Last Chance Grade Permanent Restoration Project

Advanced Planning Study Memorandum Alternative F Bridge

Submittal #SUB053b

February 2024

EA# 01-0F280
Project EFIS# 0115000099
Del Norte County, U.S. 101,
PM 12.7/16.5

Table of Contents

1. Introduction

1.1. Purpose of the Memorandum

The purpose of this *Advanced Planning Study (APS) Memorandum Alternative F Bridge* is to provide a summary of the Last Chance Grade (LCG) Alternative F Bridge, including structure type, constraints, and planning level cost estimate. The Consultant Prepared APS Checklist is included in Appendix B.

2. Project Description

The Last Chance Grade (LCG) Permanent Restoration Project (Project) is located on a section of U.S. 101 known as Last Chance Grade in southern Del Norte County, California, approximately 10 miles south of Crescent City.

The purpose of the Project is to develop a long-term solution to the slope instability and potential roadway failure at LCG. The Project would consider alternatives that provide a more reliable connection, reduce maintenance costs, and protect the economy, natural resources, and cultural landscapes.

A long-term sustainable solution at LCG is needed to address:

- Economic ramifications of a long-term failure and closure
- Risk of delay/detour to traveling public
- Increase in maintenance and emergency project costs
- Increase in frequency and severity of large storm events caused by climate change

LCG is an area of geologic instability; there is a landslide complex that is approximately 3 miles long with over 30 active landslides. This instability has required significant expenditures of tax dollars on emergency construction projects and maintenance activities to keep the highway open and safe. Between 1997 and 2021, landslide mitigation efforts, including retaining walls, drainage improvements, and roadway repairs have cost more than $85 million. There is no foreseeable end to such expenditures, and effects of climate change may exacerbate conditions.

Other than U.S. 101, there are no viable routes between Crescent City and Klamath. Klamath is a community just south of LCG; many people routinely travel to and from Crescent City for work, school, or personal business. The LCG segment of U.S. 101 had an average annual daily traffic volume of 4,200 vehicles per day, with 640 vehicles in the peak hour (Caltrans 2016a). Typically, a one-way journey between the two cities would be about 22 miles, taking approximately 30-40 minutes. However, in the event of a closure, a 449-mile detour would be required, which would take approximately 8 hours.

Potential economic consequences of an emergency 1-year closure of LCG include the loss of approximately 3,800 jobs and the reduction of business output by nearly half a billion dollars ($456 million) (Caltrans District 1, 2018). Such a closure would also lead to an estimated $236 million in travel costs, to be collectively borne by individuals, businesses, and government institutions.

A map of the project area is shown in Appendix A.

3. Alignment Description

3.1. Alternative Alignment Descriptions and Bridge Geometrics

The Project Alternatives are shown in Appendix A. There are three alternatives for this project, which include two build alternatives — X and F — that were developed to meet the purpose and need of the project, as well as a No-Build Alternative. Both build alternatives would require geotechnical investigations. The X and F alternatives are shown in Appendix A.

Alternative X would involve reengineering a 1.6-mile-long portion of the existing roadway. This alternative would include a series of retaining walls, underground drainage features, and strategic eastward retreats to minimize the risk of landslides.

Alternative F would involve constructing an approximately 5,850-foot-long (1.1-mile) tunnel to avoid the most intense area of known landslides and geologic instability, thereby avoiding the portion of U.S. 101 most prone to closure.

For the ***No-Build Alternative***, no work would be done to the existing highway; existing conditions would persist, including the continuation of emergency repairs and enhanced maintenance.

This memorandum focuses on Alternative F, which is located east of U.S. 101 and is situated predominantly underground with a two-lane, single-bore tunnel. The Alternative F alignment diverts from the existing U.S. 101 alignment at approximate post mile (PM) 14.3 and reconnects to the existing alignment around PM 15.6. The 122-foot-long Alternative F Bridge (also referred to as the Wilson Creek Tributary Bridge) is located north of the tunnel's North Portal and spans a small valley before connecting to the existing U.S. 101 alignment. The bridge layout is shown in Appendix E.

3.2. Clearances

The proposed bridge does not have any impact on existing roadway clearances.

3.3. Impact to Existing Utilities

No live or abandoned underground utilities located within or near the existing LCG Alternative F Bridge are believed to be present.

3.4. Hazardous Materials

An *Initial Site Assessment* (ISA) was prepared and submitted for the Project. The ISA identified the following recognized environmental condition (REC):

- Potential for aerially deposited lead (ADL) in exposed soil along the roadway from historical vehicle emissions during the leaded gasoline era

Refer to the *Initial Site Investigation (*ISA) for additional information.

3.5. Horizontal Clearance for Construction Operations

The LCG Alternative F Bridge north abutment and wingwalls will need to be constructed next to the existing U.S. 101 at around PM 15.5 where the alignments conform. Maintenance of traffic and traffic staging will be required during bridge construction and may require closing one lane of traffic during portions of the bridge construction.

3.6. Previous Studies

3.6.1 June 2016 Project Study Report

The *Project Study Report (*PSR) for this project was approved by the Caltrans District 1 Director on June 30, 2016. The PSR proposed seven alternatives (A1, A2, F, C3, C4, C5, and M). Caltrans also prepared an APS for the bridges and tunnels for the seven alternatives, which is included as an attachment to the PSR.

3.6.2 July 2019 Addendum to the PSR

An *Addendum to the PSR*, dated July 17, 2019, was published to document significant changes that took place after the 2016 PSR was signed and to discuss the Project's current scope, alignments, and design concepts as it proceeds with the Project Approvals and Environmental Document (PA&ED) phase. The 2019 Addendum included seven proposed alternatives (A1, A2, G1, G2, F, L, and X).

4. Bridge Type, Construction, and Dimensions

The proposed LCG Alternative F Bridge is a single-span, precast concrete I-girder with a cast-in-place concrete deck. The bridge has a total structure length of 122 feet. The bridge will carry one 12-foot-wide traffic lane in each northbound and southbound direction with two 10-foot-wide shoulders alongside each traffic lane. Both sides of the structure will have a California ST-75 Bridge Rail. The proposed abutments are seat-type abutments founded on 24-inch diameter cast-in-drilled-hole (CIDH) reinforced concrete piles.

A hydrology and hydraulics analysis was conducted, including determination of bridge water surface elevation and available hydraulic freeboard. The *Hydrology and Hydraulics Report* is included in Appendix G.

5. Geotechnical Considerations

A *Structure Preliminary Geotechnical Report* (SPGR) was prepared and submitted for this bridge. It provides preliminary foundation recommendations for the bridge and soil conditions based on limited site investigations. More detailed geotechnical work, including additional soil borings and detailed site investigations, will be performed during subsequent design phases. Additional geotechnical information can be found in Appendix F.

6. Special Foundation Requirements

The SPGR includes the following foundation recommendations:

- **For Abutments:** Small diameter drilled shafts (CIDH reinforced concrete piles) with a minimum diameter of 24 inches are recommended. Driven piles and spread footings are not recommended.
- **For Wingwalls:** Small diameter drilled shafts (CIDH reinforced concrete piles) with a minimum diameter of 24 inches are recommended to support the wingwalls. 16-inch diameter piles can be used for wingwalls if the full length of the pile is above groundwater level. Driven piles and spread footings are not recommended.

- **Scour:** Potential for scour exists; however, the size of the ravine tributary is relatively small. It is recommended that all footings be placed below respective scour depths, and the impact of scour on foundation design shall be considered. The scour impact shall be evaluated in more detail during the final design.

7. Important or Unusual Design Assumptions or Structure Features

7.1. Service Life

The bridge will be designed for a minimum 75-year service life, following the design requirements of the American Association of State Highway and Transportation Officials' (AASHTO) Load and Resistance Factor Design (LRFD) with California Amendments.

7.2. Seismic

The project site is susceptible to strong earthquake-induced ground motions during the design life of the proposed bridge. The SPGR provides preliminary values of Peak Ground Acceleration (PGA) of 0.85g,[1] deaggregated mean earthquake moment magnitude (M) for a PGA of 8.67, and the mean site-to-source distance of 20.1 kilometers (km) for a 1.0 second period spectral acceleration.

The SPGR also recommends a preliminary horizontal seismic coefficient (k_h) value of 0.425 for seismic lateral earth pressures for bridge wingwalls and for seismic slope stability analysis of the bridge abutment slopes.

The proposed bridge is not considered susceptible to surface fault rupture hazards as it is not located within 1,000 feet of any active faults.

The site of the proposed bridge is not susceptible to liquefaction or related seismic hazards, including seismic total or differential ground settlement, seismic downdrag, and lateral spreading.

The risk for tsunami-related damage does not exist because the project site is located at an elevation above +825 feet.

7.3. Noise Minimization Measures

Caltrans Environmental Scientists have recommended that noise minimization measures be incorporated into the bridge to minimize noise generated by vehicles. Such measures could include longitudinal pavement texture or polyester coating on the bridge deck and selection of bridge joints that minimize noise.

8. Discussions with Caltrans Personnel Concerning Key Assumptions

The following design assumptions were used in the development of this memorandum, and they were discussed with Caltrans staff:

- Bridge design follows current Caltrans standards and design guidelines, including AASHTO LRFD Specifications and Seismic Design Criteria.

[1] g= acceleration due to gravity

- Precast concrete I-beams are proposed for ease of construction and minimal maintenance. The precast girders can also be installed with minimal impact to protected wetlands below the bridge.
- AASHTO I-Beam Type IV (54-inch beam depth) was assumed with 8-foot beam spacing. A 12-inch-thick cast-in-place concrete deck was assumed.
- A minimum of 2 feet of freeboard is required based on a 100-year flood.
- Utilities anticipated on the freeway structures are Corridor Operating System (COS) and lighting. The Alignment F Bridge has sufficient depth to accommodate utilities should they be identified during the Plans, Specifications, and Estimates (PS&E) phase.

9. Aesthetics

The Caltrans Landscape Architect recommended using California ST-75 Bridge Rails for the bridge. The California ST-75 is an aesthetic, see-through barrier rail widely used in California. The bridge rail, when mounted on a 6-inch-tall curb, meets the AASHTO bicycle railing height requirement of 42 inches.

10. Construction Considerations (Stage Construction)

10.1. Limited Site Accessibility or Seasonal Work

The bridge is crossing a canyon with steep slopes extending northeastward toward Wilson Creek, and there are environmentally sensitive wetlands located at the bottom of the canyon. The north abutment of the bridge is also located near the existing U.S. 101.

The Draft Environmental Impact Report/Environmental Impact Statement includes mitigation measures that affect construction scheduling:

- **BAT-1: Tree Removal Work Window.** Tree removal would be conducted outside of the maternity season (March 1 – September 30) and the winter torpor period (December 1 through February 28), to the extent possible. The Limited Operating Periods may be modified at the recommendation of a biologist based on regional bat roosting data, site-specific roost status, and/or annual climate variation.
- **M-2:** No suitable fisher or Humboldt marten denning/resting habitat or potentially suitable marten den or rest trees would be removed or altered during the denning season (March 1 – September 15).

10.2. Construction Noise Mitigation

The *Caltrans Noise Study Report* recommended following best noise control practices to minimize noise and disturbance to sensitive habitat areas:

- Requiring construction equipment to have sound control devices such as exhaust mufflers, and to operate and maintain equipment to minimize noise generation.
- Using equipment powered by electric motors instead of gasoline or diesel.
- Preventing excessive noise by shutting down idle vehicles or equipment.
- Using noise-reducing enclosures or barriers around stationary noise-generating equipment.

Use of the loudest types of construction equipment are recommended to be limited to midday hours where feasible, and use of the loudest equipment should be minimized during hours of highest bird activity (dawn and dusk).

10.3. Constructability Review

Per the Memo to Designers (MTD) 1-31, a Level 1 Structure Constructability Review has been completed for this new bridge.

Previously, a 3-span steel girder bridge with concrete deck was proposed to cross a deeper part of the canyon at a location further to the east. That structure layout and type was reviewed and discussed with Caltrans staff during a site visit and constructability review that took place on February 23-25, 2022. Caltrans made the following recommendations during that site visit and constructability review:

- Use a cast-in-place box girder superstructure instead of a steel girder with concrete deck, which would reduce the use of cranes and minimize long-term maintenance.

Additionally, subsequent to the constructability review, the project team revised Alternative F to shorten the overall length of the alignment. The revised alignment allows the F Bridge to be located further to the west compared to the previous alignment, and the new alignment crosses the canyon at a shallower location.

The current structure type is primarily based on:

- The need to cross the canyon while minimizing the removal of large redwood trees.
- Allowing only one single-bridge span for crossing the environmentally sensitive wetlands versus using multiple bridge spans.
- The assumption that no temporary falsework will be allowed in the wetland and environmentally sensitive area underneath the bridge.
- The use of concrete structural elements instead of steel to minimize long-term maintenance.

10.4. Project Risk List

The following risks were identified at this phase of the Project (PA&ED) based on current available information and initial investigations by Civil, Geotechnical, Hydraulics, and Environmental groups. A full review and update of the Project risk register should be undertaken at the beginning of each subsequent phase of the Project.

Possible Risks:

- Geotechnical discoveries could potentially alter the Project’s scope: Alternatives could increase in scope or be revised.
- Unique environmental issues: The Project is in a sensitive location and the potential impacts are uniquely severe. Complex interagency coordination, permit approval, and public engagement could potentially create significant project delays and cost increases.
- Rights-of-way and easements: Due to the complex nature of the Project’s additional easements or rights-of-way that may be required, it could create cost increases.
- Landslide Activity: Active landslide activity may require changes in design and cost increases.

- Environmental Document Limits: Design changes that are outside the parameters contemplated in the environmental document could result in project delays and cost increases.
- Nesting Birds Endangered Species: Discovery of nesting birds or previously undiscovered endangered species could result in design changes and project delays.

11. Cost Estimate and Construction Schedule

11.1. Cost Estimate

The APS cost estimate for the LCG Alternative F Bridge is included in Appendix C. The estimate includes 10% mobilization, 10% time-related overhead, and 25% contingency allowances.

The level of cost detail provided is consistent with the programming purposes of these estimates. All costs should be considered as the engineer’s opinion of probable costs and are subject to change. Costs are escalated to the anticipated date of expenditure based on estimated escalation rates. Furthermore, the cost estimate is based on present conditions and no allowances are included in anticipation of additional deterioration or degradation due to natural or human-made events.

11.2. Construction Schedule

A construction schedule is included in Appendix D. Construction is assumed to begin with Contractor Notice to Proceed (NTP) in 2030, and it is expected to take approximately 12 months to complete.

Appendix A. Project Location Map

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
01	DN	101	12.7/16.5		

STATE OF CALIFORNIA

DEPARTMENT OF TRANSPORTATION

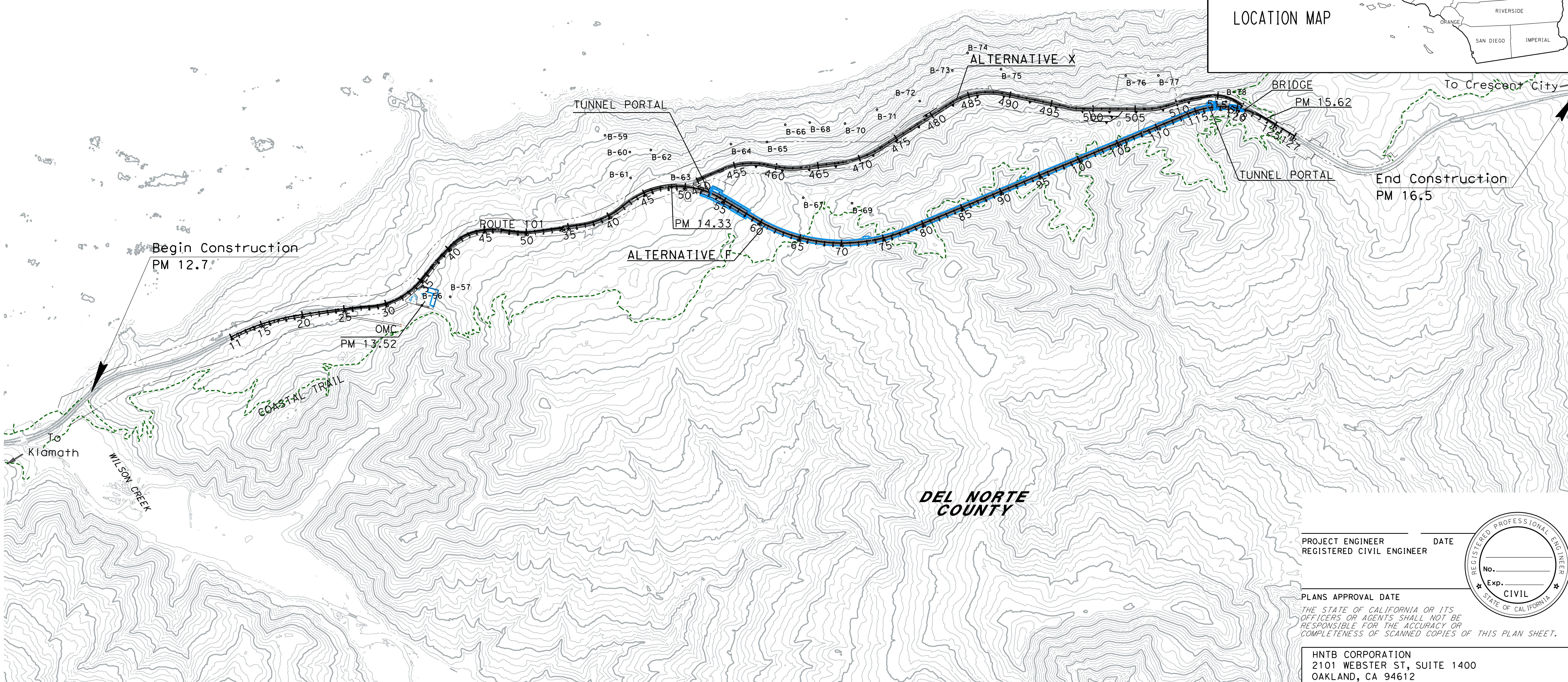
PROJECT PLANS FOR CONSTRUCTION ON

STATE HIGHWAY

IN DEL NORTE COUNTY
NEAR CRESCENT CITY
FROM WILSON CREEK BRIDGE TO
DAMNATION CREEK TRAILHEAD

TO BE SUPPLEMENTED BY STANDARD PLANS DATED 2018

GEOMETRIC APPROVAL DRAWINGS



APPROVED AS TO IMPACT ON STATE FACILITIES AND CONFORMANCE WITH APPLICABLE STATE STANDARDS AND PRACTICES AND THAT TECHNICAL OVERSIGHT WAS PERFORMED.

DATE SIGNED | LICENSE Exp DATE | REGISTRATION No. | CALTRANS DESIGN OVERSIGHT APPROVAL | CONSULTANT DESIGN MANAGER

PROJECT ENGINEER DATE
REGISTERED CIVIL ENGINEER

REGISTERED PROFESSIONAL ENGINEER
No.
Exp.
CIVIL
STATE OF CALIFORNIA

PLANS APPROVAL DATE

THE STATE OF CALIFORNIA OR ITS OFFICERS OR AGENTS SHALL NOT BE RESPONSIBLE FOR THE ACCURACY OR COMPLETENESS OF SCANNED COPIES OF THIS PLAN SHEET.

HNTB CORPORATION
2101 WEBSTER ST, SUITE 1400
OAKLAND, CA 94612

CONTRACT No.	EA 01-0F280
PROJECT ID	0115000099

THE CONTRACTOR SHALL POSSESS THE CLASS (OR CLASSES) OF LICENSE AS SPECIFIED IN THE "NOTICE TO BIDDERS."

DATE PLOTTED => 2023-10-19
TIME PLOTTED => 8:41:42 AM
LAST REVISION 00-00-00

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Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
01	DN	101	12.7/16.5		

REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

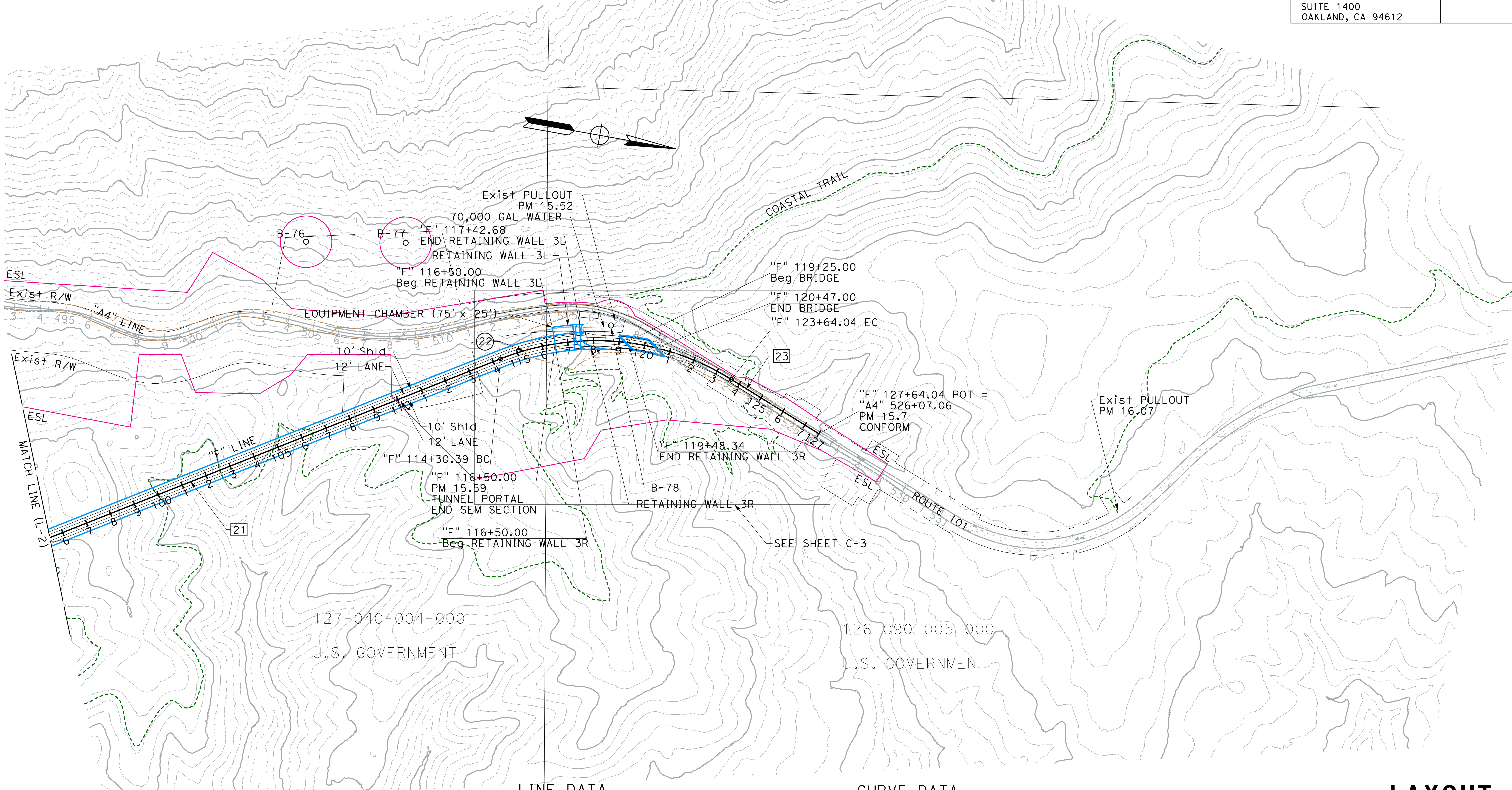
THE STATE OF CALIFORNIA OR ITS OFFICERS OR AGENTS SHALL NOT BE RESPONSIBLE FOR THE ACCURACY OR COMPLETENESS OF SCANNED COPIES OF THIS PLAN SHEET.

REGISTERED PROFESSIONAL ENGINEER No. Exp. CIVIL STATE OF CALIFORNIA

HNTB CORPORATION
2101 WEBSTER St
SUITE 1400
OAKLAND, CA 94612

LEGEND:

- CUT/FILL LINE
- COASTAL TRAIL
- ENVIRONMENTAL STUDY LIMITS (ESL)
- Exist R/W
- STRUCTURE
- RETAINING WALL
- DRAINAGE STRUCTURE
- B-XX o BORING LOCATION



LINE DATA

No.	LENGTH	DIRECTION
21	3636.31'	N 21°39'03" W
23	400.00'	N 31°50'37" E

CURVE DATA

No.	R	Δ	T	L
22	1000.00'	53°29'40"	503.98'	933.65'

LAYOUT

ALTERNATIVE F

SCALE: 1" = 200'

L-3

REVISED BY | DATE REVISED | CALCULATED-DESIGNED BY | CHECKED BY | CONSULTANT FUNCTIONAL SUPERVISOR

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION

Caltrans

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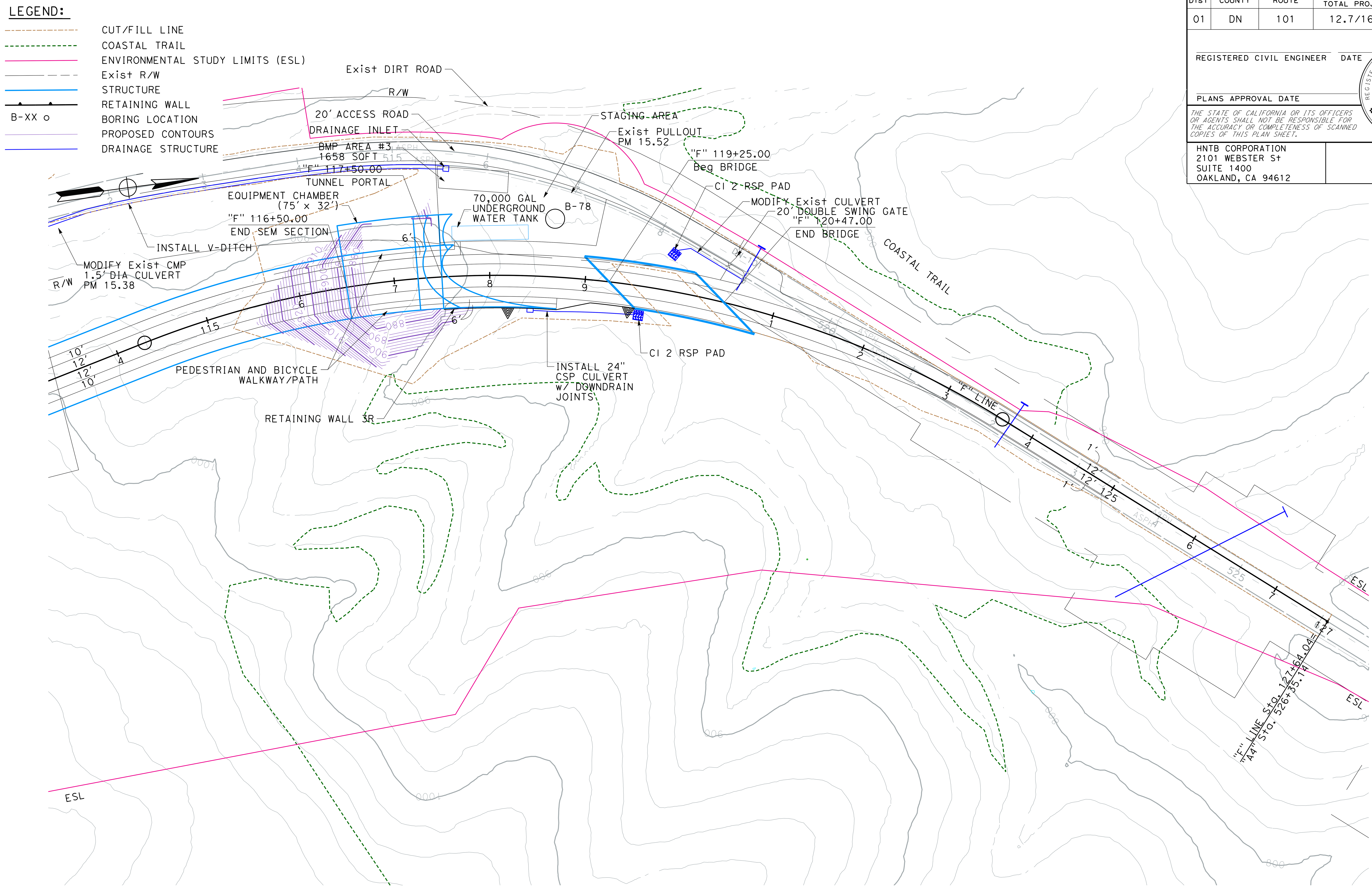

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
01	DN	101	12.7/16.5		

REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER
No.
Exp.
CIVIL
STATE OF CALIFORNIA

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HNTB CORPORATION
2101 WEBSTER St
SUITE 1400
OAKLAND, CA 94612

CONSTRUCTION DETAIL

ALTERNATIVE F

SCALE: 1" = 50'

C-3

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION
Caltrans

CONSULTANT FUNCTIONAL SUPERVISOR
CALCULATED-DESIGNED BY
CHECKED BY
REVISED BY
DATE REVISED

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Appendix B. Consultant-prepared Structures APS Checklist

Consultant Prepared Advance Planning Study (APS) Checklist

Date: 2/5/2024	Consultant Firm (for structures): HNTB Corporation		Phone No: 510-208-4599
Designed by: Erik Okada, PE, SE			Phone No: 510-208-4599
EA: 01-0F280	County: DN	Rte: 101	KP(PM) 12.7-16.5
Project Description: The Last Chance Grade Project proposes improvements to US Highway 101 located in southern Del Norte County between Wlison Creek and Crescent City.			
Bridge No(s): Alternative F	Bridge Name(s): Last Chance Grade Wilson Creek Tributary Bridge		
Total number of walls in project: 0	APS Alternative Letter or Number (if more than one):		
Purpose of this APS:	Initial APS Cost & Feasibility ☒	Revised scope ☐	Update cost ☐

Part A Items to collect and considerations prior to beginning the APS

All items listed in Part A are to be made available and submitted if requested by the Liaison Engineer. (Mark **N/A** if not applicable)

☒ Preliminary profile grade of proposed structure.

☒ Typical section of the proposed structure. (Including barrier type, sidewalks, cross slope %, etc.)

☒ Grades or spot elevations of roadway below the structure.

N/A ☐ Typical section of roadway below the structure. (Including shoulders, gutters, embankment slope.)

☒ Site map: including horizontal alignment of new structure and the roadway below, topo, contours, etc.

N/A ☐ Stage construction or detour plan for traffic <u>on the structure.</u>
(number of lanes to remain open, Temp Railing, etc.)

N/A ☐ Stage construction or detour plan for the roadway <u>below the structure</u>.
(falsework openings for each stage and any restrictions.)

N/A ☐ "As Built" plans for existing structures.

N/A ☐ Future widening plans of upper and lower roadway (verify with Route Concept Report).

☒ Site aerial photograph (at the proposed structure).

☒ Environmental and/or permit requirements (areas of potential impact, construction windows, etc.)

☒ Overhead and underground utility plans

☒ Any other information that you feel is necessary to complete the study. (Other concerns that may affect the APS: local agency requirements such as aesthetics, improvements in vicinity of structure, airspace usage, other obstructions, etc.)

