

**CONDITIONAL LETTER OF MAP REVISION (CLOMR)
FOR HAPPY CANYON CREEK AT BELFORD AVENUE
TOWN OF PARKER, COLORADO**

A Part of the NE $\frac{1}{4}$ of Section 7, SE $\frac{1}{4}$ of Section 6 and SW $\frac{1}{4}$ of
Section 5 of Township 5 South and Range 66 West of the 6th P.M.,
Douglas County, Colorado

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FHU Project No. 115360-01

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I. GENERAL LOCATION AND DESCRIPTION

A. Location

Compark South plans to develop the land surrounded by E-470 on the north, Grandview Estates on the south, Chambers Road on the east, and Peoria Street on the west. Compark South is planning on a single family residential subdivision with a regional trail. Belford Avenue is a proposed local roadway connection that will cross over Happy Canyon Creek. The project limits for Belford Avenue are from Chambers Road on the east to Peoria Street on the west. The project limits for the proposed channel work are from approximately 1500 feet upstream of Belford Avenue to approximately 500 feet downstream including a new bridge structure. The bridge, channel and associated trail improvements are located within the Town of Parker boundary, with part of the roadway located in unincorporated Douglas County. The total length of the new roadway is approximately 1.90 miles (10,000 feet).

The surrounding area consists of the following:

- Arapahoe County Water and Wastewater Authority (ACWWA) facility to the southeast.
- Grandview Estates on the south, single family residential subdivision.
- Happy Canyon and Cherokee/470 regional trails.
- Undeveloped land on both sides of Happy Canyon Creek owned by Compark.

The Happy Canyon Creek project is in the northeast $\frac{1}{4}$ of Section 7, southeast $\frac{1}{4}$ of Section 6, and southwest $\frac{1}{4}$ of Section 5 of Township 5 South, Range 66 West of the 6th P.M. in Douglas County, Colorado (see **Figure 1**).

B. Description of Property

The project will include the following proposed roadway improvements that will improve traffic conveyance and increase safety in the area:

- Belford Avenue connection from Chambers Road on the east to Peoria Street on the west.
- Future development of residential and commercial properties.
- Improvements at Happy Canyon Creek include a new bridge crossing, new trail crossing, a trail connection under Belford Avenue, drop structures, and associated channel improvements.

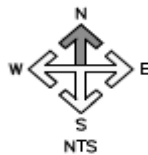
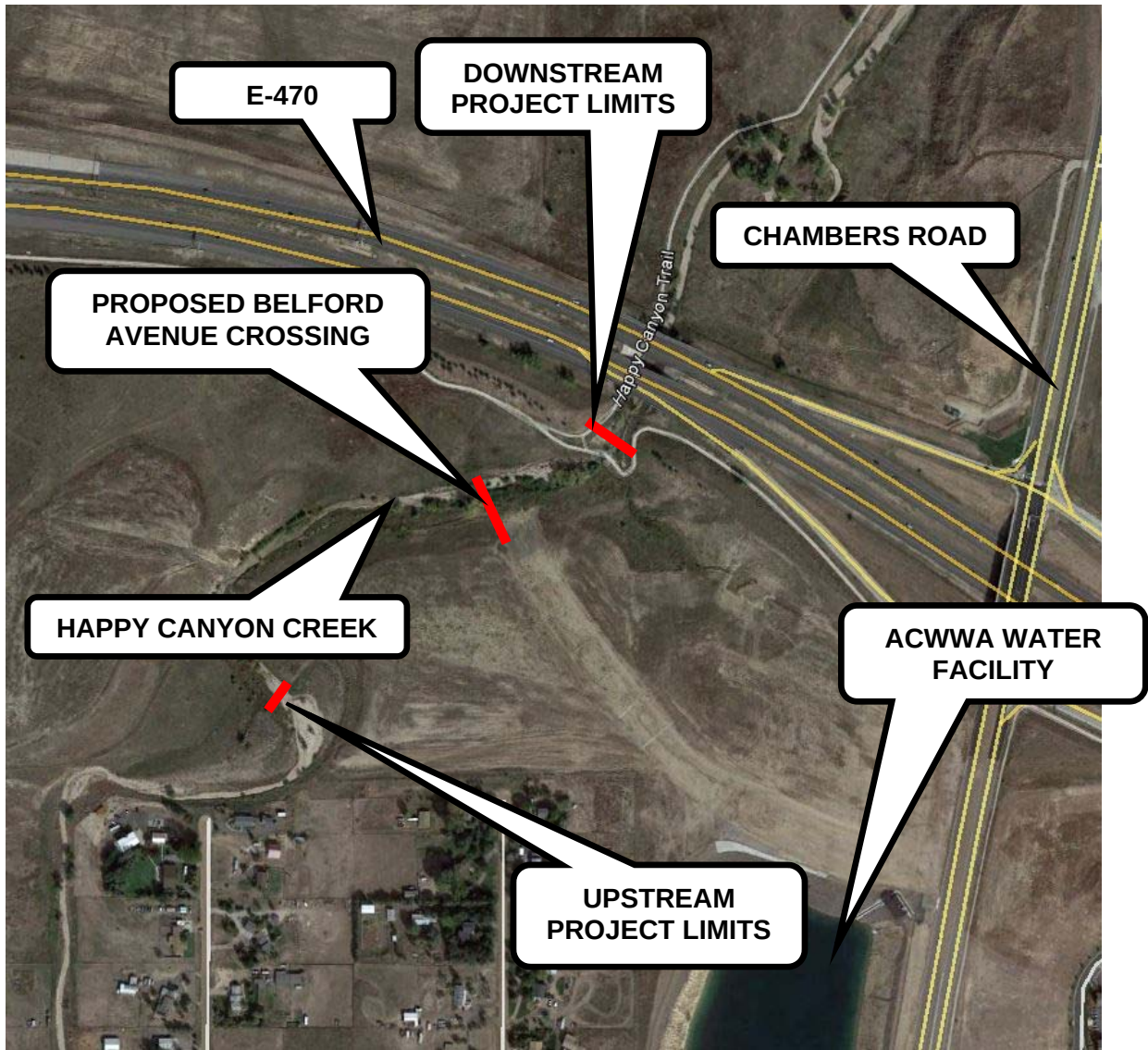


Figure 1. Vicinity Map

The National Resource Conservation Service has mapped the area as having the soil types shown on **Figure 2** and listed in **Table 1 (Reference 3)**. Ground cover currently consists of weeds, native grasses, and non-vegetated ground.

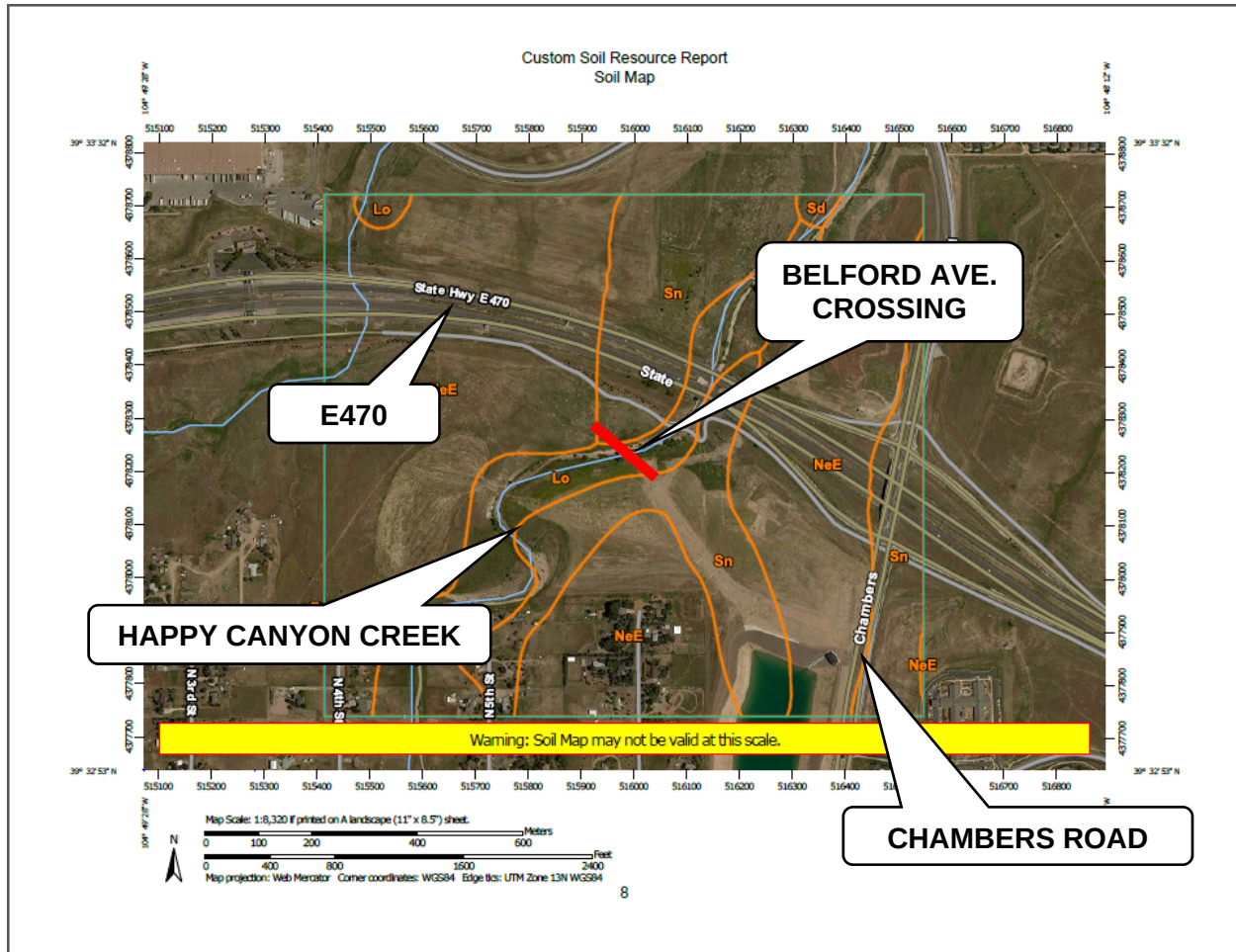


Figure 2. National Resource Conservation Service Map

Table 1. Area Soil Types

Soil Name	Map Symbol	HSG	Runoff Potential	Soil and Water Erosion Hazard
Fondis clay loam, 1 to 3 percent slopes	FoB	C	Medium	Moderately low to moderately high
<i>Loamy alluvial land</i>	<i>Lo</i>	<i>C</i>	<i>Very Low</i>	<i>Moderately high to high</i>
Newlin gravelly sandy loam, 8 to 30 percent slopes	NeE	B	Medium	Moderately high to high
Sandy alluvial land	Sd	A	Negligible	High to very high
<i>Satanta loam</i>	<i>Sn</i>	<i>B</i>	<i>Low</i>	<i>Moderately high to high</i>

Notes:

HSG = Hydraulic Soils Group as defined by the National Resource Conservation Service

Soils identified in the immediate project area are *italicized*

Soils in the immediate area include Loamy alluvial land and Satanta loam. The surrounding areas slope primarily from the southeast to the northwest with varying grades.

II. DRAINAGE BASINS

A. Major Basin Description

Happy Canyon Creek Major Basin

The Happy Canyon Creek watershed has a drainage area of 17.5 square miles from its headwaters in the City of Castle Pines to its confluence with Cherry Creek. Happy Canyon Creek flows primarily from southwest to the northeast throughout parts of Douglas County, Arapahoe County, Town of Parker, and the City of Lone Tree. Happy Canyon Creek is approximately 12.8 miles in total length.

Muller Engineering completed a Flood Hazard Area Delineation (FHAD) (July 2014) for the Urban Drainage and Flood Control District (UDFCD) and the Southeast Metro Stormwater Authority (SEMSWA) (**Reference 5**). The FHAD determined potential flood hazards along Happy Canyon Creek from its headwaters down to its confluence. The floodplain delineation was completed for the 100-year and 500-year floodplain (**Figure 3** and **Figure 4**) as well as 0.5-foot and 1.0-foot floodway encroachments. A Major Drainageway Plan (MDP) was also completed in March 2014 by Muller Engineering (**Reference 6**) addressing the same flood hazards as the FHAD.

There are currently two effective Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps (FIRMs) for Happy Canyon Creek near the project vicinity (both revised March 16, 2016). Map number 08035C0062G defines the upstream drainage and map number 08035C0066G defines the downstream drainage (see **Figure 5**, **Figure 6**, and **Reference 1**). The effective FIRMs define a floodplain, floodway, and base flood elevations for Happy Canyon Creek. The effective Flood Insurance Study (FIS), revised February 17, 2017, for the site (**Reference 8**) includes a flow rate approximately 5,000 feet upstream of this project. Both the FIRM and the FIS were based on a FHAD that was released in November 1977 by Howard, Needles, Tammen, & Bergendoff (**Reference 4**).

A preliminary revised FIRM (**Figure 6** and **Reference 2**) was completed on June 30, 2016 based on the FHAD. At the time this document was prepared, the preliminary revised FIRM is being reviewed, but has not yet been accepted by FEMA. The approach for this CLOMR has been coordinated with UDFCD and was determined that the data utilized as part of the Preliminary FIRM would be used for this project in anticipation of acceptance for the floodplain and floodway delineation of Happy Canyon Creek.

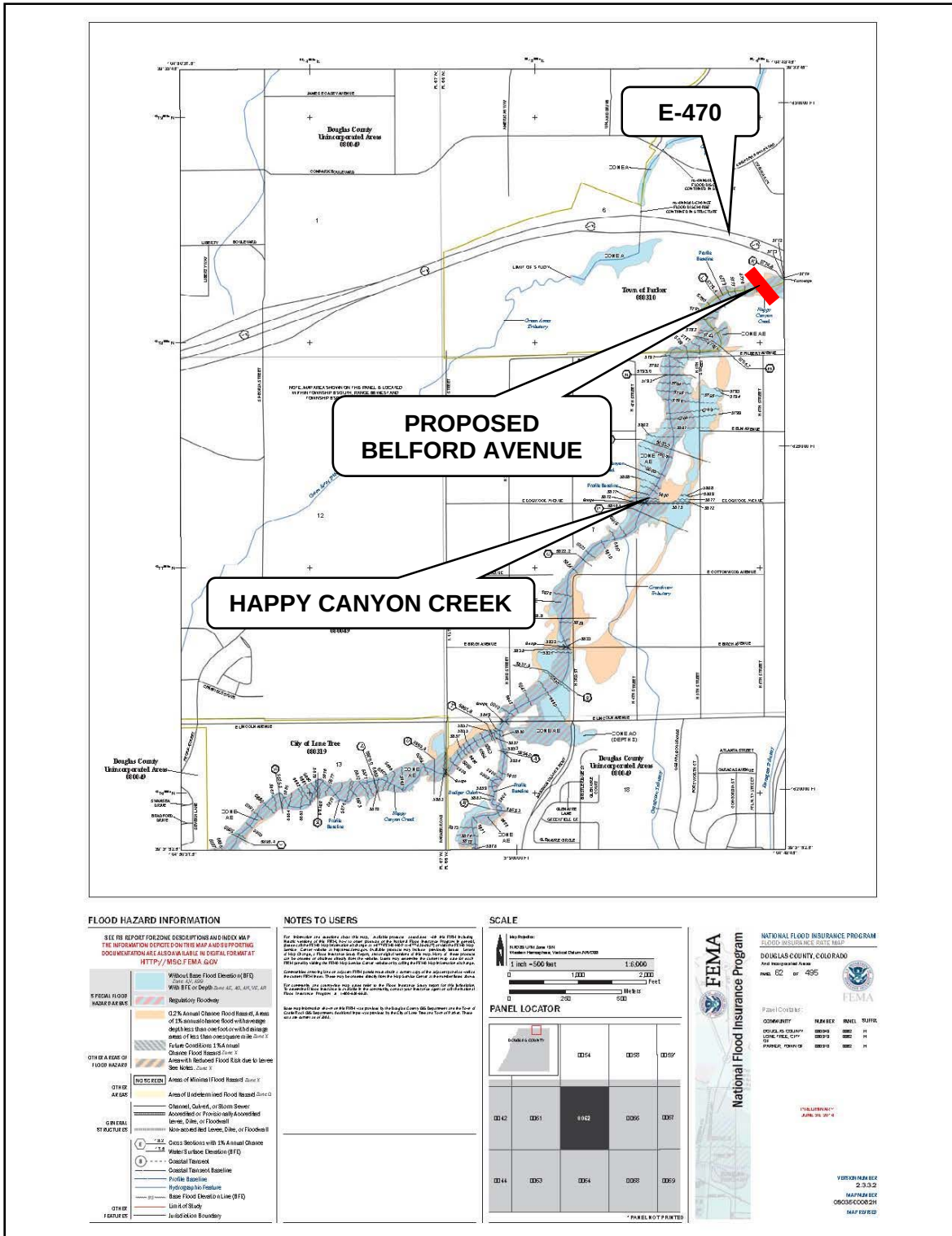
Table 2. Happy Canyon Creek Peak Flows near Project Area

Drainageway	Reference	10-Year	50-Year	100-Year	500-Year
Happy Canyon Creek	FEMA (Effective FIS) *	2,350	4,450	5,610	8,660
	FHAD (Future Flows) **	2,656	6,249	8,355	12,107

Notes:

* Approx. 5,000 ft. upstream of project site.

** Flow rates used for design from the FHAD. Flows at Stonegate Tributary Confluence.



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Refer to **Appendix B** for full size preliminary FIRM Panels 08035C0062H and 08035C0066H.

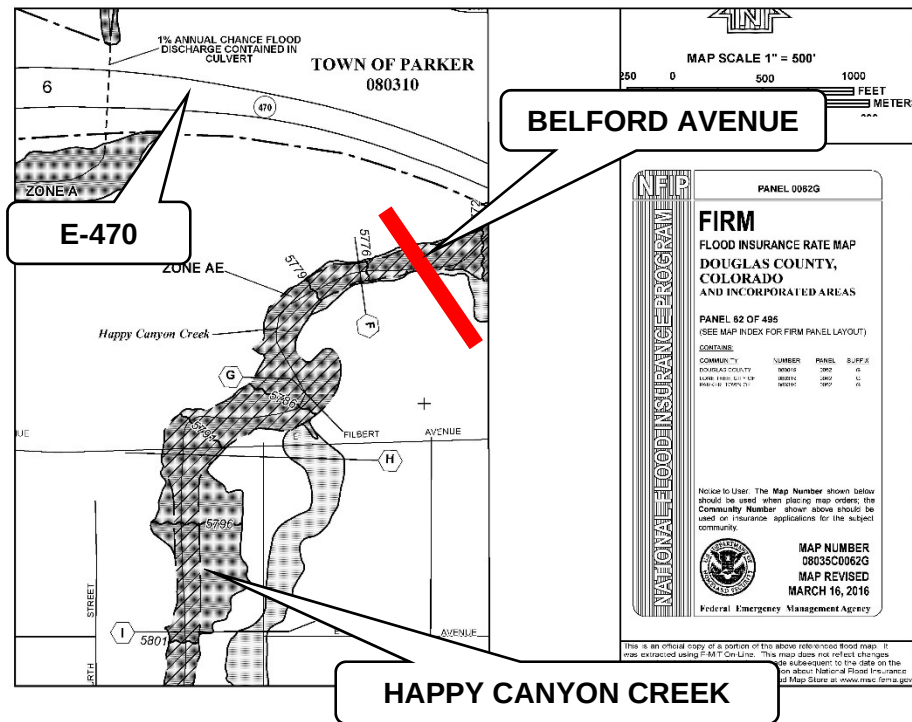


Figure 5. Effective Flood Insurance Rate Map 08035C0062G

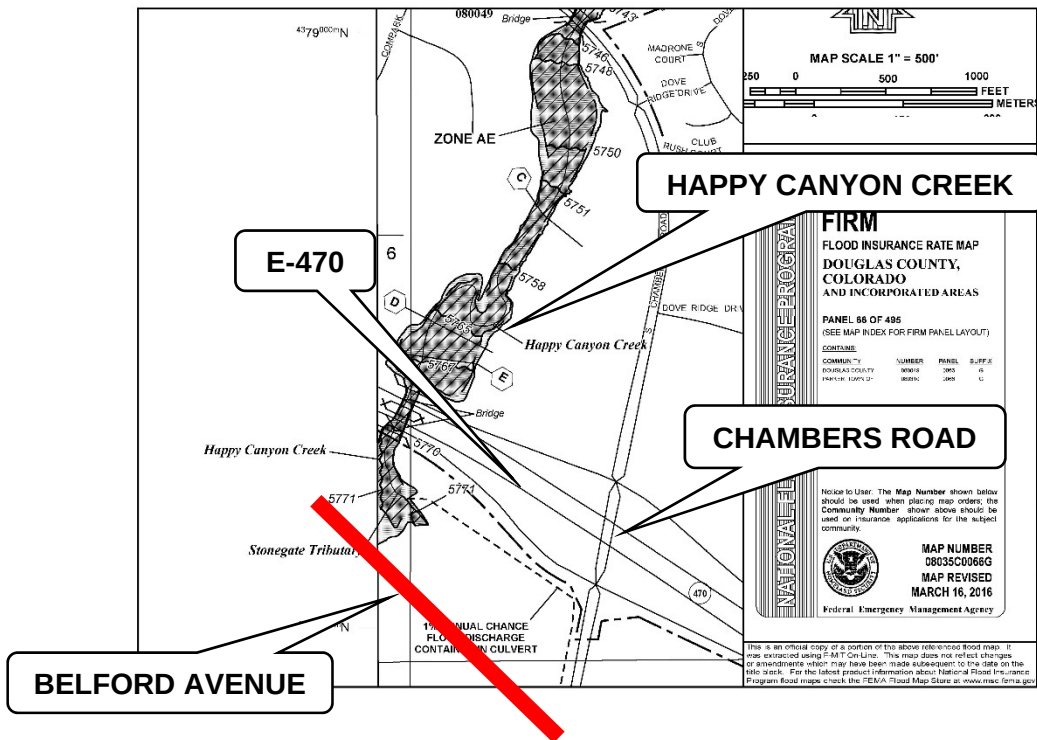


Figure 6. Effective Flood Insurance Rate Map 08035C0066G

III. DRAINAGE FACILITIES DESIGN

A. General Concept

Compark plans to develop the area south of E-470 and will add a connection between Chambers Road and Peoria Street via Belford Avenue. Belford Avenue will cross over Happy Canyon Creek via a new bridge structure. The Belford Avenue crossing over Happy Canyon Creek will be approximately 560 feet south of E-470 and 2,000 feet west of Chambers Road. As part of the development, the Cherokee Trail (parallel to E-470) will also be reconstructed with a new multi-cell reinforced concrete box culvert (RCBC) crossing. There will also be three drop structures constructed including a realigned low-flow segment of Happy Canyon Creek through the proposed Belford Ave. bridge section. Both the 2014 FHAD and MDP include recommendations for Happy Canyon Creek throughout the project limits. Those recommendations are listed below.

B. Specific Details

The Happy Canyon Creek channel will be modified upstream and downstream within the project limits of Belford Avenue. Below is a summary of the existing and proposed conditions related to the improvements associated with this project. Both the FHAD and MDP recommendations were accounted for during the design.

Happy Canyon Creek at Belford Avenue is located in Reach 8 as defined by the FHAD and the MDP. Per the FHAD, the reach has a dry, sandy bottom with some wetland vegetation. There are some cottonwood trees, native grasses, and shrubs. The stream is well defined upstream of E-470 with a couple of steep banks evident of head cutting. The existing channel slope through the project limits is approximately 0.8 percent. The 100-year flow velocities in the existing channel range from about 4 feet per second to 15 feet per second within the project limits. The Froude numbers in the existing channel range from about 0.18 (on the upstream side of the existing trail crossing) to 0.96. The existing channel alignment for Happy Canyon Creek was developed based on aerial survey performed and provided by Manhard Consulting.

There is currently aggradation in this reach with specific grade control structures suggested by the MDP. Erosion concerns will be addressed while keeping the channel in its most natural form to also minimize sensitive wetland habitat.

Happy Canyon Creek is conveyed under the existing Cherokee Trail via two 24-inch corrugated metal pipe culverts that pass very minor base flows. Sediment deposition has been a major maintenance issue at the crossing. Per the MDP, a multi-cell 20-foot by 3-foot CBC is suggested to assist with maintenance and convey more frequent runoff flows as the surrounding area develops. Downstream of the existing trail, there is riprap protection on both sides of the main low-flow channel banks.

Recommendations are made for the confluence of Happy Canyon Creek and Stonegate Tributary. Currently, Stonegate outlets via 42-inch concrete pipe culvert into Happy Canyon Creek on the east side. The swale in between the active Happy Canyon Creek channel and the pipe outlet is unstable and actively degrading. The MDP recommends filling in the ineffective floodplain fringe area near the outlet pipe to assist with conveyance of the 100-year and 500-year storm events more efficiently upstream of the existing E-470 bridges. The proposed fill area has been coordinated with UDFCD and the Town of Parker.

The channel improvements include three grouted sloping boulder (GSB) drop structures, a small section of realigned low-flow channel and existing channel toe protection along the active low-flow channel to preserve existing embankment beyond the toe as identified in the MDP and verified based on site conditions. Toe protection within the channel was provided based on recommendations provided in the MDP per the future 2-year flow and water surface elevation of approximately 3 feet. The three GSBs are located upstream of Belford Avenue.

All three crest elevations of the GSBs were based on the assumed future equilibrium channel slope of 0.3 percent as described in the MDP. All three GSB drop structures will have an 8-foot approach soil riprap section and steel sheet piles extending out to 1 foot above the 100-year water surface elevation. The main objective for the drop structure design, minor channel improvements and associated revetment is to provide grade control and stabilization per the MDP as well as minimize the disturbance to the existing channel, associated vegetation, and minimize impacts to existing wetlands.

The two most upstream GSBs will primarily be contained to the existing active low-flow channel section and remain buried until the anticipated future equilibrium slope is achieved as the surrounding area develops and runoff rates increase. The low-flow channel realignment section associated with the GSB upstream of Belford Ave. is being proposed to direct the low-flow channel section away from the proposed piers for the new bridge structure. The low-flow channel will be 25 feet wide and connect into the existing low-flow channel section just north of the proposed bridge. This section of low-flow channel will have a 0.3 percent longitudinal slope.

The proposed Belford Ave. bridge crossing will be a two span, single pier crossing that spans 150 feet total, with each span measuring 75 feet. The proposed roadway and bridge crossing is aligned perpendicular to the channel. The bridge will be built in two phases, with the south half being built first, then the north half in the future as the area develops. The total length of the bridge is 93 feet. The proposed concrete piers are 48 inch drilled caissons extending into bedrock. There will be a pedestrian trail on the west side (Regional Trail) of the bridge crossing and a maintenance access path on the east side. The pedestrian trail and the maintenance access path are both 10 feet wide. Both the pedestrian trail and maintenance access have a vertical clearance at the abutment of 10 feet. The proposed elevation of both paths have been designed to keep inundation minimized recognizing the FHAD and MDP future 5-year storm event. The Regional Trail will include a wall adjacent to the creek under the Belford Ave. bridge section to aide against potential sediment accumulation and minimize inundation up to the future 5-year storm event on the trail. The pier, both abutments, and both path embankment areas where applicable will be protected by riprap revetment. The adjacent fill slopes from Belford Avenue near the bridge section are 4:1. The 100-year and 500-year storm events will be conveyed within the proposed bridge section and not overtop Belford Ave.

The alignment of Belford Avenue is adjacent to ACWWA's emergency overflow section for the reservoir along the west side of Chambers Road. It is anticipated that Belford Avenue will provide a conveyance of the emergency overflow in the event the spillway is utilized. The proposed Belford Avenue vertical alignment continues west down grade towards Happy Canyon Creek with a proposed sump condition for the roadway west of the western abutment for the new bridge. Overtopping protection will be added to the abutments on both the north and south sides of the road to accommodate emergency overflows from the spillway.

The existing Cherokee Trail crossing culverts will be replaced by a new multi-cell 20-foot by 3-foot RCBC. To achieve clearance for the RCBC, the existing trail will be replaced with a new trail. The new trail will be straight-lined across the channel and will be raised slightly higher than

the existing trail elevation at Happy Canyon Creek. The new trail will have overtopping protection on both the upstream and downstream sides. Overtopping protection (soil riprap) has been sized and provided at the trail crossing according to the future 10-year storm event identified in the FHAD. The MDP provided a conceptual longitudinal slope for the trail crossing that included a drop structure immediately upstream of the crossing. Coordination with the Town of Parker and UDFCD concluded that maintenance may be an issue with the configuration and the drop structure was removed with the new invert elevations of the multi-cell box aligning with the existing channel invert elevations to facilitate potential sediment accumulation on the downstream side of the crossing to ease with anticipated maintenance operations.

The improvements will stabilize this reach of Happy Canyon Creek. The proposed drop structures and channel revetment will help stabilize the channel and are in general design conformance per the suggested improvements outlined in the MDP.

IV. HYDRAULIC ANALYSIS

A. HEC-RAS

Effective Model

The effective model was derived from the hydraulic model produced for the April 24, 2003 Letter of Map Revision (LOMR), provided by UDFCD. The LOMR was based on the 1977 FHAD WSPRO data. It included the 1977 FHAD sections 53, 52, 51, 50, 61, 49, and 48. Section 48 corresponds to the effective FIS section F, with LOMR section 9700 corresponding to the effective FIS section E. Section E was used as the downstream tie-in section. To tie into effective FIS section G, section 47A from the 1977 FHAD was utilized. With no cross section data for 47A in the 1977 FHAD (WSPRO) tables, 47A was included using 2 foot contours on the plan view in the 1977 FHAD. Reach lengths were calculated and Manning's n's were used accordingly based on field observations. Section G from the FIS is the upper tie-in section just north of Grandview Estates within the Compark right-of-way.

The Effective Model water surface elevations are on the North American Vertical Datum, 1988 (NAVD 88) datum. The Belford Avenue connection project is also on the NAVD 88 datum and survey was provided by Manhard Consultants. The Effective Model is included in **Appendix B** for information. (Note: The 500-year floodplain has been included with this study and analysis.) The Effective, Duplicate Effective, Corrected Effective, Pre-project, and Post-project conditions were modeled using HEC-RAS (4.1.0).

Duplicate Effective Model

The Duplicate Effective Model consisted of input of the Effective Model data. The Duplicate Effective Model is included in **Appendix C** for information.

Corrected Effective Model

The Corrected Effective Model does not reflect any man-made physical changes since the date of the Effective Model. In anticipation of the 2014 FHAD becoming effective within the next year, the FHAD hydraulic model was obtained from UDFCD and used as the base of the corrected effective model. Elevations were taken from 2-foot interval topography obtained from the Denver Democratic National Convention (DNC) LIDAR survey by Sanborn Geospatial. Manning's n's were based off aeriels and photos. Cross sections outside of the project limits were taken out of the model, with a new boundary condition set to the most downstream section.

In addition to the existing sections, 13 new sections were added and one existing section was deleted. The existing section was deleted so that the existing Cherokee Trail crossing could be accurately modeled. The FHAD had previously modeled the trail as completely blocked, so the channel bottom elevation was set at the trail crossing elevation. The inclusion of the existing trail was done to provide a comparison between the pre- and post-project trail crossing water surface elevations. The sections were added to provide a comparison between pre- and post-project conditions around the proposed Belford Avenue crossing and the proposed channel improvements.

Topography was then updated with the most up-to-date survey for the project. Elevations were based off of 1-foot interval contours taken from a flown survey performed in November 2015. All of the sections within the project limits, with the exception of a portion of the most upstream sections, 12694, were within the flown survey limits. All Manning's n's were kept consistent with the values in the effective model.

Within the project limits, the reach lengths differ slightly between the effective model and the corrected effective model. The reach length for the effective model was based off of the effective FIS and was 2685 feet through the project limits. The corrected effective model reach was based off of flown survey and was found to be 2670.23 feet through the project limits. The corrected effective reach was 14.77 feet shorter than the effective model, due to updated project survey and natural occurring low-flow channel geometry changes. The corrected effective model is included in **Appendix D** for information.

Pre-project Conditions Model

The Pre-project Conditions Model is a revision of the Corrected Effective Model that has been modified to reflect changes that have occurred within the floodplain since the date of the Effective Model but prior to construction of the project for which the revision is being requested. Because no changes have occurred since the date of the Corrected Effective Model, the Corrected Effective Model is also the Pre-project Conditions Model.

Post-project Conditions Model

The Post-Project Conditions Model consists of the Pre-project Conditions Model with the proposed Belford Avenue crossing, the realigned low-flow section of Happy Canyon Creek, the new bridge crossing, and the proposed trail connection and RCBC. Seven sections were added to this model and four existing sections were removed. These new sections were added to the locations of the proposed drop structure, although no change in the topography will occur. There is a difference in reach length of approximately 25 feet between the corrected effective model and the post-project conditions model that can be attributed to the realigned section of Happy Canyon Creek near the upstream face of the Belford Ave. crossing. The post-project conditions model is included in **Appendix E** for information.

The results of the hydraulic analysis are presented in a preliminary floodplain comparison table for the various models and have been included in **Appendix F** for information.

V. SUMMARY

If the proposed improvements are built per plan, the floodplain and floodway as shown on the hydraulic analysis and drawings will not cause overtopping of Belford Ave. and do not impact any habitable structures, but it will cause a rise when compared to the existing conditions (pre-project) water surface elevations for the 100-year floodplain/floodway, all of which will be contained entirely within the existing Compark right-of-way. The results of the improvements to the crossing by providing a new crossing, channelization, and drop structures will benefit the traveling public and adjacent property owners as well as reduce future maintenance efforts on Happy Canyon Creek at Belford Avenue and the Cherokee Trail.

The floodway was defined by being set equal to the floodplain section for this reach of Happy Canyon Creek. According to the 2014 FHAD, the floodway was generally set equal to the floodplain because of the channel cross section geometry and is contained within a well-defined channel. Ineffective flows were also set to be consistent with the 2014 FHAD which is also the basis for the pending Preliminary FIRM being reviewed by FEMA. Ineffective flow areas were added to sections just upstream or downstream of structures for contraction and is a typical modeling approach when bridge structures are present.

Sediment transport was not considered part of this CLOMR Report. The proposed drop structures, channel toe protection and revetment will aid against the potential for erosion within the project limits. Additional sediment transport and mitigation measures for Happy Canyon Creek are addressed in the MDP and included in the appendices for reference.

It is anticipated that a LOMR will be required once project construction is complete. The LOMR will be coordinated with the Town of Parker and will be submitted to FEMA for approval.

CERTIFICATION STATEMENT

"I hereby affirm that this document entitled CLOMR for Happy Canyon Creek – Belford Ave Connection was prepared in accordance with applicable, viable, and pertinent technical data and criteria for the Colorado Water Conservation Board, the Federal Emergency Management Agency, UDFCD, and the Town of Parker. The document, report, and all attachments submitted herewithin were prepared in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the necessary information and accurately prepared the document. Additionally, I hereby certify that no insurable structures are impacted due to the revisions documented in the CLOMR.

SIGNATURE: _____
Registered Professional Engineer
State of Colorado No. _____
(Affix Seal)

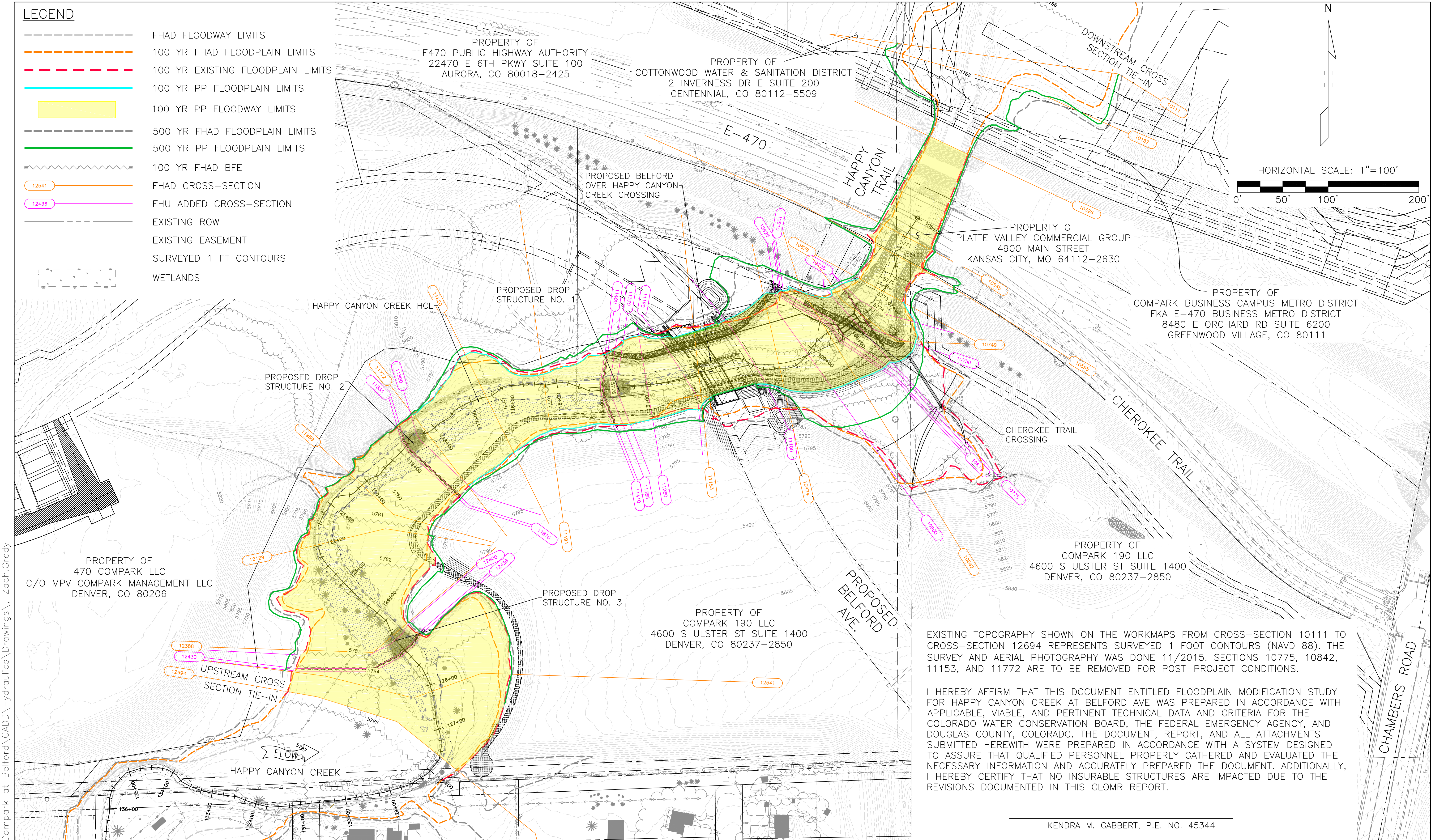
VI. REFERENCES

- 1) Federal Emergency Management Agency Flood Insurance Rate Map Community Panel Numbers 08035C0062G and 08035C0066G, Effective Date March 16, 2016.
- 2) Preliminary Federal Emergency Management Agency Flood Insurance Rate Map Community Panel Numbers 08035C0062H and 08035C0066H Preliminary June 30, 2016.
- 3) Custom Soil Resource Report for Castle Rock Area, Colorado, U.S. Department of Agriculture, Natural Resources Conservation Service, October 2016.
- 4) Flood Hazard Area Delineation, Happy Canyon Creek, November 1977, Howard, Needles, Tammen & Bergendoff.
- 5) Flood Hazard Area Delineation, Happy Canyon Creek, July 2014, Muller Engineering.
- 6) Major Drainageway Plan Conceptual Design Report, Happy Canyon Creek, March 2014, Muller Engineering.
- 7) Urban Storm Drainage Criteria Manual, Urban Drainage and Flood Control District, Volumes I, II, and III.
- 8) Federal Emergency Management Agency Flood Insurance Study, Douglas County, Colorado, 08035CV001C and 08035CV002C, February 17, 2017.

APPENDIX A. FLOODPLAIN WORK MAP

LEGEND

- FHAD FLOODWAY LIMITS
- 100 YR FHAD FLOODPLAIN LIMITS
- 100 YR EXISTING FLOODPLAIN LIMITS
- 100 YR PP FLOODPLAIN LIMITS
- 100 YR PP FLOODWAY LIMITS
- 500 YR FHAD FLOODPLAIN LIMITS
- 500 YR PP FLOODPLAIN LIMITS
- 100 YR FHAD BFE
- FHAD CROSS-SECTION
- FHU ADDED CROSS-SECTION
- EXISTING ROW
- EXISTING EASEMENT
- SURVEYED 1 FT CONTOURS
- WETLANDS



EXISTING TOPOGRAPHY SHOWN ON THE WORKMAPS FROM CROSS-SECTION 10111 TO CROSS-SECTION 12694 REPRESENTS SURVEYED 1 FOOT CONTOURS (NAVD 88). THE SURVEY AND AERIAL PHOTOGRAPHY WAS DONE 11/2015. SECTIONS 10775, 10842, 11153, AND 11772 ARE TO BE REMOVED FOR POST-PROJECT CONDITIONS.

