PRELIMINARY DRAINAGE REPORT
FOR
SOLACE APARTMENTS

Prepared For:
Jackson Dearborn Partners
404 S. Wells Street, Suite 400
Chicago, IL 60607
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September 3, 2020
Project No. 25174.00

Prepared By:
JR Engineering, LLC
5475 Tech Center Drive
Colorado Springs, CO 80919
719-593-2593

PCD File No. SP201

ENGINEER'S STATEMENT:
The attached drainage plan and report were prepared under my direction and supervision and are correct to the best of my knowledge and belief. Said drainage report has been prepared according to the criteria established by 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.

Mike Bramlett, Colorado P.E. # 32314
For and On Behalf of JR Engineering, LLC

COLORADO LICENSED MIKE BRAMLETT MB 32314 9/24/20 PROFESSIONAL ENGINEER

9/24/20
Date

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

Business Name: Jackson Dearborn Partners

By: Dane Olmstead 9/24/20

Title: CHIEF INVESTMENT OFFICER

Address: 404 S. Wells Street
Chicago, IL 60607

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

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

Conditions:

APPROVED
Engineering Department
01/04/2022 5:22:54 PM
dsdnijkamp
EPC Planning & Community Development Department

* original approval lost, retroactively approved 1/4/2022

CONTENTS

PURPOSE

This document is the Preliminary Drainage report for the Solace Apartments. The purpose of this report is to:

1. Identify on-site and off-site drainage patterns.
2. Recommend storm water facilities to collect and convey storm runoff from the proposed development to appropriate discharge and/or detention locations.
3. Recommend water quality and detention facilities to control discharge release rates to below historic.
4. Demonstrate compliance with surrounding major drainage basin planning studies, master development drainage plans and flood insurance studies.

GENERAL LOCATION AND DESCRIPTION

Location

The proposed Solace Apartments, known as "Solace" from herein, is a parcel of land located in Section 7, Township 14 South, Range 65 West of the 6th Principal Meridian in El Paso County, Colorado. Solace is a 28.99 acre, urban, multifamily-development and is comprised of 16 apartment dwellings and associated infrastructure. Solace will be split into two phases for construction, lot 1 (phase 1) contains most of the site with lot 2 (phase 2) containing the northern most section of the development. See appendix A for a site plan exhibit showing the Solace phasing. Solace is bound by existing industrial developments to the North and vacant land to the West. Galley Road bounds the property to the south and existing light industrial businesses to the east. A vicinity map of the area is presented in Appendix A.

Currently, there is one major Drainageway that runs along Solace: Sand Creek (Center Tributary) Drainageway. This Drainageway was analyzed, both hydrologically and hydraulically, in the following reports:

- Sand Creek Drainage Basin Planning Study (KEC), January 1993.
- Flood Insurance Study– El Paso County, Colorado & Incorporated Areas Vol 7 of 8, December 2018.
- Sand Creek channel Improvement Design Report for Solace Apartments (JR), December 2019.
- LOMR- Case No. 05-08-0368P Federal Emergency Management Agency, May 23, 2007.

The impact of this Drainageway and planning studies on the proposed development will be discussed later in the report.

Description of Property

Solace is currently unoccupied and undeveloped. The existing ground cover is sparse vegetation and open space, typical of a Colorado rolling range land condition. In general, Solace slopes from northwest to southeast.

Per an NRCS web soil survey of the area, Solace is made up of Type B soils with a very small percentage of Type A in the northwest corner of the property. This Type B soil is a Blendon sandy loam. This soil type has a moderate infiltration rate when thoroughly wet. It also consists of moderately deep or deep, moderately well drained or well drained soil. A soil survey map has been presented in Appendix A.

Floodplain Statement

Based on the FEMA FIRM Maps number 08041C0751G and 08041C0752G, dated December 7, 2018, a portion of the existing drainageway lies within Zone AE and Zone X. Zone AE is defined as area subject to inundation by the 1-percent-annual-chance flood event. 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 FIRM Maps have been presented in Appendix A.

DRAINAGE BASINS AND SUB-BASINS

Existing Major Basin Descriptions

Solace lies within Sand Creek Drainage Basin based on the "*Sand Creek Drainage Basin Planning Study*" prepared by Kiowa Engineering in January 1993.

The Sand Creek Drainage Basin covers approximately 54 square miles in unincorporated El Paso County, CO. The Sand Creek Drainage Basin is tributary to Fountain Creek. In its existing condition, the basin is comprised of rolling rangeland with fair to good vegetative cover associated with Colorado's semi-arid climate. The natural Drainageway within the site limits is typically deep and narrow with a well-defined flow path in most areas. Anticipated land use for the basin includes multifamily residential and open space.

As part of its drainage research, JR Engineering reviewed the following drainage studies, reports and LOMRs:

- Sand Creek Drainage Basin Planning Study prepared by Kiowa Engineering Corporation in January 1993.
- Flood Insurance Study– El Paso County, Colorado, & Incorporated Areas Vol 7, December 2018.
- LOMR- Case No. 05-08-0368P Federal Emergency Management Agency, May 23, 2007.
- Sand Creek channel Improvement Design Report for Solace Apartments (JR), December 2019

The *Sand Creek Drainage Basin Planning Study* was used to establish a stormwater management plan for the existing and future stormwater infrastructure needs within the Sand Creek Drainage Basin. Based on provided drainage maps and analysis, in its existing condition, the Sand Creek Drainageway contains a 100-year flow of 720-960 cfs along Solace's east property line. The major Sand Creek Drainageway conveys the stormwater south along the eastern property line where it ultimately outfalls into the Fountain Creek. JR Engineering has performed checks on these flow rates to verify their validity. Basin calculations show that the 720-960 cfs are still valid for this existing condition.

FEMA prepared a revised FIS for El Paso County Colorado, Volume 7 of 8, dated December 7, 2018. The effective floodplain for the site is shown on the FIRM 08041C0752G, revised to reflect LOMR, dated December 7, 2018. The study area of the FIS where the Sand Creek Drainageway crosses Galley Road, was found to overtop the culverts and flow onto the road. According to the FIS, this crossing has a 10% annual chance of flooding and is located in Zone AE of the FIRM. The *Sand Creek Drainage Basin LOMR* was executed on May 23, 2007. The LOMR revised the flood zone or the area south of Galley Road. See FIRM Map Panel 08041C0752G for limits of LOMR study and revised flood zones, presented in Appendix D.

Existing Sub-basin Drainage

On-site, existing basin drainage patterns are generally from northwest to southeast by way of on-site swales. Existing on-site areas flow directly into the Sand Creek Drainageway. For this development, the existing onsite drainage has been broken into Basin A and Basin B. All existing basins that are offsite are represented by Basin OS. All basin delineation for the existing condition can be found in the existing drainage map located in Appendix E.

Basin A contains a total of 23.98 acres and is broken down into three sub-basins: A1, A2, and A3. This basin represents a majority of the proposed development and is comprised solely of undeveloped land. Flows from this basin are tributary to the Sand Creek Drainageway in the existing condition.

Sub-basin A1 (Q_5=3.1 cfs, Q_{100}=21.0 cfs) is 14.75 acres of undeveloped land, and represents the easternmost portion of the site that is adjacent to the Sand Creek Drainageway. Storm runoff from this sub-basin flows southeast, via overland flow, directly into the Sand Creek Drainageway at Design Point 1.

Sub-basin A2 (Q_5=0.9 cfs, Q_{100}=6.2 cfs) is 3.79 acres and represents the undeveloped land in the center of the development. Storm runoff from this sub-basin flows south (Design Point 2), via overland flow, directly onto Galley Road. From here, flows are conveyed east in the existing curb and gutter into the Sand Creek Drianageway.

Sub-basin A3 (Q_5=1.4 cfs, Q_{100}=9.5 cfs) is 5.44 Acres and represents the undeveloped land on the southern property line of the development. Storm runoff from this sub basin flows south (Design

Point 3), via overland flow, directly onto Galley Road. From here, flows are conveyed east via the existing curb and gutter to the Sand Creek Drainageway.

Sub-basin B1 (Q_5=1.3 cfs, Q_{100}=9.0 cfs) Sub-basin B1 consists of 4.84 acres of undeveloped land that drains overland to the southwest (Design Point 4) and offsite where it ultimately outfalls into an existing retention pond on the northeast corner of the intersection of Galley Road and Powers Blvd. This basin represents the westernmost portion of the site.

Basin OS consists of Sub-Basins OS1-OS2 combining for a total of 26.66 acres. This basin represents the developed land located to the north of the proposed development's property line, where the site ties in to Paonia Street. These sub-basins are primarily light industrial sites, and stormwater runoff is conveyed via overland flow and local roads.

Sub-basin OS1 (Q_5=36.7 cfs, Q_{100}=73.1 cfs) consists of the existing Paonia Street and the existing light industrial properties located just north of the site. In the existing condition, a portion of runoff from this sub-basin is captured by an existing concrete line channel. The remaining runoff flows onsite into the second drainageway where it ultimately outfalls into Sand Creek Center Tributary at Galley Road. In the proposed condition, the runoff will be captured by the existing concrete channel and a proposed overflow channel at the north property line (Design Point 4) to prevent any offsite flows from entering the property. Once this existing flow has been captured, the runoff will be conveyed directly into the existing Sand Creek Drainageway at Design Point 1.1. Capturing this flow and draining it directly into the Sand Creek Drainageway will cause a slight change in the existing drainage patterns. A portion of this flow will no longer enter the existing second drainageway along the proposed Paonia Street alignment. Instead, this entire flow will enter the Sand Creek Drainageway near the north property line at Design Point 1.1. In order to accommodate this change, rip rap shall be utilized to prevent channel erosion around the outfall location. The channel bottom shall also be widened to give the drainageway adequate capacity. A typical cross section of the channel can also be found on the drainage map in Appendix E. Channel analysis and weir calculations can be found in the *Sand Creek – Center Tributary Channel Analysis Report for Solace Apartments*, prepared by JR Engineering in May 2020. This is being further evaluated and is subject to FEMA providing additional information. An update and final design will be provided in the Final Drainage report.

Sub-basin OS2 (Q_5=21.3 cfs, Q_{100}=42.5 cfs) consists of the existing Ainsworth Street and the existing light industrial properties located just east of Ainsworth Street. Runoff from this sub-basin is captured by an existing swale along N. Powers Boulevard. The Solace Apartment site has a 5' berm that is proposed along the northern property line. This berm will prevent any drainage from this basin to reach the site, and will utilize an onsite conveyance swale located at the toe of the berm to convey flow west to Design Point 5 per historic conditions.

Flows within the Sand Creek Drainageway are represented by Design Points 1.0-1.3. Flows for these design points were taken directly from the *Sand Creek Drainage Basin Planning Study*. These flows

were used in the development of the HEC-RAS model to show the 100-year capacity of the drainageway in the existing condition. 5-year storm data was not presented in these studies; however the analysis for the 5-year storm event will be completed with the final drainage report. Design Point 1.0 (Q_{100}=760 cfs) represents the flows in the drainageway prior to entering the site boundary. Design Point 1.1 (Q_{100}=720 cfs) represents the flow in the drainageway after the flows from Basin OS1 enter the channel. Design Point 1.2 (Q_{100}=960 cfs) represents the area where flows enter the drainageway from developments and roads located to the east of the site. Design Point 1.3 (Q_{100}=1340 cfs) represents the flows at the Galley Road crossing. This flow was used to analyze the overtopping of Galley Road and the existing weir structure on the south side of the road. Design Point 1.4 (Q_{100}=500 cfs) represents the offsite flows entering the existing Paonia Street just north of the site. This flow will combine with flows from Basin OS1 where some of the flows will be captured by and existing concrete channel and the rest outfalls in the second creek located onsite. Lastly, design points 1.5 and 1.6 represent the split flows in this existing condition. In the proposed condition, flows from this Design Point will be diverted to an existing concrete channel and a proposed overflow channel located at the northeast property corner (Proposed Design Point 4) where it will outfall directly into Sand Creek.

Proposed Sub-basin Drainage

The proposed Solace basin delineation is as follows;

Sub-basin A1 (Q_5=15.3 cfs, Q_{100}=36.3 cfs) contains a total of 9.13 acres. This basin represents the north eastern portion of the proposed development. This basin is primarily multi-family residential and minor open space. Stormwater runoff from this basin is conveyed via private streets, where it is captured via a series of on-grade and sump inlets. Runoff is then piped to a proposed onsite Pond A (Design Point 1). From the detention pond, the treated flows are then released directly into the Sand Creek Drainageway below historic rates at Design Point 1.2.

Basin B consists of Sub-Basins B1-B2 combining for a total of 18.52 acres. This basin represents the south western portion of the proposed development. This basin is primarily multifamily residential and minor open space, and stormwater runoff is conveyed via private streets. Runoff is captured via a series of on-grade and sump inlets. Runoff is then piped to a proposed onsite Pond B. From the detention pond, the treated flows are then released directly into the Sand Creek Drainageway at below historic rates.

Sub-basin B1 (Q_5=21.2 cfs, Q_{100}=50.0 cfs) consists of the western most portion of the development and the proposed Pond B. This basin is primarily multifamily residential and minor open space. Runoff from this sub-basin will be captured by the proposed storm sewer infrastructure, where it will outfall into the proposed Pond B at Design Point 2. Treated flows from Sub-basin B1 will then outfall into the Sand Creek Drainageway at Design Point 1.3.

Sub-basin B2 (Q_5=1.3 cfs, Q_{100}=4.6 cfs) consists of the southernmost portion of the development. This basin is primarily multifamily residential and minor open space. Runoff from this sub-basin

will be captured by the proposed storm sewer infrastructure, where it will outfall into the proposed Pond B at Design Point 3. Treated flows from Sub-basin B2 will then outfall into the Sand Creek Drainageway at Design Point 1.3 along with the treated flows from Sub-basin B1.

Sub-basin C1 (Q_5=0.6 cfs, Q_{100}=1.9 cfs) contains a total of 0.65 acres. This basin represents the southernmost portion of the proposed development. This basin is primarily proposed roadway and minor open space. Stormwater runoff from this basin is conveyed via proposed curb and gutter to a proposed crosspan (Design Point 6) at the intersection of Paonia Street and Galley Road. Runoff is then conveyed east by the existing curb and gutter in Galley Road to the Sand Creek Drainageway, per historic conditions.

A summary table of proposed basin parameters and flow rates is presented in Appendix B. A more detailed breakdown of drainage basins, runoff calculations & Design Points will be provided in the final drainage report. The final report will also provide the design for the Full-Spectrum Detention/Water Quality Ponds required for the site.

See Table 3 below for the proposed pond parameters.

Table 3: Pond Summary

Tributary Sub-Basin	Pond Name	Tributary Acres	Comp. % Imperv.	WQ Volume (ac-ft)	Total Detention Volume (ac-ft)	Provided Volume (ac-ft)
A	POND A	9.13	44.5	0.146	0.786	2.453
B	POND B	17.84	42.9	0.279	1.496	4.465

Existing Major Drainageway – Sand Creek

The Sand Creek channel conveys an existing 720-960 cfs along the sites eastern property line. In order to maintain the drainage patterns on the site, 2 detention ponds have been proposed to release developed flows, at or below historic rates. Based on the results of the *Sand Creek – Center Tributary Channel Analysis Report for Solace Apartments,* prepared by JR Engineering in May 2020, the existing channel sections will need protection from erosion as a result of the Solace development. This report analyzed the existing conditions to ensure that the Sand Creek channel is stable and velocities do not exceed allowable limits. Based on the results of this report, it was found that the channel in its current conditions is inadequate, as velocities in the channel exceeded allowable limits and overtopping occurs at the Galley Road. The report recommended several improvements to ensure channel stability, including channel lining such as riprap to protect from the high velocities, widening the channel to increase capacity and decrease velocity & adding check/ drop structures to reduce velocities. The report also indicates that improvements will be necessary to address the overtopping at the Galley Road crossing. An existing overflow structure is currently in place to convey any overtopping flows, but does not have adequate capacity. Further discussion with the county engineer about potential solutions and timelines will be necessary. Channel hydraulic analysis sheets are

presented in Appendix B of the aforementioned report. A drainage map for the Solace site can be found in Appendix E.

DRAINAGE DESIGN CRITERIA

Development Criteria Reference

Storm drainage analysis and design criteria for the project were taken from the "*City of Colorado Spring/El Paso County Drainage Criteria Manual*" Volumes 1 and 2 (EPCDCM), dated October 12, 1994, the "*Urban Storm Drainage Criteria Manual"* Volumes 1 - 3 (USDCM) and Chapter 6 and Section 3.2.1 of Chapter 13 of the "Colorado Springs Drainage Criteria Manual (CCSDCM), 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 Drainage and Flood Control District Urban Storm Drainage Criteria Manual" Volumes 1, 2, and 3. Onsite drainage improvements were designed based on the 5 year (minor) storm event and the 100-year (major) storm event. Rational Method calculations were prepared, in accordance with Chapter 6, Section 3.0 of the EPCDCM, for the sub-basins that directly impact the sizing of the proposed storm sewer outfalls. Rational method calculations are presented in Appendix B.

Mile High Flood District's MHFD-Detention, Version 4.00 workbook was used for pond sizing. Required detention volumes and allowable release rates were designed per USDCM and CCS/EPCDCM. Pond sizing spreadsheets are presented in Appendix C.

Hydraulic Criteria

GeoHECRAS was used as the primary analysis method for the site in the *Sand Creek – Center Tributary Channel Analysis Report for Solace Apartments*. GeoHECRAS was used to model existing flows within the Sand Creek Drainageway. This model was used to verify flood plains and analyze any overtopping that may occur within the project site. The 100-year water surface profiles for the model were analyzed form the north property line of the site to the area just south of the Galley Road Crossing.

DRAINAGE FACILITY DESIGN

General Concept

The proposed stormwater conveyance system was designed to convey the developed Solace runoff to two proposed full spectrum water quality and detention ponds via private storm sewer. The proposed pond bottoms are approximately 2 to 3 feet higher than the existing channel, however backflow devices may be installed once the final design for the pond have been completed. The proposed ponds were also designed to release at less than historic rates to minimize adverse impacts

downstream. Treated water will outfall directly into the Sand Creek Drainageway, where it will eventually outfall into Fountain Creek. The current site will be constructed in 2 phases. Both of the proposed ponds will be designed and constructed with the Phase 1 improvements along with the storm sewer within Paonia Street. A proposed drainage map is presented in Appendix E showing locations of the pond and channel outfall locations and improvements.

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, stabilizing drainageways, treating the water quality capture volume (WQCV), and consider the need for Industrial Commercial BMP's.

Step 1, Reducing Runoff Volumes: The development of the project site is a proposed multifamily development with open spaces and lawn areas interspersed within the development which helps disconnect impervious areas and reduce runoff volumes.

Step 2, Stabilize Drainageways: Solace utilizes private storm sewer throughout the project site. This private storm sewer directs the on-site development flows to the multiple detention ponds within the project that release at or below historic rates into the Sand Creek Drainageway. Sand Creek (Center Tributary) Drainageway is stabilized downstream of the development, however additional stabilization measures shall be implemented to prevent any negative impacts to the drainageway. Drop structures will be added in order to reduce the slope of the channel, and riprap will be utilized to prevent any erosion. An energy dissipation structure will be utilized for the offsite flows from Sub-basin OS1 (Design Point 4) to reduce flow velocities prior to entering the channel. A detail for the proposed energy dissipation structure can be found in Appendix D. The proposed reduction in released flows compared to the pre-developed flows, will also prevent any negative impacts to developments downstream.

Step 3, Provide WQCV: Runoff from this development is treated through capture and slow release of the WQCV in multiple full spectrum water quality and detention ponds that are designed per current El Paso County drainage criteria for Extended Detention Basins (EDB). These ponds will facilitate pollutant removal for the site, while also reducing peak stormwater rates into the Sand Creek Drainageway.

Step 4, Consider the need for Industrial and Commercial BMP's: No industrial or commercial uses are proposed within this development. However, a site specific storm water quality and erosion control plan and narrative will be prepared in conjunction with the final drainage report. Site specific temporary source control BMPs as well as permanent BMP's will be detailed in this plan and narrative to protect receiving waters.

Water Quality

In accordance with Section 13.3.2.1 of the CCS/EPCDCM, full spectrum water quality and detention are provided for all developed basins. Outlet structure release rates shall be limited to less than historic rates to minimize adverse impacts to downstream stormwater facilities. Complete pond and outlet structure designs shall be completed with the final drainage report.

Erosion Control Plan

The El Paso County Drainage Criteria Manual specifies an Erosion Control Plan and associated cost estimate must be submitted with each Final Drainage Report. The Erosion Control Plan for Solace will be submitted once the preliminary phase for Solace is complete.

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 the any platted County ROW will be owned and maintained by El Paso County. All proposed drainage structures within the property or tracts will be owned and maintained by the property owner. Vegetation in the natural and improved portions of Sand Creek Drainageway is the responsibility of El Paso County. This includes all mowing, seeding and weed control activities. An Inspection & Maintenance Plan will be submitted concurrently with the final drainage report that details the required maintenance activities and intervals to ensure proper function of all stormwater infrastructure in the future. The full spectrum detention ponds will be owned & maintained by the property owner.

Drainage & Bridge Fees

The site lies within the Sand Creek Drainage Basin. A conceptual estimate is presented below, exact fees to be determined at time of final plat.

2020 DRAINAGE AND BRIDGE FEES – Solace Apartments				
Impervious Acres (ac)	Drainage Fee (Per Imp. Acre)	Bridge Fee (Per Imp. Acre)	Solace Drainage Fee	Solace Bridge Fee
12.26	$19,698	$8,057	$241,498	$98,779

The Solace development will receive full credit for any channel improvements indicated in the Sand Creek DBPS. From the *Sand Creek (Center Tributary) Channel Analysis, by* JR Engineering, the preliminary estimated channel improvements will cost $554,950. Per the Sand Creek Drainage Basin Planning Study, the Center Tributary has proposed crossing improvements at Terminal Avenue and Omaha Boulevard. Both of these crossing were estimated to be $72,000. Crossing improvements were also proposed at W. Frontage Road for $106,200, US 24 Bypass for $211,500, E. Frontage Road for $84,600, Bijou Street for $84,600, Platte Avenue for $169,200, & Galley Road for $90,000. These estimates provide costs for the storm sewer required to replace the existing infrastructure at these locations. The Galley Road crossing estimate reflects upsizing the existing culverts to 5'x 8' concrete box structures. These estimates can be found in Appendix D. Based on these estimated costs, it is presumed that no drainage basin fees will be necessary.

SUMMARY

The proposed development remains consistent with pre-development drainage conditions with the construction of the recommended drainage improvements, including storm sewer, detention ponds and existing drainageways. The proposed development will not adversely affect the offsite major Drainageways or surrounding development. In order to safely convey flows through the Sand Creek Drainageway, channel improvements will be necessary to ensure channel stability and prevent channel degradation. Riprap will be required to armor the channel and stabilize the slopes during a major storm event. These improvements will ensure the drainageway functions properly as a primary drainage conveyance system for the Solace Apartments. These improvements to the Sand Creek Drainageway will be implemented with the final drainage report. This preliminary report meets the latest El Paso County Drainage Criteria requirements for this site.

REFERENCES:

1. El Paso County Drainage Criteria Manual Volume 1, El Paso County, CO, 1994.

2. Urban Storm Drainage Criteria Manual, Urban Drainage and Flood Control District, Latest Revision.

3. Flood Insurance Study- El Paso County, Colorado & Incorporated Areas Vol 7 of 8, Federal Emergency Management Agency, December 7, 2018.

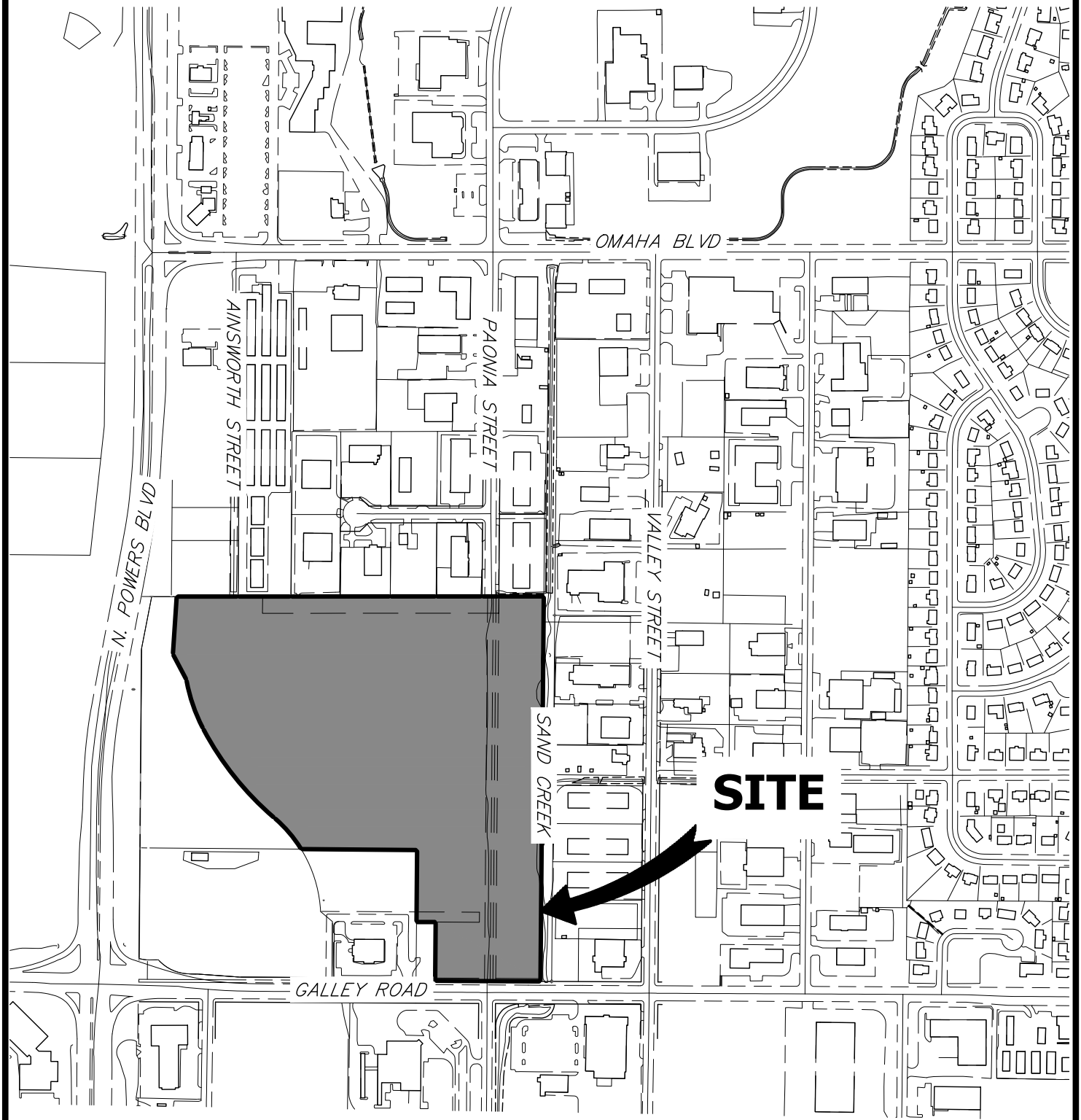
4. Sand Creek Drainage Basin Planning Study, Kiowa Engineering, January 1993.

5. Sand Creek Drainage Basin LOMR, Federal Emergency Management Agency, May 23, 2007.

6. Sand Creek - Center Tributary Channel Analysis Report for Solace Apartments, JR Engineering, May, 2020

APPENDIX A

FIGURES AND EXHIBITS



VICINITY MAP
SOLACE APARTMENTS
JOB NO. 15504.03
4/27/2018

500 250 0 500 1000

ORIGINAL SCALE: 1" = 500'

J·R ENGINEERING
A Westrian Company

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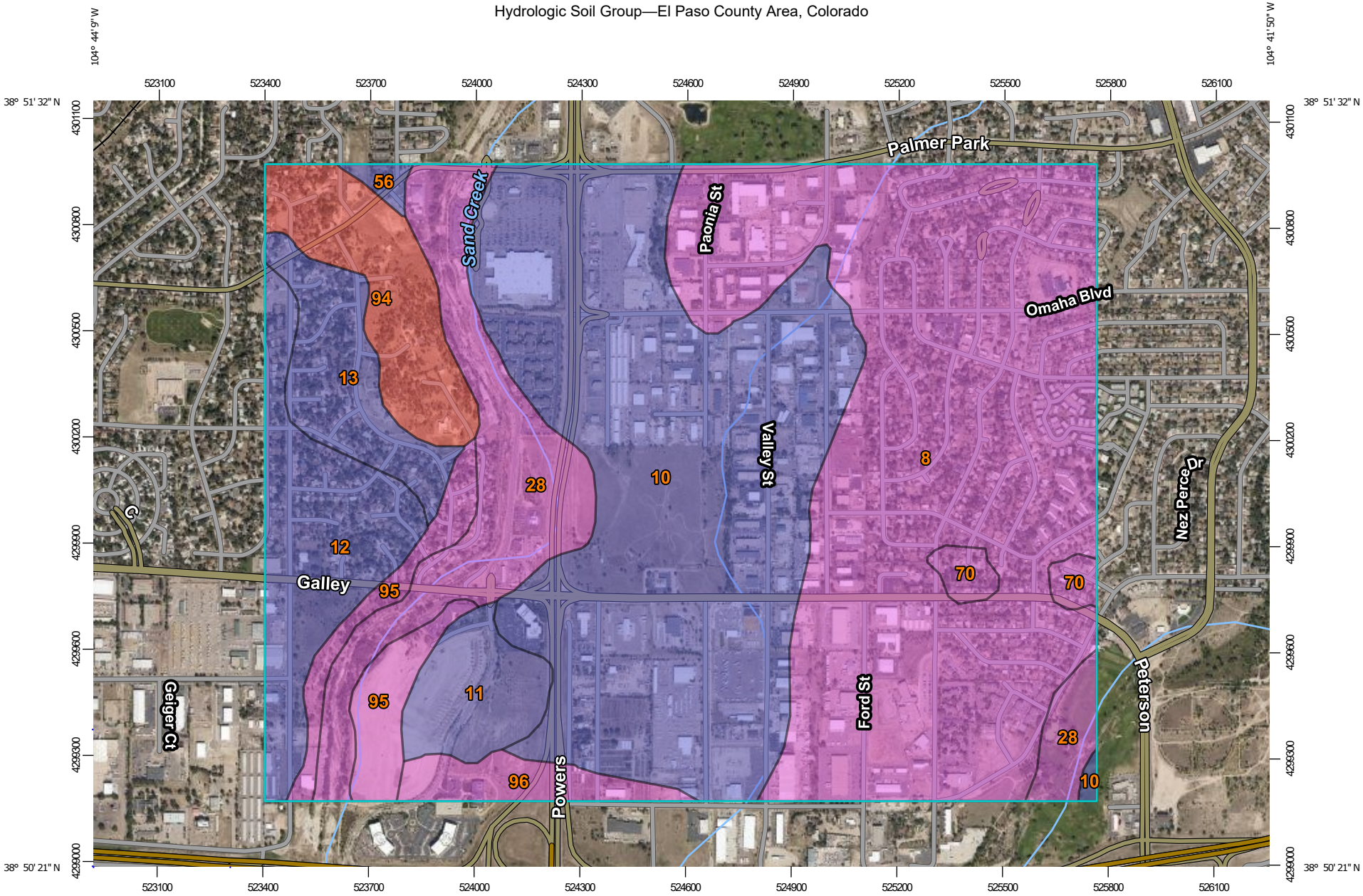


Map Scale: 1:15,300 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 200 400 800 1200

Feet: 0 500 1000 2000 3000

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

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil 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.

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

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

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

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

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

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

Date(s) aerial images were photographed: Aug 19, 2018—Sep 23, 2018

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
8	Blakeland loamy sand, 1 to 9 percent slopes	A	373.7	35.4%
10	Blendon sandy loam, 0 to 3 percent slopes	B	321.4	30.5%
11	Bresser sandy loam, cool, 0 to 3 percent slopes	B	31.9	3.0%
12	Bresser sandy loam, cool, 3 to 5 percent slopes	B	69.8	6.6%
13	Bresser sandy loam, cool, 5 to 9 percent slopes	B	41.4	3.9%
28	Ellicott loamy coarse sand, 0 to 5 percent slopes	A	96.1	9.1%
56	Nelson-Tassel fine sandy loams, 3 to 18 percent slopes	B	3.7	0.3%
70	Pits, gravel	A	10.3	1.0%
94	Travessilla-Rock outcrop complex, 8 to 90 percent slopes	D	51.5	4.9%
95	Truckton loamy sand, 1 to 9 percent slopes	A	35.7	3.4%
96	Truckton sandy loam, 0 to 3 percent slopes	A	19.7	1.9%
Totals for Area of Interest			**1,055.2**	**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.

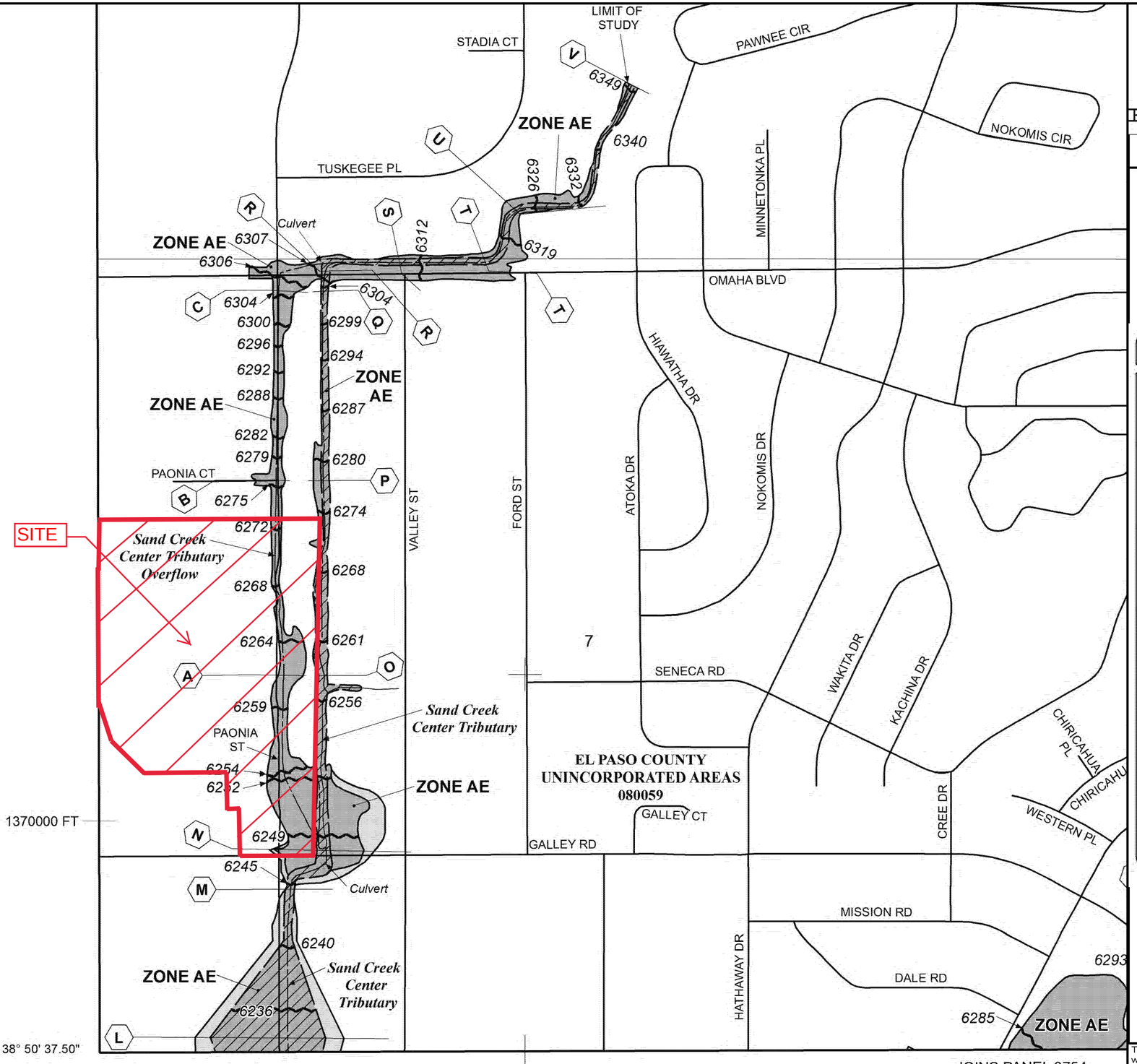
If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher



MAP SCALE 1" = 500'

0 500 1000 FEET

NFIP

PANEL 0752G

NATIONAL FLOOD INSURANCE PROGRAM

FIRM

FLOOD INSURANCE RATE MAP

EL PASO COUNTY, COLORADO AND INCORPORATED AREAS

PANEL 752 OF 1300

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
COLORADO SPRINGS, CITY OF	080060	0752	G
EL PASO COUNTY	080059	0752	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
08041C0752G

MAP REVISED
DECEMBER 7, 2018

Federal Emergency Management Agency

This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov

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.