Consultant Prepared Advance Planning Study (APS) Checklist

Part B Considerations during the APS design and cost estimate preparation

1.	Has this project been discussed with: the OSFP Liaison Engineer?	Yes ☒	No ☐
	the Caltrans District Project Manager?	Yes ☒	No ☐
	the roadway consultant?	Yes ☒	No ☐
2.	Have the Caltrans Structures Maintenance records been reviewed?	Yes ☐	No ☒
	If the records recommend any work for the structure, is it included in the APS?	Yes ☐	No ☒
3.	Are there special aesthetic considerations?	Yes ☒	No ☐
4.	(Widenings and Modifications)		
	Has this project been reviewed for seismic retrofit requirements?	Yes ☐	No ☒
	Are seismic retrofit requirements included in the APS?	Yes ☐	No ☒
5.	Any special Railroad requirements?	Yes ☐	No ☒
	Shoofly required?	Yes ☐	No ☒
	Cost of shoofly included as a separate item in the project cost estimate?	Yes ☐	No ☒
6.	Any special foundation requirements, including scour critical work, special excavation such as Type A, Type D, and/or hazardous or contaminated material?	Yes ☐	No ☒
7.	Any special construction requirements, including limited site accessibility or seasonal work?	Yes ☒	No ☐
8.	Other items to be included in the cost such as slope paving, approach slabs, and/or adjacent retaining walls?	Yes ☒	No ☐
9.	Remove existing bridge? Total Deck Area:	Yes ☐	No ☒
10.	Any other unusual or special requirements?	Yes ☐	No ☒
11.	Provide and attach a consultant prepared Design Memo to summarize and document any important assumptions, discussions, decisions, unusual items, local agency requirements such as aesthetics, improvements in vicinity of the structure, airspace usage, other obstructions, or any items noted above. Summary attached?	Yes ☒	No ☐

Designer: (Printed Name)	Designer's Signature:	Date:
Erik Okada	EKOkada	2/5/2024

Appendix C. Planning Cost Estimates

GENERAL PLAN - ADVANCED PLANNING ESTIMATE

	GENERAL PLAN ESTIMATE	X	ADVANCE PLANNING ESTIMATE

		IN EST:	11/22/2023
		OUT EST:	11/22/2023
BRIDGE NAME:	Wilson Creek Tributary Bridge (Alt F)		
BRIDGE NUMBER:	N/A	**DISTRICT:**	01
TYPE:	Precast Concrete I-Girder	**CO:**	DN
EA:	01-0F280	**RTE:**	101
PROJECT ID:	01.1500.0099	**PM:**	16.0
ACCELERATED BRIDGE PROJECT :	NO	**DEPTH**	5'-6"
		LENGTH	122'-0"
DESIGN SECTION:	Consultant	**WIDTH**	48'-0"
# OF STRUCTURES IN PROJECT :		**AREA**	5,856
		EST. NO.	
PRICES BY :	ERO	**COST INDEX:**	
PRICES CHECKED BY :	AD	**DATE:**	11/22/2023
QUANTITIES BY:	ERO	**DATE:**	11/22/2023

CONTRACT ITEMS		TYPE	UNIT	QUANTITY	UNIT COST	COST
1	STRUCTURE EXCAVATION (BRIDGE)		CY	1039.77	$ 140.00	$ 145,568
2	STRUCTURE BACKFILL (BRIDGE)		CY	399.53	$ 190.00	$ 75,911
3	24" CAST-IN-DRILLED HOLE CONCRETE PILING		LF	4860	$ 190.00	$ 923,400
4	16" CAST-IN-DRILLED HOLE CONCRETE PILING		LF	1840	$ 175.00	$ 322,000
5	FURNISH PRECAST PRESTRESSED CONCRETE GIRDER (120'-130')		EA	6	$ 47,650.00	$ 285,900
6	ERECT PRECAST PRESTRESSED CONCRETE GIRDER (120'-130')		EA	6	$ 4,590.00	$ 27,540
7	STRUCTURAL CONCRETE, BRIDGE FOOTING		CY	470.467	$ 600.00	$ 282,280
8	STRUCTURAL CONCRETE, BRIDGE		CY	990.868	$ 1,235.00	$ 1,223,722
9	STRUCTURAL CONCRETE, APPROACH SLAB (TYPE N)		CY	275.833	$ 880.00	$ 242,733
10	BAR REINFORCING STEEL (BRIDGE)		LB	218811	$ 1.10	$ 240,692
11	CALIFORNIA ST-75 BRIDGE RAIL		LF	325	$ 785.00	$ 255,125

Comments:

SUBTOTAL		$ 4,024,871
TIME RELATED OVERHEAD	10%	$ 402,487
MOBILIZATION	10%	$ 402,487
SUBTOTAL BRIDGE ITEMS		$ 4,829,845
CONTINGENCIES	25%	$ 1,207,461
BRIDGE TOTAL COST		$ 6,037,306
COST PER SQ. FT		$ 1,031
REMOVAL (CONTINGENCIES INCL.)		$ -
WORK BY UTILITY FORCES		$ -
GRAND TOTAL		
BUDGET ESTIMATE		**$ 6,038,000**

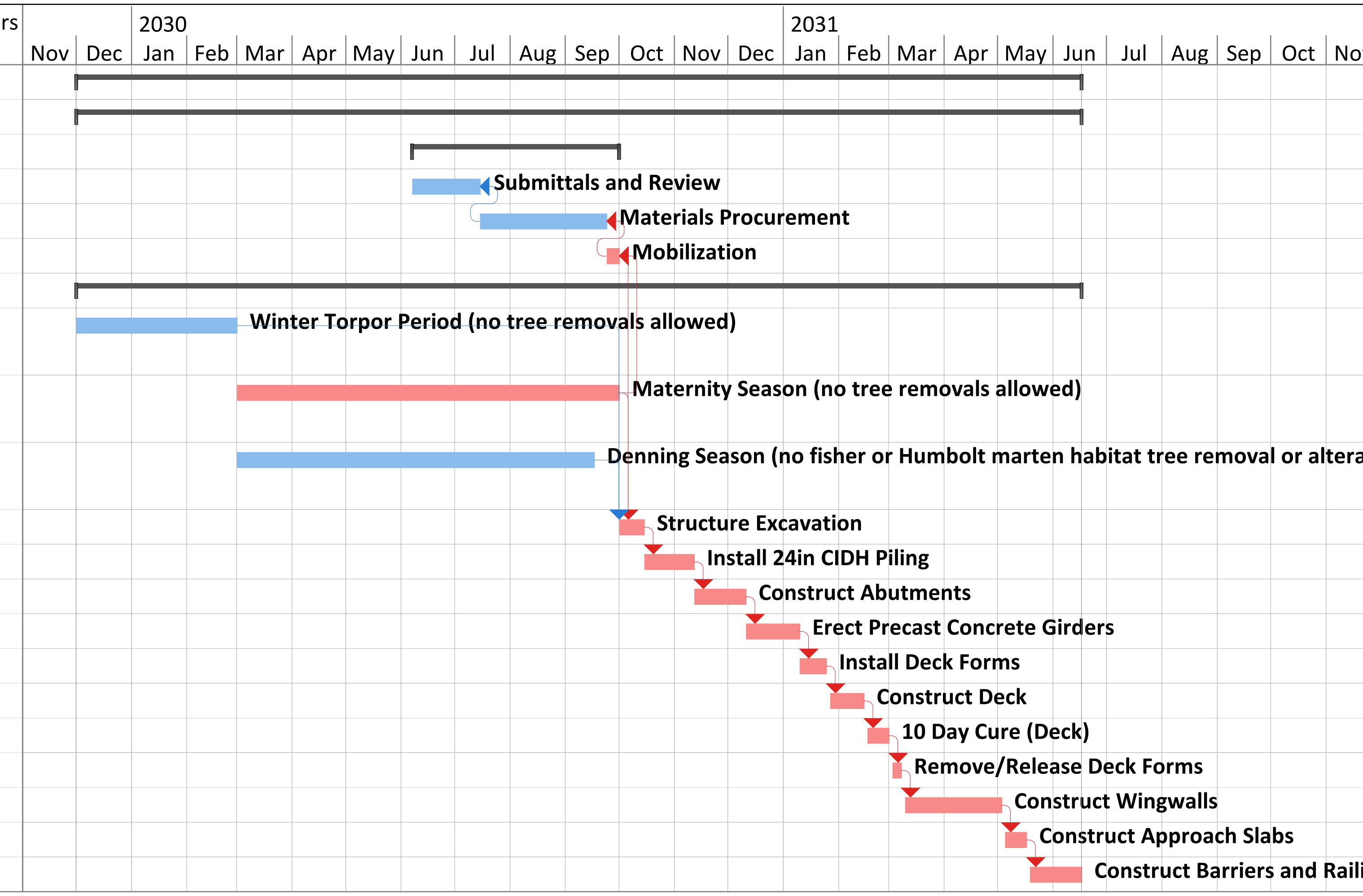
	TYPE	UNIT	QUANTITY
REMOVAL		SQFT	0

ESCALATION TO MIDPOINT OF CONSTRUCTION		
Year	Escalation	$ 6,037,306
2023-2024	1.049	$ 6,333,134
2024-2025	1.038	$ 6,573,793
2025-2026	1.038	$ 6,823,598
2026-2027	1.038	$ 7,082,894
2027-2028	1.038	$ 7,352,044
2028-2029	1.038	$ 7,631,422
2029-2030	1.038	$ 7,921,416

Appendix D. Construction Working Days

CALTRANS (71188) HNTB Gantt

ID		WBS	Task Name	Duration	Start	Finish	Predecessors
1			**Last Chance Grade**	**391 days**	**Sat 12/1/29**	**Mon 6/16/31**	
2			**Alternative F Bridge**	**391 days**	**Sat 12/1/29**	**Mon 6/16/31**	
3		**P**	**Preconstruction**	**80 days**	**Fri 6/7/30**	**Mon 9/30/30**	
4		P1000	Submittals and Review	25 days	Fri 6/7/30	Mon 7/15/30	5SF
5		P1010	Materials Procurement	50 days	Mon 7/15/30	Tue 9/24/30	6SF
6		P1020	Mobilization	5 days	Tue 9/24/30	Mon 9/30/30	9FF
7		**C**	**Construction**	**391 days**	**Sat 12/1/29**	**Mon 6/16/31**	
8		E1	Winter Torpor Period (no tree removals allowed)	62 days	Sat 12/1/29	Thu 2/28/30	
9		E2	Maternity Season (no tree removals allowed)	149 days	Fri 3/1/30	Mon 9/30/30	
10		E3	Denning Season (no fisher or Humbolt marten habitat tree removal or	139 days	Fri 3/1/30	Mon 9/16/30	
11		C1000	Structure Excavation	10 days	Tue 10/1/30	Mon 10/14/3(	6,9,8,10
12		C1010	Install 24in CIDH Piling	20 days	Tue 10/15/30	Mon 11/11/3(	11
13		C1020	Construct Abutments	20 days	Tue 11/12/30	Tue 12/10/30	12
14		C1030	Erect Precast Concrete Girders	20 days	Wed 12/11/30	Thu 1/9/31	13
15		C1040	Install Deck Forms	10 days	Fri 1/10/31	Fri 1/24/31	14
16		C1050	Construct Deck	15 days	Mon 1/27/31	Fri 2/14/31	15
17		C1060	10 Day Cure (Deck)	10 days	Mon 2/17/31	Fri 2/28/31	16
18		C1070	Remove/Release Deck Forms	5 days	Mon 3/3/31	Fri 3/7/31	17
19		C1080	Construct Wingwalls	40 days	Mon 3/10/31	Fri 5/2/31	18
20		C1090	Construct Approach Slabs	10 days	Mon 5/5/31	Fri 5/16/31	19
21		C1100	Construct Barriers and Railing	20 days	Mon 5/19/31	Mon 6/16/31	20



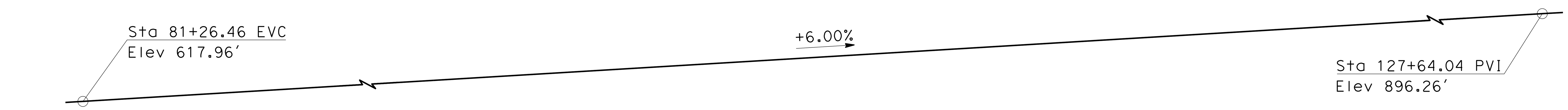
View: HNTB Gantt
Project Start: Sat 12/1/29
Project Finish: Mon 6/16/31

Task | Split | Milestone | Summary | Project Summary | External Tasks | External Milestone | Inactive Task | Inactive Milestone | Inactive Summary | Manual Task | Duration-only | Manual Summary Rollup | Manual Summary | Start-only | Finish-only | Deadline | Critical | Critical Split | Progress | Manual Progress

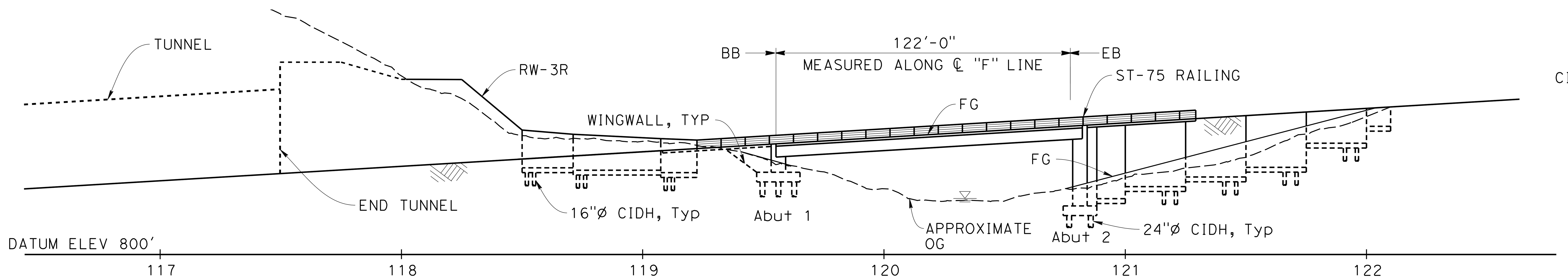
Appendix E. Structure APS Plan

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT
01	DN	101	12.7/16.5

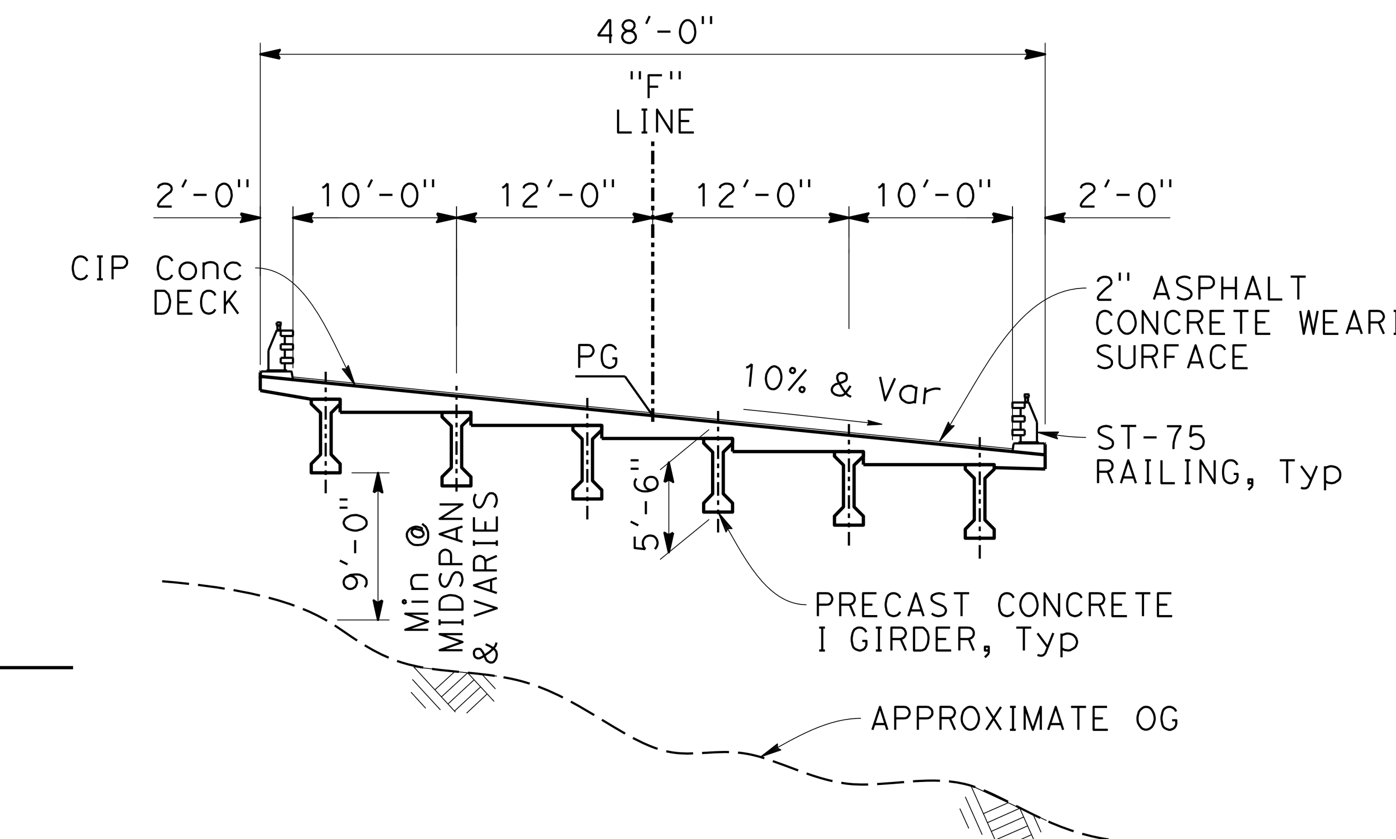
HNTB CORPORATION
2101 WEBSTER ST, SUITE 1400
OAKLAND, CA 94612



PROFILE GRADE
NO SCALE



DEVELOPED ELEVATION LOOKING WEST
SCALE: 1" = 30'



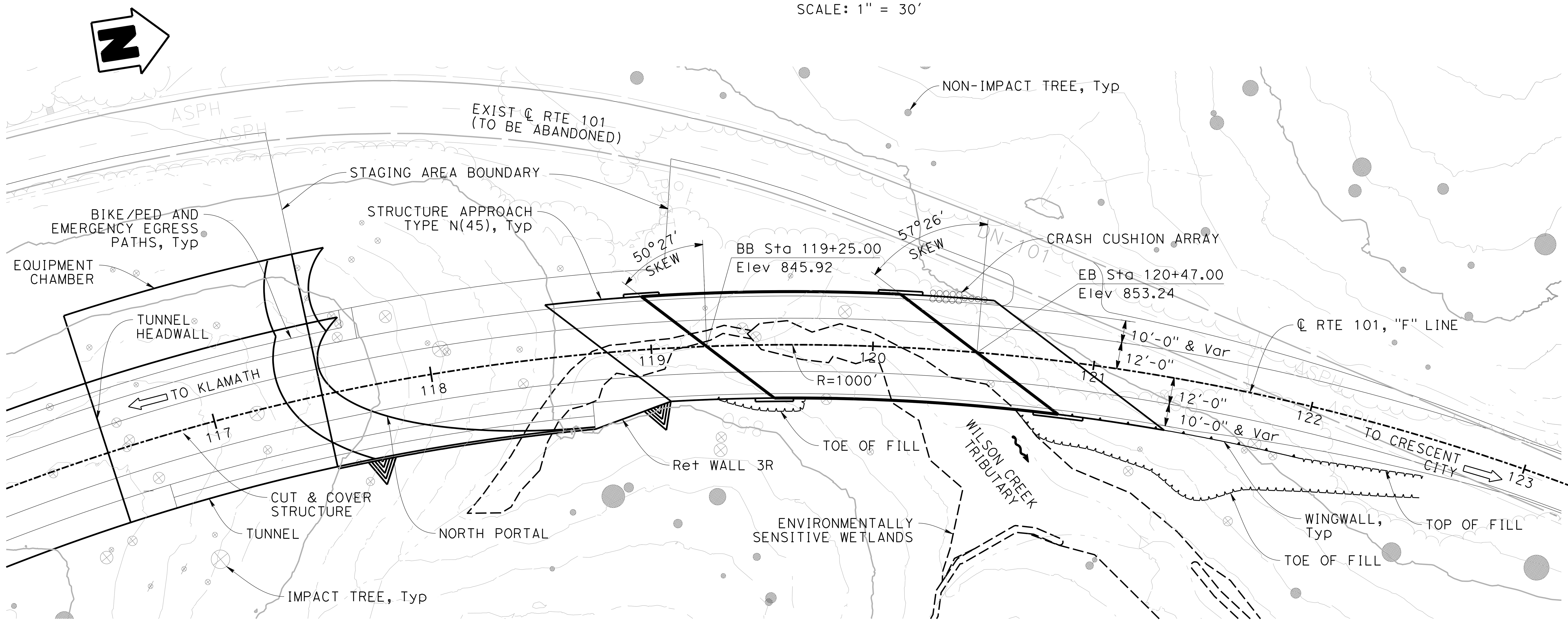
TYPICAL SECTION
SCALE: 1" = 10'

NOTES:

1. Access is limited due to steep, remote terrain, and wetland.
2. Alignment and profile shown are preliminary and approximate.
3. 24" CIDH piles were assumed in 60-ft lengths for the Abutments.
4. 16" CIDH piles were assumed in 40-ft lengths for the approach retaining walls.

LEGEND:

- Indicates Ordinary High Water (O_{50})
- Impacted Tree
- Non-Impacted Tree



PLAN
SCALE: 1" = 30'

DATE OF ESTIMATE		11-22-2023
BRIDGE REMOVAL	=	N/A
STRUCTURE HEIGHT	=	5'-6"
LENGTH	=	122'-0"
WIDTH	=	48'-0"
AREA	=	5,856 SF
COST/FT² INCLUDING TRO, MOBILIZATION & 25% CONTINGENCY	=	$1,031
TOTAL COST	=	$6,038,000

CURVE DATA
"F" LINE
R=1000.00'
Δ=53°29'40"
T=503.98'
L=933.65'

X
DESIGN OVERSIGHT
X
SIGN OFF DATE

DESIGNED BY	E. OKADA	DATE	11/22/23
DRAWN BY	H. LI	DATE	11/22/23
CHECKED BY	M. AMINI	DATE	11/22/23
APPROVED	J. LITZINGER	DATE	11/22/23

J. LITZINGER
PROJECT ENGINEER

PLANNING STUDY
WILSON CREEK TRIBUTARY BRIDGE

BRIDGE NO.
UNIT: X
SCALE:
PROJECT NUMBER & PHASE: 0115000099

PREPARED FOR THE STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION

USERNAME => muili DATE PLOTTED => 11/20/2023 TIME PLOTTED => 1:34:13 PM

ADVANCE PLANNING STUDY SHEET (ENGLISH) (REV. 7/16/10)
FILE => F1_BRIDGE.dgn
CONTRACT NO.: EA 01-0F280

Appendix F. Structure Preliminary Geotechnical Report

Last Chance Grade Permanent Restoration Project

Structure Preliminary Geotechnical Report
Alternative F Bridge

Submittal SUB-052b

December 2023 – FINAL

EA# 01-0F280
Project EFIS# 0115000099
Del Norte County, U.S. 101,
PM 12.7/16.5

Caltrans

LAST CHANCE GRADE

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Acronyms and Abbreviations

AASHTO	American Association of State Highway and Transportation Officials
APEFZ	Alquist-Priolo Earthquake Fault Zone
APS	Advance Planning Study
ARS	Acceleration Response Spectrum
ASTM	American Society for Testing and Materials
ATV	acoustic televiewer
Caltrans	California Department of Transportation
CGS	California Geological Survey
CIDH	cast-in-drilled-hole
CSZ	Cascadia Subduction Zone
CTM	California Test Methods
k_h	horizontal seismic coefficient
LCG	Last Chance Grade
LRFD	Load and Resistance Factor Design
M	Mean Earthquake Moment Magnitude
MTD	Caltrans Memo to Designers
NLCG	North Last Chance Grade Complex
OMC	operations maintenance center
PGA	peak ground acceleration
PGR	Preliminary Geotechnical Report
PM	post mile
ppm	parts per million
Project	Last Chance Grade Permanent Restoration Project
SDC 2.0	Seismic Design Criteria Version 2.0
SFRDHA	Surface Fault Rupture Displacement Hazard Analysis
SI	slope inclinometer
SPGR	Structure Preliminary Geotechnical Report
SPT	standard penetration test
UCERF3	Uniform California Earthquake Rupture Forecast, Version 3
U.S. 101	U.S. Highway 101

USGS	United States Geological Survey
V_{s30}	shear wave velocity for the upper 100 feet
VWP	vibrating wire piezometer

1 INTRODUCTION

This Structure Preliminary Geotechnical Report (SPGR) has been prepared to support the Advance Planning Study (APS) for the bridge at the North Portal approach of the proposed Alternative F design option for the Last Chance Grade Permanent Restoration Project (Project). The alignments and features considered in this report are current as of October 26, 2023 (Caltrans, 2023a), the geologic and geotechnical data gathered by and on behalf of the California Department of Transportation (Caltrans) through May 31, 2021, as presented in the Preliminary Geotechnical Data Report (Final) dated July 2022 (Caltrans, 2022), and the preliminary geotechnical analyses and recommendations presented in the Preliminary Geotechnical Report (Final) (PGR) dated December 2023 (Caltrans, 2023b).

2 PROJECT DESCRIPTION

Caltrans is studying alternative alignments and design options for the Project on U.S. Highway 101 (U.S. 101). The location of the project is shown on Plate 1a. These studies are in response to the section of U.S. 101 between post mile (PM) 12.7 and PM 16.5, extending from Wilson Creek to approximately 10 miles south of Crescent City in Del Norte County (known as “Last Chance Grade” [LCG]) that has been progressively sliding towards the Pacific Ocean since the roadway was first constructed. Due to continual road deformation resulting from slope movement, ongoing construction and maintenance activities are necessary to keep U.S. 101 open to the traveling public. The Project is considering Alternatives X and F to provide a more reliable connection, reduce maintenance costs, and protect the economy, natural resources, and cultural landscapes.

Alternative F would involve constructing an approximately 6,000-foot-long (1.1-mile) tunnel east of the existing highway to avoid the most intense areas of known landslides and geologic instability.

This alternative would be located between about PM 13.5 and PM 15.7. Main components would include a tunnel, associated North and South Portals and approaches, a bridge from the North Portal to connect to existing U.S. 101, and an Operations and Maintenance Center (OMC). The proposed tunnel and the OMC are addressed in separate SPGRs (SPGR-c and SPGR-d).

The Wilson Creek Tributary Bridge at the North Portal location would be a single-span, pre-cast concrete I-girder bridge approximately 122 feet long and 48 feet wide, with a single 12-foot-wide lane in each direction and 10-foot-wide shoulders, with approximate skew angles of 50 degrees and 57 degrees at the south and north abutments, respectively. Both sides of the structure will have a traffic barrier with tubular railing. The proposed abutments are seat-type abutments founded on cast-in-drilled-hole (CIDH) reinforced concrete piles. A new culvert would be installed under the northern tunnel approach between the bridge and the northern portal. The culvert would be 24 inches in diameter or larger, and approximately 200 feet long.

The bridge will be designed for a 75-year service life, following the design requirements of American Association of State Highway and Transportation Officials (AASHTO) Load and

Resistance Factor Design (LRFD) with California Amendments. Alternative F bridge plan view and details are presented on the attached Plates 1b through 1e.

3 GEOTECHNICAL INVESTIGATION

To date, three phases of geotechnical investigations have been performed for the project, which were identified as Phase 1, Phase 2A, and Phase 2B. Phase 1 geotechnical explorations were completed for previously considered alternatives but not in the vicinity of the Alternative F bridge. Some Phase 2A and Phase 2B explorations were performed in the vicinity of the Alternative F bridge alignment.

The Phase 2A geotechnical investigation program was completed between August 19, 2019 and February 13, 2020. Field investigation work performed within about 50 feet west of the proposed bridge site included the drilling and sampling of one vertical boring (RC-19-003), for which the boring record is included in Appendix A of the Preliminary Geotechnical Data Report (Final) (Caltrans, 2022).

The Phase 2B geotechnical investigation program included field reconnaissance mapping by geologists from Caltrans, Kleinfelder, and SHN Consulting Engineers and Geologists on May 4 through 6, 2020, and field exploration work September 22 through January 14, 2021. Details of the Phase 2B program, including laboratory testing results, are provided in the Preliminary Geotechnical Data Report (Final) (Caltrans, 2022). Field investigation work, field testing, and instrumentation and monitoring performed within about 310 feet southwest of the bridge site included the following:

- Drilling and sampling of two borings (RC-20-013 and RC-20-017) for subsurface characterization and to collect data for evaluation of geologic hazards.
- Downhole geophysical surveys to further characterize subsurface conditions and geologic structure including acoustic televiewer (ATV) logging in one borehole (RC-20-017).
- Packer permeability testing in one borehole (RC-20-017) to estimate hydraulic conductivity in low-permeability formations.
- Collection of instrumentation readings from a slope inclinometer (SI) in two boreholes (RC-20-013 and RC-20-017) to measure slope movement displacements, through November 28, 2022.
- Data collection from vibrating wire piezometers (VWPs) attached to each SI casing to measure water pressure at the depth of installation within the rock mass, through June 21, 2023.
- Time domain reflectometry cables were attached to each SI casing to measure displacement depths through deformation; however, no data was available from Caltrans as of May 31, 2021.

All borings were advanced and logged in conformance with Caltrans (2010a) Soil and Rock Logging, Classification, and Presentation Manual. All laboratory tests were performed in general accordance with California Test Methods (CTM) or American Society for Testing and Materials (ASTM) standard. Field and laboratory testing intervals are shown on the borehole records.

4 GEOTECHNICAL CONDITIONS

4.1 Geology

The LCG project is located within the Coast Ranges geomorphic province of California, near the Klamath Mountains, which lie about 10 miles to the east. The site is located about 90 miles north of the Mendocino Triple Junction, which is the crustal intersection of the Pacific, North American, and Gorda/Juan de Fuca tectonic plates. North of the triple junction, the Gorda/Juan de Fuca plate is being subducted eastward beneath the North America plate along the Cascadia Subduction Zone (CSZ), which extends approximately 800 miles from northern California to Vancouver Island, British Columbia. As is true for other coastal regions of northern California, Oregon, and Washington, the project site overlies the interface associated with the subducting crustal plate. This subduction interface is a low angle, east-dipping “megathrust” fault capable of generating great earthquakes of high magnitude (>M8.5).

The Coast Ranges in the LCG project area are underlain by regionally extensive Mesozoic- and Cenozoic-age rocks of the Franciscan Complex, an assemblage of mostly marine sedimentary materials accreted to the continental margin. The LCG site is within the Eastern belt of the Franciscan Complex (Delattre and Rosinski, 2012; Aalto, 1989), which is the oldest, least sheared, and most highly metamorphosed of the three belts (McLaughlin et al., 2000).

The Franciscan Complex at the LCG project site consists of two primary units: argillite-matrix Melange and a variety of Broken Formation units that originated as turbidite deposits of interbedded sandstone and shale. The Melange is interpreted as a large submarine landslide deposit that is in depositional contact with the underlying Broken Formation turbidite sequence (Aalto, 1989). Subsequent extensive accretion-related deformation has resulted in pervasive shearing and complex structural relationships within the two primary bedrock types.

The Wilson Creek Tributary Bridge location is about 140 feet east of the main head scarp of the North Last Chance Grade landslide complex (NLCG). Bedrock in this area is mapped as Broken Formation, described as blocks of gray, hard, massive to very thickly bedded sandstone with interbedded argillite separated by weak, sheared zones (Wills, 2000). Colluvium is also mapped at the bridge location. The Colluvium is described as a loose, heterogeneous mass of soil and/or rock fragments transported and deposited downslope by sheet flow or slow, continuous creep. The bridge is 200 feet west of a mapped dormant landslide, and additional dormant landslides are mapped a few hundred feet further north on both the east and west sides of U.S. 101 (Caltrans, 2023b).

The primary known geologic hazard for the proposed bridge is seismicity (earthquakes) and the effect on the bridge of earthquake-induced ground motions. Seismic ground motions, as described in Section 9, may be significant and large enough to activate new or unknown nested landslides in the bridge vicinity, as well as to create large displacement movement (measured in feet) along the basal failure surfaces. Due to the distance of the bridge from the NLCG, the probability of seismically activated landslide activity impacting the bridge is considered low.

4.2 Surface Conditions

The Wilson Creek Tributary Bridge is located on the southeast side of U.S. 101, where the existing highway turns and continues to the northeast. The bridge location is approximately 120 feet east of the main head scarp of the NLCG. The bridge spans across a southwest-to-northeast oriented ravine that extends northeastward toward Wilson Creek. The ground surface on the south side of the ravine faces north to northwest and slopes at approximately 3½H:1V to 4H:1V. The ground surface on the north side of the ravine faces south to southeast and slopes at approximately 3H:1V to 3½H:1V. The south side of the ravine has several intervening ridges and drainages. Surface water is anticipated to flow generally in a northeastern direction down the ravines that ultimately lead to Wilson Creek to the east.

4.3 Subsurface Conditions

The subsurface conditions at the Wilson Creek Tributary Bridge are anticipated to consist of thin (<5 feet thick) Alluvium/Colluvium, underlain by Franciscan Complex Broken Formation. Variably weathered sandstone with interbedded sandy soil layers is estimated in the upper 15 feet, underlain by alternating layers of variably weathered and variably strong argillite and sandstone with numerous interbeds of decomposed soft rock with soil-like properties.

Where the proposed bridge structure will connect to U.S. 101, the highway was constructed on log fill embankments where redwood logs were placed, and fill was then added to bring the highway to grade. Wood fragments and organics were encountered in Boring RC-19-003 between depths of 8 and 15 feet. The corresponding elevations are generally higher than the elevations of the bridge foundations; however, the potential for encountering log fill below the foundations should be considered.

It should be noted that the subsurface conditions described here are based on limited existing geotechnical data and will be verified during the future design phase.

5 GROUNDWATER

The area-wide hydrogeology is dominated by groundwater flow along fractures in the bedrock, within the Melange and Broken Formations, and the overlying landslide deposits. The permeability of intact rock within these formations is very low, and most groundwater occurs and is transmitted within fractures of unknown interconnection. Where water-laden fractures intersect the bluff face, groundwater discharges as a spring or seep. Groundwater is also likely entering the ocean below the shoreline.

Groundwater flow along fractures in the project area can be interrupted and redirected, perched, or locally mounded behind subsurface barriers to flow such as clay-filled landslide failure zones.

Based on results of packer tests, hydraulic conductivity in the Broken Formation at NLCG is estimated to be 4.07×10^{-7} to 1.88×10^{-6} feet/second at depths of 170 to 180 feet and 206 to 216 feet, respectively (RC-20-017) (Caltrans, 2023b). Hydraulic conductivity may be locally higher or lower than indicated by packer test results, and fracture intervals are likely to have the highest conductivity.

Three VWPs were installed near the head of the NLCG landslide and within 300 feet west and southwest of the south bridge abutment: RC-19-003, RC-20-013, and RC-20-017. The table below summarizes the groundwater data obtained from these VWPs. The data spans a timeframe between September 2019 and June 2023.

Table 5-1. Groundwater Data from VWPs

Boring ID	Total Bore Depth (feet)	Surveyed Ground Surface Elevation (feet)	VWP Depth (feet)	VWP Elevation (feet)	Apparent Groundwater Depth Minimum (feet)	Apparent Groundwater Elevation Maximum (feet)	Date Measured
RC-19-003	100.0	840.5	90.0	750.5	11.6	828.9	9/23/2019 through 4/19/2021
RC-20-013	134.7	830.5	133	697.5	82.5	748.0	12/18/2020 through 2/15/2022
RC-20-017	300.0	829.4	282.0	547.4	225.9	603.5	12/18/2020 through 6/21/2023
			253.0	576.4	221.8	607.6	
			217.0	612.4	207.5	621.9	
			182.0	647.4	177.8	651.6	
			150.0	679.4	137.9	691.5	

6 AS-BUILT DATA

Existing underground structures in the vicinity of Alternative F consist of current roadway stability structures (retaining walls) along U.S. 101. No live or abandoned underground utilities are believed to be present. SI casing and VWPs are located within and adjacent to the current roadway section near where Alternative F joins U.S. 101.