I HEREBY AFFIRM THAT THIS DOCUMENT ENTITLED FLOODPLAIN MODIFICATION STUDY FOR HAPPY CANYON CREEK AT BELFORD AVE WAS PREPARED IN ACCORDANCE WITH APPLICABLE, VIABLE, AND PERTINENT TECHNICAL DATA AND CRITERIA FOR THE COLORADO WATER CONSERVATION BOARD, THE FEDERAL EMERGENCY AGENCY, AND DOUGLAS COUNTY, COLORADO. THE DOCUMENT, REPORT, AND ALL ATTACHMENTS SUBMITTED HERewith WERE PREPARED IN ACCORDANCE WITH A SYSTEM DESIGNED TO ASSURE THAT QUALIFIED PERSONNEL PROPERLY GATHERED AND EVALUATED THE NECESSARY INFORMATION AND ACCURATELY PREPARED THE DOCUMENT. ADDITIONALLY, I HEREBY CERTIFY THAT NO INSURABLE STRUCTURES ARE IMPACTED DUE TO THE REVISIONS DOCUMENTED IN THIS CLOMR REPORT.

KENDRA M. GABBERT, P.E. NO. 45344

Print Date: 11/30/2017 11:05:42 AM
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Sheet Revisions			
Date	Comments	Initials	

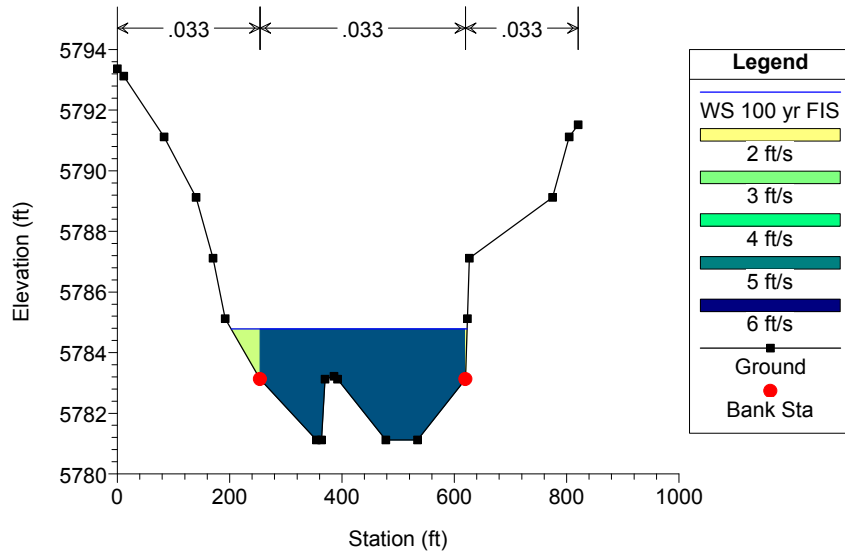
8008 E. Arapahoe Court, Suite 110, Centennial, CO 80112 ph:303.708.0500 fx:303.708.0400 manhard.com
Civil Engineers • Surveyors • Water Resource Engineers • Water & Wastewater Engineers
Construction Managers • Environmental Scientists • Landscape Architects • Planners

As Constructed		BELFORD-HAPPY CANYON CREEK FLOODPLAIN WORK MAP		Project No./Code	
No Revisions:					
Revised:		Designer:	CDT	Structure	
Void:		Detailer:	ZJG	Numbers	
		Subset:		Sheets:	1 of 1
				Sheet Number	

APPENDIX B. EFFECTIVE MODEL, SUPPORTING INFORMATION FROM FHAD AND MDP

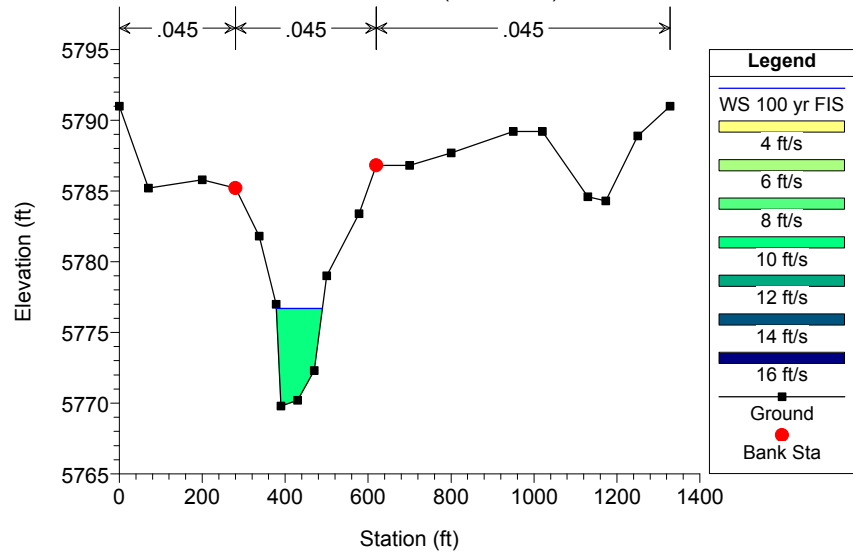
Happy Canyon Clean Plan: Effective 7/20/2017

RS = 12694



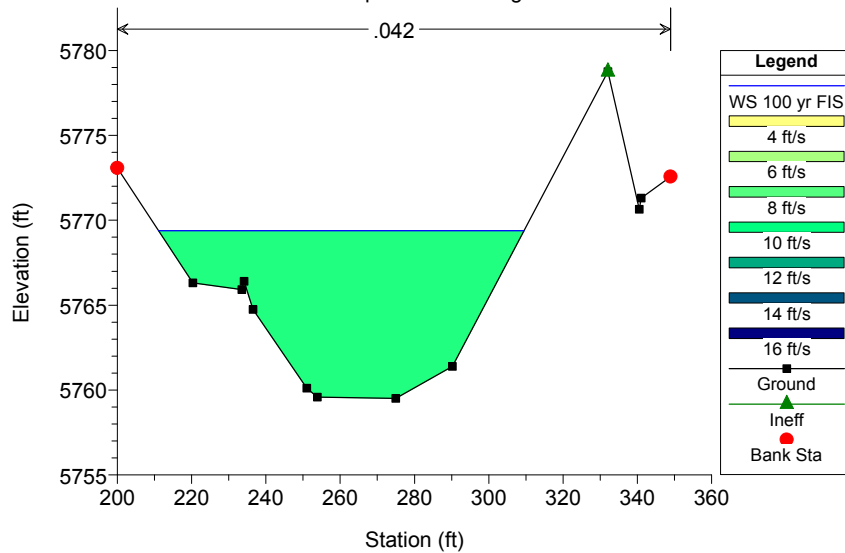
Happy Canyon Clean Plan: Effective 7/20/2017

RS = 11100 FHAD SECT 48 (RS=11390) NEW RS=11100



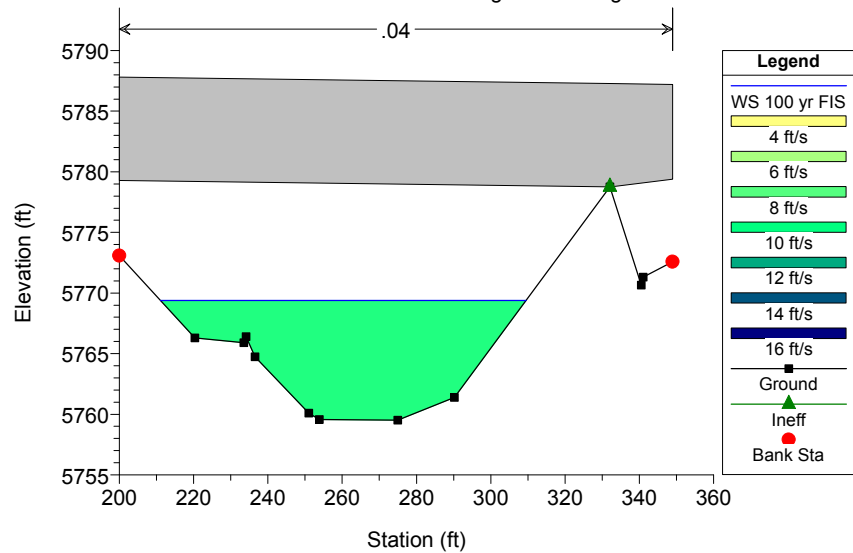
Happy Canyon Clean Plan: Effective 7/20/2017

RS = 10151 Upstream of Bridge RS = 10151



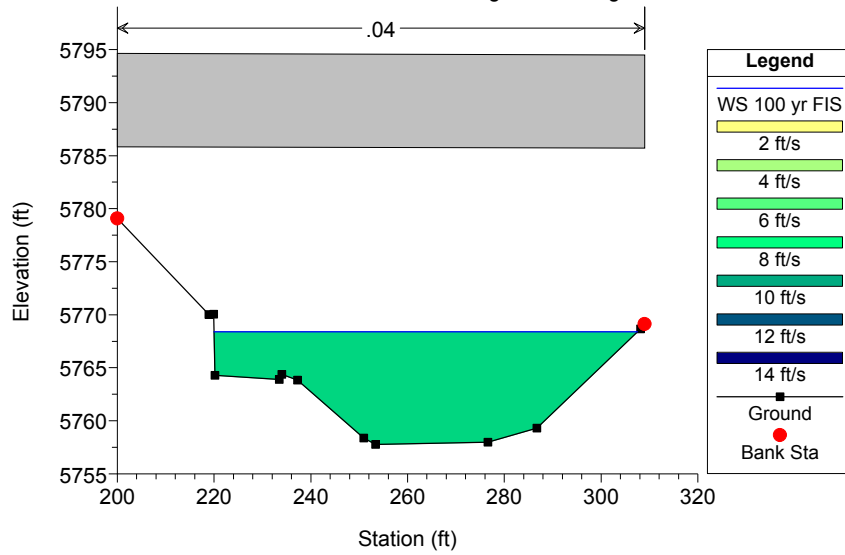
Happy Canyon Clean Plan: Effective 7/20/2017

RS = 10042 BR Existing E-470 Bridge



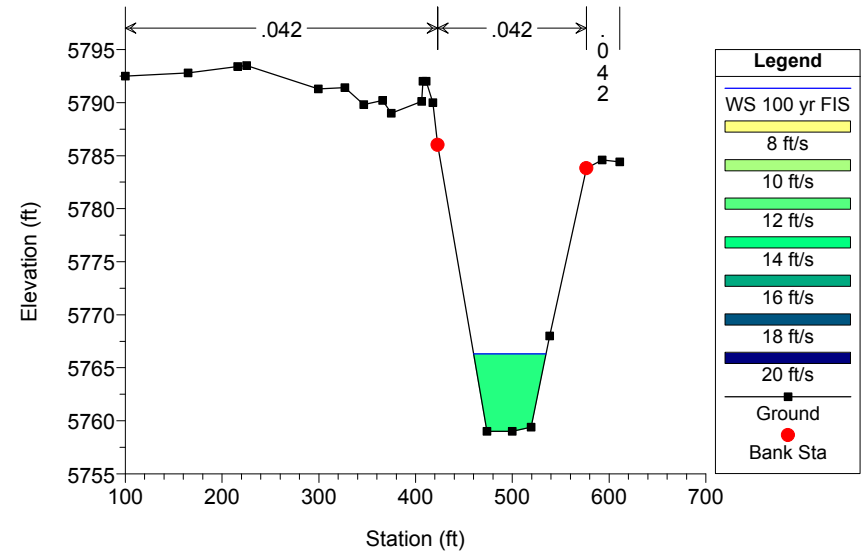
Happy Canyon Clean Plan: Effective 7/20/2017

RS = 10042 BR Existing E-470 Bridge



Happy Canyon Clean Plan: Effective 7/20/2017

RS = 9920 RS = 9920



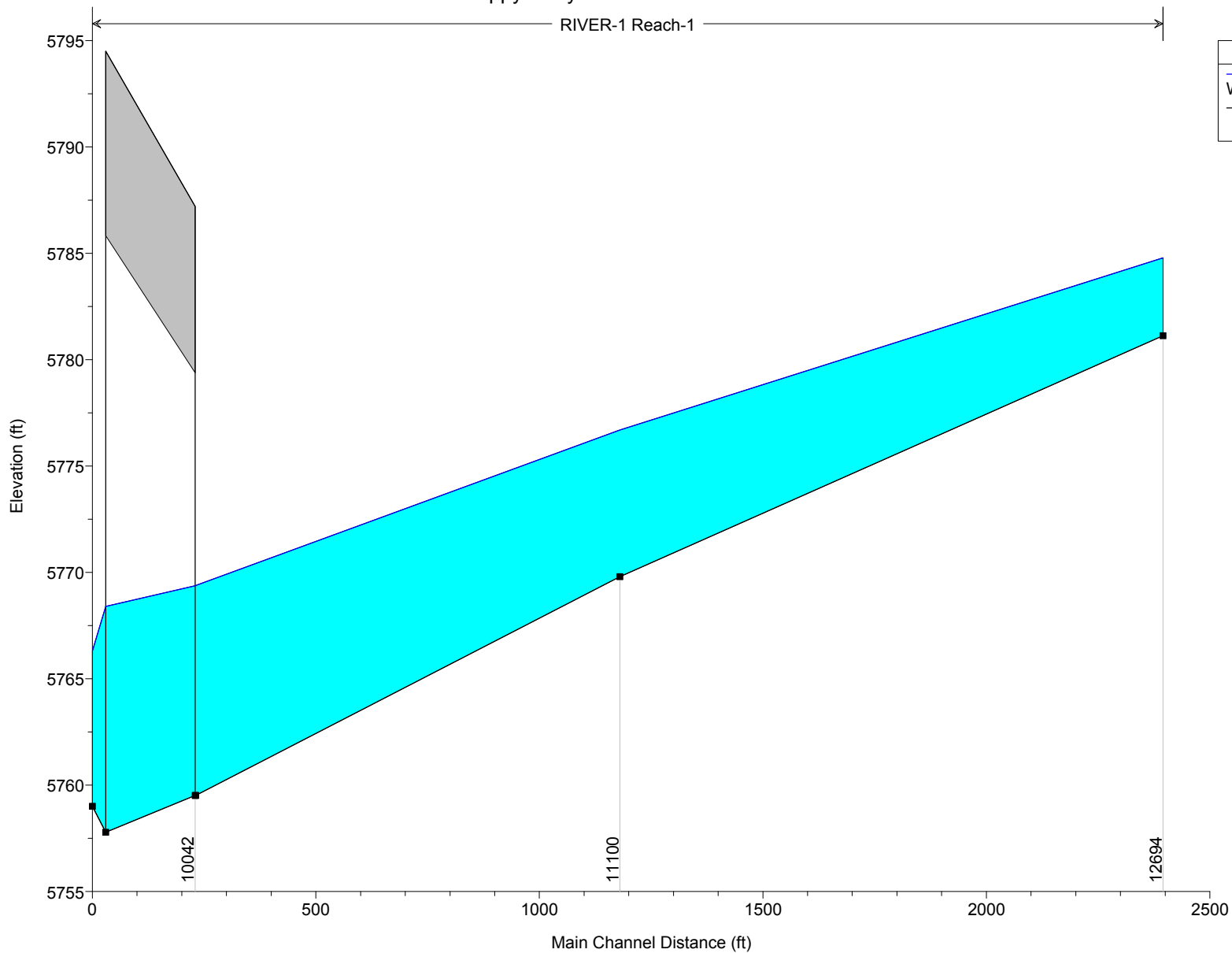
Happy Canyon Plan: Effective 7/24/2017

RIVER-1 Reach-1

Legend

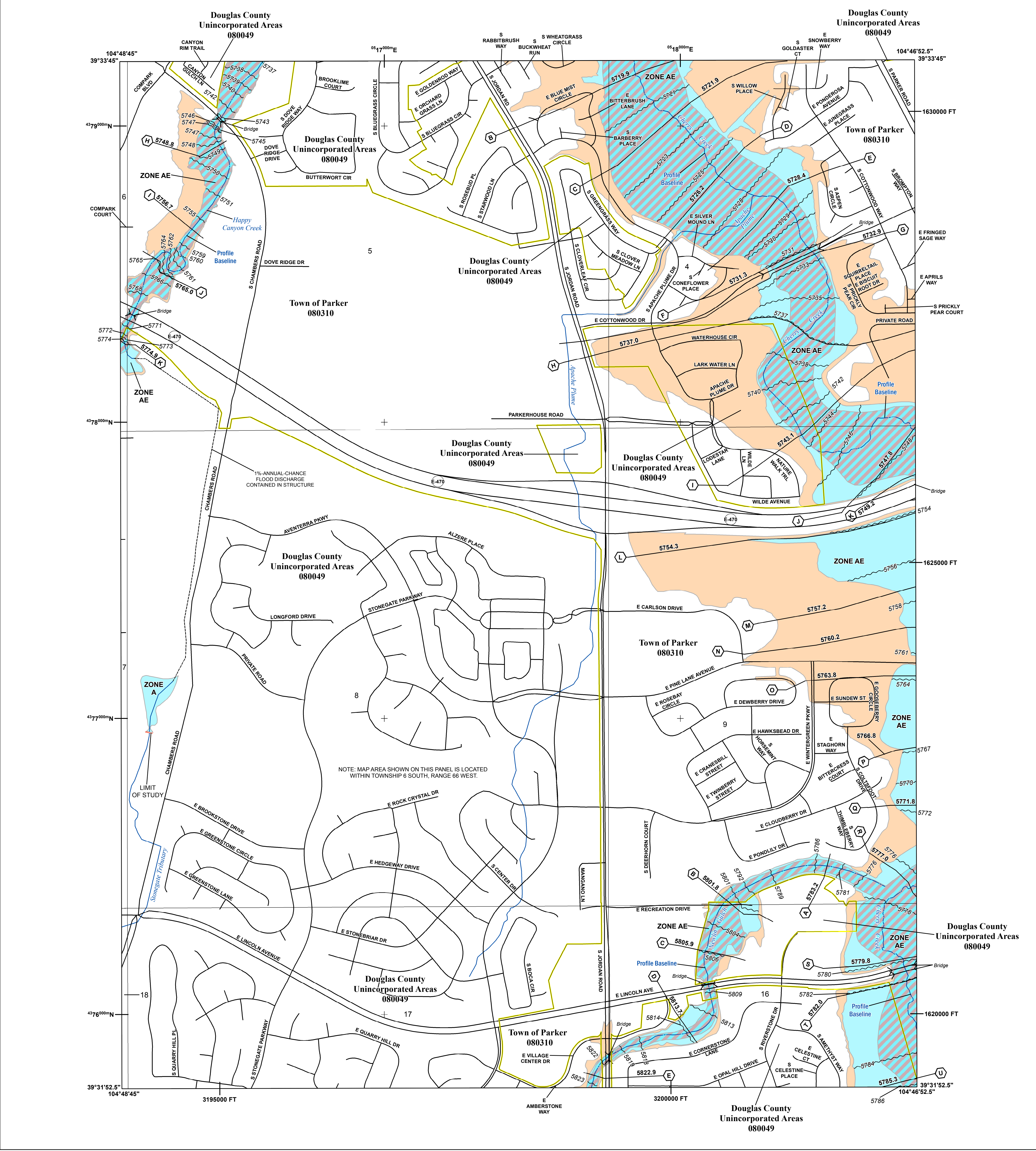
WS 100 yr FIS

Ground



HEC-RAS Plan: Effective River: RIVER-1 Reach: Reach-1 Profile: 100 yr FIS

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)	
Reach-1	12694	100 yr FIS	5560.00	5781.12	5784.78		5785.22	0.003633	5.36	1062.08	420.09	0.57
Reach-1	11100	100 yr FIS	5560.00	5769.80	5776.70		5778.18	0.010246	9.78	568.61	111.18	0.76
Reach-1	10151	100 yr FIS	5700.00	5759.51	5769.38	5767.58	5770.71	0.006167	9.23	617.86	98.41	0.65
Reach-1	10042	Bridge										
Reach-1	9920	100 yr FIS	5700.00	5759.00	5766.30	5766.12	5768.99	0.014116	13.16	433.02	74.84	0.96



FLOOD HAZARD INFORMATION

SEE FIS REPORT FOR ZONE DESCRIPTIONS AND INDEX MAP
THE INFORMATION DEPICTED ON THIS MAP AND SUPPORTING DOCUMENTATION ARE ALSO AVAILABLE IN DIGITAL FORMAT AT [HTTP://MSC.FEMA.GOV](http://MSC.FEMA.GOV)

SPECIAL FLOOD HAZARD AREAS	Without Base Flood Elevation (BFE) Zone A,V, A99 With BFE or Depth Zone AE, AO, AH, VE, AR	Regulatory Floodway
OTHER AREAS OF FLOOD HAZARD	0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile Zone X	Future Conditions 1% Annual Chance Flood Hazard Zone X
OTHER AREAS	Area with Reduced Flood Risk due to Levee See Notes, Zone X	Areas of Minimal Flood Hazard Zone X
GENERAL STRUCTURES	Channel, Culvert, or Storm Sewer Accredited or Provisionally Accredited Levee, Dike, or Floodwall	Non-accredited Levee, Dike, or Floodwall
OTHER FEATURES	Cross Sections with 1% Annual Chance Water Surface Elevation (BFE)	Coastal Transect
	Coastal Transect Baseline	Profile Baseline
	Hydrographic Feature	Base Flood Elevation Line (BFE)
	Limit of Study	Jurisdiction Boundary

NOTES TO USERS

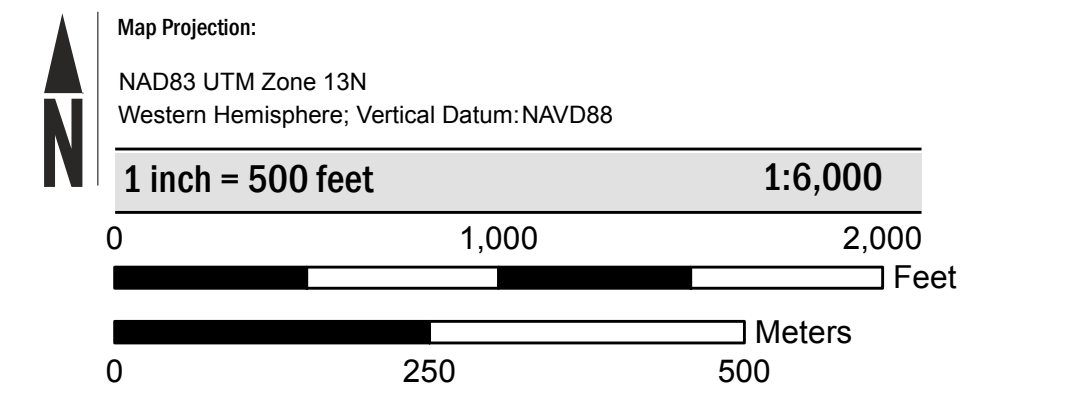
For information and questions about this map, available products associated with this FIRM including historic versions of this FIRM, how to order products or the National Flood Insurance Program in general, please call the FEMA Map Information eXchange at 1-877-FEMA-MAP (1-877-336-2627) or visit the FEMA Map Service Center website at <http://msc.fema.gov>. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. Many of these products can be ordered or obtained directly from the website. Users may determine the current map date for each FIRM panel by visiting the FEMA Map Service Center website or by calling the FEMA Map Information eXchange.

Communities annexing land on adjacent FIRM panels must obtain a current copy of the adjacent panel as well as the current FIRM Index. These may be ordered directly from the Map Service Center at the number listed above.

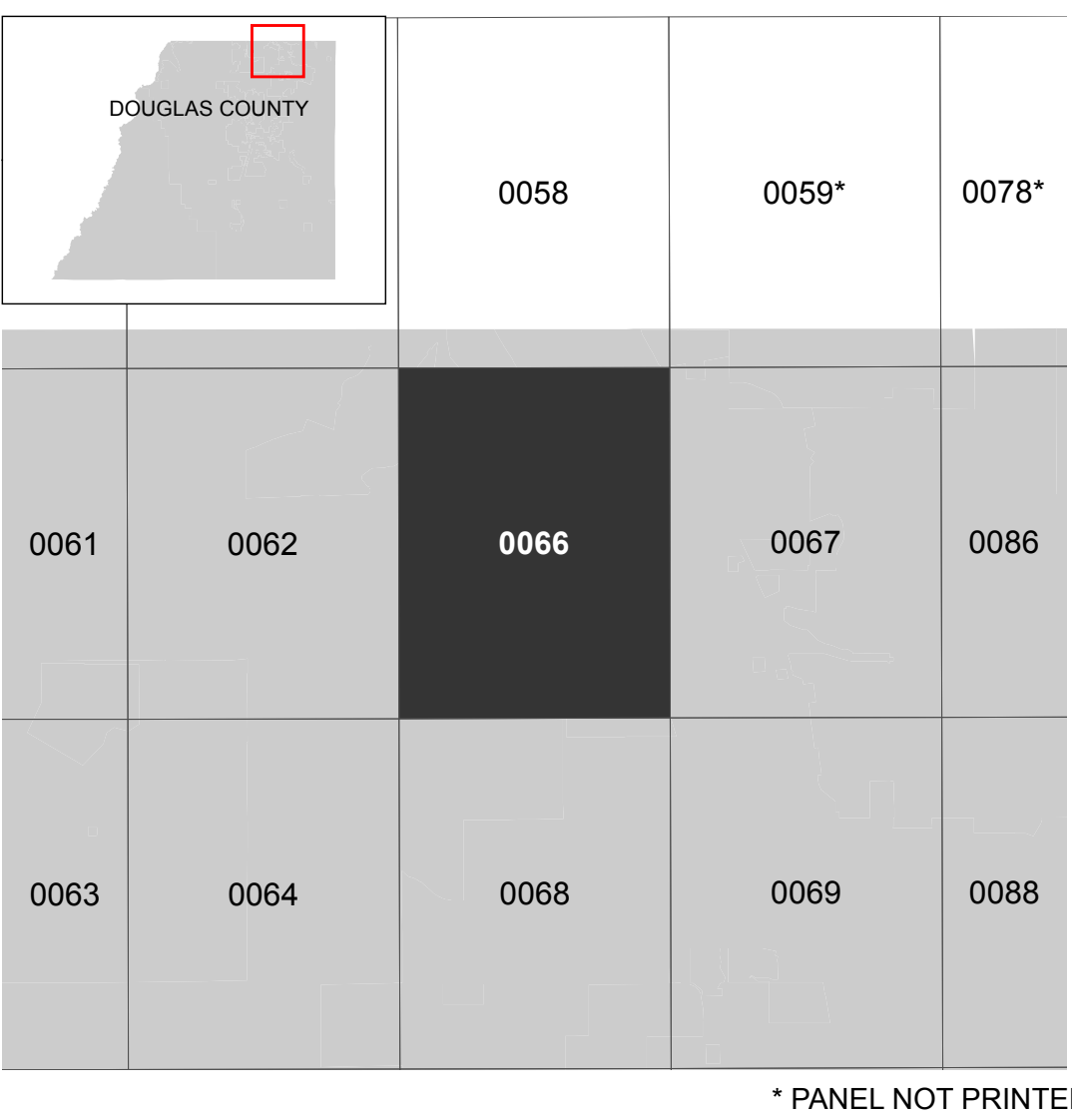
For community and countywide map dates refer to the Flood Insurance Study report for this jurisdiction. To determine if flood insurance is available in the community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

Base map information shown on this FIRM was provided by the Douglas County GIS Department and the Town of Castle Rock GIS Department. Additional input was provided by the City of Lone Tree and Town of Parker. These data are current as of 2003.

SCALE



PANEL LOCATOR



FEMA
National Flood Insurance Program

NATIONAL FLOOD INSURANCE PROGRAM
FLOOD INSURANCE RATE MAP

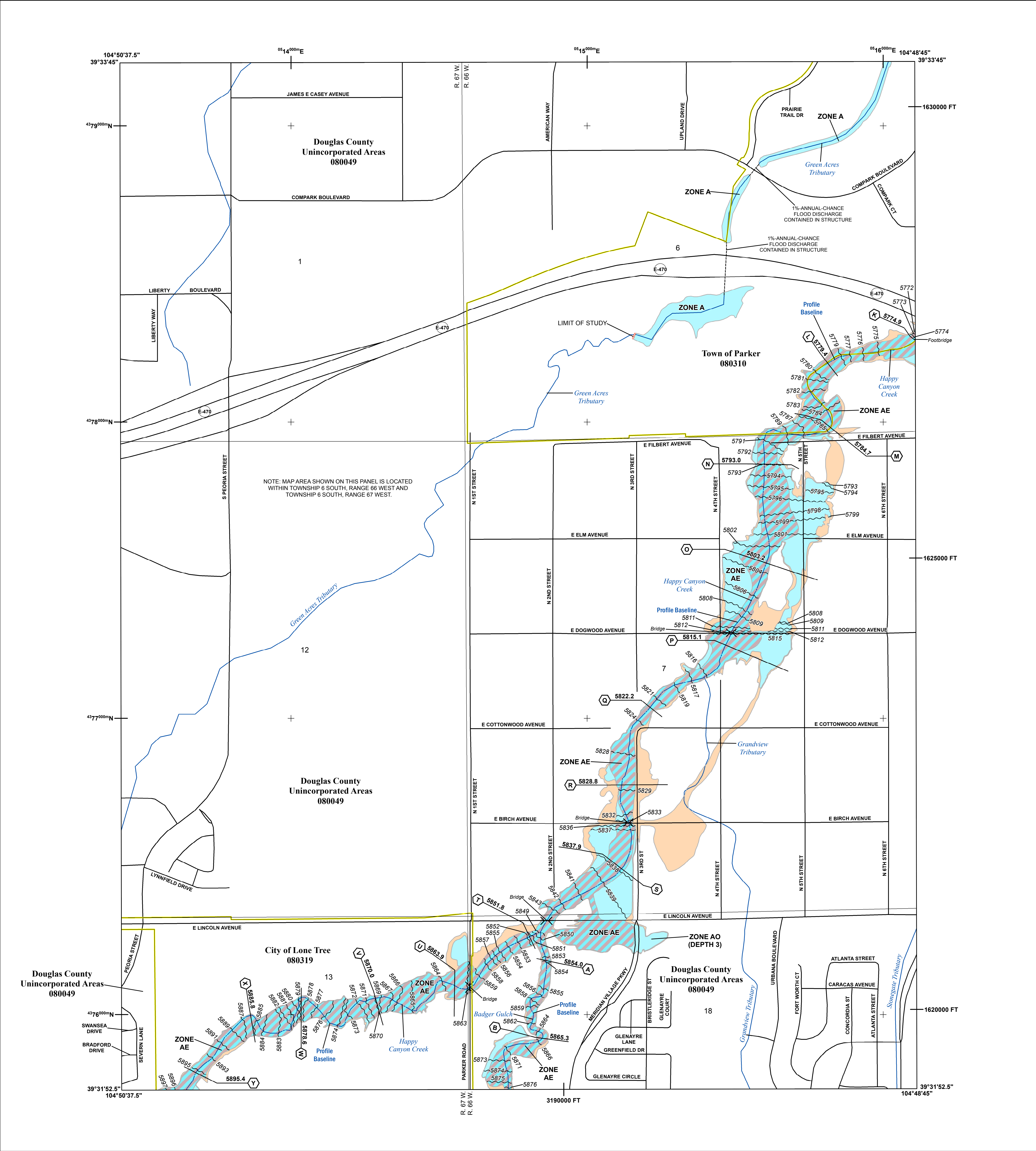
DOUGLAS COUNTY, COLORADO
And Incorporated Areas
PANEL 66 OF 495

Panel Contains:

COMMUNITY	NUMBER	PANEL	SUFFIX
DOUGLAS COUNTY	080049	0066	H
PARKER, TOWN OF	080310	0066	H

PRELIMINARY
JUNE 30, 2016

VERSION NUMBER
2.3.3.2
MAP NUMBER
08035C0066H
MAP REVISED



FLOOD HAZARD INFORMATION

SEE FIS REPORT FOR ZONE DESCRIPTIONS AND INDEX MAP
THE INFORMATION DEPICTED ON THIS MAP AND SUPPORTING DOCUMENTATION ARE ALSO AVAILABLE IN DIGITAL FORMAT AT [HTTP://MSC.FEMA.GOV](http://MSC.FEMA.GOV)

SPECIAL FLOOD HAZARD AREAS	Without Base Flood Elevation (BFE) Zone A, V, A99
	With BFE or Depth Zone AE, AO, AH, VE, AR
	Regulatory Floodway
OTHER AREAS OF FLOOD HAZARD	0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile Zone X
	Future Conditions 1% Annual Chance Flood Hazard Zone X
	Area with Reduced Flood Risk due to Levee See Notes, Zone X
OTHER AREAS	NO SCREEN Areas of Minimal Flood Hazard Zone X
	Area of Undetermined Flood Hazard Zone D
GENERAL STRUCTURES	Channel, Culvert, or Storm Sewer Accredited or Provisionally Accredited Levee, Dike, or Floodwall
	Non-accredited Levee, Dike, or Floodwall
OTHER FEATURES	Cross Sections with 1% Annual Chance Water Surface Elevation (BFE)
	Coastal Transect
	Coastal Transect Baseline
	Profile Baseline
	Hydrographic Feature
	Base Flood Elevation Line (BFE)
	Limit of Study
	Jurisdiction Boundary

NOTES TO USERS

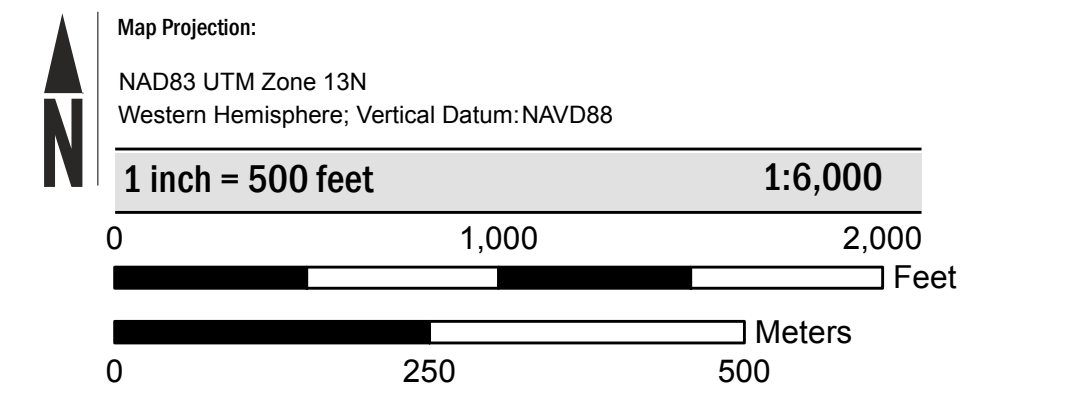
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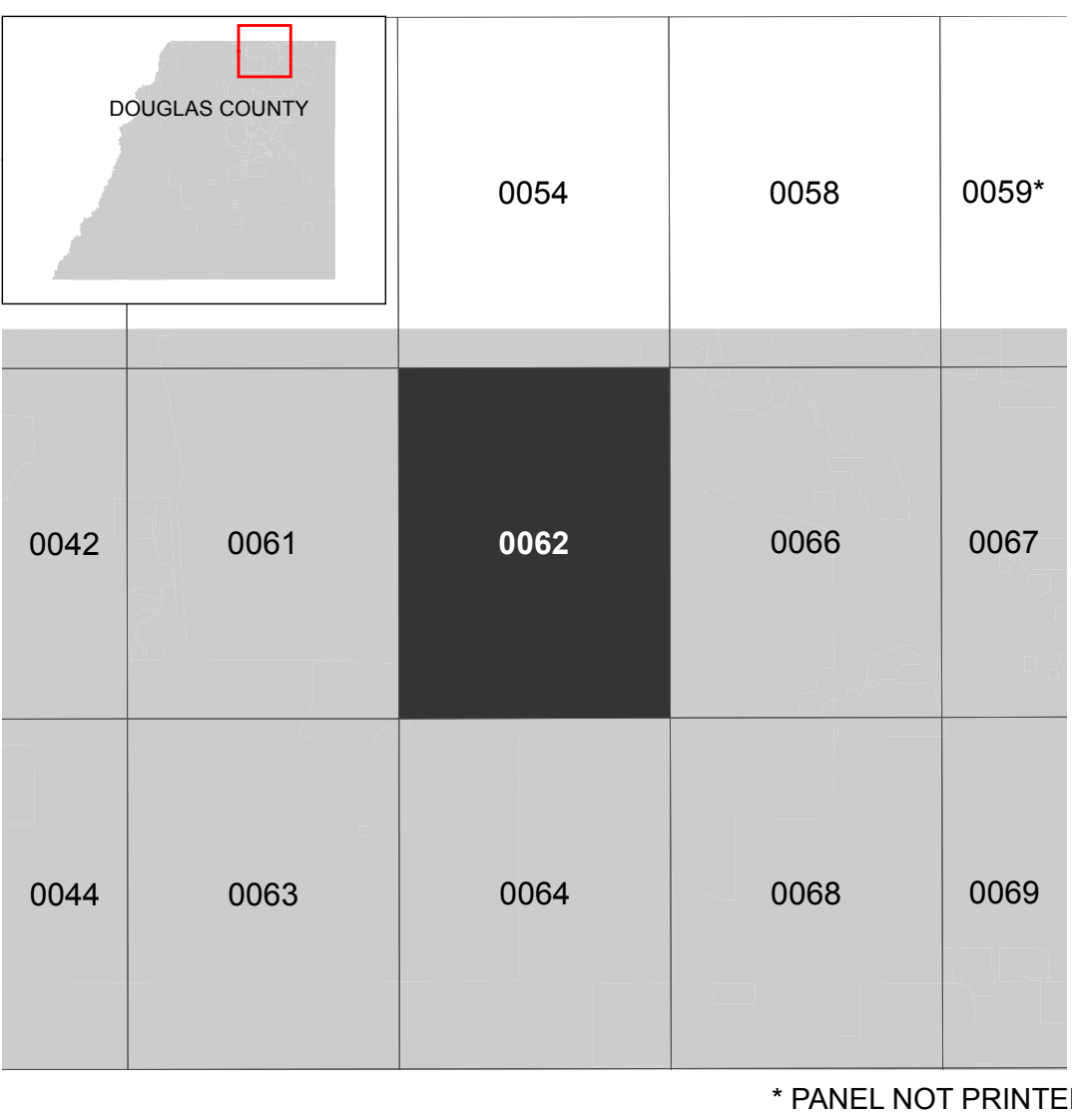
For community and countywide map dates refer to the Flood Insurance Study report for this jurisdiction. To determine if flood insurance is available in the community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

Base map information shown on this FIRM was provided by the Douglas County GIS Department and the Town of Castle Rock GIS Department. Additional input was provided by the City of Lone Tree and Town of Parker. These data are current as of 2003.

SCALE



PANEL LOCATOR



National Flood Insurance Program

NATIONAL FLOOD INSURANCE PROGRAM
FLOOD INSURANCE RATE MAP

DOUGLAS COUNTY, COLORADO
And Incorporated Areas

PANEL 62 OF 495

Panel Contains:

COMMUNITY	NUMBER	PANEL	SUFFIX
DOUGLAS COUNTY	080049	0062	H
LONE TREE, CITY OF	080319	0062	H
PARKER, TOWN OF	080310	0062	H

PRELIMINARY
JUNE 30, 2016

VERSION NUMBER
2.3.3.2

MAP NUMBER
08035C0062H

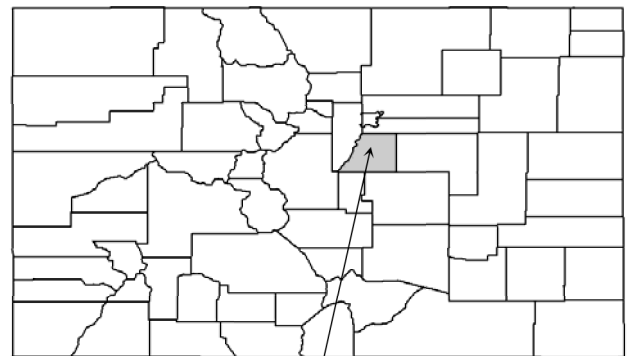
MAP REVISED

FLOOD INSURANCE STUDY

VOLUME 1 OF 4



DOUGLAS COUNTY, COLORADO AND INCORPORATED AREAS



Douglas County

COMMUNITY NAME

CASTLE PINES, CITY OF
CASTLE ROCK, TOWN OF
DOUGLAS COUNTY
(UNINCORPORATED AREAS)
LARKSPUR, TOWN OF
LONE TREE, CITY OF
PARKER, TOWN OF

COMMUNITY NUMBER

080231
080050
080049
080309
080319
080310



Revised: February 17, 2017

Federal Emergency Management Agency

FLOOD INSURANCE STUDY NUMBER
08035CV001C

Table 3 – LETTERS OF MAP REVISION

<u>Community</u>	<u>Flooding Source(s) and Project Identifier</u>	<u>Date Issued</u>	<u>Type</u>
Town of Castle Rock	East Plum Creek Tributary D	May 22, 2003	LOMR
	Tributary B Castle Rock Factory Store Expansion	September 12, 2002	LOMR
	Tributary B to East Plum Creek	October 2, 2000	LOMR
	6400 Tributary East Fork	January 24, 2003	LOMR
	Tributary D to East Plum Creek	September 12, 2000	LOMR
	Tributary B to East Plum Creek	December 3, 1999	LOMR
	Hangmans Gulch	June 18, 1996	LOMR
	Tributary C to East Plum Creek West Fork of Tributary 6400	August 7, 1995	LOMR
	Village No. Diversion Channel	April 5, 1995	LOMR
	Unnamed Tributary to Sellars Gulch	November 21, 1994	LOMR
	Omni Drainageway	March 10, 1994	LOMR
	Tributary 6400 East Fork and Tributary 6400 West Fork	January 14, 1994	LOMR
Douglas County (Unincorporated Areas)	Newlin Gulch	July 30, 2003	LOMR
	Bayou Gulch / Cherry Creek	July 23, 2003	LOMR
	Sulpher Gulch	June 25, 2003	LOMR
	East Plum Creek Tributary D	May 22, 2003	LOMR
	Happy Canyon Creek	April 24, 2003	LOMR
	Tributary A	January 24, 2003	LOMR
	Sulpher Gulch	January 16, 2003	LOMR
	Tributary B to East Plum Creek	September 12, 2002	LOMR
	Newlin Gulch	June 22, 2001	LOMR
	Green Acres Tributary	March 14, 2001	LOMR
	Tributary B to East Plum Creek	October 2, 2000	LOMR
	Tributary A of East Plum Creek	September 11, 2000	LOMR
	Big Dry Creek	June 29, 2000	LOMR
	Tributary B to East Plum Creek	December 3, 1999	LOMR
	Tallman Gulch	March 29, 1999	LOMR
	Sulpher Gulch	May 4, 1998	LOMR
	Willow Creek	April 17, 1998	LOMR
	Newlin Gulch	August 27, 1997	LOMR
	Jordan Road Tributary	March 3, 1997	LOMR
	Tributary C to East Plum Creek	August 7, 1995	LOMR
	Village No. Diversion Channel	April 5, 1995	LOMR
	East Plum Creek	November 18, 1994	LOMR
	Jordan Road Tributary	August 29, 1994	LOMR
	Tributary 6400 East Fork and Tributary 6400 West Fork	January 14, 1994	LOMR
Town of Parker	Unnamed Tributary D	December 5, 2003	LOMR
	Cherry Gulch / Newlin Gulch	July 30, 2003	LOMR
	Sulphur Gulch	June 25, 2003	LOMR

Pre-countywide Analyses

For the January 5, 1996, FIS, the synthetic hydrograph method was used to obtain peak discharge for Plum Creek, East Plum Creek, West Plum Creek (at Perry Park), Hangmans Gulch, Sellars Gulch, Unnamed Tributary to Sellars Gulch, Carpenter Creek, Happy Canyon Creek, Newlin Gulch, Baldwin Gulch, Sulphur Gulch, Tallman Gulch, Bayou Gulch, and West Creek. The analysis was based on a 24-hour storm with a Type IIA distribution, as described in the SCS National Engineering Handbook (U.S. Department of Agriculture, 1972). The amount of rainfall was obtained from a precipitation frequency-atlas (U.S. Department of Commerce, 1973) and a real adjustment was applied to convert the point precipitation values to average precipitation over the entire watershed area. Hydrologic soil cover complexes and associated Runoff Curve Numbers were obtained from field investigations, a soil survey of Castle Rock (U.S. Department of Commerce, 1973), an unpublished SCS study of the area, and land use and natural plant coverage maps of Douglas County (U.S. Department of Agriculture, 1971; U.S. Department of Agriculture, 1974; U.S. Department of Agriculture, 1973). Values of 10-, 50-, 100- and 500- year peak discharges were obtained using the computer program developed by the SCS (U.S. Department of Agriculture, 1976). The computed peak discharges compare favorably with the peak discharges estimated using the USGS Technical Manual No. 1 (U.S. Department of the Interior, Technical Manual No.1, 1976).

