

## Appendix J Floodplain Delineation Study



# Arapahoe County Floodplain Delineation Study for Magellan Denver Expansion Project

Magellan Pipeline Company, L.P.
Denver Expansion Project - Scott City To Denver Pipeline

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**Technical Report** 

## **Project Name:**

**Denver Expansion Project** 

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**Prepared and Reviewed By:** 

Jung-Hoe Hopgood, Senior Hydrotechnical Engineer Stephen Skoropat, Director of Project Management and Engineering

#### **EXP**

2510 Miccosukee Road, Suite 200 Tallahassee, FL 32308 t: 850.385.5441

## **Approved By:**

Stephen Skoropat, Director, PE - Project Management and Engineering

## **Date Submitted:**

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## **REVISION HISTORY**

DATE	REVISION	REVISION DESCRIPTION	PREPARED BY:	REVIEWED BY:	APPROVED BY:
2024-12-06	Α		JH	SS	SS



## **Acronyms and Abbreviations**

3DEP USGS 3D Elevation Program
AEP annual exceedance probability

ArcGIS A Geographic Information System computer program

ac acre

BFE base flood elevation
CAD Computer Aided and Design
cfs cubic feet per second

CL pipeline centerline alignment DEM(s) Digital Elevation Model(s)

ESRI Environmental Systems Research Institute

EXP Exp Energy Services, Inc.

FEMA Federal Emergency Management Agency

FIRM Flood Insurance Rate Map
FIS FEMA Flood Insurance Study

fps feet per second

ft feet

GIS Geographic Information System

HGL hydraulic gradeline

hrs hours in inch

kip 1000 pound-force

Lat Latitude

LiDAR Light Detection and Ranging

Long Longitude

Magellan Pipeline Company, L.P.

mi mi MP milepost PL pipeline

RMV rupture mitigation valves

ROW Right-of-Way sq square

URL Uniform Resource Locator

U.S. United States

USGS United States Geological Survey



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## 1 Certification Statement

I hereby affirm that this document entitled Arapahoe County Floodplain Delineation Study for the Denver Expansion Project was prepared in accordance with applicable, viable, and pertinent technical data and criteria for the Colorado Water Conservation Board, the Federal Emergency Management Agency, and Arapahoe 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 Floodplain Delineation Study.

Sincerely,

Jung-Hoe Hopgood

CO PE: 65459

**EXP** 



## 2 Introduction

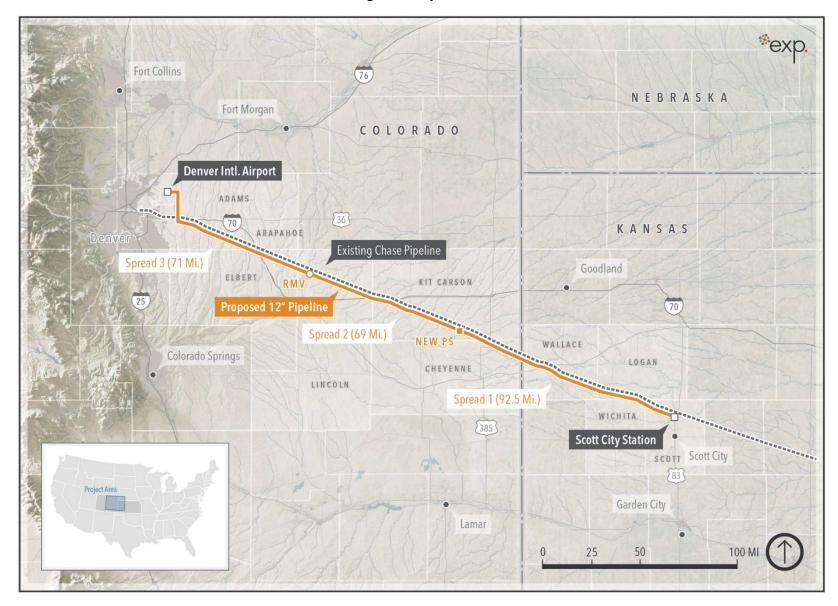
Magellan Pipeline Company (Magellan) is proposing the installation of approximately 235 miles of new buried pipeline (PL) of varying diameter (i.e., 10-inch and 16-inch) from Scott City, Kansas to the Denver International Airport (DIA), with the majority following the existing Chase Colorado PL in Kansas and Colorado. Of the 235 miles of pipeline, approximately 33 miles traverse Arapahoe County. The Project also involves the installation of several aboveground rupture mitigation valves (RMVs) and trap facilities along the new pipeline, all of which will be outside any delineated floodplains. EXP has been contracted by Magellan to provide engineering support for the Denver Expansion Project. As a part of this effort, EXP is providing engineering support needed for permitting. For the permit application for Arapahoe County (County), this report provides the floodplain delineations for drainageways crossed by the PL in the County and certifies that there will be no permanent impact within the floodplain from construction of the project. As this is an underground linear utility project, all construction within the floodplain is intended to be temporary and temporary disturbances will be restored to preexisting conditions.

The overall extent of the project and location relative to the County is provided in Figure 1.

The drawing shown in Appendix A provides an overview of the project overlain with streams and watershed boundaries. It shows the PL centerline alignment (CL) in orange overlaid on a hill shaded terrain map with the contributing watershed areas shaded in blue and drainage lines in blue. Federal Emergency Management Agency (FEMA) 100-year floodplain delineations are shown in red. Drainage paths in general travel from south to north. The County boundary is shown in black.



Figure 1 – Project Area





## 3 Scope

For the floodplain analysis, stream location data was downloaded from the U.S. Geological Survey (USGS) StreamStats website. From this stream data, all stream crossing points were identified where the CL crosses streams. Where it was indicated that the CL crosses a stream multiple times within the same floodplain, the point with the highest peak flow rate was used for the floodplain delineations to give the most conservative results. The map book in Appendix B overlays on aerial photography all stream location data from StreamStats, CL, FEMA 100-year floodplain delineations, each stream crossing location identified by milepost (MP), tributary area for each identified stream crossing the CL and indicates which stream crossings require a local floodplain delineation.

**Table 1** presents all streams crossed by the proposed CL labeled by their MP, GPS coordinate, Township Section Map Reference, stream name, tributary drainage area, and floodplain delineation category.

Table 1: Arapahoe County Streams Crossed By Project

MP	Latitude	Longitude	Section Map	Tributary Name and FEMA stream	Area (ac)	Floodplain
416.60	39.5681	-104.080	T5S,R60W:35SW	Middle Bijou Creek	88771.7	FEMA
416.77	39.5688	-104.083	T5S,R60W:34SE		73.5	<130ac
416.98	39.5698	-104.087	T5S,R60W:34SE	Unnamed Tributary to Middle Bijou Creek	143.1	Local
417.07	39.5702	-104.089	T5S,R60W:34SE		72.2	<130ac
417.47	39.5720	-104.096	T5S,R60W:34SW		32.4	<130ac
417.97	39.5746	-104.105	T5S,R60W:33NE	Willow Gulch to Middle Bijou Creek	8042.7	Local
418.29	39.5764	-104.110	T5S,R60W:33NW	Unnamed Tributary to Middle Bijou Creek	894.7	Local
419.36	39.5822	-104.129	T5S,R60W:29SW	Unnamed Tributary to Hay Glch to Middle Bijou Creek	253.6	Local
419.48	39.5828	-104.131	T5S,R60W:29SW	Hay Gulch to Middle Bijou Creek	8764.8	Local
419.72	39.5841	-104.135	T5S,R60W:29SW		100.8	<130ac
420.68	39.5893	-104.152	T5S,R60W:30NW		67.3	<130ac
420.85	39.5902	-104.155	T5S,R60W:30NW		48.5	<130ac
421.15	39.5918	-104.160	T5S,R61W:25NE	Unnamed Tributary to Middle Bijou Creek	187.0	Local
421.23	39.5923	-104.161	T5S,R61W:25NE	Unnamed Tributary to Middle Bijou Creek	298.9	Local
421.84	39.5955	-104.172	T5S,R61W:24SW		30.7	<130ac
422.04	39.5966	-104.175	T5S,R61W:23SE		78.1	<130ac
422.66	39.6000	-104.186	T5S,R61W:23SW		40.2	<130ac
423.18	39.6023	-104.195	T5S,R61W:22NE	Rattlesnake Creek to Middle Bijou Creek	7448.8	Local
423.50	39.6040	-104.201	T5S,R61W:22NE	Unnamed Tributary to Middle Bijou Creek	857.9	Local



MP	Latitude	Longitude	Section Map	Tributary Name and FEMA stream	Area (ac)	Floodplain
424.10	39.6073	-104.211	T5S,R61W:22NW		57.1	<130ac
424.59	39.6099	-104.220	T5S,R61W:16SE	Unnamed Tributary to Middle Bijou Creek	879.8	Local
424.88	39.6114	-104.225	T5S,R61W:16SW		64.4	<130ac
425.60	39.6158	-104.237	T5S,R61W:17SE		100.3	<130ac
426.24	39.6195	-104.248	T5S,R61W:17NW	Unnamed Tributary to West Bijou Creek	1201.8	FEMA
426.58	39.6214	-104.254	T5S,R61W:18NE	West Bijou Creek	161364.3	FEMA
427.14	39.6248	-104.263	T5S,R61W:7SW	Unnamed Tributary to West Bijou Creek	359.0	Local
427.16	39.6250	-104.264	T5S,R61W:7SW		122.3	<130ac
427.71	39.6272	-104.273	T5S,R62W:12SE		26.2	<130ac
427.83	39.6276	-104.276	T5S,R62W:12SE		26.3	<130ac
428.42	39.6299	-104.286	T5S,R62W:11SE		61.4	<130ac
428.45	39.6301	-104.287	T5S,R62W:11NE	Unnamed Tributary to West Bijou Creek	2846.4	Local
428.84	39.6328	-104.293	T5S,R62W:11NE	Unnamed Tributary to West Bijou Creek	498.4	Local
429.00	39.6339	-104.296	T5S,R62W:11NW	Unnamed Tributary to West Bijou Creek	351.6	Local
430.09	39.6411	-104.314	T5S,R62W:3SW	Little Comanche Creek to Comanche Creek to Kiowa Creek	3935.5	FEMA
430.45	39.6435	-104.320	T5S,R62W:3SW		92.4	<130ac
430.78	39.6451	-104.326	T5S,R62W:4NE	Unnamed Tributary to Comanche Creek to Kiowa Creek	132.8	Local
431.65	39.6507	-104.340	T5S,R62W:4NW		27.7	<130ac
431.73	39.6512	-104.342	T5S,R62W:5NE	Comanche Creek to Kiowa Creek	48288.8	FEMA
431.81	39.6518	-104.343	T4S,R62W:32SE		107.7	<130ac
432.30	39.6552	-104.351	T4S,R62W:32SW	Unnamed Tributary to Comanche Creek to Kiowa Creek	342.8	Local
432.78	39.6586	-104.359	T4S,R62W:32SW		57.2	<130ac
433.22	39.6606	-104.367	T4S,R62W:31NE		105.6	<130ac
433.42	39.6614	-104.370	T4S,R62W:31NW	Wolf Creek to Kiowa Creek	43545.0	FEMA
435.07	39.6696	-104.399	T4S,R63W:26SE	Unnamed Tributary to Wolf Creek to Kiowa Creek	550.3	Local
435.26	39.6706	-104.403	T4S,R63W:26SE	Unnamed Tributary to Wolf Creek to Kiowa Creek	371.6	Local



MP	Latitude	Longitude	Section Map	Tributary Name and FEMA stream	Area (ac)	Floodplain
435.60	39.6736	-104.407	T4S,R63W:26NW		55.5	<130ac
436.00	39.6779	-104.412	T4S,R63W:26NW		26.9	<130ac
437.18	39.6852	-104.432	T4S,R63W:22SW	Kiowa Creek	149808.9	FEMA
437.48	39.6867	-104.437	T4S,R63W:21SE	Unnamed Tributary to Kiowa Creek	4307.8	FEMA
438.92	39.6949	-104.462	T4S,R63W:17SE		33.2	<130ac
439.29	39.6976	-104.468	T4S,R63W:17SW	Unnamed Tributary to Lost Creek/Cost Creek/West Sand Creek to Middle South Platte- Cherry Creek	464.3	Local
439.85	39.7016	-104.477	T4S,R63W:18SE		108.8	<130ac
440.14	39.7040	-104.480	T4S,R63W:18NE		90.1	<130ac
440.19	39.7040	-104.481	T4S,R63W:18NW	Unnamed Tributary to Lost Creek/Cost Creek/West Sand Creek to Middle South Platte- Cherry Creek	143.3	Local
441.21	39.7097	-104.499	T4S,R64W:12SE		24.7	<130ac
441.32	39.7097	-104.501	T4S,R64W:12SW	Unnamed Tributary to Lost Creek/Cost Creek/West Sand Creek to Middle South Platte- Cherry Creek	399.7	Local
441.88	39.7097	-104.511	T4S,R64W:11SE	Unnamed Tributary to Lost Creek/Cost Creek/West Sand Creek to Middle South Platte- Cherry Creek	207.0	Local
442.09	39.7097	-104.515	T4S,R64W:11SE		27.6	<130ac
442.48	39.7099	-104.523	T4S,R64W:11SW	West Sand Creek to Middle South Platte-Cherry Creek	2315.6	Local
443.16	39.7108	-104.535	T4S,R64W:10SE		92.6	<130ac
443.30	39.7112	-104.538	T4S,R64W:10SW		127.6	<130ac
444.07	39.7131	-104.552	T4S,R64W:9SE	Box Elder Creek to Middle South Platte-Cherry Creek	105450.2	FEMA
444.29	39.7136	-104.556	T4S,R64W:9SW		86.6	<130ac
445.20	39.7181	-104.572	T4S,R64W:8NE	Cardboard Draw to Box Elder Creek to Middle South Platte- Cherry Creek	864.4	Local
445.74	39.7207	-104.582	T4S,R64W:8NW		22.5	<130ac
447.05	39.7276	-104.605	T4S,R65W:1SE		57.9	<130ac
447.25	39.7287	-104.608	T4S,R65W:1SE	Coyote Run to Box Elder Creek to Middle South Platte- Cherry Creek	8011.6	FEMA



MP	Latitude	Longitude	Section Map	Tributary Name and FEMA stream	Area (ac)	Floodplain
447.65	39.7307	-104.615	T4S,R65W:1SW	Unnamed Tributary to Coyote Run to Middle South Platte- Cherry Creek	1296.0	FEMA
448.22	39.7337	-104.625	T4S,R65W:2NE	Unnamed Tributary to Coyote Run to Middle South Platte- Cherry Creek	144.4	Local

A total of 69 StreamStats streams are crossed by the CL. Per County floodplain policy, the local floodplain delineation was performed on all streams with an upstream tributary area greater than 130 acres. 11 streams were within FEMA 100-year floodplain delineations and of the remaining 58, 25 exceed the 130 acre threshold. Therefore, local floodplain analyses was performed on these 25 stream crossing locations as described in the following sections of this report.

## 4 Local Floodplain Analysis

As discussed above, drainage basins were delineated at each intersection of the stream to the CL, along with their associated flow paths, from StreamStats by USGS. Drainage pathways were verified from several sources including civil topographic survey data collected near the CL, USGS 3D Elevation Program (3DEP) digital elevation model, aerial imagery within ArcGIS Pro and ArcHydro. These were used to determine attributes in the hydrologic analysis of the contributing drainage catchments.

## 4.1 Hydrologic Analysis

Each stream crossing location was analyzed on the StreamStat's website to determine the basin characteristics. The basin properties are included on each stream crossing drawing in Appendix C. Definitions for the basin properties are described here:

DRNAREA - Area that drains to a point on a stream

OUTLETELEV - Elevation of the stream outlet in feet above NAVD88

STATSCLAY - Percentage of clay soils from STATSGO

I6H100Y - 6-hour precipitation that is expected to occur on average once in 100-years

PRECIP - Mean Annual Precipitation

**ELEV - Mean Basin Elevation** 

BSLDEM10M - Mean basin slope computed from 10m DEM

CSL1085LFP - Change in elevation divided by length between points 10 and 85 percent of distance along the longest flow path to the basin divide, LFP from 2D grid

RCN - Runoff-curve number as defined by NRCS

(http://policy.nrcs.usda.gov/OpenNonWebContent.aspx?content=17758.wba)

TOC - Time of concentration in hours

The peak design flow for the 100-year return frequency was calculated using USGS Colorado's Foothills Region Peak Flow 2016 5099 regional regression equation of the form

 $PK1AEP = 10^{13.244}xDRNAREA^{0.572}xI6H100Y^{3.190}xSTATSCLAY^{1.013}xOUTLETELEV^{-3.631}.$ 

The result of the hydrologic analysis is summarized in **Table 2**.



Table 2: Local Floodplain Basin Characteristics and 100-Year Design Flows

MP	DRNAREA	OUTLETELEV	STATSCLAY	I6H100Y	PK1AEP
mi	sq mi	ft	%	in	cfs
416.98	0.22	5317	18.27	4.00	346
417.97	12.60	5306	22.45	4.00	4350
418.29	1.40	5325	22.00	4.01	1210
419.36	0.40	5322	20.30	4.01	544
419.48	13.70	5311	21.81	3.98	4340
421.15	0.29	5431	21.76	3.99	444
421.23	0.47	5429	24.04	3.99	648
423.18	11.60	5383	24.36	3.95	4110
423.50	1.34	5395	25.74	3.95	1250
424.59	1.37	5421	20.37	3.95	984
427.14	0.56	5431	30.71	3.92	867
428.45	4.44	5506	21.67	3.89	1850
428.84	0.78	5557	19.47	3.00	259
429.00	0.55	5590	18.30	3.90	450
430.78	0.21	5580	18.30	3.87	255
432.30	0.54	5551	18.30	3.85	438
435.07	0.86	5581	18.30	3.00	253
435.26	0.58	5585	18.30	3.81	432
439.29	0.72	5667	25.77	3.77	634
440.19	0.22	5689	18.30	3.77	224
441.32	0.62	5690	25.62	3.76	565
441.88	0.32	5680	36.49	3.00	271
442.48	3.62	5661	28.03	3.75	1720
445.20	1.35	5593	25.19	3.73	900
448.22	0.23	5560	25.30	3.00	167

## 4.2 Hydraulic Analysis

The local floodplain analysis uses a digital terrain model to represent the current condition at the crossing location. This terrain model was developed from surveyed topographic data collected in July and August of 2024 within 100 ft of the CL. Where survey data had an insufficient level of detail, it was supplemented with high resolution USGS 3DEP LiDAR data. For the channel configuration, a cross-sectional profile at each stream crossing location normal to the direction of flow was cut. Some stream crossing identified by the StreamStats stream locations when compared to existing conditions data indicate that the stream has migrated significantly from the stream location, hydraulic conditions have changed due to development or the basis for the original dataset had a poor level of resolution. In the hydraulic analysis for each crossing location, the cross section for the nearest conveyance channel

was used and all elevation points for the entire cross-section are utilized in the cross-sectional area calculation, including the lowest point near the identified crossing location and the left and right banks far beyond the possible floodplain extent.

The composite Manning's roughness coefficient was estimated from aerial photography and take into account effects from stream sinuosity, contracting or expanding section, vegetation density, channel depth and width and relative location to any nearby confluences.

A hydraulic model was developed for each crossing location to determine the normal flow depth using the cross-sectional area, Manning's n, peak design flow with a 1% annual exceedance probability (AEP) and slope from the tributary basin properties as determined by the StreamStats website. The normal flow depth was used to calculate the flood elevation for the design condition at the crossing location as the construction activity will be temporary, there are no potential at-risk structures nearby and simple hydraulic representation is appropriate. The values used in the calculation of the hydraulic gradeline (HGL) for the 100-year return frequency condition are included on each stream crossing drawing in Appendix C.

A HGL flood elevation at each crossing location was determined from the hydraulic calculations performed under the design condition and are summarized in **Table 3**.

MP DRNAREA Flow Velocity Area Width Depth sq mi fps sq ft 416.98 0.22 350 75.4 2.93 5324.08 4.64 82.9 406.8 417.97 12.60 4370 5.56 785.3 5.09 5311.94 418.29 1.40 1221 5.58 219.0 138.5 2.29 5328.85 419.36 0.40 547 6.25 87.5 2.03 76.3 5327.48 419.48 170.8 13.70 4360 7.54 578.0 7.46 5324.36 421.15 0.29 447 92.0 101.4 4.86 1.27 5442.54 421.23 0.47 651 6.04 107.7 97.8 2.16 5442.37 423.18 11.60 4123 3.56 1157.3 602.2 5.81 5389.25 1256 423.50 1.34 4.76 263.9 152.9 3.55 5396.89 424.59 995 425.5 766.1 5427.12 1.37 2.34 1.35 427.14 0.56 872 4.34 201.1 216.6 1.96 5427.01 428.45 4.44 1851 4.67 396.3 191.5 6.45 5505.41 428.84 0.78 261 3.01 86.5 76.2 1.79 5556.94 429.00 0.55 554 1.69 327.5 629.7 1.07 5592.14 430.78 0.21 258 2.11 122.5 214.4 1.29 5570.90 170.5 432.30 0.54 440 2.77 158.8 1.49 5546.75 435.07 0.86 254 5.58 45.6 46.3 2.09 5576.69 435.26 0.58 435 5.62 77.5 91.0 2.28 5583.96 439.29 0.72 643 6.98 92.2 76.9 2.38 5671.99

0.79

5690.52

136.5

**Table 3: 100-Year HGL Flood Elevations** 



440.19

0.22

227

3.62

62.6

MP	DRNAREA	Flow	Velocity	Area	Width	Depth	HGL
mi	sq mi	cfs	fps	sq ft	ft	ft	ft
441.32	0.62	573	4.03	142.1	206.4	1.68	5691.45
441.88	0.32	276	5.63	49.0	44.5	1.92	5677.60
442.48	3.62	1727	3.91	442.1	393.4	2.22	5661.19
445.20	1.35	909	3.87	234.6	327.1	1.77	5597.44
448.22	0.23	169	6.56	25.8	18.4	2.39	5550.16

## 4.3 Local Floodplain Delineation

Local floodplain delineations were developed from the design HGL flood elevation determined for each stream crossing location. This elevation was extended upstream and downstream along the drainage path using the main channel slope from the basin properties for the width of the project area and is shown for each stream crossing drawing in Appendix C.

## 5 FEMA Floodplain Analysis

11 locations were identified along the CL alignment with FEMA 100-year floodplain delineations.

Similar to the local floodplain analysis above, drainage basins were delineated at the intersection of the FEMA stream to the CL, along with their associated flow paths, from StreamStats by USGS. Drainage pathways were verified from several sources including civil topographic survey data collected near the CL, 3DEP digital elevation model, aerial imagery within ArcGIS Pro and ArcHydro. These were used to determine attributes in the hydrologic analysis of the contributing drainage catchments.

#### 5.1 Hydrologic Analysis

Each stream crossing location was analyzed on the StreamStat's website to determine the basin characteristics. The basin properties are included on each stream crossing drawing in Appendix D. Definitions for the basin properties are the same as described in the local floodplain delineations section. For the analysis at the stream crossings at MP 444.07 and MP 447.25, the FEMA Flood Insurance Study (FIS) was referenced for peak flows. The remaining stream crossings do not have peak flows developed, therefore the peak design flow for the 100-year return frequency was calculated using USGS Colorado's Foothills Region Peak Flow 2016 5099 regional regression equation of the form PK1AEP=10<sup>13.244</sup>xDRNAREA<sup>0.572</sup>xI6H100Y<sup>3.190</sup>xSTATSCLAY<sup>1.013</sup>xOUTLETELEV<sup>-3.631</sup>.

The result of the hydrologic analysis is summarized in Table 4.

Table 4: FEMA Floodplain Basin Characteristics and 100-Year Design Flows

MP	DRNAREA	OUTLETELEV	STATSCLAY	I6H100Y	PK1AEP
mi	sq mi	ft	%	in	cfs
416.60	139.00	5293	20.42	4.03	16100
426.24	1.88	5340	19.42	3.94	1180
426.58	252.00	5333	25.14	3.90	24500
430.09	6.15	5566	17.61	3.87	1710
431.73	75.40	5552	15.18	3.82	5960
433.42	68.00	5518	17.63	3.79	6520



MP	DRNAREA	OUTLETELEV	STATSCLAY	I6H100Y	PK1AEP
mi	sq mi	ft	%	in	cfs
437.18	234.00	5556	15.72	3.76	11200
437.48	6.73	5566	28.50	3.77	2690
444.07	165.00	5606	16.96	3.71	11138*
447.25	12.50	5528	25.55	3.00	5804*
447.65	2.02	5538	25.30	3.00	589

## 5.2 FEMA Floodplain HGL and Delineation Analysis

Similar to the local floodplain delineations, the FEMA floodplain channel representation uses a digital terrain model to represent the current condition at the crossing location. This terrain model was developed with high resolution USGS 3DEP LiDAR data. For the floodplain delineations at MP 444.07 and MP 447.25, the FIS was referenced for the regulatory base flood elevation (BFE) HGL. For FEMA floodplains where the BFE HGL has not been determined, the FEMA floodplain analysis uses the current delineated boundary for displaying the delineation extent on the cross-section profile in the drawings in Appendix D. It was noted that the main channel at the stream crossing at MP 437.48 has migrated and the floodplain boundary should extend another 93 feet to the east to account for the shift. This additional floodplain area has been included as FEMA Floodplain Analysis Delineation on the plans. No potential at-risk structures are nearby and all construction activity in the floodplains will be temporary, and natural ground will be restored to existing conditions.

## 6 Floodplain Delineation Results and Summary

25 locations were identified along the CL alignment where the upstream contributing area exceeds 130 acres. At these locations, the flood elevation expected for the peak design flow for the 100-year return frequency was determined. An estimate of the floodplain extent was drawn based on the calculated HGL surface and compared against the digital terrain model. In addition to the local floodplain delineations, 11 locations were identified with FEMA 100-year floodplain delineations. The Computer Aided and Design (CAD) drawings in Appendix C and D present the result of the floodplain delineation for each stream crossing. Open trenching to the PL depth of at minimum of 4 feet of cover will be used at all locations but the local floodplain at MP 417.97. 9 floodplains will be entirely bored, 4 local floodplains will be bored for most of the length near MPs 418.29, 419.48, 430.78, and 440.19, and 5 FEMA floodplains will be bored the width of the main channels at MPs 431.73, 433.42, 437.48, 447.25, and 447.65.

All construction that will occur within the floodplain is expected to be temporary. Surveys showing the before and as-built condition will be conducted to ensure restoration of natural ground elevations have been achieved. As noted on the plans, no hazardous material will be stored in the floodplain. Storage of spoil from excavation will be put back in place within 30 days. Any temporary disturbances will be restored to preexisting conditions at the end of the construction. Therefore, there is not expected to be any impact from construction within the identified floodplains on this project.

## 7 References

StreamStats (usgs.gov)

https://streamstats.usgs.gov/ss

ArapaMAP 3.10.1 (arapahoegov.com)

https://gis.arapahoegov.com/ArapaMAP/



## NSS | National Streamflow Statistics (usgs.gov)

https://streamstats.usgs.gov/nss/

Capesius, J.P., and Stephens, V. C.,

2009, Regional Regression Equations for Estimation of Natural Streamflow Statistics in Colorado: U. S. Geological Survey Scientific Investigations Report 2009-5136, 32 p.

