BLUELINE

City Heights Phase 1

(Pods B7 and C)

Cle Elum, Washington

Date: March 12, 2021

Storm Drainage Report

Prepared for
City Heights Holdings, LLC
116 ½ S. Washington Street
Seattle, WA 98104

Blueline Job No. 19-349
Prepared by: Michelle Roberge, PE
Reviewed by: Lyndsey Fedak, PE
Approved by: Brett Pudists, PE

3/12/21

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Section 1 Project Overview

Project Name:	City Heights
Project Parcels:	493935, 956732, 956734 (Phase 1)
Project Engineer:	The Blueline Group Brett Pudists, PE (425) 250-7247
Project Applicant:	City Heights Holdings, LLC Sean Northrop (206) 388-3121
Project Development Area:	29.12 acres (Phase 1) Total Disturbed: 15.94 acres
Number of Lots:	68

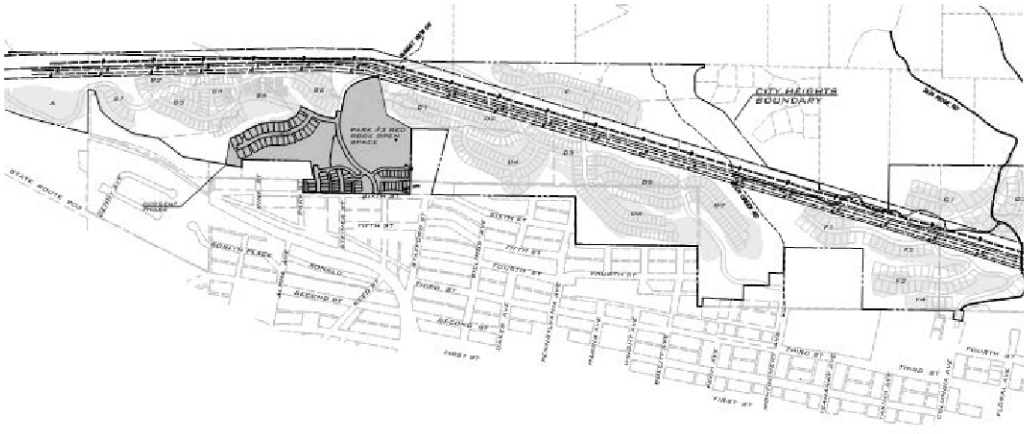
1.1 SITE INFORMATION

SITE INFORMATION	
Project location	City of Cle Elum
Zoning	Planned Mixed Use Development (PMU)
Climate Region (Figure 4.1 of 2019 SWMMEW)	Region I (East Slope Cascades)
Average Annual Precipitation (Figure 4.1 of 2019 SWMMEW)	25 in/yr
P2year,24hour (Figure 4.7 of 2019 SWMMEW)*	2 in
P10year,24hour (Figure 4.9 of 2019 SWMMEW)*	3.25 in
P25year,24hour (Figure 4.10 of 2019 SWMMEW)*	3.5 in
P100year,24hour (Figure 4.12 of 2019 SWMMEW)*	4.75 in
Type of Soil per Geotech report	Weathered siltstone/sandstone with areas of fill soils east of Summit View Road and silty sand/gravel/silt with areas fill soils containing coal waste west of Summit View Road
Design Infiltration Rate per Geotech report	N/A, deemed infeasible

*Precipitation depth adjusted for rain-on-snow and snowmelt considerations, refer to Section 6.3 for adjusted precipitation depths.

1.2 EXECUTIVE SUMMARY

This Storm Drainage Report is for the construction of Phase 1 of City Heights (Pods B7 & C), a Planned Mixed Use (PMU) development. More generally the property is located within the NE ¼ of Section 27, Township 20 N, Range 15 East, W.M. See vicinity map below.



Vicinity Map, Not to Scale

The overall City Heights project is approximately 358 acres; however, this report will limit discussion to Phase 1, which is approximately 29.12 acres. The site is mostly forested and consists of existing bike trails and an asphalt road, Summit View Rd, that heads north. There are also wetlands and a stream identified in the report prepared by Sewall Wetland Consulting, Inc. dated October 26, 2009. The site is underlain with weathered siltstone/, sandstone, silt/silty sand/gravel, and fill soils containing coal waste generally consistent with the report prepared by Terra Associates, Inc dated June 9, 2020. A Web Soil Survey Map is included in Section 4. The site contains moderate to steep slopes 2% to greater than 25%.

In the existing condition, runoff is generated from two drainage basins dictated by a stream bisecting the site, creating the Crystal Creek 3 basin, tributary to Stream C (ultimately tributary to Crystal Creek) and the Crystal Creek 5, tributary to an existing roadside ditch (ultimately tributary to Crystal Creek). Runoff from Crystal Creek 3 generally sheet flows southeast before entering an existing onsite stream (Stream C), which is tributary to Crystal Creek. Runoff from Crystal Creek 5 generally sheet flows south before entering an existing ditch along 6th Street, which is tributary to an existing roadside ditch. Please refer to the Existing Conditions Exhibit included at the end of this section and the Downstream Drainage Exhibit included in Section 3.

In the proposed condition, Crystal Creek 5 (Vault C) will consist of 40 lots (32 single-family and 4 duplexes), proposed roads/private access tracts, a relocated portion of Summit View Road, a future amenity area (Outfitter) and parking area, a biofiltration swale for water quality, and a detention vault (Vault C) for flow control. Crystal Creek 3 (Pond B7-A) will consist of 28 single family lots, proposed roads, a biofiltration swale for water quality, and a detention pond (Pond B7-A) for flow control.

The Crystal Creek 4 basin will be developed as part of a future phase. Tract R, proposed with this application, is set aside in an open space/stormwater tract and is reserved for the future detention pond (Pond B7-B) that will be sized to accommodate the future development of Pods B2-B6. Please note Pond B7-B and its associated future

development (Pod B2-B6) will be submitted under a separate permit. Refer to the Proposed Conditions Exhibit included at the end of this section and the Downstream Drainage Exhibit included in Section 3.

The project has been designed using the guidelines and requirements established in the 2019 Department of Ecology (DOE) Stormwater Management Manual for Eastern Washington (SWMMEW) and the City Heights Annexation and Development Agreement (DA), dated November 8, 2011.

The project will implement flow control BMPs per Chapter 6 of the 2019 SWMMEW. Per Section 4.3.9 of the 2019 SWMMEW, including rain-on-snow and snowmelt design, is optional guidance for detention and water quality design. However, rain-on-snow and snowmelt design requirements are applied for this project. For more information, refer to Section 6 of this report. Per the Geotechnical report provided by Terra Associates, Inc dated June 9, 2020, infiltration is infeasible.

A detention pond (Pond B7-A) and a vault (Vault C) are proposed as flow control facilities for the site per BMP F6.10 and BMP F6.12 to match the developed peak flows with existing peak flows for 50% of the 2-year storm event and the full 25-year storm event. Additionally, per the DA, while the manual stipulates that the design needs to assume a 25-year flood event, the City has requested, and the Ridge Entities have agreed, to design the stormwater system for City Heights assuming a 100-year flood event, thereby increasing the capacity of the system beyond what is required by current regulations. The project will not be required to remedy any already existing deficiencies in the existing system.

The project proposes more than 5,000 SF of pollution-generating hard surface (PGIS), is not a commercial or industrial site, and does not discharge to a wetland or phosphorous sensitive receiving waters. Per Figure 2.3 of the 2019 SWMMEW, basic water quality treatment is required. Refer to the flow charts for determining stormwater requirements in accordance with the 2019 SWMMEW on the following pages.

Figure 2.1: Flow Chart for Determining Applicable Core Elements for New Development Projects

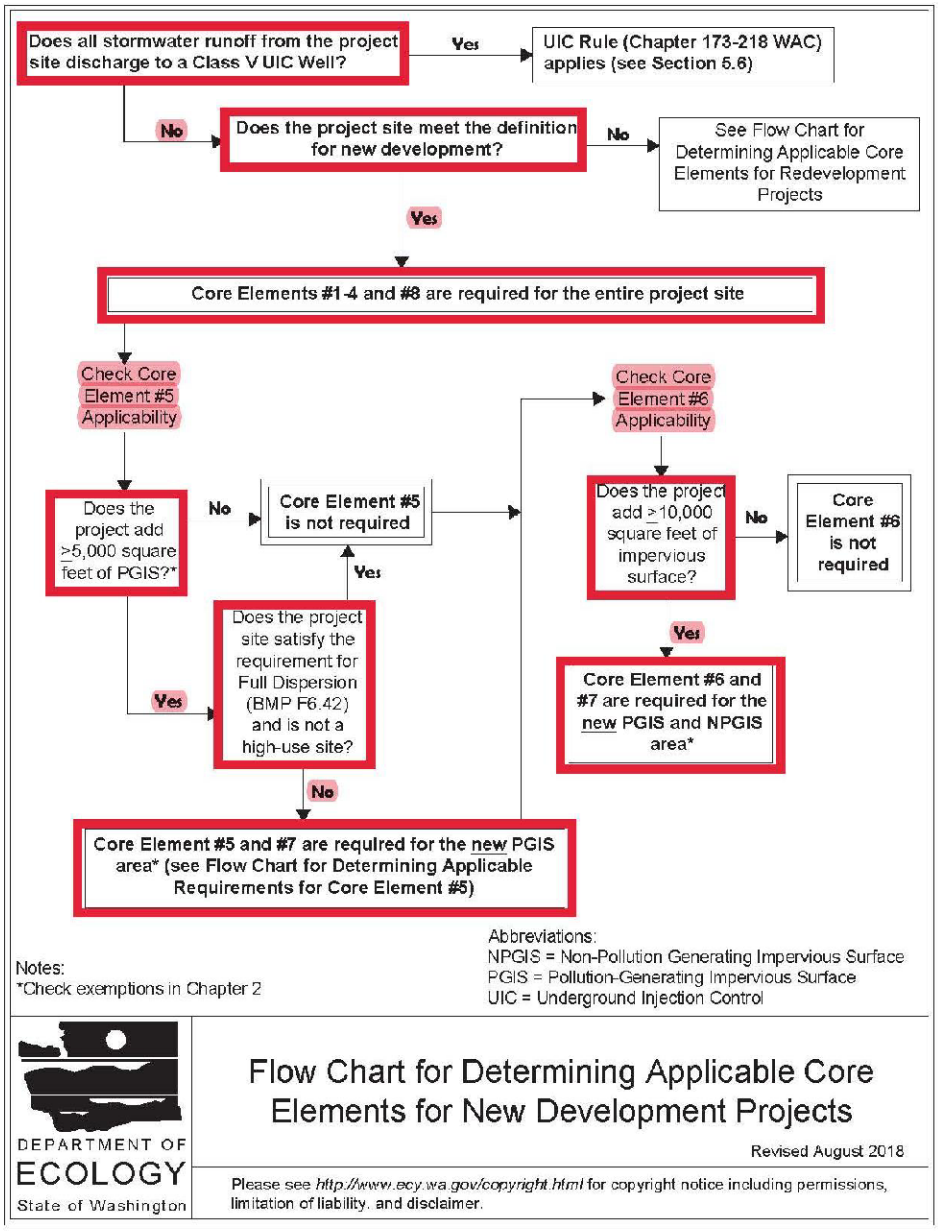
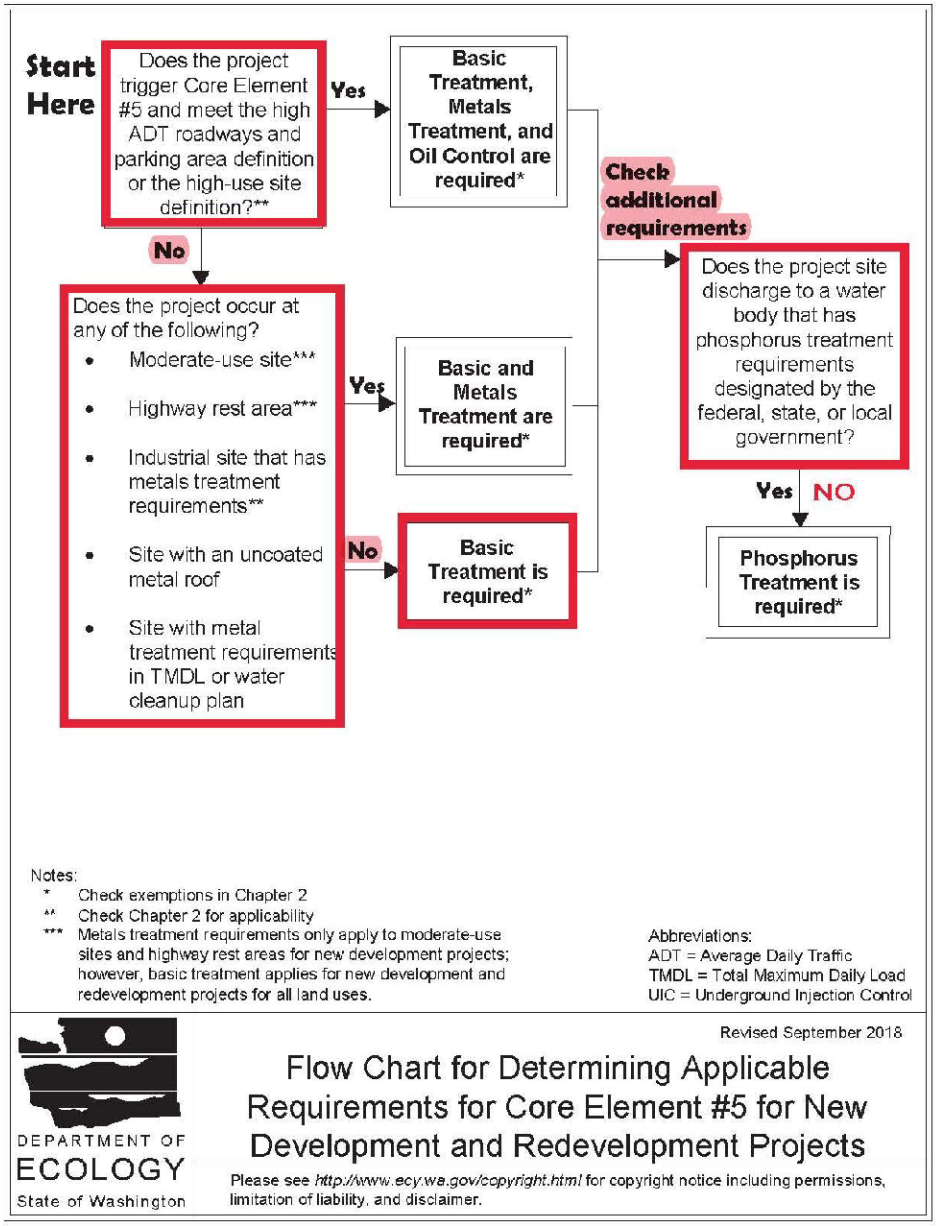


Figure 2.3: Flow Chart for Determining Applicable Requirements for Core Element #5 for New Development and Redevelopment Projects



2019 Stormwater Management Manual for Eastern Washington

Chapter 2 - Page 90

Section 2 Existing Conditions

The City Heights project is located in Cle Elum, Washington. The Site generally consists of topographic conditions ranging from nearly flat/gently sloping to relatively steeply sloped ground with multiple topographic drainage features. Per the Geotechnical Engineering Report prepared by Terra Associates, Inc dated June 9, 2020 onsite soils consist of weathered siltstone/sandstone with areas of fill soils east of Summit View Road. West of Summit view consists of silty sand/ gravel/silt with areas fill soils containing coal waste. See Geotechnical Report submitted under separate cover for more information.

The majority of the site is a forested, undeveloped land with existing bike trails within and near the proposed project site – Phase 1. Summit View Road is an existing road that serves as an access road to existing residential lots north of the City Heights development. Runoff generally sheets flow southwest to an existing onsite stream (Stream C) and the remainder of the Phase 1 areas sheet flow southeast towards a ditch along 6th Street. There are existing culverts located within the project site.

The existing site contains two drainage basins: Crystal Creek 5, tributary to an existing roadside ditch and Crystal Creek 3, tributary to Stream C. There is an existing gully created by a seasonal stream that crosses Summit View Road. Stream C acts as the natural basin divide. Phase 1 areas that drain to Stream C are associated with Crystal Creek 3. Remaining Phase 1 areas are associated with Crystal Creek 5.

An upstream area of 3.89 acres sheets flows towards Crystal Creek 5. This area will remain undeveloped and undetained. In the developed condition, this area will be collected via shallow swale and will bypass the detention/water quality facilities and, as such, are not included in the analysis. An upstream area of 2.17 acres sheets flows towards Crystal Creek 3. This area will remain undeveloped. This area will be routed through the detention/water quality facilities and, as such, is included in the analysis.

Crystal Creek 4 represents the area north of Crystal Creek 3 that will be developed as part of a future phase. These areas will be routed away from the detention/water quality facilities associated with Phase 1 and, as such, are not included in the analysis. Please note Pond B7-B and its associated future development (Pod B2-B6) will be submitted under a separate permit.

EXISTING CONDITIONS EXHIBIT

LEGEND

CRYSTAL CREEK 5 BASIN	13.19 AC
CRYSTAL CREEK 3 BASIN	8.60 AC
CRYSTAL CREEK 4 BASIN, PART OF FUTURE PHASE, SHOWN FOR REFERENCE ONLY	66.88 AC

N

SCALE: 1" = 400'
0 100 200 400

SHEET FLOW ARROW

CITY HEIGHTS PROPERTY BOUNDARY

AREA TRIBUTARY TO STREAM C/ WETLAND C THAT WILL BE ROUTED TO A DISPERSION TRENCH IN DEVELOPED CONDITIONS (0.21 ACRES)

STREAM C TYPE 4 25' BUFFER

FUTURE PHASE 2

PHASE 1 BOUNDARY

WETLAND C CATEGORY 2

PHASE 1

Tc

CRYSTAL CREEK 4 FUTURE PHASE 2 (23.10 ACRES)

CRYSTAL CREEK

PINE ST

100' BUFFER

UNDEVELOPED AREA UPSTREAM OF CRYSTAL CREEK 4 BASIN (3.89 ACRES) TO BE ROUTED AROUND VAULT C IN DEVELOPED CONDITION

UNDEVELOPED AREA UPSTREAM TO CRYSTAL CREEK 3 BASIN TO BE ROUTED THROUGH POND B7-A IN DEVELOPED CONDITION (2.17 ACRES)

DENNY AVE

MARIAN DR

WA ROUTE 903

CRYSTAL CREEK 3 BASIN (6.43 ACRES)

25' BUFFER

STREAM C TYPE 4

PHASE 1

Tc

6TH ST

18" CONCRETE CULVERT

18" CONCRETE CULVERT

E 6TH ST

E 5TH ST

STAFFORD ST

OPEN DITCH ALONG 6TH ST TO CULVERT

UNDEVELOPED AREA TRIBUTARY TO STREAM/WETLAND, NOT INCLUDED IN ANALYSIS

CRYSTAL CREEK 4 BASIN FUTURE PHASE 2 (1.96 ACRES)

CRYSTAL CREEK 5 BASIN (9.30 ACRES)

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EXISTING CONDITIONS EXHIBIT
CITY HEIGHTS
FINAL DRAINAGE REPORT

SCALE	AS NOTED
PROJECT MANAGER	BRETT PUDISTS, PE
DESIGNED BY	MICHELLE ROBERGE, PE
DRAWN BY	MICHELLE ROBERGE
PLOT DATE	January 6, 2021

JOB NUMBER: 19-349

FIGURE: EC

Jan 06, 2021 - 11:19am - User mroberge
E:\Projects\19349\Dwg\Prelim\Site - West\Exhibits\19349 EC.dwg

Section 3 Developed Conditions

The proposed development includes the creation of 68 residential lots (60 single-family detached lots and 8 lots to accommodate single-family attached duplexes) with associated utilities, stormwater detention and water quality facilities, access roadways and supporting utilities/infrastructure. Water quality and flow control improvements are described in Section 6 of this report.

Crystal Creek 5 (Vault C)

Crystal Creek 5 is the portion of Phase 1 development located north of 6th Street. A detention vault (Vault C) is proposed to serve 40 lots (32 single-family and 4 duplexes). Stormwater within Crystal Creek 5 will be collected by catch basins and area drains and conveyed via tightline conveyance to Vault C. Vault C is sized to maintain the stream protection flows as defined by the 2019 SWMMEW. Stormwater will discharge from the detention vault and be conveyed eastward to a proposed public tightline system along the 6th Street before outleting to an existing roadside ditch.

Onsite stormwater will be treated using a biofiltration swale, which is sized to treat the full water quality volume as calculated by Hydraflow software. Please refer to Section 6 for the detention sizing and the water quality selection for the project.

An upstream area of 3.89 acres sheets flows towards Crystal Creek 5. This area will remain undeveloped and undetained. In the developed condition, this area will be collected via shallow swale and will bypass the detention/water quality facilities and, as such, are not included in the analysis.

Crystal Creek 3 (Pond B7-A)

Crystal Creek 3 is the portion of Phase 1 development tributary to Stream C. A detention pond (Pond B7-A) is proposed to serve 28 single-family lots. Stormwater within Crystal Creek 3 will be collected by catch basins and area drains and conveyed via biofiltration swale and tightline conveyance to Pond B7-A. The stormwater detention pond is sized to maintain the stream protection flows as defined by the 2019 SWMMEW. Stormwater will discharge from the detention pond and be conveyed westwards to a proposed tightline system before outleting via dispersion trench and bubble-up structure to Stream C.

Onsite stormwater will be treated using a biofiltration swale, which is sized to treat the full water quality volume as calculated by Hydraflow software. Please refer to Section 6 for the detention sizing and the water quality selection for the project.

An upstream area of 2.17 acres sheets flows towards Crystal Creek 3. This area will remain undeveloped. This area will be routed through the detention/water quality facilities and, as such, is included in the analysis.

Crystal Creek 4 represents the area north of Crystal Creek 3 that will be developed as part of a future phase. These areas will be routed away from the detention/water quality facilities associated with Phase 1 and, as such, are not included in the analysis. Please note Pond B7-B and its associated future development (Pod B2-B6) will be submitted under a separate permit.

DEVELOPED CONDITIONS EXHIBIT

LEGEND

	ONSITE UNDEVELOPED AND UNDETAINED	3.89 AC
	VAULT C BASIN (POD C)	9.30 AC
	FUTURE PHASE 2 (POD B2–B6) UNDEVELOPED & UNDETAINED, SHOWN FOR REFERENCE ONLY	66.88 AC
	ONSITE UNDEVELOPED TRIBUTARY TO POND B7–A (BYPASS)	2.17 AC
	POND B7–A BASIN (POD B7)	6.43 AC

N

SCALE: 1" = 400'
0 100 200 400

SHEET FLOW ARROW
CITY HEIGHTS PROPERTY BOUNDARY
WETLAND B CATEGORY 2
AREA ROUTED TO A DISPERSION TRENCH FOR FULL DISPERSION IN PHASE 1 (0.21 ACRES)
STREAM C TYPE 4
25' BUFFER
FUTURE PHASE 2
WETLAND C CATEGORY 2
PHASE 1 BOUNDARY
PHASE 1
POND B7–A
Tc
CRYSTAL CREEK 4 FUTURE PHASE 2 POND BASIN B7–B (23.10 ACRES)
PINE ST
SWALE TO DIRECT UPSTREAM FLOWS AWAY FROM POND B7–A
100' BUFFER
UNDEVELOPED AREA UPSTREAM OF CRYSTAL CREEK 4 BASIN (3.89 ACRES) TO BE ROUTED AROUND VAULT C
POND B7–A UNDEVELOPED UPSTREAM BASIN (2.17 ACRES) TO BE ROUTED THROUGH POND B7–A
DENNY AVE
POND B7 BASIN (6.43 ACRES)
25' BUFFER
BIOFILTRATION SWALE
STREAM C TYPE 4
PHASE 1
Tc
MARIAN DR
UNDEVELOPED AREA TRIBUTARY TO STREAM/WETLAND AND NOT MODELED AS UPSTREAM
6TH ST
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E 6TH ST
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PROJECT MANAGER	BRETT PUDISTS, PE
DESIGNED BY	CHRIS WISCOMB
DRAWN BY	MICHELLE ROBERGE, PE
PLOT DATE	January 6, 2021

JOB NUMBER: 19–349

FIGURE: DC

Section 4 Off Site Analysis

Phase 1 of the City Heights development consists of two drainage basins. As part of the EIS process, an offsite analysis for the entire City Heights development was prepared by Encompass Engineering & Surveying. An additional offsite analysis prepared by Barghausen Consulting Engineers, Inc. addresses the downstream system for the City Heights development. Refer to excerpts from the *Grading, Drainage and Utilities Engineering Report* that was prepared by Encompass Engineering & Surveying, dated March 24,2010 and the *Downstream Drainage Analysis* prepared by Barghausen Consulting Engineers, Inc., dated February 25, 2011 at the end of this section. A supplemental field investigation was conducted by Blueline on Friday, April 24, 2020 to confirm the findings in these reports.

The following is a summary of the findings from the information used in preparing this report for Phase 1 (Pod B7 & C). Refer to the *Geotechnical Engineering Report and Geologic Hazard Assessment* prepared by Terra Associates, Inc. dated June 9,2020, *Wetlands and Wildlife Habitat Report* prepared by Sewall Wetland Consulting, Inc. dated October 26, 2009, and *Impacts Analysis* prepared by Sewall Wetland Consulting, Inc. dated June 16, 2020 submitted under separate cover.

- The site is located within the Upper Yakima Watershed (DOE Mapping).
- Soils consist of weathered siltstone/sandstone with areas of fill soils east of Summit View Road and silty sand/gravel/silt with areas fill soils containing coal waste west of Summit View Road. See Geotechnical Report submitted under separate cover.
- The site contains two drainage basins that ultimately drain to the Yakima River (see downstream Exhibit at end of this section).
- The site contains onsite wetlands and streams per report by Sewall Wetland Consulting, Inc dated October 26, 2009. (Refer to report submitted under separate cover for Sewall Map Figure 3.4-2).
- The site is not located within a floodplain (FEMA Flood Maps).
- The site is mapped within a critical aquifer recharge area with moderate risk of contamination (City of Cle Elum).
- The site contains slopes up to 65% in the waste rock pile area per geologic hazard assessment, Section 4.2 of Geotechnical Report by Terra Associates, Inc. See Geotechnical Report submitted under separate cover.
- For Erosion Hazard Area, refer to Section 4.6 and 4.7 of Geotechnical Report by Terra Associates, Inc. See Geotechnical Report submitted under separate cover. There is a 10’ high, 15’ wide gully formed by a seasonal stream that crosses Summit View Road.
- For geologic hazard assessment, refer to Section 4.3 of Geotechnical Report by Terra Associates, Inc. See Geotechnical Report submitted under separate cover. Shallow slope failures observed along Summit View Road.
- For Seismic Assessment refer to Section 4.1.4 of Geotechnical Report by Terra Associates, Inc. See Geotechnical Report submitted under separate cover. The coal waste pile of development is classified as Class Site E per IBC.
- For Liquefication Assessment refer to Section 4.1.3 of Geotechnical Report by Terra Associates, Inc. See Geotechnical Report submitted under separate cover. The potential for liquefaction is low.
- Sedimentation accumulation in the conveyance system downstream was observed during the supplemental field investigation conducted by Blueline on April 24, 2020. Per the DA, the project will not be required to remedy any already existing deficiencies in the existing system. Sediment removal is likely to occur as part of regular City maintenance.

4.1 UPSTREAM CONDITIONS

An upstream area of 3.89 acres sheets flows towards Crystal Creek 5. This area will remain undeveloped and undetained. In the developed condition, this area will be collected via shallow swale and will bypass the detention/water quality facilities and, as such, are not included in the analysis. An upstream area of 2.17 acres sheets flows towards Crystal Creek 3. This area will remain undeveloped. This area will be routed through the detention/water quality facilities and, as such, is included in the analysis.

Crystal Creek 4 represents the area north of Crystal Creek 3 that will be developed as part of a future phase. These areas will be routed away from the detention/water quality facilities associated with Phase 1 and, as such, are not included in the analysis. Please note Pond B7-B and its associated future development (Pod B2-B6) will be submitted under a separate permit.

4.2 DOWNSTREAM ANALYSIS

EXISTING DRAINAGE SYSTEM

Phase 1 of the City Heights development consists of two drainage basins. As part of the EIS process, an offsite analysis for the entire City Heights development was prepared by Encompass Engineering & Surveying. An additional offsite analysis prepared by Barghausen Consulting Engineers, Inc. addresses the downstream system for the City Heights development. Refer to excerpts from the *Grading, Drainage and Utilities Engineering Report* that was prepared by Encompass Engineering & Surveying, dated March 24,2010 and the *Downstream Drainage Analysis* prepared by Barghausen Consulting Engineers, Inc., dated February 25, 2011 at the end of this section. A supplemental field investigation was conducted by Blueline to confirm the findings in these reports.

A supplemental field investigation was conducted by Blueline on Friday, April 24, 2020, an overcast day and temperatures around 55°F. Downstream Photographs and a corresponding Downstream Drainage Exhibit are included at the end of this section.

EXISTING DOWNSTREAM DRAINAGE PATH

Crystal Creek 3

The Crystal Creek 3 basin generally sheet flows southeast toward an existing onsite stream (Stream C). The stream continues to flow southwest. The stream continues onto private property and could not be seen from public right-of-way. It is assumed the downstream path continues per prior reports completed by Encompass Engineering & Surveying and Barghausen. See the excerpted pages of downstream reports at the end of this section. Stream C is ultimately tributary to Crystal Creek.

Crystal Creek 5

The Crystal Creek 5 basin generally sheet flows south toward 6th Street. Runoff enters an existing ditch along 6th street and outlets to an existing roadside ditch. Flow continues south/southeast across private property and could not be seen from public right-of-way. It is assumed the downstream path continues per prior reports completed by Encompass Engineering & Surveying and Barghausen. See the excerpted pages of downstream reports at the end of this section. The existing roadside ditch is ultimately tributary to Crystal Creek.

Refer to the *Downstream Drainage Exhibit* at the end of this section.

DEVELOPED CONDITIONS EXHIBIT

LEGEND

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N

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0 100 200 400

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FUTURE PHASE 2
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PHASE 1
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PROJECT MANAGER	BRETT PUDISTS, PE
DESIGNED BY	CHRIS WISCOMB
DRAWN BY	MICHELLE ROBERGE, PE
PLOT DATE	January 6, 2021

JOB NUMBER: 19–349

FIGURE: DC

DOWNSTREAM DRAINAGE PHOTOGRAPHS

Note: See the *Downstream Drainage Exhibit* for numbered locations of pictures.

Crystal Creek 5:

Photo 1 – Facing east. Runoff sheet flows west towards culvert under 6th St.

Photo 2 – Facing west. Runoff sheet flows west towards culvert under 6th St.

Photo 3 – Facing north. 18 RCP" culvert crossing 6th St.

Photo 4 – Facing north. 18 RCP" culvert crossing 6th St.

Photo 5– Facing southwest. Runoff flows out of 18" RCP culvert to flat bottom creek, heavily vegetated.

Photo 6 – Facing east. Runoff continues to flow along flat bottom creek, heavily vegetated.

Crystal Creek 3:

Photo 1 – Facing northeast. East of Summit View Drive.

Photo 2 – Facing northeast. East of Summit View Drive. Runoff flows into 48" HDPE culvert

Photo 3 – Facing southwest. West of Summit View Drive. Runoff flows out of 48" HDPE culvert (Crystal Creek 3 Basin 3).

Photo 4 – Facing southwest. Runoff continues to flow through gully.

Grading, Drainage and Utilities Engineering Report **that was prepared by Encompass Engineering & Surveying, dated March 24,2010**

CITY HEIGHTS, CLE ELUM

GRADING, DRAINAGE, AND UTILITIES TECHNICAL ENGINEERING REPORT

March 24, 2010

Encompass
ENGINEERING & SURVEYING
108 East 2nd Street
Cle Elum, WA 98922
Tel. 509.674.7433
Fax. 509.674.7419

3. STORM DRAINAGE

This section describes alternatives for the management and mitigation of stormwater generated within the City Heights Planned Mixed-Use Development, both during construction and in the developed condition of the project.

3.1 Pre-Development Condition

This section describes existing project site drainage conditions based on different existing features that impact stormwater runoff. A preliminary downstream analysis of the project site has been performed, and the results are presented below. The bulleted items that follow are descriptions of the downstream path to the Yakima River from the City Heights site:

- West Basin is the western most downstream basin that drains directly into Crystal Creek
- Summit View Basin begins at Summit View Road and heads southwest across private property and into Crystal Creek
- Sixth Street Basin begins on Sixth Street near the City of Cle Elum water tanks and heads west, then south and into Crystal Creek
- Peoh Basin begins at the north end of Peoh Street and heads south into the City's 2nd Street stormwater conveyance system
- Montgomery Basin begins at Montgomery Avenue and heads southeast across private lands and into the City's 2nd Street stormwater conveyance system
- Columbia Basin begins at the extension of Columbia Avenue (also known as Creekside Road) and heads south into the City's 2nd Street stormwater conveyance system.

Detailed descriptions of each downstream basin from the City Height's property to the Yakima River are provided in the Downstream Drainage System maps (Figures 3.1A and 3.1B, and the Off-Site Drainage System Analysis Tables in Appendix B). Crystal Creek is identified as Category 4A Water just north (upstream) of the most western end of the City Heights project site, based on the Department of Ecology Water Quality Assessment [303(d) list] for Washington. DOE studies have determined that pollutants such as fecal coliform, dissolved oxygen, chlorine, and ammonia are present in the water. DOE has therefore issued, and Environmental Protection Agency (EPA) has approved, Total Maximum Daily Load (TMDL) criteria for Crystal Creek. See Appendix B for more information on 303(d) list and TMDL criteria. Based on the design criteria and mitigation measures for stormwater and sewer, the proposed City Heights project will not adversely affect the existing water quality of Crystal Creek.

3.1.1 Project Watershed

The City Heights site is located in the northwest quadrant of the Upper Yakima River Watershed. The Upper Yakima River watershed, which is a part of the greater Yakima River watershed, drains an area 2,139 square miles in size. Elevations range from about 7,000 feet above sea level at the crest of the Cascade Mountains to about 1,000 feet above sea level at the confluence of the Yakima and Naches Rivers. This confluence also forms the upper boundary of the Lower Yakima River watershed. This watershed contains some of the most intensively irrigated lands in the United States. The Upper Yakima River watershed is predominantly forested (1,153 square miles) in its higher elevations, and contains 85,000 acres

of irrigated agriculture in its lower elevations. The majority of irrigated acreage drains to the tributaries of Wilson Creek, Manastash Creek, and Sorenson Creek. Below the outlet of the Lake Keechelus dam, the main tributaries to the Upper Yakima River are the Kachess River, Cle Elum River, and Teanaway River. There are many other smaller tributaries to the upper Yakima River.

3.1.2 Project Sub-Basin

There are no known basin studies produced for the watershed that includes the City Heights site. For the purpose of this report, the sub-basin for the proposed City Heights Planned Mixed-Use Development has been delineated based on USGS maps and other available information. The project site is within the sub-basin located on the north side of the City of Cle Elum, encompassing an area from the Town of Roslyn on the west, Cottage Avenue in the City of Cle Elum on the east, the top of Cle Elum Ridge on the north, 3rd Street and SR-903 within the City of Cle Elum on the south. This sub-basin is approximately 470 acres in size. Crystal Creek, multiple unnamed seasonal streams, and the City of Cle Elum stormwater management system are the principal surface water features within the sub-basin that includes the project site.

3.1.3 Site-Specific Drainage Basins

Based on preliminary findings, the majority of the City Heights property hydrology is split between four significant drainage basins. These basins directly affect Crystal Creek, several other seasonal streams, and irrigation ditches. These basins are strongly influenced by snow melt and recharge over the upland areas, including on the City Heights property. Encompass Engineering & Surveying (Encompass) analyzed the aerial topographic map prepared by Degross Aerial Mapping, Inc. (2009), and delineated five separate site-specific drainage basins. These areas are shown in Appendix C. The level of detail utilized for the delineation of the site-specific basins is appropriate for the preliminary storm drainage calculation and analysis for the entire project site. A more detailed analysis of the drainage basins is recommended for the construction design. The site-specific drainage basin descriptions are as follows:

Basin A:
Drainage Basin A is located in the western-most area of the project site, and consists of 822.91 acres of forest land, underlain with ashy and Teanaway loam soils. Only 84.64 acres of this basin is considered in the analysis, as the rest of the area will be by-passed via existing drainage routes. The analyzed area is located in the southern-most portion of the Drainage Basin A, closest to the City of Cle Elum, and limited to the proposed City Heights Planned Mixed-Use Development. Run-off from this basin contributes to the headwaters of Crystal Creek to the southwest.

Basin B:
Drainage Basin B is located east of Drainage Basin A, and consists of 379.44 acres of mixed forest land and pasture, with forest land being the predominant factor. Similar to Drainage Basin A, Drainage Basin B is underlain with ashy and Teanaway loam soils. Only 57.53 acres of this basin is considered in the analysis, as the rest of the area will be by-passed via existing drainage routes. The analyzed area is located in the southern-most portion of Drainage Basin B, closest to the City of Cle Elum, and limited to the proposed City Heights Planned Mixed-Use Development. Run-off from this basin enters the City of Cle Elum storm drainage system to the south.

Basin C:
Drainage Basin C is located east of Drainage Basin B, and consists of 1,174.10 acres of mixed forest land and pasture, with forest land being the predominant factor. Similar to Drainage Basins A and B, Drainage Basin C is underlain with ashy and Teanaway loam soils. Only 179.76 acres of this basin is considered in the analysis, as the rest of the area will be by-passed via existing drainage routes. The analyzed area is located in the southern-most portion of Drainage Basin C, closest to the City of Cle Elum, and limited to the proposed City Heights Planned Mixed-Use Development. Run-off from this basin enters the City of Cle Elum storm drainage system to the south.

Basin D:
Drainage Basin D is located east of Drainage Basin C, and consists of 317.75 acres of mixed forest land and pasture, with pasture being the predominant factor. Drainage Basin D is underlain with Teanaway loam soils. Only 29.78 acres of this basin is considered in the analysis, as the rest of the area will be by-passed via existing drainage routes. The analyzed area is located in the southern-most portion of Drainage Basin C, closest to the City of Cle Elum, and is limited to the proposed City Heights Planned Mixed-Use Development. Run-off from this basin enters the City of Cle Elum storm drainage system to the south.

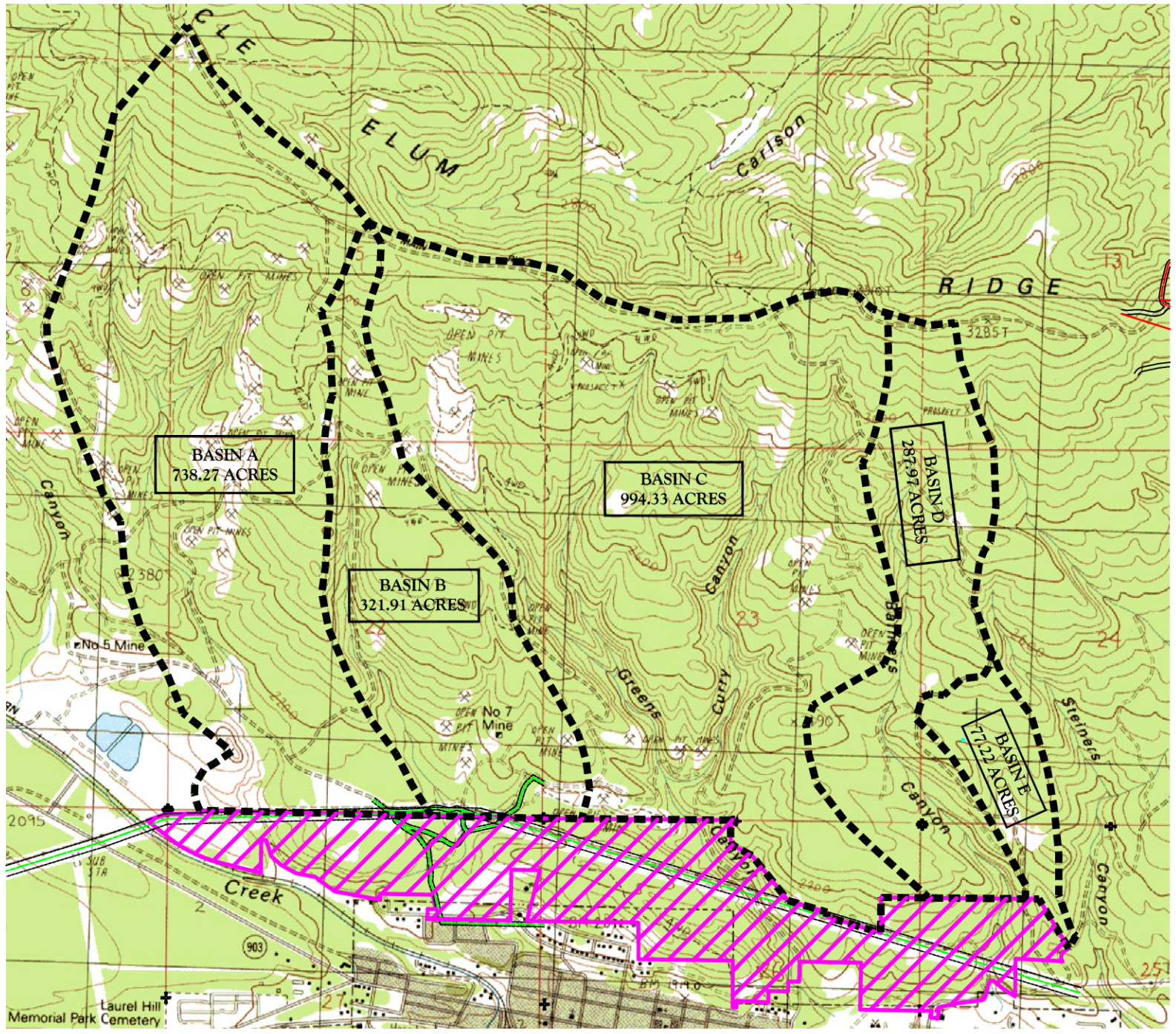
Basin E:
Drainage Basin D is located east of the southeast portion of Drainage Basin D, and consists of 83.51 acres of pasture land. Similar to Drainage Basin D, Drainage Basin E is underlain with Teanaway loam soils. Only 6.29 acres of this basin is considered in the analysis, as the rest of the area will be by-passed via existing routes patterns. The analyzed area is located in the southern-most portion of Drainage Basin C, closest to the City of Cle Elum, and is limited to the proposed City Heights Planned Mixed-Use Development. Run-off from this basin enters the City of Cle Elum storm drainage system to the south.

As it can be seen in the above descriptions, large portions of each site-specific basin are located upstream of the proposed City Heights project site. These upstream basins are not considered in the hydrologic analysis, and they will be by-passed via existing drainage routes that dissect the project site. On the overall scale, the upstream basins discharge directly to these existing drainage routes. Only small portions of the upstream basins, located along the northern property line, may sheet flow onto the project site. These amounts would not adversely affect the intent of this analysis and could be either included in the final storm drainage calculations/analysis or by-passed via proposed rock-lined swales along the northern propserty line.