Discharge magnitudes for floods in Cherry Creek analyzed in the 1996 FIS were based on an analysis of stream gaging data at the USGS stream gages located approximately 2.5 miles south of Franktown and 6 miles northwest of Parker. This information was obtained from a USACE Flood Plain Information report (USACE, 1976). Discharge-frequency relationships for the upstream and downstream limits of the study reach were developed using data from the Franktown and Parker stream gages, respectfully. The presence of 32 flood retarding structures in the Cherry Creek Basin constructed by the SCS was taken into consideration.

A continuous record of flows at stream gaging station No. 0670500, located on the South Platte River at South Platte, is available from 1900 to the present, and stream gaging station No. 06701500, below Cheesman Lake, has a continuous record of flows from 1925 to the present.

Discharge magnitudes for floods analyzed in the 1996 FIS detailed study of the South Platte River and Horse Creek were based on statistical analyses of the previously mentioned stream gaging records, as explained in U.S. Water Resources Counsel Bulletin 17 (U.S. Water Resources Council, 1976).

Discharge-probability relationships for the upstream and downstream study limits were developed using data from the gaging stations below Cheesman Lake and at South Platte, respectively.

Hydrologic information for the streams studied by approximate methods, for the 1996 FIS, was obtained from various sources. Existing UDFCD reports were used

directly for Badger Gulch, Big Dry Creek, Cottonwood Creek, Dad Clark Gulch, Happy Canyon Creek, Marcy Gulch, McMurdo Gulch, and Piney Creek (Howard, Needles, Tammen & Bergendoff, 1977; VTN Engineers, Architects, Planners, 1973; Gingery Associates, Inc., Piney Creek, 1975). A drainage area versus discharge curve was developed using UDFCD information for Happy Canyon Creek Tributary, Jordan Road Tributary, KOA Tributary, Newlin Gulch, South Newlin Gulch, and Oak Gulch. A procedure that was developed by the SCS was used for the 6400 Tributaries (U.S. Department of Agriculture, 1980), the computer model SWMM was used for Tributary A (U.S. Environmental Protection Agency, Computer Model SWMM) and the SCS TR-20 computer program was used to develop hydrologic information for Glade Gulch and Section 34 Tributary (U.S. Department of Agriculture, 1976). Technical Manual No. 1 (U.S. Department of Agriculture, Technical Manual No. 1, 1976) was used for all other approximate-study reaches.

Countywide Analyses

Peak discharges for Big Dry Creek, and Big Dry Creek Tributary C were obtained using version CUHPE/PC of the Colorado Urban Hydrograph Procedure (CUHP) by UDFCD (WRC Engineering, Inc., 1996; Urban Drainage and Flood Control District, 1984). A modified 2-hour design storm distribution recommended by the Urban Storm Drainage Criteria Manual (USDCM) (Urban Drainage and Flood Control District, 1984) was used within CUHP to produce runoff hydrographs required for the flow routing required in the UDFCD Stormwater Management Model (SWMM) (Urban Drainage and Flood Control District, 1989). Values of 10-, 50-, 100, and 500-year peak discharges were obtained using the SWMM computer program.

Peak discharges for Willow Creek, Little Willow Creek, and East Willow Creek were obtained using version CUHPF/PC of the CUHP by UDFCD (Urban Drainage and Flood Control District, 1996). One-hour rainfall depths were developed using criteria from the Douglas County Drainage Criteria Manual (Greenhorne & O'Mara, 1996; Douglas County, 1986) and the USDCM. One-hour rainfall depths distributed over a two-hour design storm were used within CUHP to produce runoff hydrographs required for the flow routing required in the UDFCD Stormwater Management Model (UDSWM386) (Urban Drainage and Flood Control District, 1985). Values of 10-, 50-, and 100-year peak discharges were obtained using the SWMM computer program.

Discharge magnitudes for Daniels Park Drain, Drainageways 6600-02, 6604-01, 6605-01, Highlands Gulch, Indian Creek, Jarre Creek, Lehigh Gulch, Louviers Gulch, Oxide Draw, Plum Creek, Rainbow Creek, Sterling Gulch, and West Plum Creek (near the Plum Creek Confluence) were obtained using version CUHP98 (WRC Engineering, Inc., 2001; Urban Drainage and Flood Control District, 1985) of the CUHP by UDFCD. Design storm distributions were developed using criteria from the Douglas County Drainage Criteria Manual and the USDCM. These storm distributions were used within CUHP to produce runoff hydrographs required for the flow routing required in the UDFCD Stormwater Management Model (UDSWM98) (Urban Drainage and Flood Control District, 1989). Values of 10-,

Table 4 – SUMMARY OF DISCHARGES (Continued)

FLOODING SOURCE AND LOCATION	DRAINAGE	PEAK DISCHARGES (cfs)			
	AREA (sq. miles)	10-YEAR	50-YEAR	100-YEAR	500-YEAR
HANGMANS GULCH					
Downstream of I-25	1.26	305	774	1,008	1,293
At the Confluence of Tributary B	*	229	591	778	933
At Upstream Limit of Detailed Study	0.05	95	209	273	370
HAPPY CANYON CREEK					
At Dogwood Avenue	13.7	2,350	4,450	5,610	8,660
At Birch Avenue	12.5	2,310	4,340	5,460	8,340
At Upstream Limit of Detailed Study	9.0	1,860	3,340	4,160	6,270
HIGHLANDS GULCH					
At Confluence with Plum Creek	2.48	290	1,150	1,890	*
At D&RWG Railroad	2.43	290	1,150	1,890	*
At AT&SF Railroad	2.28	290	1,150	1,890	*
At U.S. HWY 85	2.28	290	1,150	1,770	*
At Upstream Limit of Detailed Study	1.91	290	1,150	1,720	*
HORSE CREEK					
At Confluence with the South Platte River	214.1	*	*	2,873	*
Just downstream of West Creek and Trout Creek Confluence	204.4	*	*	2,679	*
INDIAN CREEK					
At Louviers Road	16.69	1,550	4,520	6,550	*
At Airport Road	16.20	1,500	4,450	6,500	*
At Confluence with Lehigh Gulch	15.33	1,200	3,400	4,800	*
At Private Road (Station 17997)	12.29	1,200	3,400	4,800	*
At Lambert Road	12.11	1,100	3,200	4,400	*
At Rainbow Creek Road	10.97	1,050	2,920	4,100	*
At Confluence with Rainbow Creek	10.44	1,050	2,920	4,100	*
At Cherokee Drive	7.40	1,050	2,920	4,100	*

*Data not available

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE ¹	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Happy Canyon Creek	5,165	150	685	10.2	5,729.7	5,729.7	5,729.7	0.0
	6,812	265	810	7.1	5,739.7	5,739.7	5,739.7	0.0
	8,320	102	466	12.2	5,753.4	5,753.4	5,753.4	0.0
	9,720	350	1,395	5.2	5,766.3	5,766.3	5,766.3	0.0
	9,920	407	895	8.9	5,766.3	5,766.3	5,766.3	0.0
	11,320	110	556	10.0	5,776.7	5,776.7	5,776.7	0.0
	12,605	430	5,767	1.0	5,784.8	5,784.8	5,784.8	0.0
	13,490	315	880	6.3	5,792.5	5,792.5	5,793.5	1.0 ²
	14,470	171	825	6.8	5,800.4	5,800.4	5,801.4	1.0 ²
	15,020	115	607	9.2	5,805.6	5,805.6	5,806.6	1.0 ²
	15,570	180	920	6.1	5,808.9	5,808.9	5,809.9	1.0 ²
	15,640	205	1,450	3.9	5,813.9	5,813.9	5,814.9	1.0 ²
	16,120	110	701	8.0	5,814.9	5,814.9	5,815.9	1.0 ²
	16,720	100	519	10.5	5,819.1	5,819.1	5,820.1	1.0 ²
	17,170	81	537	10.1	5,824.4	5,824.4	5,824.4	0.0
	17,835	142	763	7.1	5,827.7	5,827.7	5,828.7	1.0 ²
	18,230	136	498	8.7	5,831.2	5,831.2	5,831.2	0.0
	18,310	107	977	5.6	5,836.2	5,836.2	5,837.2	1.0
	19,020	99	509	10.8	5,837.7	5,837.7	5,838.2	0.5
	19,604	72	540	10.2	5,841.4	5,841.4	5,841.6	0.2
	19,918	113	716	7.7	5,845.3	5,845.3	5,845.3	0.0
	20,104	148	803	5.1	5,851.2	5,851.2	5,851.2	0.0
	20,571	128	423	9.8	5,854.0	5,854.0	5,854.1	0.1
	20,972	103	437	9.5	5,859.0	5,859.0	5,859.0	0.0
	21,036	112	575	7.2	5,860.3	5,860.3	5,860.3	0.0

¹ Feet Above Mouth

² Encroachment Limited to Channel Banks; Elevation Increase May Be Less Than 1.0 Foot

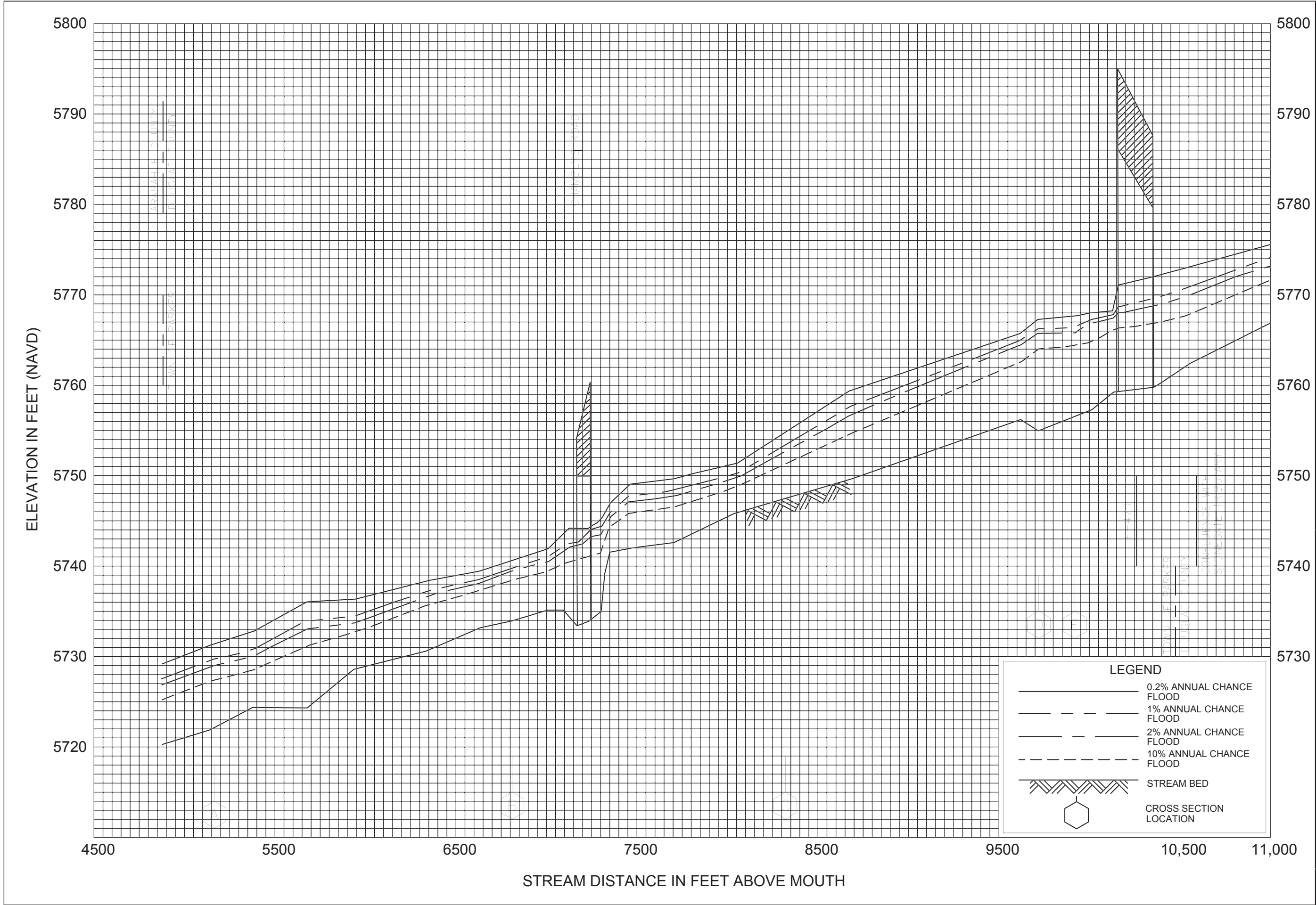
TABLE 7

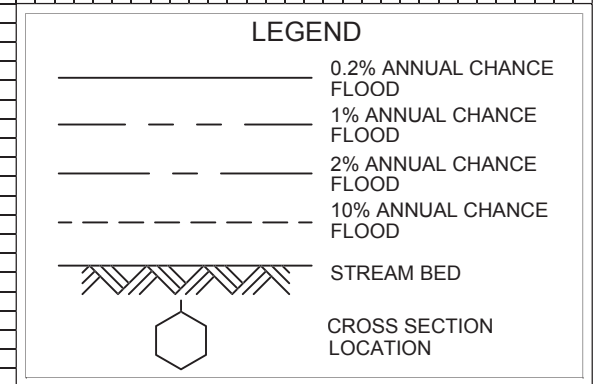
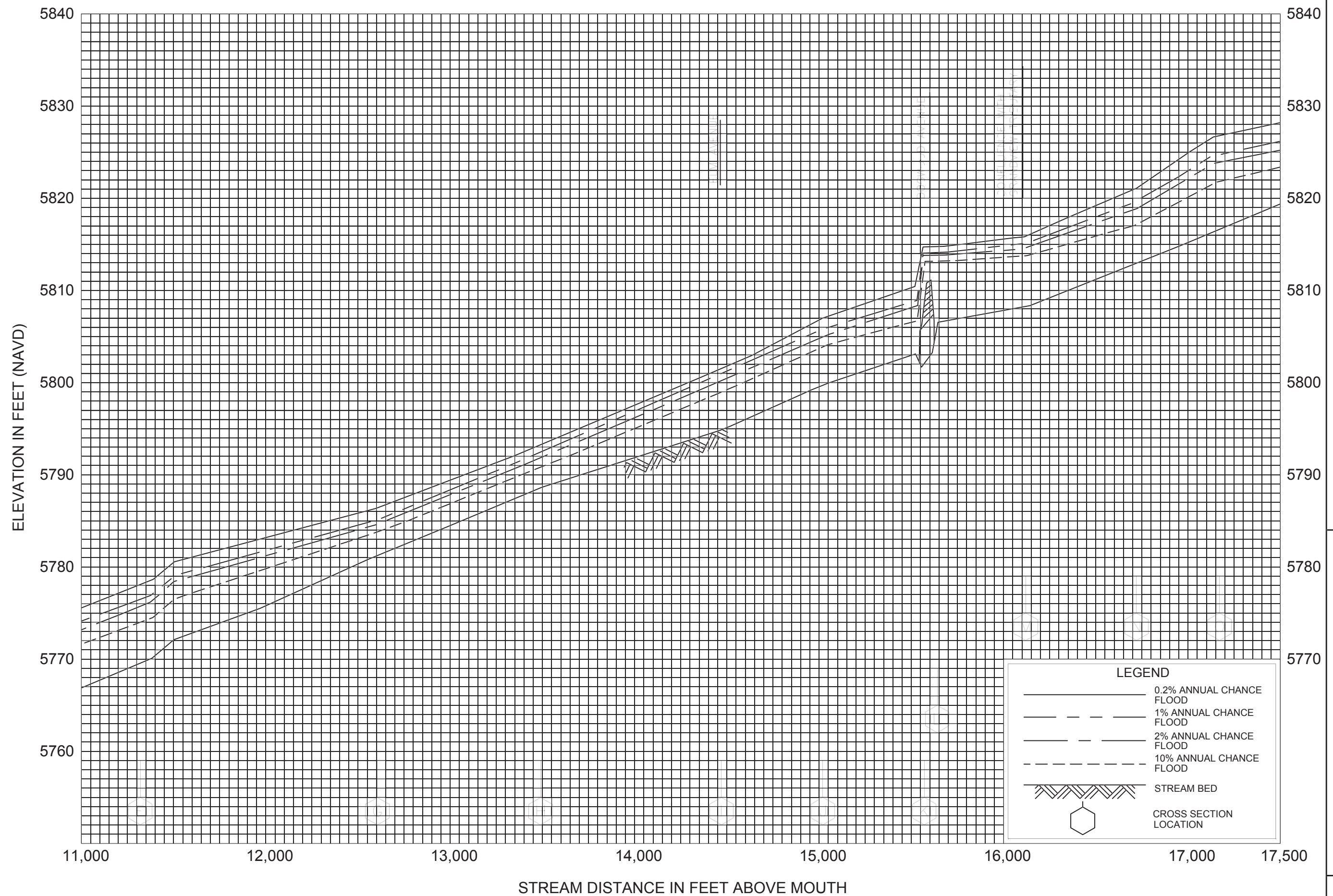
FEDERAL EMERGENCY MANAGEMENT AGENCY

**DOUGLAS COUNTY, CO
AND INCORPORATED AREAS**

FLOODWAY DATA

HAPPY CANYON CREEK





Happy Canyon Creek Flood Hazard Area Delineation (FHAD)

July 2014



CITY OF LONE TREE



1.5 Data Collection

Existing floodplain studies were compiled at the beginning of the project. The 1977 FHAD included floodplain mapping based on predicted future peak flow rates on Happy Canyon Creek from the confluence with Cherry Creek to I-25, and along Badger Gulch from the confluence with Happy Canyon Creek to a point north of present day RidgeGate Parkway. The current Flood Insurance Study (FIS) for Arapahoe County is dated December 17, 2010; the current Douglas County FIS is dated September 30, 2005. The most recent FIRM panels depicting the Happy Canyon Creek flood hazard area are identified by study reach in Table 1-2. The regulatory FIRM was initially based on the same mapping and cross sections as the FHAD, but reflected existing condition flow rates rather than future. Several Letter of Map Revision (LOMR) studies have altered the regulatory floodplain within the study reach. Map revisions were conducted in Grandview Estates in 2006 (06-08-B443P) and 2009 (09-08-0969P). A 2011 LOMR associated with the construction of the RidgeGate Parkway crossings studied 0.3-miles each of Badger Gulch and the Happy Canyon mainstem (11-08-0846P). The current mainstem regulatory floodplain limit extends approximately 2500 feet upstream of I-25 to the Oak Hills Tributary; no detailed studies above this location have been identified.

Wherever possible, hydraulic cross-sections have been oriented to match the existing LOMR and FHAD studies for the purpose of comparison. Comparison tables have been included in Appendix C.

Numerous additional reports, studies, and design plans were reviewed and utilized in the preparation of this report. A full listing is included in the References section at the end of this report.

Table 1-2
Happy Canyon Creek FIRM Panels

Panel I.D.	Community	Study Reach	Effective Date
08035C0160F	Douglas County	Reach 1 & 2	09/30/2005
08035C0044F	Douglas County	Reach 2	09/30/2005
08035C0063F	Douglas County	Reach 3 & 4	09/30/2005
08035C0064F	Douglas County	Reach 5	09/30/2005
08035C0062F	Douglas County	Reach 6, 7 & 8	09/30/2005
08035C0066F	Douglas County	Reach 8	09/30/2005
08035C0058F	Douglas County	Reach 8	09/30/2005
08005C0483K	Arapahoe County	Reach 9	12/17/2010

1.6 Acknowledgements

This report could not have been prepared without the participation and support of the following project sponsors and stakeholders. We are grateful for their contributions.

Table 1-3
Project Participants

Project Sponsors	Agency
Shea Thomas	Urban Drainage and Flood Control District
Bill DeGroot	Urban Drainage and Flood Control District
Terri Fead	Urban Drainage and Flood Control District
Brad Robenstein	Douglas County
Greg Weeks	City of Lone Tree
Tom Williams	Town of Parker
Jacob James	Town of Parker
Monica Bortolini	Southeast Metro Stormwater Authority
Stacey Thompson	Southeast Metro Stormwater Authority

Project Stakeholders	Agency
Chuck Haskins	Arapahoe County
Bryan Ruth	representing Rampart Range Metro District
Ken Linhardt	representing Rampart Range Metro District
Denise Denslow	representing Rampart Range Metro District
Brad Meyering	City of Castle Pines
Lisa Schvien	representing Castle Pines North Metro District
Bill Ruzzo	Cherry Creek Basin Water Quality Authority

Upper Watershed: West of I-25

The upper watershed includes approximately one third of the total area and is essentially fully developed. The City of Castle Pines is primarily small lot residential, with some medium lot residential and a small commercial area along Castle Pines Parkway near I-25. Small lot residential developments were grouped by density based on visual assessment, and an average % impervious was assigned to each group ranging from 40% to 60%. Undeveloped commercial parcels, golf courses, and other open space areas were assigned 2%, school sites were assigned 50%, and commercial areas were assigned 80%. Outside of Castle Pines, unincorporated Douglas County is dominated by large lot residential. Areas were separated into two groups based on lot size and average imperviousness values of 10% and 15% were calculated for the two groups. For future conditions, undeveloped areas were assumed to develop according to the surrounding areas.

The weighted impervious values for the upper watershed are 21.6 % for existing development and 22.5 % for future development.

Middle Watershed: I-25 to Lincoln Avenue

The middle watershed, which represents nearly half of the total watershed area, is largely undeveloped. This area will see significant growth, however, within the planned RidgeGate development in the City of Lone Tree’s jurisdiction. RidgeGate is a 3500 acre planned development that extends from the eastern edge of Lone Tree west across I-25 to Yosemite Street. Land use within RidgeGate will run the gamut from an ultra-dense city center just east of I-25 to rural residential and dedicated open space. Within the Happy Canyon Creek watershed, future land use is based on the PDD document and is largely residential mixed use. Impervious values for the various mixed use/residential planning areas were calculated based on maximum allowable ratios of commercial and multi-family residential development indicated in the PDD, with 85% applied to commercial areas, 80% for multi-family residential, and 50% for single family residential in the remaining area. Other land uses and their associated % impervious values within RidgeGate include city center (95%), commercial mixed use (85%), institutional (50%), rural residential (15%), central community park (10%), and open space (2%). RidgeGate Parkway, which has been constructed at half of its ultimate design width, is reflected as 50% impervious in the existing condition and 100% in the future.

South of RidgeGate, unincorporated Douglas County is zoned for agricultural use. This area is slated for another planned development, Freshfields, under the same landowner/developer as RidgeGate; however, planning for Freshfields has not yet begun and development is not expected to begin until RidgeGate is built out. Because that timeline exceeds the expected life of this plan, no future development is reflected.

Several other planned developments are located within the middle watershed. Surrounded on three sides by RidgeGate, Meridian Commons is a mixed-use/residential filing of the Meridian International Business Center (Meridian). East of Lone Tree, Meridian Filing No. 7 is under active

development. Sierra Ridge is located along the west side of Chambers Road and is currently undeveloped. Future land use for each of these planned developments is based on master drainage plans.

Overall weighted impervious values for the middle watershed are 9.8 % for existing development and 36.8 % for future development.

Lower Watershed: Lincoln Avenue to Cherry Creek

North of Lincoln Avenue, Happy Canyon Creek bisects Grandview Estates, an established large lot residential area in unincorporated Douglas County. Impervious values are set at 15% for both existing and future conditions. East of Grandview Estates, Chambers Reservoir is currently under construction. For the purpose of this study, the reservoir is assumed complete and is reflected as 100% impervious. West of Peoria Street lies additional Meridian planned development. Undeveloped industrial/business parks are located between Meridian and Grandview Estates. North of Grandview Estates, the Compark planned development spans both sides of E-470 to the Douglas-Arapahoe County line. Portions of Compark north of E-470 are within the Town of Parker; the area south of E-470 is a proposed annexation to the Town. Future impervious values for Meridian and Compark planned development areas are based on master drainage plans. Industrial/business parks are assumed to develop to 80% impervious.

North of Compark, the Happy Canyon Creek watershed crosses into Arapahoe County. The Dove Valley Business Park stretches from the county line to Jordan Road and is largely undeveloped. Future development is reflected as 80% impervious. East of Jordan Road, the creek is flanked by residential development in the Southcreek subdivision.

Weighted impervious values for the lower watershed are 19.6% for existing development and 54.2% for future development.

2.3 Reach Description

The Happy Canyon Creek channel character varies widely along its length. The character of each segment is heavily influenced by the surrounding land use; because land use varies by jurisdiction, the creek is easily divided into nine distinct reaches at the jurisdictional boundaries. A description of each reach follows; reach limits are shown in Figures B-1 and B-2.

Happy Canyon Creek Reach 1 – Castle Pines

Within the City of Castle Pines, Happy Canyon Creek lies within a dedicated open space corridor adjacent to Monarch Boulevard. The channel is generally stable and well-vegetated, with significant wetland growth supported by a base flow. Five online regional detention ponds are located within Castle Pines on Happy Canyon Creek and its tributaries; the ponds are maintained by the Castle Pines North Metro District (CPNMD). The two mainstem ponds are located at Castle Pines Parkway

Happy Canyon Creek Reach 8 – Town of Parker

Happy Canyon Creek takes a sharp turn to the east as it exits Grandview Estates, and meanders widely before crossing under dual bridges at E-470. The dry, sandy bottom continues through this reach, and the channel takes a sharp turn to the west before crossing under a bridge at Chambers Road. This bend was stabilized with soil riprap toe protection during the Chambers Road bridge construction. There is very little if any wetland vegetation in this reach, as there is no base flow to support it. Reach 8 is primarily undeveloped at this point, but lies within several planned developments. A future bridge crossing for Belford Avenue, just south of E-470, will connect two proposed Town of Parker annexations: Compark Village South and Chambers Highpoint, located on the west and east sides of the creek, respectively. North of E-470, various filings of Compark are located within current Town of Parker boundaries. Drainage tracts and/or easements have been, or will be, dedicated throughout the planned developments. The channel invert through Compark has been stabilized with drop structures at each crossing and several check structures.



Happy Canyon Creek Reach 8

Happy Canyon Creek Reach 9 – Arapahoe County

The final reach of Happy Canyon Creek extends from the Douglas-Arapahoe County line to its confluence with Cherry Creek. West of Jordan Road, it passes through the Dove Valley Business Park, which is largely undeveloped. Channel stabilization measures and an access trail have been implemented along one developed parcel that is adjacent to the creek, and there is a sloping grouted boulder drop structure upstream of the bridge at Jordan Road. East of Jordan Road, the creek is located in a wide Arapahoe County open space tract between two built out residential developments that are part of the Southcreek subdivision. Three sloping grouted boulder drop structures and a concrete box culvert pedestrian crossing were constructed with the development.

Happy Canyon joins Cherry Creek just upstream of the Broncos Parkway bridge, within the Cherry Creek Valley Ecological Park. Historically, the creek paralleled the east side of Jordan Road for a distance before turning to the east toward Cherry Creek. In 1975, the channel was realigned and the confluence moved approximately 2000’ upstream to its current location. The channel character in reach 9 is unappealing, with its wide sandy bottom, straight alignment, and dry, upland plains vegetation.



Happy Canyon Creek Reach 9



Figure 4-1 - Reach 2 – Douglas County South
Meandering with slight incision. Dense, healthy vegetation with some vertical banks.
Manning's 'n': 0.1 (overbank) / 0.05 (channel)



Figure 4-2 - Reach 4 – Lone Tree South
Overgrazed area with sparse short vegetation
Mid-Range Manning's 'n': 0.035 (overbank) / 0.03 (channel)
High-Range Manning's 'n': 0.045 (overbank) / 0.035 (channel)



Figure 4-3 - Reach 8 – Town of Parker
Sparse, bunchy vegetation with sandy, aggraded low-flow
Mid-Range Manning's 'n': 0.03 (overbank) / 0.03 (channel)
High-Range Manning's 'n': 0.04 (overbank) / 0.035 (channel)

Bridges and culvert crossings were modeled in HEC-RAS using the bridge routine. A total of fourteen major roadway crossings and three minor crossings were identified and surveyed within the study reach. Two of the major crossings are on Badger Gulch, and the remainder are at various locations along the mainstem. Of the seventeen identified crossings, sixteen were modeled using HEC-RAS bridge or culvert routines. The exception is the E-470 trail crossing, which is a low-flow crossing consisting of (2) 24" CMP culverts beneath a concrete trail. These culverts tend to be largely blocked due to accumulated debris; the channel cross section at 10749 was set based on the concrete trail elevation, and no conveyance through the culverts was considered. Bridge and culvert modeling routines are based on ground survey points and measurements, and supplemented by measurements and observations during a field visit in October 2012. Major structure capacities are summarized in Table 4-1. Additional information regarding spill flow analysis at overtopping structures can be found in Section 4.3, below.

Floodplain delineation was accomplished with the aid of terrain modeling software. The hydraulic cross-sections were exported to a HEC-RAS GIS file (.sdf), with each of the cross-sections at the appropriate WSEL (either 100-year or 500-year). The terrain modeling software was used to interpolate water surface elevations between the hydraulic sections, and this information was then

translated into a floodplain boundary. The delineation was reviewed and adjusted by hand where necessary.

The floodway locations were discussed with the project sponsors prior to the preliminary submittal. Since the majority of Happy Canyon Creek is contained in a well-defined channel, floodways have generally been set coincident to the floodplain with no additional analysis performed. In certain areas of overbank flooding (particularly within the Grandview Estates development), separate floodways have been computed. In these areas, the floodway was delineated for a 0.5-foot rise for both hydraulic grade line and energy grade line.

Floodway analysis on Badger Gulch was conducted in one area: downstream of Bristleridge Drive in the vicinity of a detention pond adjacent to the channel. No separate floodway analysis was conducted for the Green Acres Tributary.

Table B-4
Peak Flows

SWMM Node	Station (ft)	Channel Reach	Landmark	Design Storm	EXISTING DEVELOPMENT						FUTURE DEVELOPMENT							
					500-YR (cfs)	100-YR (cfs)	50-YR (cfs)	25-YR (cfs)	10-YR (cfs)	5-YR (cfs)	2-YR (cfs)	500-YR (cfs)	100-YR (cfs)	50-YR (cfs)	25-YR (cfs)	10-YR (cfs)	5-YR (cfs)	2-YR (cfs)
HAPPY CANYON CREEK																		
HC999	0	9	Cherry Creek	3-hr	12101	8161	5910	4237	2095	1166	322	13367	9234	6970	5236	3049	1994	836
HC037	2500	9	Jordan Road (D/S)	3-hr	12097	8168	5915	4241	2100	1173	326	13353	9233	6969	5236	3049	1994	832
HC036	2700	9	Jordan Rd (U/S) / Green Acres Trib (D/S)	3-hr	12093	8166	5914	4240	2100	1173	326	13344	9228	6964	5231	3046	1991	828
HC035	2700	9	Green Acres Tributary (U/S)	3-hr	11269	7621	5502	3923	1915	1047	283	12230	8449	6324	4704	2669	1705	656
HC034	7300	8	Chambers Road	3-hr	11363	7693	5558	3979	1963	1093	301	12287	8489	6355	4740	2691	1724	664
HC033	10500	8	E-470 / Stonegate Tributary (D/S)	3-hr	11364	7702	5569	3997	1982	1114	309	12259	8474	6344	4740	2691	1728	652
HC032	10500	8	Stonegate Tributary (U/S)	3-hr	11223	7593	5488	3937	1954	1100	304	12106	8354	6249	4670	2656	1708	633
HC031	12700	8	Grandview Estates / Compark South Boundary	3-hr	11154	7552	5460	3922	1953	1106	308	12023	8302	6211	4648	2647	1705	625
HC030	14600	7	Elm Avenue (extended)	3-hr	11105	7523	5440	3914	1955	1114	312	11971	8269	6189	4639	2646	1710	625
HC029	16200	7	Grandview Tributary (D/S)	3-hr	11069	7502	5425	3905	1953	1115	313	11932	8245	6172	4630	2643	1710	624
HC028	16200	7	Grandview Tributary (U/S)	3-hr	10541	7161	5190	3745	1904	1093	306	11308	7776	5803	4339	2461	1592	578
HC027	17400	7	Cottonwood Avenue (extended)	3-hr	10442	7097	5144	3714	1891	1088	305	11180	7689	5734	4288	2431	1573	569
HC026	20100	7	Lincoln Ave / Badger Gulch (D/S)	3-hr	10408	7079	5132	3715	1899	1102	311	11139	7663	5717	4287	2434	1580	572
HC025	20100	6	Badger Gulch (U/S)	2-hr	8538	5897	4340	3166	1734	1088	316	8984	6247	4689	3511	2073	1394	465
HC024	22600	6	1100' W of West Parker Road	2-hr	8517	5884	4331	3162	1739	1100	325	8950	6223	4670	3502	2069	1396	469
HC023	25600	6	East boundary of Meridian Commons	2-hr	8385	5801	4273	3130	1738	1117	339	8725	6066	4540	3410	2006	1361	462
HC022	28800	5	West boundary of Meridian Commons	2-hr	8178	5668	4174	3068	1712	1119	356	8439	5871	4382	3299	1929	1314	454
HC021	32000	4	Ridgegate Parkway	2-hr	7994	5555	4094	3020	1698	1125	370	8217	5726	4263	3216	1870	1280	452
HC020	32800	4		2-hr	7867	5476	4040	2981	1683	1120	370	8067	5627	4183	3149	1826	1251	444
HC019	36800	4		2-hr	7697	5369	3962	2932	1662	1117	376	7848	5481	4066	3062	1767	1214	434
HC018	40000	4		2-hr	7390	5169	3817	2846	1630	1117	396	7448	5212	3858	2918	1684	1169	432
HC017	42000	4		2-hr	7319	5124	3783	2831	1623	1120	406	7365	5158	3815	2896	1671	1166	438
HC016	43500	3	I-25	2-hr	6959	4899	3628	2708	1570	1099	407	6988	4920	3647	2757	1603	1133	433
HC015	44600	3		2-hr	6924	4879	3614	2697	1566	1098	408	6952	4899	3633	2747	1598	1132	435
HC014	46100	3	Oak Hills Tributary (D/S)	2-hr	6648	4700	3488	2598	1520	1078	407	6659	4708	3497	2636	1543	1105	430
HC013	46100	3	Oak Hills Tributary (U/S)	2-hr	4255	3012	2254	1698	1045	773	308	4260	3017	2260	1730	1064	796	332
HC012	49300	2		2-hr	4161	2948	2203	1676	1032	775	329	4163	2950	2205	1705	1053	797	352
HC011	51200	2		2-hr	4013	2858	2143	1624	1010	767	335	4012	2857	2144	1648	1030	788	358
HC010	52200	2		2-hr	3736	2676	2022	1519	965	744	332	3733	2674	2021	1539	983	763	355
HC009	54300	2	500' N of Oak Hills Drive / Beverly Hills Tributary (D/S)	2-hr	3617	2598	1969	1475	954	746	352	3609	2591	1964	1497	971	763	372
HC008	54500	2	Beverly Hills Tributary (U/S)	2-hr	2493	1832	1415	1028	693	560	273	2496	1834	1416	1029	694	561	274
HC007	56700	2		2-hr	2344	1733	1350	985	668	548	281	2345	1734	1351	986	669	549	281
HC006	58700	2		2-hr	2127	1591	1258	928	633	527	281	2128	1592	1258	929	633	528	282
HC005	59600	1	Castle Pines City Limit / CPNMD Pond #12 Outflow	2-hr	1855	1408	1132	853	587	495	270	1856	1409	1133	853	587	495	270
HC320	59600	1	CPNMD Pond #12 Inflow	2-hr	1965	1517	1269	1056	700	554	277	1967	1518	1270	1057	701	554	277
HC004	61000	1	Tenby Way	2-hr	1605	1259	1067	898	614	492	251	1605	1259	1067	898	614	492	251
HC003	62500	1	Castle Pines Parkway / CPNMD Pond #11 Outflow	2-hr	551	491	449	408	321	273	153	551	491	449	408	321	273	153
HC310	62500	1	CPNMD Pond #11 Inflow	2-hr	1362	1001	808	644	409	310	154	1362	1001	808	644	409	310	154
HC002	64000	1		2-hr	859	635	513	410	264	201	103	859	635	513	410	264	201	103
HC001	64700	1	Monarch Blvd.	2-hr	485	356	288	229	140	104	50	485	356	288	229	140	104	50

Happy Canyon Creek Major Drainageway Plan

March 2014



CITY OF LONE TREE



Reach 8 – Town of Parker

North of Grandview Estates, Happy Canyon Creek passes through Town of Parker annexation areas and current boundaries. Between Grandview and E-470, the Compark Village South annexation is located to the west of the channel, and the Chambers Highpoint annexation is on the east side of the channel. Drop structures are identified through this reach to provide an assumed equilibrium slope of 0.3%, and bank protection is shown along the outside bends. Bank erosion caused by recent earthwork operations is also in need of repair. A future road crossing is planned in this reach; a 100-year bridge is recommended. (Costs for this crossing have not been included.)

[CLICK HERE TO VIEW REACH 8 MAP](#)

[CLICK HERE TO VIEW REACH 8 PROFILE](#)

An existing low flow trail crossing at the E-470 trail provides little capacity and presents a maintenance issue due to sedimentation. A new crossing that incorporates a drop structure will provide additional capacity without drastically altering the existing trail profile. Aggradation in this reach is expected to continue, so the crossing should be designed with that consideration in mind, and continued (though reduced) maintenance will be necessary until the channel invert stabilizes. While a 100-year bridge crossing would generally be preferred in an aggrading reach such as this, the grades in this location are not favorable as a bridge would need to be approximately 400’ long to span the floodplain.