Chang, Howard H. 1988. "Fluvial Processes in River Engineering," Krieger Publishing, Malabar, FL, 432.p.

Chow, V.T. 1959. "Open-Channel Hydraulics," McGraw-Hill, New York, NY, 680 p.

Kohn, M.S., Stevens, M.R., Harden, T.M., Godaire, J.E., Klinger, R.E., and Mommandi, A., 2016, Paleoflood investigations to improve peak-streamflow regional-regression equations for natural streamflow in eastern Colorado, 2015: U.S. Geological Survey Scientific Investigations Report 2016–5099, 58 p.

Linsley, Ray K., Joseph B. Franzini, David L. Freyberg, and George Tchobanoglous. 1992. "Water-Resources Engineering," Fourth Edition., Irwin McGraw-Hill, Boston, 841 p.

Ries, K.G. III, M.Y. Crouse, J.B. Atkins, R. Dusenbury, M. Gray, M.E. Jennings, W.H. Kirby, H.C. Riggs, V.B. Sauer, and W.O. Thomas Jr. 2002. "The National Flood Frequency Program, Version 3: A Computer Program for Estimating Magnitude and Frequency of Floods for Ungauged Sites," U.S. Geological Survey Water Resources Investigations Report 02-4168, 43 p.

Trow Engineering Consultants, Inc. 1996. "Water-Crossing Design and Installation Manual," prepared for the Offshore and Onshore Design Application Supervisory Committee of PRC International (copyright to American Gas Association).

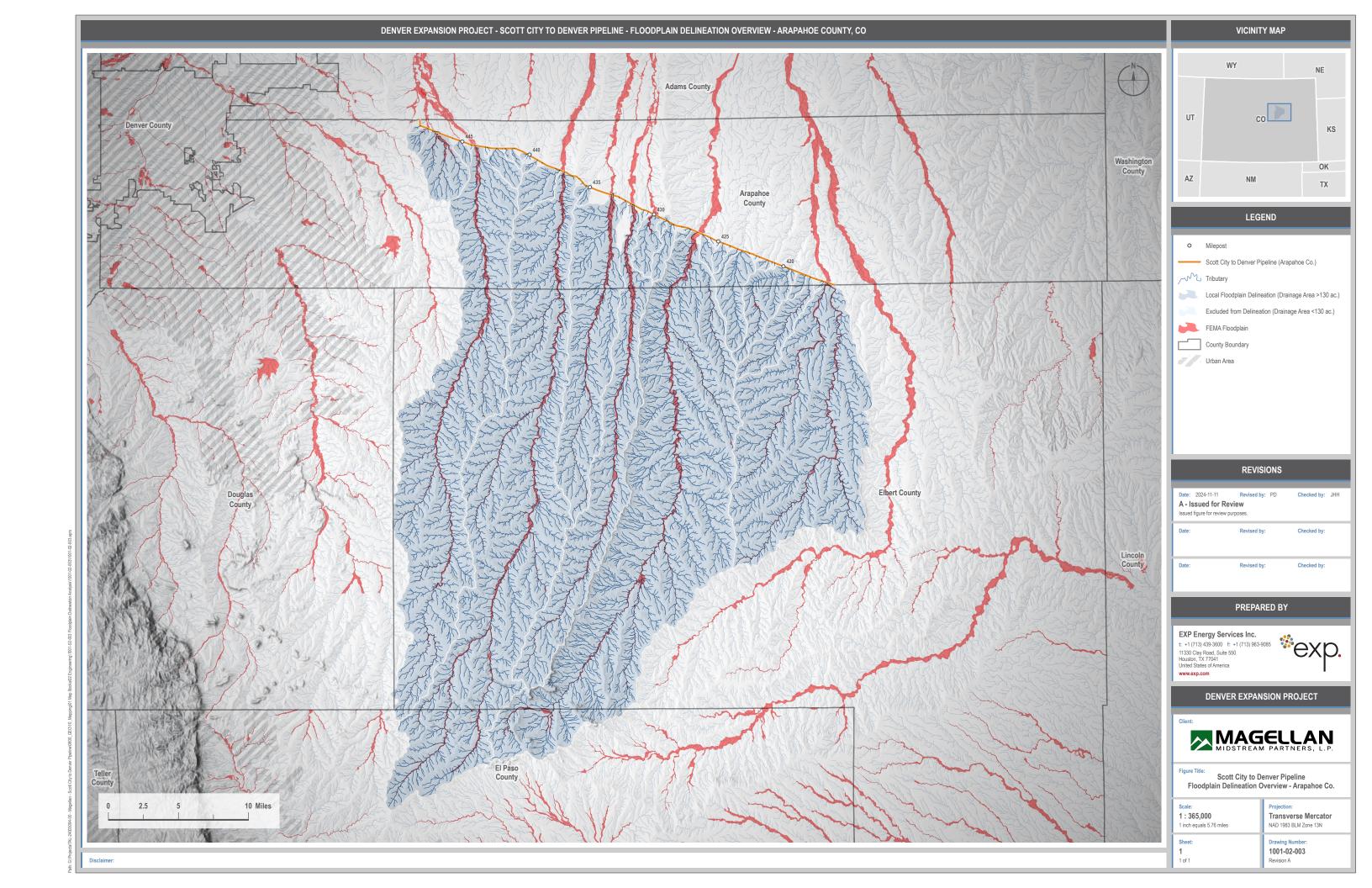
#### Waltemeyer, S.D.

2006, Analysis of the Magnitude and Frequency of Peak Discharges for the Navajo Nation in Arizona, Utah, Colorado, and New Mexico: U. S. Geological Survey Scientific Investigations Report 2006-5306, 42 p.



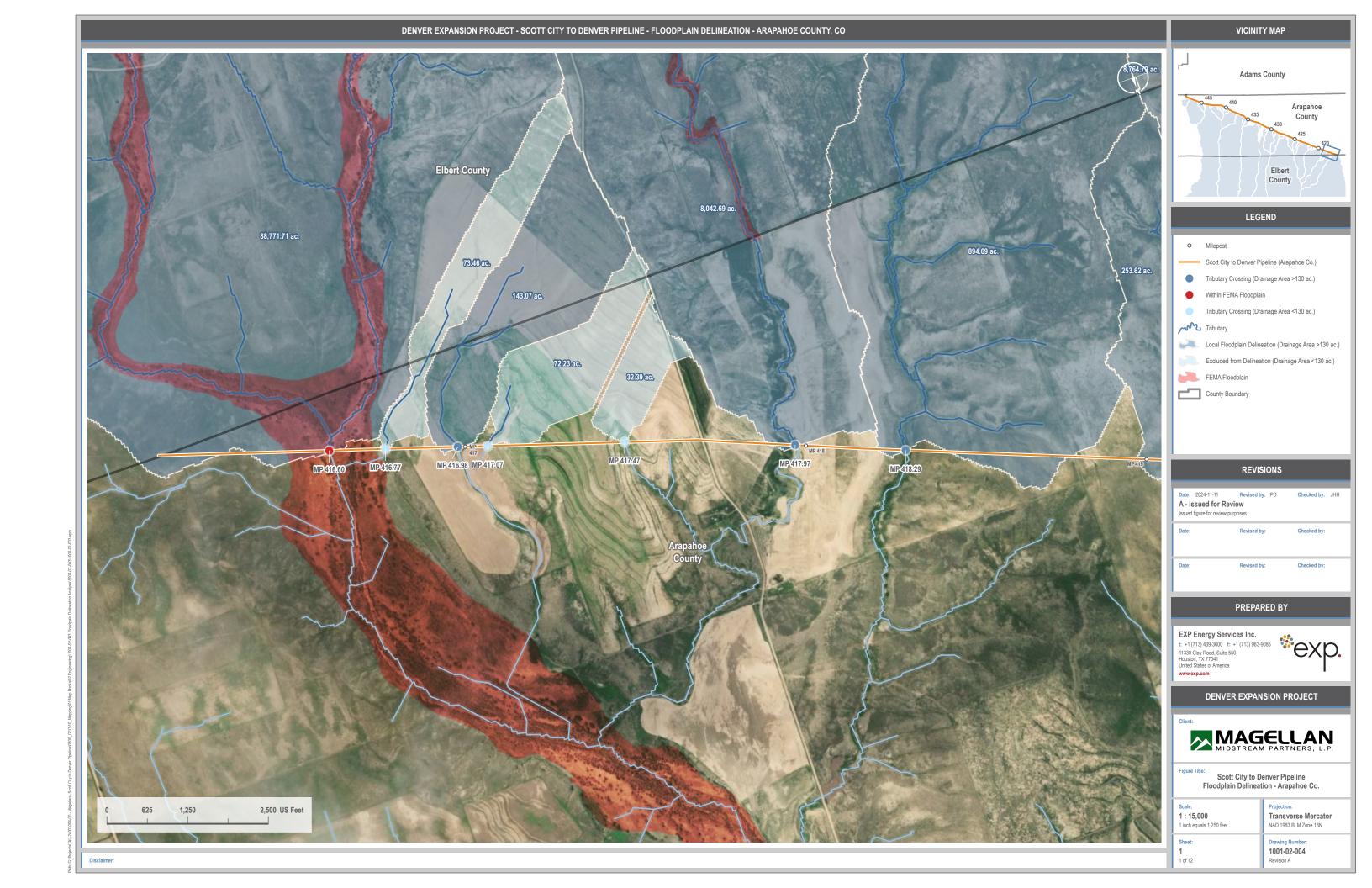
# Appendix A – Arapahoe County Overview with Watersheds



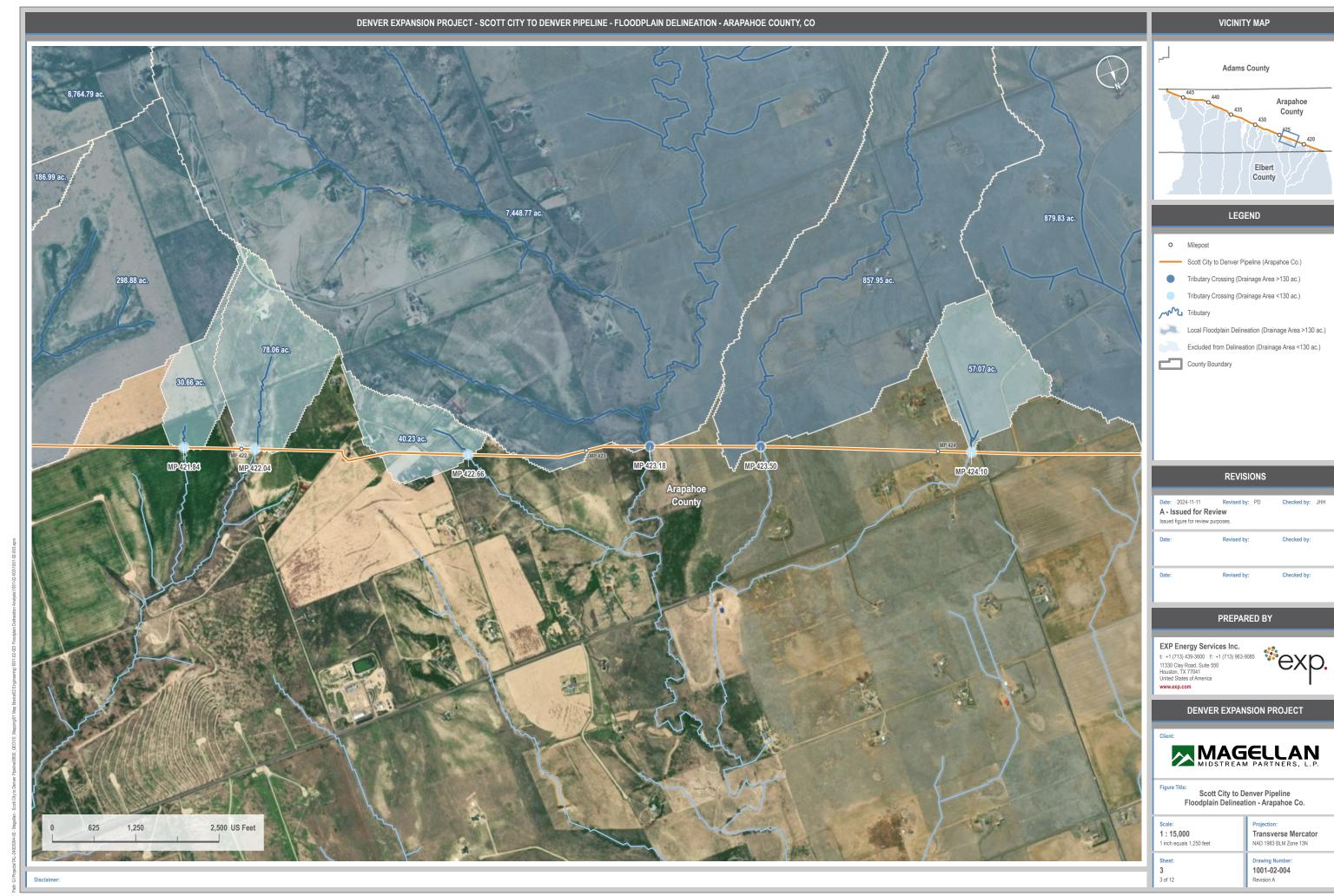


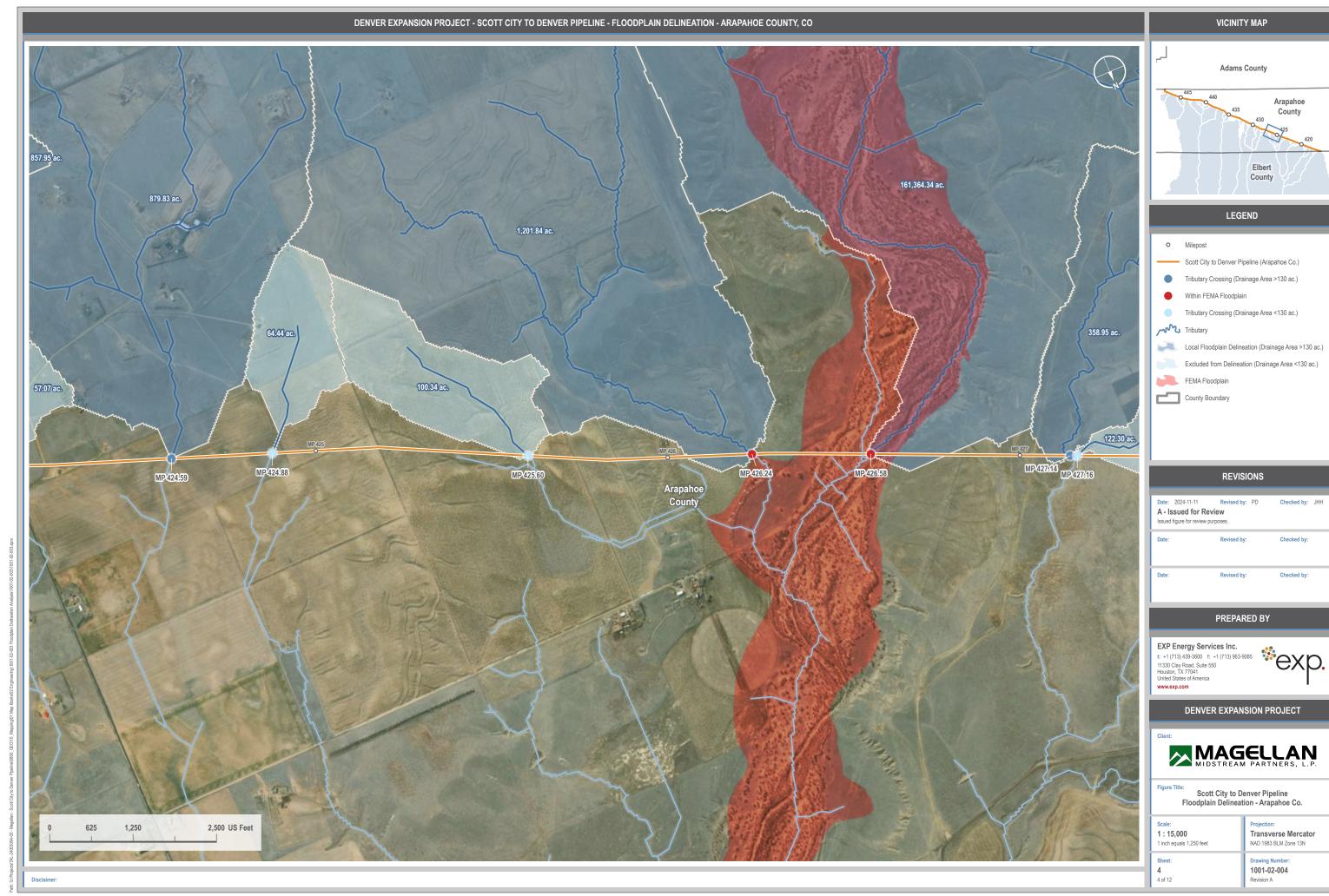
## Appendix B – Stream Crossings Map Book

