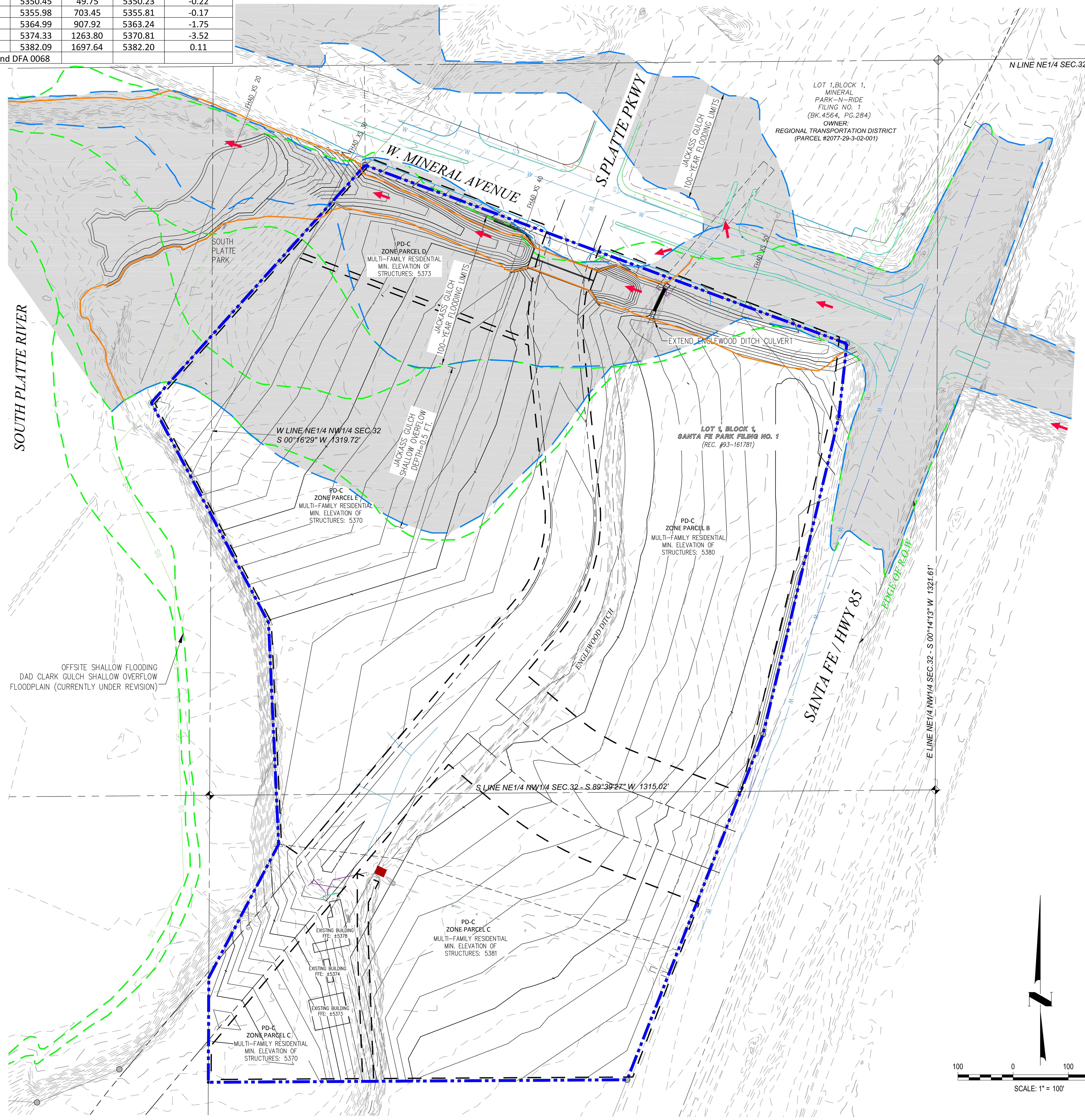
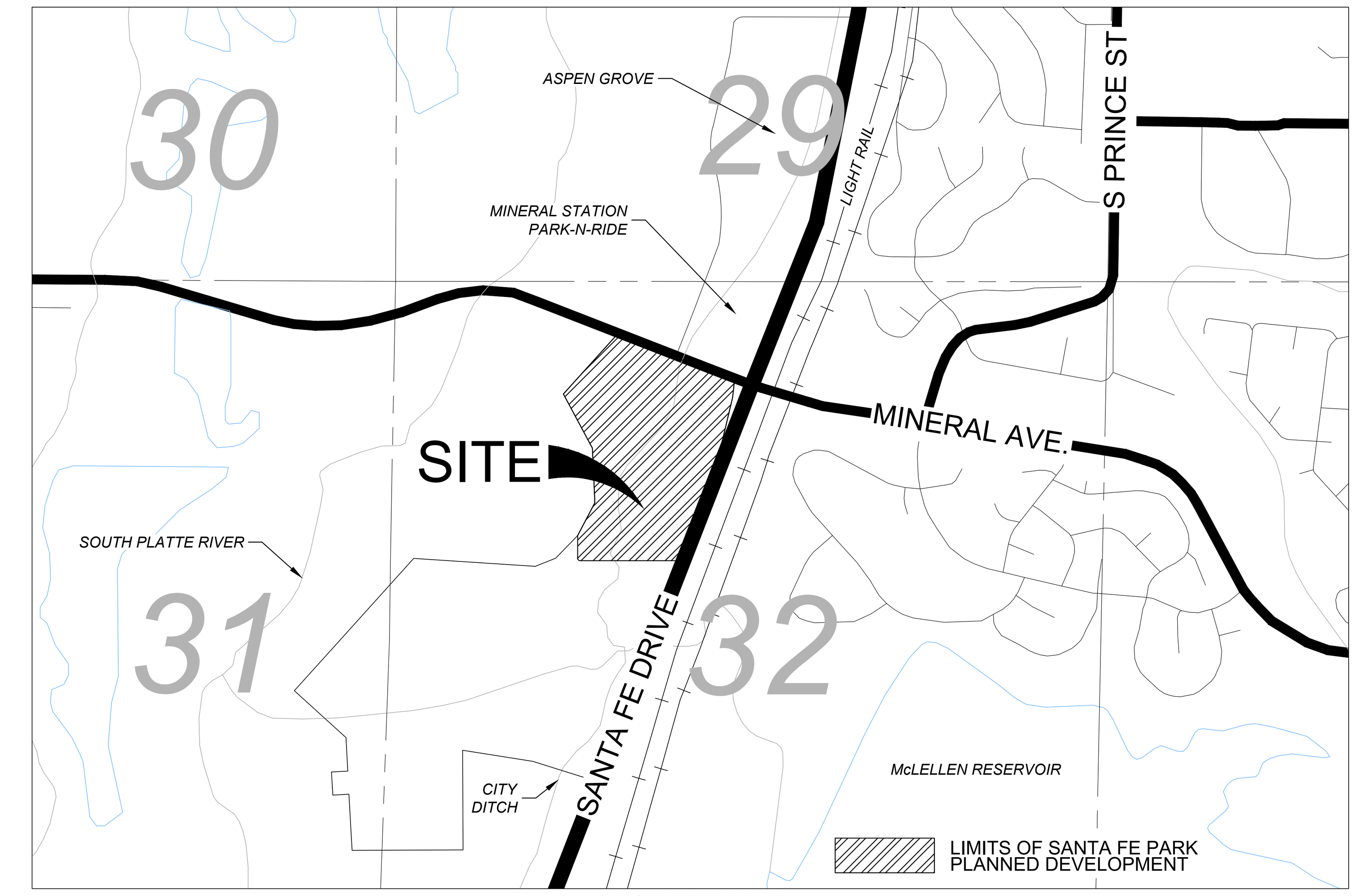
NO CHANGES ARE TO BE MADE TO THIS DRAWING WITHOUT WRITTEN PERMISSION OF HARRIS KOCHER SMITH.

SANTA FE PARK SITE PLAN
USE BY SPECIAL EXCEPTION

SITUATED IN THE NORTHWEST 1/4 OF SECTION 32, TOWNSHIP 5 SOUTH, RANGE 68 WEST OF THE 6TH P.M.
COUNTY OF ARAPAHOE, STATE OF COLORADO
CASE NUMBER: ENG17-0005

FHAD*		Corrected Effective (Existing)		Proposed Conditions		
Q100 = 1240 cfs		Q100 = 1240 cfs		Q100 = 1240 cfs		
FHAD XS	100-YR WSEL	HEC XS	100-YR WSEL	HEC XS	100-YR WSEL	Δ WSEL (Ex to Prop)
10	5350.40	49.75	5350.45	49.75	5350.23	-0.22
20	5354.60	703.45	5355.98	703.45	5355.81	-0.17
30	5365.50	907.92	5364.99	907.92	5363.24	-1.75
40	5373.90	1254.10	5374.33	1263.80	5370.81	-3.52
50	5382.10	1700.25	5382.09	1697.64	5382.20	0.11
*Per FHAD -Lower Dad Clark Gulch and DFA 0068						





VICINITY MAP

SCALE: 1" = 1,000'

CERTIFICATION OF DEDICATION AND OWNERSHIP:

KNOW ALL MEN BY THESE PRESENTS THAT KENTON C. ENSOR, JR; AND K. C. ENSOR REALTY CO., A COLORADO CORPORATION, BEING THE OWNERS OF CERTAIN LANDS IN THE CITY OF LITTLETON, COUNTY OF ARAPAHOE, STATE OF COLORADO, DESCRIBED AS FOLLOWS:

A PARCEL OF LAND BEING LOT 1, BLOCK 1, SANTA FE PARK FILING NO. 1, RECORDED AT RECEPTION NO. 161781 OF THE RECORDS OF THE ARAPAHOE COUNTY CLERK AND RECORDER, TOGETHER WITH A PORTION OF THE PARCEL DESCRIBED IN BOOK 4160 AT PAGE 33 OF SAID RECORDS, AND TOGETHER WITH A PORTION OF THE PARCEL DESCRIBED IN BOOK 3603 AT PAGE 77 OF SAID RECORDS, SITUATED IN THE NORTHWEST QUARTER OF SECTION 32, TOWNSHIP 5 SOUTH, RANGE 68 WEST OF THE 6TH PRINCIPAL MERIDIAN, CITY OF LITTLETON, COUNTY OF ARAPAHOE, STATE OF COLORADO, MORE PARTICULARLY DESCRIBED AS FOLLOWS:

COMMENCING AT THE NORTH QUARTER CORNER OF SAID SECTION 32;
THENCE SOUTH 89°29'27" WEST ALONG THE NORTH LINE OF SAID NORTHWEST QUARTER, A DISTANCE OF 1039.53 FEET;
THENCE SOUTH 00°30'33" EAST, A DISTANCE OF 181.09 FEET TO A POINT ON THE SOUTH LINE OF WEST MINERAL AVENUE, SAID POINT ALSO BEING THE NORTH CORNER OF SAID LOT 1 AND THE **POINT OF BEGINNING**;
THENCE SOUTH 69°39'40" EAST ALONG SAID SOUTH LINE, A DISTANCE OF 930.25 FEET TO THE WEST LINE OF SANTA FE DRIVE;
THENCE ALONG SAID WEST LINE THE FOLLOWING THREE (3) COURSES:
1) SOUTH 06°15'04" WEST, A DISTANCE OF 134.04 FEET;
2) SOUTH 13°24'58" WEST, A DISTANCE OF 590.30 FEET;
3) SOUTH 21°30'04" WEST, A DISTANCE OF 672.17 FEET TO THE SOUTH LINE OF SAID PARCEL DESCRIBED IN BOOK 3603 AT PAGE 77;
THENCE ALONG THE SOUTH AND WEST LINES OF SAID PARCEL THE FOLLOWING THREE (3) COURSES:
1) SOUTH 89°39'28" WEST, A DISTANCE OF 758.44 FEET;
2) NORTH 00°16'35" EAST, A DISTANCE OF 189.77 FEET;
3) NORTH 27°39'51" EAST, A DISTANCE OF 272.39 FEET TO THE SOUTHWEST CORNER OF SAID PARCEL DESCRIBED IN BOOK 4160 AT PAGE 33;
THENCE NORTH 02°37'05" WEST ALONG THE WEST LINE OF SAID PARCEL, A DISTANCE OF 201.93 FEET TO THE SOUTHWEST CORNER OF SAID LOT 1;
THENCE ALONG THE WEST LINE OF SAID LOT 1 THE FOLLOWING THREE (3) COURSES:
1) CONTINUING NORTH 02°37'05" WEST, A DISTANCE OF 200.00 FEET;
2) NORTH 28°04'01" WEST, A DISTANCE OF 451.10 FEET;
3) NORTH 42°00'11" EAST, A DISTANCE OF 578.80 FEET TO THE **POINT OF BEGINNING**;

SAID PARCEL CONTAINS 1,452,240 SQUARE FEET OR 33.34 ACRES, MORE OR LESS;

HAS BY THESE PRESENTS LAID OUT, PLATTED AND SUBDIVIDED THE SAME INTO A PARCEL AS SHOWN ON THIS PLAT, UNDER THE NAME AND STYLE OF SANTA FE PARK SUBDIVISION EXEMPTION.

SECTION 10-6-8: USE BY SPEICAL EXEMPTION - SITE PLAN

1. THE EXISTING ADJACENT DEVELOPMENTS HAVE COMMERCIAL AND RESIDENTIAL USES
2. THE PROPOSED USE OF THE SITE IS COMMERCIAL AND RESIDENTIAL DEVELOPMENT

NOTES:

1. EFFECTIVE JACKASS GULCH FLOODING FROM THE FLOOD HAZARD AREA DELINEATION (FHAD) FOR LOWER DAD CLARK GULCH AND DFA 0068 BY THE URBAN DRAINAGE AND FLOOD CONTROL DISTRICT AND THE CITY OF LITTLETON, 1990.
2. ALL FLOODPLAINS SHALL BE CONTAINED IN TRACTS, SHOWN ON THE FINAL PLAT, AND SHALL CONTAIN A DESCRIPTION OF PURPOSE, OWNERSHIP, AND MAINTENANCE RESPONSIBILITY OF SAID TRACTS.
3. THIS SITE PLAN REPRESENTS THE GENERAL DEVELOPMENT INTENT OF THE DEVELOPER IN THE EVENT THAT AN AMENDMENT TO THE CURRENT ZONING IS APPROVED.
4. ALL ROAD LOCATIONS AND ALIGNMENTS ARE CONCEPTUAL AND FOR ILLUSTRATIVE PURPOSES ONLY. FINAL LOCATIONS AND ALIGNMENTS WILL BE THROUGH PRELIMINARY AND FINAL PLATS AND SITE DEVELOPMENT PLAN(S).
5. ALL DEVELOPMENT AREA LOCATIONS AND LAYOUTS ARE PRELIMINARY AND ARE SUBJECT TO CHANGE. HOWEVER, NO STRUCTURE SHALL BE PLACED WITHIN THE FLOODPLAIN AS DETERMINED BY THE SPECIAL EXCEPTION PERMIT, CASE NO. ENG17–0005. IF ANY ADDITIONAL MODIFICATIONS OF THE FLOODPLAIN ARE PROPOSED, A NEW SPECIAL USE BY SPECIAL EXCEPTION PERMIT MUST BE SUBMITTED, REVIEWED, AND APPROVED PRIOR TO ALLOWING ANY STRUCTURES TO BE PLACED WITHIN THE FLOODPLAIN.
6. ALL STRUCTURES LOWEST FLOORS MUST BE 1' ABOVE THE HIGHEST PROPOSED WATER SURFACE ELEVATION ADJACENT TO THAT STRUCTURE.
7. BUILDING SITES SHOULD BE GRADED, SO IN THE EVENT OF A CHANNEL SPILL, SHALLOW OVERLAND FLOW SHALL BE DIRECTED AWAY FROM BUILDINGS PER FLOODPLAIN REGULATIONS SECTION 10–6–8(B)2(A)3 AND (B)3.
8. MOBILE HOMES ARE NOT ALLOWED PER FLOODPLAIN REGULATIONS SECTION 10–6–8.
9. BASED ON A TOTAL SITE AREA OF 33.3 ACRES AND A 90% WATERSHED IMPERVIOUSNESS YIELDS AN ALLOWABLE IMPERVIOUS AREA OF 30.0 ACRES.

LEGEND:

- ZONE DISTRICT BOUNDARY
- PROPOSED RIGHT OF WAY
- PROPOSED LOT
- PROPOSED SITE JAG 100-YR FLOODING LIMITS
- EXISTING WATER SUPPLY LINE
- EXISTING SITE JAG 100-YR FLOODING LIMITS
- FHAD JAG 100-YR FLOODING LIMITS
- EXISTING SANITARY SEWER
- EXISTING STORM SEWER
- EXISTING CONTOURS
- PROPOSED CONTOURS
- EXISTING / PROPOSED FLOW ARROW
- EXISTING FLOODPLAIN

HARRIS KOCHER SMITH
1120 Lincoln Street, Suite 1000
Denver, Colorado 80203
P: 303.623.6300 F: 303.623.6311
HarrisKocherSmith.com

PROJECT NUMBER: 160605

REVISION DATE:

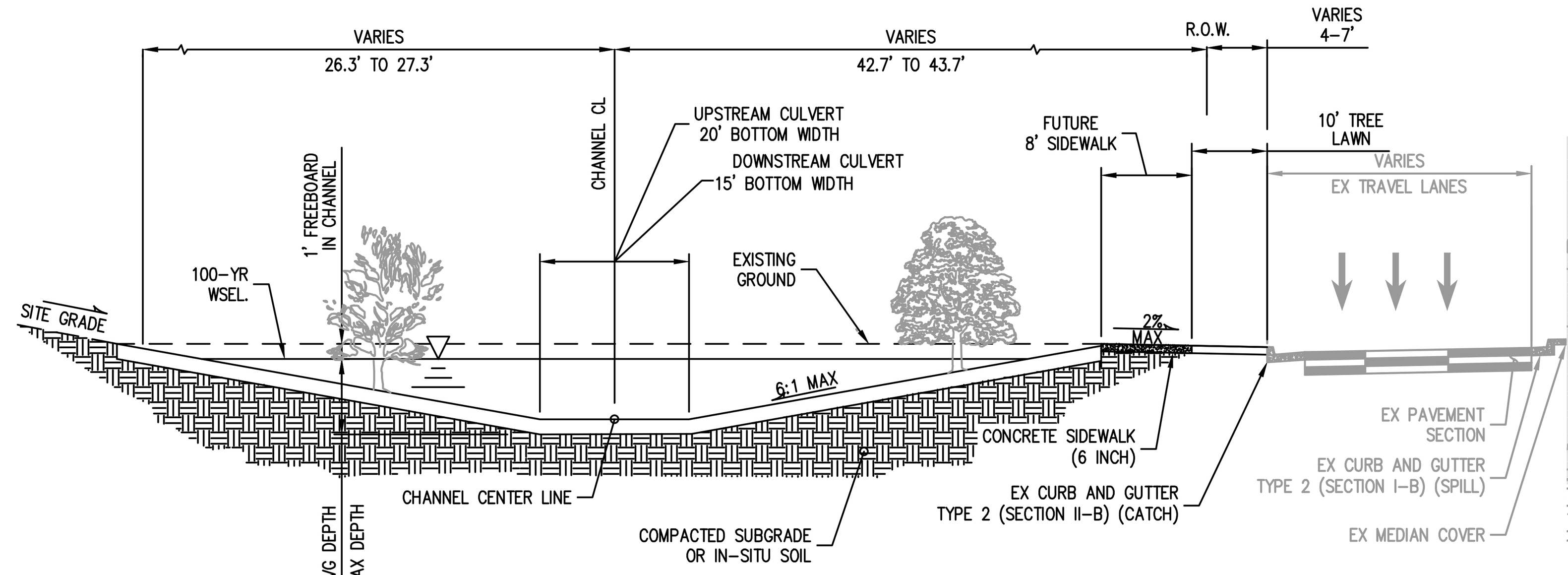
ISSUE DATE: 11/21/2017

SHEET 1 OF 2

SANTA FE PARK SITE PLAN
USE BY SPECIAL EXCEPTION

JACKASS GULCH PLAN AND PROFILE VIEW
CASE NUMBER: ENG17-0005

NO CHANGES ARE TO BE MADE TO THIS DRAWING WITHOUT WRITTEN PERMISSION OF HARRIS KOCHER SMITH.