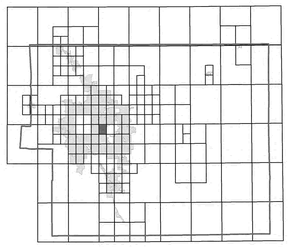
Contact **FEMA Map Service Center** (MSC) via the FEMA Map Information eXchange (FMIX) 1-877-336-2627 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this 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

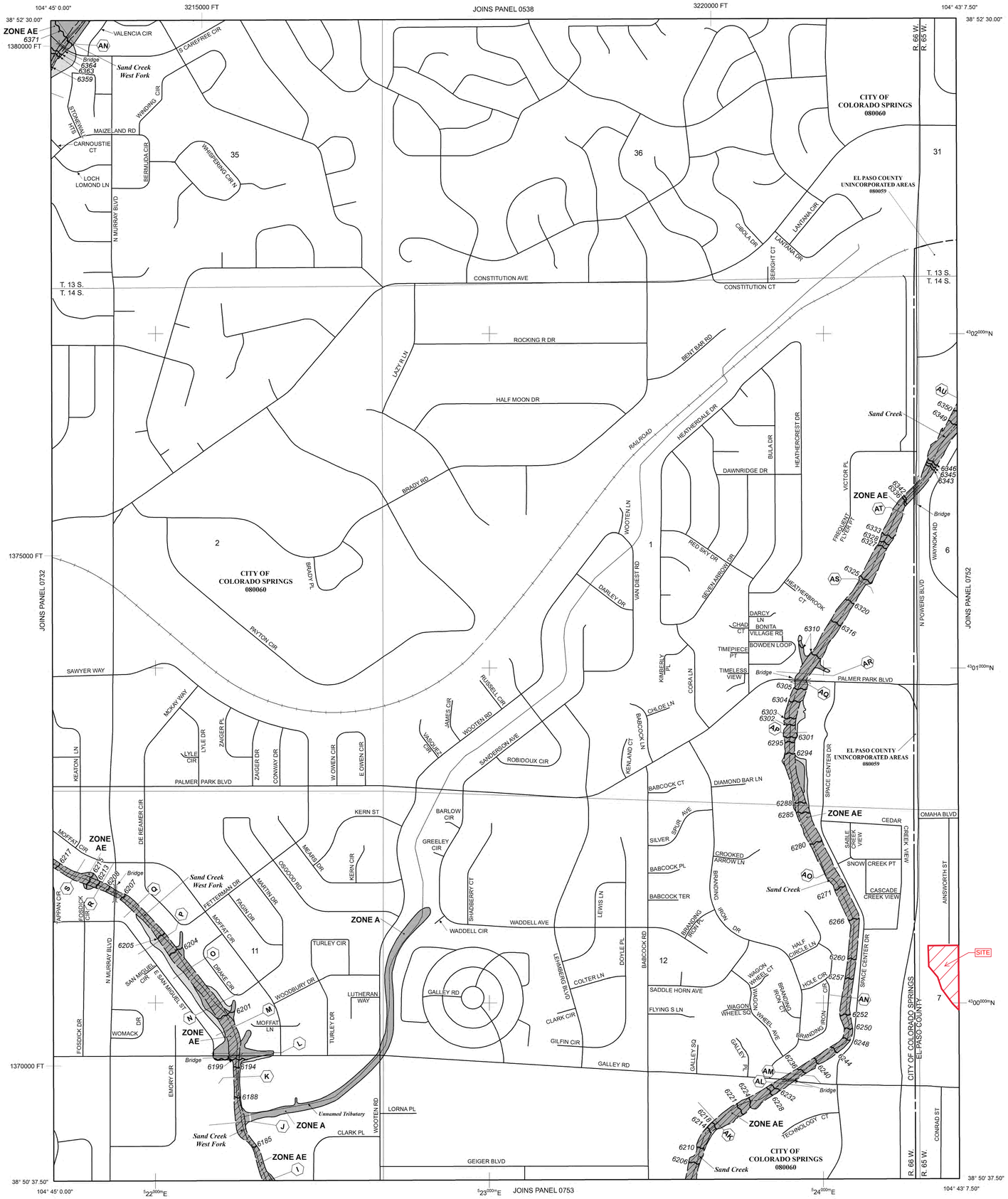
Flooding Source	Vertical Datum Offset (ft)
REFER TO SECTION 3.3 OF THE EL PASO COUNTY FLOOD INSURANCE STUDY FOR STREAM BY STREAM VERTICAL DATUM CONVERSION INFORMATION	

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.



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)
$^{4275}000m$N — 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

PANEL 0751G

NATIONAL FLOOD INSURANCE PROGRAM

FIRM

FLOOD INSURANCE RATE MAP

EL PASO COUNTY, COLORADO AND INCORPORATED AREAS

PANEL 751 OF 1300

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
COLORADO SPRINGS, CITY OF	080060	0751	G
EL PASO COUNTY	080059	0751	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 08041C0751G

MAP REVISED DECEMBER 7, 2018

Federal Emergency Management Agency

APPENDIX B

HYDROLOGIC/ HYDRAULIC CALCULATIONS

COMPOSITE % IMPERVIOUS & COMPOSITE RUNOFF COEFFICIENT CALCULATIONS

Subdivision: Solace (Existing Condition)
Location: El Paso County

Project Name: Solace Apartments
Project No.: 25174.00
Calculated By: JBP
Checked By:
Date: 6/29/20

Basin ID	Total Area (ac)	Streets (100% Impervious)				Roofs (90% Impervious)				Light Industrial (80% Impervious)				Undeveloped (2% Impervious)				Basins Total Weighted C		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}	
A1	14.75	0.90	0.96	0.00	0.0%	0.73	0.81	0.00	0.0%	0.59	0.70	0.00	0.0%	0.09	0.36	14.75	2.0%	0.09	0.36	2.0%
A2	3.79	0.90	0.96	0.00	0.0%	0.73	0.81	0.00	0.0%	0.59	0.70	0.00	0.0%	0.09	0.36	3.79	2.0%	0.09	0.36	2.0%
A3	5.44	0.90	0.96	0.00	0.0%	0.73	0.81	0.00	0.0%	0.59	0.70	0.00	0.0%	0.09	0.36	5.44	2.0%	0.09	0.36	2.0%
B1	4.84	0.90	0.96	0.00	0.0%	0.73	0.81	0.00	0.0%	0.59	0.70	0.00	0.0%	0.09	0.36	4.84	2.0%	0.09	0.36	2.0%
OS1	17.73	0.90	0.96	0.00	0.0%	0.73	0.81	0.00	0.0%	0.59	0.70	17.73	80.0%	0.09	0.36	0.00	2.0%	0.59	0.70	80.0%
OS2	8.93	0.90	0.96	0.00	0.0%	0.73	0.81	0.00	0.0%	0.73	0.81	8.93	90.0%	0.09	0.36	0.00	2.0%	0.73	0.81	90.0%
TOTAL (A1-B1)	28.82																			2.0%
TOTAL (OS1-OS3)	26.66																			83.3%
TOTAL	55.48																			41.1%

STANDARD FORM SF-2
TIME OF CONCENTRATION

Subdivision: Solace (Existing Condition)
Location: El Paso County

Project Name: Solace Apartments
Project No.: 25174.00
Calculated By: JBP
Checked By:
Date: 6/29/20

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)
A1	14.75	B	2%	0.09	0.36	100	2.4%	13.7	1119	2.0%	7.0	1.0	18.8	32.5	1219.0	39.9	32.5
A2	3.79	B	2%	0.09	0.36	100	2.0%	14.5	611	1.8%	7.0	0.9	10.8	25.4	711.0	33.8	25.4
A3	5.44	B	2%	0.09	0.36	100	1.8%	15.0	444	1.9%	7.0	1.0	7.7	22.7	544.0	31.4	22.7
B1	4.84	B	2%	0.09	0.36	100	3.0%	12.7	351	1.2%	7.0	0.8	7.6	20.3	451.0	31.4	20.3
OS1	17.73	B	80%	0.59	0.70	100	1.9%	7.5	1236	1.8%	20.0	2.7	7.7	15.1	1336.0	20.0	15.1
OS2	8.93	B	90%	0.73	0.81	100	2.1%	5.2	415	1.9%	15.0	2.1	3.3	8.6	515.0	13.0	8.6

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).

$$t_t = \frac{L_t}{60K\sqrt{S_o}} = \frac{L_t}{60V_t}$$ 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).

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

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

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.

STANDARD FORM SF-3

STORM DRAINAGE SYSTEM DESIGN

(RATIONAL METHOD PROCEDURE)

Subdivision: Solace (Existing Condition)
Location: El Paso County
Design Storm: 5-Year

Project Name: Solace Apartments
Project No.: 25174.00
Calculated By: JBP
Checked By:
Date: 6/29/20

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)	
	1	A1	14.75	0.09	32.5	1.33	2.36	3.1					3.1	1.33	0.7								Surface runoff from existing basin A1, Surface flow into Sand Creek Drainageway at DP 1
	2	A2	3.79	0.09	25.4	0.34	2.73	0.9					0.9	0.34	2.0								Surface runoff from Basin A2 Surface flow offsite to the south at DP 2
	3	A3	5.44	0.09	22.7	0.49	2.90	1.4					1.4	0.49	2.5								Surface runoff from Basin A3 Surface flow offsite to the south at DP 3
	4	B1	4.84	0.09	20.3	0.44	3.07	1.3					1.3	0.44	1.0								Surface runoff from Basin B1 Surface flow offsite to the southwest at DP 4
	5	OS1	17.73	0.59	15.1	10.46	3.51	36.7					36.7	10.46	1.78					200	2.0	1.7	Surface runoff from Basin OS1, captured by existing concrete channel at DP 5 Channel conveyance to Sand Creek at DP 1.1
	6	OS2	8.93	0.73	8.6	6.52	4.36	28.4					28.4	6.52	3.2					147	2.7	0.9	Surface runoff from Basin OS2 diverted to swale west of site at DP 6
	1.0	-	-	-	-	-	-	-															5-Year Flows were not analyzed as part of the Sand Creek Drainage Basin Planning Study.
	1.1	-	-	-	-	-	-	-															5-Year Flows were not analyzed as part of the Sand Creek Drainage Basin Planning Study.
	1.2	-	-	-	-	-	-	-															5-Year Flows were not analyzed as part of the Sand Creek Drainage Basin Planning Study.
	1.3	-	-	-	-	-	-	-															5-Year Flows were not analyzed as part of the Sand Creek Drainage Basin Planning Study.
	1.4	-	-	-	-	-	-	-															5-Year Flows were not analyzed as part of the LOMR for Sand Creek Center Tributary.
	1.5	-	-	-	-	-	-	-															5-Year Flows were not analyzed as part of the Sand Creek Drainage Basin Planning Study.
	1.6	-	-	-	-	-	-	-															5-Year Flows were not analyzed as part of the Sand Creek Drainage Basin Planning Study.

Notes:
Street and Pipe C*A values are determined by Q/i using the catchment's intensity value.
All pipes are private and RCP unless otherwise noted. Pipe size shown in table column.

STANDARD FORM SF-3

STORM DRAINAGE SYSTEM DESIGN

(RATIONAL METHOD PROCEDURE)

Subdivision: Solace (Existing Condition)
Location: El Paso County
Design Storm: 100-Year

Project Name: Solace Apartments
Project No.: 25174.00
Calculated By: JBP
Checked By:
Date: 6/29/20

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)	t_c (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)	
	1	A1	14.75	0.36	32.5	5.31	3.96	21.0					21.0	5.31	0.7								Surface runoff from existing basin A1, Surface flow into Sand Creek Drainageway at DP 1
	2	A2	3.79	0.36	25.4	1.36	4.59	6.2					6.2	1.36	2.0								Surface runoff from Basin A2 Surface flow offsite to the south at DP 2
	3	A3	5.44	0.36	22.7	1.96	4.87	9.5					9.5	1.96	2.5								Surface runoff from Basin A3 Surface flow offsite to the south at DP 3
	4	B1	4.84	0.36	20.3	1.74	5.15	9.0					9.0	1.74	1.0								Surface runoff from Basin B1 Surface flow offsite to the southwest at DP 4
	5	OS1	17.73	0.70	15.1	12.41	5.89	73.1				573.1	573.1		1.78					200	2.0	1.7	Surface runoff from Basin OS1 & DP 1.4, captured by existing concrete channel at DP 5 Street conveyance to DP 5, flow split to DP 1.5 & DP 1.6
	6	OS2	8.93	0.81	8.6	7.23	7.32	52.9					52.9	7.23	3.2					147	2.7	0.9	Surface runoff from Basin OS2 diverted to swale west of site at DP 6
	1.0	-	-	-	-	-	-	760.0					760.0										Flow taken directly from the Sand Creek Drainage Basin Planning Study
	1.1	-	-	-	-	-	-	720.0					720.0										Flow taken directly from the Sand Creek Drainage Basin Planning Study
	1.2	-	-	-	-	-	-	960.0					960.0										Flow taken directly from the Sand Creek Drainage Basin Planning Study
	1.3	-	-	-	-	-	-	1340.0					1340.0										Flow taken directly from the Sand Creek Drainage Basin Planning Study
	1.4	-	-	-	-	-	-	500.0					500.0										Flow taken directly from the LOMR for Sand Creek Center Tributary Street conveyance to DP 5
	1.5											244.0	244.0										Second Draiangeway Channel conveyance to Sand Creek at DP 1
	1.6											42.1	42.1										Existing Concrete Channel Channel conveyance to Sand Creek at DP 1.1

Notes:
Street and Pipe C*A values are determined by Q/i using the catchment's intensity value.
All pipes are private and RCP unless otherwise noted. Pipe size shown in table column.

COMPOSITE % IMPERVIOUS & COMPOSITE RUNOFF COEFFICIENT CALCULATIONS

Subdivision: Solace
Location: El Paso County

Project Name: Solace Apartments
Project No.: 25174.00
Calculated By: JBP
Checked By:
Date: 6/26/20

Basin ID	Total Area (ac)	Streets (100% Impervious)				Roofs (90% Impervious)				Light Industrial (80% Impervious)				Lawns (0% Impervious)				Basins Total Weighted C		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}	
A1	9.13	0.90	0.96	2.61	28.6%	0.73	0.81	1.61	15.9%	0.59	0.70	0.00	0.0%	0.08	0.35	4.91	0.0%	0.43	0.61	44.5%
B1	16.23	0.90	0.96	3.66	22.6%	0.73	0.81	4.13	22.9%	0.59	0.70	0.00	0.0%	0.08	0.35	8.44	0.0%	0.43	0.60	45.5%
B2	1.61	0.90	0.96	0.27	16.8%	0.73	0.81	0.00	0.0%	0.59	0.70	0.00	0.0%	0.08	0.35	1.34	0.0%	0.22	0.45	16.8%
C1	0.65	0.90	0.96	0.13	20.0%	0.73	0.81	0.00	0.0%	0.59	0.70	0.00	0.0%	0.08	0.35	0.52	0.0%	0.24	0.47	20.0%
OS1	17.73	0.90	0.96	0.00	0.0%	0.73	0.81	0.00	0.0%	0.59	0.70	17.73	80.0%	0.08	0.35	0.00	0.0%	0.59	0.70	80.0%
OS2	8.93	0.90	0.96	0.00	0.0%	0.73	0.81	0.00	0.0%	0.73	0.81	8.93	90.0%	0.08	0.35	0.00	0.0%	0.73	0.81	90.0%
TOTAL (A1-C1)	27.62																			42.9%
TOTAL (OS1-OS2)	26.66																			83.3%
TOTAL	54.28																			62.7%

STANDARD FORM SF-2
TIME OF CONCENTRATION

Subdivision: Solace
Location: El Paso County

Project Name: Solace Apartments
Project No.: 25174.00
Calculated By: JBP
Checked By:
Date: 6/26/20

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)
A1	9.13	B	44%	0.43	0.61	100	4.9%	7.2	689	1.7%	20.0	2.6	4.4	11.6	789.0	24.2	11.6
B1	16.23	B	45%	0.43	0.60	100	4.4%	7.4	1592	1.0%	20.0	2.0	13.3	20.7	1692.0	35.5	20.7
B2	1.61	B	17%	0.22	0.45	100	3.3%	10.8	273	1.0%	20.0	2.0	2.3	13.0	373.0	27.2	13.0
C1	0.65	B	20%	0.24	0.47	100	1.8%	12.8	114	1.0%	20.0	2.0	1.0	13.8	214.0	24.2	13.8
OS1	17.73	B	80%	0.59	0.70	100	1.9%	7.5	1236	1.8%	20.0	2.7	7.7	15.1	1336.0	20.0	15.1
OS2	8.93	B	90%	0.73	0.81	100	2.1%	5.2	415	1.9%	15.0	2.1	3.3	8.6	515.0	13.0	8.6

NOTES:

$$t_c = t_i + t_t$$

Where:

t_c = computed time of concentration (minutes)

t_i = overland (initial) flow time (minutes)

t_t = channelized flow time (minutes).

$$t_t = \frac{L_t}{60K\sqrt{S_o}} = \frac{L_t}{60V_t}$$

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).

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.

Equation 6-2

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

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).

Equation 6-4

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

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

STANDARD FORM SF-3

STORM DRAINAGE SYSTEM DESIGN

(RATIONAL METHOD PROCEDURE)

ubdivision: Solace
Location: El Paso County
ign Storm: 5-Year

Project Name: Solace Apartments
Project No.: 25174.00
Calculated By: JBP
Checked By:
Date: 6/26/20

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)	
	1	A1	9.13	0.43	11.6	3.92	3.91	15.3								15.3	3.92	0.5	48	20	5.8	0.1	Surface runoff from Basin A1, transported by Storm Infrastructure to North Detention Pond at DP 1
	2	B1	16.23	0.43	20.7	6.98	3.04	21.2								21.2	6.98	0.5	42	17	6.5	0.0	Surface runoff from Basin B1, transported by Storm Infrastructure to South Detention Pond at DP 2
	3	B2	1.61	0.22	13.0	0.35	3.73	1.3								1.3	0.35	1.0	18	17	4.0	0.1	Surface runoff from Basin B2, transported by Storm Infrastructure to South Detention Pond at DP 3
	4	OS1	17.73	0.59	15.1	10.46	3.51	36.7								36.7	10.46	1.0	36	225	9.7	0.4	Surface runoff from Basin OS1, captured by existing concrete channel and proposed overflow channel at DP 4 Channel conveyance to Sand Creek at DP 1.1
	5	OS2	8.93	0.73	8.6	6.52	4.36	28.4					28.4	6.52	3.2					147	2.7	0.9	Surface runoff from Basin OS2 diverted to swale west of site at DP 5
	6	C1	0.65	0.24	13.8	0.16	3.65	0.6					0.6	0.16	0.53					202	1.5	2.3	Surface runoff from Basin C1 Captured by proposed concrete pan at DP 6 and conveyed west along Galley Road per historic condition.
	1.0	-	-	-	-	-	-	-															5-Year Flows were not analyzed as part of the Sand Creek Drainage Basin Planning Study.
	1.1	-	-	-	-	-	-	-															5-Year Flows were not analyzed as part of the Sand Creek Drainage Basin Planning Study.
	1.2	-	-	-	-	-	-	-															5-Year Flows were not analyzed as part of the Sand Creek Drainage Basin Planning Study.
	1.3	-	-	-	-	-	-	-															5-Year Flows were not analyzed as part of the Sand Creek Drainage Basin Planning Study.
	1.4	-	-	-	-	-	-	-															5-Year Flows were not analyzed as part of the LOMR for Sand Creek Center Tributary.

Notes:
Street and Pipe C*A values are determined by Q/i using the catchment's intensity value.
All pipes are private and RCP unless otherwise noted. Pipe size shown in table column.

STANDARD FORM SF-3

STORM DRAINAGE SYSTEM DESIGN

(RATIONAL METHOD PROCEDURE)

Subdivision: Solace
Location: El Paso County
Design Storm: 100-Year

Project Name: Solace Apartments
Project No.: 25174.00
Calculated By: JBP
Checked By:
Date: 6/26/20

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)	
	1	A1	9.13	0.61	11.6	5.53	6.56	36.3								36.3	5.53	0.5	48	20	7.4	0.0	Surface runoff from Basin A1, transported by Storm Infrastructure to North Detention Pond at DP 1
	2	B1	16.23	0.60	20.7	9.81	5.10	50.0								50.0	9.81	0.5	42	17	8.0	0.0	Surface runoff from Basin B1, transported by Storm Infrastructure to South Detention Pond at DP 2
	3	B2	1.61	0.45	13.0	0.73	6.27	4.6								4.6	0.73	1.0	18	17	5.7	0.1	Surface runoff from Basin B2, transported by Storm Infrastructure to South Detention Pond at DP 3
	4	OS1	17.73	0.70	15.1	12.41	5.89	73.1				573.1	573.1		1.78					200	2.0	1.7	Surface runoff from Basin OS1 & DP 1.4, captured by existing concrete channel and proposed overflow channel at DP 4 Channel conveyance to Sand Creek at DP 1.1
	5	OS2	8.93	0.81	8.6	7.23	7.32	52.9					52.9	7.23	3.2					147	2.7	0.9	Surface runoff from Basin OS2 diverted to swale west of site at DP 5
	6	C1	0.65	0.47	13.8	0.31	6.12	1.9					1.9	0.31	0.53					202	1.5	2.3	Surface runoff from Basin C1 Captured by proposed concrete pan at DP 6 and conveyed west along Galley Road per historic condition.
	1.0	-	-	-	-	-	-	760.0					760.0										Flow taken directly from the Sand Creek Drainage Basin Planning Study
	1.1	-	-	-	-	-	-	720.0					720.0										Flow taken directly from the Sand Creek Drainage Basin Planning Study
	1.2	-	-	-	-	-	-	960.0					960.0										Flow taken directly from the Sand Creek Drainage Basin Planning Study
	1.3	-	-	-	-	-	-	1340.0					1340.0										Flow taken directly from the Sand Creek Drainage Basin Planning Study
	1.4	-	-	-	-	-	-	500.0					500.0										Flow taken directly from the LOMR for Sand Creek Center Tributary Channel conveyance to Sand Creek at DP 4

Notes:
Street and Pipe C*A values are determined by Q/i using the catchment's intensity value.
All pipes are private and RCP unless otherwise noted. Pipe size shown in table column.

APPENDIX C

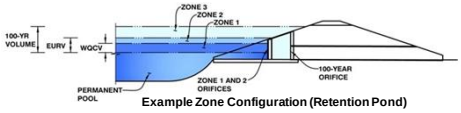
WATER QUALITY AND DETENTION CALCULATIONS

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.00 (December 2019)

Project: Solace Apartments

Basin ID: Pond A



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	EDB	
Watershed Area =	9.13	acres
Watershed Length =	800	ft
Watershed Length to Centroid =	350	ft
Watershed Slope =	0.020	ft/ft
Watershed Imperviousness =	44.50%	percent
Percentage Hydrologic Soil Group A =	1.0%	percent
Percentage Hydrologic Soil Group B =	99.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	

After providing required inputs above including 1-hour rainfall depths, click 'Run CUHP' to generate runoff hydrographs using the embedded Colorado Urban Hydrograph Procedure.

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	0.146	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	0.431	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	0.402	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	0.588	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	0.752	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	0.984	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	1.166	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	1.402	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.14 in.) =	1.873	acre-feet		inches
Approximate 2-yr Detention Volume =	0.320	acre-feet		
Approximate 5-yr Detention Volume =	0.443	acre-feet		
Approximate 10-yr Detention Volume =	0.598	acre-feet		
Approximate 25-yr Detention Volume =	0.662	acre-feet		
Approximate 50-yr Detention Volume =	0.694	acre-feet		
Approximate 100-yr Detention Volume =	0.786	acre-feet		

Define Zones and Basin Geometry

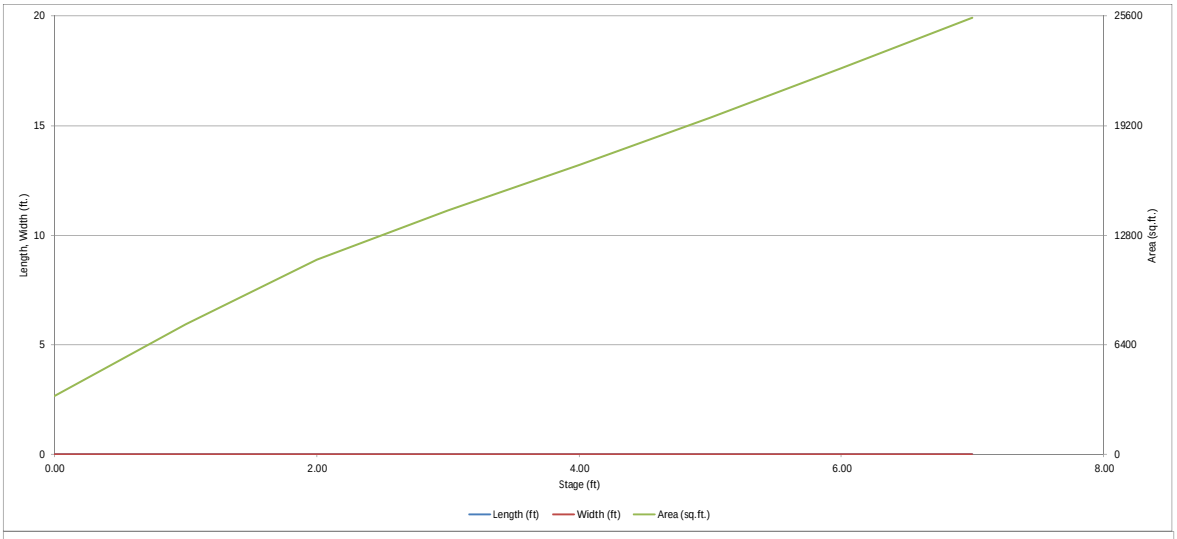
Zone 1 Volume (WQCV) =	0.146	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.285	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.355	acre-feet
Total Detention Basin Volume =	0.786	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio (R_{LW}) =	user	
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	user	acre-feet

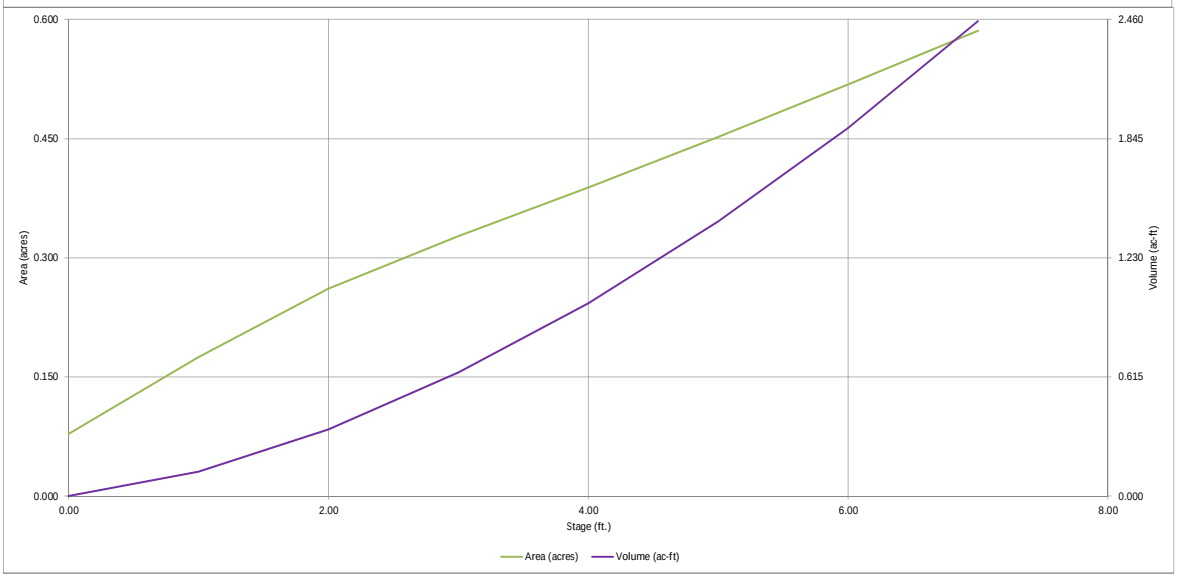
Depth Increment = ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	3,416	0.078		
ELEV: 6254.00	--	1.00	--	--	--	7,602	0.175	5,509	0.126
ELEV: 6255.00	--	2.00	--	--	--	11,378	0.261	14,999	0.344
ELEV: 6256.00	--	3.00	--	--	--	14,249	0.327	27,812	0.638
ELEV: 6257.00	--	4.00	--	--	--	16,917	0.388	43,395	0.996
ELEV: 6258.00	--	5.00	--	--	--	19,685	0.452	61,696	1.416
ELEV: 6259.00	--	6.00	--	--	--	22,554	0.518	82,816	1.901
ELEV: 6260.00	--	7.00	--	--	--	25,523	0.586	106,854	2.453

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.00 (December 2019)



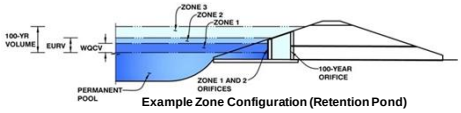


DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.00 (December 2019)

Project: Solace Apartments

Basin ID: Pond B



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	EDB	
Watershed Area =	17.84	acres
Watershed Length =	1,800	ft
Watershed Length to Centroid =	780	ft
Watershed Slope =	0.014	ft/ft
Watershed Imperviousness =	42.90%	percent
Percentage Hydrologic Soil Group A =	1.0%	percent
Percentage Hydrologic Soil Group B =	99.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	

After providing required inputs above including 1-hour rainfall depths, click 'Run CUHP' to generate runoff hydrographs using the embedded Colorado Urban Hydrograph Procedure.

			Optional User Overrides
Water Quality Capture Volume (WQCV) =	0.279	acre-feet	acre-feet
Excess Urban Runoff Volume (EURV) =	0.809	acre-feet	acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	0.784	acre-feet	1.19 inches
5-yr Runoff Volume (P1 = 1.5 in.) =	1.155	acre-feet	1.50 inches
10-yr Runoff Volume (P1 = 1.75 in.) =	1.486	acre-feet	1.75 inches
25-yr Runoff Volume (P1 = 2 in.) =	1.956	acre-feet	2.00 inches
50-yr Runoff Volume (P1 = 2.25 in.) =	2.324	acre-feet	2.25 inches
100-yr Runoff Volume (P1 = 2.52 in.) =	2.802	acre-feet	2.52 inches
500-yr Runoff Volume (P1 = 3.14 in.) =	3.755	acre-feet	inches
Approximate 2-yr Detention Volume =	0.600	acre-feet	
Approximate 5-yr Detention Volume =	0.832	acre-feet	
Approximate 10-yr Detention Volume =	1.130	acre-feet	
Approximate 25-yr Detention Volume =	1.255	acre-feet	
Approximate 50-yr Detention Volume =	1.316	acre-feet	
Approximate 100-yr Detention Volume =	1.496	acre-feet	

Define Zones and Basin Geometry

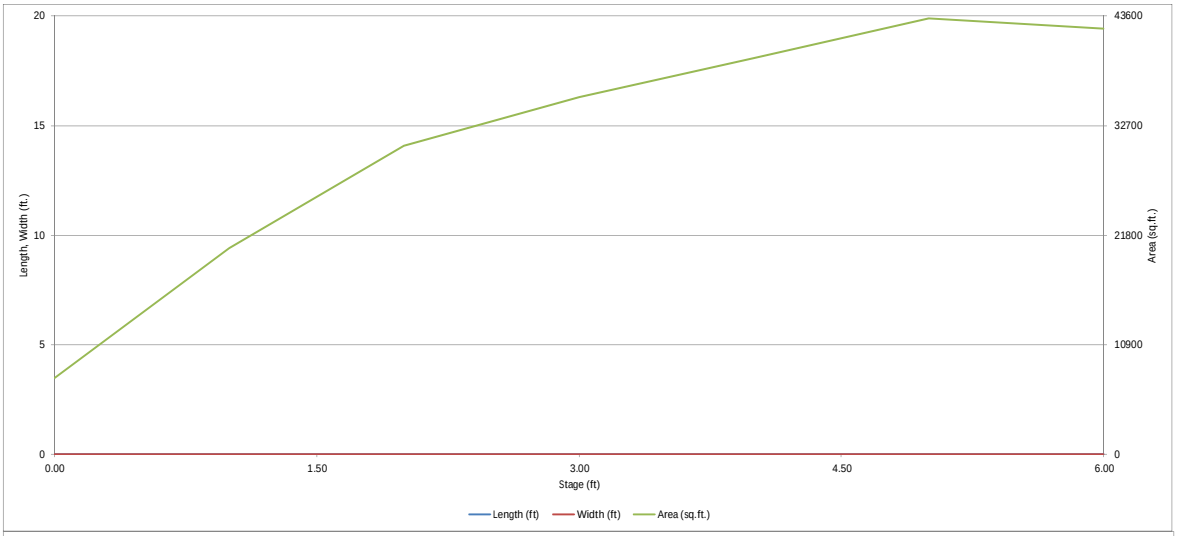
Zone 1 Volume (WQCV) =	0.279	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.530	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.688	acre-feet
Total Detention Basin Volume =	1.496	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio (R_{LW}) =	user	
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	user	acre-feet

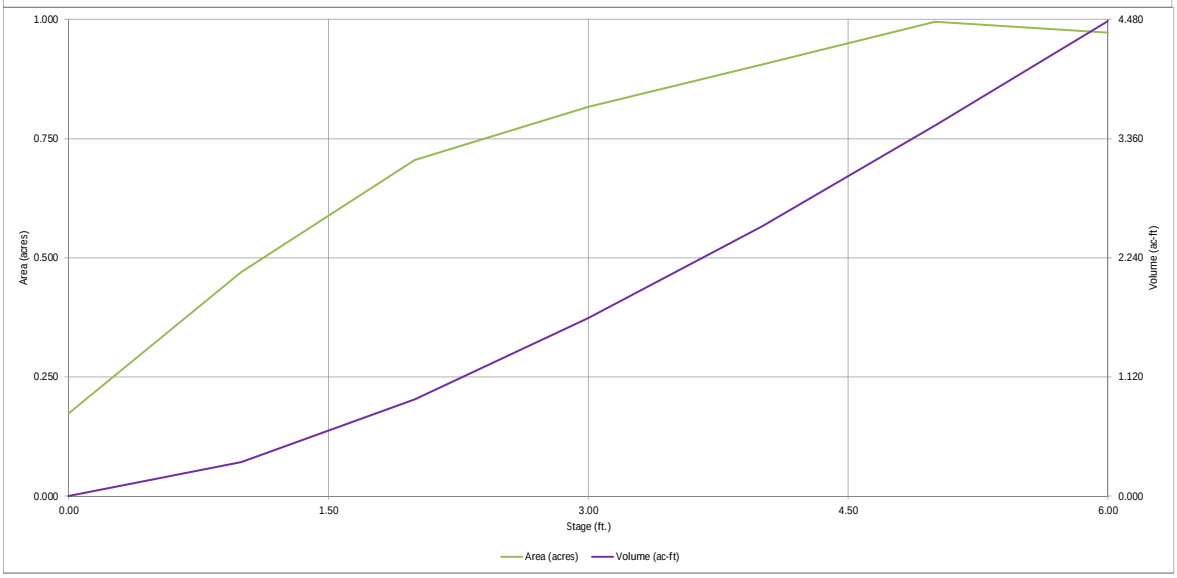
Depth Increment = ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	7,580	0.174		
ELEV: 6245.00	--	1.00	--	--	--	20,477	0.470	14,028	0.322
ELEV: 6246.00	--	2.00	--	--	--	30,713	0.705	39,623	0.910
ELEV: 6247.00	--	3.00	--	--	--	35,569	0.817	72,764	1.670
ELEV: 6248.00	--	4.00	--	--	--	39,416	0.905	110,257	2.531
ELEV: 6249.00	--	5.00	--	--	--	43,363	0.995	151,646	3.481
ELEV: 6250.00	--	6.00	--	--	--	42,375	0.973	194,515	4.465

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.00 (December 2019)





APPENDIX D

REFERENCE MATERIALS

Federal Emergency Management Agency

Washington, D.C. 20472

JAN 3 0 2007

CERTIFIED MAIL
RETURN RECEIPT REQUESTED

IN REPLY REFER TO:
Case No.: 05-08-0368P
Community Name: El Paso County, CO
Community No.: 080059
Effective Date of This Revision: MAY 2 3 2007

The Honorable Sallie Clark
Chair, El Paso County
Board of Commissioners
27 East Vermijo Avenue
Colorado Springs, CO 80903

Dear Ms. Clark:

The Flood Insurance Study report and Flood Insurance Rate Map for your community have been revised by this Letter of Map Revision (LOMR). Please use the enclosed annotated map panel(s) revised by this LOMR for floodplain management purposes and for all flood insurance policies and renewals issued in your community.

