Whipple Consulting Engineers, Inc.

WCE No. 2014-1166

July 23, 2015

City of Spokane Valley
11707 E Sprague Ave, Suite 106
Spokane valley, WA 99206

Attn: Gabe Gallinger, P.E.

Re: Painted Hills Flood Control Development Narrative (Storage Area 1, SA1)

Dear Gabe:

This letter is intended to present the flood control plan for the above referenced storage area in anticipation of the future development.

WCE is proposing storage and discharge changes to the above referenced area. These changes are separated into three parts in relation to the three directions of flow that enters into the Painted Hills Development: the main flow across Thorpe Road, the secondary flow from Highway 27, and the secondary flow across Madison Road.

The Main Flow Across Thorpe Road

Concept Design and Process

For the concept design the 100-year event was used to size facilities. The initial design was to capture the approximately 1,594,812 cf or 36.61 ac-ft into a deep pond for storage and discharge through evaporation. However, it occurred to us when reviewing the geotechnical evaluation that there are "valley gravels" or well-draining soils that lead directly to the Spokane-Rathdrum aquifer under the poor draining soils that cover the site. If we can connect into these soils the compensatory storage may be treated and discharged into these soils. Initially we were looking at 128 double depth drywells with a design outflow rate of 1.0 cfs each. That would provide twice the outflow rate of 128 cfs to the 64 cfs peak inflow rate of the flow across Thorpe Road. However, as the construction consideration of the drywells was made, it was decided that a gravel gallery sized to the storm would more evenly distribute the stormwater across a larger area.

Design

The main flow is anticipated to approach Thorpe Road as before through the natural drainage way or "Haase Reach" before being captured by a pond that is located several feet below the existing grade. We believe that given the topography of the area, aside from shallow puddles, all stormwater will enter in the proposed collection pond.

Both Ponds in Tandem

The collection pond is connected to the north pond or forebay by four 36" culverts that have a 0.5% slope towards the forebay. The inverts of these pipes are essential to the removal of solids as well as conveying the storm under Thorpe Road into the forebay. The pipe inverts are located 1.55 feet above the proposed collection pond bottom. This separation in elevation allows any solids suspended in the initial flush of stormwater to settle before moving to the forebay. The pipe inverts in the forebay have no separation in elevation as the invert and pond bottom elevation are the same. The forebay has a rocked bottom that is 6' deep and acts as an exposed gravel gallery. This feature allows for the smaller storms (such as the 2-year storm) to infiltrate quickly into the soil as the storm does not crest the weir into the distribution pond. These two ponds (Collection/Forebay) work in tandem through the four culverts to distribute the stormwater across a broad crested weir.

Yearly maintenance of the ponds includes removal of debris and the mowing of the collection pond 3 to 4 times a year. Event maintenance is done as needed to maintain the collection pond bottom elevation and for the forebay may include the removal of silt from the rock.

Broad Crested Weir

The broad crested weir is 10 feet wide by 240 feet long with a depth of 2.22 feet. The weir is proposed to be planted with native tall grasses that will filter the finely suspended solids within the stormwater between the roots/stalks/blades of the tall grasses as it flows from the forebay into the distribution pond. For large storm events the tall grass is anticipated to be bent over with the weight of the water and provide a floating filter with 10 times the collecting surface area. Once bent this natural filter material can rebound or regenerate by sending up new shoots while the root structure strengthens the weir surface.

Maintenance of the native tall grass is minimal as the only watering needed is when the grasses are being established, and is intentionally not to be mowed. Removal of the grass/silt is anticipated to only be done as needed to maintain the elevation of the weir over time.

Distribution Pond

The distribution pond receives the stormwater from the weir and provides the last phase of cleaning before discharging the stormwater into the gravel gallery system and ultimate disposal into the aquifer, its original destination. The distribution pond sits on top of a portion of the gravel gallery system and includes four manholes with beehive grates. The invert of the manholes are located a foot above the pond bottom. This allows for the further settlement of solids before discharge and the beehive grates prevent debris from entering the gravel gallery system while ensuring that storm water flow is maintained.

Maintenance of the distribution pond includes the removal debris and mowing of the grass 3-4 times a year.

Gravel Gallery System

The gravel gallery system is based upon a 12 foot wide by 12 foot deep trench that is lined with geo-fabric and filled with 2" river rock material. Within the trench runs a pipe that connects manholes located at intersections and centered within long segments. Stormwater from the distribution pond enters through the manholes and enters the system by either flowing through the drywell barrels or distributing through the pipes to the next drywell. When the next drywell fills or rises to the invert of the next pipe, stormwater will continue to the next drywell until the gravel gallery is filled. Once filled the gallery is at its maximum design infiltration rate of 98.68 cfs (see gravel gallery worksheet in the appendix). A 100-year storm has a peak flow rate of 64 cfs so this design outflow rate is one and a half times greater that the design inflow rate for a conservative measure of protection.

Infiltration Rate

The Phase I geotechnical evaluation performed laboratory grain size analysis tests on soils from the test pits, including at Test Pit TP-29 at the 10 to 12-foot depth. This test showed a fines content of 2.3 percent with design drywell rates of 0.3 and 1.0 cfs for Type A and Type B drywells, respectively. They also performed a test pit permeability test (P-3) in soils having 3.0 percent fines. Based on this data we used the design infiltration rate from P-3 ($1.1x\ 10^{-3}$ cfs/sf) for design of the gravel galleries in the proposed park on the north side of Thorpe Road. Please see attached IPEC Geotechnical Report.

Maintenance of the gravel gallery system is a semi-annual inspection of the gallery through the system manholes looking for a build-up of sediment, and if needed, the removal of sediment and debris by a vactor truck.

The Perfect Storm

In the event that a storm or multiple storms are so large and debris has blocked the beehive grates, a final measure of protection for Thorpe Road and the proposed residences in the development is provided in the proposed 10 acre park. The proposed park is to be built 2-3 feet below to an elevation of 2009.66 feet, which is also two feet below the elevation of the berm that surrounds the forebay and distribution pond. This is three feet below the lowest point in Thorpe Road. This measure ensures that Thorpe Road will not be flooded as stormwater will crest the containment berm and fill the 10 acre park before flooding the roadway or the proposed residences to the north. This last measure provides the design with confidence that Thorpe Road and the proposed houses will not be flooded.

Design Elements:

Collection Pond – 15,999 sf @ El. 2005.3 and 24,674 cf @ El. 2010.00
4- 36" CMP culverts Invert Elevation Up 2006.85, Invert Elevation Down 2006.44
Forebay – 7,500 sf @ El. 2006.44 and – 12724 sf @ El. 2009.44
Berm 10' x 240' @ El. 2009.44, Seeded with stand of tall native dry land grass.
Discharge Pond - 4,000 sf @ El. 2005.44 and 11,708 sf @ El. 2009.44, Rim Elevation 2006.44

Hydraulic Analysis

For this design a hydraulic analysis was completed using the Hydraflow Hydrographs modeling software to match the peak flows provided to us by West Consultants as detailed in an email dated March 26th, 2014.

The Hydraflow Hydrograph software is limited as a tool for modeling flood basins as its primary design is for SCS and Rational Method modeling. Although the software cannot model the series of storms that it takes for flood events and subsequently the volume of stormwater produced, the software can model the flow or intensity of the stormwater that is primarily used to size storm facilities. For design the 100-year storm was used in order to match the flow of the 100-year storm as reported by West Consultants. A theoretical basin was created which uses the existing storm IDF curves as found in the Spokane Regional Stormwater Manual (SRSM). From this the basin was manipulated until a matching flow was reported at Thorpe Road.

Additionally, because the software was not designed to report a 500-year storm event the labels of the report had to reference a different storm than what it says. The conversion is as follows: 25-yr = 50-yr, 50-yr = 100-yr, and 100-yr = 500-yr. To reduce reader confusion within this report all conversions are made to reflect and report to the reader the actual storm.

Table 1 – Target Flow Comparison

	Description	10-Yr	50-Yr	**100-Yr**	500-Yr
West Consultant	Target Peak Flow Rates	30	54	**64**	88
WCE Model	Peak Flows hyd. 3 Ponds in Tandem	17.88	43.07	**64.16**	90.75

As shown in Table 1 for the design storm (100-year) the model matched or slightly exceeded the target flow. In comparing the 10 and 50-year storm the model generated a flow that was less than the target flow but as these are not the design years and they are less than the design year then they serve the purpose of showing the systems performance. The model for the 500-year storm exceeded the target flow and will show a conservative design as the 500-year storm does not breach the design elements of the facility. As shown in the Hydraflow report in the appendix, these storms are run through the design elements presented in the appendix and are summarized at specific locations here.

Table 2 – Both Ponds in Tandem (Hyd. No. 3)

Storm	Peak Flow (IN) (cfs)	Discharge (Out) (cfs)	Hydraulic Volume (cf)	Elevation @ Pond	Elevation @ Weir	Max Storage Both ponds (cf)
Facility Limits				2012.66	2011.66	219,548
2	1.42	0.00	0	2006.92	2008.13	52,371
10	19.30	17.88	443,463	2007.79	2009.53	85,235
50	44.57	43.07	1,002,858	2008.47	2009.61	101,276
100	65.74	64.16	1,434,968	2009.02	2009.66	114,285
500	92.23	90.75	1,952,922	2010.01	2009.72	136,854

As shown in Table 2 for the collection pond, culverts and forebay over the span of storms the water level at peak flow does not go over the containment berm at elevation 2011.66. Additionally the four 36" culverts are adequately sized as the water level in the collection pond is less in elevation than the water level at the weir, until the 500-year storm when the size of the culverts begin to back the water up and the elevation in the collection pond increases above the elevation at the weir.

Table 3 – Broad Crested Weir (Hyd. No. 4)

Storm	Peak Flow (IN) (cfs)	Discharge (Out) (cfs)	Hydraulic Volume (cf)	Elevation At Weir	Water Depth At Weir (ft)	Velocity Avg. (ft/s)
Facility Limits				2009.44		
2	0.00	0.00	0	-	-	-
10	17.88	17.85	443,459	2009.53	0.09	0.04
50	43.07	43.04	1,002,855	2009.61	0.17	0.05
100	64.16	64.12	1,434,967	2009.66	0.22	0.06
500	90.75	90.70	1,952,922	2009.72	0.28	0.07

As shown in Table 3 the broad crested weir is adequately sized as the depth of the stormwater remains shallow and slow. Providing time for the suspended solids to fall and be filtered by the tall native dry grasses.

Table 4 – Distribution Pond (Hyd. No. 5)

Storm	Peak Flow (IN) (cfs)	Discharge (Out) (cfs)	Hydraulic Volume (cf)	Elevation of inlet	Max Storage (cf)
Facility Limits				2006.44	
2	0.00	0.00	0	-	-
10	17.85	17.32	403,659	2007.47	13,963
50	43.04	42.44	958,898	2007.73	15,789
100	64.12	63.50	1,389,280	2007.81	16,313
500	90.70	90.05	1,905,735	2007.91	16,975

As shown in Table 4 the outlets of the distribution pond (4 manholes) are sized appropriately as the stormwater elevation does not exceed the containment berm, and more importantly does not impound the storm water up the slope into the filter material, maintaining a single direction of stormwater flow through the tall grass.

The Secondary Flow From Highway 27

The 16 cfs flow from Highway 27 is conveyed via culvert that empties into a ditch on the Gustin property. The stormwater flows through the ditch and into the old gravel pit within the triangular parcel located northeast of 40th Lane. The Gustin Ditch has been maintained over the years to ensure that whatever stormwater comes out of the culvert under Highway 27 will be conveyed to the old gravel pit. With this project the ditch and its berms will be certified as levees so that FEMA does not immediately assume that the berms are breached and the stormwater flows to a lower area to the south.

WCE proposes to improve the outflow of the old gravel pit by regrading and expanding the bottom of the gravel pit and installing 18 double depth drywells into the bottom of an internal pond. The drywells will provide outflow during a frozen ground condition. Each double depth drywell will provide a design outflow of 1.0 cfs.

Design Elements:
Proposed Pond 1, 7060' sf @ El: 1990.00; 35,812 sf @ El. 1995.00; 84,416 sf @ El. 2000.00
Drywell spacing 30', total drywell outflow 18.0 cfs
Maintenance Access Road: 6" gravel max grade 10%

The Secondary Flow Across Madison Road:

The flow across Madison Road is divided into 5 basins from the heights above and to the east of Madison Road that correspond to the 5 culverts that are placed under Madison Road. This flow is anticipated to be separated into 4 culverts that cross Madison Road at Stations (S-N) 13+22, 20+44, 24+41, 30+42 and 38+98. As the development proposes to widen Madison Road along its eastern frontage 4 of these culverts will need to be extended. Since the proposed inverts of the culverts will fall below the proposed grade it was decided to connect the culverts into a drywell, or a series of drywells.

Per an email from West Consultants dated April 23, 2015, the culverts receive the following flows during the 100-year storm. We are using these flows to size and design storm drainage facilities.

STA.	100 Year Storm Flow (cfs)	# of Drywells
13+22	3	3
20+44	1	1
24+41	1	1
30+42	2	2

If you have any questions or comments in regard to this letter please feel free to contact us at (509) 893-2617.

Sincerely,
WHIPPLE CONSULTING ENGINEERS, INC.

Todd R. Whipple, PE

TRW/bng

CC: File

Hydraflow Table of Contents

88 cfs Storm Complete w 3 Ponds 4-3-15.gpw

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Monday, 04 / 6 / 2015

Watershed Model Schematic

Legend

Hyd.	Origin	Description
1	SCS Runoff	Chester Creek Overflow Inflow Basin
2	Reach	Haase Reach
3	Reservoir(i)	Both Ponds in Tandem
4	Reach	Weir from Pond 2 to 3
5	Reservoir	Discharge Pond 3

Hydrograph Return Period Recap

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	50 ~~25~~-yr	100 ~~50~~-yr	500 ~~100~~-yr	
1	SCS Runoff	------	-------	3.119	-------	-------	39.47	84.98	121.03	164.38	Chester Creek Overflow Inflow Basi
2	Reach	1	-------	1.421	-------	-------	19.30	44.57	65.74	92.23	Haase Reach
3	Reservoir(i)	2	-------	0.000	-------	-------	17.88	43.07	64.16	90.75	Both Ponds in Tandem
4	Reach	3	-------	0.000	-------	-------	17.85	43.04	64.12	90.70	Weir from Pond 2 to 3
5	Reservoir	4	-------	0.000	-------	-------	17.32	42.44	63.50	90.05	Discharge Pond 3

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

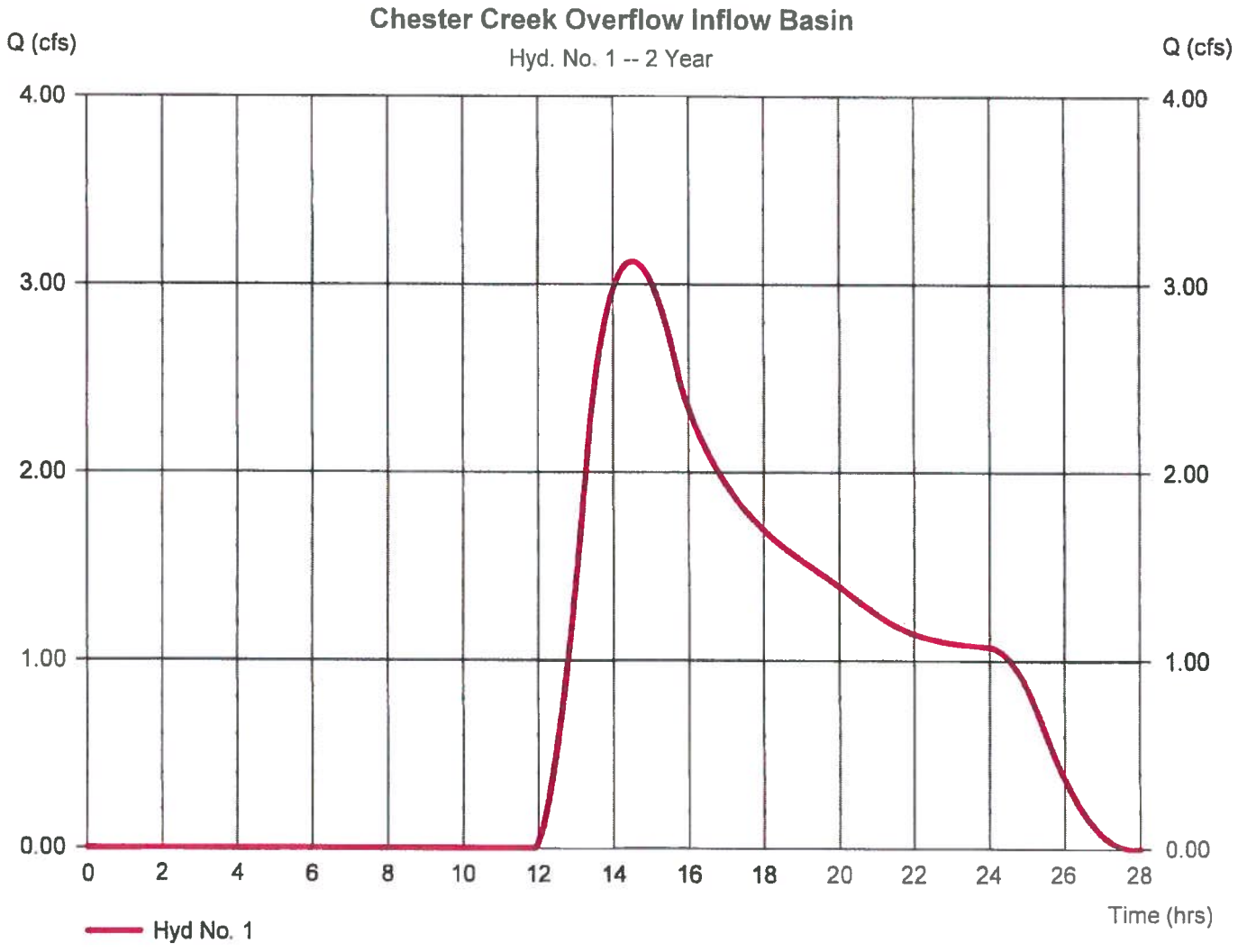
Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	3.119	2	870	80,204	------	------	------	Chester Creek Overflow Inflow Basi
2	Reach	1.421	2	1190	79,993	1	------	------	Haase Reach
3	Reservoir(i)	0.000	2	1538	0	2	2008.13	52,371	Both Ponds in Tandem
4	Reach	0.000	2	1446	0	3	------	------	Weir from Pond 2 to 3
5	Reservoir	0.000	2	n/a	0	4	2005.44	0.000	Discharge Pond 3

Hydrograph Report

Hyd. No. 1

Chester Creek Overflow Inflow Basin

Hydrograph type	= SCS Runoff	Peak discharge	= 3.119 cfs
Storm frequency	= 2 yrs	Time to peak	= 14.50 hrs
Time interval	= 2 min	Hyd. volume	= 80,204 cuft
Drainage area	= 165.000 ac	Curve number	= 62
Basin Slope	= 1.0 %	Hydraulic length	= 5000 ft
Tc method	= TR55	Time of conc. (Tc)	= 145.00 min
Total precip.	= 2.20 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