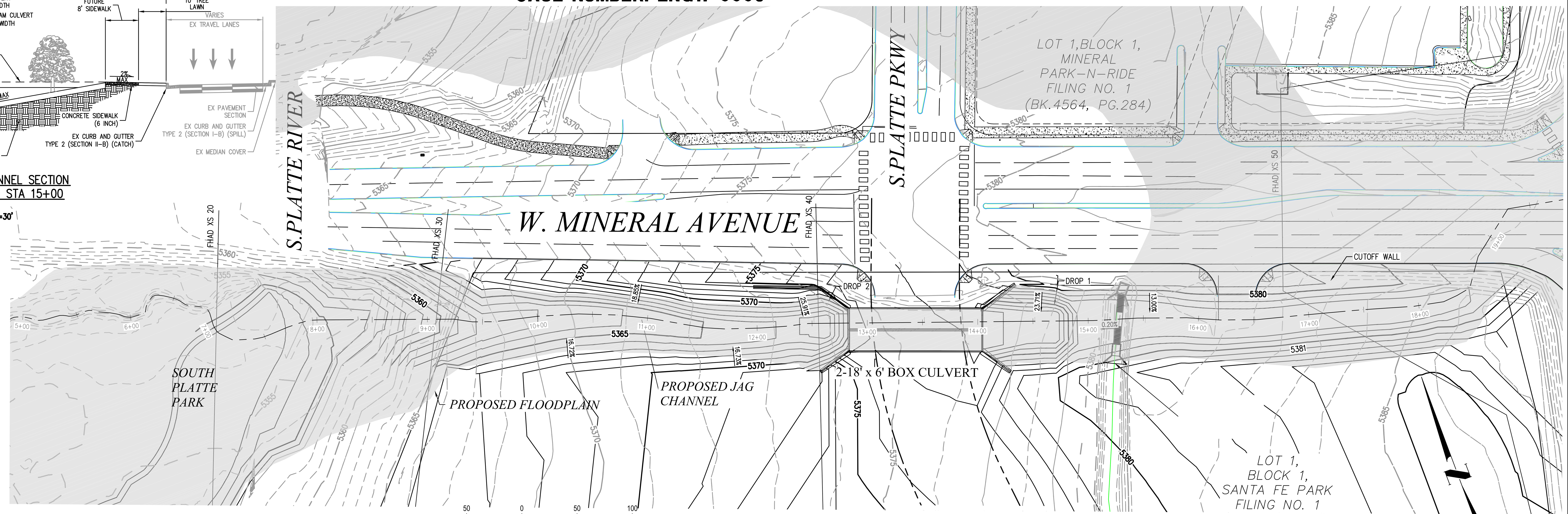


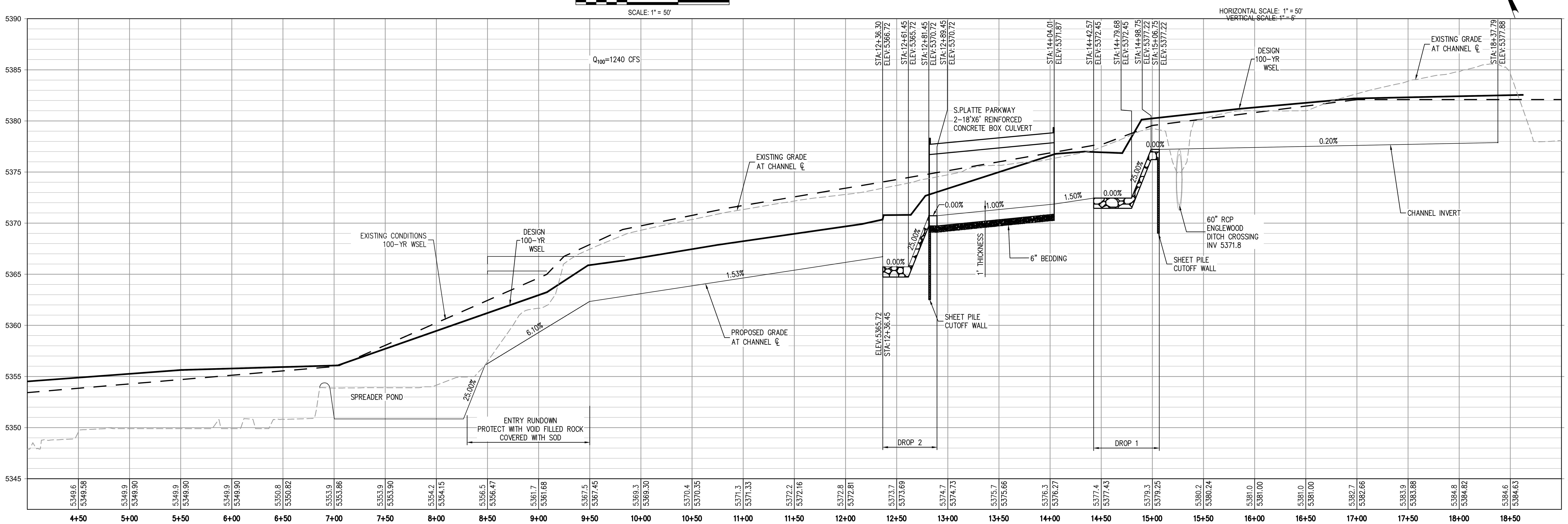
TYPICAL JAG CHANNEL SECTION
CL STA 8+50 TO STA 15+00

SCALE 1"=30'

GENERAL NOTES:

1. CHANNEL IS TO BE PERMANENTLY LINED WITH TURF REINFORCEMENT MAT. PERMISSIBLE SHEAR STRESSES WITH THE PLANTED MAT APPLICATION ARE 16 LB/SQ-FT. MAXIMUM ALLOWABLE VELOCITIES ARE 25.0 FT/SEC.
2. CHANNEL TURF REINFORCEMENT MAT TO BE PLANTED WITH APPROPRIATE GRASSES TO RETAIN COHESION OF MAT BASED ON SITE SPECIFIC SOIL CONDITIONS. CHANNEL GRASSES SHALL BE MAINTAINED POST-CONSTRUCTION TO ENSURE VEGETATION ESTABLISHMENT.





NEW JACKASS GULCH PROFILE
HORIZONTAL SCALE: 1" = 50'
VERTICAL SCALE: 1" = 5'

HARRIS KOCHER SMITH
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PROJECT NUMBER: <PROJECT NUMBER>

REVISION DATE: ISSUE DATE: 11/21/2017 SHEET 2 OF 2

November 27, 2017

City of Littleton
2255 W. Berry Avenue
Littleton, CO 80120

Attn: Ms. Carol Kuhn, AICP, Principal Planner

From: Mr. Mark A. West, PE, CFM, LEEDAP

RE: SANTA FE PARK NORTH
USE BY SPECIAL EXCEPTION – FHAD MEMORANDUM
CITY OF LITTLETON CASE NO. SDE17-0007
HKS PROJECT NO. 160605

Dear Ms. Kuhn,

This memorandum is provided as a technical support document to the Use by Special Exception application. This memo addresses the existing predevelopment and post development Flood Hazard Area Delineation (FHAD) or 100-Year event flooding limits within the subject Site from the Jackass Gulch (JAG) drainageway.

In support of the Phase I Drainage Report and Use by Special Exception Site Plan, and in response to information gathered in meetings with the City of Littleton and the Urban Drainage and Flood Control District (UDFCD) regarding this development, the following major items are addressed herein:

1. Upstream JAG Regional Detention Investigation
2. JAG Mineral Avenue Split Flow 2D Modeling (for information only)
3. Site Channel and HEC-RAS Modeling

General Background

The proposed South Santa Fe PD project (Site) is located in the Northwest ¼ of Section 32, Township 5 South, Range 68 West of the 6th Principal Meridian, County of Arapahoe, State of Colorado. The Site is comprised of approximately 33.3 acres of platted land known as Lot 1, Block 1 of the Santa Fe Park Filing No.1 (Rec #93-161781). The Site is bounded by West Mineral Avenue on the north, by undeveloped land on the south, South Santa Fe Drive to the east, and by the South Platte River on the west.

The Site is shown to be in a FEMA Zone X (unshaded) Flood Area according to FIRM map 08035C0434K, Arapahoe County, Colorado, December 17, 2010. Zone X (unshaded) is described in this map as areas determined to be outside 500-year flood plain. The Jackass Gulch major drainageway is studied in the Dad Clark Gulch Lower and DFA 0068 Flood Hazard Area Delineation (FHAD) and Outfall Systems Plan (OSP) dated 1990 and 1991 respectively.

The entire Site lies within the Jackass Gulch major drainage basin, which is tributary to the South Platte River directly downstream of the Site. The overall basin is fully developed primarily as single family housing on the central portions with a small amount of multifamily residential, commercial, and light industrial uses on the east ends of the basin. The lower half of Jackass Gulch is a well-defined drainageway with a preserved floodplain area adjacent to Mineral Avenue.

Offsite flows from the east directed towards the site crest the high point in Mineral near the northeast corner of the Site and enter the project area. In the 100-year event flood water will pond at the intersection of Santa Fe Drive and Mineral Avenue to a depth of approximately 7 feet. This ponding overflows to the west into the Site at a high point in Mineral Avenue, which in turn create flood hazard and shallow overflow areas through the Site.

I. Upstream JAG Detention Investigation

The overall Jackass Gulch basin lies south of Rangeview Gulch and is approximately 500 acres in size elongated east-west from South Broadway to the South Platte River. The basin is zoned almost entirely as Planned Development. The upper basin east of the Highline Canal is mostly commercial with some multifamily residential. All of the existing developments in the upper basin have been designed to detain stormwater runoff for the 100-year event with private on-site storm sewer facilities. The lower basin (west of Santa Fe Drive) is a commercial area and has a 60" RCP storm outfall system which discharges into an open channel which outfalls to the South Platte River in the northwest corner of the Site. The area between the Highline canal and the Railroad lines east of Santa Fe is zoned primarily as residential. The storm drainage system in the area consists of a natural channel, and portions of this middle reach are currently part of the Jackass Gulch Stabilization Project underway by the UDFCD.

The 1991 Outfall Systems Plan (OSP) for Lower Dad Clark Gulch and DFA 0068 by Centennial Engineering, Inc. presents conceptual layouts of several inline upstream detention ponds to ultimately reduce flooding effects of the JAG on the Santa Fe and Mineral intersection, and at the Site. At the time of the 1191 OSP, these ponds are located in open space or areas controlled by the City of Littleton.

Numerous developments and parcel ownership changes have occurred in the basin since the 1991 OSP was published. With this project the feasibility and effectiveness of implementation of the upstream detention ponds per the 1991 OSP was explored. To model the proposed system, the paper OSP CUHP model was recreated in CUHP 2005 Version 2.0 for use as SWMM input for the Conceptual system. Project CUHP and SWMM modeling is included with this memorandum.

The results of the upstream detention analysis in terms of total volume provided is tabulated below, and the major differences between the OSP and the 2017 conditions models are noted.

Ponds Per OSP	1991 OSP Detention Volume (ac-ft)	2017 Conceptual Detention Volume (ac-ft)	Changes from OSP
Lower RR Pond	7.2	6.3	Grading Volumetric Constraints
Upper RR Pond	17.6	11.5	Grading Volumetric Constraints
JAG Channel Pond	7.0	-	Parcel now under Private Ownership
Lower Open Space Pond	11.2	13.2	Combined Open Space Pond
Upper Open Space Pond	11.1	-	Combined Open Space Pond
Total Upstream Volume	54.1 ac-ft	31.0 ac-ft	

Roughly 65% of the total detention volume called out in the OSP could be constructed in present land use conditions. These results indicate that while upstream detention ponds may reduce the required width of the 100-year flood channel cross section on-site, but will not eliminate the need for the channel entirely, or the flooding at the Santa Fe and Mineral intersection.

There remains a large gap between detention needs and the availability for implementation of these facilities. The timing and costs of these facilities are also complex from a site development perspective, and are currently technically and economically unfeasible. From this conclusion the project will present revised HEC-RAS modeling for a flood control channel on the Site as presented below rather than further investigating upstream detention.

II. JAG Split Flow 2D Modeling (for information only)

The UDFCD Flood Hazard Area Delineation (FHAD) for the Jackass Gulch drainageway details the 100-year storm event ponding at the intersection of Santa Fe Drive and Mineral Avenue. A map excerpt from the current FHAD is included on the next page. The intersection ponding of Jackass Gulch overflows to the west into the Site at a high point in Mineral Avenue, which in turn creates a 100-year flow path and shallow overflow area through the Site. Flows at the high point in Mineral also create a shallow overflow to the north of Mineral through the RTD Park and Ride site.

The 1990 FHAD conservatively estimates the JAG 100-year flows entering the site at the split flow location as the total flow to the Mineral Avenue intersection of 1240 cfs from the upstream basins. However, the FHAD also indicates a portion of these flows that overtop the ponding at Mineral Avenue travel to the north overland to the South Platte River (550 cfs). The RTD Park and Ride site has since been developed using this split flowrate assumption.

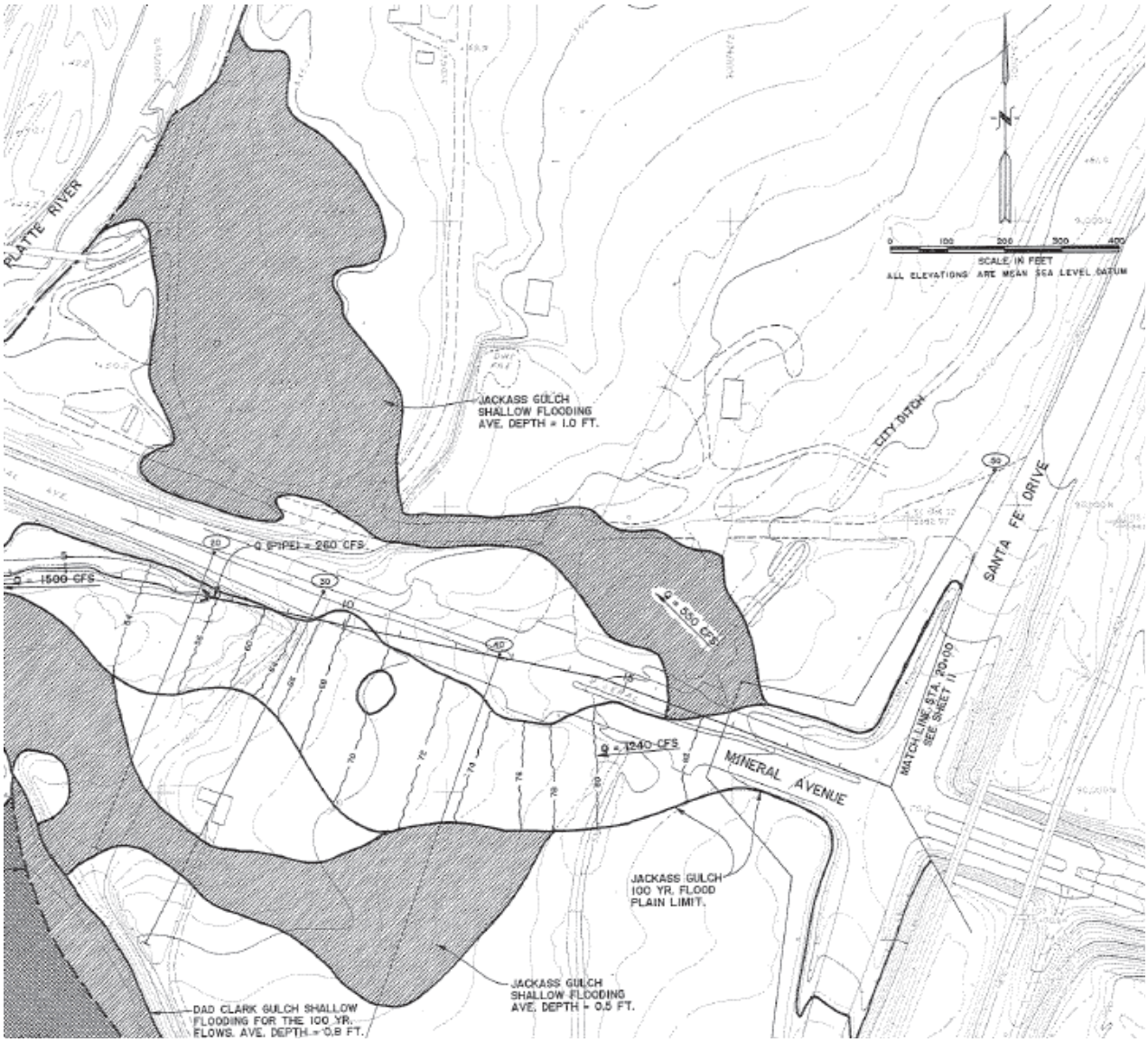
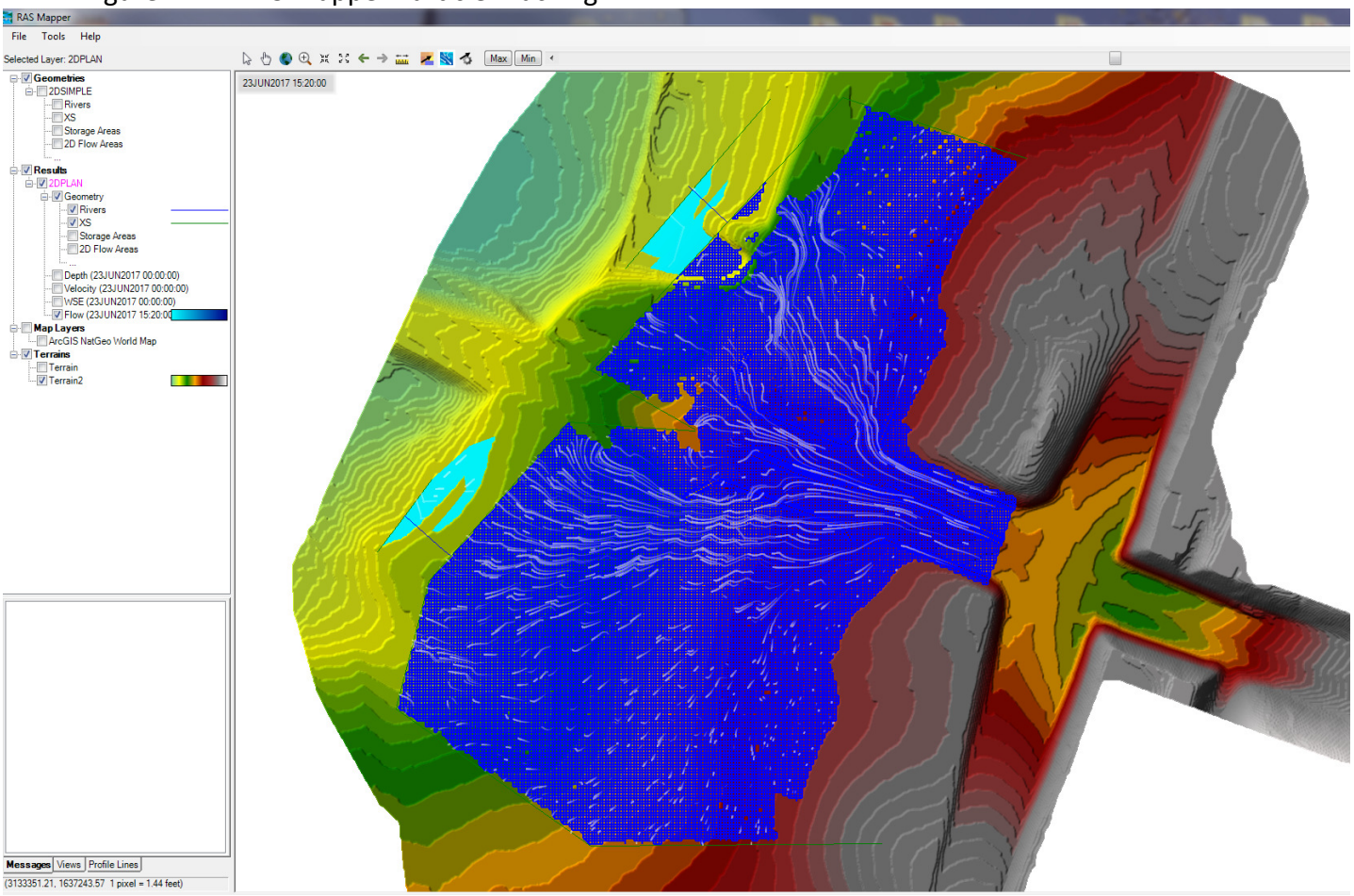


Figure 1: 1990 FHAD Flow Split Detail

To determine the design 100-year JAG channel flowrate through the site, a combined one-dimensional (1D) and two-dimensional (2D) HEC-RAS model was prepared. 2016 DRCOG DRAP project LiDAR data was obtained and reduced for the purposes of creating a terrain surface for HEC-RAS 2D model computation. An unsteady flow simulation was performed using a 24-hour duration event at continuous flowrate of 1240 cfs to allow the model to stabilize. This HEC-RAS NEWJAG2D.prj model is included in the appendix.

In this analysis the Flow Rate Split South (Q Split) is compared to the Total Combined Flow Rate (Q total), over a range of profile timesteps to determine the Split Flow relationship that can then be used to create the steady state 1-D regulatory model. Profiles that contained a Total Combined Flowrate at the downstream cross sections of within 10% of the 1240 cfs were used in the analysis, corresponding to the points the 2D model had the greatest stability. Results are included in the table below.

Figure 2: 2D RAS Mapper Particle Tracking



Profile	Flow Split South Q Split (cfs)	Total Combined Model Flow Rate Q Total (cfs)	Site Split %
23JUN2017 1330	446	1186	38%
23JUN2017 1520	496	1218	41%
23JUN2017 1740	585	1160	50%
23JUN2017 2020	643	1297	50%
23JUN2017 2050	666	1355	49%
23JUN2017 2100	509	1124	45%
		Average =	45%

While the 2D modeling is one approach for flow split determination; the existing flow patterns are also considered. As discussed previously, the RTD Park-and-Ride site to the north has been designed for the current FHAD flow of 550 cfs. The difference between the total JAG flow at this location of 1240 cfs and the FHAD split flow of 550cfs to the north is 690 cfs to the south; or 56% of the flow. Based on this analysis, the split flowrate south into the Site is modeled as the conservative case of 56% or 690 cfs.

III. Site Channel and HEC-RAS Modeling

Proposed Channel and Flowrates

The proposed constructed channel is situated directly south of Mineral Avenue to capture JAG flows and provide safe conveyance for JAG west to the outfall at the South Platte River. The JAG channel is proposed to be grass lined with drop structures into and out of the proposed culvert at S. Platte Parkway. The drops will control grade as well as dissipate energy, slow outlet velocities, and improve the vertical transitions into and out of the culvert.

The channel will extend to a point in the Mineral intersection to accept the additional flows from JAG, over those in the existing condition. This study provides evaluation of multiple design storms to see variations in flow patterns for different storm events and the resulting velocities, flow depths, etc. The following flowrates are the full FHAD flowrates used in the site channel analysis:

Q10 = 430 cfs
Q50 = 910 cfs
Q100 = 1240 cfs

It is intended that all flowrates will be confined within the channel and eliminate the wide and shallow flow across the site. The location of this channel is shown on the Site Plan. A box culvert with associated wing walls is needed to facilitate the channel crossing of future South Platte River Drive thru the Site.

Channel Hydraulics

For both the existing and proposed conditions, a HEC-RAS one-dimensional steady flow model is prepared using a series of input parameters including flowrate, channel cross section geometry, roughness coefficients, and main channel bank stations. Initial sizing of the culvert was performed with HY-8 based on the flow to the site of 1240 cfs, and this design verified within HEC-RAS.

HEC-RAS cross sections are be placed frequently along the channel in order to adequately evaluate the design hydraulic characteristics. Cross sections are generally oriented perpendicular to the channel centerline and the water flow path. A Floodplain Workmap is included with the submittal indicating cross section locations and floodplain limits.

In order to confirm that the proposed channel does not cause rises in the 100-year water surface elevation (WSEL), Table 1 is prepared detailing changes in WSEL between the FHAD, existing, and proposed conditions. The HEC-RAS model files included with this memorandum and HEC-RAS report files are included in the Appendix.

