The need for permanent water quality or sediments control will be assessed on the resubmittal.

See comments in Appendix

Sedona Sun Acres
Stormwater Drainage Study

Colorado Springs, El Paso County, Colorado

March, 2020

Completed By:

Brett Louk, P.E.

Ben Gasper, P.E.

SMH CONSULTANTS

411 South Tejon, Suite i
Colorado Springs, Colorado 80903
719-465-2145
blouk@smhconsultants.com

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Engineer's Statement:

The attached drainage plan and report were prepared under my direction and supervision and are correct to the best of my knowledge and belief. Said drainage report has been prepared according to the criteria established by the City/County for drainage reports and said report is in conformity with the master plan of the drainage basin. I accept responsibility for any liability caused by any negligent acts, errors or omissions on my part in preparing this report.

____

Brett Louk, P.E.

Developer's Statement:

I, the developer have read and will comply with all of the requirements specified in this drainage report and plan.

____

Business Name

By:_________________________________

Title:________________________________

Address: ______________________________

____

El Paso County Only:

Filed in accordance with Section 51.1 of the El Paso Land Development code, as amended.

____________________________________ __________________

Director of Public Works Date

1. INTRODUCTION

The owner of the Sedona Sun Acres has asked SMH Consultants, P.A. (SMH) to conduct a stormwater drainage analysis for the proposed Sedona Sun Acres residential subdivision to satisfy the El Paso County drainage criteria manual requirements. This analysis will determine potential impacts resulting from subdividing a 37.7-acre residential lot into 5 single-family residential lots.

a. Development Location

The property is located in the NW ¼ of NW ¼ of Section 10, Township 12 South, Range 65 West in El Paso County, Colorado. The site consists of 37.7 acres with a single residential house. The lot is bordered by Pinehurst Wood Subdivision to the north, unplatted property to the south, undeveloped park land to the east and Walker Estates Subdivision across Vollmer Road to the west. The site is accessed via private drive off of Vollmer Road. The only existing storm sewer facilities are three culverts. Two of the culverts are under the existing drives off of Vollmer Road and the third is interior to the site and is located under the driveway serving the existing residence.

b. Description of Property

The 37.7-acre site is to be divided into 5 residential lots. The majority of the site is located within the Upper Black Squirrel Drainage Basin. A small portion of the site is located in the West Kiowa Creek Drainage Basin.

Based on a Custom Soil Resource Report, obtained from the USDA NRCS Web Soil Survey (accessed January 29, 2020) for the site, the native soil consists of *Elbeth sandy loam* with slopes ranging from 8-15 percent. This is a well-drained soil, with a medium runoff class. This soil typically does not flood or pond. The rest of the site is made up of Kettle gravelly loamy sand with slopes ranging from 3-8 percent. Both of these soils are classified in Hydrologic Soil Group B. The Custom Soil Report is included as Exhibit 1 of the appendix.

2. DRAINAGE BASINS AND SUB-BASINS

a. Major Basin Descriptions

The subject site is split between two major drainage basins, the Upper Black Squirrel and the West Kiowa Creek. The site can be split into 4 smaller sub-basin drainage areas based on where flows leave the site. The Drainage Areas can be seen in Figure 1 in the appendix. A majority of the site, Drainage Areas 2-4, will sheet flow south to southeast at varying slopes from 1-5 percent and eventually meet in the Upper Black Squirrel Creek. A north portion of the site, Drainage Area 1, will sheet flow north at varying slopes from 1-4 percent and eventually end up in the Kiowa Creek Watershed Reservoir.

b. Sub-Basin Descriptions

Drainage Area 1 is approximately 7.6 acres located on the north side of the site. Stormwater runoff will sheet flow north at slopes ranging from 1-4 percent and flow along existing terrain patterns to point of concentration 1 north of Whispering Pine Trail.

Drainage Area 2 is approximately 4.6 acres located on the east side of the site. Stormwater will sheet flow southeast at slopes ranging from 1-5 percent and flow along existing terrain patterns to point of concentration 2 east of the site.

Drainage Area 3 is approximately 8.1 acres located on the east side of the site. Stormwater will sheet flow southeast at slopes ranging from 1-5 percent and flow along existing terrain patterns to point of concentration 3 east of the site.

Drainage Area 4 is approximately 17.4 acres located on the south side of the site. Stormwater will sheet flow south at slopes ranging from 1-5 percent and flow along existing terrain patterns south to an existing stormwater culvert design point C and to point of concentration 4 south of the site.

Eventually Drainage Areas 2-4 will meet farther southeast of the site and flow to the Upper Black Squirrel Creek.

3. DRAINAGE DESIGN CRITERIA

a. Development Criteria Reference

Pre- and post-development drainage characteristics were reviewed, studied, and analyzed using the *City of Colorado Springs/El Paso County Drainage Criteria Manual,* Federal Emergency Management Agency's Flood Insurance Rate Map and USDA NRCS Web Soil Survey. Hydraflow Hydrographs Extension and AutoCAD Civil3D modeling software were utilized to develop a model to determine peak flow hydrographs for the site.

b. Hydrologic Criteria

Drainage characteristics were delineated based on existing topographic information from Lidar and USGS topographical maps. In the appendix, Figure 1 shows the site drainage information.

Since the watershed area encompassing the development site is less than 100 acres, the Rational Method was used to determine peak flows for the 10-year and 100-year storm events.

A runoff coefficient (C) was chosen from Table 5-1 of the *City of Colorado Springs/El Paso County Drainage Criteria Manual.* As mentioned earlier, the site consists of Hydrological Soil Group B. It is also assumed this site's land use will consist of Residential over 1 acre for pre- and post-development. Based on these factors, a 10-year storm frequency C value of 0.30

and a 100-year storm frequency C value of 0.40 will be used for both pre- and post-development of the site.

The time of concentration was calculated for each drainage area based off methods found in section 5.2.2 of the *City of Colorado Springs/El Paso County Drainage Criteria Manual*. The first 1,000 feet of unconcentrated overland flow time was calculated and added to the subsequent channelized flow times. Channelized flow times were calculated using channel flow time nomographs (see nomographs in the appendix). Tables 1 & 2, in the appendix, depict the assumptions and variables used to determine the time of concentrations.

4. DRAINAGE FACILITY DESIGN

a. General Concept

The site will be subdivided into four single-family residential lots. This development does not include any site grading, roadway construction or drainage structure installation. Due to this, the developed drainage basins and design points are the same as pre-developed. Based on the size of the lots the post-development C-value will not change. Therefore, there should be no subsequent stormwater runoff increase or need for stormwater mitigation.

SMH analyzed three culvert design points on, or near, the site to verify these points would not be adversely affected and have the capacity to support the 10- and 100-year design storms. Design Points A & B are located west of the lot in the Vollmer Road right of way under existing entrances. It was determined these design points are able to handle existing and post-subdivision stormwater flow. Analysis can be seen in Exhibit 3 in the appendix.

Design Point C is an existing 12" culvert located in Drainage Area 4. Based on analyzed data, to achieve proper conveyance of the 10-year and 100-year design storms by Design Point C, SMH recommends to upgrade this culvert to a 24" CMP. Analysis can be seen in Exhibit 3 in the appendix.

5. SUMMARY

A drainage analysis was conducted for a 37.7-acre residential site to be subdivided into fout single-family residential lots and will be known as Sedona Sun Acres. The site is located in the Upper Black Squirrel & West Kiowa Creek drainage basins. Based on the analysis, the 10-year & 100-year post-development stormwater peak flow rates will be equal to the pre-developed stormwater peak flow rates. Subdividing the site and developing 4 additional residential lots should not adversely impact surrounding or downstream properties.

Additionally, SMH analyzed three culvert design points to determine the potential impact and whether these design point capacities are able to handle the 10- and 100-year peak flows. Based on this analysis, SMH concluded Design Points A & B are adequate and will not be adversely impacted. However, SMH recommends to upgrade Design Point C to a 24" CMP to properly convey the stormwater flows.