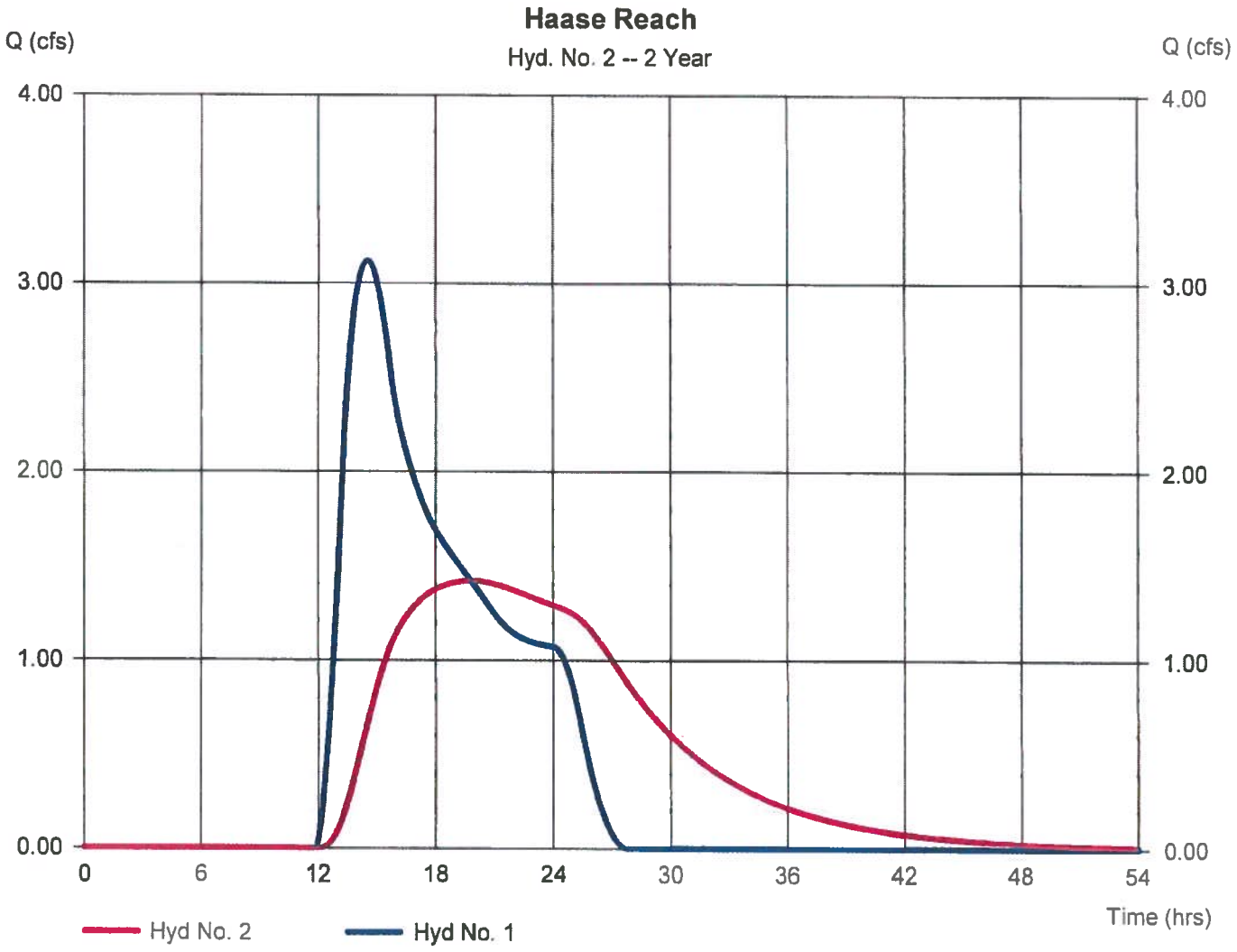
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4 Monday, 04 / 6 / 2015

Hyd. No. 2

Haase Reach

Hydrograph type	= Reach	Peak discharge	= 1.421 cfs
Storm frequency	= 2 yrs	Time to peak	= 19.83 hrs
Time interval	= 2 min	Hyd. volume	= 79,993 cuft
Inflow hyd. No.	= 1 - Chester Creek Overflow I	Section type	= Triangular
Reach length	= 7500.0 ft	Channel slope	= 0.5 %
Manning's n	= 0.150	Bottom width	= 0.0 ft
Side slope	= 50.0:1	Max. depth	= 0.0 ft
Rating curve x	= 0.120	Rating curve m	= 1.333
Ave. velocity	= 0.27 ft/s	Routing coeff.	= 0.0056

Modified Att-Kin routing method used.



Hydrograph Report

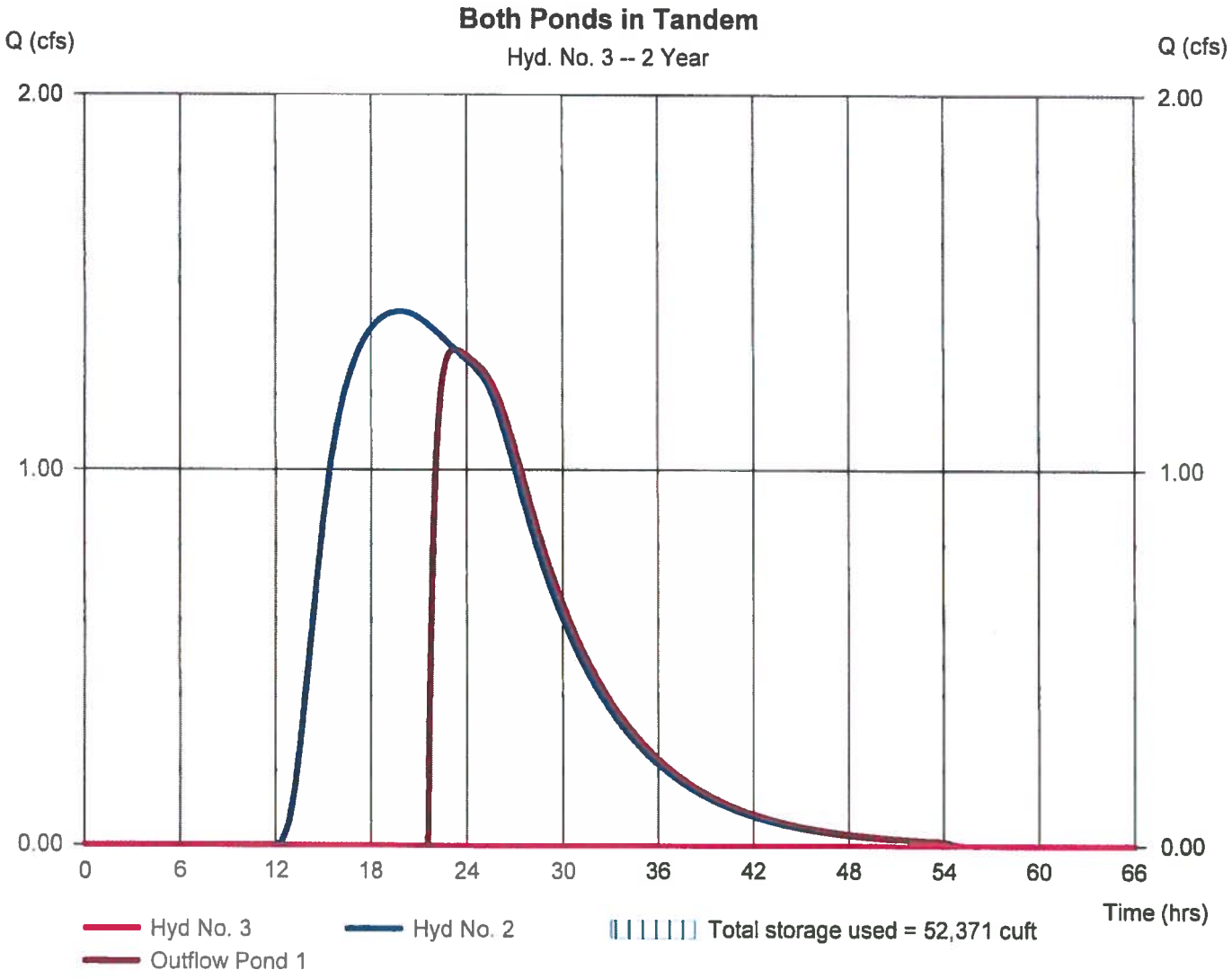
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4 Monday, 04 / 6 / 2015

Hyd. No. 3

Both Ponds in Tandem

Hydrograph type	= Reservoir (Interconnected)	Peak discharge	= 0.000 cfs
Storm frequency	= 2 yrs	Time to peak	= 25.63 hrs
Time interval	= 2 min	Hyd. volume	= 0 cuft
Upper Pond	= Haase Pond	Lower Pond	= Overflow Pond
Inflow hyd.	= 2 - Haase Reach	Other Inflow hyd.	= None
Max. Elevation	= 2006.92 ft	Max. Elevation	= 2008.13 ft
Max. Storage	= 36,133 cuft	Max. Storage	= 16,238 cuft

Interconnected Pond Routing. Storage Indication method used. Exfiltration extracted from Outflow.



Pond Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4 Monday, 04 / 6 / 2015

Pond No. 1 - Haase Pond

Pond Data

Contours -User-defined contour areas. Conic method used for volume calculation. Begining Elevation = 2005.30 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	2005.30	16,000	0	0
7.70	2013.00	29,286	171,776	171,776

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 36.00	0.00	0.00	0.00
Span (in)	= 36.00	0.00	0.00	0.00
No. Barrels	= 4	0	0	0
Invert El. (ft)	= 2006.85	0.00	0.00	0.00
Length (ft)	= 83.70	0.00	0.00	0.00
Slope (%)	= 0.50	0.00	0.00	n/a
N-Value	= .023	.013	.013	n/a
Orifice Coeff.	= 1.00	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 0.00	0.00	0.00	0.00
Crest El. (ft)	= 0.00	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= ---	---	---	---
Multi-Stage	= No	No	No	No

Exfil.(in/hr) = 0.000 (by Contour)

TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control Weir risers checked for orifice conditions (ic) and submergence (s).

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
0.00	0	2005.30	0.00	---	---	---	---	---	---	---	---	---	0.000
0.77	17,178	2006.07	0.00	---	---	---	---	---	---	---	---	---	0.000
1.54	34,355	2006.84	0.00	---	---	---	---	---	---	---	---	---	0.000
2.31	51,533	2007.61	12.76 oc	---	---	---	---	---	---	---	---	---	12.76
3.08	68,710	2008.38	41.13 oc	---	---	---	---	---	---	---	---	---	41.13
3.85	85,888	2009.15	70.26 oc	---	---	---	---	---	---	---	---	---	70.26
4.62	103,065	2009.92	86.21 oc	---	---	---	---	---	---	---	---	---	86.21
5.39	120,243	2010.69	138.37 oc	---	---	---	---	---	---	---	---	---	138.37
6.16	137,420	2011.46	175.68 oc	---	---	---	---	---	---	---	---	---	175.68
6.93	154,598	2012.23	206.35 oc	---	---	---	---	---	---	---	---	---	206.35
7.70	171,776	2013.00	233.01 oc	---	---	---	---	---	---	---	---	---	233.01

Pond Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4 Monday, 04 / 6 / 2015

Pond No. 2 - Overflow Pond

Pond Data

Contours -User-defined contour areas. Conic method used for volume calculation. Begining Elevation = 2006.44 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	2006.44	7,500	0	0
3.00	2009.44	11,840	28,761	28,761
3.56	2010.00	10,248	6,179	34,940
5.22	2011.66	27,273	30,010	64,950

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 0.00	0.00	0.00	0.00
Span (in)	= 0.00	0.00	0.00	0.00
No. Barrels	= 0	0	0	0
Invert El. (ft)	= 0.00	0.00	0.00	0.00
Length (ft)	= 0.00	0.00	0.00	0.00
Slope (%)	= 0.00	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 233.00	0.00	0.00	0.00
Crest El. (ft)	= 2009.44	0.00	0.00	0.00
Weir Coeff.	= 2.60	3.33	3.33	3.33
Weir Type	= Broad	---	---	---
Multi-Stage	= No	No	No	No

Exfil.(in/hr) = 5.000 (by Contour)

TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
0.00	0	2006.44	---	---	---	---	0.00	---	---	---	0.000	---	0.000
0.30	2,876	2006.74	---	---	---	---	0.00	---	---	---	0.137	---	0.137
0.60	5,752	2007.04	---	---	---	---	0.00	---	---	---	0.274	---	0.274
0.90	8,628	2007.34	---	---	---	---	0.00	---	---	---	0.411	---	0.411
1.20	11,504	2007.64	---	---	---	---	0.00	---	---	---	0.548	---	0.548
1.50	14,380	2007.94	---	---	---	---	0.00	---	---	---	0.685	---	0.685
1.80	17,256	2008.24	---	---	---	---	0.00	---	---	---	0.822	---	0.822
2.10	20,132	2008.54	---	---	---	---	0.00	---	---	---	0.959	---	0.959
2.40	23,008	2008.84	---	---	---	---	0.00	---	---	---	1.096	---	1.096
2.70	25,884	2009.14	---	---	---	---	0.00	---	---	---	1.233	---	1.233
3.00	28,761	2009.44	---	---	---	---	0.00	---	---	---	1.370	---	1.370
3.06	29,378	2009.50	---	---	---	---	8.03	---	---	---	1.352	---	9.387
3.11	29,996	2009.55	---	---	---	---	22.73	---	---	---	1.334	---	24.06
3.17	30,614	2009.61	---	---	---	---	41.75	---	---	---	1.315	---	43.06
3.22	31,232	2009.66	---	---	---	---	64.22	---	---	---	1.297	---	65.52
3.28	31,850	2009.72	---	---	---	---	89.77	---	---	---	1.278	---	91.05
3.34	32,468	2009.78	---	---	---	---	118.02	---	---	---	1.260	---	119.28
3.39	33,086	2009.83	---	---	---	---	148.73	---	---	---	1.241	---	149.97
3.45	33,704	2009.89	---	---	---	---	181.65	---	---	---	1.223	---	182.88
3.50	34,322	2009.94	---	---	---	---	216.78	---	---	---	1.205	---	217.98
3.56	34,940	2010.00	---	---	---	---	253.91	---	---	---	1.186	---	255.10
3.73	37,941	2010.17	---	---	---	---	374.80	---	---	---	1.383	---	376.18
3.89	40,942	2010.33	---	---	---	---	510.44	---	---	---	1.580	---	512.02
4.06	43,943	2010.50	---	---	---	---	659.36	---	---	---	1.777	---	661.14
4.22	46,944	2010.66	---	---	---	---	820.35	---	---	---	1.974	---	822.33
4.39	49,945	2010.83	---	---	---	---	992.79	---	---	---	2.171	---	994.96
4.56	52,946	2011.00	---	---	---	---	1175.86	---	---	---	2.368	---	1178.23
4.72	55,947	2011.16	---	---	---	---	1368.98	---	---	---	2.565	---	1371.54
4.89	58,948	2011.33	---	---	---	---	1571.64	---	---	---	2.762	---	1574.40
5.05	61,949	2011.49	---	---	---	---	1783.42	---	---	---	2.960	---	1786.38
5.22	64,950	2011.66	---	---	---	---	2003.95	---	---	---	3.157	---	2007.10

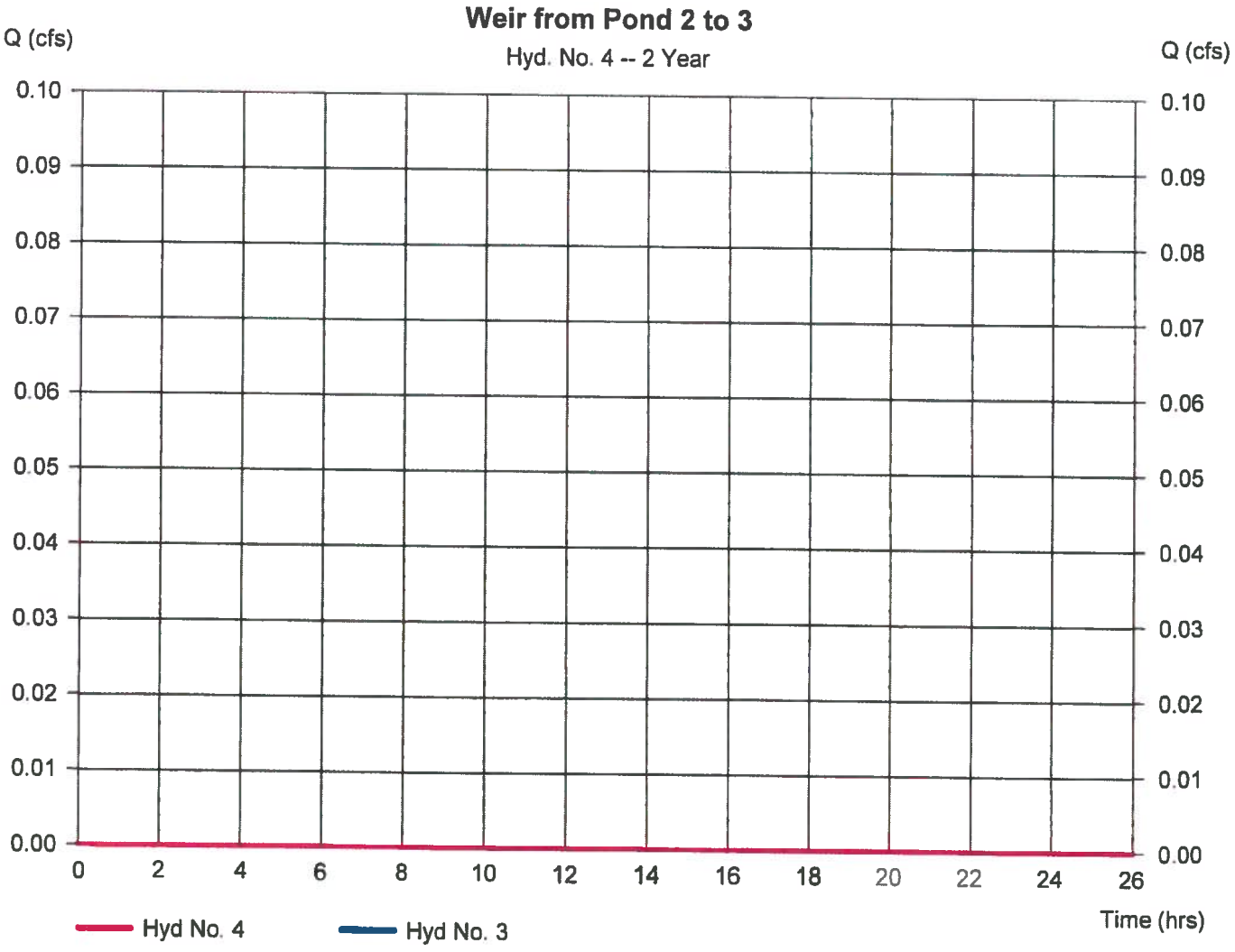
Hydrograph Report

Hyd. No. 4

Weir from Pond 2 to 3

Hydrograph type	= Reach	Peak discharge	= 0.000 cfs
Storm frequency	= 2 yrs	Time to peak	= 24.10 hrs
Time interval	= 2 min	Hyd. volume	= 0 cuft
Inflow hyd. No.	= 3 - Both Ponds in Tandem	Section type	= Rectangular
Reach length	= 20.0 ft	Channel slope	= 0.0 %
Manning's n	= 0.200	Bottom width	= 233.0 ft
Side slope	= 0.0:1	Max. depth	= 3.2 ft
Rating curve x	= 0.001	Rating curve m	= 1.664
Ave. velocity	= 0.00 ft/s	Routing coeff.	= 0.0000

Modified Att-Kin routing method used.



