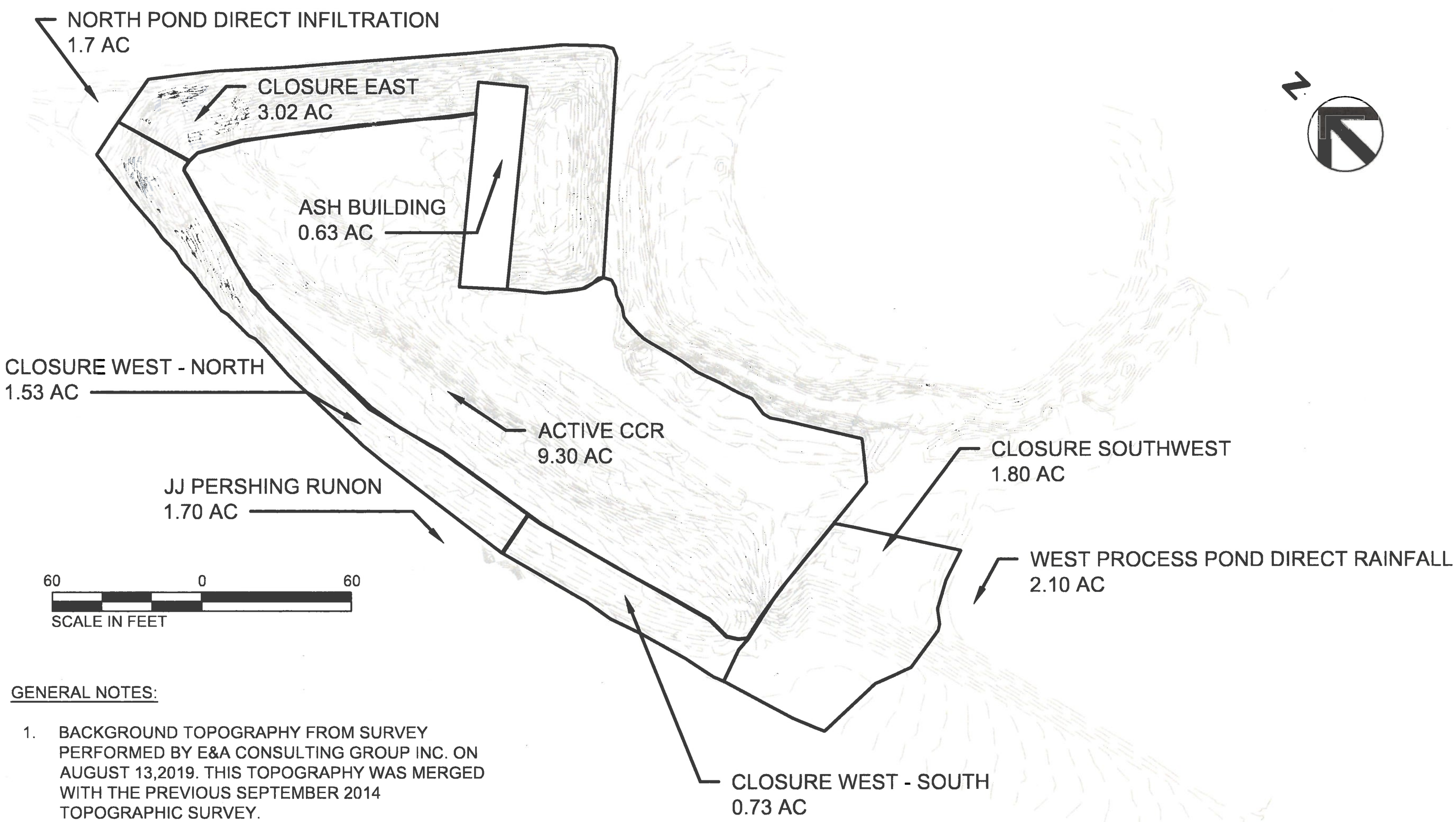

GENERAL NOTES:

1. BACKGROUND TOPOGRAPHY FROM SURVEY PERFORMED BY E&A CONSULTING GROUP INC. ON AUGUST 13,2019. THIS TOPOGRAPHY WAS MERGED WITH THE PREVIOUS SEPTEMBER 2014 TOPOGRAPHIC SURVEY.

HDR

OPPD North Omaha Station Ash Disposal Area
Stormwater Drainage Areas

Title 132 Permit Renewal Application

DATE

September 2019

FIGURE

1

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Hydraflow Table of Contents

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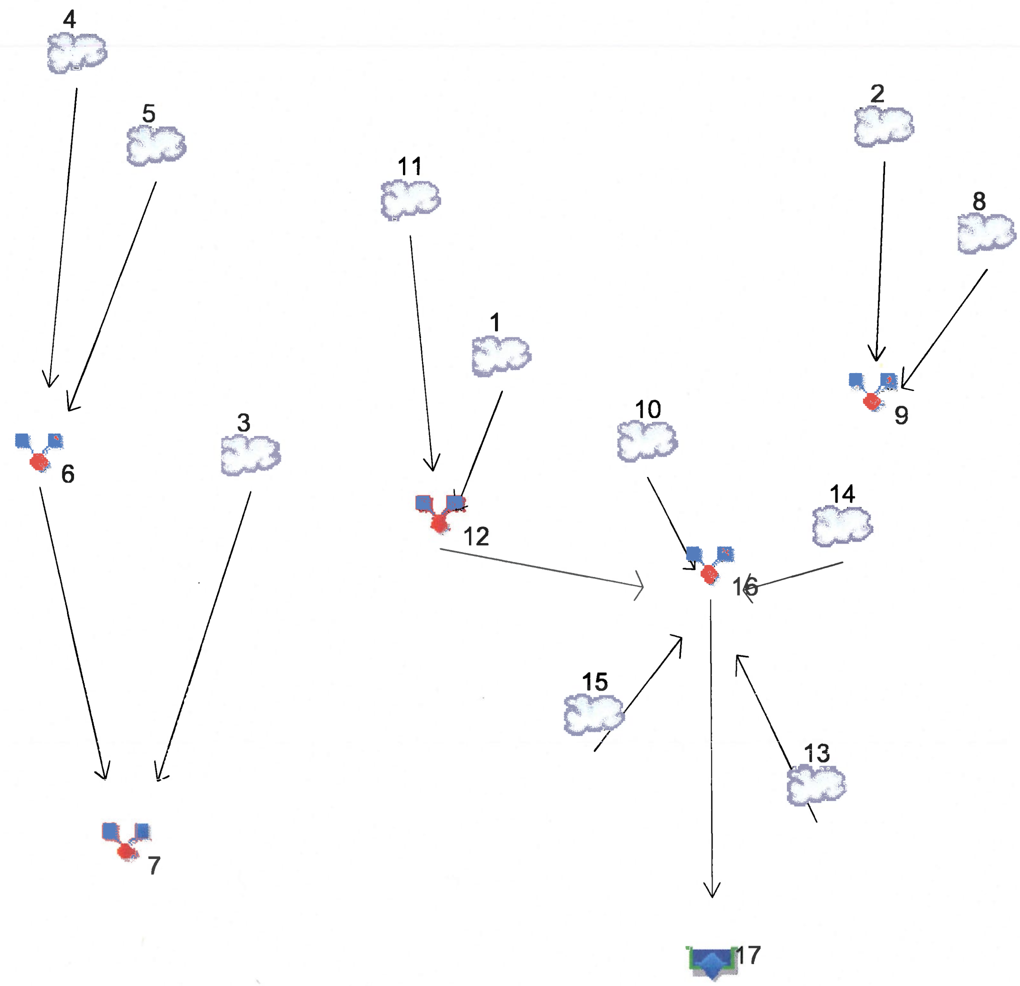
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 — Thursday, 08 / 29 / 2019

Watershed Model Schematic

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020



Legend

Hyd.	Origin	Description
1	SCS Runoff	Ash Building
2	SCS Runoff	Coal Pile Runoff
3	SCS Runoff	Closure East
4	SCS Runoff	North Pond
5	SCS Runoff	Closure West - North
6	Combine	North Pond (West Ditch)
7	Combine	North Pond (Total)
8	SCS Runoff	Coal Pile Pond
9	Combine	Total Coal Pile Runoff
10	SCS Runoff	Closure Southwest
11	SCS Runoff	Active CCR Runoff
12	Combine	Active CCR Total Runoff
13	SCS Runoff	West Proces Pond Direct Rainfall
14	SCS Runoff	JJ Pershing Runon
15	SCS Runoff	Closure West - South
16	Combine	Total Runoff - West Process Pond
17	Reservoir	West Process Pond

Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020

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	4.514	2	716	10,790	------	------	------	Ash Building
2	SCS Runoff	100.56	2	716	223,279	------	------	------	Coal Pile Runoff
3	SCS Runoff	7.820	2	718	15,766	------	------	------	Closure East
4	SCS Runoff	4.402	2	718	8,875	------	------	------	North Pond
5	SCS Runoff	3.962	2	718	7,987	------	------	------	Closure West - North
6	Combine	8.363	2	718	16,862	4, 5	------	------	North Pond (West Ditch)
7	Combine	16.18	2	718	32,628	3, 6	------	------	North Pond (Total)
8	SCS Runoff	8.641	2	716	21,521	------	------	------	Coal Pile Pond
9	Combine	109.20	2	716	244,800	2, 8	------	------	Total Coal Pilè Runoff
10	SCS Runoff	6.593	2	718	13,206	------	------	------	Closure Southwest
11	SCS Runoff	51.22	2	716	105,128	------	------	------	Active CCR Runoff
12	Combine	55.73	2	716	115,918	1, 11	------	------	Active CCR Total Runoff
13	SCS Runoff	15.12	2	716	37,662	------	------	------	West Proces Pond Direct Rainfall
14	SCS Runoff	9.599	2	716	19,782	------	------	------	JJ Pershing Runon
15	SCS Runoff	1.890	2	718	3,811	------	------	------	Closure West - South
16	Combine	88.78	2	716	190,379	10, 12, 13, 14, 15	------	------	Total Runoff - West Process Pond
17	Reservoir	0.000	2	n/a	0	16	990.37	190,379	West Process Pond

N_Omaha_amj.gpw	Return Period: 25 Year	Thursday, 08 / 29 / 2019

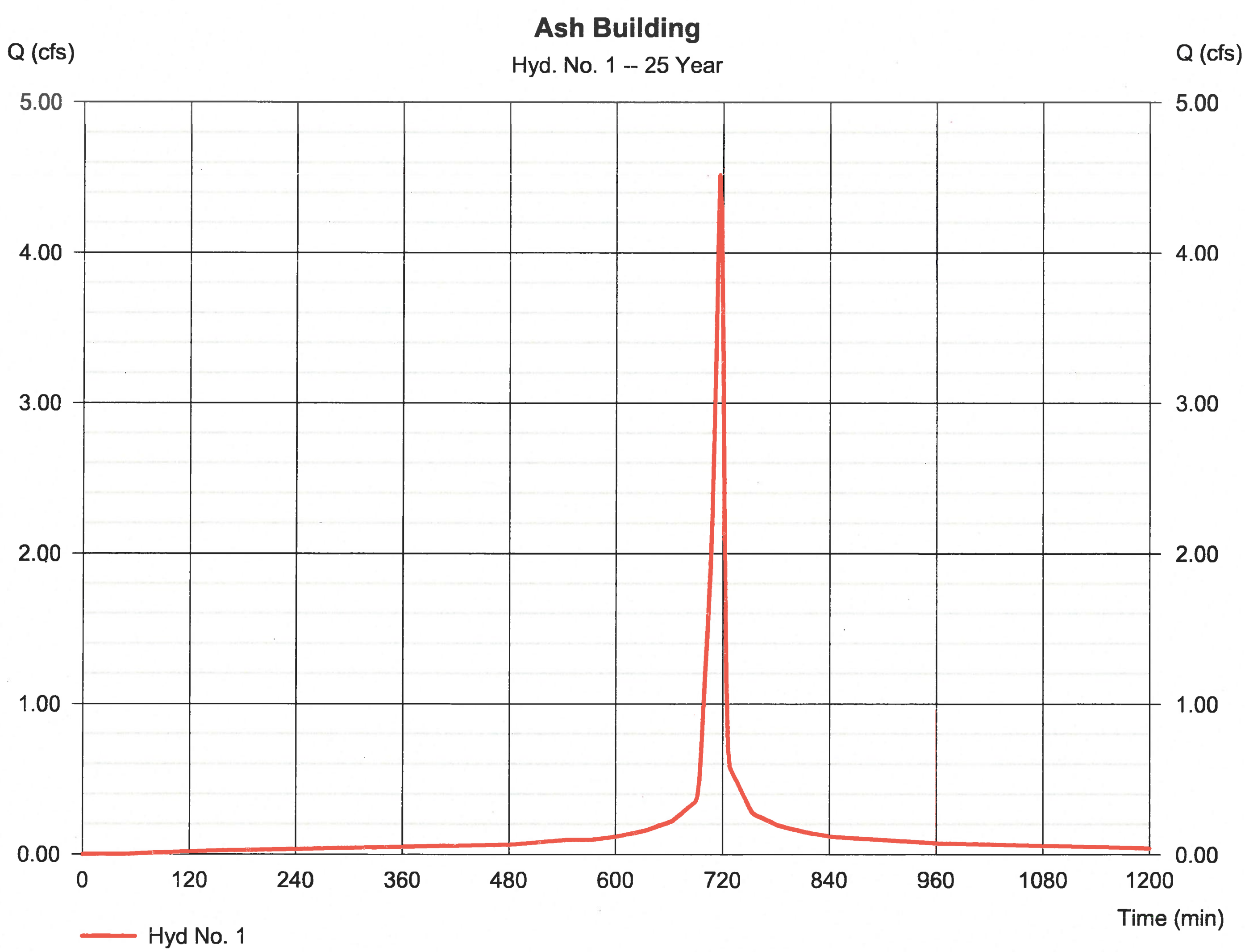
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 | Thursday, 08 / 29 / 2019

Hyd. No. 1

Ash Building

Hydrograph type	= SCS Runoff	Peak discharge	= 4.514 cfs
Storm frequency	= 25 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 10,790 cuft
Drainage area	= 0.630 ac	Curve number	= 98
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 5.27 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