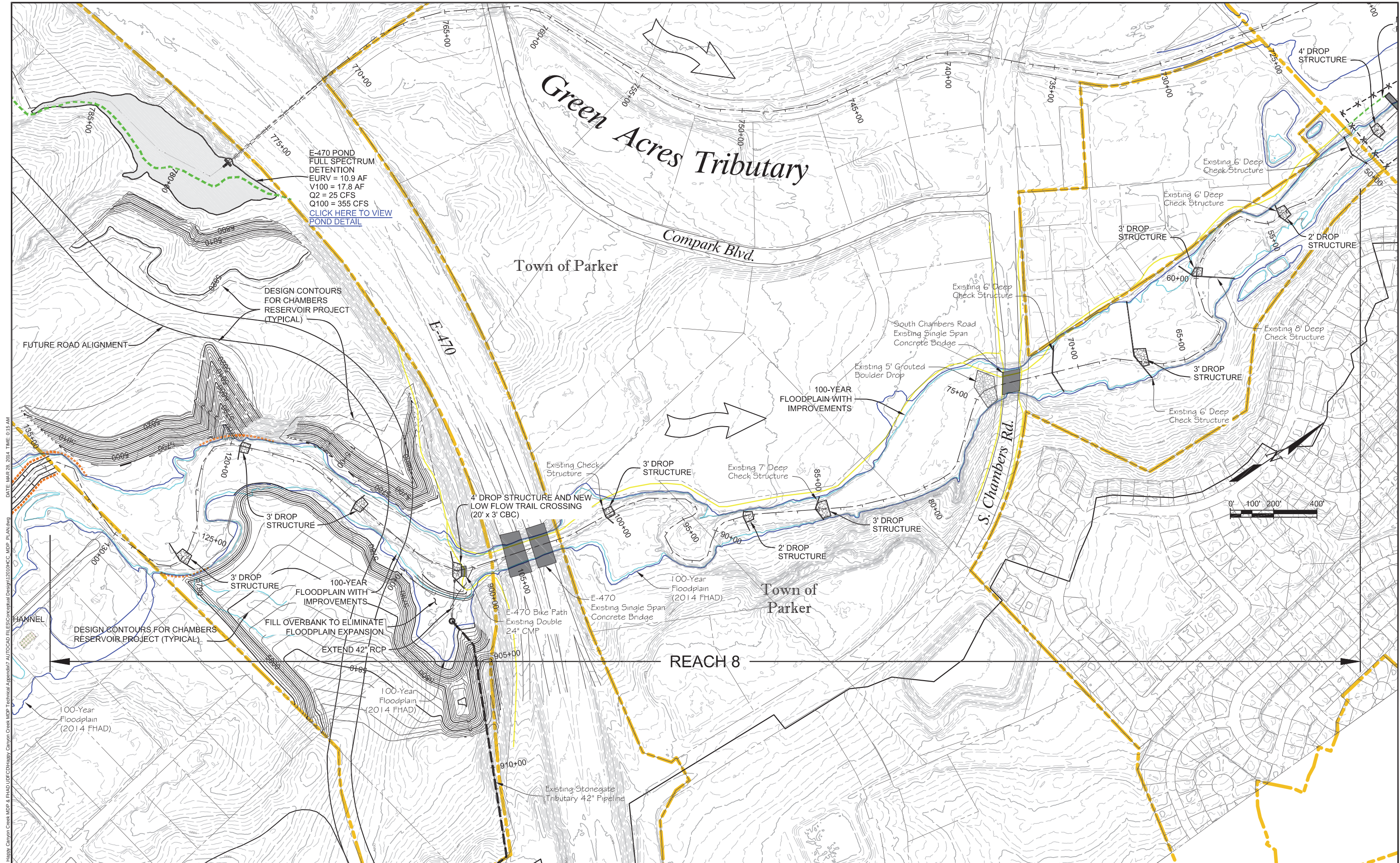
Extension of the recently constructed Stonegate Tributary pipeline an additional two hundred feet to the confluence with Happy Canyon Creek will address channel degradation that is occurring in the steep segment downstream of the existing pipe outfall. Channelization of Happy Canyon Creek through placement of fill in the right overbank immediately upstream of E-470 will eliminate an expansion in the floodplain that further promotes sedimentation in this reach.

Downstream of E-470, Happy Canyon Creek passes through open space tracts within the Compark Village planned development. Check structures have been installed throughout this reach; as improvements upstream reduce the sediment loading to this reach, some degradation is anticipated as the channel seeks a flatter equilibrium slope. Conversion of the existing check structures to drop structures is shown.

Maintenance access through Compark Village is provided by a maintenance / recreational trail; initial plans for Compark Village South show an open space corridor with a recreational trail for the remainder of the reach.

A full spectrum detention facility on the Green Acres Tributary at E-470 is tabulated with the costs for Reach 8.

The total capital improvement cost for Reach 8 is estimated at \$1.88 million. Annual operations and maintenance costs are estimated at \$30,100 per year, with a total 50-year maintenance cost of \$647,000.



NAME: P112-010-01 Happy Canyon Creek MDP & FHAD UDC/Utility Canyon Creek MDP Technical Appendix7 AUTOCAD FILES/General/Design/1201HCC-MDP-PLAN.dwg DATE: MAR 28, 2014 TIME: 01:15 AM

No.	DATE	REVISIONS	APPR.



MULLER ENGINEERING CO., INC.
CONSULTING ENGINEERS
777 SOUTH WADSWORTH BLVD. 4-100
LAKEWOOD, COLORADO 80226 (303) 988-4939

PROJECT NO. 12-010-01

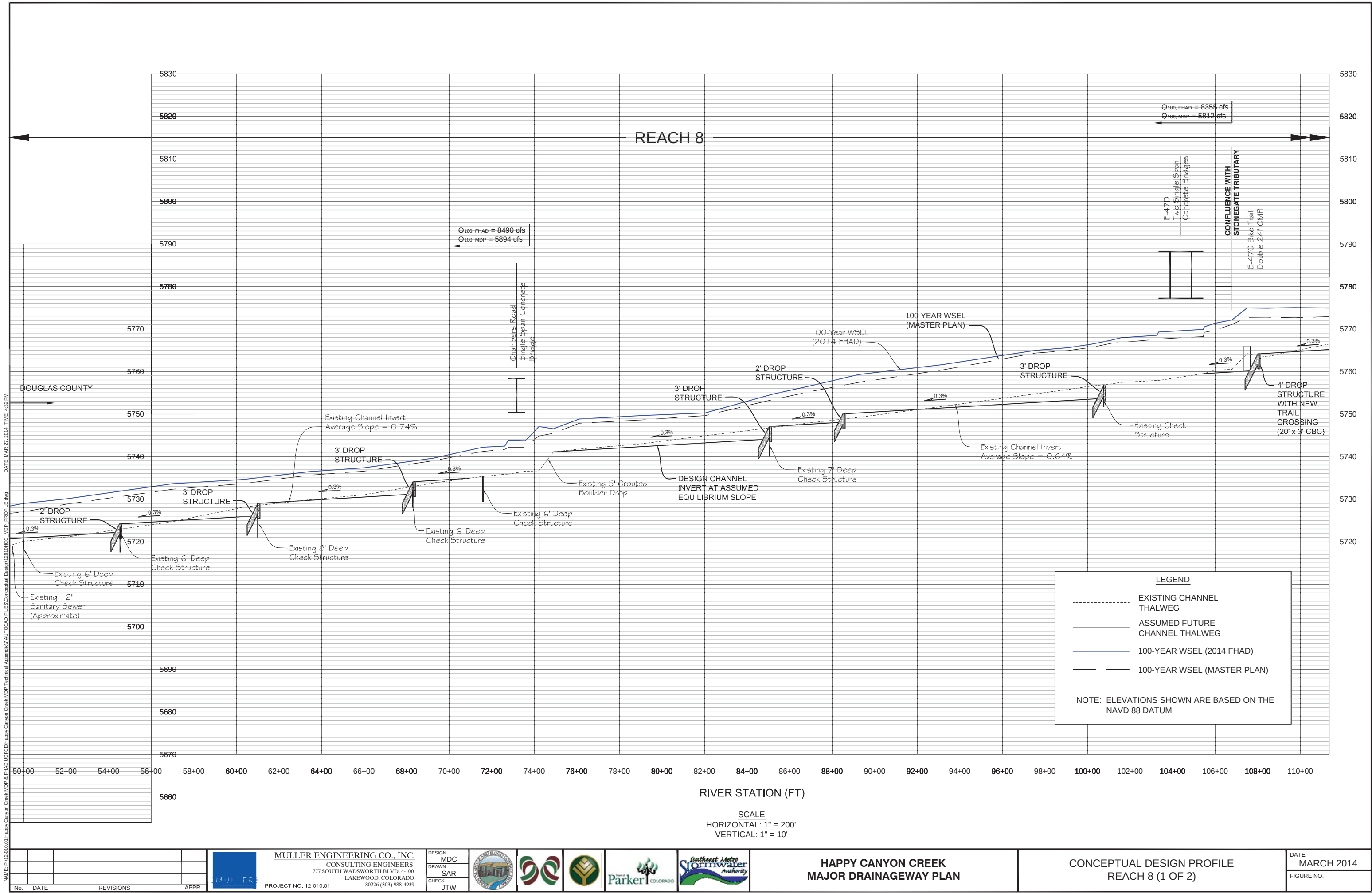
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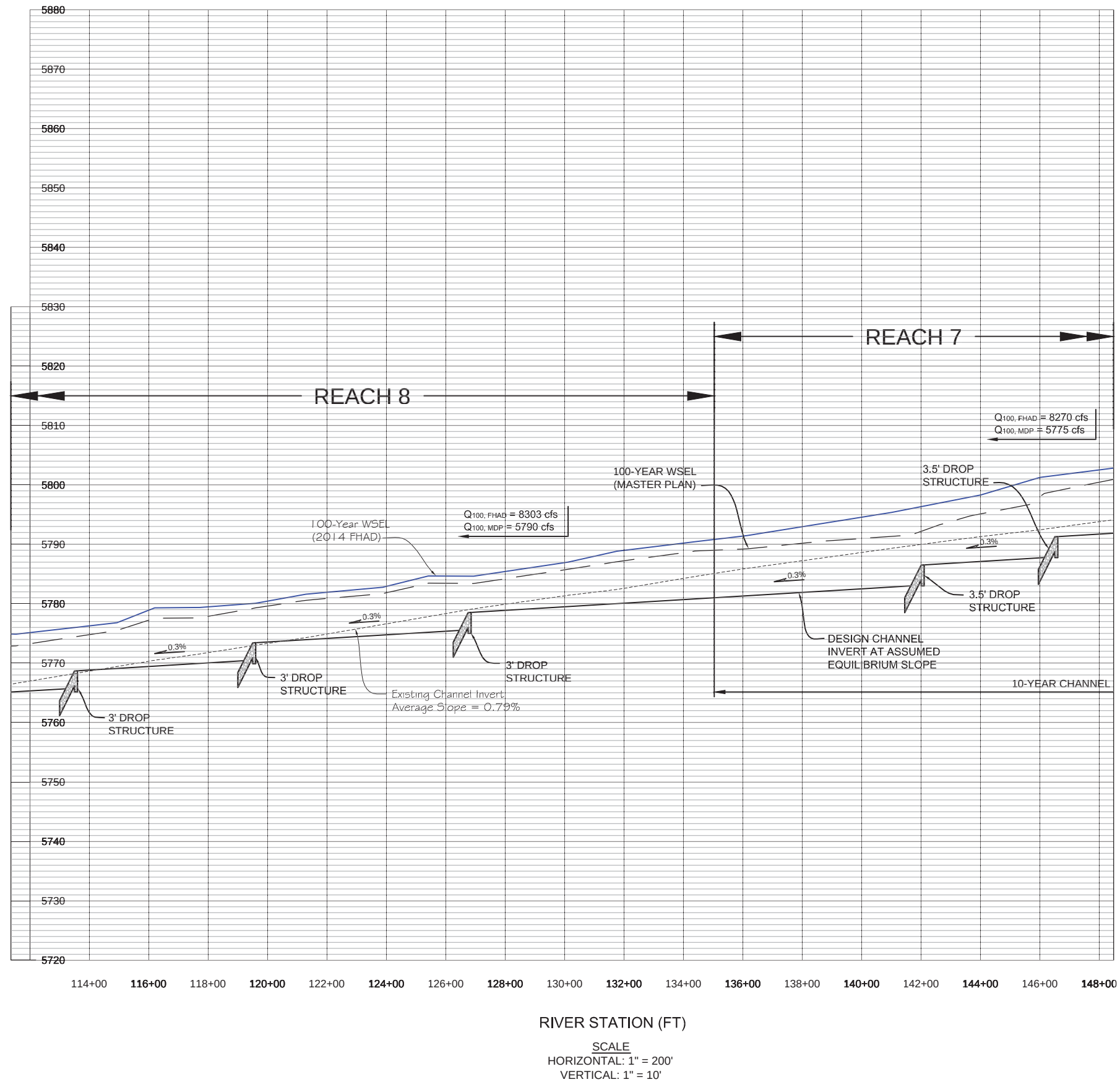
**HAPPY CANYON CREEK
MAJOR DRAINAGEWAY PLAN**

**CONCEPTUAL DESIGN PLAN
REACH 8**

DATE	MARCH 2014
FIGURE NO.	



NAME: P:\12-010.01 Happy Canyon Creek MDP & FHAD\DCD\Happy Canyon Creek MDP Technical Appendix7 AUTOCAD FILES\Conceptual Design\2014HCC_MDP_PROFILE.dwg DATE: MAR 27 2014 TIME: 4:35 PM



LEGEND

- EXISTING CHANNEL THALWEG
- ASSUMED FUTURE CHANNEL THALWEG
- 100-YEAR WSEL (2014 FHAD)
- 100-YEAR WSEL (MASTER PLAN)

NOTE: ELEVATIONS SHOWN ARE BASED ON THE NAVD 88 DATUM

No.	DATE	REVISIONS	APPR.



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DESIGN	MDC
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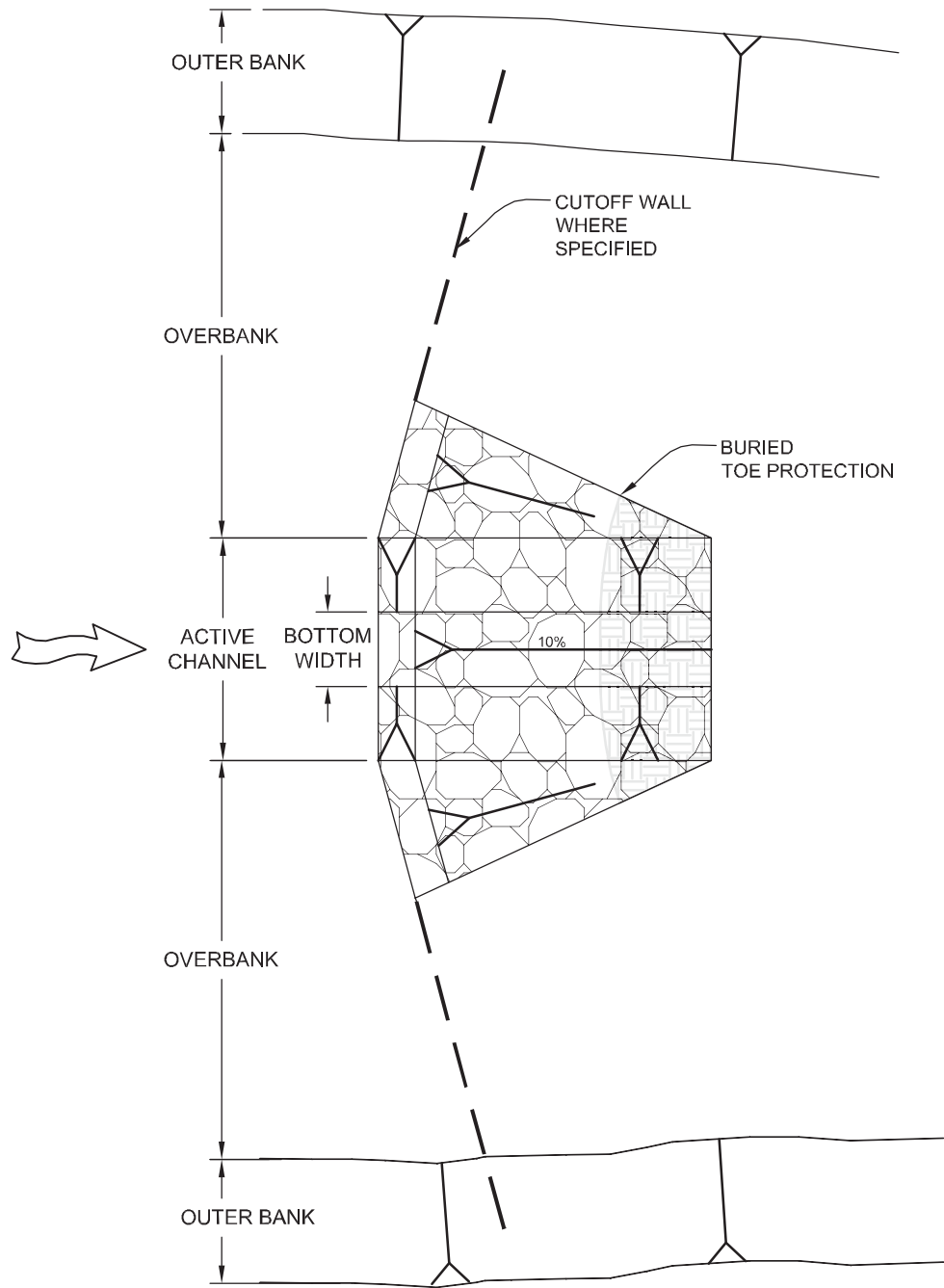


**HAPPY CANYON CREEK
MAJOR DRAINAGEWAY PLAN**

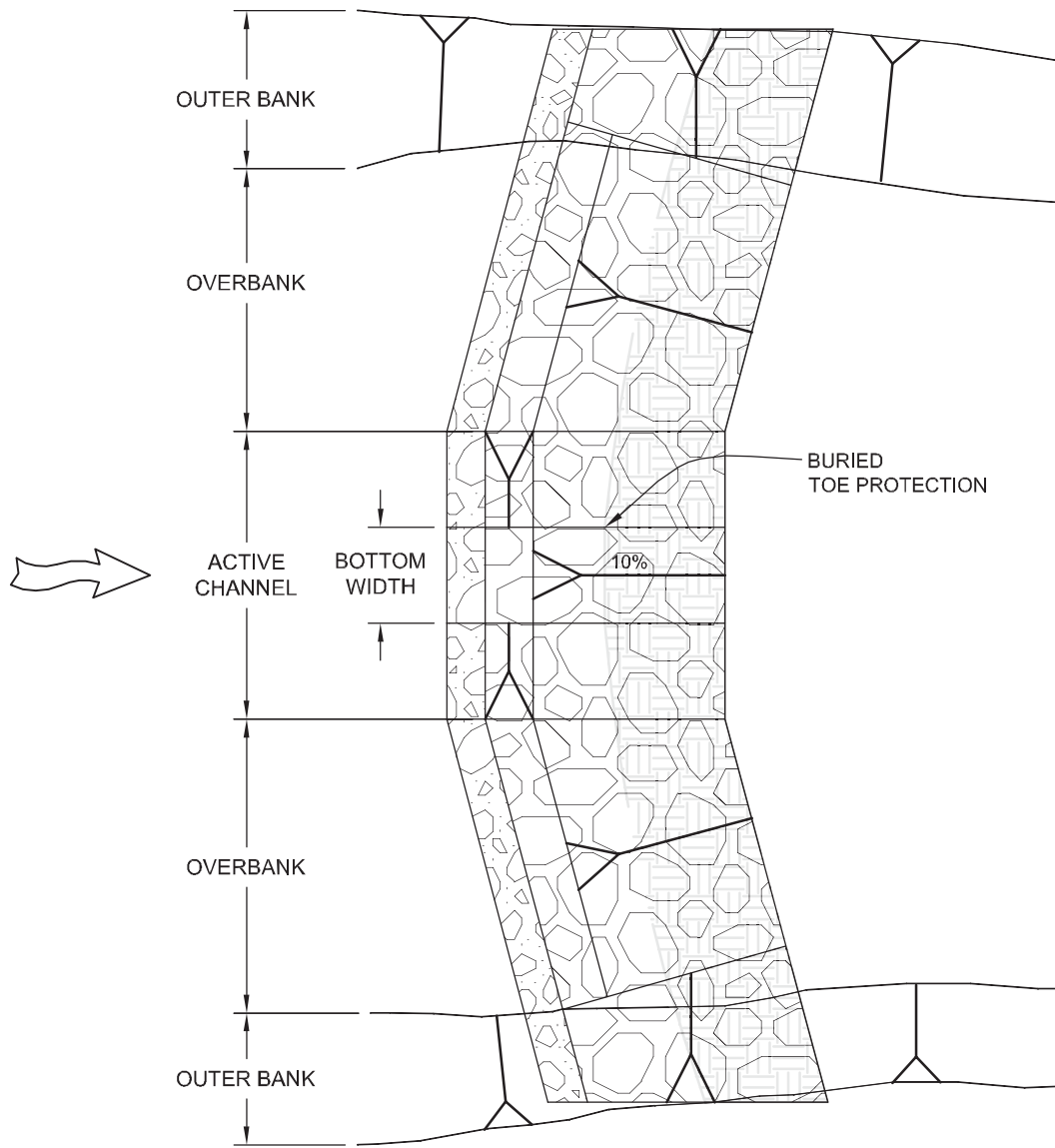
**CONCEPTUAL DESIGN PROFILE
REACH 8 (2 OF 2); REACH 7 (1 OF 2)**

DATE	MARCH 2014
FIGURE NO.	

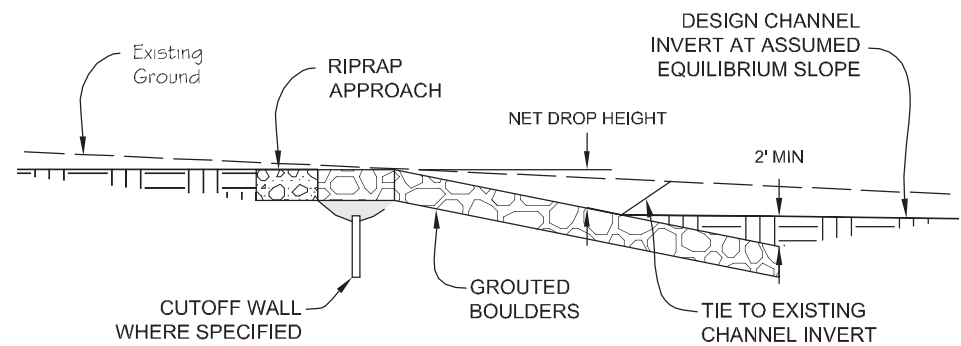
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DROP STRUCTURE PLAN
LOW-FLOW



DROP STRUCTURE PLAN
FULL WIDTH



DROP STRUCTURE
PROFILE

No.	DATE	REVISIONS	APPR.



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777 SOUTH WADSWORTH BLVD. 4-100
LAKEWOOD, COLORADO 80226 (303) 988-4939

DESIGN: MDC
DRAWN: SAR
CHECK: JTW

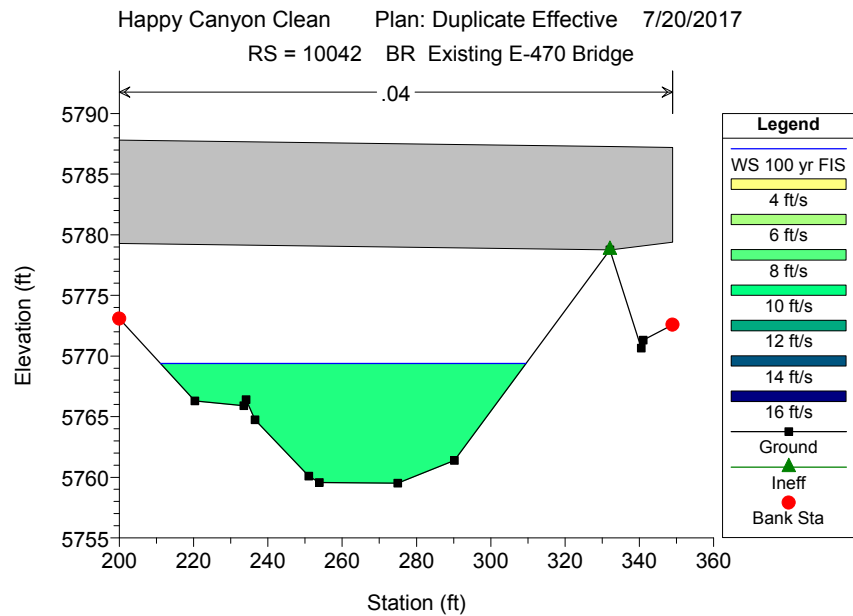
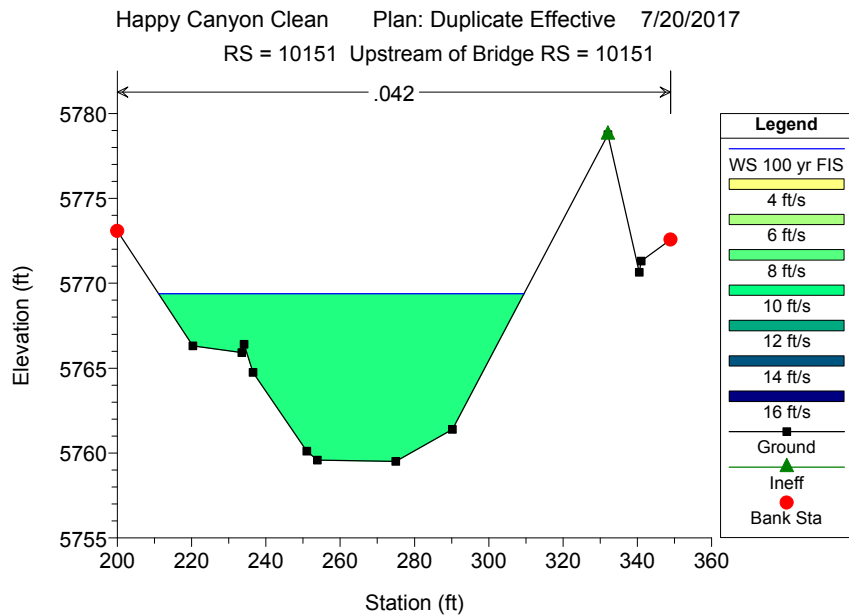
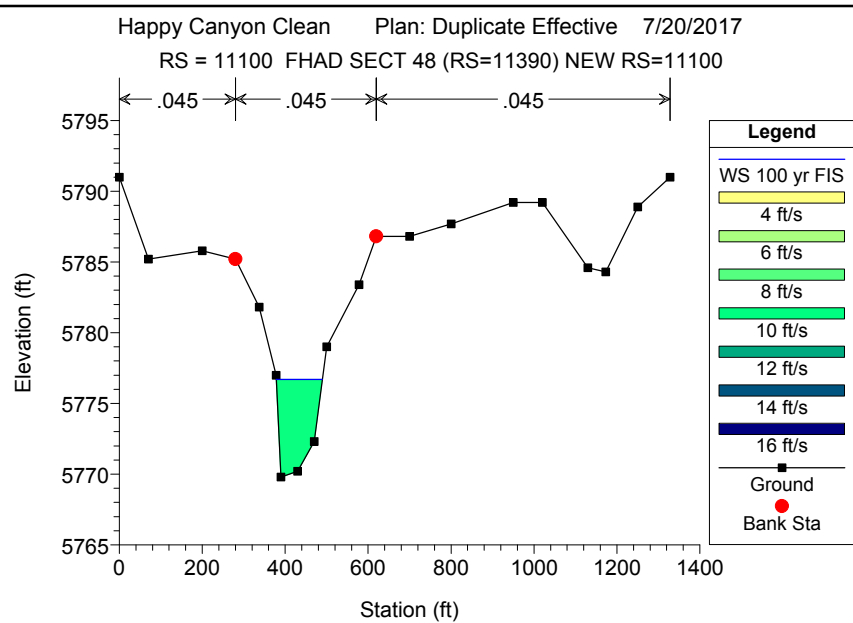
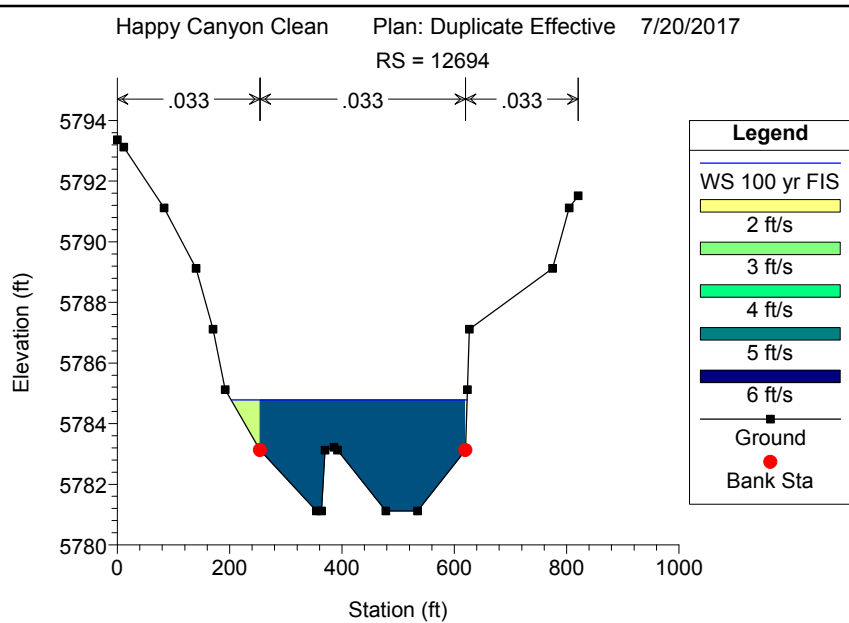


HAPPY CANYON CREEK
MAJOR DRAINAGEWAY PLAN

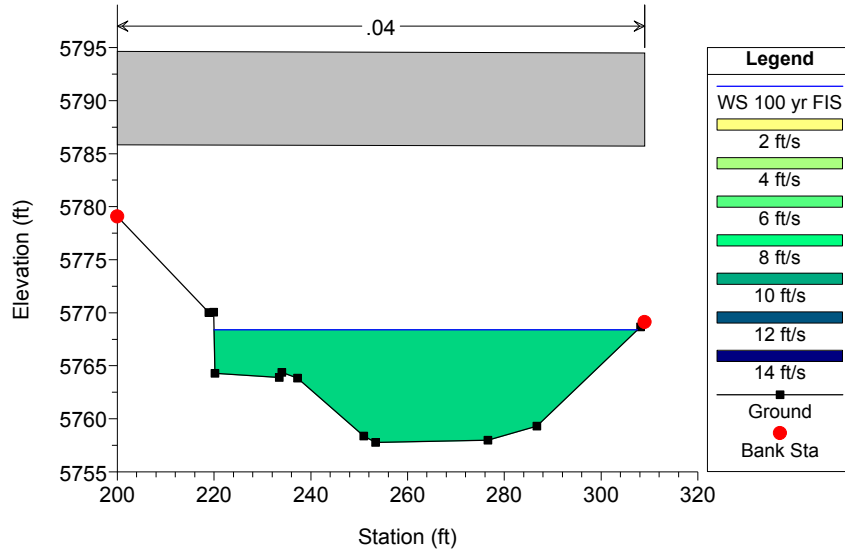
CONCEPTUAL DESIGN
TYPICAL DROP STRUCTURE DETAILS

DATE: MARCH 2014
FIGURE NO. G-5

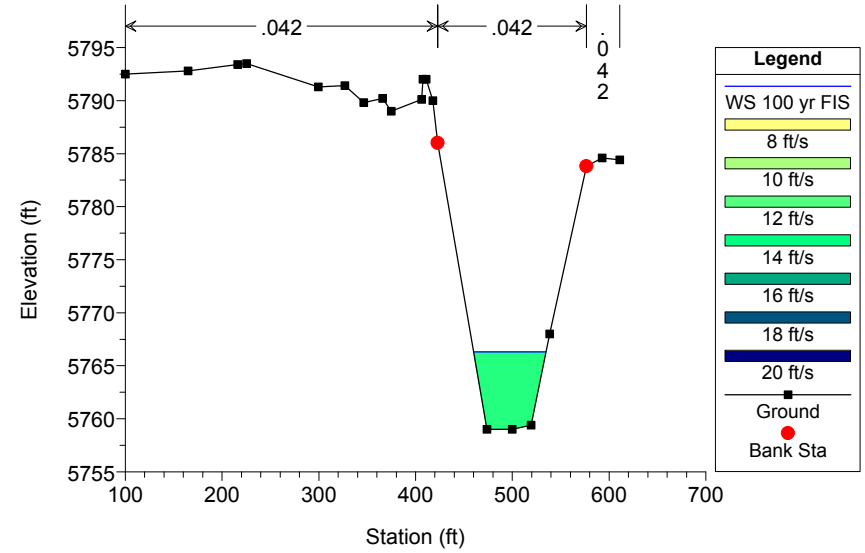
APPENDIX C. DUPLICATE EFFECTIVE MODEL (HEC-RAS MODEL)



Happy Canyon Clean Plan: Duplicate Effective 7/20/2017
 RS = 10042 BR Existing E-470 Bridge



Happy Canyon Clean Plan: Duplicate Effective 7/20/2017
 RS = 9920 RS = 9920



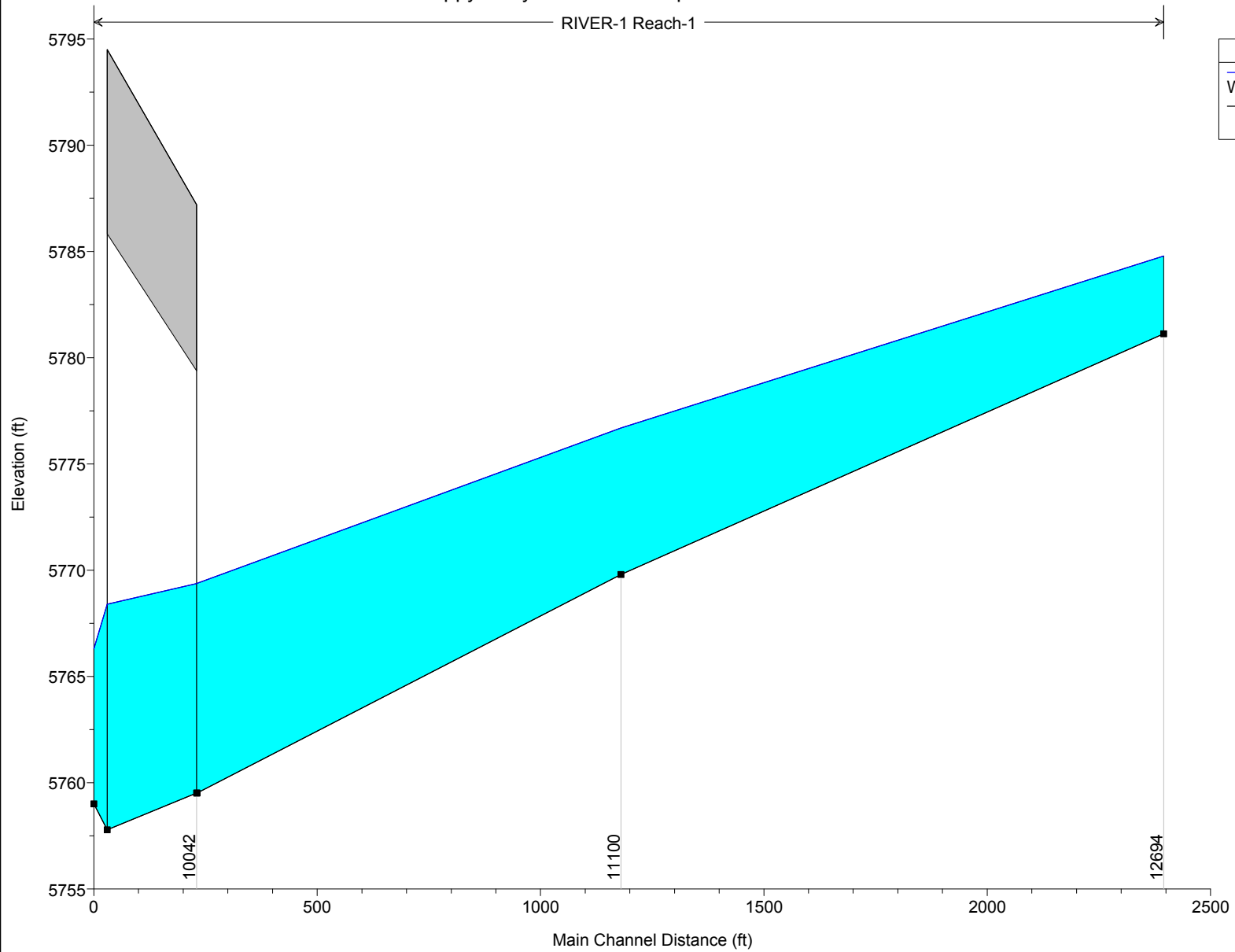
Happy Canyon Plan: Duplicate Effective 7/24/2017

RIVER-1 Reach-1

Legend

WS 100 yr FIS

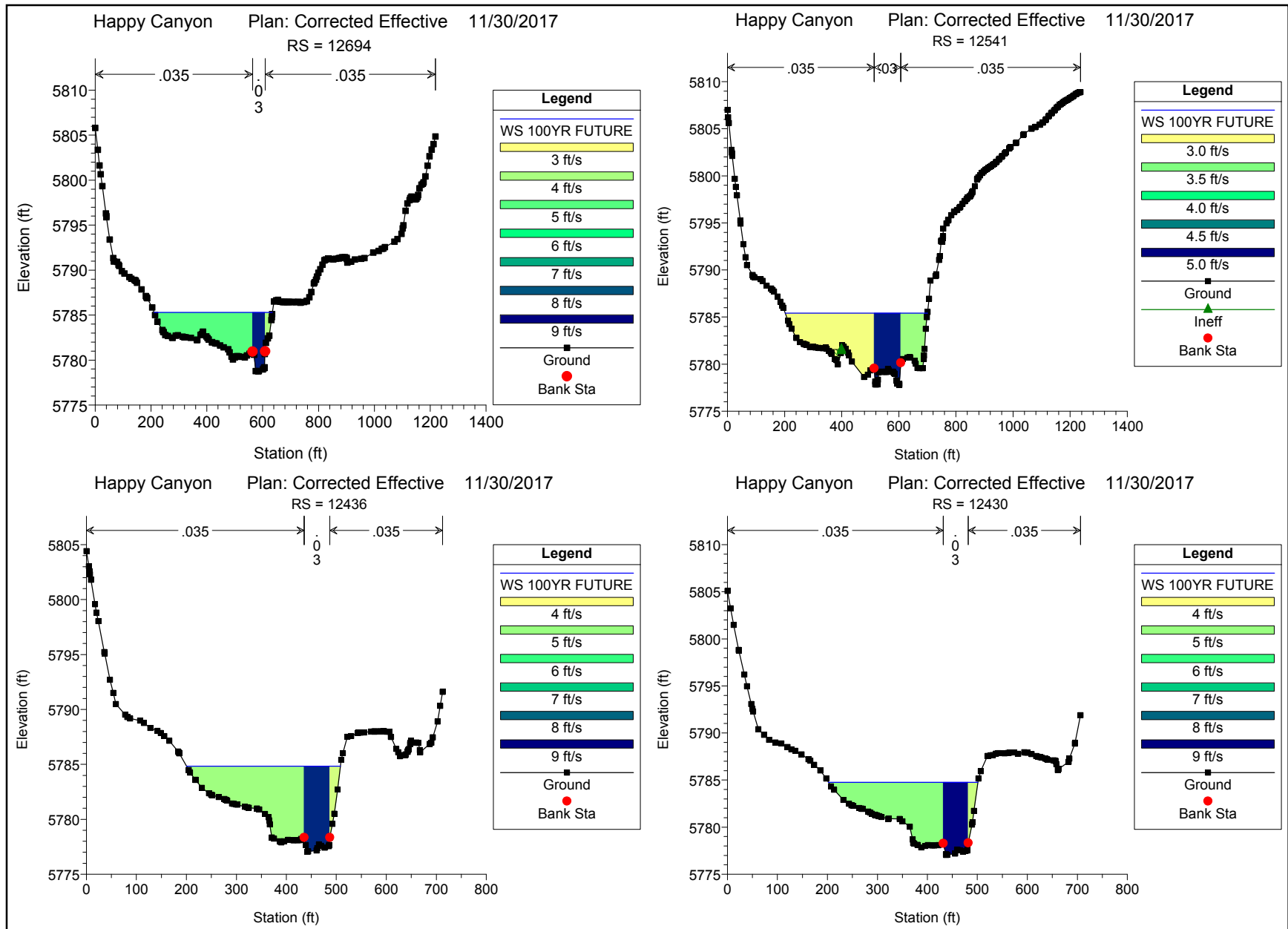
Ground

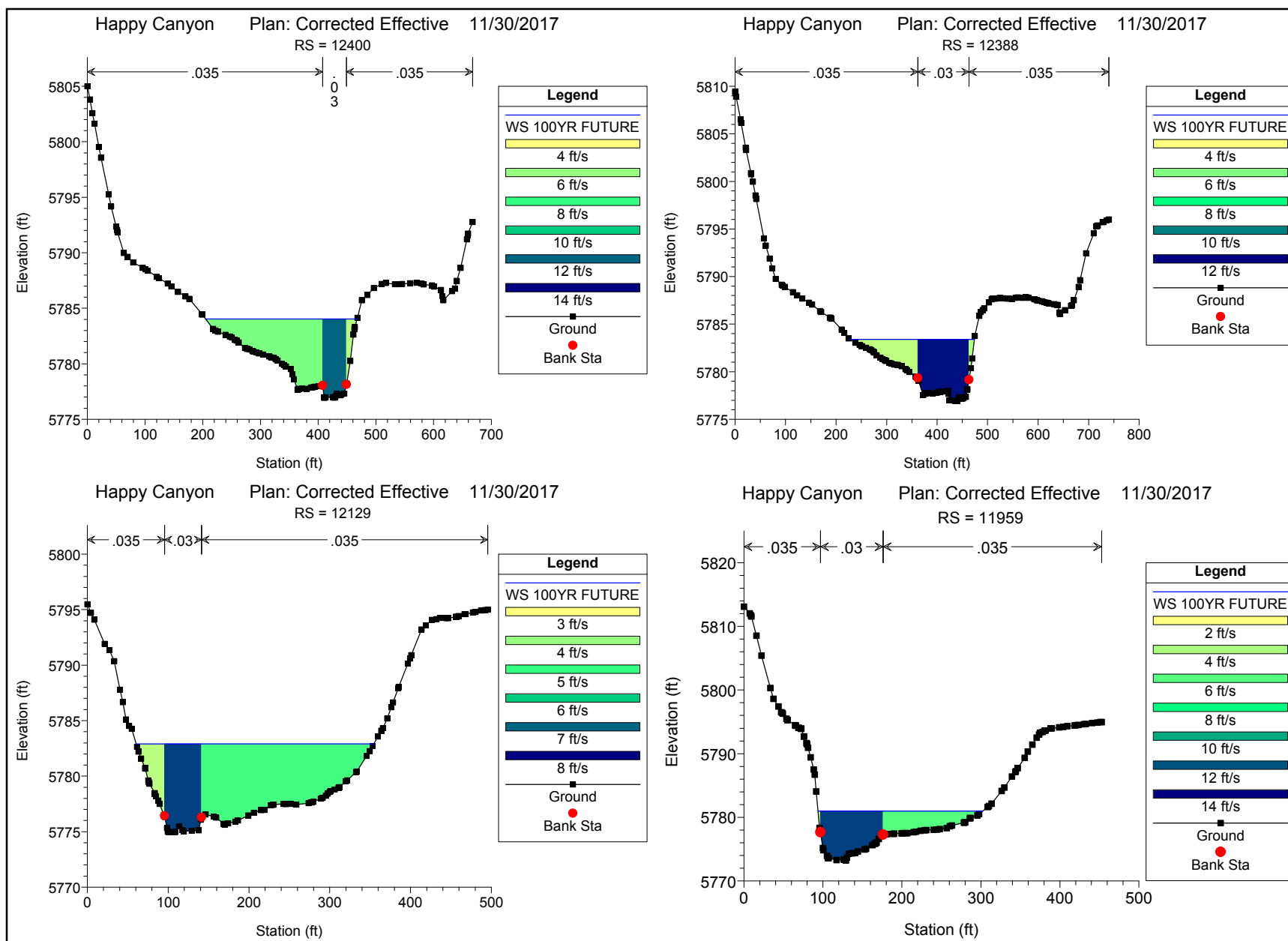


HEC-RAS Plan: Dup Eff River: RIVER-1 Reach: Reach-1 Profile: 100 yr FIS

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)	
Reach-1	12694	100 yr FIS	5560.00	5781.12	5784.78		5785.22	0.003633	5.36	1062.08	420.09	0.57
Reach-1	11100	100 yr FIS	5560.00	5769.80	5776.70		5778.18	0.010246	9.78	568.61	111.18	0.76
Reach-1	10151	100 yr FIS	5700.00	5759.51	5769.38	5767.58	5770.71	0.006167	9.23	617.86	98.41	0.65
Reach-1	10042		Bridge									
Reach-1	9920	100 yr FIS	5700.00	5759.00	5766.30	5766.12	5768.99	0.014116	13.16	433.02	74.84	0.96

