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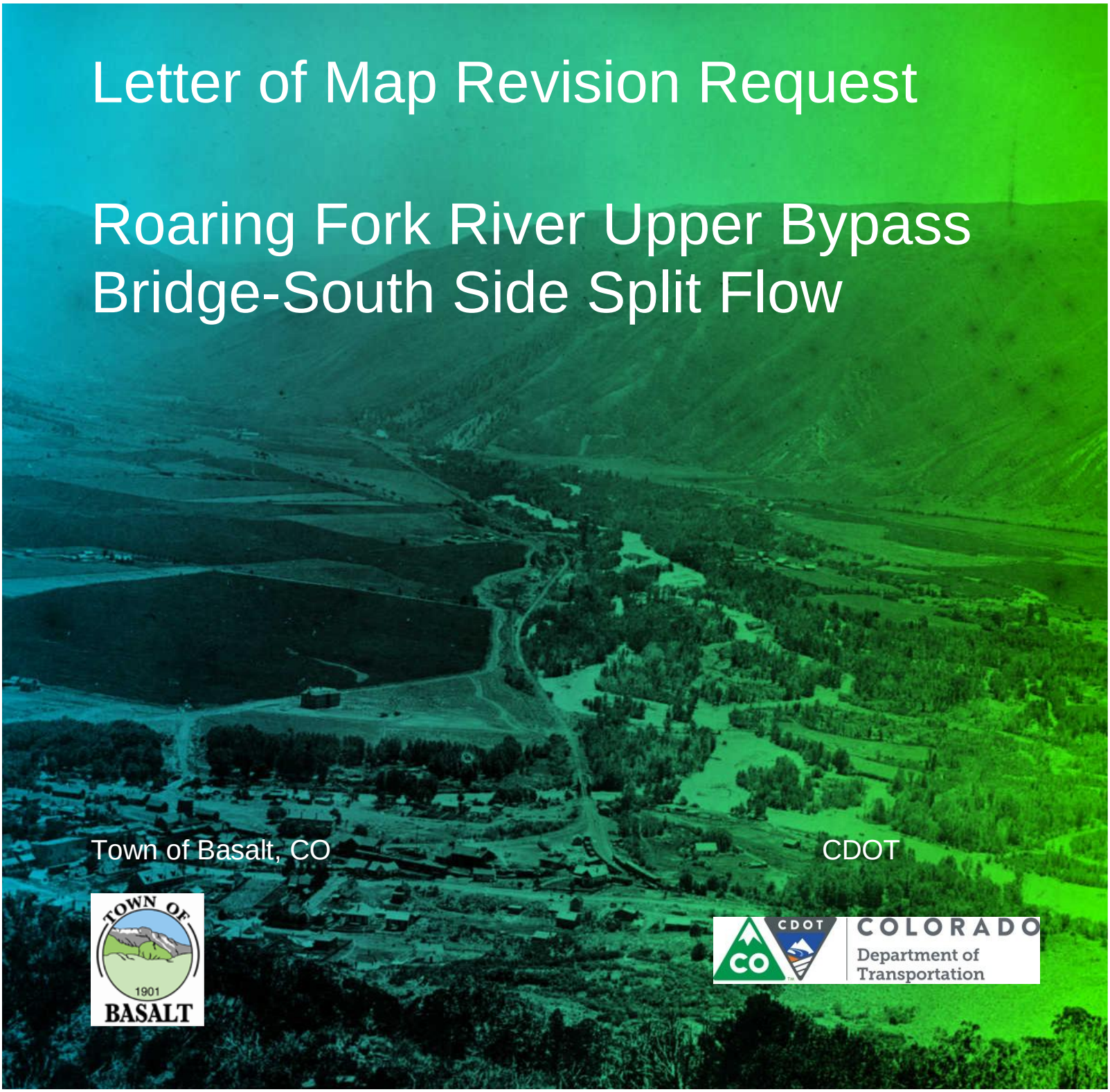
Letter of Map Revision Request

Roaring Fork River Upper Bypass Bridge-South Side Split Flow



Town of Basalt, CO

CDOT

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List of Acronyms

BFE	Base Flood Elevation
CDOT	Colorado Department of Transportation
CFR	Code of Federal Regulations
CFS	Cubic Foot Per Second
CWCB	Colorado Water Conservation Board
Elev.	Elevation
HEC-RAS	Hydrologic Engineering Center's River Analysis System
FEMA	Federal Emergency Management Agency
FHWA	Federal Highways Administration
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
FPS	Feet Per Second
J.F.S.A.	J.F. Sato and Associates
LIDAR	Light Detection and Ranging
NAVD 88	North American Vertical Datum of 1988
NGVD 29	National Geodetic Datum of 1929
PCF	Pounds Per Cubic Foot
SH	State Highway
USACE	United States Army Corps of Engineers
W.S.	Water Surface

1 Introduction

This Letter of Map Revision (LOMR) request seeks to revise the floodplain mapping of the Roaring Fork River (River) in the Town of Basalt, Pitkin County, Colorado. The Colorado Department of Transportation requests this LOMR for the Town of Basalt based on newer, more accurate topography and an improved analysis of the split flow of the Roaring Fork River based on removing the assumed 40% of the Upper Basalt Bypass Bridge on State Highway 82

All required MT-2 forms and supporting project data are included in the appendices of this report. The MT-2 forms are included in Appendix A, along with any explanations needed to clarify the information provided on the forms.

1.1 Site Location

The study reach of the Roaring Fork River is located in Township 8 South, Range 86 West of the 6th principle meridian (Figure 1-1). The site is located in both The Town of Basalt and Pitkin County in the North half of Section 18, the South half of section 7, and the Northwest ¼ of Section 17 (Figure 1-2). This LOMR application is for only the South Side split flow of the Roaring Fork River and does not propose any changes to the main stem of the Roaring Fork River floodplain maps. Because the existing regulatory FEMA flood flows for the main stem assumed all flow in the Roaring Fork River passed through the Upper Basalt Bypass Bridge, this re-analysis of the split flow only effects flows in the South Side. The reach of the South Side Split flow modeled with HEC-RAS is approximately 6148 ft long.

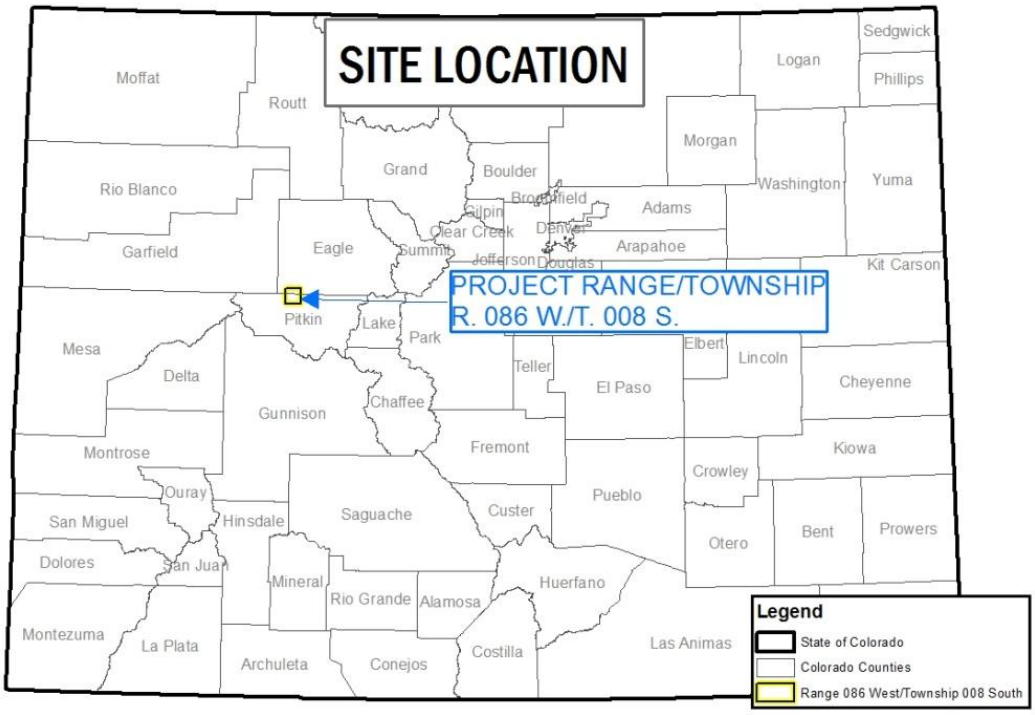

Figure 1-1. Site Location

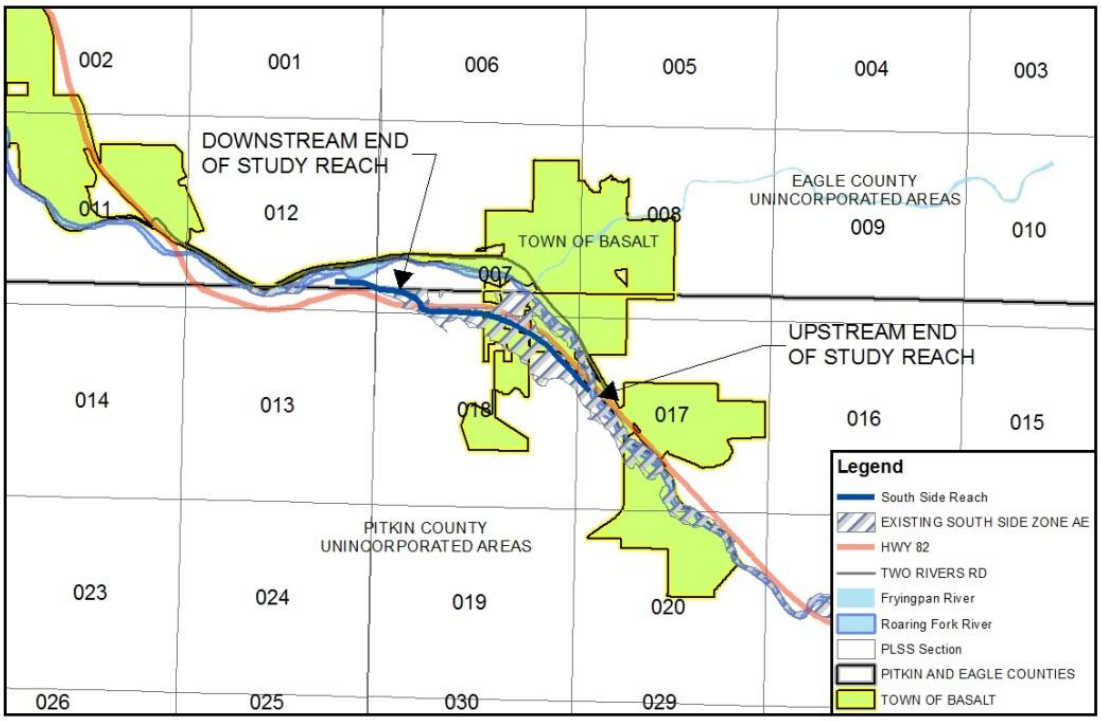

Figure 1-2. Project Reach

1.2 Project Background

The Colorado Department of Transportation (CDOT) began realigning State Highway (SH) 82 in the late 1980's in order to bypass the Town of Basalt (Basalt). Two bridges spanning the Roaring Fork River were constructed as part of the bypass; one upstream of and one downstream Town.

During the highway realignment CDOT constructed a levee upstream of the Upper Bypass Bridge with the intent of protecting what is known as the Basalt South Side (South Side) from flooding events. The Federal Emergency management Agency (FEMA) Flood Insurance Rate Maps (FIRMs) were not revised following construction of the levee. There are no engineering record drawings or documentation of the levee construction and field investigations demonstrate the material used to construct the levee is too poor quality for levee construction. It has never been maintained as a levee and has mature trees growing out of it. It also has inadequate freeboard. Therefore it cannot be considered under the new FEMA Levee Analyses and Mapping Procedures for Non-Accredited Levees (LAMP). The existing regulatory FEMA flood maps are drawn assuming the levee does not exist.

There is no documentation of the regulatory spilt flow analysis at the Upper Bypass Bridge to support the current South Side discharge of 4,400 cfs. AECOM was provided with two HEC-RAS models for the South Side. The first split flow analysis was performed by J.F. Sato in the late 1990s. While at first glance this model would appear to be a split flow analysis, the discharge modeled through the South Side reach is hard set to 4,400 cfs. The second supporting HEC-RAS model was developed by Matrix and uses more recent, higher resolution topography and a more detailed model. However, this model does not analyze the split from the Roaring Fork River, but rather uses the designated discharge from the J.F. Sato work.The Effective Regulatory Hydraulic Model of the Roaring Fork River assumes a 40% blockage at the Upper Bypass Bridge. During the late 1990s the Town requested FEMA add the 40% blockage out of concern about sediment accumulation under the bridge. Matrix Engineering subsequently incorporated this blockage into their analysis (See Section 5.1.4). The assumed blockage has a direct impact on the split flow and the resulting South Side discharge. Given the lack of documentation of the split flow and the assumed 40% blockage CDOT and the Town of Basalt decided to enter into an inter-governmental agreement to manage sediment deposition to remove the assume blockage and to re-evaluate the split flow using FLO-2D.

1.3 Site Description

The realignment of SH 82 to bypass the Town of Basalt effectively resulted in dividing the Roaring Fork River 100-year floodplain. In addition to flooding along the banks of the Roaring Fork River through the Town of Basalt, floodwaters split at the Upper Bypass Bridge and flow overland through what is known as the South Side. The South Side floodplain is not distinguished by a defined channel and is considered active only during flooding events. Floodwaters in the South Side floodplain eventually return to the Roaring Fork River main stem floodplain by flowing over SH 82 at a location near the Basalt wastewater treatment plant. Flow spills over SH 82 at several additional locations upstream as well.

Figure 1-4 provides an illustration of the factors contributing to the split flow and the need for a levee in the left over bank immediately upstream of the Upper Bypass Bridge.

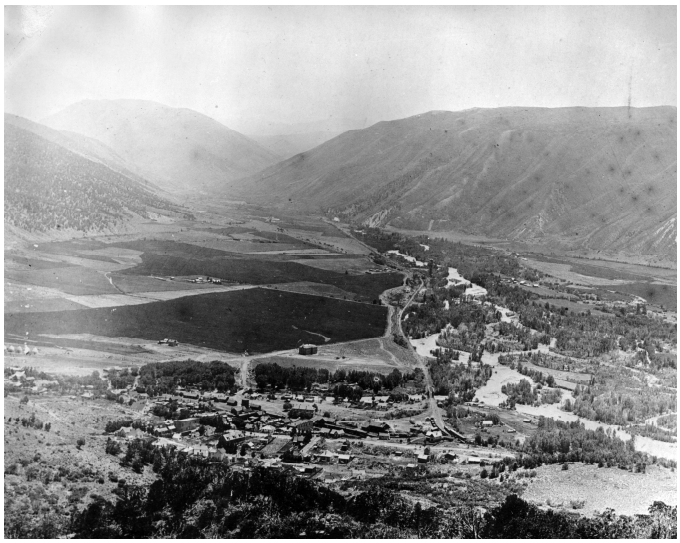

Figure 1-3. Roaring Fork River at Basalt Looking Upstream (1904)

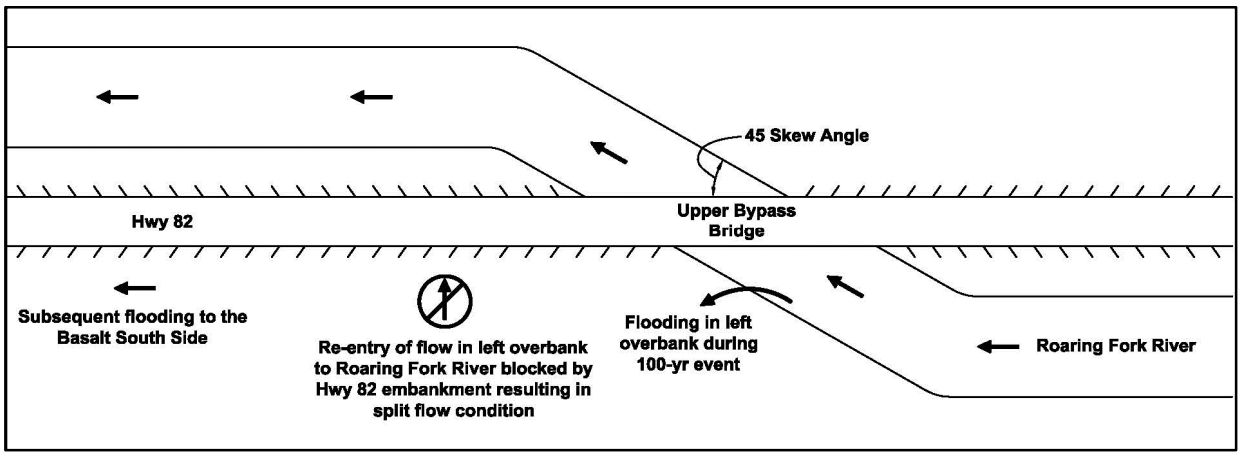

Figure 1-4. Illustration of Split Flow

Land Use: Existing land use in the project area is a mix of commercial, residential, and agricultural.

Site Topography: The project location is located in a broad alluvial valley. The valley slopes from southeast to northwest.

NRCS Soils Classification: Soils is the project area generally consist of Atencio-Azeltine complex, Evanson loam, and Redrob loam. These soils are classified as Hydrologic Soil Groups B and C with some small areas of D, having moderate to very slow infiltration rates and moderate to high runoff potential.

1.4 Floodplain Designation

The Regulatory South Side Special Flood Hazard Areas include Zone A, Zone AE, Zone X Shaded (500-Year) and Zone X. Figure 1-5 shows the current SFHA designation as well as the location of the existing levee and other relevant features. The effective FIRMS are included in Appendix B (Exhibit A and B). The DFIRM data is included in the Work Map presented in Appendix B (Exhibit C) and also submitted electronically.

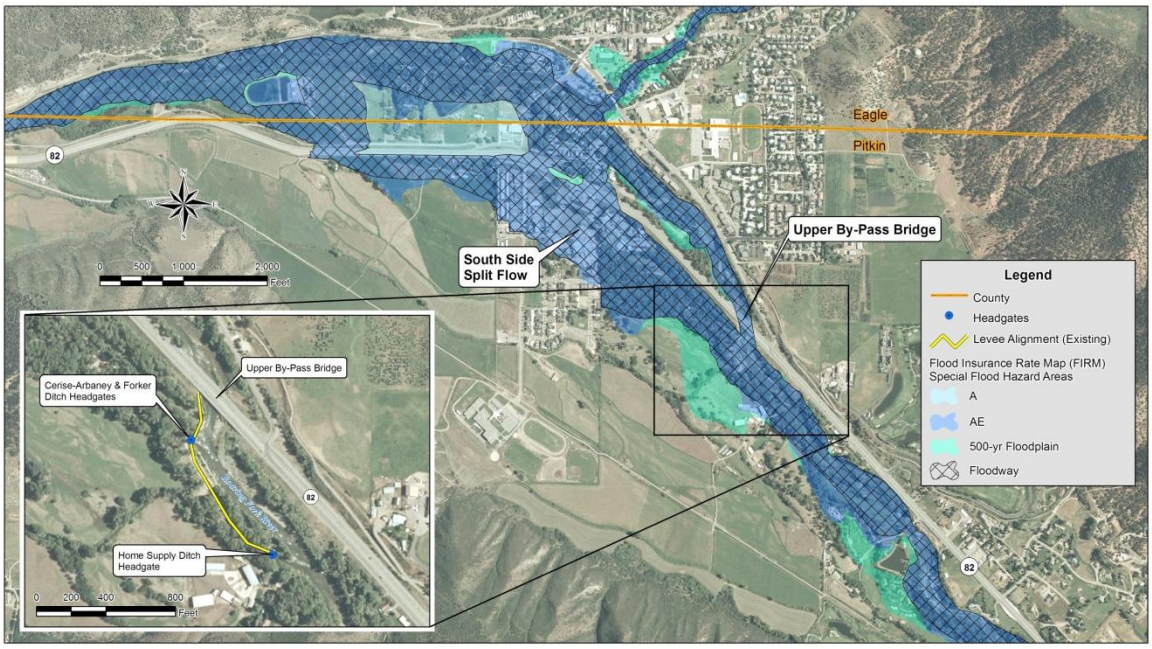

Figure 1-5. Effective Floodplain Designation

1.5 Study Limits

The HEC-RAS model that supports this LOMR request models the South Side flood hazard from the Split with the Roaring Fork River to where it rejoins the Roaring Fork between where it crosses SH 82 and the Waste Water Treatment Plant. In the Regulatory Model for the Roaring Fork River the split flow occurs upstream of Cross-Section 94 and rejoins the river at Cross-Section 68. The proposed mapping changes are limited to the South Side of SH 82.

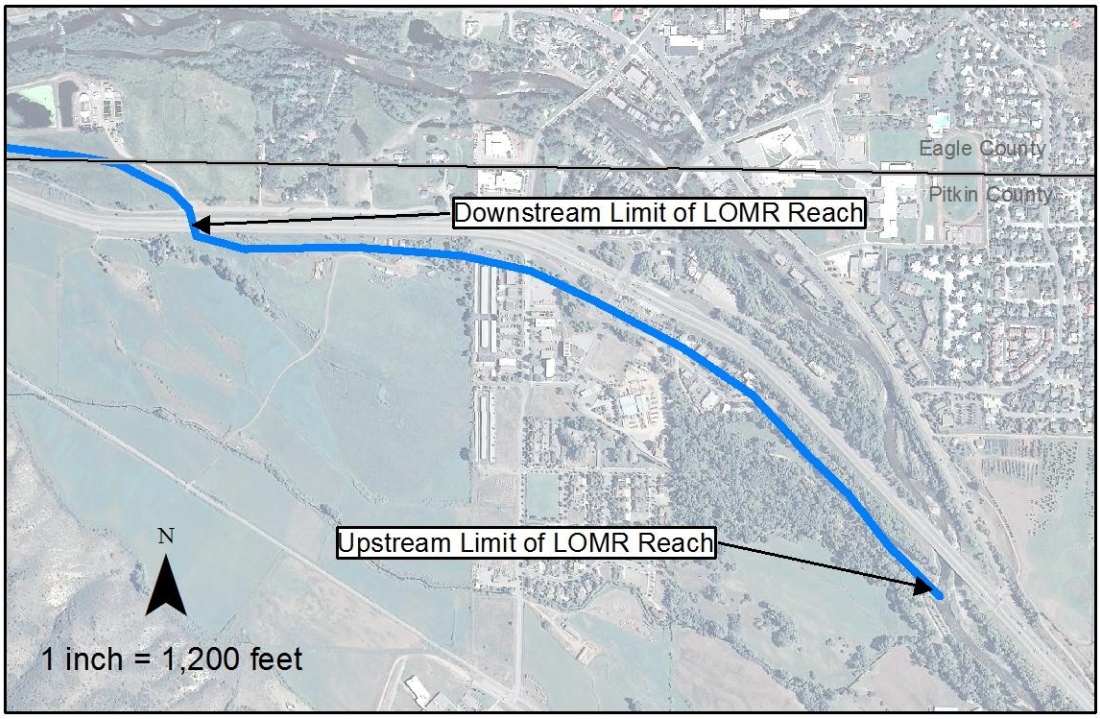

Figure 1-6. Project Reach

This LOMR does not propose to changes to the regulatory flood model along the Roaring Fork main stem. However, the two-dimensional model used to determine the overbank flow into the South Side includes the Roaring Fork River from Snowmass Canyon to the Lower Bypass Bridge to ensure appropriate boundary conditions for the two-dimensional model.

2 Analysis Criteria

2.1 Regulations

Town of Basalt Criteria: A portion of the Study Reach is located within the Town of Basalt; therefore the analysis and project are subject to the criteria provided in the Town's Flood Damage Prevention ordinance (Ordinance) at Chapter 16, Article XVII, Sections 16-351 to 16-376 of the Town's Municipal Code.

Pitkin County Criteria: A portion of the Study Reach is located within Pitkin County; therefore the analysis and project are subject to the criteria provided in the County's Code at Title 8, Chapter 7, Section 7-20-40.

FEMA Criteria: The National Flood Insurance Program (NFIP) regulations provide for the minimum floodplain management criteria for participation in the program. Title 44, Part 72 of the Code of Federal Regulations outlines the procedures and fees for processing map changes.

3 Early Studies

The earliest floodplain study of the Roaring Fork River encompassing the area of the Upper Bypass Bridge was performed by Wright-McLaughlin beginning in 1976. This study covered the Roaring Fork River upstream from its confluence with the Frying Pan. The earliest floodplain maps of the area are dated October 25, 1977, published by the Federal Housing Administration. It is unclear if these maps are based on the work performed by Wright-McLaughlin in 1976.Wright McLaughlin also prepared a separate study for Eagle County covering the Roaring Fork River downstream from its confluence with the Frying Pan approximately 6 miles.

Subsequent analysis for the Roaring Fork in Eagle County and Pitkin County were performed by Gingery Associates (1980) and Denver Engineering Corporation (DEC) (1985), respectively. Table 2.1.1 provides a summary of the map history for the applicable communities:

Table 3-1. Summary of Map History

Community Name	Initial Identification	Flood Hazard Boundary Map Revisions Date	FIRM Effective Date	FIRM Revisions Date
Eagle County	8/15/1975		11/19/1980	1/25/1983, 12/4/2007
Pitkin County	8/7/1975	10/25/1977	6/4/1987	10/19/2004
Town of Basalt	6/28/1974		3/18/1980	6/4/1987, 12/4/2007

References: Eagle County FIS and Pitkin County FIS Community Map History Tables

Construction of the Upper Bypass Bridge began after these early studies and was performed in two phases. The 1st phase began in 1987 with the construction of two lanes. The second phase widened the structure in 1993 with an additional two lanes on the upstream side of the original bridge. The levee was constructed sometime during or after the second phase.

The bridge hydraulics associated with the 100-year event were considered during the design of the bridge by CDOT as early as 1985 using HEC-2. The 100-year flow used was 9,400 cfs which matches the flow used in the effective FEMA FIS for the area. It was determined by CDOT at these early stages that a levee should be constructed in the left over bank area to reduce the floodplain width and confine 100-year flows to the channel. Correspondence from the Aspen/Pitkin Planning offices staff[1] with CDOT requested that the levee be constructed such that the Tucker-Hyde and St. Jude's properties would be removed from the 100-year floodplain. Plan sets dated 8/31/1987 include notes calling for 4 feet of freeboard above the 100-year water surface elevation and a 10 ft crest width for the levee adjacent to the bridge. These parameters are in accordance with FEMA freeboard requirements for levees within 100' of a structure as well as USACE requirements for levee crest width.

A letter of Map Revision (LOMR) was not performed to update the effective FEMA maps following realignment of SH 82, construction of the Upper Bypass Bridge, or the levee.

3.1 J.F. Sato and Associates – 1997 – 1999

From 1997 through 1999 J.F. Sato and Associates, Inc. (J.F.S.A.) contracted with FEMA to define the 100-year floodplain between the Garfield/Eagle County line and the Wingo Bridge. However the Town of Basalt[2], the CWCB[3], and John Liou of FEMA Region 8[4] all expressed concern over the delineation. The HEC-RAS model developed by J.F.S.A. was submitted to FEMA but never approved.

[1] Letter from Tom Newland, Planning Engineer – Aspen/Pitkin Planning Offices to Richard Perske, Pre-Construction Engineer – Department of Highways dated November 7, 1985.

