FINAL DRAINAGE REPORT
FOR
CANYON CREEK RANCH

October 2026

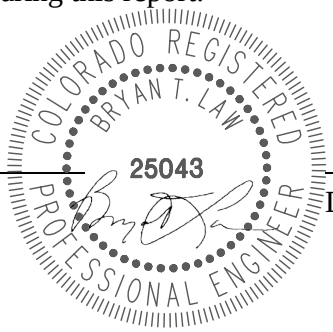
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Project No. 25322.00
PCD File No. SF2434

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 letter has been prepared according to the criteria established by El Paso County for drainage reports and said report is in conformity with the master plan of the drainage basin. I accept responsibility for any liability caused by any negligent acts, errors, or omissions on my part in preparing this report.



10/16/26

Bryan T. Law, Colorado P.E. # 25043 Date
For and On Behalf of JR Engineering, LLC

DEVELOPER'S STATEMENT:

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

By: Gregg Cawlfield

10/19/2026

Title: Owner

Address: 11550 Parallax Heights
Colorado Springs, CO 80908

EL PASO COUNTY STATEMENT:

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

El Paso County Engineer/ECM Administrator

Name Signature

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PURPOSE

This document is the Final Drainage Report for Canyon Creek Ranch. The purpose of this report is to identify on-site and off-site drainage patterns, culverts, areas tributary to the site, and to safely route developed storm water to adequate outfall facilities.

GENERAL SITE DESCRIPTION

GENERAL LOCATION

Canyon Creek Ranch (hereby referred to as the "site") is a proposed development with a total area of approximately 25 acres. The site is located in the SW ¼ of Section 14, Township 12 South, Range 66 West of the Sixth Principal Meridian in El Paso County, State of Colorado. The site is bounded by Kettle Creek to the north, Kettle Creek Subdivision to the east and unplatted large-lot single family residential parcels to the west and south. Refer to the vicinity map in Appendix A for additional information.

DESCRIPTION OF PROPERTY

A portion of existing Kettle Creek flows from east to west in the site before flowing north and leaving the site boundary. The natural drainageways are heavily vegetated with Ponderosa Pines, native bushes and grasses. Along the northern portion of Kettle Creek, there are existing eroded banks. The remaining natural drainageways appear to be reasonably stable. The average depth from the high bank along Kettle Creek to the water level varies from 30 to 45 feet. There is also an existing single-family residence with an associated driveway and utilities located on the site.

The proposed site will be developed into three large single-family lots and two no-build tracts for areas unable to be developed due to existing geographic conditions. A proposed private driveway from Creek View Lane cul-de-sac on the northeast boundary of the site will provide access to the lots that are currently undeveloped.

Soils located on the project site are Kettle gravelly loamy sand. These soils are classified as Hydrologic Soil Group B. Group B soils exhibit moderate infiltration rates when thoroughly wet, and consist mainly of moderately deep, moderately well drained to well drained soils. Refer to the soil survey map in Appendix A for additional information.

There are no known irrigation facilities located on the project site.

FLOODPLAIN STATEMENT

Based on the FEMA FIRM Map number 08041C0526G and 08041C0507G, dated December 7, 2018, the majority of the site lies within Zone X. Zone X is defined as area outside the Special Flood Hazard Area (SFHA) and higher than the elevation of the 0.2-percent-annual-chance (or 500-year) flood. The existing floodplain does cross the site as well within Zone AE. Zone AE is defined as areas within the 1% annual chance flood area that have base flood elevations determined. Refer to the FIRM Map in Appendix A for additional information. A proposed no rise certification letter is provided as a separate document for the work in the floodplain.

DRAINAGE DESIGN CRITERIA

DEVELOPMENT CRITERIA REFERENCE

Storm drainage analysis and design criteria for this project were taken from the "City of Colorado Springs/El Paso County Drainage Criteria Manual" Volumes 1 and 2 (EPCDCM), dated October 12, 1994, the "Urban Storm Drainage Criteria Manual" Volumes 1 to 3 (USDCM) and Chapter 6 and Section 3.2.1 of Chapter 13 of the "Colorado Springs Drainage Criteria Manual" (CSDCM), dated May 2014, as adopted by El Paso County.

HYDROLOGIC CRITERIA

All hydrologic data was obtained from the "El Paso Drainage Criteria Manual" Volumes 1 and 2, and the "Urban Storm Drainage Criteria Manual" Volumes 1, 2, and 3. On-site drainage improvements were designed based on the 5-year (minor) storm event and the 100-year (major) storm event. Runoff (for basins under 100 acres) was calculated using the Rational Method, and rainfall intensities for the 5-year and the 100-year storm return frequencies were obtained from Table 6-2 of the CSDCM. One-hour point rainfall data for the storm events is identified in the chart below. Runoff coefficients were determined based on proposed land use and from data in Table 6-6 from the CSDCM. Runoff (for basins greater than 100 acres) were calculated using the Colorado Unit Hydrograph Procedure (CUHP) as specified in EPCDCM Section 5.1. Time of concentrations were developed using equations from CSDCM. All runoff calculations and applicable charts and graphs are included in the Appendices.

Table 2: 1-hr Point Rainfall Data

Storm	Rainfall (in.)
5-year	1.50
100-year	2.52

HYDRAULIC CRITERIA

The Rational Method and USDCM's SF-2 and SF-3 forms were used to determine the runoff from the minor and major storms on the site. Autodesk Inc.'s Hydraflow Express Extension (Volume 10.5)

was used to size the roadside ditches and drainage swales per criteria. Per Section 6.4.1 of the EPCDCM, culverts were sized as to not overtop the road in the 100-year storm. CivilGEO Inc.'s GeoHECRAS was used to analyze the existing drainage paths that have proposed roadway crossings. See Appendix C for hydraulic calculations. The hydraulic design will be finalized with the Final Drainage Report.

EXISTING DRAINAGE CONDITIONS

MAJOR BASIN DESCRIPTIONS

Based on the map of the Drainage Basins for El Paso County, the site lies within the Kettle Creek Drainage Basin. The Kettle Creek Drainage Basin was studied in the "Drainage Basin Planning Study for Kettle Creek Basin" by JR Engineering, dated May 2015 (see Appendix D for excerpts). The Kettle Creek originates on the southern slope of Black Forest and flows in a southwesterly direction towards the City of Colorado Springs. The Black Forest area of the watershed is dominated by ponderosa pine forest and grassland on undeveloped large lot single-family residential lots. Towards Powers Boulevard, the watershed shifts to mostly undeveloped grassland. Downstream of Powers Blvd, the watershed once again shifts to single-family residences, commercial centers, and vacant land. The Kettle Creek watershed has a contributing area of approximately 16.4 square miles at the junction with I-25.

The site specifically is located near the center of the Kettle Creek Drainage Basin, within portions of Basins 16, 17 and 18 as shown in the "Drainage Basin Planning Study for Kettle Creek Basin". The specific Kettle Creek channel reach adjacent to the site is MS2213. As recommended in the Kettle Creek Basin DBPS, the design will have an approach of Minimizing Directly Connected Impervious Area (MDCIA). The entire site is composed of NRCS Type B soils which are great for permeable surfaces and landscape areas. Runoff from the impervious surfaces will flow over existing naturally vegetated areas to slow the runoff and promote infiltration before outfalling to Kettle Creek. The existing drainage patterns shall be preserved. The Kettle Creek DBPS also acknowledges that grading and grade control structures may not be feasible in Kettle Creek due to the disturbance they would cause with the presence of the Preble's jumping mouse and habitats.

There are three existing natural drainage paths that enter the site from the southeast and outfall into Kettle Creek. The natural drainage paths convey the majority of the runoff from off-site basins onto the site. The existing driveway crosses two of the existing natural drainage paths. The existing Kettle Creek flowing along the north side of the site will be protected through dedication of drainage/ floodplain easements on the plat. The proposed site development will provide a substantial "no-build" area buffer through dedication of wide floodplain easements along the existing Kettle Creek channel running through the site, with the intention of protecting the existing drainage corridor. Drainage path 1 and drainage path 3 have flows over 15 cfs and will thus be protected by a drainage easement. Property owners need to understand that Kettle Creek is an actively flowing stream subject

to potential future erosion and meandering. The wide floodplain easements dedicated in this subdivision plat are intended to provide ample setback from the drainage channel to the anticipated building areas for the residential lots. Existing vegetated buffer strips should be protected and maintained along the downstream limits of the proposed residences.

EXISTING SUB-BASIN DRAINAGE

The site was analyzed to consider off-site tributary area flowing through the site to Kettle Creek from the south. The "Drainage Basin Planning Study for Kettle Creek Basin" flow values within Kettle Creek were utilized to consider the complete off-site tributary area. The existing basin delineation for the site as shown on the map within Appendix E is as follows:

Basin OS1 is approximately 1.72 acres with a 2% impervious and is comprised of existing undeveloped land that is a portion of the Kettle Creek Subdivision. Runoff generated by this basin (Q_5=0.5 cfs, Q_{100}=3.6 cfs) flows to the basin boundary at DPO1. Flows combine at DP1.1 within Kettle Creek in Basin EXA. Located off-site to the north of Basin OS1 is Kettle Creek Junction 12 as described in the "Drainage Basin Planning Study for Kettle Creek Basin". Junction 12 flows in the existing condition are (Q_5=1,445 cfs, Q_{100}=3,218 cfs). See Appendix D for reference excerpts.

Basin OS2 is approximately 187.1 acres with a 10% impervious and is comprised of developed 5-acre single-family lots and several natural swales tributary to natural drainage path 1. Runoff generated by this basin (Q_5=41 cfs, Q_{100}=176 cfs) flows within the existing drainage path 1 and flow to the existing 48" CMP located on-site at DPO2. Flows combine at DP1.1 within Kettle Creek in Basin EXA.

Basin OS3 is approximately 0.24 acres with a 2% impervious and is comprised of existing undeveloped land that is a portion of the Kettle Creek Subdivision. Runoff generated by this basin (Q_5=0.1 cfs, Q_{100}=0.7 cfs) flows to the basin boundary at DPO3. Flows combine at DP1.1 within Kettle Creek in Basin EXA.

Basin EXA is approximately 4.39 acres with a 6% impervious and is comprised of an existing gravel driveway and a portion of the Kettle Creek drainageway. Runoff generated by this basin (Q_5=2.2 cfs, Q_{100}=11.9 cfs) flows to the existing Kettle Creek at DP1. Flows from DPO1-O3 and DP1 combine at DP1.1 (Q_5=52.5 cfs, Q_{100}=194.5 cfs) and continue flowing west within the existing Kettle Creek drainageway into Basin EXC.

Basin OS4 is approximately 2.13 acres with a 2% impervious and is comprised of existing undeveloped land that is a portion of the Kettle Creek Subdivision. Runoff generated by this basin (Q_5=0.7 cfs, Q_{100}=5.0 cfs) flows to the basin boundary at DPO4. Flows combine at DP2.1 within Basin EXB.

Basin EXB is approximately 3.63 acres with a 2% impervious and is comprised of a natural drainage path 2 and undeveloped land. Runoff generated by this basin (Q_5=1.3 cfs, Q_{100}=8.4 cfs) flows to the existing natural drainage path 2 at DP2. Flows from DPO4 and DP2 combine at DP2.1 (Q_5=2.0 cfs, Q_{100}=12.5 cfs) and enter into the existing triple 24" RCP. The DP2.1 flows continue to DP2.2 within Basin EXC.

Basin OS5 is approximately 163.7 acres with a 10% impervious and is comprised of developed 5-acre single-family lots and several natural swales tributary to natural drainage path 3. Runoff generated by this basin (Q_5=42 cfs, Q_{100}=178 cfs) flows within the existing drainage path 3 and flow to basin boundary at DPO2. Flows combine at DP3.1 within Kettle Creek in Basin EXC.

Basin EXC is approximately 9.38 acres with a 5% impervious and is comprised of an existing gravel driveway, a single-family residence, natural swales and a natural drainageway. Runoff generated by this basin (Q_5=4.0 cfs, Q_{100}=23.2 cfs) flows to the existing natural drainage path 3 at DP3. Flows from DP2.2, DPO5 and DP3 combine at DP3.1 (Q_5=100.0 cfs, Q_{100}=351.8 cfs) and continue flowing west within the existing Kettle Creek drainageway into Basin EXD. Located near DP3.1 is Kettle Creek Junction 13 as described in the "Drainage Basin Planning Study for Kettle Creek Basin". Junction 13 flows in the existing condition are (Q_5=1,475 cfs, Q_{100}=3,283 cfs). See Appendix D for reference excerpts.

Basin OS6 is approximately 5.80 acres with a 2% impervious and is comprised of existing undeveloped and unplatted land to the west. Runoff generated by this basin (Q_5=1.9 cfs, Q_{100}=12.3 cfs) flows to the basin boundary at DPO6. Flows combine at DP4.1 within Basin EXD.

Basin EXD is approximately 3.97 acres with a 2% impervious and is comprised of natural swales and a natural drainageway. Runoff generated by this basin (Q_5=1.4 cfs, Q_{100}=9.5 cfs) flows to the existing natural drainageway at DP4. Flows from DP3.1, DPO6 and DP4 combine at DP4.1 (Q_5=101.6 cfs, Q_{100}=359.9 cfs) and continue flowing west within the existing Kettle Creek drainageway off-site to the north and combine with flows at DP5.1.

Basin OS7 is approximately 1.04 acres with a 2% impervious and is comprised of existing undeveloped and unplatted land to the west. Runoff generated by this basin (Q_5=0.4 cfs, Q_{100}=2.8 cfs) flows to the basin boundary at DPO7. Flows combine at DP5.1 within Basin EXE.

Basin OS8 is approximately 0.18 acres with a 2% impervious and is comprised of existing undeveloped and unplatted land to the west. Runoff generated by this basin (Q_5=0.1 cfs, Q_{100}=0.5 cfs) flows to the basin boundary at DPO8. Flows combine at DP5.1 within Basin EXE.

Basin EXE is approximately 3.08 acres with a 2% impervious and is comprised of natural swales and a natural drainage path. Runoff generated by this basin (Q_5=1.1 cfs, Q_{100}=7.3 cfs) flows to the existing natural drainageway at DP5. Flows from DP4.1, DPO7 and DP5 combine at DP5.1

(Q_5=102.2 cfs, Q_{100}=363.5 cfs) and continue flowing west within the existing Kettle Creek drainageway off-site to the west. Located off-site to the northwest of Basin EXE is Kettle Creek Junction 14 as described in the "Drainage Basin Planning Study for Kettle Creek Basin". Junction 14 flows in the existing condition are (Q_5=1,473 cfs, Q_{100}=3,281 cfs). See Appendix D for reference excerpts.

Basin EXF is approximately 0.24 acres with a 2% impervious and is comprised of undeveloped land. Runoff generated by this basin (Q_5=0.1 cfs, Q_{100}=0.5 cfs) flows to the basin boundary at DP6. The DP6 flows continue flowing west off-site to the adjacent property. Eventually the runoff from this basin will flow to the existing Kettle Creek drainageway off-site to the west. Located off-site to the northwest of Basin EXF is Kettle Creek Junction 14 as described in the "Drainage Basin Planning Study for Kettle Creek Basin". Junction 14 flows in the existing condition are (Q_5=1,473 cfs, Q_{100}=3,281 cfs). See Appendix D for reference excerpts.

PROPOSED DRAINAGE CONDITIONS

PROPOSED DRAINAGE CONVEYANCE

In general, developed flows will follow the historic path flowing overland and to existing natural swales and drainage paths which convey water along the historic path to Kettle Creek. In addition to the swales, the existing culverts will direct flow to Kettle Creek along the historic path. Hydraulic culverts calculations are provided to ensure flows don't overtop the roadways with flows from a 100-year storm event. Detailed drainage path calculations, sections, and culvert calculations are located in Appendix C.

PROPOSED SUB-BASIN DRAINAGE

The site was analyzed to consider off-site tributary area flowing through the site to Kettle Creek from the south. The "Drainage Basin Planning Study for Kettle Creek Basin" flow values within Kettle Creek were utilized to consider the complete off-site tributary area. The proposed basin delineation for the site as shown on the map within Appendix E is as follows:

Basin OS1 is approximately 1.72 acres with a 2% impervious and is comprised of existing undeveloped land that is a portion of the Kettle Creek Subdivision. Runoff generated by this basin (Q_5=0.5 cfs, Q_{100}=3.6 cfs) flows to the basin boundary at DPO1. Flows combine at DP1.1 within Kettle Creek in Basin A. Located off-site to the north of Basin OS1 is Kettle Creek Junction 12 as described in the "Drainage Basin Planning Study for Kettle Creek Basin". Junction 12 flows in the existing condition are (Q_5=1,445 cfs, Q_{100}=3,218 cfs). See Appendix D for reference excerpts.

Basin OS2 is approximately 187.1 acres with a 10% impervious and is comprised of developed 5-acre single-family lots and several natural swales tributary to natural drainage path 1. Runoff generated by this basin (Q_5=41 cfs, Q_{100}=176 cfs) flows within the existing drainage path 1 and flow

to the existing 48" CMP located on-site at DPO2. Flows combine at DP1.1 within Kettle Creek in Basin A.

Basin OS3 is approximately 0.24 acres with a 2% impervious and is comprised of existing undeveloped land that is a portion of the Kettle Creek Subdivision. Runoff generated by this basin (Q_5=0.1 cfs, Q_{100}=0.7 cfs) flows to the basin boundary at DPO3. Flows combine at DP1.1 within Kettle Creek in Basin A.

Basin A is approximately 4.39 acres with a 12% impervious and is comprised of a portion of a proposed single-family residence, proposed gravel driveways and a portion of Kettle Creek drainageway. The size and location of the single-family residence is approximated using an approximate building envelope on the site. Runoff generated by this basin (Q_5=3.0 cfs, Q_{100}=12.9 cfs) flows to the existing Kettle Creel at DP1. Flows from DPO1-O3 and DP1 combine at DP1.1 (Q_5=53.4 cfs, Q_{100}=195.4 cfs) and continue flowing west within the existing Kettle Creek drainageway into Basin C.

Basin OS4 is approximately 2.13 acres with a 2% impervious and is comprised of existing undeveloped land that is a portion of the Kettle Creek Subdivision. Runoff generated by this basin (Q_5=0.7 cfs, Q_{100}=5.0 cfs) flows to the basin boundary at DPO4. Flows combine at DP2.1 within Basin B.

Basin B is approximately 3.63 acres with a 3% impervious and is comprised of a natural swale, undeveloped land and a portion of the proposed single-family residence. The size and location of the single-family residence is approximated using the proposed building envelope on the site. Runoff generated by this basin (Q_5=1.3 cfs, Q_{100}=8.5 cfs) flows to the existing natural swale at DP2. Flows from DPO4 and DP2 combine at DP2.1 (Q_5=2.1 cfs, Q_{100}=12.6 cfs) and enter into the existing triple 24" RCP. The DP2.1 flows continue to DP2.2 within Basin C.

Basin OS5 is approximately 163.7 acres with a 10% impervious and is comprised of developed 5-acre single-family lots and several natural swales tributary to natural drainage path 3. Runoff generated by this basin (Q_5=42 cfs, Q_{100}=178 cfs) flows within the existing drainage path 3 and flow to basin boundary at DPO2. Flows combine at DP3.1 within Kettle Creek in Basin C.

Basin C is approximately 9.38 acres with a 10% impervious and is comprised of proposed gravel driveways, a proposed fire turnaround, proposed fire cistern, an existing single-family residence, a proposed single-family residence, natural swales and a portion of the Kettle Creek drainageway. The size and location of the single-family residence is approximated using an approximate building envelope on the site. Runoff generated by this basin (Q_5=5.4 cfs, Q_{100}=25.0 cfs) flows to the existing natural swale at DP3. Flows from DPO5 and DP3 combine at DP3.1 (Q_5=51.6 cfs, Q_{100}=193.4 cfs) and then flow to DP3.2. Flows from DP2.2 and DP3.1 combine at DP3.2 (Q_5=101.6 cfs, Q_{100}=353.2 cfs) and continue flowing west within the existing Kettle Creek drainageway into Basin D. Located

near DP3.1 is Kettle Creek Junction 13 as described in the "Drainage Basin Planning Study for Kettle Creek Basin". Junction 13 flows in the existing condition are (Q_5=1,475 cfs, Q_{100}=3,283 cfs). See Appendix D for reference excerpts.

Basin OS6 is approximately 5.80 acres with a 2% impervious and is comprised of existing undeveloped and unplatted land to the west. Runoff generated by this basin (Q_5=1.9 cfs, Q_{100}=12.3 cfs) flows to the basin boundary at DPO6. Flows combine at DP4.1 within Basin D.

Basin D is approximately 3.97 acres with a 2% impervious and is comprised of natural swales and a natural drainageway. Runoff generated by this basin (Q_5=1.4 cfs, Q_{100}=9.5 cfs) flows to the existing natural drainageway at DP4. Flows from DP3.1, DPO6 and DP4 combine at DP4.1 (Q_5=103.1 cfs, Q_{100}=361.3 cfs) and continue flowing west within the existing Kettle Creek drainageway off-site to the north and combine with flows at DP5.1.

Basin OS7 is approximately 1.04 acres with a 2% impervious and is comprised of existing undeveloped and unplatted land to the west. Runoff generated by this basin (Q_5=0.4 cfs, Q_{100}=2.8 cfs) flows to the basin boundary at DPO7. Flows combine at DP5.1 within Basin E.

Basin OS8 is approximately 0.18 acres with a 2% impervious and is comprised of existing undeveloped and unplatted land to the west. Runoff generated by this basin (Q_5=0.1 cfs, Q_{100}=0.5 cfs) flows to the basin boundary at DPO8. Flows combine at DP5.1 within Basin E.

Basin E is approximately 3.08 acres with a 2% impervious and is comprised of natural swales and a natural drainageway. Runoff generated by this basin (Q_5=1.1 cfs, Q_{100}=7.3 cfs) flows to the existing natural drainageway at DP5. Flows from DP4.1, DPO7 and DP5 combine at DP5.1 (Q_5=103.8 cfs, Q_{100}=364.9 cfs) and continue flowing west within the existing Kettle Creek drainageway off-site to the west. Located off-site to the northwest of Basin E is Kettle Creek Junction 14 as described in the "Drainage Basin Planning Study for Kettle Creek Basin". Junction 14 flows in the existing condition are (Q_5=1,473 cfs, Q_{100}=3,281 cfs). See Appendix D for reference excerpts.

Basin F is approximately 0.24 acres with a 2% impervious and is comprised of undeveloped land. Runoff generated by this basin (Q_5=0.1 cfs, Q_{100}=0.5 cfs) flows to the basin boundary at DP6. The DP6 flows continue flowing west off-site to the adjacent property. Eventually the runoff from this basin will flow to the existing Kettle Creek drainageway off-site to the west. Located off-site to the northwest of Basin F is Kettle Creek Junction 14 as described in the "Drainage Basin Planning Study for Kettle Creek Basin". Junction 14 flows in the existing condition are (Q_5=1,473 cfs, Q_{100}=3,281 cfs). See Appendix D for reference excerpts.

COMPARISON OF FLOWS

There are several locations where the existing and proposed flows enter Kettle Creek from the site:

- Flows enter into Kettle Creek at existing DP1.1 and proposed DP1.1. Existing DP1.1 flows (Q_5=52.5 cfs, Q_{100}=194.5 cfs) are slightly less compared to the proposed DP1.1 flows (Q_5=53.4 cfs, Q_{100}=195.4 cfs). The calculated flow increase is Q_5=0.9 cfs and Q_{100}=0.9 cfs.

- Flows enter into Kettle Creek at existing DP2.2 and proposed DP2.2. Existing DP2.2 flows (Q_5=53.4 cfs, Q_{100}=199.6 cfs) are slightly less compared to the proposed DP2.2 flows (Q_5=54.3 cfs, Q_{100}=200.5 cfs). The calculated flow increase is Q_5=0.9 cfs and Q_{100}=0.9 cfs.

- Flows enter into Kettle Creek at existing DP3.1 and proposed DP3.2. Existing DP3.1 flows (Q_5=100.0 cfs, Q_{100}=351.8 cfs) are slightly less compared to the proposed DP3.2 flows (Q_5=101.6 cfs, Q_{100}=353.2 cfs). The calculated flow increase is Q_5=1.6 cfs and Q_{100}=1.4 cfs.

- Flows enter into Kettle Creek at existing DP4.1 and proposed DP4.1. Existing DP4.1 flows (Q_5=101.6 cfs, Q_{100}=359.9 cfs) are slightly less compared to the proposed DP4.1 flows (Q_5=103.1 cfs, Q_{100}=361.3 cfs). The calculated flow increase is Q_5=1.5 cfs and Q_{100}=1.4 cfs.

- Flows enter into Kettle Creek at existing DP5.1 and proposed DP5.1. Existing DP5.1 flows (Q_5=102.2 cfs, Q_{100}=363.5 cfs) are slightly less compared to the proposed DP5.1 flows (Q_5=103.8 cfs, Q_{100}=364.9 cfs). The calculated flow increase is Q_5=1.6 cfs and Q_{100}=1.4 cfs.

The flow increases in the proposed condition are slight and would not modify the existing drainage patterns. As shown in the Kettle Creek existing and proposed site outfall calculations, the increase in flow does not have any impact to the existing drainageway. Therefore, there is no negative impact anticipated to downstream properties.

The time to peak flows within the studied Kettle Creek DBPS are about 270 minutes for both the minor and major storms, whereas the time to peak flows from the site are 50 minutes and 62.4 minutes for the minor and major storms, respectively. The additional peak flows from the site development would not increase the peak flow within the Kettle Creek drainageway because the times to peak are hours apart. Therefore, the site outfall into Kettle Creek is stable enough to handle the slight increase in flows. See Appendix C for hydraulic calculations.

DRAINAGE PATH ANALYSIS AND DESIGN

There are several large drainage paths that traverse the site from south to north. Existing drainage path 1 leads to the existing 48” CMP culvert crossing the proposed driveway. Existing drainage path 2 leads to the existing triple 24” CMP culvert crossing the proposed driveway. Existing drainage path 3 travels through the middle of the site and then joins Kettle Creek. On September 30, 2024, a site

visit documented the existing state of the drainage paths as well as the Kettle Creek drainageway. See Appendix D for an exhibit showing the existing images.

The three drainage paths and two culvert crossings were analyzed to determine the channel stability. In conformance with the "Drainage Basin Planning Study for Kettle Creek Basin" by JR Engineering, Manning's roughness coefficient of 0.100 was used when analyzing the channel bottom and 0.030 on the sides which have less vegetation cover. The modeled results of the drainage path 1, 2 and 3 can be found in Appendix C. See Table 1 below for channel design parameters.

Table 1: Channel Design Parameters

Design Parameter	Erosive Soils or Poor Vegetation	Erosive Resistant Soils and Vegetation
Max Low-flow Velocity (ft/s)	3.5	5.0
Max 100-year Velocity (ft/s)	5.0	7.0
Froude Number Low Flow	0.5	0.7
Froude Number 100-year Flow	0.6	0.9

For drainage path 1, the GeoHECRAS model determined that the existing channel has stable average velocities, with isolated instances of high velocities, ranging from 0.2 fps to 6.2 fps. Velocities are allowable based on the max stable velocity of 7 fps for erosion resistant channels, per Table 8-1 from USDCM. In the evaluated drainage path 1 model, there are no instances where the Froude number exceeds the El Paso County maximum of 0.90. To limit the grading impacts to the existing Kettle Creek and drainage paths, a wall is proposed at the culvert crossing. Due to the anticipated flows, the headwater to depth ratio (Hw/D) exceeds the allowable limit on the existing 48" RCP culvert. To remedy this, the proposed riprap shall be increased around and above the culvert to the proposed wall. The existing 48" RCP culvert entrance and exit will also be protected with Type VL buried soil riprap as determined by the calculations in Appendix C.

For drainage path 2, the GeoHECRAS model determined that the existing channel has stable average velocities, with isolated instances of high velocities, ranging from 0.6 fps to 4.8 fps. Velocities are allowable based on the max stable velocity of 7 fps for erosion resistant channels, per Table 8-1 from USDCM. In the evaluated drainage path 2 model, there are four instances where the Froude number exceeds the El Paso County maximum of 0.90. One instance is located off-site at the southeast corner of the property and cannot be mitigated by this owner. Two other instances are located at the southeast corner of the property where the drainage path comes onto the property. This drainage path is defined by sandstone on the deep channel banks which limits the erosive potential. The final instance is located about mid-way through drainage path 2. As shown in the site visit exhibit, this drainage path 2 has sandstone located on the deep channel banks, which limits the erosion potential. To limit the grading impacts to the existing Kettle Creek and drainage paths, a wall is proposed at the culvert crossing. The existing triple 48" RCP culvert entrance and exit will be protected with Type VL buried soil riprap as determined by the calculations in Appendix C.

For drainage path 3, the GeoHECRAS model determined that the existing channel has stable average velocities, ranging from 0.1 fps to 6.0 fps. Velocities are allowable based on the max stable velocity of 7 fps for erosion resistant channels, per Table 8-1 from USDCM. In the evaluated drainage path 3 model, there are no instances where the Froude number exceeds the El Paso County maximum of 0.90.

EXISTING KETTLE CREEK DRAINAGEWAY ANALYSIS

As discussed previously, there are several locations where the Kettle Creek drainageway encroaches onto the site. On September 30, 2024, a site visit documented the existing state of the Kettle Creek drainageway, as shown in Appendix D. Per the images, the Kettle Creek drainageway on-site is heavily vegetated with Ponderosa Pines, native bushes and grasses. Along the northern portion of Kettle Creek, there are existing eroded banks. The remaining natural drainageways appear to be reasonably stable. The average depth from the high bank along Kettle Creek to the water level varies from 30 to 45 feet.

To analyze the existing Kettle Creek, representative sections were taken for the lowest slope to evaluate the capacity of the drainageway and the highest slopes to evaluate the velocity of the drainageway. Kettle Creek sections were analyzed for Basin A, C, D and E using the existing modeled flows for the reaches from the Kettle Creek DBPS. As shown in the calculations within Appendix C, the Kettle Creek drainageway has allowable velocities based on the max stable velocity of 7 fps for erosion resistant channels, per Table 8-1 from USDCM. Per the analysis, the existing Kettle Creek drainageway that is located on-site is stable with the modeled peak existing flows. Therefore, there is no need to provide any improvements. Additionally, the Kettle Creek DBPS acknowledges that grading and grade control structures may not be feasible in Kettle Creek due to the disturbance they would cause with the presence of the Preble's jumping mouse and habitats. The proposed site development will provide a substantial "no-build" area buffer through dedication of wide floodplain easements along the existing Kettle Creek channel running through the site, with the intention of protecting the existing drainage corridor as well as any Preble's jumping mouse and habitats. Those no-build areas will be proposed 50 feet from the floodplain, and 14 feet from the top of the channels for the ravines. This is in conformance with the "Soils and Geology Study: Canyon Creek Ranch" by RMG.

The existing driveway encroaches the 100-year floodplain in several locations. The proposed improvement to the driveway will also be in the 100-year floodplain at those same locations. A proposed no rise certification letter is provided as a separate document for the work in the floodplain.

DRAINAGE FACILITY DESIGN

GENERAL CONCEPT

The proposed stormwater conveyance system was designed to follow the historic drainage paths and thus minimize the possibility of adverse effects downstream. Due to this, there are no drainage problems anticipated downstream of the site.

SPECIFIC DETAILS

Four Step Process to Minimize Adverse Impacts of Urbanization

In accordance with the El Paso County Drainage Criteria Manual Volume 2, this site has implemented the four-step process to minimize adverse impacts of urbanization. The four-step process includes reducing runoff volumes, treating the water quality capture volume (WQCV), stabilizing drainage ways, and implementing long-term source controls.

Step 1: Reducing Runoff Volumes - The site development consists of minimal gravel drive aisles to provide access for the single-family residences within the development. This layout will allow for increased infiltration and reduce runoff volume as the amount of development is limited.

Step 2: Treat the WQCV - The 2.5-acre (minimum) residential houses on Lot 1-3 will be limited to a maximum of 10% imperviousness to meet the requirements of Section I.7.1.B.5 of the ECM Stormwater Quality Policy and Procedure for water quality through a plat note. Should Lot 1-3 exceed 10% imperviousness, a lot specific drainage report addressing the increased imperviousness must be submitted.

Step 3: Stabilize Drainageways – The site lies within the Kettle Creek Drainage. The drainage fees for Kettle Creek are identified in the tables within the Drainage and Bridge Fees section below. All existing natural drainage paths and the Kettle Creek drainageway will remain as is. The vegetation for each drainage path included medium height prairie grasses and small ponderosa pine trees. The site does not significantly affect the discharge directly into the open drainageway of Kettle Creek; therefore, no downstream stabilization will be required with this project.

Step 4: Implementing Long Term Source Controls - A site specific stormwater quality and erosion control plan and narrative shall be prepared in conjunction with the final drainage report. Site specific temporary source control BMPs will be detailed in that plan and narrative to protect receiving waters.

Water Quality

As previously stated, the applicable exclusions for Basins A-D located within Lot 1-3 fall under Section I.7.1.B.5 of the ECM Stormwater Quality Policy and Procedure for areas with large single-family lots (2.5-acre min.). In addition, Basins E-F fall under the Section I.7.1.B.7 of the ECM Stormwater Quality Policy and Procedure for sites with land disturbance to undeveloped land that

will remain undeveloped. See Table 3 below for the water quality treatment summary table indicating which basins are treated and which are excluded.

Table 3: Water Quality Treatment Summary Table

PBMP Summary Table		
Basins	Tributary Area (acres)	PBMP
A-D	21.37	EXCLUDED*
E-F	3.32	EXCLUDED**
*EXCLUDED BASED ON LARGE LOT SINGLE FAMILY SITES PER ECM APP. I.7.B.5 **EXCLUDED BASED ON LAND DISTURBANCE TO UNDEVELOPED LAND THAT WILL REMAIN UNDVELOPED PER ECM APP. I.7.B.7		

Erosion Control Plan

We respectfully request that the Final Erosion Control Plan and associated Cost Estimate to be submitted in conjunction with the construction drawings and plat prior to obtaining a grading permit.

Operation & Maintenance

In order to ensure the function and effectiveness of the stormwater infrastructure, maintenance activities such as; inspection, routine maintenance, restorative maintenance, rehabilitation, and repair are required. All proposed drainage structures within easements (drainageway culverts and drainageway improvements) will be owned and maintained by the property owner unless another party accepts such responsibility in writing and responsibility is properly assigned through legal documentation. Inspection access for El Paso County will be provided through a maintenance easement.

Drainage and Bridge Fees

The site lies within the Kettle Creek Drainage Basin. See Table 4 and 5 for the calculated fees per impervious acre:

Table 4: Kettle Creek Impervious Acres

Caynon Creek Ranch - Impervious Area Calculation			
Breakdown	Area (acres)	% Impervious	Impervious Acres
Lot 1-3	19.1732	10%	1.92
Tracts A & B (Open Space)	5.4593	2%	0.11
Total	24.6325		2.03
Total w/o Tracts*	19.1732		**1.92**
*Drainage fees are not paid for tracts, therefore the area excludes Tract A&B			

Table 5: Kettle Creek Drainage Basin fees.

2026 Drainage and Bridge Fee – Canyon Creek Ranch				
Impervious Acres (ac.)	Kettle Creek Drainage Fee (Per Imp. Acre)	Kettle Creek Bridge Fee (Per Imp. Acre)	Canyon Creek Ranch Drainage Fee	Canyon Creek Ranch Bridge Fee
1.92	$14,733	$0	$28,247.88	$0.00

Construction Cost Opinion

A construction cost opinion for the drainage infrastructure has been provided below. The below cost opinion is only an estimate of facility and drainage infrastructure cost and may vary.

Table 6: Construction cost opinion.

Canyon Creek Ranch (Private Non-Reimbursable)					
Item	Description	Quantity	Unit	Unit Price	Cost
1	Rip Rap, (D_{50} - 6" to 24")	198	Tons	$ 102	$ 20,196.00
				Sub-Total	$ 20,196.00

SUMMARY

The proposed Canyon Creek Ranch drainage improvements were designed to meet or exceed the El Paso County Drainage Criteria. The proposed development will not adversely affect the off-site drainageways or surrounding developments. This report is in conformance and meets the latest El Paso County Storm Drainage Criteria requirements for this site.

REFERENCES

1. Engineering Criteria Manual, El Paso County, October 14, 2020.

2. City of Colorado Springs Drainage Criteria Manual: Volume 1, City of Colorado Springs, CO, May 2014.

3. Urban Storm Drainage Criteria Manual: Volume 1, 2 and 3, Urban Drainage and Flood Control District, Latest Revisions.

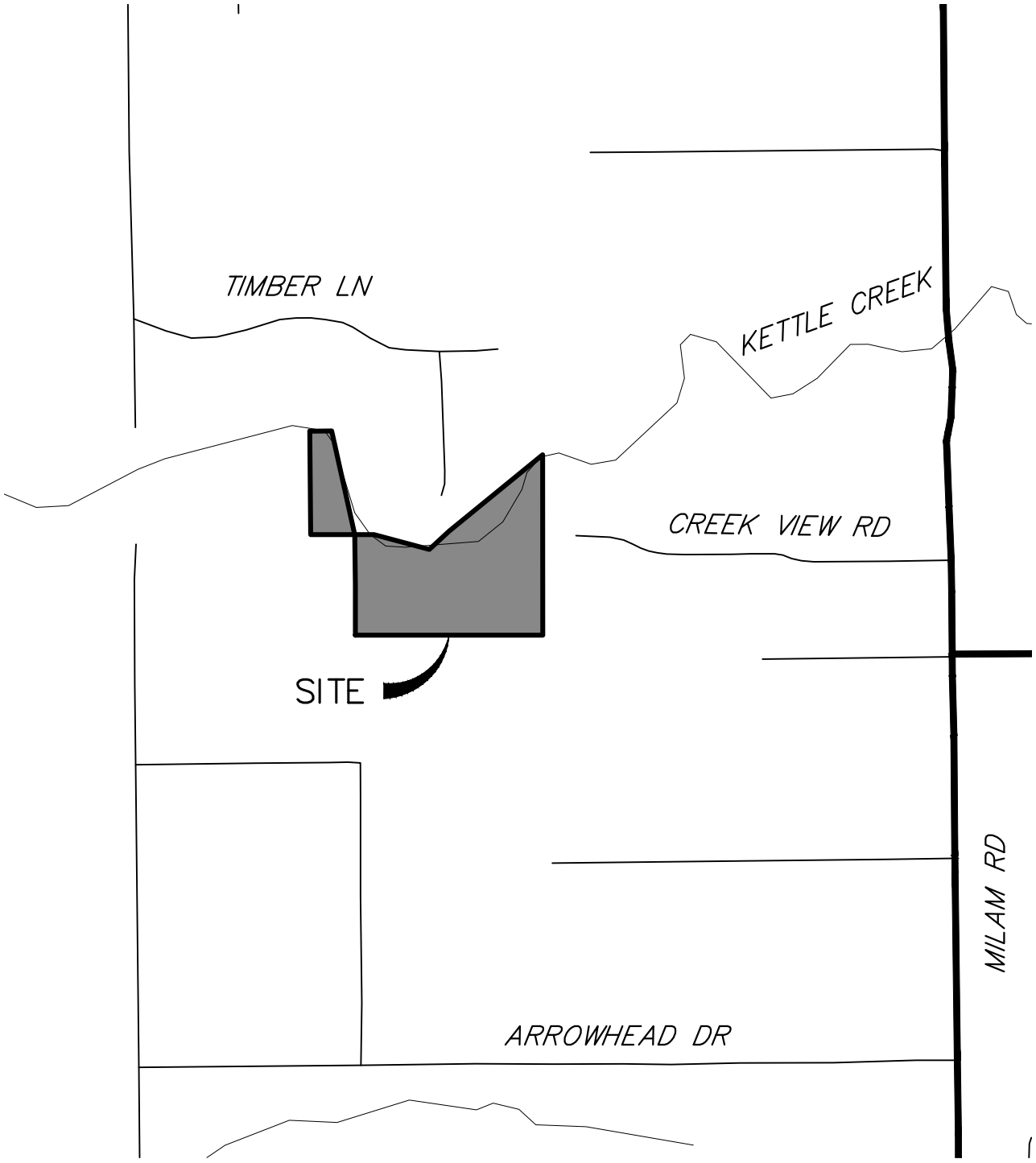
4. "Soil Survey of El Paso County Area, Colorado," by the USDA Natural Resources Conservation Service.

5. Drainage Basin Planning Study for Kettle Creek Basin, prepared by JR Engineering LLC and dated May 5, 2015.

6. Existing On-Site Drainage and Kettle Creek, prepared by JR Engineering LLC and dated September 30, 2024.

7. Soils and Geology Study: Canyon Creek Ranch, prepared by Rocky Mountain Group and revised January 9, 2025

Appendix A
Vicinity Map, Soil Descriptions, FEMA Floodplain Map



1000 500 0 1000

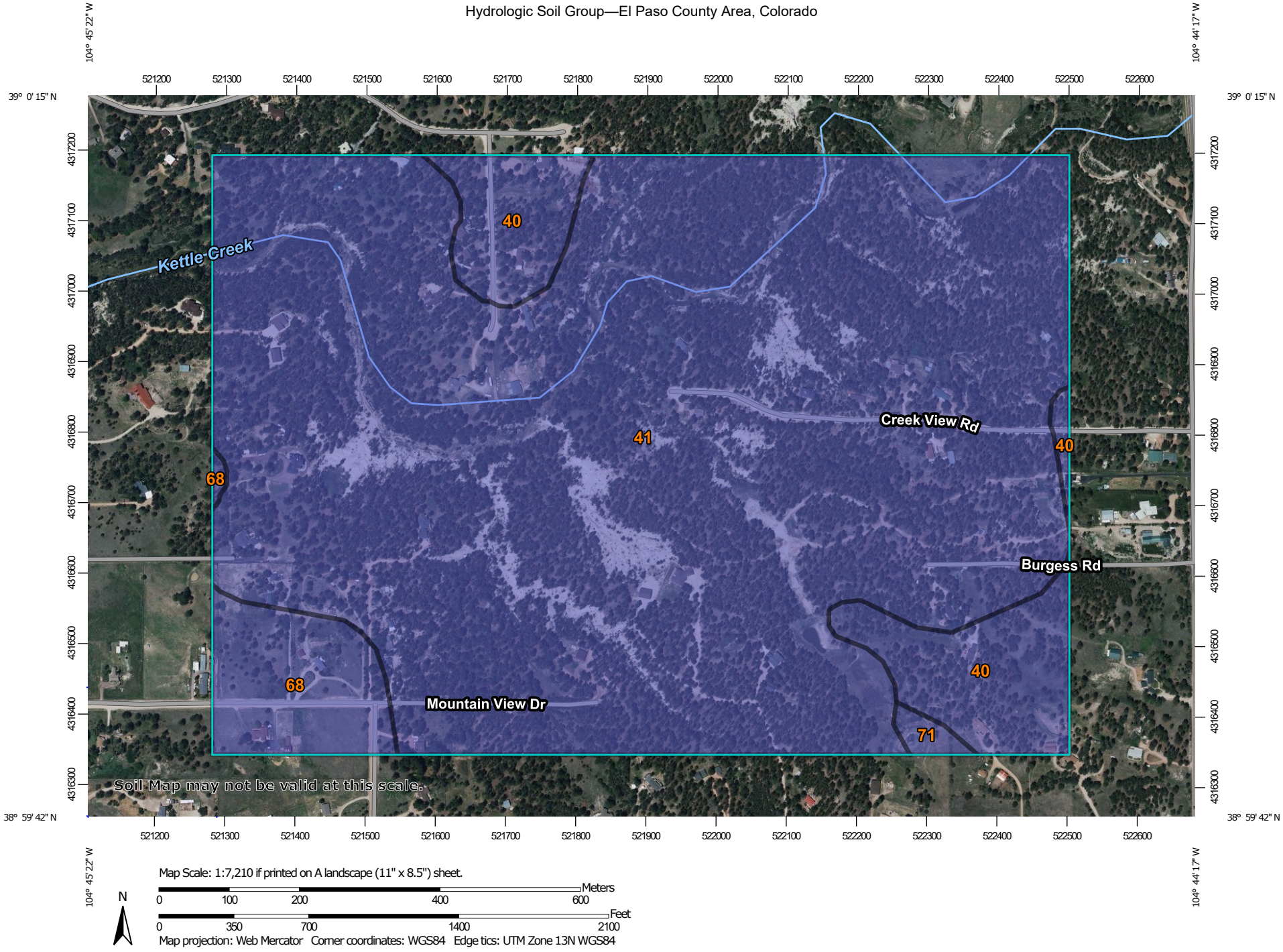
ORIGINAL SCALE: 1" = 1000'

CANYON CREEK DEVELOPMENT
VICINITY MAP
2000-5322.00
09-26-2024
SHEET 1 OF 1

J·R ENGINEERING
A Westrian Company

Centennial 303-740-9393 • Colorado Springs 719-593-2593
Fort Collins 970-491-9888 • www.jrengineering.com

X:\2530000.all\2532200\Drawings\Blocks\2532200 Vic Map.dwg, 9/26/2024 9:52:01 AM, DWG to PDF (JR).pc3



Map Scale: 1:7,210 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 100 200 400 600

Feet: 0 350 700 1400 2100

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 Rating Polygons

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Lines

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Points

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

- Aerial Photography

MAP INFORMATION

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

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

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

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

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

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

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

Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 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: Jun 9, 2021—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.

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
40	Kettle gravelly loamy sand, 3 to 8 percent slopes	B	21.9	8.5%
41	Kettle gravelly loamy sand, 8 to 40 percent slopes	B	222.0	86.1%
68	Peyton-Pring complex, 3 to 8 percent slopes	B	12.7	4.9%
71	Pring coarse sandy loam, 3 to 8 percent slopes	B	1.2	0.5%
Totals for Area of Interest			**257.7**	**100.0%**

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

NOTES TO USERS

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

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

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

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

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

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

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

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

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

Base Map information shown on this FIRM was provided in digital format by El Paso County, Colorado Springs Utilities, City of Fountain, Bureau of Land Management, National Oceanic and Atmospheric Administration, United States Geological Survey, and Anderson Consulting Engineers, Inc. These data are current as of 2006.

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

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

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

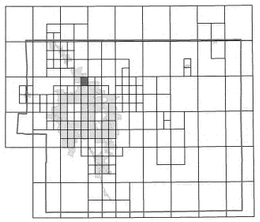
Contact **FEMA Map Service Center** (MSC) via the FEMA Map Information eXchange (FMIX) 1-877-336-2627 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this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

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

El Paso County Vertical Datum Offset Table

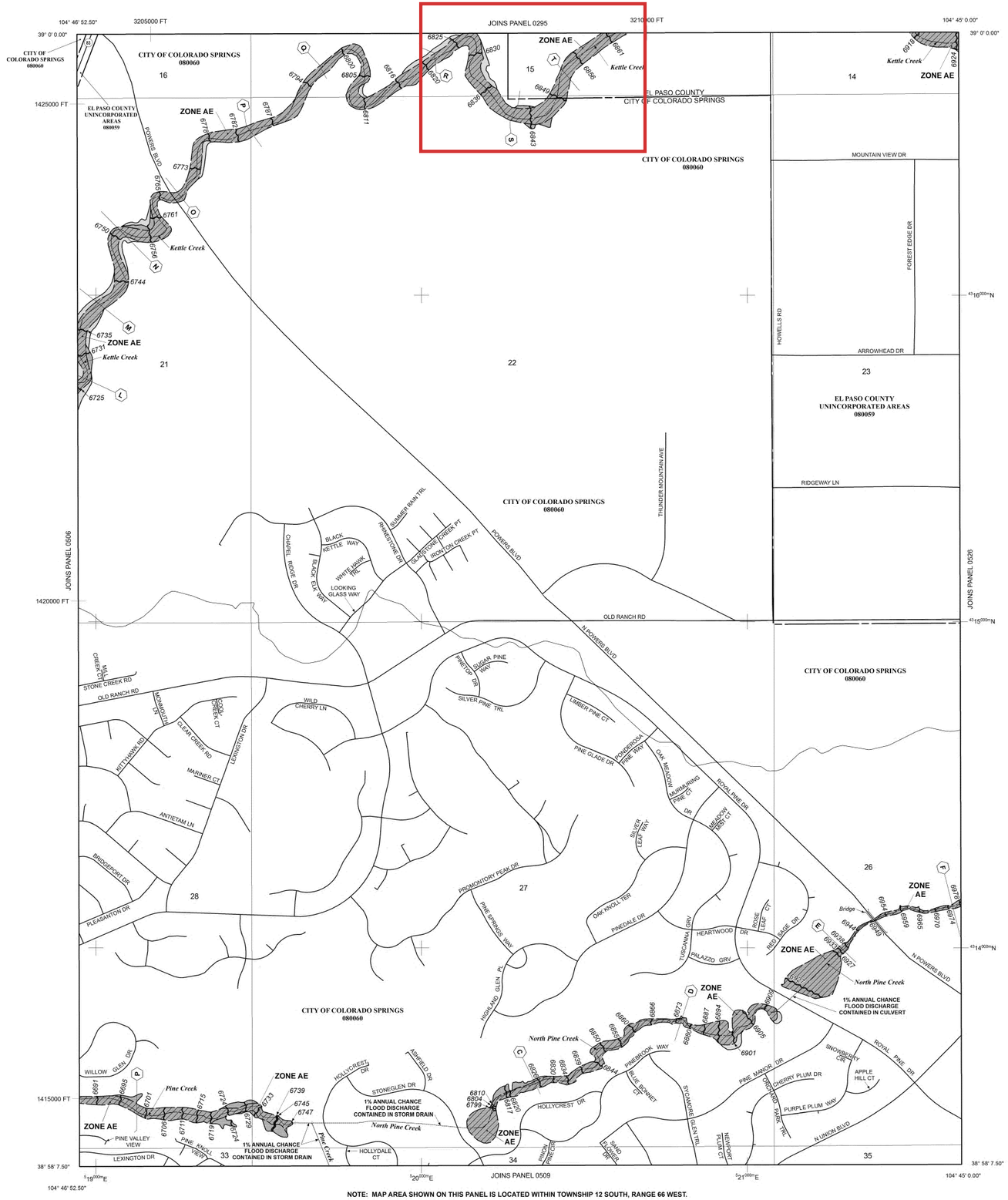
Flooding Source	Vertical Datum Offset (ft)
REFER TO SECTION 3.3 OF THE EL PASO COUNTY FLOOD INSURANCE STUDY FOR STREAM BY STREAM VERTICAL DATUM CONVERSION INFORMATION	

Panel Location Map



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

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



NOTE: MAP AREA SHOWN ON THIS PANEL IS LOCATED WITHIN TOWNSHIP 12 SOUTH, RANGE 66 WEST.

