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Grandview Reserve
FINAL DRAINAGE REPORT

April 19, 2024

HR Green Project No: 201662.03

PCD File No. CDR228

Revise the Title. This project (CDR228) is for the Gieck Ranch Main Stem Tributary 1 & 2 design and construction only.

Prepared By:

HR Green Development, LLC

Contact: Greg Panza, PE

gpanza@hrgreen.com

720-602-4999

Owner/Developer's Statement:

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

_____ _____
[Name, Title] Date
[Business Name]
[Address]

Please include all three of these signature blocks

Add back in the statements and certifications that were included with the original submittal of this FDR:

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 applicable master plan of the drainage basin. I accept responsibility for any liability caused by any negligent acts, errors or omissions on my part in preparing this report.

_____ _____
[Name, P.E. #_____] Date

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.

_____ _____
Joshua Palmer, P.E. Date
County Engineer / ECM Administrator

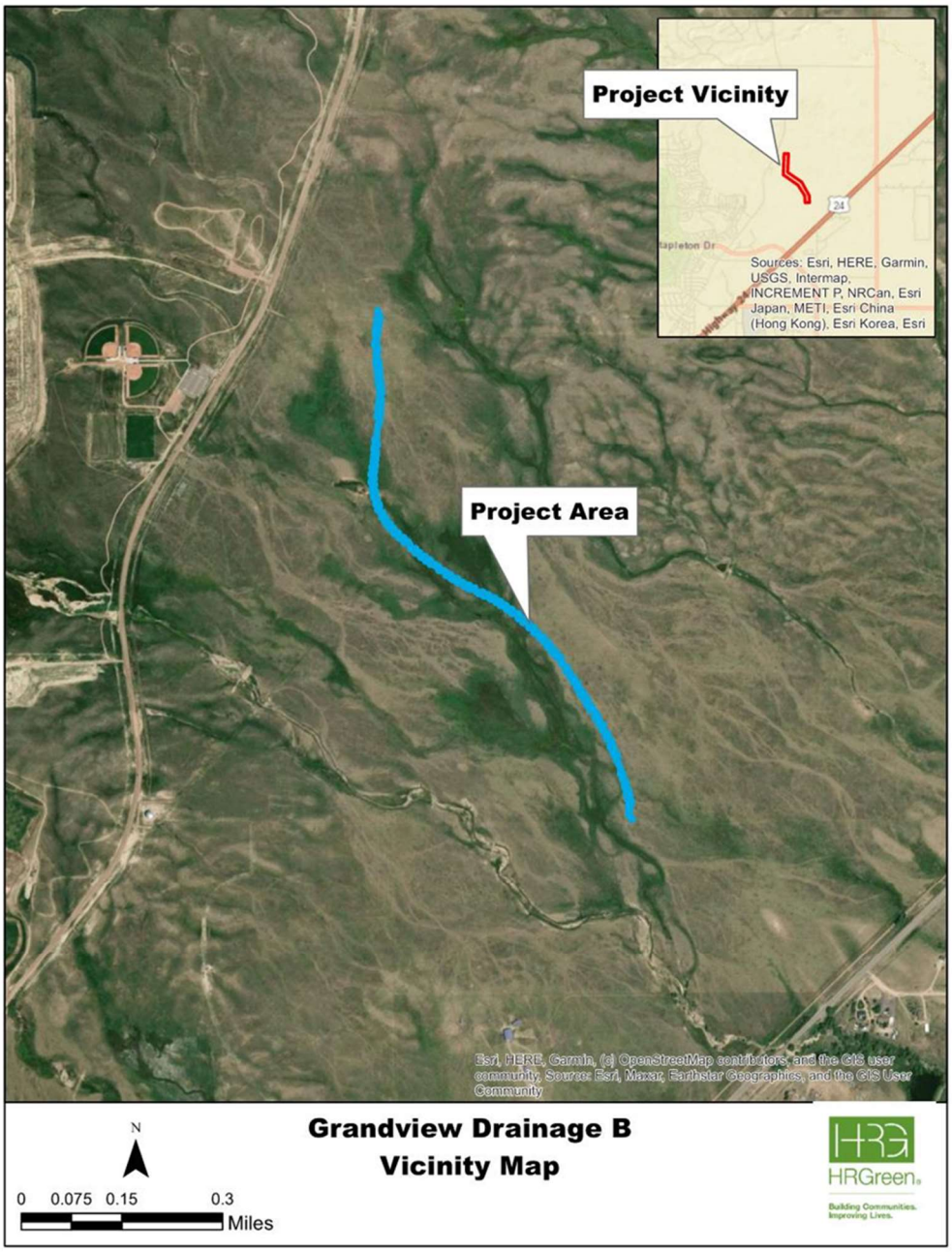
Conditions:

Grandview Reserve Final Channel 'B' Drainage Report

Introduction

This report was prepared by HR Green to support the submission of El Paso County forms and documents in a request for channel improvements along Geick Ranch Tributary 2. Figure 1 shows the location of the project.

Figure 1 – Vicinity Map



Grandview Reserve is located in Falcon, Colorado within El Paso County and contains approximately 776 acres within the south half of section 21 and 22 and the north half of section 27 and 28, Township 12 South, and Range 66 West of the Sixth Principal Meridian in El Paso County, Colorado. Grandview Reserve is bordered to the north and west by Eastonville Road and to the south by State Highway 24. The surrounding are is undeveloped at this time.

Grandview Reserve (GVR) falls within the Gieck Ranch Drainage Basin which covers approximately 22 square miles. This drainage basin is tributary to Black Squirrel Creek and joins said creek just to the south of Ellicott, CO about 18 miles to the south. Black Squirrel Creek eventually drains to the Arkansas River in Pueblo Colorado. Much of the Gieck Ranch Drainage basin is undeveloped and consists of rural farmland. The Gieck Ranch Drainage basin lies north of the Haegler Ranch drainage basin. The channels through the Grandview property can all be described as gently sloping drainages that roll through the site towards the creeks to which they are tributary. There is currently no irrigation on this site.

Per the NRCS web soil survey, the site is made up entirely of Type A and B soils. The majority of which are Type B soils. The vegetation found within Grandview Reserve consists of wetland communities in the floodplain with a transitional area to shortgrass prairie communities that dominate the site. The primary species found in the shortgrass prairie regions include little bluestem, blue grama, and buffalograss. The transitional area between the wetlands and shortgrass prairie includes patches of snowberry, and wood's rose. There are a few plains cottonwoods along the main channels. The area has historically been heavily grazed and there are weeds throughout the site. Weeds found onsite include Canada thistle, Russian thistle, common mullein and yellow toadflax spp.

This creek is a FEMA regulated floodplain Zone A. There is currently a Conditional Letter of Map Revision (CLOMR) into FEMA to obtain their opinion on the floodplain impacts from this project. Once this project is complete a Letter of Map Revision based on As-Built conditions will be submitted to FEMA and the floodplain will become a model backed Zone AE with established Base Flood Elevations. There are currently no insurable structures within the vicinity of the reach to be revised by this project. Provide copy of floodplain map in appendix.

Observations of the existing channels suggest that they are at equilibrium with their watershed flows; evidence including relatively stable bank full channels, adequate floodplain (above bank full channel elevations) and in-tact plant communities that would be expected in this type of reach support the notion that the reach is in equilibrium.

At present, the preliminary analysis and design of Geick Ranch Tributary 2 (GRT2) has been completed. Proposed improvements for Geick Ranch Tributary 2 include refinement of the existing channel alignment and a stabilizing natural stream design that will allow a more predictable floodplain. There is to be a dedicated 100' wide corridor in which the channel valley will meander. The valley is the area needed to fully contain the 100-year event. Preliminary analysis indicates the valley will have an average width of approximately 63'; initial sizing approximates the bank full width to be 8.8' – 13.8'. The valley and channel thalweg will generally follow the same profile, with some deviation as the bank full channel meanders through the valley in turn decreasing the low flow channels average slope. The average valley profile is to be approximately 0.9% with a series of grade control structures to both decrease elevation and dissipate energy to meet natural channel criteria as outlined in El Paso County criteria.

Hydrology

El Paso County criteria states that all developments are required to detain storm flows down to their historic peaks. For this reason GRT2 has been designed using the flows that drain to it in the existing conditions.

HEC-HMS 4.11 was used to determine the existing flows. The terrain used to delineation basins was obtained from the Colorado Water Conservation Board LiDAR library on November 3, 2023. See Appendix A for a delineation of the drainage basins and for the HEC-HMS output report. Table shows the characteristics of the drainage basins.

How do these flows compare to FEMA flows?

Table 2 –DRAINAGE BASIN CHARACTERISTICS

Basin ID	Area [sq mi]	Curve Number	10-year peak	100-year peak
Offsite	0.33	78.64	125.2	241.65
Meridian	0.3	80.16	137.2	261.88
Subbasin-4	0.04	70.32	23.9	47.38
Subbasin-3	0.05	72.81	32.1	62.65
Subbasin-2	0.12	73.76	52.7	103.28
Subbasin-1	0.05	79.41	35.5	67.11

The land cover data was obtained from United States Geological Survey Land Cover Data Download site, also on November 3. Upstream of this proposed project a development in in construction. This development, Meridian Ranch, will increase the imperviousness of the contributing basin to GRT2, therefore the imperviousness of the portion of the basin that will be developed has been updated based on this development. Appropriate excerpts from the Meridian Ranch drainage report can be found in Appendix J. While the Meridian Ranch development will utilize stormwater detention to attenuate flows, this analysis assumed that all stormwater runoff would drain to Geick Tributary 2 without detention.

The soil hydric classification was determined using a downloaded GIS raster file from the Natural Resources Conservation Service. The land cover and soil hydric classification were combined to create a Curve Number grid as outlined in *Creating SCS Curve Number Grid using Land Cover and Soil Data*, by Dr. Venkatesh Merwade in February 2019. Currently the United States Army Corps of Engineers website containing guidelines on using HEC-HMS 4.11 to create a Curve Number grid is offline with no known date for when it will again be active.

The hydrologic method used was the SCS Unit Hydrograph method using a Frequency Storm Meteorologic Model with inputs taken from the National Oceanic and Atmospheric Administration's Atlas 14 Point Precipitation Estimates for Colorado, and more specifically at this site. These inputs can be found in Appendix J. The loss method used was the SCS Curve Number method and the Curve Number was derived using the procedure outlined previously on this page. The Reach Routing method used was the Muskingum-Cunge method due to the inputs for this method being readily available.

See Table 1 for summaries of flows discharged to the existing GRT2 at specific design points. See Table 2 for summaries of flows discharged to the proposed GRT2 at the equivalent design points. Flows in the HEC-RAS model are rounded up to the nearest whole integer from the HEC-HMS results for simplicity.

Table 2 –FLOWS FOR THE EXISTING GEICK RANCH TRIBUTARY 2

STATION	CUMULATIVE 100-YR STORM (CFS)	INPUT DESCRIPTION AND FLOW (CFS)
70+29.02	262	Upstream end of Existing Model
48+58.05	536	Equivalent location for Rex Road
33+61.62	621	Equivalent location for Dawlish Road
6+13.67	649	Equivalent location for Low Water Crossing

Table 3- FLOWS FOR PROPOSED GEICK RANCH TRIBUTARY 2

STATION	CUMULATIVE 100-YR STORM (CFS)	INPUT DESCRIPTION AND FLOW (CFS)
9426.04	262	Upstream end of Existing Model
71+60.32	536	Immediately downstream of Rex Road
57+28.67	621	Immediately downstream of Dawlish Road
17+47.66	649	Immediately downstream of Low Water Crossing

There exist no historic flood elevations high water marks to use for calibration of this model and the nearest stream gage is downstream enough to make the ratio of contributing watersheds different in size by orders of magnitude. Therefore there was no available data to use to calibrate this model, so no calibration was performed.

Hydraulics

Design criteria were developed to guide a preliminary layout of channel dimension, planform, and profile for the realigned segment of GRT2. Published criteria from the Urban Stormwater Drainage Criteria Manual, Volume 1 (USDCM; Urban Drainage and Flood Control District, 2016), El Paso County DCM and various other reports currently in process for the drainages through GVR and completed for GVR drainages were used for initial design parameter and flow rates. Parameters used and minimum bank full geometry is summarized in Table .

Table 3 - DESIGN PARAMETERS

Design Parameter	Design Value
Roughness values	EPC Table 10-2
Maximum 5-year velocity, main channel (within bank full channel width) (ft/s)	EPC: 2.5 ft/s MHFD: 5 ft/s*
Maximum 100-year velocity, main channel (within bank full channel width) (ft/s)	EPC: 2.5 ft/s MHFD: 7 ft/s*
Froude No., 5-year, main channel (within bank full channel width)	0.7
Froude No., 100-year, main channel (within bank full channel width)	0.85
Maximum shear stress, 100-year, main channel (within bank full channel width)	1.2 lb./sf
Minimum bank full capacity of bank full channel (based on future development conditions)	2-year, 19 - 33.5 cfs
Minimum bank full channel geometry[1]	
Design Channel Type	C4
Entrenchment Ratio	2.7-31.65 (x=5.26)
Width to depth ratio	13.5-75.0 (x=29.28)
Sinuosity	1.43-2.80 (x=1.92)
Slope	0.0001-0.0184 (x=0.0045)
D_{50}	12-14mm (~0.5 in)
d_{84}	32-48mm (~1.6in)
Meander Length[2]	34-92 (x=56)
Belt Width[2]	18-55 (x=32)
Radius of Curvature[2]	7-28 (x=11)
Minimum Floodplain Terrace	6 ft
Maximum overbank side slope	4(H):1(V)
Maximum bank full side slope	2.5(H):1(V)
Maximum bank full side slope	2.5(H):1(V)
Minimum bottom width[3]	4.8 ft
Freeboard	1.5 ft

[1] These values were derived from empirical data and will be used as guidelines for design and will be used in conjunction with hydraulic regime equations as outlined in "Spreadsheet Tools for River Evaluation, Assessment, and Monitoring: The STREAM Diagnostic Modules"
[2]These values are derived from "Spreadsheet Tools for River Evaluation, Assessment, and Monitoring: The STREAM Diagnostic Modules"
[3]Minimum bottom width shown is for the low flow channel only. The main channel will be ~41 ft wide

The 2-year frequency was selected for the design of the bank full channel to approximate the flow most likely to govern a stable geometry. Prior reports estimated future 2-year flow as ~15-cfs and assume no culvert effects, i.e., open channel flow un-affected by a culvert. The future 2-year flow (19-33.5 cfs) was used to size the low flow

It's possible that I have not been involved with offline conversations related to our requirements for this FDR. However, if you haven't been told otherwise, please add back in the Four Step Process. It was included in your first submittal of the FDR in May 2022. Gilbert had comments on that section, none of which were asking you to remove the section from the FDR altogether. Please revise that section per his comments before copy/pasting it back into this report. Be sure to address WQ treatment exclusions.

channel. This resulted in a channel with a minimum bottom width varying from 4.8 feet - 9.8 feet, 0.8 feet deep with 2.5:1 side slopes for a bank full width varying from 8.8 feet to 13.8 feet, assuming a mean channel longitudinal slope of 0.9%. Equations as shown in the spreadsheet should produce low shear values within the channel section. However, further analysis using HEC-RAS was completed to determine the final geometry of said channel. The effective discharge channel is highly correlated to the "bank full" channel (Leopold 1994) as several channel geometrics are derived from bank full channel width, depth, cross sectional area and sinuosity, and that USDCM and the OSP report design criteria parameters relate to bank full width, we have chosen bank full width to serve as the foundation of design.

To determine an appropriate bank full width, Leopold's generalized width estimate was first calculated (1994, as presented in USDCM Vol 1):

$W = aQ^{0.5}$

Where:

w = bank full width of channel (top width when conveying bank full discharge)

Q = bank full discharge (10.5 cfs)

a = 2.7 (wide bank full channel)
2.1 (average bank full channel width)
1.5 (narrow bank full channel)

Assuming an average bank full width, the equation would estimate a 6.8-ft bank full width. It is important to note that the Leopold equation lumps all channel types of varying width-to-depth rations. To perform a check on this estimation, worksheet alternative iterations of channel width from 4-12 feet were performed to find the depth associated with the 2-year flow. Chanel slope was set to 0.09 to best fit the average valley slope, side slopes were assumed to be 2.5:1 and manning's "n" was assumed to be 0.035. The resulting channel depth was divided into each iteration's width to identify the iteration with a width-to-depth ratio most closely associated with a Type-C channel. Given the valley type of the proposed project (Unconfined Alluvial Valley), we can expect Type-C and Type-E channels to represent stable channel geomorphologies. Given the setting and valley slope, we have chosen a Type-C (riffle-pool morphology) channel. Type-C channels typical have width-to-depth ratios >12, with gravel and sand bottomed systems averaging 29 and 27, respectively (13.5-28.7 for 60% of gravel bed streams 12.6-29.2 for 50% of sand bed streams; Rosgen 1996). Given these ranges, the channel alternative with a OPC 2-yr flow-dependent channel depth that, when divided into its corresponding width, yielded a W/D between 10.7 – 36.7.

The resulting channel, then, has the following general dimensions:

- Bottom width = 4.8 ft – 9.8 ft
- Top Width = 8.8 ft – 13.8 ft
- Average Depth $_{Riffle}$ = 0.8 ft
- Width: Depth (W/D) Ratio = 11.3
- Cross Sectional Area = 5.44 ft^2 - 9.44 ft^2

The resulting channel dimensions listed above were then used to do the initial site grading of GRT2. The channel was then modeled in HEC- RAS and the geometry was further refined to reduce velocities, shear stresses, and the Froude number to fall within acceptable ranges.

Include reference section, listing manuals and other reports in the area

Discuss deviation which is being requested.

Include discussion on: freeboard provided, scour at channel bends and culverts (include outlet protection), drop design, Froude number, etc

Include section on drainage fees

Include discussion on structures which are being constructed with channel improvements.

Include Construction Cost Estimate

Include conclusion section

Include section on maintenance of channel

Appendix A
Proposed Hydrology Calculations and Reference Materials

NOAA Atlas 14, Volume 8, Version 2
Location name: Peyton, Colorado, USA*
Latitude: 38.9859°, Longitude: -104.5647°
Elevation: 6982 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

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

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

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

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**0.239** (0.189-0.303)	**0.291** (0.231-0.370)	**0.381** (0.301-0.486)	**0.461** (0.361-0.589)	**0.576** (0.440-0.768)	**0.671** (0.499-0.904)	**0.770** (0.554-1.06)	**0.875** (0.604-1.24)	**1.02** (0.678-1.48)	**1.14** (0.733-1.67)
10-min	**0.350** (0.277-0.444)	**0.426** (0.338-0.542)	**0.558** (0.441-0.711)	**0.674** (0.529-0.863)	**0.844** (0.644-1.12)	**0.982** (0.731-1.32)	**1.13** (0.811-1.56)	**1.28** (0.884-1.81)	**1.49** (0.992-2.17)	**1.66** (1.07-2.44)
15-min	**0.426** (0.338-0.541)	**0.520** (0.412-0.660)	**0.681** (0.537-0.867)	**0.823** (0.645-1.05)	**1.03** (0.785-1.37)	**1.20** (0.891-1.62)	**1.37** (0.988-1.90)	**1.56** (1.08-2.21)	**1.82** (1.21-2.65)	**2.03** (1.31-2.98)
30-min	**0.608** (0.482-0.771)	**0.740** (0.586-0.940)	**0.968** (0.764-1.23)	**1.17** (0.916-1.49)	**1.46** (1.11-1.94)	**1.70** (1.26-2.28)	**1.94** (1.40-2.68)	**2.20** (1.52-3.12)	**2.57** (1.71-3.73)	**2.86** (1.84-4.19)
60-min	**0.775** (0.615-0.984)	**0.933** (0.739-1.18)	**1.21** (0.956-1.54)	**1.46** (1.15-1.87)	**1.84** (1.41-2.47)	**2.16** (1.61-2.92)	**2.49** (1.80-3.45)	**2.85** (1.97-4.05)	**3.37** (2.24-4.90)	**3.78** (2.44-5.54)
2-hr	**0.943** (0.754-1.19)	**1.12** (0.898-1.42)	**1.46** (1.16-1.84)	**1.76** (1.39-2.23)	**2.22** (1.72-2.97)	**2.62** (1.97-3.52)	**3.04** (2.21-4.19)	**3.50** (2.45-4.95)	**4.16** (2.80-6.03)	**4.70** (3.06-6.85)
3-hr	**1.03** (0.829-1.29)	**1.22** (0.978-1.53)	**1.57** (1.25-1.97)	**1.90** (1.51-2.40)	**2.41** (1.88-3.22)	**2.86** (2.17-3.84)	**3.34** (2.45-4.60)	**3.88** (2.73-5.48)	**4.66** (3.15-6.74)	**5.29** (3.46-7.69)
6-hr	**1.20** (0.968-1.48)	**1.40** (1.13-1.74)	**1.78** (1.44-2.22)	**2.16** (1.73-2.70)	**2.76** (2.18-3.66)	**3.28** (2.52-4.39)	**3.86** (2.86-5.29)	**4.51** (3.20-6.34)	**5.46** (3.73-7.86)	**6.24** (4.12-9.01)
12-hr	**1.38** (1.13-1.70)	**1.61** (1.31-1.98)	**2.05** (1.66-2.53)	**2.48** (2.00-3.07)	**3.15** (2.51-4.15)	**3.74** (2.89-4.96)	**4.39** (3.28-5.96)	**5.12** (3.66-7.13)	**6.17** (4.25-8.82)	**7.04** (4.69-10.1)
24-hr	**1.60** (1.31-1.95)	**1.87** (1.54-2.28)	**2.38** (1.94-2.91)	**2.85** (2.32-3.51)	**3.60** (2.88-4.67)	**4.24** (3.29-5.56)	**4.94** (3.71-6.63)	**5.71** (4.12-7.87)	**6.82** (4.73-9.66)	**7.73** (5.20-11.0)
2-day	**1.85** (1.54-2.24)	**2.18** (1.80-2.63)	**2.76** (2.28-3.34)	**3.29** (2.70-4.01)	**4.11** (3.30-5.27)	**4.80** (3.76-6.22)	**5.54** (4.19-7.36)	**6.35** (4.62-8.68)	**7.50** (5.25-10.5)	**8.44** (5.73-11.9)
3-day	**2.03** (1.69-2.44)	**2.39** (1.98-2.87)	**3.02** (2.50-3.64)	**3.60** (2.97-4.36)	**4.47** (3.60-5.69)	**5.20** (4.08-6.70)	**5.98** (4.55-7.90)	**6.83** (4.99-9.28)	**8.03** (5.65-11.2)	**9.00** (6.15-12.7)
4-day	**2.18** (1.82-2.61)	**2.56** (2.13-3.06)	**3.22** (2.68-3.87)	**3.82** (3.16-4.62)	**4.73** (3.83-6.00)	**5.49** (4.33-7.04)	**6.30** (4.81-8.30)	**7.18** (5.26-9.72)	**8.43** (5.94-11.7)	**9.43** (6.46-13.3)
7-day	**2.58** (2.17-3.07)	**2.98** (2.50-3.54)	**3.68** (3.08-4.39)	**4.32** (3.60-5.18)	**5.29** (4.30-6.65)	**6.09** (4.84-7.76)	**6.96** (5.34-9.09)	**7.89** (5.82-10.6)	**9.21** (6.55-12.8)	**10.3** (7.10-14.4)
10-day	**2.93** (2.48-3.47)	**3.36** (2.84-3.98)	**4.13** (3.47-4.90)	**4.81** (4.02-5.74)	**5.83** (4.76-7.28)	**6.68** (5.32-8.45)	**7.58** (5.85-9.86)	**8.55** (6.34-11.4)	**9.92** (7.08-13.7)	**11.0** (7.65-15.4)
20-day	**3.91** (3.33-4.58)	**4.51** (3.84-5.29)	**5.52** (4.68-6.50)	**6.39** (5.39-7.55)	**7.63** (6.25-9.37)	**8.62** (6.90-10.8)	**9.64** (7.47-12.4)	**10.7** (7.98-14.1)	**12.2** (8.74-16.6)	**13.3** (9.31-18.4)
30-day	**4.70** (4.02-5.47)	**5.44** (4.65-6.34)	**6.65** (5.66-7.78)	**7.66** (6.49-9.00)	**9.06** (7.44-11.0)	**10.1** (8.15-12.5)	**11.2** (8.74-14.3)	**12.3** (9.24-16.2)	**13.8** (9.98-18.7)	**15.0** (10.5-20.6)
45-day	**5.67** (4.88-6.57)	**6.55** (5.63-7.60)	**7.97** (6.82-9.27)	**9.12** (7.77-10.7)	**10.7** (8.79-12.9)	**11.9** (9.56-14.5)	**13.0** (10.2-16.4)	**14.2** (10.6-18.4)	**15.6** (11.3-21.0)	**16.7** (11.9-23.0)
60-day	**6.48** (5.60-7.48)	**7.46** (6.43-8.62)	**9.01** (7.74-10.4)	**10.3** (8.77-11.9)	**11.9** (9.82-14.3)	**13.1** (10.6-16.0)	**14.3** (11.2-18.0)	**15.5** (11.7-20.0)	**16.9** (12.3-22.6)	**18.0** (12.8-24.6)

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

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

Please refer to NOAA Atlas 14 document for more information.

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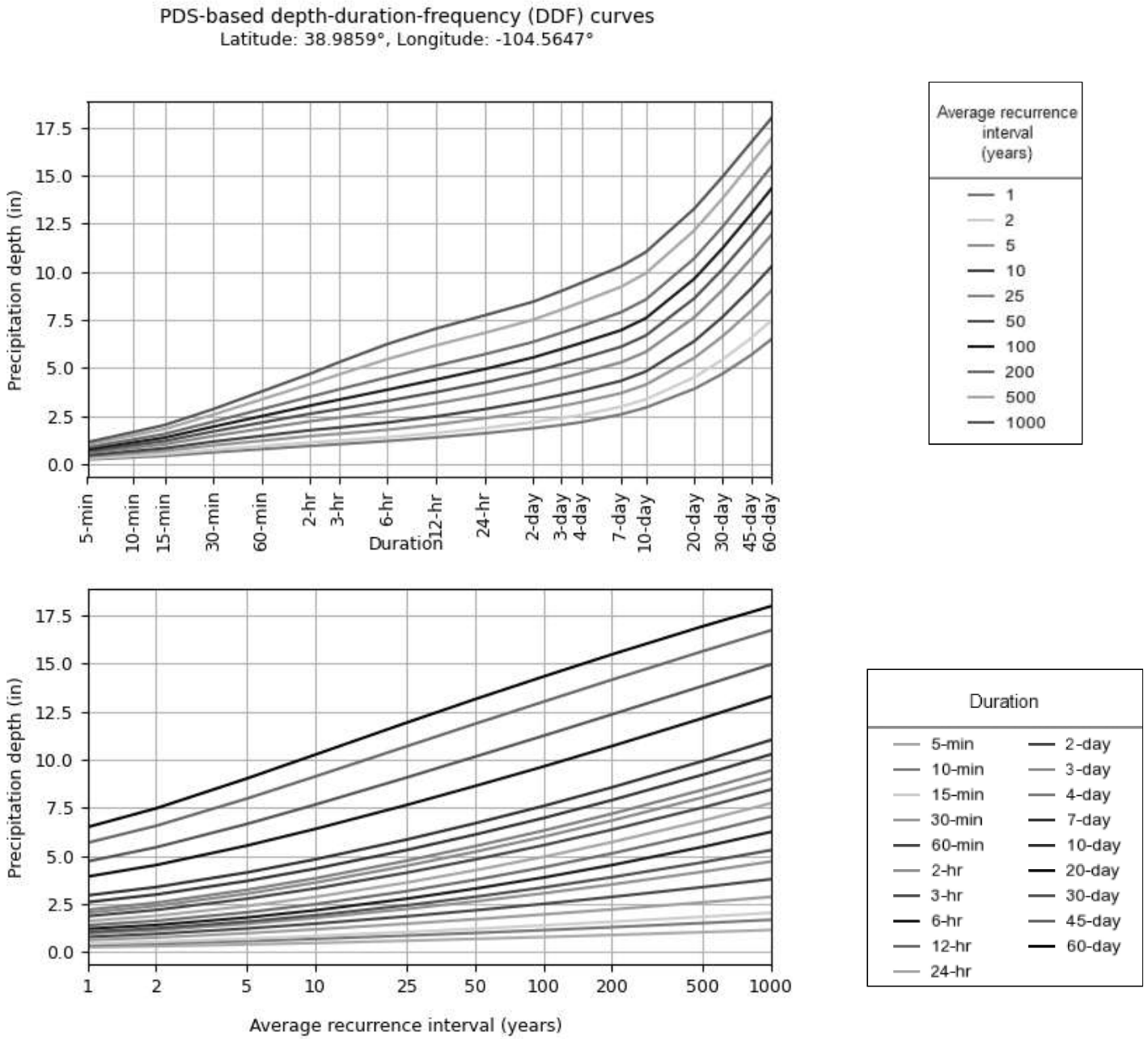
PF graphical



NOAA Atlas 14, Volume 8, Version 2

Created (GMT): Mon Nov 6 00:36:21 2023

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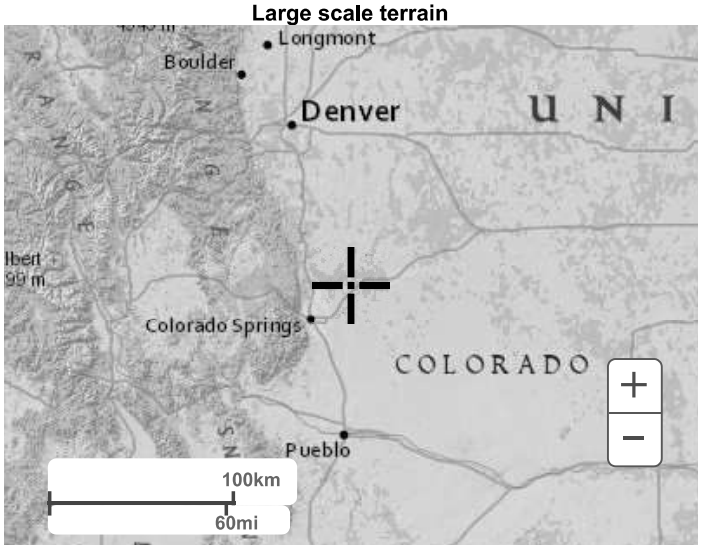
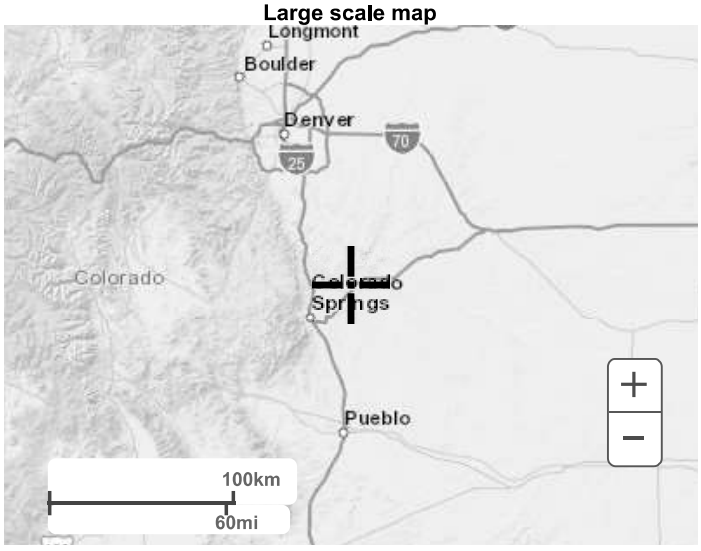
Maps & aerials

Small scale terrain

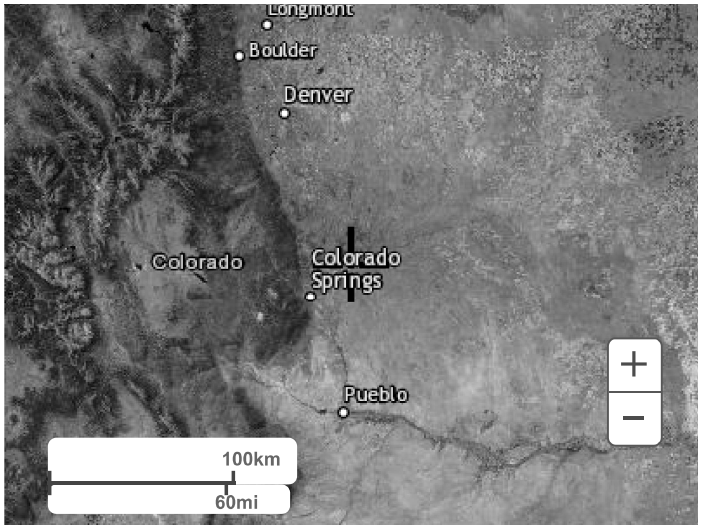
Large scale terrain



Large scale map



Large scale aerial



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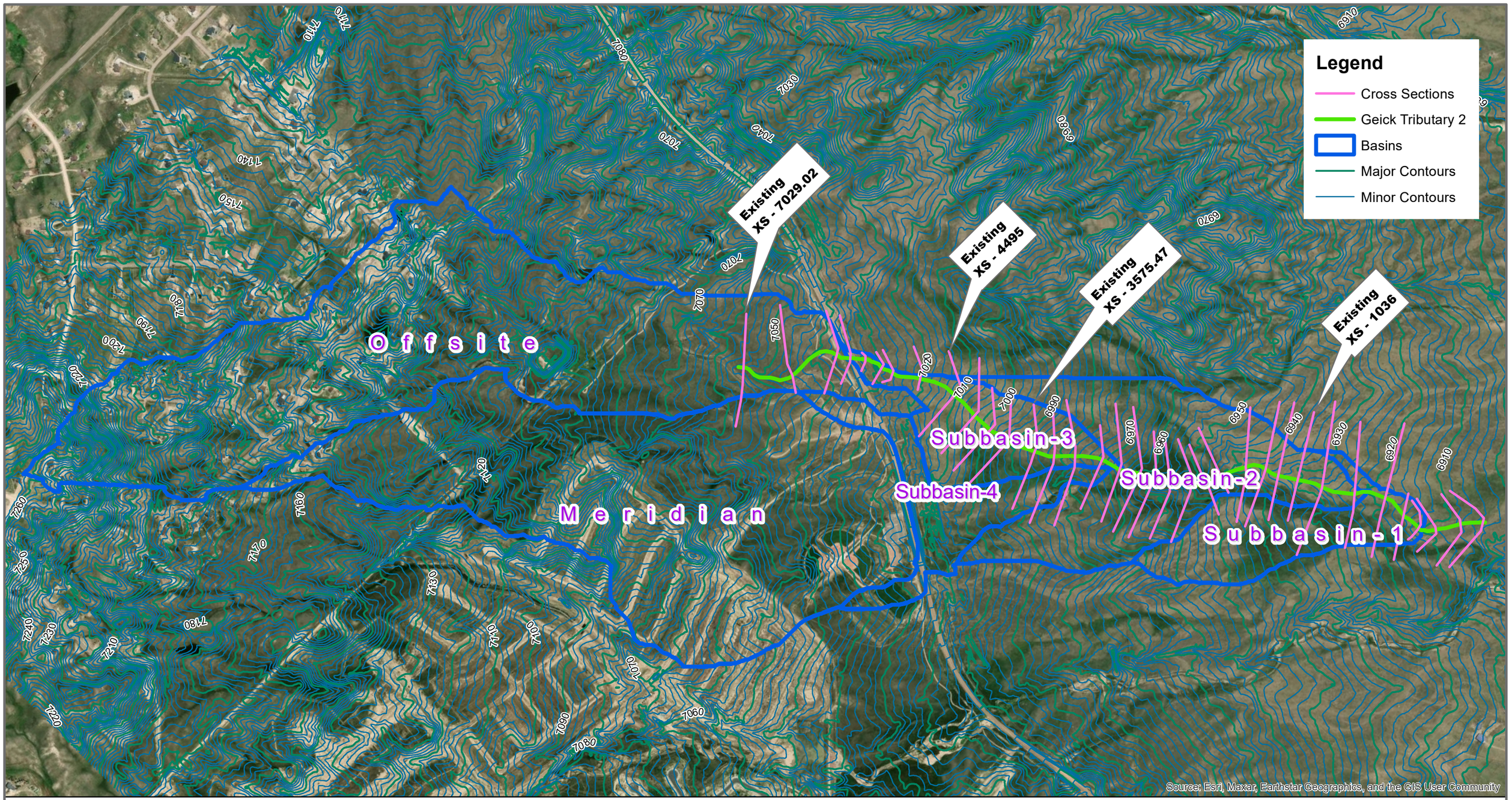
US Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

Disclaimer



Grandview Tributary 2
Topographic Hydrologic Work Map

Datum = NAVD88

N

0 0.1 0.2 0.4 Miles

HRGreen®

Building Communities. Improving Lives.

REVISION TO:
MASTER DEVELOPMENT
DRAINAGE PLAN
MERIDIAN RANCH
EL PASO COUNTY, COLORADO

MERIDIAN RANCH

A GOLF & RECREATIONAL COMMUNITY

July 2021

Prepared For:

GTL DEVELOPMENT, INC.
P.O. Box 80036
San Diego, CA 92138

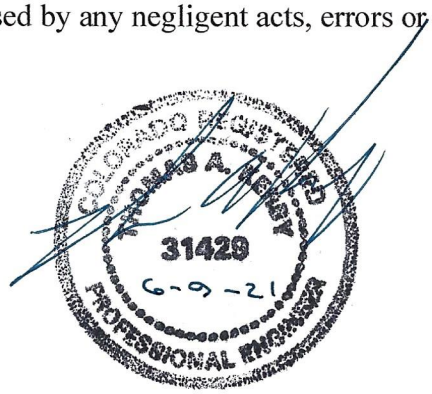
Prepared By:
Tech Contractors
11886 Stapleton Drive
Falcon, CO 80831
719.495.7444

PCD Project No. SKP-21003

CERTIFICATIONS

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 applicable master plan of the drainage basin. I accept responsibility for any liability caused by any negligent acts, errors or omissions on my part in preparing this report.



Thomas A. Kerby, P.E.
#31429

Owner/Developer's Statement:

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

Raul Guzman, Vice President
GTL Development, Inc.
P.O. Box 80036
San Diego, CA 92138

July 8, 2021
Date

El Paso County:

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

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

APPROVED
Engineering Department
07/15/2021 8:53:01 AM
dsdnijkamp
EPC Planning & Community Development Department

The land cover assumptions for the portion of the GRT2 drainage basin that is being developed were altered to be consistent with these parameters

EXECUTIVE SUMMARY

The purpose of the revision to the following Master Development Drainage Plan is to present updated conceptual drainage improvements for the remaining undeveloped portions of the Meridian Ranch Development based upon the proposed sketch plan amendment and to update data from within the development tributary to area of interest. Runoff quantities and proposed facilities have been calculated using the current City of Colorado Springs/El Paso County Drainage Criteria Manual (DCM) (1994 version) and portions of the City of Colorado Springs Drainage Criteria Manual, Volume 1 (DCM-1) ((2014 version). Concepts presented in this report will be refined and specific improvements addressed during the Final Plat process.

The revisions included within this report include the density increase as proposed with this sketch plan amendment. The previous revision to the MDDP (2017) included the removal of the 40-acre business park near the northwest corner of Stapleton Dr. and Eastonville Rd. and repurposing it to residential land use. The developed calculations reflect the density increase sought in this revision.

The hydrologic calculations within this report follow method outlined in Chapter 6 of the 2014 version of the City of Colorado Springs Drainage Criteria Manual (COSDCM) as adopted by the El Paso County Board of County Commissioners by Resolution 15-042. Chapter 6 addresses the hydrologic calculation methods and includes an updated hydrograph to be used with storm drainage runoff. The Board adopted by the same resolution, Section 3.2.1 of Chapter 13 of the COSDCM referencing Full Spectrum Detention; the concept "provides better control of the full range of runoff rates that pass-through detention facilities than the convention multi-stage concept. This section of the COSDCM identifies the necessity to provide full spectrum detention but does not prescribe a methodology to reach such the detention requirements. This report includes hydrologic models from HEC-HMS for the historic and future conditions for the 2-yr, 5-yr, 10-yr, 50-yr, and 100-yr design storm frequencies. The future conditions include detention facilities sized and modeled such that *"frequent and infrequent inflows are released at rates approximating undeveloped conditions."*

On November 16, 2000 the El Paso County Board of County Commissioners approved the rezoning of the Meridian Ranch project (PUD-00-010) from A-35 to PUD with several conditions. Condition number seven stated in part that "drainage plans shall release and/or retain at approximately eighty percent (80%) of historic rates." The previous report (2017 MDDP) removed this condition and allow the project to release developed flow at historic rates as outlined in the current City of Colorado Springs/El Paso County Drainage Criteria Manual (DCM) (1994 version) and those portions of the City of Colorado Springs Drainage Criteria Manual, Volume 1 (DCM-1) ((2014 version) adopted by the El Paso County Board of County Commissioners by Resolution No. 15-042.

The original boundary limits of Meridian Ranch encompassed 2620 acre proposed development and is located approximately 12 miles northeast of the City of Colorado Springs, 2.5 miles north of the town of Falcon and immediately north of the Woodmen Hills development.

The Sketch Plan amendment includes all the remaining 197 acres of the undeveloped portion of Meridian Ranch. Of the undeveloped land it is proposed to have 110 acres of residential development, 49 acres of open space, drainage/detention facilities and park sites, and 38 acres of R.O.W.

The calculated developed flow rates greater than the historic discharge flow rates will be mitigated with the use of full spectrum detention facilities to be located within the project and along eastern boundary of the project. The Meridian Ranch Development will not adversely impact the downstream properties.

Subbasin	CN	L [mi]	L [ft]	Y	Y[%]	S	Tc [hr]	Tc [min]	Lag [hr]	Lag [min]
1	79.41	0.52	2727.6	0.023	2.31	2.59	0.79	47.52	0.4752	28.51
2	73.76	0.75	3954.4	0.022	2.21	3.56	1.29	77.24	0.7724	46.35
3	72.81	0.34	1782.5	0.023	2.34	3.73	0.68	40.76	0.4076	24.46
4	70.32	0.42	2238.8	0.027	2.66	4.22	0.82	49.10	0.491	29.46
Meridian	80.16	1.37	7254.6	0.024	2.37	2.48	1.67	100.17	1.0017	60.10
Offsite	78.64	1.76	9293.3	0.027	2.68	2.72	2.01	120.52	1.2052	72.31

Time of Concentration (Tc)

Time taken by a rainfall drop to travel from the farthest point in the watershed to the outlet.

$$T_c = \frac{\ell^{0.8}(S+1)^{0.7}}{1{,}140 Y^{0.5}} \qquad \text{Lag} = 0.6T_c$$

where:

L = lag, h
T_c = time of concentration, h
ℓ = flow length, ft
Y = average watershed land slope, %
S = maximum potential retention, in

$$S = \frac{1000}{CN} - 10$$

(American Units; $0 < CN < 100$)

Project: M G
Simulation Run: 100-year
Simulation Start: 1 January 2023, 01:00
Simulation End: 2 January 2023, 01:00

HMS Version: 4.11
Executed: 26 March 2024, 16:21

Global Parameter Summary - Subbasin

Location

Element Name	Longitude Degrees	Latitude Degrees
Offsite	-104.57	39
Meridian	-104.57	38.99
Subbasin - 3	-104.56	38.99
Subbasin - 4	-104.57	38.99
Subbasin - 2	-104.56	38.99
Subbasin - 1	-104.56	38.98

Area (MI2)

Element Name	Area (MI2)
Offsite	0.33
Meridian	0.3
Subbasin - 3	0.05
Subbasin - 4	0.04
Subbasin - 2	0.12
Subbasin - 1	0.05

Downstream

Element Name	Downstream
Offsite	Reach - 3
Meridian	Reach - 4
Subbasin - 3	Reach - 2
Subbasin - 4	Reach - 2
Subbasin - 2	Reach - 1
Subbasin - 1	Sink - 1

Loss Rate: Scs

Element Name	Percent Impervious Area	Curve Number	Initial Abstraction
Offsite	0	78.64	0
Meridian	0	80.16	0
Subbasin - 3	0	72.81	0
Subbasin - 4	0	70.32	0
Subbasin - 2	0	73.76	0
Subbasin - 1	0	79.41	0

Transform: Scs

Element Name	Lag	Unitgraph Type
Offsite	72.31	Standard
Meridian	60.1	Standard
Subbasin - 3	24.46	Standard
Subbasin - 4	29.46	Standard
Subbasin - 2	46.35	Standard
Subbasin - 1	28.51	Standard

Global Parameter Summary - Reach

Downstream

Element Name	Downstream
Reach - 3	Reach - 2
Reach - 4	Reach - 2
Reach - 2	Reach - 1
Reach - 1	Sink - 1

Route: Muskingum Cunge

Element Name	Method	Channel	Length (FT)	Energy Slope (FT/FT)	Mannings n	Bottom Width (FT)	Side Slope (FT/FT)	Initial Variable	Space - Time Method	Index Parameter Type	Index Celerity	Nu Sub
Reach - 3	Muskingum Cunge	Trapezoid	1865.37	0.03	0.04	38.76	4	Combined Inflow	Automatic DX and DT	Index Celerity	1.33	
Reach - 4	Muskingum Cunge	Trapezoid	1902.61	0.02	0.04	38.76	4	Combined Inflow	Automatic DX and DT	Index Celerity	1.33	
Reach - 2	Muskingum Cunge	Trapezoid	2337.51	0.02	0.04	38.76	4	Combined Inflow	Automatic DX and DT	Index Celerity	1.33	
Reach - 1	Muskingum Cunge	Trapezoid	849.59	0.01	0.04	38.76	4	Combined Inflow	Automatic DX and DT	Index Celerity	1.33	

Global Results Summary

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Offsite	0.33	241.65	01Jan2023, 14:20	3.14
Reach - 3	0.33	241.33	01Jan2023, 14:25	3.12
Meridian	0.3	261.88	01Jan2023, 14:05	3.25
Reach - 4	0.3	261.88	01Jan2023, 14:10	3.24
Subbasin - 3	0.05	62.65	01Jan2023, 13:30	2.8
Subbasin - 4	0.04	47.38	01Jan2023, 13:35	2.65
Reach - 2	0.72	536.09	01Jan2023, 14:15	3.11
Subbasin - 2	0.12	103.28	01Jan2023, 13:50	2.84
Reach - 1	0.84	621.27	01Jan2023, 14:10	3.07
Subbasin - 1	0.05	67.11	01Jan2023, 13:35	3.22
Sink - 1	0.89	649.23	01Jan2023, 14:10	3.08

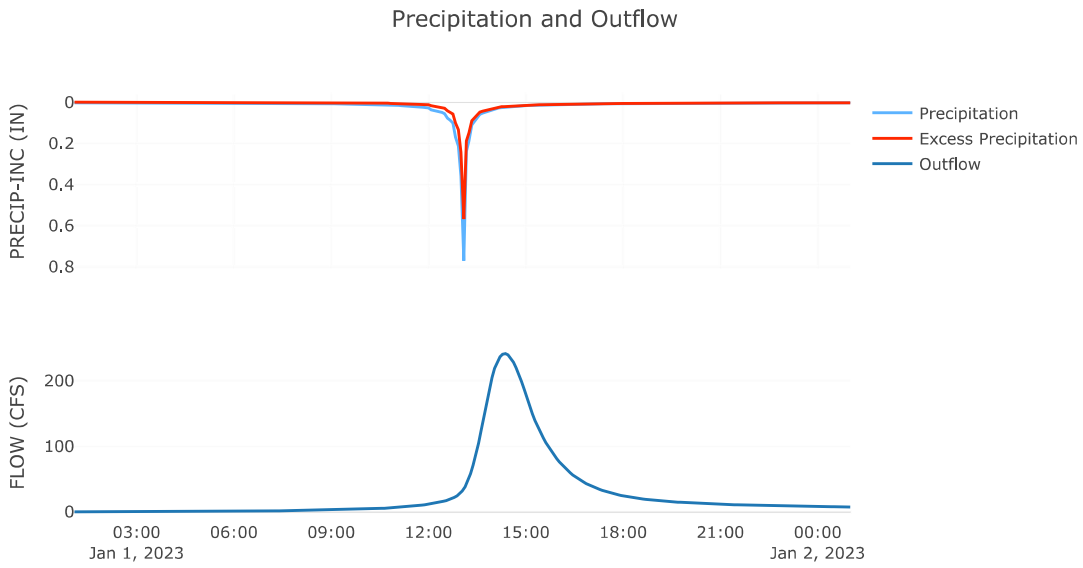
Subbasin: Offsite

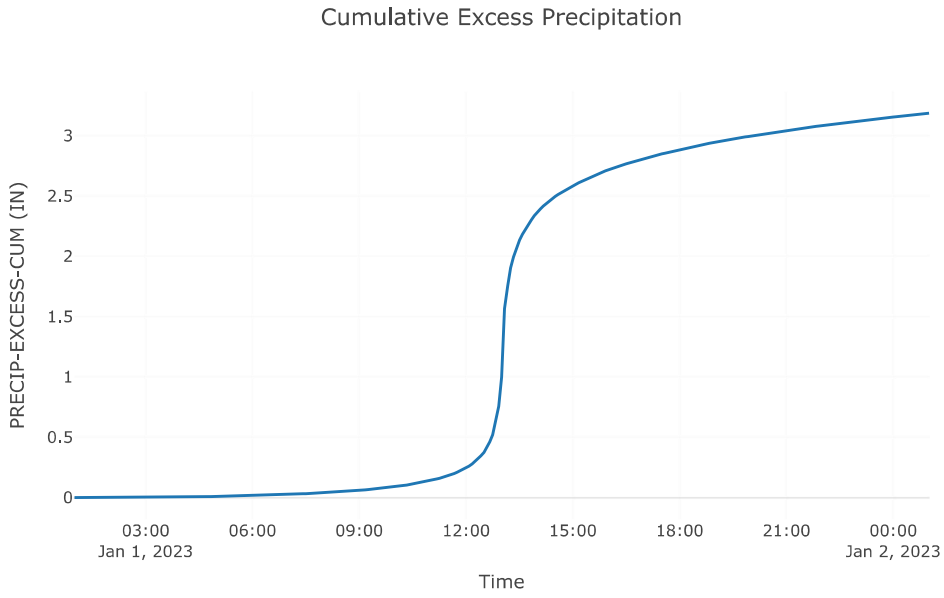
Area (MI2) : 0.33
Latitude Degrees : 39
Longitude Degrees : -104.57
Downstream : Reach - 3

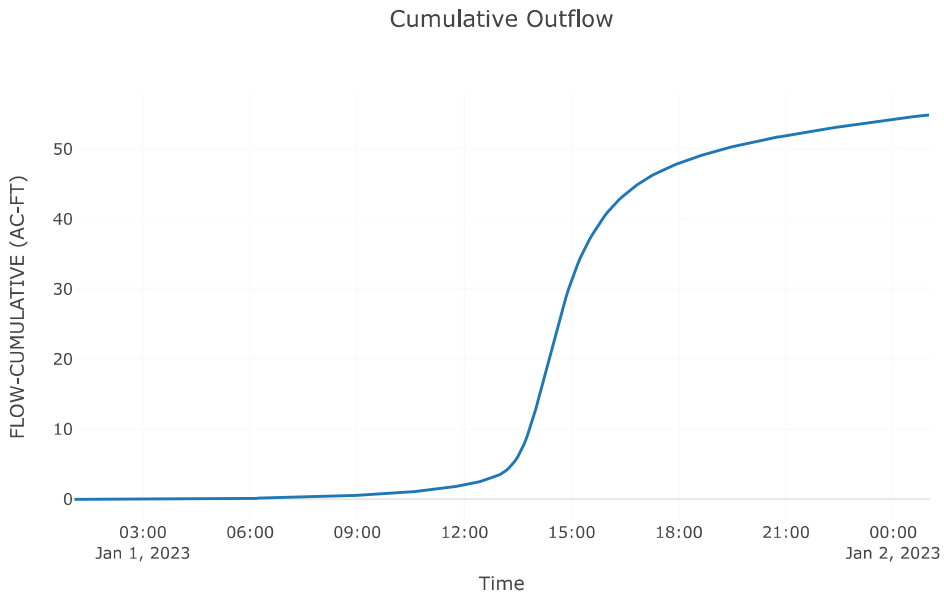
Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	78.64
Initial Abstraction	0