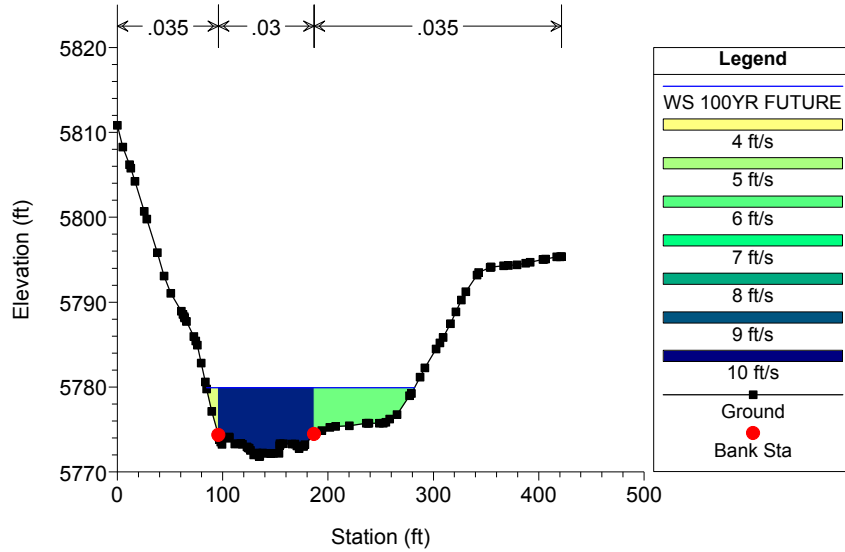
APPENDIX D. CORRECTED EFFECTIVE MODEL (HEC-RAS MODEL)





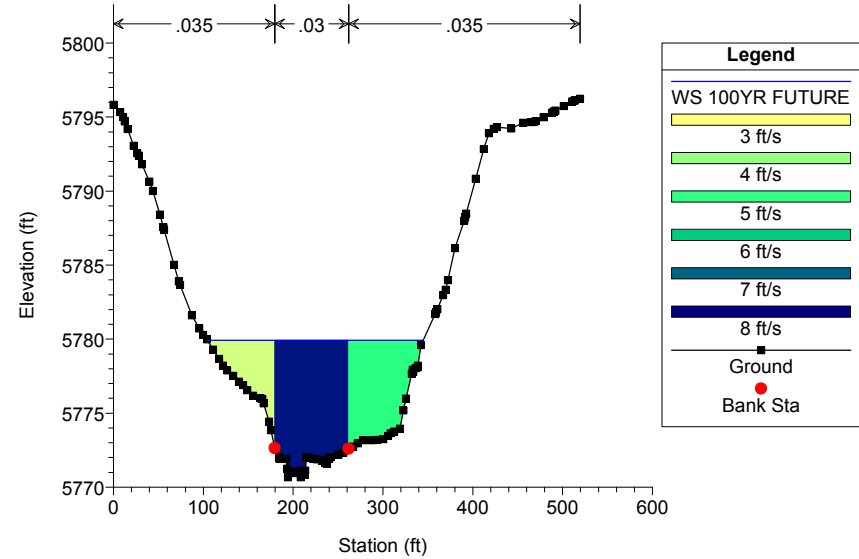
Happy Canyon Plan: Corrected Effective 11/30/2017

RS = 11772



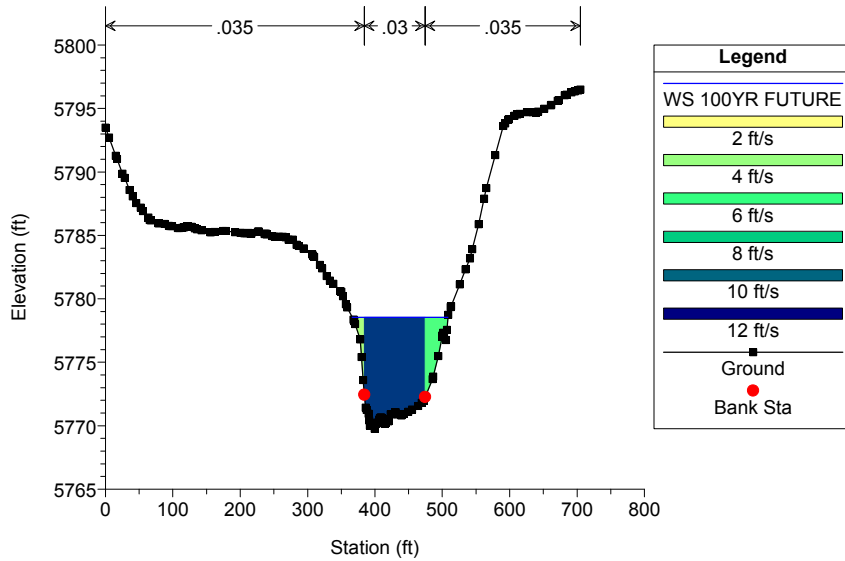
Happy Canyon Plan: Corrected Effective 11/30/2017

RS = 11620



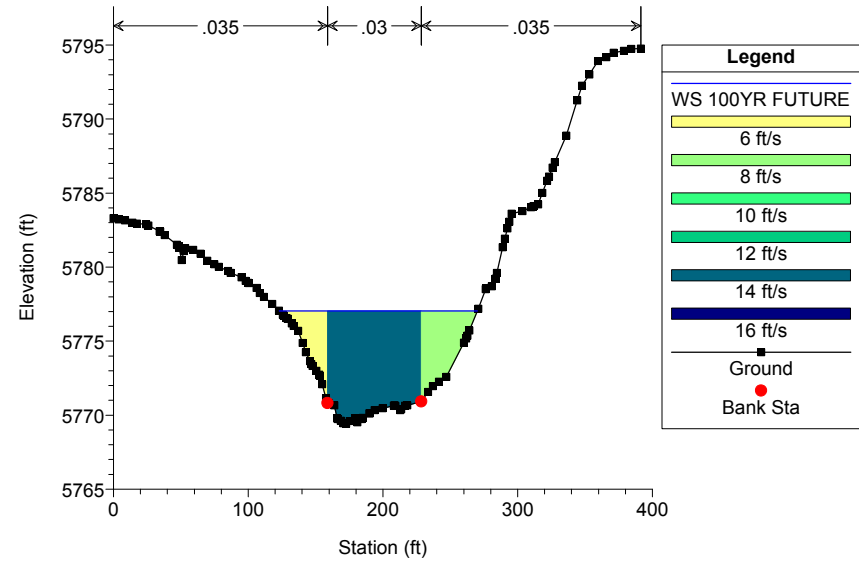
Happy Canyon Plan: Corrected Effective 11/30/2017

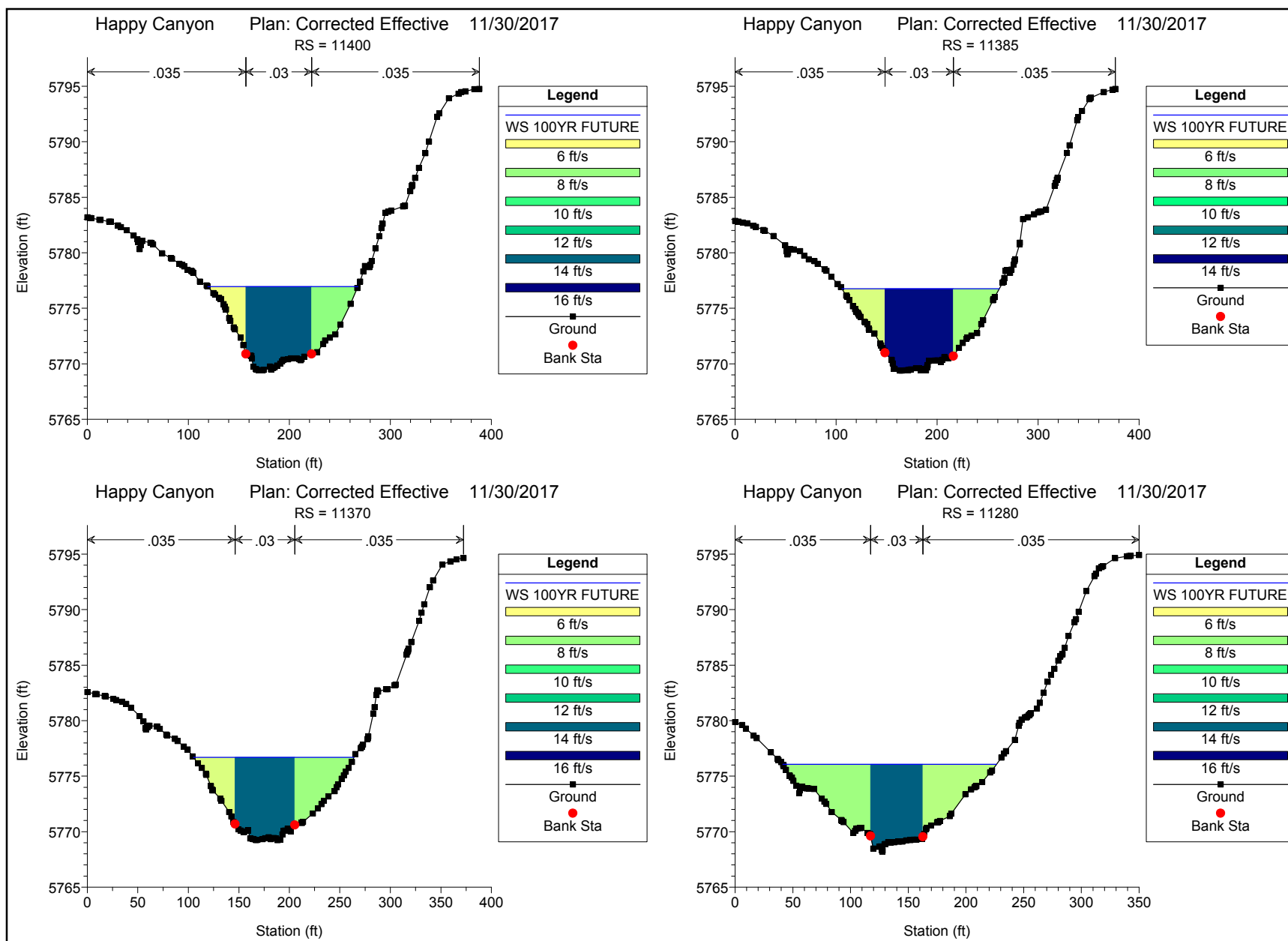
RS = 11494

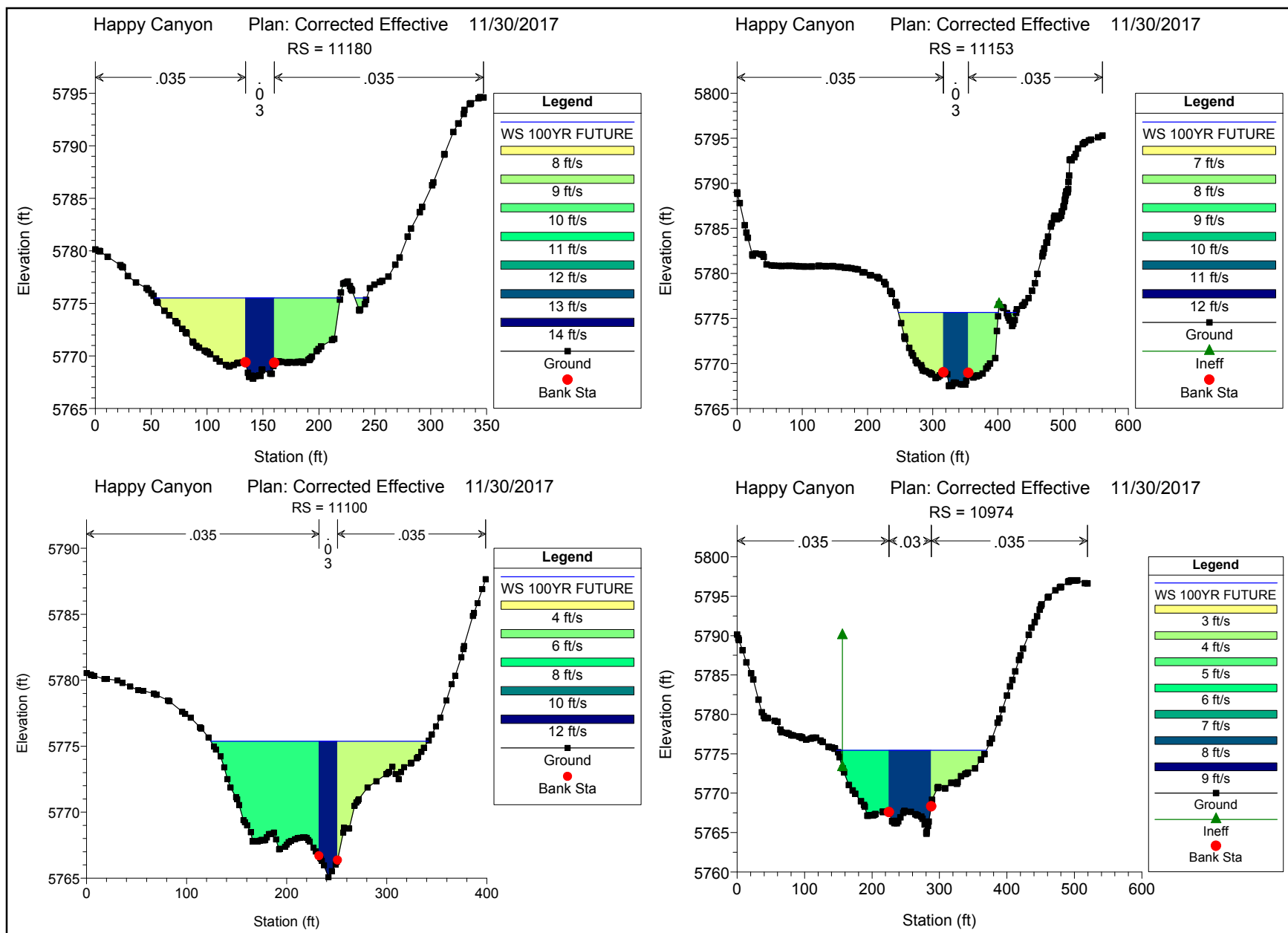


Happy Canyon Plan: Corrected Effective 11/30/2017

RS = 11410

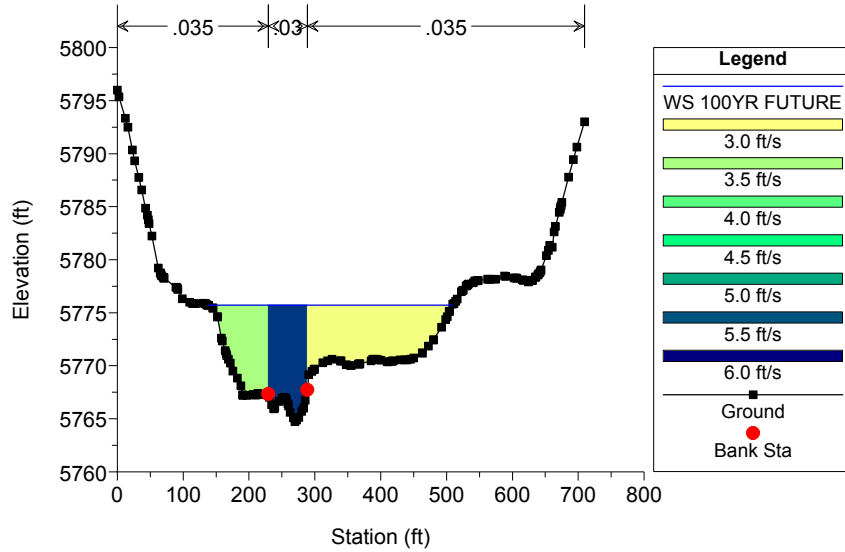






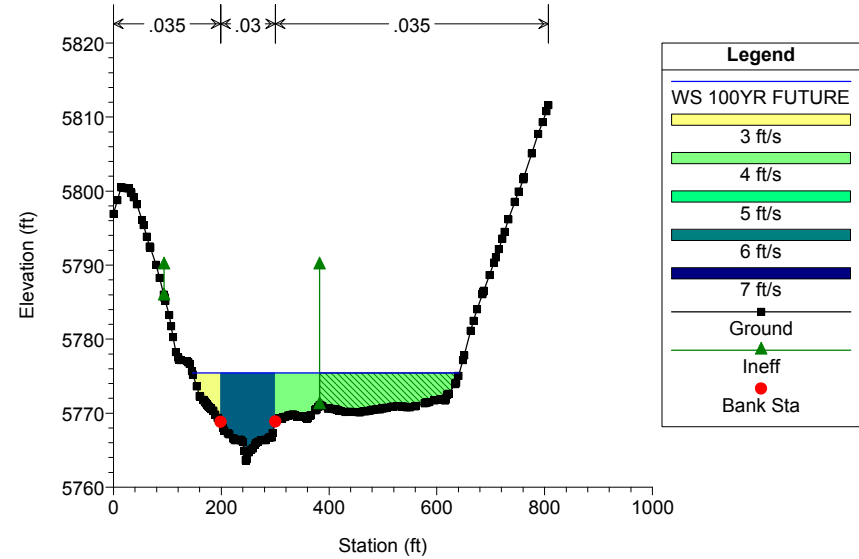
Happy Canyon Plan: Corrected Effective 11/30/2017

RS = 10900



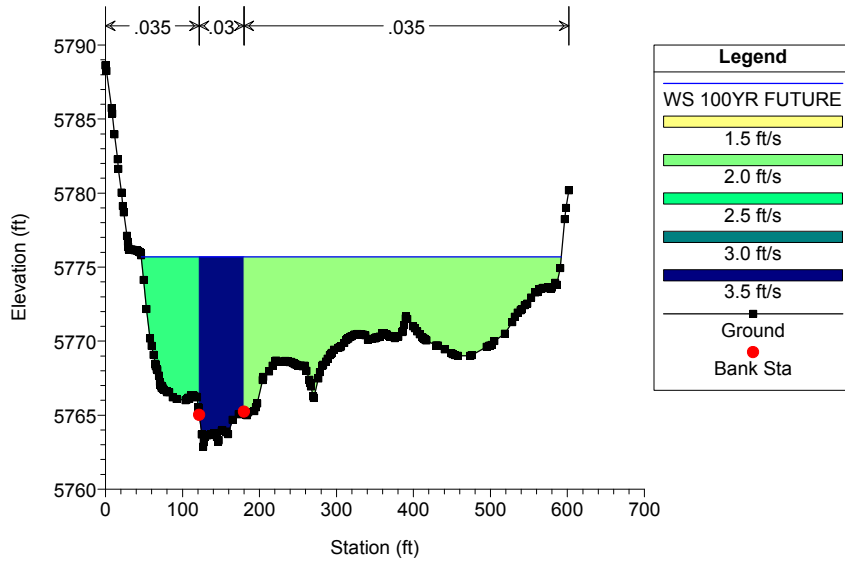
Happy Canyon Plan: Corrected Effective 11/30/2017

RS = 10842



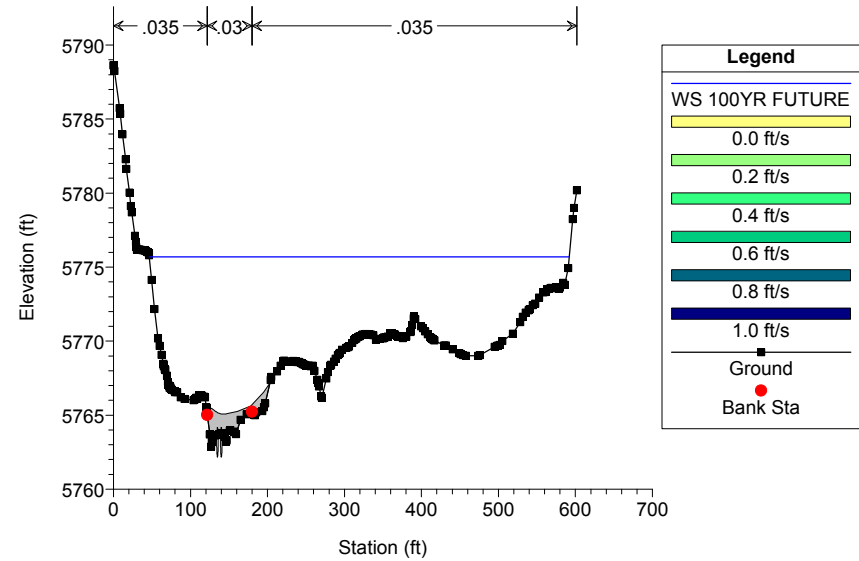
Happy Canyon Plan: Corrected Effective 11/30/2017

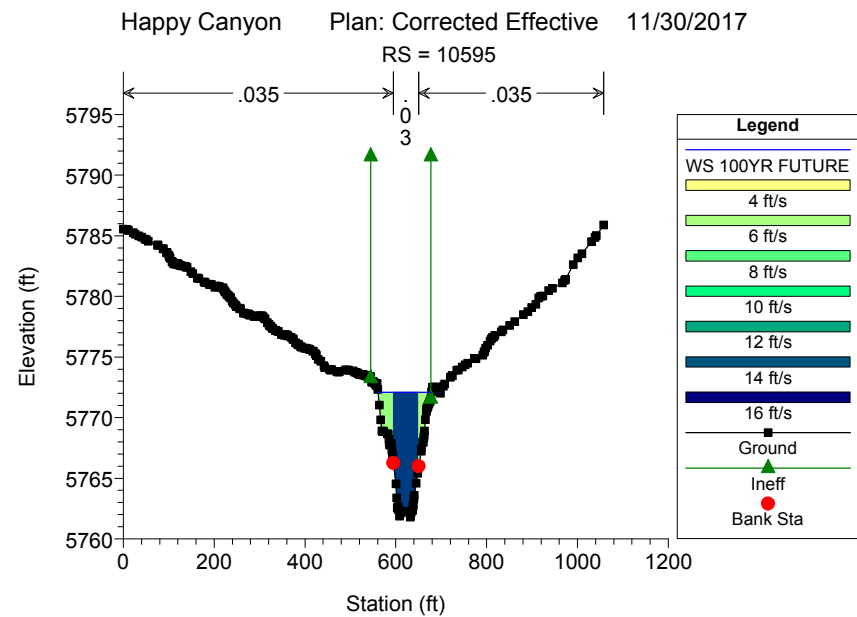
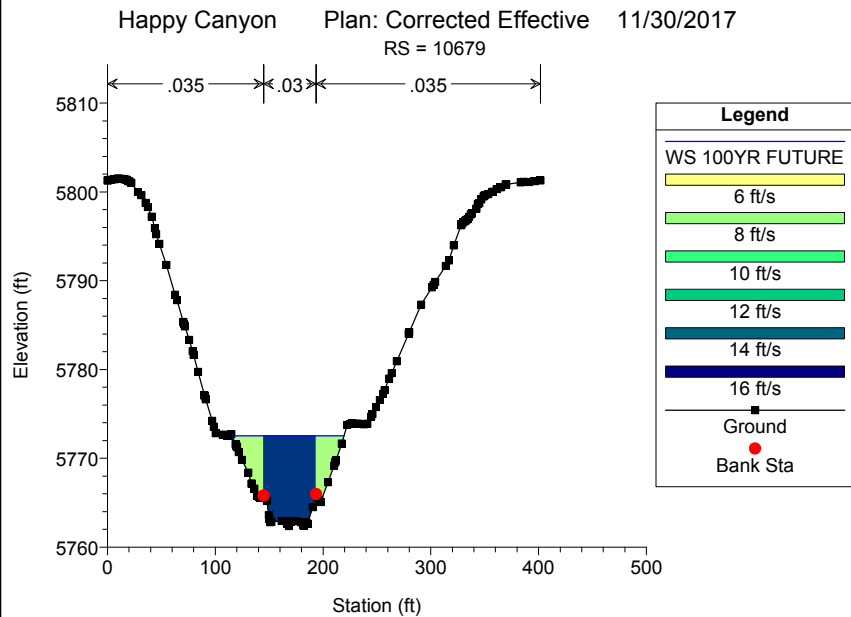
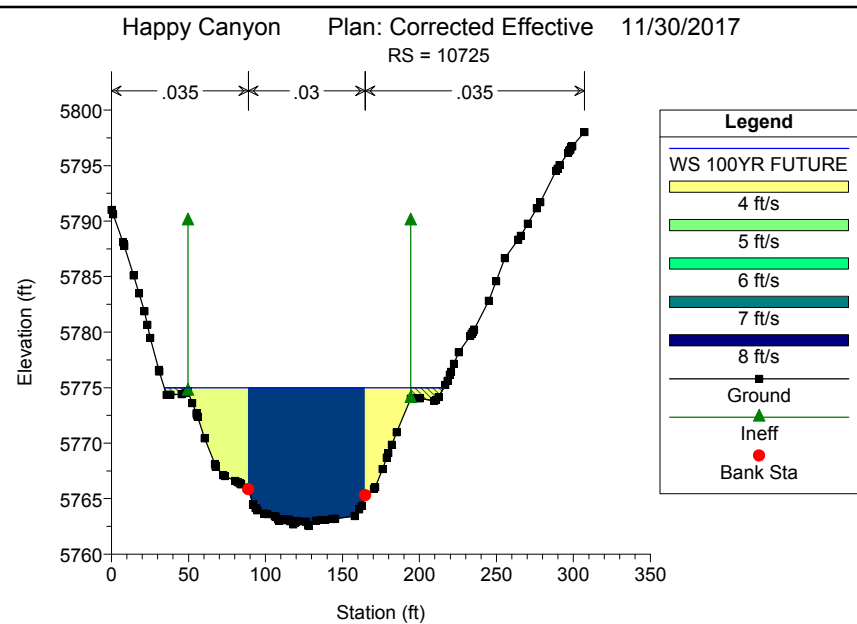
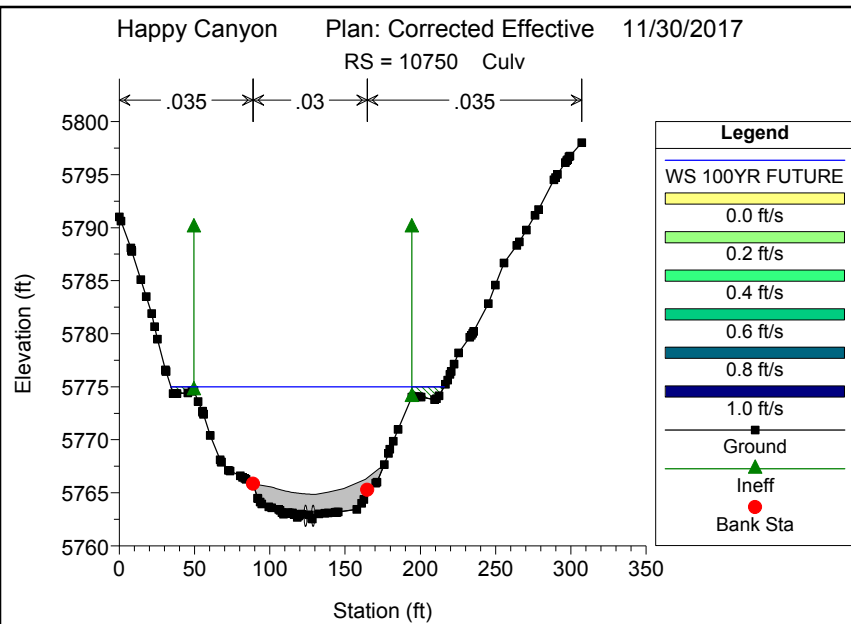
RS = 10775



Happy Canyon Plan: Corrected Effective 11/30/2017

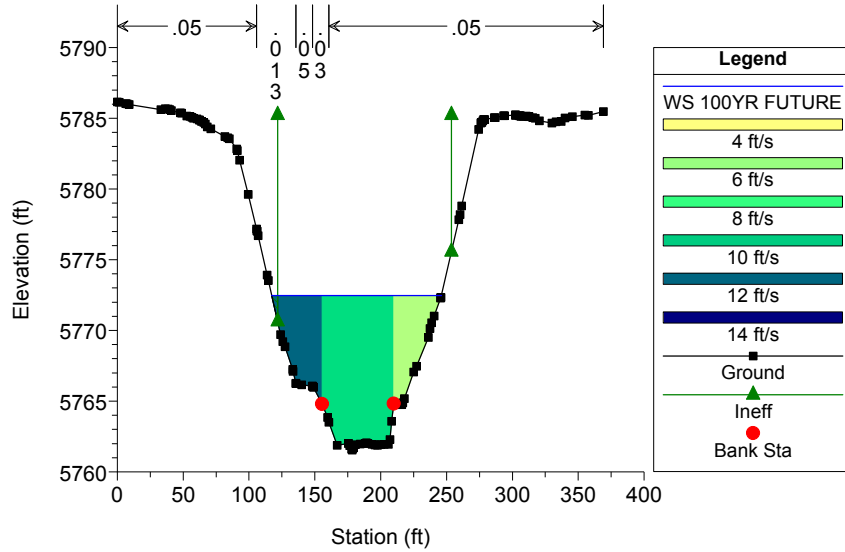
RS = 10750 Culv





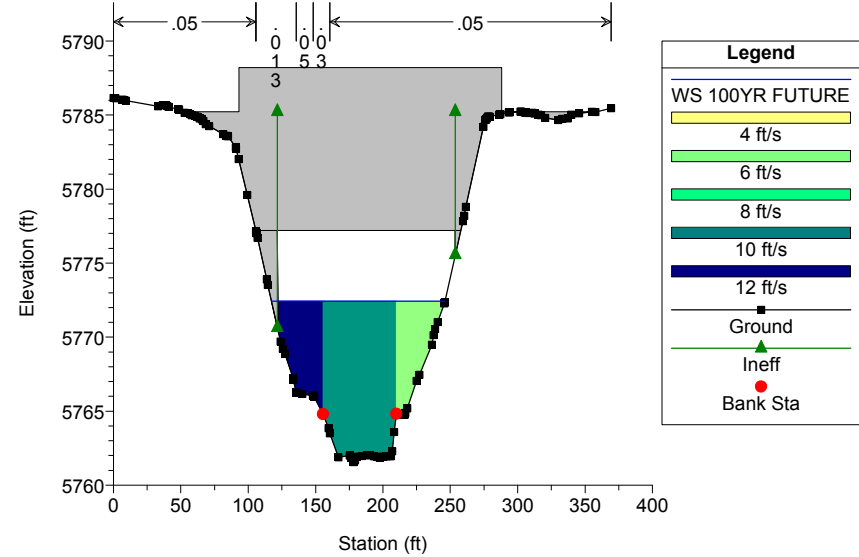
Happy Canyon Plan: Corrected Effective 11/30/2017

RS = 10548



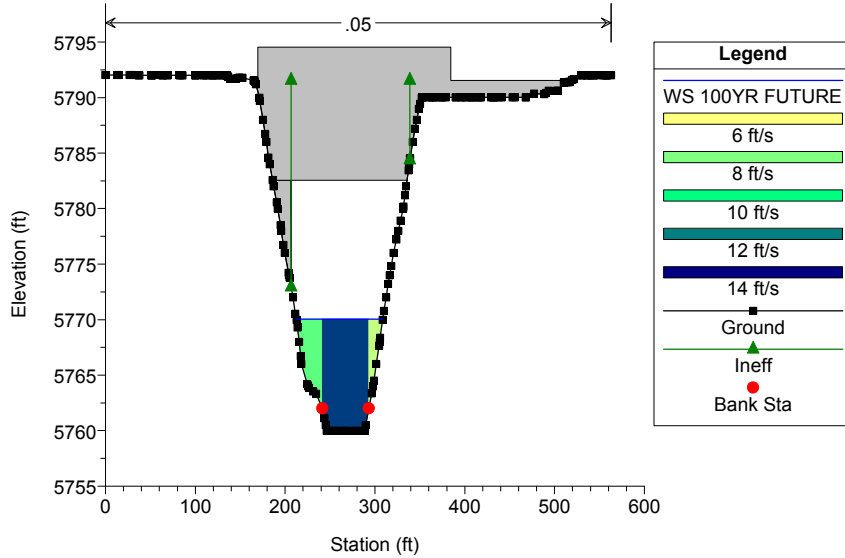
Happy Canyon Plan: Corrected Effective 11/30/2017

RS = 10500 BR E-470 / Crossing 21 / (two bridges combined in one crossing)



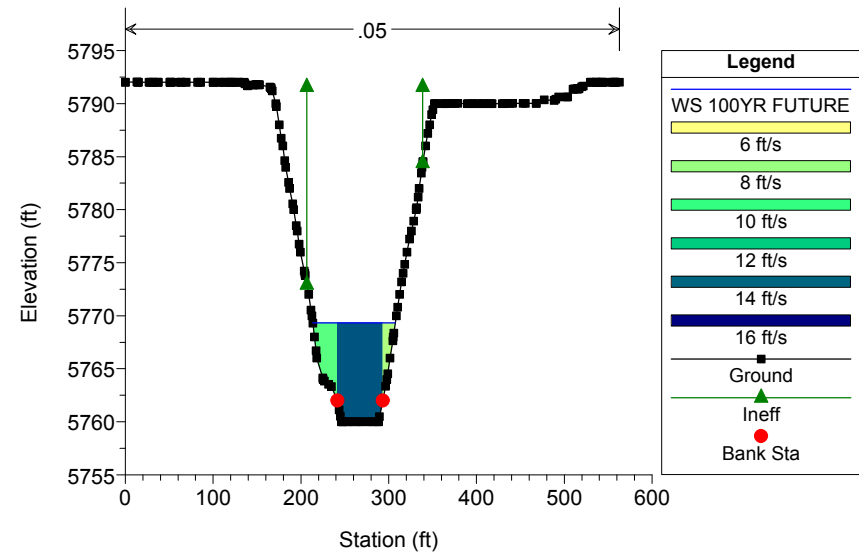
Happy Canyon Plan: Corrected Effective 11/30/2017

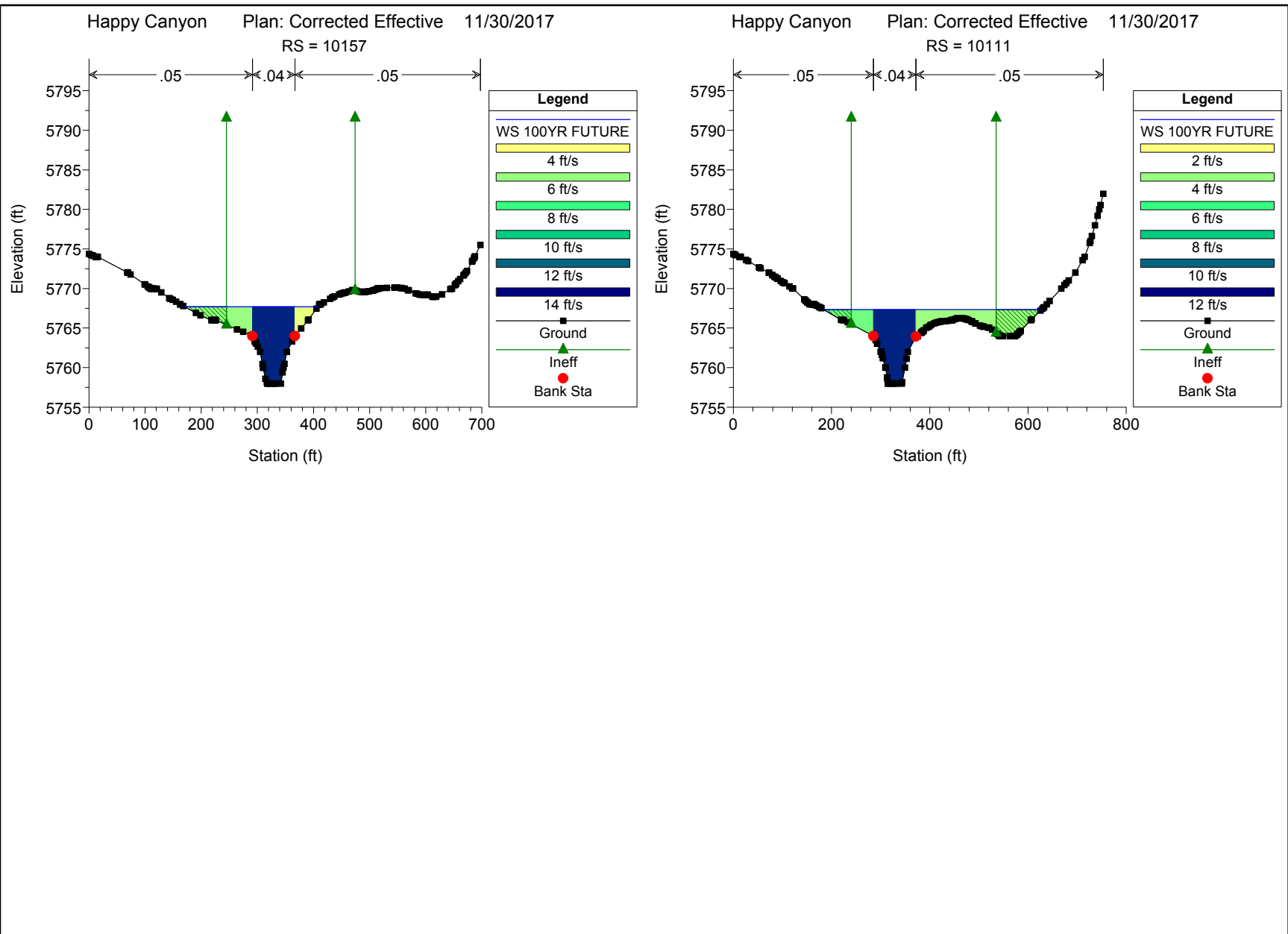
RS = 10500 BR E-470 / Crossing 21 / (two bridges combined in one crossing)