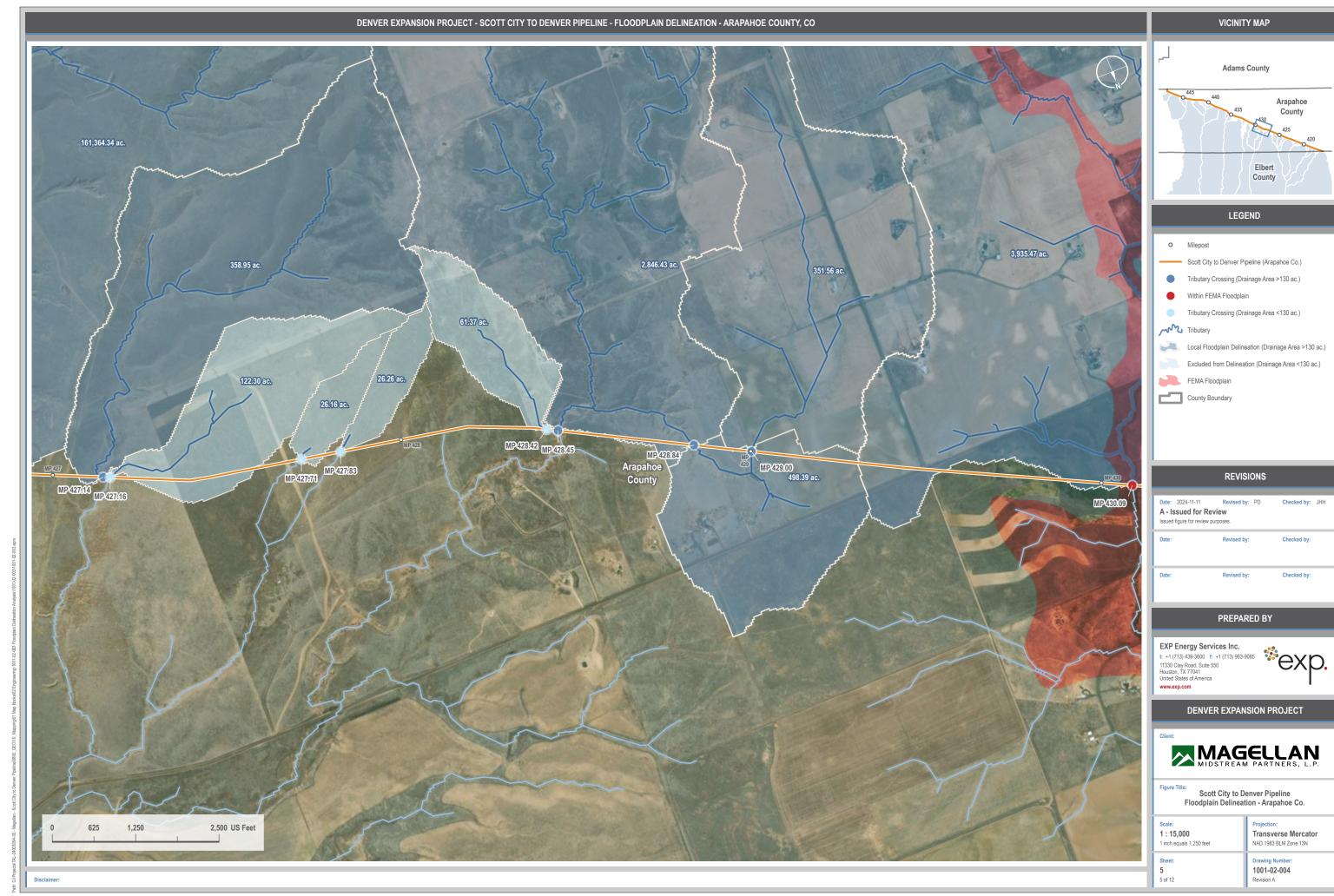


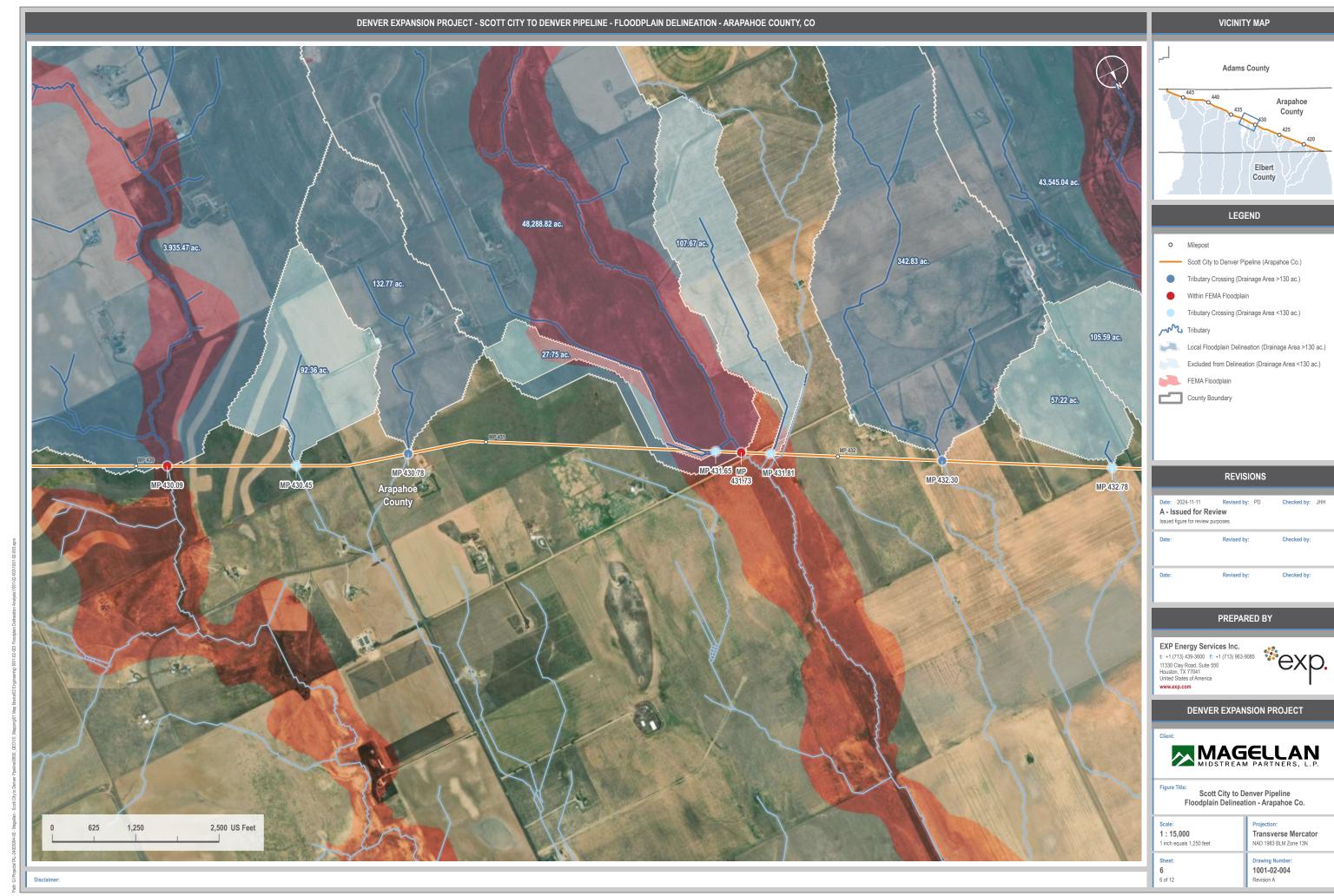


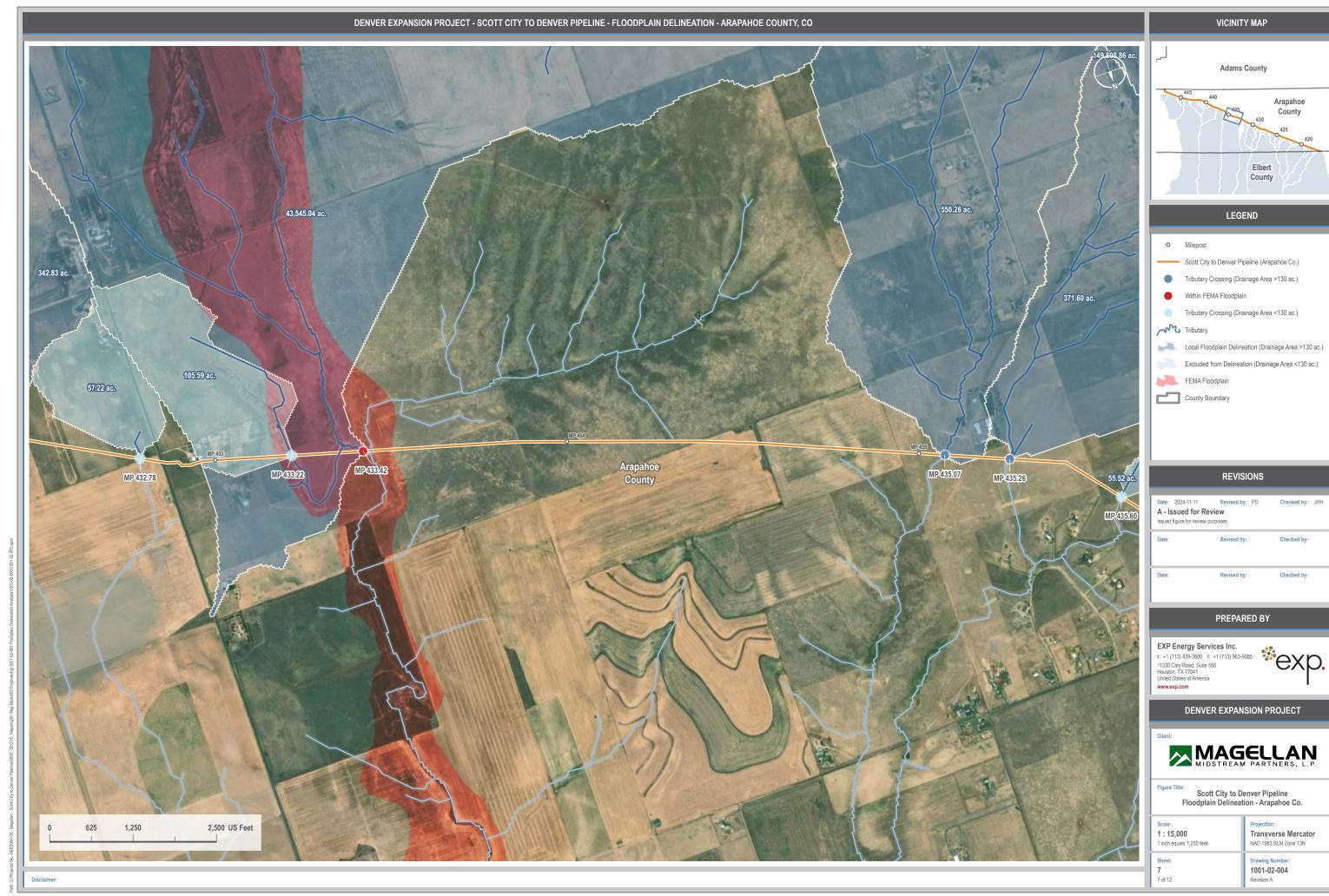


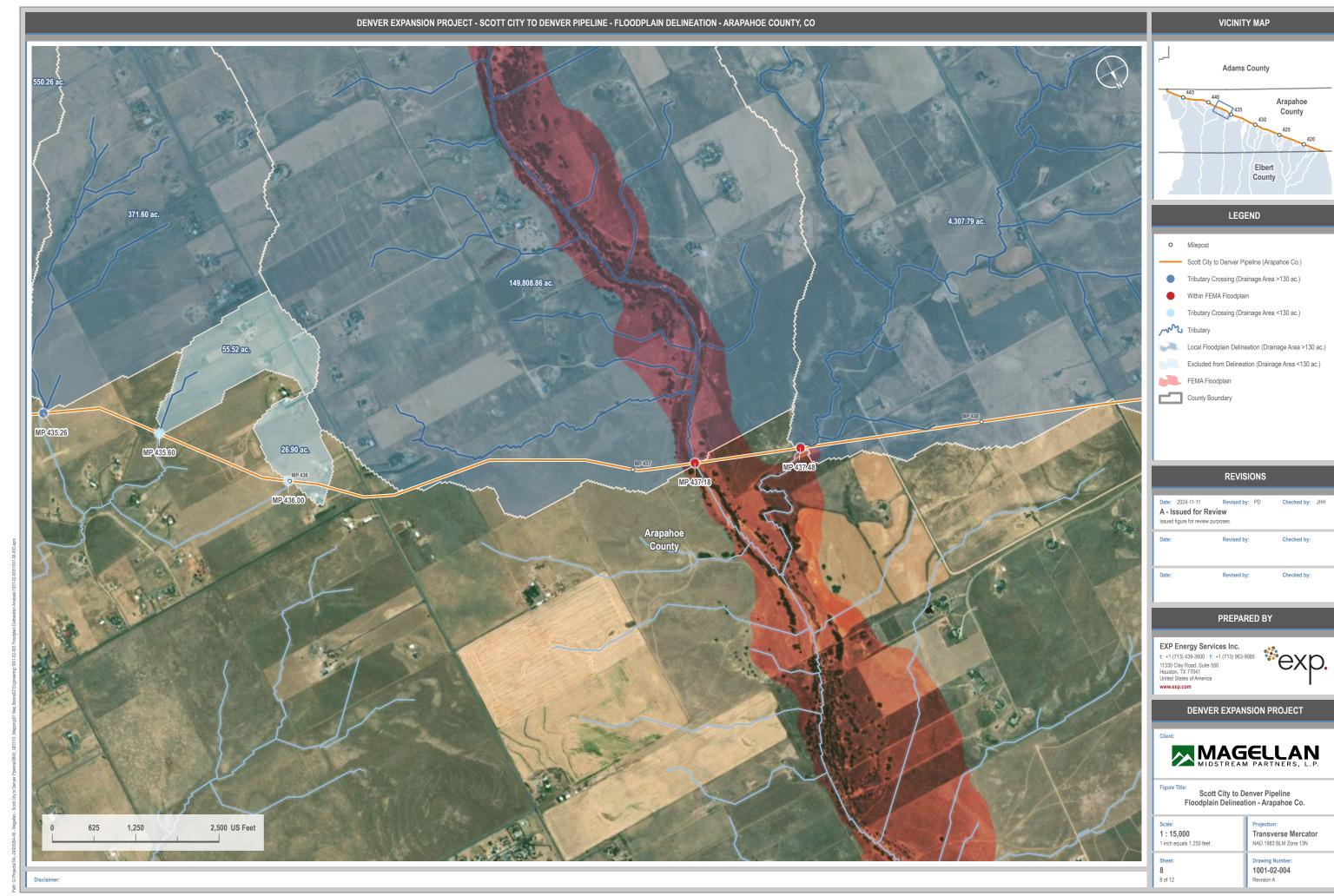


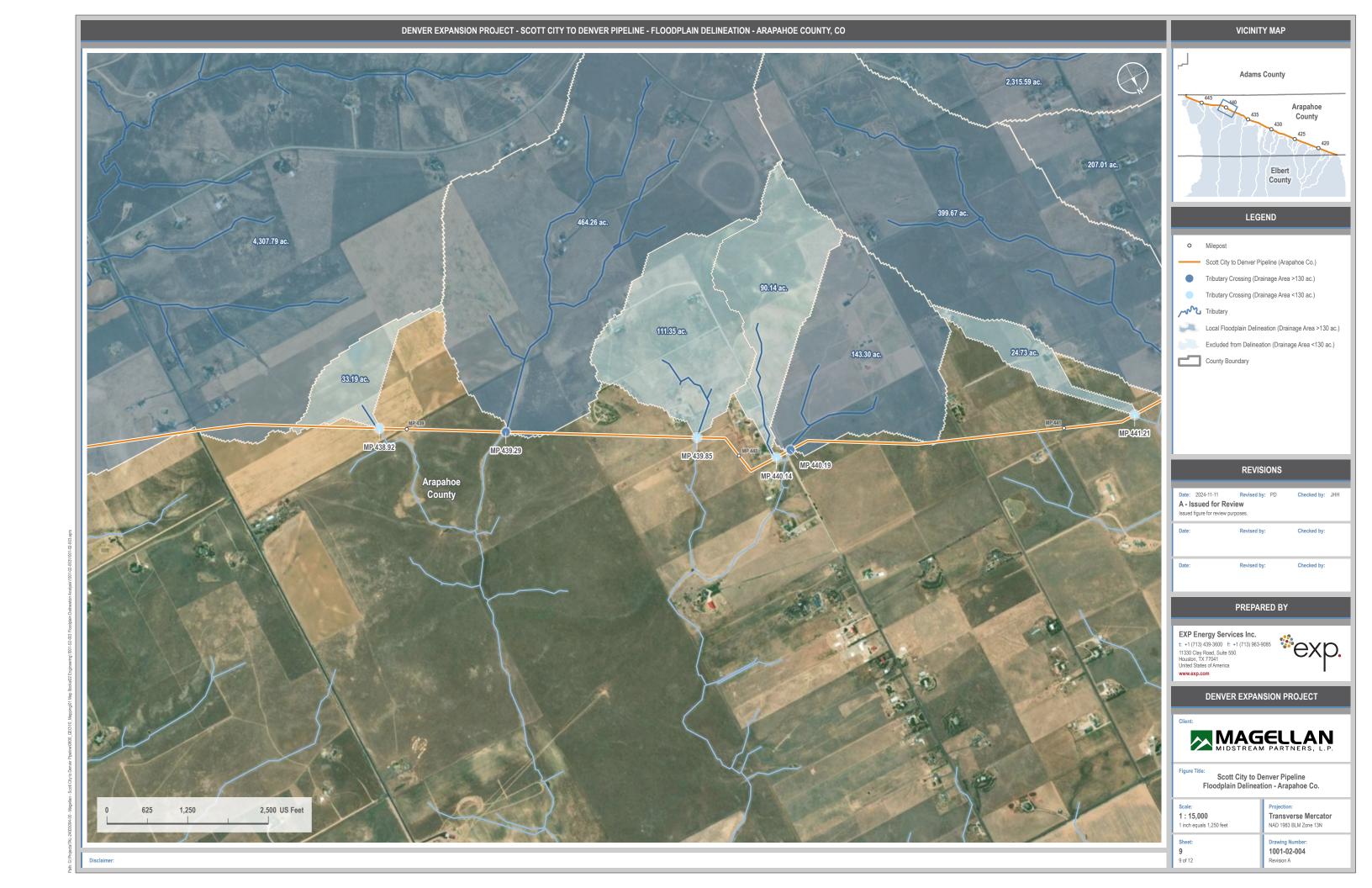


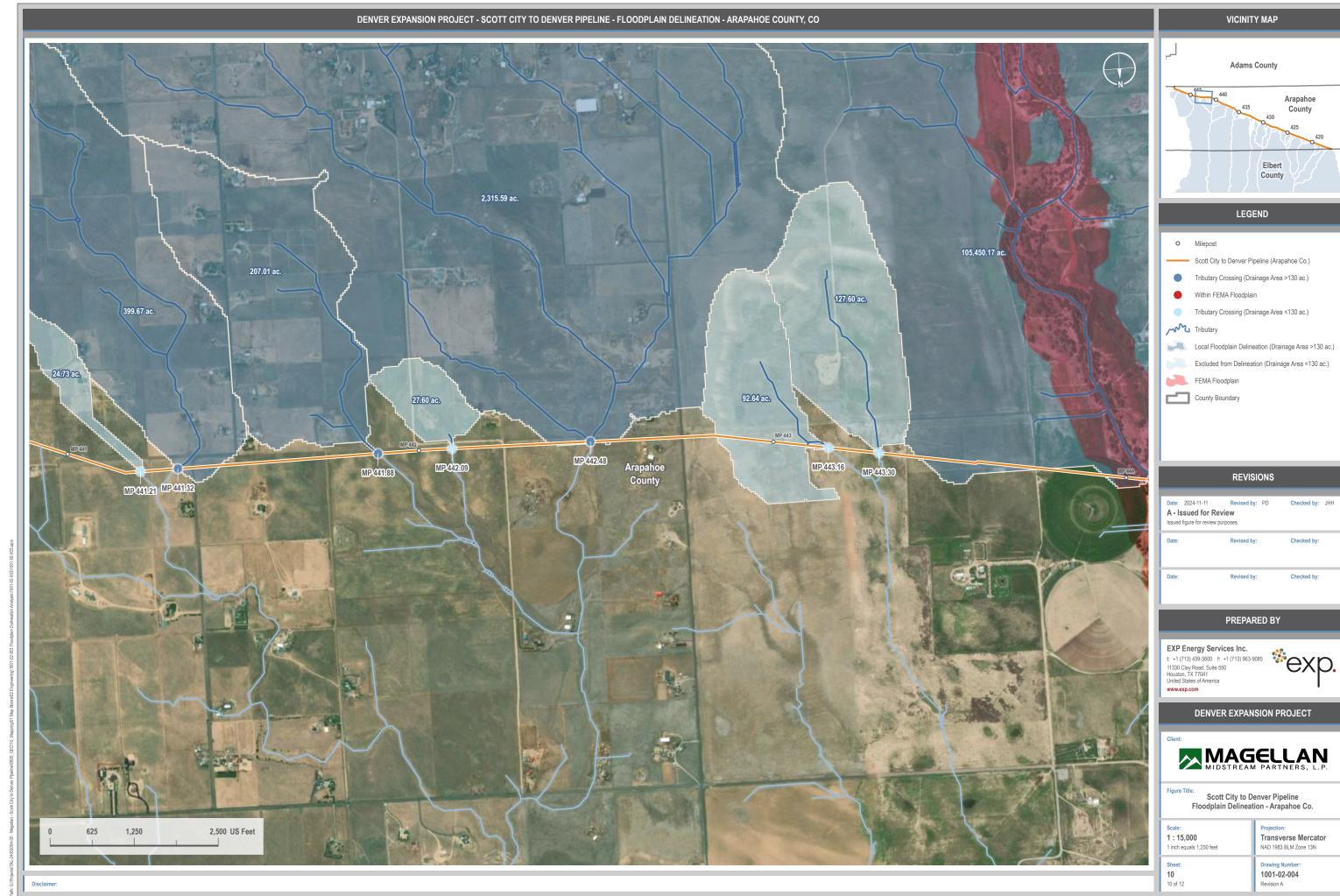


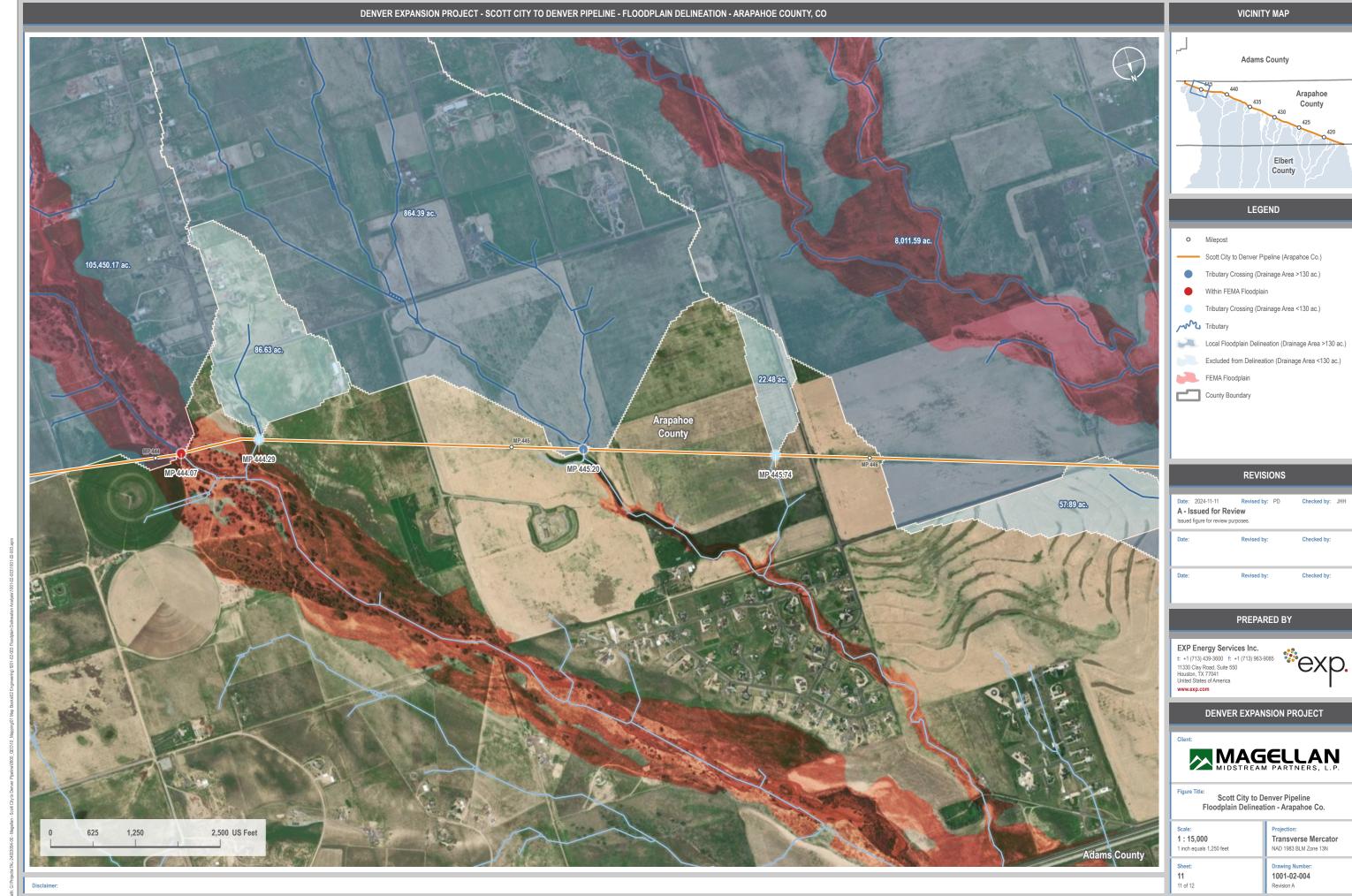


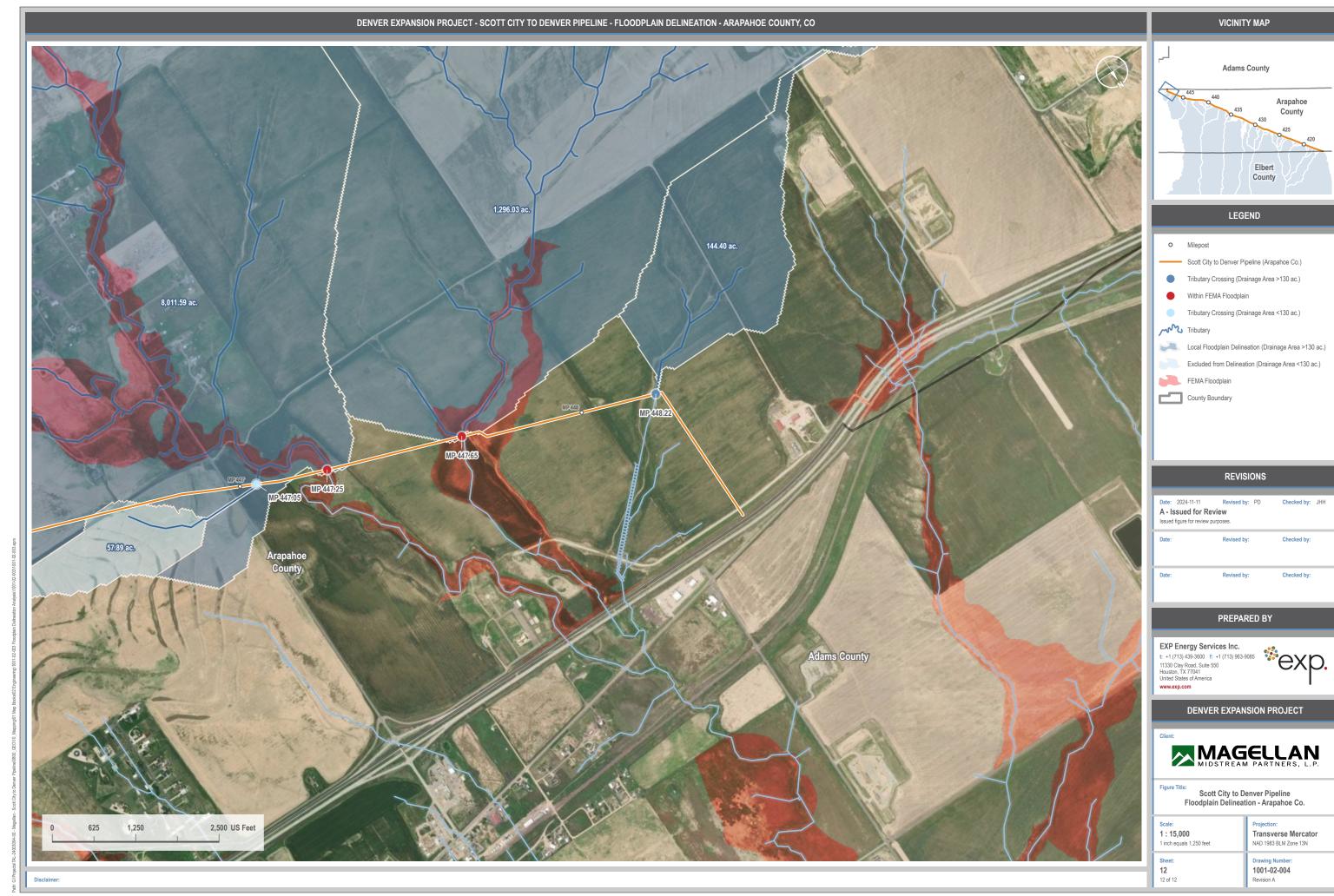












## Appendix C – Local Floodplain Delineation Drawings





SECTION VIEW
HORIZ. SCALE: SCALE 1:100
VERT. SCALE: 1:25 HYDRAULIC CALCULATIONS: Channel Design Invert Roughness Invert Water Sope Coefficient Bevation Depth Discharge Number Velocity Flow Area Top Width Perimeter Radius Depth Predicted Top Width Perimeter Radius Depth Specific of Flow Sp 
 ft²
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 ft

SCOTT CITY TO DENVER PIPELINE

FLOOD PLAIN DELINEATION MAP DRAINAGE AT MP 416.98

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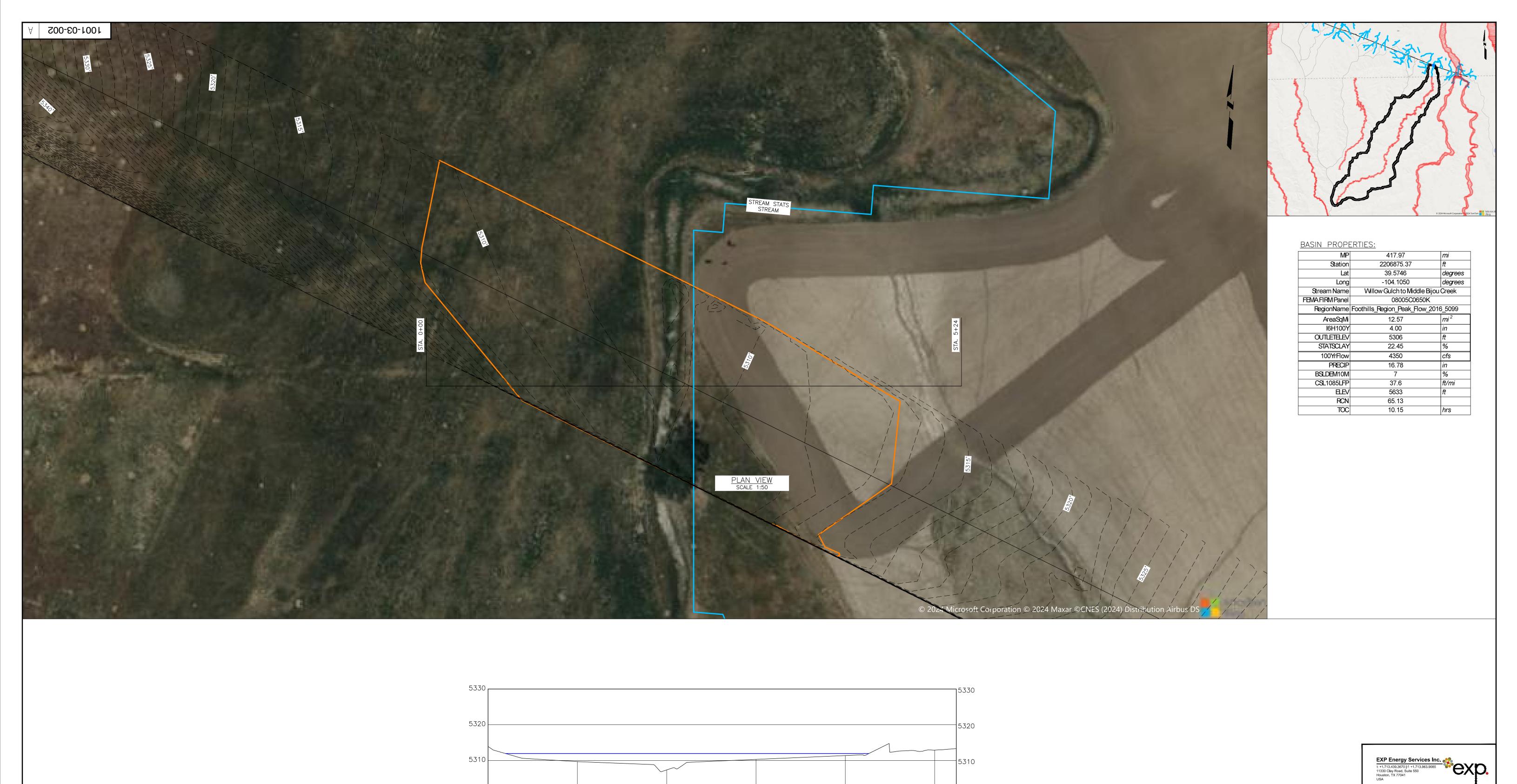
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1. Hydraulic gradeline based on cross section from civil survey from July-August 2024.