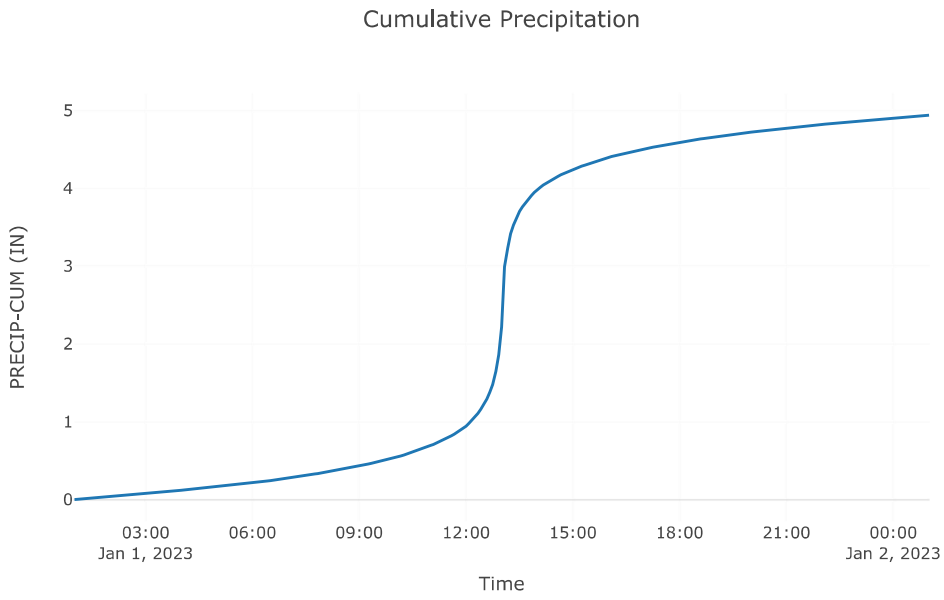
Transform: Scs	
Lag	72.31
Unitgraph Type	Standard

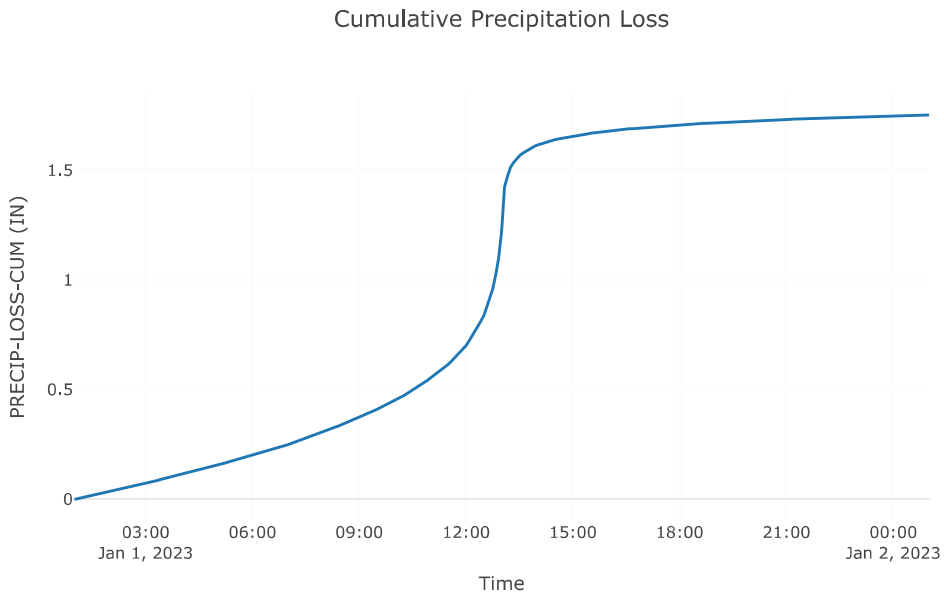
Results: Offsite	
Peak Discharge (CFS)	241.65
Time of Peak Discharge	01Jan2023, 14:20
Volume (IN)	3.14
Precipitation Volume (AC - FT)	86.48
Loss Volume (AC - FT)	30.69
Excess Volume (AC - FT)	55.8
Direct Runoff Volume (AC - FT)	54.89
Baseflow Volume (AC - FT)	0

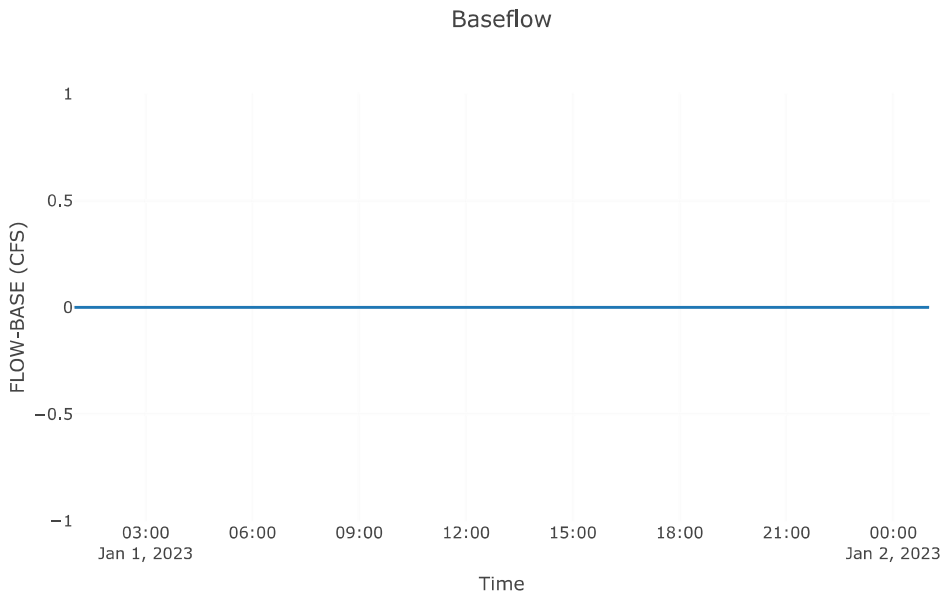

Precipitation and Outflow
PRECIP-INC (IN)
0
0.2
0.4
0.6
0.8
Precipitation
Excess Precipitation
Outflow
FLOW (CFS)
200
100
0
03:00
Jan 1, 2023
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2023

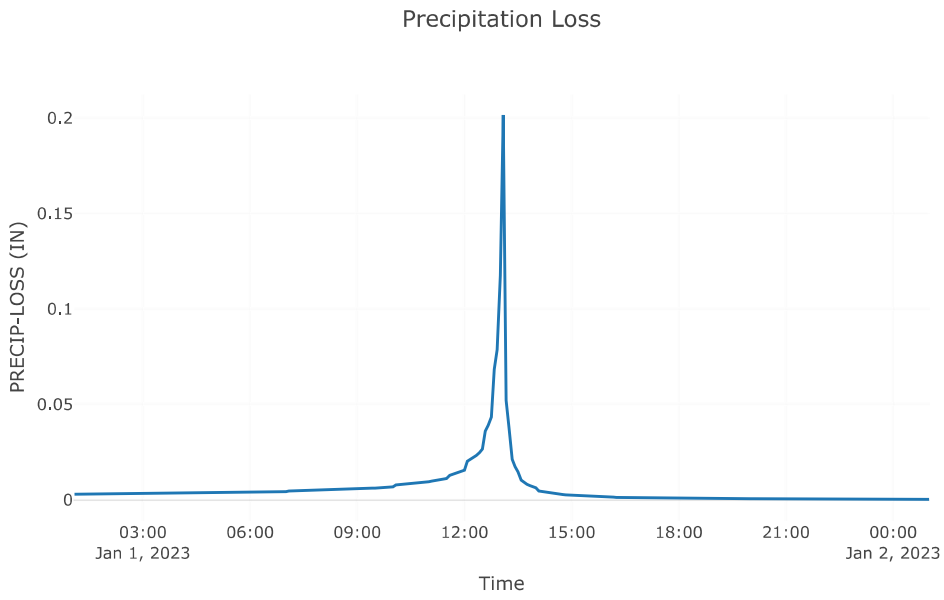

Cumulative Excess Precipitation
PRECIP-EXCESS-CUM (IN)
3
2.5
2
1.5
1
0.5
0
03:00
Jan 1, 2023
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2023
Time

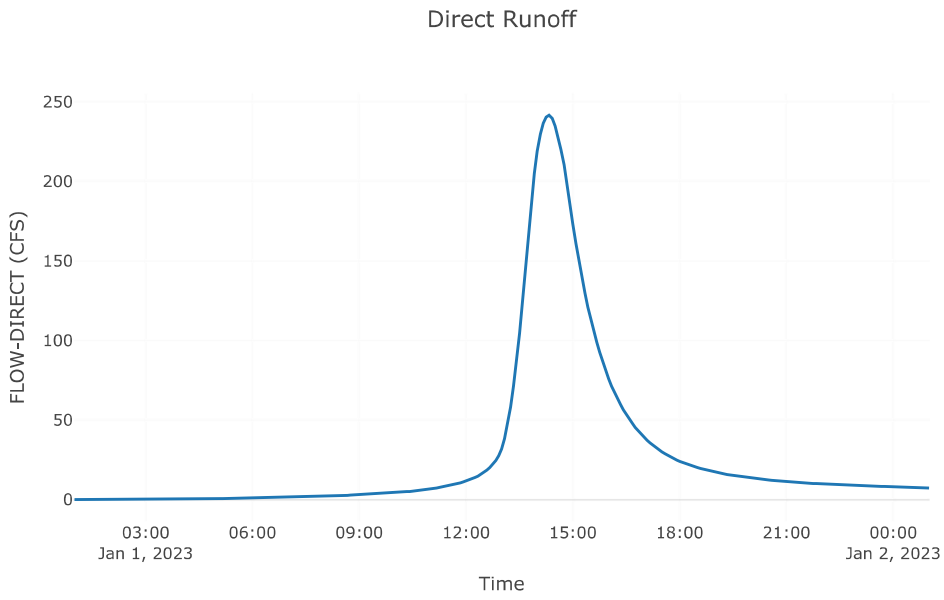

Cumulative Outflow
FLOW-CUMULATIVE (AC-FT)
50
40
30
20
10
0
03:00
Jan 1, 2023
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2023
Time

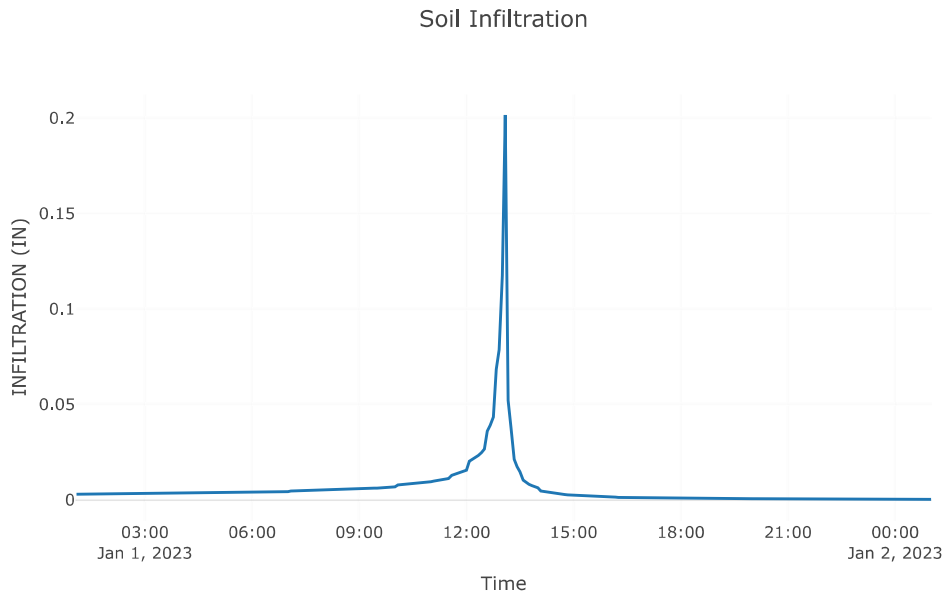

Cumulative Precipitation
PRECIP-CUM (IN)
5
4
3
2
1
0
03:00
Jan 1, 2023
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2023
Time


Cumulative Precipitation Loss
PRECIP-LOSS-CUM (IN)
1.5
1
0.5
0
03:00
Jan 1, 2023
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2023
Time


Baseflow
FLOW-BASE (CFS)
1
0.5
0
−0.5
−1
03:00
Jan 1, 2023
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2023
Time


Precipitation Loss
PRECIP-LOSS (IN)
0.2
0.15
0.1
0.05
0
03:00
Jan 1, 2023
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2023
Time


Direct Runoff
FLOW-DIRECT (CFS)
250
200
150
100
50
0
03:00
Jan 1, 2023
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2023
Time

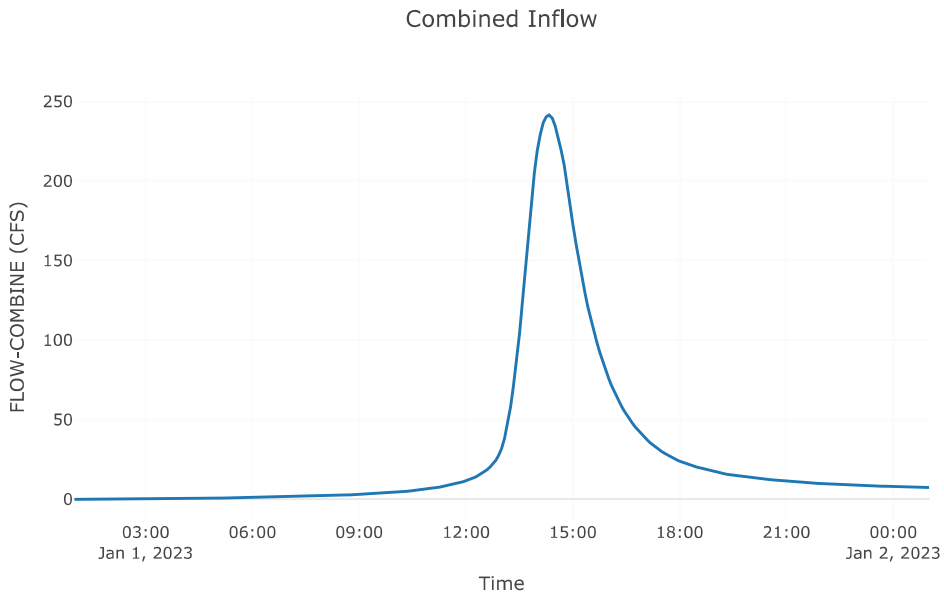

Soil Infiltration
INFILTRATION (IN)
0.2
0.15
0.1
0.05
0
03:00
Jan 1, 2023
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2023
Time

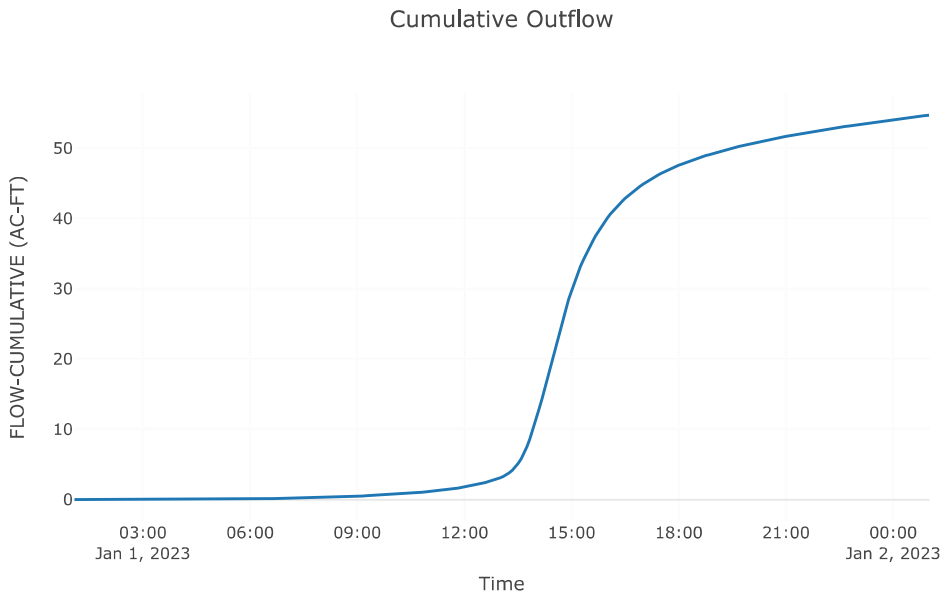
Reach: Reach-3

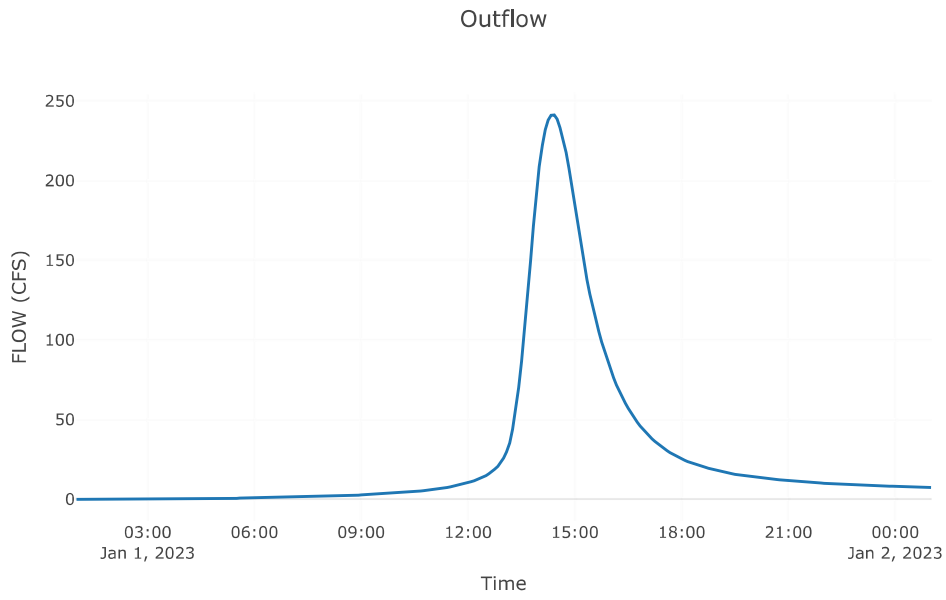
Downstream : Reach - 2

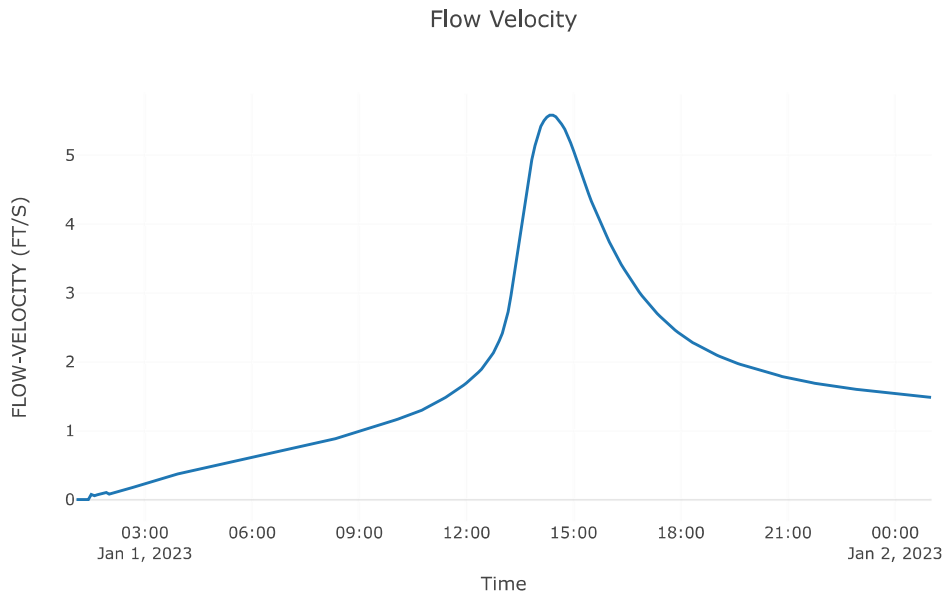
Route: Muskingum Cunge	
Method	Muskingum Cunge
Channel	Trapezoid
Length (FT)	1865.37
Energy Slope (FT/FT)	0.03
Mannings n	0.04
Bottom Width (FT)	38.76
Side Slope (FT/FT)	4
Initial Variable	Combined Inflow
Space - Time Method	Automatic DX and DT
Index Parameter Type	Index Celerity
Index Celerity	1.33
Number Subreaches	1
Maximum Depth Iterations	20
Maximum Route Step Iterations	30

Results: Reach-3	
Peak Discharge (CFS)	241.33
Time of Peak Discharge	01Jan2023, 14:25
Volume (IN)	3.12
Peak Inflow (CFS)	241.65
Inflow Volume (AC - FT)	54.89


Combined Inflow
FLOW-COMBINE (CFS)
250
200
150
100
50
0
03:00
Jan 1, 2023
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2023
Time


Cumulative Outflow
FLOW-CUMULATIVE (AC-FT)
50
40
30
20
10
0
03:00
Jan 1, 2023
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2023
Time


Outflow
250
200
150
100
50
0
FLOW (CFS)
03:00
Jan 1, 2023
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2023
Time


Flow Velocity
5
4
3
2
1
0
FLOW-VELOCITY (FT/S)
03:00
Jan 1, 2023
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2023
Time

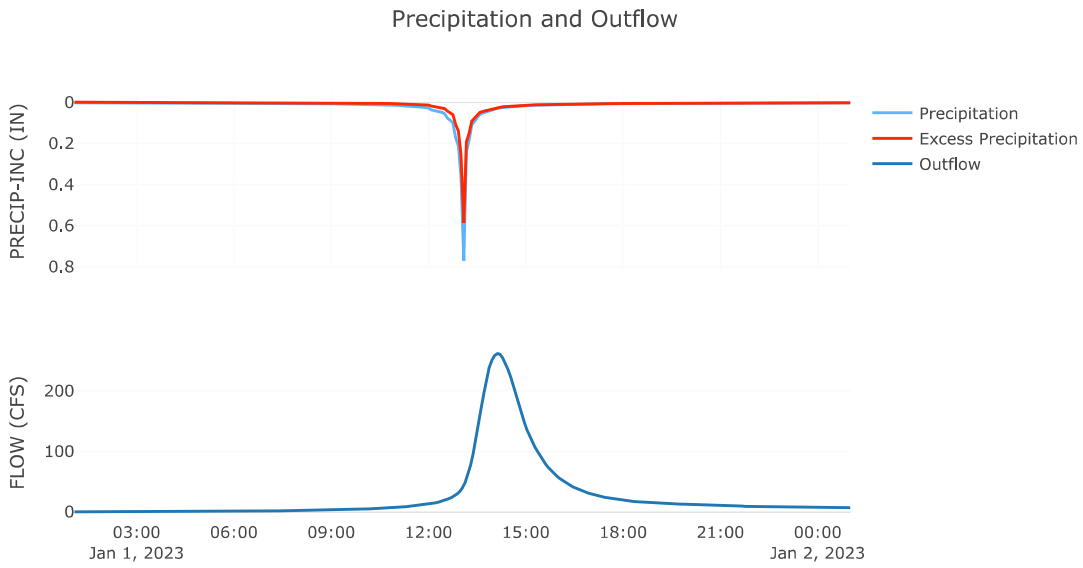
Subbasin: Meridian

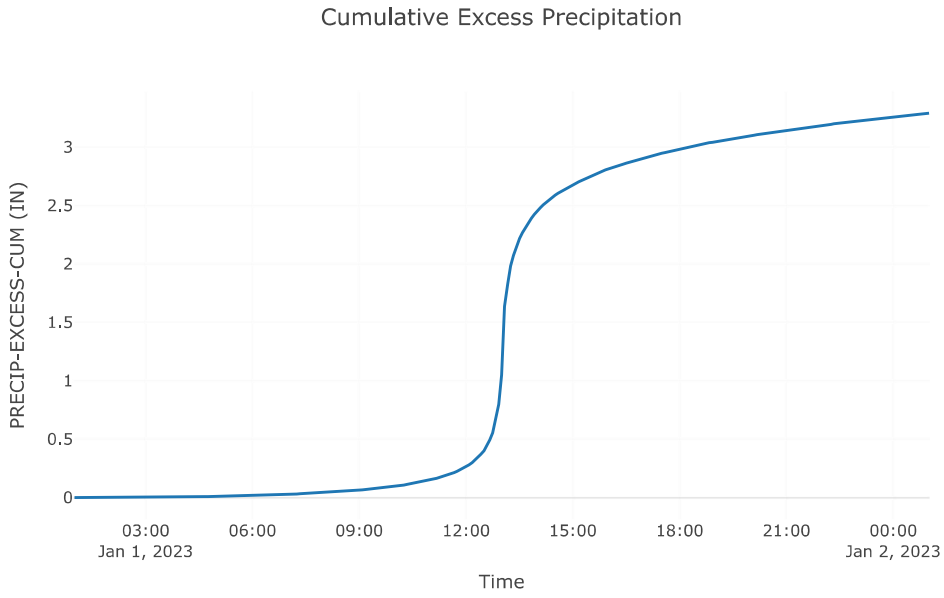
Area (MI2) : 0.3
Latitude Degrees : 38.99
Longitude Degrees : -104.57
Downstream : Reach - 4

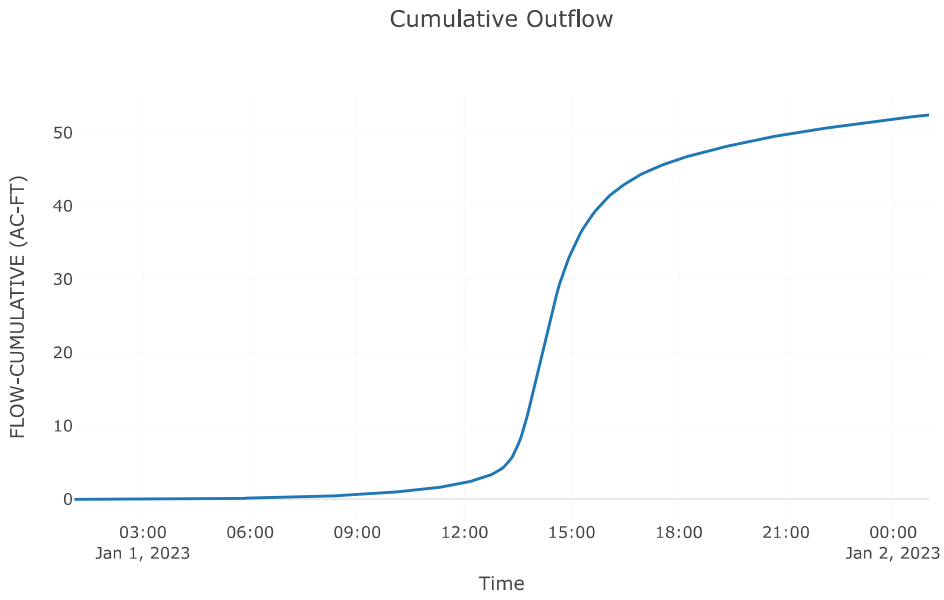
Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	80.16
Initial Abstraction	0

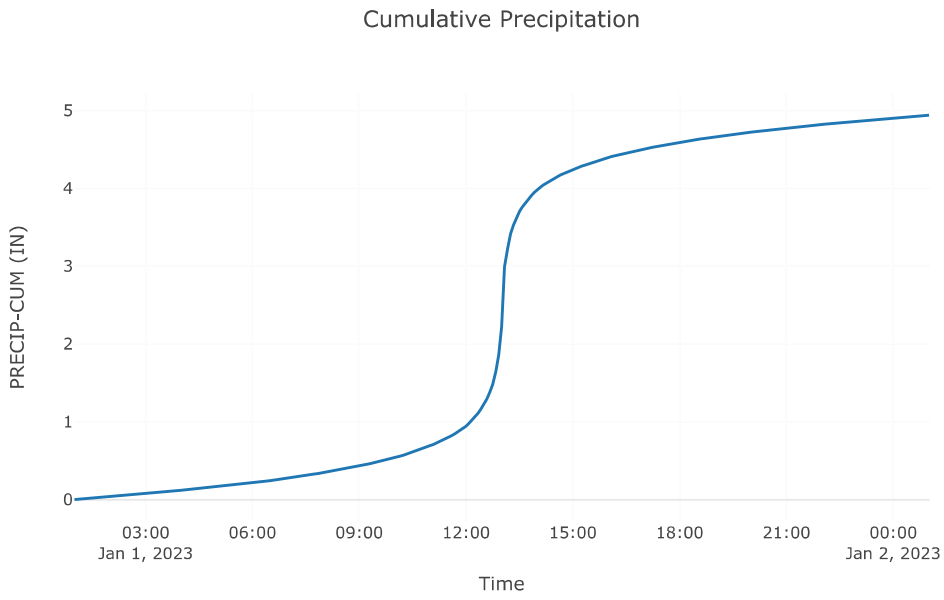
Transform: Scs	
Lag	60.1
Unitgraph Type	Standard

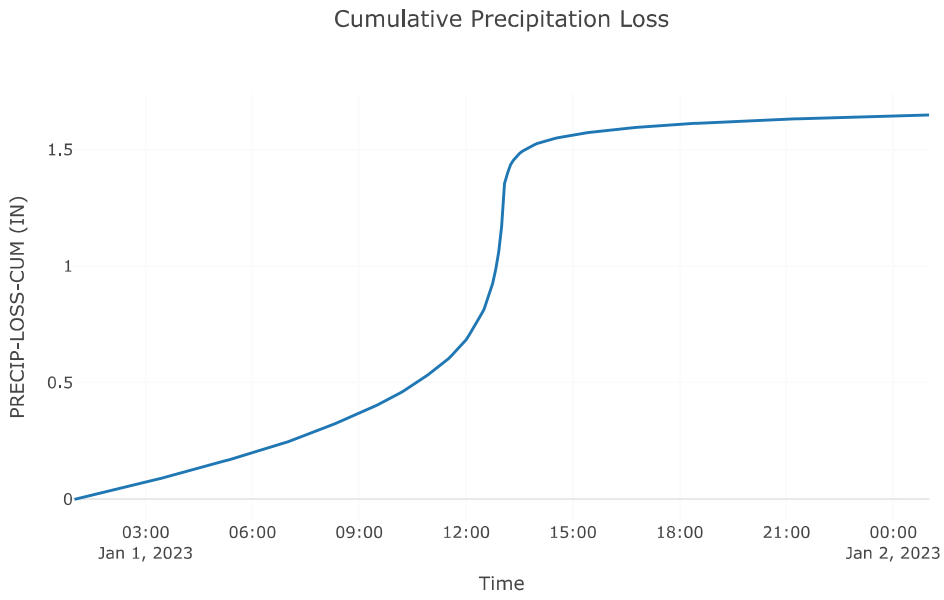
Results: Meridian	
Peak Discharge (CFS)	261.88
Time of Peak Discharge	01Jan2023, 14:05
Volume (IN)	3.25
Precipitation Volume (AC - FT)	79.77
Loss Volume (AC - FT)	26.63
Excess Volume (AC - FT)	53.14
Direct Runoff Volume (AC - FT)	52.44
Baseflow Volume (AC - FT)	0

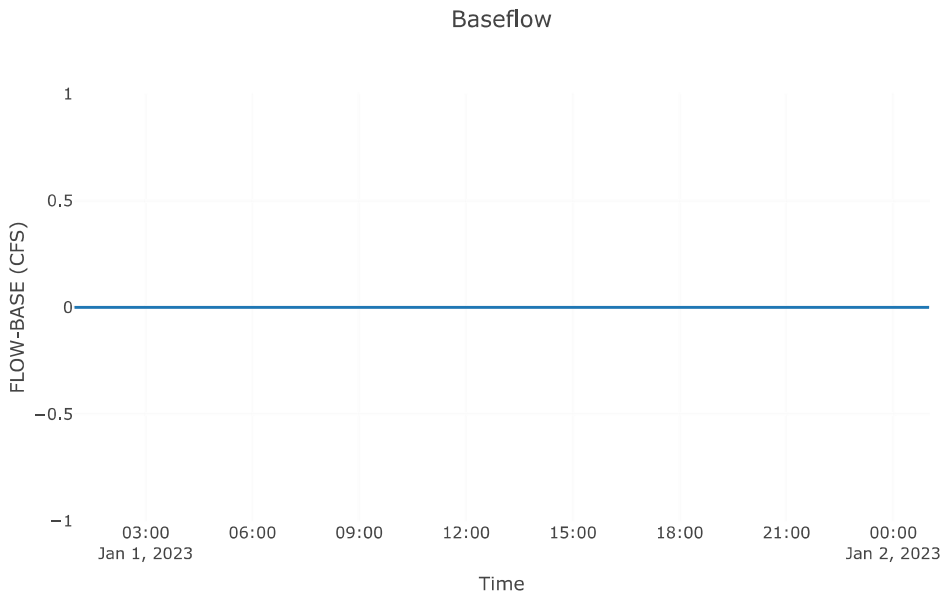

Precipitation and Outflow
PRECIP-INC (IN)
0
0.2
0.4
0.6
0.8
Precipitation
Excess Precipitation
Outflow
FLOW (CFS)
200
100
0
03:00
Jan 1, 2023
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2023

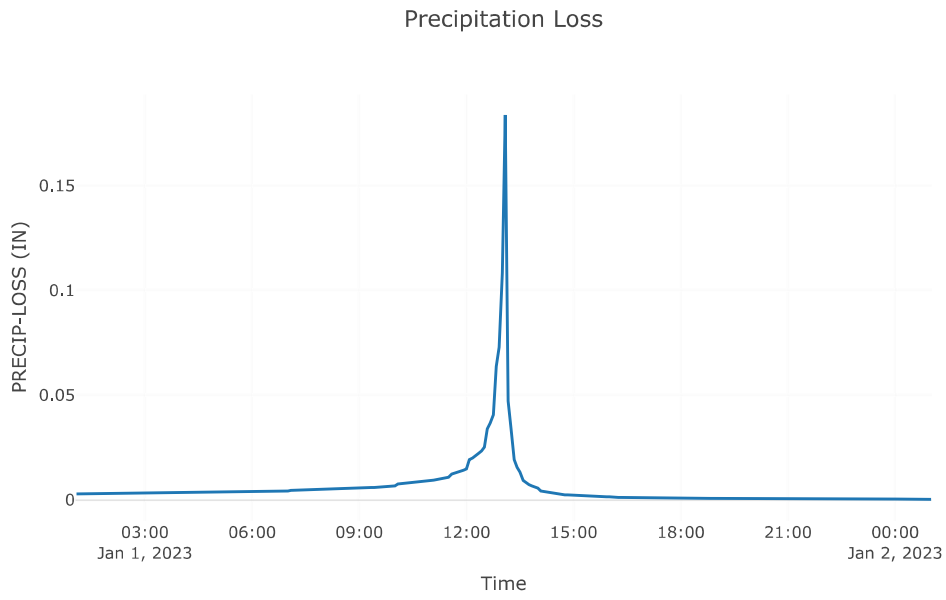

Cumulative Excess Precipitation
PRECIP-EXCESS-CUM (IN)
3
2.5
2
1.5
1
0.5
0
03:00
Jan 1, 2023
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2023
Time

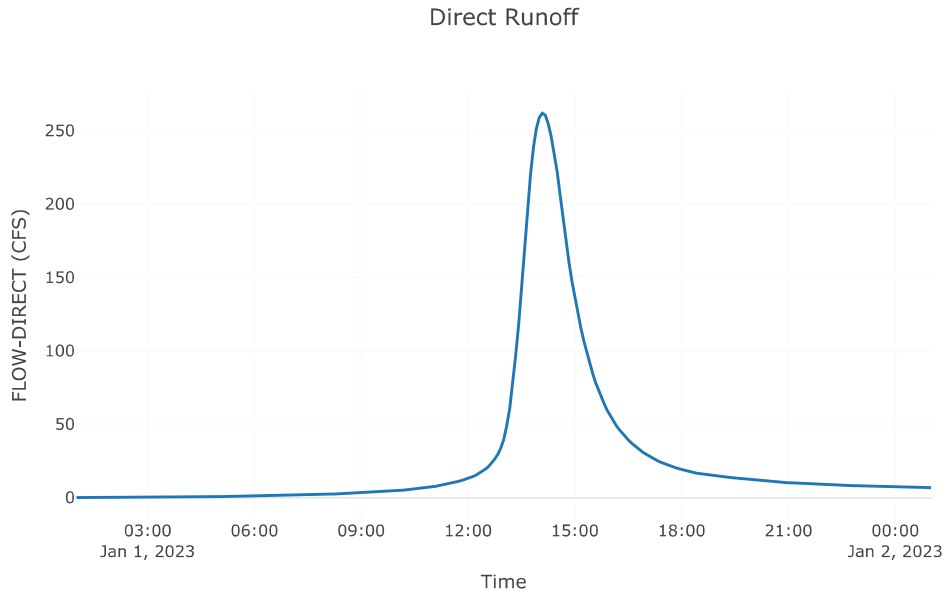

Cumulative Outflow
FLOW-CUMULATIVE (AC-FT)
50
40
30
20
10
0
03:00
Jan 1, 2023
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2023
Time

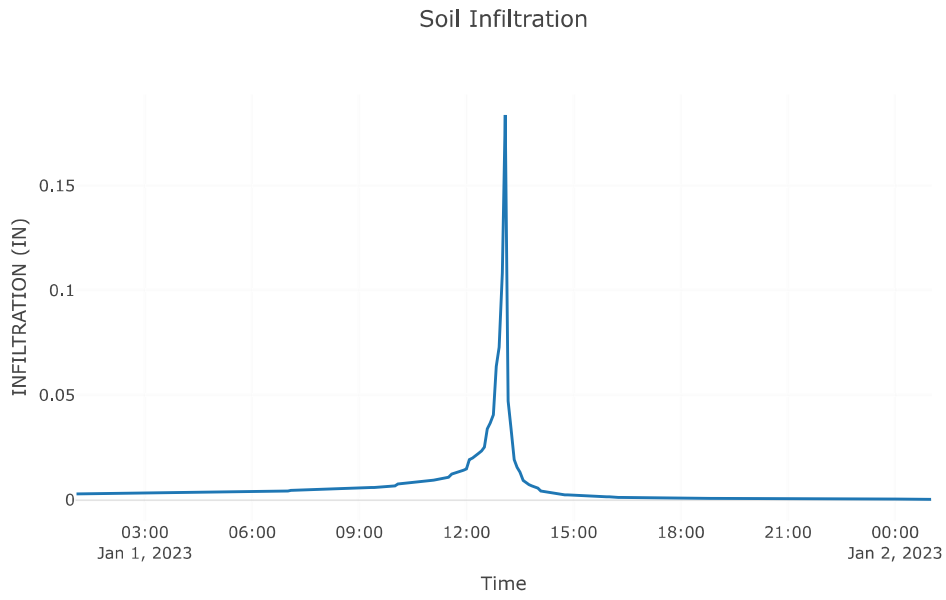

Cumulative Precipitation
PRECIP-CUM (IN)
5
4
3
2
1
0
03:00
Jan 1, 2023
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2023
Time


Cumulative Precipitation Loss
PRECIP-LOSS-CUM (IN)
1.5
1
0.5
0
03:00
Jan 1, 2023
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2023
Time


Baseflow
FLOW-BASE (CFS)
1
0.5
0
−0.5
−1
03:00
Jan 1, 2023
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2023
Time


Precipitation Loss
PRECIP-LOSS (IN)
0.15
0.1
0.05
0
03:00
Jan 1, 2023
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2023
Time


Direct Runoff
FLOW-DIRECT (CFS)
250
200
150
100
50
0
03:00
Jan 1, 2023
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2023
Time

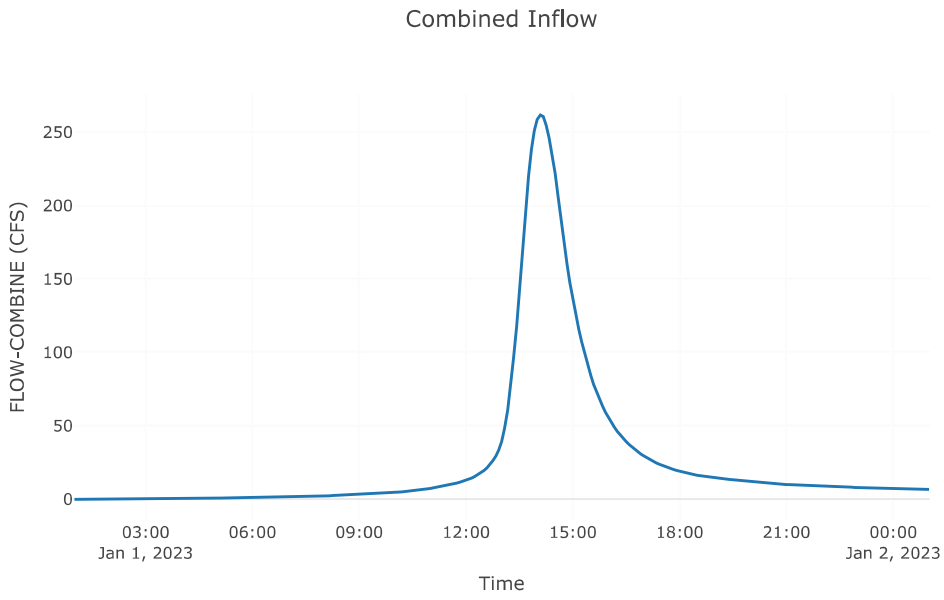

Soil Infiltration
INFILTRATION (IN)
0.15
0.1
0.05
0
03:00
Jan 1, 2023
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2023
Time

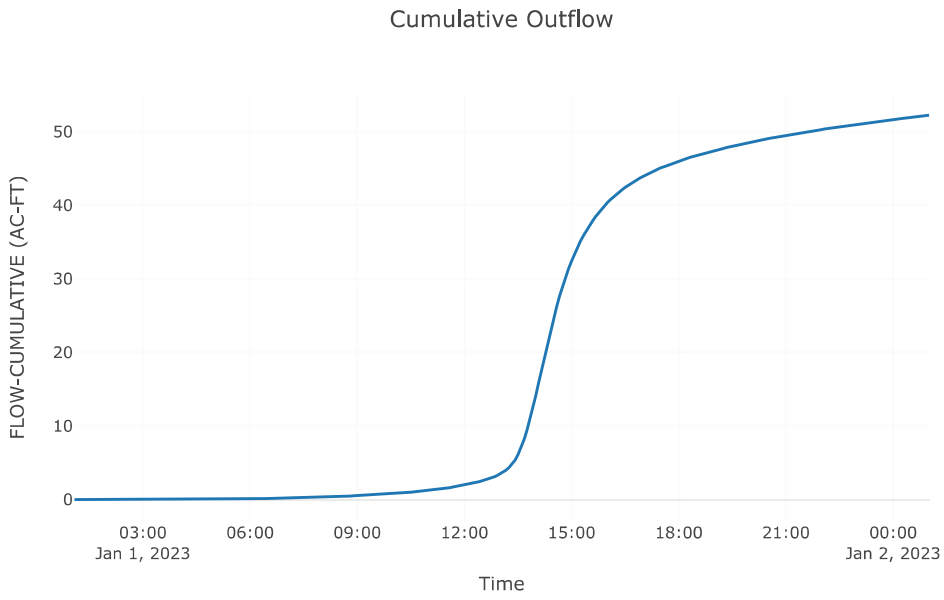
Reach: Reach-4

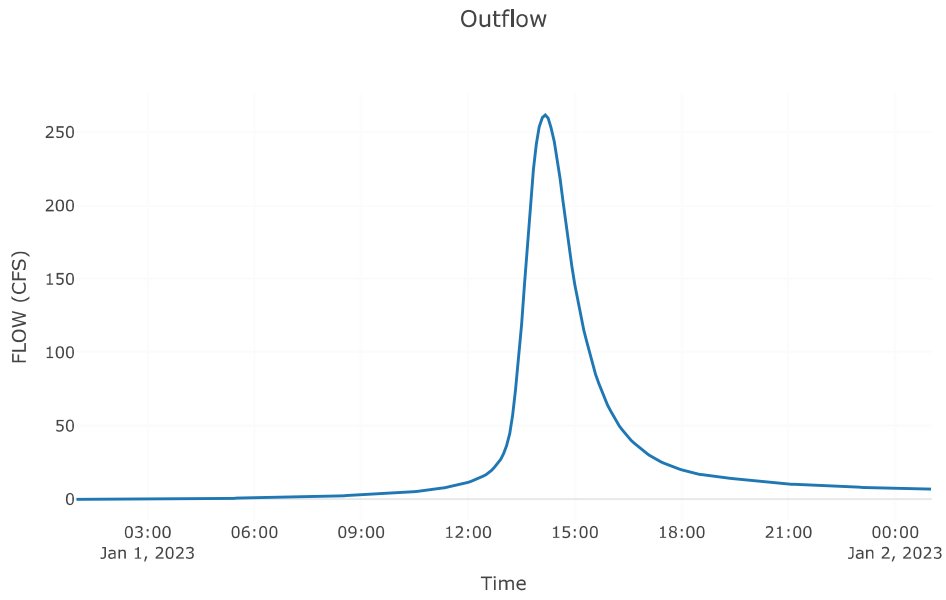
Downstream : Reach - 2

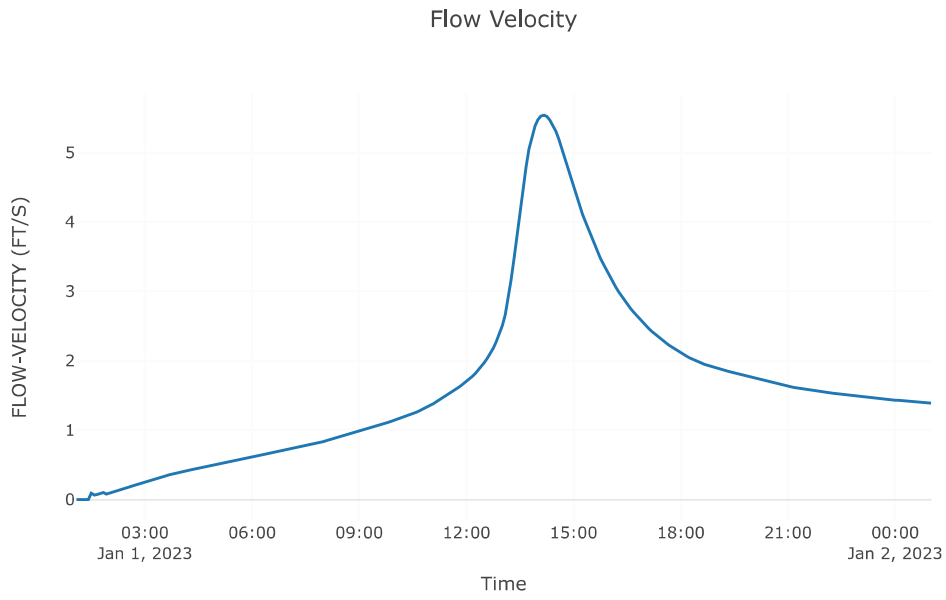
Route: Muskingum Cunge	
Method	Muskingum Cunge
Channel	Trapezoid
Length (FT)	1902.61
Energy Slope (FT/FT)	0.02
Mannings n	0.04
Bottom Width (FT)	38.76
Side Slope (FT/FT)	4
Initial Variable	Combined Inflow
Space - Time Method	Automatic DX and DT
Index Parameter Type	Index Celerity
Index Celerity	1.33
Number Subreaches	1
Maximum Depth Iterations	20
Maximum Route Step Iterations	30

Results: Reach-4	
Peak Discharge (CFS)	261.88
Time of Peak Discharge	01Jan2023, 14:10
Volume (IN)	3.24
Peak Inflow (CFS)	261.88
Inflow Volume (AC - FT)	52.44


Combined Inflow
FLOW-COMBINE (CFS)
250
200
150
100
50
0
03:00
Jan 1, 2023
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2023
Time


Cumulative Outflow
FLOW-CUMULATIVE (AC-FT)
50
40
30
20
10
0
03:00
Jan 1, 2023
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2023
Time


Outflow
250
200
150
100
50
0
FLOW (CFS)
03:00
Jan 1, 2023
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2023
Time


Flow Velocity
5
4
3
2
1
0
FLOW-VELOCITY (FT/S)
03:00
Jan 1, 2023
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2023
Time

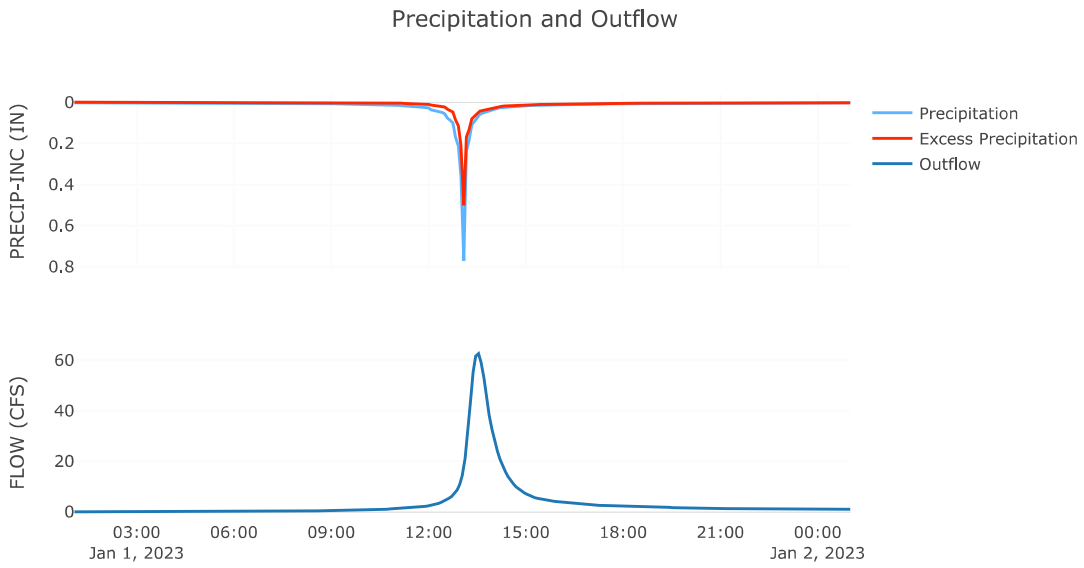
Subbasin: Subbasin-3

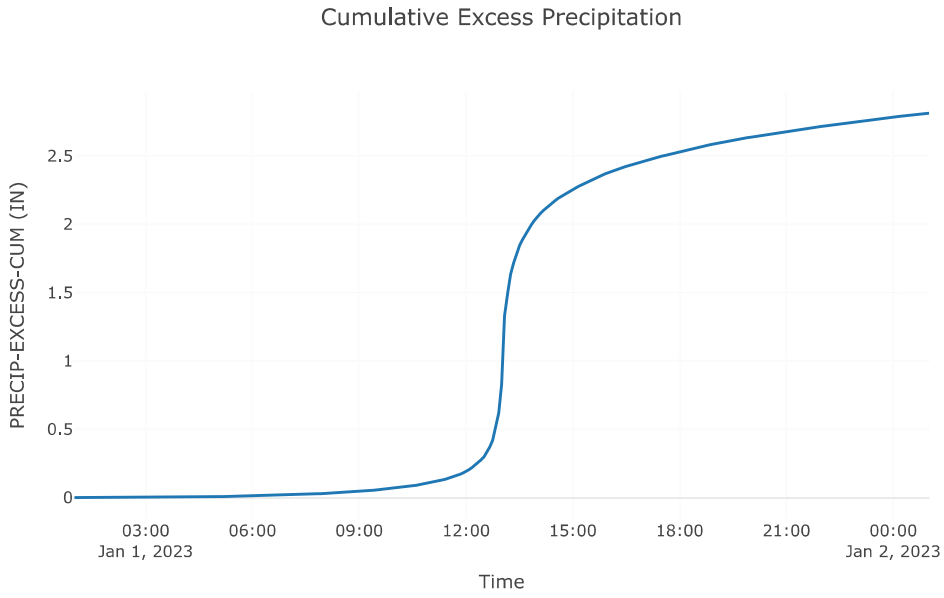
Area (MI2) : 0.05
Latitude Degrees : 38.99
Longitude Degrees : -104.56
Downstream : Reach - 2