3.1.4 Hydrologic Characteristics

Runoff modeling for the proposed City Heights Planned Mixed-Use Development was done using the Santa Barbara Urban Hydrograph method version 4.21B accepted by the Department of Ecology (Ecology) as a proper simulation modeling program. As required by Ecology's 2004 *Stormwater Management Manual for Eastern Washington* (SWMMEW), the run-off analysis is performed for the 2-year and 25-year events. Due to existing flooding issues downstream of the project site, the 100-year storm event was also analyzed. The average annual precipitation in the site area for the 24-hour duration is 2 inches for the 2-year storm, 3.5 inches for the 25-year storm, and 4.75 inches for the 100-year storm events based on Ecology's Isopluvial Maps for Eastern Washington. In order to account for the rain-on-snow event, a water equivalent value is calculated based on the average daily snow depth for Cle Elum and 20 percent moisture content, which is added to the average annual precipitation for each storm event. The water

Figure 3.2 – Upstream Storm Basin Map



N

Legend

Upstream Storm Basin Boundary

Project Site

Figure 3.2
Upstream Storm Basin Map

November 23, 2009

Scale: 1" = 2000'

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APPENDIX B

Off-Site Drainage System / Downstream Analysis

OFF-SITE ANALYSIS DRAINAGE SYSTEM TABLE SURFACE WATER DESIGN MANUAL, CORE REQUIREMENT #2						
	Basin:West		**Sub.**		**Sub. Number:**	
Symbol	**Drainage, Component Type, Name and Size**	**Drainage Component Description**	**Slope**	**Distance from site discharge**	**Existing Problems/Potential Problems**	**Oberservations of field inspector, resource reviewer, or resident**
see map	Type: Sheet flow, swale, stream, channel, pipe, pond: Size: diameter, surface area	Dranage basin, vegetation, cover, depth, type of sensitive area, volume	%	1/4 ml = 1,320 ft.	Constrictions, under capacity, ponding, overtopping, flooding, habitat or organism destruction, scouring, bank sloughing, sedimentation, incision, other erosion	Tributary area, likelihood of problem overflow pathways, potential impacts
A	6-ft bottom	Abundant natural veg.	2%	0'		
B	4-ft bottom	Abundant natural veg.	2%	10°-150°	Some erosion & ponding from narrowing channel above	
	4-ft bottom	Abundant natural veg.	2%	200'-400'	Naturally flowing	
C	6-ft bottom	Abundant natural veg.	2%	400'	Crk hits coal mine eroding fill @ bend in crk. Crk then follows N. edge of trail	
	5-ft bottom	Abundant natural veg.	2%-3%	400'-700'	Naturally flowing	
D		Crystal Crk. Crosses trail @NE corner Cle Elum Pines		700'	Joins streams	
	7-ft bottom	Abundant natural veg.	3%	700'-850'		
E	8-ft bottom		3%	850'	Stream bends into fill for coal mine trail	Sloughing & erosion of fill
	6-ft bottom		3%	850'-950'	Naturally flowing	
F	8-ft bottom		3%	950'	Sloughing & erosion on edge trail	
	6-ft bottom			950'-1100'	Naturally flowing	
G		No evidence of flooding		1100"	Boulder in crk for riprap (recent)	
H		Some erosion of fill on trail		1200'-1250'	Boulder in crk for riprap (recent)	
	6-ft bottom	Abundant natural veg.	3%+	1250'-1450'	Naturally flowing	
I		Concrete Bridge w/5' cmp. CMP caved in some in center trail	3%	1450'	Flows under coal mine trail	

OFF-SITE ANALYSIS DRAINAGE SYSTEM TABLE SURFACE WATER DESIGN MANUAL, CORE REQUIREMENT #2						
	Basin:West		**Sub.**		**Sub. Number:**	
Symbol	**Drainage, Component Type, Name and Size**	**Drainage Component Description**	**Slope**	**Distance from site discharge**	**Existing Problems/Potential Problems**	**Oberservations of field inspector, resource reviewer, or resident**
see map	Type: Sheet flow, swale, stream, channel, pipe, pond: Size: diameter, surface area	Dranage basin, vegetation, cover, depth, type of sensitive area, volume	%	1/4 ml = 1,320 ft.	Constrictions, under capacity, ponding, overtopping, flooding, habitat or organism destruction, scouring, bank sloughing, sedimentation, incision, other erosion	Tributary area, likelihood of problem overflow pathways, potential impacts
I cont.		Riprap on corner 30' below bridge no evidence of erosion		1475'		
	8-ft bottom swale	Abundent Nat. Veg.	3%-4%	1475'-1600'	Naturally flowing	
J	10-ft bottom swale	Abundent Nat. Veg.	3%-4%	1600'	Bend in crk. Erosion of bank, underwelling outside bend	Trees & Debris Jams
	5-ft bottom swale	Abundent Nat. Veg.	3%-4%	1600'-1750'	Naturally flowing	
K	5-ft bottom swale	Abundent Nat. Veg.	3%-4&	1750'-1850'	Naturally flowing	Minor erosion S bank flooding N gradual slope
	5-ft bottom swale	Abundent Nat. Veg.		1850'-2000'	Naturally flowing	
L	6-ft bottom swale	Abundent Nat. Veg.	3%-4%	2000'-2100'	Flood canal to N	Evident flooding man made burm S.
M	6-ft bottom swale	Abundent Nat. Veg.	3%-4%	2200'	Eroding N bank under mining	
			3%-4%	2200'-2450'	Naturally flowing, minor erosion, evidence flooding	
N		Bridge Across Driveway	3%-4%	2450'		No obstructions
O				2475'	18" iron pipe exposed x-ing crk	
P	Bridge crossing 2nd St.	20-ft concrete deck	2500'			No obstructions
	7-ft bottom swale	Abundent Nat. Veg.	2%-3%	2525%-2700%	Naturally flowing	
Q	Wood bridge deck	15-ft wood deck	2%	2700'	Naturally flowing	No obstructions
		Natural veg.	2%	2700'-2900'	Flowing w/ minor ponding, some erosion riprap & obstructions	Veg. in stream

OFF-SITE ANALYSIS DRAINAGE SYSTEM TABLE SURFACE WATER DESIGN MANUAL, CORE REQUIREMENT #2

	Basin:West		**Sub.**		**Sub. Number:**	
Symbol	**Drainage, Component Type, Name and Size**	**Drainage Component Description**	**Slope**	**Distance from site discharge**	**Existing Problems/Potential Problems**	**Oberservations of field inspector, resource reviewer, or resident**
see map	Type: Sheet flow, swale, stream, channel, pipe, pond: Size: diameter, surface area	Dranage basin, vegetation, cover, depth, type of sensitive area, volume	%	1/4 ml = 1,320 ft.	Constrictions, under capacity, ponding, overtopping, flooding, habitat or organism destruction, scouring, bank sloughing, sedimentation, incision, other erosion	Tributary area, likelihood of problem overflow pathways, potential impacts
R	**Conc. Bridge x-ing 1st**	**20-ft concrete deck**		**2900"**	**Grass & Debris up stream causing ponding. Gravel & Debris under Bridge restriction flow**	
S	**Wooden walk bridge**			**2950"**		**Severe erosion on dirt bank supporting bridge**
	7-ft bottom swale	**Abundent veg. w/ some debris in flow**	**2%**	**3000'-3000'**	**Flowing with minor obstructions**	
T	**Wood deck bridge in alley**	**Debris & sed. Restricting flow (minor)**	**1%-2%**	**3200'**		
	8-ft bottom swale	**Abundent veg.**	**2%**	**3200'-3350'**	**Flowing with minor debris obstructions**	
	10-ft bottom swale	**Vegetated w/ minor debris in crk**	**1%**	**3350'-4300'**	**Some slack water & ponding debris jam 75' upstream bridge restricting flow**	**No erosion restricting flow**
	Conc. bridge x-ing S. Cle Elum way		**1%**	**4300'**		
U					**Slack water under bridge & downstream alder cluster up hill bridge no other obstructions**	
					18' cmp plastic corr.	
					Down side bridge heads west across into area w/ponding water & possible plugged culvert	
	12-ft bottom swale	**Vegetated slack water**		**4300'-4500'**	**No obstructions**	

OFF-SITE ANALYSIS DRAINAGE SYSTEM TABLE SURFACE WATER DESIGN MANUAL, CORE REQUIREMENT #2						
	Basin:West		**Sub.**		**Sub. Number:**	
Symbol	**Drainage, Component Type, Name and Size**	**Drainage Component Description**	**Slope**	**Distance from site discharge**	**Existing Problems/Potential Problems**	**Oberservations of field inspector, resource reviewer, or resident**
see map	Type: Sheet flow, swale, stream, channel, pipe, pond: Size: diameter, surface area	Dranage basin, vegetation, cover, depth, type of sensitive area, volume	%	1/4 ml = 1,320 ft.	Constrictions, under capacity, ponding, overtopping, flooding, habitat or organism destruction, scouring, bank sloughing, sedimentation, incision, other erosion	Tributary area, likelihood of problem overflow pathways, potential impacts
V	**Bridge x-ing under RR tracks**	**10-ft x 7-ft concrete**		**4500'**	**No obstructions**	
					Slack water	
					***All stack water back to 4000 dist. From site appears to be caused by high water flows in Yakima River**	
	Final destination the flooding Yakima River			**4700'**		

OFF-SITE ANALYSIS DRAINAGE SYSTEM TABLE SURFACE WATER DESIGN MANUAL, CORE REQUIREMENT #2

Basin:Summit View			Sub.		Sub. Number:	
Symbol	Drainage, Component Type, Name and Size	Drainage Component Description	Slope	Distance from site discharge	Existing Problems/Potential Problems	Oberservations of field inspector, resource reviewer, or resident
see map	Type: Sheet flow, swale, stream, channel, pipe, pond: Size: diameter, surface area	Dranage basin, vegetation, cover, depth, type of sensitive area, volume	%	1/4 ml = 1,320 ft.	Constrictions, under capacity, ponding, overtopping, flooding, habitat or organism destruction, scouring, bank sloughing, sedimentation, incision, other erosion	Tributary area, likelihood of problem overflow pathways, potential impacts
A	48" plastic culvert	Unobstructed	2%	0'		
	Swale - 10t wide bottom	Natural Veg.	3%	0'-100'	Flat bottom crk. Swale some debris not disrupting flow	
B	Old bridge x-ing			100'	Some debris, bridge & debris restrict flow another drainage enters uphill side bridge bearing NNW	
C	Stream - V-shape w/1:1 bank slopes	Natural veg. w/fallen trees & dirt in creek bottom	4%-5%	100'-350'	Mass erosion under cut banks. Steep enough gradient that debris does not restrict flow	
D	Sheet flow - 20-ft wide	Natural veg. w/quanity of new gravel deposits	3%-4%	350'-450'	Broad flat w/ gravel flooding to SE. crk to SW	

OFF-SITE ANALYSIS DRAINAGE SYSTEM TABLE SURFACE WATER DESIGN MANUAL, CORE REQUIREMENT #2

Basin:Summit View			Sub.		Sub. Number:	
Symbol	**Drainage, Component Type, Name and Size**	**Drainage Component Description**	**Slope**	**Distance from site discharge**	**Existing Problems/Potential Problems**	**Oberservations of field inspector, resource reviewer, or resident**
see map	Type: Sheet flow, swale, stream, channel, pipe, pond: Size: diameter, surface area	Dranage basin, vegetation, cover, depth, type of sensitive area, volume	%	1/4 ml = 1,320 ft.	Constrictions, under capacity, ponding, overtopping, flooding, habitat or organism destruction, scouring, bank sloughing, sedimentation, incision, other erosion	Tributary area, likelihood of problem overflow pathways, potential impacts
	35-ft wide	**Vegetated swale w/debris**	**3%-4%**	**450'-600'**		
E	**N side driveway**	**Swale narrows & bends to follow drive**	**2%-3%**	**600"**	**35' swale to v-ditch some erosion in constricted bend**	
		Natural veg.	**3%**	**600'-700'**	**Debris in crk not likely to restrict flow**	
F	**30'-40' wide sheet flow**	**Natural veg.**	**3%**	**700'-950'**	**Broad sheet flow thru thick veg. & debris new deposits of sand & gravel**	
		Abundant nat. veg.		**950'-1100'**	**Heavy veg. no erosion & no apparent restrictions**	
		24" concrete culvert	**2%-3%**	**1100'**	**Erosion along bank where crk 90°s into culvert**	
G		**No obstruction in culvert**				
		Natural veg.	**1%-2%**	**1100'-1300'**	**Debris & veg. in ditch N apparent restrictions**	
		1300' is ~ 100' upstream culvert xing@NE Cle Elum Pines				

OFF-SITE ANALYSIS DRAINAGE SYSTEM TABLE SURFACE WATER DESIGN MANUAL, CORE REQUIREMENT #2

Basin:6th Street			Sub.		Sub. Number:	
Symbol	**Drainage, Component Type, Name and Size**	**Drainage Component Description**	**Slope**	**Distance from site discharge**	**Existing Problems/Potential Problems**	**Oberservations of field inspector, resource reviewer, or resident**
see map	Type: Sheet flow, swale, stream, channel, pipe, pond; Size: diameter, surface area	Dranage basin, vegetation, cover, depth, type of sensitive area, volume	%	1/4 ml = 1,320 ft.	Constrictions, under capacity, ponding, overtopping, flooding, habitat or organism destruction, scouring, bank sloughing, sedimentation, incision, other erosion	Tributary area, likelihood of problem overflow pathways, potential impacts
A	**18" plastic corr. 8" cmp**		**3%**	**0'**	**Dead skunks in 18" pipe otherwise ok**	
	12" steel pipe					
	V-ditch	**Heavily veg.**	**3%**	**0'-200'**	**Debris in ditch that do no appear to restrict flow**	
	Sheet flow to v-ditch	**Heavily veg.**		**200'-300'**	**Debris in ditch that do no appear to restrict flow**	
B	**18" cone culvert**			**300'**		
					Main drainage starts 100' N 18" conc culvert @Base slag pile seeping out of bottom	
C	Flat bottom crk	Heavily veg. w/debris	**2%**	**0'-100'**	**Areas of ponding stagnent water**	
	18" conc. Culvert			**100'**	**Same as 300' above**	
D	**24" cmp other end 18"**		**2%**	**130'**	**Drops 2.5**	
	3-ft bottom swale	**Heavily veg.**	**2%**	**200'-600'**	**Naturally flowing thru veg.**	
	2-ft bottom swale	**Heavily veg.**	**2%**	**200'-600'**	**Naturally flowing thru veg. & debris**	

OFF-SITE ANALYSIS DRAINAGE SYSTEM TABLE SURFACE WATER DESIGN MANUAL, CORE REQUIREMENT #2

Basin: 6th Street			Sub.		Sub. Number:	
Symbol	**Drainage, Component Type, Name and Size**	**Drainage Component Description**	**Slope**	**Distance from site discharge**	**Existing Problems/Potential Problems**	**Oberservations of field inspector, resource reviewer, or resident**
see map	Type: Sheet flow, swale, stream, channel, pipe, pond: Size: diameter, surface area	Dranage basin, vegetation, cover, depth, type of sensitive area, volume	%	1/4 ml = 1,320 ft.	Constrictions, under capacity, ponding, overtopping, flooding, habitat or organism destruction, scouring, bank sloughing, sedimentation, incision, other erosion	Tributary area, likelihood of problem overflow pathways, potential impacts
E		3-18" conc. Culv.		600'	N. plugged-S. unobstructed-middle 1/2 filled gravel	
				630'	Other end culverts under trail. All 3 partially blocked heavily veg.	
	2-ft bottom	Heavily Veg.	2%	630'-850'	Heavily veg. no restriction to water flow	
F		18" conc. w/1" plastic pipe/w trash rack		850'	Appears to have no obstructions	12" cmp enters up stream of 18" conc. Along w/1" plastic pipe in 18" conc.
					No direction of flow from 18" conc. w/trash pack to 302 Stafford Rd.	
G	24" cmp.	Partially filled w/ sed.		~1250'	Can't find other end culvert	
	2-ft bottom	Grass in ditch	2%	1250'-1375'	Grass in ditch no restriction	
H	24" cmp	Partially filled w/ sed.		1375'-1400'		
	4-ft bottom	Natural Veg.	2%	1400'-1475'	No restrictions	
I	2-24" conc.			1475"-1550"	No restrictions	
	4-ft bottom	Natural veg.		1550'-1600'	No restrictions Trib. 50' up from wooden bridge 2450	
					Go to Basin: West, pg2	

OFF-SITE ANALYSIS DRAINAGE SYSTEM TABLE SURFACE WATER DESIGN MANUAL, CORE REQUIREMENT #2

	Basin: Peoh		Sub.		Sub. Number:	
Symbol	Drainage, Component Type, Name and Size	Drainage Component Description	Slope	Distance from site discharge	Existing Problems/Potential Problems	Oberservations of field inspector, resource reviewer, or resident
see map	Type: Sheet flow, swale, stream, channel, pipe, pond: Size: diameter, surface area	Dranage basin, vegetation, cover, depth, type of sensitive area, volume	%	1/4 mi = 1,320 ft.	Constrictions, under capacity, ponding, overtopping, flooding, habitat or organism destruction, scouring, bank sloughing, sedimentation, incision, other erosion	Tributary area, likelihood of problem overflow pathways, potential impacts
A	18" Wooden @ culvert	Prop-Line Rd. x-ing	3%-4%	0-30	No obstructions in culvert	
	2-3 ft bottom swale	Heavy Veg. grass/shrubs	5%-6%	30'-100'	Naturally flowing	
	10-20 ft bottom swale	Heavey Veg. grass/shrubs	10%-15%	100'-230'		
B	Sheet flow thru alley	No culverts		230	Area of concern, 1 small cb nearby & no culverts	
C	CB SE of 90° bend in alley	6" ductile iron out to (s)		275	Grass around lid, not in best condtion to catch water, sed to bottom pipe	
D	CB SE 4th/4-s alley	18" plastic corr. In (N) &out (S)		415	CB in good working condition	
E	CB 3rd/Alley to N	18" Plastic Corr. In (N0 12" PVC out (S)		575	CB in good working condition	
F	CB 24" cmp stand pipe w/round CB lid			No pipes visible 4' down to H20/sediment		

OFF-SITE ANALYSIS DRAINAGE SYSTEM TABLE SURFACE WATER DESIGN MANUAL, CORE REQUIREMENT #2

Basin: Montgomery			Sub.		Sub. Number:	
Symbol	Drainage, Component Type, Name and Size	Drainage Component Description	Slope	Distance from site discharge	Existing Problems/Potential Problems	Oberservations of field inspector, resource reviewer, or resident
see map	Type: Sheet flow, swale, stream, channel, pipe, pond: Size: diameter, surface area	Dranage basin, vegetation, cover, depth, type of sensitive area, volume	%	1/4 mi = 1,320 ft.	Constrictions, under capacity, ponding, overtopping, flooding, habitat or organism destruction, scouring, bank sloughing, sedimentation, incision, other erosion	Tributary area, likelihood of problem overflow pathways, potential impacts
A	(1.) 36' cmp (2.) 30" cmp		1%	A-B ~ 350'		Under Montgomery Rd.
B	Fenced Stretched Across channel		1%-2%	B-C~ 100'	Possible flow Restriction	
C	Building built over channel			C-D ~50'	Wood Bracing not stable	Building set on ~4' concrete walls @ East + West edges of channel w/wooden braces in water @ mid span
D	Channel enters tunnel			D-E ~ 350'		Arched tunnel measuring 3.8' wide X 4.0'high w/concrete wind walls + concret armored bank
E	Man hole lid (no manhole)			E-F ~ 850'		Ring and lid set in gravel enclosing capped 6" ABX stub set vertically, directly over tunnell
F	Vault w/round lid			F-G ~ 200'		Hand made vault uneven shape connot see in-flow from north 36" concrete out flow heading east

OFF-SITE ANALYSIS DRAINAGE SYSTEM TABLE SURFACE WATER DESIGN MANUAL, CORE REQUIREMENT #2

Basin: Montgomery			Sub.		Sub. Number:	
Symbol	Drainage, Component Type, Name and Size	Drainage Component Description	Slope	Distance from site discharge	Existing Problems/Potential Problems	Oberservations of field inspector, resource reviewer, or resident
see map	Type: Sheet flow, swale, stream, channel, pipe, pond: Size: diameter, surface area	Dranage basin, vegetation, cover, depth, type of sensitive area, volume	%	1/4 ml = 1,320 ft.	Constrictions, under capacity, ponding, overtopping, flooding, habitat or organism destruction, scouring, bank sloughing, sedimentation, incision, other erosion	Tributary area, likelihood of problem overflow pathways, potential impacts
G	Vault (Round lid)	Custom Vault odd-shaped		G-H ~ 250'		36" concrete in-flow from west cannot see out flow to east
H	Vault (Round lid)	Flowing West to East		H-I ~ 300'		Unable to see in flow or out flow
I	Vault (Round Lid)	Flowing West to East		I-J ~ 400'		Unable to see inflow or outflow
J	Out flow to swale	Outflow pipe is 44" wide by 48" high concrete arch pipe				Swale flows East
K	6' diameter cmp under paved st.	~ 60' long	1%	K-L ~ 100'		Ditch w/~36" homemade metal culvert enters swale @ W. end 6' culvert
L	5' tall X 6' wide cmp squash pipe under paved parking lot entry	~ 40' long	<1%	L-M ~ 120'		
M	Same description as "L"		<1%	M-N ~ 120'		

OFF-SITE ANALYSIS DRAINAGE SYSTEM TABLE SURFACE WATER DESIGN MANUAL, CORE REQUIREMENT #2

Basin: Montgomery			Sub.		Sub. Number:	
Symbol	Drainage, Component Type, Name and Size	Drainage Component Description	Slope	Distance from site discharge	Existing Problems/Potential Problems	Oberservations of field inspector, resource reviewer, or resident
see map	Type: Sheet flow, swale, stream, channel, pipe, pond: Size: diameter, surface area	Dranage basin, vegetation, cover, depth, type of sensitive area, volume	%	1/4 mi = 1,320 ft.	Constrictions, under capacity, ponding, overtopping, flooding, habitat or organism destruction, scouring, bank sloughing, sedimentation, incision, other erosion	Tributary area, likelihood of problem overflow pathways, potential impacts
N	6' wide X 4' tall cmp squash pipe	~ 50' long running under paved st.	<1%	N-O ~ 400'		Partially silted @ E. end
O	Wire fence stretched across channel		<1%	O-P~ 75'	Possible flow restriction	
P	3' tall X 4' wide cmp squash pipe under farm crossing		<1%	P-Q ~ 125'		Pipe beat up & misshapen
Q	Fence stretched across channel		<1%	Q-R ~ 25'		Suspended above H20 no flow restriction
R	6' wide X 4' high cmp squash pipe	Under paved street	<1%	R-S ~ 175%		~30' long pipe
S	6' wide X 4' deep concrete box culvert	~ 55' long under SR970		S-T ~ 70'		
T	7' wide x 4' high concrete box culvert	~25' long	1%	T-U ~ 50'		Bottom partially silted

OFF-SITE ANALYSIS DRAINAGE SYSTEM TABLE SURFACE WATER DESIGN MANUAL, CORE REQUIREMENT #2

Basin: Montgomery			Sub.		Sub. Number:	
Symbol	Drainage, Component Type, Name and Size	Drainage Component Description	Slope	Distance from site discharge	Existing Problems/Potential Problems	Oberservations of field inspector, resource reviewer, or resident
see map	Type: Sheet flow, swale, stream, channel, pipe, pond: Size: diameter, surface area	Dranage basin, vegetation, cover, depth, type of sensitive area, volume	%	1/4 ml = 1,320 ft.	Constrictions, under capacity, ponding, overtopping, flooding, habitat or organism destruction, scouring, bank sloughing, sedimentation, incision, other erosion	Tributary area, likelihood of problem overflow pathways, potential impacts
U	36"cmp culvert	~ 30' long under dirt rd.	1%	U-V ~ 70'		
V	36" cmp culvert	~20' long	1%	V-W ` 70'		
W	(2) 48' concrete culverts (side by side)	~40' running under RR tracks	2%	W-X ~ 50'		
X	48" cmp culvert	~20' long running under gravel rd.	1%	X-Y ~ 250'		
Y	36" diameter DIP suspended over H20		1%-2%	Y-Z ~1300'		Connects flowing ditch south to north. No flow restriction
Z	Wire fence suspended over channel		1%	Z-AA ~600'		No flow restrictions
AA	Bend in Stream		1%-2%			
BB	Creek feeds swamp	Swamp filled w/cat tails to N. of bend in stream	<1%	BB-CC ~1200'		Definite H20 detention area
CC	Bend in creek		1%	CC-DD ~ 550'		
DD	6' diameter concrete culvert	Flowing under overpass for freeway on ramp ~150' long culvert	2%	DD-EE ~ 1300'		

OFF-SITE ANALYSIS DRAINAGE SYSTEM TABLE SURFACE WATER DESIGN MANUAL, CORE REQUIREMENT #2

Basin: Montgomery			Sub.		Sub. Number:	
Symbol	**Drainage, Component Type, Name and Size**	**Drainage Component Description**	**Slope**	**Distance from site discharge**	**Existing Problems/Potential Problems**	**Oberservations of field inspector, resource reviewer, or resident**
see map	Type: Sheet flow, swale, stream, channel, pipe, pond: Size: diameter, surface area	Dranage basin, vegetation, cover, depth, type of sensitive area, volume	%	1/4 ml = 1,320 ft.	Constrictions, under capacity, ponding, overtopping, flooding, habitat or organism destruction, scouring, bank sloughing, sedimentation, incision, other erosion	Tributary area, likelihood of problem overflow pathways, potential impacts
EE	**Change in channel/ vegetation**	**Banks become more defined/channel becomes less defined**	**<1%**	**EE-FF ~ 600'**		
FF	**Pond inlet to stream**	**Swampy area connecting pond to stream definite flow from pond to stream**	**1%**	**FF-GG ~200'**	**Beaver dam + lodge @ Pond edge/Partial Dam in stream restricting flow**	
GG	**Stream meets Yakima River**	**Discernable channel downstream from "FF"**	**<1%**			**Beaver swamp lots of standing water & downed trees**

OFF-SITE ANALYSIS DRAINAGE SYSTEM TABLE SURFACE WATER DESIGN MANUAL, CORE REQUIREMENT #2

Basin:Columbia			Sub. #4		Sub. Number:	
Symbol	Drainage, Component Type, Name and Size	Drainage Component Description	Slope	Distance from site discharge	Existing Problems/Potential Problems	Oberservations of field inspector, resource reviewer, or resident
see map	Type: Sheet flow, swale, stream, channel, pipe, pond: Size: diameter, surface area	Dranage basin, vegetation, cover, depth, type of sensitive area, volume	%	1/4 mi = 1,320 ft.	Constrictions, under capacity, ponding, overtopping, flooding, habitat or organism destruction, scouring, bank sloughing, sedimentation, incision, other erosion	Tributary area, likelihood of problem overflow pathways, potential impacts
A	24" Black Plastic Corrugated Pipe	~ 40' long under gravel rd.	1%	A-B= ~ 140'		Channel splits for ~ 120'
B	18" cmp culvert under gravel DW		4%	B-C=~100'		Channel re-joins
C	30" cmp culvert	Under gravel rd.	3%	C-D ~250'		
D	24" cmp culvert	Under paved st.	3%-4%	D-E ~ 150'		
E	24" Black corrugated plastic pipe	~ 20' long buried in rip-rap & dirt	3%-4%	E-F ~ 125'		Pipe laid to protect SSMH @ W. Edge ditch from washout
F	Bend in channel 18" cone culvert	90° turn to E.	1%-2%	F-G ` 125'		Channel B joined by small ditch from W.
G	18" cone culvert	~ 55'	1%-2%	G-H ~ 225'		S. ~ 10' of culvert is 24" cmp sleeved over concrete
H	Homemade ~36" culvert under concrete SW	~ 10' long made of old fuel tank w/ends cut out	2%-3%	H-I ~15'		
I	Dumps into Montgomery Downstream		2%-3%			
		(See location "K" in Basin: Montgomery)				

APPENDIX C

Project Specific Sub-basins Map

N

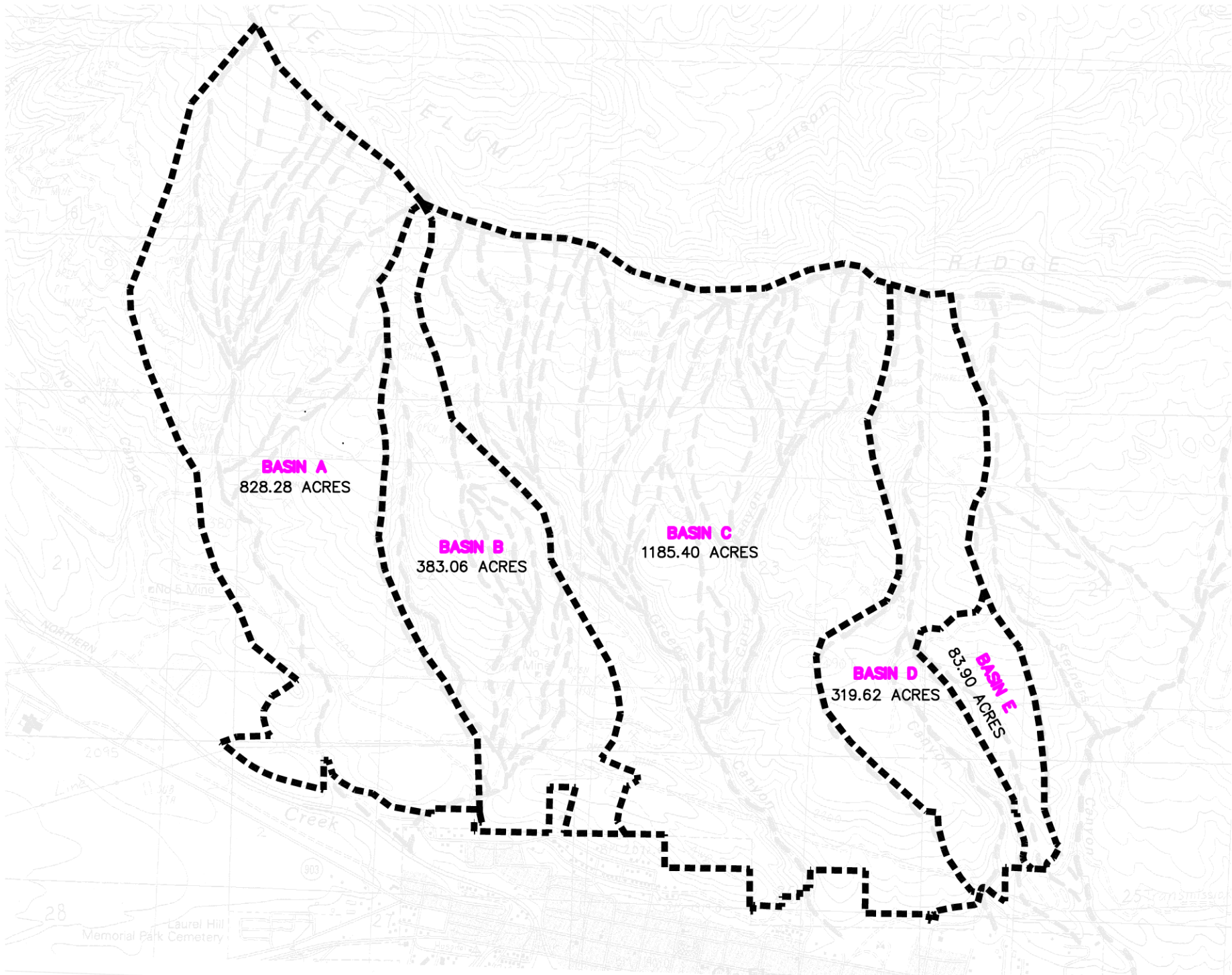

Figure C.1
Project Specific Sub-Basins

November 23, 2009

Scale: 1" = 2000'

Encompass
ENGINEERING & SURVEYING
108 EAST 2ND STREET
CLE ELUM, WA 98922
PHONE: (509) 674-7433
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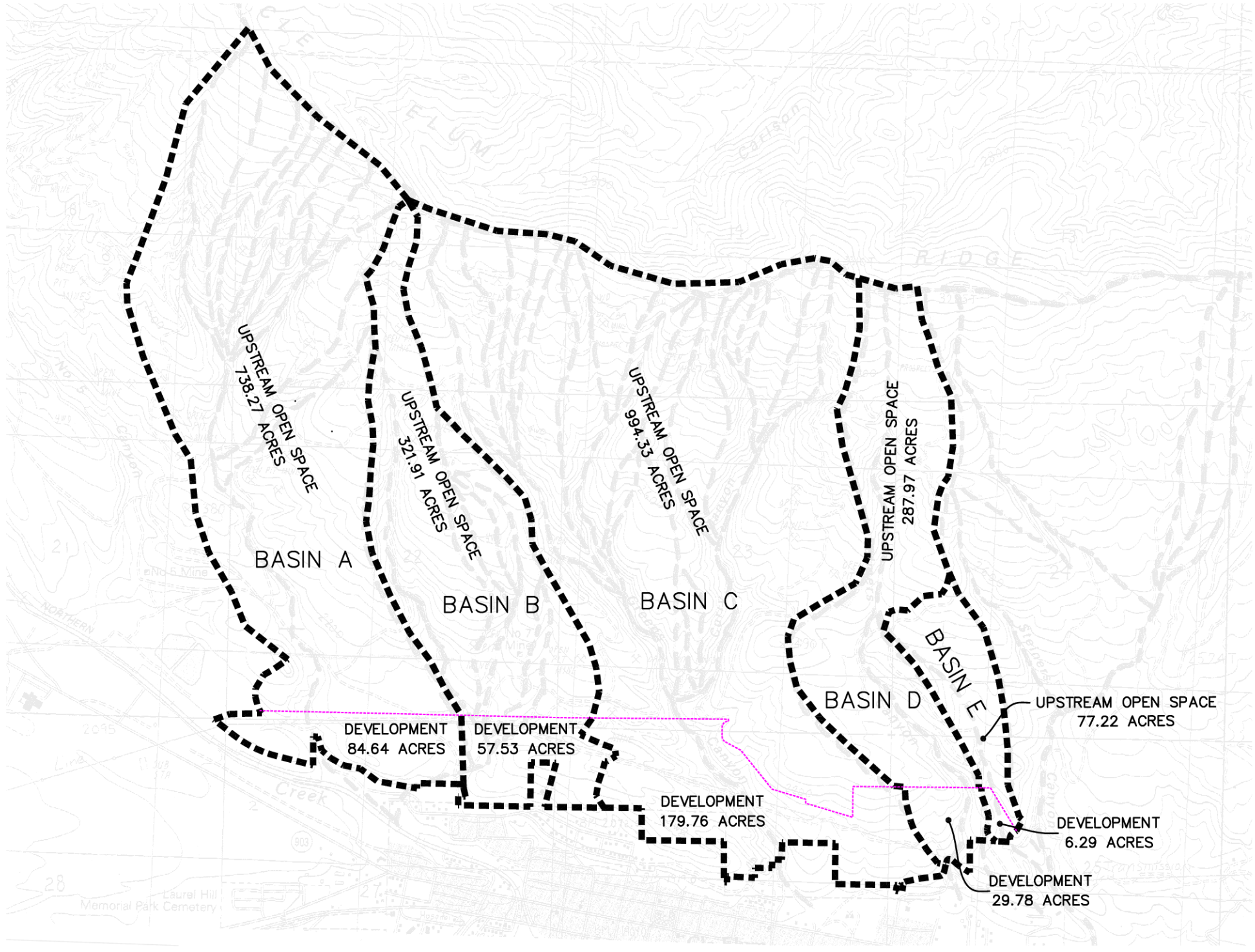

Figure C.2
Pre-Development Sub-Basins Breakdown

November 23, 2009

Scale: 1" = 2000'

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Downstream Drainage Analysis **prepared by Barghausen Consulting Engineers, Inc., dated February 25, 2011**

DOWNSTREAM DRAINAGE ANALYSIS

Proposed City Heights Project

Cle Elum, Washington

Prepared for:
Green Canyon LLC / High Mark Resources LLC / Cooper Pass LLC
206 West First Street
Cle Elum, Washington 98922
(509) 674-6828

February 25, 2011
Our Job No. 14953

2-25-11

JERRY JACOBS
STATE OF WASHINGTON
27694
REGISTERED
PROFESSIONAL ENGINEER

BARGHAUSEN CONSULTING ENGINEERS, INC.

CIVIL ENGINEERING, LAND PLANNING, SURVEYING
18215 72ND AVENUE SOUTH KENT, WA 98032 (425) 251-6222 (425) 251-8782 FAX
BRANCH OFFICES ◆ OLYMPIA, WA ◆ CONCORD, CA ◆ TEMECULA, CA
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APPENDIX

1.0 INTRODUCTION / GENERAL INFORMATION

INTRODUCTION/GENERAL INFORMATION

The 358-acre site of the City Heights planned mixed-use development is located within the Urban Growth Area north of the City Limits of Cle Elum in Kittitas County, Washington. The site is within an upland region above the Yakima River Valley on the south face of Cle Elum Ridge, bounded to the south by the Mine Heritage Trail, West 6th Street, West 5th Street, East Russ Street, North Montgomery Avenue, East 3rd Street, North Columbia Avenue, and West Cemetery Road, and to the north by undeveloped woodlands and former coal mine areas. Please refer to the Vicinity Map.

Encompass Engineering and Surveying, a company located in Cle Elum, Washington, prepared a detailed grading, drainage, and utilities technical engineering report for this overall development dated March 24, 2010. In that report, a preliminary off-site analysis was performed on all of the drainage basins draining through the City Heights project and through the City of Cle Elum to the Yakima River further downstream. In that analysis several problem areas were identified. In addition, based on conversations with City personnel and site visits, one in January 2010 and one in February 2011, our office performed a subsequent analysis of the downstream drainage system based on City personnel's indications of downstream drainage problems occurring within the City of Cle Elum.

The proposed City Heights project site is within a watershed located on the north side of the City of Cle Elum, encompassing an area from the town of Roslyn on the west, Cottage Avenue in the City of Cle Elum on the east, the top of the Cle Elum Ridge on the north, Third Street and SR-903 within the City of Cle Elum on the south.

The proposed City Heights property hydrology is divided into four significant drainage basins.

Basin A (West Basin)

Drainage Basin A is located in the western portion of the project and consists of approximately 777 acres of forest land. Runoff from this basin contributes to the headwater of Crystal Creek to the southwest. The West Basin is the westernmost downstream basin that drains directly into Crystal Creek.

Basin B (Summit View Basin)

Drainage Basin B is located east of Drainage Basin A and consists of approximately 449 acres of mixed forest land and pasture. Runoff from this basin enters Crystal Creek downstream of Basin A. Summit View Basin begins at Summit View Road and heads southwest across private property and into Crystal Creek. Please refer to the Downstream Drainage System Map in Exhibit C for more detail. Approximately seven (7) acres of the drainage basin known as Sixth Street Basin is also tributary to the downstream conveyance system for Basins A and B. Sixth Street Basin begins on Sixth Street near the City of Cle Elum water tank and heads west, then south, and into Crystal Creek.

Basin C (Montgomery Basin)

Drainage Basin C is located east of Drainage Basin B and consists of approximately 1,124 acres of mixed forest land and pasture. Runoff from this Basin is tributary to the Second Street storm system within the City of Cle Elum.

Approximately 10 acres of the drainage basin known as Peoh Basin is also tributary to Basin C, known as Montgomery Basin. Peoh Basin begins at the north end of Peoh Street and heads south into the City's Second Street stormwater conveyance system. Montgomery Basin begins at Montgomery Avenue and heads southeast across private land and into the City Second Street stormwater conveyance system.

Basin D (Columbia Basin)

Drainage Basin D is located east of Drainage Basin C and consists of approximately 300 acres of mixed forest land and pasture. Storm runoff from this basin drains to the same downstream conveyance system as Basin C, connecting up at Second Street and then flowing east, ultimately draining to the Yakima River. Columbia Basin begins at the extension of Columbia Avenue (also known as Creekside Road) and heads south into the City's Second Street stormwater conveyance system.

A detailed description of each downstream basin from the City Heights property to the Yakima River is provided in the Downstream Drainage System Map within the Appendix of this report.

FEMA has performed a flood analysis of Crystal Creek coursing through the City of Cle Elum. Based on the FEMA study, portions of West Second Street and West First Street between Bullitt Avenue and Stafford Avenue are within a Zone B floodplain. Zone B is designated as the area between limits of the 100-year flood and the 500-year flood, or certain areas subject to 100-year flooding with average depth less than 1 foot, or where the contributing drainage area is less than 1 square mile, or areas protected by levies from the base flood.

The entire City of Cle Elum and it Urban Growth Area are acknowledged as being located within a highly erosive area susceptible to frequent flooding. Many flooding events have occurred in recent years from the poorly maintained and deteriorated drainage structure and undersized storm drainage system within the City Limits.

The development of the project site would create a large amount of impervious surface and decrease the amount of pervious area, therefore increasing the duration of the peak surface water runoff. Due to the existing flooding issue downstream of the project site, 100-year storm event detention for the developed runoff is proposed to be implemented to maintain existing runoff rates to the downstream system.

Given that the proposal will comply with all applicable stormwater management regulations under the developed condition, and the project proposes to detain the 100-year storm event based on past flooding experiences in the area, any storm and/or flood events beyond the 100-year storm event is considered unavoidable adverse impact.

A basin analysis is performed to determine an estimated 100-year peak flow rate for each basin and then analysis of the conveyance pipe and ditches was performed to determine adequate capacity to convey the flow from each basin. The majority of the conveyance pipes analyzed were determined to be undersized; however, it should be noted that the Santa Barbara Urban Hydrograph (SBUH) methodology uses to estimate the peak flow creates higher than actual flow rates, especially for forested and pasture conditions, which most of the upstream basin consists of.

The City Heights project will provide flow control matching the 2-year, 25-year, and 100-year release rate to match the pre-developed runoff rate for the area of the City Heights project contributing to each basin, thereby there should be no impact to the peak flow rate coming into the City from this project. However, the duration of the peak flow will increase. Sediment accumulation in the conveyance system from all of the basins appears to be a major problem in the City of Cle Elum.

Vactoring out the catch basins and conveyance pipes from the City mains and removal of the excess vegetation within the open channels must be implemented to increase flow rates through the City conveyance system.

Conclusions and Recommendations

A detailed description of each downstream basin from the City Heights property to the Yakima River, including tributary area, estimated 100-year peak flow rate, and recommendations to minimize flooding problems are provided in the Drainage System Table in Appendix C.

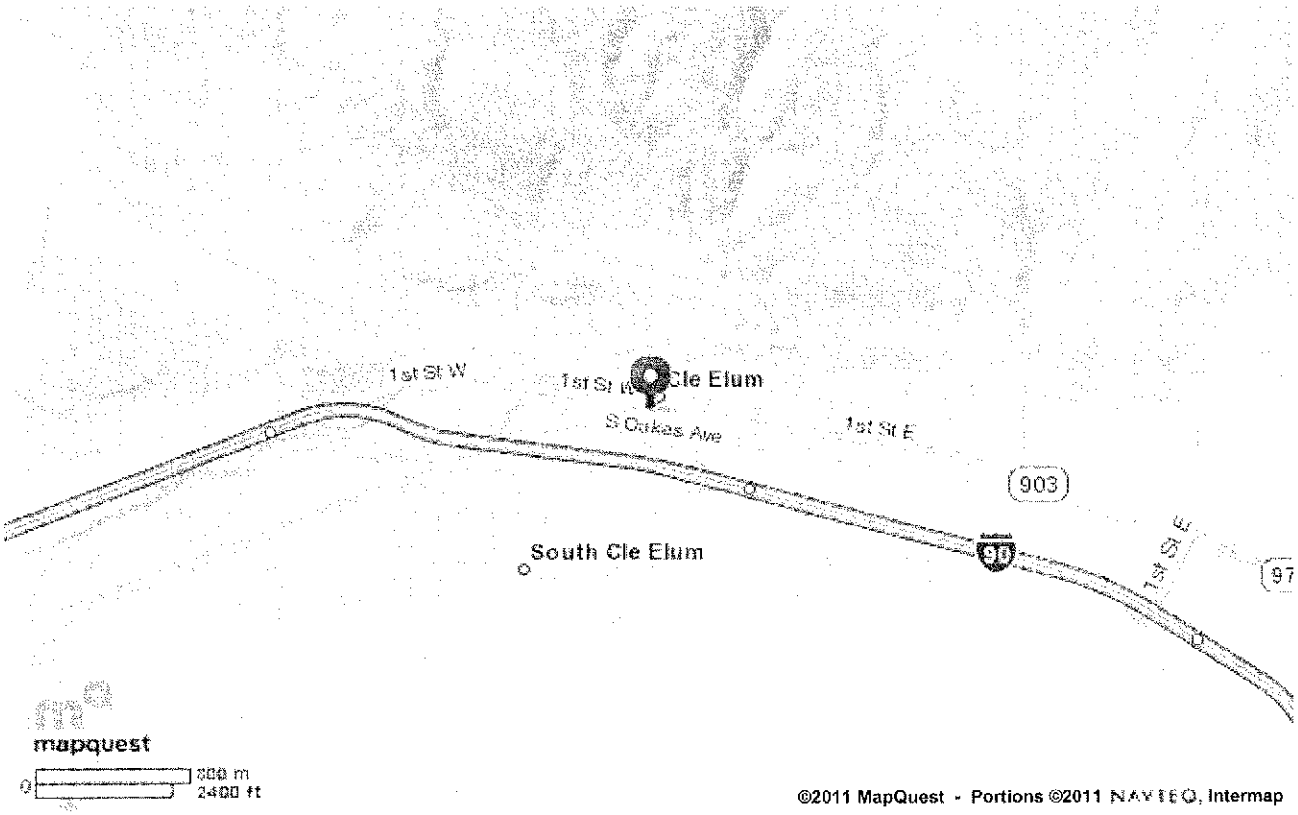
VICINITY MAP

mapquest

Notes

Map of:

119 W 1st St
Cle Elum, WA 98922-1105



APPENDIX

EXHIBIT A
OFF-SITE ANALYSIS DRAINAGE SYSTEM TABLE

West Basin OFF-SITE ANALYSIS DRAINAGE SYSTEM TABLE SURFACE WATER DESIGN MANUAL, CORE REQUIREMENT #2				
Drainage Component Type/Size (see map)	**Condition**	**Estimated 100-Year/24-Hour Flow Rate (cfs)**	**Existing/Potential Problems**	**Action Recommended**
A 6-foot-wide channel bottom	Abundant vegetation	284 cfs		No action required
B 4-foot bottom	Abundant vegetation		Some erosion	No action required
C 6-foot bottom	Abundant vegetation		None noted	No action required
D 7-foot bottom	Creek crosses trail		None noted	No action required
E 8-foot bottom		407 cfs	None noted	No action required
F 8-foot bottom			Sloughing and erosion on trail edge	No action required
G 6-foot bottom	No evidence of flooding		None noted	No action required
H 6-foot bottom	Some erosion of fill on trail		None noted	No action required
I 5-foot CMP culvert	CMP caved in some in trail center		None noted	No action required
J 10-foot bottom	Abundant vegetation		Trees and debris jams	Remove excess vegetation, trees, and debris jamming channel.
K 5-foot bottom	Abundant vegetation		Minor erosion on south bank	Place riprap on south bank and repair erosion.
L 6-foot bottom	Abundant vegetation		Evident flooding	Remove excess vegetation, trees, and debris jamming channel.
M 6-foot bottom	Abundant vegetation		Minor erosion and flooding evidence	Place riprap and repair erosion
N Bridge	Across driveway		None noted	No action required
O			None noted	No action required
P Bridge crossing 2nd Street	20-foot concrete deck		None noted	No action required
Q Wood bridge	15-foot wood deck		Some erosion and obstructions downstream of bridge	Remove obstructions in channel.
R Bridge crossing 1st Street	20-foot concrete deck		Grass and gravel upstream causing ponding. Gravel and debris under bridge.	Remove grass, gravel, and debris upstream and under bridge.
S Wooden walk bridge 7-foot bottom	Abundant vegetation with some debris		Severe erosion in channel supporting bridge	Place riprap in side slope of channel and repair erosion.

West Basin				
OFF-SITE ANALYSIS DRAINAGE SYSTEM TABLE SURFACE WATER DESIGN MANUAL, CORE REQUIREMENT #2				
Drainage Component Type/Size (see map)	**Condition**	**Estimated 100-Year/24-Hour Flow Rate (cfs)**	**Existing/Potential Problems**	**Action Recommended**
T Wood bridge in alley	Debris and sediment restricting flow		Minor debris obstructions downstream of bridge	Remove debris and sediment in channel
10-foot bottom	Vegetated with minor debris		Debris jam in channel	Remove debris jam in channel.
U 12-foot bottom	Vegetated slack water		None noted	No action required
V Concrete bridge under railroad tracks	10- by 7-foot RCB		No obstructions	No action required

Summit View Basin				
OFF-SITE ANALYSIS DRAINAGE SYSTEM TABLE SURFACE WATER DESIGN MANUAL, CORE REQUIREMENT #2				
Drainage Component Type/Size (see map)	**Condition**	**Computed SBUH 100-Year Flow Rate (cfs)**	**Existing/Potential Problems**	**Action Recommended**
A 48-Inch CPEP Culvert Discharges to 10-foot-wide bottom swale	Unobstructed	127 ±* * 100-year flow rate was computed by SBUH methodology, which appears to be yielding inflated flow rates.	Some debris that is not disrupting flow	No action required
B Old bridge crossing			Bridge and debris restrict flow	No action required
C V-shape channel 1:1 side slopes	Fallen trees in channel		Mass erosion undercut banks	No action required
D 20- to 35-foot-wide bottom	New sediment in stream		None noted	No action required
E Swale narrows	Follows north side driveway		Some erosion in bend	No action required
F 30- to 40-foot-wide swale to 24-inch RCP	Abundant vegetation		Erosion along bank where creek bends into culvert	Replace 24-inch RCP with 48-inch culvert with wing walls
G				

6th Street Basin				
OFF-SITE ANALYSIS DRAINAGE SYSTEM TABLE SURFACE WATER DESIGN MANUAL, CORE REQUIREMENT #2				
Drainage Component Type/Size (see map)	**Condition**	**Estimated 100-Year/24-Hour Flow Rate (cfs)**	**Existing Potential Problems**	**Action Recommended**
A 18-inch CPEP 8-inch CMP 12-inch steel pipe discharge to V-ditch	Pipes clear. V-ditch heavily vegetated.		Debris in ditch does not appear to restrict flow	No action required
B 18-inch RCP			None noted	No action required
C Flat bottom creek	Heavily vegetated with debris		Areas of ponding	No action required
D 18-inch RCP to 24-inch CMP			None noted	No action required
E Three 18-inch RCPs			N. plugged, S. clear, middle 1/2 filled with gravel	Clean out sediment
F 18-inch RCP			No obstructions	No action required
G 24-inch CMP	Partially filled with sediment		Downstream end buried	Clean out sediment
H 24-inch CMP	Partially filled with sediment			Clean out sediment
I Two 24-inch RCPs	Clear		No restrictions	No action required

Peoh Basin				
OFF-SITE ANALYSIS DRAINAGE SYSTEM TABLE SURFACE WATER DESIGN MANUAL, CORE REQUIREMENT #2				
Drainage Component Type/Size (see map)	**Condition**	**Estimated 100-Year/24-Hour Flow Rate (cfs)**	**Existing/Potential Problems**	**Solution to Flooding Problem**
A 18-inch wood culvert **2- to 3-foot bottom swale** **10- to 20-foot bottom swale**	Prop. – Line Rd. x-ing Heavily vegetated Heavily vegetated		No obstructions	The Peoh basin has a very small upstream contributing area of approximately 26 acres of forest. The flows from this area are minor compared to the other basins. City personnel did not indicate any flooding problems in this downstream course; however, it appears from the field reconnaissance that several of the catch basins need to be vactored.
B Sheetflow through alley	No culverts		None noted	No action required
C Catch basin southeast of bend in alley	6-inch DIP out to south		Sediment of IE to pipe	No action required
D 18-inch CPEP	Catch basin to catch basin		Catch basin in good condition	No action required
E Catch basin in 3rd Street alley to north	18-inch CPEP in 12-inch PVC out		Catch basin in good condition	No action required
F Catch basin 24-inch standpipe			Full of water and sediment	No action required

Montgomery Basin				
OFF-SITE ANALYSIS DRAINAGE SYSTEM TABLE SURFACE WATER DESIGN MANUAL, CORE REQUIREMENT #2				
Drainage Component Type/Size (see map)	**Condition**	**Estimated 100-Year Flow by SBUH (cfs)**	**Existing/Potential Problems**	**Action Recommended**
A 36-inch CMP 30-inch CMP		362* * Since the 100-year flow rate was computed by SBUH, the rate is likely highly inflated.	None noted	City has indicated that there are flooding problems in this downstream course. 36- and 30-inch culverts are likely needed to be replaced with larger.
B Fence across channel			Possible flow restriction	Remove fence.
C Building built over channel			Wood bracing in center of channel not stable	Replace bracing with concrete.
D Channel enters tunnel	3.8 feet wide and 4.0 feet high with concrete wing walls		None noted	Analyze tunnel for conveyance capability. May require replacement with larger system.
E Manhole lid (no MH)	Covers 6-inch stub over tunnel		None noted	No action required
F Vault with round lid	36-inch RCP out to east		None noted	36-inch RCP needs to be upsized to a minimum of 54 inches
G Vault odd shaped (custom built)	36-inch RCP in from west		Cannot see outflow	36-inch RCP needs to be upsized to a minimum of 54 inches.
H Vault	Flowing west-to-east		Cannot see inflow or outflow pipes	City has indicated there are problems in this drainage course. Further analysis is required. Columbia Basin runoff joins this basin at K location. Add 300 more upstream acres and approximately 130 cfs flow to system.
I Vault	Flows west-to-east		None noted	No action required
J 44-inch-wide by 48-inch-high arch pipe	Outflows to swale		Swale flows east	No action required

Montgomery Basin				
OFF-SITE ANALYSIS DRAINAGE SYSTEM TABLE SURFACE WATER DESIGN MANUAL, CORE REQUIREMENT #2				
Drainage Component Type/Size (see map)	**Condition**	**Estimated 100-Year Flow by SBUH (cfs)**	**Existing/Potential Problems**	**Action Recommended**
K 6-foot-diameter CMP	Under paved street	492 cfs*	Ditch and 36-inch culvert enter swale at west end of 6-foot CMP	No action required
L 5- by 6-inch arch pipe	Under paved parking lot entry		None noted	No action required
M			None noted	No action required
N 6-foot-wide by 4-foot-high CMP arch	Under paved street		Partially silted at east end	Remove accumulated sediment from bottom of culvert
O Wire fence across channel			Possible flow restriction	No action required
P 3-foot-high by 4-foot-wide CMP arch	Under farm crossing		Pipe beat up and misshapen	Replace arch culvert
Q Fence across channel	Suspended above water		No restriction	No action required
R 6-foot-wide by 4-foot-high CMP arch	Under paved street		30-foot-long pipe	No action required
S 6- by 4-foot RCB	Under SR-970		55-feet long	No action required
T 7- by 4-foot RCB	Bottom partially silted		25 feet long	No action required
U 36-inch CMP culvert	Under dirt road		30 feet long	Locations U, V, W, X, and Y all are culverts smaller in diameter than the upstream culverts contributing. They have to be upsized.
V 36-inch CMP			20 feet long	
W Two 48-inch RCP culverts	Side by side		Under railroad tracks	
X 48-inch CMP	Under gravel road		20 feet long	
Y 36-inch DIP	Suspended over water		No restriction	
Z Wire fence	Suspended over channel		No restriction	No action required
AA Bend in stream			None noted	No action required
BB Creek feeds swamp			Stormwater detention area	No action required
CC Bend in creek			None noted	No action required
DD 72-inch RCP	Under freeway overpass		150 feet long	No action required
EE	Change in channel vegetation		None noted	No action required

Montgomery Basin				
OFF-SITE ANALYSIS DRAINAGE SYSTEM TABLE SURFACE WATER DESIGN MANUAL, CORE REQUIREMENT #2				
Drainage Component Type/Size (see map)	**Condition**	**Estimated 100-Year Flow by SBUH (cfs)**	**Existing/Potential Problems**	**Action Recommended**
FF Pond inlet to stream	Beaver dam		Partial flow restriction	No action required
GG Stream meets river			None noted	No action required

Columbia Basin				
OFF-SITE ANALYSIS DRAINAGE SYSTEM TABLE SURFACE WATER DESIGN MANUAL, CORE REQUIREMENT #2				
Drainage Component Type/Size (see map)	**Condition**	**Estimated SBUH 100-Year Flow (cfs)**	**Existing/Potential Problems**	**Action Recommended**
A 24-inch CPEP	Under gravel road 40 feet long	138 cfs* * Flows determined with SBUH are substantially higher than what actually occurs, especially in a forested or pasture condition, which these basins are modeled as.	Channel splits for approximately 120 feet	The City has indicated there are flooding problems in this Columbia Basin downstream drainage course. Based on the slopes given, all of these culverts are undersized.
B 18-inch CMP culvert	Under gravel driveway		Channel reconnects	The City has indicated there are flooding problems in this Columbia Basin downstream drainage course. Based on the slopes given, all of these culverts are undersized.
C 30-inch CMP culvert	Under gravel road		None noted	The City has indicated there are flooding problems in this Columbia Basin downstream drainage course. Based on the slopes given, all of these culverts are undersized.
D 24-inch CMP culvert	Under paved street		None noted	The City has indicated there are flooding problems in this Columbia Basin downstream drainage course. Based on the slopes given, all of these culverts are undersized.

Columbia Basin				
OFF-SITE ANALYSIS DRAINAGE SYSTEM TABLE SURFACE WATER DESIGN MANUAL, CORE REQUIREMENT #2				
Drainage Component Type/Size (see map)	**Condition**	**Estimated SBUH 100-Year Flow (cfs)**	**Existing/Potential Problems**	**Action Recommended**
E 24-inch CPEP	20 feet long		None noted	The City has indicated there are flooding problems in this Columbia Basin downstream drainage course. Based on the slopes given, all of these culverts are undersized.
F 18-inch RCP culvert	Bend in channel		None noted	The City has indicated there are flooding problems in this Columbia Basin downstream drainage course. Based on the slopes given, all of these culverts are undersized.
G 18-inch RCP culvert	55 feet long		None noted	The City has indicated there are flooding problems in this Columbia Basin downstream drainage course. Based on the slopes given, all of these culverts are undersized.
H 36-inch culvert	Under sidewalk, 10 feet long		Homemade from old fuel tanks	The City has indicated there are flooding problems in this Columbia Basin downstream drainage course. Based on the slopes given, all of these culverts are undersized.