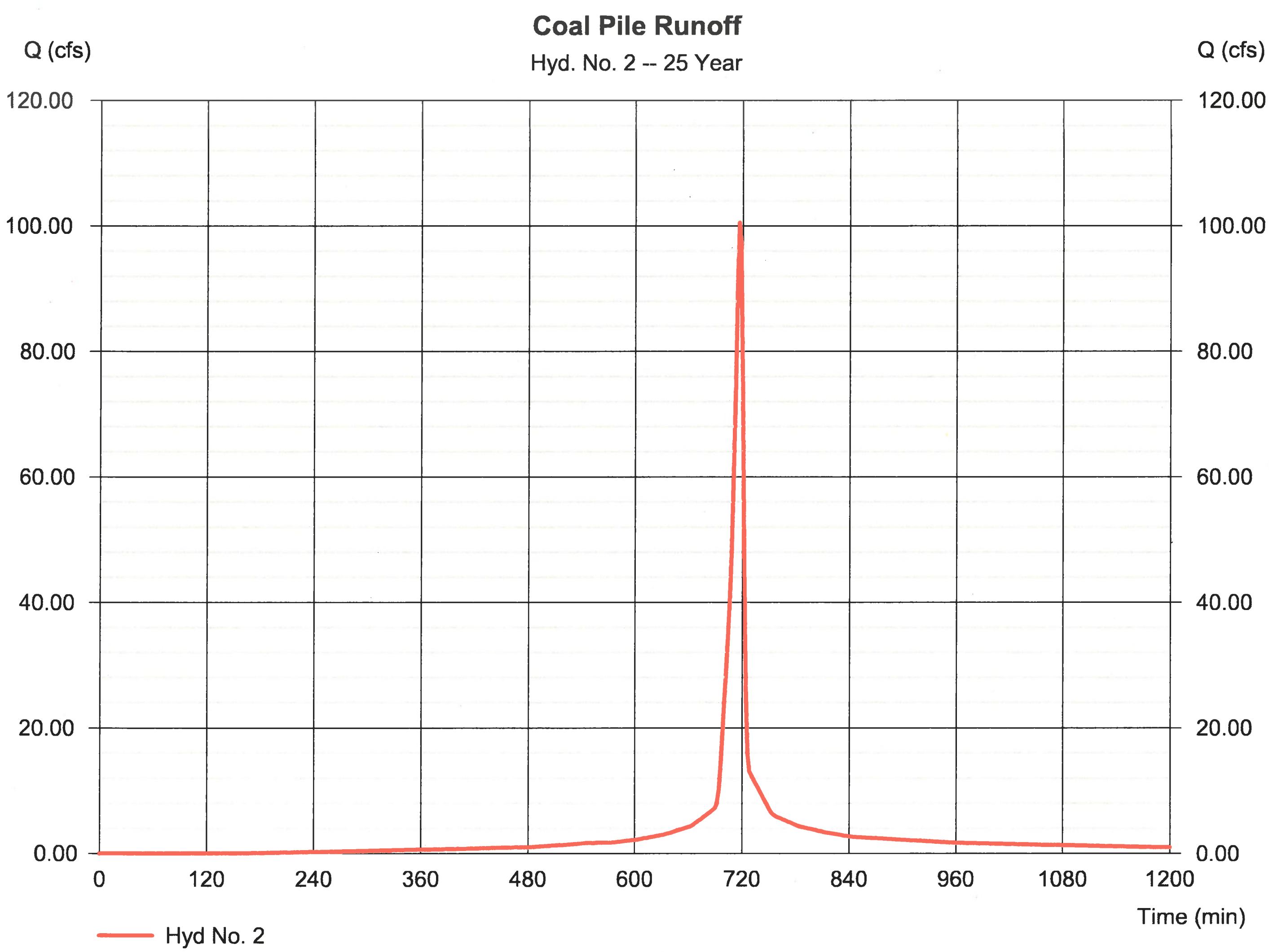
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Thursday, 08 / 29 / 2019

Hyd. No. 2

Coal Pile Runoff

Hydrograph type	= SCS Runoff	Peak discharge	= 100.56 cfs
Storm frequency	= 25 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 223,279 cuft
Drainage area	= 14.700 ac	Curve number	= 93
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 5.27 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

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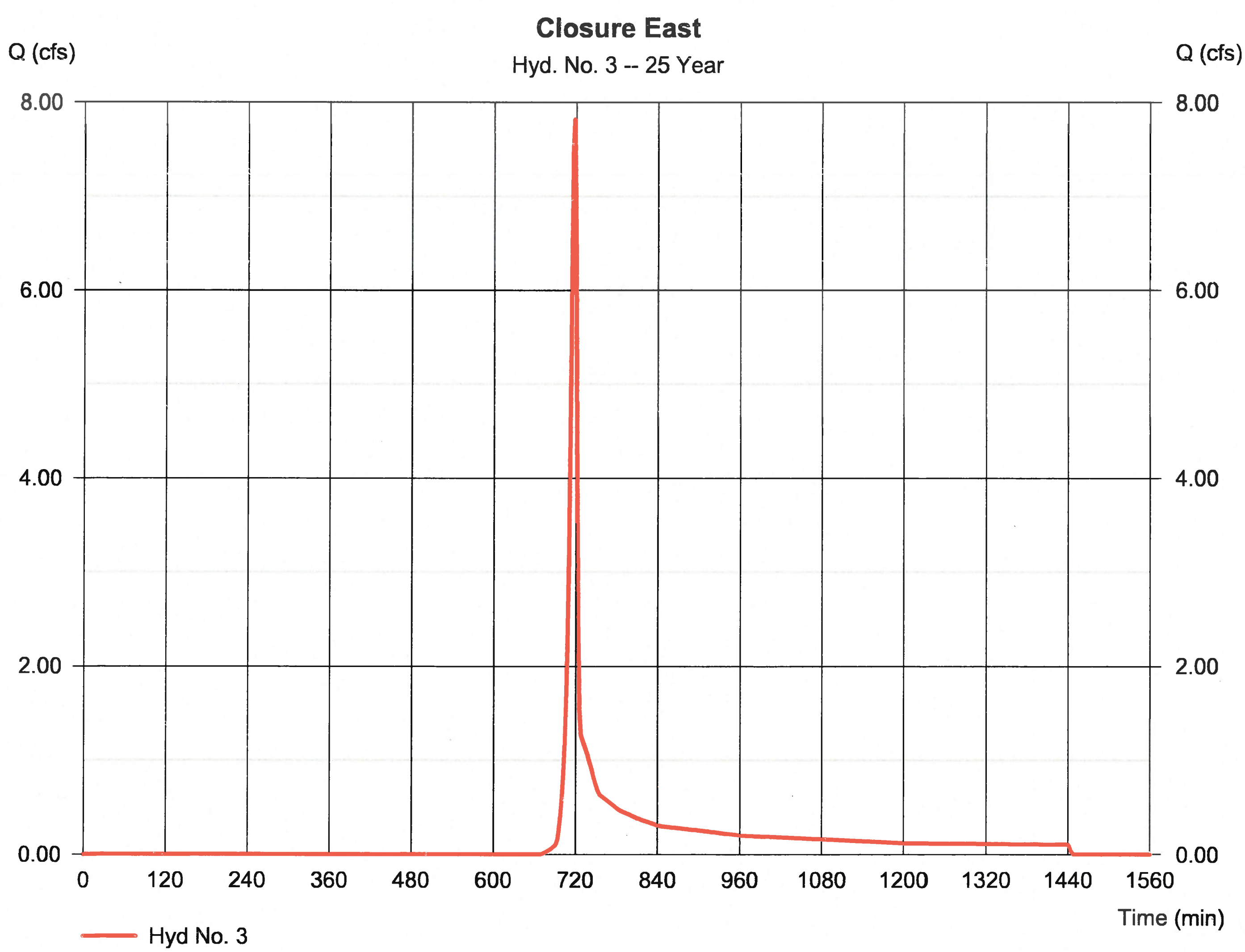
Hyd. No. 3

Closure East

Hydrograph type	= SCS Runoff	Peak discharge	= 7.820 cfs
Storm frequency	= 25 yrs	Time to peak	= 718 min
Time interval	= 2 min	Hyd. volume	= 15,766 cuft
Drainage area	= 3.020 ac	Curve number	= 61
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 5.27 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



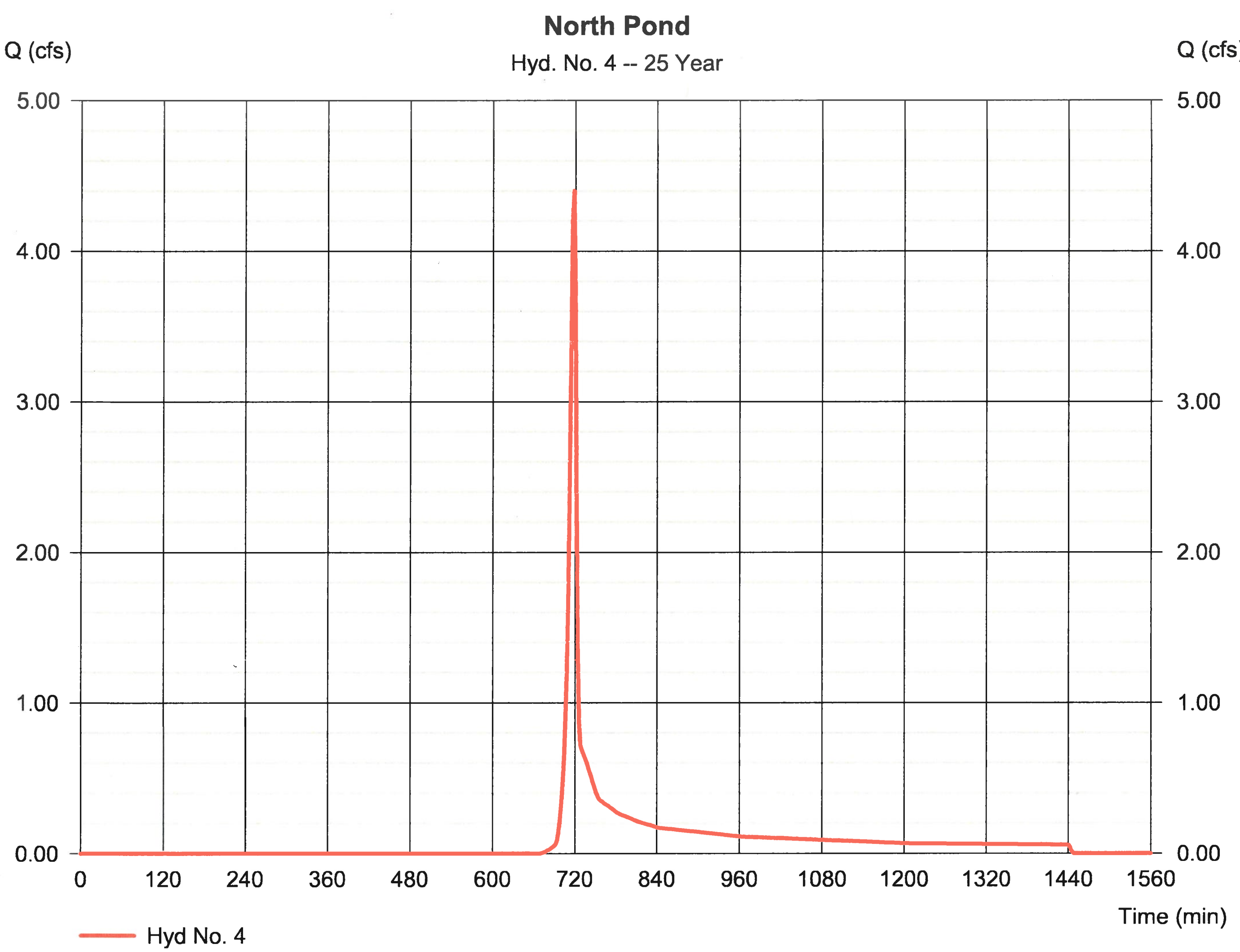
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Thursday, 08 / 29 / 2019

Hyd. No. 4

North Pond

Hydrograph type	= SCS Runoff	Peak discharge	= 4.402 cfs
Storm frequency	= 25 yrs	Time to peak	= 718 min
Time interval	= 2 min	Hyd. volume	= 8,875 cuft
Drainage area	= 1.700 ac	Curve number	= 61
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 5.27 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



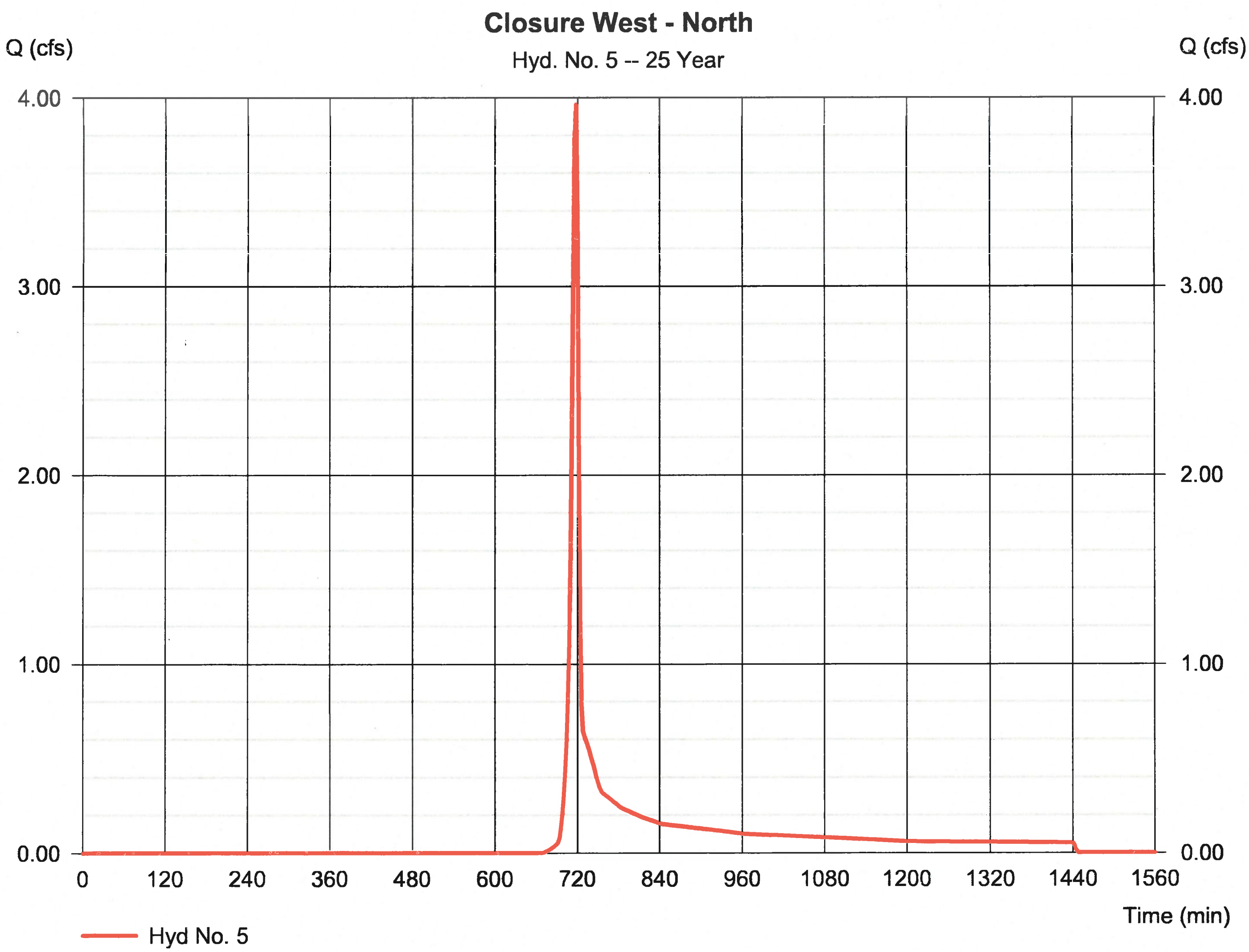
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Thursday, 08 / 29 / 2019