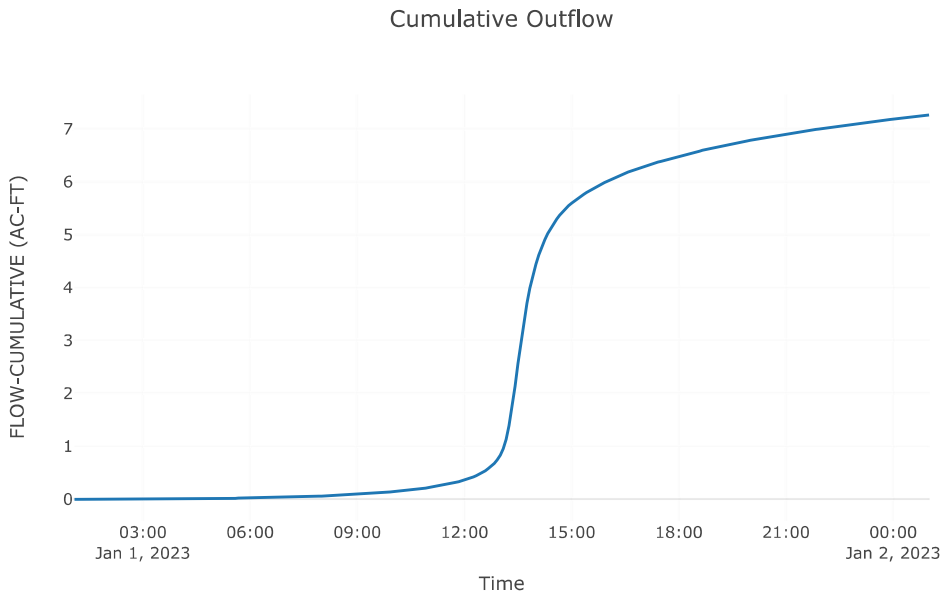
Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	72.81
Initial Abstraction	0

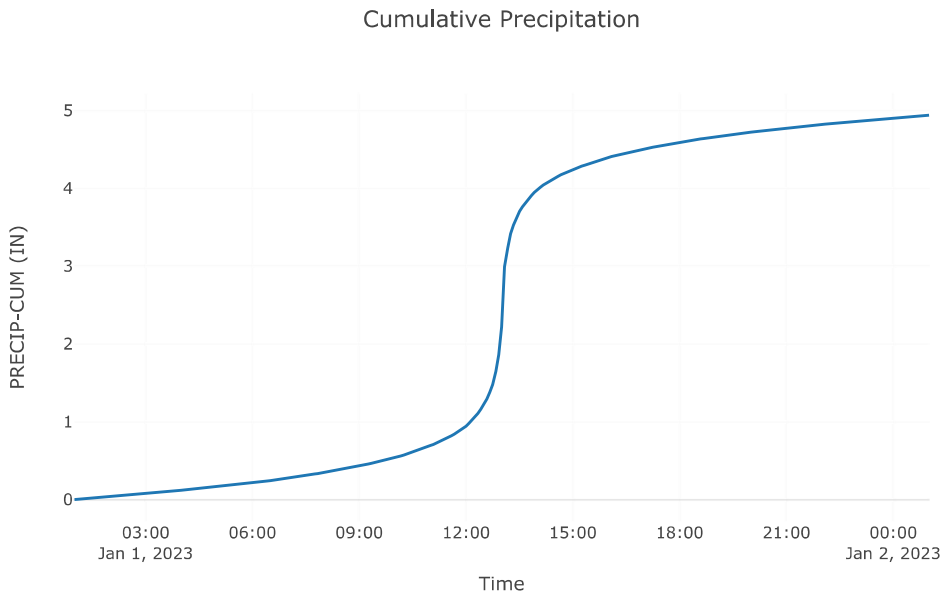
Transform: Scs	
Lag	24.46
Unitgraph Type	Standard

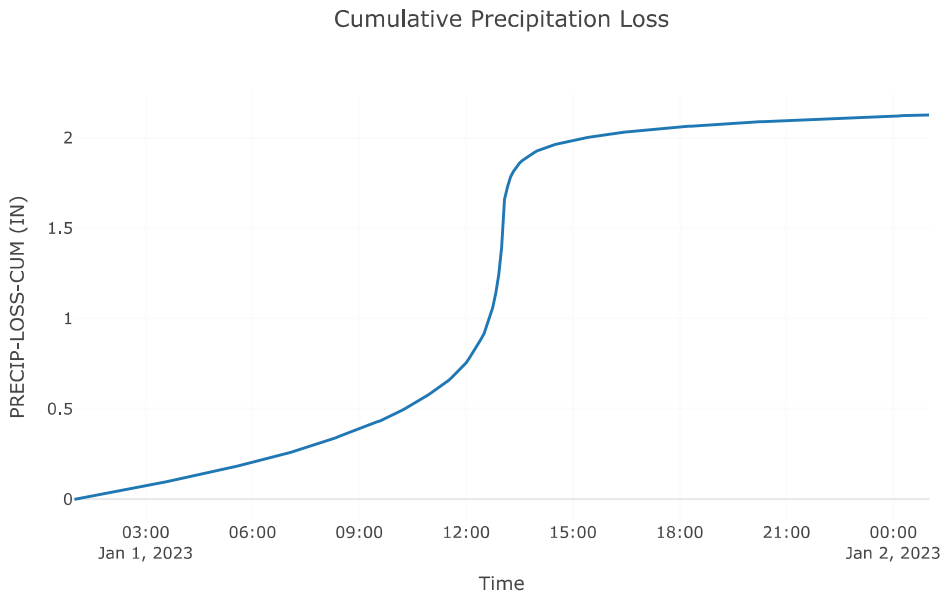
Results: Subbasin-3	
Peak Discharge (CFS)	62.65
Time of Peak Discharge	01Jan2023, 13:30
Volume (IN)	2.8
Precipitation Volume (AC - FT)	12.83
Loss Volume (AC - FT)	5.52
Excess Volume (AC - FT)	7.31
Direct Runoff Volume (AC - FT)	7.27
Baseflow Volume (AC - FT)	0

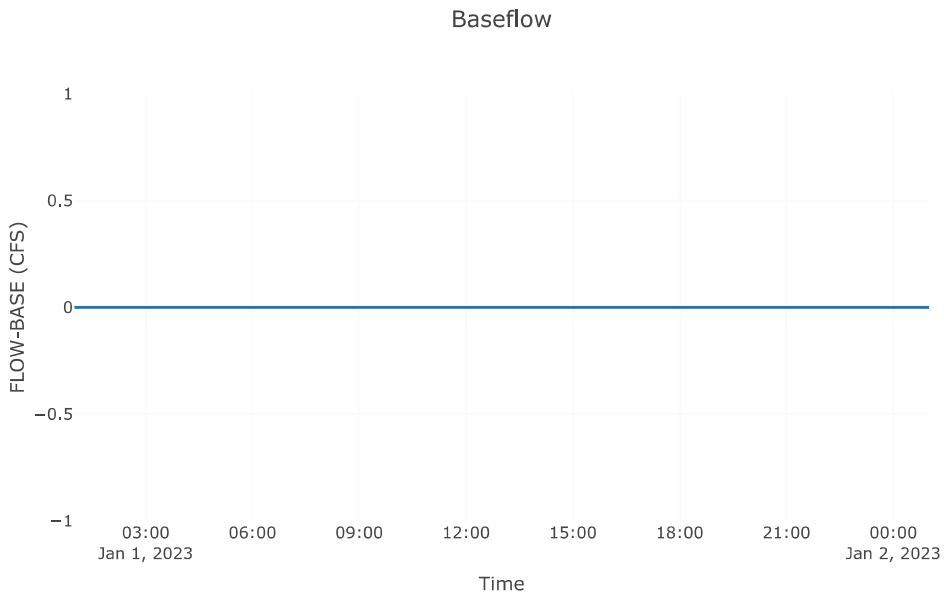

Precipitation and Outflow
PRECIP-INC (IN)
0
0.2
0.4
0.6
0.8
Precipitation
Excess Precipitation
Outflow
FLOW (CFS)
60
40
20
0
03:00
Jan 1, 2023
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2023

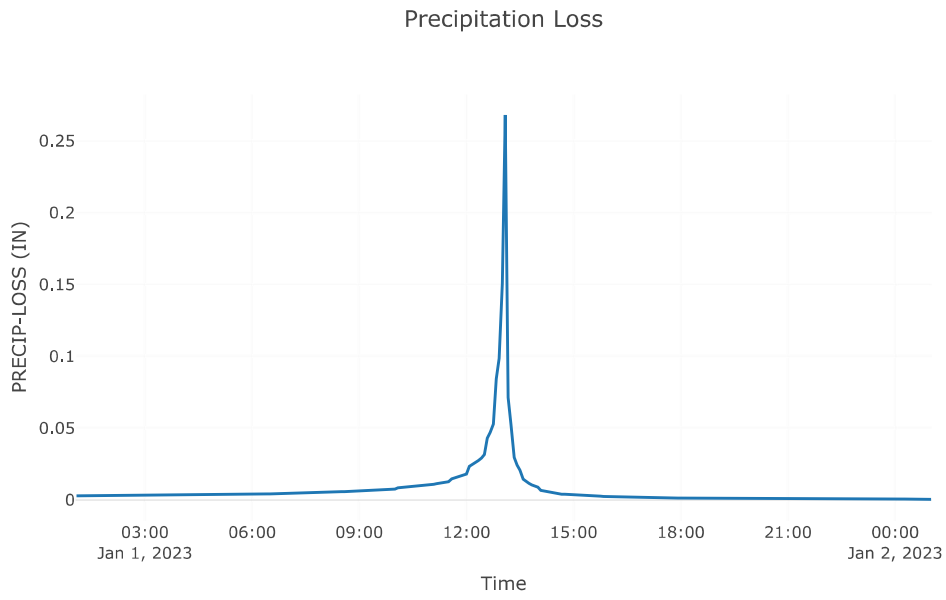

Cumulative Excess Precipitation
PRECIP-EXCESS-CUM (IN)
2.5
2
1.5
1
0.5
0
03:00
Jan 1, 2023
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2023
Time

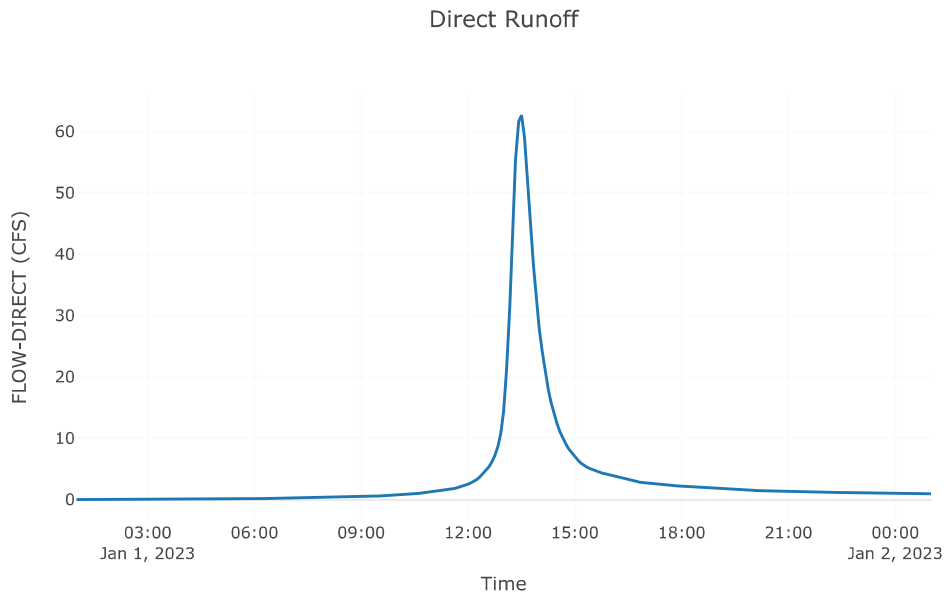

Cumulative Outflow
FLOW-CUMULATIVE (AC-FT)
0
1
2
3
4
5
6
7
03:00
Jan 1, 2023
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2023
Time

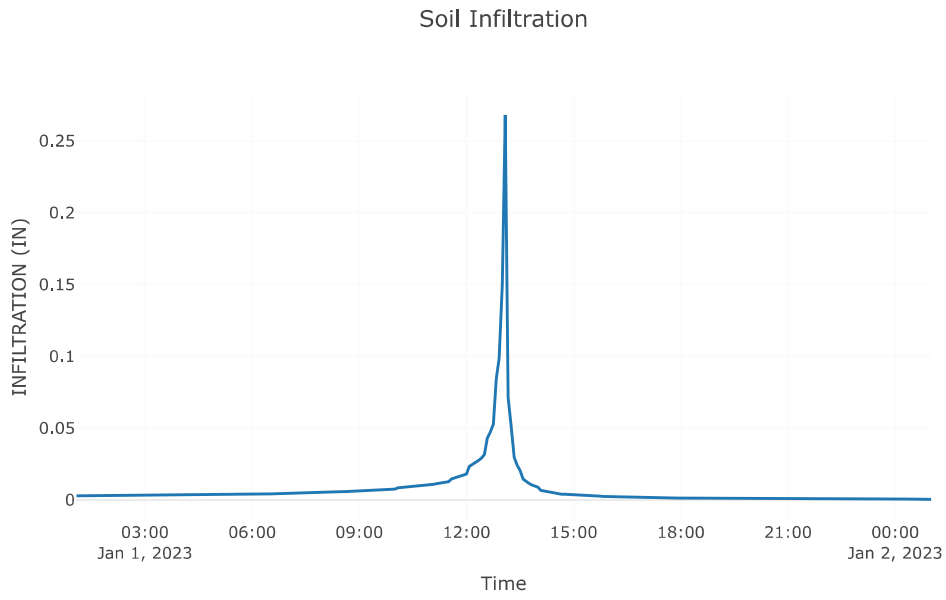

Cumulative Precipitation
PRECIP-CUM (IN)
0
1
2
3
4
5
03:00
Jan 1, 2023
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2023
Time


Cumulative Precipitation Loss
PRECIP-LOSS-CUM (IN)
2
1.5
1
0.5
0
03:00
Jan 1, 2023
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2023
Time


Baseflow
FLOW-BASE (CFS)
1
0.5
0
−0.5
−1
03:00
Jan 1, 2023
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2023
Time


Precipitation Loss
PRECIP-LOSS (IN)
0.25
0.2
0.15
0.1
0.05
0
03:00
Jan 1, 2023
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2023
Time


Direct Runoff
FLOW-DIRECT (CFS)
60
50
40
30
20
10
0
03:00
Jan 1, 2023
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2023
Time


Soil Infiltration
INFILTRATION (IN)
0.25
0.2
0.15
0.1
0.05
0
03:00
Jan 1, 2023
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2023
Time

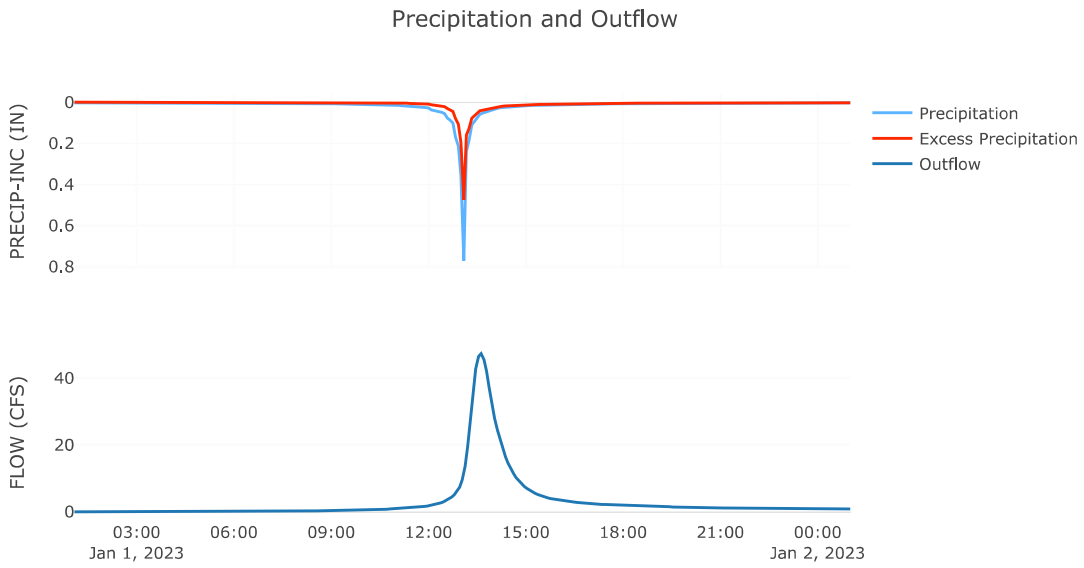
Subbasin: Subbasin-4

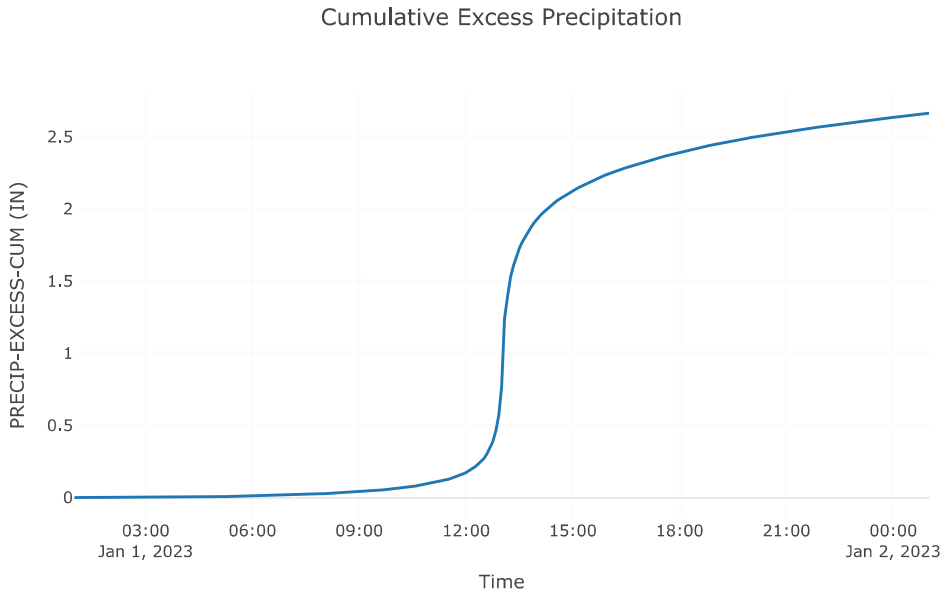
Area (MI2) : 0.04
Latitude Degrees : 38.99
Longitude Degrees : -104.57
Downstream : Reach - 2

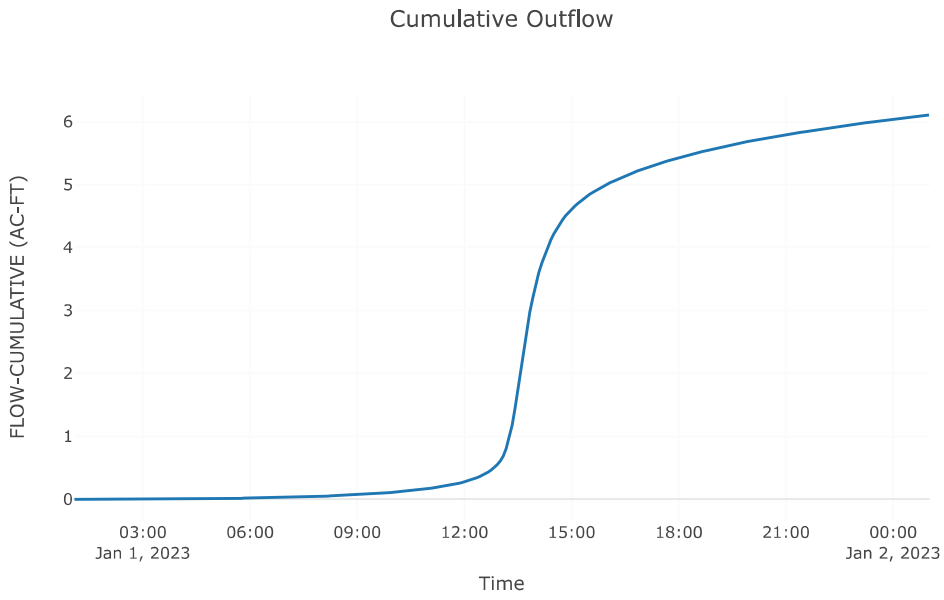
Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	70.32
Initial Abstraction	0

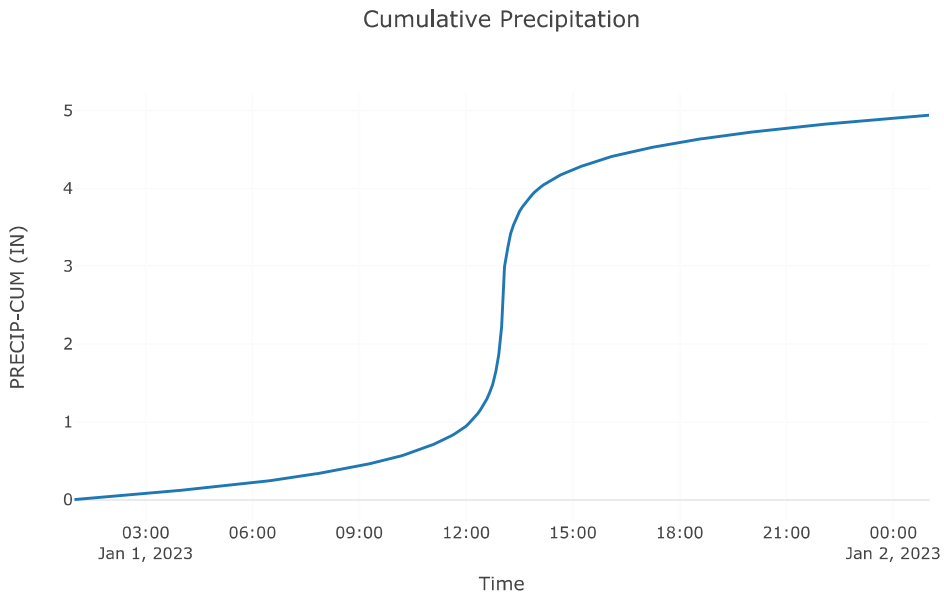
Transform: Scs	
Lag	29.46
Unitgraph Type	Standard

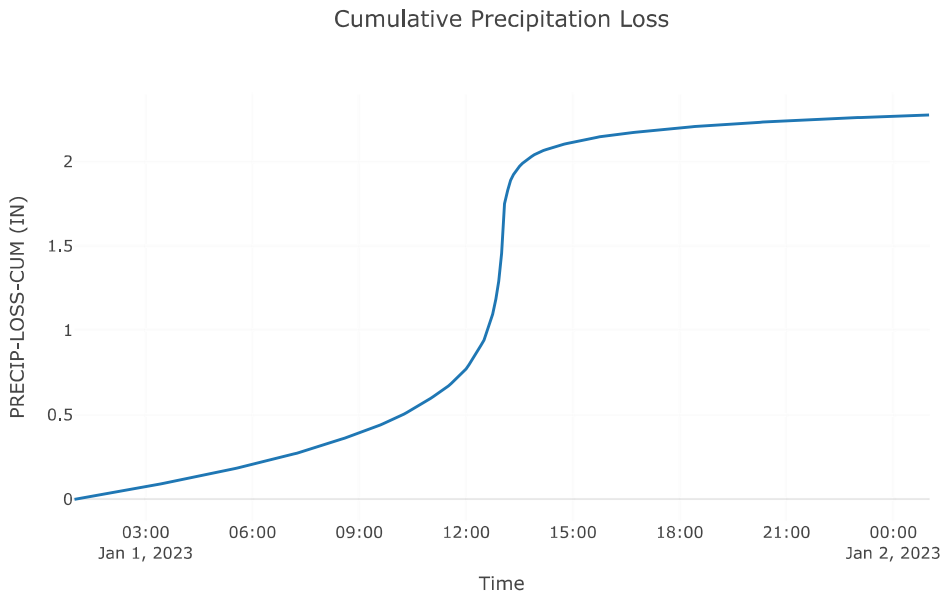
Results: Subbasin-4	
Peak Discharge (CFS)	47.38
Time of Peak Discharge	01Jan2023, 13:35
Volume (IN)	2.65
Precipitation Volume (AC - FT)	11.41
Loss Volume (AC - FT)	5.26
Excess Volume (AC - FT)	6.15
Direct Runoff Volume (AC - FT)	6.11
Baseflow Volume (AC - FT)	0

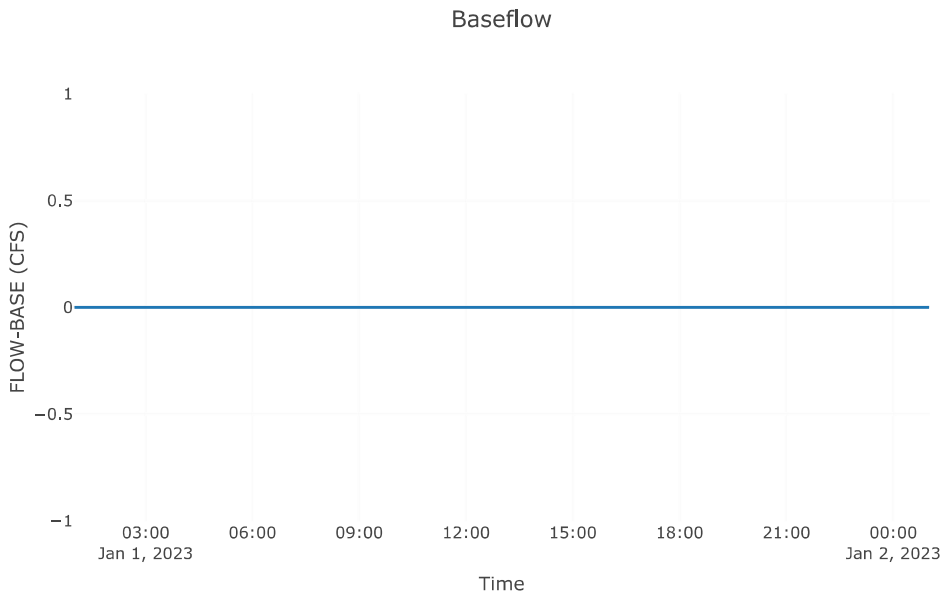

Precipitation and Outflow
PRECIP-INC (IN)
0
0.2
0.4
0.6
0.8
Precipitation
Excess Precipitation
Outflow
FLOW (CFS)
40
20
0
03:00
Jan 1, 2023
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2023

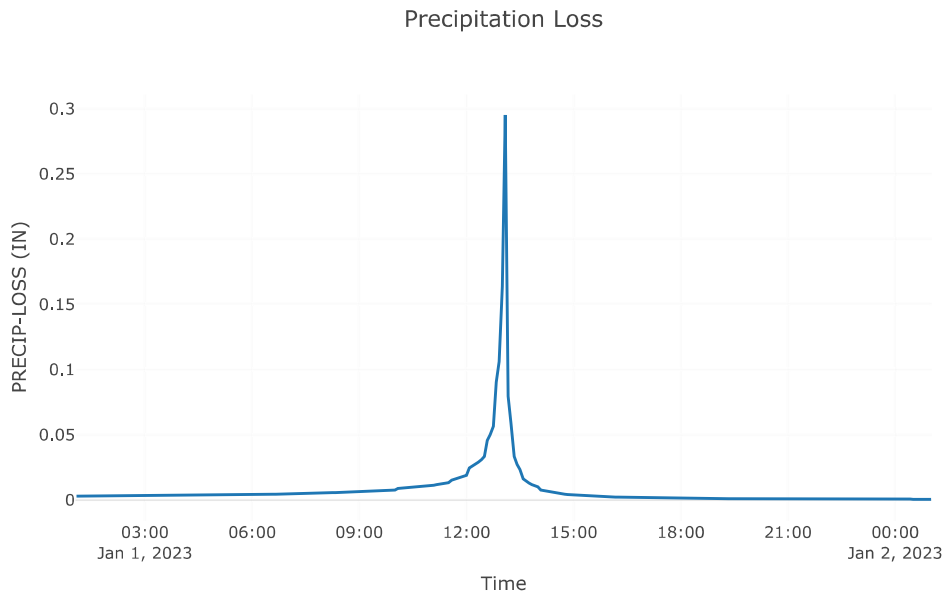

Cumulative Excess Precipitation
PRECIP-EXCESS-CUM (IN)
2.5
2
1.5
1
0.5
0
03:00
Jan 1, 2023
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2023
Time

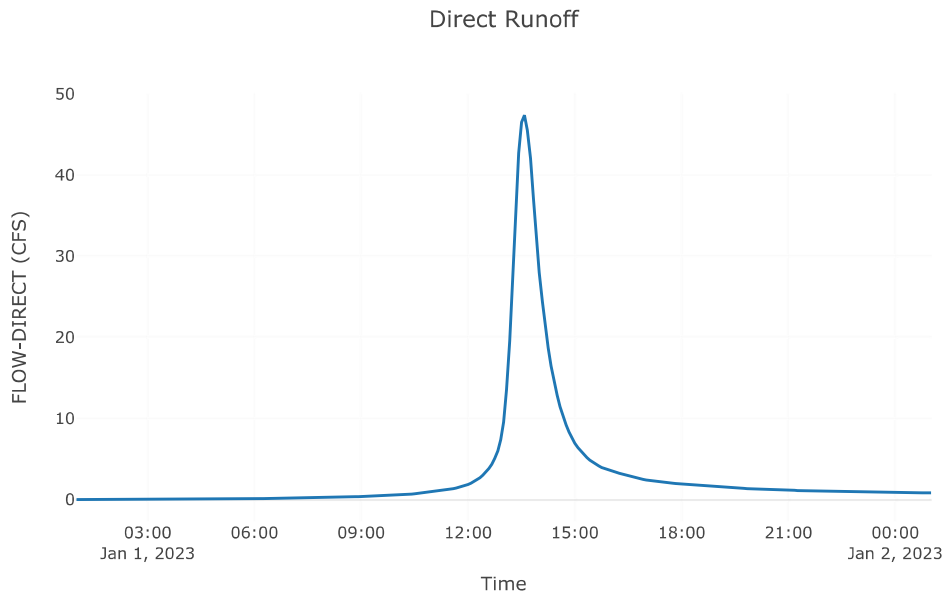

Cumulative Outflow
FLOW-CUMULATIVE (AC-FT)
0
1
2
3
4
5
6
03:00
Jan 1, 2023
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2023
Time

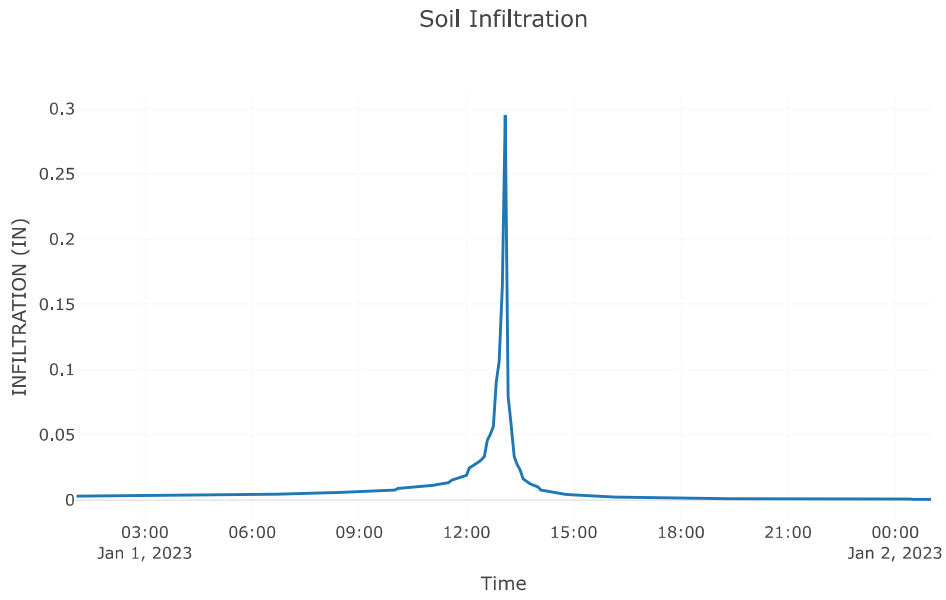

Cumulative Precipitation
PRECIP-CUM (IN)
0
1
2
3
4
5
03:00
Jan 1, 2023
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2023
Time


Cumulative Precipitation Loss
PRECIP-LOSS-CUM (IN)
2
1.5
1
0.5
0
03:00
Jan 1, 2023
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2023
Time


Baseflow
FLOW-BASE (CFS)
1
0.5
0
−0.5
−1
03:00
Jan 1, 2023
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2023
Time


Precipitation Loss
PRECIP-LOSS (IN)
0.3
0.25
0.2
0.15
0.1
0.05
0
03:00
Jan 1, 2023
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2023
Time


Direct Runoff
FLOW-DIRECT (CFS)
50
40
30
20
10
0
03:00
Jan 1, 2023
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2023
Time

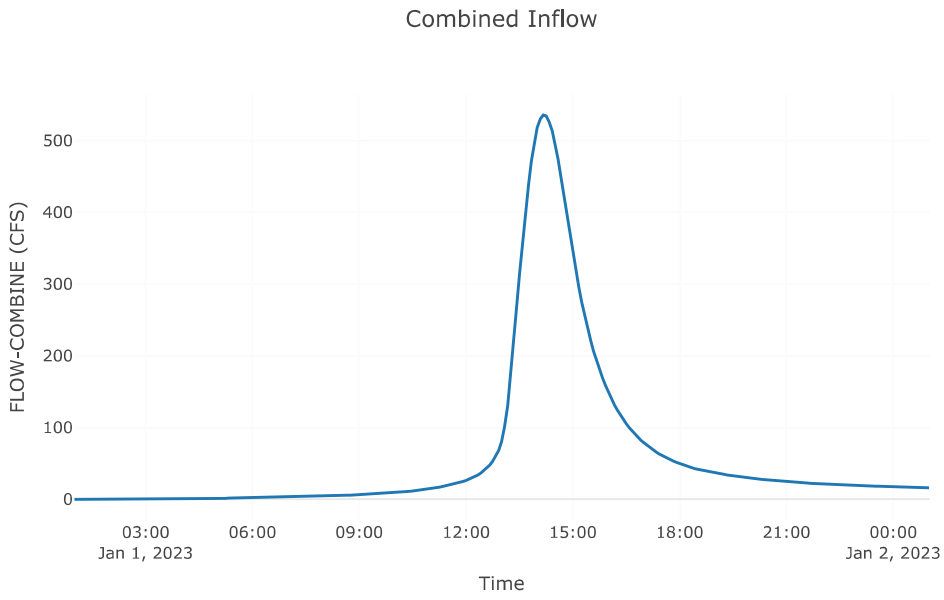

Soil Infiltration
INFILTRATION (IN)
0.3
0.25
0.2
0.15
0.1
0.05
0
03:00
Jan 1, 2023
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2023
Time

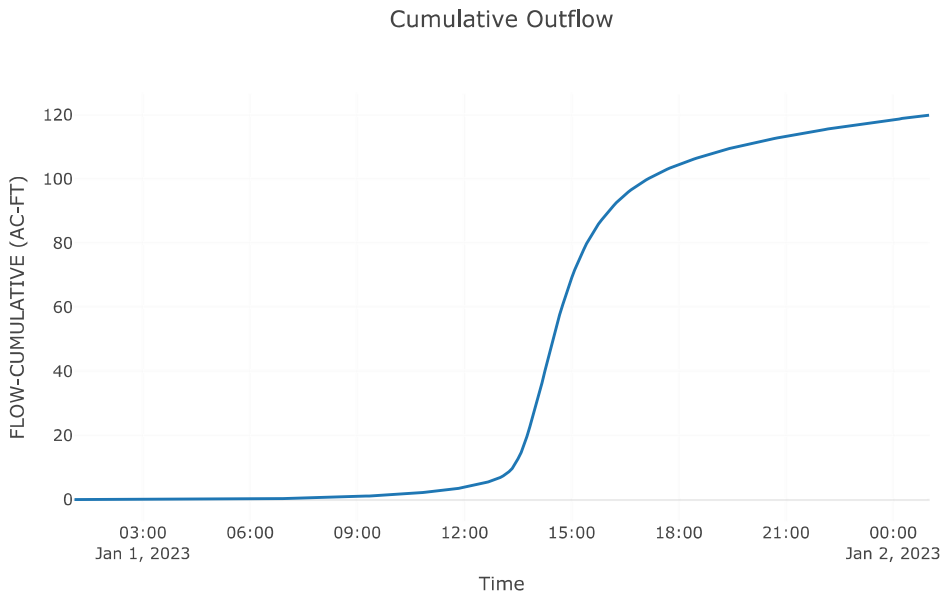
Reach: Reach-2

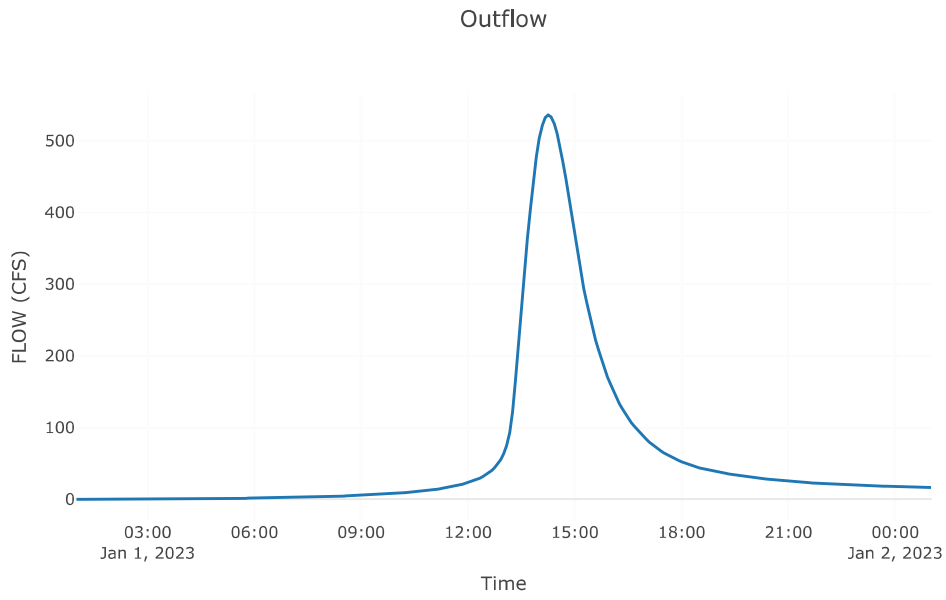
Downstream : Reach - 1

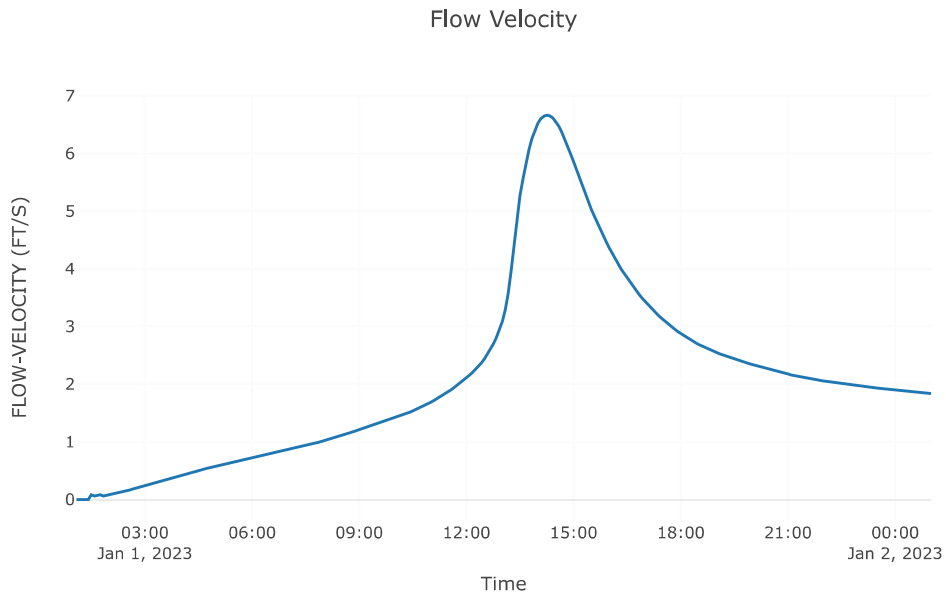
Route: Muskingum Cunge	
Method	Muskingum Cunge
Channel	Trapezoid
Length (FT)	2337.51
Energy Slope (FT/FT)	0.02
Mannings n	0.04
Bottom Width (FT)	38.76
Side Slope (FT/FT)	4
Initial Variable	Combined Inflow
Space - Time Method	Automatic DX and DT
Index Parameter Type	Index Celerity
Index Celerity	1.33
Number Subreaches	1
Maximum Depth Iterations	20
Maximum Route Step Iterations	30

Results: Reach-2	
Peak Discharge (CFS)	536.09
Time of Peak Discharge	01Jan2023, 14:15
Volume (IN)	3.11
Peak Inflow (CFS)	535.98
Inflow Volume (AC - FT)	120.33


Combined Inflow
FLOW-COMBINE (CFS)
500
400
300
200
100
0
03:00
Jan 1, 2023
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2023
Time


Cumulative Outflow
FLOW-CUMULATIVE (AC-FT)
120
100
80
60
40
20
0
03:00
Jan 1, 2023
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2023
Time


Outflow
FLOW (CFS)
500
400
300
200
100
0
03:00
Jan 1, 2023
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2023
Time


Flow Velocity
FLOW-VELOCITY (FT/S)
7
6
5
4
3
2
1
0
03:00
Jan 1, 2023
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2023
Time

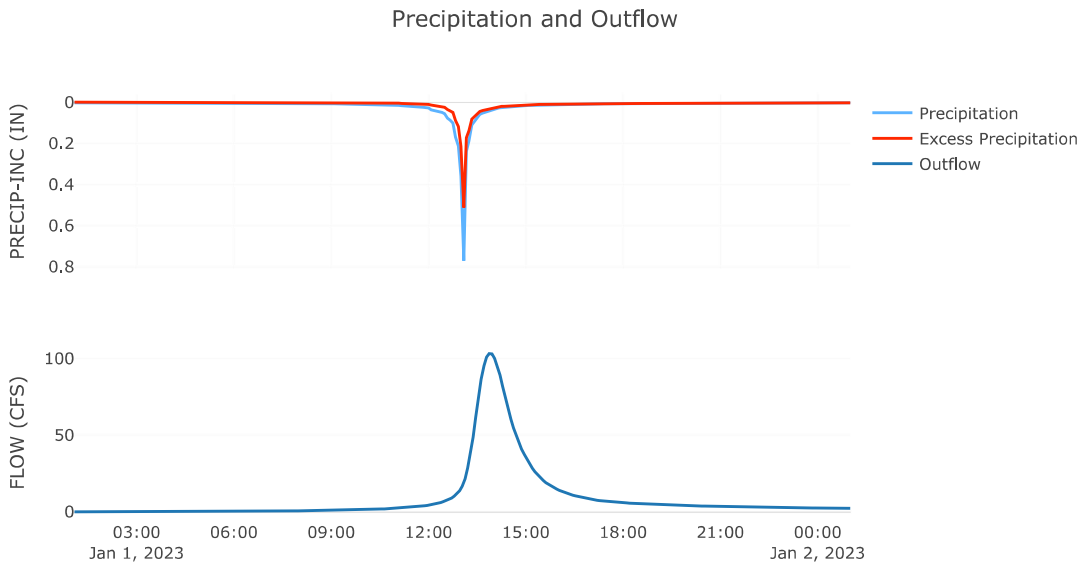
Subbasin: Subbasin-2

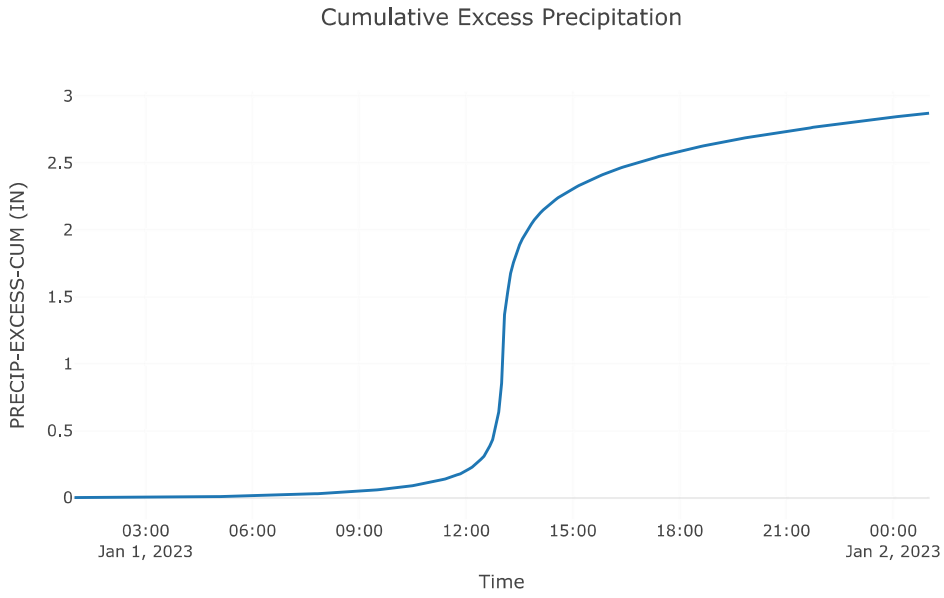
Area (MI2) : 0.12
Latitude Degrees : 38.99
Longitude Degrees : -104.56
Downstream : Reach - 1

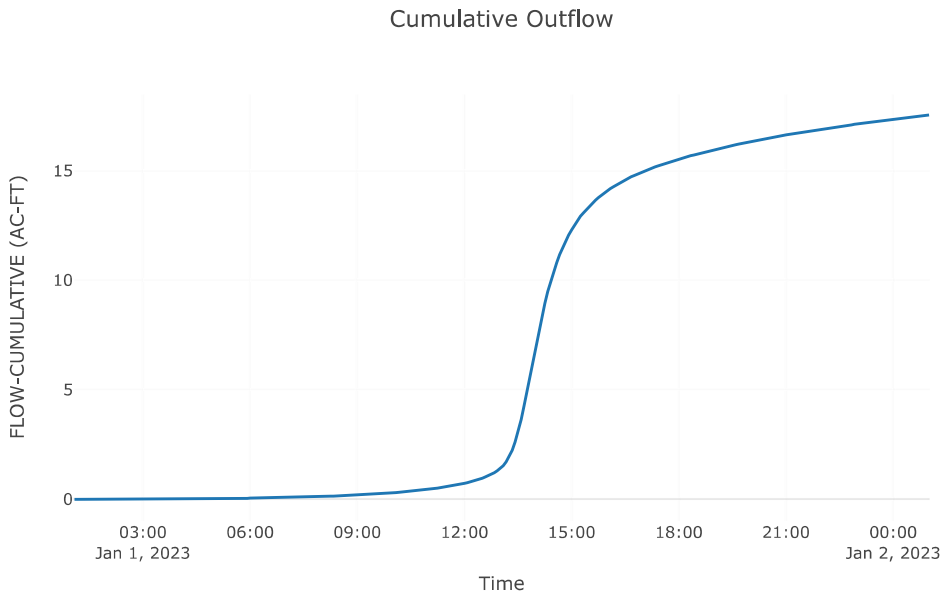
Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	73.76
Initial Abstraction	0

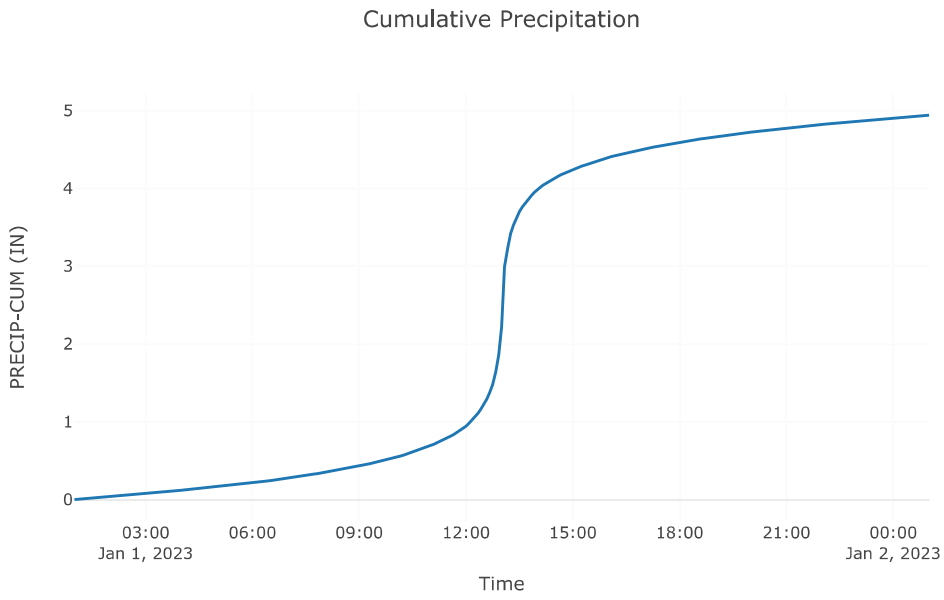
Transform: Scs	
Lag	46.35
Unitgraph Type	Standard

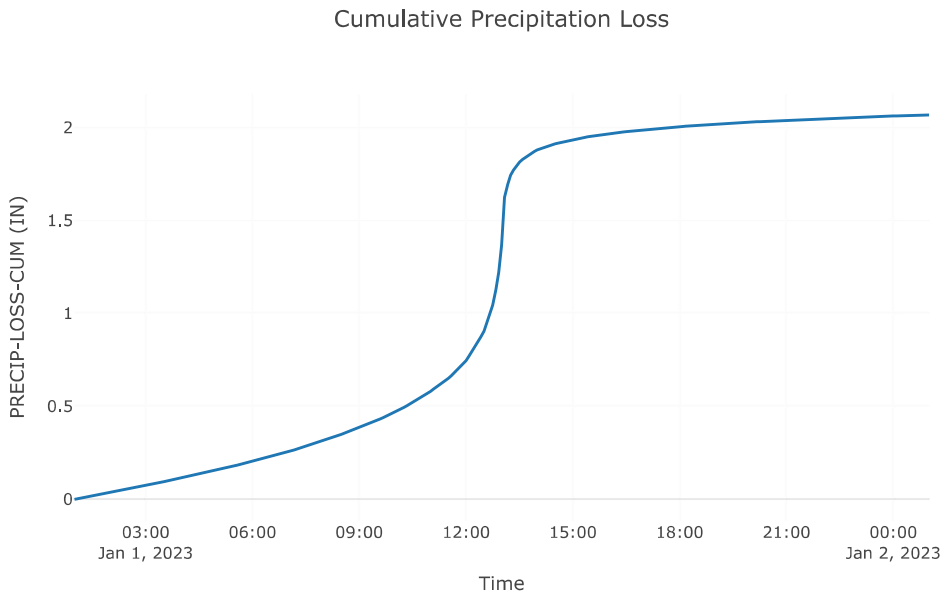
Results: Subbasin-2	
Peak Discharge (CFS)	103.28
Time of Peak Discharge	01Jan2023, 13:50
Volume (IN)	2.84
Precipitation Volume (AC - FT)	30.52
Loss Volume (AC - FT)	12.78
Excess Volume (AC - FT)	17.74
Direct Runoff Volume (AC - FT)	17.55
Baseflow Volume (AC - FT)	0