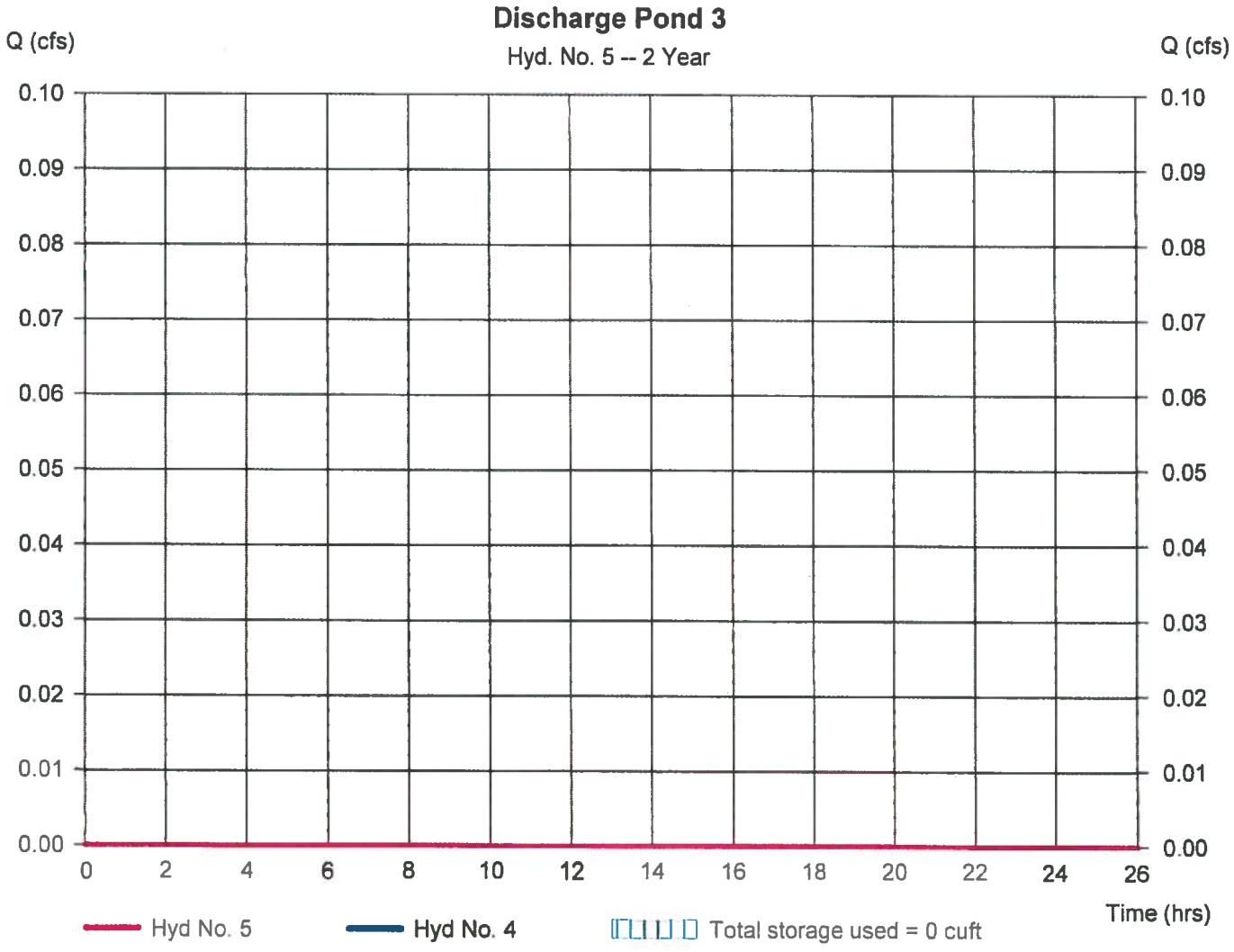
Hydrograph Report

Hyd. No. 5

Discharge Pond 3

Hydrograph type	= Reservoir	Peak discharge	= 0.000 cfs
Storm frequency	= 2 yrs	Time to peak	= n/a
Time interval	= 2 min	Hyd. volume	= 0 cuft
Inflow hyd. No.	= 4 - Weir from Pond 2 to 3	Max. Elevation	= 2005.44 ft
Reservoir name	= Pond 3 - Discharge Pond	Max. Storage	= 0 cuft

Storage Indication method used. Exfiltration extracted from Outflow.



Pond Report

Pond No. 3 - Pond 3 - Discharge Pond

Pond Data

Contours -User-defined contour areas. Conic method used for volume calculation. Begining Elevation = 2005.44 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	2005.44	4,000	0	0
4.56	2010.00	10,248	31,386	31,386
6.16	2011.60	31,209	31,644	63,030

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 36.00	0.00	0.00	0.00
Span (in)	= 36.00	0.00	0.00	0.00
No. Barrels	= 4	0	0	0
Invert El. (ft)	= 2001.44	0.00	0.00	0.00
Length (ft)	= 400.00	0.00	0.00	0.00
Slope (%)	= 0.50	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 78.24	0.00	0.00	0.00
Crest El. (ft)	= 2007.44	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= 1	---	---	---
Multi-Stage	= Yes	No	No	No
Exfil.(in/hr)	= 5.000 (by Contour)			
TW Elev. (ft)	= 0.00			

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s)

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
0.00	0	2005.44	0.00	---	---	---	0.00	---	---	---	0.000	---	0.000
0.46	3,139	2005.90	187.88 oc	---	---	---	0.00	---	---	---	0.119	---	0.119
0.91	6,277	2006.35	187.88 oc	---	---	---	0.00	---	---	---	0.237	---	0.237
1.37	9,416	2006.81	187.88 oc	---	---	---	0.00	---	---	---	0.356	---	0.356
1.82	12,554	2007.26	187.88 oc	---	---	---	0.00	---	---	---	0.474	---	0.474
2.28	15,693	2007.72	187.88 oc	---	---	---	38.61	---	---	---	0.593	---	39.20
2.74	18,832	2008.18	187.88 oc	---	---	---	164.54	---	---	---	0.712	---	165.25
3.19	21,970	2008.63	260.08 oc	---	---	---	260.07 s	---	---	---	0.830	---	260.90
3.65	25,109	2009.09	275.71 oc	---	---	---	275.70 s	---	---	---	0.949	---	276.65
4.10	28,247	2009.54	287.05 oc	---	---	---	287.03 s	---	---	---	1.067	---	288.10
4.56	31,386	2010.00	297.02 oc	---	---	---	296.95 s	---	---	---	1.186	---	298.13
4.72	34,550	2010.16	300.34 oc	---	---	---	300.17 s	---	---	---	1.429	---	301.60
4.88	37,715	2010.32	303.59 oc	---	---	---	303.45 s	---	---	---	1.671	---	305.13
5.04	40,879	2010.48	306.78 oc	---	---	---	306.62 s	---	---	---	1.914	---	308.53
5.20	44,044	2010.64	309.93 oc	---	---	---	309.69 s	---	---	---	2.157	---	311.85
5.36	47,208	2010.80	313.02 oc	---	---	---	312.86 s	---	---	---	2.399	---	315.26
5.52	50,372	2010.96	316.08 oc	---	---	---	315.77 s	---	---	---	2.642	---	318.41
5.68	53,537	2011.12	319.10 oc	---	---	---	318.78 s	---	---	---	2.884	---	321.67
5.84	56,701	2011.28	322.08 oc	---	---	---	321.76 s	---	---	---	3.127	---	324.88
6.00	59,866	2011.44	325.02 oc	---	---	---	324.96 s	---	---	---	3.370	---	328.33
6.16	63,030	2011.60	327.94 oc	---	---	---	327.71 s	---	---	---	3.612	---	331.33

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

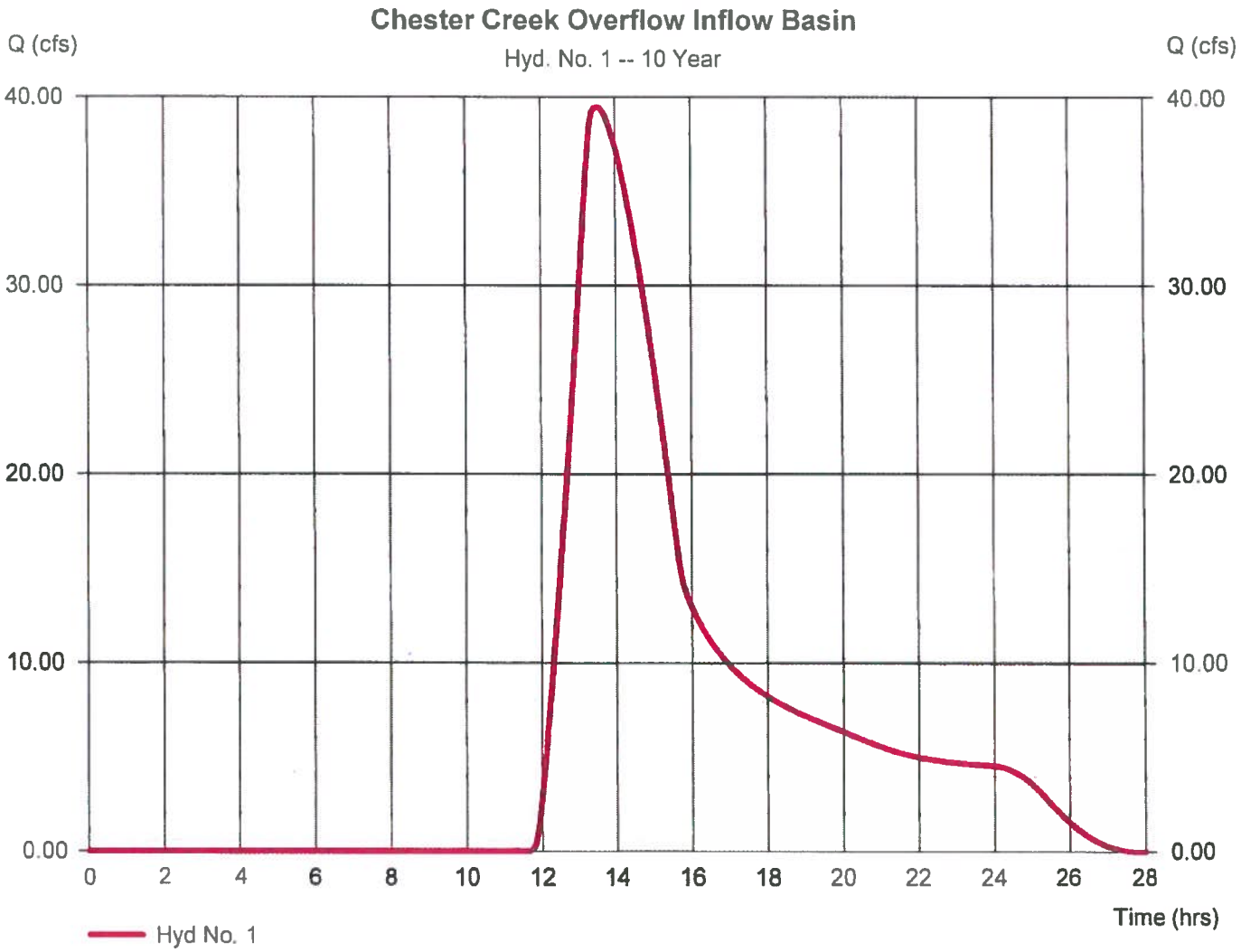
Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	39.47	2	810	600,200	-----	------	------	Chester Creek Overflow Inflow Basi
2	Reach	19.30	2	926	600,089	1	------	------	Haase Reach
3	Reservoir(i)	17.88	2	936	443,463	2	2009.53	85,235	Both Ponds in Tandem
4	Reach	17.85	2	944	443,459	3	------	------	Weir from Pond 2 to 3
5	Reservoir	17.32	2	944	403,659	4	2007.47	13,963	Discharge Pond 3

Hydrograph Report

Hyd. No. 1

Chester Creek Overflow Inflow Basin

Hydrograph type	= SCS Runoff	Peak discharge	= 39.47 cfs
Storm frequency	= 10 yrs	Time to peak	= 13.50 hrs
Time interval	= 2 min	Hyd. volume	= 600,200 cuft
Drainage area	= 165.000 ac	Curve number	= 62
Basin Slope	= 1.0 %	Hydraulic length	= 5000 ft
Tc method	= TR55	Time of conc. (Tc)	= 145.00 min
Total precip.	= 4.25 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

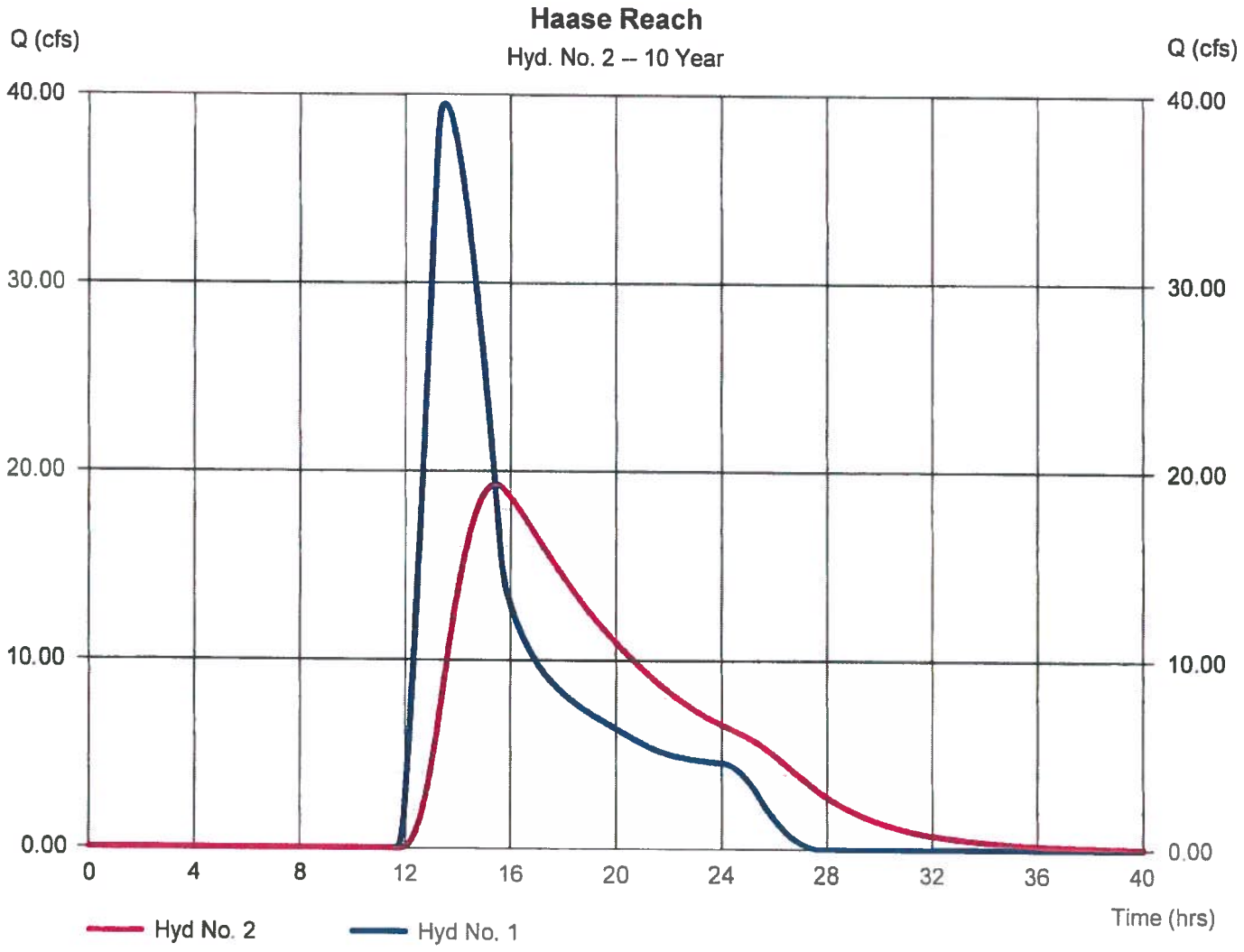
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4 Monday, 04 / 6 / 2015

Hyd. No. 2

Haase Reach

Hydrograph type	= Reach	Peak discharge	= 19.30 cfs
Storm frequency	= 10 yrs	Time to peak	= 15.43 hrs
Time interval	= 2 min	Hyd. volume	= 600,089 cuft
Inflow hyd. No.	= 1 - Chester Creek Overflow Infiltration Basin	Section type	= Triangular
Reach length	= 7500.0 ft	Channel slope	= 0.5 %
Manning's n	= 0.150	Bottom width	= 0.0 ft
Side slope	= 50.0:1	Max. depth	= 0.0 ft
Rating curve x	= 0.120	Rating curve m	= 1.333
Ave. velocity	= 0.51 ft/s	Routing coeff.	= 0.0109

Modified Att-Kin routing method used.