LEGEND

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

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

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

FLOODWAY AREAS IN ZONE AE

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

OTHER FLOOD AREAS

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

OTHER AREAS

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

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

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

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

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

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

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

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

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

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

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

MAP SCALE 1" = 500'

250 0 500 1000 FEET
150 0 150 300 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0507G

FIRM

FLOOD INSURANCE RATE MAP

EL PASO COUNTY, COLORADO AND INCORPORATED AREAS

PANEL 507 OF 1300

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
COLORADO SPRINGS, CITY OF	080060	0507	G
EL PASO COUNTY	080059	0507	G

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

MAP NUMBER
08041C0507G

MAP REVISED
DECEMBER 7, 2018

Federal Emergency Management Agency

Appendix B
Hydrologic Calculations

PRE-DEVELOPMENT COMPOSITE % IMPERVIOUS & COMPOSITE RUNOFF COEFFICIENT CALCULATIONS

Subdivision: Canyon Creek Ranch
Location: El Paso County

Project Name: Canyon Creek Ranch
Project No.: 25322.00
Calculated By: GAG
Checked By:
Date: 10/8/24

Basin ID	Total Area (ac)	Rural 5-Acre Lots (10% Impervious)				Roofs (90% Impervious)				Streets-Gravel (80% Impervious)				Historical Analysis (2% Impervious)				Basins Total Weighted C Values		Basins Total Weighted % Imp.
		C_5	C_{100}	Area (ac)	Weighted % Imp.	C_5	C_{100}	Area (ac)	Weighted % Imp.	C_5	C_{100}	Area (ac)	Weighted % Imp.	C_5	C_{100}	Area (ac)	Weighted % Imp.	C_5	C_{100}	
EXA	4.39	0.16	0.41	0.00	0.0%	0.73	0.81	0.00	0.0%	0.59	0.70	0.22	4.0%	0.09	0.36	4.17	1.9%	0.12	0.38	5.9%
EXB	3.63	0.16	0.41	0.00	0.0%	0.73	0.81	0.00	0.0%	0.59	0.70	0.00	0.0%	0.09	0.36	3.63	2.0%	0.09	0.36	2.0%
EXC	9.38	0.16	0.41	0.00	0.0%	0.73	0.81	0.10	1.0%	0.59	0.70	0.19	1.6%	0.09	0.36	9.09	1.9%	0.11	0.37	4.5%
EXD	3.97	0.16	0.41	0.00	0.0%	0.73	0.81	0.00	0.0%	0.59	0.70	0.00	0.0%	0.09	0.36	3.97	2.0%	0.09	0.36	2.0%
EXE	3.08	0.16	0.41	0.00	0.0%	0.73	0.81	0.00	0.0%	0.59	0.70	0.00	0.0%	0.09	0.36	3.08	2.0%	0.09	0.36	2.0%
EXF	0.24	0.16	0.41	0.00	0.0%	0.73	0.81	0.00	0.0%	0.59	0.70	0.00	0.0%	0.09	0.36	0.24	2.0%	0.09	0.36	2.0%
OS1	1.72	0.16	0.41	0.00	0.0%	0.73	0.81	0.00	0.0%	0.59	0.70	0.00	0.0%	0.09	0.36	1.72	2.0%	0.09	0.36	2.0%
OS2	187.1	0.16	0.41	187.1	10.0%	0.73	0.81	0.00	0.0%	0.59	0.70	0.00	0.0%	0.09	0.36	0.00	0.0%	0.16	0.41	10.0%
OS3	0.24	0.16	0.41	0.00	0.0%	0.73	0.81	0.00	0.0%	0.59	0.70	0.00	0.0%	0.09	0.36	0.24	2.0%	0.09	0.36	2.0%
OS4	2.13	0.16	0.41	0.00	0.0%	0.73	0.81	0.00	0.0%	0.59	0.70	0.00	0.0%	0.09	0.36	2.13	2.0%	0.09	0.36	2.0%
OS5	163.7	0.16	0.41	163.7	10.0%	0.73	0.81	0.00	0.0%	0.59	0.70	0.00	0.0%	0.09	0.36	0.00	0.0%	0.16	0.41	10.0%
OS6	5.80	0.16	0.41	0.00	0.0%	0.73	0.81	0.01	0.2%	0.59	0.70	0.00	0.0%	0.09	0.36	5.79	2.0%	0.09	0.36	2.2%
OS7	1.04	0.16	0.41	0.00	0.0%	0.73	0.81	0.00	0.0%	0.59	0.70	0.00	0.0%	0.09	0.36	1.04	2.0%	0.09	0.36	2.0%
OS8	0.18	0.16	0.41	0.00	0.0%	0.73	0.81	0.00	0.0%	0.59	0.70	0.00	0.0%	0.09	0.36	0.18	2.0%	0.09	0.36	2.0%
TOTAL ON-SITE	24.69																			3.7%
TOTAL OFF-SITE	360.2																			9.8%

PRE-DEVELOPMENT
STANDARD FORM SF-2
TIME OF CONCENTRATION

Subdivision: Canyon Creek Ranch
Location: El Paso County

Project Name: Canyon Creek Ranch
Project No.: 25322.00
Calculated By: GAG
Checked By:
Date: 10/8/24

SUB-BASIN DATA						INITIAL/OVERLAND (T_i)			TRAVEL TIME (T_t)					*tc* CHECK (URBANIZED BASINS)			FINAL
BASIN ID	D.A. (ac)	Hydrologic Soils Group	Impervious (%)	C_5	C_{100}	L (ft)	S_o (%)	t_i (min)	L_t (ft)	S_t (%)	K	VEL. (ft/s)	t_t (min)	COMP. t_c (min)	TOTAL LENGTH (ft)	Urbanized t_c (min)	t_c (min)
EXA	4.39	B	6%	0.12	0.38	65	38.0%	4.3	570	4.0%	10.0	2.0	4.8	9.1	635.0	29.8	9.1
EXB	3.63	B	2%	0.09	0.36	110	14.0%	8.0	680	7.3%	10.0	2.7	4.2	12.2	790.0	30.2	12.2
EXC	9.38	B	5%	0.11	0.37	65	10.8%	6.6	840	9.1%	10.0	3.0	4.6	11.2	905.0	30.0	11.2
EXD	3.97	B	2%	0.09	0.36	100	14.8%	7.5	755	11.7%	10.0	3.4	3.7	11.2	855.0	29.6	11.2
EXE	3.08	B	2%	0.09	0.36	300	25.0%	10.9	55	4.0%	10.0	2.0	0.5	11.4	355.0	26.2	11.4
EXF	0.24	B	2%	0.09	0.36	180	4.5%	14.9	0	0.0%	10.0	0.0	0.0	14.9	180.0	25.7	14.9
OS1	1.7	B	2%	0.09	0.36	300	10.3%	14.6	180	13.4%	10.0	3.7	0.8	15.4	480.0	26.5	15.4
OS2	187.1	B	10%	0.16	0.41	-	-	-	-	-	-	-	-	-	-	-	-
OS3	0.24	B	2%	0.09	0.36	135	15.1%	8.7	0	0.0%	10.0	0.0	0.0	8.7	135.0	25.7	8.7
OS4	2.13	B	2%	0.09	0.36	50	2.0%	10.3	405	14.0%	10.0	3.7	1.8	12.1	455.0	27.6	12.1
OS5	163.7	B	10%	0.16	0.41	-	-	-	-	-	-	-	-	-	-	-	-
OS6	5.80	B	2%	0.09	0.36	300	16.5%	12.5	650	17.0%	10.0	4.1	2.6	15.1	950.0	28.5	15.1
OS7	1.04	B	2%	0.09	0.36	115	18.0%	7.5	0	0.0%	10.0	0.0	0.0	7.5	115.0	25.7	7.5
OS8	0.18	B	2%	0.09	0.36	125	24.0%	7.1	0	0.0%	10.0	0.0	0.0	7.1	125.0	25.7	7.1

NOTES:

$$t_c = t_i + t_t$$ Equation 6-2

Where:

t_c = computed time of concentration (minutes)

t_i = overland (initial) flow time (minutes)

t_t = channelized flow time (minutes).

$$t_i = \frac{0.395(1.1 - C_5)\sqrt{L_i}}{S_o^{.033}}$$ Equation 6-3

Where:

t_i = overland (initial) flow time (minutes)
C_5 = runoff coefficient for 5-year frequency (from Table 6-4)
L_i = length of overland flow (ft)
S_o = average slope along the overland flow path (ft/ft).

Use a minimum t_c value of 5 minutes for urbanized areas and a minimum t_c value of 10 minutes for areas that are not considered urban. Use minimum values even when calculations result in a lesser time of concentration.

$$t_t = \frac{L_t}{60K\sqrt{S_o}} = \frac{L_t}{60V_t}$$ Equation 6-4

Where:

t_t = channelized flow time (travel time, min)
L_t = waterway length (ft)
S_o = waterway slope (ft/ft)
V_t = travel time velocity (ft/sec) = $K\sqrt{S_o}$
K = NRCS conveyance factor (see Table 6-2).

$$t_c = (26 - 17i) + \frac{L_t}{60(14i + 9)\sqrt{S_t}}$$ Equation 6-5

Where:

t_c = minimum time of concentration for first design point when less than t_c from Equation 6-1.
L_t = length of channelized flow path (ft)
i = imperviousness (expressed as a decimal)
S_t = slope of the channelized flow path (ft/ft).

Table 6-2. NRCS Conveyance factors, K

Type of Land Surface	Conveyance Factor, K
Heavy meadow	2.5
Tillage/field	5
Short pasture and lawns	7
Nearly bare ground	10
Grassed waterway	15
Paved areas and shallow paved swales	20

PRE-DEVELOPMENT STANDARD FORM SF-3

STORM DRAINAGE SYSTEM DESIGN

(RATIONAL METHOD PROCEDURE)

Subdivision: Canyon Creek Ranch
Location: El Paso County
Design Storm: 5-Year

Project Name: Canyon Creek Ranch
Project No.: 25322.00
Calculated By: GAG
Checked By:
Date: 10/8/24

		DIRECT RUNOFF							TOTAL RUNOFF				STREET/SWALE			PIPE				TRAVEL TIME			
STREET	Design Point	Basin ID	Area (Ac)	Runoff Coeff.	t_c (min)	C*A (Ac)	I (in/hr)	Q (cfs)	tc (min)	C*A (ac)	I (in/hr)	Q (cfs)	$Q_{street/swale}$ (cfs)	C*A (ac)	Slope (%)	Q_{pipe} (cfs)	C*A (ac)	Slope (%)	Pipe Size (inches)	Length (ft)	Velocity (fps)	t_t (min)	REMARKS
	O1	OS1	1.72	0.09	15.4	0.15	3.48	0.5															Sheet flows overland to basin boundary at DPO1 Combines flow within Kettle Creek at DP1.1
	O2	OS2	187.10	0.16	50.0	29.94	-	41.0															Flows along ex. natural swales to the ex. 48" RCP culvert at DPO2 Combines flow within Kettle Creek at DP1.1
	O3	OS3	0.24	0.09	8.7	0.02	4.35	0.1															Sheet flows overland to basin boundary at DPO3 Combines flow within Kettle Creek at DP1.1
	1	EXA	4.39	0.12	9.1	0.51	4.28	2.2															Flows to ex. natural swale to DP1 Combines flow within Kettle Creek at DP1.1
	1.1								50.0	30.62	1.71	52.5											Combines flow of DPO1, DPO2, DPO3 and DP1 within Kettle Creek Continues flowing west along Kettle Creek to DP2.2
	O4	OS4	2.13	0.09	12.1	0.19	3.85	0.7															Flows to ex. natural swale to basin boundary at DPO4 Combines flow at ex. triple 24" RCP culvert at DP2.1
	2	EXB	3.63	0.09	12.2	0.33	3.83	1.3															Flows to ex. natural swale to DP2 Combines flow at ex. triple 24" RCP culvert at DP2.1
	2.1								12.2	0.52	3.83	2.0											Combines flow of DPO4 and DP2 at the ex. triple 24" RCP culvert Continues flowing north and west along Kettle Creek to DP2.2
	2.2								50.0	31.14	1.71	53.4											Combines flow of DP1.1 and DP2.1 within Kettle Creek Continues flowing west along Kettle Creek to DP3.1
	O5	OS5	163.70	0.16	45.0	26.19	-	42.0															Flows to ex. natural swales to basin boundary at DPO5 Combines flow within Kettle Creek at DP3.1
	3	EXC	9.38	0.11	11.2	1.00	3.95	4.0															Flows overland to ex. natural swale to DP3 Combines flow within Kettle Creek at DP3.1
	3.1								50.0	58.33	1.71	100.0											Combines flow of DP2.2, DPO5 and DP3 within Kettle Creek Continues flowing northwest along Kettle Creek to DP4.1
	O6	OS6	5.80	0.09	15.1	0.53	3.51	1.9															Flows to ex. natural swale to basin boundary at DPO6 Combines flow within Kettle Creek at DP4.1
	4	EXD	3.97	0.09	11.2	0.36	3.96	1.4															Flows to ex. natural swale to DP4 Combines flow within Kettle Creek at DP4.1
	4.1								50.0	59.22	1.71	101.6											Combines flow of DP3.1, DPO6 and DP4 within Kettle Creek Continues flowing north along Kettle Creek off-site

PRE-DEVELOPMENT STANDARD FORM SF-3

STORM DRAINAGE SYSTEM DESIGN

(RATIONAL METHOD PROCEDURE)

Subdivision: Canyon Creek Ranch
Location: El Paso County
Design Storm: 5-Year

Project Name: Canyon Creek Ranch
Project No.: 25322.00
Calculated By: GAG
Checked By:
Date: 10/8/24

		DIRECT RUNOFF							TOTAL RUNOFF				STREET/SWALE			PIPE				TRAVEL TIME			
STREET	Design Point	Basin ID	Area (Ac)	Runoff Coeff.	t_c (min)	C*A (Ac)	I (in/hr)	Q (cfs)	tc (min)	C*A (ac)	I (in/hr)	Q (cfs)	$Q_{street/swale}$ (cfs)	C*A (ac)	Slope (%)	Q_{pipe} (cfs)	C*A (ac)	Slope (%)	Pipe Size (inches)	Length (ft)	Velocity (fps)	t_t (min)	REMARKS
	O7	OS7	1.04	0.09	7.5	0.09	4.55	0.4															Flows to ex. natural swale to basin boundary at DPO7 Combines flow within Kettle Creek at DP5.1
	O8	OS8	0.18	0.09	7.1	0.02	4.63	0.1															Sheet flows overland to basin boundary at DPO8 Combines flow within Kettle Creek at DP5.1
	5	EXE	3.08	0.09	11.4	0.28	3.94	1.1															Flows to ex. natural swale to DP5 Combines flow within Kettle Creek at DP5.1
	5.1								50.0	59.61	1.71	102.2											Combines flow DP4.1, DPO7, DPO8 and DP5 within Kettle Creek Continues flowing north and then west along Kettle Creek off-site
	6	EXF	0.24	0.09	14.9	0.02	3.53	0.1															Sheet flows overland to basin boundary at DP6 Continues flowing west eventually flowing to Kettle Creek off-site

Notes:
Street and Pipe C*A values are determined by Q/i using the catchment's intensity value.
Values in RED determined from the CUHP method for basins over 100 acres. See separate CUHP calculations.

PRE-DEVELOPMENT STANDARD FORM SF-3

STORM DRAINAGE SYSTEM DESIGN

(RATIONAL METHOD PROCEDURE)

Subdivision: Canyon Creek Ranch
Location: El Paso County
Design Storm: 100-Year

Project Name: Canyon Creek Ranch
Project No.: 25322.00
Calculated By: GAG
Checked By:
Date: 10/8/24

Description	Design Point	DIRECT RUNOFF							TOTAL RUNOFF				STREET/SWALE			PIPE				TRAVEL TIME			REMARKS
		Basin ID	Area (ac)	Runoff Coeff.	t_c (min)	C*A (ac)	I (in/hr)	Q (cfs)	tc (min)	C*A (ac)	I (in/hr)	Q (cfs)	$Q_{street/swale}$ (cfs)	C*A (ac)	Slope (%)	Q_{pipe} (cfs)	C*A (ac)	Slope (%)	Pipe Size (inches)	Length (ft)	Velocity (fps)	t_t (min)	
	O1	OS1	1.72	0.36	15.4	0.62	5.84	3.6					3.6	0.62	5.0					555	4.5	2.1	Sheet flows overland to basin boundary at DPO1 Combines flow within Kettle Creek at DP1.1
	O2	OS2	187.10	0.41	59.0	76.71	-	176.0															Flows along ex. natural swales to the ex. 48" RCP culvert at DPO2 Combines flow within Kettle Creek at DP1.1
	O3	OS3	0.24	0.36	8.7	0.09	7.30	0.7					0.7	0.09	14.0					485	7.5	1.1	Sheet flows overland to basin boundary at DPO3 Combines flow within Kettle Creek at DP1.1
	1	EXA	4.39	0.38	9.1	1.66	7.18	11.9															Flows to ex. natural swale to DP1 Combines flow within Kettle Creek at DP1.1
	1.1								59.0	79.08	2.46	194.5											Combines flow of DPO1, DPO2, DPO3 and DP1 within Kettle Creek Continues flowing west along Kettle Creek to DP2.2
	O4	OS4	2.13	0.36	12.1	0.77	6.46	5.0					5.0	0.77	7.6					790	5.5	2.4	Flows to ex. natural swale to basin boundary at DPO4 Combines flow at ex. triple 24" RCP culvert at DP2.1
	2	EXB	3.63	0.36	12.2	1.31	6.43	8.4															Flows to ex. natural swale to DP2 Combines flow at ex. triple 24" RCP culvert at DP2.1
	2.1								14.5	2.08	6.00	12.5											Combines flow of DPO4 and DP2 at the ex. triple 24" RCP culvert Continues flowing north and west along Kettle Creek to DP2.2
	2.2								59.0	81.16	2.46	199.6	199.6	81.16	1.1					430	2.1	3.4	Combines flow of DP1.1 and DP2.1 within Kettle Creek Continues flowing west along Kettle Creek to DP3.1
	O5	OS5	163.70	0.41	53.0	67.12	-	178.0															Flows to ex. natural swales to basin boundary at DPO5 Combines flow within Kettle Creek at DP3.1
	3	EXC	9.38	0.37	11.2	3.49	6.64	23.2															Flows overland to ex. natural swale to DP3 Combines flow within Kettle Creek at DP3.1
	3.1								62.4	151.77	2.32	351.8	351.8	151.77	1.1					325	2.1	2.6	Combines flow of DP2.2, DPO5 and DP3 within Kettle Creek Continues flowing northwest along Kettle Creek to DP4.1
	O6	OS6	5.80	0.36	15.1	2.09	5.89	12.3					12.3	2.09	14.8					350	7.7	0.8	Flows to ex. natural swale to basin boundary at DPO6 Combines flow within Kettle Creek at DP4.1
	4	EXD	3.97	0.36	11.2	1.43	6.65	9.5															Flows to ex. natural swale to DP4 Combines flow within Kettle Creek at DP4.1
	4.1								62.4	155.29	2.32	359.9	359.9	155.29	1.6					755	2.5	5.0	Combines flow of DP3.1, DPO6 and DP4 within Kettle Creek Continues flowing north along Kettle Creek off-site

PRE-DEVELOPMENT STANDARD FORM SF-3

STORM DRAINAGE SYSTEM DESIGN

(RATIONAL METHOD PROCEDURE)

Subdivision: Canyon Creek Ranch
Location: El Paso County
Design Storm: 100-Year

Project Name: Canyon Creek Ranch
Project No.: 25322.00
Calculated By: GAG
Checked By:
Date: 10/8/24

Description	Design Point	DIRECT RUNOFF							TOTAL RUNOFF				STREET/SWALE			PIPE				TRAVEL TIME			REMARKS
		Basin ID	Area (ac)	Runoff Coeff.	t_c (min)	C*A (ac)	I (in/hr)	Q (cfs)	tc (min)	C*A (ac)	I (in/hr)	Q (cfs)	$Q_{street/swale}$ (cfs)	C*A (ac)	Slope (%)	Q_{pipe} (cfs)	C*A (ac)	Slope (%)	Pipe Size (inches)	Length (ft)	Velocity (fps)	t_t (min)	
	O7	OS7	1.04	0.36	7.5	0.37	7.65	2.8					2.8	0.37	23.4					315	9.7	0.5	Flows to ex. natural swale to basin boundary at DPO7 Combines flow within Kettle Creek at DP5.1
	O8	OS8	0.18	0.36	7.1	0.06	7.78	0.5					0.5	0.06	21.0					190	9.2	0.3	Sheet flows overland to basin boundary at DPO8 Combines flow within Kettle Creek at DP5.1
	5	EXE	3.08	0.36	11.4	1.11	6.61	7.3															Flows to ex. natural swale to DP5 Combines flow within Kettle Creek at DP5.1
	5.1								62.4	156.83	2.32	363.5											Combines flow DP4.1, DPO7, DPO8 and DP5 within Kettle Creek Continues flowing north and then west along Kettle Creek off-site
	6	EXF	0.24	0.36	14.9	0.09	5.93	0.5															Sheet flows overland to basin boundary at DP6 Continues flowing west eventually flowing to Kettle Creek off-site

Notes:
Street and Pipe C*A values are determined by Q/i using the catchment's intensity value.
Values in RED determined from the CUHP method for basins over 100 acres. See separate CUHP calculations.

PROPOSED COMPOSITE % IMPERVIOUS & COMPOSITE RUNOFF COEFFICIENT CALCULATIONS

Subdivision: Canyon Creek Ranch
Location: El Paso County

Project Name: Canyon Creek Ranch
Project No.: 25322.00
Calculated By: GAG
Checked By: BTL
Date: 3/27/26

Basin ID	Total Area (ac)	Rural 5-Acre Lots (10% Impervious)				Roofs (90% Impervious)				Streets-Gravel (80% Impervious)				Historical Analysis/Lawn (2% Impervious)				Basins Total Weighted C Values		Basins Total Weighted % Imp.
		C_5	C_{100}	Area (ac)	Weighted % Imp.	C_5	C_{100}	Area (ac)	Weighted % Imp.	C_5	C_{100}	Area (ac)	Weighted % Imp.	C_5	C_{100}	Area (ac)	Weighted % Imp.	C_5	C_{100}	
A	4.39	0.16	0.41	0.00	0.0%	0.73	0.81	0.26	5.3%	0.59	0.70	0.28	5.1%	0.09	0.36	3.85	1.8%	0.16	0.41	12.2%
B	3.63	0.16	0.41	0.00	0.0%	0.73	0.81	0.04	1.0%	0.59	0.70	0.00	0.0%	0.09	0.36	3.59	2.0%	0.10	0.36	3.0%
C	9.38	0.16	0.41	0.00	0.0%	0.73	0.81	0.42	4.0%	0.59	0.70	0.49	4.2%	0.09	0.36	8.47	1.8%	0.14	0.40	10.0%
D	3.97	0.16	0.41	0.00	0.0%	0.73	0.81	0.00	0.0%	0.59	0.70	0.00	0.0%	0.09	0.36	3.97	2.0%	0.09	0.36	2.0%
E	3.08	0.16	0.41	0.00	0.0%	0.73	0.81	0.00	0.0%	0.59	0.70	0.00	0.0%	0.09	0.36	3.08	2.0%	0.09	0.36	2.0%
F	0.24	0.16	0.41	0.00	0.0%	0.73	0.81	0.00	0.0%	0.59	0.70	0.00	0.0%	0.09	0.36	0.24	2.0%	0.09	0.36	2.0%
OS1	1.72	0.16	0.41	0.00	0.0%	0.73	0.81	0.00	0.0%	0.59	0.70	0.00	0.0%	0.09	0.36	1.72	2.0%	0.09	0.36	2.0%
OS2	187.1	0.16	0.41	186.3	10.0%	0.73	0.81	0.03	0.0%	0.59	0.70	0.75	0.3%	0.09	0.36	0.00	0.0%	0.16	0.41	10.3%
OS3	0.24	0.16	0.41	0.00	0.0%	0.73	0.81	0.00	0.0%	0.59	0.70	0.00	0.0%	0.09	0.36	0.24	2.0%	0.09	0.36	2.0%
OS4	2.13	0.16	0.41	0.00	0.0%	0.73	0.81	0.00	0.0%	0.59	0.70	0.00	0.0%	0.09	0.36	2.13	2.0%	0.09	0.36	2.0%
OS5	163.7	0.16	0.41	163.7	10.0%	0.73	0.81	0.00	0.0%	0.59	0.70	0.00	0.0%	0.09	0.36	0.00	0.0%	0.16	0.41	10.0%
OS6	5.80	0.16	0.41	0.00	0.0%	0.73	0.81	0.01	0.2%	0.59	0.70	0.00	0.0%	0.09	0.36	5.79	2.0%	0.09	0.36	2.2%
OS7	1.04	0.16	0.41	0.00	0.0%	0.73	0.81	0.00	0.0%	0.59	0.70	0.00	0.0%	0.09	0.36	1.04	2.0%	0.09	0.36	2.0%
OS8	0.18	0.16	0.41	0.00	0.0%	0.73	0.81	0.00	0.0%	0.59	0.70	0.00	0.0%	0.09	0.36	0.18	2.0%	0.09	0.36	2.0%
TOTAL ON-SITE	24.69																			7.0%
TOTAL OFF-SITE	361.9																			9.9%

PROPOSED
STANDARD FORM SF-2
TIME OF CONCENTRATION

Subdivision: Canyon Creek Ranch
Location: El Paso County

Project Name: Canyon Creek Ranch
Project No.: 25322.00
Calculated By: GAG
Checked By: BTL
Date: 3/27/26

SUB-BASIN						INITIAL/OVERLAND			TRAVEL TIME					*tc* CHECK			FINAL
DATA						(T_i)			(T_t)					(URBANIZED BASINS)			
BASIN ID	D.A. (ac)	Hydrologic Soils Group	Impervious (%)	C_5	C_{100}	L (ft)	S_o (%)	t_i (min)	L_t (ft)	S_t (%)	K	VEL. (ft/s)	t_t (min)	COMP. t_c (min)	TOTAL LENGTH (ft)	Urbanized t_c (min)	t_c (min)
A	4.39	B	12%	0.16	0.41	65	38.0%	4.1	570	4.0%	10.0	2.0	4.8	8.9	635.0	28.4	8.9
B	3.63	B	3%	0.10	0.36	110	14.0%	7.9	680	7.3%	10.0	2.7	4.2	12.1	790.0	30.0	12.1
C	9.38	B	10%	0.14	0.40	65	10.8%	6.3	840	9.1%	10.0	3.0	4.6	11.0	905.0	28.8	11.0
D	3.97	B	2%	0.09	0.36	100	14.8%	7.5	755	11.7%	10.0	3.4	3.7	11.2	855.0	29.6	11.2
E	3.08	B	2%	0.09	0.36	300	25.0%	10.9	55	4.0%	10.0	2.0	0.5	11.4	355.0	26.2	11.4
F	0.24	B	2%	0.09	0.36	180	4.5%	14.9	0	0.0%	10.0	0.0	0.0	14.9	180.0	25.7	14.9
OS1	1.72	B	2%	0.09	0.36	300	10.3%	14.6	180	13.4%	10.0	3.7	0.8	15.4	480.0	26.5	15.4
OS2	187.1	B	10%	0.16	0.41	-	-	-	-	-	-	-	-	-	-	-	-
OS3	0.24	B	2%	0.09	0.36	135	15.1%	8.7	0	0.0%	10.0	0.0	0.0	8.7	135.0	25.7	8.7
OS4	2.13	B	2%	0.09	0.36	50	2.0%	10.3	405	14.0%	10.0	3.7	1.8	12.1	455.0	27.6	12.1
OS5	163.7	B	10%	0.16	0.41	-	-	-	-	-	-	-	-	-	-	-	-
OS6	5.80	B	2%	0.09	0.36	300	16.5%	12.5	650	17.0%	10.0	4.1	2.6	15.1	950.0	28.5	15.1
OS7	1.04	B	2%	0.09	0.36	115	18.0%	7.5	0	0.0%	10.0	0.0	0.0	7.5	115.0	25.7	7.5
OS8	0.18	B	2%	0.09	0.36	125	24.0%	7.1	0	0.0%	10.0	0.0	0.0	7.1	125.0	25.7	7.1

NOTES:

$$t_c = t_i + t_t$$ Equation 6-2

Where:

t_c = computed time of concentration (minutes)

t_i = overland (initial) flow time (minutes)

t_t = channelized flow time (minutes).

$$t_i = \frac{0.395(1.1 - C_5)\sqrt{L_i}}{S_o^{0.33}}$$ Equation 6-3

Where:

t_i = overland (initial) flow time (minutes)
C_5 = runoff coefficient for 5-year frequency (from Table 6-4)
L_i = length of overland flow (ft)
S_o = average slope along the overland flow path (ft/ft).

PROPOSED
STANDARD FORM SF-2
TIME OF CONCENTRATION

Subdivision: Canyon Creek Ranch
Location: El Paso County

Project Name: Canyon Creek Ranch
Project No.: 25322.00
Calculated By: GAG
Checked By: BTL
Date: 3/27/26

SUB-BASIN						INITIAL/OVERLAND			TRAVEL TIME					*tc* CHECK			FINAL
DATA						(T_i)			(T_t)					(URBANIZED BASINS)			
BASIN	D.A.	Hydrologic	Impervious	C_5	C_{100}	L	S_o	t_i	L_t	S_t	K	VEL.	t_t	COMP. t_c	TOTAL	Urbanized t_c	t_c

Use a minimum t_c value of 5 minutes for urbanized areas and a minimum t_c value of 10 minutes for areas that are not considered urban. Use minimum values even when calculations result in a lesser time of concentration.

$$t_t = \frac{L_t}{60K\sqrt{S_o}} = \frac{L_t}{60V_t}$$ Equation 6-4

Where:

t_t = channelized flow time (travel time, min)
L_t = waterway length (ft)
S_o = waterway slope (ft/ft)
V_t = travel time velocity (ft/sec) = $K\sqrt{S_o}$
K = NRCS conveyance factor (see Table 6-2).

$$t_c = (26 - 17i) + \frac{L_t}{60(14i + 9)\sqrt{S_t}}$$ Equation 6-5

Where:

t_c = minimum time of concentration for first design point when less than t_c from Equation 6-1.
L_t = length of channelized flow path (ft)
i = imperviousness (expressed as a decimal)
S_t = slope of the channelized flow path (ft/ft).

Table 6-2. NRCS Conveyance factors, K

Type of Land Surface	Conveyance Factor, K
Heavy meadow	2.5
Tillage/field	5
Short pasture and lawns	7
Nearly bare ground	10
Grassed waterway	15
Paved areas and shallow paved swales	20

PROPOSED STANDARD FORM SF-3

STORM DRAINAGE SYSTEM DESIGN

(RATIONAL METHOD PROCEDURE)

Subdivision: Canyon Creek Ranch
Location: El Paso County
Design Storm: 5-Year

Project Name: Canyon Creek Ranch
Project No.: 25322.00
Calculated By: GAG
Checked By: BTL
Date: 3/27/26

STREET	Design Point	DIRECT RUNOFF							TOTAL RUNOFF				STREET/SWALE			PIPE				TRAVEL TIME			REMARKS
		Basin ID	Area (Ac)	Runoff Coeff.	t_c (min)	C*A (Ac)	I (in/hr)	Q (cfs)	tc (min)	C*A (ac)	I (in/hr)	Q (cfs)	$Q_{street/swale}$ (cfs)	C*A (ac)	Slope (%)	Q_{pipe} (cfs)	C*A (ac)	Slope (%)	Pipe Size (inches)	Length (ft)	Velocity (fps)	t_t (min)	
	O1	OS1	1.72	0.09	15.4	0.15	3.48	0.5															Sheet flows overland to basin boundary at DPO1 Combines flow within Kettle Creek at DP1.1
	O2	OS2	187.1	0.16	50.0	30.28	-	41.0															Flows along ex. natural swales to the ex. 48" RCP culvert at DPO2 Combines flow within Kettle Creek at DP1.1
	O3	OS3	0.24	0.09	8.7	0.02	4.35	0.1															Sheet flows overland to basin boundary at DPO3 Combines flow within Kettle Creek at DP1.1
	1	A	4.39	0.16	8.9	0.70	4.31	3.0															Flows to ex. natural swale to DP1 Combines flow within Kettle Creek at DP1.1
	1.1								50.0	31.15	1.71	53.4											Combines flow of DPO1, DPO2, DPO3 and DP1 within Kettle Creek Continues flowing west along Kettle Creek to DP2.2
	O4	OS4	2.13	0.09	12.1	0.19	3.85	0.7															Flows to ex. natural swale to basin boundary at DPO4 Combines flow at ex. triple 24" RCP culvert at DP2.1
	2	B	3.63	0.10	12.1	0.35	3.84	1.3															Flows to ex. natural swale to DP2 Combines flow at ex. triple 24" RCP culvert at DP2.1
	2.1								12.1	0.54	3.84	2.1											Combines flow of DPO4 and DP2 at the ex. triple 24" RCP culvert Continues flowing north and west along Kettle Creek to DP2.2
	2.2								50.0	31.69	1.71	54.3											Combines flow of DP1.1 and DP2.1 within Kettle Creek Continues flowing west along Kettle Creek to DP3.2
	O5	OS5	163.7	0.16	45.0	26.19	-	42.0															Flows to ex. natural swales to basin boundary at DPO5 Combines flow within Kettle Creek at DP3.1
	3	C	9.38	0.14	11.0	1.36	3.99	5.4															Flows overland to ex. natural swale to DP3 Combines flow within Kettle Creek at DP3.1
	3.1								45.0	27.55	1.87	51.6											Combines flow of DPO5 and DP3 within Kettle Creek Continues flowing northwest along Kettle Creek to DP3.2
	3.2								50.0	59.24	1.71	101.6											Combines flow of DP2.2 and DP3.1 within Kettle Creek Continues flowing northwest along Kettle Creek to DP4.1
	O6	OS6	5.80	0.09	15.1	0.53	3.51	1.9															Flows to ex. natural swale to basin boundary at DPO6 Combines flow within Kettle Creek at DP4.1
	4	D	3.97	0.09	11.2	0.36	3.96	1.4															Flows to ex. natural swale to DP4 Combines flow within Kettle Creek at DP4.1
	4.1								50.0	60.13	1.71	103.1											Combines flow of DP3.1, DPO6 and DP4 within Kettle Creek Continues flowing north along Kettle Creek off-site

PROPOSED STANDARD FORM SF-3

STORM DRAINAGE SYSTEM DESIGN

(RATIONAL METHOD PROCEDURE)

Subdivision: Canyon Creek Ranch
Location: El Paso County
Design Storm: 5-Year

Project Name: Canyon Creek Ranch
Project No.: 25322.00
Calculated By: GAG
Checked By: BTL
Date: 3/27/26

		DIRECT RUNOFF							TOTAL RUNOFF				STREET/SWALE			PIPE				TRAVEL TIME			
STREET	Design Point	Basin ID	Area (Ac)	Runoff Coeff.	t_c (min)	C*A (Ac)	I (in/hr)	Q (cfs)	tc (min)	C*A (ac)	I (in/hr)	Q (cfs)	$Q_{street/swale}$ (cfs)	C*A (ac)	Slope (%)	Q_{pipe} (cfs)	C*A (ac)	Slope (%)	Pipe Size (inches)	Length (ft)	Velocity (fps)	t_t (min)	REMARKS
	O7	OS7	1.04	0.09	7.5	0.09	4.55	0.4															Flows to ex. natural swale to basin boundary at DPO7 Combines flow within Kettle Creek at DP5.1
	O8	OS8	0.18	0.09	7.1	0.02	4.63	0.1															Sheet flows overland to basin boundary at DPO8 Combines flow within Kettle Creek at DP5.1
	5	E	3.08	0.09	11.4	0.28	3.94	1.1															Flows to ex. natural swale to DP5 Combines flow within Kettle Creek at DP5.1
	5.1								50.0	60.52	1.71	103.8											Combines flow DP4.1, DPO7, DPO8 and DP5 within Kettle Creek Continues flowing north and then west along Kettle Creek off-site
	6	F	0.24	0.09	14.9	0.02	3.53	0.1															Sheet flows overland to basin boundary at DP6 Continues flowing west eventually flowing to Kettle Creek off-site

Notes:
Street and Pipe C*A values are determined by Q/i using the catchment's intensity value.
Values in RED determined from the CUHP method for basins over 100 acres. See separate CUHP calculations.

PROPOSED STANDARD FORM SF-3

STORM DRAINAGE SYSTEM DESIGN

(RATIONAL METHOD PROCEDURE)

Subdivision: Canyon Creek Ranch
Location: El Paso County
Design Storm: 100-Year

Project Name: Canyon Creek Ranch
Project No.: 25322.00
Calculated By: GAG
Checked By: BTL
Date: 3/27/26

		DIRECT RUNOFF							TOTAL RUNOFF				STREET/SWALE			PIPE				TRAVEL TIME			
Description	Design Point	Basin ID	Area (ac)	Runoff Coeff.	t_c (min)	C*A (ac)	I (in/hr)	Q (cfs)	tc (min)	C*A (ac)	I (in/hr)	Q (cfs)	$Q_{street/swale}$ (cfs)	C*A (ac)	Slope (%)	Q_{pipe} (cfs)	C*A (ac)	Slope (%)	Pipe Size (inches)	Length (ft)	Velocity (fps)	t_t (min)	REMARKS
	O1	OS1	1.72	0.36	15.4	0.62	5.84	3.6					3.6	0.62	5.0					555	4.5	2.1	Sheet flows overland to basin boundary at DPO1 Combines flow within Kettle Creek at DP1.1
	O2	OS2	187.1	0.41	59.0	76.94	-	176.0															Flows along ex. natural swales to the ex. 48" RCP culvert at DPO2 Combines flow within Kettle Creek at DP1.1
	O3	OS3	0.24	0.36	8.7	0.09	7.30	0.7					0.7	0.09	14.0					485	7.5	1.1	Sheet flows overland to basin boundary at DPO3 Combines flow within Kettle Creek at DP1.1
	1	A	4.39	0.41	8.9	1.79	7.23	12.9															Flows to ex. natural swale to DP1 Combines flow within Kettle Creek at DP1.1
	1.1								59.0	79.44	2.46	195.4											Combines flow of DPO1, DPO2, DPO3 and DP1 within Kettle Creek Continues flowing west along Kettle Creek to DP2.2
	O4	OS4	2.13	0.36	12.1	0.77	6.46	5.0					5.0	0.77	7.6					790	5.5	2.4	Flows to ex. natural swale to basin boundary at DPO4 Combines flow at ex. triple 24" RCP culvert at DP2.1
	2	B	3.63	0.36	12.1	1.32	6.44	8.5															Flows to ex. natural swale to DP2 Combines flow at ex. triple 24" RCP culvert at DP2.1
	2.1								14.5	2.09	6.00	12.6											Combines flow of DPO4 and DP2 at the ex. triple 24" RCP culvert Continues flowing north and west along Kettle Creek to DP2.2
	2.2								59.0	81.53	2.46	200.5	200.5	81.53	1.1					430	2.1	3.4	Combines flow of DP1.1 and DP2.1 within Kettle Creek Continues flowing west along Kettle Creek to DP3.2
	O5	OS5	163.7	0.41	53.0	67.12	-	178.0															Flows to ex. natural swales to basin boundary at DPO5 Combines flow within Kettle Creek at DP3.1
	3	C	9.38	0.40	11.0	3.73	6.70	25.0															Flows overland to ex. natural swale to DP3 Combines flow within Kettle Creek at DP3.1
	3.1								53.0	70.85	2.73	193.4											Combines flow of DPO5 and DP3 within Kettle Creek Continues flowing northwest along Kettle Creek to DP3.2
	3.2								62.4	152.38	2.32	353.2	353.2	152.38	1.1					325	2.1	2.6	Combines flow of DP2.2 and DP3.1 within Kettle Creek Continues flowing northwest along Kettle Creek to DP4.1
	O6	OS6	5.80	0.36	15.1	2.09	5.89	12.3					12.3	2.09	14.8					350	7.7	0.8	Flows to ex. natural swale to basin boundary at DPO6 Combines flow within Kettle Creek at DP4.1
	4	D	3.97	0.36	11.2	1.43	6.65	9.5															Flows to ex. natural swale to DP4 Combines flow within Kettle Creek at DP4.1
	4.1								62.4	155.90	2.32	361.3	361.3	155.90	1.6					755	2.5	5.0	Combines flow of DP3.1, DPO6 and DP4 within Kettle Creek Continues flowing north along Kettle Creek off-site

PROPOSED STANDARD FORM SF-3

STORM DRAINAGE SYSTEM DESIGN

(RATIONAL METHOD PROCEDURE)

Subdivision: Canyon Creek Ranch
Location: El Paso County
Design Storm: 100-Year

Project Name: Canyon Creek Ranch
Project No.: 25322.00
Calculated By: GAG
Checked By: BTL
Date: 3/27/26

Description	Design Point	DIRECT RUNOFF							TOTAL RUNOFF				STREET/SWALE			PIPE				TRAVEL TIME			REMARKS
		Basin ID	Area (ac)	Runoff Coeff.	t_c (min)	C*A (ac)	I (in/hr)	Q (cfs)	tc (min)	C*A (ac)	I (in/hr)	Q (cfs)	$Q_{street/swale}$ (cfs)	C*A (ac)	Slope (%)	Q_{pipe} (cfs)	C*A (ac)	Slope (%)	Pipe Size (inches)	Length (ft)	Velocity (fps)	t_t (min)	
	O7	OS7	1.04	0.36	7.5	0.37	7.65	2.8					2.8	0.37	23.4					315	9.7	0.5	Flows to ex. natural swale to basin boundary at DPO7 Combines flow within Kettle Creek at DP5.1
	O8	OS8	0.18	0.36	7.1	0.06	7.78	0.5					0.5	0.06	21.0					190	9.2	0.3	Sheet flows overland to basin boundary at DPO8 Combines flow within Kettle Creek at DP5.1
	5	E	3.08	0.36	11.4	1.11	6.61	7.3															Flows to ex. natural swale to DP5 Combines flow within Kettle Creek at DP5.1
	5.1								62.4	157.44	2.32	364.9											Combines flow DP4.1, DPO7, DPO8 and DP5 within Kettle Creek Continues flowing north and then west along Kettle Creek off-site
	6	F	0.24	0.36	14.9	0.09	5.93	0.5															Sheet flows overland to basin boundary at DP6 Continues flowing west eventually flowing to Kettle Creek off-site

Notes:
Street and Pipe C*A values are determined by Q/i using the catchment's intensity value.
Values in RED determined from the CUHP method for basins over 100 acres. See separate CUHP calculations.