Hyd. No. 5

Closure West - North

Hydrograph type	= SCS Runoff	Peak discharge	= 3.962 cfs
Storm frequency	= 25 yrs	Time to peak	= 718 min
Time interval	= 2 min	Hyd. volume	= 7,987 cuft
Drainage area	= 1.530 ac	Curve number	= 61
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 5.27 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



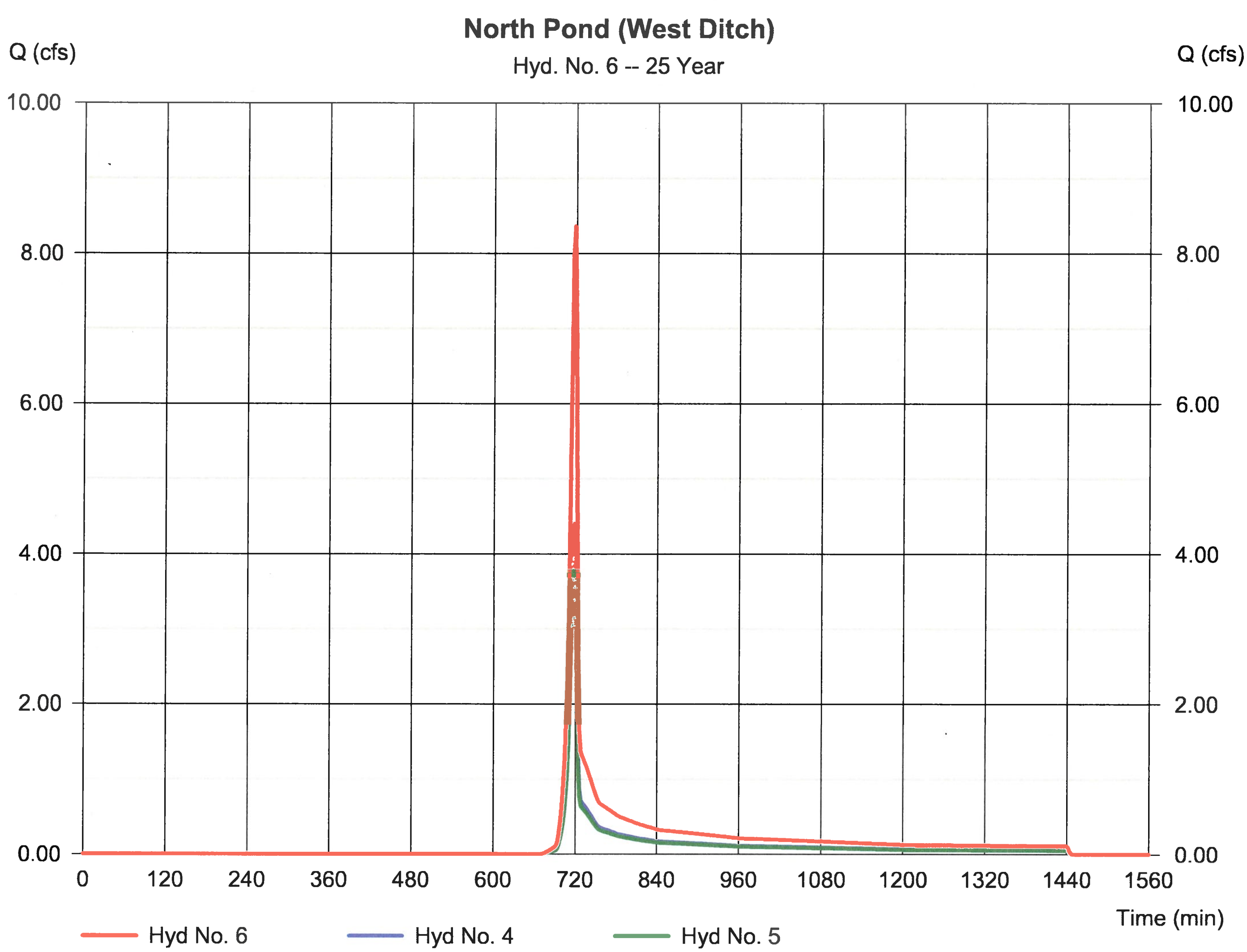
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Thursday, 08 / 29 / 2019

Hyd. No. 6

North Pond (West Ditch)

Hydrograph type	= Combine	Peak discharge	= 8.363 cfs
Storm frequency	= 25 yrs	Time to peak	= 718 min
Time interval	= 2 min	Hyd. volume	= 16,862 cuft
Inflow hyds.	= 4, 5	Contrib. drain. area	= 3.230 ac



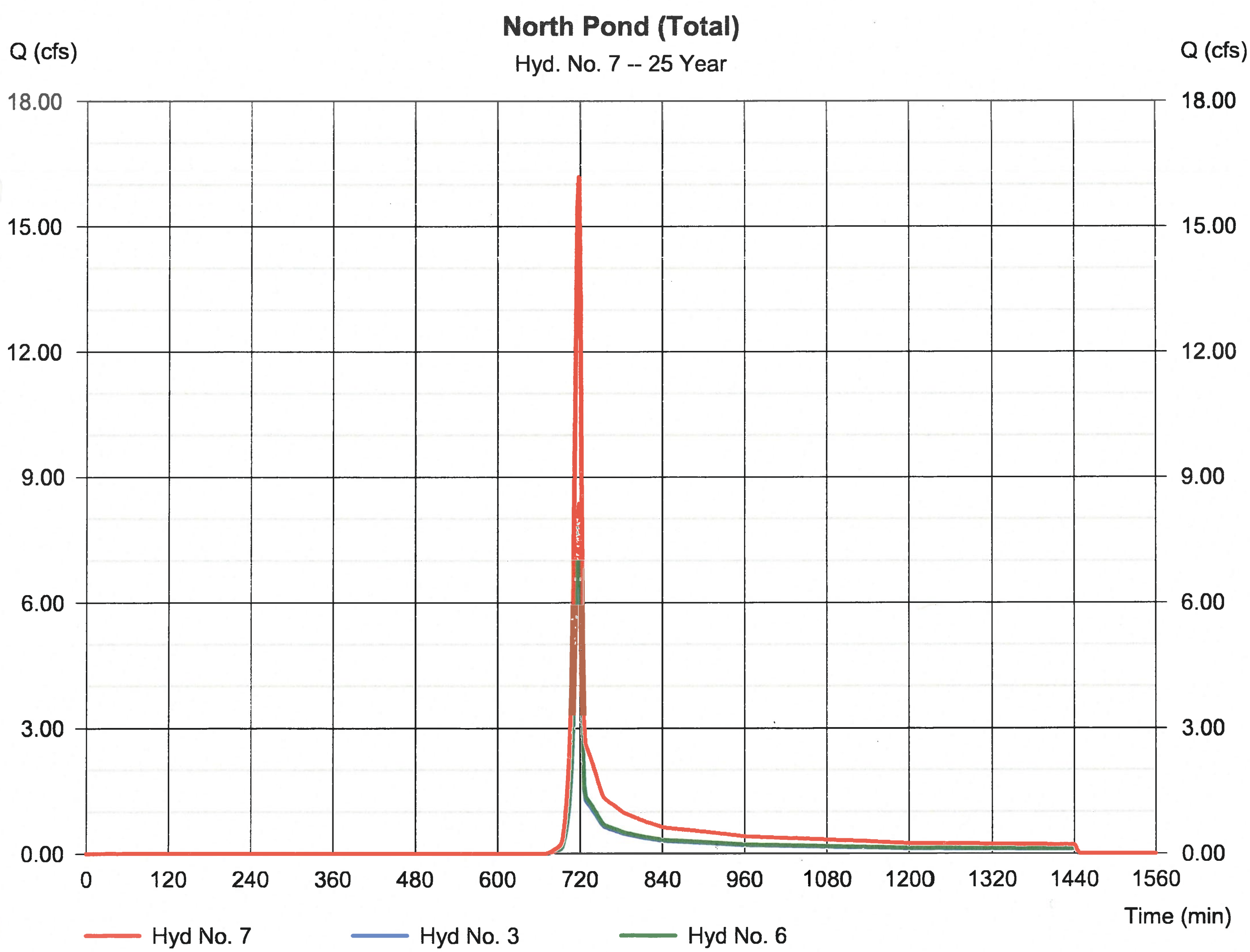
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Thursday, 08 / 29 / 2019

Hyd. No. 7

North Pond (Total)

Hydrograph type	= Combine	Peak discharge	= 16.18 cfs
Storm frequency	= 25 yrs	Time to peak	= 718 min
Time interval	= 2 min	Hyd. volume	= 32,628 cuft
Inflow hyds.	= 3, 6	Contrib. drain. area	= 3.020 ac



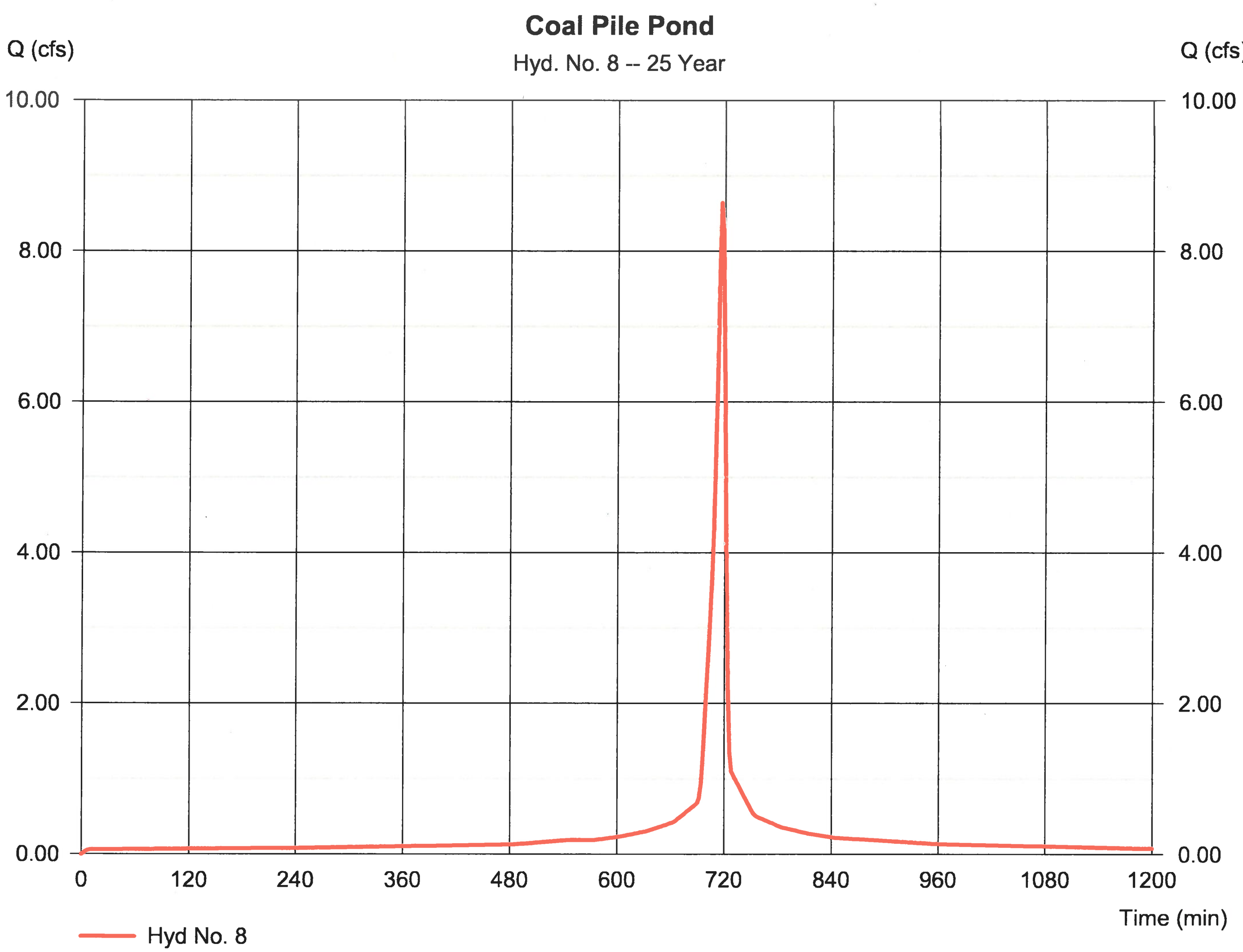
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 | Thursday, 08 / 29 / 2019

Hyd. No. 8

Coal Pile Pond

Hydrograph type	= SCS Runoff	Peak discharge	= 8.641 cfs
Storm frequency	= 25 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 21,521 cuft
Drainage area	= 1.200 ac	Curve number	= 100
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 5.27 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