Hydrograph Report

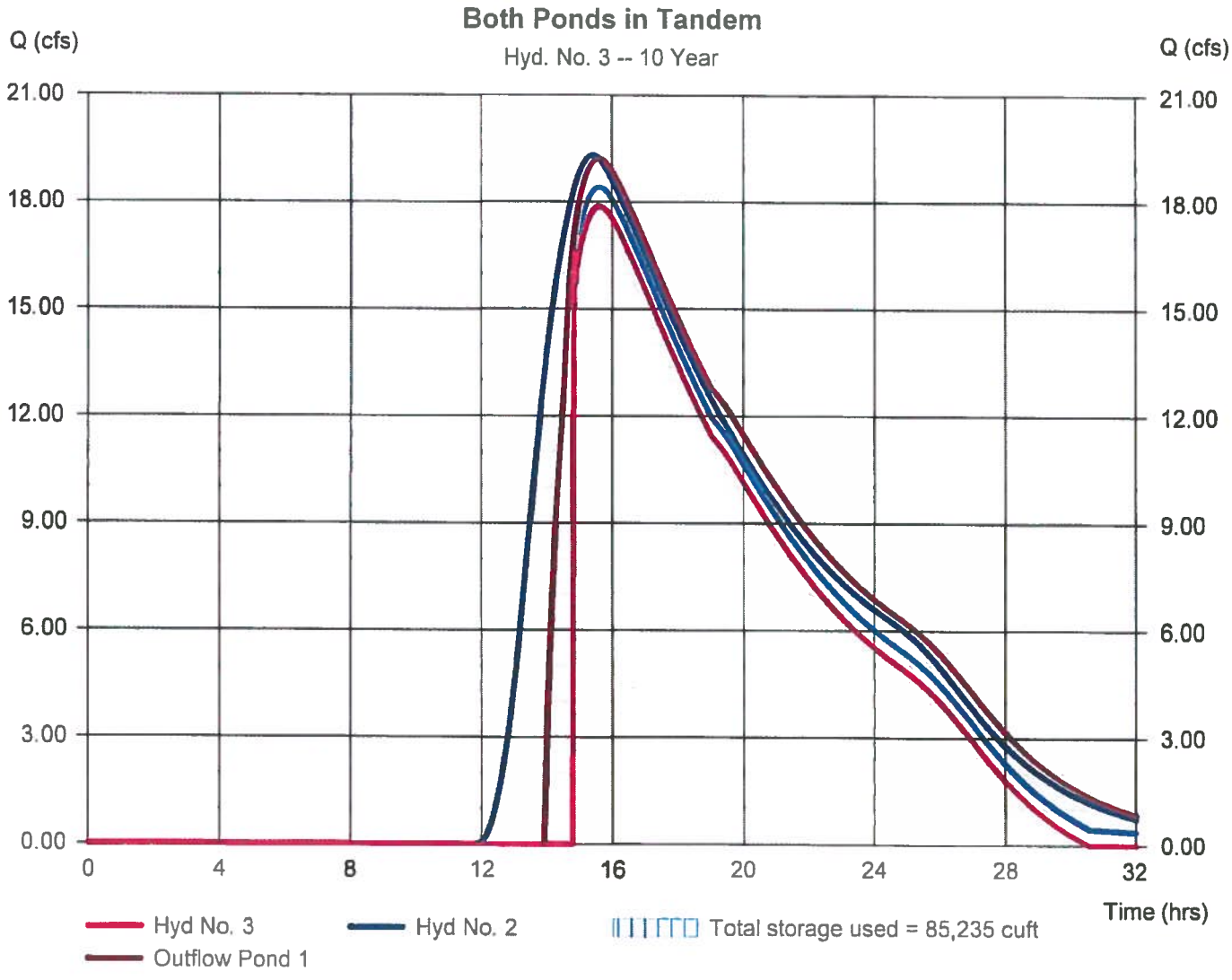
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4 Monday, 04 / 6 / 2015

Hyd. No. 3

Both Ponds in Tandem

Hydrograph type	= Reservoir (Interconnected)	Peak discharge	= 17.88 cfs
Storm frequency	= 10 yrs	Time to peak	= 15.60 hrs
Time interval	= 2 min	Hyd. volume	= 443,463 cuft
Upper Pond	= Haase Pond	Lower Pond	= Overflow Pond
Inflow hyd.	= 2 - Haase Reach	Other Inflow hyd.	= None
Max. Elevation	= 2007.79 ft	Max. Elevation	= 2009.53 ft
Max. Storage	= 55,442 cuft	Max. Storage	= 29,793 cuft

Interconnected Pond Routing. Storage Indication method used. Exfiltration extracted from Outflow.



Hydrograph Report

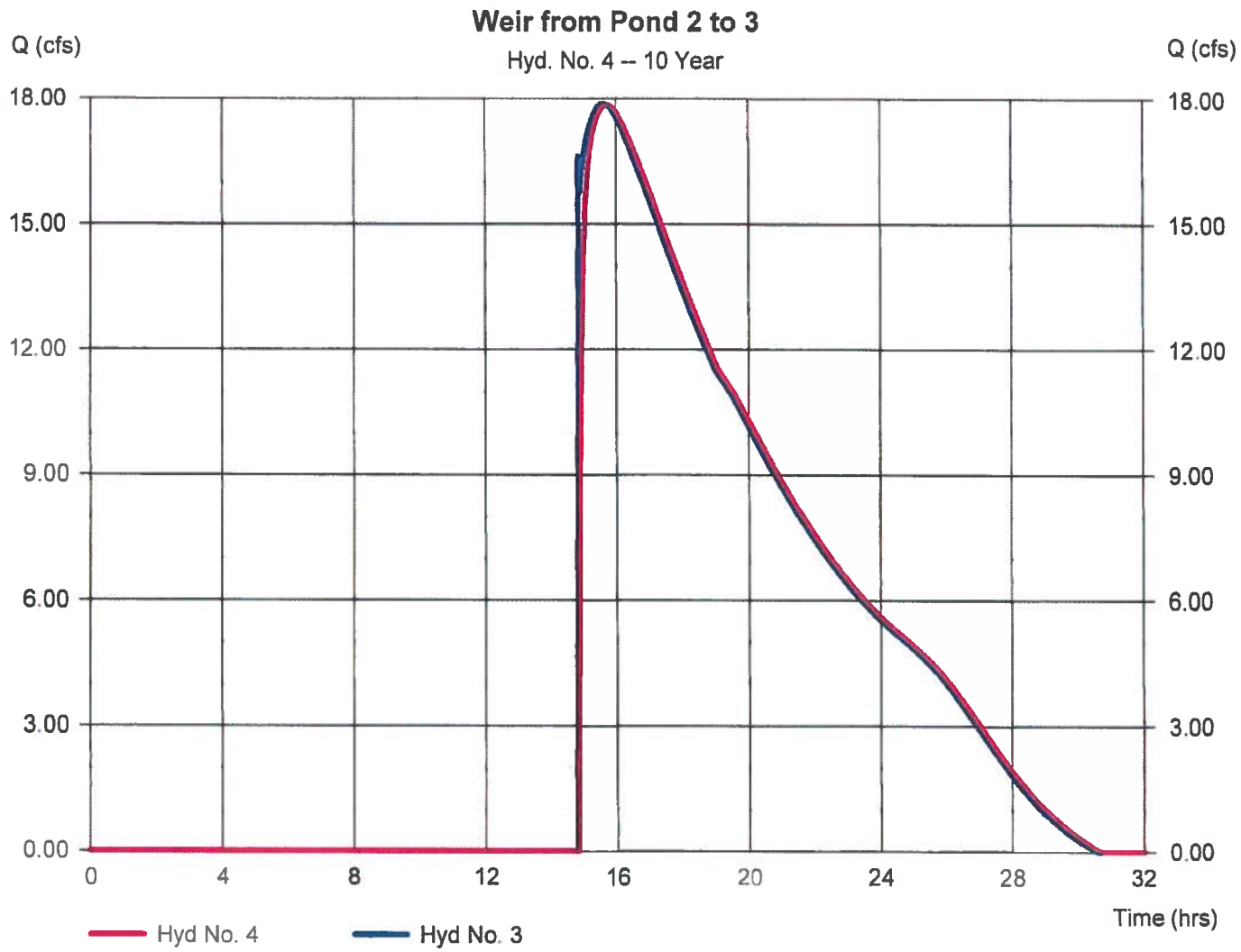
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4 Monday, 04 / 6 / 2015

Hyd. No. 4

Weir from Pond 2 to 3

Hydrograph type	= Reach	Peak discharge	= 17.85 cfs
Storm frequency	= 10 yrs	Time to peak	= 15.73 hrs
Time interval	= 2 min	Hyd. volume	= 443,459 cuft
Inflow hyd. No.	= 3 - Both Ponds in Tandem	Section type	= Rectangular
Reach length	= 20.0 ft	Channel slope	= 0.0 %
Manning's n	= 0.200	Bottom width	= 233.0 ft
Side slope	= 0.0:1	Max. depth	= 3.2 ft
Rating curve x	= 0.001	Rating curve m	= 1.664
Ave. velocity	= 0.04 ft/s	Routing coeff.	= 0.3147

Modified Att-Kin routing method used.



Hydrograph Report

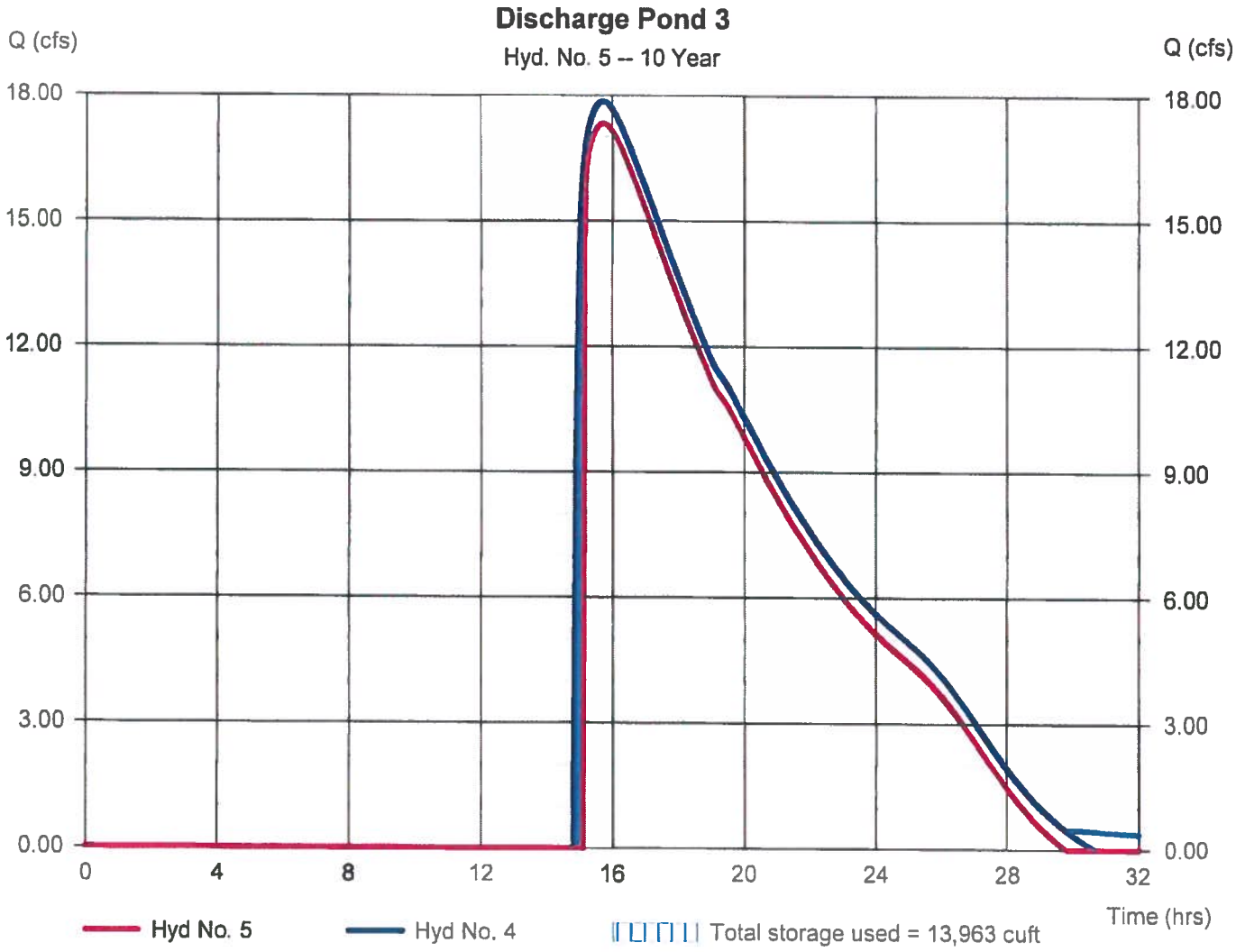
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4 Monday, 04 / 6 / 2015

Hyd. No. 5

Discharge Pond 3

Hydrograph type	= Reservoir	Peak discharge	= 17.32 cfs
Storm frequency	= 10 yrs	Time to peak	= 15.73 hrs
Time interval	= 2 min	Hyd. volume	= 403,659 cuft
Inflow hyd. No.	= 4 - Weir from Pond 2 to 3	Max. Elevation	= 2007.47 ft
Reservoir name	= Pond 3 - Discharge Pond	Max. Storage	= 13,963 cuft

Storage Indication method used. Exfiltration extracted from Outflow.



Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

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	84.98	2	804	1,162,167	------	------	------	Chester Creek Overflow Inflow Basi
2	Reach	44.57	2	910	1,162,075	1	------	------	Haase Reach
3	Reservoir(i)	43.07	2	920	1,002,858	2	2009.61	101,276	Both Ponds in Tandem
4	Reach	43.04	2	924	1,002,855	3	------	------	Weir from Pond 2 to 3
5	Reservoir	42.44	2	924	958,898	4	2007.73	15,789	Discharge Pond 3

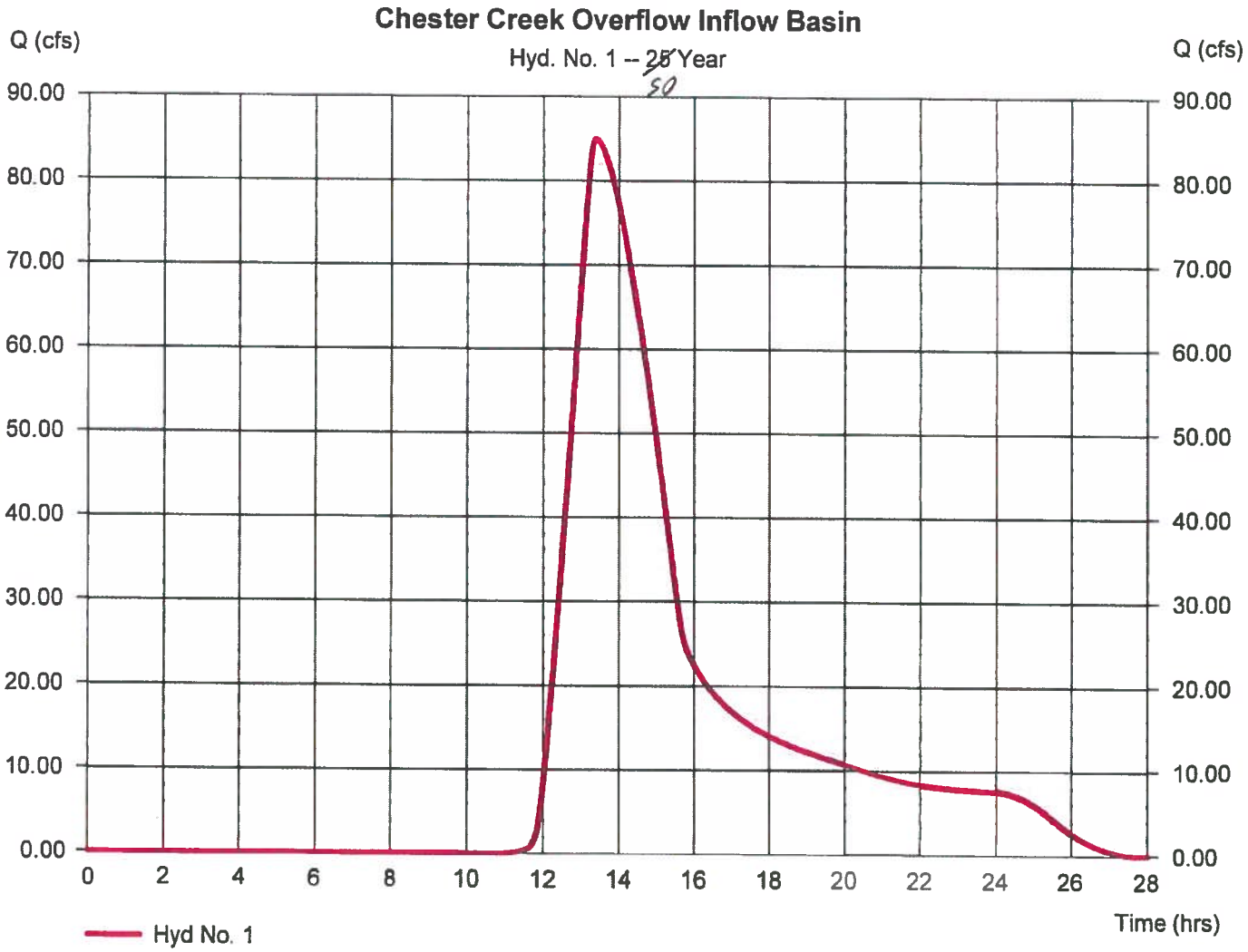
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4 Monday, 04 / 6 / 2015

Hyd. No. 1

Chester Creek Overflow Inflow Basin

Hydrograph type	= SCS Runoff	Peak discharge	= 84.98 cfs
Storm frequency	= ~~25 yrs~~ 50 yrs	Time to peak	= 13.40 hrs
Time interval	= 2 min	Hyd. volume	= 1,162,167 cuft
Drainage area	= 165.000 ac	Curve number	= 62
Basin Slope	= 1.0 %	Hydraulic length	= 5000 ft
Tc method	= TR55	Time of conc. (Tc)	= 145.00 min
Total precip.	= 5.77 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

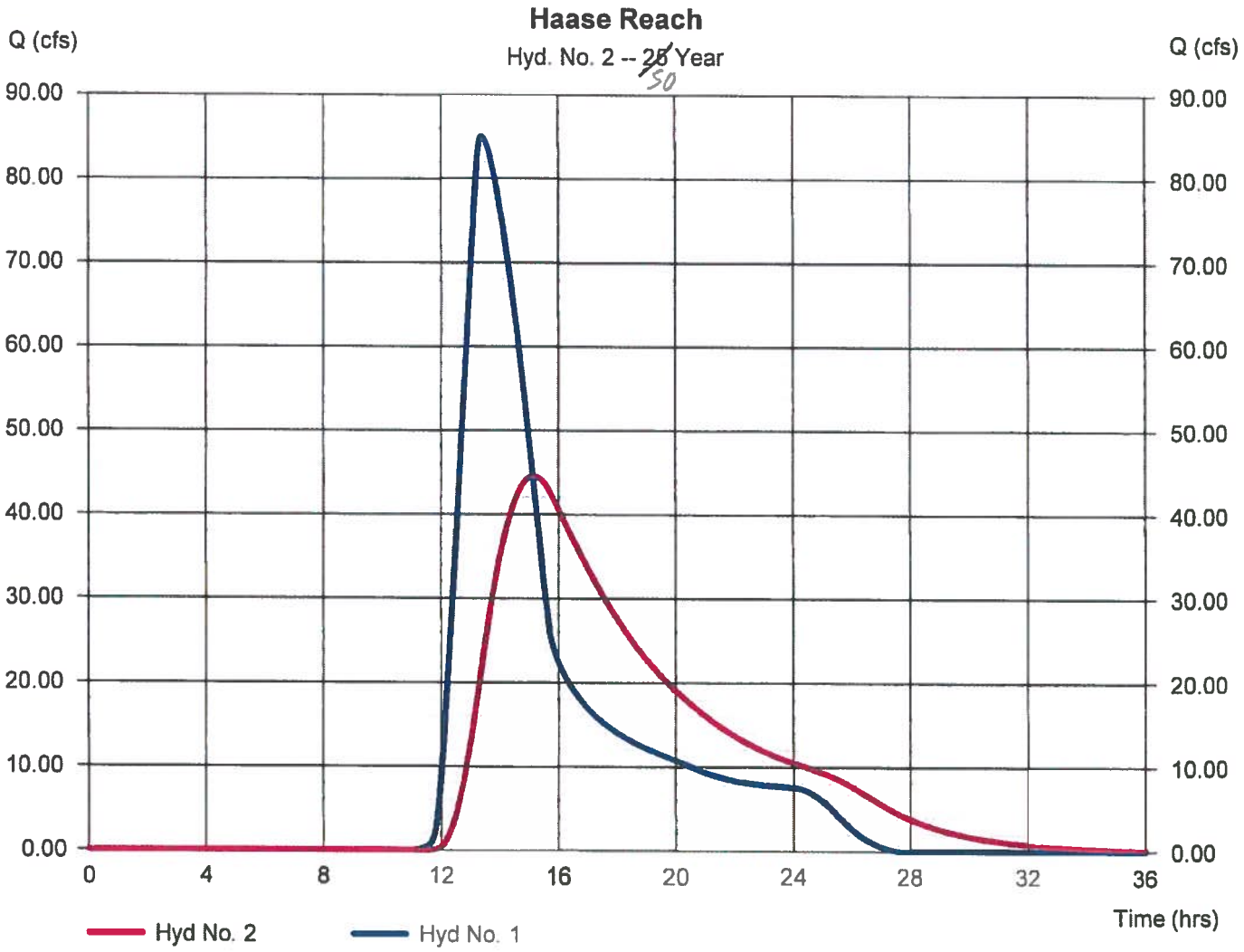
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4 Monday, 04 / 6 / 2015

Hyd. No. 2

Haase Reach

Hydrograph type	= Reach	Peak discharge	= 44.57 cfs
Storm frequency	= ~~25 yrs~~ 50 yrs	Time to peak	= 15.17 hrs
Time interval	= 2 min	Hyd. volume	= 1,162,075 cuft
Inflow hyd. No.	= 1 - Chester Creek Overflow Infiltration	Section type	= Triangular
Reach length	= 7500.0 ft	Channel slope	= 0.5 %
Manning's n	= 0.150	Bottom width	= 0.0 ft
Side slope	= 50.0:1	Max. depth	= 0.0 ft
Rating curve x	= 0.120	Rating curve m	= 1.333
Ave. velocity	= 0.62 ft/s	Routing coeff.	= 0.0132

Modified Att-Kin routing method used.