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**DENVER EXPANSION PROJECT** SCOTT CITY TO DENVER PIPELINE

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APPROVED BY SAS

1. Hydraulic gradeline based on cross section from civil survey from July-August 2024.

NOTES:

Invert Roughness Invert Water Froude Flow Welted Hydraulic Hydraulic Specific of Flow Specific Low Point Predicted Coefficient Bevation Depth Discharge Number Velocity Flow Area Top Width Perimeter Radius Depth Energy Area Force BFEHGL on CL at Station CLdepth 
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SECTION VIEW
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VERT. SCALE: 1:25

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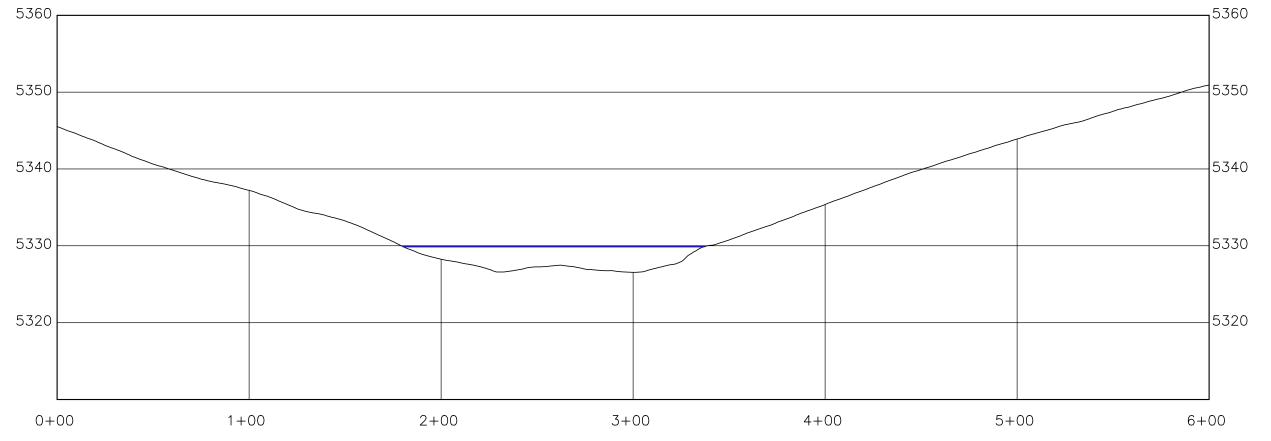
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Channel Design

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SECTION VIEW
HORIZ. SCALE: SCALE 1:100
VERT. SCALE: 1:25

HYDRAULIC CALCULATIONS:

Channel		Channel	Design										Centroid					
Invert	Roughness	Invert	Water .		Froude	Flow			Wetted	Hydraulic	Hydraulic	Specific	of Flow	Specific		Low Point		Predicted
Slope	Coefficient	⊟evation	Depth	Discharge	Number	Velocity	Flow Area	Top Width	Perimeter	Radius	Depth	Energy	Area	Force	BFEHGL	on CL	at Station	CLdepth
ft/ft		ft	ft	cfs		fps	ft <sup>2</sup>	ft	ft	ft	ft	ft	ft	kip	ft	ft	ft	ft
0.012	0.04	5326.56	2.29	1221.5	0.78	5.58	219.0	138.5	138.7	1.58	1.58	2.77	1.38	32.1	5328.85	5326.47	2208655.9	2.38

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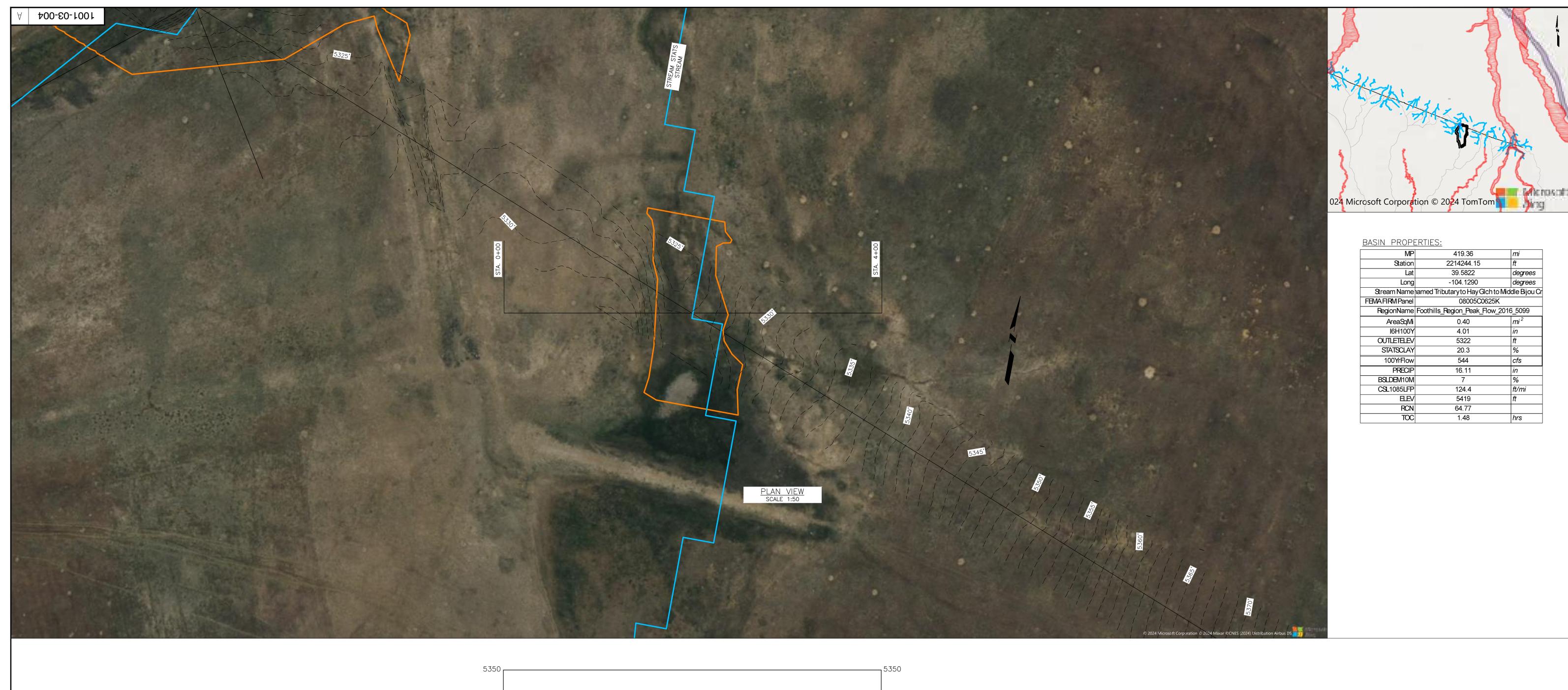
FLOOD PLAIN DELINEATION MAP DRAINAGE AT MP 418.29 ARAPAHOE COUNTY

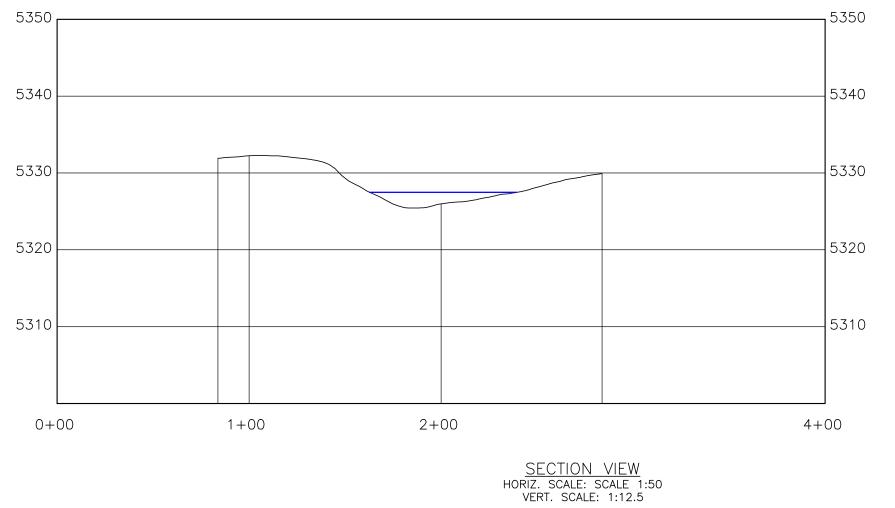
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1. Floodplain delineation based on 3DEP LiDAR digital terrain model.

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HYDRAULIC CALCULATIONS:

Channel		Channel	Design										Centroid					
Invert	Roughness	Invert	Water		Froude	Flow			Wetted	Hydraulic	Hydraulic	Specific	of Flow	Specific		Low Point		Predicted
Slope	Coefficient	⊟evation	Depth	Discharge	Number	Velocity	Flow Area	Top Width	Perimeter	Radius	Depth	Energy	Area	Force	BFEHGL	on CL	at Station	CLdepth
ft/ft		ft	ft	cfs		fps	ft <sup>2</sup>	ft	ft	ft	ft	ft	ft	kip	ft	ft	ft	ft
0.024	0.04	5325.45	2.03	547.3	1.03	6.25	87.5	76.3	76.5	1.14	1.15	2.64	1.28	13.6	5327.48	5325.17	2214286.9	2.31

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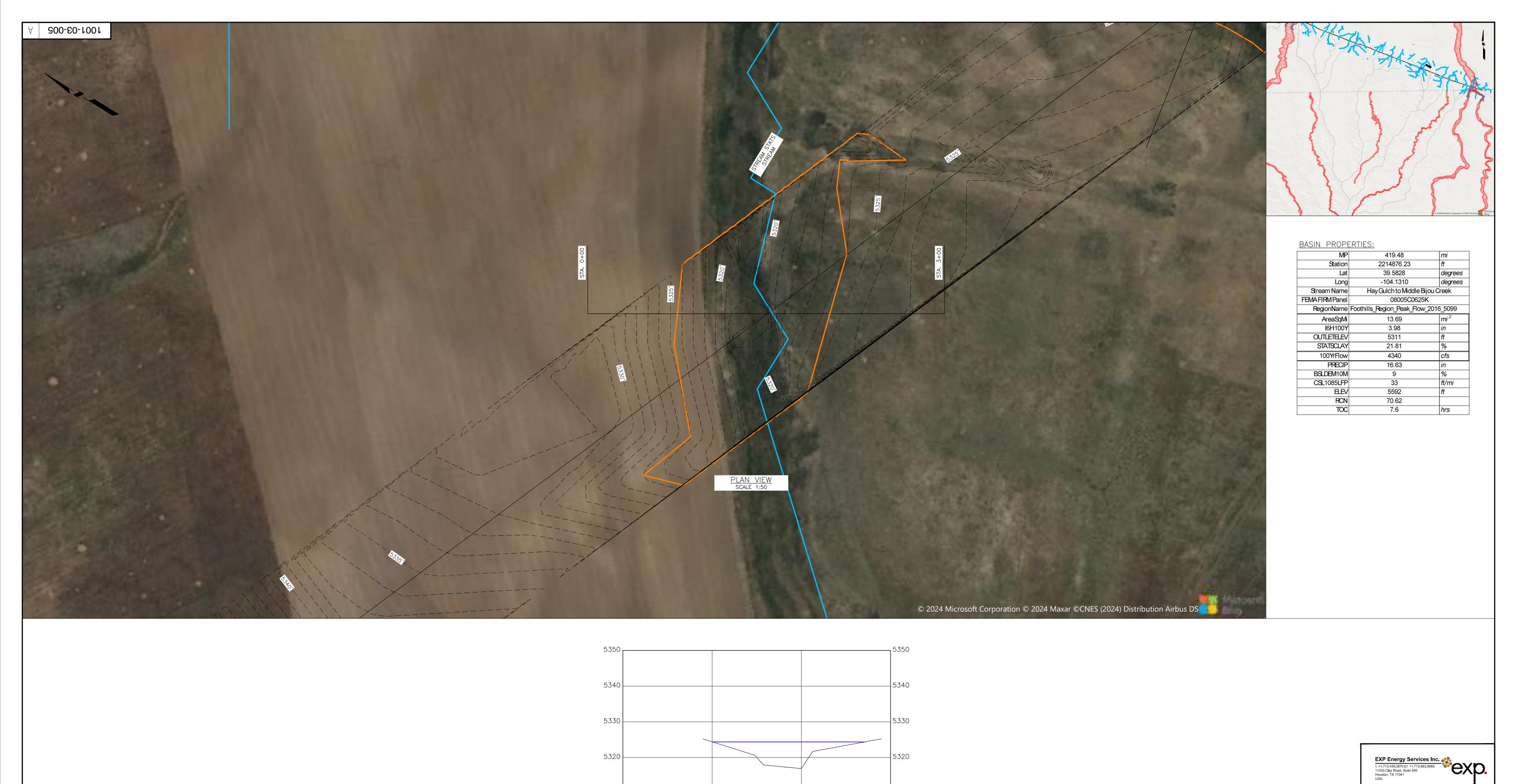
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SCOTT CITY TO DENVER PIPELINE FLOOD PLAIN DELINEATION MAP DRAINAGE AT MP 419.36

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1. Floodplain delineation based on 3DEP LiDAR digital terrain model.



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DENVER EXPANSION PROJECT SCOTT CITY TO DENVER PIPELINE

SCOTT CITY TO DENVER PIPELINE
FLOOD PLAIN DELINEATION MAP DRAINAGE AT MP 419.48

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Slope	Coefficient	⊟evation	Depth	Discharge	Number	Velocity	Flow Area	Top Width Perimete	r Radius	Depth	Energy	Area	Force	BFEHGL	on CL	at Station	CLdepth	l
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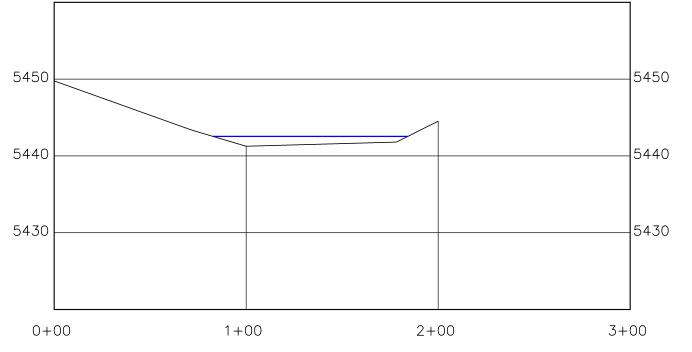
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NOTES:

1. Hydraulic gradeline based on cross section from civil survey from July-August 2024.





HYDRAULIC CALCULATIONS:

Channel		Channel	Design										Centroid					
Invert	Roughness	Invert	Water		Froude	Flow			Wetted	Hydraulic	Hydraulic	Specific	of Flow	Specific		Low Point		Predicted
Slope	Coefficient	⊟evation	Depth	Discharge	Number	Velocity	Flow Area	Top Width	Perimeter	Radius	Depth	Energy	Area	Force	BFEHGL	on CL	at Station	CLdepth
ft/ft		ft	ft	cfs		fps	ft <sup>2</sup>	ft	ft	ft	ft	ft	ft	kip	ft	ft	ft	ft
0.019	0.04	5441.27	1.27	447.1	0.90	4.86	92.0	101.4	101.5	0.91	0.91	1.64	0.77	8.6	5442.54	5441.27	2223671.9	1.27



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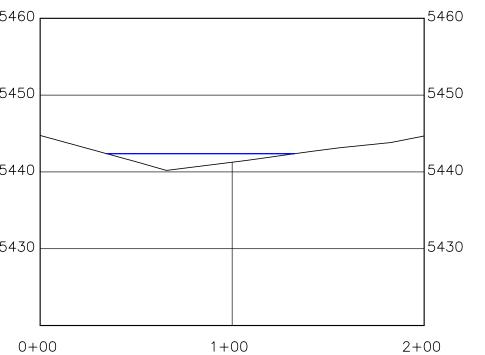
FLOOD PLAIN DELINEATION MAP DRAINAGE AT MP 421.15 arapahoe county colorado

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1. Hydraulic gradeline based on cross section from civil survey from July-August 2024.

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HYDRAULIC CALCULATIONS:

Channel		Channel	Design										Centroid					, 
Invert	Roughness	Invert	Water		Froude	Flow			Wetted	Hydraulic	Hydraulic	Specific	of Flow	Specific		Low Point		Predicted
Slope	Coefficient	⊟evation	Depth	Discharge	Number	Velocity	Flow Area	Top Width	Perimeter	Radius	Depth	Energy	Area	Force	BFEHGL	on CL	at Station	CLdepth
ft/ft		ft	ft	cfs		fps	ft <sup>2</sup>	ft	ft	ft	ft	ft	ft	kip	ft	ft	ft	ft
0.023	0.04	5440.21	2.16	650.9	1.01	6.04	107.7	97.8	97.9	1.10	1.10	2.73	1.43	17.2	5442.37	5440.24	2224133.9	2.13



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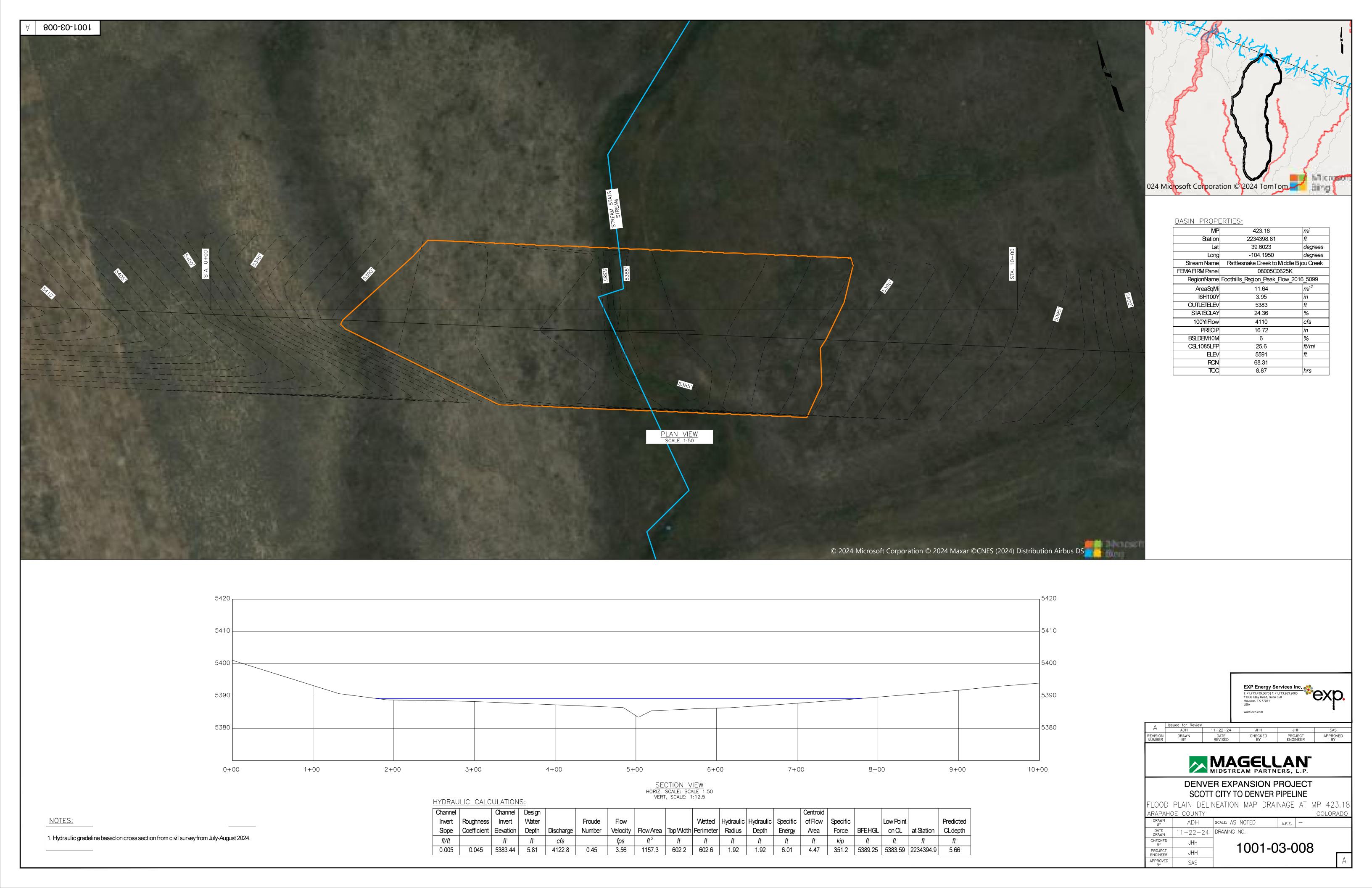
FLOOD PLAIN DELINEATION MAP DRAINAGE AT MP 421.23
ARAPAHOE COUNTY COLORADO

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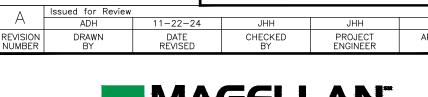
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HYDRAULIC CALCULATIONS:

Channel		Channel	Design										Centroid						
Invert	Roughness	Invert	Water		Froude	Flow			Wetted	Hydraulic	Hydraulic	Specific	of Flow	Specific		Low Point		Predicted	
Sope	Coefficient	⊟evation	Depth	Discharge	Number	Velocity	Flow Area	Top Width	Perimeter	Radius	Depth	Energy	Area	Force	BFEHGL	on CL	at Station	CLdepth	
ft/ft		ft	ft	cfs		fps	ft <sup>2</sup>	ft	ft	ft	ft	ft	ft	kip	ft	ft	ft	ft	
0.008	0.04	5393 34	3.55	1255.7	0.64	4 76	263.9	152.9	153 1	1 72	1 73	3.90	2.37	50.7	5396 89	5393 43	2236038.9	3 46	



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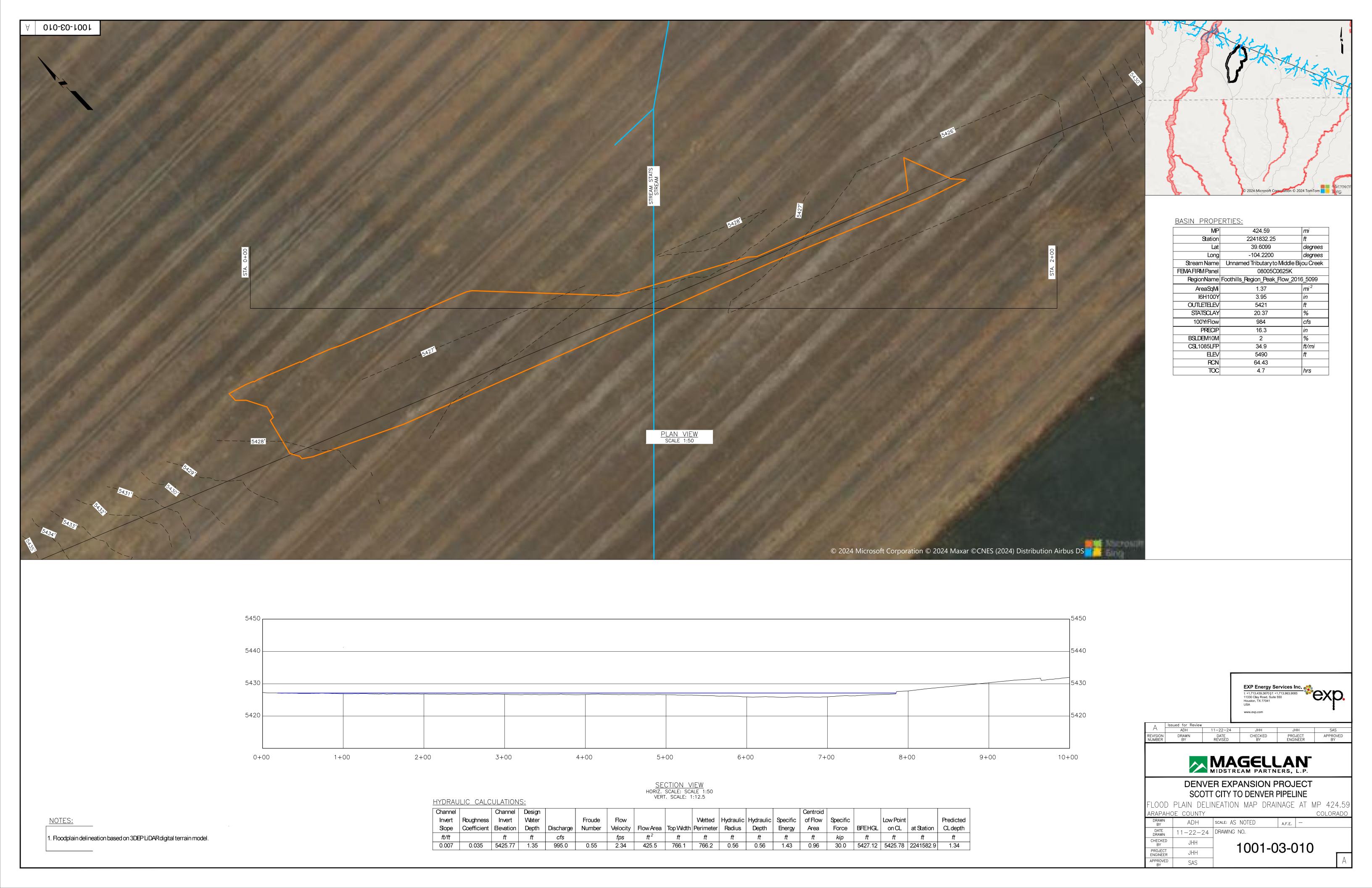
FLOOD PLAIN DELINEATION MAP DRAINAGE AT MP 423.50 ARAPAHOE COUNTY

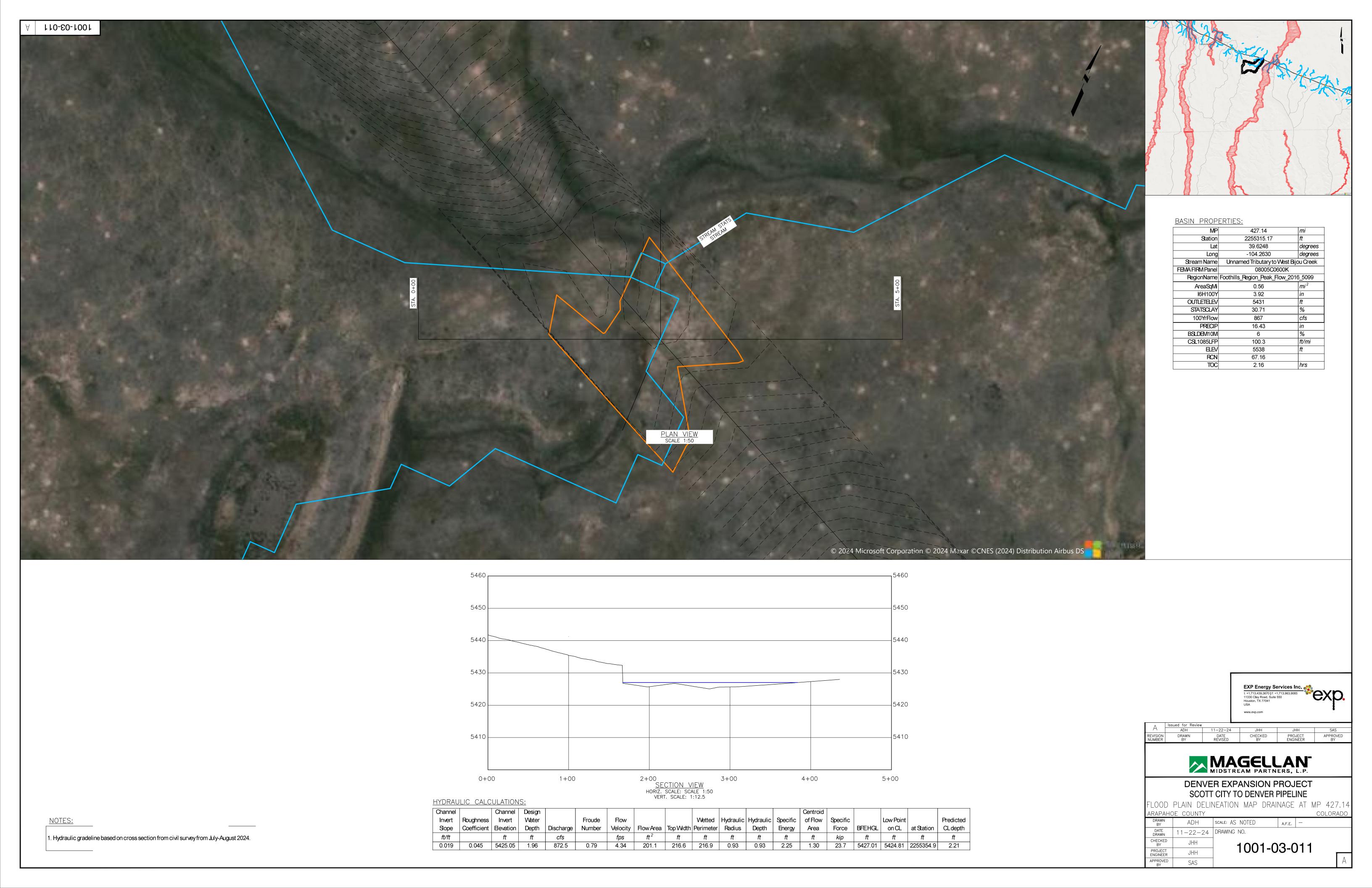
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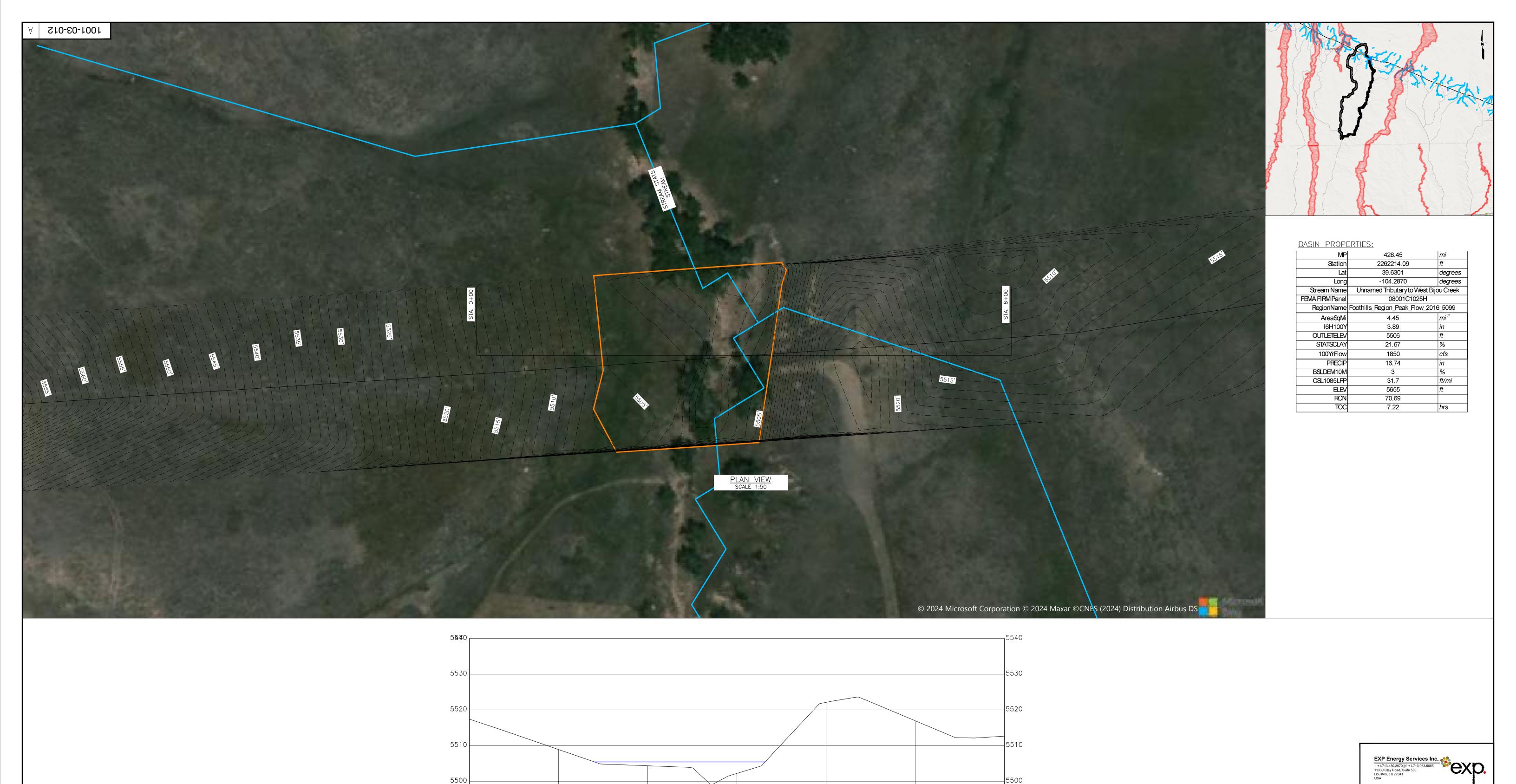
1. Hydraulic gradeline based on cross section from civil survey from July-August 2024.

