Final Drainage Report

Palmer Solar Facility
El Paso County, Colorado

Prepared for:
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Project #: 096495003

Prepared: January 18, 2019
Revised: February 5, 2019

AASI-18-006

PPR-19-006

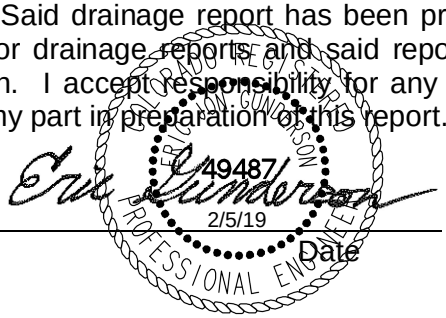
The Palmer Solar Facility Drainage Report will be reviewed for acceptance during the Site Development Stage of this Project.

Kimley»Horn

CERTIFICATION

DESIGN 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 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 preparation of this report.



SIGNATURE (Affix Seal): _____

Colorado P.E. No. 49487 Date

OWNER/DEVELOPER'S STATEMENT

I, the developer, have read and will comply with all of the requirements specified in this Drainage Report and Plan.

_____
Name of Developer

_____
Authorized Signature Date

Provide developer's signature.

_____
Printed Name

_____
Title

_____
Address:

EL PASO COUNTY

Filed in accordance with the requirements of the Drainage Criteria Manual, Volumes 1 and 2, El Paso County Engineering Criteria Manual and Land Development Code as amended.

_____ _____
Jennifer Irvine, P.E. Date
County Engineer/ ECM Administrator

Conditions:

TABLE OF CONTENTS

PURPOSE AND SCOPE OF STUDY

The purpose of this Final Drainage Report (FDR) is to provide the hydrologic and hydraulic calculations and to document and finalize the drainage design methodology in support of the proposed Palmer Solar Facility ("the Project") for JSI Construction Group LLC. The Project is located within the jurisdictional limits of El Paso County ("the County"). Thus, the guidelines for the hydrologic and hydraulic design components were based on the criteria for the County and City of Colorado Springs, described below.

GENERAL LOCATON AND DESCRIPTION

LOCATION

The Project is located approximately 3.5 miles southeast of Fountain, Colorado within Township 16 South, Range 65 West of the 6th Principal Meridian, County of El Paso, State of Colorado (the "Site"). More specifically, the Site is located north of Birdsall Road, approximately 1 mile east of Old Pueblo Road. The surrounding platted developments include Coalson Farms to the west, Woodmoor Water and Sanitation District land to the north, City of Colorado Springs land to the east, and State of Colorado land to the south. A vicinity map has been provided in the Appendix of this report.

The Site is split into two primary site areas, the first being the Birdsall Road Site located along the west boundary of the Site and the second being the Squirrel Creek Site located along the east boundary of the Site. The west side of the Site, or Birdsall Road Site, is located within El Paso County's Calhan Reservoir basin. The east side of the Site, or Squirrel Creek Site, is located within El Paso County's Lower Williams Creek basin.

The Site is currently owned by the Woodmoor Water and Sanitation District (the "District") and will be leased to JSI Construction Group LLC to develop the Project.

DESCRIPTION OF PROPERTY

The Project is located on approximately 523 acres of land consisting of vacant land with native vegetation and is classified as "Pasture and Meadow" per Table 6-6 of the City of Colorado Springs Drainage Criteria Manual. The Site does not currently provide water quality or detention for the Project area. The existing land use is undeveloped vacant land. The proposed land use is a solar facility with native ground cover.

The existing topography at the Birdsall Road Site, consists of slopes ranging from 2% to 4:1. The existing topography at the Squirrel Creek Site, consists of slopes ranging from 2% to 4:1.

NRCS soil data is available for this Site and it has been noted that soils onsite are generally USCS Type C and D. Reference the Geotechnical Engineering Report for CO404 Palmer Solar Facility prepared by Terracon Consultants, Inc. dated May 21, 2018 for additional information on specific soil types and other geotechnical information. There are no major drainage ways or irrigation facilities within the Site.

Improvements will consist of mowing, clearing and grubbing, weed control, gravel access road construction, overlot grading, solar array installation, roadside ditches, culverts, drainage swales, native seeding and a proposed channel to convey off-site flows through the Squirrel Creek Site.

The Project proposes to install underground electric lines connecting power stations for the solar panels to a larger sub-station located on the northeast corner of the Site. There will also be a proposed overhead transmission line that connects the two sites to a proposed substation.

ALTA and topographic field survey was completed for the Project by Clark Land Surveying Inc. dated April 23rd, 2018 and is the basis for design for the drainage improvements.

DRAINAGE BASINS AND SUB-BASINS

MAJOR BASIN DESCRIPTIONS

There are no previous drainage studies, master plans or site constraints for this Site.

No portion of the Project is located within the 100-year floodplain as determined by the Flood Insurance Rate Map (FIRM) numbers 08041C0970G and 08041C1160G effective date, December 7, 2018 (see Appendix).

The Birdsall Road Site, is located within El Paso County's Calhan Reservoir basin. The Squirrel Creek Site, is located within El Paso County's Lower Williams Creek basin.

EXISTING SUB-BASIN DESCRIPTIONS

The Birdsall Road Site, has been divided into 4 drainage sub-basins (W1-W4). Existing drainage patterns are split by a ridge that runs north-south and generally divides the drainage areas in half. Drainage along the west side flows west overland to existing agricultural land which ultimately drains southward to Fountain Creek (sub-basins W1 and W3). Drainage along the east side flows overland to the east. More specifically, sub-basin W2 flows east to Calhan Reservoir and sub-basin W4 flows east and eventually south, beneath Birdsall Road ultimately to Fountain Creek. Fountain Creek is a part of the Arkansas River Basin.

The west sub-basin areas, minor 5-year storm event runoffs, and major 100-year storm event runoffs are provided in Table 1.

Basin	Basin Area (Acres)	Direct 5-Year Runoff (cfs)	Direct 100-Year Runoff (cfs)
W1	88.40	23.37	107.98
W2	151.70	25.17	115.88
W3	91.27	45.72	196.20
W4	303.81	129.49	563.91

Table 1. Existing West Sub-Basin Data

The Squirrel Creek Site, has been divided into 3 drainage sub-basins (E1-E3). Existing drainage patterns are split by a ridge that runs east-west along the southern 1/3 of the Site. Drainage along the north side flows south, through the Site and eventually southeast outside of the

property limits. Sub-basin E1 is approximately 7776.17 acres and consists of a large off-site area north of the Squirrel Creek Site that flows through the property southeasterly and ultimately off-site. Ultimately drainage from this area reaches Fountain Creek. Drainage along the southern 1/3 of the Site flows south overland to existing unnamed drainageways and ultimately southward to Fountain Creek (sub-basins E2 and E3). Prior to ultimate discharge to Fountain Creek, sub-basins E1-E3 flow through a series of manmade ponds between the Site and Fountain Creek.

The east sub-basin areas, minor 5-year storm event runoffs, and major 100-year storm event runoffs are provided Table 2.

Basin	Basin Area (Acres)	Direct 5-Year Runoff (cfs)	Direct 100-Year Runoff (cfs)
E1	776.17	115.86	530.57
E2	24.35	5.99	27.66
E3	90.83	24.02	110.95

Table 2. Existing East Sub-Basin Data

Offsite flows entering the Site will be conveyed through the Site following historical drainage paths and outfall to Fountain Creek or the unnamed drainage ditches which ultimately outfall to Fountain Creek. Offsite flows will not be detained on site.

An Existing Drainage Conditions Map and hydrologic calculations are included in the Appendix of this report for reference.

DRAINAGE DESIGN CRITERIA

DEVELOPMENT CRITERIA REFERENCE

The proposed storm facilities are designed to be in compliance with the City of Colorado Springs and El Paso County “Drainage Criteria Manual (DCM)” dated November 1991 (”the MANUAL”), El Paso County “Engineering Criteria Manual” (“the Engineering Manual”), Chapter 6 and Section 3.2.1 of Chapter 13 of the City of Colorado Springs Drainage Criteria Manual dated May 2014 (“the Colorado Springs MANUAL”).

Site drainage is not significantly impacted by such constraints as utilities or existing development.

There are no previous drainage studies, master plans or site constraints for this Site.

HYDROLOGIC CRITERIA

The 5-year and 100-year design storm events were used in determining rainfall and runoff for the proposed drainage analysis per the MANUAL. Table 6-2 of the Colorado Springs MANUAL is the source for rainfall data for the 5-year and 100-year design storm events. Design runoff

was calculated using the Soil Conversation Service (SCS) method for developed conditions as established in the MANUAL. The SCS Method was used for existing conditions and proposed conditions due to the on-site and off-site basins containing more than 130 acres. Runoff curve numbers for the existing drainage basins used the curve numbers from Table 6-9 of the MANUAL, ARC I conditions for Pre-Development. The use was assumed to be pasture, grassland or range with a fair hydrologic condition resulting in curve numbers of 61 and 69 for the Hydrologic Soil Groups C and D respectively. For the proposed development curve numbers were determined using Table 6-10 of the MANUAL, ARC II conditions for Post-Development. For the gravel roads a curve number of 91 was used. For the substation pads, Newly Graded Area was the assumed use with a curve number of 94 used. Calculations for the composite curve numbers are included in the Appendix.

The Project does not provide water quality or detention as the Project is not significantly increasing the imperviousness of the Site, the Project is not altering historic drainage patterns and not significantly increasing developed flows.

There are no additional provisions selected or deviations from the criteria in both the MANUAL and Colorado Springs MANUAL.

HYDRAULIC CRITERIA

Applicable design methods were utilized to size the proposed culverts and drainage channel, which includes the use of the UDFCD UD Culvert spreadsheet and FlowMaster, V8i software.

Proposed drainage features on-site have been analyzed and sized for the following design storm events:

- Major Storm: 100-year Storm Event

THE FOUR STEP PROCESS

The Project was designed in accordance with the four-step process to minimize adverse impacts of urbanization, as outlined in Chapter 1 Section 4.0 of the Colorado Springs MANUAL.

Step 1. **Employ Runoff Reduction Practices**- The Project was designed to conserve as much of the existing vegetation as possible and to minimize the extent of disturbance. All the disturbed area beneath the solar arrays will be replanted with native grasses. The proposed roadways will be constructed with aggregate base to minimize impervious surfaces. Additionally, proposed roadside swales add a buffer between the road surface and array locations which slows down flows and prevents erosion.

Step 2. Implement BMPs That Provide a Water Quality Capture Volume with Slow Release –Permanent water quality measures and detention facilities will not be necessary for the Project. Temporary water quality and erosion control measures will be provided during construction to prevent sediment laden water from discharging from the Site. Three foot check dams with riprap openings will be built along the west side to also decrease the velocity of the water headed down the hill and increase the time of concentration.

Step 3 Stabilize Drainageways– The Project is part of the El Paso County's Calhan Reservoir basin and Lower Williams Creek basin. The Project does not alter the existing

drainage patterns in the Calhan Reservoir Basin because it does not discharge concentrated flow into the existing drainageways. The Project does include channelizing part of the Lower Williams Creek Basin to minimize flooding and erosion.

Step 4. Implement Site Specific and Other Source Control BMPs – The erosion control construction BMPs of the Project were designed to reduce contamination. Source control BMPs include the use of vehicle tracking control, culvert protection, stockpile management, and stabilized staging areas.

DRAINAGE FACILITY DESIGN

GENERAL CONCEPT

The proposed drainage patterns will match the historic patterns. Overlot grading of specific areas within the Site will be required to facilitate the construction of the solar arrays on adequate slopes. The overlot grading will follow the existing topography and will not alter the historic drainage patterns to Fountain Creek. Areas that are overlot graded will be revegetated with native seeding. Native seeding and vegetation will be established beneath the solar arrays such that the overall impervious area of the Site will not increase except for the addition of gravel access roads throughout the Site. Additionally, the solar arrays provide a level of shade to the underlying vegetation to facilitate growth. Mowing operations are included as part of the operations and maintenance plan for the facility.

Water quality and detention are not provided for the Site per justification provided in the "Hydrologic Response of Solar Farms" ASCE white paper prepared by Lauren M. Cook and Richard H. McCuen at the University of Maryland, dated May 2013 (the "white paper"). The white paper outlines the hydrologic effects of solar panels and the applicability of stormwater management on solar sites to control runoff volumes and rates. The white paper concluded that "The addition of solar panels over a grassy field does not have much of an effect on the volume of runoff, the peak discharge, nor the time to peak. With each analysis, the runoff volume increased slightly but not enough to require storm-water management facilities." The white paper then goes on to emphasize the impact that ground cover plays on the runoff volume, peak discharge, and time to peak. Gravel or pavement underneath the solar panels will increase the volume of runoff significantly. However, ground cover plays a significant role regardless of the type of development. "The solar panels are impervious to rain water; however, they are mounted on metal rods and placed over pervious land," as stated in the white paper. Therefore, water quality and detention are not provided for the Site.

Provided in the Appendix are hydrologic calculations utilizing the SCS method for the existing and proposed conditions, Flowmaster details and cross sections for proposed drainage features, and existing and proposed drainage maps of the Birdsall Road Site and the Squirrel Creek Site.

SPECIFIC DETAILS

Runoff conditions for the Site were developed utilizing the previously referenced Hydrologic Criteria. The Birdsall Road Site, has been divided into 4 proposed drainage sub-basins (W1-W4). The proposed west drainage basins extents match the existing drainage basins due to the site grading matching existing conditions except for the proposed grading of roadways and roadside ditches. The proposed basins are split by a ridge that runs north-south. The west side

of the ridge consists of sub-Basins W1 and W3. The east side of the ridge consists of sub-basins W2 and W4.

Sub-basins W1 and W3 consist of solar panels, native vegetation, permanent check dams, and gravel roadways. The flow patterns within the basins follow historic drainage patterns and drain to the west to existing agricultural land which ultimately drains to Fountain Creek. Check dams are to be installed to help dissipate flow velocities of the overland sheet flow from east to west for Sub-Basins W1 and W3. The check dams increase the time of concentration by a half of a minute (flowing through one check dam, Sub-Basin W1) or by a minute (flowing through two check dams, Sub-Basin W3). Sub-basin W2 consists of offsite native vegetation. Sub-basin W4 consists of solar panels, roadside ditches, and gravel roadways. Sub-basins W2 and W4 follow historic drainage patterns and flow east to either Calhan Reservoir or southward to Fountain Creek.

The west sub-basin areas, minor 5-year storm event runoffs, and major 100-year storm event runoffs are provided in Table 3.

Basin	Basin Area (Acres)	Direct 5-Year Runoff (cfs)	Direct 100-Year Runoff (cfs)
W1	88.40	26.41	114.02
W2	154.60	25.65	118.10
W3	84.89	42.53	182.48
W4	318.15	135.61	590.53

Table 3. Proposed West Sub-Basin Data

The Squirrel Creek Site, is divided into 5 drainage sub-basins (E1-E5). Existing drainage patterns are split by a ridge that runs east-west along the southern 1/3 of the area. The proposed drainage patterns will remain split by the east-west ridge. The north side of the ridge consists of sub-basins E1-E4. The south side of the ridge consists of sub-basin E5.

Sub-Basin E1 in the proposed condition represents the large off-site area that drains from the north, through the Squirrel Creek Site in a southeasterly direction. To account for this off-site flow through the Site, drainage is proposed to be conveyed in a channel through the Site, following the historic direction and eventually off-site. Sub-basins E2 through E4 consist of solar panels, native vegetation, drainage channel, and gravel roadways. Sub-basins E1-E4 follow historic drainage patterns and flow south overland to existing unnamed drainage ditches, eastward and ultimately southward to Fountain Creek. Sub-basin E5 consists of solar panels, native vegetation, and gravel roadways. Sub-Basin E5 follows historic drainage patterns and flows south overland to existing unnamed drainage ditches, and ultimately southward to Fountain Creek.

The east sub-basin areas, minor 5-year storm event runoffs, and major 100-year storm event runoffs are provided in Table 4.

Basin	Basin Area (Acres)	Direct 5-Year Runoff (cfs)	Direct 100-Year Runoff (cfs)
E1	508.88	95.27	388.43
E2	121.72	28.37	123.02
E3	24.35	5.99	27.66
E4	145.86	32.35	140.43
E5	89.81	26.83	115.84

Table 4. Proposed East Sub-Basin Data

A Proposed Drainage Conditions Map and hydrologic calculations are included in the Appendix of this report for reference.

The Project utilizes a proposed drainage channel within the Squirrel Creek Site to convey offsite and minimal onsite flows through the Site for the protection of the solar panels. The proposed channel is designed to carry the minor and major storm events and will run dry for most of the year. The channel has an average depth of approximately 2 feet, a 55-foot bottom width, a left-side slope of 4:1, and a right-side slope of 4:1. The channel was sized to convey the 100-year storm event of and has a maximum capacity of 762.73 cfs. This channel conveys the off-site flows from sub basin EI and the developed flows within sub basin E2. Channel calculations are provided in the Appendix.

The Project also utilizes check dams on the west perimeter of the Birdsall Road Site. Two neighborhood meetings and two public hearings were held prior to completion of this report. The neighborhood meetings were hosted by JSI Construction Group LLC and the public hearings were hosted by the County. The neighboring public was invited to attend to comment on the Project. During those meetings, existing home owners along the west side of the Site raised concerns about existing drainage issues relative to the hillside that drains westward, towards their property. These areas are shown on the Existing Drainage Conditions Map. Based upon these public comments, proposed check dams are provided along the west side of the Birdsall Road Site to decrease the velocity of the overland flows from east to west. The check dams are three feet earthen berms with a maximum length of 300'. The check dams are designed with a high point in the center which slopes outward at a minimum of 1% each direction. There are breaks in the check dams that contain riprap pads.

Roadside ditches are provided on the uphill side of the proposed roadways to route flows to the proposed culverts. The roadside ditches are sized to convey the minor event flow and have a minimum capacity of 23.25 cfs. The roadside ditches have an average depth of approximately 1 foot, a 4-foot bottom width, a left-side slope of 6:1, and a right-side slope of 4:1. Roadside ditch sizing and capacity calculations are provided in the Appendix.

Culverts were sized to convey flows from the ditches, underneath the gravel site access roads. The proposed culverts are 18" or 24" in diameter and have been designed to convey the 100-

year storm event. Culvert calculations are provided in the Appendix and culvert locations are provided in the Proposed Drainage Maps.

The Site will disturb more than 1 acre and will require a Colorado Discharge Permit System (CDPS) General Permit for Stormwater Discharge Associated with Construction Activities from the Colorado Department of Public Health and Environment (CDPHE).

The estimated opinion of probable cost for the stormwater infrastructure is $202,708. An opinion of cost is provided in the Appendix.

There are no drainage and bridge fees for the Project. The Project is leasing two parcels of land from Woodmoor Water and Sanitation District and the Site does not require platting.

SUMMARY

The proposed drainage design is to maintain the historic drainage patterns, the overall imperviousness and release rates for the Site. Runoff from the Site will flow overland to existing El Paso County drainage basins: the Calhan Reservoir Basin and the Lower Williams Creek Basin. Both basins ultimately discharge to Fountain Creek. The drainage design presented within this report conforms to the criteria presented in both the MANUAL and the Colorado Springs MANUAL. Additionally, the Site runoff and storm drain facilities will not adversely affect the downstream and surrounding developments, including Fountain Creek.

REFERENCES

1. City of Colorado Springs and El Paso County “Drainage Criteria Manual (DCM)”, dated November 1991

2. El Paso County “Engineering Criteria Manual” Revision 6, dated December 13, 2016

3. Chapter 6 and Section 3.2.1. of Chapter 13-City of Colorado Springs Drainage Criteria Manual, May 2014.

4. Urban Drainage and Flood Control District Drainage Criteria Manual (UDFCDCM), Vol. 1, prepared by Wright-McLaughlin Engineers, June 2001, with latest revisions.

5. Flood Insurance Rate Map, El Paso County, Colorado and Incorporated Areas, Map Number 08041C0970F and 08041C1160F, Effective Date March 17, 1997, prepared by the Federal Emergency Management Agency (FEMA).

6. Hydrologic Response of Solar Farms, prepared by Lauren M. Cook and Richard H. McCuen, University of Maryland, May 2013.

APPENDIX

VICINITY MAP AND FEMA FIRM MAP

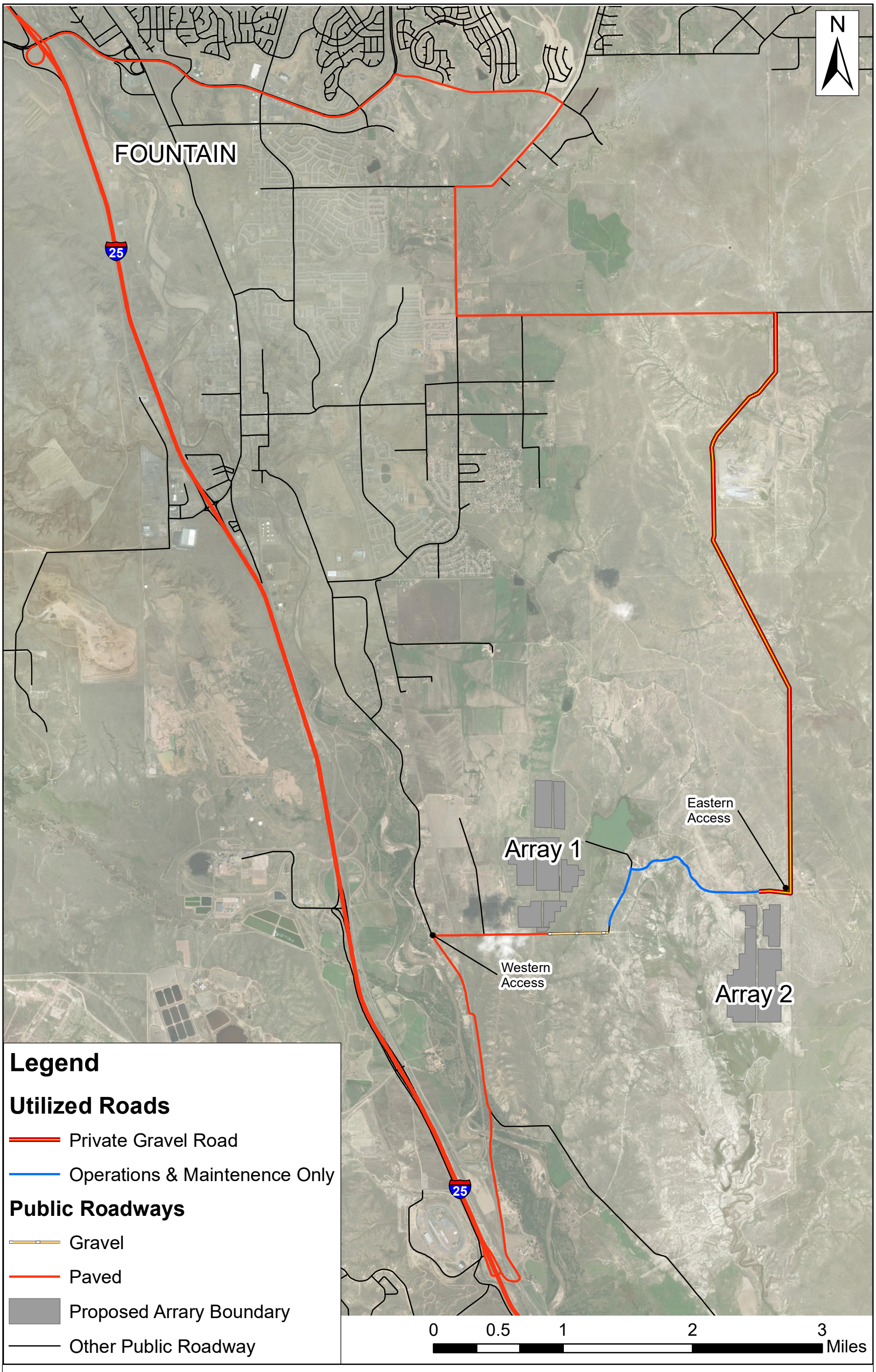


Figure 1

Vicinity Map

El Paso County, Colorado

Kimley»Horn

NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The **community map repository** should be consulted for possible updated or additional flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevations** (BFEs) and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles and Floodway Data and/or Summary of Stillwater Elevations tables contained within the Flood Insurance Study (FIS) report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS report should be utilized in conjunction with the FIRM for purposes of construction and/or floodplain management.

Coastal Base Flood Elevations shown on this map apply only landward of 0.0' North American Vertical Datum of 1988 (NAVD88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations table in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations table should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study report for this jurisdiction.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures**. Refer to section 2.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures for this jurisdiction.

The **projection** used in the preparation of this map was Universal Transverse Mercator (UTM) zone 13. The **horizontal datum** was NAD83, GRS80 spheroid. Differences in datum, spheroid, projection or UTM zones zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

Flood elevations on this map are referenced to the **North American Vertical Datum of 1988 (NAVD88)**. These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum**. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at http://www.ngs.noaa.gov/ or contact the National Geodetic Survey at the following address:

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, MD 20910-3282

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at (301) 713-3242 or visit its website at http://www.ngs.noaa.gov/.

Base Map information shown on this FIRM was provided in digital format by El Paso County, Colorado Springs Utilities, and Anderson Consulting Engineers, Inc. These data are current as of 2008.

This map reflects more detailed and up-to-date **stream channel configurations and floodplain delineations** than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables in the Flood Insurance Study Report (which contains authoritative hydraulic data) may reflect stream channel distances that differ from what is shown on this map. The profile baselines depicted on this map represent the hydraulic modeling baselines that match the flood profiles and Floodway Data Tables if applicable, in the FIS report. As a result, the profile baselines may deviate significantly from the new base map channel representation and may appear outside of the floodplain.

Corporate limits shown on this map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels; community map repository addresses; and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which each community is located.

Contact **FEMA Map Service Center** (MSC) via the FEMA Map Information eXchange (FMIX) 1-877-336-2627 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. The MSC may also be reached by Fax at 1-800-358-9620 and its website at http://www.msc.fema.gov/.

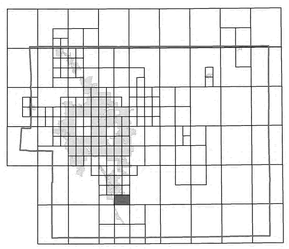
If you have **questions about this map** or questions concerning the National Flood Insurance Program in general, please call **1-877-FEMA MAP** (1-877-336-2627) or visit the FEMA website at http://www.fema.gov/business/nfip.

El Paso County Vertical Datum Offset Table

Flooding Source	Vertical Datum Offset (ft)

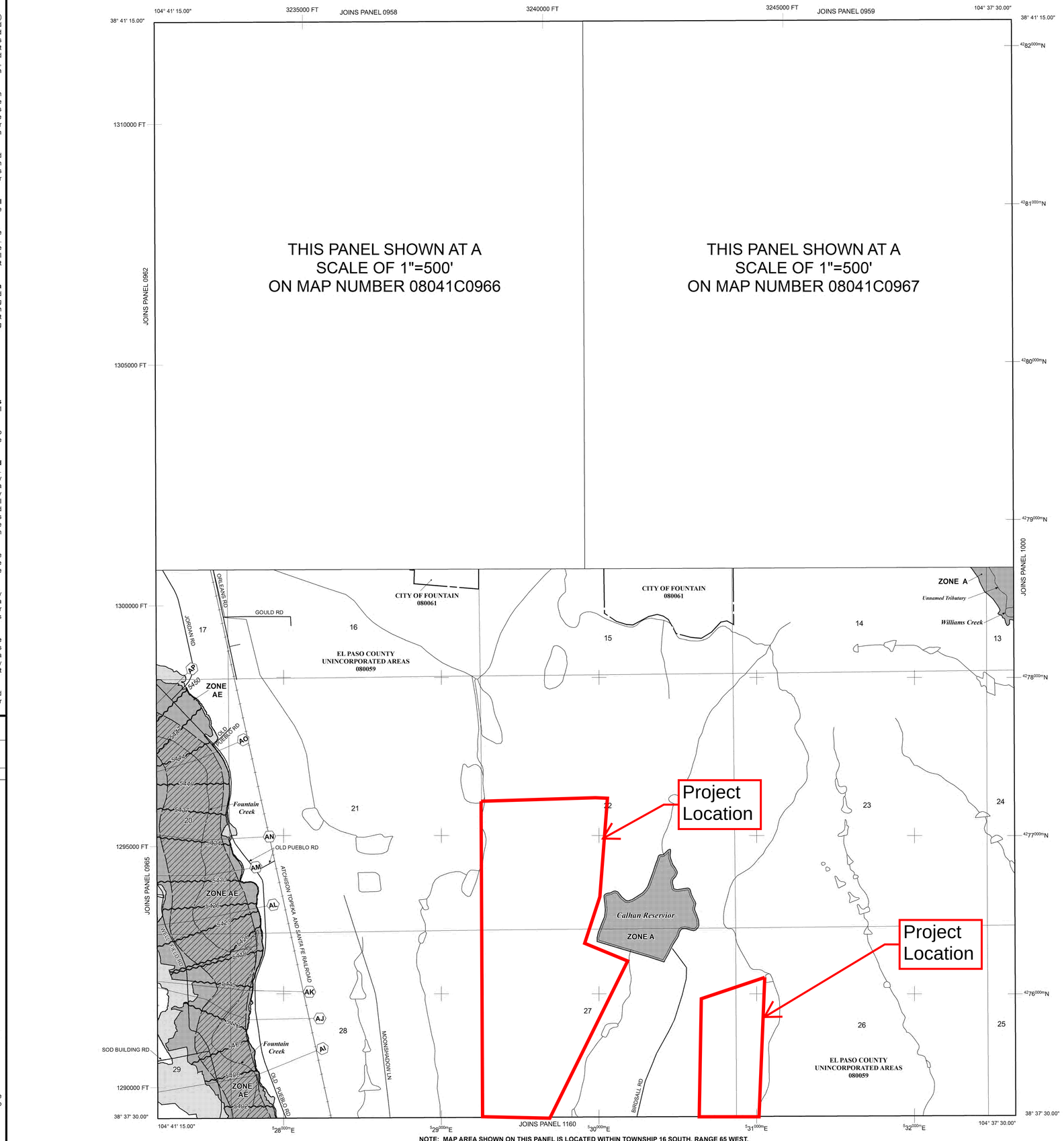
REFER TO SECTION 3.3 OF THE EL PASO COUNTY FLOOD INSURANCE STUDY FOR STREAM BY STREAM VERTICAL DATUM CONVERSION INFORMATION

Panel Location Map



This Digital Flood Insurance Rate Map (DFIRM) was produced through a Cooperating Technical Partner (CTP) agreement between the State of Colorado Water Conservation Board (CWCB) and the Federal Emergency Management Agency (FEMA).

Additional Flood Hazard information and resources are available from local communities and the Colorado Water Conservation Board.



LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHAS) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A No Base Flood Elevations determined.
ZONE AE Base Flood Elevations determined.
ZONE AH Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
ZONE AO Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
ZONE AR Special Flood Hazard Area Formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
ZONE A99 Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
ZONE V Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
ZONE VE Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X Areas determined to be outside the 0.2% annual chance floodplain.
ZONE D Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

Floodplain boundary
Floodway boundary
Zone D Boundary
CBRS and OPA boundary
Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.
513 — Base Flood Elevation line and value; elevation in feet*
(EL 987) — Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988 (NAVD 88)

A — A — Cross section line
23 — 23 — Transect line
97° 07' 30.00" / 32° 22' 30.00" — Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
4275000mN — 1000-meter Universal Transverse Mercator grid ticks, zone 13
6000000 FT — 5000-foot grid ticks: Colorado State Plane coordinate system, central zone (FIPSZONE 0502), Lambert Conformal Conic Projection
DX5510 — Bench mark (see explanation in Notes to Users section of this FIRM panel)
M1.5 — River Mile

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE FLOOD INSURANCE RATE MAP
MARCH 17, 1997

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL
DECEMBER 7, 2018 - to update corporate limits, to change Base Flood Elevations and Special Flood Hazard Areas, to update map format, to add roads and road names, and to incorporate previously issued Letters of Map Revision.

For community map revision history prior to countywide mapping, refer to the Community Map History Table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

MAP SCALE 1" = 1000'
500 0 1000 2000 FEET
300 0 300 600 METERS

NFIP

PANEL 0970G

NATIONAL FLOOD INSURANCE PROGRAM

FIRM

FLOOD INSURANCE RATE MAP

EL PASO COUNTY, COLORADO AND INCORPORATED AREAS

PANEL 970 OF 1300

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
EL PASO COUNTY	080059	0970	G
FOUNTAIN, CITY OF	080061	0970	G

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER 08041C0970G

MAP REVISED DECEMBER 7, 2018

Federal Emergency Management Agency

NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The **community map repository** should be consulted for possible updated or additional flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevations** (BFEs) and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles and Floodway Data and/or Summary of Stillwater Elevations tables contained within the Flood Insurance Study (FIS) report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS report should be utilized in conjunction with the FIRM for purposes of construction and/or floodplain management.

Coastal Base Flood Elevations shown on this map apply only landward of 0.0' North American Vertical Datum of 1988 (NAVD88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations table in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations table should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study report for this jurisdiction.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures**. Refer to section 2.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures for this jurisdiction.

The **projection** used in the preparation of this map was Universal Transverse Mercator (UTM) zone 13. The **horizontal datum** was NAD83, GRS80 spheroid. Differences in datum, spheroid, projection or UTM zones zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

Flood elevations on this map are referenced to the **North American Vertical Datum of 1988 (NAVD88)**. These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum**. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at http://www.ngs.noaa.gov/ or contact the National Geodetic Survey at the following address:

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, MD 20910-3282

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at (301) 713-3242 or visit its website at http://www.ngs.noaa.gov/.

Base Map information shown on this FIRM was provided in digital format by El Paso County, Colorado Springs Utilities, and Anderson Consulting Engineers, Inc. These data are current as of 2008.

This map reflects more detailed and up-to-date **stream channel configurations and floodplain delineations** than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables in the Flood Insurance Study Report (which contains authoritative hydraulic data) may reflect stream channel distances that differ from what is shown on this map. The profile baselines depicted on this map represent the hydraulic modeling baselines that match the flood profiles and Floodway Data Tables if applicable, in the FIS report. As a result, the profile baselines may deviate significantly from the new base map channel representation and may appear outside of the floodplain.

Corporate limits shown on this map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels; community map repository addresses; and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which each community is located.

Contact **FEMA Map Service Center** (MSC) via the FEMA Map Information eXchange (FMIX) 1-877-336-2627 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. The MSC may also be reached by Fax at 1-800-358-9620 and its website at http://www.msc.fema.gov/.

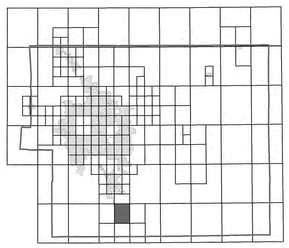
If you have **questions about this map** or questions concerning the National Flood Insurance Program in general, please call **1-877-FEMA MAP** (1-877-336-2627) or visit the FEMA website at http://www.fema.gov/business/nfip.

