ARRC Bridge 147.4 Pier and Approach Span Replacement

Knik-Matanuska No-Rise Hydraulic Report

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Revision History

Revision	Date	Description
0	6/25/2021	Final Report for Client Use
B	6/14/2021	Draft Report for Client Review – Report and Model Revised
A	5/28/2021	Draft Report for Client Review

Contents

1. Purpose

The Alaska Railroad Corporation (ARRC) proposes to replace the north bridge pier (Pier #2) and north bridge approach span at ARRC milepost (MP) 147.4 that crosses the north channel of Knik River at approximately 61.4950 N, 149.2392 W, approximately 30 miles northeast of Anchorage, Alaska. The existing concrete pier will be removed to the mud-line elevation and replaced with an array of eight (8), 24-inch diameter piles, four (4) on either side of the existing pier. Affixed to the top of each group of four (4) piles will be a precast concrete sub cap. To facilitate construction, maintenance pads will be constructed within the ARRC right-of-way (ROW) on both sides of the tracks on the north side of Bridge 147.4. Class III/IV riprap that was removed to install temporary pier bracing in 2020 will be replaced against the north abutment and will be extended downstream to the existing riprap revetment, and upstream alongside the existing slough. The maintenance pads will remain in place after construction is completed for future maintenance needs. Side slopes will be stabilized with riprap to prevent erosion of the new maintenance pads. All aggregate material and riprap will be placed above the Mean Tide Line (MTL), Mean Higher High Water (MHHW), and controlling Ordinary High Water (OHW) elevations.

A No-Rise Certification is required to document that the north pier replacement and proposed gravel fill will not impact flood elevations as stipulated by Federal Emergency Management Agency (FEMA) and the Matanuska Susitna Borough (MSB). The intent of a No-Rise Certification is to document that a proposed project encroaching into a FEMA-mapped floodplain will not exceed an allowable increase in water surface elevations during the base (100-year) flood discharge. This report presents the H&H analysis performed to analyze the hydraulic impacts of proposed gravel fill at ARRC Bridge 147.4 and satisfy No-Rise Certification requirements.

2. Background

2.1 General

The Knik River flows west along the Old Glenn Highway toward Cook Inlet. The drainage area for the Knik River is approximately 3,250 square miles at the Knik-Matanuska Confluence (USACE 2013). Both the Knik and Matanuska rivers are anastomosed, low gradient rivers up to approximately 7 miles upstream of the railroad, where geography confines each river to a single braided reach.

The Knik River floodplain is bisected by both ARRC and Alaska Department of Transportation (ADOT&PF) infrastructure, including culverts and bridges. The ARRC railroad consists of a gravel prism with four bridges spanning four anabranches of the Knik River. Approximately 1,200 feet downstream of ARRC infrastructure is the Glenn Highway, running near parallel with the railroad, consisting of four sets of paired bridges spanning three anabranches of the Knik River. ADOT&PF bridge numbers 1888 and 1887 are located downstream of ARRC Bridge 147.4, spanning the North Channel of the Knik River. The confluence of the Matanuska River is approximately 3.2 river miles upstream of the Bridge 147.4.

2.2 FEMA Flood Hazard Area - Matanuska-Susitna Borough, Alaska & Incorporated Areas

The proposed ARRC Bridge 147.4 project is located in a FEMA National Flood Insurance Program (NFIP) flood zone which was most recently updated in an effective digital flood insurance rate map (DFIRM) on September 26, 2019. The accompanying effective Flood Insurance Study (FIS), published September 27, 2019, provides a brief description of the updated methodology used to determine flood zone extents and elevations (FEMA 2019). Effective mapping of the area is based on a US Army Corps of Engineers (USACE) study of the Knik River, Matanuska River, and Bodenburg Creek (2016). Bodenberg Creek is located approximately 7 miles upstream of the proposed project and is not considered in this study.

Effective mapping locates the project within an approximate Zone A (FIRM Panel 8805). The effective mapping retains the prior Zone A classification, however, mapping extents are based on an approximate one-dimensional HEC-RAS model of the Knik River. This approximate model extends from approximately 3.5 river miles upstream of Bridge 147.4 to approximately 125 feet downstream of Bridge 147.4. Gravel fill and hydraulic structures associated with the Alaska Railroad and Glenn Highway are not included in the approximate model. Ineffective areas were assigned to the two downstream-most cross sections to approximate the hydraulic influence of the railroad infrastructure. Normal depth slope was used as the downstream boundary condition. The 100-year discharge of the Knik River was modeled and does not account for contributing discharge from the Matanuska River downstream of the confluence (see Section 4). A short reach (~ 2.6 miles) of the Matanuska River was also modeled using HEC-RAS to cover the reach between detailed modeling and the Matanuska-Knik confluence. This approximate model used normal depth slope as the downstream boundary condition.

Effective mapping includes model cross sections and associated 100-year water surface elevations of the approximate models. Effective FIRM panel (8805) are provided in Appendix A. Mapping of the Knik River as a Zone AE with floodway terminates approximately 0.5 river miles upstream of the Knik-Matanuska Confluence, and the Matanuska River as a Zone AE terminates approximately 2.6 river miles upstream of the Knik-Matanuska Confluence (Appendix B, Figure B-1).

NFIP regulations prohibit encroachments, including fill, new construction, substantial improvements, and other development within the adopted regulatory floodway unless it has been demonstrated through hydrologic and hydraulic analyses performed in accordance with standard engineering practice that the proposed encroachment would not result in any increase in flood levels within the community during the occurrence of the base flood discharge (44 CFR 60.3(d)(3)). In the absence of a regulatory floodway no new construction, substantial improvements, or other development (including fill) shall be permitted within Zones A1-30 and AE on the community's FIRM, unless it is demonstrated that the cumulative effect of the proposed development, when combined with all other existing and anticipated development, will not increase the water surface elevation of the base flood more than one foot at any point within the community (44 CFR 60.3(c)(10)). To ensure NFIP regulations are satisfied a hydrologic and hydraulic analysis should be performed to document that the proposed project will not result in an increase in flood heights; greater than 1.0 feet in Zone A and Zone AE, and greater than 0.00 feet in Zone AE with Floodway. This engineering analysis must be done before a permit can be issued, and should include a No-Rise Certification or an equivalent document supported by technical data and signed by a registered professional engineer.

Though the project is located in an area mapped as Zone A backwater impacts from the project could propagate upstream to areas mapped as Zone AE and Zone AE with floodway. To best evaluate the extent of potential impacts this hydraulic study encompasses both Zone A and Zone AE mapped floodplains. Supporting technical data should typically be based on the computer model used to develop the regulatory mapping shown on the FIRM and the results tabulated in the Flood Insurance Study. However, the Zone A HEC-RAS model does not encompass or accurately model ARRC and ADOT&PF infrastructure. For these reasons, the Zone A model was not used as the base conditions model. The Zone AE and Matanuska Zone A HEC-RAS models do not encompass the project area, nor do they consider potential backwater influences from ARRC and ADOT&PF infrastructure or influences from overbank flooding of the adjacent channel. Given downstream hydraulic complexity, Zone AE models were not adopted as a starting point for this study.

An independent two-dimensional finite element surface water model was selected for this hydraulic analysis, for the following reasons:

1. Existing models do not include ARRC or ADOT&PF infrastructure.
2. Orientation of the railroad and placement of hydraulic structures across the floodplain prohibit reasonable and representative modeling of those structures by a one-dimensional model alone.
3. The selected hydraulic model allows for representative modeling of bridge hydraulics including piers, abutments, pressure flow, and overtopping as required.
4. The simplistic nature of one-dimensional models is poorly suited for the complex convergent and divergent flow paths of the Knik and Matanuska rivers.
5. The two-dimensional mesh of a finite element model allows for varied mesh density to adequately represent local terrain and optimize model accuracy, providing detail where required.

A duplicate effective model was not developed for the reasons described above. Every attempt was made to tie into the effective models, as described in the results section below.

3. Study Limits

The two-dimensional model covers an area of approximately 41 square miles (Appendix B, Figure B-1). The downstream boundary is located approximately 0.6 miles downstream of the Glenn Highway spanning 5.9 miles to encompass the entire paleo-braidplain. Lateral model limits parallel high ground north and south of the paleo-braidplain. The upstream limit is located approximately 7 miles upstream of the study area; immediately downstream of the Old Glenn Highway Knik River bridge and at a confined pinch point of the Matanuska River approximately 3.7 miles downstream of the Old Glenn Highway Matanuska River bridge.

The model extents were established to fully encompass both the Matanuska and Knik rivers beyond the Matanuska-Knik confluence and within Zone AE mapping. The proposed process for hydraulic modeling was to develop a model that encompassed the Knik River Zone A HEC-RAS model, extending downstream of the Glenn Highway and upstream to the Old Glenn Highway bridge. This would be the best representation of preliminary effective modeling proximal to and impacted by the proposed project. This would also allow for modeling potential upstream impacts within the Knik River Zone AE with floodway. If this Knik River model suggested that impacts extended into the Matanuska River Zone A and/or Zone AE, an additional model condition could be developed to track those impacts. The proposed project scenario represented by the Knik River model did not yield a rise in water surface elevation that extends into the Matanuska River (see Section 6). As such a hydraulic model of the Matanuska River was not developed.