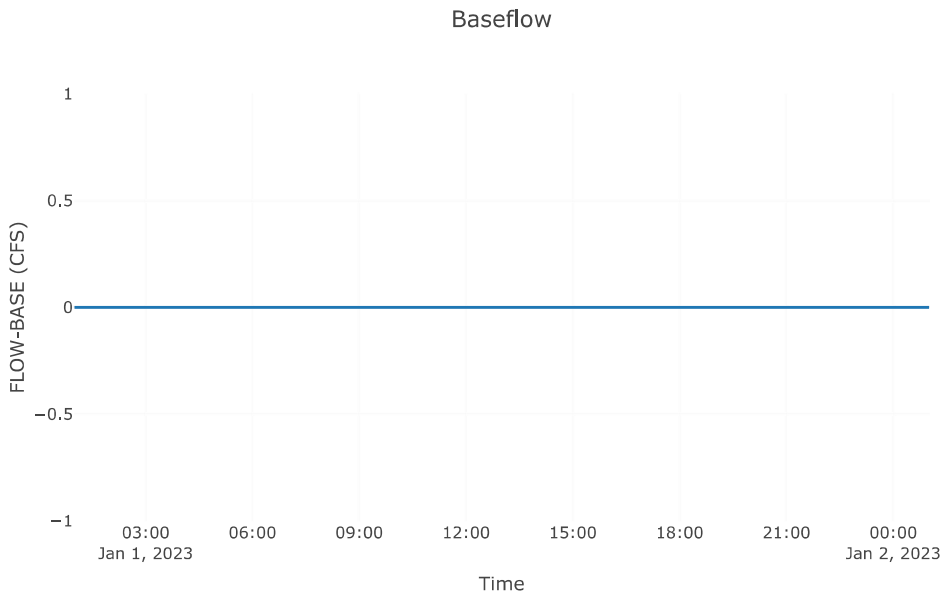

Precipitation and Outflow
PRECIP-INC (IN)
0
0.2
0.4
0.6
0.8
Precipitation
Excess Precipitation
Outflow
FLOW (CFS)
100
50
0
03:00
Jan 1, 2023
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2023

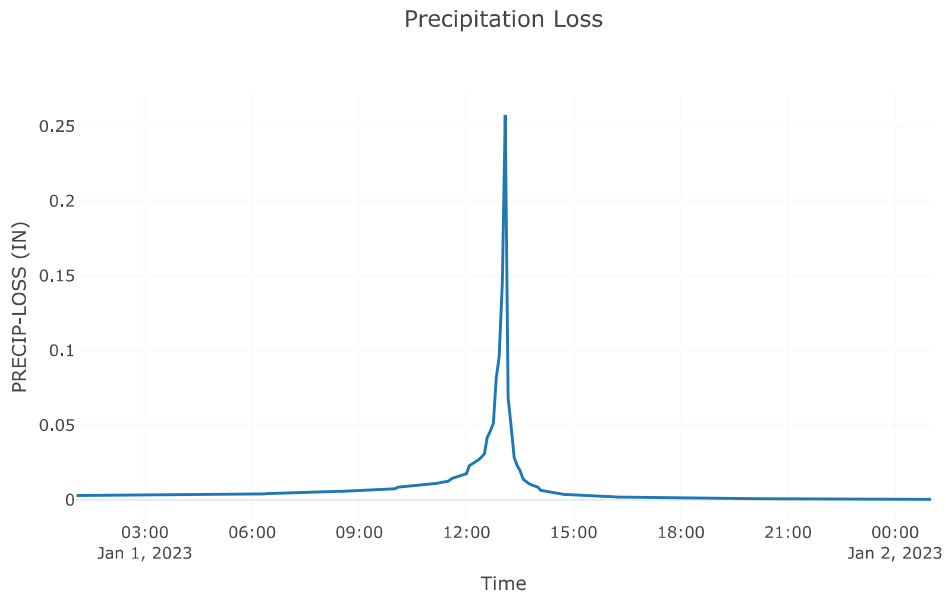

Cumulative Excess Precipitation
PRECIP-EXCESS-CUM (IN)
3
2.5
2
1.5
1
0.5
0
03:00
Jan 1, 2023
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2023
Time

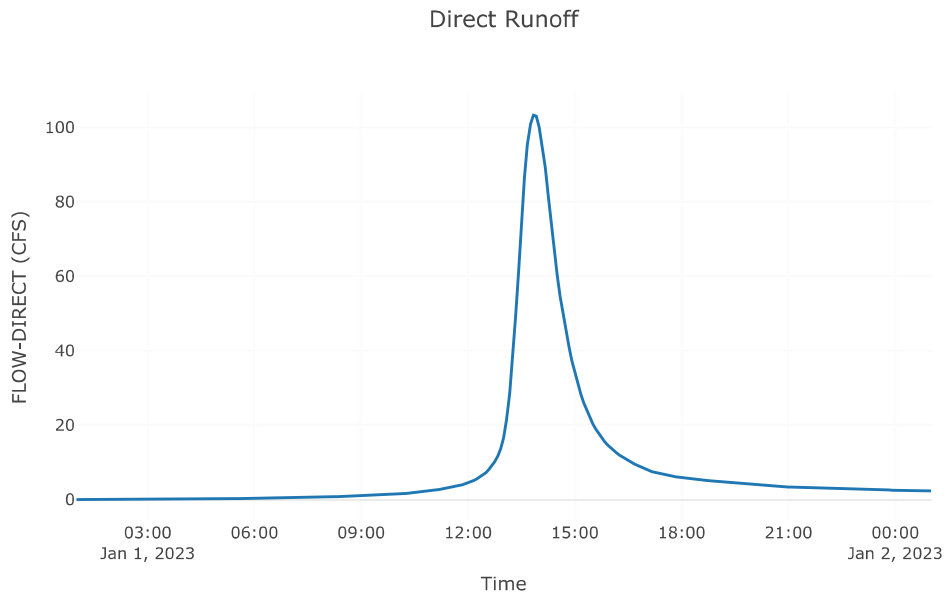

Cumulative Outflow
FLOW-CUMULATIVE (AC-FT)
15
10
5
0
03:00
Jan 1, 2023
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2023
Time

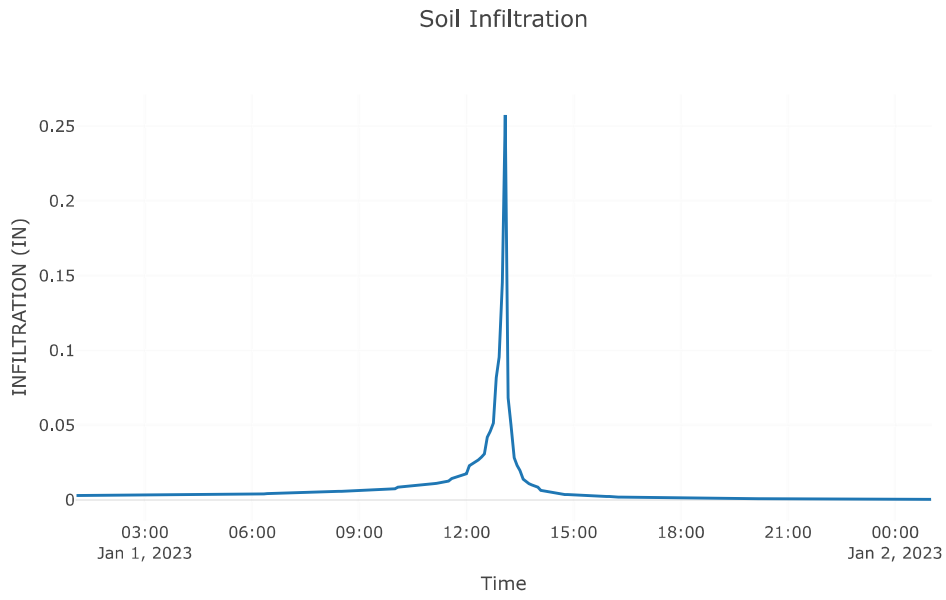

Cumulative Precipitation
PRECIP-CUM (IN)
5
4
3
2
1
0
03:00
Jan 1, 2023
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2023
Time


Cumulative Precipitation Loss
PRECIP-LOSS-CUM (IN)
2
1.5
1
0.5
0
03:00
Jan 1, 2023
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2023
Time


Baseflow
FLOW-BASE (CFS)
1
0.5
0
−0.5
−1
03:00
Jan 1, 2023
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2023
Time


Precipitation Loss
PRECIP-LOSS (IN)
0.25
0.2
0.15
0.1
0.05
0
03:00
Jan 1, 2023
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2023
Time


Direct Runoff
FLOW-DIRECT (CFS)
100
80
60
40
20
0
03:00
Jan 1, 2023
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2023
Time

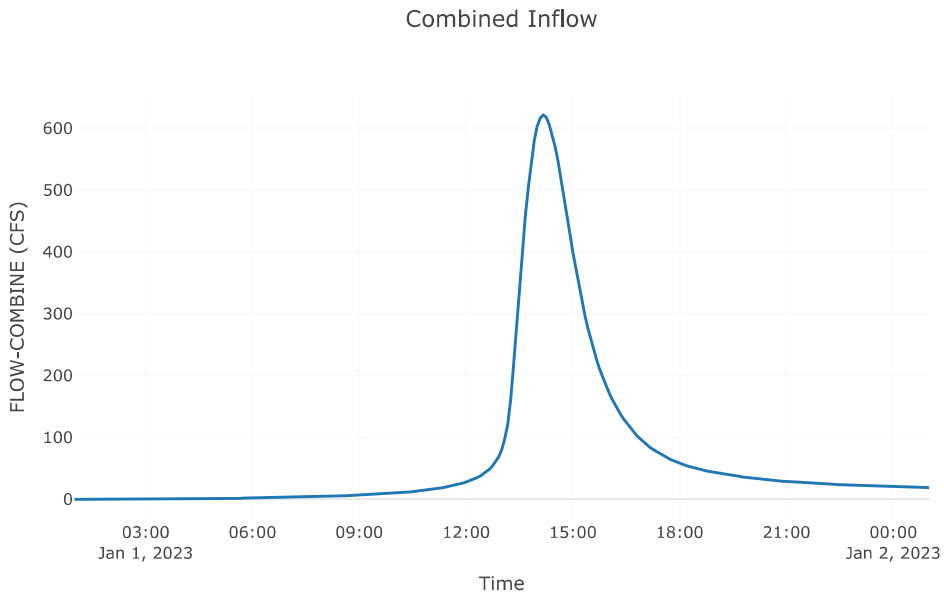

Soil Infiltration
INFILTRATION (IN)
0.25
0.2
0.15
0.1
0.05
0
03:00
Jan 1, 2023
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2023
Time

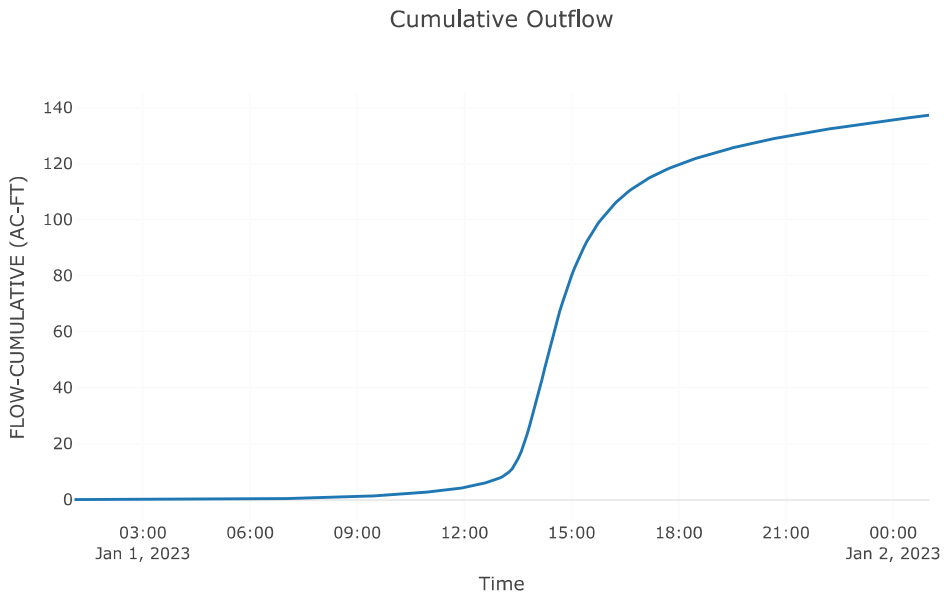
Reach: Reach-1

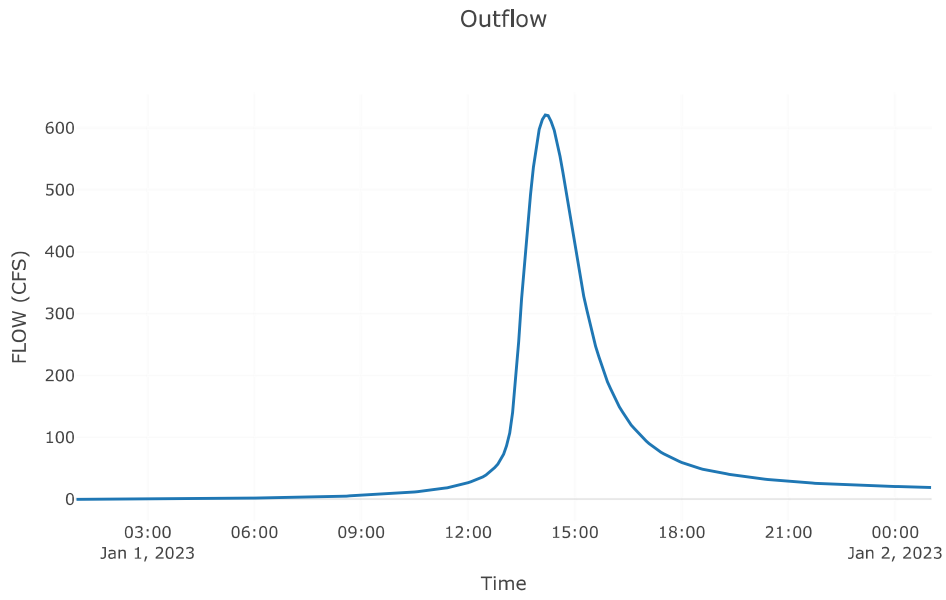
Downstream : Sink - 1

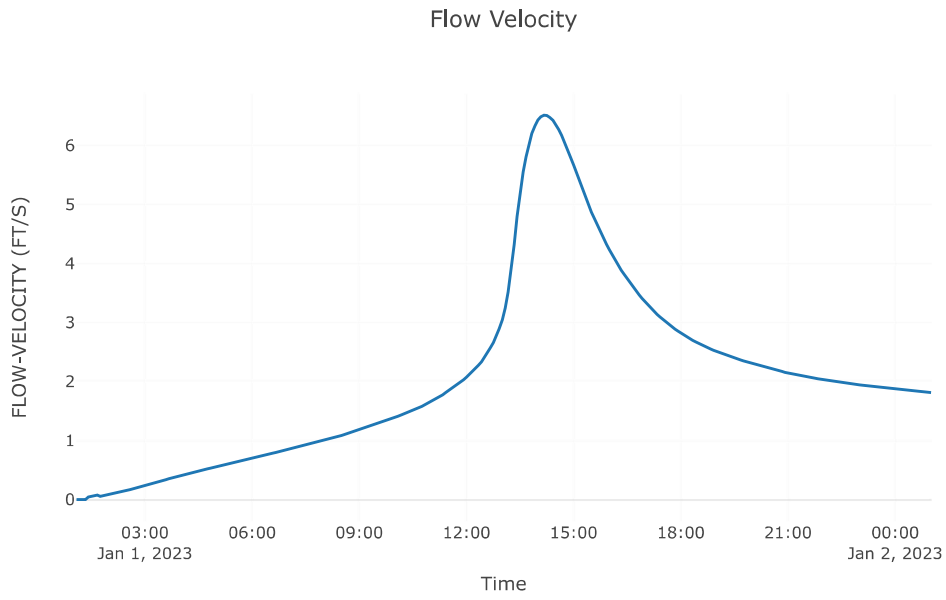
Route: Muskingum Cunge	
Method	Muskingum Cunge
Channel	Trapezoid
Length (FT)	849.59
Energy Slope (FT/FT)	0.01
Mannings n	0.04
Bottom Width (FT)	38.76
Side Slope (FT/FT)	4
Initial Variable	Combined Inflow
Space - Time Method	Automatic DX and DT
Index Parameter Type	Index Celerity
Index Celerity	1.33
Number Subreaches	1
Maximum Depth Iterations	20
Maximum Route Step Iterations	30

Results: Reach-1	
Peak Discharge (CFS)	621.27
Time of Peak Discharge	01Jan2023, 14:10
Volume (IN)	3.07
Peak Inflow (CFS)	621.77
Inflow Volume (AC - FT)	137.46


Combined Inflow
FLOW-COMBINE (CFS)
600
500
400
300
200
100
0
03:00
Jan 1, 2023
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2023
Time


Cumulative Outflow
FLOW-CUMULATIVE (AC-FT)
140
120
100
80
60
40
20
0
03:00
Jan 1, 2023
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2023
Time


Outflow
600
500
400
300
200
100
0
FLOW (CFS)
03:00
Jan 1, 2023
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2023
Time


Flow Velocity
6
5
4
3
2
1
0
FLOW-VELOCITY (FT/S)
03:00
Jan 1, 2023
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2023
Time

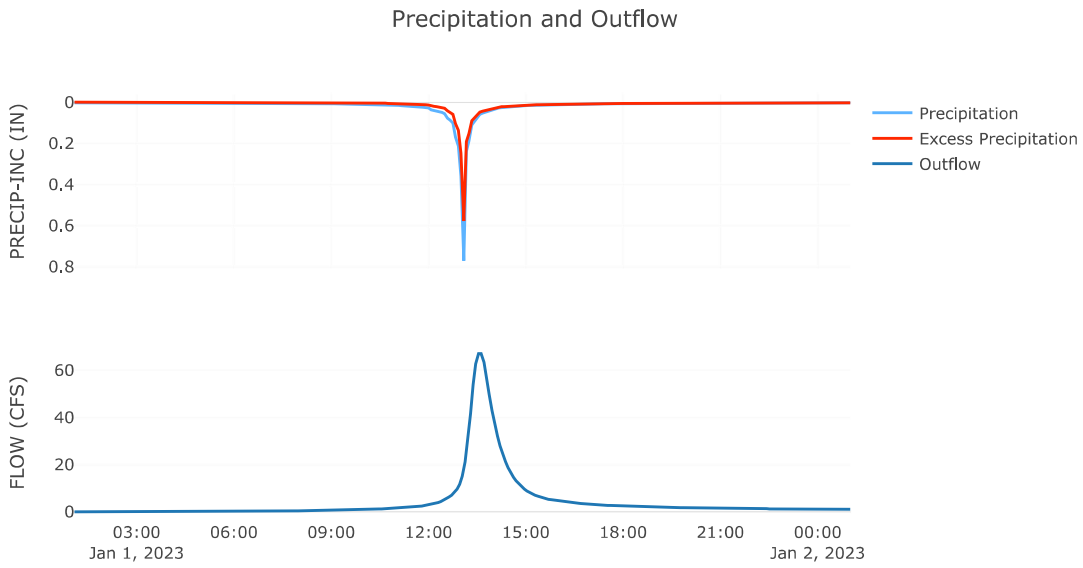
Subbasin: Subbasin-1

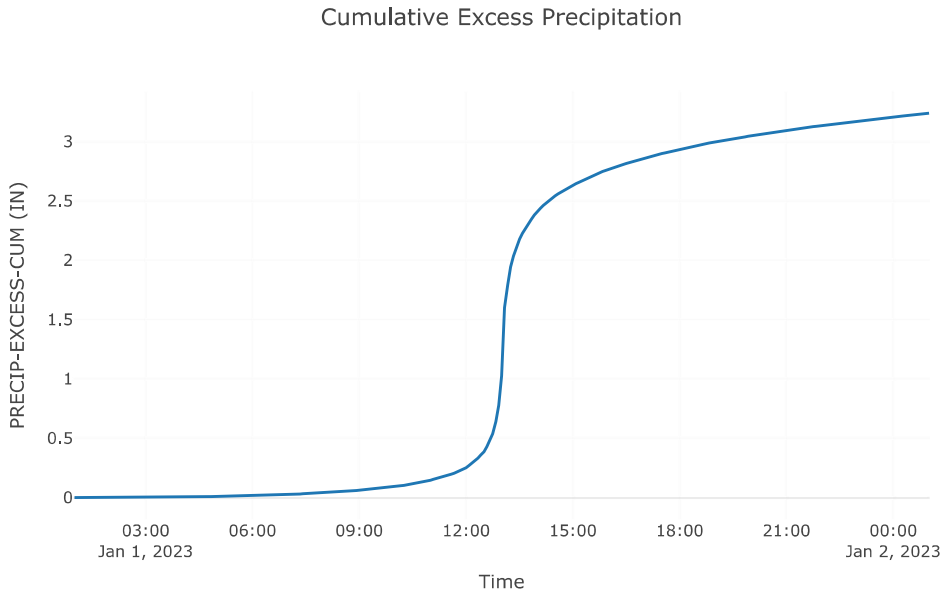
Area (MI2) : 0.05
Latitude Degrees : 38.98
Longitude Degrees : -104.56
Downstream : Sink - 1

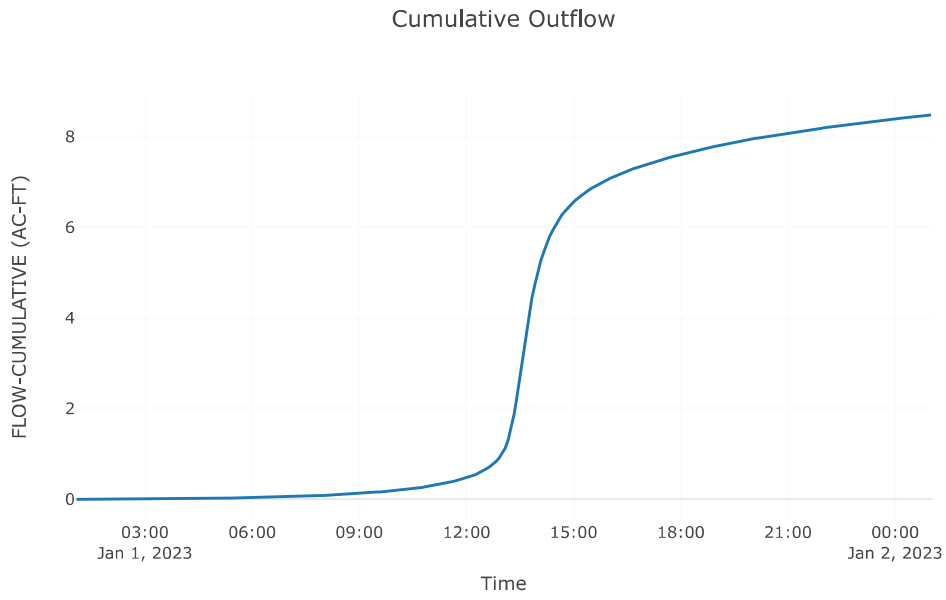
Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	79.41
Initial Abstraction	0

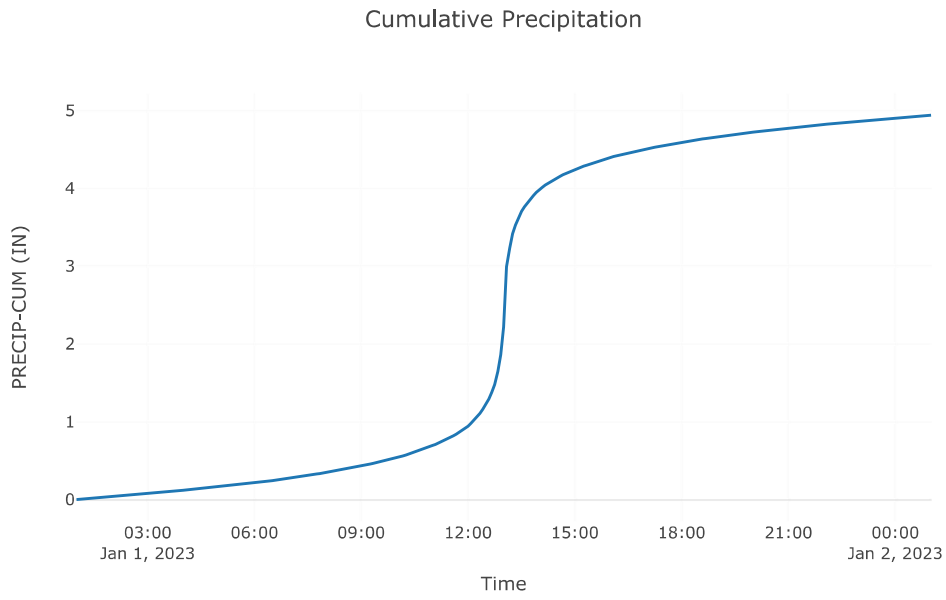
Transform: Scs	
Lag	28.51
Unitgraph Type	Standard

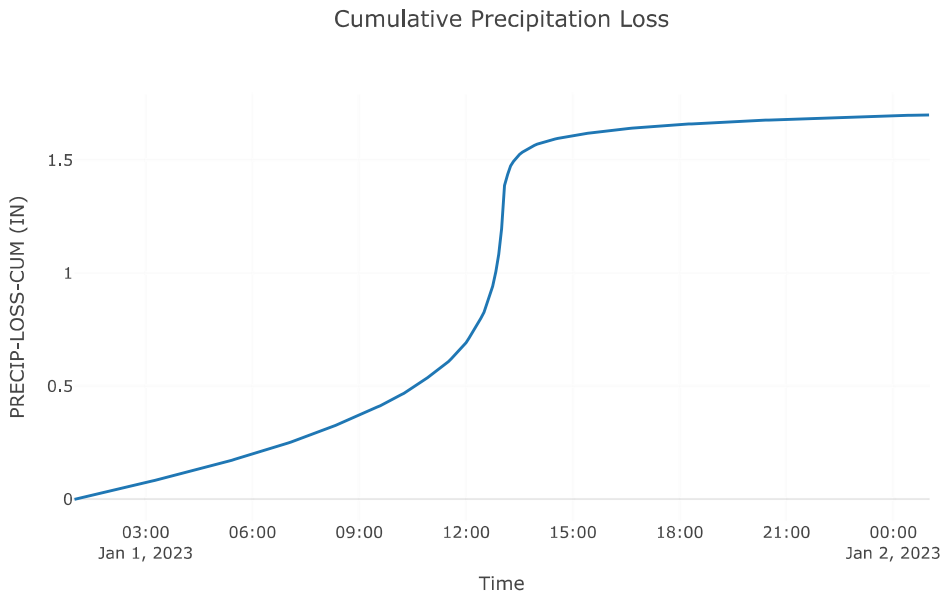
Results: Subbasin-1	
Peak Discharge (CFS)	67.11
Time of Peak Discharge	01Jan2023, 13:35
Volume (IN)	3.22
Precipitation Volume (AC - FT)	13.01
Loss Volume (AC - FT)	4.48
Excess Volume (AC - FT)	8.53
Direct Runoff Volume (AC - FT)	8.48
Baseflow Volume (AC - FT)	0

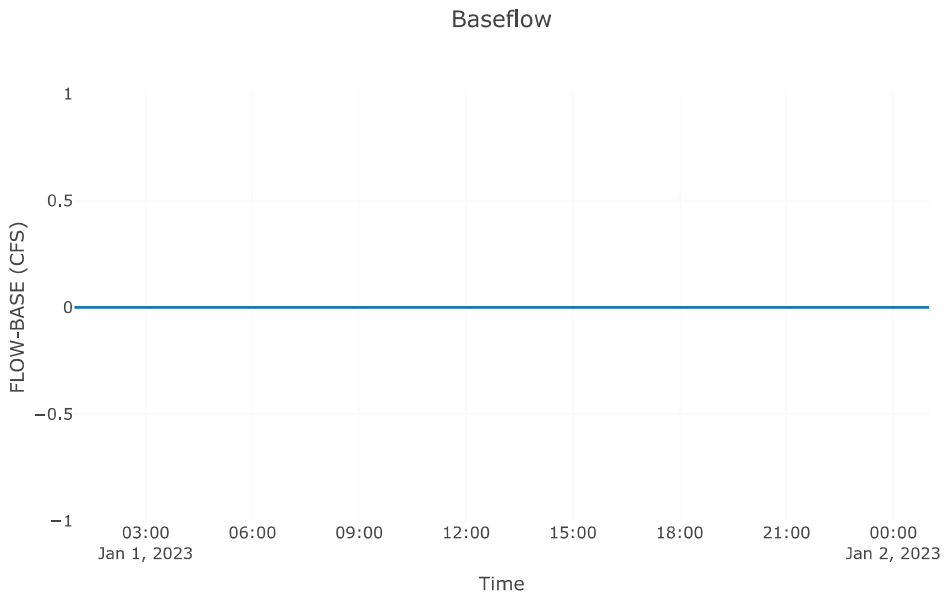

Precipitation and Outflow
PRECIP-INC (IN)
0
0.2
0.4
0.6
0.8
Precipitation
Excess Precipitation
Outflow
FLOW (CFS)
60
40
20
0
03:00
Jan 1, 2023
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2023

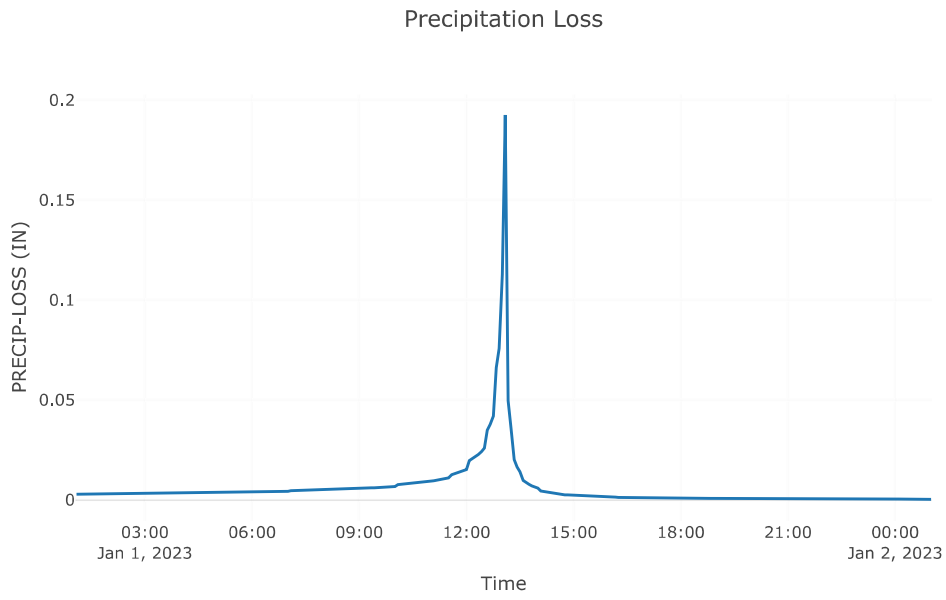

Cumulative Excess Precipitation
PRECIP-EXCESS-CUM (IN)
3
2.5
2
1.5
1
0.5
0
03:00
Jan 1, 2023
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2023
Time

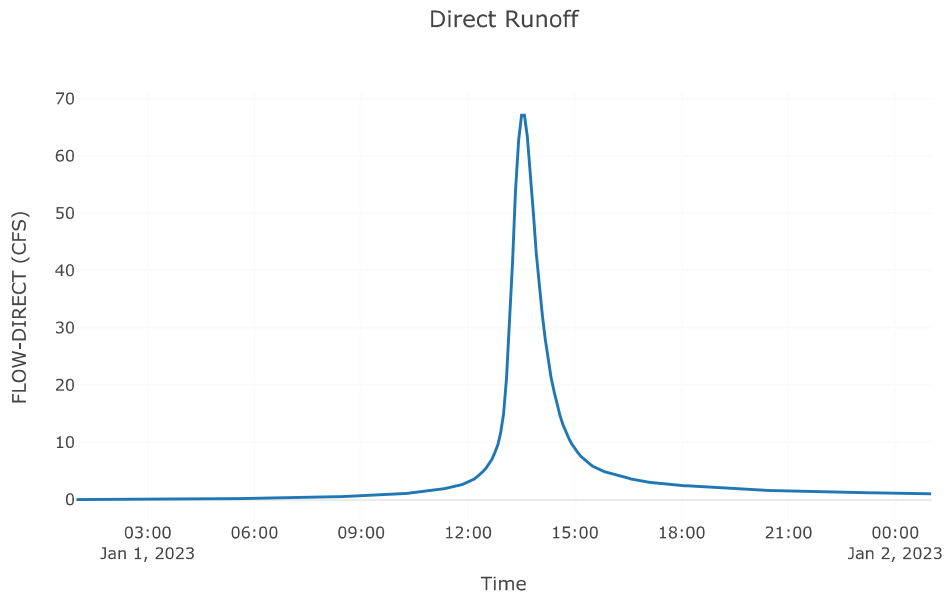

Cumulative Outflow
FLOW-CUMULATIVE (AC-FT)
0
2
4
6
8
03:00
Jan 1, 2023
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2023
Time

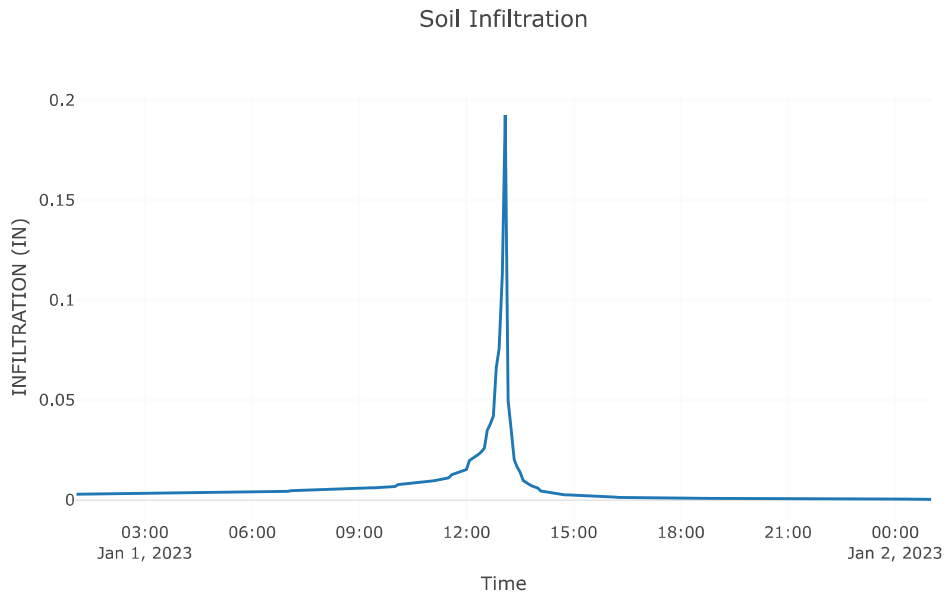

Cumulative Precipitation
PRECIP-CUM (IN)
0
1
2
3
4
5
03:00
Jan 1, 2023
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2023
Time


Cumulative Precipitation Loss
PRECIP-LOSS-CUM (IN)
1.5
1
0.5
0
03:00
Jan 1, 2023
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2023
Time


Baseflow
FLOW-BASE (CFS)
1
0.5
0
−0.5
−1
03:00
Jan 1, 2023
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2023
Time

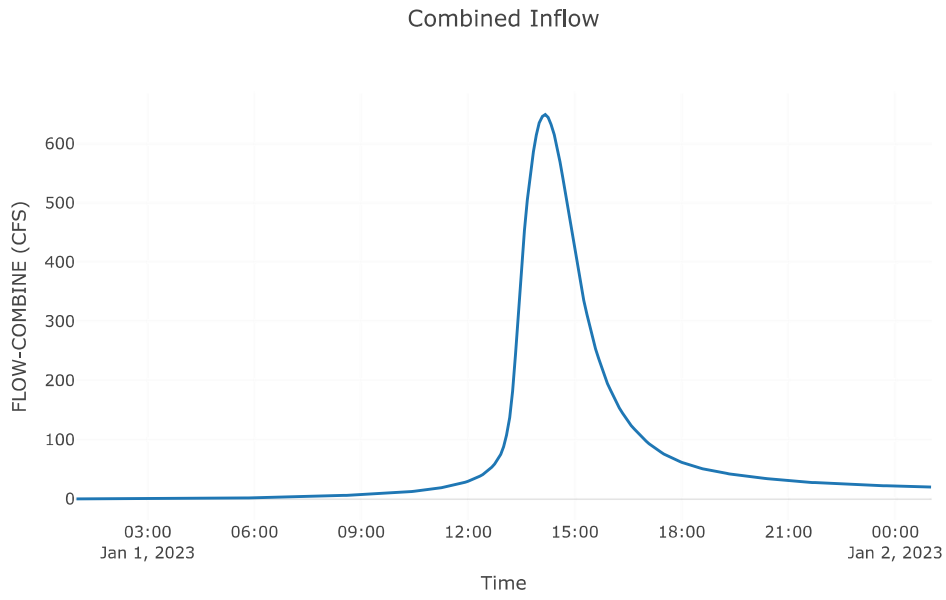

Precipitation Loss
PRECIP-LOSS (IN)
0.2
0.15
0.1
0.05
0
03:00
Jan 1, 2023
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2023
Time

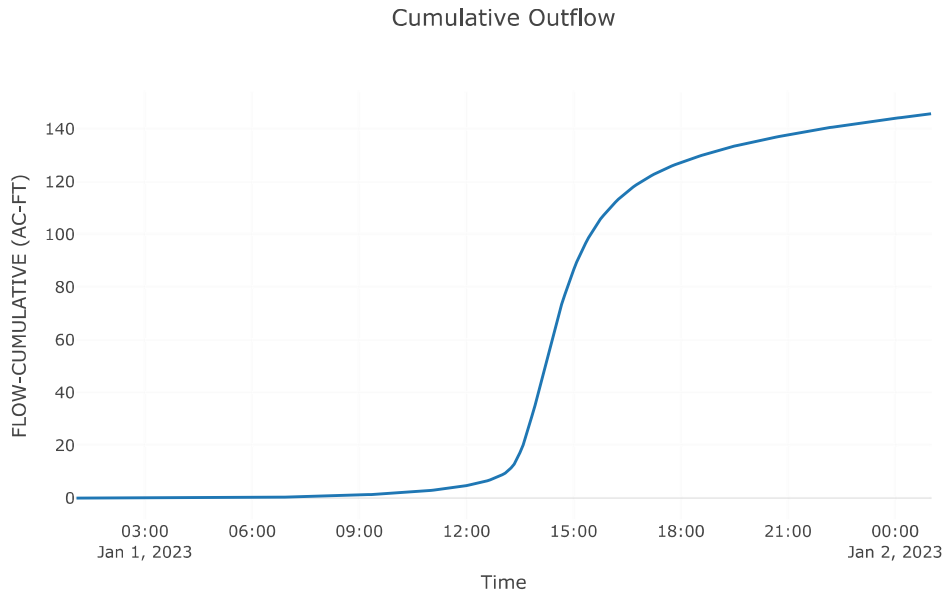

Direct Runoff
FLOW-DIRECT (CFS)
70
60
50
40
30
20
10
0
03:00
Jan 1, 2023
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2023
Time

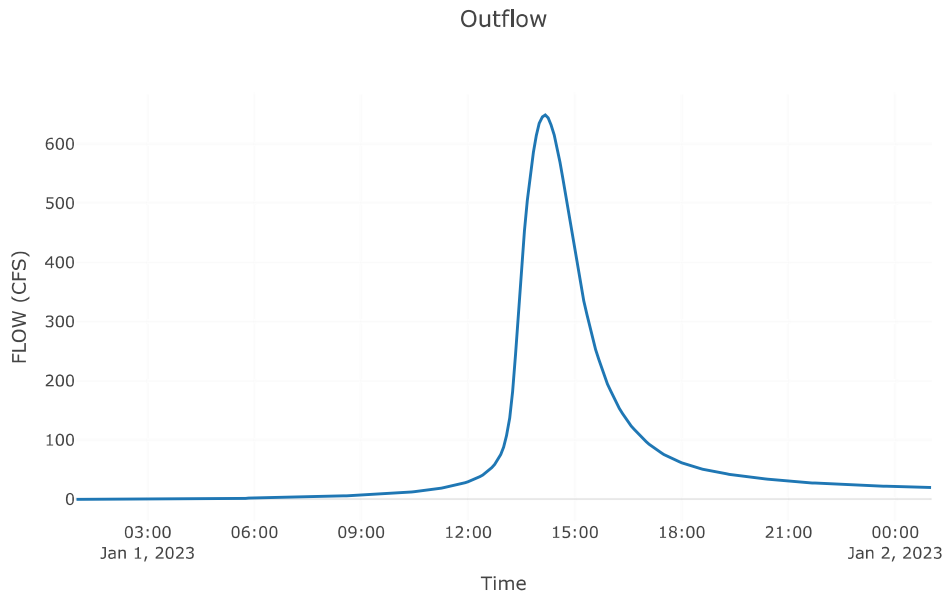

Soil Infiltration
INFILTRATION (IN)
0.2
0.15
0.1
0.05
0
03:00
Jan 1, 2023
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2023
Time

Sink: Sink-1

Results: Sink-1	
Peak Discharge (CFS)	649.23
Time of Peak Discharge	01Jan2023, 14:10
Volume (IN)	3.08






Outflow
FLOW (CFS)
600
500
400
300
200
100
0
03:00
Jan 1, 2023
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2023
Time

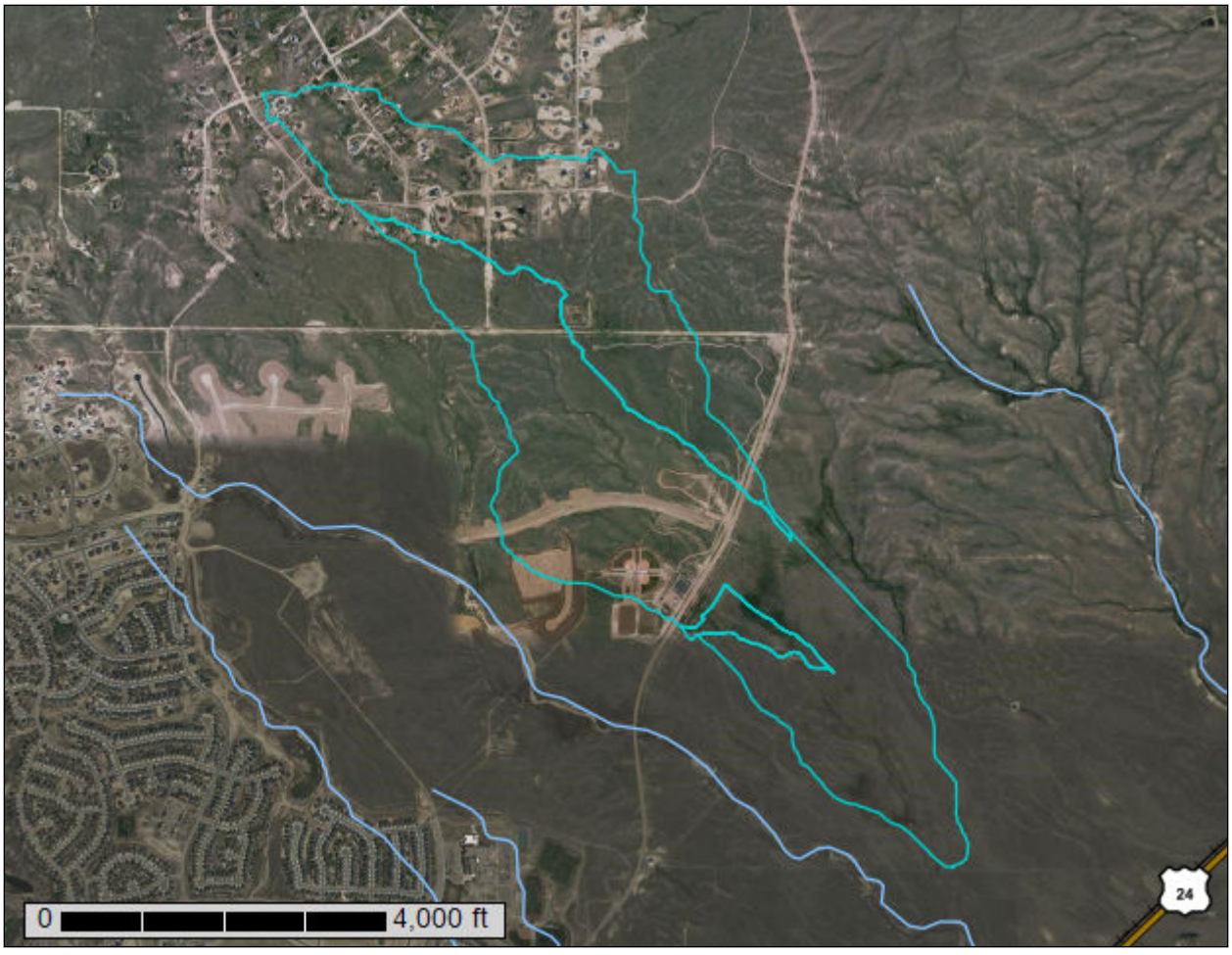
United States Department of Agriculture

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



November 9, 2023

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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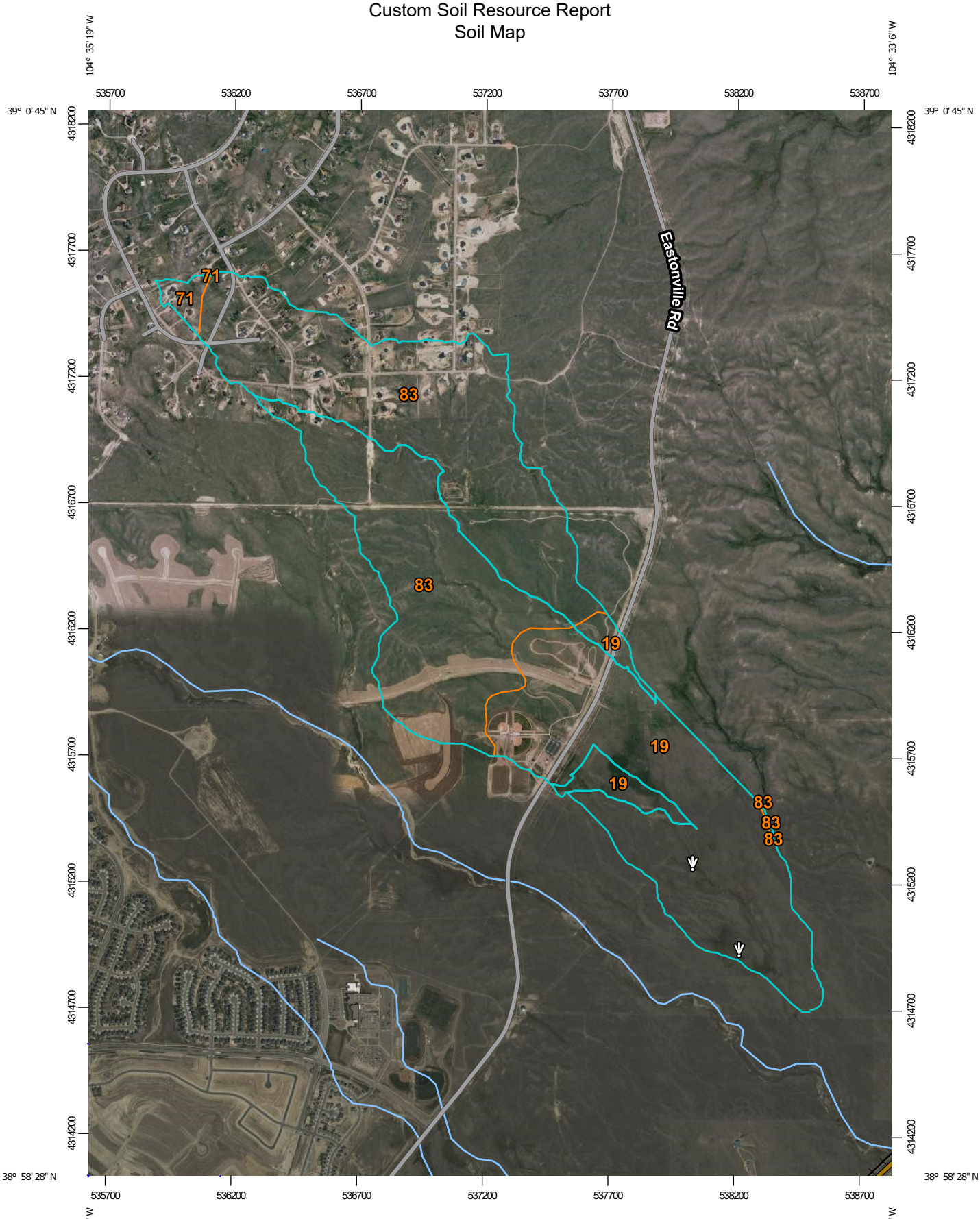
Contents

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: 1:20,600 if printed on A portrait (8.5" x 11") sheet.