El Paso County Vertical Datum Offset Table

Flooding Source	Vertical Datum Offset (ft)

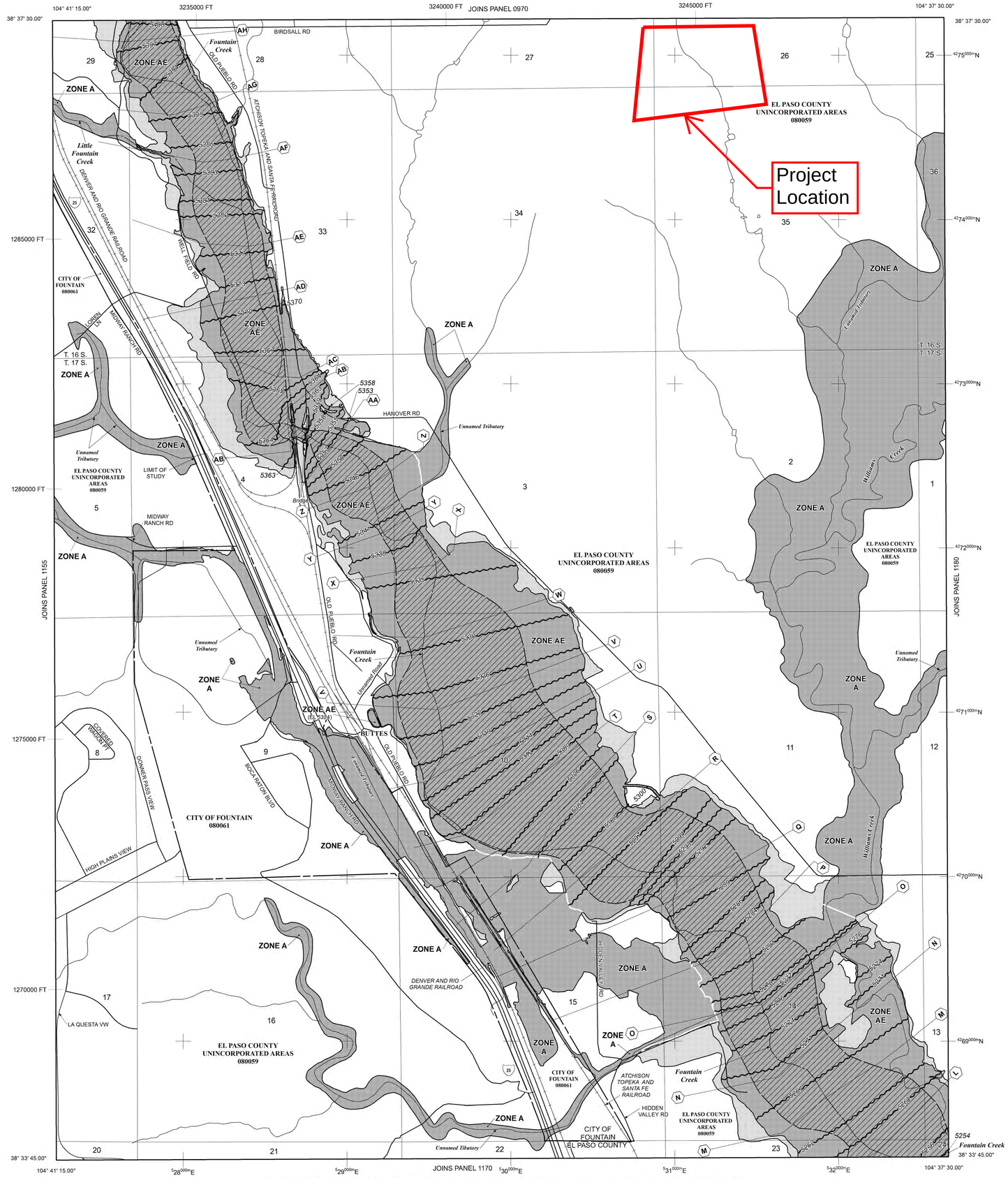
REFER TO SECTION 3.3 OF THE EL PASO COUNTY FLOOD INSURANCE STUDY FOR STREAM BY STREAM VERTICAL DATUM CONVERSION INFORMATION

Panel Location Map



This Digital Flood Insurance Rate Map (DFIRM) was produced through a Cooperating Technical Partner (CTP) agreement between the State of Colorado Water Conservation Board (CWCB) and the Federal Emergency Management Agency (FEMA).

Additional Flood Hazard information and resources are available from local communities and the Colorado Water Conservation Board.



NOTE: MAP AREA SHOWN ON THIS PANEL IS LOCATED WITHIN TOWNSHIP 16 SOUTH, RANGE 65 WEST, AND TOWNSHIP 17 SOUTH, RANGE 65 WEST.

LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHAS) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A No Base Flood Elevations determined.
ZONE AE Base Flood Elevations determined.
ZONE AH Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
ZONE AO Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
ZONE AR Special Flood Hazard Area Formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
ZONE A99 Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
ZONE V Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
ZONE VE Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X Areas determined to be outside the 0.2% annual chance floodplain.
ZONE D Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

Floodplain boundary
Floodway boundary
Zone D Boundary
CBRS and OPA boundary
Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.
513 — Base Flood Elevation line and value; elevation in feet*
(EL 987) — Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988 (NAVD 88)

A — A — Cross section line
23 — 23 — Transect line
97° 07' 30.00" / 32° 22' 30.00" — Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
4275000mN — 1000-meter Universal Transverse Mercator grid ticks, zone 13
6000000 FT — 5000-foot grid ticks: Colorado State Plane coordinate system, central zone (FIPSZONE 0502), Lambert Conformal Conic Projection
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M1.5 — River Mile

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Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE FLOOD INSURANCE RATE MAP
MARCH 17, 1997

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL
DECEMBER 7, 2018 - to update corporate limits, to change Base Flood Elevations and Special Flood Hazard Areas, to update map format, to add roads and road names, and to incorporate previously issued Letters of Map Revision.

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MAP SCALE 1" = 1000'
500 0 1000 2000 FEET
300 0 300 600 METERS

NFIP
NATIONAL FLOOD INSURANCE PROGRAM

PANEL 1160G

FIRM
FLOOD INSURANCE RATE MAP
EL PASO COUNTY, COLORADO AND INCORPORATED AREAS

PANEL 1160 OF 1300

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
EL PASO COUNTY	080059	1160	G
FOUNTAIN, CITY OF	080061	1160	G

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
08041C1160G

MAP REVISED
DECEMBER 7, 2018

Federal Emergency Management Agency

SOILS MAP

United States Department of Agriculture

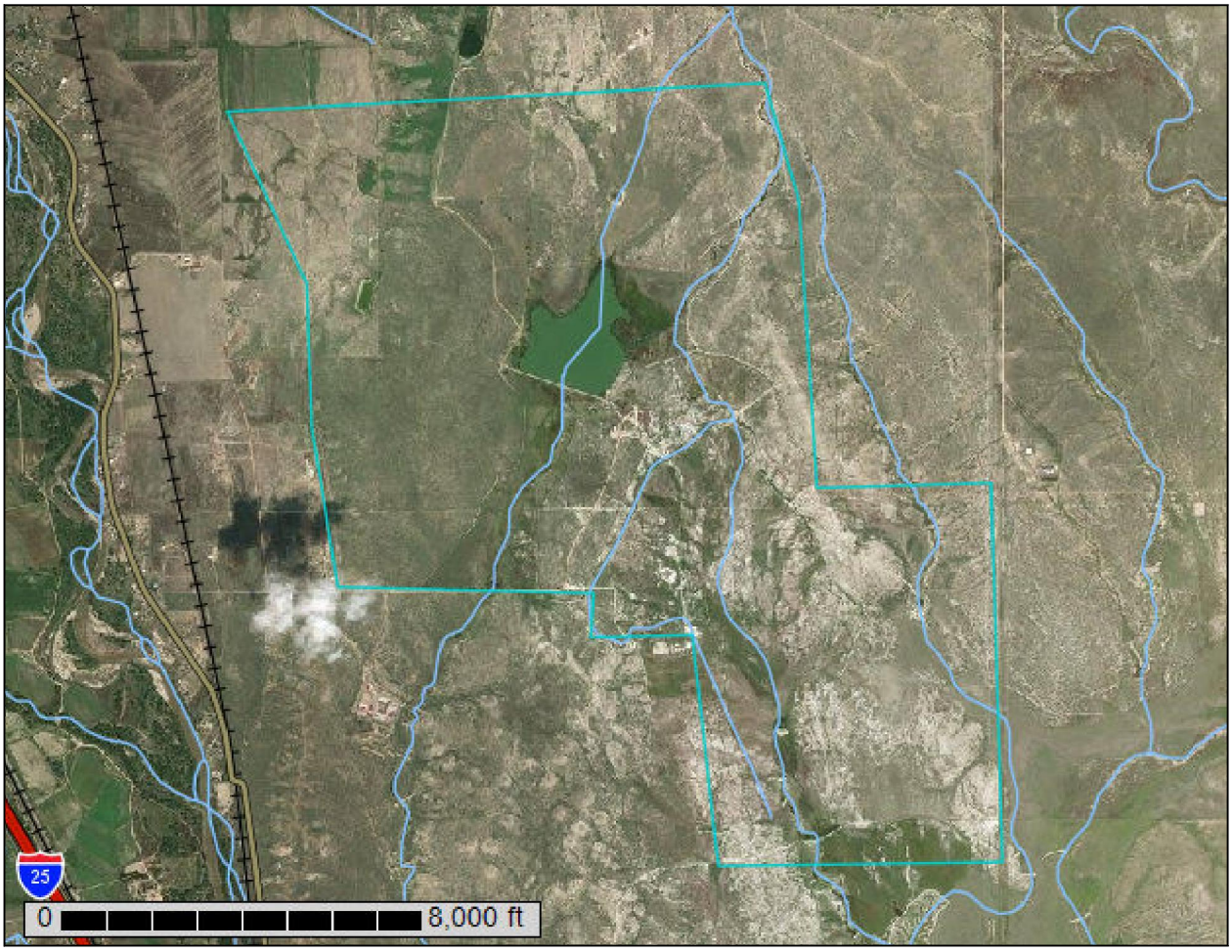
NRCS

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

Palmer Solar



June 13, 2018

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.

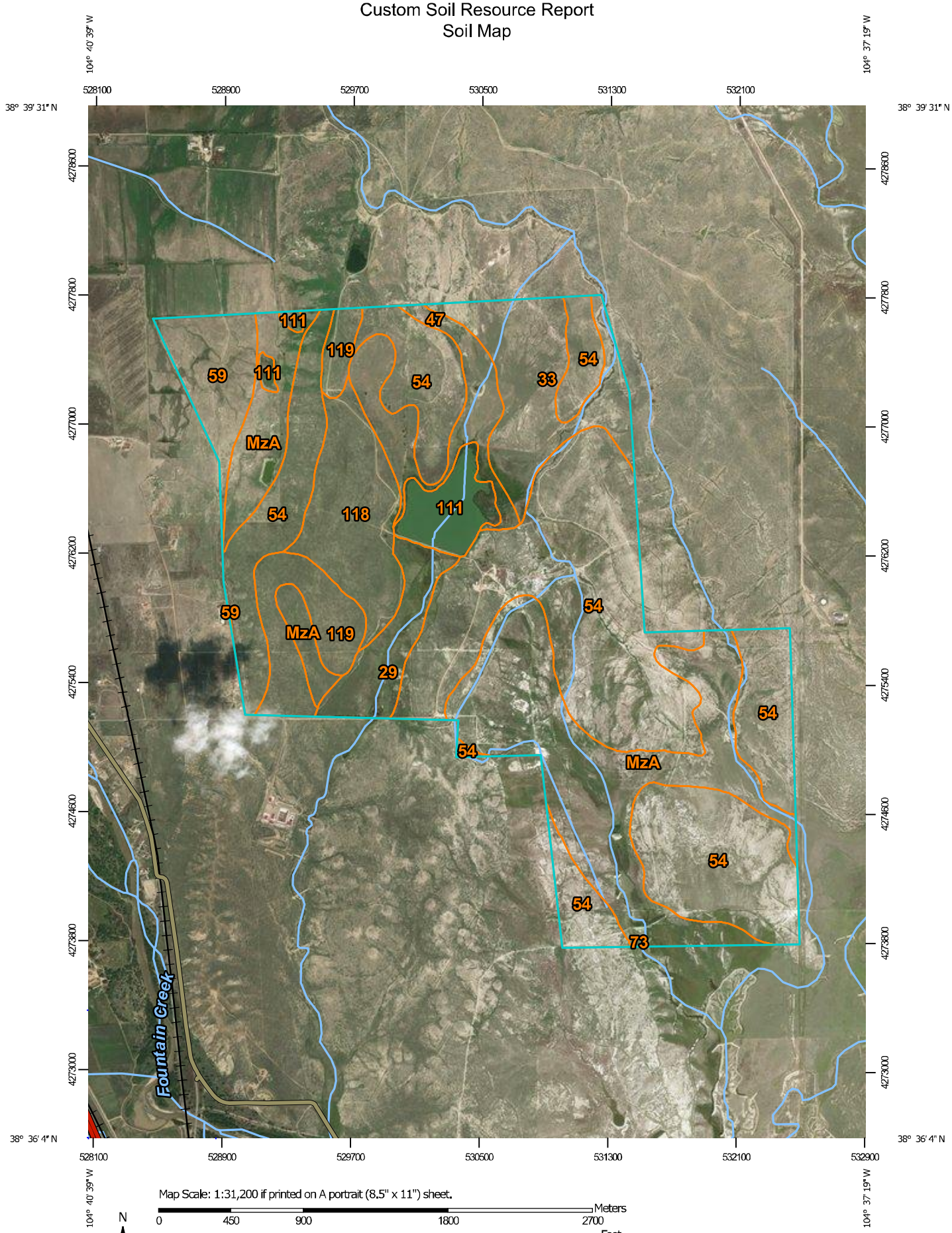
After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and

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.

Custom Soil Resource Report
Soil Map



Map Scale: 1:31,200 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0 450 900 1800 2700

Feet: 0 1500 3000 6000 9000

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.

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 15, Oct 10, 2017

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

Date(s) aerial images were photographed: Nov 7, 2015—Mar 9, 2017

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
29	Fluvaquentic Haplaquolls, nearly level	82.3	3.5%
33	Heldt clay loam, 0 to 3 percent slopes	177.2	7.5%
47	Limon clay, 0 to 3 percent slopes	111.5	4.7%
54	Midway clay loam, 3 to 25 percent slopes	1,040.4	44.2%
59	Nunn clay loam, 0 to 3 percent slopes	93.3	4.0%
73	Razor clay loam, 3 to 9 percent slopes	1.2	0.1%
111	Water	72.2	3.1%
118	Fort loam, 1 to 5 percent slopes, cool	154.8	6.6%
119	Fort sandy loam, 1 to 8 percent slopes, cool	121.6	5.2%
MzA	Manzanola silty clay loam, saline, 0 to 2 percent slopes	497.1	21.1%
Totals for Area of Interest		**2,351.5**	**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

29—Fluvaquentic Haplaquolls, nearly level

Map Unit Setting

National map unit symbol: 3681
Elevation: 5,000 to 7,800 feet
Mean annual precipitation: 13 to 15 inches
Mean annual air temperature: 46 to 52 degrees F
Frost-free period: 110 to 165 days
Farmland classification: Not prime farmland

Map Unit Composition

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

Description of Fluvaquentic Haplaquolls

Setting

Landform: Flood plains, marshes, swales
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Poorly drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 6.00 in/hr)
Depth to water table: About 0 to 24 inches
Frequency of flooding: Frequent
Frequency of ponding: None
Salinity, maximum in profile: Nonsaline to slightly saline (0.0 to 4.0 mmhos/cm)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 5w
Hydrologic Soil Group: D
Ecological site: Sandy Meadow (R067BY029CO)
Hydric soil rating: Yes

Minor Components

Haplaquolls

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

Other soils

Percent of map unit:
Hydric soil rating: No

33—Heldt clay loam, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: 3686
Elevation: 5,200 to 6,500 feet
Mean annual precipitation: 12 to 14 inches
Mean annual air temperature: 48 to 52 degrees F
Frost-free period: 135 to 155 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

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

Description of Heldt

Setting

Landform: Alluvial fans, stream terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Clayey alluvium derived from shale

Typical profile

Ap - 0 to 8 inches: clay loam
Bw - 8 to 41 inches: silty clay
Bk - 41 to 60 inches: silty clay loam

Properties and qualities

Slope: 0 to 3 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 low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 10 percent
Gypsum, maximum in profile: 4 percent
Salinity, maximum in profile: Nonsaline to slightly saline (0.0 to 4.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 10.0
Available water storage in profile: High (about 10.4 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 4c
Hydrologic Soil Group: C
Ecological site: Alkaline Plains LRU's A & B (R069XY047CO)
Other vegetative classification: ALKALINE PLAINS (069BY047CO)

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

47—Limon clay, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: 368p
Elevation: 5,200 to 6,200 feet
Mean annual precipitation: 12 to 14 inches
Mean annual air temperature: 48 to 52 degrees F
Frost-free period: 135 to 155 days
Farmland classification: Not prime farmland

Map Unit Composition

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

Description of Limon, Occasionally Flooded

Setting

Landform: Alluvial fans, flood plains
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Clayey alluvium derived from shale

Typical profile

A - 0 to 4 inches: clay
AC - 4 to 12 inches: silty clay
C - 12 to 60 inches: silty clay loam

Properties and qualities

Slope: 0 to 3 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 low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: Occasional
Frequency of ponding: None
Calcium carbonate, maximum in profile: 10 percent

Gypsum, maximum in profile: 2 percent
Salinity, maximum in profile: Very slightly saline to moderately saline (2.0 to 8.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 10.0
Available water storage in profile: High (about 9.9 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: C
Ecological site: Salt Flat LRU's A & B (R069XY033CO)
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

54—Midway clay loam, 3 to 25 percent slopes

Map Unit Setting

National map unit symbol: 368y
Elevation: 5,200 to 6,200 feet
Mean annual precipitation: 12 to 14 inches
Mean annual air temperature: 48 to 52 degrees F
Frost-free period: 135 to 155 days
Farmland classification: Not prime farmland

Map Unit Composition

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

Description of Midway

Setting

Landform: Hills
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Slope alluvium over residuum weathered from shale

Typical profile

A - 0 to 4 inches: clay loam
C - 4 to 13 inches: clay
Cr - 13 to 17 inches: weathered bedrock

Properties and qualities

Slope: 3 to 25 percent
Depth to restrictive feature: 6 to 20 inches to paralithic bedrock
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 15 percent
Gypsum, maximum in profile: 15 percent
Salinity, maximum in profile: Very slightly saline to moderately saline (2.0 to 8.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 15.0
Available water storage in profile: Very low (about 2.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: D
Ecological site: Shaly Plains LRU's A & B (R069XY046CO)
Other vegetative classification: SHALY PLAINS (069AY046CO)
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

59—Nunn clay loam, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: 3693
Elevation: 5,400 to 6,500 feet
Mean annual precipitation: 13 to 15 inches
Mean annual air temperature: 46 to 50 degrees F
Frost-free period: 135 to 155 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

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

Description of Nunn

Setting

Landform: Terraces, fans
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Mixed alluvium

Typical profile

A - 0 to 12 inches: clay loam
Bt - 12 to 26 inches: clay loam
BC - 26 to 30 inches: clay loam
Bk - 30 to 58 inches: sandy clay loam
C - 58 to 72 inches: clay

Properties and qualities

Slope: 0 to 3 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 low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 15 percent
Gypsum, maximum in profile: 2 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: High (about 9.8 inches)

Interpretive groups

Land capability classification (irrigated): 2e
Land capability classification (nonirrigated): 3c
Hydrologic Soil Group: C
Ecological site: Clayey Plains LRU's A & B (R069XY042CO)
Other vegetative classification: CLAYEY PLAINS (069AY042CO)
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

73—Razor clay loam, 3 to 9 percent slopes

Map Unit Setting

National map unit symbol: 369m
Elevation: 5,300 to 6,100 feet
Mean annual precipitation: 12 to 14 inches
Mean annual air temperature: 48 to 52 degrees F
Frost-free period: 135 to 155 days
Farmland classification: Not prime farmland

Map Unit Composition

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

Description of Razor

Setting

Landform: Hills
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Clayey slope alluvium over residuum weathered from shale

Typical profile

A - 0 to 3 inches: clay loam
Bw - 3 to 9 inches: clay loam
Bk - 9 to 31 inches: clay
Cr - 31 to 35 inches: weathered bedrock

Properties and qualities

Slope: 3 to 9 percent
Depth to restrictive feature: 20 to 40 inches to paralithic bedrock
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 15 percent
Gypsum, maximum in profile: 5 percent
Salinity, maximum in profile: Moderately saline to strongly saline (8.0 to 16.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 15.0
Available water storage in profile: Low (about 5.5 inches)

Interpretive groups

Land capability classification (irrigated): 6e
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: D

Ecological site: Alkaline Plains LRU's A & B (R069XY047CO)
Other vegetative classification: ALKALINE PLAINS (069AY047CO)
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

111—Water

Map Unit Composition
Water: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

118—Fort loam, 1 to 5 percent slopes, cool

Map Unit Setting
National map unit symbol: 2rgqs
Elevation: 5,500 to 6,500 feet
Mean annual precipitation: 12 to 14 inches
Mean annual air temperature: 48 to 54 degrees F
Frost-free period: 125 to 160 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition
Fort and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Fort

Setting
Landform: Interfluves, fans
Landform position (two-dimensional): Backslope, footslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Linear
Parent material: Loamy alluvium and/or eolian deposits

Typical profile
A - 0 to 4 inches: loam
Bt - 4 to 12 inches: clay loam

Btk - 12 to 33 inches: clay loam
Bk1 - 33 to 47 inches: loam
Bk2 - 47 to 79 inches: sandy loam

Properties and qualities

Slope: 1 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
Calcium carbonate, maximum in profile: 25 percent
Gypsum, maximum in profile: 2 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.5 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 3.0
Available water storage in profile: Moderate (about 8.5 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 4c
Hydrologic Soil Group: C
Ecological site: Loamy Plains, LRU's A & B 10-14 Inches, P.Z. (R069XY006CO)
Forage suitability group: Loamy (G069XW017CO)
Other vegetative classification: Loamy Plains #6 (069XY006CO_2)
Hydric soil rating: No

Minor Components

Wilid

Percent of map unit: 10 percent
Landform: Interfluves
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: Loamy Plains, LRU's A & B 10-14 Inches, P.Z. (R069XY006CO)
Other vegetative classification: Loamy Plains #6 (069XY006CO_2)
Hydric soil rating: No

Oterodry

Percent of map unit: 5 percent
Landform: Hillslopes
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Linear
Ecological site: Sandy Plains LRU's A & B (R069XY026CO)
Hydric soil rating: No

119—Fort sandy loam, 1 to 8 percent slopes, cool

Map Unit Setting

National map unit symbol: 2t50n
Elevation: 4,500 to 6,000 feet
Mean annual precipitation: 12 to 14 inches
Mean annual air temperature: 48 to 54 degrees F
Frost-free period: 125 to 170 days
Farmland classification: Not prime farmland

Map Unit Composition

Fort, cool, and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Fort, Cool

Setting

Landform: Hills, interfluves
Landform position (two-dimensional): Footslope, backslope
Landform position (three-dimensional): Side slope, head slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium and/or eolian deposits

Typical profile

A - 0 to 5 inches: sandy loam
Bt - 5 to 13 inches: clay loam
Btk - 13 to 28 inches: clay loam
Bk1 - 28 to 36 inches: loam
Bk2 - 36 to 79 inches: sandy loam

Properties and qualities

Slope: 1 to 8 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 25 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.1 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 2.0
Available water storage in profile: Moderate (about 8.2 inches)

Interpretive groups

Land capability classification (irrigated): 4e
Land capability classification (nonirrigated): 6e

Hydrologic Soil Group: B
Ecological site: Sandy Plains LRU's A & B (R069XY026CO)
Forage suitability group: Loamy (G069XW017CO)
Other vegetative classification: Sandy Plains #26 (069XY026CO_2)
Hydric soil rating: No

Minor Components

Wilid

Percent of map unit: 5 percent
Landform: Interfluves
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: Loamy Plains, LRU's A & B 10-14 Inches, P.Z. (R069XY006CO)
Other vegetative classification: Loamy Plains #6 (069XY006CO_2)
Hydric soil rating: No

Vonid

Percent of map unit: 5 percent
Landform: Ridges, hills
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex, linear
Across-slope shape: Convex
Ecological site: Sandy Plains LRU's A & B (R069XY026CO)
Hydric soil rating: No

Kimera

Percent of map unit: 5 percent
Landform: Interfluves, fan remnants
Landform position (two-dimensional): Shoulder, backslope
Landform position (three-dimensional): Interfluve, side slope
Down-slope shape: Convex, linear
Across-slope shape: Linear
Ecological site: Loamy Plains, LRU's A & B 10-14 Inches, P.Z. (R069XY006CO)
Hydric soil rating: No

MzA—Manzanola silty clay loam, saline, 0 to 2 percent slopes

Map Unit Setting

National map unit symbol: 2rgrg
Elevation: 3,900 to 6,000 feet
Mean annual precipitation: 12 to 14 inches
Mean annual air temperature: 48 to 54 degrees F
Frost-free period: 130 to 170 days
Farmland classification: Not prime farmland

Map Unit Composition

Manzanola and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Manzanola

Setting

Landform: Fan remnants, interfluves, terraces, drainageways
Landform position (two-dimensional): Footslope, summit
Landform position (three-dimensional): Side slope, tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from shale

Typical profile

A - 0 to 4 inches: silty clay loam
Bt1 - 4 to 11 inches: silty clay loam
Bt2 - 11 to 26 inches: silty clay loam
Bk1 - 26 to 38 inches: silty clay loam
Bk2 - 38 to 79 inches: silty clay loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 14 percent
Gypsum, maximum in profile: 3 percent
Salinity, maximum in profile: Moderately saline (8.0 to 15.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 13.0
Available water storage in profile: Very high (about 12.1 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 4c
Hydrologic Soil Group: C
Ecological site: Saline Overflow LRU's A & B (R069XY037CO)
Other vegetative classification: Saline Overflow (069XY037CO_1)
Hydric soil rating: No

Minor Components

Aguilar

Percent of map unit: 5 percent
Landform: Fan remnants
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: Salt Flat LRU's A & B (R069XY033CO)
Other vegetative classification: Salt Flat #33 (069AY033CO_2)

Hydric soil rating: No

Haversid

Percent of map unit: 5 percent
Landform: Terraces, drainageways
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: Saline Overflow LRU's A & B (R069XY037CO)
Hydric soil rating: No

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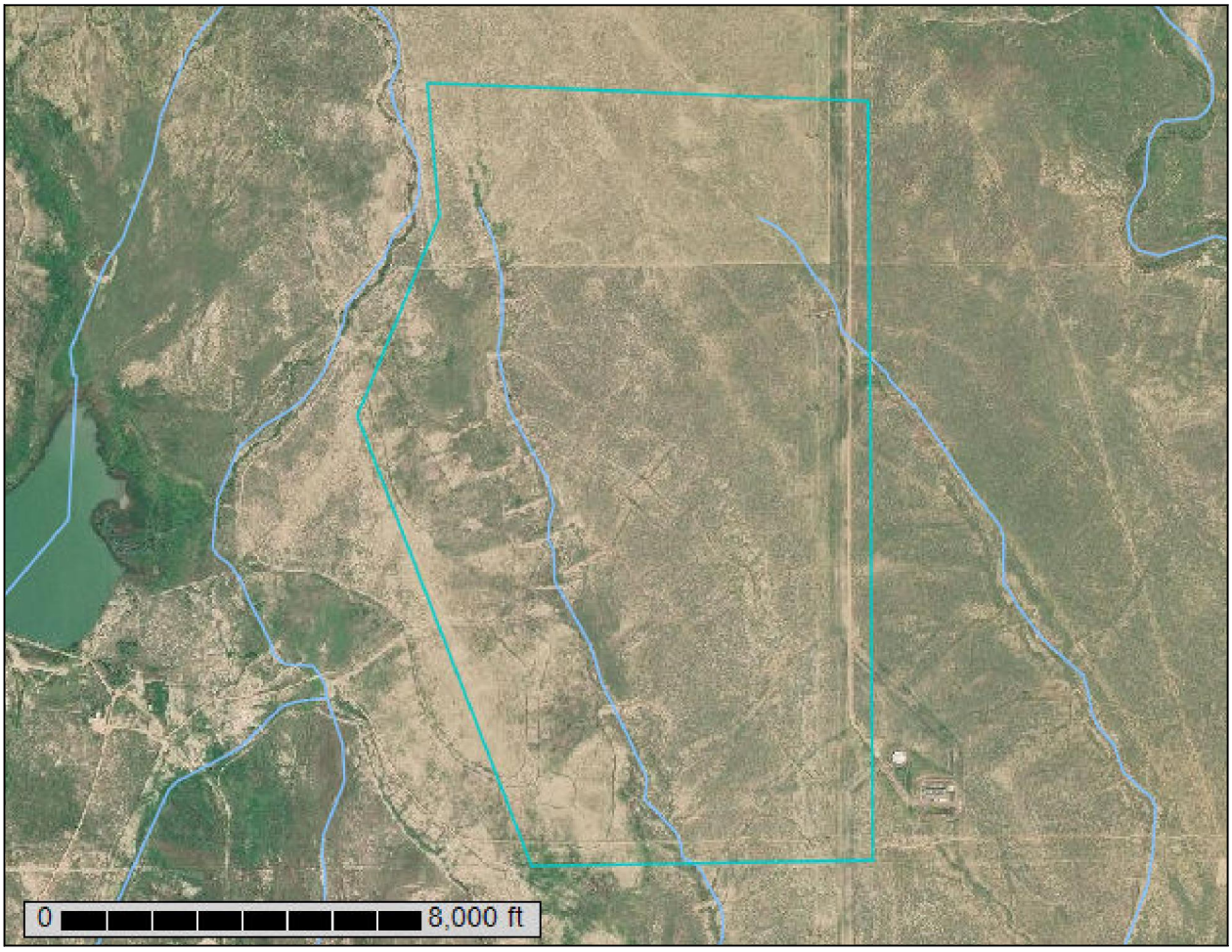
United States Department of Agriculture

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



October 31, 2018

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.

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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.

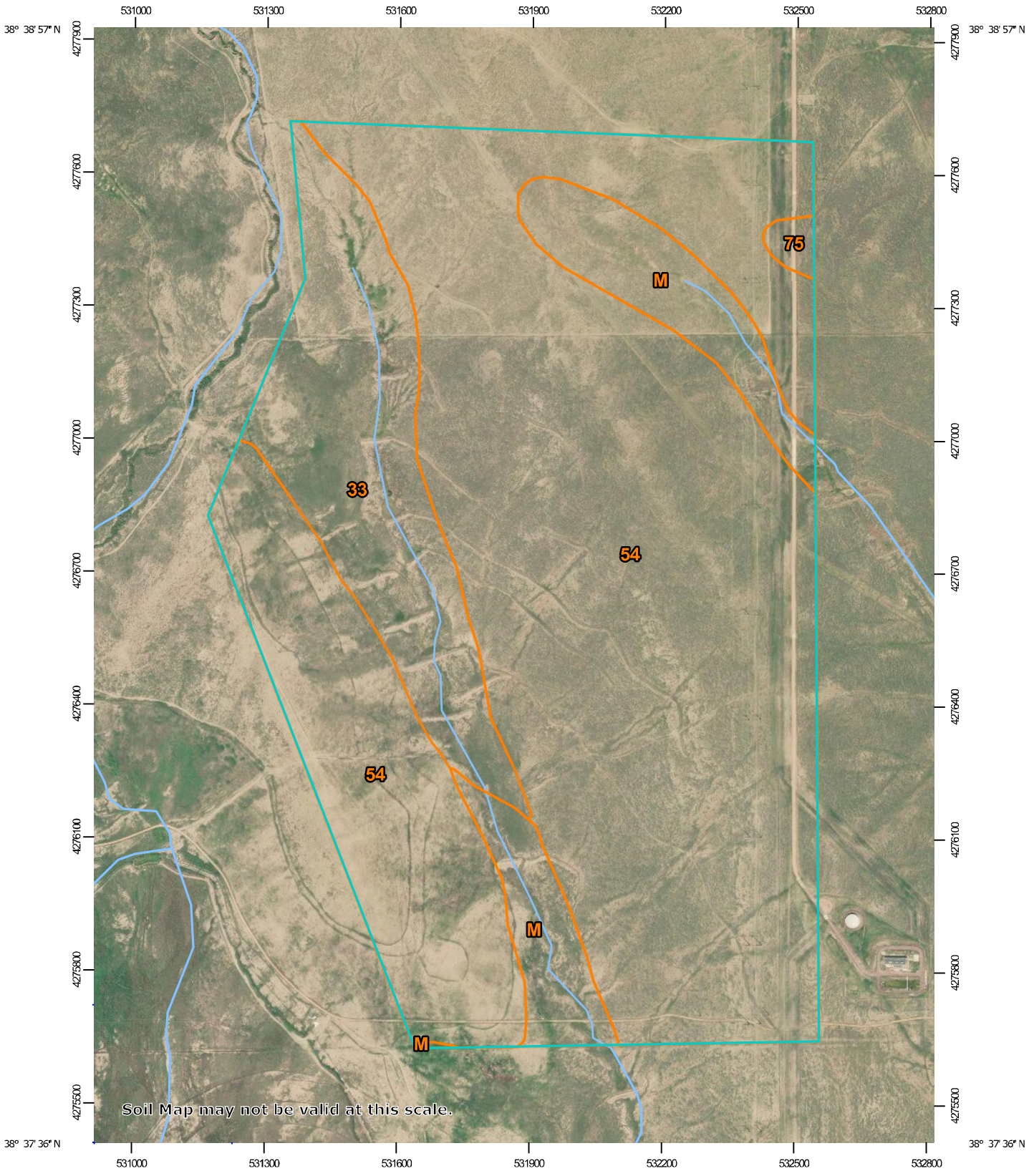
After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and

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.

Custom Soil Resource Report
Soil Map



Map Scale: 1:12,300 if printed on A portrait (8.5" x 11") sheet.