[2] Letter from Dave Konchan (Town of Basalt) to John Liou (FEMA Region 8) dated June 25, 1999

[3] Letter from Bryan R. Hyde (CWCB) to Emilio Rios, P.E. (J.F.S.A.) dated June 17, 1999

[4] Summary of minutes from the July 16, 1999 meeting held at the Town of Basalt attended by representatives from Basalt, Eagle County, Pitkin County, J.F.S.A., FEMA Region 8, and the CWCB indicates consensus that the levee not be certified to provide protection during the 100-year event.

3.2 Matrix Design Group, Inc. – 2001

The basis for the current FEMA FIS and associated FIRM Panels is the HEC-RAS model developed by Matrix Design Group, Inc. (Matrix). References in this report to the "FEMA Effective Model" refer to the Matrix model. The Town of Basalt contracted Matrix Design Group, Inc. (Matrix) in 2000 to consolidate four different floodplain studies into one. These studies included the following:

1. Wright McLaughlin Water Engineers' hydraulic model from the Lower to Upper Basalt Bypass Bridge.
2. Matrix's HEC-RAS model from Willits Lane to the Lower Basalt Bypass Bridge
3. The LOMR performed by the Roaring Fork Club between the Wingo Bridge and the Upper Basalt Bypass Bridge.
4. HEC-RAS model developed by Matrix for Pitkin County between the Wingo Bridge and the confluence with Snowmass Creek.

Note: Items 1 and 2 were contracted by Basalt and were the result of review by Wright McLaughlin and Matrix, respectively, of the work completed by J.F.S.A. between 1997 and 1999.

The resulting Floodplain Information Report was first completed on July 24, 2000 and republished on November 14, 2001 to include detailed mapping and BFEs of the South Side area. The Matrix model assumed a 40% channel blockage at the Upper Bypass Bridge at the request of the Town of Basalt to represent aggradation of sediment upstream of the bridge that had been observed since the bridge's construction. The resulting 100-year water surface profile at the bridge shown in the Matrix model is higher than the profile developed by CDOT during design. Subsequently, the levee did not have adequate freeboard above the 100-year water surface elevations[5]. Additional concerns relating to the levee construction such as crest width[6], the gradation of materials used for construction, and rip rap protection contributed to FEMA's determination that the levee is not suitable to provide protection during a 100-year event[7]. As a result, while the levee is indicated on the FEMA flood maps[8] the split-flow condition is shown to occur at the Upper Basalt Bypass Bridge and the South Side is depicted in the 100-year floodplain and the floodway.

The Pitkin County FIS published on October 19, 2004 is based on the floodplain mapping and BFEs developed by Matrix. The Eagle County FIS published December 4, 2007 overlaps with the Pitkin County FIS in the vicinity of Basalt and is also based on Matrix's results. It is important to distinguish that the Eagle County FIS is not based on a more recent study superseding the work performed by Matrix; the flood maps and BFEs presented for the Roaring Fork River in the vicinity of Basalt in these areas of overlap are both based on the work performed by Matrix and the Special Flood Hazard Area (SFHA) delineations are identical. However the BFEs for the Roaring Fork River published in the Eagle County FIS were converted to NAVD 88 while the vertical datum of the BFEs presented in the Pitkin County FIS are NGVD 29. NAVD 88 is approximately 5 ft higher than NGVD 29 in the vicinity of the Upper Bypass Bridge (the topic of vertical datum is discussed in Section 4.1.2).

3.3 McLaughlin-Rincon – 2005

The Town of Basalt contracted McLaughlin-Rincon to investigate the Roaring Fork River between the Lower and Upper Bypass Bridges. The Town had suggested that the construction of the Upper Bypass Bridge had created problems in the river

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[5] It should be noted that removing the blockage assumption in the Matrix model results in adequate freeboard upstream of the bridge for the existing levee. However, portions of the levee upstream from the Cerise-Arbaney and Forker Ditch headgates where the water surface profile is not influenced by the blockage do not have adequate freeboard, regardless of the presence or absence of the blockage assumption.

[6] Generally, the levee geometry with respect to freeboard (assuming the blockage is removed - see [2] above) and crest width between the bridge and the Cerise-Arbaney and Forker Ditch headgates appears to be acceptable.

[7] The Floodplain Information Report states that John Liou visited the levee and determined it was not a "FEMA compliant Levee."

[8] While the levee alignment shown on the FEMA FIRM panels is generally correct, the alignment of the upstream tie-in is incorrect: the existing levee ends at a location closer to the Roaring Fork River

channel as well as the floodplain. The McLaughlin-Rincon report outlined $4.9 million in work near the Upper Bypass Bridge that included the construction of a levee. A total of $17 million in improvements for the entire study reach was recommended. The costs exceeded Basalt's budget and the recommendations have not been actively pursued.

3.4 HDR – 2007

CDOT contracted with HDR in the summer of 2005 to investigate the hydraulics at the Upper Bypass Bridge and to outline a course of action relating to levee improvements to bring the levee into compliance with FEMA and USACE standards. HDR reviewed the work completed by Matrix (2001) and McLaughlin-Rincon (2005) and also reviewed the original HEC-2 model prepared by CDOT in 1986. Key conclusions of the HDR report were that the bridge was capable of passing the 100-year flood event and that the levee does not have adequate freeboard or crest width.

- The bridge passes the 50-yr and 100-year flows. However the freeboard for both events does not meet CDOT requirements.
- Dredging the river channel upstream of the bridge to re-establish the channel invert to the condition represented in the 1986 HEC-2 files would improve the hydraulic performance and lower the 100-year water approximately 1.3 ft at the bridge. Periodic dredging was recommended as a viable alternative to the $4.9 million in improvements near the bridge described by McLaughlin-Rincon or the estimated $8 million cost of replacing the bridge.
- The levee does not have the required freeboard or top width to be certified by FEMA.
- *In July of 2006, FHWA conducted a review of the Upper Bypass Bridge and recommended that the HEC-RAS analysis not include the 40% blockage assumption at the bridge (see Section 3.5)*.

HDR issued a draft report in 2007 summarizing these findings.

3.5 FHWA Review

In July of 2006, FHWA conducted a CDOT Drainage Review. It was requested that the FHWA Review Team review the Upper Basalt Bridge Hydraulic Analysis and provide their recommendations and guidance on how to proceed with the existing SH 82 Upper Basalt Bridge. All necessary documents were provided to the review team.

Following are the FHWA Review Team comments regarding the Upper Basalt Bypass Bridge. These comments are part of the FHWA Final Draft Report for CDOT Drainage Review:

"It is the opinion of the Review Team that the town's requested HEC RAS analysis of the bridge with a blockage as used in the McLaughlin-Rincon study is an unrealistic representation of future hydraulic conditions at the bridge and should not be accepted by CDOT. The Review Team feels that the HDR HEC-RAS model of existing conditions best represents the site condition and should be the accepted model by both the town of Basalt and FEMA.

The Review Team also recommends that some work be done on the stream channel upstream of the bridge. The Team recommends that installation of dikes be considered along the outside of the bend upstream of the bridge to redirect the flow into the center of the channel and that the sediment filled areas of the channel be cleaned to restore the bridge to its full opening potential upstream of and under the bridge.

In regards to the berm, the Review Team believes that the issue of the berm ownership must be resolved and that the owner can then determine what must be done to protect the development in the FEMA floodplain."

4 Topographic Mapping & Coordinate Systems

The following section presents information related to topographic mapping and geographic coordinate systems for both the existing, effective regulatory model support documentation as well as for this study. The Town requested supporting files from FEMA. The Town provided AECOM all supporting documents (CAD files, HEC-RAS models, etc.) for the current, effective FIS, including some files from their own records. These models and maps were used as the basis of this study.

4.1 Effective FIS Data

4.1.1 Base Maps and Horizontal Coordinate System

The Town of Basalt submitted a data request to FEMA for the Roaring Fork and the South Side Split Flow. FEMA provided a file (686422729_Z1008081.zip) that contained the following AutoCAD drawings:

1. BasaltTownLimit.dwg
2. roar02.dwg
3. WorkMap.dwg
4. Xc-basalt.dwg
5. RoaringFork01.dwg (profile)
6. RoaringFork02.dwg (profile)
7. RoaringFork03.dwg (profile)
8. RoaringFork04.dwg (profile)
9. RoaringFork05.dwg (profile)
10. RoaringFork06.dwg (profile)
11. RoaringFork07.dwg (profile)

Review of these drawings indicates that they were produced by J.F. Sato and Associates and submitted as part of the study in the late 1990's and do not fully represent the effective FEMA data. The current regulatory model was developed by Matrix Design Group during their 2001 study. Notes from the Matrix HEC-RAS model indicate that it was based upon J.F. Sato's 1999 study, Roaring Fork Club's Reach 1 model in Pitkin County, McLaughlin's model through the Town of Basalt, and Matrix Design Group's model of River Oaks Subdivision and the Basalt Trade Center. While these CAD files are pertinent to the effective regulatory model they do not represent the final work product for the Effective Regulatory Model.

The Town of Basalt also provided a number of relevant files from their archives which included an AutoCAD file named Basalt-Fldplain-Aug2001-9-10-01.dwg (submitted electronically).This CAD file shows the cross-sections used in the hydraulic models for the main stem Roaring Fork River and the South Side Split Flow. The cross-section numbers in the drawing correspond to cross-sections in the South Side Regulatory Model as well as the DFIRM and FIRM. It also contains section lines, buildings, roads, contours, political boundaries.

The coordinate system indicated in Basalt-Fldplain-Aug2001-9-10-01.dwg, is UTM-WGS 1984 datum, Zone 19 North, Meter; Cent. Meridian 69d W. When projected using desktop GIS software (ESRI ArcGIS 10.2.2 or AutoCAD Civil 3D 2013) the drawing does not line up in the expected location based on PLSS Section Lines. ArcGIS was used to determine the correct

projection for the drawing. This was done my projecting the DFIRM data for Eagle and Pitkin Counties into Colorado State Plane, Central Zone, US Feet, NAD 83. Different coordinate systems were iteratively assigned to the Work Map drawing data to determine the best fit. The closest fit was Colorado State Plane, Central Zone, US Feet, NAD 83. Civil 3D was then used to translate the data in Basalt-Fldplain-Aug2001-9-10-01.dwg. The data was translated approximately 1100.4 ft along a bearing of S. 58” 40’ 44.66° W. as shown in Figure 4-1. This data was assigned a Colorado State Plane, Central Zone, US Feet, NAD 83 projection and was used to support this study.

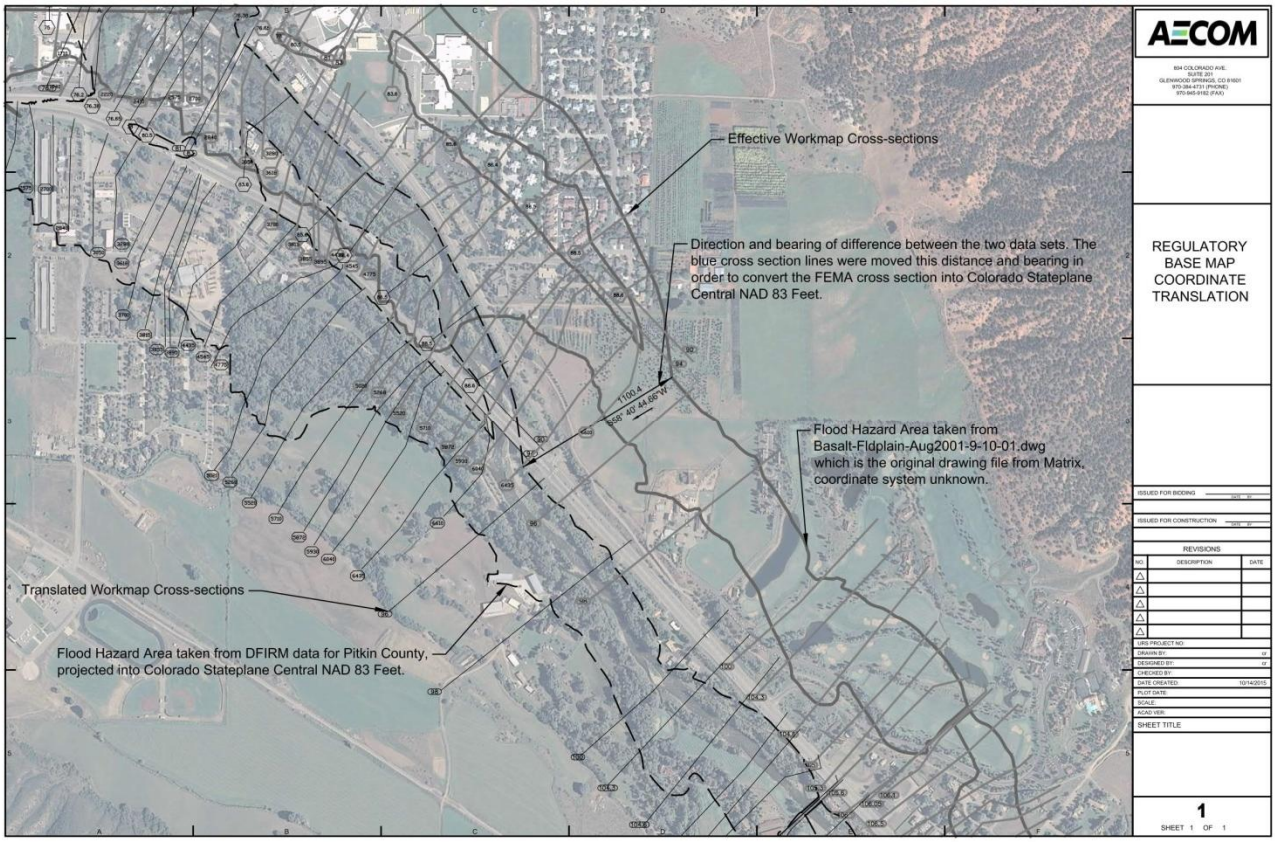


Figure 4-1. Matrix Workmap Coordinate Transormation

The Regulatory FIS and supporting models developed by Matrix used a number of different topographic data sources as follows:

- Topographic mapping from the Garfield/Eagle County line through the Wingo Bridge was provided by the Greenhorne & O’Mara.
- On November 8, 2000, Aero-Metric, Inc. of Fort Collins, Colorado flew over the Town of Basalt to produce high resolution imagery and topographic mapping for the town, and specifically for the area known as “South Side.” Horizontal and vertical Ground control was set by Sopris Engineering, LLC of Carbondale, Colorado.
- Sopris Engineering surveyed 44 cross-sections in areas of special interest (e.g. bridges, wide valley bottoms, or where floodplain development had occurred).

The effective, regulatory HEC-RAS models produced by matrix are not geo-referenced.

4.1.2 Vertical Datum

There are two primary vertical datums utilized in FEMA Flood Insurance Studies:

- ***NAVD 88***: The North American Vertical Datum of 1988 is FEMA's default vertical datum.
- ***NGVD 29***: The National Geodetic Vertical Datum of 1929 is the basis for older flood insurance studies.

The CAD drawings developed by J.F. Sato indicate that they use NGVD 29. The Matrix drawings do not indicate the vertical datum, but the Matrix flood information report states that the surveys were based on a NGVD 29 Vertical Datum. The Town of Basalt is located in Eagle and Pitkin Counties and the flood insurance studies associated with each of these counties overlap in the area of the Upper Bypass Bridge. The Pitkin County FIS was published in 2004 and uses a vertical Datum of NGVD 29 while the Eagle County FIS was published in 2007 and uses a vertical datum of NAVD 88. AECOM cross-checked the HEC-RAS vertical data with the J.F. Sato and Matrix CAD files, local NGS bench marks, and recent survey to verify that the Regulatory HEC-RAS model uses the NGVD 29 Datum. A datum shift of +4.83 ft was applied to the HEC-RAS files to convert from NGVD 29 to NAVD 88. NAVD 88 is the preferred FEMA vertical datum and matches the datum used in the Eagle County Flood Insurance Study, the most recent FEMA floodplain publication for the Upper Bypass Bridge area.

It's important to note that the South Side Floodplain is mapped on two different sets of FIRMS. It is mapped in Eagle County on FIRM Panel Numbers, 08037C0931D and 08037C0932D, published in 2007 and two in Pitkin County, 08097C0406D and 08097C0407D published in 2004. The work submitted by Matrix for the FIS was done in NGVD 29. The Pitkin County panels are presented in NGVD 29. The Eagle County panels have been re-published in NAVD 88. However, the BFEs for the Eagle County study were raised by a round 5 ft to adjust to NAVD 88 while the corrected datum adjustment value is +4.83 ft. Thus the BFEs for Eagle County are approximate to within a foot.

4.2 Proposed Data

AECOM utilized both LIDAR and ground survey data as described below.

4.2.1 2008 Merrick LIDAR

The Town of Basalt provided AECOM with LIDAR data to be used for this project. The LIDAR data was produced in 2008 by Merrick and Company for the Town of Basalt. URS obtained a copy of the ground control report associated with the LIDAR data. The report indicated a vertical accuracy within the prescribed standards set forth in FEMA's mapping standards suitable for 2 ft contours[9]. A copy of the Ground Control Report is included in Appendix C. This Data was used to update the HEC-RAS model in the overbank regions as outlined in Section 5.1.

4.2.2 2010 and 2015 Ground Survey

In August, 2010, Eagle County personnel surveyed the Roaring Fork River channel on the upstream and downstream sides of the bridge (cross-sections 94 and 90). The vertical datum of the survey was NAVD 88. The survey also included the bridge abutments, top of deck, bottom chord, and the location and dimension of piers. The survey data was used for comparison to previous data at the bridge to evaluate the channel blockage assumption in the Matrix model (Section 5.1.4) and also to verify the bridge geometry. Agreement between the 2010 survey data and Matrix model was good with respect to bridge geometry with higher channel elevations extending right to left (looking downstream) beginning approximately mid channel.

Cross-Sections 90 and 94 were surveyed again in 2015 by SurvCO, Inc. using NAVD 88. This data was used to assess channel changes that occurred between 2010 and 2015. This data was used in the modeling for this LOMR request. A copy of the Surveyor's Certification is included in Appendix C.

4.2.3 Modify Topography to Eliminate Levee

The goal of the FLO-2D modeling is to calculate the South Side Split Flow without the non-certifiable levee. This is referred to by FEMA as a "No Levee" analysis. FLO-2D builds an elevation grid directly from the LIDAR elevation points. In order to produce an elevation grid without a levee the raw LIDAR point data from the Merrick aerial survey were edited as follows:

[9] "Appendix A: Guidance for Aerial Mapping and Survey" from FEMA's *Guidelines and Standards for Flood Hazard Mapping Partners* outlines horizontal and vertical accuracy standards.

1. Field survey was performed by SurvCO, Inc. to identify the toe of the levee.

2. The field survey points and Merrick LIDAR points were imported into AutoCAD Civil 3D.

3. The field survey points were used to define the limits of the existing levee.

4. The LIDAR points inside the levee limits were deleted.

5. To visualize the impact of the point removal, two TIN surfaces were made to compare the original data with the “no levee” data (see Figure 4-2 and Figure 4-3).

This edited set of LIDAR points, referred to here as “No Levee” points, where then used to develop the elevation grid for FLO-2D. See Section 5 for more details on the FLO-2D model development.

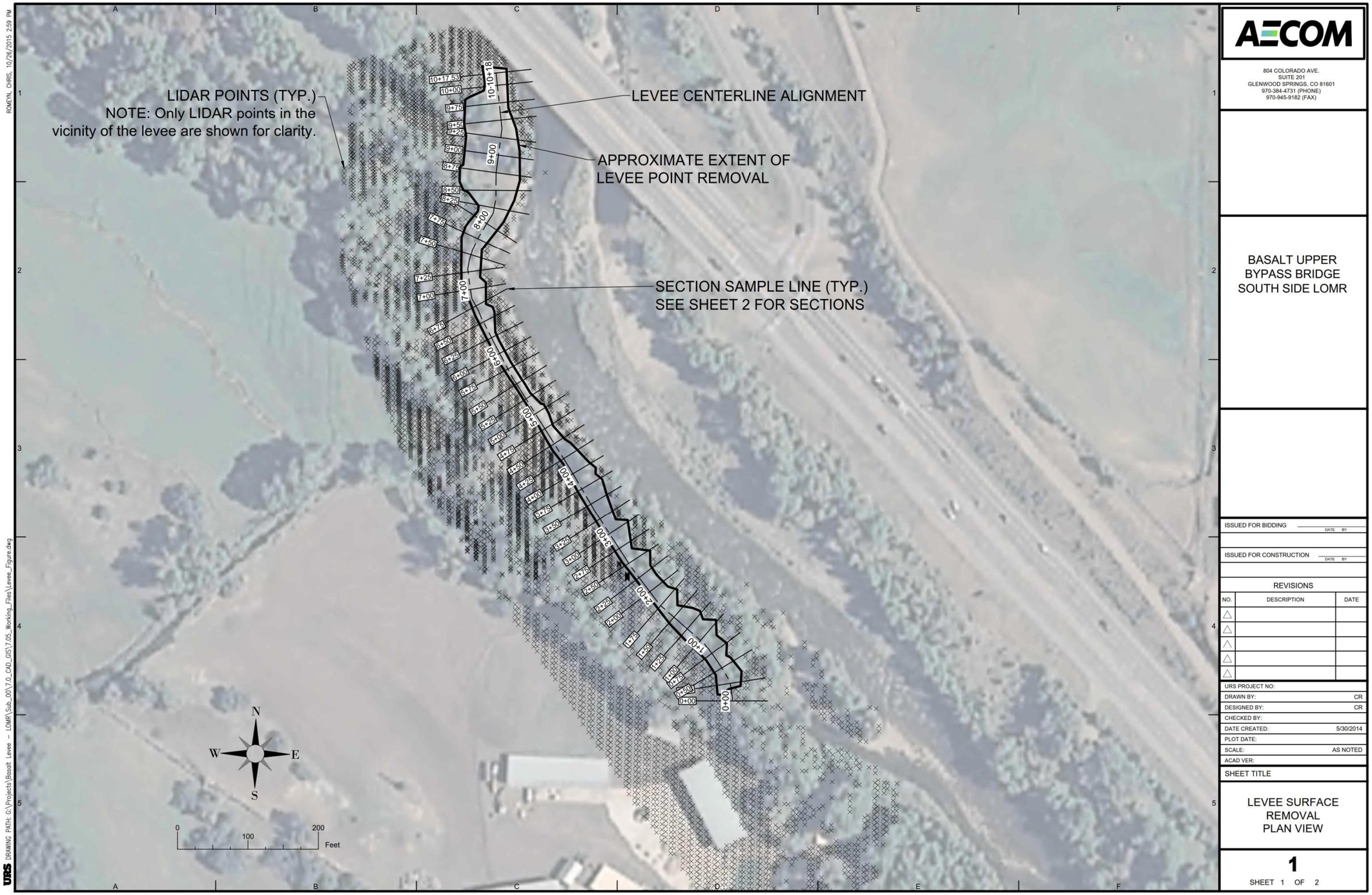


Figure 4-2. Plan view of LIDAR point editing for "No Levee" condition.

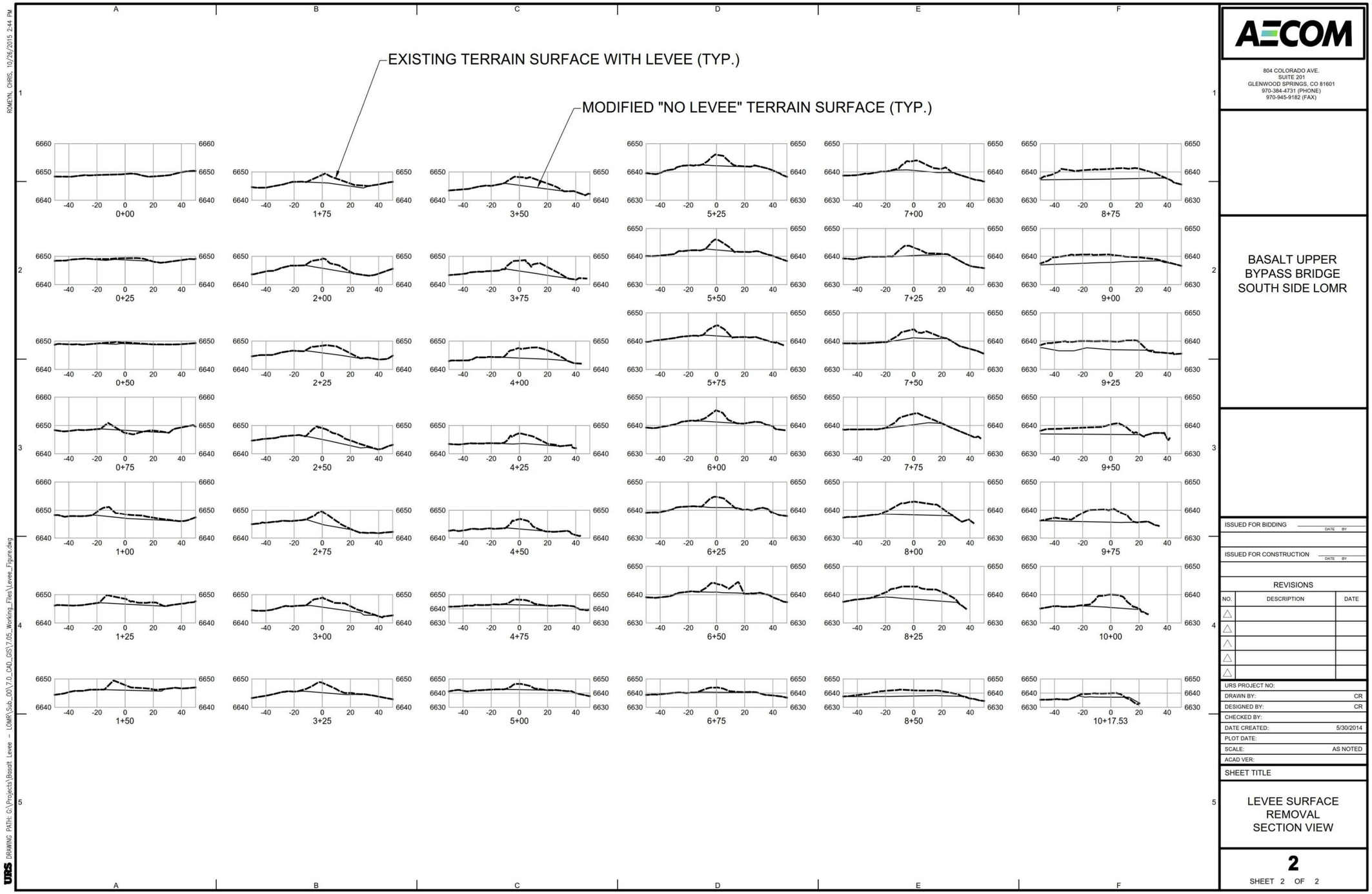


Figure 4-3 Section view of LIDAR point editing for "No Levee" condition.

5 Hydrology

This LOMR request only proposes changes to the floodplain mapping for the South Side Split Flow, south of Highway 82. There are no changes proposed to the main stem Roaring Fork River floodplain mapping. There are also no changes proposed to the Hydrology of the main stem Roaring Fork River. The Regulatory flows published in the FIS for the main stem Roaring Fork River and the South Side Split Flow are presented in Table 5-1.

Table 5-1. Roaring Fork River FIS Flows

River Reach	100-Year Discharge [cfs]	500-Year Discharge [cfs]
Main Stem Roaring Fork River	9,400	12,200
South Side Split Flow	4,400	NA

The South Side flood flowrate is dictated by the hydraulics of the split flow above the Upper Bypass Bridge. This complex, two-dimensional flow is not accurately simulated by one-dimensional models such as HEC-RAS. Previous modeling efforts failed to accurately model this split flow. AECOM utilized a detailed two-dimensional hydraulic model of the Roaring Fork River using FLO-2D to develop a more accurate estimate of the South Side Hydrology. The following sections outline the steps used to develop the FLO-2D model.