Columbia Basin				
OFF-SITE ANALYSIS DRAINAGE SYSTEM TABLE SURFACE WATER DESIGN MANUAL, CORE REQUIREMENT #2				
Drainage Component Type/Size (see map)	**Condition**	**Estimated SBUH 100-Year Flow (cfs)**	**Existing/Potential Problems**	**Action Recommended**
I Connects to Montgomery downstream				The City has indicated there are flooding problems in this Columbia Basin downstream drainage course. Based on the slopes given, all of these culverts are undersized.

These are an indication of channel/culvert capacity problem. All existing culvers must be replaced with minimum 36-inch culverts.

EXHIBIT B
BASIN MAP

TOPO! map printed on 01/12/11 from "Untitled.tpo"

120°59.000' W 120°58.000' W 120°57.000' W 120°56.000' W 120°55.000' W 120°54.000' W 120°53.000' W WGS84 120°52.000' W

47°13.000' N

47°12.000' N

BASIN A
693 ACRES
UPSTREAM
777.64 AC
TOTAL

BASIN C
944 AC. UPSTREAM
1123.76 AC
TOTAL

BASIN D
270 AC UPSTREAM
299.78 AC TOTAL

BASIN B
392 AC UPSTREAM
449.53 AC
TOTAL

6th. St.
Basin

Peoh
Basin

Unnamed Street
Carlson Canyon
No 5 Canyon
Main Ridge
Ridge
Whiteley Rd
South Ave
A St
903
Crystal Shan St
Main Rd
No 5 Mine
Cle Elum High Sch
Northern
Transmission Line
3rd
Creek
Roslyn Pl
7th Ave
W 6th St
W 4th St
W 3rd St
2nd St W
W 1st St
E 4th St
E 2nd St
E 3rd St
21st St E
E Railroad St
Forest Service Rd
Laurel Hill
Memorial Park Cemetery
Pine St
Reed St
S Cle Elum Rd
Ranger Station Rd
970
90
Grant St
4th St
Washington St
Broadway St
Lincoln St
Cleveland St
Madison St
8th St
7th St
6th St
3rd St
River
South Cle Elum
Greens Canyon
Curry
Stemers
Palmers
Sterners
Lanigan Spring
Buena View Rd
Powerline Rd
Danko Rd
Cle Elum Municipal Airport
White Rd
Airport Rd
Gravel Pit
Doile Rd
Sewage Disposal Plant
Sunset Hwy
Burlington
Garden St
N Pearl Ave
Sinon Ave
College Ave

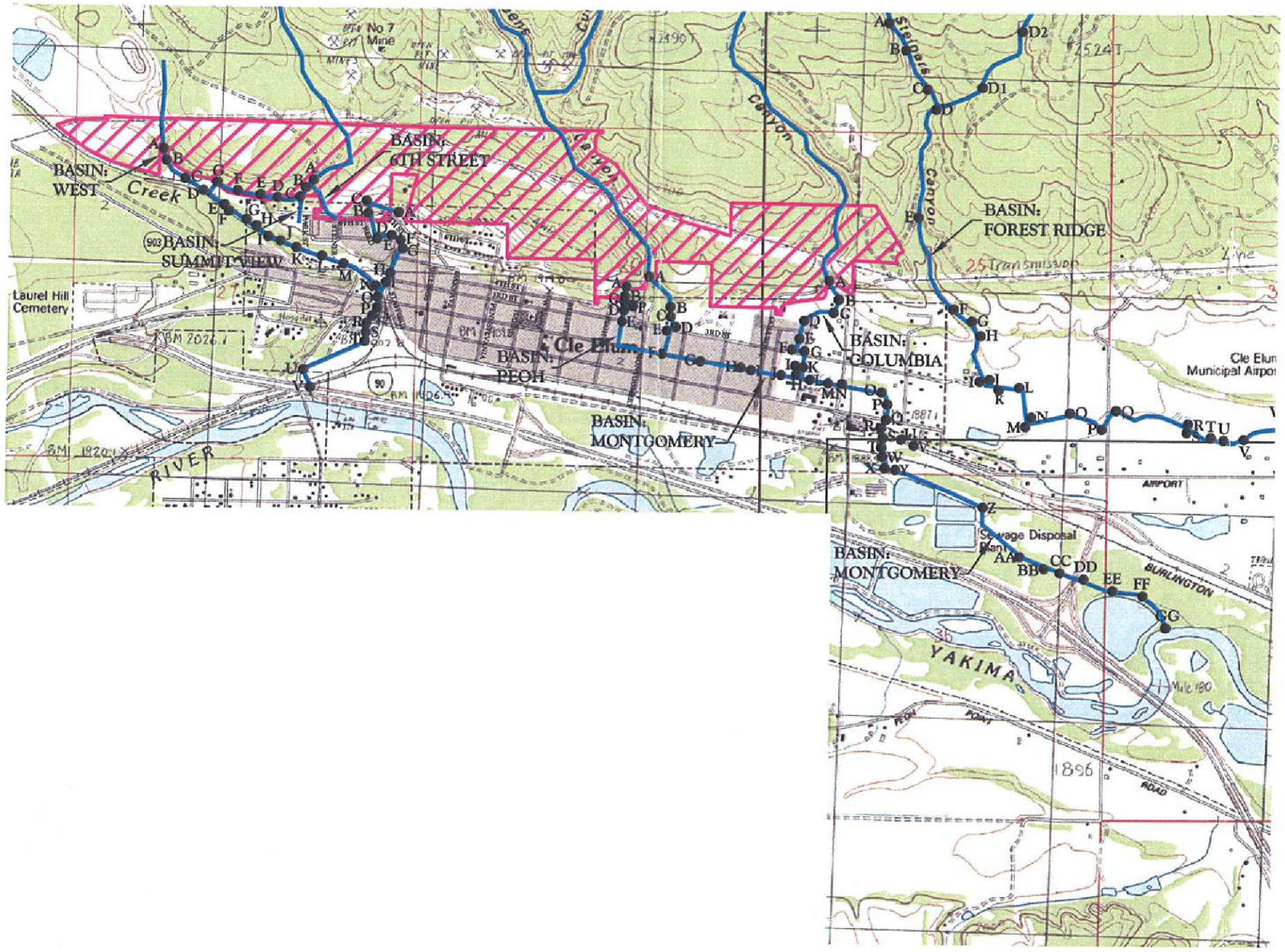
Map created with TOPO!® ©2007 National Geographic, ©2005 Tele Atlas, Rel. 8/2005

NATIONAL GEOGRAPHIC

0.0 0.5 miles
0.0 0.5 1.0 km

TN MN
16½°
01/12/11

EXHIBIT C
DOWNSTREAM DRAINAGE COURSE MAP



Legend

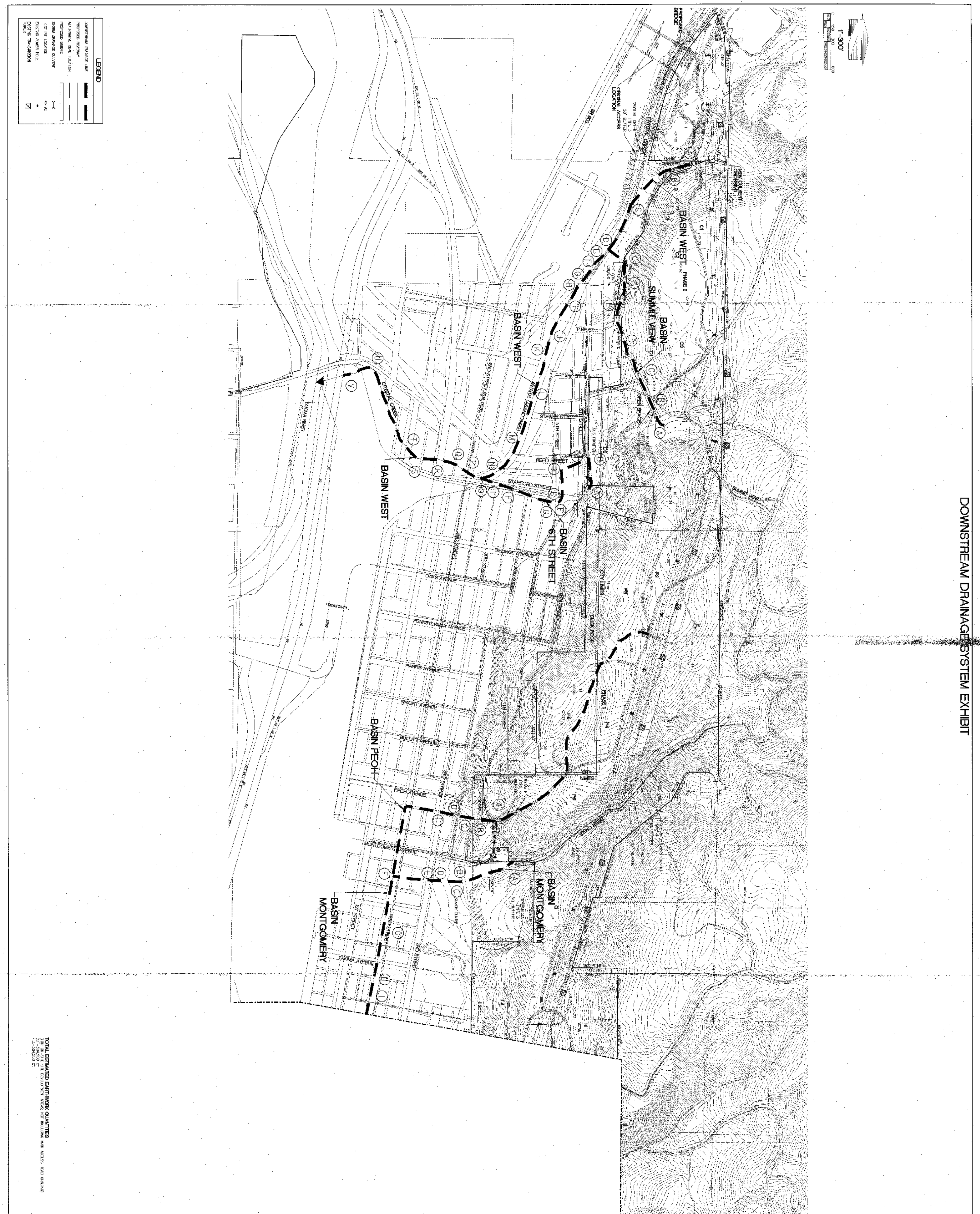
- A — See Downstream Table for Site Description
- Downstream Path
- Project Site

Downstream Drainage System

November 23, 2009

Scale: 1" = 2000'

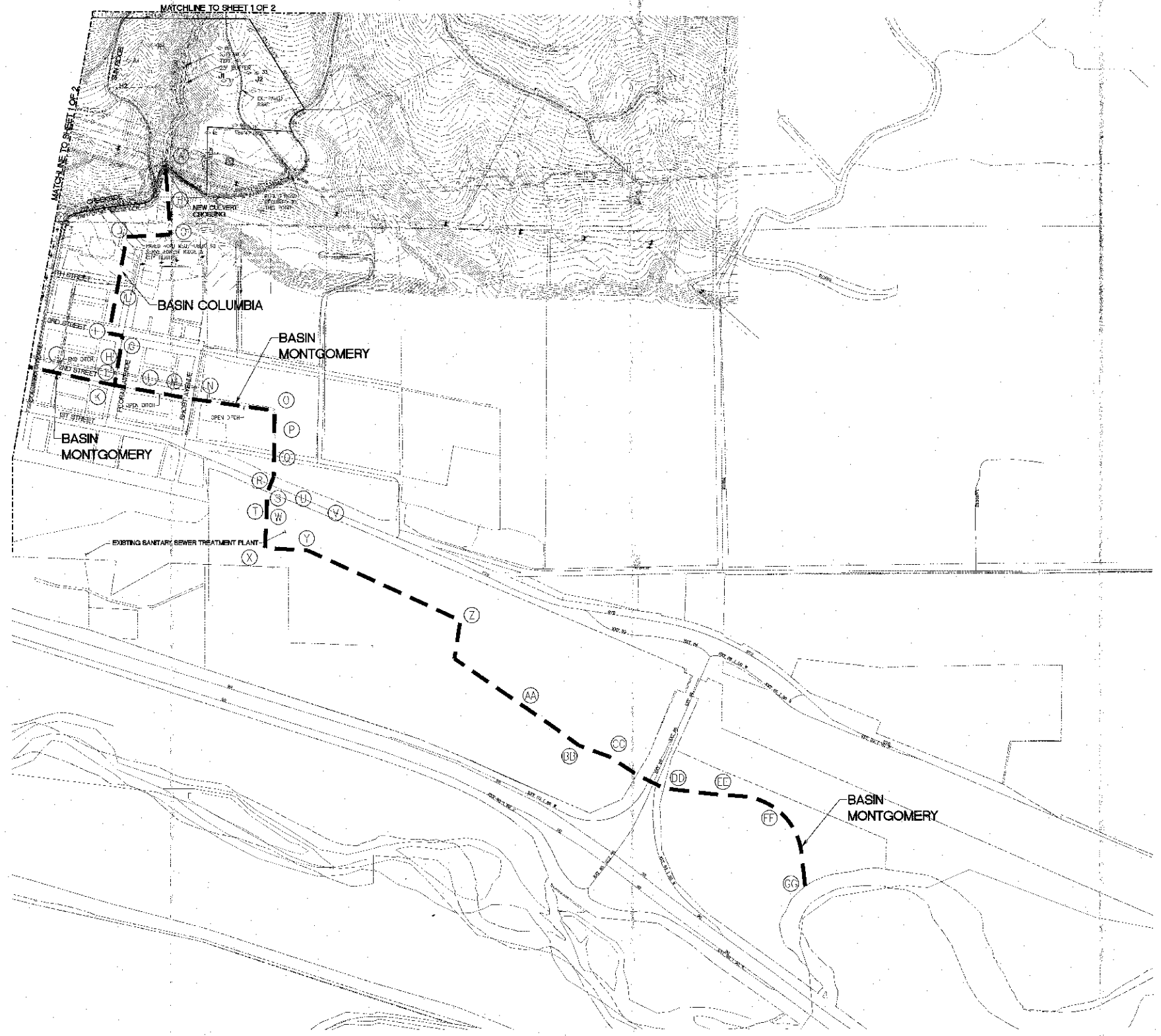
Encompass
ENGINEERING & SURVEYING
108 EAST 2ND STREET
CLE ELUM, WA 98922
PHONE: (509) 674-7433
FAX: (509) 674-7419



DOWNSTREAM DRAINAGE SYSTEM EXHIBIT

Job Number 14953 Sheet 1 of 2	BARGHAUSEN CONSULTING ENGINEERS, INC. 18215 72ND AVENUE SOUTH KENT, WA 98032 (425)251-6222 (425)251-5782 FAX CIVIL ENGINEERING, LAND PLANNING, SURVEYING, ENVIRONMENTAL SERVICES	Designed CMI Drawn AZ Checked CMI Approved DKB Date 3/23/11 Scale: Horizontal 1"=300' Vertical N/A	For: GREEN CANYON LLC / HIGH MARK RESOURCES LLC / COOPER PASS LLC 206 WEST FIRST STREET CLE ELUM, WA 98922 (509) 674-6828	Title: DOWNSTREAM DRAINAGE SYSTEM EXHIBIT CITY HEIGHTS CLE ELUM, WASHINGTON

DOWNSTREAM DRAINAGE SYSTEM EXHIBIT



LEGEND

- DOWNSTREAM DRAINAGE LINE
- PROPOSED ROADWAY
- ALTERNATIVE ROAD LOCATION
- PROPOSED BRIDGE
- STORM DRAINAGE CULVERT
- TEST PIT LOCATION
- EXISTING POWER POLE
- EXISTING TRANSMISSION TOWER

TOTAL ESTIMATED EARTHWORK QUANTITIES
(FOR ON-SITE SITE DEVELOPMENT AREAS, NOT INCLUDING MAIN ACCESS ROAD GRADING)
CUT=504,000 CY
FILL=504,000 CY

Title: DOWNSTREAM DRAINAGE SYSTEM EXHIBIT
CITY HEIGHTS
CLE ELUM, WASHINGTON

For: GREEN CANYON LLC / HIGH MARK RESOURCES LLC / COOPER PASS LLC
206 WEST FIRST STREET
CLE ELUM, WA 98922 (509) 674-6828

BARGHAUSEN CONSULTING ENGINEERS, INC.
18215 72ND AVENUE SOUTH
KENT, WA 98032
(425) 251-6222 FAX
CIVIL ENGINEERING, LAND PLANNING,
SURVEYING, ENVIRONMENTAL SERVICES

Designed JWC | Scale horizontal 1"=300'
Drawn AL | vertical N/A
Checked JWC
Approved JWB
Date 12/20/11

Job Number 14953
Sheet 2 of 2

Section 5 Core Elements

Compliance with Core Elements 1 through 8, per Section 2.7 of the 2019 SWMMEW, are listed below.

Core Element #1: Preparation of a Stormwater Site Plan:
Clearing, Grading & Infrastructure Plans under separate cover and Storm Drainage Report herein have been prepared for the subject property.

Core Element #2: Construction Stormwater Pollution Prevention:
The project will include temporary measures (silt fence, construction entrance) as well as permanent measures (seeding, landscaping) for control of stormwater during construction. See Section 7 for more information.

Core Element #3: Source Control of Pollution:
The site is mostly residential and is, therefore, anticipated to have minimal opportunities for pollution. The community will have an HOA which is encouraged to share educational information to future residents regarding water quality and to promote voluntary use of BMP's.

Core Element #4: Preservation of Natural Drainage Systems:
The site consists of two drainage basins with separate discharge locations divided by an existing onsite stream (Stream C). In the existing condition, runoff from the Crystal Creek 5 basin sheets flows south towards a ditch along 6th Street. Runoff continues east along a ditch prior to outleting to an existing roadside ditch. In the developed condition, Crystal Creek 5 will enter the proposed conveyance system which will be routed to a biofiltration swale and a detention vault (Vault C), prior to outleting into the existing roadside ditch.

In the existing condition, runoff from the Crystal Creek 3 basin sheet flows southeast towards an existing onsite stream (Stream C), which is ultimately tributary to Crystal Creek. In the developed condition, Crystal Creek 3 will enter the proposed conveyance system (includes a biofiltration swale) which will be routed to a detention pond (Pond B7-A), prior to outleting into Stream C.

The proposed project will preserve the natural drainage system. See Section 4 of this report for the downstream analysis.

Core Element #5: Runoff Treatment:
The project proposes more than 5,000 SF of PGIS, is not a commercial or industrial site, and does not discharge to a wetland or phosphorous sensitive receiving waters. Per Figure 2.3 of the 2019 SWMMEW, basic water quality treatment is required.

Core Element #6: Flow Control:
The project will implement flow control BMPs per Chapter 6 of the 2019 SWMMEW. A detention pond (Pond B7-A) and detention vault (Vault C) are proposed per BMP F6.10 and BMP F6.12 to meet the allowable developed peak flows and not exceed the pre-developed rates for the following storm events: 50% of the 2-year storm event, 25-year storm event, and 100-year storm event (per DA).

Core Element #7: Operation and Maintenance:
An Operation and Maintenance Manual will be provided with the final engineering submittal.
Core Element #8: Local Requirements:

The project has been designed using the guidelines and requirements established in the 2019 Department of Ecology (DOE) Stormwater Management Manual for Eastern Washington (SWMMEW) and the City Heights Annexation and Development Agreement (DA), dated November 8, 2011. The DA contains references to local requirements and vesting.

Section 6 Permanent Stormwater Control Plan

6.1 EXISTING HYDROLOGY

The existing site is undeveloped and mostly forested. There are existing bike trails that are within the premises of Phase 1 site, part of the City Heights development. For modelling purposes, the existing site was modeled as the existing condition in accordance with Section 2.7.7 of the 2019 SWMMEW. There are two basin that generate runoff: the Crystal Creek 3 basin that outlets to an onsite stream (Stream C) prior to entering Crystal Creek and the Crystal Creek 5 basin that outlets to an existing roadside ditch prior to entering Crystal Creek south of the site. Refer to the *Existing Conditions Exhibit* Included in Section 2 of this report for more information. The existing condition areas used to run the drainage model are summarized below. Refer to Appendix for full Hydraflow report.

TRIBUTARY TO CRYSTAL CREEK 3

EXISTING CONDITIONS

Onsite Pervious		
Forest (CN=73)	6.43	ac
TOTAL FOREST (SOIL GROUP C)	6.43	ac
Upstream Pervious		
Forest (CN=73)	2.17	ac
TOTAL FOREST (SOIL GROUP C)	2.17	ac
TOTAL EXISTING CONDITIONS	**8.60**	**ac**

TRIBUTARY TO CRYSTAL CREEK 5

EXISTING CONDITIONS

Pervious		
Forest (CN=73)	8.23	ac
Pasture (CN=79)	0.92	ac
TOTAL PERVIOUS (SOIL GROUP C)	9.15	ac
Impervious		
Road (Existing Summit View Rd, CN=98)	0.15	ac
TOTAL IMPERVIOUS	0.15	ac
TOTAL EXISTING CONDITIONS	**9.30**	**ac**

6.2 DEVELOPED HYDROLOGY

The project proposes 68 lots. Flows for each basin will be collected by the proposed conveyance systems and conveyed to the detention and water quality facilities.

There are two basins analyzed for Phase 1, part of the City Heights development. The developed basins for the Crystal Creek 3 basin and Crystal Creek 5 basin match the existing basins.

For the Crystal Creek 3 basin, runoff will be routed to Pond B7-A before discharging to a location that will mimic existing drainage patterns. Pond B7-A is sized to detain developed runoff in order to maintain the stream protection flow of the existing forested site. The upstream areas will remain undeveloped and runoff will be collected and routed through Pond B7-A as bypass and discharged to the downstream system.

For the Crystal Creek 5 basin, runoff will be routed to Vault C before discharging to a location that will mimic existing drainage patterns. Vault C is sized to detain developed runoff in order to maintain the stream protection flow of the site, which is mostly forested with an existing drive. Upstream areas will remain undeveloped and will be routed around the detention/water quality facilities and, as such are not included in the analysis.

Onsite storm drain infrastructure will collect and convey drainage for the site. Please refer to the Clearing, Grading & Infrastructure Plans for more information on the proposed storm drain improvements. The areas used to run the drainage model associated with the developed basins conditions are summarized below and on the following pages. Refer to Appendix for full Hydraflow report.

The percent impervious for each type of area is listed in the area tables below. Lot area coverage is based on maximized house and garage footprints. The majority of lots contain 60% impervious coverage or less. Lots that are between 60% and 70% coverage are modeled as 70% impervious. Right-of-way and private access tract impervious areas are based on the road sections and is increased where there are driveway cuts in the right-of-way. The drainage tract for the pond is assumed 80% impervious based on the area associated with the access road and area below the maximum water surface of the pond. The open space tracts are assumed to have 10% impervious coverage to account for trail areas, bike paths and parking. The impervious coverage for each basin was conservatively rounded up to the nearest 5% for the Hydraflow models.

TRIBUTARY TO CRYSTAL CREEK 3 (Pond B7-A)

DEVELOPED CONDITIONS

Impervious (CN=98) *		
Lots *(60% impervious: Lots 41-68)*	2.31	ac
50' ROW *(68% impervious)*	1.06	ac
Drainage Tract *(80% impervious)*	0.56	ac
Open Space Tracts *(10% impervious)*	0.03	ac
TOTAL IMPERVIOUS	3.96	ac

Pervious (CN=79) *		
Lots *(40% pervious: Lots 41-68)*	1.54	ac
50' ROW *(32% pervious)*	0.50	ac
Drainage Tract *(20% pervious)*	0.14	ac
Open Space Tracts *(90% pervious)*	0.29	ac
TOTAL PERVIOUS (SOIL GROUP C)	2.47	ac
Onsite Upstream Pervious (Bypass)		
Forest (CN=73)	2.17	ac
TOTAL FOREST (SOIL GROUP C)	2.17	ac
TOTAL DEVELOPED CONDITIONS	**8.60**	**ac**

*Actual impervious is 3.96 ac (approximately 62% of developed basin) and actual pervious is 2.44 ac (approximately 38% of developed basin). Drainage model conservatively assumes 4.18 ac impervious (65% of developed basin, CN=98) and 2.25 ac pervious (35% of developed basin, Pasture CN=79).

TRIBUTARY TO CRYSTAL CREEK 5 (Vault C)

DEVELOPED CONDITIONS

Impervious (CN=98) *		
Lots *(60% impervious: Lots 1-19, 24-25, 30-40)*	1.68	ac
Lots *(70% impervious: Lots 20-23, 26-29)*	0.31	ac
45' ROW *(73% impervious)*	0.65	ac
Modified Road/Private Access *(90% impervious)*	0.97	ac
Amenity Area (Outfitter) *(25% impervious)*	0.36	ac
Public Access (Parking) *(60% impervious)*	0.16	ac
Open Space/Drainage Tracts *(10% impervious)*	0.24	ac
TOTAL IMPERVIOUS	4.37	ac
Pervious (CN=79) *		
Lots *(40% pervious: Lots 1-19, 24-25, 30-40)*	1.12	ac
Lots *(30% pervious: Lots 20-23, 26-29)*	0.13	ac
45' ROW *(27% pervious)*	0.24	ac
Modified Road/Private Access *(10% pervious)*	0.10	ac
Amenity Area (Outfitter) *(75% pervious)*	1.07	ac
Public Access (Parking) *(40% pervious)*	0.11	ac
Open Space/Drainage Tracts *(90% pervious)* **	2.16	ac
TOTAL PERVIOUS (SOIL GROUP C)	4.93	ac
TOTAL DEVELOPED CONDITIONS	**9.30**	**ac**

*Actual impervious is 4.37 ac (approximately 47% of basin) and actual pervious is 4.93 ac (approximately 53% of basin). Drainage model conservatively assumes 4.65 ac impervious (50% of basin, CN=98) and 4.65 ac pervious (50% of basin, 50% Pasture CN=79/50% Forest CN=73).
**Pervious areas for this basin are modeled as 50% Pasture CN=79 and 50% Forest CN=73 in anticipation that forested areas will remain where feasible to preserve the natural feel of the development.

6.3 DESIGN PARAMETERS

The flow control and water quality elements are designed per 2019 SWWMWEW.

- Rain Distribution: SCS Type 1A
- 24-hrs Precipitations:

Storm Event Return Period	24-hr Depth (inches)
6-month (WQ)	1.40
2-year	2.00
10-year	3.25
25-year	3.50
100-year	4.75

Per Section 4.3.9 of the 2019 SWMMEW, including rain-on-snow and snowmelt design, is optional guidance for detention and water quality design. However, rain-on-snow and snowmelt design requirements are applied for this project per City Heights Annexation and Development Agreement, dated November 8, 2011. The 2019 SWMMEW does not contain snowmelt adjustment factors for Cle Elum. Snowmelt adjustment factors for another relatively close, similar location were used to determine the water equivalent precipitation adjustment for Cle Elum.

Cle Elum:
Avg Annual Precipitation (2019 SWMMEW Figure 4.1): 25 inches
Avg Daily Snow Depth (inches 2019 SWMMEW Table 4.9): to determine

Wenatchee:
Avg Annual Precipitation (2019 SWMMEW Figure 4.1): 10 inches
Avg Daily Snow Depth (inches 2019 SWMMEW Table 4.9)2.67 inches

2.67” * 25” / 10” = 6.675”
6.675” * 20% moisture content = 1.34”
(1.34” to be added to each design storm, not including water quality storm)

- 24-hr precipitation depths with applied snowmelt adjustment factor are as below:

Storm Event Return Period Including snowmelt design factor	24-hr Depth (inches)
6-month (WQ)	1.40
2-year	3.34
10-year	4.59
25-year	4.84
100-year	6.09

6.4 FLOW CONTROL

The proposed Phase 1, part of City Heights development, will implement Basic Water Quality Treatment and match 50% of the 2-year peak flow and the full 10-year peak flow, 25-year peak flow and 100-year peak flow as described in the 2019 SWMMEW and City Heights Annexation and Development Agreement, dated November 8, 2011

The existing and developed site conditions were modeled using the Hydraflow hydrology model. Vault C is proposed for the Clear Creek 5 basin and Pond B7-A is proposed for the Clear Creek 3 basin so that the developed discharge peak flows match the pre-developed peak flows for 50% of the 2-year peak flow up to the full 25-year peak flow and full 100-year peak flow (Core Element #6).

Approximately 0.21 acres of Summit View Road right-of-way will be collected via thickened edge and catch basin and routed to a dispersion trench for full dispersion. Refer to sizing at the end of this section.

POND/VAULT PERFORMANCE

Pond B7A:

The pond is sized to detain developed runoff in order to maintain the stream protection flow of the existing site conditions. The undeveloped areas runoff will be routed through the project site to the pond. Please see table below for discharge calculations to include the undeveloped areas runoff.

	A	B	C	D	E	F	G
Storm Event	Existing[1] Peak Flow (cfs)	Existing[2] Peak Flow (cfs)	Existing Match Flow (cfs)*	Dev[3] Peak Flow (cfs)	Dev[4] Peak Flow (cfs)	Dev[5] Peak Flow (cfs) **	100-year Elevation
2-year	1.25	0.42	**1.05**	3.98	4.40	**1.02**	
10-year	2.73	0.92	**3.65**	6.03	6.95	**2.82**	
25-year	3.06	1.03	**4.09**	6.44	7.47	**3.36**	
100-year	4.79	1.62	**6.41**	8.48	10.1	**6.40**	**106.20**

1: Existing: onsite existing area
2: Existing: onsite existing area + onsite upstream area
3: Dev: unmitigated onsite developed area
4: Dev: unmitigated onsite developed area + onsite upstream area (column B + column D)
5: Dev: mitigated onsite developed area + onsite upstream area

** Existing Match Flow (includes onsite upstream area) = 50% onsite undeveloped peak flow + onsite upstream area, these are the allowable peak flows used for designing the detention facility*
*** Developed peak flows for mitigated onsite developed area + onsite upstream area are obtained from Hydraflow*

The required volume for the proposed pond is 25,721 cubic feet. The design water surface elevation (100-Year water surface elevation) corresponds to a depth of 6.20 feet which is determined based on the 100-year mitigated outflow and the Hydraflow discharge peak stage. See full Hydraflow output in Appendix.

The proposed water surface elevation will be 6.20'. The provided pond volume will exceed the minimum required. The proposed 6.20' deep pond will provide 28,199 cubic feet of live storage. The proposed pond is therefore adequately sized to accommodate the required flow control.

Pond B7-A - Live Storage Volume
Required = 25,721 cubic feet
Provided = 28,199 cubic feet

The primary overflow for the pond is the riser pipe on the control structure. The water surface elevation above the riser for the 100-year developed flow is calculated assuming all orifices are plugged. To pass the 100-year return period storm, 6.40 cfs, 0.58 feet of head is required per the following equation: $Q = 9.739DH^{3/2}$ or $6.40 = 9.739(1.5)H^{3/2}$. The overflow elevation, would therefore, be equal to the elevation of the top of the riser, 2028.50,

plus the amount of head required to pass the 100-year return period storm, 0.58 feet. A minimum freeboard of approximately 0.58 feet will be provided.

A secondary inlet into the control structure is provided by a "Jailhouse Weir". The bottom of the Jailhouse Weir will be located at the design water surface elevation, 2028.50. The provided head over the weir will be 0.58 feet. To pass the 100-year return period storm, 6.40 cfs, through the Jailhouse Weir, 4.50 feet of length is required per the following equation, $Q=(3.27+0.4*(H/P))*(L-0.2H)(H^{3/2})$, where P is the live storage depth (6.20 feet). A 6-foot long by 0.58-foot tall Jailhouse Weir opening will be provided.

A type-II manhole fitted with a birdcage debris barrier will provide an emergency overflow route to the downstream system. Utilizing this structure, in lieu of an overflow spillway, will allow overflow to be routed away from the steeper sections of the stream to avoid erosion in the area of the constructed pond. To pass the 100-year return period, 6.40 cfs, 0.26 feet of head is required per the following equation: $Q = 9.739DH^{3/2}$ or $6.40 = 9.739(5)H^{3/2}$. The rim of the emergency overflow structure is set at the top of the primary overflow elevation, 2029.08. The calculated head over the structure puts the emergency overflow water surface elevation at 2029.34, which is below the berm elevation, 9030.00.

Vault C:

The Vault is sized to detain developed runoff in order to maintain the stream protection flow of the existing pre-developed site conditions. The onsite areas upstream, 3.89 ac, will remain undeveloped and undetained. This area will be collected via shallow swale and will bypass the vault/water quality facilities and, as such, is not included in the analysis. Please see table below for discharge calculations to include the bypassing of the undeveloped areas runoff.

Storm Event	Existing[1] Peak Flow (cfs)	Existing Match Flow[2] (cfs)	Dev[3] Peak Flow (cfs)	Dev[4] Peak Flow (cfs)*	100-year Elevation
2-year	1.98	**0.99**	4.83	**0.99**	
10-year	4.18	**4.18**	7.76	**1.96**	
25-year	4.67	**4.67**	8.35	**2.53**	
100-year	7.22	**7.22**	11.35	**7.22**	**106.69**

1: Existing: onsite existing
2: Existing: onsite allowable peak flows
3: Dev: unmitigated onsite developed area
4: Developed: mitigated onsite developed area

**Developed peak flows for mitigated onsite developed areas are obtained from Hydraflow*

The required volume for the proposed vault is 35,457 cubic feet. The design water surface elevation (100-Year water surface elevation) corresponds to a depth of 6.69 feet which is determined based on the 100-year mitigated outflow and the Hydraflow discharge peak stage. See full Hydraflow output on Appendix.

The provided pond volume will exceed the minimum required. The proposed vault (2 cells @104 L' x 19'W x 6.69'D + 1 cell @ 80'L x 19'W x 6.69'D will provide 34,353 cubic feet of live storage. The proposed pond is therefore adequately sized to accommodate the required flow control.

Vault C - Live Storage Volume
Required = 35,457 cubic feet
Provided = 36,608 cubic feet

The overflow for the vault is the riser pipe on the flow restrictor. The water surface elevation above the riser for the 100-year developed flow is calculated assuming all orifices are plugged. To pass the 100-year return period storm, 7.22 cfs, 0.72 feet of head is required per the following equation: $Q = 3.782D^2H^{1/2}$ or $7.22 = 3.782(1.5)^2H^{1/2}$. The overflow elevation, would therefore, be equal to the elevation of the top of the riser, 2000.69, plus the amount of head required to pass the 100-year return period storm, 0.72 feet. A minimum freeboard of approximately 0.72 feet will be provided.

FLOW DISPERSION TRENCH DESIGN

Approximately 0.21 acres of Summit View Road right-of-way will be collected via thickened edge and catch basin and routed to a dispersion trench for full dispersion.

Per BMP F6.42 Full Dispersion in the 2019 SWMMEW, discharge points with between 0.2 and 0.5 cfs discharge for the 100-year storm shall use only dispersion trenches to disperse flows. Dispersion trenches shall be designed to accept surface flows (free discharge) from a pipe, culvert, or ditch end, shall be aligned perpendicular to the flow path, and shall be minimum 2' by 2' in section, 50' in length, filled with 0.75- to 1.5-in washed rock, and provided with a level notched grade board. The 50' dispersion trench can treat up to 0.5 cfs, which equates to 10' length of trench for each 0.1 cfs. The 100-year storm based on the areas tributary to the dispersion trench (below) is 0.298 cfs based on Hydraflow output and, therefore, 30 ft of trench is required. A 30' dispersion trench is proposed for full dispersion.

TRIBUTARY TO DISPERSION TRENCH

DEVELOPED CONDITIONS		
Impervious (CN=98) *		
45' ROW *(73% impervious)*	0.15	ac
TOTAL IMPERVIOUS	0.15	ac
Pervious (CN=79) *		
45' ROW *(27% pervious)*	0.06	ac
TOTAL PERVIOUS (SOIL GROUP C)	0.06	ac
TOTAL DEVELOPED CONDITIONS	**0.21**	**ac**

6.5 WATER QUALITY

The project proposes more than 5,000 SF of PGIS, is not a commercial or industrial site, and does not discharge to a wetland or phosphorous sensitive receiving waters. Per Figure 2.3 of the 2019 SWMMEW, the project will comply with basic water quality requirements using a biofiltration swale upstream of detention pond (B7-A) and Vault (C). The project is not required to provide oil control BMPs, metals treatment BMPs, or phosphorus treatment BMPs.

Per email coordination with the City of Cle Elum on 6/1/2020, the water quality precipitation depth assumptions have been deemed acceptable. The 2-year, 24-hour precipitation depth (2.00 in) is multiplied by the c_{wqs} coefficient from Table 4.5 in the 2019 SWMMEW (0.70 for Climate Region 1) to determine the water quality precipitation depth (1.4 in). The water quality design flow rate for the 6-month, 24-hour storm is then determined with Hydraflow analysis model for each basin.

It is anticipated that basic water quality treatment Pond B7-A and Vault C will be satisfied using the BMP T5.40 design requirements per Section 5.5.5 of the 2019 SWMMEW. The biofiltration swale will also act as a conveyance element with capacity for the 25-year and 100-year storms if it is located online. An online trapezoidal shape with 3:1 side slope has been proposed. Refer to water quality flow rates and sizing included on the following pages.

Per Section 5.5.5 of the 2019 SWMMEW, Manning's Equation (Equation 5.3) is used to estimate the bottom width of the biofiltration swale. Manning's Equation for English units is as follows:

Q = (1.486 * A * R0.667 * S 0.5) / n

where:

Q = flow (cfs)

A = cross-sectional area of flow (square feet [sf])

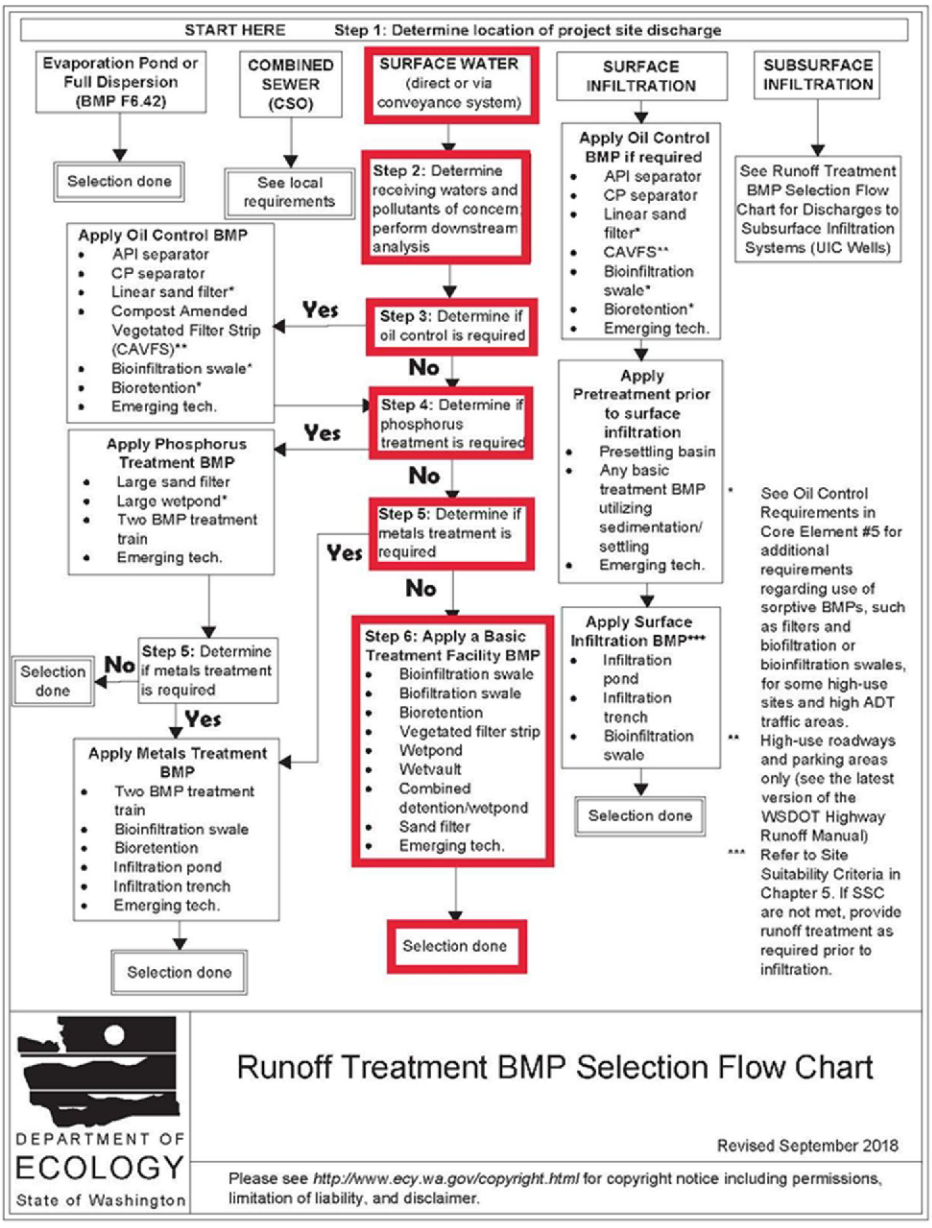
R = hydraulic radius of flow cross section (feet [ft])

S = longitudinal slope of biofiltration swale (feet per foot [ft/ft])

n = Manning's roughness coefficient.

n = 0.20 for a biofiltration swale with less dense vegetation such as meadow or pasture

Figure 5.1: Runoff Treatment BMP Selection Flow Chart



POND B7-A

BMP	FLOW RATE FOR 6-MONTH STORM EVENT (CFS)[1]	SWALE BOTTOM WIDTH (FT)	REQUIRED SWALE LENGTH (FT)[2]	PROVIDED SWALE LENGTH (%)[3]	SLOPE (%)[4]	FLOW DEPTH (FT)	VELOCITY AT WQ DESIGN FLOW RATE, V (FT/SEC)	VELOCITY AT 100-YR FLOW RATE, V (FT/SEC)[5]
Pond B7-A Swale, 1.5%	0.979	3	91.2	682	1.5	0.48	0.456 < 1	0.861 < 2
Pond B7-A Swale, 5%	0.979	3	139	682	5	0.35	0.695 < 1	1.344 < 2

1. The flow rate is conservatively taken to be the full flow rate tributary to Pond B7-A (including upstream). There is a high point in the road, which will divide the biofiltration swale, and therefore the amount of flow to each swale will be less.
2. Required length is determined based on velocity associated with the water quality design flow rate.
3. The provided length is the full length of swale shown on the plans minus an assumed 20' of driveway width per lot.
4. The slope of the swale varies based on road grade. Minimum and maximum slopes have been provided to show variation in flow depths, velocities, and required length of swale.
5. The maximum velocity is checked to ensure flows do not cause erosion. Velocity not to exceed 2 ft/sec per the 2019 SWMMEW.

VAULT C

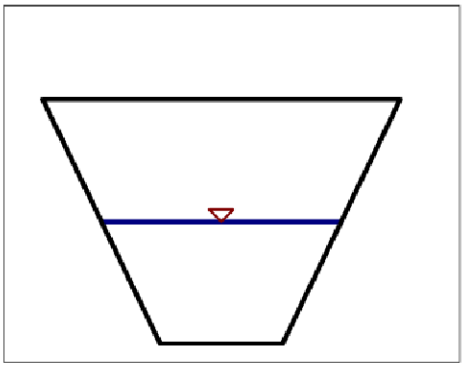
BMP	FLOW RATE FOR 6-MONTH STORM EVENT (CFS)[1]	SWALE BOTTOM WIDTH (FT)	REQUIRED SWALE LENGTH (FT)[2]	PROVIDED SWALE LENGTH (%)	SLOPE (%)	FLOW DEPTH (FT)	VELOCITY AT WQ DESIGN FLOW RATE, V (FT/SEC)	VELOCITY AT 100-YR FLOW RATE, V (FT/SEC)[3]
Vault C Swale	0.844	3	75.6	78	1	0.50	0.378 < 1	0.764 < 2

1. The flow rate for the sizing the biofiltration swale upstream of Vault C is conservatively taken to be the full flow rate tributary to Vault C (includes non-PGIS). There will be a portion of area tributary to the vault (lots 1-8) that cannot physically be routed to this swale. Minimal PGIS is anticipated on lots 1-8 (driveway areas, ~3200sf). Based on the existing grades in 6th street, a portion of existing road (not developed/required for treatment) will drain to proposed catch basins that are routed to the biofiltrations swale. Water quality will be provided for this non-target area to offset the PGIS on lots 1-8 that will tie directly into Vault C without water quality treatment.
2. Required length is determined based on velocity associated with the water quality design flow rate.
3. The maximum velocity is checked to ensure flows do not cause erosion. Velocity not to exceed 2 ft/sec per the 2019 SWMMEW.

Crystal Creek 3 (Pond B7-A):

1.5% slope scenario

	Input	Output	
Q (cfs)	0.00	0.98	
n	0.200	0.200	
B (ft)	3.00	3.00	Trap.
LSSlope (X:1)	3.00	3.00	
RSSlope (X:1)	3.00	3.00	
y (ft)	0.48	0.48	
S (ft/ft)	0.015	0.015	

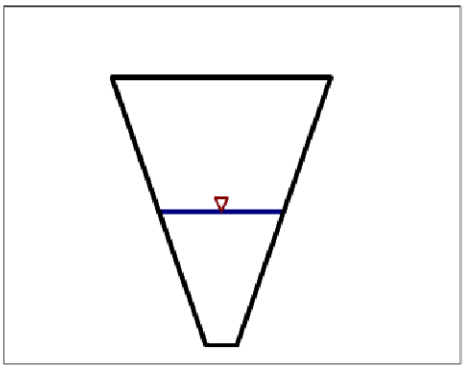


A (sf)	2.147		
Pw (ft)	6.053	V (ft/s)	0.456
R (ft)	0.355		

Job: City Heights Phase 1
By:

Description: Pond B7-A - WQ flow, 1.5% slope
Date: 6/16/2020

	Input	Output	
Q (cfs)	0.00	10.10	
n	0.200	0.200	
B (ft)	3.00	3.00	Trap.
LSSlope (X:1)	3.00	3.00	
RSSlope (X:1)	3.00	3.00	
y (ft)	1.54	1.54	
S (ft/ft)	0.015	0.015	



A (sf)	11.730		
Pw (ft)	12.737	V (ft/s)	0.861
R (ft)	0.921		

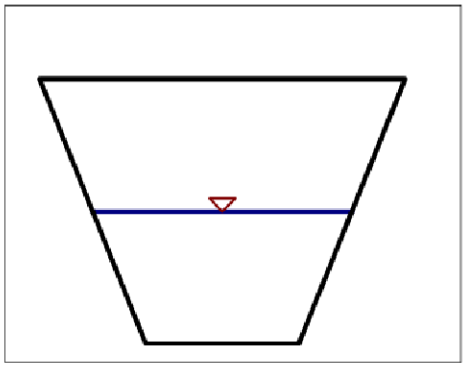
Job: City Heights Phase 1
By:

Description: Pond B7-A - 100-yr flow, 1.5% slope
Date: 6/16/2020

The flow depth for flow during the 100-year 24-hrs storm is 1.54' which is slightly higher than the total depth (1.50'). As mentioned, the flow rate is conservatively taken to be the full flow rate tributary to Pond B7-A (including upstream). There is a high point in the road, which will divide the biofiltration swale, and therefore the amount of flow to each swale will be less. Also, the maximum velocity for the total depth of channel is less than 2 ft/s and should not cause erosion.

5% slope scenario

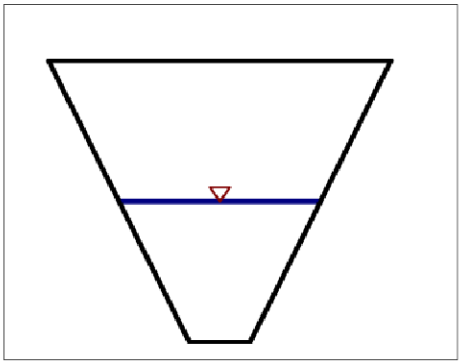
	Input	Output	
Q (cfs)	0.00	0.98	
n	0.200	0.200	
B (ft)	3.00	3.00	Trap.
LSSlope (X:1)	3.00	3.00	
RSSlope (X:1)	3.00	3.00	
y (ft)	0.35	0.35	
S (ft/ft)	0.050	0.050	



A (sf)	1.408		
Pw (ft)	5.202	V (ft/s)	0.695
R (ft)	0.271		

Job: City Heights Phase 1 **Description:** Pond B7-A - WQ flow, 5% slope
By: **Date:** 6/16/2020

	Input	Output	
Q (cfs)	0.00	10.10	
n	0.200	0.200	
B (ft)	3.00	3.00	Trap.
LSSlope (X:1)	3.00	3.00	
RSSlope (X:1)	3.00	3.00	
y (ft)	1.16	1.16	
S (ft/ft)	0.050	0.050	



A (sf)	7.519		
Pw (ft)	10.338	V (ft/s)	1.344
R (ft)	0.727		

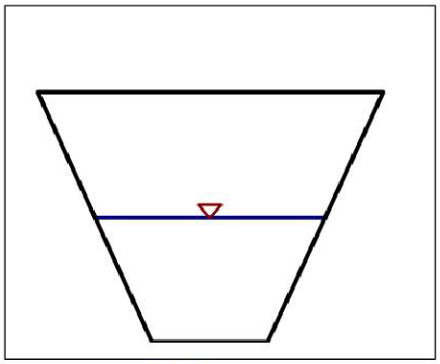
Job: City Heights Phase 1 **Description:** Pond B7-A - 100-yr flow, 5% slope
By: **Date:** 6/16/2020

The flow depth for flow during the 100-year, 24-hrs storm is 1.16’ which is lower than the total depth (1.50’). Also, the maximum velocity for the total depth of channel is less than 2 ft/s and should not cause erosion.