1) Move drainage maps to the end of the document for review purposes.
2) Include maps to include the existing and proposed conditions per the Drainage Criteria Manual Vol. I, Section I, Chapter 4.5 Small Subdivision Drainage Report Format:
(a) general existing drainage characteristics (on and off site)
(b) general proposed drainage characteristics (on and off site)

APPENDIX

LEGEND

- DRAINAGE AREA BOUNDARY LINE
- FLOW PATH
- X DRAINAGE AREA ID

DRAINAGE MAP TABLE						
DRAINAGE AREA ID	AREA (ACRE)	C10	C100	TIME OF CONCENTRATION (TC)	Q10 (CFS)	Q100 (CFS)
1	7.61	0.30	0.40	48	4.61	6.91
2	4.59	0.30	0.40	43	2.99	4.50
3	8.11	0.30	0.40	40	5.51	8.31
4	17.39	0.30	0.40	42	11.49	17.29

DESIGN POINTS							
DESIGN POINT ID	CULVERT SIZE	AREA (ACRE)	C10	C100	TIME OF CONCENTRATION (TC)	Q10 (CFS)	Q100 (CFS)
A	2-5"	0.39	0.30	0.40	22	0.39	0.79
B	24"	1.02	0.30	0.40	34	0.75	1.52
C	12"	10.82	0.30	0.40	40	7.35	14.78

SMH CONSULTANTS
www.smhconsultants.com
Civil Engineering ● Land Surveying
Landscape Architecture
Manhattan, KS - HQ
(785) 776-0541
Dodge City, KS
(620) 255-1952
Overland Park, KS
(913) 444-9615
Colorado Springs, CO
(719) 428-8677

AZTEC RESIDENTIAL SUBDIVISION

DRAINAGE STUDY

EL PASO COUNTY, COLORADO

REVISION DATE: 00/00/00
REVISION DESCRIPTION: (DESCRIPTION)

DRAINAGE MAP

NORTH

200' 100' 0' 200'
SCALE: 1" = 200'

PROJECT #: 1908CS4030
CHECKED BY: BML
DRAWN BY: BCG

DATE: 3/20/20

FIGURE 1

Table 1 - Calculation of Time of Concentration - Pre-Development											
Drainage Area ID	Area (SF)	Area (Acre)	C10	C100	Longest Flow Path (ft)	High Elev.	Low Elev.	Average Slope	Unconcentrated Flow Time 10-year	Channel Travel Time From Nomograph Figure 5602-3 (Minutes)	Time of Concentration (Minutes)
1	331660	7.6	0.30	0.40	1327	2343.04	2329.31	1.03%	46.77	1.30	48
2	199780	4.6	0.30	0.40	1993	2343	2310.78	1.62%	40.31	3.10	43
3	353269	8.1	0.30	0.40	1441	2343.01	2317.1	1.80%	38.91	1.40	40
4	757504	17.4	0.30	0.40	1875	2343.05	2310.54	1.73%	39.38	2.60	42

Table 2 - Calculation of Time of Concentration - Post-Development											
Drainage Area ID	Area (SF)	Area (Acre)	C10	C100	Longest Flow Path (ft)	High Elev.	Low Elev.	Average Slope	Unconcentrated Flow Time 10-year	Channel Travel Time From Nomograph Figure 5602-3 (Minutes)	Time of Concentration (Minutes)
1	331660	7.6	0.30	0.40	1327	2343.04	2329.31	1.03%	46.77	1.30	48
2	199780	4.6	0.30	0.40	1993	2343	2310.78	1.62%	40.31	3.10	43
3	353269	8.1	0.30	0.40	1441	2343.01	2317.1	1.80%	38.91	1.40	40
4	757504	17.4	0.30	0.40	1875	2343.05	2310.54	1.73%	39.38	2.60	42

Exhibit 1

CUSTOM SOIL RESOURCE REPORT

United States Department of Agriculture

NRCS

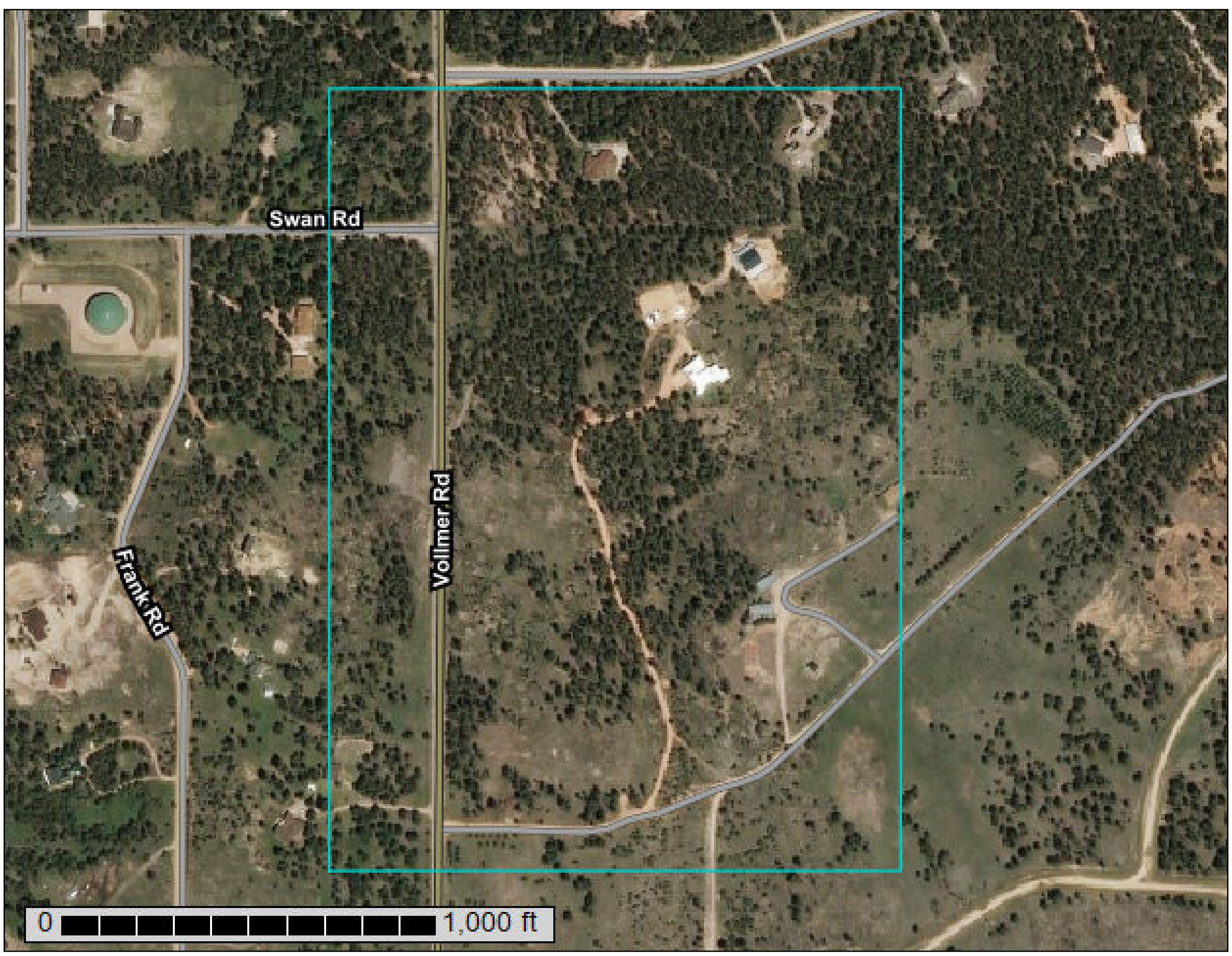
Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for

El Paso County Area, Colorado

Aztec Residential Subdivision



January 29, 2020

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination, write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410 or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.