Summary of CUHP Input Parameters (Version 2.0.1)

								Depression Storage		Horton's Infiltration Parameters			DCIA Level and Fractions			
Catchment Name/ID	SWMM Node/ID	Raingage Name/ID	Area (sq.mi.)	Dist. to Centroid (miles)	Length (miles)	Slope (ft./ft.)	Percent Imperv.	Pervious (inches)	Imperv. (inches)	Initial Rate (in./hr.)	Final Rate (in.hr.)	Decay Coeff. (1/sec.)	DCIA Level	Dir. Con'ct Imperv. Fraction	Receiv. Perv. Fraction	Percent Eff. Imperv.
OS2		5 YR DESIGN STORM	0.292	0.658	1.606	0.059	10.0	0.40	0.10	4.50	0.60	0.0018	0.00	0.20	0.10	8.19
OS3		5 YR DESIGN STORM	0.256	0.512	1.125	0.047	10.0	0.40	0.10	4.50	0.60	0.0018	0.00	0.20	0.10	8.19

(5-year) Summary of Unit Hydrograph Parameters Used By Program and Calculated Results (Version 2.0.1)

		Unit Hydrograph Parameters and Results									Excess Precip.		Storm Hydrograph			
Catchment Name/ID	User Comment for Catchment	CT	Cp	W50 (min.)	W50 Before Peak	W75 (min.)	W75 Before Peak	Time to Peak (min.)	Peak (cfs)	Volume (c.f)	Excess (inches)	Excess (c.f.)	Time to Peak (min.)	Peak Flow (cfs)	Total Volume (c.f.)	Runoff per Unit Area (cfs/acre)
OS2		0.133	0.215	58.7	9.97	30.5	7.05	16.6	149	679,173	0.31	213,763	50.0	41	213,761	0.22
OS3		0.133	0.206	48.2	7.93	25.1	5.61	13.2	159	594,231	0.31	187,028	45.0	42	187,029	0.26

(100-year) Summary of Unit Hydrograph Parameters Used By Program and Calculated Results (Version 2.0.1)

		Unit Hydrograph Parameters and Results									Excess Precip.		Storm Hydrograph			
Catchment Name/ID	User Comment for Catchment	CT	Cp	W50 (min.)	W50 Before Peak	W75 (min.)	W75 Before Peak	Time to Peak (min.)	Peak (cfs)	Volume (c.f)	Excess (inches)	Excess (c.f.)	Time to Peak (min.)	Peak Flow (cfs)	Total Volume (c.f.)	Runoff per Unit Area (cfs/acre)
OS2		0.130	0.211	58.5	9.79	30.4	6.92	16.3	150	679,173	1.42	967,207	59.0	176	967,198	0.94
OS5		0.130	0.203	48.1	7.79	25.0	5.51	13.0	160	594,231	1.42	846,241	53.0	178	846,245	1.09

Appendix C
Hydraulic Calculations

Culvert Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Wednesday, Mar 25 2026

DPO2 - Existing 48-Inch CMP (5 year)

Invert Elev Dn (ft)	=	6939.06
Pipe Length (ft)	=	50.23
Slope (%)	=	5.49
Invert Elev Up (ft)	=	6941.82
Rise (in)	=	48.0
Shape	=	Circular
Span (in)	=	48.0
No. Barrels	=	1
n-Value	=	0.024
Culvert Type	=	Circular Concrete
Culvert Entrance	=	Groove end projecting (C)
Coeff. K,M,c,Y,k	=	0.0045, 2, 0.0317, 0.69, 0.2

Embankment

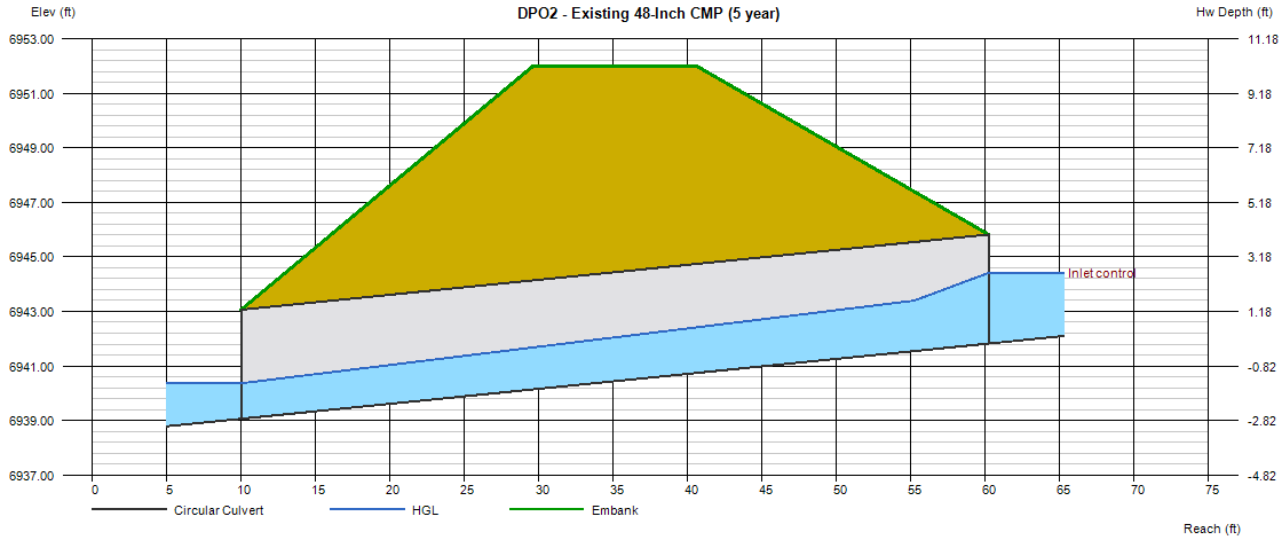
Top Elevation (ft)	=	6952.00
Top Width (ft)	=	11.00
Crest Width (ft)	=	100.00

Calculations

Qmin (cfs)	=	41.00
Qmax (cfs)	=	41.00
Tailwater Elev (ft)	=	Normal

Highlighted

Qtotal (cfs)	=	41.00
Qpipe (cfs)	=	41.00
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	11.54
Veloc Up (ft/s)	=	6.92
HGL Dn (ft)	=	6940.36
HGL Up (ft)	=	6943.73
Hw Elev (ft)	=	6944.41
Hw/D (ft)	=	0.65
Flow Regime	=	Inlet Control



Culvert Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Wednesday, Mar 25 2026

DPO2 - Existing 48-Inch CMP (100 year)

Invert Elev Dn (ft)	=	6939.06
Pipe Length (ft)	=	50.23
Slope (%)	=	5.49
Invert Elev Up (ft)	=	6941.82
Rise (in)	=	48.0
Shape	=	Circular
Span (in)	=	48.0
No. Barrels	=	1
n-Value	=	0.024
Culvert Type	=	Circular Concrete
Culvert Entrance	=	Groove end projecting (C)
Coeff. K,M,c,Y,k	=	0.0045, 2, 0.0317, 0.69, 0.2

Embankment

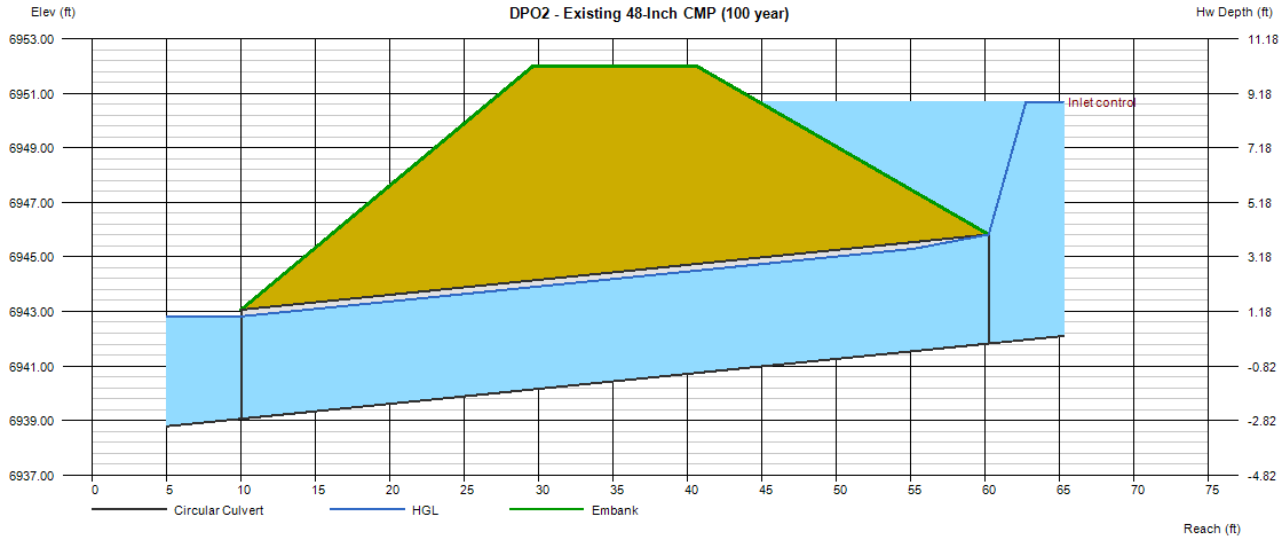
Top Elevation (ft)	=	6952.00
Top Width (ft)	=	11.00
Crest Width (ft)	=	100.00

Calculations

Qmin (cfs)	=	176.00
Qmax (cfs)	=	176.00
Tailwater Elev (ft)	=	Normal

Highlighted

Qtotal (cfs)	=	176.00
Qpipe (cfs)	=	176.00
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	14.37
Veloc Up (ft/s)	=	14.37
HGL Dn (ft)	=	6942.82
HGL Up (ft)	=	6945.58
Hw Elev (ft)	=	6950.69
Hw/D (ft)	=	2.22
Flow Regime	=	Inlet Control



Culvert Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Wednesday, Mar 25 2026

DP2.1 - Existing Triple 24-Inch CMP (5-year)

Invert Elev Dn (ft)	=	6926.27
Pipe Length (ft)	=	30.57
Slope (%)	=	6.28
Invert Elev Up (ft)	=	6928.19
Rise (in)	=	24.0
Shape	=	Circular
Span (in)	=	24.0
No. Barrels	=	3
n-Value	=	0.024
Culvert Type	=	Circular Concrete
Culvert Entrance	=	Groove end projecting (C)
Coeff. K,M,c,Y,k	=	0.0045, 2, 0.0317, 0.69, 0.2

Embankment

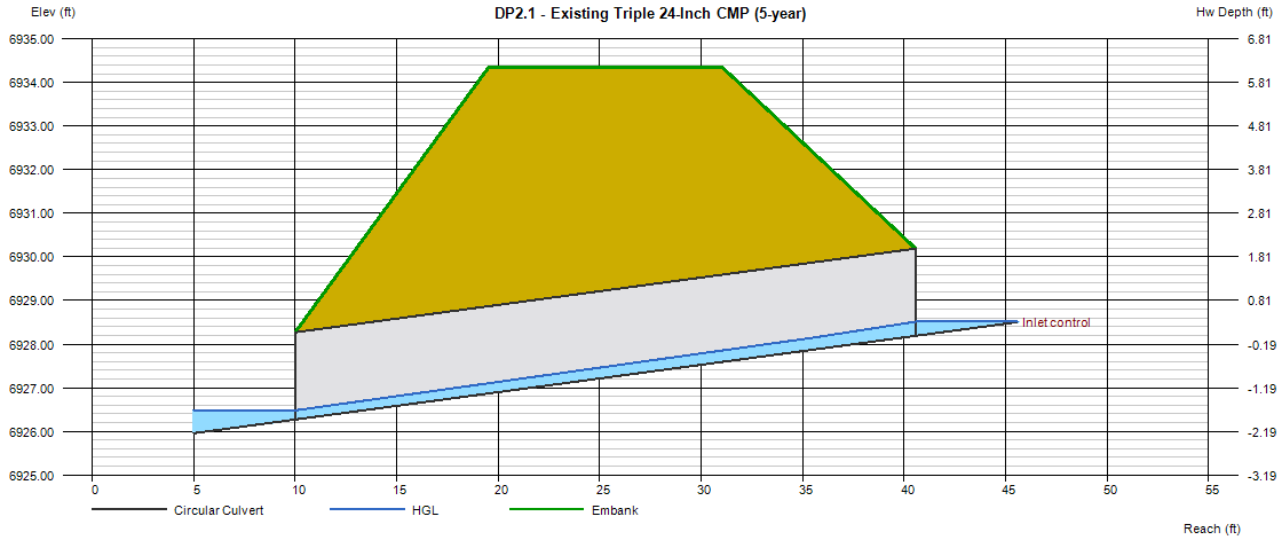
Top Elevation (ft)	=	6934.35
Top Width (ft)	=	11.50
Crest Width (ft)	=	100.00

Calculations

Qmin (cfs)	=	2.10
Qmax (cfs)	=	2.10
Tailwater Elev (ft)	=	Normal

Highlighted

Qtotal (cfs)	=	2.10
Qpipe (cfs)	=	2.10
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	3.99
Veloc Up (ft/s)	=	2.53
HGL Dn (ft)	=	6926.48
HGL Up (ft)	=	6928.48
Hw Elev (ft)	=	6928.51
Hw/D (ft)	=	0.16
Flow Regime	=	Inlet Control



Culvert Report

DP2.1 - Existing Triple 24-Inch CMP (100-year)

Invert Elev Dn (ft)	=	6926.27
Pipe Length (ft)	=	30.57
Slope (%)	=	6.28
Invert Elev Up (ft)	=	6928.19
Rise (in)	=	24.0
Shape	=	Circular
Span (in)	=	24.0
No. Barrels	=	3
n-Value	=	0.024
Culvert Type	=	Circular Concrete
Culvert Entrance	=	Groove end projecting (C)
Coeff. K,M,c,Y,k	=	0.0045, 2, 0.0317, 0.69, 0.2

Embankment

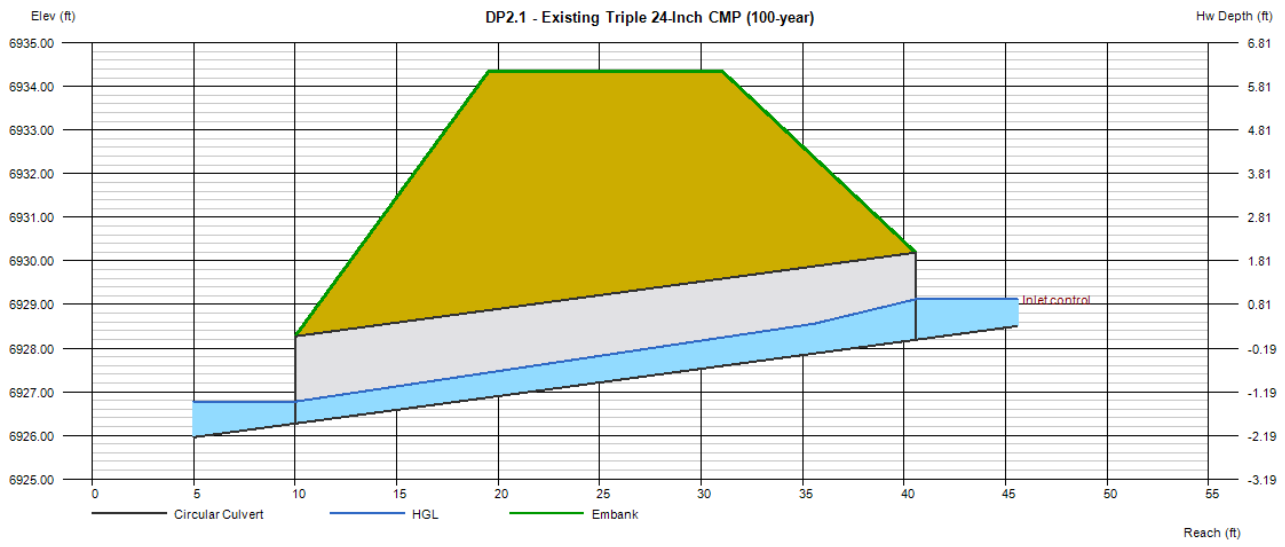
Top Elevation (ft)	=	6934.35
Top Width (ft)	=	11.50
Crest Width (ft)	=	100.00

Calculations

Qmin (cfs)	=	12.60
Qmax (cfs)	=	12.60
Tailwater Elev (ft)	=	Normal

Highlighted

Qtotal (cfs)	=	12.60
Qpipe (cfs)	=	12.60
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	6.79
Veloc Up (ft/s)	=	4.13
HGL Dn (ft)	=	6926.77
HGL Up (ft)	=	6928.91
Hw Elev (ft)	=	6929.12
Hw/D (ft)	=	0.46
Flow Regime	=	Inlet Control



Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Wednesday, Mar 25 2026

DPO2 - Drainage Path 1-100 Year

User-defined

Invert Elev (ft)	= 6942.29
Slope (%)	= 2.90
N-Value	= 0.010

Calculations

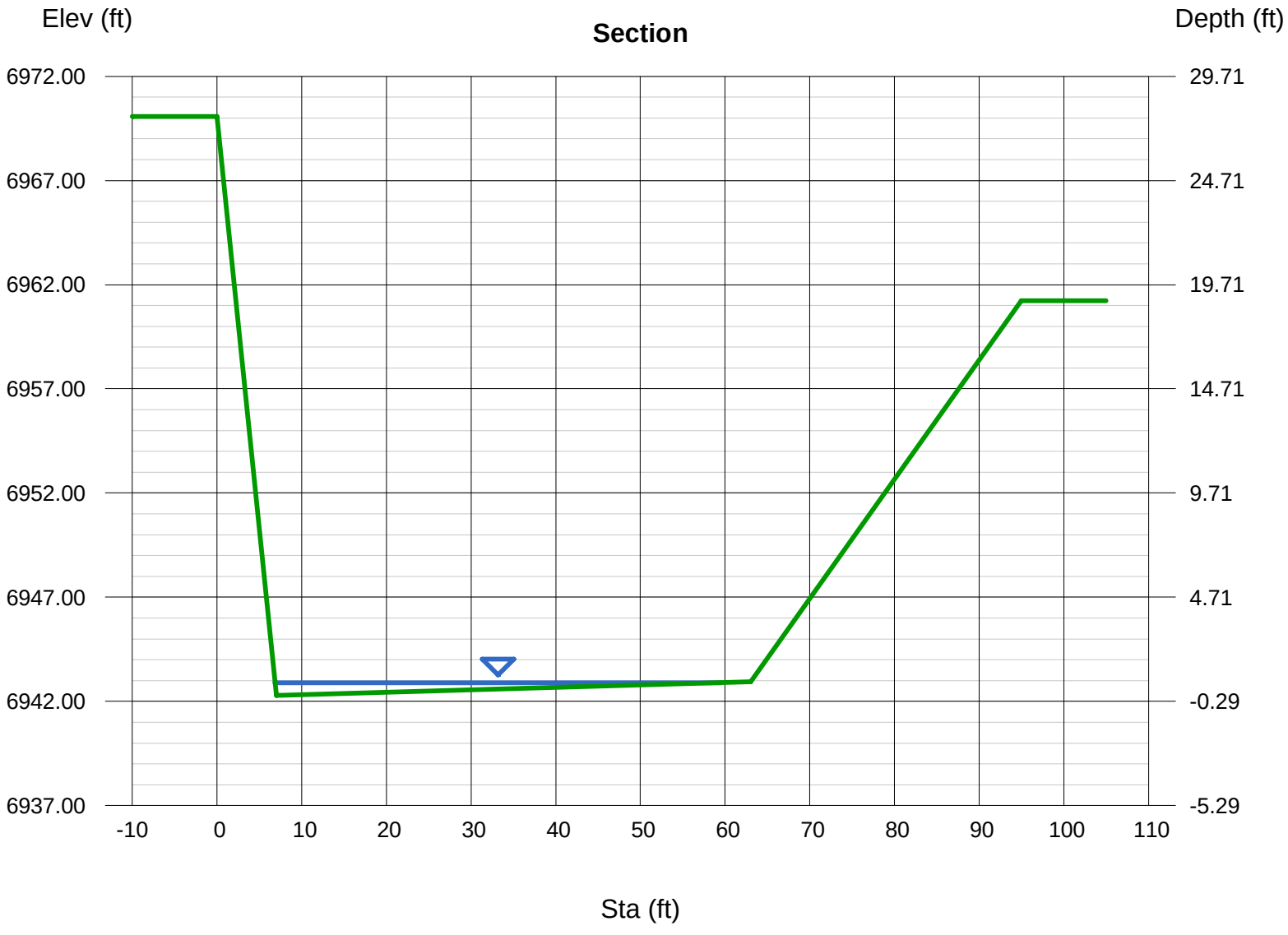
Compute by:	Known Q
Known Q (cfs)	= 176.00

Highlighted

Depth (ft)	= 0.61
Q (cfs)	= 176.00
Area (sqft)	= 16.07
Velocity (ft/s)	= 10.95
Wetted Perim (ft)	= 53.18
Crit Depth, Yc (ft)	= 1.00
Top Width (ft)	= 52.70
EGL (ft)	= 2.47

(Sta, El, n)-(Sta, El, n)...

(0.00, 6970.07) -(7.00, 6942.29, 0.030) -(63.00, 6942.94, 0.010) -(95.00, 6961.22, 0.030)



Channel Report

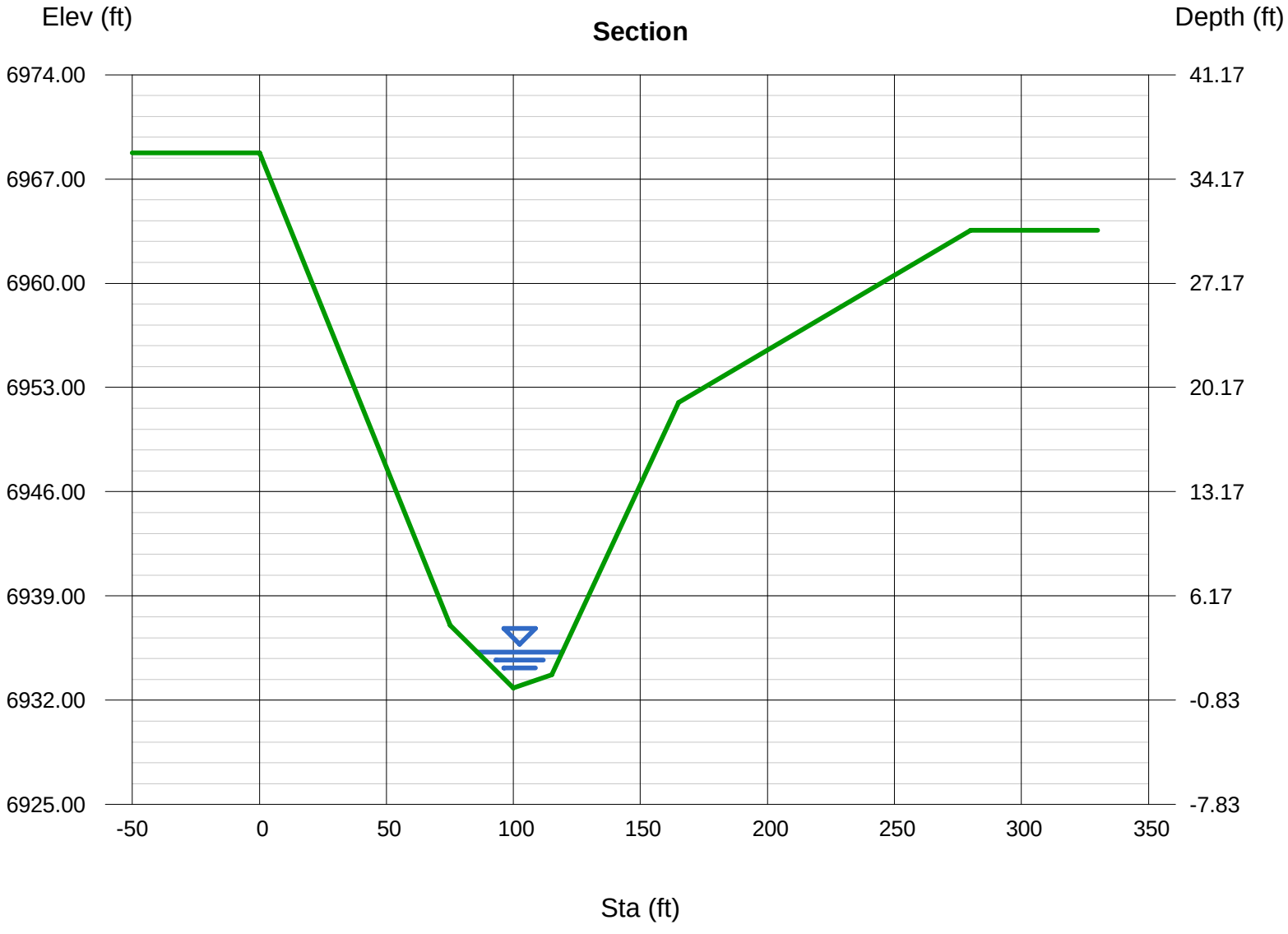
Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Wednesday, Mar 25 2026

DP3.1 - Drainage Path 3-100 Year

User-defined		Highlighted	
Invert Elev (ft)	= 6932.83	Depth (ft)	= 2.41
Slope (%)	= 3.50	Q (cfs)	= 193.40
N-Value	= 0.092	Area (sqft)	= 50.11
		Velocity (ft/s)	= 3.86
Calculations		Wetted Perim (ft)	= 34.02
Compute by:	Known Q	Crit Depth, Yc (ft)	= 1.83
Known Q (cfs)	= 193.40	Top Width (ft)	= 33.52
		EGL (ft)	= 2.64

(Sta, El, n)-(Sta, El, n)...

(0.00, 6968.77) -(75.00, 6937.04, 0.030) -(100.00, 6932.83, 0.100) -(115.00, 6933.70, 0.100) -(165.00, 6952.00, 0.030) -(280.00, 6963.54, 0.030)



PIPE OUTFALL RIPRAP SIZING CALCULATIONS

Subdivision: Canyon Creek Ranch
Location: El Paso County

Project Name: Canyon Creek Ranch
Project No.: 25322.00
Calculated By: GAG
Checked By:
Date: 8/22/25

	STORM DRAIN SYSTEM			
	DPO2	DP2.1		Notes
Q_{100} (cfs):	176.0	12.6		Flows are the greater of proposed vs. future
Conduit	Pipe	Pipe		
D_c, Pipe Diameter (in):	48	24		
W, Box Width (ft):	N/A	N/A		
H, Box Height (ft):	N/A	N/A		
Y_t, Tailwater Depth (ft):	1.60	0.80		If unknown, use Y_t/D_c (or H)=0.4
Y_t/Dc or Y_t/H	0.40	0.40		
$Q/D^{2.5}$ or $Q/(WH^{3/2})$	5.50	2.23		
Supercritical?	No	No		
Y_n, Normal Depth (ft) [Supercritical]:				
D_a, H_a (in) [Supercritical]:	N/A	N/A		$D_a=(D_c+Y_n)/2$
Riprap d_{50} (in) [Supercritical]:	N/A	N/A		
Riprap d_{50} (in) [Subcritical]:	18.23	3.69		
Required Riprap Size:	VH	L		Fig. 9-38 or Fig. 9-36
d_{50} (in):	18	9		
Expansion Factor, $1/(2\tan\theta)$:	2.10	5.50		Read from Fig. 9-35 or 9-36
θ:	0.23	0.09		
Erosive Soils?	No	No		
Area of Flow, A_t (ft^2):	25.14	1.80		$A_t=Q/V$
Length of Protection, L_p (ft):	24.6	1.4		L=(1/(2 tan θ))(At/Yt - D)
Min Length (ft)	12.0	6.0		Min L=3D or 3H
Max Length (ft)	40.0	20.0		Max L=10D or 10H
Min Bottom Width, T (ft):	15.5	2.2		$T=2*(L_p*\tan\theta)+W$
Design Length (ft)	25.0	6.0		
Design Width (ft)	15.5	2.2		
Riprap Depth (in)	36	18		Depth=2(d_{50})
Type II Bedding Depth (in)*	8	6		*Not used if Soil Riprap
Cutoff Wall	No	No		
Cutoff Wall Depth (ft)				Depth of Riprap and Base
Cutoff Wall Width (ft)				

Note: No Type II Base to be used if Soil Riprap is specified within the plans

* For use when the flow in the culvert is supercritical (and less than full).

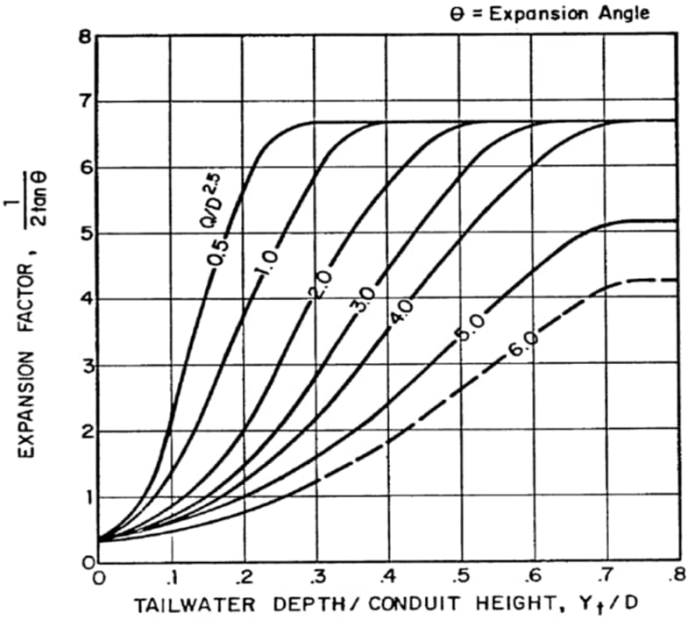


Figure 9-35. Expansion factor for circular conduits

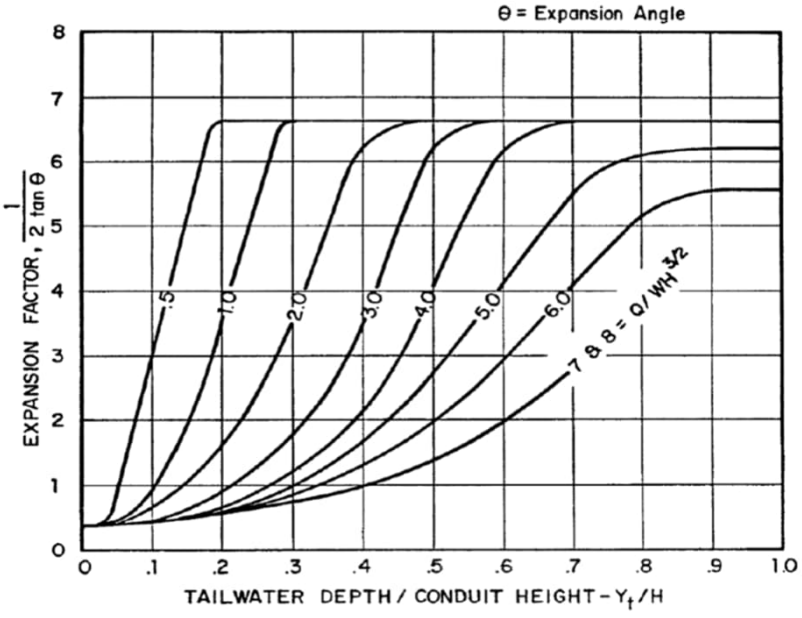


Figure 9-36. Expansion factor for rectangular conduits

Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Thursday, Aug 28 2025

Existing Kettle Creek - Basin A Capacity

User-defined

Invert Elev (ft)	= 6924.00
Slope (%)	= 0.40
N-Value	= 0.088

Calculations

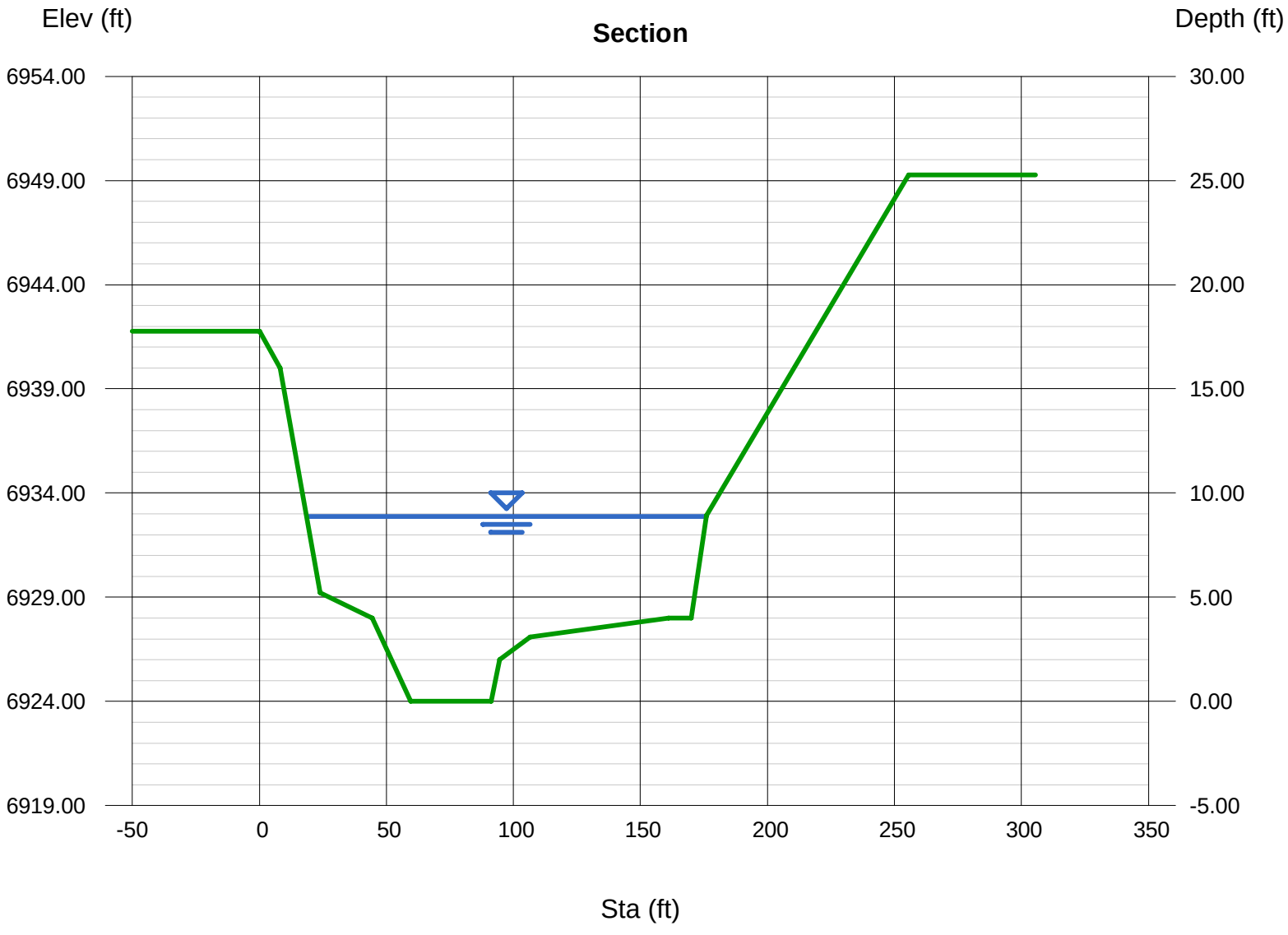
Compute by:	Known Q
Known Q (cfs)	= 3218.00

Highlighted

Depth (ft)	= 8.87
Q (cfs)	= 3,218
Area (sqft)	= 931.50
Velocity (ft/s)	= 3.45
Wetted Perim (ft)	= 161.34
Crit Depth, Yc (ft)	= 5.13
Top Width (ft)	= 157.29
EGL (ft)	= 9.06

(Sta, El, n)-(Sta, El, n)...

(0.00, 6941.77) -(8.20, 6940.00, 0.030) -(24.00, 6929.21, 0.030) -(44.50, 6928.00, 0.030) -(59.50, 6924.00, 0.100) -(91.20, 6924.00, 0.100) -(94.50, 6926.00, 0.100) -(106.50, 6927.10, 0.100) -(161.00, 6928.00, 0.100) -(170.00, 6928.00, 0.100) -(176.00, 6932.93, 0.030) -(255.50, 6949.27, 0.030)



Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Thursday, Aug 28 2025

Existing Kettle Creek - Basin A Velocity

User-defined

Invert Elev (ft)	= 6921.00
Slope (%)	= 2.65
N-Value	= 0.098

Calculations

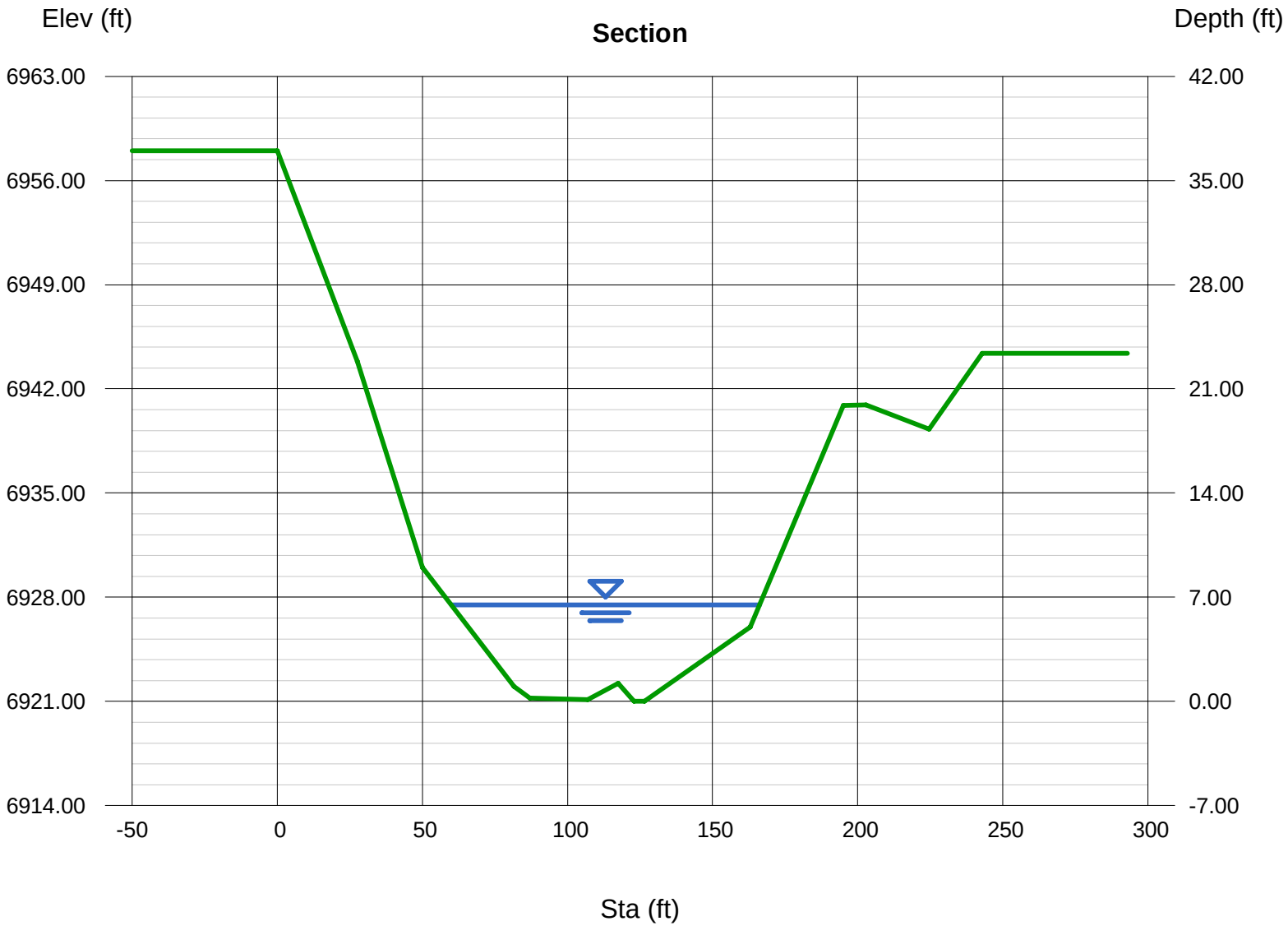
Compute by:	Known Q
Known Q (cfs)	= 3218.00

Highlighted

Depth (ft)	= 6.48
Q (cfs)	= 3,218
Area (sqft)	= 481.19
Velocity (ft/s)	= 6.69
Wetted Perim (ft)	= 107.85
Crit Depth, Yc (ft)	= 4.82
Top Width (ft)	= 106.26
EGL (ft)	= 7.18

(Sta, El, n)-(Sta, El, n)...

(0.00, 6958.00) -(27.50, 6943.85, 0.030) -(50.00, 6930.00, 0.030) -(81.50, 6922.00, 0.100) -(87.00, 6921.24, 0.100) -(107.00, 6921.12, 0.100) -(117.50, 6922.22, 0.100) -(123.00, 6921.00, 0.100) -(126.60, 6921.00, 0.100) -(163.00, 6926.00, 0.100) -(195.00, 6940.90, 0.030) -(202.80, 6940.93, 0.030) -(224.60, 6939.29, 0.030) -(243.00, 69



Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Thursday, Aug 28 2025

Existing Kettle Creek - Basin C Capacity

User-defined

Invert Elev (ft)	= 6917.38
Slope (%)	= 0.70
N-Value	= 0.084

Calculations

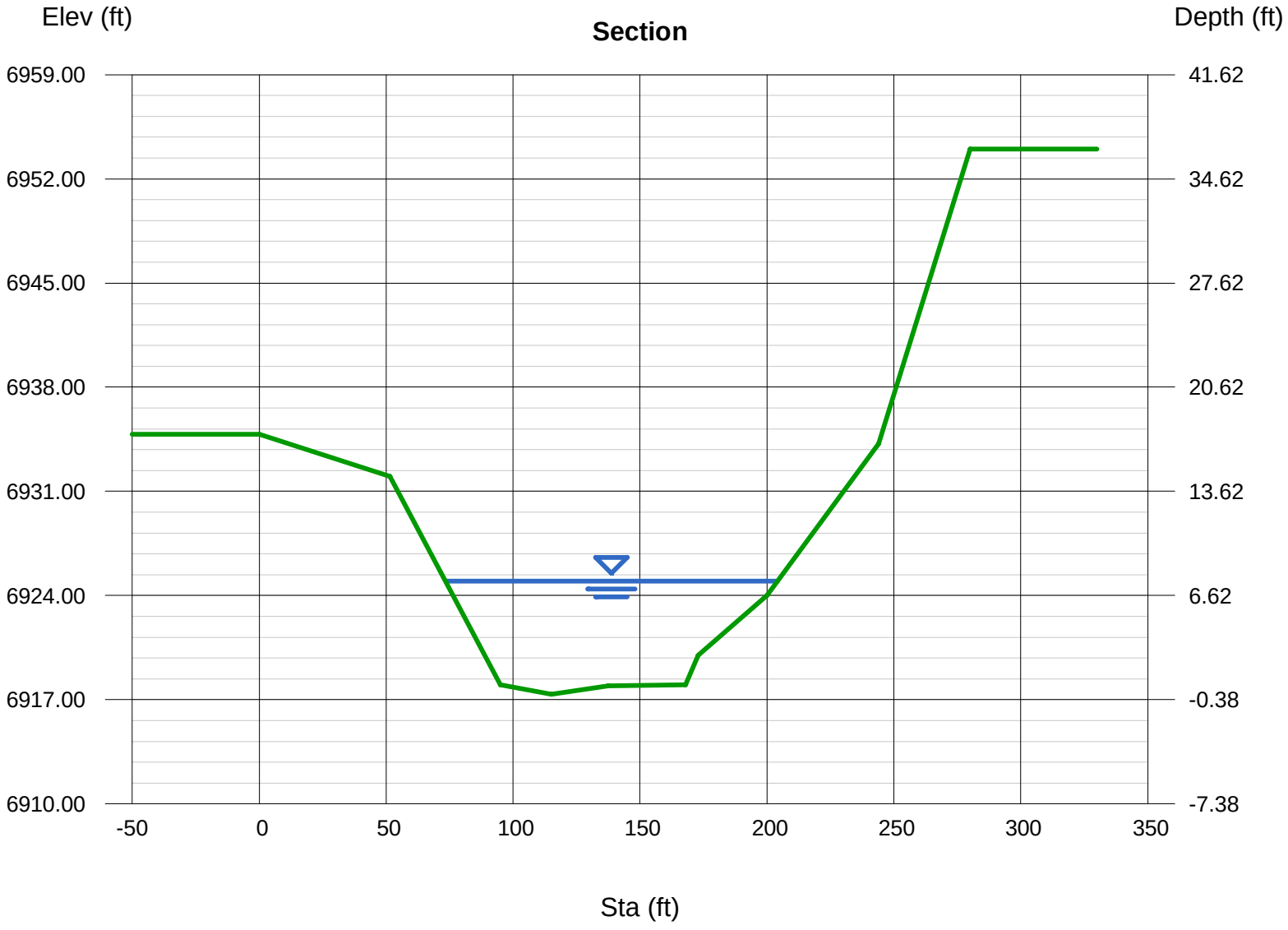
Compute by:	Known Q
Known Q (cfs)	= 3218.00

Highlighted

Depth (ft)	= 7.58
Q (cfs)	= 3,218
Area (sqft)	= 709.81
Velocity (ft/s)	= 4.53
Wetted Perim (ft)	= 132.67
Crit Depth, Yc (ft)	= 4.21
Top Width (ft)	= 130.77
EGL (ft)	= 7.90

(Sta, El, n)-(Sta, El, n)...

(0.00, 6934.82) -(51.50, 6932.00, 0.030) -(95.00, 6918.00, 0.100) -(115.00, 6917.38, 0.100) -(137.50, 6917.94, 0.100) -(168.00, 6918.00, 0.100) -(173.00, 6920.00, 0.030) -(200.00, 6924.00, 0.030) -(244.00, 6934.20, 0.030) -(280.00, 6954.00, 0.030)



Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Thursday, Aug 28 2025

Existing Kettle Creek - Basin C Velocity

User-defined

Invert Elev (ft)	= 6918.07
Slope (%)	= 2.75
N-Value	= 0.094

Calculations

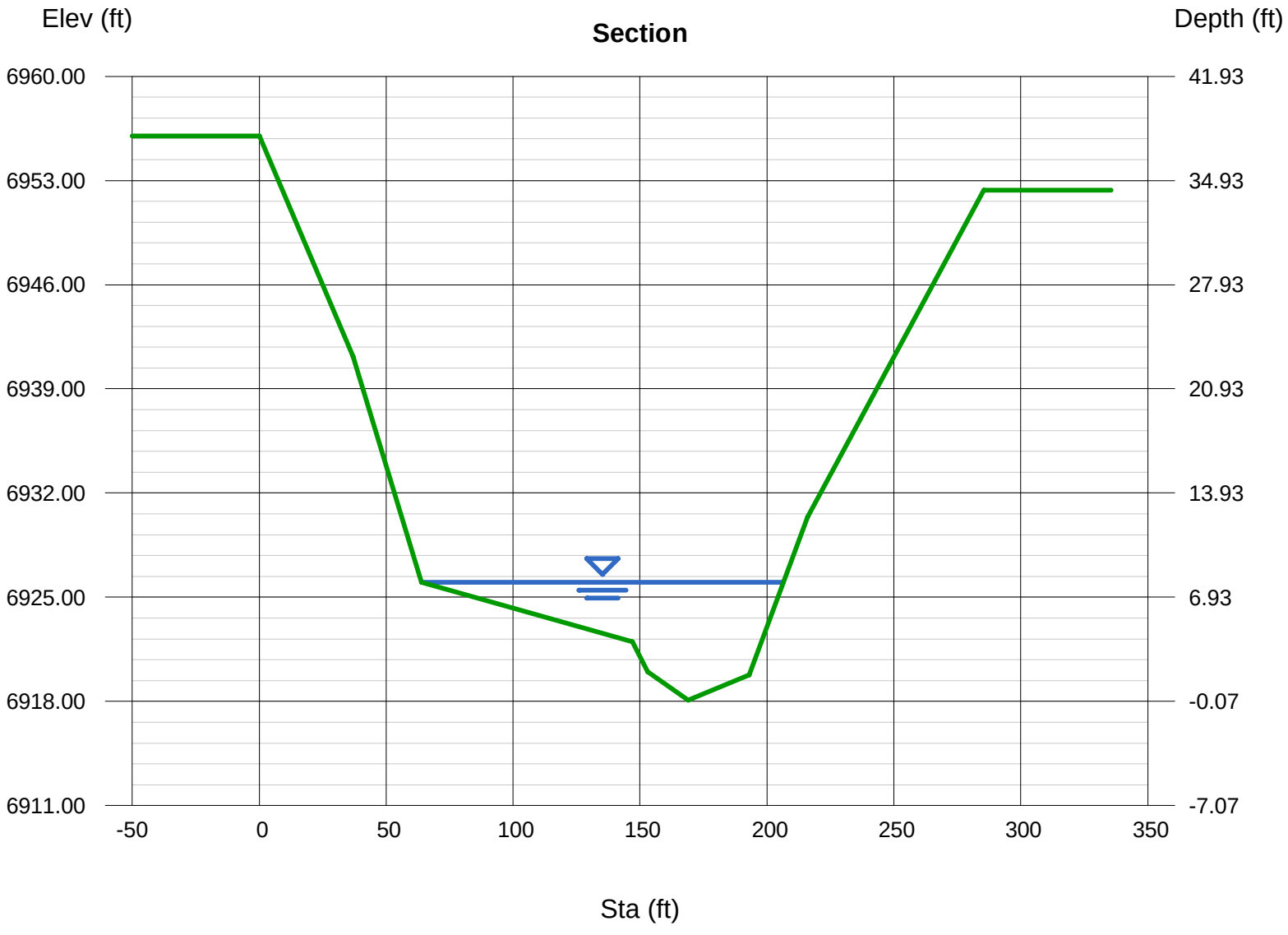
Compute by:	Known Q
Known Q (cfs)	= 3218.00

Highlighted

Depth (ft)	= 7.95
Q (cfs)	= 3,218
Area (sqft)	= 522.21
Velocity (ft/s)	= 6.16
Wetted Perim (ft)	= 144.54
Crit Depth, Yc (ft)	= 6.38
Top Width (ft)	= 142.56
EGL (ft)	= 8.54

(Sta, El, n)-(Sta, El, n)...

(0.00, 6956.00) -(37.00, 6941.16, 0.030) -(64.00, 6926.00, 0.030) -(147.00, 6922.00, 0.100) -(153.00, 6920.00, 0.100) -(169.00, 6918.07, 0.100) -(193.00, 6919.77, 0.100) -(216.00, 6930.40, 0.030) -(285.50, 6952.35, 0.030)



Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Thursday, Aug 28 2025

Existing Kettle Creek - Basin D Capacity

User-defined

Invert Elev (ft)	= 6908.00
Slope (%)	= 0.50
N-Value	= 0.093

Calculations

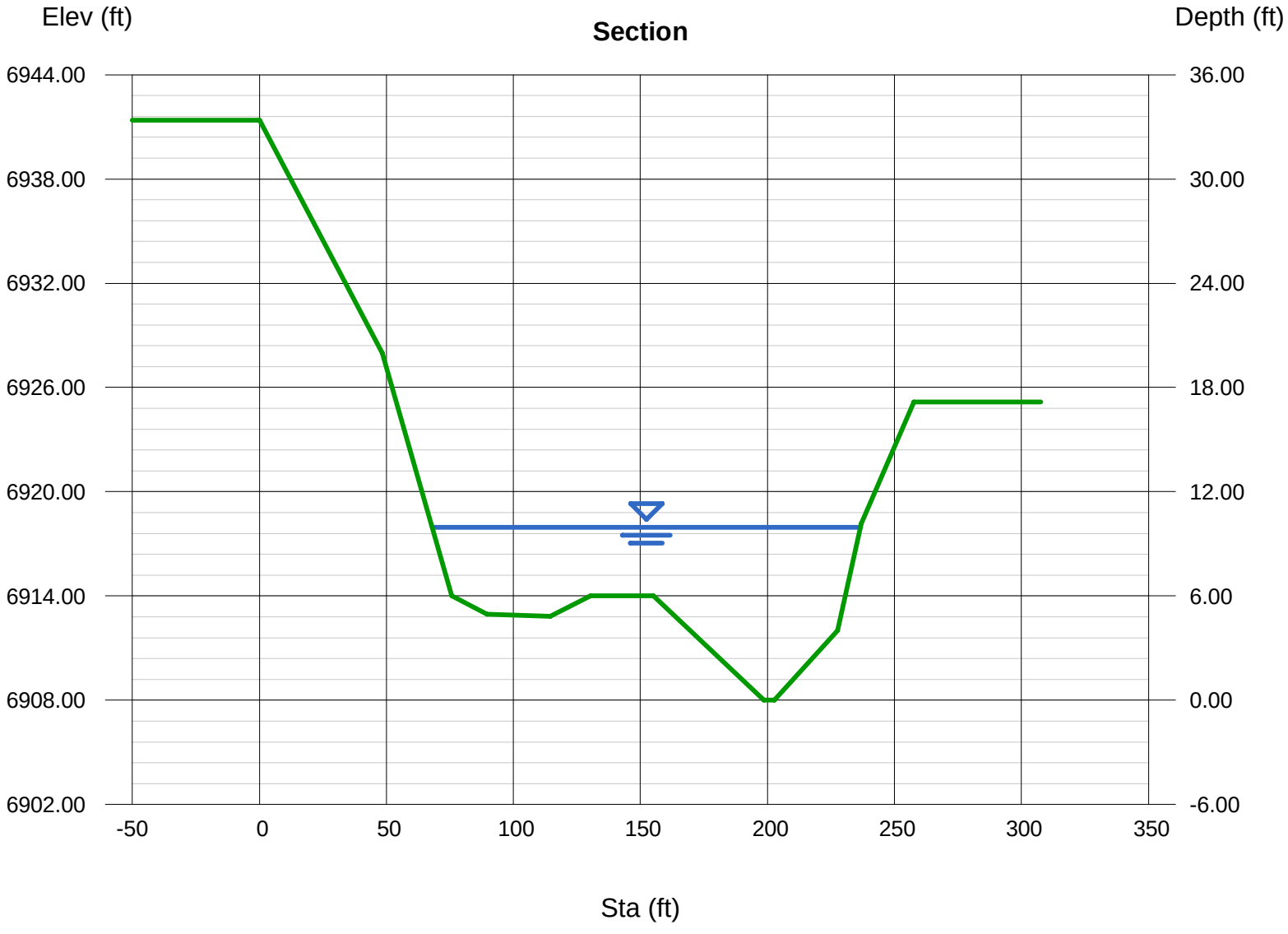
Compute by:	Known Q
Known Q (cfs)	= 3283.00

Highlighted

Depth (ft)	= 9.95
Q (cfs)	= 3,283
Area (sqft)	= 941.81
Velocity (ft/s)	= 3.49
Wetted Perim (ft)	= 172.19
Crit Depth, Yc (ft)	= 6.46
Top Width (ft)	= 168.64
EGL (ft)	= 10.14

(Sta, El, n)-(Sta, El, n)...