N

Meters
0 150 300 600 900

Feet
0 500 1000 2000 3000

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 16, Sep 10, 2018

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

Date(s) aerial images were photographed: Apr 12, 2017—Nov 17, 2017

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
33	Heldt clay loam, 0 to 3 percent slopes	88.7	14.7%
54	Midway clay loam, 3 to 25 percent slopes	459.0	76.1%
75	Razor-Midway complex	2.9	0.5%
MzA	Manzanola silty clay loam, saline, 0 to 2 percent slopes	52.5	8.7%
Totals for Area of Interest		**603.2**	**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

33—Heldt clay loam, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: 3686
Elevation: 5,200 to 6,500 feet
Mean annual precipitation: 12 to 14 inches
Mean annual air temperature: 48 to 52 degrees F
Frost-free period: 135 to 155 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

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

Description of Heldt

Setting

Landform: Alluvial fans, stream terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Clayey alluvium derived from shale

Typical profile

Ap - 0 to 8 inches: clay loam
Bw - 8 to 41 inches: silty clay
Bk - 41 to 60 inches: silty clay loam

Properties and qualities

Slope: 0 to 3 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 low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 10 percent
Gypsum, maximum in profile: 4 percent
Salinity, maximum in profile: Nonsaline to slightly saline (0.0 to 4.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 10.0
Available water storage in profile: High (about 10.4 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 4c
Hydrologic Soil Group: C
Ecological site: Alkaline Plains LRU's A & B (R069XY047CO)
Other vegetative classification: ALKALINE PLAINS (069BY047CO)
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

54—Midway clay loam, 3 to 25 percent slopes

Map Unit Setting

National map unit symbol: 368y
Elevation: 5,200 to 6,200 feet
Mean annual precipitation: 12 to 14 inches
Mean annual air temperature: 48 to 52 degrees F
Frost-free period: 135 to 155 days
Farmland classification: Not prime farmland

Map Unit Composition

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

Description of Midway

Setting

Landform: Hills
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Slope alluvium over residuum weathered from shale

Typical profile

A - 0 to 4 inches: clay loam
C - 4 to 13 inches: clay
Cr - 13 to 17 inches: weathered bedrock

Properties and qualities

Slope: 3 to 25 percent
Depth to restrictive feature: 6 to 20 inches to paralithic bedrock
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 15 percent

Gypsum, maximum in profile: 15 percent
Salinity, maximum in profile: Very slightly saline to moderately saline (2.0 to 8.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 15.0
Available water storage in profile: Very low (about 2.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: D
Ecological site: Shaly Plains LRU's A & B (R069XY046CO)
Other vegetative classification: SHALY PLAINS (069AY046CO)
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

75—Razor-Midway complex

Map Unit Setting

National map unit symbol: 369p
Elevation: 5,300 to 6,100 feet
Mean annual precipitation: 12 to 14 inches
Mean annual air temperature: 48 to 52 degrees F
Frost-free period: 135 to 155 days
Farmland classification: Not prime farmland

Map Unit Composition

Razor and similar soils: 50 percent
Midway and similar soils: 30 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Razor

Setting

Landform: Hills
Landform position (three-dimensional): Side slope
Down-slope shape: Concave, linear
Across-slope shape: Linear
Parent material: Clayey slope alluvium over residuum weathered from shale

Typical profile

A - 0 to 4 inches: stony clay loam

Bw - 4 to 22 inches: cobbly clay loam
Bk - 22 to 29 inches: cobbly clay
Cr - 29 to 33 inches: weathered bedrock

Properties and qualities

Slope: 3 to 15 percent
Depth to restrictive feature: 20 to 40 inches to paralithic bedrock
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 15 percent
Gypsum, maximum in profile: 5 percent
Salinity, maximum in profile: Moderately saline to strongly saline (8.0 to 16.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 15.0
Available water storage in profile: Low (about 4.7 inches)

Interpretive groups

Land capability classification (irrigated): 6e
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: D
Ecological site: Alkaline Plains LRU's A & B (R069XY047CO)
Other vegetative classification: ALKALINE PLAINS (069AY047CO)
Hydric soil rating: No

Description of Midway

Setting

Landform: Hills
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Slope alluvium over residuum weathered from shale

Typical profile

A - 0 to 4 inches: clay loam
C - 4 to 13 inches: clay
Cr - 13 to 17 inches: weathered bedrock

Properties and qualities

Slope: 3 to 25 percent
Depth to restrictive feature: 6 to 20 inches to paralithic bedrock
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 15 percent
Gypsum, maximum in profile: 15 percent
Salinity, maximum in profile: Very slightly saline to moderately saline (2.0 to 8.0 mmhos/cm)

Sodium adsorption ratio, maximum in profile: 15.0
Available water storage in profile: Very low (about 2.2 inches)

Interpretive groups
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: D
Ecological site: Shaly Plains LRU's A & B (R069XY046CO)
Other vegetative classification: SHALY PLAINS (069AY045CO)
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

MzA—Manzanola silty clay loam, saline, 0 to 2 percent slopes

Map Unit Setting
National map unit symbol: 2rgrg
Elevation: 3,900 to 6,000 feet
Mean annual precipitation: 12 to 14 inches
Mean annual air temperature: 48 to 54 degrees F
Frost-free period: 130 to 170 days
Farmland classification: Not prime farmland

Map Unit Composition
Manzanola and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Manzanola

Setting
Landform: Terraces, drainageways, fan remnants, interfluves
Landform position (two-dimensional): Footslope, summit
Landform position (three-dimensional): Side slope, tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from shale

Typical profile
A - 0 to 4 inches: silty clay loam
Bt1 - 4 to 11 inches: silty clay loam

Bt2 - 11 to 26 inches: silty clay loam
Bk1 - 26 to 38 inches: silty clay loam
Bk2 - 38 to 79 inches: silty clay loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 14 percent
Gypsum, maximum in profile: 3 percent
Salinity, maximum in profile: Moderately saline (8.0 to 15.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 13.0
Available water storage in profile: Very high (about 12.1 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 4c
Hydrologic Soil Group: C
Ecological site: Saline Overflow LRU's A & B (R069XY037CO)
Other vegetative classification: Saline Overflow (069XY037CO_1)
Hydric soil rating: No

Minor Components

Haversid

Percent of map unit: 5 percent
Landform: Drainageways, terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: Saline Overflow LRU's A & B (R069XY037CO)
Hydric soil rating: No

Aguilar

Percent of map unit: 5 percent
Landform: Fan remnants
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: Salt Flat LRU's A & B (R069XY033CO)
Other vegetative classification: Salt Flat #33 (069AY033CO_2)
Hydric soil rating: No

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EXISTING HYDROLOGIC CALCULATIONS

Weighted Curve Number-Existing Conditions

SUB-BASIN	AREA (SF)	AREA (Acres)	PASTURE AREA (AC)	HSG C PERCENTAGE	HSG D PERCENTAGE	HSG C AREA	HSG D AREA	NEWLY GRADED AREA	HSG C PERCENTAGE	HSG D PERCENTAGE	HSG C AREA	HSG D AREA	GRAVEL ROAD AREA	HSG C PERCENTAGE	HSG D PERCENTAGE	HSG C AREA	HSG D AREA	WEIGHTED CN
W1	3,850,776	88.40	88	20%	80%	17.68	70.72	0	20%	80%	0.00	0.00	0	20%	80%	0.00	0.00	67
W2	6,606,512	151.66	152	20%	80%	30.33	121.33	0	20%	80%	0.00	0.00	0	20%	80%	0.00	0.00	67
W3	3,975,782	91.27	91	20%	80%	18.25	73.02	0	20%	80%	0.00	0.00	0	20%	80%	0.00	0.00	67
W4	13,234,172	303.81	304	20%	80%	60.76	243.05	0	20%	80%	0.00	0.00	0	20%	80%	0.00	0.00	67
E1	33,810,096	776.17	776	20%	80%	155.23	620.94	0	20%	80%	0.00	0.00	0	20%	80%	0.00	0.00	67
E2	1,060,550	24.35	24	20%	80%	4.87	19.48	0	20%	80%	0.00	0.00	0	20%	80%	0.00	0.00	67
E3	3,956,372	90.83	91	20%	80%	18.17	72.66	0	20%	80%	0.00	0.00	0	20%	80%	0.00	0.00	67
TOTAL	62,643,484	1438.10	1,438	20%	80%	287.62	1150.48	0	20%	80%	0.00	0.00	0	20%	80%	0.00	0.00	67

Curve Numbers	Pre Devlopement (ARC I)		Post Devlopement (ARC II)	
	HSG C	HSG D	HSG C	HSG D
Pasture, grassland, rande -FAIR	61	69	-	-
Newly Graded Area (Pervious, no vegeation)			91	94
Gravel Streets			89	91

Curve Numbers are based on on Table 6-9 and Table 6-10 of the Colorado Springs DCM

Existing Runoff							
BASIN	BASIN AREA (ACRES)	DIRECT 5-YR RUNOFF (CFS)	DIRECT 10-YR RUNOFF (CFS)	DIRECT 25-YR RUNOFF (CFS)	DIRECT 100-YR RUNOFF (CFS)	Time of Concentration (min)	Notes
W1	88.40	23.37	41.68	58.88	107.98	32.10	
W2	151.66	25.17	44.52	62.79	115.88	62.00	
W3	91.27	45.72	80.19	110.79	196.20	10.60	
W4	303.81	129.49	228.69	317.03	563.91	15.40	
E1	776.17	115.86	203.95	287.26	530.57	74.30	
E2	24.35	5.99	10.67	15.07	27.66	34.00	
E3	90.83	24.02	42.82	60.50	110.95	32.60	
TOTAL	1526.50	369.62	652.52	912.32	1653.15		

Hydrograph Report

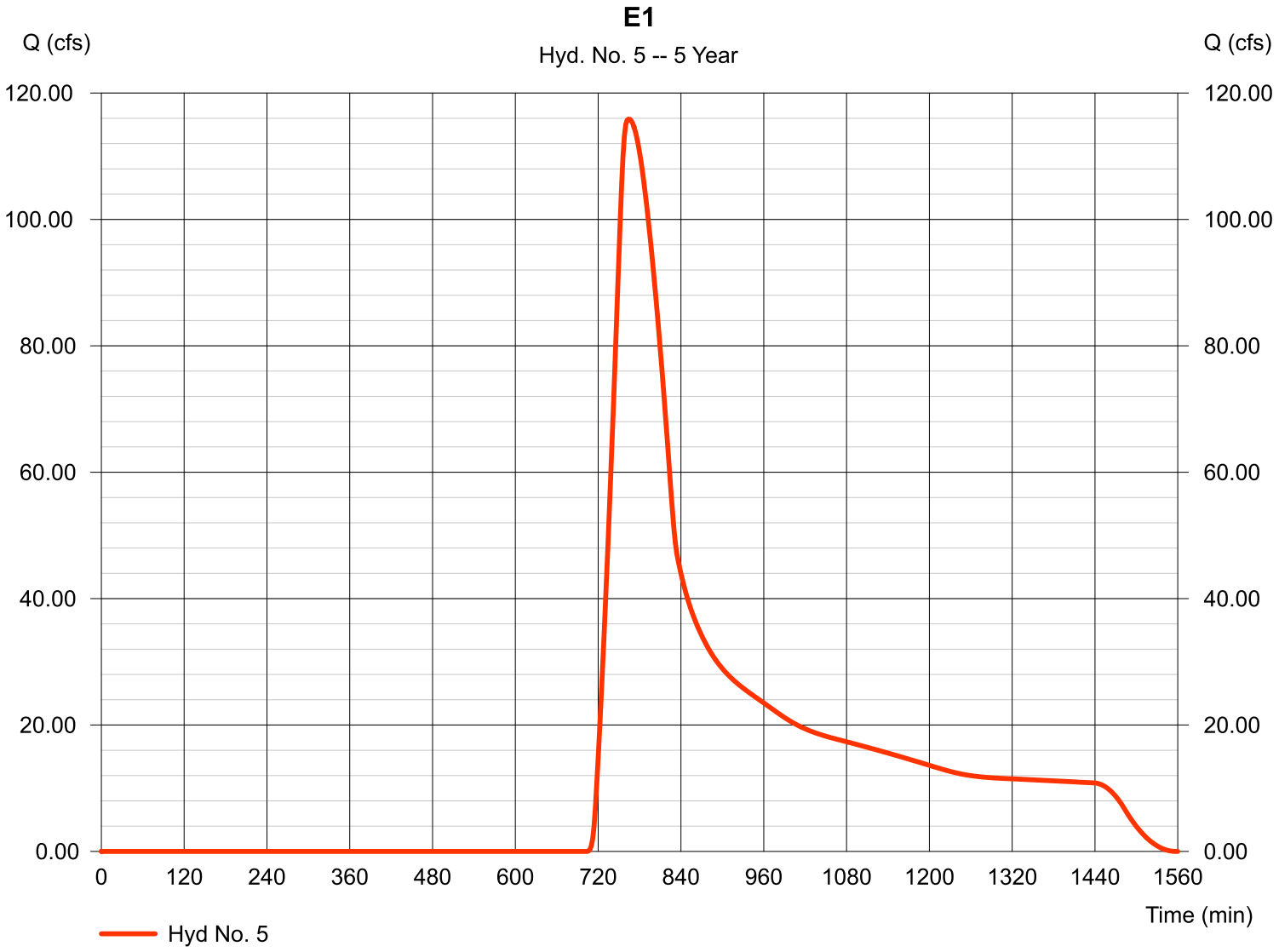
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Thursday, 01 / 17 / 2019

Hyd. No. 5

E1

Hydrograph type	=	SCS Runoff	Peak discharge	=	115.86 cfs
Storm frequency	=	5 yrs	Time to peak	=	764 min
Time interval	=	2 min	Hyd. volume	=	1,254,490 cuft
Drainage area	=	776.170 ac	Curve number	=	67*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	74.30 min
Total precip.	=	2.70 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(155.230 x 61) + (620.940 x 69)] / 776.170



TR55 Tc Worksheet

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

Hyd. No. 5

E1

Description	A		B		C		Totals
Sheet Flow							
Manning's n-value	= 0.130		0.011		0.011		
Flow length (ft)	= 300.0		0.0		0.0		
Two-year 24-hr precip. (in)	= 2.10		0.00		0.00		
Land slope (%)	= 2.10		0.00		0.00		
Travel Time (min)	**= 25.47**	**+**	**0.00**	**+**	**0.00**	**=**	**25.47**
Shallow Concentrated Flow							
Flow length (ft)	= 6410.00		0.00		0.00		
Watercourse slope (%)	= 2.10		0.00		0.00		
Surface description	= Unpaved		Paved		Paved		
Average velocity (ft/s)	=2.34		0.00		0.00		
Travel Time (min)	**= 45.69**	**+**	**0.00**	**+**	**0.00**	**=**	**45.69**
Channel Flow							
X sectional flow area (sqft)	= 1440.00		0.00		0.00		
Wetted perimeter (ft)	= 117.00		0.00		0.00		
Channel slope (%)	= 1.80		0.00		0.00		
Manning's n-value	= 0.030		0.015		0.015		
Velocity (ft/s)	=35.82						
			0.00				
					0.00		
Flow length (ft)	({0})6640.0		0.0		0.0		
Travel Time (min)	**= 3.09**	**+**	**0.00**	**+**	**0.00**	**=**	**3.09**

Total Travel Time, Tc ..... 74.30 min

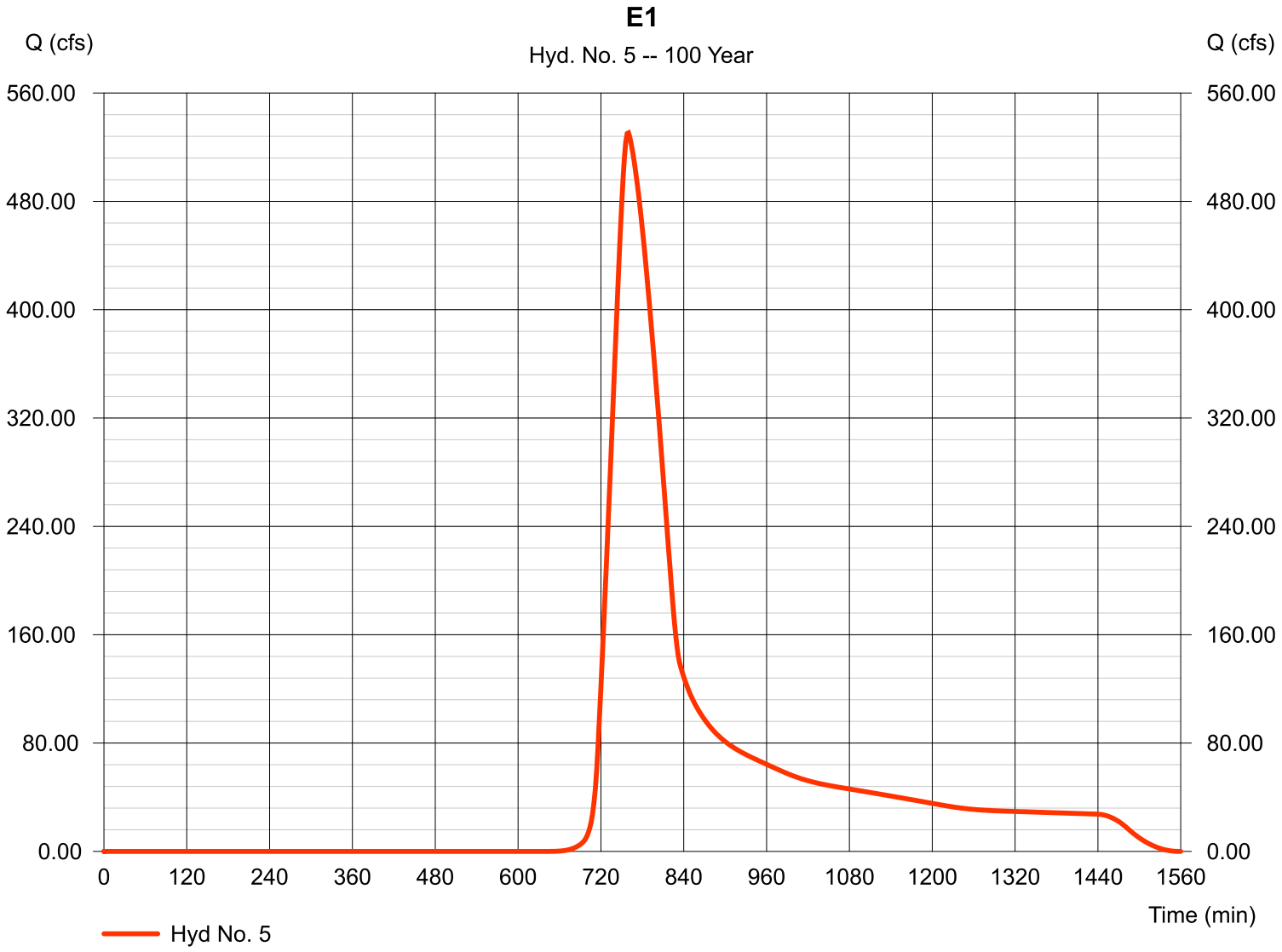
Hydrograph Report

Hyd. No. 5

E1

Hydrograph type	=	SCS Runoff	Peak discharge	=	530.57 cfs
Storm frequency	=	100 yrs	Time to peak	=	760 min
Time interval	=	2 min	Hyd. volume	=	4,335,597 cuft
Drainage area	=	776.170 ac	Curve number	=	67*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	74.30 min
Total precip.	=	4.60 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(155.230 x 61) + (620.940 x 69)] / 776.170



Hydrograph Report

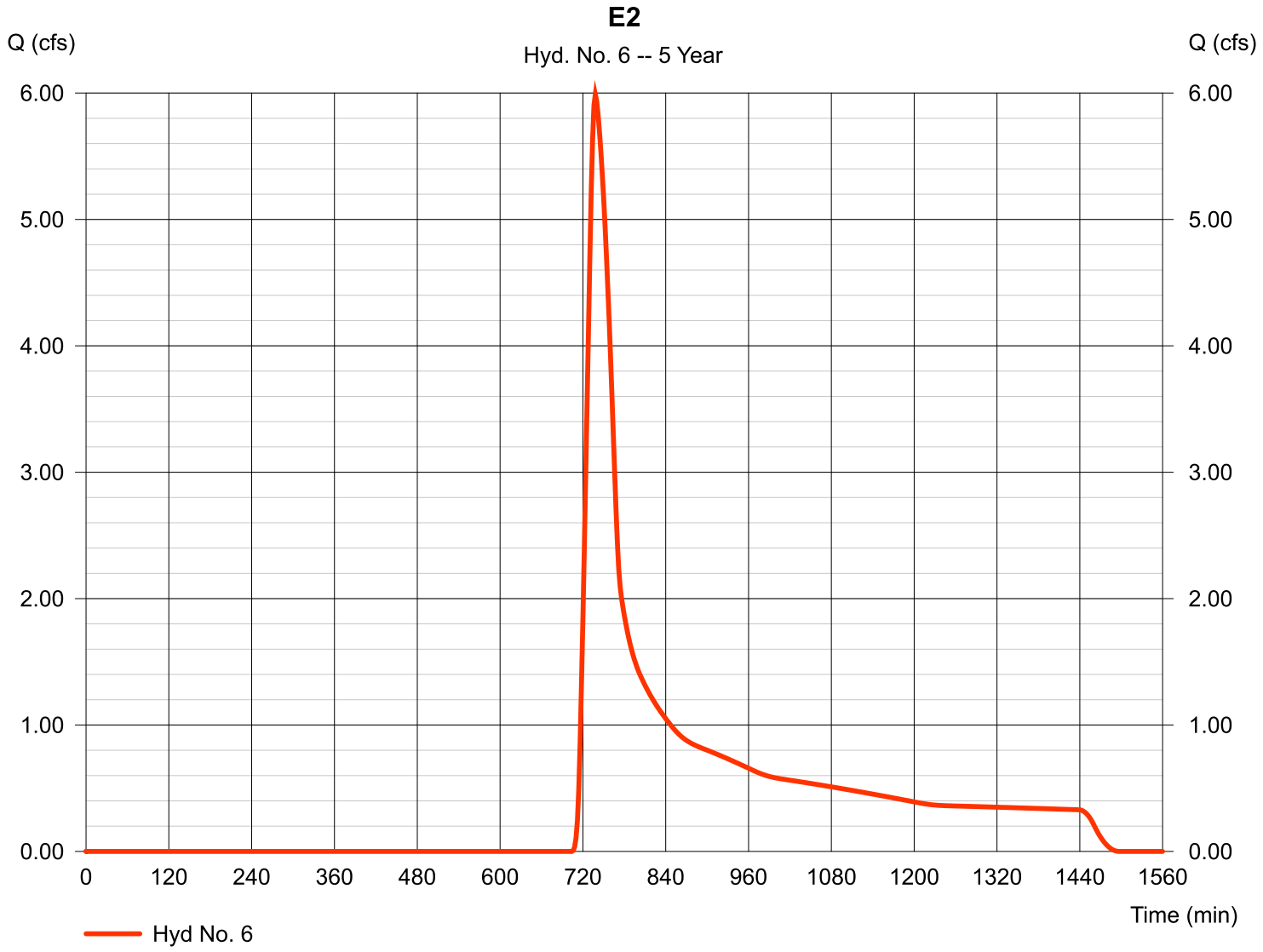
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Tuesday, 12 / 18 / 2018

Hyd. No. 6

E2

Hydrograph type	=	SCS Runoff	Peak discharge	=	5.989 cfs
Storm frequency	=	5 yrs	Time to peak	=	738 min
Time interval	=	2 min	Hyd. volume	=	38,689 cuft
Drainage area	=	24.350 ac	Curve number	=	67*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	34.00 min
Total precip.	=	2.70 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(4.870 x 61) + (19.480 x 69)] / 24.350



TR55 Tc Worksheet

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

Hyd. No. 6

E2

Description	A		B		C		Totals
Sheet Flow							
Manning's n-value	= 0.130		0.011		0.011		
Flow length (ft)	= 300.0		0.0		0.0		
Two-year 24-hr precip. (in)	= 2.10		0.00		0.00		
Land slope (%)	= 1.50		0.00		0.00		
Travel Time (min)	**= 29.14**	**+**	**0.00**	**+**	**0.00**	**=**	**29.14**
Shallow Concentrated Flow							
Flow length (ft)	= 570.00		0.00		0.00		
Watercourse slope (%)	= 1.50		0.00		0.00		
Surface description	= Unpaved		Paved		Paved		
Average velocity (ft/s)	=1.98		0.00		0.00		
Travel Time (min)	**= 4.81**	**+**	**0.00**	**+**	**0.00**	**=**	**4.81**
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 ..... 34.00 min

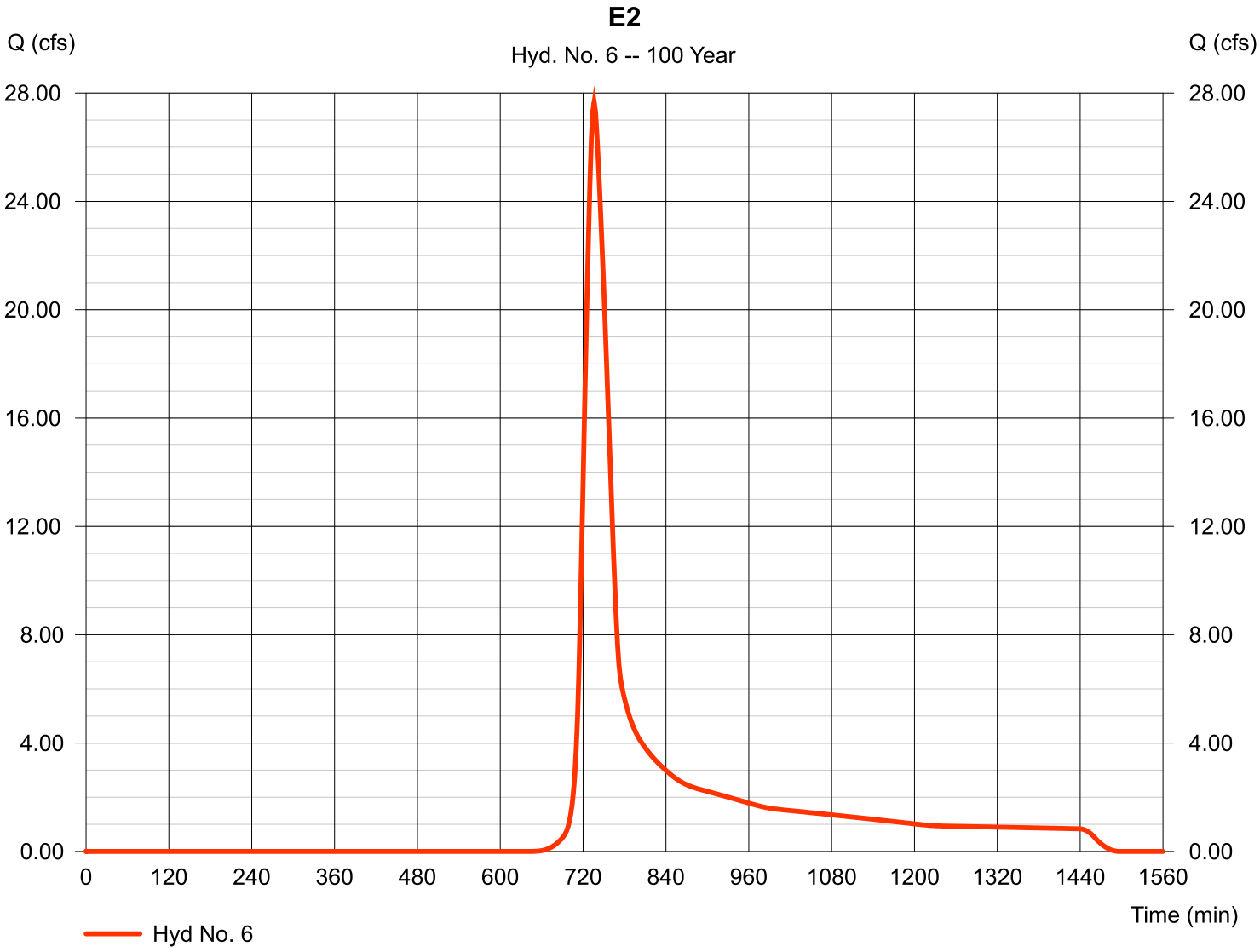
Hydrograph Report

Hyd. No. 6

E2

Hydrograph type	=	SCS Runoff	Peak discharge	=	27.66 cfs
Storm frequency	=	100 yrs	Time to peak	=	736 min
Time interval	=	2 min	Hyd. volume	=	133,711 cuft
Drainage area	=	24.350 ac	Curve number	=	67*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	34.00 min
Total precip.	=	4.60 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(4.870 x 61) + (19.480 x 69)] / 24.350



Hydrograph Report

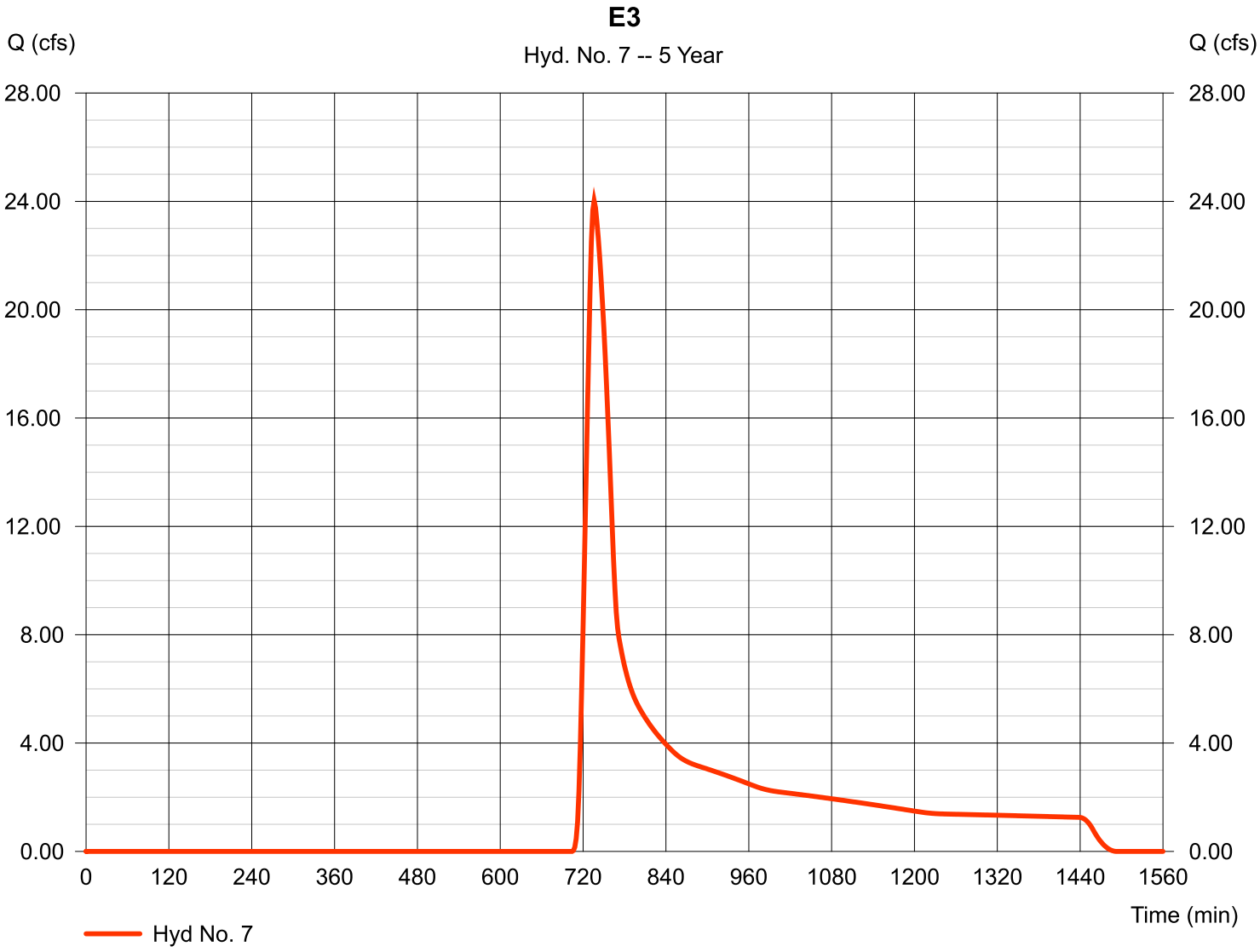
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Tuesday, 12 / 18 / 2018

Hyd. No. 7

E3

Hydrograph type	=	SCS Runoff	Peak discharge	=	24.02 cfs
Storm frequency	=	5 yrs	Time to peak	=	736 min
Time interval	=	2 min	Hyd. volume	=	147,800 cuft
Drainage area	=	90.830 ac	Curve number	=	67*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	32.60 min
Total precip.	=	2.70 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(18.170 x 61) + (72.660 x 69)] / 90.830



TR55 Tc Worksheet

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

Hyd. No. 7

E3

Description	A		B		C		Totals
Sheet Flow							
Manning's n-value	= 0.130		0.011		0.011		
Flow length (ft)	= 300.0		0.0		0.0		
Two-year 24-hr precip. (in)	= 2.10		0.00		0.00		
Land slope (%)	= 2.50		0.00		0.00		
Travel Time (min)	**= 23.76**	**+**	**0.00**	**+**	**0.00**	**=**	**23.76**
Shallow Concentrated Flow							
Flow length (ft)	= 1350.00		0.00		0.00		
Watercourse slope (%)	= 2.50		0.00		0.00		
Surface description	= Unpaved		Paved		Paved		
Average velocity (ft/s)	=2.55		0.00		0.00		
Travel Time (min)	**= 8.82**	**+**	**0.00**	**+**	**0.00**	**=**	**8.82**
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 ..... 32.60 min

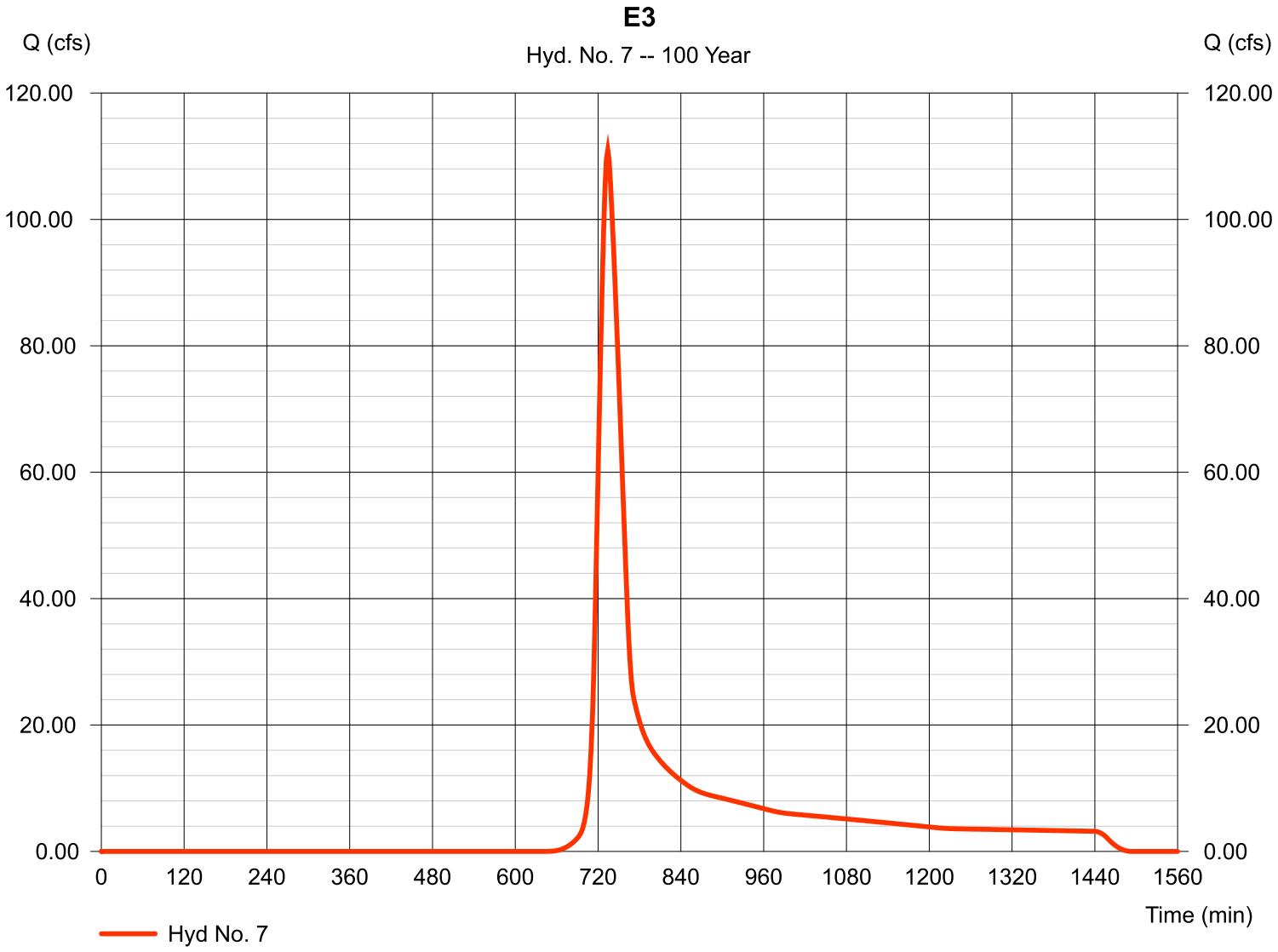
Hydrograph Report

Hyd. No. 7

E3

Hydrograph type	=	SCS Runoff	Peak discharge	=	110.95 cfs
Storm frequency	=	100 yrs	Time to peak	=	734 min
Time interval	=	2 min	Hyd. volume	=	510,806 cuft
Drainage area	=	90.830 ac	Curve number	=	67*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	32.60 min
Total precip.	=	4.60 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(18.170 x 61) + (72.660 x 69)] / 90.830