4. Hydrology

The selected 1% annual exceedance probability (100-year) discharges for the Knik River was obtained from the preliminary FIS and associated USACE study. The USACE-delineated Knik River drainage basin terminates at the upstream limit of the two-dimensional model (Old Glenn Highway Bridge) and includes the Bodenburg Creek drainage. There is additional contributing area downstream of the delineated drainage basin, though the FIS indicates the reported discharges are valid to the downstream limits of mapping. The selected 100-year discharge was computed from USGS gage data collected at the Old Glenn Highway Bridge using methods outlined in Bulletin 17B.

The detailed Zone AE and approximate Zone A models assume no coincident flooding of the Knik and Matanuska rivers. The approximate Zone A model uses only the Knik River discharge downstream of the Matanuska River confluence. This study adopts the same hydrology as the preliminary effective model.

Summary of Modeled Discharges		
Reach	Basin Area (square miles) [1]	1% Annual Exceedance Probability (cfs) [1]
Knik River	1,180	117,800
Notes: 1. Values obtained from Preliminary FIS (FEMA 2016) and checked against USACE study (2014) and preliminary effective hydraulic model.		

5. Hydraulic Analysis

Numerical computations for the hydraulic analysis were performed using the FEMA-approved Sedimentation and River Hydraulic – Two-Dimensional model (SRH-2D), version 3.2.3, developed and maintained by the US Bureau of Reclamation (USBR). Surface-water Modeling System (SMS) software, version 13.0.12, was used as a graphical user interface to set up, initiate, and view results of the model.

5.1 Model Development

5.1.1 Topographic Mapping & Structure Survey

Modeled topography was based on Light Detection and Ranging (LiDAR) data, collected in 2011 by Aerometric for the MSB (2013). LiDAR data was collected for an area of approximately 3,680 square miles. LiDAR specifications were based on the USGS National Geospatial Program Base LiDAR Specification. The horizontal projection is Alaska State Plane Zone 4, North American Datum of 1983 (NAD83) in units of feet, while the vertical datum is based on North American Vertical Datum of 1988 (NAVD88) in units of feet. LiDAR data was obtained from MSB as a one meter bare earth hydro flattened DEM file (Appendix B, Figure B-2). The LiDAR satisfies the “Highest” specification level of 0.61 feet (18.5 cm) for contour generation necessary to meet the FEMA requirement for detailed floodplain analysis.

Rapid assessment LiDAR was collected in 2018 by Kodiak Mapping to assess impacts of the 2018 earthquake on the Glenn Highway. LiDAR was collected December 6-9 during snow cover causing decreased point density and negatively impacting overall surface usability in some areas. Vertical accuracy of the data could not be verified. This data set was not used to enhance the 2011 LiDAR.

Bathymetric, ground, and structure survey was collected by SurvBase between September 26 and October 6, 2017. Field survey was completed using an Oceanscience Z-Boat remote control hydrographic vessel, as well as GPS and Total Station methods. Control was established on ADOT&PF monuments using static GPS, with secondary control being established with RTK GPS methods. Bathymetric and ground survey was collected upstream of ARRC Bridges 147.5 and 147.4 and downstream of the Glenn Highway. Structure survey was also collected for the ARRC Bridges 147.5 and 147.4, as well as the Glenn Highway bridges (No. 1888 and 1887) spanning the central Knik River anabranch. Survey points of bridge support structure are present in Figure B-3 (Appendix B).

Abutment and pier locations and geometries were located using the ground survey. Low chord elevations of the surveyed bridges were also checked against modeled water surface elevations (WSE) to ensure pressure flow was not occurring.

Gravel fill associated with the ARRC Bridge 147.5 project, completed in 2018, is absent from the 2011 LiDAR and 2017 ground survey. Mesh node elevations were manually adjusted to represent the existing gravel fill geometry associated with Bridge 147.5.

The LiDAR DEM was collected at low flow, presumably limiting the absence of bathymetric data to a small portion of the bankfull conveyance area. Bathymetry survey points were used to develop a DEM below the water surface represented in the hydro flattened LiDAR DEM. This surface was burned into the LiDAR DEM to develop a new DEM which served as the topographic basis for the model mesh (Appendix B, Figure B-3). Gravel fill associated with the ARRC Bridge 147.5 project, completed in 2018, is absent from the 2011 LiDAR and 2017 ground survey. Mesh node elevations were manually adjusted to represent the existing gravel fill geometry associated with Bridge 147.5 and as a result are not depicted in Appendix B, Figure B-3.

The hydraulic model, associated parameters, and output files included in this submittal were prepared as follows:

- Vertical Datum – NAVD88
- Horizontal Datum – North American Datum of 1983 (NAD83)
- Projection Coordinate System – NAD_1983_StatePlane_Alaska_4_FIPS_5004_Feet

5.1.2 Finite Element Mesh

The finite element mesh is a network of triangular and rectangular elements representing a topographic basemap of the model domain. Local elevations are stored at mesh nodes located at element vertices. The finite element mesh is much larger than most model applications, at approximately 957,000 elements. Mesh density could have been reduced through an iterative process, however this would have been a lengthy exercise in developing and validating multiple mesh densities with associated model solutions. Ultimately the only sacrifice for such a large mesh was extended computation times and file size.

The finite element mesh was generated using the SMS graphical user interface. A conceptual model was used to define the thalweg of primary anabranches, crown of ARRC and Glenn Highway fill, bridge openings, abutments, and piers. Node density was reduced in the upper reaches of the model domain (minimum 60 foot spacing), with higher density (minimum 7 ft spacing) near infrastructure (Appendix B, Figure B-4).

ARRC Bridge 147.4 has two existing concrete piers, each immediately adjacent to the north and south abutments. Piers were modeled as obstructions to facilitate a direct comparison of existing and proposed condition solutions. Existing piers were modeled using feature arcs with dimensions of 7 feet (width) and 25 feet (length) using a drag coefficient of 1.72 to represent the octagonal nose of the pier. The proposed pier was modeled using two (2) feature points located at the center of each pier group with a width dimension equivalent to the concrete sub cap (9.5 feet) and an assigned drag coefficient of 2.0 to represent the square nose of the pier. At ARRC Bridge 147.5 piers were modeled as rectangular voids in the mesh using as-built dimensions of 7 feet (width) and 25 feet (length). Piers were not modeled at any other structures (i.e. Glen Highway bridges).

Mesh quality parameters pertaining to element geometry, including aspect ratios, interior angles, and element-to-element area transitions, were visualized in SMS. Deviation from recommended values was largely limited to element slope along channel banks and infrastructure fill. Mesh quality was deemed adequate and further validated by model stability.

5.1.3 Hydraulic Roughness

Hydraulic roughness was based in-part on the Manning's roughness values used in the preliminary effective HEC-RAS models and as presented in the preliminary FIS. The assigned Manning's roughness values were attributed to two simplified terrain types; channel and overbank. Polygons were digitized from the LiDAR DEM and aerial imagery to represent the two terrain types; Channel (low water channel and exposed sand/gravel) and the Overbank (vegetated floodplain) (Appendix B, Figure B-5).

One common error in two-dimensional hydraulic modeling is to strictly adopt Manning's roughness coefficients used in one-dimensional hydraulic models. Manning's roughness encompasses multiple influences that result in energy loss between modeled cross sections; including surface material roughness, cross section irregularity, channel variations, obstructions, vegetation, and degree of channel meander. Due to the increased granularity offered by two-dimensional modeling most of these energy losses are captured in numerical computations and need not be accounted for in the assigned hydraulic roughness. A review of Manning's roughness coefficients recommended in the HEC-RAS user manual suggests channel meander alone can increase Manning's roughness by as much as 25%. A recent study conducted by Friend and McBroom suggests Manning's roughness coefficients assigned in a one-dimensional model should be reduced when relating them to hydraulic roughness coefficients assigned in a two-dimensional model of the same study reach (2017). Based on the authors' recommendation, Manning's roughness assigned in HEC-RAS should be reduced by 20% to 40% when modeling complex flow paths in SRH-2D. For this study, the assigned hydraulic roughness coefficients were reduced from those used in the preliminary effective models by an average of 30% in channels and 40% in the overbank. These values are further validated by tie-in with the Knik River Zone AE model, as discussed in the results section below.

Hydraulic Roughness Coefficients	Preliminary Effective 1D (HEC-RAS) [1]		No-Rise 2D (SRH-2D) [2]	
Reach	Channel	Overbank	Channel	Overbank
Knik River	0.027	0.100-0.150	0.02	0.065
Matanuska River	0.027-0.03	0.090-0.150	0.02	0.065

Notes:
1. Roughness coefficients reported in preliminary FIS Table 14 for approximate study. There is slight variation in coefficients used for preliminary detailed studies of the respective reaches (FEMA 2019).
2. Preliminary effective roughness coefficients were adjusted for the no-rise two-dimensional model per findings of comparative studies (Friend and McBroom 2017) and best engineering judgement. Tie-in with the preliminary effective was achieved with adjusted roughness values.

5.1.4 Boundary Conditions

5.1.4.1 Upstream Boundary

An inflow boundary was assigned to the Knik River reach along the eastern model domain. The 1% annual exceedance probability (AEP) was assigned as a steady state discharge. This is a conservative approach which does not consider short duration peak hydrographs.

Though the model domain encompasses the Matanuska River, model results of the Knik River indicated proposed project impacts are limited to the Knik River reach, satisfying the requirements of this no-rise study.

Upstream Boundary Conditions	
Reach	Steady State Discharge (cfs)
Knik River	117,800

5.1.4.2 Downstream Boundary

Downstream boundary conditions were varied over the simulation period. To expedite model convergence the initial six hours of model simulation time used a constant water surface elevation across the downstream model domain. Subsequent simulations used a constant exit discharge equivalent to the inflow discharge of the Knik River.