Contents

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

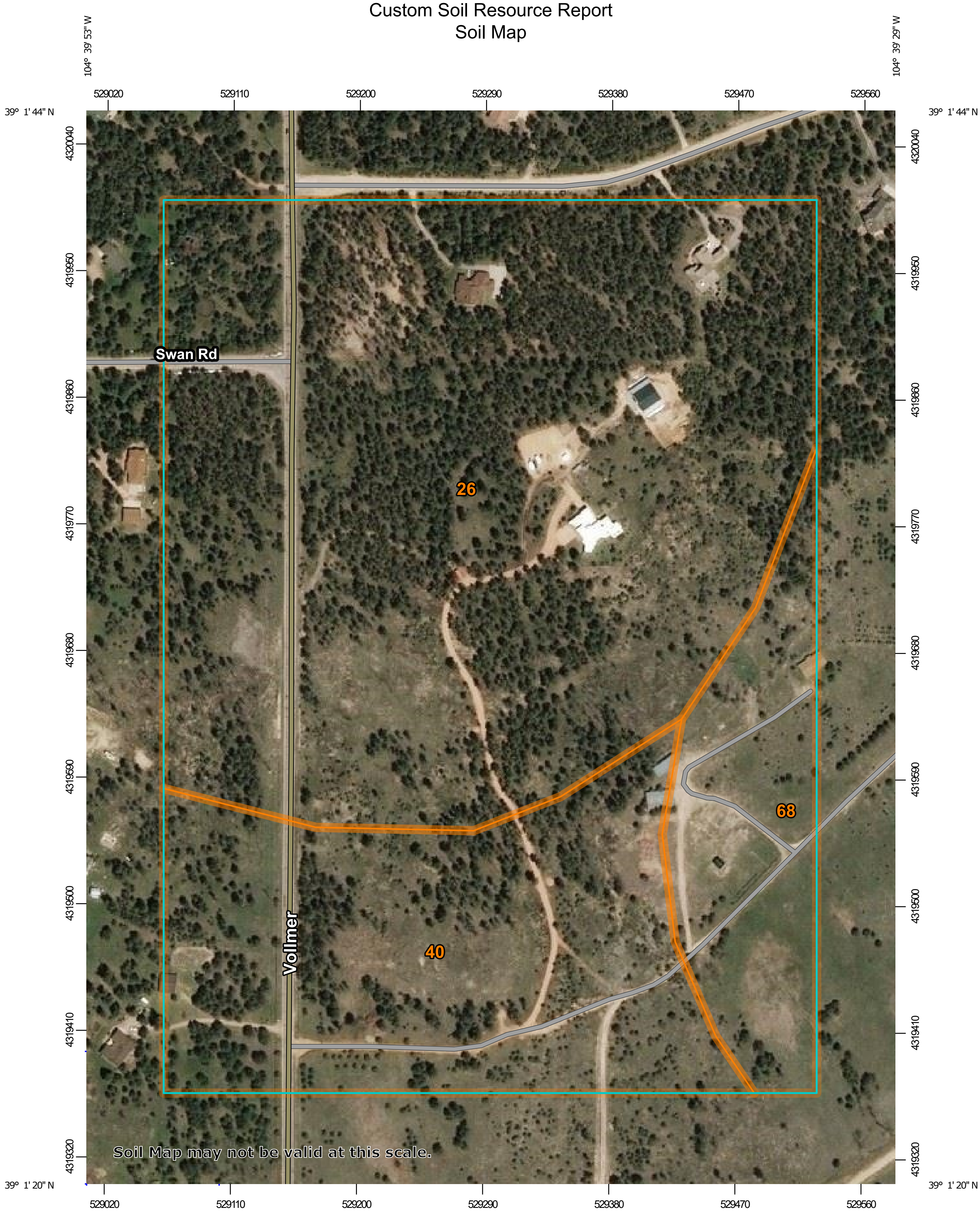
Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Soil Map



Map Scale: 1:3,720 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0, 50, 100, 200, 300

Feet: 0, 150, 300, 600, 900

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 13N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Map Unit Polygons

Soil Map Unit Lines

Soil Map Unit Points

Special Point Features

Blowout

Borrow Pit

Clay Spot

Closed Depression

Gravel Pit

Gravelly Spot

Landfill

Lava Flow

Marsh or swamp

Mine or Quarry

Miscellaneous Water

Perennial Water

Rock Outcrop

Saline Spot

Sandy Spot

Severely Eroded Spot

Sinkhole

Slide or Slip

Sodic Spot

Spoil Area

Stony Spot

Very Stony Spot

Wet Spot

Other

Special Line Features

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

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

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

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

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

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

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

Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 17, Sep 13, 2019

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

Date(s) aerial images were photographed: Sep 8, 2018—May 26, 2019

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

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
26	Elbeth sandy loam, 8 to 15 percent slopes	46.2	62.9%
40	Kettle gravelly loamy sand, 3 to 8 percent slopes	19.1	26.0%
68	Peyton-Pring complex, 3 to 8 percent slopes	8.1	11.1%
Totals for Area of Interest		**73.4**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

El Paso County Area, Colorado

26—Elbeth sandy loam, 8 to 15 percent slopes

Map Unit Setting

National map unit symbol: 367y
Elevation: 7,300 to 7,600 feet
Farmland classification: Not prime farmland

Map Unit Composition

Elbeth and similar soils: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Elbeth

Setting

Landform: Hills
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from arkose

Typical profile

A - 0 to 3 inches: sandy loam
E - 3 to 23 inches: loamy sand
Bt - 23 to 68 inches: sandy clay loam
C - 68 to 74 inches: sandy clay loam

Properties and qualities

Slope: 8 to 15 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 7.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: B
Hydric soil rating: No

Minor Components

Other soils

Percent of map unit:
Hydric soil rating: No

Pleasant

Percent of map unit:
Landform: Depressions
Hydric soil rating: Yes

40—Kettle gravelly loamy sand, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: 368g
Elevation: 7,000 to 7,700 feet
Farmland classification: Not prime farmland

Map Unit Composition

Kettle and similar soils: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Kettle

Setting

Landform: Hills
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Sandy alluvium derived from arkose

Typical profile

E - 0 to 16 inches: gravelly loamy sand
Bt - 16 to 40 inches: gravelly sandy loam
C - 40 to 60 inches: extremely gravelly loamy sand

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat excessively drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 3.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: B
Hydric soil rating: No

Minor Components

Pleasant

Percent of map unit:
Landform: Depressions
Hydric soil rating: Yes

Other soils

Percent of map unit:
Hydric soil rating: No

68—Peyton-Pring complex, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: 369f
Elevation: 6,800 to 7,600 feet
Farmland classification: Not prime farmland

Map Unit Composition

Peyton and similar soils: 40 percent
Pring and similar soils: 30 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Peyton

Setting

Landform: Hills
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Arkosic alluvium derived from sedimentary rock and/or arkosic residuum weathered from sedimentary rock

Typical profile

A - 0 to 12 inches: sandy loam
Bt - 12 to 25 inches: sandy clay loam
BC - 25 to 35 inches: sandy loam
C - 35 to 60 inches: sandy loam

Properties and qualities

Slope: 3 to 5 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 7.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4c
Hydrologic Soil Group: B
Ecological site: Sandy Divide (R049BY216CO)
Hydric soil rating: No

Description of Pring

Setting

Landform: Hills
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Arkosic alluvium derived from sedimentary rock

Typical profile

A - 0 to 14 inches: coarse sandy loam
C - 14 to 60 inches: gravelly sandy loam

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 6.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: B
Ecological site: Loamy Park (R048AY222CO)
Hydric soil rating: No

Minor Components

Other soils

Percent of map unit:
Hydric soil rating: No

Pleasant

Percent of map unit:
Landform: Depressions
Hydric soil rating: Yes

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Exhibit 2

HYDRAFLOW OUTPUT FOR 10-YEAR AND 100-YEAR EVENTS

Hydrograph Summary Report

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

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	Rational	4.611	1	48	13,281	------	------	------	1
2	Rational	2.993	1	43	7,721	------	------	------	2
3	Rational	5.513	1	40	13,231	------	------	------	3
4	Rational	11.49	1	42	28,950	------	------	------	4

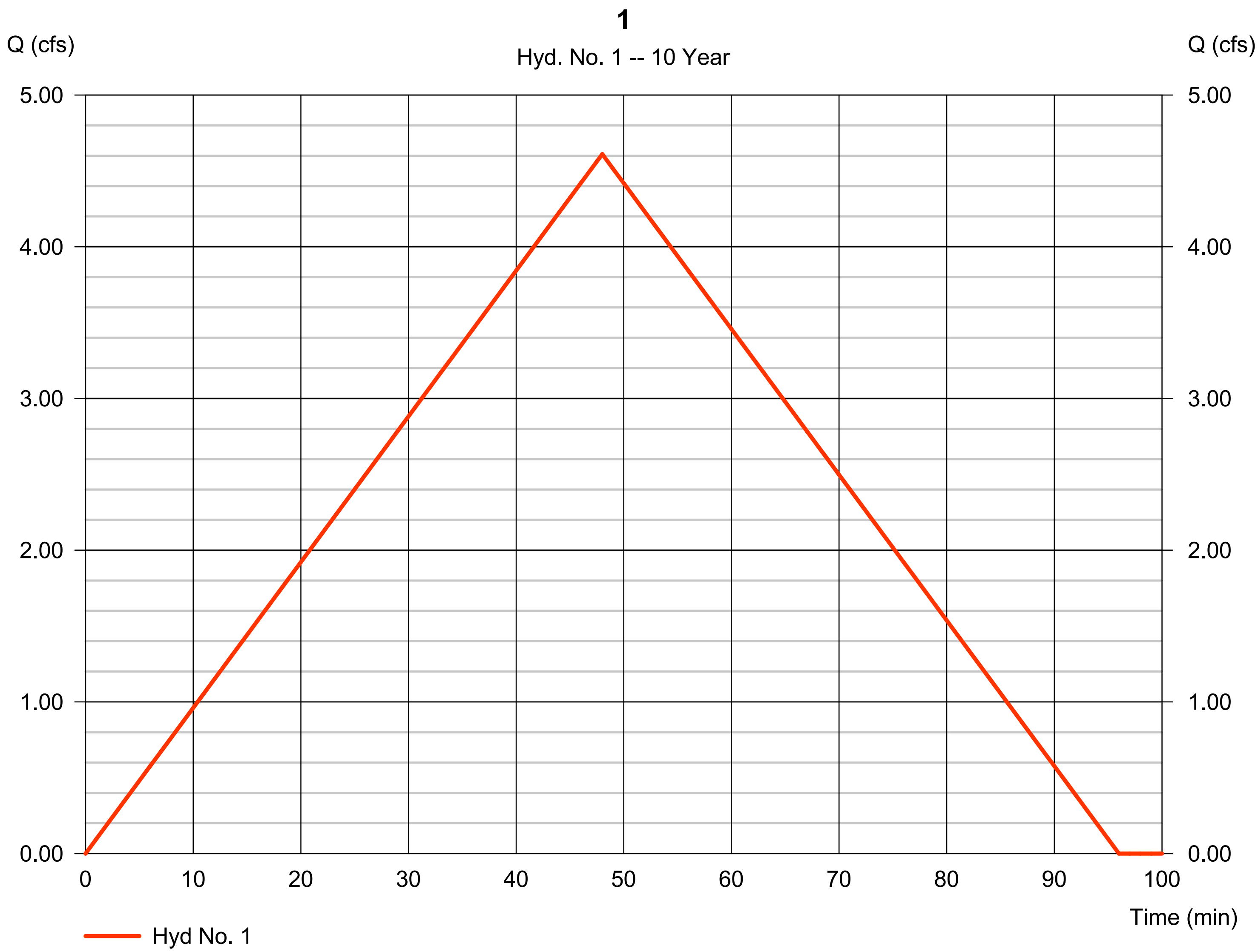
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020 | Wednesday, 02 / 19 / 2020