Plans and/or details for Caltrans repair structures along the existing highway alignment dated between 2015 and 2021 were provided by Caltrans but are not in the vicinity of the proposed bridge. The information provided by Caltrans indicated that most of the existing highway alignment where the bridge structure will connect to U.S. 101 was constructed on log fill embankments where redwood logs were placed, and fill was then added to bring the highway to grade.

As-built plans for the repair structures completed in 2023 along the existing highway at PM 15.48, approximately 220 feet south of the proposed bridge, are available from Caltrans.

7 SCOUR DATA

The bridge crosses a ravine that extends northeastward toward Wilson Creek. Surface water is anticipated to flow generally in a northeastern direction down the ravine that ultimately leads to Wilson Creek to the east. Potential for scour exists, particularly for the south abutment (see Plate 1e); however, the size of the ravine tributary area is relatively small. All footings will be placed below respective scour depths, and impact of scour in foundation bearing and lateral capacities will be considered. The scour impact will be evaluated in more detail during the final design.

8 CORROSION EVALUATION

Four soil/rock samples and one groundwater sample were collected at various locations of the Project and were tested for corrosion as shown in the following table.

Table 8-1. Preliminary Corrosion Test Results

Boring ID	Sample Depth (feet)	Sample Description	Minimum Resistivity (ohm-cm)	pH	Chloride Content (ppm)	Sulfate Content (ppm)	Corrosive
RC-20-014	71.2 to 71.5	Sandstone with iron oxide, Broken Formation	1,050	7.55	35.5	57.8	No
RC-20-019	251.6 to 251.9	Argillite interbed in Sandstone of Broken Formation	5,360	6.32	5.1	1.7	No
RC-21-001	30.0 to 31.5	Argillite/Earthflow	2,170	7.59	2.5	79.1	No
RC-20-015	128.8 to 129.0	Argillite below Earthflow	2,200	7.56	2.6	126.8	No
P-20-012	-	Groundwater	-	7.58	25	110	No

According to the Caltrans Corrosion Guidelines (Caltrans, 2021a), soils are considered corrosive if the pH is 5.5 or less, or chloride content is 500 parts per million (ppm) or greater, or sulfate content is 1,500 ppm or greater. Also, as stated in the Caltrans Corrosion Guidelines, a minimum resistivity value for soil and/or water less than or equal to 1500 ohm-cm indicates the presence of high quantities of soluble salts and a higher propensity for corrosion.

Based on the corrosion test results and Caltrans criteria, the soil samples tested were not found to be corrosive to bare metals and concrete. The corrosion potential is based on limited data mainly along the current U.S. 101 alignment and may not represent the conditions at the Wilson Creek Tributary Bridge. It should be noted that the project site is not within 1,000 feet of the ocean; therefore, according to Caltrans Corrosion Guidelines (2021a), the site is not in a marine atmosphere zone.

More detailed corrosion evaluation for the bridge site will be performed using site-specific borings and soil samples.

Section 90-1.02H Concrete in Corrosive Environments of the Caltrans Standard Specifications provides specification language for corrosion resistant concrete mix designs that address corrosive conditions.

9 SEISMIC INFORMATION

9.1 Ground Motion Hazard

The project site is susceptible to strong earthquake-induced ground motions during the design life of the proposed bridge. Following the procedures described in Caltrans Seismic Design Criteria Version 2.0 (SDC 2.0) (2019a) and October 2019 Interim Revisions to SDC 2.0 (2019b), the preliminary Acceleration Response Spectrum (ARS) curve for a 975-year Return Period was determined using the Caltrans ARS Online V3.0.2 (2021b) and utilizing the small-strain shear wave velocity for the upper 100 feet (V_{S30}) of the project site. The preliminary value of V_{S30} was estimated from the soil data of existing Borings RC-19-003, RC-20-013 and RC-20-017 (approximately 150 to 600 feet away from the site), and the standard penetration test (SPT) correlations provided in the Methodology for Developing Design Response Spectrum for Use in Seismic Design Recommendations (Caltrans, 2012). The 2021 correlations described by Attachment 2 in Caltrans Geotechnical Manual – Design Acceleration Response Spectrum module (Caltrans, 2021c) were not adopted, because it was determined that they are not representative of the site conditions. In order to determine whether 2021 correlations are suitable for the site, the estimated shear wave velocity from these correlations were compared with available seismic refraction survey results near the same locations, as shown in the PGR (Caltrans, 2023b). The 2021 correlations tend to yield a lower V_{S30} value than direct shear wave velocity measurements from seismic refraction lines, while the 2012 correlations provide reasonably close results. Therefore, the 2012 correlations have been adopted for this site.

Preliminary site seismic parameters are listed in the following table.

Table 9-1. Preliminary Site Seismic Parameters

Structure	**Wilson Creek Tributary Bridge**
Station Range[1]	“F” 119+25 to “F” 120+47
Reference Boring(s)[2]	RC-19-003, RC-20-013, RC-20-017
Site Geospatial Coordinates (latitude, longitude)[3]	41.6432°, -124.1147°
V_{S30} (m/s)	340

Notes:

(1) Based on the current Geometric Approval Drawings.
(2) Based on Preliminary Geotechnical Data Report (Final) (Caltrans, 2022).
(3) Estimated from Google Maps and the current Geometric Approval Drawings.

Based on the Caltrans ARS Online V3.0.2 (2021b), the preliminary values of Peak Ground Acceleration (PGA), the deaggregated mean earthquake moment magnitude (M) for PGA, and the mean site-to-source distance (R) for 1.0 second period spectral acceleration are 0.85g, 8.67, and 20.1 km, respectively. The Ground Motion Data Sheets, presenting the preliminary ARS data, plots, and other relevant information are included in Appendix A. The soil at the project site is identified as “Class S1,” per Section 6.1 and 6.2.3 of the Caltrans SDC 2.0 (2019a).

According to the Caltrans Geotechnical Manual – Landslides module (Caltrans, 2020) and Caltrans Geotechnical Manual – Embankments module (Caltrans, 2014), a horizontal seismic coefficient (k_h) for seismic slope stability analysis may be equal to one-third of the PGA at the site. For earth retaining structures, the current Caltrans Geotechnical Manual - Geotechnical Seismic Design of Earth Retaining Systems (Caltrans, 2023c) recommends k_h equal to one-third of the PGA for sliding retaining walls, and k_h equal to one-half of the PGA for non-sliding retaining walls. Since the bridge abutments are supported on piles, a preliminary k_h value of 0.425 g, equal to one-half of the PGA is recommended to estimate the seismic lateral earth pressure for bridge wingwalls and abutment walls.

Preliminary ground motion parameters for the site are listed in the following table.

Table 9-2. Preliminary Ground Motion Parameters

Structure/Location	Wilson Creek Tributary Bridge
PGA (g)	0.850
SA at 0.1 s (g)	1.430
SA at 0.2 s (g)	1.760
SA at 0.3 s (g)	1.820
SA at 0.5 s (g)	1.570
SA at 0.75 s (g)	1.310
SA at 1.0 s (g)	1.100
SA at 2.0 s (g)	0.560
SA at 3.0 s (g)	0.340
SA at 4.0 s (g)	0.230
SA at 5.0 s (g)	0.160
Mean Earthquake Moment Magnitude	8.67
Mean Site to Fault Source Distance for S_a at 1 second (km)	20.1
Site Class(1)	S1
Horizontal Seismic Coefficient, k_h(2)	0.425

Notes:
Per Section 6.1 and 6.2.3 of the Caltrans SDC 2.0 (2019a).
k_h = one-half of PGA.

9.2 Other Seismic Hazards

The proposed bridge site is not located within 1,000 feet of any active faults as delineated by the Alquist-Priolo Earthquake Fault Zone (APEFZ) (CGS, 2007) or Uniform California Earthquake Rupture Forecast, Version 3 (UCERF3) model (USGS, 2013). Therefore, per Caltrans MTD 20-10 (2013) and Caltrans Geotechnical Manual – Fault Rupture module (2017), the proposed bridge is not considered susceptible to surface fault rupture hazards, and no Surface Fault Rupture Displacement Hazard Analysis (SFRDHA) is needed.

Preliminary liquefaction potential analysis was performed, using the procedures outlined by Youd et al. (2001), and the blow counts and measured groundwater depths of existing

Borings RC-19-003, RC-20-013 and RC-20-017, extracted from the Preliminary Geotechnical Data Report (Final) (Caltrans, 2022). Due to presence of dense subsurface materials below groundwater table, no liquefiable layers are identified. Therefore, the project site is not susceptible to liquefaction or related seismic hazards, including seismic total or differential ground settlement, seismic downdrag and lateral spreading.

The project site is located in a small valley with a natural slope gradient up to 1.5H:1V, and the bedrock is expected to appear at a shallow depth of about 5 to 15 feet, according to existing Borings RC-19-003 and RC-20-013, and Plate 10 of the PGR (Caltrans, 2023b). Based on these conditions and the absence of liquefaction potential, the proposed abutment slopes at the site are preliminarily not considered subject to instability during the design seismic ground motion event. This assumption will be verified during the final design.

According to Caltrans MTD 20-13 (2010b), the tsunami hazard is significantly reduced at locations beyond one-half mile of the coast or at elevations greater than 40 feet above mean sea level. The proposed bridge site is located only about 0.28 mile from the nearest coastline. However, because the project site is situated at elevation above +825 feet (much higher than +40 feet), the risk for tsunami-related damage does not exist, per Caltrans MTD 20-13.

10 PRELIMINARY GEOTECHNICAL RECOMMENDATIONS

The proposed LCG Alternative F Bridge is a 122-foot-long, single-span, precast concrete I-girder with a cast-in-place concrete deck, as shown on Plate 1b. Approach embankments at both abutments are retained by wingwalls.

The seismic demand for the project site is expected to be very high, as indicated by the preliminary PGA of 0.85g. There is no liquefaction potential. Bedrock or dense material is expected to appear at a shallow depth of about 5 to 15 feet. However, it should be noted that most of the existing U.S. 101 highway alignment where the bridge structure will connect was constructed on log fill embankments, where redwood logs were placed, and fill was then added to bring the highway to grade. Therefore, the possibility of encountering log fill material in some of the foundations should be considered in foundation type selection.

Based on these considerations, a discussion of the appropriate foundation system alternatives is listed as follows:

For abutments:

- <u>Small Diameter Drilled Shafts (CIDH Concrete Piles)</u>: Small diameter drilled shafts (as a pile group), with a minimum diameter of 24 inches, are recommended to support the abutments, and are the preferred foundation alternative.
- <u>Large Diameter CIDH Piles</u>: Since the bridge is single span with relatively shallow bedrock and in a remote site, large diameter CIDH piles are not recommended for the bridge.
- <u>Spread Footings</u>: Due to shallow bedrock, spread footings could be feasible to support the abutments, particularly when short abutment walls and sufficient

embedment depth are used. However, considering the large seismic loading, presence of log fill in the bridge vicinity, lack of soil borings at the bridge site, and scour potential, small diameter drilled shafts are preferable to spread footings at this time.

- Driven Piles: Driven piles are not recommended for support of abutment foundations, because the bedrock or dense material appears at a shallow depth, and it is difficult to drive the piles down to elevations that provide adequate support for lateral loads and tension.

For wingwalls:

- Small Diameter Drilled Shafts (CIDH Concrete Piles): Small diameter drilled shafts (as a pile group), with a diameter of 24 inches, are recommended to support wingwalls, and are the preferred foundation alternative. Smaller diameter (16 inches) CIDH piles can be used for wingwalls, if the full length of the pile is above groundwater level.
- Spread Footings: Spread footings could be feasible to support portions of the wingwalls, particularly for shorter walls and when sufficient embedment depth is used. However, bedrock contact elevations cannot be determined using existing geotechnical data, and there is potential for encountering log fill material below the footing depths. Considering the large seismic loading, presence of log fill near the wingwalls, lack of soil borings at bridge site, and scour potential, small diameter CIDH piles are preferable to spread footings at this time.

Because Abutment 1 of the bridge is located in an inaccessible area about 150 feet away from U.S. 101, an access road for bridge construction will be needed.

11 ADDITIONAL FIELD WORK AND LABORATORY TESTING

To supplement the existing subsurface data that is limited and far from the site, a field investigation program needs to be performed. In addition, the bridge location is just east of the main head scarp of the NLCG, and it is prudent to confirm the location of the bridge relative to NLCG during field investigation and subsequent monitoring. Additional geologic hazard mapping and site reconnaissance is recommended for the bridge site.

Based on preliminary plans, four mud rotary borings for Alternative F bridge (two borings at each abutment) are proposed to assist in design of bridge and wingwall foundations and to collect additional data for the characterization of the overall landslide. The proposed boring depth should extend at least 20 feet below the estimated pile tip elevation, and if possible, one or more borings instrumented and sufficiently deep to confirm the bridge location east of the main NLCG head scarp.

Samples recovered during the field investigation will be transported to the laboratory for testing. Soil samples will be visually classified and moisture content/density tests will be performed. Additional samples will be selected for sieve analysis, No. 200 wash, corrosion, and direct shear and unconfined compression tests. Other laboratory tests such as Point

Load Strength Index tests may be required, depending upon the nature of the soils and bedrock encountered during the investigation.

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PLATES

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
01	DN	101	12.7/16.5		

STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

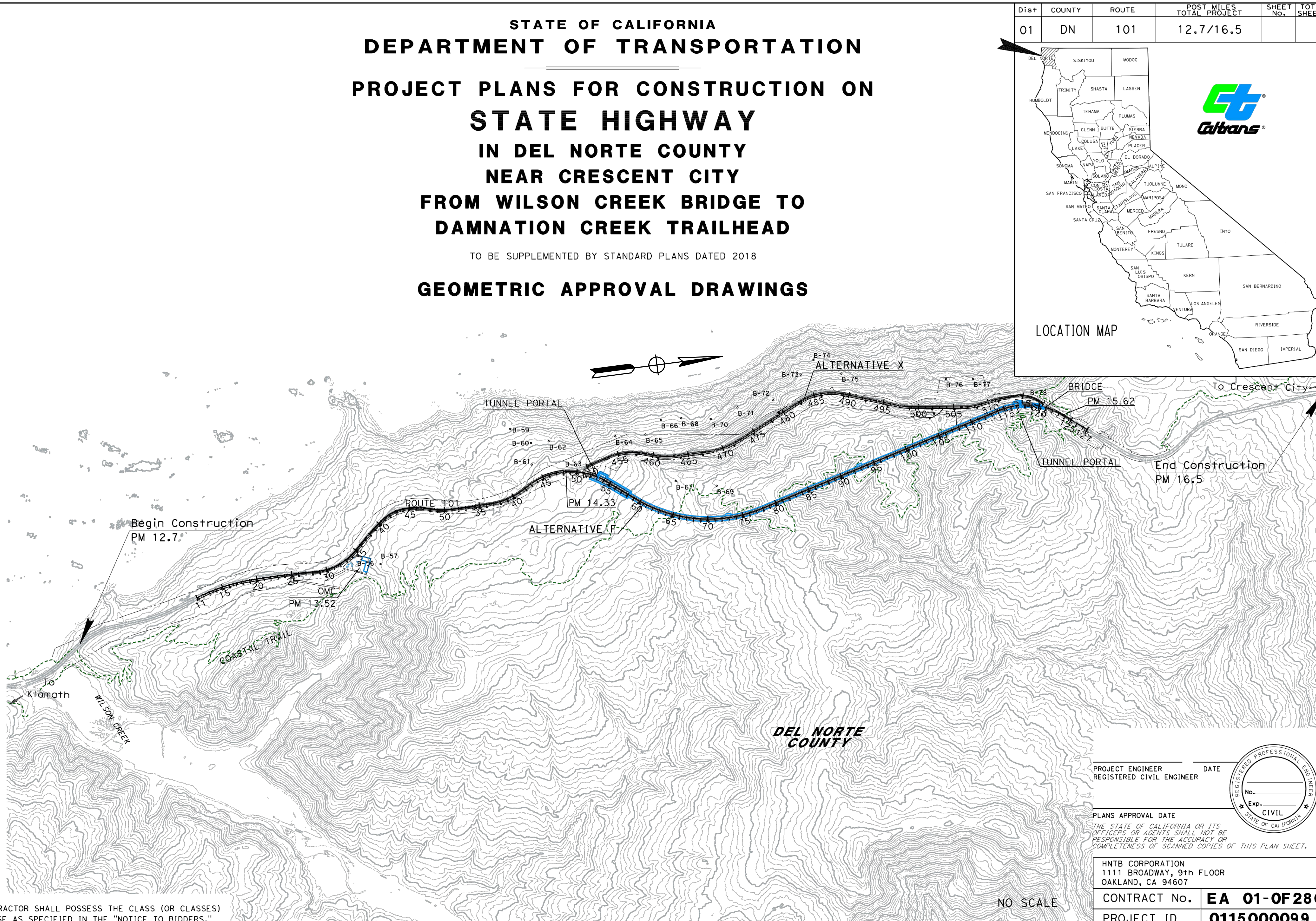
PROJECT PLANS FOR CONSTRUCTION ON
STATE HIGHWAY
IN DEL NORTE COUNTY NEAR CRESCENT CITY FROM WILSON CREEK BRIDGE TO DAMNATION CREEK TRAILHEAD

TO BE SUPPLEMENTED BY STANDARD PLANS DATED 2018

GEOMETRIC APPROVAL DRAWINGS

APPROVED AS TO IMPACT ON STATE FACILITIES AND CONFORMANCE WITH APPLICABLE STATE STANDARDS AND PRACTICES AND THAT TECHNICAL OVERSIGHT WAS PERFORMED.

CONSULTANT DESIGN MANAGER | CALTRANS DESIGN OVERSIGHT APPROVAL | REGISTRATION No. | LICENSE Exp DATE | DATE SIGNED



THE CONTRACTOR SHALL POSSESS THE CLASS (OR CLASSES) OF LICENSE AS SPECIFIED IN THE "NOTICE TO BIDDERS."

PROJECT ENGINEER DATE
REGISTERED CIVIL ENGINEER

REGISTERED PROFESSIONAL ENGINEER No. Exp. CIVIL STATE OF CALIFORNIA

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PROJECT ID 0115000099

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LAST CHANCE GRADE PERMANENT RESTORATION PROJECT
STRUCTURE PRELIMINARY GEOTECHNICAL REPORT - FINAL
NOVEMBER 2023

GEOMETRIC APPROVAL DRAWINGS
Cover Sheet

PLATE
1a

PLOTTED: 15 Nov 2023, 9:16pm, DFahmey
LAYOUT: 1a
CAD FILE: C:\Users\DFahmey\Downloads\202080000\

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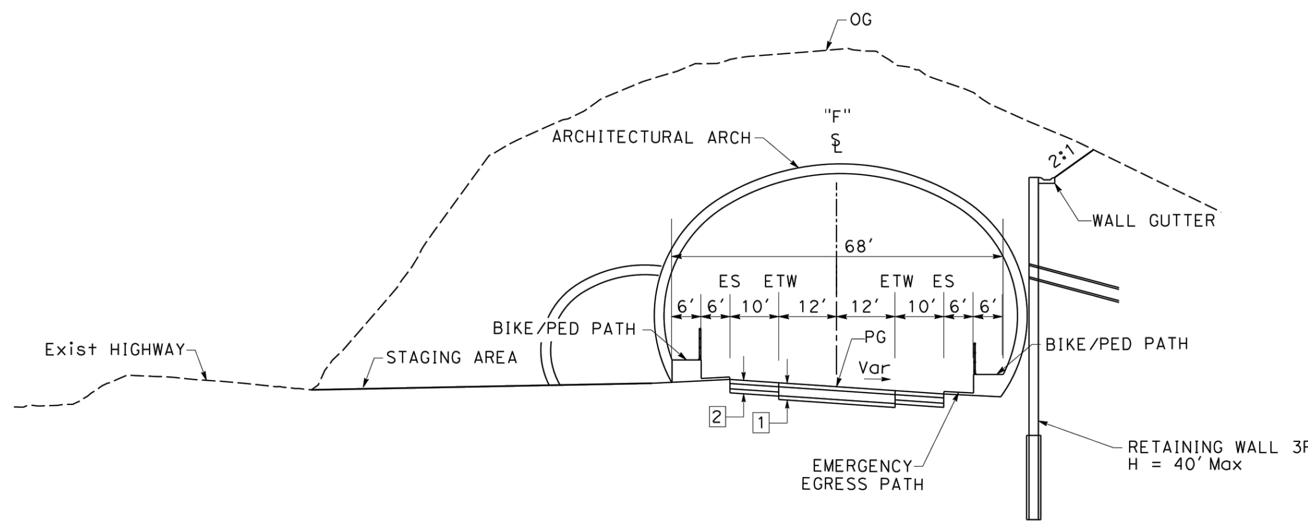
2. INITIAL SEQUENTIAL EXCAVATION LINING (BOLTS AND SHOTCRETE) NOT SHOWN.



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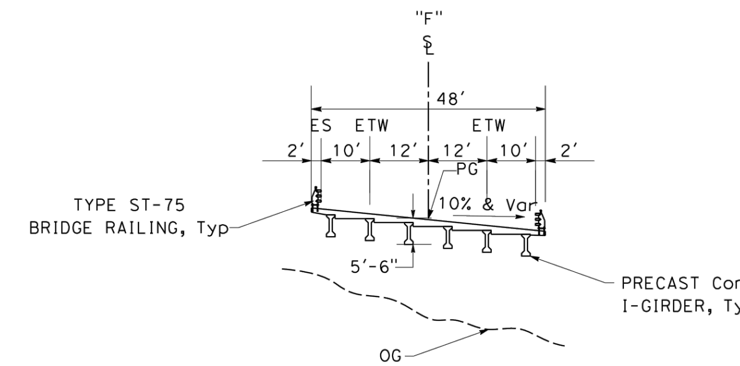
TUNNEL APPROACH



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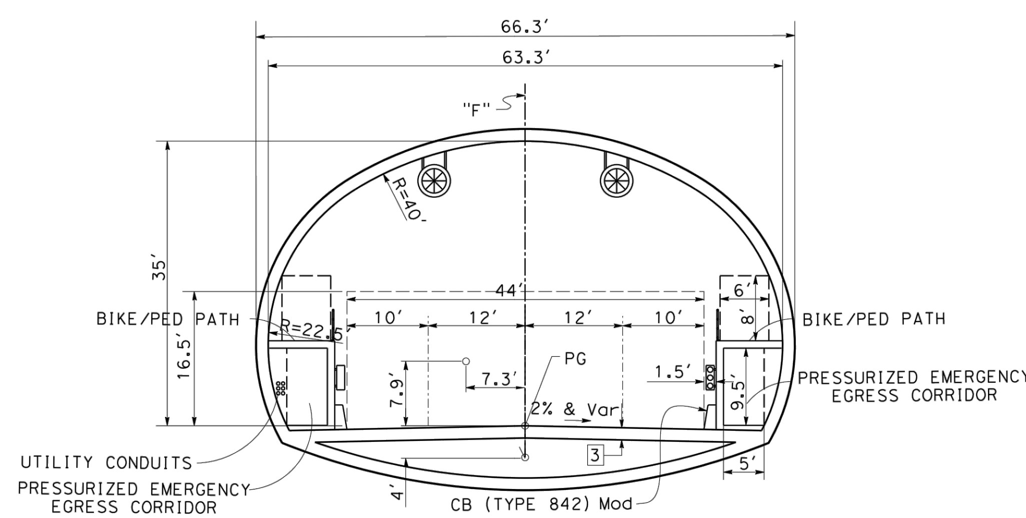

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TUNNEL - SEM SECTION

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TYPICAL CROSS SECTIONS

NO SCALE

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LEGEND:

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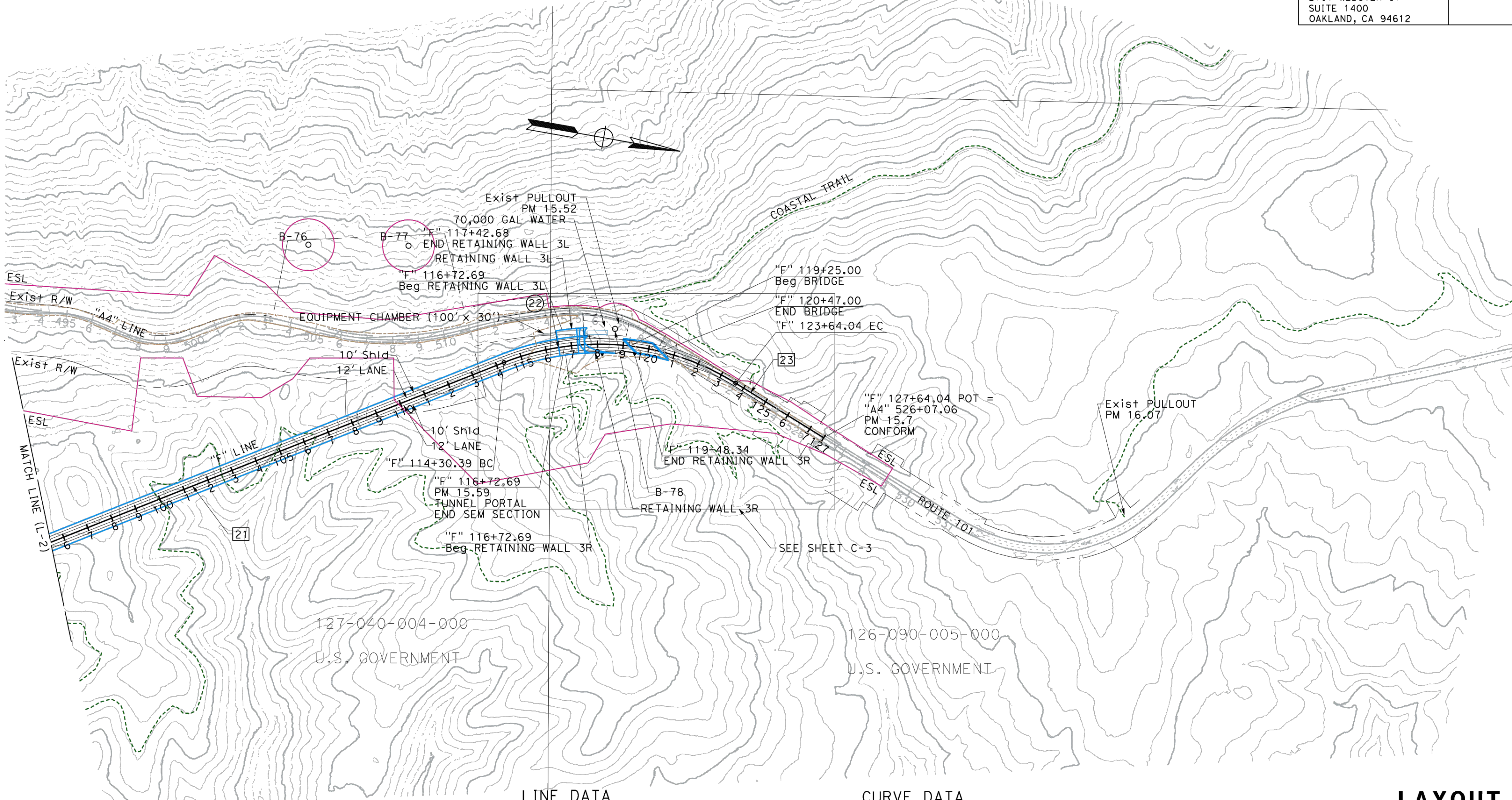
- COASTAL TRAIL
- ENVIRONMENTAL STUDY LIMITS (ESL)
- Exist R/W
- STRUCTURE
- RETAINING WALL
- DRAINAGE STRUCTURE
- B-XX o BORING LOCATION



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23	400.00'	N 31°50'37" E

CURVE DATA

No.	R	Δ	T	L
22	1000.00'	53°29'40"	503.98'	933.65'

LAYOUT

ALTERNATIVE F

SCALE: 1" = 200'

L-3

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LAST CHANCE GRADE PERMANENT RESTORATION PROJECT
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NOVEMBER 2023

GEOMETRIC APPROVAL DRAWINGS
Sheet L-3

PLATE **1c**

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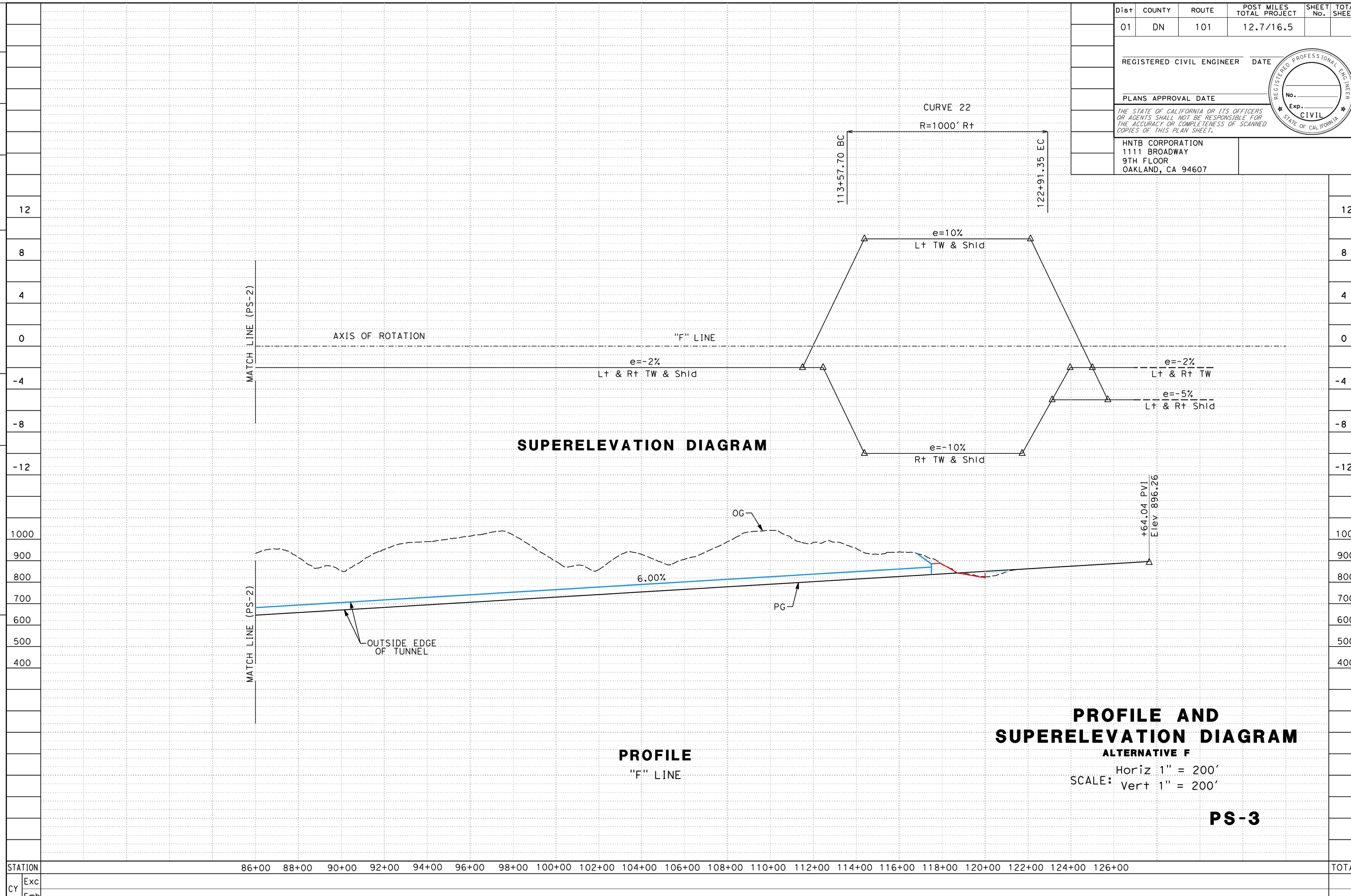

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PROFILE AND SUPERELEVATION DIAGRAM

ALTERNATIVE F

SCALE: Horiz 1" = 200'
Vert 1" = 200'

PS-3

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GEOMETRIC APPROVAL DRAWINGS
Sheet PS-3