Downstream Boundary Conditions	
Model Simulation Period [1]	**Downstream**
0-6 hours	Constant WSE = 27.5 feet
6-36 hours	Constant discharge = 117,800 cfs

Notes:
1. Initial condition for the simulation period of 0-6 hours was modeled as a constant WSE. Subsequent model simulations were modeled using a restart file from the final solution of the prior simulation period. Proposed conditions were modeled using the existing conditions solution at 24 hours and were run for a simulation period of 12 hours.

5.1.5 Simulation Parameters & Model Convergence

A modeled time step of 2 seconds was selected for all simulations. At 24 hours the existing conditions model outflow stabilized to within 0.0001% of model inflow and the WSE profile through ARRC Bridge 147.4 varied by less than 0.00003 feet from the prior timestep. The existing conditions model solution at the 24-hour time-step was subsequently used as the start file for proposed conditions. Proposed condition simulation was run for a 12-hour period. Proposed model solutions at 36 hours yielded an outflow that had stabilized to within 0.0036% of total model inflow and a WSE profile through ARRC Bridge 147.4 that varied by less than 0.00001 feet from the prior timestep.

5.2 Model Scenarios

Two model scenarios were developed to assess the impacts of the proposed gravel pads at the ARRC Bridge 147.4 north abutment. Mesh structure did not vary between scenarios; only node elevations were modified at select locations to represent the proposed extents of gravel fill.

5.2.1 Existing Conditions

The existing conditions model represents the existing geometry, without proposed gravel fill or replacement pier.

5.2.2 Proposed Conditions

The proposed project will include the replacement of the north pier (#2) and placement of approximately 0.39 acres of gravel fill above the existing riprap revetment and OHW, spanning upstream and downstream of the north abutment (Appendix C). Ordinary high water (25.5 ft NAVD88) was distinguished by topographic grade breaks and vegetation, determined from LiDAR, ground survey, and site photos. NOAA tide gage 9455920, located at the Port of Anchorage, identifies a MTL elevation of 4.57 ft NAVD88 and MHHW elevation of 18.39 ft NAVD88. To model this condition, mesh node elevations best representing the top of gravel fill were manually adjusted to represent the proposed ARRC gravel pads. Piers were modeled using obstruction points assigned a representative width and drag coefficient.

6. Results

6.1 Model Solutions

Model solutions were extracted for each scenario at a simulation timestep of 36 hours. Node-specific coordinates, elevation, WSE, depth, velocity magnitude, and velocity direction were exported as a tabular file. Water surface elevations computed at each node were converted to point data in ArcGIS. Inundation extents were extracted as polygon shapefiles and compared in ArcGIS. Model results were clipped downstream of the Glenn Highway to remove localized errors associated with the downstream boundary.

6.2 Existing Conditions vs Effective

Inundation extents were compared to the effective DFIRM (Appendix B, Figure B-6). Modeled top-widths were predominantly less than the preliminary effective top-widths by more than 5% of the FIRM map scale. Differences are largely attributable to the inclusion of downstream infrastructure in lieu of ineffective flow areas and greater detail in hydraulic roughness assignment to northern anabranches of the Knik River. Given the added detail of the two-dimensional model, resulting flood extents are considered to be a more accurate representation of 1% AEP flood conditions than the preliminary effective mapping and are deemed accepted for this analysis.

Water surface elevation tie-in was achieved to within the required 0.5 feet of the preliminary effective profile at the downstream limit (Cross Section A) of the Knik River Zone AE with floodway map extents (Appendix B, Figure B-6 and Table 24 of FEMA 2016). The preliminary effective WSE is based on a one-dimensional model, which assumes a uniform WSE across the modeled cross section. The two-dimensional model is not limited by this assumption, allowing variable WSE within adjacent anabranches. As such the resulting two-dimensional WSE, was averaged across the Effective Cross Section A, yielding an average WSE of 37.20 feet as compared to the regulatory water surface elevation of 37.60 feet. Looking further upstream to the first BFE (38 feet), the average modeled WSE is within 0.2 feet of the regulatory water surface elevation at 37.8 feet.

Tie-in could not be achieved at the downstream boundary for two reasons; this study extends downstream of the approximate study limits and includes the hydraulic influences of ARRC and ADOT&PF infrastructure rather than the ineffective areas modeled in the Zone A model. Flow vectors computed in the two-dimensional model suggest that the broad extents of ineffective areas used in the Zone A model are excessive and do not accurately represent the hydraulic influences of downstream infrastructure, artificially raising water surface elevations.

6.3 Impact on Flood Extents

The proposed project has only localized and minor impacts on flood extents as compared to existing conditions (Appendix B, Figure B-7). The Proposed conditions scenario yields no change in floodplain extents.

Difference in Floodplain Extents	
Model Scenario	**Maximum Change in Top Width [1]**
Proposed 2021	0 feet (0% Existing Top Width)
Notes: 1. Change in top width relative to Existing Conditions solution.	

6.4 Impact on Water Surface Elevation

The proposed scenario results in higher WSEs that are confined to the Knik River Zone A at bridge 147.4, however this rise is less than the 1.0 feet limit allowed within a Zone A (Appendix B, Figure B-8). No rise in WSE greater than or equal to 0.01 feet (>0.0049 feet) extended into the Knik River Zone AE with floodway. The modeled rise in WSE does not extend to the Matanuska River Zone A or Zone AE model extents. Modeling of the Matanuska River was deemed unnecessary to satisfy regulatory guidance for a no-rise condition.

DIFFERENCE IN FLOODPLAIN EXTENTS	Maximum Water Surface Elevation Differential, dWSE (feet) [1]		
Model Scenario	**Zone A**	**Knik Zone AE**	**Matanuska Zone A/AE**
Proposed 2021	0.26 feet	0.00	0.00

Notes:
1. Water surface elevation differential relative to Existing conditions solution. Differential computed by subtracting Proposed conditions WSE raster from Existing condition WSE raster in GIS.

7. Conclusions

The proposed ARRC Bridge 147.4 project includes the replacement of the north bridge pier (Pier #2), north bridge approach span, and permanent placement of gravel maintenance pads around the north abutment and approach fill at ARRC milepost (MP) 147.4. The existing north bridge concrete pier will be removed and replaced with two pile groups affixed with a precast concrete sub cap, located upstream and downstream of the existing pier. Gravel maintenance pads will be placed above the controlling OHW elevation and armored with riprap protection where hydraulic and debris impacts threaten material erosion.

Effective mapping locates the project within FEMA-mapped approximate Zone A. a No-Rise Certification is required to document that the north pier replacement and proposed maintenance pads will not impact flood elevations as stipulated by Federal Emergency Management Agency (FEMA) and the Matanuska Susitna Borough (MSB). The intent of a No-Rise Certification is to document that a proposed project encroaching into a FEMA-mapped floodplain will not exceed an allowable increase in water surface elevations during the base (100-year) flood discharge.

The H&H analysis presented here was performed to analyze the hydraulic impacts of the proposed project. Hydrology was based on the Knik River base flood discharge computed by the USGS and documented in the effective FEMA FIS. Hydraulics were modeled using the FEMA-approved SRH-2D, version 3.2.3, surface water model. Mesh were developed for existing and proposed conditions to model both local and broadscale hydraulics to assess impacts of the proposed project on 100-year water surface elevation and flood hazard extents.

Results of the H&H analysis yield a maximum water surface elevation rise of 0.26 feet around the project area in the effective Zone A and no water surface elevation rise (0.00 feet) in the upstream Knick River Zone AE with floodway. The proposed project satisfies the NFIP and MSB no-rise condition; no greater than than 1.0 feet in Zone A and Zone AE, and no greater than 0.00 feet in Zone AE with Floodway.