5.1 Updating the Regulatory Roaring Fork River HEC-RAS Model

In this study the main stem Roaring Fork River HEC-RAS model was used two ways as follows:

1. The full, updated HEC-RAS model was used to develop a stage discharge relationship for the Upper Bypass Bridge for use in the FLO-2D model. FLO-2D uses a stage discharge lookup table to model bridge hydraulics.

2. HEC-RAS cross-sections (from To-of-Bank to Top-of-Bank) from above the Lower Bypass Bridge to below Wingo Bridge were used within FLO-2D to model channel flow. The FLO-2D model has the capability to represent river channel flow using HEC-RAS cross-sections and one dimensional hydraulic modeling for flow contained within the channel. Once the modeled water surface is higher than the channel banks water spills from the 1-D channel to the floodplain which is modeled in 2-D. This results in greater correlation with the HEC-RAS model and more accurate floodplain and split flow modeling.

The regulatory HEC-RAS model for the main stem Roaring Fork River was updated for these purposes. As indicated in Section 4.1.2 the elevations for the HEC-RAS model were adjusted by 4.83 ft to convert from NGVD 29 to NAVD 88. The HEC-RAS model was then updated as outlined in the following sections.

5.1.1 Incorporation of Cross-section Survey

The 2015 bridge cross-section survey (see Section 4.2.2) data was used to update cross-section 90 and 94 to reflect the most recent conditions.

5.1.2 Incorporation of LIDAR Data

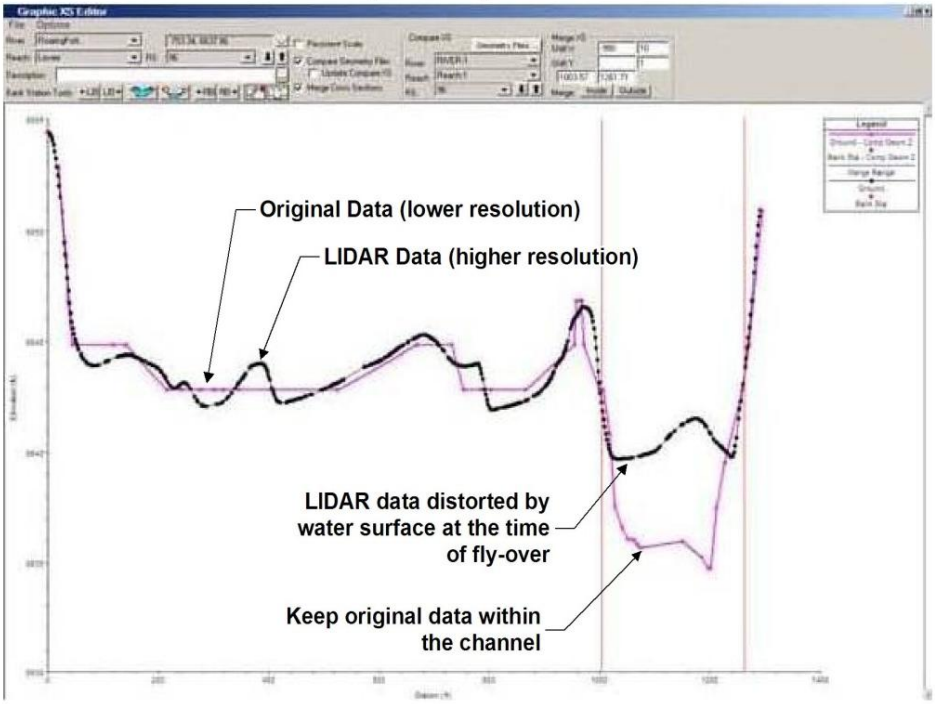
The LIDAR data (Section 4.2.1) was used to update the regulatory model cross-sections in the overbank area. Inspection of the Regulatory HEC-RAS sections revealed very coarse topographic data in the overbank areas. The Floodplain Information Report as well as correspondence with Matrix staff familiar with the HEC-RAS model confirmed that channel portions of the cross sections were surveyed. LIDAR is not accurate below the water surface so the LIDAR data was used for the over bank areas and the surveyed cross sections from the Matrix model were used for the river channel (including AECOM 2015 Survey for cross-section 90 and 94). The “Merge Cross Sections” option was utilized within the HEC-RAS “Graphical Cross Section Editor” to merge the LIDAR data into the original HEC-RAS cross sections. An example of the process is shown in Figure 5-1 LIDAR data was merged into all cross sections between cross sections 86.4 and 117 (31 sections).

5.1.3 Cross-Section Interpolation

Only four cross sections (94, 96, 98, 100) were present in the FEMA Effective Model along the Roaring Fork River adjacent to the proposed levee. The typical cross section spacing through this reach was greater than 600 feet. Additional cross sections were inserted to lower the average cross section spacing to 160 feet. The additional cross sections were added by interpolating between the existing cross sections and inserting LIDAR data was used to replace interpolated data in the overbank areas. The resulting additional cross sections are representative, but not exact, within the channel. Overall, 9 cross sections (94.6, 95.5, 96.5, 97, 97.5, 97.4, 98.8, 99.2, and 99.6) were inserted between existing cross sections 94 and 100.

It is important to note that the use of the additional interpolated cross-sections does not impact the stage-discharge relationship of the Upper Bypass Bridge.

Step 1: Compare Data



Step 2: Merge Data

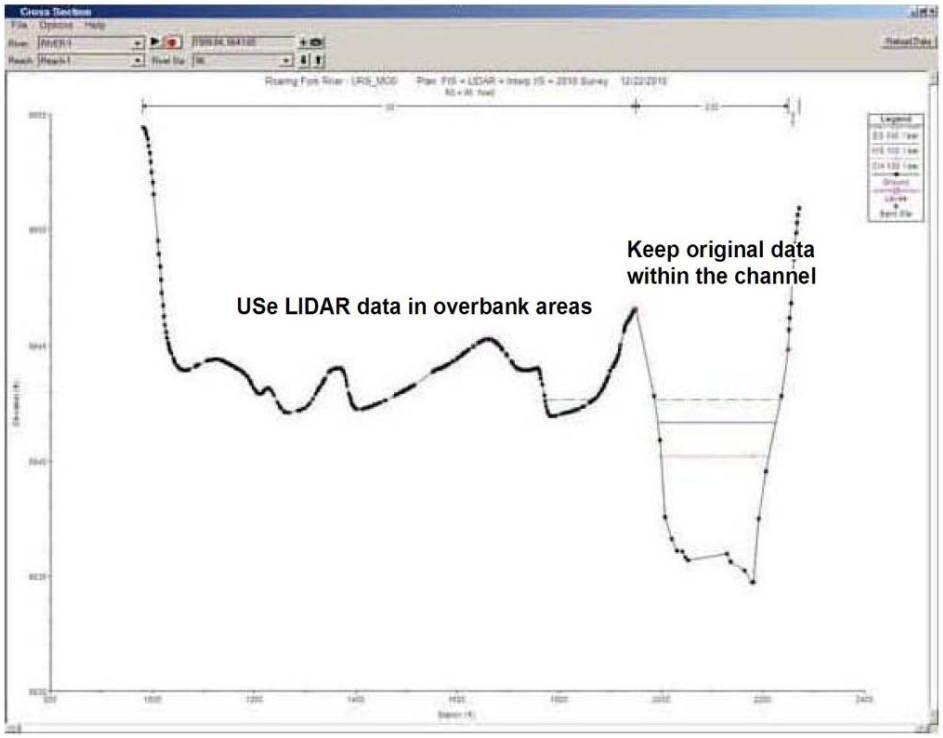


Figure 5-1. Example of HEC-RAS cross-section merge.

5.1.4 Channel Blockage

A major factor contributing to the determination that flows will split at the Upper Bypass Bridge is the assumption that the channel will become partially blocked during a flood event. The accumulation of gravels, cobbles, and sand in the right bay (when viewed looking downstream) since the bridge's construction has raised the Town's concerns that the hydraulic efficiency of the bridge to pass extreme flows is less than what was considered during design. The Town of Basalt recommended that a 40% blockage be included in the HEC-RAS model at the bridge[10]. This blockage assumption was incorporated into the regulatory hydraulic model (Figure 5-3). When modeling the 100-year flow through the bridge using the 40% blockage assumption the resulting 100-year water surface elevation is higher than it would be without the blockage.

While this reach of the Roaring Fork River has an active alluvial channel that is constantly changing, there is no historic evidence of the channel being obstructed by 40% through the bridge during floods. Elliot (2002) investigated the bed material entrainment potential of the Roaring Fork River from above the Upper Bypass Bridge to below the confluence with the Frying Pan. This study looked at 14 cross-sections from the Matrix HEC-RAS model including cross-section 96 (#3 in study), upstream of the Upper Bypass Bridge, and 88.6 (#6 in study), below the Upper Bypass Bridge. His results for a 100-year flood event are presented in Figure 5-2 below.

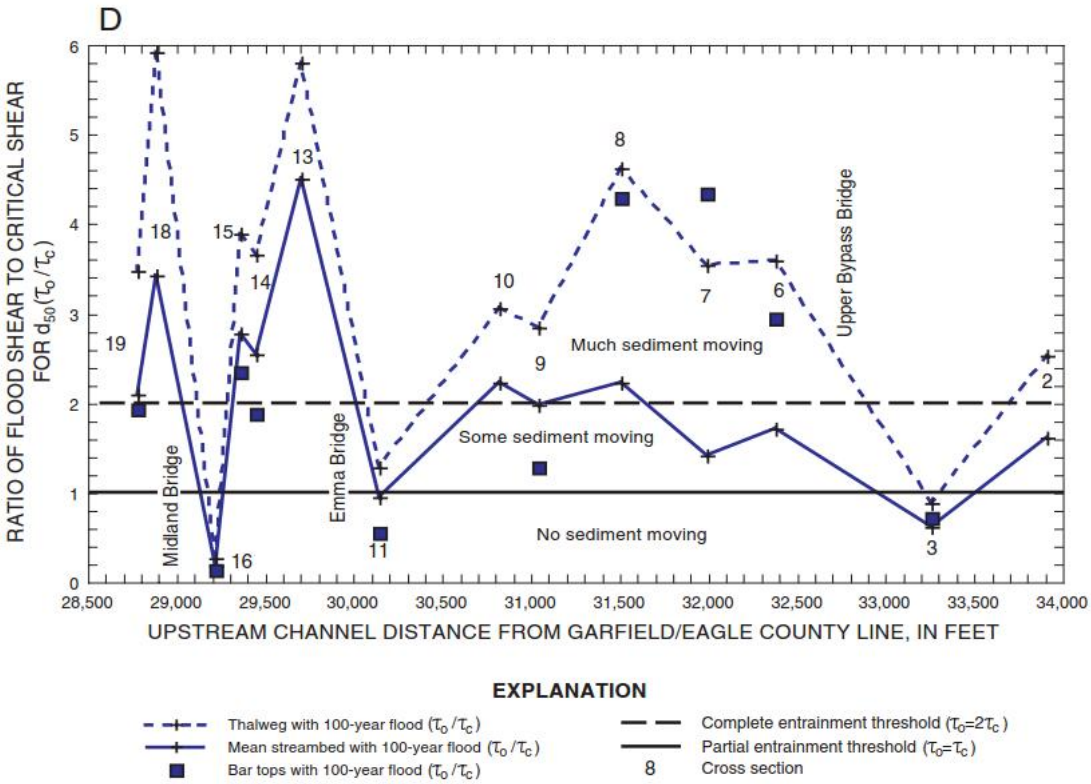


Figure 7. Entrainment potential (τ_o/τ_c) of the streambed, thalweg, and alluvial bars at the (A) bar-inundating discharge, (B) 10-year flood, (C) 50-year flood, and (D) 100-year flood, Roaring Fork River at Basalt—Continued.

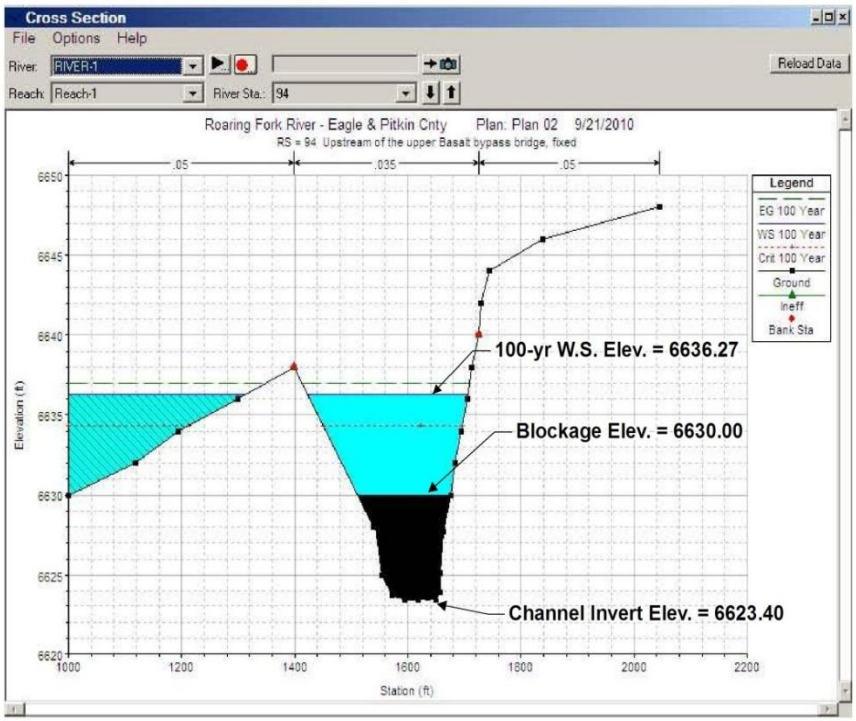
Figure 5-2. Entrainment Potential, Figure 7D from Elliot (2002)

When the ratio of flood shear stress to critical shear stress is above 1 (solid black horizontal line) sediment transport is occurring. The analysis was performed for the whole cross-section (mean streambed) and for just the thalweg. Cross-section 96 (#3) is located at station 33,259 and the Upper Bypass Bridge is located at station 32,726, approximately 530 ft downstream. It is apparent in Figure 5-2 that the shear stress ratio is below 1 at cross-section 96 (#3), which is located upstream of the Cerise-Arbaney & Forker Ditch Headgates. Elliot identifies this cross-section as a location of a potential

[10] Letter from Tom Baker (Town of Basalt) to John Liou (FEMA Region 8) dated April 26, 1999

aggradation issue. Moving downstream towards the Upper Bypass Bridge the shear stress ratio increases and exceeds a value of 1 at approximately station 32900 ft and continues to increase downstream. These results would indicate that during a 100-year flood sediment is being transported through the bridge and there is little risk of aggradation at this flow.

Inspection records maintained by CDOT staff at the bridge indicate some deposition occurred in the right bay from 1994 to 1998. Records also indicate scour has occurred in the left and middle bay. Overall, the inspection records indicate the channel thalweg upstream of the bridge appears to have moved from right to left (viewing downstream). The CDOT staff records are presented in Table 5-2. Comparison of the 2010 survey data to historic data revealed little to no alteration to the channel since the survey associated with HDR's report in 2006.



Note: Vertical Datum of elevations is NGVD 29.

Figure 5-3. Matrix Model –Cross Section 94, Upstream of Bridge

Year	Left Bay	Middle Bay	Right Bay
1989	6'	8'	6'
1991	6'	8'	6'
1994	10'	7'	10'
1996	10'	10'	6'
1998	7'	10'	7'
2002	6'	10'	n/a'
2004	6'	10'	n/a
2006	10.6'	9.5'	9.5'

Table 5-2. CDOT Staff Bridge Design and Maintenance Section Records

Subsequent to the 2010 cross-section survey CDOT performed channel maintenance to restore capacity to the bridge. They removed sediment from under the bridge through the right bay. AECOM compared results from the 2015 cross-section survey, the 2010 cross-section survey, the post-CDOT-maintenance cross-section, and the cross-section used in the Regulatory Model to understand how the channel has changed over time. Figure 5-4 shows how Cross-Section 94 has changed since the Matrix study. The cross-sections shown have been skewed to account for the 45° skew angle of the bridge. Several things are apparent from this figure, most notably the higher resolution of the recent survey data. While there has been some change in the overall cross-section shape, the cross-sectional conveyance area has changed very little in the last five years. It is apparent that the section of channel excavated by CDOT has filled back in but there is no indication of significant aggradation. Since the 2010 survey there have been three years (2011, 2014, and 2015) that had above average runoff.

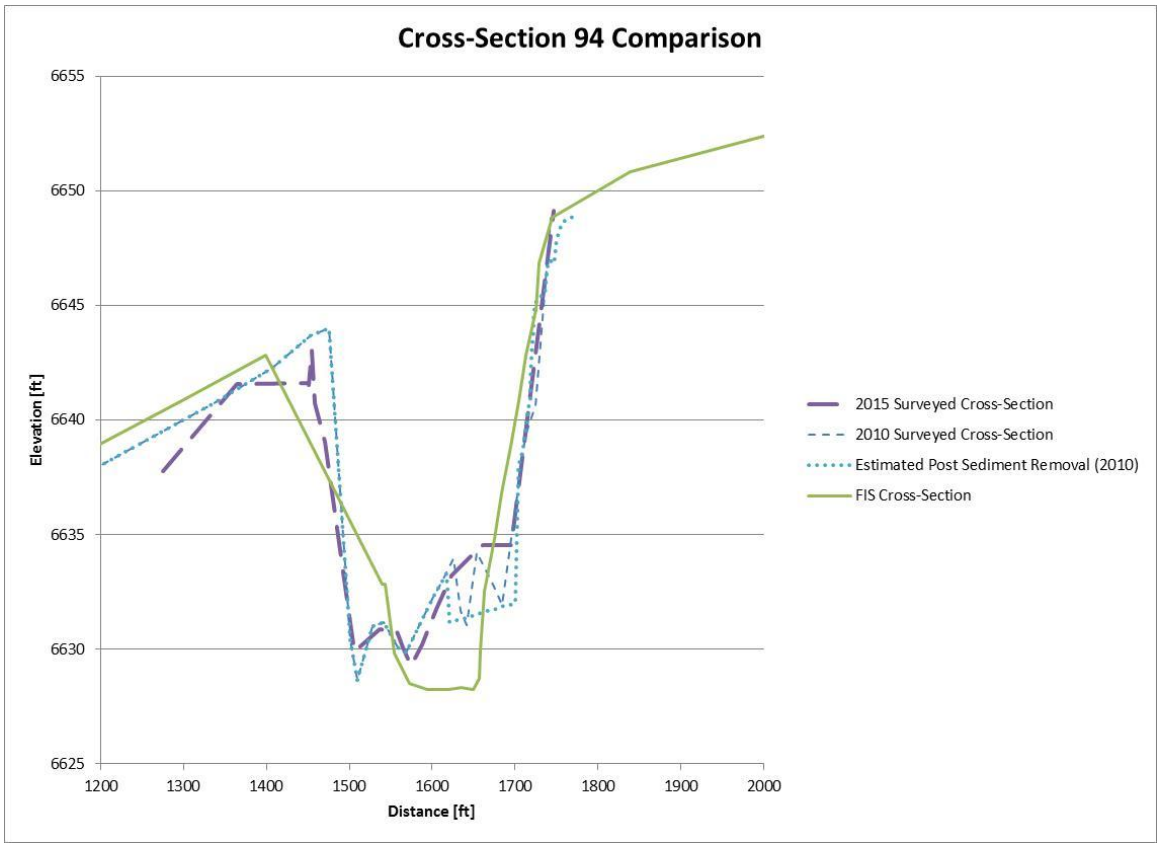


Figure 5-4. Comparison of Cross-section 94 surveys

Based on this assessment AECOM concluded that the 40% blockage assumption should be removed for the following reasons:

- Deposition of sediment in the right bay is offset by apparent scour in the left bay based on CDOT inspection records. The hydraulic capacity upstream of the bridge remains adequate to pass the 100-year event.
- Deposition of sediment occurs during low flow conditions when channel velocities are lower as opposed to extreme flow events when velocities are higher. A scour condition is more likely to occur during the 100-year peak event as opposed to one in which sediment is deposited.

- Typical hydraulic modeling practice is to model existing conditions as opposed to anticipated or future conditions. This is in agreement with a conclusion of FHWA upon reviewing HDR's report (see section 2.1.5) which was to remove the channel blockage.
- The FHWA recommended removing the blockage.

It's important to note that the previous floodplain studies of the Roaring Fork River did not include any sediment transport analysis. The proposed Channel Maintenance Agreement outlined below addresses the potential for sediment aggradation at the Upper Bypass Bridge.

5.1.4.1 Channel Maintenance Agreement

While it's unlikely that there will be significant aggradation during a flood event, there is the potential for some deposition to occur on the receding limb of the hydrograph. To account for this possibility the Town of Basalt and CDOT have entered into a maintenance agreement (MOU) for maintaining the conveyance under the Upper Bypass Bridge. The agreement is included in Appendix C.

The protocol outlined for maintaining conveyance through the Upper Bypass Bridge is as follows:

1. Six measurement locations have been established along the upstream side of the bridge. Type 5(s) Monuments have been placed on the top of the upstream curb.

2. In August of each year CDOT maintenance crews will measure the distance from the river bed to the top of the Monuments at each of the six locations.

3. Any deposition measurements that exceed 1 foot of aggradation within the cross section will be a means for CDOT Maintenance to begin planning and budgeting for a channel maintenance project which could potentially be triggered the following year should the threshold be exceeded.

4. Upon determining the 1.5 feet of aggradation has been exceeded, and no later than October 31st, the Town of Basalt will coordinate and perform a topographic survey of the channel reach for sediment removal as depicted in in the MOU. The sediment removal plan will be executed prior to the following year's runoff (See MOU for additional details).

5.1.4.2 HEC-RAS Cross-Section Modifications

Cross-sections 94 and 90 were surveyed in 2015 during the development of the MOU. These two cross-sections control the stage discharge relationship for the Upper Bypass Bridge. The riverbed elevations for these two cross-sections were increased by 1.5 ft to account for the potential aggradation at the Upper Bypass Bridge. The HEC-RAS model was run with these aggraded cross-sections to estimate the stage discharge for the Upper Bypass Bridge. The resulting stage-discharge relationship was used in the final FLO-2D model. Figure 5-6 and Figure 5-5 show the surveyed cross-sections and aggraded cross-sections for 94 and 90 respectively.

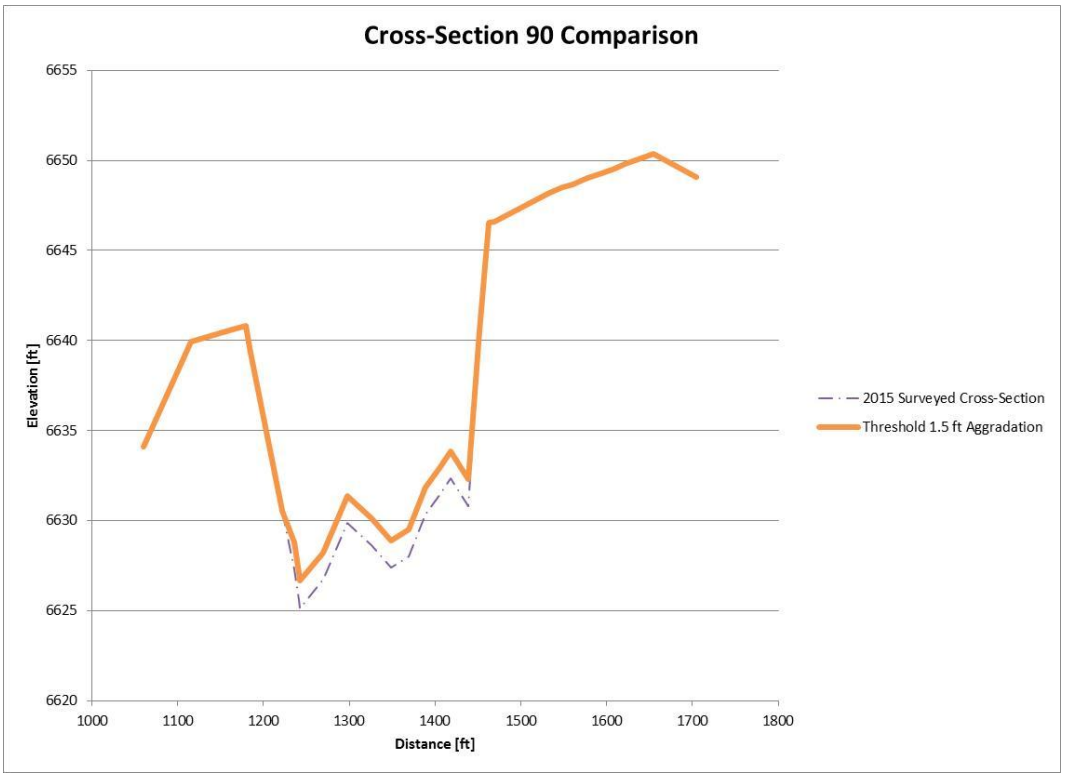


Figure 5-5. Aggraded Cross-Section 90

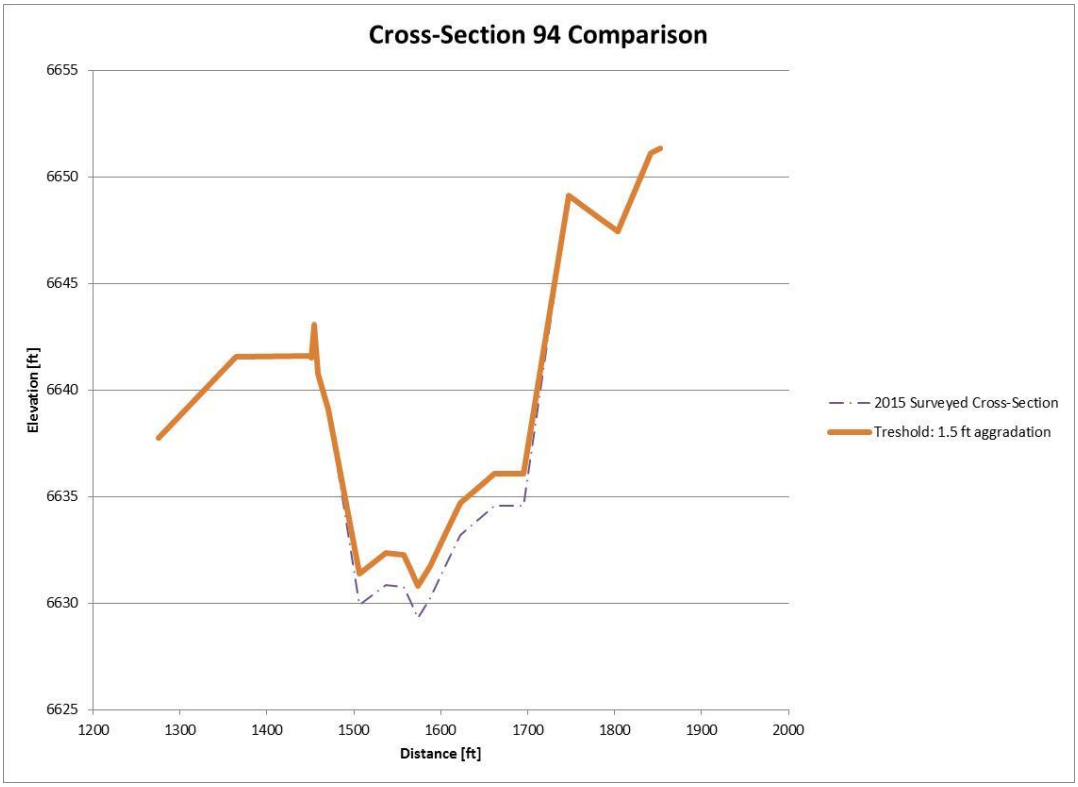


Figure 5-6. Aggraded Cross-Section 94

5.1.5 Upper Bypass Bridge Stage Storage

In summary the following changes to the regulatory HEC-RAS model:

1. Update regulatory model to NVAD 88 by adding 4.83 ft.
2. Incorporate 2015 cross-section survey for cross-sections 90 and 94.
3. Incorporated 2008 Merrick LIDAR data for overbank areas.
4. Remove 40% channel blockage from Upper Bypass Bridge.
5. Increased river bed elevations by 1.5 ft at Cross-Sections 90 and 94 to represent potential aggradation.