(0.00, 6941.37) -(48.30, 6928.00, 0.030) -(75.80, 6914.00, 0.030) -(89.70, 6912.94, 0.100) -(114.50, 6912.84, 0.100) -(130.40, 6914.00, 0.100) -(155.00, 6914.00, 0.100) -(198.60, 6908.00, 0.100) -(202.80, 6908.00, 0.100) -(227.70, 6912.00, 0.100) -(237.00, 6918.16, 0.030) -(257.70, 6925.18, 0.030)



Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Thursday, Aug 28 2025

Existing Kettle Creek - Basin D Velocity

User-defined

Invert Elev (ft)	= 6912.00
Slope (%)	= 1.95
N-Value	= 0.099

Calculations

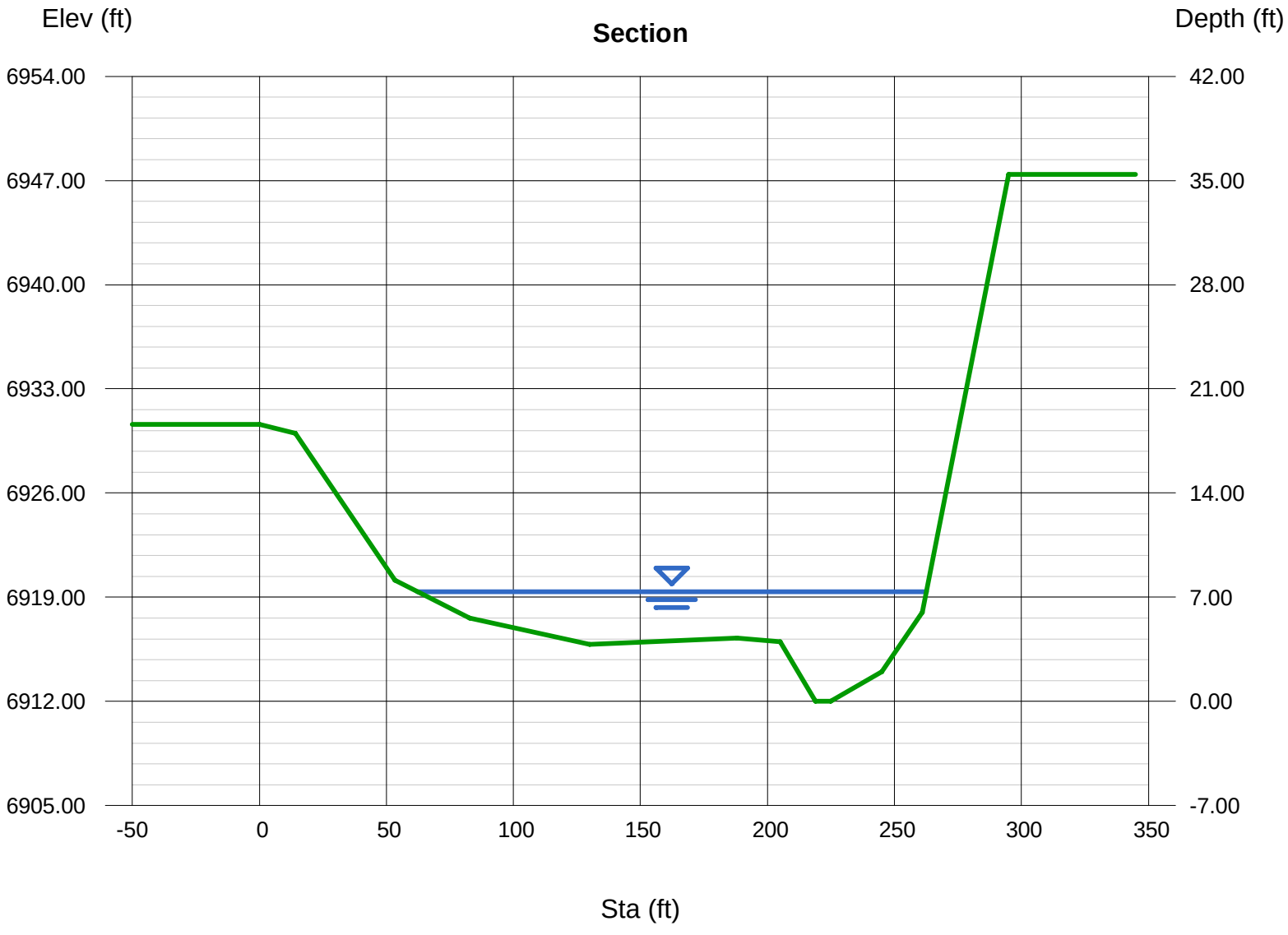
Compute by:	Known Q
Known Q (cfs)	= 3283.00

Highlighted

Depth (ft)	= 7.37
Q (cfs)	= 3,283
Area (sqft)	= 693.40
Velocity (ft/s)	= 4.73
Wetted Perim (ft)	= 202.19
Crit Depth, Yc (ft)	= 5.79
Top Width (ft)	= 200.42
EGL (ft)	= 7.72

(Sta, El, n)-(Sta, El, n)...

(0.00, 6930.63) -(14.10, 6930.00, 0.030) -(53.30, 6920.13, 0.100) -(82.70, 6917.61, 0.100) -(130.00, 6915.84, 0.100) -(188.00, 6916.24, 0.100) -(205.00, 6916.00, 0.100) -(219.00, 6912.00, 0.100) -(225.00, 6912.00, 0.100) -(245.00, 6914.00, 0.100) -(261.00, 6918.00, 0.100) -(295.00, 6947.42, 0.030)



Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Thursday, Aug 28 2025

Existing Kettle Creek - Basin E Capacity and Velocity

User-defined

Invert Elev (ft)	= 6898.00
Slope (%)	= 0.70
N-Value	= 0.047

Calculations

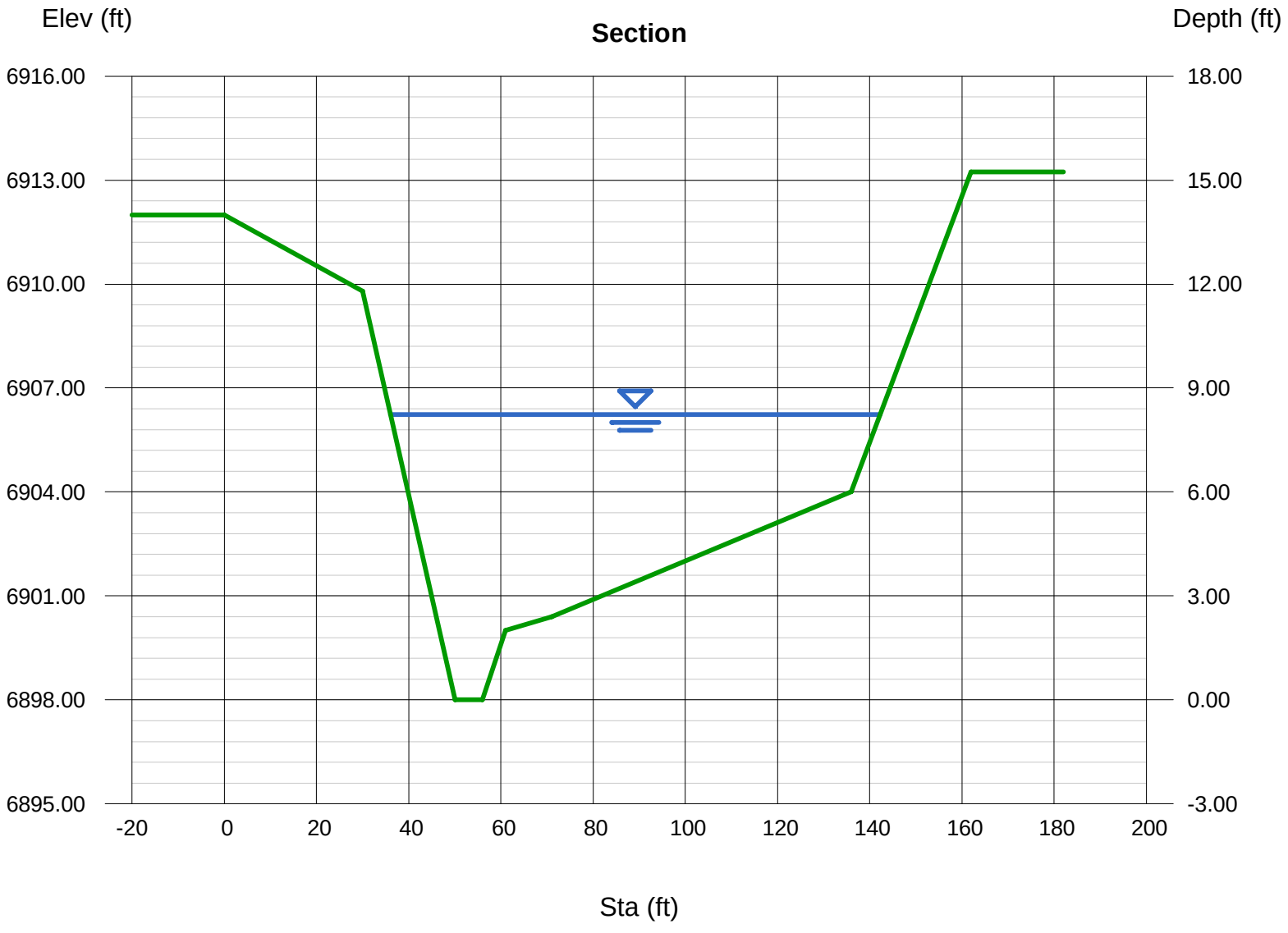
Compute by:	Known Q
Known Q (cfs)	= 3281.00

Highlighted

Depth (ft)	= 8.24
Q (cfs)	= 3,281
Area (sqft)	= 473.27
Velocity (ft/s)	= 6.93
Wetted Perim (ft)	= 109.40
Crit Depth, Yc (ft)	= 6.77
Top Width (ft)	= 106.27
EGL (ft)	= 8.99

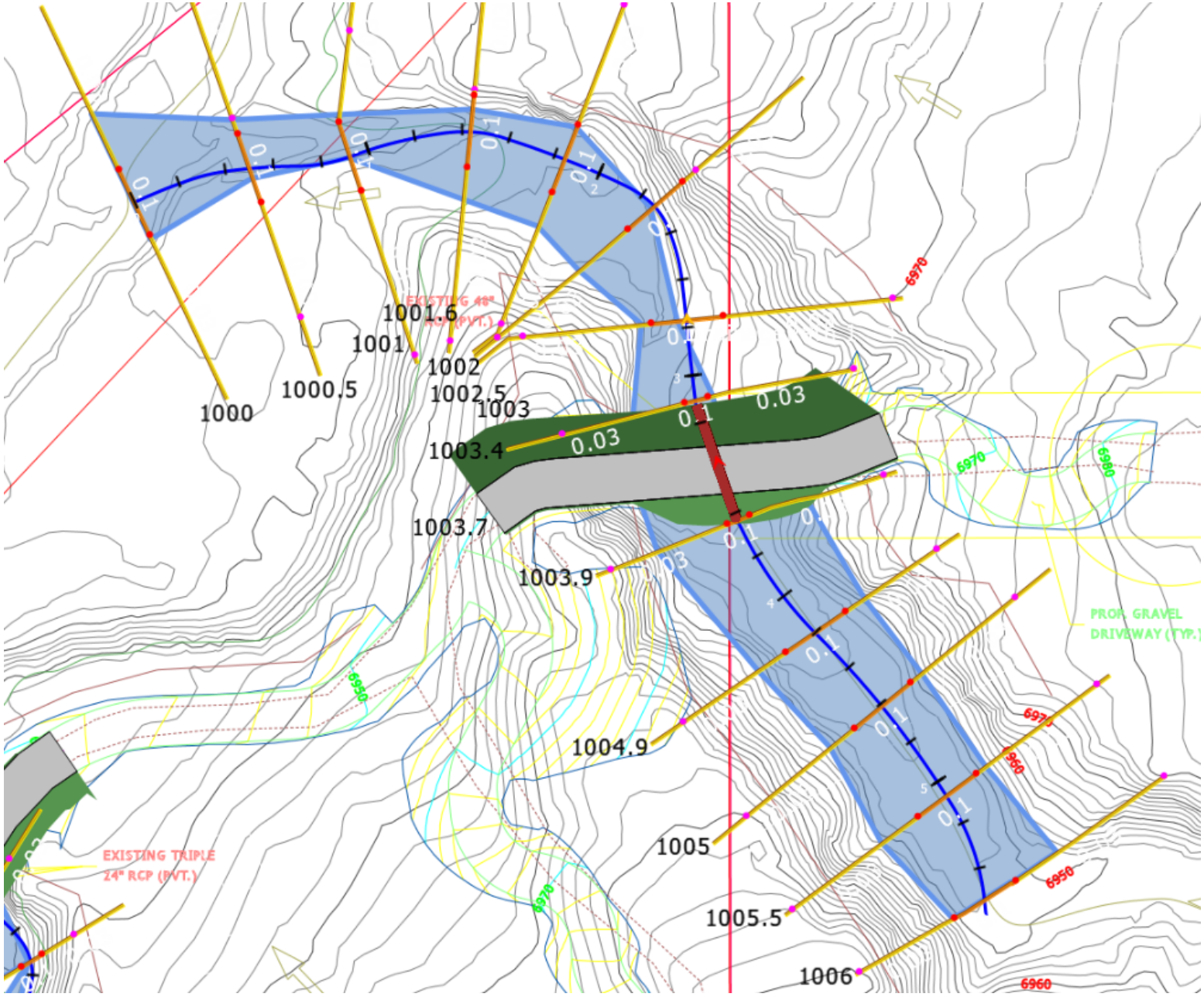
(Sta, El, n)-(Sta, El, n)...

(0.00, 6912.00) -(30.00, 6909.80, 0.030) -(50.00, 6898.00, 0.030) -(56.00, 6898.00, 0.100) -(61.00, 6900.00, 0.100) -(71.00, 6900.40, 0.100) -(136.00, 6904.00, 0.030) -(162.00, 6913.24, 0.030)

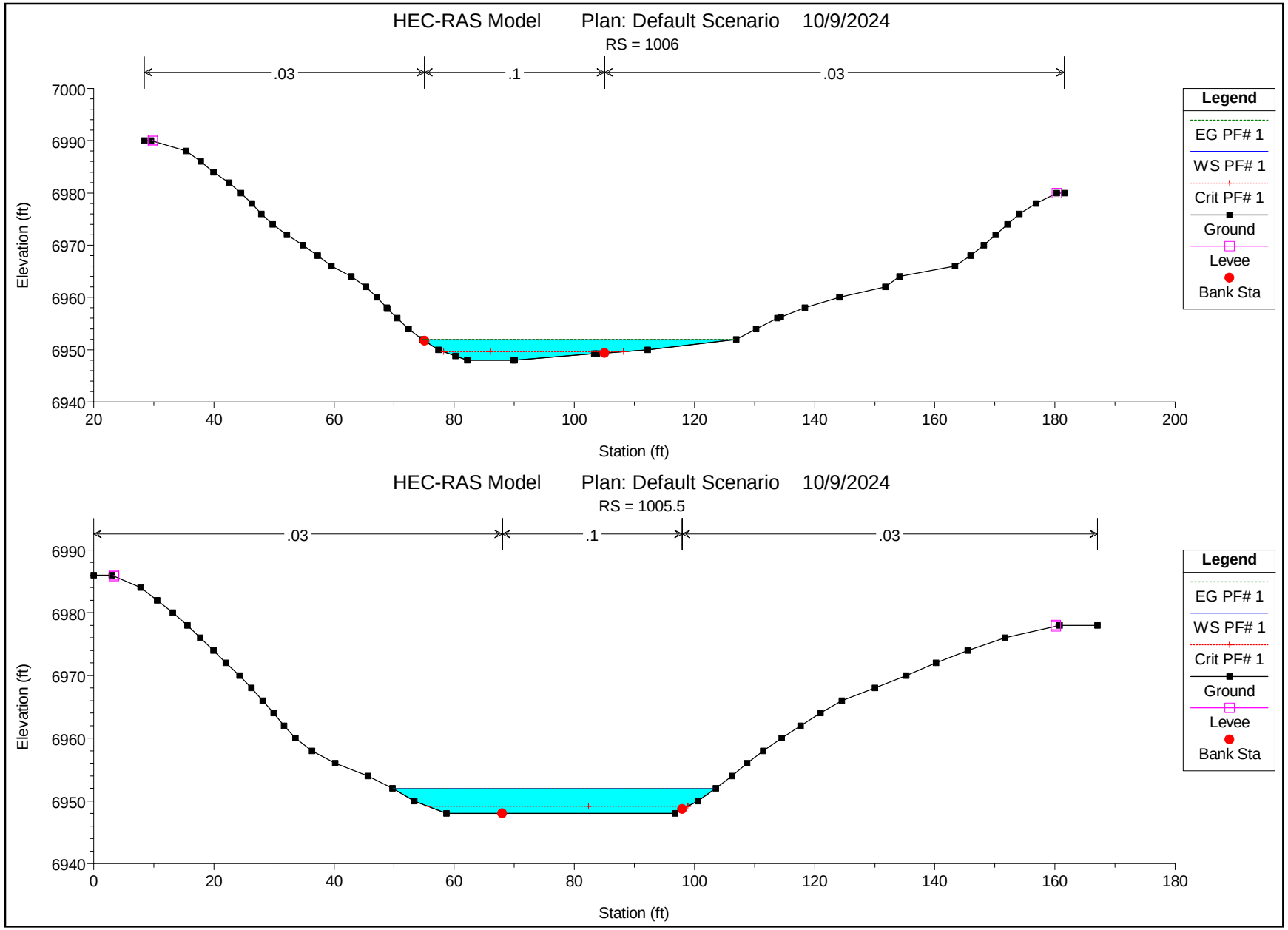


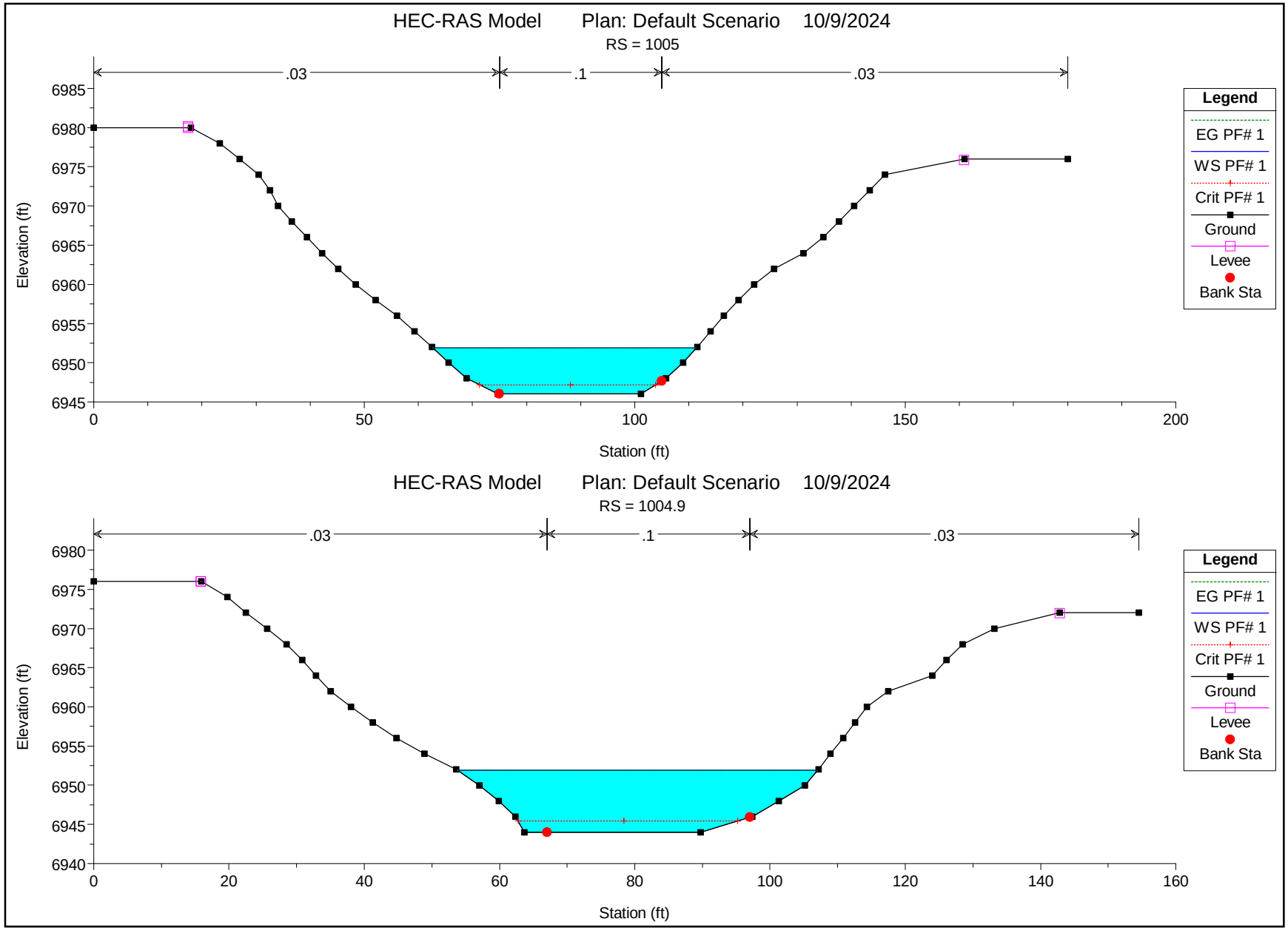
HEC-RAS Plan: Default Scenario River: DrainagePath 1 Reach: 1 Profile: PF# 1

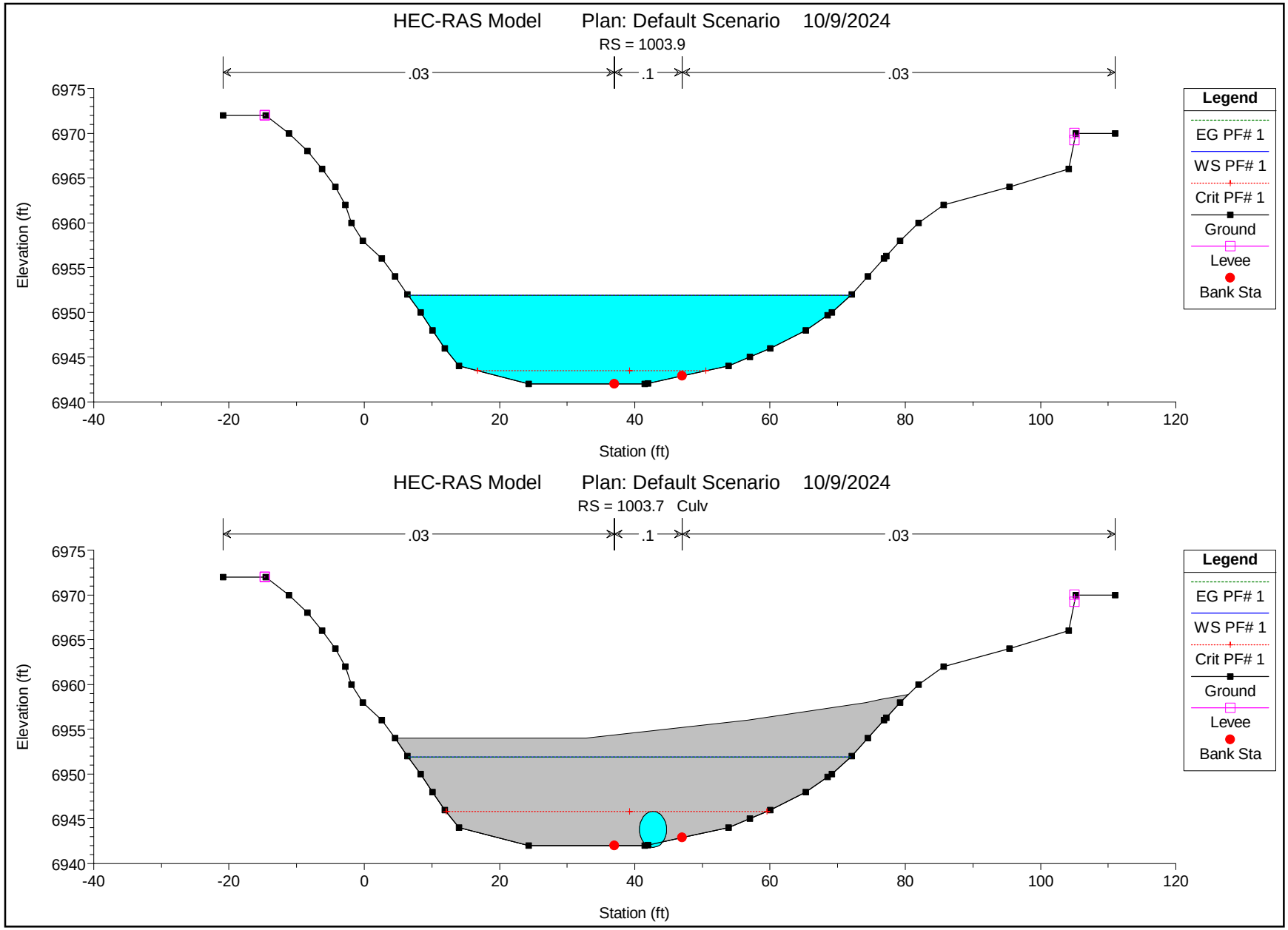
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear LOB	Shear Chan	Shear ROB
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)	(lb/sq ft)	(lb/sq ft)
1	1006	PF# 1	176.00	6948.00	6951.91	6949.64	6951.96	0.001344	1.15	124.88	51.48	0.11	0.01	0.26	0.12
1	1005.5	PF# 1	176.00	6948.00	6951.90	6949.15	6951.93	0.000286	0.62	180.87	53.48	0.06	0.05	0.07	0.03
1	1005	PF# 1	176.00	6946.00	6951.90	6947.17	6951.91	0.000162	0.60	230.93	48.75	0.04	0.03	0.06	0.02
1	1004.9	PF# 1	176.00	6944.00	6951.90	6945.43	6951.91	0.000056	0.43	323.32	53.28	0.03	0.01	0.03	0.01
1	1003.9	PF# 1	176.00	6942.00	6951.90	6943.46	6951.90	0.000006	0.16	484.35	65.44	0.01	0.00	0.00	0.00
1	1003.7		Culvert												
1	1003.4	PF# 1	176.00	6939.06	6940.68	6940.66	6941.19	0.024549	3.21	35.23	33.96	0.44	1.19	2.48	1.05
1	1003	PF# 1	176.00	6936.00	6938.73	6938.73	6939.77	0.081231	6.20	24.95	14.94	0.79	4.27	8.99	
1	1002.5	PF# 1	176.00	6936.00	6936.94	6937.07	6937.59	0.024915	2.11	33.48	39.47	0.40	1.30	1.33	
1	1002	PF# 1	176.00	6934.00	6935.54	6935.19	6935.79	0.035765	3.44	47.01	44.10	0.52	1.02	3.02	
1	1001.6	PF# 1	176.00	6932.00	6933.64	6933.43	6934.00	0.054100	4.19	38.74	37.47	0.63	1.45	4.51	
1	1001	PF# 1	176.00	6928.00	6930.09	6929.84	6930.66	0.078747	5.96	29.22	18.69	0.78		8.40	1.90
1	1000.5	PF# 1	176.00	6926.00	6927.63	6927.63	6928.30	0.041625	3.93	35.58	25.68	0.56		3.83	2.49
1	1000	PF# 1	176.00	6924.00	6924.55	6924.83	6925.51	0.076573	2.77	31.13	57.53	0.66	1.85	2.64	2.56

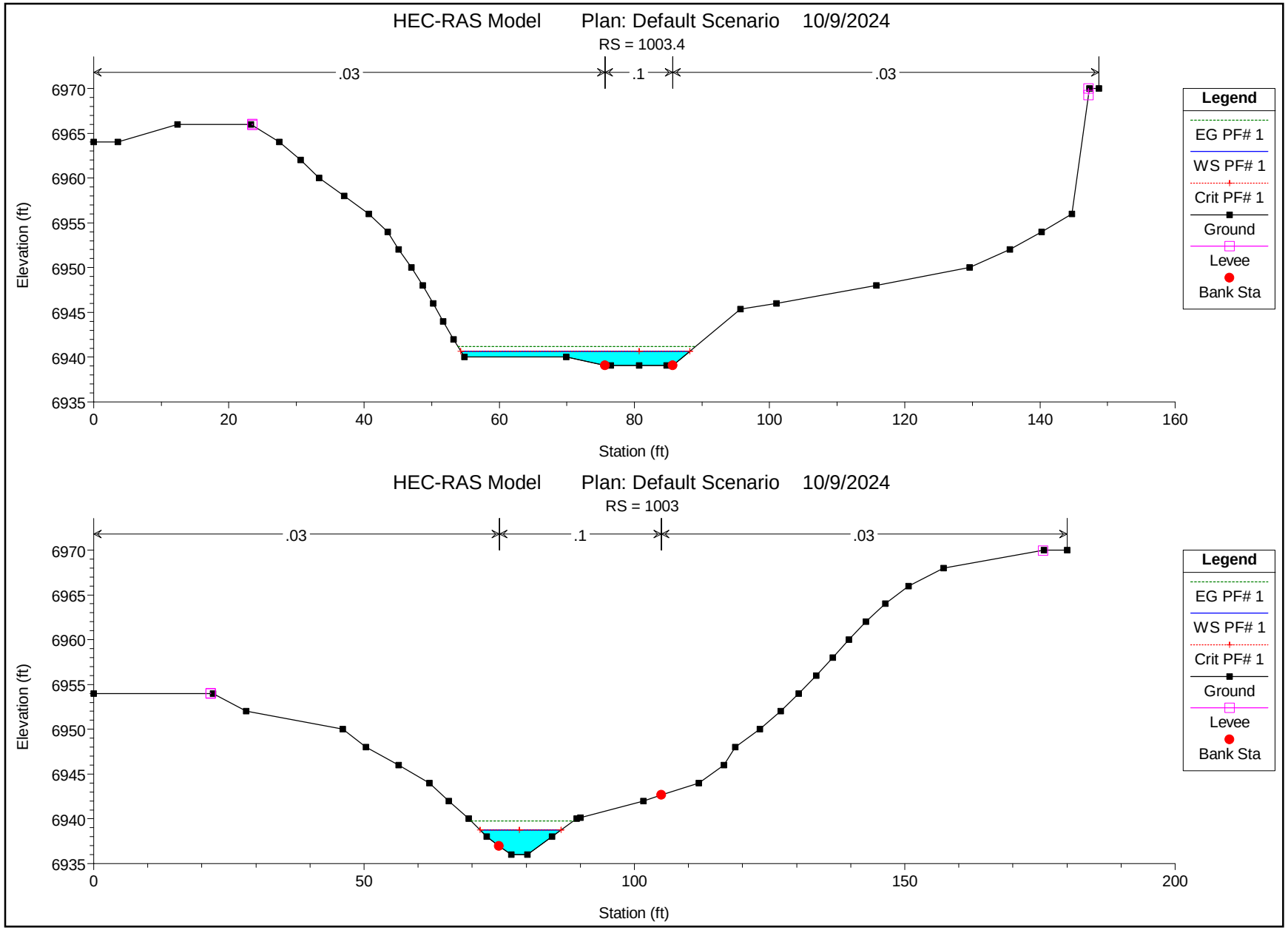


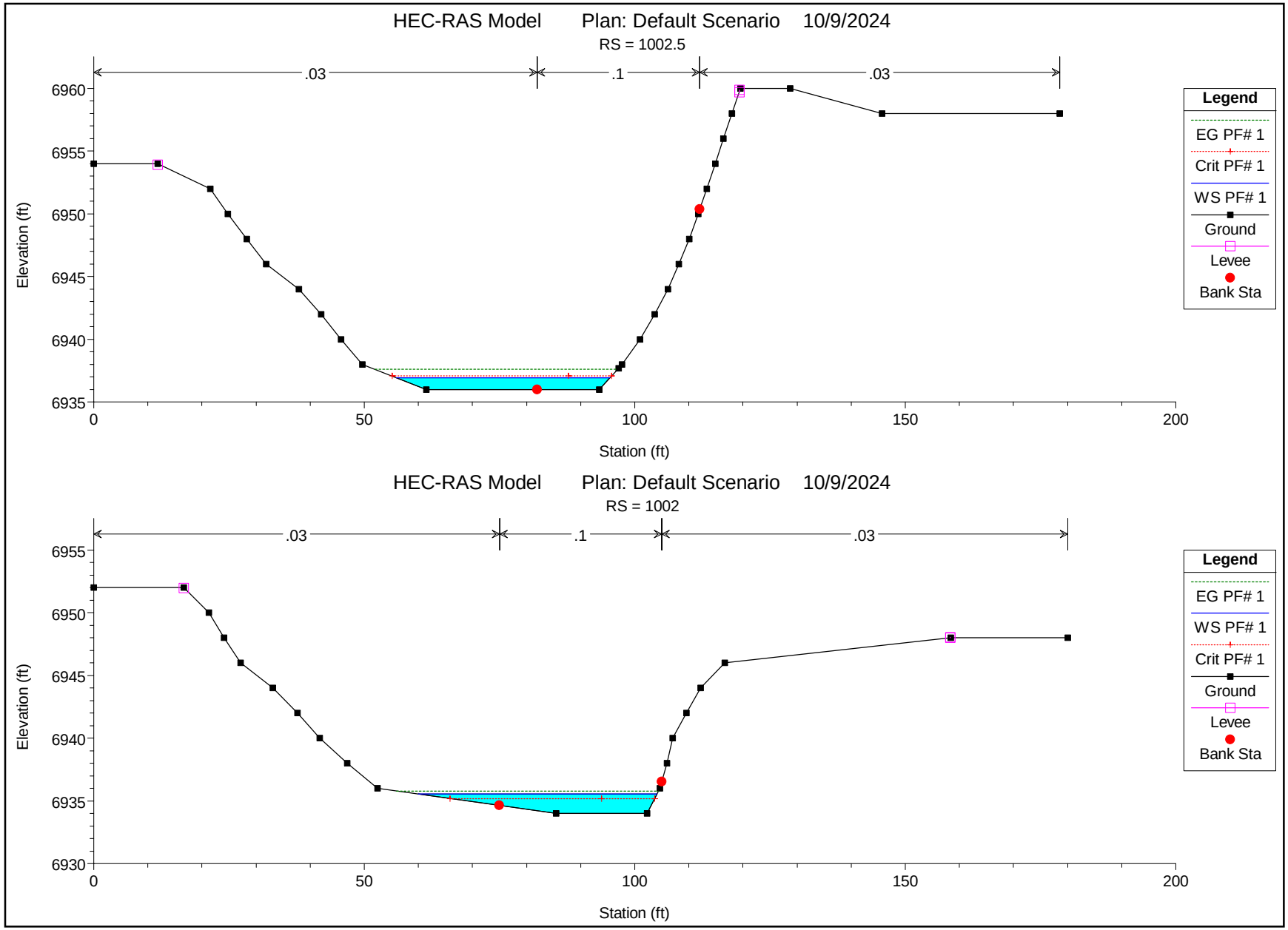
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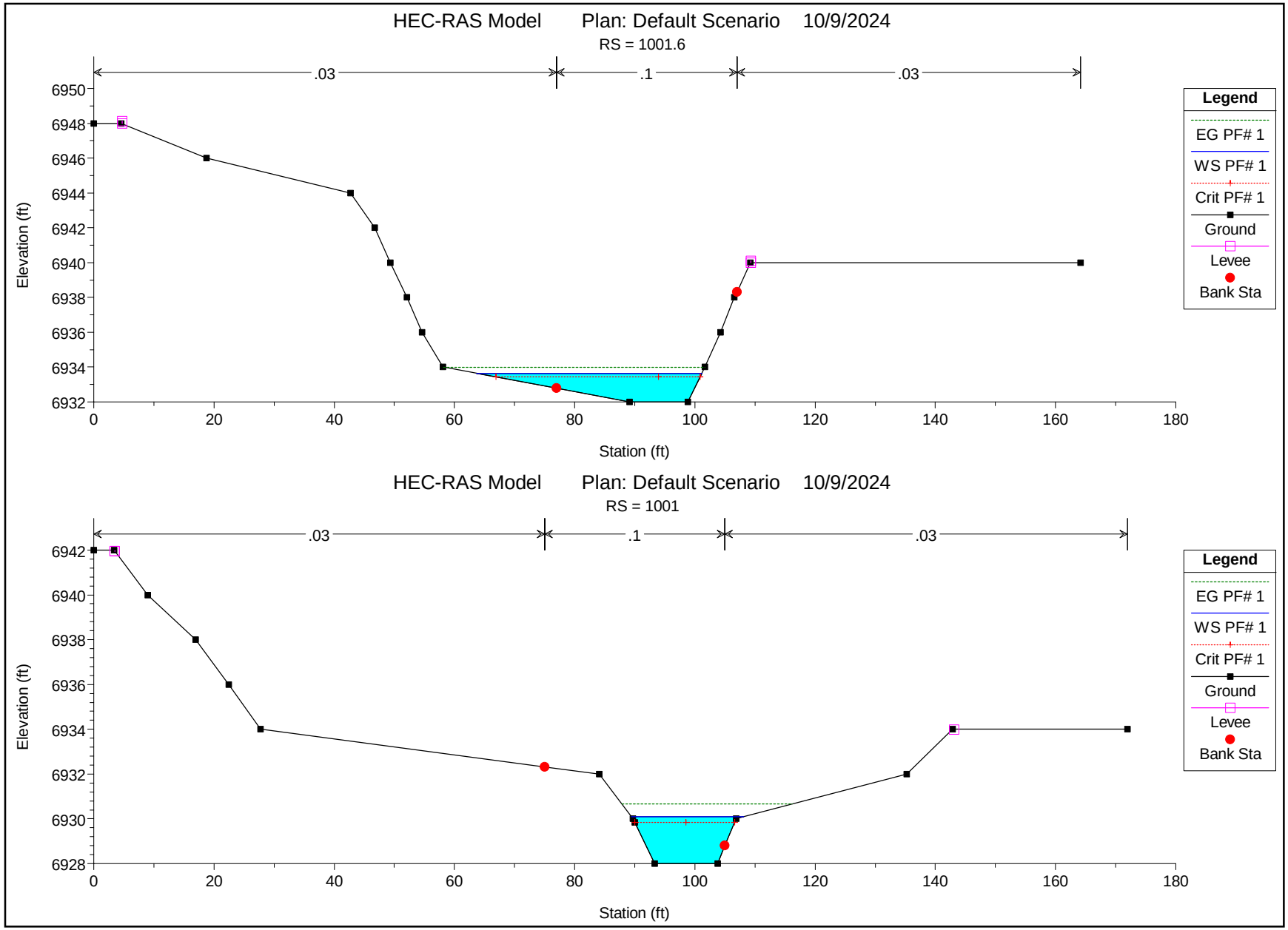

HEC-RAS Model Plan: Default Scenario 10/9/2024
RS = 1006
.03
.1
.03
Elevation (ft)
Station (ft)
Legend
EG PF# 1
WS PF# 1
Crit PF# 1
Ground
Levee
Bank Sta
HEC-RAS Model Plan: Default Scenario 10/9/2024
RS = 1005.5
.03
.1
.03
Elevation (ft)
Station (ft)
Legend
EG PF# 1
WS PF# 1
Crit PF# 1
Ground
Levee
Bank Sta

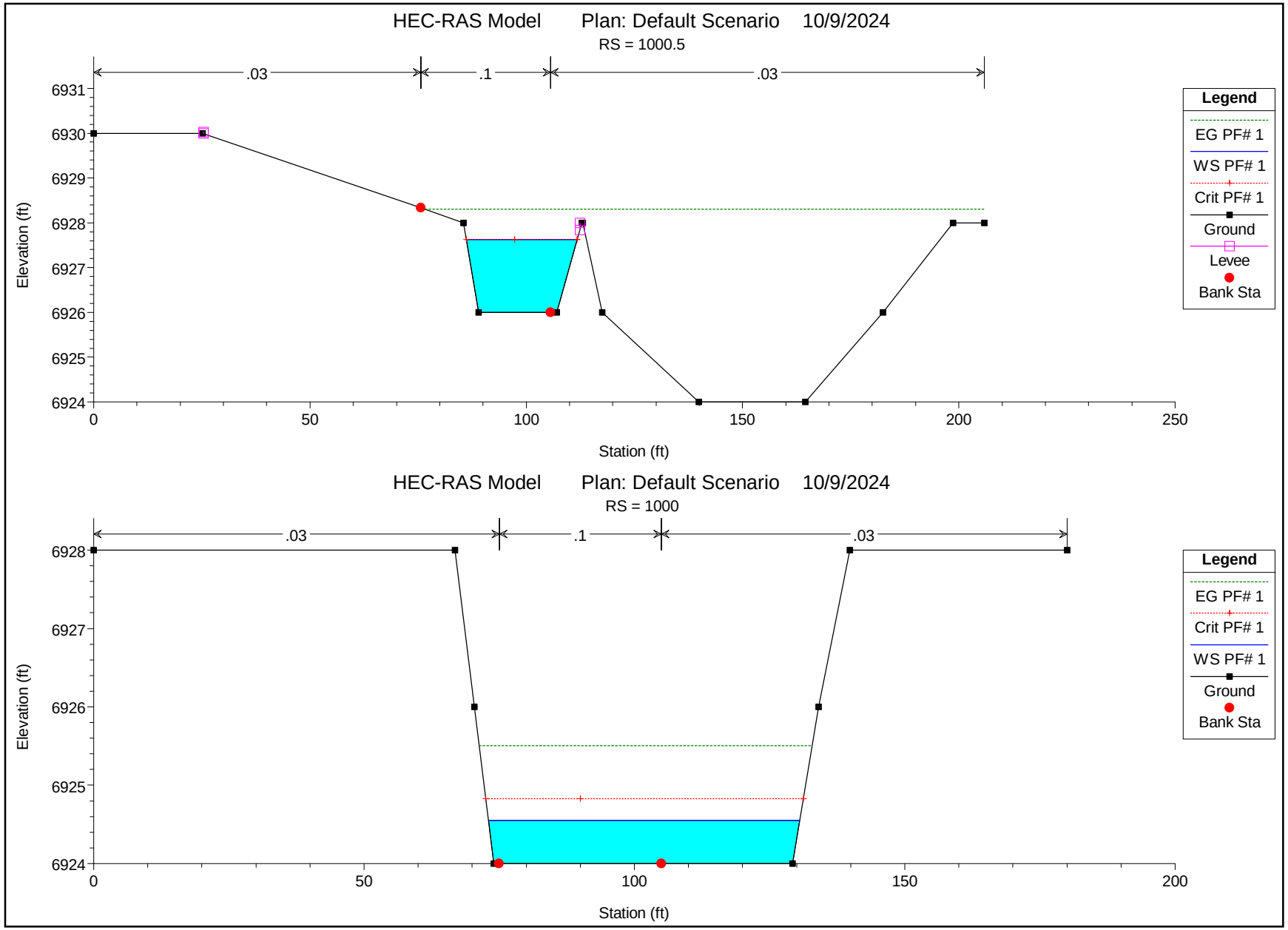

HEC-RAS Model Plan: Default Scenario 10/9/2024
RS = 1005
.03
.1
.03
Elevation (ft)
6985
6980
6975
6970
6965
6960
6955
6950
6945
0
50
100
150
200
Station (ft)
Legend
EG PF# 1
WS PF# 1
Crit PF# 1
Ground
Levee
Bank Sta
HEC-RAS Model Plan: Default Scenario 10/9/2024
RS = 1004.9
.03
.1
.03
Elevation (ft)
6980
6975
6970
6965
6960
6955
6950
6945
6940
0
20
40
60
80
100
120
140
160
Station (ft)
Legend
EG PF# 1
WS PF# 1
Crit PF# 1
Ground
Levee
Bank Sta

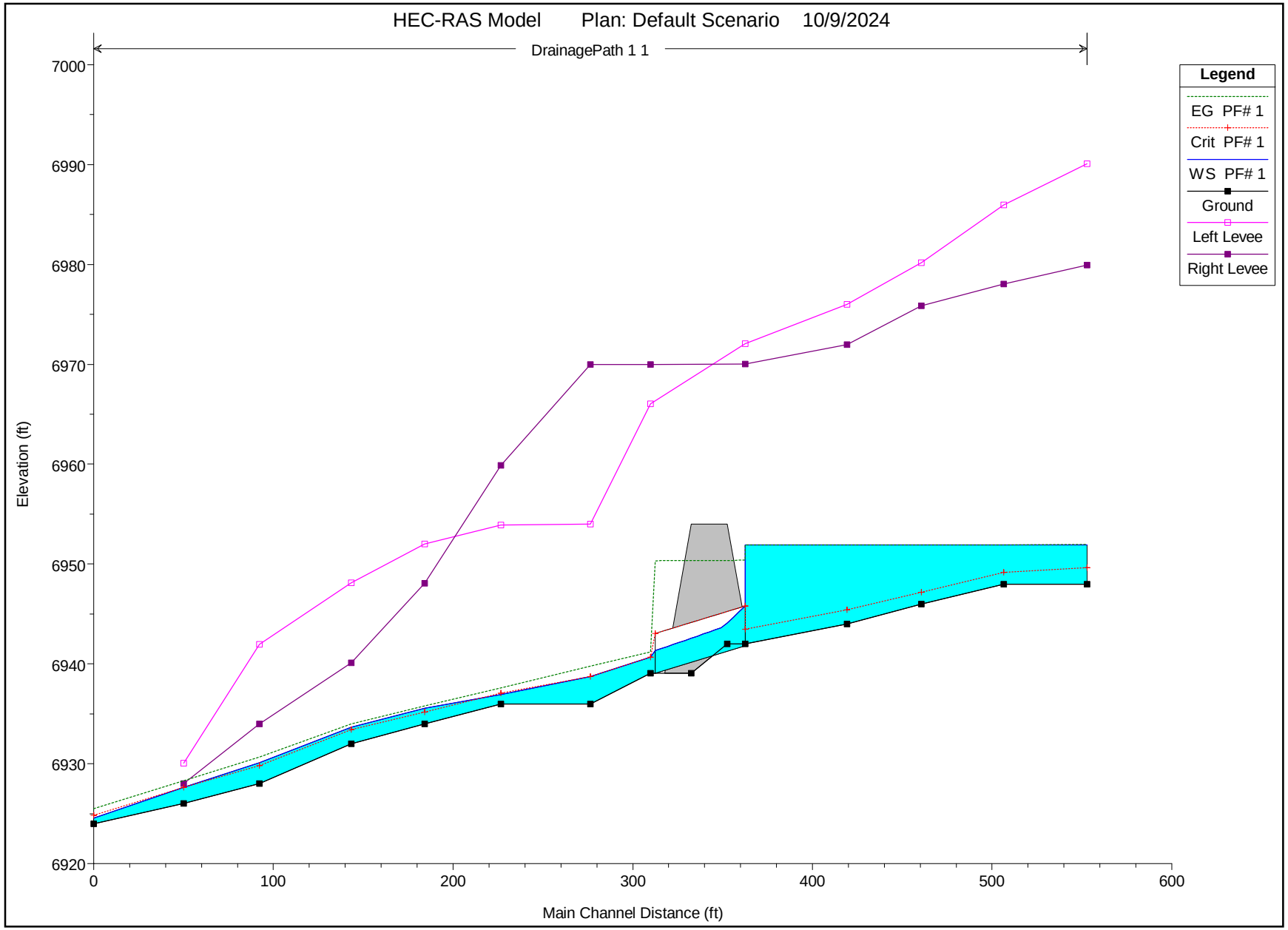

HEC-RAS Model Plan: Default Scenario 10/9/2024
RS = 1003.9
.03
.1
.03
Elevation (ft)
6975
6970
6965
6960
6955
6950
6945
6940
-40
-20
0
20
40
60
80
100
120
Station (ft)
Legend
EG PF# 1
WS PF# 1
Crit PF# 1
Ground
Levee
Bank Sta
HEC-RAS Model Plan: Default Scenario 10/9/2024
RS = 1003.7 Culv
.03
.1
.03
Elevation (ft)
6975
6970
6965
6960
6955
6950
6945
6940
-40
-20
0
20
40
60
80
100
120
Station (ft)
Legend
EG PF# 1
WS PF# 1
Crit PF# 1
Ground
Levee
Bank Sta