Hyd. No. 1

1

Hydrograph type	= Rational	Peak discharge	= 4.611 cfs
Storm frequency	= 10 yrs	Time to peak	= 48 min
Time interval	= 1 min	Hyd. volume	= 13,281 cuft
Drainage area	= 7.600 ac	Runoff coeff.	= 0.3
Intensity	= 2.023 in/hr	Tc by User	= 48.00 min
IDF Curve	= El Paso County Colorado.IDF	Asc/Rec limb fact	= 1/1



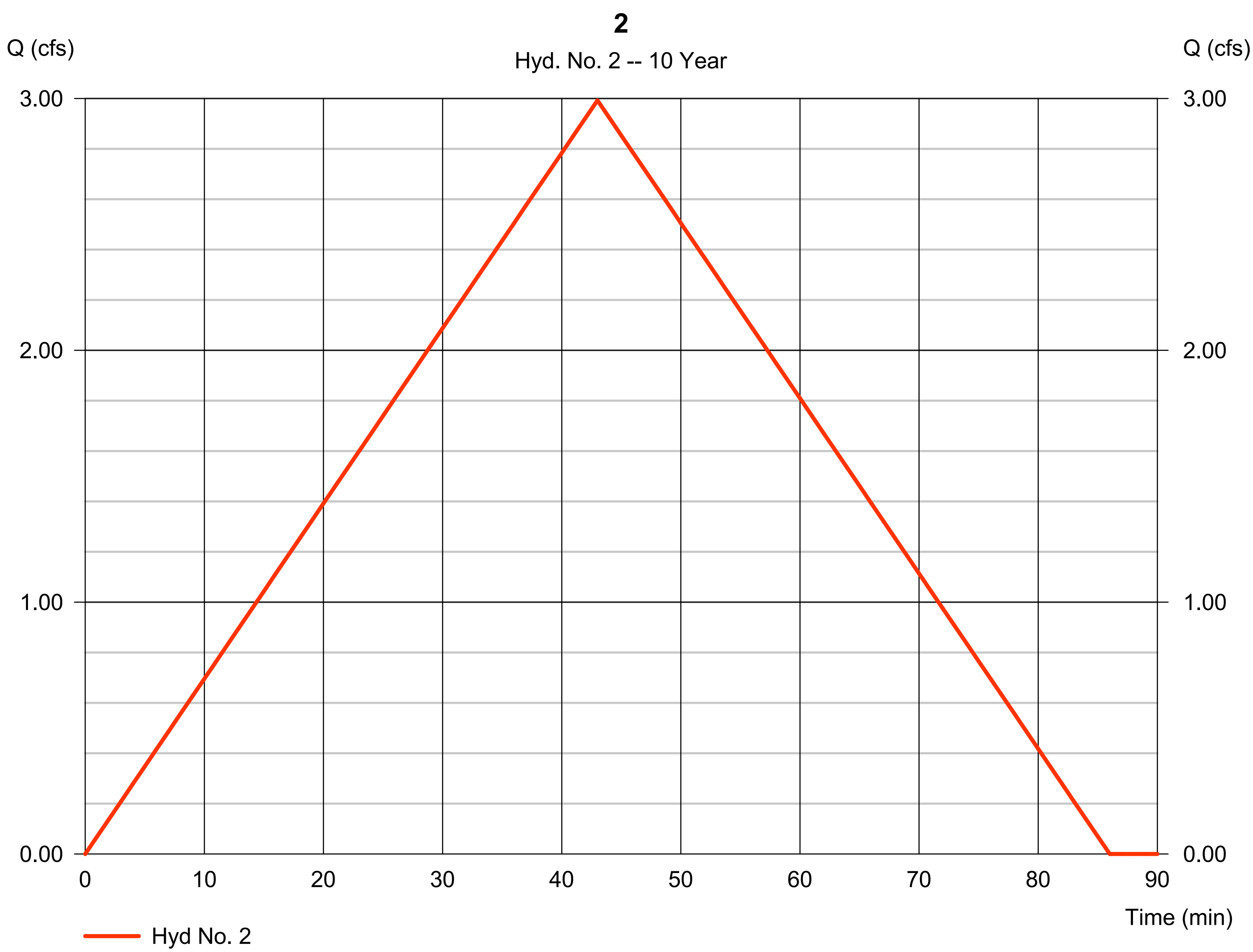
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020 Wednesday, 02 / 19 / 2020

Hyd. No. 2

2

Hydrograph type	= Rational	Peak discharge	= 2.993 cfs
Storm frequency	= 10 yrs	Time to peak	= 43 min
Time interval	= 1 min	Hyd. volume	= 7,721 cuft
Drainage area	= 4.600 ac	Runoff coeff.	= 0.3
Intensity	= 2.169 in/hr	Tc by User	= 43.00 min
IDF Curve	= El Paso County Colorado.IDF	Asc/Rec limb fact	= 1/1



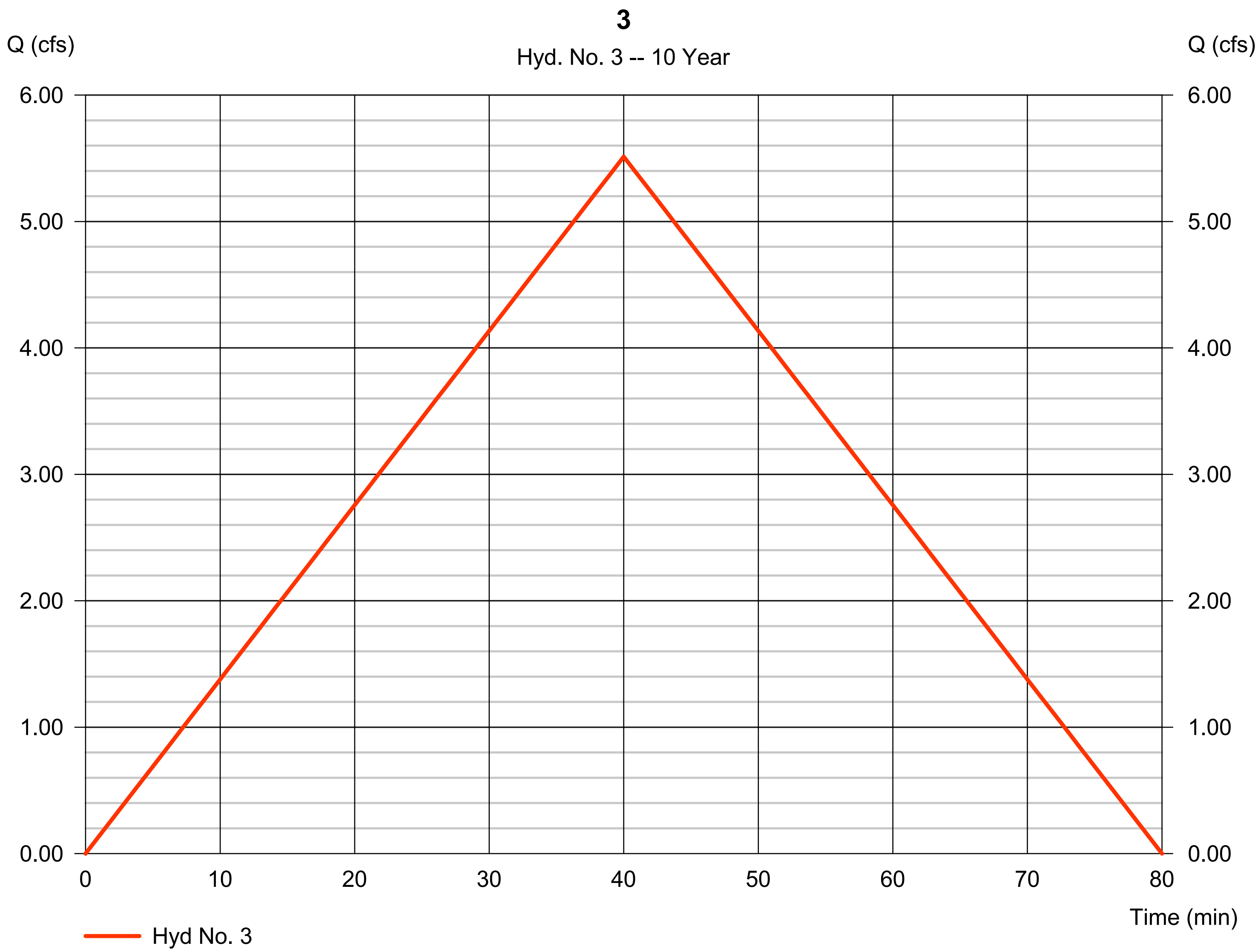
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020 Wednesday, 02 / 19 / 2020