8. References

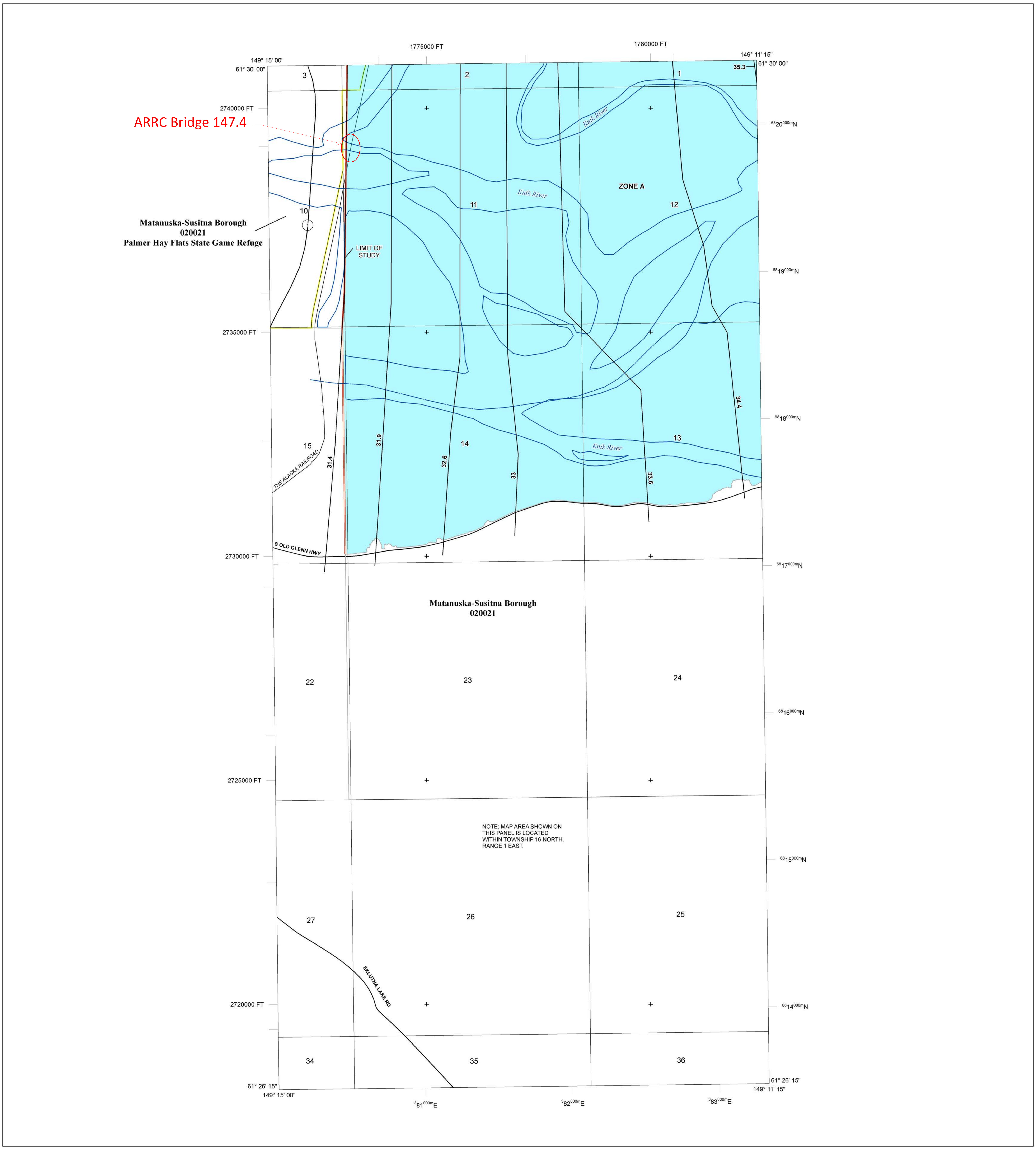
Federal Emergency Management Agency (FEMA). 2019. Flood Insurance Study, Matanuska-Susitna Borough, Alaska and Incorporated Areas. Revised: September 27, 2019. Volume 1 of 2. 02170CV001B.

Friend, A. and M. McBroom. 2017. Smooth Transitions – How to Adjust Manning's n Values for 2D Modeling. Colorado Association of Floodplain Managers 2017 Annual Conference. September 21, 2017. Michael Baker International.

Matanuska Susitna Borough (MSB). 2013. MSB LiDAR & Imagery Project (2011/2012), Frequently Asked Questions. Version 2. April 2, 2013.

US Army Corps of Engineers (USACE). 2014. Hydrology and Hydraulics for the Knik-Matanuska Floodplain Study, Supplement to the FEMA Floodplain Information Report. Final September 2014.

Appendix A. Effective FIRM Panel 8805, Matanuska-Susitna Borough, Alaska & Incorporated Areas



FLOOD HAZARD INFORMATION

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

THE INFORMATION DEPICTED ON THIS MAP AND SUPPORTING DOCUMENTATION ARE ALSO AVAILABLE IN DIGITAL FORMAT AT

HTTPS://MSC.FEMA.GOV

SPECIAL FLOOD HAZARD AREAS	Without Base Flood Elevation (BFE) *Zone A,V, A99*
	With BFE or Depth *Zone AE, AO, AH, VE, AR*
	Regulatory Floodway
OTHER AREAS OF FLOOD HAZARD	0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
	Future Conditions 1% Annual Chance Flood Hazard *Zone X*
	Area with Reduced Flood Risk due to Levee See Notes. *Zone X*
OTHER AREAS	NO SCREEN Areas of Minimal Flood Hazard *Zone X*
	Area of Undetermined Flood Hazard *Zone D*
GENERAL STRUCTURES	Channel, Culvert, or Storm Sewer
	Levee, Dike, or Floodwall
OTHER FEATURES	E 18.2 17.5 Cross Sections with 1% Annual Chance Water Surface Elevation
	8 Coastal Transect
	Coastal Transect Baseline
	Profile Baseline
	Hydrographic Feature
	513 Base Flood Elevation Line (BFE)
	Limit of Study
	Jurisdiction Boundary

NOTES TO USERS

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

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

For community and countywide map dates refer to the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in the community, contact your Insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

Base map information shown on this FIRM was provided in digital format by the United States Geological Survey (USGS), Matanuska-Susitna Borough GIS Department, Alaska State Geo-Spatial Data Clearinghouse, and Alaska Department of Natural Resources. Other information was derived from digital orthophotography at a 2-foot resolution from photography dated 2011.

SCALE

N

Map Projection:
NAD 1983 StatePlane Alaska 4 FIPS 5004 Feet;
Western Hemisphere; Vertical Datum: NAVD 88

1 inch = 1,000 feet 1:12,000

0 1,000 2,000 4,000 feet

0 255 510 1,020 meters

PANEL LOCATOR

* PANEL NOT PRINTED

FEMA

National Flood Insurance Program

NATIONAL FLOOD INSURANCE PROGRAM
FLOOD INSURANCE RATE MAP

MATANUSKA-SUSITNA BOROUGH, ALASKA
and Incorporated Areas

PANEL **8805** OF **9855**

FEMA

Panel Contains:

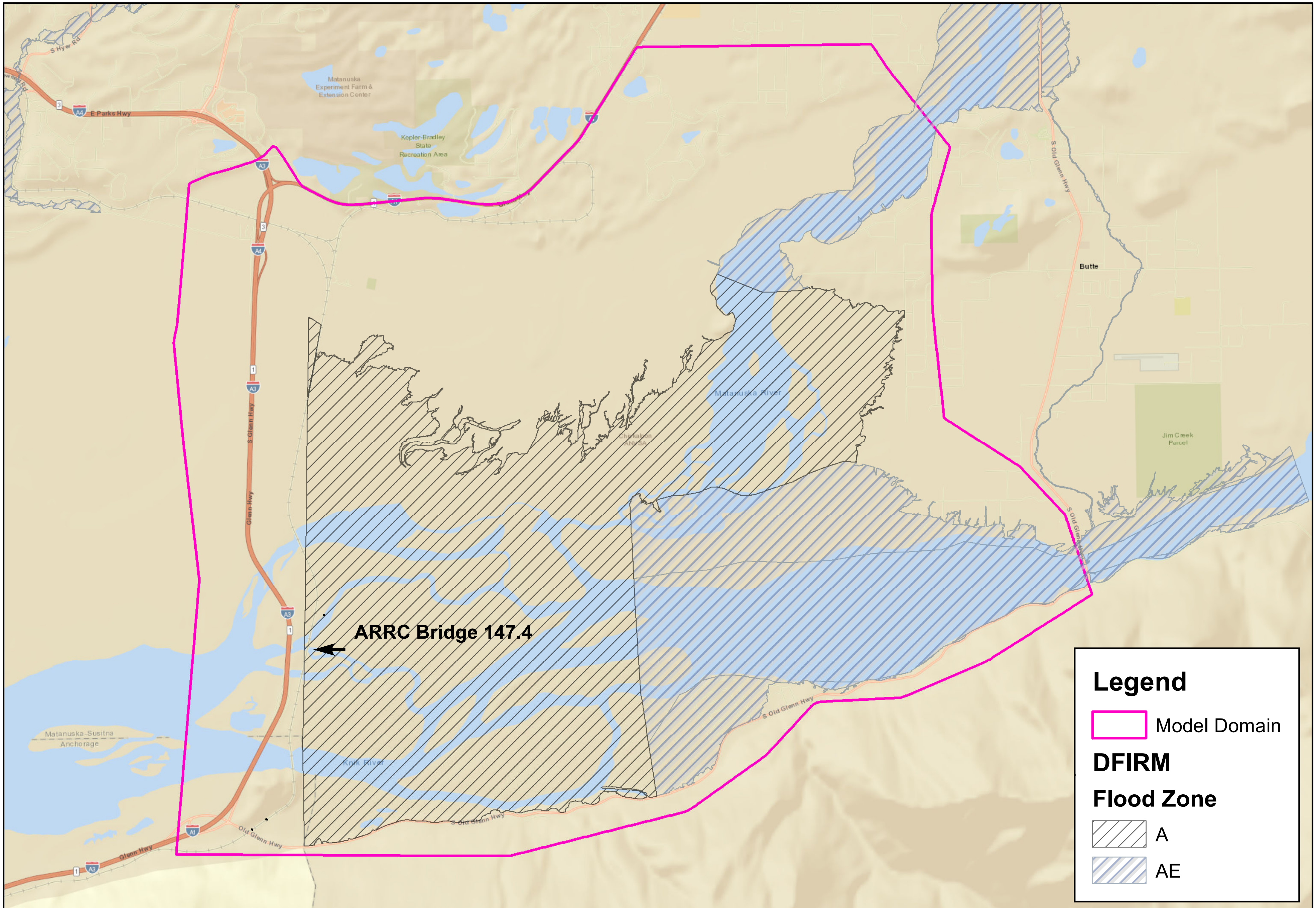
COMMUNITY	NUMBER	PANEL	SUFFIX
MATANUSKA-SUSITNA BOROUGH	020021	8805	F