Table 1: WSEL Comparison Table

FHAD*		Corrected Effective (Existing)		Proposed Conditions		
Q_{100} = 1240 cfs		Q100 = 1240 cfs		Q100 = 1240 cfs		
FHAD XS	100-YR WSEL	HEC XS	100-YR WSEL	HEC XS	100-YR WSEL	Δ WSEL (Ex to Prop)
10	5350.40	49.75	5350.45	49.75	5350.23	-0.22
20	5354.60	703.45	5355.98	703.45	5356.08	0.10
30	5365.50	907.92	5364.99	907.92	5363.24	-1.75
40	5373.90	1254.10	5374.33	1263.80	5370.81	-3.52
50	5382.10	1700.25	5382.09	1697.64	5382.20	0.11

*Per FHAD -Lower Dad Clark Gulch and DFA 0068

From the HECRAS modeling analysis numerous output variables are reviewed to confirm that the design falls within acceptable criteria. These results are indicated in Table 2 for the 10-Year event and Table 3 for the 100-year event.

Table 2: 10-Year event Existing and Proposed Channel Shear Stress and Velocity

FHAD XS	SHEAR STRESS (LB/SQFT)					
	LOB		CHANNEL		ROB	
	EXISTING	PROPOSED	EXISTING	PROPOSED	EXISTING	PROPOSED
10	0.36	0.02	1.20	0.68	0.25	*
20	0.56	0.01	1.60	0.77	0.36	0.36
30	0.36	*	0.93	1.01	0.22	*
40	0.56	*	0.54	0.40	0.02	*
50	*	*	0.44	0.37	*	*

*No overbank flow

FHAD XS	VELOCITY (FT/S)					
	LOB		CHANNEL		ROB	
	EXISTING	PROPOSED	EXISTING	PROPOSED	EXISTING	PROPOSED
10	2.74	0.32	8.15	5.69	2.17	*
20	3.41	0.25	9.18	5.86	2.52	2.12
30	2.58	*	6.44	6.62	1.85	*
40	3.14	*	3.65	4.52	0.34	*
50	*	*	3.93	4.23	*	*

*No overbank flow

Table 3: 100-Year event Existing and Proposed Channel Shear Stress and Velocity

FHAD XS	SHEAR STRESS (LB/SQFT)					
	LOB		CHANNEL		ROB	
	EXISTING	PROPOSED	EXISTING	PROPOSED	EXISTING	PROPOSED
10	0.44	0.16	1.27	0.99	0.25	0.15
20	0.49	0.26	1.33	0.70	0.44	0.35
30	0.53	*	1.34	1.37	0.42	*
40	0.74	*	0.78	0.83	0.23	*
50	0.05	0.01	0.93	0.38	0.16	0.11

*No overbank flow

FHAD XS	VELOCITY (FT/S)					
	LOB		CHANNEL		ROB	
	EXISTING	PROPOSED	EXISTING	PROPOSED	EXISTING	PROPOSED
10	3.33	1.33	9.03	7.36	2.55	1.28
20	3.46	1.91	8.94	6.14	3.18	2.33
30	3.48	*	8.56	8.34	2.99	*
40	3.62	*	5.02	6.93	1.69	*
50	0.69	0.28	6.22	4.66	1.43	3.16

*No overbank flow

Per the UDFCD Criteria Manual prudent values for natural channel hydraulic parameters below:

Design Parameter	**Cohesive Soils and Vegetation**
Flow velocity (average of section)	7 ft/s
Depth outside bankfull channel	5 ft

The hydraulic performance of the proposed channel reach compares favorably to these design parameters; however, there are locations in the reach where these parameters are slightly exceeded. This is primarily due to the increased slope of the main channel reach (per UDFCD comment) in order to reduce the amount of drop structures shown in the initial design. Additionally, several efforts were made to improve the hydraulics in the locations that exceed the parameters. These efforts include widening of the channel bottom width from 5-feet to 15-feet and decreasing the channel side slopes from 4:1 to 6:1.

With these revisions there remain isolated areas where increased velocities and shear exist within the modeled results; however, these are primarily at locations into and out of the channel drop structures where the flow is critical and the areas are protected with hard armoring. Within the constructed channel, the maximum channel depth meets 5-foot depth criteria in all locations. Additionally, these design parameters are for natural channels; whereas the proposed channel will be lined with a with Turf Reinforcement Mat product, which have permissible allowable shear stresses of 16 lb/square-foot, and with a maximum allowable velocity of 25 ft/sec per below.

Channel Lining and Vegetation

Vegetation measures including grasses along the channel banks are proposed with the design. To establish this vegetation and provide a stable substrate for the anticipated flowrates, the channel is to be permanently lined with Turf Reinforcement Mat product, which have permissible allowable shear stresses of 16 lb/square-foot, and with a maximum allowable velocity of 25 ft/sec when properly vegetated. The channel turf reinforcement mat will be planted with appropriate grasses to retain cohesion of the mat and substrate. The final design of the mat and grasses will be based on site specific soil conditions. Channel grasses will be maintained post-construction to ensure vegetation establishment.

Drop Structures

Drop structures are proposed in the channel and are designed to be either Grouted Sloping Boulder (GSB) drops or Sculpted Concrete (SC) drops, designed per Section 2.0, UDFCD Criteria Manual Volume 2. The drops may contain stilling basin elements will be surrounded by void filled riprap. There will be a weep drain system installed in the drops, and the upstream ends of the drops will have adequate seepage cutoff walls.

Parallel Storm Sewer

UDFCD preference is to route parallel storm sewer system flows into adjacent open channels. In this case the storm sewer in Mineral Ave adjacent to the site is very deep (> 24'); the mid-manhole shelf at an adjacent manhole being at EL~5359. The JAG channel as described herein adjacent to the sewer is at elevation EL~5380. Since the storm sewer is not able to gravity flow into the proposed JAG channel, these flows are proposed to remain in the existing storm sewer system.

Englewood Ditch

The channel will cross the existing Englewood Ditch in place. The Englewood Ditch enters a concrete box structure with a 60" RCP outlet at the northern border of the site, directly south of Mineral Avenue. The elevation of the invert has been shown in the channel profile to indicate its constraint on the vertical placement of the channel.

IV. References

1. Urban Storm Drainage Criteria Manual, Vol. 1 and Vol. 2, Urban Drainage and Flood Control District, 2017.

2. Flood Hazard Area Delineation (FHAD) Lower Dad Clark Gulch and DFA 0068 by Centennial Engineering, Inc. dated November 1990.

3. Outfall Systems Plan (OSP) Lower Dad Clark Gulch and DFA 0068 by Centennial Engineering, Inc. dated February 1991.

HARRIS KOCHER SMITH
DENVER • DALLAS/FORT WORTH

APPENDIX

EXHIBITS

1. Excerpt from Dad Clark Gulch Lower and DFS 0068 OSP Ph B 1991.pdf
2. Upstream Pond Layout and Summary.pdf
3. HEC-RAS Standard Tables
4. HEC-RAS Cross Sections
5. HEC-RAS Profiles
6. HEC-RAS Culvert Output
7. Floodplain Workmap

MODEL FILES

CUHP

- CUHP_200.xltm
- JAG OUT.xlsx

HEC RAS

- JAGProposedChanne.prj

SWMM (.ini, .inp, .out, & .rpt files)

- JAG
- JAG-1
- JAG-2
- JAG-3
- JAG-4

NOTES

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5. UTILITIES ARE SHOWN FOR INFORMATION PURPOSES ONLY. CONTACT UTILITY NOTIFICATION CENTER OF COLORADO AT 534-6700 FOR UP-TO-DATE LOCATION INFORMATION.
6. TYPICAL SECTIONS AND DETAILS ARE SHOWN ON SHEETS 4 AND 5.

N

0 200 400
SCALE IN FEET

MATCH LINE SHEET 7

EXISTING WETLANDS

EXISTING WETLANDS BOTTOM CHANNEL
Q_{100} = 260 CFS

EXISTING 60" RCP AT 1.0%
Q_{100} = 260 CFS

CONNECT DETENTION OUTLET PIPE TO EXISTING 60" RCP STA. 23+00

EXISTING CHANNEL AND STORM SEWER SYSTEM (SEE FEDERAL AID PROJECT NO. M1030 (3), CONSTRUCTION PLANS, 1982) STA. 0+50 TO STA. 23+00

33" SAN

UPPER RAILROAD POND (SEE DETAIL E)
R.O.W. REQUIRED = 0
STORAGE VOLUME = 17.6 AC.-FT.
MAXIMUM STAGE = 10 FT.
Q_{IN} = 433 CFS
Q_{OUT} = 270 CFS
TOP OF EMB. = 5418
100-YR. W.S. = 5415
OUTLET VELOCITY = 28 FPS

EXISTING WETLAND CHANNEL

WETLANDS

150' ROW

EXISTING TWO 48" CMP CULVERTS INSTALL INLETS

18" SAN

EXISTING 48" CMP (PLUG & ABANDON)

LOWER RAILROAD POND
R.O.W. REQUIRED = 0
STORAGE VOLUME = 7.2 AC.-FT.
MAXIMUM STAGE = 10 FT.
Q_{IN} = 270 CFS
Q_{OUT} = 240 CFS
TOP OF EMB. = 5404
100-YR. W.S. = 5401
OUTLET VELOCITY = N/A
(SEE DETAIL E)

JACKASS GULCH
(SEE SHEET 12 FOR PROFILE)

EXISTING JACKASS HILL ROAD DETENTION
R.O.W. REQUIRED = 0
STORAGE VOLUME = 4.4 AC.-FT.
MAXIMUM STAGE = 13 FT.
Q_{IN} = 515 CFS
Q_{OUT} = 400 CFS
TOP OF ROAD = 5334.8
100-YR. W.S. = 5432.0

EXISTING WETLANDS
PROPOSED GRASS-LINED CHANNEL
B = 5 FT.
S = 0.9%
Q_{100} = 400 CFS
STA. 35+00 TO STA. 37+00
(SEE DETAIL A)

APPROX. 100-YR. FLOOD PLAIN LIMITS

**NOTE: TEMPORARY SEDEMENTATION TRAP FOR THE LOWER RAILROAD POND MUST BE INSTALLED AND MAINTAINED DURING UPSTREAM CONSTRUCTION UNTIL DISTURBED AREAS ARE STABILIZED.

LOWER DAD CLARK GULCH
(SEE SHEET 13 FOR PROFILE)

MATCH LINE SHEET 9

89,000 N

**NOTE: THE LAND ADJACENT TO LOWER DAD CLARK GULCH MUST BE FILLED PRIOR TO DEVELOPMENT. STA. 12+00 TO STA. 24+50, MINIMUM FILL ELEVATIONS ARE SHOWN.

FLUME STRUCTURE LEAVE IN PLACE PROTECT W/RIPRAP

GRADE CHANNEL TO MATCH EXISTING AT UPSTREAM SIDE OF FLUME. (MINIMIZE DISTURBANCE TO WETLANDS)

EXISTING WETLANDS

NO CHANNEL IMPROVEMENTS STA. 33+00 TO STA. 56+50 NO R.O.W. ACQUISITION REQUIRED.

88,000 N

SOUTH PLATTE PARK BOUNDARY
NO R.O.W. ACQUISITION NECESSARY FOR DRAINAGE FACILITIES IN THE PUBLIC PARK AREA.

PROPOSED WETLANDS BOTTOM CHANNEL
B = 30 FT.
S = 0.2%
Q = 870 CFS
STA. 12+10 TO STA. 33+00
(SEE DETAIL B)

PROTECT SAN.

EXISTING 30" PIPE (FOR McCLELLAN)

REGRADE EXISTING DITCH. EXACT ALIGNMENT OF EXISTING DITCH WILL BE DETERMINED DURING FINAL DESIGN.
S = 0.2%
Q = 154 CFS
(SEE DETAIL C)

OUTLET 30" PIPE INTO PROPOSED CHANNEL W/ENERGY DISSIPATOR. REMOVE 30" AS NEEDED D/S.

PUMP STATION

EXISTING WETLANDS

FUTURE IMPROVEMENTS TO SANTA FE DRIVE AND D. & R.G.W. BRIDGES. (PRELIMINARY PLANNING DONE BY C.D.O.H.)

McLELLAN RESERVOIR
(OWNED BY ENGLEWOOD)

TOP OF DAM

GRADE CHANNEL TO MATCH EXISTING AT THE SOUTH PLATTE PARK BOUNDARY

EXISTING WETLANDS

EXISTING 30" PIPE (FOR McCLELLAN)

EXISTING 24" PIPE

EXISTING OUTFALL STRUCTURE

ABANDONED PUMP STATION

87,000 N

FLOOD STORAGE ASSUMED IN McLELLAN RESERVOIR (ADEQUATE ASSURANCES AGREEMENT NECESSARY)

ALL ELEVATIONS ARE MEAN SEA LEVEL DATUM

SEE SHEETS 12 & 13 FOR PROFILES

GROUND CONTROL SURVEY BY LANDMARK, LTD.
AERIAL PHOTOGRAPHY BY SCHARF & ASSOC.
TOPOGRAPHIC MAPPING BY LANDMARK, LTD.
CONTOUR INTERVAL 2 FT DATE FLOWN 4-13-89

CENTENNIAL ENGINEERING INC
ARVADA CO. 80001 420-0221
CEI JN. 906.00

DESIGNED DJN DATE 8/90
DRAWN CJH DATE 11/90
CHECKED DLM DATE 7/91
REVISED ____ DATE ____

URBAN DRAINAGE AND FLOOD CONTROL DISTRICT
CITY OF LITTLETON

OUTFALL SYSTEMS PLANNING
LOWER DAD CLARK GULCH AND DFA 0068

PLAN
JACKASS GULCH AND LOWER DAD CLARK GULCH

SHEET 8 OF 13

MATCH LINE SHEET 6

EXISTING 24" RCP STORM SEWER OUTFALL W/EXIST. ENERGY DISSIPATOR

COTTONWOOD TREES TO BE PROTECTED

JACKASS CHANNEL POND
R.O.W. REQUIRED = 1.7 AC.
STORAGE VOLUME = 7.0 AC.-FT.
MAXIMUM STAGE = 10.0 FT.
Q IN = 225 CFS
Q OUT = 200 CFS
TOP OF EMB. = 5467
100 YEAR W.S. = 5464
OUTLET VELOCITY = 13 FPS
(SEE DETAIL E)

DROP STRUCTURES

70' R.O.W.

18" SAN

PROPOSED GRASS-LINED CHANNEL
B = 5'
S = 0.9%
Q_{100} = 400 CFS
STA. 40+30 TO STA. 45+00
(SEE DETAIL 'A')

PROPOSED GRASS-LINED CHANNEL
B = 3'
S = 0.9%
Q_{100} = 200 CFS
STA. 47+65 TO STA. 48+65
(SEE DETAIL A)

PROPOSED GRASS-LINED CHANNEL
B = 5'
S = 0.9%
Q_{100} = 225 CFS
STA. 52+10 TO STA. 52+80

LIMITS OF CITY'S OPEN SPACE AREA (NO R.O.W. ACQUISITION NECESSARY FOR DRAINAGE FACILITIES IN THE PARK) (FUTURE EQUESTRIAN PARK)

EXISTING WETLANDS

LOWER OPEN SPACE POND
R.O.W. REQUIRED = 0
STORAGE VOLUME = 11.2 AC.-FT.
MAXIMUM STAGE = 10 FT.
Q IN = 275 CFS
Q OUT = 225 CFS
TOP OF EMB. = 5492
100 YEAR W.S. = 5489
OUTLET VELOCITY = 15 FPS
(SEE DETAIL E)

EXISTING 27" RCP DETENTION OUTFALL
Q_{100} = 78 CFS, REQ'D. ENERGY DISSIPATOR

EXISTING 42" RCP STORM SEWER OUTFALL
Q_{100} = 162 CFS, REQ'D. ENERGY DISSIPATOR

UPPER OPEN SPACE POND
R.O.W. REQUIRED = 0
STORAGE VOLUME = 11.1 AC.-FT.
MAXIMUM STAGE = 10 FT.
Q IN = 406 CFS
Q OUT = 275 CFS
TOP OF EMB. = 5505
100 YEAR W.S. = 5502
OUTLET VELOCITY = 15 FPS
(SEE DETAIL E)

JACKASS GULCH
(SEE SHEET 12 FOR PROFILE)

EXISTING 54" RCP STORM SEWER OUTFALL
Q_{100} = 146 CFS
CONSTRUCT NEW OUTFALL WITH ENERGY DISSIPATION

NO IMPROVEMENTS STA. 69+00 TO STA. 85+00

APPROX. 100-YR. FLOOD PLAIN LIMIT

ON-SITE DETENTION

NOTE: UPPER BASIN PRIVATE DETENTION FACILITIES RECOGNIZED THROUGH CITY OF LITTLETON'S MAINTENANCE PROGRAM. (NO R.O.W. ACQUISITION NECESSARY)

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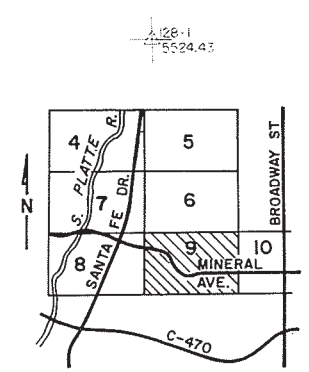


0 200 400
SCALE IN FEET

MATCH LINE SHEET 8

MATCH LINE SHEET 10

SEE SHEET 12 FOR PROFILE

ALL ELEVATIONS ARE MEAN SEA LEVEL DATUM

GROUND CONTROL SURVEY BY LANDMARK, LTD.
AERIAL PHOTOGRAPHY BY SCHARF & ASSOC.
TOPOGRAPHIC MAPPING BY LANDMARK, LTD.
CONTOUR INTERVAL 2 FT DATE FLOWN 4-13-89

CENTENNIAL ENGINEERING INC
ARVADA CO. 80001 420 0221
CEI JN. 905 00

DESIGNED DJN DATE 8/90
DRAWN CJH DATE 11/90
CHECKED DLM DATE 2/91
REVISED ____ DATE ____

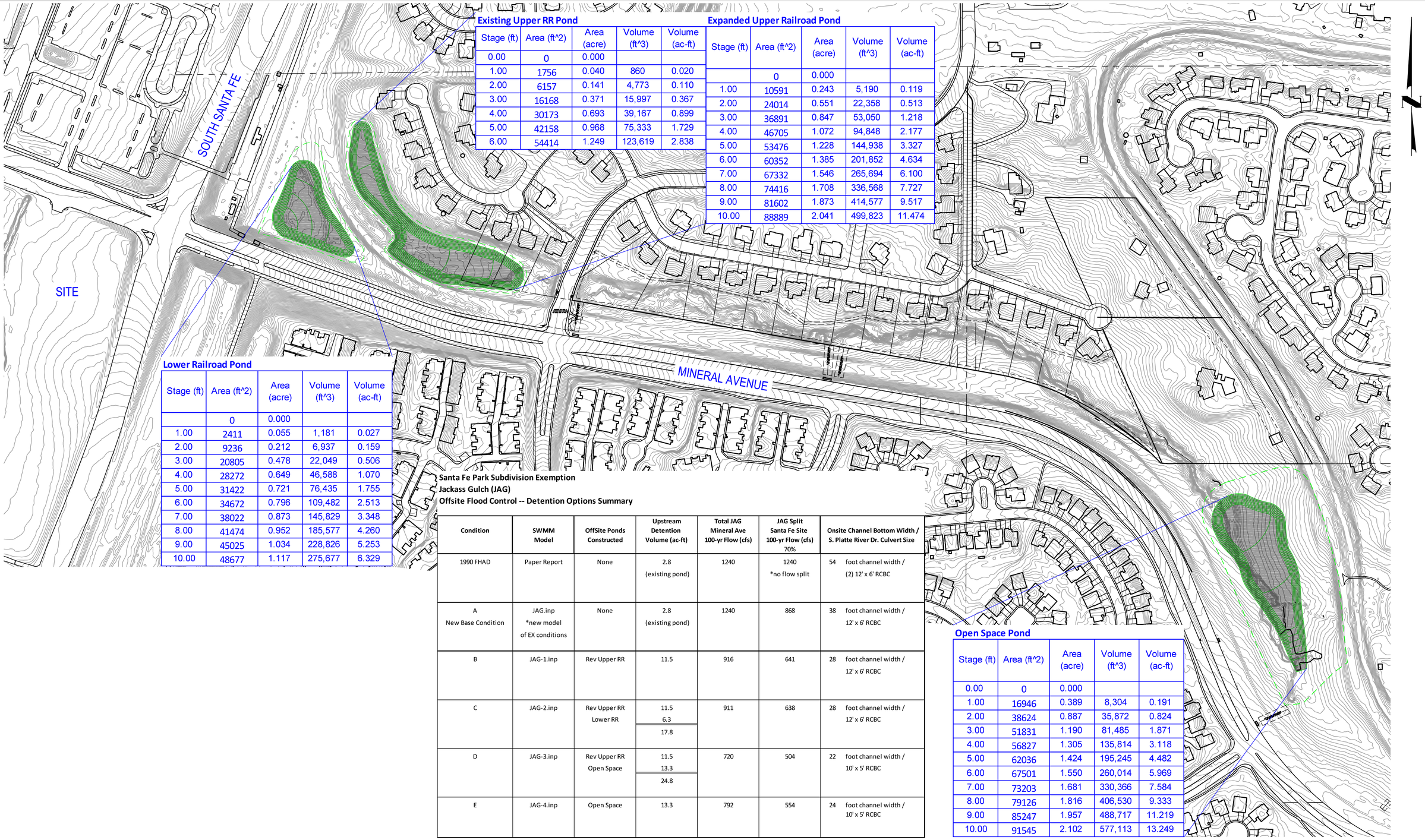
URBAN DRAINAGE AND FLOOD CONTROL DISTRICT
CITY OF LITTLETON