The updated HEC-RAS model is titled FLO-2D_Bridge.prj and has been submitted electronically. There are two model plans included in the model: 2015_UpperLimitStageDischarge1.5 which uses the interpolated cross-sections (94.6, 95.5, 96.5, 97, 97.5, 97.4, 98.8, 99.2, and 99.6) and 2015_UpperLimitStageDischarge1.5-FISXC which uses just the original FIS cross-sections (94, 96, 98, and 100). Figure 5-7 shows the results of this analysis for the upstream cross-section (94). The resulting Upper Bypass Bridge Stage-Storage Relationship Table is presented in .

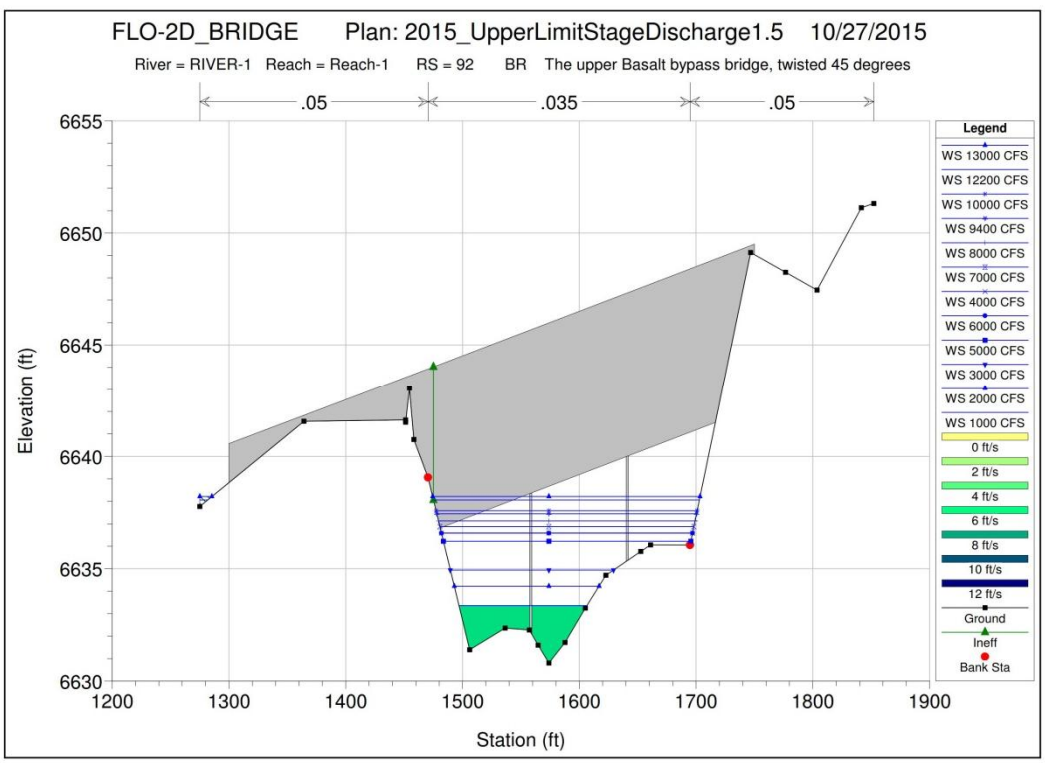


Figure 5-7. Upper Bypass Bridge Stage Discharge Calculation.

TIME	100-Year Discharge	500-Year Discharge
(HRS)	[CFS]	[CFS]
0.25	0	0
0.5	0	0

0.75	474.06	1561.55
1	934.46	1807.95
1.25	957.12	1780.04
1.5	959.95	1828.16
1.75	965.03	1787.68
2	971.11	1844.81
2.25	982.04	1854.59
2.5	985.35	1879.27
2.75	990.87	1870.33
3	991.19	1874.8
3.25	988.19	1872.39
3.5	991.49	1877.15
3.75	989.66	1877.02
4	991.71	1878.04
4.25	992.53	1879.23
4.5	992.39	1877.38
4.75	994.02	1877.3
5	993.45	1879.38
5.25	994.39	1878.82
5.5	993.59	1881.34
5.75	992.82	1883.01
6	993.62	1878.5

5.2 FLO-2D Model Development

The following sections outline the procedures used to develop the FLO-2D model of the Roaring Fork River. The purpose of this modeling is to determine the South Side Split Flow overbank discharge. The results of this analysis are not intended for any other use.

5.2.1 HEC-RAS Cross-Sections

Georeferencing

The regulatory HEC-RAS model was georeferenced for use in the FLO-2D model. The georeferenced cross-sections from the Matrix work map (see Section 4.1) were imported into Civil 3D (Colorado State Plane, Central Zone, US Ft. NAD 83). HEC-GeoRAS was used to export a georeferenced HEC-RAS model. The cross-section cut line information was then used to update the GIS cut line table for the Regulatory HEC-RAS model. The cross-sections were imported into FLO-2D model using the built in tools.

Channel Model Domain

Two-Dimensional hydraulic models are very demanding on computer resources so the domain of two-dimensional models should be kept as small as possible to limit computational run times. The Regulatory HEC-RAS model extends from the Garfield County/Eagle County line upstream to the confluence of the Roaring Fork River and Snowmass Creek. To limit run time the FLO-2D model domain extends from above the Lower Bypass Bridge to below Wingo Bridge at the mouth of Snowmass Canyon. The HEC-RAS model was trimmed down to match the FLO-2D model. The downstream limit is cross-section 50.1 from the regulatory model and the upstream limit is cross-section 126 from the regulatory model. The total channel length is approximately 4.3 miles. The upstream boundary of the FLO-2D model is approximately 1.7 miles upstream downstream from the Upper Bypass Bridge. The downstream boundary is approximately 1.2 miles below the point where the South Side Split Flow re-joins the Roaring Fork River just above the Lower Bypass Bridge.

The HEC-RAS cross-sections were trimmed to eliminate all overbank topography. Cross-sections were trimmed at the apparent top of bank based on the merged (LIDAR and Matrix) elevation data. The cross-sections located along the existing levee were modified so that their maximum left bank elevation corresponded to the surveyed levee toe elevations at each location. Figure 5-9 shows the locations of the trimmed cross-section used in the FLO-2D model. A typical trimmed cross-section (no. 96) is shown in Figure 5-8. The shortened cross-sections are in HEC-RAS Model FLO2D_Short.prj which has been submitted electronically.

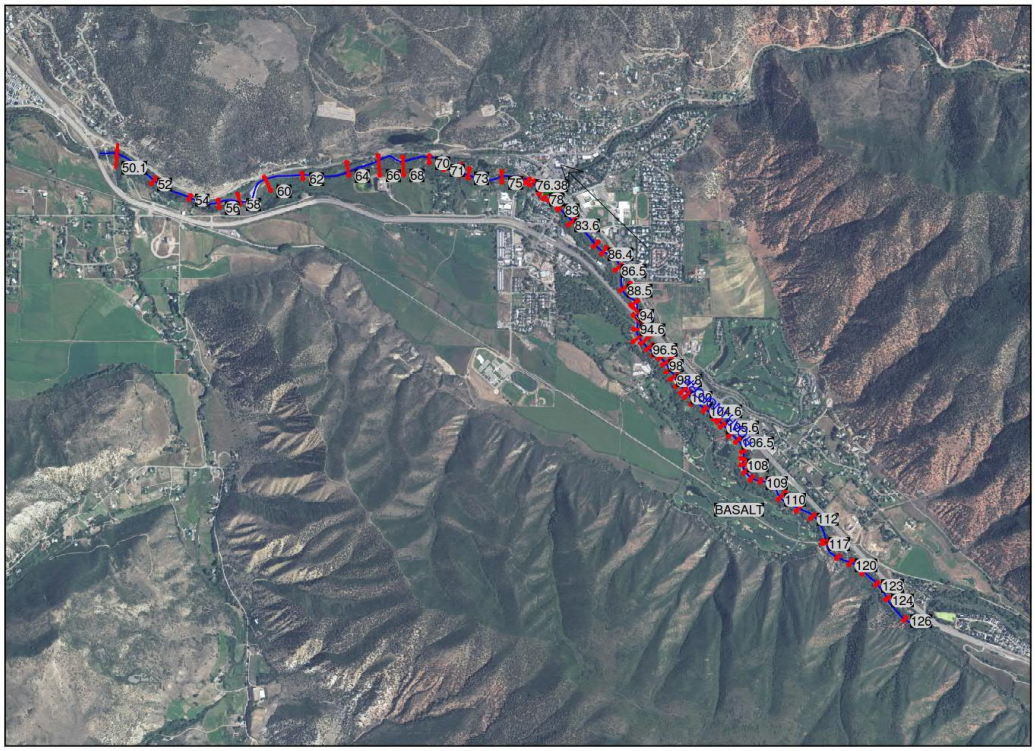


Figure 5-9. Trimmed HEC-RAS Cross-Section for FLO-2D Model

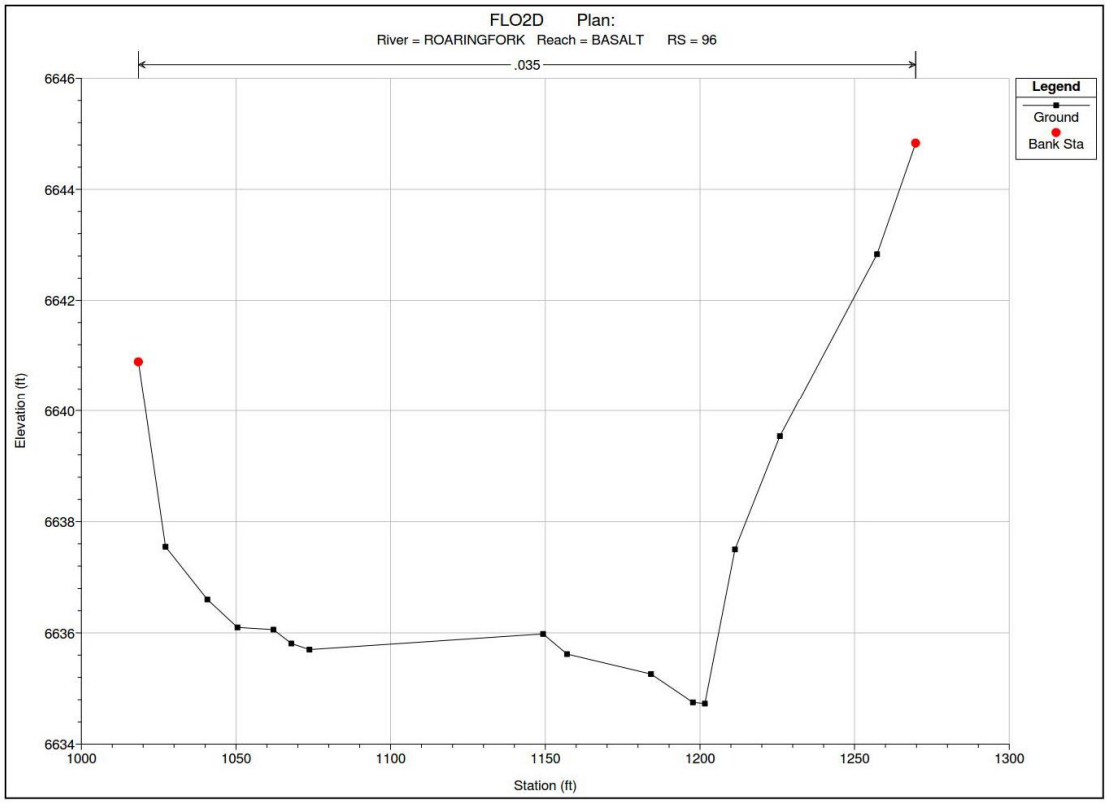


Figure 5-8. Typical Trimmed HEC-RAS Cross-Section (no. 96)

5.2.2 FLO-2D Elevation Grid

The raw Merrick LIDAR bare ground point data was used to create the FLO-2D elevation grid using FLO-2D internal routines. A smaller the grid cell size results in a more accurate model but a longer computation time whereas a larger grid cell size results in faster computation. A balance must be found between model accuracy and computation time. The FLO-2D documentation recommends a cell size such that the peak flow divided by the cell area is less than 1 cfs/ft^2 ($Q_{peak}/A_{grid} < 1.0$ cfs/ft^2). Following this guideline the Roaring Fork's peak discharge of 9,400 cfs would require a cell size of approximately 100 ft by 100 ft. This cell size was considered too coarse for the purposes of this project so a number of cell sizes were tried ranging from 25 ft by 25 ft up to 50 ft by 50 ft. Preliminary model run times ranged from 2.5 hours to over 48 hours. The computation times for a cell size of 35 by 35 ft were approximately 6 hours. A grid cell size of 35 ft by 35 ft provides an appropriate level of resolution for determining the split flow along the 1000 ft levee alignment and was used for this analysis.

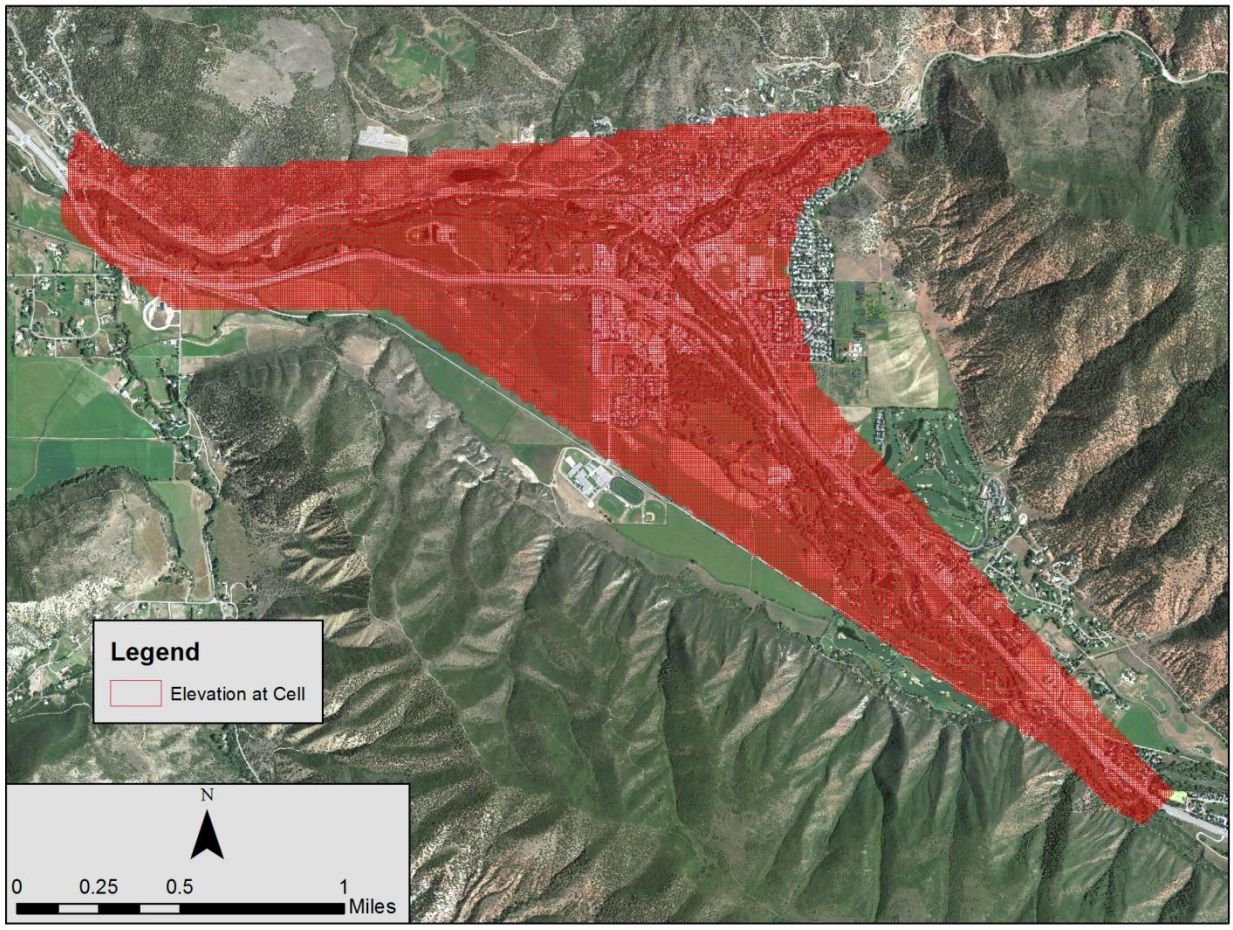
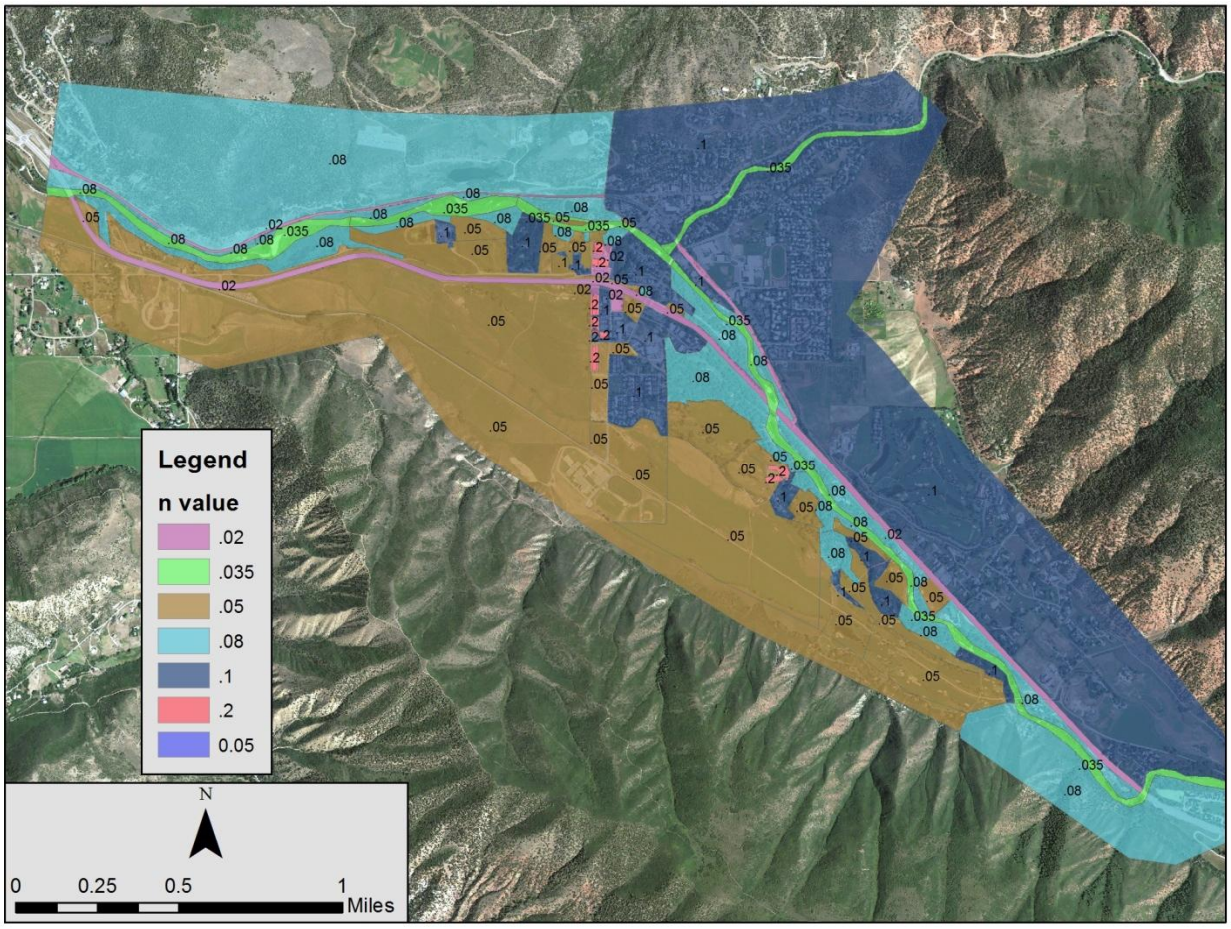


Figure 5-10. FLO-2D Computational Grid

5.2.3 FLO-2D Manning's n

Manning's n values were assigned to the individual grid elements visually based on the 2009 NAIP aerial photography. Conservatively low Manning's n values were estimated for the computational domain. The resulting map of Manning's values is presented in Figure 5-11.



5.2.4 FLO-2D Area and Width Reduction Factors

The 2009 aerial photo was used to identify structure locations. Appropriate Area Reduction and Width Reduction factors were assigned to each grid element containing all or part of a building.

Figure 5-11. FLO-2D Manning's n Values

5.2.5 FLO-2D Hydrology

The FLO-2D model was run with the 100-year discharge of 9,400 cfs and the 500-year discharge of 12,200 cfs. The Upper Bypass Bridge is the hydraulic control for the main stem Roaring Fork River at the location of the South Side Split. There is no impact from downstream tributary flow from the Frying Pan River so it is not included in the model.

The most severe flooding on the Roaring Fork River is the result of rapid snowmelt runoff in the spring, possibly combined with a large rain event. In contrast to the flashy nature of floods caused by short duration thunderstorm events typical in many parts of the country, the springtime runoff flood events on the Roaring Fork River are long term events, lasting days or even weeks. Floodplain storage has less of an impact on peak flows during these long events because the floodplain storage is

filled early in the hydrograph and the peak flows are passed downstream unattenuated. FLO-2D is an unsteady state model; therefore a 6 hour hydrograph with a constant discharge of 9,400 cfs (100-Year) and 12,200 cfs (500-Year) were used for the FLO-2D model. The duration of this hydrograph is long enough to ensure that steady state flow conditions have been achieved. The Inflow node was located at Wingo Bridge.

5.2.6 FLO-2D Upper Bypass Bridge

The updated main stem Roaring Fork River HEC-RAS model (Section 5.1) was used to develop a Stage Discharge relationship for the Upper Bypass Bridge. It is important to note that the 40% blockage has been removed from the HEC-RAS model. See Section 5.1.5 for more details on the calculation of the Stage Discharge relationship.

5.2.7 FLO-2D Floodplain Cross-Sections

Floodplain cross-sections can be used in the FLO-2D model which provide details about the flow rate through the cross-section. Three floodplain cross-sections were placed in the Roaring Fork River model to estimate the South Side Split Flow. Two floodplain cross-sections were placed between the Upper Bypass Bridge and Cody Ln (#1 & #2). These sections are perpendicular to the expected floodplain flow, which is Southeast to Northwest. The 100-year and 500-year discharge at these two cross-sections were used in the South Side HEC-RAS model. A third section was placed along Highway 82 (#3) at the intersection with Basalt Ave to calculate the flow that splits across Highway 82. The Work Map shows the location of the three floodplain cross-sections.

5.3 FLO-2D Model Results

The FLO-2D model is being used to calculate the 100-year and 500-year flood discharges for South Side Split Flow. The model is not being used for any other purpose (e.g. floodplain delineation, flow velocities, etc.). The FLO-2D results at Floodplain cross-sections #1, #2, and #3 (Section 5.2.7) are presented in Figure 5-12 and Table 5-3. Additional model results .

It's important to note that these results are based on the assumption that the Roaring Fork River channel will aggrade by up to 1.5 ft and are not reflective of existing conditions at the time of this LOMR request. The maintenance MOU between the Town and CDOT requires that the channel be maintained such that the conveyance is always equal to or greater than the aggraded condition represented in the modeling. See Section 5.1.4 for more details on the channel aggradation and the maintenance.

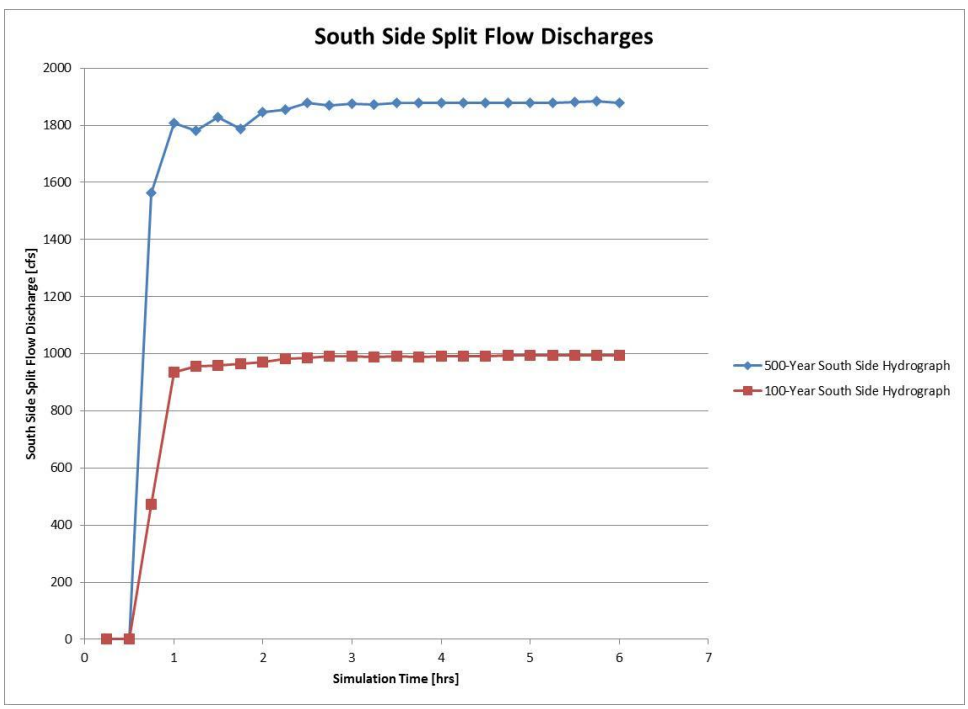


Figure 5-12. FLO-2D South Side Split Flow Results

Time [HRS]	100-Year Discharge [CFS]	500-Year Discharge [CFS]
0.25	0	0
0.5	0	0
0.75	474.06	1561.55
1	934.46	1807.95
1.25	957.12	1780.04
1.5	959.95	1828.16
1.75	965.03	1787.68
2	971.11	1844.81
2.25	982.04	1854.59
2.5	985.35	1879.27
2.75	990.87	1870.33
3	991.19	1874.8
3.25	988.19	1872.39
3.5	991.49	1877.15
3.75	989.66	1877.02
4	991.71	1878.04
4.25	992.53	1879.23
4.5	992.39	1877.38
4.75	994.02	1877.3
5	993.45	1879.38
5.25	994.39	1878.82
5.5	993.59	1881.34
5.75	992.82	1883.01
6	993.62	1878.5

Table 5-3. FLO-2D South Side Split Flow Results

The FLO-2D model results are presented in Appendix B (Exhibit D) and have been submitted electronically.