VERSION NUMBER
2.3.3.2

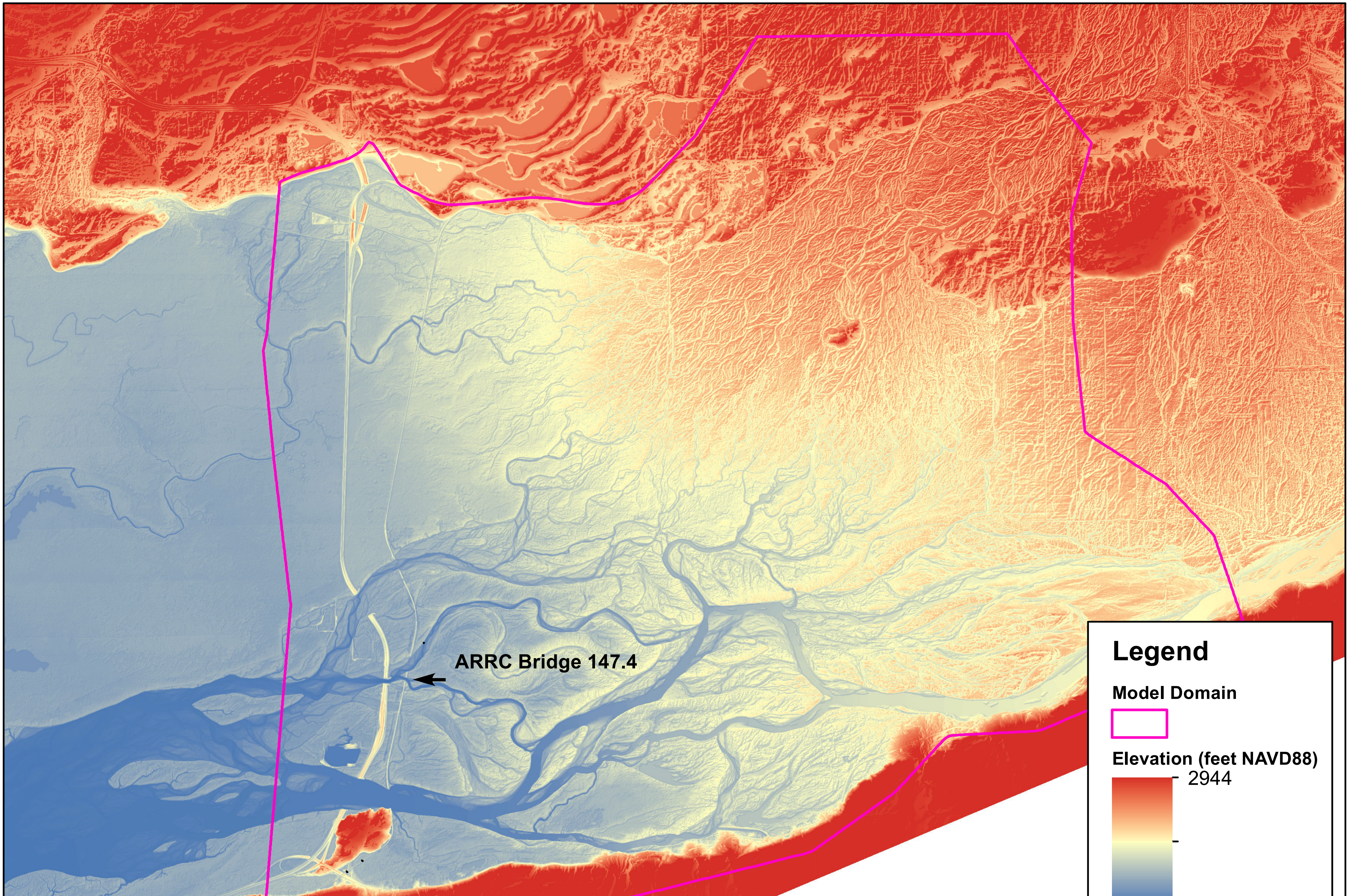
MAP NUMBER
02170C8805F

MAP REVISED
SEPTEMBER 27, 2019

Appendix B. Figures

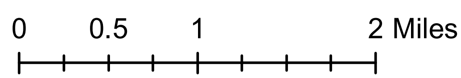


Project: ARRC Bridge 147.4 No-Rise	Figure B-1: Two-Dimensional Hydraulic Model Domain	0 0.5 1 2 Miles	Michael Baker INTERNATIONAL



Project:
ARRC Bridge 147.4 No-Rise

Figure B-2:
Matanuska Susitna Borough LiDAR DEM



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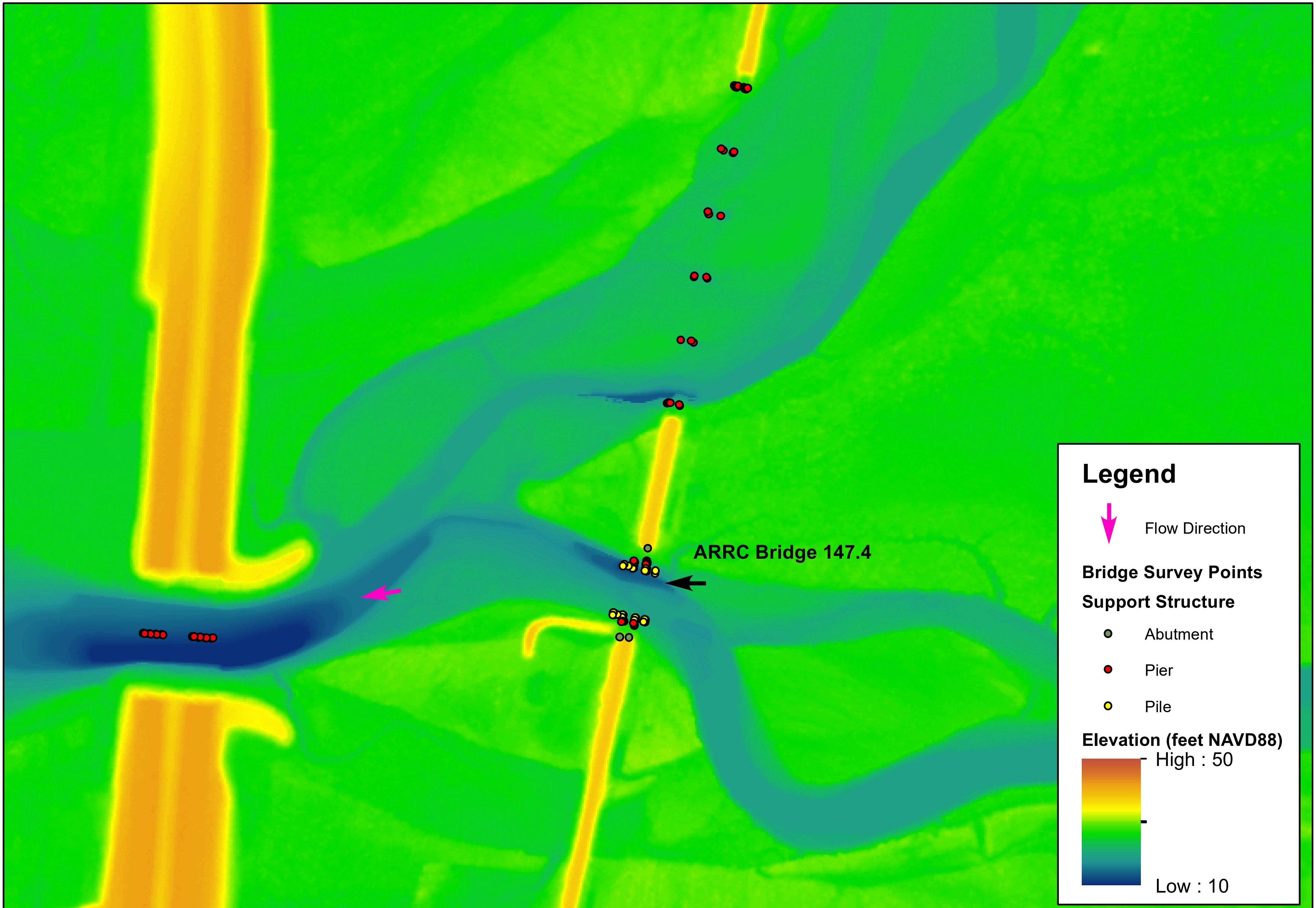
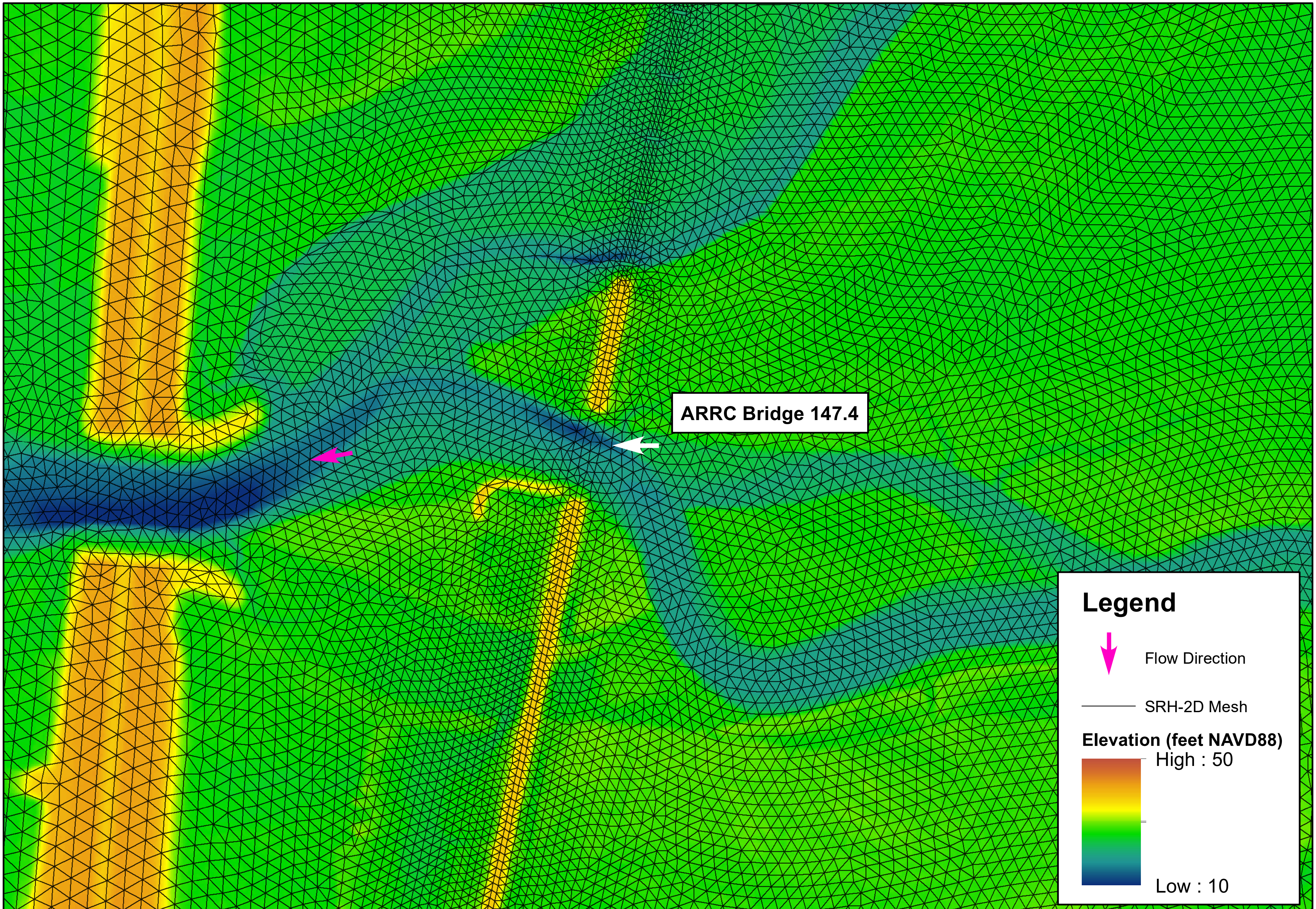