N

Meters
0 300 600 1200 1800

Feet
0 1000 2000 4000 6000

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 21, Aug 24, 2023

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

Date(s) aerial images were photographed: Sep 11, 2018—Jun 12, 2021

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
19	Columbine gravelly sandy loam, 0 to 3 percent slopes	211.4	38.0%
71	Pring coarse sandy loam, 3 to 8 percent slopes	6.5	1.2%
83	Stapleton sandy loam, 3 to 8 percent slopes	338.4	60.8%
Totals for Area of Interest		**556.3**	**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

19—Columbine gravelly sandy loam, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: 367p
Elevation: 6,500 to 7,300 feet
Mean annual precipitation: 14 to 16 inches
Mean annual air temperature: 46 to 50 degrees F
Frost-free period: 125 to 145 days
Farmland classification: Not prime farmland

Map Unit Composition

Columbine and similar soils: 97 percent
Minor components: 3 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Columbine

Setting

Landform: Flood plains, fan terraces, fans
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium

Typical profile

A - 0 to 14 inches: gravelly sandy loam
C - 14 to 60 inches: very gravelly loamy sand

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Very low (about 2.5 inches)

Interpretive groups

Land capability classification (irrigated): 4e
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: A
Ecological site: R049XY214CO - Gravelly Foothill
Hydric soil rating: No

Minor Components

Fluvaquentic haplaquolls

Percent of map unit: 1 percent
Landform: Swales
Hydric soil rating: Yes

Other soils

Percent of map unit: 1 percent
Hydric soil rating: No

Pleasant

Percent of map unit: 1 percent
Landform: Depressions
Hydric soil rating: Yes

71—Pring coarse sandy loam, 3 to 8 percent slopes

Map Unit Setting

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

Map Unit Composition

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

Description of Pring

Setting

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

Typical profile

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

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 6.0 inches)

Interpretive groups

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

Minor Components

Pleasant

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

Other soils

Percent of map unit:
Hydric soil rating: No

83—Stapleton sandy loam, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: 369z
Elevation: 6,500 to 7,300 feet
Mean annual precipitation: 14 to 16 inches
Mean annual air temperature: 46 to 48 degrees F
Frost-free period: 125 to 145 days
Farmland classification: Not prime farmland

Map Unit Composition

Stapleton and similar soils: 97 percent
Minor components: 3 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Stapleton

Setting

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

Typical profile

A - 0 to 11 inches: sandy loam
Bw - 11 to 17 inches: gravelly sandy loam
C - 17 to 60 inches: gravelly loamy sand

Properties and qualities

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

Available water supply, 0 to 60 inches: Low (about 4.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: B
Ecological site: R049XY214CO - Gravelly Foothill
Hydric soil rating: No

Minor Components

Fluvaquentic haplaquolls

Percent of map unit: 1 percent
Landform: Swales
Hydric soil rating: Yes

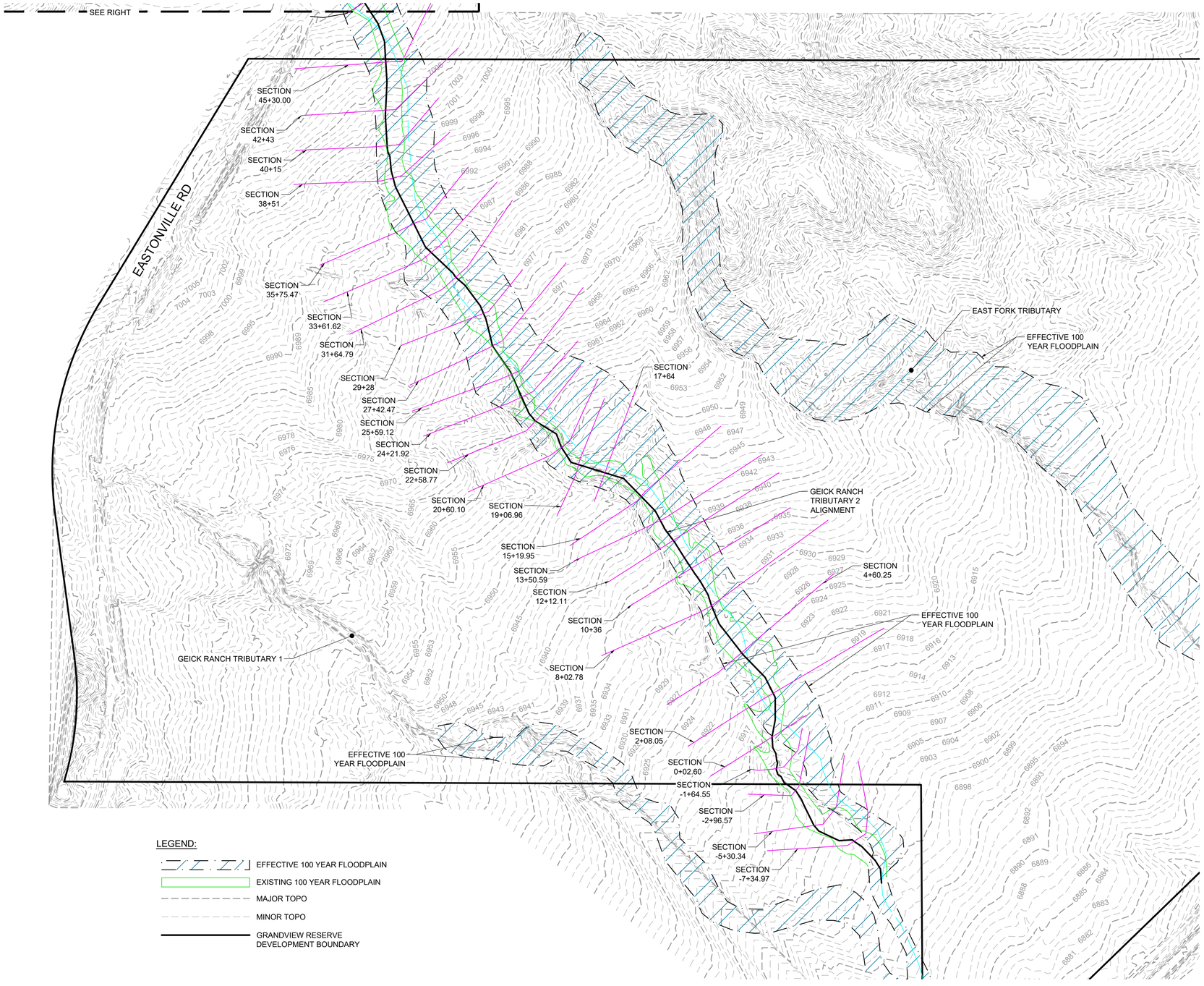
Other soils

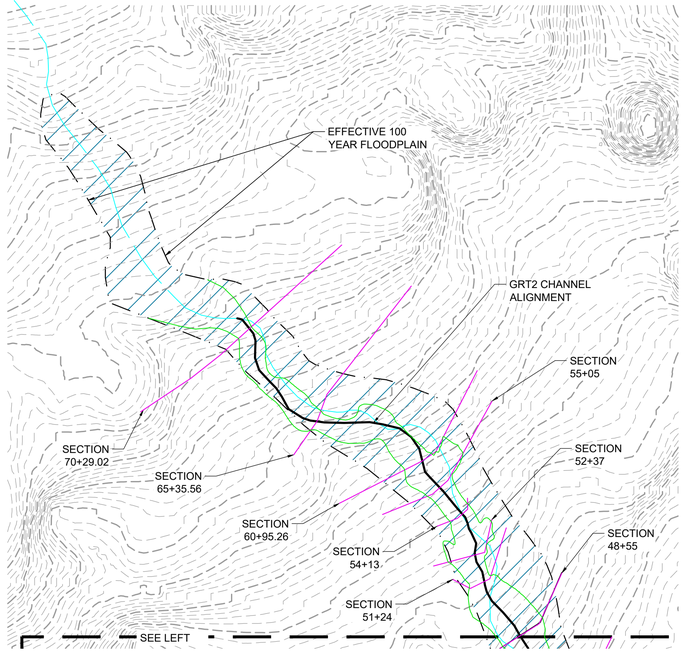
Percent of map unit: 1 percent
Hydric soil rating: No

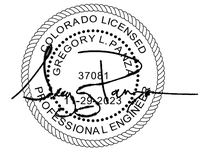
Pleasant

Percent of map unit: 1 percent
Landform: Depressions
Hydric soil rating: Yes

Appendix B
Topographic Map







NOTES:

1. BASIS OF BEARINGS: THE EAST LINE OF SECTION 21, BEING MONUMENTED AT THE SOUTHEAST CORNER BY A 3-1/4" ALUMINUM SURVEYOR'S CAP STAMPED "PS INC PLS 30087 1996", BEING APPROPRIATELY MARKED, AND BEING MONUMENTED AT THE NORTHEAST CORNER BY A 3-1/4" ALUMINUM SURVEYOR'S CAP STAMPED "PS INC PLS 30087 1996", BEING APPROPRIATELY MARKED, BEING ASSUMED TO BEAR NORTH 00 DEGREES 52 MINUTES 26 SECONDS WEST, A DISTANCE OF 5290.17 FEET.

   NAVD88 6866.33

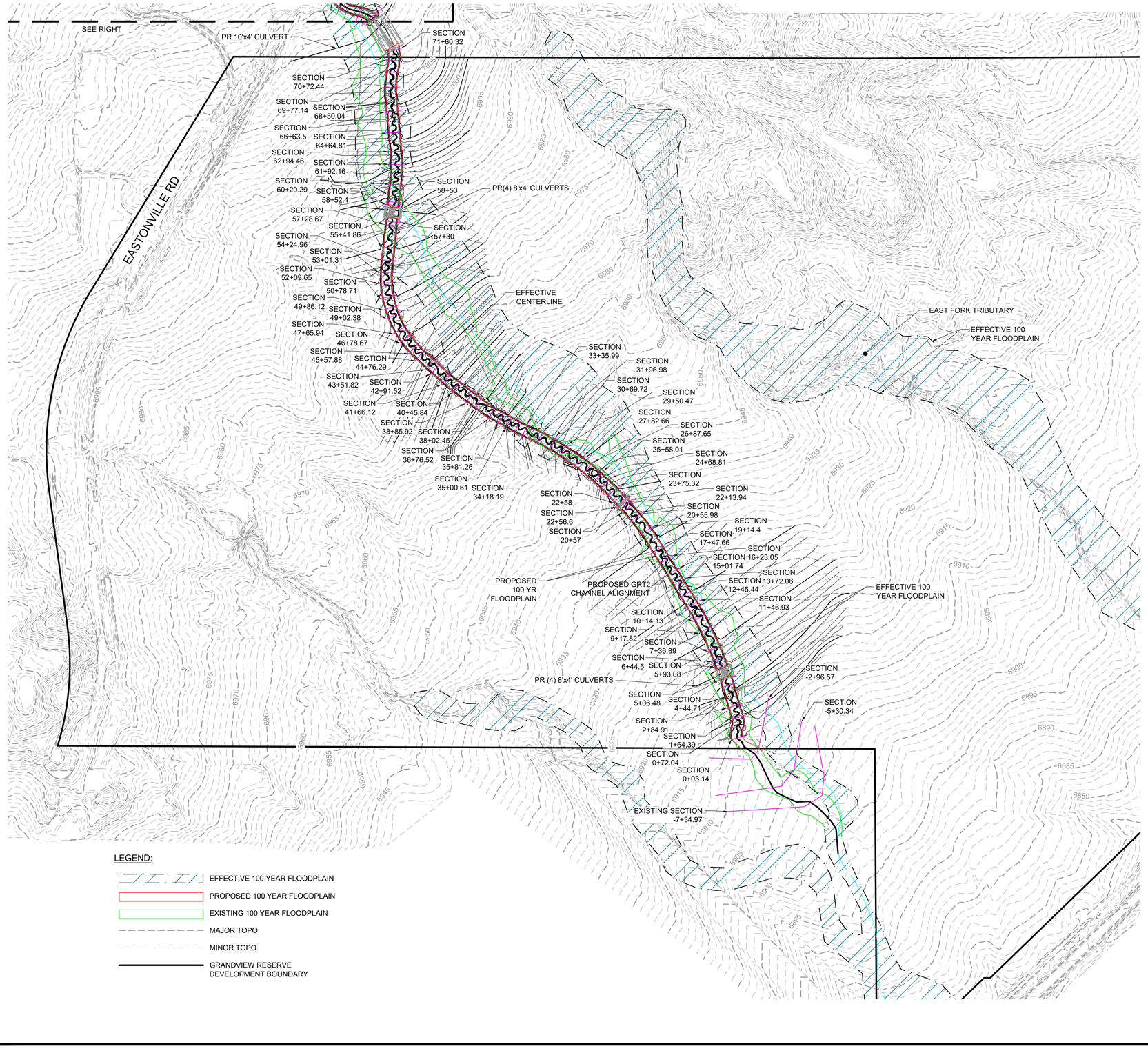
NORTH
0 300
150

HRGreen

Job No.:	201662
Prepared By:	SJF
Date:	4/8/2024

EXISTING FLOODPLAIN EXHIBIT

FIG.1



LEGEND:

- EFFECTIVE 100 YEAR FLOODPLAIN
- PROPOSED 100 YEAR FLOODPLAIN
- EXISTING 100 YEAR FLOODPLAIN
- MAJOR TOPO
- MINOR TOPO
- GRANDVIEW RESERVE DEVELOPMENT BOUNDARY

COLORADO LICENSED
GREGORY L. PAYNE
37081
4-8-2024
PROFESSIONAL ENGINEER

NOTES:

1. BASIS OF BEARINGS: THE EAST LINE OF SECTION 21, BEING MONUMENTED AT THE SOUTHEAST CORNER BY A 3-1/4" ALUMINUM SURVEYOR'S CAP STAMPED "PS INC PLS 30087 1996", BEING APPROPRIATELY MARKED, AND BEING MONUMENTED AT THE NORTHEAST CORNER BY A 3-1/4" ALUMINUM SURVEYOR'S CAP STAMPED "PS INC PLS 30087 1996", BEING APPROPRIATELY MARKED, BEING ASSUMED TO BEAR NORTH 00 DEGREES 52 MINUTES 26 SECONDS WEST, A DISTANCE OF 5290.17 FEET.

   NAVD88

NORTH
0 300
150

HRGreen

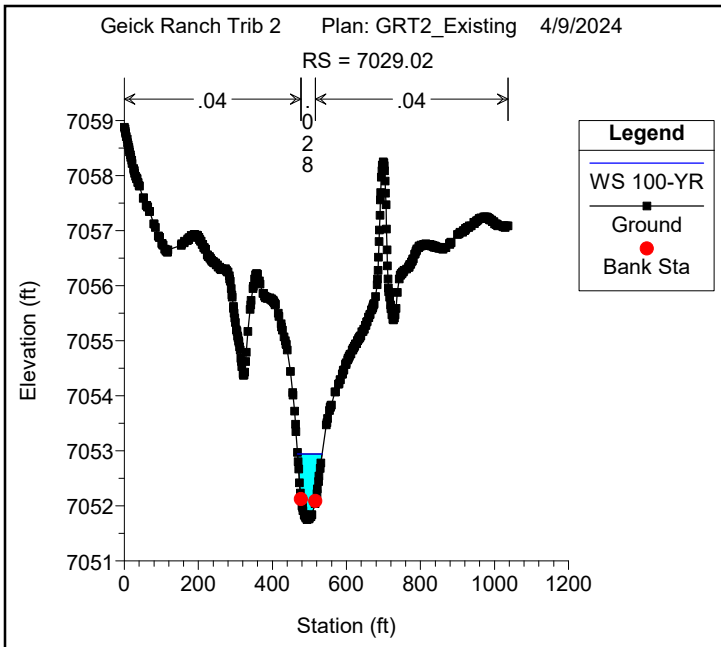
Job No.:	201662
Prepared By:	SJF
Date:	4/8/2024

PROPOSED FLOODPLAIN EXHIBIT

FIG.2

Appendix C
Existing Conditions Cross Sections

Provide profile & output table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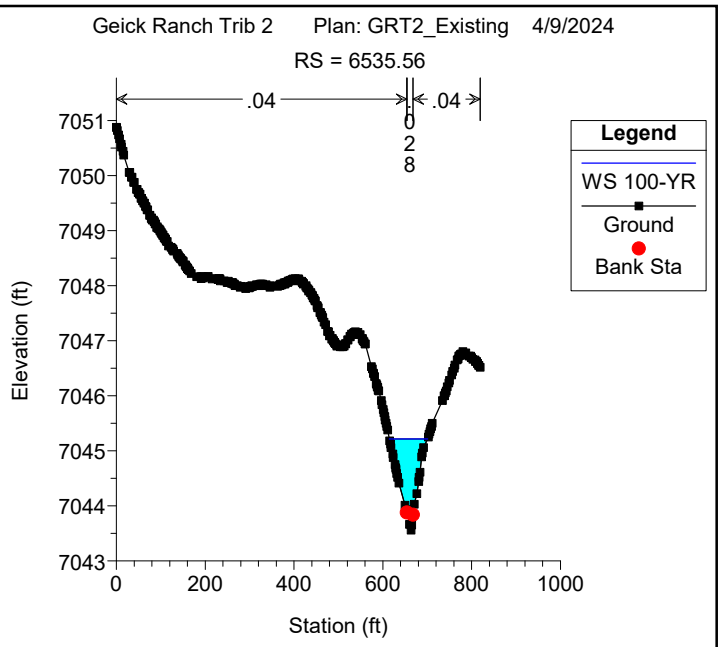
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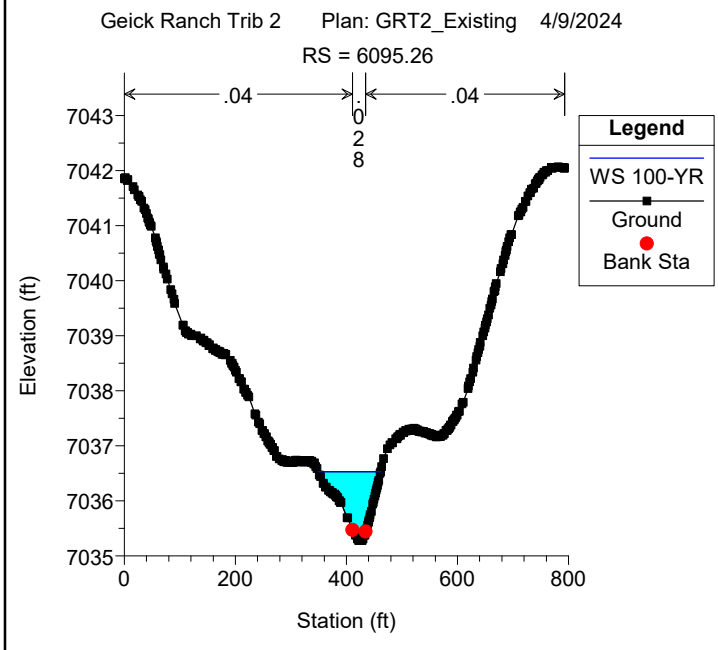
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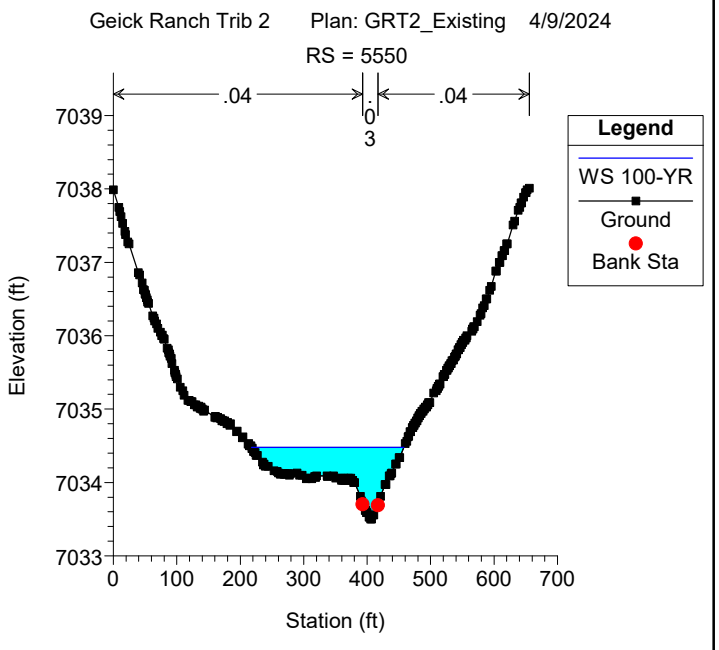
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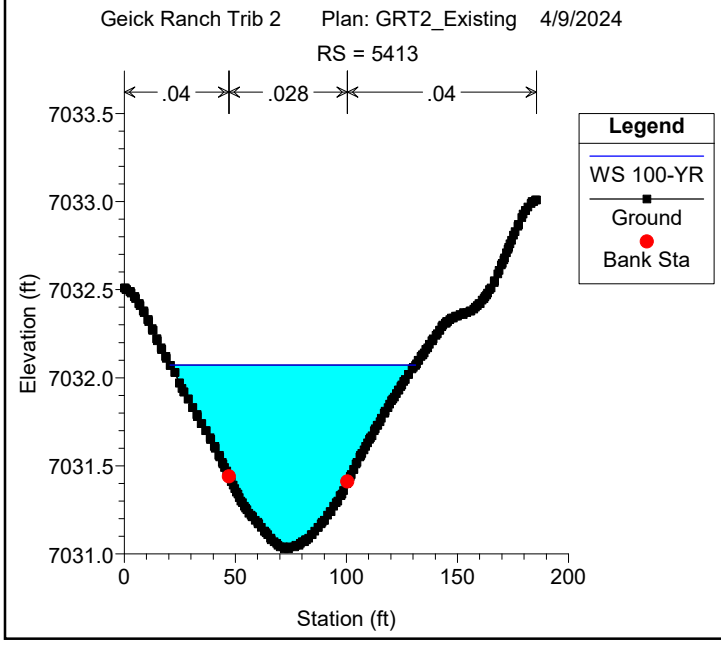
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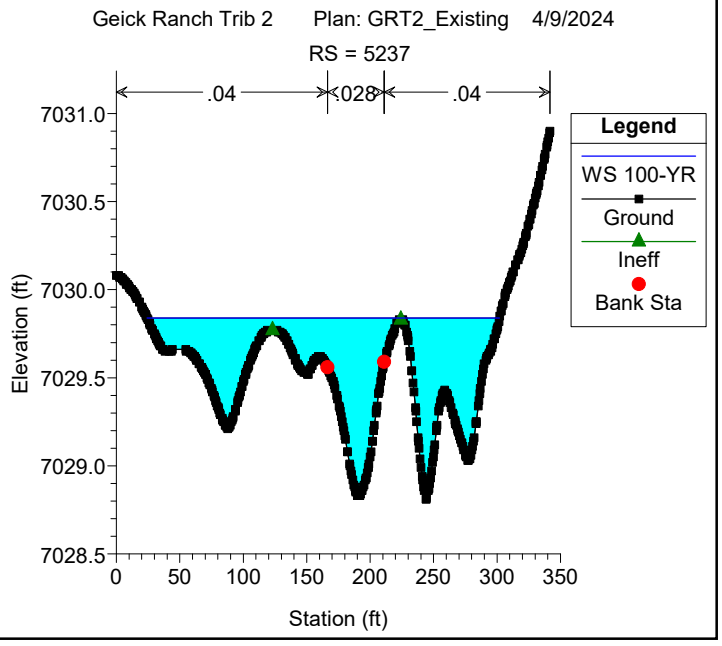
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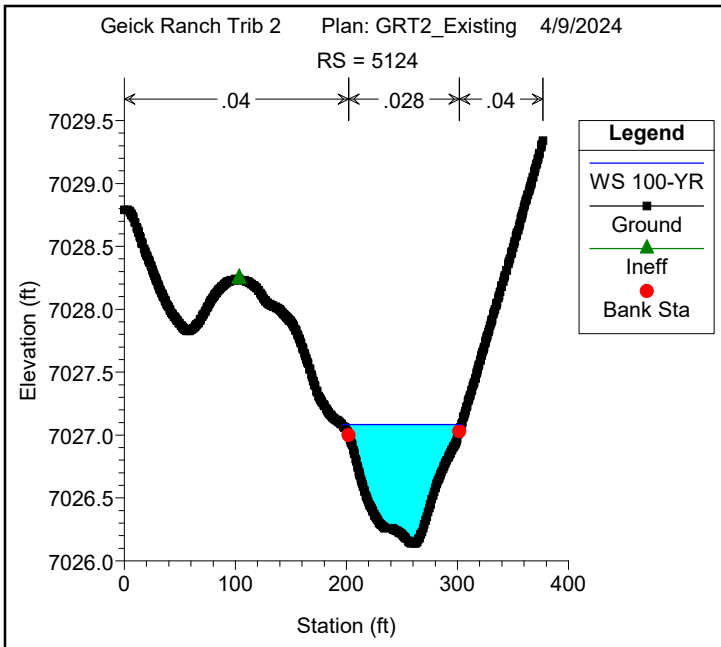
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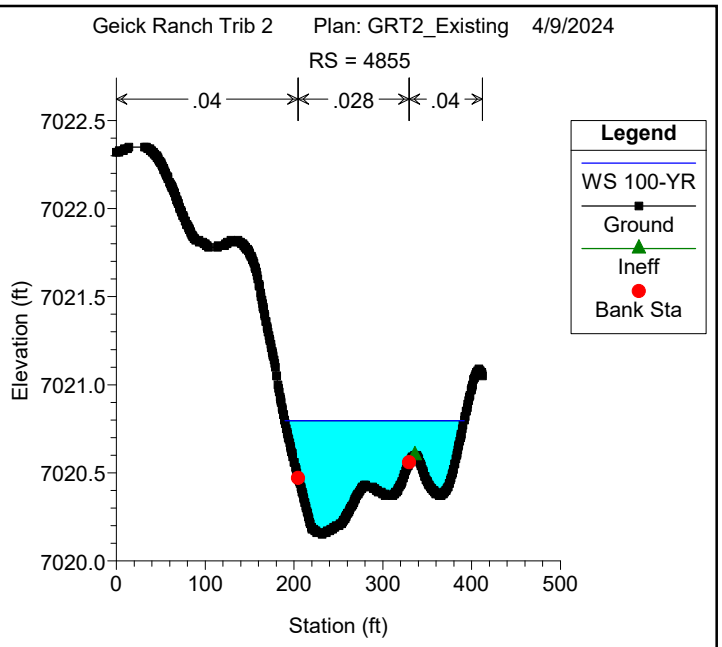
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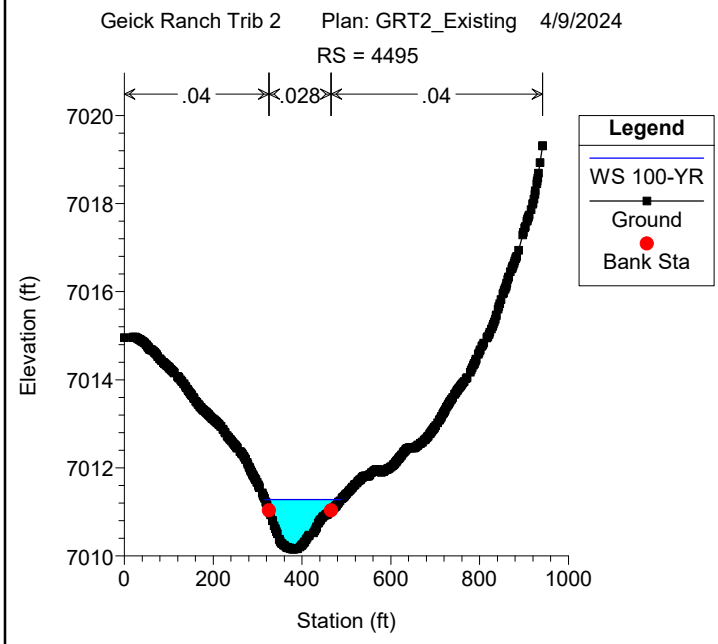
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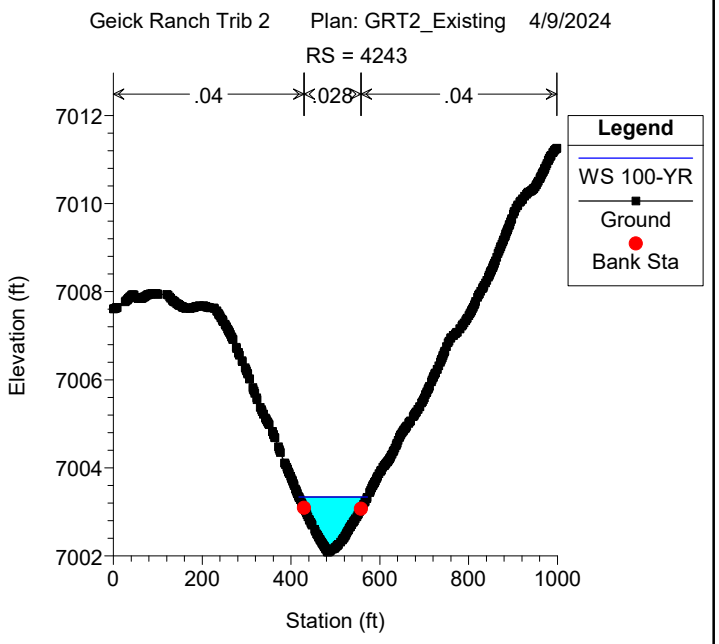
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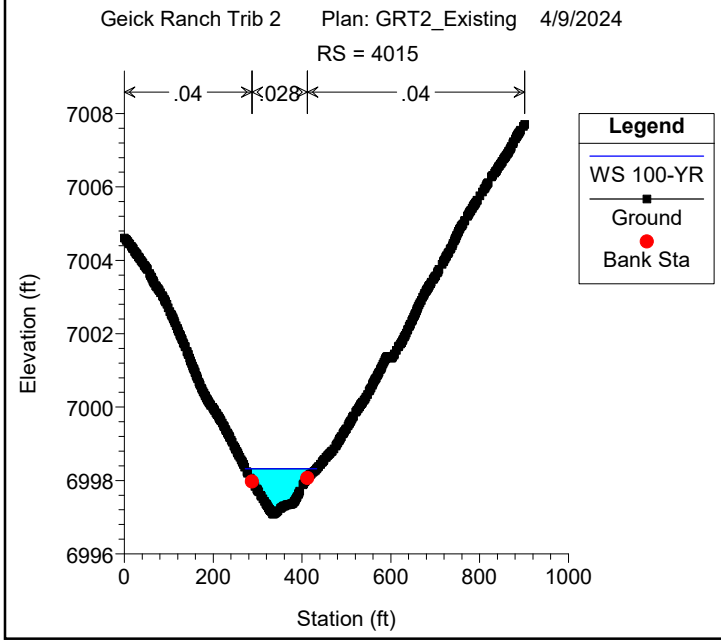
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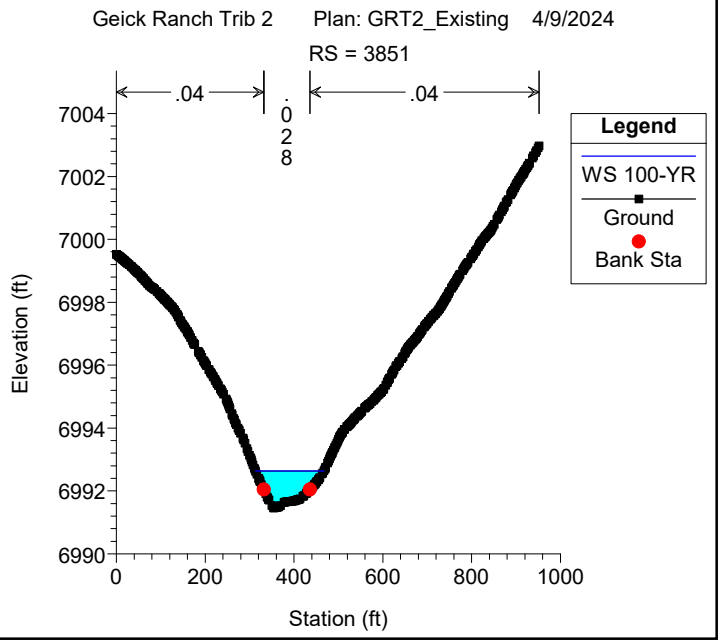
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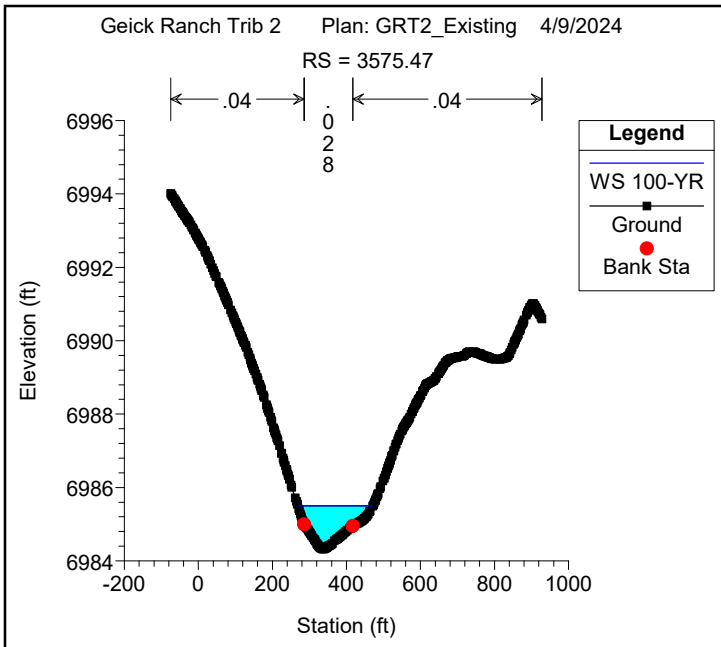
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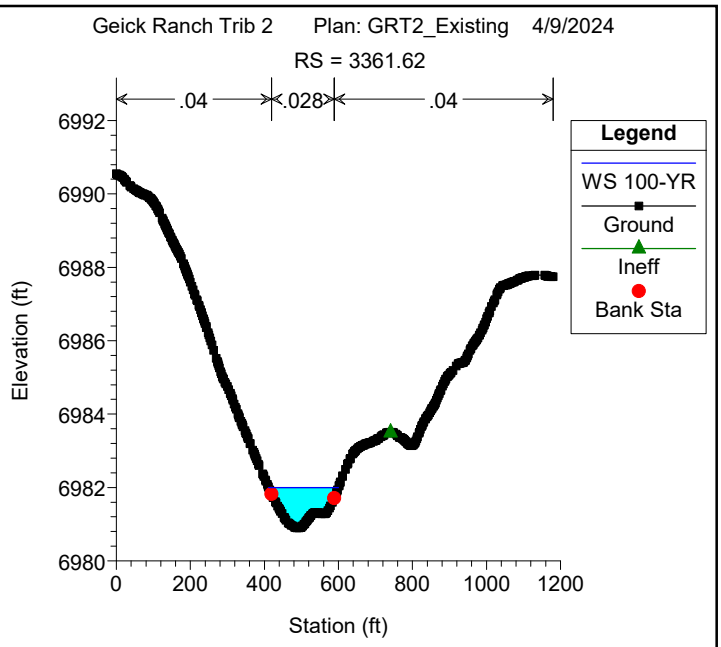
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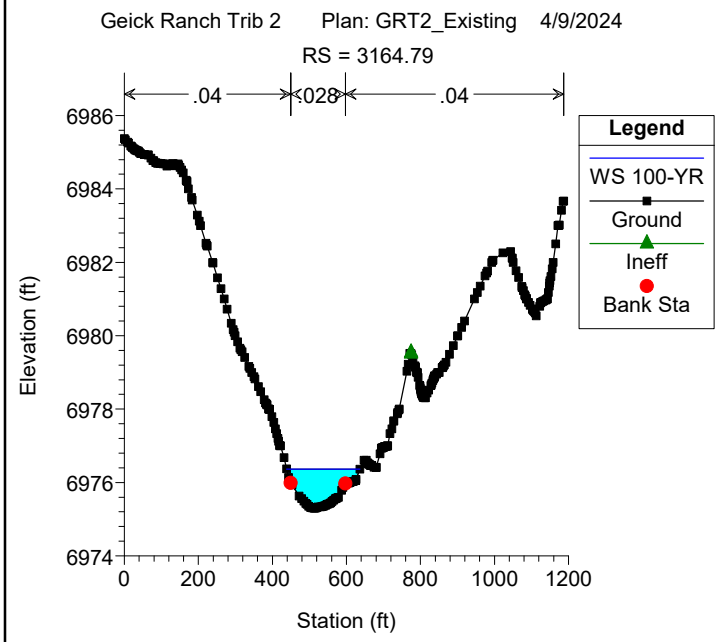
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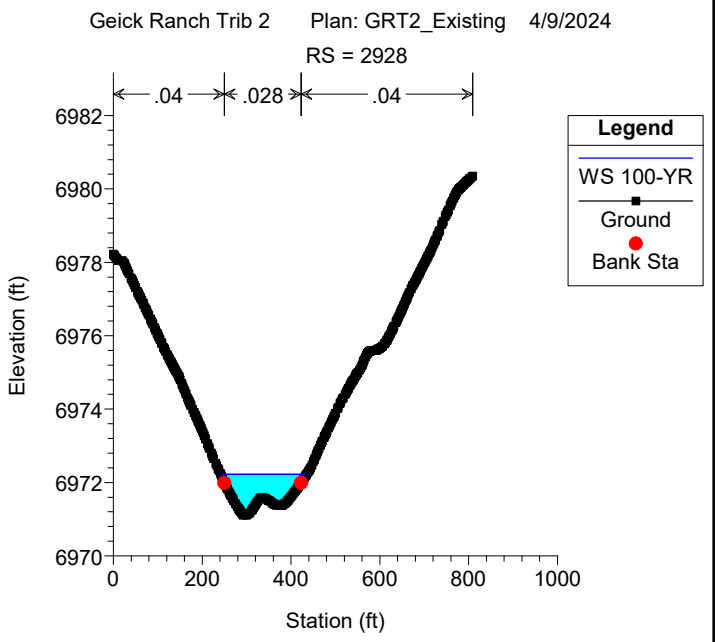
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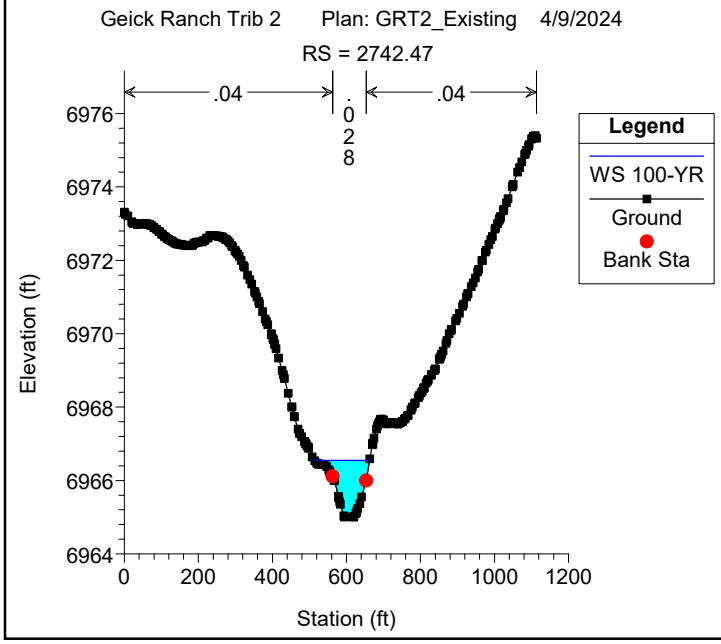
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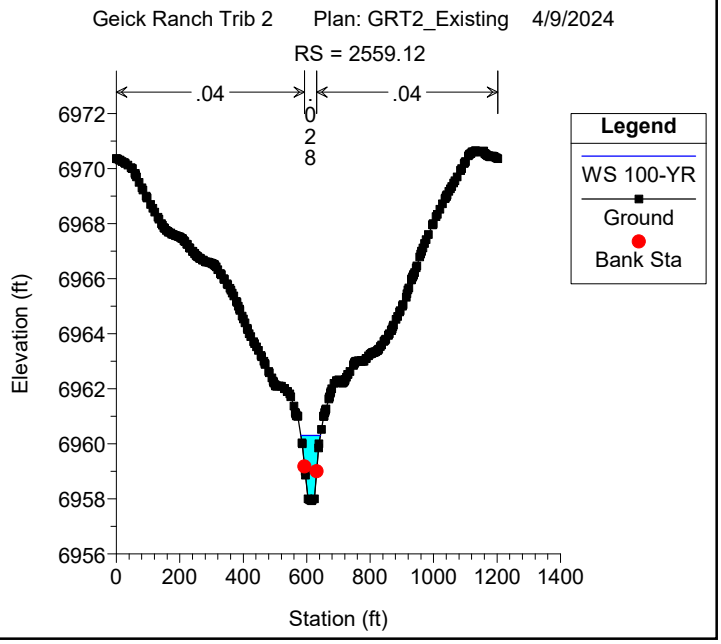
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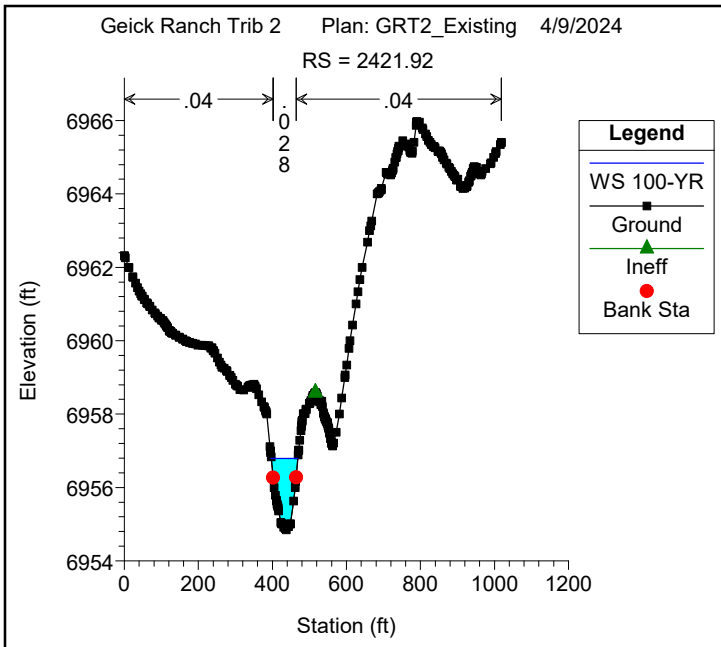
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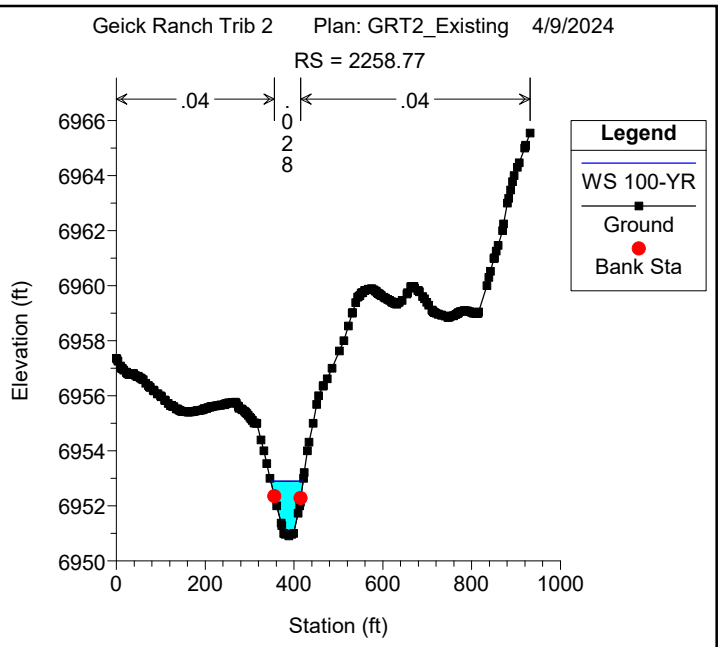
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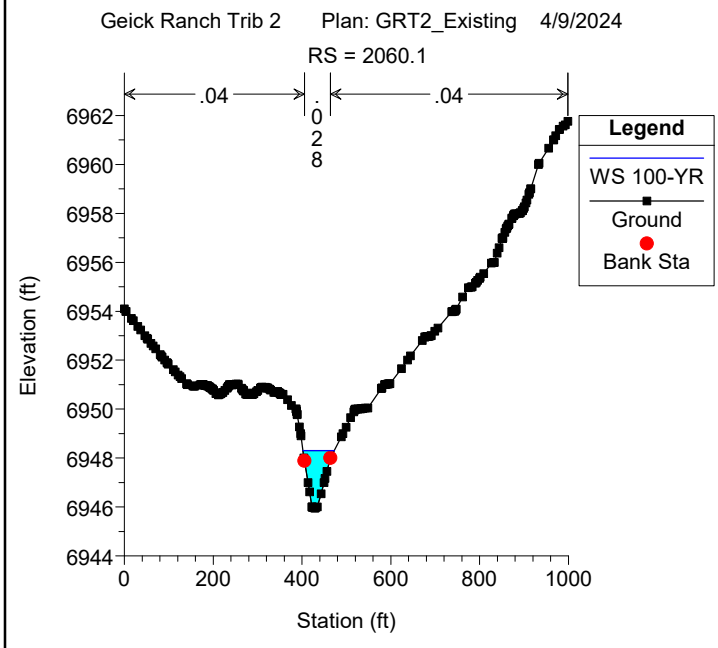
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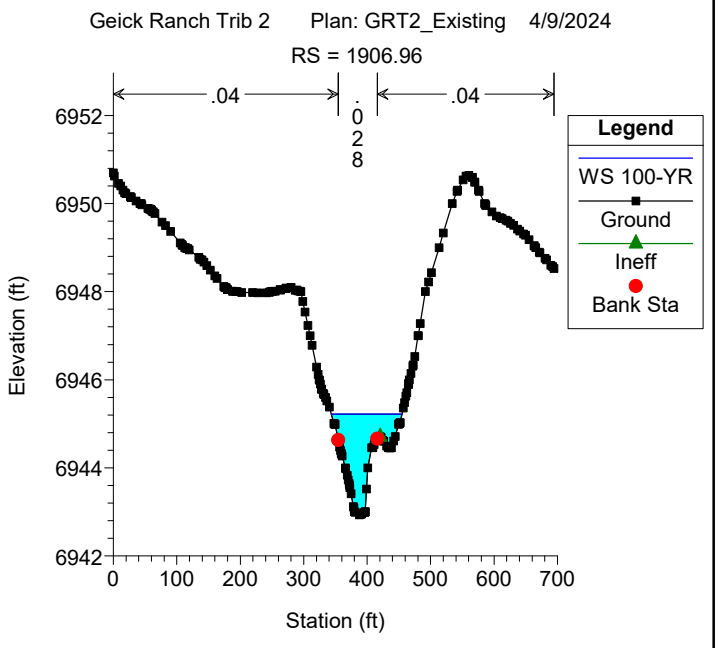
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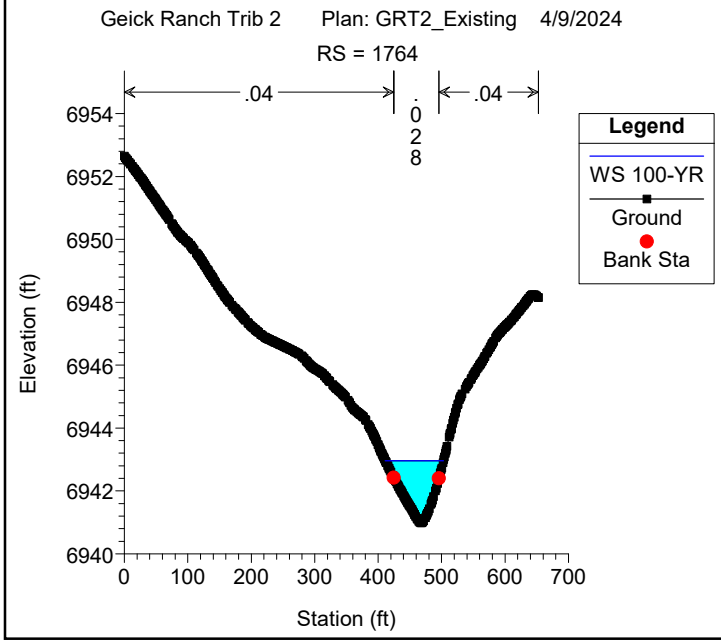
Elevation (ft)
Station (ft)