OUTFALL SYSTEMS PLANNING
LOWER DAD CLARK GULCH AND DFA 0068

PLAN
JACKASS GULCH

SHEET 9 OF 13

NO CHANGES ARE TO BE MADE TO THIS DRAWING WITHOUT WRITTEN PERMISSION OF HARRIS KOCHER SMITH



Existing Upper RR Pond

Stage (ft)	Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
0.00	0	0.000		
1.00	1756	0.040	860	0.020
2.00	6157	0.141	4,773	0.110
3.00	16168	0.371	15,997	0.367
4.00	30173	0.693	39,167	0.899
5.00	42158	0.968	75,333	1.729
6.00	54414	1.249	123,619	2.838

Expanded Upper Railroad Pond

Stage (ft)	Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
	0	0.000		
1.00	10591	0.243	5,190	0.119
2.00	24014	0.551	22,358	0.513
3.00	36891	0.847	53,050	1.218
4.00	46705	1.072	94,848	2.177
5.00	53476	1.228	144,938	3.327
6.00	60352	1.385	201,852	4.634
7.00	67332	1.546	265,694	6.100
8.00	74416	1.708	336,568	7.727
9.00	81602	1.873	414,577	9.517
10.00	88889	2.041	499,823	11.474

Lower Railroad Pond

Stage (ft)	Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
	0	0.000		
1.00	2411	0.055	1,181	0.027
2.00	9236	0.212	6,937	0.159
3.00	20805	0.478	22,049	0.506
4.00	28272	0.649	46,588	1.070
5.00	31422	0.721	76,435	1.755
6.00	34672	0.796	109,482	2.513
7.00	38022	0.873	145,829	3.348
8.00	41474	0.952	185,577	4.260
9.00	45025	1.034	228,826	5.253
10.00	48677	1.117	275,677	6.329

Santa Fe Park Subdivision Exemption
Jackass Gulch (JAG)
Offsite Flood Control -- Detention Options Summary

Condition	SWMM Model	OffSite Ponds Constructed	Upstream Detention Volume (ac-ft)	Total JAG Mineral Ave 100-yr Flow (cfs)	JAG Split Santa Fe Site 100-yr Flow (cfs) 70%	Onsite Channel Bottom Width / S. Platte River Dr. Culvert Size
1990 FHAD	Paper Report	None	2.8 (existing pond)	1240	1240 *no flow split	54 foot channel width / (2) 12' x 6' RCBC
A New Base Condition	JAG.inp *new model of EX conditions	None	2.8 (existing pond)	1240	868	38 foot channel width / 12' x 6' RCBC
B	JAG-1.inp	Rev Upper RR	11.5	916	641	28 foot channel width / 12' x 6' RCBC
C	JAG-2.inp	Rev Upper RR Lower RR	11.5 6.3 17.8	911	638	28 foot channel width / 12' x 6' RCBC
D	JAG-3.inp	Rev Upper RR Open Space	11.5 13.3 24.8	720	504	22 foot channel width / 10' x 5' RCBC
E	JAG-4.inp	Open Space	13.3	792	554	24 foot channel width / 10' x 5' RCBC

Open Space Pond

Stage (ft)	Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
0.00	0	0.000		
1.00	16946	0.389	8,304	0.191
2.00	38624	0.887	35,872	0.824
3.00	51831	1.190	81,485	1.871
4.00	56827	1.305	135,814	3.118
5.00	62036	1.424	195,245	4.482
6.00	67501	1.550	260,014	5.969
7.00	73203	1.681	330,366	7.584
8.00	79126	1.816	406,530	9.333
9.00	85247	1.957	488,717	11.219
10.00	91545	2.102	577,113	13.249

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

CALL 3 BUSINESS DAYS IN ADVANCE BEFORE YOU DIG, GRADE, OR EXCAVATE FOR THE MARKING OF UNDERGROUND MEMBER UTILITIES.

DESIGNED BY: MAW
CHECKED BY: MM
DRAWN BY: MAW

HKS HARRIS KOCHER SMITH
1120 Lincoln Street, Suite 1000
Denver, Colorado 80203
P: 303.623.6300 F: 303.623.6311
HarrisKocherSmith.com

EXHIBIT 1
JAG OFFSITE - UPPER BASIN

SANTA FE PARK SUBDIVISION
ARAPAHOE COUNTY, CO
SOUTH SANTA FE DRIVE AT MINERAL AVENUE

ISSUE DATE: May 2017 | PROJECT #: 160308

DATE	REVISION COMMENTS

PRELIMINARY NOT FOR CONSTRUCTION

SHEET NO. 1

1 OF 1

FILEPATH: P:\160605\ENGINEERING\DRAINAGE\JACKASS GULCH GIS.DWG LAYOUT: LAYOUT1
? XREFs: e-ent, s-utl-byot, p-base-byot, p-legal, p-legal-byot, p-util, p-util-byot
PLOTTED: TUE 6/27/17 7:50:14A BY: MARK WEST

HEC-RAS Plan: CorrEff River: Jackass Gulch Reach: Jackass Gulch Ch Profile: Q100

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)	
Jackass Gulch Ch	1700.25	Q100	1240.00	5380.27	5382.09	5382.09	5382.69	0.012461	6.22	200.39	176.62	1.00
Jackass Gulch Ch	1254.1	Q100	1240.00	5373.68	5374.33	5374.33	5374.61	0.022360	5.02	302.91	568.34	1.18
Jackass Gulch Ch	907.92	Q100	1240.00	5361.71	5364.99	5364.99	5365.95	0.007865	8.56	186.78	109.78	0.91
Jackass Gulch Ch	703.45	Q100	1500.00	5350.90	5355.98	5355.98	5356.69	0.006020	8.94	303.58	191.77	0.82
Jackass Gulch Ch	49.75	Q100	1500.00	5344.90	5350.46	5350.46	5351.41	0.004651	9.03	263.12	152.77	0.75

HEC-RAS Plan: CorrEff River: Jackass Gulch Reach: Jackass Gulch Ch Profile: Q50

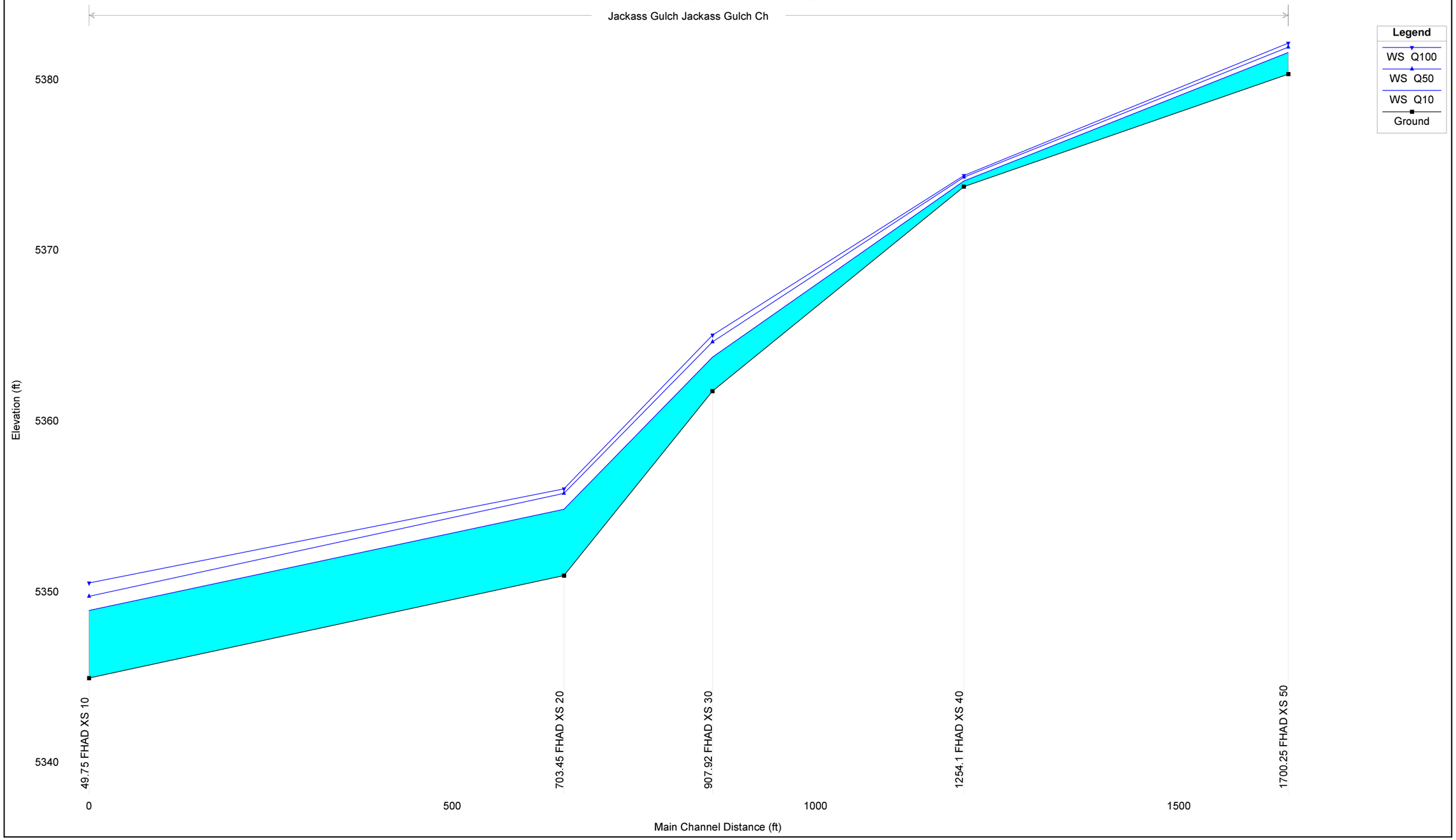
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Jackass Gulch Ch	1700.25	Q50	910.00	5380.27	5381.85	5381.85	5382.35	0.013486	5.67	160.75	166.20	1.01
Jackass Gulch Ch	1254.1	Q50	910.00	5373.68	5374.23	5374.23	5374.46	0.022552	4.46	249.48	559.87	1.15
Jackass Gulch Ch	907.92	Q50	910.00	5361.71	5364.59	5364.59	5365.39	0.007860	7.71	145.80	95.56	0.88
Jackass Gulch Ch	703.45	Q50	1170.00	5350.90	5355.71	5355.71	5356.36	0.005728	8.29	253.37	181.21	0.79
Jackass Gulch Ch	49.75	Q50	1170.00	5344.90	5349.69	5349.69	5350.87	0.006748	9.59	162.69	83.98	0.88

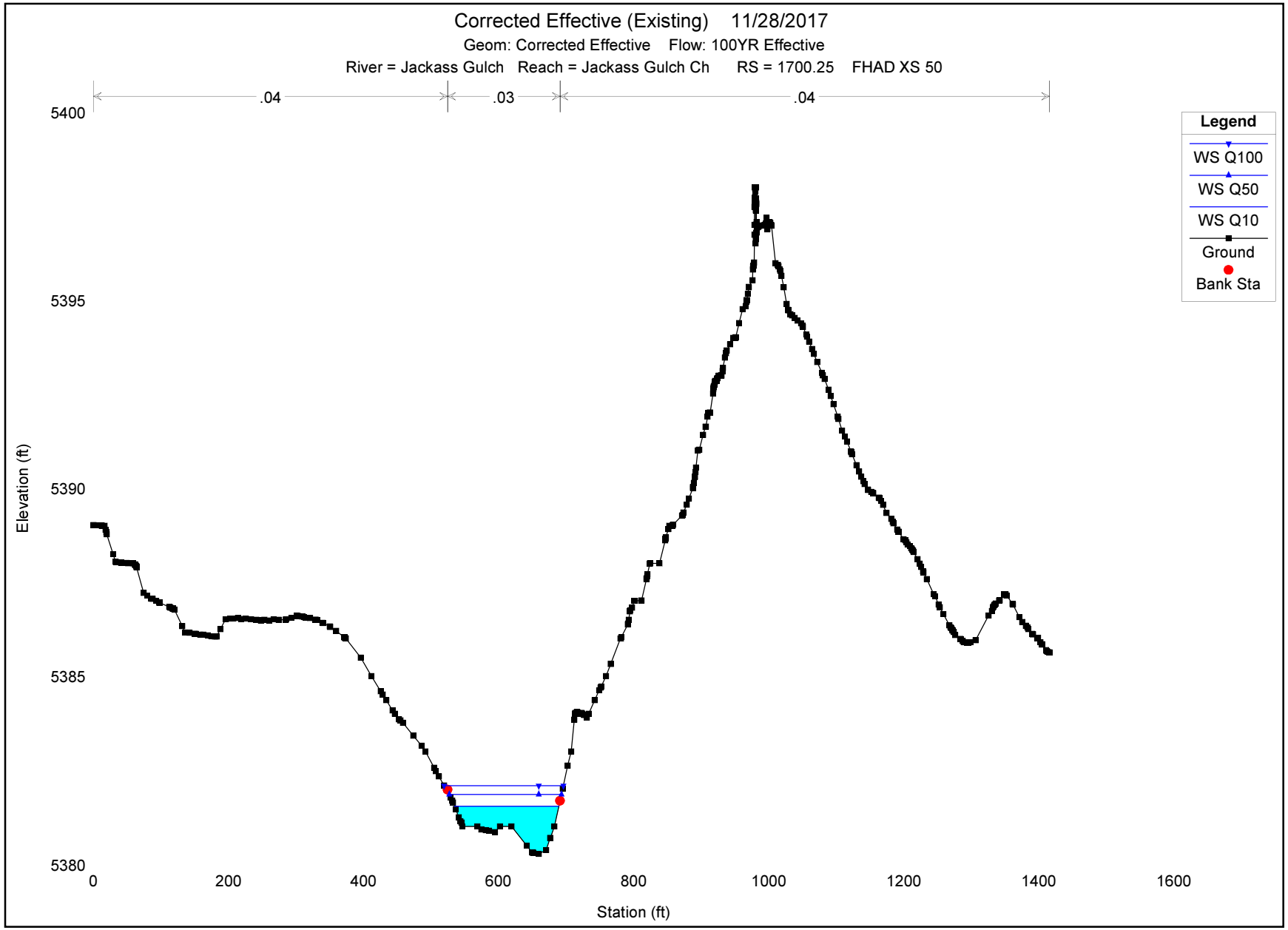
HEC-RAS Plan: CorrEff River: Jackass Gulch Reach: Jackass Gulch Ch Profile: Q10

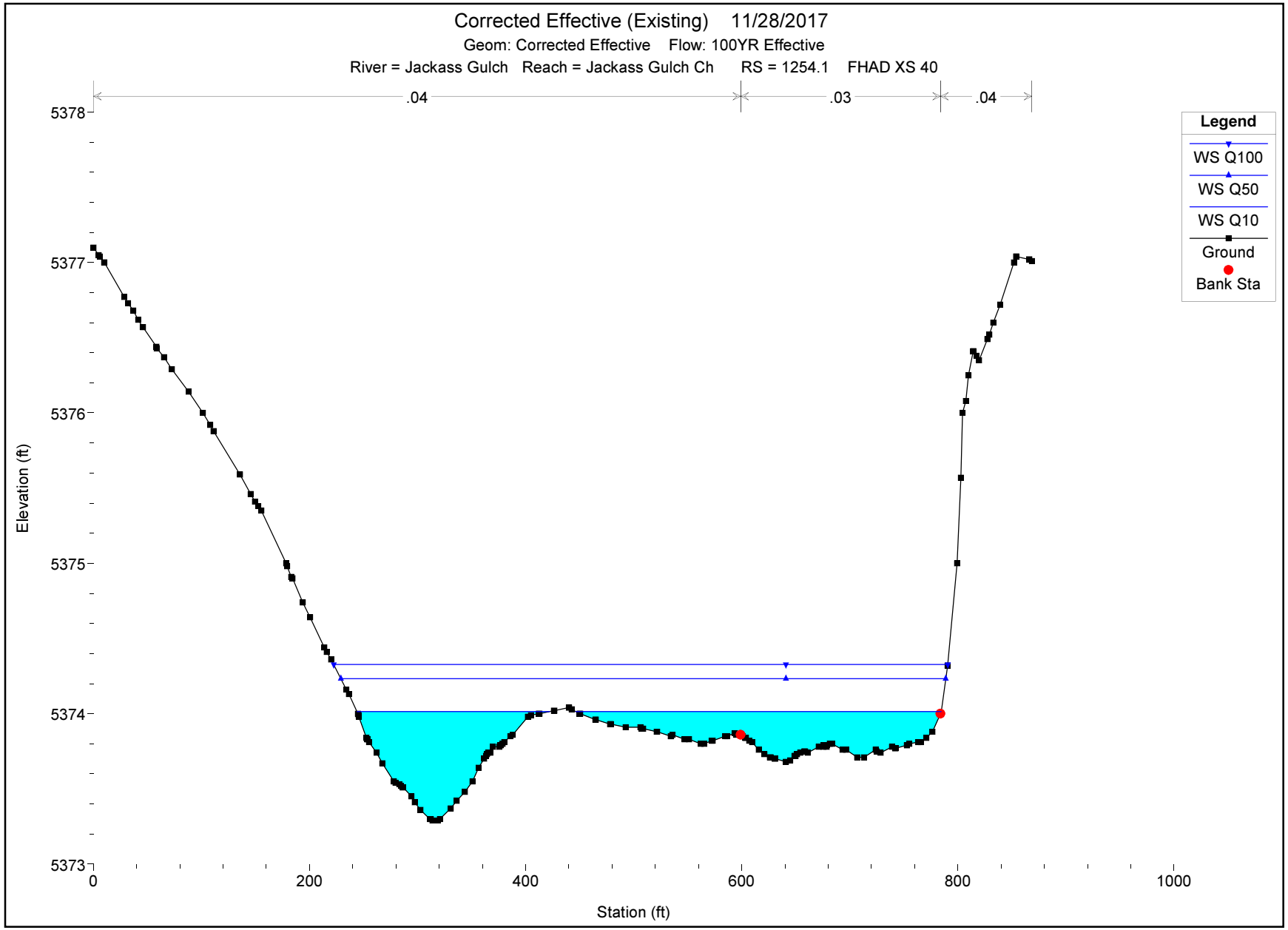
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Jackass Gulch Ch	1700.25	Q10	430.00	5380.27	5381.54		5381.77	0.009945	3.93	109.54	154.53	0.82
Jackass Gulch Ch	1254.1	Q10	430.00	5373.68	5374.01	5374.01	5374.19	0.035312	3.65	129.72	516.69	1.30
Jackass Gulch Ch	907.92	Q10	430.00	5361.71	5363.70	5363.70	5364.31	0.010306	6.44	73.28	63.06	0.94
Jackass Gulch Ch	703.45	Q10	690.00	5350.90	5354.78	5354.78	5355.80	0.010717	9.18	108.63	88.10	1.02
Jackass Gulch Ch	49.75	Q10	690.00	5344.90	5348.86	5348.86	5349.79	0.006835	8.15	103.92	62.91	0.85

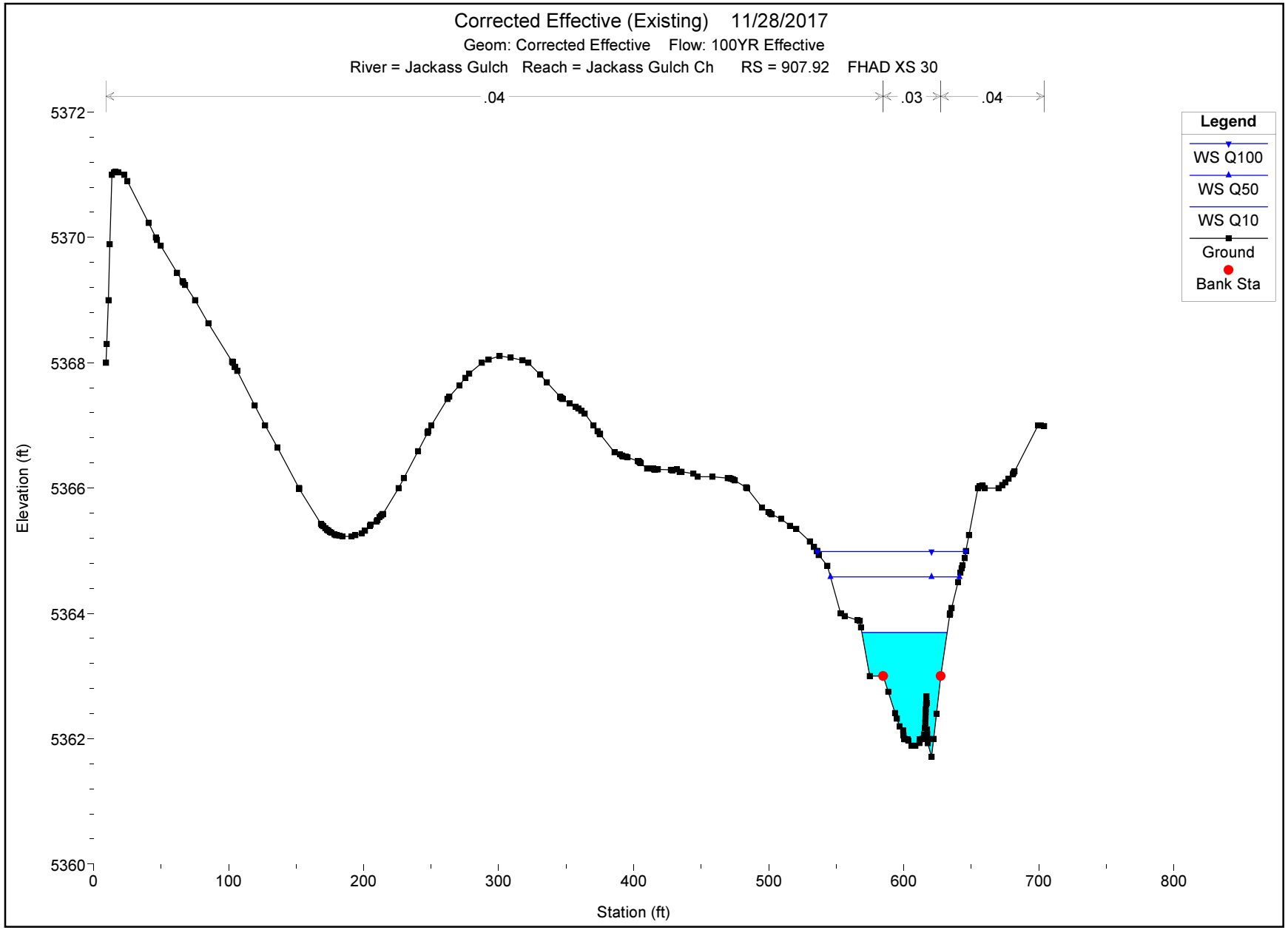
Corrected Effective (Existing) 11/28/2017