HEC-RAS Model Plan: Default Scenario 10/9/2024
RS = 1003.4
.03
.1
.03
Elevation (ft)
6970
6965
6960
6955
6950
6945
6940
6935
0
20
40
60
80
100
120
140
160
Station (ft)
Legend
EG PF# 1
WS PF# 1
Crit PF# 1
Ground
Levee
Bank Sta
HEC-RAS Model Plan: Default Scenario 10/9/2024
RS = 1003
.03
.1
.03
Elevation (ft)
6970
6965
6960
6955
6950
6945
6940
6935
0
50
100
150
200
Station (ft)
Legend
EG PF# 1
WS PF# 1
Crit PF# 1
Ground
Levee
Bank Sta


HEC-RAS Model Plan: Default Scenario 10/9/2024
RS = 1002.5
.03
.1
.03
6960
6955
6950
6945
6940
6935
Elevation (ft)
0
50
100
150
200
Station (ft)
Legend
EG PF# 1
Crit PF# 1
WS PF# 1
Ground
Levee
Bank Sta
HEC-RAS Model Plan: Default Scenario 10/9/2024
RS = 1002
.03
.1
.03
6955
6950
6945
6940
6935
6930
Elevation (ft)
0
50
100
150
200
Station (ft)
Legend
EG PF# 1
WS PF# 1
Crit PF# 1
Ground
Levee
Bank Sta

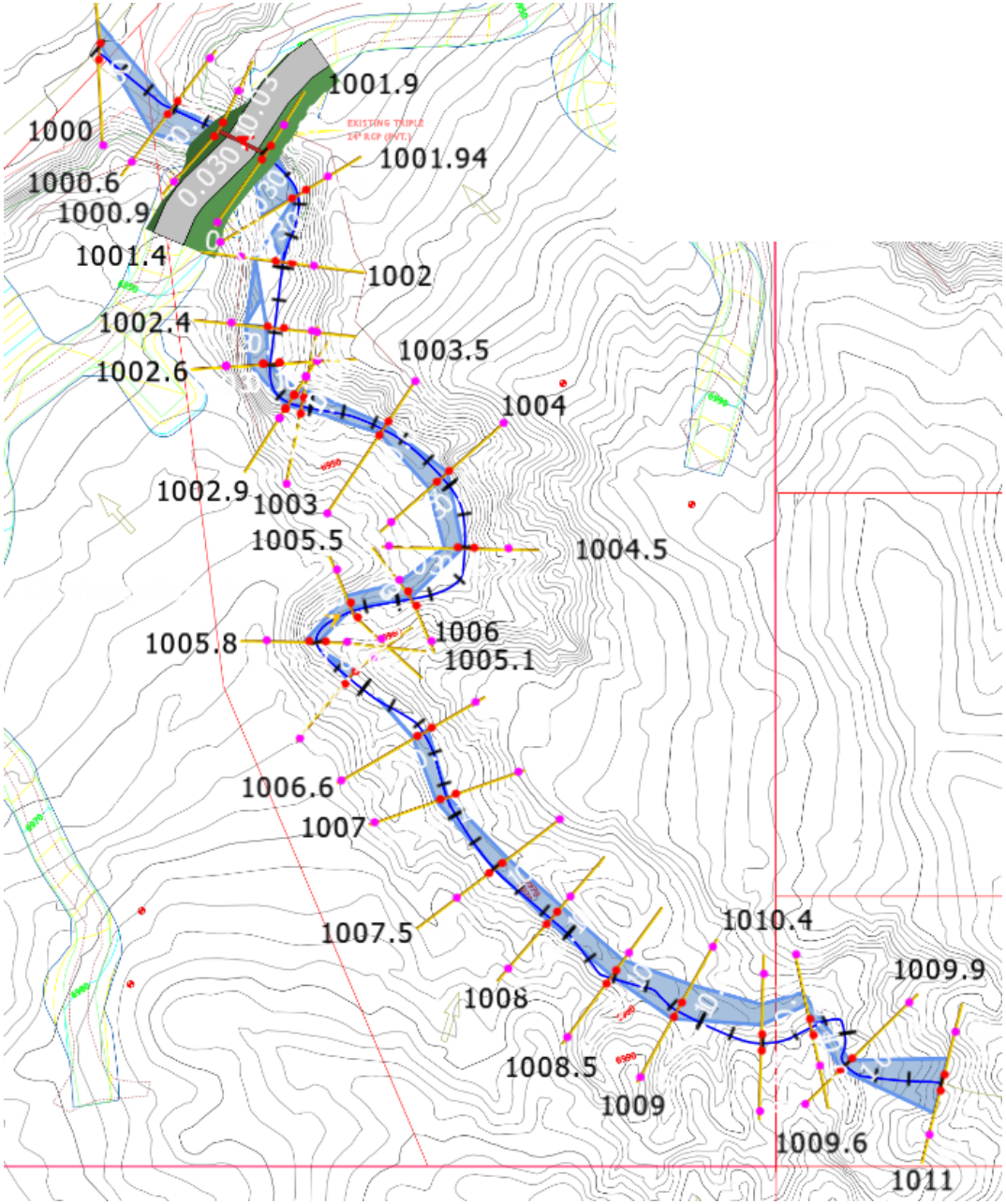

HEC-RAS Model Plan: Default Scenario 10/9/2024
RS = 1001.6
.03
.1
.03
Elevation (ft)
6950
6948
6946
6944
6942
6940
6938
6936
6934
6932
0
20
40
60
80
100
120
140
160
180
Station (ft)
Legend
EG PF# 1
WS PF# 1
Crit PF# 1
Ground
Levee
Bank Sta
HEC-RAS Model Plan: Default Scenario 10/9/2024
RS = 1001
.03
.1
.03
Elevation (ft)
6942
6940
6938
6936
6934
6932
6930
6928
0
20
40
60
80
100
120
140
160
180
Station (ft)
Legend
EG PF# 1
WS PF# 1
Crit PF# 1
Ground
Levee
Bank Sta


HEC-RAS Model Plan: Default Scenario 10/9/2024
RS = 1000.5
.03
.1
.03
6931
6930
6929
6928
6927
6926
6925
6924
Elevation (ft)
0
50
100
150
200
250
Station (ft)
Legend
EG PF# 1
WS PF# 1
Crit PF# 1
Ground
Levee
Bank Sta
HEC-RAS Model Plan: Default Scenario 10/9/2024
RS = 1000
.03
.1
.03
6928
6927
6926
6925
6924
Elevation (ft)
0
50
100
150
200
Station (ft)
Legend
EG PF# 1
Crit PF# 1
WS PF# 1
Ground
Bank Sta

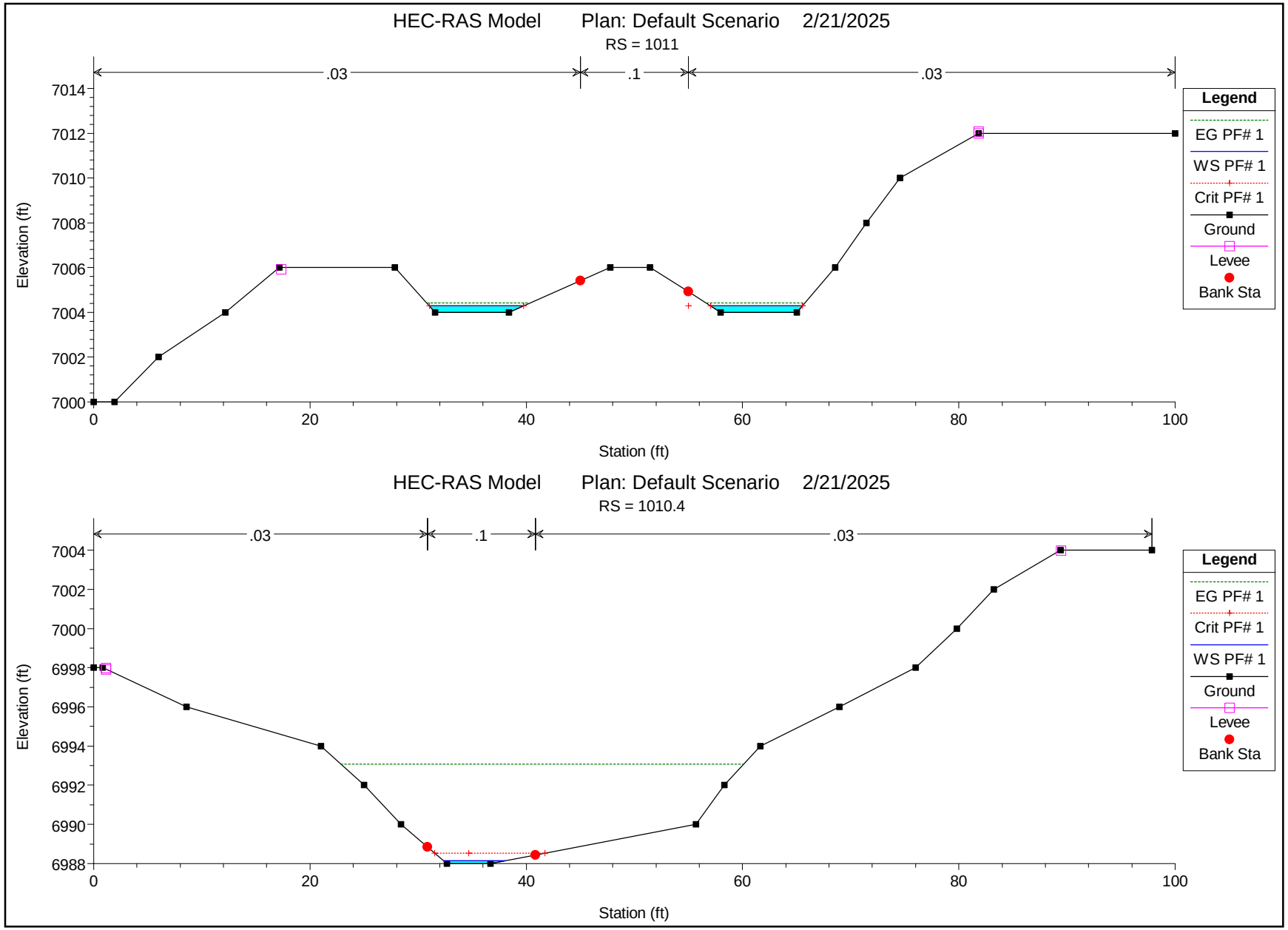

HEC-RAS Model Plan: Default Scenario 10/9/2024
DrainagePath 1 1
Legend
EG PF# 1
Crit PF# 1
WS PF# 1
Ground
Left Levee
Right Levee
Elevation (ft)
7000
6990
6980
6970
6960
6950
6940
6930
6920
0
100
200
300
400
500
600
Main Channel Distance (ft)

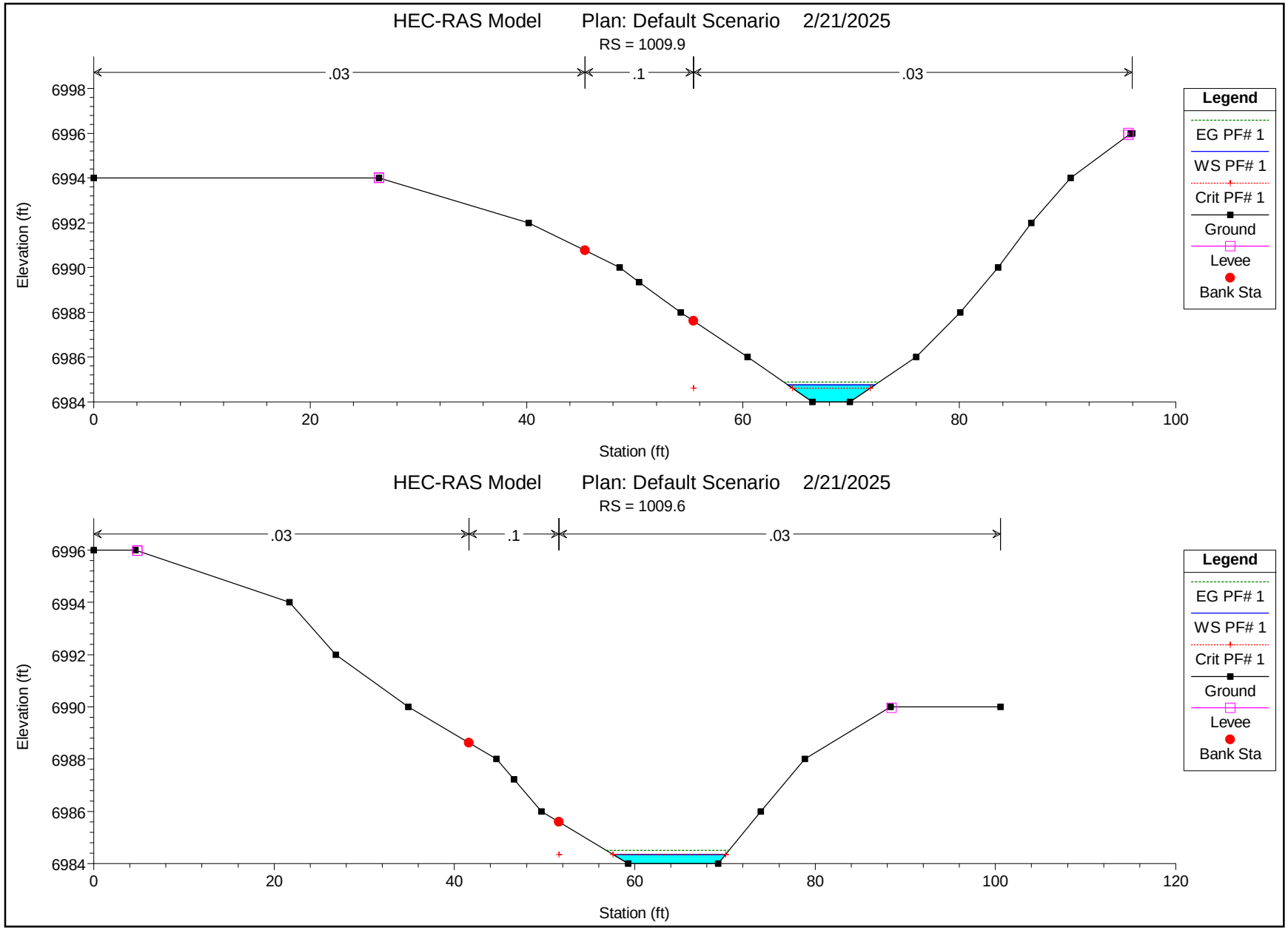
HEC-RAS Plan: Default Scenario Locations: User Defined Profile: PF# 1

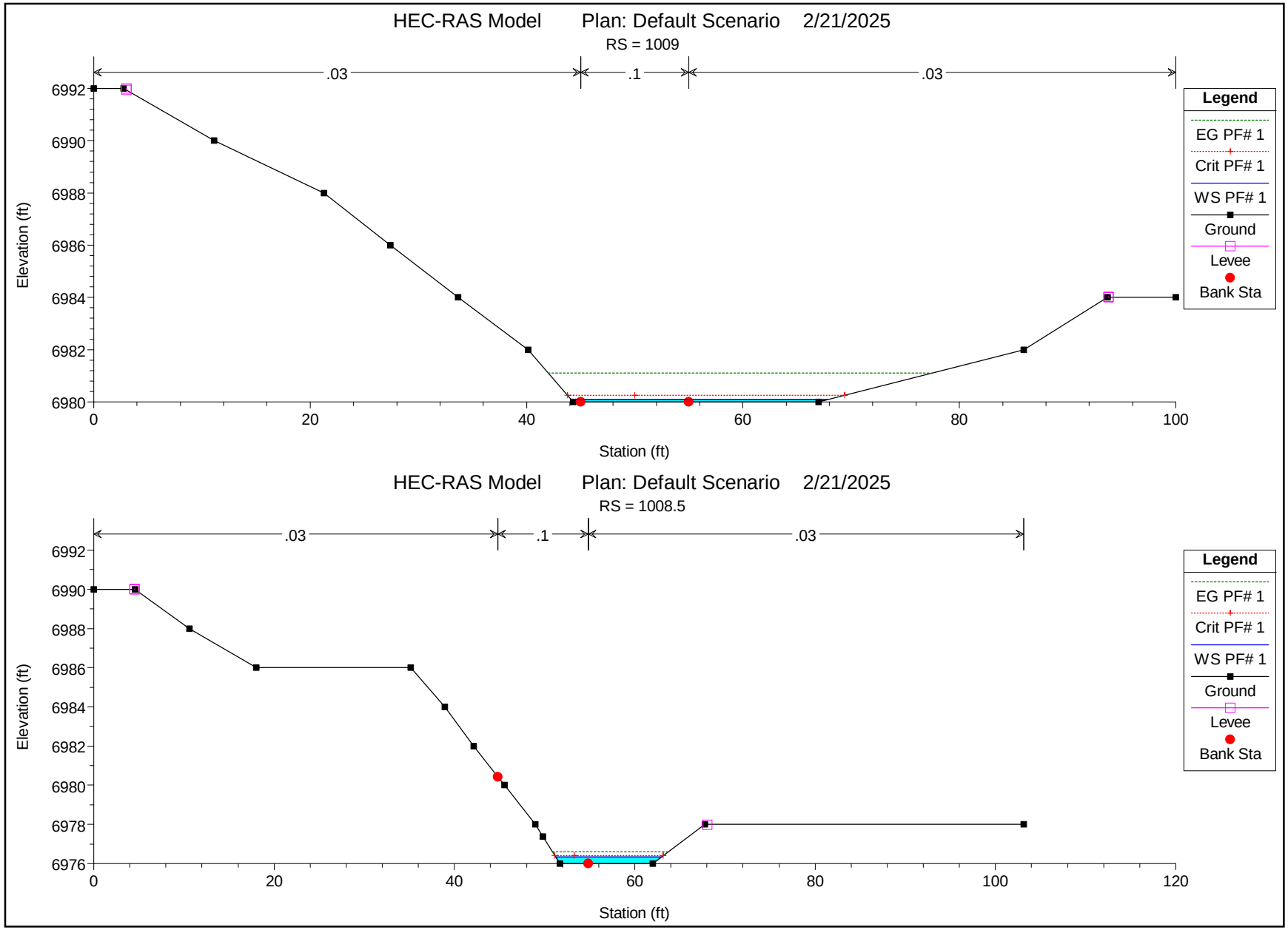
River	Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear LOB	Shear Chan	Shear ROB
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)	(lb/sq ft)	(lb/sq ft)
DrainagePath 2	2	1011	PF# 1	12.70	7004.92	7004.29	7004.29	7004.41	0.020450		4.45	17.18	0.00	0.32		0.33
DrainagePath 2	2	1010.4	PF# 1	12.70	6988.00	6988.15	6988.53	6993.07	23.310710	17.80	0.71	5.74	8.89		179.78	
DrainagePath 2	2	1009.9	PF# 1	12.70	6987.62	6984.76	6984.61	6984.89	0.007824		4.43	8.10	0.00			0.26
DrainagePath 2	2	1009.6	PF# 1	12.70	6985.60	6984.35	6984.35	6984.51	0.019907		3.94	12.49	0.00			0.39
DrainagePath 2	2	1009	PF# 1	12.70	6980.00	6980.09	6980.25	6981.10	0.867133	2.74	2.04	23.70	1.63	4.17	4.76	4.60
DrainagePath 2	2	1008.5	PF# 1	12.70	6976.00	6976.35	6976.40	6976.60	0.032923	1.25	3.83	11.77	0.39		0.65	0.66
DrainagePath 2	2	1008	PF# 1	12.70	6972.00	6972.23	6972.42	6973.00	0.216653	2.52	2.60	11.78	0.94		2.98	2.91
DrainagePath 2	2	1007.5	PF# 1	12.70	6968.00	6968.42	6968.53	6968.78	0.048618	1.60	3.57	10.32	0.48		1.04	1.04
DrainagePath 2	2	1007	PF# 1	12.70	6964.00	6964.57	6964.75	6965.13	0.106053	2.78	3.17	7.33	0.74	2.46	2.89	
DrainagePath 2	2	1006.6	PF# 1	12.70	6962.00	6962.55	6962.47	6962.71	0.053140	2.21	4.99	10.26	0.54	0.97	1.72	
DrainagePath 2	2	1006	PF# 1	12.70	6958.00	6958.58	6958.58	6958.83	0.092478	2.95	3.83	7.40	0.71	1.75	3.04	
DrainagePath 2	2	1005.8	PF# 1	12.70	6956.00	6956.55	6956.59	6956.84	0.048507	2.06	4.37	8.75	0.51	1.27	1.51	
DrainagePath 2	2	1005.5	PF# 1	12.70	6954.00	6954.35	6954.53	6954.92	0.078987	1.90	2.71	8.32	0.60	1.61	1.51	
DrainagePath 2	2	1005.1	PF# 1	12.70	6952.00	6952.32	6952.40	6952.65	0.047597	1.43	3.49	11.36	0.46	0.91	0.87	
DrainagePath 2	2	1004.5	PF# 1	12.70	6948.00	6948.25	6948.43	6948.84	0.126832	1.95	2.53	11.08	0.72	1.81	1.77	
DrainagePath 2	2	1004	PF# 1	12.70	6946.00	6946.41	6946.41	6946.58	0.034102	1.48	5.55	14.96	0.41	0.66	0.84	
DrainagePath 2	2	1003.5	PF# 1	12.70	6942.00	6942.55	6942.63	6942.92	0.331825	4.84	2.62	5.90	1.28		8.82	
DrainagePath 2	2	1003	PF# 1	12.70	6940.00	6940.69	6940.48	6940.79	0.006576	0.84	6.92	11.25	0.19		0.24	0.25
DrainagePath 2	2	1002.9	PF# 1	12.70	6940.00	6940.46	6940.46	6940.68	0.028377	1.44	4.98	11.41	0.38		0.77	0.73
DrainagePath 2	2	1002.6	PF# 1	12.70	6938.00	6938.21	6938.40	6938.97	0.186784	2.17	2.24	10.95	0.86	2.40	2.28	
DrainagePath 2	2	1002.4	PF# 1	12.70	6936.14	6936.23	6936.33	6936.56	0.066171	0.45	2.75	12.66	0.38	0.90	0.16	
DrainagePath 2	2	1002	PF# 1	12.70	6934.00	6934.25	6934.30	6934.46	0.041145	1.16	4.12	16.79	0.41		0.61	0.63
DrainagePath 2	2	1001.94	PF# 1	12.70	6932.00	6932.17	6932.22	6932.36	0.059080	1.07	3.94	23.74	0.47	0.61	0.59	
DrainagePath 2	2	1001.9	PF# 1	12.70	6928.19	6929.30	6928.57	6929.31	0.001399	0.59	16.11	19.10	0.10	0.05	0.10	0.04
DrainagePath 2	2	1001.4		Culvert												
DrainagePath 2	2	1000.9	PF# 1	12.70	6926.00	6926.61	6926.37	6926.67	0.004068	0.61	9.12	16.89	0.15	0.14	0.13	
DrainagePath 2	2	1000.6	PF# 1	12.70	6926.00	6926.26	6926.26	6926.40	0.024990	0.92	4.99	19.63	0.33	0.40	0.38	
DrainagePath 2	2	1000	PF# 1	12.70	6920.11	6920.10	6920.31	6921.47	0.824629		1.35	14.18	0.00			4.91

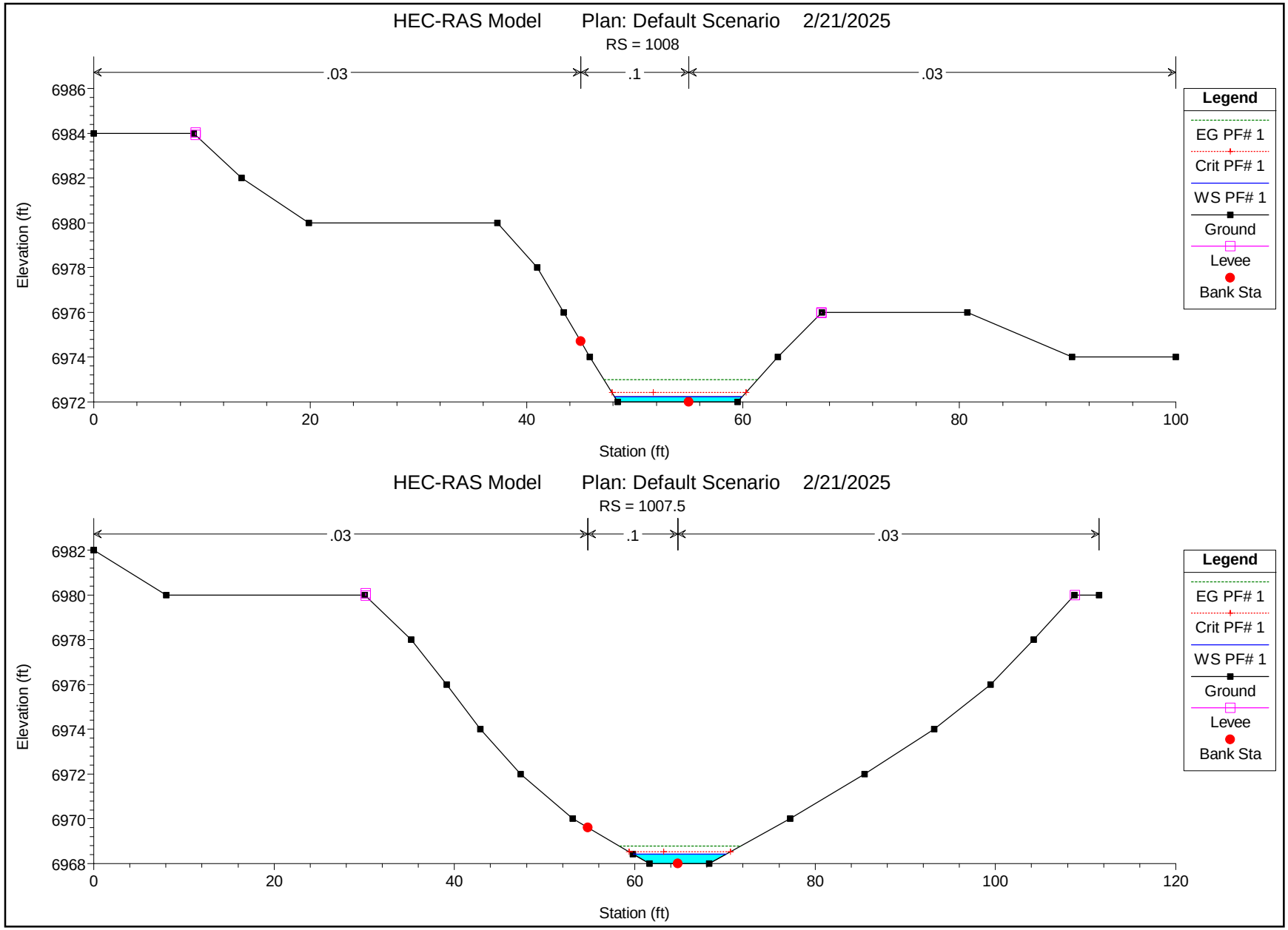


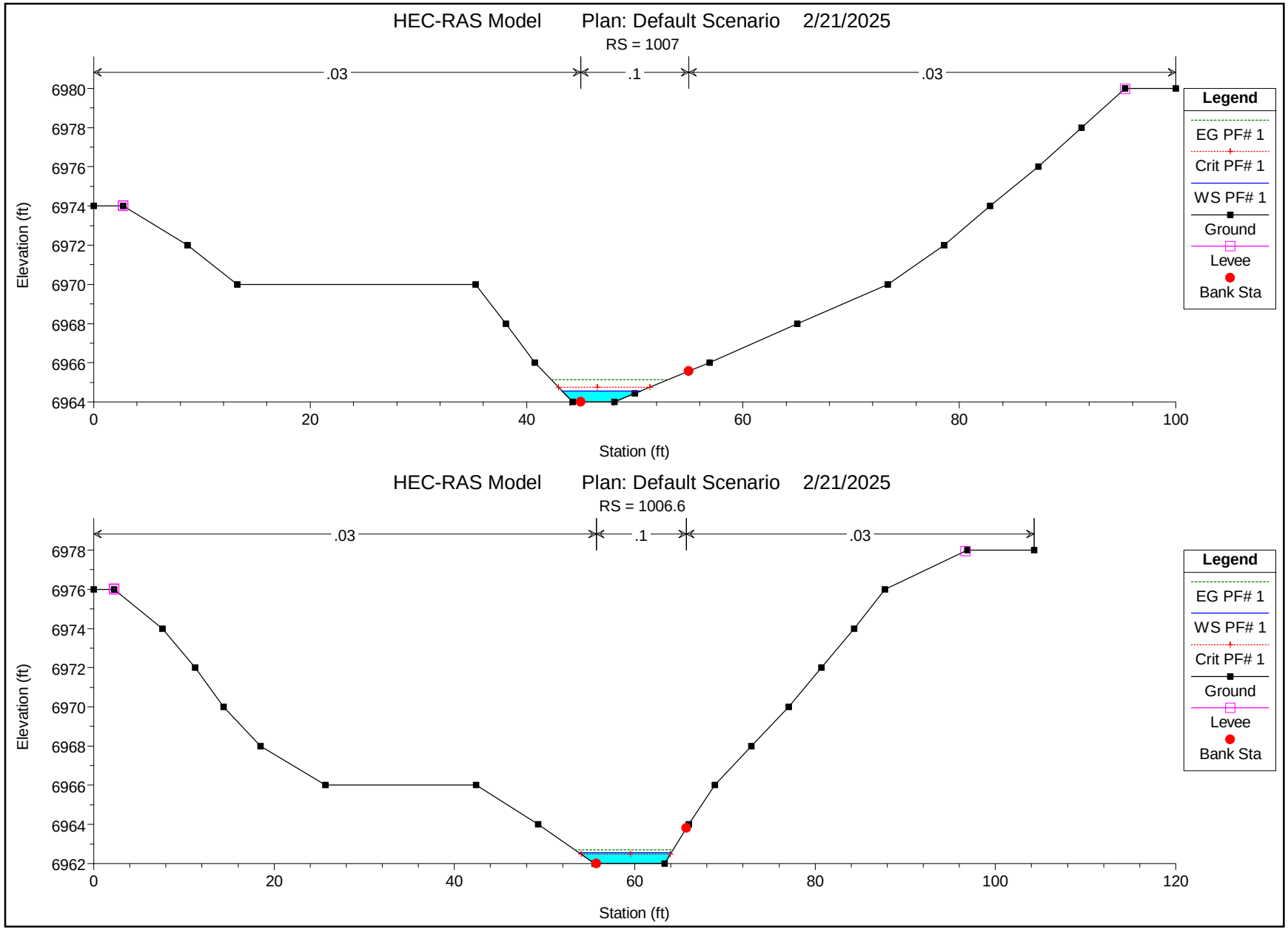
Created with GeoHECRAS v4.1.0.2943

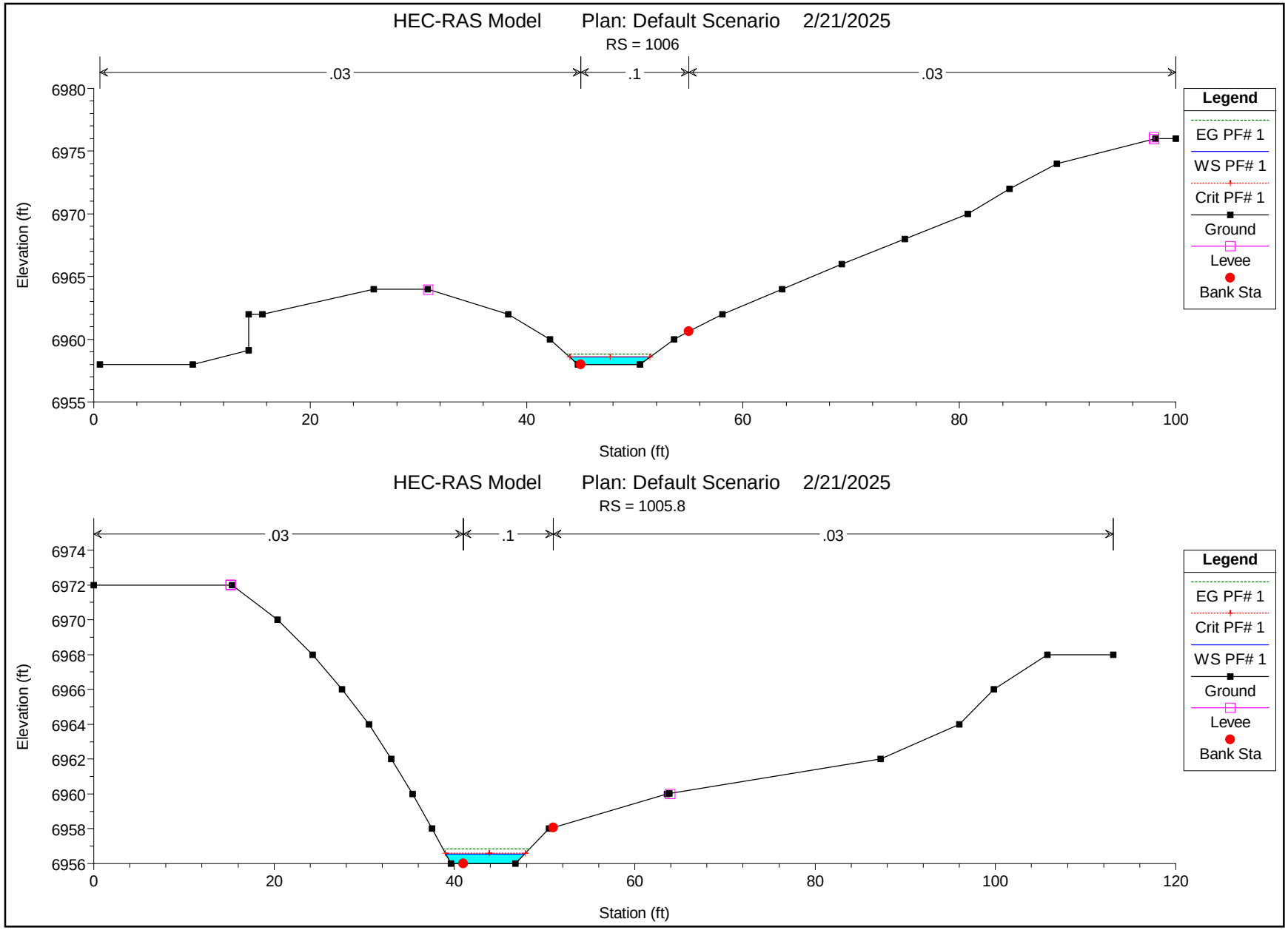

HEC-RAS Model Plan: Default Scenario 2/21/2025
RS = 1011
.03
.1
.03
Elevation (ft)
7014
7012
7010
7008
7006
7004
7002
7000
0
20
40
60
80
100
Station (ft)
Legend
EG PF# 1
WS PF# 1
Crit PF# 1
Ground
Levee
Bank Sta
HEC-RAS Model Plan: Default Scenario 2/21/2025
RS = 1010.4
.03
.1
.03
Elevation (ft)
7004
7002
7000
6998
6996
6994
6992
6990
6988
0
20
40
60
80
100
Station (ft)
Legend
EG PF# 1
Crit PF# 1
WS PF# 1
Ground
Levee
Bank Sta

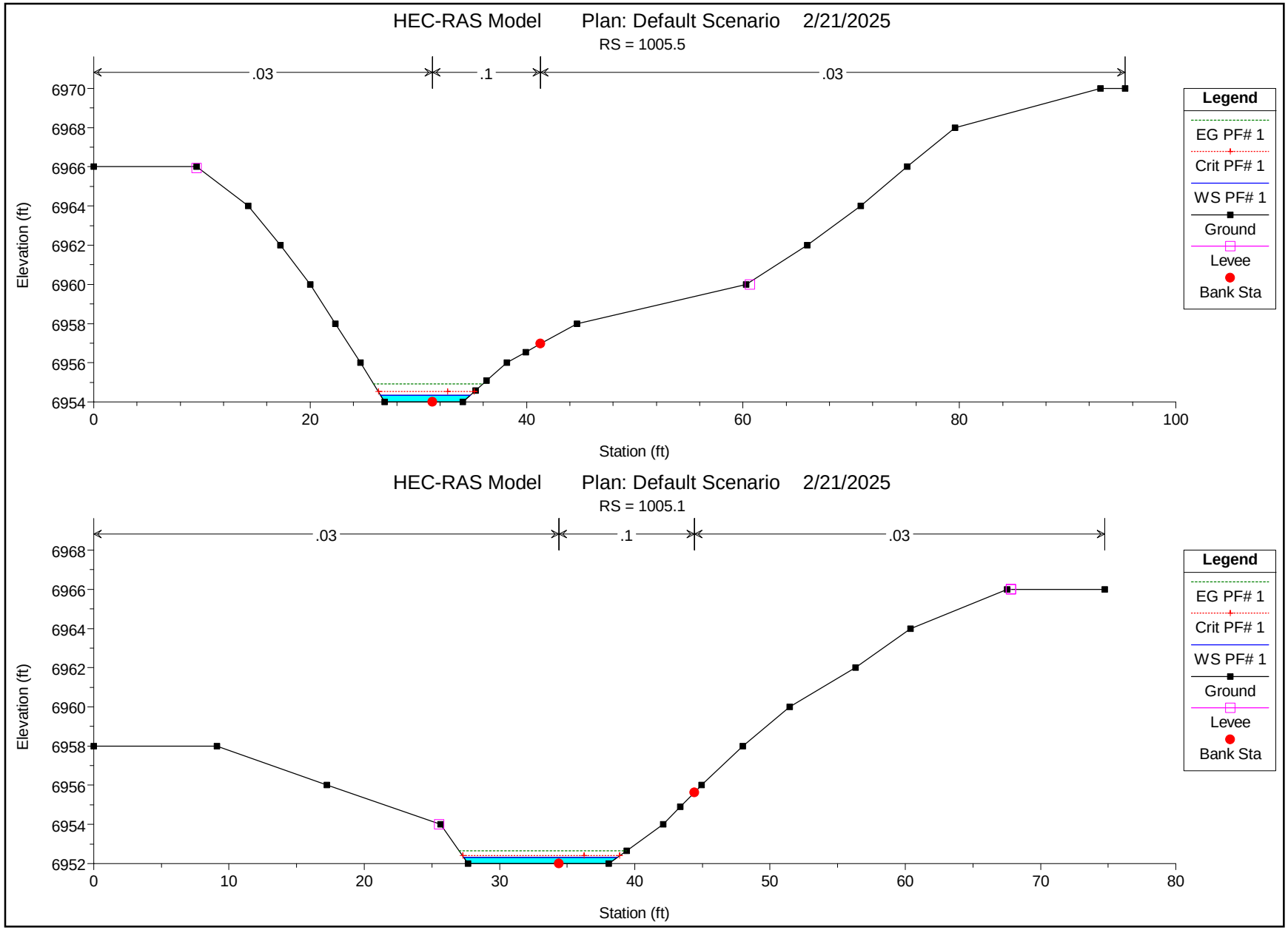

HEC-RAS Model Plan: Default Scenario 2/21/2025
RS = 1009.9
.03
.1
.03
Elevation (ft)
6998
6996
6994
6992
6990
6988
6986
6984
0
20
40
60
80
100
Station (ft)
Legend
EG PF# 1
WS PF# 1
Crit PF# 1
Ground
Levee
Bank Sta
HEC-RAS Model Plan: Default Scenario 2/21/2025
RS = 1009.6
.03
.1
.03
Elevation (ft)
6996
6994
6992
6990
6988
6986
6984
0
20
40
60
80
100
120
Station (ft)
Legend
EG PF# 1
WS PF# 1
Crit PF# 1
Ground
Levee
Bank Sta

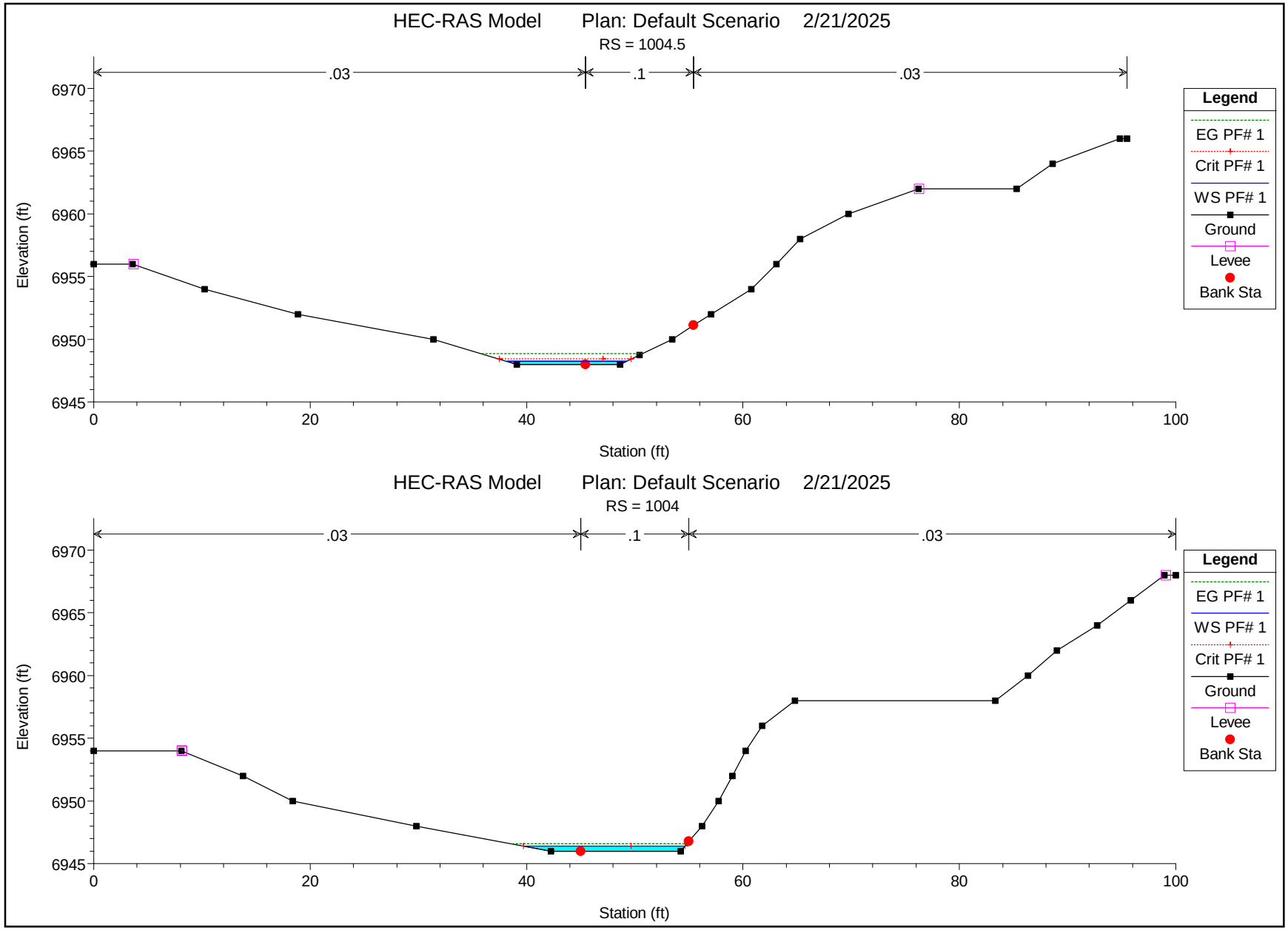

HEC-RAS Model Plan: Default Scenario 2/21/2025
RS = 1009
.03
.1
.03
6992
6990
6988
6986
6984
6982
6980
Elevation (ft)
0
20
40
60
80
100
Station (ft)
Legend
EG PF# 1
Crit PF# 1
WS PF# 1
Ground
Levee
Bank Sta
HEC-RAS Model Plan: Default Scenario 2/21/2025
RS = 1008.5
.03
.1
.03
6992
6990
6988
6986
6984
6982
6980
6978
6976
Elevation (ft)
0
20
40
60
80
100
120
Station (ft)
Legend
EG PF# 1
Crit PF# 1
WS PF# 1
Ground
Levee
Bank Sta

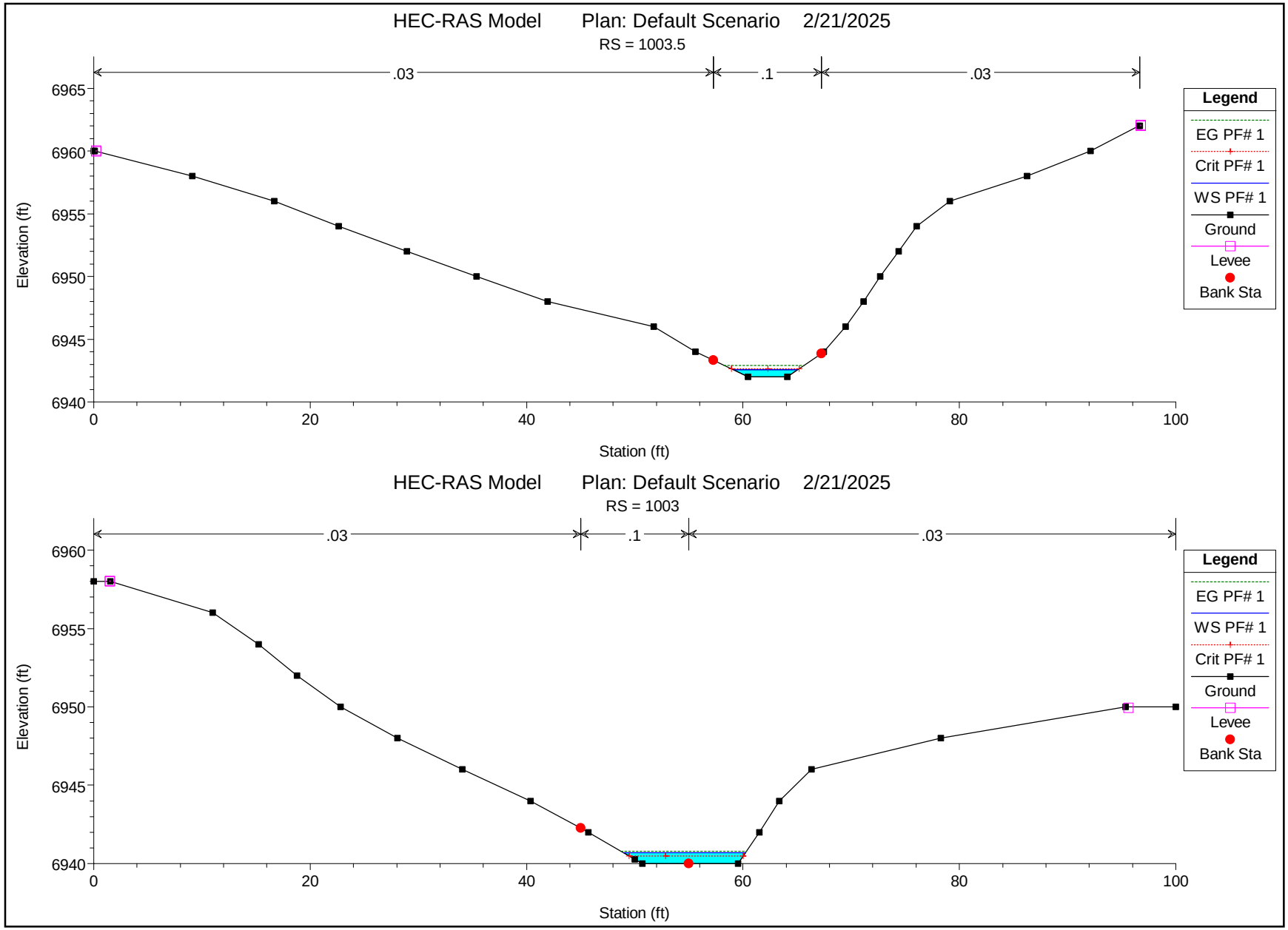

HEC-RAS Model Plan: Default Scenario 2/21/2025
RS = 1008
.03
.1
.03
Elevation (ft)
6986
6984
6982
6980
6978
6976
6974
6972
0
20
40
60
80
100
Station (ft)
Legend
EG PF# 1
Crit PF# 1
WS PF# 1
Ground
Levee
Bank Sta
HEC-RAS Model Plan: Default Scenario 2/21/2025
RS = 1007.5
.03
.1
.03
Elevation (ft)
6982
6980
6978
6976
6974
6972
6970
6968
0
20
40
60
80
100
120
Station (ft)
Legend
EG PF# 1
Crit PF# 1
WS PF# 1
Ground
Levee
Bank Sta