Happy Canyon Plan: Corrected Effective 11/30/2017

RS = 10326





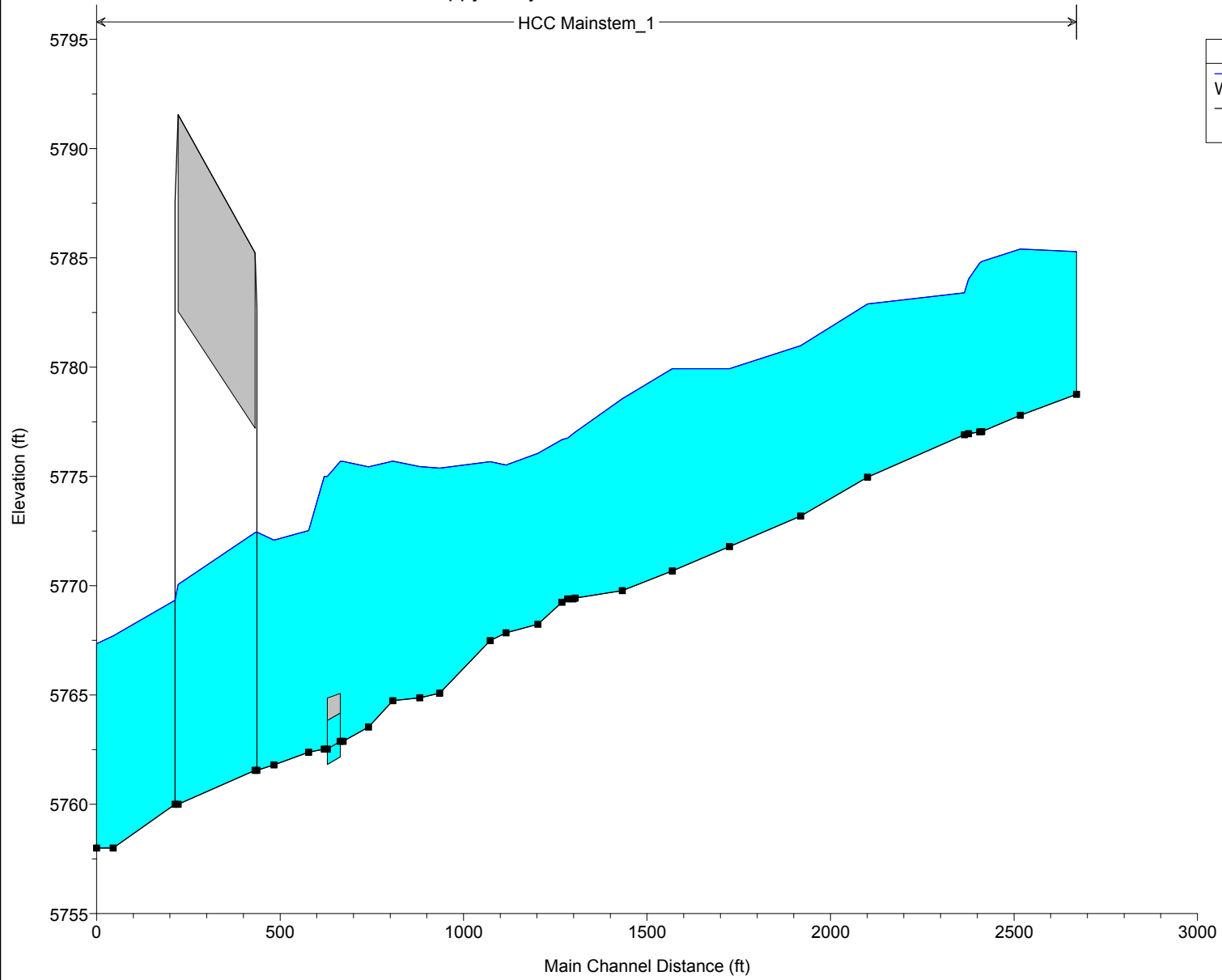
Happy Canyon Plan: Corrected Effective 11/30/2017

HCC Mainstem_1

Legend

WS 100YR FUTURE

Ground



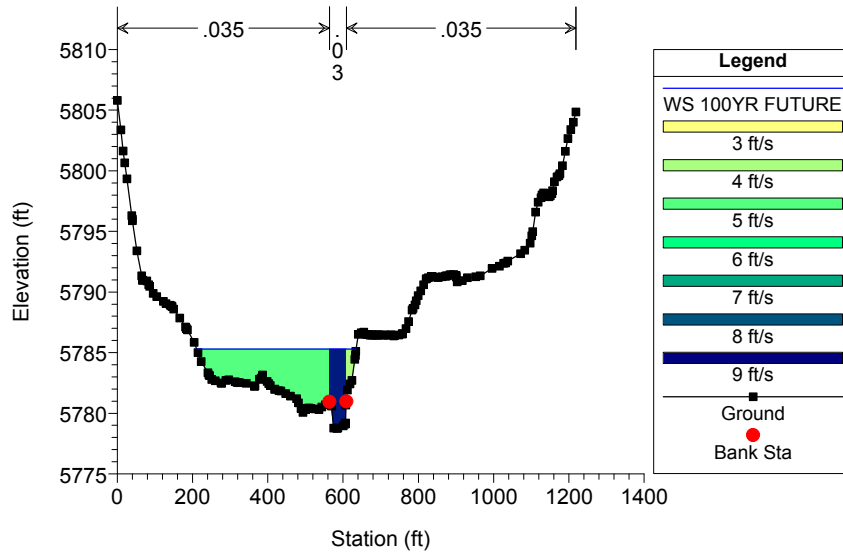
HEC-RAS Plan: Corr Eff River: HCC Reach: Mainstem_1 Profile: 100YR FUTURE

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)	
Mainstem_1	12694	100YR FUTURE	8303.00	5778.76	5785.29		5785.89	0.002885	8.68	1475.77	424.04	0.62
Mainstem_1	12541	100YR FUTURE	8303.00	5777.80	5785.41		5785.64	0.000810	4.90	2302.56	498.02	0.34
Mainstem_1	12436	100YR FUTURE	8303.00	5777.05	5784.84		5785.52	0.002107	8.62	1406.68	307.90	0.56
Mainstem_1	12430	100YR FUTURE	8303.00	5777.04	5784.76		5785.50	0.002308	8.98	1351.73	299.18	0.58
Mainstem_1	12400	100YR FUTURE	8303.00	5776.95	5784.03	5783.60	5785.35	0.004592	12.05	1034.77	262.35	0.81
Mainstem_1	12388	100YR FUTURE	8303.00	5776.91	5783.40	5783.40	5785.24	0.005516	11.75	874.49	246.29	0.86
Mainstem_1	12129	100YR FUTURE	8303.00	5774.96	5782.90		5783.40	0.001482	7.38	1559.86	294.03	0.47
Mainstem_1	11959	100YR FUTURE	8303.00	5773.19	5780.98	5780.98	5782.95	0.005534	12.49	841.19	208.59	0.87
Mainstem_1	11772	100YR FUTURE	8303.00	5771.79	5779.92		5781.10	0.002911	9.61	1034.75	197.53	0.64
Mainstem_1	11620	100YR FUTURE	8303.00	5770.67	5779.93		5780.65	0.001528	7.80	1346.20	240.35	0.48
Mainstem_1	11494	100YR FUTURE	8303.00	5769.78	5778.55		5780.27	0.003259	10.91	843.99	141.91	0.70
Mainstem_1	11410	100YR FUTURE	8303.00	5769.43	5777.03	5777.03	5779.62	0.006282	14.01	708.81	146.91	0.95
Mainstem_1	11400	100YR FUTURE	8303.00	5769.40	5776.95	5776.95	5779.57	0.006479	14.26	708.82	148.61	0.96
Mainstem_1	11385	100YR FUTURE	8303.00	5769.39	5776.76	5776.76	5779.21	0.006085	13.82	735.72	155.85	0.93
Mainstem_1	11370	100YR FUTURE	8303.00	5769.24	5776.69	5776.69	5779.09	0.006104	14.06	747.97	158.83	0.94
Mainstem_1	11280	100YR FUTURE	8303.00	5768.23	5776.06	5776.06	5778.17	0.006127	14.14	812.78	185.09	0.94
Mainstem_1	11180	100YR FUTURE	8303.00	5767.85	5775.53	5775.00	5777.26	0.005743	13.70	839.07	176.65	0.90
Mainstem_1	11153	100YR FUTURE	8303.00	5767.48	5775.68		5777.03	0.003483	11.29	936.01	168.27	0.72
Mainstem_1	11100	100YR FUTURE	8303.00	5765.08	5775.38		5776.45	0.002770	11.63	1125.31	217.42	0.66
Mainstem_1	10974	100YR FUTURE	8303.00	5764.87	5775.45		5776.24	0.001667	8.30	1272.71	222.43	0.50
Mainstem_1	10900	100YR FUTURE	8303.00	5764.74	5775.71		5776.00	0.000655	5.68	2149.86	370.84	0.32
Mainstem_1	10842	100YR FUTURE	8303.00	5763.53	5775.44		5775.93	0.000859	6.26	1601.81	494.93	0.37
Mainstem_1	10775	100YR FUTURE	8303.00	5762.88	5775.69	5770.43	5775.79	0.000189	3.46	3693.50	545.39	0.18
Mainstem_1	10750		Culvert									
Mainstem_1	10725	100YR FUTURE	8355.00	5762.52	5775.00	5770.34	5775.75	0.000893	7.54	1298.13	181.51	0.39
Mainstem_1	10679	100YR FUTURE	8475.00	5762.39	5772.53	5772.16	5775.47	0.004940	14.96	681.19	103.80	0.87
Mainstem_1	10595	100YR FUTURE	8475.00	5761.80	5772.08	5772.08	5775.00	0.004825	14.58	690.71	120.64	0.86
Mainstem_1	10548	100YR FUTURE	8475.00	5761.55	5772.46	5770.32	5774.01	0.004638	9.65	904.01	128.82	0.53
Mainstem_1	10500		Bridge									
Mainstem_1	10326	100YR FUTURE	8475.00	5760.00	5769.34	5768.71	5772.13	0.012390	14.32	666.57	93.87	0.83
Mainstem_1	10157	100YR FUTURE	8475.00	5758.00	5767.71	5767.71	5770.13	0.009372	13.29	766.17	237.59	0.87
Mainstem_1	10111	100YR FUTURE	8475.00	5758.00	5767.35	5767.34	5768.99	0.007289	11.32	1017.90	443.82	0.76

APPENDIX E. POST-PROJECT MODEL (HEC-RAS MODEL)

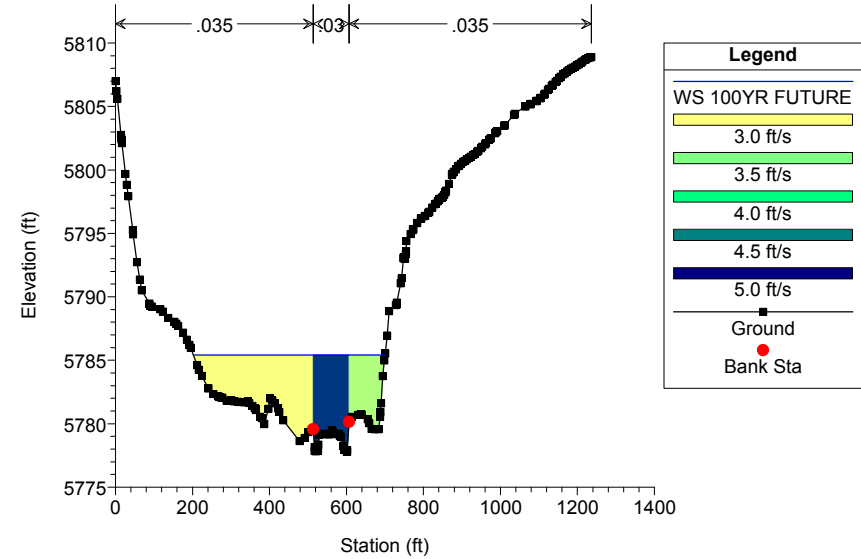
Happy Canyon Plan: Post-Project 11/29/2017

RS = 12694



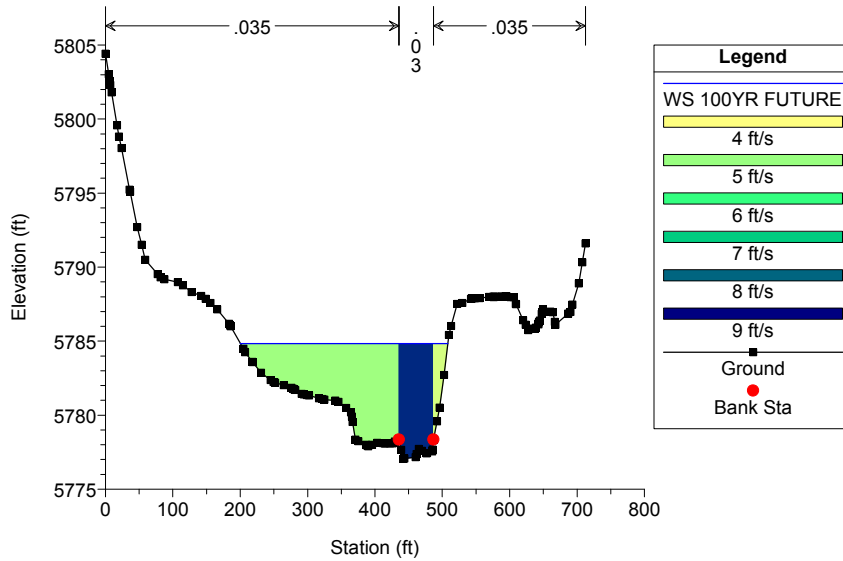
Happy Canyon Plan: Post-Project 11/29/2017

RS = 12541



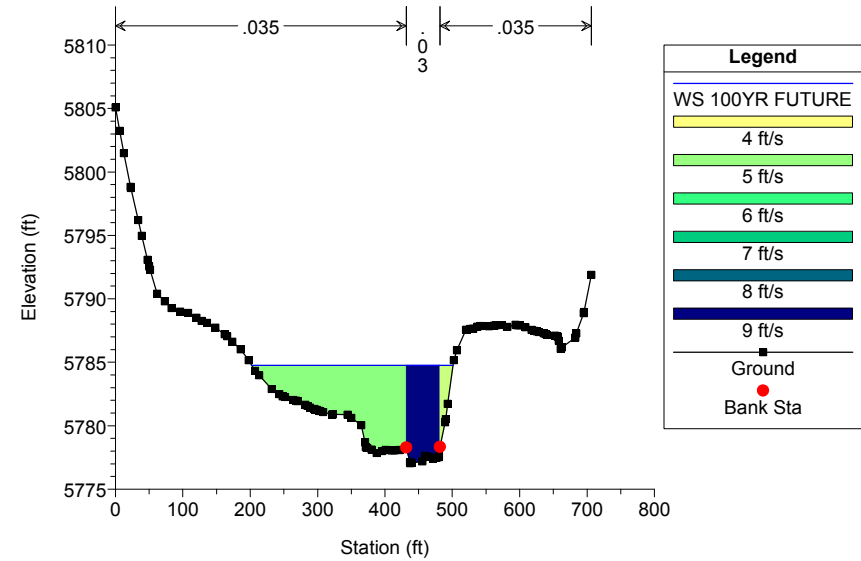
Happy Canyon Plan: Post-Project 11/29/2017

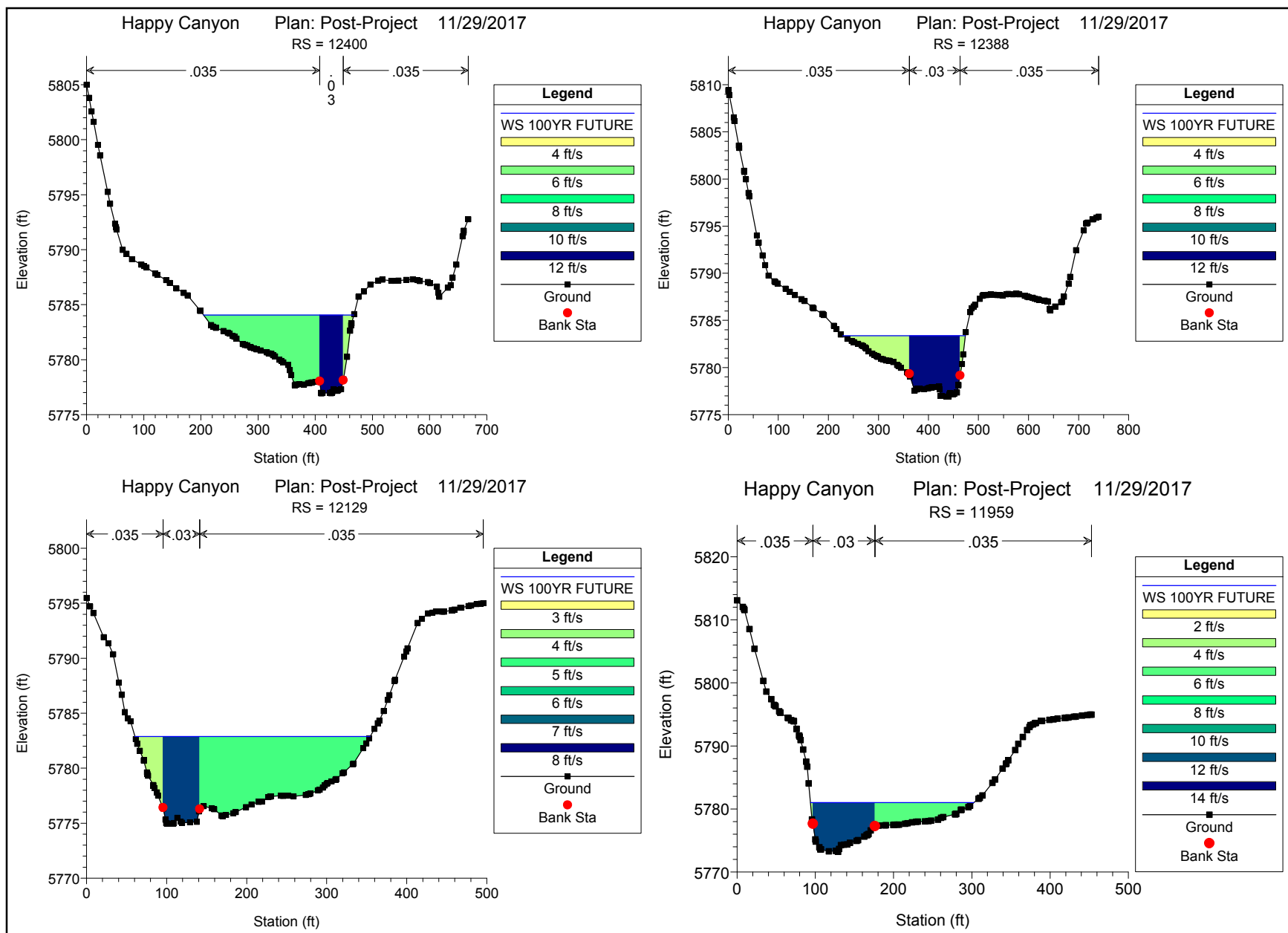
RS = 12436



Happy Canyon Plan: Post-Project 11/29/2017

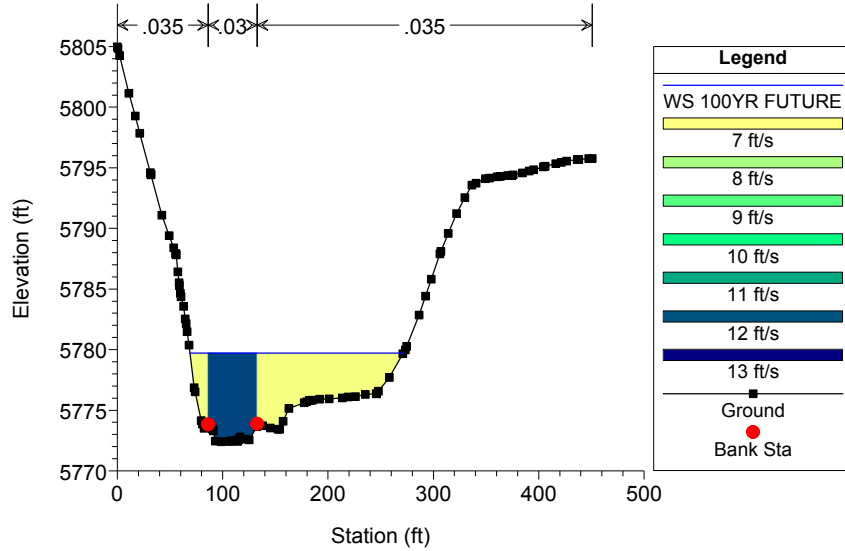
RS = 12430





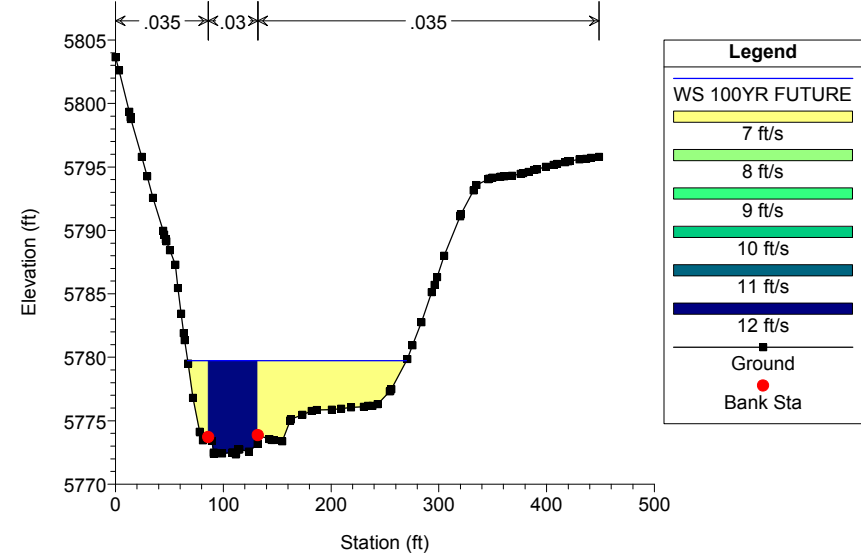
Happy Canyon Plan: Post-Project 11/29/2017

RS = 11835



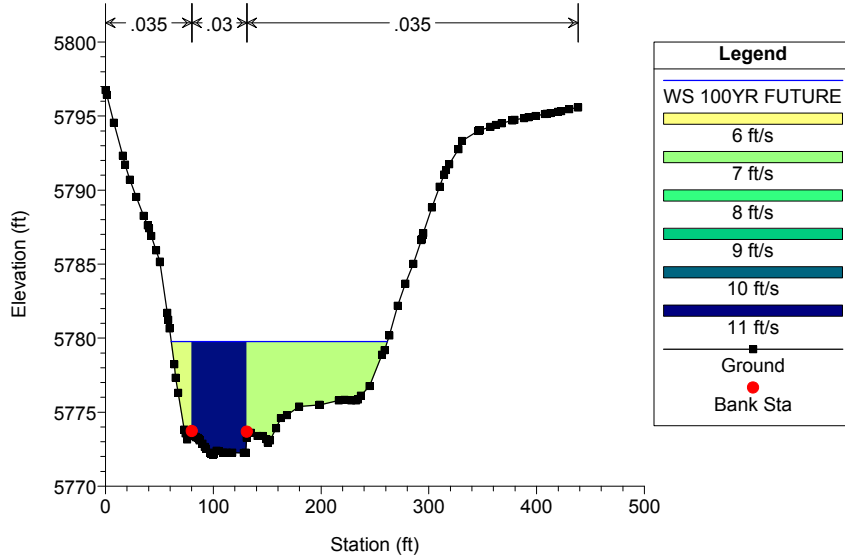
Happy Canyon Plan: Post-Project 11/29/2017

RS = 11830



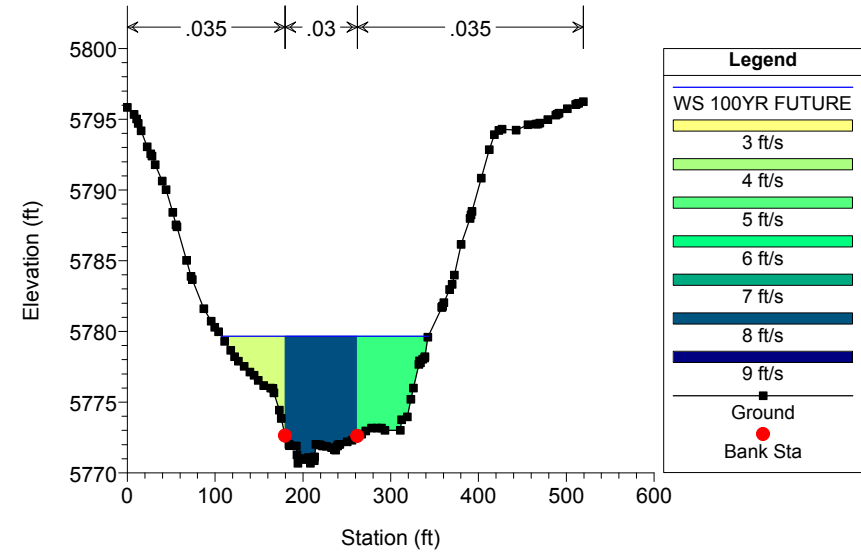
Happy Canyon Plan: Post-Project 11/29/2017

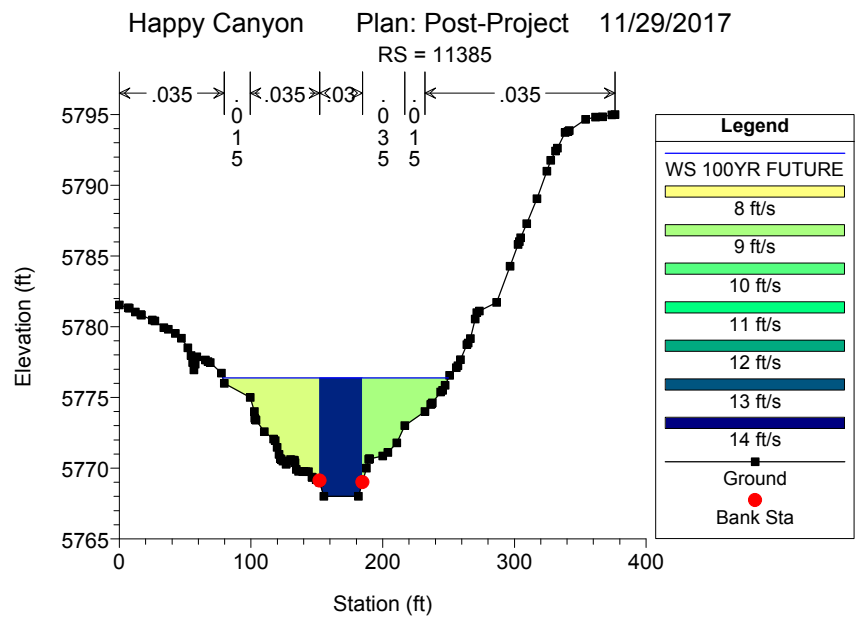
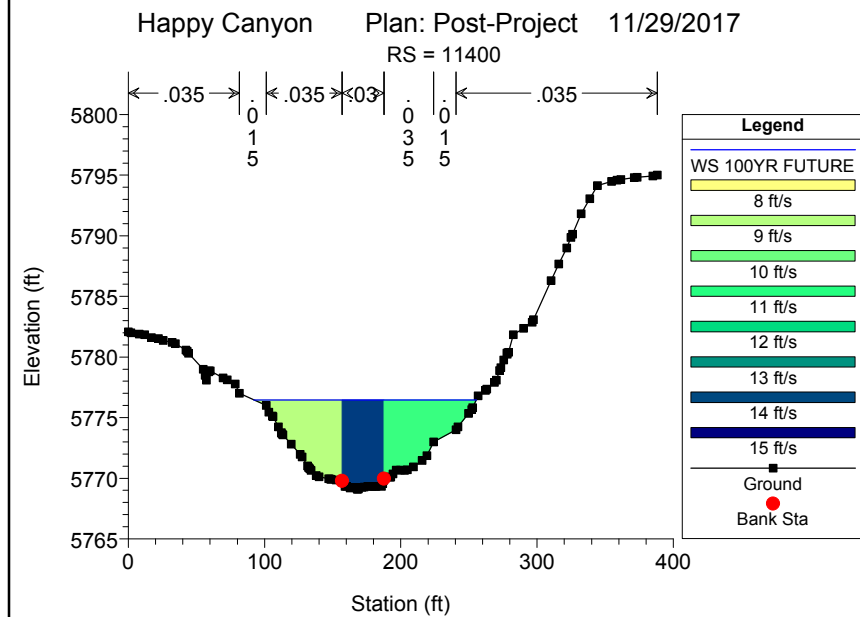
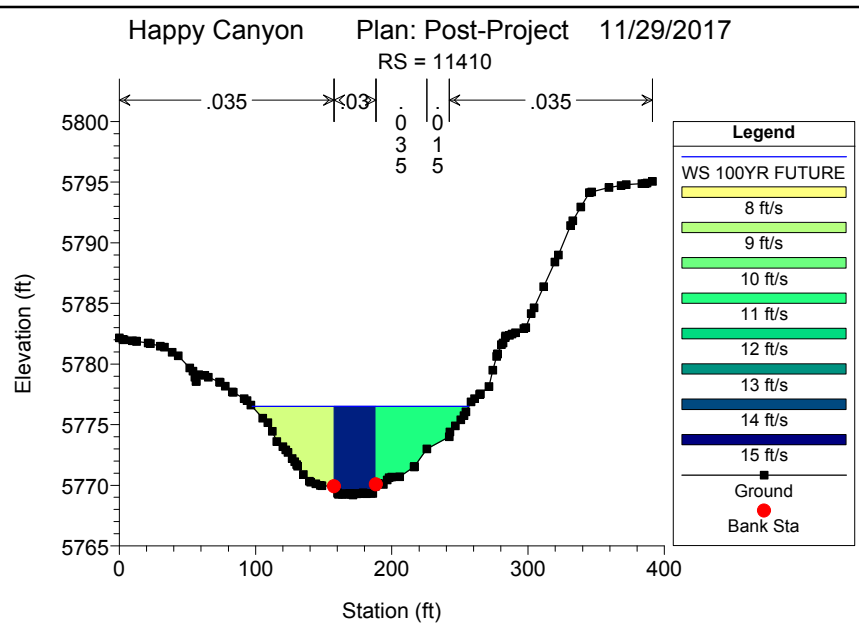
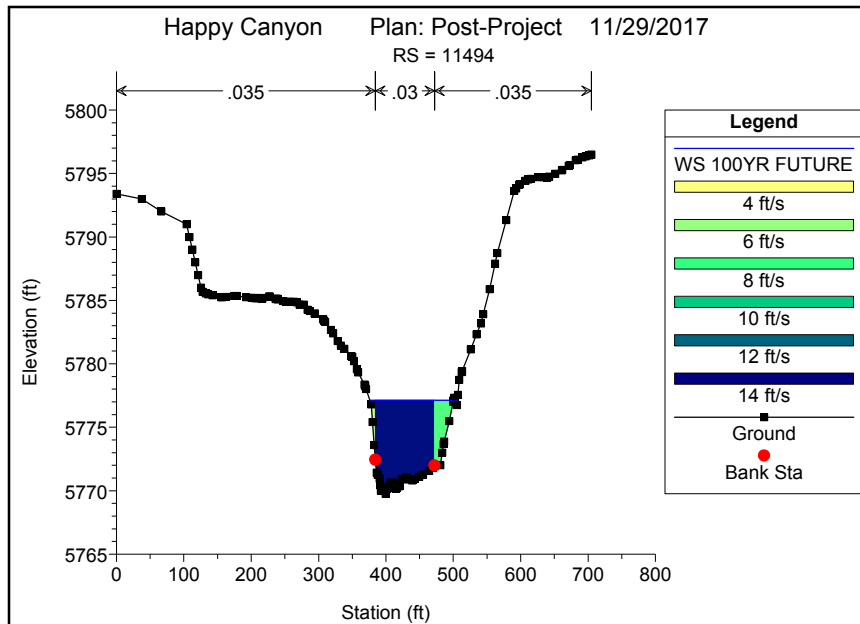
RS = 11800



Happy Canyon Plan: Post-Project 11/29/2017

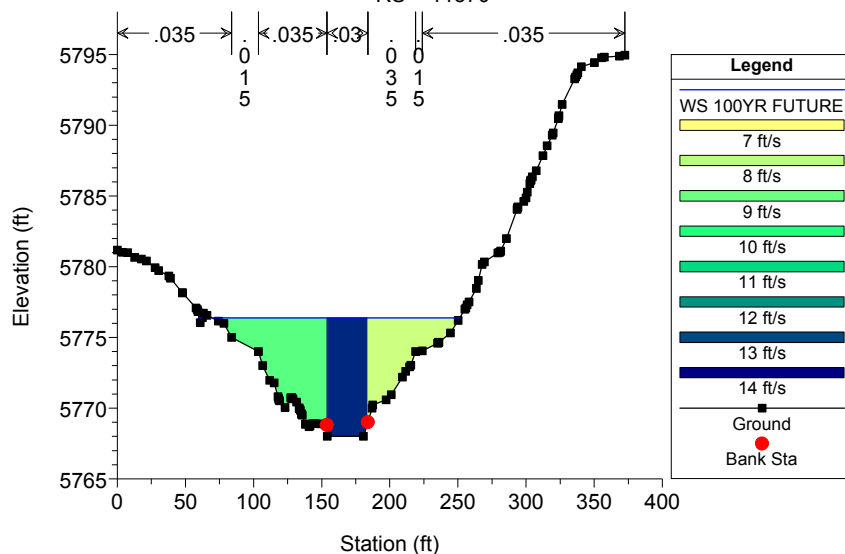
RS = 11620





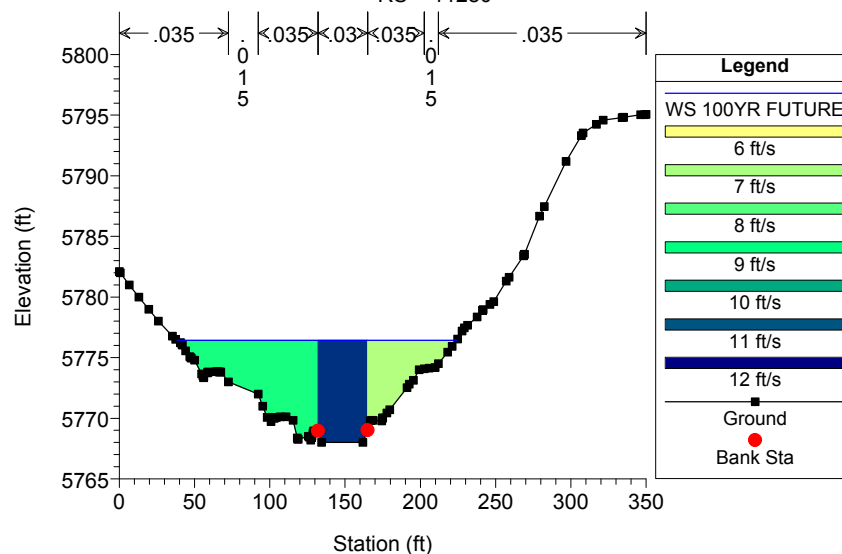
Happy Canyon Plan: Post-Project 11/29/2017

RS = 11370



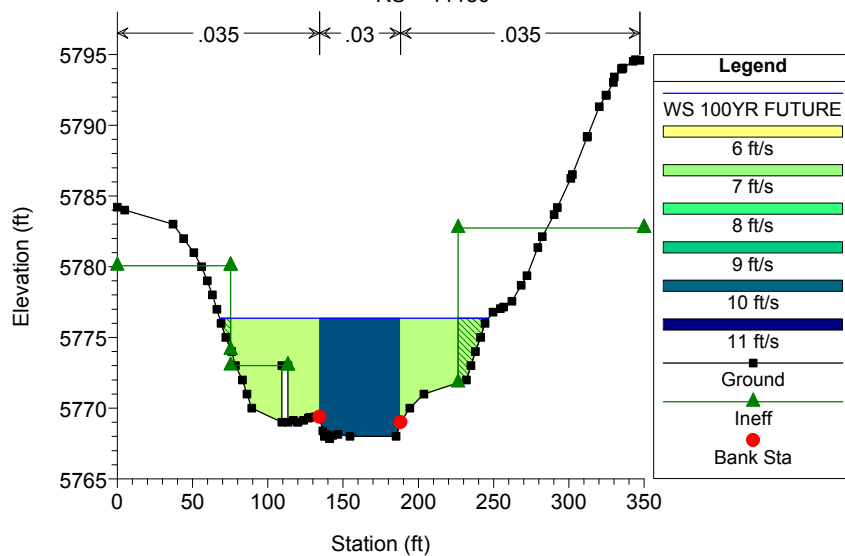
Happy Canyon Plan: Post-Project 11/29/2017

RS = 11280



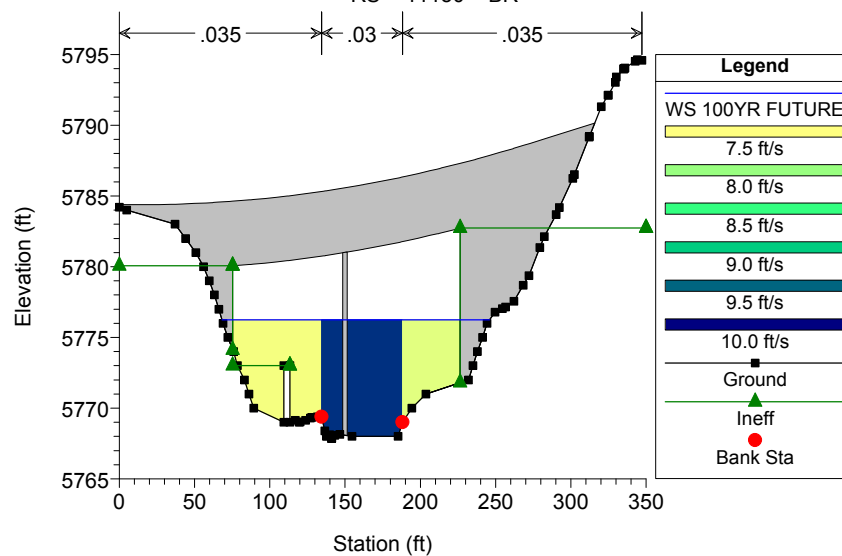
Happy Canyon Plan: Post-Project 11/29/2017

RS = 11180



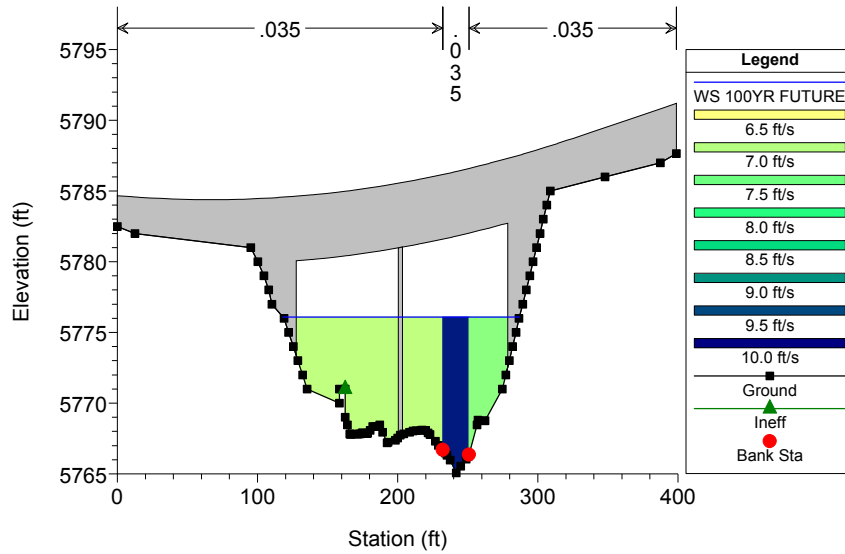
Happy Canyon Plan: Post-Project 11/29/2017

RS = 11150 BR



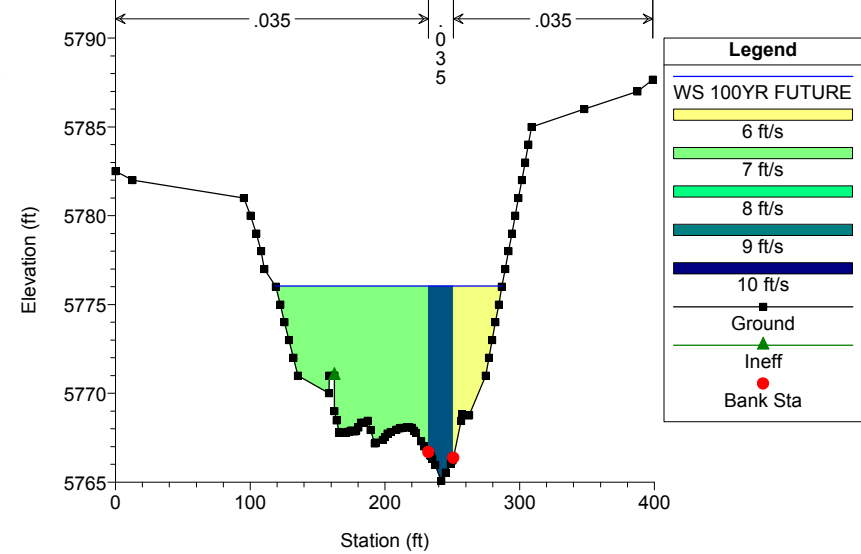
Happy Canyon Plan: Post-Project 11/29/2017