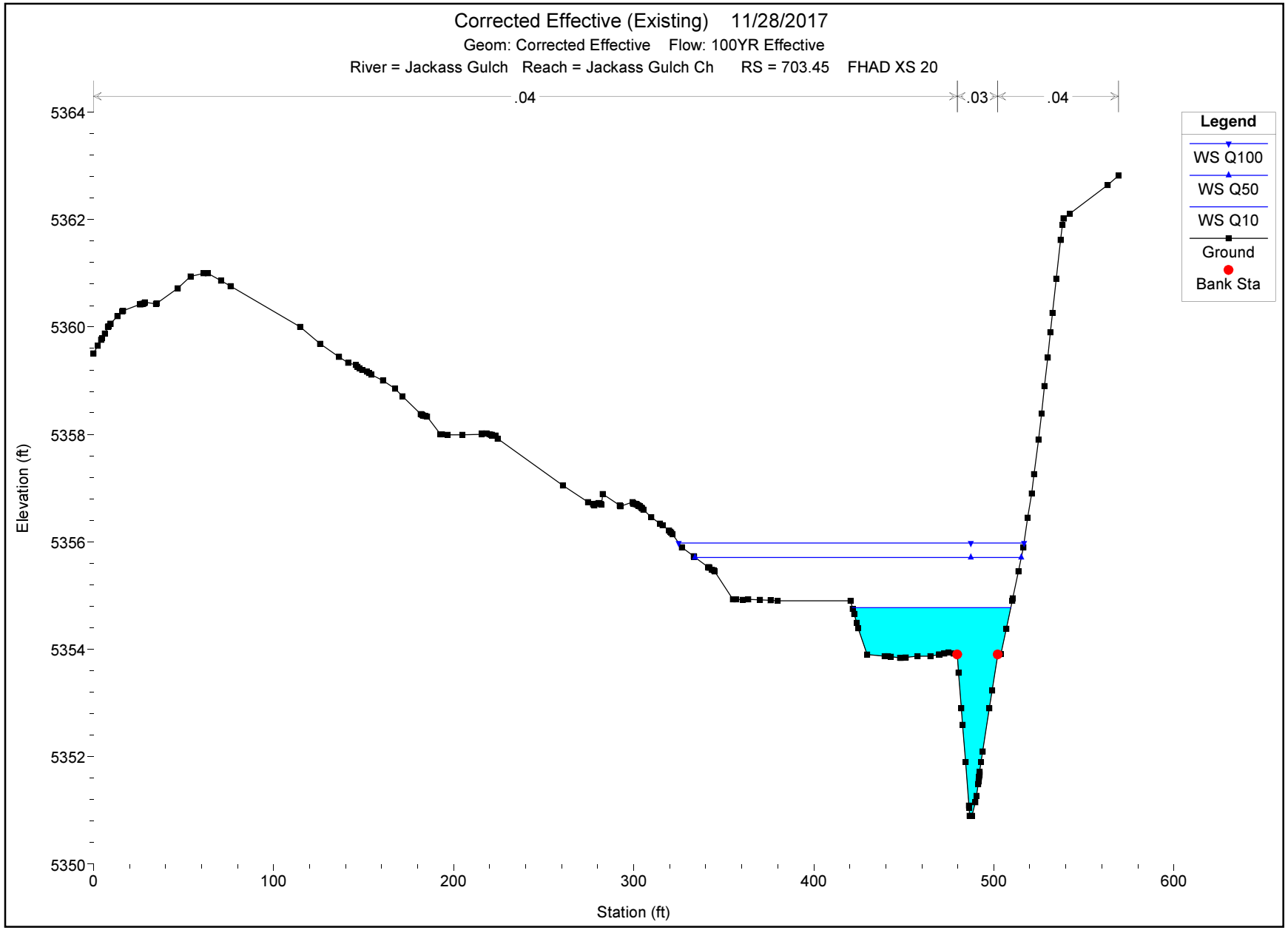
Geom: Corrected Effective Flow: 100YR Effective

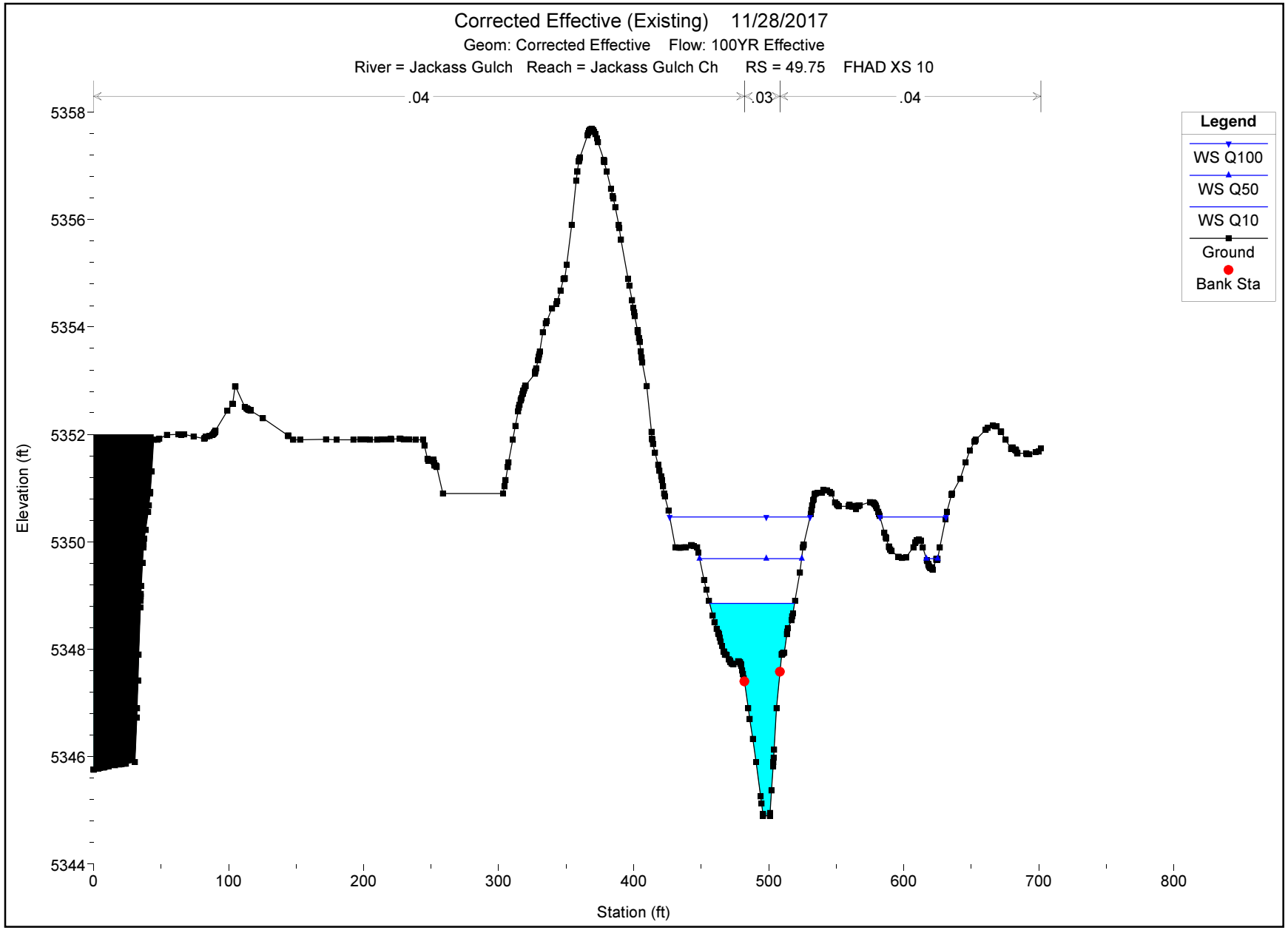



Corrected Effective (Existing) 11/28/2017
Geom: Corrected Effective Flow: 100YR Effective
River = Jackass Gulch Reach = Jackass Gulch Ch RS = 1700.25 FHAD XS 50
.04
.03
.04
Legend
WS Q100
WS Q50
WS Q10
Ground
Bank Sta
Elevation (ft)
5400
5395
5390
5385
5380
0
200
400
600
800
1000
1200
1400
1600
Station (ft)


Corrected Effective (Existing) 11/28/2017
Geom: Corrected Effective Flow: 100YR Effective
River = Jackass Gulch Reach = Jackass Gulch Ch RS = 1254.1 FHAD XS 40
.04
.03
.04
Legend
WS Q100
WS Q50
WS Q10
Ground
Bank Sta
Elevation (ft)
5378
5377
5376
5375
5374
5373
0
200
400
600
800
1000
Station (ft)


Corrected Effective (Existing) 11/28/2017
Geom: Corrected Effective Flow: 100YR Effective
River = Jackass Gulch Reach = Jackass Gulch Ch RS = 907.92 FHAD XS 30
.04
.03
.04
Legend
WS Q100
WS Q50
WS Q10
Ground
Bank Sta
Elevation (ft)
5372
5370
5368
5366
5364
5362
5360
0
100
200
300
400
500
600
700
800
Station (ft)


Corrected Effective (Existing) 11/28/2017
Geom: Corrected Effective Flow: 100YR Effective
River = Jackass Gulch Reach = Jackass Gulch Ch RS = 703.45 FHAD XS 20
.04
.03
.04
Legend
WS Q100
WS Q50
WS Q10
Ground
Bank Sta
Elevation (ft)
5364
5362
5360
5358
5356
5354
5352
5350
0
100
200
300
400
500
600
Station (ft)


Corrected Effective (Existing) 11/28/2017
Geom: Corrected Effective Flow: 100YR Effective
River = Jackass Gulch Reach = Jackass Gulch Ch RS = 49.75 FHAD XS 10
.04
.03
.04
Legend
WS Q100
WS Q50
WS Q10
Ground
Bank Sta
Elevation (ft)
5358
5356
5354
5352
5350
5348
5346
5344
0
100
200
300
400
500
600
700
800
Station (ft)

HEC-RAS Plan: Proposed River: Jackass Gulch Reach: New Jackass Gulc Profile: Q100

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)	
New Jackass Gulc	1862.83	Q100	1240.00	5378.20	5382.55		5382.59	0.000188	1.55	808.87	351.20	0.15
New Jackass Gulc	1697.64	Q100	1240.00	5377.60	5382.20		5382.50	0.001937	4.66	291.15	155.69	0.46
New Jackass Gulc	1584.87	Q100	1240.00	5377.38	5381.18	5380.85	5382.07	0.006979	7.55	164.16	65.93	0.84
New Jackass Gulc	1489.47	Q100	1240.00	5377.20	5380.13	5380.13	5381.24	0.010310	8.46	146.59	66.70	1.01
New Jackass Gulc	1470.56	Q100	1240.00	5372.62	5376.85		5377.73	0.005576	7.53	164.63	55.57	0.77
New Jackass Gulc	1433.68	Q100	1240.00	5371.99	5376.93		5377.49	0.003016	6.02	206.14	61.35	0.58
New Jackass Gulc	1405.54	Q100	1240.00	5371.57	5376.78	5374.83	5377.40	0.002491	6.35	195.32	38.19	0.49
New Jackass Gulc	1345		Culvert									
New Jackass Gulc	1278.14	Q100	1240.00	5369.36	5372.68	5372.68	5374.25	0.010258	10.06	123.23	39.55	1.01
New Jackass Gulc	1263.8	Q100	1240.00	5365.78	5370.81		5371.55	0.004131	6.93	178.94	54.39	0.67
New Jackass Gulc	1237.26	Q100	1240.00	5365.33	5370.78		5371.42	0.003823	6.37	194.68	62.17	0.63
New Jackass Gulc	1236.26	Q100	1240.00	5366.29	5370.35	5370.08	5371.37	0.007456	8.11	152.94	57.76	0.88
New Jackass Gulc	1215.88	Q100	1240.00	5366.00	5369.91	5369.91	5371.18	0.009929	9.03	137.37	54.75	1.00
New Jackass Gulc	1075.48	Q100	1240.00	5363.98	5367.88	5367.88	5369.19	0.009957	9.16	135.30	52.71	1.01
New Jackass Gulc	983.76	Q100	1240.00	5362.78	5366.36	5366.36	5367.52	0.010280	8.63	143.74	63.29	1.01
New Jackass Gulc	948.22	Q100	1240.00	5362.22	5365.87	5365.87	5366.97	0.010177	8.41	147.41	66.98	1.00
New Jackass Gulc	907.92	Q100	1240.00	5359.78	5363.24	5363.24	5364.32	0.010244	8.34	148.63	68.78	1.00
New Jackass Gulc	703.45	Q100	1500.00	5350.90	5356.08		5356.59	0.004309	6.14	324.23	194.49	0.67
New Jackass Gulc	550.88	Q100	1500.00	5349.90	5355.64		5356.08	0.002567	5.97	389.85	236.46	0.54
New Jackass Gulc	368.16	Q100	1500.00	5347.73	5354.28	5354.28	5355.35	0.005902	8.52	217.49	346.84	0.81
New Jackass Gulc	216.6	Q100	1500.00	5345.87	5352.64	5352.64	5353.68	0.006164	8.38	219.51	439.33	0.81
New Jackass Gulc	49.75	Q100	1500.00	5344.90	5350.23	5349.90	5351.05	0.006004	7.36	228.50	183.06	0.79

HEC-RAS Plan: Proposed River: Jackass Gulch Reach: New Jackass Gulc Profile: Q50

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)	
New Jackass Gulc	1862.83	Q50	910.00	5378.20	5382.01		5382.05	0.000237	1.55	621.24	343.05	0.16
New Jackass Gulc	1697.64	Q50	910.00	5377.60	5381.54		5381.93	0.002914	5.06	195.37	143.56	0.55
New Jackass Gulc	1584.87	Q50	910.00	5377.38	5380.71		5381.42	0.006482	6.76	134.55	60.37	0.80
New Jackass Gulc	1489.47	Q50	910.00	5377.20	5379.66	5379.66	5380.61	0.010800	7.83	116.27	61.60	1.00
New Jackass Gulc	1470.56	Q50	910.00	5372.62	5375.70	5375.70	5376.85	0.010402	8.60	105.83	46.88	1.01
New Jackass Gulc	1433.68	Q50	910.00	5371.99	5375.82		5376.44	0.004380	6.36	143.16	51.94	0.68
New Jackass Gulc	1405.54	Q50	910.00	5371.57	5375.81	5374.23	5376.32	0.002555	5.75	158.28	37.95	0.50
New Jackass Gulc	1345		Culvert									
New Jackass Gulc	1278.14	Q50	910.00	5369.36	5372.09	5372.09	5373.37	0.010636	9.09	100.12	39.33	1.00
New Jackass Gulc	1263.8	Q50	910.00	5365.78	5370.22		5370.81	0.003711	6.13	148.41	50.06	0.63
New Jackass Gulc	1237.26	Q50	910.00	5365.33	5370.18		5370.69	0.003555	5.73	158.90	56.24	0.60
New Jackass Gulc	1236.26	Q50	910.00	5366.29	5369.77	5369.51	5370.65	0.007582	7.51	121.22	52.07	0.87
New Jackass Gulc	1215.88	Q50	910.00	5366.00	5369.35	5369.35	5370.45	0.010354	8.43	107.96	49.25	1.00
New Jackass Gulc	1075.48	Q50	910.00	5363.98	5367.30	5367.30	5368.44	0.010418	8.57	106.23	47.42	1.01
New Jackass Gulc	983.76	Q50	910.00	5362.78	5365.85	5365.85	5366.86	0.010744	8.06	112.92	56.95	1.01
New Jackass Gulc	948.22	Q50	910.00	5362.22	5365.36	5365.36	5366.33	0.010762	7.93	114.80	59.49	1.01
New Jackass Gulc	907.92	Q50	910.00	5359.78	5362.74	5362.74	5363.70	0.010810	7.83	116.15	61.51	1.01
New Jackass Gulc	703.45	Q50	1170.00	5350.90	5355.71		5356.19	0.004805	5.85	254.16	181.42	0.69
New Jackass Gulc	550.88	Q50	1170.00	5349.90	5355.19		5355.64	0.002862	5.79	285.56	222.85	0.56
New Jackass Gulc	368.16	Q50	1170.00	5347.73	5353.46	5353.46	5354.71	0.008884	9.03	136.56	198.50	0.95
New Jackass Gulc	216.6	Q50	1170.00	5345.87	5351.52	5351.52	5353.00	0.009917	9.75	120.00	325.89	1.00
New Jackass Gulc	49.75	Q50	1170.00	5344.90	5349.84	5349.48	5350.56	0.006001	6.84	176.69	140.21	0.78

HEC-RAS Plan: Proposed River: Jackass Gulch Reach: New Jackass Gulc Profile: Q10

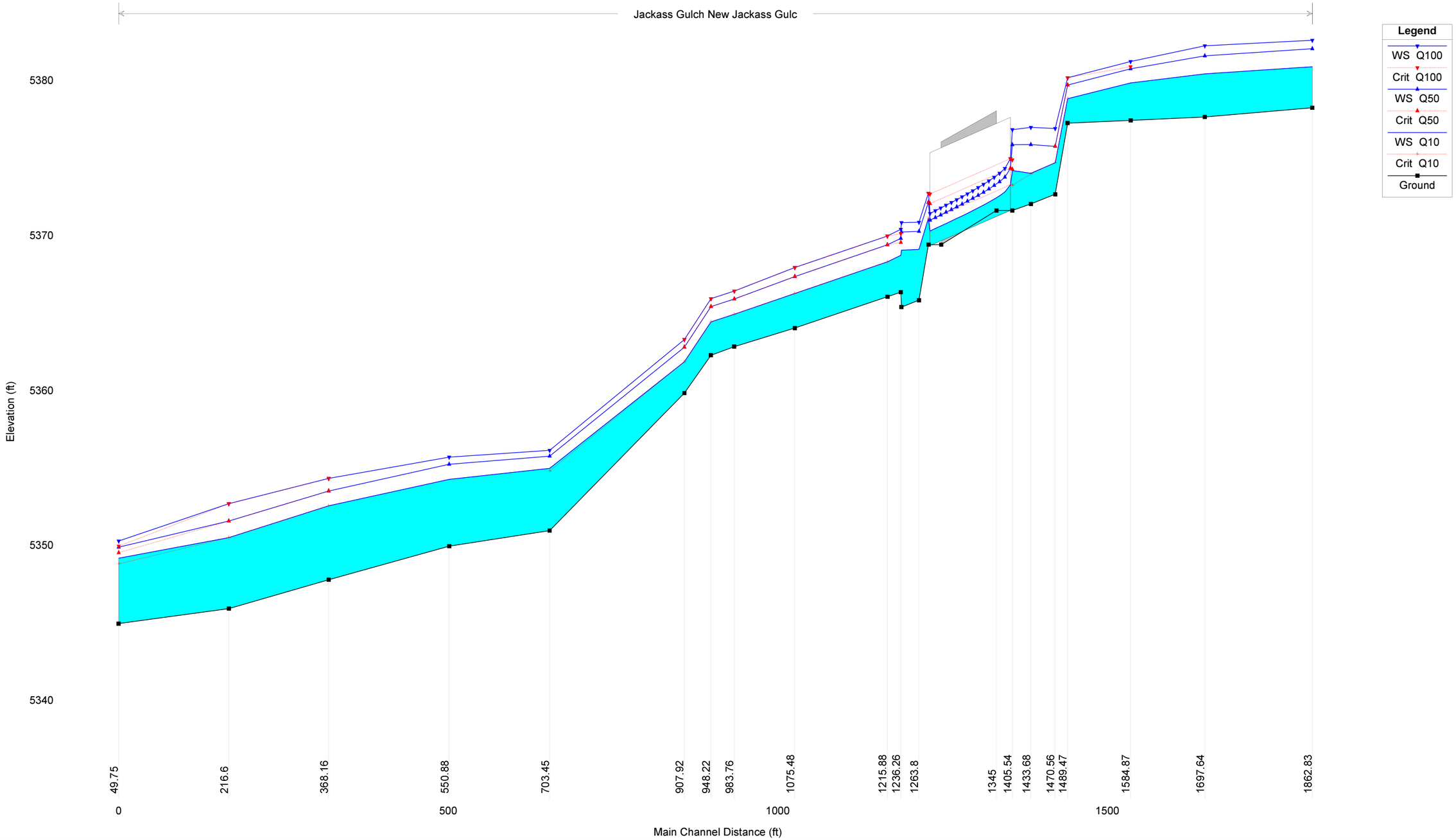
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
New Jackass Gulc	1862.83	Q10	430.00	5378.20	5380.84		5380.89	0.000737	1.97	241.02	231.66	0.26
New Jackass Gulc	1697.64	Q10	430.00	5377.60	5380.38		5380.66	0.003106	4.23	101.59	53.03	0.54
New Jackass Gulc	1584.87	Q10	430.00	5377.38	5379.79		5380.20	0.005271	5.11	84.21	49.37	0.69
New Jackass Gulc	1489.47	Q10	430.00	5377.20	5378.78	5378.78	5379.44	0.012476	6.48	66.37	52.13	1.01
New Jackass Gulc	1470.56	Q10	430.00	5372.62	5374.65	5374.65	5375.43	0.011621	7.11	60.48	38.87	1.00
New Jackass Gulc	1433.68	Q10	430.00	5371.99	5373.97	5373.92	5374.73	0.010546	7.01	61.38	37.37	0.96
New Jackass Gulc	1405.54	Q10	430.00	5371.57	5374.14	5373.19	5374.46	0.002783	4.51	95.40	37.54	0.50
New Jackass Gulc	1345		Culvert									
New Jackass Gulc	1278.14	Q10	430.00	5369.36	5371.07	5371.07	5371.86	0.012061	7.14	60.26	38.94	1.01
New Jackass Gulc	1263.8	Q10	430.00	5365.78	5369.06		5369.38	0.002816	4.52	95.15	41.35	0.53
New Jackass Gulc	1237.26	Q10	430.00	5365.33	5369.00		5369.29	0.002797	4.32	99.58	44.70	0.51
New Jackass Gulc	1236.26	Q10	430.00	5366.29	5368.67		5369.26	0.007811	6.17	69.72	41.20	0.84
New Jackass Gulc	1215.88	Q10	430.00	5366.00	5368.25	5368.25	5369.05	0.011645	7.16	60.02	38.23	1.01
New Jackass Gulc	1075.48	Q10	430.00	5363.98	5366.21	5366.21	5367.01	0.011553	7.20	59.70	37.44	1.01
New Jackass Gulc	983.76	Q10	430.00	5362.78	5364.87	5364.87	5365.59	0.012046	6.80	63.22	44.88	1.01
New Jackass Gulc	948.22	Q10	430.00	5362.22	5364.38	5364.38	5365.09	0.012016	6.78	63.46	45.23	1.01
New Jackass Gulc	907.92	Q10	430.00	5359.78	5361.81	5361.81	5362.49	0.012011	6.62	64.91	47.90	1.00
New Jackass Gulc	703.45	Q10	690.00	5350.90	5354.93	5354.75	5355.45	0.008539	5.86	123.34	149.06	0.85
New Jackass Gulc	550.88	Q10	690.00	5349.90	5354.22		5354.60	0.003661	5.18	157.60	97.99	0.60
New Jackass Gulc	368.16	Q10	690.00	5347.73	5352.50	5352.50	5353.50	0.010168	8.00	87.50	170.75	0.97
New Jackass Gulc	216.6	Q10	690.00	5345.87	5350.45	5350.45	5351.62	0.010610	8.66	79.63	156.17	1.00
New Jackass Gulc	49.75	Q10	690.00	5344.90	5349.12	5348.76	5349.63	0.006007	5.69	121.34	102.56	0.74