PLATE **1d**

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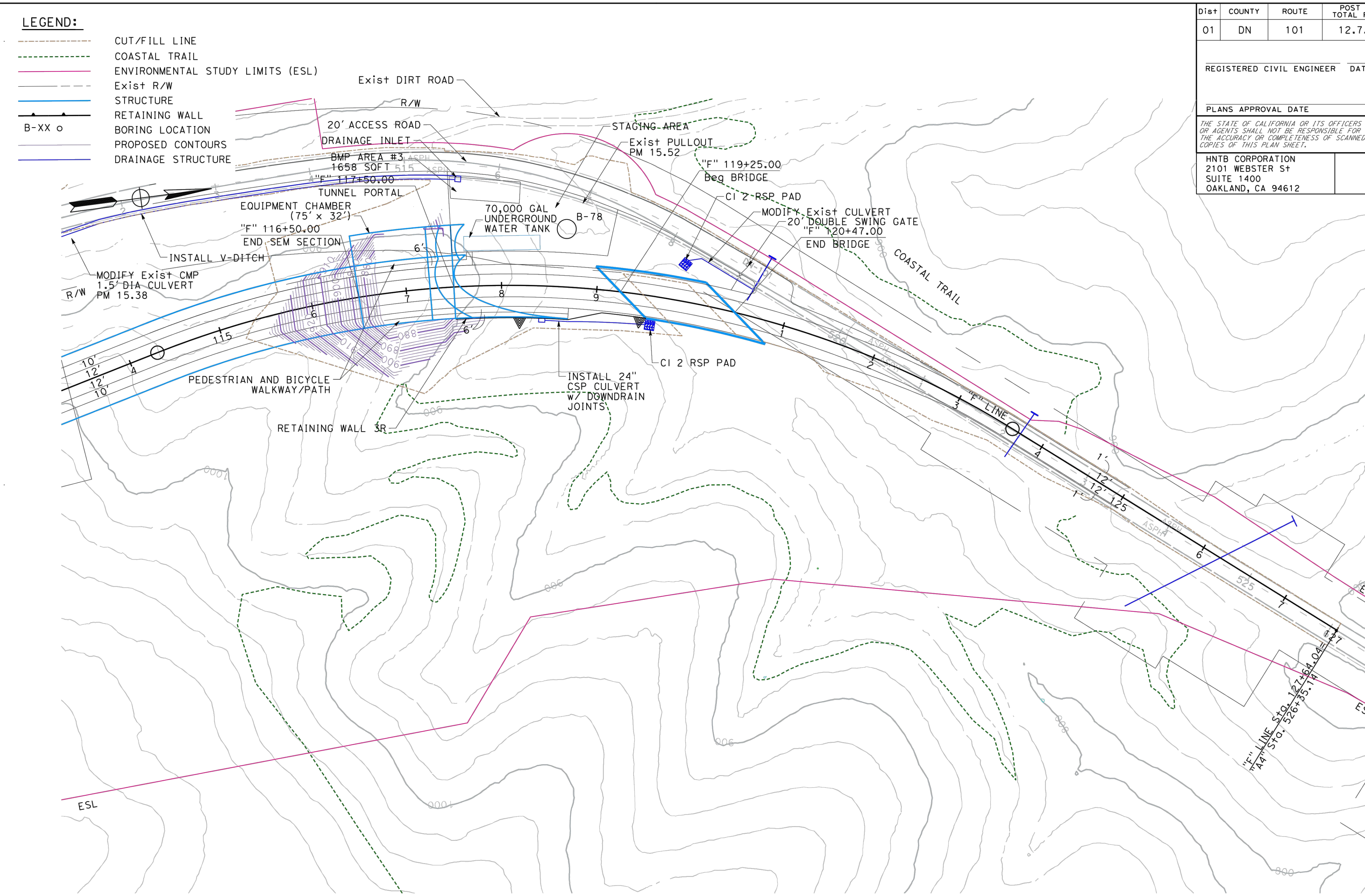

CONSTRUCTION DETAIL

ALTERNATIVE F

SCALE: 1" = 50'

C-3

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STRUCTURE PRELIMINARY GEOTECHNICAL REPORT - FINAL
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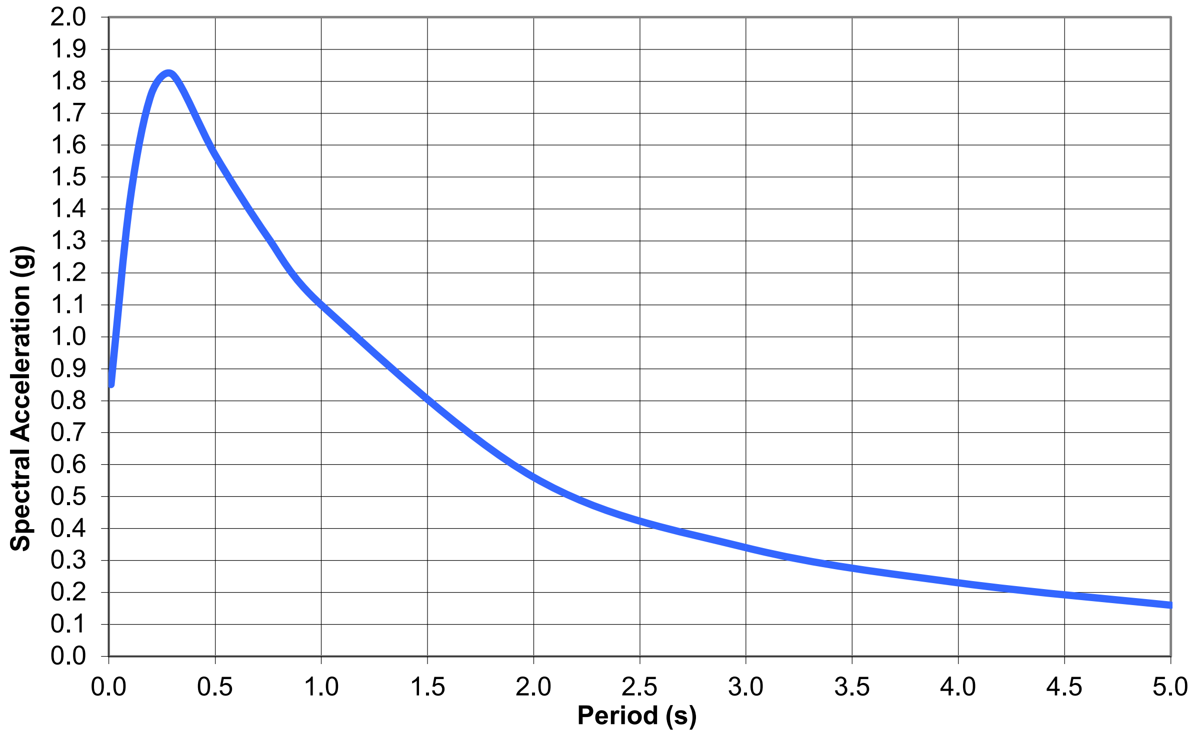
GEOMETRIC APPROVAL DRAWINGS
Sheet C-3

PLATE
1e

APPENDICES

APPENDIX A Preliminary Design Acceleration Response Spectra



Preliminary ARS Curve (5% Damping)

Caltrans ARS (V3.0.2) (Vs30 = 340m/s = 1,115ft/s)

Return Period = 975 Years

Latitude: 41.6432 Longitude:-124.1147

Peak Ground Acceleration (PGA) = 0.850g

Mean earthquake moment magnitude (M) for PGA = 8.67

Mean Site-to-Source Distance (R) for S1 = 20.1km = 12.5ml

Spectral Coordinates:

Period (sec)	**Acc.** (g)
0.01	0.850
0.10	1.430
0.20	1.760
0.30	1.820
0.50	1.570
0.75	1.310
1.00	1.100
2.00	0.560
3.00	0.340
4.00	0.230
5.00	0.160

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

Project Number : 20-103	Date: July, 2022
Last Chance Grade Permanent Restoration Project **Alternative F Bridge**	
Preliminary ARS Curve	Figure --

Appendix G. Hydrology and Hydraulics Report

Last Chance Grade Permanent Restoration Project
Hydrology and Hydraulics Study Report

Submittal #SUB080

February 2024

EA# 01-0F280
Project EFIS# 0115000099
Del Norte County, U.S. 101,
PM 12.7/16.5

Caltrans

LAST CHANCE GRADE

WRECO
3003 Oak Road, Suite 500
Walnut Creek, CA 94597
Phone: 925.465.2700
www.wreco.com

Memorandum

Date: February 8, 2024

To: Karen Wang, Rodney Pimentel, and John Litzinger – HNTB

From: Analette Ochoa – WRECO

Project: Last Chance Grade Permanent Restoration Project

Subject: Preliminary Alternative F Bridge Water Surface Elevation and Freeboard Hydraulic Analysis (EA 01-0F280)

INTRODUCTION

The Last Chance Grade (LCG) Permanent Restoration Project is located on a section of U.S. Highway 101 (U.S. 101) known as Last Chance Grade in southern Del Norte County, California. It is approximately 10 miles south of Crescent City, between post miles (PM) 12.7 and 16.5 (Figure 1).

The purpose of the Project is to develop a long-term solution to the instability and potential roadway failure at LCG. The Project would consider alternatives that provide a more reliable connection, reduce maintenance costs, and protect the economy, natural resources, and cultural landscapes.

A long-term sustainable solution at LCG is needed to address:

- Economic ramifications of a long-term failure and closure
- Risk of delay/detour to the traveling public
- Increasing maintenance and emergency project costs
- Increases in the frequency and severity of large storm events caused by climate change

LCG is an area of geologic instability; there is a landslide complex that is approximately 3-miles-long with over 30 active landslides. This instability has required significant expenditures of tax dollars on emergency construction projects and maintenance activities to keep the highway open and safe. Between 1997 and 2021, landslide mitigation efforts, including retaining walls, drainage improvements, and roadway repairs cost more than $85 million. There is no foreseeable end to such expenditures, and effects of climate change may exacerbate conditions.

Other than U.S. 101, there are no viable routes between Crescent City and Klamath. Klamath is a community just south of LCG; many people routinely travel to and from Crescent City for work, school, or personal business. Typically, a one-way journey between the two communities would be about 22 miles, taking approximately 30-40 minutes. However, in the event of a closure, a 449-mile detour would be required, which would take approximately 8 hours (Figure 2).

Potential economic consequences of an emergency one-year closure of LCG include the loss of approximately 3,800 jobs and the reduction of business output by nearly half a billion dollars ($456 million) (Caltrans District 1, 2018). Such a closure would also lead to an estimated $236 million in travel costs to be collectively borne by individuals, businesses, and government institutions.

This *Memorandum* summarizes the preliminary hydrologic and hydraulic analysis to assist on the engineering design to verify the Alternative F Bridge Planning Study wetland crossings water surface elevation (WSE), WSE depth, and validate soffit elevations for ample freeboard for proposed Alternative F Bridge (Alignment "F" Line Station 119+25 to 120+47) for U.S. 101 LCG (EA 01-0F280). Due to limited creek crossing survey information at this time, this *Memorandum* is not intended for an environmental impact analysis and does not provide a detailed bridge hydraulic assessment.

Refer to Figure 1 for the Project Location Map and Figure 2 for the Regional Location and Detour Map.

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Walnut Creek, CA 94597
Phone: 925.465.2700
www.wreco.com

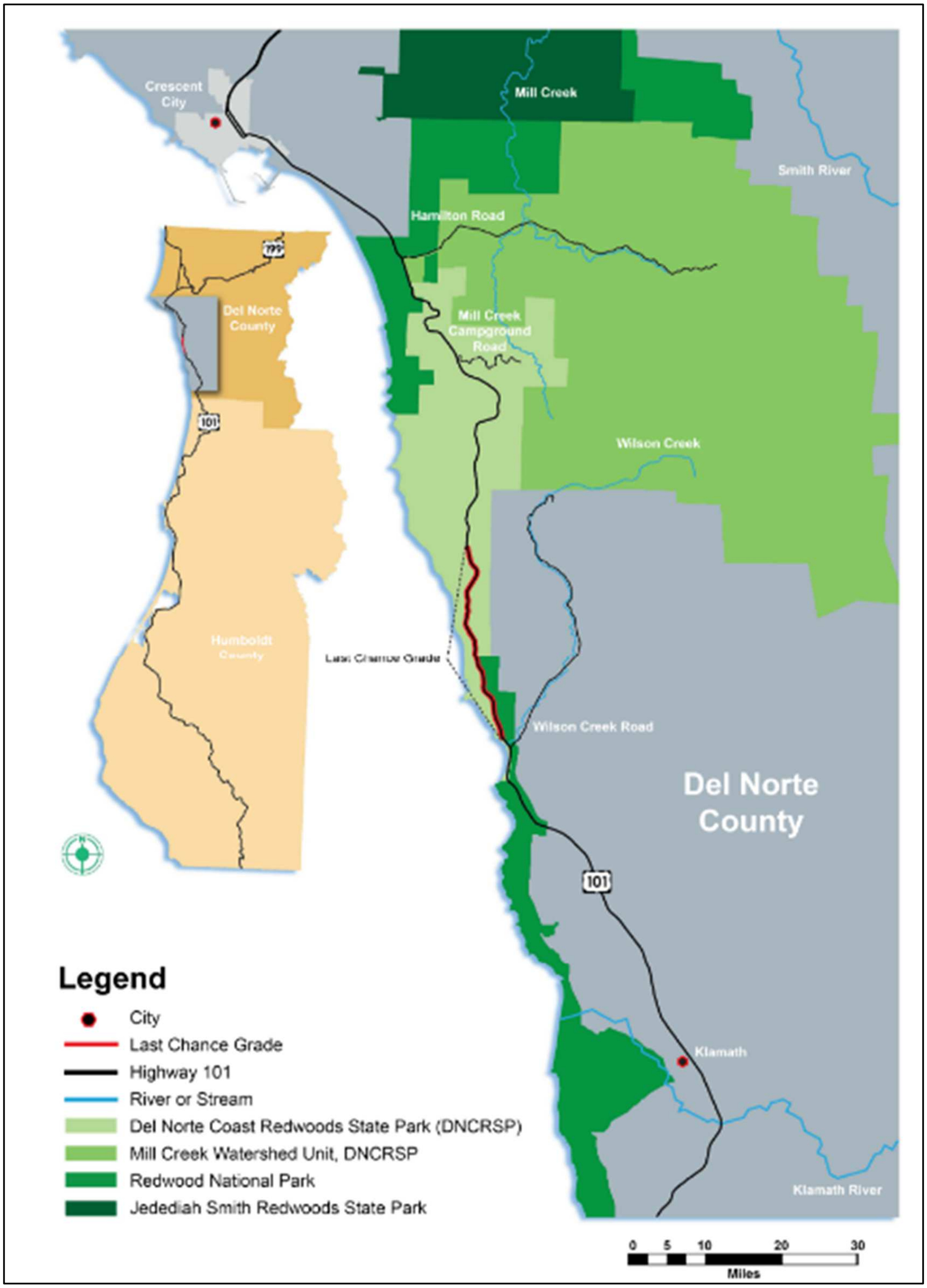

Figure 1. Project Location Map

Source: Caltrans, 2023a

3003 Oak Road, Suite 500
Walnut Creek, CA 94597
Phone: 925.465.2700
www.wreco.com

Figure 2. Regional Location and Detour Route

Source: Caltrans, 2023a

Alternatives

There are three alternatives for this Project, which include two build alternatives—F and X—were developed to meet the purpose and need of the Project (Figure 3), as well as a no-build alternative. Both build alternatives would require geotechnical investigations.

Alternative F
Alternative F would involve constructing an approximately 6,000-foot-long (1.1-mile) tunnel to avoid the most intense area of known landslides and geologic instability, thereby avoiding the portion of U.S. 101 most prone to closure.

Alternative X
Alternative X would involve reengineering a 1.6-mile-long portion of the existing roadway. This alternative would include a series of retaining walls, underground drainage features, and strategic eastward retreats to minimize the risk of landslides.

No-Build Alternative
For the No-Build Alternative, no work would be done to the existing highway; existing conditions would persist, including the continuation of emergency repairs and enhanced maintenance.

Alternative F

Alternative F would involve constructing an approximately 6,000-foot (1.1-mile) tunnel to the east of the existing highway to avoid the most intense areas of known landslides and geologic instability.

This alternative would be between PM 13.42 and 15.7. Portions of the alternative are near sections of the California Coastal Trail. However, no work is proposed on the trail and it is anticipated the trail would remain accessible during construction.

Main components of this alternative include the construction of tunnel portals and the tunnel, a bridge, and an Operations Maintenance Center (OMC). Geotechnical investigations would be conducted to inform Project design.

From the south, Alternative F would diverge from the existing highway near the end of the existing truck climbing lane (PM 14.2), traveling approximately 800 feet towards the southern portal. The portal would open into a single, large diameter tunnel, which would be approximately 200 feet below ground for most of its length. The tunnel would exit the hillside just north of the existing slide. A bridge would be constructed at the northern portal to reconnect the new alignment to the existing highway. An OMC would be built south of the tunnel to facilitate tunnel operation and maintenance.

More details on these features and other Project components are included below.

Bridge
A bridge would be constructed to span a Wilson Creek tributary between the northern portal and where the new alignment merges with U.S. 101 to the north.

The single-span, pre-cast, concrete girder bridge would be approximately 150-feet-long and 48-feet-wide, with a single 12-foot-wide lane in each direction, and 10-foot-wide shoulders. The wider shoulders would improve access for bicyclists and pedestrians, and provide refuge for stranded vehicles. Furthermore, a separate 6-foot-wide path is proposed, which would allow southbound bicyclists and pedestrians an alternative access route around the bridge to the southbound pedestrian/bike lane in the tunnel (Figure 4).

The bridge abutment locations would be accessed by the existing highway from the north and through a staging area created for bridge construction and tunnel access located immediately to the south. The concrete abutments and associated wingwalls would be constructed on cast-in-drilled-hole (CIDH) pile foundations. A crane would place pre-cast concrete girders on the abutments, and falsework would be constructed using the girders as support. Rebar would be installed, the concrete deck would be cast, and see-through bridge rails installed. Rock Slope Protection (RSP) may be placed for bank stabilization.

The bridge deck would not contain drains (scuppers). Instead, water would be conveyed to the ends of the bridge via gravity and discharged to adjacent vegetated slopes or RSP. The layout of Alternative F Bridge is shown in Figure 4, and the planning study of Alternative F Bridge is shown in Figure 5.

Roadway Drainage

In addition to drainage features associated with the tunnel, bridge, and OMC described above, there would be changes to drainages at various other locations.

At the tunnel portals, bridge, and OMC, stormwater runoff would be captured and conveyed to existing drainages at PMs 14.08 and 14.35 for the south portal; at PM 15.38 for the north portal and bridge, and PM 13.42 for the OMC. Some culverts would be extended to accommodate roadway changes. In addition, new inlets and culverts would be installed near the south portal, the north portal, and the OMC, which would be connected to existing culverts. Culvert outfall locations would remain unchanged; any lengthening of existing culverts would occur to the east. RSP may be needed at the outlets.

A new culvert would be installed under the northern tunnel approach between the bridge and the northern portal; the culvert would be 24 inches in diameter or larger, and approximately 200-feet-long.

Best management practices (BMP), such as bioswales, may be implemented to offset impacts to water quality. Potential areas for bioswales or other BMPs have been identified near the northern and southern portals and the OMC.

Datum

The preliminary analysis references the North American Vertical Datum of 1988 (NAVD 88).

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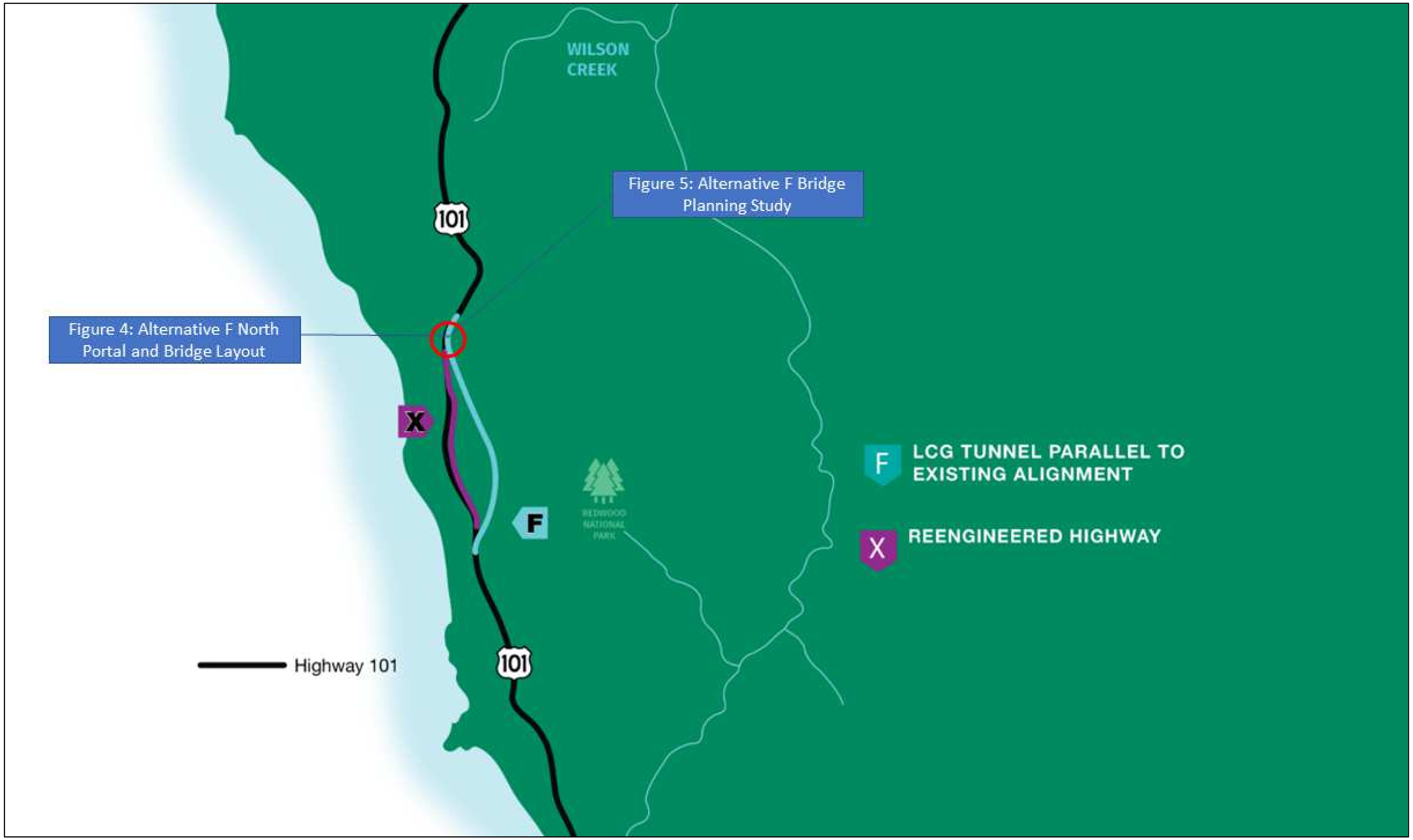

Figure 3. Build Alternatives Overview

Source: Caltrans, 2023a

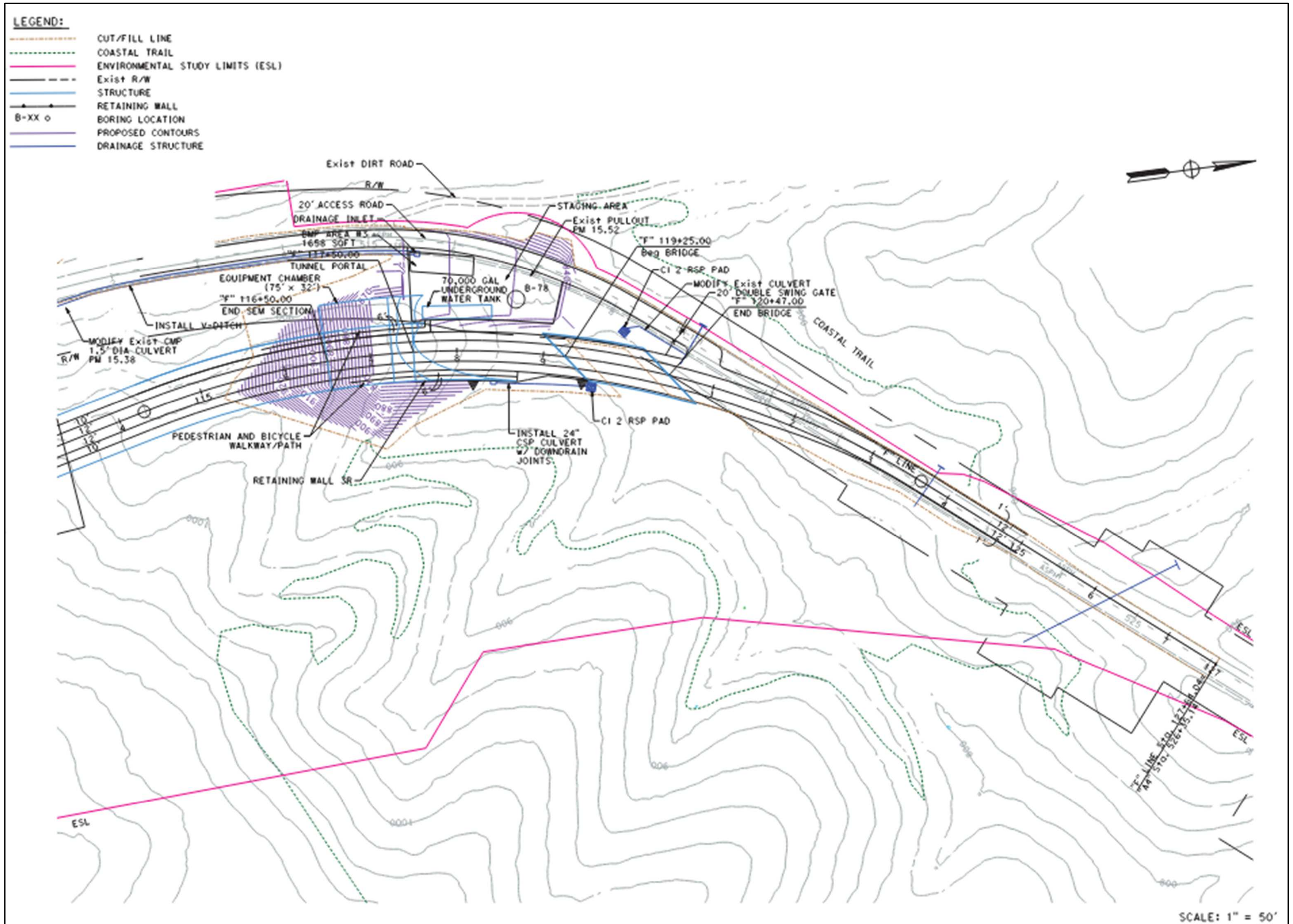

Figure 4. Alternative F North Portal and Bridge Layout

Source: Caltrans, 2023a

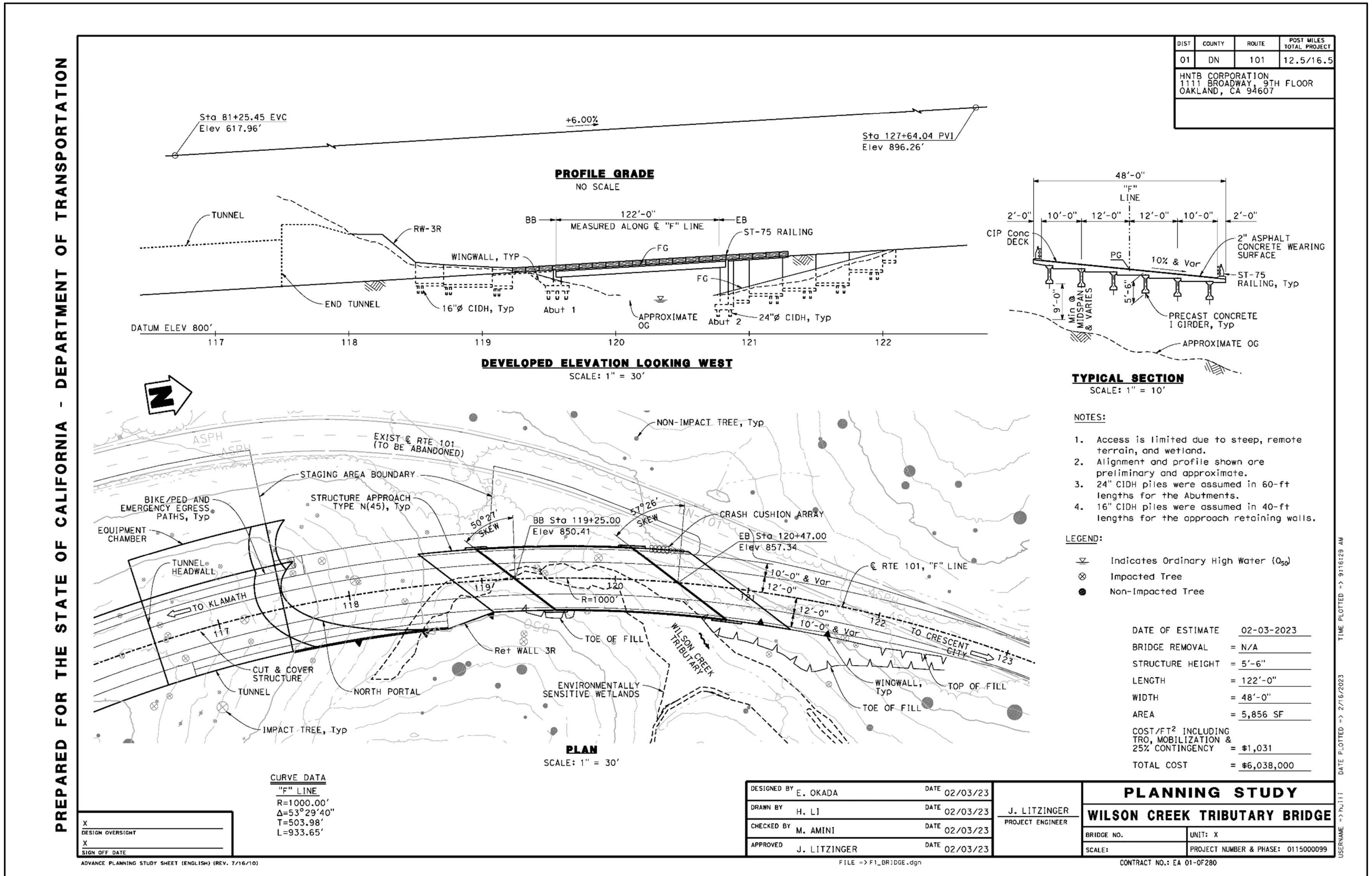

Figure 5. LCG Alternative F Bridge Planning Study

Source: Caltrans, 2023b

HYDRAULIC BRIDGE DESIGN CRITERIA

The following criteria are applicable to the Project area and are being considered in the development of alternative for the bridge.

Federal Highway Administration Standards

Bridges must be designed per the 2017 *California Amendments to the American Association of State Highways and Transportation Officials Load and Resistance Factor Design Bridge Design Specifications* (AASHTO LRFD BDS) (Caltrans, 2019). AASHTO LRFD BDS Section 2.6.3 defers to state requirements for hydraulic studies.

From *Memo to Designers 16-1 Hydraulic Design for Structures over Waterways* (Caltrans, 2017), the proposed bridge soffit should provide adequate freeboard to pass anticipated drift for the 50-year design flood, or to pass the 100-year base flood without freeboard, whichever is greater.

Caltrans Standards

From Chapter 820 of the Caltrans' *Highway Design Manual* (HDM) (2020), the criterion for the hydraulic design of bridges is that they are designed to pass the 2% probability of annual exceedance flow (50-year design discharge) with adequate freeboard to pass anticipated drift and debris. Two (2) feet of freeboard is commonly used in bridge designs. Alternatively, the bridge can also be designed to pass the 1% probability of annual exceedance flow (100-year design discharge, or base flood). No freeboard is added to the base flood.

PRELIMINARY HYDROLOGIC ANALYSIS

The following sub-sections describe the hydrologic data sources that were used to estimate the design flows for the Project area.

Hydrologic Design Methods

WRECO evaluated the hydrology for proposed Alternative F bridge area using the following references:

1. Project's survey imagery 2021 Light Detection and Ranging (LiDAR) (provided by Caltrans)
2. National Oceanic and Atmospheric Administration (NOAA) (2022) 2020 United States Geological Survey (USGS) Coastal National Elevation Database (CoNED) Topobathy DEM
3. NOAA Atlas 14, Volume 6, Version 2, Precipitation Frequency Data Server (PFDS) web application (2022)
4. Project's preliminary wetland delineation for Alternative F Bridge crossing (Caltrans, 2023c)

Rainfall Data and Intensities

Precipitation data was collected using NOAA Atlas 14, Volume 6, Version 2, PFDS web application (2022). The rainfall data generated from NOAA's PFDS website is summarized in Table 1, and the full dataset can be found in the NOAA Atlas 14 Rainfall Intensity Attachment.

Table 1. NOAA Atlas 14 Intensity-Duration-Frequency Summary

DURATION	INTENSITY (INCHES/HOUR)	
	50-year	100-year
5 minutes	5.15	5.72
10 minutes	3.68	4.10
30 minutes	2.08	2.31
1 hour	1.54	1.71
2 hours	1.14	1.27
24 hours	0.45	0.47

Source: NOAA, 2022

Receiving Waterbodies

The southern end of Project drains to Wilson Creek near PM 12.0 on U.S. 101. Wetlands within the Alternative F proposed bridge crossing were provided by Caltrans in April 2023 (Caltrans, 2023c). Figure 6 shows the wetlands within the vicinity of the Alternative F Bridge.