Crystal Creek 5 (Vault C):

Ditch

	Input	Output	
Q (cfs)	0.00	0.84	
n	0.200	0.200	
B (ft)	3.00	3.00	Trap.
LSSlope (X:1)	3.00	3.00	
RSSlope (X:1)	3.00	3.00	
y (ft)	0.50	0.50	
S (ft/ft)	0.010	0.010	

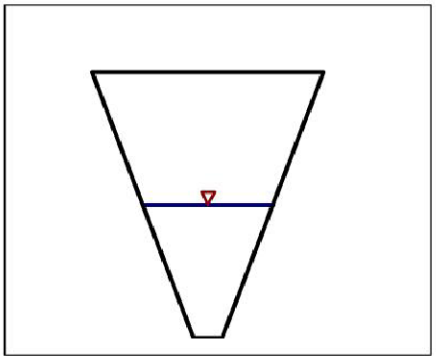


A (sf)	2.231		
Pw (ft)	6.143	V (ft/s)	0.378
R (ft)	0.363		

Job: City Heights Phase 1 **Description:** Vault C - WQ flow
By: **Date:** 3/4/2021

Ditch

	Input	Output	
Q (cfs)	0.00	11.35	
n	0.200	0.200	
B (ft)	3.00	3.00	Trap.
LSSlope (X:1)	3.00	3.00	
RSSlope (X:1)	3.00	3.00	
y (ft)	1.78	1.78	
S (ft/ft)	0.010	0.010	



A (sf)	14.864		
Pw (ft)	14.267	V (ft/s)	0.764
R (ft)	1.042		

Job: City Heights Phase 1 **Description:** Vault C - 100-yr flow
By: **Date:** 3/4/2021

The flow depth for flow during the 100-year, 24-hrs storm is 1.78' which is lower than the total depth (2.00'). Also, the maximum velocity for the total depth of channel is less than 2 ft/s and should not cause erosion.

6.6 LID BMP IMPLEMENTATION

LID BMPs will be implemented for the project to the maximum extent feasible per the 2019 DOE requirements.

Amended soils will be applied to landscaped areas on the site. Additionally, critical areas will be set aside in critical area tracts and native vegetation will be preserved.

Per the Geotechnical Engineering Report prepared by Terra Associates, infiltration as a primary means of stormwater flow control and management will not be feasible.

6.7 CONVEYANCE SYSTEM DESIGN

Per the City Heights Annexation and Development Agreement, dated November 8, 2011 the storm drain conveyance system will be designed to convey the 100-year storm. The conveyance system is designed with sufficient capacity to convey and contain the 100-yr peak flow and no overtopping.

The Rational Method is most appropriate for sizing new conveyance systems that drain smaller, quickly responding tributary areas (i.e., less than 10 acres) where very short, intense storms tend to generate the highest peak flows. For conveyance sizing and analysis tributary to Pond B7A and Vault C, the peak flows from Hydraflow (Hydrograph Extension for Autodesk Civil 3D 2019) are most accurate where tributary areas are greater than or equal to 10 acres. Hydraflow will be used for conveyance system sizing.

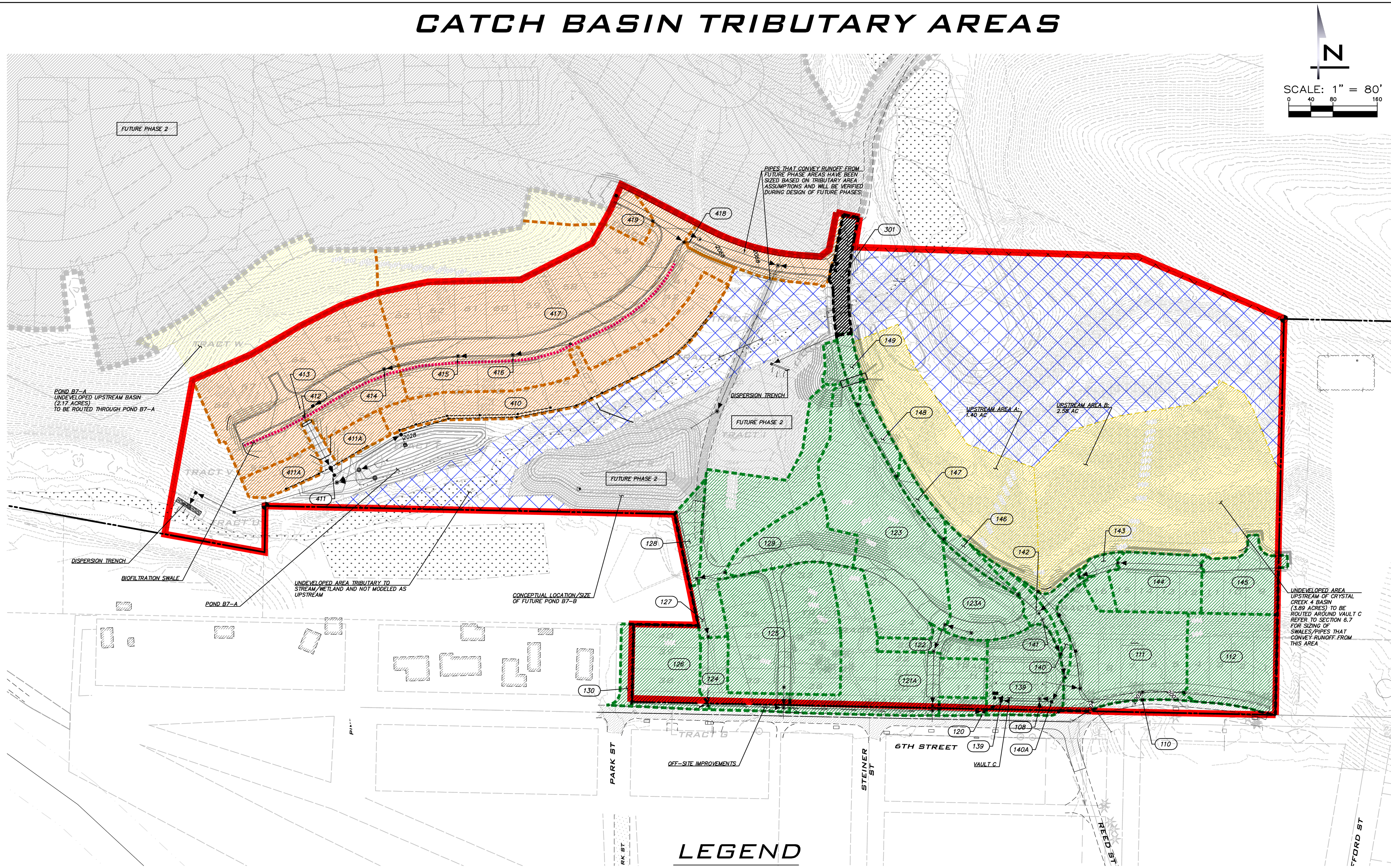
The hydraulic grade line is calculated using a backwater analysis spreadsheet. The spreadsheet performs a standard step backwater analysis on the network based on flows to each pipe, accounting for friction losses, bend losses, and velocity head losses. The steady state energy (Bernoulli) equation is used to calculate the hydraulic grade line at each on-site catch basin from downstream to upstream, beginning with the maximum water surface elevation of the downstream facility as the initial network tailwater elevation.

A tabular summary of the backwater spreadsheet analysis for each tributary area is included at the end of this section. The table identifies the total hydraulic headwater elevation at each catch basin for the 100-year event.

Areas upstream of Vault C will bypass the detention facility. Runoff from these areas will be collected via swales and then routed to the storm system downstream of the vault via tightline system. Refer to sizing information following the conveyance design for Pond B7-A and Vault C.

Refer to the conveyance analysis tables and CB Tributary Area Exhibit on the following pages.

CATCH BASIN TRIBUTARY AREAS



LEGEND

- TRIBUTARY TO POND B7-A (POD B7)
- TRIBUTARY TO VAULT C (POD C)
- TRIBUTARY TO DISPERSION TRENCH
- PHASE 1 (ONSITE)

BLUELINE

CATCH BASIN TRIBUTARY AREAS
CITY HEIGHTS PHASE 1
STORM DRAINAGE REPORT

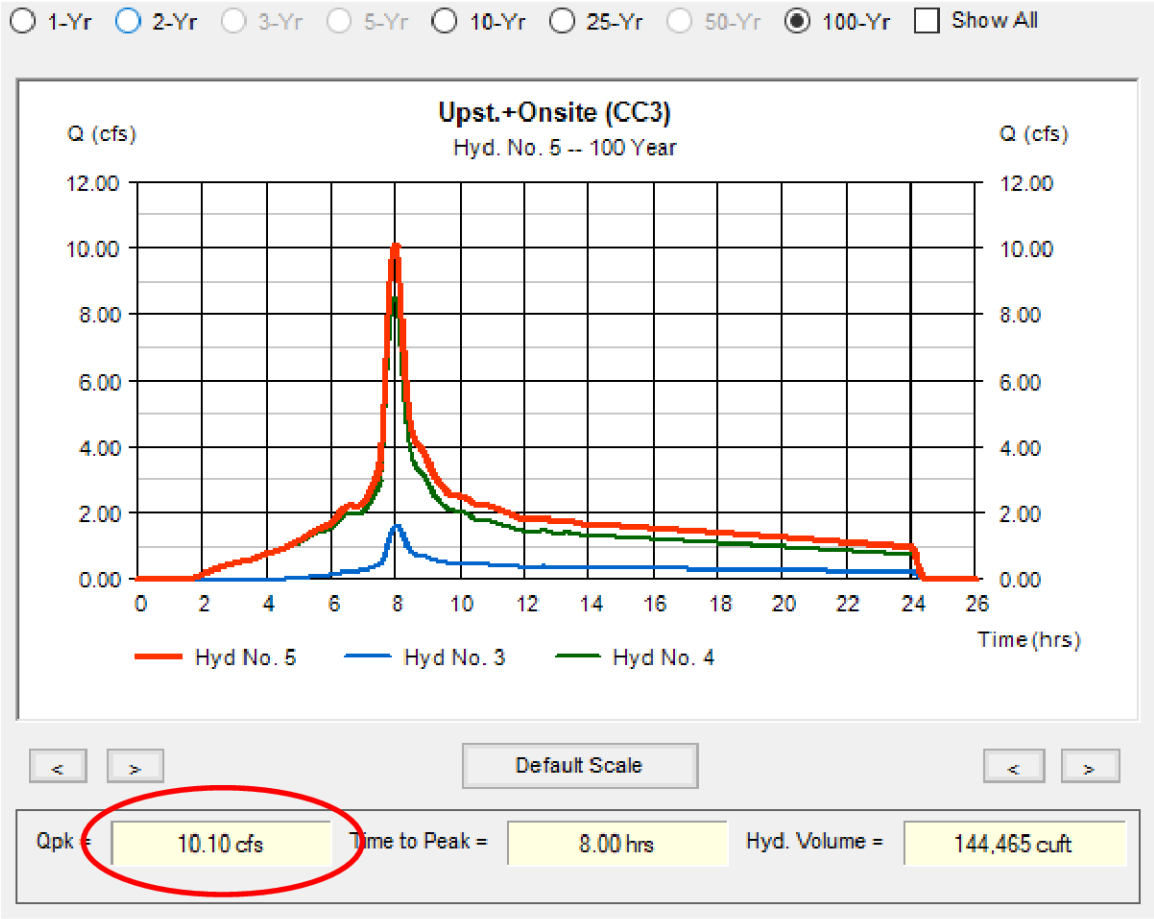
SCALE	AS NOTED
PROJECT MANAGER	BRETT PUDISTS, PE
DESIGNED BY	CHRIS WISCOMB
DRAWN BY	MICHELLE ROBERGE
PLOT DATE	March 12, 2021

JOB NUMBER: 19-349

FIGURE: TA

Pond B7-A – Hydraflow Method, 100-year event

The developed, unmitigated 100-year storm event is 10.1 cfs. These flows are associated with the entire area tributary to Pond B7-A. The area associated with the pond within Tract T is not included in the conveyance spreadsheet as it is not conveyed to Pond B7-A via the main storm system, however, the entire flow, 10.1 cfs, is conservatively used for determining the flow tributary to each catch basin.



In order to determine the flow tributary to each catch basin, the percent of the total area tributary to the catch basin was determined and then multiplied by the total tributary to the pond. For example, the total flow tributary to CB 419 is equal to 0.28 acres divided by 7.70 acres multiplied by 10.1 cfs, or 0.37 cfs. The conveyance system tailwater elevation is taken to be the 100-year water surface elevation at Pond B7-A, 2028.50. As shown on the spreadsheets on the following pages, the headwater elevations remained below the rims during the 100-year storm. Therefore, the system meets the requirements of the City Heights Annexation and Development Agreement, dated November 8, 2011 and is adequately designed.

BACKWATER CALCULATIONS

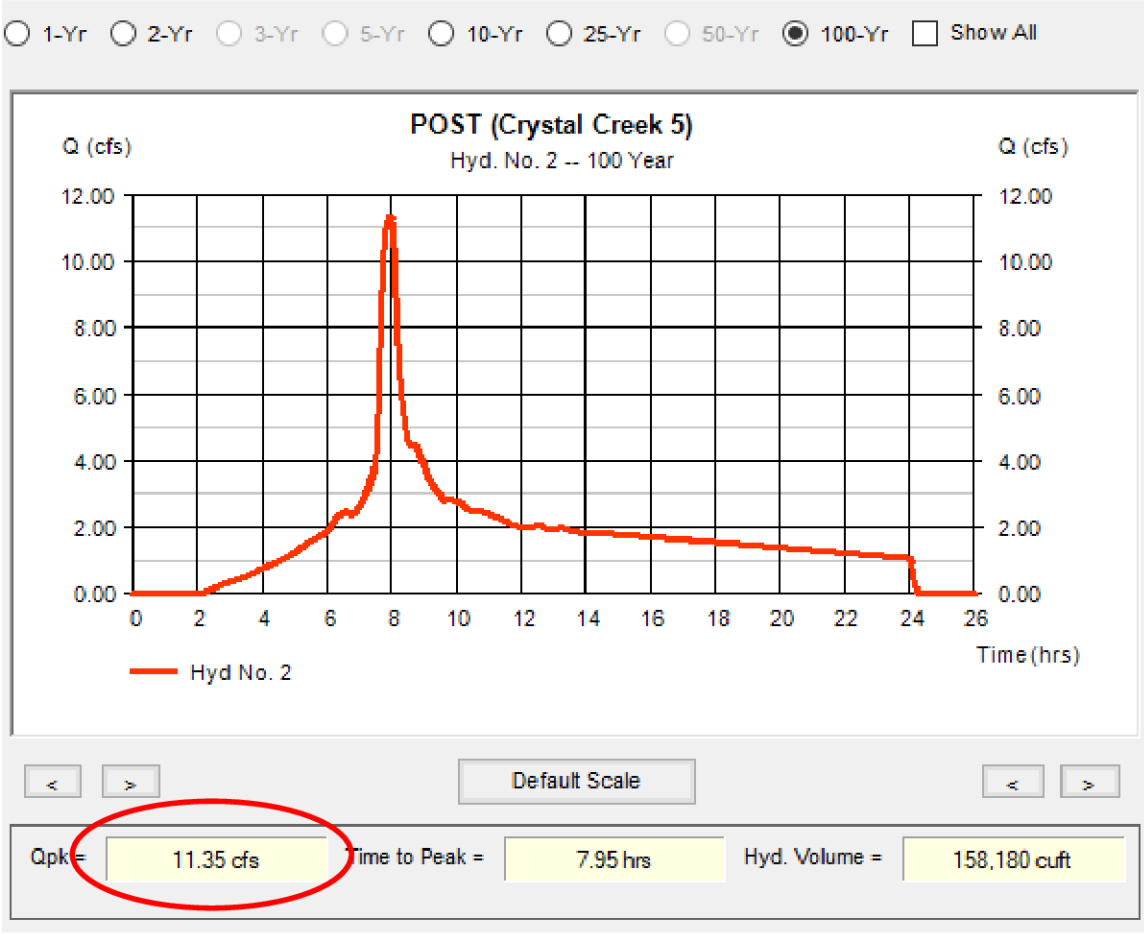
PROJECT NAME: City Heights - Phase 1 (Pods B7 and C) **PREPARED BY:** Michelle Roberge

PROJECT NUMBER: 19349 **DESIGN STORM:** 100 YEAR

PIPE SEGMENT FROM CB	PIPE SEGMENT TO CB	Q (CFS)	PIPE LENGTH (FT)	PIPE SIZE (IN)	MANNING'S "n" VALUE	OUTLET ELEVATION (FT)	INLET ELEVATION (FT)	PIPE AREA (SQ FT)	FULL VELOCITY (FT/SEC)	VELOCITY HEAD (FT)	TAILWATER ELEVATION (FT)	FRICTION LOSS (FT)	ENTRANCE HGL ELEVATION (FT)	ENTRANCE HEAD LOSS (FT)	EXIT HEAD LOSS (FT)	OUTLET CONTROL ELEVATION (FT)	INLET CONTROL ELEVATION (FT)	APPROACH VELOCITY HEAD (FT)	BEND HEAD LOSS (FT)	JUNCTION HEAD LOSS (FT)	HEADWATER ELEVATION (FT)	RIM ELEVATION (FT)	FREEBOARD (FT)
Pond	CB 410	10.10	26	18	0.011	2025.00	2026.40	1.77	5.72	0.51	2028.50	0.17	2028.67	0.25	0.51	2029.43	2028.66	0.00	0.67	0.00	2030.10	2031.40	1.30
CB 410	CB 411	9.03	141	18	0.011	2026.40	2029.65	1.77	5.11	0.41	2030.10	0.74	2031.15	0.20	0.41	2031.76	2031.68	0.41	0.54	0.00	2031.89	2034.65	2.76
CB 411	CB 411A	9.03	15	18	0.011	2029.65	2033.37	1.77	5.11	0.41	2031.89	0.08	2034.87	0.20	0.41	2035.48	2035.23	0.37	0.01	0.00	2035.11	2036.87	1.76
CB 411A	CB 412	8.65	101	18	0.011	2033.37	2045.46	1.77	4.90	0.37	2035.11	0.49	2046.96	0.19	0.37	2047.52	2047.33	0.13	0.01	0.00	2047.40	2048.96	1.56
CB 412	CB 413	5.10	11	18	0.011	2045.46	2046.22	1.77	2.88	0.13	2048.96	0.02	2048.98	0.06	0.13	2049.17	2047.72	0.13	0.17	0.00	2049.21	2049.72	0.51
CB 413	CB 414	5.10	168	18	0.011	2046.22	2050.22	1.77	2.88	0.13	2049.21	0.28	2051.72	0.06	0.13	2051.91	2051.72	0.13	0.01	0.00	2051.80	2057.30	5.50
CB 414	CB 415	5.10	136	18	0.011	2050.22	2051.03	1.77	2.88	0.13	2051.80	0.23	2052.53	0.06	0.13	2052.73	2052.53	0.13	0.01	0.00	2052.61	2057.52	4.91
CB 415	CB 416	5.10	99	18	0.011	2051.03	2051.63	1.77	2.88	0.13	2052.61	0.17	2053.13	0.06	0.13	2053.32	2053.13	0.13	0.01	0.00	2053.20	2056.48	3.28
CB 416	CB 417	5.10	107	18	0.011	2051.63	2052.27	1.77	2.88	0.13	2053.20	0.18	2053.77	0.06	0.13	2053.96	2053.77	0.00	0.00	0.00	2053.97	2055.61	1.64
Swale	CB 418	0.78	39	12	0.011	2063.00	2063.24	0.79	1.00	0.02	2064.35	0.01	2064.36	0.01	0.02	2064.39	2064.24	0.00	0.02	0.00	2064.40	2065.57	1.17
CB 418	CB 419	0.37	68	12	0.011	2063.24	2063.65	0.79	0.47	0.00	2064.40	0.01	2064.65	0.00	0.00	2064.66	2064.65	0.00	0.00	0.00	2064.66	2066.57	1.91

Vault C – Hydraflow Method, 100-year event

The developed, unmitigated 100-year storm event is 11.35 cfs. These flows represent flows from areas that are conveyed to Vault C via the storm system tributary to Vault C. Please note 3.89 acres of undeveloped upstream area will be routed around Vault C via a separate conveyance system.



In order to determine the flow tributary to each catch basin, the percent of the total area tributary to the catch basin was determined and then multiplied by the total tributary to the pond. For example, the total flow tributary to CB 149 is equal to 0.07 acres divided by 9.34 acres multiplied by 11.35 cfs, or 0.09 cfs. The conveyance system tailwater elevation is taken to be the 100-year water surface elevation at Vault C, 2000.69. As shown on the spreadsheets on the following pages, all headwater elevations remained below the rims during the 100-year storm. Therefore, the system meets the requirements of the City Heights Annexation and Development Agreement, dated November 8, 2011 and is adequately designed.

BACKWATER CALCULATIONS

PROJECT NAME: City Heights - Phase 1 (Pods B7 and C) **PREPARED BY:** Michelle Roberge

PROJECT NUMBER: 19349 **DESIGN STORM:** 100 YEAR

PIPE SEGMENT FROM CB	PIPE SEGMENT TO CB	Q (CFS)	PIPE LENGTH (FT)	PIPE SIZE (IN)	MANNING'S "n" VALUE	OUTLET ELEVATION (FT)	INLET ELEVATION (FT)	PIPE AREA (SQ FT)	FULL VELOCITY (FT/SEC)	VELOCITY HEAD (FT)	TAILWATER ELEVATION (FT)	FRICTION LOSS (FT)	ENTRANCE HGL ELEVATION (FT)	ENTRANCE HEAD LOSS (FT)	EXIT HEAD LOSS (FT)	OUTLET CONTROL ELEVATION (FT)	INLET CONTROL ELEVATION (FT)	APPROACH VELOCITY HEAD (FT)	BEND HEAD LOSS (FT)	JUNCTION HEAD LOSS (FT)	HEADWATER ELEVATION (FT)	CROWN EL.	RIM ELEVATION (FT)	FREEBOARD (FT)
Vault C	CB 109A	11.35	6	24	0.011	1995.71	1995.75	3.14	3.61	0.20	2000.69	0.01	2000.70	0.10	0.20	2001.01	1997.75	0.20	0.27	0.00	2001.07	1997.75	2007.38	6.31
CB 109A	CB 109	11.35	81	24	0.011	1995.75	1996.24	3.14	3.61	0.20	2001.07	0.14	2001.21	0.10	0.20	2001.52	1998.24	0.45	0.26	0.03	2001.36	1998.24	2006.11	4.75
CB 109	CB 110	1.83	186	12	0.011	1997.24	1998.36	0.79	2.33	0.08	2001.07	0.35	2001.42	0.04	0.08	2001.55	1999.36	0.08	0.11	0.00	2001.57	1999.36	2001.73	0.16
CB 110	CB 111	1.83	14	12	0.011	1998.36	1998.45	0.79	2.33	0.08	2001.57	0.03	2001.60	0.04	0.08	2001.72	1999.45	0.01	0.11	0.00	2001.82	1999.45	2001.98	0.16
CB 111	CB 112	0.75	75	12	0.011	1998.45	1998.90	0.79	0.96	0.01	2001.82	0.02	2001.84	0.01	0.01	2001.86	1999.90	0.00	0.00	0.00	2001.86	1999.90	2001.90	0.04
CB 109	(WQ Sw	9.52	17	18	0.011	1996.74	2000.28	1.77	5.39	0.45	2001.07	0.10	2001.78	0.23	0.45	2002.46	2002.28	0.26	0.01	0.08	2002.28	2001.78	2005.28	3.00
WQ swale	CB 120	7.27	30	18	0.011	2004.25	2004.44	1.77	4.11	0.26	2006.03	0.10	2006.13	0.13	0.26	2006.53	2005.94	0.26	0.05	0.00	2006.32	2005.94	2007.60	1.28
CB 120	CB 121	7.19	93	18	0.011	2004.44	2005.00	1.77	4.07	0.26	2006.32	0.31	2006.63	0.13	0.26	2007.02	2006.50	0.07	0.01	0.13	2007.08	2006.50	2007.73	0.65
CB 121	CB 121A	3.36	8	12	0.011	2005.50	2005.55	0.79	4.28	0.28	2007.08	0.05	2007.13	0.14	0.28	2007.56	2006.94	0.13	0.01	0.00	2007.43	2006.55	2007.64	0.21
CB 121A	CB 122	2.27	99	12	0.011	2005.55	2011.89	0.79	2.89	0.13	2007.43	0.29	2012.89	0.07	0.13	2013.09	2012.89	0.11	0.02	0.00	2012.99	2012.89	2016.89	3.90
CB 122	CB 123	2.09	52	12	0.011	2011.89	2013.20	0.79	2.66	0.11	2012.99	0.13	2014.20	0.06	0.11	2014.37	2014.20	0.01	0.12	0.00	2014.49	2014.20	2018.00	3.51
CB 123	CB 123A	0.45	54	12	0.011	2013.20	2013.50	0.79	0.57	0.01	2014.49	0.01	2014.50	0.00	0.01	2014.51	2014.50	0.00	0.00	0.00	2014.51	2014.50	2015.96	1.45
CB 121	CB 124	3.83	269	18	0.011	2005.00	2006.61	1.77	2.17	0.07	2007.08	0.25	2008.11	0.04	0.07	2008.22	2008.11	0.13	0.00	0.03	2008.12	2008.11	2009.28	1.16
CB 124	CB 125	1.29	37	12	0.011	2007.11	2007.34	0.79	1.65	0.04	2008.12	0.03	2008.34	0.02	0.04	2008.40	2008.34	0.00	0.00	0.00	2008.40	2008.34	2008.64	0.24
CB 124	CB 126	2.26	137	12	0.011	2007.11	2007.93	0.79	2.88	0.13	2008.12	0.39	2008.93	0.06	0.13	2009.13	2008.93	0.07	0.17	0.01	2009.23	2008.93	2010.70	1.47
CB 126	CB 130	0.09	138	12	0.011	2007.93	2009.54	0.79	0.12	0.00	2009.23	0.00	2010.54	0.00	0.00	2010.54	2010.54	0.00	0.00	`	2010.54	2010.54	2012.54	2.00
CB 126	CB 127	1.65	125	12	0.011	2007.93	2009.54	0.79	2.11	0.07	2009.23	0.19	2010.54	0.03	0.07	2010.64	2010.54	0.01	0.00	0.00	2010.64	2010.54	2012.58	1.94
CB 127	CB 128	0.67	107	12	0.011	2009.54	2014.84	0.79	0.85	0.01	2010.64	0.03	2015.84	0.01	0.01	2015.86	2015.84	0.01	0.01	0.00	2015.87	2015.84	2019.02	3.15
CB 128	CB 129	0.50	52	12	0.011	2014.84	2015.16	0.79	0.64	0.01	2015.87	0.01	2016.16	0.00	0.01	2016.17	2016.16	0.00	0.00	0.00	2016.17	2016.16	2018.16	1.99
WQ swale	CB 139	1.70	4	12	0.011	2004.25	2004.28	0.79	2.16	0.07	2006.03	0.01	2006.04	0.04	0.07	2006.15	2005.28	0.07	0.10	0.00	2006.17	2005.28	2006.17	0.00
CB 139	CB 140A	1.70	91	12	0.011	2004.28	2004.83	0.79	2.16	0.07	2006.17	0.15	2006.32	0.04	0.07	2006.42	2005.83	0.07	0.04	0.00	2006.40	2005.83	2006.40	0.00
CB 140A	CB 140	1.70	51	12	0.011	2004.83	2005.14	0.79	2.16	0.07	2006.40	0.08	2006.48	0.04	0.07	2006.59	2006.14	0.06	0.03	0.00	2006.55	2006.14	2007.47	0.92
CB 140	CB 141	1.57	43	12	0.011	2005.14	2008.87	0.79	2.00	0.06	2006.55	0.06	2009.87	0.03	0.06	2009.96	2009.87	0.05	0.01	0.00	2009.92	2009.87	2012.87	2.95
CB 141	CB 142	1.45	85	12	0.011	2008.87	2018.41	0.79	1.85	0.05	2009.92	0.10	2019.41	0.03	0.05	2019.49	2019.41	0.03	0.05	0.01	2019.53	2019.41	2023.69	4.16
CB 142	CB 143	1.04	98	12	0.011	2018.41	2024.55	0.79	1.32	0.03	2019.53	0.06	2025.55	0.01	0.03	2025.59	2025.55	0.02	0.00	0.00	2025.57	2025.55	2029.07	3.50
CB 143	CB 144	0.90	74	12	0.011	2024.55	2029.98	0.79	1.15	0.02	2025.57	0.03	2030.98	0.01	0.02	2031.01	2030.98	0.00	0.00	0.00	2031.01	2030.98	2033.97	2.96
CB 144	CB 145	0.43	151	12	0.011	2029.98	2032.00	0.79	0.55	0.00	2031.01	0.02	2033.00	0.00	0.00	2033.01	2033.00	0.00	0.00	0.00	2033.01	2033.00	2036.00	2.99
CB 142	CB 146	0.42	49	12	0.011	2018.41	2026.89	0.79	0.53	0.00	2019.53	0.00	2027.89	0.00	0.00	2027.90	2027.89	0.00	0.00	0.00	2027.89	2027.89	2029.89	2.00
CB 146	CB 147	0.32	168	12	0.011	2026.89	2045.61	0.79	0.40	0.00	2027.89	0.01	2046.61	0.00	0.00	2046.61	2046.61	0.00	0.00	0.00	2046.61	2046.61	2048.61	2.00
CB 147	CB 148	0.21	142	12	0.011	2045.61	2049.23	0.79	0.26	0.00	2046.61	0.00	2050.23	0.00	0.00	2050.23	2050.23	0.00	0.00	0.00	2050.23	2050.23	2052.23	2.00
CB 148	CB 149	0.09	147	12	0.011	2049.23	2052.97	0.79	0.11	0.00	2050.23	0.00	2053.97	0.00	0.00	2053.97	2053.97	0.00	0.00	0.00	2053.97	2053.97	2055.97	2.00

Vault C Upstream Area Bypass – Hydraflow Method, 100-year event
The stormwater runoff from areas upstream of Vault C will be collected and conveyed via a V-ditch swale along Summit View Drive and V-ditch swale along Road E prior to entering a separate 12-inch tightline conveyance system tributary to Crystal Creek 5. The swales and 12" conveyance system will convey the 100-year storm without overtopping, per the Development Agreement dated November 8, 2011.

The swales and 12-inch conveyance system were sized using the flows from Hydraflow and Manning's Equation.

Summit View Drive Swale:

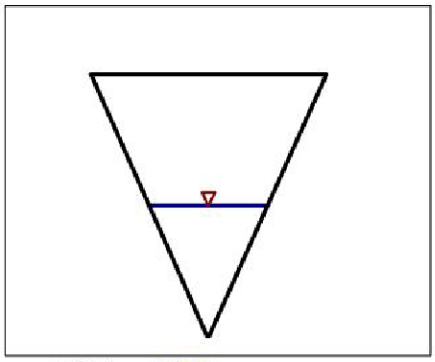
Upstream Tributary A (refer to the TA exhibit), 1.40 ac, was used to calculate the peak flow to the V-ditch swale along Summit View Drive, 1.10-cfs, for the 100-year storm event. A 1' deep V-ditch shape with 1:1 side slope is proposed. Refer to the sizing calculation below.

Upstream Area A (Summit View Drive Swale Calculations):

2.5% slope scenario (used to be conservative; swales range between 2.5% to 12.4%)
n=0.03 (SWMMEW, Table 4.12: Other Values of the Roughness Coefficient n for Channel Flow, constructed channels with grass, some weeds)

Ditch

	Input	Output	
Q (cfs)	0.00	1.10	
n	0.030	0.030	
B (ft)	0.00	0.00	Trap.
LSSlope (X:1)	1.00	1.00	
RSSlope (X:1)	1.00	1.00	
y (ft)	0.62	0.62	
S (ft/ft)	0.025	0.025	



A (sf)	0.386		
Pw (ft)	1.757	V (ft/s)	2.851
R (ft)	0.220		

Job: City Heights Phase 1 Description: Summit View Drive Swale, 2.5%
By: Date: 3/12/2021

Road E Swale:

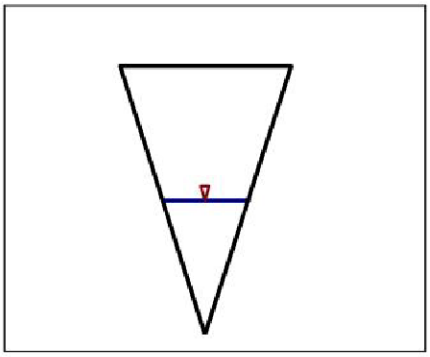
Upstream Tributary B (refer to the TA exhibit), 2.58 ac, was used to calculate the peak flow to the V-ditch swale along Road E, 2.02-cfs for the 100-year storm event. A 1' deep V-ditch shape with 1:1 side slope is proposed. Refer to the sizing calculation below.

Upstream Area B (Road E Swale Calculations):

1.1% slope scenario (used to be conservative; swales range between 1.1% to 10.4%)
n=0.03 (SWMMEW, Table 4.12: Other Values of the Roughness Coefficient n for Channel Flow, constructed channels with grass, some weeds)

Ditch

	Input	Output	
Q (cfs)	0.00	2.02	
n	0.030	0.030	
B (ft)	0.00	0.00	Trap.
LSSlope (X:1)	1.00	1.00	
RSSlope (X:1)	1.00	1.00	
y (ft)	0.91	0.91	
S (ft/ft)	0.011	0.011	



A (sf)	0.828		
Pw (ft)	2.574	V (ft/s)	2.439
R (ft)	0.322		

Job: City Heights Phase 1
By:

Description: Road E Swale, 1.1%
Date: 3/12/2021

12-inch conveyance system (Combined Upstream Areas – Upstream Area A+ Upstream Area B):

The peak flow, tributary to the conveyance system is 3.12-cfs for the 100-year storm event. Please see calculations below. The capacity for the 12-inch conveyance system was calculated using Manning's Equation. Using Manning's equation, a 12-inch pipe at 2% has capacity to convey 5.98-cfs. Pipe slopes exceed 2%; therefore, the 12-inch conveyance system has adequate capacity to convey the 100-year storm. Please see calculations below

Manning's Equation: 6" Pipe at 2% Slope

$Q = 1.486/n * A * R^{2/3} * S^{1/2}$

n = roughness coefficient = **0.011**

A = cross sectional area of pipe = $\pi (D/2)^2 = \pi (1\text{ ft}/2)^2$ = **0.79**

R = wetted perimeter of pipe

$R^{2/3} = (D/4)^{2/3} = (1\text{ ft}/4)^{2/3}$ = **0.40**

S = slope

$S^{1/2} = (0.02\text{ ft/ft})^{1/2}$ = **0.14**

$Q = (1.486/0.011) * 0.79 * 0.40 * 0.14$ = **5.98 cfs**

Section 7 Construction Stormwater Pollution Prevention

Refer to the TESC Plans (TP-01 and TP-02) and TESC Details (TD-01) in the Clearing, Grading & Infrastructure plans for proposed temporary measures as well as permanent measures for control of stormwater during construction. A SWPPP will be provided under separate cover.

Section 8 Special Reports and Studies

Refer to the *Geotechnical Engineering Report and Geologic Hazard Assessment* prepared by Terra Associates, Inc. dated June 9,2020, *Wetlands and Wildlife Habitat Report* prepared by Sewall Wetland Consulting, Inc. dated October 26, 2009, and *Impacts Analysis* prepared by Sewall Wetland Consulting, Inc. dated June 16, 2020 included under separate cover.

Section 9 Other Permits

At this time, no other permits related to City Heights Phase 1 are assumed to be required.

Section 10 Operation and Maintenance

The City Heights project detention pond, vault and water quality biofiltration swales will be located within a stormwater tract and will be maintained by the City of Cle Elum. The City will also maintain drainage features in the public right-of-way.

Lot owners will be responsible for maintaining service lines and drains (if used) within their individual property limits. Symptoms of failure are clean-outs or yard drains overtopping. If this happens, the homeowners should remove the structure lid and remove visible debris. If problems persist, the service drain should be flushed or professionally cleaned.

Semi-annual inspections are recommended before and after the wet season (Oct/Nov and April/May) to ensure proper operation of the drainage system. Any detected maintenance problems should be corrected prior to the winter season. Sediment can build up inside control structures and catch basins, blocking or restricting flow to the inlet. To prevent this problem, these structures should be regularly inspected and routinely cleaned.

The following maintenance instructions per the 2019 SWMMEW are included at the end of this section:

5.A.6 Maintenance Criteria for Catch Basins
5.A.7 Maintenance Criteria for Debris Barriers (e.g., Trash Racks)
5.A.8 Maintenance Criteria for Energy Dissipaters
5.A.9 Maintenance Criteria for Biofiltration Swales
5.A.17 Maintenance Criteria for Catch Basins Inserts
6.A.2 Maintenance Criteria for Detention Ponds
6.A.3 Maintenance Criteria for Detention Vaults/Tanks
6.A.4 Maintenance Criteria for Control Structures
6.A.11 Maintenance Criteria for Amended Construction Site Soils

5.A.5 Maintenance Criteria for Control Structure/Flow Restrictor for Wetponds

Table 5.39: Maintenance Criteria for Control Structure/Flow Restrictor for Wetponds

Maintenance Component	Defect	Condition When Maintenance Is Needed	Results Expected When Maintenance Is Performed
General	Trash and Debris (Includes Sediment)	Material > 25% of sump depth or 1 foot below orifice plate.	Control structure orifice is not blocked. All trash and debris removed.
	Structural Damage	Structure is not securely attached to manhole wall.	Structure securely attached to wall and outlet pipe.
		Structure is not in upright position (allow up to 10% from plumb).	Structure in correct position.
		Connections to outlet pipe are not watertight and show signs of rust.	Connections to outlet pipe are water tight; structure repaired or replaced and works as designed.
		Any holes—other than designed holes—in the structure.	Structure has no holes other than designed holes.
Clean-Out Gate	Damaged or Missing	Clean-out gate is not watertight or is missing.	Gate is watertight and works as designed.
		Gate cannot be moved up and down by one maintenance person.	Gate moves up and down easily and is watertight.
		Chain/rod leading to gate is missing or damaged.	Chain is in place and works as designed.
		Gate is rusted > 50% of its surface area.	Gate is repaired or replaced to meet design standards.
Orifice Plate	Damaged or Missing	Control device is not working properly due to missing, out of place, or bent orifice plate.	Plate is in place and works as designed.
	Obstructions	Any trash, debris, sediment, or vegetation blocking the plate.	Plate is free of all obstructions and works as designed.
Overflow Pipe	Obstructions	Any trash or debris blocking (or having the potential of blocking) the overflow pipe.	Pipe is free of all obstructions and works as designed.
Manhole	See criteria for vaults/tanks in Table 5.38: Maintenance Criteria for Closed Treatment Systems (Tanks/Vaults).		
Catch Basin	See criteria in Table 5.40: Maintenance Criteria for Catch Basins.		

5.A.6 Maintenance Criteria for Catch Basins

Table 5.40: Maintenance Criteria for Catch Basins

Maintenance Component	Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed
General	Trash and Debris	Trash or debris that is located immediately in front of the catch basin opening or is blocking inletting capacity of the basin by > 10%.	No trash or debris located immediately in front of catch basin or on grate opening.
		Trash or debris (in the basin) > 60% of the sump depth as measured from the bottom of basin to invert of the lowest pipe into or out of the basin, but in no case < 6 inches clearance from the debris surface to the invert of the lowest pipe.	No trash or debris in the catch basin.
		Trash or debris in any inlet or outlet pipe blocking > one-third of its height.	Inlet and outlet pipes free of trash or debris.
		Dead animals or vegetation that could generate odors that could cause complaints or dangerous gases (e.g., methane).	No dead animals or vegetation present within the catch basin.
	Sediment	Sediment (in the basin) > 60% of the sump depth as measured from the bottom of basin to invert of the lowest pipe into or out of the basin, but in no case < 6 inches clearance from the sediment surface to the invert of the lowest pipe.	No sediment in the catch basin
	Structure Damage to	Top slab has holes > 2 square inches or cracks > 0.25 inches	Top slab is free of holes and cracks.

Table 5.40: Maintenance Criteria for Catch Basins (continued)

Maintenance Component	Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed
	Frame and/or Top Slab	(Intent is to make sure no material is running into basin).	
		Frame not sitting flush on top slab, i.e., separation of > 0.75 inches of the frame from the top slab. Frame not securely attached	Frame is sitting flush on the riser rings or top slab and firmly attached.
	Fractures or Cracks in Basin Walls/Bottom	Maintenance person judges that structure is unsound.	Basin replaced or repaired to design standards.
	Fractures or Cracks in Basin Walls/ Bottom (cont'd)	Grout fillet has separated or cracked > 0.5 inches and > 1 foot at the joint of any inlet/outlet pipe or any evidence of soil particles entering catch basin through cracks.	Pipe is regrouted and secure at basin wall.
	Settlement/ Misalignment	If failure of basin has created a safety, function, or design problem.	Basin replaced or repaired to design standards.
	Vegetation	Vegetation growing across and blocking > 10% of the basin opening.	No vegetation blocking opening to basin.
		Vegetation growing in inlet/outlet pipe joints that is > 6 inches tall and < 6 inches apart.	No vegetation or root growth present.
	Contamination and Pollution	See "Wetponds" (Table 5.36: Maintenance Criteria for Wetponds).	No pollution present.
Catch Basin Cover	Cover Not in Place	Cover is missing or only partially in place. Any open catch basin requires maintenance.	Catch basin cover is closed
	Locking Mechanism Not Working	Mechanism cannot be opened by one maintenance person with proper tools. Bolts into frame have < 0.5 inches of thread.	Mechanism opens with proper tools.
	Cover Difficult to Remove	One maintenance person cannot remove lid after applying normal lifting pressure. (Intent is keep cover from sealing off access to maintenance.)	Cover can be removed by one maintenance person.
Ladder	Ladder Rungs Unsafe	Ladder is unsafe due to missing rungs, not securely attached to basin wall, misalignment, rust, cracks, or sharp edges.	Ladder meets design standards and allows maintenance person safe access.
Metal Grates (If Applicable)	Grate opening Unsafe	Grate with opening > 0.875 inches.	Grate opening meets design standards.
	Trash and Debris	Trash and debris that is blocking > 20% of grate surface inletting capacity.	Grate free of trash and debris.
	Damaged or Missing	Grate missing or broken member(s) of the grate.	Grate is in place and meets design standards.

5.A.7 Maintenance Criteria for Debris Barriers (e.g., Trash Racks)

Table 5.41: Maintenance Criteria for Debris Barriers (e.g., Trash Racks)

Maintenance Components	Defect	Condition When Maintenance Is Needed	Results Expected When Maintenance Is Performed
General	Trash and Debris	Trash or debris that is plugging > 20% of the openings in the barrier.	Barrier cleared to design flow capacity.
Metal	Damaged/ Missing Bars	Bars are bent out of shape > 3 inches.	Bars in place with no bends > 0.75 inches.
		Bars are missing or entire barrier missing.	Bars in place according to design.
		Bars are loose and rust is causing 50% deterioration to any part of barrier.	Barrier replaced or repaired to design standards.
	Inlet/Outlet Pipe	Debris barrier missing or not attached to pipe	Barrier firmly attached to pipe

5.A.8 Maintenance Criteria for Energy Dissipaters

Table 5.42: Maintenance Criteria for Energy Dissipaters

Maintenance Components	Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed
External			
Rock Pad	Missing or Moved Rock	Only one layer of rock exists above native soil in area ≥ 5 square feet (sf), or any exposure of native soil.	Rock pad replaced to design standards.
	Erosion	Soil erosion in or adjacent to rock pad.	Rock pad replaced to design standards.
Dispersion Trench	Pipe Plugged With Sediment	Accumulated sediment > 20% of the design depth.	Pipe cleaned/flushed so that it matches design.
	Not Discharging Water Properly	Visual evidence of water discharging at concentrated points along trench (normal condition is a "sheet flow" of water along trench). Intent is to prevent erosion damage.	Trench redesigned or rebuilt to standards.
	Perforations Plugged	> 50% of the perforations in pipe are plugged with debris and sediment.	Perforated pipe cleaned or replaced.
	Water Flowing out Top of "Distributor" Catch Basin	Maintenance person observes or receives credible report of water flowing out during any storm less than the design storm or is causing or appears likely to cause damage.	Energy dissipater rebuilt or redesigned to standards.
	Receiving Area Oversaturated	Water in receiving area is causing or has potential of causing landslide problems.	No danger of landslides.
Internal			
Manhole/ Chamber	Worn or Damaged Post, Baffles, or Side of Chamber	Structure dissipating flow deteriorates to one-half the original size or any concentrated worn spot > 1 sf, which would make structure unsound.	Structure replaced to design standards.
	Other Defects	See criteria in Table 5.40: Maintenance Criteria for Catch Basins.	See criteria in Table 5.40: Maintenance Criteria for Catch Basins.

5.A.9 Maintenance Criteria for Biofiltration Swales

Table 5.43: Maintenance Criteria for Biofiltration Swales

Maintenance Component	Defect or Problem	Condition When Maintenance Is Needed	Recommended Maintenance to Correct Problem
General	Sediment Accumulation on Grass	Sediment depth > 2 inches.	Remove sediment deposits on grass treatment area of the biofiltration swale. When finished, swale should be level from side to side and drain freely toward outlet. There should be no areas of standing water once inflow has ceased.
	Standing Water	When water stands in the swale between storms and does not drain freely.	Any of the following may apply: remove sediment or trash blockages, improve grade from head to foot of swale, remove clogged check dams, add underdrains or convert to a wet biofiltration swale.
	Flow Spreader	Flow spreader uneven or clogged so that flows are not uniformly distributed through entire swale width.	Level the spreader and clean so that flows are spread evenly over entire swale width.
	Constant Base Flow	When small quantities of water continually flow through the swale, even when it has been dry for weeks, and an eroded, muddy channel has formed in the swale bottom.	Add a low-flow pea-gravel drain the length of the swale or by-pass the base flow around the swale.
	Poor Vegetation Coverage	When grass is sparse or bare or eroded patches occur in > 10% of the swale bottom.	Determine why grass growth is poor and correct that condition. Replant with plugs of grass from the upper slope: plant in the swale bottom at 8-inch intervals. Or reseed into loosened, fertile soil.

Table 5.43: Maintenance Criteria for Biofiltration Swales (continued)

Maintenance Component	Defect or Problem	Condition When Maintenance Is Needed	Recommended Maintenance to Correct Problem
	Vegetation	When the grass becomes excessively tall (> 10 inches); when nuisance weeds and other vegetation start to take over.	Mow vegetation or remove nuisance vegetation so that flow not impeded. Grass should be mowed to a height of 3 to 4 inches. Remove grass clippings.
	Excessive Shading	Grass growth is poor because sunlight does not reach swale.	If possible, trim back overhanging limbs and remove brushy vegetation on adjacent slopes.
	Inlet/Outlet	Inlet/outlet areas clogged with sediment and/or debris.	Remove material so that there is no clogging or blockage in the inlet and outlet area.
	Trash and Debris Accumulation	Trash and debris accumulated in the biofiltration swale.	Remove trash and debris from biofiltration swale.
	Erosion/ Scouring	Eroded or scoured swale bottom due to flow channelization, or higher flows.	For ruts or bare areas < 12 inches wide, repair the damaged area by filling with crushed gravel. If bare areas are large, generally > 12 inches wide, the swale should be regraded and reseeded. For smaller bare areas, overseed when bare spots are evident, or take plugs of grass from the upper slope and plant in the swale bottom at 8-inch intervals.

5.A.10 Maintenance Criteria for Vegetated Filter Strips

Table 5.44: Maintenance Criteria for Vegetated Filter Strips

Maintenance Component	Defect or Problem	Condition When Maintenance Is Needed	Recommended Maintenance to Correct Problem
General	Sediment Accumulation on Grass	Sediment depth > 2 inches.	Remove sediment deposits, relevel so slope is even and flows pass evenly through strip.
	Vegetation	When the grass becomes excessively tall (> 10 inches); when nuisance weeds and other vegetation starts to take over.	Mow grass, control nuisance vegetation, such that flow not impeded. Grass should be mowed to a height between 3 to 4 inches.
	Trash and Debris Accumu-lation	Trash and debris accumulated on the filter strip.	Remove trash and debris from filter.
	Erosion/ Scouring	Eroded or scoured areas due to flow channelization, or higher flows.	For ruts or bare areas < 12 inches wide, repair the damaged area by filling with crushed gravel. The grass will creep in over the rock in time. If bare areas are large, generally > 12 inches wide, the filter strip should be regraded and reseeded. For smaller bare areas, overseed when bare spots are evident.
	Flow Spreader	Flow spreader uneven or clogged so that flows are not uniformly distributed through entire filter width.	Level the spreader and clean so that flows are spread evenly over entire filter width.

6.A.2 Maintenance Criteria for Detention Ponds

Table 6.15: Maintenance Criteria for Detention Ponds

Maintenance Component	Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed
General	Trash and Debris	Any trash and debris > 5 cubic feet (cf) per 1,000 square feet (sf), which is about equal to the amount of trash it would take to fill up one standard size garbage can. In general, there should be no visual evidence of dumping. If less than threshold all trash and debris will be removed as part of next scheduled maintenance.	Trash and debris cleared from site.
	Poisonous Vegetation and Noxious Weeds	Any poisonous or nuisance vegetation which may constitute a hazard to maintenance personnel or the public. Any evidence of noxious weeds as defined by State or local regulations. (Apply requirements of adopted integrated pest management (IPM) policies for the use of herbicides).	No danger of poisonous vegetation where maintenance personnel or the public might normally be. (Coordinate with local health department). Complete eradication of noxious weeds may not be possible. Compliance with State or local eradication policies required.
	Contaminants and Pollution	Any evidence of oil, gasoline, contaminants or other pollutants (Coordinate removal/cleanup with local water quality response agency).	No contaminants or pollutants present.
	Rodent Holes	Any evidence of rodent holes if pond is acting as a dam or berm, or any evidence of water piping through dam or berm via rodent holes.	Rodents destroyed and dam or berm repaired. (Coordinate with local health department and Ecology Dam Safety Office if pond ≥ 10 acre-feet).
	Beaver Dams	Dam results in change or function of the pond.	Pond is returned to design function. (Coordinate trapping of beavers and removal of dams with appropriate permitting agencies).
	Insects	When insects such as wasps and hornets interfere with maintenance activities.	Insects destroyed or removed from site. Apply insecticides in compliance with adopted IPM policies.
	Tree Growth and Hazard Trees	Tree growth does not allow maintenance access or interferes with maintenance activity (i.e., slope mowing, silt removal, vacuuming, or equipment movements). If trees are not interfering with access or maintenance, do not remove If dead, diseased, or dying trees are identified (Use a certified arborist to determine health of tree or removal requirements)	Trees do not hinder maintenance activities. Harvested trees should be recycled into mulch or other beneficial uses (e.g., alders for firewood). Remove hazard trees.
Side Slopes of Pond	Erosion	Eroded damage over 2 inches deep where cause of damage is still present or where there is potential for continued erosion. Any erosion observed on a compacted berm embankment.	Slopes should be stabilized using appropriate erosion control measure(s); e.g., rock reinforcement, planting of grass, compaction. If erosion is occurring on compacted berms a licensed engineer in the state of Washington should be consulted to resolve source of erosion.
Storage Area	Sediment	Accumulated sediment that exceeds 10% of the designed pond depth unless otherwise specified or affects inletting or outletting condition of the pond.	Sediment cleaned out to designed pond shape and depth; pond reseeded if necessary to control erosion.
	Liner	Liner is visible and has > three 0.25-inch holes in it.	Liner repaired or replaced. Liner is fully covered.