Project: ARRC Bridge 147.4 No-Rise	Figure B-3: Bridge Survey Point Data and Base Topography	0 100 200 400 Feet	Michael Baker INTERNATIONAL



Project:
ARRC Bridge 147.4 No-Rise

Figure B-4:
Project Area Finite Element Mesh

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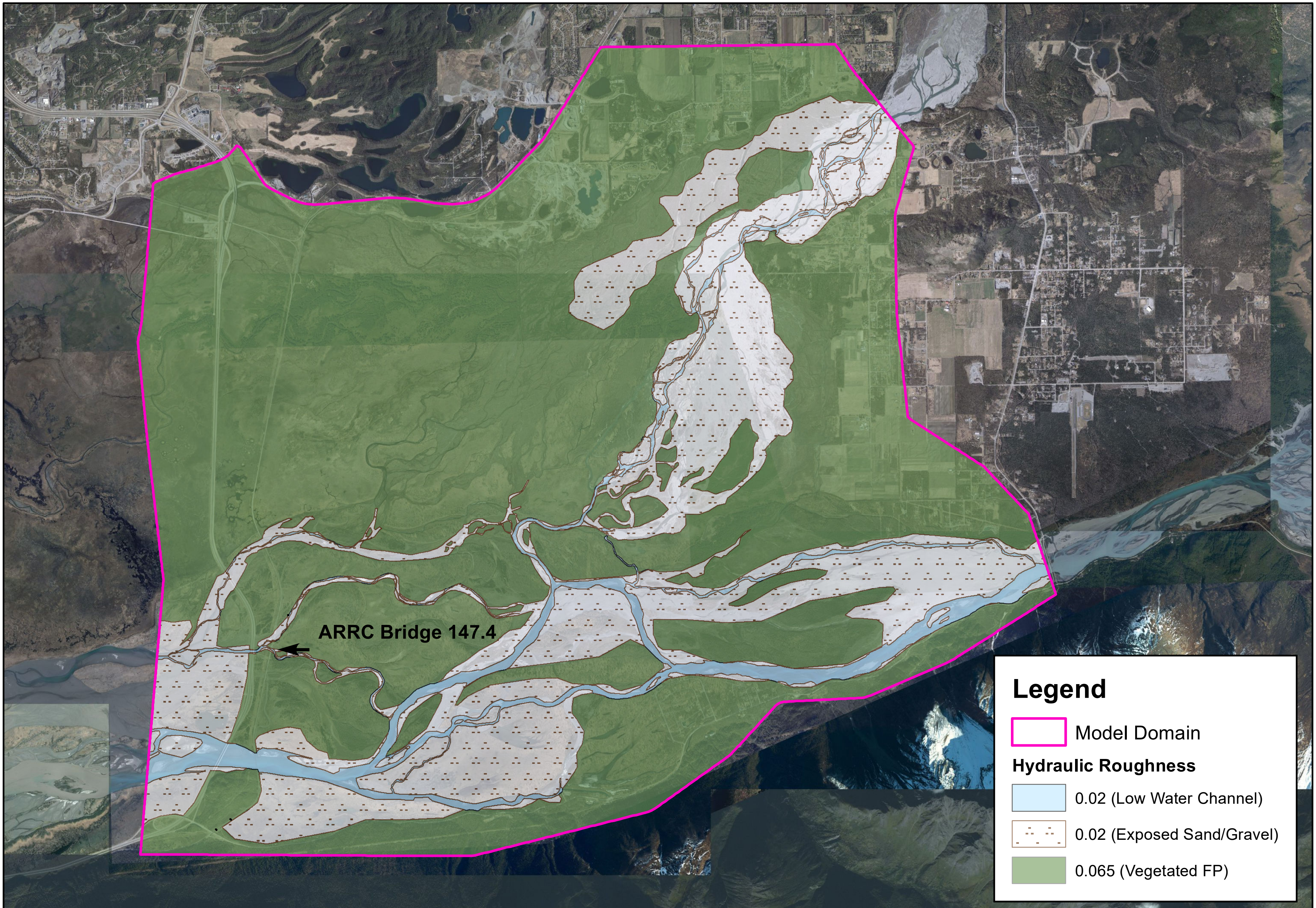
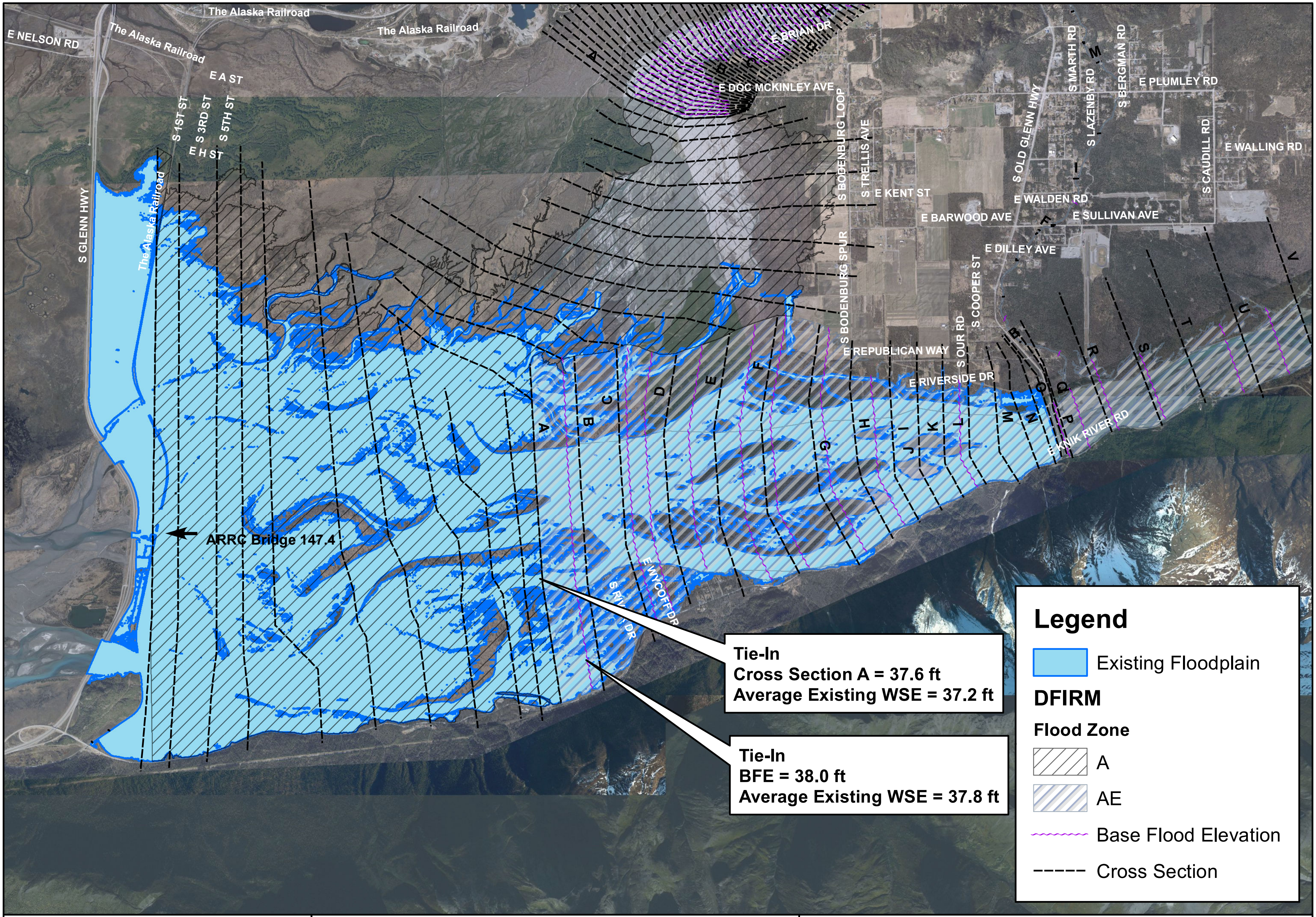
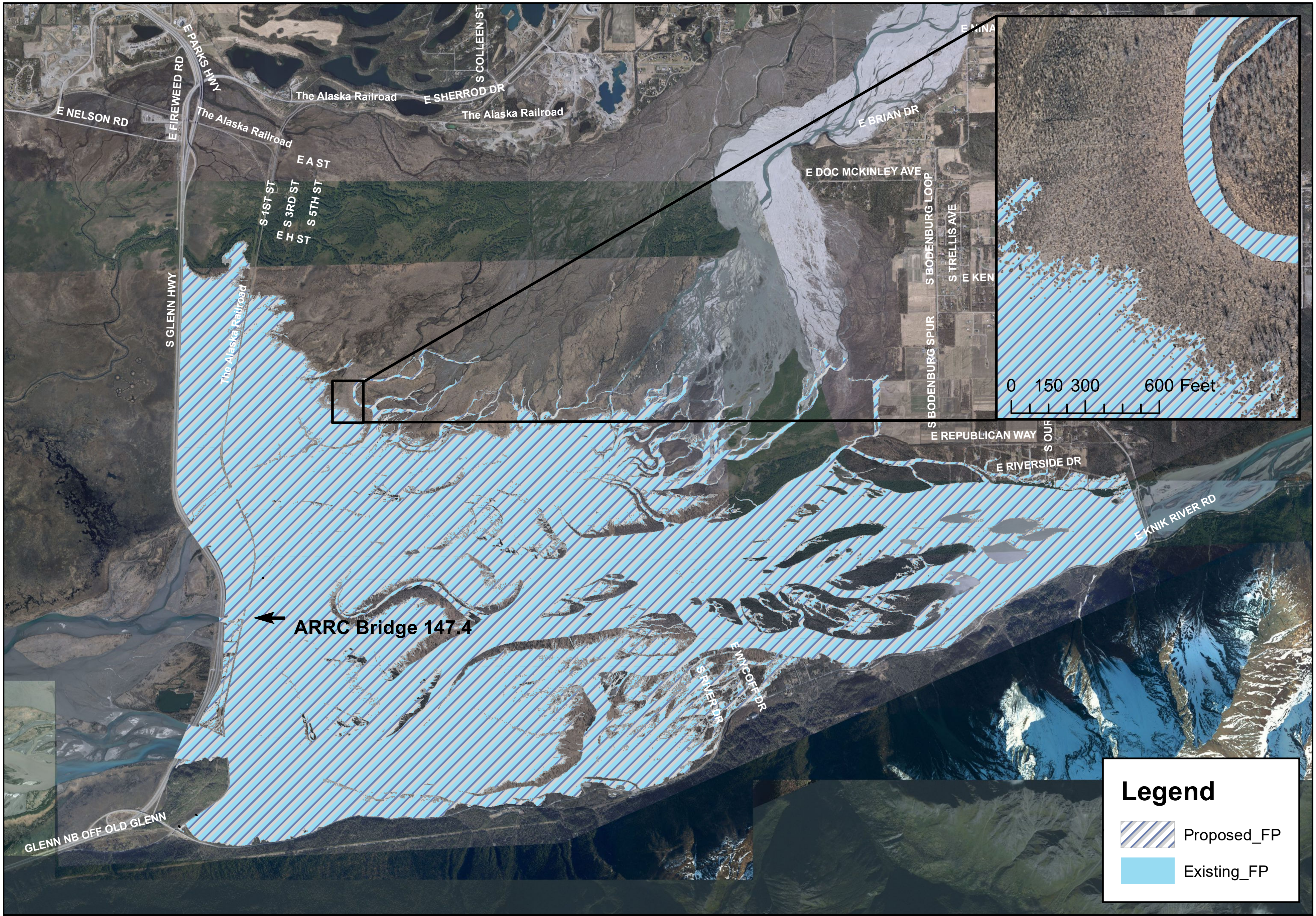