Hyd. No. 3

3

Hydrograph type	= Rational	Peak discharge	= 5.513 cfs
Storm frequency	= 10 yrs	Time to peak	= 40 min
Time interval	= 1 min	Hyd. volume	= 13,231 cuft
Drainage area	= 8.100 ac	Runoff coeff.	= 0.3
Intensity	= 2.269 in/hr	Tc by User	= 40.00 min
IDF Curve	= El Paso County Colorado.IDF	Asc/Rec limb fact	= 1/1



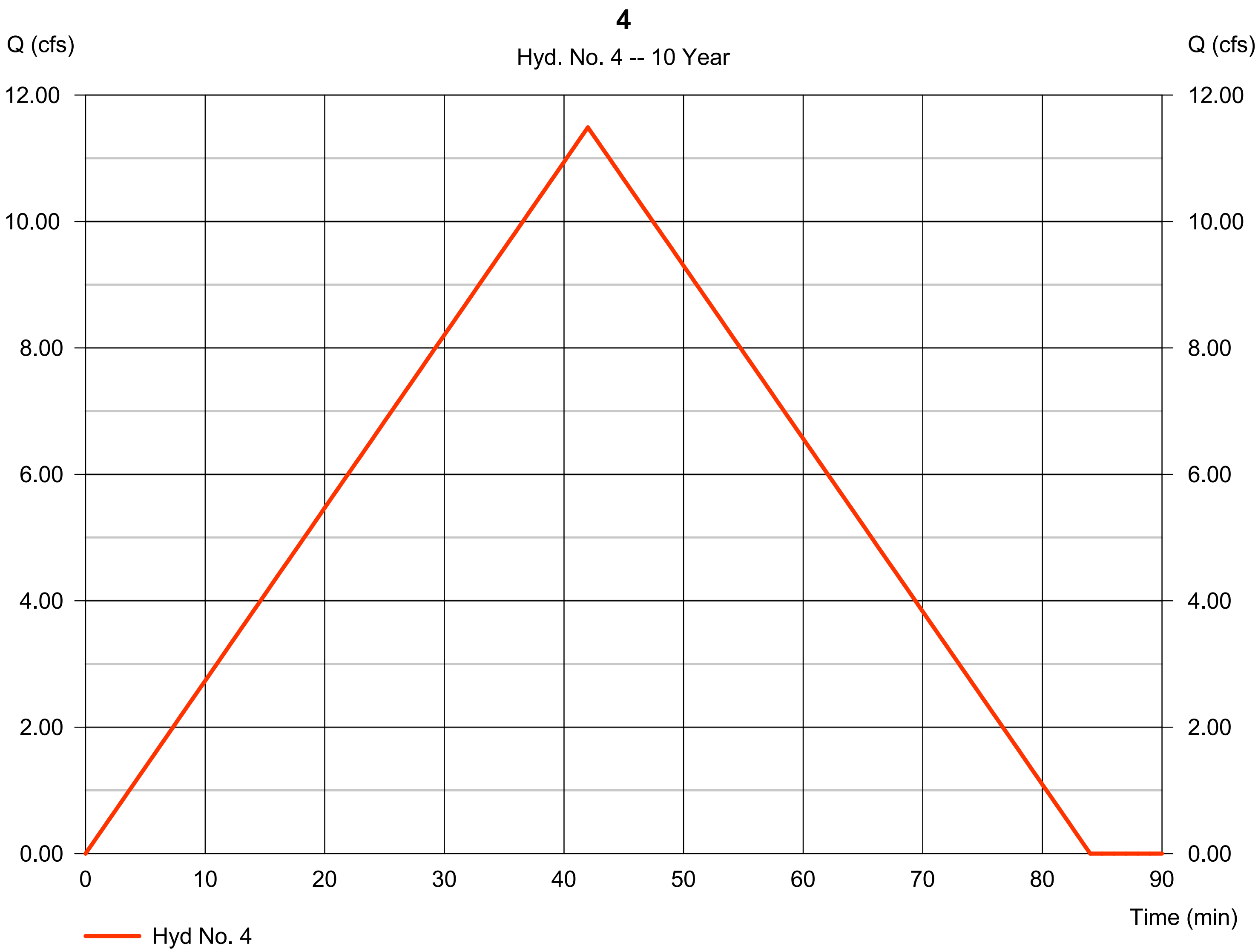
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020 Wednesday, 02 / 19 / 2020

Hyd. No. 4

4

Hydrograph type	= Rational	Peak discharge	= 11.49 cfs
Storm frequency	= 10 yrs	Time to peak	= 42 min
Time interval	= 1 min	Hyd. volume	= 28,950 cuft
Drainage area	= 17.400 ac	Runoff coeff.	= 0.3
Intensity	= 2.201 in/hr	Tc by User	= 42.00 min
IDF Curve	= El Paso County Colorado.IDF	Asc/Rec limb fact	= 1/1



Hydrograph Summary Report

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

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	Rational	6.911	1	48	19,904	------	------	------	1
2	Rational	4.502	1	43	11,614	------	------	------	2
3	Rational	8.312	1	40	19,948	------	------	------	3
4	Rational	17.29	1	42	43,581	------	------	------	4

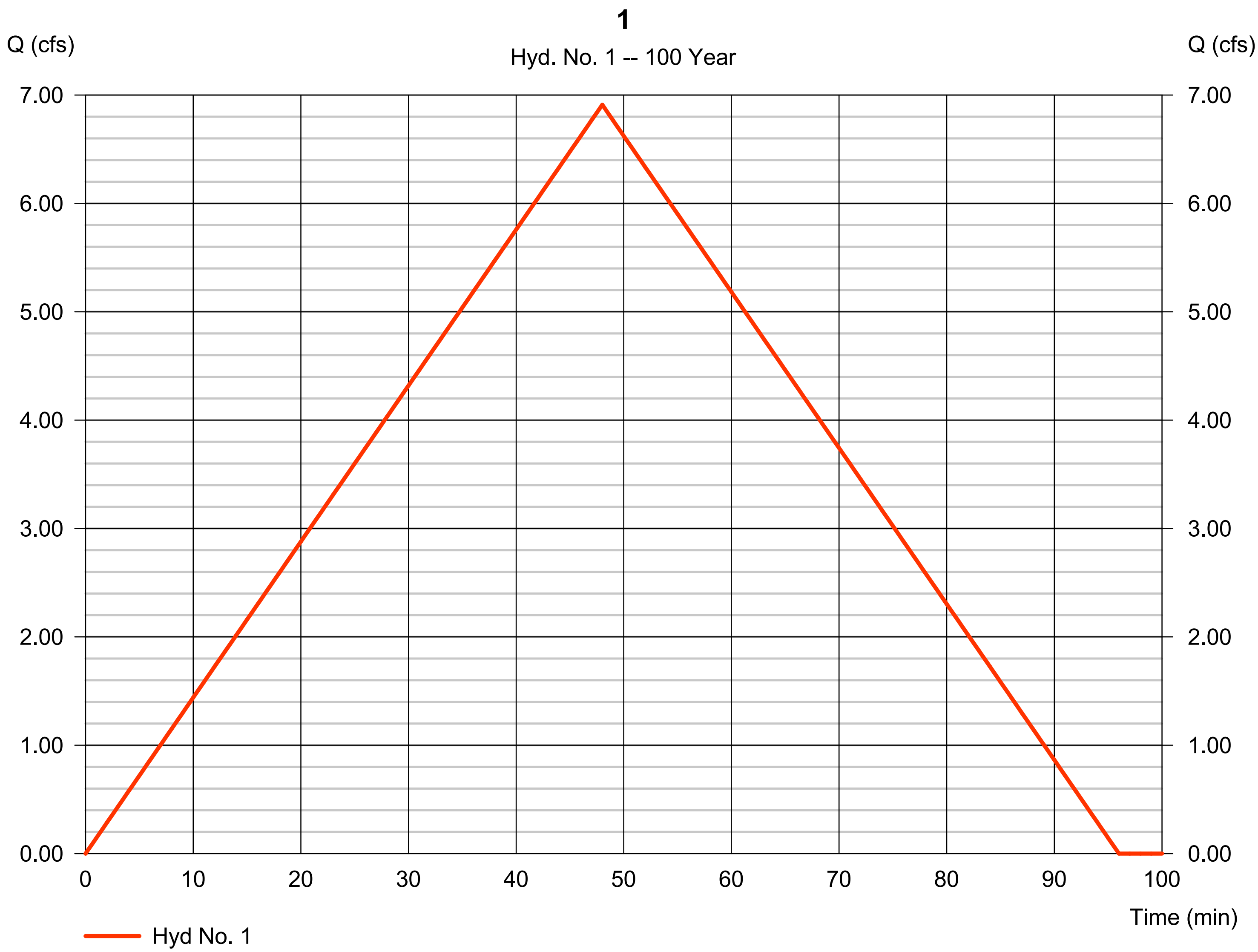
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020 Wednesday, 02 / 19 / 2020