Geick Ranch Trib 2 Plan: GRT2_Existing 4/9/2024
RS = 1764
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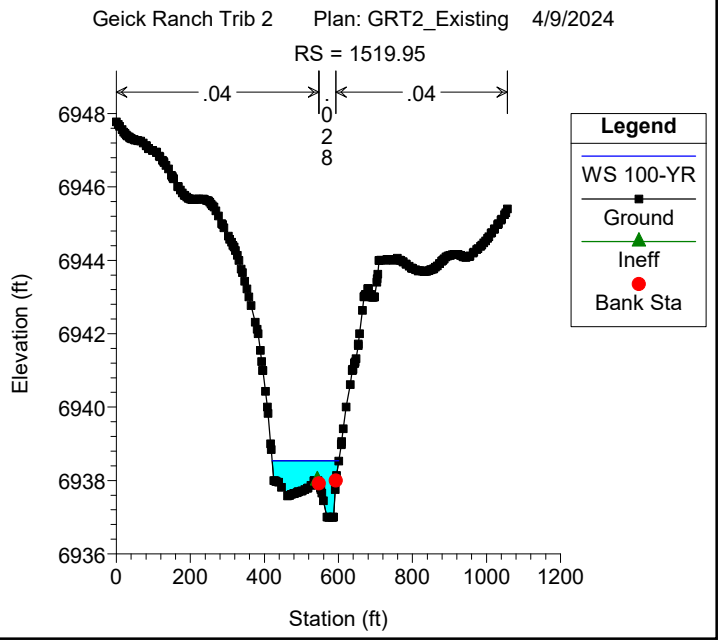
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Trib 2 Plan: GRT2_Existing 4/9/2024
RS = 1519.95
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.028
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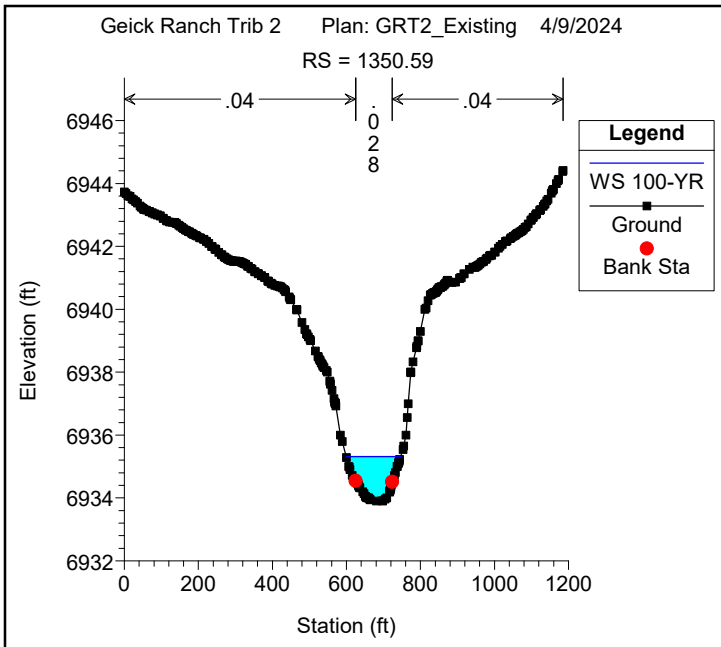
Legend
WS 100-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Trib 2 Plan: GRT2_Existing 4/9/2024
RS = 1350.59
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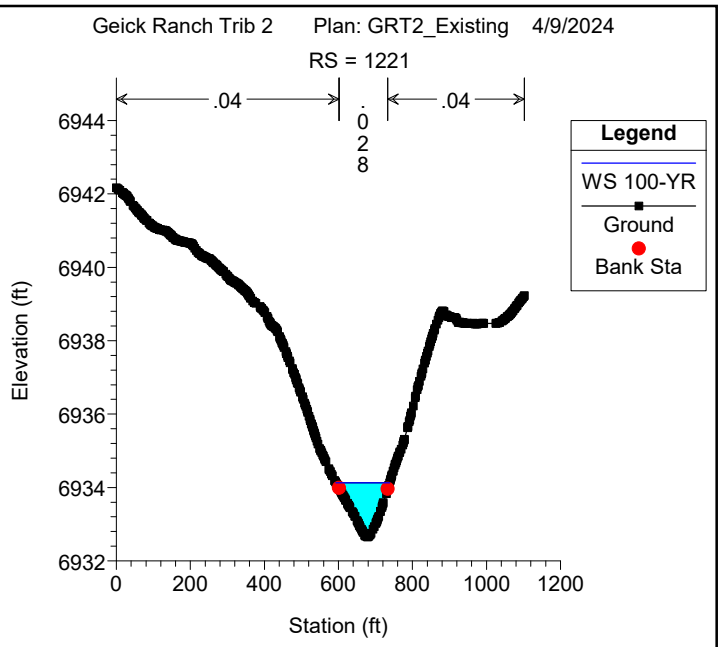
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Trib 2 Plan: GRT2_Existing 4/9/2024
RS = 1221
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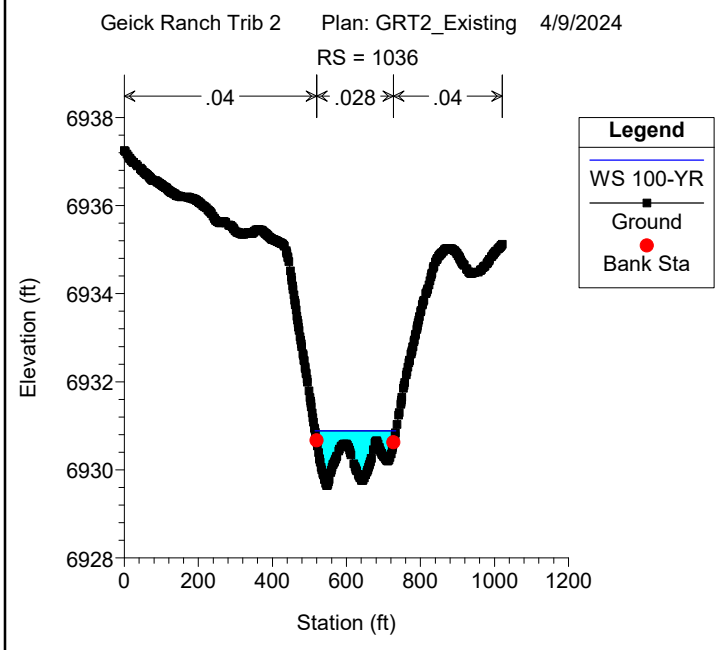
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Trib 2 Plan: GRT2_Existing 4/9/2024
RS = 1036
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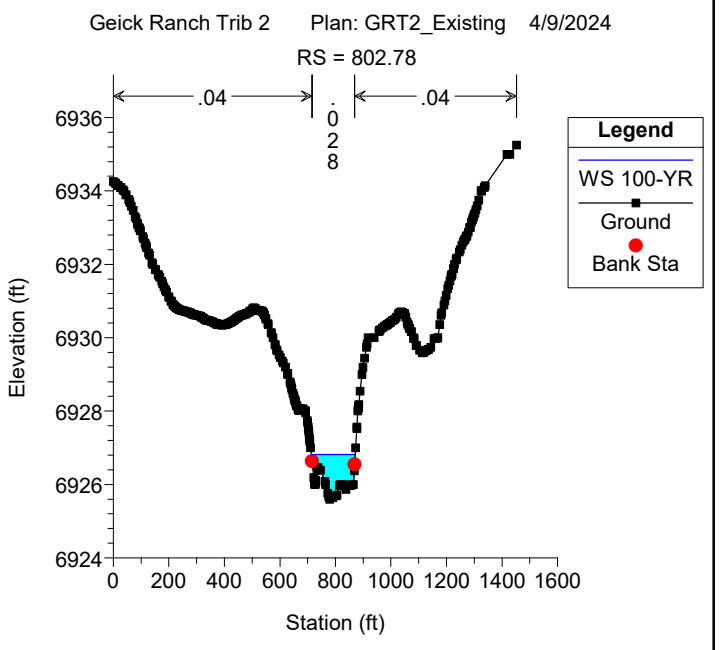
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Trib 2 Plan: GRT2_Existing 4/9/2024
RS = 802.78
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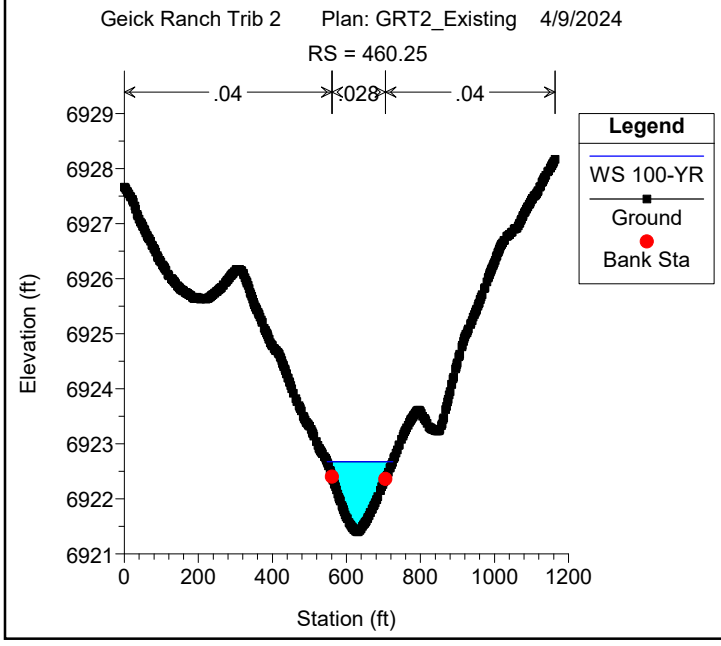
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Trib 2 Plan: GRT2_Existing 4/9/2024
RS = 460.25
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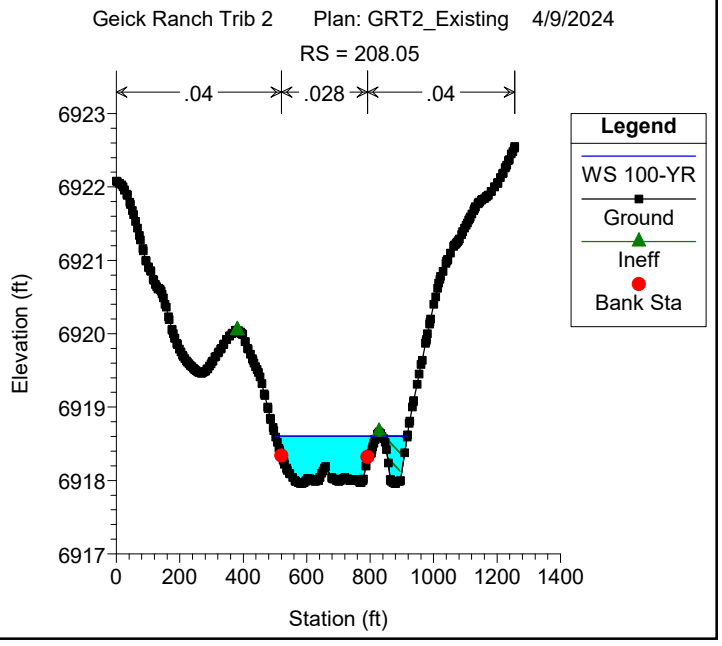
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Trib 2 Plan: GRT2_Existing 4/9/2024
RS = 208.05
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.028
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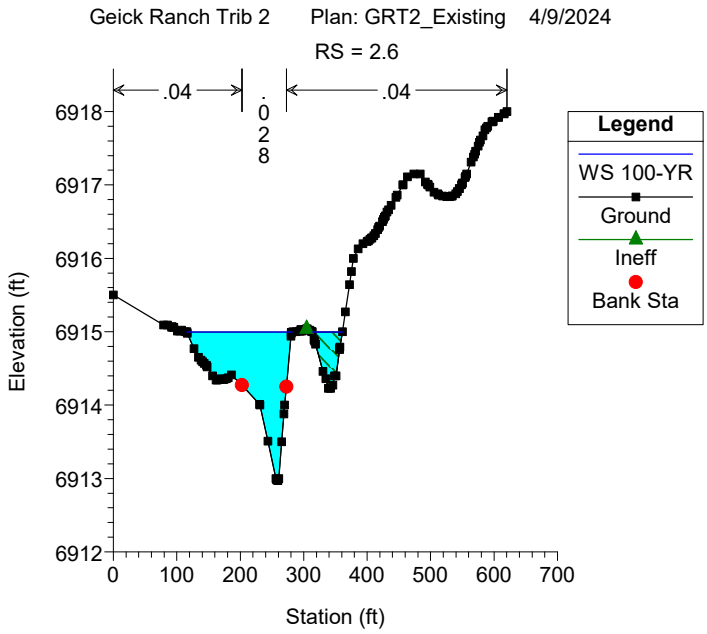
Legend
WS 100-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Trib 2 Plan: GRT2_Existing 4/9/2024
RS = 2.6
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.028
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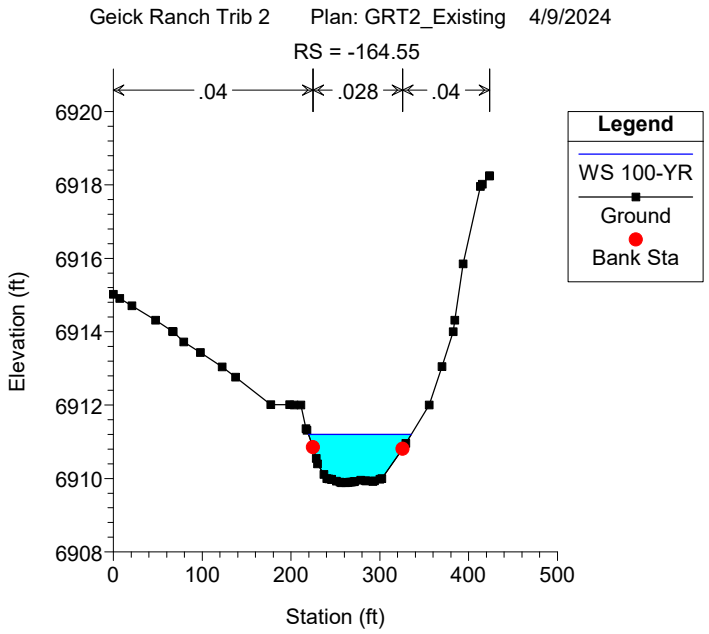
Legend
WS 100-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Trib 2 Plan: GRT2_Existing 4/9/2024
RS = -164.55
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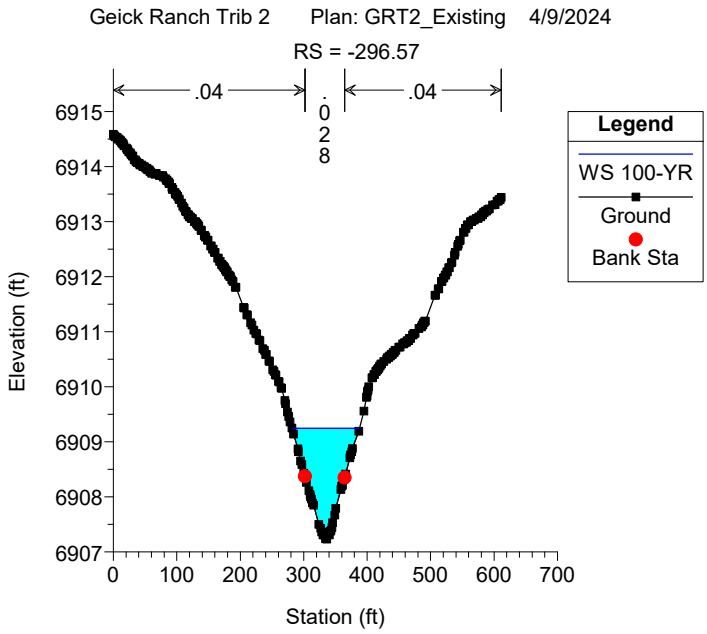
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Trib 2 Plan: GRT2_Existing 4/9/2024
RS = -296.57
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.028
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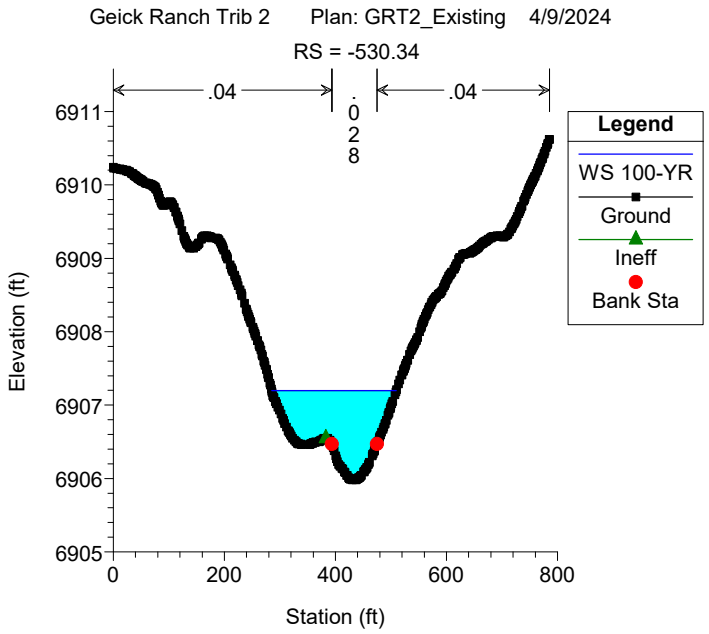
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Trib 2 Plan: GRT2_Existing 4/9/2024
RS = -530.34
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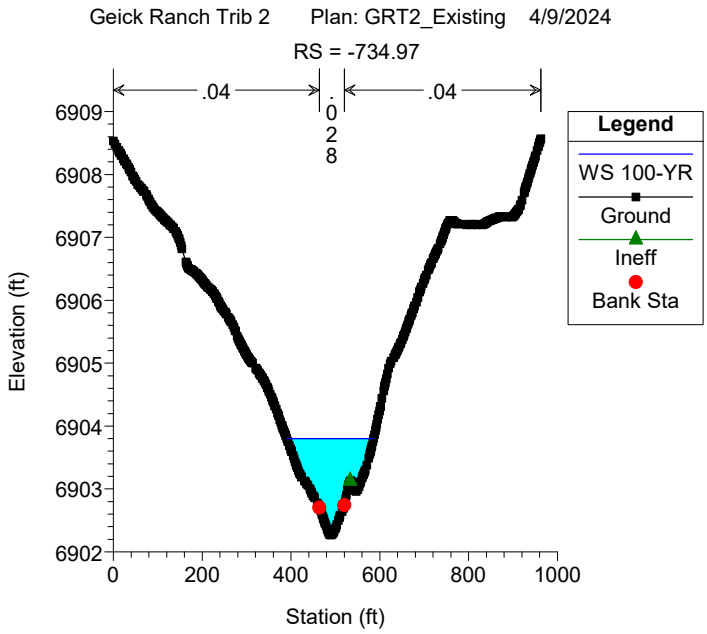
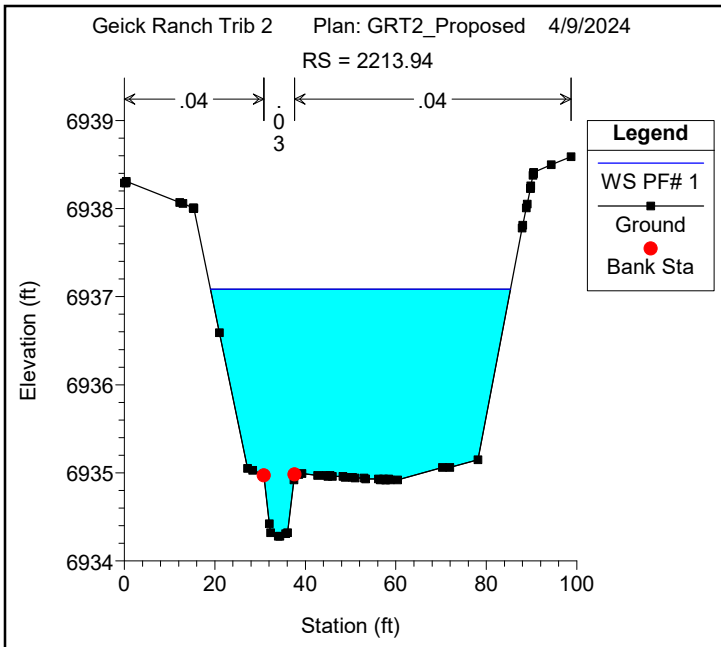
.028
.04
Legend
WS 100-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Trib 2 Plan: GRT2_Existing 4/9/2024
RS = -734.97
.04
.028
.04
Legend
WS 100-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

Appendix D
Proposed Conditions Cross Sections

Provide profile & output table (include velocity, shear and Froude #)


Geick Ranch Trib 2 Plan: GRT2_Proposed 4/9/2024
RS = 2213.94
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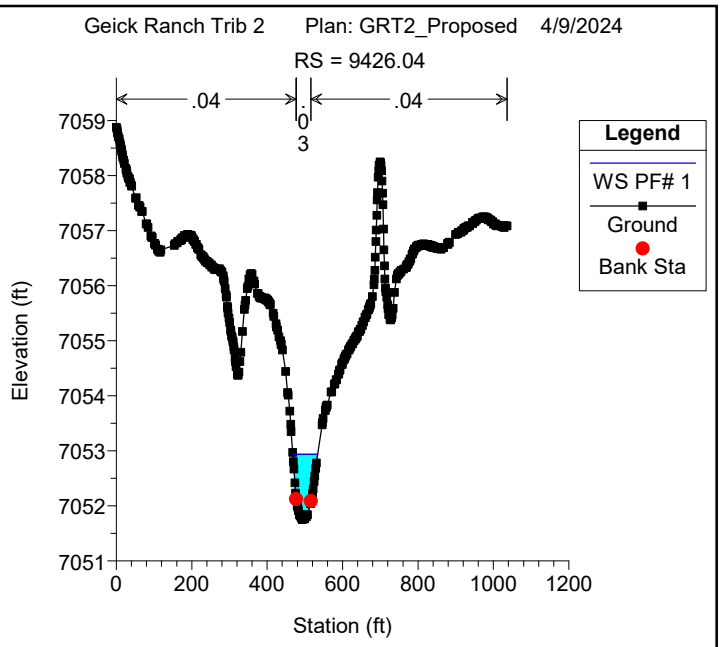
.03
.04
Legend
WS PF# 1
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Trib 2 Plan: GRT2_Proposed 4/9/2024
RS = 9426.04
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.03
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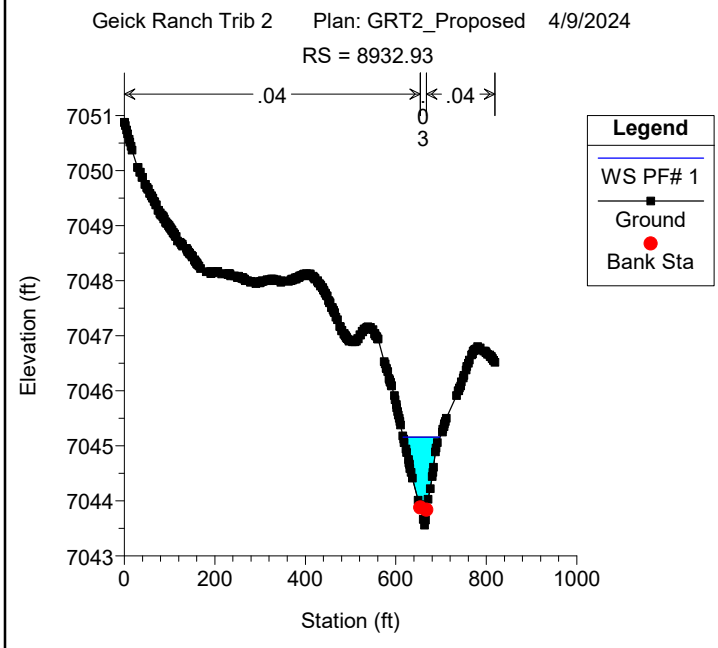
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Trib 2 Plan: GRT2_Proposed 4/9/2024
RS = 8932.93
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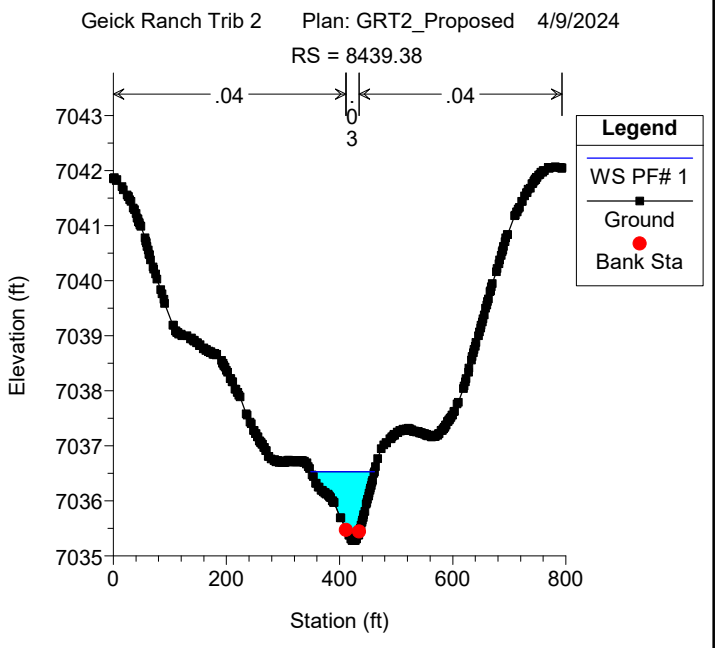
Legend
WS PF# 1
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Trib 2 Plan: GRT2_Proposed 4/9/2024
RS = 8439.38
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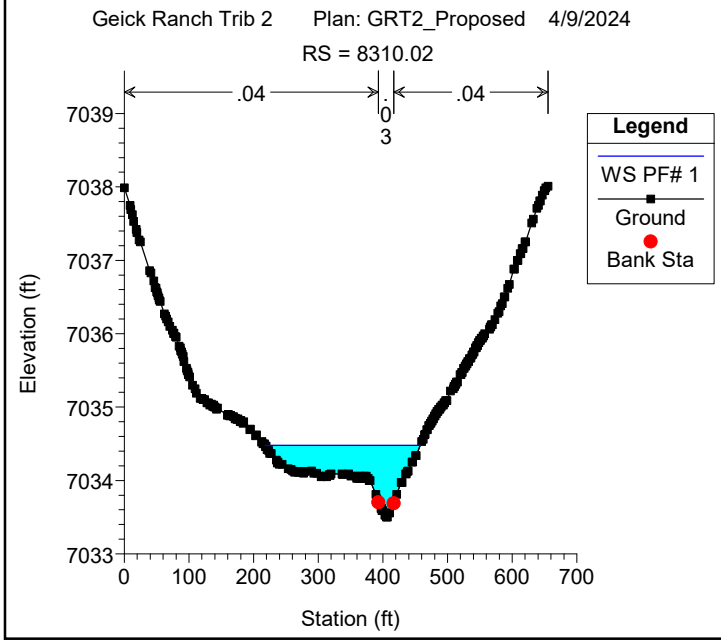
.03
.04
Legend
WS PF# 1
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Trib 2 Plan: GRT2_Proposed 4/9/2024
RS = 8310.02
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.03
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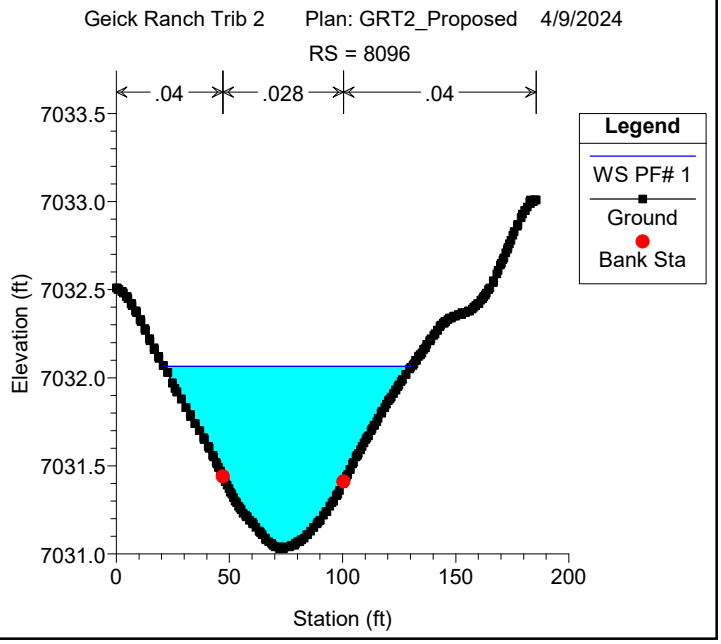
Legend
WS PF# 1
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Trib 2 Plan: GRT2_Proposed 4/9/2024
RS = 8096
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.028
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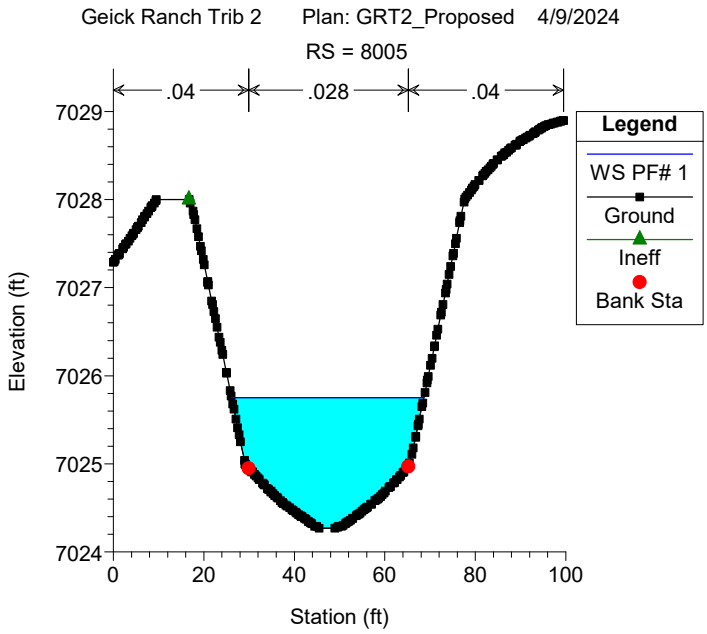
Legend
WS PF# 1
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Trib 2 Plan: GRT2_Proposed 4/9/2024
RS = 8005
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.028
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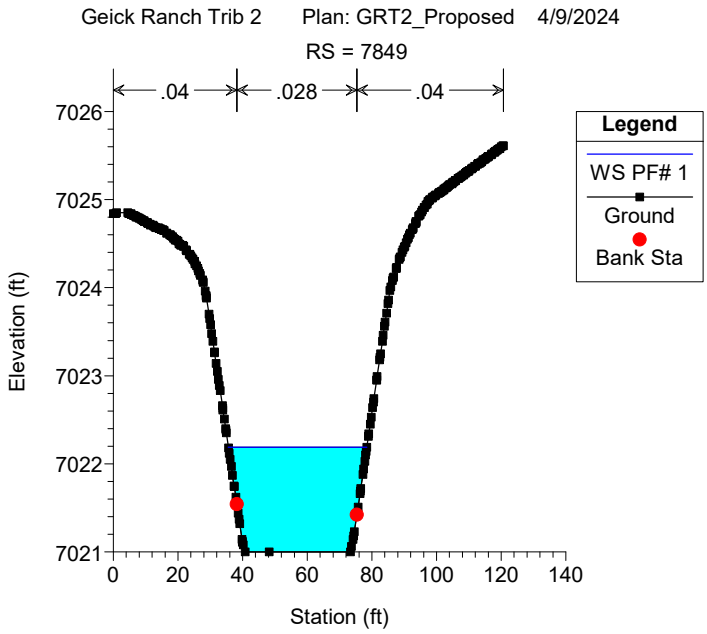
Legend
WS PF# 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Trib 2 Plan: GRT2_Proposed 4/9/2024
RS = 7849
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.028
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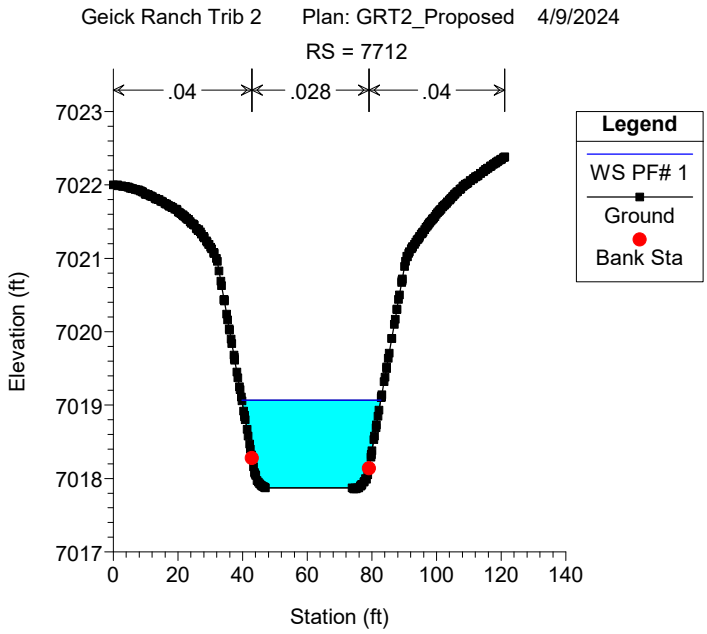
Legend
WS PF# 1
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Trib 2 Plan: GRT2_Proposed 4/9/2024
RS = 7712
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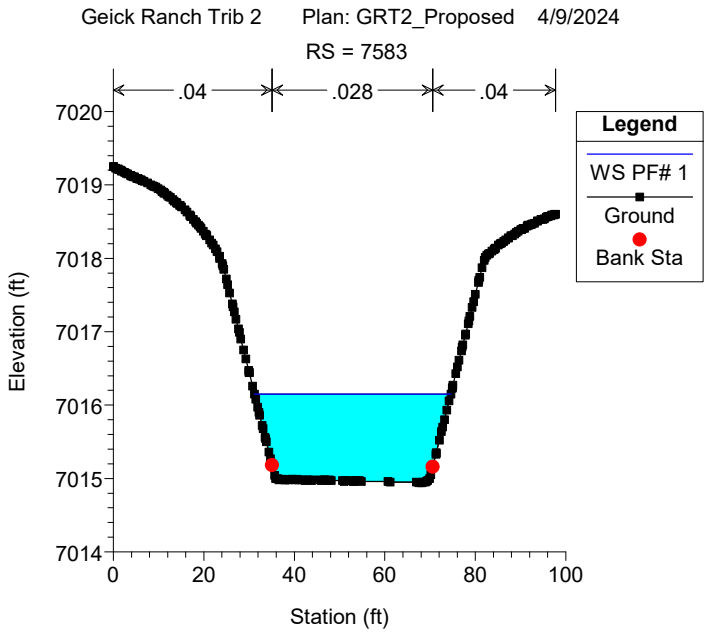
.028
.04
Legend
WS PF# 1
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Trib 2 Plan: GRT2_Proposed 4/9/2024
RS = 7583
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.028
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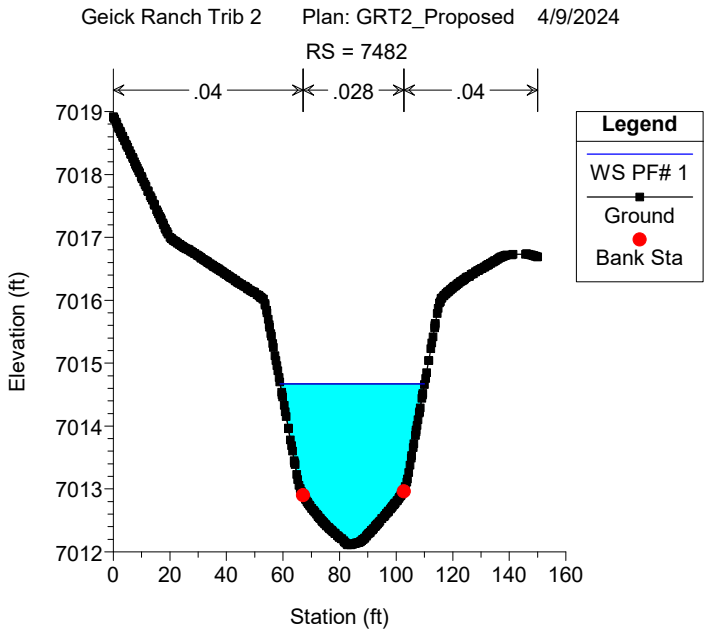
Legend
WS PF# 1
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Trib 2 Plan: GRT2_Proposed 4/9/2024
RS = 7482
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.028
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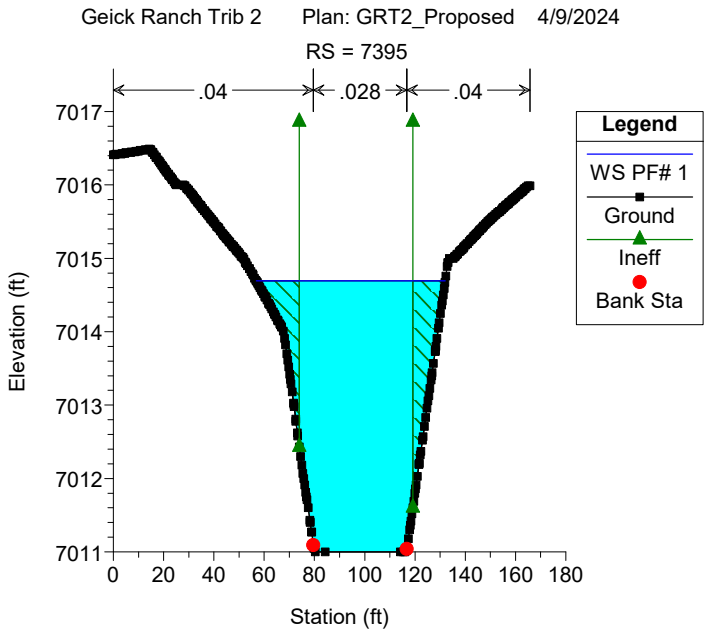
Legend
WS PF# 1
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Trib 2 Plan: GRT2_Proposed 4/9/2024
RS = 7395
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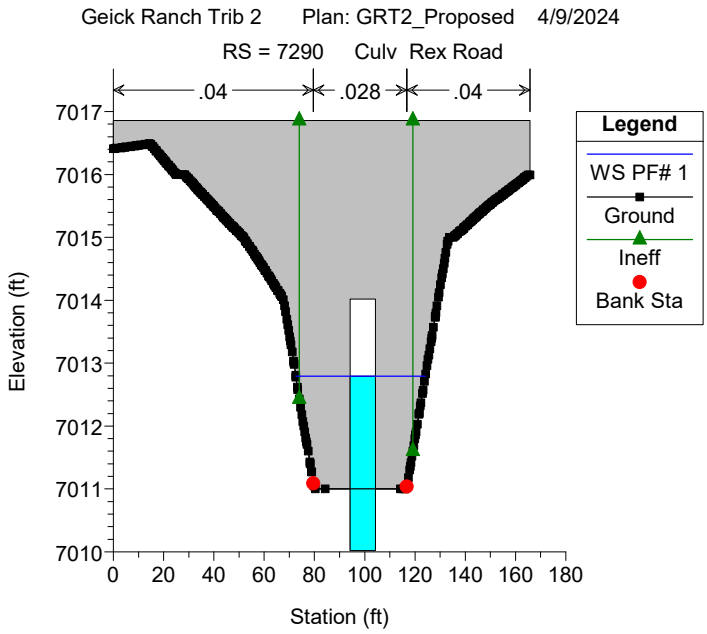
Legend
WS PF# 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Trib 2 Plan: GRT2_Proposed 4/9/2024
RS = 7290 Culv Rex Road
.04
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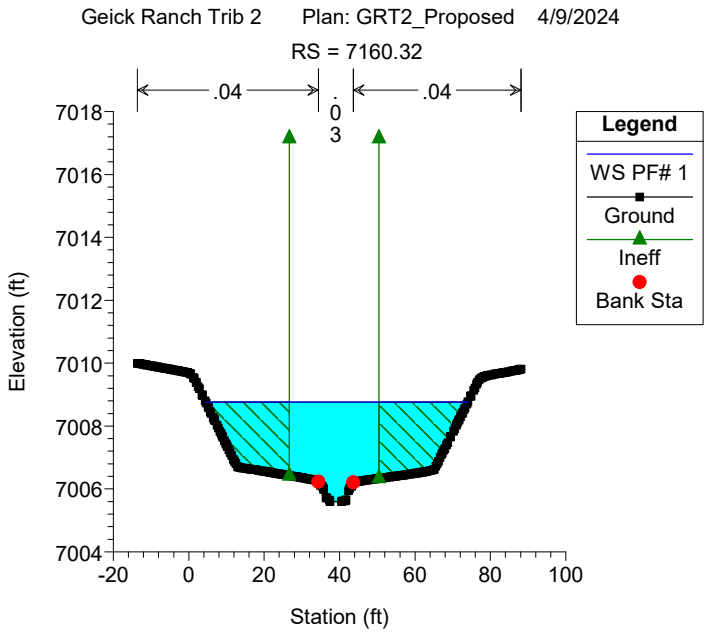
Legend
WS PF# 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Trib 2 Plan: GRT2_Proposed 4/9/2024
RS = 7160.32
.04
.03
.04
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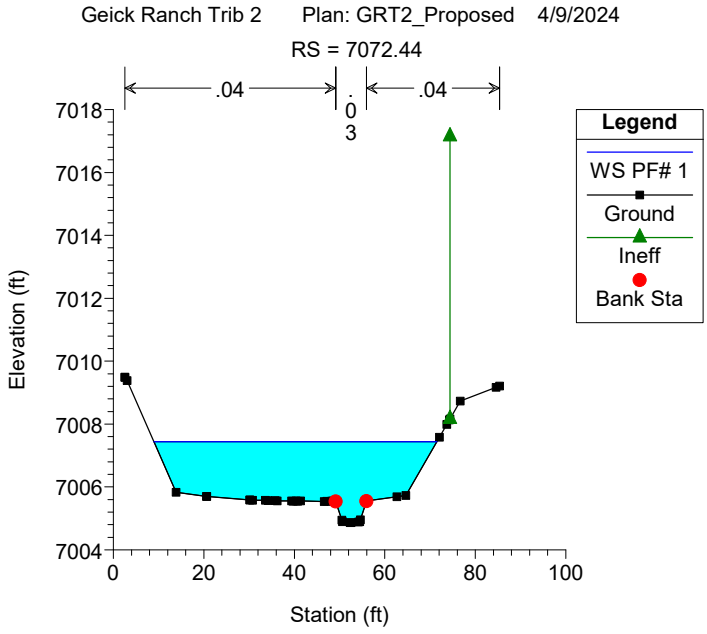
WS PF# 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Trib 2 Plan: GRT2_Proposed 4/9/2024
RS = 7072.44
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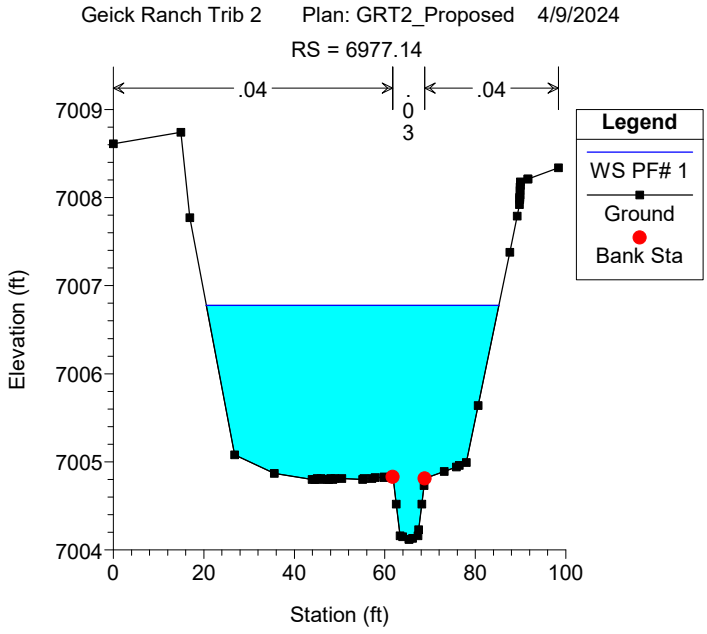
Legend
WS PF# 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Trib 2 Plan: GRT2_Proposed 4/9/2024
RS = 6977.14
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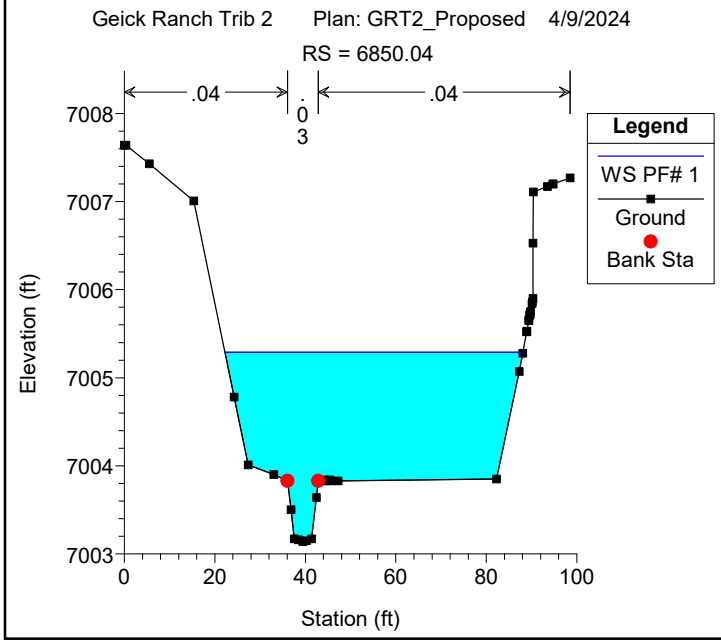
.04
Legend
WS PF# 1
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Trib 2 Plan: GRT2_Proposed 4/9/2024
RS = 6850.04
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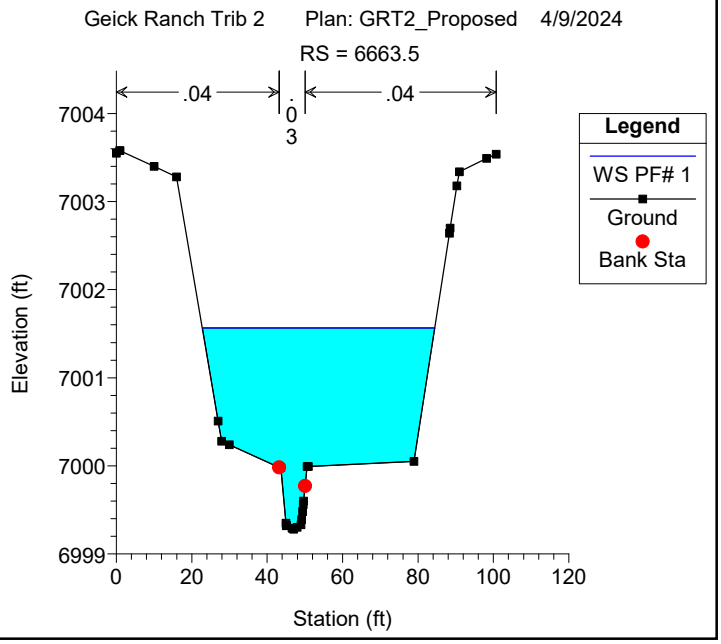
Legend
WS PF# 1
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Trib 2 Plan: GRT2_Proposed 4/9/2024
RS = 6663.5
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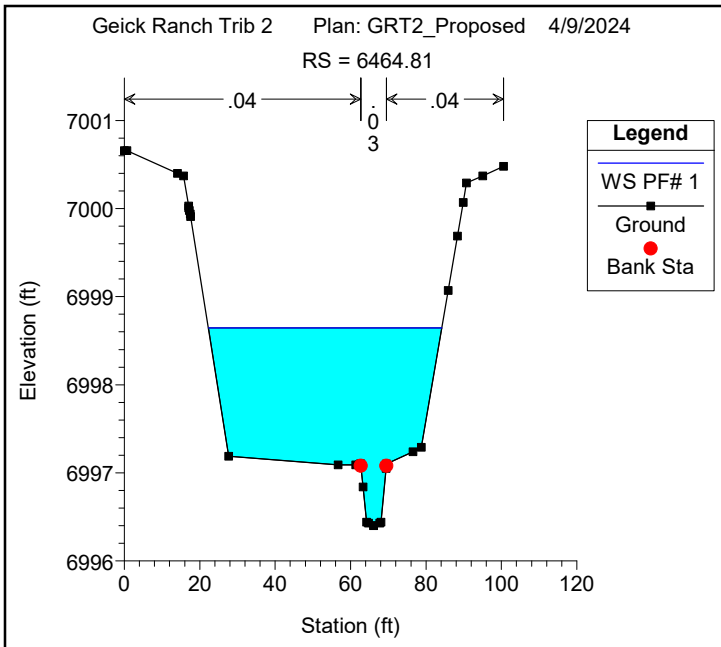
Legend
WS PF# 1
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Trib 2 Plan: GRT2_Proposed 4/9/2024
RS = 6464.81
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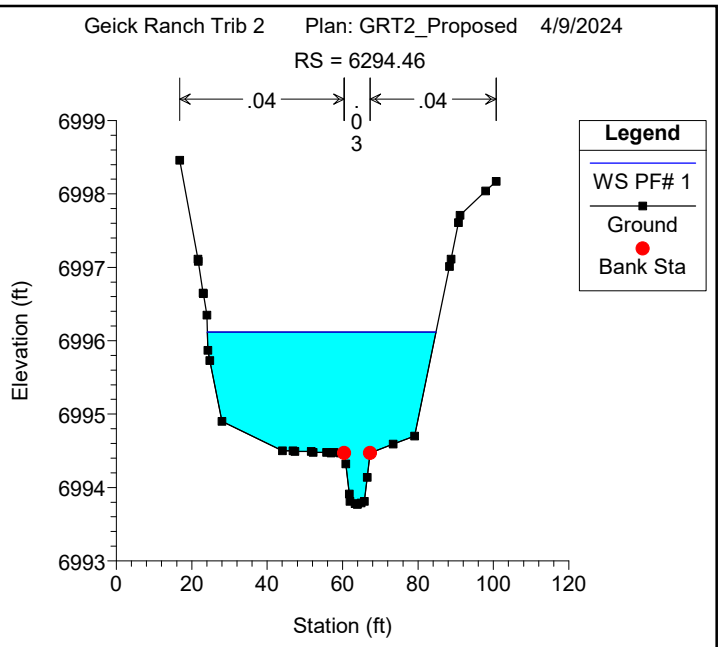
.03
.04
Legend
WS PF# 1
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Trib 2 Plan: GRT2_Proposed 4/9/2024
RS = 6294.46
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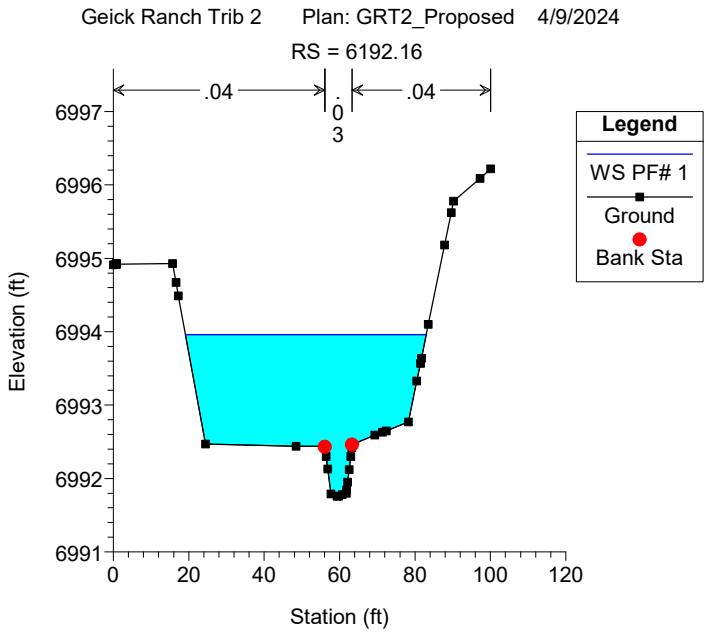
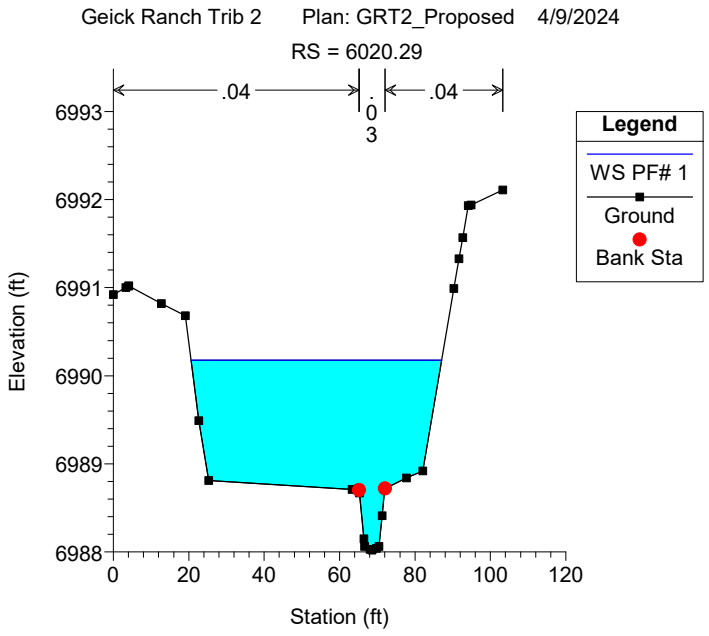
.03
.04
Legend
WS PF# 1
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Trib 2 Plan: GRT2_Proposed 4/9/2024
RS = 6192.16
.04
.03
.04
Legend
WS PF# 1
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Trib 2 Plan: GRT2_Proposed 4/9/2024
RS = 6020.29
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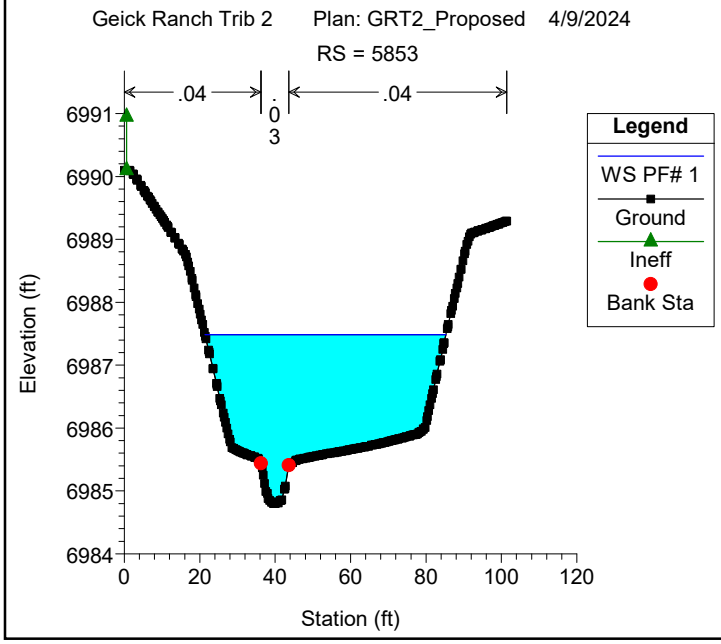
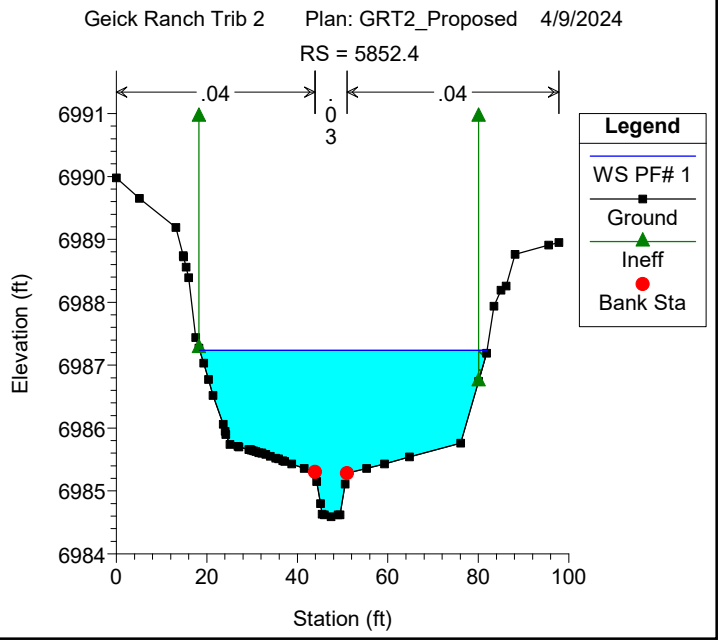
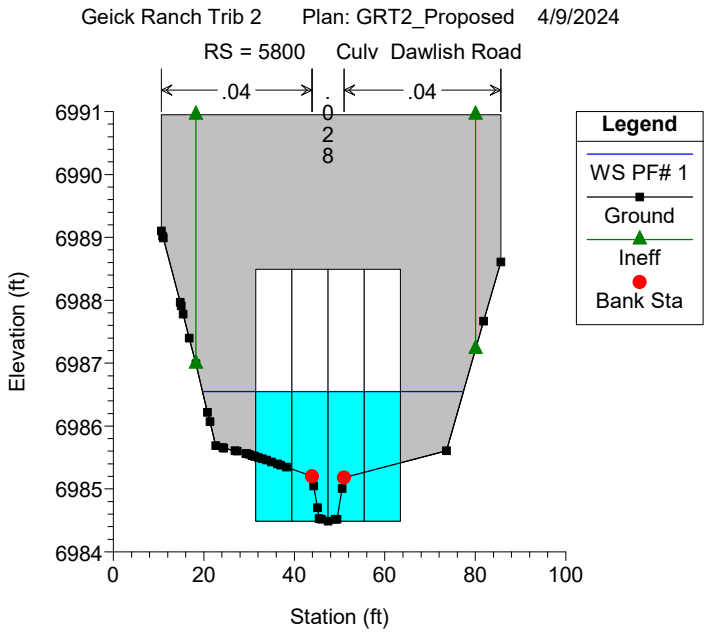
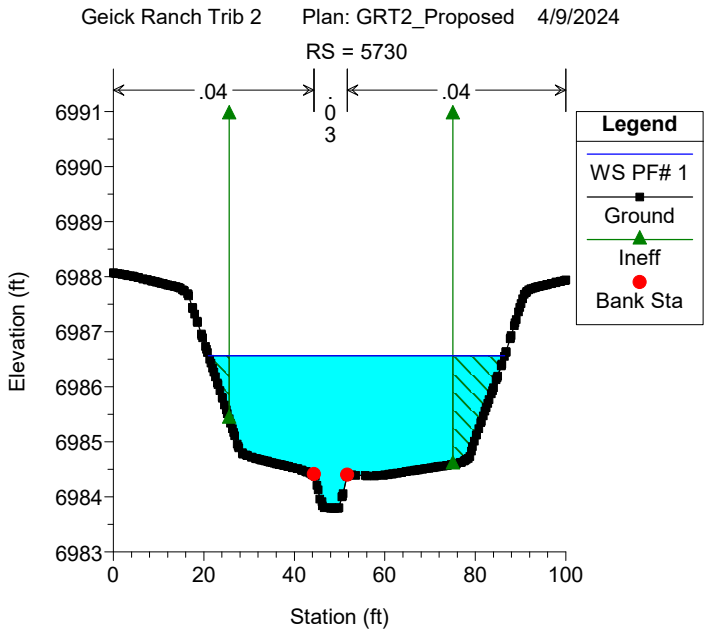
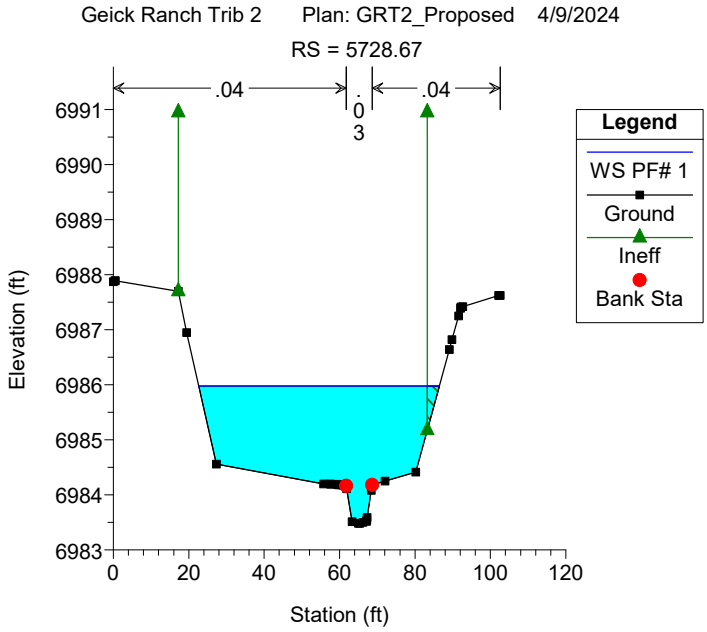
.03
.04
Legend
WS PF# 1
Ground
Bank Sta
Elevation (ft)
Station (ft)