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MIDSTREAM PARTNERS, L.P.

### **DENVER EXPANSION PROJECT**

SCOTT CITY TO DENVER PIPELINE

FLOOD PLAIN DELINEATION MAP DRAINAGE AT MP 428.45 DRAWN BY ADH SCALE: AS NOTED A.F.E.

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1. Hydraulic gradeline based on cross section from civil survey from July-August 2024.

NOTES:

Channel		Channel	Design										Centroid					
Invert	Roughness	Invert	Water		Froude	Flow			Wetted	Hydraulic	Hydraulic	Specific	of Flow	Specific		Low Point		Predicted
Slope	Coefficient	⊟evation	Depth	Discharge	Number	Velocity	Flow Area	Top Width	Perimeter	Radius	Depth	Energy	Area	Force	BFEHGL	on CL	at Station	CLdepth
ft/ft		ft	ft	cfs		fps	ft <sup>2</sup>	ft	ft	ft	ft	ft	ft	kip	ft	ft	ft	ft
0.006	0.04	5498.96	6.45	1851.0	0.57	4.67	396.3	191.5	192.5	2.06	2.07	6.79	4.76	134.4	5505.41	5498.99	2262243.9	6.42

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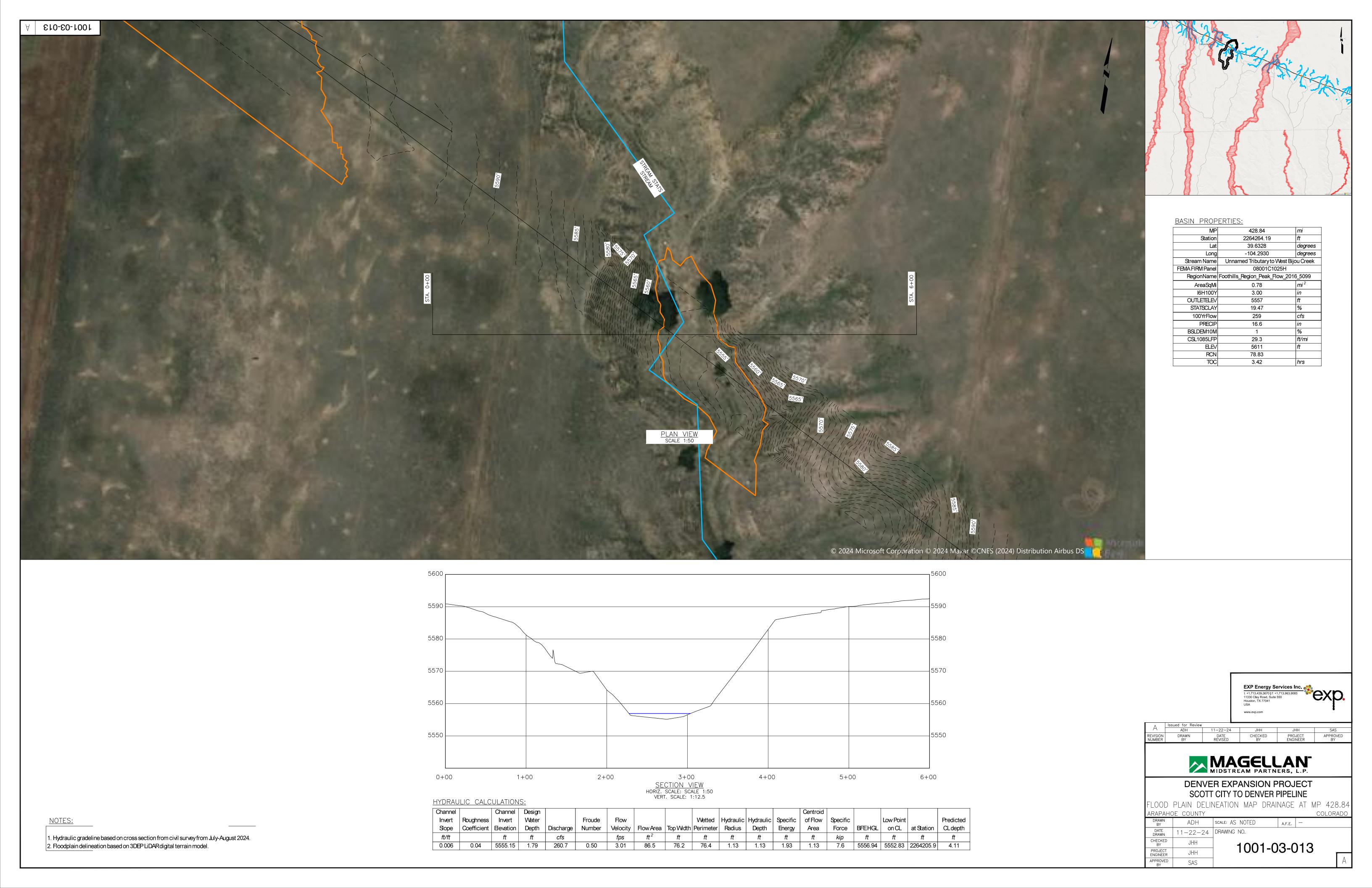
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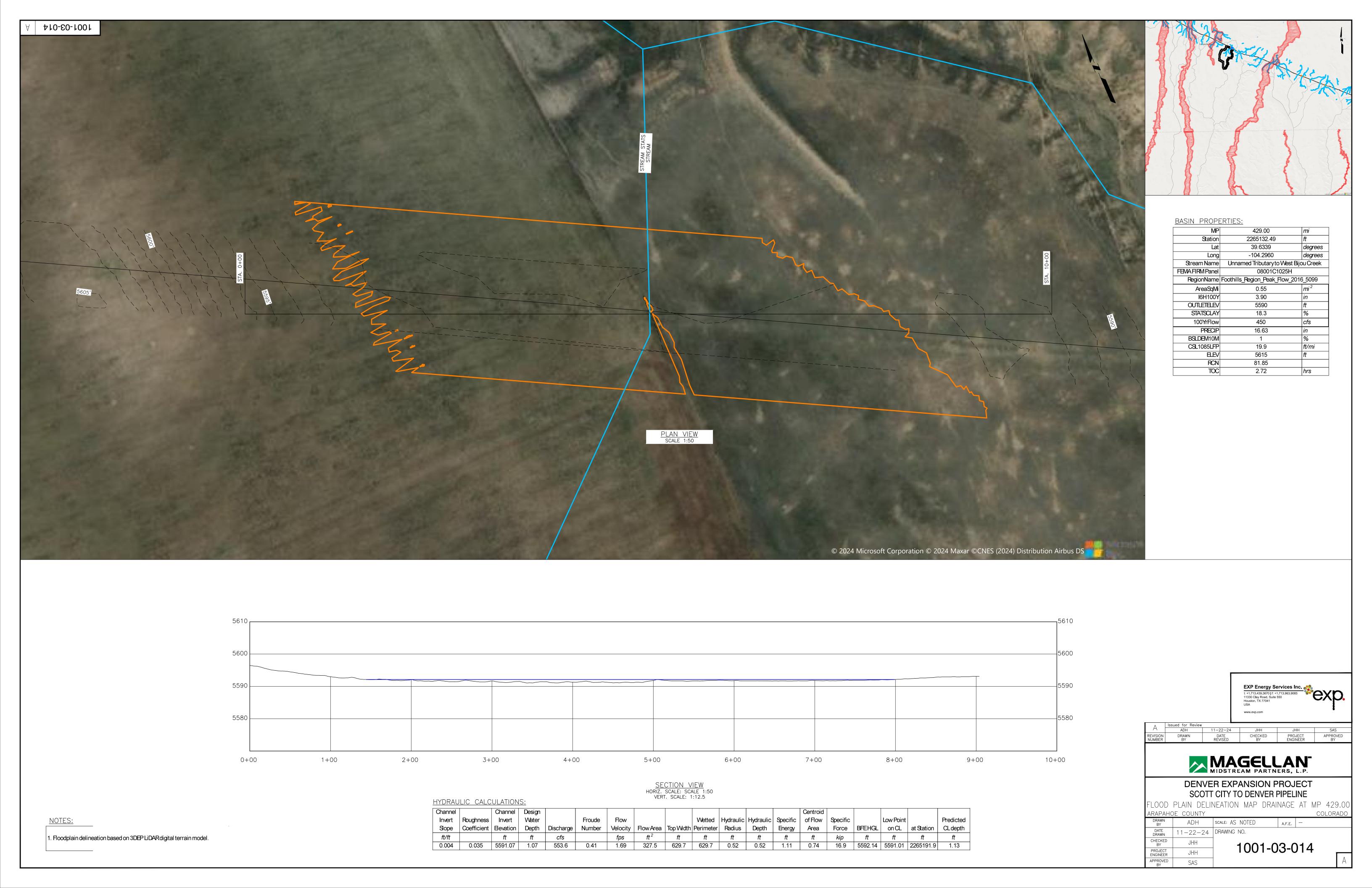
HYDRAULIC CALCULATIONS:

SECTION VIEW

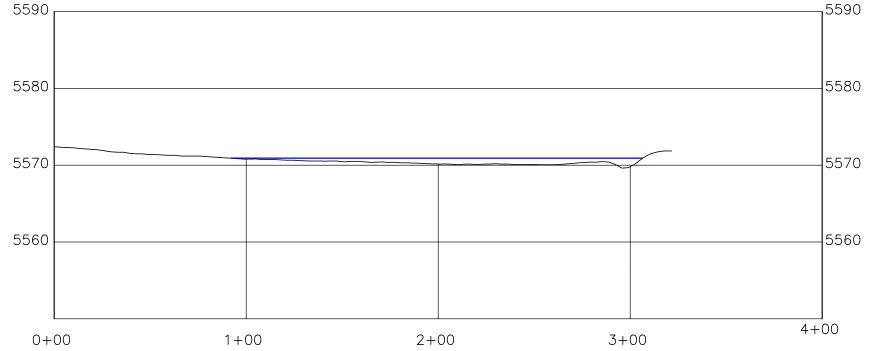
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HYDRAULIC CALCULATIONS:

NOTES:

1. Hydraulic gradeline based on cross section from civil survey from July-August 2024.

Chan	nel	Channel	Design										Centroid					
Inve	rt Roughness	Invert	Water		Froude	Flow			Wetted	Hydraulic	Hydraulic	Specific	of Flow	Specific		Low Point		Predicted
Slop	e Coefficient	⊟evation	Depth	Discharge	Number	Velocity	Flow Area	Top Width	Perimeter	Radius	Depth	Energy	Area	Force	BFEHGL	on CL	at Station	CLdepth
ft/f	t	ft	ft	cfs		fps	ft <sup>2</sup>	ft	ft	ft	ft	ft	ft	kip	ft	ft	ft	ft
0.00	0.04	5569.61	1.29	257.9	0.49	2.11	122.5	214.4	214.5	0.57	0.57	1.36	0.94	8.2	5570.90	5569.64	2273651.9	1.27



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#### **DENVER EXPANSION PROJECT** SCOTT CITY TO DENVER PIPELINE

FLOOD PLAIN DELINEATION MAP DRAINAGE AT MP 430.78 ARAPAHOE COUNTY

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ENGINEER JHH

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HYDRAULIC CALCULATIONS:

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Channel		Channel	Design										Centroid					
Invert	Roughness	Invert	Water		Froude	Flow			Wetted	Hydraulic	Hydraulic	Specific	of Flow	Specific		Low Point		Predicted
Slope	Coefficient	⊟evation	Depth	Discharge	Number	Velocity	Flow Area	Top Width	Perimeter	Radius	Depth	Energy	Area	Force	BFEHGL	on CL	at Station	CLdepth
ft/ft		ft	ft	cfs		fps	ft <sup>2</sup>	ft	ft	ft	ft	ft	ft	kip	ft	ft	ft	ft
0.005	0.035	5545.26	1.49	439.8	0.51	2.77	158.8	170.5	170.5	0.93	0.93	1.61	0.91	11.4	5546.75	5546.15	2282354.9	0.60



DENVER EXPANSION PROJECT SCOTT CITY TO DENVER PIPELINE

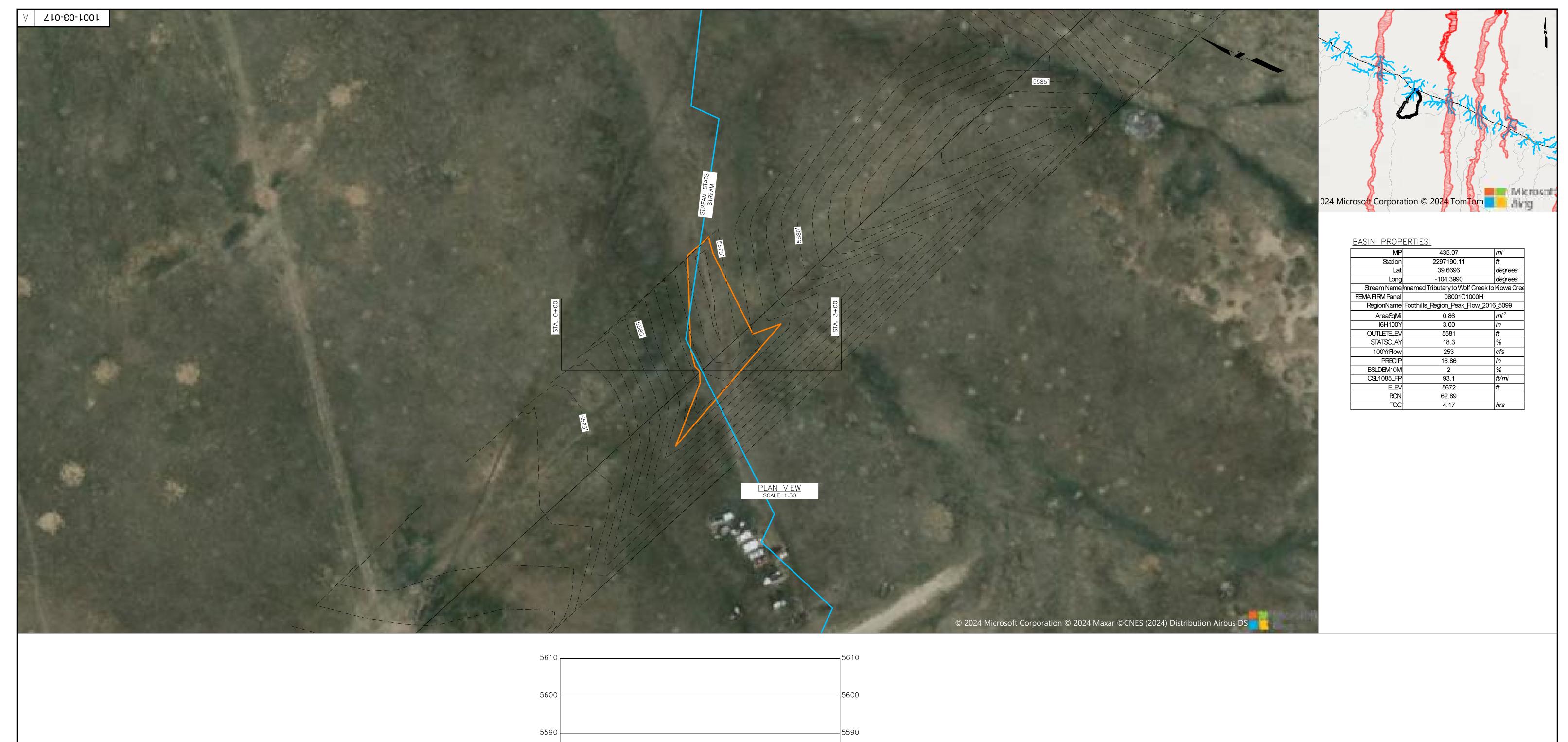
FLOOD PLAIN DELINEATION MAP DRAINAGE AT MP 432.30

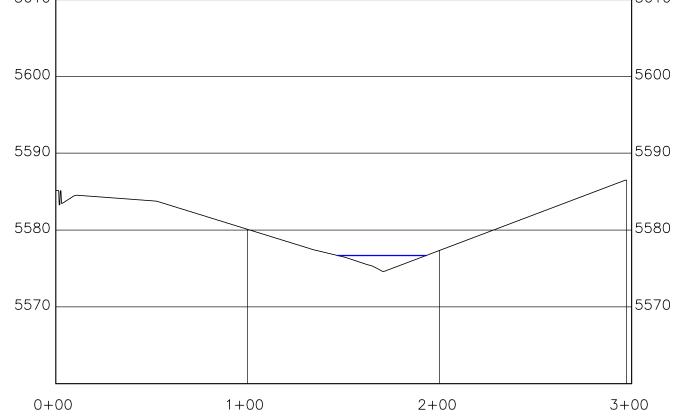
BY	ADH	SCALE: AS NOTED	A.F.E.	
DATE DRAWN	11-22-24	DRAWING NO.		
CHECKED BY	JHH	1001-0	2 (	۱1
PROJECT ENGINEER	JHH	1001-0	<b>3-</b> 0	) I

6 SAS

1. Floodplain delineation based on 3DEP LiDAR digital terrain model.

NOTES:





HYDRAULIC CALCULATIONS:

1. Hydraulic gradeline based on cross section from civil survey from July-August 2024.

NOTES:

Channel		Channel	Design										Centroid					
Invert	Roughness	Invert	Water		Froude	Flow			Wetted	Hydraulic	Hydraulic	Specific	of Flow	Specific		Low Point		Predicted
Slope	Coefficient	⊟evation	Depth	Discharge	Number	Velocity	Flow Area	Top Width	Perimeter	Radius	Depth	Energy	Area	Force	BFEHGL	on CL	at Station	CLdepth
ft/ft		ft	ft	cfs		fps	ft <sup>2</sup>	ft	ft	ft	ft	ft	ft	kip	ft	ft	ft	ft
0.018	0.035	5574.60	2.09	254.1	0.99	5.58	45.6	46.3	46.5	0.98	0.98	2.57	1.40	6.7	5576.69	5573.92	2297160.9	2.77



$\vdash$	ADH	11-22-24	JHH	JHH	SAS
REVISION	DRAWN	DATE	CHECKED	PROJECT	APPROVED
NUMBER	BY	REVISED	BY	ENGINEER	BY



DENVER EXPANSION PROJECT SCOTT CITY TO DENVER PIPELINE

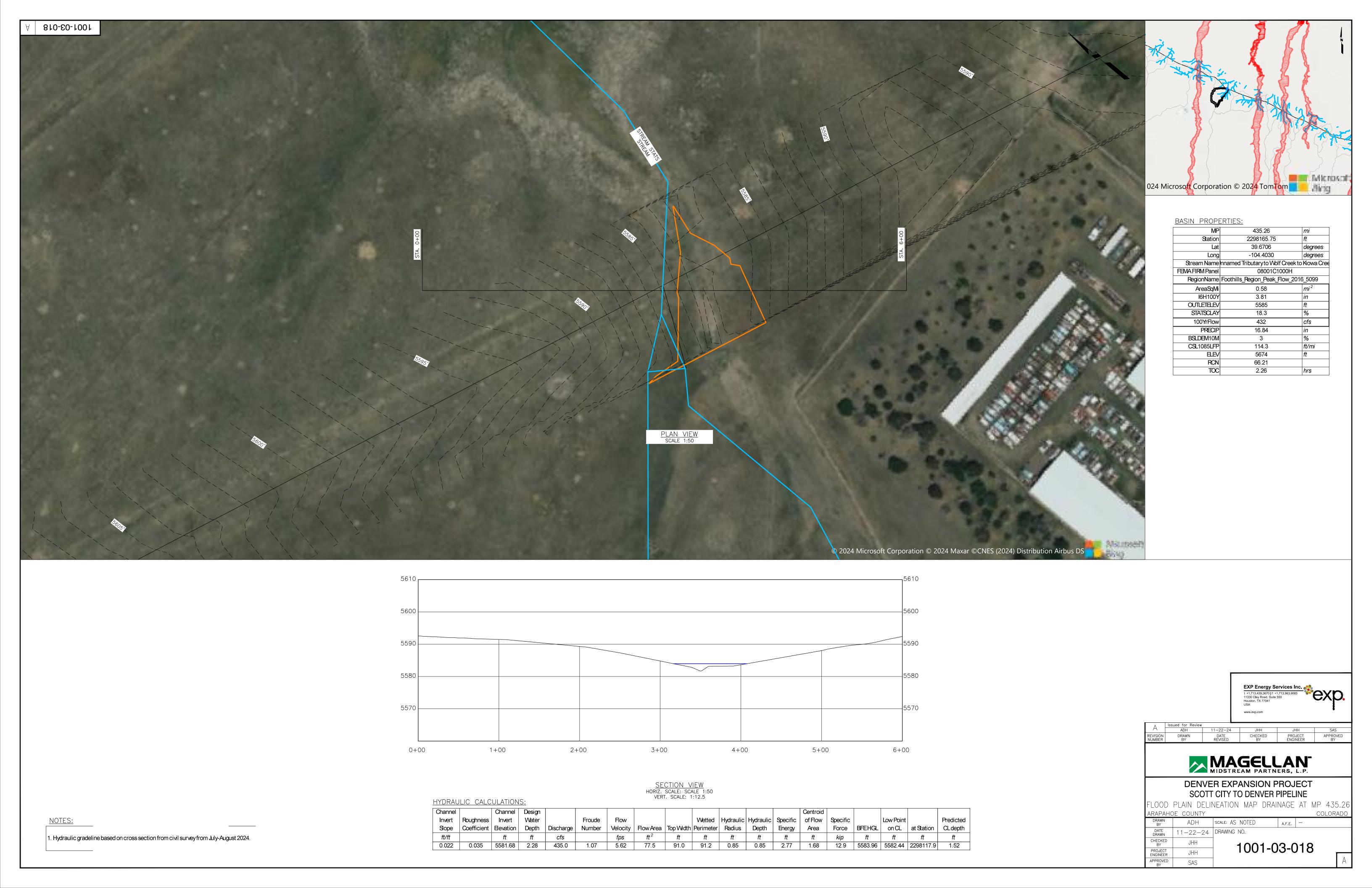
FLOOD PLAIN DELINEATION MAP DRAINAGE AT MP 435.0

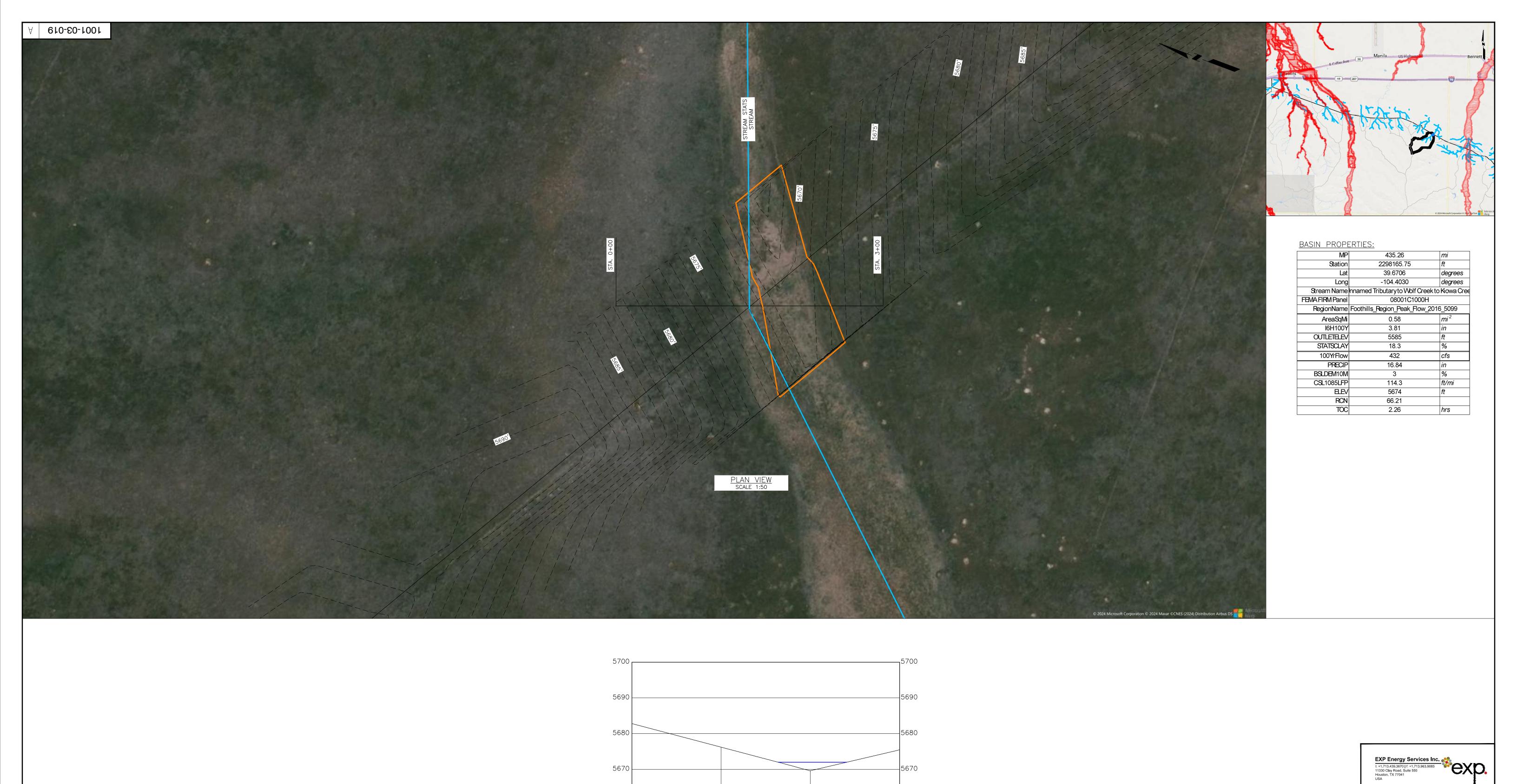
DRAWN BY	ADH	scale: AS NOTED
DATE DRAWN	11-22-24	DRAWING NO.
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PROJECT ENGINEER	JHH	100
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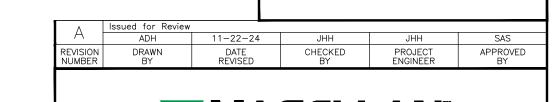
1001-03-017