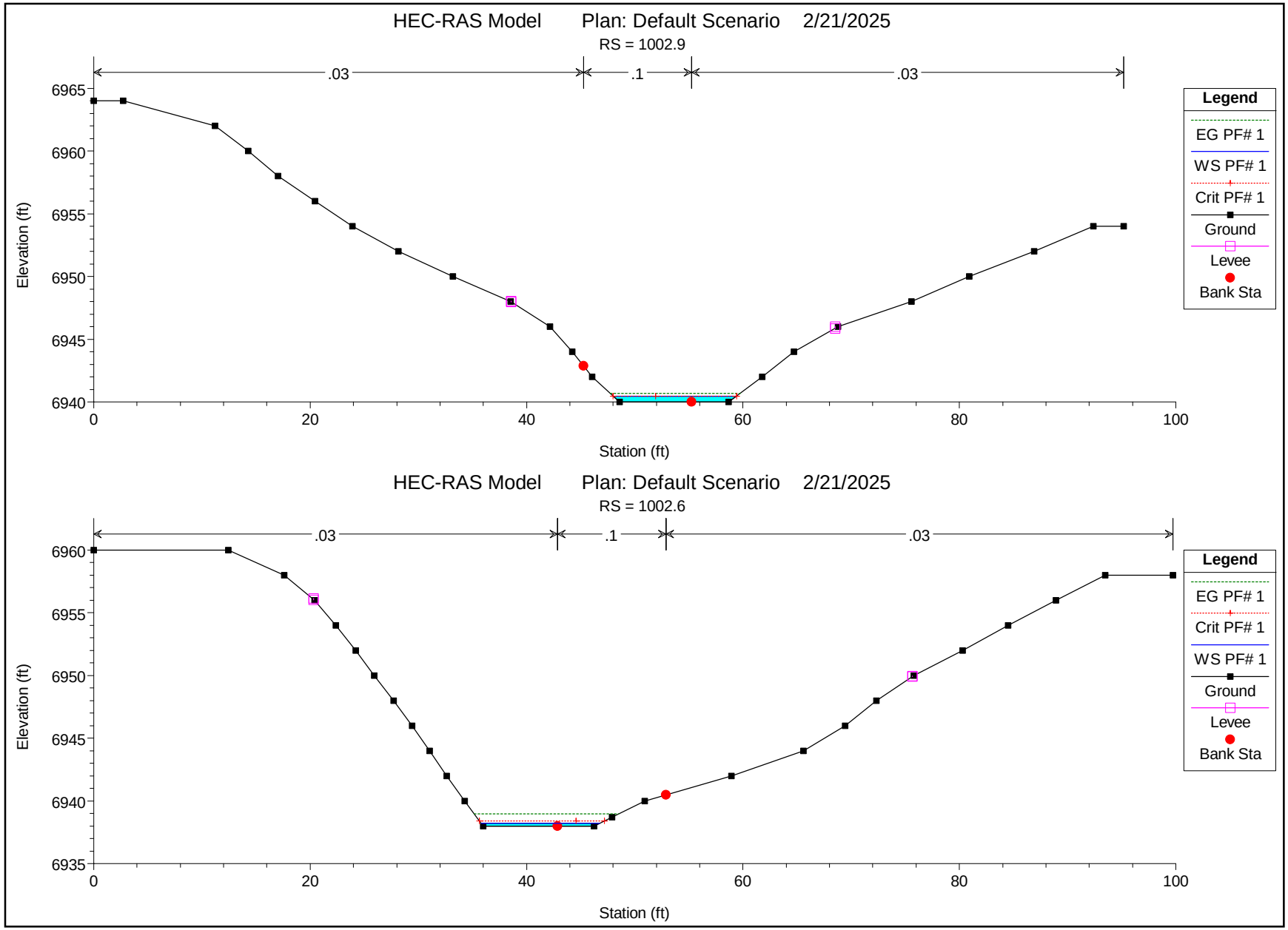

HEC-RAS Model Plan: Default Scenario 2/21/2025
RS = 1007
.03
.1
.03
Elevation (ft)
6980
6978
6976
6974
6972
6970
6968
6966
6964
0
20
40
60
80
100
Station (ft)
Legend
EG PF# 1
Crit PF# 1
WS PF# 1
Ground
Levee
Bank Sta
HEC-RAS Model Plan: Default Scenario 2/21/2025
RS = 1006.6
.03
.1
.03
Elevation (ft)
6978
6976
6974
6972
6970
6968
6966
6964
6962
0
20
40
60
80
100
120
Station (ft)
Legend
EG PF# 1
WS PF# 1
Crit PF# 1
Ground
Levee
Bank Sta

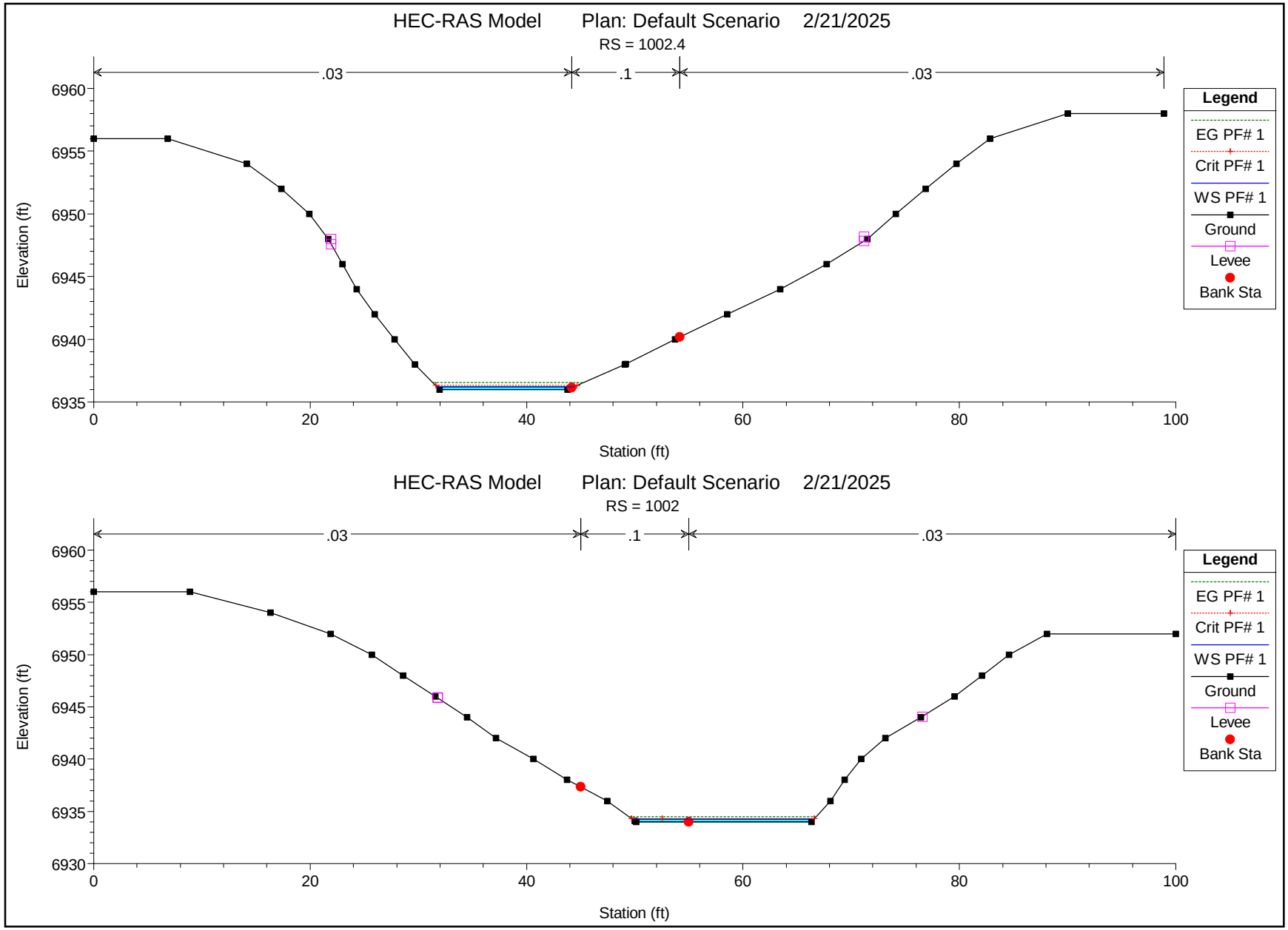

HEC-RAS Model Plan: Default Scenario 2/21/2025
RS = 1006
.03
.1
.03
Elevation (ft)
6980
6975
6970
6965
6960
6955
0
20
40
60
80
100
Station (ft)
Legend
EG PF# 1
WS PF# 1
Crit PF# 1
Ground
Levee
Bank Sta
HEC-RAS Model Plan: Default Scenario 2/21/2025
RS = 1005.8
.03
.1
.03
Elevation (ft)
6974
6972
6970
6968
6966
6964
6962
6960
6958
6956
0
20
40
60
80
100
120
Station (ft)
Legend
EG PF# 1
Crit PF# 1
WS PF# 1
Ground
Levee
Bank Sta

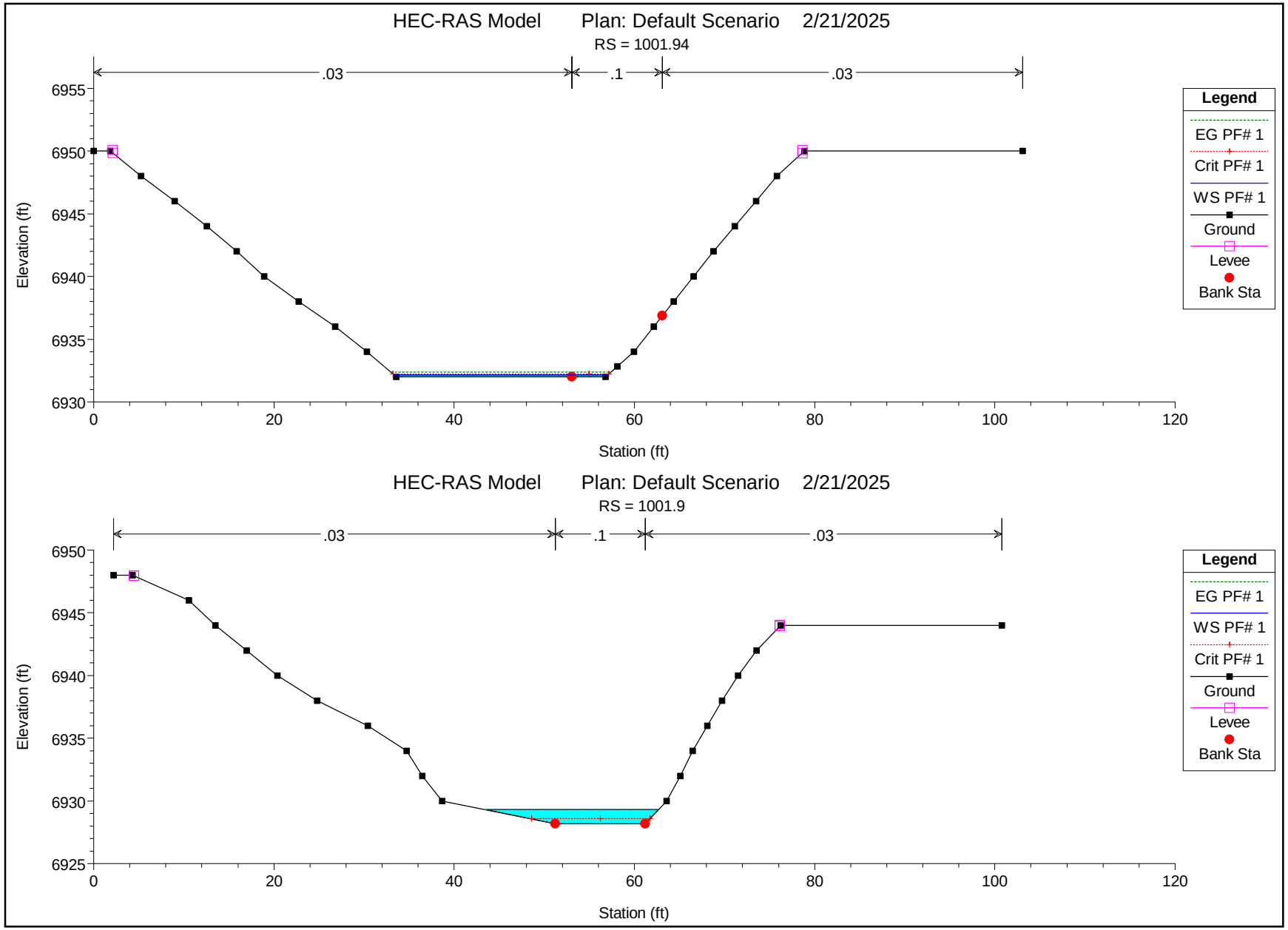

HEC-RAS Model Plan: Default Scenario 2/21/2025
RS = 1005.5
.03
.1
.03
Elevation (ft)
6970
6968
6966
6964
6962
6960
6958
6956
6954
0
20
40
60
80
100
Station (ft)
Legend
EG PF# 1
Crit PF# 1
WS PF# 1
Ground
Levee
Bank Sta
HEC-RAS Model Plan: Default Scenario 2/21/2025
RS = 1005.1
.03
.1
.03
Elevation (ft)
6968
6966
6964
6962
6960
6958
6956
6954
6952
0
10
20
30
40
50
60
70
80
Station (ft)
Legend
EG PF# 1
Crit PF# 1
WS PF# 1
Ground
Levee
Bank Sta

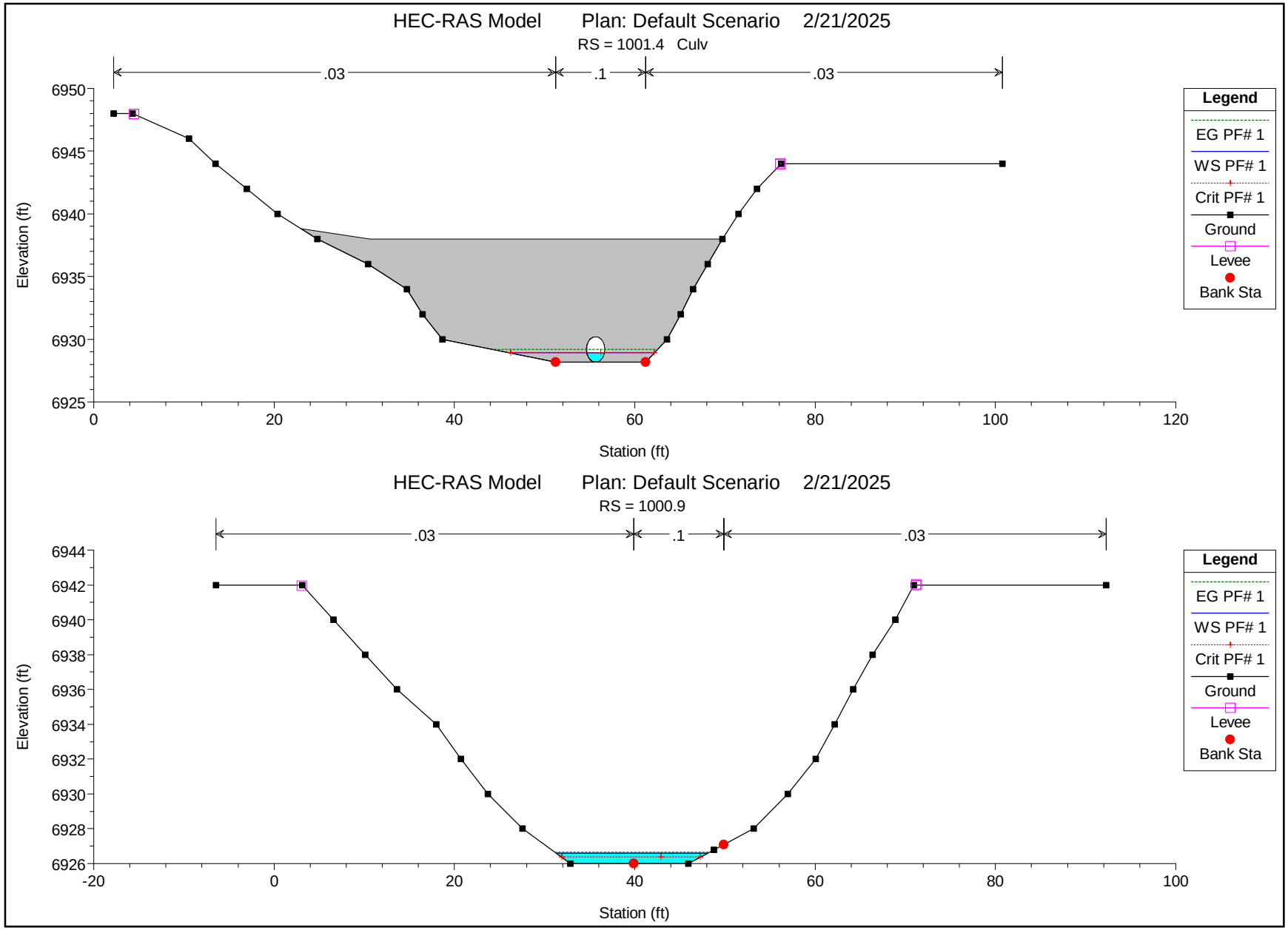

HEC-RAS Model Plan: Default Scenario 2/21/2025
RS = 1004.5
.03
.1
.03
6970
6965
6960
6955
6950
6945
Elevation (ft)
0
20
40
60
80
100
Station (ft)
Legend
EG PF# 1
Crit PF# 1
WS PF# 1
Ground
Levee
Bank Sta
HEC-RAS Model Plan: Default Scenario 2/21/2025
RS = 1004
.03
.1
.03
6970
6965
6960
6955
6950
6945
Elevation (ft)
0
20
40
60
80
100
Station (ft)
Legend
EG PF# 1
WS PF# 1
Crit PF# 1
Ground
Levee
Bank Sta

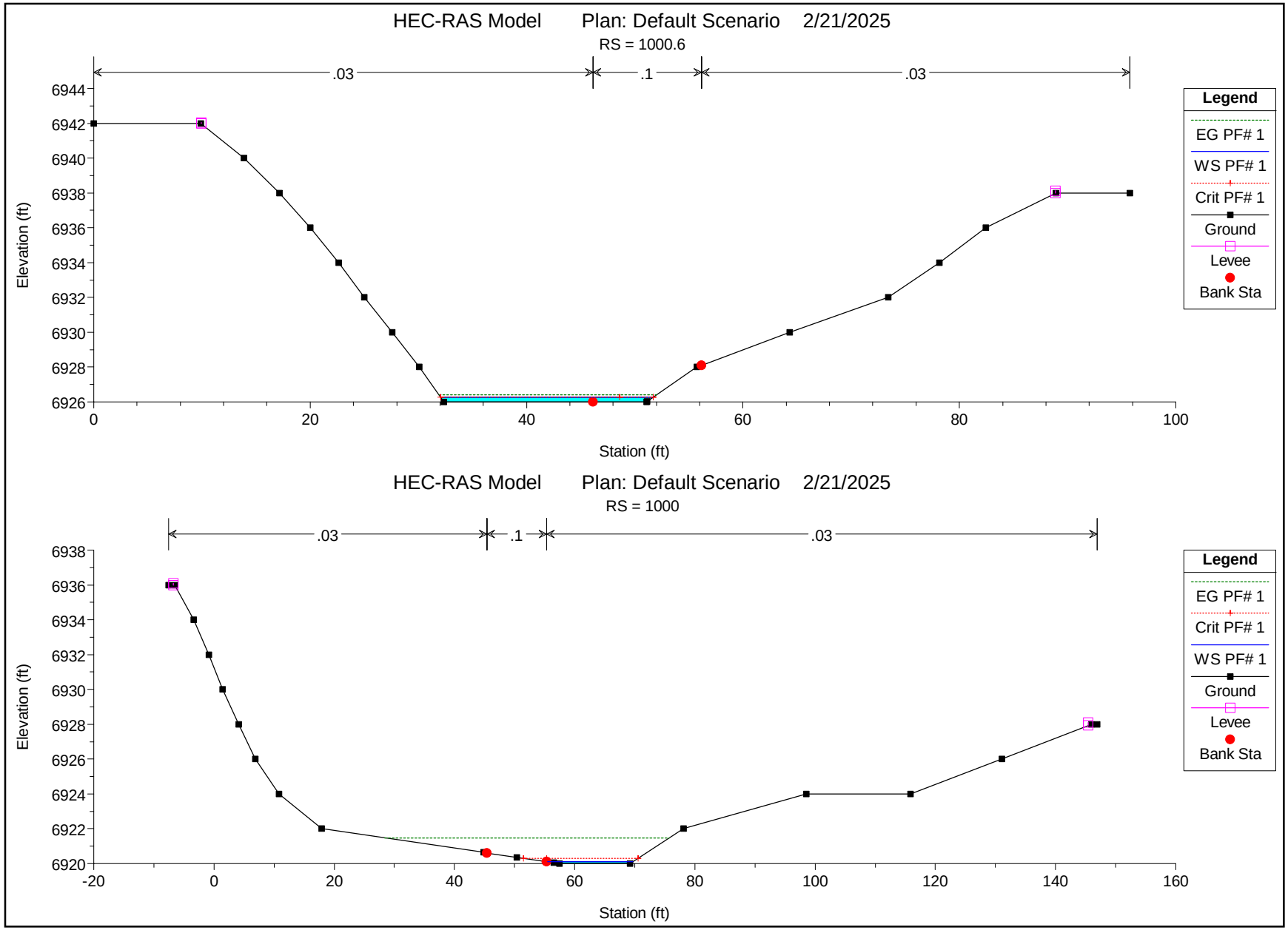

HEC-RAS Model Plan: Default Scenario 2/21/2025
RS = 1003.5
.03
.1
.03
6965
6960
6955
6950
6945
6940
Elevation (ft)
0
20
40
60
80
100
Station (ft)
Legend
EG PF# 1
Crit PF# 1
WS PF# 1
Ground
Levee
Bank Sta
HEC-RAS Model Plan: Default Scenario 2/21/2025
RS = 1003
.03
.1
.03
6960
6955
6950
6945
6940
Elevation (ft)
0
20
40
60
80
100
Station (ft)
Legend
EG PF# 1
WS PF# 1
Crit PF# 1
Ground
Levee
Bank Sta

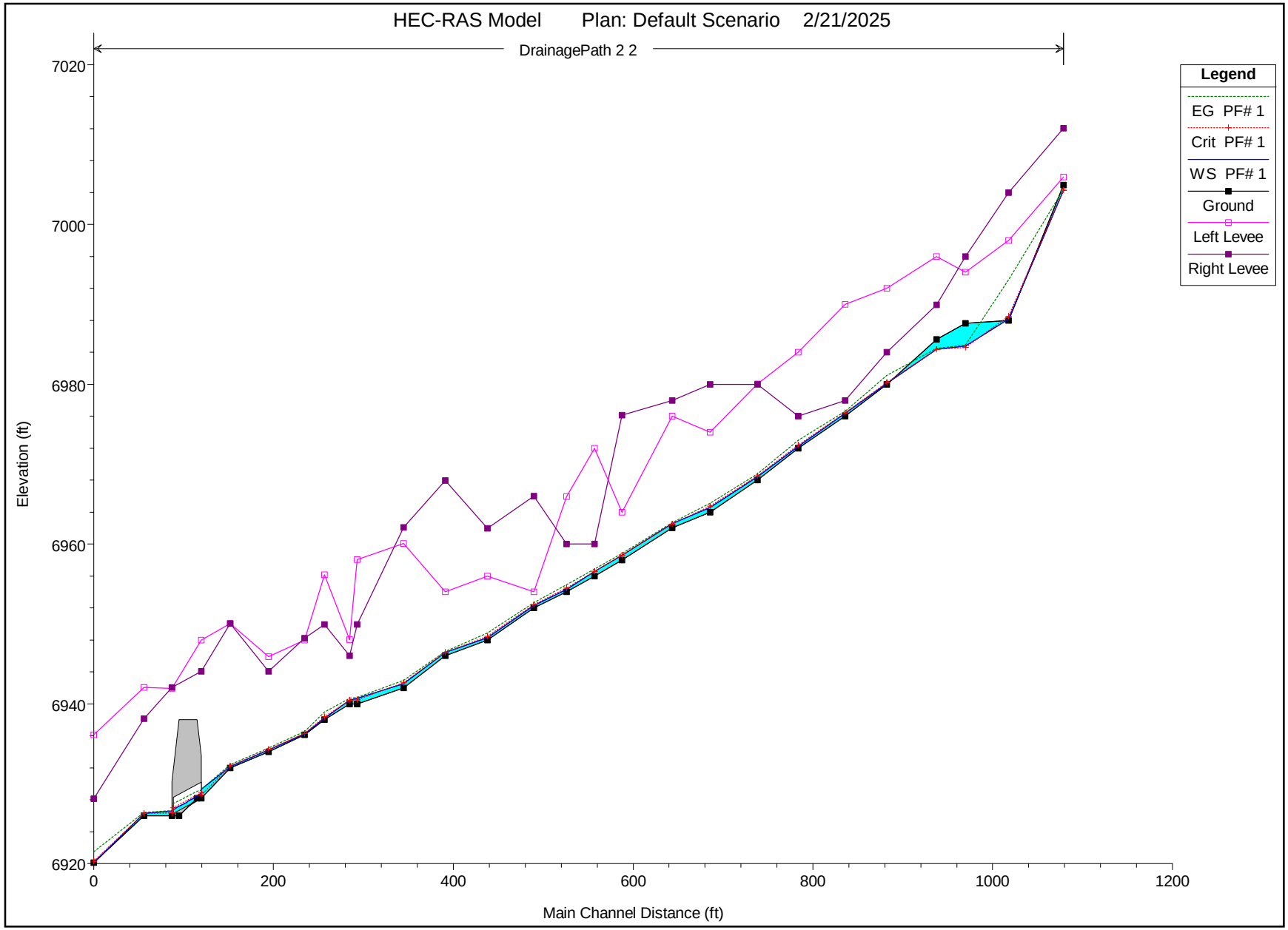

HEC-RAS Model Plan: Default Scenario 2/21/2025
RS = 1002.9
.03
.1
.03
6965
6960
6955
6950
6945
6940
Elevation (ft)
0
20
40
60
80
100
Station (ft)
Legend
EG PF# 1
WS PF# 1
Crit PF# 1
Ground
Levee
Bank Sta
HEC-RAS Model Plan: Default Scenario 2/21/2025
RS = 1002.6
.03
.1
.03
6960
6955
6950
6945
6940
6935
Elevation (ft)
0
20
40
60
80
100
Station (ft)
Legend
EG PF# 1
Crit PF# 1
WS PF# 1
Ground
Levee
Bank Sta


HEC-RAS Model Plan: Default Scenario 2/21/2025
RS = 1002.4
.03
.1
.03
Elevation (ft)
6960
6955
6950
6945
6940
6935
0
20
40
60
80
100
Station (ft)
Legend
EG PF# 1
Crit PF# 1
WS PF# 1
Ground
Levee
Bank Sta
HEC-RAS Model Plan: Default Scenario 2/21/2025
RS = 1002
.03
.1
.03
Elevation (ft)
6960
6955
6950
6945
6940
6935
6930
0
20
40
60
80
100
Station (ft)
Legend
EG PF# 1
Crit PF# 1
WS PF# 1
Ground
Levee
Bank Sta


HEC-RAS Model Plan: Default Scenario 2/21/2025
RS = 1001.94
.03
.1
.03
Elevation (ft)
6955
6950
6945
6940
6935
6930
0
20
40
60
80
100
120
Station (ft)
Legend
EG PF# 1
Crit PF# 1
WS PF# 1
Ground
Levee
Bank Sta
HEC-RAS Model Plan: Default Scenario 2/21/2025
RS = 1001.9
.03
.1
.03
Elevation (ft)
6950
6945
6940
6935
6930
6925
0
20
40
60
80
100
120
Station (ft)
Legend
EG PF# 1
WS PF# 1
Crit PF# 1
Ground
Levee
Bank Sta

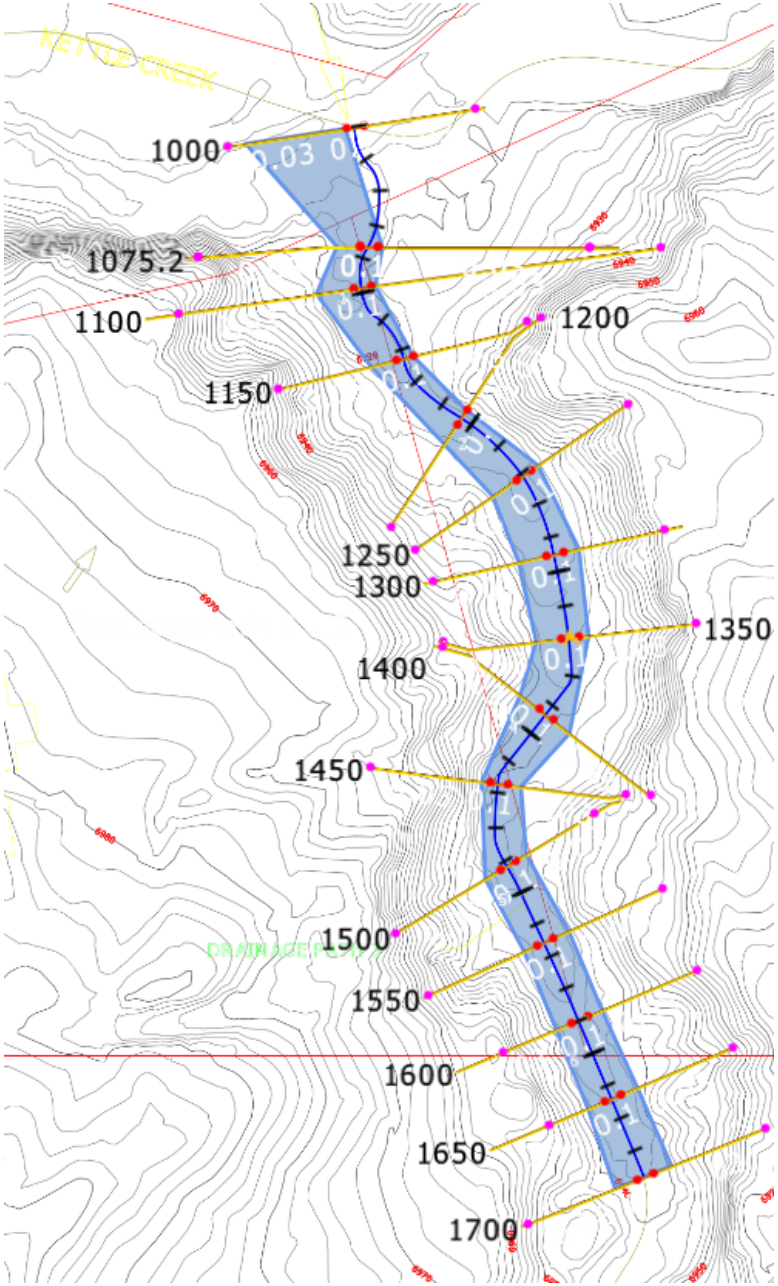

HEC-RAS Model Plan: Default Scenario 2/21/2025
RS = 1001.4 Culv
.03
.1
.03
6950
6945
6940
6935
6930
6925
Elevation (ft)
0
20
40
60
80
100
120
Station (ft)
Legend
EG PF# 1
WS PF# 1
Crit PF# 1
Ground
Levee
Bank Sta
HEC-RAS Model Plan: Default Scenario 2/21/2025
RS = 1000.9
.03
.1
.03
6944
6942
6940
6938
6936
6934
6932
6930
6928
6926
Elevation (ft)
-20
0
20
40
60
80
100
Station (ft)
Legend
EG PF# 1
WS PF# 1
Crit PF# 1
Ground
Levee
Bank Sta


HEC-RAS Model Plan: Default Scenario 2/21/2025
RS = 1000.6
.03
.1
.03
Elevation (ft)
6944
6942
6940
6938
6936
6934
6932
6930
6928
6926
0
20
40
60
80
100
Station (ft)
Legend
EG PF# 1
WS PF# 1
Crit PF# 1
Ground
Levee
Bank Sta
HEC-RAS Model Plan: Default Scenario 2/21/2025
RS = 1000
.03
.1
.03
Elevation (ft)
6938
6936
6934
6932
6930
6928
6926
6924
6922
6920
-20
0
20
40
60
80
100
120
140
160
Station (ft)
Legend
EG PF# 1
Crit PF# 1
WS PF# 1
Ground
Levee
Bank Sta

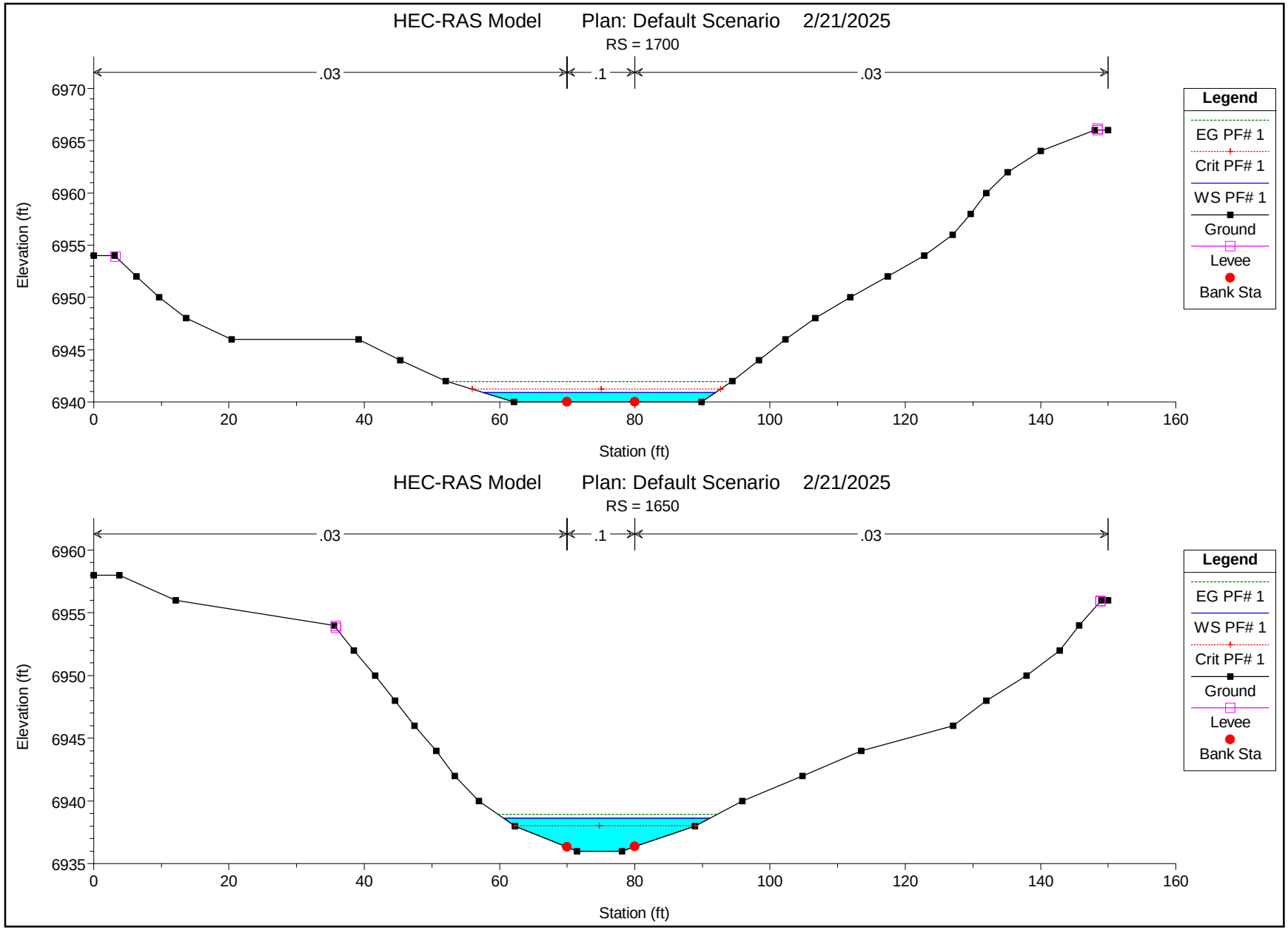

HEC-RAS Model Plan: Default Scenario 2/21/2025
DrainagePath 2 2
Legend
EG PF# 1
Crit PF# 1
WS PF# 1
Ground
Left Levee
Right Levee
Elevation (ft)
7020
7000
6980
6960
6940
6920
0
200
400
600
800
1000
1200
Main Channel Distance (ft)

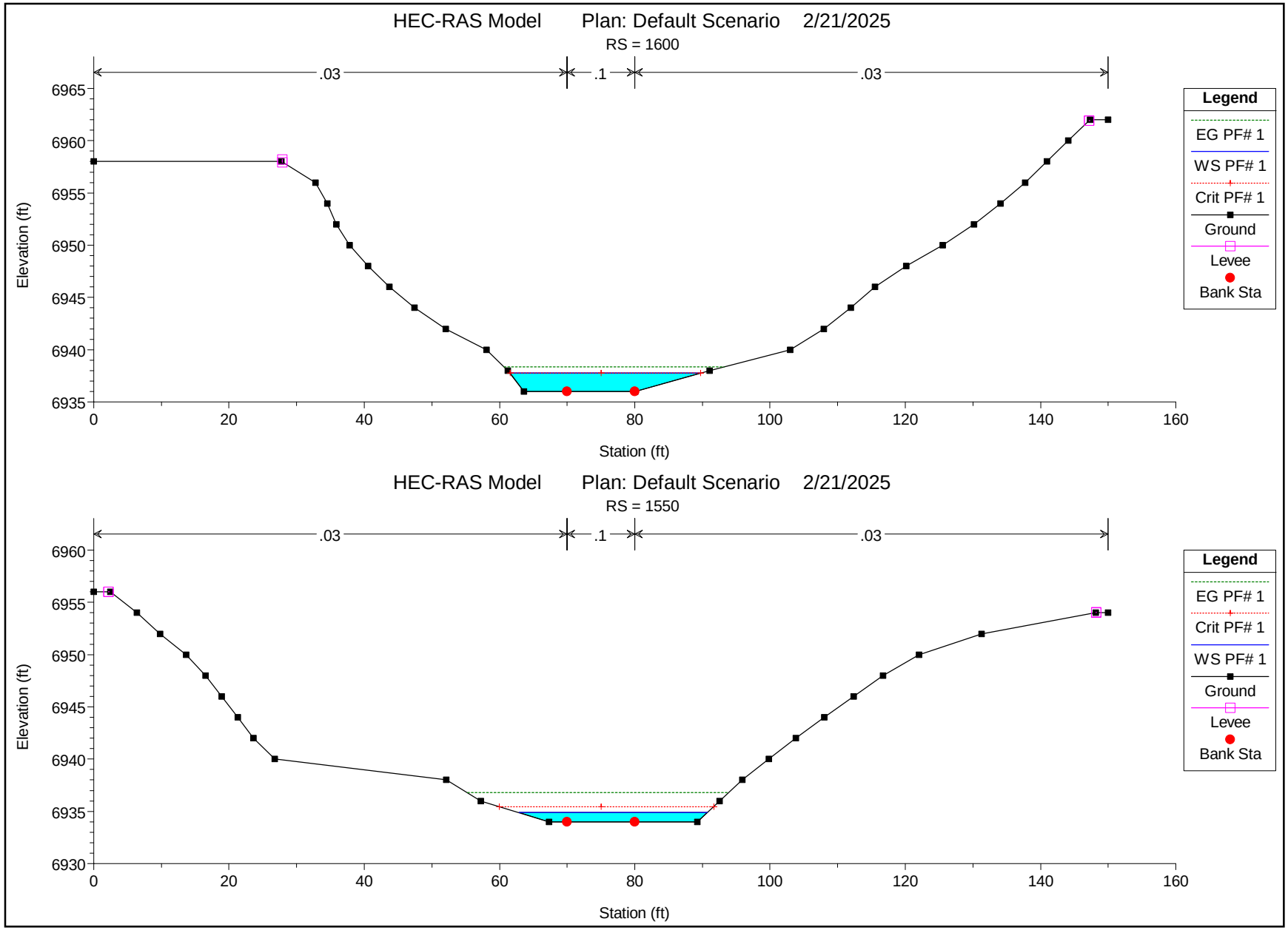
HEC-RAS Plan: Default Scenario River: DrainagePath 3 Reach: 3 Profile: PF# 1

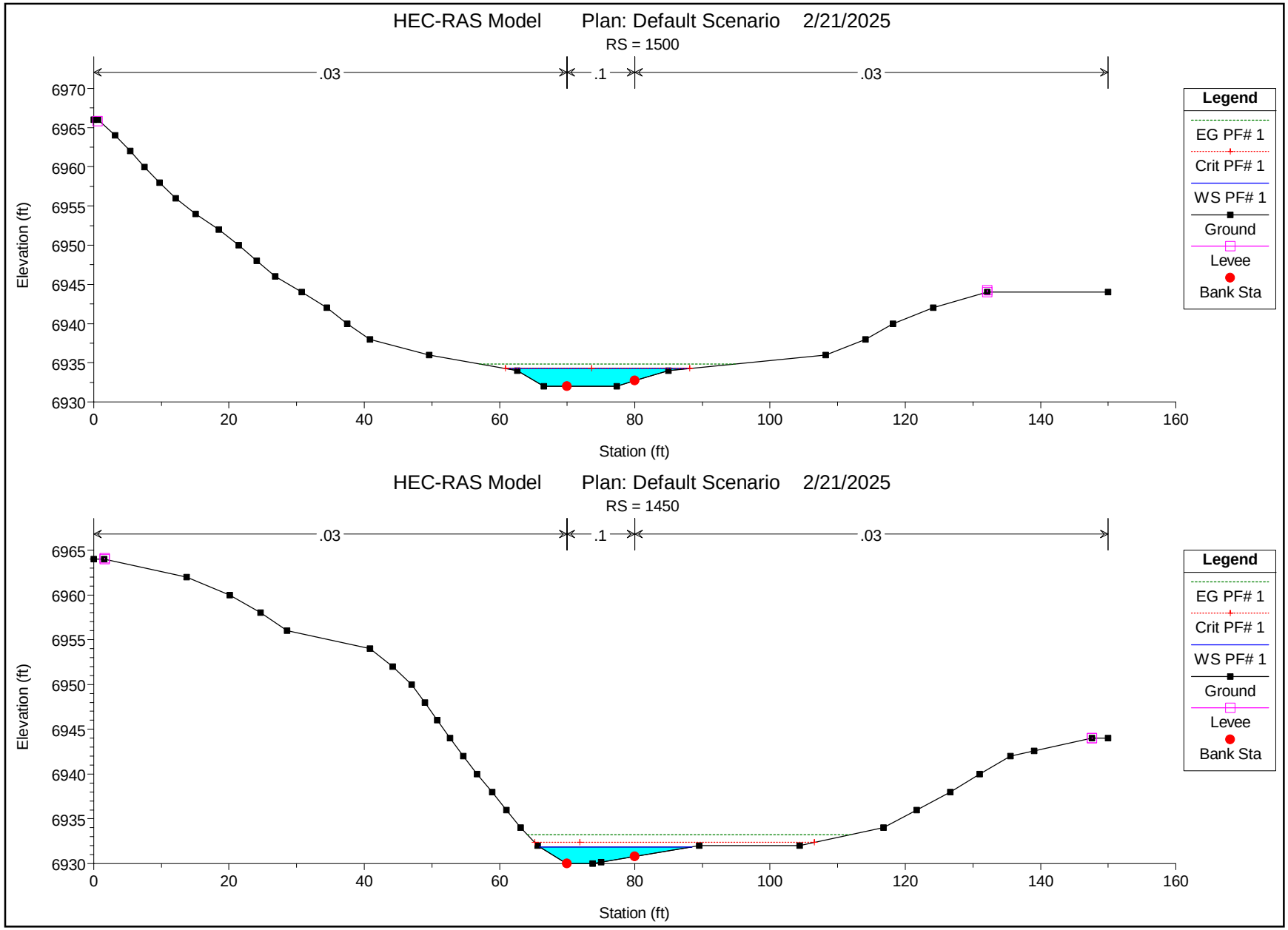
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear LOB	Shear Chan	Shear ROB
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)	(lb/sq ft)	(lb/sq ft)
3	1700	PF# 1	193.00	6940.00	6940.92	6941.22	6941.93	0.041490	2.86	28.60	34.47	0.53	1.93	2.38	2.14
3	1650	PF# 1	193.00	6936.00	6938.62	6938.01	6938.92	0.008192	2.51	50.94	30.42	0.28	0.63	1.30	0.61
3	1600	PF# 1	193.00	6936.00	6937.75	6937.75	6938.37	0.014980	2.64	39.02	28.16	0.35	1.34	1.64	0.81
3	1550	PF# 1	193.00	6934.00	6934.88	6935.46	6936.78	0.087996	4.05	21.96	27.84	0.76	3.30	4.84	4.42
3	1500	PF# 1	193.00	6932.00	6934.27	6934.28	6934.86	0.016629	3.19	39.61	27.12	0.38	1.40	2.23	0.62
3	1450	PF# 1	193.00	6930.00	6931.86	6932.35	6933.22	0.088346	6.06	24.53	22.49	0.84	4.76	8.86	2.93
3	1400	PF# 1	193.00	6930.00	6931.44	6931.44	6931.96	0.014759	2.30	40.28	35.39	0.34	1.11	1.32	0.75
3	1350	PF# 1	193.00	6928.00	6928.87	6929.38	6930.49	0.073420	3.68	23.41	29.85	0.69	3.63	4.01	2.75
3	1300	PF# 1	193.00	6926.00	6926.91	6927.19	6927.85	0.036966	2.68	29.49	34.96	0.50	1.90	2.09	1.81
3	1250	PF# 1	193.00	6924.00	6925.66	6925.79	6926.35	0.024309	3.19	35.38	31.01	0.44	1.54	2.45	0.92
3	1200	PF# 1	193.00	6922.00	6923.35	6923.81	6924.78	0.040570	3.34	26.44	23.03	0.54	2.80	2.99	0.21
3	1150	PF# 1	193.00	6920.00	6921.27	6921.75	6922.73	0.044214	3.33	25.86	24.55	0.55	2.86	3.04	0.31
3	1100	PF# 1	193.00	6920.00	6921.29	6921.29	6921.85	0.013750	2.07	39.37	33.80	0.32	1.01	1.11	0.49
3	1075.2	PF# 1	193.00	6918.00	6918.96	6919.56	6920.99	0.101208	4.60	21.27	25.67	0.83	4.69	6.07	4.32
3	1000	PF# 1	193.00	6914.57	6914.58	6914.83	6915.36	0.054381	0.09	27.29	57.13	0.24	1.63		