Hydrograph Report

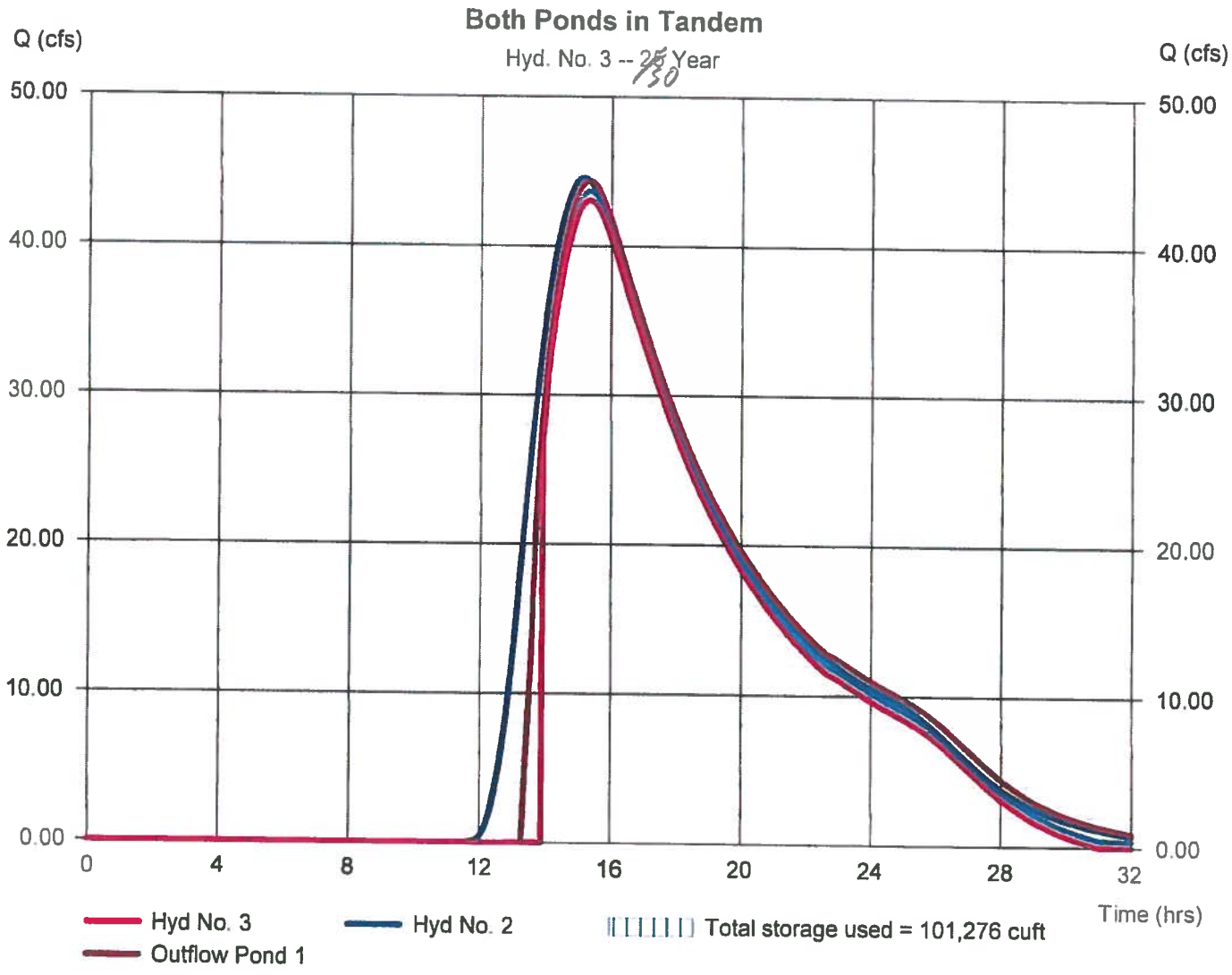
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4 Monday, 04 / 6 / 2015

Hyd. No. 3

Both Ponds in Tandem

Hydrograph type	= Reservoir (Interconnected)	Peak discharge	= 43.07 cfs
Storm frequency	= ~~25 yrs~~ 50 Yrs	Time to peak	= 15.33 hrs
Time interval	= 2 min	Hyd. volume	= 1,002,858 cuft
~~Upper Pond~~	= Haase Pond	~~Lower Pond~~	= Overflow Pond
Inflow hyd.	= 2 - Haase Reach	Other Inflow hyd.	= None
Max. Elevation	= 2008.47 ft	Max. Elevation	= 2009.61 ft
Max. Storage	= 70,625 cuft	Max. Storage	= 30,651 cuft

Interconnected Pond Routing. Storage Indication method used. Exfiltration extracted from Outflow.



Hydrograph Report

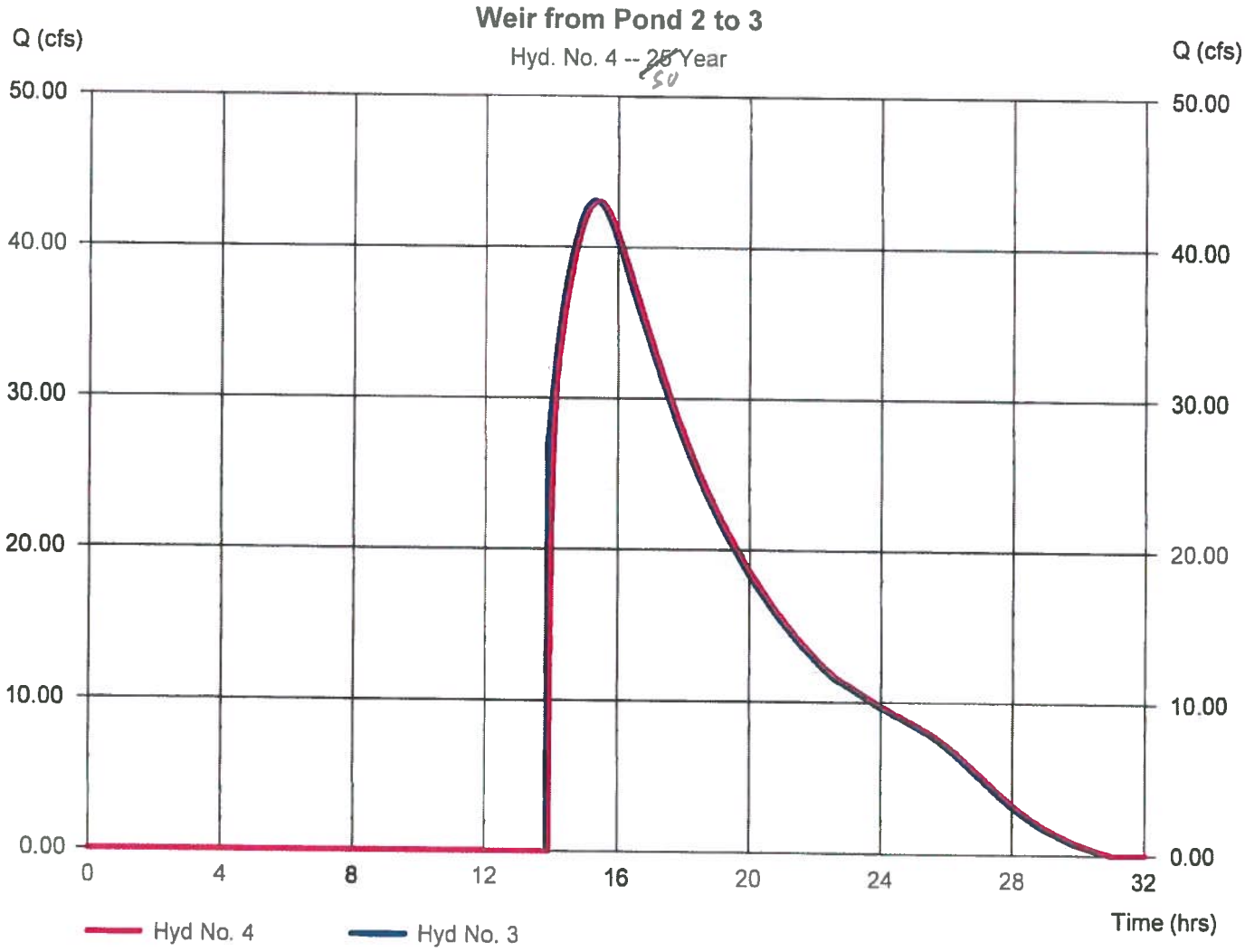
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4 Monday, 04 / 6 / 2015

Hyd. No. 4

Weir from Pond 2 to 3

Hydrograph type	= Reach	Peak discharge	= 43.04 cfs
Storm frequency	= ~~25 yrs~~ 50 yrs	Time to peak	= 15.40 hrs
Time interval	= 2 min	Hyd. volume	= 1,002,855 cuft
Inflow hyd. No.	= 3 - Both Ponds in Tandem	Section type	= Rectangular
Reach length	= 20.0 ft	Channel slope	= 0.0 %
Manning's n	= 0.200	Bottom width	= 233.0 ft
Side slope	= 0.0:1	Max. depth	= 3.2 ft
Rating curve x	= 0.001	Rating curve m	= 1.664
Ave. velocity	= 0.05 ft/s	Routing coeff.	= 0.4193

Modified Att-Kin routing method used.



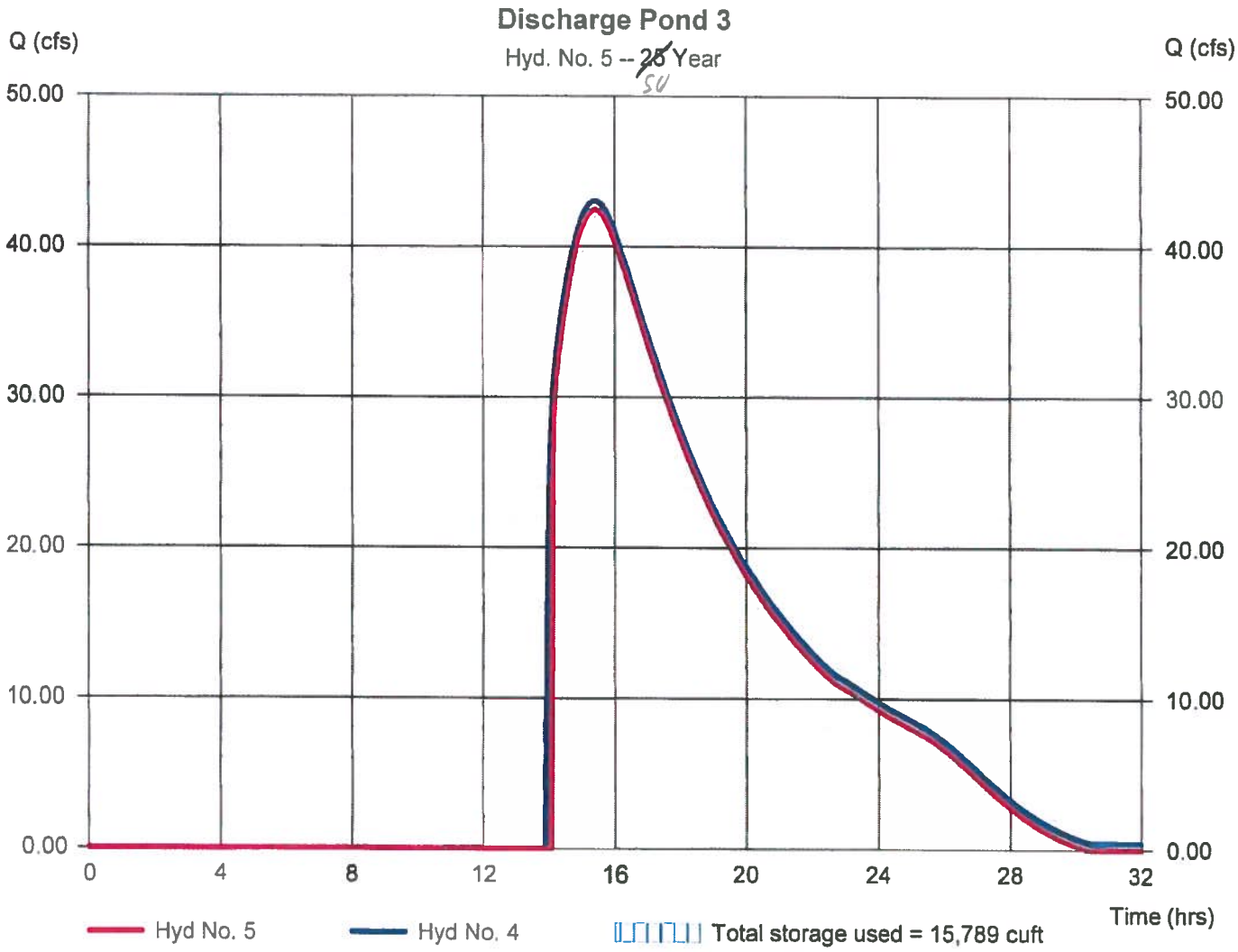
Hydrograph Report

Hyd. No. 5

Discharge Pond 3

Hydrograph type	= Reservoir	Peak discharge	= 42.44 cfs
Storm frequency	= ~~25 yrs~~ 50 YRS	Time to peak	= 15.40 hrs
Time interval	= 2 min	Hyd. volume	= 958,898 cuft
Inflow hyd. No.	= 4 - Weir from Pond 2 to 3	Max. Elevation	= 2007.73 ft
Reservoir name	= Pond 3 - Discharge Pond	Max. Storage	= 15,789 cuft

Storage Indication method used. Exfiltration extracted from Outflow.



Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

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	121.03	2	802	1,594,812	------	------	------	Chester Creek Overflow Inflow Basi
2	Reach	65.74	2	902	1,594,731	1	------	------	Haase Reach
3	Reservoir(i)	64.16	2	912	1,434,968	2	2009.66	114,285	Both Ponds in Tandem
4	Reach	64.12	2	916	1,434,967	3	------	------	Weir from Pond 2 to 3
5	Reservoir	63.50	2	916	1,389,280	4	2007.81	16,313	Discharge Pond 3

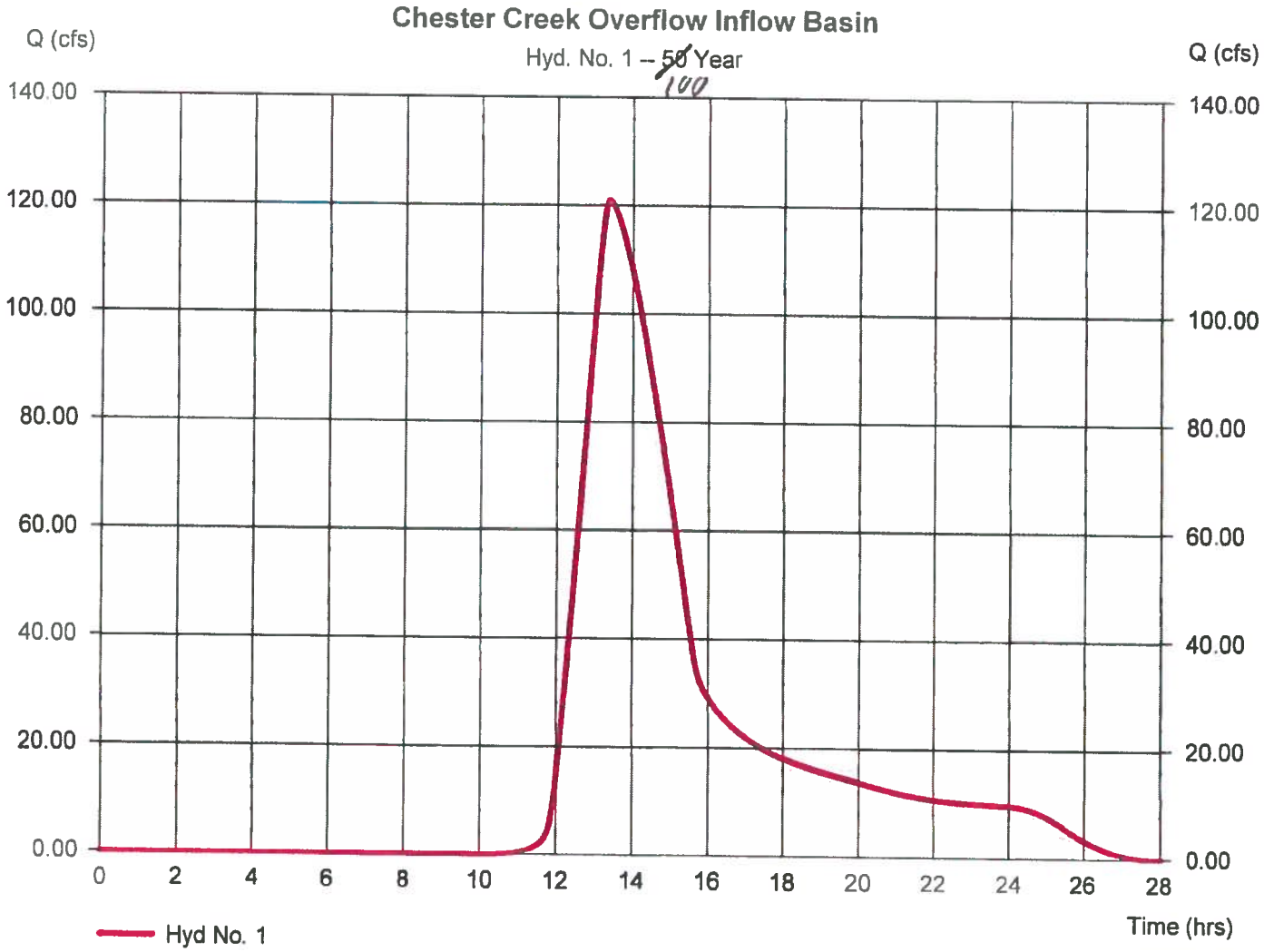
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4 Monday, 04 / 6 / 2015