A.F.E. —

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**DENVER EXPANSION PROJECT** SCOTT CITY TO DENVER PIPELINE

FLOOD PLAIN DELINEATION MAP DRAINAGE AT MP 435.20

ARAPAHU	DE COUNTY	
DRAWN BY	ADH	scale: AS NOTED
DATE DRAWN	11-22-24	DRAWING NO.
CHECKED BY	JHH	1001
PROJECT ENGINEER	JHH	1001

BY	7.011		A.F.E.	
DATE DRAWN	11-22-24	DRAWING NO.		
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PROJECT NGINEER	JHH	1001-0	<b>3-</b> 0	) I <del>S</del>
PPROVED	CAC			

NOTES:

1. Hydraulic gradeline based on cross section from civil survey from July-August 2024.

Channel Design Invert Roughness Invert Water Sope Coefficient Bevation Depth Discharge Number Velocity Flow Area Fround Flow Velocity Flow Area Top Width Perimeter Radius Depth Depth Discharge Number Velocity Flow Area Top Width Perimeter Radius Depth Fround Flow Depth Discharge Number Velocity Flow Area Number Veloci 0.022 0.035 5581.68 2.28 435.0

2+00

1+00

SECTION VIEW

HORIZ. SCALE: SCALE 1:50

VERT. SCALE: 1:12.5

3+00

5660

HYDRAULIC CALCULATIONS:

0+00





IVIP	440.19	1111
Station	2324195.23	ft
Lat	39.7040	degrees
Long	-104.4810	degrees
Stream Name	Creek/Cost Creek/West Sand Cre	ek to Middle
FEMA FIRM Panel	08001C0980H	
RegionName	Foothills_Region_Peak_Flow_2010	5_5099
AreaSqMi	0.22	mi²
I6H100Y	3.77	in
OUTLETELEV	5689	ft
STATSCLAY	18.3	%
100YrFlow	224	cfs
PRECIP	17.33	in
BSLDEM10M	3	%
CSL1085LFP	108	ft/mi
ELEV	5748	ft
RCN	74.25	
TOC	1.15	hrs

0+00 1+00 2+00 3+00

SECTION VIEW

HORIZ. SCALE: SCALE 1:50

VERT. SCALE: 1:12.5

HYDRAULIC CALCULATIONS:

Channel		Channel	Design										Centroid					
Invert	Roughness	Invert	Water		Froude	Flow			Wetted	Hydraulic	Hydraulic	Specific	of Flow	Specific		Low Point		Predicted
Slope	Coefficient	⊟evation	Depth	Discharge	Number	Velocity	Flow Area	Top Width	Perimeter	Radius	Depth	Energy	Area	Force	BFEHGL	on CL	at Station	CLdepth
ft/ft		ft	ft	cfs		fps	ft <sup>2</sup>	ft	ft	ft	ft	ft	ft	kip	ft	ft	ft	ft
0.020	0.035	5689.73	0.79	226.7	0.94	3.62	62.6	136.5	136.5	0.46	0.46	0.99	0.53	3.7	5690.52	5689.23	2324150.9	1.29

А	ADH	11-22-24	JHH	JHH	SAS
REVISION	DRAWN	DATE	CHECKED	PROJECT	APPROVED
NUMBER	BY	REVISED	BY	ENGINEER	BY



DENVER EXPANSION PROJECT SCOTT CITY TO DENVER PIPELINE

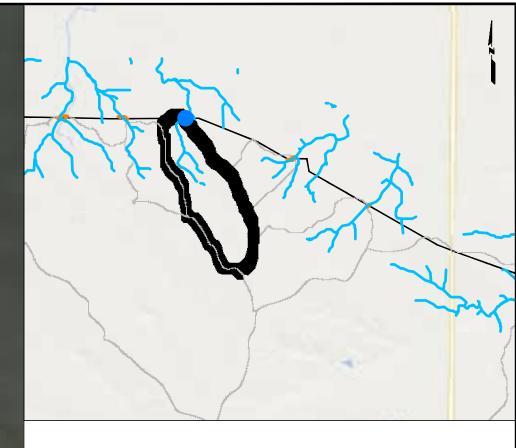
FLOOD PLAIN DELINEATION MAP DRAINAGE AT MP 440.19

DRAWN BY	ADH	scale: AS NOTED	A.F.
DATE DRAWN	11-22-24	DRAWING NO.	
CHECKED BY	JHH	1001-0	2
PROJECT ENGINEER	JHH	1001-0	<del>ن</del>
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APPROVED SAS

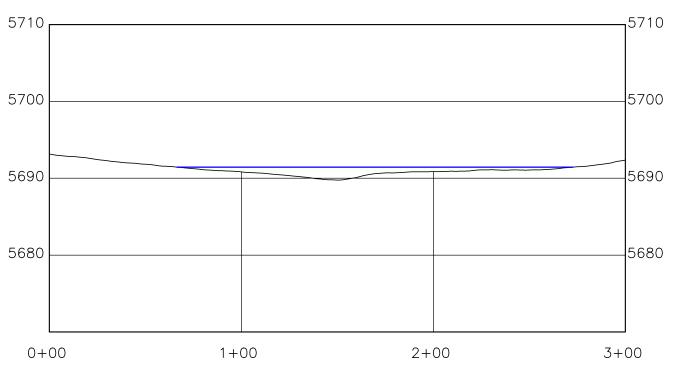
 $1.\ Hydraulic\ gradeline\ based\ on\ cross\ section\ from\ civil\ survey\ from\ July-August\ 2024.$ 





#### BASIN PROPERTIES:

MP	441.32	mi
Station	2330165.64	ft
Lat	39.7097	degrees
Long	-104.5010	degrees
Stream Name	Creek/Cost Creek/West Sand Cree	ek to Middle
FBMA FIRM Panel	08001C0960H	
RegionName	Foothills_Region_Peak_Flow_2016	6_5099
AreaSqMi	0.62	mi <sup>2</sup>
I6H100Y	3.76	in
OUTLETELEV	5690	ft
STATSCLAY	25.62	%
100YrFlow	565	cfs
PRECIP	17.42	in
BSLD⊟M10M	3	%
CSL1085LFP	78	ft/mi
ELEV	5768	ft
RCN	60.52	
TOC	3.4	hrs



SECTION VIEW HORIZ. SCALE: SCALE 1:50 VERT. SCALE: 1:12.5

HYDRAULIC CALCULATIONS:

11101010	, LIO 07 (LO	, O L/ (111O1)	<u></u>															
Channel		Channel	Design										Centroid					
Invert	Roughness	Invert	Water .		Froude	Flow			Wetted	Hydraulic	Hydraulic	Specific	of Flow	Specific		Low Point		Predicted
Slope	Coefficient	⊟evation	Depth	Discharge	Number	Velocity	Flow Area	Top Width	Perimeter	Radius	Depth	Energy	Area	Force	BFEHGL	on CL	at Station	CLdepth
ft/ft		ft	ft	cfs		fps	ft <sup>2</sup>	ft	ft	ft	ft	ft	ft	kip	ft	ft	ft	ft
0.015	0.035	5689.77	1.68	572.9	0.86	4.03	142.1	206.4	206.5	0.69	0.69	1.93	1.20	15.1	5691.45	5689.76	2330164.9	1.69



А	ADH	11-22-24	JHH	JHH	SAS
REVISION	DRAWN	DATE	CHECKED	PROJECT	APPROVED
NUMBER	BY	REVISED	BY	ENGINEER	BY



DENVER EXPANSION PROJECT SCOTT CITY TO DENVER PIPELINE

FLOOD PLAIN DELINEATION MAP DRAINAGE AT MP 441.32 Arapahoe county colorado

DRAWN BY	ADH	scale: AS NOTED	A.F.E.
DATE DRAWN	11-22-24	DRAWING NO.	
HECKED BY	JHH	1001-0	2
PROJECT NGINEER	JHH	1001-0	<b>5</b> -
PPROVED BY	SAS		

1. Floodplain delineation based on 3DEP LiDAR digital terrain model.



0+00 1+00 2+00

SECTION VIEW
HORIZ. SCALE: SCALE 1:50
VERT. SCALE: 1:12.5

HYDRAULIC CALCULATIONS:

Channel		Channel	Design										Centroid					
Invert	Roughness	Invert	Water		Froude	Flow			Wetted	Hydraulic	Hydraulic	Specific	of Flow	Specific		Low Point		Predicted
Slope	Coefficient	⊟evation	Depth	Discharge	Number	Velocity	Flow Area	Top Width	Perimeter	Radius	Depth	Energy	Area	Force	BFEHGL	on CL	at Station	CLdepth
ft/ft		ft	ft	cfs		fps	ft <sup>2</sup>	ft	ft	ft	ft	ft	ft	kip	ft	ft	ft	ft
0.015	0.035	5674 14	1 92	275.9	0.95	5.63	49.0	44.5	44 7	1 10	1 10	2 41	1 20	6.7	5677 60	5676 16	2333000.9	1 44



A	ADH	11-22-24	JHH	JHH	SAS
REVISION	DRAWN	DATE	CHECKED	PROJECT	APPROVED
NUMBER	BY	REVISED	BY	ENGINEER	BY



#### **DENVER EXPANSION PROJECT** SCOTT CITY TO DENVER PIPELINE

FLOOD PLAIN DELINEATION MAP DRAINAGE AT MP 441.88

DRAWN BY	ADH	scale: AS NOTED	A.F.E.	_
DATE DRAWN	11-22-24	DRAWING NO.		
CHECKED BY	JHH	1001-0	2 (	100
PROJECT ENGINEER	JHH	1001-0	<b>3-</b> 0	)22
		1		

APPROVED SAS

1. Floodplain delineation based on 3DEP LiDAR digital terrain model.



6+00

HYDRAULIC CALCULATIONS:

2+00

3+00

1+00

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1. Floodplain delineation based on 3DEP LiDAR digital terrain model.

Channel Design Invert Roughness Invert Water Sopecific Specific 
 ft²
 ft
 ft

4+00

5+00

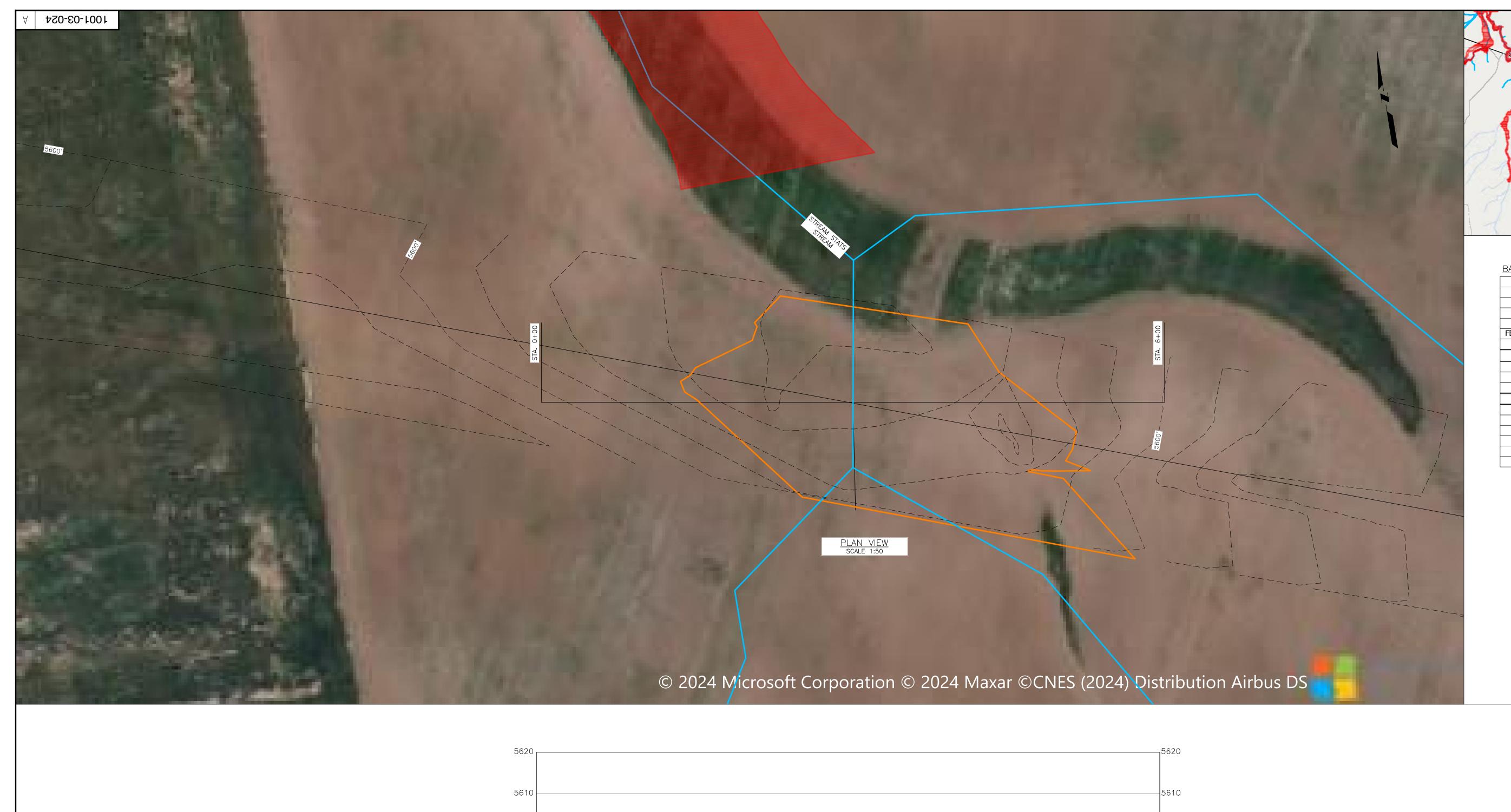
MAGELLAN\*
MIDSTREAM PARTNERS, L.P.

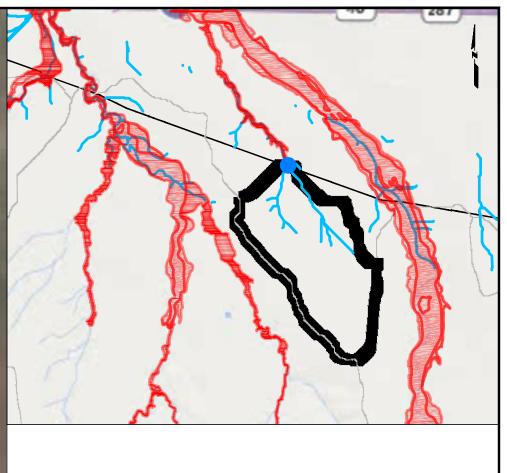
# **DENVER EXPANSION PROJECT**

SCOTT CITY TO DENVER PIPELINE

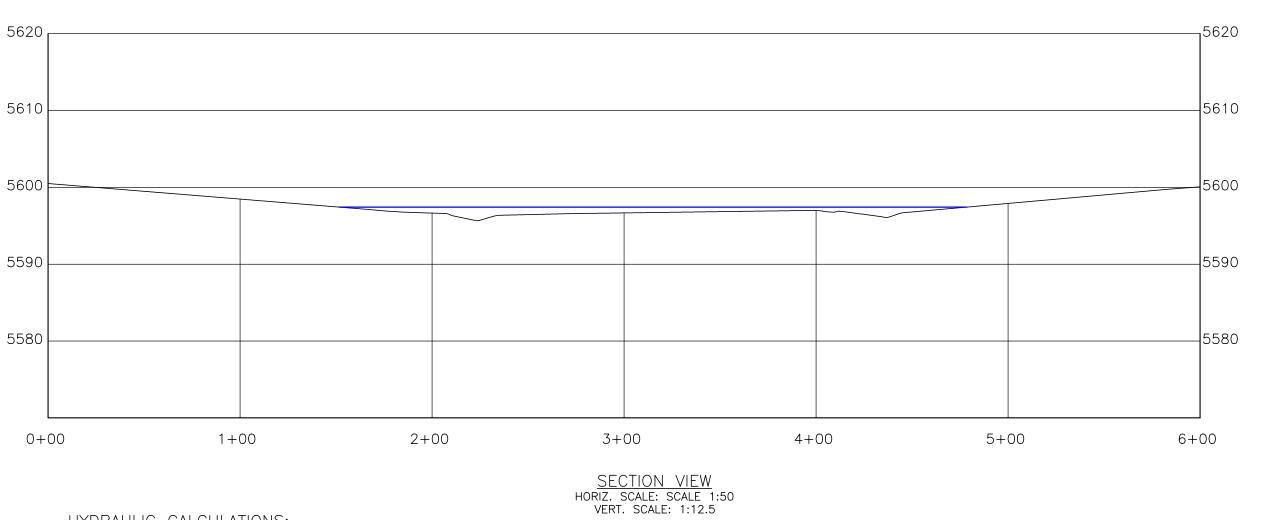
FLOOD PLAIN DELINEATION MAP DRAINAGE AT MP 442.48

DRAWN BY	ADH	scale: AS NOTED	A.F.E.	_
DATE DRAWN	11-22-24	DRAWING NO.		
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PROJECT ENGINEER	JHH	1001-0	<b>3-</b> C	<i>1</i> 23
4 DDD 0 VED				





MP	445.20	mi
Station	2350657.75	ft
Lat	39.7181	degrees
Long	-104.5720	degrees
Stream Name	raw to Box∃der Creek to Middle S	outh Platte
FBMA FIRM Panel	08001C0975H	
RegionName	Foothills_Region_Peak_Flow_201	6_5099
AreaSqMi	1.35	mi <sup>2</sup>
I6H100Y	3.73	in
OUTLETELEV	5593	ft
STATSCLAY	25.19	%
100YrFlow	900	cfs
PRECIP	17.82	in
BSLDEM10M	2	%
CSL1085LFP	89	ft/mi
ELEV	5677	ft
RCN	79.45	
TOC	2.76	hrs



1. Hydraulic gradeline based on cross section from civil survey from July-August 2024.

HYDRAULIC CALCULATIONS: Channel Design

Invert Roughness Invert Froude Wetted Hydraulic Hydraulic Specific of Flow Specific Predicted Slope Coefficient Bevation Depth Discharge Number Velocity Flow Area Top Width Perimeter Radius Depth Energy Area Force BFEHGL on CL at Station CL depth 
 ft/ft
 ft
 ft
 fcs
 fps
 ft²
 ft
 <



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#### **DENVER EXPANSION PROJECT** SCOTT CITY TO DENVER PIPELINE

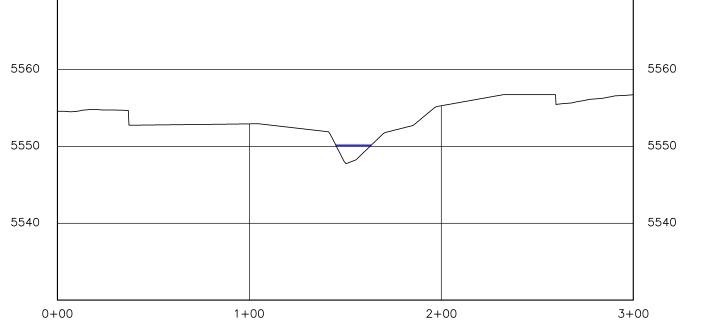
FLOOD PLAIN DELINEATION MAP DRAINAGE AT MP 445.20

BY	ADH	SCALE:
DATE DRAWN	11-22-24	DRAWII
CHECKED BY	JHH	
PROJECT ENGINEER	JHH	

1001-03-024

A.F.E. —





HYDRAULIC CALCULATIONS:

1. Hydraulic gradeline based on cross section from civil survey from July-August 2024. 2. Floodplain delineation based on 3DEPLiDARdigital terrain model.

NOTES:

11101010	CIO ONCO	O L/ (IIIO I V	<u> </u>															
Channel		Channel	Design										Centroid					
Invert	Roughness	Invert	Water		Froude	Flow			Wetted	Hydraulic	Hydraulic	Specific	of Flow	Specific		Low Point		Predicted
Slope	Coefficient	⊟evation	Depth	Discharge	Number	Velocity	Flow Area	Top Width	Perimeter	Radius	Depth	Energy	Area	Force	BFEHGL	on CL	at Station	CLdepth
ft/ft		ft	ft	cfs		fps	ft <sup>2</sup>	ft	ft	ft	ft	ft	ft	kip	ft	ft	ft	ft
0.021	0.04	5547.77	2.39	169.3	0.98	6.56	25.8	18.4	19.2	1.35	1.40	3.06	1.49	4.6	5550.16	5548.90	2366450.9	1.25



4	ADH	11-22-24	JHH	JHH	SAS
REVISION	DRAWN	DATE	CHECKED	PROJECT	APPROVED
NUMBER	BY	REVISED	BY	ENGINEER	BY



### DENVER EXPANSION PROJECT

SCOTT CITY TO DENVER PIPELINE FLOOD PLAIN DELINEATION MAP DRAINAGE AT MP 448 22

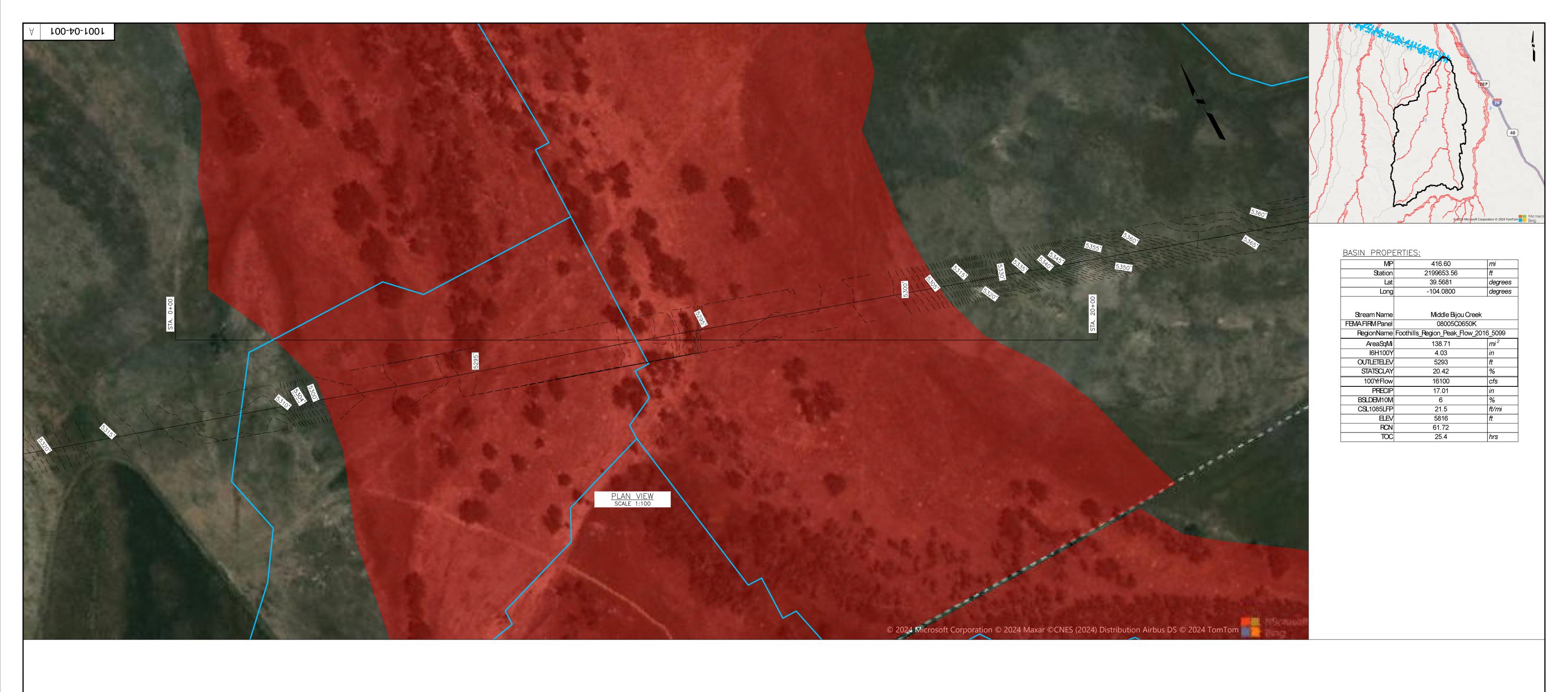
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ARAPAHC	E COUNTY				C(	DLORADO
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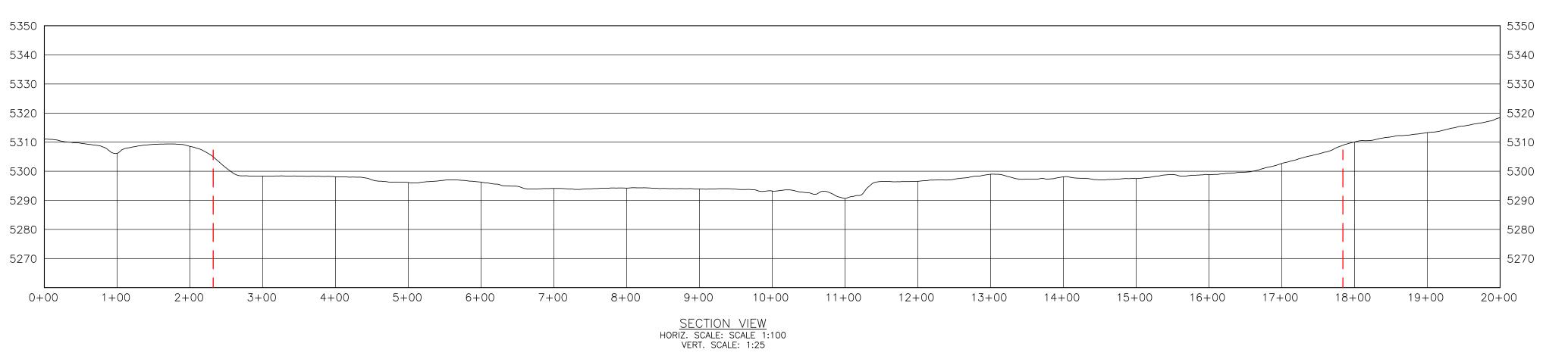
RAWN	11-22-24	DRAWING NO.
ECKED BY	JHH	1001-03
DJECT SINEER	JHH	1001-03
ROVED	646	