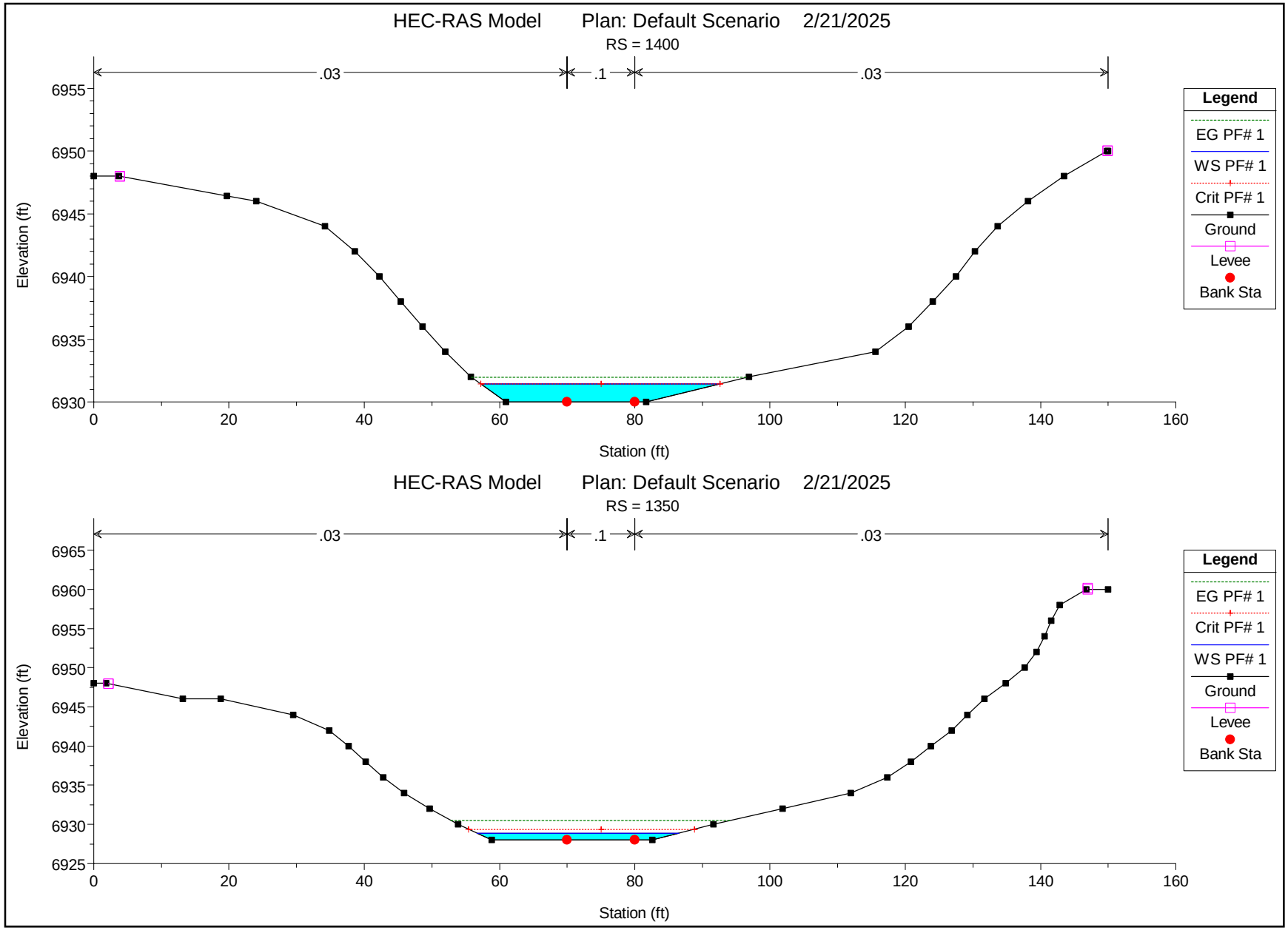


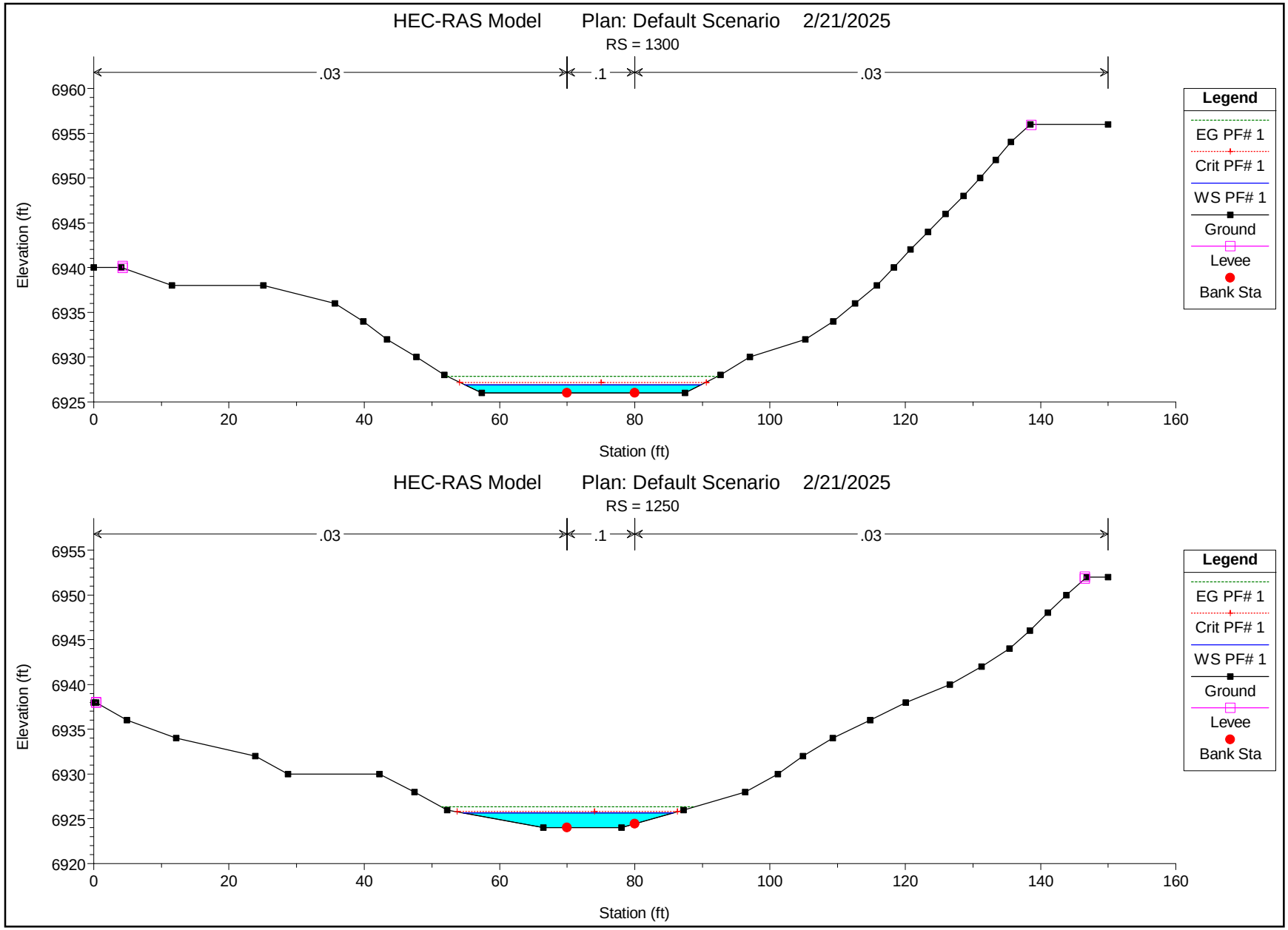
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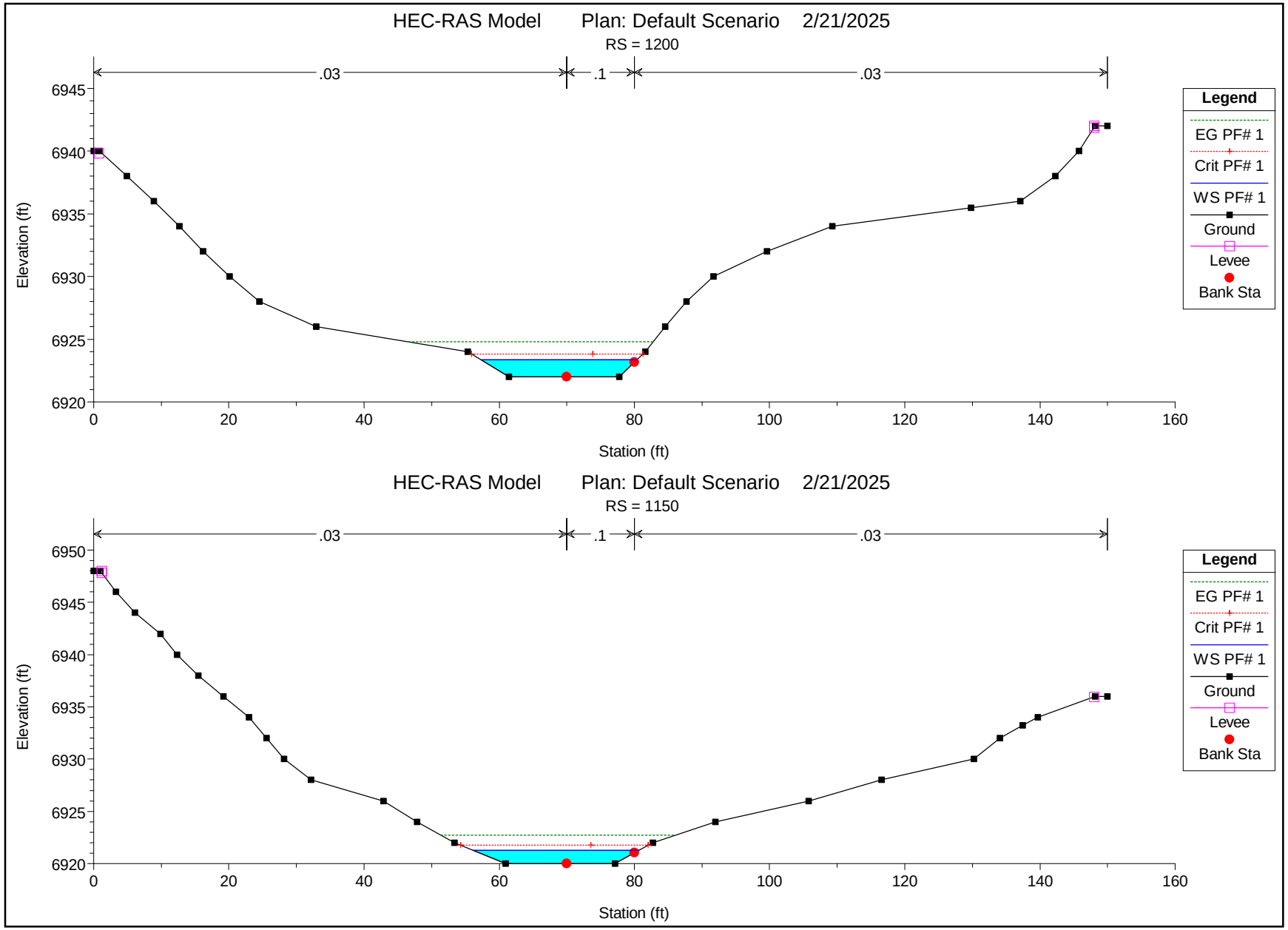

HEC-RAS Model Plan: Default Scenario 2/21/2025
RS = 1700
.03
.1
.03
Elevation (ft)
6970
6965
6960
6955
6950
6945
6940
0
20
40
60
80
100
120
140
160
Station (ft)
Legend
EG PF# 1
Crit PF# 1
WS PF# 1
Ground
Levee
Bank Sta
HEC-RAS Model Plan: Default Scenario 2/21/2025
RS = 1650
.03
.1
.03
Elevation (ft)
6960
6955
6950
6945
6940
6935
0
20
40
60
80
100
120
140
160
Station (ft)
Legend
EG PF# 1
WS PF# 1
Crit PF# 1
Ground
Levee
Bank Sta

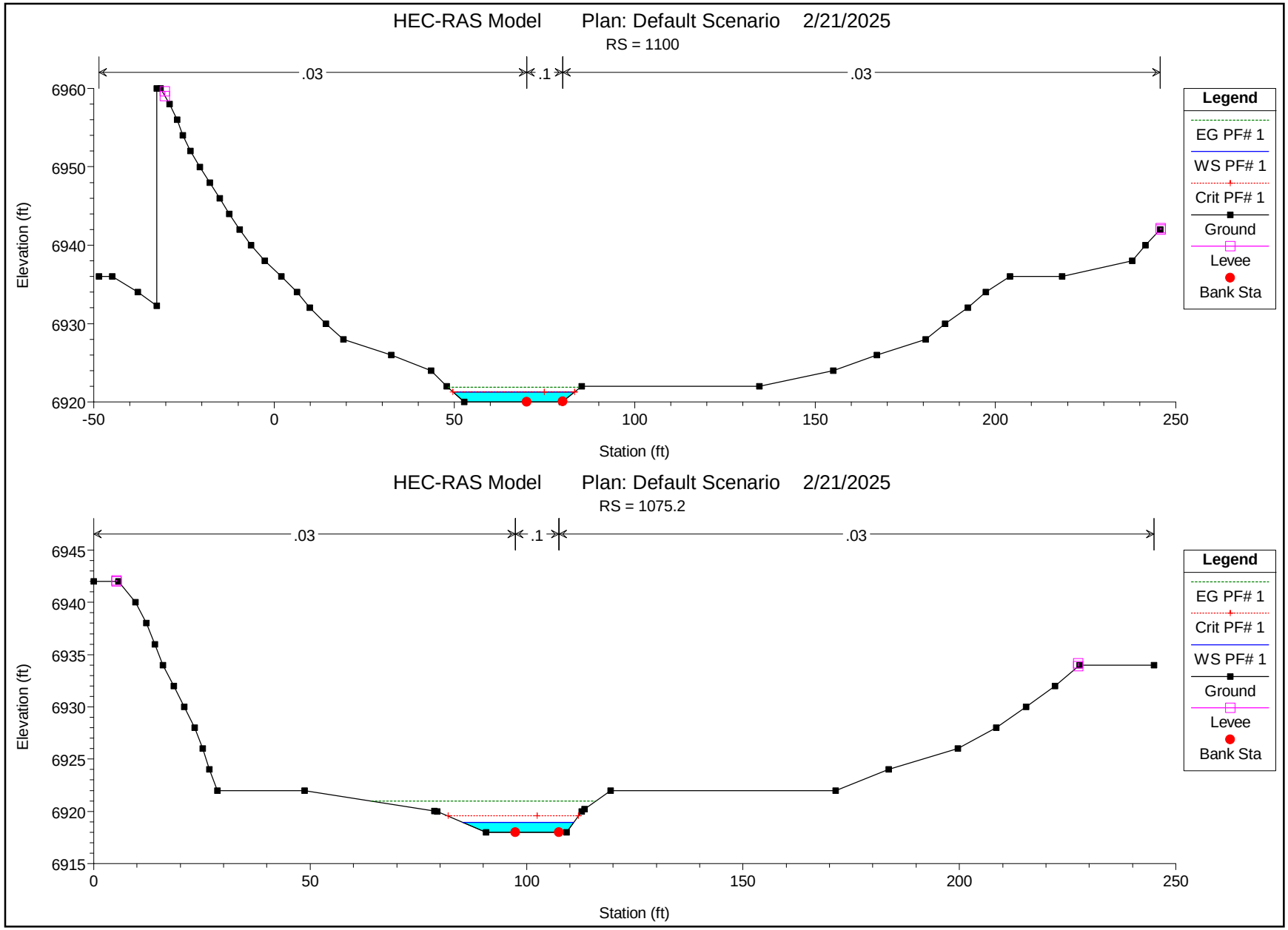

HEC-RAS Model Plan: Default Scenario 2/21/2025
RS = 1600
.03
.1
.03
Elevation (ft)
6965
6960
6955
6950
6945
6940
6935
0
20
40
60
80
100
120
140
160
Station (ft)
Legend
EG PF# 1
WS PF# 1
Crit PF# 1
Ground
Levee
Bank Sta
HEC-RAS Model Plan: Default Scenario 2/21/2025
RS = 1550
.03
.1
.03
Elevation (ft)
6960
6955
6950
6945
6940
6935
6930
0
20
40
60
80
100
120
140
160
Station (ft)
Legend
EG PF# 1
Crit PF# 1
WS PF# 1
Ground
Levee
Bank Sta

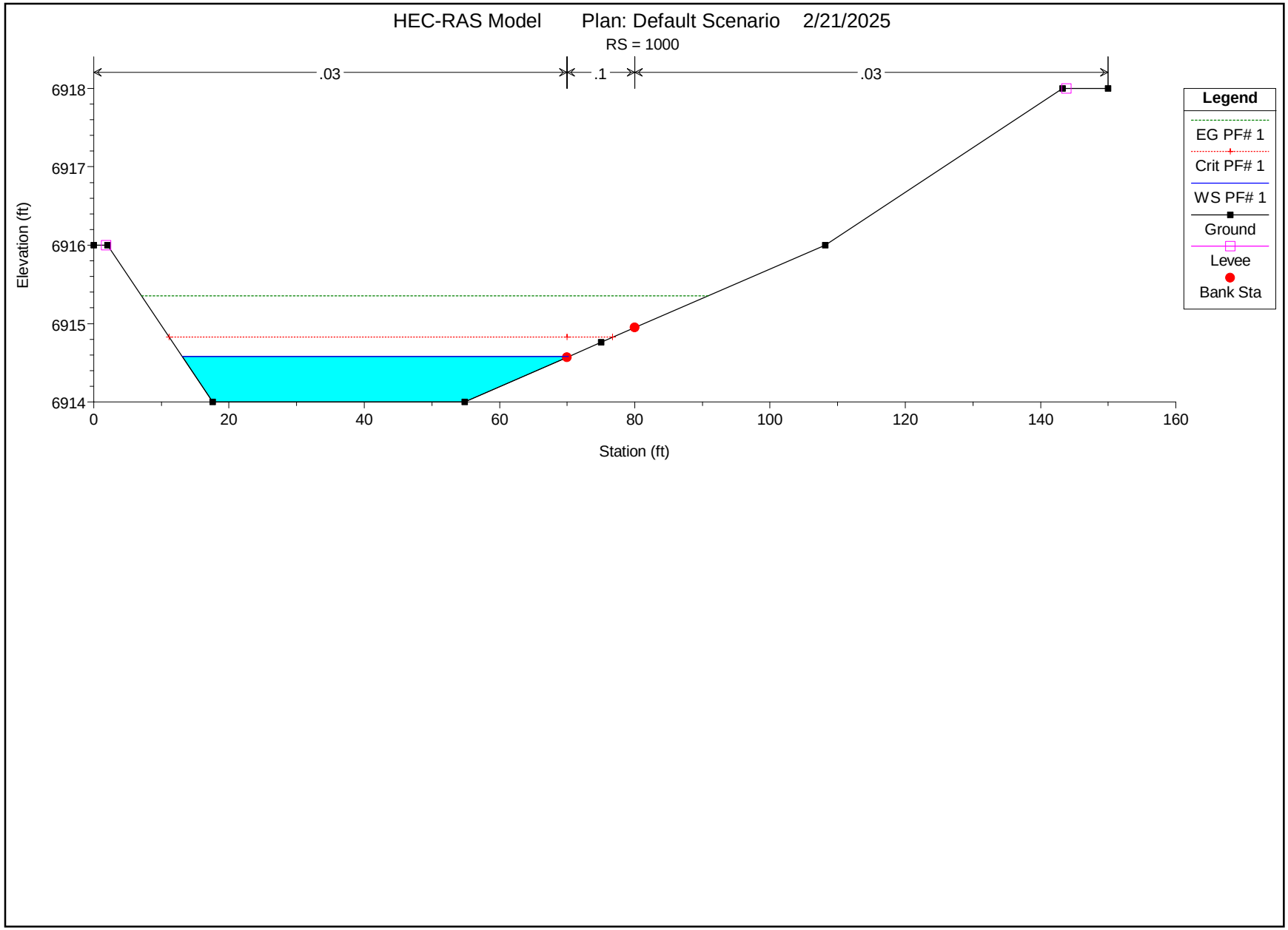

HEC-RAS Model Plan: Default Scenario 2/21/2025
RS = 1500
.03
.1
.03
Elevation (ft)
6970
6965
6960
6955
6950
6945
6940
6935
6930
0
20
40
60
80
100
120
140
160
Station (ft)
Legend
EG PF# 1
Crit PF# 1
WS PF# 1
Ground
Levee
Bank Sta
HEC-RAS Model Plan: Default Scenario 2/21/2025
RS = 1450
.03
.1
.03
Elevation (ft)
6965
6960
6955
6950
6945
6940
6935
6930
0
20
40
60
80
100
120
140
160
Station (ft)
Legend
EG PF# 1
Crit PF# 1
WS PF# 1
Ground
Levee
Bank Sta

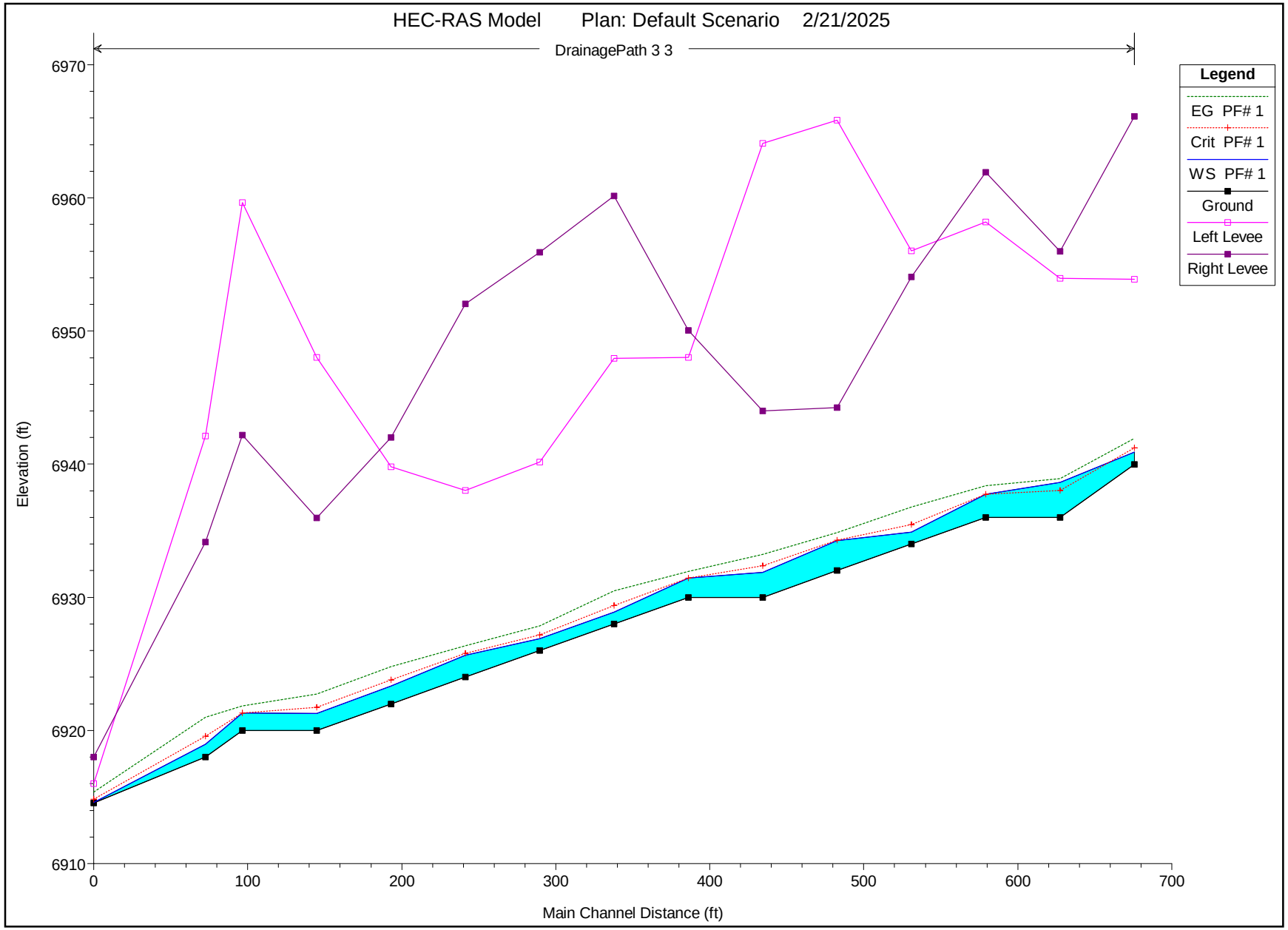

HEC-RAS Model Plan: Default Scenario 2/21/2025
RS = 1400
.03
.1
.03
Elevation (ft)
6955
6950
6945
6940
6935
6930
0
20
40
60
80
100
120
140
160
Station (ft)
Legend
EG PF# 1
WS PF# 1
Crit PF# 1
Ground
Levee
Bank Sta
HEC-RAS Model Plan: Default Scenario 2/21/2025
RS = 1350
.03
.1
.03
Elevation (ft)
6965
6960
6955
6950
6945
6940
6935
6930
6925
0
20
40
60
80
100
120
140
160
Station (ft)
Legend
EG PF# 1
Crit PF# 1
WS PF# 1
Ground
Levee
Bank Sta


HEC-RAS Model Plan: Default Scenario 2/21/2025
RS = 1300
.03
.1
.03
Elevation (ft)
6960
6955
6950
6945
6940
6935
6930
6925
0
20
40
60
80
100
120
140
160
Station (ft)
Legend
EG PF# 1
Crit PF# 1
WS PF# 1
Ground
Levee
Bank Sta
HEC-RAS Model Plan: Default Scenario 2/21/2025
RS = 1250
.03
.1
.03
Elevation (ft)
6955
6950
6945
6940
6935
6930
6925
6920
0
20
40
60
80
100
120
140
160
Station (ft)
Legend
EG PF# 1
Crit PF# 1
WS PF# 1
Ground
Levee
Bank Sta


HEC-RAS Model Plan: Default Scenario 2/21/2025
RS = 1200
.03
.1
.03
Elevation (ft)
6945
6940
6935
6930
6925
6920
0
20
40
60
80
100
120
140
160
Station (ft)
Legend
EG PF# 1
Crit PF# 1
WS PF# 1
Ground
Levee
Bank Sta
HEC-RAS Model Plan: Default Scenario 2/21/2025
RS = 1150
.03
.1
.03
Elevation (ft)
6950
6945
6940
6935
6930
6925
6920
0
20
40
60
80
100
120
140
160
Station (ft)
Legend
EG PF# 1
Crit PF# 1
WS PF# 1
Ground
Levee
Bank Sta


HEC-RAS Model Plan: Default Scenario 2/21/2025
RS = 1100
.03
.1
.03
Elevation (ft)
6960
6950
6940
6930
6920
-50
0
50
100
150
200
250
Station (ft)
Legend
EG PF# 1
WS PF# 1
Crit PF# 1
Ground
Levee
Bank Sta
HEC-RAS Model Plan: Default Scenario 2/21/2025
RS = 1075.2
.03
.1
.03
Elevation (ft)
6945
6940
6935
6930
6925
6920
6915
0
50
100
150
200
250
Station (ft)
Legend
EG PF# 1
Crit PF# 1
WS PF# 1
Ground
Levee
Bank Sta


HEC-RAS Model
Plan: Default Scenario
2/21/2025
RS = 1000
.03
.1
.03
6918
6917
6916
6915
6914
Elevation (ft)
0
20
40
60
80
100
120
140
160
Station (ft)
Legend
EG PF# 1
Crit PF# 1
WS PF# 1
Ground
Levee
Bank Sta


HEC-RAS Model Plan: Default Scenario 2/21/2025
DrainagePath 3 3
Legend
EG PF# 1
Crit PF# 1
WS PF# 1
Ground
Left Levee
Right Levee
Elevation (ft)
6970
6960
6950
6940
6930
6920
6910
0
100
200
300
400
500
600
700
Main Channel Distance (ft)

Appendix D
Reference Materials

Drainage Basin Planning Study
For
Kettle Creek Basin

Prepared for:

High Valley Land Company, Inc.
1755 Telestar Drive, Suite 211
Colorado Springs, CO 80920
Contact: Tom Taylor

Prepared by:

JR Engineering LLC
3730 Sinton Road, Suite
Colorado Springs, CO 80903
(719) 593-2593
Contact: Steve Rossoll

JR Project Number: 25100.00
May 5, 2015
X:\2510000.all\2510000\Word\Reports\Kettle Creek DBPS

1 INTRODUCTION

1.1 Contract Authorization

This Drainage Basin Planning Study was authorized under the terms of an agreement between the City of Colorado Springs Engineering Development Review and Stormwater Departments and High Valley Land Company, Inc. and paid for with private funds. This study covers drainage development only within the Kettle Creek Drainage Basin.

1.2 Purpose and Scope

The purpose of the drainage basin planning study is to give an initial comprehensive study of the entire Kettle Creek Basin. This Study shall show the conduits, channels, natural drainage courses, detention reservoirs, easements, culverts and all other hydraulic facilities required to control surface water from the 100-year event within the Kettle Creek Basin and to carry such waters to points of insignificant impact and to develop a plan to address future stormwater and infrastructure needs within the Kettle Creek Watershed. The process used to develop a DBPS provides opportunity for interested parties to offer input on drainage issues, needs, and facilities within the watershed. The DBPS is intended to provide an inventory of required drainage facilities and determine a drainage fee per developed acre.

1.3 Past Studies

A complete Drainage Basin Planning Study (DBPS) has not been performed for the entire Kettle Creek Watershed. However, Master Development Drainage Plans (MDDP) and Final Drainage Reports (FDR) have been prepared for areas within the study area that have been developed in the last 13 years. A number of previous studies and reports were reviewed during the preparation of the current study. The most relevant studies are listed below along with a brief synopsis of the relevance of the current study. Additional reports that were reviewed are noted in the reference section of this study.

Fountain Creek Watershed Study, January 2009, U.S. Army Corps of Engineers.
The Fountain Creek Watershed Study ties together four separate studies, a hydrology report, a hydraulics report, and environmental conditions report, and a geomorphology report, into a watershed study establishing the objectives for reduced flood risk, erosion, and sedimentation in the Fountain Creek Basin. The Watershed Study presents percent change data for existing versus future peak discharges and volumes in Monument Creek and adjacent tributaries, although no Kettle Creek flow data is presented in the Watershed Study. The hydrologic study and hydraulic study were not available from the City of Colorado Springs or from the U.S. Army Corps of Engineers to compare hydrology for common basins at the time of the preparation of this DBPS.

Master Development Drainage Plan For North Fork at Briargate, May, 2014, by JR Engineering.
A proposed mixed use development comprised of a single family residential, multifamily, an elementary school, and park site. The Site covers 267 acres located north-east of Powers Boulevard and Old Ranch Road.

Kettle Creek Drainage Basin Old Ranch Road Tributary Drainage Basin Planning Study and Master Development Drainage Plan, April 2001, by JR Engineering. (Kettle Creek MDDP/DBPS)
This MDDP/DBPS covers the portion of the Kettle Creek Basin along old Ranch Road. This study provides hydrologic data for the existing and future development along Old Ranch Road, Creekside Estates, and drainage facilities at Pine Creek High School.

U.S. Air Force Academy Kettle Creek Watershed Hydrology Study Findings and Recommendations Report, March 2002, by URS Group, Inc. (AFA Study)
This report was prepared for the U.S. Air Force Academy to study the hydrologic, hydraulic, and sediment transport for the entire Kettle Creek basin. The report recommends alternatives to reduce sediment accumulation, evaluate Preble's meadow jumping mouse habitat, and enhance existing wetlands on Academy property.

Flood Insurance Study for El Paso County and Incorporated Areas
FEMA performed a Flood Insurance Study (FIS) in 1999 with detailed analysis and base flood elevations from State Highway 83 to Templeton Gap Road at the headwaters of Kettle Creek in the Black Forest. The FEMA FIRM maps and FIS data are included in **Appendix B**.

1.4 Stakeholder Process

Stakeholders who may be affected by this study results must be identified and included in numerous public meetings and presentations to committees, council and commissions. This DBPS is prepared for the High Valley Land Company, Inc. and is the only stakeholder that is affected in the Kettle Creek Basin study. Thus there are no stakeholder meetings and presentations required.

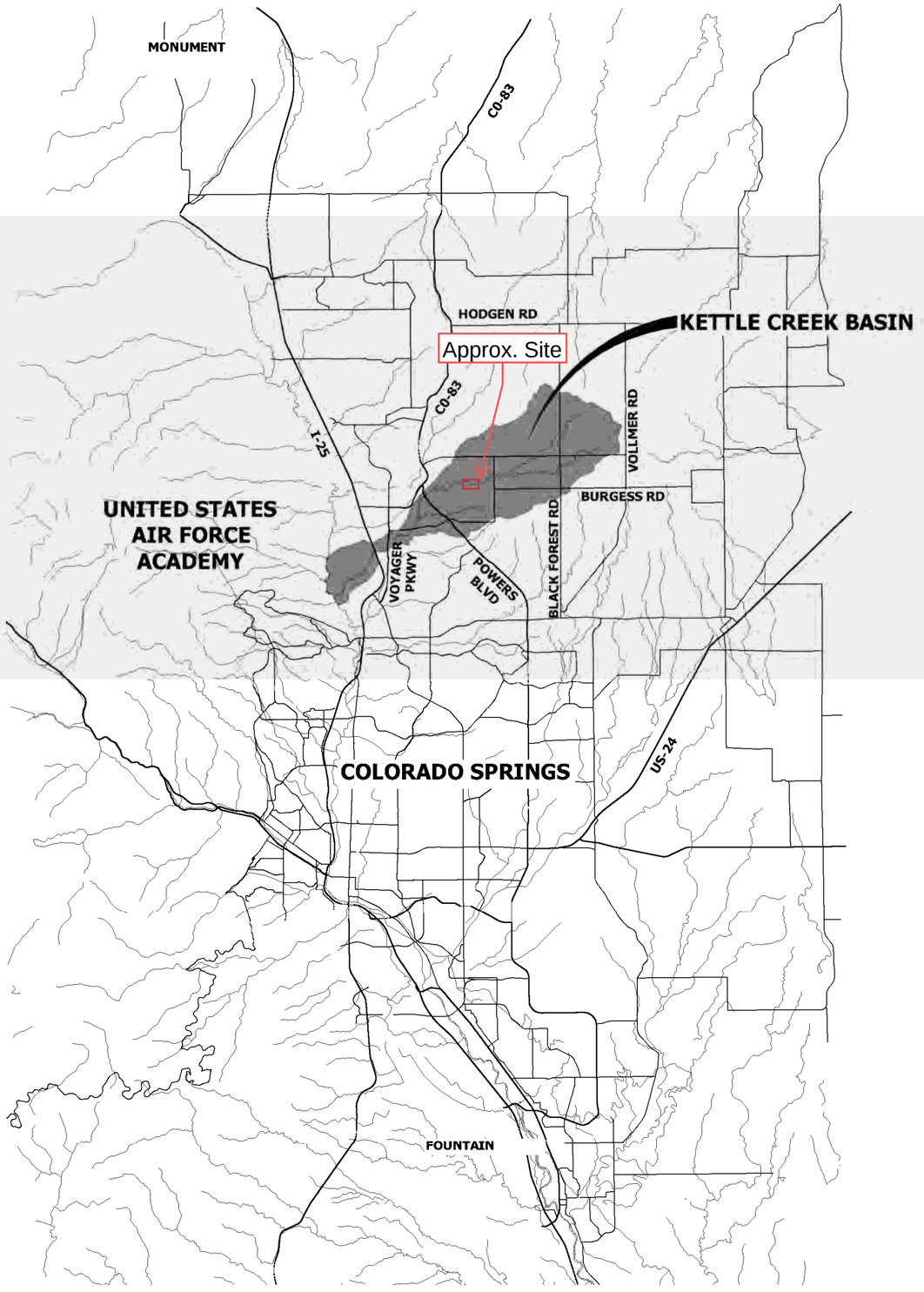
1.5 Agency Jurisdictions

Future development in the Kettle Creek basin will predominately be located within the City of Colorado Springs city limits. Improvements outside the city limits will be located and governed by El Paso County.

1.6 General Basin Description

The Kettle Creek watershed is located in the north central portion of El Paso County, Colorado. Kettle Creek and its tributaries originate on the southern slope of the Black Forest and flow in a southwesterly direction towards the City of Colorado Springs. The Kettle Creek watershed has a contributing area of approximately 16.41 square miles at its junction with Interstate Highway 25 (I-25).

The headwaters of Kettle Creek are located in the Black Forest, an area dominated by ponderosa pine forest and grassland on undeveloped large acreage tracts and 2- to 5-acre rural residential lots. In the vicinity of Powers Boulevard, the watershed changes to predominately undeveloped grassland. Downstream of Powers Boulevard, the watershed is dominated by residential development consisting of single-family homes, commercial centers, and vacant land. A vicinity map is provided in **Figure 1-1**.



2 1 0 2 4

ORIGINAL SCALE: 1" = 4 MILES

FIGURE 1–1 VICINITY MAP
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4 HYDRAULIC ANALYSIS

4.1 Major Drainageways

A hydraulic analysis was undertaken to evaluate the distribution of flow, determine areas covered by water during flooding events, and related characteristics of the water flow in the channel and overbank areas along Kettle Creek. While the hydrologic computations define the rate of flow for floods of selected frequencies at various points within the drainage basin, the hydraulic computations reflect dynamic conditions of the water flowing downstream as affected by the channel size, subsurface roughness, structures along the channel, channel vegetation, and similar physical characteristics. The physical characteristics of Kettle Creek and its tributaries in combination with the peak flood discharge rates described in Section 3 of this report provide the primary input characteristics to the hydraulic analysis, and the basis for evaluating the hydraulic adequacy of the outfall system.

Kettle Creek and its tributaries in the Black Forest area are defined in many places by deep channels with steep side slopes. A field investigation was conducted throughout the lower portion of the drainage basin, which will be the segment primarily affected by future development. It is understood that little future development is expected to occur in the Black Forest.

A field investigation was conducted from Powers Boulevard to I-25 in August 2014. The site investigation established a basis to define any areas in need of improvements, and determine the adequacy of the assumed channel characteristics and existing structures in this area. The visit also identified some areas where stream bank and bed erosion exists in the lower portion of the basin, and where other physical problems have resulted due to the stream hydraulics. Some of these areas are presented in **Appendix D** with photos taken in August 2014.

4.2 Methodology

Hydraulic calculations were performed on Kettle Creek to determine the existing and future floodplain limits. This was accomplished by utilizing the U.S. Army Corps of Engineer's HEC-RAS River Analysis System program (version 4.1.0, January 2010). For this study, Kettle Creek was divided into separate reaches corresponding to the designations as shown on **Figure 3-2**, and described in Section 3 of this report. The delineated historic, existing and future floodplain boundaries can be seen on the work maps, **Figures 4-1** and **4-2**, and the depths are depicted on the profile sheets included as **Figure 4-3** through **Figure 4-7**.

4.2.1 Parameters

Hydraulic analyses for existing and future hydrologic conditions were completed for the main stem of Kettle Creek from Howells Road to I-25. These analyses were completed to represent peak flows for the flood events with 2-, 5-, 10-, 25-, 50- and 100-year recurrence intervals. Cross-section topography data was obtained from a triangulated irregular network (TIN) in AutoCAD that was created from the contour information obtained from City of Colorado Springs FIMS topographic data.

4.2.2 Structures

Bridges and ineffective flow areas were added to the HEC-RAS model. Physical parameters for measured structures were incorporated into the hydraulic model using HEC-RAS bridge and cross-section data editors. All of the drainageway crossings from Powers Boulevard to I-25 were modeled to represent existing conditions which consist of bridges over Kettle Creek. These crossings are located at Powers Boulevard (bridge), Old Ranch Road (bridge), Otero Avenue (bridge), and Voyager Parkway (State Highway 83) (bridge).

4.2.3 Reaches

The reach analyzed consists of the Kettle Creek main stem from Howells Road (approximate, Howells Road does not cross Kettle Creek) to the Kettle Creek Detention Facility just east of I-25, approximately 24,850 linear feet or 4.7 miles of channel. This downstream limit extends 3,000 feet past the FIS and FEMA FIRM maps. The upstream limit of model was taken to be the approximate limit of significant planned future development at the east city limits. Upstream of Howells Road is the Black Forest (El Paso County jurisdiction), where land use is expected to remain unchanged in the future. The downstream limit was taken to be the embankment of the regional detention pond at I-25. Information from the U.S. Air Force Academy Kettle Creek Watershed Hydrology Study (April 2002) was used to determine the water surface elevations of the Kettle Creek detention facility for each respective storm recurrence interval.

The main stem of Kettle Creek in the subject reach is defined by a deeply incised main channel with heavy brush and wetland-type vegetation. Above the banks of the main channel, overbanks exist within the Kettle Creek drainageway with steep side slopes and natural grasses and sparse scrub vegetation.

4.2.4 Manning's *n* Values

The Manning's n values were applied across the channel cross-section to reflect changes in vegetative cover between the main channel and overbank areas. Manning's n values were obtained from the Major Drainage chapter of the UDFCD Drainage Criteria Manual. The Manning's *n* values for the channels and floodplains are summarized in Table 4-1.

Table 4-1
Manning's *n* Values

Parameter	Historic Conditions	Existing Conditions	Future Conditions
Main Channel *n*	0.100	0.100	0.100
Overbank *n*	0.030	0.030	0.030

The Manning's *n* for the main channel was selected for "very weedy reaches, deep pools, or floodways with heavy stand of timber and underbrush". Manning's *n* values for the overbank areas reflect conditions of

The regional detention alternatives presented herein only are considered for the purposes of attenuating developed flow rates. Consideration of regional detention alternatives will have significant environmental impacts as discussed in Section 5. Sub-regional detention alone will not reduce flow rates in Kettle Creek to historic levels, as past development in the upper portion of the basin is a contributing factor to the increased flows under existing conditions. Regional detention must be owned and maintained by a public entity, with ownership and maintenance responsibilities clearly defined to ensure the proper function of the facility in perpetuity.

6.3 Sub-Regional Detention

The anticipated approach is sub-regional detention with full spectrum detention and water quality treatment. Any future development in the Kettle Creek basin within the City of Colorado Springs shall have sub-regional detention for each development/phase. Detention facilities serving drainage basins between 20 and 130 acres are considered "sub-regional detention". Sub-regional detention may be constructed by a public entity such as a municipality or special district to serve several landowners in the upstream watershed or by a single landowner. It may be possible for a single landowner to construct sub-regional detention if the upper part of the watershed is owned by others and if the necessary conditions are achieved. Sub-regional detention should be addressed in subsequent Master Development Drainage Plans (MDDP) for individual development projects. The ownership and maintenance of these ponds are anticipated to be public or quasi-public. In order to be considered for public maintenance the contributory area shall be in the range of 70-120 acres. A conceptual map illustrating the locations of required sub-regional detention facilities is shown in **Figure 6-1**.

6.3.1 Full Spectrum Detention

The full spectrum detention approach, as defined in Chapter 13 of the DCM, shall be implemented as the standard detention approach. Impervious surfaces associated with development increase peak flows, frequency of runoff and total volume of stormwater surface runoff when compared to pre-development conditions. This increase is most pronounced for the smaller, more frequent storms and can result in stream degradation and water quality impacts as well as flooding during large storm events.

In addition to detaining developed conditions stormwater discharge for flood control and for water quality considerations, it is also important to expand the focus to the range of flows responsible for transporting the most bedload in the receiving stream. This range depends on reach specific characteristics but is between the annual event and the 5-year event. Runoff events in this range can produce geomorphic changes in local receiving streams resulting in severe erosion, loss of riparian habitat, and water quality degradation.

Outflow hydrographs from traditional flood-control detention facilities tend to maintain flows near the maximum release rates for relatively long periods of time. This allows hydrographs released from multiple independent ponds to overlap and add to each other to generate flows exceeding pre-development conditions. Traditional flood-control detention concepts can result in an increase in total watershed discharges even if individual detention facilities each control peak discharges to pre-developed conditions. Full spectrum detention modeling reduces urban runoff peaks to levels similar to pre-development conditions for a wide range of storms over an entire watershed, even with multiple independent detention facilities. A result of full spectrum detention is that discharges from storms smaller than approximately the 2-year event will be reduced to very low flows near or below the sediment carrying threshold value for downstream drainageways.

6.3.2 Water Quality

Each sub-regional detention pond shall detain flows not only for flood control, but also for water quality. The Water Quality Capture Volume (WQCV) is intended to capture most runoff events and reduce their pollutant load prior to discharging into drainageways. The size of this storage element depends primarily on the amount of tributary impervious area and can be reduced by implementing development practices that reduce the effective imperviousness, discussed in more detail below.

Future development in the basin shall consider other land planning and engineering design approaches to manage stormwater runoff and water quality. Low Impact Development (LID) is a comprehensive approach with the goal of mimicking the pre-development hydrologic regime. LID emphasizes conservation of natural features and use of engineered, on-site, small-scale hydrologic controls that infiltrate, filter, store, evaporate, and detain runoff close to its source. Portions of the site that aid in reducing the developed conditions discharge should be preserved, which may include mature trees, stream corridors, wetlands, and NRCS Type A/B soils with higher infiltration rates.

Minimizing Directly Connected Impervious Area (MDCIA) includes a variety of runoff reduction strategies based on reducing impervious areas and routing runoff from impervious surfaces over grassy areas to slow runoff and promote infiltration. MDCIA is a technique for reducing runoff peaks and volumes following urbanization. Paved areas can be reduced in extent to the minimum amount practical, and implement methods to route runoff over grassed areas rather than directly into storm sewer. When soils vary over the site, concentrate new impervious areas over NRCS Type C and D soils, while preserving NRCS Type A and B soils for landscape areas and other permeable surfaces. Increasing the number and lengths of flow paths will all reduce the impact of the development.

Volume reduction is a key hydrologic objective, as opposed to peak flow reduction being the only objective. Volume reduction is emphasized not only to reduce pollutant loading and peak flows, but also to move toward hydrologic regimes with flow durations and frequencies closer to the natural hydrologic regime.

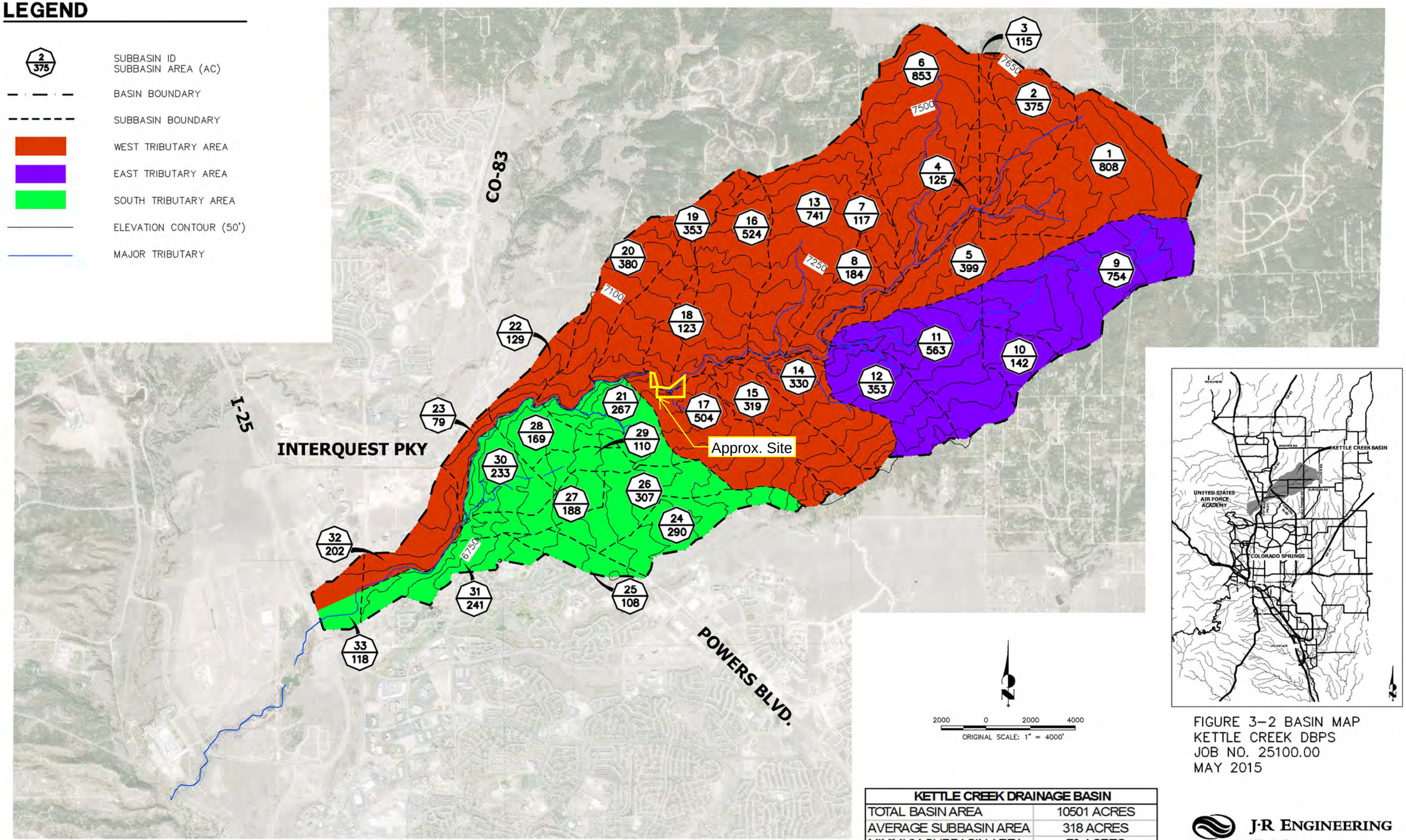
6.4 Limited Channel Stabilization Alternative

Channel improvements may be necessary in the main study reach of Kettle Creek to limit erosion and deposition resulting from high velocities as determined in Section 4. However, grading and grade control structures may not be feasible in Kettle Creek due to the disturbance they would cause with the presence of the Preble's meadow jumping mouse. Conceptual check structure placement is provided for reference, should grade control structures become an option in the future.

The locations of these conceptual check structures were determined by areas where mean channel velocities exceeded 5 feet per second for the 100-year event. Future grade between check structures was estimated to stabilize at approximately 0.20 percent. Check structure placement was shown to lower velocities above 5

LEGEND

- SUBBASIN ID / SUBBASIN AREA (AC)
- BASIN BOUNDARY
- SUBBASIN BOUNDARY
- WEST TRIBUTARY AREA
- EAST TRIBUTARY AREA
- SOUTH TRIBUTARY AREA
- ELEVATION CONTOUR (50')
- MAJOR TRIBUTARY



2000 0 2000 4000
ORIGINAL SCALE: 1" = 4000'

KETTLE CREEK DRAINAGE BASIN	
TOTAL BASIN AREA	10501 ACRES
AVERAGE SUBBASIN AREA	318 ACRES
MINIMUM SUBBASIN AREA	79 ACRES
MAXIMUM SUBBASIN AREA	853 ACRES

FIGURE 3–2 BASIN MAP
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LEGEND

- SUBBASIN ID
- 100-YEAR 24-HOUR FLOWS (CFS)
- 5-YEAR 24-HOUR FLOWS (CFS)
- BASIN BOUNDARY
- SUBBASIN BOUNDARY
- MAJOR TRIBUTARY
- JUNCTION

CO-83

INTERQUEST PKY

VOYAGER PKY

I-25

POWERS BLVD.

Approx. Site

1	111	402
2	59	217
3	17	60
4	20	75
5	42	150
6	93	332
7	20	71
8	35	113
9	81	287
10	24	87
11	89	332
12	52	184
13	80	285
14	59	207
15	57	201
16	68	241
17	74	264
18	23	80
19	46	157
20	73	244
21	65	207
22	35	107
23	35	109
24	54	166
25	54	159
26	64	199
27	52	157
28	8	120
29	30	92
30	65	200
31	58	241
32	37	147
33	24	93

J1 J2 J3 J4 J5 J6 J7 J8 J9 J10 J11 J12 J13 J14 J15 J16 J17 J18 J19 J20 J21 J22 J23 J24 J25 J26

N

3000 1500 0 3000

ORIGINAL SCALE: 1" = 3000'

FIGURE 3-12 HYDROLOGY MAP (HISTORIC)
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LEGEND

- SUBBASIN ID
- 100-YEAR 24-HOUR FLOWS (CFS)
- 5-YEAR 24-HOUR FLOWS (CFS)
- BASIN BOUNDARY
- SUBBASIN BOUNDARY
- MAJOR TRIBUTARY
- JUNCTION

CO-83

INTERQUEST PKY

VOYAGER PKY

I-25

POWERS BLVD.