Table 6.15: Maintenance Criteria for Detention Ponds (continued)

Maintenance Component	Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed
	(if applicable)		
Pond Berms (Dikes)	Settlements	Any part of berm which has settled 4 inches lower than the design elevation. If settlement is apparent measure berm to determine amount of settlement. Settling can be an indication of more severe problems with the berm or outlet works. A licensed engineer in the state of Washington should be consulted to determine the source of the settlement.	Dike is built back to the design elevation.
	Piping	Discernible water flow through pond berm. Ongoing erosion with potential for erosion to continue. (Recommend a licensed engineer in the state of Washington with geotechnical expertise be called in to inspect and evaluate condition and recommend repair of condition.	Piping eliminated. Erosion potential resolved.
Emergency Overflow/Spillway	Tree Growth	Tree growth on emergency spillways creates blockage problems and may cause failure of the berm due to uncontrolled overtopping. Tree growth on berms > 4 feet in height may lead to piping through the berm which could lead to failure of the berm.	Trees should be removed. If root system is small (base < 4 inches) the root system may be left in place. Otherwise the roots should be removed and the berm restored. A licensed engineer in the state of Washington should be consulted for proper berm/spillway restoration.
	Piping	Discernible water flow through pond berm. Ongoing erosion with potential for erosion to continue. (Recommend a licensed engineer in the state of Washington with geotechnical expertise be called in to inspect and evaluate condition and recommend repair of condition.	Piping eliminated. Erosion potential resolved.
	Emergency Overflow/ Spillway	Only one layer of rock exists above native soil in area ≥ 5 sf, or any exposure of native soil at the top of outflow path of spillway. (Riprap on inside slopes need not be replaced.)	Rocks and pad depth are restored to design standards.
	Erosion	See Side Slopes of Pond.	

6.A.3 Maintenance Criteria for Detention Vaults/Tanks

Table 6.16: Maintenance Criteria for Detention Vaults/Tanks

Maintenance Component	Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed
Storage Area	Plugged Air Vents	One-half the cross section of a vent is blocked at any point or the vent is damaged.	Vents open and functioning.
	Debris and Sediment	Accumulated sediment depth exceeds 10% of the diameter of the storage area for one-half the length of storage vault, or any point depth exceeds 15% of diameter. (Example: 72-inch-diameter storage tank would require cleaning when sediment reaches depth of 7 inches, for > one-half length of the tank.)	All sediment and debris removed from storage area.
	Joints Between Tank/ Pipe Section	Any openings or voids allowing material to be transported into vault/tank. (Will require engineering analysis to determine structural stability).	All joint between tank/pipe sections are sealed.
	Tank Pipe Bent out of Shape	Any part of tank/pipe is bent out of shape > 10% of its design shape. (Review required by a licensed engineer in the state of Washington to determine structural stability).	Tank/pipe repaired or replaced to design.
	Vault Structure Includes Cracks in Wall, Bottom, Damage to Frame and/or Top Slab	Cracks > 0.5 inches and any evidence of soil particles entering the structure through the cracks, or maintenance/inspection personnel determines that the vault is not structurally sound.	Vault replaced or repaired to design specifications and is structurally sound.
		Cracks > 0.5 inches at the joint of any inlet/outlet pipe or any evidence of soil particles entering the vault through the walls.	No cracks > 0.25 inches wide at the joint of the inlet/outlet pipe.
Manhole	Cover Not in Place	Cover is missing or only partially in place. Any open manhole requires maintenance.	Manhole is closed.
	Locking Mechanism Not Working	Mechanism cannot be opened by one maintenance person with proper tools. Bolts into frame have < 0.5 inches of thread (may not apply to self-locking lids).	Mechanism opens with proper tools.
	Cover Difficult to Remove	One maintenance person cannot remove lid after applying normal lifting pressure. Intent is to keep cover from sealing off access to maintenance.	Cover can be removed and reinstalled by one maintenance person.
	Ladder Rungs Unsafe	Ladder is unsafe due to missing rungs, misalignment, not securely attached to structure wall, rust, or cracks.	Ladder meets design standards. Allows maintenance person safe access.
Catch Basins	See criteria in Table 6.18: Maintenance Criteria for Catch Basins.		

6.A.4 Maintenance Criteria for Control Structures

Table 6.17: Maintenance Criteria for Control Structures

Maintenance Component	Defect	Condition When Maintenance Is Needed	Results Expected When Maintenance Is Performed
General	Trash and Debris (includes sediment)	Material exceeds 25% of sump depth or 1 foot below orifice plate.	Control structure orifice is not blocked. All trash and debris removed.
	Structural Damage	Structure is not securely attached to manhole wall.	Structure securely attached to wall and outlet pipe.
		Structure is not in upright position (allow up to 10% from plumb).	Structure in correct position.
		Connections to outlet pipe are not watertight and show signs of rust.	Connections to outlet pipe are water tight; structure repaired or replaced and works as designed.
		Any holes—other than designed holes—in the structure.	Structure has no holes other than designed holes.
Clean-out Gate	Damaged or Missing	Clean-out gate is not watertight or is missing.	Gate is watertight and works as designed.
		Gate cannot be moved up and down by one maintenance person.	Gate moves up and down easily and is watertight.
		Chain/rod leading to gate is missing or damaged.	Chain is in place and works as designed.
		Gate is rusted > 50% of its surface area.	Gate is repaired or replaced to meet design standards.
Orifice Plate	Damaged or Missing	Control device is not working properly due to missing, out of place, or bent orifice plate.	Plate is in place and works as designed.
	Obstructions	Any trash, debris, sediment, or vegetation blocking the plate.	Plate is free of all obstructions and works as designed.
Overflow Pipe	Obstructions	Any trash or debris blocking (or having the potential of blocking) the overflow pipe.	Pipe is free of all obstructions and works as designed.
Manhole	See criteria for vaults/tanks in Table 6.16: Maintenance Criteria for Detention Vaults/Tanks.		
Catch Basin	See criteria in Table 6.18: Maintenance Criteria for Catch Basins.		

6.A.5 Maintenance Criteria for Catch Basins

Table 6.18: Maintenance Criteria for Catch Basins

Maintenance Component	Defect	Condition When Maintenance Is Needed	Results Expected When Maintenance Is Performed
General	Trash and Debris	Trash or debris which is located immediately in front of the catch basin opening or is blocking inletting capacity of the basin by > 10%.	No trash or debris located immediately in front of catch basin or on grate opening.
		Trash or debris (in the basin) that exceeds 60% of the sump depth as measured from the bottom of basin to invert of the lowest pipe into or out of the basin, but in no case < 6 inches clearance from the debris surface to the invert of the lowest pipe.	No trash or debris in the catch basin.
		Trash or debris in any inlet or outlet pipe blocking > one-third its height.	Inlet and outlet pipes free of trash or debris.
		Dead animals or vegetation that could generate odors that could cause complaints or dangerous gases (e.g., methane).	No dead animals or vegetation present within the catch basin.
	Sediment	Sediment (in the basin) that exceeds 60% of the sump depth as measured from the bottom of basin to invert of the lowest pipe into or out of the basin, but in no case < 6 inches clearance from the sediment surface to the invert of the lowest pipe.	No sediment in the catch basin

Table 6.23: Maintenance Criteria for Permeable Pavement (continued)

Maintenance Component	Activity	Objective	Schedule	Notes
				types or local conditions and should be treated accordingly.
	Replace Grasspave2 installation: Place units over porous gravel base, fill with grass.	Restore system capability	Determined by inspection	Do not place any form of topsoil between sandy gravel base and Grasspave2 units.
	Invasive or nuisance plants: Remove manually and without herbicide applications.	Promote selected plant growth and survival, maintain aesthetics	Twice annually	At a minimum, schedule weeding with inspections to coincide with important horticultural cycles (e.g., prior to major weed varieties dispersing seeds).
	Fertilization: If necessary apply by hand. See Notes.	Plant growth and survival	Determined by inspection	Installations should be designed to not require fertilization after plant establishment. If fertilization is necessary during plant establishment or for plant health and survivability after establishment, use an encapsulated, slow release fertilizer (excessive fertilization can contribute to increased nutrient loads in the stormwater system and receiving waters).
	Irrigate: Use subsurface or drip irrigation.		Determined by inspection and only when absolutely necessary for plant survival.	Surface irrigation systems can promote weed establishment, root development near the drier surface layer of the soil substrate, and increase plant dependence on irrigation. Accordingly, subsurface irrigation methods are preferred. If surface irrigation is the only method available, use drip irrigation to deliver water to the base of the plant.
	Replace permeable pavement material	Maintain infiltration and stormwater storage capability	Determined by inspection	If BMP is designed, installed and maintained properly, permeable pavement should last as long as conventional pavement.

6.A.11 Maintenance Criteria for Amended Construction Site Soils

Table 6.24: Maintenance Criteria for Amended Construction Site Soils

Maintenance Component	Activity	Objective	Schedule	Notes
Routine Maintenance				
General	Add compost or mulch: Spread material by hand to minimize damage to plant material.	Maintain organic matter content of soil, optimize soil moisture retention, prevent erosion, and enhance plant growth and survivability.	Once every 1 or 2 years	Compost amended landscapes are stormwater management BMPs and pesticide inputs should be eliminated or used only in unusual circumstances. Landscape management personnel should be trained to adjust chemical applications accordingly.

5.A.16 Maintenance Criteria for Coalescing Plate Oil and Water Separators

Table 5.50: Maintenance Criteria for Coalescing Plate Oil and Water Separators

Maintenance Component	Defect	Condition When Maintenance Is Needed	Results Expected When Maintenance Is Performed
General	Monitoring	Inspection of discharge water for obvious signs of poor water quality.	Effluent discharge from vault should be clear with no thick visible sheen.
	Sediment Accumulation	Sediment depth in bottom of vault > 6 inches in depth and/or visible signs of sediment on plates.	No sediment deposits on vault bottom and plate media, which would impede flow through the vault and reduce separation efficiency.
	Trash and Debris Accumulation	Trash and debris accumulated in vault, or pipe inlet/outlet, floatables and nonfloatables.	Trash and debris removed from vault and inlet/outlet piping.
	Oil Accumulation	Oil accumulation > 1 inch at the water surface.	Oil is extracted from vault using Vactoring methods. Coalescing plates are cleaned by thoroughly rinsing and flushing. Should be no visible oil depth on water.
	Damaged Coalescing Plates	Plate media broken, deformed, cracked and/or showing signs of failure.	A portion of the media pack or the entire plate pack is replaced depending on severity of failure.
	Damaged Pipes	Inlet or outlet piping damaged or broken and in need of repair.	Pipe repaired and or replaced.
	Baffles	Baffles corroding, cracking, warping and/or showing signs of failure as determined by maintenance/inspection person.	Baffles repaired or replaced to specifications.
	Vault Structure Damage – Includes Cracks in Walls, Cracks in Bottom, or Damage to Frame and/or Top Slab	Cracks > 0.5 inches or evidence of soil particles entering the structure through the cracks, or maintenance/inspection personnel determine that the vault is not structurally sound.	Vault replaced or repairs made so that vault meets design specifications and is structurally sound.
		Cracks > 0.5 inches at the joint of any inlet/outlet pipe or evidence of soil particles entering through the cracks.	Vault repaired so that no cracks exist > 0.25 inches at the joint of the inlet/outlet pipe.
	Access Ladder Damaged	Ladder is corroded or deteriorated, not functioning properly, not securely attached to structure wall, missing rungs, cracks, and misaligned.	Ladder replaced or repaired and meets specifications, and is safe to use as determined by inspection personnel.

5.A.17 Maintenance Criteria for Catch Basin Inserts

Table 5.51: Maintenance Criteria for Catch Basin Inserts

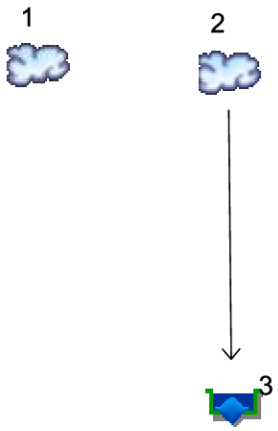
Maintenance Component	Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed
General	Sediment Accumulation	When sediment forms a cap over the insert media of the insert and/or unit.	No sediment cap on the insert media and its unit.
	Trash and Debris Accumulation	Trash and debris accumulates on insert unit creating a blockage/restriction.	Trash and debris removed from insert unit. Runoff freely flows into catch basin.
	Media Insert Not Removing Oil	Effluent water from media insert has a visible sheen.	Effluent water from media insert is free of oils and has no visible sheen.
	Media Insert Water Saturated	Catch basin insert is saturated with water and no longer has the capacity to absorb.	Remove and replace media insert
	Media Insert Oil Saturated	Media oil saturated due to petroleum spill that drains into catch basin.	Remove and replace media insert.
	Media Insert Use Beyond Normal Product Life	Media has been used beyond the typical average life of media insert product.	Remove and replace media at regular intervals, depending on insert product.

Appendix

Crystal Creek 5 Detention Vault C Output

Watershed Model Schematic

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



Hydraflow Rainfall Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Wednesday, 01 / 6 / 2021

Return Period (Yrs)	Intensity-Duration-Frequency Equation Coefficients (FHA)			
	B	D	E	(N/A)
1	0.0000	0.0000	0.0000	--------
2	0.0000	0.0000	0.0000	--------
3	0.0000	0.0000	0.0000	--------
5	0.0000	0.0000	0.0000	--------
10	0.0000	0.0000	0.0000	--------
25	0.0000	0.0000	0.0000	--------
50	0.0000	0.0000	0.0000	--------
100	0.0000	0.0000	0.0000	--------

File name: SampleFHA.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	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
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	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
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
50	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	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Tc = time in minutes. Values may exceed 60.

*1-yr column is the 6 mo, 24 hr precip

Precip. file name: E:\Projects\19349\Engineering\Hydraflow\Phase 1\Vault\precip.pcp

Storm Distribution	Rainfall Precipitation Table (in)							
	1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr
SCS 24-hour	1.40	3.34	0.00	3.30	4.59	4.84	6.80	6.09
SCS 6-Hr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-1st	0.00	0.00	0.00	2.75	0.00	0.00	6.50	0.00
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	0.00	0.00	2.80	0.00	0.00	6.00	0.00

TR55 Tc Worksheet

Hyd. No. 1

PRE (Crystal Creek 5)

Description	A		B		C		Totals
Sheet Flow							
Manning's n-value	= 0.350		0.011		0.011		
Flow length (ft)	= 200.0		0.0		0.0		
Two-year 24-hr precip. (in)	= 3.34		3.34		0.00		
Land slope (%)	= 18.00		0.00		0.00		
Travel Time (min)	**= 13.66**	**+**	**0.00**	**+**	**0.00**	**=**	**13.66**
Shallow Concentrated Flow							
Flow length (ft)	= 254.00		0.00		0.00		
Watercourse slope (%)	= 6.00		0.00		0.00		
Surface description	= Unpaved		Paved		Paved		
Average velocity (ft/s)	=3.95		0.00		0.00		
Travel Time (min)	**= 1.07**	**+**	**0.00**	**+**	**0.00**	**=**	**1.07**
Channel Flow							
X sectional flow area (sqft)	= 0.00		0.00		0.00		
Wetted perimeter (ft)	= 0.00		0.00		0.00		
Channel slope (%)	= 0.00		0.00		0.00		
Manning's n-value	= 0.015		0.015		0.015		
Velocity (ft/s)	=0.00						
			0.00				
					0.00		
Flow length (ft)	({0})0.0		0.0		0.0		
Travel Time (min)	**= 0.00**	**+**	**0.00**	**+**	**0.00**	**=**	**0.00**

Total Travel Time, Tc ..... 14.70 min

Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Wednesday, 01 / 6 / 2021

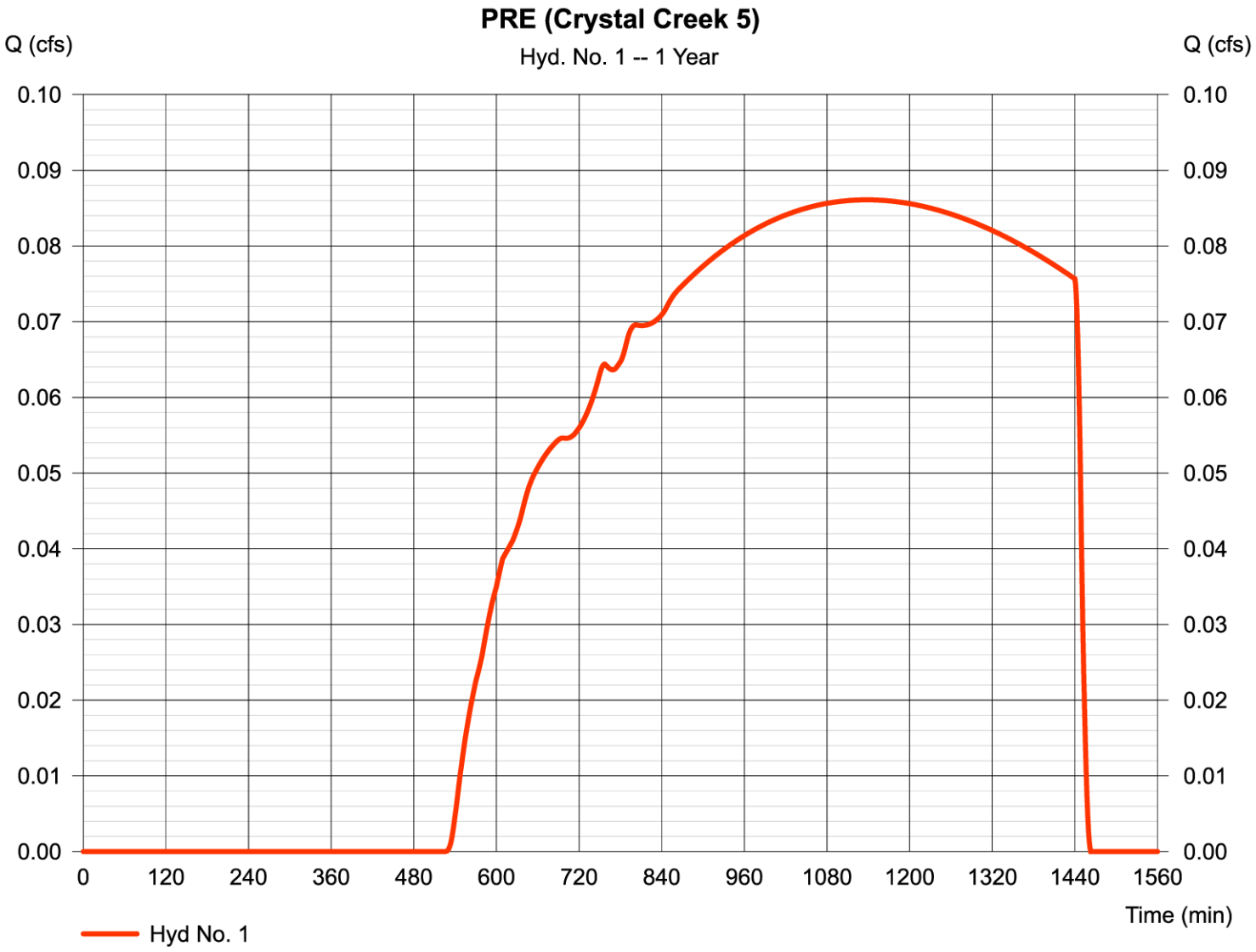
Hyd. No. 1

*1-yr is model for the 6 mo, 24 hr precip

PRE (Crystal Creek 5)

Hydrograph type	= SCS Runoff	Peak discharge	= 0.086 cfs
Storm frequency	= 1 yrs	Time to peak	= 1138 min
Time interval	= 1 min	Hyd. volume	= 3,898 cuft
Drainage area	= 9.300 ac	Curve number	= 74*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 14.70 min
Total precip.	= 1.40 in	Distribution	= Type IA
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(8.230 x 73) + (0.920 x 79) + (0.150 x 98)] / 9.300



Hydrograph Report

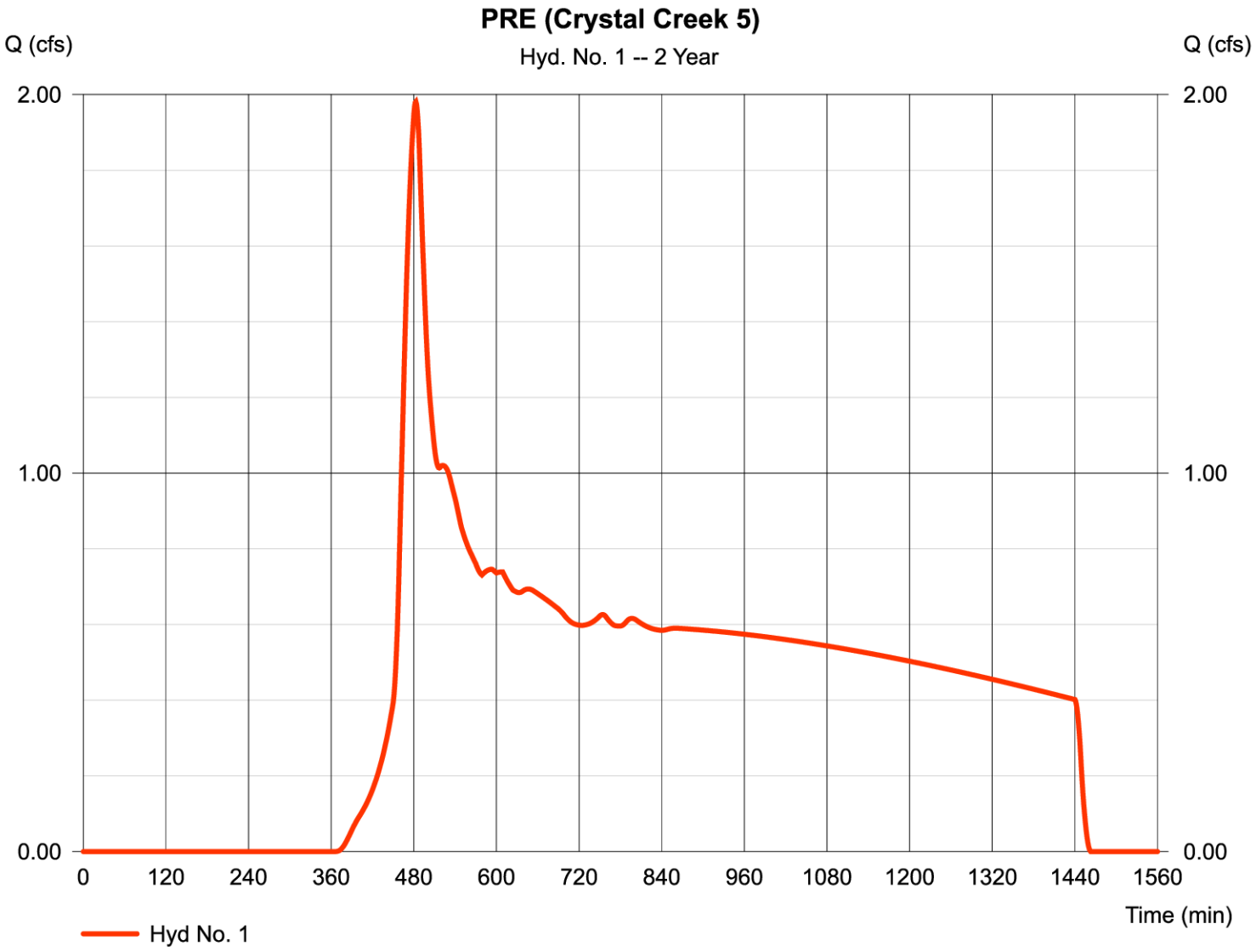
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Wednesday, 01 / 6 / 2021

Hyd. No. 1

PRE (Crystal Creek 5)

Hydrograph type	= SCS Runoff	Peak discharge	= 1.981 cfs
Storm frequency	= 2 yrs	Time to peak	= 483 min
Time interval	= 1 min	Hyd. volume	= 38,175 cuft
Drainage area	= 9.300 ac	Curve number	= 74*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 14.70 min
Total precip.	= 3.34 in	Distribution	= Type IA
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(8.230 x 73) + (0.920 x 79) + (0.150 x 98)] / 9.300



Hydrograph Report

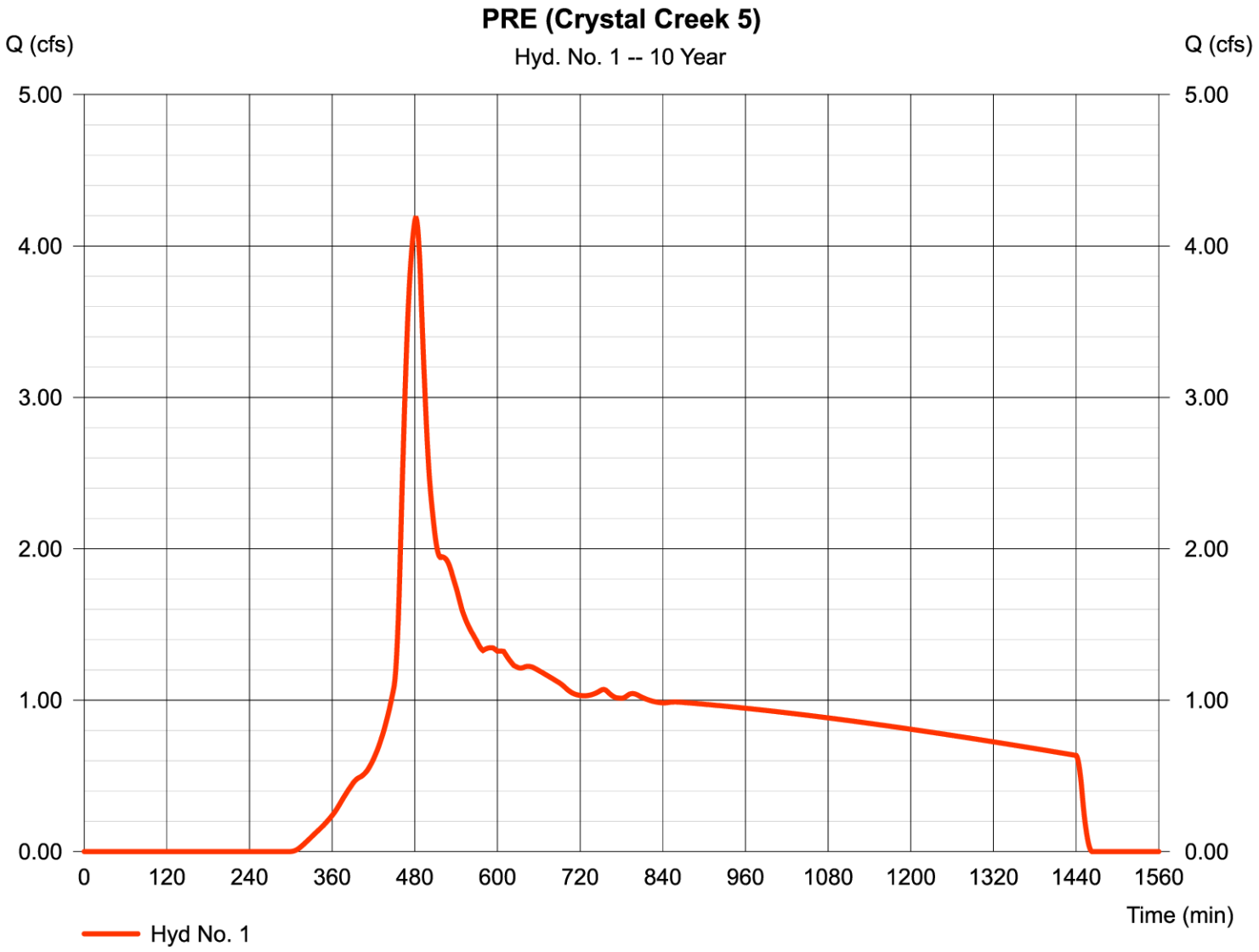
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Wednesday, 01 / 6 / 2021

Hyd. No. 1

PRE (Crystal Creek 5)

Hydrograph type	= SCS Runoff	Peak discharge	= 4.183 cfs
Storm frequency	= 10 yrs	Time to peak	= 481 min
Time interval	= 1 min	Hyd. volume	= 68,930 cuft
Drainage area	= 9.300 ac	Curve number	= 74*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 14.70 min
Total precip.	= 4.59 in	Distribution	= Type IA
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(8.230 x 73) + (0.920 x 79) + (0.150 x 98)] / 9.300



Hydrograph Report

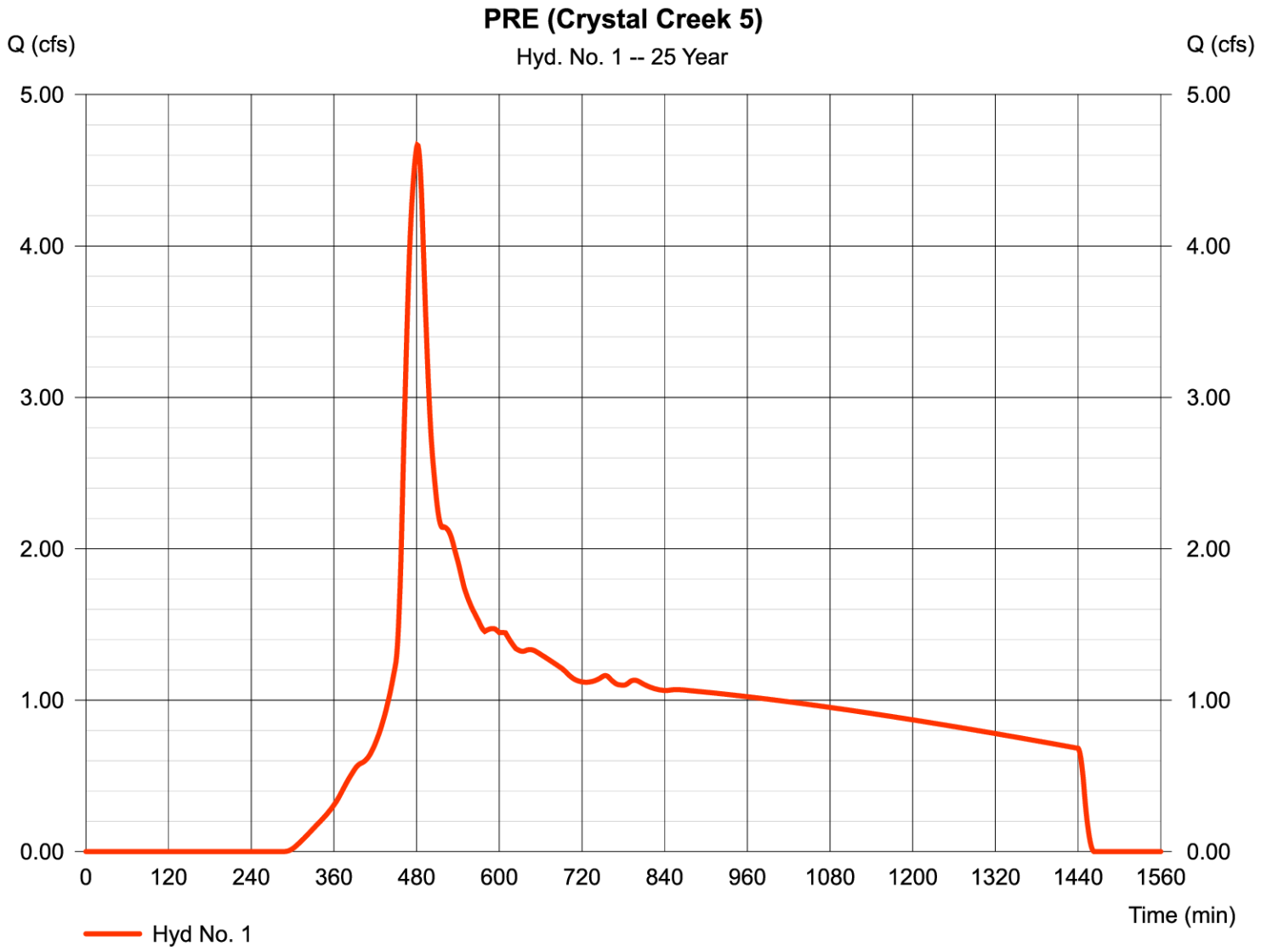
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Wednesday, 01 / 6 / 2021

Hyd. No. 1

PRE (Crystal Creek 5)

Hydrograph type	= SCS Runoff	Peak discharge	= 4.666 cfs
Storm frequency	= 25 yrs	Time to peak	= 481 min
Time interval	= 1 min	Hyd. volume	= 75,529 cuft
Drainage area	= 9.300 ac	Curve number	= 74*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 14.70 min
Total precip.	= 4.84 in	Distribution	= Type IA
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(8.230 x 73) + (0.920 x 79) + (0.150 x 98)] / 9.300



Hydrograph Report

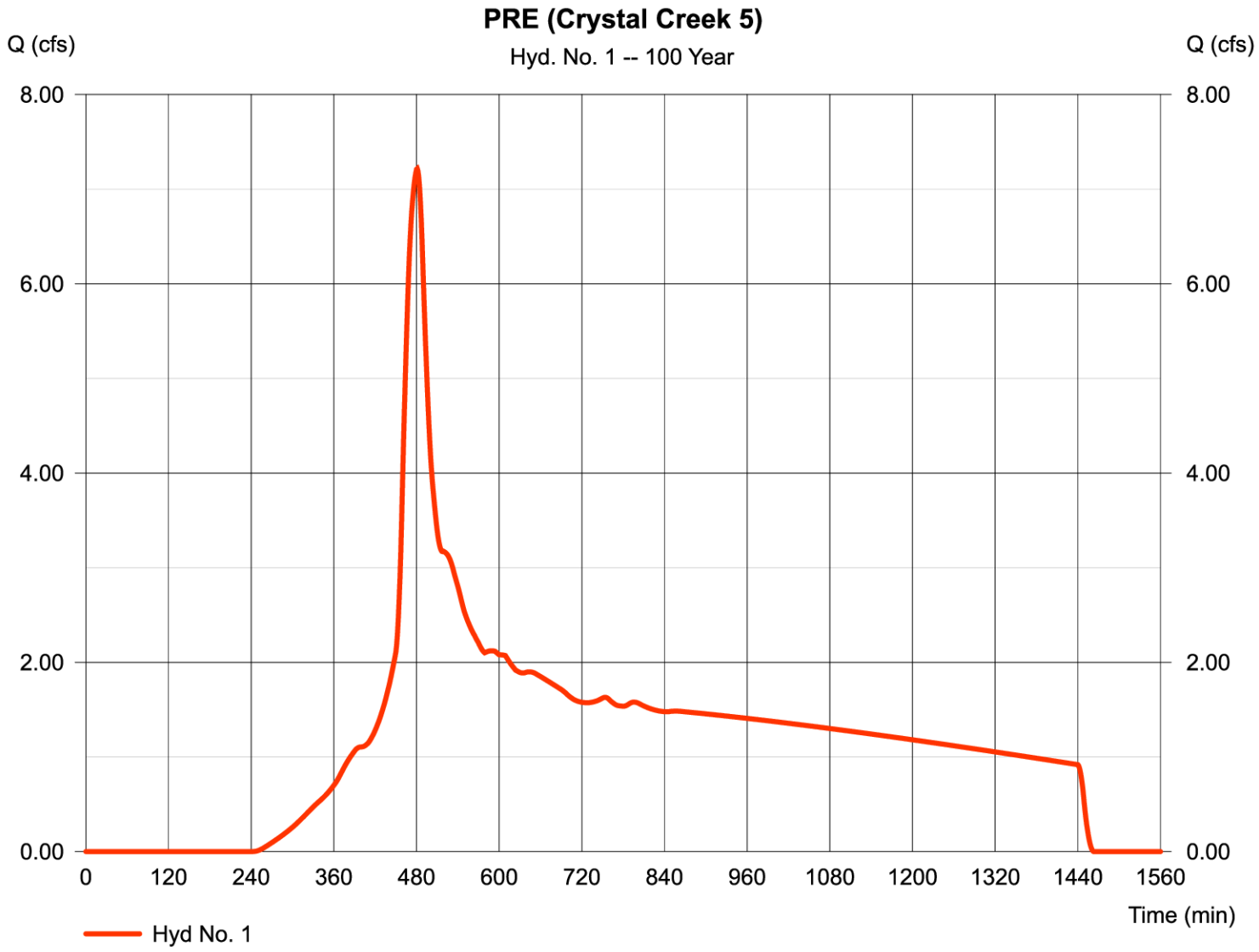
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Wednesday, 01 / 6 / 2021

Hyd. No. 1

PRE (Crystal Creek 5)

Hydrograph type	= SCS Runoff	Peak discharge	= 7.217 cfs
Storm frequency	= 100 yrs	Time to peak	= 481 min
Time interval	= 1 min	Hyd. volume	= 110,078 cuft
Drainage area	= 9.300 ac	Curve number	= 74*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 14.70 min
Total precip.	= 6.09 in	Distribution	= Type IA
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(8.230 x 73) + (0.920 x 79) + (0.150 x 98)] / 9.300



TR55 Tc Worksheet

Hyd. No. 2

POST (Crystal Creek 5)

Description	A		B		C		Totals
Sheet Flow							
Manning's n-value	= 0.350		0.011		0.011		
Flow length (ft)	= 100.0		0.0		0.0		
Two-year 24-hr precip. (in)	= 3.34		0.00		0.00		
Land slope (%)	= 12.00		0.00		0.00		
Travel Time (min)	**= 9.22**	**+**	**0.00**	**+**	**0.00**	**=**	**9.22**
Shallow Concentrated Flow							
Flow length (ft)	= 110.00		0.00		0.00		
Watercourse slope (%)	= 4.00		0.00		0.00		
Surface description	= Paved		Paved		Paved		
Average velocity (ft/s)	=4.07		0.00		0.00		
Travel Time (min)	**= 0.45**	**+**	**0.00**	**+**	**0.00**	**=**	**0.45**
Channel Flow							
X sectional flow area (sqft)	= 2.00		0.00		0.00		
Wetted perimeter (ft)	= 3.58		0.00		0.00		
Channel slope (%)	= 0.60		0.00		0.00		
Manning's n-value	= 0.012		0.015		0.015		
Velocity (ft/s)	=6.51						
			0.00				
					0.00		
Flow length (ft)	({0})236.0		0.0		0.0		
Travel Time (min)	**= 0.60**	**+**	**0.00**	**+**	**0.00**	**=**	**0.60**

Total Travel Time, Tc ..... 10.30 min

Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Wednesday, 01 / 6 / 2021

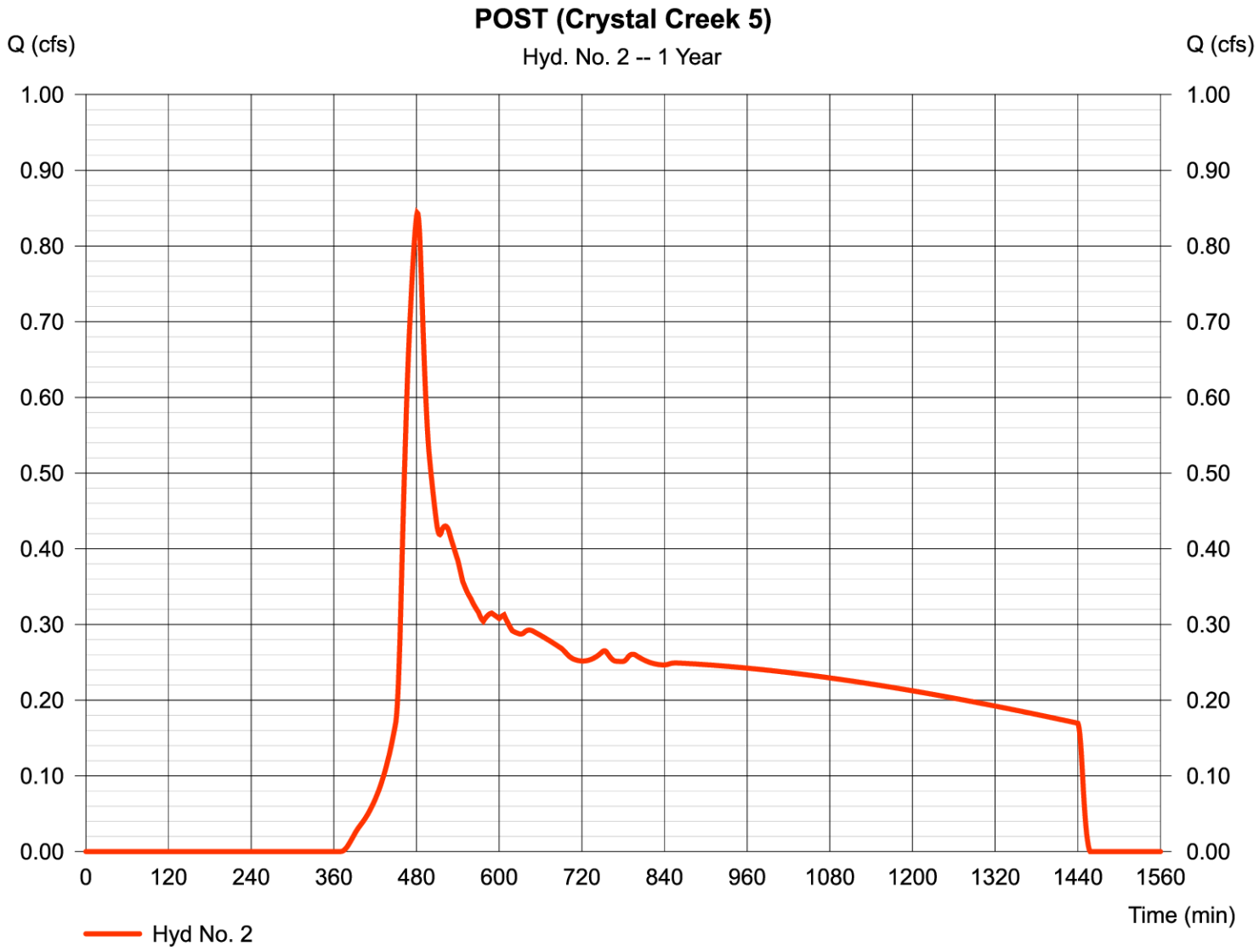
Hyd. No. 2

*1-yr is model for the 6 mo, 24 hr precip

POST (Crystal Creek 5)

Hydrograph type	= SCS Runoff	Peak discharge	= 0.844 cfs
Storm frequency	= 1 yrs	Time to peak	= 481 min
Time interval	= 1 min	Hyd. volume	= 16,053 cuft
Drainage area	= 9.300 ac	Curve number	= 87*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 10.30 min
Total precip.	= 1.40 in	Distribution	= Type IA
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(4.650 x 98) + (2.320 x 73) + (2.330 x 79)] / 9.300



Hydrograph Report

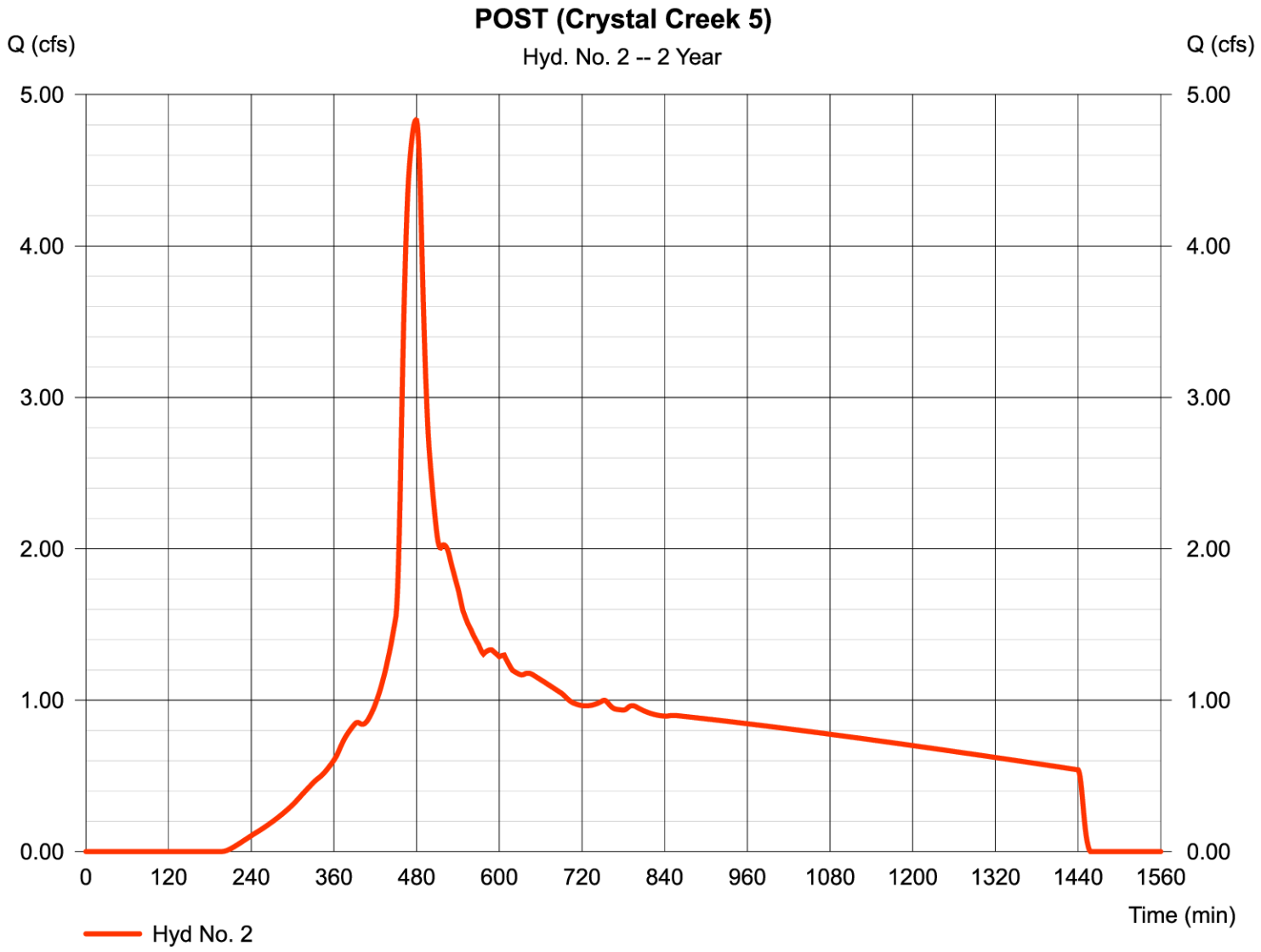
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Wednesday, 01 / 6 / 2021

Hyd. No. 2

POST (Crystal Creek 5)

Hydrograph type	= SCS Runoff	Peak discharge	= 4.832 cfs
Storm frequency	= 2 yrs	Time to peak	= 479 min
Time interval	= 1 min	Hyd. volume	= 70,071 cuft
Drainage area	= 9.300 ac	Curve number	= 87*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 10.30 min
Total precip.	= 3.34 in	Distribution	= Type IA
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(4.650 x 98) + (2.320 x 73) + (2.330 x 79)] / 9.300



Hydrograph Report

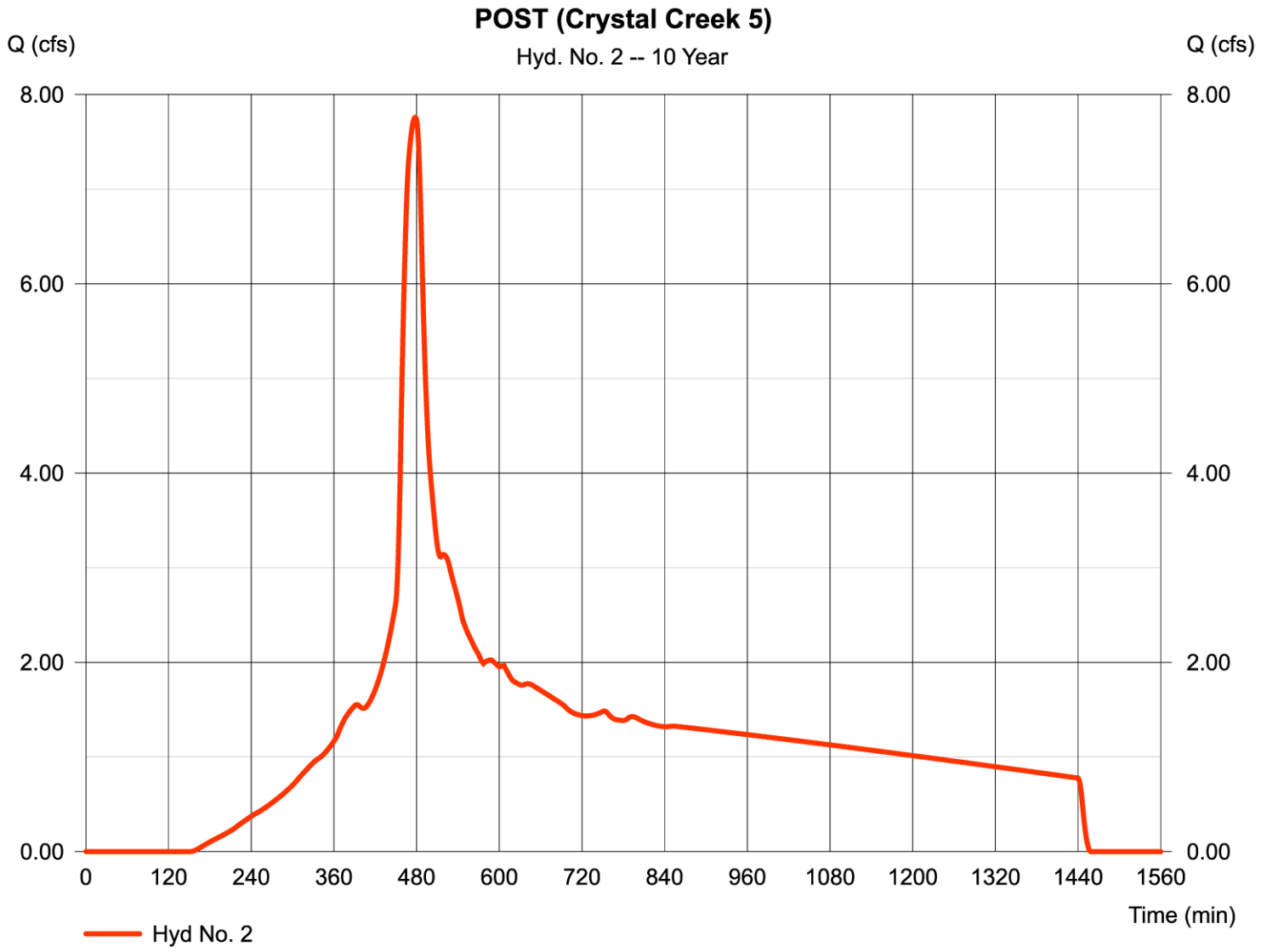
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Wednesday, 01 / 6 / 2021