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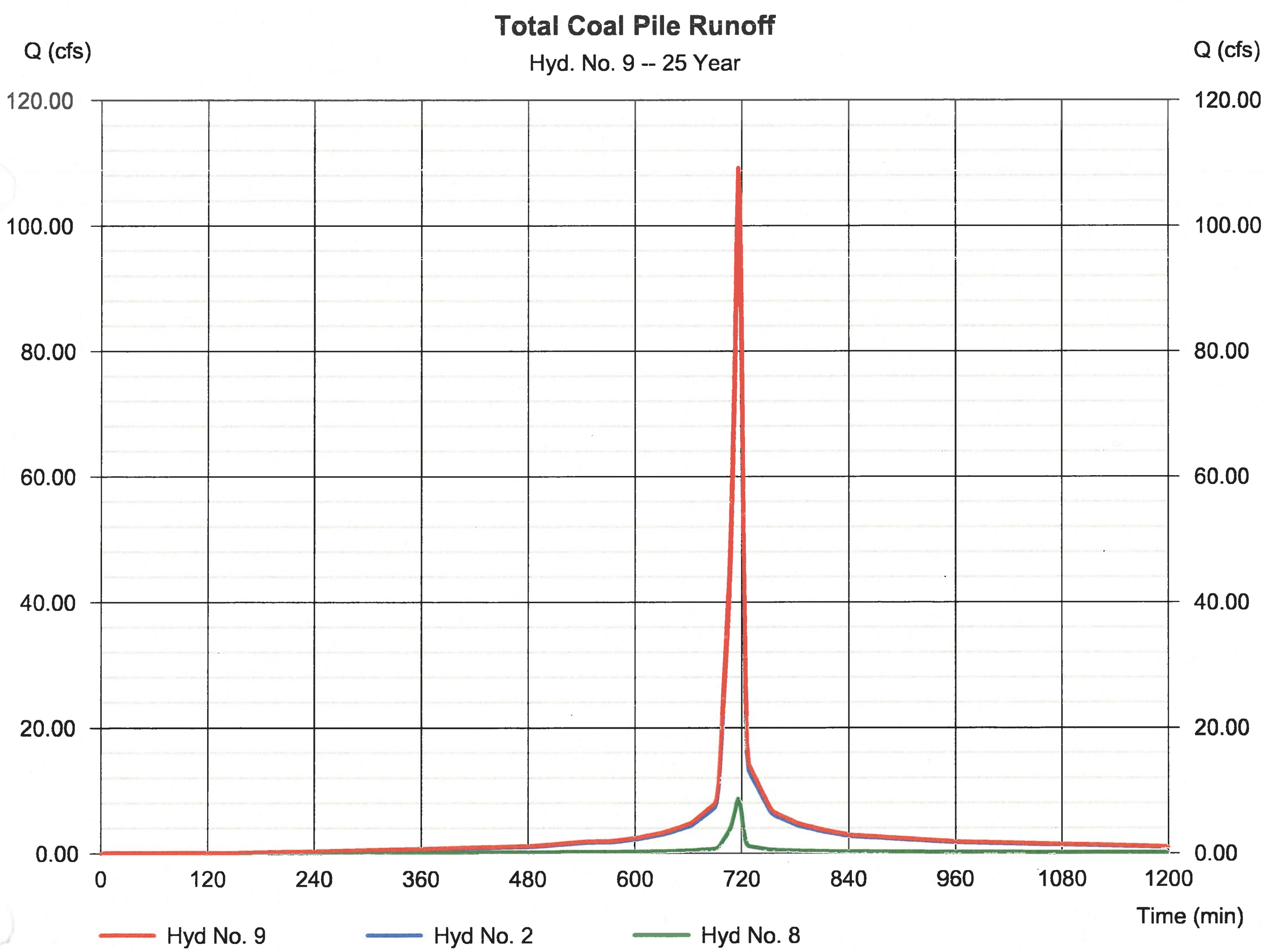
Hyd. No. 9

Total Coal Pile Runoff

Hydrograph type	= Combine	Peak discharge	= 109.20 cfs
Storm frequency	= 25 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 244,800 cuft
Inflow hyds.	= 2, 8	Contrib. drain. area	= 15.900 ac



Hydrograph Report

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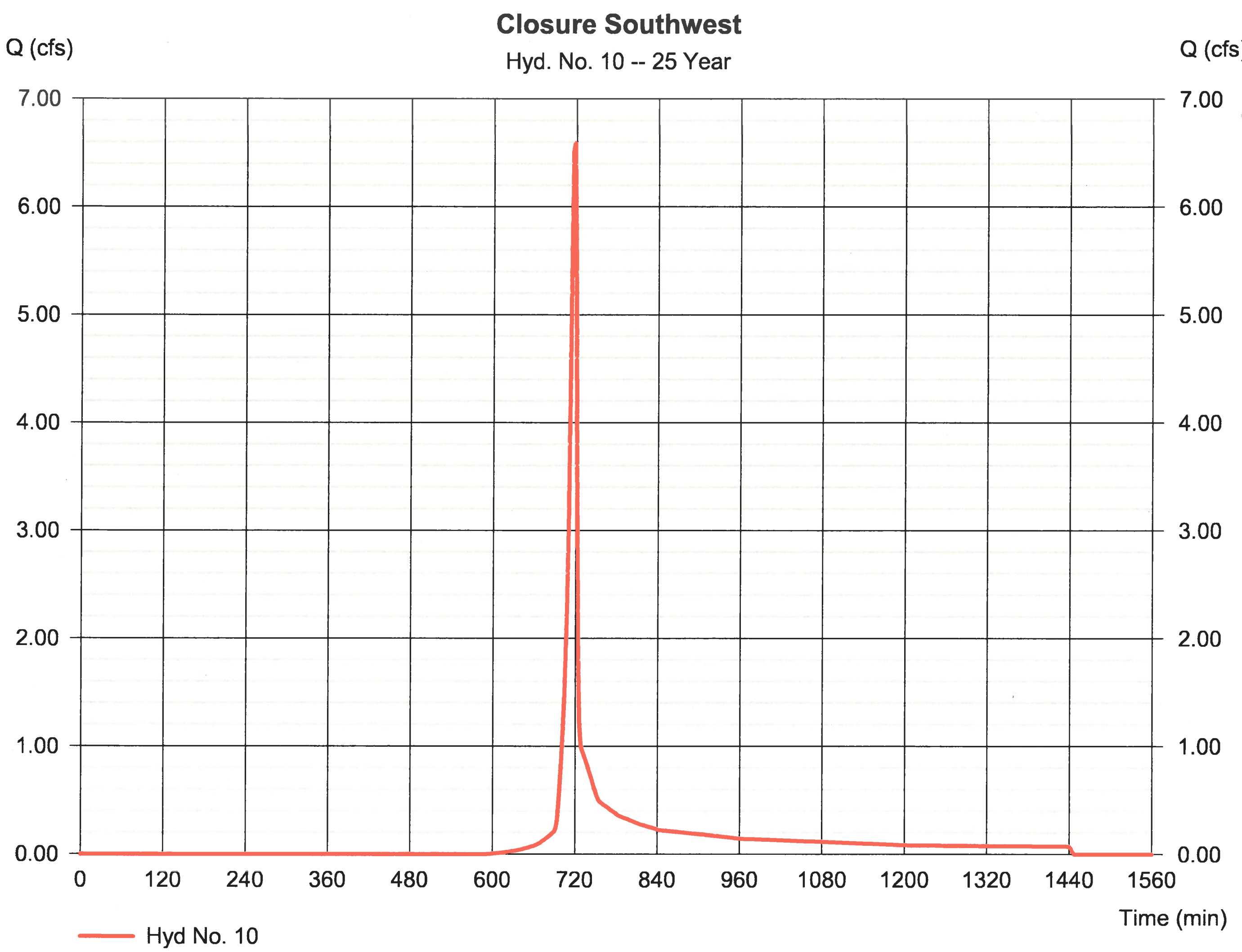
Hyd. No. 10

Closure Southwest

Hydrograph type	= SCS Runoff	Peak discharge	= 6.593 cfs
Storm frequency	= 25 yrs	Time to peak	= 718 min
Time interval	= 2 min	Hyd. volume	= 13,206 cuft
Drainage area	= 1.800 ac	Curve number	= 69
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 5.27 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

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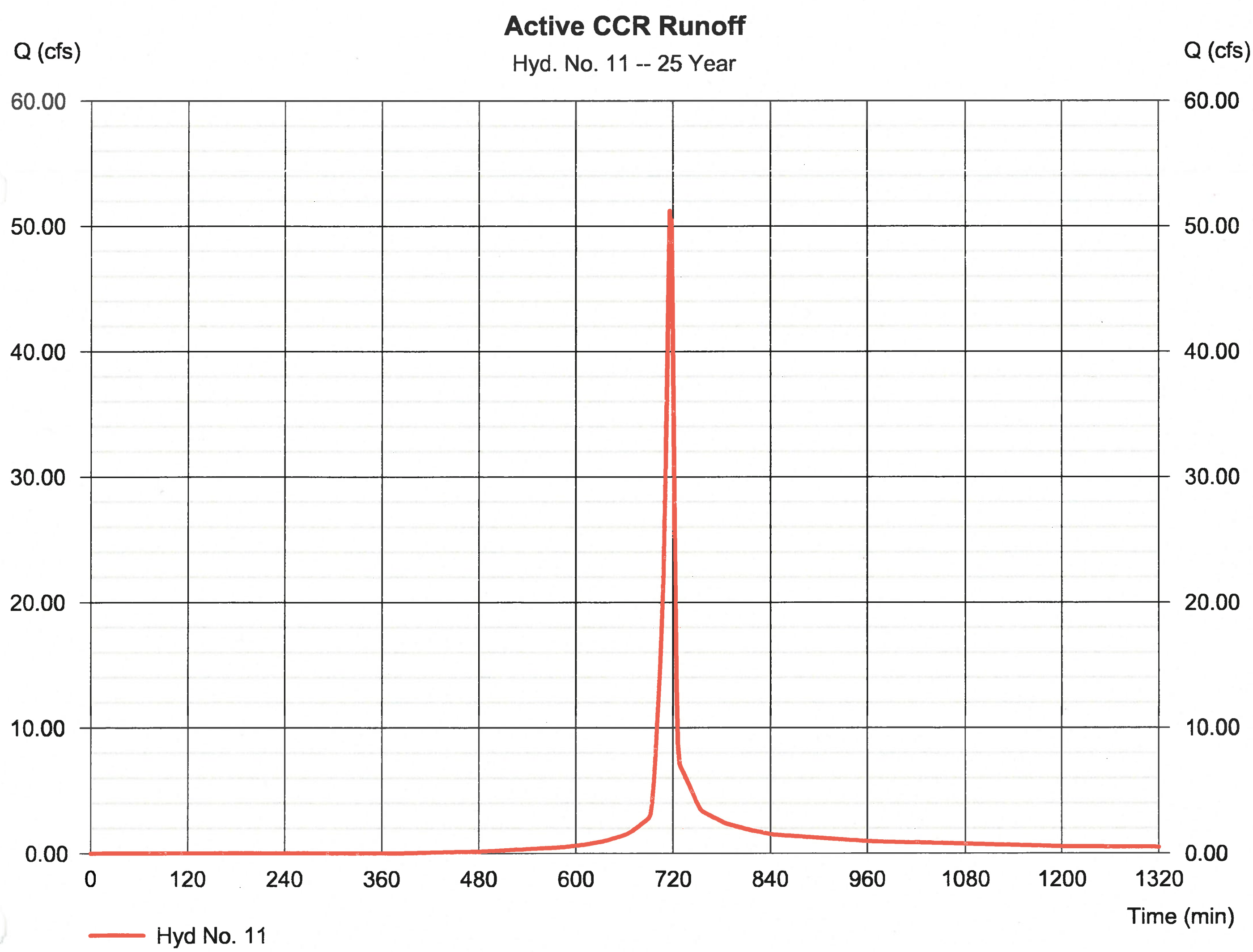
Hyd. No. 11

Active CCR Runoff

Hydrograph type	= SCS Runoff	Peak discharge	= 51.22 cfs
Storm frequency	= 25 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 105,128 cuft
Drainage area	= 9.300 ac	Curve number	= 82
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 5.27 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

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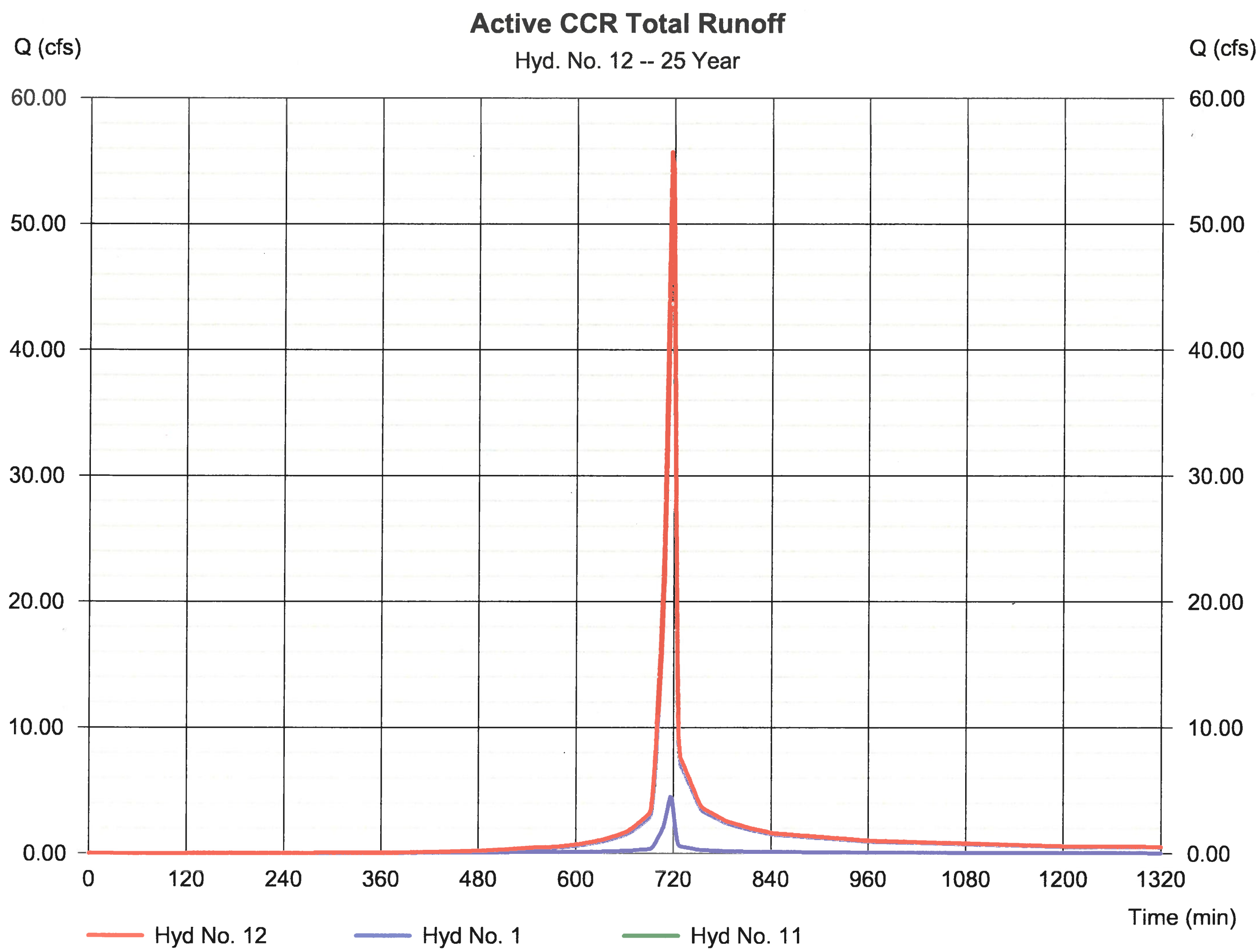
Hyd. No. 12