6 Hydraulics

The following sections outline the HEC-RAS modeling procedures used to develop the proposed floodplain delineation.

6.1 Effective Model

The regulatory HEC-RAS model completed by Matrix utilized 39 cross-sections between the split above the Upper Bypass Bridge and where it rejoins the main stem near the wastewater treatment plant. As indicated in Section 5.1.2 the cross-sections were based on ground survey and are coarse when compared to cross-sections cut from LIDAR data. The Matrix base mapping includes the locations for the South Side HEC-RAS cross-sections but it doesn't include the reach centerline. Additionally, the regulatory model is not georeferenced. A copy of the Regulatory Model has been submitted electronically.

6.2 Duplicate Effective Model

The Duplicate Effective Model is an exact duplicate of the effective, regulatory model produced by Matrix. This model has been provided (Basalt_SS_Dup.prj).

The only change to this model was made to address the following error:

> *HEC-RAS Error - Incomplete data, the following errors were found:*
> *River:"Split1" Reach: "Reach 1" - A flow is specified at RS: "2020 " but this cross section does not exist in the geometric data.*

This error was corrected by deleted the appropriate line from the flow file, overbank6.F01:

> *River Rch & RM=Split1,Reach 1 ,2020*
>
> *600*

The results of the Duplicate Model match the published BFE within 0.1 ft.

6.3 Proposed Model

Given the issues related to the regulatory model (see Section 6.1) AECOM made significant changes to the new hydraulic model for the South Side flood delineation as outlined in the following sections.

6.3.1 Topography

The HEC-RAS cross-sections were cut using the 2008 LIDAR data discussed above. See Section 4.2.1. for more details on this topography.

6.3.2 Cross-Sections

The FLO-2D output includes flow direction vectors for each grid element. The flow direction vectors for the 100-year event were used to guide the placement of the HEC-RAS cross-sections to ensure that the cross-sections are orthogonal to the flow. The Work Map (Exhibit C, Appendix B) shows the location of the cross-sections used for the Proposed Effective Model. A total of 85 cross-sections were used with an average spacing of 74 ft.

6.3.3 Hydrology

The duplicate effective model uses the same hydrology as the effective, regulatory model completed by Matrix. The effective FIS does not include a profile for the South Side for the 500-year flood event so only the 100-year event model profile is presented. The effective, regulatory 100-year discharge is 4,400 cfs. The new hydrology determined using two-dimensional

modeling of the Upper Bypass Bridge split flow is 1000 cfs for the 100-year flood and 1900 cfs for the 500-year (see Section 5.3).

6.3.4 Blocked Obstructions and Ineffective Flow Areas

Blocked obstructions were added at all building locations. Ineffective Flow Areas were added as necessary at locations such as backwater areas and flow paths approaching buildings.

6.3.5 Lateral Structures

The FLO-2D model results indicate that the 100-year flood event splits and flows over Highway 82 near Basalt Ave. The FLO-2D floodplain cross-section results indicate that the split flow discharge is 100 cfs for the 100-year event and 200-cfs for the 500 year evet. A single lateral structure was added to the model to represent this split. The length and discharge coefficient were adjusted to match the FLO-2D results. This lateral weir discharges out of the system.

6.3.6 Boundary Conditions

The upstream and downstream boundary conditions for the South Side model were hard set to ensure the model ties into the Roaring Fork River main stem floodplain. These elevations were taken from the regulatory model at the appropriate location to ensure floodplain tie-in. The downstream boundary cross-section was located in the same location as cross-section D (Matrix Cross-Section 20) in the South Side DFIRM and cross-section R (Matrix Cross-Section 68) from the Roaring Fork DFIM. The upstream cross-section was located in the same approximate location as cross-section 6610 from the Matrix basemap (Upstream from Cross-Section K on FIRM).

This LOMR request's downstream limit is SH 82 (Matrix Section 660). The 500-year flood discharge was not modeled in the regulatory HEC-RAS model so there are no known water surface elevations to tie into. Therefore the model was extended downstream to Matrix Section 20 to ensure the water surface ties into the roaring fork river. To ensure that the 100-year profile ties into the regulatory profile at SH 82, an internal boundary was added to cross-section 120. The 100-year W.S.E. was set to 6580.69 ft (NAVD 88).

6.3.7 Manning's n

A more detailed delineation of Manning's n was developed for the HEC-RAS model. Manning's n values ranged from 0.02 to 0.18.

Location	Profile	Elevation [NAVD 88, ft]
Downstream (XC 1826.87)	Profile 1 (100-Year)	6567.24
Downstream (XC 1826.87)	Profile 2 (500-Year)	6568.15
Upstream (XC 7974.656)	Profile 1 (100-Year)	6641.78
Upstream (XC 7974.656)	Profile 2 (500-Year)	6643.39

Table 6-1. HEC-RAS Model Boundary Conditions

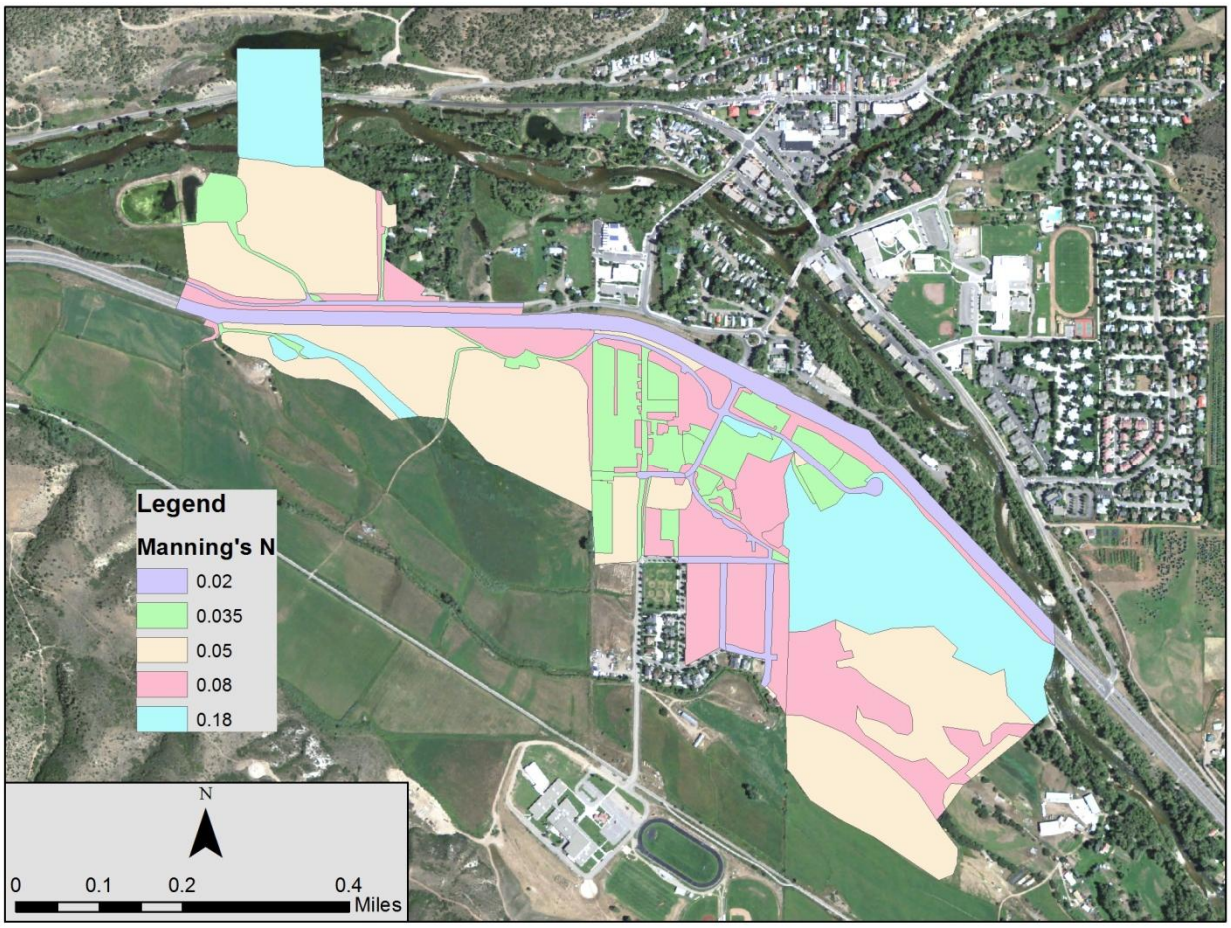


Figure 6-1. HEC-RAS Manning's n values.

6.3.8 Results

The floodplain profile table for the Duplicate Effective and Proposed models is presented in Table 6-2.

Model Reference Section Number	Matrix Cross Section Number	FIS Cross Section Letter	AECOM Stationing from Confluence with Roaring Fork (feet)	Reference Location	AECOM Streambed Elevation (feet)	Base Flood Elevations				
						Effective FIS		Proposed		Delta W.S. Elevation
						W.S. Elev NAVD 88 (ft)	Peak Discharge (cfs)	W.S. Elev NAVD 88 (ft)	Peak Discharge (cfs)	Proposed Elev. - Effective Elev. (ft)
850	6610		7977.55	Roaring Fork River Split	6636.02	6641.78	4,400	6641.78	1,000	0.00
840	6435	K	7832.13		6635.08	6637.90	4,400	6637.84	1,000	-0.06
830			7712.15		6632.80	6636.42	4,400	6636.04	1,000	-0.38
820			7520.86		6629.50	6634.07	4,400	6633.22	1,000	-0.85
810			7401.03		6627.39	6632.60	4,400	6631.71	1,000	-0.89
800			7314.28		6626.46	6631.29	4,400	6630.41	1,000	-0.88
790			7263.68		6626.10	6630.60	4,400	6629.47	1,000	-1.13
780			7152.77		6623.71	6627.68	4,400	6627.70	1,000	0.02
770	5710	J	7102.98		6623.17	6626.37	4,400	6626.76	1,000	0.39
760			7027.47		6622.00	6626.05	4,400	6625.48	1,000	-0.57
750			6927.41		6620.61	6625.62	4,400	6624.07	1,000	-1.55
740			6861.34		6619.16	6625.27	4,400	6622.76	1,000	-2.51
730			6740.97		6617.77	6624.64	4,400	6621.68	1,000	-2.96
720			6660.82		6614.85	6624.22	4,400	6620.46	1,000	-3.76
710			6573.56		6614.59	6622.11	4,400	6619.15	1,000	-2.96
700			6490.72		6614.86	6620.10	4,400	6617.96	1,000	-2.14
690			6431.26		6615.12	6617.96	4,400	6617.40	1,000	-0.56
680			6388.71		6614.18	6616.57	4,400	6616.84	1,000	0.27
670			6365.23		6613.85	6616.33	4,400	6616.55	1,000	0.22
660			6345.06		6613.54	6616.12	4,400	6616.33	1,000	0.21
650			6289.51		6615.15	6615.55	4,400	6615.80	1,000	0.25
640			6173.41		6613.84	6614.36	4,400	6614.03	1,000	-0.33
630			6091.32		6612.93	6613.52	4,400	6613.01	1,000	-0.51
620			5985.84		6610.78	6612.96	4,400	6611.57	1,000	-1.39
610			5907.95		6609.80	6612.54	4,400	6610.41	1,000	-2.13
600			5787.05		6605.86	6611.90	4,400	6609.98	1,000	-1.92
590			5655.43		6607.72	6611.20	4,400	6609.19	1,000	-2.01
580			5643.51	Lateral Structure						
570			5539.60		6605.22	6608.46	4,128	6608.31	996	-0.15
560			5502.78		6605.35	6607.16	4,128	6607.67	950	0.51
550			5446.53		6604.76	6605.85	3,792	6606.25	892	0.40
540			5407.52		6603.83	6605.19	3,792	6605.34	891	0.15
530			5378.49		6600.47	6604.69	3,792	6604.11	891	-0.58
520			5353.15		6602.03	6604.25	3,790	6603.12	891	-1.13
510			5305.16	Basalt Ave.	6600.61	6603.57	3,790	6602.49	891	-1.08
500	3618	G	5269.68		6600.49	6603.07	3,790	6602.33	891	-0.74
490			5224.27		6599.46	6602.58	3,790	6601.98	891	-0.60

Table 6-2. Flood Profile Table

Model Reference Section Number	Matrix Cross Section Number	FIS Cross Section Letter	AECOM Stationing from Confluence with Roaring Fork (feet)	Reference Location	AECOM Streambed Elevation (feet)	Base Flood Elevations				
						Effective FIS		Proposed		Delta W.S. Elevation
						W.S. Elev NAVD 88 (ft)	Peak Discharge (cfs)	W.S. Elev NAVD 88 (ft)	Peak Discharge (cfs)	Proposed Elev. - Effective Elev. (ft)
480			5175.34		6598.60	6602.06	3,790	6601.46	891	-0.60
470			5079.77		6597.93	6601.03	3,790	6600.83	891	-0.20
460			5033.85		6596.43	6600.53	3,790	6599.36	891	-1.17
450			4989.76		6597.56	6600.06	3,790	6598.89	891	-1.17
440			4959.51		6598.15	6599.73	3,790	6598.34	891	-1.39
430			4934.86		6597.45	6599.74	3,790	6598.38	891	-1.36
420			4915.82		6596.81	6599.63	3,790	6598.25	891	-1.38
410			4892.96		6596.20	6599.50	3,790	6598.03	891	-1.47
400			4828.21		6594.84	6599.13	3,790	6597.24	891	-1.89
390			4777.43		6594.11	6598.88	3,790	6596.83	891	-2.05
380			4714.84	South Side Dr.	6595.20	6598.57	3,790	6596.83	891	-1.74
370			4672.32		6594.96	6598.36	3,790	6596.61	891	-1.75
360			4636.88		6592.39	6598.19	3,790	6595.82	891	-2.37
350			4614.69		6591.98	6598.08	3,790	6595.14	891	-2.94
340			4549.09		6590.75	6597.35	3,790	6594.13	891	-3.22
330			4500.21		6590.45	6596.81	3,789	6594.23	891	-2.58
320			4441.36		6591.55	6595.08	3,789	6594.08	891	-1.00
310			4387.47		6591.79	6593.49	3,789	6593.51	891	0.02
300			4325.75		6587.99	6592.88	3,717	6590.14	891	-2.74
290	2410	F	4259.68		6586.87	6592.48	3,717	6589.04	891	-3.44
280			4180.32		6586.58	6592.07	3,717	6588.46	891	-3.61
270			4108.24		6582.64	6591.70	3,717	6588.04	891	-3.66
260			3927.07		6584.38	6589.69	3,717	6586.44	891	-3.25
250			3875.84		6582.57	6589.10	3,717	6585.94	891	-3.16
240			3838.75		6581.86	6588.67	3,717	6585.51	891	-3.16
230			3767.38		6580.71	6588.05	3,717	6584.53	891	-3.52
220			3702.87		6579.50	6587.61	3,717	6584.17	891	-3.44
210			3636.60		6578.35	6587.15	3,717	6583.96	891	-3.19
200			3580.89		6578.81	6586.76	3,717	6583.73	891	-3.03
190			3434.79		6579.62	6586.35	3,717	6583.10	891	-3.25
180			3305.54		6578.58	6585.98	3,717	6582.41	891	-3.57
170	1270	E	3141.31		6577.20	6585.52	3,717	6581.31	891	-4.21
160			3003.65		6576.86	6584.81	3,717	6581.21	891	-3.60
150			2675.86		6576.46	6583.11	3,717	6580.81	891	-2.30
140			2571.58	Highway 82	6579.99	6581.72	3,717	6580.70	891	-1.02
130			2555.22	Highway 82	6580.32	6581.08	3,594	6580.67	891	-0.41
120			2538.50	Highway 82	6580.17	6580.69	3,594	6580.69	891	0.00

Table 6-2 (Continued) Flood Profile Table

7 Floodplain Mapping

7.1 Floodway

The existing regulatory FIS delineates a floodway across much of the South Side Zone AE. Much of the area designated as regulatory floodway is either developed land or mature forest. Additionally the main stem Roaring Fork River floodplain model uses the full 100-year discharge of 9,400 cfs to delineate the Regulatory Floodway elevations. With the removal of the blockage at the Upper Bypass Bridge, and updated hydrology (Section 5) the Town has requested that the South Side floodway be removed from the FIRMs.

This LOMR requests to remove the floodway as outlined in Section C.4.3.3 of Guidelines and Specifications Appendix C-Guidance for Riverine Flooding Analysis and Mapping which states:

> "The regulatory floodway on a tributary stream is based on the base (1-percent-annual¬chance) flood discharge and elevation of that stream only and normally should not include consideration of any backwater flooding from the main stream. Therefore, the floodway elevations in the lower reach of a tributary subject to backwater flooding may be lower than those used to plot the Flood Profiles.
>
> The Mapping Partner should re-compute flood flow values along each flow path associated with reaches with split and/or diverted flow situations, as described in Split Flow under Section C.3.2.1, One-dimensional Steady Flow, under encroached (floodway) conditions. If the primary flow path (originating reach) can safely carry the entire base flood flow without increasing flood heights more than the maximum allowable surcharge, only the primary flow path requires a floodway. If not, other flow paths require floodways."

Based on the Guidelines and results of the hydrologic and hydraulic modeling this LOMR requests to remove the Floodway designation from the South Side.

7.2 Floodplain Delineation

The Floodplain Work Map is included in Appendix B (Exhibit C) and has been submitted electronically (both .pdf and .mxd files). Floodplain boundaries for the Corrected Effective and Proposed Conditions 100-and 500-year storm events and the 100-year floodway were delineated using HEC-GeoRAS and then were manually adjusted, using engineering judgment, based on the results of the HEC-RAS model. The floodplain and floodway boundaries for the Duplicate Effective (from DFIRM) and Proposed Conditions are shown on the Work Map (Appendix B, also submitted electronically). The South Side SFHA is depicted on four different effective FIRMS, two for Eagle County (08037C0931D and 08037C09032D) in NAVD 88 and two for Pitkin County (08097C0406D and 08097C0406D) in NGVD 29. For this LOMR application the Eagle County FIRM panels are being used for datum consistency, however the Eagle County BFEs are only accurate to with one foot. Annotated copies of FBFM Panels 08037C0931D (Exhibit E) and 08037C09032D (Exhibit F) are included in Appendix B (also submitted electronically). It should be noted that the FIRMs downloaded from FEMA are not accurately geo-referenced. They have been presented with the projection information provided by FEMA. Thus the Annotated FIRM information may not align correctly.

The proposed SFHA Zone AE and SFHA Zone X-Shaded are both smaller than the effective SFHAs. For most cross-sections the proposed BFE is lower than the effective BFE. The maximum decrease in BFE is -4.21 ft at cross-section 170 (Matrix 1270 and FIS E). The maximum increase is 0.51 ft at cross section 560. The full Flood Profiles Table is presented in Table 6-2 and submitted electronically.

8 Conclusions

8.1 Compliance with Standards

This study lies with the City of Basalt, Pitkin County, CWCB and Federal floodplain requirements.

8.2 Variances

No variances were requested for the project.

8.3 Impacts to Adjacent Properties

Most cross-sections show a decrease in BFE for the proposed conditions with a maximum of -4.21 ft. Ten cross-sections show a minor increase in BFE. The maximum increase in BFE is 0.51 ft. The overall impact of the new model results is a decrease in the extent of Zone AE, an overall decrease in the extent of Zone X-Shaded and removal of the Floodway.

9 Summary of Electronic Files

9.1 CAD FILES

Translation of Matrix Work Map into State Plane coordinate system: *Coordinate-Translation.dwg*

9.2 ArcGIS FILES

Work Map: *Basalt_South_Side_WorkMap.mxd*

9.3 FLO-2D FILES

100-Year Model is in Folder titled 35ft_Grid_100. The FLO-2D file is Basalt.TOP. To run model place 35ft_Grid_100 folder on root directory folder C:\FLO, and rename to 35ft_Grid (e.g. C:\FLO\35ft_Grid).

500-Year Model is in Folder titled 35ft_Grid_500. The FLO-2D file is Basalt.TOP. To run model place 35ft_Grid_500 folder on root directory, C:\FLO, and rename to 35ft_Grid (e.g. C:\FLO\35ft_Grid).

9.4 HEC-RAS FILES

9.4.1 HEC-RAS for FLO-2D

Stage Storage Model: *FLO-2D_Bridge.prj*

FLO-2D trimmed Cross-Sections: *FLO2D_Short.prj*

9.4.2 Regulatory Models

South Side Regulatory Model: *overbank6.prj*

9.4.3 Duplicate Effective

South Side Duplicate Model: *Basalt_SS_Dup.prj*

9.4.4 Proposed

South Side Duplicate Model: *Basalt_SS_Prop.prj*

9.5 Excel Spredsheets

Final LOMR Proposed BFE Flood Profile Table: Profiles_Final.xls

9.6 Maps

Work Map PDF: Basalt_South_Side_WorkMap .pdf
FLO-2D Results: Basalt_FLO-2D.pdf

10 References

10.1 References

HDR Engineering. *CDOT SH 82 Upper Basalt By-Pass Bridge: Preliminary Hydraulic Investigation*. Denver, CO: HDR Engineering, 2007.

FEMA, Flood Insurance Study: Pitkin County, CO & Incorporated Areas. Washington, DC, 2004.

FEMA, Flood Insurance Study: Eagle County, CO & Incorporated Areas. Washington, DC, 2007.

FEMA, *Guidelines and Specifications for Flood Hazard Mapping Partners, Appendix C-Guidance for Riverine Flooding Analysis and Mapping*, Washington, DC, 2009

Matrix Design Group. *Roaring Fork River Flood Plain Information Report.* Denver, CO: Matrix Design Group, 2001.

U.S. Department of the Interior. U.S. Geological Survey. *Bed-Material Entrainment Potential Roaring Fork River at Basalt*, Colorado. by John G. Elliot. Water Resources Investigation Report 02-4223. Denver, CO: The Survey, 2002. http://pubs.usgs.gov/wri/wri02-4223/.

Appendix A.
MT-2 Forms

Appendix A.
MT-2 Forms

U.S. DEPARTMENT OF HOMELAND SECURITY
FEDERAL EMERGENCY MANAGEMENT AGENCY

OVERVIEW & CONCURRENCE FORM

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

PAPERWORK BURDEN DISCLOSURE NOTICE

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

PRIVACY ACT STATEMENT

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

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

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

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

A. REQUESTED RESPONSE FROM DHS-FEMA

This request is for a (check one):

☐ CLOMR: A letter from DHS-FEMA commenting on whether a proposed project, if built as proposed, would justify a map revision, or proposed hydrology changes (See 44 CFR Ch. 1, Parts 60, 65 & 72).

☒ LOMR: A letter from DHS-FEMA officially revising the current NFIP map to show the changes to floodplains, regulatory floodway or flood elevations. (See 44 CFR Ch. 1, Parts 60, 65 & 72)

B. OVERVIEW

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

Community No.	Community Name	State	Map No.	Panel No.	Effective Date
Example: 480301 480287	City of Katy Harris County	TX TX	48473C 48201C	0005D 0220G	02/08/83 09/28/90
080052	Town of Basalt, Pitkin County	CO	08037C	0931	12/4/07
080052	Town of Basalt, Pitkin County	CO	08037C	0932	12/4/07

2. a. Flooding Source:

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

3. Project Name/Identifier:

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

5. Basis for Request and Type of Revision:

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

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

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

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

Structures: ☐ Channelization ☐ Levee/Floodwall ☐ Bridge/Culvert

☐ Dam ☐ Fill ☐ Other (Attach Description)

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

C. REVIEW FEE

Has the review fee for the appropriate request category been included? ☒ Yes Fee amount: $8,000

☐ No, Attach Explanation

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

D. SIGNATURE

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

Name: Stuart Gardner, PE	Company: Colorado Dept of Transportation	
Mailing Address: 606 South 9th Street Grand Junction, CO 81501	Daytime Telephone No.: 970-683-6354	Fax No.: 970-683-6369
	E-Mail Address: stuart.gardner@state.co.us	
Signature of Requester (required):	Date: 10/23/2015	

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

Community Official's Name and Title: Michael J. Scanlon	Community Name: Town of Basalt	
Mailing Address: 101 Midland Avenue, Basalt, CO 81621	Daytime Telephone No.: 970-927-4701	Fax No.: 970-927-4703
	E-Mail Address: mike.scanlon@basalt.net	
Community Official's Signature (required):	Date: 10/20/2015	

CERTIFICATION BY REGISTERED PROFESSIONAL ENGINEER AND/OR LAND SURVEYOR

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

Certifier's Name: Christian Romeyn	License No.: 0043882	Expiration Date: 10/31/2017
Company Name: AECOM Technical Services	Telephone No.: 970-384-4736	Fax No.: 970-945-9182
Signature:	Date: 10/23/15	E-Mail Address: chris.romeyn@aecom.com

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

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

COLORADO LICENSED
CHRISTIAN ROMEYN
43882
PROFESSIONAL ENGINEER

U.S. DEPARTMENT OF HOMELAND SECURITY
FEDERAL EMERGENCY MANAGEMENT AGENCY

RIVERINE HYDROLOGY & HYDRAULICS FORM

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

PAPERWORK BURDEN DISCLOSURE NOTICE

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

PRIVACY ACT STATEMENT

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

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

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

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

Flooding Source: Roaring Fork River

Note: Fill out one form for each flooding source studied

A. HYDROLOGY

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

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

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

Location	Drainage Area (Sq. Mi.)	Effective/FIS (cfs)	Revised (cfs)
Roaring Fork River South	NA	4,400	1000

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

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

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

4. Review/Approval of Analysis

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

5. Impacts of Sediment Transport on Hydrology

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

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

B. HYDRAULICS

1. Reach to be Revised

	Description	Cross Section	Water-Surface Elevations (ft.) Effective	Proposed/Revised
Downstream Limit*	HIghway 82	AECOM XC 120	6580.69	6580.69
Upstream Limit*	Roaring Fork River Above Bridge	AECOM XC 850	6641.78	6641.78

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

2. Hydraulic Method/Model Used: 1-D Steady State/HEC-RAS v 4.1.0

3. Pre-Submittal Review of Hydraulic Models*

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

4.

Models Submitted	Natural Run		Floodway Run		Datum
Duplicate Effective Model*	File Name: Basalt_SS_Dup.prj	Plan Name: Basalt_SS_Dup	File Name:	Plan Name:	NGVD 29
Corrected Effective Model*	File Name: Basalt_SS_Cor.prj	Plan Name: Basalt_SS_Cor	File Name:	Plan Name:	NGVD 29
Existing or Pre-Project Conditions Model	File Name:	Plan Name:	File Name:	Plan Name:	
Revised or Post-Project Conditions Model	File Name:	Plan Name:	File Name:	Plan Name:	
Other - (attach description)	File Name: Basalt_SS_Prop.prj	Plan Name: Basal_SS_Prop	File Name:	Plan Name:	NAVD 88

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

☒ Digital Models Submitted? (Required)

C. MAPPING REQUIREMENTS

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

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

Topographic Information: Merrick LIDAR Data

Source: Town of Basalt Date: 11-02-2015

Accuracy: 1.2 ft

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

☒ Annotated FIRM and/or FBFM (Required)

D. COMMON REGULATORY REQUIREMENTS*

1. For LOMR/CLOMR requests, do Base Flood Elevations (BFEs) increase? Yes ☐ No ☒

   a. For CLOMR requests, if either of the following is true, please submit **evidence of compliance with Section 65.12 of the NFIP regulations**:

      · The proposed project encroaches upon a regulatory floodway and would result in increases above 0.00 foot compared to pre-project conditions.