Hyd. No. 2

POST (Crystal Creek 5)

Hydrograph type	= SCS Runoff	Peak discharge	= 7.758 cfs
Storm frequency	= 10 yrs	Time to peak	= 478 min
Time interval	= 1 min	Hyd. volume	= 109,368 cuft
Drainage area	= 9.300 ac	Curve number	= 87*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 10.30 min
Total precip.	= 4.59 in	Distribution	= Type IA
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(4.650 x 98) + (2.320 x 73) + (2.330 x 79)] / 9.300



Hydrograph Report

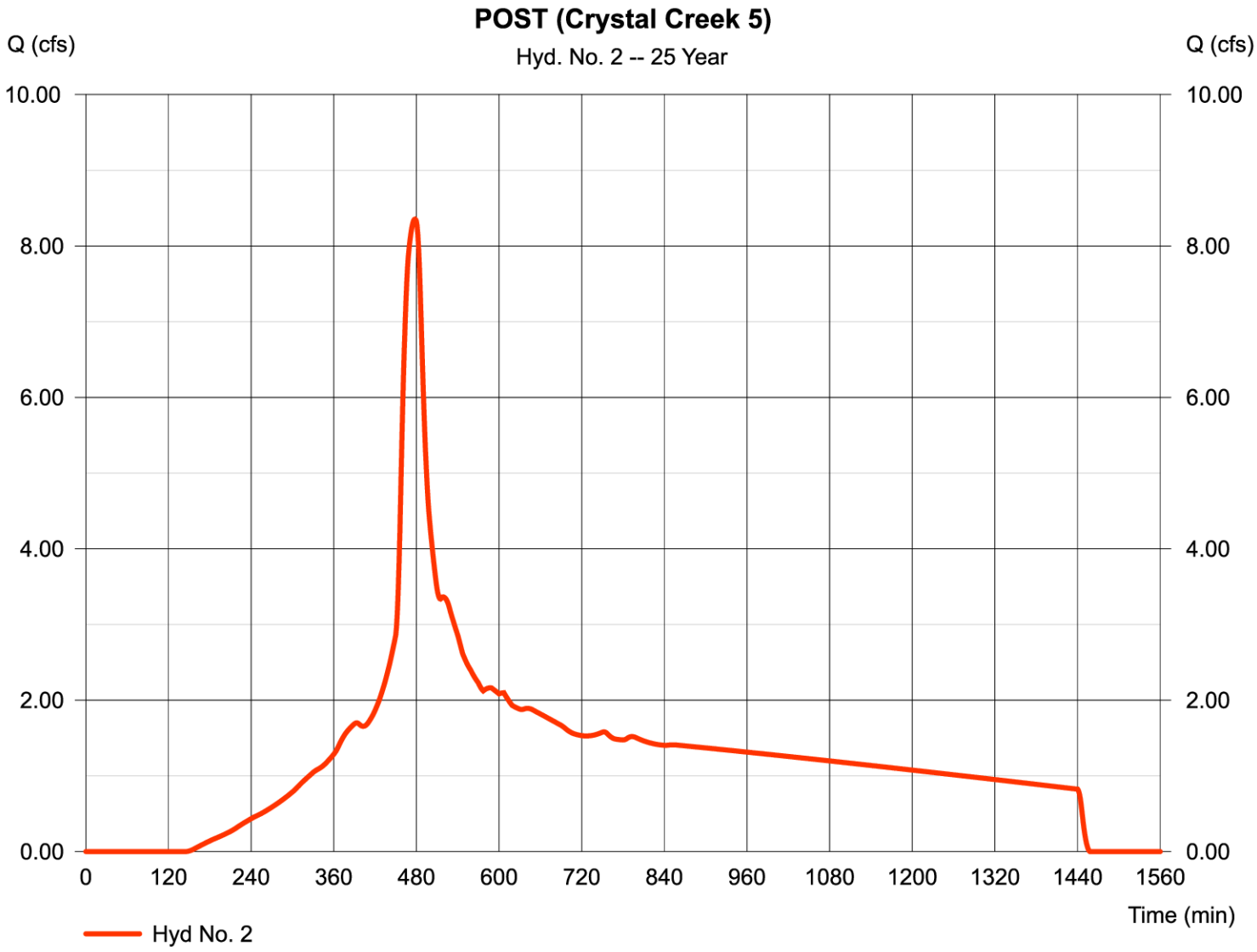
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Wednesday, 01 / 6 / 2021

Hyd. No. 2

POST (Crystal Creek 5)

Hydrograph type	= SCS Runoff	Peak discharge	= 8.353 cfs
Storm frequency	= 25 yrs	Time to peak	= 478 min
Time interval	= 1 min	Hyd. volume	= 117,409 cuft
Drainage area	= 9.300 ac	Curve number	= 87*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 10.30 min
Total precip.	= 4.84 in	Distribution	= Type IA
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(4.650 x 98) + (2.320 x 73) + (2.330 x 79)] / 9.300



Hydrograph Report

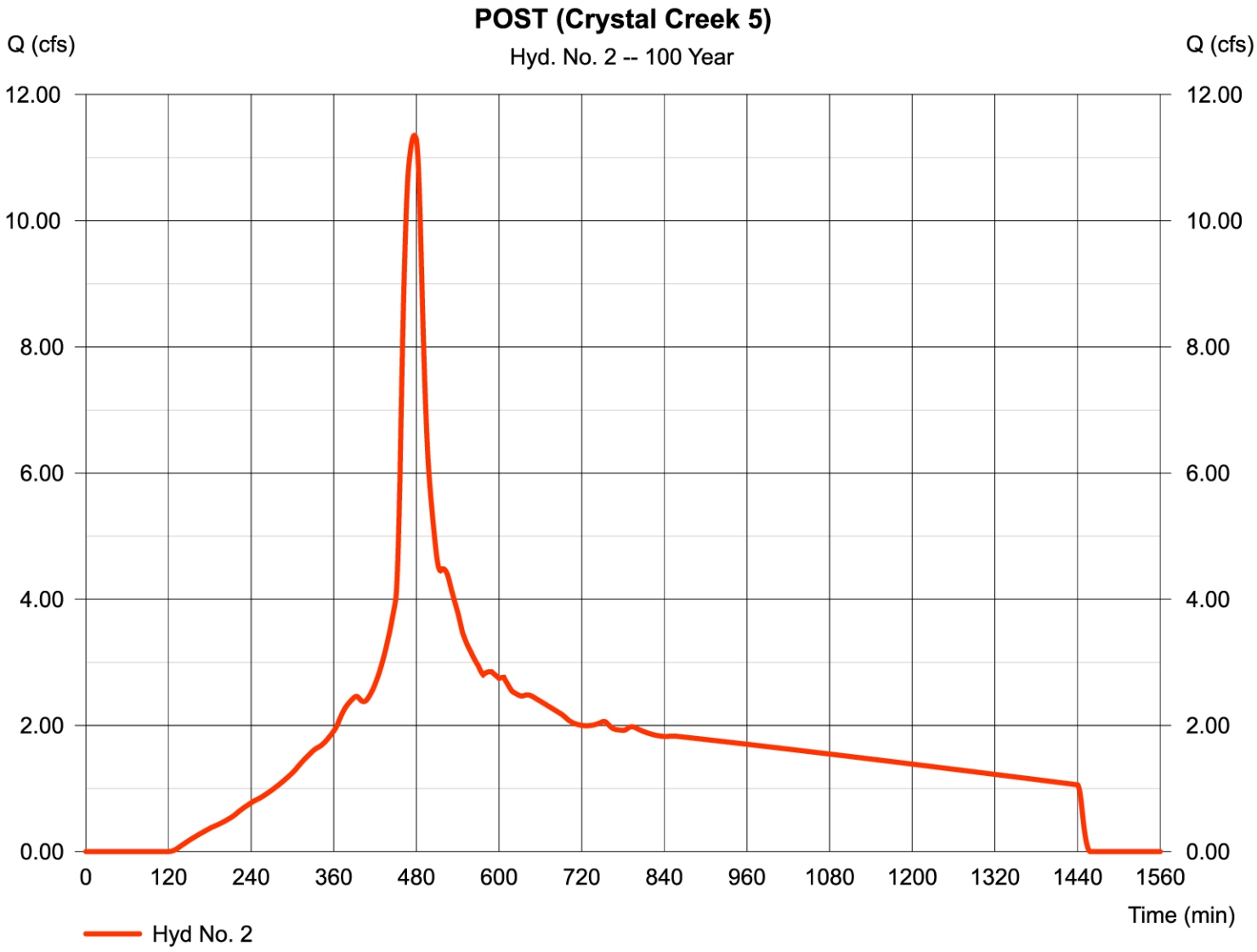
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Wednesday, 01 / 6 / 2021

Hyd. No. 2

POST (Crystal Creek 5)

Hydrograph type	= SCS Runoff	Peak discharge	= 11.35 cfs
Storm frequency	= 100 yrs	Time to peak	= 477 min
Time interval	= 1 min	Hyd. volume	= 158,180 cuft
Drainage area	= 9.300 ac	Curve number	= 87*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 10.30 min
Total precip.	= 6.09 in	Distribution	= Type IA
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(4.650 x 98) + (2.320 x 73) + (2.330 x 79)] / 9.300



Pond Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 — Thursday, 03 / 4 / 2021

Pond No. 1 - Vault C (5300)

Pond Data

Contours -User-defined contour areas. Average end area method used for volume calculation. Begining Elevation = 100.00 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	100.00	5,300	0	0
1.00	101.00	5,300	5,300	5,300
2.00	102.00	5,300	5,300	10,600
3.00	103.00	5,300	5,300	15,900
4.00	104.00	5,300	5,300	21,200
5.00	105.00	5,300	5,300	26,500
6.00	106.00	5,300	5,300	31,800
7.00	107.00	5,300	5,300	37,100
8.00	108.00	5,300	5,300	42,400
9.00	109.00	5,300	5,300	47,700

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 18.00	4.56	Inactive	Inactive
Span (in)	= 18.00	4.56	0.00	0.00
No. Barrels	= 1	1	1	1
Invert El. (ft)	= 100.00	100.00	0.00	0.00
Length (ft)	= 104.00	0.00	0.00	0.00
Slope (%)	= 0.60	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	Yes	No	No

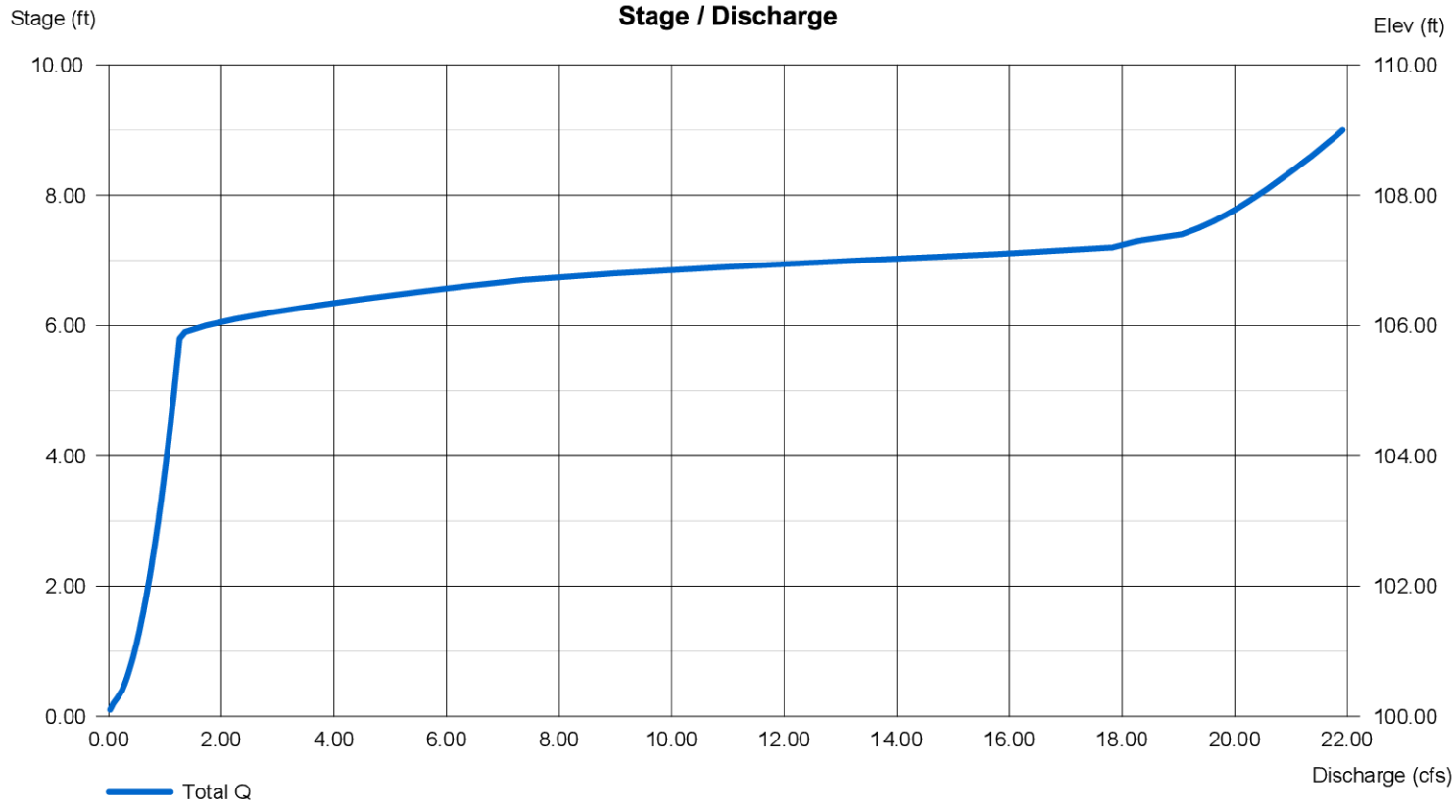
Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 4.71	2.35	Inactive	0.00
Crest El. (ft)	= 106.69	105.85	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= 1	Rect	Rect	---
Multi-Stage	= Yes	Yes	No	No

Exfil.(in/hr) = 0.000 (by Wet area)

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).



Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Thursday, 03 / 4 / 2021

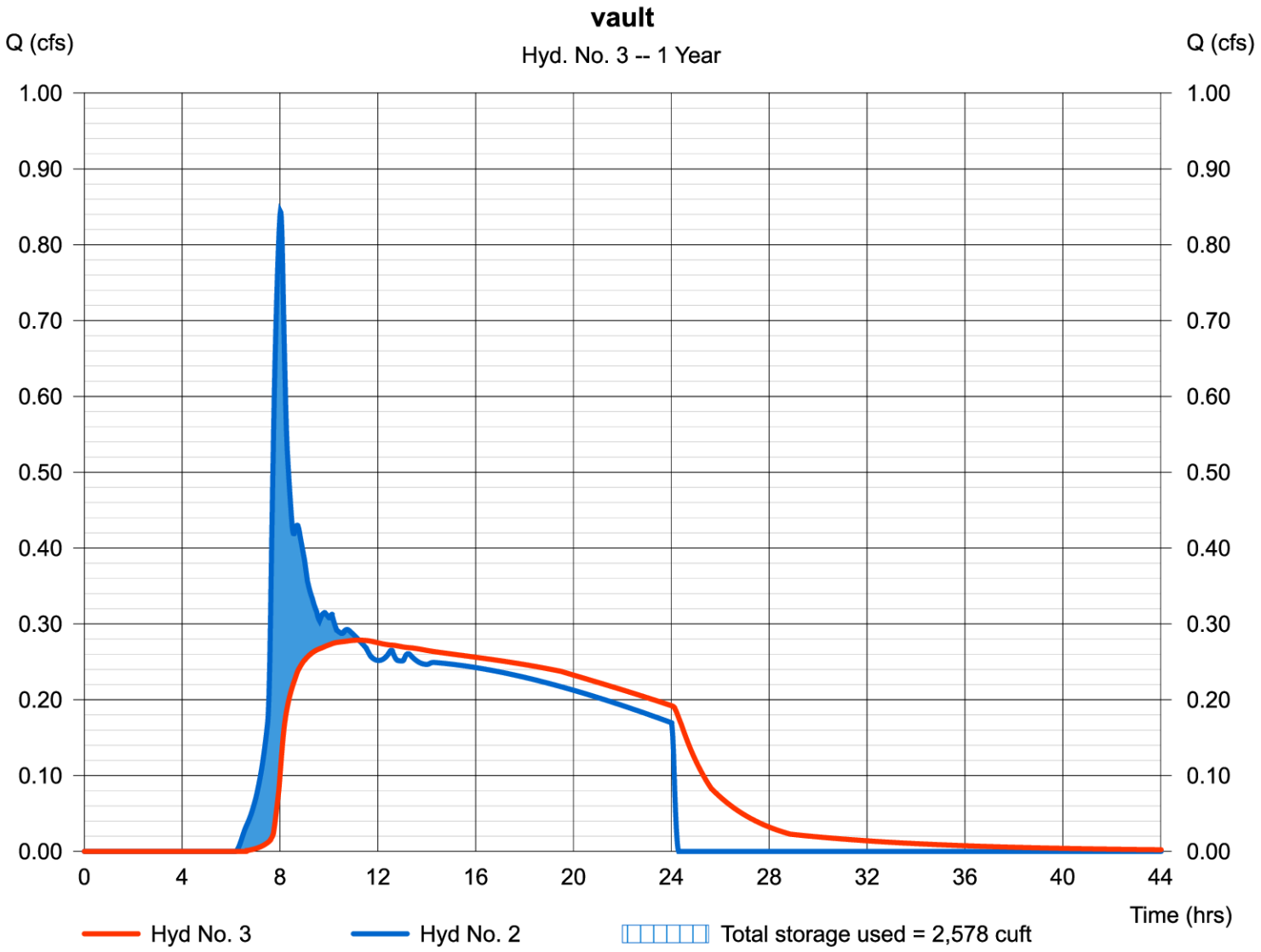
Hyd. No. 3

*1-yr is model for the 6 mo, 24 hr precip

vault

Hydrograph type	=	Reservoir	Peak discharge	=	0.279 cfs
Storm frequency	=	1 yrs	Time to peak	=	11.22 hrs
Time interval	=	1 min	Hyd. volume	=	16,026 cuft
Inflow hyd. No.	=	2 - POST (Crystal Creek 5)	Max. Elevation	=	100.49 ft
Reservoir name	=	Vault C (5300)	Max. Storage	=	2,578 cuft

Storage Indication method used.



Hydrograph Report

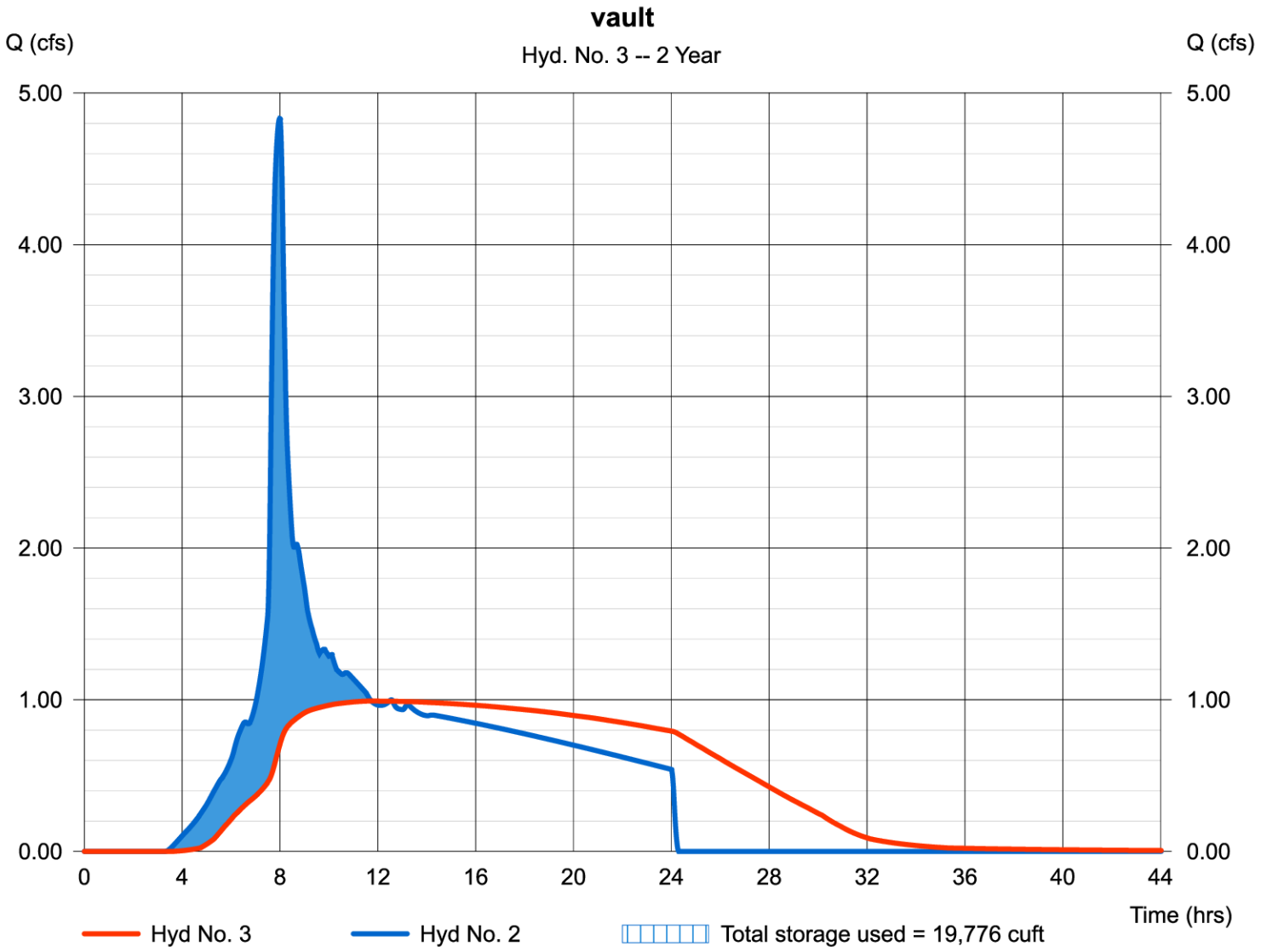
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Thursday, 03 / 4 / 2021

Hyd. No. 3

vault

Hydrograph type	=	Reservoir	Peak discharge	=	0.991 cfs
Storm frequency	=	2 yrs	Time to peak	=	11.73 hrs
Time interval	=	1 min	Hyd. volume	=	69,997 cuft
Inflow hyd. No.	=	2 - POST (Crystal Creek 5)	Max. Elevation	=	103.73 ft
Reservoir name	=	Vault C (5300)	Max. Storage	=	19,776 cuft

Storage Indication method used.



Hydrograph Report

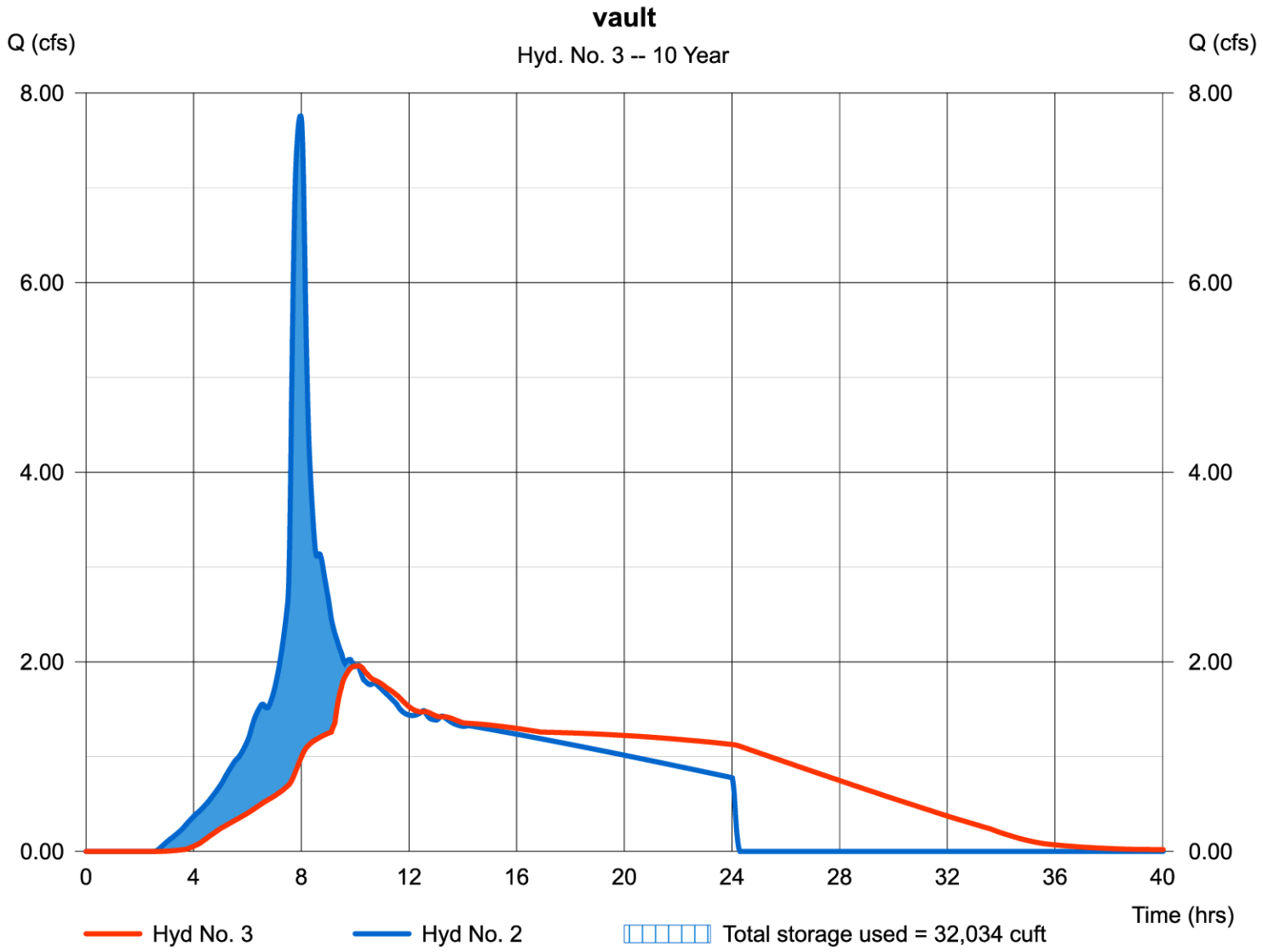
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Thursday, 03 / 4 / 2021

Hyd. No. 3

vault

Hydrograph type	=	Reservoir	Peak discharge	=	1.957 cfs
Storm frequency	=	10 yrs	Time to peak	=	10.13 hrs
Time interval	=	1 min	Hyd. volume	=	109,242 cuft
Inflow hyd. No.	=	2 - POST (Crystal Creek 5)	Max. Elevation	=	106.04 ft
Reservoir name	=	Vault C (5300)	Max. Storage	=	32,034 cuft

Storage Indication method used.



Hydrograph Report

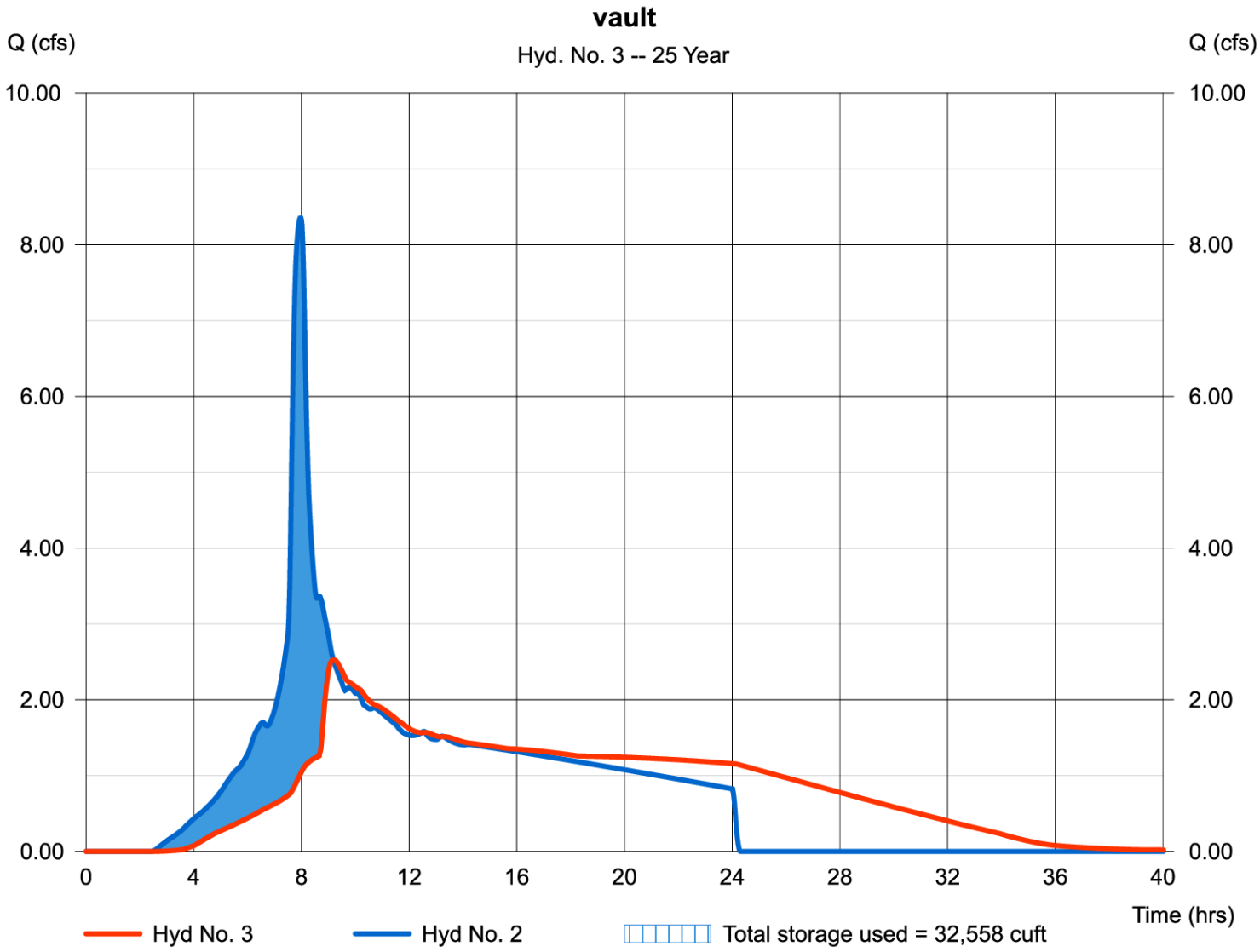
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Thursday, 03 / 4 / 2021

Hyd. No. 3

vault

Hydrograph type	=	Reservoir	Peak discharge	=	2.526 cfs
Storm frequency	=	25 yrs	Time to peak	=	9.18 hrs
Time interval	=	1 min	Hyd. volume	=	117,277 cuft
Inflow hyd. No.	=	2 - POST (Crystal Creek 5)	Max. Elevation	=	106.14 ft
Reservoir name	=	Vault C (5300)	Max. Storage	=	32,558 cuft

Storage Indication method used.



Hydrograph Report

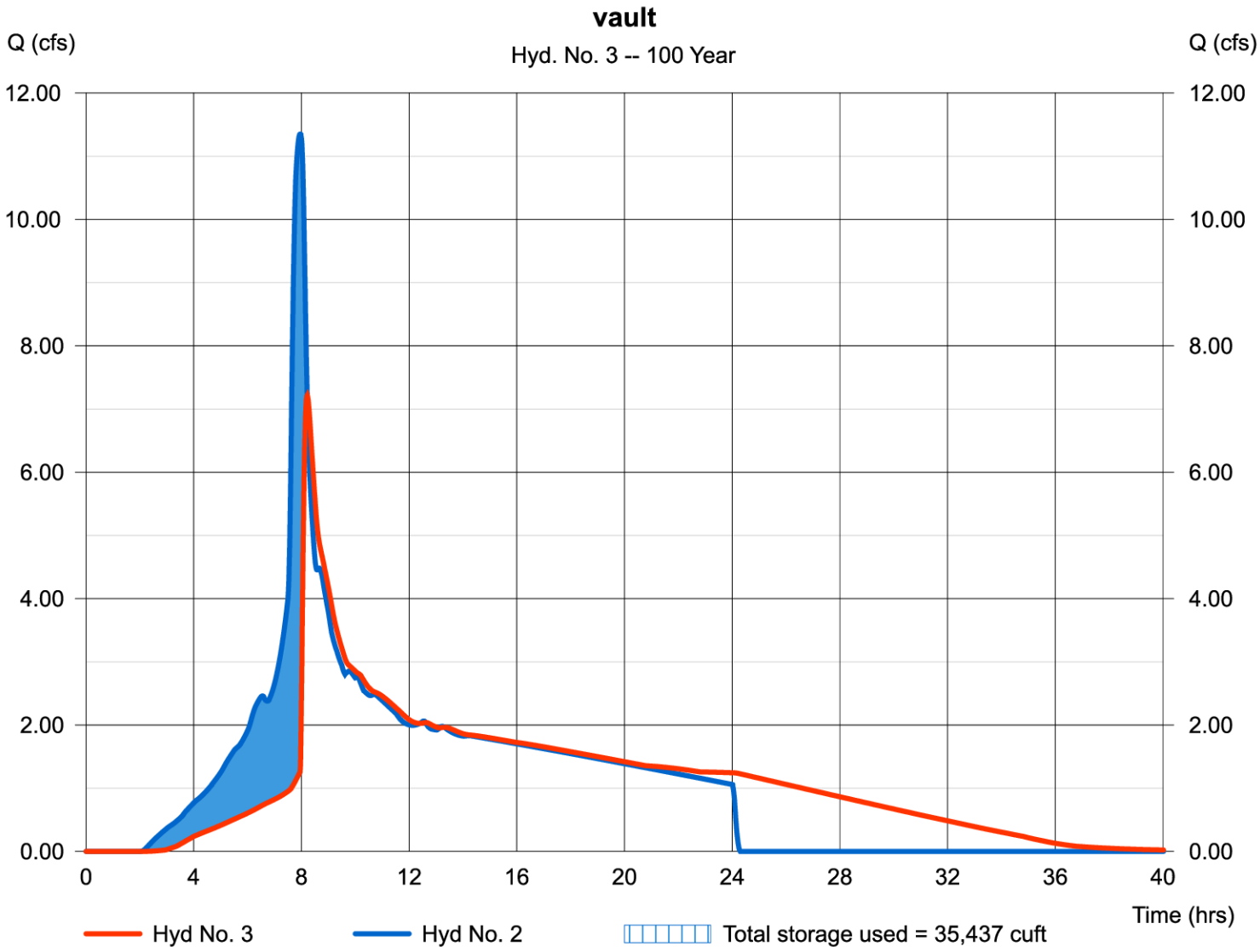
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Thursday, 03 / 4 / 2021

Hyd. No. 3

vault

Hydrograph type	= Reservoir	Peak discharge	= 7.215 cfs
Storm frequency	= 100 yrs	Time to peak	= 8.22 hrs
Time interval	= 1 min	Hyd. volume	= 158,028 cuft
Inflow hyd. No.	= 2 - POST (Crystal Creek 5)	Max. Elevation	= 106.69 ft
Reservoir name	= Vault C (5300)	Max. Storage	= 35,437 cuft

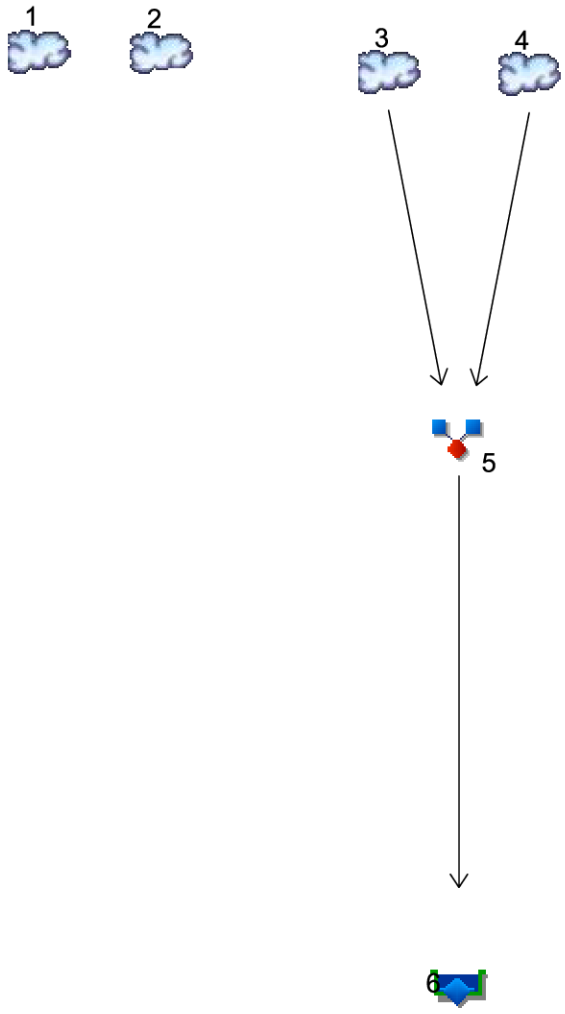
Storage Indication method used.



Crystal Creek 3 Detention Pond B7-A Output

Watershed Model Schematic

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



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	0.0000	0.0000	0.0000	--------
3	0.0000	0.0000	0.0000	--------
5	0.0000	0.0000	0.0000	--------
10	0.0000	0.0000	0.0000	--------
25	0.0000	0.0000	0.0000	--------
50	0.0000	0.0000	0.0000	--------
100	0.0000	0.0000	0.0000	--------

File name: SampleFHA.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	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
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	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
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
50	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	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Tc = time in minutes. Values may exceed 60.

*1-yr column is the 6 mo, 24 hr precip

Precip. file name: E:\Projects\19349\Engineering\Hydraflow\Phase 1\Pond 7B-A\precip.pcp

Storm Distribution	Rainfall Precipitation Table (in)							
	1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr
SCS 24-hour	1.40	3.34	0.00	3.30	4.59	4.84	6.80	6.09
SCS 6-Hr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-1st	0.00	0.00	0.00	2.75	0.00	0.00	6.50	0.00
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	0.00	0.00	2.80	0.00	0.00	6.00	0.00

TR55 Tc Worksheet

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

Hyd. No. 1

Upstream PRE (Crystal Creek 3)

Description	A		B		C		Totals
Sheet Flow							
Manning's n-value	= 0.350		0.011		0.011		
Flow length (ft)	= 209.0		0.0		0.0		
Two-year 24-hr precip. (in)	= 3.34		0.00		0.00		
Land slope (%)	= 12.00		0.00		0.00		
Travel Time (min)	**= 16.64**	**+**	**0.00**	**+**	**0.00**	**=**	**16.64**
Shallow Concentrated Flow							
Flow length (ft)	= 0.00		0.00		0.00		
Watercourse slope (%)	= 0.00		0.00		0.00		
Surface description	= Paved		Paved		Paved		
Average velocity (ft/s)	=0.00		0.00		0.00		
Travel Time (min)	**= 0.00**	**+**	**0.00**	**+**	**0.00**	**=**	**0.00**
Channel Flow							
X sectional flow area (sqft)	= 0.00		0.00		0.00		
Wetted perimeter (ft)	= 0.00		0.00		0.00		
Channel slope (%)	= 0.00		0.00		0.00		
Manning's n-value	= 0.015		0.015		0.015		
Velocity (ft/s)	=0.00						
			0.00				
					0.00		
Flow length (ft)	({0})0.0		0.0		0.0		
Travel Time (min)	**= 0.00**	**+**	**0.00**	**+**	**0.00**	**=**	**0.00**

Total Travel Time, Tc ..... 16.60 min

Hydrograph Report

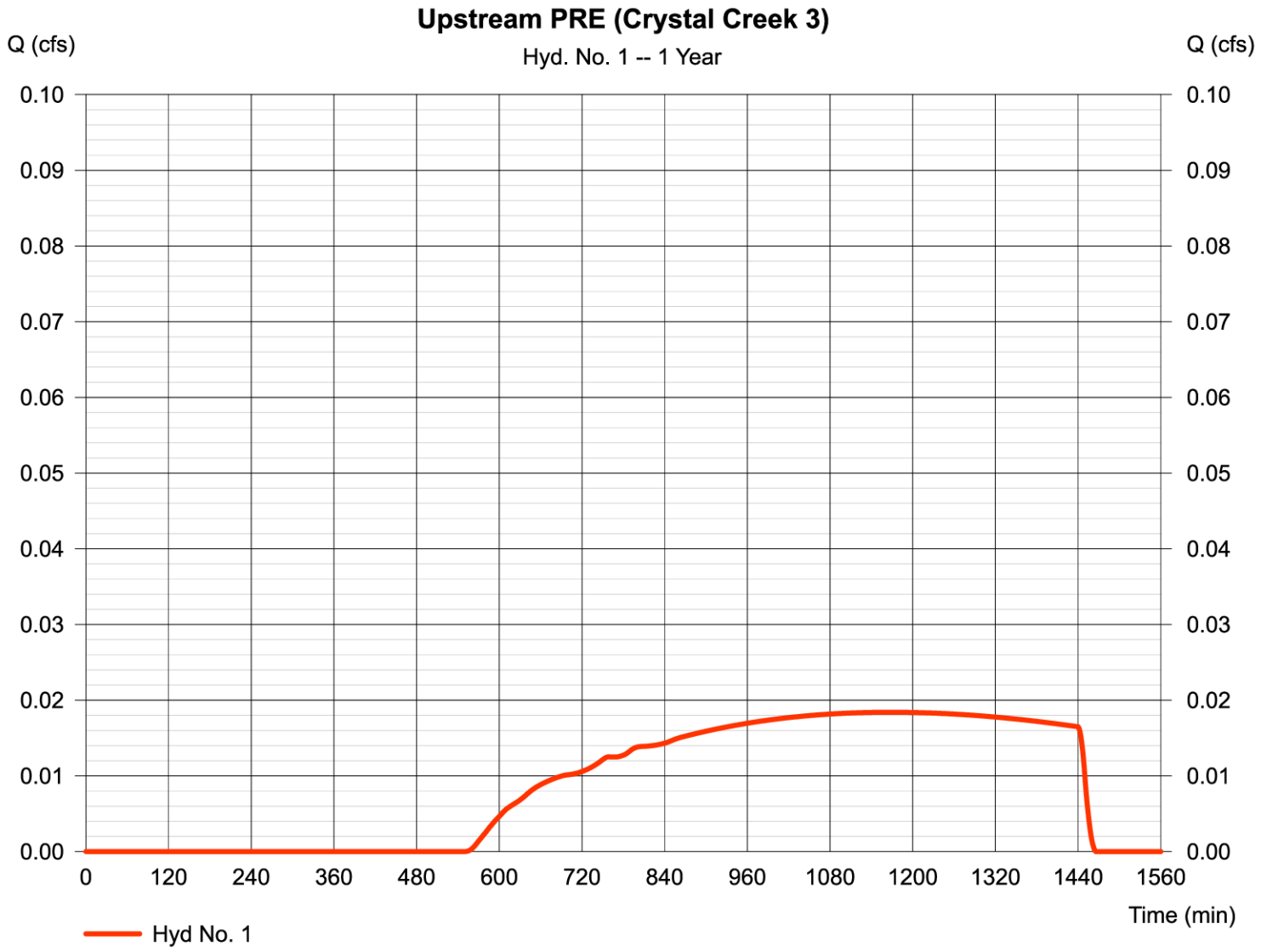
Hyd. No. 1

*1-yr is model for the 6 mo, 24 hr precip

Upstream PRE (Crystal Creek 3)

Hydrograph type	= SCS Runoff	Peak discharge	= 0.018 cfs
Storm frequency	= 1 yrs	Time to peak	= 1168 min
Time interval	= 1 min	Hyd. volume	= 798 cuft
Drainage area	= 2.170 ac	Curve number	= 73*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 16.60 min
Total precip.	= 1.40 in	Distribution	= Type IA
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(2.170 x 73)] / 2.170



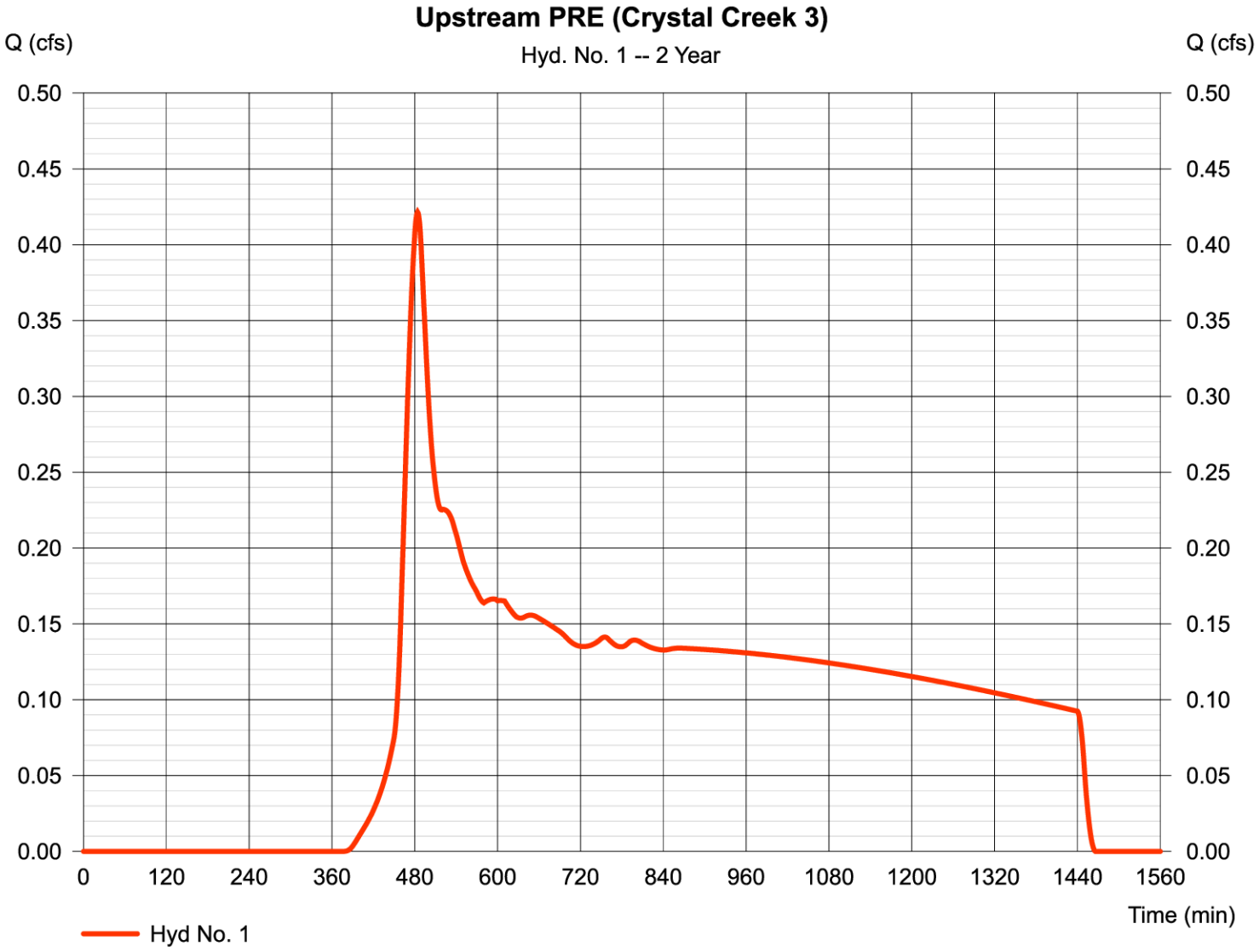
Hydrograph Report

Hyd. No. 1

Upstream PRE (Crystal Creek 3)

Hydrograph type	= SCS Runoff	Peak discharge	= 0.421 cfs
Storm frequency	= 2 yrs	Time to peak	= 484 min
Time interval	= 1 min	Hyd. volume	= 8,561 cuft
Drainage area	= 2.170 ac	Curve number	= 73*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 16.60 min
Total precip.	= 3.34 in	Distribution	= Type IA
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(2.170 x 73)] / 2.170



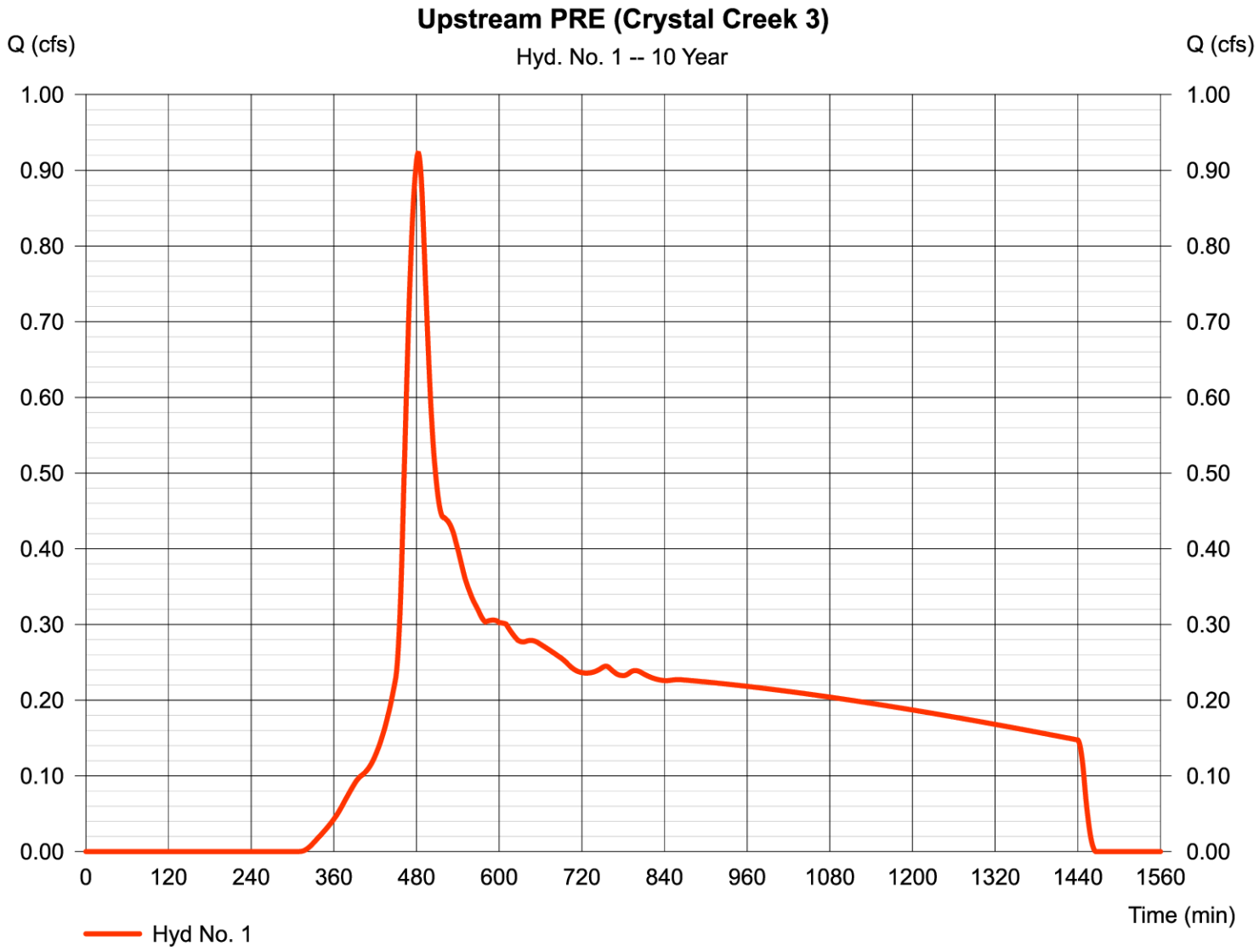
Hydrograph Report

Hyd. No. 1

Upstream PRE (Crystal Creek 3)