RS = 11150 BR



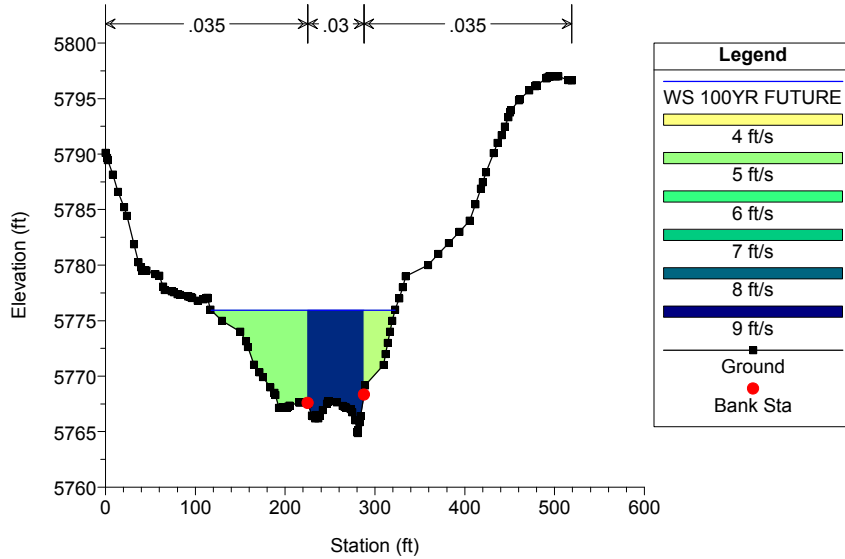
Happy Canyon Plan: Post-Project 11/29/2017

RS = 11100



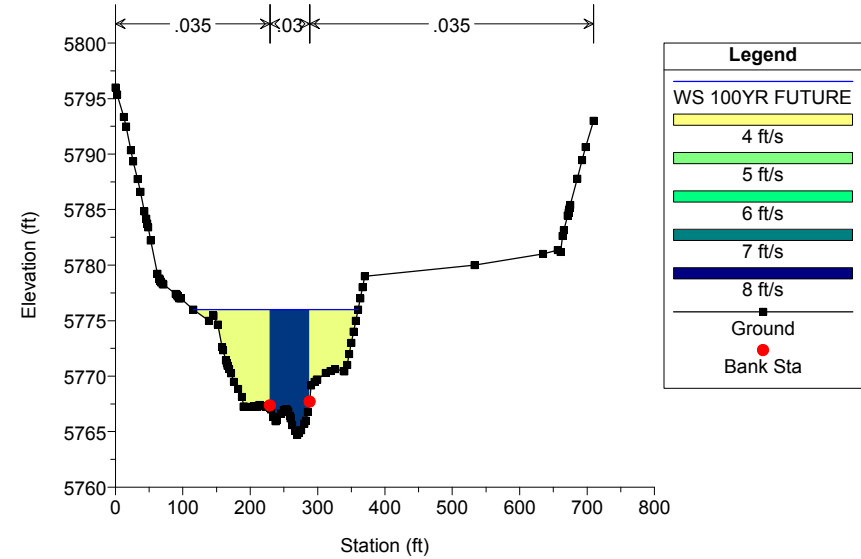
Happy Canyon Plan: Post-Project 11/29/2017

RS = 10974



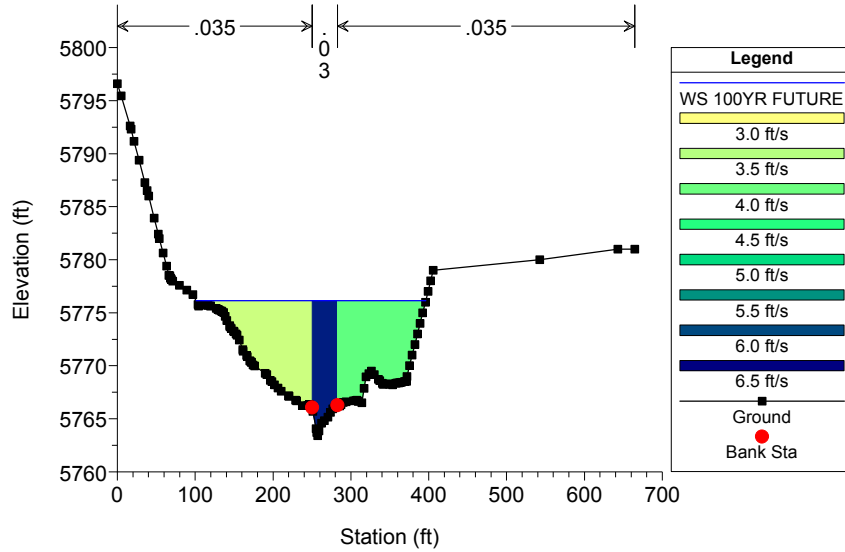
Happy Canyon Plan: Post-Project 11/29/2017

RS = 10900



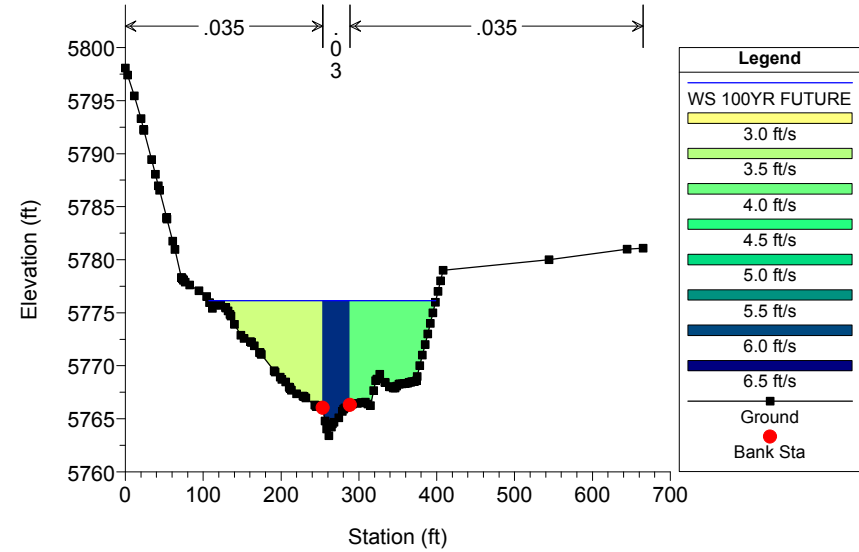
Happy Canyon Plan: Post-Project 11/29/2017

RS = 10825



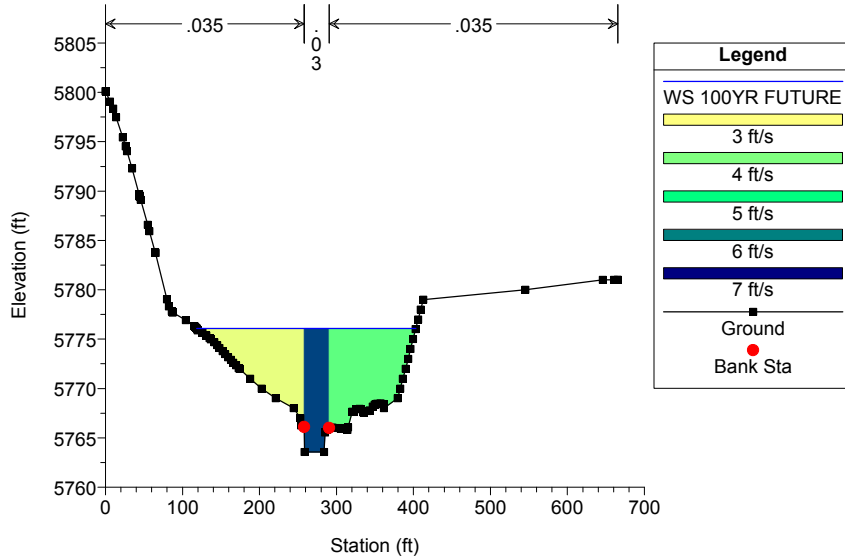
Happy Canyon Plan: Post-Project 11/29/2017

RS = 10819



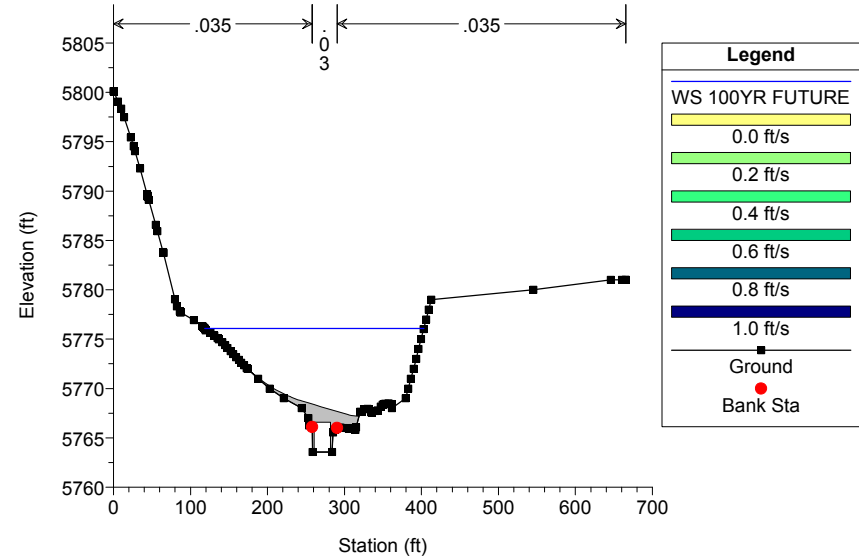
Happy Canyon Plan: Post-Project 11/29/2017

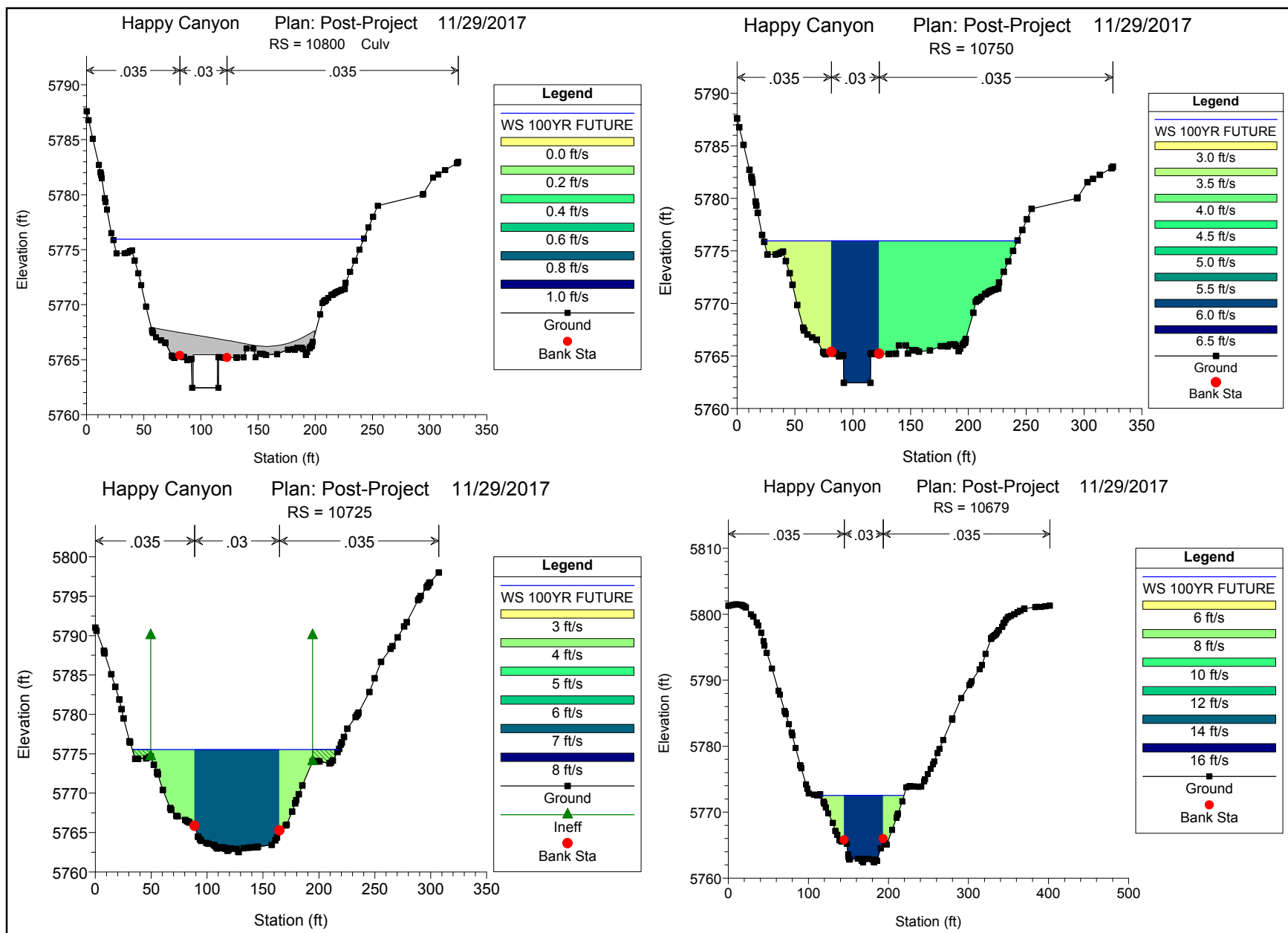
RS = 10810

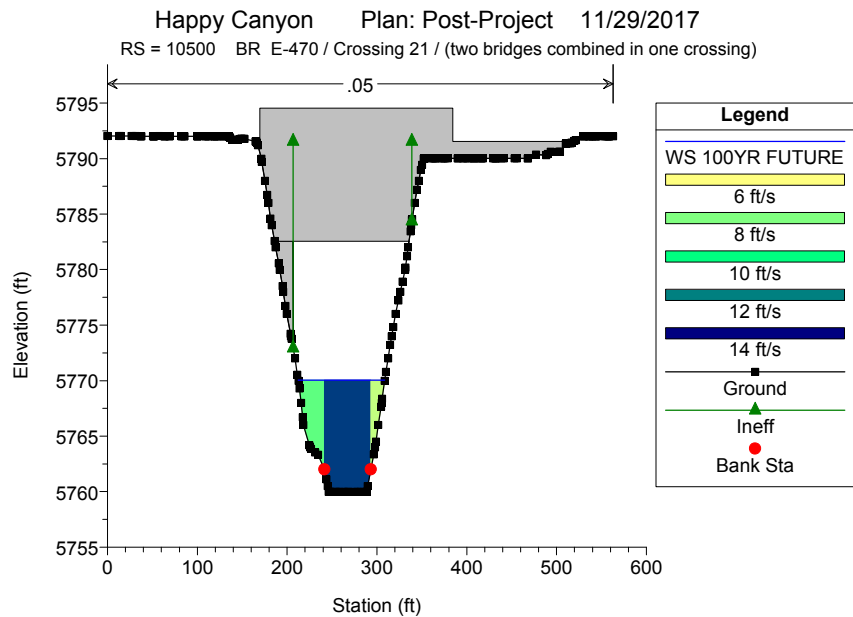
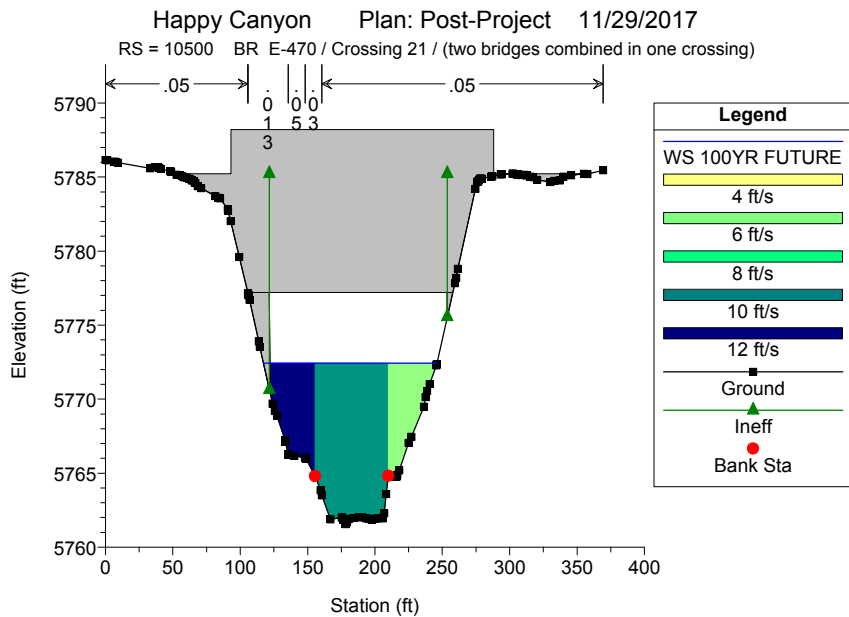
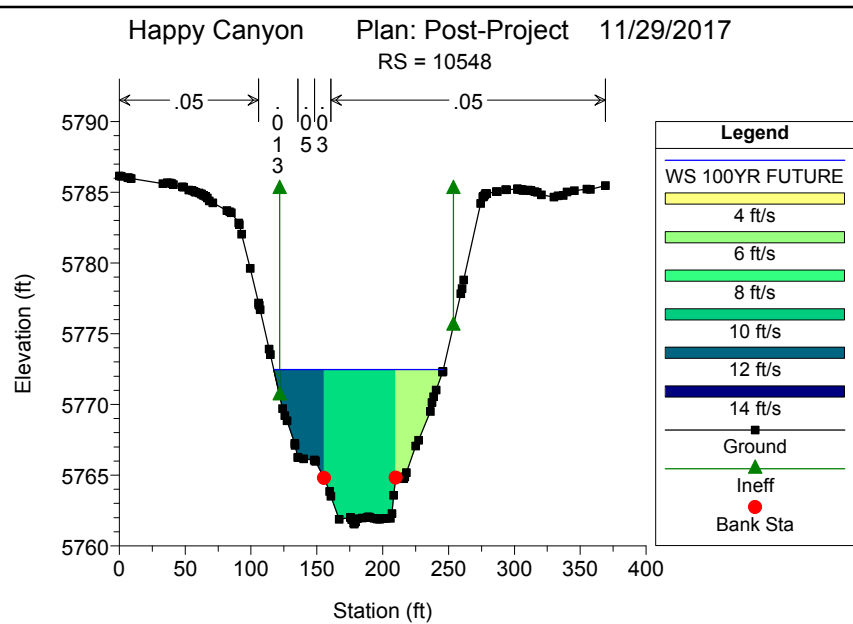
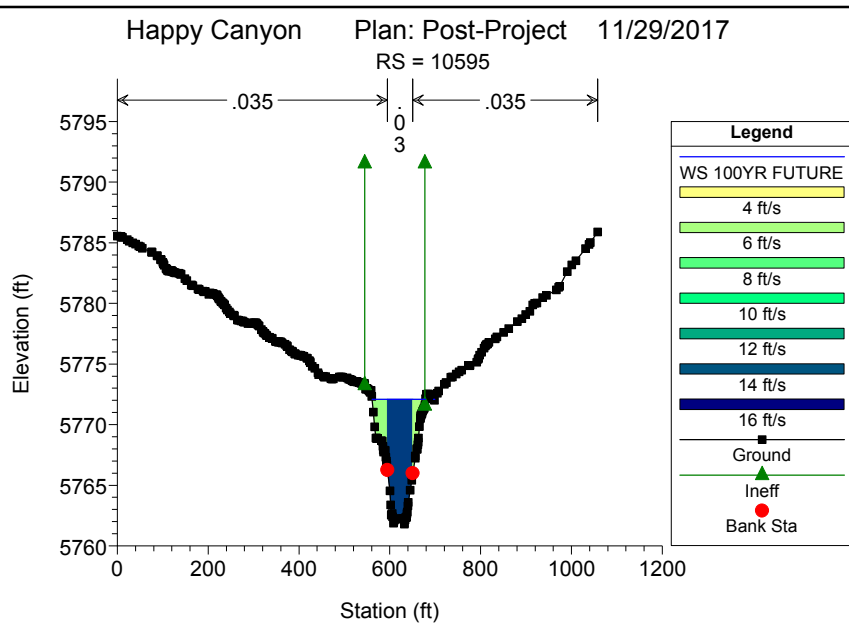


Happy Canyon Plan: Post-Project 11/29/2017

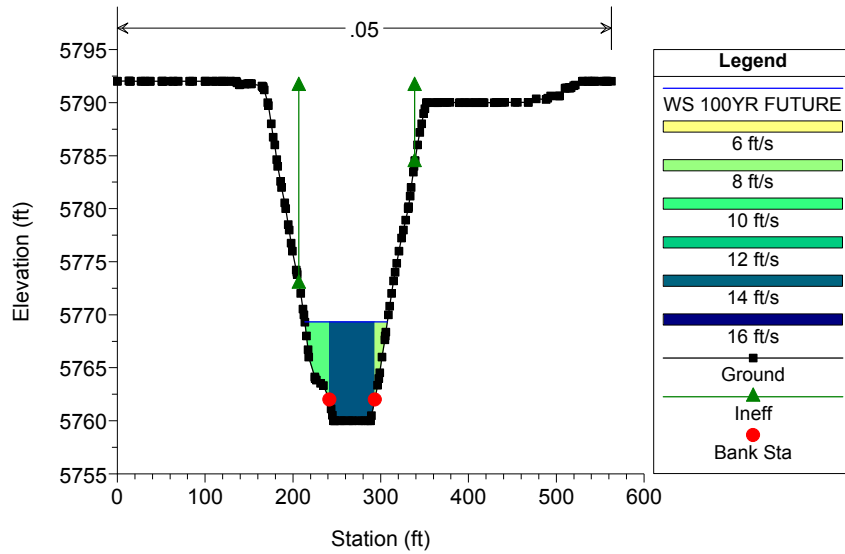
RS = 10800 Culv



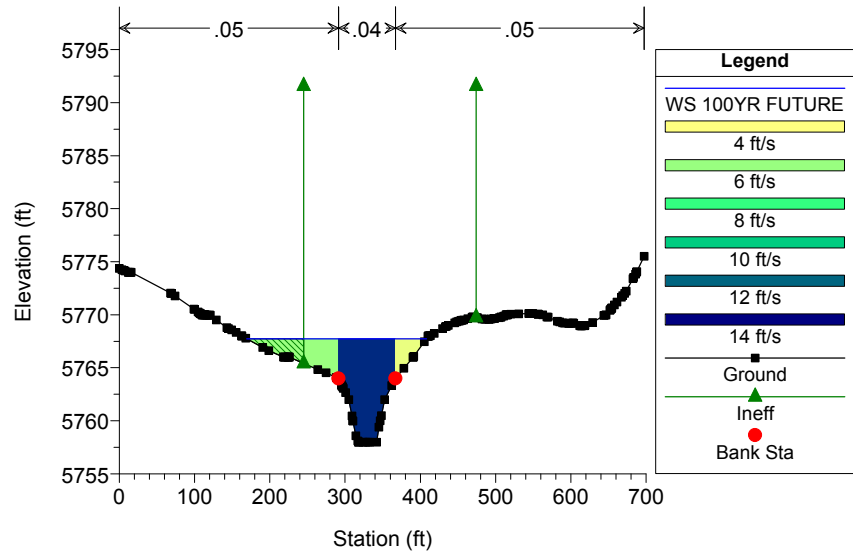




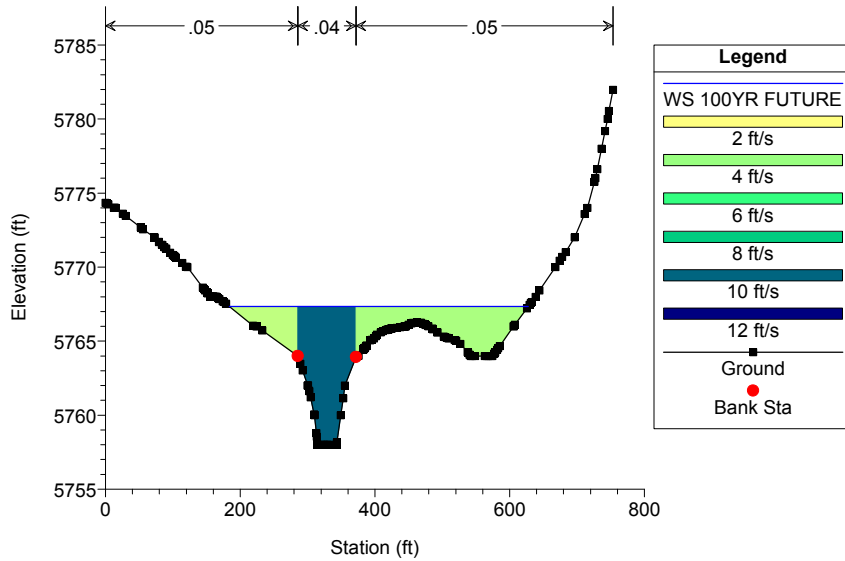
Happy Canyon Plan: Post-Project 11/29/2017
RS = 10326



Happy Canyon Plan: Post-Project 11/29/2017
RS = 10157

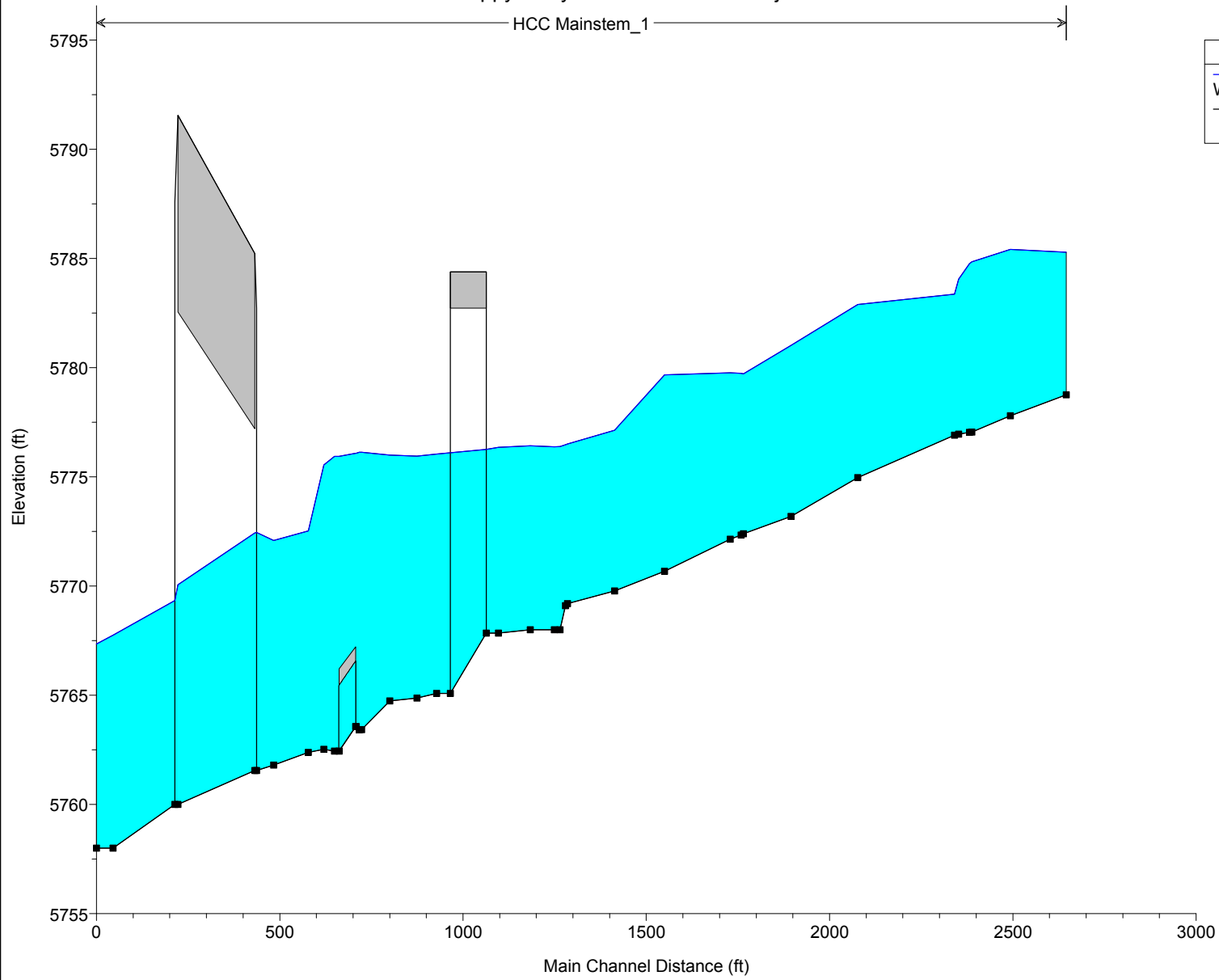


Happy Canyon Plan: Post-Project 11/29/2017
RS = 10111



Happy Canyon Plan: Post-Project 11/29/2017

HCC Mainstem_1



HEC-RAS Plan: Post-Project River: HCC Reach: Mainstem_1 Profile: 100YR FUTURE

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)	
Mainstem_1	12694	100YR FUTURE	8303.00	5778.76	5785.29		5785.89	0.002893	8.69	1474.52	423.99	0.62
Mainstem_1	12541	100YR FUTURE	8303.00	5777.80	5785.42		5785.64	0.000770	4.79	2344.05	498.21	0.33
Mainstem_1	12436	100YR FUTURE	8303.00	5777.05	5784.84		5785.52	0.002101	8.61	1408.04	307.97	0.56
Mainstem_1	12430	100YR FUTURE	8303.00	5777.04	5784.77		5785.50	0.002301	8.97	1353.19	299.25	0.58
Mainstem_1	12400	100YR FUTURE	8303.00	5776.95	5784.05	5783.62	5785.35	0.004533	12.00	1039.52	262.70	0.81
Mainstem_1	12388	100YR FUTURE	8303.00	5776.91	5783.36	5783.36	5785.24	0.005668	11.86	865.25	245.14	0.87
Mainstem_1	12129	100YR FUTURE	8303.00	5774.96	5782.89		5783.40	0.001488	7.39	1557.85	293.95	0.47
Mainstem_1	11959	100YR FUTURE	8303.00	5773.19	5781.02	5781.02	5782.95	0.005406	12.39	848.43	208.96	0.86
Mainstem_1	11835	100YR FUTURE	8303.00	5772.39	5779.72		5781.23	0.004603	12.19	936.38	202.39	0.81
Mainstem_1	11830	100YR FUTURE	8303.00	5772.34	5779.74		5781.18	0.004377	11.93	953.94	202.95	0.79
Mainstem_1	11800	100YR FUTURE	8303.00	5772.14	5779.76		5781.00	0.003488	10.86	1018.32	200.45	0.71
Mainstem_1	11620	100YR FUTURE	8303.00	5770.67	5779.67		5780.45	0.001708	8.07	1291.73	235.74	0.51
Mainstem_1	11494	100YR FUTURE	8303.00	5769.78	5777.13	5777.13	5779.86	0.006734	13.72	658.12	127.68	0.97
Mainstem_1	11410	100YR FUTURE	8303.00	5769.19	5776.50	5776.50	5778.75	0.006347	14.58	734.78	158.97	0.96
Mainstem_1	11400	100YR FUTURE	8303.00	5769.10	5776.47	5776.47	5778.61	0.005986	14.17	745.21	163.48	0.93
Mainstem_1	11385	100YR FUTURE	8303.00	5768.00	5776.39	5776.24	5778.31	0.004553	13.59	803.40	171.36	0.83
Mainstem_1	11370	100YR FUTURE	8303.00	5768.00	5776.37	5776.14	5778.21	0.004542	13.46	821.88	183.51	0.82
Mainstem_1	11280	100YR FUTURE	8303.00	5768.00	5776.43		5777.85	0.003191	11.43	912.37	185.72	0.70
Mainstem_1	11180	100YR FUTURE	8303.00	5767.85	5776.35	5774.61	5777.54	0.002574	10.21	1013.74	178.64	0.63
Mainstem_1	11150		Bridge									
Mainstem_1	11100	100YR FUTURE	8303.00	5765.08	5776.05	5773.39	5776.90	0.002228	9.35	1152.44	168.24	0.52
Mainstem_1	10974	100YR FUTURE	8303.00	5764.87	5775.94		5776.77	0.001661	8.60	1260.89	204.67	0.51
Mainstem_1	10900	100YR FUTURE	8303.00	5764.74	5776.00		5776.60	0.001119	7.57	1521.31	244.69	0.42
Mainstem_1	10825	100YR FUTURE	8303.00	5763.42	5776.13		5776.46	0.000675	6.30	1978.06	295.10	0.33
Mainstem_1	10819	100YR FUTURE	8303.00	5763.41	5776.13		5776.45	0.000652	6.19	1984.85	291.53	0.33
Mainstem_1	10810	100YR FUTURE	8303.00	5763.57	5776.08	5771.89	5776.44	0.000693	6.47	1915.77	284.70	0.33
Mainstem_1	10800		Culvert									
Mainstem_1	10750	100YR FUTURE	8303.00	5762.44	5775.94		5776.32	0.000618	6.11	1812.78	219.13	0.31
Mainstem_1	10725	100YR FUTURE	8355.00	5762.52	5775.54	5770.34	5776.21	0.000745	7.10	1376.84	184.86	0.36
Mainstem_1	10679	100YR FUTURE	8475.00	5762.39	5772.53	5772.16	5775.47	0.004939	14.96	681.24	103.80	0.87
Mainstem_1	10595	100YR FUTURE	8475.00	5761.80	5772.08	5772.08	5775.00	0.004822	14.58	690.88	120.70	0.86
Mainstem_1	10548	100YR FUTURE	8475.00	5761.55	5772.46	5770.39	5774.01	0.004638	9.65	904.01	128.82	0.53
Mainstem_1	10500		Bridge									
Mainstem_1	10326	100YR FUTURE	8475.00	5760.00	5769.34	5768.77	5772.13	0.012398	14.33	666.43	93.87	0.83
Mainstem_1	10157	100YR FUTURE	8475.00	5758.00	5767.74	5767.74	5770.13	0.009174	13.19	772.38	238.97	0.86
Mainstem_1	10111	100YR FUTURE	8475.00	5758.00	5767.35	5767.14	5768.53	0.005790	10.09	1292.58	443.82	0.68

HEC-RAS Plan: Post-Project River: HCC Reach: Mainstem_1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Mainstem_1	12694	10YR FUTURE	2647.00	5778.76	5782.73	5782.73	5783.49	0.006172	8.78	457.37	343.65	0.83
Mainstem_1	12694	50YR FUTURE	6212.00	5778.76	5784.32		5785.02	0.004203	9.32	1072.68	407.93	0.73
Mainstem_1	12694	2YR FUTURE	625.00	5778.76	5781.07	5781.07	5781.56	0.007261	6.16	131.20	130.83	0.81
Mainstem_1	12694	5YR FUTURE	1705.00	5778.76	5782.13	5782.13	5782.83	0.006774	8.09	303.83	201.71	0.84
Mainstem_1	12541	10YR FUTURE	2647.00	5777.80	5782.23		5782.44	0.001604	4.45	849.11	429.99	0.43
Mainstem_1	12541	50YR FUTURE	6212.00	5777.80	5784.50		5784.70	0.000823	4.48	1895.82	483.35	0.33
Mainstem_1	12541	2YR FUTURE	625.00	5777.80	5779.79	5779.79	5780.16	0.012096	5.27	135.87	179.84	0.95
Mainstem_1	12541	5YR FUTURE	1705.00	5777.80	5781.15		5781.41	0.003014	4.72	460.09	300.18	0.55
Mainstem_1	12436	10YR FUTURE	2647.00	5777.05	5781.79		5782.26	0.002561	6.68	563.00	221.28	0.56
Mainstem_1	12436	50YR FUTURE	6212.00	5777.05	5784.00		5784.58	0.002095	7.93	1152.20	294.20	0.54
Mainstem_1	12436	2YR FUTURE	625.00	5777.05	5779.36		5779.57	0.002860	4.11	184.38	124.06	0.52
Mainstem_1	12436	5YR FUTURE	1705.00	5777.05	5780.84		5781.20	0.002524	5.63	380.14	149.27	0.54
Mainstem_1	12430	10YR FUTURE	2647.00	5777.04	5781.74		5782.25	0.002757	6.91	544.31	215.17	0.58
Mainstem_1	12430	50YR FUTURE	6212.00	5777.04	5783.93		5784.56	0.002284	8.24	1107.86	285.07	0.57
Mainstem_1	12430	2YR FUTURE	625.00	5777.04	5779.32		5779.55	0.003146	4.29	175.58	117.82	0.54
Mainstem_1	12430	5YR FUTURE	1705.00	5777.04	5780.77		5781.18	0.002868	5.95	359.94	144.13	0.57
Mainstem_1	12400	10YR FUTURE	2647.00	5776.95	5780.54	5780.54	5782.00	0.010545	11.36	303.87	132.89	1.09
Mainstem_1	12400	50YR FUTURE	6212.00	5776.95	5782.70	5782.70	5784.35	0.007204	13.08	705.56	226.51	0.98
Mainstem_1	12400	2YR FUTURE	625.00	5776.95	5778.79	5778.79	5779.36	0.009777	6.72	112.62	94.34	0.93
Mainstem_1	12400	5YR FUTURE	1705.00	5776.95	5779.93	5779.93	5780.98	0.009494	9.43	227.55	115.18	1.00
Mainstem_1	12388	10YR FUTURE	2647.00	5776.91	5780.51	5780.51	5781.73	0.008132	8.96	310.28	135.96	0.93
Mainstem_1	12388	50YR FUTURE	6212.00	5776.91	5782.44	5782.44	5784.19	0.006427	11.23	653.70	209.13	0.90
Mainstem_1	12388	2YR FUTURE	625.00	5776.91	5778.71	5778.69	5779.23	0.011640	5.77	108.35	96.11	0.96
Mainstem_1	12388	5YR FUTURE	1705.00	5776.91	5779.76	5779.76	5780.75	0.009678	7.98	216.20	114.59	0.97
Mainstem_1	12129	10YR FUTURE	2647.00	5774.96	5779.67		5779.96	0.001747	5.57	680.38	247.10	0.46
Mainstem_1	12129	50YR FUTURE	6212.00	5774.96	5781.92		5782.35	0.001498	6.78	1279.22	281.81	0.46
Mainstem_1	12129	2YR FUTURE	625.00	5774.96	5777.15		5777.47	0.004469	5.11	157.71	131.53	0.65
Mainstem_1	12129	5YR FUTURE	1705.00	5774.96	5778.68		5778.98	0.002338	5.46	448.48	220.37	0.52
Mainstem_1	11959	10YR FUTURE	2647.00	5773.19	5778.17	5778.17	5779.44	0.006528	9.18	315.64	152.85	0.86
Mainstem_1	11959	50YR FUTURE	6212.00	5773.19	5780.16	5780.16	5781.90	0.005660	11.51	672.25	198.23	0.86
Mainstem_1	11959	2YR FUTURE	625.00	5773.19	5775.66	5775.63	5776.35	0.010970	6.67	93.72	63.70	0.97
Mainstem_1	11959	5YR FUTURE	1705.00	5773.19	5777.05	5777.05	5778.27	0.009583	8.87	192.25	76.50	0.99
Mainstem_1	11835	10YR FUTURE	2647.00	5772.39	5776.86	5776.86	5777.89	0.005535	9.41	391.83	177.34	0.82
Mainstem_1	11835	50YR FUTURE	6212.00	5772.39	5778.49	5778.49	5780.10	0.006198	12.43	693.35	192.47	0.91

HEC-RAS Plan: Post-Project River: HCC Reach: Mainstem_1 (Continued)