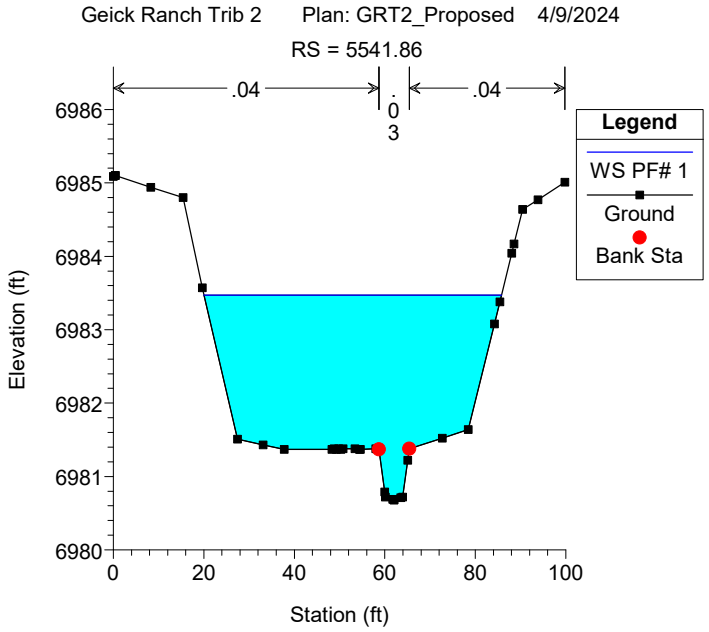

Geick Ranch Trib 2 Plan: GRT2_Proposed 4/9/2024
RS = 5853
.04
.03
.04
Legend
WS PF# 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Trib 2 Plan: GRT2_Proposed 4/9/2024
RS = 5852.4
.04
.03
.04
Legend
WS PF# 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Trib 2 Plan: GRT2_Proposed 4/9/2024
RS = 5800 Culv Dawlish Road
.04
.028
.04
Legend
WS PF# 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Trib 2 Plan: GRT2_Proposed 4/9/2024
RS = 5730
.04
.03
.04
Legend
WS PF# 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Trib 2 Plan: GRT2_Proposed 4/9/2024
RS = 5728.67
.04
.03
.04
Legend
WS PF# 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Trib 2 Plan: GRT2_Proposed 4/9/2024
RS = 5541.86
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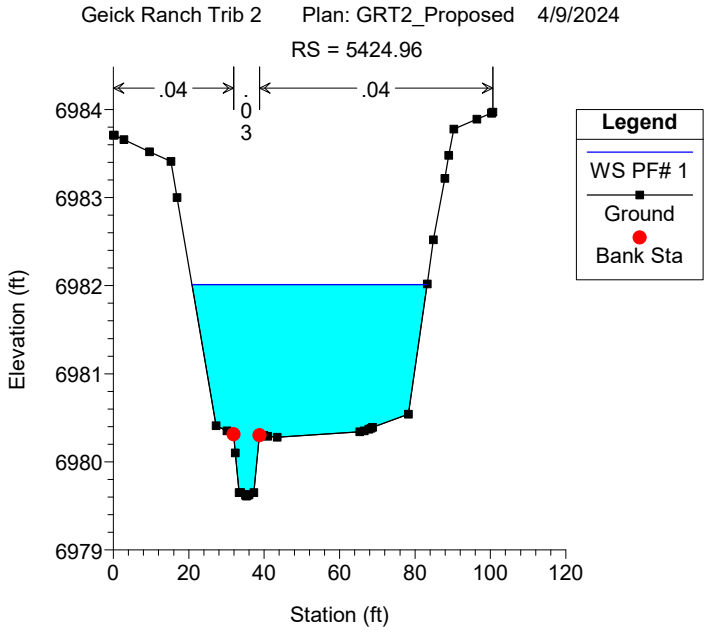
Legend
WS PF# 1
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Trib 2 Plan: GRT2_Proposed 4/9/2024
RS = 5424.96
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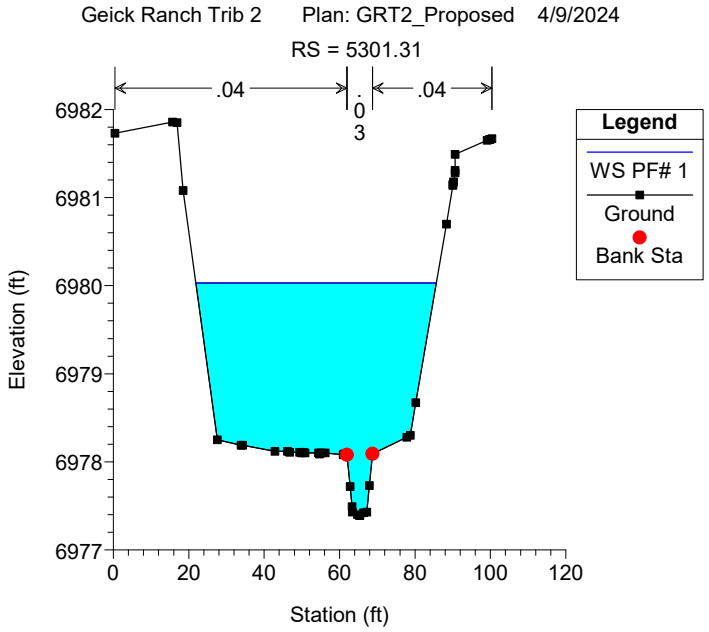
Legend
WS PF# 1
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Trib 2 Plan: GRT2_Proposed 4/9/2024
RS = 5301.31
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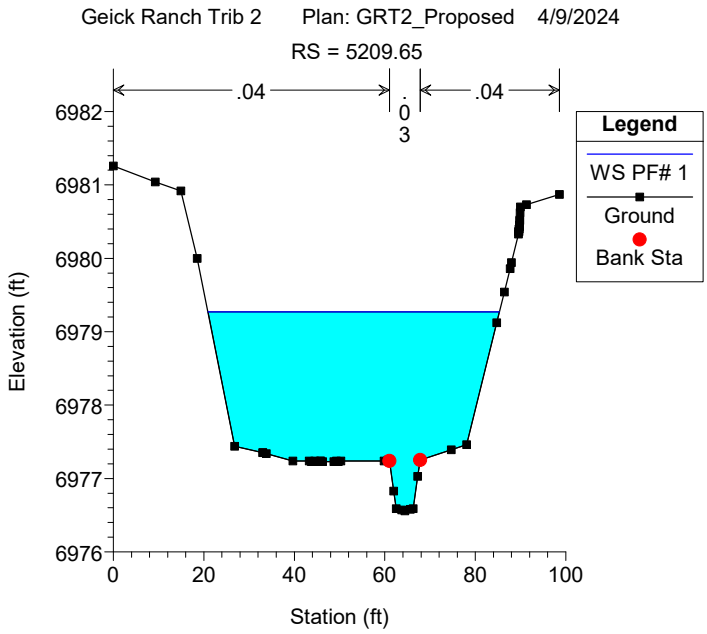
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Trib 2 Plan: GRT2_Proposed 4/9/2024
RS = 5209.65
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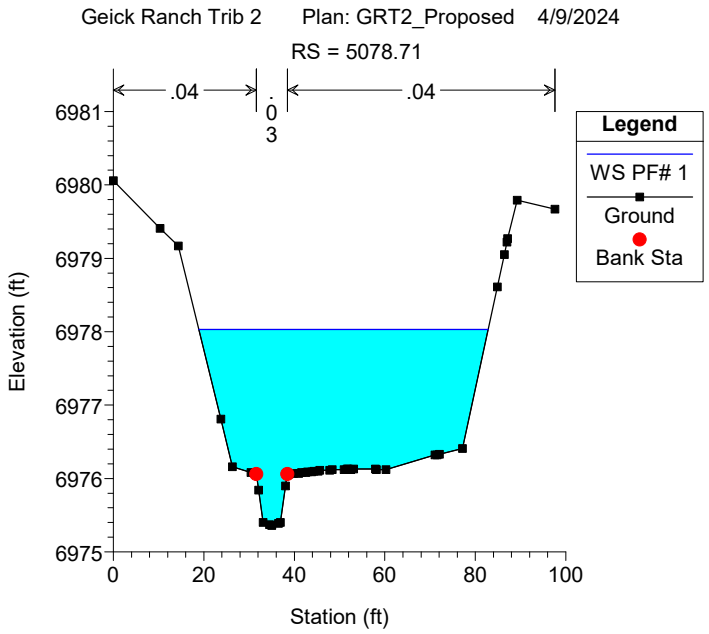
Legend
WS PF# 1
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Trib 2 Plan: GRT2_Proposed 4/9/2024
RS = 5078.71
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Legend
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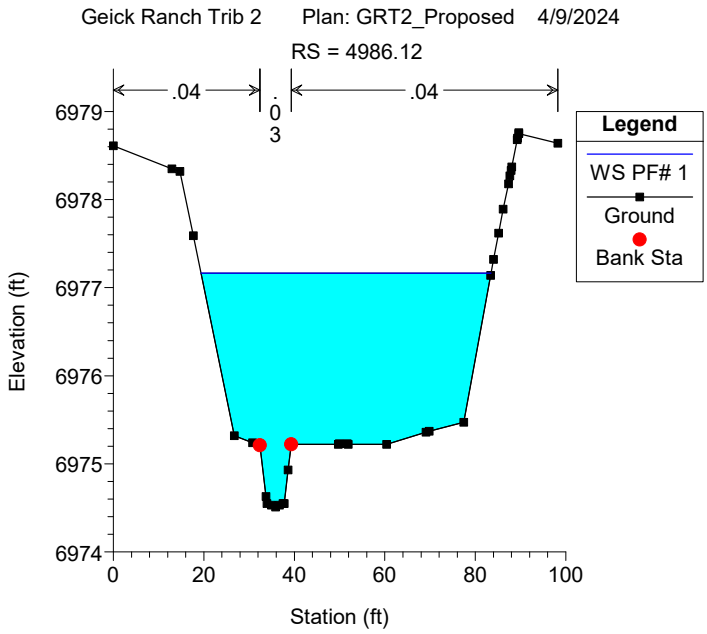
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Trib 2 Plan: GRT2_Proposed 4/9/2024
RS = 4986.12
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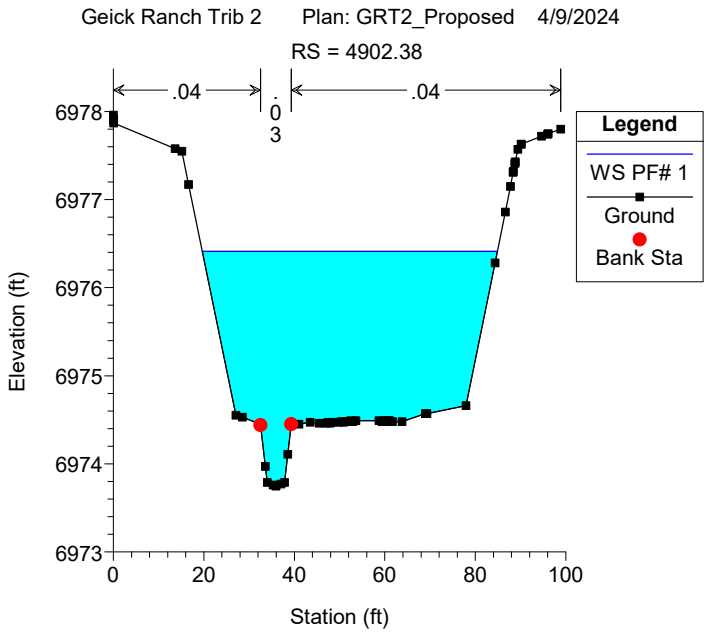
Legend
WS PF# 1
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Trib 2 Plan: GRT2_Proposed 4/9/2024
RS = 4902.38
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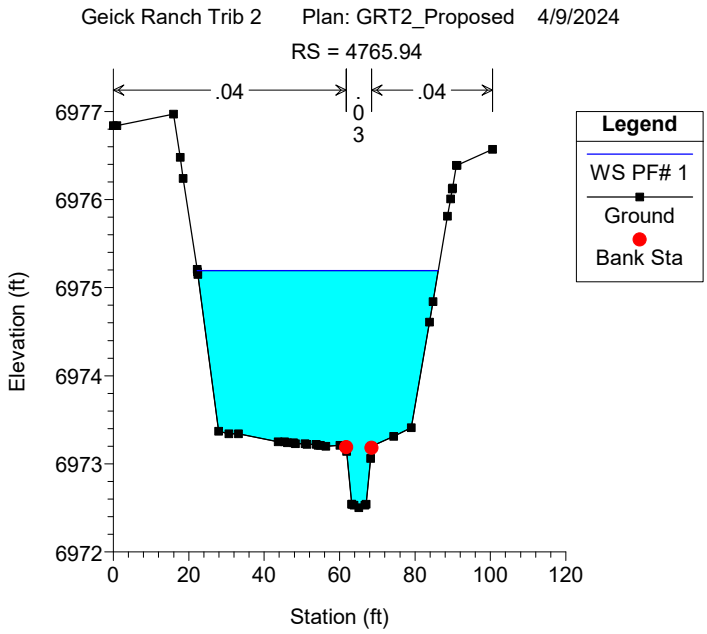
Legend
WS PF# 1
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Trib 2 Plan: GRT2_Proposed 4/9/2024
RS = 4765.94
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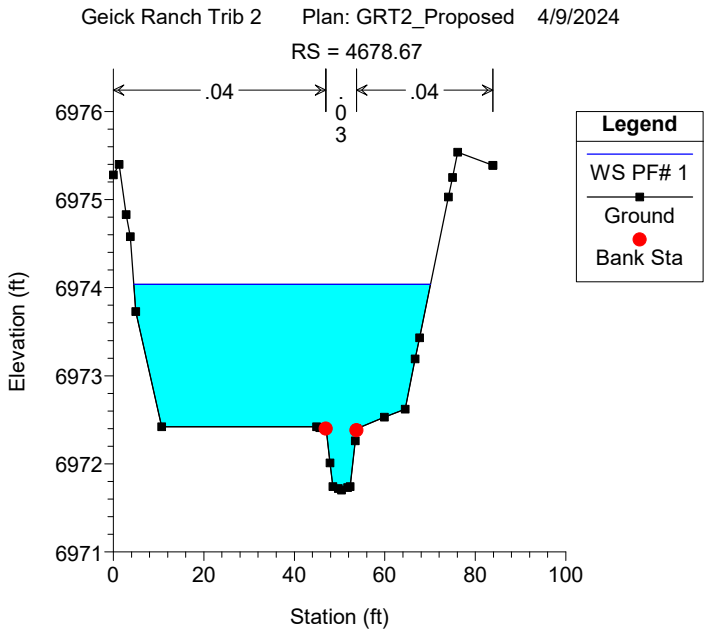
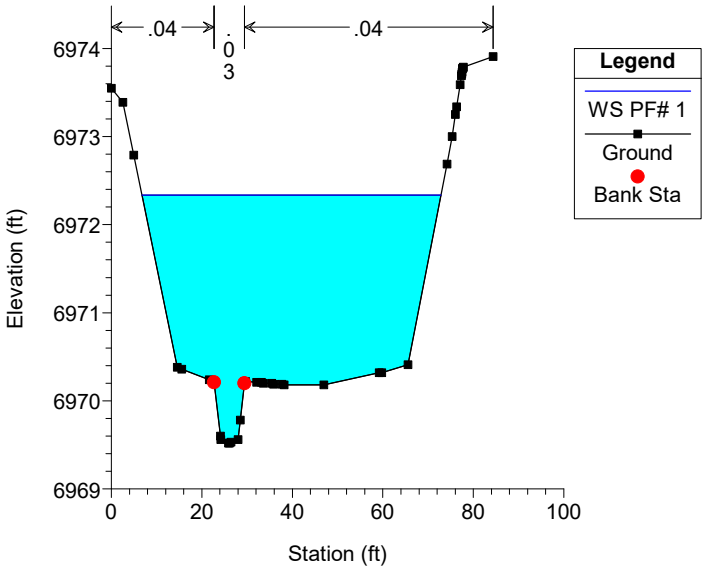
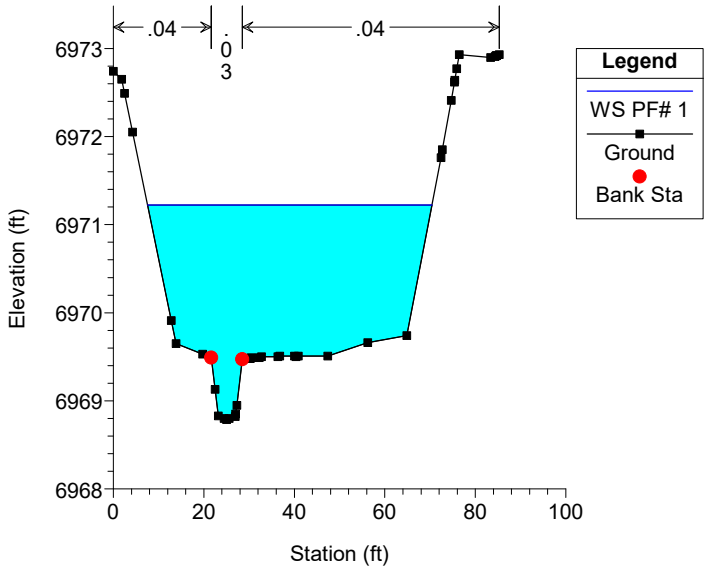
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Trib 2 Plan: GRT2_Proposed 4/9/2024
RS = 4678.67
.04
.03
.04
Legend
WS PF# 1
Ground
Bank Sta
Elevation (ft)
Station (ft)

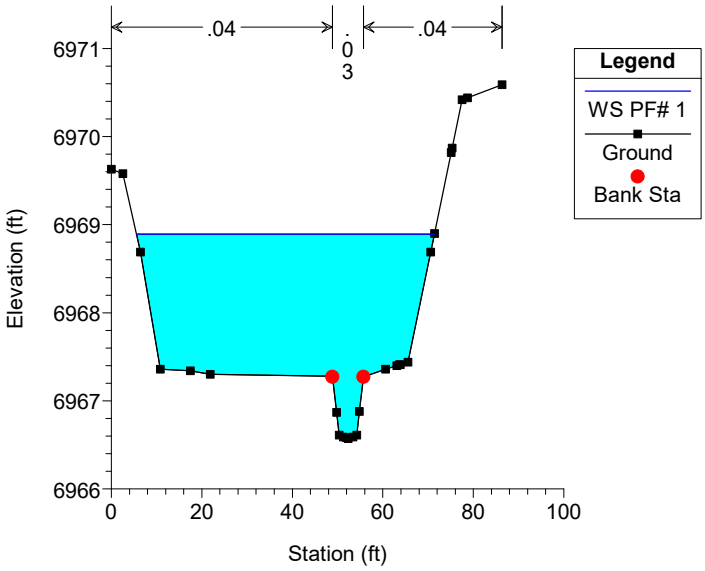
Geick Ranch Trib 2 Plan: GRT2_Proposed 4/9/2024
RS = 4557.88



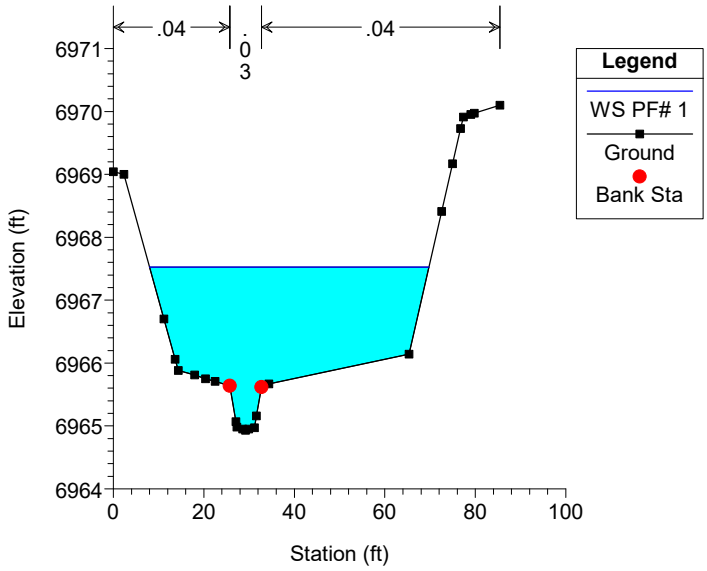
Geick Ranch Trib 2 Plan: GRT2_Proposed 4/9/2024
RS = 4476.29



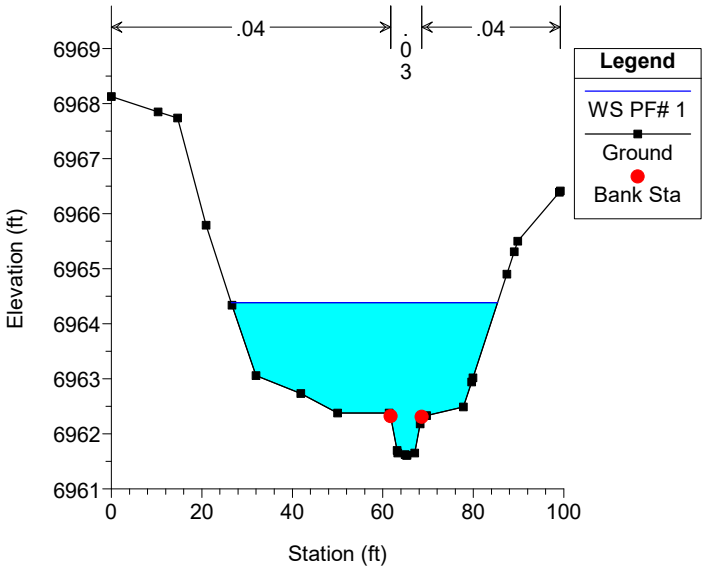
Geick Ranch Trib 2 Plan: GRT2_Proposed 4/9/2024
RS = 4351.82



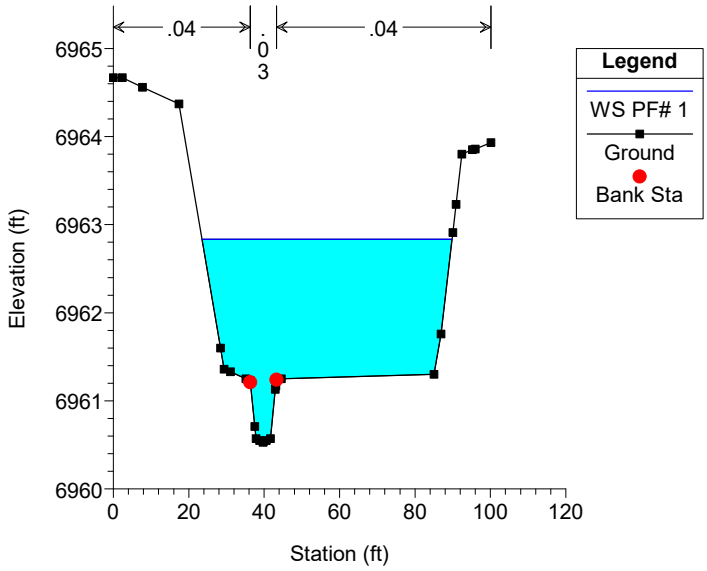
Geick Ranch Trib 2 Plan: GRT2_Proposed 4/9/2024
RS = 4291.52



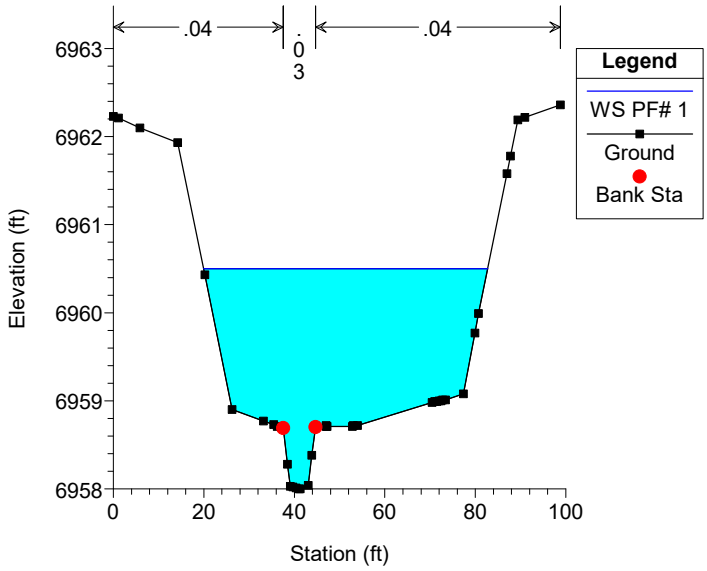
Geick Ranch Trib 2 Plan: GRT2_Proposed 4/9/2024
RS = 4166.12



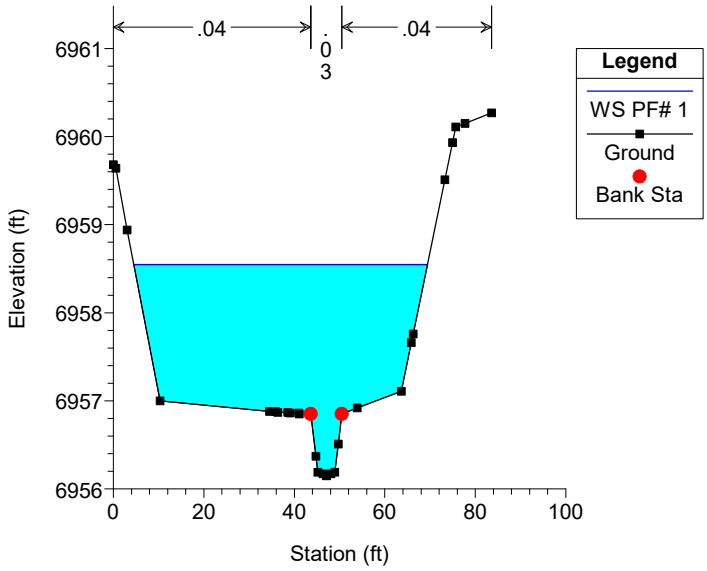
Geick Ranch Trib 2 Plan: GRT2_Proposed 4/9/2024
RS = 4045.84



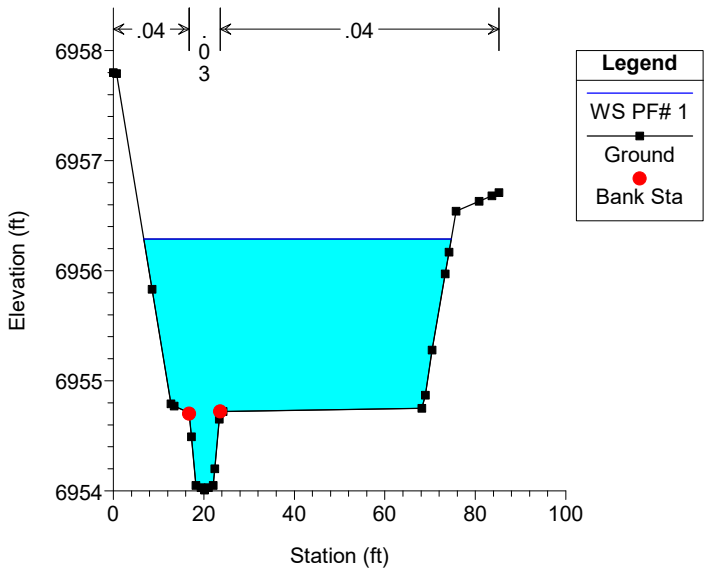
Geick Ranch Trib 2 Plan: GRT2_Proposed 4/9/2024
RS = 3885.92



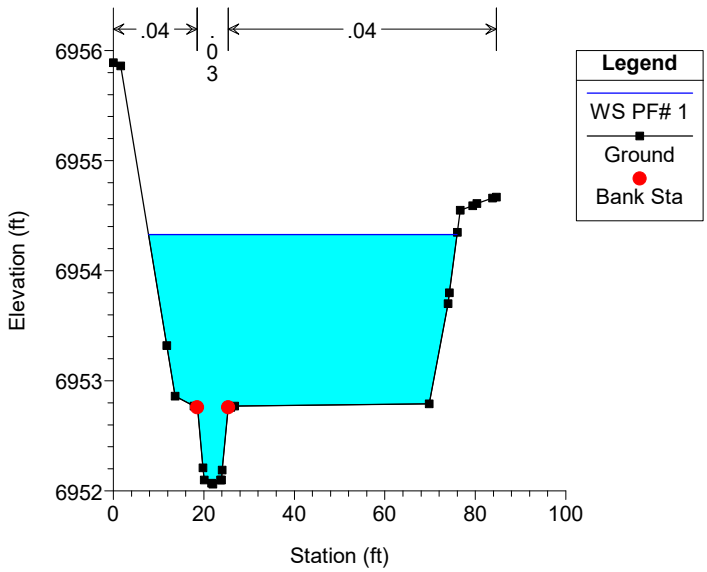
Geick Ranch Trib 2 Plan: GRT2_Proposed 4/9/2024
RS = 3802.45



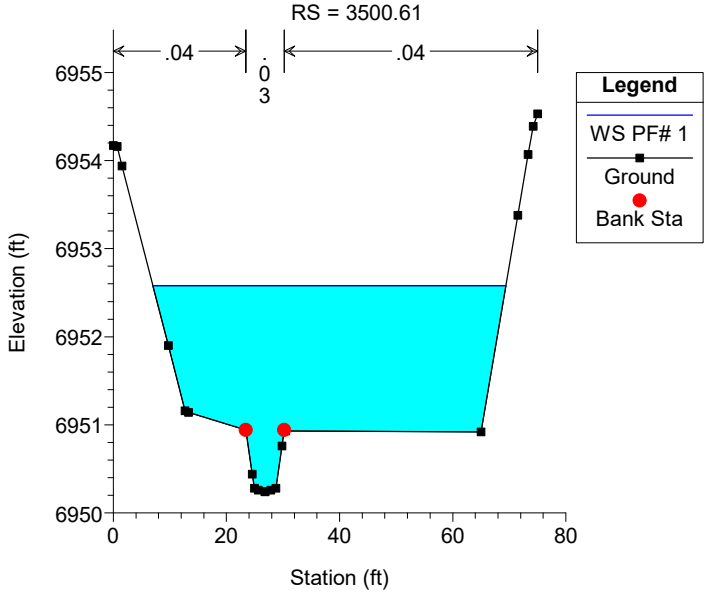
Geick Ranch Trib 2 Plan: GRT2_Proposed 4/9/2024
RS = 3676.52



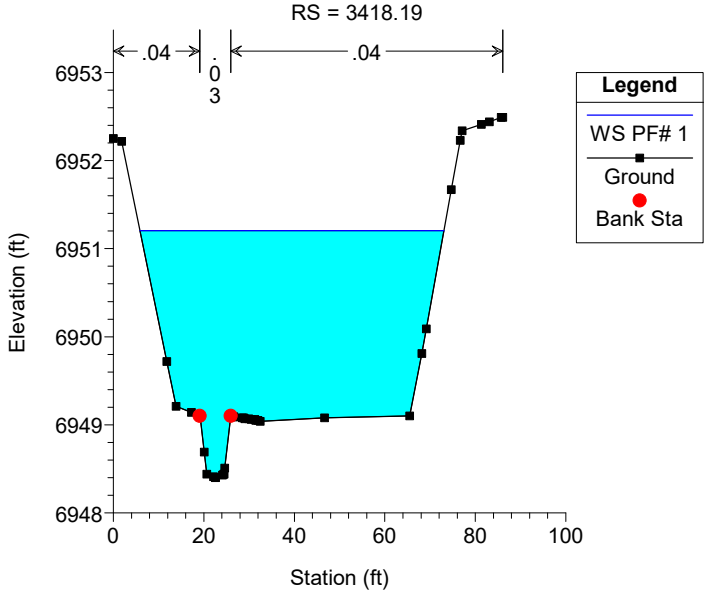
Geick Ranch Trib 2 Plan: GRT2_Proposed 4/9/2024
RS = 3581.26

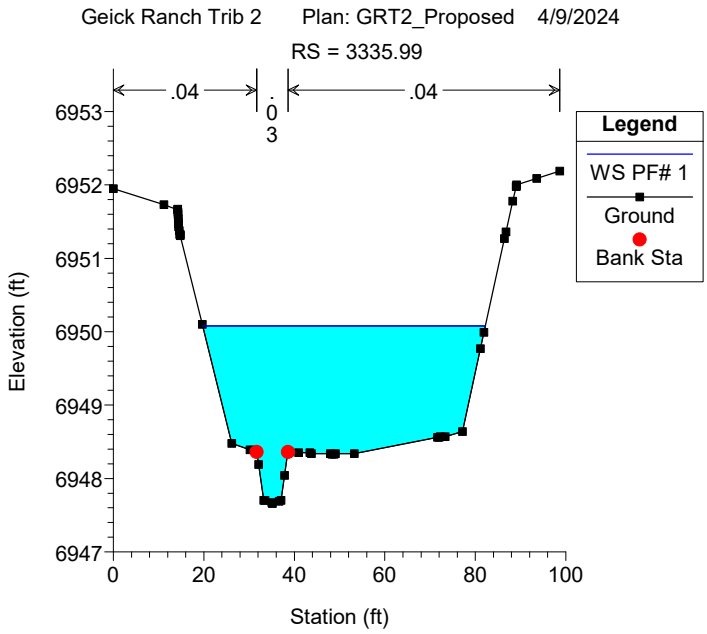


Geick Ranch Trib 2 Plan: GRT2_Proposed 4/9/2024
RS = 3500.61



Geick Ranch Trib 2 Plan: GRT2_Proposed 4/9/2024
RS = 3418.19




Geick Ranch Trib 2 Plan: GRT2_Proposed 4/9/2024
RS = 3335.99
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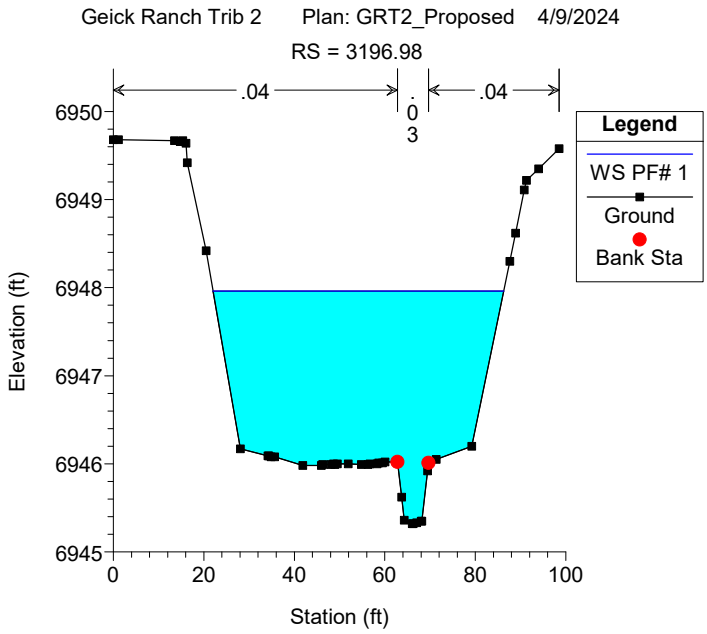
Legend
WS PF# 1
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Trib 2 Plan: GRT2_Proposed 4/9/2024
RS = 3196.98
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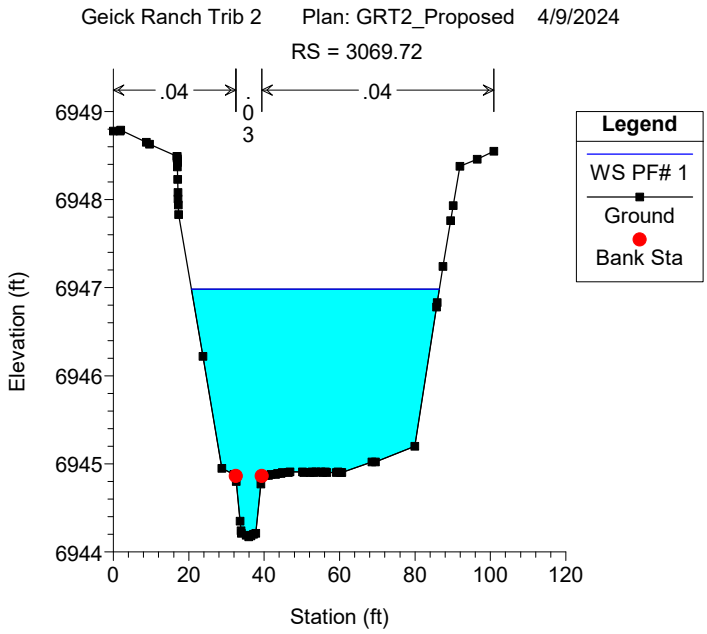
Legend
WS PF# 1
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Trib 2 Plan: GRT2_Proposed 4/9/2024
RS = 3069.72
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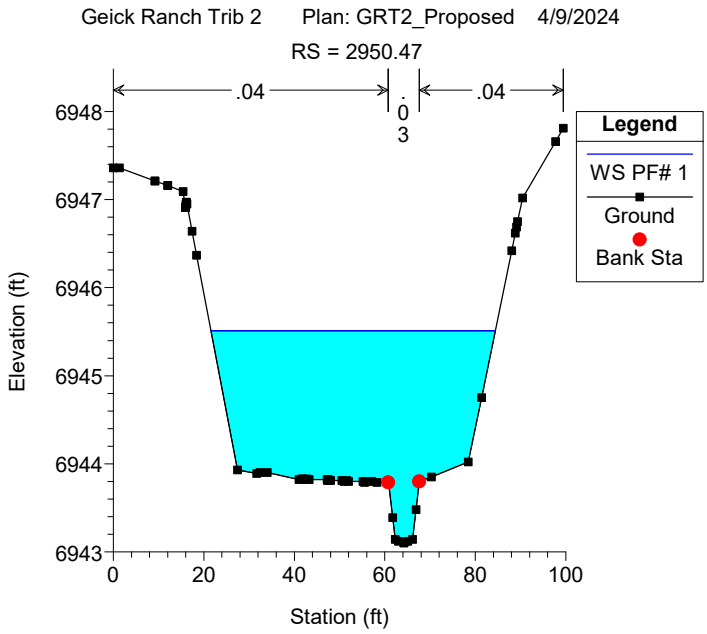
Legend
WS PF# 1
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Trib 2 Plan: GRT2_Proposed 4/9/2024
RS = 2950.47
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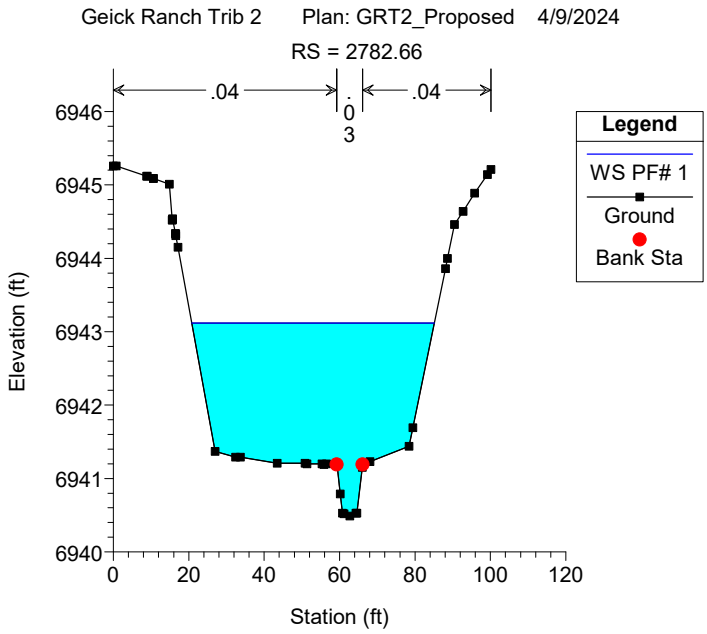
Legend
WS PF# 1
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Trib 2 Plan: GRT2_Proposed 4/9/2024
RS = 2782.66
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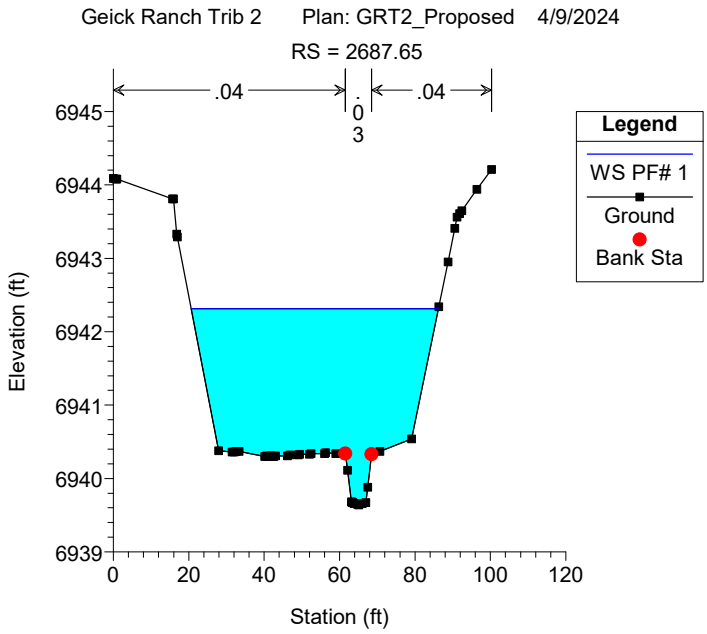
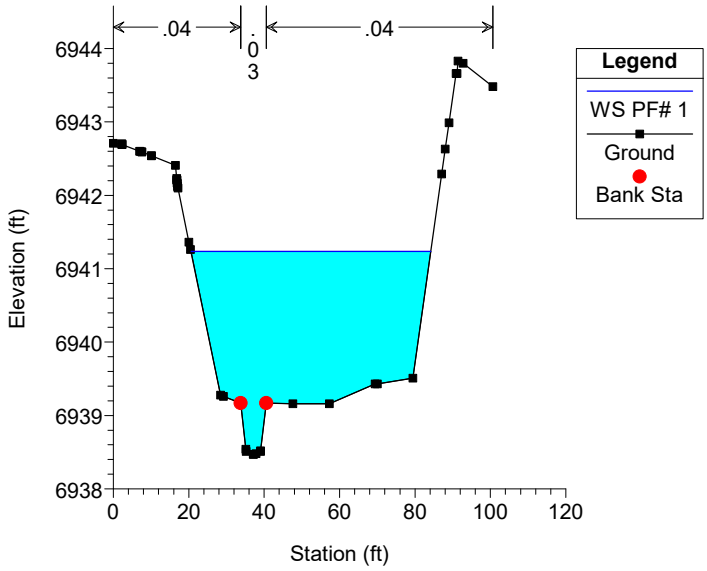
Legend
WS PF# 1
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Trib 2 Plan: GRT2_Proposed 4/9/2024
RS = 2687.65
.04
.03
.04
Legend
WS PF# 1
Ground
Bank Sta
Elevation (ft)
Station (ft)

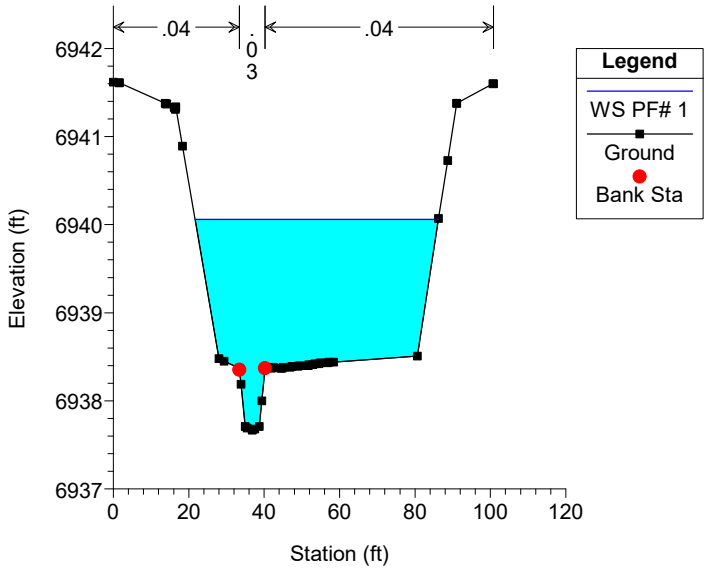
Geick Ranch Trib 2 Plan: GRT2_Proposed 4/9/2024

RS = 2558.01



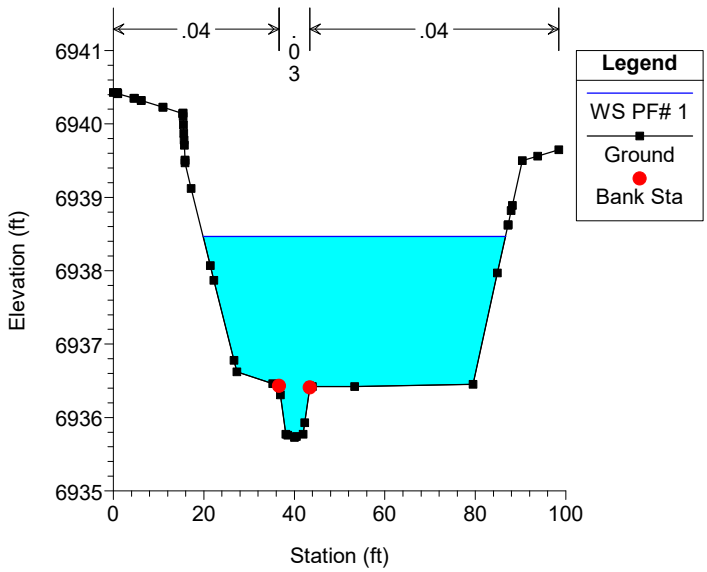
Geick Ranch Trib 2 Plan: GRT2_Proposed 4/9/2024

RS = 2468.81



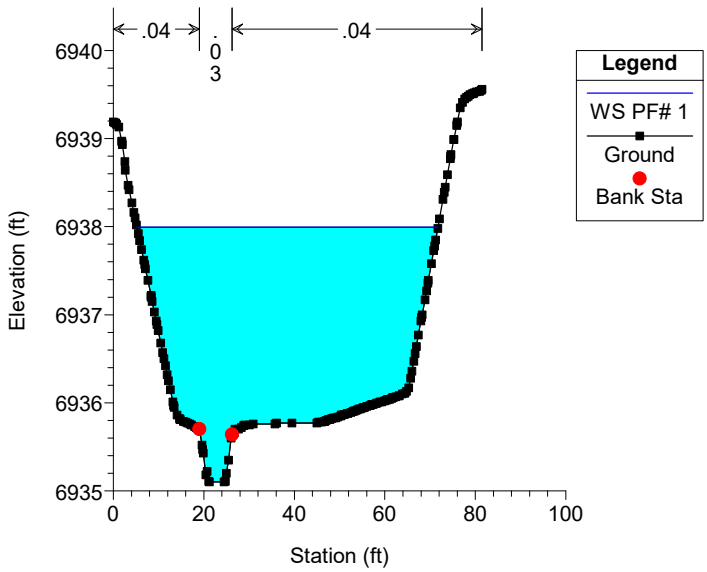
Geick Ranch Trib 2 Plan: GRT2_Proposed 4/9/2024

RS = 2375.32



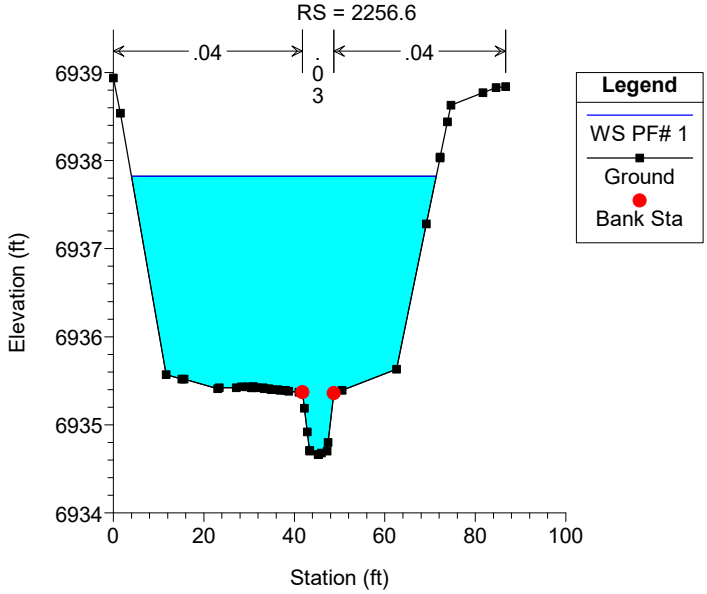
Geick Ranch Trib 2 Plan: GRT2_Proposed 4/9/2024