      · The proposed project encroaches upon a SFHA with or without BFEs established and would result in increases above 1.00 foot compared to pre-project conditions.

   b. Does this LOMR request cause increase in the BFE and/or SFHA compared with the effective BFEs and/or SFHA? Yes ☐ No ☒

      If Yes, please attach **proof of property owner notification and acceptance (if available)**. Elements of and examples of property owner notifications can be found in the MT-2 Form 2 Instructions.

2. Does the request involve the placement or proposed placement of fill? Yes ☐ No ☒

   If Yes, the community must be able to certify that the area to be removed from the special flood hazard area, to include any structures or proposed structures, meets all of the standards of the local floodplain ordinances, and is reasonably safe from flooding in accordance with the NFIP regulations set forth at 44 CFR 60.3(A)(3), 65.5(a)(4), and 65.6(a)(14). Please see the MT-2 instructions for more information.

3. For LOMR requests, is the regulatory floodway being revised? * Yes ☐ No ☒

   If Yes, attach **evidence of regulatory floodway revision notification**. As per Paragraph 65.7(b)(1) of the NFIP Regulations, notification is required for requests involving revisions to the regulatory floodway. (Not required for revisions to approximate 1%-annual-chance floodplains [studied Zone A designation] unless a regulatory floodway is being established. Elements and examples of regulatory floodway revision notification can be found in the MT-2 Form 2 Instructions.)

4. For CLOMR requests, please submit documentation to FEMA and the community to show that you have complied with Sections 9 and 10 of the Endangered Species Act (ESA).

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

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

* The Floodway is being eliminated from the mapping therefore no public notice was given. The main stem Roaring Fork Rive has a mapped floodway with full 100-year discharge. Per Sec. C.4.3.3 of Appendix C the South Side Floodway is not required. See report for more details.

DEPARTMENT OF HOMELAND SECURITY
FEDERAL EMERGENCY MANAGEMENT AGENCY

RIVERINE STRUCTURES FORM

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

PAPERWORK BURDEN DISCLOSURE NOTICE

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

PRIVACY ACT STATEMENT

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

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

Flooding Source: Roaring Fork River

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

A. GENERAL

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

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

Description Of Modeled Structure

1. Name of Structure: _____

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

   Location of Structure: _____

   Downstream Limit/Cross Section: _____

   Upstream Limit/Cross Section: _____

2. Name of Structure: _____

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

   Location of Structure: _____

   Downstream Limit/Cross Section: _____

   Upstream Limit/Cross Section: _____

3. Name of Structure: _____

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

   Location of Structure: _____

   Downstream Limit/Cross Section: _____

   Upstream Limit/Cross Section: _____

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

B. CHANNELIZATION

Flooding Source: _____

Name of Structure: _____

1. Hydraulic Considerations

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

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

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

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

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

☐ Other locations (specify): _____

2. Channel Design Plans

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

3. Accessory Structures

The channelization includes (check one):

☐ Levees [Attach Section E (Levee/Floodwall)] ☐ Drop structures ☐ Superelevated sections

☐ Transitions in cross sectional geometry ☐ Debris basin/detention basin [Attach Section D (Dam/Basin)] ☐ Energy dissipator

☐ Weir ☐ Other (Describe):

4. Sediment Transport Considerations

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

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

C. BRIDGE/CULVERT

Flooding Source: _____

Name of Structure: _____

1. This revision reflects (check one):

☐ Bridge/culvert not modeled in the FIS

☐ Modified bridge/culvert previously modeled in the FIS

☐ Revised analysis of bridge/culvert previously modeled in the FIS

2. Hydraulic model used to analyze the structure (e.g., HEC-2 with special bridge routine, WSPRO, HY8): _____
If different than hydraulic analysis for the flooding source, justify why the hydraulic analysis used for the flooding source could not analyze the structures. Attach justification.

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

☐ Dimensions (height, width, span, radius, length)

☐ Shape (culverts only)

☐ Material

☐ Beveling or Rounding

☐ Wing Wall Angle

☐ Skew Angle

☐ Distances Between Cross Sections

☐ Erosion Protection

☐ Low Chord Elevations – Upstream and Downstream

☐ Top of Road Elevations – Upstream and Downstream

☐ Structure Invert Elevations – Upstream and Downstream

☐ Stream Invert Elevations – Upstream and Downstream

☐ Cross-Section Locations

4. Sediment Transport Considerations

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

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

D. DAM/BASIN

Flooding Source: _____
Name of Structure: _____

1. This request is for (check one): ☐ Existing dam/basin ☐ New dam/basin ☐ Modification of existing dam/basin

2. The dam/basin was designed by (check one): ☐ Federal agency ☐ State agency ☐ Private organization ☐ Local government agency

   Name of the agency or organization: _____

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

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

   Permit or ID number _____ Permitting Agency or Organization _____

   a. ☐ Local Government Dam ☐ Private Dam

   Provided related drawings, specification and supporting design information.

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

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

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

   ☐ Yes, provide supporting documentation with your completed Form 2.

   ☐ No, provide a written explanation and justification for not using the critical duration storm.

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

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

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

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

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

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

E. LEVEE/FLOODWALL

1. System Elements

a. This Levee/Floodwall analysis is based on (check one): ☐ upgrading of an existing levee/floodwall system ☐ a newly constructed levee/floodwall system ☐ reanalysis of an existing levee/floodwall system

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

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

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

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

☐ Yes ☐ No

If Yes, by which agency? _____

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

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

2. Freeboard

a. The minimum freeboard provided above the BFE is:

Riverine

3.0 feet or more at the downstream end and throughout ☐ Yes ☐ No

3.5 feet or more at the upstream end ☐ Yes ☐ No

4.0 feet within 100 feet upstream of all structures and/or constrictions ☐ Yes ☐ No

Coastal

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

2.0 feet above the 1%-annual-chance stillwater surge elevation ☐ Yes ☐ No

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

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

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

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

3. Closures

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

If opening exists, list all closures:

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

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

Note: Geotechnical and geologic data

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

4. Embankment Protection

a. The maximum levee slope land side is: _____

b. The maximum levee slope flood side is: _____

c. The range of velocities along the levee during the base flood is: _____ (min.) to _____ (max.)

d. Embankment material is protected by (describe what kind): _____

e. Riprap Design Parameters (check one): ☐ Velocity ☐ Tractive stress
Attach references

Reach		Sideslope	Flow Depth	Velocity	Curve or Straight	Stone Riprap			Depth of Toedown
						D_{100}	D_{50}	Thickness	
Sta	to								
Sta	to								
Sta	to								
Sta	to								
Sta	to								
Sta	to								

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

f. Is a bedding/filter analysis and design attached? ☐ Yes ☐ No

g. Describe the analysis used for other kinds of protection used (include copies of the design analysis):

Attach engineering analysis to support construction plans.

5. Embankment And Foundation Stability

a. Identify locations and describe the basis for selection of critical location for analysis:
_____

☐ Overall height: Sta.: _____, height _____ ft.

☐ Limiting foundation soil strength:

Strength f = _____ degrees, c = _____ psf

Slope: SS = _____ (h) to _____ (v)

(Repeat as needed on an added sheet for additional locations)

b. Specify the embankment stability analysis methodology used (e.g., circular arc, sliding block, infinite slope, etc.):
_____

c. Summary of stability analysis results:

E. LEVEE/FLOODWALL (CONTINUED)

5. Embankment And Foundation Stability (continued)

Case	Loading Conditions	Critical Safety Factor	Criteria (Min.)
I	End of construction		1.3
II	Sudden drawdown		1.0
III	Critical flood stage		1.4
IV	Steady seepage at flood stage		1.4
VI	Earthquake (Case I)		1.0

(Reference: USACE EM-1110-2-1913 Table 6-1)

d. Was a seepage analysis for the embankment performed? ☐ Yes ☐ No

If Yes, describe methodology used:

e. Was a seepage analysis for the foundation performed? ☐ Yes ☐ No

f. Were uplift pressures at the embankment landside toe checked? ☐ Yes ☐ No

g. Were seepage exit gradients checked for piping potential? ☐ Yes ☐ No

h. The duration of the base flood hydrograph against the embankment is _____ hours.

Attach engineering analysis to support construction plans.

6. Floodwall And Foundation Stability

a. Describe analysis submittal based on Code (check one): ☐ UBC (1988) ☐ Other (specify): _____

b. Stability analysis submitted provides for: ☐ Overturning ☐ Sliding If not, explain: _____

c. Loading included in the analyses were: ☐ Lateral earth @ P_A = _____ psf; P_p = _____ psf

☐ Surcharge-Slope @ _____, ☐ surface _____ psf

☐ Wind @ P_w = _____ psf

☐ Seepage (Uplift); _____ ☐ Earthquake @ P_{eq} = _____ %g

☐ 1%-annual-chance significant wave height: _____ ft.

☐ 1%-annual-chance significant wave period: _____ sec.

d. Summary of Stability Analysis Results: Factors of Safety.
Itemize for each range in site layout dimension and loading condition limitation for each respective reach.

Loading Condition	Criteria (Min)		Sta	To	Sta	To
	Overturn	Sliding	Overturn	Sliding	Overturn	Sliding
Dead & Wind	1.5	1.5				
Dead & Soil	1.5	1.5				
Dead, Soil, Flood, & Impact	1.5	1.5				
Dead, Soil, & Seismic	1.3	1.3				

(Ref: FEMA 114 Sept 1986; USACE EM 1110-2-2502)
Note: (Extend table on an added sheet as needed and reference)

E. LEVEE/FLOODWALL (CONTINUED)

6. Floodwall And Foundation Stability (continued)

e. Foundation bearing strength for each soil type:

Bearing Pressure	Sustained Load (psf)	Short Term Load (psf)
Computed design maximum		
Maximum allowable		

f. Foundation scour protection ☐ is, ☐ is not provided. If provided, attach explanation and supporting documentation:

Attach engineering analysis to support construction plans.

7. Settlement

a. Has anticipated potential settlement been determined and incorporated into the specified construction elevations to maintain the established freeboard margin? ☐ Yes ☐ No

b. The computed range of settlement is _____ ft. to _____ ft.

c. Settlement of the levee crest is determined to be primarily from : ☐ Foundation consolidation ☐ Embankment compression ☐ Other (Describe): _____

d. Differential settlement of floodwalls ☐ has ☐ has not been accommodated in the structural design and construction.

Attach engineering analysis to support construction plans.

8. Interior Drainage

a. Specify size of each interior watershed:

Draining to pressure conduit: _____ acres
Draining to ponding area: _____ acres

b. Relationships Established

Ponding elevation vs. storage	☐ Yes	☐ No
Ponding elevation vs. gravity flow	☐ Yes	☐ No
Differential head vs. gravity flow	☐ Yes	☐ No

c. The river flow duration curve is enclosed: ☐ Yes ☐ No

d. Specify the discharge capacity of the head pressure conduit: _____ cfs

e. Which flooding conditions were analyzed?

· Gravity flow (Interior Watershed)	☐ Yes	☐ No
· Common storm (River Watershed)	☐ Yes	☐ No
· Historical ponding probability	☐ Yes	☐ No
· Coastal wave overtopping	☐ Yes	☐ No

If No for any of the above, attach explanation.

e. Interior drainage has been analyzed based on joint probability of interior and exterior flooding and the capacities of pumping and outlet facilities to provide the established level of flood protection. ☐ Yes ☐ No If No, attach explanation.

g. The rate of seepage through the levee system for the base flood is _____ cfs

h. The length of levee system used to drive this seepage rate in item g: _____ ft.

E. LEVEE/FLOODWALL (CONTINUED)

8. Interior Drainage (continued)

i. Will pumping plants be used for interior drainage? ☐ Yes ☐ No

If Yes, include the number of pumping plants: _____ For each pumping plant, list:

	Plant #1	Plant #2
The number of pumps		
The ponding storage capacity		
The maximum pumping rate		
The maximum pumping head		
The pumping starting elevation		
The pumping stopping elevation		
Is the discharge facility protected?		
Is there a flood warning plan?		
How much time is available between warning and flooding?		

Will the operation be automatic? ☐ Yes ☐ No

If the pumps are electric, are there backup power sources? ☐ Yes ☐ No

(Reference: USACE EM-1110-2-3101, 3102, 3103, 3104, and 3105)

Include a copy of supporting documentation of data and analysis. Provide a map showing the flooded area and maximum ponding elevations for all interior watersheds that result in flooding.

9. Other Design Criteria

a. The following items have been addressed as stated:

Liquefaction ☐ is ☐ is not a problem

Hydrocompaction ☐ is ☐ is not a problem

Heave differential movement due to soils of high shrink/swell ☐ is ☐ is not a problem

b. For each of these problems, state the basic facts and corrective action taken:

Attach supporting documentation

c. If the levee/floodwall is new or enlarged, will the structure adversely impact flood levels and/or flow velocities floodside of the structure?
☐ Yes ☐ No Attach supporting documentation

d. Sediment Transport Considerations:

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

10. Operational Plan And Criteria

a. Are the planned/installed works in full compliance with Part 65.10 of the NFIP Regulations? ☐ Yes ☐ No

b. Does the operation plan incorporate all the provisions for closure devices as required in Paragraph 65.10(c)(1) of the NFIP regulations?
☐ Yes ☐ No

c. Does the operation plan incorporate all the provisions for interior drainage as required in Paragraph 65.10(c)(2) of the NFIP regulations?
☐ Yes ☐ No If the answer is No to any of the above, please attach supporting documentation.

E. LEVEE/FLOODWALL (CONTINUED)

11. Maintenance Plan

Please attach a copy of the fomal maintenance plan for the levee/floodwall

12. Operations and Maintenance Plan

Please attach a copy of the formal Operations and Maintenance Plan for the levee/floodwall.

CERTIFICATION OF THE LEVEE DOCUMENTION

This certification is to be signed and sealed by a licensed registered professional engineer authorized by law to certify elevation information data, hydrologic and hydraulic analysis, and any other supporting information as per NFIP regulations paragraph 65.10(e) and as described in the MT-2 Forms Instructions. All documents submitted in support of this request are correct to the best of my knowledge. I understand that any false statement may be punishable by fine or imprisonment under Title 18 of the United States Code, Section 1001.

Certifier's Name: _____ License No.: _____ Expiration Date: _____

Company Name: _____ Telephone No.: _____ Fax No.: _____

Signature: _____ Date: _____ E-Mail Address: _____

F. SEDIMENT TRANSPORT

Flooding Source: Roaring Fork River

Name of Structure: SH 82 Upper Bypass Bridge

If there is any indication from historical records that sediment transport (including scour and deposition) can affect the Base Flood Elevation (BFE); and/or based on the stream morphology, vegetative cover, development of the watershed and bank conditions, there is a potential for debris and sediment transport (including scour and deposition) to affect the BFEs, then provide the following information along with the supporting documentation:

Sediment load associated with the base flood discharge: Volume _____ acre-feet

Debris load associated with the base flood discharge: Volume _____ acre-feet

Sediment transport rate _____ (percent concentration by volume)

Method used to estimate sediment transport: _____

Most sediment transport formulas are intended for a range of hydraulic conditions and sediment sizes; attach a detailed explanation for using the selected method.

Method used to estimate scour and/or deposition: See Report

Method used to revise hydraulic or hydrologic analysis (model) to account for sediment transport: See Report

Please note that bulked flows are used to evaluate the performance of a structure during the base flood; however, FEMA does not map BFEs based on bulked flows.

If a sediment analysis has not been performed, an explanation as to why sediment transport (including scour and deposition) will not affect the BFEs or structures must be provided.

TOWN OF BASALT 36807

VENDOR: 10024 NATIONAL FLOOD INS PROGRAM 10/27/2015 36807

DATE	INVOICE #	DESCRIPTION	AMOUNT
10/27/2015	UPPER BYPAS	ROARING FORK RIVER UPPER BYPASS B	8,000.00

Total Amount: $8,000.00

36807

TOWN OF BASALT
101 MIDLAND AVE.
BASALT, CO 81621
(970) 927-4701

Alpine Bank
P.O. Box R, 137 Midland Avenue
Basalt, Colorado 81621
(970) 927-3101 • Alpine Info-Line (970) 945-4433
82-340-1021

36807

PAY ***Eight Thousand and 00/100 Dollars***

DATE 10/27/2015

AMOUNT $**8,000.00**

TO THE ORDER OF NATIONAL FLOOD INS PROGRAM

AUTHORIZED SIGNATURE

Security features. Details on back.

⑈036807⑈ ⑆102103407⑆ 5050500070⑈

Appendix B.
Maps

Appendix B.
Maps

NOTES TO USERS

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

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

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

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

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

The **projection** used in the preparation of this map is Universal Tranverse Mercator (UTM) zone 13. The **horizontal datum** is NAD83, GRS1980 spheroid. Differences in datum, spheroid, projection or UTM zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of the FIRM.

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

Spatial Reference System Division
National Geodetic Survey, NOAA
Silver Spring Metro Center
1315 East-West Highway
Silver Spring, Maryland 20910
(301) 713-3242

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

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An accompanying Flood Insurance Study report, Letters of Map Revision or Letters of Map Amendment revising portions of this panel, and digital versions of this PANEL may be available. Contact the **FEMA Map Service Center** at the following phone numbers and Internet address for information on all related products available from FEMA;

Phone: 800-358-9616
FAX: 800-358-9620
http://msc.fema.gov/

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

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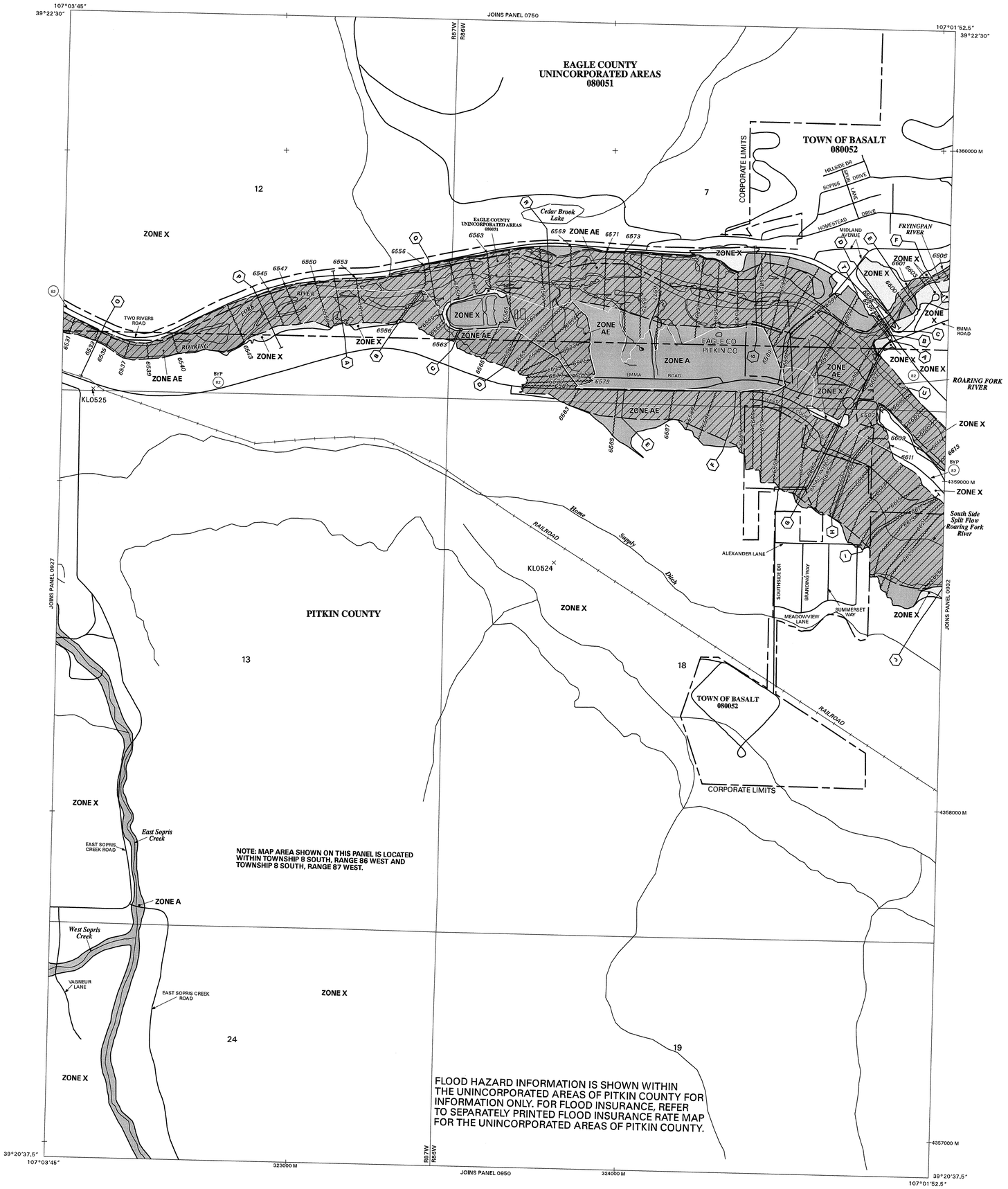
EXHIBIT A



LEGEND

SPECIAL FLOOD HAZARD AREAS SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD EVENT

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

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

FLOODWAY AREAS IN ZONE AE

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

OTHER FLOOD AREAS

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

OTHER AREAS

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

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

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

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

*Referenced to the North American Vertical Datum of 1988

A — A	Cross Section Line
23 - - - - 23	Transect Line
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4276000M	1000-meter Universal Transverse Mercator grid values, zone 13
600000 FT	5000-foot grid ticks
DX5510 ×	Bench mark (see explanation in Notes to Users section of this FIRM panel).
• M1.5	River Mile

MAP REPOSITORY
Refer to Repository Listing on Index Map

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
DECEMBER 4, 2007

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

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MAP SCALE 1" = 500'

250 0 500 1000 FEET
150 0 150 300 METERS

NFIP
NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0931D

FIRM
FLOOD INSURANCE RATE MAP
EAGLE COUNTY,
COLORADO
AND INCORPORATED AREAS

PANEL 931 OF 1125

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
EAGLE COUNTY, UNINCORPORATED AREAS	080051	0931	D
BASALT, TOWN OF	080052	0931	D

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

MAP NUMBER
08037C0931D

EFFECTIVE DATE:
DECEMBER 4, 2007

Federal Emergency Management Agency

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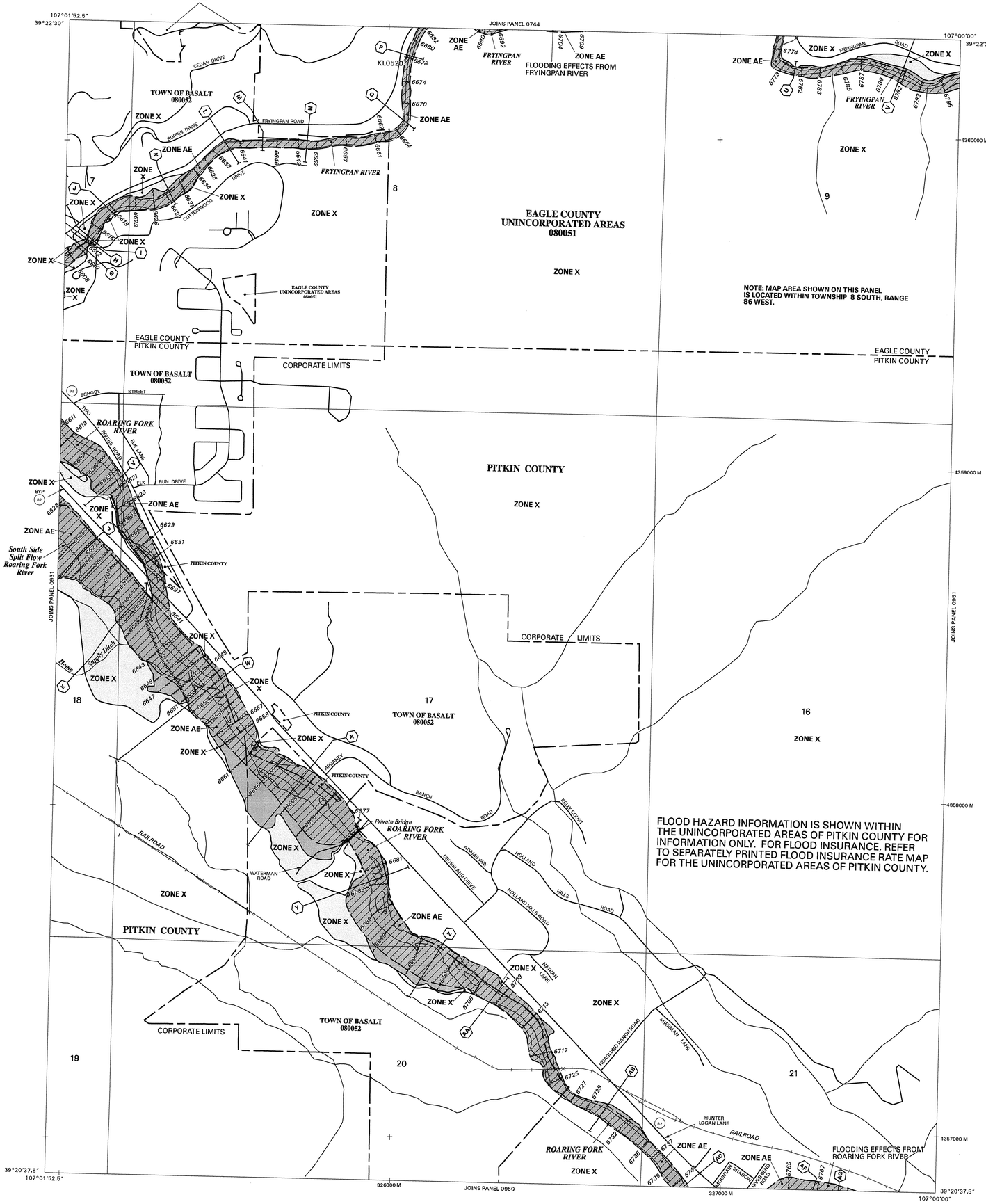

LEGEND

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DX5510 ×	Bench mark (see explanation in Notes to Users section of this FIRM panel).
• M1.5	River Mile

MAP REPOSITORY
Refer to Repository Listing on Index Map

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
DECEMBER 4, 2007

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

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NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0932D