Hydrograph type	= SCS Runoff	Peak discharge	= 0.922 cfs
Storm frequency	= 10 yrs	Time to peak	= 482 min
Time interval	= 1 min	Hyd. volume	= 15,662 cuft
Drainage area	= 2.170 ac	Curve number	= 73*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 16.60 min
Total precip.	= 4.59 in	Distribution	= Type IA
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(2.170 x 73)] / 2.170



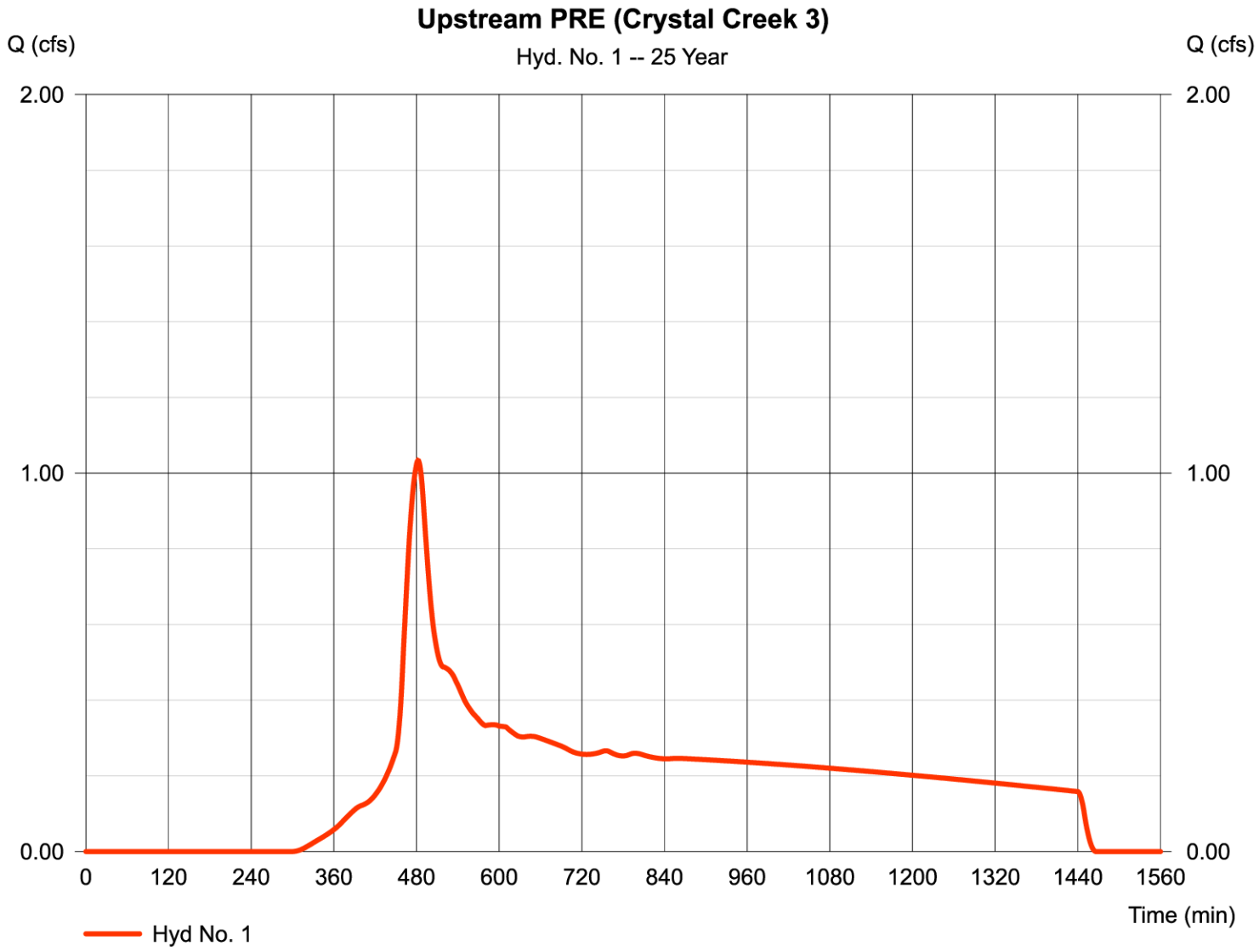
Hydrograph Report

Hyd. No. 1

Upstream PRE (Crystal Creek 3)

Hydrograph type	= SCS Runoff	Peak discharge	= 1.033 cfs
Storm frequency	= 25 yrs	Time to peak	= 482 min
Time interval	= 1 min	Hyd. volume	= 17,193 cuft
Drainage area	= 2.170 ac	Curve number	= 73*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 16.60 min
Total precip.	= 4.84 in	Distribution	= Type IA
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(2.170 x 73)] / 2.170



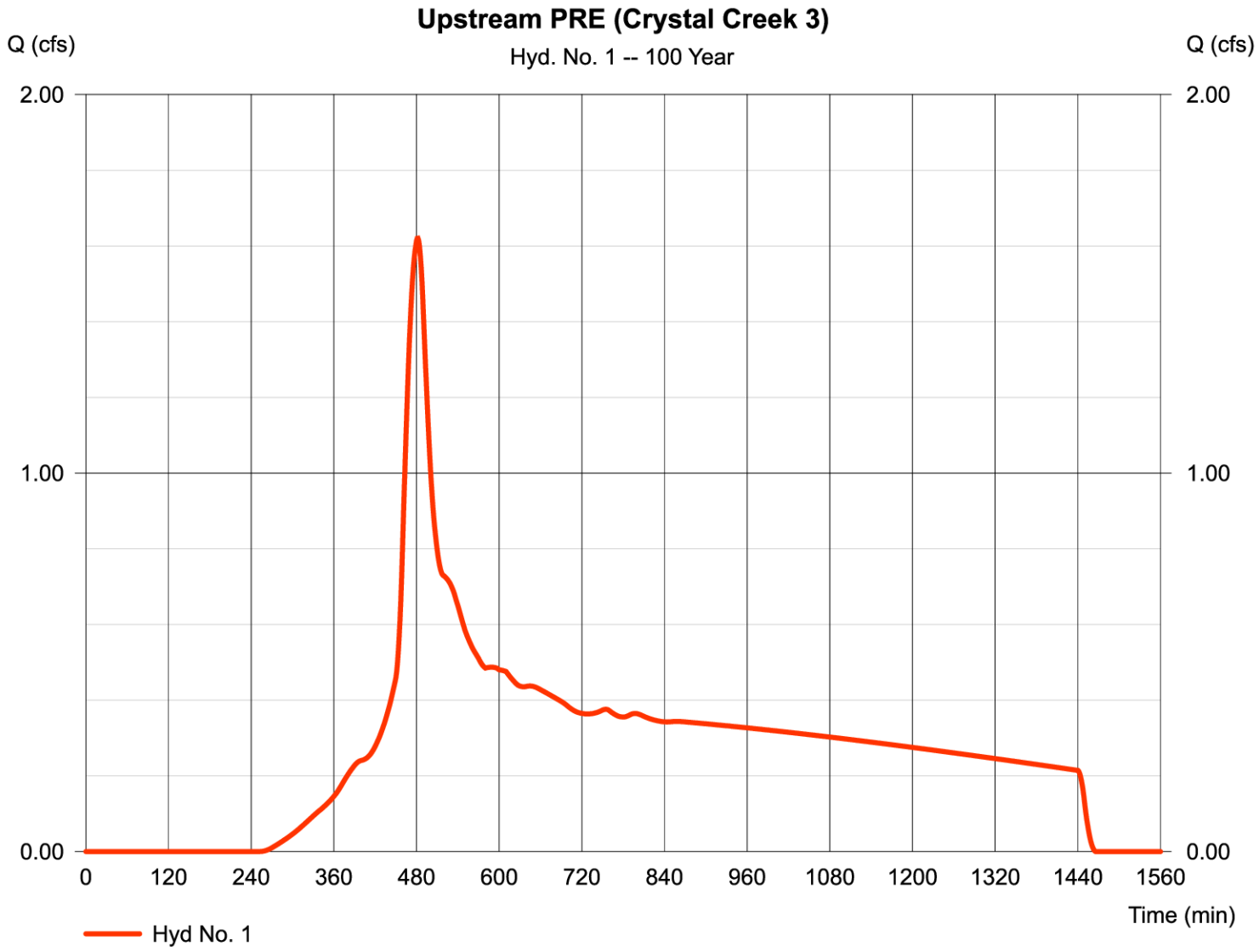
Hydrograph Report

Hyd. No. 1

Upstream PRE (Crystal Creek 3)

Hydrograph type	= SCS Runoff	Peak discharge	= 1.620 cfs
Storm frequency	= 100 yrs	Time to peak	= 482 min
Time interval	= 1 min	Hyd. volume	= 25,230 cuft
Drainage area	= 2.170 ac	Curve number	= 73*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 16.60 min
Total precip.	= 6.09 in	Distribution	= Type IA
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(2.170 x 73)] / 2.170



TR55 Tc Worksheet

Hyd. No. 2

Onsite PRE (Crystal Creek 3)

Description	A		B		C		Totals
Sheet Flow							
Manning's n-value	= 0.350		0.011		0.011		
Flow length (ft)	= 200.0		0.0		0.0		
Two-year 24-hr precip. (in)	= 3.34		0.00		0.00		
Land slope (%)	= 18.00		0.00		0.00		
Travel Time (min)	**= 13.66**	**+**	**0.00**	**+**	**0.00**	**=**	**13.66**
Shallow Concentrated Flow							
Flow length (ft)	= 110.00		0.00		0.00		
Watercourse slope (%)	= 18.00		0.00		0.00		
Surface description	= Unpaved		Paved		Paved		
Average velocity (ft/s)	=6.85		0.00		0.00		
Travel Time (min)	**= 0.27**	**+**	**0.00**	**+**	**0.00**	**=**	**0.27**
Channel Flow							
X sectional flow area (sqft)	= 0.00		0.00		0.00		
Wetted perimeter (ft)	= 0.00		0.00		0.00		
Channel slope (%)	= 0.00		0.00		0.00		
Manning's n-value	= 0.015		0.015		0.015		
Velocity (ft/s)	=0.00						
			0.00				
					0.00		
Flow length (ft)	({0})0.0		0.0		0.0		
Travel Time (min)	**= 0.00**	**+**	**0.00**	**+**	**0.00**	**=**	**0.00**

Total Travel Time, Tc ..... 13.90 min

Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Tuesday, 06 / 16 / 2020

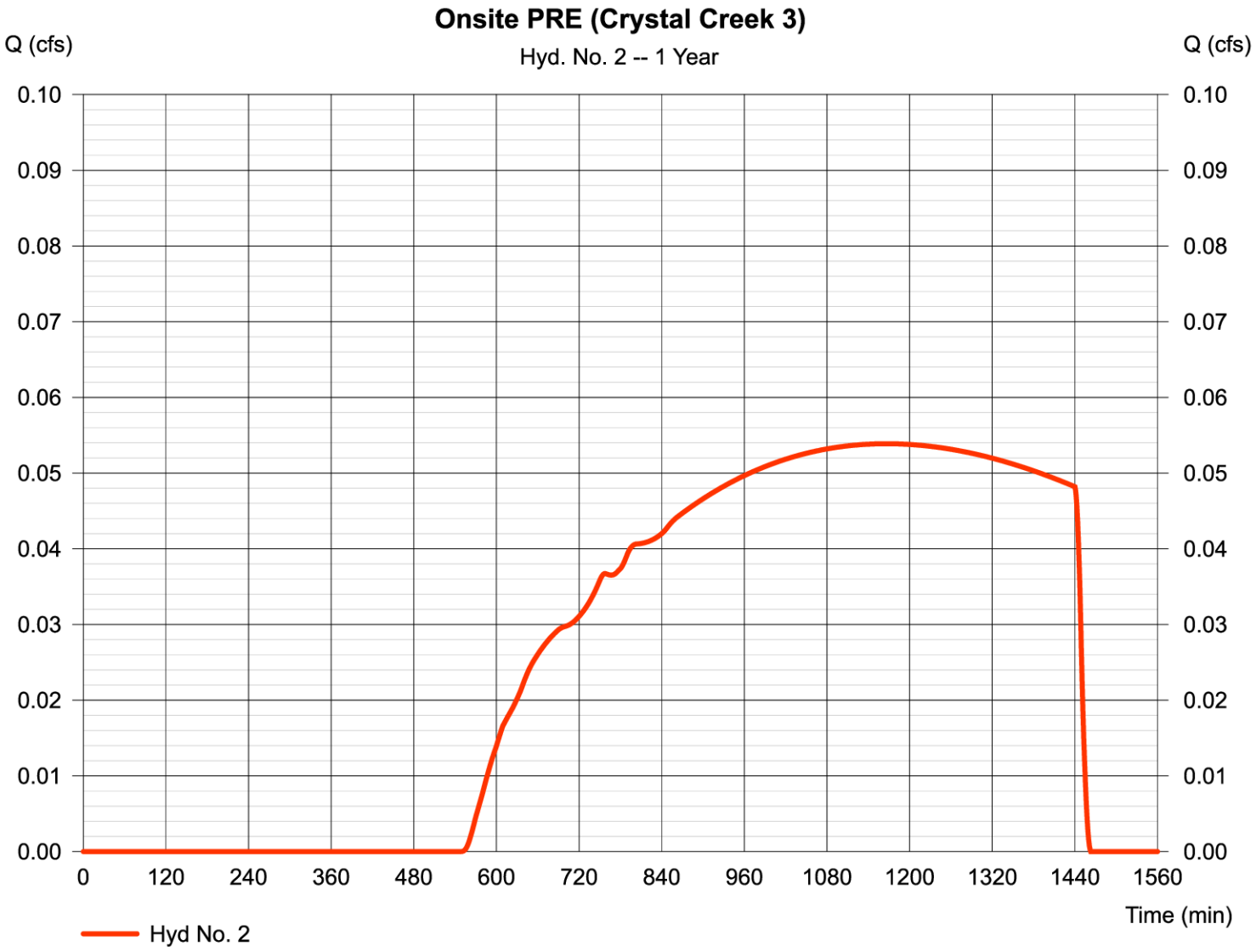
Hyd. No. 2

*1-yr is model for the 6 mo, 24 hr precip

Onsite PRE (Crystal Creek 3)

Hydrograph type	= SCS Runoff	Peak discharge	= 0.054 cfs
Storm frequency	= 1 yrs	Time to peak	= 1167 min
Time interval	= 1 min	Hyd. volume	= 2,334 cuft
Drainage area	= 6.430 ac	Curve number	= 73*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 13.90 min
Total precip.	= 1.40 in	Distribution	= Type IA
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(6.430 x 73)] / 6.430



Hydrograph Report

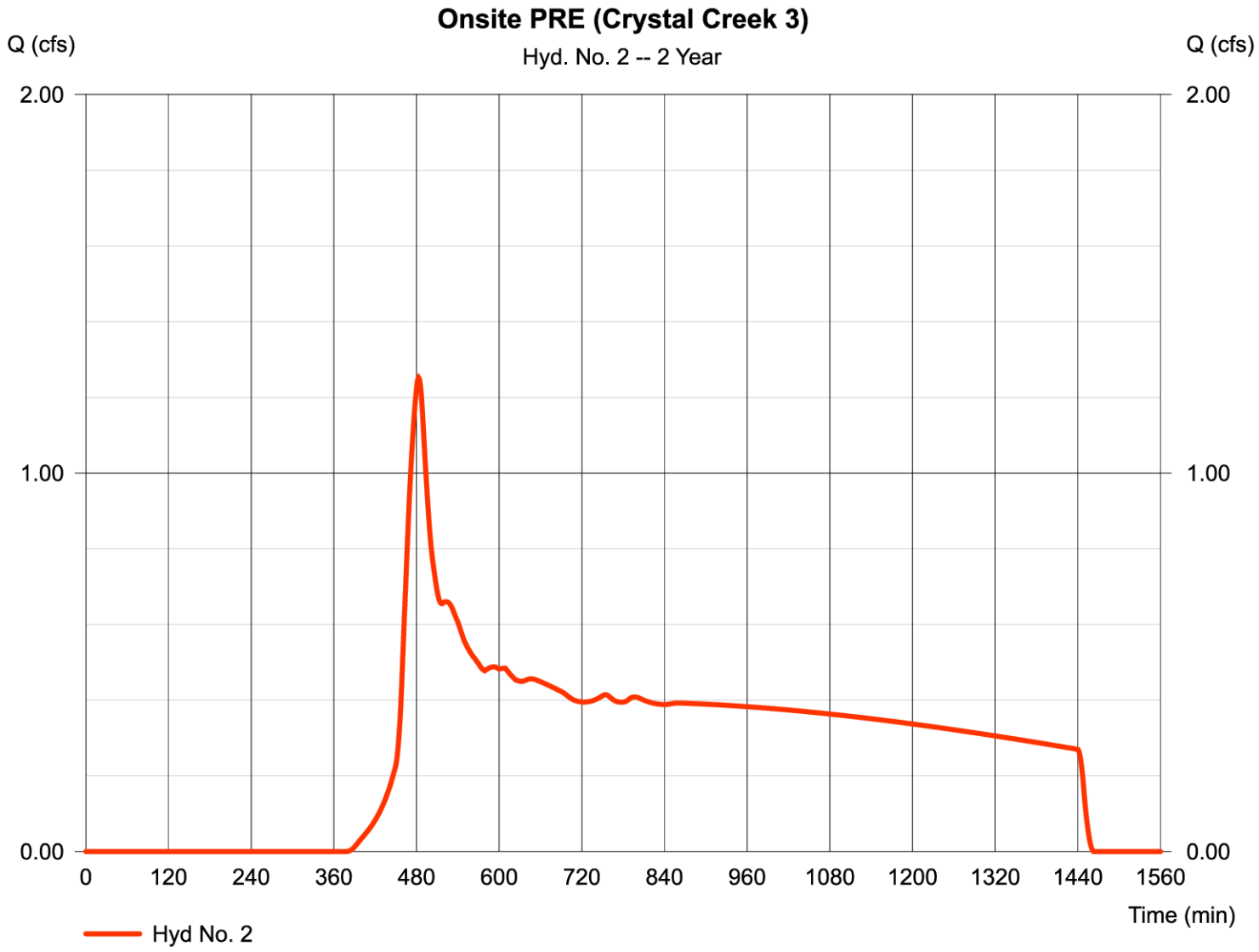
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Tuesday, 06 / 16 / 2020

Hyd. No. 2

Onsite PRE (Crystal Creek 3)

Hydrograph type	= SCS Runoff	Peak discharge	= 1.252 cfs
Storm frequency	= 2 yrs	Time to peak	= 483 min
Time interval	= 1 min	Hyd. volume	= 25,055 cuft
Drainage area	= 6.430 ac	Curve number	= 73*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 13.90 min
Total precip.	= 3.34 in	Distribution	= Type IA
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(6.430 x 73)] / 6.430



Hydrograph Report

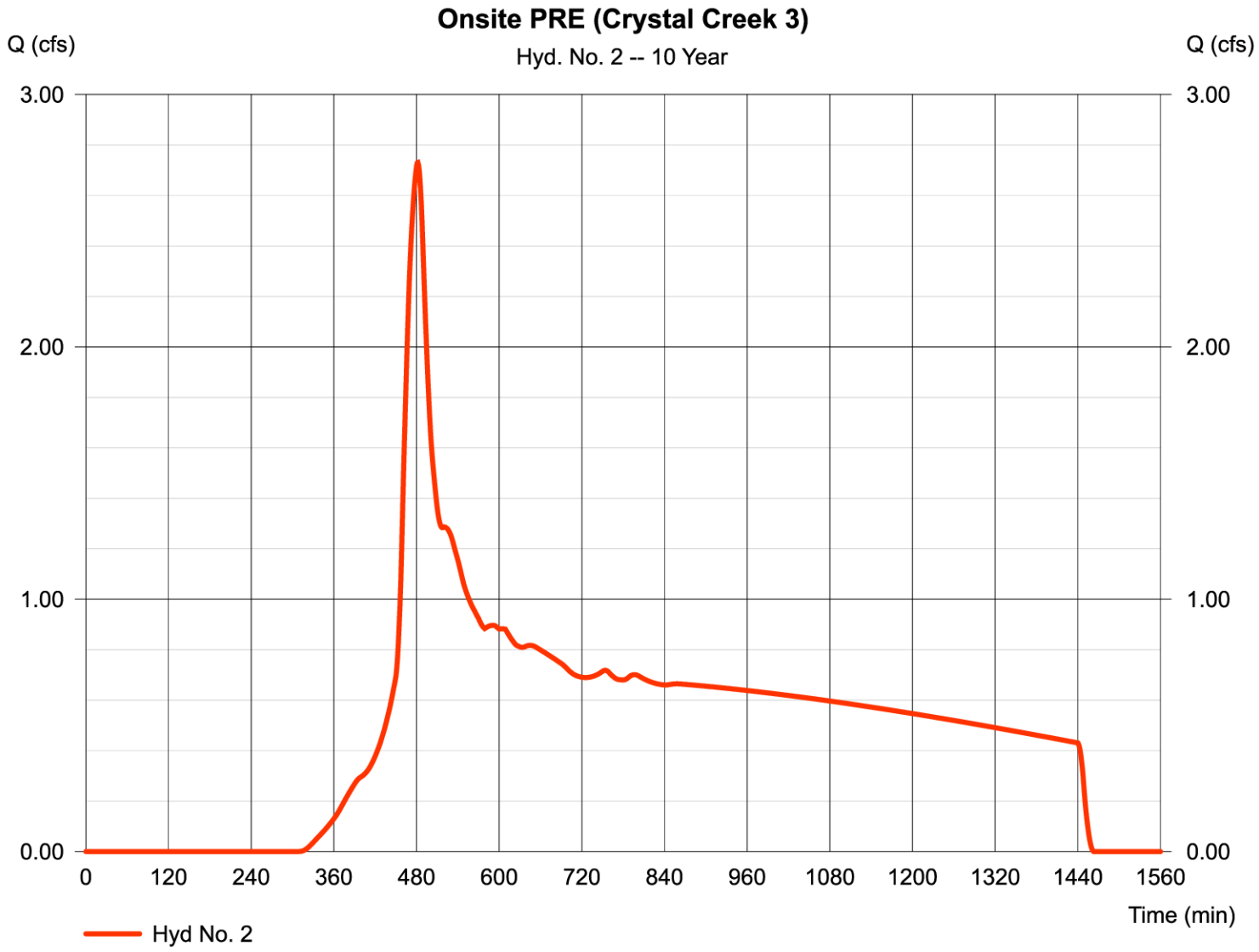
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Tuesday, 06 / 16 / 2020

Hyd. No. 2

Onsite PRE (Crystal Creek 3)

Hydrograph type	= SCS Runoff	Peak discharge	= 2.730 cfs
Storm frequency	= 10 yrs	Time to peak	= 482 min
Time interval	= 1 min	Hyd. volume	= 45,837 cuft
Drainage area	= 6.430 ac	Curve number	= 73*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 13.90 min
Total precip.	= 4.59 in	Distribution	= Type IA
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(6.430 x 73)] / 6.430



Hydrograph Report

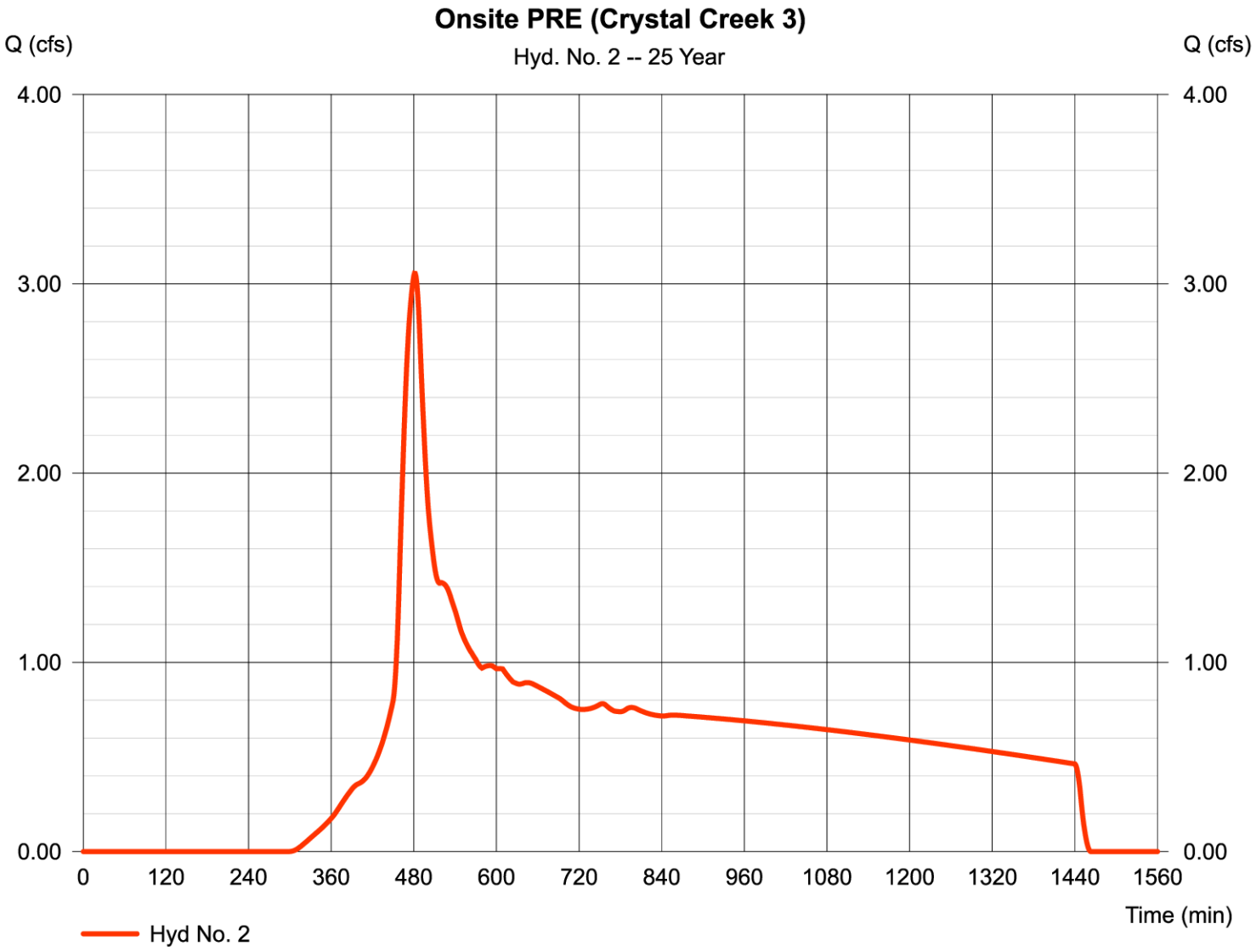
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Tuesday, 06 / 16 / 2020

Hyd. No. 2

Onsite PRE (Crystal Creek 3)

Hydrograph type	= SCS Runoff	Peak discharge	= 3.055 cfs
Storm frequency	= 25 yrs	Time to peak	= 481 min
Time interval	= 1 min	Hyd. volume	= 50,316 cuft
Drainage area	= 6.430 ac	Curve number	= 73*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 13.90 min
Total precip.	= 4.84 in	Distribution	= Type IA
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(6.430 x 73)] / 6.430



Hydrograph Report

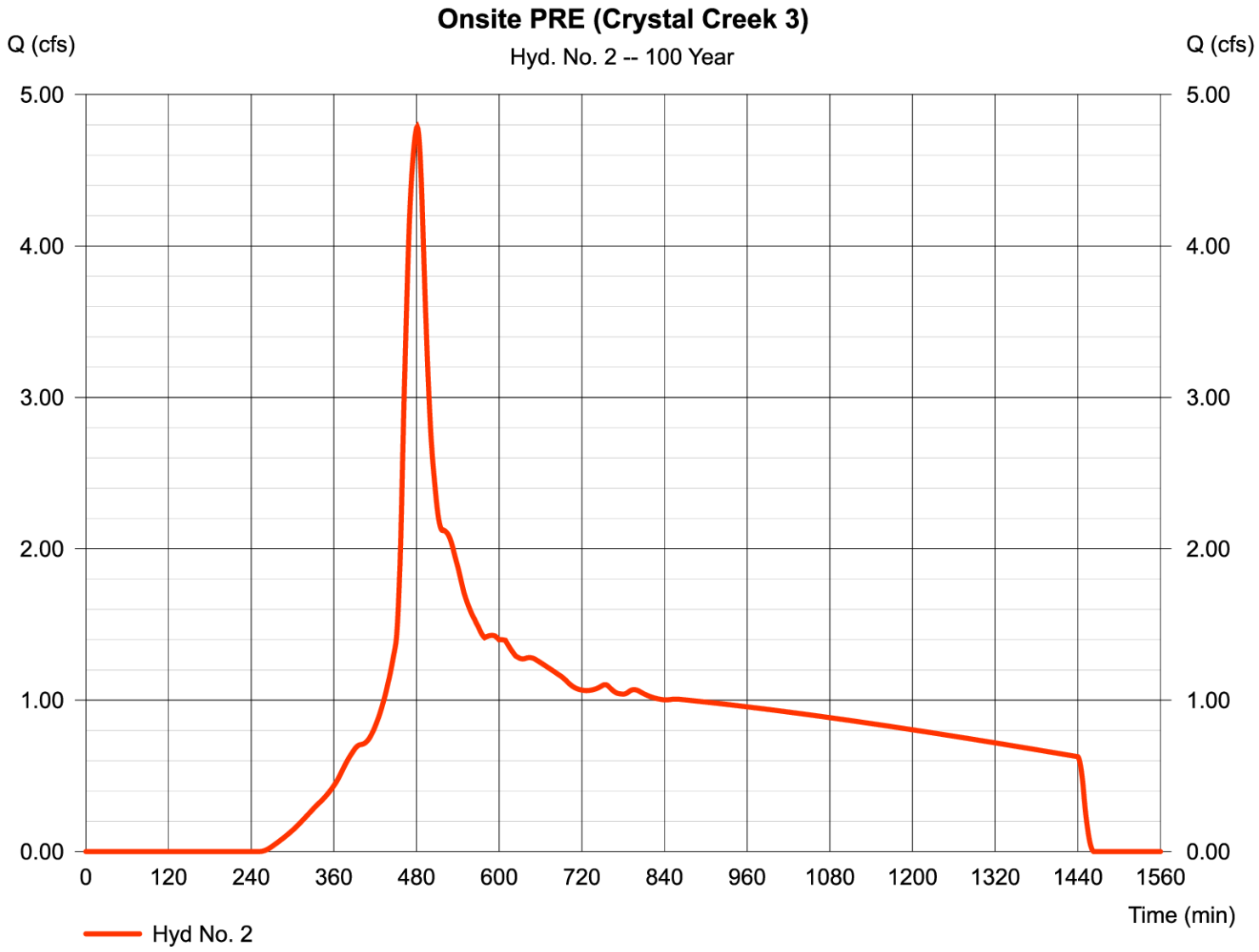
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Tuesday, 06 / 16 / 2020

Hyd. No. 2

Onsite PRE (Crystal Creek 3)

Hydrograph type	= SCS Runoff	Peak discharge	= 4.787 cfs
Storm frequency	= 100 yrs	Time to peak	= 481 min
Time interval	= 1 min	Hyd. volume	= 73,837 cuft
Drainage area	= 6.430 ac	Curve number	= 73*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 13.90 min
Total precip.	= 6.09 in	Distribution	= Type IA
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(6.430 x 73)] / 6.430



TR55 Tc Worksheet

Hyd. No. 3

Upstream Post (Crystal Creek 3)

Description	A		B		C		Totals
Sheet Flow							
Manning's n-value	= 0.350		0.011		0.011		
Flow length (ft)	= 209.0		0.0		0.0		
Two-year 24-hr precip. (in)	= 3.34		0.00		0.00		
Land slope (%)	= 12.00		0.00		0.00		
Travel Time (min)	**= 16.64**	**+**	**0.00**	**+**	**0.00**	**=**	**16.64**
Shallow Concentrated Flow							
Flow length (ft)	= 0.00		0.00		0.00		
Watercourse slope (%)	= 0.00		0.00		0.00		
Surface description	= Paved		Paved		Paved		
Average velocity (ft/s)	=0.00		0.00		0.00		
Travel Time (min)	**= 0.00**	**+**	**0.00**	**+**	**0.00**	**=**	**0.00**
Channel Flow							
X sectional flow area (sqft)	= 0.00		0.00		0.00		
Wetted perimeter (ft)	= 0.00		0.00		0.00		
Channel slope (%)	= 0.00		0.00		0.00		
Manning's n-value	= 0.015		0.015		0.015		
Velocity (ft/s)	=0.00						
			0.00				
					0.00		
Flow length (ft)	({0})0.0		0.0		0.0		
Travel Time (min)	**= 0.00**	**+**	**0.00**	**+**	**0.00**	**=**	**0.00**

Total Travel Time, Tc ..... 16.60 min

Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Tuesday, 06 / 16 / 2020

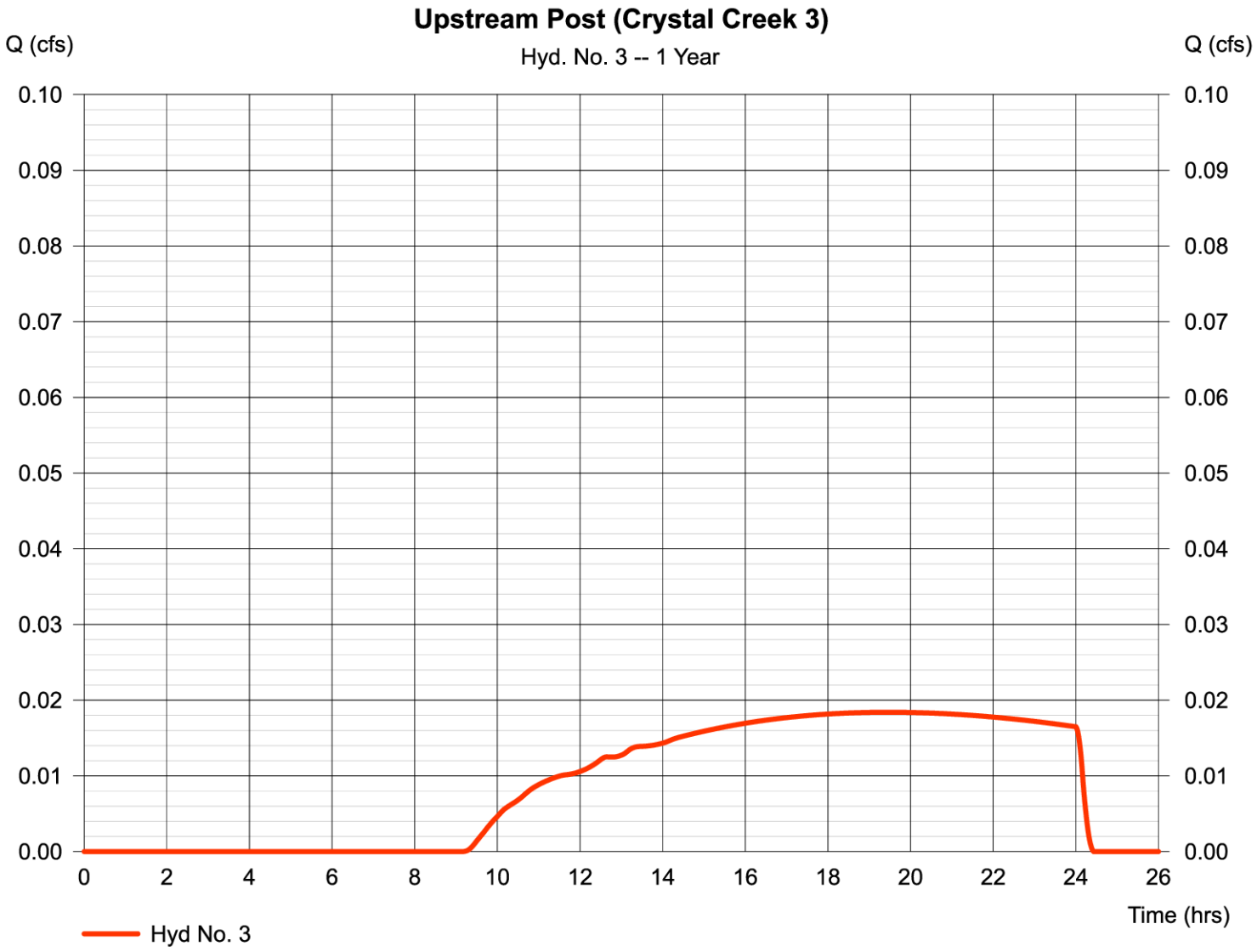
Hyd. No. 3

*1-yr is model for the 6 mo, 24 hr precip

Upstream Post (Crystal Creek 3)

Hydrograph type	= SCS Runoff	Peak discharge	= 0.018 cfs
Storm frequency	= 1 yrs	Time to peak	= 19.47 hrs
Time interval	= 1 min	Hyd. volume	= 798 cuft
Drainage area	= 2.170 ac	Curve number	= 73*
Basin Slope	= 1.0 %	Hydraulic length	= 1 ft
Tc method	= TR55	Time of conc. (Tc)	= 16.60 min
Total precip.	= 1.40 in	Distribution	= Type IA
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(2.170 x 73)] / 2.170



Hydrograph Report

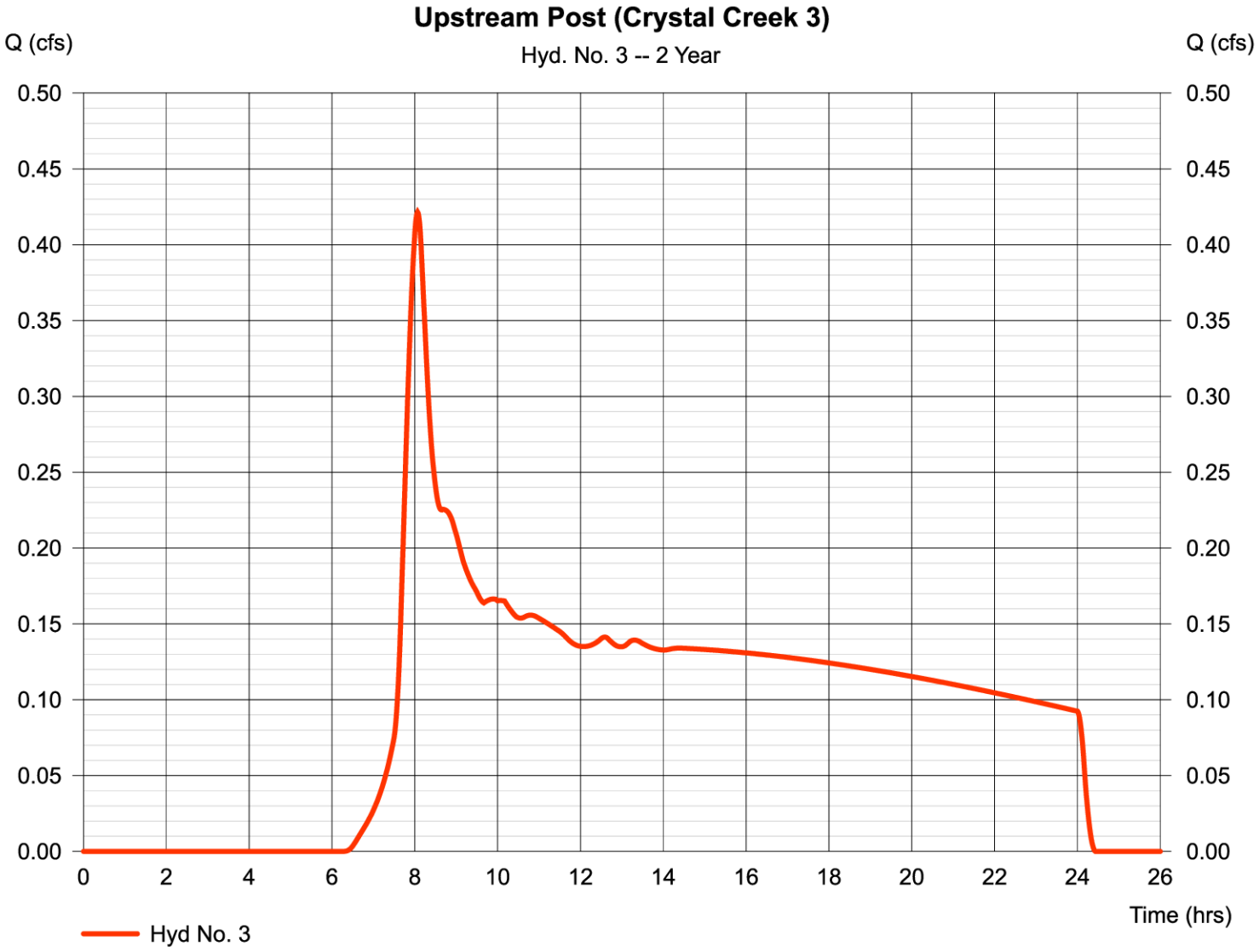
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Tuesday, 06 / 16 / 2020

Hyd. No. 3

Upstream Post (Crystal Creek 3)

Hydrograph type	= SCS Runoff	Peak discharge	= 0.421 cfs
Storm frequency	= 2 yrs	Time to peak	= 8.07 hrs
Time interval	= 1 min	Hyd. volume	= 8,561 cuft
Drainage area	= 2.170 ac	Curve number	= 73*
Basin Slope	= 1.0 %	Hydraulic length	= 1 ft
Tc method	= TR55	Time of conc. (Tc)	= 16.60 min
Total precip.	= 3.34 in	Distribution	= Type IA
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(2.170 x 73)] / 2.170



Hydrograph Report

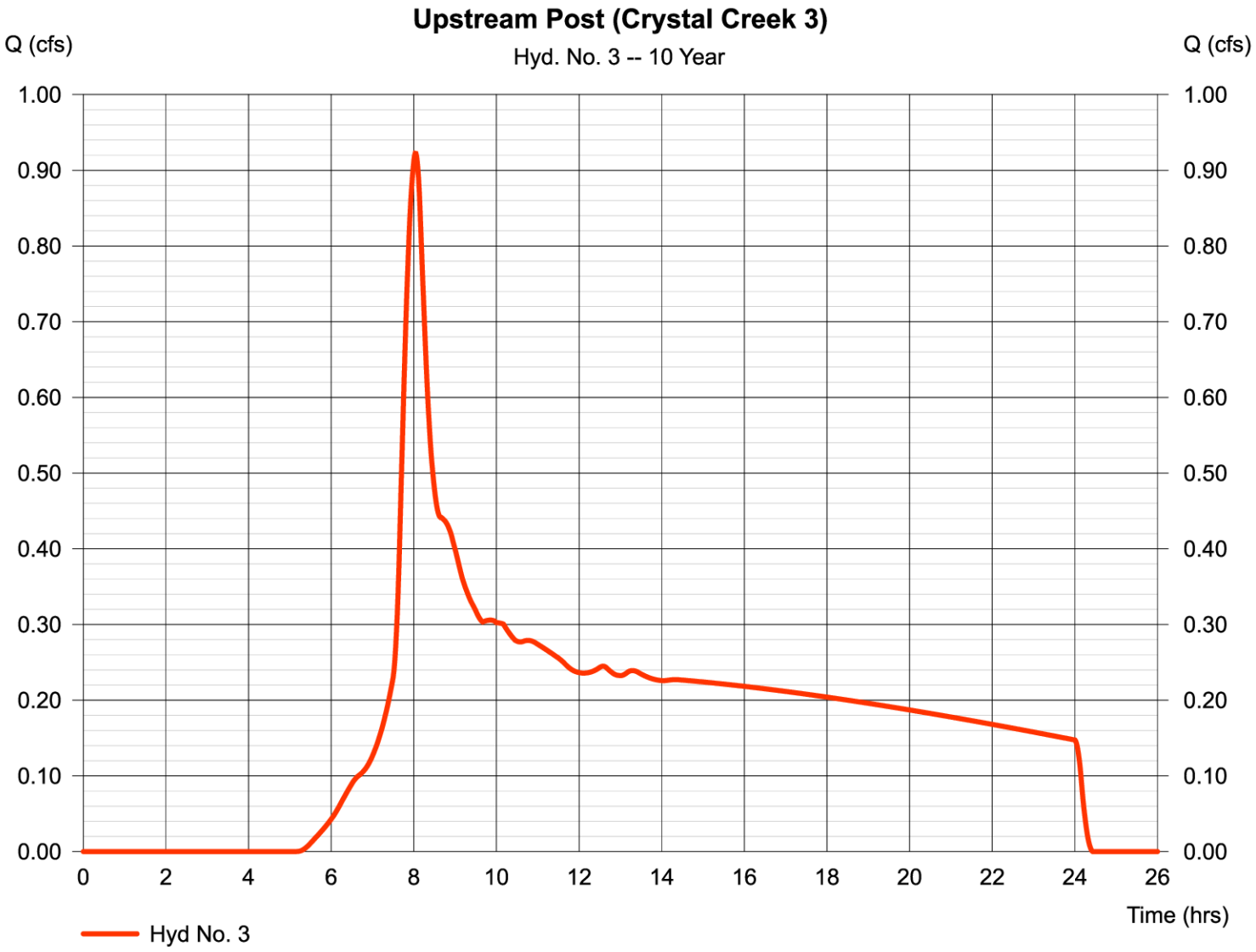
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Tuesday, 06 / 16 / 2020

Hyd. No. 3

Upstream Post (Crystal Creek 3)

Hydrograph type	= SCS Runoff	Peak discharge	= 0.922 cfs
Storm frequency	= 10 yrs	Time to peak	= 8.03 hrs
Time interval	= 1 min	Hyd. volume	= 15,662 cuft
Drainage area	= 2.170 ac	Curve number	= 73*
Basin Slope	= 1.0 %	Hydraulic length	= 1 ft
Tc method	= TR55	Time of conc. (Tc)	= 16.60 min
Total precip.	= 4.59 in	Distribution	= Type IA
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(2.170 x 73)] / 2.170



Hydrograph Report

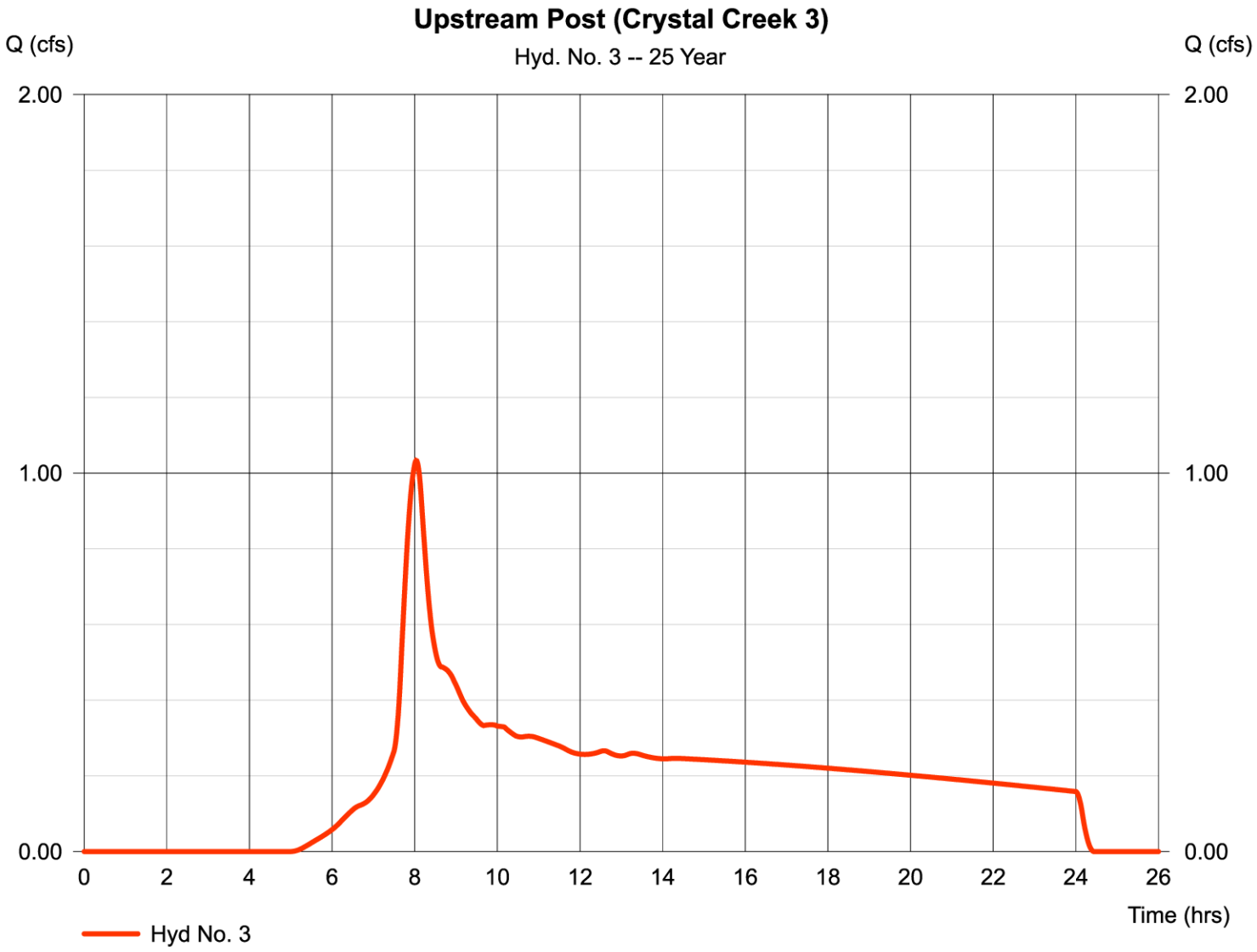
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Tuesday, 06 / 16 / 2020