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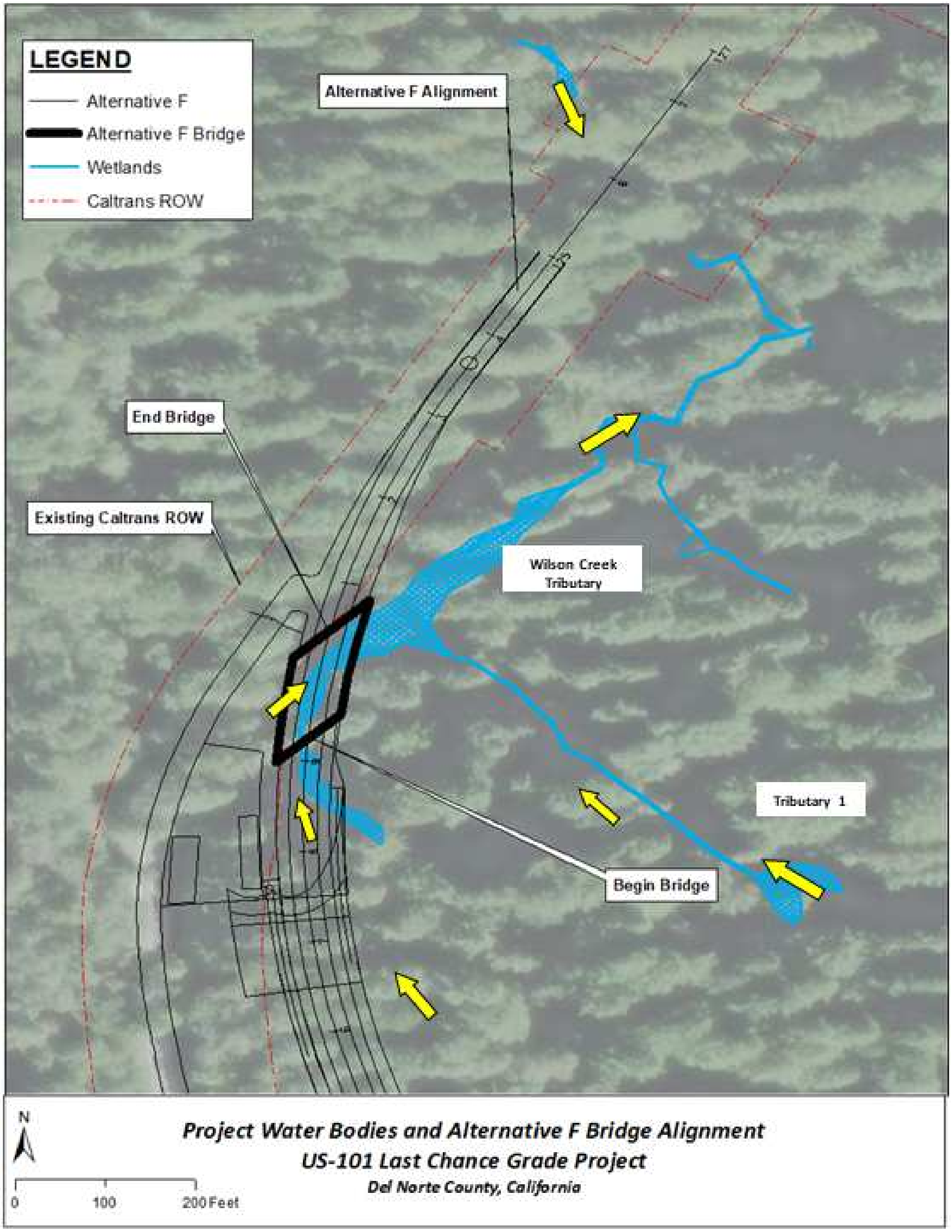

Figure 6. Project Water Bodies and Alternative F Bridge Alignment

Source: Caltrans, 2023c

Design Watershed Drainage Area and Discharge

Federal Emergency Management Agency Flood Insurance Study

The effective Federal Emergency Management Agency (FEMA) Flood Insurance Study (FIS) for Del Norte County, California, and unincorporated areas did not provide hydrologic analysis or information on the wetlands or Wilson Creek. The effective FEMA FIS was not used to determine the peak flow rates for this analysis.

NOAA USGS Topobathy

The NOAA 2020 USGS Topobathy CoNED (USGS, 2022) and ESRI's ArcMap spatial analysis hydrology tool (2019) was used to determine the drainage area for the Alternative F proposed bridge wetland crossing.

Table 2 shows the watershed drainage areas and Figure 7 shows the watershed delineations of the wetlands. The Wilson Creek Tributary downstream of the confluence with Tributary 1 is the sum of both Wilson Creek Tributary upstream of Tributary 1's confluence and Tributary 1's watershed drainage area.

Table 2. Wetland Drainage Area for Alternative F

Wetlands	Watershed Drainage Area (acre)
Wilson Creek Tributary (Upstream of Tributary 1 Confluence)	37.4
Tributary 1	3.8
Wilson Creek Tributary (Downstream of Tributary 1 Confluence	41.2

Rational Method

Runoff for the wetland drainage areas was determined using the Rational Method, as per HDM Index 819.2 (1) criterion, with the following assumptions:

1. The rainfall is of equal intensity over the entire watershed.
2. The peak flow occurs when the entire watershed is contributing to the flow.

The formula used to calculate the runoff is below:

$$Q = C(f)CiA \qquad (1)$$

Where:

Q = Design discharge in cubic feet per second.
$C(f)$ = Frequency factor (1.0 for 10-year storm event; 1.1 for 25-year storm event).
C = Weighted runoff coefficient for the entire tributary area.
i = Average rainfall intensity in inches per hour for the selected frequency and for a duration equal to the time of concentration (5 minutes).
A = Tributary shed area in acres

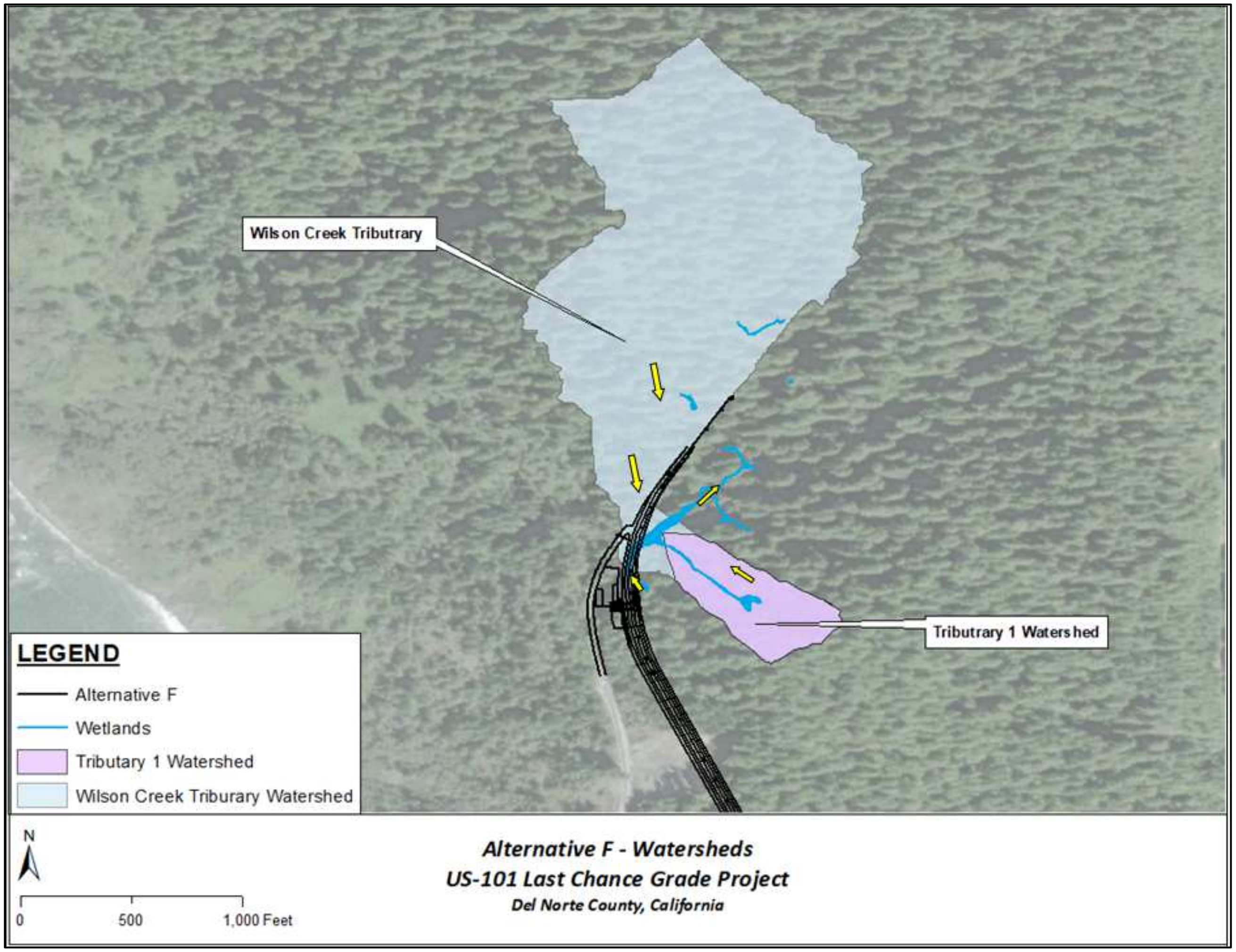

Figure 7. Alternative F Bridge Watersheds

Source: Caltrans, 2023b; Caltrans 2023c

Runoff Coefficient

Runoff coefficient "*C*" in equation (1) represents the percent of water that will run off onto the ground surface during a storm. The remaining percent of precipitation is lost to infiltration, transpiration, evaporation, and depression storage.

Caltrans' HDM (2020) Figure 819.2A shows the runoff coefficient for undeveloped watershed types, the undeveloped watershed "*C*" value for the wetland areas within the proposed Alternative F bridge crossing was determined to be 0.5. Table 3 provides the calculation of "*C*".

Table 3. Runoff Coefficient Calculation

Undeveloped Watershed	Characteristic	Value
Relief	Hilly, with average slopes of 10 to 30%	0.20 – 0.28
Soil Infiltration	High; deep sand or other soil that takes up water readily; very light well drained soils	0.04 – 0.06
Vegetal Cover	Good to excellent; about 90% of drainage area in good grassland, woodland, or equivalent cover	0.04 – 0.06
Surface Storage	Negligible surface depression few and shallow; drainageways steep and small , no marshes	0.10 – 0.12
Total *C* value		0.38 – 0.52

Source: Caltrans, 2020

Design Discharge

The 200-, 100- and 50-year design discharge for the wetlands within the proposed Alternative F bridge crossing, provided by the USGS StreamStats web-based spatial analytical tool, are shown in Table 4 and in the Attachments.

Table 4. Wetland Design Discharge for Alternative F

Wetlands	Drainage Area (ac)	Design Discharge (cfs)		
		200-year	100-year	50-year
Wilson Creek Tributary (Upstream of Tributary 1 Confluence)	37.4	80	70	60
Tributary 1	3.8	13	10	7
Wilson Creek Tributary (Downstream of Tributary 1 Confluence)	41.2	90	80	70

Source: USGS, 2022

Sea Level Rise and Tsunami Impacts

No sea level rise impacts are anticipated as the proposed bridge is located at an elevation above 825 feet. Tsunami inundation is not anticipated; thus no tsunami-related damage is expected.

PRELIMINARY HYDRAULIC ANALYSIS

The preliminary hydraulics analysis of the proposed LCG Alternative F bridge crossing was performed using United States Army Corps of Engineers' (USACE) Hydrologic Engineering Center's River Analysis System (HEC-RAS) modeling software, Version 6.2.0. The inputs to the hydraulic model were based on NOAA 2020 USGS Topobathy CoNED, LCG LiDAR provided by Caltrans (2021), preliminary wetland delineations and *Alternative F Bridge Planning Study* provided by Caltrans (2023b) (Figure 5).

Due to limited elevation information from the LiDAR DEM and no creek crossing survey information being available at this time, the preliminary proposed bridge model is based on the *Alternative F Bridge Planning Study* Caltrans, (2023b) control points and available LiDAR for the Project site. The normal depth was used in the hydraulic model as the downstream boundary condition. Figure 8 shows the cross section locations of the model.

Further hydraulic analysis of proposed Alternative F bridge will be updated once survey information is available and the proposed roadway grading is available for Alternative F.

Scour analysis will be analyzed in the Plans, Specifications, and Estimate (PS&E) phase. If detailed geotechnical studies performed determine that soil material is highly erodible and that there is lateral migration, then additional investigation may be necessary during the PS&E phase to identify potential bank stability issues.

Model Boundary Conditions

The normal depth of the Wilson Creek Tributary was used in the hydraulic model as the downstream boundary condition.

Manning's Roughness Coefficients

Manning's roughness coefficients were used in the hydraulic model to estimate energy losses in the flow due to friction. A roughness coefficient of 0.045 was used to describe the channel and channel bank areas.

Expansion and Contraction Coefficients

Expansion and contraction coefficients were used in the hydraulic model to represent energy losses in the channel. An expansion coefficient of 0.3 and a contraction coefficient of 0.1 were used to represent the channel. These values represent a channel with gradual transitions between the cross sections. An expansion coefficient of 0.5 and a contraction coefficient of 0.3 were used to represent the channel in the vicinity of the structures. These values represent the flow interference caused by the structures.

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Bridge Culvert Crossings

Due to limited information and the design of the culvert crossing along Alternative F bridge crossing, this preliminary hydraulic analysis assumes all proposed culvert crossing(s) will perpetuate existing flows and follow all design standards and criteria.

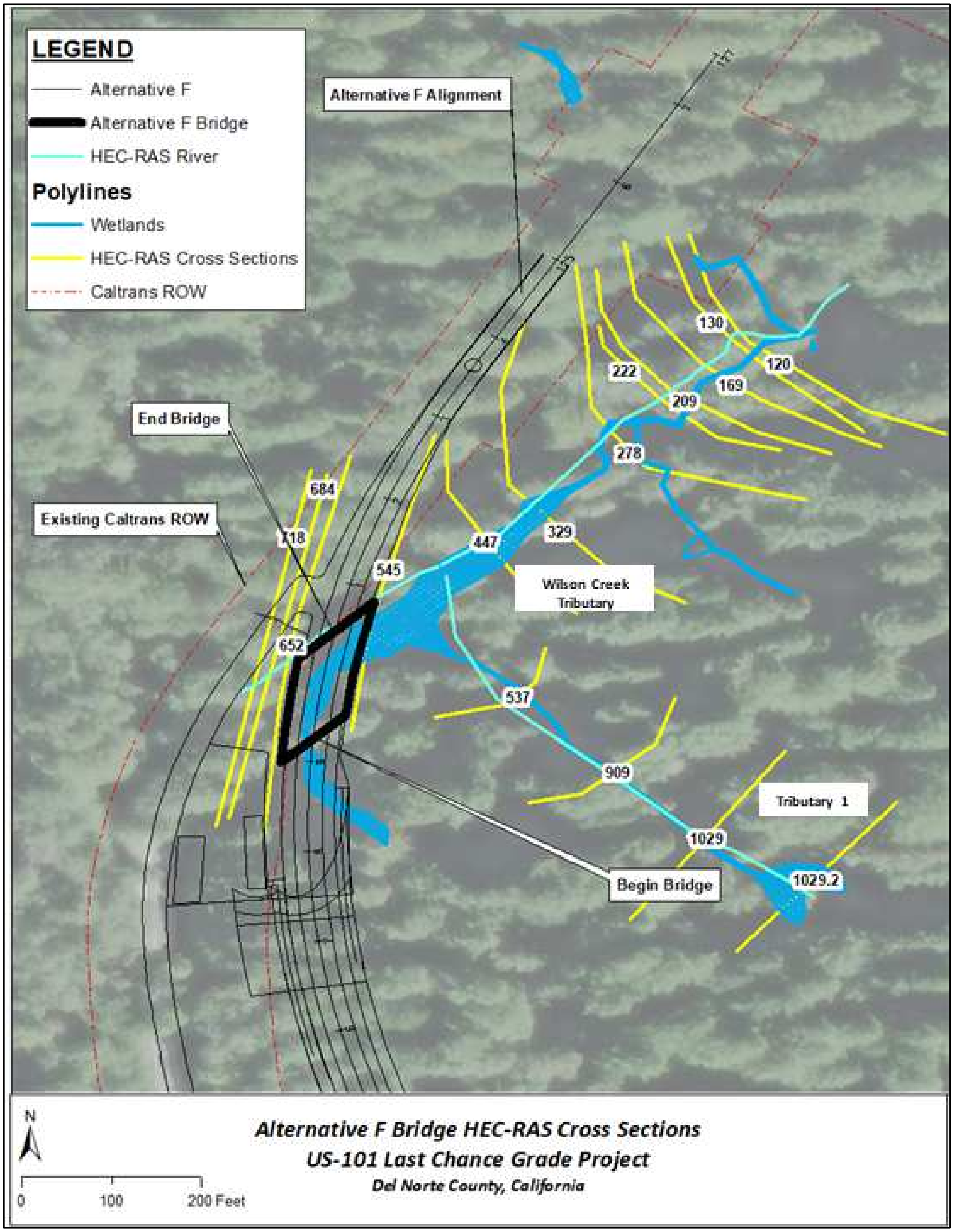

Figure 8. Alternative F Bridge HEC-RAS Cross Sections

Source: Caltrans, 2023c

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Preliminary Hydraulic Model Results

The preliminary hydraulic model was developed to assist design and verify the *Alternative F Planning Study* (Caltrans, 2023b) crossing at the Wilson Creek Tributary's WSE and WSE depth, validate soffit elevation, and meet the freeboard criterion. The model was computed using a steady flow analysis. This section summarizes the results of the preliminary hydraulic model analysis for the existing and proposed conditions. The preliminary hydraulic model results can be found in the HEC-RAS Results for the Existing and Proposed Conditions Attachments.

Alternative F Bridge Water Surface Elevation

The 200-year, 100-year, and 50-year storm WSE for the Alternative F bridge at the Wilson Creek Tributary is presented in Table 5, Table 6, and Table 7.

The construction of the new abutments along the bridge would potentially increase the WSE due to a blockage of flow impacting the flow during the 200-, 100-, and 50-year storm event. Based on preliminary models, the preliminary existing and proposed conditions for the flow during the 200-year storm event show an increase upstream of 0.6 feet in WSE and no change in the downstream WSE. Based on preliminary models, the preliminary existing and proposed conditions during the 100-year storm event show an increase upstream of 0.5 feet in WSE and no change in the downstream WSE. Based on preliminary models, the preliminary existing and proposed conditions during the 50-year storm event show an increase upstream of 0.6 feet in WSE and 0.1 ft increase in the downstream WSE. Figure 9 through Figure 11 shows the downstream face of Alternative F Bridge, Looking Upstream. Figure 12 shows the profile of the 200-year, 100-year, and 50-year WSEs.

Table 5. Alternative F Bridge Tributary 1 200-year Water Surface Elevations and Velocities

River Station	Description/Distance from Existing Bridge Centerline (ft)	100-Year (80 cfs) Water Surface Elevation (ft NAVD 88)		WSE Difference between Existing and Proposed Improvements	200-year Channel Velocity (ft/s)	
		Existing	Proposed		Existing	Proposed
652	Upstream of Alt. F Bridge and Tributary 1 crossing	834.2	834.8	0.6	6.0	4.6
545	Downstream of Alt. F Bridge and Tributary 1 crossing	824.2	824.2	0.0	4.3	4.7

Table 6. Alternative F Bridge Tributary 1 100-year Water Surface Elevations and Velocities

River Station	Description/Distance from Existing Bridge Centerline (ft)	100-Year (70 cfs) Water Surface Elevation (ft NAVD 88)		WSE Difference between Existing and Proposed Improvements	100-year Channel Velocity (ft/s)	
		Existing	Proposed		Existing	Proposed
652	Upstream of Alt. F Bridge and Tributary 1 crossing	834.2	834.7	0.5	5.8	4.4
545	Downstream of Alt. F Bridge and Tributary 1 crossing	824.1	824.1	0.0	4.3	4.6

Table 7. Alternative F Bridge Tributary 1 50-year Water Surface Elevations and Velocities

River Station	Description/Distance from Existing Bridge Centerline (ft)	50-Year (60 cfs) Water Surface Elevation (ft NAVD 88)		Difference between Existing and Proposed Improvements	50-year Channel Velocity (ft/s)	
		Existing	Proposed		Existing	Proposed
652	Upstream of Proposed Alt. F Bridge and Tributary 1 crossing	834.0	834.6	0.6	5.5	4.1
545	Downstream of Proposed Alt. F Bridge and Tributary 1 crossing	824.0	824.1	0.1	4.1	4.2

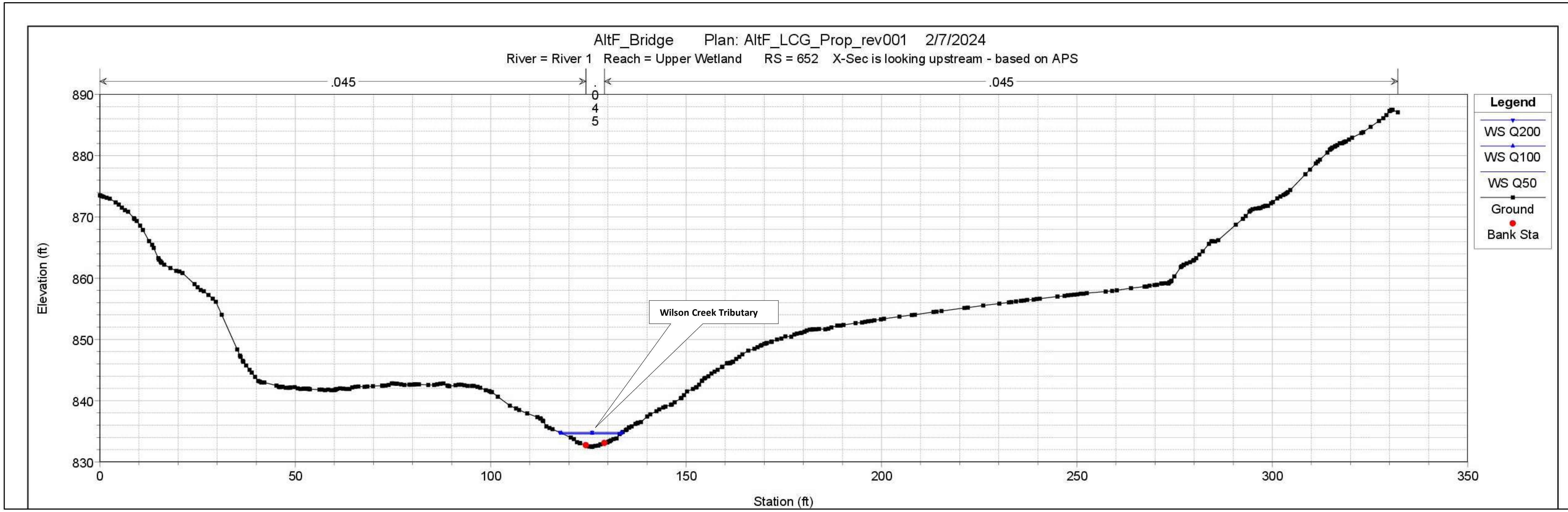

Figure 9. Upstream Face of Alternative F Bridge, Looking Upstream

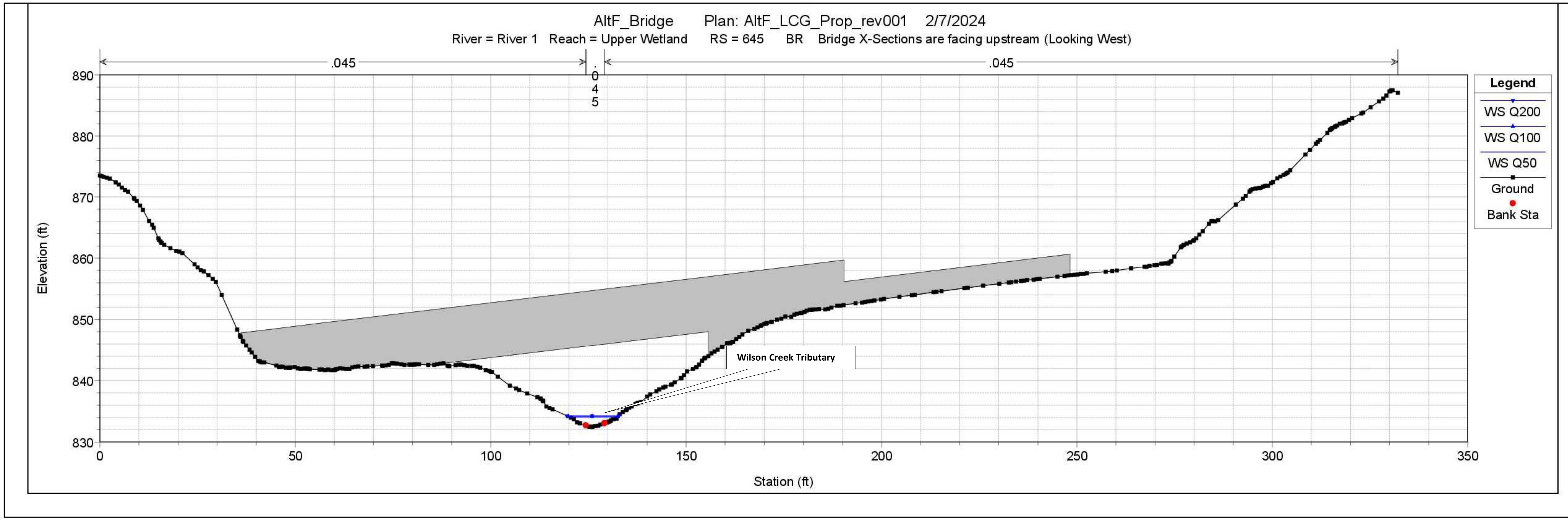

Figure 10. Upstream Face of Alternative F Bridge, Looking Upstream

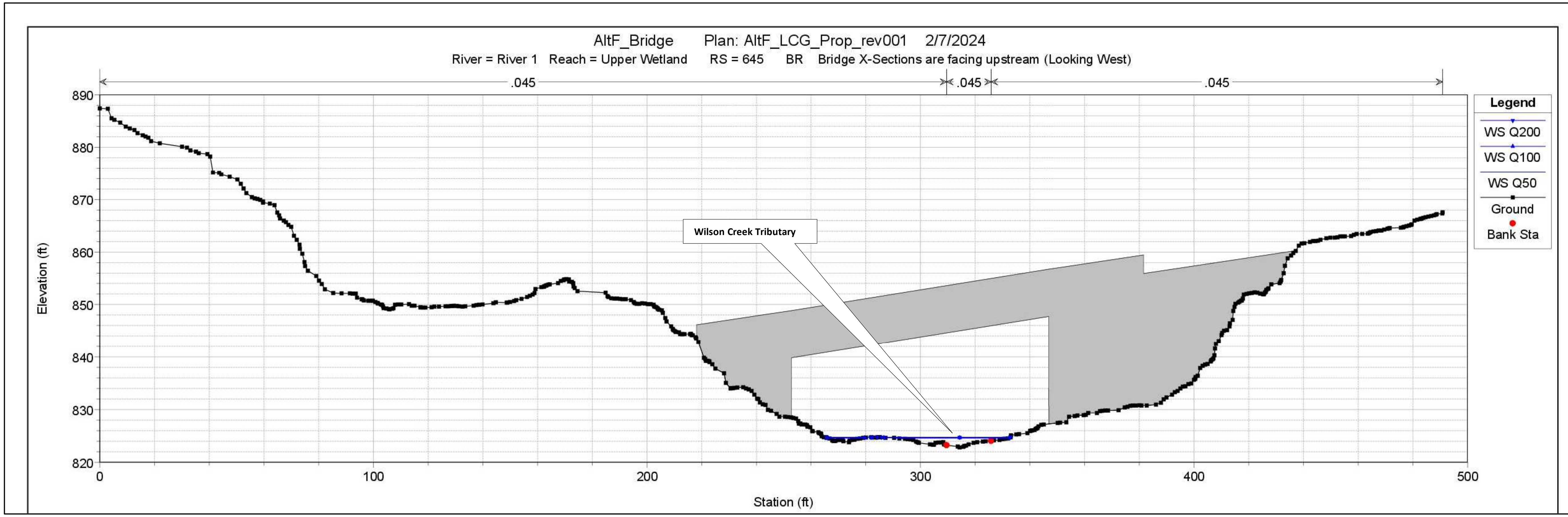

Figure 11. Downstream Face of Alternative F Bridge, Looking Upstream

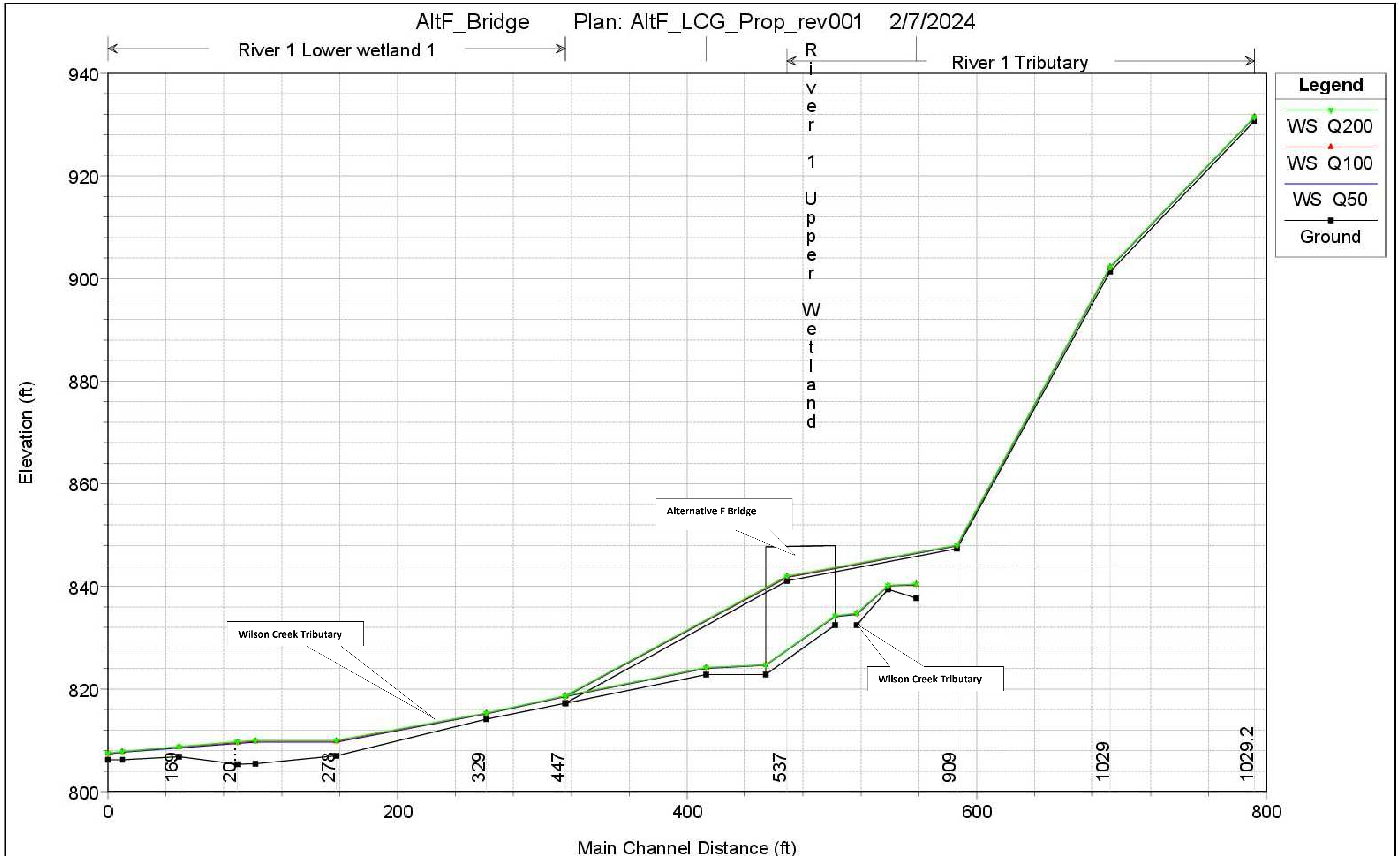

Figure 12. Alternative F Bridge 50- and 100-Year Water Surface Profile

Bridge Freeboard

Based on the preliminary bottom creek elevation provided by the Project site LiDAR imagery (Caltrans, 2021), WSE depth due to the Alternative F bridge was determined for Wilson Creek Tributary at the proposed upstream and downstream face was approximately 2.1 and 1.2 feet, respectively (Table 8), during the 50-year storm event. The proposed Alternative F bridge crossing at Wilson Creek Tributary has approximately 8.1 to 16.1 feet of freeboard during the 50-year storm event. The lowest soffit elevation for the proposed Alternative F bridge crossing was estimated to be 842.76 feet near Abutment 1 at the upstream face of the proposed bridge, and 839.4 feet at the downstream face near Abutment 1.

Table 8. Alternative F Bridge Q50 WSE Depth and Freeboard

Proposed Bridge	50-Year Storm Event (60 cfs)		
	WSE (ft NAVD 88)	WSE Depth of Crossing (feet)	Freeboard (feet)
Upstream Face (Soffit Elevation: 842.76 ft)	834.6	2.1	8.1
Downstream Face (Soffit Elevation: 839.4 ft)	824.1	1.2	15.3

The WSE depth due to the proposed Alternative F bridge crossing was determined for the Wilson Creek Tributary at the proposed upstream and downstream face to be approximately 2.2 and 1.2 feet, respectively, during the 100-year storm event. During the 100-year storm, the available freeboard is shown in Table 9. Based on the preliminary analysis, the proposed Alternative F bridge has approximately 8.0 to 15.3 feet of freeboard.