Hyd. No. 1

1

Hydrograph type	= Rational	Peak discharge	= 6.911 cfs
Storm frequency	= 100 yrs	Time to peak	= 48 min
Time interval	= 1 min	Hyd. volume	= 19,904 cuft
Drainage area	= 7.600 ac	Runoff coeff.	= 0.3
Intensity	= 3.031 in/hr	Tc by User	= 48.00 min
IDF Curve	= El Paso County Colorado.IDF	Asc/Rec limb fact	= 1/1

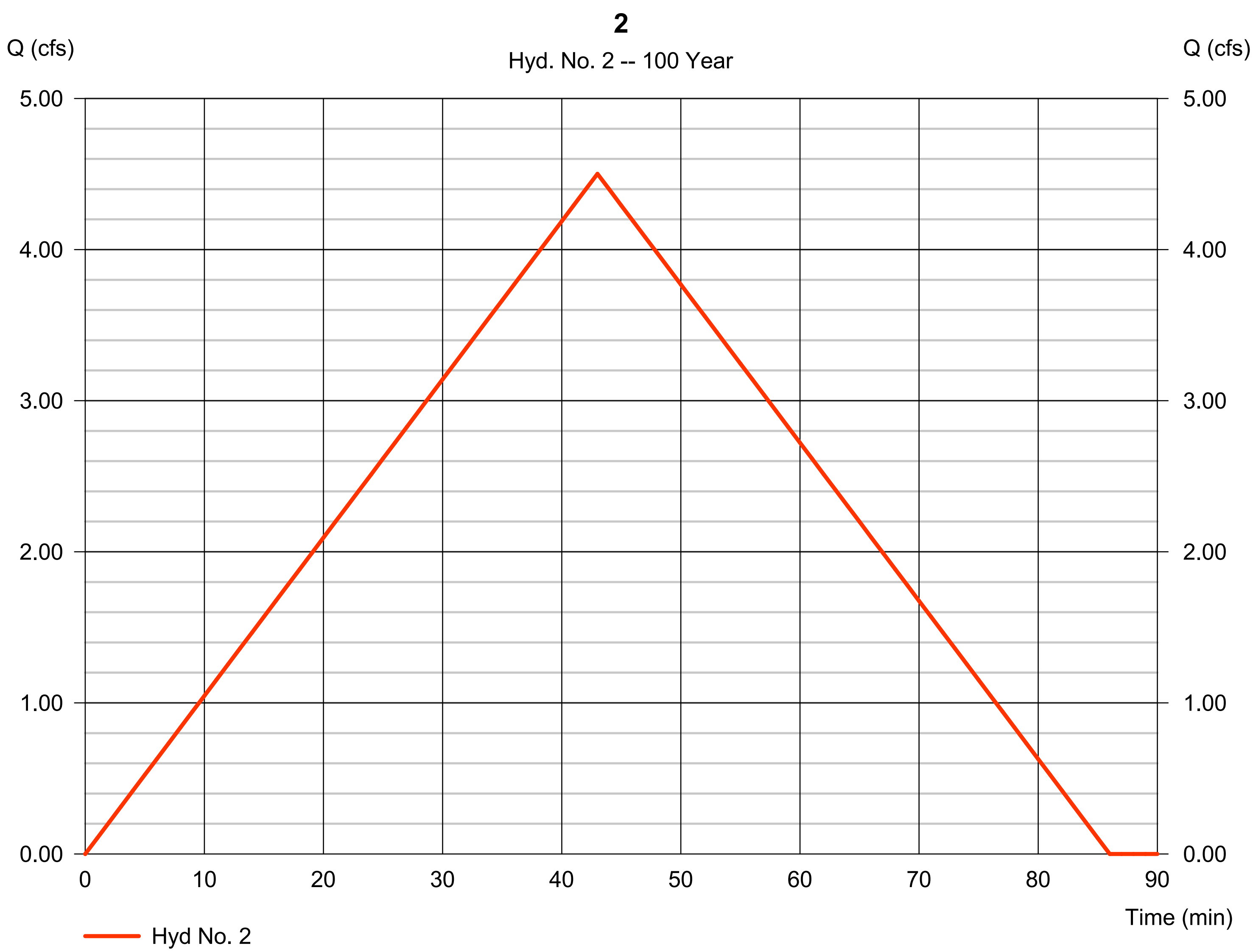


Hydrograph Report

Hyd. No. 2

2

Hydrograph type	= Rational	Peak discharge	= 4.502 cfs
Storm frequency	= 100 yrs	Time to peak	= 43 min
Time interval	= 1 min	Hyd. volume	= 11,614 cuft
Drainage area	= 4.600 ac	Runoff coeff.	= 0.3
Intensity	= 3.262 in/hr	Tc by User	= 43.00 min
IDF Curve	= El Paso County Colorado.IDF	Asc/Rec limb fact	= 1/1



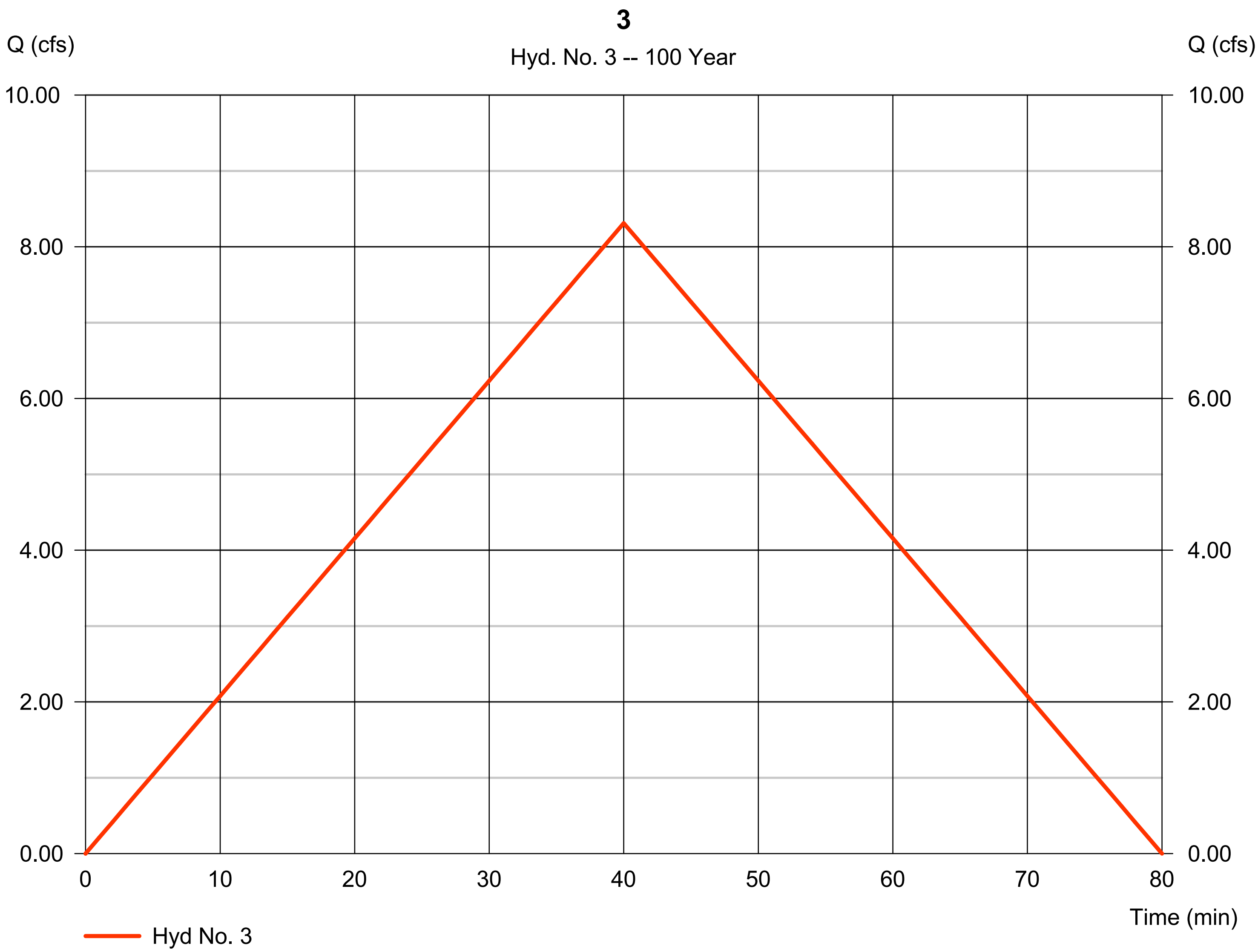
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020 — Wednesday, 02 / 19 / 2020