Hydrograph Report

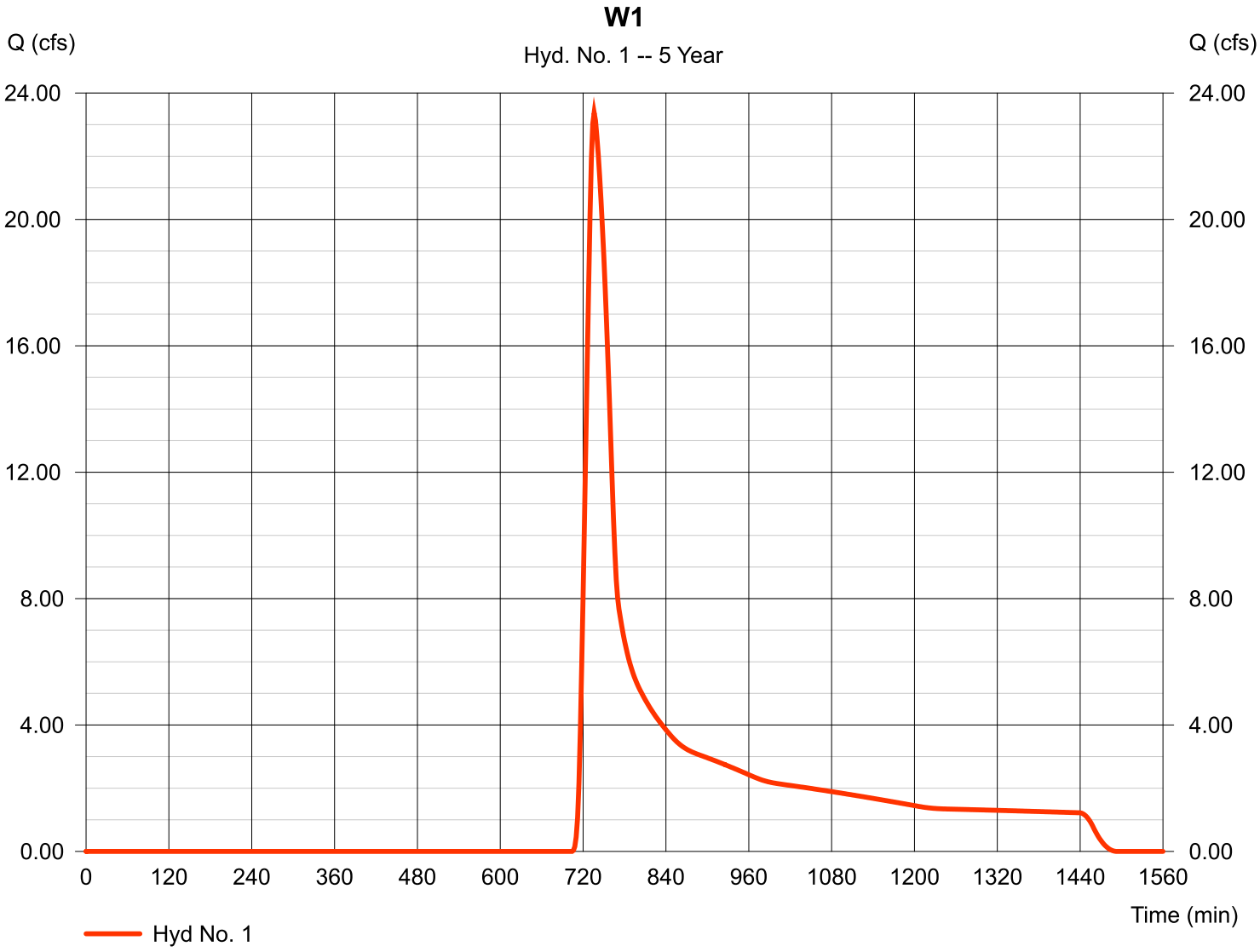
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Thursday, 01 / 17 / 2019

Hyd. No. 1

W1

Hydrograph type	=	SCS Runoff	Peak discharge	=	23.37 cfs
Storm frequency	=	5 yrs	Time to peak	=	736 min
Time interval	=	2 min	Hyd. volume	=	143,846 cuft
Drainage area	=	88.400 ac	Curve number	=	67*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	30.30 min
Total precip.	=	2.70 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(17.680 x 61) + (70.720 x 69)] / 88.400



TR55 Tc Worksheet

Hyd. No. 1

W1

Description	A		B		C		Totals
Sheet Flow							
Manning's n-value	= 0.130		0.011		0.011		
Flow length (ft)	= 300.0		0.0		0.0		
Two-year 24-hr precip. (in)	= 2.10		0.00		0.00		
Land slope (%)	= 2.50		0.00		0.00		
Travel Time (min)	**= 23.76**	**+**	**0.00**	**+**	**0.00**	**=**	**23.76**
Shallow Concentrated Flow							
Flow length (ft)	= 1000.00		0.00		0.00		
Watercourse slope (%)	= 2.50		0.00		0.00		
Surface description	= Unpaved		Paved		Paved		
Average velocity (ft/s)	=2.55		0.00		0.00		
Travel Time (min)	**= 6.53**	**+**	**0.00**	**+**	**0.00**	**=**	**6.53**
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	= 0.025		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 ..... 30.30 min

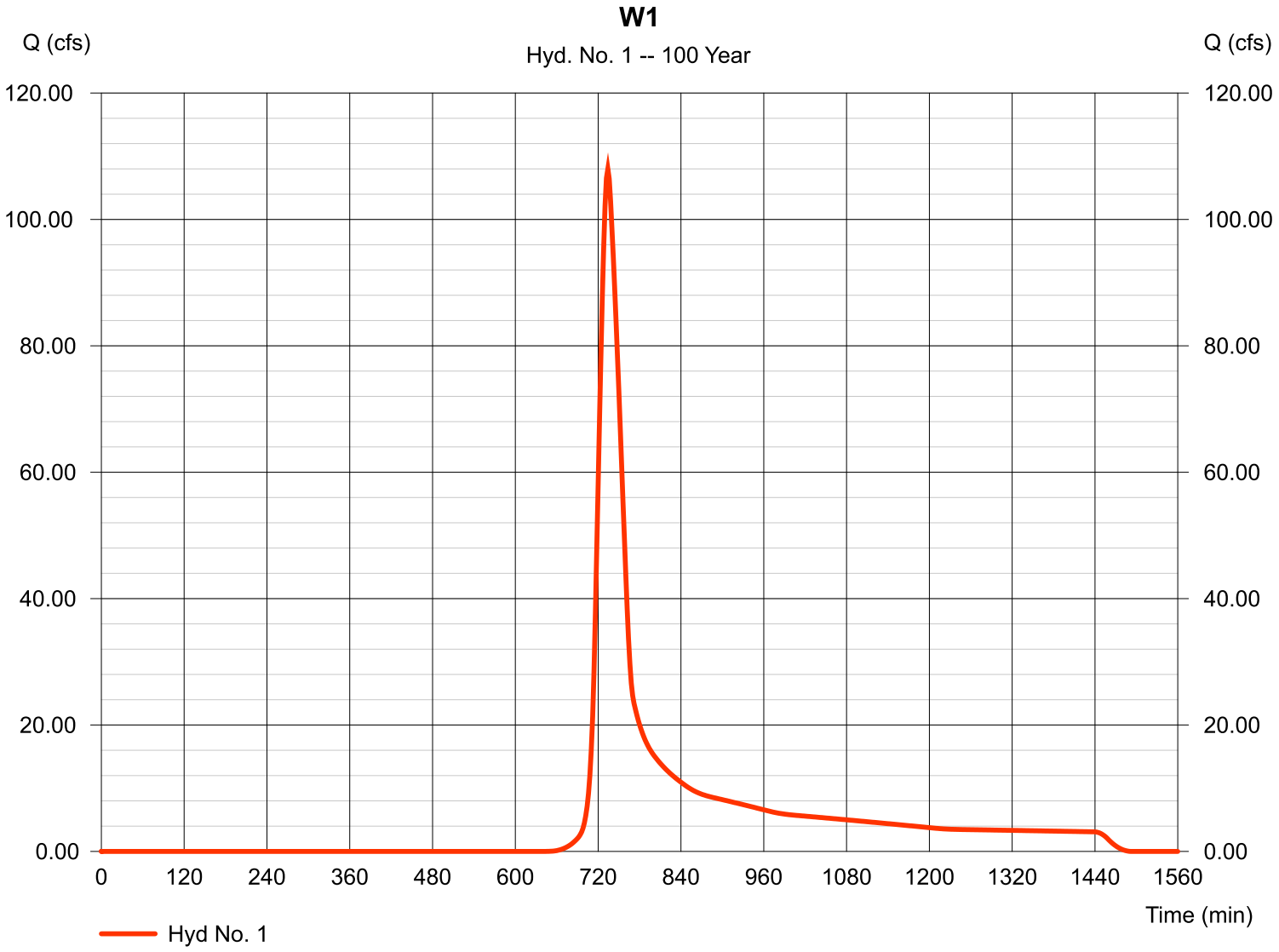
Hydrograph Report

Hyd. No. 1

W1

Hydrograph type	=	SCS Runoff	Peak discharge	=	107.98 cfs
Storm frequency	=	100 yrs	Time to peak	=	734 min
Time interval	=	2 min	Hyd. volume	=	497,140 cuft
Drainage area	=	88.400 ac	Curve number	=	67*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	30.30 min
Total precip.	=	4.60 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(17.680 x 61) + (70.720 x 69)] / 88.400



Hydrograph Report

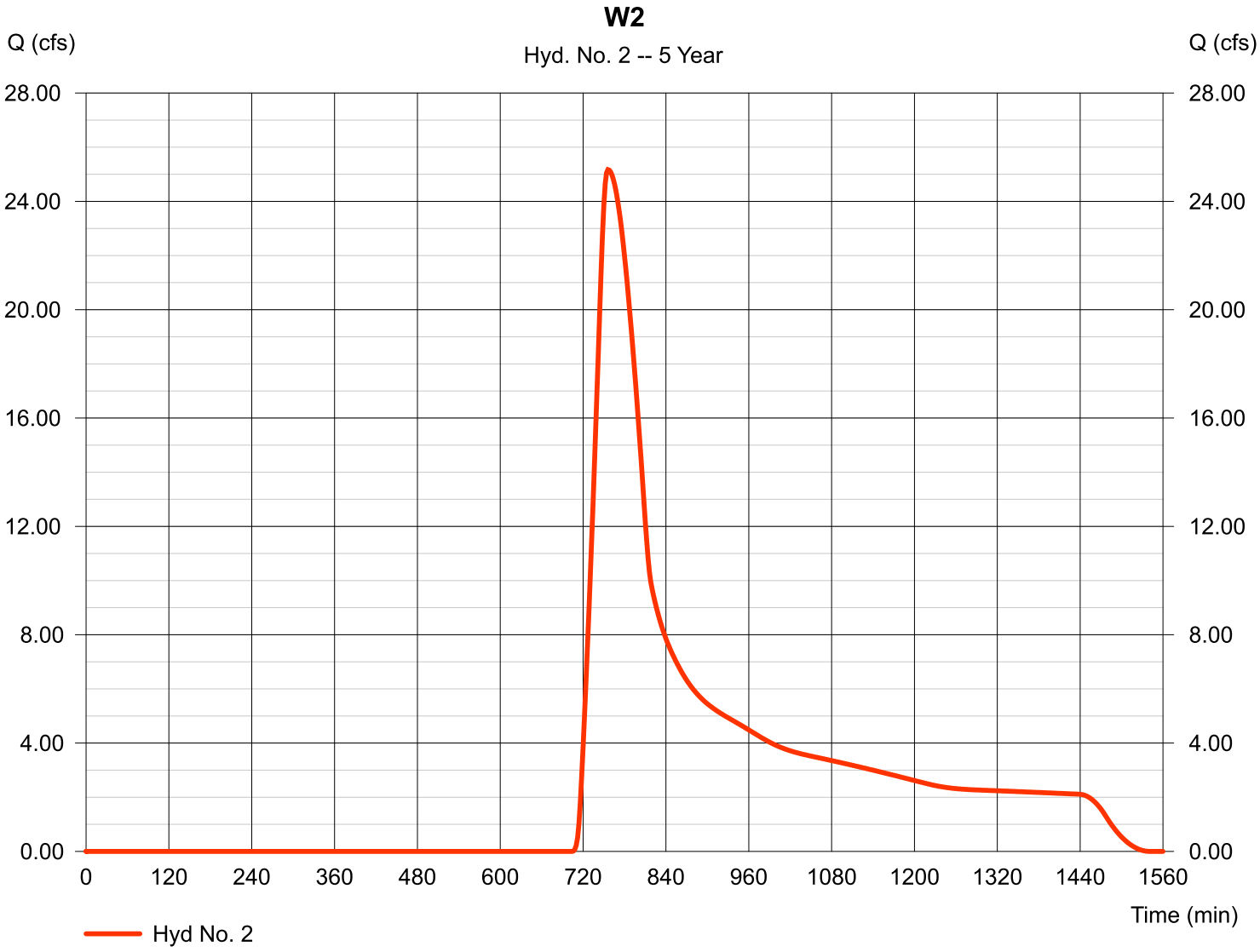
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Tuesday, 12 / 18 / 2018

Hyd. No. 2

W2

Hydrograph type	=	SCS Runoff	Peak discharge	=	25.17 cfs
Storm frequency	=	5 yrs	Time to peak	=	756 min
Time interval	=	2 min	Hyd. volume	=	245,405 cuft
Drainage area	=	151.700 ac	Curve number	=	67*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	62.00 min
Total precip.	=	2.70 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(30.300 x 61) + (121.400 x 69)] / 151.700



TR55 Tc Worksheet

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

Hyd. No. 2

W2

Description	A		B		C		Totals
Sheet Flow							
Manning's n-value	= 0.130		0.011		0.011		
Flow length (ft)	= 300.0		0.0		0.0		
Two-year 24-hr precip. (in)	= 2.10		0.00		0.00		
Land slope (%)	= 2.00		0.00		0.00		
Travel Time (min)	**= 25.98**	**+**	**0.00**	**+**	**0.00**	**=**	**25.98**
Shallow Concentrated Flow							
Flow length (ft)	= 3485.00		0.00		0.00		
Watercourse slope (%)	= 1.00		0.00		0.00		
Surface description	= Unpaved		Paved		Paved		
Average velocity (ft/s)	=1.61		0.00		0.00		
Travel Time (min)	**= 36.00**	**+**	**0.00**	**+**	**0.00**	**=**	**36.00**
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 ..... 62.00 min

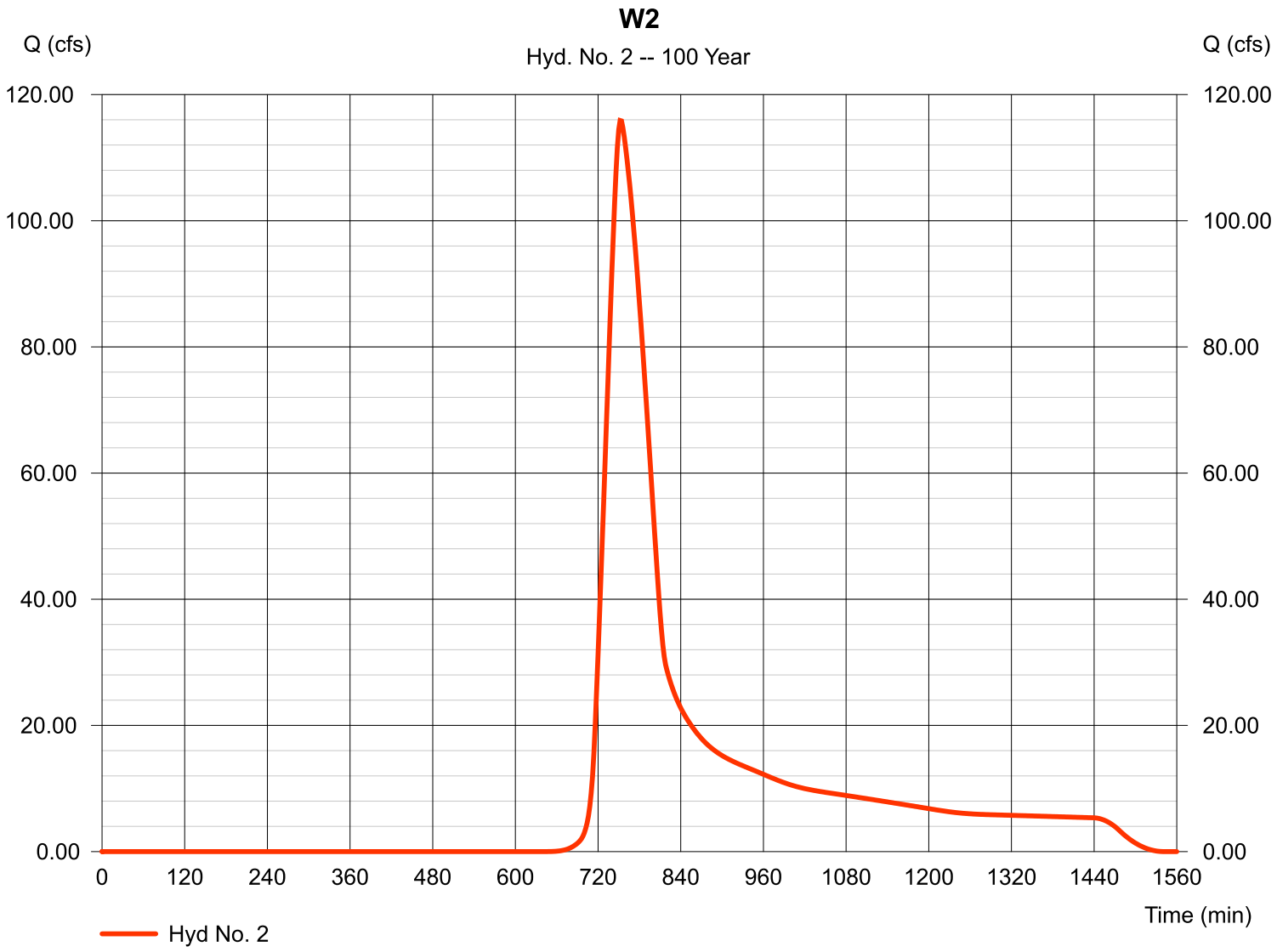
Hydrograph Report

Hyd. No. 2

W2

Hydrograph type	=	SCS Runoff	Peak discharge	=	115.88 cfs
Storm frequency	=	100 yrs	Time to peak	=	752 min
Time interval	=	2 min	Hyd. volume	=	848,135 cuft
Drainage area	=	151.700 ac	Curve number	=	67*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	62.00 min
Total precip.	=	4.60 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(30.300 x 61) + (121.400 x 69)] / 151.700



Hydrograph Report

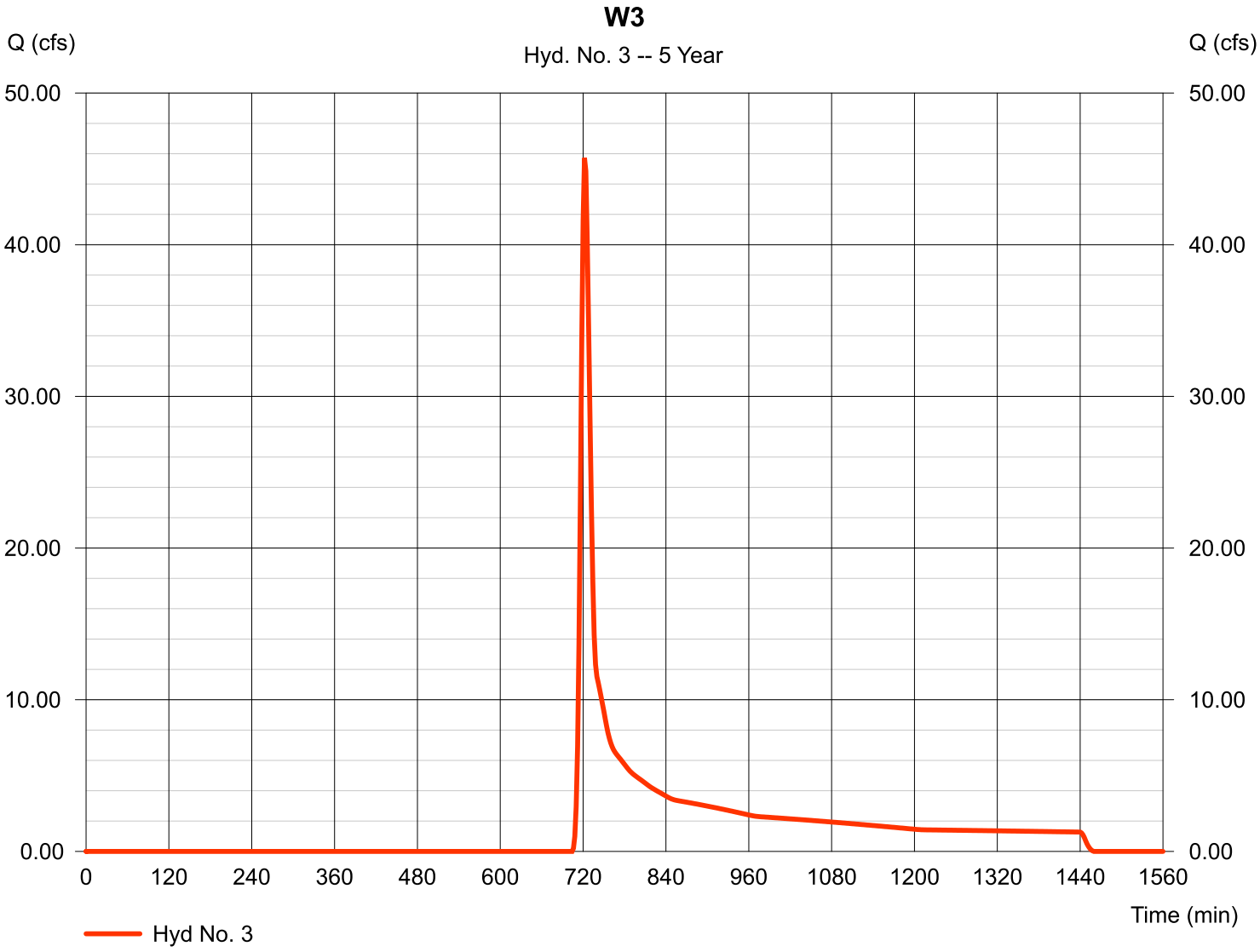
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Thursday, 01 / 17 / 2019

Hyd. No. 3

W3

Hydrograph type	=	SCS Runoff	Peak discharge	=	45.72 cfs
Storm frequency	=	5 yrs	Time to peak	=	722 min
Time interval	=	2 min	Hyd. volume	=	151,266 cuft
Drainage area	=	91.270 ac	Curve number	=	67*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	11.10 min
Total precip.	=	2.70 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(18.250 x 61) + (73.020 x 69)] / 91.270



TR55 Tc Worksheet

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

Hyd. No. 3

W3

Description	A		B		C		Totals
Sheet Flow							
Manning's n-value	= 0.013		0.011		0.011		
Flow length (ft)	= 300.0		0.0		0.0		
Two-year 24-hr precip. (in)	= 2.10		0.00		0.00		
Land slope (%)	= 6.30		0.00		0.00		
Travel Time (min)	**= 2.60**	**+**	**0.00**	**+**	**0.00**	**=**	**2.60**
Shallow Concentrated Flow							
Flow length (ft)	= 1585.00		0.00		0.00		
Watercourse slope (%)	= 3.70		0.00		0.00		
Surface description	= Unpaved		Paved		Paved		
Average velocity (ft/s)	=3.10		0.00		0.00		
Travel Time (min)	**= 8.51**	**+**	**0.00**	**+**	**0.00**	**=**	**8.51**
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							**11.10 min**

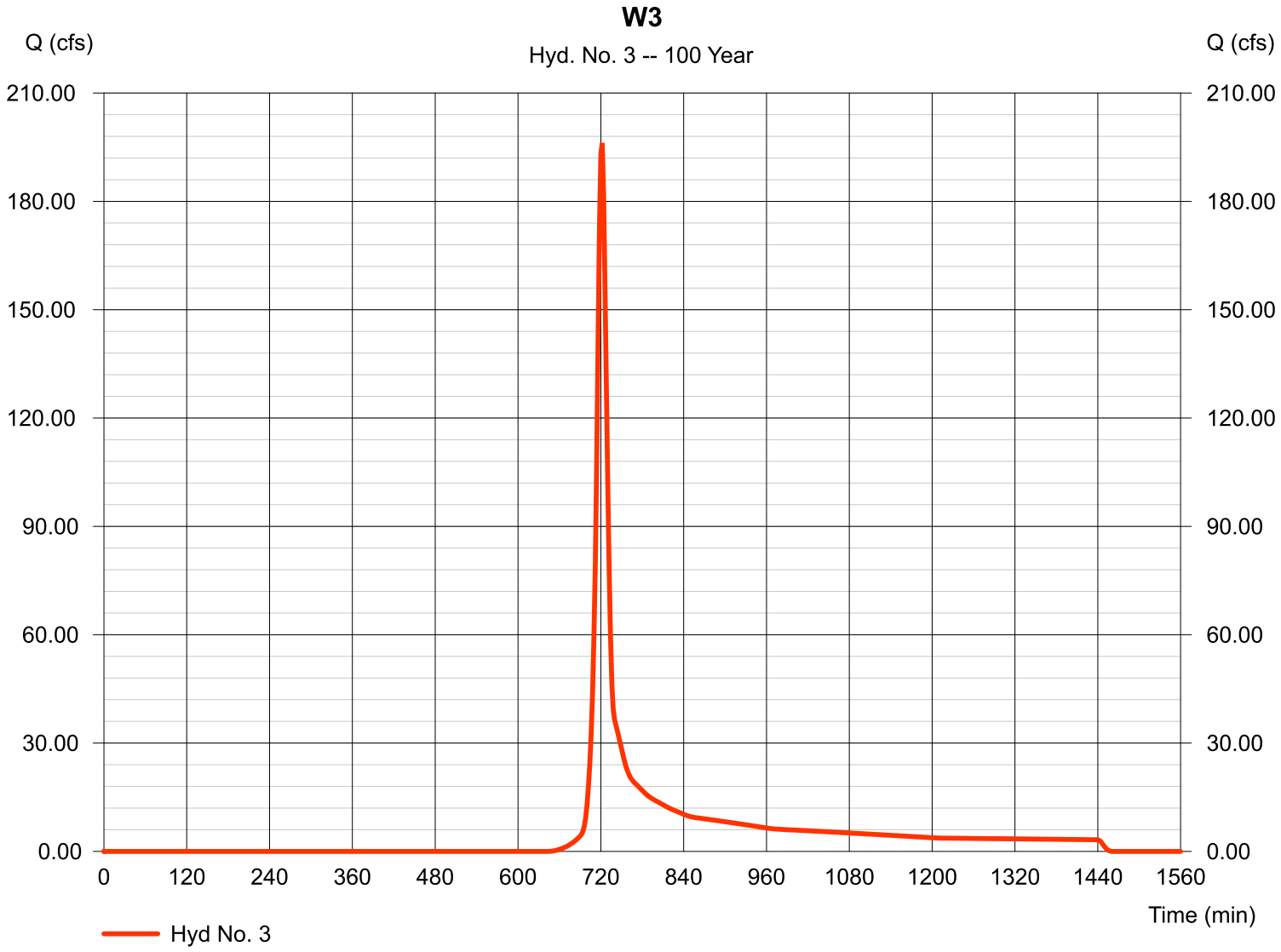
Hydrograph Report

Hyd. No. 3

W3

Hydrograph type	=	SCS Runoff	Peak discharge	=	196.20 cfs
Storm frequency	=	100 yrs	Time to peak	=	722 min
Time interval	=	2 min	Hyd. volume	=	522,785 cuft
Drainage area	=	91.270 ac	Curve number	=	67*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	11.10 min
Total precip.	=	4.60 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(18.250 x 61) + (73.020 x 69)] / 91.270



Hydrograph Report

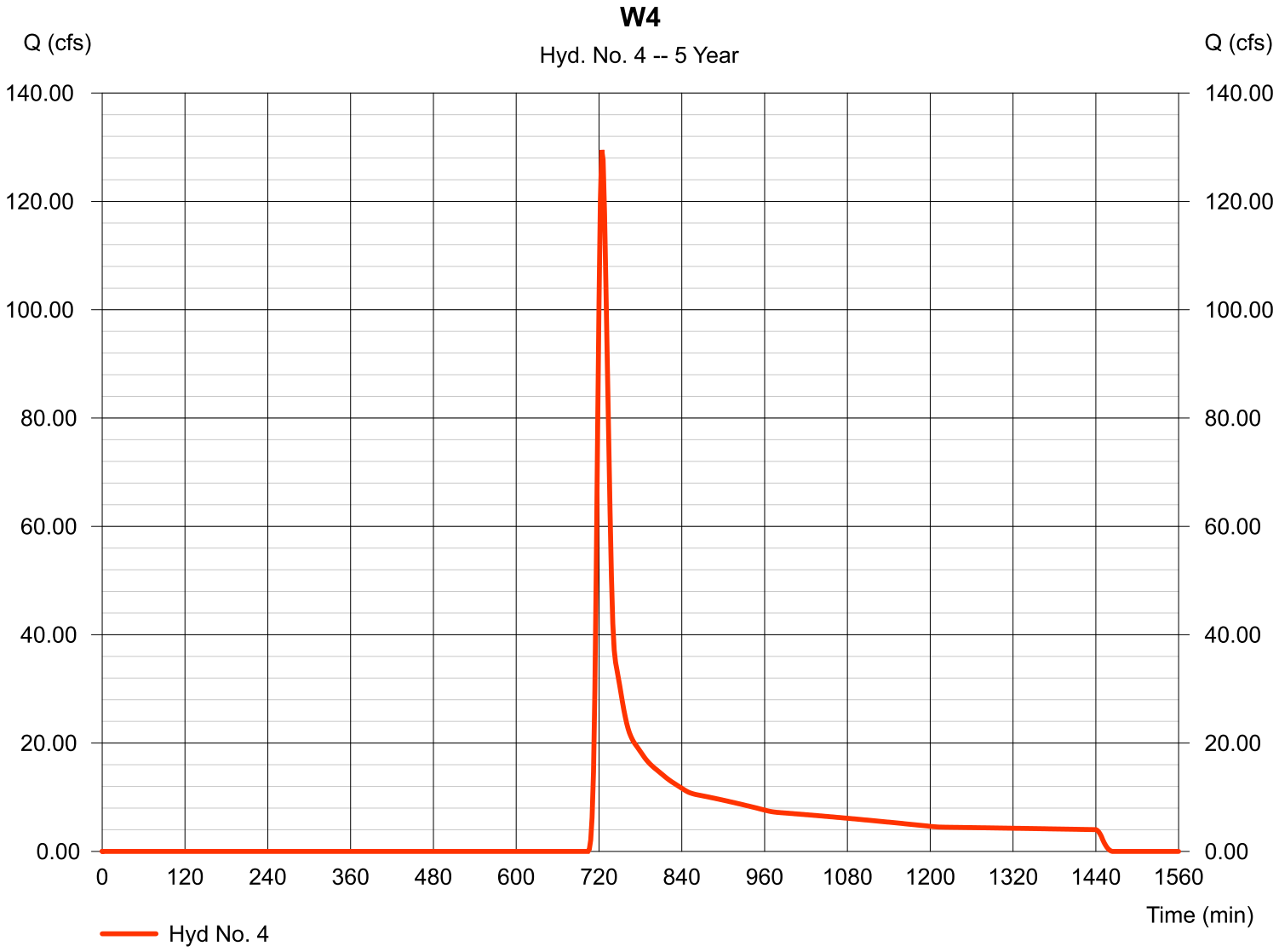
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Tuesday, 12 / 18 / 2018

Hyd. No. 4

W4

Hydrograph type	= SCS Runoff	Peak discharge	= 129.49 cfs
Storm frequency	= 5 yrs	Time to peak	= 724 min
Time interval	= 2 min	Hyd. volume	= 476,054 cuft
Drainage area	= 303.810 ac	Curve number	= 67*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 15.40 min
Total precip.	= 2.70 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(60.760 x 61) + (243.050 x 69)] / 303.810



TR55 Tc Worksheet

Hyd. No. 4

W4

Description	A		B		C		Totals
Sheet Flow							
Manning's n-value	= 0.011		0.011		0.011		
Flow length (ft)	= 300.0		0.0		0.0		
Two-year 24-hr precip. (in)	= 2.10		0.00		0.00		
Land slope (%)	= 3.90		0.00		0.00		
Travel Time (min)	**= 2.76**	**+**	**0.00**	**+**	**0.00**	**=**	**2.76**
Shallow Concentrated Flow							
Flow length (ft)	= 2400.00		0.00		0.00		
Watercourse slope (%)	= 3.90		0.00		0.00		
Surface description	= Unpaved		Paved		Paved		
Average velocity (ft/s)	=3.19		0.00		0.00		
Travel Time (min)	**= 12.55**	**+**	**0.00**	**+**	**0.00**	**=**	**12.55**
Channel Flow							
X sectional flow area (sqft)	= 874500.00		0.00		0.00		
Wetted perimeter (ft)	= 1275.00		0.00		0.00		
Channel slope (%)	= 1.00		0.00		0.00		
Manning's n-value	= 0.030		0.015		0.015		
Velocity (ft/s)	=394.78						
			0.00				
					0.00		
Flow length (ft)	({0})2700.0		0.0		0.0		
Travel Time (min)	**= 0.11**	**+**	**0.00**	**+**	**0.00**	**=**	**0.11**

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

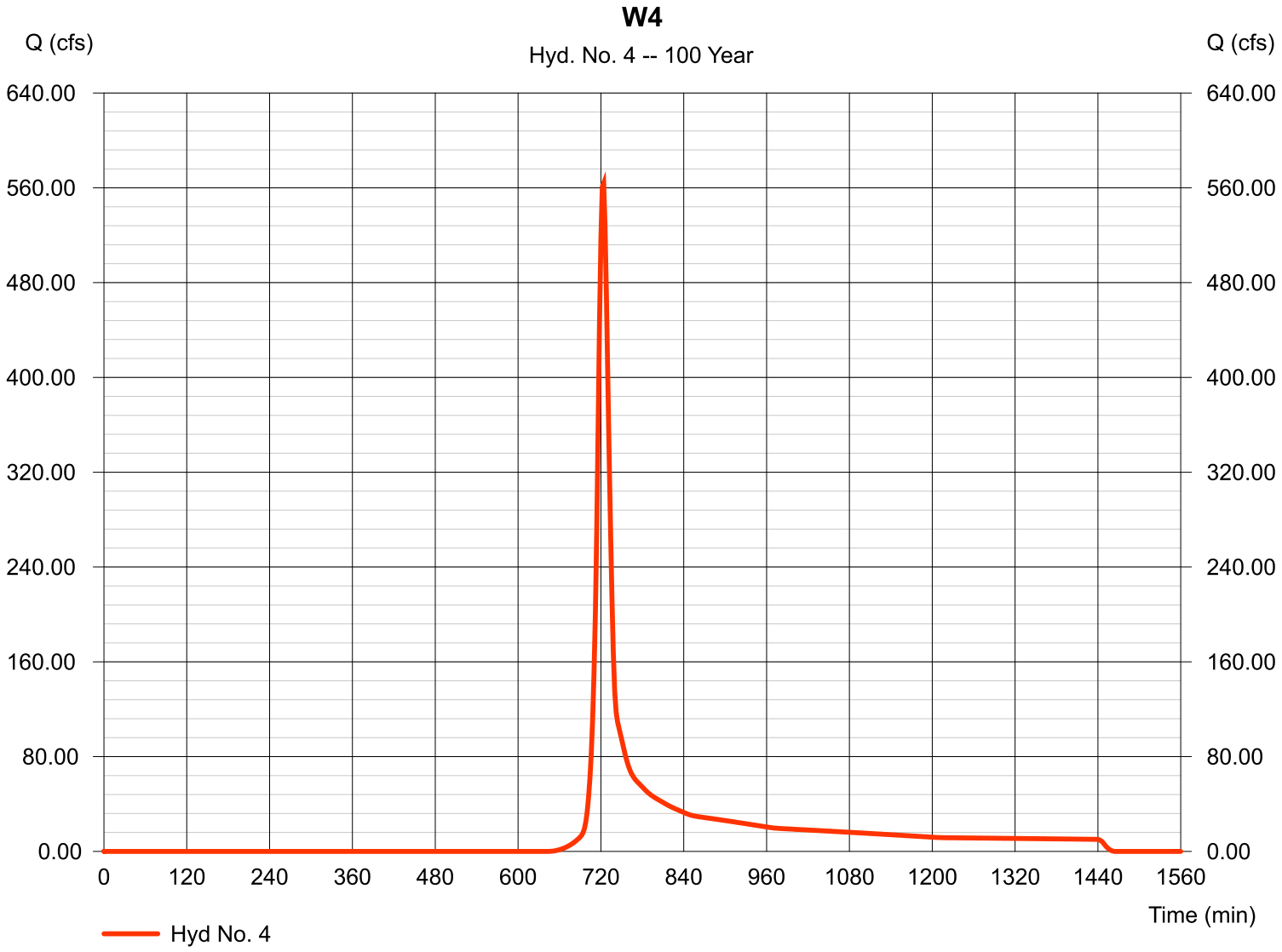
Hydrograph Report

Hyd. No. 4

W4

Hydrograph type	=	SCS Runoff	Peak discharge	=	563.91 cfs
Storm frequency	=	100 yrs	Time to peak	=	724 min
Time interval	=	2 min	Hyd. volume	=	1,645,272 cuft
Drainage area	=	303.810 ac	Curve number	=	67*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	15.40 min
Total precip.	=	4.60 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(60.760 x 61) + (243.050 x 69)] / 303.810



PROPOSED HYDROLOGIC CALCULATIONS

Weighted Curve Number-Proposed Conditions

SUB-BASIN	AREA (SF)	AREA (Acres)	PASTURE AREA (AC)	HSG C PERCENTAGE	HSG D PERCENTAGE	HSG C AREA	HSG D AREA	NEWLY GRADED AREA*	HSG C PERCENTAGE	HSG D PERCENTAGE	HSG C AREA	HSG D AREA	GRAVEL ROAD AREA	HSG C PERCENTAGE	HSG D PERCENTAGE	HSG C AREA	HSG D AREA	PAVED AREA	HSG C PERCENTAGE	HSG D PERCENTAGE	HSG C AREA	HSG D AREA	WEIGHTED CN
W1	3,850,776	88.40	86.82	20%	80%	17.36	69.46	0.00	20%	80%	0.00	0.00	1.58	0%	100%	0.00	1.58	0.00	0%	100%	0.00	0.00	68
W2	6,734,361	154.60	154.51	20%	80%	30.90	123.61	0.00	20%	80%	0.00	0.00	0.09	0%	100%	0.00	0.09	0.00	0%	100%	0.00	0.00	67
W3	3,697,886	84.89	84.53	20%	80%	16.91	67.63	0.00	20%	80%	0.00	0.00	0.36	0%	100%	0.00	0.36	0.00	0%	100%	0.00	0.00	67
W4	13,858,723	318.15	318.15	20%	80%	63.63	254.52	0.00	20%	80%	0.00	0.00	0.00	0%	100%	0.00	0.00	0.00	0%	100%	0.00	0.00	67
E1	22,166,677	508.88	484.13	20%	80%	96.83	387.30	22.20	20%	80%	4.44	17.76	2.43	0%	100%	0.00	2.43	0.12	0%	100%	0.00	0.12	69
E2	5,302,084	121.72	119.67	20%	80%	23.93	95.74	0.00	20%	80%	0.00	0.00	1.76	0%	100%	0.00	1.76	0.29	0%	100%	0.00	0.29	68
E3	1,060,549	24.35	24.35	20%	80%	4.87	19.48	0.00	20%	80%	0.00	0.00	0.00	0%	100%	0.00	0.00	0.00	0%	100%	0.00	0.00	67
E4	6,353,583	145.86	144.72	20%	80%	28.94	115.78	0.00	20%	80%	0.00	0.00	1.14	0%	100%	0.00	1.14	0.00	0%	100%	0.00	0.00	68
E5	3,911,975	89.81	88.18	20%	80%	17.64	70.54	0.00	20%	80%	0.00	0.00	0.79	0%	100%	0.00	0.79	0.84	0%	100%	0.00	0.84	67
TOTAL	66,936,614	1536.65																					

*Newly Graded Area represents the substation pads.