Additional documents are enclosed which provide information regarding this LOMR. Please see the List of Enclosures below to determine which documents are included. Other attachments specific to this request may be included as referenced in the Determination Document. If you have any questions regarding floodplain management regulations for your community or the National Flood Insurance Program (NFIP) in general, please contact the Consultation Coordination Officer for your community. If you have any technical questions regarding this LOMR, please contact the Director, Federal Insurance and Mitigation Division of the Department of Homeland Security's Federal Emergency Management Agency (FEMA) in Denver, Colorado, at (303) 235-4830, or the FEMA Map Assistance Center toll free at 1-877-336-2627 (1-877-FEMA MAP). Additional information about the NFIP is available on our website at http://www.fema.gov/nfip.

Sincerely,

Patrick, F. Sacbibit, P.E., CFM, Project Engineer
Engineering Management Section
Mitigation Division

For: William R. Blanton Jr., CFM, Chief
Engineering Management Section
Mitigation Division

List of Enclosures:

Letter of Map Revision Determination Document
Annotated Flood Insurance Rate Map
Annotated Flood Insurance Study Report

cc: The Honorable Lionel Rivera
Mayor, City of Colorado Springs

[redacted]
Regional Floodplain Administrator
Pikes Peak Regional Building Department

[redacted]
J. F. Sato and Associates, Inc.

[redacted]
Engineering and Surveying, Inc.

 | Issue Date: JAN 3 0 2007 | Effective Date: MAY 2 3 2007 | Case No.: 05-08-0368P | LOMR-APP

Federal Emergency Management Agency

Washington, D.C. 20472

LETTER OF MAP REVISION
DETERMINATION DOCUMENT

COMMUNITY AND REVISION INFORMATION		PROJECT DESCRIPTION	BASIS OF REQUEST
COMMUNITY	El Paso County Colorado (Unincorporated Areas)	CHANNELIZATION CULVERT	FLOODWAY HYDRAULIC ANALYSIS NEW TOPOGRAPHIC DATA BASEMAP CHANGES
	COMMUNITY NO.: 080059		
IDENTIFIER	Sand Creek Center Tributary and East Fork LOMR	APPROXIMATE LATITUDE & LONGITUDE: 38.846, -104.720 SOURCE: USGS QUADRANGLE DATUM: NAD 27	

ANNOTATED MAPPING ENCLOSURES			ANNOTATED STUDY ENCLOSURES
TYPE: FIRM*	NO.: 08041C0752 F	DATE: March 17, 1997	DATE OF EFFECTIVE FLOOD INSURANCE STUDY: August 23, 1999
TYPE: FIRM	NO.: 08041C0753 F	DATE: March 17, 1997	PROFILE(S): 206P
TYPE: FIRM	NO.: 08041C0754 F	DATE: March 17, 1997	FLOODWAY DATA TABLE: 5

Enclosures reflect changes to flooding sources affected by this revision.
* FIRM - Flood Insurance Rate Map; ** FBFM - Flood Boundary and Floodway Map; *** FHBM - Flood Hazard Boundary Map

FLOODING SOURCE(S) & REVISED REACH(ES)

Sand Creek Center Tributary – from approximately 1,350 feet upstream of East Frontage Road to just upstream of Galley Road

SUMMARY OF REVISIONS

Flooding Source	Effective Flooding	Revised Flooding	Increases	Decreases
Sand Creek Center Tributary	Zone AE	Zone AE	YES	YES
	Floodway	Floodway	YES	YES
	BFEs*	BFEs	NONE	YES
	Zone X (shaded)	Zone X (shaded)	YES	YES

* BFEs - Base Flood Elevations

DETERMINATION

This document provides the determination from the Department of Homeland Security's Federal Emergency Management Agency (FEMA) regarding a request for a Letter of Map Revision (LOMR) for the area described above. Using the information submitted, we have determined that a revision to the flood hazards depicted in the Flood Insurance Study (FIS) report and/or National Flood Insurance Program (NFIP) map is warranted. This document revises the effective NFIP map, as indicated in the attached documentation. Please use the enclosed annotated map panels revised by this LOMR for floodplain management purposes and for all flood insurance policies and renewals in your community.

This determination is based on the flood data presently available. The enclosed documents provide additional information regarding this determination. If you have any questions about this document, please contact the FEMA Map Assistance Center toll free at 1-877-336-2627 (1-877-FEMA MAP) or by letter addressed to the LOMR Depot, 3601 Eisenhower Avenue, Alexandria, VA 22304. Additional Information about the NFIP is available on our website at http://www.fema.gov/nfip.

Patrick F. Sacbibit, P.E., CFM, Project Engineer
Engineering Management Section
Mitigation Division

Federal Emergency Management Agency
Washington, D.C. 20472

LETTER OF MAP REVISION
DETERMINATION DOCUMENT (CONTINUED)

OTHER COMMUNITIES AFFECTED BY THIS REVISION

CID Number: 080060 **Name:** City of Colorado Springs, Colorado

AFFECTED MAP PANELS	AFFECTED PORTIONS OF THE FLOOD INSURANCE STUDY REPORT
TYPE: FIRM NO.: 08041C0753 F DATE: March 17, 1997 TYPE: FIRM NO.: 08041C0754 F DATE: March 17, 1997	DATE OF EFFECTIVE FLOOD INSURANCE STUDY: August 23, 1999 PROFILE(S): 205P, 206P, 209P, and 210P FLOODWAY DATA TABLE: 5

This determination is based on the flood data presently available. The enclosed documents provide additional information regarding this determination. If you have any questions about this document, please contact the FEMA Map Assistance Center toll free at 1-877-336-2627 (1-877-FEMA MAP) or by letter addressed to the LOMR Depot, 3601 Eisenhower Avenue, Alexandria, VA 22304. Additional Information about the NFIP is available on our website at http://www.fema.gov/nfip.

Patrick F. Sacbibit, P.E., CFM, Project Engineer
Engineering Management Section
Mitigation Division

Federal Emergency Management Agency
Washington, D.C. 20472

LETTER OF MAP REVISION
DETERMINATION DOCUMENT (CONTINUED)

COMMUNITY INFORMATION

APPLICABLE NFIP REGULATIONS/COMMUNITY OBLIGATION

We have made this determination pursuant to Section 206 of the Flood Disaster Protection Act of 1973 (P.L. 93-234) and in accordance with the National Flood Insurance Act of 1968, as amended (Title XIII of the Housing and Urban Development Act of 1968, P.L. 90-448), 42 U.S.C. 4001-4128, and 44 CFR Part 65. Pursuant to Section 1361 of the National Flood Insurance Act of 1968, as amended, communities participating in the NFIP are required to adopt and enforce floodplain management regulations that meet or exceed NFIP criteria. These criteria, including adoption of the FIS report and FIRM, and the modifications made by this LOMR, are the minimum requirements for continued NFIP participation and do not supersede more stringent State/Commonwealth or local requirements to which the regulations apply.

We provide the floodway designation to your community as a tool to regulate floodplain development. Therefore, the floodway revision we have described in this letter, while acceptable to us, must also be acceptable to your community and adopted by appropriate community action, as specified in Paragraph 60.3(d) of the NFIP regulations.

NFIP regulations Subparagraph 60.3(b)(7) requires communities to ensure that the flood-carrying capacity within the altered or relocated portion of any watercourse is maintained. This provision is incorporated into your community's existing floodplain management ordinances; therefore, responsibility for maintenance of the altered or relocated watercourse, including any related appurtenances such as bridges, culverts, and other drainage structures, rests with your community. We may request that your community submit a description and schedule of maintenance activities necessary to ensure this requirement.

COMMUNITY REMINDERS

We based this determination on the 1-percent-annual-chance flood discharges computed in the FIS for your community without considering subsequent changes in watershed characteristics that could increase flood discharges. Future development of projects upstream could cause increased flood discharges, which could cause increased flood hazards. A comprehensive restudy of your community's flood hazards would consider the cumulative effects of development on flood discharges subsequent to the publication of the FIS report for your community and could, therefore, establish greater flood hazards in this area.

Your community must regulate all proposed floodplain development and ensure that permits required by Federal and/or State/Commonwealth law have been obtained. State/Commonwealth or community officials, based on knowledge of local conditions and in the interest of safety, may set higher standards for construction or may limit development in floodplain areas. If your State/Commonwealth or community has adopted more restrictive or comprehensive floodplain management criteria, those criteria take precedence over the minimum NFIP requirements.

We will not print and distribute this LOMR to primary users, such as local insurance agents or mortgage lenders; instead, the community will serve as a repository for the new data. We encourage you to disseminate the information in this LOMR by preparing a news release for publication in your community's newspaper that describes the revision and explains how your community will provide the data and help interpret the NFIP maps. In that way, interested persons, such as property owners, insurance agents, and mortgage lenders, can benefit from the information.

This determination is based on the flood data presently available. The enclosed documents provide additional information regarding this determination. If you have any questions about this document, please contact the FEMA Map Assistance Center toll free at 1-877-336-2627 (1-877-FEMA MAP) or by letter addressed to the LOMR Depot, 3601 Eisenhower Avenue, Alexandria, VA 22304. Additional Information about the NFIP is available on our website at http://www.fema.gov/nfip.

Patrick F. Sacbibit, P.E., CFM, Project Engineer
Engineering Management Section
Mitigation Division

Federal Emergency Management Agency

Washington, D.C. 20472

LETTER OF MAP REVISION
DETERMINATION DOCUMENT (CONTINUED)

We have designated a Consultation Coordination Officer (CCO) to assist your community. The CCO will be the primary liaison between your community and FEMA. For information regarding your CCO, please contact:

Ms. Jeanine D. Petterson
Director, Federal Insurance and Mitigation Division
Federal Emergency Management Agency, Region VIII
Denver Federal Center, Building 710
P.O. Box 25267
Denver, CO 80225-0267
(303) 235-4830

STATUS OF THE COMMUNITY NFIP MAPS

We will not physically revise and republish the FIRM and FIS report for your community to reflect the modifications made by this LOMR at this time. When changes to the previously cited FIRM panel(s) and FIS report warrant physical revision and republication in the future, we will incorporate the modifications made by this LOMR at that time.

This determination is based on the flood data presently available. The enclosed documents provide additional information regarding this determination. If you have any questions about this document, please contact the FEMA Map Assistance Center toll free at 1-877-336-2627 (1-877-FEMA MAP) or by letter addressed to the LOMR Depot, 3601 Eisenhower Avenue, Alexandria, VA 22304. Additional Information about the NFIP is available on our website at http://www.fema.gov/nfip.

Patrick F. Sacbibit, P.E., CFM, Project Engineer
Engineering Management Section
Mitigation Division

Federal Emergency Management Agency

Washington, D.C. 20472

LETTER OF MAP REVISION
DETERMINATION DOCUMENT (CONTINUED)

PUBLIC NOTIFICATION OF REVISION

PUBLIC NOTIFICATION

FLOODING SOURCE	LOCATION OF REFERENCED ELEVATION	BFE (FEET NGVD 29)		MAP PANEL NUMBER(S)
		EFFECTIVE	REVISED	
Sand Creek Center Tributary	Approximately 1,350 feet upstream of East Frontage Road	6,170	6,165	08041C0753 F
	Just downstream of Terminal Avenue	6,216	6,213	08041C0754 F

Within 90 days of the second publication in the local newspaper, a citizen may request that we reconsider this determination. Any request for reconsideration must be based on scientific or technical data. Therefore, this letter will be effective only after the 90-day appeal period has elapsed and we have resolved any appeals that we receive during this appeal period. Until this LOMR is effective, the revised BFEs presented in this LOMR may be changed.

A notice of changes will be published in the *Federal Register*. This information also will be published in your local newspaper on or about the dates listed below.

LOCAL NEWSPAPER Name: *El Paso County News*
Dates: 02/14/2007 02/21/2007

This determination is based on the flood data presently available. The enclosed documents provide additional information regarding this determination. If you have any questions about this document, please contact the FEMA Map Assistance Center toll free at 1-877-336-2627 (1-877-FEMA MAP) or by letter addressed to the LOMR Depot, 3601 Eisenhower Avenue, Alexandria, VA 22304. Additional Information about the NFIP is available on our website at http://www.fema.gov/nfip.

Patrick F. Sacbibit, P.E., CFM, Project Engineer
Engineering Management Section
Mitigation Division

CHANGES ARE MADE IN DETERMINATIONS OF BASE FLOOD ELEVATIONS FOR THE CITY OF COLORADO SPRINGS AND THE UNINCORPORATED AREAS OF EL PASO COUNTY, COLORADO, UNDER THE NATIONAL FLOOD INSURANCE PROGRAM

On March 17, 1997, the Department of Homeland Security's Federal Emergency Management Agency identified Special Flood Hazard Areas (SFHAs) in the City of Colorado Springs and in the unincorporated areas of El Paso County, Colorado, through issuance of a Flood Insurance Rate Map (FIRM). The Mitigation Division has determined that modification of the elevations of the flood having a 1-percent chance of being equaled or exceeded in any given year (base flood) for certain locations in these communities is appropriate. The modified Base Flood Elevations (BFEs) revise the FIRM for the communities.

The changes are being made pursuant to Section 206 of the Flood Disaster Protection Act of 1973 (Public Law 93-234) and are in accordance with the National Flood Insurance Act of 1968, as amended (Title XIII of the Housing and Urban Development Act of 1968, Public Law 90-448), 42 U.S.C. 4001-4128, and 44 CFR Part 65.

A hydraulic analysis was performed to incorporate new topographic data for Sand Creek Center Tributary from just upstream of Airport Road to just upstream of Galley Road and for Sand Creek East Fork from approximately 970 feet downstream of Powers Boulevard to just downstream of Stewart Avenue. This has resulted in a revised delineation of the regulatory floodway, increases and decreases in SFHA width, and increased and decreased BFEs for both aforementioned flooding sources. The table below indicates existing and modified BFEs for selected locations along the affected lengths of the flooding source(s) cited above.

Location	Existing BFE (feet)*	Modified BFE (feet)*
Sand Creek Center Tributary:		
[1]Approximately 150 feet upstream of Airport Road	6,109	6,108
[1]Approximately 1,250 feet upstream of East Frontage Road	6,168	6,164
[2]Approximately 1,350 feet upstream of East Frontage Road	6,170	6,165
[2]Just downstream of Terminal Avenue	6,216	6,213
Sand Creek East Fork:		
[1]Approximately 810 feet downstream of Powers Boulevard	6,099	6,096
[1]Approximately 140 feet downstream of Stewart Avenue	6,206	6,205

*National Geodetic Vertical Datum, rounded to nearest whole foot
[1]City of Colorado Springs
[2]Unincorporated areas of El Paso County

Under the above-mentioned Acts of 1968 and 1973, the Mitigation Division must develop criteria for floodplain management. To participate in the National Flood Insurance Program (NFIP), the community must use the modified BFEs to administer the floodplain management measures of the NFIP. These modified BFEs will also be used to calculate the appropriate flood insurance premium rates for new buildings and their contents and for the second layer of insurance on existing buildings and contents.

Upon the second publication of notice of these changes in this newspaper, any person has 90 days in which he or she can request, through the Chief Executive Officer of the community, that the Mitigation Division reconsider the determination. Any request for reconsideration must be based on knowledge of

changed conditions or new scientific or technical data. All interested parties are on notice that until the 90-day period elapses, the Mitigation Division's determination to modify the BFEs may itself be changed.

Any person having knowledge or wishing to comment on these changes should immediately notify:

The Honorable Sallie Clark
Chair, El Paso County
Board of Commissioners
27 East Vermijo Avenue
Colorado Springs, CO 80903

OR

The Honorable Lionel Rivera
Mayor, City of Colorado Springs
P.O. Box 1575
Colorado Springs, CO 80901

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
						FEET (NGVD)		
Sand Creek East Fork								
A	1,100	100	455	11.9	6,038.7	6,038.7	6,038.7	0.0
B	2,400	100	446	12.2	6,054.3	6,054.3	6,054.3	0.0
C	3,330	100	450	12.0	6,069.9	6,069.9	6,069.9	0.0
D	4,240	100	449	12.1	6,085.1	6,085.1	6,085.1	0.0
E	4,870	102	446	12.0	6,095.1	6,095.1	6,095.1	0.0
F	6,188	70	489	10.9	6,118.5	6,118.5	6,118.5	0.0
G	7,403	71	396	13.5	6,136.0	6,136.0	6,136.0	0.0
H	7,931	148	507	10.5	6,158.8	6,158.8	6,158.8	0.0
I	8,943	98	444	12.0	6,169.0	6,169.0	6,169.0	0.0
J	9,666	86	423	12.6	6,177.0	6,177.0	6,177.0	0.0
K	10,721	81	415	12.8	6,193.3	6,193.3	6,193.3	0.0
L	11,347	166	526	10.1	6,207.3	6,207.3	6,207.3	0.0
M	11,375	173	632	8.4	6,207.9	6,207.9	6,207.9	0.0
N	12,610	367	699	7.6	6,228.8	6,228.8	6,228.9	0.1
O	13,720	188	570	10.0	6,241.7	6,241.7	6,241.7	0.0
P	14,805	125	479	11.1	6,257.9	6,257.9	6,257.9	0.0
Q	14,885	125	601	8.9	6,259.9	6,259.9	6,259.9	1.0
R	15,850	228	582	9.2	6,268.7	6,268.7	6,268.7	0.0
S	16,325	300	678	7.9	6,277.3	6,277.3	6,277.5	0.2
T	16,995	321	690	7.7	6,291.4	6,291.4	6,292.0	0.6
U	17,065	326	667	8.0	6,291.4	6,291.4	6,292.1	0.7
V	17,915	388	1,598	3.3	6,293.4	6,293.4	6,294.0	0.6
W	18,995	367	683	7.8	6,307.2	6,307.2	6,307.6	0.4
X	20,525	413	706	7.5	6,326.4	6,326.4	6,327.1	0.7
Y	22,125	255	620	8.6	6,348.7	6,348.7	6,348.8	0.1
Z	23,105	397	706	7.6	6,359.9	6,359.9	6,359.9	0.0
AA	24,835	431	705	7.4	6,383.7	6,383.7	6,383.7	0.0
AB	26,505	353	667	7.8	6,401.0	6,401.0	6,401.5	0.5

Revised Data

Revised by LOMR dated OCT 07 2004

[1] Feet above confluence with Sand Creek

TABLE 5

FEDERAL EMERGENCY MANAGEMENT AGENCY

EL PASO COUNTY, CO

AND INCORPORATED AREAS

FLOODWAY DATA

SAND CREEK EAST FORK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
						FEET (NGVD)		
Sand Creek Center Tributary				Revised Data				
A	940	40	92	8.6	6,106.5	6,106.5	6,106.5	0.0
B	990	40	118	6.7	6,107.2	6,107.2	6,107.2	0.0
C	2,238	91	120	6.6	6,120.2	6,120.2	6,120.2	0.0
D	3,948	46	95	8.0	6,138.3	6,138.3	6,138.3	0.0
E	4,547	170	159	4.8	6,147.4	6,147.4	6,147.4	0.0
F	5,539	52	97	7.8	6,156.8	6,156.8	6,156.8	0.0
G	7,191	63	104	7.3	6,176.2	6,176.2	6,176.2	0.0
H	7,940	52	98	7.8	6,189.6	6,189.6	6,189.6	0.0
I	8,527	40	97	7.7	6,197.6	6,197.6	6,197.6	0.0
J	9,366	17	42	9.0	6,213.4	6,213.4	6,213.4	0.0
K	10,055	232	278	4.0	6,221.9	6,221.9	6,221.9	0.0
L	10,627	539	469	2.4	6,230.6	6,230.6	6,230.6	0.0
M	11,321	31	79	9.1	6,241.1	6,241.1	6,241.1	0.0
N	11,648	60	99	7.3	6,244.6	6,244.6	6,245.4	0.8
O	12,840	29	85	9.6	6,253.8	6,253.8	6,253.8	0.0
P	13,730	27	83	9.9	6,273.6	6,273.6	6,273.6	0.0
Q	14,592	26	68	9.3	6,299.7	6,299.7	6,299.7	0.0
R	14,670	40	61	6.9	6,304.2	6,304.2	6,305.2	1.0
S	15,050	20	63	10.1	6,307.6	6,307.6	6,308.1	0.5
T	15,460	25	68	9.5	6,310.8	6,310.8	6,311.4	0.6
U	15,750	20	41	7.8	6,319.6	6,319.6	6,319.6	0.0
V	16,670	20	39	8.1	6,346.0	6,346.0	6,346.0	0.0

Flow rate = 792 cfs

Flow rate = 822 cfs

[1] Feet Above confluence with Sand Creek East Fork

TABLE 5

FEDERAL EMERGENCY MANAGEMENT AGENCY

EL PASO COUNTY, CO

AND INCORPORATED AREAS

FLOODWAY DATA

Sand Creek Center Tributary

ELEVATION IN FEET (NGVD 29)

6120 6140 6160 6180 6200 6220 6240 6260 6280 6300

STREAM DISTANCE IN THOUSANDS OF FEET ABOVE CONFLUENCE WITH SAND CREEK EAST FORK

6.5 7.0 7.5 8.0 8.5 9.0 9.5 10.0 10.5 11.0 11.5 12.0 12.5 13.0

CITY OF COLORADO SPRINGS
EL PASO COUNTY

U.S. HIGHWAY 24
EAST PLATTE AVENUE

TERMINAL AVENUE

STATION 11.848
STATION 12.020

GALLEY ROAD

CONVERGENCE OF
SAND CREEK CENTER
TRIBUTARY OVERFLOW

REVISED REACH

0.2% AND 1% CHANCE
FLOODS COINCIDE

0.2% AND 2% CHANCE
FLOODS COINCIDE

G H I J K L M N O

LEGEND

- 0.2% ANNUAL CHANCE FLOOD
- 1% ANNUAL CHANCE FLOOD
- 2% ANNUAL CHANCE FLOOD
- 10% ANNUAL CHANCE FLOOD
- STREAM BED
- CROSS SECTION LOCATION

206P

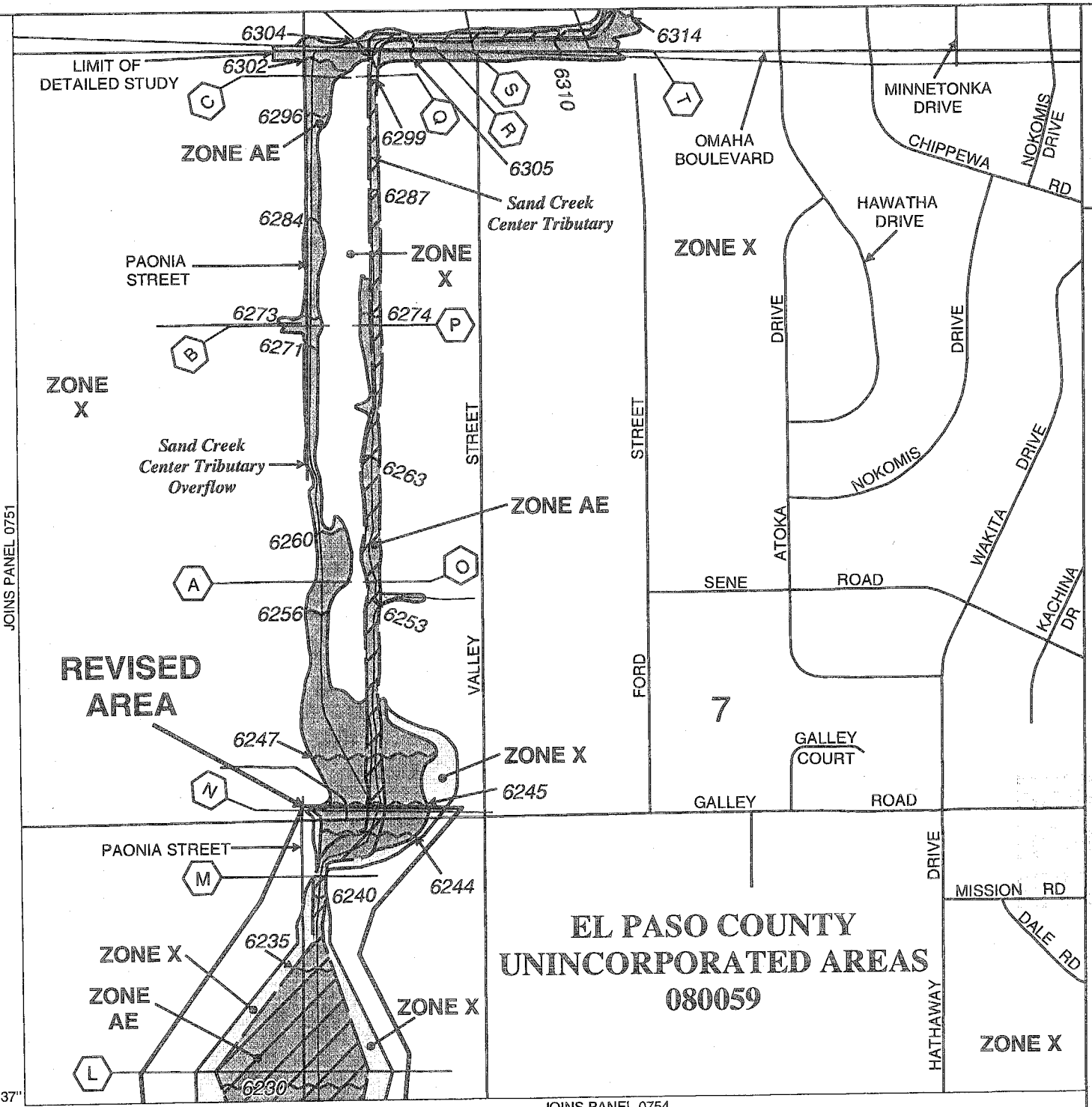
FEDERAL EMERGENCY MANAGEMENT AGENCY

EL PASO COUNTY, CO
AND INCORPORATED AREAS

FLOOD PROFILES

SAND CREEK CENTER TRIBUTARY

MAY 23 2007



Legend

1% annual chance (100-Year) Floodplain

1% annual chance (100-Year) Floodway

0.2% annual chance (500-Year) Floodplain

APPROXIMATE SCALE IN FEET

500 0 500

NATIONAL FLOOD INSURANCE PROGRAM

FIRM
FLOOD INSURANCE RATE MAP

EL PASO COUNTY, COLORADO AND INCORPORATED AREAS

PANEL 752 OF 1300
(SEE MAP INDEX FOR PANELS NOT PRINTED)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
COLORADO SPRINGS, CITY OF	080060	0752	F
EL PASO COUNTY, UNINCORPORATED AREAS	080059	0752	F

MAY 2 3 2007

MAP NUMBER
08041C0752 F

EFFECTIVE DATE:
MARCH 17, 1997

Federal Emergency Management Agency

Legend

1% annual chance (100-Year) Floodplain

1% annual chance (100-Year) Floodway

0.2% annual chance (500-Year) Floodplain

APPROXIMATE SCALE IN FEET

500 0 500

NATIONAL FLOOD INSURANCE PROGRAM

FIRM
FLOOD INSURANCE RATE MAP

EL PASO COUNTY, COLORADO AND INCORPORATED AREAS

PANEL 753 OF 1300
(SEE MAP INDEX FOR PANELS NOT PRINTED)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
COLORADO SPRINGS, CITY OF	080060	0753	F
EL PASO COUNTY, UNINCORPORATED AREAS	080059	0753	F

REVISED TO REFLECT LOMR EFFECTIVE MAY 23 2007

MAP NUMBER
08041C0753 F

EFFECTIVE DATE:
MARCH 17, 1997

Federal Emergency Management Agency

EL PASO COUNTY
UNINCORPORATED AREAS
080059

CITY OF COLORADO SPRINGS
080060

NOTE: MAP AREA SHOWN ON THIS PANEL IS LOCATED WITHIN TOWNSHIP 14 SOUTH, RANGE 65 WEST AND TOWNSHIP 14 SOUTH, RANGE 66 WEST.

REVISED AREA

REVISED AREA

0.2% ANNUAL CHANCE FLOOD DISCHARGE CONTAINED IN CULVERT

0.2% ANNUAL CHANCE FLOOD DISCHARGE CONTAINED IN CULVERT

0.2% ANNUAL CHANCE FLOOD DISCHARGE CONTAINED IN CULVERT

JOINS PANEL 0754

12 13 7 18 24 19

ZONE X ZONE AE ZONE A

EAST PLATTE AVENUE

PIKES PEAK ROAD

KARR ROAD

TROY HILL ROAD

AIRPORT ROAD

BOULEVARD

FRONTAGE ROAD

NOLTE DRIVE NORTH

CITA LN

CITA DRIVE

IVOR DRIVE

BADGER DRIVE

HOOSIER DRIVE

NOLTE CT

NORDIC DRIVE

POWERS

CHEYENNE-COLORADO SPRINGS

EL PASO COUNTY

Sand Creek Center Tributary

Sand Creek East Fork

Bridge

R66W R65W

104°43'07"
38°50'37"
JOINS PANEL 0752
JOINS PANEL 0753

EL PASO COUNTY UNINCORPORATED AREAS 080059

CITY OF COLORADO SPRINGS 080060

ZONE X
ZONE AE
6227
6223
6216
6213
6211
6207
6201
6196
6202
6198
6194
6192
6184
6190
6185
6182
6179
6258
6255
6250
6246
6238
6241
6234
6229
6225
6220
6217
6208
6206
6204
6201
6198
6194
6190
6187
6182
6177
6172
6167
6161
PAONIA STREET
TERMINAL AVENUE
AMELIA STREET
VALLEY STREET
FORD STREET
HATHAWAY DRIVE
EAST PLATTE AVENUE
0.2% ANNUAL CHANCE FLOOD DISCHARGE CONTAINED IN CULVERT
0.2% ANNUAL CHANCE FLOOD DISCHARGE CONTAINED IN CULVERT
REVISED AREA
REVISED AREA
Sand Creek Center Tributary
Sand Creek East Fork
Sand Creek East Fork
NOTE: MAP AREA SHOWN ON THIS PANEL IS LOCATED WITHIN TOWNSHIP 14 SOUTH, RANGE 65 WEST.
EAST BIJOU STREET
EL PASO COUNTY
CITY OF COLORADO SPRINGS
AREA REVISED BY LOMR DATED OCTOBER 7, 2004
CORPORATE LIMITS
STEWART AVENUE
GOODFELLOW STREET
PAINE STREET
OTIS STREET
TRUAX AVENUE
HAMILTON AVENUE
PETERSON BOULEVARD
ENT STREET
7
18
19
24

Legend

1% annual chance (100-Year) Floodplain

1% annual chance (100-Year) Floodway

0.2% annual chance (500-Year) Floodplain

APPROXIMATE SCALE IN FEET
500 0 500

NATIONAL FLOOD INSURANCE PROGRAM

FIRM
FLOOD INSURANCE RATE MAP

EL PASO COUNTY, COLORADO
AND INCORPORATED AREAS

PANEL 754 OF 1300
(SEE MAP INDEX FOR PANELS NOT PRINTED)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
COLORADO SPRINGS, CITY OF	080060	0754	F
EL PASO COUNTY, UNINCORPORATED AREAS	080059	0754	F

REVISED TO REFLECT LOMR EFFECTIVE MAY 23 2007

MAP NUMBER
08041C0754 F

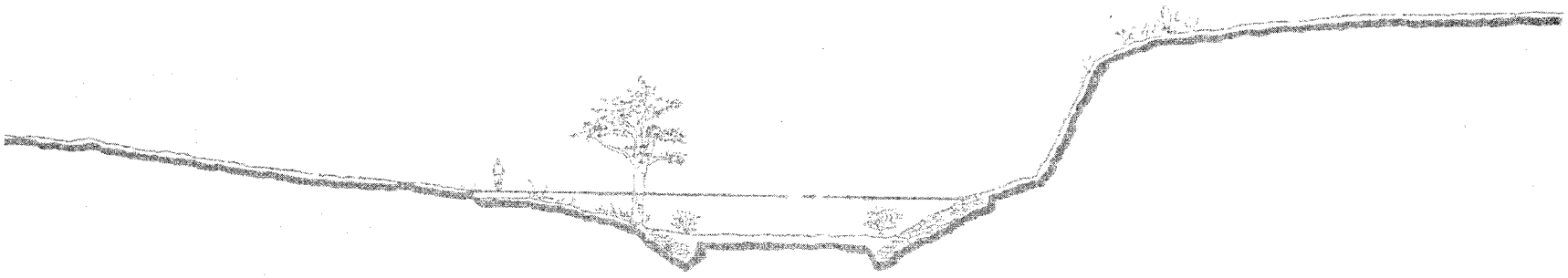
EFFECTIVE DATE:
MARCH 17, 1997

Federal Emergency Management Agency

SAND CREEK DRAINAGE BASIN PLANNING STUDY

PRELIMINARY DESIGN REPORT

CITY OF COLORADO SPRINGS, EL PASO COUNTY, COLORADO



PREPARED FOR:

City of Colorado Springs
Department of Comprehensive Planning, Development and Finance
Engineering Division
30 S. Nevada
Colorado Springs, Colorado 80903

PREPARED BY:

Kiowa Engineering Corporation
1011 North Weber
Colorado Springs, CO 80903

SAND CREEK
DRAINAGE BASIN PLANNING STUDY

PRELIMINARY DESIGN REPORT

Prepared for:

City of Colorado Springs
Department of Comprehensive Planning, Development And Finance
Engineering Division - MAIL CODE 435
P.O. Box 1575
Colorado Springs, CO 80901-1575

Prepared by:

Kiowa Engineering Corporation
1001 North Weber #200
Colorado Springs, CO 80903

KIOWA Project No. 90.04.09
R185

JANUARY 1993
Revised APRIL 1993
Revised FEBRUARY 1995
Revised APRIL 1995
Revised OCTOBER 1995
Revised March 1996

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Resolution No. 189-95

A RESOLUTION ADOPTING THE SAND CREEK DRAINAGE BASIN PLANNING STUDY AND ESTABLISHING A DRAINAGE FEE, A DETENTION POND CAPITAL FEE, A DETENTION POND LAND FEE, AND AN ARTERIAL BRIDGE FEE FOR THE BASIN.

WHEREAS, the City Engineering Division of the City of Colorado Springs Department of Planning and Development has reviewed the Sand Creek Drainage Basin Planning Study as prepared by Kiowa Engineering Corporation, Colorado Springs, Colorado dated November 2, 1995, and

WHEREAS, the City/County Drainage Board has recommended approval of the above study at their November 2, 1995, meeting;

WHEREAS, the Sand Creek Drainage Basin includes unplatted land within the City limits;

NOW THEREFORE, BE IT RESOLVED by the City Council of the City of Colorado Springs:

Section 1. That the Sand Creek Drainage Basin Planning Study, dated November 1995, by Kiowa Engineering Corporation is adopted for use. City Engineering will utilize that study to assist in evaluating subdivision drainage reports.

Section 2. That a Sand Creek Drainage Basin Fee be established as $4,895/acre, that a Sand Creek Detention Pond Capital Fee be established as $1,213/acre, that a Sand Creek Detention Pond Land Fee be established as $167/acre, and that a Sand Creek Arterial Bridge Fee be established as $323/acre, as part of.

Dated at Colorado Springs, Colorado, this 28th day of November, 1995.

Mayor

ATTEST:

City Clerk

ENGINEER'S STATEMENT:

The attached SAND CREEK DRAINAGE BASIN PLANNING STUDY report was prepared under my direction and supervision and are correct to the best of my knowledge and belief. Said drainage report has been prepared according to the criteria established by the City for drainage reports. I accept responsibility for any liability caused by any negligent acts, errors and omissions on my part in preparing this report.

Kiowa Engineering Corporation, 1011 North Weber St., Suite 200, Colorado Springs, CO 80903

Registered Engineer # 19510

Date 7/20/96

I. INTRODUCTION

Authorization

The preliminary design of the drainageway and roadway crossing facilities within the Sand Creek Drainage Basin was authorized under the terms of Agreement Number 90-85 between the City of Colorado Springs (City) and Kiowa Engineering Corporation. The agreement was approved by the Colorado Springs City Council, April 10, 1990. Subsequent to this agreement, a change order to the contract to allow for the inclusion of technical information contained in the draft East Fork Sand Creek Drainage Basin Planning Study was approved July, 1993.

Purpose and Scope

The purpose of the study is to identify feasible stormwater management plans to satisfy the existing and future needs within the Sand Creek Drainage Basin. The Sand Creek basin is to be referred to throughout this study and is inclusive of the Sand Creek mainstem and East Fork Sand Creek watersheds. The specific scope of work for this study included the following tasks:

1. Meet with the City to: insure compliance with the services required by this agreement, obtain existing data and general information from participating entities, solicit desires of participating entities and other interested agencies or groups in order to develop alternate plans, procure current information relative to development plans in the basin, procure information relative to right-of-way limitations, proposed stormwater projects, potential hazards due to flooding, and avoid duplication of effort whenever possible by utilizing existing information available from other agencies.
2. Contact the City, County, individuals, and other agencies who have knowledge and/or interest in the study area.
3. Utilize City policies and criteria and applicable information wherever possible.
4. Perform hydraulic and hydrologic analyses within the study area.
5. Identify environmental setting of basin.
6. Identify existing and potential drainage and/or flooding problems.
7. Develop improvement alternatives to reduce existing and potential flooding problems, and to mitigate the impact of stormwater runoff upon environmentally significant areas along the drainageway(s).
8. Examine the operation and maintenance aspects of feasible alternatives.
9. Conduct an economic analysis of each alternative.
10. Recommend and prepare a preliminary design for a selected alternative plan.
11. Develop drainage and bridge fees for the basin.
12. Prepare a written report discussing all items examined in the study.
13. Conduct presentations to public and private entities in order to define project goals, and to involve agencies with specific interest to help define feasible alternatives.