Hyd. No. 3

3

Hydrograph type	= Rational	Peak discharge	= 8.312 cfs
Storm frequency	= 100 yrs	Time to peak	= 40 min
Time interval	= 1 min	Hyd. volume	= 19,948 cuft
Drainage area	= 8.100 ac	Runoff coeff.	= 0.3
Intensity	= 3.420 in/hr	Tc by User	= 40.00 min
IDF Curve	= El Paso County Colorado.IDF	Asc/Rec limb fact	= 1/1



Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020 Wednesday, 02 / 19 / 2020

Hyd. No. 4

4

Hydrograph type	= Rational	Peak discharge	= 17.29 cfs
Storm frequency	= 100 yrs	Time to peak	= 42 min
Time interval	= 1 min	Hyd. volume	= 43,581 cuft
Drainage area	= 17.400 ac	Runoff coeff.	= 0.3
Intensity	= 3.313 in/hr	Tc by User	= 42.00 min
IDF Curve	= El Paso County Colorado.IDF	Asc/Rec limb fact	= 1/1

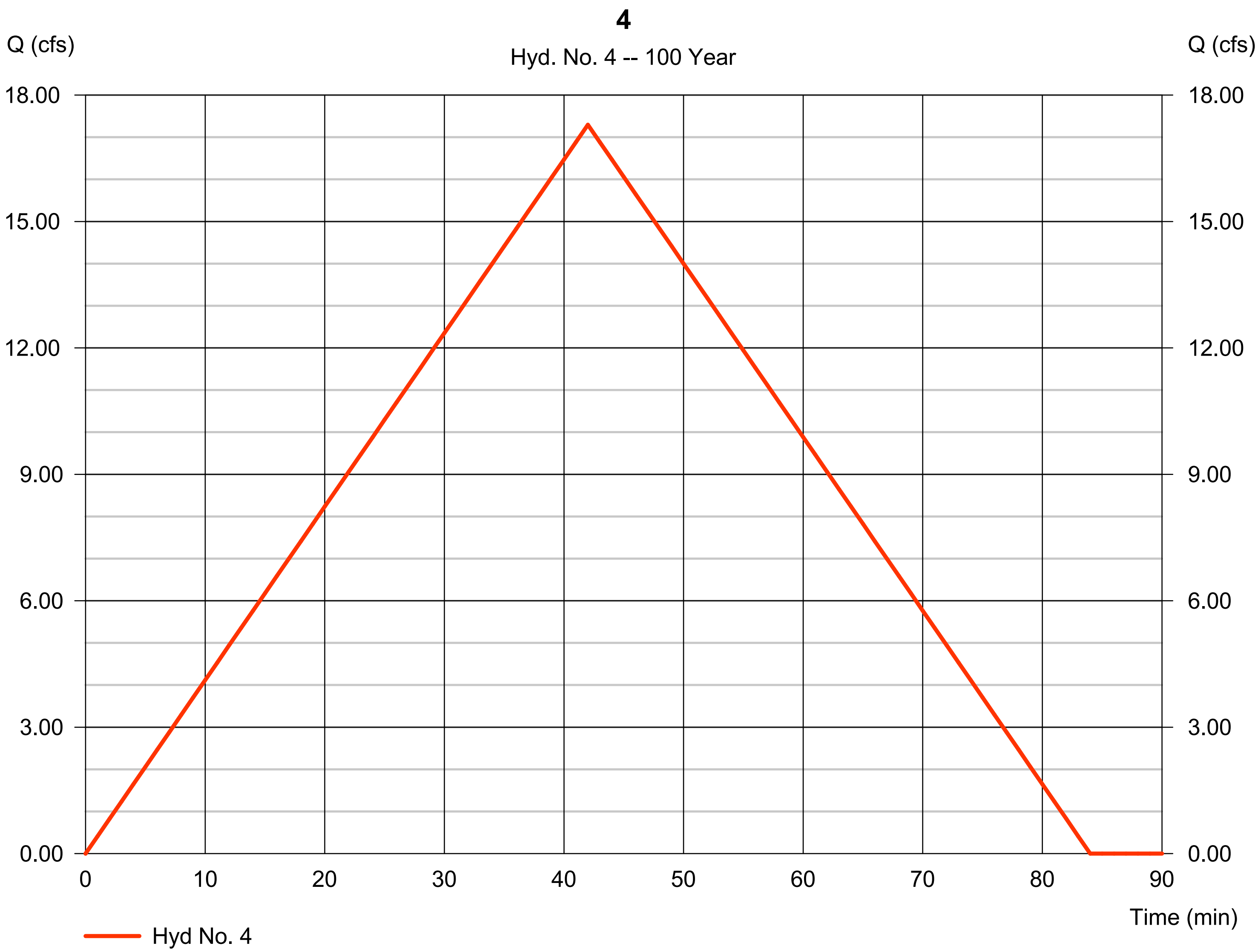


Exhibit 3

DESIGN POINTS A-C OUTPUT FOR 100-YEAR EVENT

Culvert Report

Design Point A

Invert Elev Dn (ft)	=	2331.11
Pipe Length (ft)	=	16.00
Slope (%)	=	2.75
Invert Elev Up (ft)	=	2331.55
Rise (in)	=	5.0
Shape	=	Circular
Span (in)	=	5.0
No. Barrels	=	2
n-Value	=	0.012
Culvert Type	=	Circular Concrete
Culvert Entrance	=	Square edge w/headwall (C)
Coeff. K,M,c,Y,k	=	0.0098, 2, 0.0398, 0.67, 0.5

Embankment

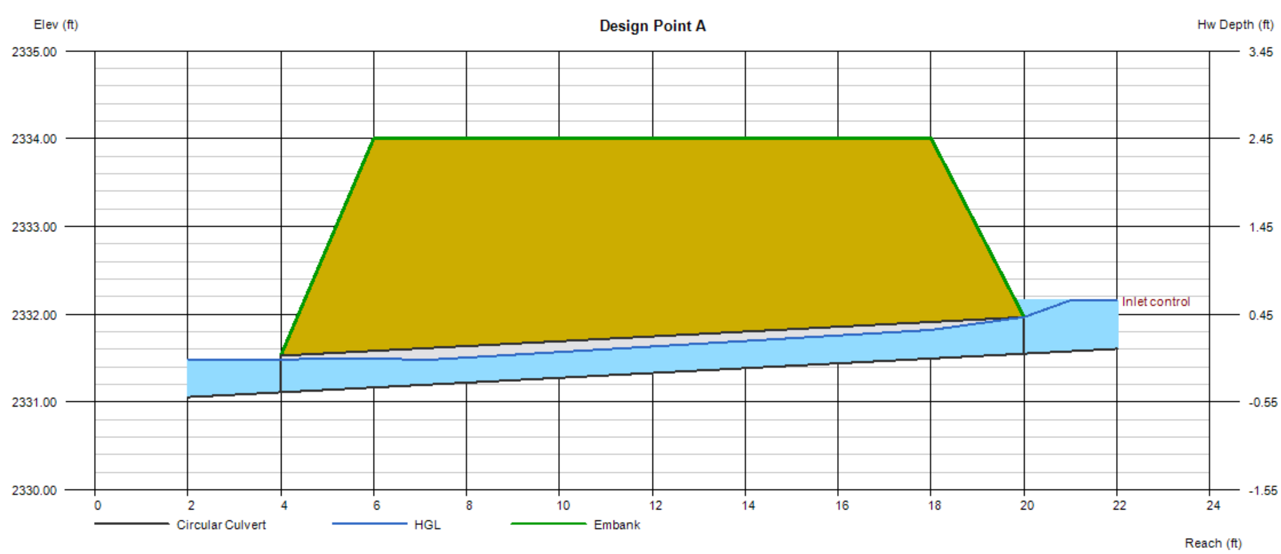
Top Elevation (ft)	=	2334.00
Top Width (ft)	=	12.00
Crest Width (ft)	=	1.00