Curve Numbers	Pre Devlopement (ARC I)		Post Devlopement (ARC II)	
	HSG C	HSG D	HSG C	HSG D
Pasture, grassland, rande -FAIR	61	69	-	-
Newly Graded Area (Pervious, no vegeation)			91	94
Paved-Open Ditches			92	93
Gravel Streets			89	91

Curve Numbers are based on on Table 6-9 and Table 6-10 of the Colorado Springs DCM

Proposed Runoff							
BASIN	BASIN AREA (ACRES)	DIRECT 5-YR RUNOFF (CFS)	DIRECT 10-YR RUNOFF (CFS)	DIRECT 25-YR RUNOFF (CFS)	DIRECT 100-YR RUNOFF (CFS)	Time of Concentration (min)	Notes
W1	88.40	26.41	45.71	63.65	114.02	30.90	Check Dam decreases TC by 0.5 min
W2	154.60	25.65	45.37	63.99	118.10	62.00	
W3	84.89	42.53	74.58	103.05	182.48	10.10	
W4	318.15	135.61	239.48	332.00	590.53	15.80	
E1	508.88	95.27	159.82	219.38	388.43	72.00	
E2	121.72	28.37	49.10	68.23	123.02	44.50	
E3	24.35	5.99	10.67	15.07	27.66	33.90	
E4	145.86	32.35	56.00	77.84	140.43	50.40	
E5	89.81	26.83	46.44	64.66	115.84	32.10	
TOTAL	1536.65	419.01	727.17	1007.87	1800.51		

Hydrograph Report

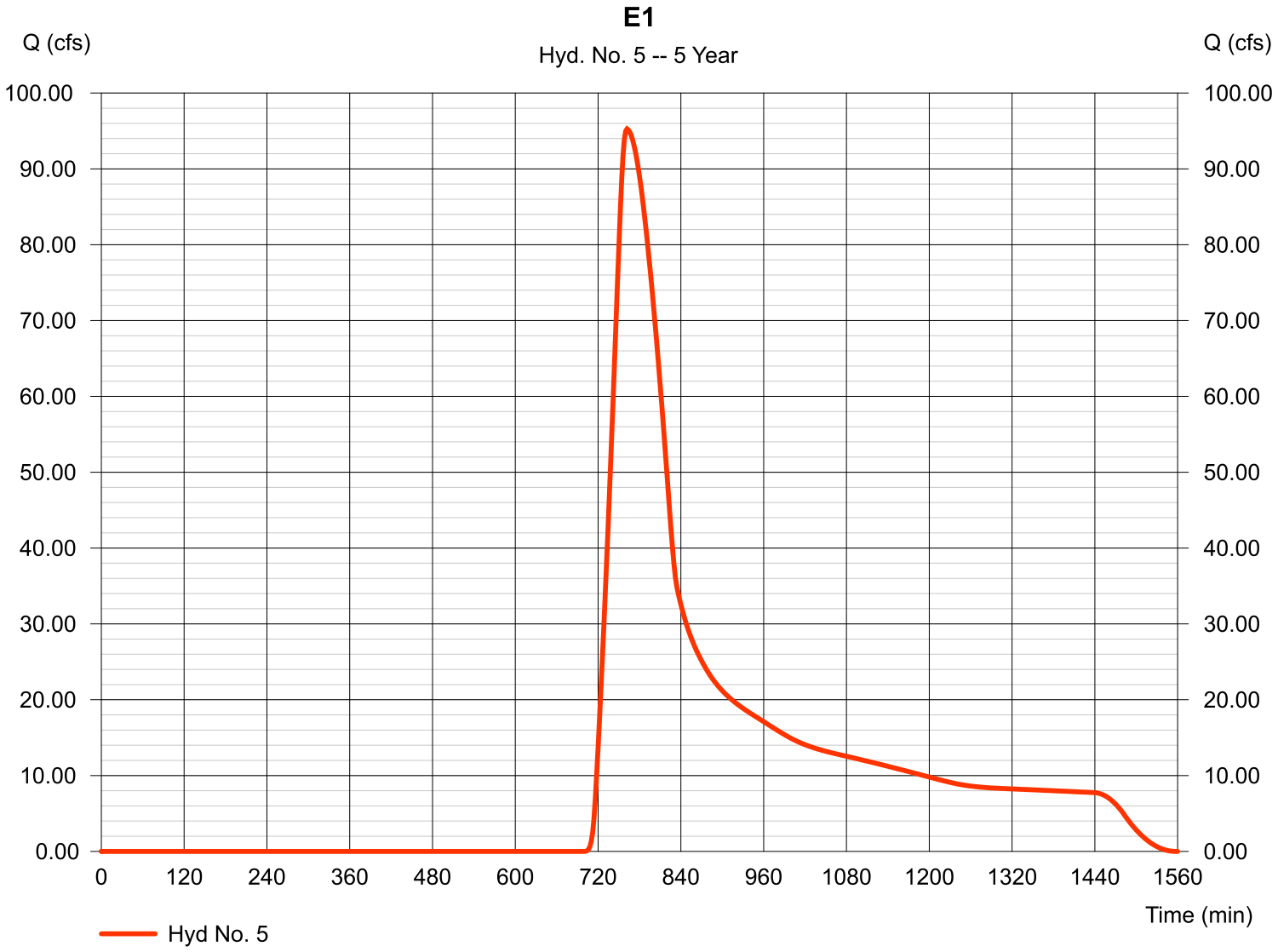
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Thursday, 01 / 17 / 2019

Hyd. No. 5

E1

Hydrograph type	=	SCS Runoff	Peak discharge	=	95.27 cfs
Storm frequency	=	5 yrs	Time to peak	=	762 min
Time interval	=	2 min	Hyd. volume	=	957,795 cuft
Drainage area	=	508.880 ac	Curve number	=	69*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	72.00 min
Total precip.	=	2.70 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = + (22.320 x 94) + (2.430 x 91) + (96.830 x 61) + (387.300 x 69)] / 508.880



TR55 Tc Worksheet

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

Hyd. No. 5

E1

Description	A		B		C		Totals
Sheet Flow							
Manning's n-value	= 0.130		0.011		0.011		
Flow length (ft)	= 300.0		0.0		0.0		
Two-year 24-hr precip. (in)	= 2.10		0.00		0.00		
Land slope (%)	= 2.10		0.00		0.00		
Travel Time (min)	**= 25.47**	**+**	**0.00**	**+**	**0.00**	**=**	**25.47**
Shallow Concentrated Flow							
Flow length (ft)	= 6410.00		0.00		0.00		
Watercourse slope (%)	= 2.10		0.00		0.00		
Surface description	= Unpaved		Paved		Paved		
Average velocity (ft/s)	=2.34		0.00		0.00		
Travel Time (min)	**= 45.69**	**+**	**0.00**	**+**	**0.00**	**=**	**45.69**
Channel Flow							
X sectional flow area (sqft)	= 1440.00		0.00		0.00		
Wetted perimeter (ft)	= 117.00		0.00		0.00		
Channel slope (%)	= 1.80		0.00		0.00		
Manning's n-value	= 0.030		0.015		0.015		
Velocity (ft/s)	=35.82						
			0.00				
					0.00		
Flow length (ft)	({0})1745.0		0.0		0.0		
Travel Time (min)	**= 0.81**	**+**	**0.00**	**+**	**0.00**	**=**	**0.81**

Total Travel Time, Tc ..... 72.00 min

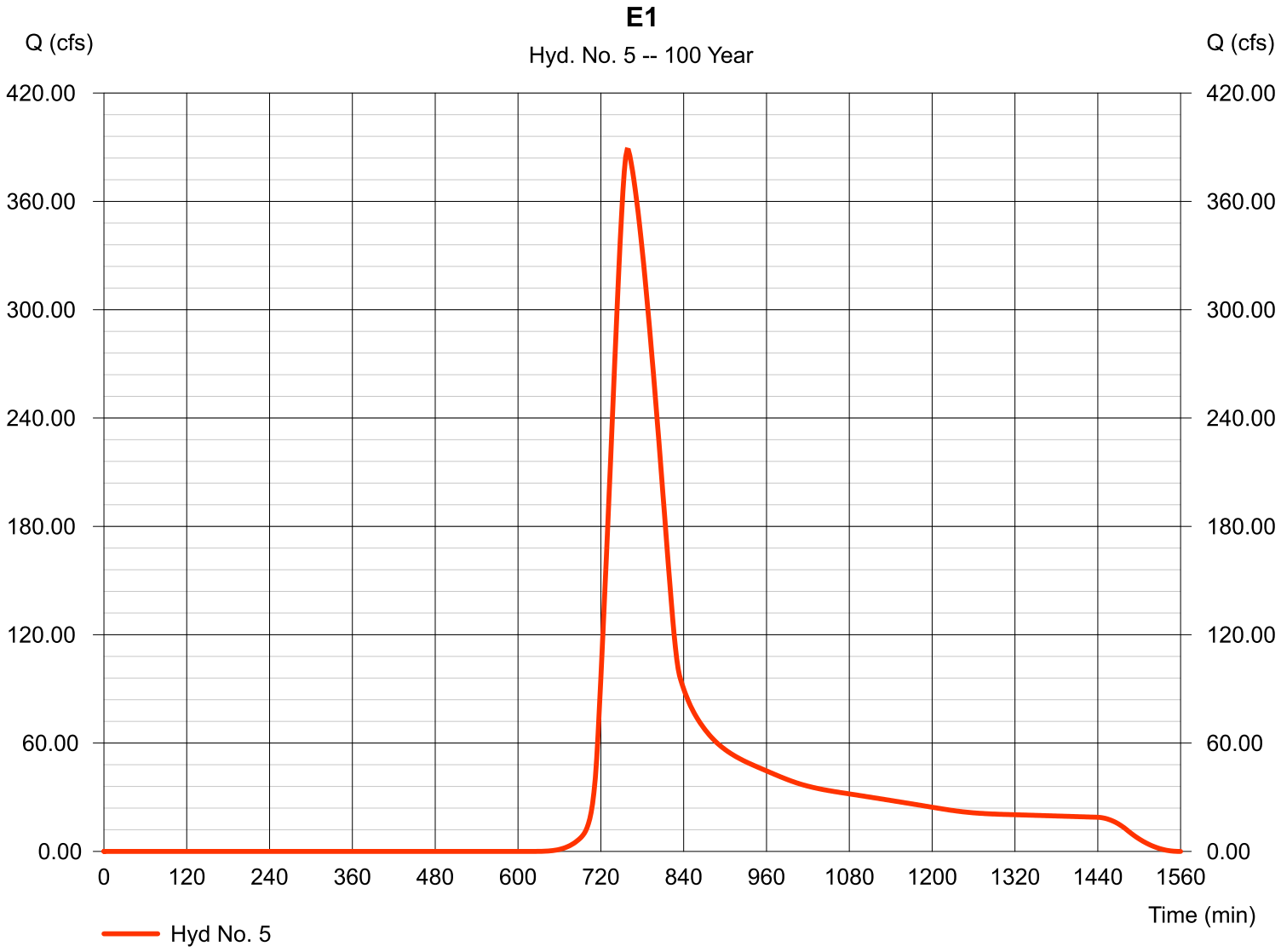
Hydrograph Report

Hyd. No. 5

E1

Hydrograph type	=	SCS Runoff	Peak discharge	=	388.43 cfs
Storm frequency	=	100 yrs	Time to peak	=	758 min
Time interval	=	2 min	Hyd. volume	=	3,106,127 cuft
Drainage area	=	508.880 ac	Curve number	=	69*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	72.00 min
Total precip.	=	4.60 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = + (22.320 x 94) + (2.430 x 91) + (96.830 x 61) + (387.300 x 69)] / 508.880



Hydrograph Report

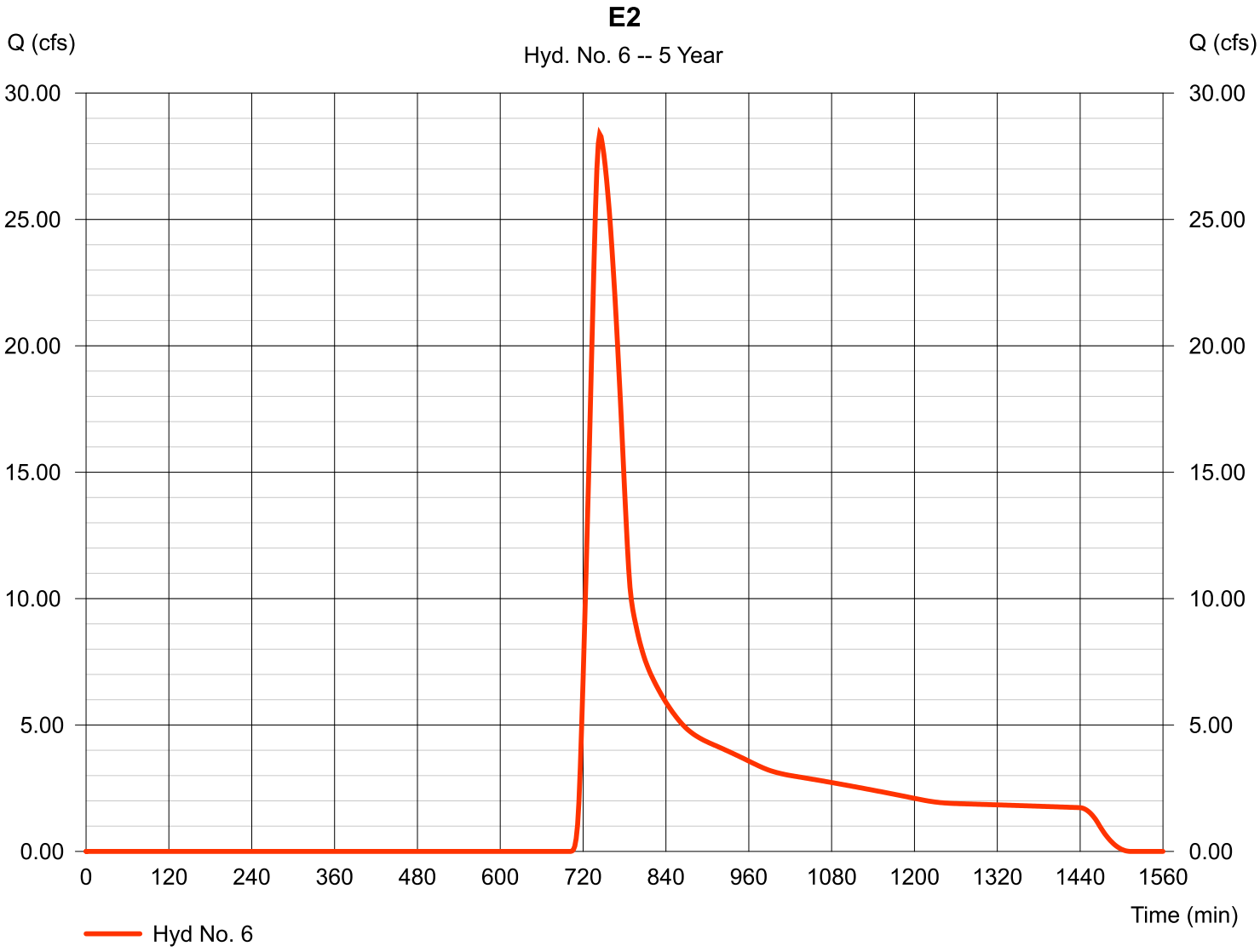
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Thursday, 01 / 17 / 2019

Hyd. No. 6

E2

Hydrograph type	=	SCS Runoff	Peak discharge	=	28.37 cfs
Storm frequency	=	5 yrs	Time to peak	=	744 min
Time interval	=	2 min	Hyd. volume	=	209,519 cuft
Drainage area	=	121.720 ac	Curve number	=	68*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	44.50 min
Total precip.	=	2.70 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = + (1.760 x 91) + (0.290 x 93) + (23.930 x 61) + (95.740 x 69)] / 121.720



TR55 Tc Worksheet

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

Hyd. No. 6

E2

Description	A		B		C		Totals
Sheet Flow							
Manning's n-value	= 0.130		0.011		0.011		
Flow length (ft)	= 300.0		0.0		0.0		
Two-year 24-hr precip. (in)	= 2.10		0.00		0.00		
Land slope (%)	= 1.50		0.00		0.00		
Travel Time (min)	**= 29.14**	**+**	**0.00**	**+**	**0.00**	**=**	**29.14**
Shallow Concentrated Flow							
Flow length (ft)	= 670.00		0.00		0.00		
Watercourse slope (%)	= 2.10		0.00		0.00		
Surface description	= Unpaved		Paved		Paved		
Average velocity (ft/s)	=2.34		0.00		0.00		
Travel Time (min)	**= 4.78**	**+**	**0.00**	**+**	**0.00**	**=**	**4.78**
Channel Flow							
X sectional flow area (sqft)	= 126.00		0.00		0.00		
Wetted perimeter (ft)	= 71.00		0.00		0.00		
Channel slope (%)	= 0.50		0.00		0.00		
Manning's n-value	= 0.030		0.015		0.015		
Velocity (ft/s)	=5.16						
			0.00				
					0.00		
Flow length (ft)	({0})3270.0		0.0		0.0		
Travel Time (min)	**= 10.57**	**+**	**0.00**	**+**	**0.00**	**=**	**10.57**

Total Travel Time, Tc ..... 44.50 min

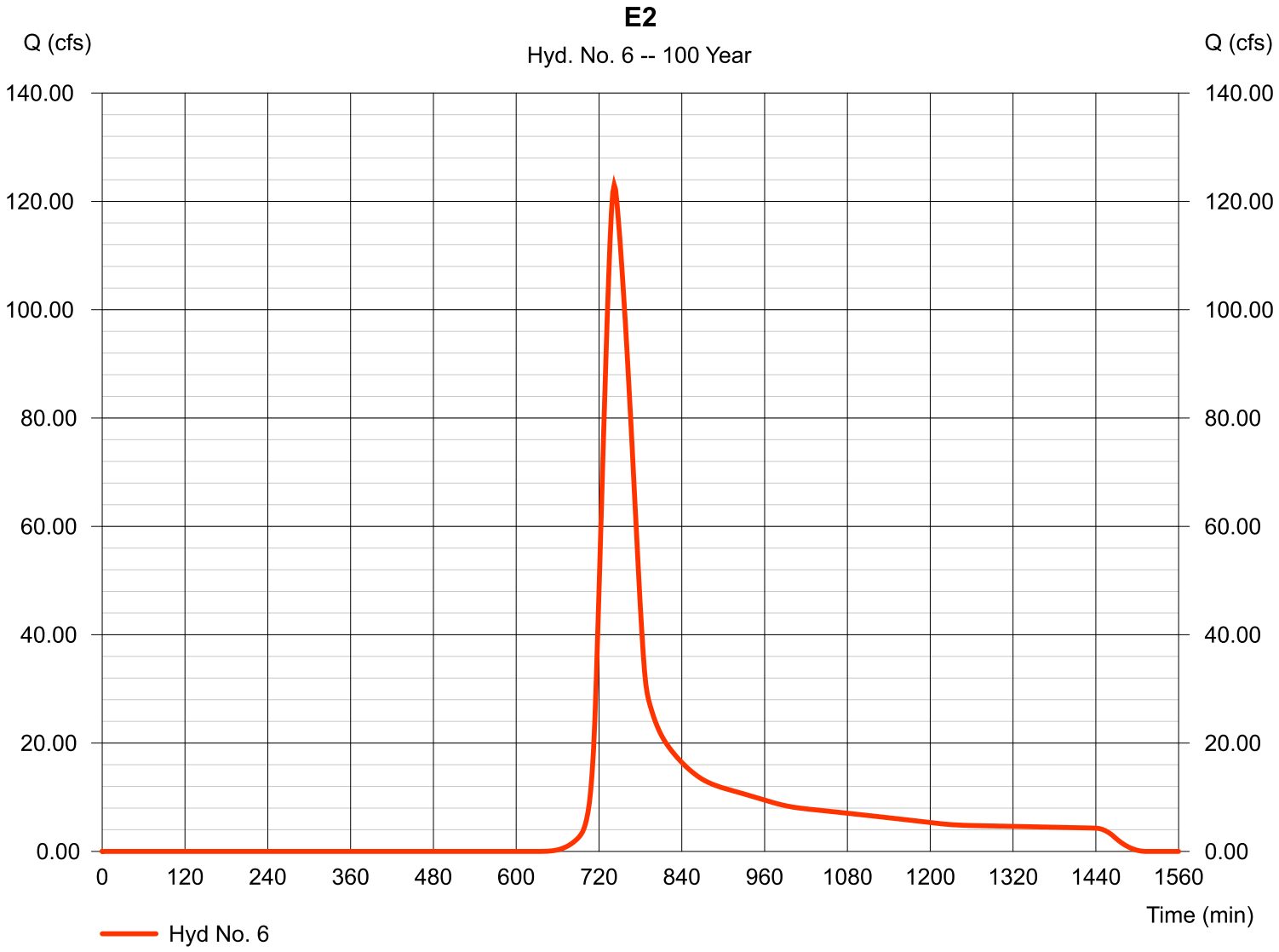
Hydrograph Report

Hyd. No. 6

E2

Hydrograph type	=	SCS Runoff	Peak discharge	=	123.02 cfs
Storm frequency	=	100 yrs	Time to peak	=	742 min
Time interval	=	2 min	Hyd. volume	=	700,818 cuft
Drainage area	=	121.720 ac	Curve number	=	68*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	44.50 min
Total precip.	=	4.60 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = + (1.760 x 91) + (0.290 x 93) + (23.930 x 61) + (95.740 x 69)] / 121.720



Hydrograph Report

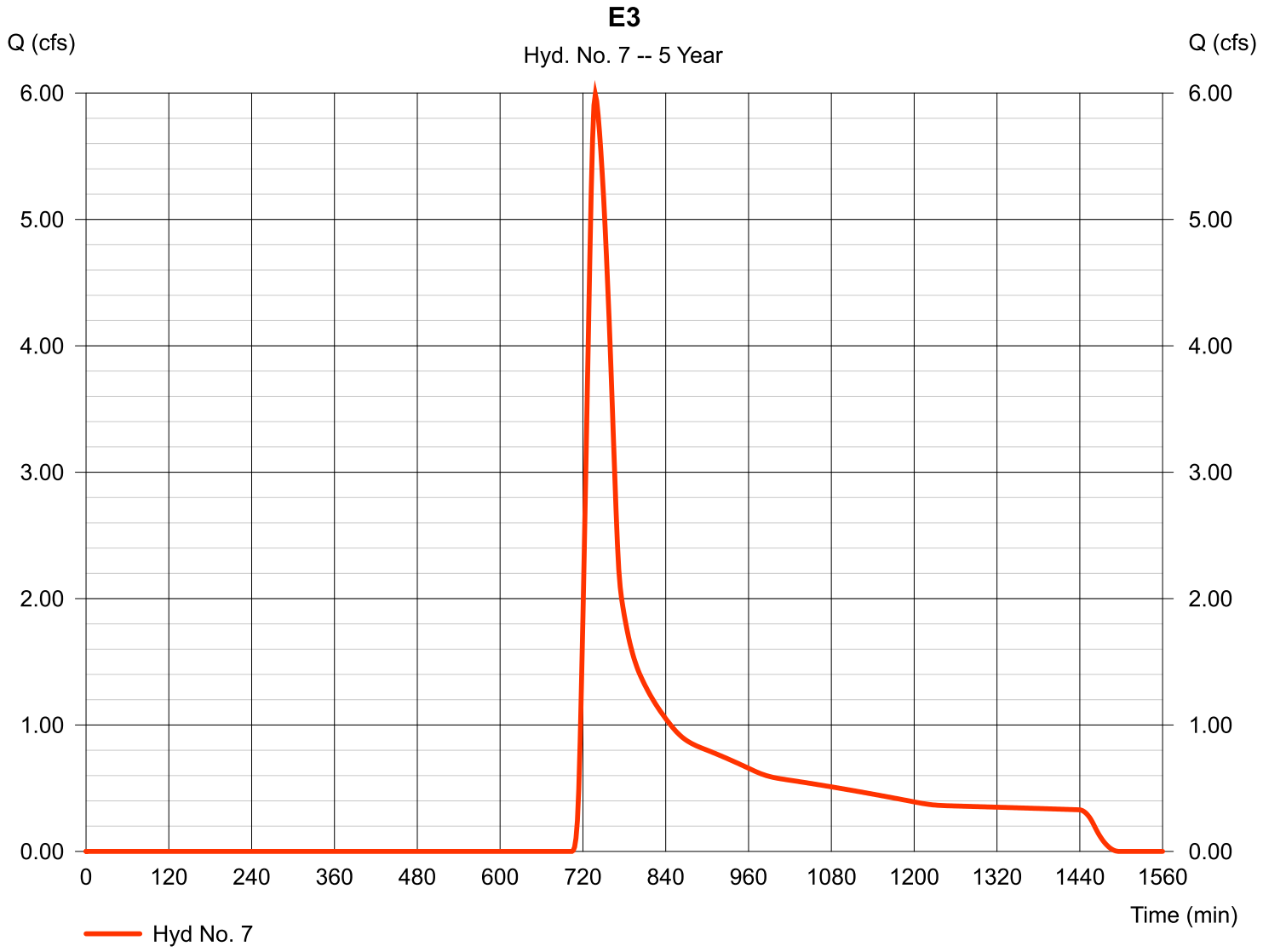
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Thursday, 01 / 17 / 2019

Hyd. No. 7

E3

Hydrograph type	=	SCS Runoff	Peak discharge	=	5.989 cfs
Storm frequency	=	5 yrs	Time to peak	=	738 min
Time interval	=	2 min	Hyd. volume	=	38,689 cuft
Drainage area	=	24.350 ac	Curve number	=	67*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	33.90 min
Total precip.	=	2.70 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = + (4.870 x 61) + (19.480 x 69)] / 24.350



TR55 Tc Worksheet

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

Hyd. No. 7

E3

Description	A		B		C		Totals
Sheet Flow							
Manning's n-value	= 0.130		0.011		0.011		
Flow length (ft)	= 300.0		0.0		0.0		
Two-year 24-hr precip. (in)	= 2.10		0.00		0.00		
Land slope (%)	= 1.50		0.00		0.00		
Travel Time (min)	**= 29.14**	**+**	**0.00**	**+**	**0.00**	**=**	**29.14**
Shallow Concentrated Flow							
Flow length (ft)	= 565.00		0.00		0.00		
Watercourse slope (%)	= 1.50		0.00		0.00		
Surface description	= Unpaved		Paved		Paved		
Average velocity (ft/s)	=1.98		0.00		0.00		
Travel Time (min)	**= 4.77**	**+**	**0.00**	**+**	**0.00**	**=**	**4.77**
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 ..... 33.90 min

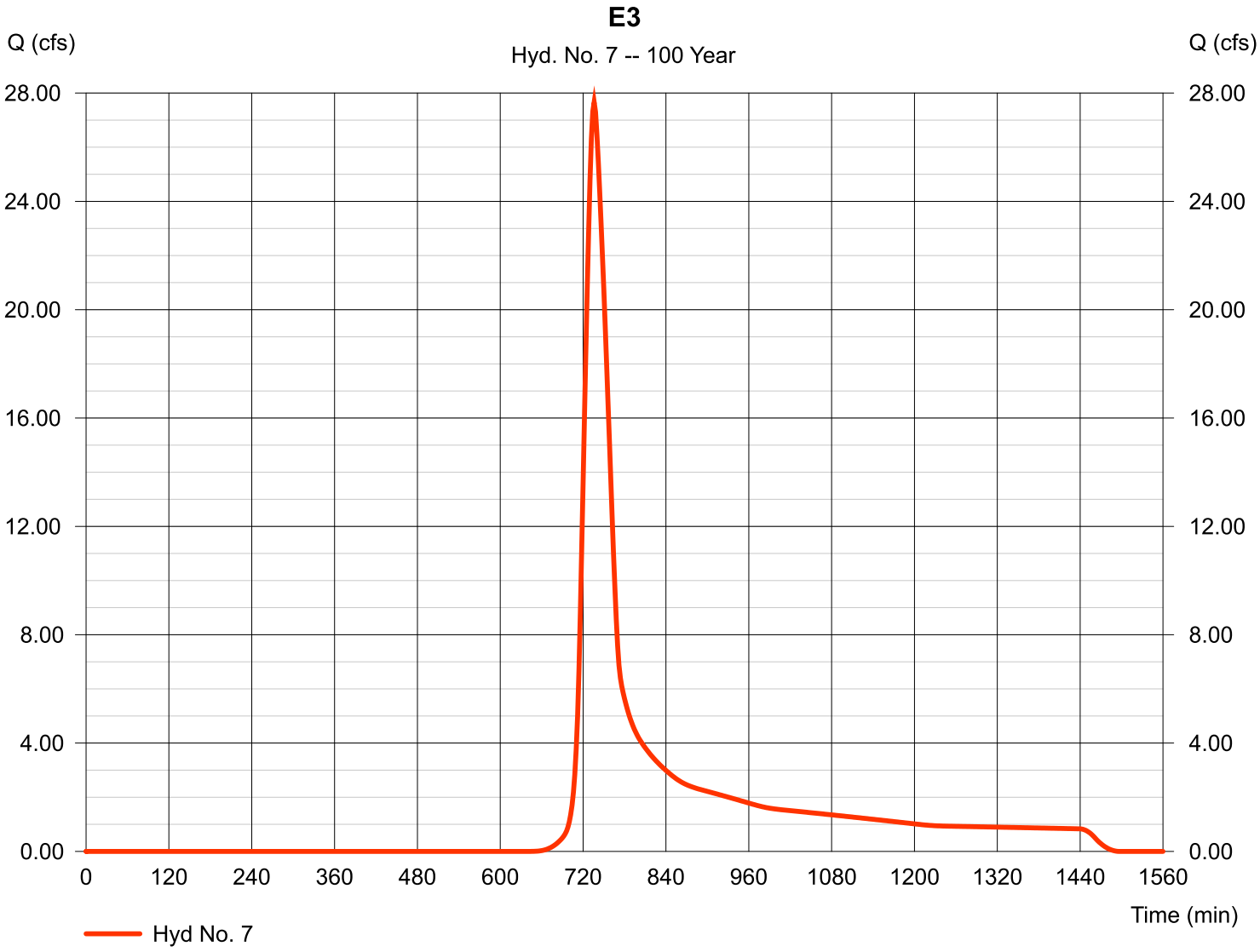
Hydrograph Report

Hyd. No. 7

E3

Hydrograph type	=	SCS Runoff	Peak discharge	=	27.66 cfs
Storm frequency	=	100 yrs	Time to peak	=	736 min
Time interval	=	2 min	Hyd. volume	=	133,711 cuft
Drainage area	=	24.350 ac	Curve number	=	67*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	33.90 min
Total precip.	=	4.60 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = + (4.870 x 61) + (19.480 x 69)] / 24.350