FIRM
FLOOD INSURANCE RATE MAP

EAGLE COUNTY,
COLORADO
AND INCORPORATED AREAS

PANEL 932 OF 1125

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
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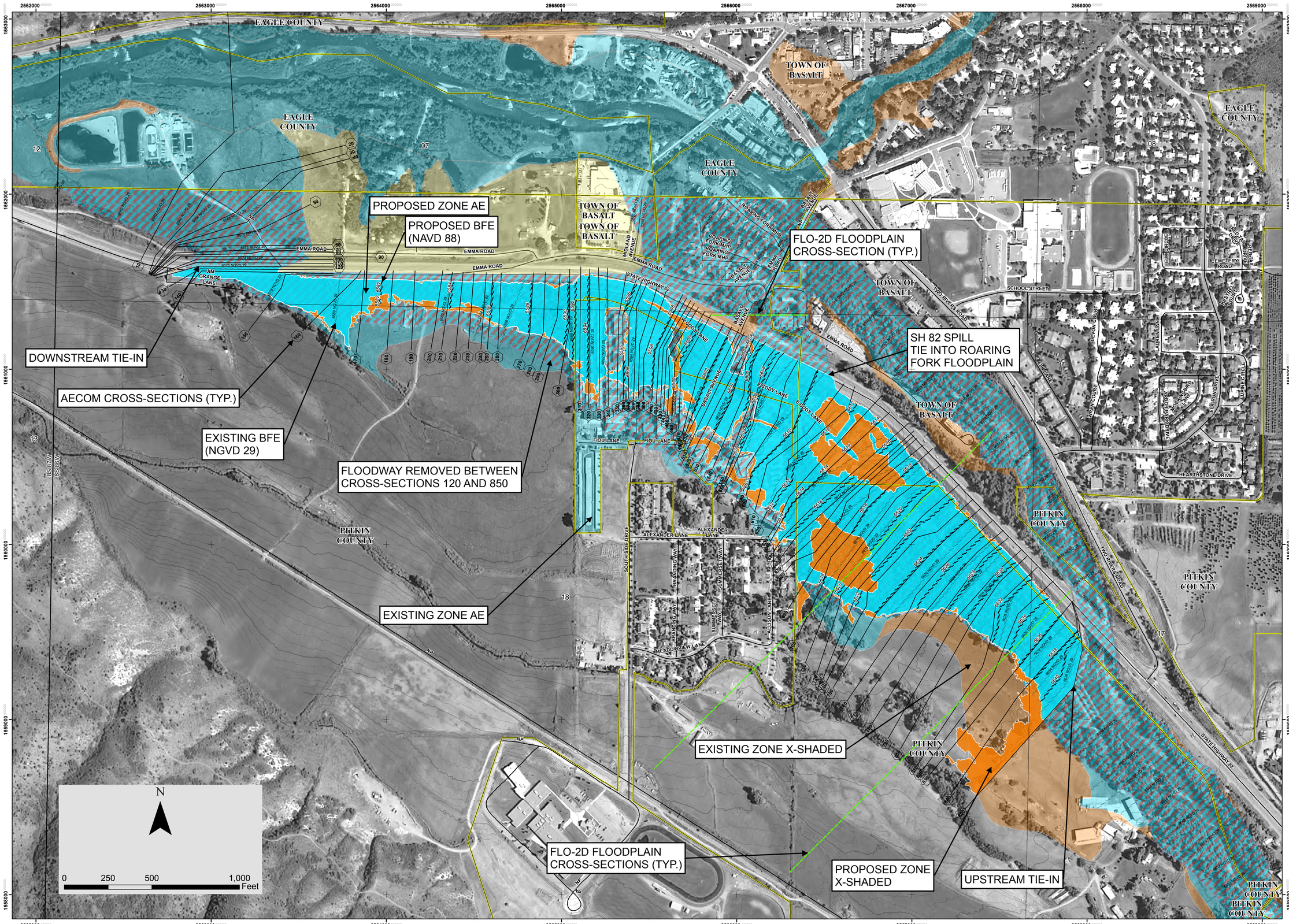
BASALT, TOWN OF	080052	0932	D

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

MAP NUMBER
08037C0932D

EFFECTIVE DATE:
DECEMBER 4, 2007

Federal Emergency Management Agency



AECOM

CDOT/TOWN OF BASALT LOMR REQUEST

Roaring Fork River Upper Bypass Bridge South Slde Split Flow

AECOM Workmap
EXHIBIT C

Community No: 080052
Community Name: Town of Basalt, Pitkin County
Map No.: 08037C
Panel No. & Effective Date: 0931 & 12/4/07
Panel No. & Effective Date: 0932 & 12/4/07

COLORADO LICENSED CHRISTIAN ROMERO 43882 PROFESSIONAL ENGINEER

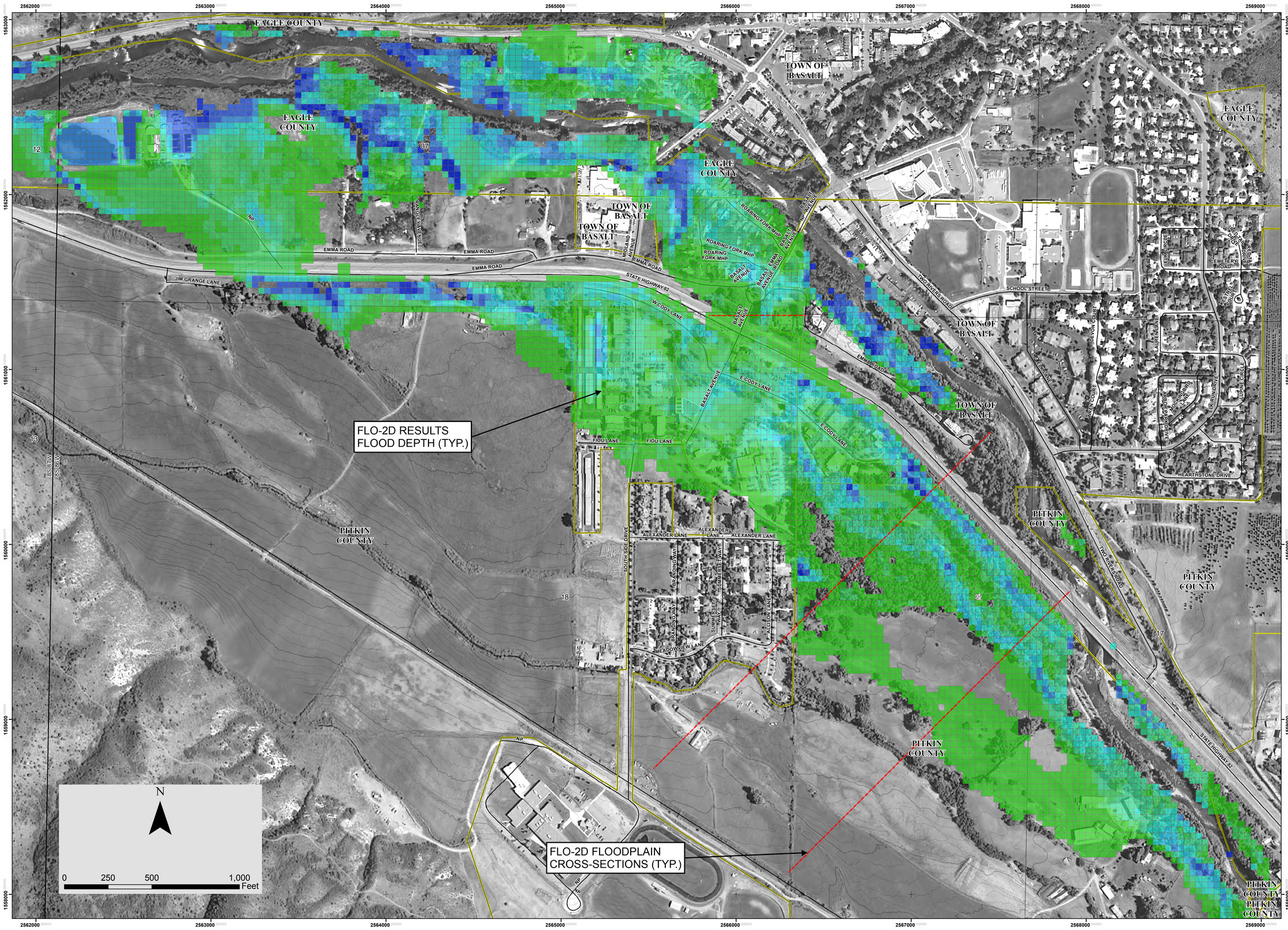
Date: 11/02/2015

Legend

- 1
- Floodplain Cross-Sections
- AECOM Cross-Sections
- DFIRM BFE
- Jurisdiction Boundaries
- PLSS_SECT
- PLSS_TWNSHP
- Basalt Proposed Zone AE
- Basalt Final Zone X Shaded
- FLOODWAY
- Existing Zone X Shaded
- Existing Zone A
- Existing Zone AE
- Existing Zone X
- Index Contour
- Intermediate Contour

Vertical Datum Information:
DFIRM BFE: NGVD 29 Datum
Proposed BFE: NAVD 88
Contours: NAVD 88

Coordinate System: NAD 1983 StatePlane Colorado Central FIPS 0502 Feet
Projection: Lambert Conformal Conic
Datum: North American 1983
false easting: 3,000,000.0003
false northing: 1,000,000.0000
central meridian: -105.5000
standard parallel 1: 38.4500
standard parallel 2: 39.7500
latitude of origin: 37.8333
Units: Foot US



AECOM

CDOT/TOWN OF BASALT LOMR REQUEST

Roaring Fork River
Upper Bypass Bridge
South SIde
Split Flow

FLO-2D RESULTS
EXHIBIT D

Community No: 080052
Community Name: Town of Basalt, Pitkin County
Map No.: 08037C
Panel No. & Effective Date: 0931 & 12/4/07
Panel No. & Effective Date: 0932 & 12/4/07

COLORADO LICENSED CHRISTIAN ROMAN 43882 PROFESSIONAL ENGINEER

Date: 11/02/2015

Legend

- Floodplain Cross-Sections

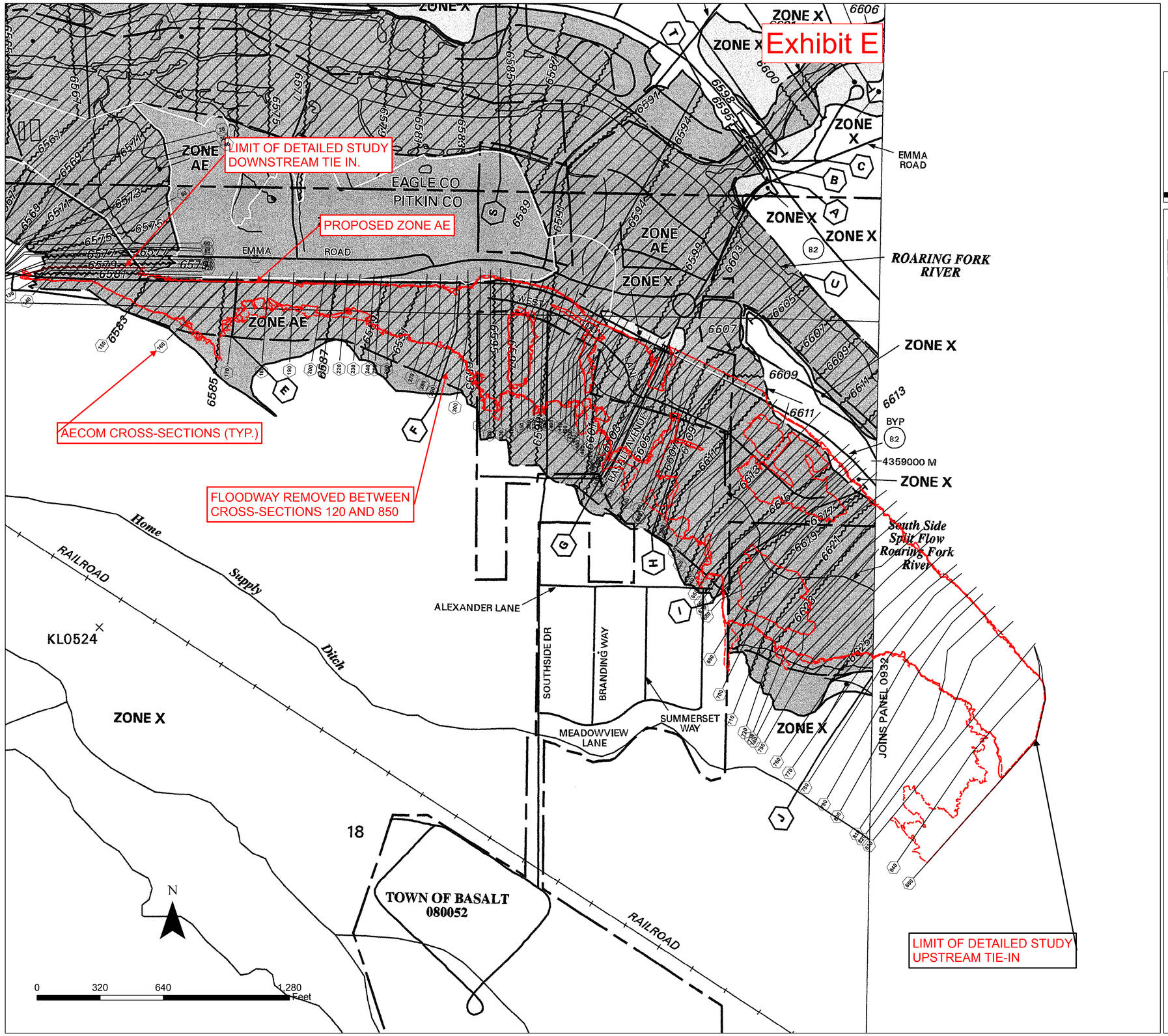
Var

- 0.010 - 0.500
- 0.501 - 1.000
- 1.001 - 1.500
- 1.501 - 2.000
- 2.001 - 2.500
- 2.501 - 3.000
- 3.001 - 3.500
- 3.501 - 4.000
- Jurisdiction Boundaries
- PLSS_SECT
- PLSS_TWNSHP
- Index Contour
- Intermediate Contour

Vertical Datum Information:
NAVD 88

Coordinate System: NAD 1983 StatePlane Colorado Central FIPS 0502 Feet
Projection: Lambert Conformal Conic
Datum: North American 1983
false easting: 3,000,000.0003
false northing: 1,000,000.0000
central meridian: -105.5000
standard parallel 1: 38.4500
standard parallel 2: 39.7500
latitude of origin: 37.8333
Units: Foot US

Roaring Fork River
South Side LOMR
Annotated FIRM Panel 0931D



Legend

- AECOM Cross-Sections
- Basalt Proposed Zone AE
- Basalt Final Zone X Shaded

MAP SCALE 1" = 500'

250 0 500 1000 FEET

150 0 150 300 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0931D

FIRM
FLOOD INSURANCE RATE MAP

EAGLE COUNTY,
COLORADO
AND INCORPORATED AREAS

PANEL 931 OF 1125

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
EAGLE COUNTY, UNINCORPORATED AREAS	080051	0931	D
BASALT, TOWN OF	080052	0931	D

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

MAP NUMBER
08037C0931D

EFFECTIVE DATE:
DECEMBER 4, 2007

Federal Emergency Management Agency

Roaring Fork River
South Side LOMR
Annotated FIRM Panel 0932D

in this jurisdiction.

The **projection** used in the preparation of this map is Universal Tranverse Mercator (UTM) zone 13. The **horizontal datum** is NAD83, GRS1980 spheroid. Differences in datum, spheroid, projection or UTM zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of the FIRM.

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

[illegible] System Division
[illegible] NOAA
[illegible] Spring Metro Center
[illegible] 5 East-West Highway
Silver Spring, Maryland 20910
(301) 713-3242

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

Base [illegible] FIRM was provided in digital format by the Eagle County Geographic Information Systems.

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

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

An accompanying Flood Insurance Study report, Letters of Map Revision or Letters of Map Amendment revising portions of this panel, and digital versions of this PANEL may be available. Contact the **FEMA Map Service Center** at the following phone numbers and Internet address for infomation on all related products available from FEMA;

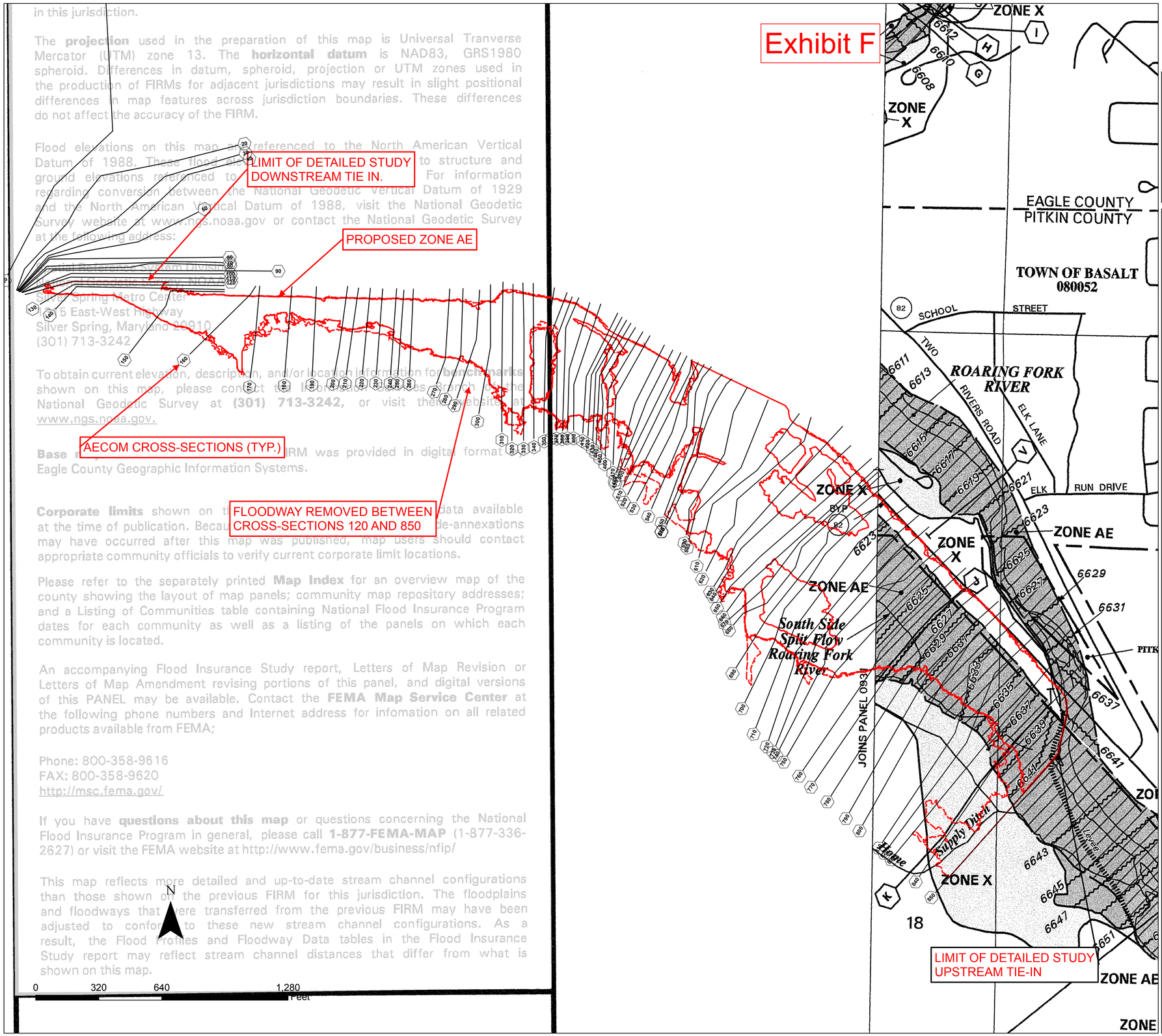
Phone: 800-358-9616
FAX: 800-358-9620
http://msc.fema.gov/

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

This map reflects more detailed and up-to-date stream channel configurations than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables in the Flood Insurance Study report may reflect stream channel distances that differ from what is shown on this map.

N

0 320 640 1,280 Feet



Legend
- AECOM Cross-Sections
- Basalt Proposed Zone AE
- Basalt Final Zone X Shaded

MAP SCALE 1" = 500'

250 0 500 1000 FEET

150 0 150 300 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0932D

FIRM
FLOOD INSURANCE RATE MAP
EAGLE COUNTY, COLORADO
AND INCORPORATED AREAS

PANEL 932 OF 1125

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
EAGLE COUNTY, UNINCORPORATED AREAS	080051	0932	D
BASALT, TOWN OF	080052	0932	D

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

MAP NUMBER
08037C0932D

EFFECTIVE DATE:
DECEMBER 4, 2007

Federal Emergency Management Agency

Appendix C.
Additional Supporting Documents

Appendix C.
Additional Supporting Documents

October 19, 2015

LOMR Technical Manager
LOMC Clearinghouse
847 South Pickett Street
Alexandria, VA 22304

Re: Cross Section Survey of the Roaring Fork River at the CO Highway 82

Dear Sir or Madam:

With this letter, I provide the following information:

I, Samuel D. Phelps, a duly licensed land surveyor in the State of Colorado, do hereby state that the field shots taken to and within the Roaring Fork River channel that were subsequently incorporated into the geometric data associated with Cross Sections 92 and 94 in AECOM's hydraulic analysis of said river were completed under my direct supervision on March 19, 2015.

Should you have any questions regarding this information, please contact me at 970-945-5945 or at survco@gmail.com

Sincerely,

COLORADO LICENSED PROFESSIONAL LAND SURVEYOR
Samuel D. Phelps
27613

19 Oct. 2015

Samuel D. Phelps
Colorado Licensed Professional
Land Surveyor No. 27613
For and on Behalf of SurvCo, Inc.
A Colorado Corp.

MERRICK GROUND CONTROL REPORT

Project File	
Project Unit	Feet
Date	Friday
Vertical Accuracy Objective	
Requirement Type	Accuracy(z)
Accuracy(z) Objective	1.2
Confidence Level	95%
Control Points in Report	55
Elevation Calculation Method	Interpolated from TIN
Control Points with LiDAR Coverage	41
Control Points with Required Accuracy (+/- 1.20)	41
Percent of Control Points with Required Accuracy (+/- 1.20)	100
Average Control Error Reported	0.02
Maximum (highest) Control Error Reported	0.42
Median Control Error Reported	0.08
Minimum (lowest) Control Error Reported	-0.43
Standard deviation (sigma) of Z for sample	0.24
RMSE of Z for sample (RMSE(z))	0.24
FGDC/NSSDA Vertical Accuracy (Accuracy(z))	0.47
NSSDA Achievable Contour Interval	0.9
ASPRS Class 1 Achievable Contour Interval	0.8
NMAS Achievable Contour Interval	0.8

Control Point Id	Control Point X
649L	2572723.89
627L	2866938.58
663L	2627545.26
642L	2679780.02
641L2	2557513.29
656L	2548004.81
662L	2580446.13
641L	2557454.22
665L	2665306.98
911L	2874756.46
659L	2667709.56
643L	2547805.37
661L	2745766.83
644L	2677191.54
654L	2643766.58
645L	2550982.93
646L	2552048.09
640L	2609063.41
628L	2859562.36
639L	2656350.37
650L	2755132.27
639L1	2656427.66
653L	2684256.34
905L	2881402.13
624L	2809584.6
664L	2573241.1
655L	2590235.7
648L	2625708.68

651L	2779973.52
660L	2711532.58
616L	2911913.69
630L	2847515.91
634L	2856239.98
658L	2640205.47
652L	2748643.73
614L	2915456.82
647L	2637528.11
906L	2861654.64
908L	2837576.15
615L	2895446.05
630L2	2847454.17
631L	2850251.18
909L	2799367.6
912L	2882388.64
633L	2829453.59
913L	2844815.48
915L	2857466.08
907L	2846401.14
623L2	2825140.7
623L	2825190.64
622L	2829622.41
629L	2843975.13
914L	2839530.55
913L2	2844717.92
910L	2809600

September 04 2009

PASS
PASS

Control Point Y	Coverage	Control Point Z	Z from LiDAR	Z Error
1555074.75	Yes	6774.41	6774.83	0.42
1616435.38	Yes	9585.8	9586.2	0.4
1752535.9	Yes	6567.57	6567.95	0.38
1728741.01	Yes	7472.57	7472.94	0.37
1683426.96	Yes	6224.71	6225.05	0.34
1588416.35	Yes	7541.59	7541.93	0.34
1712146.41	Yes	6397.31	6397.6	0.29
1683410.2	Yes	6227.28	6227.56	0.28
1747529.3	Yes	6729.87	6730.15	0.28
1605607.02	Yes	9984.38	9984.61	0.23
1707963.23	Yes	7624.82	7625.03	0.21
1657137.12	Yes	6152.09	6152.29	0.2
1628448.03	Yes	8109.14	8109.27	0.13
1672832.24	Yes	7074.5	7074.63	0.13
1634955.83	Yes	7339.55	7339.67	0.12
1617108.99	Yes	8018.26	8018.38	0.12
1561669.84	Yes	6578.78	6578.88	0.1
1747012.22	Yes	6504	6504.09	0.09
1644067.11	Yes	9135.15	9135.24	0.09
1760204.21	Yes	6696.07	6696.15	0.08
1612924.31	Yes	8649.87	8649.95	0.08
1760208.06	Yes	6698.86	6698.93	0.07
1648030.85	Yes	7894.99	7895.05	0.06
1597350.5	Yes	10727.14	10727.15	0.01
1607280.3	Yes	10132.45	10132.35	-0.1
1567977.64	Yes	7384.21	7384.09	-0.12
1636251.91	Yes	6965.02	6964.88	-0.14
1568283.77	Yes	8320.43	8320.26	-0.17

1652447.09	Yes	8664.12	8663.95	-0.17
1664085.39	Yes	8459.97	8459.78	-0.19
1643767.67	Yes	10886.74	10886.55	-0.19
1607912.06	Yes	9710.04	9709.83	-0.21
1601638.67	Yes	9954.03	9953.81	-0.22
1673660.87	Yes	6725.64	6725.39	-0.25
1662976.84	Yes	8660.69	8660.43	-0.26
1646741.15	Yes	11093.24	11092.98	-0.26
1563686.88	Yes	8169.3	8169.04	-0.26
1595821.61	Yes	11266.16	11265.87	-0.29
1597733.74	Yes	10675.45	10675.14	-0.31
1640776.07	Yes	10006.59	10006.23	-0.36
1608008.77	Yes	9701.71	9701.28	-0.43
1659994.19	No	9234.95		
1556110.53	No	10783.01		
1591940.21	No	11588.02		
1651030.56	No	9693.02		
1561790.4	No	11088.92		
1584384.29	No	10356.92		
1593071.4	No	10038.18		
1632417.5	No	9179.82		
1632438.78	No	9179.31		
1677959.86	No	8541.35		
1629770.44	No	9069.56		
1565138.24	No	10897.53		
1561829.31	No	11075.42		
1555863.71	No	11181.37		

Minimum Z	Median Z	Maximum Z	Intensity	Scan Angle	R1	R2
6774.65	6774.75	6775.34	62	17	1	1
9585.78	9586.06	9586.39	59	6	1	1
6567.65	6567.99	6568.03	62	-5	1	1
7472.93	7472.93	7473.02	28	-8	1	1
6224.88	6225.09	6225.3	75	1	1	1
7541.48	7541.84	7542.13	98	21	1	1
6397.47	6397.63	6397.69	47	-8	1	1
6226.87	6227.44	6227.8	62	1	1	1
6730.08	6730.11	6730.41	41	2	1	1
9984.54	9984.69	9984.8	211	-20	1	1
7624.41	7624.97	7625.04	38	0	1	1
6151.93	6152.05	6152.59	40	17	1	1
8108.94	8109.26	8109.45	99	-6	1	1
7073.74	7074.62	7074.78	34	5	1	1
7339.64	7339.66	7339.78	31	13	1	1
8018.35	8018.44	8018.47	107	-6	1	1
6578.54	6579.03	6579.21	45	-5	1	1
6504.02	6504.11	6504.14	24	0	1	1
9135.09	9135.17	9135.66	62	-9	1	1
6696.01	6696.43	6696.75	17	5	1	1
8649.85	8649.95	8649.95	59	0	1	1
6698.87	6699.01	6699.22	33	5	1	1
7894.57	7895.01	7895.22	41	6	1	1
10725.24	10727.16	10727.17	76	-12	2	1
10132.02	10132.23	10132.44	143	9	1	1
7384.03	7384.19	7384.73	89	2	1	1
6964.8	6964.87	6964.99	60	8	1	1
8319.99	8320.22	8320.49	83	2	1	1

8663.84	8663.99	8664.02	34	-1	1	1
8459.74	8459.79	8460	41	-4	1	1
10886.51	10886.56	10886.59	93	-1	1	1
9709.24	9709.52	9710.37	74	-4	1	1
9953.59	9953.89	9954.02	142	1	1	1
6724.69	6724.73	6725.98	7	0	1	1
8660.26	8660.36	8660.55	73	3	1	1
11092.96	11092.99	11093.24	74	8	1	1
8168.8	8168.98	8169.16	80	5	1	1
11265.61	11265.83	11266.05	120	11	1	1
10674.86	10675.04	10675.31	81	4	1	1
10006	10006.38	10006.46	218	-6	1	1
9701.08	9701.55	9701.86	49	5	1	1

R3	AGC	Description
1	250	
1	251	
1	250	
1	250	
1	250	
1	250	
1	250	
1	250	
1	250	
1	244	
1	250	
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1	227	
1	250	
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1	249	

1	250
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1	249
1	245
1	250
1	249
1	198
1	250
1	250
1	250
1	241
1	250

Scope of Work

CDOT Region 3 Maintenance / Town of Basalt
Channel Maintenance Agreement for the Roaring Fork River at STR G-08-T
SH 82 MP 23.5

September 15, 2015

Description:

CDOT and the Town of Basalt have collaborated on a FEMA re-mapping effort to remove the South Side from the floodway and re-map the floodplain based on more realistic flood flows.