Summary of Data Obtained

Listed below are the technical reports collected for the review as part of preparing this study:

1. Soil Survey for El Paso County, Colorado, dated June 1981.
2. "City of Colorado Springs/El Paso County Drainage Criteria Manual", prepared by City of Colorado Springs, El Paso County, and HDR Infrastructure, Inc., dated May 1987.
3. "Flood Insurance Studies for Colorado Springs, and El Paso County, Colorado", prepared by the Federal Emergency Management Agency (FEMA), revised 1989.
4. Flood Insurance Restudy, Hydrology Report and Hydrologic Analyses, prepared by RCI, Inc., 1989.
5. Sand Creek Drainage Basin Planning Study prepared by Simons, Li & Associates, Inc., dated July, 1985.
6. Flood Hazard Analysis, Sand Creek, City of Colorado Springs and El Paso County, Colorado, prepared by the Soil Conservation Service, dated December, 1973.
7. Banning-Lewis Ranch Master Drainage Plan, prepared by MSM Consultants, Inc., dated June 1981.
8. Sand Creek Drainage Basin Study, prepared by United Planning and Engineering Company, October, 1977.
9. Draft East Fork Sand Creek Drainage Basin Planning Study, prepared by Kiowa Engineering Corporation, January, 1989.
10. Drainage Basin Inventory, Sand Creek Drainage Basin, prepared by Oliver E. Watts, P.E., June 1990.

In addition to the above listed reports there were a number of drainage study reports, sketch plans, preliminary and final design drawings, land use and zoning maps, development

plans, and existing drainage facility maps that were collected from the City, County, and other local agencies.

Reports which were prepared previous to the preliminary design report include the "Sand Creek Drainage Basin Planning Study Hydrology Report," and the "Sand Creek Drainage Basin Planning Study Development of Alternatives Report." These reports were prepared as part of the overall planning effort and have been referred to throughout this report. The Hydrology Report summarized peak flow data for existing and future basin development conditions without improvements in the basin, and established the base line hydrologic conditions from which the alternative planning then proceeded. The Development of Alternatives report evaluated the various combinations of drainageway improvements for the basin, taking into account environmental, cost, construction, right-of-way, maintenance and implementation factors for each feasible alternate plan. These reports are on file with the City Engineering Division, as well as technical addenda for each report. Both of these reports covered only the mainstem of the Sand Creek Basin. The similar information prepared for the draft East Fork Sand Creek Drainage Basin Planning Study has been summarized in this preliminary design report.

Mapping and Surveying

Mapping used in the planning effort for the mainstem of Sand Creek consisted of USGS 7-1/2 minute quadrangles, and 2-foot contour interval, 1-inch to 200-foot scale planimetric topographic maps. For the area of the basin north of Woodmen Road, aerial topographic mapping was compiled in May 1990. For the balance of the basin, the City of Colorado Springs Department of Public Utilities provided topographic mapping compiled from aerial photographs dated 1989. This mapping has been prepared as part of the Facility Inventory Management System (FIMS). The aerial topographic mapping was used in the drainage inventory, hydrologic/hydraulic analyses, and in the alternative planning phases of this project. All topographic mapping was based upon USGS vertical datum.

For the East Fork Sand Creek basin, mapping from the FIMS office and two-foot contour interval topography prepared in 1987 for the Banning-Lewis Ranch property were used in the preparation of the preliminary design. Where topographic mapping was not available, USGS quadrangle maps were used.

Stream cross-section data was obtained from the aerial mapping described above. These sections were verified against the cross-sections compiled in the 1986 City of Colorado Springs Flood Insurance Study (FIS), wherever possible.

Drainageway site inspections were conducted throughout the study area, and photographs were taken documenting the key drainage features.

The following general conditions have been placed upon the use of the FIMS topographic mapping:

-- Use of these products is restricted to the project for which the FIMS products are provided.

-- Only the body content found within the neatline of the borrowed maps may appear in any report/publication developed for your study. Also, the labeling that appears on any photographs provided shall not appear in any such report/publication.

-- All FIMS' products provided to contractors involved in the subject study shall be retrieved by your department upon conclusion of the study and either returned to FIMS or destroyed.

-- The report(s) developed in which the FIMS' products are used shall include the following disclaimer statement:

"The maps and photographs included in this report were developed for purposes of the Colorado Springs Department of Utilities and are for internal use only. The Colorado Springs Department of Utilities makes no warranty, expressed or implied, as to the completeness, accuracy, or content of such products or any reproductions thereof. Any other use is not recommended and occurs at the risk of the user; such user is solely responsible and/or liable for the use of such products.

Original maps and photographs are the property of the Colorado Springs Department of Utilities. All rights are reserved. These maps and photographs or any associated record may not, wholly or in part, be reproduced, stored, or transmitted in any form or by any means, electronic, mechanical, photocopying, or otherwise, without the express prior written permission of the Colorado Springs Department of Utilities.

Regardless of the existence of purported copies of these official maps and photographs which may from time to time be made or published, there is only one set of official maps and photographs, which are those kept and maintained by the Colorado Springs Department of Utilities."

Project Coordination

Throughout the course of the study, meetings were held with representatives of City, County, State, and Federal agencies with an interest in drainageway planning in general. The primary reason for the coordination effort was to obtain technical information and to identify concerns with regard to the development of drainageway facilities within the basin. During the course of preparing the Development of Alternatives report, the planning constraints and concepts were discussed with the agencies and interested individuals and their input used to refine the feasible alternatives and to eventually identify a recommended drainageway plan for further design evaluation. The complete mailing list and project correspondence is contained in Appendix A of this report.

Coordination with a similar list of agencies and individuals was conducted during the preparation of the draft East Fork Sand Creek Drainage Basin Planning study. This study was authorized and conducted for Aries Properties, Inc. Meetings with state and federal agencies, the City and the County were involved in a series of meetings during the development of the alternative planning concepts and the preliminary design for the East Fork Sand Creek basin.

Acknowledgements

During the preparation of the study, several government agencies and interested individuals were routinely involved in the coordination activities. Representatives from the Colorado Division of Wildlife, U.S. Army Corps of Engineers (COE), and various City Departments provided valuable commentary during the development of the alternative plans. A listing of the individuals and agencies routinely coordinated with during the study has been presented below:

Name	Agency
Alan Morrice	El Paso County Department of Public Works
John Fisher	El Paso County Land Use Department
Sue Johnson	El Paso County Parks Department
Rick O'Connor	El Paso County Planning Department
Hugh King	City of Colorado Springs Street Division
Gary Haynes	City Engineering Division
Bruce Thorson	City Engineering Division
Ken Sampley	City Engineering Division
Steve Jacobsen	City Engineering Division
Christine Lytle	City Engineering Division
Bruce Goforth	Colorado Division of Wildlife
Dan Bunting	Regional Building Department
Sarah Fowler	Environmental Protection Agency
John Liou	Federal Emergency Management Agency
Dave Frick	RCI, Inc., Fort Collins, Colorado
Bill Noonan	U.S. Fish and Wildlife
Anita Culp	U.S. Army Corps of Engineers
John Maynard	Aiken/Audobon Society
John Covert	Palmer Foundation
Peter Kernkamp	City Planning Department
Jim Rees	Department of Planning and Development
Fred Mais	City Parks and Recreation
Diana Medina	City of Colorado Springs Department of Public Utilities Gas Division
Dan Tippie	City of Colorado Springs Department of Public Utilities Wastewater Division
Russ Nicklin	City of Colorado Springs Department of Public Utilities Water Division
Wes Tyson	City Attorney's Office

II. STUDY AREA DESCRIPTION

The Sand Creek drainage basin is a left-bank tributary to the Fountain Creek lying in the west-central portions of El Paso County. Sand Creek's drainage area at Fountain Creek is approximately 54 square miles of which approximately 18.8 square miles are inside the City of Colorado Springs corporate limits. The basin is divided into five major sub-basins, the Sand Creek mainstem, the East Fork Sand Creek, the Central Tributary to East Fork, the West Fork, and the East Fork Subtributary. Figure II-1 shows the location of the Sand Creek basin.

Basin Description

The Sand Creek basin covers a total of 54 square miles in unincorporated El Paso County and Colorado Springs, Colorado. Of this total, approximately 28 square miles is encompassed by the Sand Creek basin, and 26 square miles for the East Fork Sand Creek basin. The basin trends in generally a south to southwesterly direction, entering the Fountain Creek approximately two miles upstream of the Academy Boulevard bridge over Fountain Creek. Two main tributaries drain the basin, those being the mainstem of Sand Creek and East Fork Sand Creek. Development presence in most evident along the mainstream. At this time, approximately 25 percent of the basin is developed. This alternative evaluation focuses upon the Sand Creek basin only.

The maximum basin elevation is approximately 7,620 feet above mean sea level, and falls to approximately 5,790 feet at the confluence with Fountain Creek. The headwaters of the basin originate in the conifer covered areas of The Black Forest. The middle eastern portions of the basin are typified by rolling range land with fair to good vegetative cover associated with semi-arid climates.

Climate

This area of El Paso County can be described, in general as high plains, with total precipitation amounts typical of a semi-arid region. Winters are generally cold and dry. Precipitation ranges from 14 to 16 inches per year, with the majority of this precipitation occurring in spring and summer in the form of rainfall. Thunderstorms are common during the summer months, and are typified by quick-moving low pressure cells which draw moisture from the Gulf of Mexico into the region. Average temperatures range from about 30^{o}F in the winter to 75^{o} in the summer. The relative humidity ranges from about 25 percent in the summer to 45 percent in the winter.

Soils and Geology

Soils within the Sand Creek basin vary between soil types A through D, as identified by the U. S. Department of Agriculture, Soil Conservation Service. The predominant soil groupings are in the Truckton and Bresser soil associations. The soils consist of deep, well drained soils that formed in alluvium and residium, derived from sedimentary rock. The soils have high to moderate infiltration rates, and are extremely susceptible to wind and water erosion where poor vegetation cover exists. In undeveloped areas, the predominance of Type A and B soils give this basin a lower runoff per unit area as compared to basins with soils dominated by Types C and D. Presented on Figure II-2 is the Hydrologic Soil distribution map for the Sand Creek basin.

Property Ownership and Impervious Land Densities

Property ownership along the major drainageway within the Sand Creek basin vary from public to private. Along the developed reaches, drainage right-of-ways and greenbelts have been dedicated during the development of the adjacent residential and commercial land. Where development has not occurred, the drainageways remain under private ownership with no delineated drainage right-of-way or easements. There are several public parks which abut the mainstem of Sand Creek. Roadway and utility easements abutting or crossing the major drainageways occur most frequently in the developed portions of the basin.

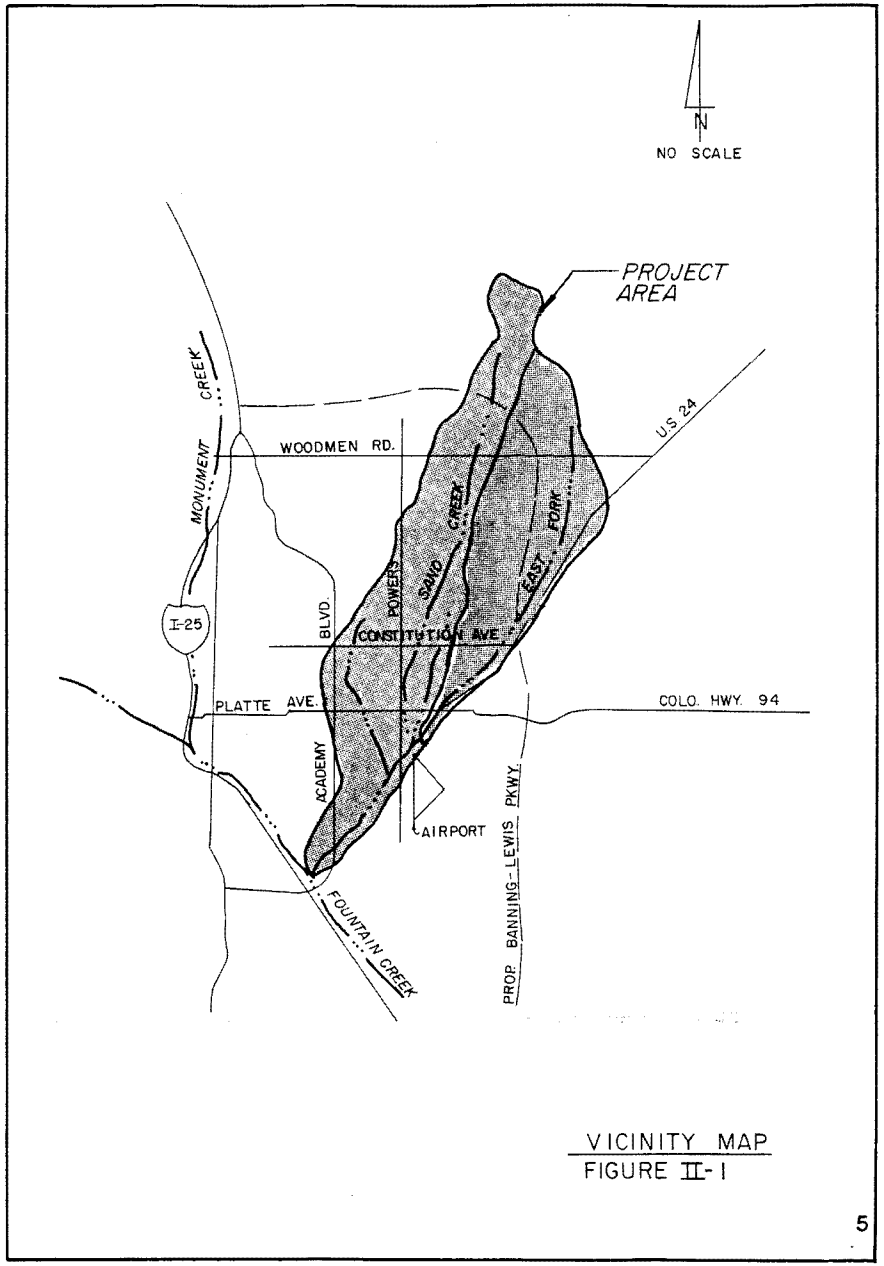
Land use information for the existing and future conditions were reviewed as part of the planning effort. This information is used in the hydrologic analysis to predict runoff rates and volumes for the purposes of facility evaluation. The identification of land uses abutting the drainageways is also useful in the identification of feasible plans for stabilization and aesthetic treatment of the creek. Presented on Figure II-3 is the proposed land use map used in the evaluation of impervious land densities discussed in the hydrologic section of this report. Figure II-3 is not intended to reflect the future zoning or land use policies of the City or the County.

The land use information within the Banning-Lewis Ranch property was obtained from Aries Properties during the time the draft East Fork Sand Creek Drainage Basin Planning Study was being prepared. The land use information was again reviewed with the City of Colorado Springs Department of Planning and was found to be appropriate for use in the estimation of hydrology for the East Fork Basin. The location of future arterial streets and roadways within

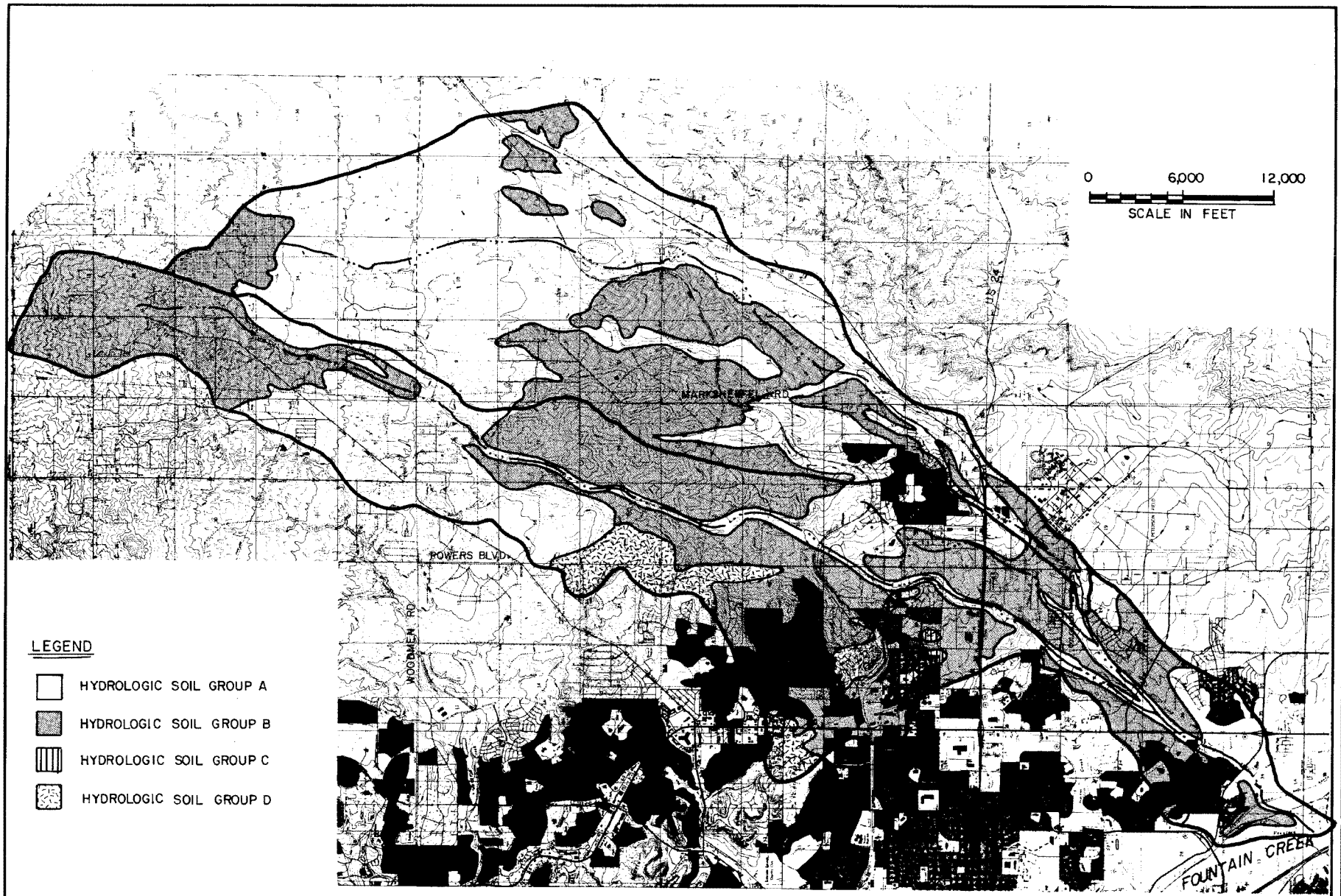
the Banning Lewis property were obtained from the Banning-Lewis Ranch master plan. The location of roadways offsite from the Banning Lewis-Ranch were obtained from the El Paso County Major Transportation Plan dated 1988.

Park Land and Open Space

An inventory of park land and public open space was prepared. Many times, the combination of the drainageway and adjacent park lands can be used to visually extend the limits of a park or open space. The drainageway can also act to link parks and other land uses within the basin if multiple use trails are incorporated into the channel section(s). The Sand Creek drainageway has been identified as a major trail corridor within the City of Colorado Springs Trails Plan. Park land designated within the Banning-Lewis Ranch master plan were taken into account during the siting of stormwater facilities within the Banning-Lewis property.



VICINITY MAP
FIGURE II-1



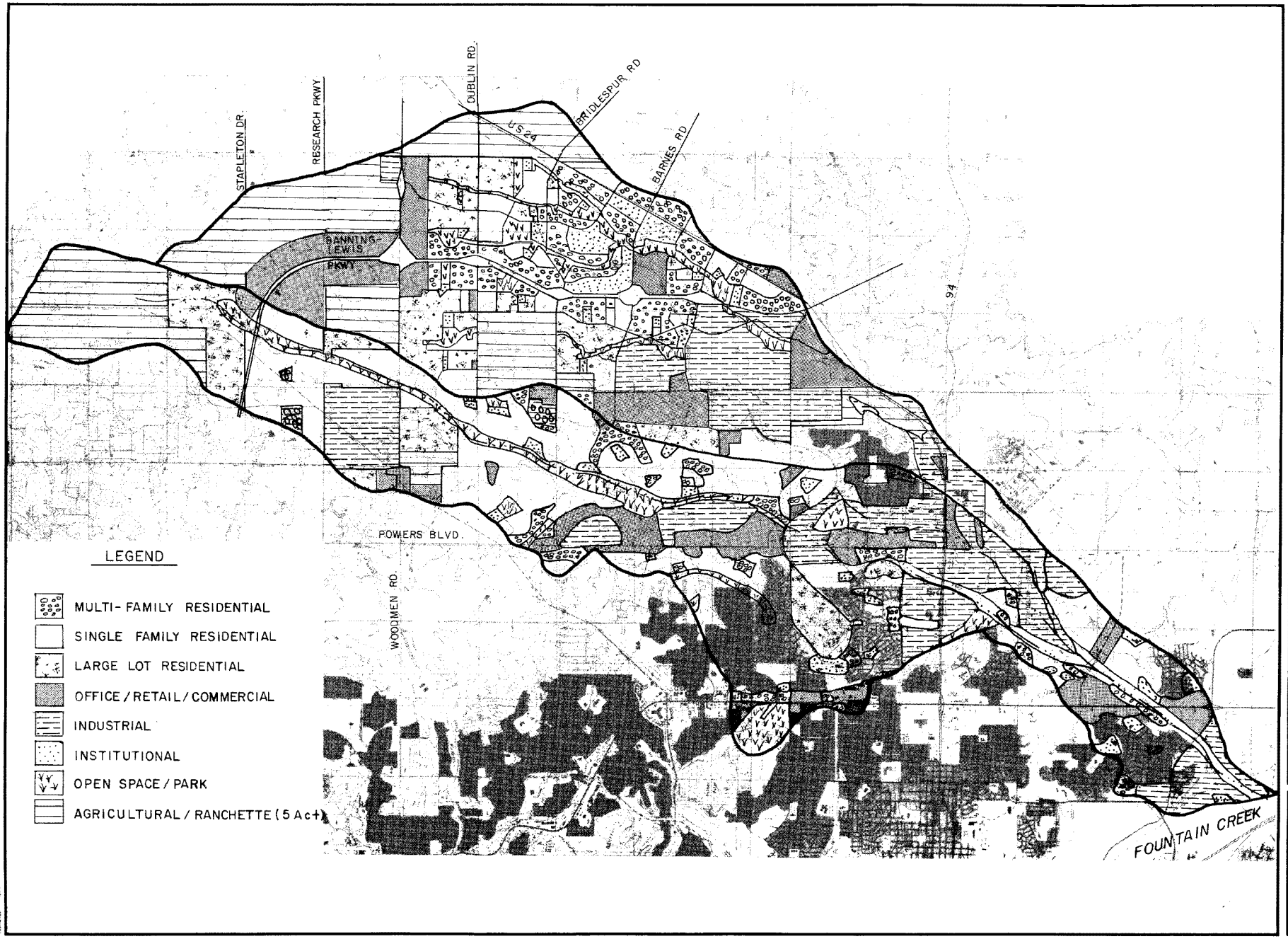
Kiowa Engineering Corporation
419 W. Bijou Street
Colorado Springs, Colorado
80905-1308

SAND CREEK DRAINAGE
BASIN PLANNING STUDY

HYDROLOGIC SOILS MAP

Project No.	90-04-09
Date:	10/90
Design:	
Drawn:	EAK
Check:	
Revisions:	

FIG. II-2



Kiowa Engineering Corporation
419 W. Bijou Street
Colorado Springs, Colorado
80905-1308

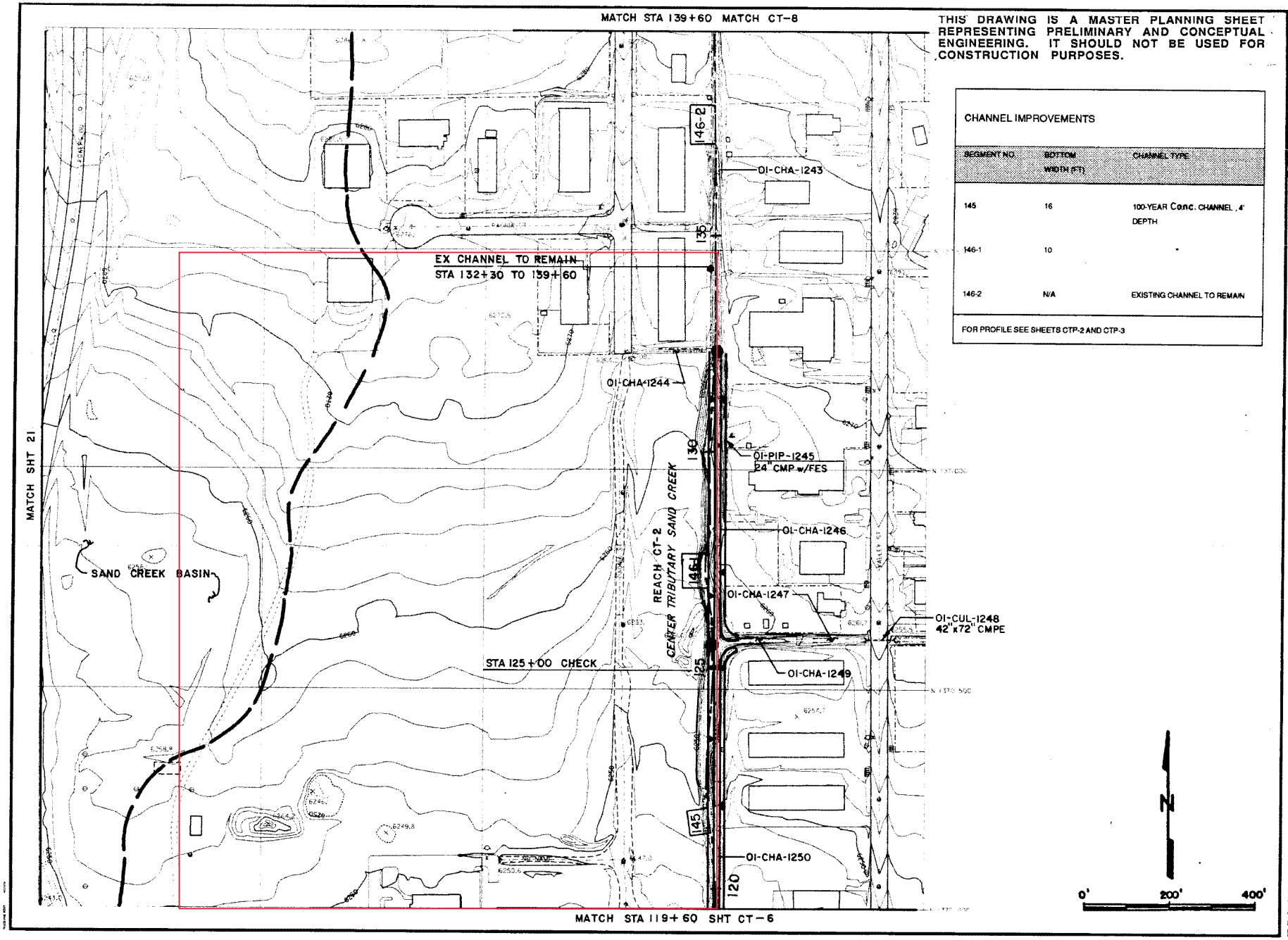
SAND CREEK DRAINAGE BASIN PLANNING STUDY

PROPOSED LAND USE

Project No.	90-04-09
Date:	9/90
Design:	
Drawn:	EAK
Check:	
Revisions:	

7

FIG. II-3



THIS DRAWING IS A MASTER PLANNING SHEET REPRESENTING PRELIMINARY AND CONCEPTUAL ENGINEERING. IT SHOULD NOT BE USED FOR CONSTRUCTION PURPOSES.

CHANNEL IMPROVEMENTS

SEGMENT NO.	BOTTOM WIDTH (FT)	CHANNEL TYPE
145	16	100-YEAR Conc. CHANNEL, 4' DEPTH
146-1	10	"
146-2	N/A	EXISTING CHANNEL TO REMAIN

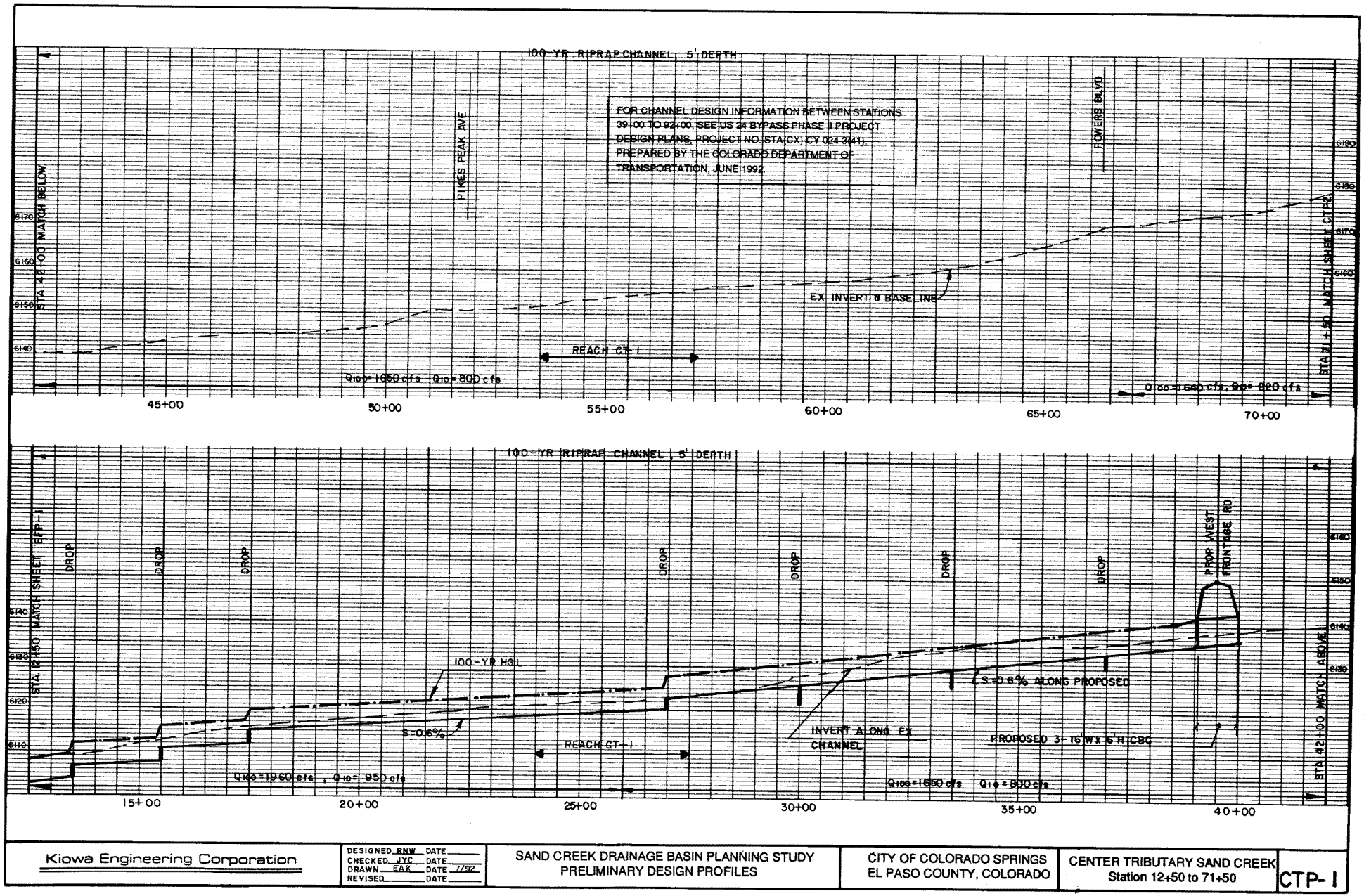
FOR PROFILE SEE SHEETS CTP-2 AND CTP-3

Kiowa Engineering Corporation
419 W. Bijou Street
Colorado Springs, Colorado
80905-1308

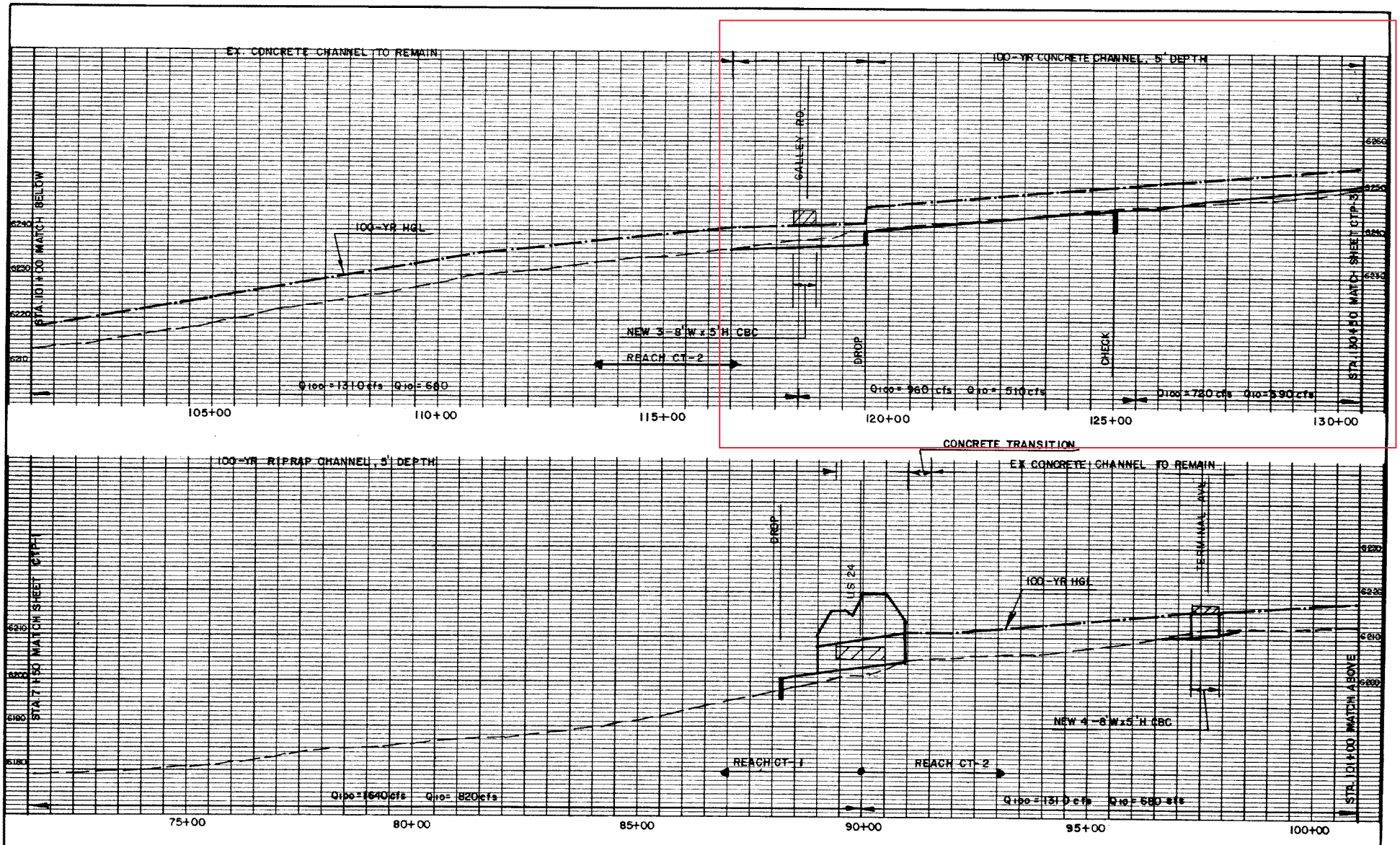
SAND CREEK DRAINAGE BASIN PLANNING STUDY
PRELIMINARY DESIGN PLANS

Project No.	90-04-09
Date:	9/92
Design:	RNW
Drawn:	EAK
Check:	RNW
Revisions:	