Calculations

Qmin (cfs)	=	0.79
Qmax (cfs)	=	0.79
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	0.79
Qpipe (cfs)	=	0.79
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	3.05
Veloc Up (ft/s)	=	3.37
HGL Dn (ft)	=	2331.49
HGL Up (ft)	=	2331.88
Hw Elev (ft)	=	2332.16
Hw/D (ft)	=	1.46
Flow Regime	=	Inlet Control



Culvert Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. — Tuesday, Mar 17 2020

Design Point B

Invert Elev Dn (ft)	=	2320.31
Pipe Length (ft)	=	16.00
Slope (%)	=	1.56
Invert Elev Up (ft)	=	2320.56
Rise (in)	=	24.0
Shape	=	Circular
Span (in)	=	24.0
No. Barrels	=	1
n-Value	=	0.012
Culvert Type	=	Circular Concrete
Culvert Entrance	=	Square edge w/headwall (C)
Coeff. K,M,c,Y,k	=	0.0098, 2, 0.0398, 0.67, 0.5

Embankment

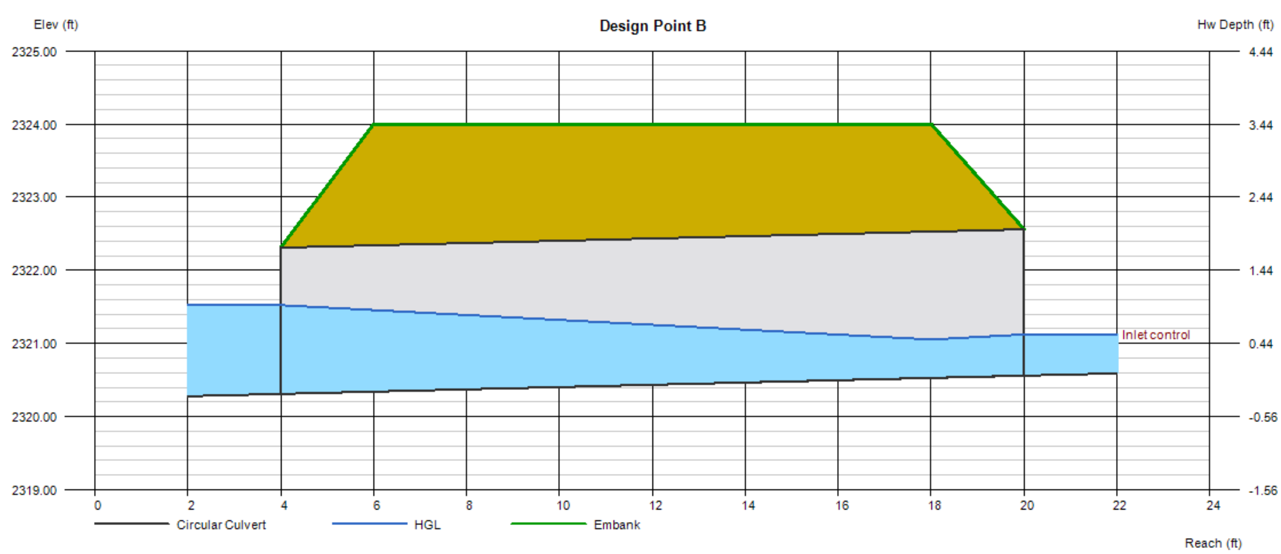
Top Elevation (ft)	=	2324.00
Top Width (ft)	=	12.00
Crest Width (ft)	=	1.00

Calculations

Qmin (cfs)	=	1.52
Qmax (cfs)	=	1.52
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	1.52
Qpipe (cfs)	=	1.52
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	0.76
Veloc Up (ft/s)	=	3.11
HGL Dn (ft)	=	2321.52
HGL Up (ft)	=	2320.99
Hw Elev (ft)	=	2321.12
Hw/D (ft)	=	0.28
Flow Regime	=	Inlet Control



Culvert Report

Design Point C

Invert Elev Dn (ft)	=	2316.41
Pipe Length (ft)	=	16.00
Slope (%)	=	1.88
Invert Elev Up (ft)	=	2316.71
Rise (in)	=	12.0
Shape	=	Circular
Span (in)	=	12.0
No. Barrels	=	1
n-Value	=	0.012
Culvert Type	=	Circular Concrete
Culvert Entrance	=	Square edge w/headwall (C)
Coeff. K,M,c,Y,k	=	0.0098, 2, 0.0398, 0.67, 0.5

Embankment

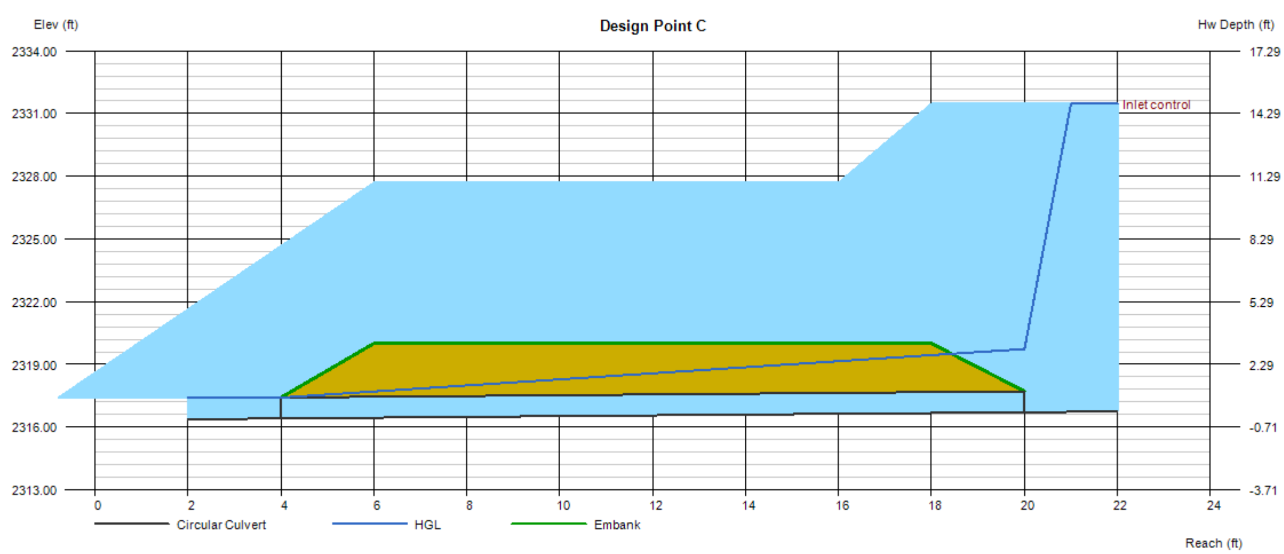
Top Elevation (ft)	=	2320.00
Top Width (ft)	=	12.00
Crest Width (ft)	=	1.00

Calculations

Qmin (cfs)	=	14.78
Qmax (cfs)	=	14.78
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	14.78
Qpipe (cfs)	=	14.78
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	18.82
Veloc Up (ft/s)	=	18.82
HGL Dn (ft)	=	2317.41
HGL Up (ft)	=	2319.73
Hw Elev (ft)	=	2331.47
Hw/D (ft)	=	14.76
Flow Regime	=	Inlet Control



Culvert Report

Design Point C

Invert Elev Dn (ft)	=	2316.41
Pipe Length (ft)	=	16.00
Slope (%)	=	1.88
Invert Elev Up (ft)	=	2316.71
Rise (in)	=	24.0
Shape	=	Circular
Span (in)	=	24.0
No. Barrels	=	1
n-Value	=	0.012
Culvert Type	=	Circular Concrete
Culvert Entrance	=	Square edge w/headwall (C)
Coeff. K,M,c,Y,k	=	0.0098, 2, 0.0398, 0.67, 0.5

Embankment

Top Elevation (ft)	=	2320.00
Top Width (ft)	=	12.00
Crest Width (ft)	=	1.00

Calculations

Qmin (cfs)	=	14.78
Qmax (cfs)	=	14.78
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	14.78
Qpipe (cfs)	=	14.78
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	5.21
Veloc Up (ft/s)	=	6.37
HGL Dn (ft)	=	2318.10
HGL Up (ft)	=	2318.09
Hw Elev (ft)	=	2318.92
Hw/D (ft)	=	1.11
Flow Regime	=	Inlet Control