Hyd. No. 3

Upstream Post (Crystal Creek 3)

Hydrograph type	= SCS Runoff	Peak discharge	= 1.033 cfs
Storm frequency	= 25 yrs	Time to peak	= 8.03 hrs
Time interval	= 1 min	Hyd. volume	= 17,193 cuft
Drainage area	= 2.170 ac	Curve number	= 73*
Basin Slope	= 1.0 %	Hydraulic length	= 1 ft
Tc method	= TR55	Time of conc. (Tc)	= 16.60 min
Total precip.	= 4.84 in	Distribution	= Type IA
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(2.170 x 73)] / 2.170



Hydrograph Report

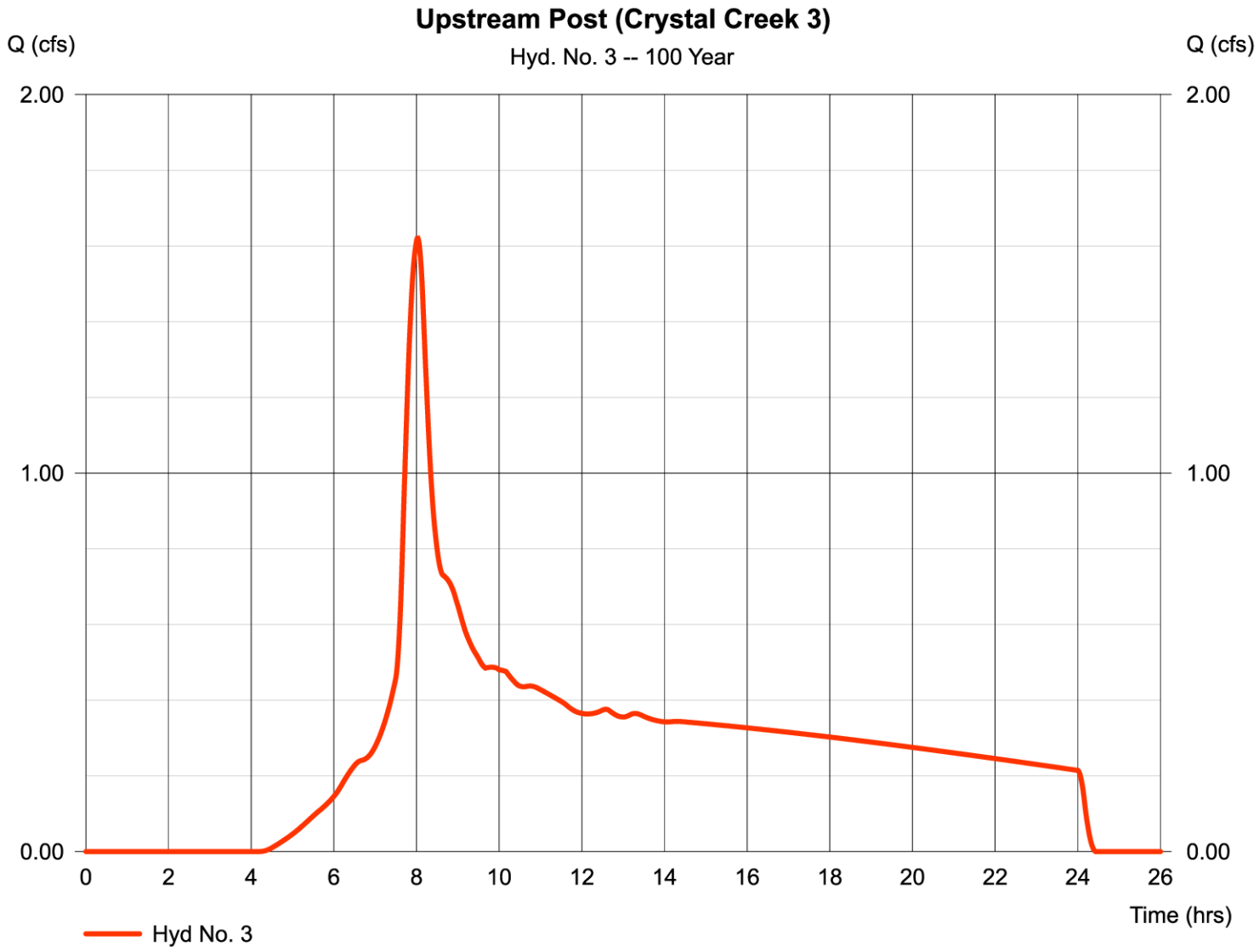
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Tuesday, 06 / 16 / 2020

Hyd. No. 3

Upstream Post (Crystal Creek 3)

Hydrograph type	= SCS Runoff	Peak discharge	= 1.620 cfs
Storm frequency	= 100 yrs	Time to peak	= 8.03 hrs
Time interval	= 1 min	Hyd. volume	= 25,230 cuft
Drainage area	= 2.170 ac	Curve number	= 73*
Basin Slope	= 1.0 %	Hydraulic length	= 1 ft
Tc method	= TR55	Time of conc. (Tc)	= 16.60 min
Total precip.	= 6.09 in	Distribution	= Type IA
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(2.170 x 73)] / 2.170



TR55 Tc Worksheet

Hyd. No. 4

POST (Crystal Creek 3)

Description	A		B		C		Totals
Sheet Flow							
Manning's n-value	= 0.350		0.011		0.011		
Flow length (ft)	= 95.0		0.0		0.0		
Two-year 24-hr precip. (in)	= 3.34		0.00		0.00		
Land slope (%)	= 19.00		0.00		0.00		
Travel Time (min)	**= 7.37**	**+**	**0.00**	**+**	**0.00**	**=**	**7.37**
Shallow Concentrated Flow							
Flow length (ft)	= 40.00		6.00		0.00		
Watercourse slope (%)	= 2.00		33.00		0.00		
Surface description	= Paved		Unpaved		Paved		
Average velocity (ft/s)	=2.87		9.27		0.00		
Travel Time (min)	**= 0.23**	**+**	**0.01**	**+**	**0.00**	**=**	**0.24**
Channel Flow							
X sectional flow area (sqft)	= 11.25		0.08		0.00		
Wetted perimeter (ft)	= 12.48		0.52		0.00		
Channel slope (%)	= 4.00		12.00		0.00		
Manning's n-value	= 0.350		0.012		0.015		
Velocity (ft/s)	=0.79						
			12.27				
					0.00		
Flow length (ft)	({0})357.0		223.0		0.0		
Travel Time (min)	**= 7.49**	**+**	**0.30**	**+**	**0.00**	**=**	**7.79**

Total Travel Time, Tc ..... 15.40 min

Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Tuesday, 06 / 16 / 2020

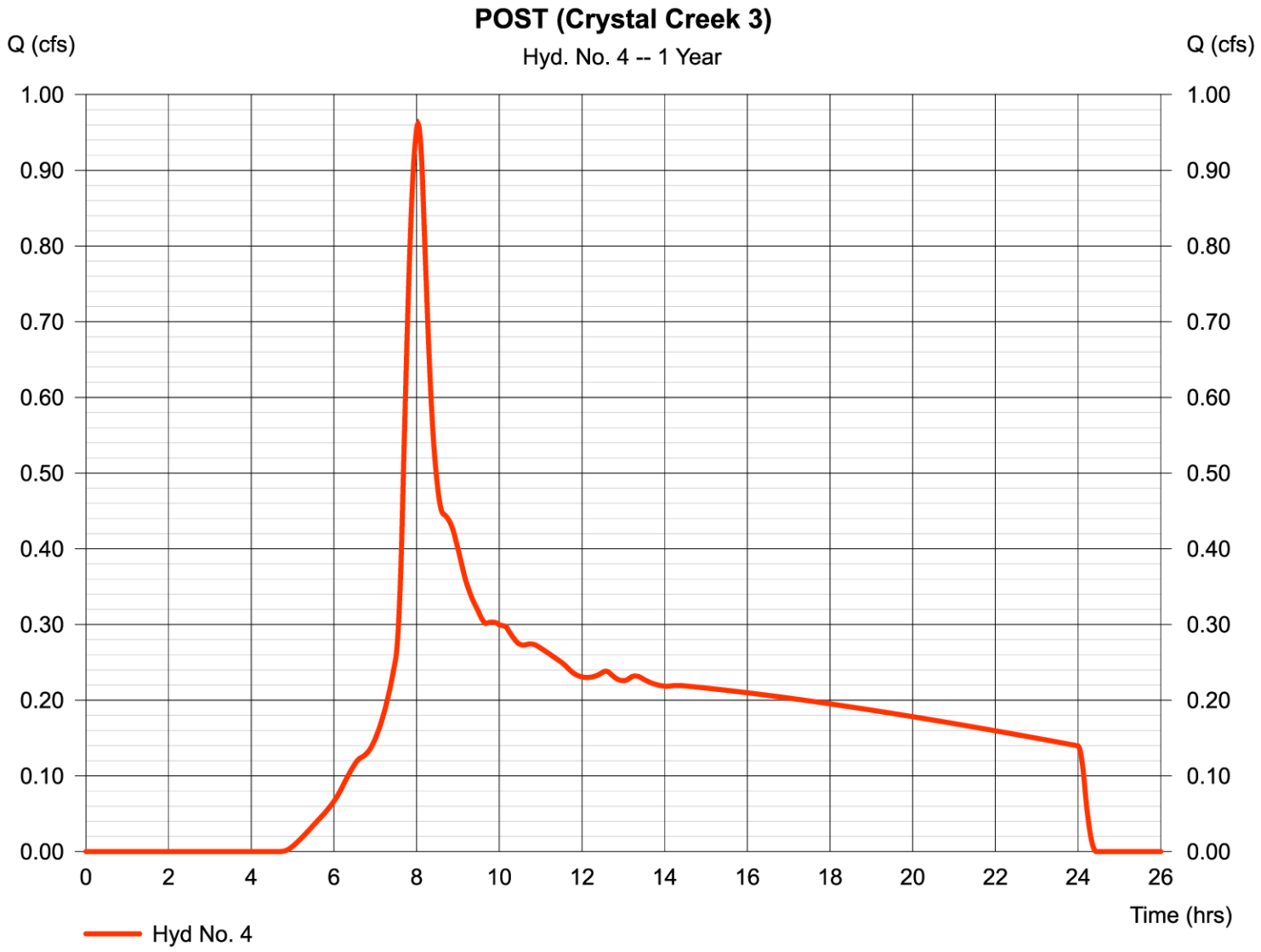
Hyd. No. 4

*1-yr is model for the 6 mo, 24 hr precip

POST (Crystal Creek 3)

Hydrograph type	= SCS Runoff	Peak discharge	= 0.961 cfs
Storm frequency	= 1 yrs	Time to peak	= 8.03 hrs
Time interval	= 1 min	Hyd. volume	= 15,588 cuft
Drainage area	= 6.430 ac	Curve number	= 91*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 15.40 min
Total precip.	= 1.40 in	Distribution	= Type IA
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(4.180 x 98) + (2.250 x 79)] / 6.430



Hydrograph Report

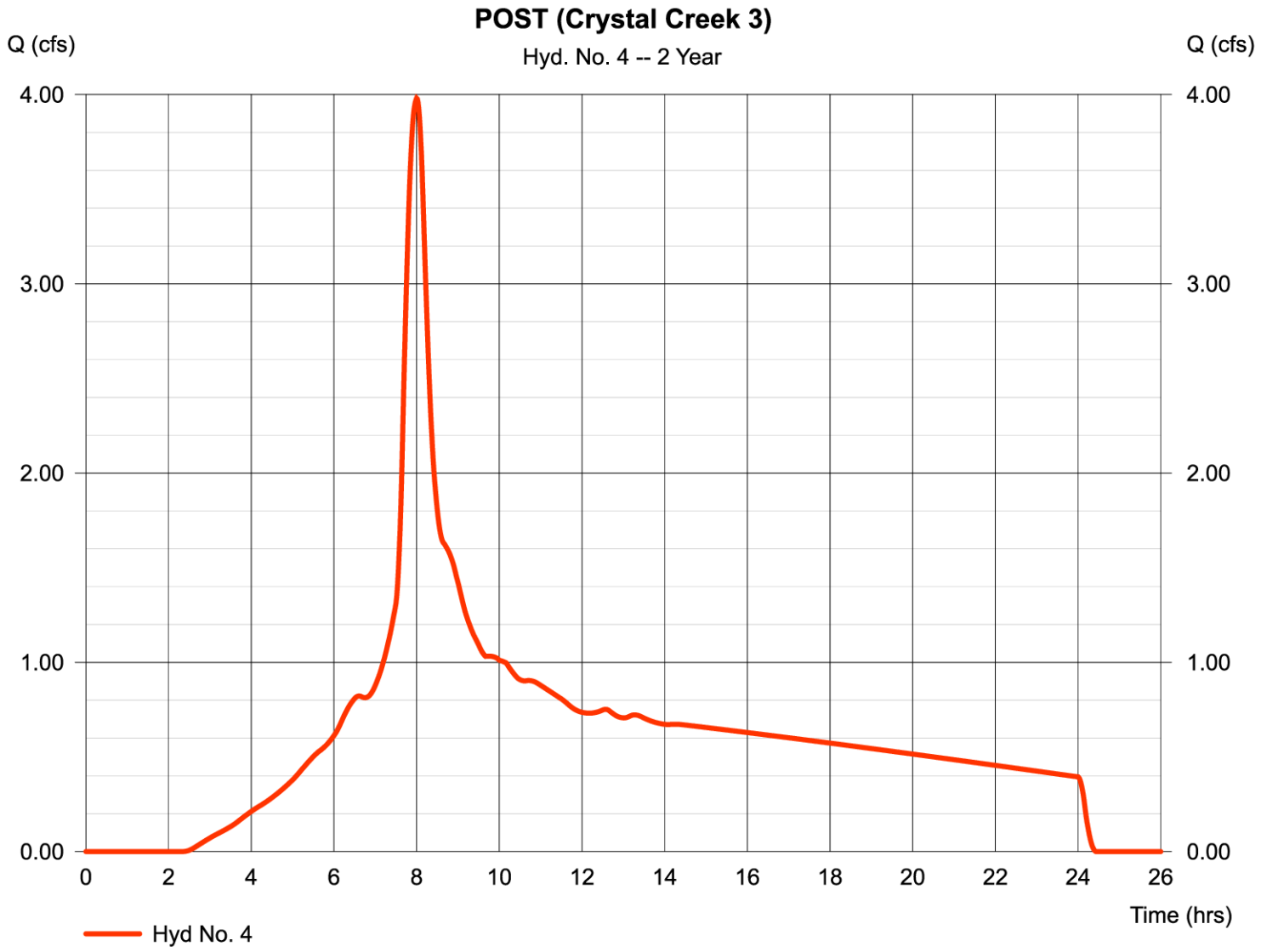
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Tuesday, 06 / 16 / 2020

Hyd. No. 4

POST (Crystal Creek 3)

Hydrograph type	= SCS Runoff	Peak discharge	= 3.981 cfs
Storm frequency	= 2 yrs	Time to peak	= 8.00 hrs
Time interval	= 1 min	Hyd. volume	= 56,481 cuft
Drainage area	= 6.430 ac	Curve number	= 91*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 15.40 min
Total precip.	= 3.34 in	Distribution	= Type IA
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(4.180 x 98) + (2.250 x 79)] / 6.430



Hydrograph Report

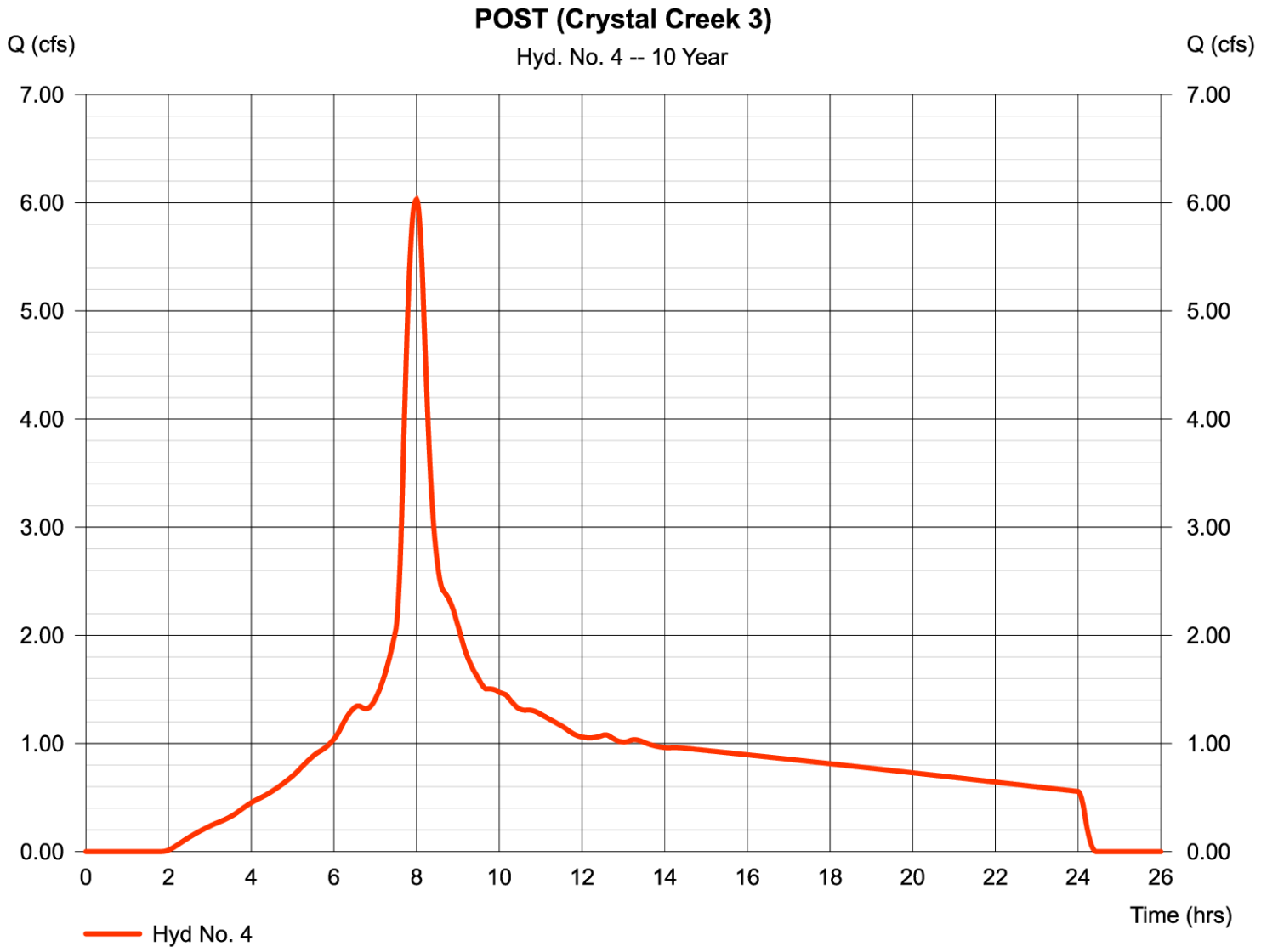
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Tuesday, 06 / 16 / 2020

Hyd. No. 4

POST (Crystal Creek 3)

Hydrograph type	= SCS Runoff	Peak discharge	= 6.030 cfs
Storm frequency	= 10 yrs	Time to peak	= 8.00 hrs
Time interval	= 1 min	Hyd. volume	= 84,722 cuft
Drainage area	= 6.430 ac	Curve number	= 91*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 15.40 min
Total precip.	= 4.59 in	Distribution	= Type IA
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(4.180 x 98) + (2.250 x 79)] / 6.430



Hydrograph Report

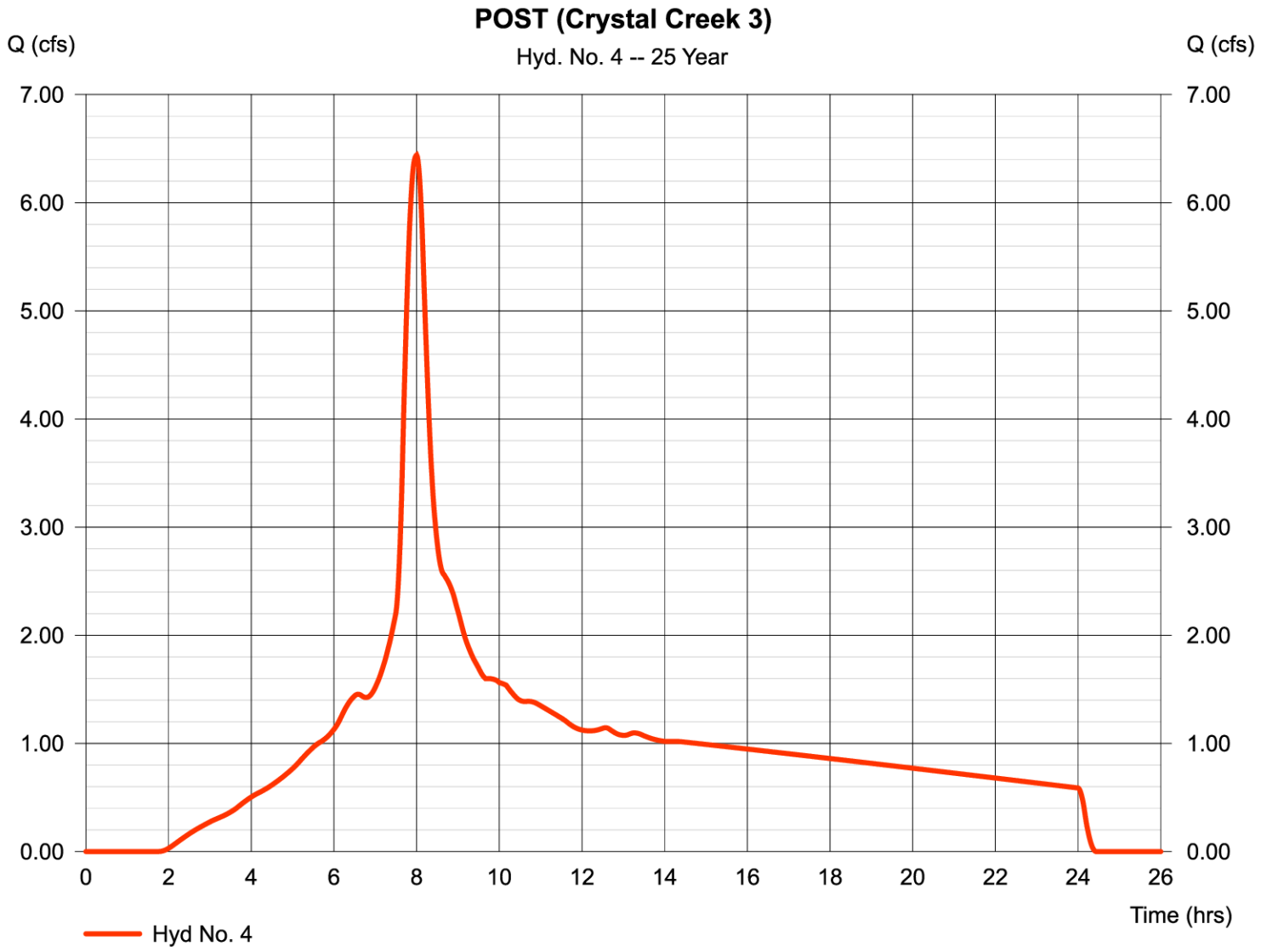
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Tuesday, 06 / 16 / 2020

Hyd. No. 4

POST (Crystal Creek 3)

Hydrograph type	= SCS Runoff	Peak discharge	= 6.440 cfs
Storm frequency	= 25 yrs	Time to peak	= 8.00 hrs
Time interval	= 1 min	Hyd. volume	= 90,440 cuft
Drainage area	= 6.430 ac	Curve number	= 91*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 15.40 min
Total precip.	= 4.84 in	Distribution	= Type IA
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(4.180 x 98) + (2.250 x 79)] / 6.430



Hydrograph Report

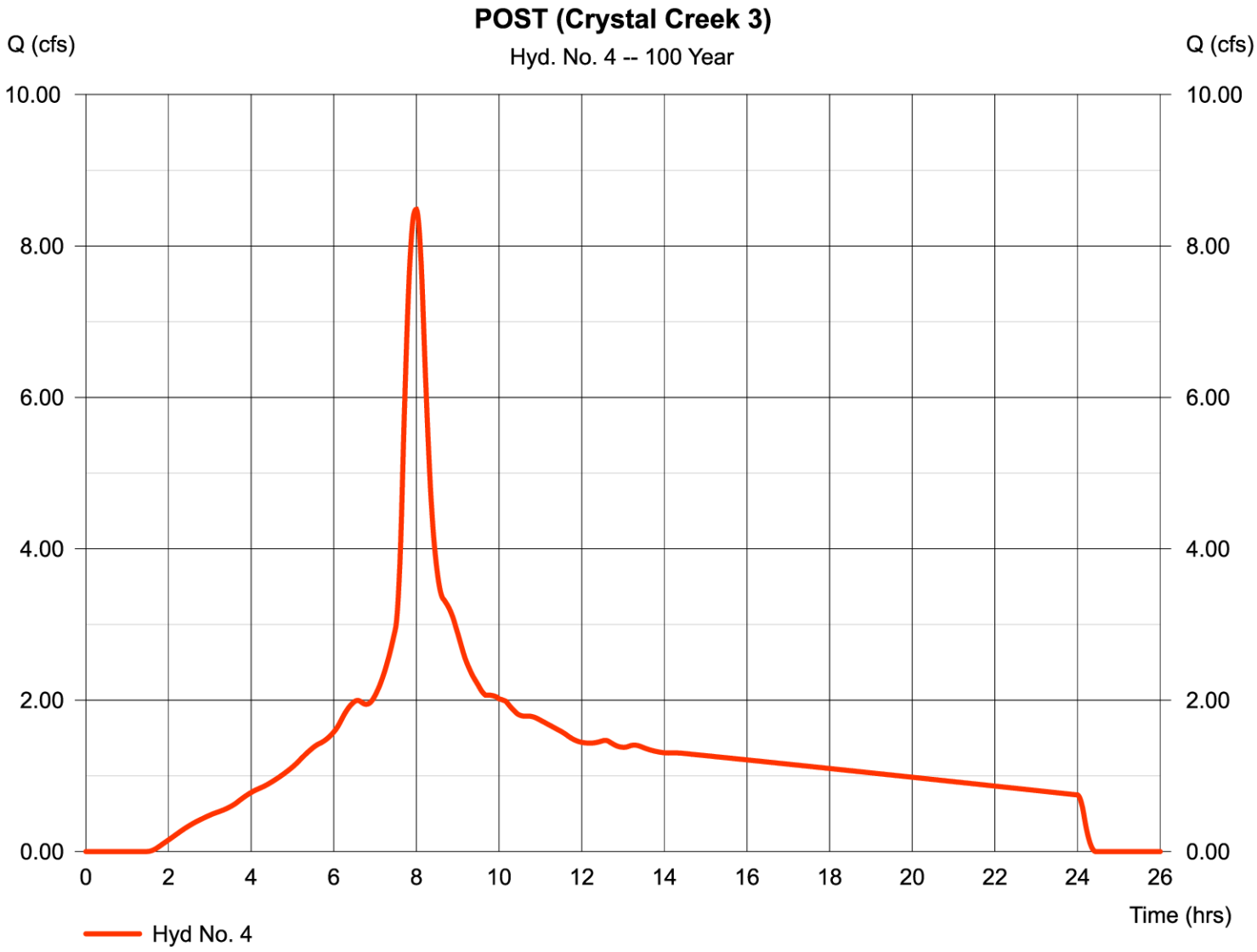
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Tuesday, 06 / 16 / 2020

Hyd. No. 4

POST (Crystal Creek 3)

Hydrograph type	= SCS Runoff	Peak discharge	= 8.483 cfs
Storm frequency	= 100 yrs	Time to peak	= 8.00 hrs
Time interval	= 1 min	Hyd. volume	= 119,235 cuft
Drainage area	= 6.430 ac	Curve number	= 91*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 15.40 min
Total precip.	= 6.09 in	Distribution	= Type IA
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(4.180 x 98) + (2.250 x 79)] / 6.430



Pond Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 03 / 8 / 2021

Pond No. 3 - Pond B7-A

Pond Data

Contours -User-defined contour areas. Average end area method used for volume calculation. Begining Elevation = 100.00 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	100.00	806	0	0
1.00	101.00	1,596	1,201	1,201
2.00	102.00	2,596	2,096	3,297
3.00	103.00	3,779	3,188	6,485
4.00	104.00	5,096	4,438	10,922
5.00	105.00	6,535	5,816	16,738
6.00	106.00	8,097	7,316	24,054
6.50	106.50	8,846	4,236	28,289
8.00	108.00	11,427	15,205	43,494

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 18.00	4.38	Inactive	0.00
Span (in)	= 18.00	4.38	0.00	0.00
No. Barrels	= 1	1	1	0
Invert El. (ft)	= 100.00	100.00	0.00	0.00
Length (ft)	= 405.00	0.00	0.00	0.00
Slope (%)	= 1.95	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	Yes	Yes	No

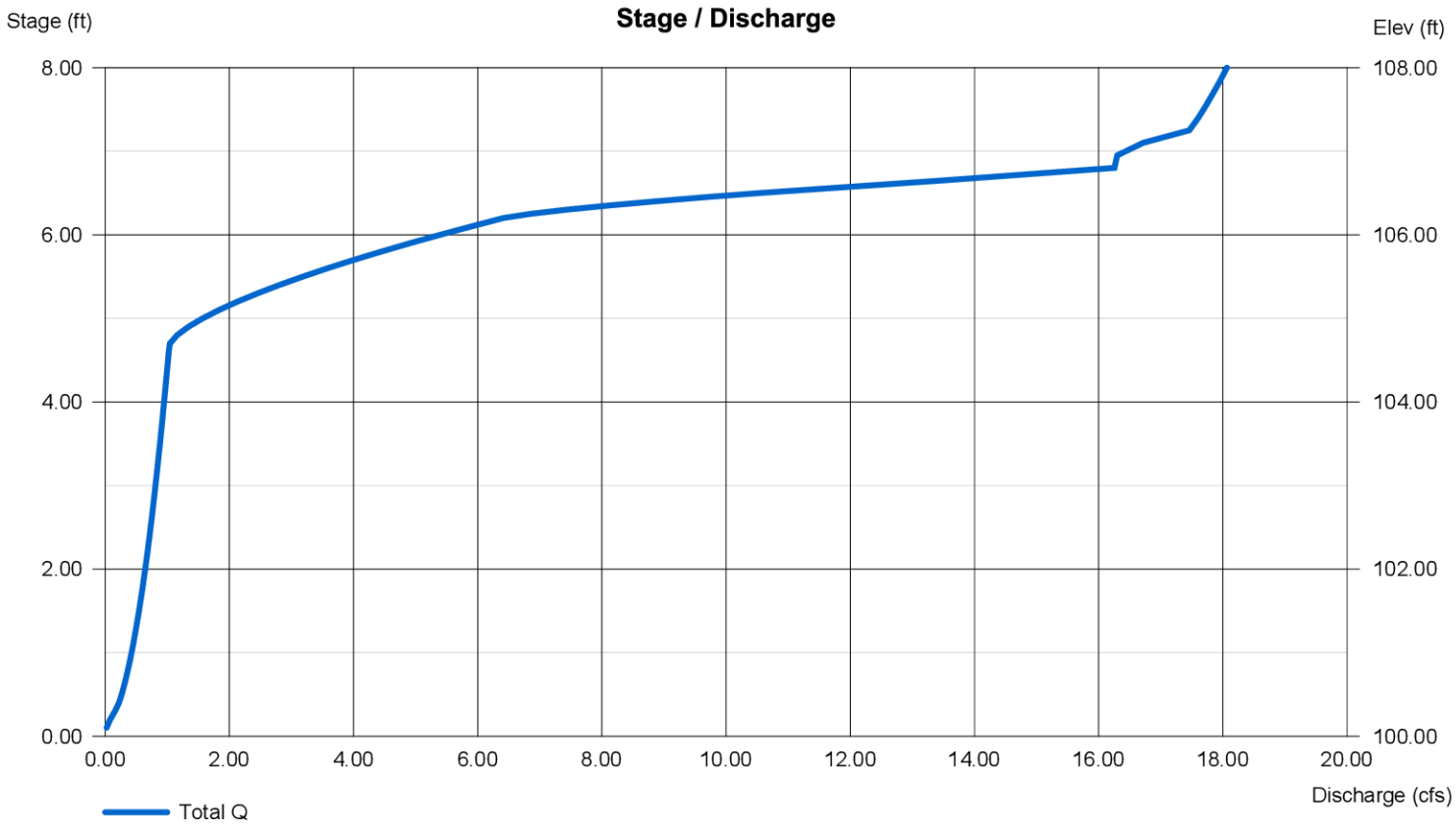
Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 4.71	0.85	Inactive	Inactive
Crest El. (ft)	= 106.20	104.68	0.00	0.00
Weir Coeff.	= 3.33	3.33	2.60	3.33
Weir Type	= 1	Rect	Broad	Rect
Multi-Stage	= Yes	Yes	No	Yes

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).



Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 03 / 8 / 2021

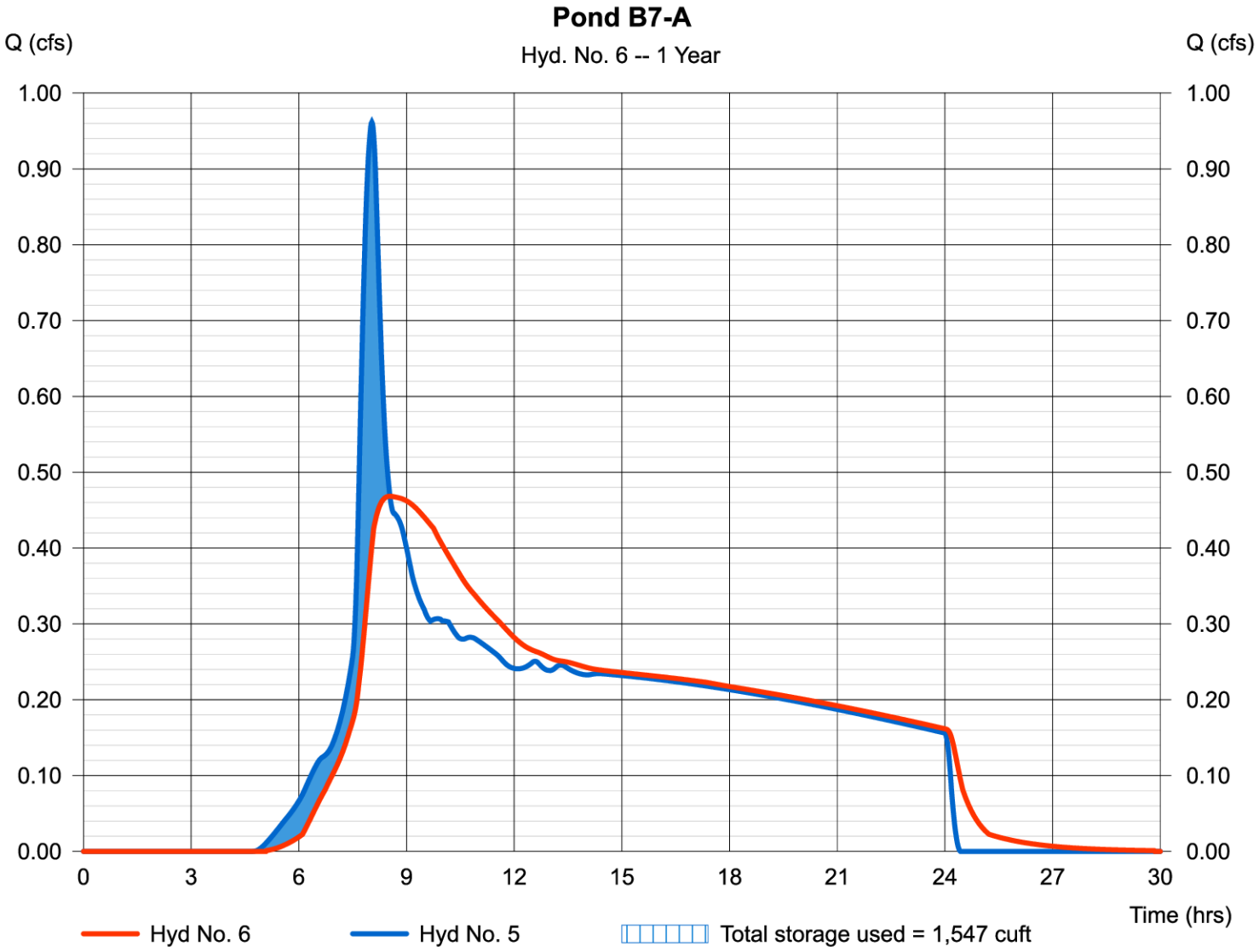
Hyd. No. 6

*1-yr is model for the 6 mo, 24 hr precip

Pond B7-A

Hydrograph type	= Reservoir	Peak discharge	= 0.468 cfs
Storm frequency	= 1 yrs	Time to peak	= 8.53 hrs
Time interval	= 1 min	Hyd. volume	= 16,380 cuft
Inflow hyd. No.	= 5 - Upst.+Onsite (CC3)	Max. Elevation	= 101.17 ft
Reservoir name	= Pond B7-A	Max. Storage	= 1,547 cuft

Storage Indication method used.



Hydrograph Report

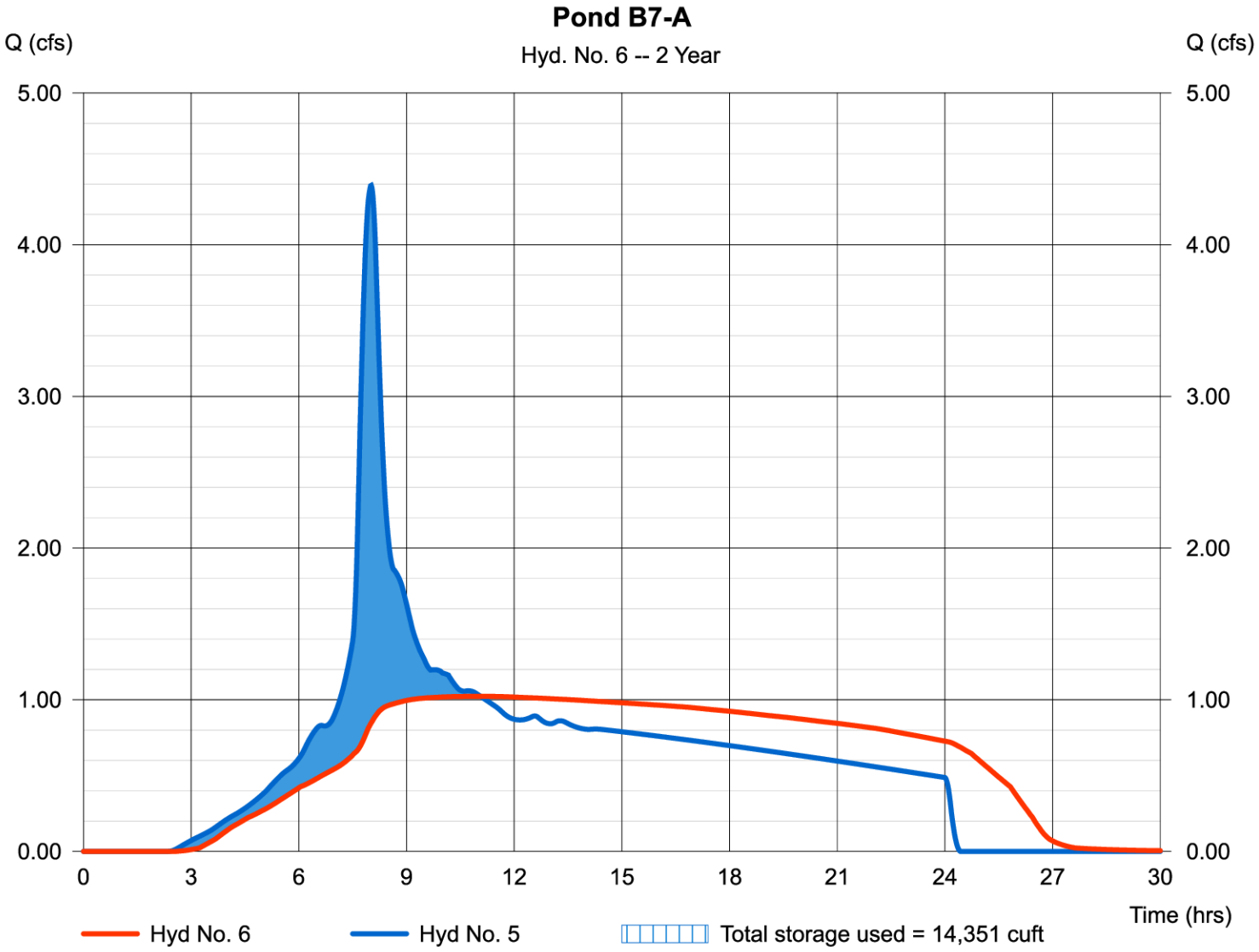
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 03 / 8 / 2021

Hyd. No. 6

Pond B7-A

Hydrograph type	= Reservoir	Peak discharge	= 1.023 cfs
Storm frequency	= 2 yrs	Time to peak	= 11.07 hrs
Time interval	= 1 min	Hyd. volume	= 65,037 cuft
Inflow hyd. No.	= 5 - Upst.+Onsite (CC3)	Max. Elevation	= 104.59 ft
Reservoir name	= Pond B7-A	Max. Storage	= 14,351 cuft

Storage Indication method used.



Hydrograph Report

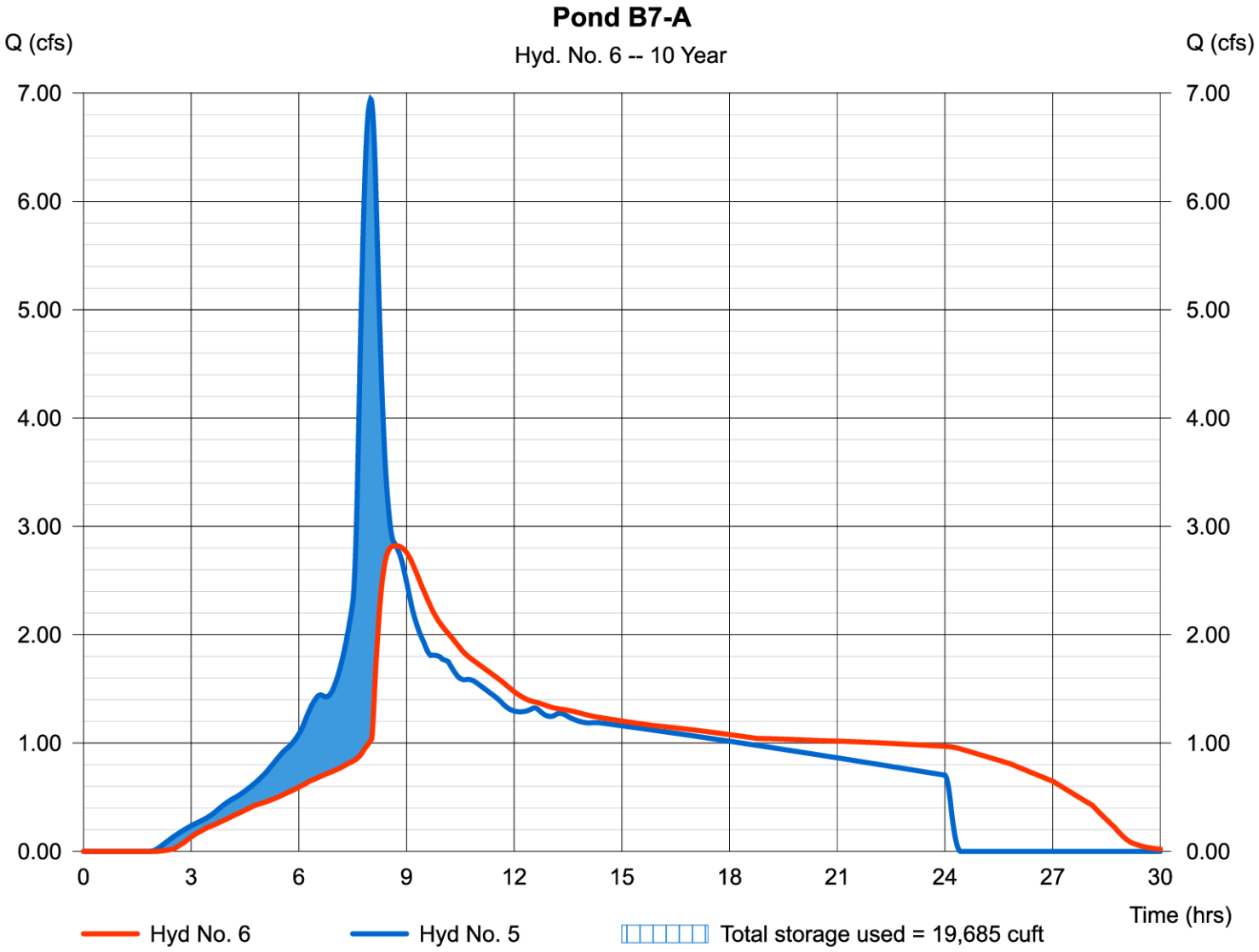
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 03 / 8 / 2021

Hyd. No. 6

Pond B7-A

Hydrograph type	=	Reservoir	Peak discharge	=	2.821 cfs
Storm frequency	=	10 yrs	Time to peak	=	8.70 hrs
Time interval	=	1 min	Hyd. volume	=	100,379 cuft
Inflow hyd. No.	=	5 - Upst.+Onsite (CC3)	Max. Elevation	=	105.40 ft
Reservoir name	=	Pond B7-A	Max. Storage	=	19,685 cuft

Storage Indication method used.



Hydrograph Report

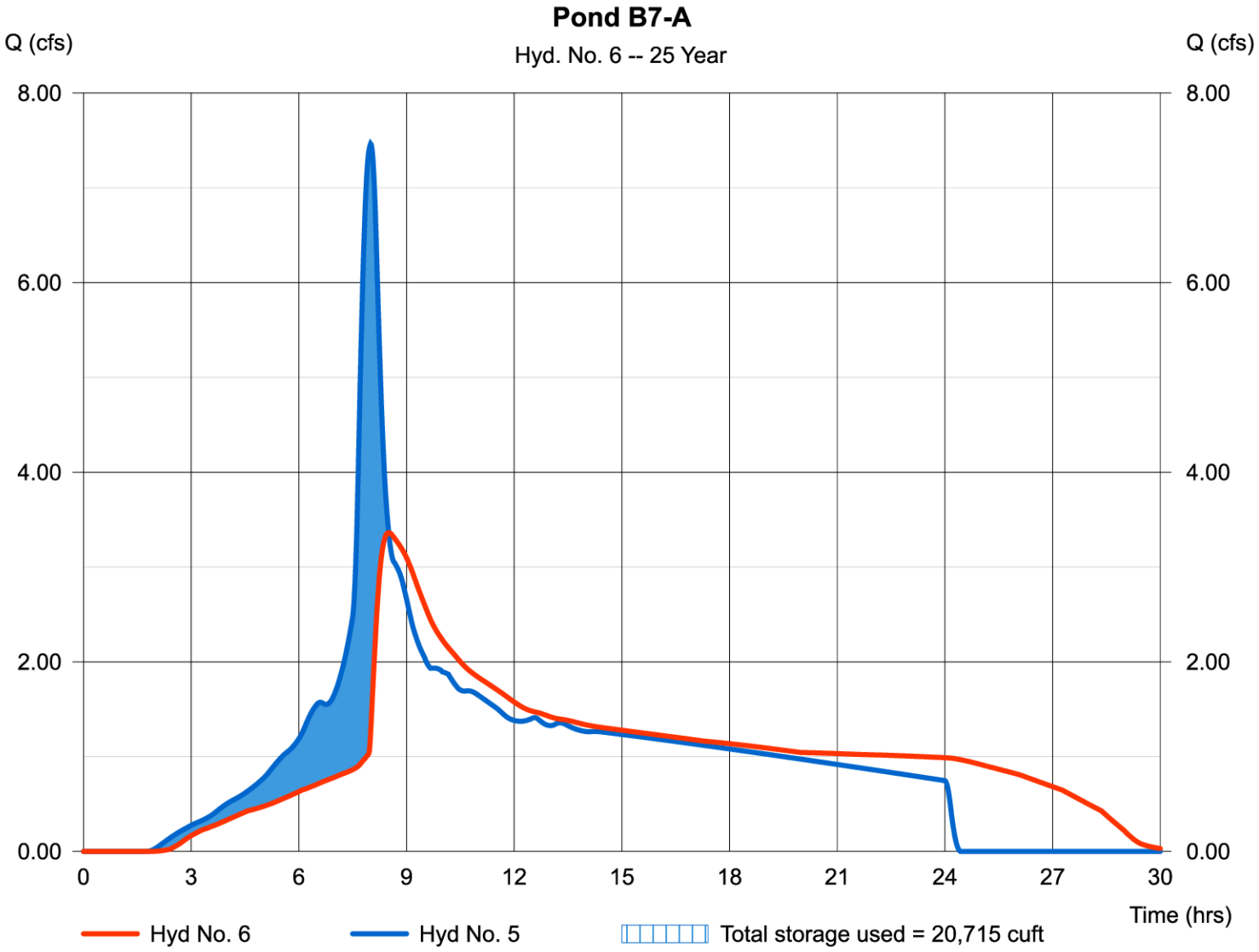
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 03 / 8 / 2021

Hyd. No. 6

Pond B7-A

Hydrograph type	=	Reservoir	Peak discharge	=	3.362 cfs
Storm frequency	=	25 yrs	Time to peak	=	8.50 hrs
Time interval	=	1 min	Hyd. volume	=	107,627 cuft
Inflow hyd. No.	=	5 - Upst.+Onsite (CC3)	Max. Elevation	=	105.54 ft
Reservoir name	=	Pond B7-A	Max. Storage	=	20,715 cuft

Storage Indication method used.



Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 03 / 8 / 2021

Hyd. No. 6

Pond B7-A

Hydrograph type	=	Reservoir	Peak discharge	=	6.399 cfs
Storm frequency	=	100 yrs	Time to peak	=	8.30 hrs
Time interval	=	1 min	Hyd. volume	=	144,459 cuft
Inflow hyd. No.	=	5 - Upst.+Onsite (CC3)	Max. Elevation	=	106.20 ft
Reservoir name	=	Pond B7-A	Max. Storage	=	25,721 cuft

Storage Indication method used.