Table 9. Alternative F Bridge Q100 WSE Depth and Freeboard

Proposed Bridge	100-Year Storm Event (70 cfs)		
	WSE (ft NAVD 88)	WSE Depth of Crossing (feet)	Freeboard (feet)
Upstream Face (Soffit Elevation: 842.76 ft)	834.7	2.2	8.0
Downstream Face (Soffit Elevation: 839.4 ft)	824.1	1.2	15.3

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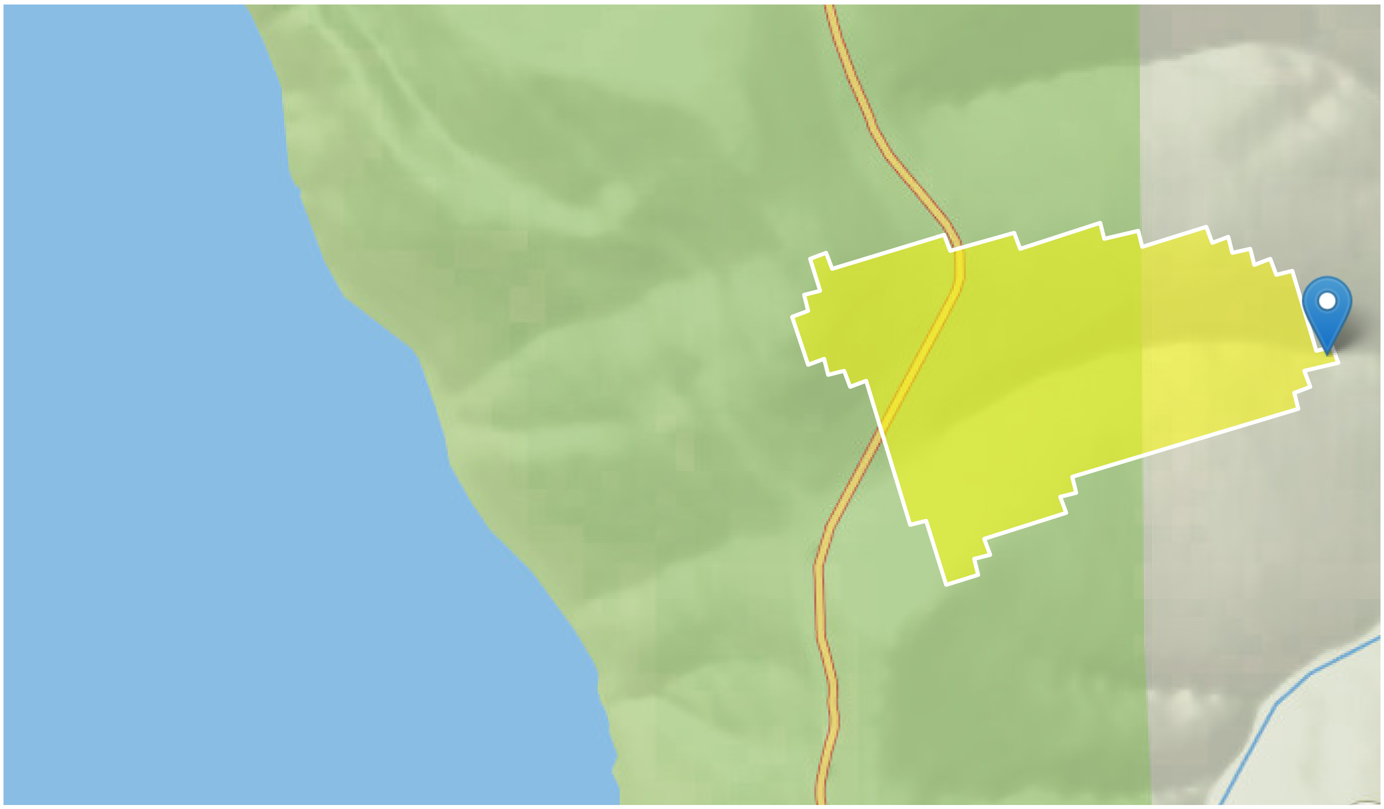
ATTACHMENTS

- NOAA Atlas 14 Rainfall Intensity
- USGS StreamStats Report
- HEC-RAS Results for Existing Conditions
- HEC-RAS Results for Proposed Conditions

StreamStats Report

Region ID: CA
Workspace ID: CA20220211010159446000
Clicked Point (Latitude, Longitude): 41.64559, -124.10427
Time: 2022-02-10 17:02:23 -0800



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
DRNAREA	Area that drains to a point on a stream	0.1	square miles
PRECIP	Mean Annual Precipitation	83.1	inches
BASINPERIM	Perimeter of the drainage basin as defined in SIR 2004-5262	1.9	miles
BSLDEM30M	Mean basin slope computed from 30 m DEM	22.7	percent
EL6000	Percent of area above 6000 ft	0	percent
ELEV	Mean Basin Elevation	859	feet
ELEVMAX	Maximum basin elevation	1131	feet

Parameter Code	Parameter Description	Value	Unit
FOREST	Percentage of area covered by forest	82.7	percent
JANMAXTMP	Mean Maximum January Temperature	50.73	degrees F
JANMINTMP	Mean Minimum January Temperature	35.18	degrees F
LAKEAREA	Percentage of Lakes and Ponds	0	percent
LC11DEV	Percentage of developed (urban) land from NLCD 2011 classes 21-24	12.6	percent
LC11IMP	Average percentage of impervious area determined from NLCD 2011 impervious dataset	0.2	percent
LFPLENGTH	Length of longest flow path	1	miles
MINBELEV	Minimum basin elevation	533	feet
OUTLETELEV	Elevation of the stream outlet in feet above NAVD88	533	feet
RELIEF	Maximum - minimum elevation	598	feet
RELRELF	Basin relief divided by basin perimeter	315	feet per mi

Peak-Flow Statistics Parameters [2012 5113 Region 1 North Coast]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.1	square miles	0.04	3200
PRECIP	Mean Annual Precipitation	83.1	inches	20	125

Peak-Flow Statistics Flow Report [2012 5113 Region 1 North Coast]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, ASEp: Average Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	ASEp
50-percent AEP flood	17.5	ft^3/s	6.97	43.9	58.6
20-percent AEP flood	31.9	ft^3/s	14.9	68.5	47.4
10-percent AEP flood	42.3	ft^3/s	20.4	87.6	44.2
4-percent AEP flood	55.8	ft^3/s	27.8	112	42.7
2-percent AEP flood	66.2	ft^3/s	32.8	133	42.7

Statistic	Value	Unit	PIl	PIu	ASEp
1-percent AEP flood	77.1	ft^3/s	37.3	160	44.3
0.5-percent AEP flood	87.4	ft^3/s	42.1	182	44.4
0.2-percent AEP flood	101	ft^3/s	47.4	215	46

Peak-Flow Statistics Citations

Gotvald, A.J., Barth, N.A., Veilleux, A.G., and Parrett, Charles,2012, Methods for determining magnitude and frequency of floods in California, based on data through water year 2006: U.S. Geological Survey Scientific Investigations Report 2012–5113, 38 p., 1 pl. (http://pubs.usgs.gov/sir/2012/5113/)

Application Version: 4.6.2
StreamStats Services Version: 1.2.22
NSS Services Version: 2.1.2

NOAA Atlas 14, Volume 6, Version 2
Location name: Klamath, California, USA*
Latitude: 41.6469°, Longitude: -124.1122°
Elevation: 956.24 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sarah Dietz, Sarah Heim, Lillian Hiner, Kazungu Maitaria, Deborah Martin, Sandra Pavlovic, Ishani Roy, Carl Trypaluk, Dale Unruh, Fenglin Yan, Michael Yekta, Tan Zhao, Geoffrey Bonnin, Daniel Brewer, Li-Chuan Chen, Tye Parzybok, John Yarchoan

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches/hour)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**2.16** (1.88-2.51)	**2.66** (2.32-3.08)	**3.31** (2.87-3.85)	**3.84** (3.31-4.51)	**4.57** (3.79-5.58)	**5.15** (4.16-6.42)	**5.72** (4.51-7.34)	**6.32** (4.84-8.36)	**7.15** (5.22-9.91)	**7.80** (5.48-11.2)
10-min	**1.55** (1.35-1.80)	**1.91** (1.66-2.21)	**2.37** (2.06-2.76)	**2.75** (2.37-3.24)	**3.28** (2.72-4.00)	**3.68** (2.98-4.60)	**4.10** (3.23-5.26)	**4.54** (3.46-6.00)	**5.12** (3.74-7.10)	**5.59** (3.92-8.05)
15-min	**1.25** (1.09-1.45)	**1.54** (1.34-1.78)	**1.91** (1.66-2.23)	**2.22** (1.91-2.61)	**2.64** (2.19-3.22)	**2.97** (2.40-3.71)	**3.31** (2.60-4.24)	**3.66** (2.79-4.84)	**4.13** (3.02-5.72)	**4.51** (3.16-6.48)
30-min	**0.874** (0.762-1.01)	**1.07** (0.934-1.25)	**1.34** (1.16-1.56)	**1.55** (1.34-1.82)	**1.85** (1.53-2.25)	**2.08** (1.68-2.59)	**2.31** (1.82-2.96)	**2.55** (1.95-3.38)	**2.89** (2.11-4.00)	**3.15** (2.21-4.53)
60-min	**0.648** (0.565-0.751)	**0.796** (0.693-0.923)	**0.991** (0.860-1.15)	**1.15** (0.990-1.35)	**1.37** (1.14-1.67)	**1.54** (1.25-1.92)	**1.71** (1.35-2.20)	**1.89** (1.45-2.50)	**2.14** (1.56-2.96)	**2.34** (1.64-3.36)
2-hr	**0.498** (0.434-0.577)	**0.606** (0.527-0.702)	**0.747** (0.648-0.870)	**0.863** (0.742-1.01)	**1.02** (0.846-1.24)	**1.14** (0.925-1.43)	**1.27** (0.998-1.63)	**1.40** (1.07-1.85)	**1.57** (1.15-2.18)	**1.71** (1.20-2.46)
3-hr	**0.428** (0.373-0.496)	**0.518** (0.451-0.601)	**0.636** (0.552-0.740)	**0.732** (0.629-0.859)	**0.861** (0.714-1.05)	**0.961** (0.778-1.20)	**1.06** (0.837-1.36)	**1.17** (0.891-1.54)	**1.31** (0.954-1.81)	**1.42** (0.996-2.04)
6-hr	**0.332** (0.289-0.384)	**0.400** (0.349-0.465)	**0.489** (0.424-0.569)	**0.559** (0.481-0.657)	**0.653** (0.541-0.796)	**0.724** (0.586-0.903)	**0.795** (0.626-1.02)	**0.867** (0.662-1.15)	**0.962** (0.702-1.33)	**1.04** (0.727-1.49)
12-hr	**0.247** (0.215-0.286)	**0.303** (0.264-0.352)	**0.373** (0.324-0.434)	**0.427** (0.368-0.502)	**0.498** (0.412-0.606)	**0.549** (0.444-0.685)	**0.599** (0.471-0.768)	**0.648** (0.495-0.857)	**0.711** (0.519-0.985)	**0.759** (0.533-1.09)
24-hr	**0.190** (0.169-0.217)	**0.238** (0.212-0.272)	**0.296** (0.263-0.339)	**0.340** (0.300-0.393)	**0.396** (0.340-0.470)	**0.435** (0.367-0.526)	**0.473** (0.391-0.584)	**0.510** (0.411-0.645)	**0.556** (0.433-0.729)	**0.590** (0.445-0.797)
2-day	**0.131** (0.117-0.149)	**0.163** (0.146-0.187)	**0.202** (0.180-0.232)	**0.232** (0.205-0.268)	**0.270** (0.232-0.321)	**0.297** (0.250-0.359)	**0.322** (0.266-0.398)	**0.347** (0.280-0.439)	**0.379** (0.295-0.497)	**0.401** (0.303-0.543)
3-day	**0.101** (0.090-0.116)	**0.126** (0.112-0.144)	**0.155** (0.138-0.178)	**0.178** (0.157-0.206)	**0.207** (0.178-0.246)	**0.227** (0.192-0.275)	**0.247** (0.204-0.305)	**0.266** (0.215-0.337)	**0.290** (0.226-0.380)	**0.307** (0.232-0.416)
4-day	**0.086** (0.076-0.098)	**0.106** (0.095-0.122)	**0.131** (0.117-0.151)	**0.150** (0.133-0.174)	**0.174** (0.150-0.207)	**0.191** (0.161-0.231)	**0.207** (0.171-0.256)	**0.223** (0.180-0.282)	**0.243** (0.189-0.319)	**0.257** (0.194-0.348)
7-day	**0.062** (0.055-0.071)	**0.077** (0.068-0.088)	**0.094** (0.084-0.108)	**0.107** (0.095-0.124)	**0.124** (0.106-0.147)	**0.135** (0.114-0.164)	**0.146** (0.121-0.181)	**0.157** (0.126-0.198)	**0.170** (0.132-0.223)	**0.179** (0.135-0.242)
10-day	**0.051** (0.046-0.058)	**0.063** (0.056-0.072)	**0.077** (0.069-0.088)	**0.087** (0.077-0.101)	**0.100** (0.086-0.119)	**0.109** (0.092-0.132)	**0.118** (0.097-0.145)	**0.126** (0.101-0.159)	**0.136** (0.106-0.178)	**0.143** (0.108-0.193)
20-day	**0.035** (0.031-0.040)	**0.043** (0.038-0.049)	**0.052** (0.046-0.059)	**0.058** (0.052-0.067)	**0.066** (0.057-0.079)	**0.072** (0.061-0.087)	**0.077** (0.064-0.095)	**0.082** (0.066-0.103)	**0.087** (0.068-0.114)	**0.091** (0.069-0.123)
30-day	**0.029** (0.026-0.034)	**0.036** (0.032-0.041)	**0.043** (0.038-0.049)	**0.048** (0.043-0.056)	**0.055** (0.047-0.065)	**0.059** (0.050-0.071)	**0.063** (0.052-0.078)	**0.066** (0.054-0.084)	**0.071** (0.055-0.093)	**0.074** (0.056-0.099)
45-day	**0.025** (0.023-0.029)	**0.031** (0.027-0.035)	**0.036** (0.032-0.042)	**0.041** (0.036-0.047)	**0.046** (0.039-0.054)	**0.049** (0.041-0.059)	**0.052** (0.043-0.064)	**0.055** (0.044-0.069)	**0.058** (0.045-0.076)	**0.060** (0.045-0.081)
60-day	**0.023** (0.020-0.026)	**0.027** (0.024-0.031)	**0.032** (0.029-0.037)	**0.036** (0.032-0.042)	**0.040** (0.034-0.048)	**0.043** (0.036-0.052)	**0.045** (0.037-0.056)	**0.047** (0.038-0.060)	**0.050** (0.039-0.066)	**0.052** (0.039-0.070)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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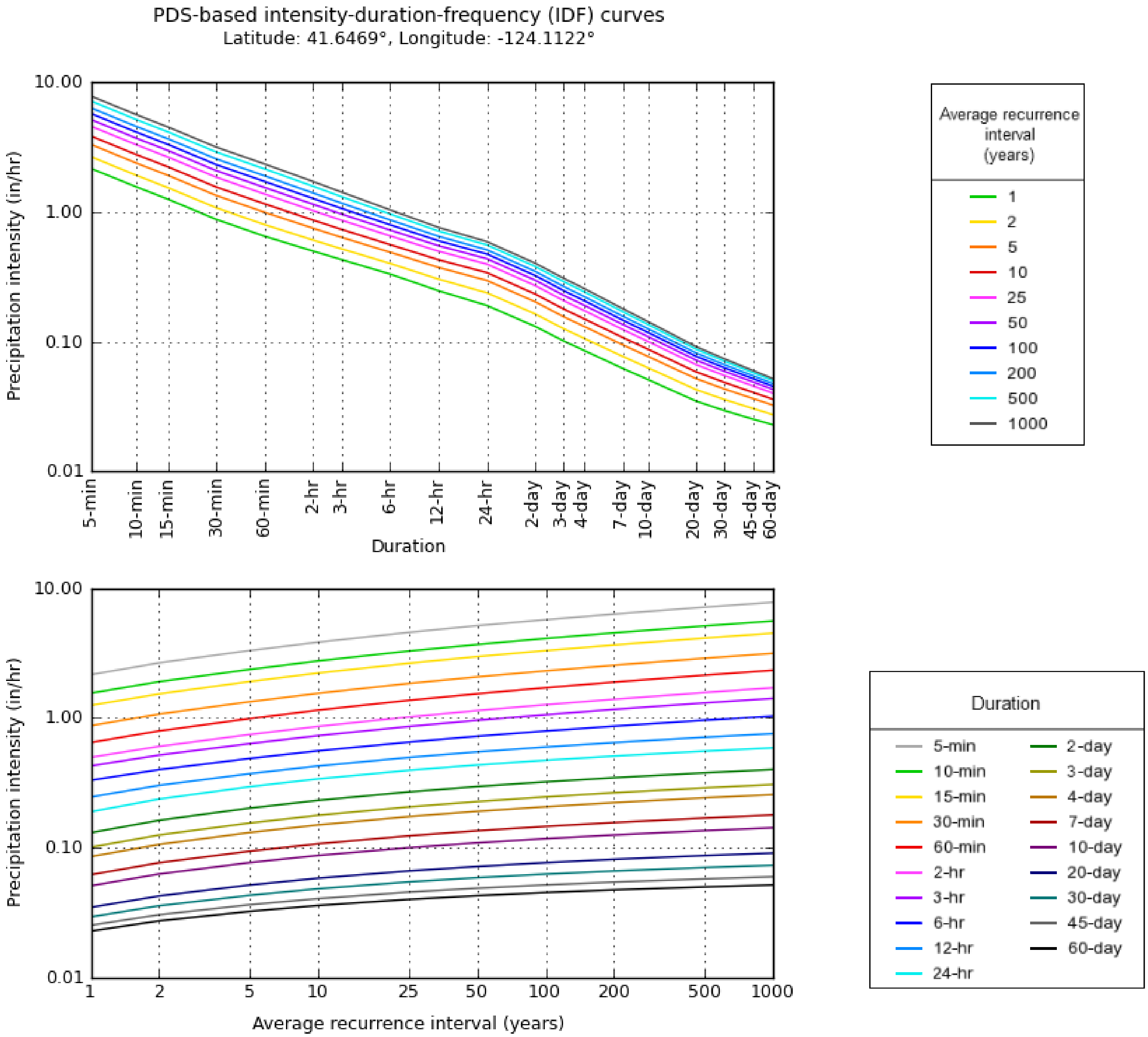
PF graphical



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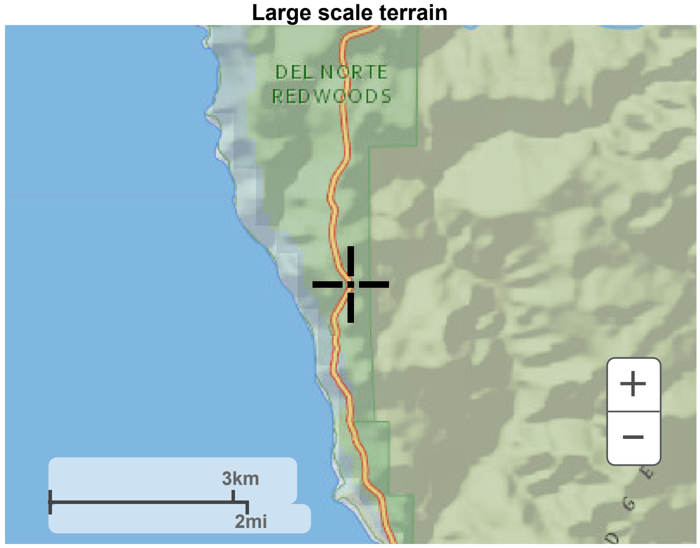
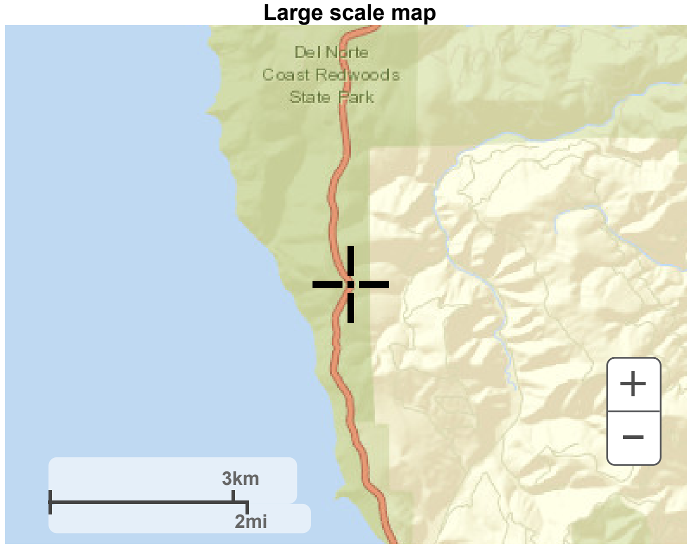
Maps & aerials

Small scale terrain

Large scale terrain



Large scale map



Large scale aerial

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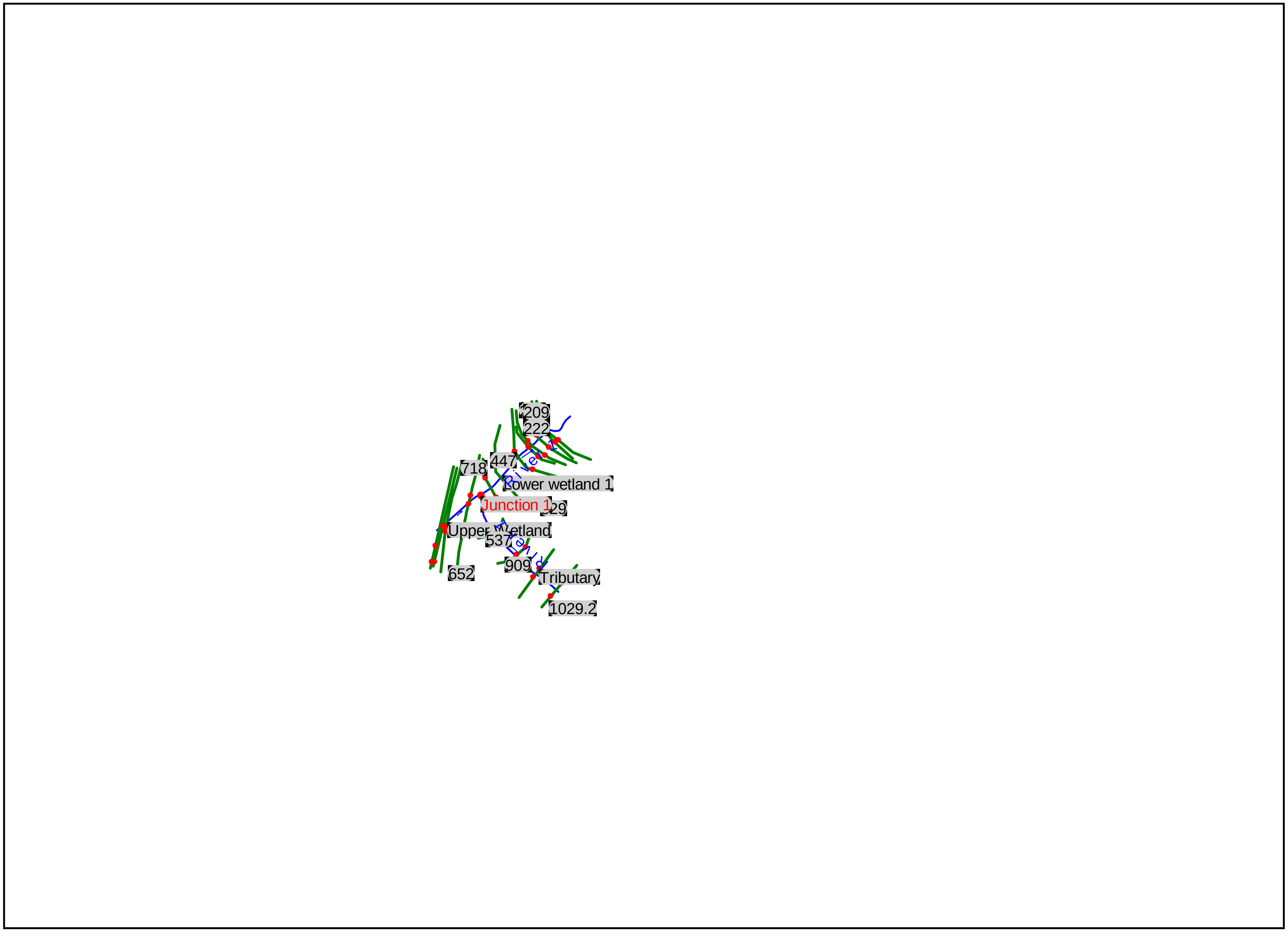
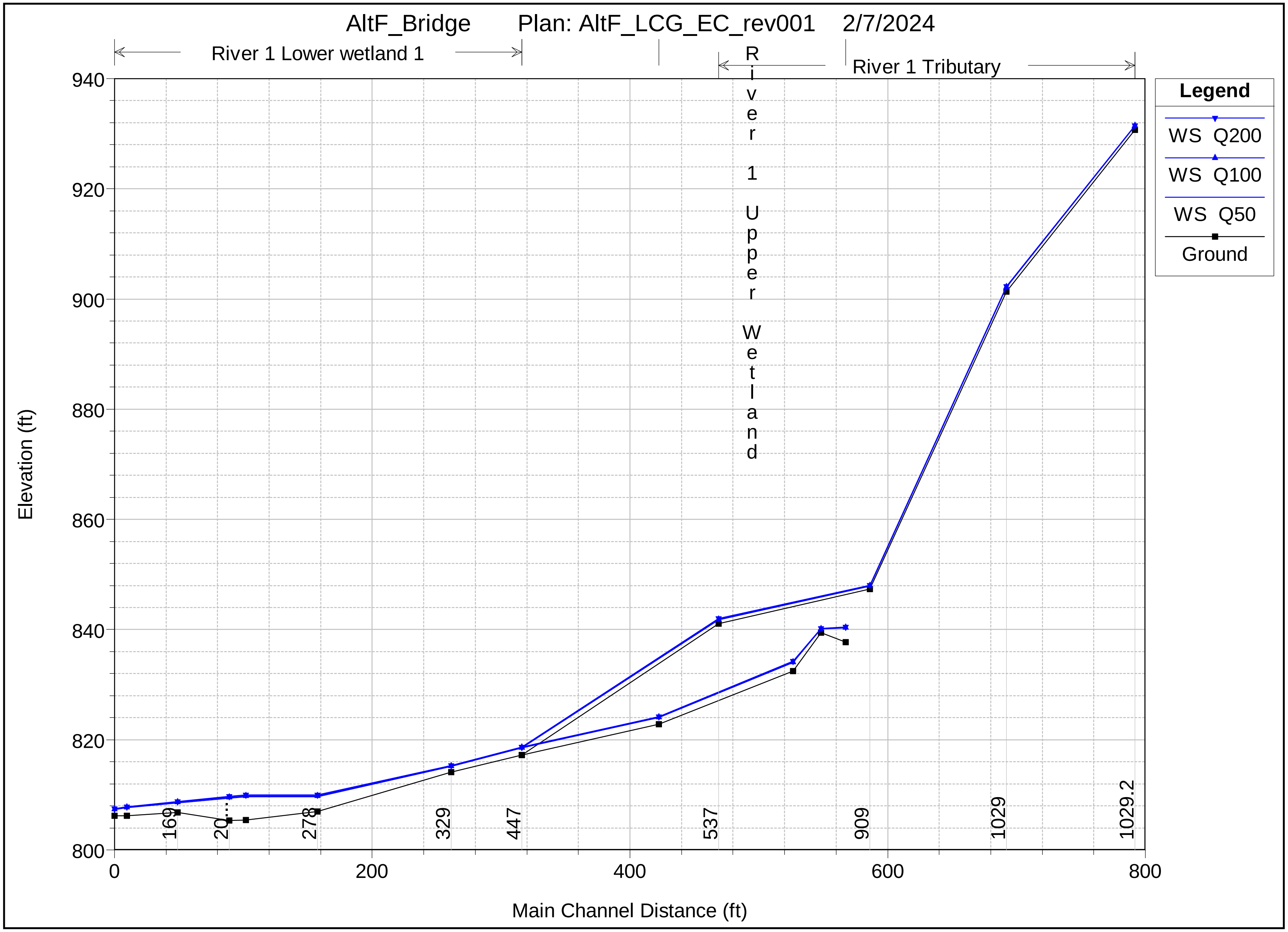


209
222
447
718
River1
Lower wetland 1
Junction 1
29
Upper Wetland
537
909
Tributary
652
1029.2


AltF_Bridge Plan: AltF_LCG_EC_rev001 2/7/2024
River 1 Lower wetland 1
River 1 Upper Wetland
River 1 Tributary
Legend
WS Q200
WS Q100
WS Q50
Ground
Elevation (ft)
Main Channel Distance (ft)
940
920
900
880
860
840
820
800
0
200
400
600
800
169
20
278
329
447
537
909
1029
1029.2

HEC-RAS Plan: OG_AltF_rev001 Profile: Q200

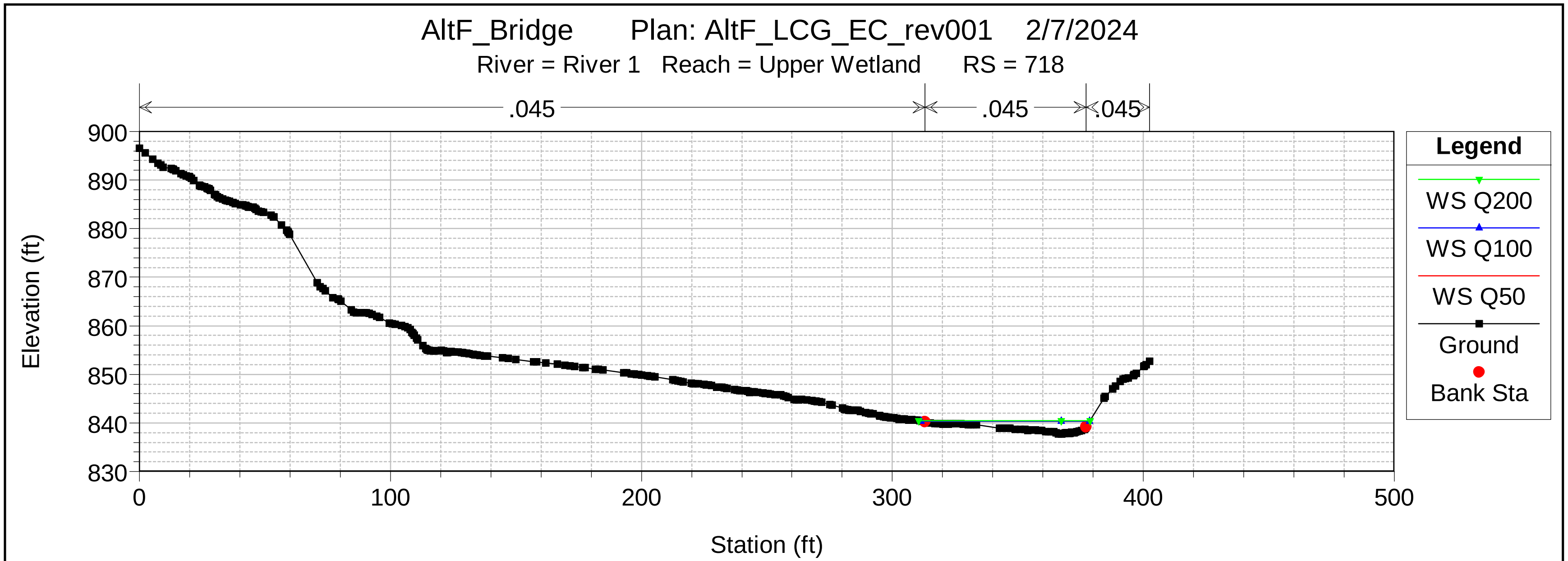
Reach	River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
		(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Upper Wetland	718	80.00	837.70	840.45		840.46	0.000397	0.85	95.36	68.18	0.12
Upper Wetland	684	80.00	839.42	840.17	840.17	840.41	0.039577	3.91	20.46	44.30	1.01
Upper Wetland	652	80.00	832.49	834.23	834.23	834.78	0.030387	5.95	13.51	12.93	1.00
Upper Wetland	545	80.00	822.83	824.17	824.17	824.46	0.033654	4.34	18.83	33.54	0.97
Tributary	1029.2	13.00	930.74	931.51	931.51	931.67	0.046241	3.26	3.98	12.55	1.02
Tributary	1029	13.00	901.38	902.33	902.33	902.61	0.040547	4.26	3.05	5.51	1.01
Tributary	909	13.00	847.35	848.05	848.05	848.22	0.043722	3.28	3.97	11.98	1.00
Tributary	537	13.00	841.04	841.99	841.99	842.27	0.040432	4.29	3.03	5.42	1.01
Lower wetland 1	447	90.00	817.19	818.65	818.65	819.11	0.032560	5.42	16.59	18.54	1.01
Lower wetland 1	329	90.00	814.10	815.30	815.30	815.71	0.033819	5.09	17.68	22.43	1.01
Lower wetland 1	278	90.00	806.96	809.98		810.07	0.002902	2.37	37.94	23.66	0.33
Lower wetland 1	222	90.00	805.41	809.97		810.00	0.000442	1.29	70.04	25.35	0.14
Lower wetland 1	209	90.00	805.30	809.71		809.96	0.007680	3.99	22.53	9.22	0.45
Lower wetland 1	169	90.00	806.79	808.76	808.76	809.38	0.030741	6.28	14.33	11.93	1.01
Lower wetland 1	130	90.00	806.23	807.87		808.01	0.007140	2.95	30.52	27.81	0.50
Lower wetland 1	120	90.00	806.24	807.45	807.45	807.85	0.033133	5.06	17.79	22.87	1.01

HEC-RAS Plan: OG_AltF_rev001 Profile: Q100

Reach	River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
		(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Upper Wetland	718	70.00	837.70	840.39		840.40	0.000352	0.77	91.15	67.16	0.11
Upper Wetland	684	70.00	839.42	840.13	840.13	840.35	0.040461	3.76	18.63	43.53	1.01
Upper Wetland	652	70.00	832.49	834.12	834.12	834.64	0.031792	5.75	12.20	12.45	1.01
Upper Wetland	545	70.00	822.83	824.10	824.10	824.38	0.037714	4.32	16.48	31.68	1.01
Tributary	1029.2	10.00	930.74	931.45	931.45	931.59	0.046998	3.07	3.26	11.40	1.01
Tributary	1029	10.00	901.38	902.22	902.22	902.47	0.042060	4.03	2.48	5.05	1.01
Tributary	909	10.00	847.35	847.98	847.98	848.14	0.046724	3.12	3.21	10.97	1.02
Tributary	537	10.00	841.04	841.88	841.88	842.13	0.041831	4.02	2.49	5.07	1.01
Lower wetland 1	447	80.00	817.19	818.58	818.58	819.01	0.033439	5.26	15.21	18.20	1.01
Lower wetland 1	329	80.00	814.10	815.24	815.24	815.62	0.034708	4.91	16.28	22.25	1.01
Lower wetland 1	278	80.00	806.96	809.81		809.90	0.003092	2.35	34.01	22.53	0.34
Lower wetland 1	222	80.00	805.41	809.80		809.83	0.000412	1.22	65.84	24.64	0.13
Lower wetland 1	209	80.00	805.30	809.57		809.79	0.007077	3.76	21.26	8.97	0.43
Lower wetland 1	169	80.00	806.79	808.66	808.66	809.24	0.030928	6.11	13.10	11.44	1.01
Lower wetland 1	130	80.00	806.23	807.79		807.91	0.006991	2.83	28.30	27.05	0.49
Lower wetland 1	120	80.00	806.24	807.38	807.38	807.76	0.033656	4.92	16.25	22.03	1.01