Approx. Site

1	315 / 735	2	173 / 403
3	56 / 122	4	56 / 135
5	134 / 308	6	240 / 588
7	51 / 125	8	117 / 273
9	223 / 520	10	62 / 152
11	322 / 720	12	144 / 338
13	212 / 505	14	138 / 337
15	143 / 342	16	193 / 449
17	184 / 447	18	55 / 134
19	101 / 248	20	134 / 343
21	100 / 264	22	36 / 109
23	42 / 121	24	24 / 93
28	38 / 120	29	37 / 102
30	116 / 279	31	217 / 490
32	124 / 289	33	24 / 93
S1	109 / 576		

J1, J2, J3, J4, J5, J6, J7, J8, J9, J10, J11, J12, J13, J14, J15, J16, J17, J18, J19, J20, J23, J24, J25, J26

3000 1500 0 3000

ORIGINAL SCALE: 1" = 3000'

FIGURE 3-13 HYDROLOGY MAP (EXISTING)
KETTLE CREEK DBPS
JOB NO. 25100.00
MAY 2015

NOTE

1. SUBBASIN 24-27 DATA IS REPLACED WITH DATA FROM THE KETTLE CREEK DRAINAGE BASIN OLD RANCH ROAD TRIBUTARY MASTER DEVELOPMENT DRAINAGE PLAN AND LABELED AS SOURCE-1 (S1).

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LEGEND

- SUBBASIN ID
- 100-YEAR 24-HOUR FLOWS (CFS)
- 5-YEAR 24-HOUR FLOWS (CFS)
- BASIN BOUNDARY
- SUBBASIN BOUNDARY
- MAJOR TRIBUTARY
- JUNCTION

CO-83

INTERQUEST PKY

VOYAGER PKY

I-25

POWERS BLVD.

Approx. Site

1	315 / 735	2	173 / 403
3	56 / 122	4	56 / 135
5	134 / 308	6	240 / 588
7	51 / 125	8	117 / 273
9	223 / 520	10	62 / 152
11	322 / 720	12	144 / 338
13	212 / 505	14	138 / 337
15	143 / 342	16	193 / 449
17	184 / 447	18	55 / 134
19	111 / 262	20	206 / 448
21	114 / 284	22	112 / 219
23	44 / 124	24	93 / 24
28	123 / 241	29	111 / 207
30	158 / 340	31	290 / 606
32	274 / 500	33	24 / 93
S1	109 / 576		

3000 1500 0 3000

ORIGINAL SCALE: 1" = 3000'

FIGURE 3-14 HYDROLOGY MAP (FUTURE)
KETTLE CREEK DBPS
JOB NO. 25100.00
MAY 2015

NOTE

1. SUBBASIN 24-27 DATA IS REPLACED WITH DATA FROM THE KETTLE CREEK DRAINAGE BASIN OLD RANCH ROAD TRIBUTARY MASTER DEVELOPMENT DRAINAGE PLAN AND LABELED AS SOURCE-1 (S1).

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EXISTING CONDITIONS
MODEL RESULTS
(5-YEAR)

5-Year, 2-Hour Storm			
Hydrologic Element	Drainage Area (mi^2)	Peak Discharge (CFS)	Volume (in)
Subbasin-1	1.263	286	0.51
Subbasin-2	0.586	160	0.52
Subbasin-3	0.180	56	0.65
Junction-1	2.029	492	0.52
Reach-1	2.029	490	0.52
Subbasin-4	0.195	50	0.45
Junction-2	2.224	536	0.52
Reach-2	2.224	536	0.52
Subbasin-5	0.625	119	0.56
Junction-3	2.849	644	0.53
Reach-3	2.849	644	0.53
Subbasin-6	1.333	203	0.43
Junction-4	4.182	846	0.5
Reach-4	4.182	846	0.5
Subbasin-7	0.183	45	0.44
Junction-5	4.365	865	0.49
Reach-5	4.365	862	0.49
Subbasin-8	0.288	104	0.52
Junction-6	4.653	885	0.49
Reach-6	4.653	883	0.49
Subbasin-9	1.177	195	0.51
Subbasin-10	0.222	55	0.43
Junction-7	1.399	217	0.49
Reach-7	1.399	217	0.49
Subbasin-11	0.880	302	0.61
Junction-8	2.279	437	0.54
Reach-8	2.279	434	0.54
Subbasin-12	0.552	127	0.5
Junction-9	2.831	546	0.53
Reach-9	2.831	545	0.53
Junction-10	7.484	1,305	0.51
Reach-10	7.484	1,305	0.51
Subbasin-13	1.156	183	0.47
Subbasin-14	0.516	122	0.44
Junction-11	9.156	1,437	0.5
Reach-11	9.156	1,435	0.5
Subbasin-15	0.498	127	0.47
Junction-12	9.654	1,445	0.5
Reach-12	9.654	1,442	0.5
Subbasin-16	0.819	175	0.51
Subbasin-17	0.788	164	0.44
Junction-13	11.261	1,475	0.49

5-Year, 2-Hour Storm			
Hydrologic Element	Drainage Area (mi^2)	Peak Discharge (CFS)	Volume (in)
Reach-13	11.261	1,473	0.49
Subbasin-18	0.192	50	0.44
Junction-14	11.453	1,473	0.49
Reach-14	11.453	1,473	0.49
Subbasin-19	0.552	86	0.44
Junction-15	12.005	1,488	0.49
Reach-15	12.005	1,485	0.49
Subbasin-20	0.594	113	0.38
Junction-16	12.599	1,487	0.49
Reach-16	12.599	1,487	0.49
Subbasin-21	0.417	82	0.33
Junction-17	13.016	1,487	0.48
Reach-17	13.016	1,486	0.48
Subbasin-22	0.200	24	0.21
Junction-18	13.216	1,486	0.48
Reach-18	13.216	1,484	0.48
Subbasin-23	0.123	30	0.25
Junction-19	13.339	1,484	0.47
Reach-19	13.339	1,482	0.47
Subbasin-24	0.453	81	0.45
Subbasin-25	0.169	206	1.12
Subbasin-26	0.480	111	0.51
Junction-21	1.102	250	0.58
Reach-21	1.102	245	0.58
Subbasin-27	0.294	139	0.75
Junction-22	1.396	346	0.61
Reach-22	1.396	344	0.61
Subbasin-28	0.264	25	0.19
Subbasin-29	0.172	28	0.27
Junction-20	0.436	50	0.22
Reach-20	0.436	50	0.22
Subbasin-30	0.364	107	0.47
Junction-23	15.535	1,484	0.48
Reach-23	15.535	1,482	0.48
Subbasin-31	0.377	219	0.55
Subbasin-32	0.316	137	0.5
Junction-24	16.228	1,482	0.48
Reach-24	16.228	1,481	0.48
Subbasin-33	0.184	13	0.1
Junction-25	16.412	1481.1	0.48
Reach-25	16.412	1481.1	0.48
Junction-26	16.412	1481.1	0.48

5-Year, 24-Hour Storm			
Hydrologic Element	Drainage Area (mi^2)	Peak Discharge (CFS)	Volume (in)
Subbasin-1	1.263	315	1.06
Subbasin-2	0.586	173	1.06
Subbasin-3	0.180	56	1.27
Junction-1	2.029	527	1.08
Reach-1	2.029	526	1.08
Subbasin-4	0.195	56	0.97
Junction-2	2.224	572	1.07
Reach-2	2.224	568	1.07
Subbasin-5	0.625	134	1.14
Junction-3	2.849	689	1.08
Reach-3	2.849	689	1.08
Subbasin-6	1.333	240	0.94
Junction-4	4.182	928	1.04
Reach-4	4.182	917	1.04
Subbasin-7	0.183	51	0.97
Junction-5	4.365	940	1.03
Reach-5	4.365	929	1.03
Subbasin-8	0.288	117	1.1
Junction-6	4.653	959	1.04
Reach-6	4.653	944	1.04
Subbasin-9	1.177	223	1.05
Subbasin-10	0.222	62	0.93
Junction-7	1.399	252	1.03
Reach-7	1.399	250	1.03
Subbasin-11	0.880	322	1.23
Junction-8	2.279	484	1.11
Reach-8	2.279	484	1.11
Subbasin-12	0.552	144	1.06
Junction-9	2.831	609	1.1
Reach-9	2.831	594	1.1
Junction-10	7.484	1,444	1.06
Reach-10	7.484	1,428	1.06
Subbasin-13	1.156	212	1
Subbasin-14	0.516	138	0.95
Junction-11	9.156	1,605	1.05
Reach-11	9.156	1,604	1.05
Subbasin-15	0.498	143	1
Junction-12	9.654	1,636	1.05
Reach-12	9.654	1,634	1.05

5-Year, 24-Hour Storm			
Hydrologic Element	Drainage Area (mi^2)	Peak Discharge (CFS)	Volume (in)
Subbasin-16	0.819	193	1.06
Subbasin-17	0.788	184	0.95
Junction-13	11.261	1,730	1.04
Reach-13	11.261	1,705	1.04
Subbasin-18	0.192	55	0.95
Junction-14	11.453	1,711	1.04
Reach-14	11.453	1,710	1.04
Subbasin-19	0.552	101	0.95
Junction-15	12.005	1,745	1.03
Reach-15	12.005	1,741	1.03
Subbasin-20	0.594	134	0.86
Junction-16	12.599	1,760	1.03
Reach-16	12.599	1,741	1.03
Subbasin-21	0.417	100	0.79
Junction-17	13.016	1,752	1.02
Reach-17	13.016	1,752	1.02
Subbasin-22	0.200	36	0.59
Junction-18	13.216	1,756	1.01
Reach-18	13.216	1,746	1.01
Subbasin-23	0.123	42	0.66
Junction-19	13.339	1,748	1.01
Reach-19	13.339	1,747	1.01
Source-1	1.396	109	0.58
Subbasin-28	0.264	38	0.57
Subbasin-29	0.172	37	0.7
Junction-20	0.436	75	0.62
Reach-20	0.436	70	0.62
Subbasin-30	0.364	116	1
Junction-23	15.535	1,764	0.96
Reach-23	15.535	1,751	0.96
Subbasin-31	0.377	217	1.05
Subbasin-32	0.316	124	1.01
Junction-24	16.228	1,766	0.96
Reach-24	16.228	1,754	0.96
Subbasin-33	0.184	24	0.37
Junction-25	16.412	1,756	0.96
Reach-25	16.412	1,750	0.96
Junction-26	16.412	1,750	0.96

NOTE:

1. SOURCE-1 IS THE 24 HOUR FLOW DATA FOR SUBBASINS 24-27, JUNCTION 22, AND REACHES 21-22. SUBBASINS 24-27 DATA HAS BEEN REPLACED WITH KETTLE CREEK DRAINAGE BASIN OLD RANCH ROAD TRIBUTARY MASTER DEVELOPMENT PLAN FLOW DATA (JR ENG. 2001).

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EXISTING CONDITIONS
MODEL RESULTS
(100-YEAR)

100-Year, 2-Hour Storm			
Hydrologic Element	Drainage Area (mi^2)	Peak Discharge (CFS)	Volume (in)
Subbasin-1	1.263	634	1.12
Subbasin-2	0.586	355	1.13
Subbasin-3	0.180	115	1.33
Junction-1	2.029	1,082	1.14
Reach-1	2.029	1,080	1.14
Subbasin-4	0.195	117	1.03
Junction-2	2.224	1,184	1.13
Reach-2	2.224	1,184	1.13
Subbasin-5	0.625	262	1.21
Junction-3	2.849	1,423	1.15
Reach-3	2.849	1,423	1.15
Subbasin-6	1.333	474	0.99
Junction-4	4.182	1,895	1.10
Reach-4	4.182	1,894	1.10
Subbasin-7	0.183	106	1.03
Junction-5	4.365	1,938	1.10
Reach-5	4.365	1,931	1.10
Subbasin-8	0.288	242	1.17
Junction-6	4.653	1,980	1.10
Reach-6	4.653	1,977	1.10
Subbasin-9	1.177	433	1.11
Subbasin-10	0.222	132	0.99
Junction-7	1.399	483	1.09
Reach-7	1.399	483	1.09
Subbasin-11	0.880	657	1.30
Junction-8	2.279	959	1.17
Reach-8	2.279	953	1.17
Subbasin-12	0.552	291	1.12
Junction-9	2.831	1,208	1.16
Reach-9	2.831	1,205	1.16
Junction-10	7.484	2,905	1.12
Reach-10	7.484	2,903	1.12
Subbasin-13	1.156	418	1.06
Subbasin-14	0.516	285	1.01
Junction-11	9.156	3,198	1.11
Reach-11	9.156	3,195	1.11
Subbasin-15	0.498	293	1.06
Junction-12	9.654	3,218	1.11
Reach-12	9.654	3,213	1.11
Subbasin-16	0.819	387	1.12
Subbasin-17	0.788	382	1.01
Junction-13	11.261	3,283	1.10

100-Year, 2-Hour Storm			
Hydrologic Element	Drainage Area (mi^2)	Peak Discharge (CFS)	Volume (in)
Reach-13	11.261	3,280	1.10
Subbasin-18	0.192	118	1.01
Junction-14	11.453	3,281	1.10
Reach-14	11.453	3,279	1.10
Subbasin-19	0.552	201	1.00
Junction-15	12.005	3,314	1.09
Reach-15	12.005	3,309	1.09
Subbasin-20	0.594	279	0.91
Junction-16	12.599	3,313	1.09
Reach-16	12.599	3,312	1.09
Subbasin-21	0.417	217	0.84
Junction-17	13.016	3,312	1.08
Reach-17	13.016	3,308	1.08
Subbasin-22	0.200	81	0.64
Junction-18	13.216	3,308	1.07
Reach-18	13.216	3,305	1.07
Subbasin-23	0.123	93	0.71
Junction-19	13.339	3,305	1.07
Reach-19	13.339	3,302	1.07
Subbasin-24	0.453	188	1.03
Subbasin-25	0.169	374	2.01
Subbasin-26	0.480	247	1.12
Junction-21	1.102	463	1.22
Reach-21	1.102	463	1.22
Subbasin-27	0.294	279	1.49
Junction-22	1.396	689	1.28
Reach-22	1.396	687	1.28
Subbasin-28	0.264	83	0.62
Subbasin-29	0.172	80	0.75
Junction-20	0.436	157	0.67
Reach-20	0.436	156	0.67
Subbasin-30	0.364	250	1.06
Junction-23	15.535	3,305	1.08
Reach-23	15.535	3,298	1.08
Subbasin-31	0.377	458	1.11
Subbasin-32	0.316	298	1.06
Junction-24	16.228	3,298	1.08
Reach-24	16.228	3,297	1.08
Subbasin-33	0.184	57	0.41
Junction-25	16.412	3297.4	1.07
Reach-25	16.412	3297.4	1.07
Junction-26	16.412	3297.4	1.07

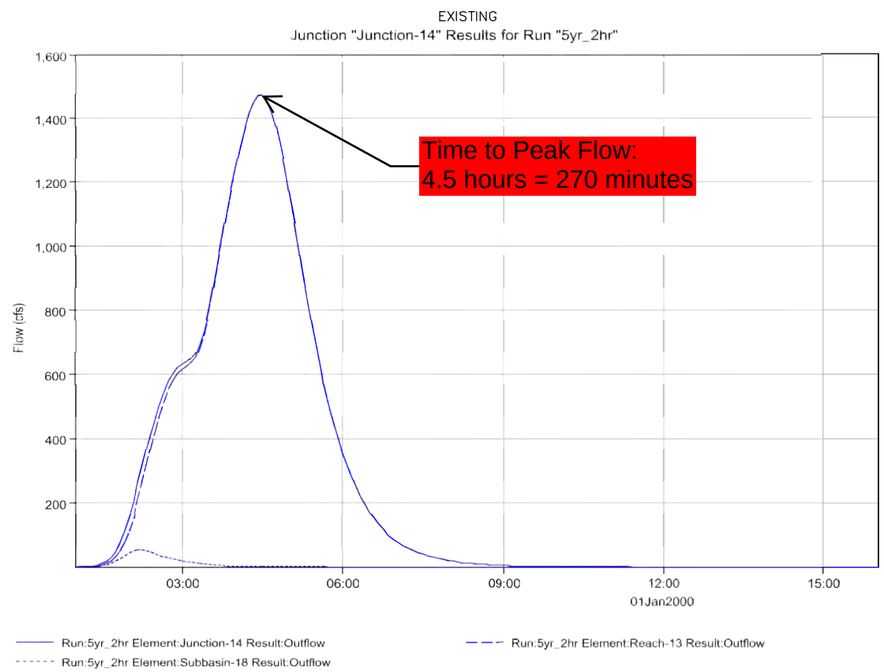
100-Year, 24-Hour Storm			
Hydrologic Element	Drainage Area (mi^2)	Peak Discharge (CFS)	Volume (in)
Subbasin-1	1.263	735	2.36
Subbasin-2	0.586	403	2.37
Subbasin-3	0.180	122	2.67
Junction-1	2.029	1,217	2.39
Reach-1	2.029	1,216	2.39
Subbasin-4	0.195	135	2.22
Junction-2	2.224	1,325	2.38
Reach-2	2.224	1,322	2.38
Subbasin-5	0.625	308	2.52
Junction-3	2.849	1,602	2.41
Reach-3	2.849	1,602	2.41
Subbasin-6	1.333	588	2.18
Junction-4	4.182	2,190	2.34
Reach-4	4.182	2,153	2.34
Subbasin-7	0.183	125	2.24
Junction-5	4.365	2,208	2.33
Reach-5	4.365	2,186	2.33
Subbasin-8	0.288	273.3	2.48
Junction-6	4.653	2253.3	2.34
Reach-6	4.653	2,213	2.34
Subbasin-9	1.177	520	2.35
Subbasin-10	0.222	152	2.17
Junction-7	1.399	593	2.32
Reach-7	1.399	588	2.32
Subbasin-11	0.880	720	2.66
Junction-8	2.279	1,114	2.45
Reach-8	2.279	1,112	2.45
Subbasin-12	0.552	338	2.39
Junction-9	2.831	1,403	2.44
Reach-9	2.831	1,368	2.44
Junction-10	7.484	3,375	2.38
Reach-10	7.484	3,329	2.38
Subbasin-13	1.156	505	2.28
Subbasin-14	0.516	337	2.20
Junction-11	9.156	3,761	2.36
Reach-11	9.156	3,756	2.36
Subbasin-15	0.498	342	2.28
Junction-12	9.654	3,828	2.35
Reach-12	9.654	3,823	2.35

100-Year, 24-Hour Storm			
Hydrologic Element	Drainage Area (mi^2)	Peak Discharge (CFS)	Volume (in)
Subbasin-16	0.819	449	2.37
Subbasin-17	0.788	447	2.20
Junction-13	11.261	4,038	2.34
Reach-13	11.261	3,975	2.34
Subbasin-18	0.192	134.1	2.2
Junction-14	11.453	3,992	2.34
Reach-14	11.453	3,987	2.34
Subbasin-19	0.552	248	2.19
Junction-15	12.005	4,069	2.33
Reach-15	12.005	4,058	2.33
Subbasin-20	0.594	343	2.06
Junction-16	12.599	4,103	2.32
Reach-16	12.599	4,064	2.32
Subbasin-21	0.417	264	1.96
Junction-17	13.016	4,091	2.31
Reach-17	13.016	4,081	2.31
Subbasin-22	0.200	109	1.66
Junction-18	13.216	4,091	2.30
Reach-18	13.216	4,080	2.30
Subbasin-23	0.123	121	1.75
Junction-19	13.339	4,086	2.29
Reach-19	13.339	4,081	2.29
Source-1	1.396	576	1.58
Subbasin-28	0.264	120	1.63
Subbasin-29	0.172	102	1.83
Junction-20	0.436	222	1.71
Reach-20	0.436	207	1.71
Subbasin-30	0.364	279	2.28
Junction-23	15.535	4,121	2.21
Reach-23	15.535	4,081	2.21
Subbasin-31	0.377	490	2.26
Subbasin-32	0.316	289	2.22
Junction-24	16.228	4,114	2.22
Reach-24	16.228	4,096	2.22
Subbasin-33	0.184	93	1.21
Junction-25	16.412	4,102	2.20
Reach-25	16.412	4,084	2.20
Junction-26	16.412	4,084	2.20

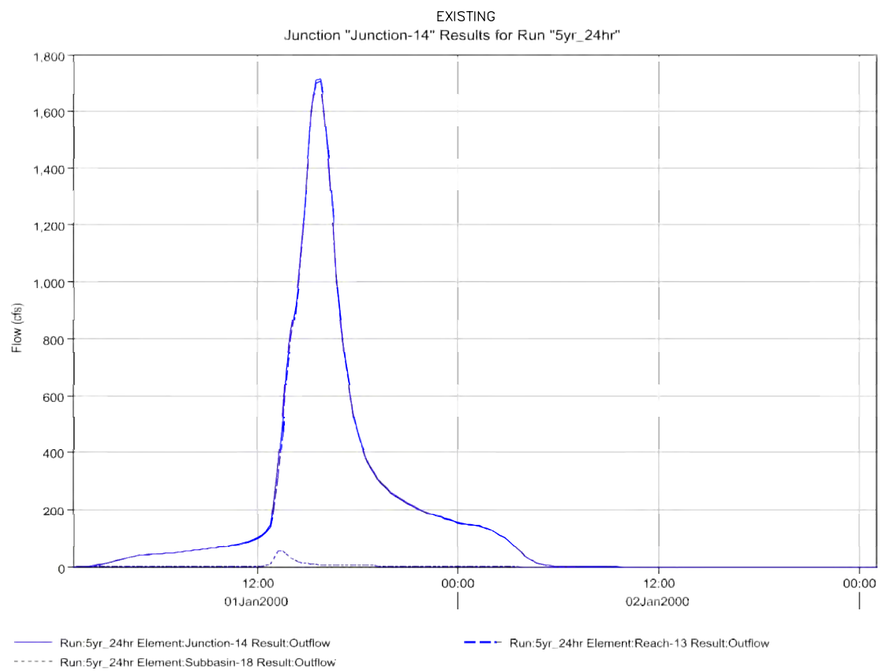
NOTE:

1. SOURCE–1 IS THE 24 HOUR FLOW DATA FOR SUBBASINS 24–27, JUNCTION 22, AND REACHES 21–22. SUBBASINS 24–27 DATA HAS BEEN REPLACED WITH KETTLE CREEK DRAINAGE BASIN OLD RANCH ROAD TRIBUTARY MASTER DEVELOPMENT PLAN FLOW DATA (JR ENG. 2001).

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5–YR
2–HR



5–YR
24–HR

JUNCTION 14
HOWELLS ROAD (APPROXIMATE)

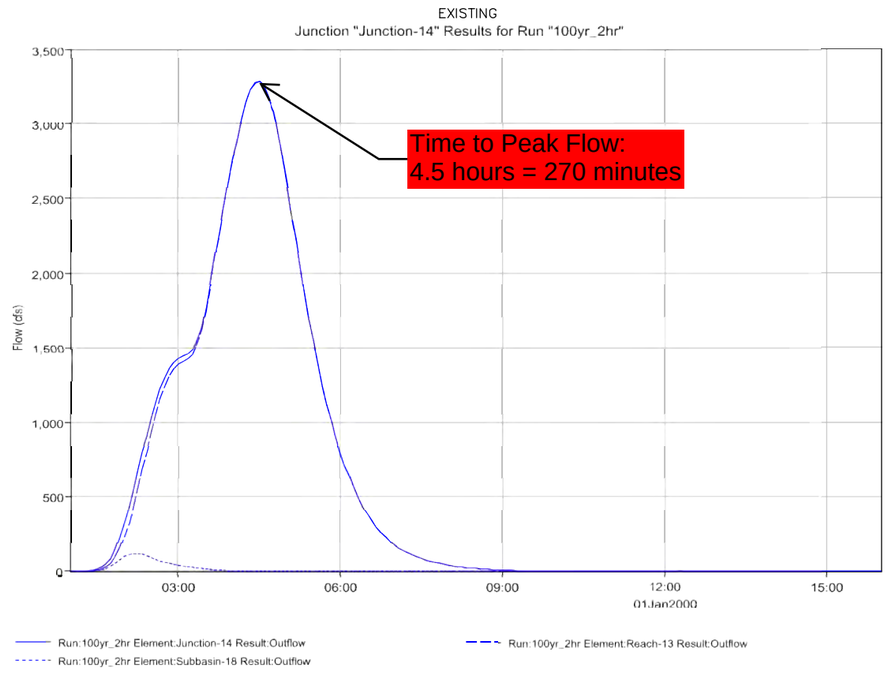
EXISTING CONDITIONS HYDROGRAPHS
AT SELECT LOCATIONS
5-YEAR

APPENDIX B – HYDROLOGIC
RESULTS – EXISTING
HYDROGRAPHS 5–YR J–14
KETTLE CREEK DBPS
JOB NO. 25100.00
MAY 2015
B–51

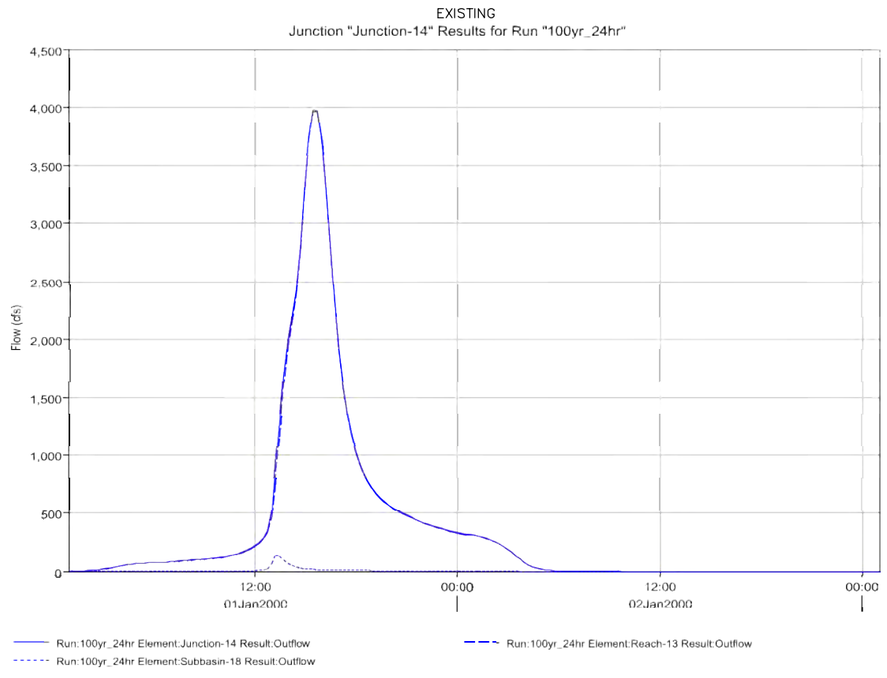
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JUNCTION 18
POWERS BLVD BRIDGE

JUNCTION 24
HWY 83 BRIDGE



100–YR
2–HR



100–YR
24–HR

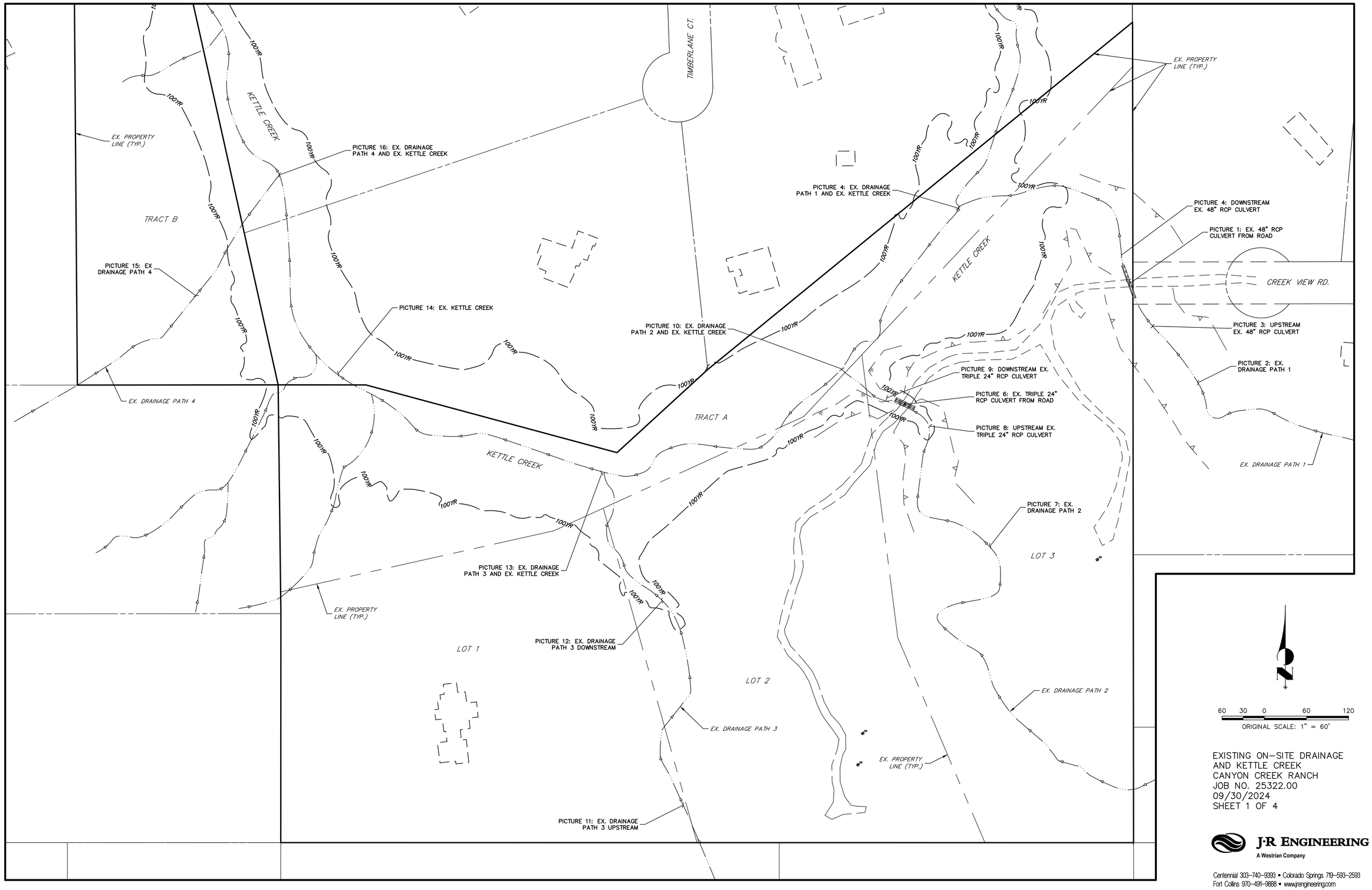
JUNCTION 14
HOWELLS ROAD (APPROXIMATE)

EXISTING CONDITIONS HYDROGRAPHS
AT SELECT LOCATIONS
100-YEAR

APPENDIX B– HYDROLOGIC RESULTS– EXISTING HYDROGRAPHS 100–YR J–14
KETTLE CREEK DBPS
JOB NO. 25100.00
MAY 2015
B–63

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CANYON CREEK RANCH
EXISTING ON-SITE DRAINAGE AND KETTLE CREEK



N

60 30 0 60 120

ORIGINAL SCALE: 1" = 60'

EXISTING ON-SITE DRAINAGE
AND KETTLE CREEK
CANYON CREEK RANCH
JOB NO. 25322.00
09/30/2024
SHEET 1 OF 4

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CANYON CREEK RANCH
EXISTING ON-SITE DRAINAGE AND KETTLE CREEK



1. EXISTING 48" RCP CULVERT FROM ROAD



2. EXISTING DRAINAGE PATH 1



3. EXISTING 48" RCP CULVERT-UPSTREAM



4. EXISTING 48" RCP CULVERT-DOWNSTREAM



5. EXISTING DRAINAGE PATH 1 AT CONFLUENCE WITH KETTLE CREEK



6. EXISTING TRIPLE 24" RCP CULVERT FROM ROAD

NOTES

1. PHOTOS PROVIDED FROM A SITE VISIT CONDUCTED BY JR ENGINEERING ON SEPTEMBER 30, 2024

EXISTING ON-SITE DRAINAGE
AND KETTLE CREEK
CANYON CREEK RANCH
JOB NO. 25322.00
09/30/2024
SHEET 2 OF 4

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CANYON CREEK RANCH
EXISTING ON-SITE DRAINAGE AND KETTLE CREEK



7. EXISTING DRAINAGE PATH 2



8. EXISTING TRIPLE 24" RCP CULVERT-UPSTREAM



9. EXISTING TRIPLE 24" RCP CULVERT-DOWNSTREAM



10. EXISTING DRAINAGE PATH 2 AT CONFLUENCE WITH KETTLE CREEK



11. EXISTING DRAINAGE PATH 3-UPSTREAM



12. EXISTING DRAINAGE PATH 3-DOWNSTREAM

NOTES

1. PHOTOS PROVIDED FROM A SITE VISIT CONDUCTED BY JR ENGINEERING ON SEPTEMBER 30, 2024

EXISTING ON-SITE DRAINAGE
AND KETTLE CREEK
CANYON CREEK RANCH
JOB NO. 25322.00
09/30/2024
SHEET 3 OF 4

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CANYON CREEK RANCH
EXISTING ON-SITE DRAINAGE AND KETTLE CREEK



13. EXISTING DRAINAGE PATH 3 AT CONFLUENCE WITH KETTLE CREEK



14. EXISTING KETTLE CREEK



15. EXISTING DRAINAGE PATH 4



16. EXISTING DRAINAGE PATH 4 AT CONFLUENCE WITH KETTLE CREEK

NOTES

1. PHOTOS PROVIDED FROM A SITE VISIT CONDUCTED BY JR ENGINEERING ON SEPTEMBER 30, 2024

EXISTING ON-SITE DRAINAGE
AND KETTLE CREEK
CANYON CREEK RANCH
JOB NO. 25322.00
09/30/2024
SHEET 4 OF 4

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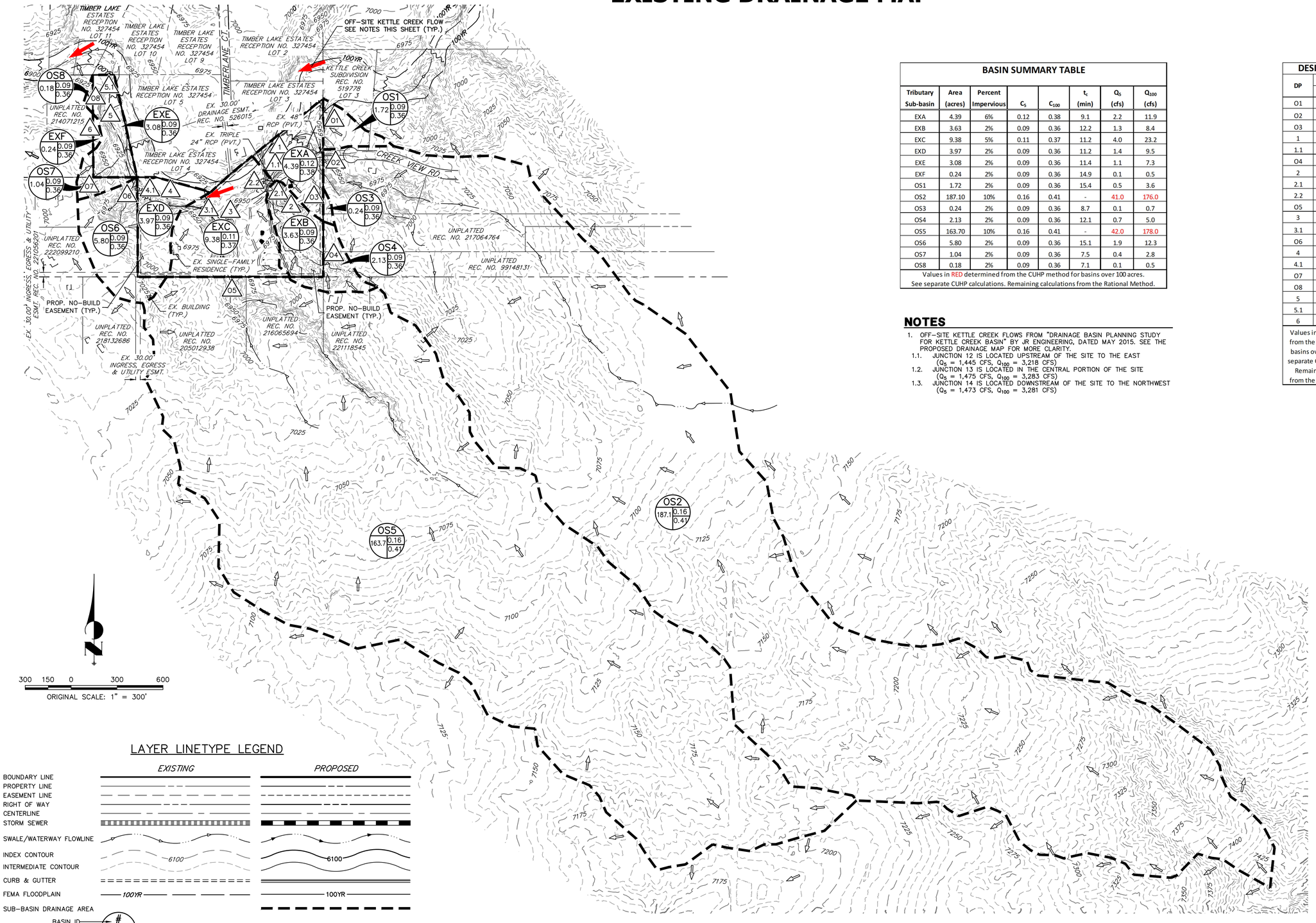
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Appendix E
Drainage Maps

CANYON CREEK RANCH

EXISTING DRAINAGE MAP



300 150 0 300 600

ORIGINAL SCALE: 1" = 300'

LAYER LINETYPE LEGEND

	EXISTING	PROPOSED
BOUNDARY LINE		
PROPERTY LINE		
EASEMENT LINE		
RIGHT OF WAY		
CENTERLINE		
STORM SEWER		
SWALE/WATERWAY FLOWLINE		
INDEX CONTOUR	6100	6100
INTERMEDIATE CONTOUR		
CURB & GUTTER		
FEMA FLOODPLAIN	100YR	100YR
SUB-BASIN DRAINAGE AREA		

BASIN TAG — BASIN ID, AREA [AC], C_5, C_{100}

1 DESIGN POINT DESIGNATION

FLOW DIRECTION (EXISTING)

FLOW DIRECTION (PROPOSED)

OFF-SITE STUDIED FLOW

BASIN SUMMARY TABLE

Tributary Sub-basin	Area (acres)	Percent Impervious	C_5	C_{100}	t_c (min)	Q_5 (cfs)	Q_{100} (cfs)
EXA	4.39	6%	0.12	0.38	9.1	2.2	11.9
EXB	3.63	2%	0.09	0.36	12.2	1.3	8.4
EXC	9.38	5%	0.11	0.37	11.2	4.0	23.2
EXD	3.97	2%	0.09	0.36	11.2	1.4	9.5
EXE	3.08	2%	0.09	0.36	11.4	1.1	7.3
EXF	0.24	2%	0.09	0.36	14.9	0.1	0.5
OS1	1.72	2%	0.09	0.36	15.4	0.5	3.6
OS2	187.10	10%	0.16	0.41	-	41.0	176.0
OS3	0.24	2%	0.09	0.36	8.7	0.1	0.7
OS4	2.13	2%	0.09	0.36	12.1	0.7	5.0
OS5	163.70	10%	0.16	0.41	-	42.0	178.0
OS6	5.80	2%	0.09	0.36	15.1	1.9	12.3
OS7	1.04	2%	0.09	0.36	7.5	0.4	2.8
OS8	0.18	2%	0.09	0.36	7.1	0.1	0.5

Values in RED determined from the CUHP method for basins over 100 acres.
See separate CUHP calculations. Remaining calculations from the Rational Method.

DESIGN POINT

DP	Q_5 Total	Q_{100} Total
O1	0.5	3.6
O2	41.0	176.0
O3	0.1	0.7
1	2.2	11.9
1.1	52.5	194.5
O4	0.7	5.0
2	1.3	8.4
2.1	2.0	12.5
2.2	53.4	199.6
O5	42.0	178.0
3	4.0	23.2
3.1	100.0	351.8
O6	1.9	12.3
4	1.4	9.5
4.1	101.6	359.9
O7	0.4	2.8
O8	0.1	0.5
5	1.1	7.3
5.1	102.2	363.5
6	0.1	0.5

Values in RED determined from the CUHP method for basins over 100 acres. See separate CUHP calculations. Remaining calculations from the Rational Method.

NOTES

1. OFF-SITE KETTLE CREEK FLOWS FROM "DRAINAGE BASIN PLANNING STUDY FOR KETTLE CREEK BASIN" BY JR ENGINEERING, DATED MAY 2015. SEE THE PROPOSED DRAINAGE MAP FOR MORE CLARITY.
   - 1.1. JUNCTION 12 IS LOCATED UPSTREAM OF THE SITE TO THE EAST (Q_5 = 1,445 CFS, Q_{100} = 3,218 CFS)
   - 1.2. JUNCTION 13 IS LOCATED IN THE CENTRAL PORTION OF THE SITE (Q_5 = 1,475 CFS, Q_{100} = 3,283 CFS)
   - 1.3. JUNCTION 14 IS LOCATED DOWNSTREAM OF THE SITE TO THE NORTHWEST (Q_5 = 1,473 CFS, Q_{100} = 3,281 CFS)

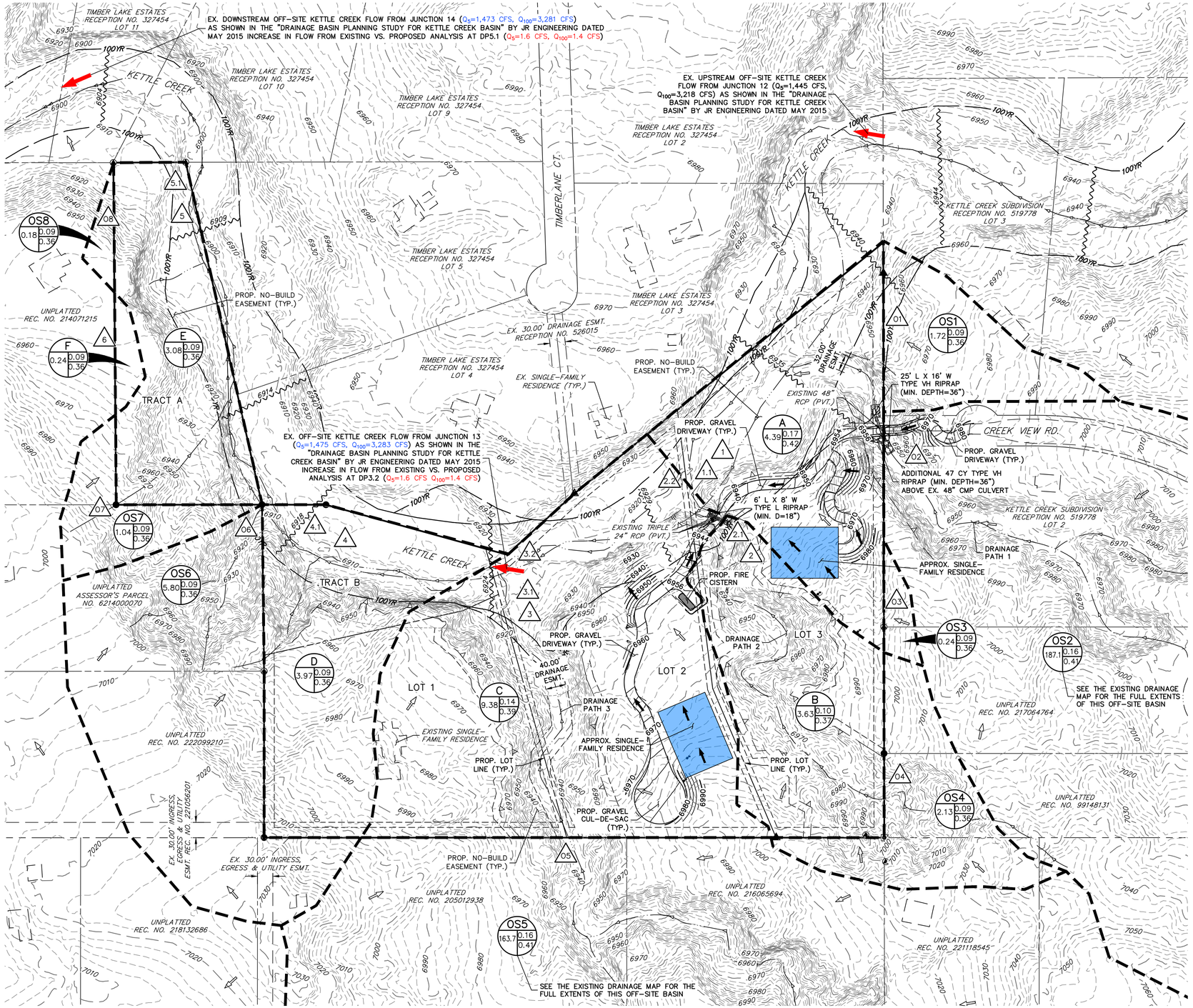
EXISTING DRAINAGE MAP
CANYON CREEK RANCH
JOB NO. 25322.00
03/27/2026
SHEET 1 OF 1

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CANYON CREEK RANCH
PROPOSED DRAINAGE MAP



BASIN SUMMARY TABLE

Tributary Sub-basin	Area (acres)	Percent Impervious	C_5	C_{100}	t_c (min)	Q_5 (cfs)	Q_{100} (cfs)
A	4.39	12%	0.16	0.41	8.9	3.0	12.9
B	3.63	3%	0.10	0.36	12.1	1.3	8.5
C	9.38	10%	0.14	0.40	11.0	5.4	25.0
D	3.97	2%	0.09	0.36	11.2	1.4	9.5
E	3.08	2%	0.09	0.36	11.4	1.1	7.3
F	0.24	2%	0.09	0.36	14.9	0.1	0.5
OS1	1.72	2%	0.09	0.36	15.4	0.5	3.6
OS2	187.10	10%	0.16	0.41	-	41.0	176.0
OS3	0.24	2%	0.09	0.36	8.7	0.1	0.7
OS4	2.13	2%	0.09	0.36	12.1	0.7	5.0
OS5	163.70	10%	0.16	0.41	-	42.0	178.0
OS6	5.80	2%	0.09	0.36	15.1	1.9	12.3
OS7	1.04	2%	0.09	0.36	7.5	0.4	2.8
OS8	0.18	2%	0.09	0.36	7.1	0.1	0.5

Values in RED determined from the CUHP method for basins over 100 acres. See separate CUHP calculations. Remaining calculations from the Rational Method.

DESIGN POINT

DP	Q_5 Total	Q_{100} Total
O1	0.5	3.6
O2	41.0	176.0
O3	0.1	0.7
1	3.0	12.9
1.1	53.4	195.4
O4	0.7	5.0
2	1.3	8.5
2.1	2.1	12.6
2.2	54.3	200.5
O5	42.0	178.0
3	5.4	25.0
3.1	51.6	193.4
3.2	101.6	353.2
O6	1.9	12.3
4	1.4	9.5
4.1	103.1	361.3
O7	0.4	2.8
O8	0.1	0.5
5	1.1	7.3
5.1	103.8	364.9
6	0.1	0.5

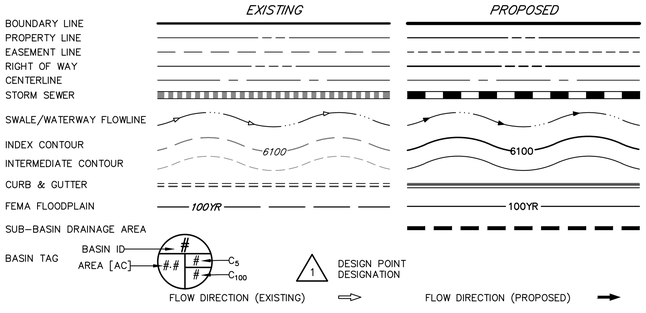
Values in RED determined from the CUHP method for basins over 100 acres. See separate CUHP calculations. Remaining calculations from the Rational Method.

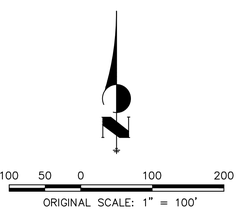
PBMP Summary Table

Basins	Tributary Area (acres)	PBMP
A-D	21.37	EXCLUDED*
E-F	3.32	EXCLUDED**

*EXCLUDED BASED ON LARGE LOT SINGLE FAMILY SITES PER ECM APP. I.7.B.5
**EXCLUDED BASED ON LAND DISTURBANCE TO UNDEVELOPED LAND THAT WILL REMAIN UNDVELOPED PER ECM APP. I.7.B.7

LAYER LINETYPE LEGEND





PROPOSED DRAINAGE MAP
CANYON CREEK RANCH
JOB NO. 25322.00
10/19/2026
SHEET 1 OF 1

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