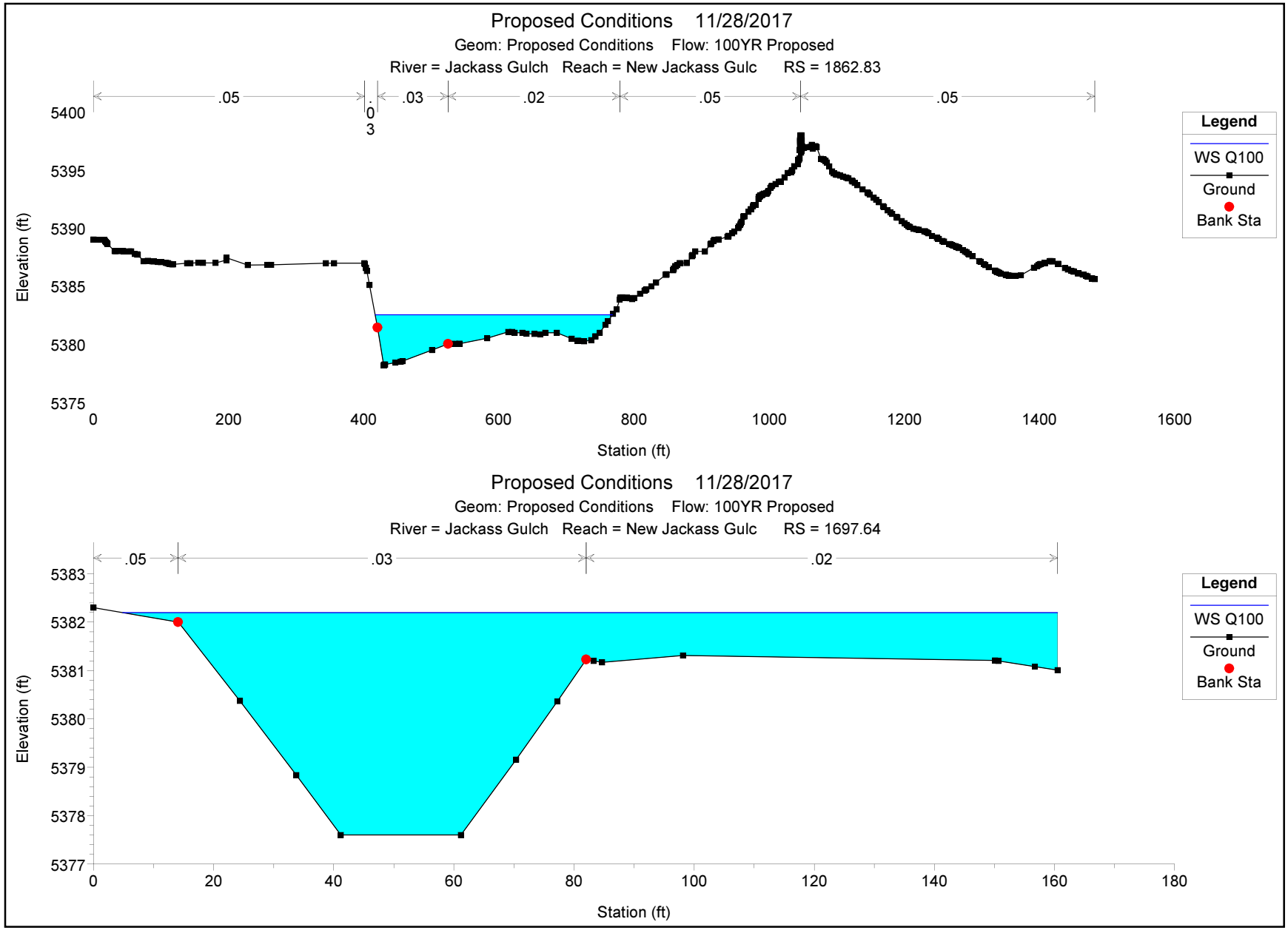
Plan: Proposed Jackass Gulch New Jackass Gulc RS: 1345 Culv Group: Culvert #1 Profile: Q100

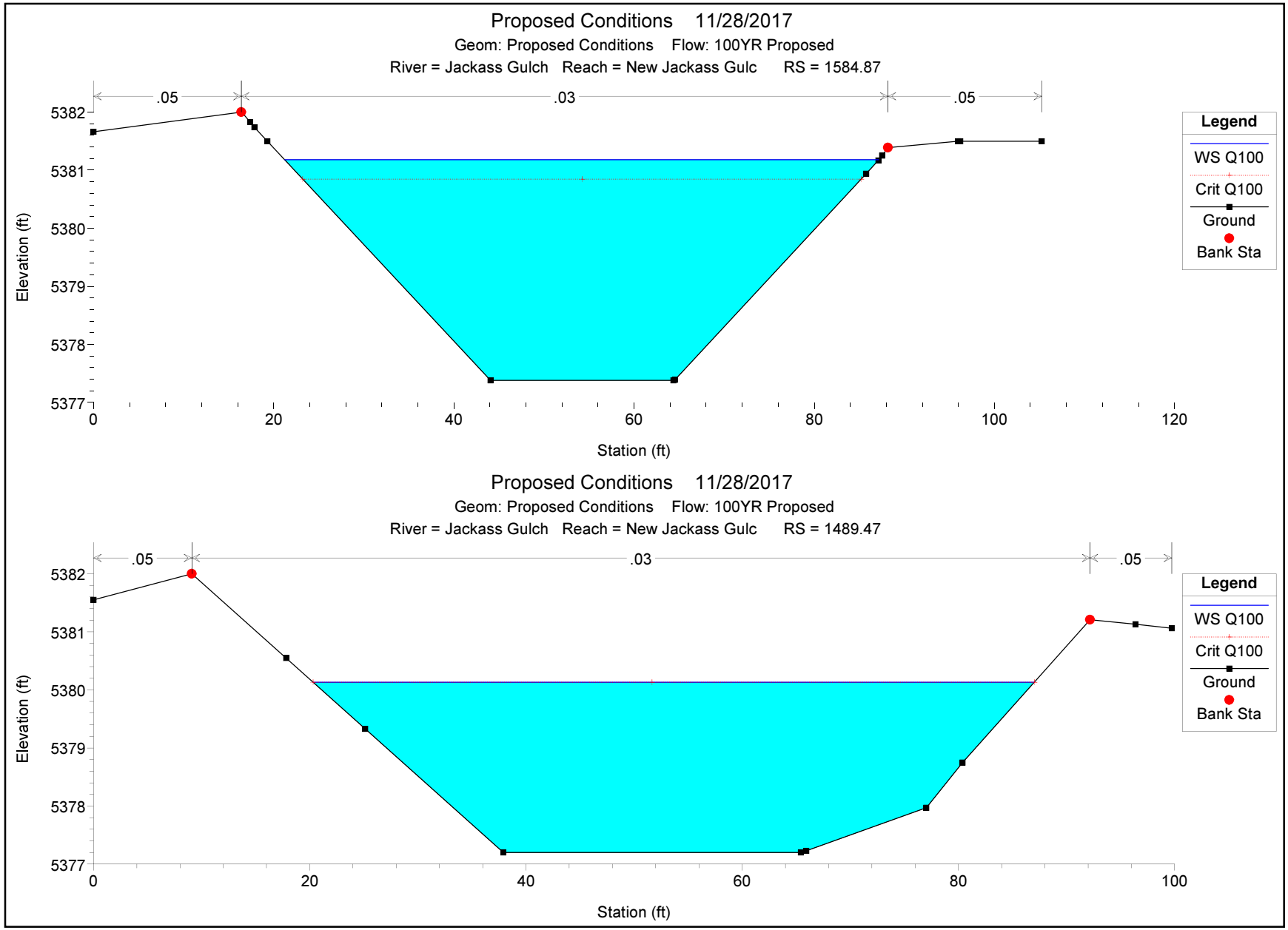
Q Culv Group (cfs)	1240.00	Culv Full Len (ft)	
# Barrels	2	Culv Vel US (ft/s)	10.35
Q Barrel (cfs)	620.00	Culv Vel DS (ft/s)	16.63
E.G. US. (ft)	5377.41	Culv Inv El Up (ft)	5371.58
W.S. US. (ft)	5376.78	Culv Inv El Dn (ft)	5369.30
E.G. DS (ft)	5374.25	Culv Frctn Ls (ft)	0.00
W.S. DS (ft)	5372.68	Culv Exit Loss (ft)	1.42
Delta EG (ft)	3.16	Culv Entr Loss (ft)	0.83
Delta WS (ft)	4.10	Q Weir (cfs)	
E.G. IC (ft)	5376.88	Weir Sta Lft (ft)	
E.G. OC (ft)	5377.41	Weir Sta Rgt (ft)	
Culvert Control	Outlet	Weir Submerg	
Culv WS Inlet (ft)	5374.91	Weir Max Depth (ft)	
Culv WS Outlet (ft)	5371.37	Weir Avg Depth (ft)	
Culv Nml Depth (ft)	1.72	Weir Flow Area (sq ft)	
Culv Crt Depth (ft)	3.33	Min El Weir Flow (ft)	5378.01

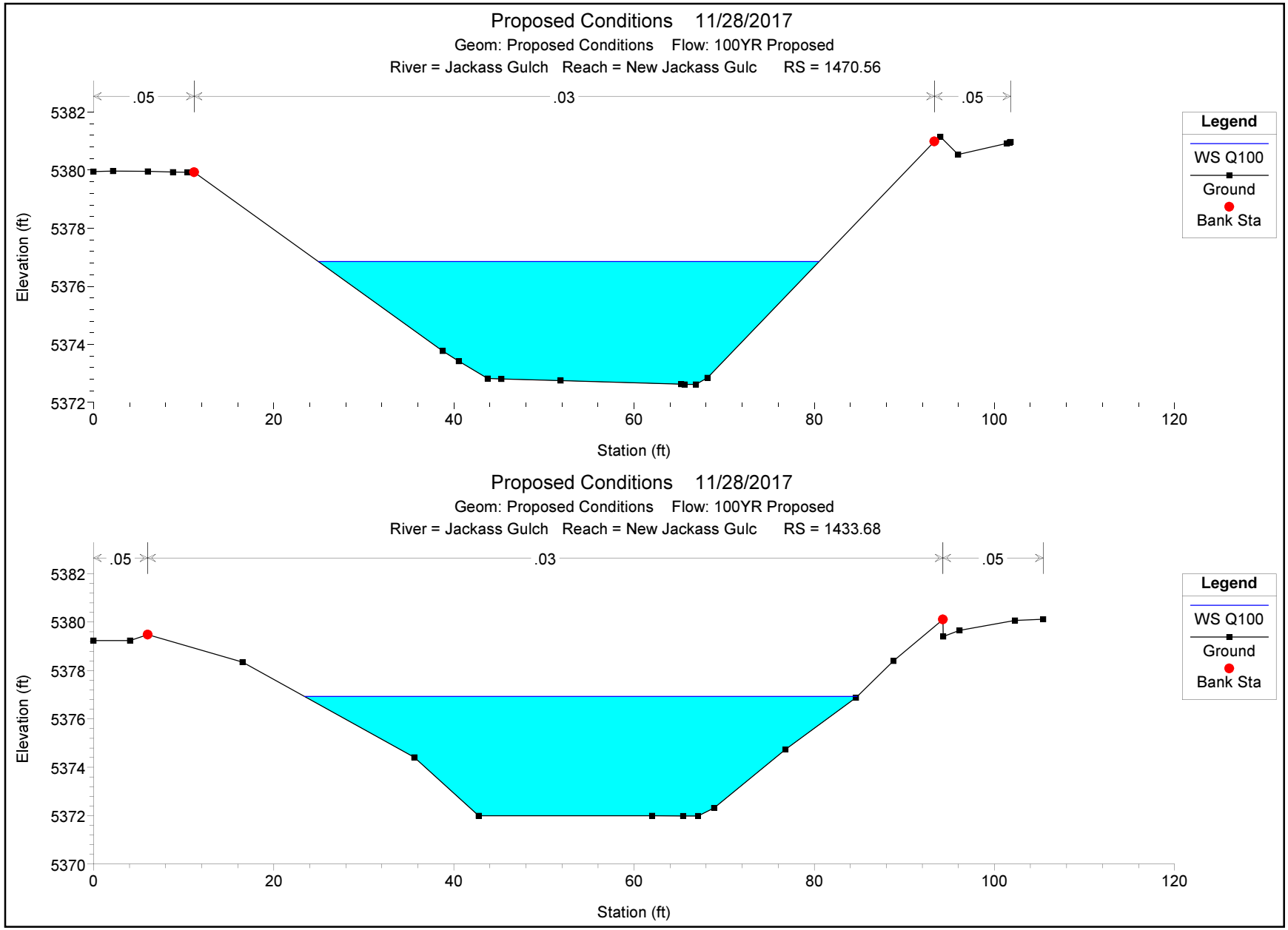
Proposed Conditions 11/28/2017

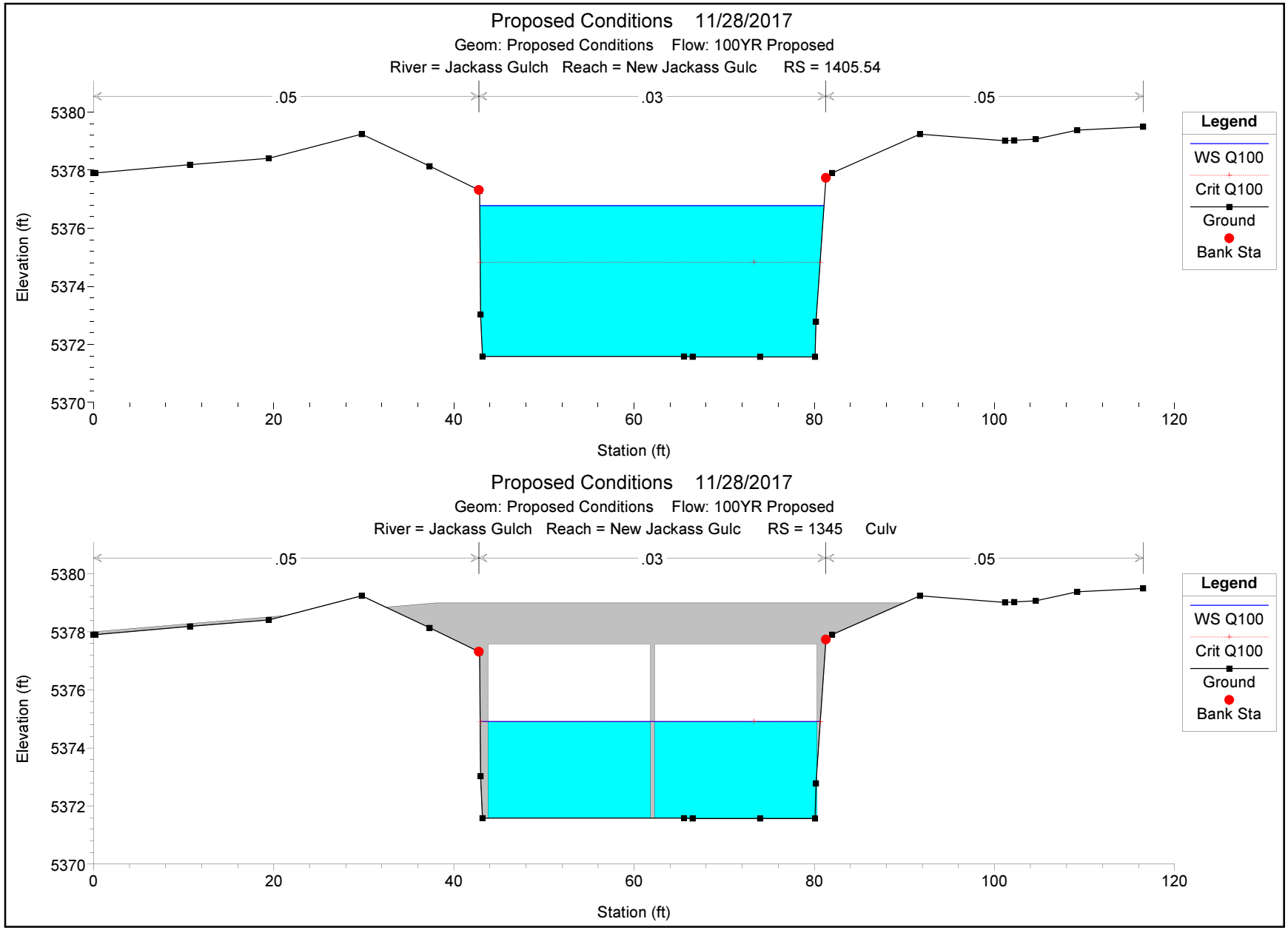
Geom: Proposed Conditions Flow: 100YR Proposed