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)	
Mainstem_1	11835	2YR FUTURE	625.00	5772.39	5774.51	5774.46	5775.09	0.008184	6.51	109.63	80.86	0.86
Mainstem_1	11835	5YR FUTURE	1705.00	5772.39	5775.77	5775.77	5776.90	0.008211	9.34	222.95	105.93	0.95
Mainstem_1	11830	10YR FUTURE	2647.00	5772.34	5776.81	5776.81	5777.81	0.005464	9.33	394.59	176.85	0.81
Mainstem_1	11830	50YR FUTURE	6212.00	5772.34	5778.41	5778.41	5780.03	0.006281	12.44	691.74	192.46	0.92
Mainstem_1	11830	2YR FUTURE	625.00	5772.34	5774.47	5774.40	5775.04	0.007949	6.43	111.49	82.32	0.85
Mainstem_1	11830	5YR FUTURE	1705.00	5772.34	5775.69	5775.69	5776.82	0.008401	9.37	221.79	105.05	0.95
Mainstem_1	11800	10YR FUTURE	2647.00	5772.14	5776.40	5776.40	5777.42	0.005854	9.28	385.04	173.37	0.83
Mainstem_1	11800	50YR FUTURE	6212.00	5772.14	5778.37		5779.71	0.004913	11.18	745.71	190.17	0.81
Mainstem_1	11800	2YR FUTURE	625.00	5772.14	5774.35		5774.79	0.005962	5.68	125.80	89.22	0.74
Mainstem_1	11800	5YR FUTURE	1705.00	5772.14	5775.37	5775.37	5776.43	0.008406	9.06	226.57	110.03	0.94
Mainstem_1	11620	10YR FUTURE	2647.00	5770.67	5775.40		5776.02	0.003427	6.83	448.60	155.31	0.63
Mainstem_1	11620	50YR FUTURE	6212.00	5770.67	5778.19		5778.99	0.002206	7.99	959.03	216.54	0.56
Mainstem_1	11620	2YR FUTURE	625.00	5770.67	5773.14	5772.99	5773.58	0.007815	5.40	121.14	120.11	0.81
Mainstem_1	11620	5YR FUTURE	1705.00	5770.67	5774.43		5775.01	0.004705	6.50	301.10	147.16	0.70
Mainstem_1	11494	10YR FUTURE	2647.00	5769.78	5774.71		5775.53	0.003798	7.43	375.23	109.54	0.67
Mainstem_1	11494	50YR FUTURE	6212.00	5769.78	5776.28	5776.07	5778.40	0.006315	12.04	554.14	118.38	0.91
Mainstem_1	11494	2YR FUTURE	625.00	5769.78	5772.49		5772.78	0.004184	4.37	145.70	97.77	0.61
Mainstem_1	11494	5YR FUTURE	1705.00	5769.78	5773.89		5774.46	0.003600	6.16	287.88	104.71	0.63
Mainstem_1	11410	10YR FUTURE	2647.00	5769.19	5773.49	5773.49	5774.81	0.007602	11.08	316.03	117.00	0.96
Mainstem_1	11410	50YR FUTURE	6212.00	5769.19	5775.58	5775.58	5777.52	0.006600	13.56	593.38	147.03	0.96
Mainstem_1	11410	2YR FUTURE	625.00	5769.19	5771.36	5771.33	5772.01	0.008526	7.24	108.94	82.14	0.90
Mainstem_1	11410	5YR FUTURE	1705.00	5769.19	5772.59	5772.59	5773.73	0.008646	10.04	220.89	98.55	0.98
Mainstem_1	11400	10YR FUTURE	2647.00	5769.10	5773.41	5773.41	5774.72	0.007623	11.02	316.32	115.97	0.96
Mainstem_1	11400	50YR FUTURE	6212.00	5769.10	5775.50	5775.50	5777.42	0.006581	13.49	596.55	147.93	0.96
Mainstem_1	11400	2YR FUTURE	625.00	5769.10	5771.31	5771.31	5771.95	0.008437	7.18	110.01	83.89	0.90
Mainstem_1	11400	5YR FUTURE	1705.00	5769.10	5772.57	5772.57	5773.65	0.008142	9.78	227.21	100.76	0.96
Mainstem_1	11385	10YR FUTURE	2647.00	5768.00	5773.37		5774.44	0.004254	9.72	368.67	118.67	0.75
Mainstem_1	11385	50YR FUTURE	6212.00	5768.00	5775.27	5775.26	5777.15	0.005310	13.33	621.48	149.07	0.88
Mainstem_1	11385	2YR FUTURE	625.00	5768.00	5770.82		5771.36	0.004218	6.22	120.59	76.41	0.66
Mainstem_1	11385	5YR FUTURE	1705.00	5768.00	5772.39		5773.28	0.004404	8.61	260.97	101.15	0.73
Mainstem_1	11370	10YR FUTURE	2647.00	5768.00	5773.42		5774.33	0.003758	9.15	387.79	111.36	0.70
Mainstem_1	11370	50YR FUTURE	6212.00	5768.00	5775.16	5775.16	5777.05	0.005654	13.53	617.09	159.62	0.89
Mainstem_1	11370	2YR FUTURE	625.00	5768.00	5770.84		5771.26	0.003587	5.77	136.77	81.94	0.61
Mainstem_1	11370	5YR FUTURE	1705.00	5768.00	5772.45		5773.17	0.003724	7.97	283.46	101.34	0.67

HEC-RAS Plan: Post-Project River: HCC Reach: Mainstem_1 (Continued)

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Mainstem_1	11280	10YR FUTURE	2647.00	5768.00	5773.27		5774.08	0.003292	8.46	403.08	125.32	0.65
Mainstem_1	11280	50YR FUTURE	6212.00	5768.00	5774.79	5774.79	5776.57	0.005328	12.77	625.15	164.06	0.87
Mainstem_1	11280	2YR FUTURE	625.00	5768.00	5770.60		5771.02	0.003993	5.75	135.41	82.45	0.64
Mainstem_1	11280	5YR FUTURE	1705.00	5768.00	5772.24		5772.93	0.003619	7.66	284.45	102.04	0.66
Mainstem_1	11180	10YR FUTURE	2647.00	5767.85	5773.35	5772.00	5773.78	0.001656	6.06	561.33	158.56	0.47
Mainstem_1	11180	50YR FUTURE	6212.00	5767.85	5774.81	5773.75	5775.98	0.003292	10.07	782.15	167.96	0.68
Mainstem_1	11180	2YR FUTURE	625.00	5767.85	5770.45	5769.75	5770.72	0.002486	4.35	159.94	106.43	0.50
Mainstem_1	11180	5YR FUTURE	1705.00	5767.85	5772.11	5771.00	5772.63	0.002502	6.23	324.73	145.66	0.55
Mainstem_1	11150	Bridge										
Mainstem_1	11100	10YR FUTURE	2647.00	5765.08	5771.28	5770.51	5772.04	0.004929	9.14	415.35	140.90	0.69
Mainstem_1	11100	50YR FUTURE	6212.00	5765.08	5774.26	5772.54	5775.13	0.002999	9.54	860.63	157.97	0.58
Mainstem_1	11100	2YR FUTURE	625.00	5765.08	5769.16	5768.71	5769.45	0.003155	5.26	168.36	102.00	0.51
Mainstem_1	11100	5YR FUTURE	1705.00	5765.08	5770.52	5769.81	5771.06	0.003781	7.24	312.36	121.67	0.59
Mainstem_1	10974	10YR FUTURE	2647.00	5764.87	5771.11		5771.73	0.003080	7.00	449.98	144.68	0.60
Mainstem_1	10974	50YR FUTURE	6212.00	5764.87	5774.13		5774.95	0.002120	8.36	918.20	169.54	0.55
Mainstem_1	10974	2YR FUTURE	625.00	5764.87	5769.07		5769.24	0.002019	3.62	193.29	105.95	0.44
Mainstem_1	10974	5YR FUTURE	1705.00	5764.87	5770.39		5770.81	0.002605	5.68	349.99	131.88	0.54
Mainstem_1	10900	10YR FUTURE	2647.00	5764.74	5771.04		5771.54	0.001964	6.30	528.90	178.07	0.50
Mainstem_1	10900	50YR FUTURE	6212.00	5764.74	5774.18		5774.76	0.001319	7.17	1125.66	200.70	0.45
Mainstem_1	10900	2YR FUTURE	625.00	5764.74	5769.03		5769.14	0.000859	2.93	247.12	109.94	0.30
Mainstem_1	10900	5YR FUTURE	1705.00	5764.74	5770.33		5770.65	0.001527	5.01	410.21	142.79	0.43
Mainstem_1	10825	10YR FUTURE	2647.00	5763.42	5771.11		5771.36	0.001061	5.28	752.26	214.36	0.38
Mainstem_1	10825	50YR FUTURE	6212.00	5763.42	5774.29		5774.61	0.000794	6.06	1488.20	249.42	0.35
Mainstem_1	10825	2YR FUTURE	625.00	5763.42	5769.01		5769.08	0.000468	2.64	338.76	166.70	0.23
Mainstem_1	10825	5YR FUTURE	1705.00	5763.42	5770.35		5770.53	0.000871	4.38	592.77	204.38	0.34
Mainstem_1	10819	10YR FUTURE	2647.00	5763.41	5771.11		5771.36	0.001024	5.18	748.78	207.49	0.37
Mainstem_1	10819	50YR FUTURE	6212.00	5763.41	5774.28		5774.61	0.000797	6.06	1489.17	254.83	0.35
Mainstem_1	10819	2YR FUTURE	625.00	5763.41	5769.01		5769.08	0.000455	2.60	345.29	173.93	0.23
Mainstem_1	10819	5YR FUTURE	1705.00	5763.41	5770.35		5770.52	0.000813	4.22	596.10	196.81	0.32
Mainstem_1	10810	10YR FUTURE	2647.00	5763.57	5771.03	5769.38	5771.34	0.001095	5.67	699.66	198.80	0.38
Mainstem_1	10810	50YR FUTURE	6212.00	5763.57	5774.22	5771.12	5774.59	0.000875	6.50	1418.27	250.22	0.36
Mainstem_1	10810	2YR FUTURE	625.00	5763.57	5768.99	5766.47	5769.08	0.000403	2.73	334.03	158.00	0.22
Mainstem_1	10810	5YR FUTURE	1705.00	5763.57	5770.30	5768.33	5770.51	0.000822	4.56	559.37	185.53	0.32

HEC-RAS Plan: Post-Project River: HCC Reach: Mainstem_1 (Continued)

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Mainstem_1	10800		Culvert									
Mainstem_1	10750	10YR FUTURE	2647.00	5762.44	5770.00		5770.25	0.000912	4.79	703.16	154.34	0.33
Mainstem_1	10750	50YR FUTURE	6212.00	5762.44	5774.11		5774.44	0.000656	5.66	1431.05	193.12	0.31
Mainstem_1	10750	2YR FUTURE	625.00	5762.44	5766.00	5765.72	5766.45	0.004803	5.69	132.51	111.75	0.65
Mainstem_1	10750	5YR FUTURE	1705.00	5762.44	5768.42		5768.68	0.001315	4.76	465.52	147.03	0.38
Mainstem_1	10725	10YR FUTURE	2656.00	5762.52	5769.86	5766.84	5770.20	0.000804	4.84	611.00	120.06	0.34
Mainstem_1	10725	50YR FUTURE	6249.00	5762.52	5773.78	5769.27	5774.35	0.000766	6.48	1123.12	141.75	0.35
Mainstem_1	10725	2YR FUTURE	633.00	5762.52	5766.10	5764.64	5766.25	0.001021	3.06	209.48	85.43	0.33
Mainstem_1	10725	5YR FUTURE	1708.00	5762.52	5768.38	5765.93	5768.64	0.000868	4.23	438.76	111.58	0.33
Mainstem_1	10679	10YR FUTURE	2691.00	5762.39	5768.62		5769.86	0.003996	9.32	322.80	78.83	0.71
Mainstem_1	10679	50YR FUTURE	6345.00	5762.39	5771.70	5770.87	5773.82	0.003987	12.62	597.02	98.88	0.77
Mainstem_1	10679	2YR FUTURE	652.00	5762.39	5765.41		5766.02	0.005594	6.28	104.15	47.82	0.73
Mainstem_1	10679	5YR FUTURE	1728.00	5762.39	5767.31		5768.34	0.004653	8.33	224.67	71.25	0.73
Mainstem_1	10595	10YR FUTURE	2691.00	5761.80	5767.63	5767.34	5769.35	0.006323	10.58	260.83	67.03	0.88
Mainstem_1	10595	50YR FUTURE	6345.00	5761.80	5770.58	5770.58	5773.33	0.005555	13.85	523.64	102.66	0.89
Mainstem_1	10595	2YR FUTURE	652.00	5761.80	5764.90		5765.50	0.005456	6.17	105.74	47.03	0.72
Mainstem_1	10595	5YR FUTURE	1728.00	5761.80	5766.65		5767.83	0.005939	8.72	199.06	59.80	0.82
Mainstem_1	10548	10YR FUTURE	2691.00	5761.55	5767.72	5766.73	5768.63	0.007366	7.98	368.07	96.82	0.61
Mainstem_1	10548	50YR FUTURE	6345.00	5761.55	5770.99	5769.32	5772.28	0.005296	9.28	724.84	119.49	0.56
Mainstem_1	10548	2YR FUTURE	652.00	5761.55	5764.68	5763.85	5765.08	0.008921	5.08	128.24	53.84	0.58
Mainstem_1	10548	5YR FUTURE	1728.00	5761.55	5766.56	5765.59	5767.30	0.007978	7.06	260.99	88.23	0.61
Mainstem_1	10500		Bridge									
Mainstem_1	10326	10YR FUTURE	2691.00	5760.00	5766.14		5767.00	0.006459	7.76	382.05	83.88	0.56
Mainstem_1	10326	50YR FUTURE	6345.00	5760.00	5768.49		5770.50	0.010070	12.10	587.74	91.18	0.74
Mainstem_1	10326	2YR FUTURE	652.00	5760.00	5762.74		5763.11	0.007979	4.91	134.27	57.26	0.54
Mainstem_1	10326	5YR FUTURE	1728.00	5760.00	5764.99		5765.60	0.005965	6.47	288.96	77.94	0.52
Mainstem_1	10157	10YR FUTURE	2691.00	5758.00	5764.76		5765.80	0.007122	8.19	339.22	109.26	0.69
Mainstem_1	10157	50YR FUTURE	6345.00	5758.00	5766.73	5766.73	5768.82	0.009443	12.11	612.00	202.07	0.85
Mainstem_1	10157	2YR FUTURE	652.00	5758.00	5761.31		5761.82	0.006875	5.72	113.99	43.90	0.63
Mainstem_1	10157	5YR FUTURE	1728.00	5758.00	5763.41		5764.31	0.008648	7.62	226.69	67.58	0.73
Mainstem_1	10111	10YR FUTURE	2691.00	5758.00	5764.59	5763.49	5765.43	0.006241	7.44	390.96	171.31	0.65
Mainstem_1	10111	50YR FUTURE	6345.00	5758.00	5766.77	5766.58	5767.79	0.005263	9.07	1042.36	418.89	0.64

HEC-RAS Plan: Post-Project River: HCC Reach: Mainstem_1 (Continued)

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)	
Mainstem_1	10111	2YR FUTURE	652.00	5758.00	5760.68	5760.37	5761.39	0.012284	6.77	96.37	44.82	0.81
Mainstem_1	10111	5YR FUTURE	1728.00	5758.00	5762.96	5762.22	5763.90	0.009681	7.77	222.51	70.44	0.77

APPENDIX F. SUPPLEMENTAL INFORMATION AND PLAN SHEETS

**FEDERAL EMERGENCY MANAGEMENT AGENCY
PAYMENT INFORMATION FORM**

Community Name: _____

Project Identifier: _____

THIS FORM MUST BE MAILED, ALONG WITH THE APPROPRIATE FEE, TO THE ADDRESS BELOW OR FAXED TO THE FAX NUMBER BELOW.

Please make check or money order payable to the National Flood Insurance Program.

Type of Request:

☐ MT-1 application }
☐ MT-2 application }

LOMC Clearinghouse
3601 Eisenhower Ave. Suite 500
Alexandria, VA 22304-6426
Attn.: LOMC Manager

☐ EDR application }

FEMA Project Library
3601 Eisenhower Ave. Suite 500
Alexandria, VA 22304-6426
FAX (703) 960-9125

Request No. (if known): _____ **Check No.:** _____ **Amount:** _____

☐ INITIAL FEE* ☐ FINAL FEE ☐ FEE BALANCE** ☐ MASTER CARD ☐ VISA ☐ CHECK ☐ MONEY ORDER

*Note: Check only for EDR and/or Alluvial Fan requests (as appropriate).

**Note: Check only if submitting a corrected fee for an ongoing request.

COMPLETE THIS SECTION ONLY IF PAYING BY CREDIT CARD

CARD NUMBER

EXP. DATE

				—					—					—				
1	2	3	4		5	6	7	8		9	10	11	12		13	14	15	16

		—		
Month			Year	

Date

Signature

NAME (AS IT APPEARS ON CARD): _____
(please print or type)

ADDRESS: _____
(for your
credit card
receipt—please
print or type)

DAYTIME PHONE: _____

U.S. DEPARTMENT OF HOMELAND SECURITY
FEDERAL EMERGENCY MANAGEMENT AGENCY
OVERVIEW & CONCURRENCE FORM

O.M.B No. 1660-0016
Expires February 28, 2014

PAPERWORK BURDEN DISCLOSURE NOTICE

Public reporting burden for this form is estimated to average 1 hours per response. The burden estimate includes the time for reviewing instructions, searching existing data sources, gathering and maintaining the needed data, and completing, reviewing, and submitting the form. You are not required to respond to this collection of information unless it displays a valid OMB control number. Send comments regarding the accuracy of the burden estimate and any suggestions for reducing this burden to: Information Collections Management, Department of Homeland Security, Federal Emergency Management Agency, 1800 South Bell Street, Arlington, VA 20958-3005, Paperwork Reduction Project (1660-0016). Submission of the form is required to obtain or retain benefits under the National Flood Insurance Program. **Please do not send your completed survey to the above address.**

PRIVACY ACT STATEMENT

AUTHORITY: The National Flood Insurance Act of 1968, Public Law 90-448, as amended by the Flood Disaster Protection Act of 1973, Public Law 93-234.

PRINCIPAL PURPOSE(S): This information is being collected for the purpose of determining an applicant's eligibility to request changes to National Flood Insurance Program (NFIP) Flood Insurance Rate Maps (FIRM).

ROUTINE USE(S): The information on this form may be disclosed as generally permitted under 5 U.S.C § 552a(b) of the Privacy Act of 1974, as amended. This includes using this information as necessary and authorized by the routine uses published in DHS/FEMA/NFIP/LOMA-1 National Flood Insurance Program (NFIP); Letter of Map Amendment (LOMA) February 15, 2006, 71 FR 7990.

DISCLOSURE: The disclosure of information on this form is voluntary; however, failure to provide the information requested may delay or prevent FEMA from processing a determination regarding a requested change to a (NFIP) Flood Insurance Rate Maps (FIRM).

A. REQUESTED RESPONSE FROM DHS-FEMA

This request is for a (check one):

- ☒ CLOMR: A letter from DHS-FEMA commenting on whether a proposed project, if built as proposed, would justify a map revision, or proposed hydrology changes (See 44 CFR Ch. 1, Parts 60, 65 & 72).
- ☐ LOMR: A letter from DHS-FEMA officially revising the current NFIP map to show the changes to floodplains, regulatory floodway or flood elevations. (See 44 CFR Ch. 1, Parts 60, 65 & 72)

B. OVERVIEW

1. The NFIP map panel(s) affected for all impacted communities is (are):

Community No.	Community Name	State	Map No.	Panel No.	Effective Date
Example: 480301 480287	City of Katy Harris County	TX TX	48473C 48201C	0005D 0220G	02/08/83 09/28/90
080310	Town of Parker	CO	08035C	0062G	03/16/16
080310	Town of Parker	CO	08035C	0066G	03/16/16

2. a. Flooding Source: Happy Canyon Creek

- b. Types of Flooding: ☒ Riverine ☐ Coastal ☐ Shallow Flooding (e.g., Zones AO and AH)
- ☐ Alluvial fan ☐ Lakes ☐ Other (Attach Description)

3. Project Name/Identifier: Compark at Belford Avenue

4. FEMA zone designations affected: AE, X (choices: A, AH, AO, A1-A30, A99, AE, AR, V, V1-V30, VE, B, C, D, X)

5. Basis for Request and Type of Revision:

a. The basis for this revision request is (check all that apply)

- ☒ Physical Change ☐ Improved Methodology/Data ☒ Regulatory Floodway Revision ☒ Base Map Changes
- ☐ Coastal Analysis ☒ Hydraulic Analysis ☐ Hydrologic Analysis ☐ Corrections
- ☐ Weir-Dam Changes ☐ Levee Certification ☐ Alluvial Fan Analysis ☐ Natural Changes
- ☒ New Topographic Data ☐ Other (Attach Description)

Note: A photograph and narrative description of the area of concern is not required, but is very helpful during review.

b. The area of revision encompasses the following structures (check all that apply)

Structures: ☒ Channelization ☐ Levee/Floodwall ☒ Bridge/Culvert
☐ Dam ☒ Fill ☐ Other (Attach Description)

6. ☒ Documentation of ESA compliance is submitted (required to initiate CLOMR review). Please refer to the instructions for more information.

C. REVIEW FEE

Has the review fee for the appropriate request category been included? ☒ Yes Fee amount: \$6500
☐ No, Attach Explanation

Please see the DHS-FEMA Web site at http://www.fema.gov/plan/prevent/fhm/fm_fees.shtm for Fee Amounts and Exemptions.

D. SIGNATURE

All documents submitted in support of this request are correct to the best of my knowledge. I understand that any false statement may be punishable by fine or imprisonment under Title 18 of the United States Code, Section 1001.

Name: Zachary J Grady	Company: Felsburg Holt & Ullevig	
Mailing Address: 6300 South Syracuse Way, Suite 600 Centennial, CO 80111	Daytime Telephone No.: 3037211440	Fax No.: 3037210832
	E-Mail Address: zach.grady@fhueng.com	
Signature of Requester (required):		Date:

As the community official responsible for floodplain management, I hereby acknowledge that we have received and reviewed this Letter of Map Revision (LOMR) or conditional LOMR request. Based upon the community's review, we find the completed or proposed project meets or is designed to meet all of the community floodplain management requirements, including the requirements for when fill is placed in the regulatory floodway, and that all necessary Federal, State, and local permits have been, or in the case of a conditional LOMR, will be obtained. For Conditional LOMR requests, the applicant has documented Endangered Species Act (ESA) compliance to FEMA prior to FEMA's review of the Conditional LOMR application. For LOMR requests, I acknowledge that compliance with Sections 9 and 10 of the ESA has been achieved independently of FEMA's process. For actions authorized, funded, or being carried out by Federal or State agencies, documentation from the agency showing its compliance with Section 7(a)(2) of the ESA will be submitted. In addition, we have determined that the land and any existing or proposed structures to be removed from the SFHA are or will be reasonably safe from flooding as defined in 44CFR 65.2(c), and that we have available upon request by FEMA, all analyses and documentation used to make this determination.

Community Official's Name and Title:		Community Name:	
Mailing Address:	Daytime Telephone No.:	Fax No.:	
	E-Mail Address:		
Community Official's Signature (required):		Date:	

CERTIFICATION BY REGISTERED PROFESSIONAL ENGINEER AND/OR LAND SURVEYOR

This certification is to be signed and sealed by a licensed land surveyor, registered professional engineer, or architect authorized by law to certify elevation information data, hydrologic and hydraulic analysis, and any other supporting information as per NFIP regulations paragraph 65.2(b) and as described in the MT-2 Forms Instructions. All documents submitted in support of this request are correct to the best of my knowledge. I understand that any false statement may be punishable by fine or imprisonment under Title 18 of the United States Code, Section 1001.

Certifier's Name: Kendra Gabbert	License No.: 45344	Expiration Date: 10/31/2017
Company Name: Felsburg Holt & Ullevig	Telephone No.: 303-721-1440	Fax No.: 303-721-0832
Signature:	Date:	E-Mail Address: kendra.gabbert@fhueng.com

Ensure the forms that are appropriate to your revision request are included in your submittal.

Form Name and (Number)

Required if ...

- | | |
|---|--|
| ☒ Riverine Hydrology and Hydraulics Form (Form 2) | New or revised discharges or water-surface elevations |
| ☒ Riverine Structures Form (Form 3) | Channel is modified, addition/revision of bridge/culverts,
addition/revision of levee/floodwall, addition/revision of dam |
| ☐ Coastal Analysis Form (Form 4) | New or revised coastal elevations |
| ☐ Coastal Structures Form (Form 5) | Addition/revision of coastal structure |
| ☐ Alluvial Fan Flooding Form (Form 6) | Flood control measures on alluvial fans |

Seal (Optional)

U.S. DEPARTMENT OF HOMELAND SECURITY
FEDERAL EMERGENCY MANAGEMENT AGENCY
RIVERINE HYDROLOGY & HYDRAULICS FORM

O.M.B No. 1660-0016
Expires February 28, 2014

PAPERWORK BURDEN DISCLOSURE NOTICE

Public reporting burden for this form is estimated to average 3.5 hours per response. The burden estimate includes the time for reviewing instructions, searching existing data sources, gathering and maintaining the needed data, and completing, reviewing, and submitting the form. You are not required to respond to this collection of information unless a valid OMB control number appears in the upper right corner of this form. Send comments regarding the accuracy of the burden estimate and any suggestions for reducing this burden to: Information Collections Management, Department of Homeland Security, Federal Emergency Management Agency, 1800 South Bell Street, Arlington VA 20958-3005, Paperwork Reduction Project (1660-0016). Submission of the form is required to obtain or retain benefits under the National Flood Insurance Program. **Please do not send your completed survey to the above address.**

PRIVACY ACT STATEMENT

AUTHORITY: The National Flood Insurance Act of 1968, Public Law 90-448, as amended by the Flood Disaster Protection Act of 1973, Public Law 93-234.

PRINCIPAL PURPOSE(S): This information is being collected for the purpose of determining an applicant's eligibility to request changes to National Flood Insurance Program (NFIP) Flood Insurance Rate Maps (FIRM).

ROUTINE USE(S): The information on this form may be disclosed as generally permitted under 5 U.S.C § 552a(b) of the Privacy Act of 1974, as amended. This includes using this information as necessary and authorized by the routine uses published in DHS/FEMA/NFIP/LOMA-1 National Flood Insurance Program (NFIP); Letter of Map Amendment (LOMA) February 15, 2006, 71 FR 7990.

DISCLOSURE: The disclosure of information on this form is voluntary; however, failure to provide the information requested may delay or prevent FEMA from processing a determination regarding a requested change to a NFIP Flood Insurance Rate Maps (FIRM).

Flooding Source: Happy Canyon Creek

Note: Fill out one form for each flooding source studied

A. HYDROLOGY

1. Reason for New Hydrologic Analysis (check all that apply)

- | | | |
|---|--|--|
| ☒ Not revised (skip to section B) | ☐ No existing analysis | ☐ Improved data |
| ☐ Alternative methodology | ☐ Proposed Conditions (CLOMR) | ☐ Changed physical condition of watershed |

2. Comparison of Representative 1%-Annual-Chance Discharges

Location	Drainage Area (Sq. Mi.)	Effective/FIS (cfs)	Revised (cfs)
----------	-------------------------	---------------------	---------------

3. Methodology for New Hydrologic Analysis (check all that apply)

- | | |
|---|--|
| ☐ Statistical Analysis of Gage Records | ☐ Precipitation/Runoff Model → Specify Model: _____ |
| ☐ Regional Regression Equations | ☐ Other (please attach description) |

Please enclose all relevant models in digital format, maps, computations (including computation of parameters), and documentation to support the new analysis.

4. Review/Approval of Analysis

If your community requires a regional, state, or federal agency to review the hydrologic analysis, please attach evidence of approval/review.

5. Impacts of Sediment Transport on Hydrology

Is the hydrology for the revised flooding source(s) affected by sediment transport? ☐ Yes ☐ No

If yes, then fill out Section F (Sediment Transport) of Form 3. If No, then attach your explanation..

B. HYDRAULICS

1. Reach to be Revised

	Description	Cross Section	Water-Surface Elevations (ft.)	
			Effective	Proposed/Revised
Downstream Limit*	<u>FIS Section E</u>	<u>10111</u>	<u>5766.3</u>	<u>5766.3</u>
Upstream Limit*	<u>FIS Section G</u>	<u>12694</u>	<u>5784.8</u>	<u>5783.92</u>

*Proposed/Revised elevations must tie-into the Effective elevations within 0.5 foot at the downstream and upstream limits of revision.

2. Hydraulic Method/Model Used: HEC-RAS 4.1.0

3. Pre-Submittal Review of Hydraulic Models*

DHS-FEMA has developed two review programs, CHECK-2 and CHECK-RAS, to aid in the review of HEC-2 and HEC-RAS hydraulic models, respectively. We recommend that you review your HEC-2 and HEC-RAS models with CHECK-2 and CHECK-RAS.

4.

<u>Models Submitted</u>	<u>Natural Run</u>		<u>Floodway Run</u>		<u>Datum</u>
Duplicate Effective Model*	File Name: Happy Canyon	Plan Name: Duplicate Effective	File Name: N/A	Plan Name: N/A	NAVD 88
Corrected Effective Model*	File Name: Happy Canyon	Plan Name: Corrected Effective	File Name: N/A	Plan Name: N/A	NAVD 88
Existing or Pre-Project Conditions Model	File Name: N/A	Plan Name: N/A	File Name: N/A	Plan Name: N/A	N/A
Revised or Post-Project Conditions Model	File Name: Happy Canyon	Plan Name: Post-Project	File Name: Happy Canyon	Plan Name: Post-Project Floodwa	NAVD 88
Other - (attach description)	File Name: N/A	Plan Name: N/A	File Name: N/A	Plan Name: N/A	N/A

* For details, refer to the corresponding section of the instructions.

☒ Digital Models Submitted? (Required)

C. MAPPING REQUIREMENTS

A **certified topographic work map** must be submitted showing the following information (where applicable): the boundaries of the effective, existing, and proposed conditions 1%-annual-chance floodplain (for approximate Zone A revisions) or the boundaries of the 1%- and 0.2%-annual-chance floodplains and regulatory floodway (for detailed Zone AE, AO, and AH revisions); location and alignment of all cross sections with stationing control indicated; stream, road, and other alignments (e.g., dams, levees, etc.); current community easements and boundaries; boundaries of the requester's property; certification of a registered professional engineer registered in the subject State; location and description of reference marks; and the referenced vertical datum (NGVD, NAVD, etc.).

☐ Digital Mapping (GIS/CADD) Data Submitted (preferred)

Topographic Information: Flown Aerial Survey for Belford Ave.

Source: Manhard Consultants

Date: 03-31-16

Accuracy: 1-Foot Interval Contours

Note that the boundaries of the existing or proposed conditions floodplains and regulatory floodway to be shown on the revised FIRM and/or FBFM must tie-in with the effective floodplain and regulatory floodway boundaries. Please attach **a copy of the effective FIRM and/or FBFM**, at the same scale as the original, annotated to show the boundaries of the revised 1%-and 0.2%-annual-chance floodplains and regulatory floodway that tie-in with the boundaries of the effective 1%-and 0.2%-annual-chance floodplain and regulatory floodway at the upstream and downstream limits of the area on revision.

☐ Annotated FIRM and/or FBFM (Required)

D. COMMON REGULATORY REQUIREMENTS*

1. For LOMR/CLOMR requests, do Base Flood Elevations (BFEs) increase? ☒ Yes ☐ No
- a. For CLOMR requests, if either of the following is true, please submit **evidence of compliance with Section 65.12 of the NFIP regulations**:
- The proposed project encroaches upon a regulatory floodway and would result in increases above 0.00 foot compared to pre-project conditions.
 - The proposed project encroaches upon a SFHA with or without BFEs established and would result in increases above 1.00 foot compared to pre-project conditions.
- b. Does this LOMR request cause increase in the BFE and/or SFHA compared with the effective BFEs and/or SFHA? ☒ Yes ☐ No
If Yes, please attach **proof of property owner notification and acceptance (if available)**. Elements of and examples of property owner notifications can be found in the MT-2 Form 2 Instructions.
2. Does the request involve the placement or proposed placement of fill? ☒ Yes ☐ No
- If Yes, the community must be able to certify that the area to be removed from the special flood hazard area, to include any structures or proposed structures, meets all of the standards of the local floodplain ordinances, and is reasonably safe from flooding in accordance with the NFIP regulations set forth at 44 CFR 60.3(A)(3), 65.5(a)(4), and 65.6(a)(14). Please see the MT-2 instructions for more information.
3. For LOMR requests, is the regulatory floodway being revised? ☒ Yes ☐ No
- If Yes, attach **evidence of regulatory floodway revision notification**. As per Paragraph 65.7(b)(1) of the NFIP Regulations, notification is required for requests involving revisions to the regulatory floodway. (Not required for revisions to approximate 1%-annual-chance floodplains [studied Zone A designation] unless a regulatory floodway is being established. Elements and examples of regulatory floodway revision notification can be found in the MT-2 Form 2 Instructions.)
4. For CLOMR requests, please submit documentation to FEMA and the community to show that you have complied with Sections 9 and 10 of the Endangered Species Act (ESA).

For actions authorized, funded, or being carried out by Federal or State agencies, please submit documentation from the agency showing its compliance with Section 7(a)(2) of the ESA. Please see the MT-2 instructions for more detail.

* Not inclusive of all applicable regulatory requirements. For details, see 44 CFR parts 60 and 65.

DEPARTMENT OF HOMELAND SECURITY
FEDERAL EMERGENCY MANAGEMENT AGENCY
RIVERINE STRUCTURES FORM

O.M.B. NO. 1660-0016
Expires February 28, 2014

PAPERWORK BURDEN DISCLOSURE NOTICE

Public reporting burden for this form is estimated to average 7 hours per response. The burden estimate includes the time for reviewing instructions, searching existing data sources, gathering and maintaining the needed data, and completing, reviewing, and submitting the form. You are not required to respond to this collection of information unless a valid OMB control number appears in the upper right corner of this form. Send comments regarding the accuracy of the burden estimate and any suggestions for reducing this burden to: Information Collections Management, Department of Homeland Security, Federal Emergency Management Agency, 1800 South Bell Street, Arlington, VA 20598-3005, Paperwork Reduction Project (1660-0016). Submission of the form is required to obtain or retain benefits under the National Flood Insurance Program. **Please do not send your completed survey to the above address.**

PRIVACY ACT STATEMENT

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DISCLOSURE: The disclosure of information on this form is voluntary; however, failure to provide the information requested may delay or prevent FEMA from processing a determination regarding a requested change to a NFIP Flood Insurance Rate Maps (FIRM).

Flooding Source: Happy Canyon Creek

Note: Fill out one form for each flooding source studied.

A. GENERAL

Complete the appropriate section(s) for each Structure listed below:

Channelization.....complete Section B
Bridge/Culvert.....complete Section C
Dam.....complete Section D
Levee/Floodwall.....complete Section E
Sediment Transport.....complete Section F (if required)

Description Of Modeled Structure

1. Name of Structure: Belford Avenue Bridge

Type (check one): ☒ Channelization ☒ Bridge/Culvert ☐ Levee/Floodwall ☐ Dam

Location of Structure: _____

Downstream Limit/Cross Section: 11100

Upstream Limit/Cross Section: 11180

2. Name of Structure: E-470 Pedestrian Train Crossing

Type (check one): ☒ Channelization ☒ Bridge/Culvert ☐ Levee/Floodwall ☐ Dam

Location of Structure: _____

Downstream Limit/Cross Section: 10750

Upstream Limit/Cross Section: 10810

3. Name of Structure: _____

Type (check one) ☐ Channelization ☐ Bridge/Culvert ☐ Levee/Floodwall ☐ Dam

Location of Structure: _____

Downstream Limit/Cross Section: _____

Upstream Limit/Cross Section: _____

NOTE: FOR MORE STRUCTURES, ATTACH ADDITIONAL PAGES AS NEEDED.

B. CHANNELIZATION

Flooding Source: Happy Canyon Creek

Name of Structure: Belford Avenue Bridge

1. Hydraulic Considerations

The channel was designed to carry _____ (cfs) and/or the _____-year flood.

The design elevation in the channel is based on (check one):

☒ Subcritical flow ☐ Critical flow ☐ Supercritical flow ☐ Energy grade line

If there is the potential for a hydraulic jump at the following locations, check all that apply and attach an explanation of how the hydraulic jump is controlled without affecting the stability of the channel.

☐ Inlet to channel ☐ Outlet of channel ☒ At Drop Structures ☐ At Transitions

☐ Other locations (specify): _____

2. Channel Design Plans

Attach the plans of the channelization certified by a registered professional engineer, as described in the instructions.

3. Accessory Structures

The channelization includes (check one):

☐ Levees [Attach Section E (Levee/Floodwall)] ☒ Drop structures ☐ Superelevated sections
☒ Transitions in cross sectional geometry ☐ Debris basin/detention basin [Attach Section D (Dam/Basin)] ☐ Energy dissipator
☐ Weir ☐ Other (Describe): _____

4. Sediment Transport Considerations

Are the hydraulics of the channel affected by sediment transport? ☐ Yes ☒ No

If yes, then fill out Section F (Sediment Transport) of Form 3. If No, then attach your explanation for why sediment transport was not considered.

C. BRIDGE/CULVERT

Flooding Source: Happy Canyon Creek

Name of Structure: Belford Avenue Bridge

1. This revision reflects (check one):

☒ Bridge/culvert not modeled in the FIS
☐ Modified bridge/culvert previously modeled in the FIS
☐ Revised analysis of bridge/culvert previously modeled in the FIS

2. Hydraulic model used to analyze the structure (e.g., HEC-2 with special bridge routine, WSPRO, HY8): HEC-RAS 4.1.0

If different than hydraulic analysis for the flooding source, justify why the hydraulic analysis used for the flooding source could not analyze the structures. Attach justification.

3. Attach plans of the structures certified by a registered professional engineer. The plan detail and information should include the following (check the information that has been provided):

☒ Dimensions (height, width, span, radius, length)	☐ Distances Between Cross Sections
☐ Shape (culverts only)	☐ Erosion Protection
☒ Material	☒ Low Chord Elevations – Upstream and Downstream
☒ Beveling or Rounding	☒ Top of Road Elevations – Upstream and Downstream
☒ Wing Wall Angle	☐ Structure Invert Elevations – Upstream and Downstream
☐ Skew Angle	☐ Stream Invert Elevations – Upstream and Downstream
	☐ Cross-Section Locations

4. Sediment Transport Considerations

Are the hydraulics of the structure affected by sediment transport? ☐ Yes ☒ No

If Yes, then fill out Section F (Sediment Transport) of Form 3. If no, then attach an explanation.

D. DAM/BASIN

Flooding Source: _____

Name of Structure: _____

1. This request is for (check one): ☐ Existing dam/basin ☐ New dam/basin ☐ Modification of existing dam/basin
2. The dam/basin was designed by (check one): ☐ Federal agency ☐ State agency ☐ Private organization ☐ Local government agency

Name of the agency or organization: _____

3. The Dam was permitted as (check one): ☐ Federal Dam ☐ State Dam

Provide the permit or identification number (ID) for the dam and the appropriate permitting agency or organization

Permit or ID number _____ Permitting Agency or Organization _____

- a. ☐ Local Government Dam ☐ Private Dam

Provided related drawings, specification and supporting design information.

4. Does the project involve revised hydrology? ☐ Yes ☐ No

If Yes, complete the Riverine Hydrology & Hydraulics Form (Form 2).

Was the dam/basin designed using critical duration storm? (must account for the maximum volume of runoff)

- ☐ Yes, provide supporting documentation with your completed Form 2.
- ☐ No, provide a written explanation and justification for not using the critical duration storm.

5. Does the submittal include debris/sediment yield analysis? ☐ Yes ☐ No

If Yes, then fill out Section F (Sediment Transport). If No, then attach your explanation for why debris/sediment analysis was not considered?

6. Does the Base Flood Elevation behind the dam/basin or downstream of the dam/basin change? ☐ Yes ☐ No

If Yes, complete the Riverine Hydrology & Hydraulics Form (Form 2) and complete the table below.

FREQUENCY (% annual chance)	Stillwater Elevation Behind the Dam/Basin	
	FIS	REVISED
10-year (10%)	_____	_____
50-year (2%)	_____	_____
100-year (1%)	_____	_____
500-year (0.2%)	_____	_____
Normal Pool Elevation	_____	_____

7. Please attach a copy of the formal Operation and Maintenance Plan

E. LEVEE/FLOODWALL

1. System Elements

a. This Levee/Floodwall analysis is based on (check one):

- ☐ upgrading of
an existing
levee/floodwall
system
- ☐ a newly
constructed
levee/floodwall
system
- ☐ reanalysis of
an existing
levee/floodwall
system

b. Levee elements and locations are (check one):

- ☐ earthen embankment, dike, berm, etc. Station _____ to _____
- ☐ structural floodwall Station _____ to _____
- ☐ Other (describe): Station _____ to _____

c. Structural Type (check one): ☐ monolithic cast-in place reinforced concrete ☐ reinforced concrete masonry block ☐ sheet piling
☐ Other (describe): _____

d. Has this levee/floodwall system been certified by a Federal agency to provide protection from the base flood?

☐ Yes ☐ No

If Yes, by which agency? _____

e. Attach certified drawings containing the following information (indicate drawing sheet numbers):

- | | |
|---|----------------------|
| 1. Plan of the levee embankment and floodwall structures. | Sheet Numbers: _____ |
| 2. A profile of the levee/floodwall system showing the Base Flood Elevation (BFE),
levee and/or wall crest and foundation, and closure locations for the total levee system. | Sheet Numbers: _____ |
| 3. A profile of the BFE, closure opening outlet and inlet invert elevations, type and size
of opening, and kind of closure. | Sheet Numbers: _____ |
| 4. A layout detail for the embankment protection measures. | Sheet Numbers: _____ |
| 5. Location, layout, and size and shape of the levee embankment features, foundation treatment,
Floodwall structure, closure structures, and pump stations. | Sheet Numbers: _____ |

2. Freeboard

a. The minimum freeboard provided above the BFE is:

Riverine

- | | | |
|--|------------------------------|-----------------------------|
| 3.0 feet or more at the downstream end and throughout | ☐ Yes | ☐ No |
| 3.5 feet or more at the upstream end | ☐ Yes | ☐ No |
| 4.0 feet within 100 feet upstream of all structures and/or constrictions | ☐ Yes | ☐ No |

Coastal

- | | | |
|--|------------------------------|-----------------------------|
| 1.0 foot above the height of the one percent wave associated with the 1%-annual-chance
stillwater surge elevation or maximum wave runup (whichever is greater). | ☐ Yes | ☐ No |
| 2.0 feet above the 1%-annual-chance stillwater surge elevation | ☐ Yes | ☐ No |

Please note, occasionally exceptions are made to the minimum freeboard requirement. If an exception is requested, attach documentation addressing Paragraph 65.10(b)(1)(ii) of the NFIP Regulations.

If No is answered to any of the above, please attach an explanation.

b. Is there an indication from historical records that ice-jamming can affect the BFE? ☐ Yes ☐ No

If Yes, provide ice-jam analysis profile and evidence that the minimum freeboard discussed above still exists.

3. Closures

a. Openings through the levee system (check one): ☐ exists ☐ does not exist

If opening exists, list all closures:

Channel Station	Left or Right Bank	Opening Type	Highest Elevation for Opening Invert	Type of Closure Device

(Extend table on an added sheet as needed and reference)

Note: Geotechnical and geologic data

In addition to the required detailed analysis reports, data obtained during field and laboratory investigations and used in the design analysis for the following system features should be submitted in a tabulated summary form. (Reference U.S. Army Corps of Engineers [USACE] EM-1110-2-1906 Form 2086.)