Project: ARRC Bridge 147.4 No-Rise	Figure B-5: Modeled Hydraulic Roughness	0 0.5 1 2 Miles	Michael Baker INTERNATIONAL



Project: ARRC Bridge 147.4 No-Rise	Figure B-6: Existing Conditions Floodplain	0 0.5 1 2 Miles — Michael Baker INTERNATIONAL



Project:
ARRC Bridge 147.4 No-Rise

Figure B-7:
Floodplain Comparison

0 0.5 1 2 Miles

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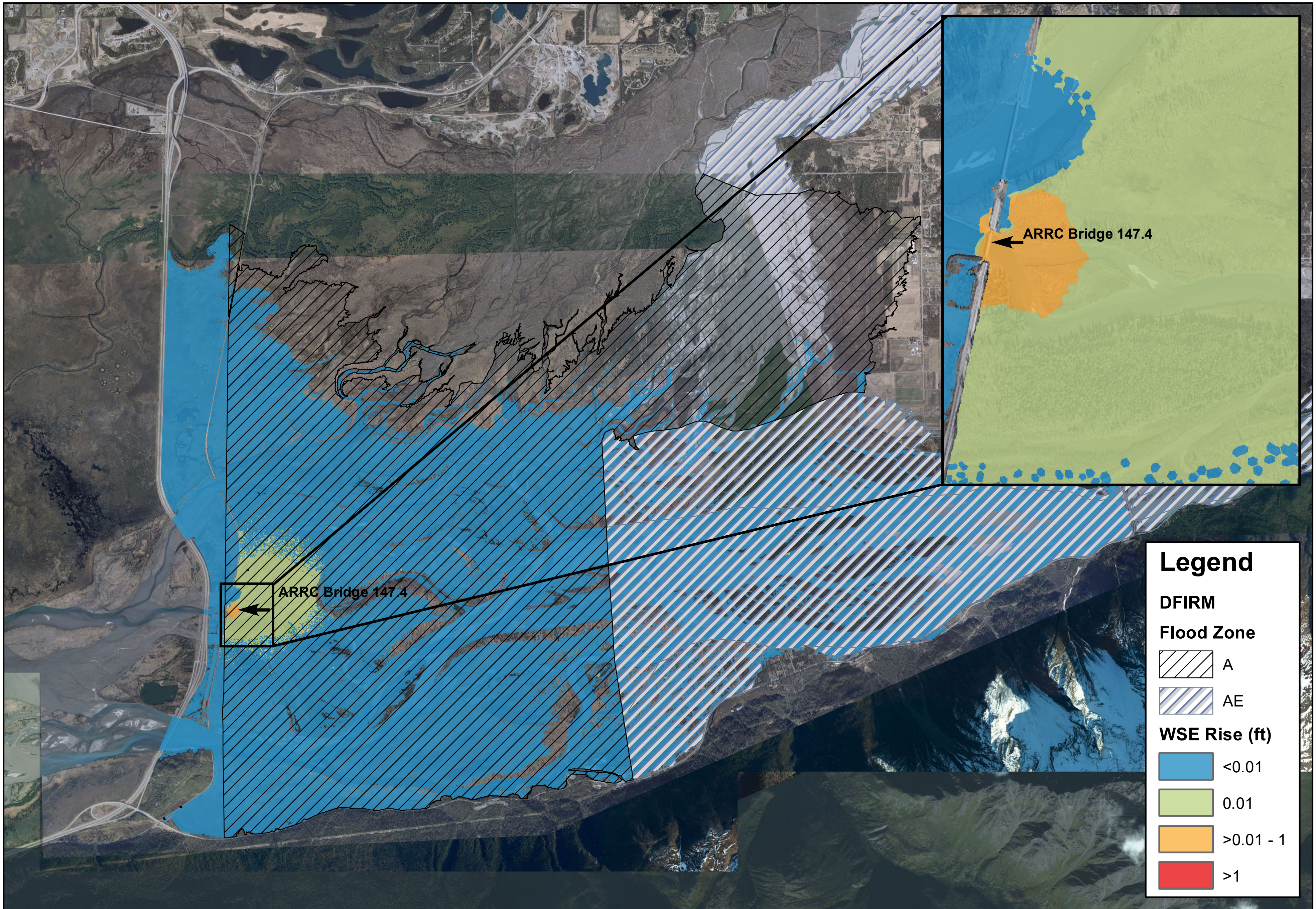