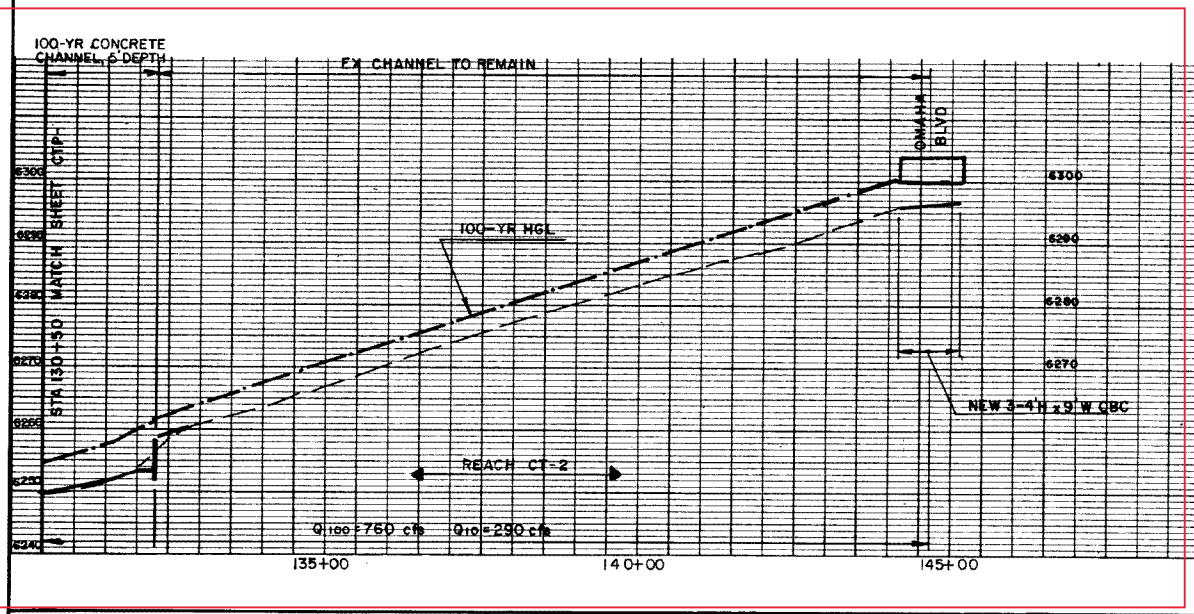
CT-7



Kiowa Engineering Corporation	DESIGNED RNW DATE CHECKED JYC DATE DRAWN EAK DATE 7/92 REVISED DATE	SAND CREEK DRAINAGE BASIN PLANNING STUDY PRELIMINARY DESIGN PROFILES	CITY OF COLORADO SPRINGS EL PASO COUNTY, COLORADO	CENTER TRIBUTARY SAND CREEK Station 12+50 to 71+50	CTP-1



Kiowa Engineering Corporation	DESIGNED RNW DATE CHECKED JYC DATE DRAWN EAK DATE 7/92 REVISED DATE	SAND CREEK DRAINAGE BASIN PLANNING STUDY PRELIMINARY DESIGN PROFILES	CITY OF COLORADO SPRINGS EL PASO COUNTY, COLORADO	CENTER TRIBUTARY SAND CREEK Station 71+50 to 130+50	CTP-2



Kiowa Engineering Corporation	DESIGNED RNW DATE /92 CHECKED JYC DATE /92 DRAWN EAK DATE 7/92 REVISED DATE	SAND CREEK DRAINAGE BASIN PLANNING STUDY PRELIMINARY DESIGN PROFILES	CITY OF COLORADO SPRINGS EL PASO COUNTY, COLORADO	CENTER TRIBUTARY SAND CREEK Station 130+50 to 144+50	CTP-3

TABLE VIII-4: SAND CREEK DRAINAGE BASIN PLANNING STUDY
ROADWAY CULVERT CROSSING COST ESTIMATE
SAND CREEK BASINS

ROADWAY	REACH NUMBER	DRAINAGEWAY SEGMENT	CROSSING TYPE	LENGTH	UNIT	UNIT COST	TOTAL COST	TOTAL REIMBURSABLE COST
BANNING-LEWIS PRKW	SC-8	186	6'Hx10'W CBC	120	LF	$390	$46,800	$46,800
ARROYO LANE	SC-9	171	6'Hx12'W CBC	80	LF	$510	$40,800	$0
VOLLMER ROAD	SC-8	169	60-INCH CMP	80	LF	$120	$9,600	$0
"	SC-9	173	"	80	LF	$120	$9,600	$0
BURGESS ROAD	SC-9	176	42-INCH CMP	80	LF	$75	$6,000	$0
"	SC-9	178	2-42-INCH CMP	80	LF	$150	$12,000	$0
		CENTER TRIBUTARY						
TERMINAL AVENUE	CT-2	144	4-5'Hx8'W CBC	60	LF	$1,200	$72,000	$0
OMAHA BOULEVARD	CT-2	146-2	3-4'Hx9'W CBC	80	LF	$900	$72,000	$0
		WEST FORK SAND CREEK						
WOOTEN ROAD	WF-1	153	2-4'Hx6'W CBC	100	LF	$480	$48,000	$0
EDISON AVENUE	WF-1	153	2-4'Hx6'W CBC	60	LF	$240	$14,400	$0
PALMER PARK BLVD.	WF-1	154-2	2-4'Hx10'W CBC	80	LF	$540	$43,200	$0
CHICAGO RI RR	WF-1	165-1	4'Hx8'W CBC	220	LF	$270	$59,400	$0
HALF MOON DRIVE	WF-1	165-2	4'Hx6'W CBC	60	LF	$240	$14,400	$0
TOTAL CULVERT CONSTRUCTION COSTS, SAND CREEK							$1,902,600	$1,111,000

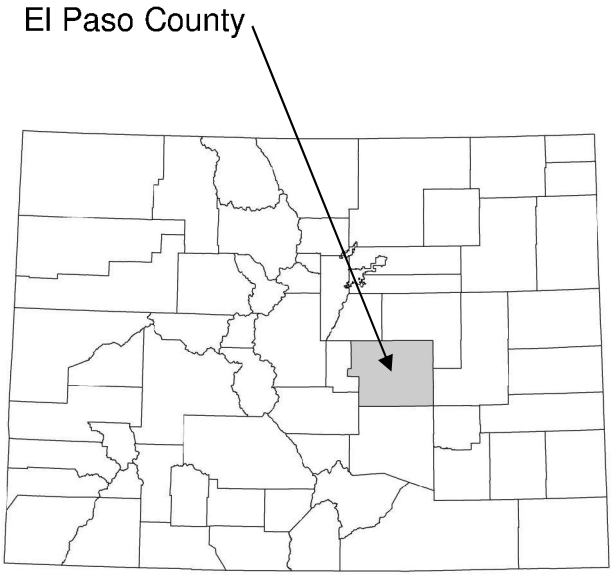
Table VIII-7:

SAND CREEK DRAINAGE BASIN PLANNING STUDY
BRIDGE CROSSING COST ESTIMATE
SAND CREEK DRAINAGE BASINS

ROADWAY	REACH NUMBER	DRAINAGEWAY SEGMENT	CROSSING TYPE	JURISIDICTION CITY	JURISIDICTION COUNTY	SIZE	UNIT	UNIT COST	TOTAL COST COUNTY	TOTAL COST CITY
		SAND CREEK								
CHELTON ROAD	SC-1	115	210' TWO-SPAN BRIDGE	X		16800	SF	$80	$0	$1,344,000
STETSON HILLS BLVD.	SC-6	130	3- 8'Hx10'W CBC	X		200	LF	$1,110	$0	$222,000
JEDEDIAH SMITH RD.	SC-6	137	3- 8'Hx10'W CBC	X		60	LF	$1,110	$0	$66,600
PETERSON ROAD	SC-6	141	80' CLEAR SPAN BRIDGE	X		6400	SF	$80	$0	$512,000
DUBLIN BOULEVARD	SC-7	141	80' CLEAR SPAN BRIDGE	X		6400	SF	$80	$0	$512,000
MARKSHEFFEL ROAD	SC-8	151	3- 10'Hx10'W CBC		X	80	LF	$1,260	$100,800	$0
RESEARCH PARKWAY	SC-8	163	4- 8'Hx10'W CBC		X	80	LF	$1,560	$124,800	$0
BANNING-LEWIS PRKWY	SC-8	187	4- 8'Hx10'W CBC		X	80	LF	$1,560	$124,800	$0
		CENTER TRIBUTARY								
W. FRONTAGE ROAD	CT-1	142	3- 6'Hx16'W CBC		X	60	LF	$1,770	$106,200	$0
US 24 BYPASS	CT-1	142	3- 6'Hx14'W CBC		X	150	LF	$1,410	$211,500	$0
E. FRONTAGE RD, US 24	CT-1	142	3- 6'Hx14'W CBC		X	60	LF	$1,410	$84,600	$0
BIJOU STREET, US 24	CT-1	142	3- 6'Hx14'W CBC		X	60	LF	$1,410	$84,600	$0
PLATTE AVENUE, US 24	CT-2	142	3- 6'Hx14'W CBC		X	120	LF	$1,410	$169,200	$0
GALLEY ROAD	CT-4	144	3- 5'Hx8'W CBC		X	100	LF	$900	$90,000	$0
		WEST FORK SAND CREEK								
GALLEY ROAD	WF-2	155	54' CLEAR SPAN BRIDGE	X		5130	SF	$80	$0	$410,400
PALMER PARK BLVD.	WF-2	156	54' CLEAR SPAN BRIDGE	X		5130	SF	$80	$0	$410,400
CONSTITUTION AVE.	WF-3	159	40' CLEAR SPAN BRIDGE	X		3200	SF	$80	$0	$256,000
MAIZELAND ROAD	WF-3	170	30' CLEAR SPAN BRIDGE	X		2400	SF	$80	$0	$192,000
SO. CAREFREE	WF-3	170	2- 6'Hx15'W CBC	X		80	LF	$1,200	$0	$96,000
TOTAL BRIDGE CONSTRUCTION COSTS, SAND CREEK									$1,096,500	$4,021,400

FLOOD INSURANCE STUDY

EL PASO COUNTY, COLORADO, AND INCORPORATED AREAS



COMMUNITY NAME	COMMUNNITY NUMBER
CALHAN, TOWN OF	080192
COLORADO SPRINGS, CITY OF	080060
EL PASO COUNTY (UNINCORPORATED AREAS)	080059
FOUNTAIN, CITY OF	080061
GREEN MOUNTAIN FALLS, TOWN OF	080062
MANITOU SPRINGS, CITY OF	080063
MONUMENT, TOWN OF	080064
PALMER LAKE, TOWN OF	080065
RAMAH, TOWN OF	080066

Revised: December 7, 2018

Federal Emergency Management Agency

FLOOD INSURANCE STUDY NUMBER
08041CV007A

NOTICE TO
FLOOD INSURANCE STUDY USERS

Communities participating in the National Flood Insurance Program have established repositories of flood hazard data for floodplain management and flood insurance purposes. This Flood Insurance Study (FIS) report may not contain all data available within the repository. It is advisable to contact the community repository for any additional data.

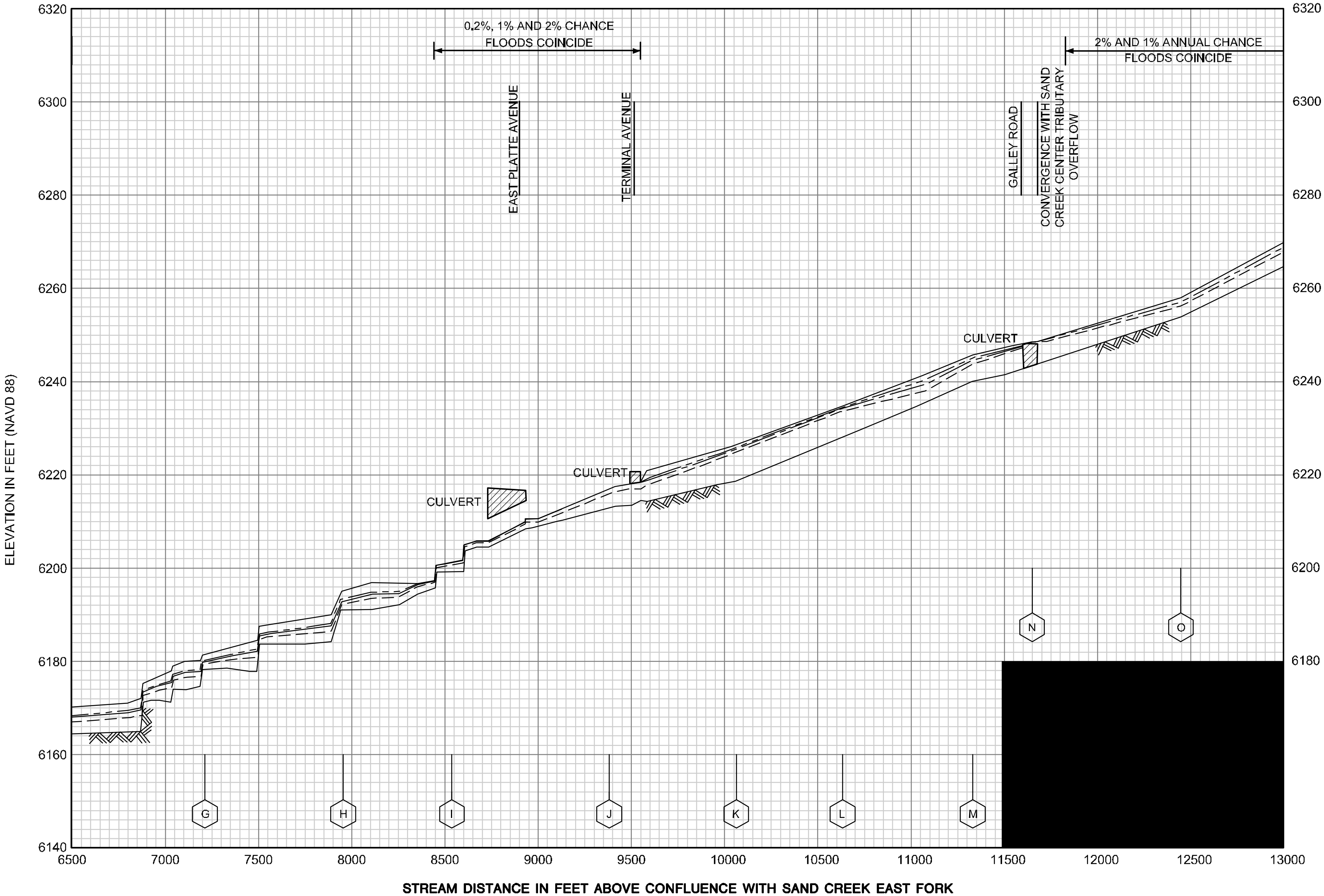
Part or all of this FIS report may be revised and republished at any time. In addition, part of this FIS report may be revised by the Letter of Map Revision process, which does not involve republication or redistribution of the FIS report. It is, therefore, the responsibility of the user to consult with community officials and to check the community repository to obtain the most current FIS report components.

This FIS report was revised on December 7, 2018. Users should refer to Section 10.0, Revisions Description, for further information. Section 10.0 is intended to present the most up-to-date information for specific portions of this FIS report. Therefore, users of this report should be aware that the information presented in Section 10.0 superseded information in Sections 1.0 through 9.0 of this FIS report.

Initial Countywide FIS Report Effective Date: March 17, 1997

First Revised Countywide FIS Report Effective Date: August 23, 1999 - to add base flood elevations, to add special flood hazard areas, and to change special flood hazard areas.

Second Revised Countywide FIS Report Effective Date: 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.



FLOOD PROFILES

SAND CREEK CENTER TRIBUTARY

FEDERAL EMERGENCY MANAGEMENT AGENCY

EL PASO COUNTY, CO

(AND INCORPORATED AREAS)

335P

SAND CREEK - CENTER TRIBUTARY
CHANNEL ANALYSIS REPORT
FOR
SOLACE APARTMENTS

Prepared For:
Jackson Dearborn Partners
404 S. Wells Street, Suite 400
Chicago, IL 60607
(734) 216-2577

June 30, 2020
Project No. 25174.00

Prepared By:
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5475 Tech Center Drive
Colorado Springs, CO 80919
719-593-2593

PCD File NO. SP201

CONTENTS

OVERVIEW

This report was prepared to provide design information for the existing Sand Creek -Center Tributary Drainageway as part of the Solace Apartment development. This document is the Channel Analysis report for the Solace Apartments. The Sand Creek-Center Tributary Drainageway has been studied as part of a Flood Insurance Study (FIS) for El Paso County Colorado, Volume 7 of 8, revised December 7, 2018 and Sand Creek Drainage Basin Planning Study, dated January 1993. Existing flow rates from the Sand Creek Planning Study were used as the basis for the design of the existing channel condition.

GENERAL LOCATION AND DESCRIPTION

Location

The proposed Solace Apartments, known as "Solace" from herein, is a parcel of land located in Section 7, Township 14 South, Range 65 West of the 6th Principal Meridian in El Paso County, Colorado. Solace is a 28.99 acre, urban, multifamily-development and is comprised of 16 apartment buildings and associated infrastructure. Solace is bound by existing industrial developments to the North and vacant land to the West. Galley Road bounds the property to the south and existing light industrial businesses to the east. A vicinity map of the area is presented in Appendix A.

Description of Property

Solace is currently unoccupied and undeveloped. The existing ground cover is sparse vegetation and open space, typical of a Colorado rolling range land condition. In general, Solace slopes from northwest to southeast. The existing conditions of the Sand Creek -Center Tributary Drainageway on the site are heavily wooded for the length of the channel throughout the Solace site.

Per an NRCS web soil survey of the area, Solace is made up of Type B soils with a very small percentage of Type A in the northwest corner of the property. This Type B soil is a blendon sandy loam. This soil type has a moderate infiltration rate when thoroughly wet. It also consists of moderately deep or deep, moderately well drained or well drained soil. A soil survey map has been presented in Appendix A.

Floodplain Statement

Based on the FEMA FIRM Map numbers 08041C0751G & 08041C0752G, dated December 7, 2018, a portion of the existing drainageway lies within Zone AE and Zone X. Zone AE is defined as area subject to inundation by the 1-percent-annual-chance flood event and is a flood hazard area. 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 FIRM Map has been presented in Appendix A. Currently a portion of the Solace site lies within Zone AE at the extension of Paonia Street to Galley Road, as seen in FEMA FIRM Map number 08041C0752G.

PREVIOUS SAND CREEK STUDIES

Solace lies within Sand Creek Drainage Basin based on the "*Sand Creek Drainage Basin Planning Study*" prepared by Kiowa Engineering in January 1993.

The Sand Creek Drainage Basin covers approximately 54 square miles in unincorporated El Paso County, CO. The Sand Creek Drainage Basin is tributary to Fountain Creek. In its existing condition, the basin is comprised of developed land with the exception of the Solace Parcel which is comprised of rolling rangeland with fair to good vegetative cover associated with Colorado's semi-arid climate. The natural Drainageway within the site limits is typically deep and narrow with a well-defined flow path in most areas. Anticipated land use for the Solace parcel includes multifamily residential and open space.

As part of its drainage research, JR Engineering reviewed the following drainage studies, reports and LOMRs:

- Sand Creek Drainage Basin Planning Study prepared by Kiowa Engineering Corporation in January 1993.
- Flood Insurance Study– El Paso County, Colorado & Incorporated Areas Vol 7 of 8, December 2018.
- LOMR- Case No. 05-08-0368P Federal Emergency Management Agency, May 23, 2007.

The *Sand Creek Drainage Basin Planning Study* was used to establish a stormwater management plan for the existing and future stormwater infrastructure needs within the Sand Creek Drainage Basin. The *Sand Creek Drainage Basin Planning Study* conducted a hydrologic analysis using a runoff model named the Soil Conservation Service (SCS) Computer Program for the Project Formulation Hydrology (TR20). Based on provided drainage maps and analysis, in its existing condition, the Sand Creek-Center Tributary Drainageway contains a 100-year flow of 720 cfs at upstream station 1053 then jumps to 960 cfs at station 1030 in Sand Creek along Solace's east property line. The flow then changes again at station 1014, to a value of 956 cfs, where the flow from the secondary drainageway on Paonia Street converges with the Sand Creek Drainageway, this flow was based on JR Engineering analysis. These flows were used in the model as they were depicted as being the flows present in the project section of the Sand Creek Tributary Drainageway as called out in *Sand Creek Drainage Basin Planning Study*. The major Sand Creek-Center Tributary Drainageway conveys the stormwater south along the eastern property line where it ultimately outfalls into the Fountain Creek. JR Engineering also performed a hydrologic analysis to determine the flows in the Sand Creek-Center Tributary Drainageway and arrived at similar results to those shown in the *Sand Creek Drainage Basin Planning Study*, thus verifying the validity of these flows. These basin calculations show that the 720-960 cfs, based on the *Sand Creek Drainage Basin Planning Study*, are still valid for this existing condition, a summary table of the flows in the Sand Creek Drainageway based on various studies can be found below.

SOLACE APARTMENTS		
Sand Creek Center Tributary Flow Summary Table		
Report/Study	Location	Flow (cfs)
Sand Creek DBPS, Kiowa Engineering, Rev. March 1996, Table III-2	DP 45, @ Galley Rd. Crossing	1,340
Sand Creek DBPS, Kiowa Engineering, Rev. March 1996, CTP-2	@ STA 125+00	960
Sand Creek DBPS, Kiowa Engineering, Rev. March 1996, CTP-2	@ STA 132+30	720
Flood Insurance Study, El Paso County, Rev. December 7, 2018	Section N, @ Galley Road	723
JR Engineering October 2019	@ Galley Road	956

FEMA prepared a revised FIS for El Paso County Colorado, Volume 7 of 8, dated December 7, 2018. The effective floodplain for the site is shown on the FIRM 08041C0752G, revised to reflect LOMR, dated May 23, 2007. The study area of the FIS where the Sand Creek Drainageway crosses Galley Road, was found to overtop the culverts and flow onto the road. According to the FIS, this crossing has a 10% annual chance of flooding and is located in Zone AE of the FIRM. This location is a Special Flood Hazard Area (SFHA) inundated by the 100-year flood, Zone AE (base flood elevations determined). The *Sand Creek Drainage Basin LOMR* was executed on May 23, 2007. The LOMR revised the flood zone or the area south of Galley Road. See FIRM Map Panel 08041C0752G for limits of LOMR study and revised flood zones, presented in Appendix C.

To the west of the Sand Creek-Center Tributary Drainageway is a secondary Drainageway that captures the flow coming from the west side of Paonia Street. This drainage way is located at the proposed extension of Paonia Street to meet Galley Road. The flows created by the secondary drainageway and the development north of the site will be captured on the Solace site, and transported to the Sand Creek-Center Tributary Drainageway. According to *Sand Creek Drainage Basin LOMR*, the flow present in this secondary drainageway in a 1-percent-annual-chance flood event is 213 cfs. This was calculated by use of the LOMR maps, and evaluating the difference in flow as the Sand Creek Center Tributary Drainageway splits as it crosses Omaha Boulevard. Section R of the FEMA Map Panel 08041C0752G, shows the split as the flow present in the channel drops to 421 cfs from 634 cfs at section S just upstream. The difference in these flows is 213 cfs this flow is assumed to overtop the road at Omaha Boulevard crossing structure, and travel west to Paonia Street and is routed south in the Sand Creek Center Tributary onto the Solace site. A calculation of the flows present in Paonia was also conducted by Galloway Engineering in the *Preliminary Drainage Report and Floodplain Certification for Powers Center Point*, dated October 1st, 2007. This report used a similar methodology in calculating the flows; however this analysis was made using LOMR data from 1997 with higher flows thus resulting in a calculated flow of 500 cfs. To be conservative, JR Engineering's design will be based on the 500 cfs specified, rather than the 213 cfs calculated. Additional information has been requested via FEMA FIS data request. When this additional data

can be obtained, a proposed channel improvements report including both main channel and overflow improvements will be updated to reflect the latest available information. At the current point in time, all available published data has been exhausted to prove a reduced flow rate in the overflow channel (Paonia Street).

Just north of the Solace site on Paonia Street a concrete channel exists that diverts a portion of the flows present in Paonia Street back into the Sand Creek-Center Tributary Drainageway. However the size of this channel will not convey all flows present in Paonia, therefore improvements are necessary to mitigate the offsite flows. Potential options to mitigate these flows are discussed below. Each possible alternative has been preliminarily evaluated to ensure feasibility in mitigating the secondary drainageway currently existing in Paonia Street.

The first conceptual option would be to have future Paonia Street continue to maintain an existing super elevation that will direct all flows present on Paonia towards the east side of the road. GIS contours indicate this super elevation exists, as well as confirmation stated by the Galloway Engineering Preliminary Drainage Report. The curb and gutter along the east side of Paonia will be omitted to create a 110 ft weir that will route flows back to the existing Sand Creek-Center Tributary Drainageway. The 110 ft weir would reduce into a 40 ft wide channel as it approaches the existing channel at a 45 degree angle. Flow calculations for this overflow design can be found in Appendix B, along with flow capacity calculations for existing Paonia Street & existing concrete channel north of the site.

A second conceptual option would be to create a low point in Paonia shortly after crossing south onto the subject property, thus creating a sump condition. The sump inlets would capture minor runoff and pipe it to the main channel, while a larger event would behave in a similar manner to the above scenario, routing via the same overflow weir and channel back to the main Sand Creek-Center Tributary Channel. The alternative profile for this scenario can be found in Appendix B, as well as on the preliminary Paonia Street Improvement plans.

Finally, a third option would be to widen the existing concrete channel at the property line to increase capacity enough to accept all flows from the overflow channel.

The first option has been presented in the drainage maps and preliminary plans associated with this report; however no alternative has been definitively selected at this time. One alternative or a combination of these alternatives may be utilized at time of final design to safely and efficiently route the Paonia Street overflow channel back to the main channel near the northern site boundary.

Channel Deficiencies

The *Sand Creek Drainage Basin Planning Study* performed a hydraulic analysis of the Sand Creek-Center Tributary Drainageway between Galley Road and Paonia Street, and an analysis of the crossing structure for Sand Creek at Galley Road. For the crossing structure at Galley Road they determined that the existing crossing structures were inadequate for the demands of the Drainageway

and would require improvements to expand the capacity of these structures. These results can be seen in Table IV-1 Summary of Hydraulic Structures – Crossings: Sand Creek Drainage Basin Planning Study shown below. The Study proposed improvements to the existing crossing structures by replacing them with 3-8'Wx 5'H Concrete Box Culverts.

TABLE IV-1: SUMMARY OF HYDRAULIC STRUCTURES - CROSSINGS
SAND CREEK DRAINAGE BASIN PLANNING STUDY

LOCATION	REACH #	SIZE	TYPE	CAPACITY EXISTING	CAPACITY FUTURE (1)	COMMENTS
Airport Road	CT-1	5-6'x8'	BOX CULVERT	ADEQUATE	ADEQUATE	
Pikes Peak Ave.	CT-1	NONE		INADEQUATE	INADEQUATE	POWERS BLVD. OVERTOPPED FREQUENTLY BETWEEN BIJOU ST. AND PIKES PEAK AVE.
Powers Blvd.	CT-1	VARIOUS	METAL PIPE	INADEQUATE	INADEQUATE	
Platte Ave (US 24)	CT-1	8'x4'	BOX CULVERT	INADEQUATE	INADEQUATE	APPROACH CHANNEL IN NEED OF REALIGNMENT
Terminal Avenue	CT-2	2-4'x8'	BOX CULVERT	INADEQUATE	INADEQUATE	
Galley Road	CT-2	3-42"x72"	METAL ARCH PIPE	INADEQUATE	INADEQUATE	
Omaha Boulevard	CT-2	2-36"x57"	METAL ARCH PIPE	INADEQUATE	INADEQUATE	

The study also found the existing channel for the Sand Creek-Center Tributary Drainageway between Galley Road and Paonia Street to be inadequate for the given flow rate. The report says that the existing channel has limited maintenance access, leading to the channel degrading and being filled with obstructions. Those findings can be seen in Table IV-2 Summary of Hydraulic Structures – Channels: Sand Creek Drainage Basin Planning Study. The *Sand Creek Drainage Basin Planning Study* recommended improvements to the existing channel by lining the channel with concrete.

TABLE IV-2: SUMMARY OF HYDRAULIC STRUCTURES - CHANNELS
SAND CREEK DRAINAGE BASIN PLANNING STUDY

LOCATION FROM / TO	REACH #	DIMENSIONS TW (ft)	SS	DEPTH (ft)	TYPE	CAPACITY (1) ADQ	INADQ	COMMENTS
CENTER TRIBUTARY								
East Fork Sand Creek to Airport Road	CT-1	45	2:1	6	Riprap lined trapezoidal channel	X	X	Riprap has failed or is non-existent along some portions of this segment of the Center Tributary
Pikes Peak to Bijou St.	CT-1			N/A	Rubble lined ditches along Powers Blvd.			Flow passes over and along Powers Blvd. street section on a frequent basis. Road closures common.
Bijou St. to Platte Ave.	CT-1			N/A	Unlined, natural.			Overbanks vegetated, channel dry with sand invert, no. vegetation. Channel eroded at outlet of US24 culvert.
Platte Ave. to Terminal Ave.	CT-2	15-25	1:1	4-6	Trapezoidal concrete lined.	X		Channel has adequate capacity.
Terminal Avenue to Galley Road	CT-2	21	1:1	5	Trapezoidal concrete lined.	X		Channel has adequate capacity.
Galley Road to Paonia Ct. (ext)	CT-2	30-40	varies	4-5	Unimproved segment.		X	Channel is degraded and filled with debris. Poor maintainance access.
Paonia Ct. to Omaha Blvd.	CT-2	21	1:1	5	Trapezoidal concrete lined channel.	X		Maintainence access poor. Debris and trash in channel.

The GeoHecRas model results completed with this report contain similar findings to those in the drainage basin planning study. This model was based on the existing channel conditions; a model will be created for the sites proposed conditions in the final drainage report. Average velocities of 10-12 fps for a majority of the channel reach exceed allowable limits for an unprotected channel. The current Galley road crossing structures lack of capacity also leads to overtopping of the road during these events. This report confirms that both this Sand Creek channel reach and Galley Road crossing structures are inadequate for the 100-yr storm event.

Channel Improvement Recommendations

The *Sand Creek Drainage Basin Planning Study (DBPS)* concluded that the Sand Creek-Center Tributary Drainageway channel, in its current state, is inadequate to handle the historical flows tributary to the channel. This report falls in line, indicating that improvements shall be made to the channel in order to provide adequate capacity and prevent erosion. In the DBPS improvements are also designated for the crossing structures at Galley Road to provide adequate capacity and prevent overtopping of the road. Upon further investigation, this report found that overtopping of Galley Road appears to be addressed via the overflow structure and associate downstream bank protections shown in Figure 1. This weir was analyzed to determine the effectiveness to safely pass overtopping flows. From the HEC-RAS model, it was determined that approximately 581 cfs overtops the roadway during a 100-year event. The weir in its current configuration could only adequately pass approximately 40 cfs of this flow. On the north side of the Galley road crossing, there is a section of roadway without curb & gutter; this allows the water transported along the north half of galley road to directly flow into the Sand Creek Center Tributary Drainageway. A picture of this curb opening is shown below in figure 2.

Figure 1: Existing Drainage Structures at Galley Road (Viewed from South)

Figure 2: Curb Opening on North Half of the Galley Road Crossing (Looking to the North)

This analysis notes existing overtopping, further discussion with the county engineer to discuss potential solutions is recommended. One possible solution is that the existing culverts be replaced to prevent overtopping at Galley Road by upsizing to a larger culvert(s). Ultimately, culvert

improvements will be necessary when the County deems the historic overtopping of Galley Road above acceptable tolerance. Currently, no adjacent structures are impacted by this overtopping. Weir calculations can be found in the appendix.

Based upon the findings to the *Sand Creek Drainage Basin Planning Study* and the conforming GeoHecRas modeling contained in this report, potential recommended channel improvements include:

- Widening of the channel west bank to reduce flow depth, thus corresponding velocities
- Lining portions of the channel with riprap or other protective surfaces
- Adding check structures and potentially drop structures to reduce channel grade, a conceptual profile can be seen in Appendix A.
- Replacing existing culverts at Galley Road to prevent roadway overtopping

Stable slopes of 1% were chosen for the channel based on stable slope specified by The *Sand Creek Drainage Basin Planning Study (DBPS.)*

CONCEPT COST ESTIMATE

Below is Conceptual Cost Estimate for the proposed channel improvements to the Sand Creek-Center Tributary Drainageway.

Table 3: Cost Opinion-Public Reimbursable

PUBLIC DRAINAGE FACILITIES				
Item	**Quantity**	**Unit**	**Unit Price**	**Extended Cost**
Clearing & Grubbing	2	AC	$5,000.00	$10,000.00
Channel Widening Earthwork (Cut)	7000	CY	$3.00	$21,000.00
Riprap Lining (Type M)	5100	CY	$85.00	$433,500.00
Drop Structures	2	EA	$20,000.00	$40,000.00
			Sub-Total	$504,500.00
	10% Eng. And Contingency			$50,450.00
			Grand Total	$554,950.00

DRAINAGE DESIGN CRITERIA

Development Criteria Reference

Storm drainage analysis techniques were taken from the "*City of Colorado Spring/El Paso County Drainage Criteria Manual*" Volumes 1 and 2 (EPCDCM), dated October 12, 1994, the "*Urban Storm Drainage Criteria Manual"* Volumes 1 - 3 (USDCM) and Chapter 6 and Section 3.2.1 of Chapter 13 of the "Colorado Springs Drainage Criteria Manual (CCSDCM), dated May 2014, as adopted by El Paso County.

Hydrologic Criteria

The hydrologic analysis for this project is based on the *Sand Creek Drainage Basin Planning Study*. The flow rates for the 100-yr storm event were taken from sheets CTP-2 & CTP-3 of this study. The Baseline Flows from the *Sand Creek Drainage Basin Planning Study* are included in Appendix C.

Hydraulic Criteria

GeoHecRas was used as the primary analysis method for the site. GeoHecRas was used to model existing flows within the Sand Creek-Center Tributary Drainageway. This model was used to verify flood plains and analyze any overtopping that may occur within the project site. The 100-year water surface profiles for the model were analyzed form the north property line of the site to the area 100 feet south of the Galley Road Crossing. Hydraulic computations for the models are contained in Appendix B. In the model the value for the roughness coefficient (n) were based upon those shown in Table 12-2 of the City of Colorado Springs Drainage Criteria Manual, Volume 1. The manning's roughness coefficient for the sides of the channel was evaluated as n = 0.05, as the channel sides are most closely categorized as sluggish reaches with weeds, the minimum value of n was taken. For the bottom of the channel a manning's roughness coefficient value of n = 0.025, as the existing channel bottom being very clear and free of plants or other debris, the minimum value of n was taken. Table 12-2 highlights the manning values used for the model. The channel was analyzed as a winding channel in the GeoHecRas model.

Table 12-2. Roughness Coefficients

Channel Description	Roughness Coefficient (n)		
	Minimum	Typical	Maximum
Natural Streams (top width at flood stage <100 feet			
1. Streams on Plain			
a. Clean, straight, full stage, no rifts or deep pools	0.025	0.030	0.033
b. Same as above, but more stones and weeds	0.030	0.035	0.040
c. Clean, winding, some pools and shoals	0.033	0.040	0.045
d. Same as above, but some weeds and stones	0.035	0.045	0.050
e. Same as above, lower stages, more ineffective slopes and sections	0.040	0.048	0.055
f. Same as c, but more stones	0.045	0.050	0.060
g. Sluggish reaches, weedy, deep pools	0.050	0.070	0.080
h. Very weedy reaches, deep pools, or floodways with heavy stand of timber and underbrush	0.075	0.100	0.150
2. Mountain Streams, no vegetation in channel, banks usually steep, trees and brush along banks submerged at high stages			
a. Bottom: gravels, cobbles, and few boulders	See Jarrett's equation*		
b. Bottom: cobbles with large boulders			

The flows in the channel, upstream and downstream of the Solace site, were determined using the sheet CTP-2 of the *Sand Creek Drainage Basin Planning Study*, with the flow 720 cfs being used at the upstream end of the channel till river station 1031 where the flow changes to 960 cfs, and once again at the Galley Road crossing to 1340 cfs. These can be seen in the GeoHecRas output table. Geometry of the channel and the crossing structure at Galley Road was determined from survey

conducted by JR Engineering's internal survey department. The Galley road crossing structure was modeled in the GeoHecRas model; its geometric parameters were determined using survey obtained data to the crossing. The sizes of the 48" CMP culverts in the crossing were also determined from survey data.