HEC-RAS Plan: OG_AltF_rev001 Profile: Q50

Reach	River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
		(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Upper Wetland	718	60.00	837.70	840.32		840.33	0.000304	0.70	86.74	66.16	0.11
Upper Wetland	684	60.00	839.42	840.09	840.09	840.29	0.041826	3.60	16.68	42.73	1.01
Upper Wetland	652	60.00	832.49	834.02	834.02	834.49	0.033230	5.51	10.90	11.96	1.02
Upper Wetland	545	60.00	822.83	824.04	824.04	824.30	0.037310	4.10	14.83	29.97	1.00
Tributary	1029.2	7.00	930.74	931.38	931.38	931.50	0.049921	2.79	2.51	10.58	1.01
Tributary	1029	7.00	901.38	902.09	902.09	902.31	0.043857	3.72	1.88	4.46	1.01
Tributary	909	7.00	847.35	847.91	847.91	848.04	0.046584	2.86	2.45	9.49	0.99
Tributary	537	7.00	841.04	841.76	841.76	841.97	0.044111	3.68	1.90	4.65	1.01
Lower wetland 1	447	70.00	817.19	818.50	818.50	818.90	0.034167	5.06	13.84	17.85	1.01
Lower wetland 1	329	70.00	814.10	815.18	815.18	815.52	0.034748	4.68	14.97	22.07	1.00
Lower wetland 1	278	70.00	806.96	809.63		809.71	0.003376	2.33	30.00	21.51	0.35
Lower wetland 1	222	70.00	805.41	809.63		809.65	0.000380	1.14	61.49	23.88	0.13
Lower wetland 1	209	70.00	805.30	809.42		809.62	0.006427	3.51	19.94	8.70	0.41
Lower wetland 1	169	70.00	806.79	808.54	808.54	809.09	0.031703	5.95	11.76	10.89	1.01
Lower wetland 1	130	70.00	806.23	807.70		807.82	0.006836	2.70	25.97	26.24	0.48
Lower wetland 1	120	70.00	806.24	807.31	807.31	807.66	0.034182	4.76	14.70	21.20	1.01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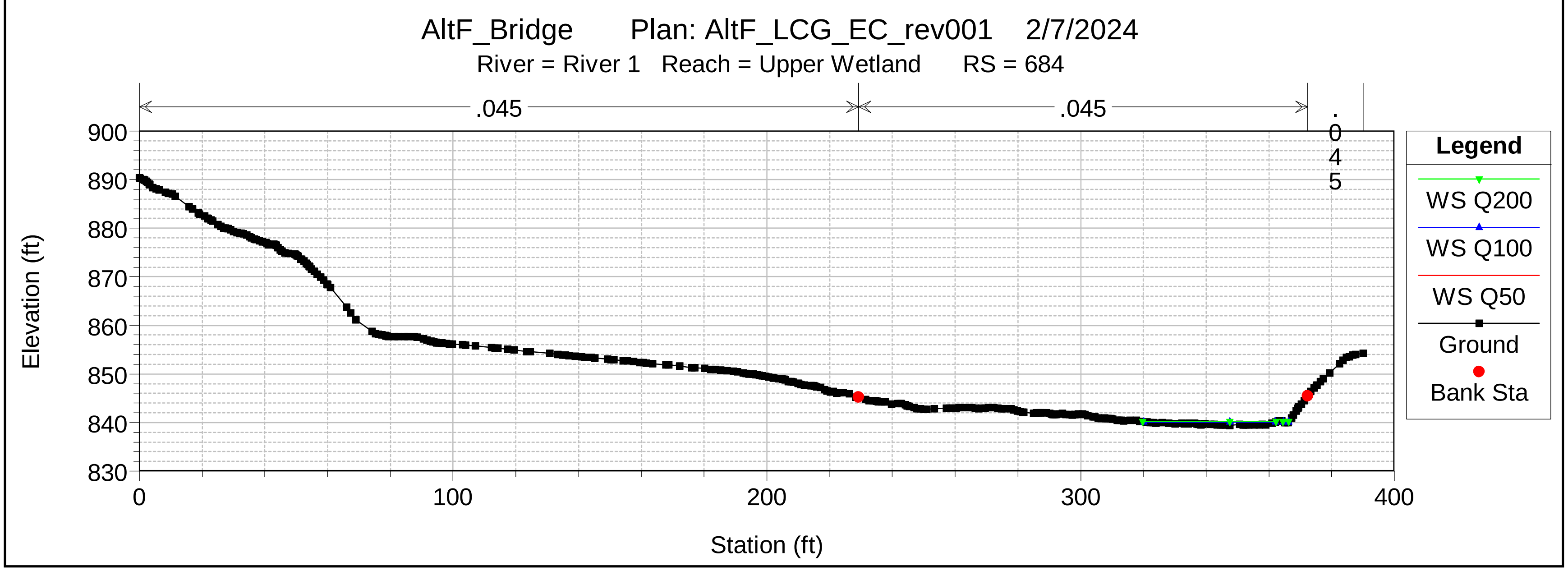
River = River 1 Reach = Upper Wetland RS = 718
.045
.045
.045
Elevation (ft)
900
890
880
870
860
850
840
830
0
100
200
300
400
500
Station (ft)
Legend
WS Q200
WS Q100
WS Q50
Ground
Bank Sta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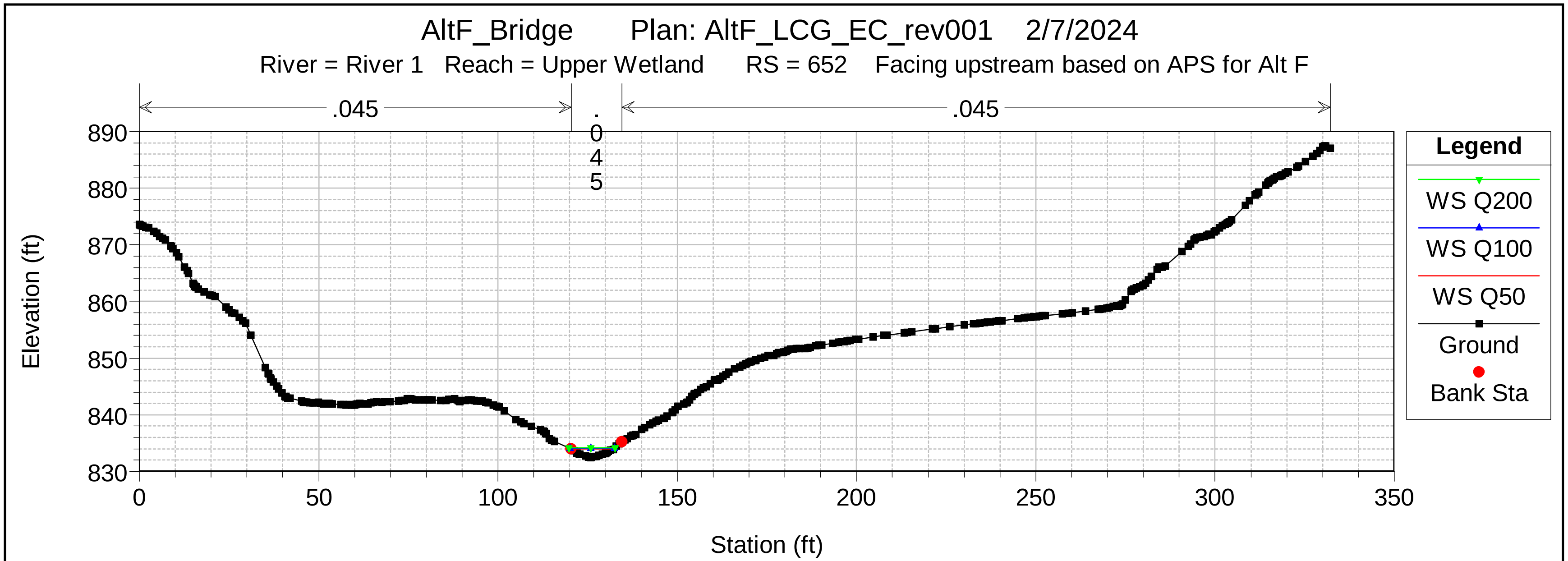
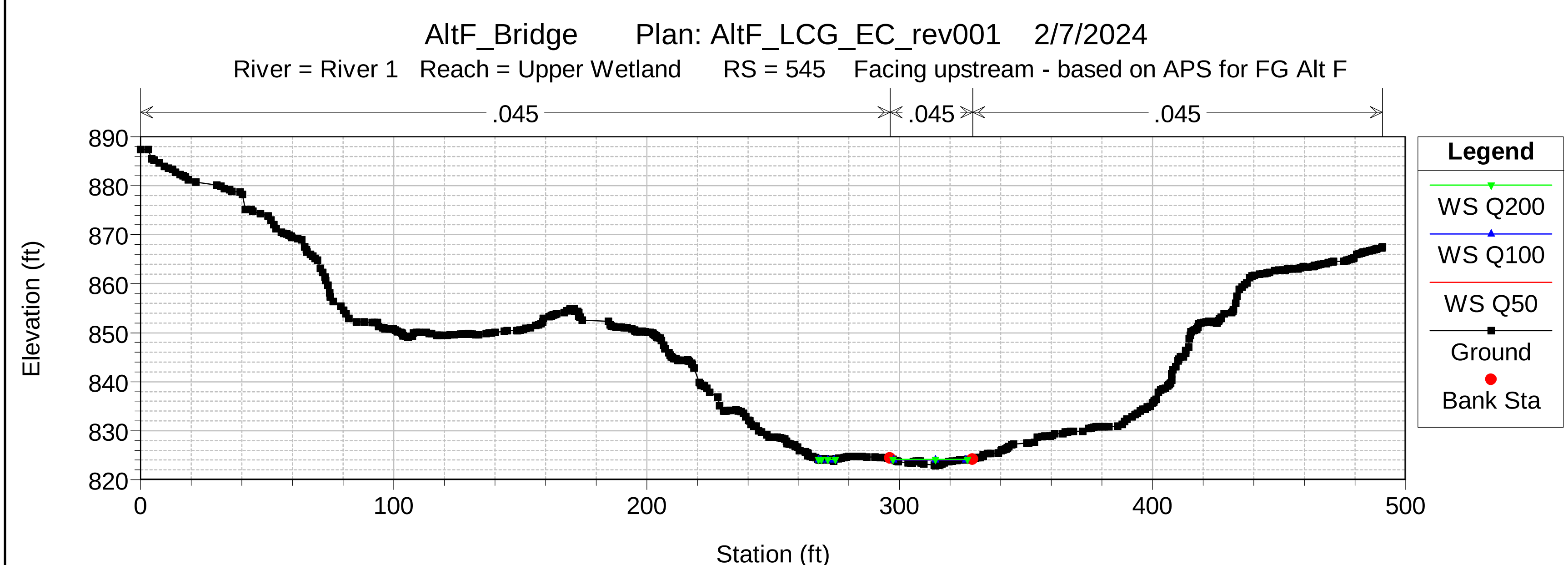
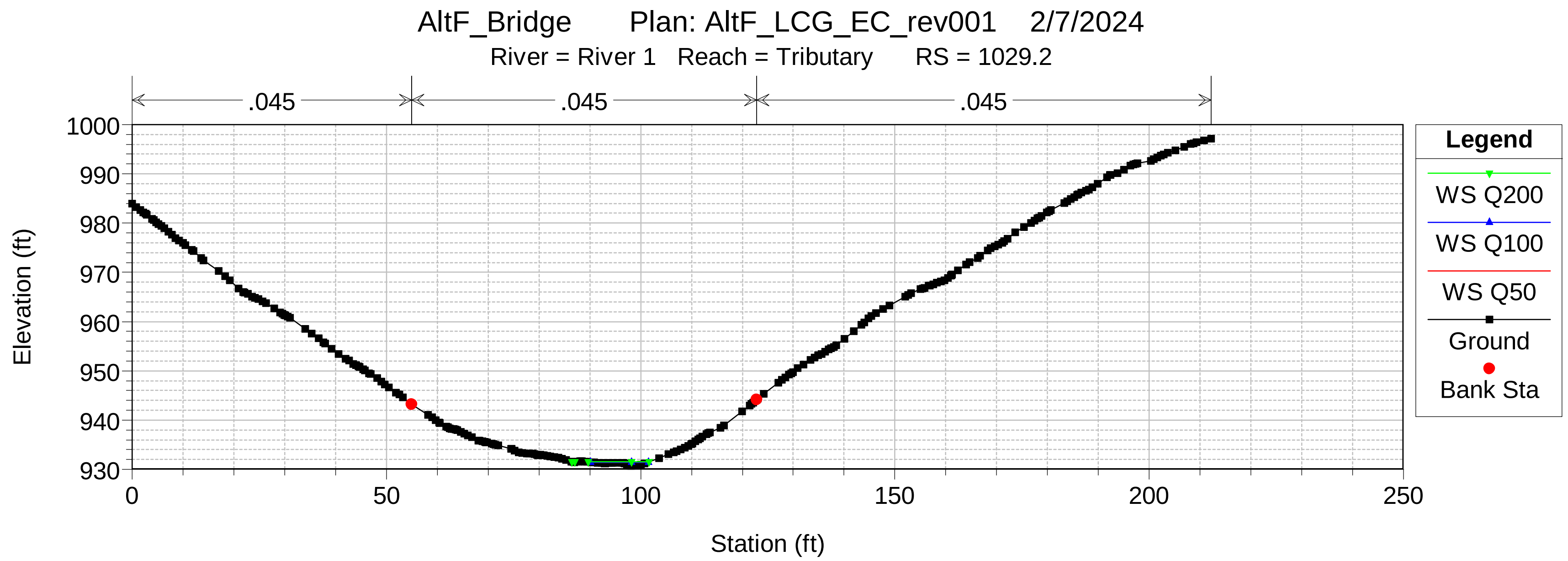
River = River 1 Reach = Upper Wetland RS = 684
.045
.045
.045
Elevation (ft)
900
890
880
870
860
850
840
830
0
100
200
300
400
Station (ft)
Legend
WS Q200
WS Q100
WS Q50
Ground
Bank Sta



AltF_Bridge Plan: AltF_LCG_EC_rev001 2/7/2024
River = River 1 Reach = Upper Wetland RS = 652 Facing upstream based on APS for Alt F
.045
.045
.045
Elevation (ft)
Station (ft)
Legend
WS Q200
WS Q100
WS Q50
Ground
Bank Sta



AltF_Bridge Plan: AltF_LCG_EC_rev001 2/7/2024
River = River 1 Reach = Upper Wetland RS = 545 Facing upstream - based on APS for FG Alt F
.045
.045
.045
Elevation (ft)
Station (ft)
Legend
WS Q200
WS Q100
WS Q50
Ground
Bank Sta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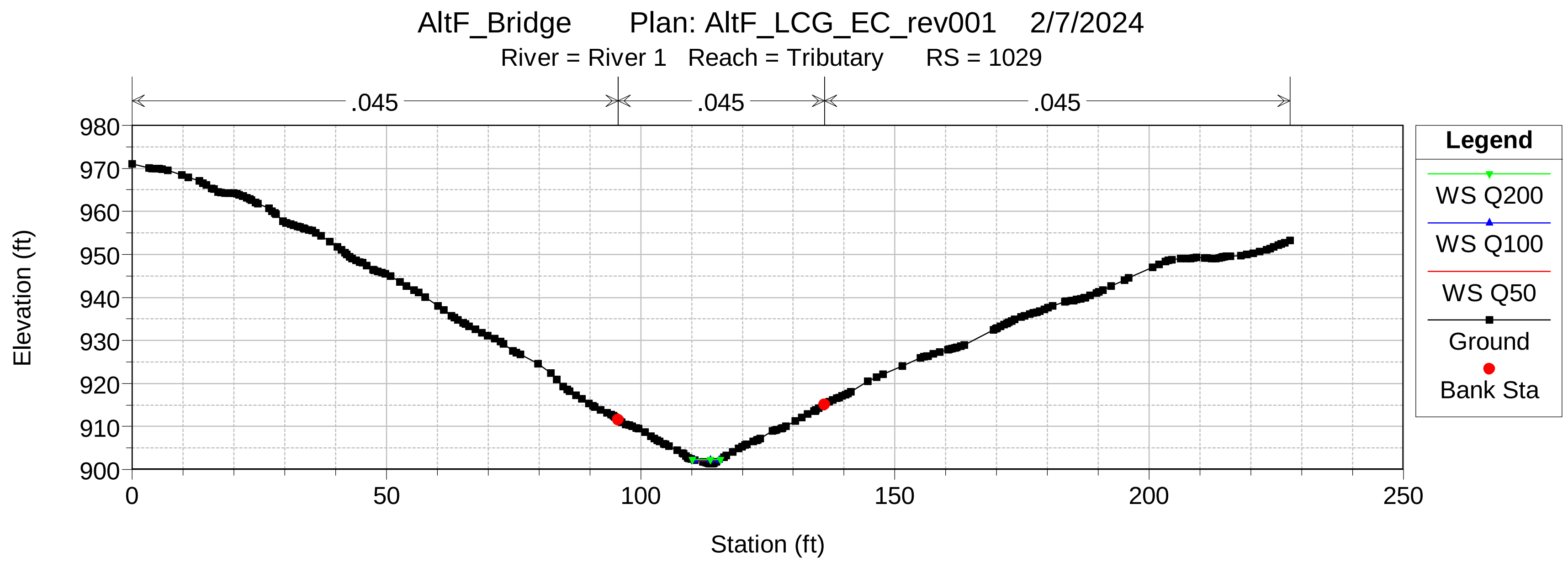
River = River 1 Reach = Tributary RS = 1029.2
.045
.045
.045
Elevation (ft)
Station (ft)
Legend
WS Q200
WS Q100
WS Q50
Ground
Bank Sta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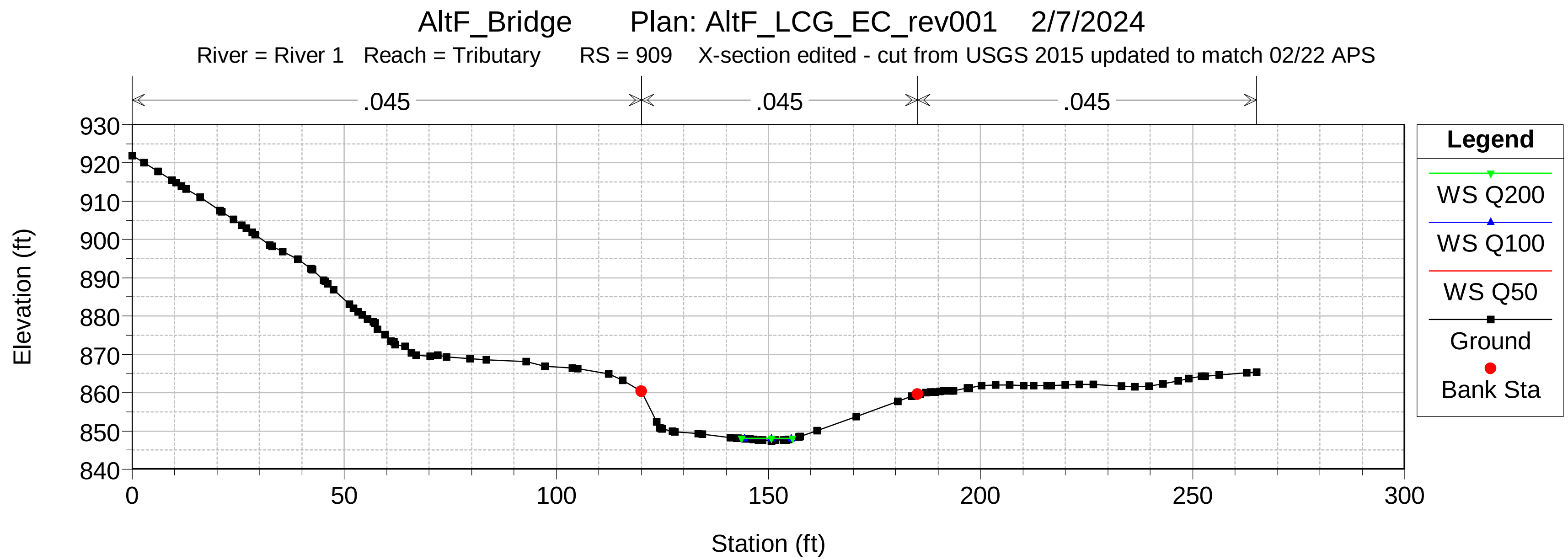
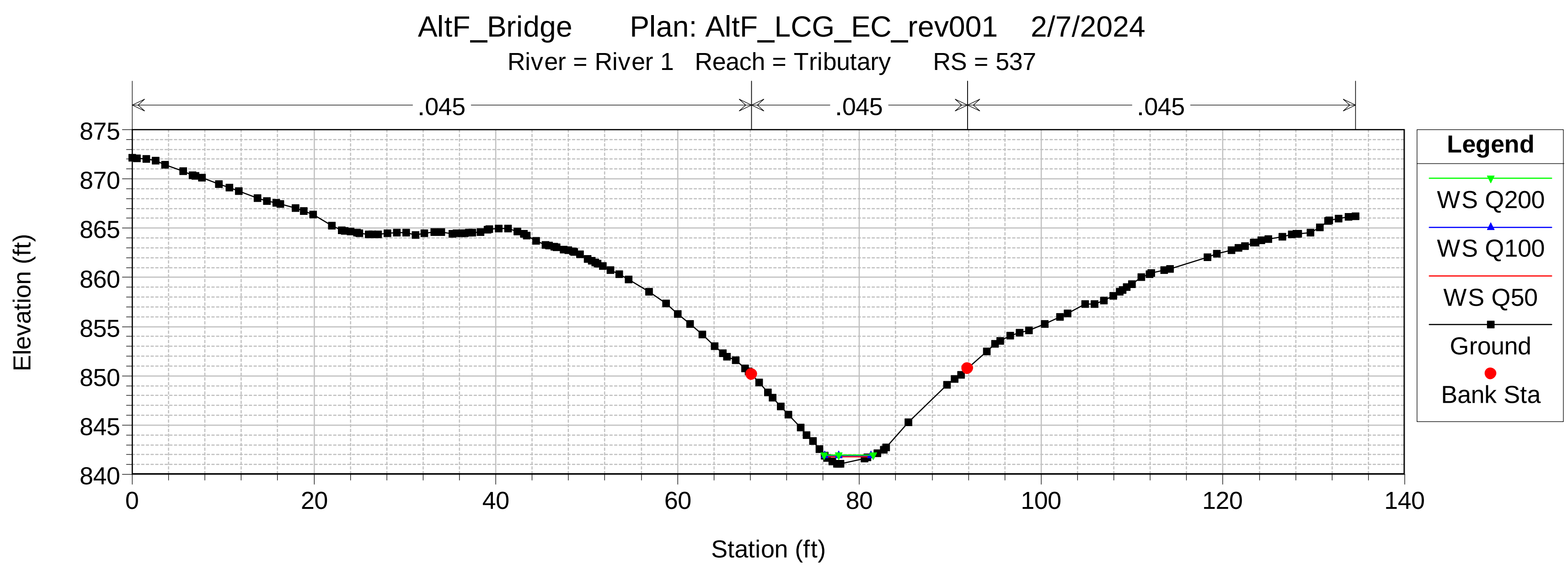
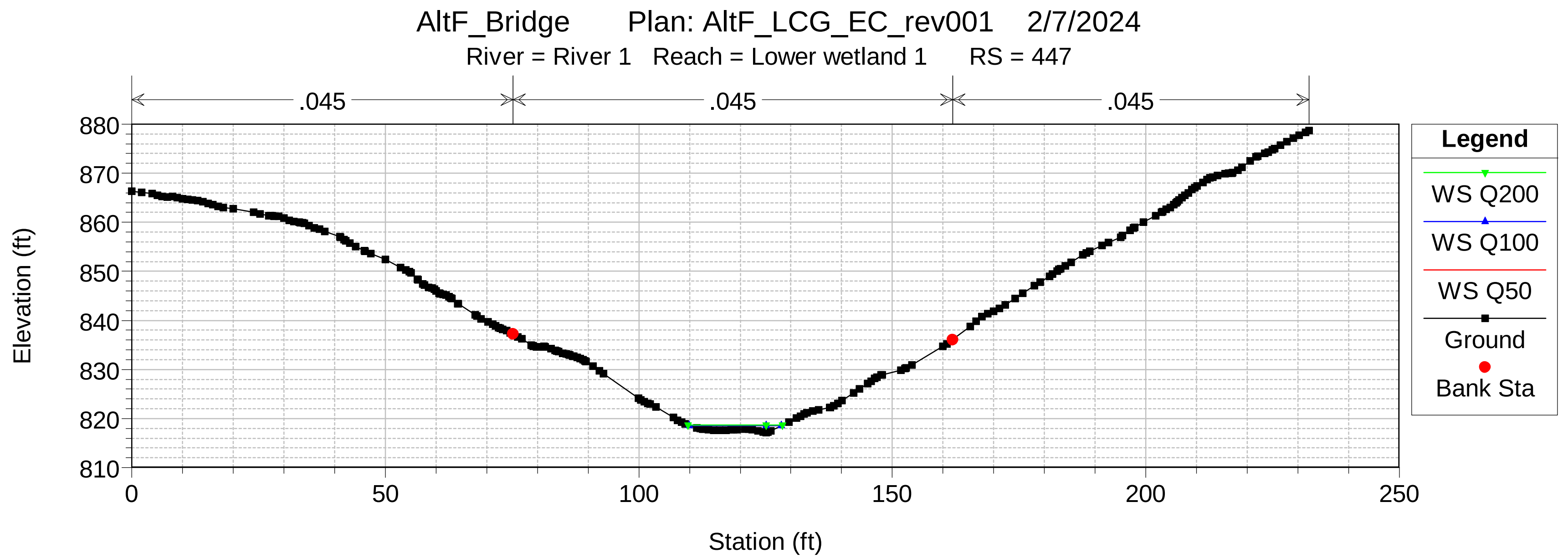
River = River 1 Reach = Tributary RS = 1029
.045
.045
.045
Elevation (ft)
Station (ft)
Legend
WS Q200
WS Q100
WS Q50
Ground
Bank Sta

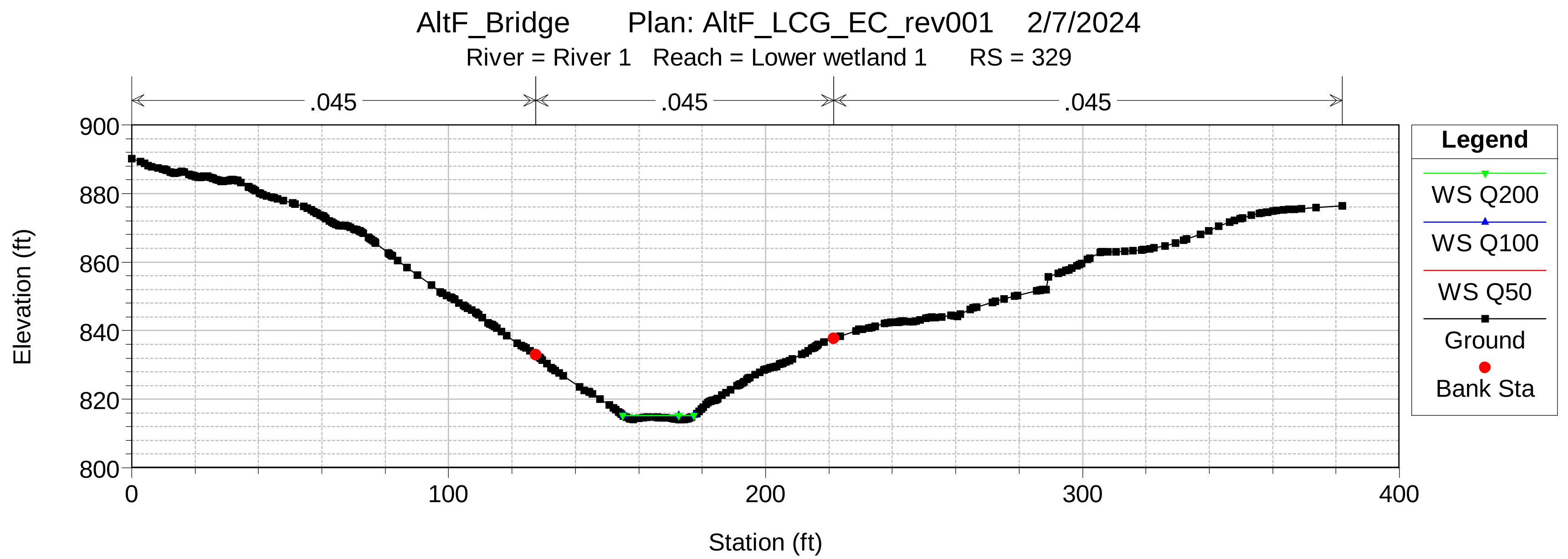


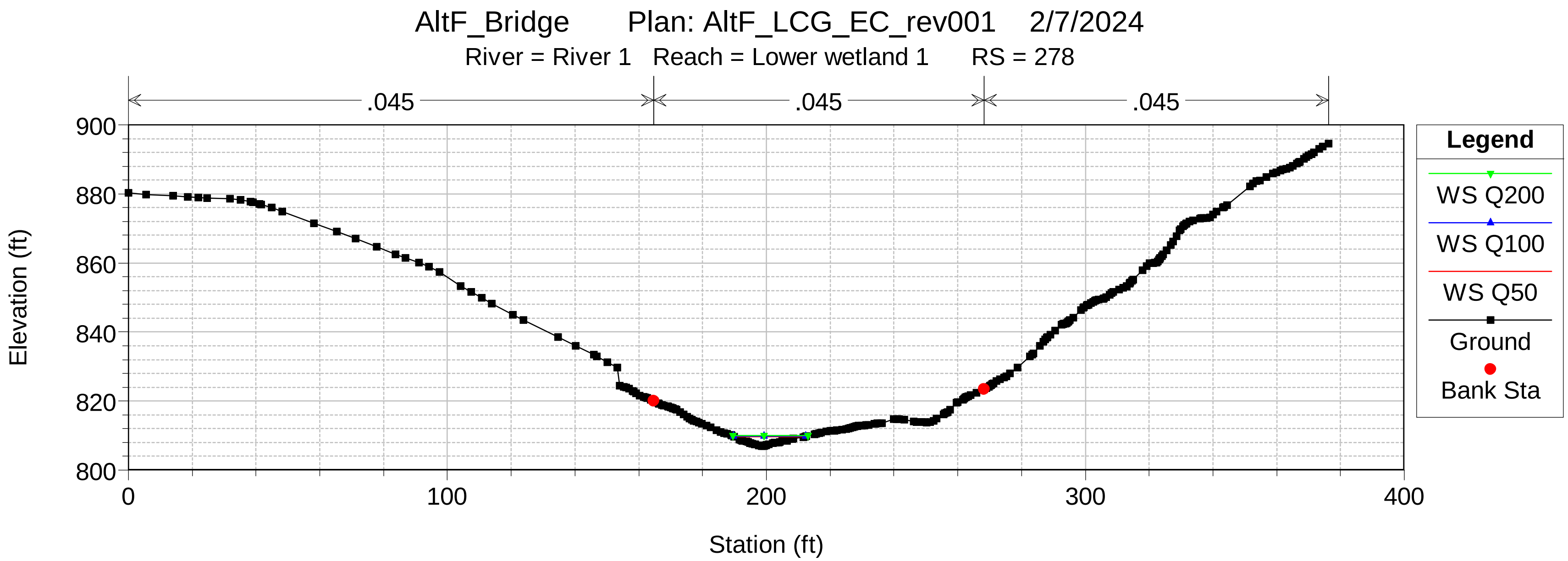
AltF_Bridge Plan: AltF_LCG_EC_rev001 2/7/2024
River = River 1 Reach = Tributary RS = 909 X-section edited - cut from USGS 2015 updated to match 02/22 APS
.045
.045
.045
Elevation (ft)
Station (ft)
Legend
WS Q200
WS Q100
WS Q50
Ground
Bank Sta