Active CCR Total Runoff

Hydrograph type	= Combine	Peak discharge	= 55.73 cfs
Storm frequency	= 25 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 115,918 cuft
Inflow hyds.	= 1, 11	Contrib. drain. area	= 9.930 ac



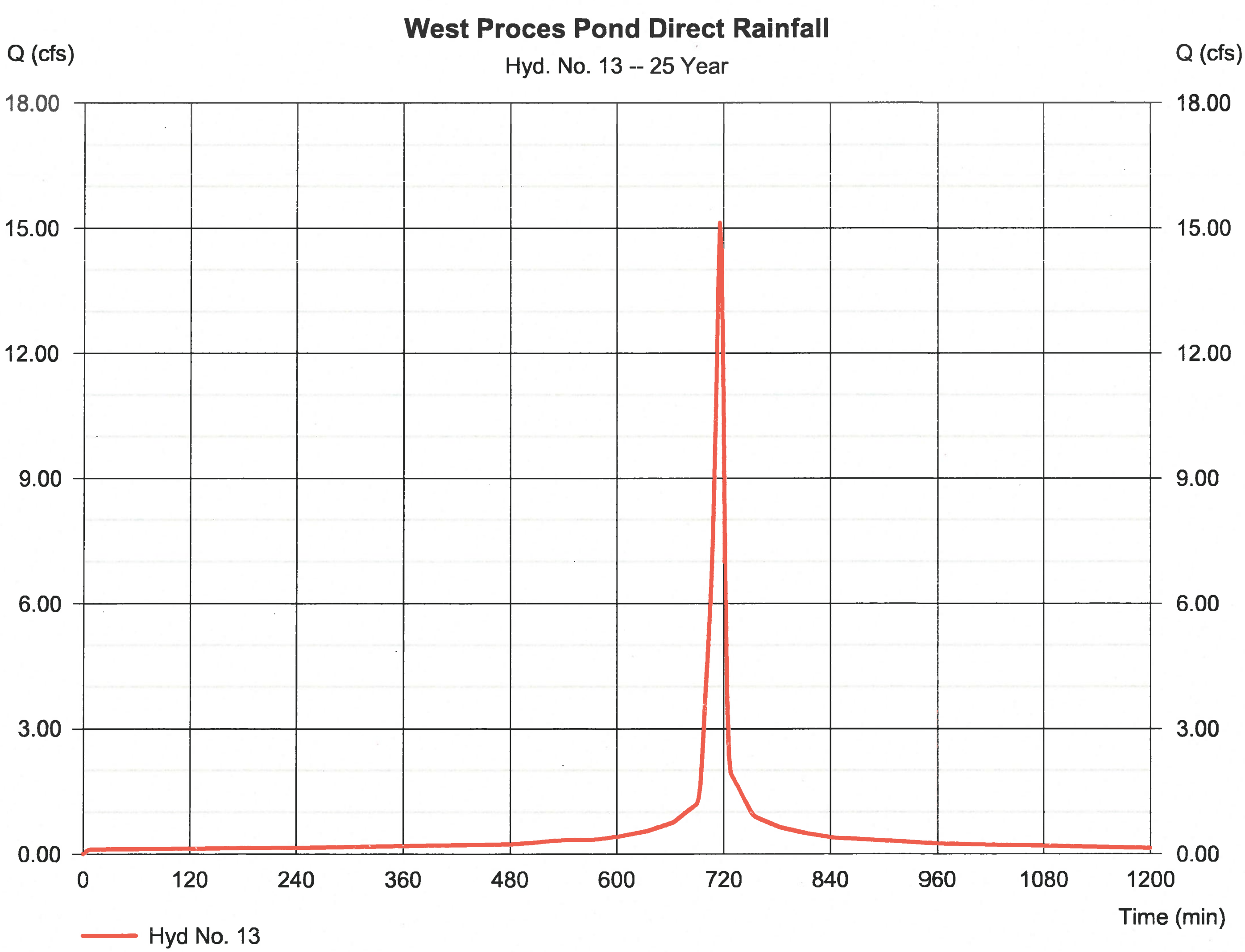
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Thursday, 08 / 29 / 2019

Hyd. No. 13

West Proces Pond Direct Rainfall

Hydrograph type	= SCS Runoff	Peak discharge	= 15.12 cfs
Storm frequency	= 25 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 37,662 cuft
Drainage area	= 2.100 ac	Curve number	= 100
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 5.27 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



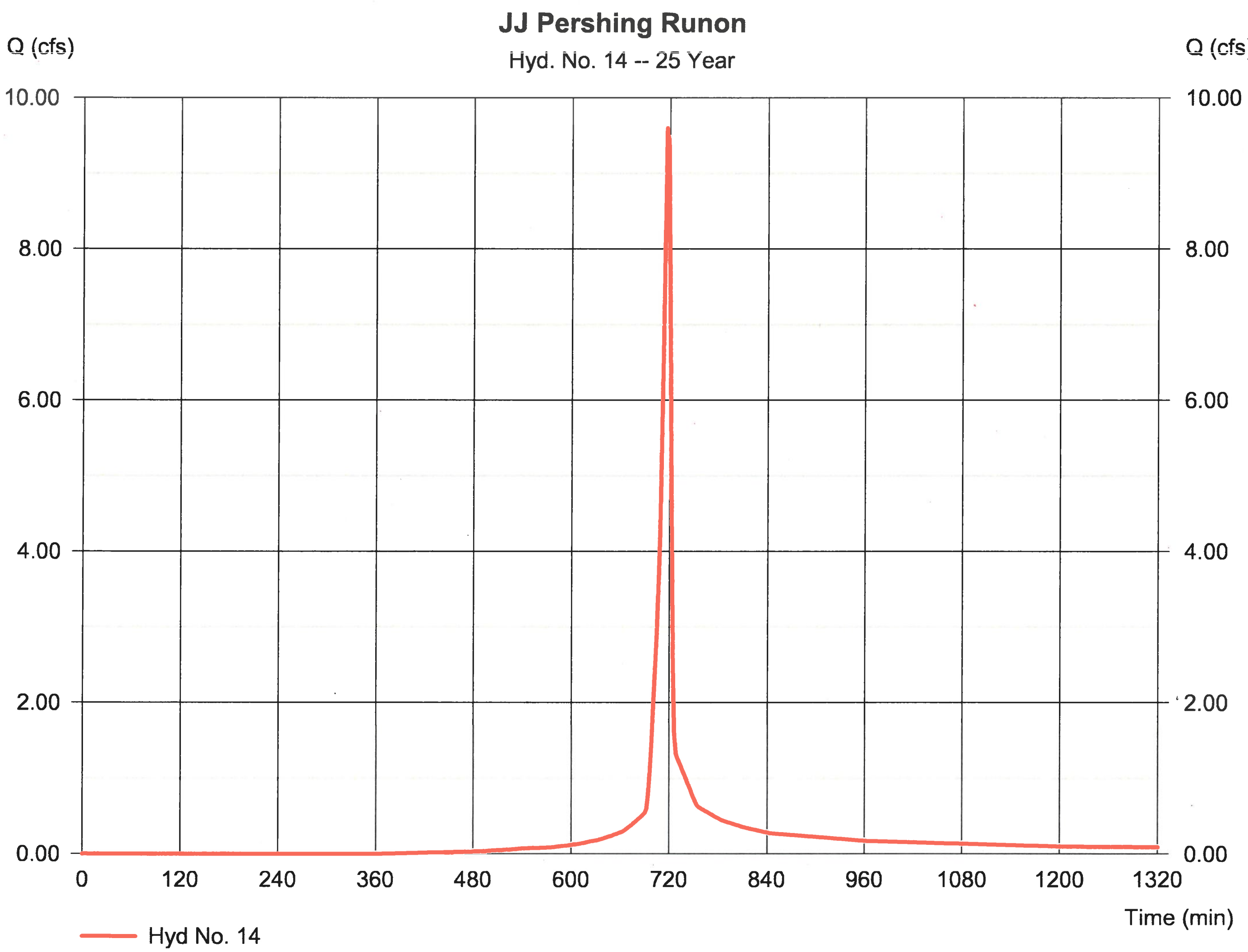
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Thursday, 08 / 29 / 2019

Hyd. No. 14

JJ Pershing Runon

Hydrograph type	= SCS Runoff	Peak discharge	= 9.599 cfs
Storm frequency	= 25 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 19,782 cuft
Drainage area	= 1.700 ac	Curve number	= 83
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 5.27 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



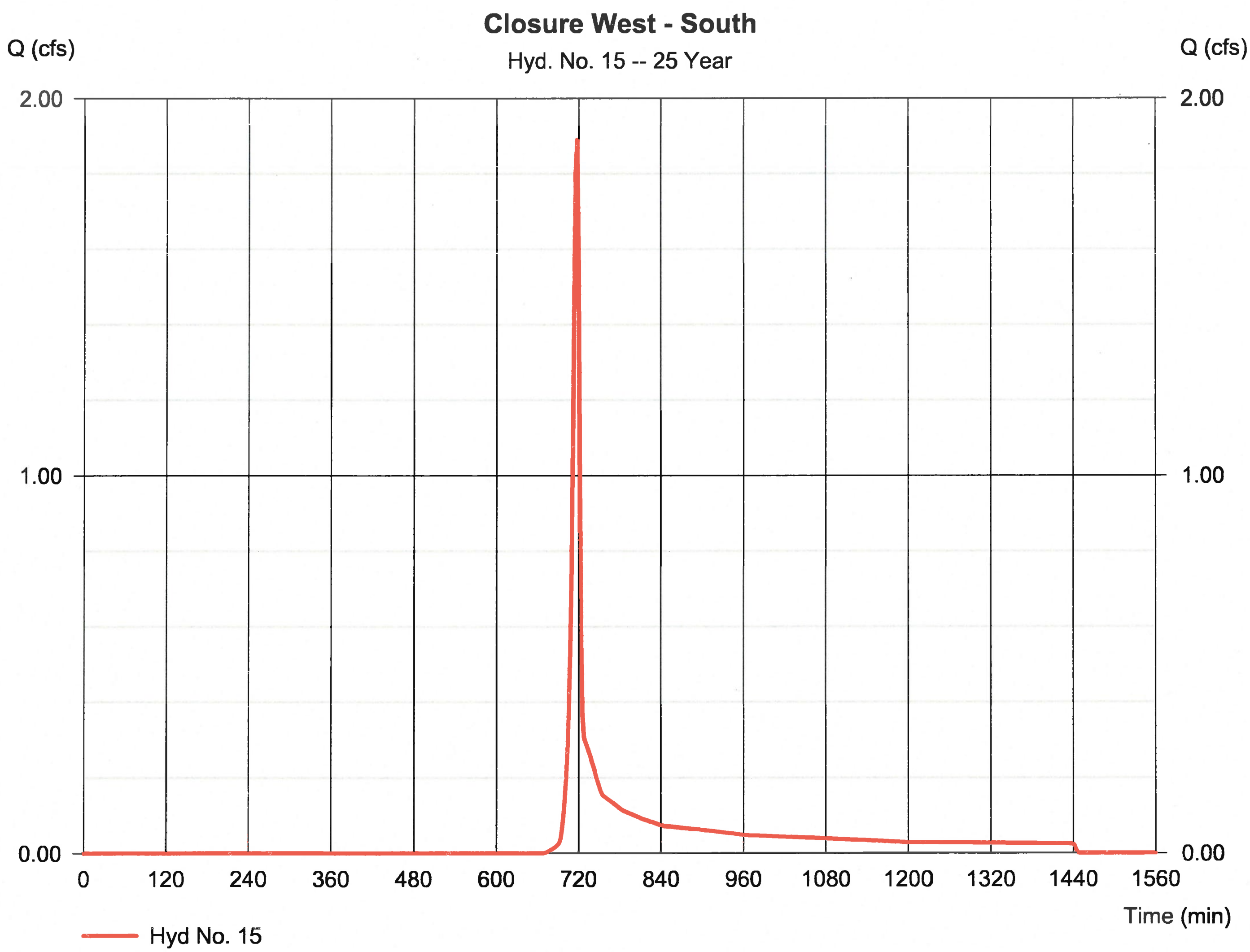
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 — Thursday, 08 / 29 / 2019

Hyd. No. 15

Closure West - South

Hydrograph type	= SCS Runoff	Peak discharge	= 1.890 cfs
Storm frequency	= 25 yrs	Time to peak	= 718 min
Time interval	= 2 min	Hyd. volume	= 3,811 cuft
Drainage area	= 0.730 ac	Curve number	= 61
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 5.27 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