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# Appendix D – FEMA Floodplain Delineation Drawings







EXP Energy Services Inc.
t: +1.713.439.3670 | f: +1.713.963.9085
11330 Clay Road, Suite 550
Houston, TX 77041
USA
www.exp.com

A Issued for Review

ADH 11-22-24 JHH JHH SAS

REVISION DRAWN DATE CHECKED PROJECT APPROVED BY ENGINEER BY



DENVER EXPANSION PROJECT SCOTT CITY TO DENVER PIPELINE

FLOOD PLAIN DELINEATION MAP DRAINAGE AT MP 416.60 arapahoe county colorado

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SCALE: AS NOTED

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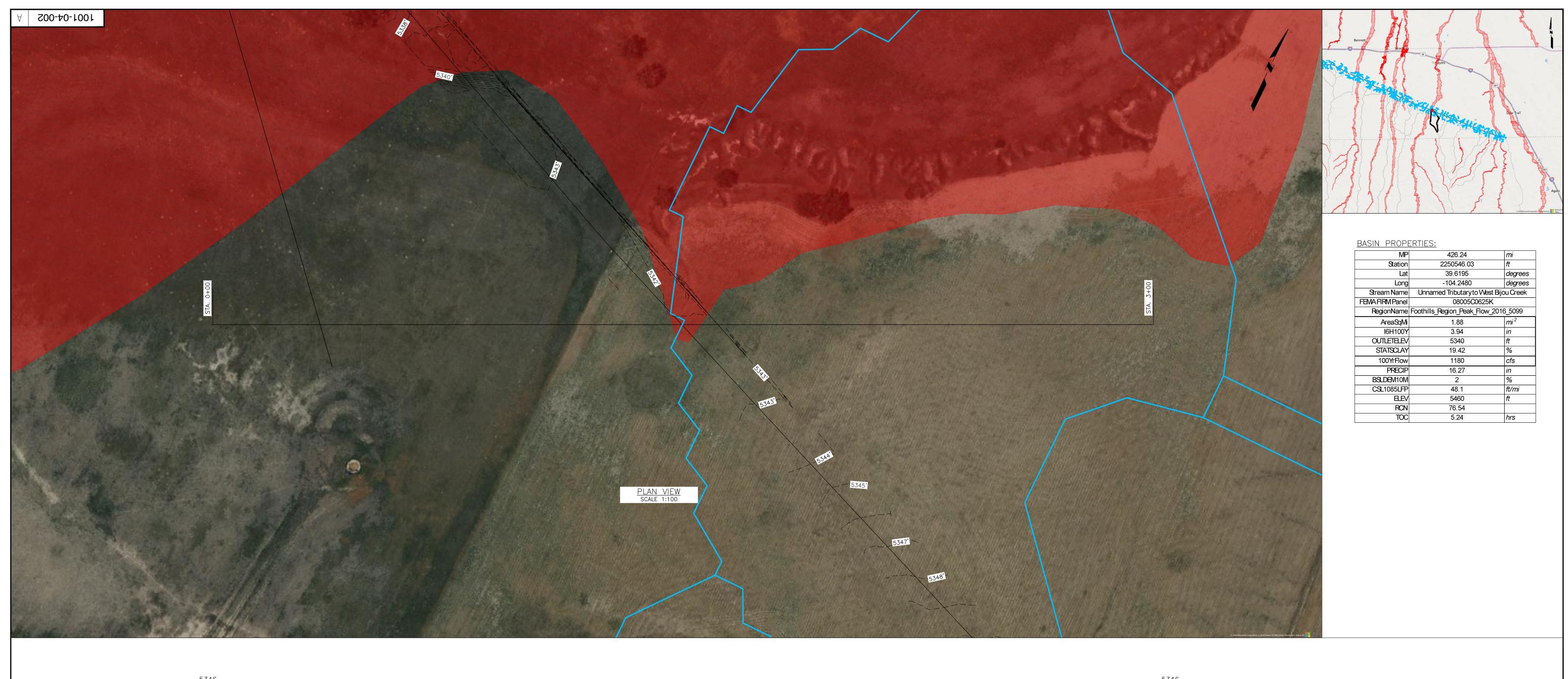
1001-04-001

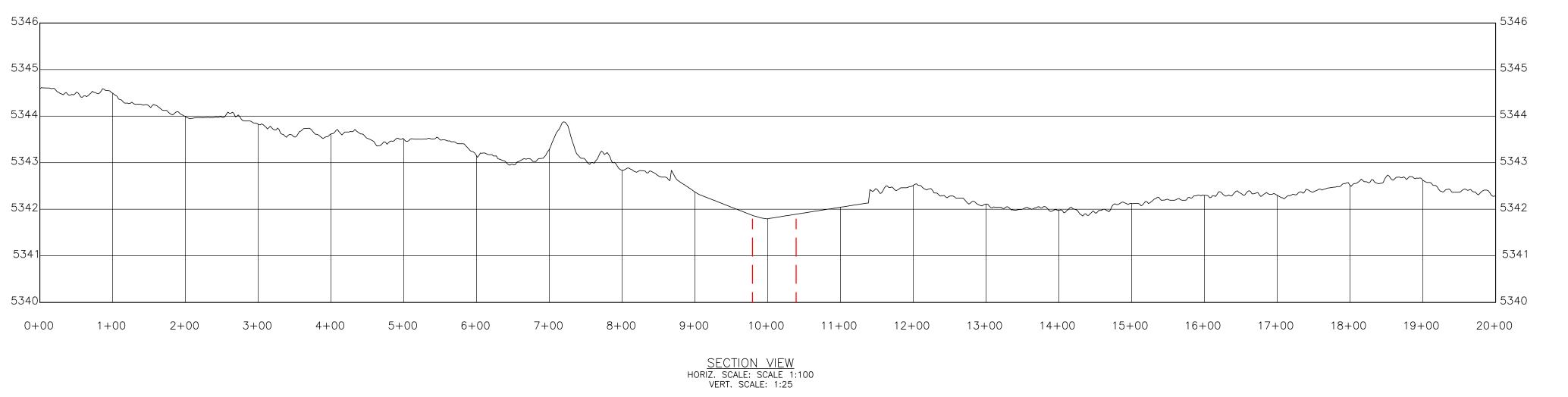
A.F.E. -

NOTES:

1. Showing extent of FEMA 100 Year Floodplain Delineation boundaries

2. Bevations based on 3DEP LiDAR digital terrain model.





EXP Energy Services Inc.
t: +1.713.439.3670 | f: +1.713.963.9085
11330 Clay Road, Suite 550
Houston, TX 77041
USA
www.exp.com



DENVER EXPANSION PROJECT SCOTT CITY TO DENVER PIPELINE

FLOOD PLAIN DELINEATION MAP DRAINAGE AT MP 426.24 arapahoe county colorado

DRAWN
BY
ADH
SCALE: AS NOTED

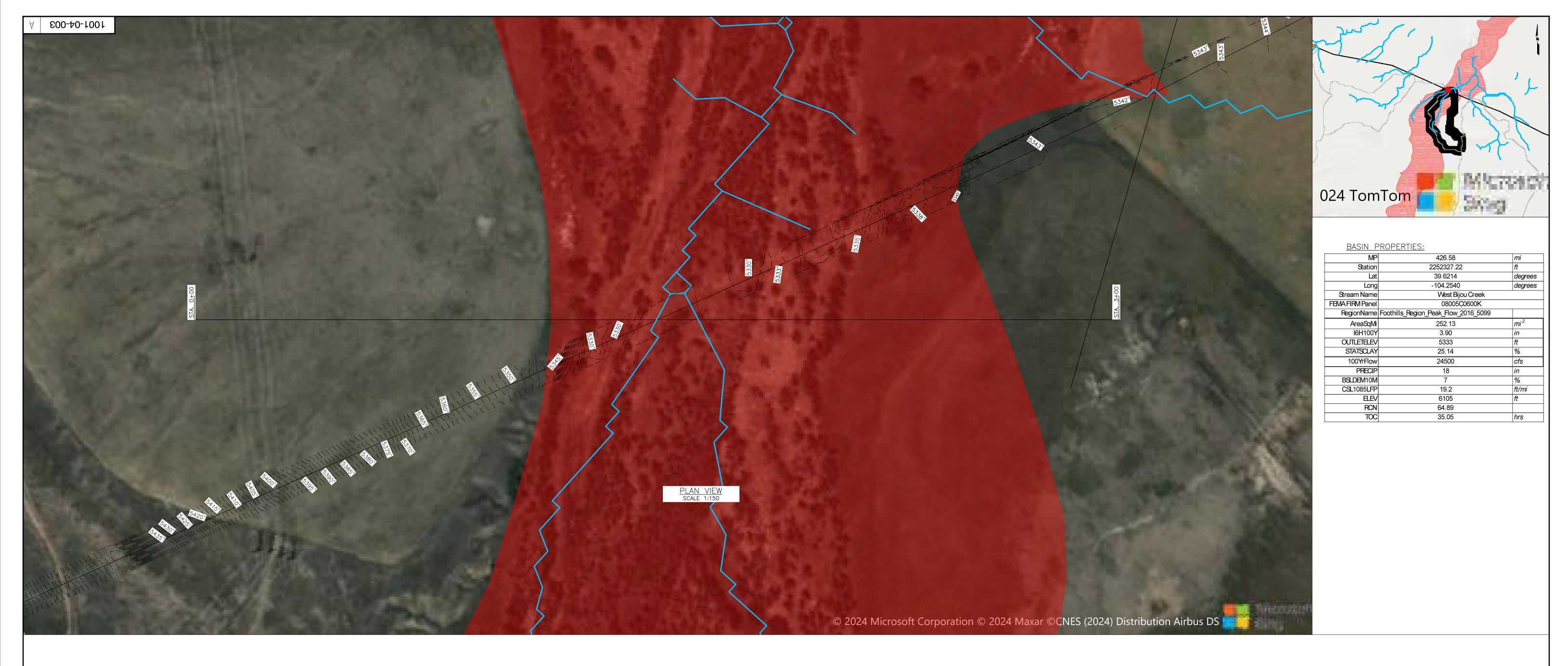
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BY
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ENGINEER
APPROVED
BY
SAS

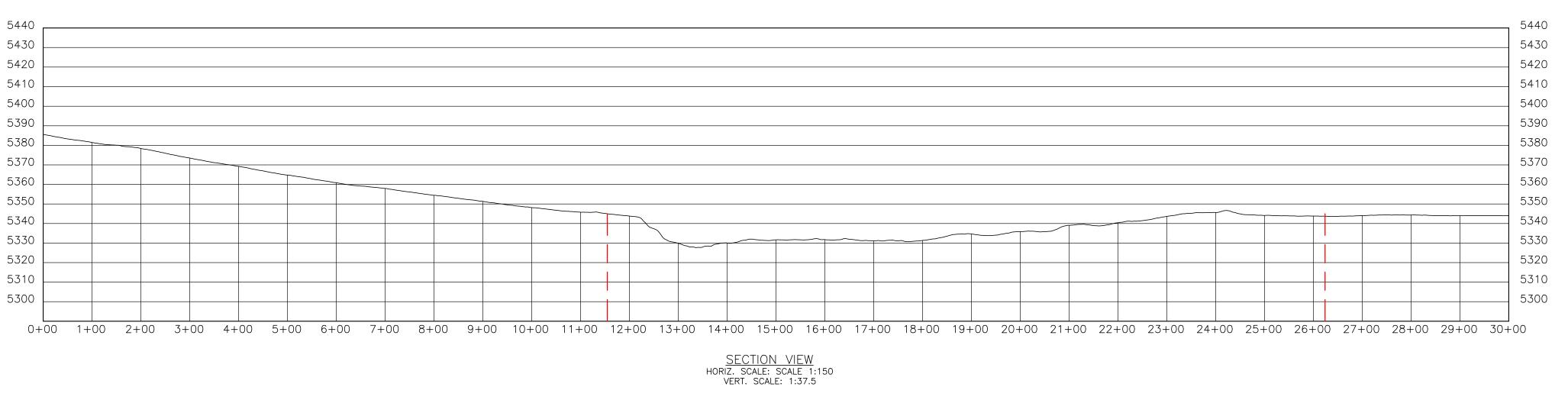
1001-04-002

A.F.E. -

NOTES:

Showing extent of FEWA 100 Year Floodplain Delineation boundaries
 Bevations based on 3DEP LiDAR digital terrain model.





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www.exp.com



DENVER EXPANSION PROJECT SCOTT CITY TO DENVER PIPELINE

FLOOD PLAIN DELINEATION MAP DRAINAGE AT MP 426.58

DRAWN BY	ADH	scale: AS NOTED
DATE DRAWN	11-22-24	DRAWING NO.
CHECKED BY	JHH	100
PROJECT ENGINEER	JHH	100
APPROVED	CA6	

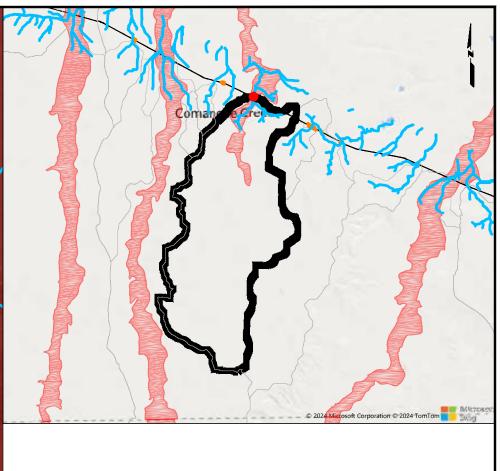
1001-04-003

A.F.E. —

NOTES:

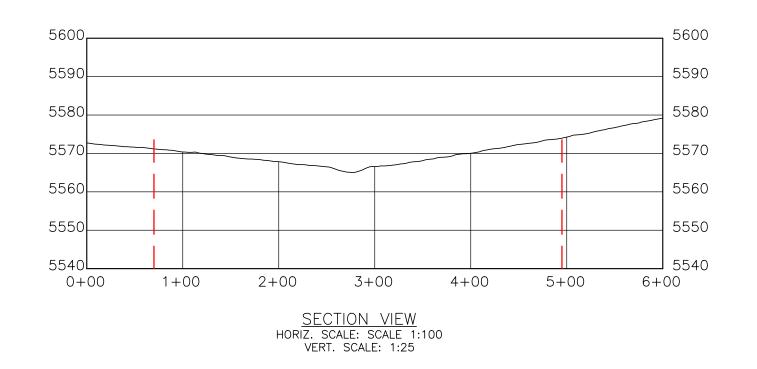
Showing extent of FBMA 100 Year Floodplain Delineation boundaries
 Bevations based on 3DEP LiDAR digital terrain model.





#### BASIN PROPERTIES:

MP	430.09	mi
		mi
Station	2270865.45	ft
Lat	39.6411	degrees
Long	-104.3140	degrees
	Little Comanche Creek to Comanche	Creek to
Stream Name	Kiowa Creek	
FBMA FIRM Panel	08001C1025H	
RegionName	Foothills_Region_Peak_Flow_2016_50	
AreaSqMi	6.15	mi <sup>2</sup>
I6H100Y	3.87	in
OUTLETELEV	5566	ft
STATSCLAY	17.61	%
100YrFlow	1710	cfs
PRECIP	16.85	in
BSLDEM10M	1	%
CSL1085LFP	34.1	ft/mi
ELEV	5654	ft
RCN	71.39	
TOC	10.49	hrs



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11330 Clay Road, Suite 550
Houston, TX 77041
USA

A.F.E. -



DENVER EXPANSION PROJECT SCOTT CITY TO DENVER PIPELINE

FLOOD PLAIN DELINEATION MAP DRAINAGE AT MP 430.09

DRAWN BY ADH SCALE: AS NOTED

DATE DRAWN 11-22-24

CHECKED BY JHH

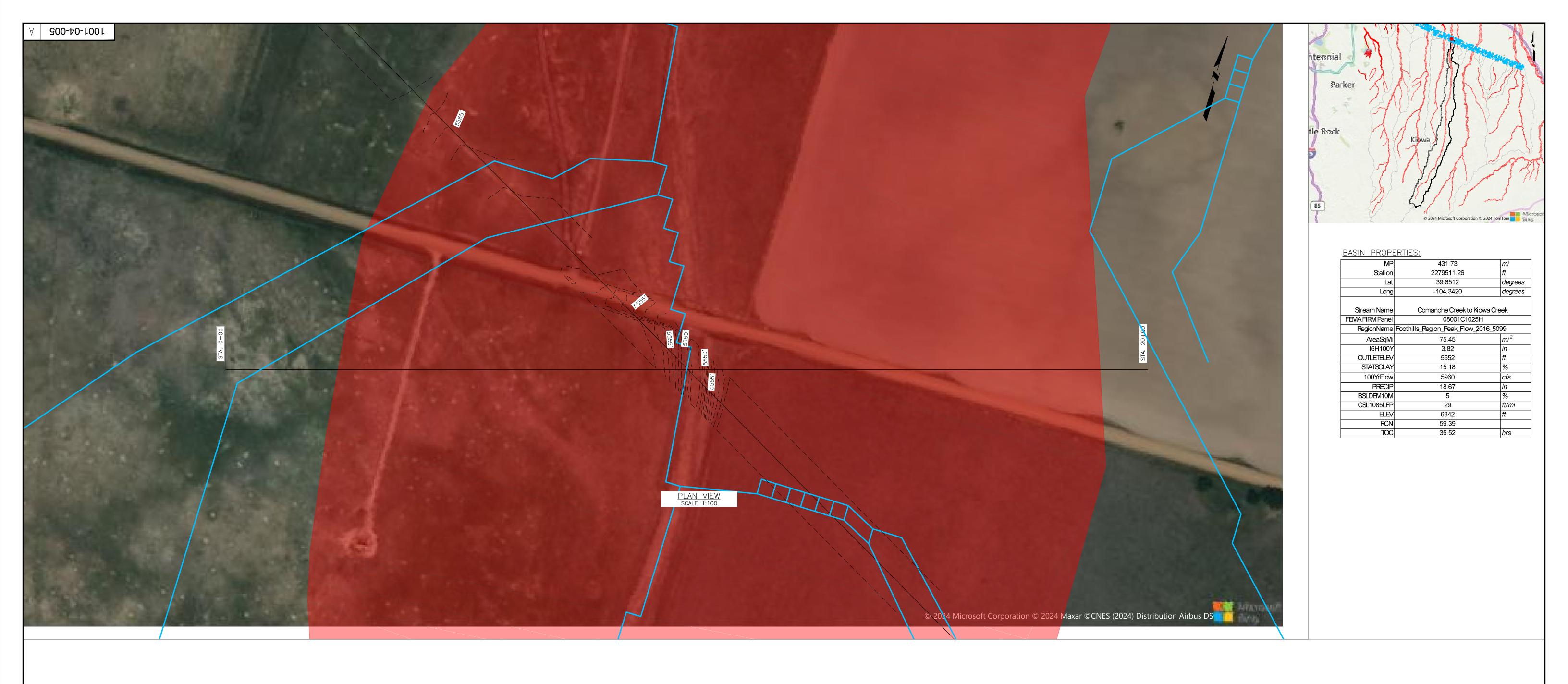
PROJECT ENGINEER JHH

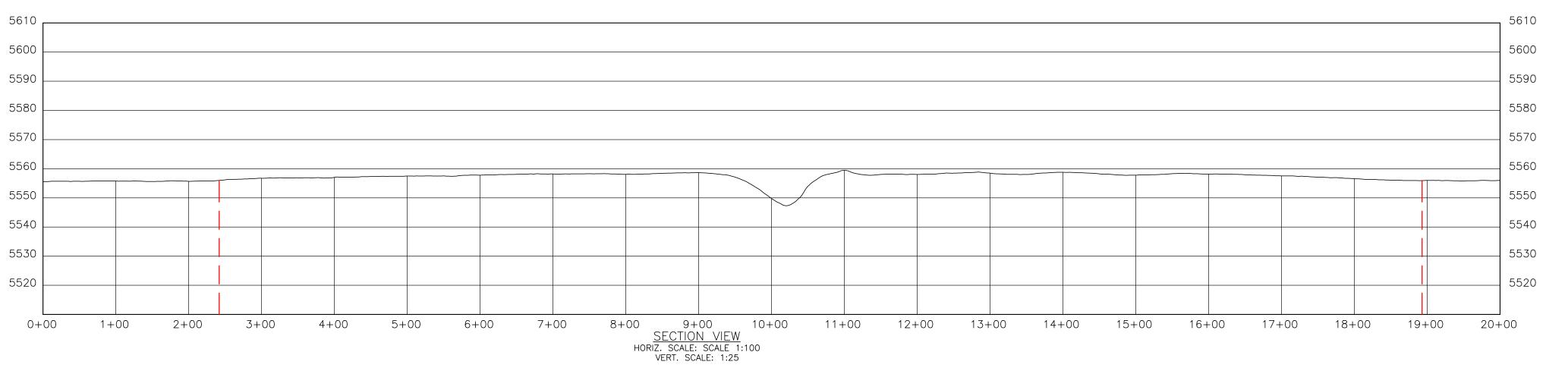
APPROVED BY SAS

1001-04-004

NOTES:

1. Showing extent of FEMA 100 Year Floodplain Delineation boundaries 2. Bevations based on 3DEP LiDAR digital terrain model.





MAGELLAN"
MIDSTREAM PARTNERS, L.P.

DENVER EXPANSION PROJECT SCOTT CITY TO DENVER PIPELINE

FLOOD PLAIN DELINEATION MAP DRAINAGE AT MP 431.7 Arapahoe county colorado drawn adh scale: as noted a.f.e. –

5.		
DATE DRAWN	11-22-24	DRA
CHECKED BY	JHH	
PROJECT ENGINEER	JHH	
ADDDOVED		

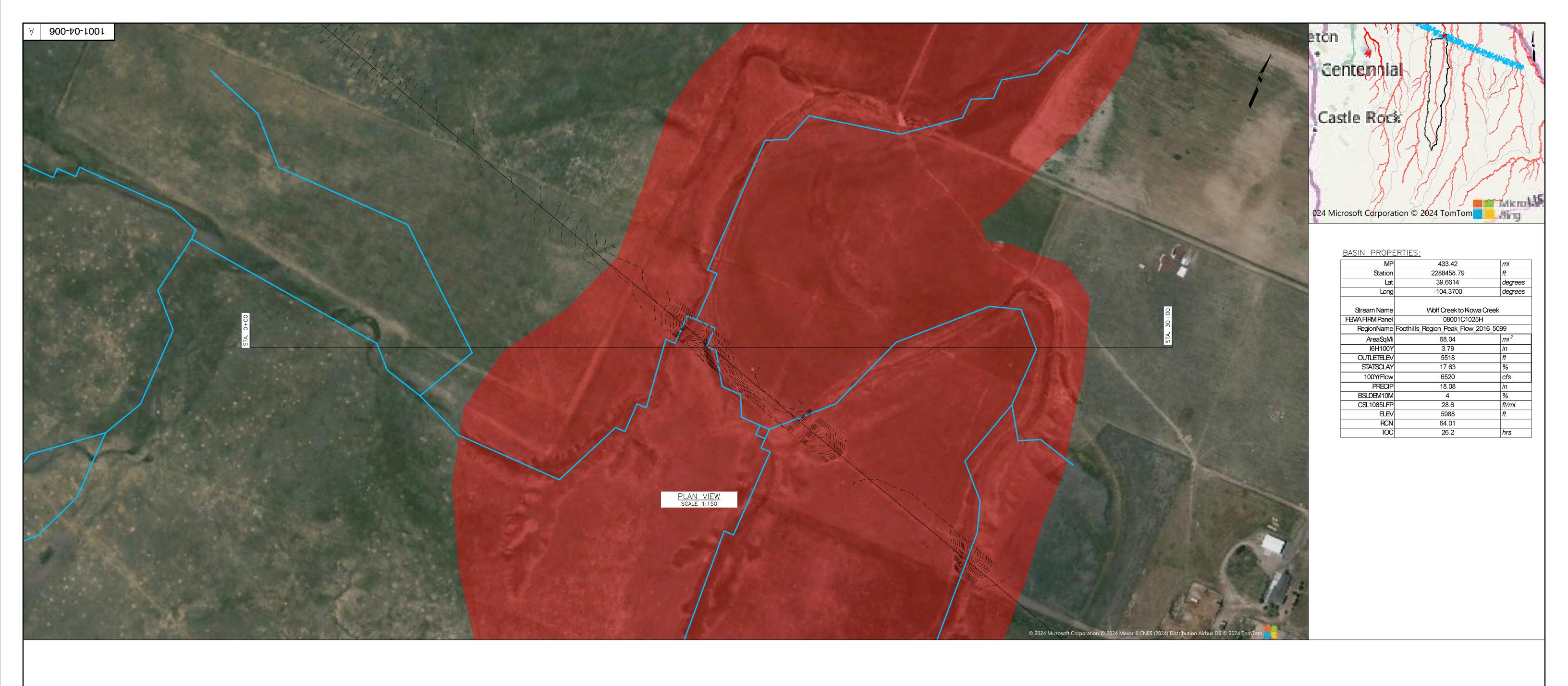
1001-04-005

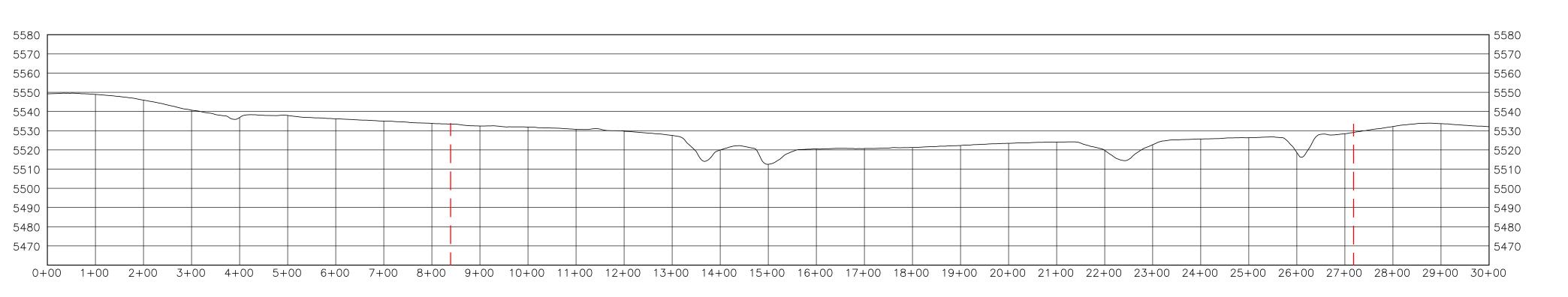
EXP Energy Services Inc.
t: +1.713.439.3670 | f: +1.713.963.9085
11330 Clay Road, Suite 550
Houston, TX 77041
USA

NOTES:

1. Showing extent of FBMA 100 Year Floodplain Delineation boundaries

2. Bevations based on 3DEP LiDAR digital terrain model.





1. Showing extent of FBVA 100 Year Floodplain Delineation boundaries

2. Bevations based on 3DEP LiDAR digital terrain model.





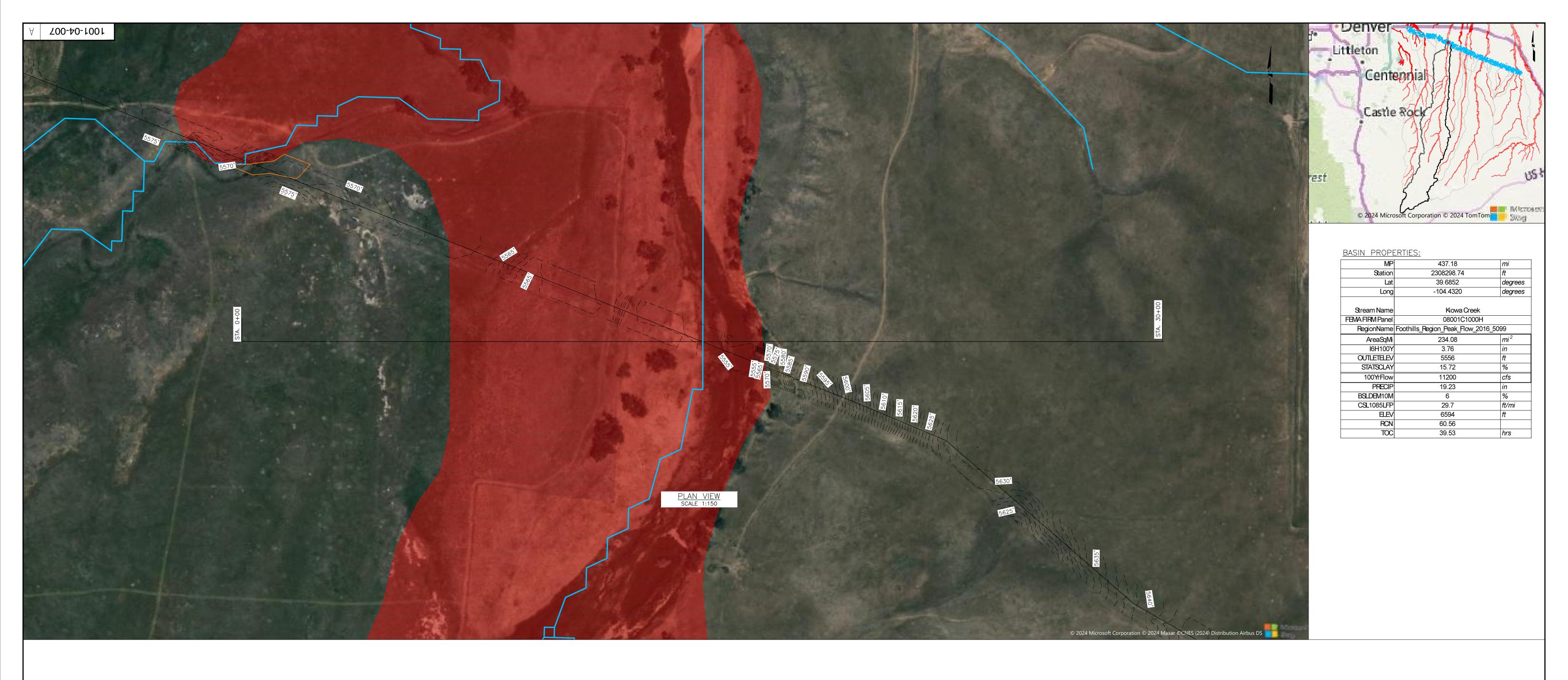
**DENVER EXPANSION PROJECT** SCOTT CITY TO DENVER PIPELINE

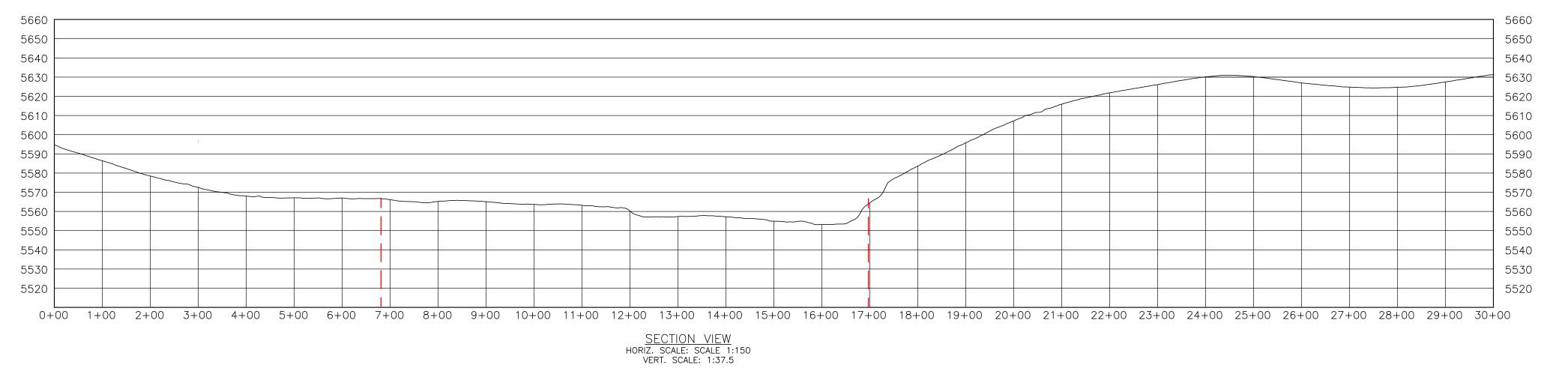
FLOOD PLAIN DELINEATION MAP DRAINAGE AT MP 433.42 ARAPAHOE COUNTY

DRAWN BY	ADH	SCALE:
DATE DRAWN	11-22-24	DRAWII
CHECKED BY	JHH	
PROJECT ENGINEER	JHH	
APPROVED BY	SAS	

1001-04-006

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1. Showing extent of FBMA 100 Year Floodplain Delineation boundaries

2. Bevations based on 3DEP LiDAR digital terrain model.



$\wedge$	Issued for Review				
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REVISION NUMBER	DRAWN BY	DATE REVISED	CHECKED BY	PROJECT ENGINEER	APPROVED BY

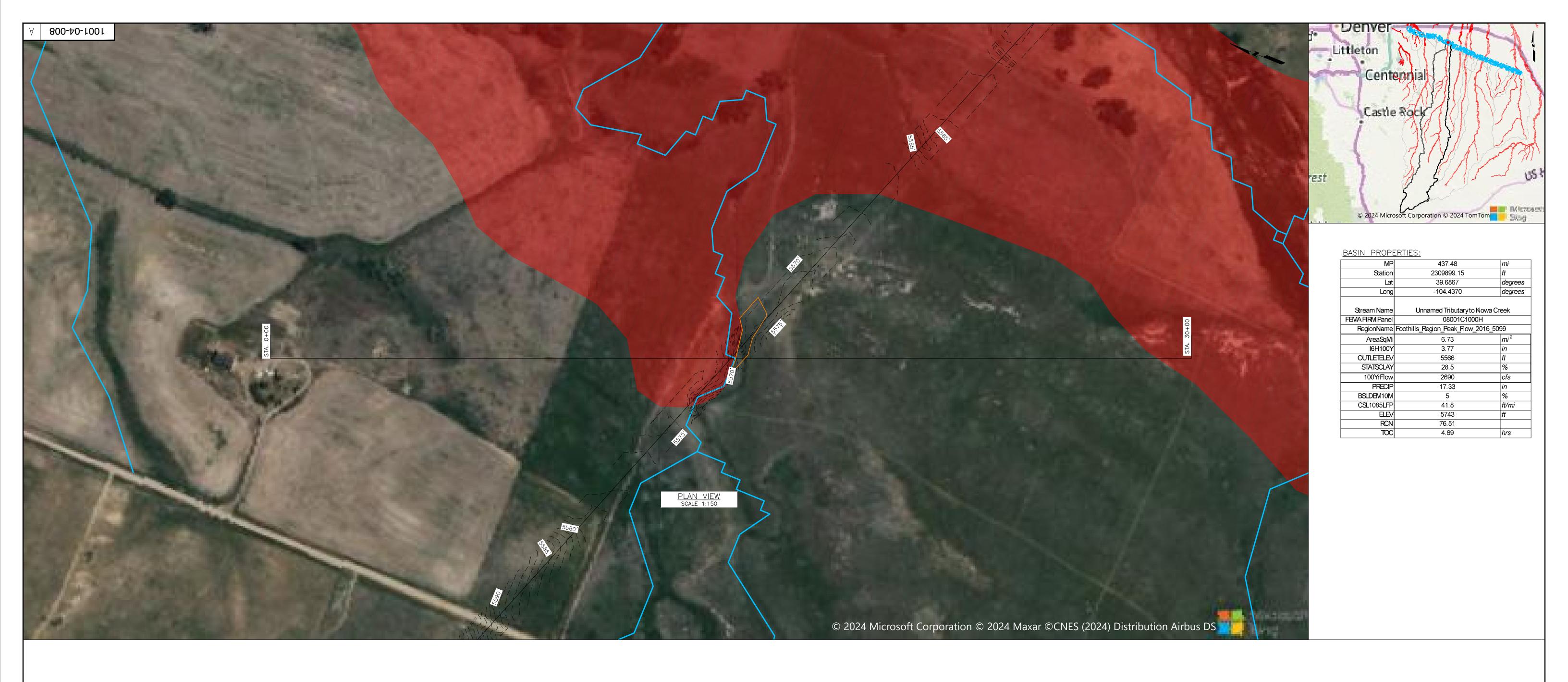


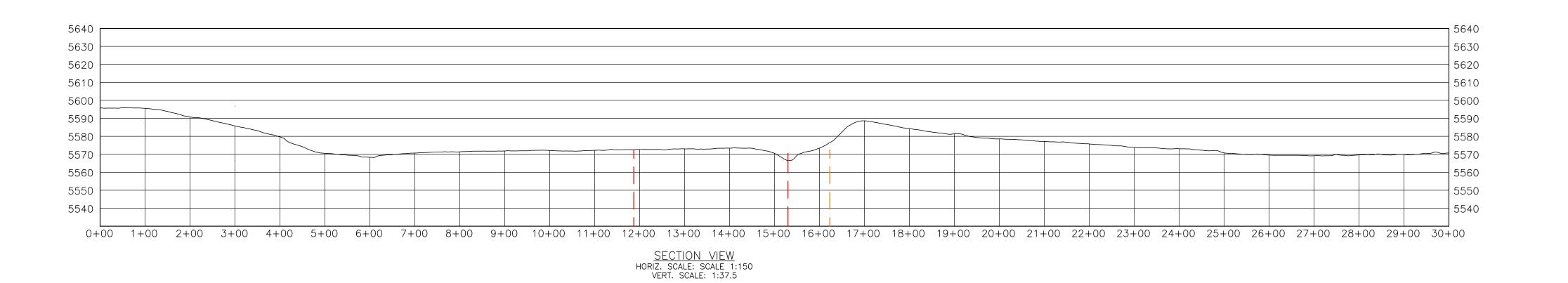
**DENVER EXPANSION PROJECT** SCOTT CITY TO DENVER PIPELINE

FLOOD PLAIN DELINEATION MAP DRAINAGE AT MP 437.1

DRAWN BY	ADH	scale: AS NOTED	A.F.E.	-
DATE DRAWN	11-22-24	DRAWING NO.		
HECKED BY	JHH	1001-0	<i>A</i> (	۱۸
ROJECT NGINEER	JHH	1001-0	4-(	JU

001-04-007





1. Showing extent of FEMA 100 Year Floodplain Delineation boundaries, channel has migrated and boundary appears to extend 93 ft to the east

2. Elevations based on 3DEP LiDAR digital terrain model.



Η	ADH	11-22-24	JHH	JHH	SAS
REVISION	DRAWN	DATE	CHECKED	PROJECT	APPROVEI
NUMBER	BY	REVISED	BY	ENGINEER	BY

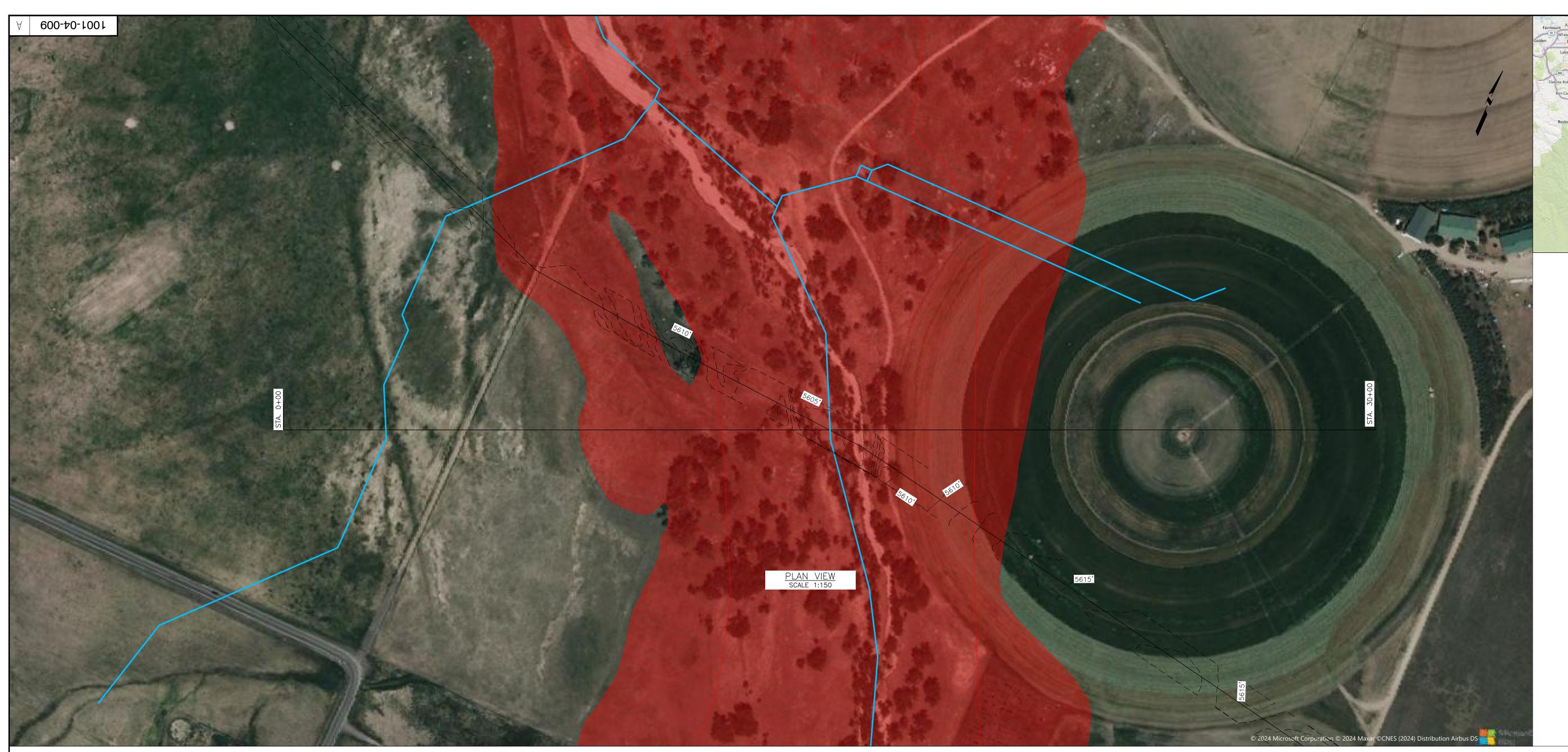


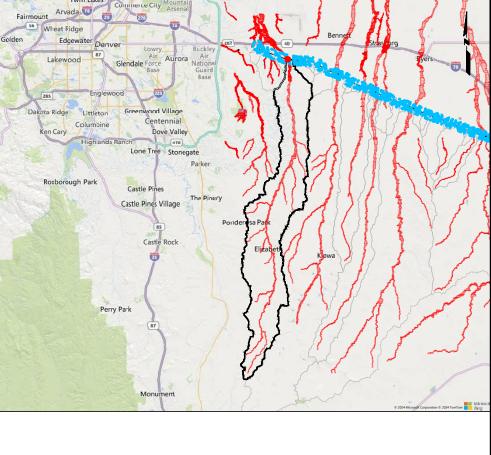
**DENVER EXPANSION PROJECT** SCOTT CITY TO DENVER PIPELINE

FLOOD PLAIN DELINEATION MAP DRAINAGE AT MP 437.48 ARAPAHOE COUNTY

DRAWN BY	ADH	scale: AS NOTED	A.F.E.	l
DATE DRAWN	11-22-24	DRAWING NO.		
HECKED BY	JHH	1001-0	1	$\mathbf{a}$
ROJECT NGINEER	JHH	1001-0	4-(	
PROVED BY	SAS			

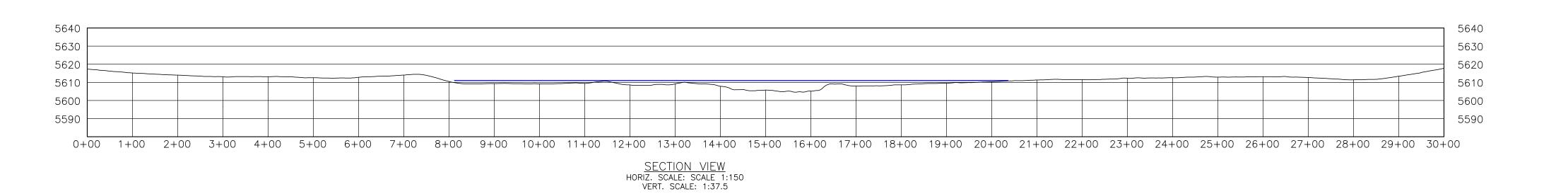
04-008





### BASIN PROPERTIES:

8.4FD	444.07		
MP	444.07	mi	
Station	2344704.49	ft	
Lat	39.7131	degrees	
Long	-104.5520	degrees	
	Box Elder Creek to Middle South Plat	te-Cherry	
Stream Name	Creek		
FBMA FIRM Panel	08001C0960H		
RegionName	Foothills_Region_Peak_Flow_2016_50		
AreaSqMi	164.77	mi <sup>2</sup>	
I6H100Y	3.71	in	
OUTLETELEV	5606	ft	
STATSCLAY	16.96	%	
100YrFlow	11164*	cfs	
PRECIP	19.2	in	
BSLDEM10M	5	%	
CSL1085LFP	28.5	ft/mi	
BLEV	6448	ft	
RCN	62.37		
TOC	37.38	hrs	



NOTES:

1. Showing extent of FBMA 100 Year Floodplain Delineation and Regulatory BFEHGL

2. Bevations based on 3DEP LiDAR digital terrain model.

EXP Energy Services Inc.
t: +1.713.439.3670 | f: +1.713.963.9085
11330 Clay Road, Suite 550
Houston, TX 77041
USA

A	ADH	11-22-24	JHH	JHH	SAS
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DENVER EXPANSION PROJECT SCOTT CITY TO DENVER PIPELINE

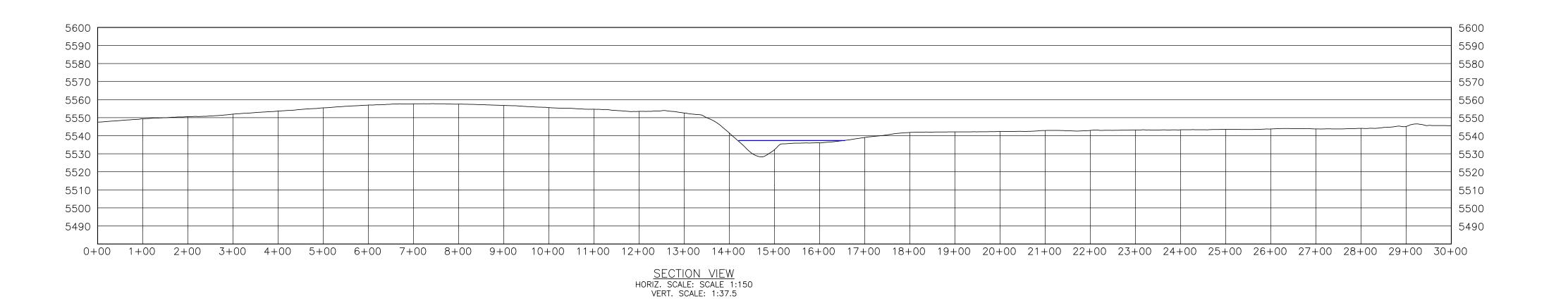
FLOOD PLAIN DELINEATION MAP DRAINAGE AT MP 444.07 ARAPAHOE COUNTY

DRAWN BY	ADH	scale: AS NOTE
DATE DRAWN	11-22-24	DRAWING NO.
CHECKED BY	JHH	10
PROJECT ENGINEER	JHH	10
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1001-04-009

A.F.E. —





1. Showing extent of FBMA 100 Year Floodplain Delineation and Regulatory BFEHGL

2. Bevations based on 3DEP LiDAR digital terrain model.



Η	ADH	11-22-24	JHH	JHH	SAS
REVISION	DRAWN	DATE	CHECKED	PROJECT	APPROVED
NUMBER	BY	REVISED	BY	ENGINEER	BY



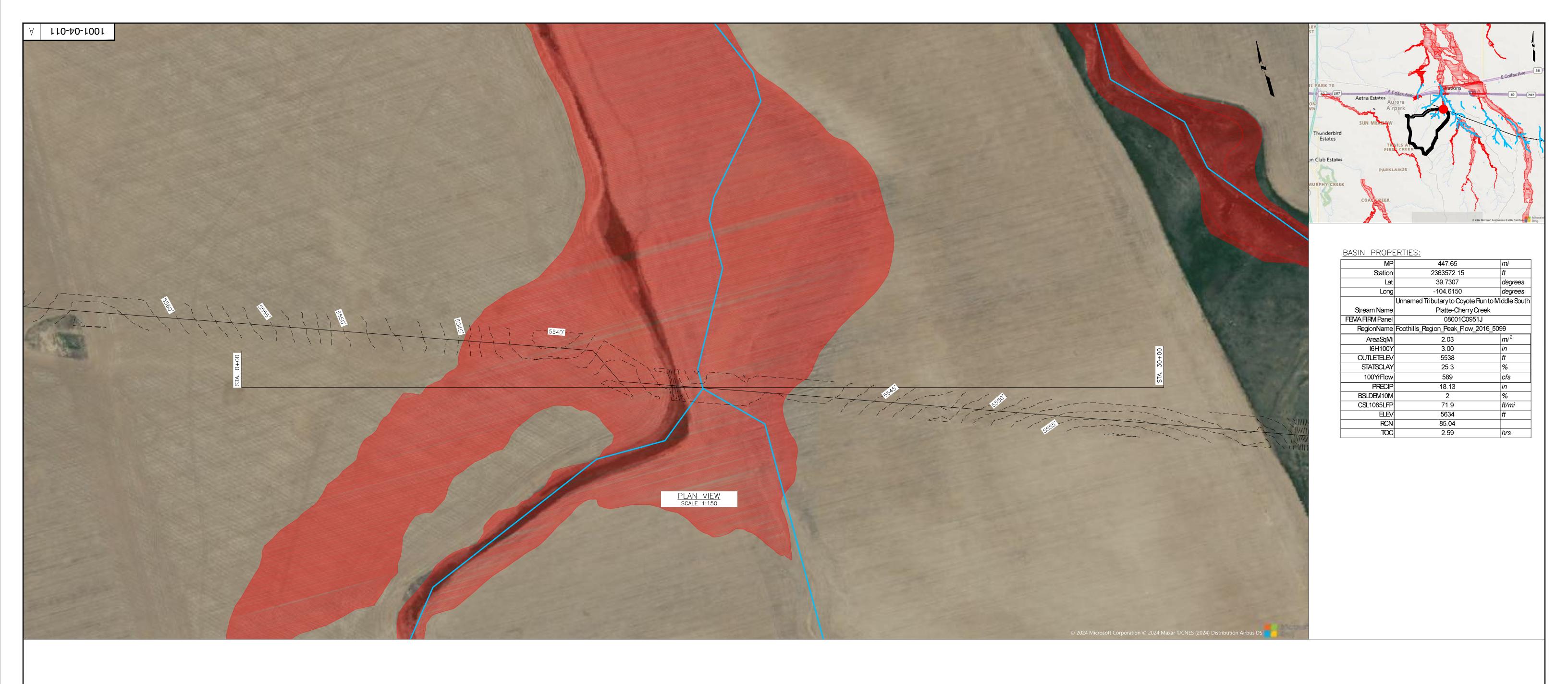
**DENVER EXPANSION PROJECT** SCOTT CITY TO DENVER PIPELINE

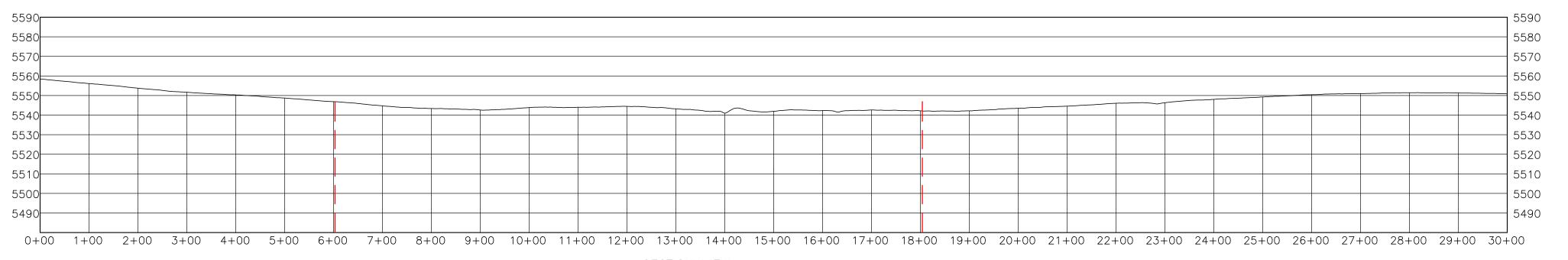
FLOOD PLAIN DELINEATION MAP DRAINAGE AT MP 447.25

BY	ADH	SCALE: AS NOTE
DATE DRAWN	11-22-24	DRAWING NO.
CHECKED BY	JHH	10
PROJECT ENGINEER	JHH	10

1001-04-010

A.F.E. —





NOTES:

Showing extent of FEMA 100 Year Floodplain Delineation boundaries
 Bevations based on 3DEP LiDAR digital terrain model.

MAGELLAN MIDSTREAM PARTNERS, L.P.

# DENVER EXPANSION PROJECT SCOTT CITY TO DENVER PIPELINE

SCOTT CITY TO DENVER PIPELINE FLOOD PLAIN DELINEATION MAP DRAINAGE AT MP 447.65

BY	ADH	SCALE: AS NOTE
DATE DRAWN	11-22-24	DRAWING NO.
CHECKED BY	JHH	10
PROJECT ENGINEER	JHH	IU

1001-04-011

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EXP Energy Services Inc.
t: +1.713.439.3670 | f: +1.713.963.9085
11330 Clay Road, Suite 550
Houston, TX 77041
USA