Hyd. No. 1

Chester Creek Overflow Inflow Basin

Hydrograph type	= SCS Runoff	Peak discharge	= 121.03 cfs
Storm frequency	= ~~50 yrs~~ 100 yrs	Time to peak	= 13.37 hrs
Time interval	= 2 min	Hyd. volume	= 1,594,812 cuft
Drainage area	= 165.000 ac	Curve number	= 62
Basin Slope	= 1.0 %	Hydraulic length	= 5000 ft
Tc method	= TR55	Time of conc. (Tc)	= 145.00 min
Total precip.	= 6.80 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

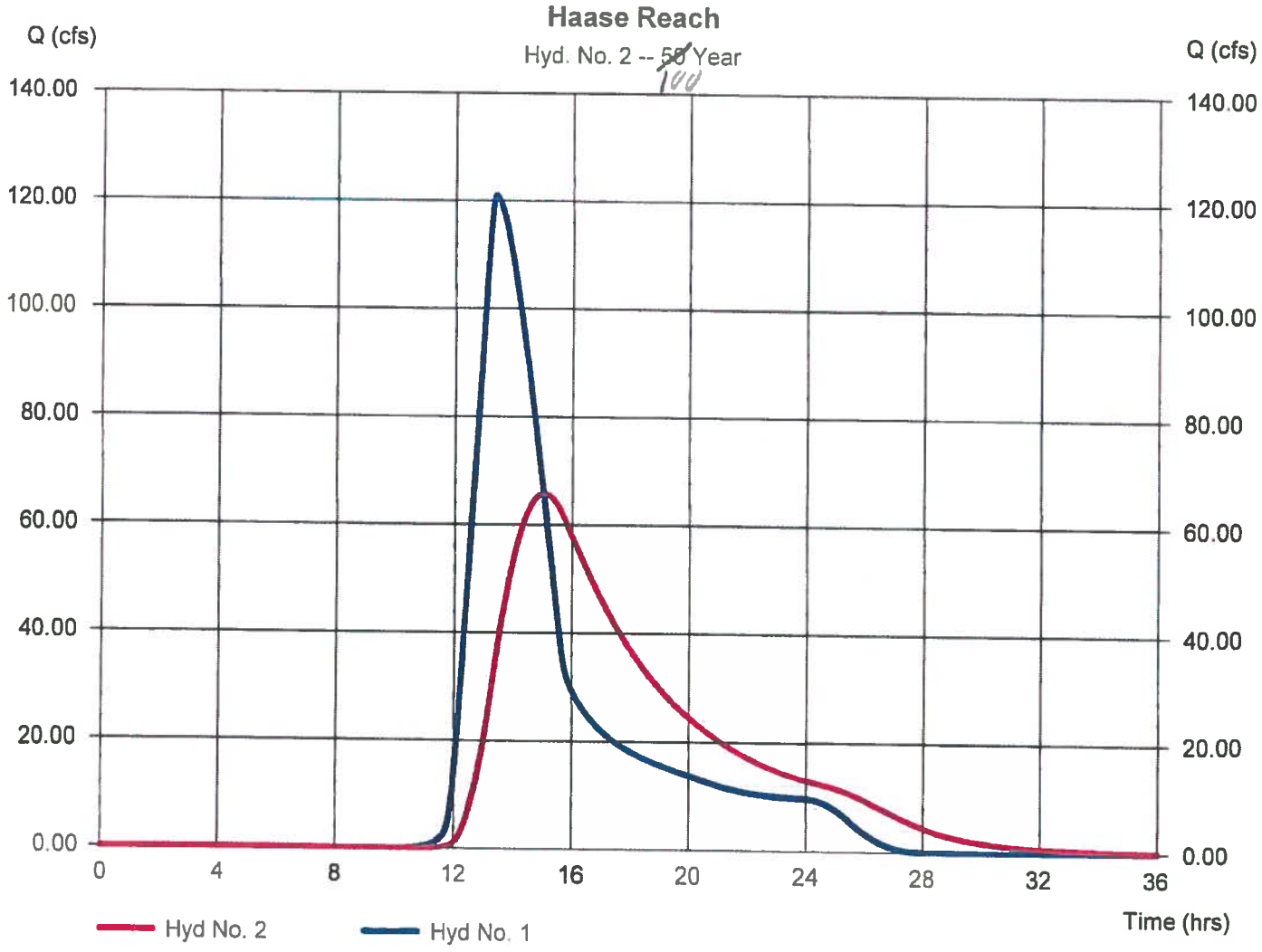
Monday, 04 / 6 / 2015

Hyd. No. 2

Haase Reach

Hydrograph type	= Reach	Peak discharge	= 65.74 cfs
Storm frequency	= ~~50 yrs~~ 100 yrs	Time to peak	= 15.03 hrs
Time interval	= 2 min	Hyd. volume	= 1,594,731 cuft
Inflow hyd. No.	= 1 - Chester Creek Overflow Infiltration	Section type	= Triangular
Reach length	= 7500.0 ft	Channel slope	= 0.5 %
Manning's n	= 0.150	Bottom width	= 0.0 ft
Side slope	= 50.0:1	Max. depth	= 0.0 ft
Rating curve x	= 0.120	Rating curve m	= 1.333
Ave. velocity	= 0.68 ft/s	Routing coeff.	= 0.0144

Modified Att-Kin routing method used



Hydrograph Report

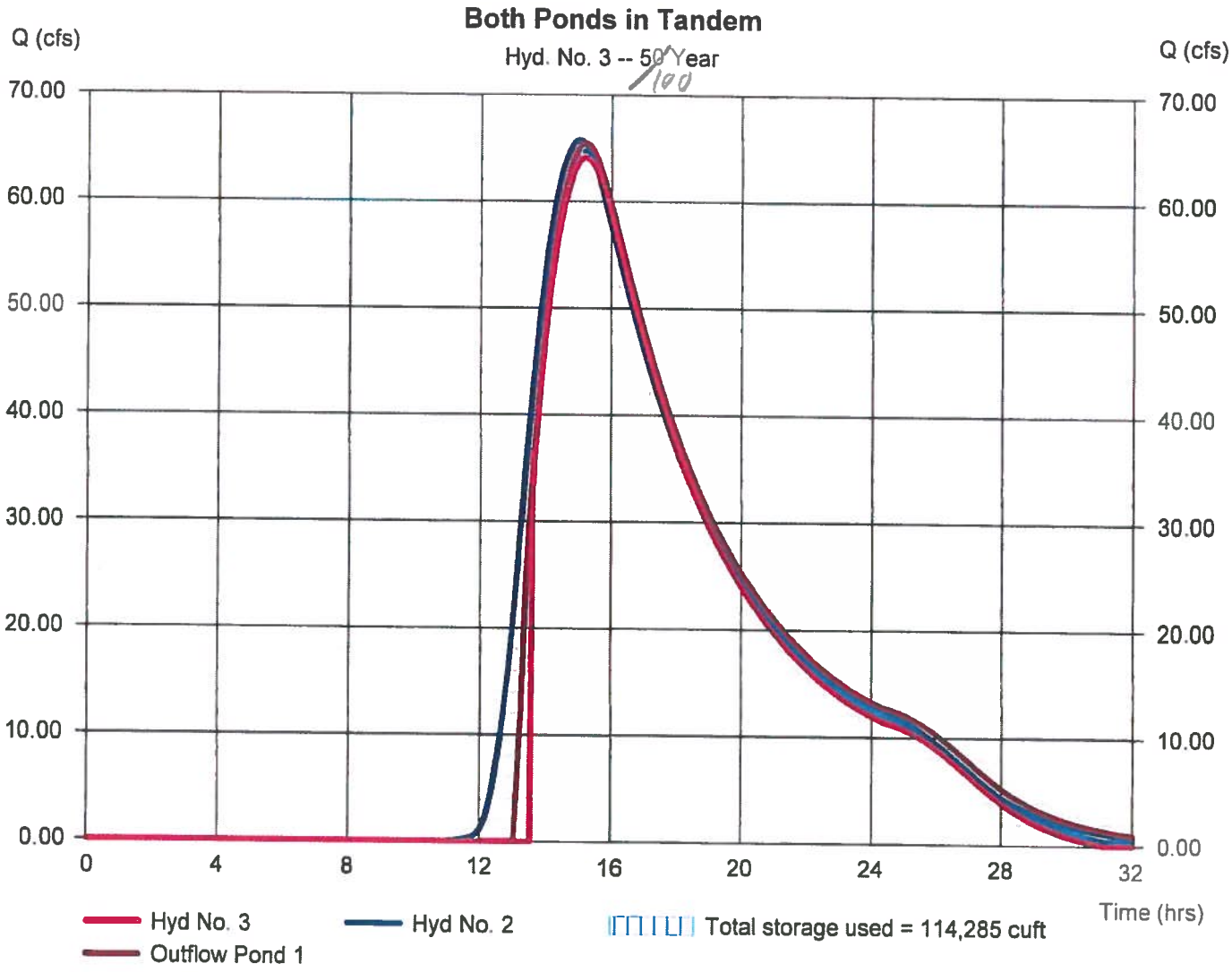
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4 Monday, 04 / 6 / 2015

Hyd. No. 3

Both Ponds in Tandem

Hydrograph type	= Reservoir (Interconnected)	Peak discharge	= 64.16 cfs
Storm frequency	= ~~50 yrs~~ 100 yrs	Time to peak	= 15.20 hrs
Time interval	= 2 min	Hyd. volume	= 1,434,968 cuft
~~Upper Pond~~	= Haase Pond	~~Lower Pond~~	= Overflow Pond
Inflow hyd.	= 2 - Haase Reach	Other Inflow hyd.	= None
Max. Elevation	= 2009.02 ft	Max. Elevation	= 2009.66 ft
Max. Storage	= 83,055 cuft	Max. Storage	= 31,230 cuft

Interconnected Pond Routing. Storage Indication method used. Exfiltration extracted from Outflow.



Hydrograph Report

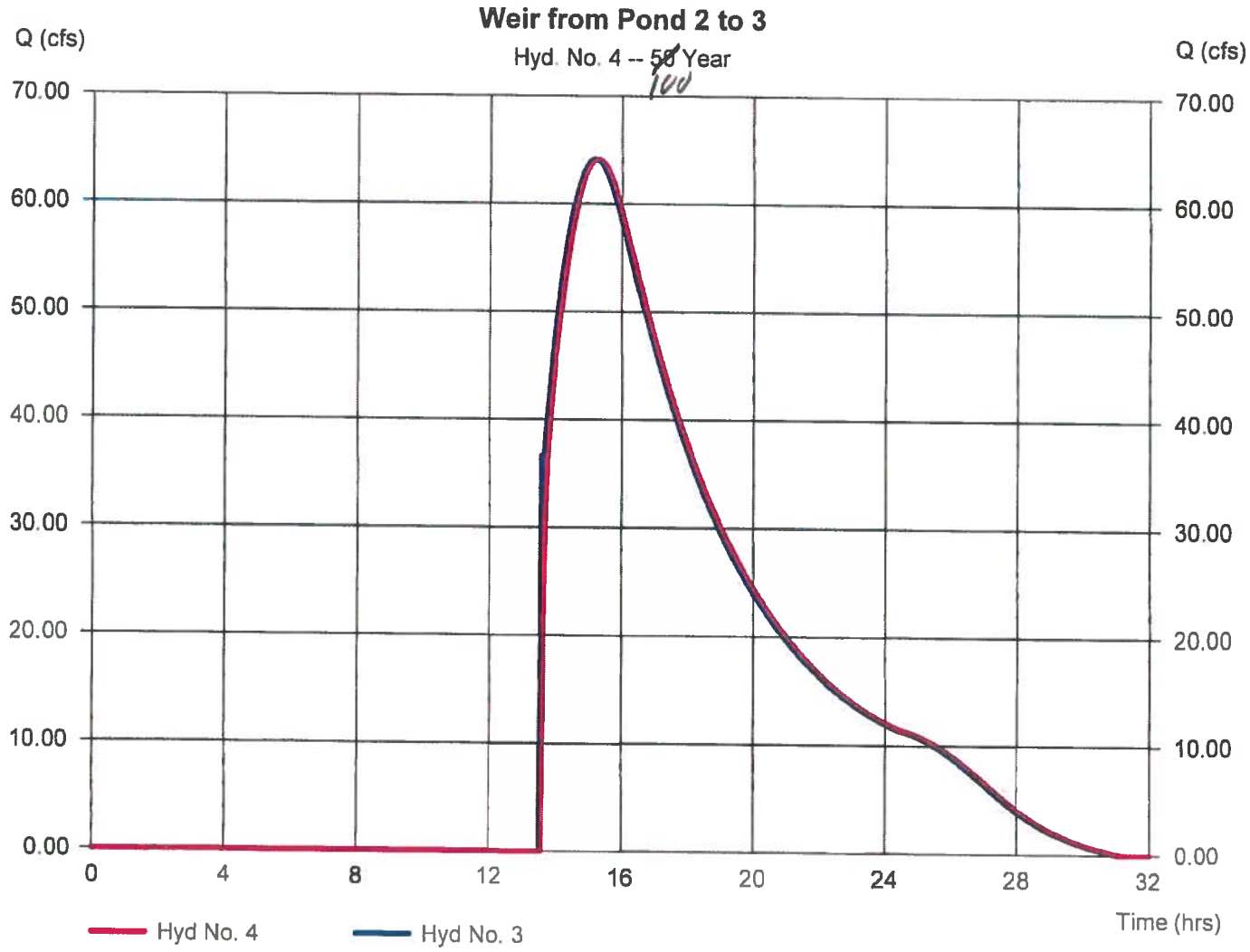
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4 Monday, 04 / 6 / 2015

Hyd. No. 4

Weir from Pond 2 to 3

Hydrograph type	= Reach	Peak discharge	= 64.12 cfs
Storm frequency	= ~~50 yrs~~ 100 yrs	Time to peak	= 15.27 hrs
Time interval	= 2 min	Hyd. volume	= 1,434,967 cuft
Inflow hyd. No.	= 3 - Both Ponds in Tandem	Section type	= Rectangular
Reach length	= 20.0 ft	Channel slope	= 0.0 %
Manning's n	= 0.200	Bottom width	= 233.0 ft
Side slope	= 0.0:1	Max. depth	= 3.2 ft
Rating curve x	= 0.001	Rating curve m	= 1.664
Ave. velocity	= 0.06 ft/s	Routing coeff.	= 0.4744

Modified Att-Kin routing method used.



Hydrograph Report

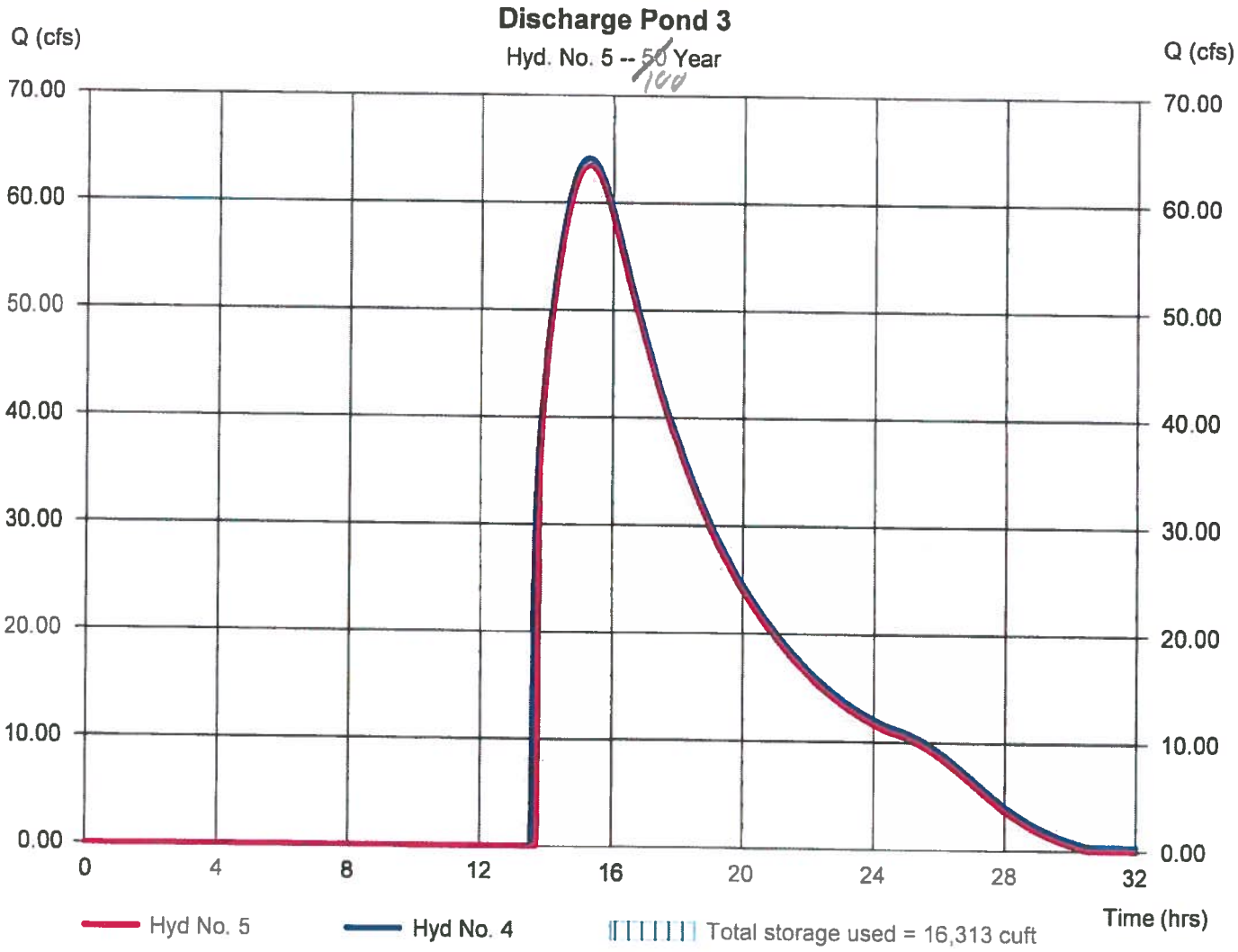
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4 — Monday, 04 / 6 / 2015

Hyd. No. 5

Discharge Pond 3

Hydrograph type	= Reservoir	Peak discharge	= 63.50 cfs
Storm frequency	= ~~50-yrs~~ 100yrs	Time to peak	= 15.27 hrs
Time interval	= 2 min	Hyd. volume	= 1,389,280 cuft
Inflow hyd. No.	= 4 - Weir from Pond 2 to 3	Max. Elevation	= 2007.81 ft
Reservoir name	= Pond 3 - Discharge Pond	Max. Storage	= 16,313 cuft

Storage Indication method used. Exfiltration extracted from Outflow.



Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

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	164.38	2	802	2,113,096	------	------	------	Chester Creek Overflow Inflow Basi
2	Reach	92.23	2	896	2,113,017	1	------	------	Haase Reach
3	Reservoir(i)	90.75	2	902	1,952,922	2	2010.01	136,854	Both Ponds in Tandem
4	Reach	90.70	2	906	1,952,922	3	------	------	Weir from Pond 2 to 3
5	Reservoir	90.05	2	906	1,905,735	4	2007.91	16,975	Discharge Pond 3

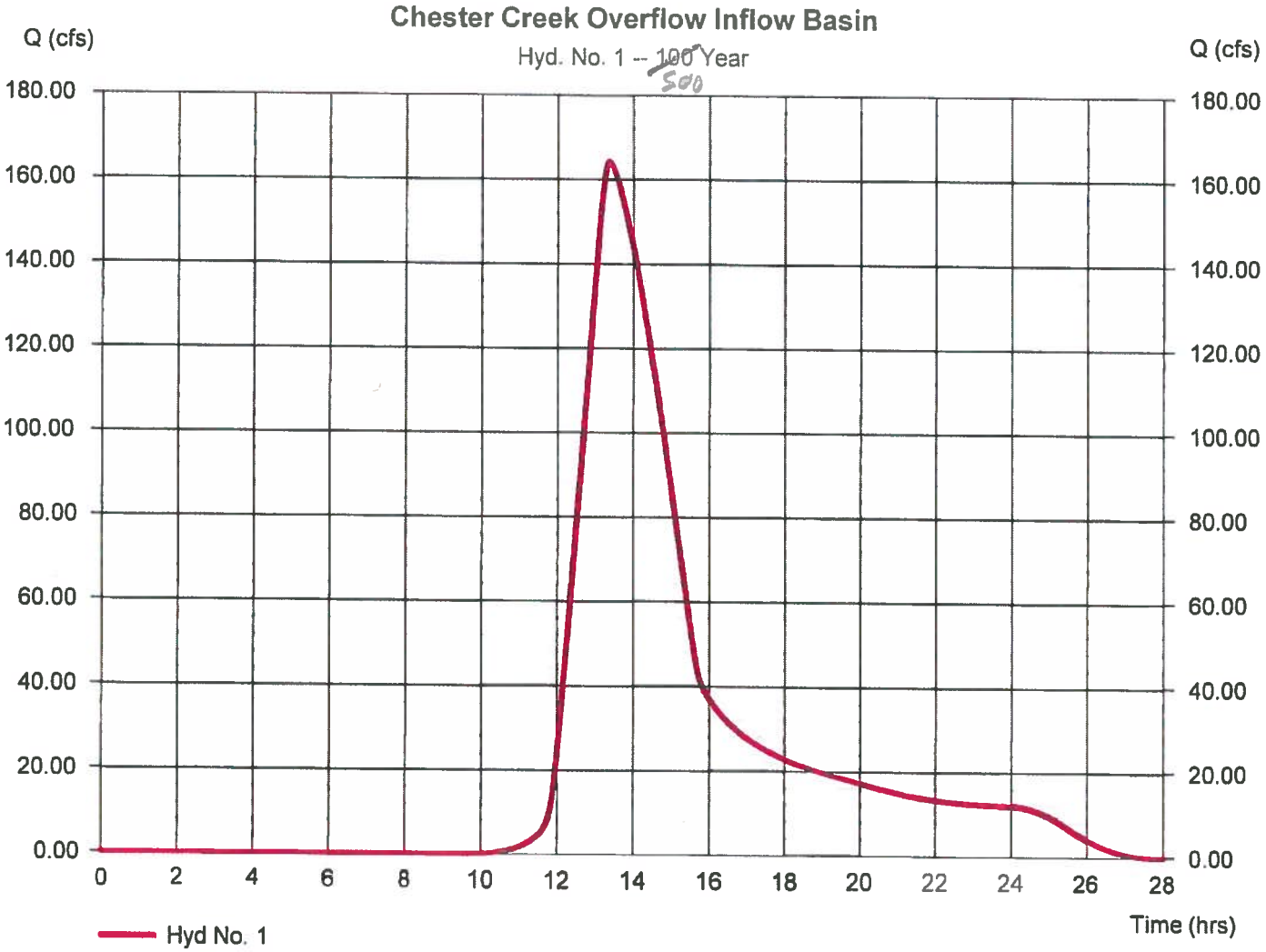
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4 Monday, 04 / 6 / 2015

Hyd. No. 1

Chester Creek Overflow Inflow Basin

Hydrograph type	= SCS Runoff	Peak discharge	= 164.38 cfs
Storm frequency	= ~~100 yrs~~ 500 yrs	Time to peak	= 13.37 hrs
Time interval	= 2 min	Hyd. volume	= 2,113,096 cuft
Drainage area	= 165.000 ac	Curve number	= 62
Basin Slope	= 1.0 %	Hydraulic length	= 5000 ft
Tc method	= TR55	Time of conc. (Tc)	= 145.00 min
Total precip.	= 7.95 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

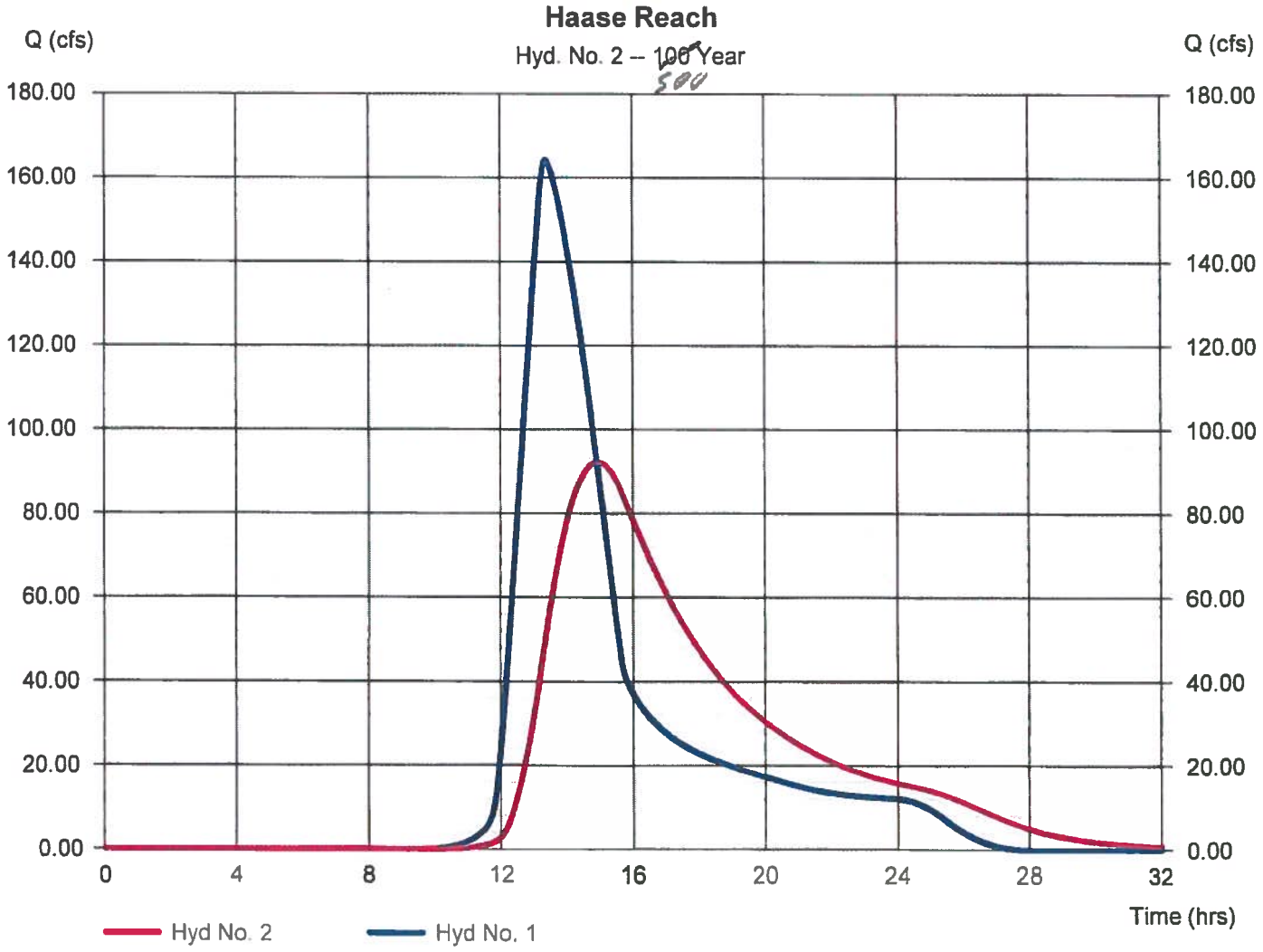
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4 Monday, 04 / 6 / 2015

Hyd. No. 2

Haase Reach

Hydrograph type	= Reach	Peak discharge	= 92.23 cfs
Storm frequency	= ~~100 yrs~~ 500 yrs	Time to peak	= 14.93 hrs
Time interval	= 2 min	Hyd. volume	= 2,113,017 cuft
Inflow hyd. No.	= 1 - Chester Creek Overflow Infiltration	Section type	= Triangular
Reach length	= 7500.0 ft	Channel slope	= 0.5 %
Manning's n	= 0.150	Bottom width	= 0.0 ft
Side slope	= 50.0:1	Max. depth	= 0.0 ft
Rating curve x	= 0.120	Rating curve m	= 1.333
Ave. velocity	= 0.73 ft/s	Routing coeff.	= 0.0155

Modified Att-Kin routing method used.



Hydrograph Report

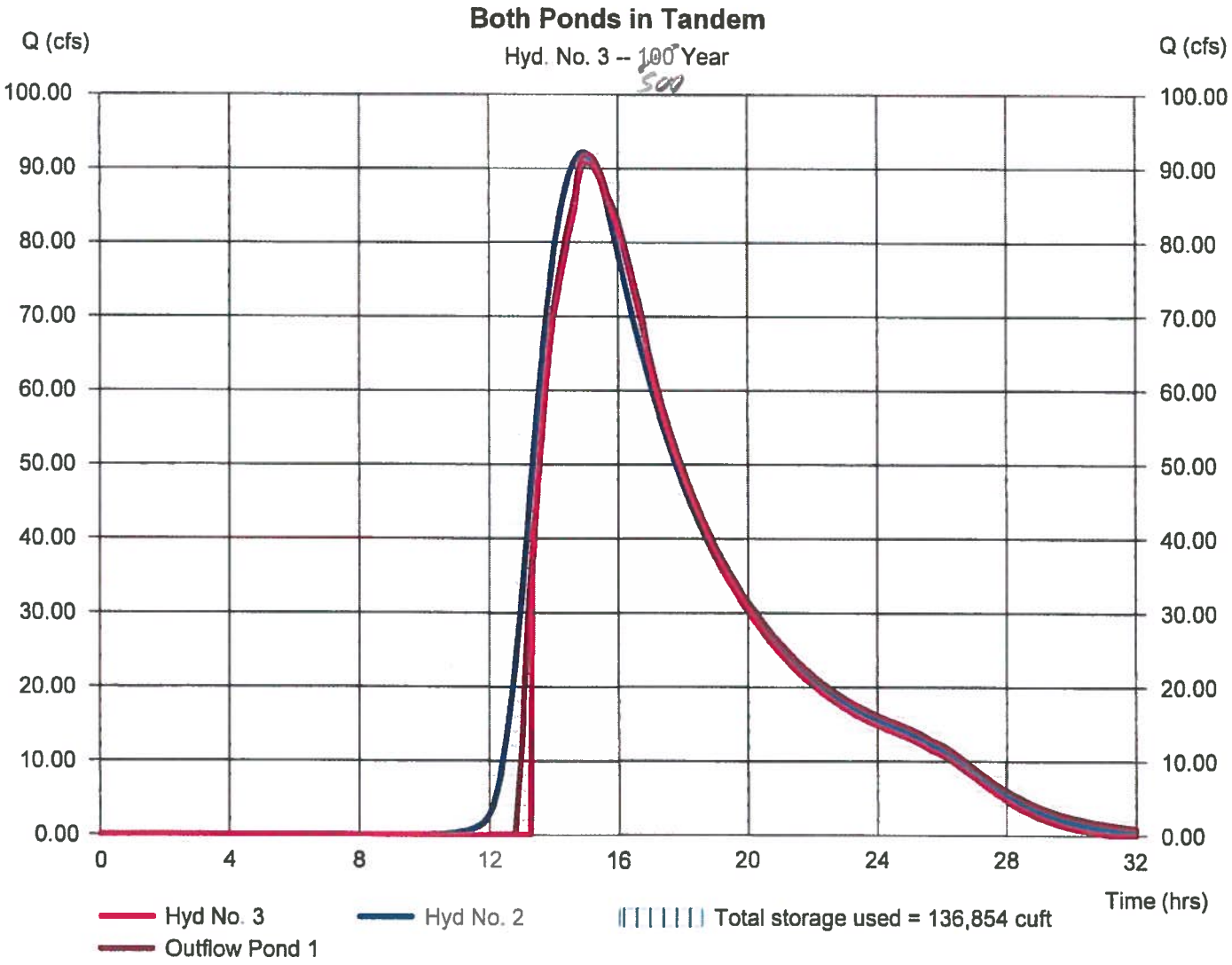
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4 Monday, 04 / 6 / 2015

Hyd. No. 3

Both Ponds in Tandem

Hydrograph type	= Reservoir (Interconnected)	Peak discharge	= 90.75 cfs
Storm frequency	= ~~100 yrs~~ 500 yrs	Time to peak	= 15.03 hrs
Time interval	= 2 min	Hyd. volume	= 1,952,922 cuft
Upper Pond	= Haase Pond	Lower Pond	= Overflow Pond
Inflow hyd.	= 2 - Haase Reach	Other Inflow hyd.	= None
Max. Elevation	= 2010.01 ft	Max. Elevation	= 2009.72 ft
Max. Storage	= 104,983 cuft	Max. Storage	= 31,872 cuft

Interconnected Pond Routing. Storage Indication method used. Exfiltration extracted from Outflow.



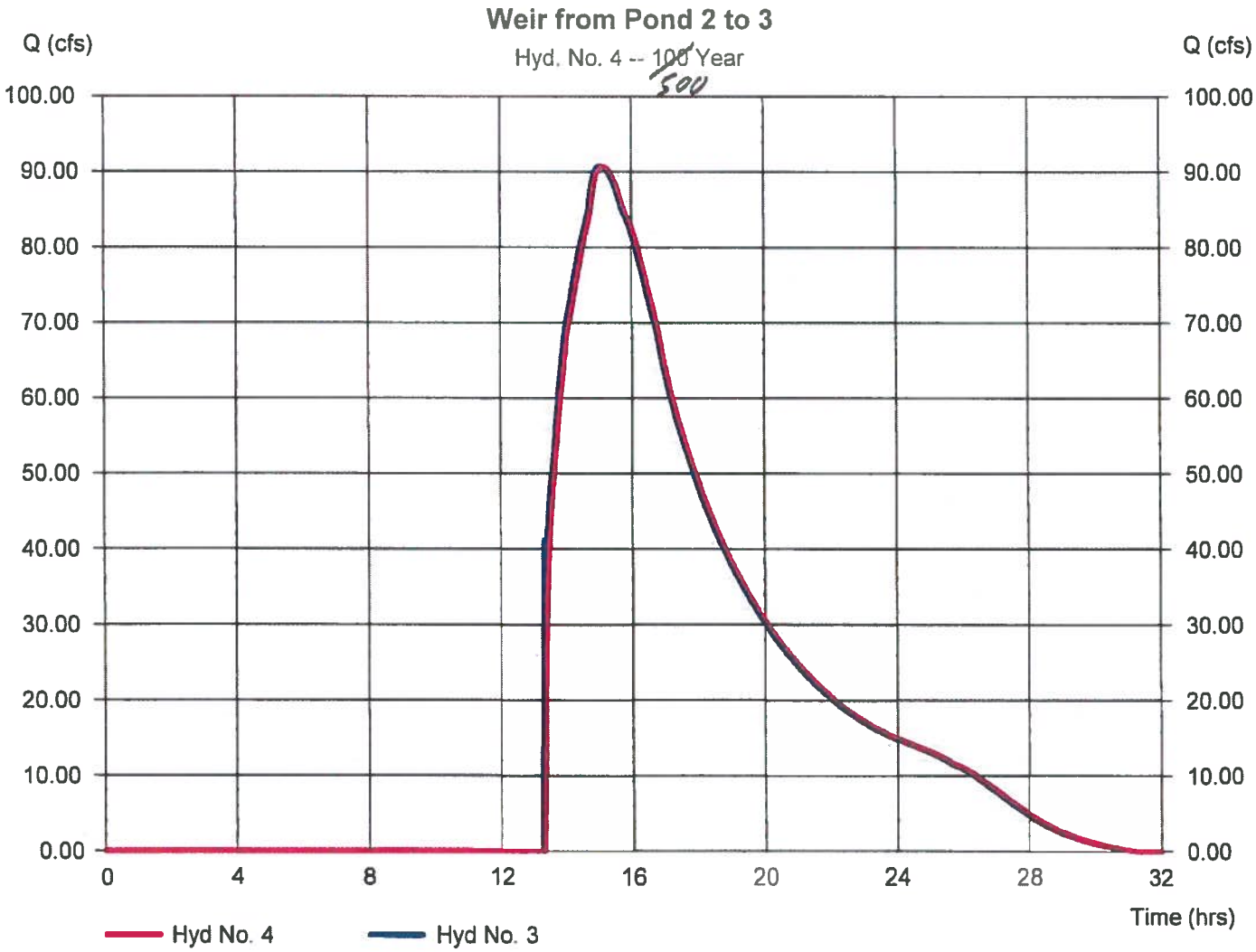
Hydrograph Report

Hyd. No. 4

Weir from Pond 2 to 3

Hydrograph type	= Reach	Peak discharge	= 90.70 cfs
Storm frequency	= ~~100 yrs~~ 500 yrs	Time to peak	= 15.10 hrs
Time interval	= 2 min	Hyd. volume	= 1,952,922 cuft
Inflow hyd. No.	= 3 - Both Ponds in Tandem	Section type	= Rectangular
Reach length	= 20.0 ft	Channel slope	= 0.0 %
Manning's n	= 0.200	Bottom width	= 233.0 ft
Side slope	= 0.0:1	Max. depth	= 3.2 ft
Rating curve x	= 0.001	Rating curve m	= 1.664
Ave. velocity	= 0.07 ft/s	Routing coeff.	= 0.5263

Modified Att-Kin routing method used.