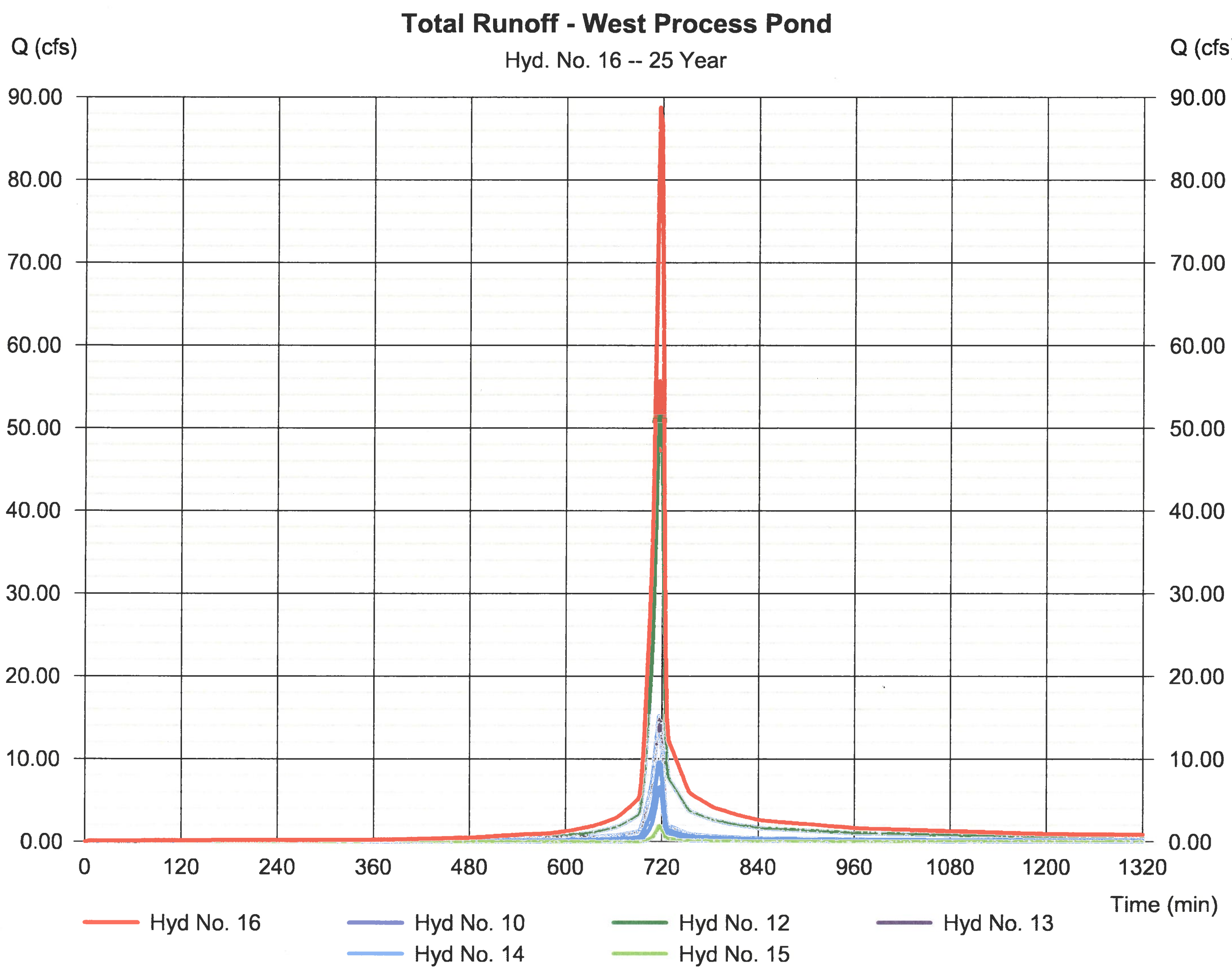
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Thursday, 08 / 29 / 2019

Hyd. No. 16

Total Runoff - West Process Pond

Hydrograph type	= Combine	Peak discharge	= 88.78 cfs
Storm frequency	= 25 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 190,379 cuft
Inflow hyds.	= 10, 12, 13, 14, 15	Contrib. drain. area	= 6.330 ac



Hydrograph Report

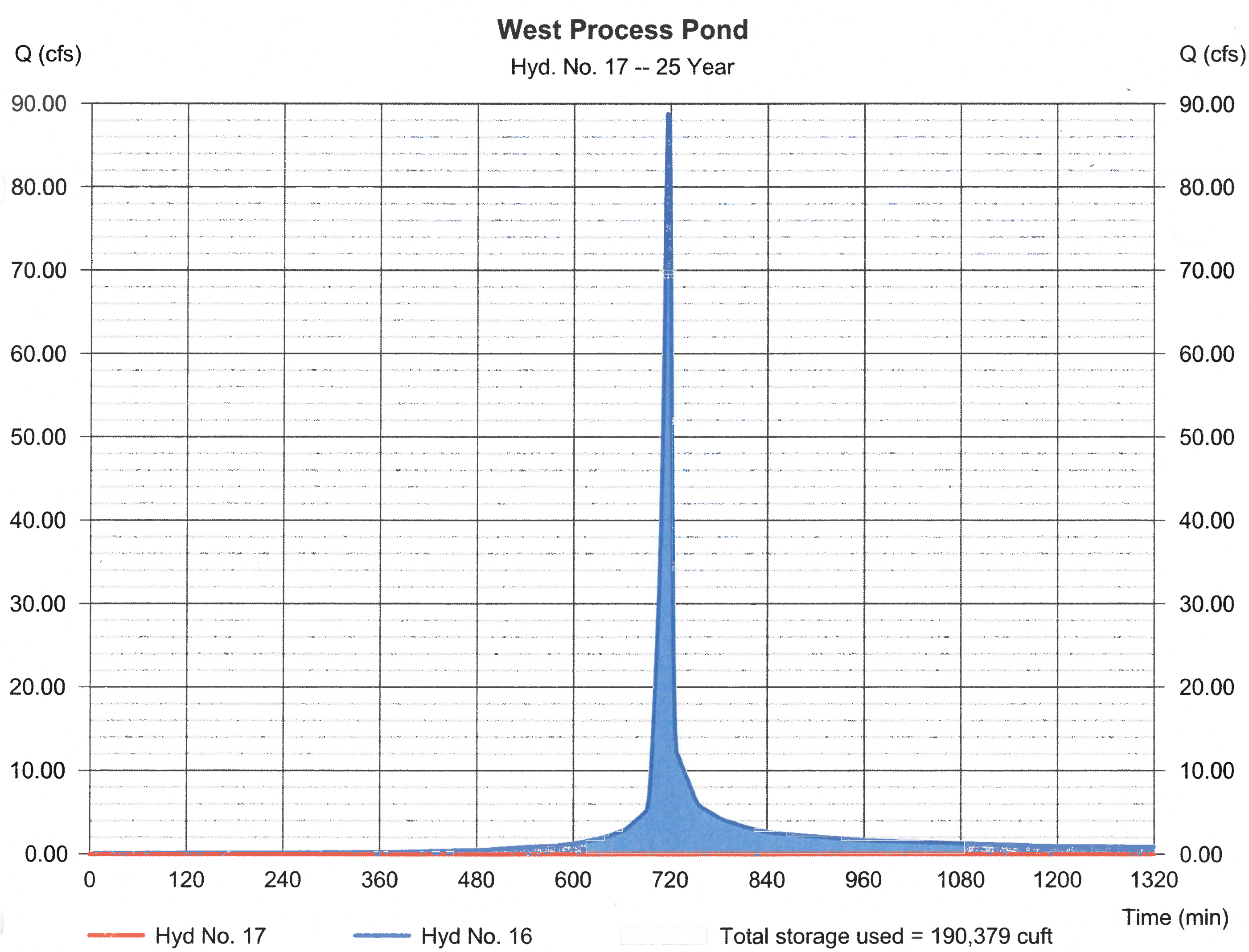
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 — Thursday, 08 / 29 / 2019

Hyd. No. 17

West Process Pond

Hydrograph type	= Reservoir	Peak discharge	= 0.000 cfs
Storm frequency	= 25 yrs	Time to peak	= n/a
Time interval	= 2 min	Hyd. volume	= 0 cuft
Inflow hyd. No.	= 16 - Total Runoff - West Process Pond	Max. Elevation	= 990.37 ft
Reservoir name	= West Process Pond	Max. Storage	= 190,379 cuft

Storage Indication method used.



NOAA Atlas 14, Volume 8, Version 2
Location name: Omaha, Nebraska, US*
Latitude: 41.3302°, Longitude: -95.9496°
Elevation: 994 ft*
* source: Google Maps

POINT PRECIPITATION FREQUENCY ESTIMATES

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

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

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

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.354 (0.300–0.424)	0.421 (0.356–0.503)	0.532 (0.449–0.638)	0.627 (0.526–0.755)	0.763 (0.617–0.944)	0.870 (0.687–1.09)	0.981 (0.746–1.25)	1.10 (0.798–1.43)	1.25 (0.875–1.66)	1.38 (0.933–1.85)
10-min	0.519 (0.440–0.621)	0.616 (0.521–0.737)	0.779 (0.657–0.934)	0.918 (0.770–1.11)	1.12 (0.904–1.38)	1.27 (1.01–1.59)	1.44 (1.09–1.83)	1.61 (1.17–2.09)	1.83 (1.28–2.44)	2.01 (1.37–2.70)
15-min	0.633 (0.536–0.757)	0.751 (0.636–0.899)	0.950 (0.801–1.14)	1.12 (0.939–1.35)	1.36 (1.10–1.69)	1.55 (1.23–1.94)	1.75 (1.33–2.23)	1.96 (1.42–2.55)	2.24 (1.56–2.97)	2.46 (1.67–3.30)
30-min	0.935 (0.792–1.12)	1.12 (0.944–1.33)	1.42 (1.19–1.70)	1.67 (1.40–2.01)	2.03 (1.65–2.52)	2.32 (1.83–2.90)	2.61 (1.99–3.32)	2.91 (2.12–3.79)	3.32 (2.32–4.42)	3.64 (2.47–4.89)
60-min	1.22 (1.04–1.46)	1.47 (1.25–1.76)	1.90 (1.60–2.28)	2.28 (1.91–2.74)	2.81 (2.28–3.50)	3.25 (2.57–4.08)	3.70 (2.82–4.73)	4.18 (3.05–5.45)	4.84 (3.39–6.45)	5.37 (3.64–7.20)
2-hr	1.51 (1.29–1.80)	1.83 (1.56–2.18)	2.39 (2.03–2.85)	2.88 (2.43–3.44)	3.60 (2.94–4.45)	4.18 (3.33–5.22)	4.80 (3.68–6.10)	5.45 (4.00–7.07)	6.36 (4.48–8.43)	7.09 (4.84–9.46)
3-hr	1.68 (1.43–1.98)	2.03 (1.74–2.41)	2.66 (2.27–3.16)	3.23 (2.73–3.85)	4.08 (3.36–5.05)	4.78 (3.83–5.96)	5.53 (4.26–7.02)	6.33 (4.67–8.20)	7.47 (5.28–9.87)	8.38 (5.74–11.1)
6-hr	1.97 (1.69–2.31)	2.35 (2.02–2.76)	3.05 (2.61–3.59)	3.70 (3.15–4.37)	4.70 (3.90–5.81)	5.54 (4.48–6.89)	6.46 (5.03–8.18)	7.47 (5.55–9.64)	8.90 (6.35–11.7)	10.1 (6.95–13.3)
12-hr	2.28 (1.97–2.66)	2.64 (2.28–3.09)	3.32 (2.86–3.89)	3.96 (3.39–4.65)	4.97 (4.17–6.12)	5.84 (4.76–7.23)	6.80 (5.33–8.56)	7.86 (5.89–10.1)	9.38 (6.74–12.3)	10.6 (7.39–14.0)
24-hr	2.61 (2.27–3.02)	2.95 (2.57–3.42)	3.61 (3.13–4.20)	4.25 (3.66–4.96)	5.27 (4.46–6.45)	6.17 (5.06–7.59)	7.16 (5.65–8.96)	8.26 (6.24–10.6)	9.87 (7.15–12.9)	11.2 (7.83–14.6)
2-day	2.94 (2.58–3.39)	3.34 (2.93–3.85)	4.09 (3.56–4.72)	4.79 (4.15–5.54)	5.87 (4.98–7.11)	6.81 (5.61–8.29)	7.83 (6.21–9.71)	8.95 (6.79–11.3)	10.6 (7.69–13.6)	11.9 (8.37–15.4)
3-day	3.20 (2.82–3.67)	3.65 (3.21–4.19)	4.47 (3.91–5.14)	5.22 (4.54–6.02)	6.37 (5.40–7.65)	7.34 (6.05–8.87)	8.38 (6.66–10.3)	9.52 (7.24–12.0)	11.1 (8.13–14.3)	12.5 (8.81–16.1)
4-day	3.44 (3.04–3.94)	3.93 (3.46–4.49)	4.79 (4.20–5.49)	5.57 (4.86–6.41)	6.75 (5.73–8.06)	7.73 (6.39–9.31)	8.79 (7.00–10.8)	9.93 (7.57–12.4)	11.5 (8.44–14.8)	12.8 (9.10–16.5)
7-day	4.10 (3.64–4.67)	4.63 (4.10–5.27)	5.56 (4.90–6.34)	6.38 (5.59–7.30)	7.59 (6.46–8.97)	8.58 (7.12–10.2)	9.63 (7.70–11.7)	10.7 (8.22–13.3)	12.3 (9.04–15.6)	13.6 (9.66–17.3)
10-day	4.69 (4.17–5.31)	5.27 (4.68–5.98)	6.27 (5.55–7.12)	7.14 (6.28–8.13)	8.39 (7.16–9.86)	9.41 (7.82–11.2)	10.5 (8.40–12.7)	11.6 (8.90–14.3)	13.1 (9.68–16.6)	14.4 (10.3–18.3)
20-day	6.33 (5.67–7.13)	7.12 (6.36–8.02)	8.42 (7.50–9.50)	9.51 (8.42–10.8)	11.0 (9.43–12.8)	12.2 (10.2–14.3)	13.4 (10.8–16.1)	14.7 (11.3–17.9)	16.3 (12.1–20.4)	17.6 (12.7–22.2)
30-day	7.71 (6.92–8.63)	8.68 (7.78–9.73)	10.2 (9.15–11.5)	11.5 (10.2–13.0)	13.3 (11.4–15.3)	14.6 (12.2–17.0)	15.9 (12.9–18.9)	17.3 (13.3–20.9)	19.0 (14.1–23.6)	20.3 (14.7–25.6)
45-day	9.46 (8.53–10.6)	10.7 (9.59–11.9)	12.5 (11.2–14.0)	14.1 (12.5–15.8)	16.1 (13.8–18.4)	17.5 (14.7–20.3)	19.0 (15.4–22.4)	20.4 (15.8–24.6)	22.1 (16.5–27.3)	23.4 (17.0–29.4)
60-day	11.0 (9.92–12.2)	12.3 (11.1–13.7)	14.5 (13.0–16.2)	16.2 (14.5–18.1)	18.4 (15.8–20.9)	19.9 (16.7–23.0)	21.4 (17.4–25.2)	22.9 (17.7–27.4)	24.6 (18.3–30.2)	25.8 (18.8–32.3)

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

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

Please refer to NOAA Atlas 14 document for more information.