Hydrograph Report

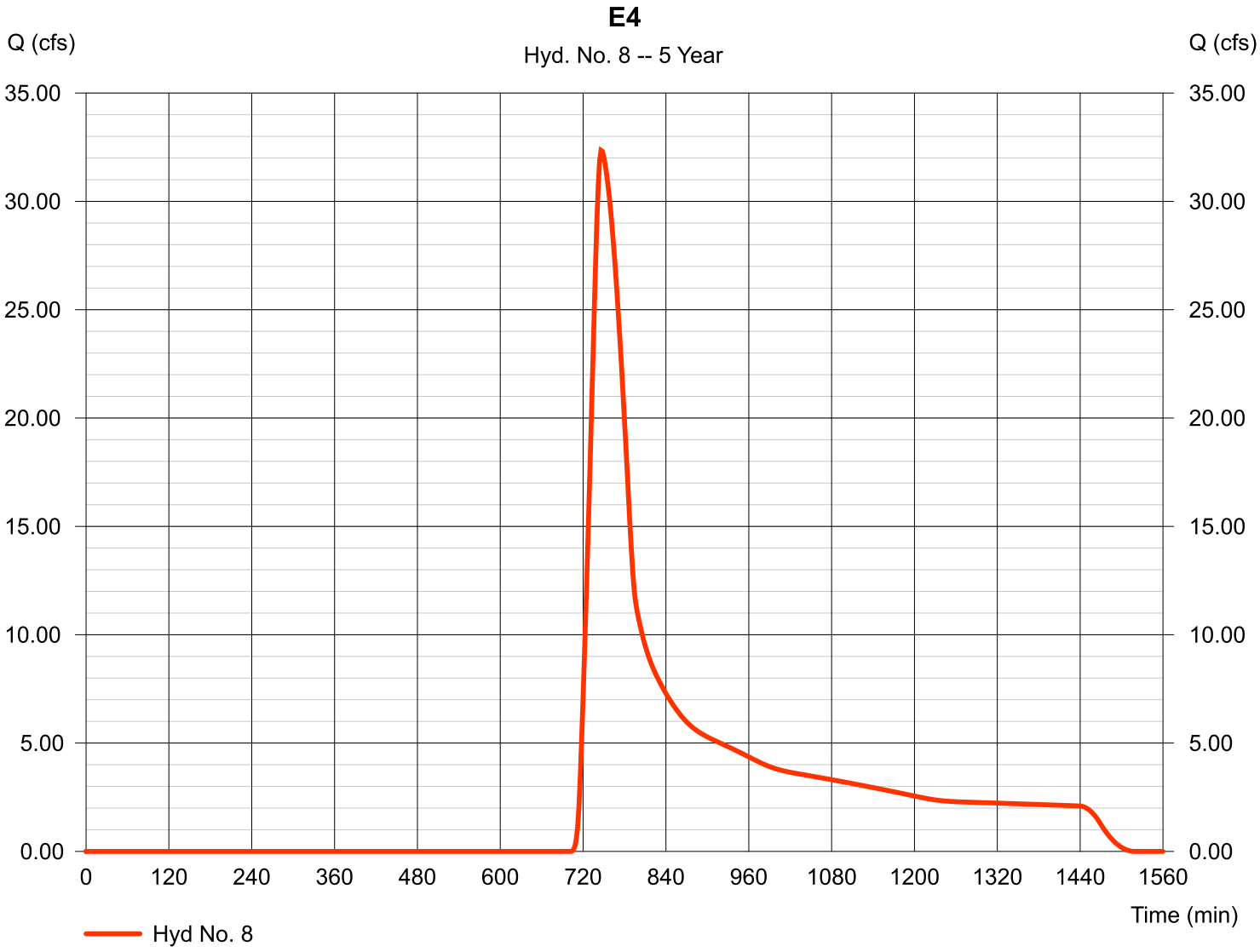
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Thursday, 01 / 17 / 2019

Hyd. No. 8

E4

Hydrograph type	=	SCS Runoff	Peak discharge	=	32.35 cfs
Storm frequency	=	5 yrs	Time to peak	=	746 min
Time interval	=	2 min	Hyd. volume	=	253,333 cuft
Drainage area	=	145.860 ac	Curve number	=	68*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	50.40 min
Total precip.	=	2.70 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = + (1.140 x 91) + (28.940 x 61) + (115.780 x 69)] / 145.860



TR55 Tc Worksheet

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

Hyd. No. 8

E4

Description	A		B		C		Totals
Sheet Flow							
Manning's n-value	= 0.130		0.011		0.011		
Flow length (ft)	= 300.0		0.0		0.0		
Two-year 24-hr precip. (in)	= 2.10		0.00		0.00		
Land slope (%)	= 2.10		0.00		0.00		
Travel Time (min)	**= 25.47**	**+**	**0.00**	**+**	**0.00**	**=**	**25.47**
Shallow Concentrated Flow							
Flow length (ft)	= 1560.00		0.00		0.00		
Watercourse slope (%)	= 2.10		0.00		0.00		
Surface description	= Unpaved		Paved		Paved		
Average velocity (ft/s)	=2.34		0.00		0.00		
Travel Time (min)	**= 11.12**	**+**	**0.00**	**+**	**0.00**	**=**	**11.12**
Channel Flow							
X sectional flow area (sqft)	= 15.00		0.00		0.00		
Wetted perimeter (ft)	= 15.00		0.00		0.00		
Channel slope (%)	= 0.30		0.00		0.00		
Manning's n-value	= 0.030		0.015		0.015		
Velocity (ft/s)	=2.72						
			0.00				
					0.00		
Flow length (ft)	({0})2260.0		0.0		0.0		
Travel Time (min)	**= 13.85**	**+**	**0.00**	**+**	**0.00**	**=**	**13.85**

Total Travel Time, Tc ..... 50.40 min

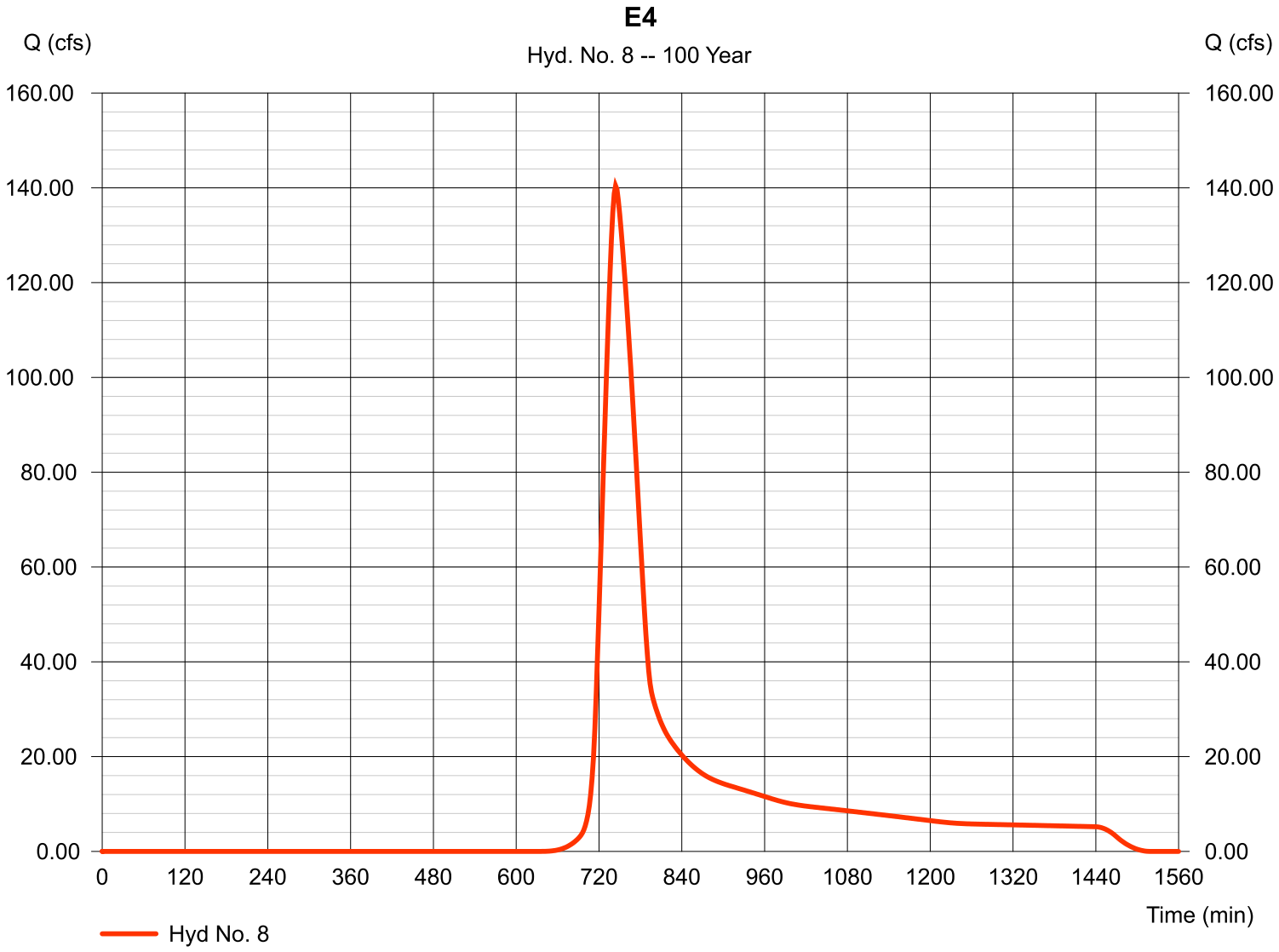
Hydrograph Report

Hyd. No. 8

E4

Hydrograph type	=	SCS Runoff	Peak discharge	=	140.43 cfs
Storm frequency	=	100 yrs	Time to peak	=	744 min
Time interval	=	2 min	Hyd. volume	=	847,373 cuft
Drainage area	=	145.860 ac	Curve number	=	68*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	50.40 min
Total precip.	=	4.60 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = + (1.140 x 91) + (28.940 x 61) + (115.780 x 69)] / 145.860



Hydrograph Report

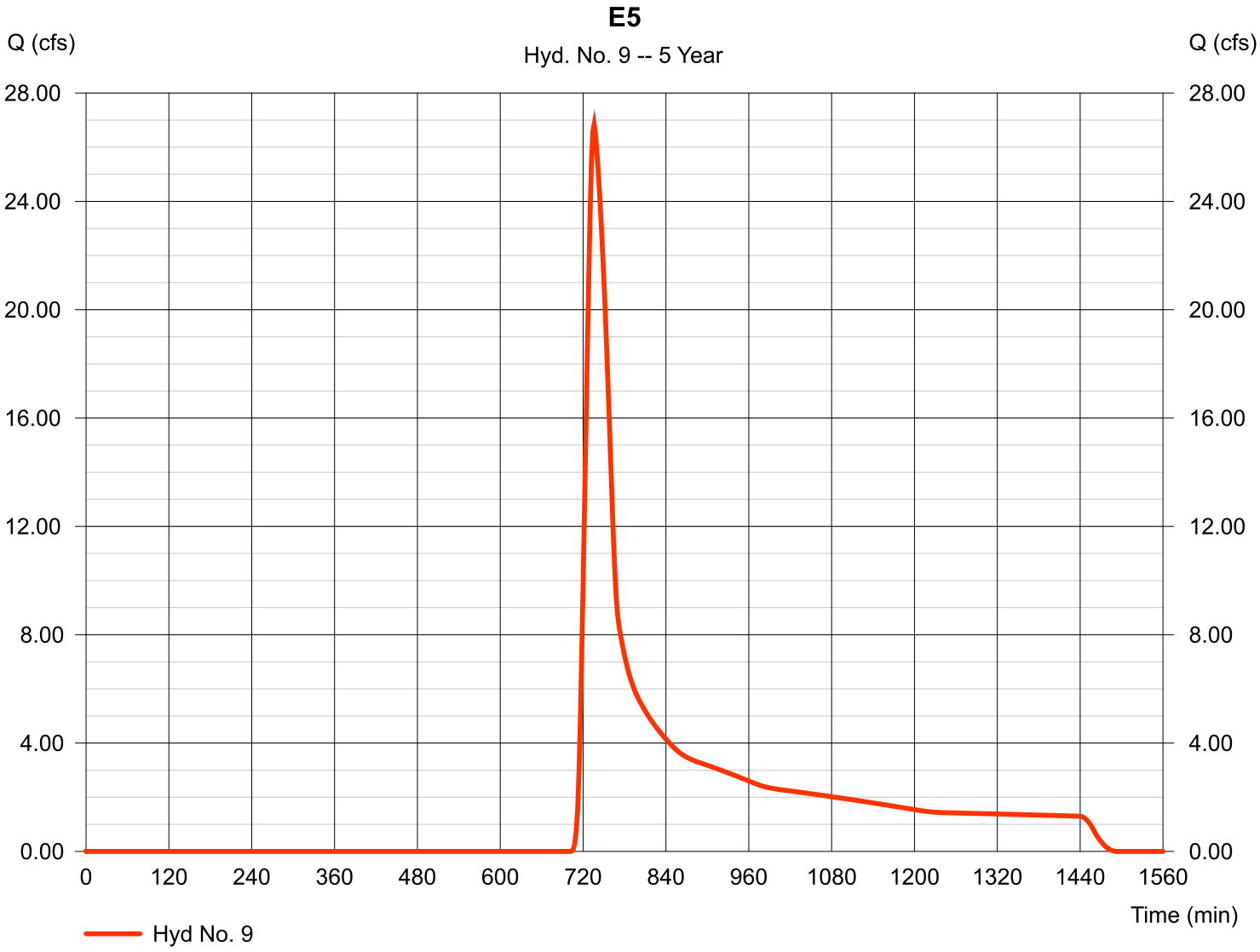
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Thursday, 01 / 17 / 2019

Hyd. No. 9

E5

Hydrograph type	=	SCS Runoff	Peak discharge	=	26.83 cfs
Storm frequency	=	5 yrs	Time to peak	=	736 min
Time interval	=	2 min	Hyd. volume	=	157,934 cuft
Drainage area	=	89.810 ac	Curve number	=	68*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	32.10 min
Total precip.	=	2.70 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.840 x 93) + (0.790 x 91) + (17.640 x 61) + (70.540 x 69)] / 89.810



TR55 Tc Worksheet

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

Hyd. No. 9

E5

Description	A		B		C		Totals
Sheet Flow							
Manning's n-value	= 0.130		0.011		0.011		
Flow length (ft)	= 300.0		0.0		0.0		
Two-year 24-hr precip. (in)	= 2.10		0.00		0.00		
Land slope (%)	= 2.50		0.00		0.00		
Travel Time (min)	**= 23.76**	**+**	**0.00**	**+**	**0.00**	**=**	**23.76**
Shallow Concentrated Flow							
Flow length (ft)	= 1280.00		0.00		0.00		
Watercourse slope (%)	= 2.50		0.00		0.00		
Surface description	= Unpaved		Paved		Paved		
Average velocity (ft/s)	=2.55		0.00		0.00		
Travel Time (min)	**= 8.36**	**+**	**0.00**	**+**	**0.00**	**=**	**8.36**
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 ..... 32.10 min

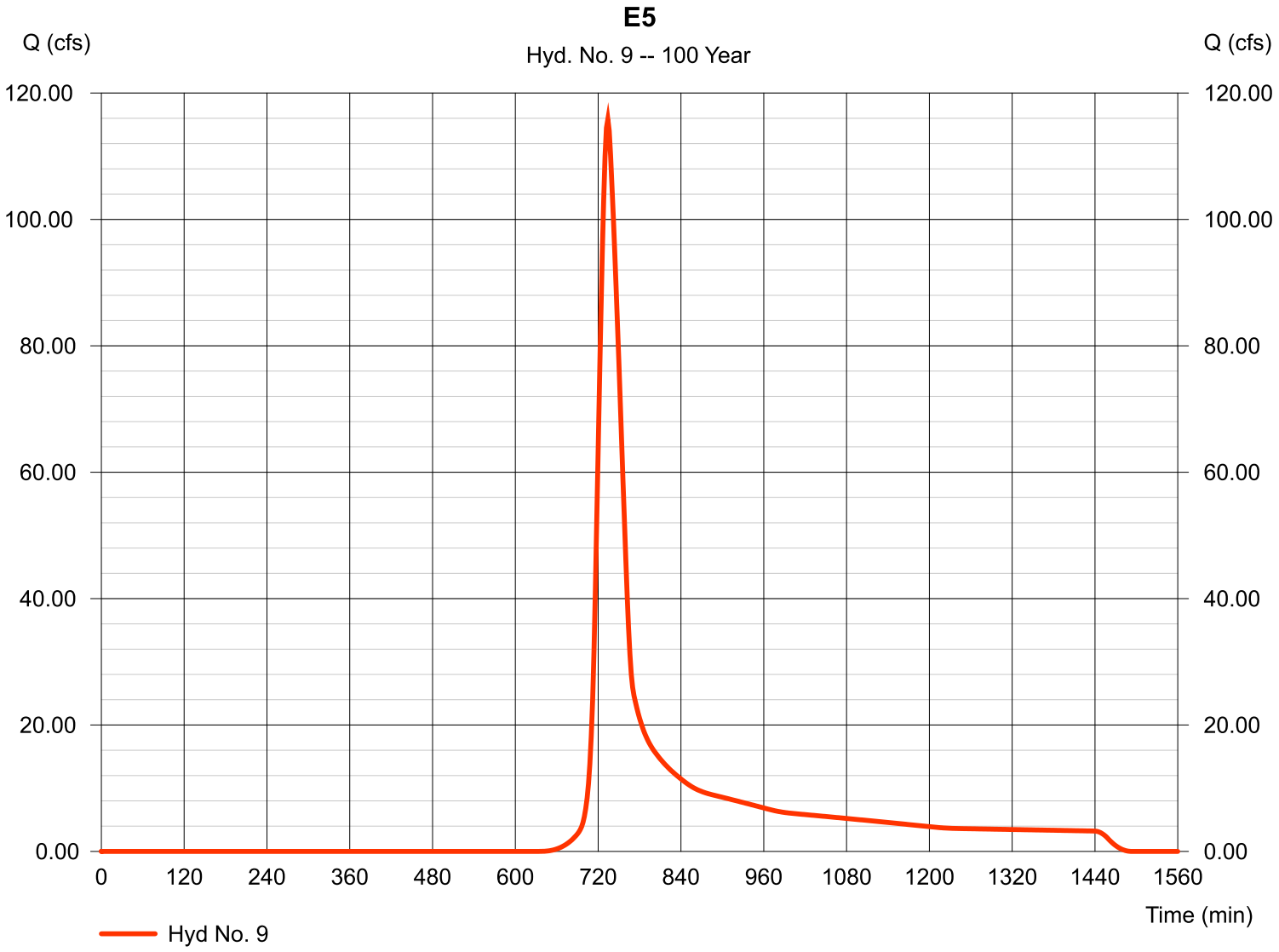
Hydrograph Report

Hyd. No. 9

E5

Hydrograph type	=	SCS Runoff	Peak discharge	=	115.84 cfs
Storm frequency	=	100 yrs	Time to peak	=	734 min
Time interval	=	2 min	Hyd. volume	=	528,273 cuft
Drainage area	=	89.810 ac	Curve number	=	68*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	32.10 min
Total precip.	=	4.60 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.840 x 93) + (0.790 x 91) + (17.640 x 61) + (70.540 x 69)] / 89.810



Hydrograph Report

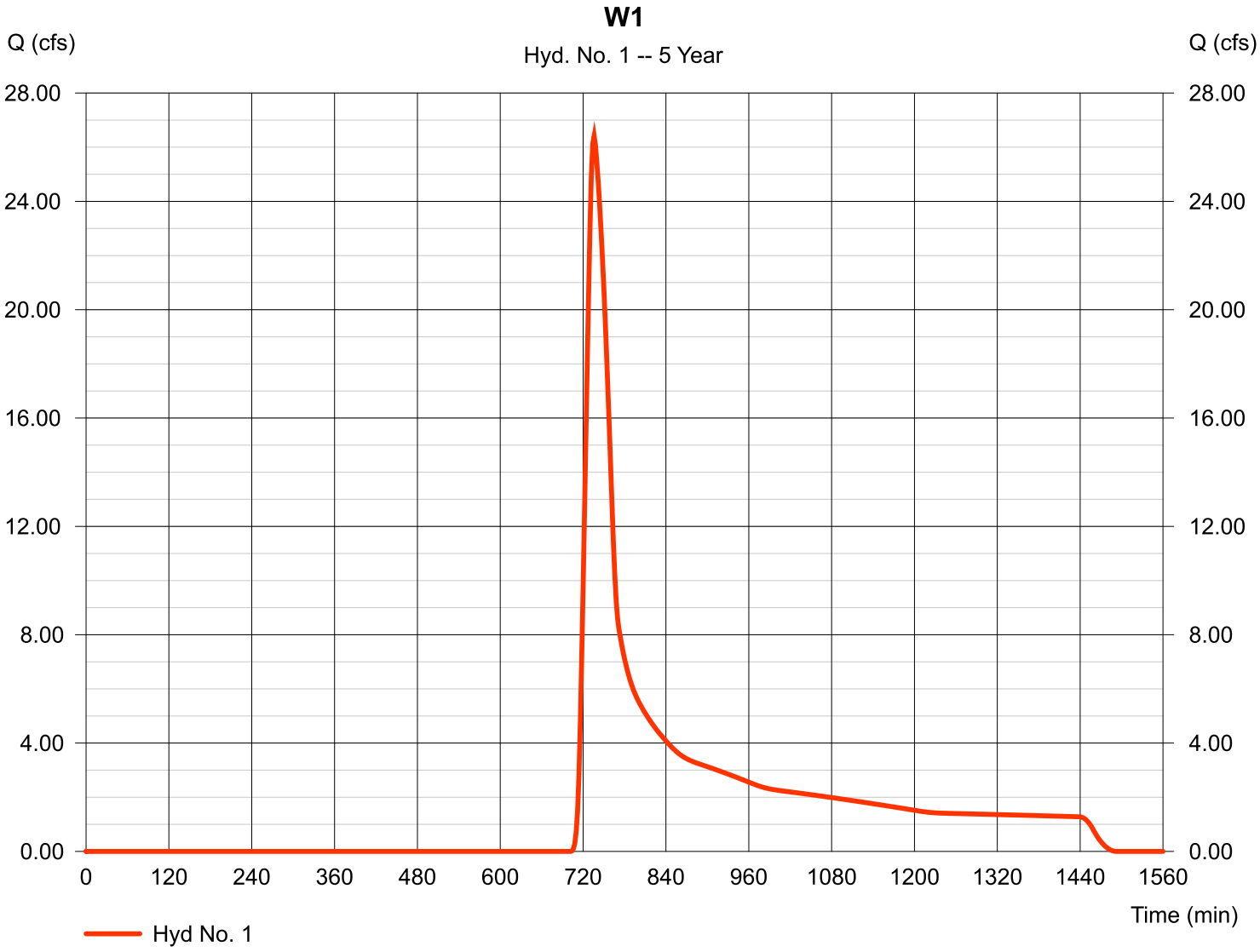
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Thursday, 01 / 17 / 2019

Hyd. No. 1

W1

Hydrograph type	=	SCS Runoff	Peak discharge	=	26.41 cfs
Storm frequency	=	5 yrs	Time to peak	=	736 min
Time interval	=	2 min	Hyd. volume	=	155,454 cuft
Drainage area	=	88.400 ac	Curve number	=	68*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	30.90 min
Total precip.	=	2.70 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = + (1.580 x 91) + (17.360 x 61) + (69.460 x 69)] / 88.400



TR55 Tc Worksheet

Hyd. No. 1

W1

Description	A		B		C		Totals
Sheet Flow							
Manning's n-value	= 0.130		0.011		0.011		
Flow length (ft)	= 300.0		0.0		0.0		
Two-year 24-hr precip. (in)	= 2.10		0.00		0.00		
Land slope (%)	= 2.30		0.00		0.00		
Travel Time (min)	**= 24.56**	**+**	**0.00**	**+**	**0.00**	**=**	**24.56**
Shallow Concentrated Flow							
Flow length (ft)	= 1255.00		0.00		0.00		
Watercourse slope (%)	= 4.20		0.00		0.00		
Surface description	= Unpaved		Paved		Paved		
Average velocity (ft/s)	=3.31		0.00		0.00		
Travel Time (min)	**= 6.33**	**+**	**0.00**	**+**	**0.00**	**=**	**6.33**
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	= 0.030		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 ..... 30.90 min

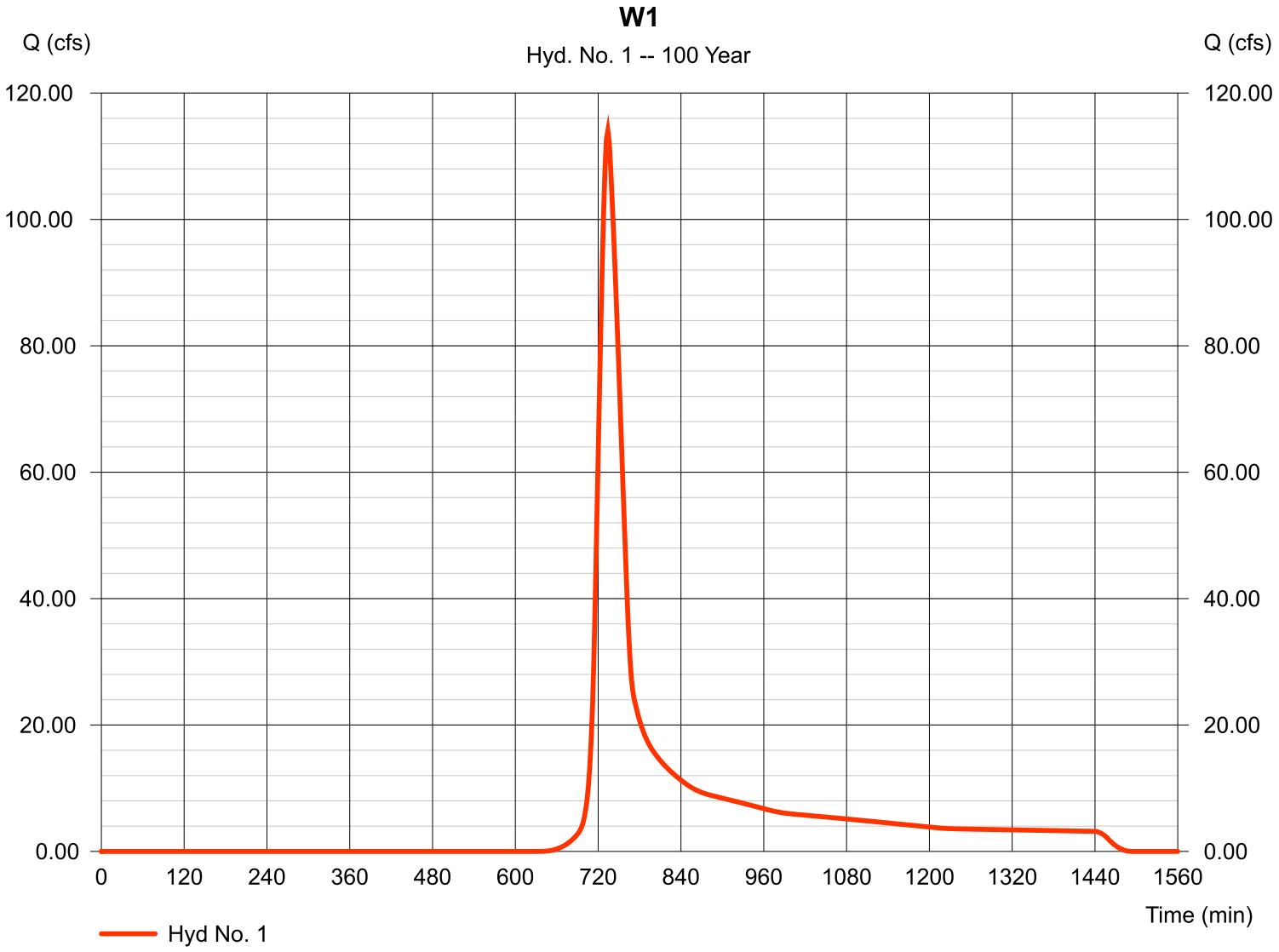
Hydrograph Report

Hyd. No. 1

W1

Hydrograph type	=	SCS Runoff	Peak discharge	=	114.02 cfs
Storm frequency	=	100 yrs	Time to peak	=	734 min
Time interval	=	2 min	Hyd. volume	=	519,979 cuft
Drainage area	=	88.400 ac	Curve number	=	68*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	30.90 min
Total precip.	=	4.60 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = + (1.580 x 91) + (17.360 x 61) + (69.460 x 69)] / 88.400



Hydrograph Report

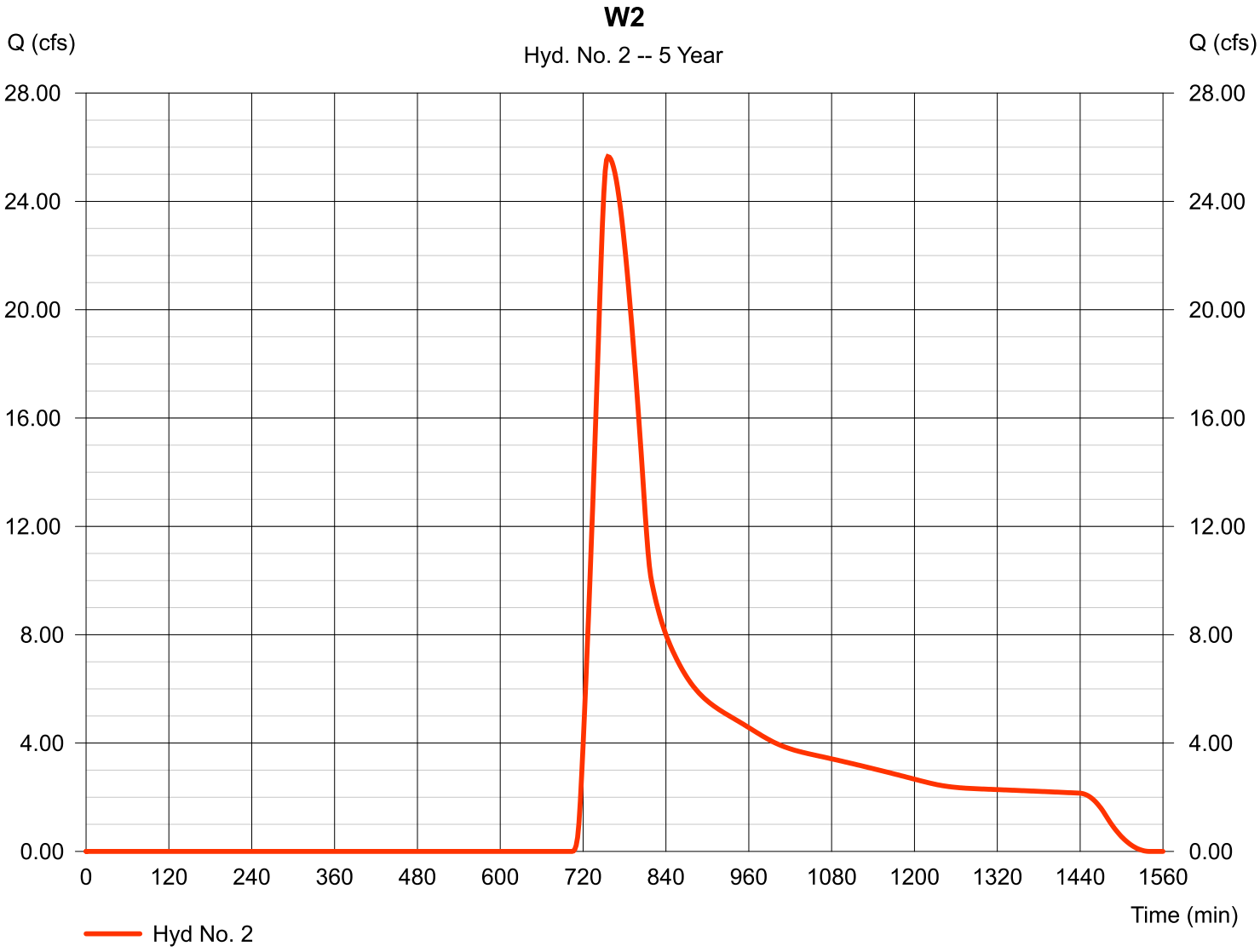
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Thursday, 01 / 17 / 2019

Hyd. No. 2

W2

Hydrograph type	=	SCS Runoff	Peak discharge	=	25.65 cfs
Storm frequency	=	5 yrs	Time to peak	=	756 min
Time interval	=	2 min	Hyd. volume	=	250,096 cuft
Drainage area	=	154.600 ac	Curve number	=	67*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	62.00 min
Total precip.	=	2.70 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = + (0.090 x 91) + (30.900 x 61) + (123.610 x 69)] / 154.600



TR55 Tc Worksheet

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

Hyd. No. 2

W2

Description	A		B		C		Totals
Sheet Flow							
Manning's n-value	= 0.130		0.011		0.011		
Flow length (ft)	= 300.0		0.0		0.0		
Two-year 24-hr precip. (in)	= 2.10		0.00		0.00		
Land slope (%)	= 2.00		0.00		0.00		
Travel Time (min)	**= 25.98**	**+**	**0.00**	**+**	**0.00**	**=**	**25.98**
Shallow Concentrated Flow							
Flow length (ft)	= 3485.00		0.00		0.00		
Watercourse slope (%)	= 1.00		0.00		0.00		
Surface description	= Unpaved		Paved		Paved		
Average velocity (ft/s)	=1.61		0.00		0.00		
Travel Time (min)	**= 36.00**	**+**	**0.00**	**+**	**0.00**	**=**	**36.00**
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 ..... 62.00 min

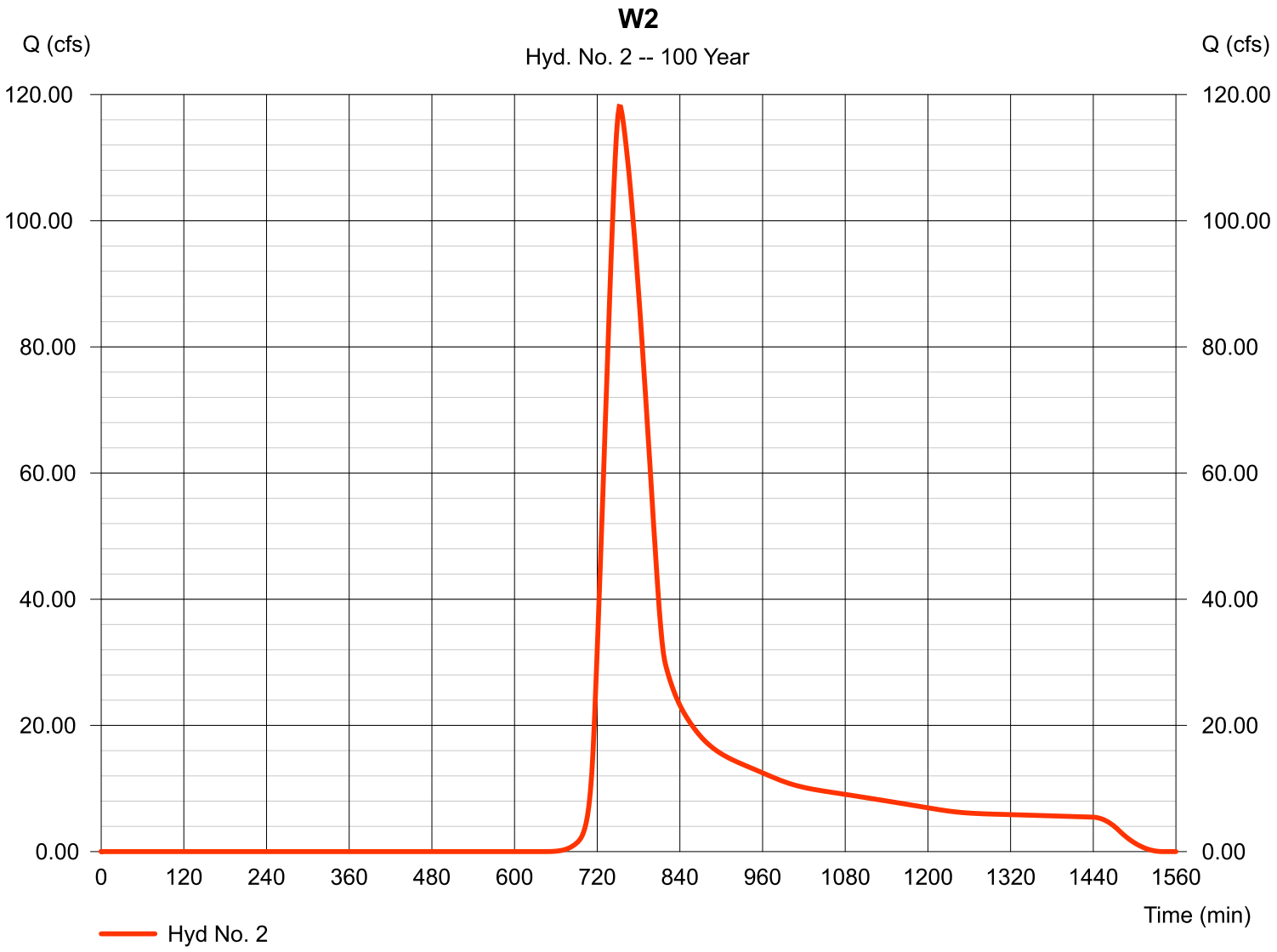
Hydrograph Report

Hyd. No. 2

W2

Hydrograph type	=	SCS Runoff	Peak discharge	=	118.10 cfs
Storm frequency	=	100 yrs	Time to peak	=	752 min
Time interval	=	2 min	Hyd. volume	=	864,348 cuft
Drainage area	=	154.600 ac	Curve number	=	67*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	62.00 min
Total precip.	=	4.60 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = + (0.090 x 91) + (30.900 x 61) + (123.610 x 69)] / 154.600