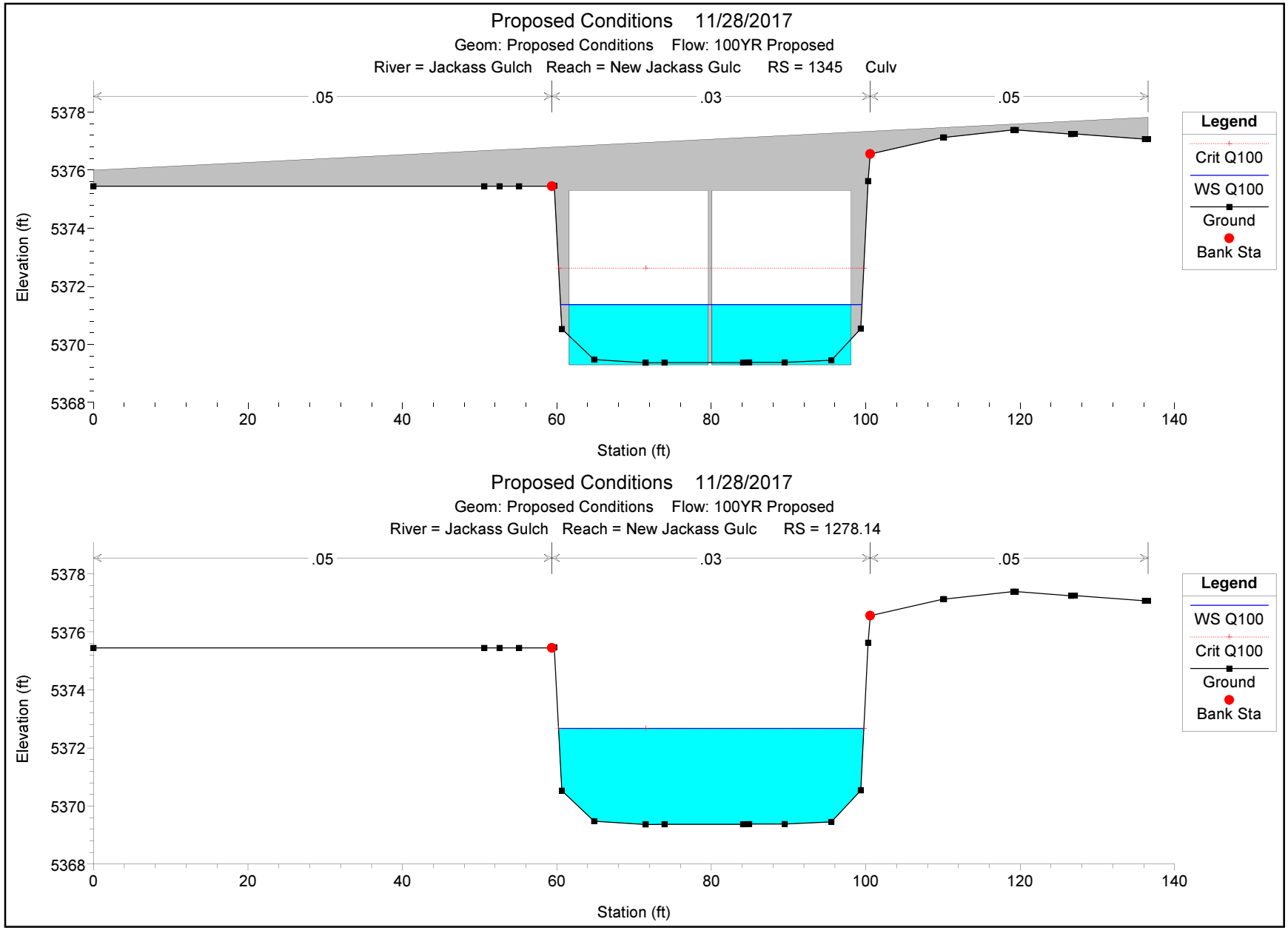


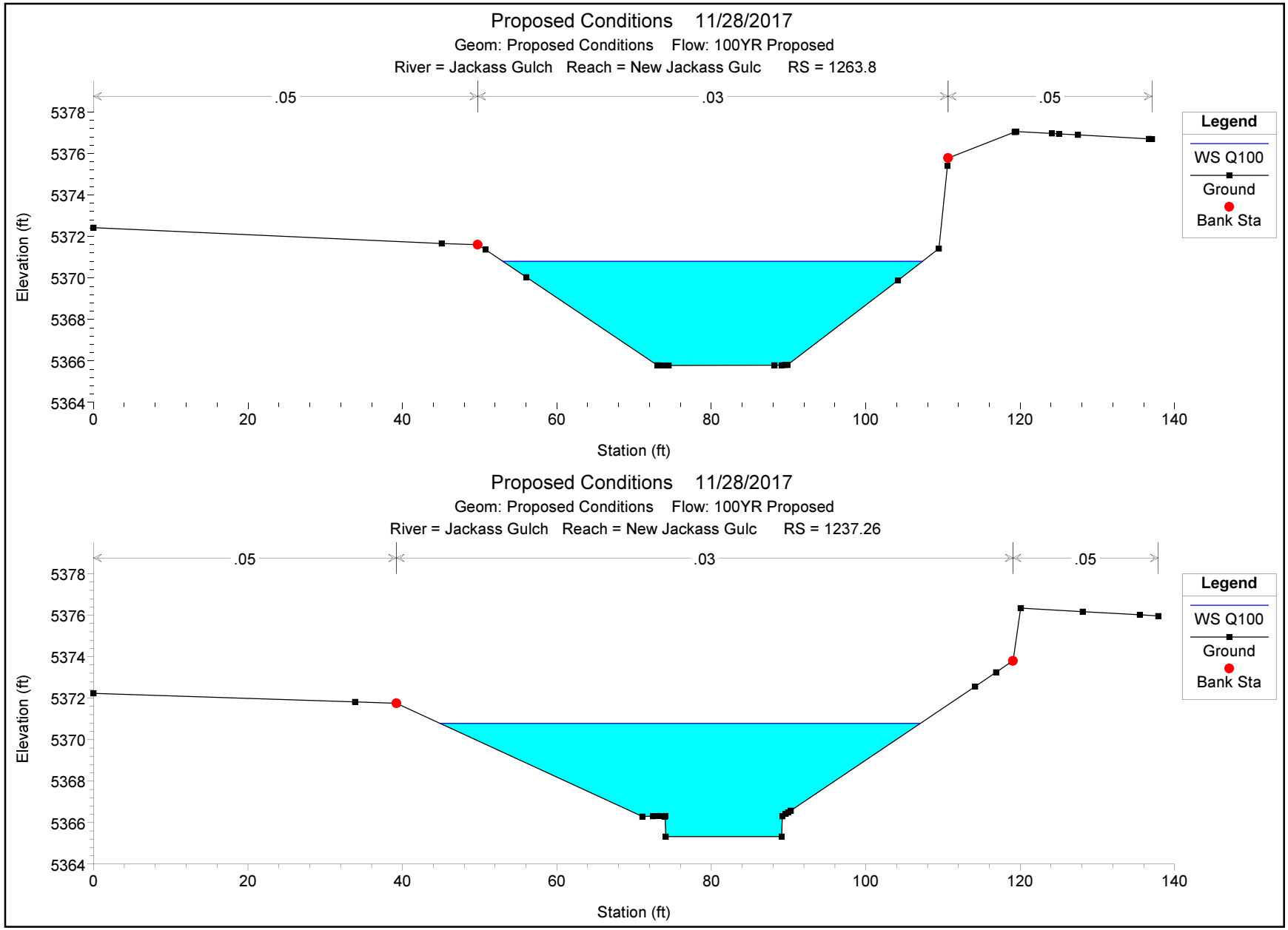

Proposed Conditions 11/28/2017
Geom: Proposed Conditions Flow: 100YR Proposed
River = Jackass Gulch Reach = New Jackass Gulc RS = 1862.83
.05
.03
.02
.05
.05
Legend
WS Q100
Ground
Bank Sta
Elevation (ft)
5400
5395
5390
5385
5380
5375
0
200
400
600
800
1000
1200
1400
1600
Station (ft)
Proposed Conditions 11/28/2017
Geom: Proposed Conditions Flow: 100YR Proposed
River = Jackass Gulch Reach = New Jackass Gulc RS = 1697.64
.05
.03
.02
Legend
WS Q100
Ground
Bank Sta
Elevation (ft)
5383
5382
5381
5380
5379
5378
5377
0
20
40
60
80
100
120
140
160
180
Station (ft)

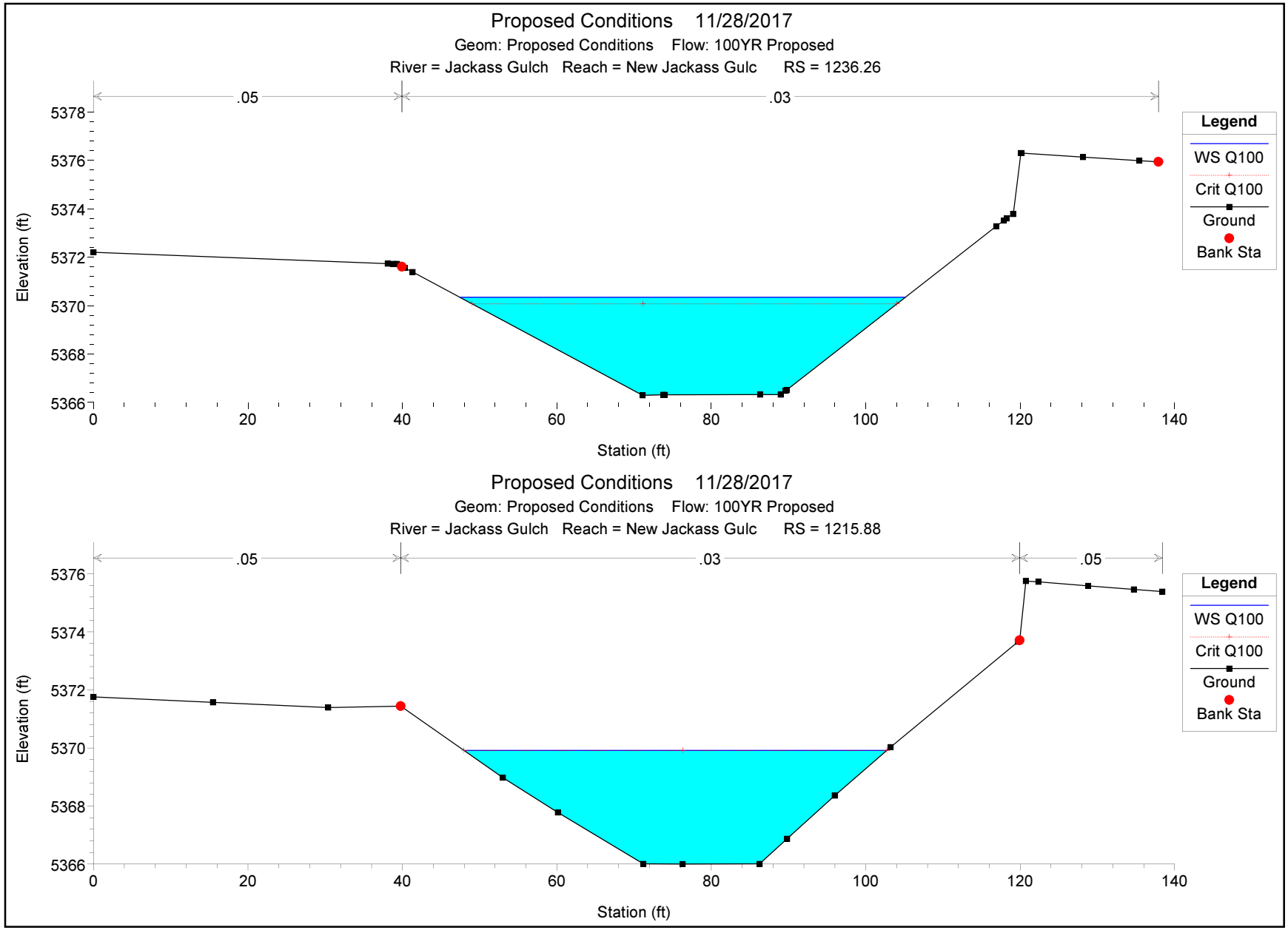

Proposed Conditions 11/28/2017
Geom: Proposed Conditions Flow: 100YR Proposed
River = Jackass Gulch Reach = New Jackass Gulc RS = 1584.87
.05
.03
.05
Elevation (ft)
5382
5381
5380
5379
5378
5377
0
20
40
60
80
100
120
Station (ft)
Legend
WS Q100
Crit Q100
Ground
Bank Sta
Proposed Conditions 11/28/2017
Geom: Proposed Conditions Flow: 100YR Proposed
River = Jackass Gulch Reach = New Jackass Gulc RS = 1489.47
.05
.03
.05
Elevation (ft)
5382
5381
5380
5379
5378
5377
0
20
40
60
80
100
Station (ft)
Legend
WS Q100
Crit Q100
Ground
Bank Sta

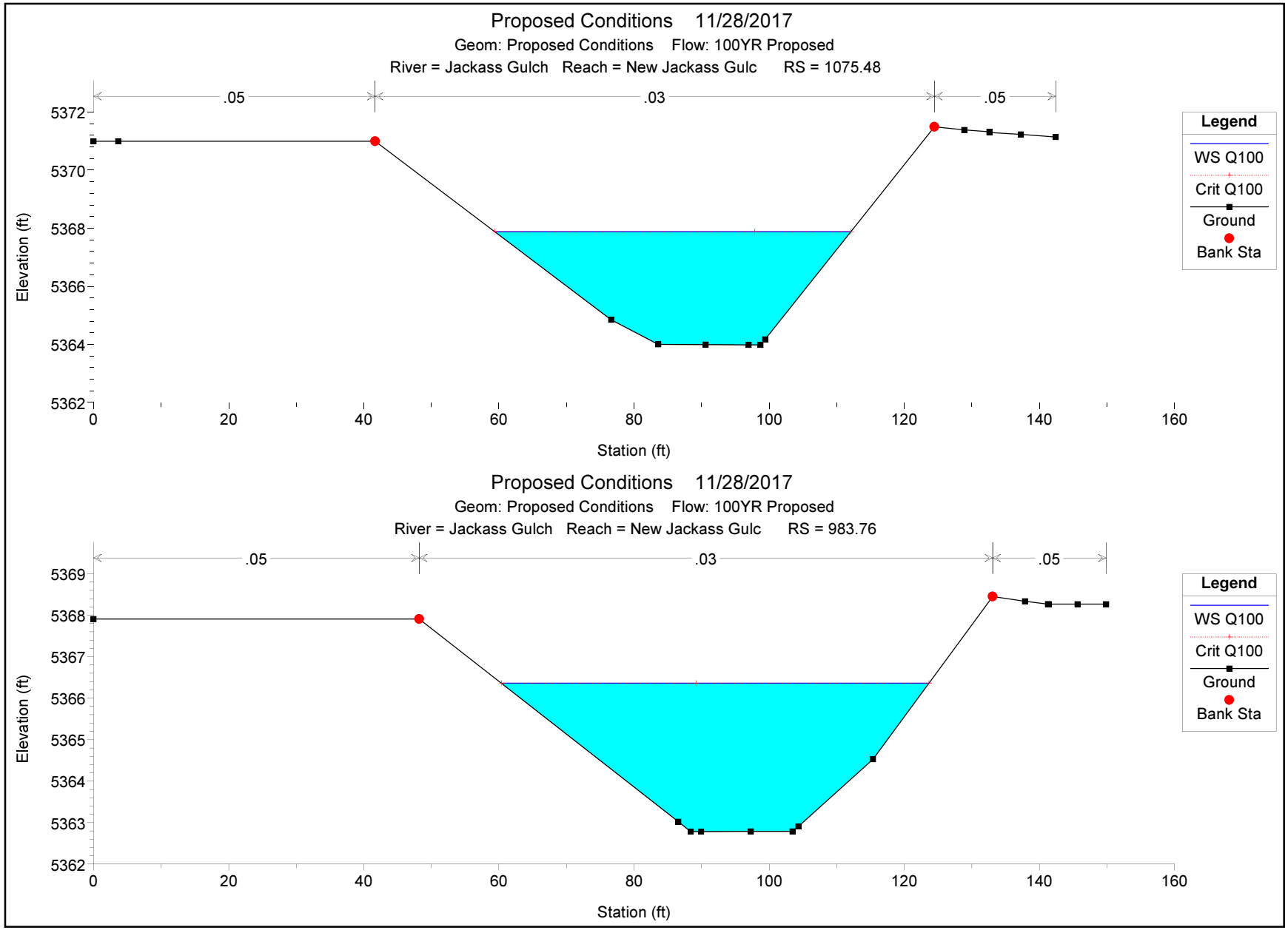

Proposed Conditions 11/28/2017
Geom: Proposed Conditions Flow: 100YR Proposed
River = Jackass Gulch Reach = New Jackass Gulc RS = 1470.56
.05
.03
.05
Elevation (ft)
5382
5380
5378
5376
5374
5372
0
20
40
60
80
100
120
Station (ft)
Legend
WS Q100
Ground
Bank Sta
Proposed Conditions 11/28/2017
Geom: Proposed Conditions Flow: 100YR Proposed
River = Jackass Gulch Reach = New Jackass Gulc RS = 1433.68
.05
.03
.05
Elevation (ft)
5382
5380
5378
5376
5374
5372
5370
0
20
40
60
80
100
120
Station (ft)
Legend
WS Q100
Ground
Bank Sta

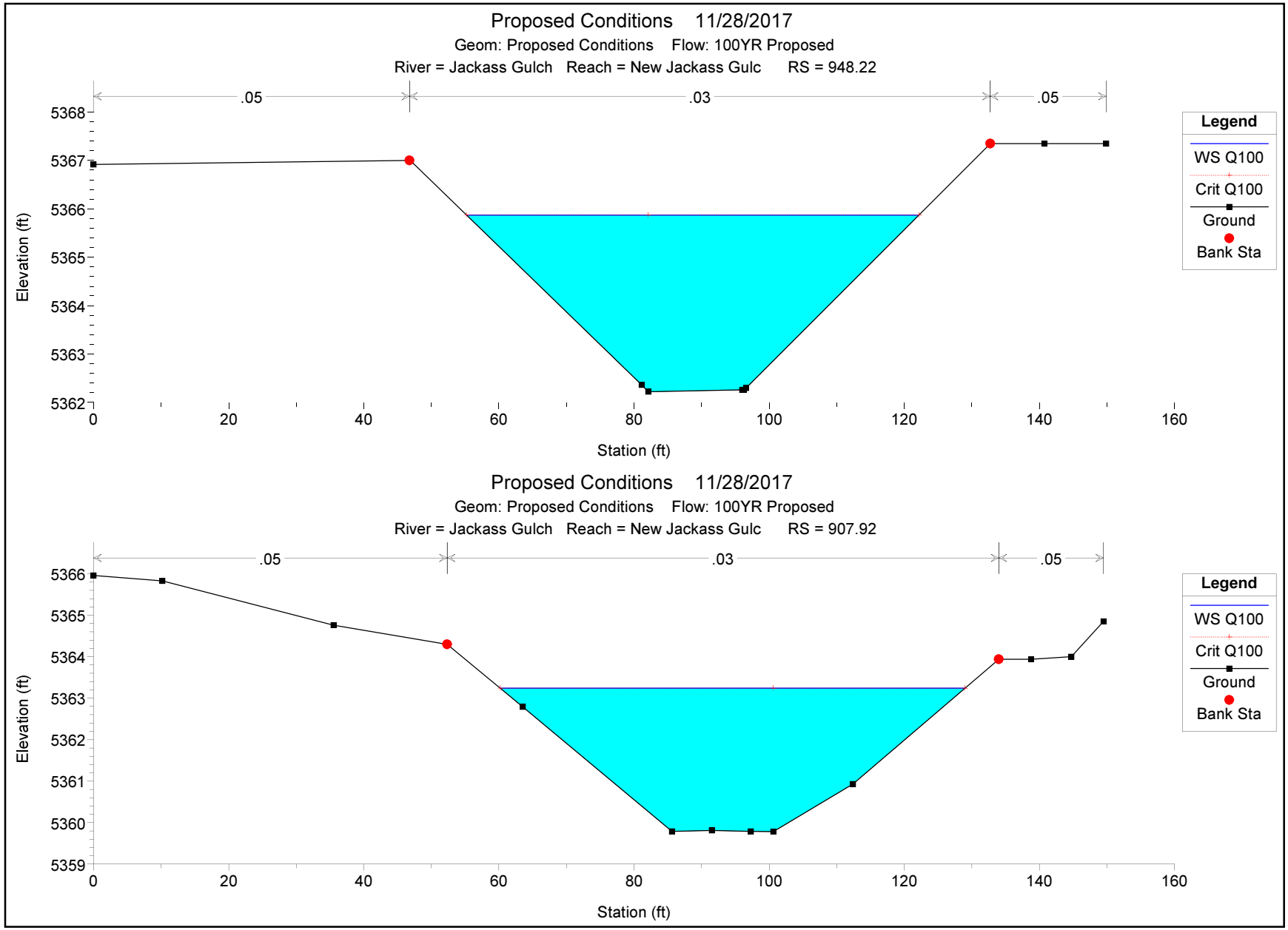

Proposed Conditions 11/28/2017
Geom: Proposed Conditions Flow: 100YR Proposed
River = Jackass Gulch Reach = New Jackass Gulc RS = 1405.54
.05
.03
.05
Elevation (ft)
5380
5378
5376
5374
5372
5370
0
20
40
60
80
100
120
Station (ft)
Legend
WS Q100
Crit Q100
Ground
Bank Sta
Proposed Conditions 11/28/2017
Geom: Proposed Conditions Flow: 100YR Proposed
River = Jackass Gulch Reach = New Jackass Gulc RS = 1345 Culv
.05
.03
.05
Elevation (ft)
5380
5378
5376
5374
5372
5370
0
20
40
60
80
100
120
Station (ft)
Legend
WS Q100
Crit Q100
Ground
Bank Sta

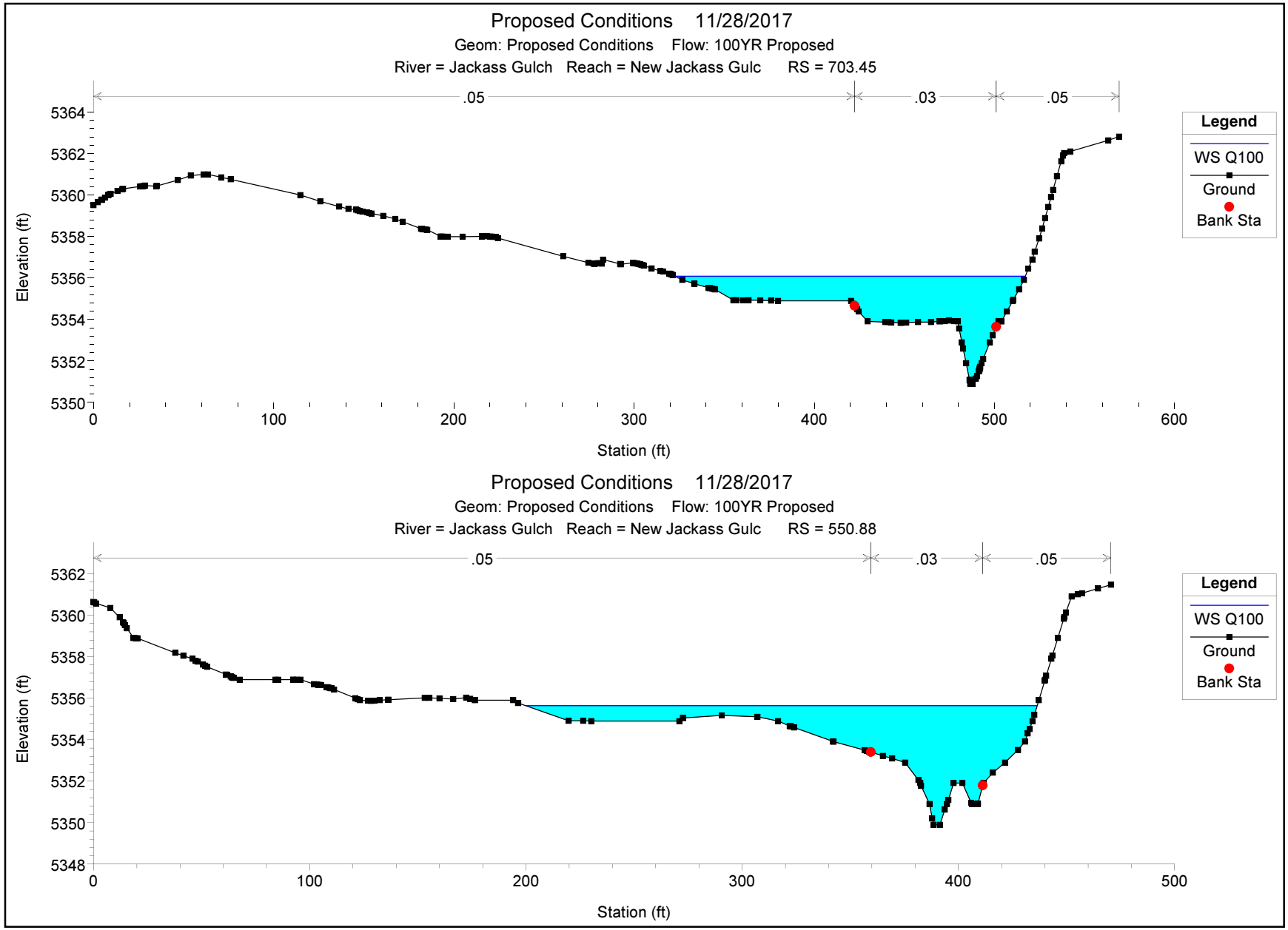

Proposed Conditions 11/28/2017
Geom: Proposed Conditions Flow: 100YR Proposed
River = Jackass Gulch Reach = New Jackass Gulc RS = 1345 Culv
.05
.03
.05
Elevation (ft)
5378
5376
5374
5372
5370
5368
0
20
40
60
80
100
120
140
Station (ft)
Legend
Crit Q100
WS Q100
Ground
Bank Sta
Proposed Conditions 11/28/2017
Geom: Proposed Conditions Flow: 100YR Proposed
River = Jackass Gulch Reach = New Jackass Gulc RS = 1278.14
.05
.03
.05
Elevation (ft)
5378
5376
5374
5372
5370
5368
0
20
40
60
80
100
120
140
Station (ft)
Legend
WS Q100
Crit Q100
Ground
Bank Sta