SUMMARY

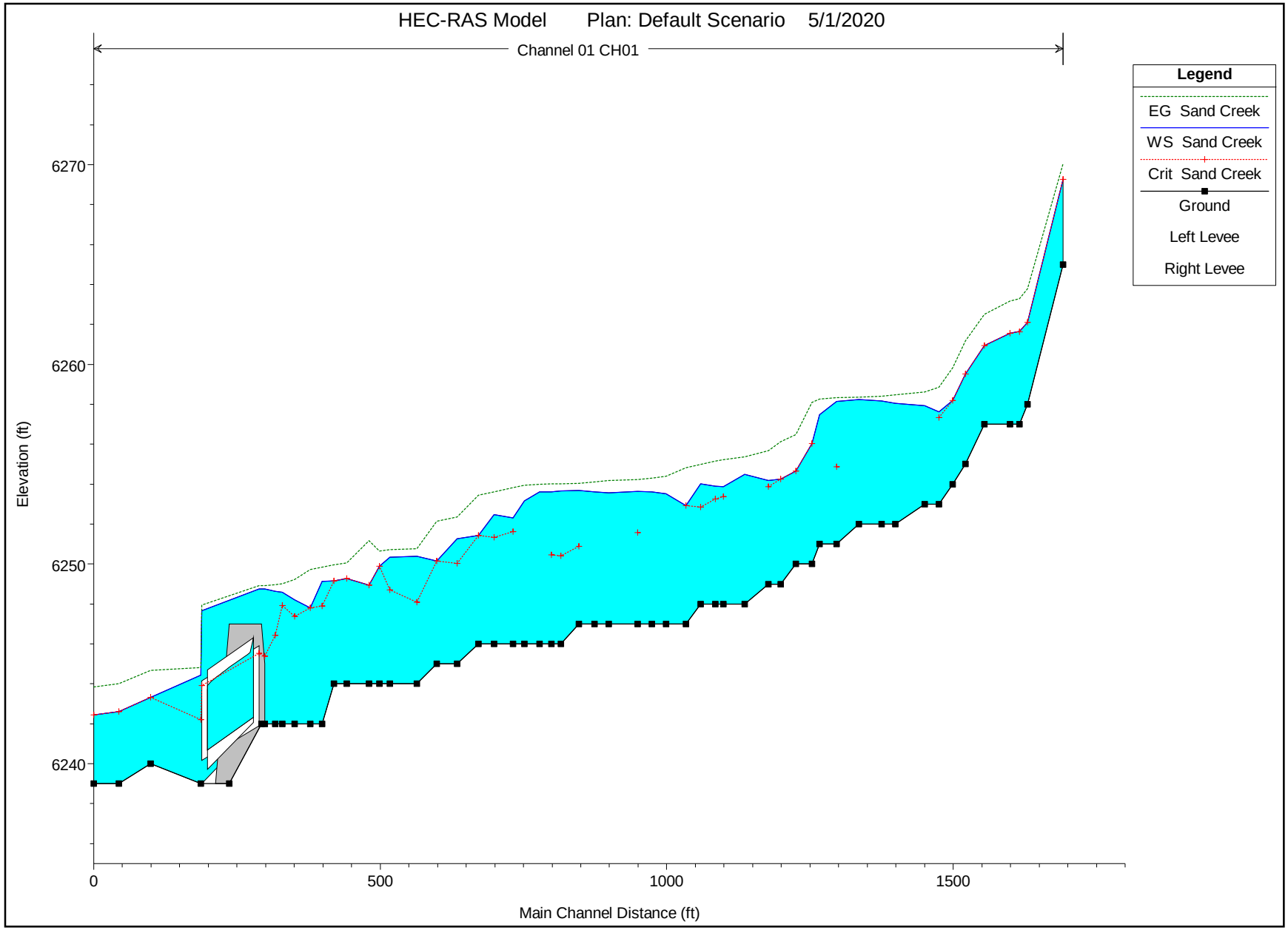
This analysis of the Sand Creek-Center Tributary Drainageway remains consistent with previous studies. Velocities in the drainageway are of concern and require channel improvements, such as widening and riprap lining to ensure the Sand Creek Drainageway remains stable during a 100-yr event. This report meets the latest El Paso County Drainage Criteria requirements for this site. The results of JR Engineering's GeoHecRas model for the channel appear accurate as the water surface elevations of the channel matchup very closely to the elevations called out in the FEMA FIS along the channel. The overtopping elevation at Galley Road shown in the model matches the elevation shown in the FEMA floodplain map of 6249, showing that the GeoHecRas model results are valid.

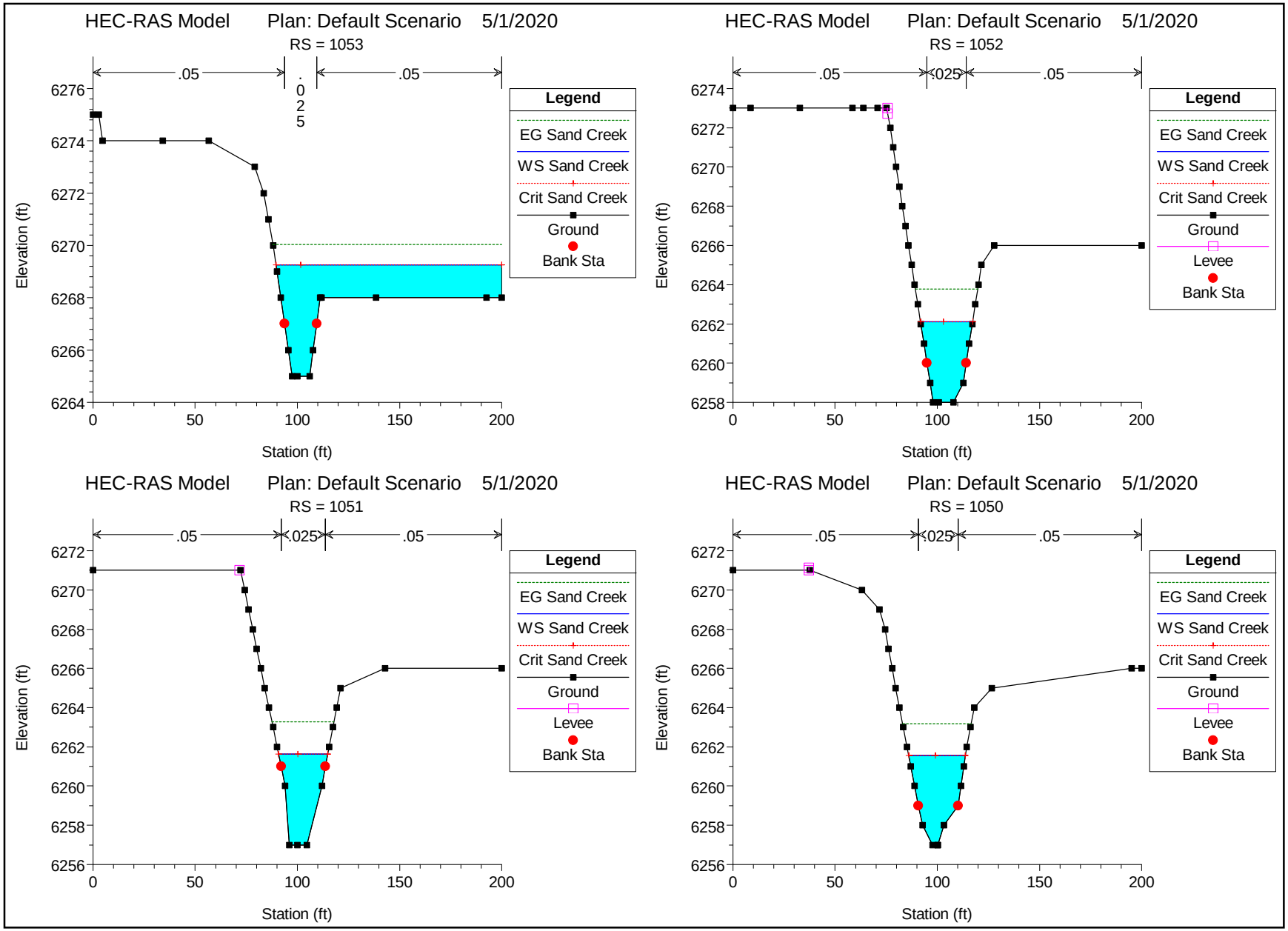
REFERENCES:

1. El Paso County Drainage Criteria Manual Volume 1, El Paso County, CO, 1994.
2. Urban Storm Drainage Criteria Manual, Urban Drainage and Flood Control District, Latest Revision.
3. Flood Insurance Study- El Paso County, Colorado & Incorporated Areas Vol 7 of 8, Federal Emergency Management Agency, December 7, 2018.
4. Sand Creek Drainage Basin Planning Study, Kiowa Engineering, January 1993.
5. Sand Creek Drainage Basin LOMR, Federal Emergency Management Agency, May 23, 2007.
6. Preliminary Drainage Report and Floodplain Certification for Powers Center Point, Galloway Engineering, October 2007.

HEC-RAS Plan: Default Scenario River: Channel 01 Reach: CH01 Profile: Sand Creek

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
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
CH01	1053	Sand Creek	760.00	6265.00	6269.26	6269.26	6270.04	0.003762	8.51	179.27	110.42	0.77
CH01	1052	Sand Creek	760.00	6258.00	6262.11	6262.11	6263.78	0.005804	10.49	77.83	25.50	0.96
CH01	1051	Sand Creek	760.00	6257.00	6261.64	6261.64	6263.29	0.006883	10.30	74.47	24.12	0.98
CH01	1050	Sand Creek	760.00	6257.00	6261.55	6261.55	6263.17	0.005614	10.36	81.50	27.77	0.96
CH01	1049	Sand Creek	760.00	6257.00	6260.93	6260.93	6262.50	0.005917	10.15	80.51	28.71	0.97
CH01	1048	Sand Creek	760.00	6255.00	6259.52	6259.52	6261.19	0.005730	10.51	80.21	27.19	0.97
CH01	1047	Sand Creek	760.00	6254.00	6258.20	6258.20	6259.83	0.006013	10.34	79.30	27.50	0.98
CH01	1046	Sand Creek	760.00	6253.00	6257.62	6257.33	6258.86	0.004369	9.10	93.85	32.59	0.85
CH01	1045	Sand Creek	760.00	6253.00	6257.94		6258.62	0.002044	6.71	123.65	36.54	0.59
CH01	1044	Sand Creek	760.00	6252.00	6258.04		6258.47	0.000942	5.39	158.77	38.15	0.42
CH01	1043	Sand Creek	760.00	6252.00	6258.17		6258.40	0.000450	3.84	219.34	49.10	0.29
CH01	1042	Sand Creek	760.00	6252.00	6258.25		6258.35	0.000192	2.60	333.13	72.33	0.19
CH01	1041	Sand Creek	760.00	6251.00	6258.15	6254.86	6258.33	0.000342	3.46	250.00	54.53	0.26
CH01	1040	Sand Creek	760.00	6251.00	6257.48		6258.25	0.001509	7.34	129.48	31.17	0.53
CH01	1039	Sand Creek	720.00	6250.00	6256.03	6256.03	6258.09	0.005145	12.17	78.63	22.88	0.93
CH01	1038	Sand Creek	720.00	6250.00	6254.65	6254.65	6256.48	0.005632	11.04	74.30	23.99	0.96
CH01	1037	Sand Creek	720.00	6249.00	6254.26	6254.26	6256.12	0.005266	11.39	78.61	25.24	0.94
CH01	1036	Sand Creek	720.00	6249.00	6254.18	6253.87	6255.67	0.004153	10.16	86.85	27.64	0.84
CH01	1035	Sand Creek	720.00	6248.00	6254.49		6255.37	0.001997	8.12	123.42	33.33	0.60
CH01	1034	Sand Creek	720.00	6248.00	6253.87	6253.37	6255.23	0.003530	9.97	96.29	27.50	0.78
CH01	1033	Sand Creek	720.00	6248.00	6253.90	6253.27	6255.15	0.003218	9.54	100.27	28.48	0.75
CH01	1032	Sand Creek	720.00	6248.00	6254.02	6252.85	6254.99	0.002212	8.21	107.83	28.30	0.63
CH01	1031	Sand Creek	720.00	6247.00	6252.93	6252.93	6254.82	0.005902	11.67	81.05	24.65	0.92
CH01	1030	Sand Creek	960.00	6247.00	6253.53		6254.38	0.001956	8.14	169.51	45.64	0.61
CH01	1029	Sand Creek	960.00	6247.00	6253.61		6254.29	0.001452	7.08	180.40	43.93	0.52
CH01	1028	Sand Creek	960.00	6247.00	6253.63	6251.57	6254.24	0.001217	6.58	184.56	43.62	0.48
CH01	1027	Sand Creek	960.00	6247.00	6253.56		6254.17	0.001232	7.01	201.11	46.32	0.50
CH01	1026	Sand Creek	960.00	6247.00	6253.62		6254.11	0.000969	5.82	199.63	47.17	0.43
CH01	1025	Sand Creek	960.00	6247.00	6253.70	6250.88	6254.05	0.000644	4.85	227.01	48.43	0.35
CH01	1024	Sand Creek	960.00	6246.00	6253.67	6250.42	6254.02	0.000576	4.98	235.21	46.35	0.34
CH01	1023	Sand Creek	960.00	6246.00	6253.62	6250.47	6254.01	0.000626	5.21	225.63	43.80	0.35
CH01	1022	Sand Creek	960.00	6246.00	6253.61		6254.00	0.000607	5.19	221.85	41.91	0.35
CH01	1021	Sand Creek	960.00	6246.00	6253.17		6253.94	0.001350	7.37	164.92	36.16	0.51
CH01	1020	Sand Creek	960.00	6246.00	6252.32	6251.61	6253.82	0.003159	10.30	118.91	30.63	0.76
CH01	1019	Sand Creek	960.00	6246.00	6252.49	6251.34	6253.62	0.002313	9.03	140.23	36.35	0.66
CH01	1018	Sand Creek	960.00	6246.00	6251.44	6251.44	6253.45	0.004819	12.21	109.12	31.63	0.94
CH01	1017	Sand Creek	960.00	6245.00	6251.26	6250.03	6252.37	0.002324	8.73	133.16	32.49	0.65
CH01	1016	Sand Creek	960.00	6245.00	6250.14	6250.14	6252.15	0.005299	11.66	96.28	28.21	0.95
CH01	1015	Sand Creek	960.00	6244.00	6250.38	6248.09	6250.77	0.000839	5.11	215.92	53.82	0.39
CH01	1014	Sand Creek	956.00	6244.00	6250.35	6248.71	6250.72	0.000950	5.78	370.06	207.76	0.42
CH01	1013	Sand Creek	956.00	6244.00	6249.89	6249.89	6250.66	0.001931	8.21	274.84	196.01	0.61
CH01	1012	Sand Creek	956.00	6244.00	6248.95	6248.95	6251.16	0.005865	12.67	104.90	38.16	1.02
CH01	1011	Sand Creek	956.00	6244.00	6249.28	6249.28	6250.05	0.002387	8.46	279.17	203.66	0.66
CH01	1010	Sand Creek	956.00	6244.00	6249.16	6249.16	6249.97	0.002504	8.54	254.79	169.44	0.67
CH01	1009	Sand Creek	956.00	6242.00	6249.14	6247.90	6249.85	0.001612	7.93	276.71	166.57	0.55
CH01	1008	Sand Creek	956.00	6242.00	6247.80	6247.80	6249.73	0.004748	11.73	106.54	31.47	0.91
CH01	1007	Sand Creek	956.00	6242.00	6248.22	6247.39	6249.22	0.002263	9.17	222.13	127.82	0.66
CH01	1006	Sand Creek	956.00	6242.00	6248.59	6247.92	6249.01	0.001105	6.67	368.21	181.76	0.46
CH01	1005	Sand Creek	956.00	6242.00	6248.64	6246.43	6248.97	0.000738	5.28	352.19	168.51	0.38
CH01	1004	Sand Creek	956.00	6242.00	6248.76	6245.39	6248.91	0.000242	3.31	399.38	160.30	0.22
CH01	1003.56		Culvert									
CH01	1003	Sand Creek	956.00	6239.00	6244.43	6242.22	6244.82	0.000233	4.99	191.73	160.51	0.40
CH01	1002	Sand Creek	956.00	6240.00	6243.32	6243.32	6244.68	0.001891	9.35	102.20	38.15	1.01
CH01	1001	Sand Creek	956.00	6239.00	6242.61	6242.61	6244.01	0.001806	9.51	100.52	34.95	0.99
CH01	1000	Sand Creek	956.00	6239.00	6242.44	6242.44	6243.85	0.001879	9.55	100.10	35.71	1.01


HEC-RAS Model Plan: Default Scenario 5/1/2020
Channel 01 CH01
Legend
EG Sand Creek
WS Sand Creek
Crit Sand Creek
Ground
Left Levee
Right Levee
Elevation (ft)
6270
6260
6250
6240
0
500
1000
1500
Main Channel Distance (ft)


HEC-RAS Model Plan: Default Scenario 5/1/2020
RS = 1053
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Elevation (ft)
Station (ft)
Legend
EG Sand Creek
WS Sand Creek
Crit Sand Creek
Ground
Bank Sta
HEC-RAS Model Plan: Default Scenario 5/1/2020
RS = 1052
.05
.025
.05
Elevation (ft)
Station (ft)
Legend
EG Sand Creek
WS Sand Creek
Crit Sand Creek
Ground
Levee
Bank Sta
HEC-RAS Model Plan: Default Scenario 5/1/2020
RS = 1051
.05
.025
.05
Elevation (ft)
Station (ft)
Legend
EG Sand Creek
WS Sand Creek
Crit Sand Creek
Ground
Levee
Bank Sta
HEC-RAS Model Plan: Default Scenario 5/1/2020
RS = 1050
.05
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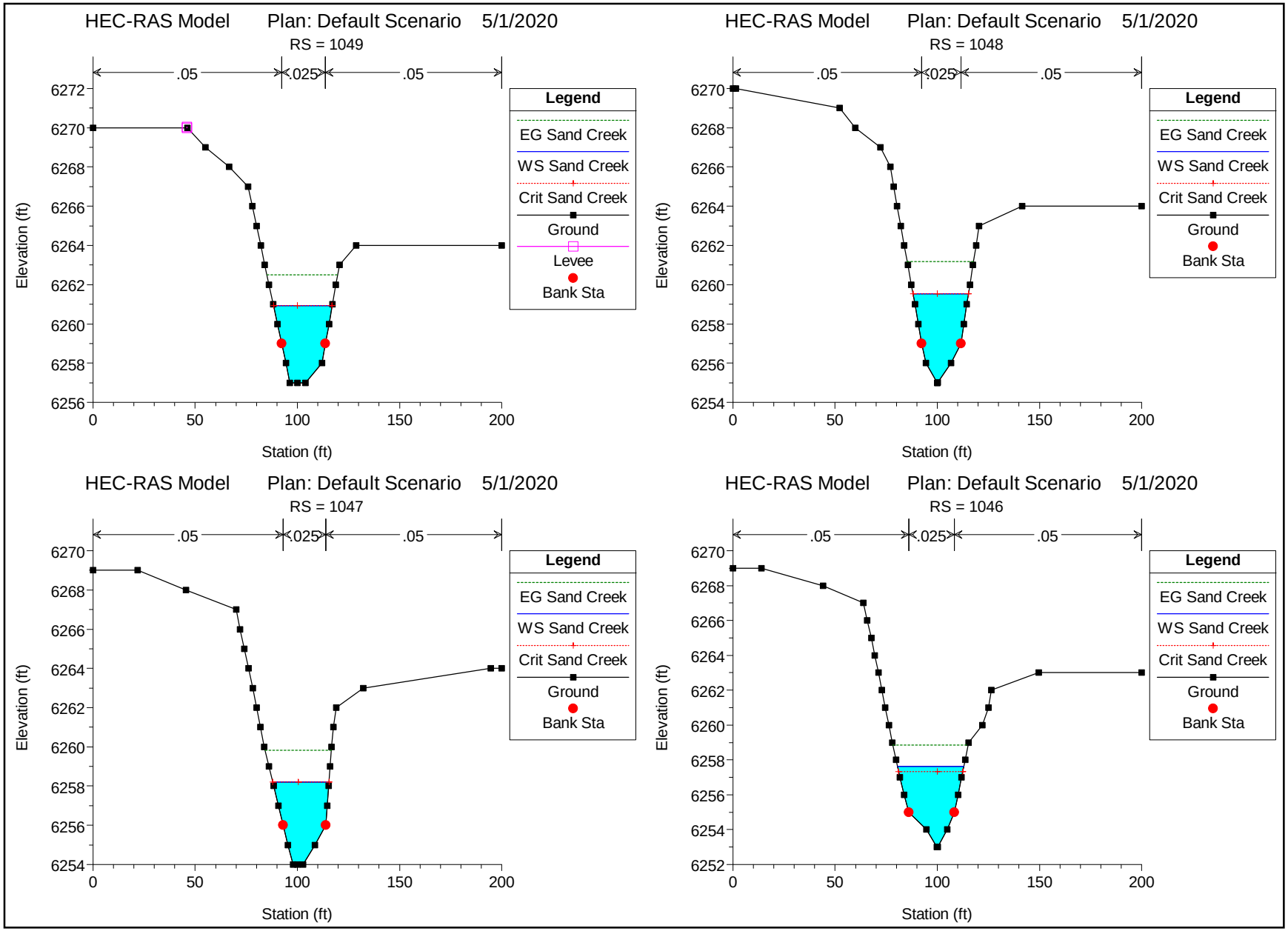
.05
Elevation (ft)
Station (ft)
Legend
EG Sand Creek
WS Sand Creek
Crit Sand Creek
Ground
Levee
Bank Sta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RS = 1049
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Elevation (ft)
Station (ft)
Legend
EG Sand Creek
WS Sand Creek
Crit Sand Creek
Ground
Levee
Bank Sta
HEC-RAS Model Plan: Default Scenario 5/1/2020
RS = 1048
.05
.025
.05
Elevation (ft)
Station (ft)
Legend
EG Sand Creek
WS Sand Creek
Crit Sand Creek
Ground
Bank Sta
HEC-RAS Model Plan: Default Scenario 5/1/2020
RS = 1047
.05
.025
.05
Elevation (ft)
Station (ft)
Legend
EG Sand Creek
WS Sand Creek
Crit Sand Creek
Ground
Bank Sta
HEC-RAS Model Plan: Default Scenario 5/1/2020
RS = 1046
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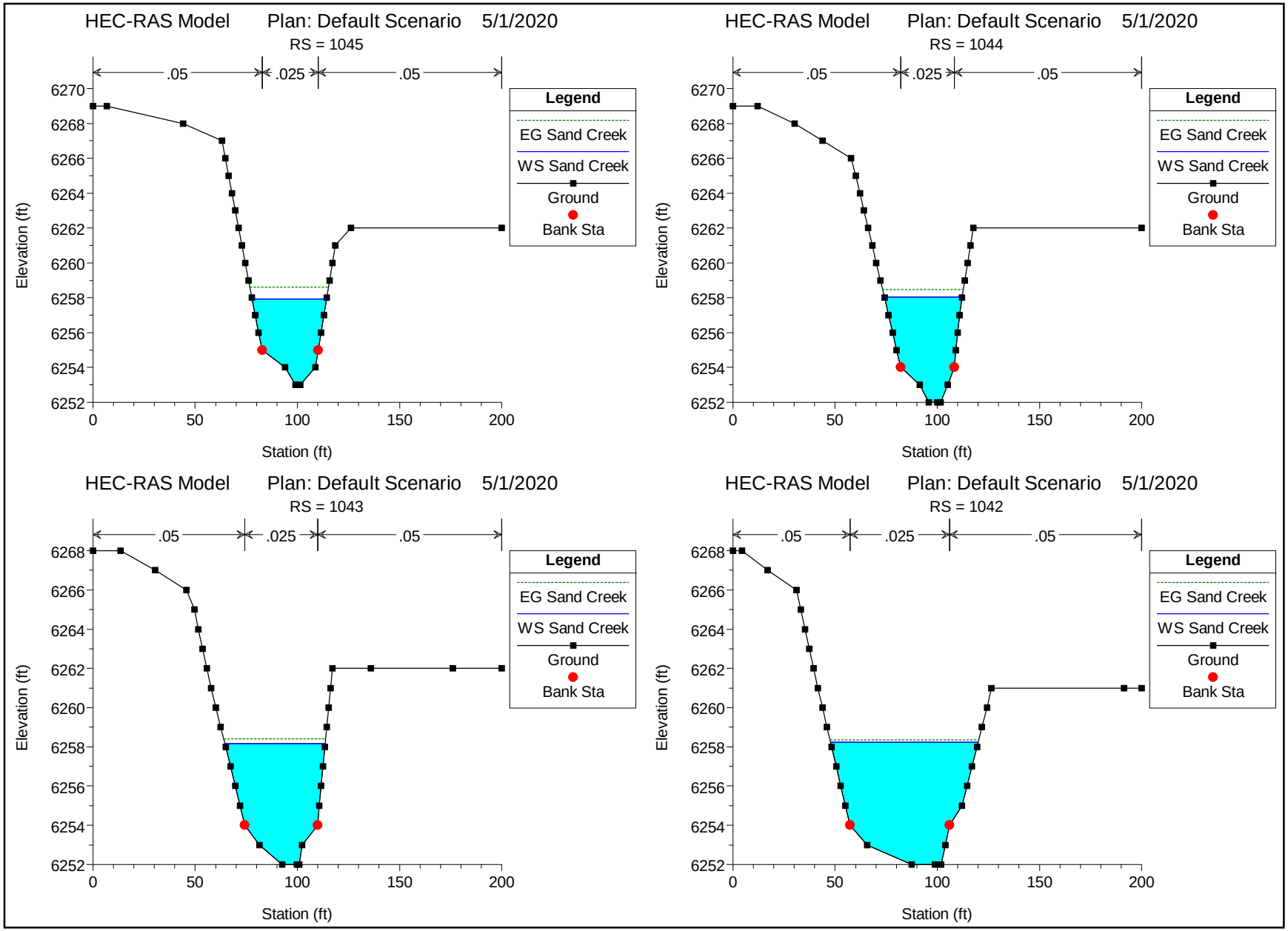
Elevation (ft)
Station (ft)
Legend
EG Sand Creek
WS Sand Creek
Crit Sand Creek
Ground
Bank Sta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RS = 1045
.05
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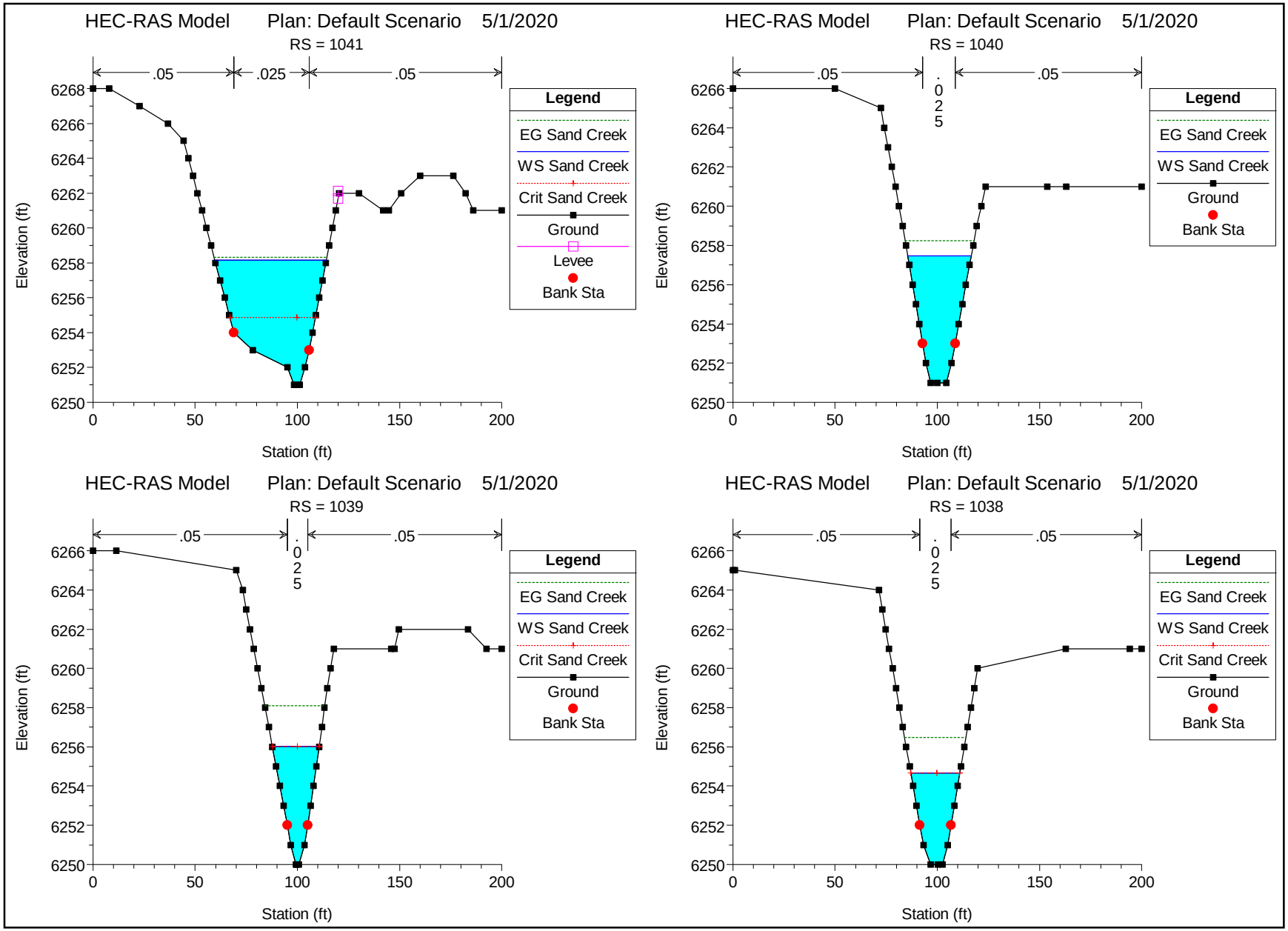
Elevation (ft)
Station (ft)
Legend
EG Sand Creek
WS Sand Creek
Ground
Bank Sta
HEC-RAS Model Plan: Default Scenario 5/1/2020
RS = 1044
HEC-RAS Model Plan: Default Scenario 5/1/2020
RS = 1043
HEC-RAS Model Plan: Default Scenario 5/1/2020
RS = 1042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RS = 1041
.05
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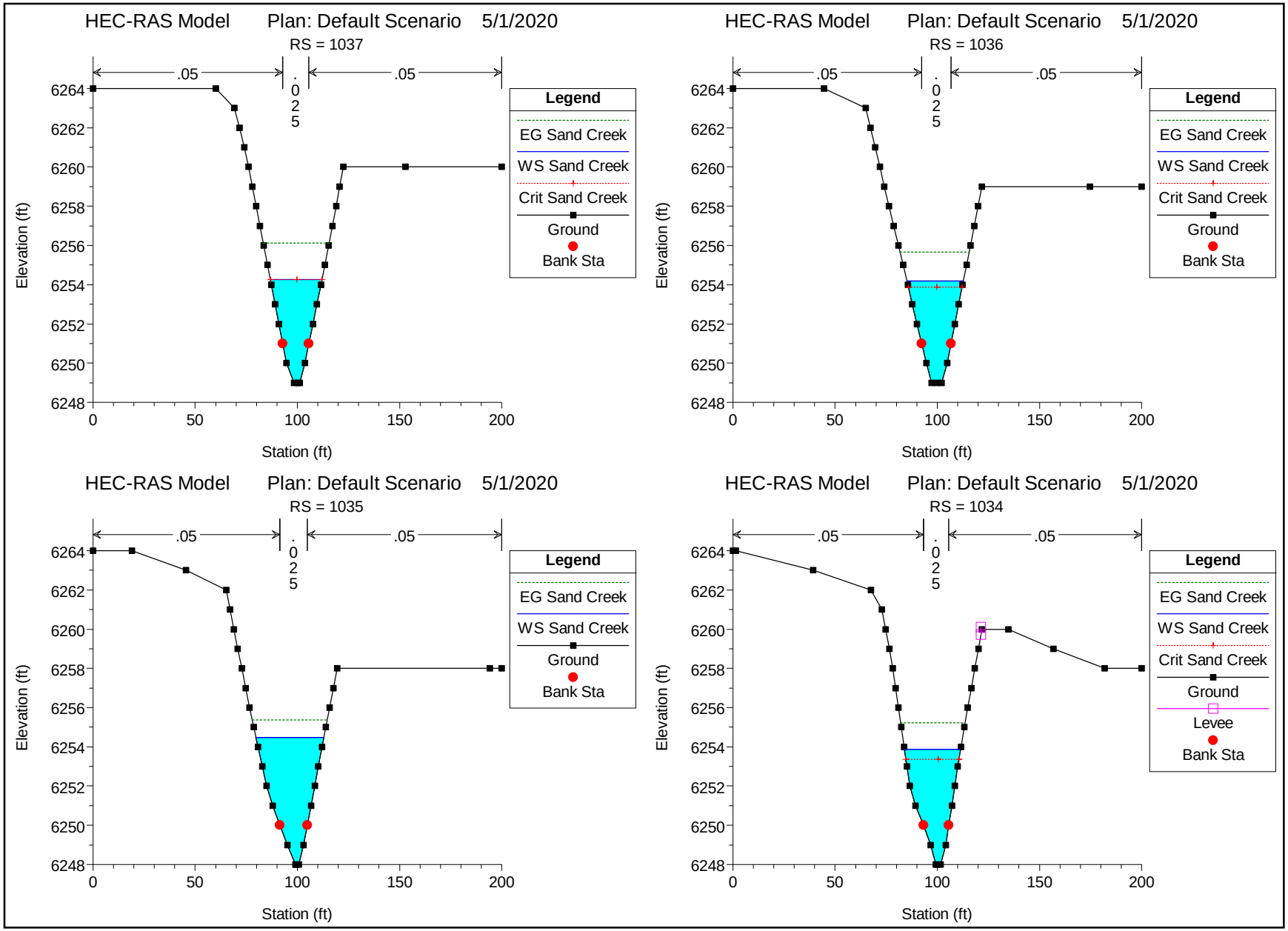
Elevation (ft)
Station (ft)
Legend
EG Sand Creek
WS Sand Creek
Crit Sand Creek
Ground
Levee
Bank Sta
HEC-RAS Model Plan: Default Scenario 5/1/2020
RS = 1040
.05
.025
.05
Elevation (ft)
Station (ft)
Legend
EG Sand Creek
WS Sand Creek
Ground
Bank Sta
HEC-RAS Model Plan: Default Scenario 5/1/2020
RS = 1039
.05
.025
.05
Elevation (ft)
Station (ft)
Legend
EG Sand Creek
WS Sand Creek
Crit Sand Creek
Ground
Bank Sta
HEC-RAS Model Plan: Default Scenario 5/1/2020
RS = 1038
.05
.025
.05
Elevation (ft)
Station (ft)
Legend
EG Sand Creek
WS Sand Creek
Crit Sand Creek
Ground
Bank Sta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RS = 1037
.05
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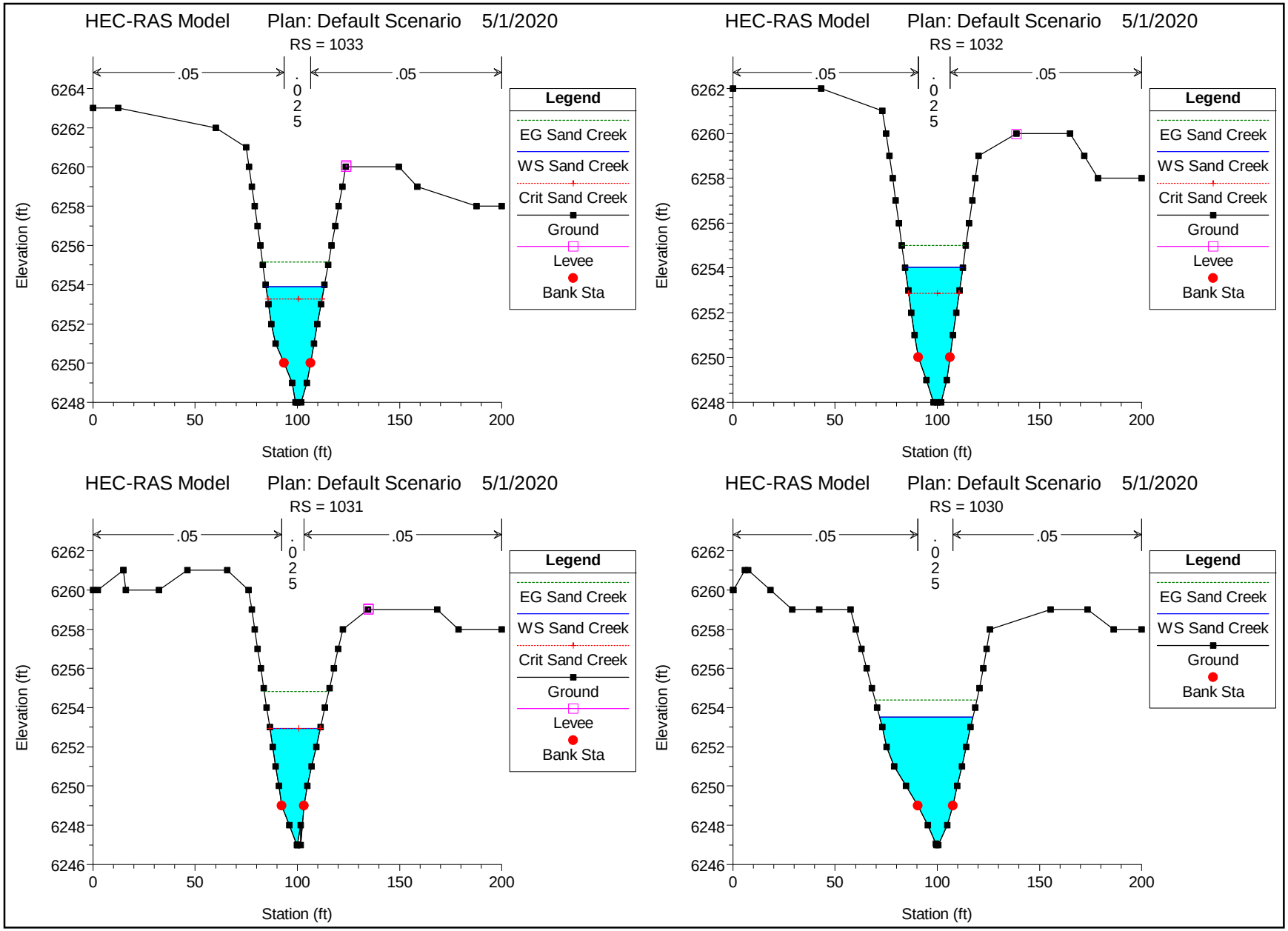
Elevation (ft)
Station (ft)
Legend
EG Sand Creek
WS Sand Creek
Crit Sand Creek
Ground
Bank Sta
HEC-RAS Model Plan: Default Scenario 5/1/2020
RS = 1036
.05
.025
.05
Elevation (ft)
Station (ft)
Legend
EG Sand Creek
WS Sand Creek
Crit Sand Creek
Ground
Bank Sta
HEC-RAS Model Plan: Default Scenario 5/1/2020
RS = 1035
.05
.025
.05
Elevation (ft)
Station (ft)
Legend
EG Sand Creek
WS Sand Creek
Ground
Bank Sta
HEC-RAS Model Plan: Default Scenario 5/1/2020
RS = 1034
.05
.025
.05
Elevation (ft)
Station (ft)
Legend
EG Sand Creek
WS Sand Creek
Crit Sand Creek
Ground
Levee
Bank Sta