Hydrograph Report

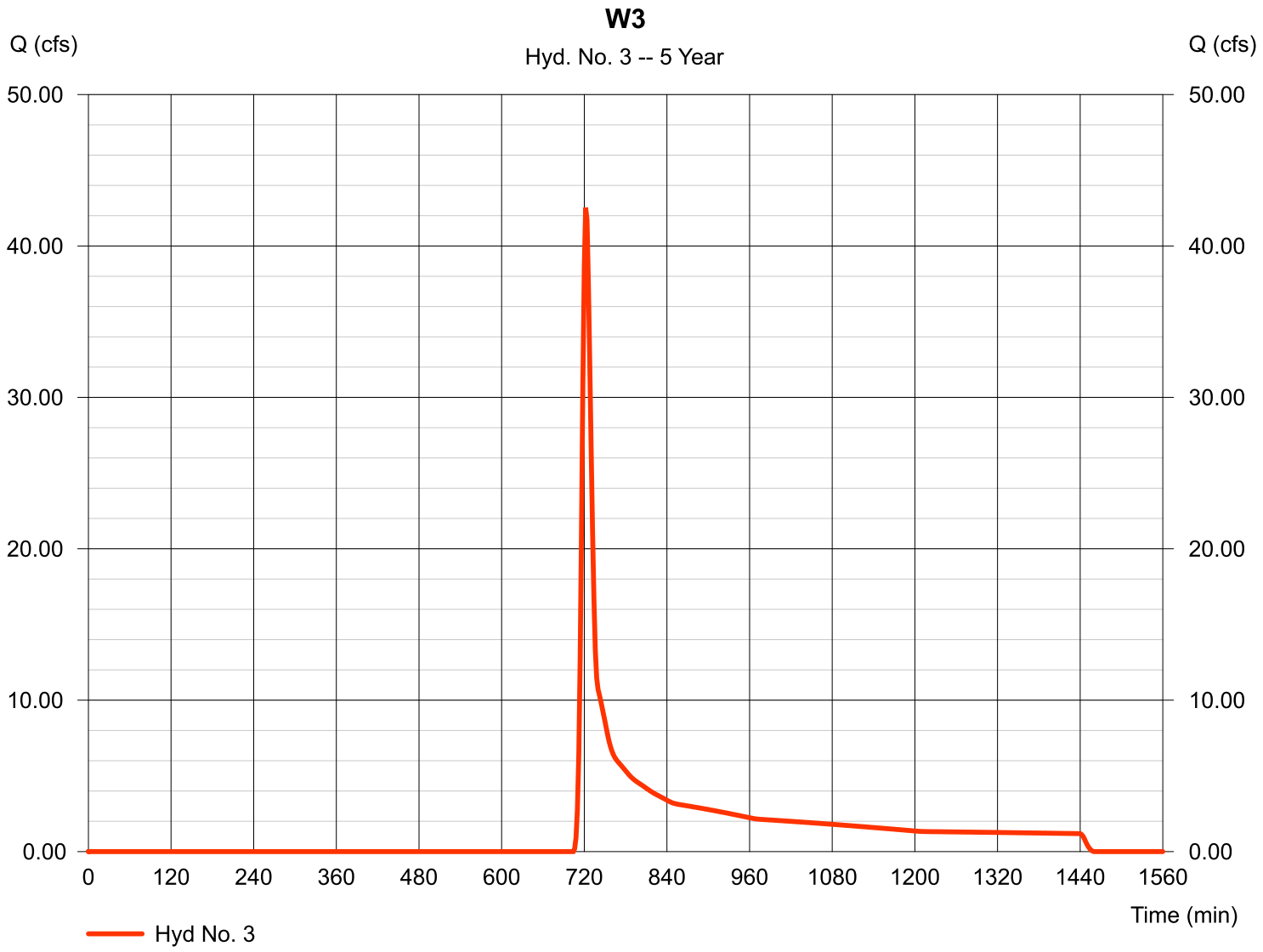
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Thursday, 01 / 17 / 2019

Hyd. No. 3

W3

Hydrograph type	=	SCS Runoff	Peak discharge	=	42.53 cfs
Storm frequency	=	5 yrs	Time to peak	=	722 min
Time interval	=	2 min	Hyd. volume	=	140,692 cuft
Drainage area	=	84.890 ac	Curve number	=	67*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	10.10 min
Total precip.	=	2.70 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(18.180 x 61) + (72.730 x 69) + (0.360 x 91)] / 84.890



TR55 Tc Worksheet

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

Hyd. No. 3

W3

Description	A		B		C		Totals
Sheet Flow							
Manning's n-value	= 0.013		0.011		0.011		
Flow length (ft)	= 300.0		0.0		0.0		
Two-year 24-hr precip. (in)	= 2.10		0.00		0.00		
Land slope (%)	= 6.30		0.00		0.00		
Travel Time (min)	**= 2.60**	**+**	**0.00**	**+**	**0.00**	**=**	**2.60**
Shallow Concentrated Flow							
Flow length (ft)	= 1400.00		0.00		0.00		
Watercourse slope (%)	= 3.70		0.00		0.00		
Surface description	= Unpaved		Paved		Paved		
Average velocity (ft/s)	=3.10		0.00		0.00		
Travel Time (min)	**= 7.52**	**+**	**0.00**	**+**	**0.00**	**=**	**7.52**
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 ..... 10.10 min

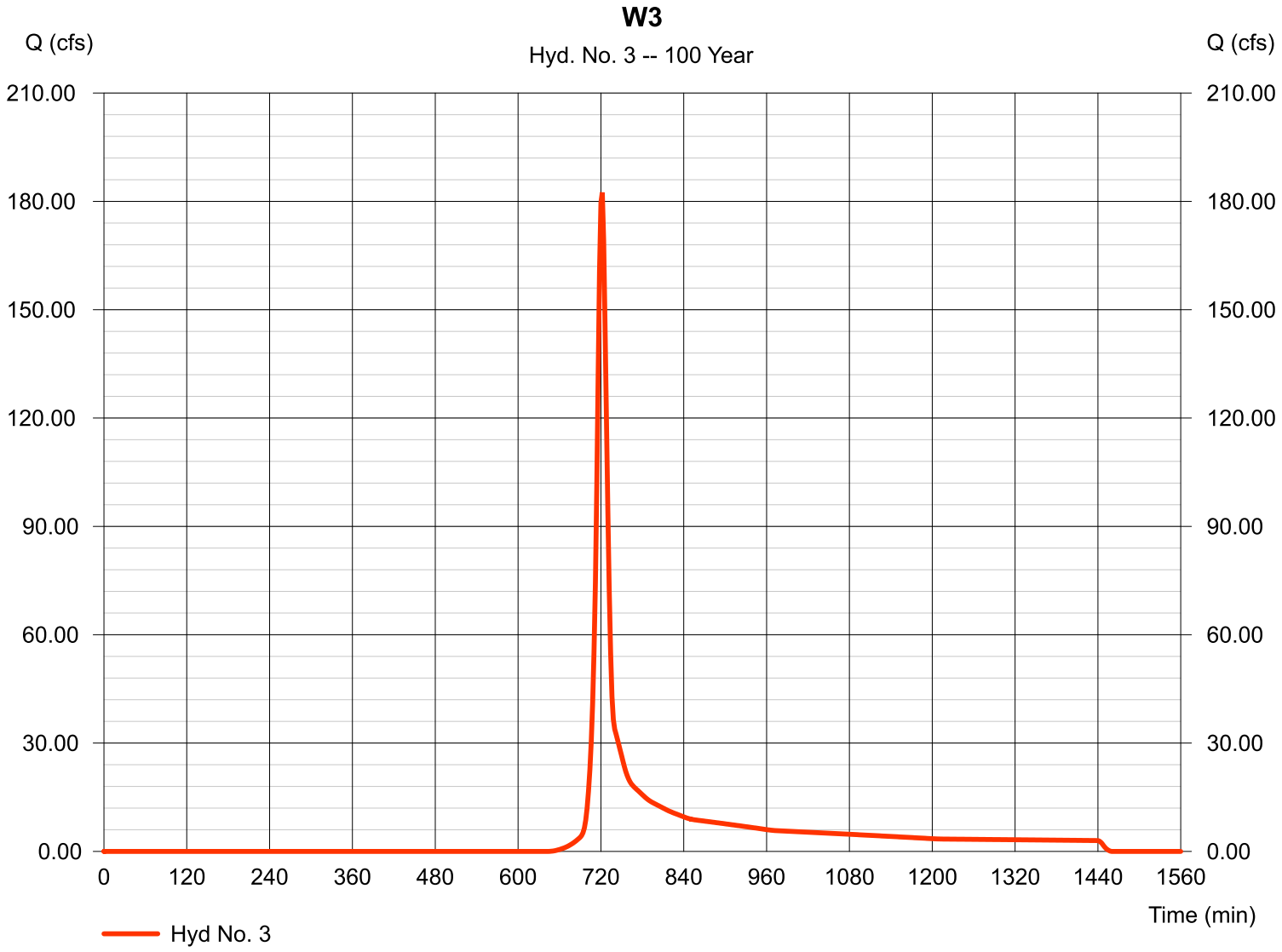
Hydrograph Report

Hyd. No. 3

W3

Hydrograph type	=	SCS Runoff	Peak discharge	=	182.48 cfs
Storm frequency	=	100 yrs	Time to peak	=	722 min
Time interval	=	2 min	Hyd. volume	=	486,241 cuft
Drainage area	=	84.890 ac	Curve number	=	67*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	10.10 min
Total precip.	=	4.60 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(18.180 x 61) + (72.730 x 69) + (0.360 x 91)] / 84.890



Hydrograph Report

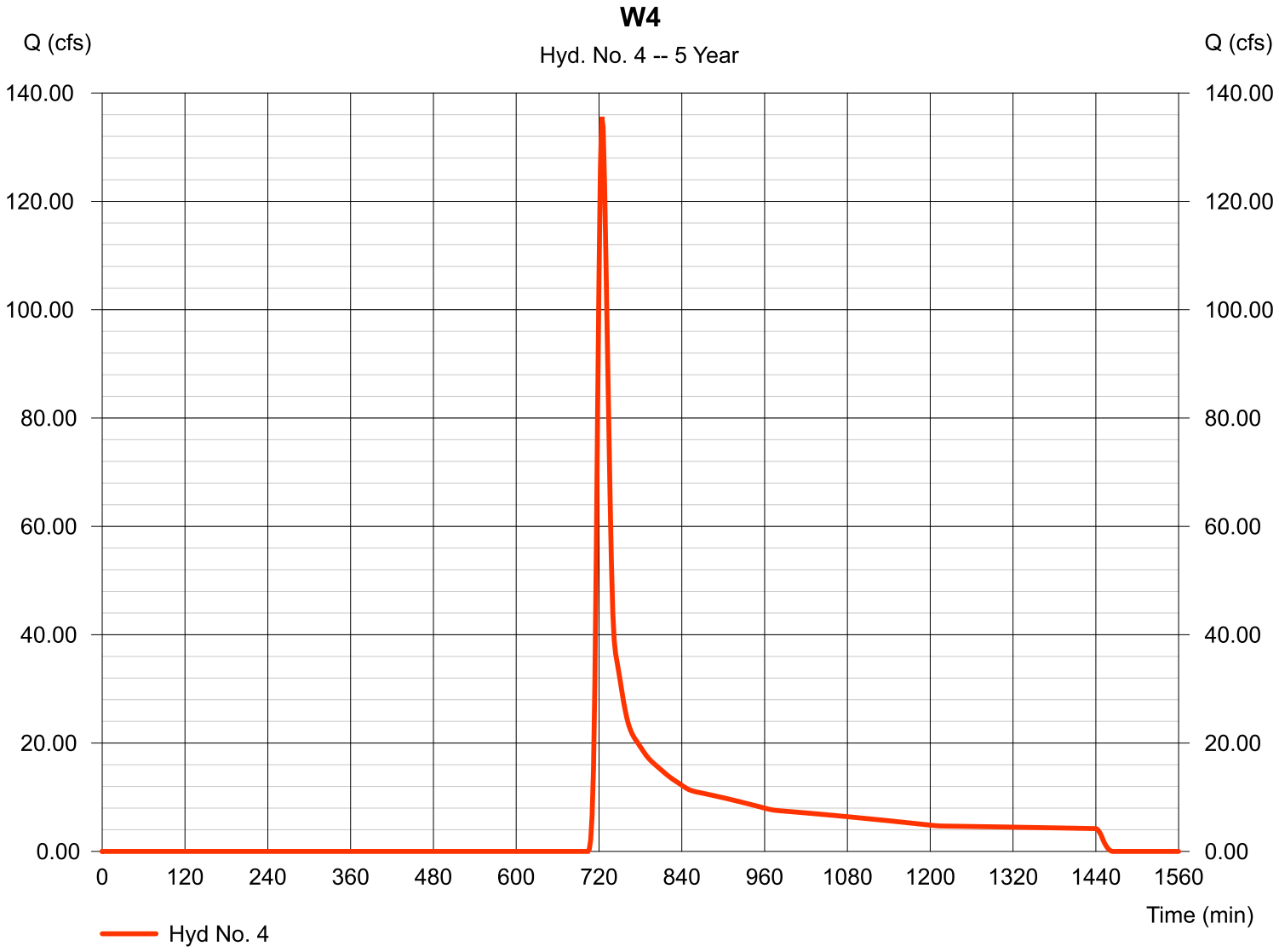
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Thursday, 01 / 17 / 2019

Hyd. No. 4

W4

Hydrograph type	= SCS Runoff	Peak discharge	= 135.61 cfs
Storm frequency	= 5 yrs	Time to peak	= 724 min
Time interval	= 2 min	Hyd. volume	= 498,524 cuft
Drainage area	= 318.150 ac	Curve number	= 67*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 15.80 min
Total precip.	= 2.70 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(63.630 x 61) + (254.520 x 69)] / 318.150



TR55 Tc Worksheet

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

Hyd. No. 4

W4

Description	A		B		C		Totals
Sheet Flow							
Manning's n-value	= 0.011		0.011		0.011		
Flow length (ft)	= 300.0		0.0		0.0		
Two-year 24-hr precip. (in)	= 2.10		0.00		0.00		
Land slope (%)	= 3.90		0.00		0.00		
Travel Time (min)	**= 2.76**	**+**	**0.00**	**+**	**0.00**	**=**	**2.76**
Shallow Concentrated Flow							
Flow length (ft)	= 2400.00		0.00		0.00		
Watercourse slope (%)	= 3.90		0.00		0.00		
Surface description	= Unpaved		Paved		Paved		
Average velocity (ft/s)	=3.19		0.00		0.00		
Travel Time (min)	**= 12.55**	**+**	**0.00**	**+**	**0.00**	**=**	**12.55**
Channel Flow							
X sectional flow area (sqft)	= 87450.00		0.00		0.00		
Wetted perimeter (ft)	= 1275.00		0.00		0.00		
Channel slope (%)	= 1.00		0.00		0.00		
Manning's n-value	= 0.030		0.015		0.015		
Velocity (ft/s)	=84.40						
			0.00				
					0.00		
Flow length (ft)	({0})2700.0		0.0		0.0		
Travel Time (min)	**= 0.53**	**+**	**0.00**	**+**	**0.00**	**=**	**0.53**

Total Travel Time, Tc ..... 15.80 min

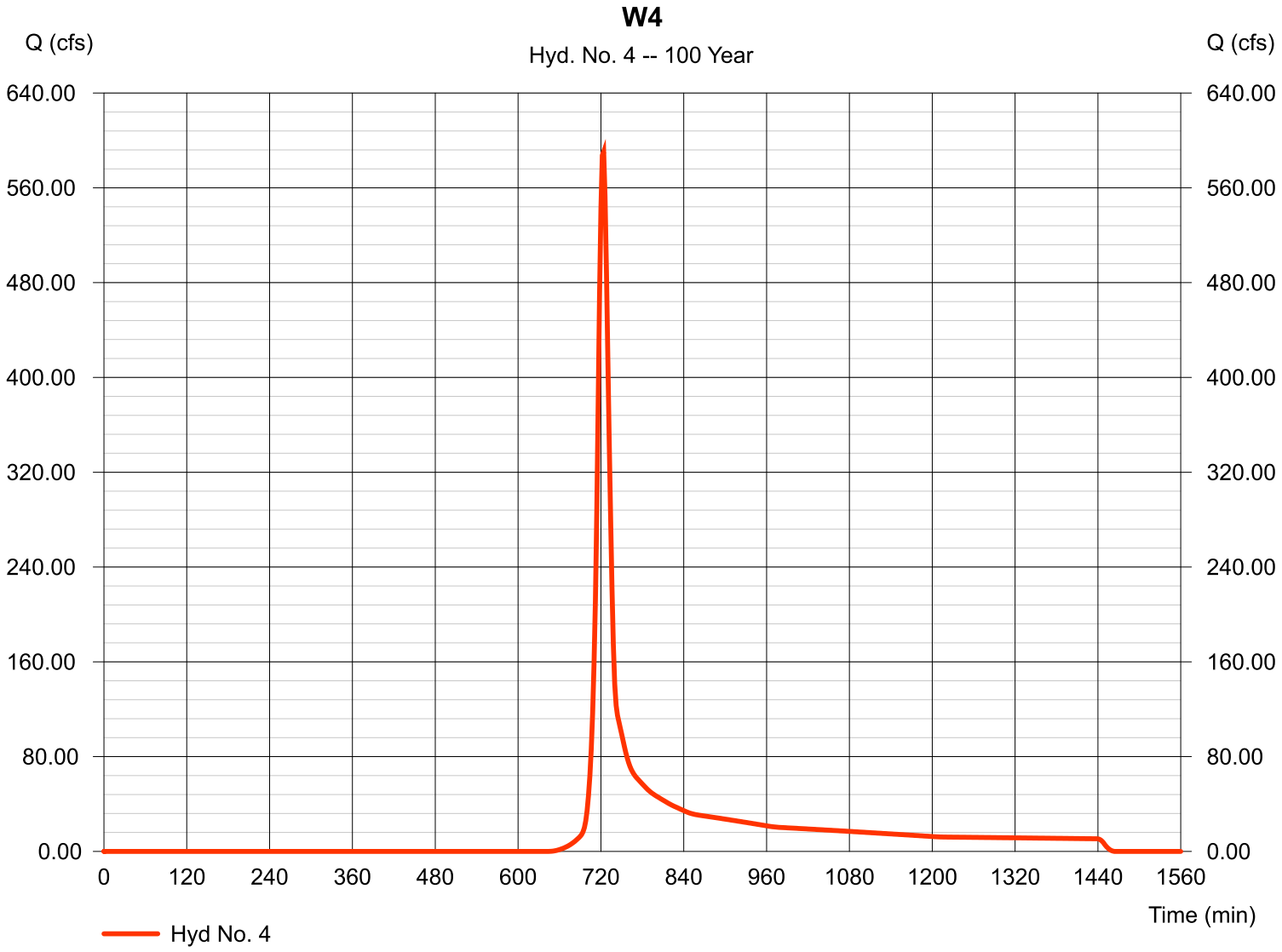
Hydrograph Report

Hyd. No. 4

W4

Hydrograph type	=	SCS Runoff	Peak discharge	=	590.53 cfs
Storm frequency	=	100 yrs	Time to peak	=	724 min
Time interval	=	2 min	Hyd. volume	=	1,722,931 cuft
Drainage area	=	318.150 ac	Curve number	=	67*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	15.80 min
Total precip.	=	4.60 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(63.630 x 61) + (254.520 x 69)] / 318.150



HYDRAULIC CALCULATIONS

Cross Section for Drainage Channel

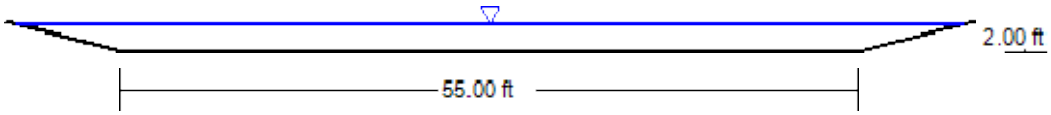
Project Description

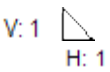
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.030	
Channel Slope	0.00700	ft/ft
Normal Depth	2.00	ft
Left Side Slope	4.00	ft/ft (H:V)
Right Side Slope	4.00	ft/ft (H:V)
Bottom Width	55.00	ft
Discharge	762.73	ft³/s

Cross Section Image





Worksheet for Drainage Channel

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.030	
Channel Slope	0.00700	ft/ft
Left Side Slope	4.00	ft/ft (H:V)
Right Side Slope	4.00	ft/ft (H:V)
Bottom Width	55.00	ft
Discharge	762.73	ft^3/s

Results

Normal Depth	2.00	ft
Flow Area	126.11	ft^2
Wetted Perimeter	71.51	ft
Hydraulic Radius	1.76	ft
Top Width	71.01	ft
Critical Depth	1.74	ft
Critical Slope	0.01140	ft/ft
Velocity	6.05	ft/s
Velocity Head	0.57	ft
Specific Energy	2.57	ft
Froude Number	0.80	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	2.00	ft
Critical Depth	1.74	ft
Channel Slope	0.00700	ft/ft

Worksheet for Drainage Channel

GVF Output Data

Critical Slope	0.01140	ft/ft

Cross Section for Trapezoidal Roadside Ditch

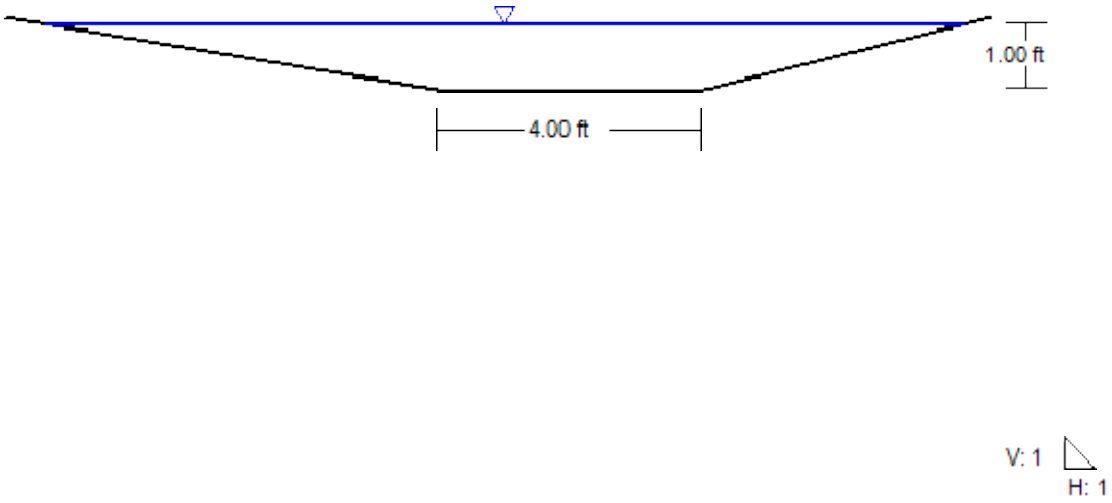
Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Roughness Coefficient	0.030	
Channel Slope	0.00500	ft/ft
Normal Depth	1.00	ft
Left Side Slope	6.00	ft/ft (H:V)
Right Side Slope	4.00	ft/ft (H:V)
Bottom Width	4.00	ft
Discharge	23.25	ft³/s

Cross Section Image



Worksheet for Trapezoidal Roadside Ditch

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Roughness Coefficient	0.030	
Channel Slope	0.00500	ft/ft
Normal Depth	1.00	ft
Left Side Slope	6.00	ft/ft (H:V)
Right Side Slope	4.00	ft/ft (H:V)
Bottom Width	4.00	ft

Results

Discharge	23.25	ft^3/s
Flow Area	9.00	ft^2
Wetted Perimeter	14.21	ft
Hydraulic Radius	0.63	ft
Top Width	14.00	ft
Critical Depth	0.75	ft
Critical Slope	0.01678	ft/ft
Velocity	2.58	ft/s
Velocity Head	0.10	ft
Specific Energy	1.10	ft
Froude Number	0.57	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	1.00	ft
Critical Depth	0.75	ft
Channel Slope	0.00500	ft/ft

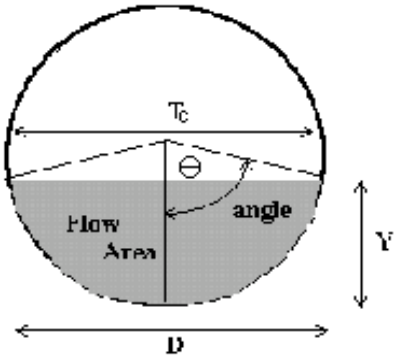
Worksheet for Trapezoidal Roadside Ditch

GVF Output Data

Critical Slope	0.01678	ft/ft

CIRCULAR CONDUIT FLOW (Normal & Critical Depth Computation)

Project: Palmer Solar Facility
Pipe ID: 18" Culvert



Design Information (Input)			
Pipe Invert Slope	So =	0.0100	ft/ft
Pipe Manning's n-value	n =	0.0130	
Pipe Diameter	D =	18.00	inches
Design discharge	**Q =**	**10.53**	**cfs**

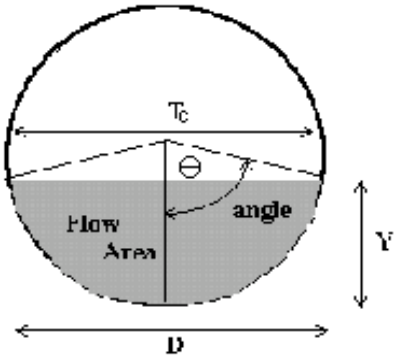
Full-flow Capacity (Calculated)			
Full-flow area	Af =	1.77	sq ft
Full-flow wetted perimeter	Pf =	4.71	ft
Half Central Angle	Theta =	3.14	radians
Full-flow capacity	Qf =	10.53	cfs

Calculation of Normal Flow Condition			
Half Central Angle (0<Theta<3.14)	Theta =	2.26	radians
Flow area	An =	1.55	sq ft
Top width	Tn =	1.15	ft
Wetted perimeter	Pn =	3.40	ft
Flow depth	Yn =	1.23	ft
Flow velocity	Vn =	6.79	fps
Discharge	Qn =	10.53	cfs
Percent Full Flow	Flow =	100.0%	of full flow
Normal Depth Froude Number	Fr_n =	1.03	supercritical

Calculation of Critical Flow Condition			
Half Central Angle (0<Theta-c<3.14)	Theta-c =	2.29	radians
Critical flow area	Ac =	1.57	sq ft
Critical top width	Tc =	1.12	ft
Critical flow depth	Yc =	1.25	ft
Critical flow velocity	Vc =	6.71	fps
Critical Depth Froude Number	Fr_c =	1.00	

CIRCULAR CONDUIT FLOW (Normal & Critical Depth Computation)

Project: Palmer Solar Facility
Pipe ID: 24" Culvert Maximum Capacity



Design Information (Input)			
Pipe Invert Slope	So =	0.0100	ft/ft
Pipe Manning's n-value	n =	0.0130	
Pipe Diameter	D =	24.00	inches
Design discharge	**Q =**	**22.68**	**cfs**

Full-flow Capacity (Calculated)			
Full-flow area	Af =	3.14	sq ft
Full-flow wetted perimeter	Pf =	6.28	ft
Half Central Angle	Theta =	3.14	radians
Full-flow capacity	Qf =	22.68	cfs

Calculation of Normal Flow Condition			
Half Central Angle (0<Theta<3.14)	Theta =	2.26	radians
Flow area	An =	2.76	sq ft
Top width	Tn =	1.54	ft
Wetted perimeter	Pn =	4.53	ft
Flow depth	Yn =	1.64	ft
Flow velocity	Vn =	8.23	fps
Discharge	Qn =	22.68	cfs
Percent Full Flow	Flow =	100.0%	of full flow
Normal Depth Froude Number	Fr_n =	1.08	supercritical

Calculation of Critical Flow Condition			
Half Central Angle (0<Theta-c<3.14)	Theta-c =	2.34	radians
Critical flow area	Ac =	2.84	sq ft
Critical top width	Tc =	1.44	ft
Critical flow depth	Yc =	1.70	ft
Critical flow velocity	Vc =	7.98	fps
Critical Depth Froude Number	Fr_c =	1.00	

Rip-Rap Calculation
DRAINAGE CHANNEL

.

Applicable Equations:

$L_p = (1/2\tan\Theta)(A_t/Y_t-D)$	Equation 9-11 per USCDM
$A_t = Q/V$	Equation 9-12 per USDCM
$\Theta = \tan^{-1}(1/(2*\text{ExpansionFactor}))$	Equation 9-13 per USDCM
$W = 2(L_p\tan\Theta)+D$	Equation 9-14 per USDCM
$T = 2D_{50}$	Equation 9-15 per USDCM

Assumptions

Maximum Major Event Velocity is 7fps for FES outletting into trickle channels

Input parameters:

Description		Variable	Input	Unit
Width of the conduit (use diameter for circular conduits),		D:	55.00	ft
HGL Elevation			1.74	ft
Invert Elevation			0.00	ft
Tailwater depth (ft),		Y_t:	1.74	ft
Expansion angle of the culvert flow		Θ:	0.79	radians
Design discharge (cfs)*		Q:	762.73	cfs
Froude Number		F_r	0.04	Subcritical
Unitless Variables for Tables:				
	For Figure 9-35	$Q/D^{2.5}$	0.03	
	For Figure 9-35	Y_t/D	0.03	
	For Figure 9-38	$Q/D^{1.5}$	1.87	
	For Figure 9-38	Y_t/D	0.03	
Allowable non-eroding velocity in the downstream channel (ft/sec)		V:	2	ft/sec
Expansion Factor (Figure 9-35), 1/(2tan(θ))			0.5	

Solve for:

Description	Variable	Output	Unit
1. Required area of flow at allowable velocity (ft^2)	A_t:	381.37	ft^2
2. Length of Protection	L_p:	82.09	ft
	$L_p < 3D$?	Yes	
	L_{pmin}:	165.00	ft
3. Width of downstream riprap protection	W:	385.00	ft
4. Rip Rap Type (Figure 9-38)	-	H	
5. Rip Rap Size (Figure 8-34)	D_{50}:	18	inches

Rip Rap Summary

Length	L_p	165.00	ft
Width	W	385.00	ft
Size	D_{50}	18	inches
Type	-	H	-
Thickness	T	36	inches

Rip-Rap Calculation
CULVERT OUTFALL

.

Applicable Equations:

$L_p = (1/2\tan\Theta)(A_t/Y_t - D)$	Equation 9-11 per USCDM
$A_t = Q/V$	Equation 9-12 per USDCM
$\Theta = \tan^{-1}(1/(2*\text{ExpansionFactor}))$	Equation 9-13 per USDCM
$W = 2(L_p\tan\Theta)+D$	Equation 9-14 per USDCM
$T = 2D_{50}$	Equation 9-15 per USDCM

Assumptions

Maximum Major Event Velocity is 7fps for FES outletting into trickle channels

Input parameters:

Description		Variable	Input	Unit
Width of the conduit (use diameter for circular conduits),		D:	2.00	ft
HGL Elevation			1.64	ft
Invert Elevation			0.00	ft
Tailwater depth (ft),		Y_t:	1.64	ft
Expansion angle of the culvert flow		Θ:	0.07	radians
Design discharge (cfs)*		Q:	22.68	cfs
Froude Number		F_r	0.99	Subcritical
Unitless Variables for Tables:				
	For Figure 9-35	$Q/D^{2.5}$	4.01	
	For Figure 9-35	Y_t/D	0.82	
	For Figure 9-38	$Q/D^{1.5}$	8.02	
	For Figure 9-38	Y_t/D	0.82	
Allowable non-eroding velocity in the downstream channel (ft/sec)		V:	2	ft/sec
Expansion Factor (Figure 9-35), 1/(2tan(θ))			6.7	

Solve for:

Description	Variable	Output	Unit
1. Required area of flow at allowable velocity (ft^2)	A_t:	11.34	ft^2
2. Length of Protection	L_p:	32.93	ft
	$L_p < 3D$?	No	
	L_{pmin}:	32.93	ft
3. Width of downstream riprap protection	W:	7.00	ft
4. Rip Rap Type (Figure 9-38)	-	L	
5. Rip Rap Size (Figure 8-34)	D_{50}:	9	inches

Rip Rap Summary

Length	L_p	33.00	ft
Width	W	7.00	ft
Size	D_{50}	9	inches
Type	-	L	-
Thickness	T	18	inches

Rip-Rap Calculation
CONVEYANCE DITCH 1

.

Applicable Equations:

$L_p = (1/2\tan\Theta)(A_t/Y_t-D)$	Equation 9-11 per USCDM
$A_t = Q/V$	Equation 9-12 per USDCM
$\Theta = \tan^{-1}(1/(2*\text{ExpansionFactor}))$	Equation 9-13 per USDCM
$W = 2(L_p\tan\Theta)+D$	Equation 9-14 per USDCM
$T = 2D_{50}$	Equation 9-15 per USDCM

Assumptions

Maximum Major Event Velocity is 7fps for FES outletting into trickle channels

Input parameters:

Description		Variable	Input	Unit
Width of the conduit (use diameter for circular conduits),		D:	8.00	ft
HGL Elevation			0.41	ft
Invert Elevation			0.00	ft
Tailwater depth (ft),		Y_t:	0.41	ft
Expansion angle of the culvert flow		Θ:	0.46	radians
Design discharge (cfs)*		Q:	24.22	cfs
Froude Number		F_r	0.13	Subcritical
Unitless Variables for Tables:				
	For Figure 9-35	$Q/D^{2.5}$	0.13	
	For Figure 9-35	Y_t/D	0.05	
	For Figure 9-38	$Q/D^{1.5}$	1.07	
	For Figure 9-38	Y_t/D	0.05	
Allowable non-eroding velocity in the downstream channel (ft/sec)		V:	4	ft/sec
Expansion Factor (Figure 9-35), 1/(2tan(θ))			1	

Solve for:

Description	Variable	Output	Unit
1. Required area of flow at allowable velocity (ft^2)	A_t:	6.06	ft^2
2. Length of Protection	L_p:	6.77	ft
	L_p < 3D?	Yes	
	L_{pmin}:	24.00	ft
3. Width of downstream riprap protection	W:	32.00	ft
4. Rip Rap Type (Figure 9-38)	-	L	
5. Rip Rap Size (Figure 8-34)	D_{50}:	9	inches

Rip Rap Summary

Length	L_p	24.00	ft
Width	W	32.00	ft
Size	D_{50}	9	inches
Type	-	L	-
Thickness	T	18	inches

Rip-Rap Calculation
CONVEYANCE DITCH 2

.