SH 82 is mainly an east/west highway. SH 82 crosses the Roaring Fork River at approximate mile post 23.5 by way of Structure G-08-T, also known as the Upper Basalt Bridge. The area in the left overbank area is referred to as the South Side.

This collaborative effort has been conducted through a re-mapping and Letter of Map Revision (LOMR) submittal process.

As part of the LOMR process, CDOT and the Town of Basalt have reached an agreement for ongoing channel maintenance adjacent to the SH 82 bridge as defined in Attachment D (Sediment Excavation Plan and Profile) which requires the removal and disposal of deposited river material along the right bank of the Roaring Fork River, below and immediately upstream and downstream of Structure G-08-T.

Attachment A is an aerial image showing the approximate location for channel maintenance.

MOU - Ongoing Channel Maintenance:

- As depicted in Attachment C (Sediment Deposition Measurements Spreadsheet), a 1.5 foot aggradation at any one of six measurement locations of the river bed across a cross-section at the upstream face of Structure G-08-T has been determined as the measuring location for triggering a channel maintenance project. During the month of August, beginning in 2015 and continuing for the duration of the MOU, representatives from the Town of Basalt and CDOT Maintenance will collaborate in taking annual measurements of the river bed from existing Type 5(s) Monuments installed on the top of the upstream curb at Structure G-08-T. Six monuments have been installed on Structure G-08-T to measure from the bridge down to the river invert location immediately upstream from the bridge as shown in Attachment B (Monument Location Plan).
- Deposition measurements exceeding the threshold will trigger the need for a channel maintenance project which will be performed prior to the next runoff period by CDOT Maintenance resources or by the Town of Basalt Contracting the work out.
- Any deposition measurements that exceed 1 foot of aggradation within the cross section will be a means for CDOT Maintenance to begin planning and budgeting for a channel

maintenance project which could potentially be triggered the following year should the threshold be exceeded in future years.

- Upon determining the 1.5 feet of aggradation has been exceeded, and no later than October 31st, the Town of Basalt will coordinate and perform a topographic survey of the channel reach for sediment removal as depicted in Attachment D.
    - The Town's survey will include cut stakes for two cross-sections upstream and two downstream from Structure G-08-T. This will guide the efforts of the sediment removal.
    - Should the staking fail or be disturbed through the winter, the Town will re-survey prior to the project commencement.
- After execution of this MOU, the initial channel maintenance project will require the following:
    - The existing maintenance access shall be improved to make ingress/egress from the site more easily managed. Excavated sediment material shall be used to improve the access. A culvert shall be installed beneath the access to pass overflow and SH 82 runoff. The culvert shall be a minimum of 36 Inch Reinforced Concrete Pipe at a minimum.
    - At the conclusion of the initial project, CDOT Maintenance will install an access gate, within CDOT right-of-way, to keep unauthorized people from using the access.
- Environmental Considerations:
    - Should the annual measurements indicate sediment removal is required, CDOT's Region 3 Environmental Unit shall be notified.
    - Since the 2009 Maintenance project, the existing access and depositional areas have revegetated enough that a 404 permit will be obtained for at least the initial channel maintenance project. Future 404 permits will be considered based on the term between individual projects and on-site evaluation.
    - Wetland impacts are expected during the initial channel maintenance project and would likely need to purchase some credit at a wetland bank.
    - A Threatened and Endangered Species review (T&E) will be conducted through CDOT's Region Environmental Unit prior to each channel maintenance project.
    - For any in-stream work, spring and fall fish spawning restrictions are expected.

MOU – Channel Maintenance by CDOT Maintenance Resources:

- CDOT Maintenance resources will plan and budget for a channel maintenance project when annual deposition measurements equal or exceed 1 foot.
- When annual deposition measurements exceed the threshold, CDOT Maintenance will coordinate with the Town of Basalt and confirm CDOT has the resources to perform the work. Confirmation is required by October 31st.
- Upon confirmation, CDOT Maintenance resources will prepare to deploy for a channel maintenance project prior to the spring runoff.

- CDOT will assume all expenses for the channel maintenance project.

IGA (Optional) – Channel Maintenance Contracted Out by the Town of Basalt:

- Should CDOT Maintenance determine they do not have the resources available to perform a triggered channel maintenance project, CDOT Maintenance will enter into an IGA with the Town of Basalt where the Town will Contract the work out.
- October 31st is the deadline for CDOT Maintenance to confirm the Town will need to Contract the work out. This will allow the Town enough time to set up and execute a Contract.
- CDOT will reimburse the Town for the amount of the Contracted work.
- The Town will need to obtain a permit from CDOT's Access Department for work performed through a Contractor.

Funding:

- Annual deposition measurements: The Town of Basalt and CDOT Maintenance will assume their own expenses.
- Channel Survey: The Town of Basalt will assume all expenses.
- A channel maintenance project performed by CDOT Maintenance: CDOT Maintenance will assume all expenses.
- A channel maintenance project where the work is contracted out by the Town of Basalt: CDOT Maintenance will reimburse the Town through an IGA.
- Maintenance access gate: CDOT Maintenance will assume all expenses.

Estimated Costs for a channel maintenance project:

- An independent cost estimate for an executed construction Contract for the sediment removal and disposal work is estimated at $150,000. This estimate includes traffic control, clearing, excavation, and disposal of excavated material at a nearby pit ($130/load).

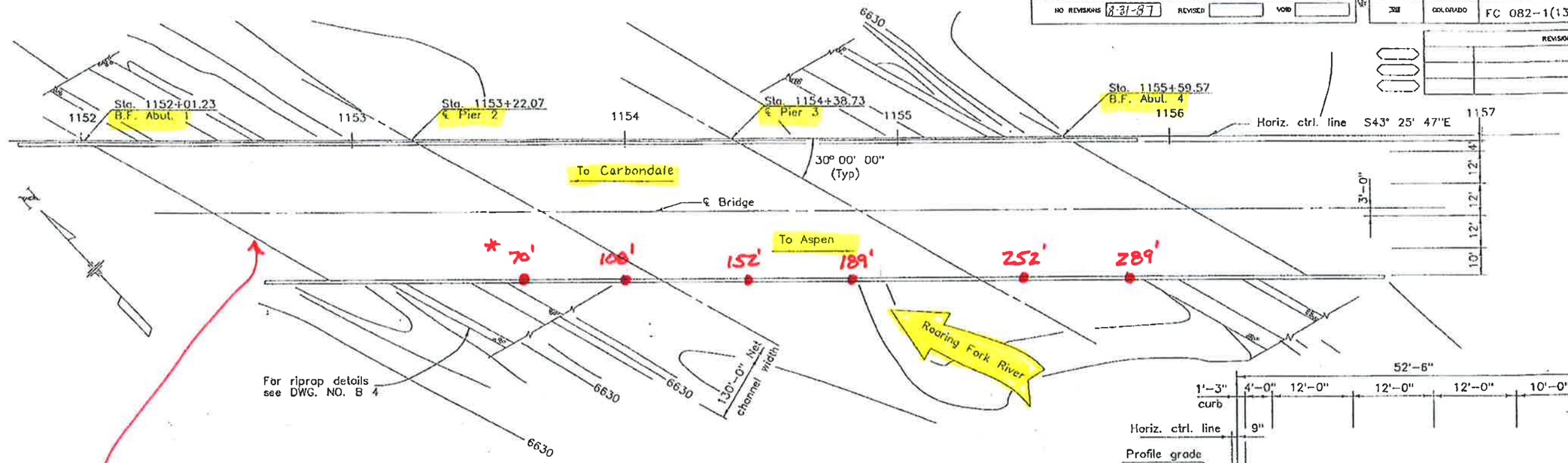
Attachments:

- Attachment A – Aerial Image
- Attachment B – Monument Location Plan
- Attachment C – Sediment Deposition Spreadsheet
- Attachment D – Sediment Excavation Plan and Profile

WB SH 82
STR G-08-T
Two Rivers Road
EB SH 82
Roaring Fork River
Google earth
Tour Guide
1994
Imagery Date: 4/3/2015 39°21'34.49" N 107°01'39.01" W elev 6640 ft eye alt 7583 ft

AS CONSTRUCTED				FEDERAL ROAD REGION NO.	DIVISION	PROJECT NUMBER	SHEET NUMBER
NO REVISIONS	8-31-87	REVISED	VOID	VIII	COLORADO	FC 082-1(13)	40

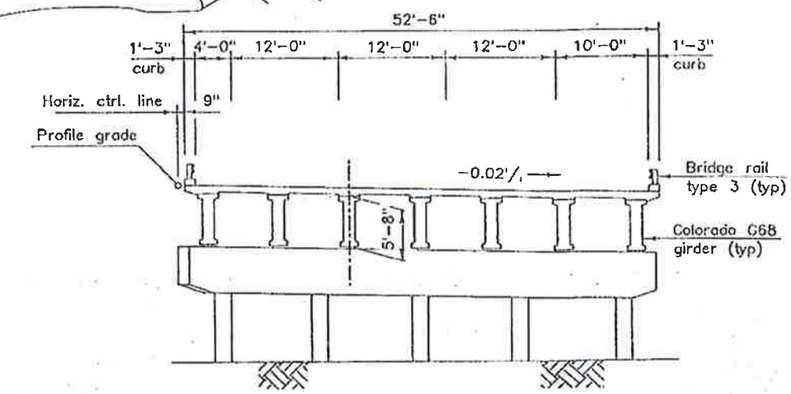
REVISIONS



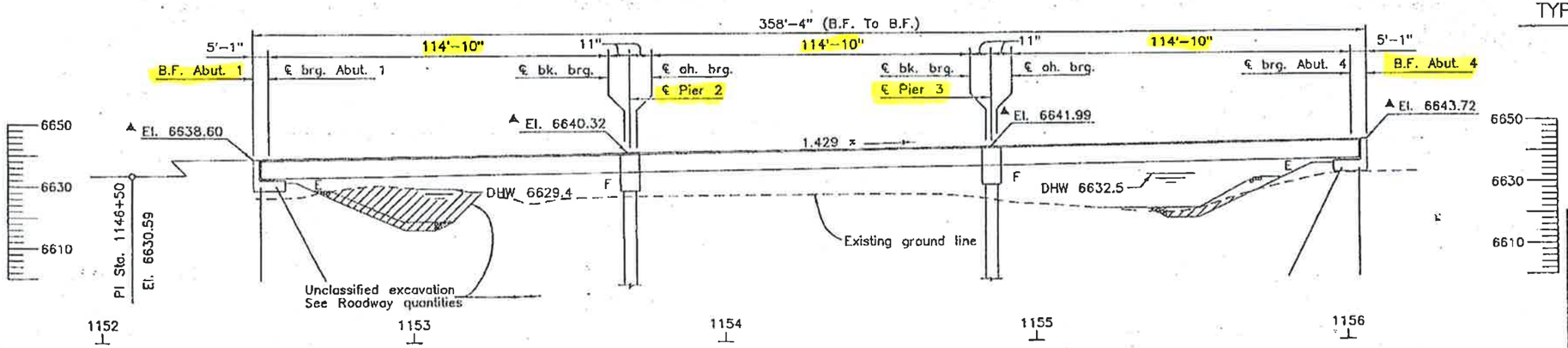
PLAN

EXPANSION JOINT @ ABUTMENT 1

TYPE S(s) MONUMENT LOCATIONS.
* MEASUREMENTS WERE TAKEN FROM ABUT 1 EXPANSION JOINT, ALONG THE FLOWLINE OF THE UPSTREAM CURB.



TYPICAL SECTION



SECTION

(Taken at ℄ bridge)
▲ Elev. at finished grade with 2" H.B.P. (future).

Live loading: HS-20-44 and Interstate alternate.

DIVISION OF HIGHWAYS

GENERAL LAYOUT

MONUMENT LOCATION PLAN

Designer	Garcia	Structure Numbers	C-08-T
Detailer	K. Heater		
Drawing Number	B 2 of 21	Drawings	

Revision Dates (Preliminary Stage Only)

Designed By	INITIAL	DATE	Checked By	DATE
	R J G	01-86	W D C	05-86
Checked By	D A G	05-86	Quantities By	05-86
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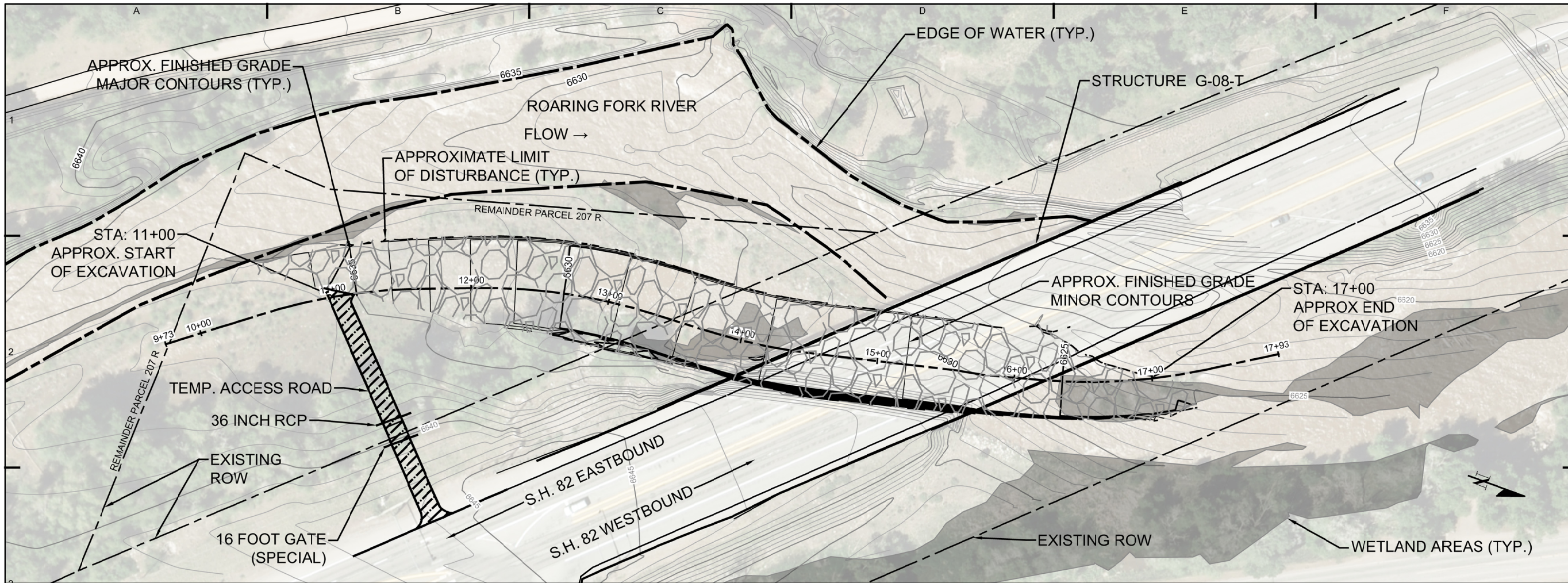
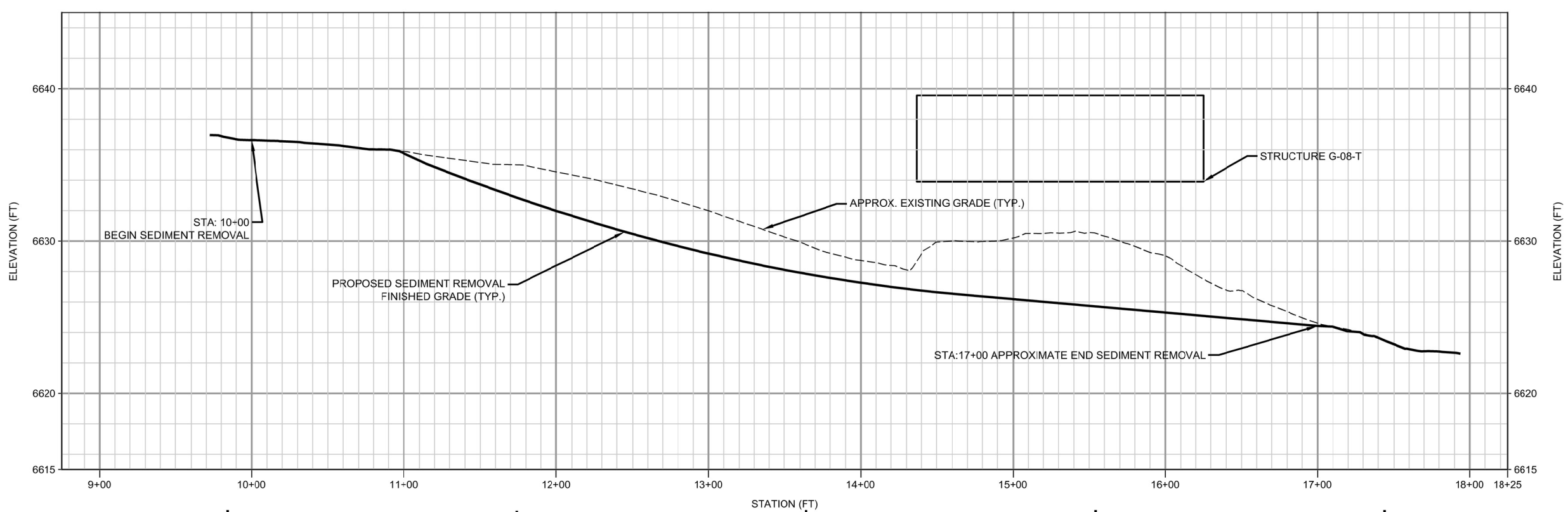
12345678





AECOM
804 COLORADO AVE.
SUITE 201
GLENWOOD SPRINGS, CO 81601
970-384-4731 (PHONE)
970-945-9182 (FAX)

TOWN OF BASALT/CDOT
18748 M.O.U.

ISSUED FOR BIDDING — DATE BY

ISSUED FOR CONSTRUCTION — DATE BY

REVISIONS

NO.	DESCRIPTION	DATE
△		
△		
△		
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URS PROJECT NO:	
DRAWN BY:	CR
DESIGNED BY:	CR
CHECKED BY:	CR
DATE CREATED:	07/28/2015
PLOT DATE:	
SCALE:	1"=40"
ACAD VER:	

SHEET TITLE

SEDIMENT EXCAVATION PLAN AND PROFILE

1

SHEET 1 OF 1

Appendix D.
Letter of Support from Town of Basalt, Pitkin County and Eagle County

Appendix D.
Letter of Support from Town of Basalt, Pitkin County and Eagle County

OFFICE OF THE
BOARD OF COMMISSIONERS
970-328-8605
FAX: 970-328-8629
Email:eagleadmin@eaglecounty.us
www.eaglecounty.us

EAGLE COUNTY

KATHY CHANDLER-HENRY
JEANNE MCQUEENEY
JILL RYAN

October 13, 2015

LOMC Clearinghouse
847 South Pickett Street
Alexandria, VA 22304

RE: Letter of Support - Town of Basalt's Letter of Map Revision (LOMR)

Dear Madam/Sir:

We support the Town of Basalt's effort to revise the Floodplain Map. We understand the Southside Floodplain is formed when the floodplain splits upstream at the Upper SH 82 Basalt Bridge on the Roaring Fork River and is considered active only during large flooding events.

The current FEMA regulatory maps used 4,400 cfs in the split flow and assumed a 40 percent blockage of the Upper Basalt SH 82 Bridge. AECOM Technology Corporation evaluated the mapping assumptions and was unable to locate documentation for the 4,400 cfs. AECOM evaluated the split flow using FLO-2D and estimated the split flow to be 1,000 cfs, significantly lower. In addition, the Town of Basalt and Colorado Department of Transportation (CDOT) have entered into a maintenance agreement to prevent sediment buildup at the Upper SH82 Basalt Bridge.

Based on AECOM's split flow analysis and the maintenance agreement between the Town of Basalt and CDOT, Eagle County supports the Town of Basalt's LOMR application.

Sincerely,
Eagle County Board of Commissioners

Kathy Chandler-Henry
Chairman

Jeanne McQueeney
Commissioner

Jill H. Ryan
Commissioner

PITKIN COUNTY

COMMUNITY DEVELOPMENT

Pitkin County Community Development
Susan Pearson, Floodplain Administrator
131 South Galena Street
Aspen Colorado 81611

September 30, 2015

LOMC Clearinghouse
847 South Pickett Street
Alexandria, VA 22304

RE: Town of Basalt Colorado LOMR South Side Floodplain – Pitkin County, Colorado

Dear Madam/Sir:

As the Pitkin/Eagle County official in charge of floodplain management, I am writing you to express Pitkin/Eagle County support for the Town of Basalt's Letter of Map Revision (LOMR) request for the South Side Floodplain in Pitkin County, Colorado. The South Side floodplain is formed when the floodplain splits upstream from the Upper SH 82 Basalt Bridge on the Roaring Fork River. The South Side floodplain is not distinguished by a defined channel and is considered active only during large flooding events. Flood waters in the South Side floodplain eventually return to the Roaring Fork River main stem floodplain by flowing over Highway 82 at a location near the Basalt Wastewater Treatment Plant. The current FEMA regulatory maps for the Southside floodplain define the floodplain and zero rise floodway using 4,400 cfs in the split flow, and assuming a 40% blockage of the Upper Basalt SH 82 Bridge.

The Stakeholders in this LOMR evaluation consist of the Town of Basalt, Colorado Department of Transportation (CDOT), Pitkin County, and Eagle County. The Stakeholders have contracted with AECOM to re-evaluate the 4,400 cfs split flow and the 40% blockage assumption. AECOM located a letter from the Town of Basalt to FEMA Region 8 (letter attached) that recommended the 40% blockage. AECOM has surveyed cross sections before and after recent floods where minimal deposition has occurred and the deposition is not close to the 40% blockage assumption. To assure FEMA this existing cross section will be maintained the Town of Basalt and CDOT have entered into a maintenance agreement to excavate deposited sediment if deposition occurs in the future. AECOM was unable to locate documentation for the 4,400 cfs split flow assumption and re-evaluated the split flow using FLO-2D and estimated the split flow to be 1,000 cfs. Significantly less than the 4,400 cfs assumption.

Based on the re-evaluation of the split flow analysis and the maintenance agreement between the Town of Basalt and CDOT, we support and are recommending approval of the Town of Basalt's LOMR application.

The Pitkin/Eagle County Board of County Commissioners have authorized me to sign this letter of support. If you have additional questions or need more information, please contact me at 970-618-9963 or 970-429-2799 or via email at Susan.Pearson@pitkincounty.com

Sincerely,

Susan Pearson

Susan Pearson
Floodplain Adminisrator
Pitkin County

101 MIDLAND AVENUE • BASALT, CO 81621
(970) 927-4701 • FAX (970) 927-4703

TOWN OF BASALT

April 26, 1999

John Liou, Regional Hydrologist

Region #8 FEMA, Denver Federal Center Bldg. 710

Box 25267, Denver, CO 80225-0267

Telephone: (303) 625-3579

Dear John:

The purpose of this letter is to present our recent observations concerning the condition of the Roaring Fork River channel and floodplain adjacent to the State Highway 82 Bypass Bridge. The Town of Basalt has determined that the river hydraulic parameters incorporated into the bridge design have altered significantly. The most recent measurement of the river channel cross-section at the bridge shows excessive levels of deposition under the structure. The measured channel clearance under the bridge demonstrates significant blockage to the river channel. The degree of blockage and associated change in river hydraulics is becoming a major concern of the Town.

The original hydraulic profile of the river was studied to determine if there has been a significant change in the river channel since the Highway Bridge was completed. The thalwag of the river was initially contained within the far right span of the bridge opening. A series of aerial photographs show that approximately 200 feet of lateral migration has resulted in the river channel alignment to pass through the left bridge bay. The clearance of the bridge structure for the left bay did not consider this re-alignment of the main channel as free-board clearance is lost by the slope of the bridge girders due to road grade transition. Deposition within the channel has caused the level of the river bottom to match the normal high water level resulting in a significant loss of freeboard under the bridge girders. The measurement of the total deposition located directly under the bridge was used to calculate the reduction from the original design for the bridge opening. The calculated blockage from our formula resulted in a value of 40%.

The 40% blockage does not take into consideration the altered stream current dynamics which are further compromised by scattered debris and solid tree trunks that are wedged under the structure and wrapped around its center piers. Normal

current flow is disrupted by the lack of a properly dimensioned channel, which is forced to make a 90-degree angle through the center piers. The change in direction under the bridge is pushing water through eight bridge piers simultaneously. The instability of the river and excessive scour potential will continue to accelerate the rate of deposition adding to the blockage problem.

The effects of straining high discharge flows through eight separate bridge piers will continue to accelerate the blockage and subsequent scour and high erosion of the river channel. The scour and excessive bank erosion immediately down stream of the bridge is compounded by the earthen embankment designed to reduce the width of the flood prone area immediately upstream of the constricted flow area. This river dike has significantly increased river velocities by eliminating the floodplain. The Engineer's hydraulic designs indicate their deliberate intention to construct the berm to reduce the width of the floodplain above the bridge. It is our opinion that the dike does not meet FEMA guidelines and therefor should be ignored in any flood plain models.

Summary of key issues:

1) The river channel has relocated to the far left bridge bay

2) The 100 year flood clearance is minimal

3) Measured deposition has created 40 % blockage

4) Additional blockage from trees and debris wedged under structure

5) Main channel directional change under structure

6) Eight bridge piers obstruct channel cross section

7) Restricted flood way accelerates flow through constricted abutments

8) Accelerated bank erosion immediately down stream of bridge

9) The normal high water level is now the river bed level

The Town is requesting that FEMA consider using this information to model the flood plain within our region. The measured 40% blockage of the channel when combined with the non-compliant earthen embankment are immediate concerns. If you have any questions or if we can be of further assistance, please contact Tom Baker, Town of Basalt Administrator at Phone # (970) 927-4723, FAX # (970) 927-4703.

Sincerely,

Tom Baker

Tom Baker, Town Administrator

About AECOM

AECOM (NYSE: ACM) is a global provider of professional technical and management support services to a broad range of markets, including transportation, facilities, environmental, energy, water and government. With approximately 45,000 employees around the world, AECOM is a leader in all of the key markets that it serves. AECOM provides a blend of global reach, local knowledge, innovation, and collaborative technical excellence in delivering solutions that enhance and sustain the world's built, natural, and social environments. A Fortune 500 company, AECOM serves clients in more than 100 countries and has annual revenue in excess of $6 billion.

More information on AECOM and its services can be found at www.aecom.com.

Address
Phone number
Other Contact Information