Hydrograph Report

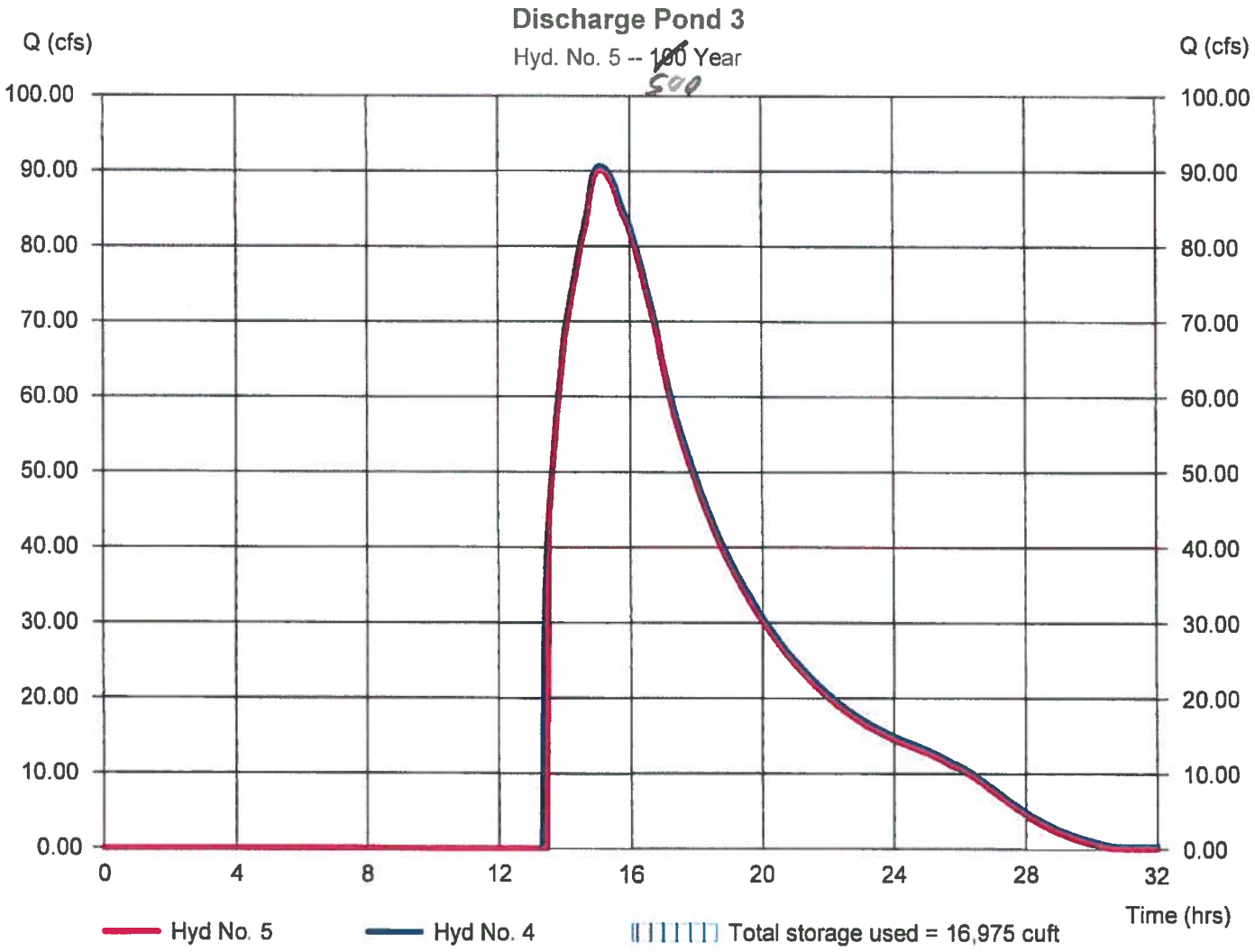
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4 — Monday, 04 / 6 / 2015

Hyd. No. 5

Discharge Pond 3

Hydrograph type	= Reservoir	Peak discharge	= 90.05 cfs
Storm frequency	= ~~100 yrs~~ 500 yrs	Time to peak	= 15.10 hrs
Time interval	= 2 min	Hyd. volume	= 1,905,735 cuft
Inflow hyd. No.	= 4 - Weir from Pond 2 to 3	Max. Elevation	= 2007.91 ft
Reservoir name	= Pond 3 - Discharge Pond	Max. Storage	= 16,975 cuft

Storage Indication method used. Exfiltration extracted from Outflow



Hydraflow Rainfall Report

Return Period (Yrs)	Intensity-Duration-Frequency Equation Coefficients (FHA)			
	B	D	E	(N/A)
1	0.0000	0.0000	0.0000	--------
2	3.1790	0.1000	0.5318	--------
3	0.0000	0.0000	0.0000	--------
5	0.0000	0.0000	0.0000	--------
10	6.8534	0.1000	0.6029	--------
50 ~~25~~	0.0000	0.0000	0.0000	--------
100 ~~50~~	10.8789	0.1000	0.6403	--------
500 ~~100~~	12.0329	0.1000	0.6277	--------

File name: spokane.IDF

Intensity = B / (Tc + D)^E

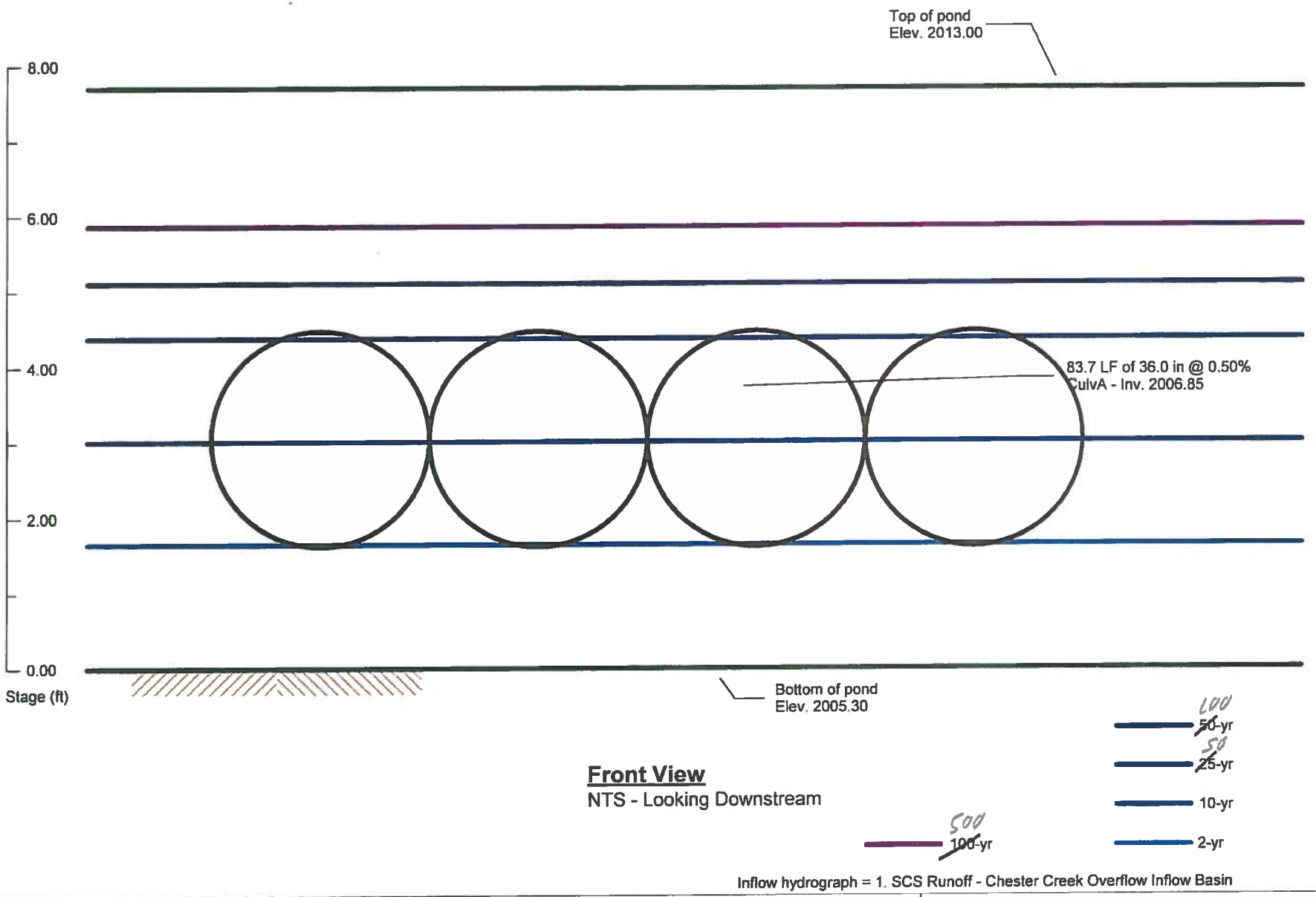
Return Period (Yrs)	Intensity Values (in/hr)											
	5 min	10	15	20	25	30	35	40	45	50	55	60
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	1.34	0.93	0.75	0.64	0.57	0.52	0.48	0.45	0.42	0.40	0.38	0.36
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	2.57	1.70	1.33	1.12	0.98	0.88	0.80	0.74	0.69	0.65	0.61	0.58
50 ~~25~~	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
100 ~~50~~	3.83	2.47	1.91	1.59	1.38	1.23	1.11	1.02	0.95	0.89	0.84	0.79
500 ~~100~~	4.33	2.82	2.19	1.83	1.59	1.42	1.29	1.19	1.10	1.03	0.97	0.92

Tc = time in minutes. Values may exceed 60.

Precip. file name: P:\WCE_WORK\DOCUMENTS\!!! A Storm Drainage File\Spokane SCS.pcp

Storm Distribution	Rainfall Precipitation Table (in)							
	1-yr	2-yr	3-yr	5-yr	10-yr	50 ~~25-yr~~	100 ~~50-yr~~	500 ~~100-yr~~
SCS 24-hour	0.00	2.20	0.00	3.30	4.25	5.77	6.80	7.95
SCS 6-Hr	0.00	1.80	0.00	0.00	2.60	0.00	0.00	4.00
Huff-1st	0.00	1.55	0.00	2.75	4.00	5.38	6.50	8.00
Huff-2nd	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-3rd	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-4th	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-Indy	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Custom	0.00	1.75	0.00	2.80	3.90	5.25	6.00	7.10

Pond No. 1 - Haase Pond

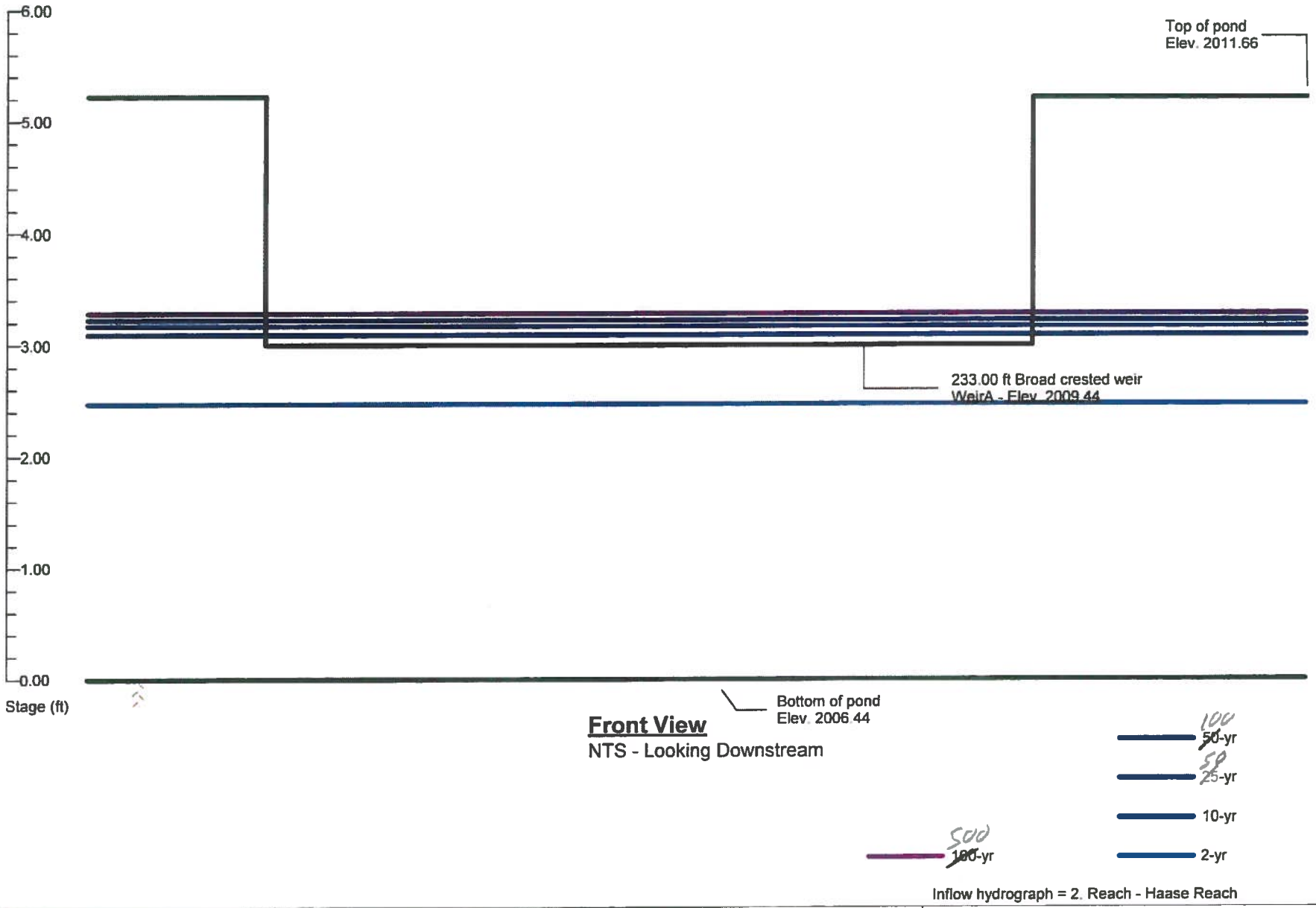


Front View
NTS - Looking Downstream

Inflow hydrograph = 1, SCS Runoff - Chester Creek Overflow Inflow Basin

Pond No. 2 - Overflow Pond

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

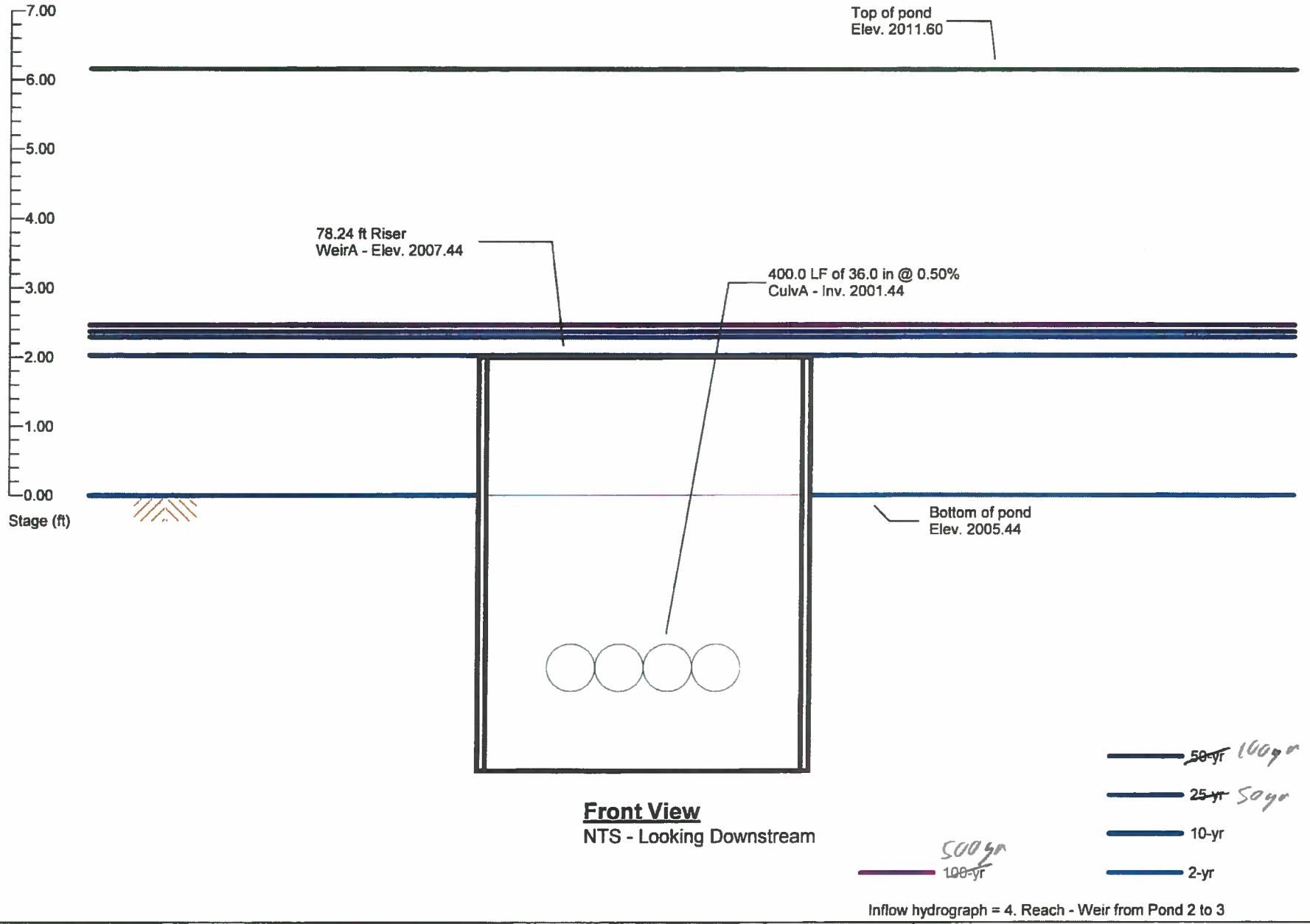


Front View

NTS - Looking Downstream

Inflow hydrograph = 2. Reach - Haase Reach

Pond No. 3 - Pond 3 - Discharge Pond



Inflow hydrograph = 4. Reach - Weir from Pond 2 to 3

WHIPPLE CONSULTING ENGINEERS

GRAVEL GALLERY CALC SHEET

4/1/2015

13-1166 Painted Hills PRD
ENGINEER BNG

Note: infiltration rates per IPEC Geotechnical Report Dated December 31, 2013

Gallery Depth (Min)	Porosity of Gravel (Typ)			Infiltration Rate
ft	cf/cf			cfs/sf
12	0.3			1.10E-03

Run		Number of Galleries	Length	Width	Ground Water EL.	Gravel Gallery Bott. EL	Volume	Storage Volume	Perimeter	Sidewall Area	Bottom Area	Outflow
			ft	ft	ft	ft	cf	cf	ft	sf	sf	cfs
A		1	398.00	12.00	-	1993.66	57,312	17,194	820	9,840	4,776	16.08
B		1	690.00	12.00	-	1993.66	99,360	29,808	1,404	16,848	8,280	27.64
C		1	423.00	12.00	-	1993.66	60,912	18,274	870	10,440	5,076	17.07
D		1	440.00	12.00	-	1993.66	63,360	19,008	904	10,848	5,280	17.74
E		1	501.00	12.00	-	1993.66	72,144	21,643	1,026	12,312	6,012	20.16
Totals		3	1589	12			228,816	68,645	3,250	39,000	19,068	98.68

Storage Volume = Volume* Porosity
Sidewall Area= Perimeter*Depth
OutFlow = Sidewall Area+ Bottom Area * Infiltration Rate

100yr = 64cfs x 1.5 = 96.00 ≤ 98.68

Note: Outflow Assumes a Full Gallery