Project:
ARRC Bridge 147.4 No-Rise

Figure B-8:
Water Surface Rise Due to Proposed Project

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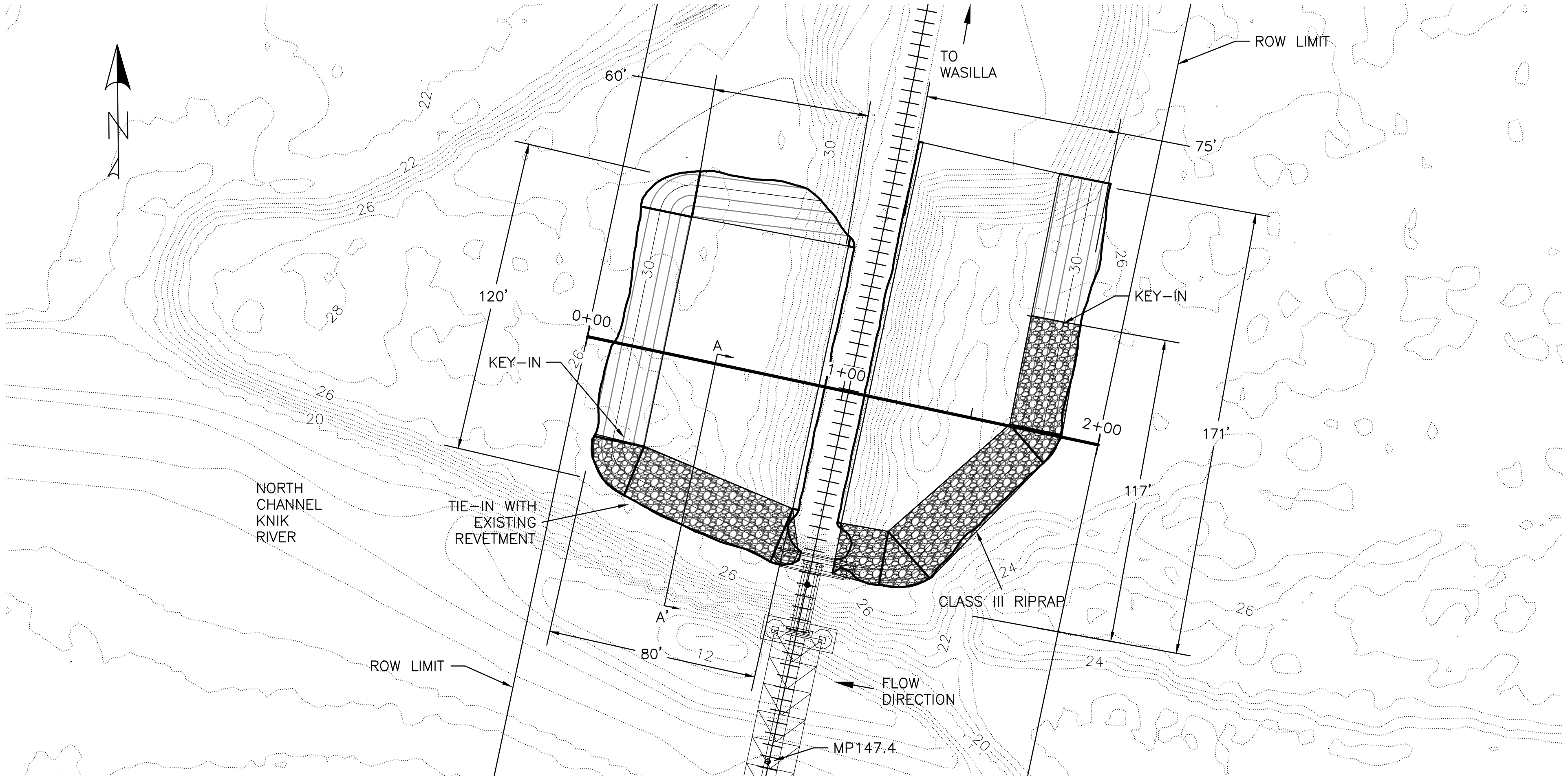
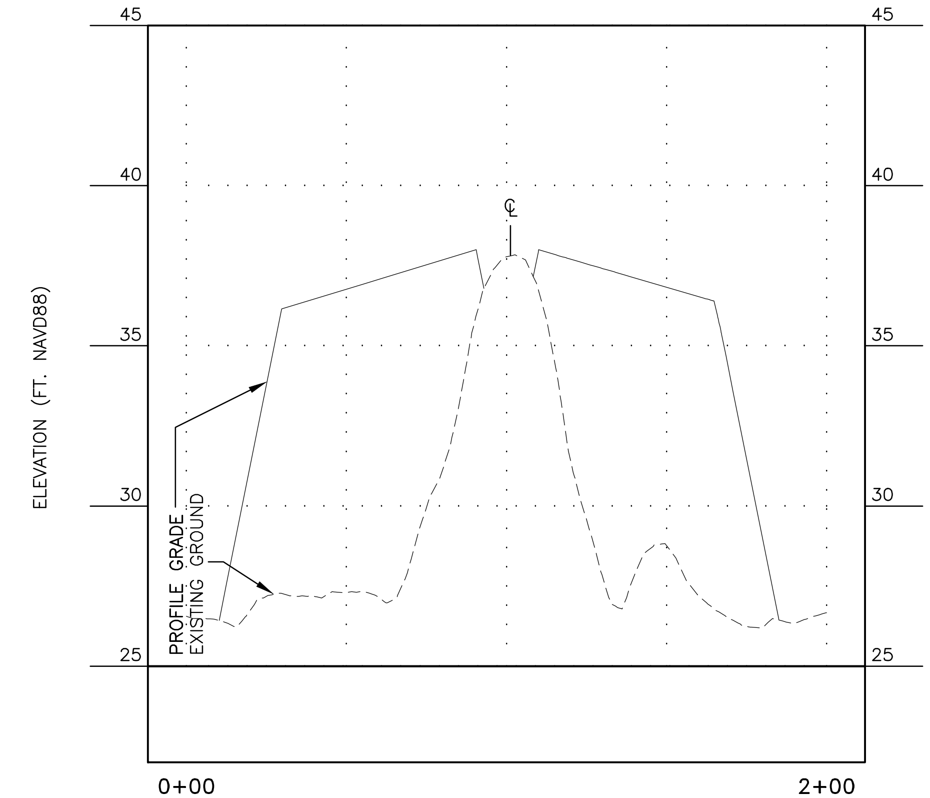
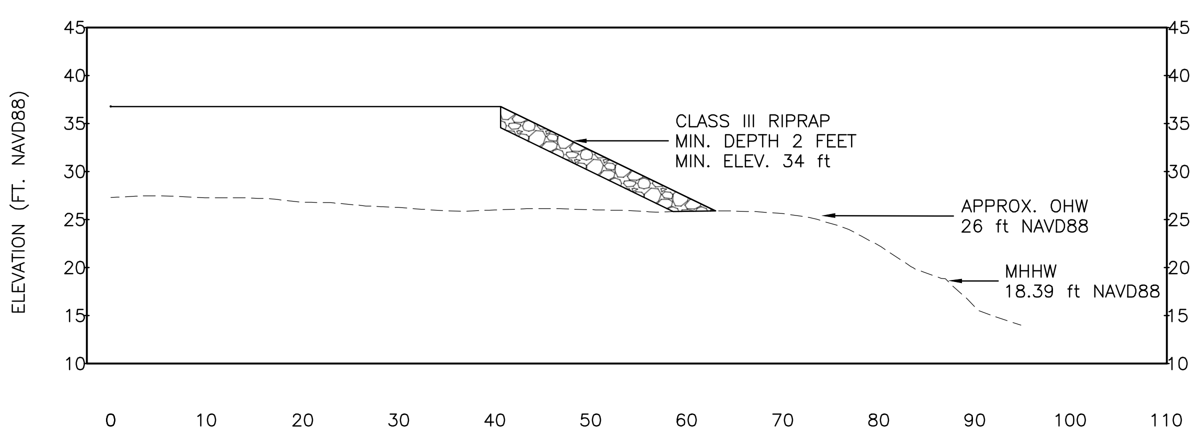
Appendix C. Proposed Construction Drawings



1 PLAN VIEW
1" = 30'



3 PROFILE (STA 0+00 to 2+00)
1" = 30'
VERT. EXAG. 10:1



2 CROSS SECTION A-A'
1" = 10'

MATERIAL QUANTITIES

MATERIAL TYPE	QUANTITY	UNIT
FILL	4,800	CU. YD
CLASS III RIPRAP	350	CU. YD

CONSTRUCTION FOOTPRINT

	QUANTITY	UNIT
FILL AREA	22,275	SQ. FEET

NO.	DATE	REVISION	BY	CHK	APPD
B	6/20/21	ISSUED FOR H&H REPORT	WAB	GCY	GCY

PRELIMINARY NOT FOR CONSTRUCTION

ENGINEERING RECORD		DATE
DRN:	WAB	5/13/2021
DSGN:	MDM	5/13/2021
CHK:	GCY	5/28/2021
APP:		
APP:		
SCALE:	VARIES	

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ARRC MP 147.4 CONSTRUCTION PAD
PLAN & PROFILE
CROSS SECTION

TASK ORDER	DOCUMENT NUMBER	SHEET	REVISION
4		01	B
DELIVERABLE NUMBER 183620			