RS = 2258



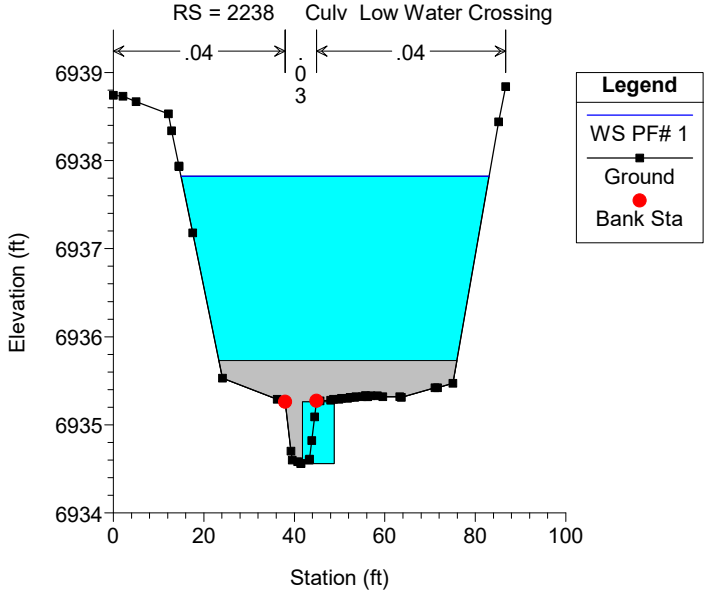
Geick Ranch Trib 2 Plan: GRT2_Proposed 4/9/2024

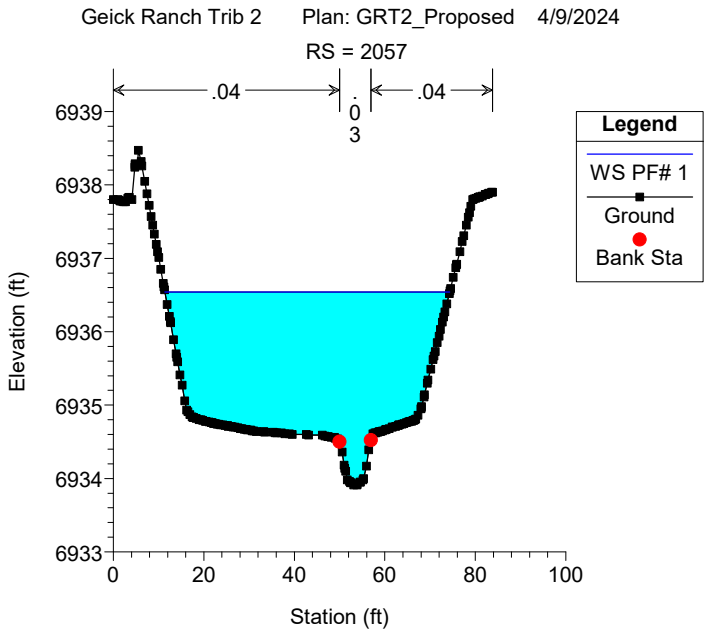
RS = 2256.6

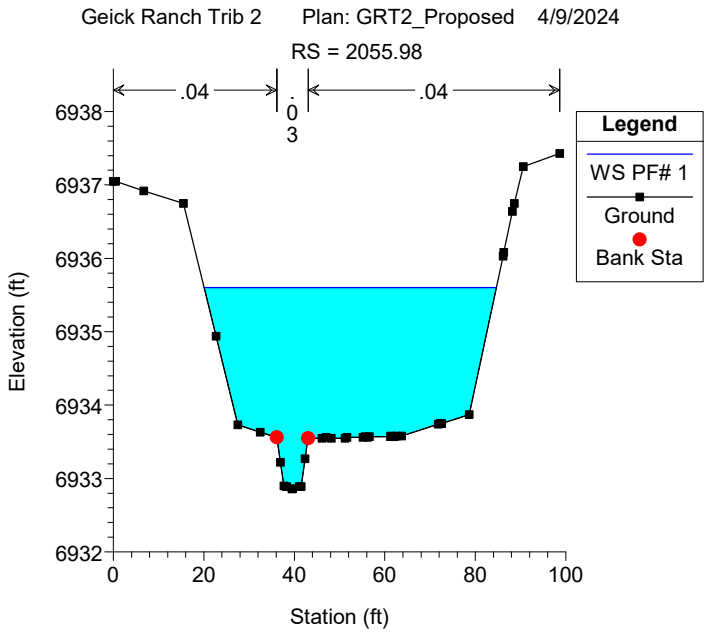


Geick Ranch Trib 2 Plan: GRT2_Proposed 4/9/2024

RS = 2238 Culv Low Water Crossing




Geick Ranch Trib 2 Plan: GRT2_Proposed 4/9/2024
RS = 2057
.04
.03
.04
Legend
WS PF# 1
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Trib 2 Plan: GRT2_Proposed 4/9/2024
RS = 2055.98
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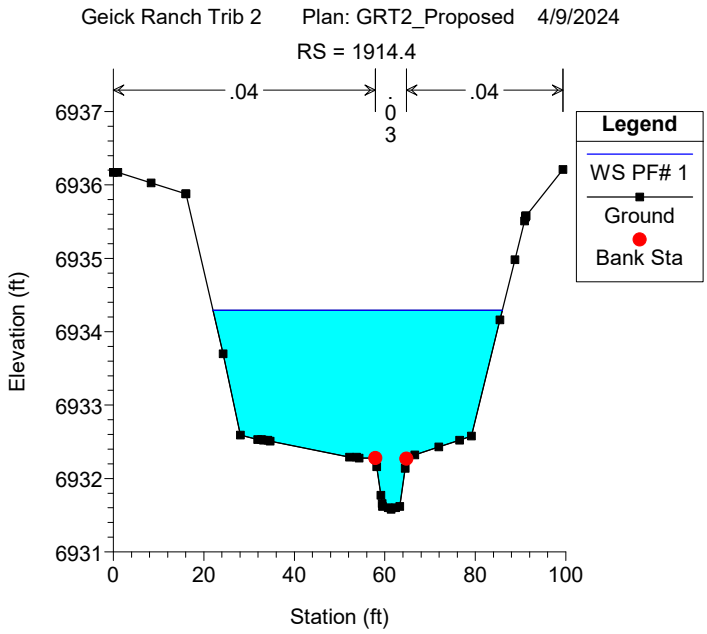
Legend
WS PF# 1
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Trib 2 Plan: GRT2_Proposed 4/9/2024
RS = 1914.4
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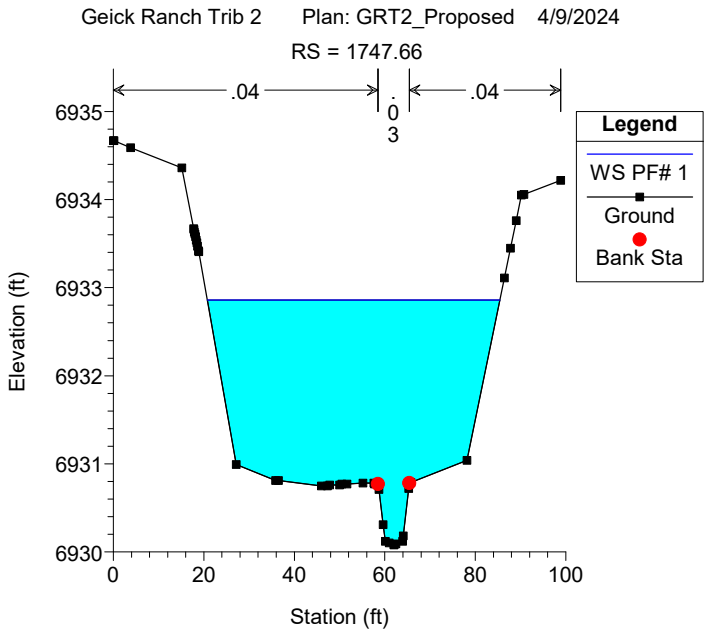
Legend
WS PF# 1
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Trib 2 Plan: GRT2_Proposed 4/9/2024
RS = 1747.66
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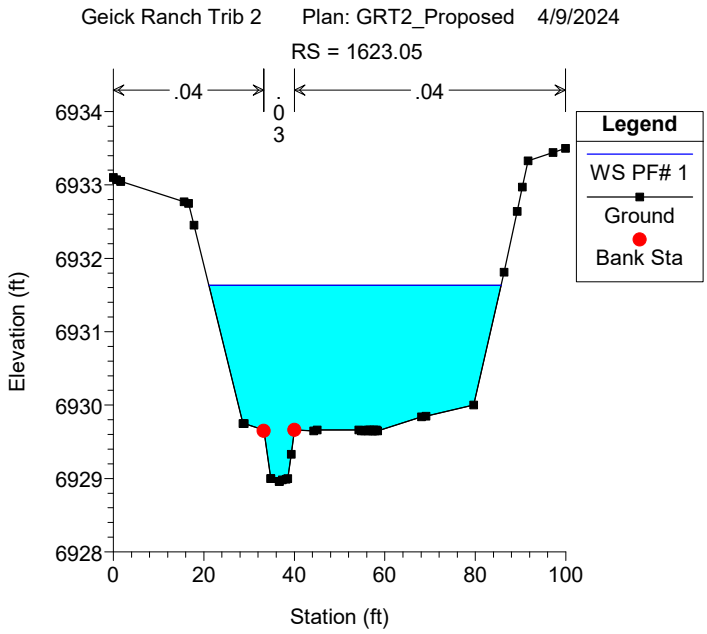
.03
.04
Legend
WS PF# 1
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Trib 2 Plan: GRT2_Proposed 4/9/2024
RS = 1623.05
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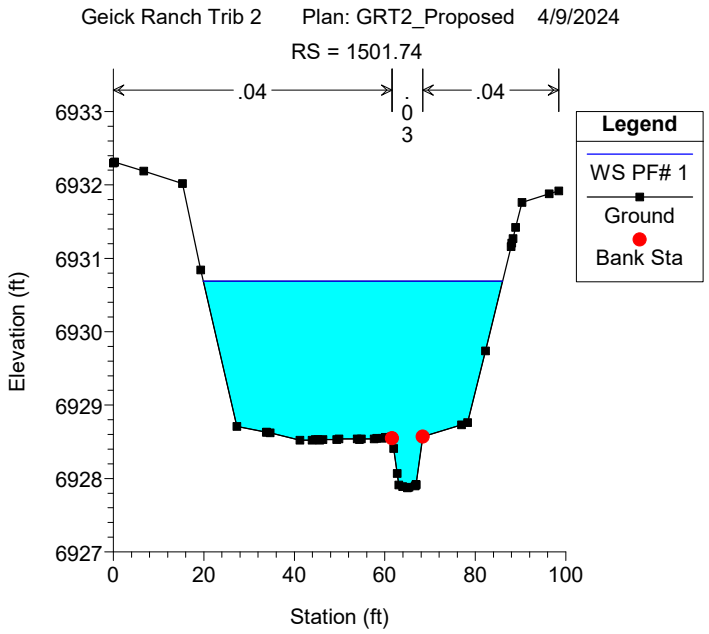
.03
.04
Legend
WS PF# 1
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Trib 2 Plan: GRT2_Proposed 4/9/2024
RS = 1501.74
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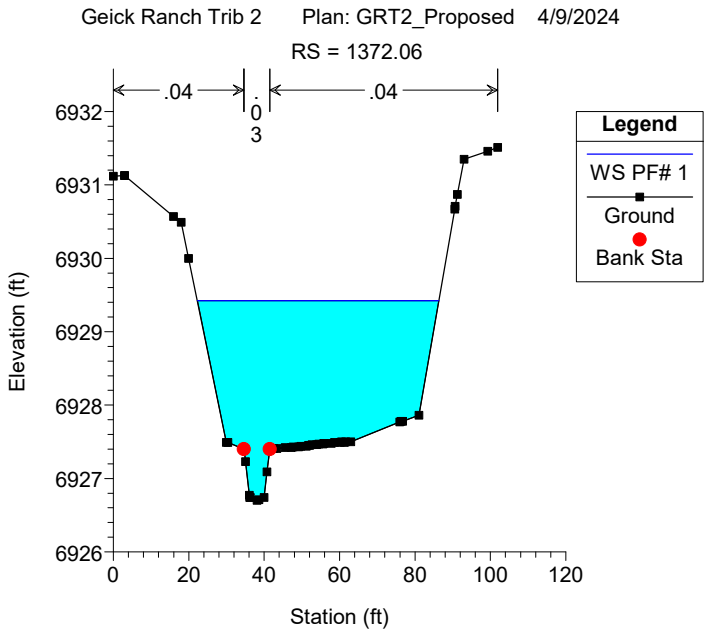
.03
.04
Legend
WS PF# 1
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Trib 2 Plan: GRT2_Proposed 4/9/2024
RS = 1372.06
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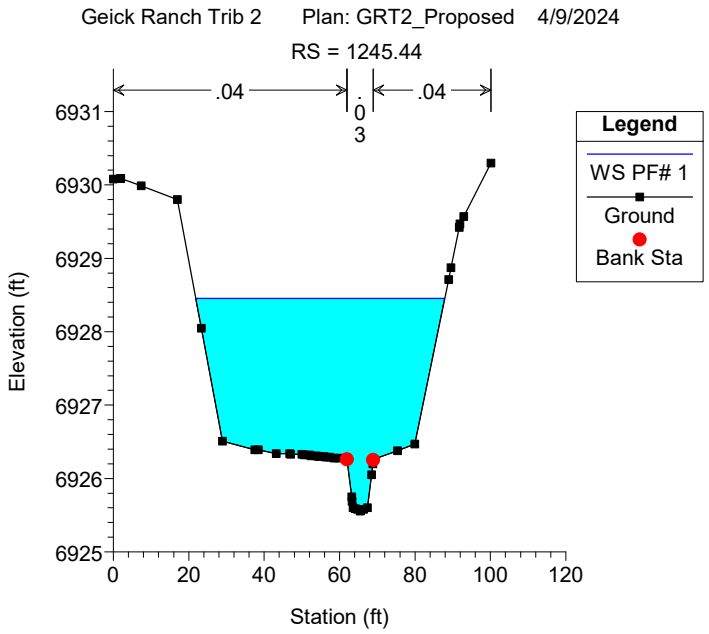
.03
.04
Legend
WS PF# 1
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Trib 2 Plan: GRT2_Proposed 4/9/2024
RS = 1245.44
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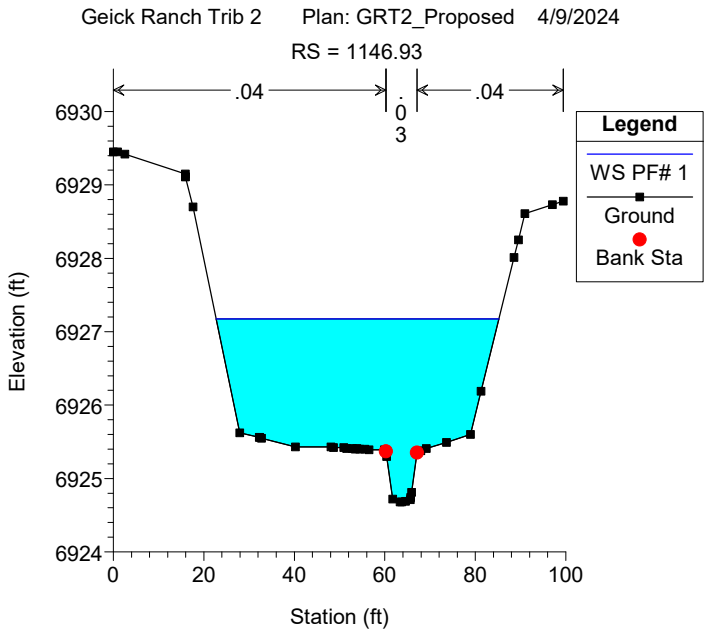
.04
Legend
WS PF# 1
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Trib 2 Plan: GRT2_Proposed 4/9/2024
RS = 1146.93
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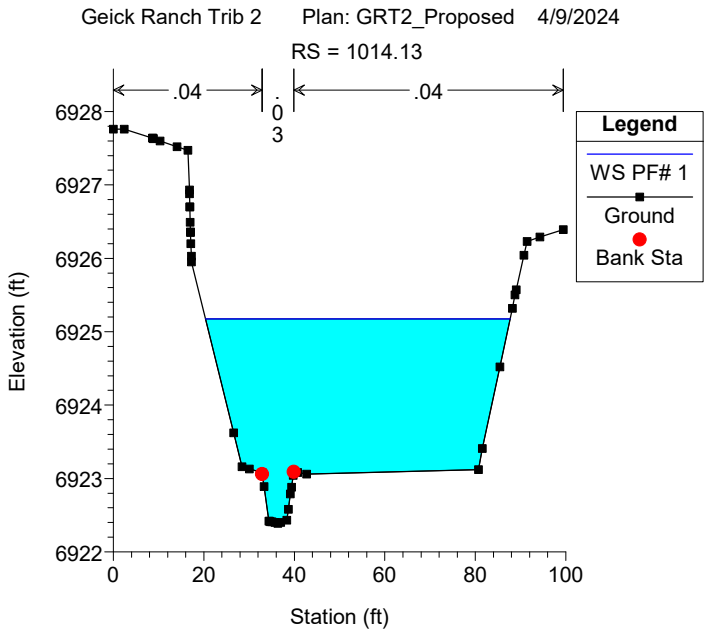
.03
.04
Legend
WS PF# 1
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Trib 2 Plan: GRT2_Proposed 4/9/2024
RS = 1014.13
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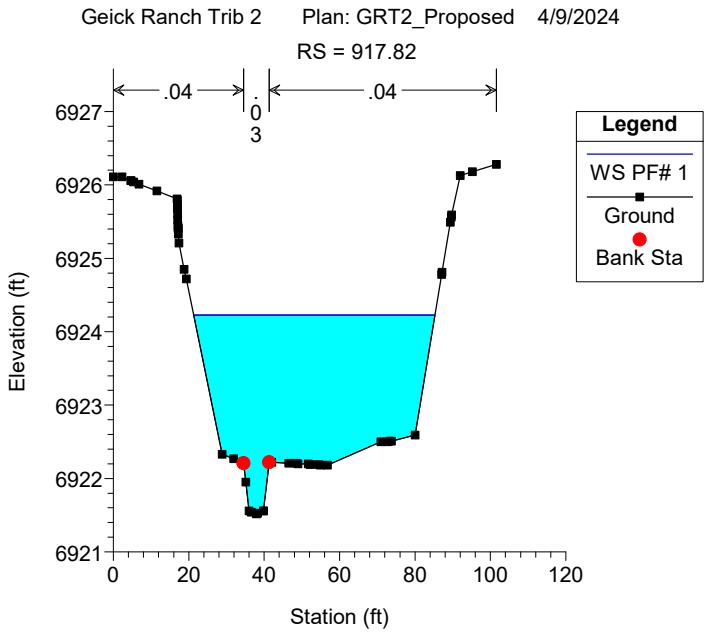
.03
.04
Legend
WS PF# 1
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Trib 2 Plan: GRT2_Proposed 4/9/2024
RS = 917.82
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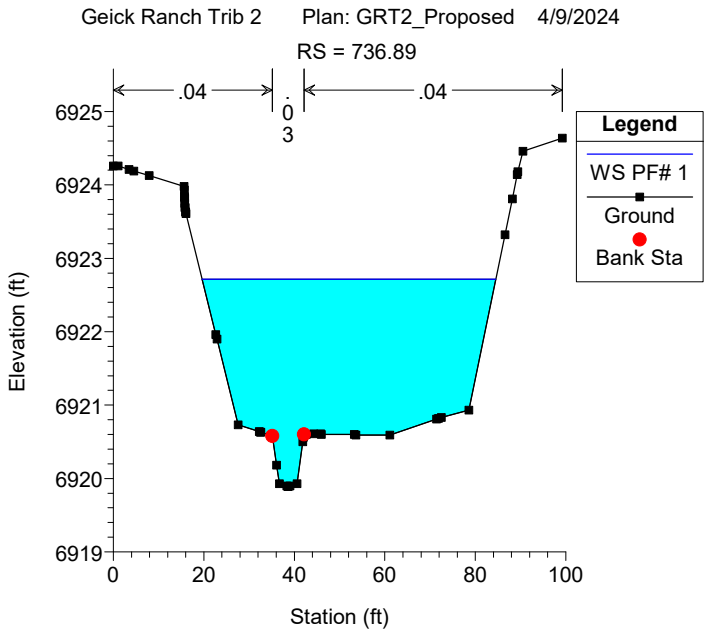
.03
.04
Legend
WS PF# 1
Ground
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Trib 2 Plan: GRT2_Proposed 4/9/2024
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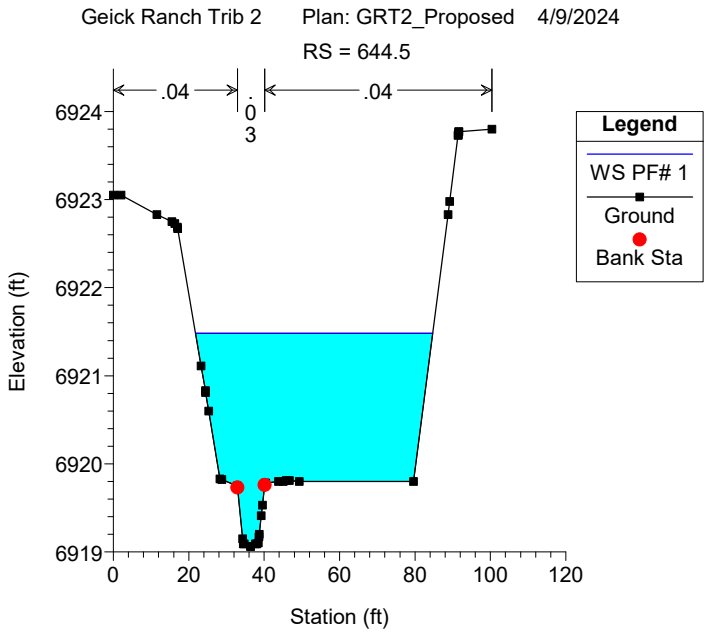
.03
.04
Legend
WS PF# 1
Ground
Bank Sta
Elevation (ft)
Station (ft)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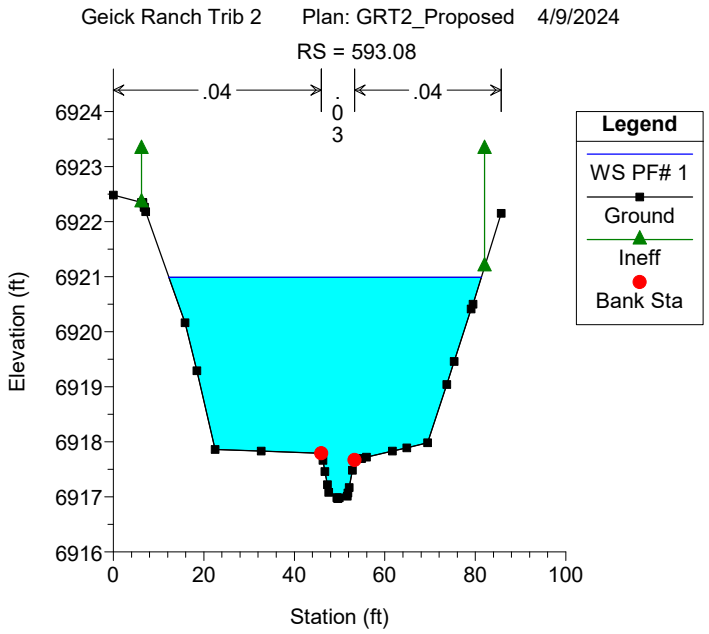
WS PF# 1
Ground
Bank Sta
Elevation (ft)
Station (ft)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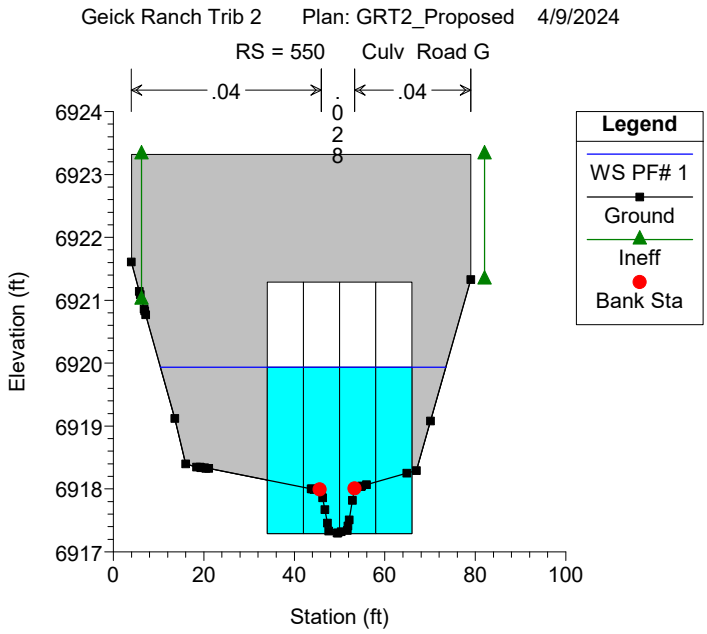
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


Geick Ranch Trib 2 Plan: GRT2_Proposed 4/9/2024
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Legend
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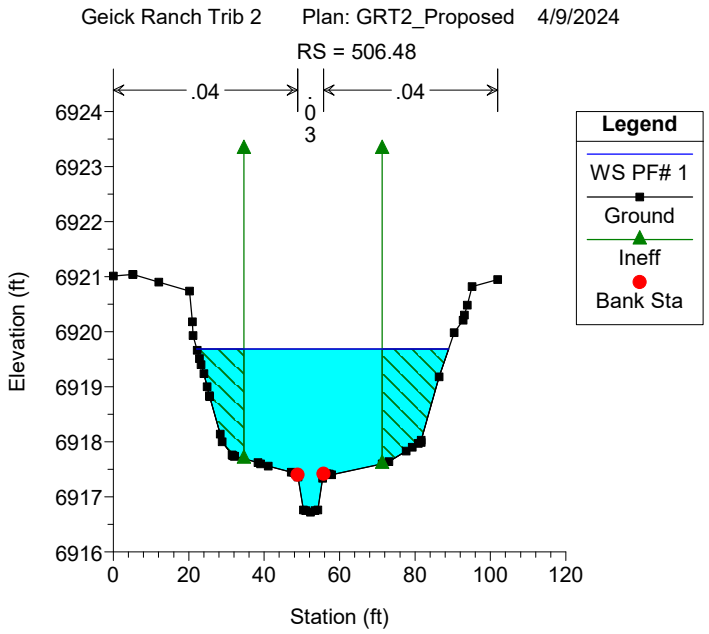
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)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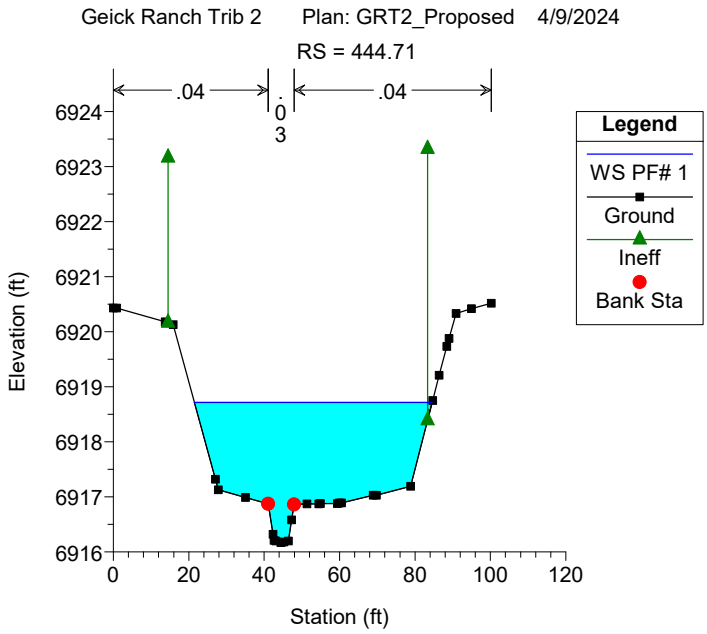
Ineff
Bank Sta
Elevation (ft)
Station (ft)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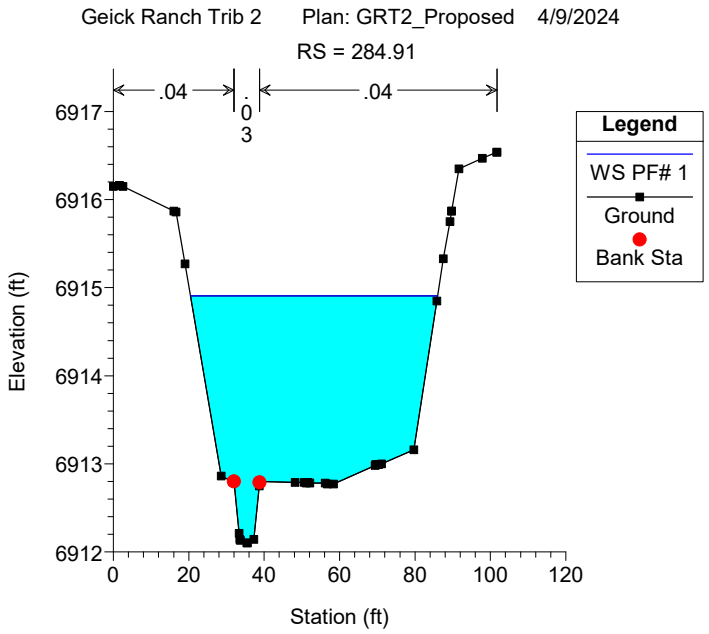
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)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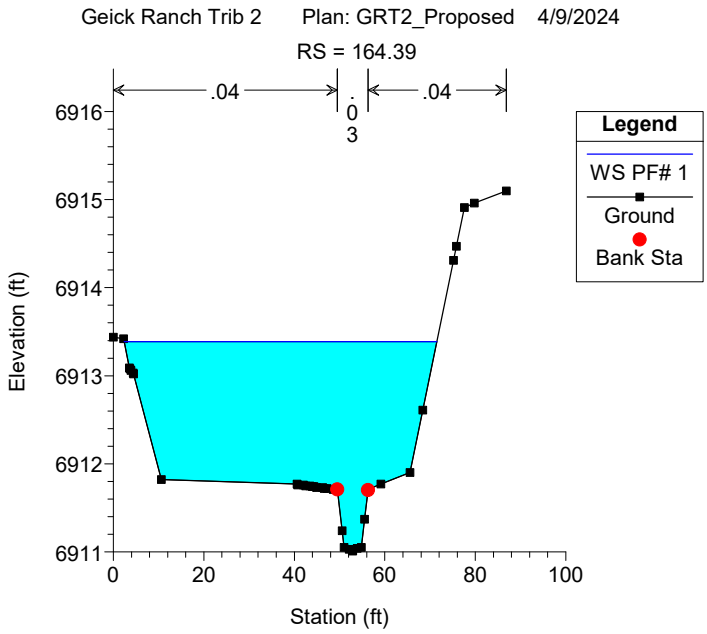
Bank Sta
Elevation (ft)
Station (ft)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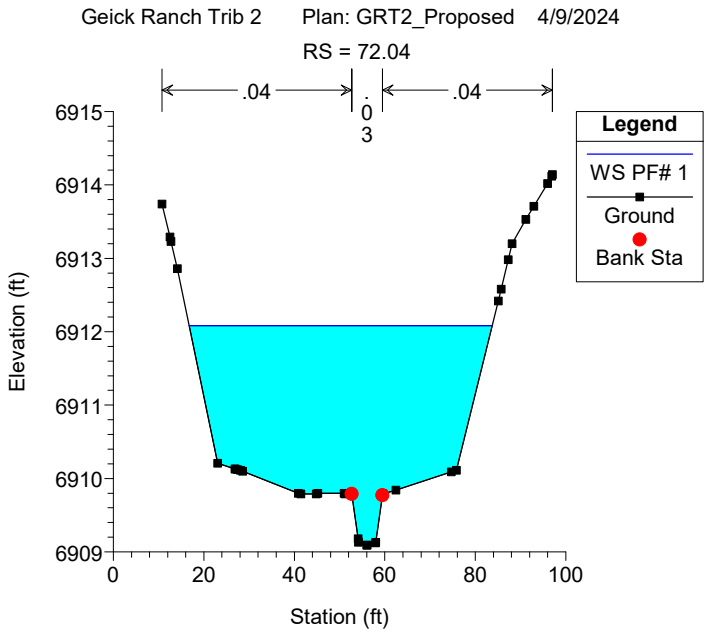
Bank Sta
Elevation (ft)
Station (ft)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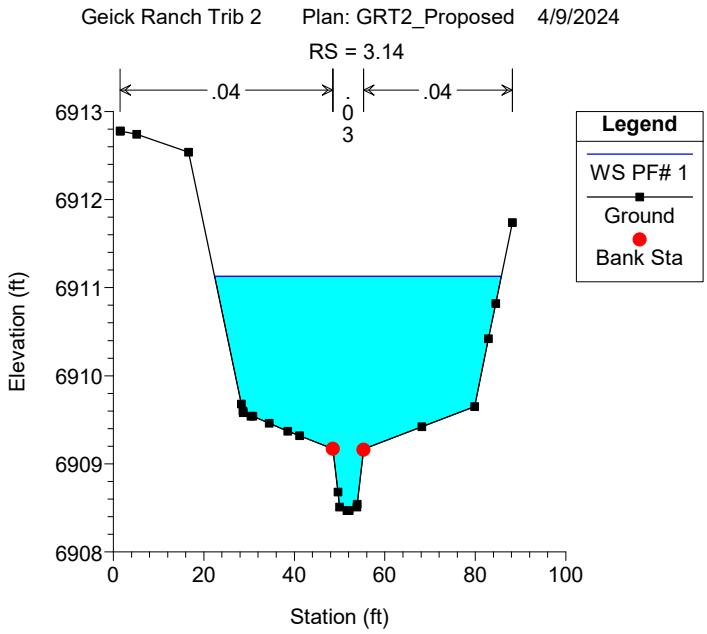
Ground
Bank Sta
Elevation (ft)
Station (ft)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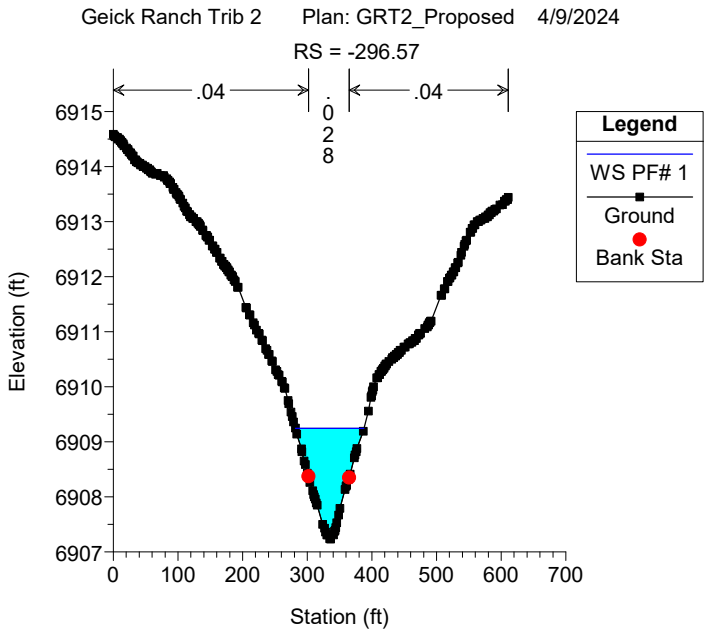
Ground
Bank Sta
Elevation (ft)
Station (ft)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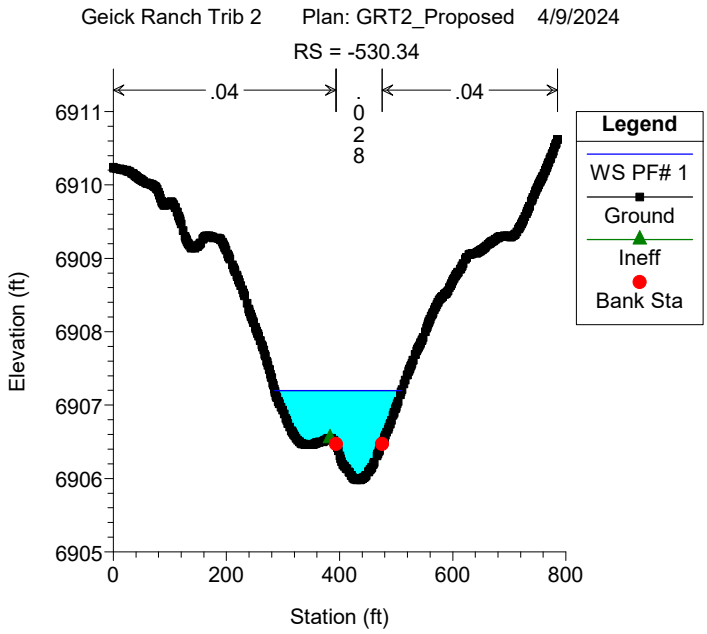
Ground
Bank Sta
Elevation (ft)
Station (ft)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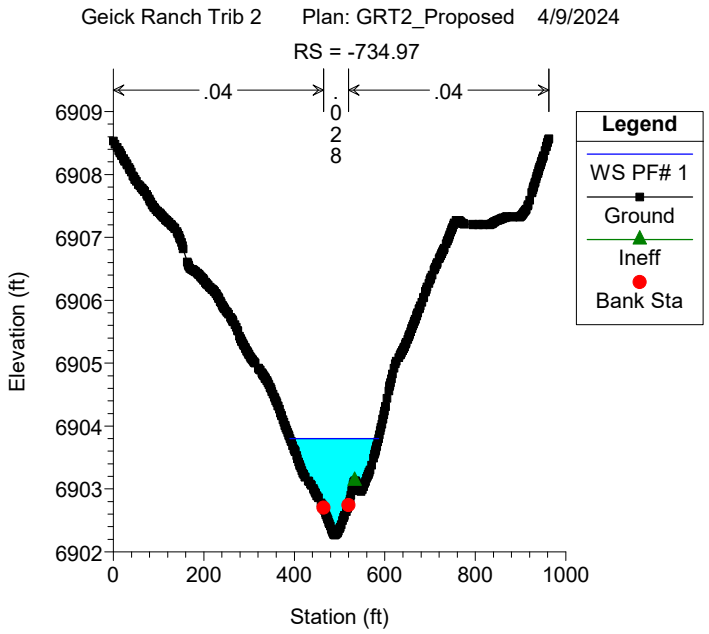
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)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.028
.04
Legend
WS PF# 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

GRANDVIEW OUTLET PROTECTION RIPRAP CALCULATIONS

$$D_{50} = 0.023D\left(\frac{Q}{\alpha D^{2.5}}\right)\left(\frac{D}{TW}\right)^{1.2} \quad \text{(D.1a)}$$

$$D_{50} = 0.014D\left(\frac{Q}{\alpha BD^{1.5}}\right)\left(\frac{D}{TW}\right) \quad \text{(D.1b)}$$

where,

- D_{50} = riprap size, m (ft)
- Q = design discharge, m^3/s (ft^3/s)
- D = culvert diameter (circular) or culvert rise (rectangular), m (ft)
- B = culvert span (rectangular), m (ft)
- TW = tailwater depth, m (ft)
- α = unit conversion constant, 1.811 (SI) and 1.0 (CU)

Provide design calculations for each culvert

Rex Rd Culvert	
Q (cfs) =	262
D (ft) =	4
B (ft) =	10
TW (ft) =	2.66
D50 (ft) =	0.276
D50 Selected	**6 in**
Apron Length (L)	**16 ft**

Dawlish Rd Culvert	
Q (cfs) =	536
D (ft) =	4
B (ft) =	32
TW (ft) =	2.1
D50 (ft) =	0.223
D50 Selected	**6 in**
Apron Length (L)	**16 ft**

Low Water Crossing	
Q (cfs) =	32.05
D (ft) =	0.7
B (ft) =	7
TW (ft) =	1.89
D50 (ft) =	0.028
D50 Selected	**6 in**
Apron Length (L)	**2.8 ft (Use 3 ft)**

Road G	
Q (cfs) =	649
D (ft) =	4
B (ft) =	32
TW (ft) =	2.28
D50 (ft) =	0.249
D50 Selected	**6 in**
Apron Length (L)	**16 ft**

Riprap Bankful Channel Calculations

Model Station	River Station	Q Total (cfs)	Max Chl Dpth (ft)	Vel Chnl (ft/s)	Froude # Chl	Invert Slope	Riprap Req.	Rock Type
8005	62+23	262	1.48	5.98	0.96	0.021	2.4	VL
7849	60+67	262	1.19	5.99	0.98	0.023	2.4	VL
7712	59+31	262	1.21	6.02	0.98	0.0226	2.4	VL
7583	58+03	262	1.21	6.05	0.98	0.0278	2.5	VL
7482	57+01	262	2.56	3.1	0.37	0.0154	1.2	VL
7395	56+29	262	3.69	1.72	0.16	0.023	0.7	VL
7160.32	53+87	536	3.17	10.44	1.07	0.0096	3.6	L
7072.44	53+31	536	2.58	7.78	0.88	0.0078	2.6	VL
6977.14	52+63	536	2.66	7.22	0.81	0.0077	2.4	VL
6850.04	51+76	536	2.15	9.25	1.16	0.0207	3.7	L
6663.5	50+34	536	2.29	9.47	1.15	0.0145	3.5	L
6464.81	49+13	536	2.25	9.46	1.16	0.0154	3.6	L
6294.46	48+06	536	2.35	9.38	1.12	0.0197	3.7	L
6192.16	47+29	536	2.2	9.31	1.15	0.0218	3.7	L
6020.29	46+16	536	2.16	9.27	1.16	0.0254	3.8	L
5853	45+16	536	2.69	7.75	0.86	0.0108	2.7	VL
5852.4	44+95	536	2.65	8.27	0.93	0.0083	2.8	VL
5730	44+00	536	2.77	7.27	0.79	0.0125	2.6	VL
5728.67	43+80	621	2.5	9.7	1.12	0.015	3.6	L
5541.86	42+51	621	2.79	7.81	0.85	0.0092	2.7	VL
5424.96	41+78	621	2.4	9.76	1.15	0.018	3.8	L
5301.31	41+07	621	2.64	8.56	0.96	0.0091	2.9	VL
5209.65	40+47	621	2.71	8.09	0.9	0.0092	2.8	VL
5078.71	39+66	621	2.67	8.72	0.97	0.0092	3.0	VL
4986.12	39+04	621	2.66	8.53	0.96	0.0091	2.9	VL
4902.38	38+56	621	2.66	8.43	0.94	0.0092	2.9	VL
4765.94	37+67	621	2.69	8.39	0.93	0.0092	2.9	VL
4678.67	37+10	621	2.34	9.65	1.16	0.018	3.7	L
4557.88	36+35	621	2.82	7.62	0.83	0.0089	2.6	VL
4476.29	35+83	621	2.43	9.91	1.16	0.0178	3.8	L
4351.82	35+05	621	2.32	9.76	1.17	0.0272	4.0	M
4291.52	34+63	621	2.6	9.97	1.13	0.0265	4.1	M
4166.12	33+82	621	2.77	9.85	1.08	0.009	3.4	L
4045.84	33+07	621	2.3	9.68	1.17	0.0158	3.7	L
3885.92	32+09	621	2.5	9.87	1.14	0.0222	4.0	M
3802.45	31+51	621	2.4	9.83	1.16	0.017	3.8	L
3676.52	30+57	621	2.28	9.68	1.18	0.0205	3.8	L
3581.26	29+94	621	2.27	9.58	1.17	0.0226	3.8	L
3500.61	29+44	621	2.34	9.8	1.17	0.0223	3.9	M
3418.19	298+89	621	2.8	7.25	0.79	0.009	2.5	VL
3335.99	28+39	621	2.42	9.87	1.16	0.0168	3.8	L

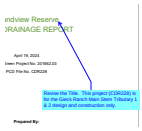
3196.98	27+43	621	2.64	8.34	0.94	0.009	2.9	VL
3069.72	26+62	621	2.81	7.86	0.85	0.009	2.7	VL
2950.47	25+88	621	2.41	9.83	1.16	0.0156	3.7	L
2782.66	24+82	621	2.63	8.67	0.98	0.0089	3.0	VL
2687.65	24+17	621	2.68	8.09	0.9	0.009	2.8	VL
2558.01	23+38	621	2.76	8.21	0.9	0.009	2.8	VL
2468.81	22+84	621	2.39	9.79	1.16	0.0208	3.9	L
2375.32	22+21	621	2.74	7.69	0.85	0.0084	2.6	VL
2258	21+69	621	2.89	7.33	0.78	0.0111	2.6	VL
2256.6	21+42	621	3.16	6.67	0.68	0.0089	2.3	VL
2213.94	21+15	621	2.81	7.49	0.81	0.0089	2.6	VL
2057	20+87	621	2.63	8.75	0.98	0.0108	3.1	VL
2055.98	20+19	621	2.74	8.16	0.9	0.009	2.8	VL
1914.4	19+22	621	2.71	8.7	0.96	0.009	3.0	VL
1747.66	17+99	649	2.78	8.3	0.91	0.009	2.9	VL
1623.05	17+21	649	2.67	8.94	1	0.009	3.1	VL
1501.74	16+43	649	2.82	7.89	0.85	0.009	2.7	VL
1372.06	15+73	649	2.72	9.02	1	0.009	3.1	VL
1245.44	14+93	649	2.89	7.96	0.85	0.0089	2.7	VL
1146.93	14+23	649	2.49	10.03	1.16	0.0172	3.8	L
1014.13	13+38	649	2.78	7.69	0.84	0.009	2.6	VL
917.82	12+62	649	2.71	8.84	0.98	0.009	3.0	VL
736.89	11+39	649	2.82	8.19	0.89	0.009	2.8	VL
644.5	10+79	649	2.42	9.9	1.16	0.0406	4.4	M
593.08	10+41	649	4.02	5.4	0.49	0.0029	1.5	VL
506.48	9+55	649	2.97	10.64	1.12	0.0089	3.6	L
444.71	9+11	649	2.55	9.8	1.12	0.0255	4.0	M
284.91	7+91	649	2.81	8.19	0.89	0.009	2.8	VL
164.39	7+23	649	2.38	9.94	1.18	0.0208	3.9	M
72.04	6+60	649	2.99	7.67	0.8	0.009	2.6	VL
3.14	6+00	649	2.66	10.06	1.12	0.0086	3.4	L

*Riprap sizing calculation based on El Paso Criteria Manual (Section 10.10.2)

Provide calculations for channel banks at bends (check for need for additional protection)

V4_Drainage Report.pdf Markup Summary

Callout (1)



Subject: Callout
Page Label: 1
Author: Bret
Date: 6/10/2024 1:27:17 PM
Status:
Color:
Layer:
Space:

Revise the Title. This project (CDR228) is for the Gieck Ranch Main Stem Tributary 1 & 2 design and construction only.

Drainage Report - County (1)

Subject: Drainage Report - County
Page Label: 2
Author: Bret
Date: 6/10/2024 1:31:15 PM
Status:
Color:
Layer:
Space:

El Paso County:

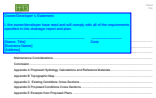
Filed in accordance with the requirements of the Drainage Criteria Manual, Volumes 1 and 2, El Paso County Engineering Criteria Manual and Land Development Code as amended.

_____

_ _____
Joshua Palmer, P.E.
Date
County Engineer / ECM Administrator

Conditions:

Drainage Report: Developer (1)



Subject: Drainage Report: Developer
Page Label: 2
Author: Bret
Date: 6/10/2024 1:32:23 PM
Status:
Color:
Layer:
Space:

Owner/Developer's Statement:

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

_____

_____
[Name, Title]
Date
[Business Name]
[Address]

Drainage Report-Engineer (1)

Subject: Drainage Report-Engineer
Page Label: 2
Author: Bret
Date: 6/10/2024 1:31:49 PM
Status:
Color:
Layer:
Space:

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 applicable master plan of the drainage basin. I accept responsibility for any liability caused by any negligent acts, errors or omissions on my part in preparing this report.

_____

_____
[Name, P.E. #_____]
Date

Engineer (1)

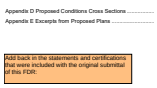
Subject: Engineer
Page Label: 2
Author: Bret
Date: 6/10/2024 1:33:45 PM
Status:
Color:
Layer:
Space:

Please include all three of these signature blocks

File Attachment (1)

Subject: File Attachment
Page Label: 2
Author: Glenn Reese - EPC Stormwater
Date: 6/10/2024 11:56:07 AM
Status:
Color:
Layer:
Space:

SW - Textbox (2)



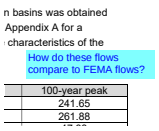
Subject: SW - Textbox
Page Label: 2
Author: Glenn Reese - EPC Stormwater
Date: 6/10/2024 11:56:07 AM
Status:
Color:
Layer:
Space:

Add back in the statements and certifications that were included with the original submittal of this FDR:

Subject: SW - Textbox
Page Label: 8
Author: Glenn Reese - EPC Stormwater
Date: 6/10/2024 11:56:49 AM
Status:
Color:
Layer:
Space:

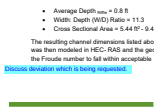
It's possible that I have not been involved with offline conversations related to our requirements for this FDR. However, if you haven't been told otherwise, please add back in the Four Step Process. It was included in your first submittal of the FDR in May 2022. Gilbert had comments on that section, none of which were asking you to remove the section from the FDR altogether. Please revise that section per his comments before copy/pasting it back into this report. Be sure to address WQ treatment exclusions.

Text Box (13)



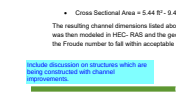
Subject: Text Box
Page Label: 5
Author: CDurham
Date: 6/10/2024 4:51:14 PM
Status:
Color:
Layer:
Space:

How do these flows compare to FEMA flows?



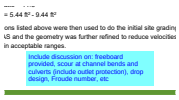
Subject: Text Box
Page Label: 8
Author: CDurham
Date: 6/10/2024 5:02:43 PM
Status:
Color:
Layer:
Space:

Discuss deviation which is being requested.



Subject: Text Box
Page Label: 8
Author: CDurham
Date: 6/10/2024 5:02:45 PM
Status:
Color:
Layer:
Space:

Include discussion on structures which are being constructed with channel improvements.



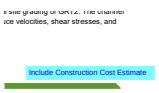
Subject: Text Box
Page Label: 8
Author: CDurham
Date: 6/10/2024 5:07:38 PM
Status:
Color:
Layer:
Space:

Include discussion on: freeboard provided, scour at channel bends and culverts (include outlet protection), drop design, Froude number, etc

---

Subject: Text Box
Page Label: 8
Author: CDurham
Date: 6/10/2024 5:07:21 PM
Status:
Color:
Layer:
Space:

Include section on maintenance of channel



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Date: 6/10/2024 5:03:52 PM
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Color:
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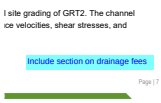
Include Construction Cost Estimate



Subject: Text Box
Page Label: 8
Author: CDurham
Date: 6/10/2024 5:03:47 PM
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Include section on drainage fees

Subject: Text Box
Page Label: 8
Author: CDurham
Date: 6/10/2024 5:03:55 PM
Status:
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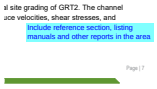
Include conclusion section



Subject: Text Box
Page Label: 8
Author: CDurham
Date: 6/10/2024 5:03:43 PM
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Include reference section, listing manuals and other reports in the area

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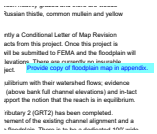

Subject: Text Box
Page Label: 4
Author: CDurham
Date: 6/10/2024 5:07:00 PM
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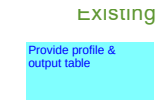
Provide copy of floodplain map in appendix.



Subject: Text Box
Page Label: 88
Author: CDurham
Date: 6/10/2024 5:10:22 PM
Status:
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Provide profile & output table

Subject: Text Box
Page Label: 95
Author: CDurham
Date: 6/10/2024 5:11:49 PM
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Color:
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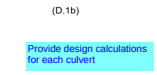
Provide profile & output table (include velocity, shear and Froude #)



Subject: Text Box
Page Label: 110
Author: CDurham
Date: 6/10/2024 5:48:14 PM
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Provide design calculations for each culvert