HEC-RAS Model Plan: Default Scenario 5/1/2020
RS = 1033
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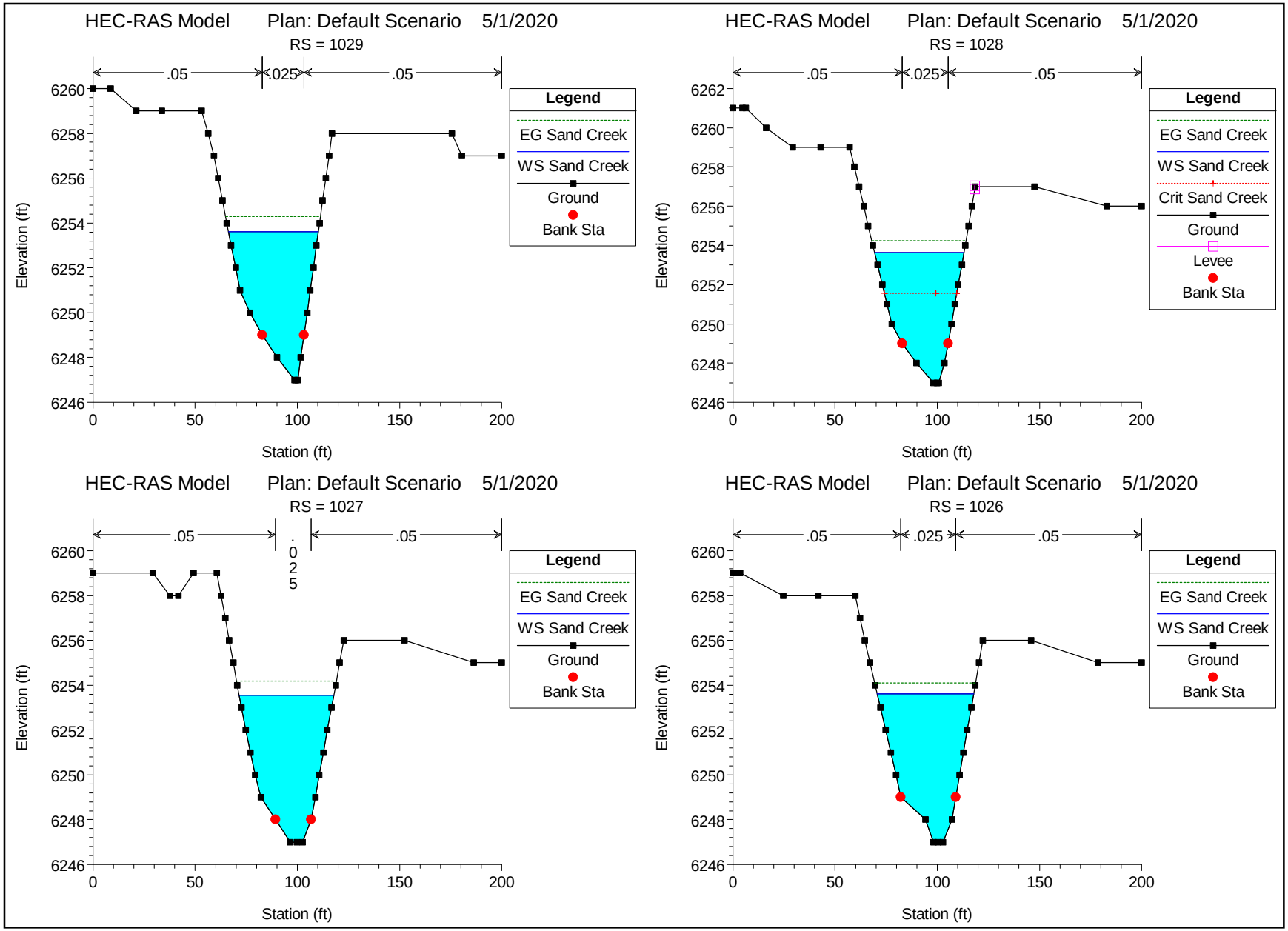
.05
Elevation (ft)
Station (ft)
Legend
EG Sand Creek
WS Sand Creek
Crit Sand Creek
Ground
Levee
Bank Sta
HEC-RAS Model Plan: Default Scenario 5/1/2020
RS = 1032
HEC-RAS Model Plan: Default Scenario 5/1/2020
RS = 1031
HEC-RAS Model Plan: Default Scenario 5/1/2020
RS = 1030


HEC-RAS Model Plan: Default Scenario 5/1/2020
RS = 1029
.05
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Elevation (ft)
Station (ft)
Legend
EG Sand Creek
WS Sand Creek
Ground
Bank Sta
HEC-RAS Model Plan: Default Scenario 5/1/2020
RS = 1028
.05
.025
.05
Elevation (ft)
Station (ft)
Legend
EG Sand Creek
WS Sand Creek
Crit Sand Creek
Ground
Levee
Bank Sta
HEC-RAS Model Plan: Default Scenario 5/1/2020
RS = 1027
.05
.025
.05
Elevation (ft)
Station (ft)
Legend
EG Sand Creek
WS Sand Creek
Ground
Bank Sta
HEC-RAS Model Plan: Default Scenario 5/1/2020
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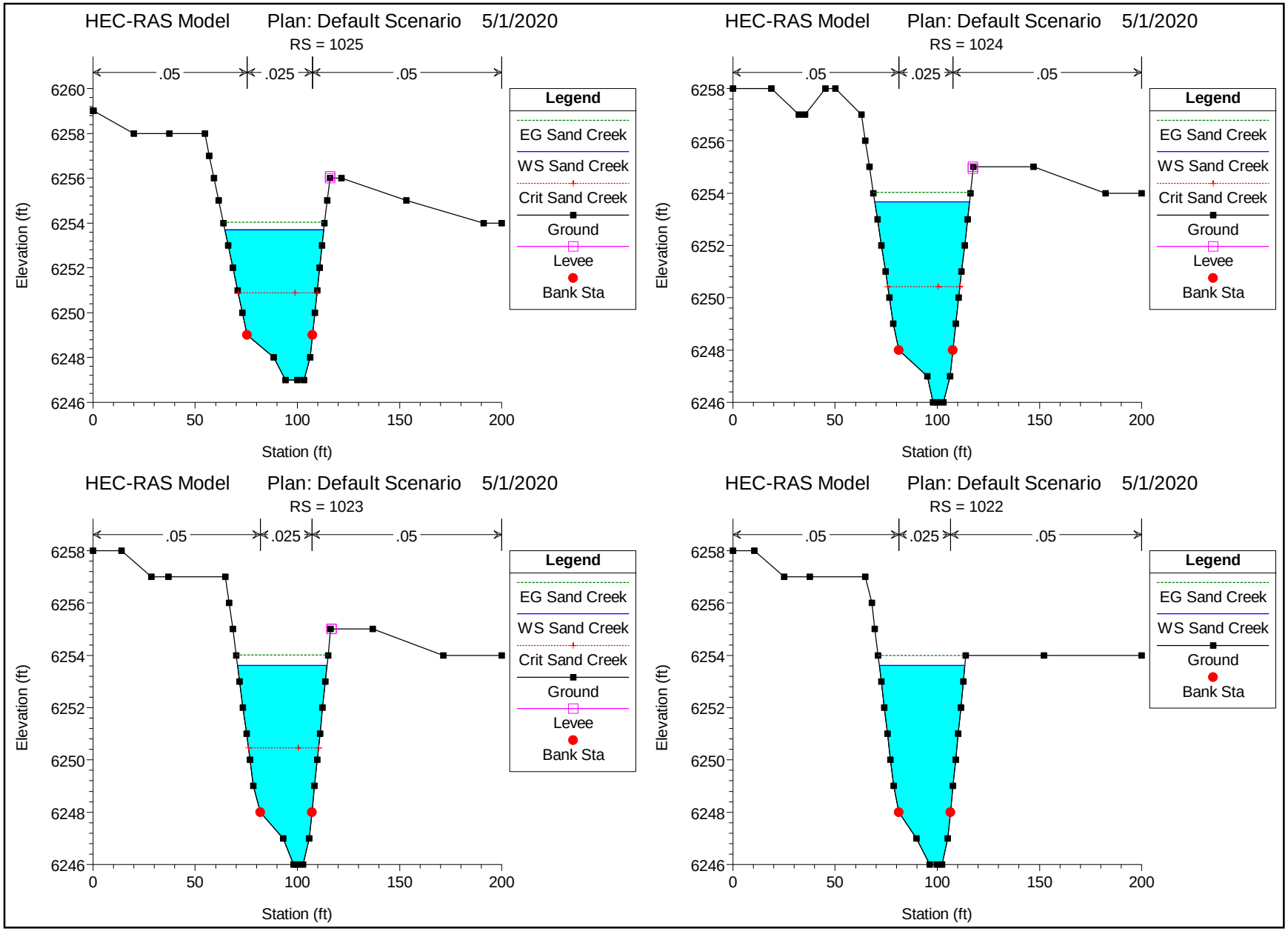
.05
.025
.05
Elevation (ft)
Station (ft)
Legend
EG Sand Creek
WS Sand Creek
Ground
Bank Sta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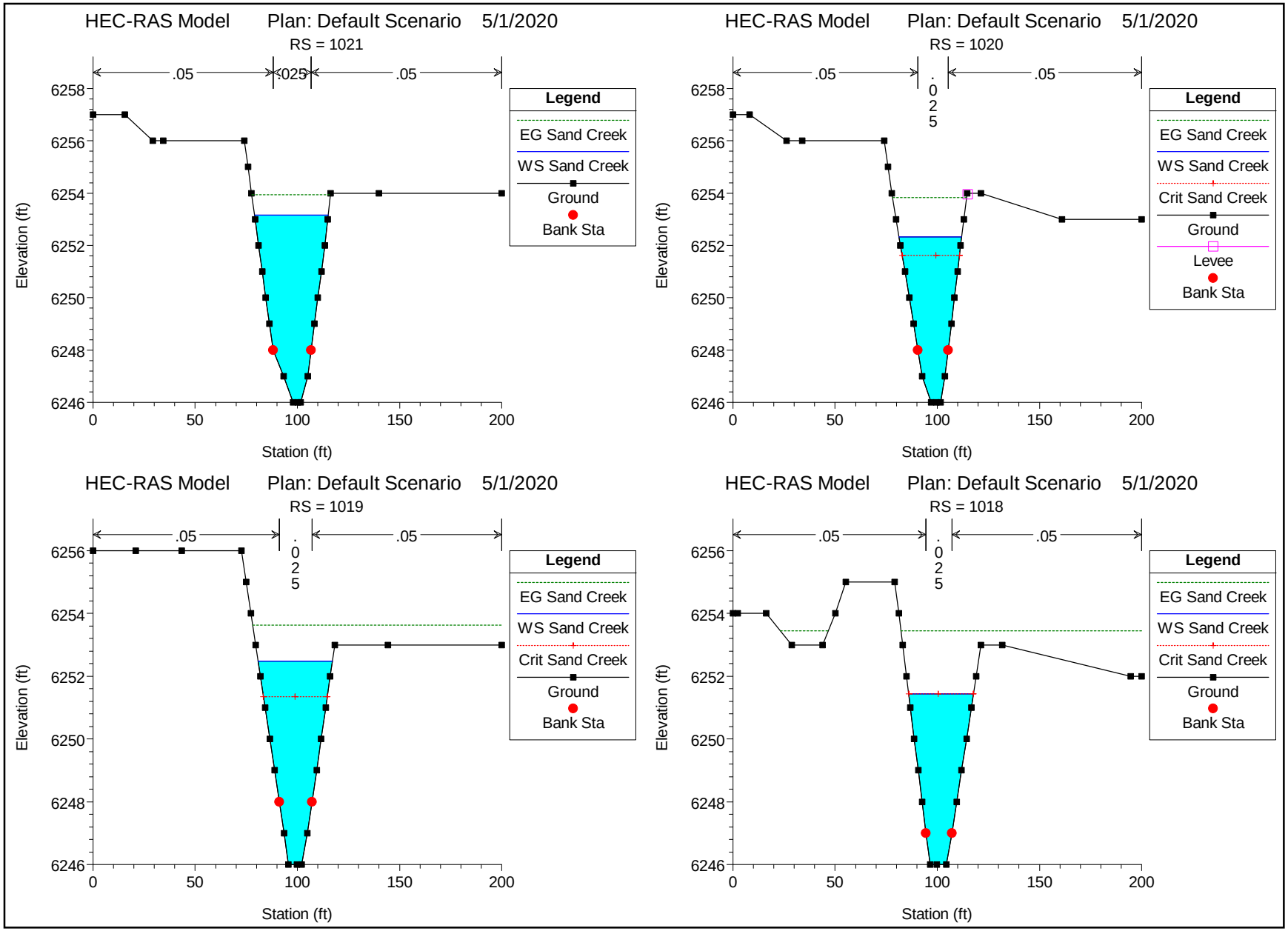
Elevation (ft)
Station (ft)
Legend
EG Sand Creek
WS Sand Creek
Crit Sand Creek
Ground
Levee
Bank Sta
HEC-RAS Model Plan: Default Scenario 5/1/2020
RS = 1024
HEC-RAS Model Plan: Default Scenario 5/1/2020
RS = 1023
HEC-RAS Model Plan: Default Scenario 5/1/2020
RS = 1022


HEC-RAS Model Plan: Default Scenario 5/1/2020
RS = 1021
.05
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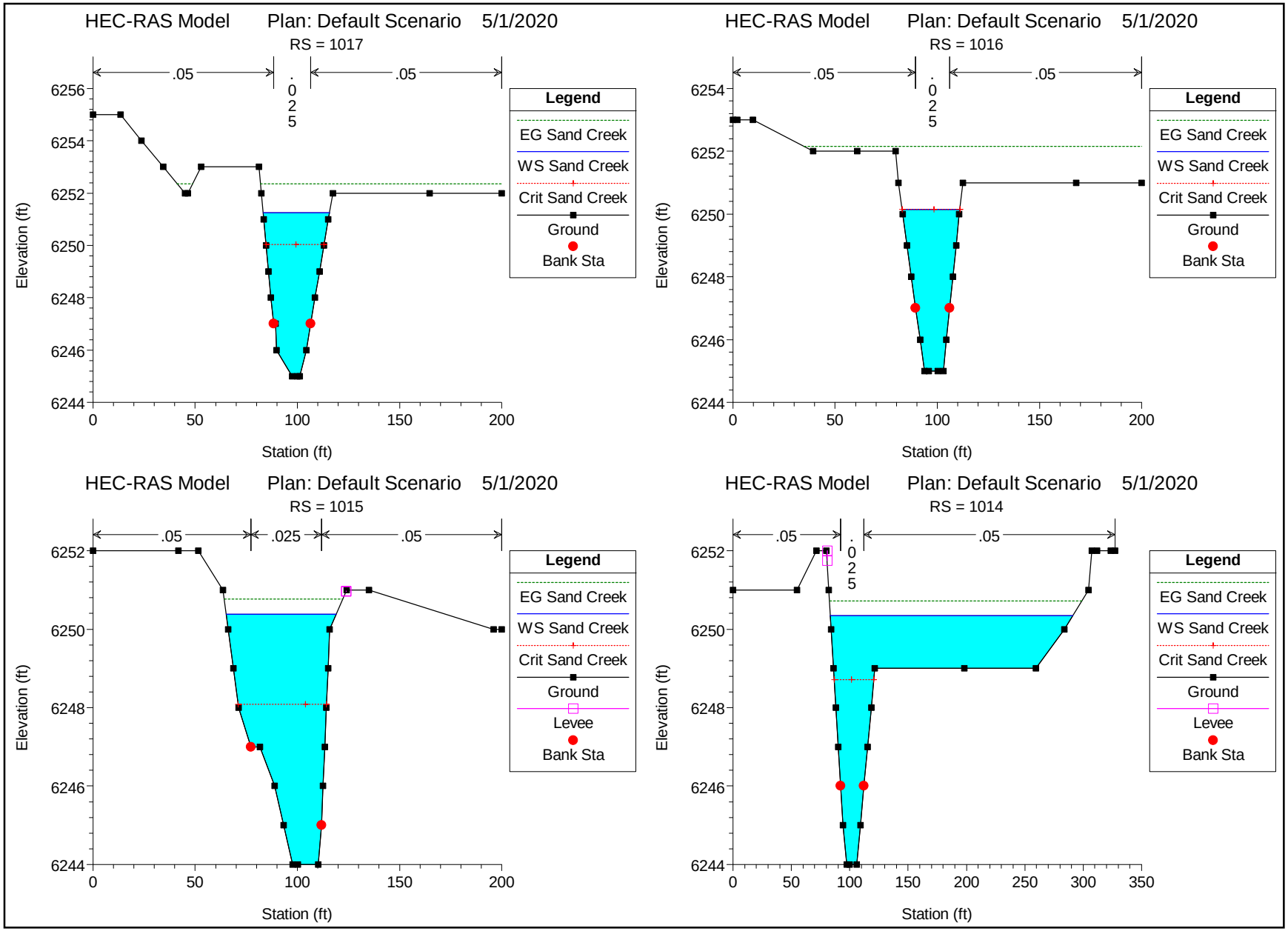
Elevation (ft)
Station (ft)
Legend
EG Sand Creek
WS Sand Creek
Ground
Bank Sta
HEC-RAS Model Plan: Default Scenario 5/1/2020
RS = 1020
.05
.025
.05
Elevation (ft)
Station (ft)
Legend
EG Sand Creek
WS Sand Creek
Crit Sand Creek
Ground
Levee
Bank Sta
HEC-RAS Model Plan: Default Scenario 5/1/2020
RS = 1019
.05
.025
.05
Elevation (ft)
Station (ft)
Legend
EG Sand Creek
WS Sand Creek
Crit Sand Creek
Ground
Bank Sta
HEC-RAS Model Plan: Default Scenario 5/1/2020
RS = 1018
.05
.025
.05
Elevation (ft)
Station (ft)
Legend
EG Sand Creek
WS Sand Creek
Crit Sand Creek
Ground
Bank Sta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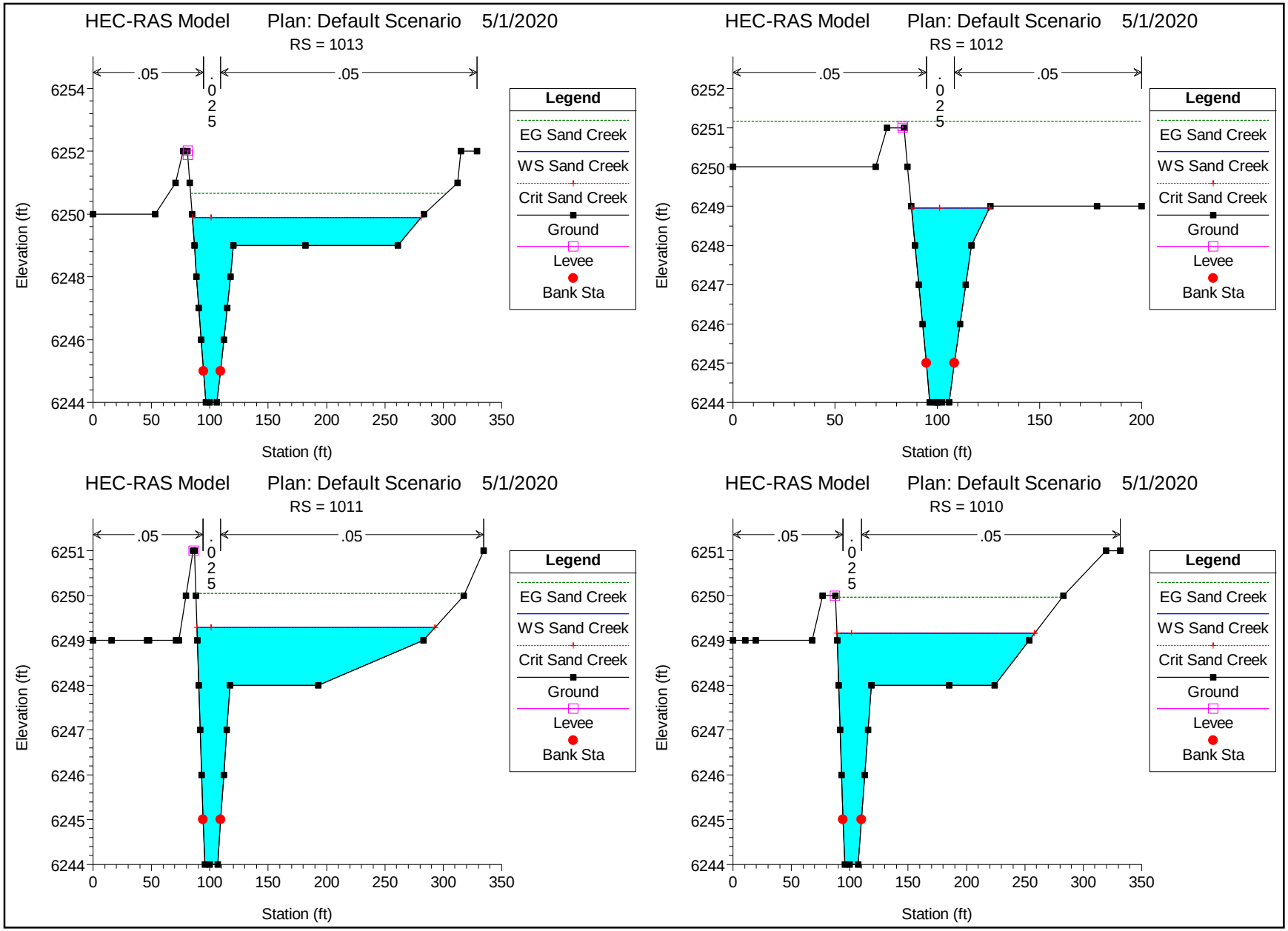
Legend
EG Sand Creek
WS Sand Creek
Crit Sand Creek
Ground
Bank Sta
Elevation (ft)
Station (ft)
HEC-RAS Model Plan: Default Scenario 5/1/2020
RS = 1016
.05
.025
.05
Legend
EG Sand Creek
WS Sand Creek
Crit Sand Creek
Ground
Bank Sta
Elevation (ft)
Station (ft)
HEC-RAS Model Plan: Default Scenario 5/1/2020
RS = 1015
.05
.025
.05
Legend
EG Sand Creek
WS Sand Creek
Crit Sand Creek
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
HEC-RAS Model Plan: Default Scenario 5/1/2020
RS = 1014
.05
.025
.05
Legend
EG Sand Creek
WS Sand Creek
Crit Sand Creek
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)


HEC-RAS Model Plan: Default Scenario 5/1/2020
RS = 1013
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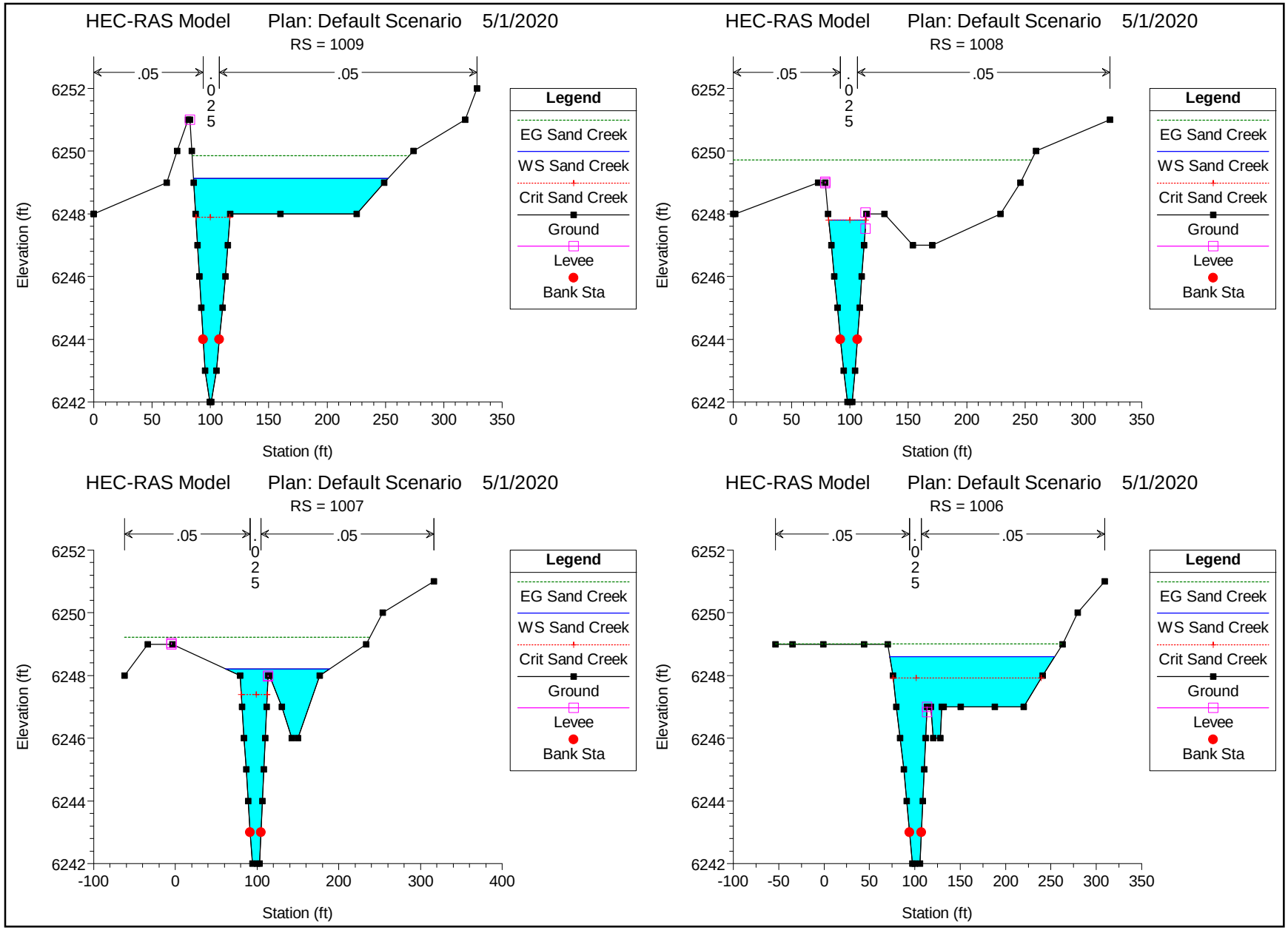
Elevation (ft)
Station (ft)
Legend
EG Sand Creek
WS Sand Creek
Crit Sand Creek
Ground
Levee
Bank Sta
HEC-RAS Model Plan: Default Scenario 5/1/2020
RS = 1012
HEC-RAS Model Plan: Default Scenario 5/1/2020
RS = 1011
HEC-RAS Model Plan: Default Scenario 5/1/2020
RS = 1010


HEC-RAS Model Plan: Default Scenario 5/1/2020
RS = 1009
.05
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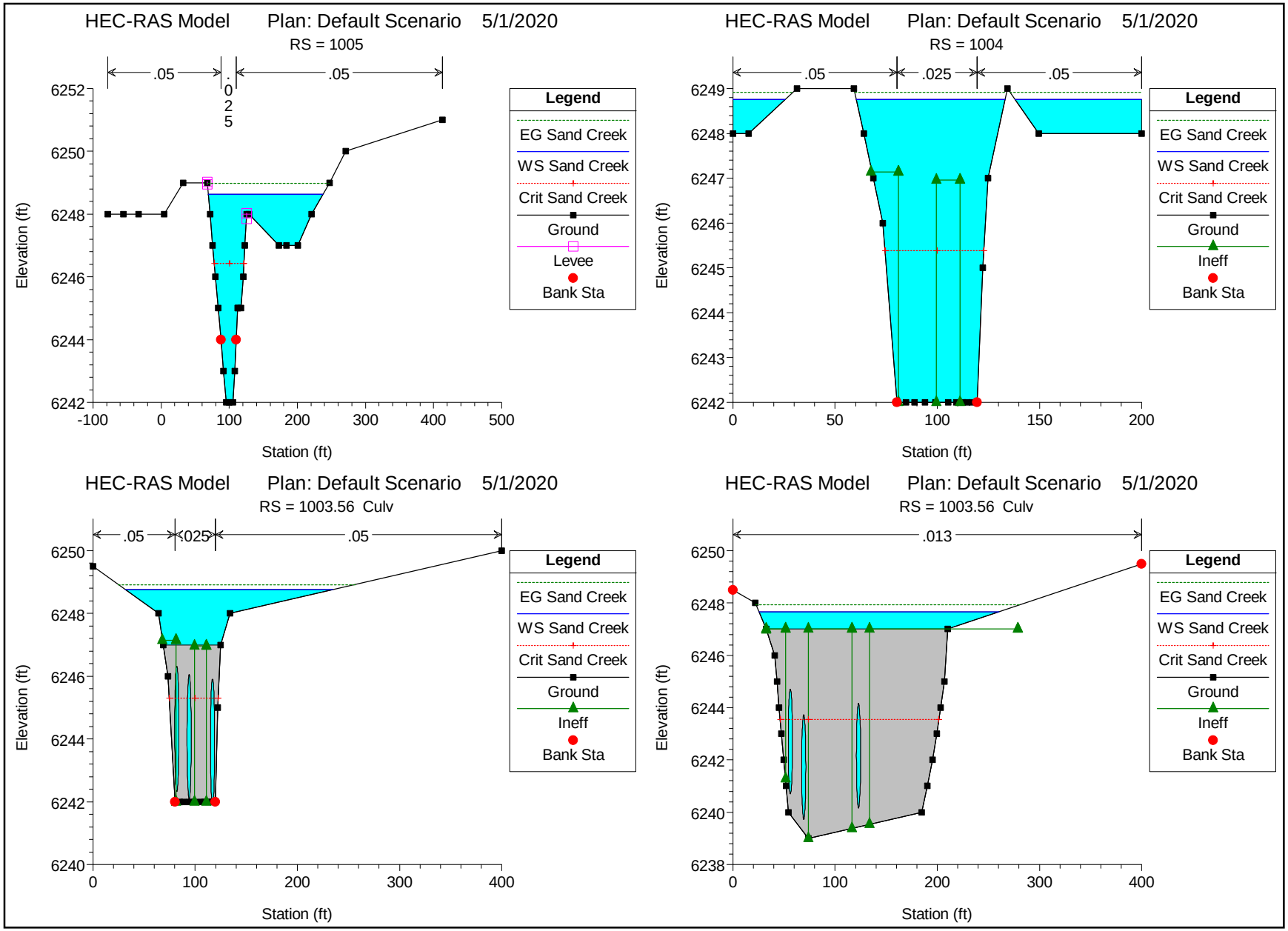
.05
Elevation (ft)
Station (ft)
Legend
EG Sand Creek
WS Sand Creek
Crit Sand Creek
Ground
Levee
Bank Sta
HEC-RAS Model Plan: Default Scenario 5/1/2020
RS = 1008
HEC-RAS Model Plan: Default Scenario 5/1/2020
RS = 1007
HEC-RAS Model Plan: Default Scenario 5/1/2020
RS = 1006


HEC-RAS Model Plan: Default Scenario 5/1/2020
RS = 1005
.05
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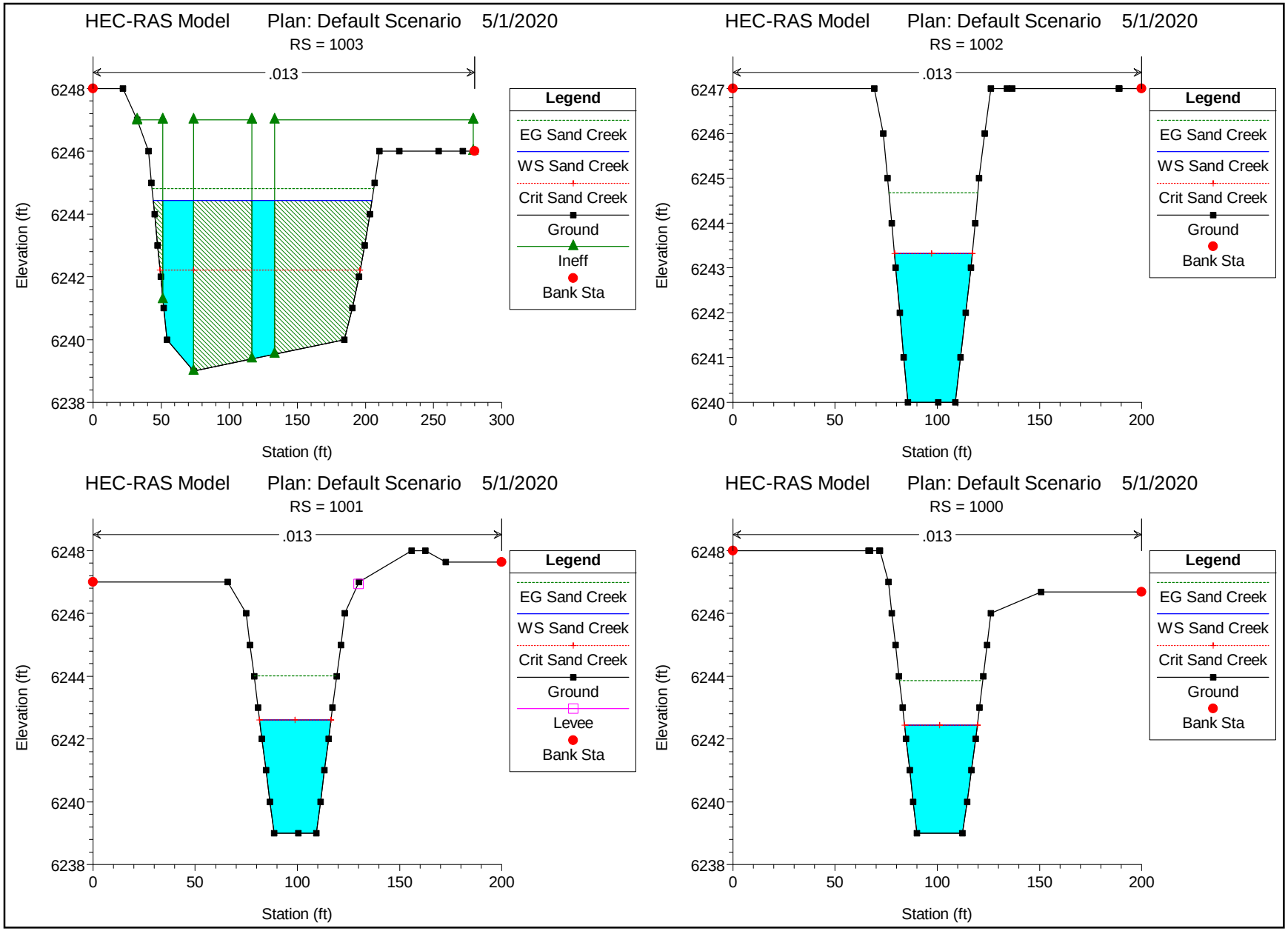
Elevation (ft)
Station (ft)
Legend
EG Sand Creek
WS Sand Creek
Crit Sand Creek
Ground
Levee
Bank Sta
HEC-RAS Model Plan: Default Scenario 5/1/2020
RS = 1004
.05
.025
.05
Elevation (ft)
Station (ft)
Legend
EG Sand Creek
WS Sand Creek
Crit Sand Creek
Ground
Ineff
Bank Sta
HEC-RAS Model Plan: Default Scenario 5/1/2020
RS = 1003.56 Culv
.05
.025
.05
Elevation (ft)
Station (ft)
Legend
EG Sand Creek
WS Sand Creek
Crit Sand Creek
Ground
Ineff
Bank Sta
HEC-RAS Model Plan: Default Scenario 5/1/2020
RS = 1003.56 Culv
.013
Elevation (ft)
Station (ft)
Legend
EG Sand Creek
WS Sand Creek
Crit Sand Creek
Ground
Ineff
Bank Sta