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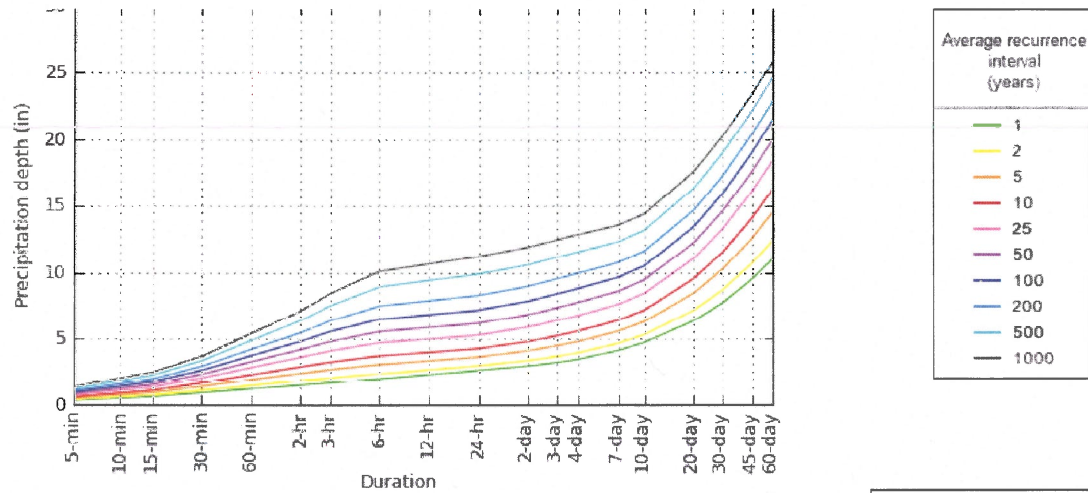
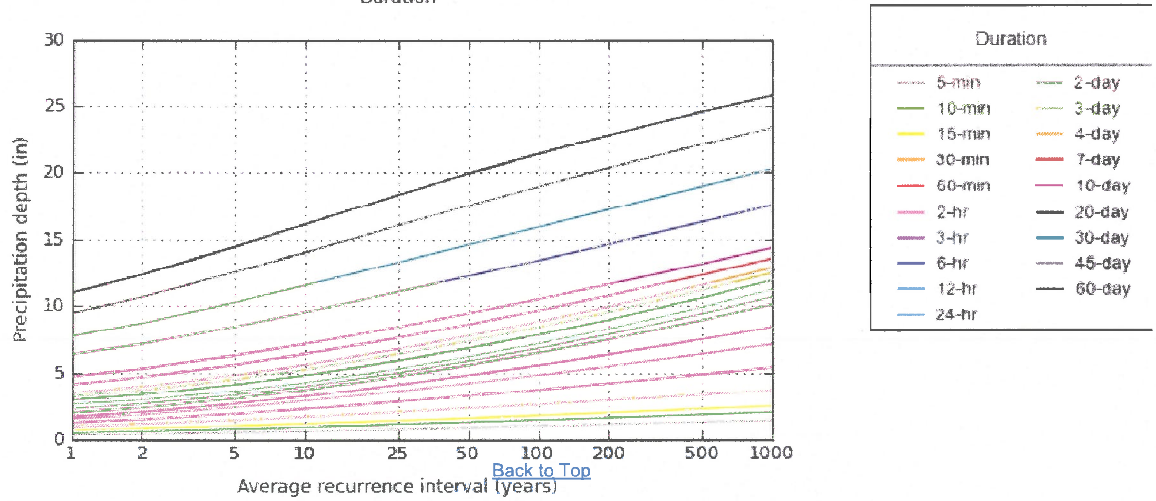
PF graphical





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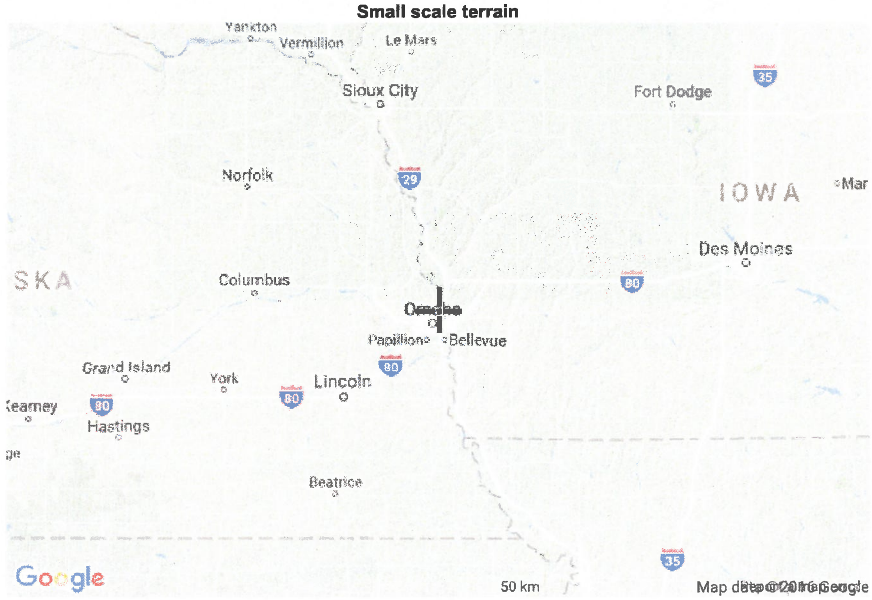
NOAA Atlas 14, Volume 8, Version 2

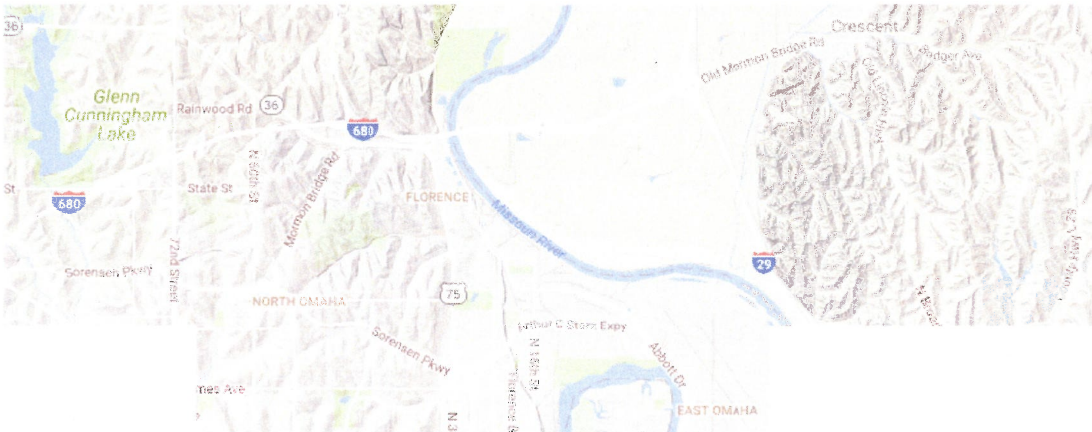
Created (GMT): Thu Aug 25 14:16:29 2016

Maps & aerials

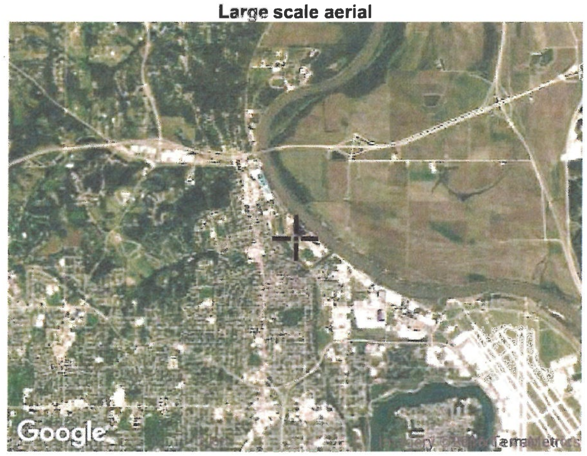
Small scale terrain



Large scale terrain



Large scale aerial



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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

Appendix B
Perimeter Ditch Sizing Calculations

FDR

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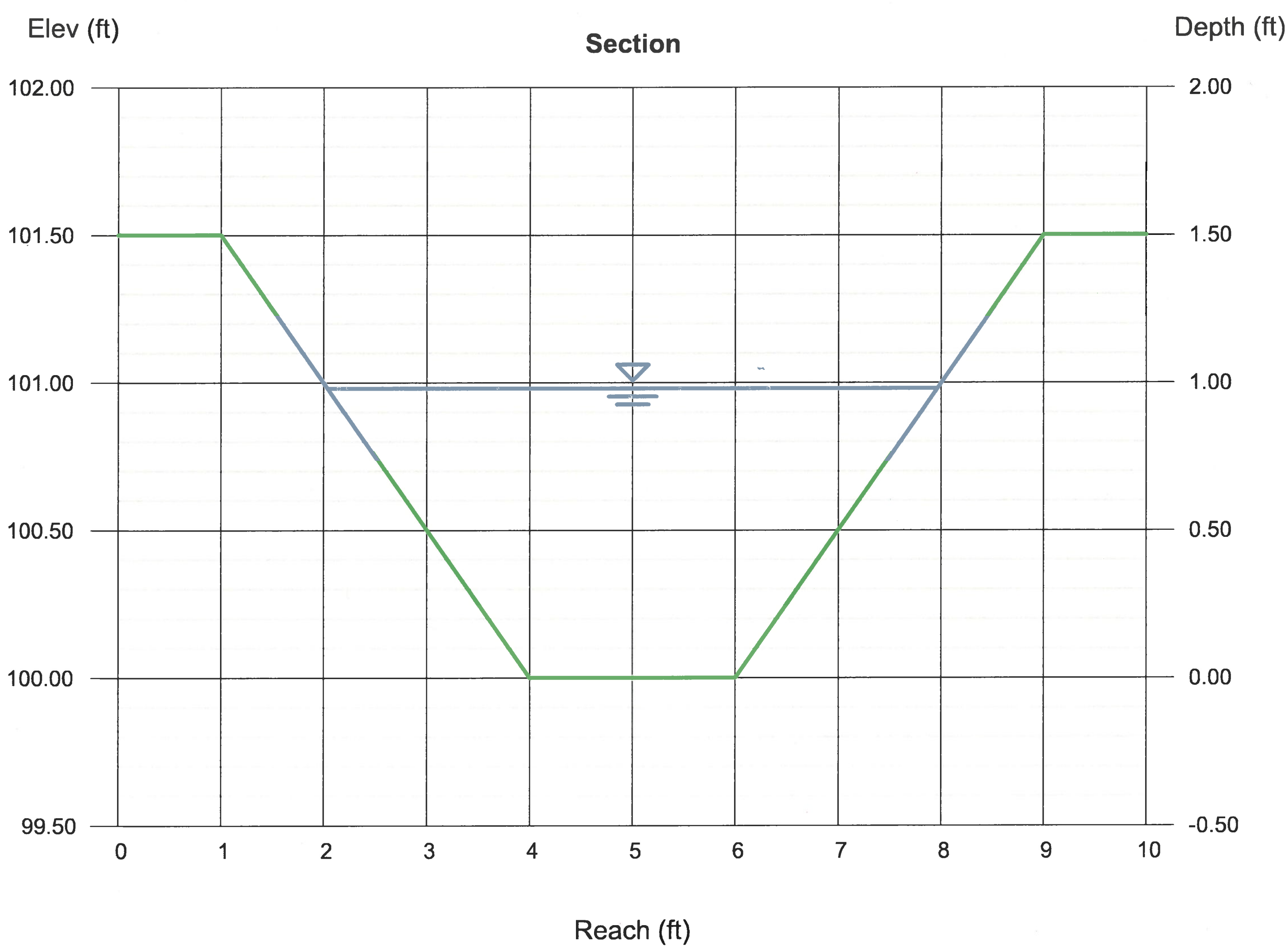
Channel Report

East Ditch - 0.5% Slope

Trapezoidal		**Highlighted**	
Bottom Width (ft)	= 2.00	Depth (ft)	= 0.98
Side Slopes (z:1)	= 2.00, 2.00	Q (cfs)	= 13.14
Total Depth (ft)	= 1.50	Area (sqft)	= 3.88
Invert Elev (ft)	= 100.00	Velocity (ft/s)	= 3.39
Slope (%)	= 0.50	Wetted Perim (ft)	= 6.38
N-Value	= 0.022	Crit Depth, Yc (ft)	= 0.84
		Top Width (ft)	= 5.92
		EGL (ft)	= 1.16