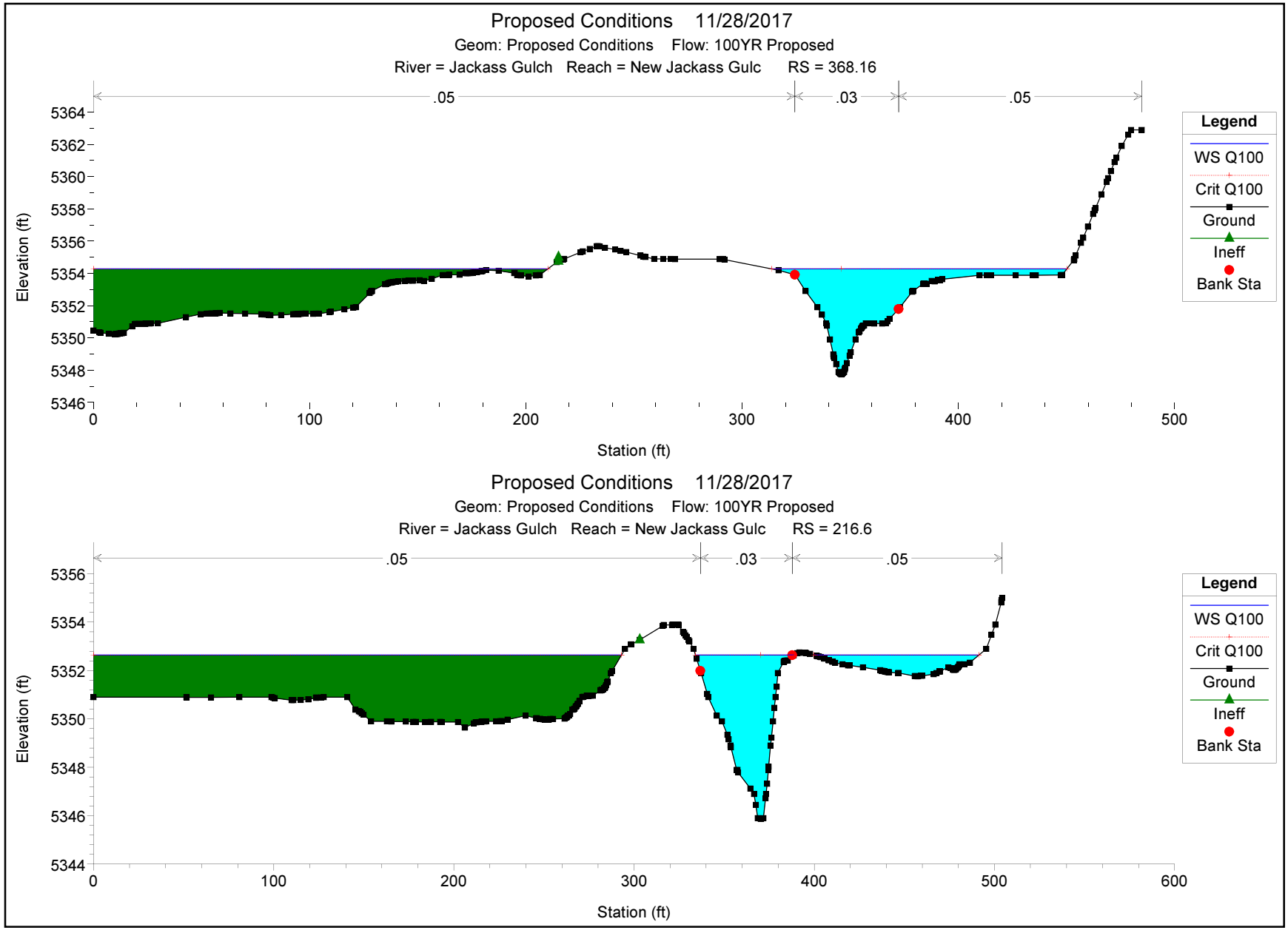

Proposed Conditions 11/28/2017
Geom: Proposed Conditions Flow: 100YR Proposed
River = Jackass Gulch Reach = New Jackass Gulc RS = 1263.8
.05
.03
.05
Elevation (ft)
5378
5376
5374
5372
5370
5368
5366
5364
0
20
40
60
80
100
120
140
Station (ft)
Legend
WS Q100
Ground
Bank Sta
Proposed Conditions 11/28/2017
Geom: Proposed Conditions Flow: 100YR Proposed
River = Jackass Gulch Reach = New Jackass Gulc RS = 1237.26
.05
.03
.05
Elevation (ft)
5378
5376
5374
5372
5370
5368
5366
5364
0
20
40
60
80
100
120
140
Station (ft)
Legend
WS Q100
Ground
Bank Sta

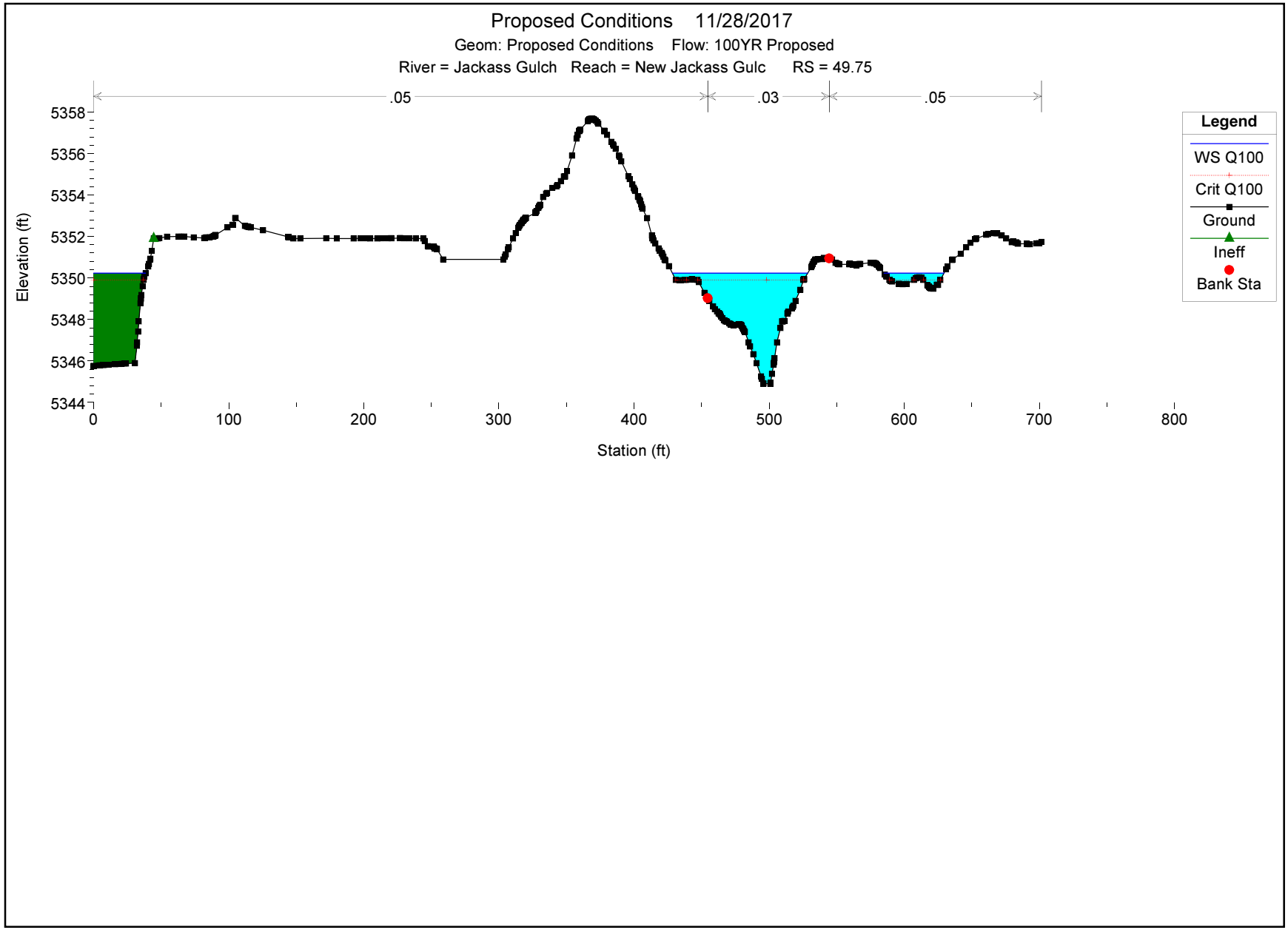

Proposed Conditions 11/28/2017
Geom: Proposed Conditions Flow: 100YR Proposed
River = Jackass Gulch Reach = New Jackass Gulc RS = 1236.26
.05
.03
Elevation (ft)
5378
5376
5374
5372
5370
5368
5366
0
20
40
60
80
100
120
140
Station (ft)
Legend
WS Q100
Crit Q100
Ground
Bank Sta
Proposed Conditions 11/28/2017
Geom: Proposed Conditions Flow: 100YR Proposed
River = Jackass Gulch Reach = New Jackass Gulc RS = 1215.88
.05
.03
.05
Elevation (ft)
5376
5374
5372
5370
5368
5366
0
20
40
60
80
100
120
140
Station (ft)
Legend
WS Q100
Crit Q100
Ground
Bank Sta


Proposed Conditions 11/28/2017
Geom: Proposed Conditions Flow: 100YR Proposed
River = Jackass Gulch Reach = New Jackass Gulc RS = 1075.48
.05
.03
.05
Elevation (ft)
5372
5370
5368
5366
5364
5362
0
20
40
60
80
100
120
140
160
Station (ft)
Legend
WS Q100
Crit Q100
Ground
Bank Sta
Proposed Conditions 11/28/2017
Geom: Proposed Conditions Flow: 100YR Proposed
River = Jackass Gulch Reach = New Jackass Gulc RS = 983.76
.05
.03
.05
Elevation (ft)
5369
5368
5367
5366
5365
5364
5363
5362
0
20
40
60
80
100
120
140
160
Station (ft)
Legend
WS Q100
Crit Q100
Ground
Bank Sta


Proposed Conditions 11/28/2017
Geom: Proposed Conditions Flow: 100YR Proposed
River = Jackass Gulch Reach = New Jackass Gulc RS = 948.22
.05
.03
.05
Elevation (ft)
5368
5367
5366
5365
5364
5363
5362
0
20
40
60
80
100
120
140
160
Station (ft)
Legend
WS Q100
Crit Q100
Ground
Bank Sta
Proposed Conditions 11/28/2017
Geom: Proposed Conditions Flow: 100YR Proposed
River = Jackass Gulch Reach = New Jackass Gulc RS = 907.92
.05
.03
.05
Elevation (ft)
5366
5365
5364
5363
5362
5361
5360
5359
0
20
40
60
80
100
120
140
160
Station (ft)
Legend
WS Q100
Crit Q100
Ground
Bank Sta


Proposed Conditions 11/28/2017
Geom: Proposed Conditions Flow: 100YR Proposed
River = Jackass Gulch Reach = New Jackass Gulc RS = 703.45
.05
.03
.05
Legend
WS Q100
Ground
Bank Sta
Elevation (ft)
5364
5362
5360
5358
5356
5354
5352
5350
0
100
200
300
400
500
600
Station (ft)
Proposed Conditions 11/28/2017
Geom: Proposed Conditions Flow: 100YR Proposed
River = Jackass Gulch Reach = New Jackass Gulc RS = 550.88
.05
.03
.05
Legend
WS Q100
Ground
Bank Sta
Elevation (ft)
5362
5360
5358
5356
5354
5352
5350
5348
0
100
200
300
400
500
Station (ft)


Proposed Conditions 11/28/2017
Geom: Proposed Conditions Flow: 100YR Proposed
River = Jackass Gulch Reach = New Jackass Gulc RS = 368.16
.05
.03
.05
Elevation (ft)
5364
5362
5360
5358
5356
5354
5352
5350
5348
5346
0
100
200
300
400
500
Station (ft)
Legend
WS Q100
Crit Q100
Ground
Ineff
Bank Sta
Proposed Conditions 11/28/2017
Geom: Proposed Conditions Flow: 100YR Proposed
River = Jackass Gulch Reach = New Jackass Gulc RS = 216.6
.05
.03
.05
Elevation (ft)
5356
5354
5352
5350
5348
5346
5344
0
100
200
300
400
500
600
Station (ft)
Legend
WS Q100
Crit Q100
Ground
Ineff
Bank Sta


Proposed Conditions 11/28/2017
Geom: Proposed Conditions Flow: 100YR Proposed
River = Jackass Gulch Reach = New Jackass Gulc RS = 49.75
.05
.03
.05
Elevation (ft)
5358
5356
5354
5352
5350
5348
5346
5344
0
100
200
300
400
500
600
700
800
Station (ft)
Legend
WS Q100
Crit Q100
Ground
Ineff
Bank Sta

PYRAMAT® high performance turf reinforcement mat (HPTRM) is a three-dimensional, lofty, woven polypropylene geotextile that is available in green or tan which is specially designed for erosion control applications on steep slopes and vegetated waterways. The matrix is composed of polypropylene monofilament yarns ***featuring X3® technology*** woven into a uniform configuration of resilient pyramid-like projections. The material exhibits very high interlock and reinforcement capacity with both soil and root systems, demonstrates superior UV resistance, and enhances seedling emergence.

PYRAMAT conforms to the property values listed below[1] and is manufactured at a Propex facility having achieved ISO 9001:2000 certification. Propex performs internal Manufacturing Quality Control (MQC) tests that have been accredited by the Geosynthetic Accreditation Institute – Laboratory Accreditation Program (GAI-LAP). This product is NTPEP approved for AASHTO standards.

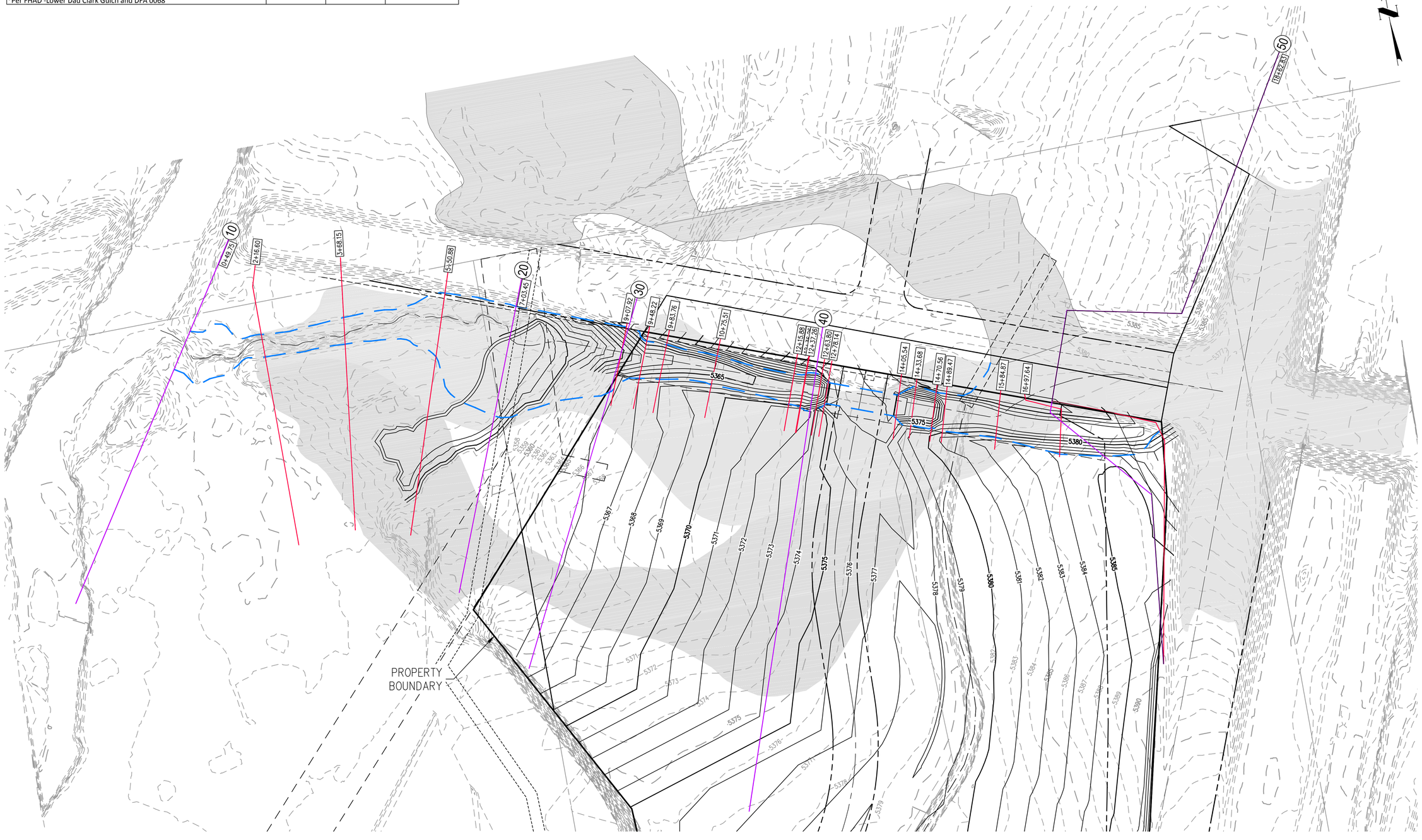
		MARV[2]	
PROPERTY	TEST METHOD	ENGLISH	METRIC
ORIGIN OF MATERIALS			
% U.S. Manufactured Inputs		100%	100%
% U.S. Manufactured		100%	100%
PHYSICAL			
Mass/Unit Area	ASTM D-6566	13.5 oz/yd^2	457.7g/m^2
Thickness	ASTM D-6525	0.4 in	10.2 mm
Light Penetration (% Passing)	ASTM D-6567	15% (Max)	15% (Max)
Color	Visual	Green or Tan	
MECHANICAL			
Tensile Strength (Grab)	ASTM D-6818	4000 x 3000 lb/ft	58.4 x 43.8 kN/m
Elongation	ASTM D-6818	40 x 35%	40 x 35%
Resiliency	ASTM D-6524	80%	80%
Flexibility	ASTM D-6575	0.534 in-lb (avg)	615,000 mg-cm (avg)
ENDURANCE			
UV Resistance % Retained 6000 hrs	ASTM D-4355	90%	90%
UV Resistance % Retained 10000 hrs	ASTM D-4355	85%	85%
PERFORMANCE			
Velocity[3] (Fully Vegetated)	Large Scale	25 ft/sec	7.6 m/sec
Shear Stress[3] (Fully Vegetated)	Large Scale	16lb/ft^2	766 Pa
Manning's "n"[4] (Unvegetated)	Calculated	0.028	0.028
Seedling Emergence[4]	ECTC Draft Method #4	296%	296%
ROLL SIZES		8.5 ft x 90 ft	2.6 m x 27.4 m

NOTES:

1. The property values listed are effective 04/2011 and are subject to change without notice.
2. MARV indicates minimum average roll value calculated as the typical minus two standard deviations. Statistically, it yields a 97.7% degree of confidence that any sample taken during quality assurance testing will exceed the value reported.
3. Maximum permissible velocity and shear stress has been obtained through vegetated testing programs featuring specific soil types, vegetation classes, flow conditions, and failure criteria. These conditions may not be relevant to every project nor are they replicated by other manufacturers. Please contact Propex for further information.
4. Calculated as typical values from large-scale flexible channel lining test programs with a flow depth of 6 to 12 inches.

FHAD*		Corrected Effective (Existing)		Proposed Conditions		
Q100 = 1240 cfs		Q100 = 1240 cfs		Q100 = 1240 cfs		
FHAD XS	100-YR WSEL	HEC XS	100-YR WSEL	HEC XS	100-YR WSEL	Δ WSEL (Ex to Prop)
10	5350.40	49.75	5350.45	49.75	5350.23	-0.22
20	5354.60	703.45	5355.98	703.45	5356.08	0.10
30	5365.50	907.92	5364.99	907.92	5363.24	-1.75
40	5373.90	1254.10	5374.33	1263.80	5370.81	-3.52
50	5382.10	1700.25	5382.09	1697.64	5382.20	0.11
*Per FHAD -Lower Dad Clark Gulch and DFA 0068						

LEGEND
- PROPOSED 100-YR FLOODPLAIN
- FHAD 100-YR FLOODPLAIN
- PROPOSED CROSS-SECTIONS
- FHAD CROSS-SECTIONS
- PROPOSED CONTOURS
- EXISTING CONTOURS



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

CALL 3 BUSINESS DAYS IN ADVANCE BEFORE YOU DIG, GRADE, OR EXCAVATE FOR THE MARKING OF UNDERGROUND MEMBER UTILITIES.

80 0 80 160
SCALE: 1" = 80'

DESIGNED BY: RHM
CHECKED BY: MAW
DRAWN BY: RHM

HKS HARRIS KOCHER SMITH
1120 Lincoln Street, Suite 1000
Denver, Colorado 80203
P: 303.623.6300 F: 303.623.6311
HarrisKocherSmith.com

JACKASS GULCH
FLOODPLAIN WORKMAP

ISSUE DATE: 11/28/2017 | PROJECT #: 160605

DATE	REVISION COMMENTS
####	####
####	####
####	####
####	####
####	####
####	####
####	####

PRELIMINARY NOT FOR CONSTRUCTION

SHEET NO. 1
1 OF 1

FILEPATH: P:\160605\ENGINEERING\DRAINAGE\FLOODPLAIN WORKMAP.DWG LAYOUT: LAYOUT1
XREFs: e-legal, p-legal
PLOTTED: TUE 11/28/17 1:59:47P BY: RACHEL MOLLENHOFF