Applicable Equations:

$L_p = (1/2\tan\Theta)(A_t/Y_t-D)$	Equation 9-11 per USCDM
$A_t = Q/V$	Equation 9-12 per USDCM
$\Theta = \tan^{-1}(1/(2*\text{ExpansionFactor}))$	Equation 9-13 per USDCM
$W = 2(L_p\tan\Theta)+D$	Equation 9-14 per USDCM
$T = 2D_{50}$	Equation 9-15 per USDCM

Assumptions

Maximum Major Event Velocity is 7fps for FES outletting into trickle channels

Input parameters:

Description		Variable	Input	Unit
Width of the conduit (use diameter for circular conduits),		D:	4.00	ft
HGL Elevation			0.64	ft
Invert Elevation			0.00	ft
Tailwater depth (ft),		Y_t:	0.64	ft
Expansion angle of the culvert flow		Θ:	0.17	radians
Design discharge (cfs)*		Q:	25.47	cfs
Froude Number		F_r	0.45	Subcritical
Unitless Variables for Tables:				
	For Figure 9-35	$Q/D^{2.5}$	0.80	
	For Figure 9-35	Y_t/D	0.16	
	For Figure 9-38	$Q/D^{1.5}$	3.18	
	For Figure 9-38	Y_t/D	0.16	
Allowable non-eroding velocity in the downstream channel (ft/sec)		V:	4	ft/sec
Expansion Factor (Figure 9-35), 1/(2tan(θ))			3	

Solve for:

Description	Variable	Output	Unit
1. Required area of flow at allowable velocity (ft^2)	A_t:	6.37	ft^2
2. Length of Protection	L_p:	17.85	ft
	$L_p < 3D$?	No	
	L_{pmin}:	17.85	ft
3. Width of downstream riprap protection	W:	10.00	ft
4. Rip Rap Type (Figure 9-38)	-	L	
5. Rip Rap Size (Figure 8-34)	D_{50}:	9	inches

Rip Rap Summary

Length	L_p	18.00	ft
Width	W	10.00	ft
Size	D_{50}	9	inches
Type	-	L	-
Thickness	T	18	inches

Rip-Rap Calculation
CONVEYANCE DITCH 3

.

Applicable Equations:

$L_p = (1/2\tan\Theta)(A_t/Y_t - D)$	Equation 9-11 per USCDM
$A_t = Q/V$	Equation 9-12 per USDCM
$\Theta = \tan^{-1}(1/(2*\text{ExpansionFactor}))$	Equation 9-13 per USDCM
$W = 2(L_p\tan\Theta)+D$	Equation 9-14 per USDCM
$T = 2D_{50}$	Equation 9-15 per USDCM

Assumptions

Maximum Major Event Velocity is 7fps for FES outletting into trickle channels

Input parameters:

Description		Variable	Input	Unit
Width of the conduit (use diameter for circular conduits),		D:	8.00	ft
HGL Elevation			0.75	ft
Invert Elevation			0.00	ft
Tailwater depth (ft),		Y_t:	0.75	ft
Expansion angle of the culvert flow		Θ:	0.20	radians
Design discharge (cfs)*		Q:	46.26	cfs
Froude Number		F_r	0.19	Subcritical
Unitless Variables for Tables:				
	For Figure 9-35	$Q/D^{2.5}$	0.26	
	For Figure 9-35	Y_t/D	0.09	
	For Figure 9-38	$Q/D^{1.5}$	2.04	
	For Figure 9-38	Y_t/D	0.09	
Allowable non-eroding velocity in the downstream channel (ft/sec)		V:	4	ft/sec
Expansion Factor (Figure 9-35), 1/(2tan(θ))			2.5	

Solve for:

Description	Variable	Output	Unit
1. Required area of flow at allowable velocity (ft^2)	A_t:	11.57	ft^2
2. Length of Protection	L_p:	18.55	ft
	L_p < 3D?	Yes	
	L_{pmin}:	24.00	ft
3. Width of downstream riprap protection	W:	18.00	ft
4. Rip Rap Type (Figure 9-38)	-	L	
5. Rip Rap Size (Figure 8-34)	D_{50}:	9	inches

Rip Rap Summary

Length	L_p	24.00	ft
Width	W	18.00	ft
Size	D_{50}	9	inches
Type	-	L	-
Thickness	T	18	inches

Rip-Rap Calculation
CONVEYANCE DITCH 4

.

Applicable Equations:

$L_p = (1/2\tan\Theta)(A_t/Y_t - D)$	Equation 9-11 per USCDM
$A_t = Q/V$	Equation 9-12 per USDCM
$\Theta = \tan^{-1}(1/(2*\text{ExpansionFactor}))$	Equation 9-13 per USDCM
$W = 2(L_p\tan\Theta)+D$	Equation 9-14 per USDCM
$T = 2D_{50}$	Equation 9-15 per USDCM

Assumptions

Maximum Major Event Velocity is 7fps for FES outletting into trickle channels

Input parameters:

Description		Variable	Input	Unit
Width of the conduit (use diameter for circular conduits),		D:	4.00	ft
HGL Elevation			1.23	ft
Invert Elevation			0.00	ft
Tailwater depth (ft),		Y_t:	1.23	ft
Expansion angle of the culvert flow		Θ:	0.09	radians
Design discharge (cfs)*		Q:	49.37	cfs
Froude Number		F_r	0.62	Subcritical
Unitless Variables for Tables:				
	For Figure 9-35	$Q/D^{2.5}$	1.54	
	For Figure 9-35	Y_t/D	0.31	
	For Figure 9-38	$Q/D^{1.5}$	6.17	
	For Figure 9-38	Y_t/D	0.31	
Allowable non-eroding velocity in the downstream channel (ft/sec)		V:	4	ft/sec
Expansion Factor (Figure 9-35), 1/(2tan(θ))			5.5	

Solve for:

Description	Variable	Output	Unit
1. Required area of flow at allowable velocity (ft^2)	A_t:	12.34	ft^2
2. Length of Protection	L_p:	33.19	ft
	$L_p < 3D$?	No	
	L_{pmin}:	33.19	ft
3. Width of downstream riprap protection	W:	10.00	ft
4. Rip Rap Type (Figure 9-38)	-	L	
5. Rip Rap Size (Figure 8-34)	D_{50}:	9	inches

Rip Rap Summary

Length	L_p	33.00	ft
Width	W	10.00	ft
Size	D_{50}	9	inches
Type	-	L	-
Thickness	T	18	inches

Rip-Rap Calculation
CONVEYANCE DITCH 5

.

Applicable Equations:

$L_p = (1/2\tan\Theta)(A_t/Y_t-D)$	Equation 9-11 per USCDM
$A_t = Q/V$	Equation 9-12 per USDCM
$\Theta = \tan^{-1}(1/(2*\text{ExpansionFactor}))$	Equation 9-13 per USDCM
$W = 2(L_p\tan\Theta)+D$	Equation 9-14 per USDCM
$T = 2D_{50}$	Equation 9-15 per USDCM

Assumptions

Maximum Major Event Velocity is 7fps for FES outletting into trickle channels

Input parameters:

Description		Variable	Input	Unit
Width of the conduit (use diameter for circular conduits),		D:	8.00	ft
HGL Elevation			1.79	ft
Invert Elevation			0.00	ft
Tailwater depth (ft),		Y_t:	1.79	ft
Expansion angle of the culvert flow		Θ:	0.09	radians
Design discharge (cfs)*		Q:	93.44	cfs
Froude Number		F_r	0.24	Subcritical
Unitless Variables for Tables:				
	For Figure 9-35	$Q/D^{2.5}$	0.52	
	For Figure 9-35	Y_t/D	0.22	
	For Figure 9-38	$Q/D^{1.5}$	4.13	
	For Figure 9-38	Y_t/D	0.22	
Allowable non-eroding velocity in the downstream channel (ft/sec)		V:	4	ft/sec
Expansion Factor (Figure 9-35), 1/(2tan(θ))			5.8	

Solve for:

Description	Variable	Output	Unit
1. Required area of flow at allowable velocity (ft^2)	A_t:	23.36	ft^2
2. Length of Protection	L_p:	29.29	ft
	$L_p < 3D$?	No	
	L_{pmin}:	29.29	ft
3. Width of downstream riprap protection	W:	13.00	ft
4. Rip Rap Type (Figure 9-38)	-	L	
5. Rip Rap Size (Figure 8-34)	D_{50}:	9	inches

Rip Rap Summary

Length	L_p	29.00	ft
Width	W	13.00	ft
Size	D_{50}	9	inches
Type	-	L	-
Thickness	T	18	inches

DRAINAGE MAPS

LEGEND

A = BASIN DESIGNATION
B = AREA (ACRES)
C = CURVE NUMBER
D = 100YR DESIGN STORM RUNOFF (CFS)

= DESIGN POINT

FLOW DIRECTION

DRAINAGE BASIN BOUNDARY

XXXX EXISTING MAJOR CONTOUR (25 FT)

XXXX EXISTING MINOR CONTOUR (5 FT)

Existing Runoff

BASIN	DESIGN POINT	BASIN AREA (ACRES)	DIRECT 5-YR RUNOFF (CFS)	DIRECT 100-YR RUNOFF (CFS)
W1	1	88.40	23.37	107.98
W2	2	151.66	25.17	115.88
W3	3	91.27	45.72	196.20
W4	4	303.81	129.49	563.91
E1	5	776.17	115.86	530.57
E2	6	24.35	5.99	27.66
E3	7	90.83	24.02	110.95
TOTAL		1526.50	369.62	1653.15

KEYMAP

811 Know what's below. Call before you dig.

GRAPHIC SCALE IN FEET
0 125 250 500

NORTH

Kimley»Horn

2 North Nevada Avenue, Suite 300
Colorado Springs, Colorado 80903 (719) 453-0180

PALMER SOLAR-EXISTING DRAINAGE MAP

LEGEND

A = BASIN DESIGNATION
B = AREA (ACRES)
C = CURVE NUMBER
D = 100YR DESIGN STORM RUNOFF (CFS)

= DESIGN POINT

FLOW DIRECTION

DRAINAGE BASIN BOUNDARY

XXXX EXISTING MAJOR CONTOUR (25 FT)

XXXX EXISTING MINOR CONTOUR (5 FT)

Existing Runoff

BASIN	DESIGN POINT	BASIN AREA (ACRES)	DIRECT 5-YR RUNOFF (CFS)	DIRECT 100-YR RUNOFF (CFS)
W1	1	88.40	23.37	107.98
W2	2	151.66	25.17	115.88
W3	3	91.27	45.72	196.20
W4	4	303.81	129.49	563.91
E1	5	776.17	115.86	530.57
E2	6	24.35	5.99	27.66
E3	7	90.83	24.02	110.95
TOTAL		1526.50	369.62	1653.15

TC PATH

HAROLD SNOWDEN
SYLVIA BYSON
13425 MOONSHADOW LANE

W4
303.8 | 67 | 563.91

PROPERTY LINE

W3
91.27 | 67 | 196.20

DANIEL MCCARTAN
8790 BIRDSALL RD

PROPERTY LINE

BIRDSALL ROAD

TC PATH

EXISTING POND

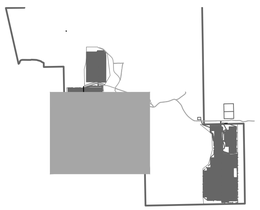
PROPERTY LINE

BIRDSALL ROAD

PROPERTY LINE

TC PATH

KEYMAP



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Existing Runoff

BASIN	BASIN AREA (ACRES)	DIRECT 5-YR RUNOFF (CFS)	DIRECT 100-YR RUNOFF (CFS)
W1	94.49	24.99	115.43
W2	151.66	25.17	115.88
W3	91.27	45.72	196.20
W4	303.81	129.49	563.91
E1	776.17	115.86	530.57
E2	24.35	5.99	27.66
E3	90.83	24.02	110.95
TOTAL	1532.59	371.24	1660.60

Horn

ATES, INC.

719) 453-0180

STING DRAINAGE MAP

LEGEND

A = BASIN DESIGNATION
B = AREA (ACRES)
C = CURVE NUMBER
D = 100YR DESIGN STORM RUNOFF (CFS)

= DESIGN POINT

FLOW DIRECTION

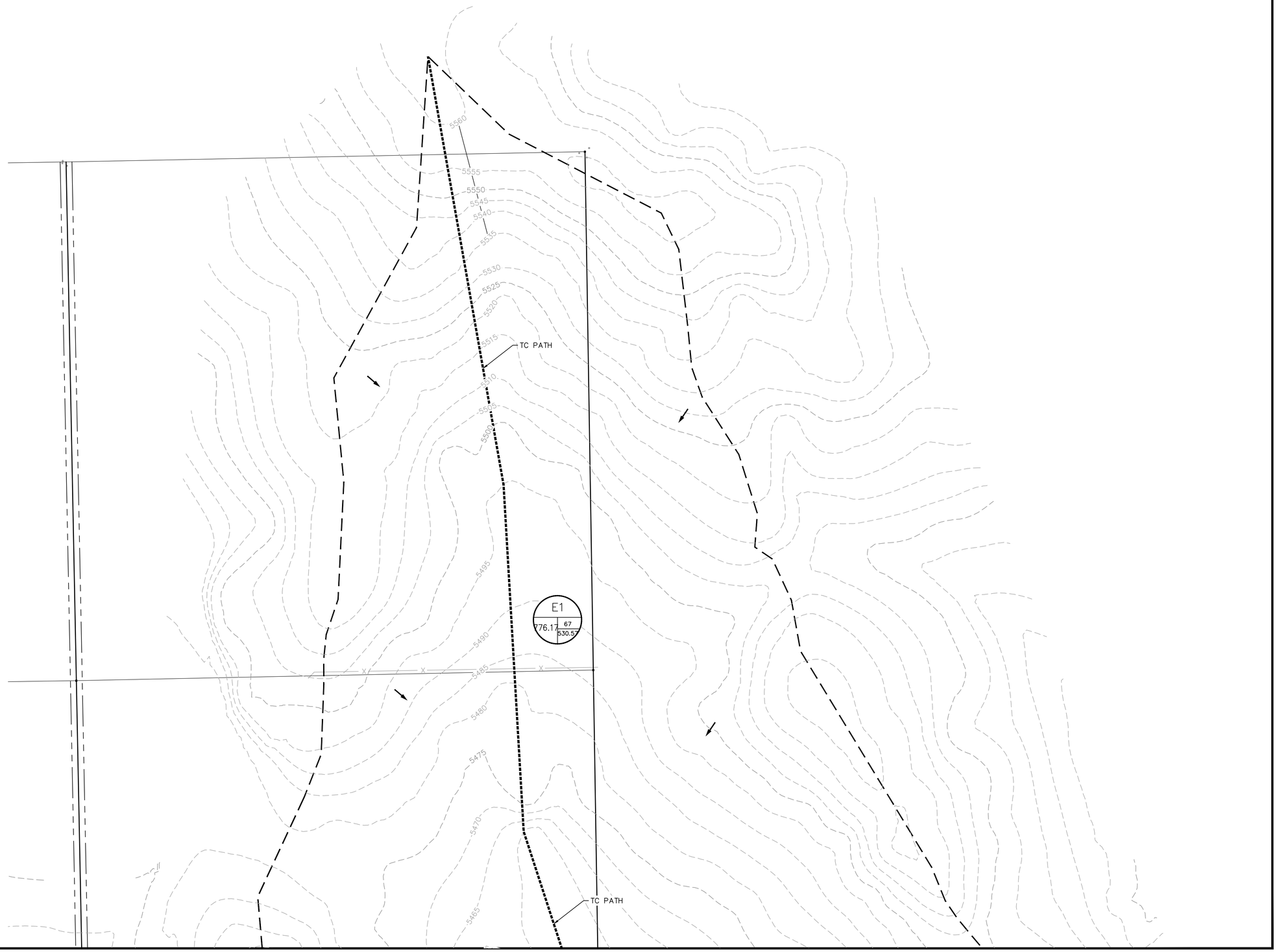
DRAINAGE BASIN BOUNDARY

XXXX EXISTING MAJOR CONTOUR (25 FT)

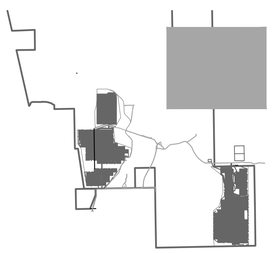
XXXX EXISTING MINOR CONTOUR (5 FT)

Existing Runoff

BASIN	DESIGN POINT	BASIN AREA (ACRES)	DIRECT 5-YR RUNOFF (CFS)	DIRECT 100-YR RUNOFF (CFS)
W1	1	88.40	23.37	107.98
W2	2	151.66	25.17	115.88
W3	3	91.27	45.72	196.20
W4	4	303.81	129.49	563.91
E1	5	776.17	115.86	530.57
E2	6	24.35	5.99	27.66
E3	7	90.83	24.02	110.95
TOTAL		1526.50	369.62	1653.15



KEYMAP



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GRAPHIC SCALE IN FEET
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Colorado Springs, Colorado 80903 (719) 453-0180

PALMER SOLAR-EXISTING DRAINAGE MAP

LEGEND

A = BASIN DESIGNATION
B = AREA (ACRES)
C = CURVE NUMBER
D = 100YR DESIGN STORM RUNOFF (CFS)

= DESIGN POINT

FLOW DIRECTION

DRAINAGE BASIN BOUNDARY

XXXX EXISTING MAJOR CONTOUR (25 FT)

XXXX EXISTING MINOR CONTOUR (5 FT)

Existing Runoff

BASIN	DESIGN POINT	BASIN AREA (ACRES)	DIRECT 5-YR RUNOFF (CFS)	DIRECT 100-YR RUNOFF (CFS)
W1	1	88.40	23.37	107.98
W2	2	151.66	25.17	115.88
W3	3	91.27	45.72	196.20
W4	4	303.81	129.49	563.91
E1	5	776.17	115.86	530.57
E2	6	24.35	5.99	27.66
E3	7	90.83	24.02	110.95
TOTAL		1526.50	369.62	1653.15

TC PATH

WOODMOOR WATER AND SANITATION DISTRICT SCHEDULE NUMBER 5600000122

E1
776.17 | 67 | 530.57

PROPERTY LINE

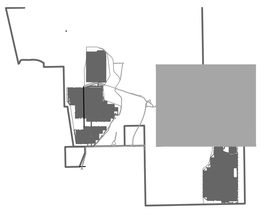
CITY OF COLORADO SPRINGS SCHEDULE NUMBER 5600000123

CSU SUBSTATION

PROPERTY LINE

TC PATH

KEYMAP



Know what's below. Call before you dig.

GRAPHIC SCALE IN FEET
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PALMER SOLAR-EXISTING DRAINAGE MAP

LEGEND

A = BASIN DESIGNATION
B = AREA (ACRES)
C = CURVE NUMBER
D = 100YR DESIGN STORM RUNOFF (CFS)

= DESIGN POINT

FLOW DIRECTION

DRAINAGE BASIN BOUNDARY

XXXX EXISTING MAJOR CONTOUR (25 FT)

XXXX EXISTING MINOR CONTOUR (5 FT)

Existing Runoff

BASIN	DESIGN POINT	BASIN AREA (ACRES)	DIRECT 5-YR RUNOFF (CFS)	DIRECT 100-YR RUNOFF (CFS)
W1	1	88.40	23.37	107.98
W2	2	151.66	25.17	115.88
W3	3	91.27	45.72	196.20
W4	4	303.81	129.49	563.91
E1	5	776.17	115.86	530.57
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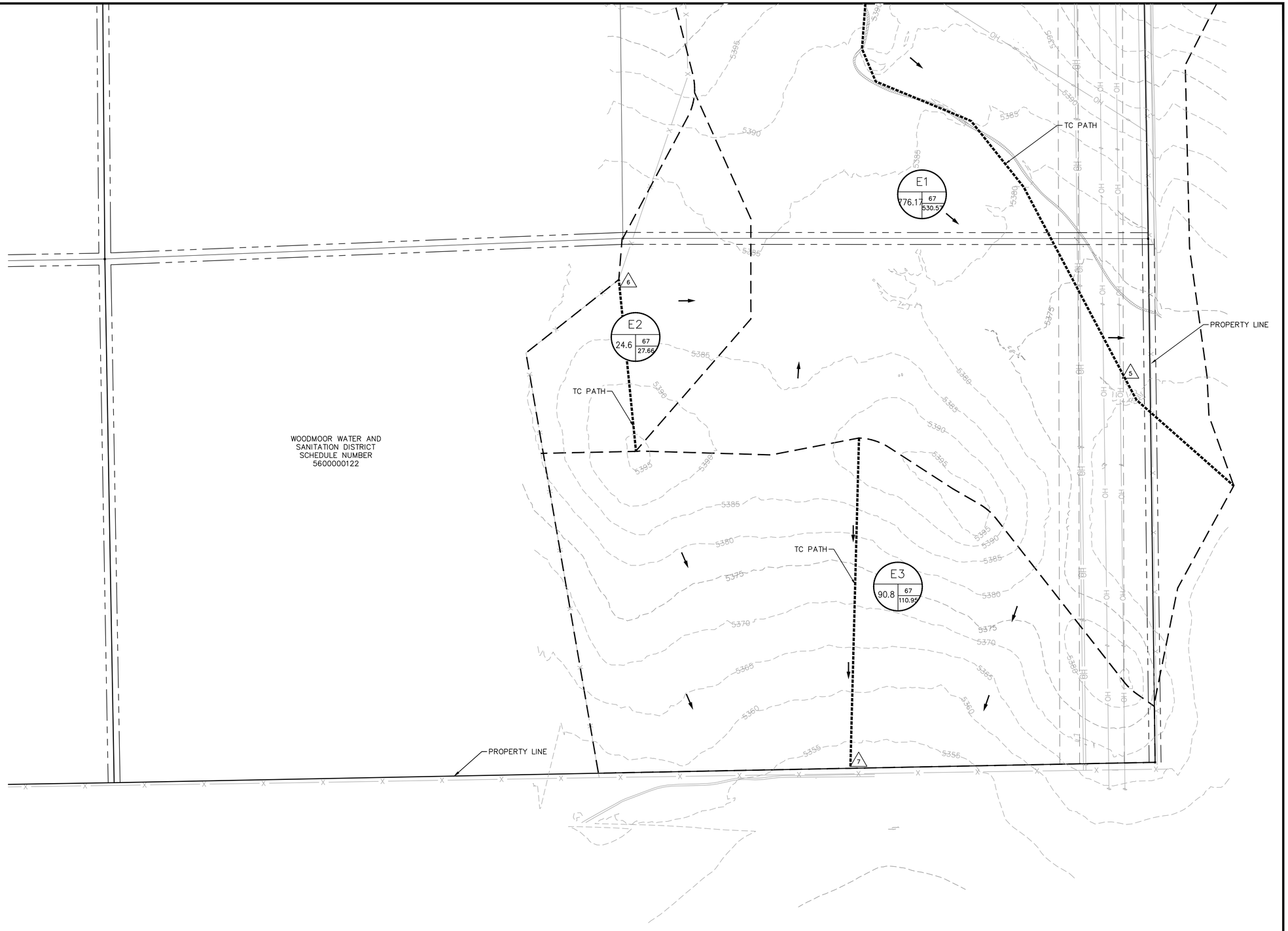
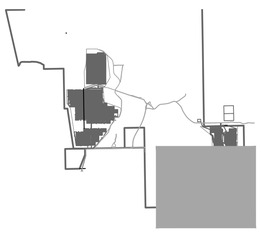


KEYMAP



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GRAPHIC SCALE IN FEET
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PALMER SOLAR-EXISTING DRAINAGE MAP

LEGEND

A = BASIN DESIGNATION
B = AREA (ACRES)
C = CURVE NUMBER
D = 100YR DESIGN STORM RUNOFF (CFS)

= DESIGN POINT

FLOW DIRECTION

DRAINAGE BASIN BOUNDARY

EMERGENCY OVERFLOW PATH

XXXX PROPOSED MAJOR CONTOUR

XXXX PROPOSED MINOR CONTOUR

XXXX EXISTING MAJOR CONTOUR

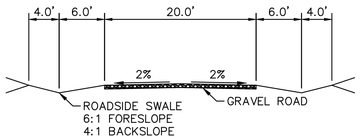
XXXX EXISTING MINOR CONTOUR

ROADSIDE SWALE/DITCH

PROPOSED CULVERT

BASIN	DESIGN POINT	BASIN AREA (ACRES)	DIRECT 5-YR RUNOFF (CFS)	DIRECT 100-YR RUNOFF (CFS)
W1	1	88.40	26.41	114.02
W2	2	154.60	25.65	118.10
W3	3	84.89	42.53	182.48
W4	4	318.15	135.61	590.53
E1	5	508.88	95.27	388.43
E2	6	121.72	28.37	123.02
E3	7	24.35	5.99	27.66
E4	8	145.86	32.35	140.43
E5	9	89.81	26.83	115.84
TOTAL		1536.65	419.01	1800.51

TYPICAL ACCESS ROAD SECTION



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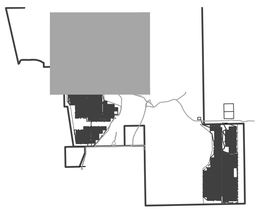

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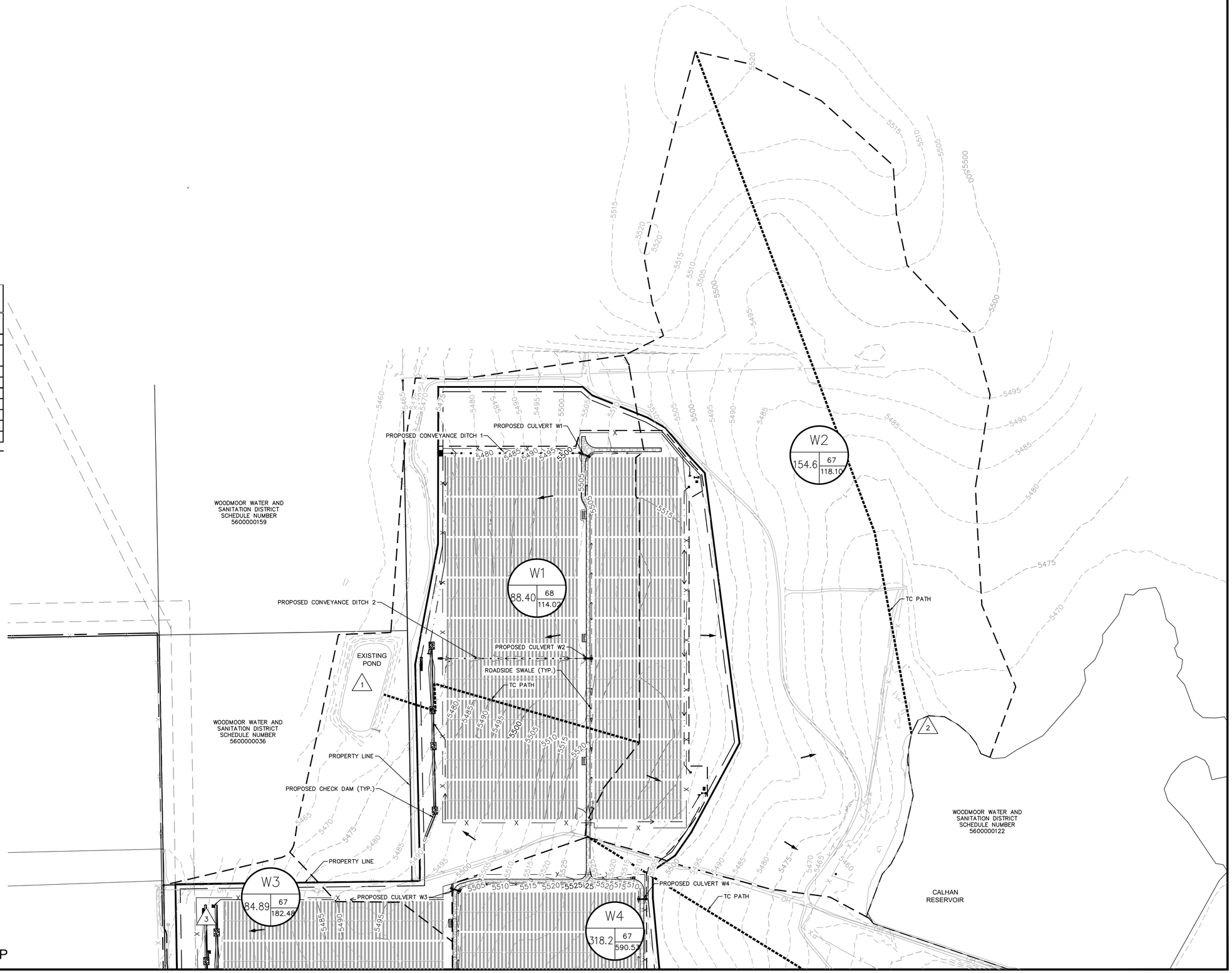
PALMER SOLAR-PROPOSED DRAINAGE MAP



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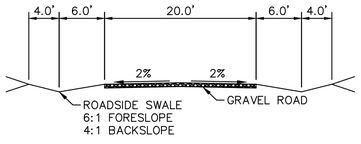

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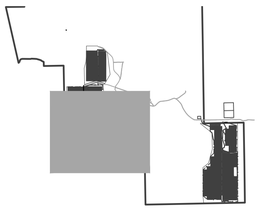

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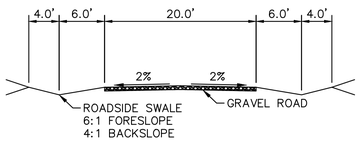

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PALMER SOLAR-PROPOSED DRAINAGE MAP

PROPERTY LINE

TC PATH

E1
508.9
69
388.43

LEGEND

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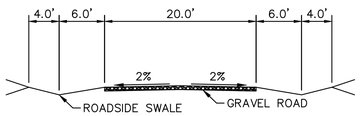

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PALMER SOLAR-PROPOSED DRAINAGE MAP

WOODMOOR WATER AND SANITATION DISTRICT SCHEDULE NUMBER 5600000122

CITY OF COLORADO SPRINGS SCHEDULE NUMBER 5600000123

PROPERTY LINE

TC PATH

PROPOSED CULVERT E1

PROPOSED CULVERT E2

PROPOSED CULVERT E3

PROPOSED CULVERT E4

PROPOSED CULVERT E5

PROPOSED CULVERT E6

PROPOSED CULVERT E7

PROPOSED CULVERT E8

PROPOSED CONVEYANCE SWALE

PROPOSED CHANNEL

ROADSIDE SWALE (TYP.)

E1
508.9 | 69 | 388.43

E2
121.7 | 68 | 123.02

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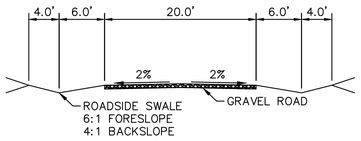

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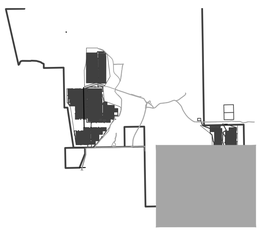

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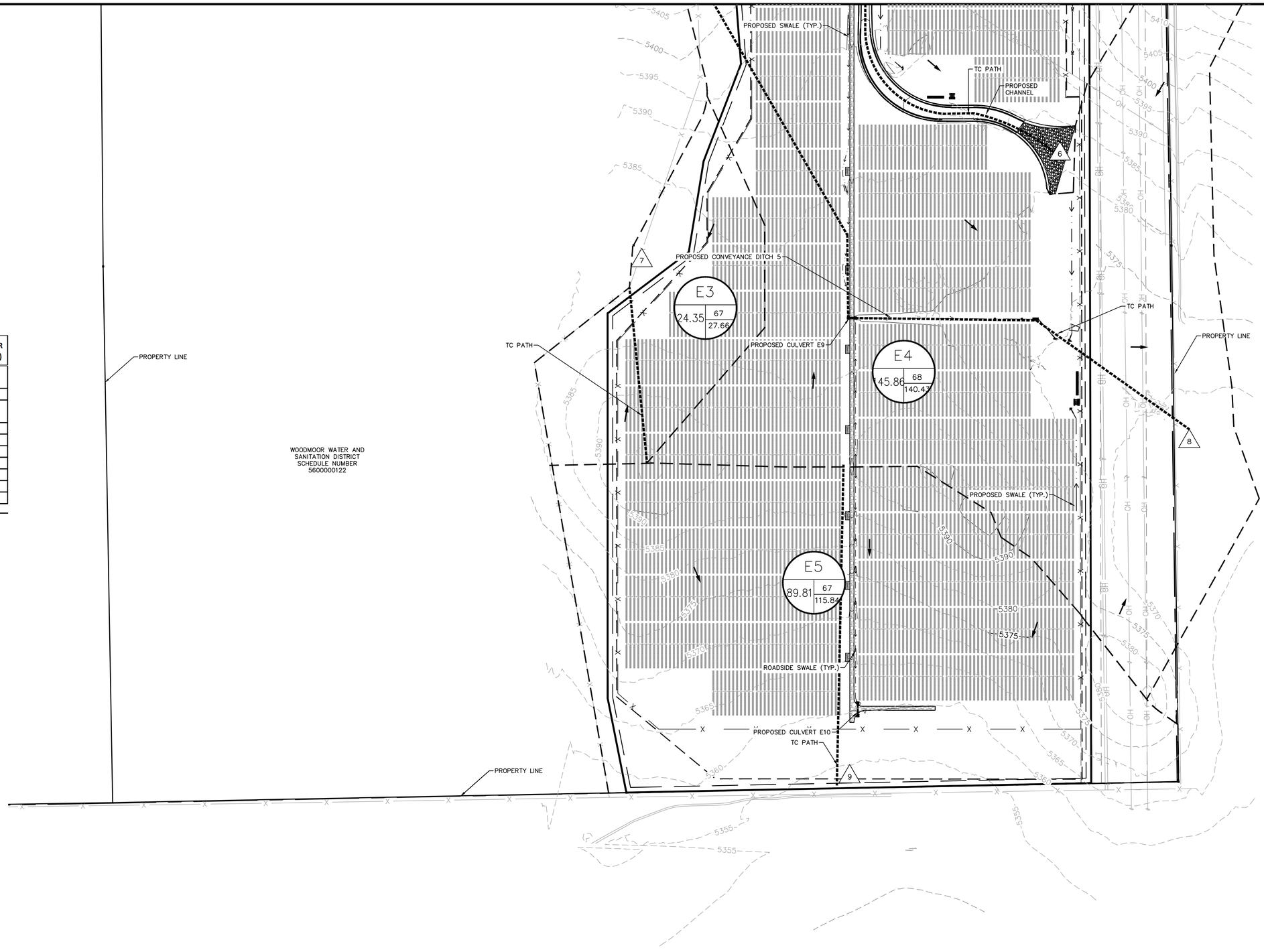
PALMER SOLAR-PROPOSED DRAINAGE MAP



OPINION OF PROBABLE COST

Kimley»Horn

Kimley-Horn & Associates, Inc. **Opinion of Probable Construction Cost**

Client:	**JSI Construction Group LLC**	**Date:**	**1/18/2019**
Project:	**Palmer Solar Facility**	**Prepared By:**	**JJM**
KHA No.:	**096495003**	**Checked By:**	**EJG**

No:		**Sheet:**	**1 of 1**

Kimley-Horn & Associates, Inc. has not prepared fully engineered construction drawings for this site; therefore, the final quantities are subject to change. Additionally, the final land plan could change significantly through the development process. This OPC is not intended for basing financial decisions, or securing funding. Review all notes and assumptions. Since Kimley-Horn & Associates, Inc. has no control over the cost of labor, materials, equipment, or services furnished by others, or over methods of determining price, or over competitive bidding or market conditions, any and all opinions as to the cost herein, including but not limited to opinions as to the costs of construction materials, shall be made on the basis of experience and best available data. Kimley-Horn & Associates, Inc. cannot and does not guarantee that proposals, bids, or actual costs will not vary from the opinions on costs shown herein. The total costs and other numbers in this Opinion of Probable Cost have been rounded.

Item No.	Item Description	Quantity	Unit		Unit Price	Item Cost
	Permanent BMP Costs (Private)					
1	24" CMP Culvert	1,343	LF		$90.00	$120,870
2	24" Culvert End Section	72	EA		$2,600.00	$187,200
3	18" CMP Culvert	304	LF		$70.00	$21,280
4	18" Culvert End Section	18	EA		$2,000.00	$36,000
		Subtotal:				$365,350
		Contingency (%,+/-)			10%	$36,535
		Project Total:				**$401,885**

Basis for Cost Projection:

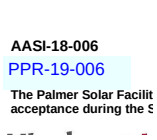
- ☐ No Design Completed
- ☐ Preliminary Design
- ☑ Final Design

Design Engineer:

Eric J. Gunderson
Registered Professional Engineer, State of Colorado No. 49487

Markup Summary

Text Box (2)



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