Calculations

Compute by:	Known Q
Known Q (cfs)	= 13.14



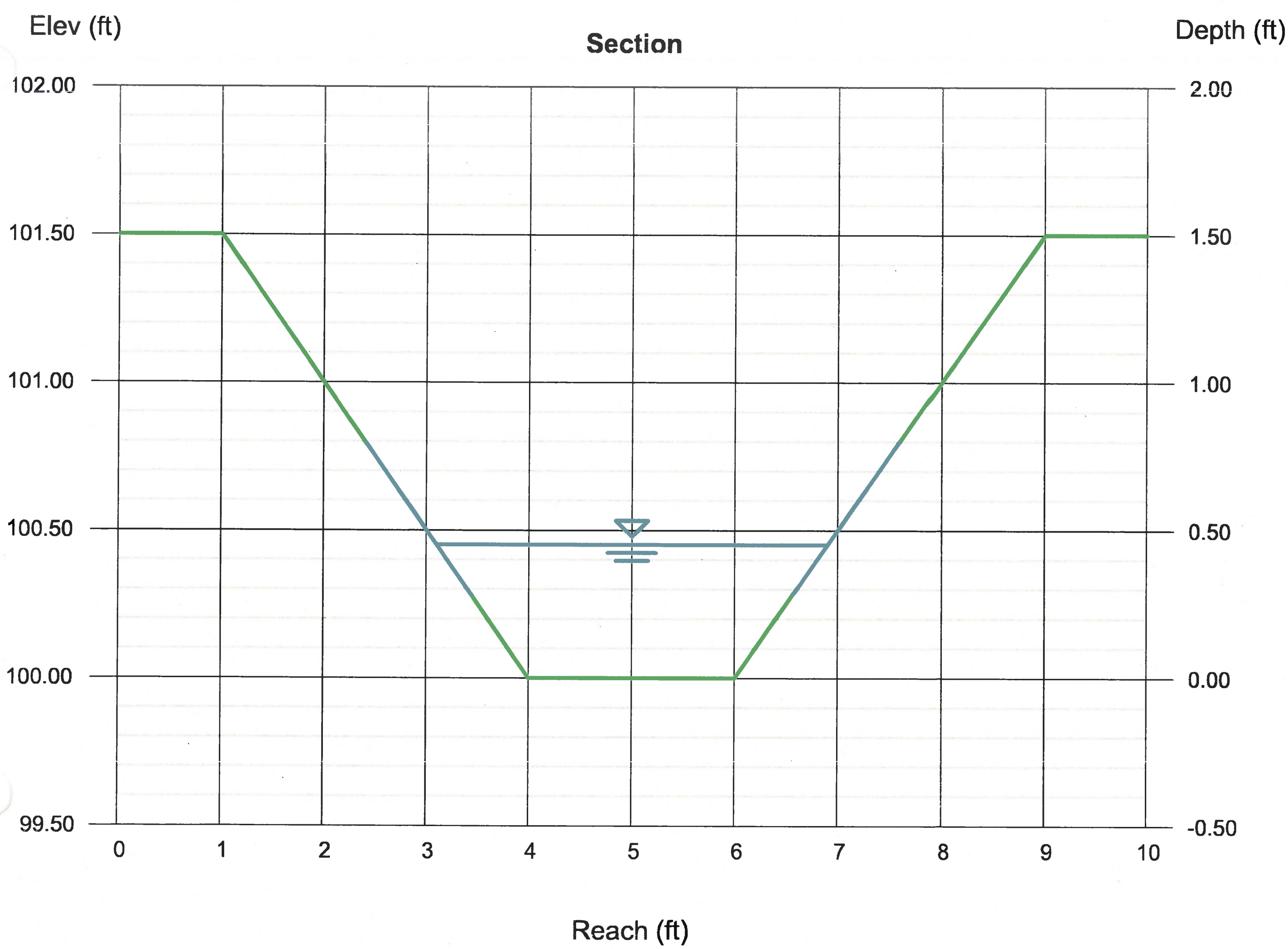
Channel Report

West Ditch - North

Trapezoidal	
Bottom Width (ft)	= 2.00
Side Slopes (z:1)	= 2.00, 2.00
Total Depth (ft)	= 1.50
Invert Elev (ft)	= 100.00
Slope (%)	= 7.50
N-Value	= 0.022

Calculations	
Compute by:	Known Q
Known Q (cfs)	= 11.10

Highlighted	
Depth (ft)	= 0.45
Q (cfs)	= 11.10
Area (sqft)	= 1.30
Velocity (ft/s)	= 8.51
Wetted Perim (ft)	= 4.01
Crit Depth, Yc (ft)	= 0.77
Top Width (ft)	= 3.80
EGL (ft)	= 1.57



Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. — Friday, Aug 30 2019

West Ditch - North

Trapezoidal

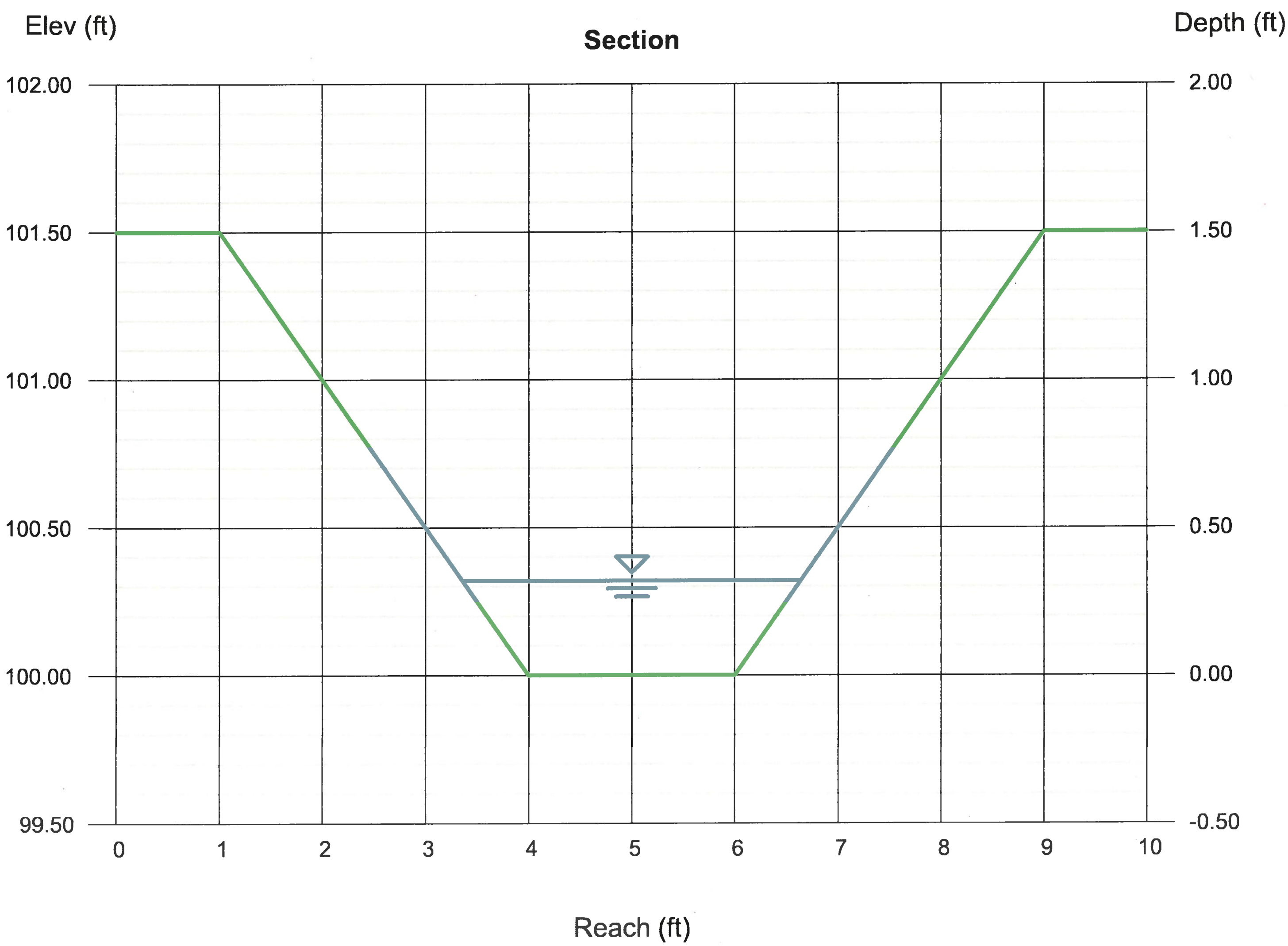
Bottom Width (ft)	= 2.00
Side Slopes (z:1)	= 2.00, 2.00
Total Depth (ft)	= 1.50
Invert Elev (ft)	= 100.00
Slope (%)	= 33.00
N-Value	= 0.022

Calculations

Compute by:	Known Q
Known Q (cfs)	= 12.78

Highlighted

Depth (ft)	= 0.32
Q (cfs)	= 12.78
Area (sqft)	= 0.84
Velocity (ft/s)	= 15.13
Wetted Perim (ft)	= 3.43
Crit Depth, Yc (ft)	= 0.83
Top Width (ft)	= 3.28
EGL (ft)	= 3.88



Appendix C
Interior Channel and Culvert to Ash Landfill Drainage Pond Sizing Calculations

HDR

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Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Friday, Aug 30 2019

Central Drainageway

Trapezoidal

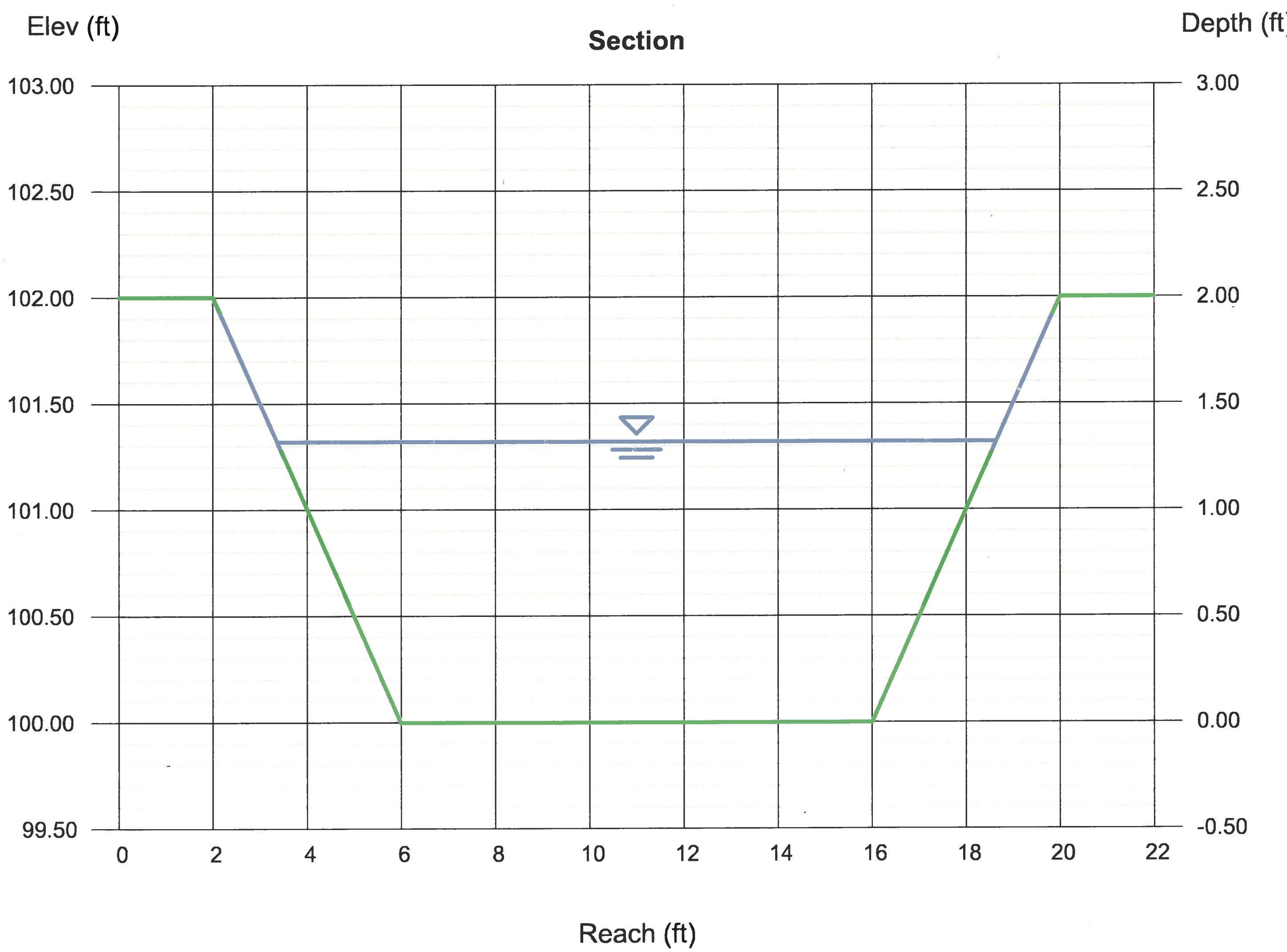
Bottom Width (ft)	= 10.00
Side Slopes (z:1)	= 2.00, 2.00
Total Depth (ft)	= 2.00
Invert Elev (ft)	= 100.00
Slope (%)	= 0.50
N-Value	= 0.022

Calculations

Compute by:	Known Q
Known Q (cfs)	= 81.32

Highlighted

Depth (ft)	= 1.32
Q (cfs)	= 81.32
Area (sqft)	= 16.68
Velocity (ft/s)	= 4.87
Wetted Perim (ft)	= 15.90
Crit Depth, Yc (ft)	= 1.18
Top Width (ft)	= 15.28
EGL (ft)	= 1.69



Culvert Report

Central Drainageway Culverts - 3 30-inch Reinforced Concrete Pipes

Invert Elev Dn (ft)	= 999.65
Pipe Length (ft)	= 85.00
Slope (%)	= 0.51
Invert Elev Up (ft)	= 1000.08
Rise (in)	= 30.0
Shape	= Circular
Span (in)	= 30.0
No. Barrels	= 3
n-Value	= 0.013
Culvert Type	= Circular Concrete
Culvert Entrance	= Groove end projecting (C)
Coeff. K,M,c,Y,k	= 0.0045, 2, 0.0317, 0.69, 0.2

Embankment

Top Elevation (ft)	= 1006.00
Top Width (ft)	= 45.00
Crest Width (ft)	= 85.00

Calculations

Qmin (cfs)	= 0.00
Qmax (cfs)	= 81.32
Tailwater Elev (ft)	= Normal

Highlighted

Qtotal (cfs)	= 81.00
Qpipe (cfs)	= 81.00
Qovertop (cfs)	= 0.00
Veloc Dn (ft/s)	= 6.74
Veloc Up (ft/s)	= 7.27
HGL Dn (ft)	= 1001.55
HGL Up (ft)	= 1001.85
Hw Elev (ft)	= 1002.80
Hw/D (ft)	= 1.09
Flow Regime	= Inlet Control