HEC-RAS Model Plan: Default Scenario 5/1/2020
RS = 1003
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Elevation (ft)
Station (ft)
Legend
EG Sand Creek
WS Sand Creek
Crit Sand Creek
Ground
Ineff
Bank Sta
HEC-RAS Model Plan: Default Scenario 5/1/2020
RS = 1002
.013
Elevation (ft)
Station (ft)
Legend
EG Sand Creek
WS Sand Creek
Crit Sand Creek
Ground
Bank Sta
HEC-RAS Model Plan: Default Scenario 5/1/2020
RS = 1001
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Elevation (ft)
Station (ft)
Legend
EG Sand Creek
WS Sand Creek
Crit Sand Creek
Ground
Levee
Bank Sta
HEC-RAS Model Plan: Default Scenario 5/1/2020
RS = 1000
.013
Elevation (ft)
Station (ft)
Legend
EG Sand Creek
WS Sand Creek
Crit Sand Creek
Ground
Bank Sta

Worksheet for Rectangular Weir - 4' Openings (10)

Project Description

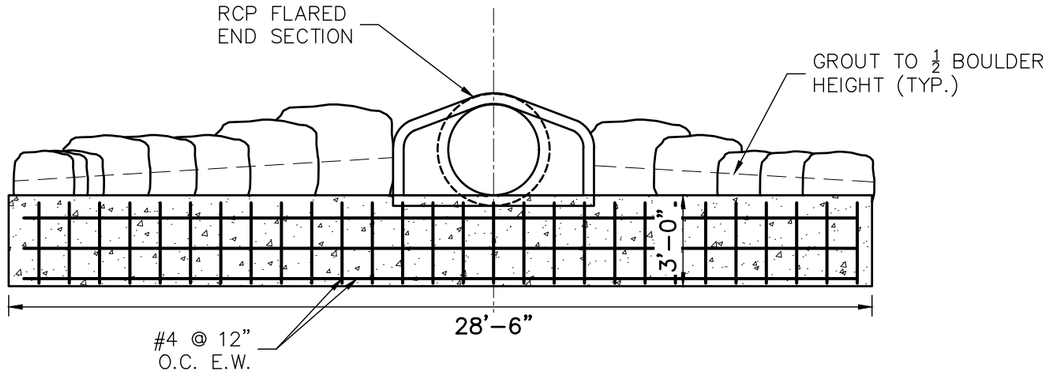
Solve For	Discharge

Input Data

Headwater Elevation		0.50	ft
Crest Elevation		0.00	ft
Tailwater Elevation		0.00	ft
Weir Coefficient		3.10	US
Crest Length		4.00	ft
Number Of Contractions	0		

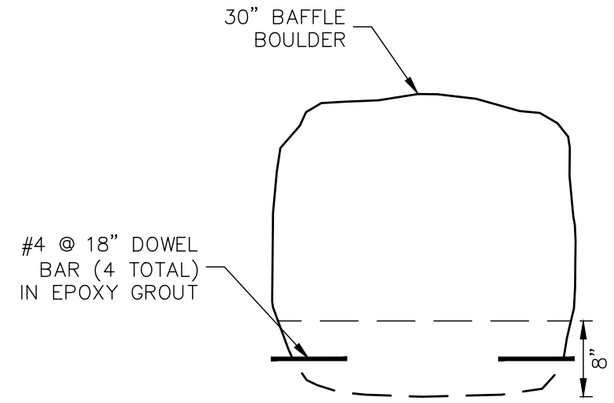
Results

Discharge	4.38	ft^3/s
Headwater Height Above Crest	0.50	ft
Tailwater Height Above Crest	0.00	ft
Flow Area	2.00	ft^2
Velocity	2.19	ft/s
Wetted Perimeter	5.00	ft
Top Width	4.00	ft



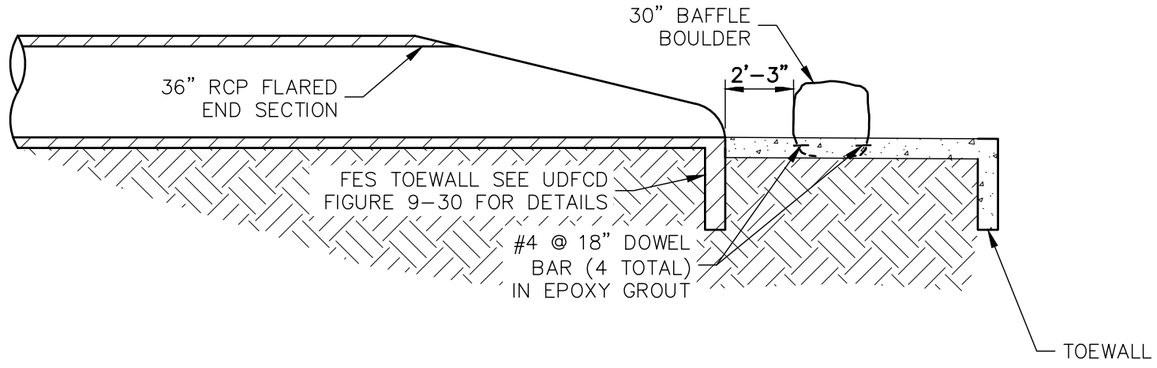
36" RCP TOEWALL FOOTING
ELEVATION VIEW

SCALE: 1" = 5'



BAFFLE BOULDER DETAIL

SCALE: NTS



TOEWALL FOOTING PROFILE

SCALE: 1" = 5'

ENERGY DISSIPATION
STRUCTURE
SOLACE APARTMENTS
JOB NO. 25174.00
5/1/20
SHEET 1 OF 1

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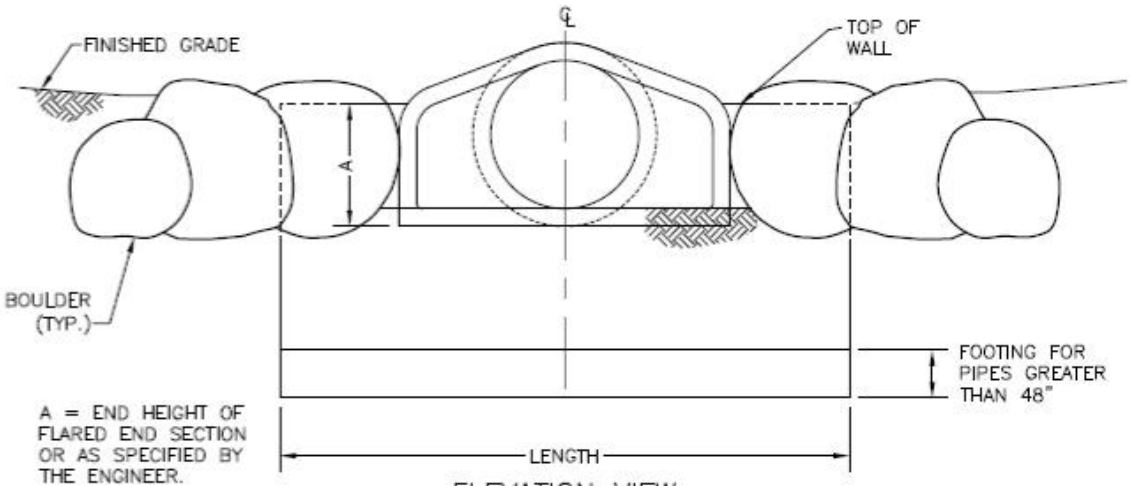
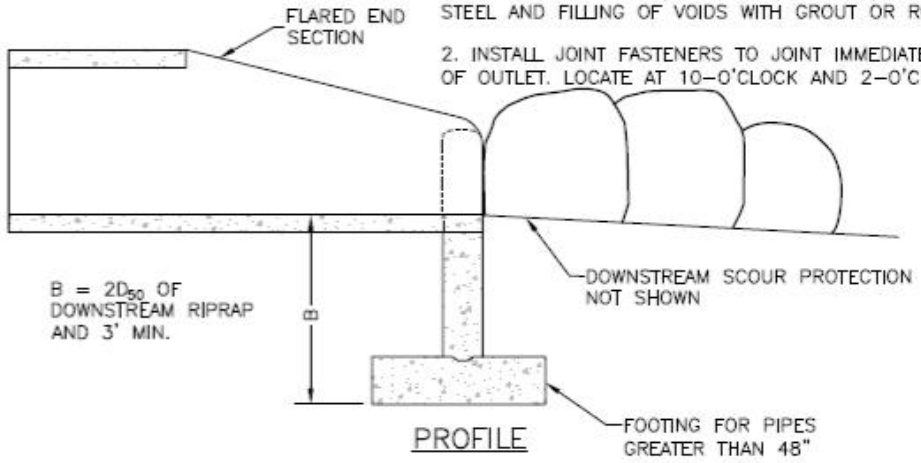


ELEVATION VIEW

NOTES:

1. IT IS THE DESIGN ENGINEER'S RESPONSIBILITY TO EVALUATE THE SITE CONDITIONS AND PROVIDE FINAL DESIGN OF BOULDER SIZES AND PLACEMENT, HEADWALL, FOOTING, REINFORCING STEEL AND FILLING OF VOIDS WITH GROUT OR ROCK.

2. INSTALL JOINT FASTENERS TO JOINT IMMEDIATELY UPSTREAM OF OUTLET. LOCATE AT 10–O'CLOCK AND 2–O'CLOCK. TRIM THREAD FLUSH WITH INTERIOR BOLTS.

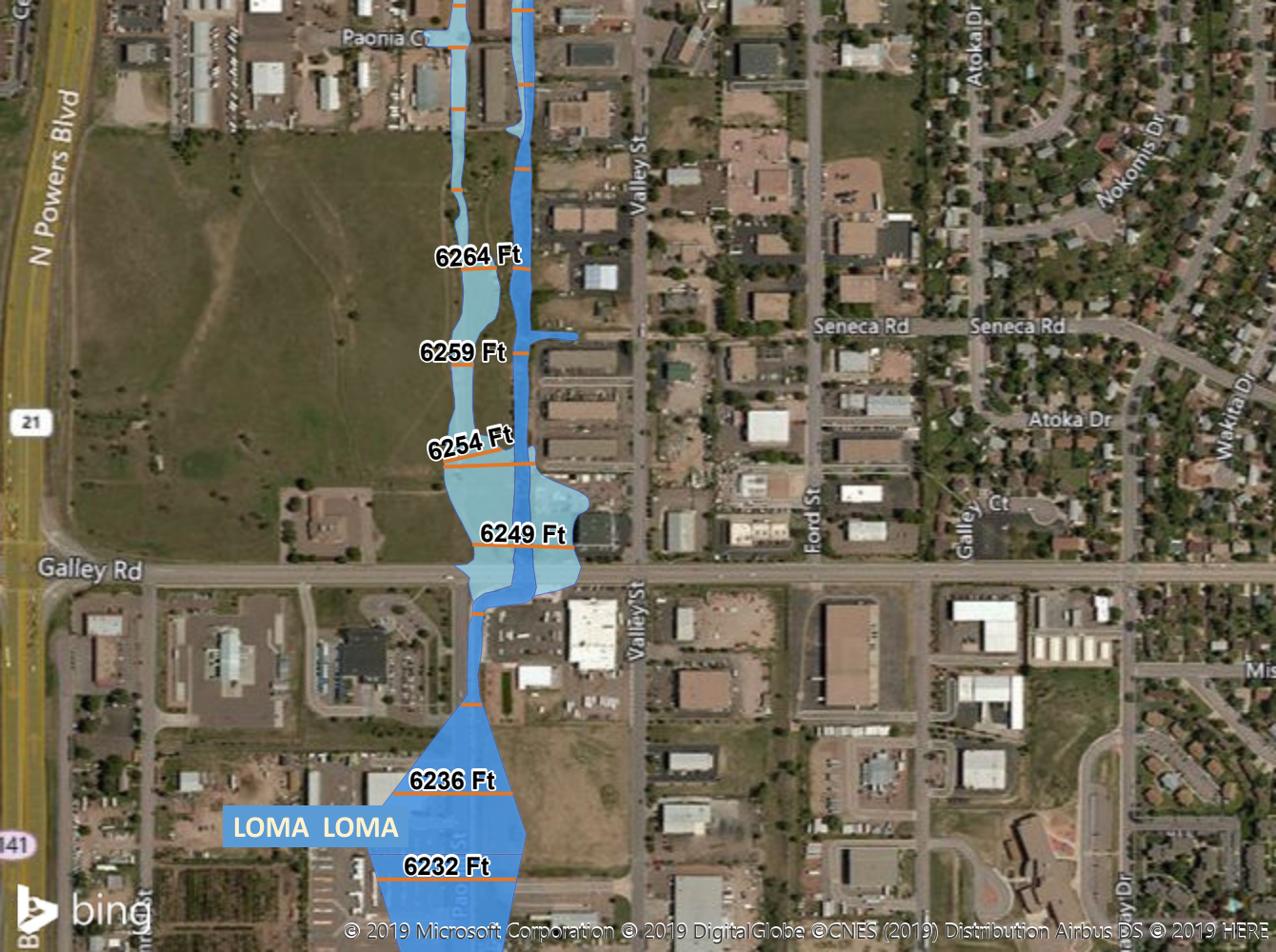


PROFILE

TOEWALL DESIGN TABLE

PIPE SIZE	LENGTH, MIN.
18"	7'–0"
24"	8'–0"
30"	10'–0"
36"	12'–0"
42"	12'–6"
48"	13'–0"
54"	13'–6"
60"	14'–0"
66"	14'–6"
72"	15'–0"

Figure 9-30. Flared end section (FES) headwall concept


6264 Ft
6259 Ft
6254 Ft
6249 Ft
6236 Ft
LOMA LOMA
6232 Ft
N Powers Blvd
Paonia Ct
Valley St
Seneca Rd
Seneca Rd
Atoka Dr
Atoka Dr
Nokomis Dr
Wakita Dr
Galley Ct
Ford St
Galley Rd
Valley St
21
141
bing
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Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Thursday, Jun 25 2020

Ex. Concrete Channel

Trapezoidal

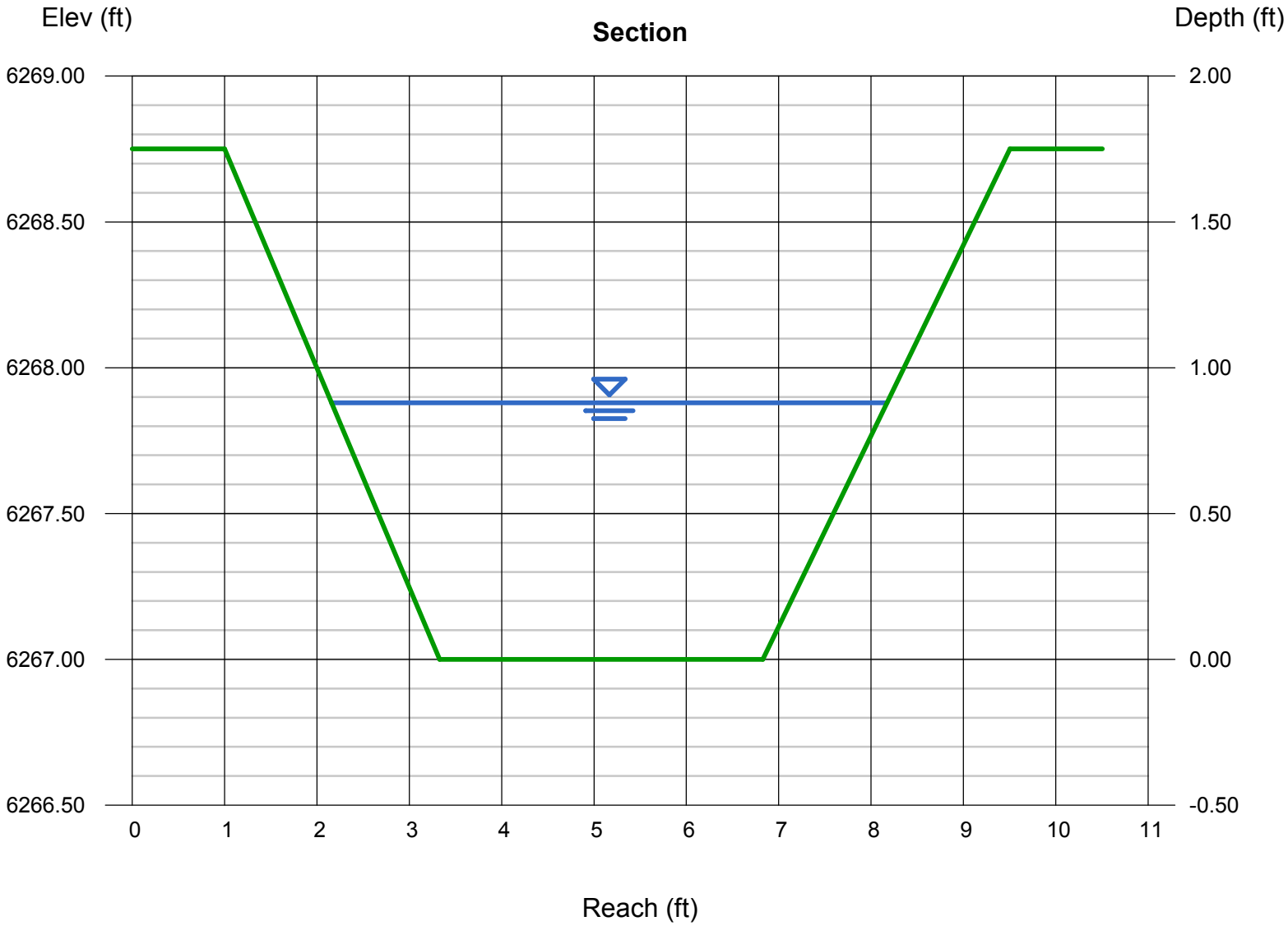
Bottom Width (ft)	= 3.50
Side Slopes (z:1)	= 1.33, 1.53
Total Depth (ft)	= 1.75
Invert Elev (ft)	= 6267.00
Slope (%)	= 1.41
N-Value	= 0.013

Calculations

Compute by:	Known Depth
Known Depth (ft)	= 0.88

Highlighted

Depth (ft)	= 0.88
Q (cfs)	= 42.08
Area (sqft)	= 4.19
Velocity (ft/s)	= 10.05
Wetted Perim (ft)	= 6.57
Crit Depth, Yc (ft)	= 1.37
Top Width (ft)	= 6.02
EGL (ft)	= 2.45



Weir Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Wednesday, Aug 26 2020

Paonia Street Weir

Compound Weir

Crest	= Sharp
Bottom Length (ft)	= 115.00
Total Depth (ft)	= 1.25
Length, x (ft)	= 80.00
Depth, a (ft)	= 0.50

Highlighted

Depth (ft)	= 1.24
Q (cfs)	= 439.00
Area (sqft)	= 125.10
Velocity (ft/s)	= 3.51
Top Width (ft)	= 115.00

Calculations

Weir Coeff. Cw	= 3.33
Compute by:	Known Q
Known Q (cfs)	= 439.00

Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Wednesday, Aug 26 2020

Overflow Channel

Trapezoidal

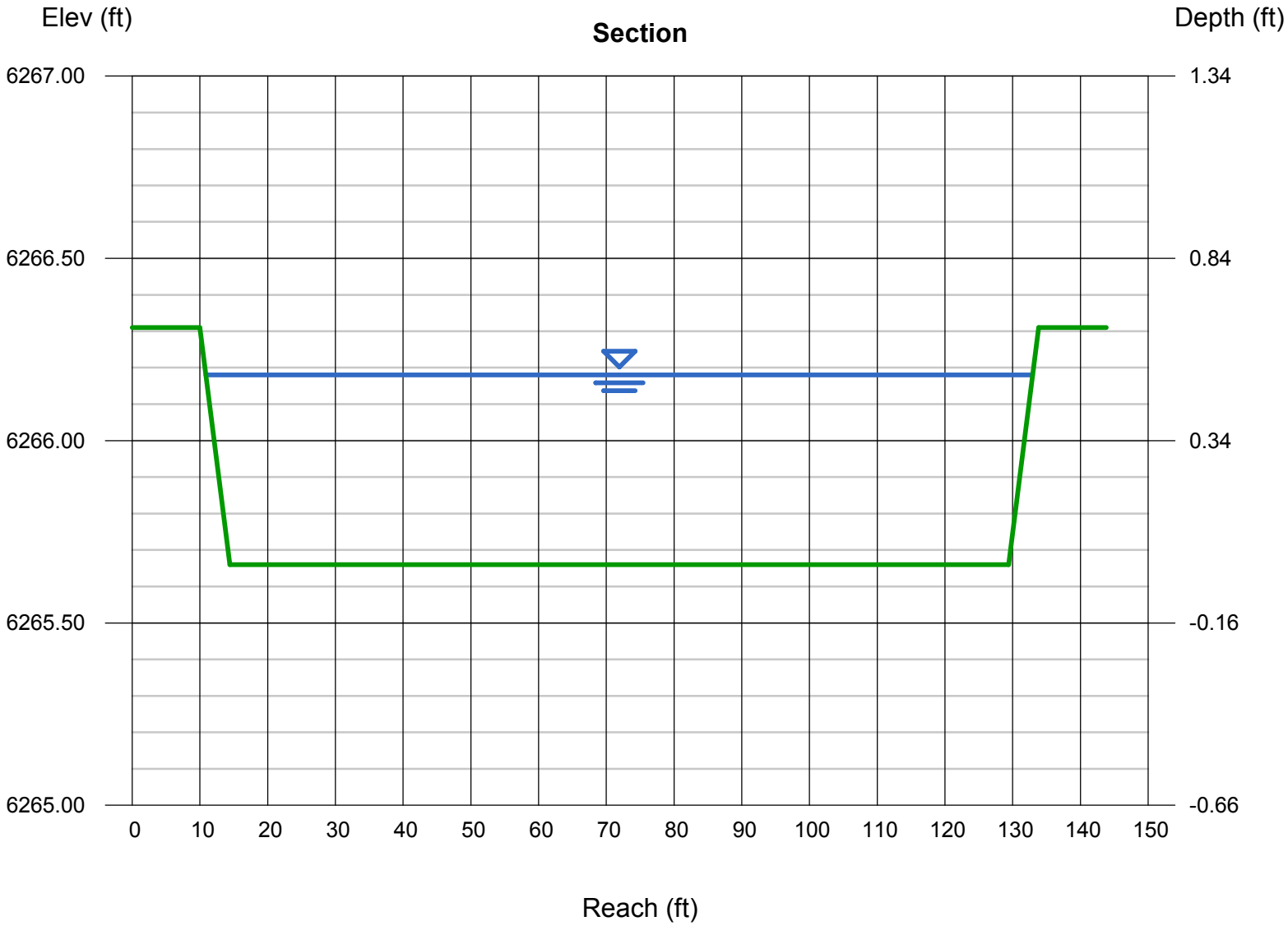
Bottom Width (ft)	= 115.00
Side Slopes (z:1)	= 6.80, 6.80
Total Depth (ft)	= 0.65
Invert Elev (ft)	= 6265.66
Slope (%)	= 1.68
N-Value	= 0.017

Calculations

Compute by:	Known Q
Known Q (cfs)	= 439.00

Highlighted

Depth (ft)	= 0.52
Q (cfs)	= 439.00
Area (sqft)	= 61.64
Velocity (ft/s)	= 7.12
Wetted Perim (ft)	= 122.15
Crit Depth, Yc (ft)	= 0.65
Top Width (ft)	= 122.07
EGL (ft)	= 1.31



Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Wednesday, Aug 26 2020

Paonia Street Ex.

User-defined

Invert Elev (ft)	= 6271.04
Slope (%)	= 1.00
N-Value	= 0.016

Calculations

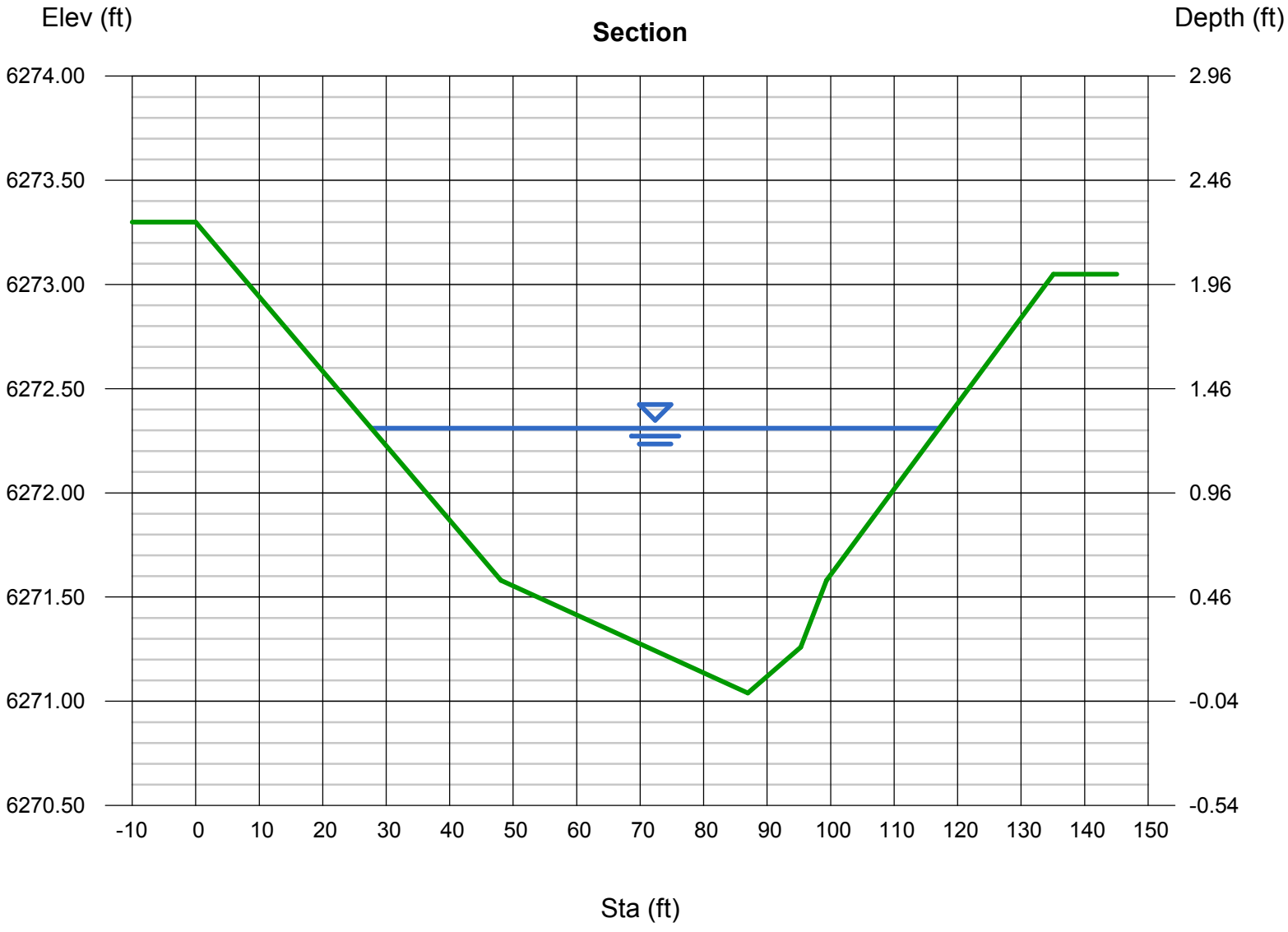
Compute by:	Known Q
Known Q (cfs)	= 500.00

Highlighted

Depth (ft)	= 1.27
Q (cfs)	= 500.00
Area (sqft)	= 66.09
Velocity (ft/s)	= 7.57
Wetted Perim (ft)	= 89.48
Crit Depth, Yc (ft)	= 1.56
Top Width (ft)	= 89.43
EGL (ft)	= 2.16

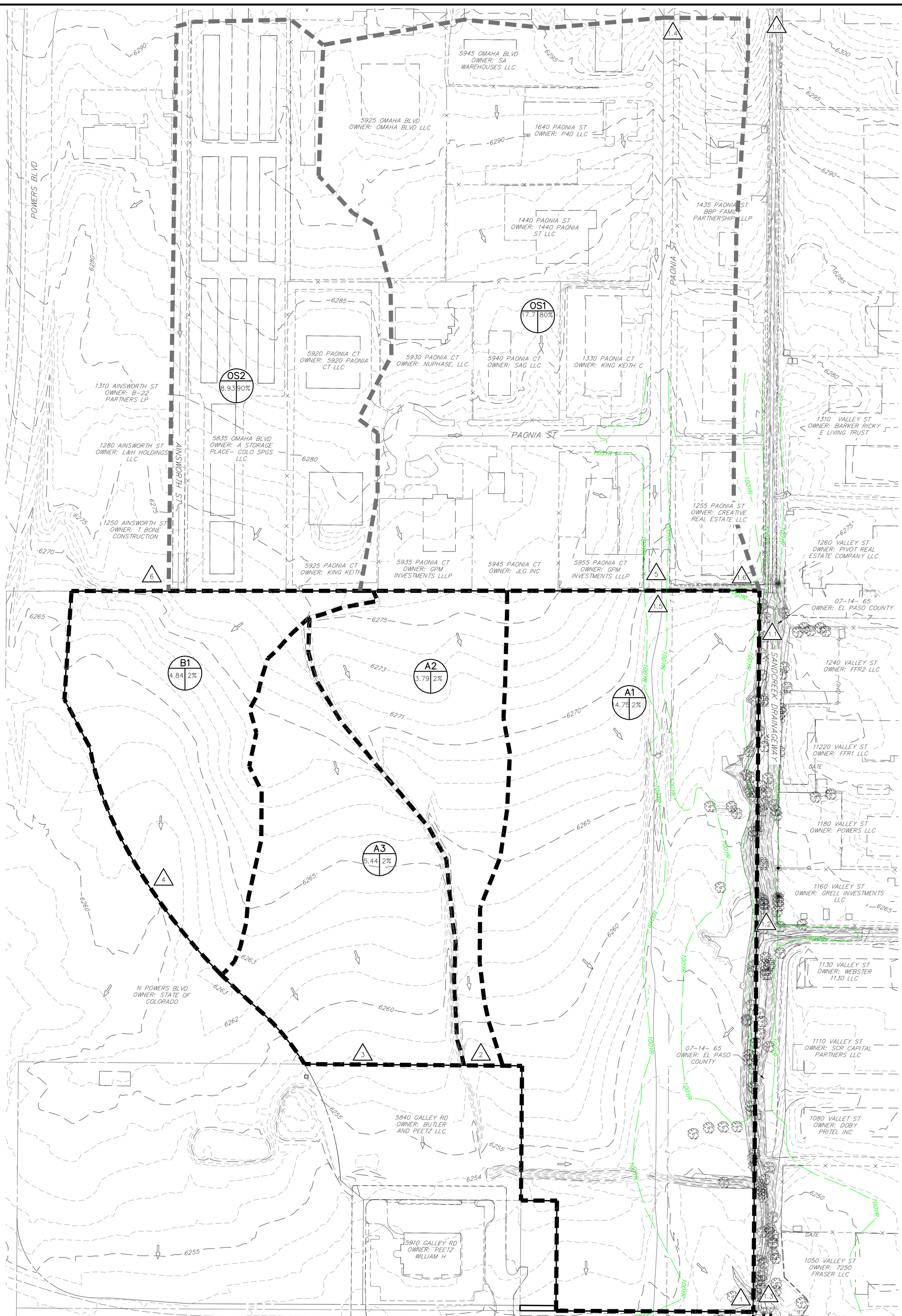
(Sta, El, n)-(Sta, El, n)...

(0.00, 6273.30)-(48.06, 6271.58, 0.016)-(86.95, 6271.04, 0.016)-(95.27, 6271.26, 0.016)-(99.33, 6271.58, 0.016)-(135.09, 6273.05, 0.016)



APPENDIX E

DRAINAGE MAPS & PLANS



DESIGN POINT SUMMARY TABLE		
DP	Q5	Q100
	Total	Total
1	3.1	21.0
2	0.9	6.2
3	1.4	9.5
4	1.3	9.0
5	36.7	573.1
6	28.4	52.9
1.0	-	760.0
1.1	-	720.0
1.2	-	960.0
1.3	-	1340.0
1.4	-	500.0
1.5	-	244.0
1.6	-	42.1

BASIN SUMMARY TABLE							
Tributary Sub-basin	Area (acres)	Percent Impervious	C_5	C_{100}	t_c (min)	Q_5 (cfs)	Q_{100} (cfs)
A1	14.75	2%	0.09	0.36	32.5	3.1	21.0
A2	3.79	2%	0.09	0.36	25.4	0.9	6.2
A3	5.44	2%	0.09	0.36	22.7	1.4	9.5
B1	4.84	2%	0.09	0.36	20.3	1.3	9.0
OS1	17.73	80%	0.59	0.70	15.1	36.7	73.1
OS2	8.93	90%	0.73	0.81	8.6	28.4	52.9

LEGEND:

- 6200 — EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- DRAINAGE BASIN
- A / B / C — A = BASIN DESIGNATION; B = AREA IN ACRES; C = PERCENT IMPERVIOUS
- 1 — DESIGN POINT
- HP — HIGH POINT
- LP — LOW POINT
- EXISTING DRAINAGE ARROW

N

85 43 0 85 170

ORIGINAL SCALE: 1" = 85'

EXISTING DRAINAGE MAP
SOLACE APARTMENTS
JOB NO. 25174.00
8/26/20
SHEET 1 OF 1

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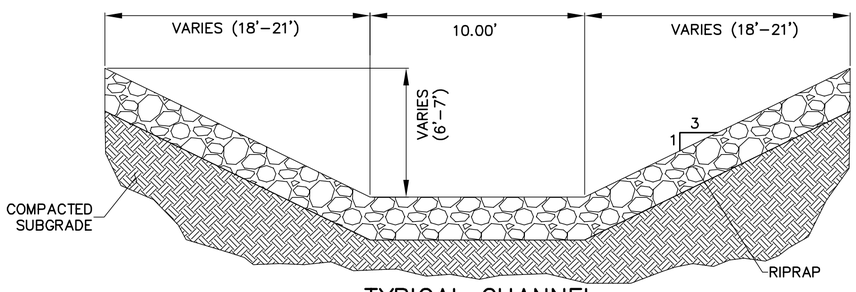
DESIGN POINT		
DP	Q5 Total	Q100 Total
1	15.3	36.3
2	21.2	50.0
3	1.3	4.6
4	36.7	573.1
5	28.4	52.9
6	0.6	1.9
1.0	-	760.0
1.1	-	720.0
1.2	-	960.0
1.3	-	1340.0
1.4	-	500.0

BASIN SUMMARY TABLE

Tributary Sub-basin	Area (acres)	Percent Impervious	C_5	C_{100}	t_c (min)	Q_5 (cfs)	Q_{100} (cfs)
A1	9.13	44%	0.43	0.61	11.6	15.3	36.3
B1	16.23	45%	0.43	0.60	20.7	21.2	50.0
B2	1.61	17%	0.22	0.45	13.0	1.3	4.6
C1	0.65	20%	0.24	0.47	13.8	0.6	1.9
OS1	17.73	80%	0.59	0.70	15.1	36.7	73.1
OS2	8.93	90%	0.73	0.81	8.6	28.4	52.9

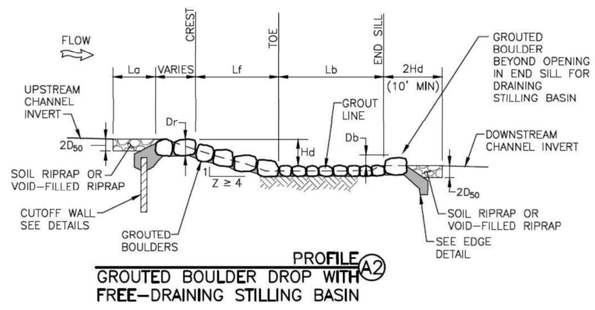
LEGEND:

- PROPOSED STORM SEWER
- 6200 PROPOSED MAJOR CONTOUR
- PROPOSED MINOR CONTOUR
- 6200 EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- DRAINAGE BASIN
- A = BASIN DESIGNATION; B = AREA IN ACRES; C = PERCENT IMPERVIOUS
- 1 DESIGN POINT
- HP HIGH POINT
- LP LOW POINT
- DRAINAGE ARROW
- EXISTING DRAINAGE ARROW



TYPICAL CHANNEL SECTION

SCALE: NTS



PROFILE A2

GROUTED BOULDER DROP WITH FREE–DRAINING STILLING BASIN

DROP STRUCTURE DETAIL

SCALE: NTS

85 43 0 85 170

ORIGINAL SCALE: 1" = 85'

DRAINAGE MAP
SOLACE APARTMENTS
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8/26/20
SHEET 1 OF 1

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