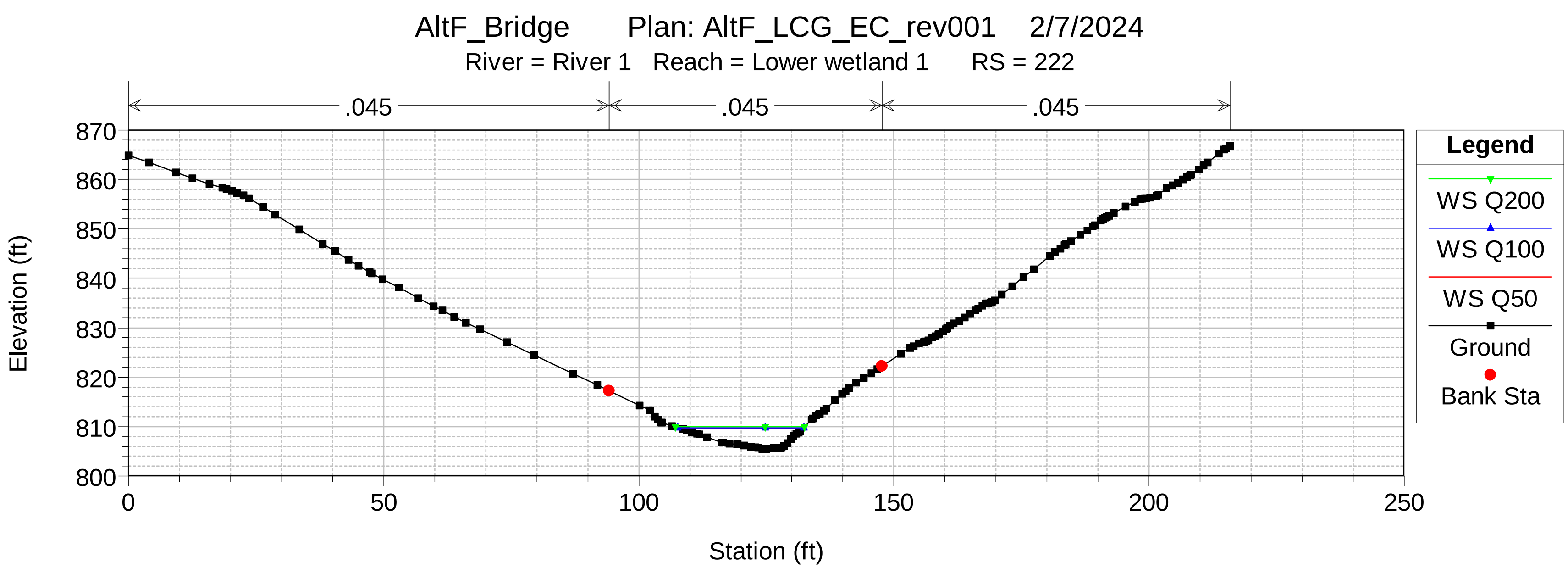


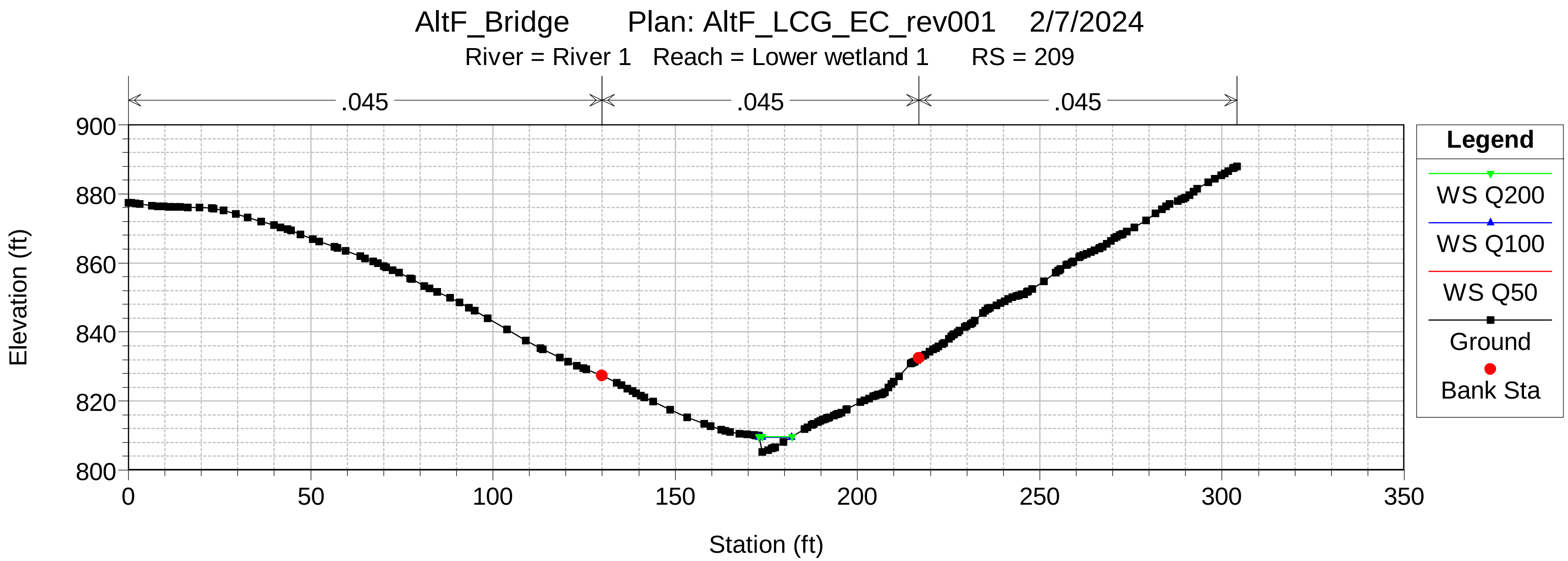
AltF_Bridge Plan: AltF_LCG_EC_rev001 2/7/2024
River = River 1 Reach = Tributary RS = 537
.045
.045
.045
Elevation (ft)
Station (ft)
Legend
WS Q200
WS Q100
WS Q50
Ground
Bank Sta

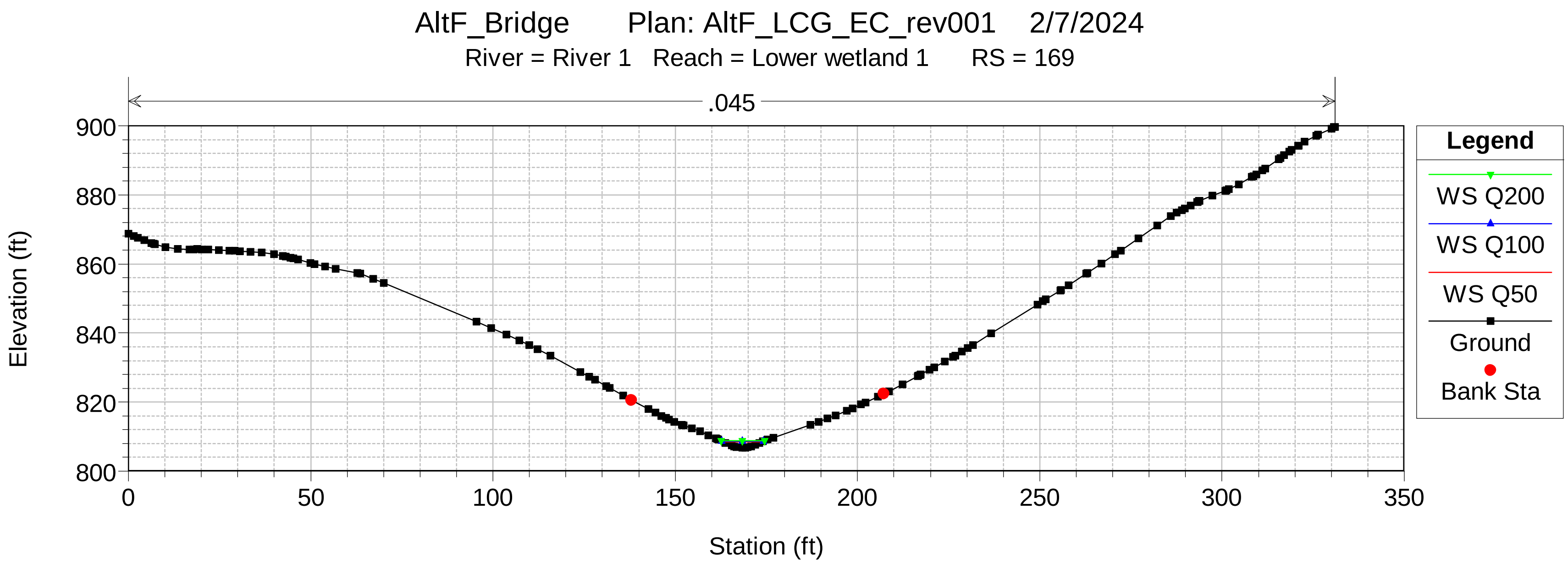

AltF_Bridge Plan: AltF_LCG_EC_rev001 2/7/2024
River = River 1 Reach = Lower wetland 1 RS = 447
.045
.045
.045
Elevation (ft)
880
870
860
850
840
830
820
810
0
50
100
150
200
250
Station (ft)
Legend
WS Q200
WS Q100
WS Q50
Ground
Bank Sta

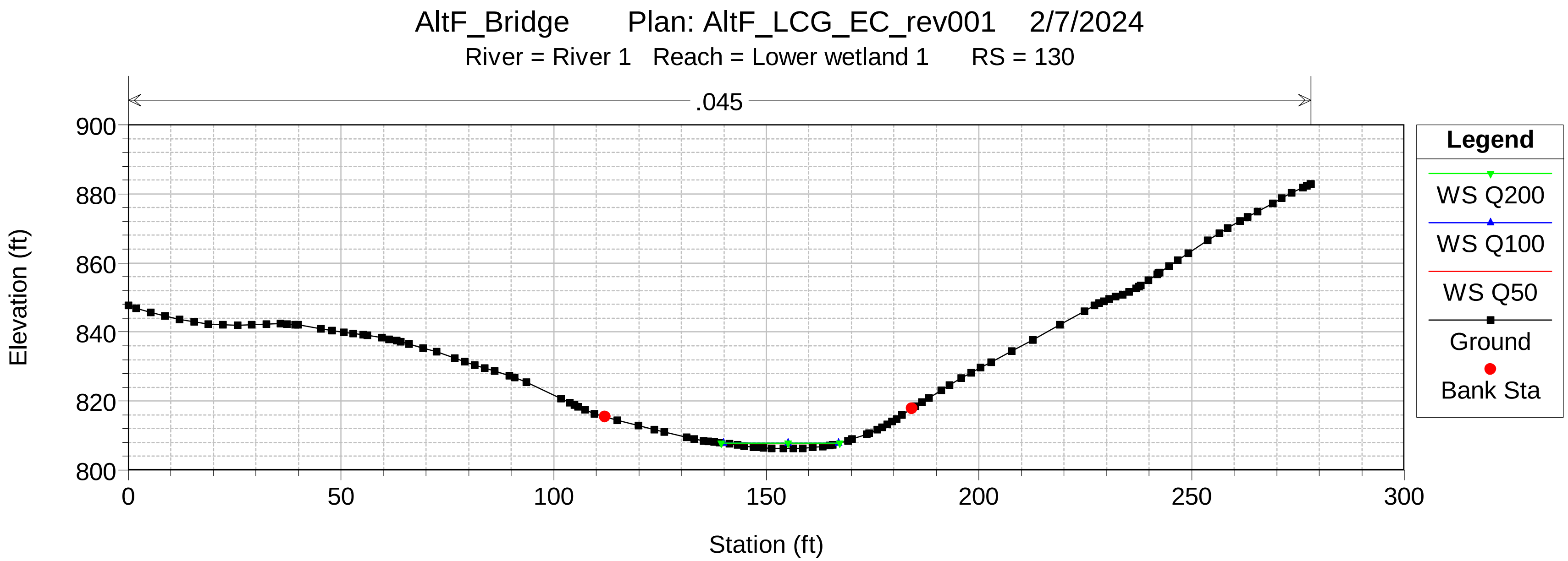

AltF_Bridge Plan: AltF_LCG_EC_rev001 2/7/2024
River = River 1 Reach = Lower wetland 1 RS = 329
.045
.045
.045
Elevation (ft)
900
880
860
840
820
800
0
100
200
300
400
Station (ft)
Legend
WS Q200
WS Q100
WS Q50
Ground
Bank Sta


AltF_Bridge Plan: AltF_LCG_EC_rev001 2/7/2024
River = River 1 Reach = Lower wetland 1 RS = 278
.045
.045
.045
Elevation (ft)
900
880
860
840
820
800
0
100
200
300
400
Station (ft)
Legend
WS Q200
WS Q100
WS Q50
Ground
Bank Sta

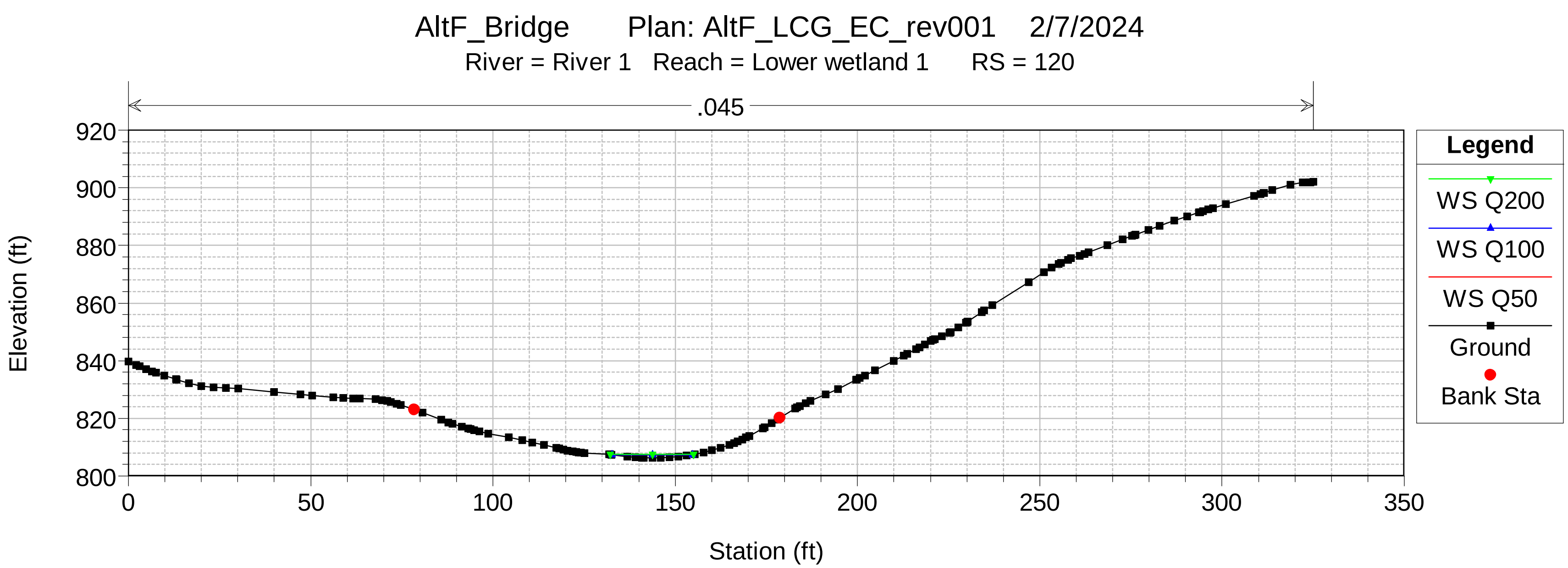

AltF_Bridge Plan: AltF_LCG_EC_rev001 2/7/2024
River = River 1 Reach = Lower wetland 1 RS = 222
.045
.045
.045
Elevation (ft)
870
860
850
840
830
820
810
800
0
50
100
150
200
250
Station (ft)
Legend
WS Q200
WS Q100
WS Q50
Ground
Bank Sta


AltF_Bridge Plan: AltF_LCG_EC_rev001 2/7/2024
River = River 1 Reach = Lower wetland 1 RS = 209
.045
.045
.045
Elevation (ft)
Station (ft)
Legend
WS Q200
WS Q100
WS Q50
Ground
Bank Sta

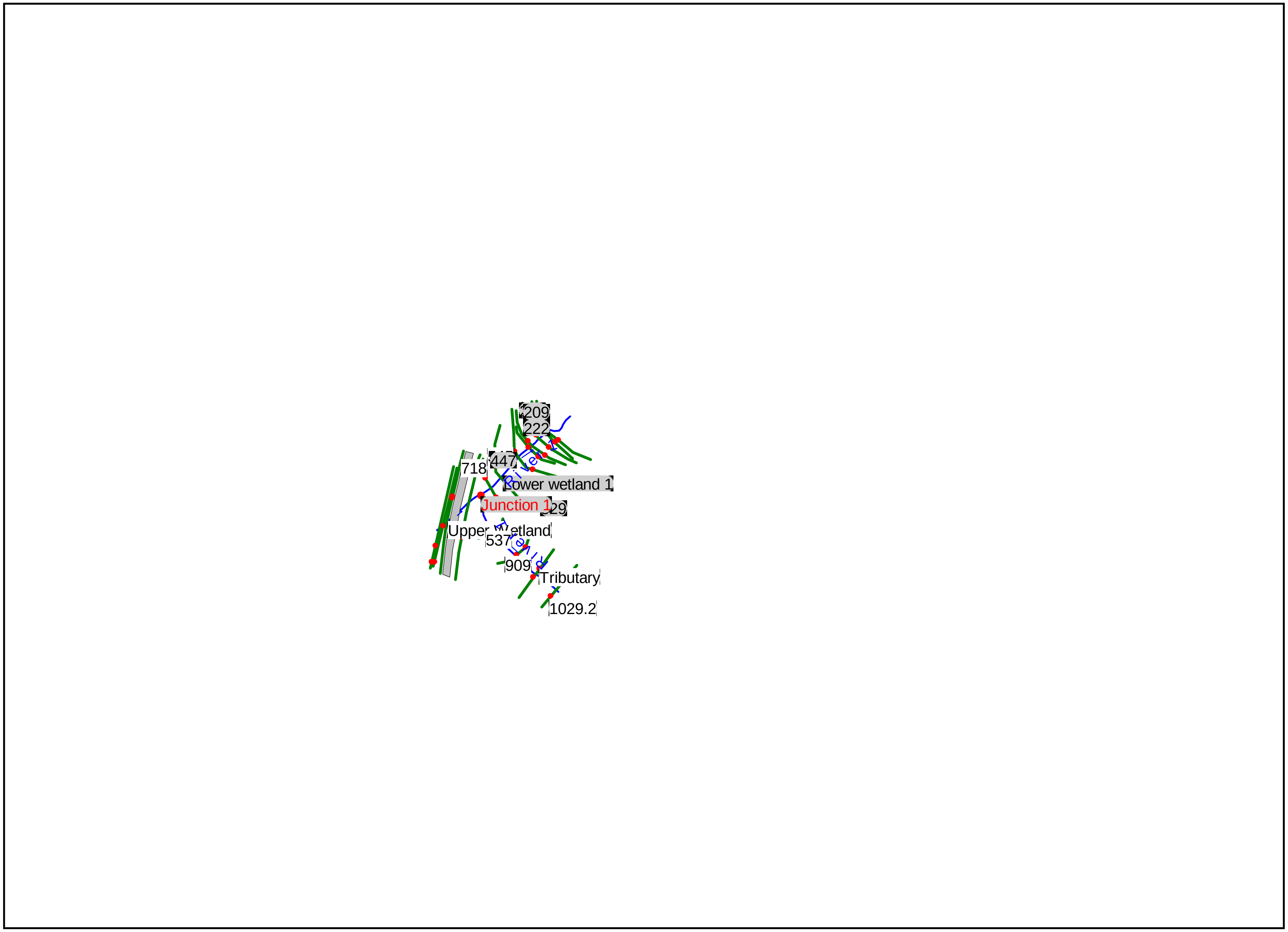

AltF_Bridge Plan: AltF_LCG_EC_rev001 2/7/2024
River = River 1 Reach = Lower wetland 1 RS = 169
.045
Elevation (ft)
Station (ft)
Legend
WS Q200
WS Q100
WS Q50
Ground
Bank Sta



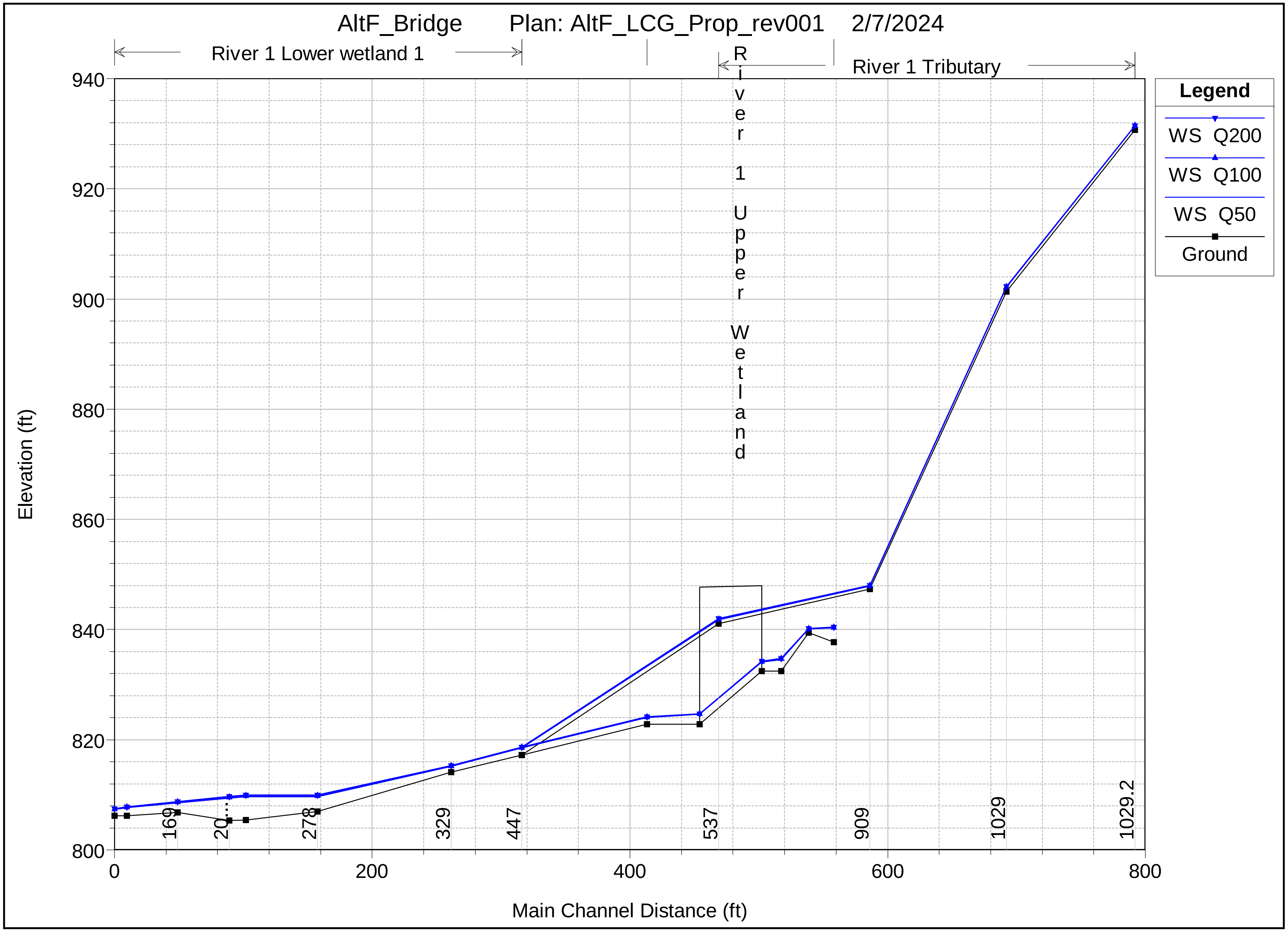
AltF_Bridge Plan: AltF_LCG_EC_rev001 2/7/2024
River = River 1 Reach = Lower wetland 1 RS = 130
.045
Elevation (ft)
900
880
860
840
820
800
0
50
100
150
200
250
300
Station (ft)
Legend
WS Q200
WS Q100
WS Q50
Ground
Bank Sta



AltF_Bridge Plan: AltF_LCG_EC_rev001 2/7/2024
River = River 1 Reach = Lower wetland 1 RS = 120
.045
Elevation (ft)
920
900
880
860
840
820
800
0
50
100
150
200
250
300
350
Station (ft)
Legend
WS Q200
WS Q100
WS Q50
Ground
Bank Sta



209
222
447
718
Lower wetland 1
Junction 1
Upper Wetland
537
909
Tributary
1029.2


AltF_Bridge Plan: AltF_LCG_Prop_rev001 2/7/2024
River 1 Lower wetland 1
River 1 Upper Wetland
River 1 Tributary
Legend
WS Q200
WS Q100
WS Q50
Ground
Elevation (ft)
Main Channel Distance (ft)
940
920
900
880
860
840
820
800
0
200
400
600
800
169
20
278
329
447
537
909
1029
1029.2

HEC-RAS Plan: AltF_LCG_Prop_rev001 Profile: Q200

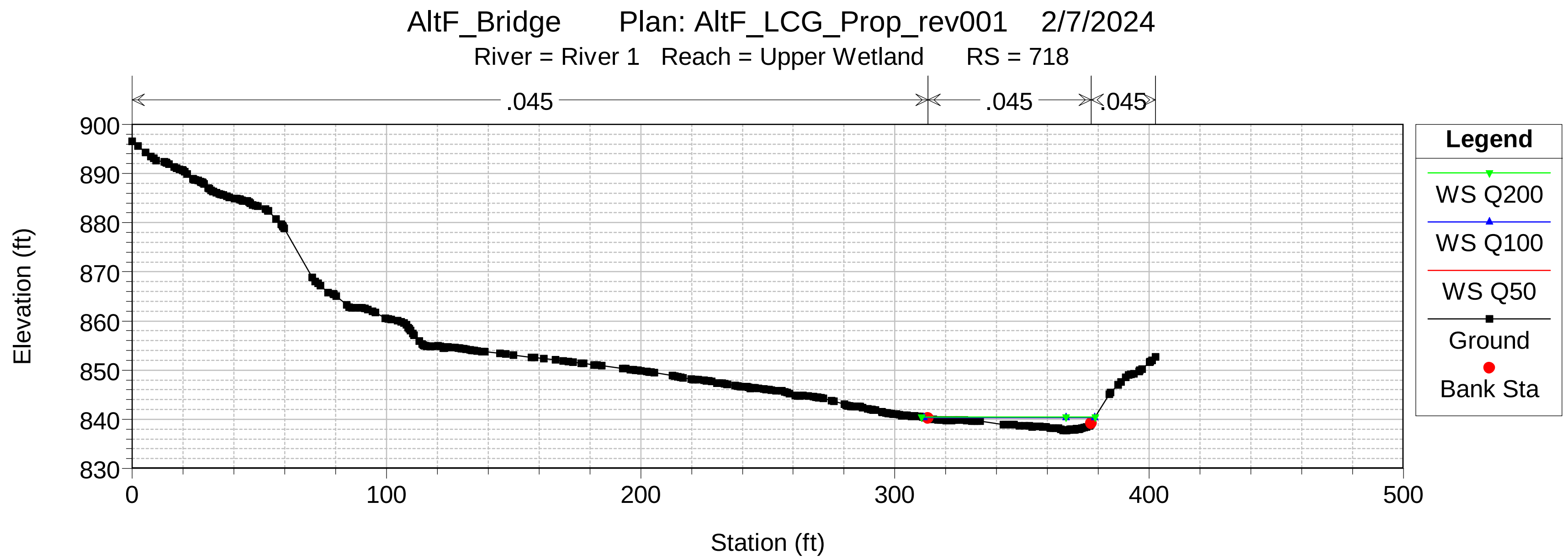
Reach	River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
		(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Upper Wetland	718	80.00	837.70	840.45		840.46	0.000397	0.85	95.35	68.18	0.12
Upper Wetland	684	80.00	839.42	840.17	840.17	840.41	0.039513	3.91	20.47	44.31	1.01
Upper Wetland	652	80.00	832.49	834.82	834.29	835.06	0.007266	4.60	22.08	15.96	0.56
Upper Wetland	645 BR U	80.00	832.49	834.30	834.30	834.85	0.022934	6.77	14.47	13.27	0.94
Upper Wetland	645 BR D	80.00	822.83	824.74	824.17	824.80	0.003399	2.26	46.16	65.16	0.35
Upper Wetland	545	80.00	822.83	824.17	824.17	824.46	0.031787	4.66	18.83	33.54	0.97
Tributary	1029.2	13.00	930.74	931.51	931.51	931.67	0.046241	3.26	3.98	12.55	1.02
Tributary	1029	13.00	901.38	902.33	902.33	902.61	0.040547	4.26	3.05	5.51	1.01
Tributary	909	13.00	847.35	848.05	848.05	848.22	0.043722	3.28	3.97	11.98	1.00
Tributary	537	13.00	841.04	841.99	841.99	842.27	0.040432	4.29	3.03	5.42	1.01
Lower wetland 1	447	90.00	817.19	818.65	818.65	819.11	0.032560	5.42	16.59	18.54	1.01
Lower wetland 1	329	90.00	814.10	815.30	815.30	815.71	0.033819	5.09	17.68	22.43	1.01
Lower wetland 1	278	90.00	806.96	809.98		810.07	0.002902	2.37	37.94	23.66	0.33
Lower wetland 1	222	90.00	805.41	809.97		810.00	0.000442	1.29	70.04	25.35	0.14
Lower wetland 1	209	90.00	805.30	809.71		809.96	0.007680	3.99	22.53	9.22	0.45
Lower wetland 1	169	90.00	806.79	808.76	808.76	809.38	0.030741	6.28	14.33	11.93	1.01
Lower wetland 1	130	90.00	806.23	807.87		808.01	0.007140	2.95	30.52	27.81	0.50
Lower wetland 1	120	90.00	806.24	807.45	807.45	807.85	0.033133	5.06	17.79	22.87	1.01

HEC-RAS Plan: AltF_LCG_Prop_rev001 Profile: Q100

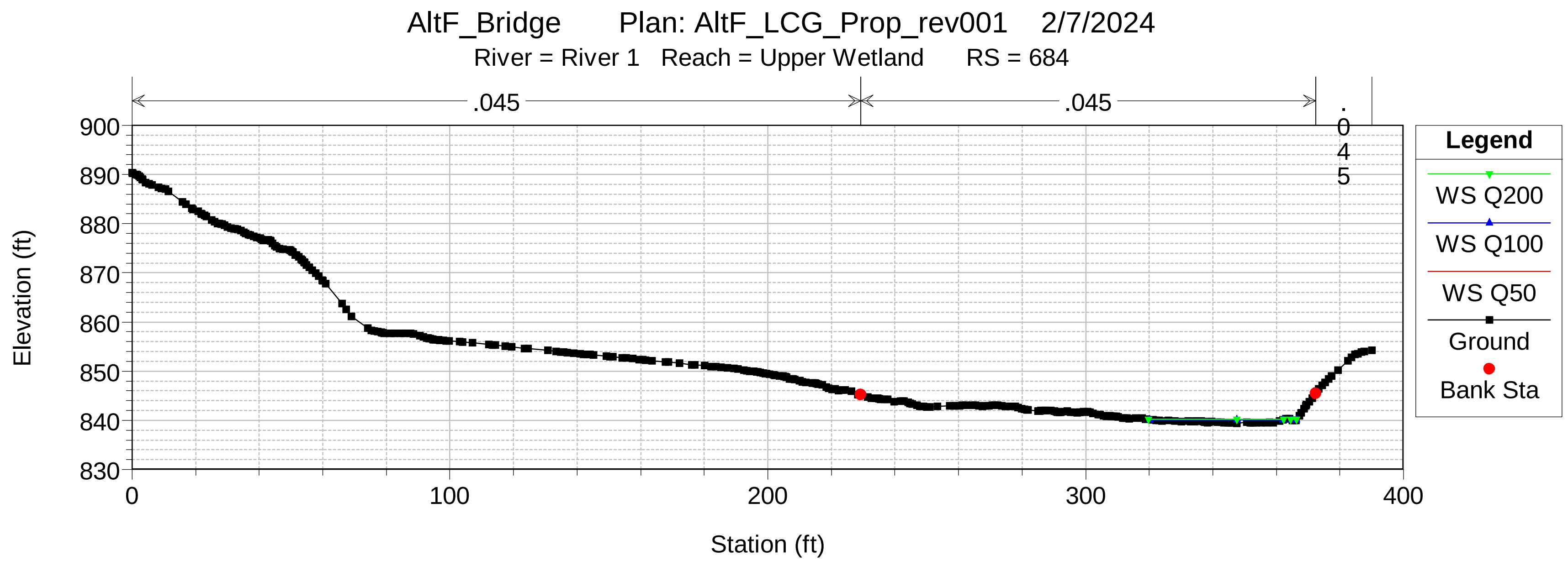
Reach	River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
		(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Upper Wetland	718	70.00	837.70	840.39		840.39	0.000352	0.77	91.13	67.15	0.12
Upper Wetland	684	70.00	839.42	840.13	840.13	840.35	0.040461	3.76	18.63	43.53	1.01
Upper Wetland	652	70.00	832.49	834.69	834.19	834.92	0.007160	4.38	20.10	15.26	0.55
Upper Wetland	645 BR U	70.00	832.49	834.20	834.20	834.71	0.023013	6.49	13.12	12.79	0.93
Upper Wetland	645 BR D	70.00	822.83	824.67	824.12	824.73	0.003334	2.16	41.89	59.77	0.35
Upper Wetland	545	70.00	822.83	824.11	824.11	824.39	0.034377	4.55	16.76	31.85	1.00
Tributary	1029.2	10.00	930.74	931.45	931.45	931.59	0.046998	3.07	3.26	11.40	1.01
Tributary	1029	10.00	901.38	902.22	902.22	902.47	0.042060	4.03	2.48	5.05	1.01
Tributary	909	10.00	847.35	847.98	847.98	848.14	0.046724	3.12	3.21	10.97	1.02
Tributary	537	10.00	841.04	841.88	841.88	842.13	0.041831	4.02	2.49	5.07	1.01
Lower wetland 1	447	80.00	817.19	818.58	818.58	819.01	0.033439	5.26	15.21	18.20	1.01
Lower wetland 1	329	80.00	814.10	815.24	815.24	815.62	0.034708	4.91	16.28	22.25	1.01
Lower wetland 1	278	80.00	806.96	809.81		809.90	0.003092	2.35	34.01	22.53	0.34
Lower wetland 1	222	80.00	805.41	809.80		809.83	0.000412	1.22	65.84	24.64	0.13
Lower wetland 1	209	80.00	805.30	809.57		809.79	0.007077	3.76	21.26	8.97	0.43
Lower wetland 1	169	80.00	806.79	808.66	808.66	809.24	0.030928	6.11	13.10	11.44	1.01
Lower wetland 1	130	80.00	806.23	807.79		807.91	0.006991	2.83	28.30	27.05	0.49
Lower wetland 1	120	80.00	806.24	807.38	807.38	807.76	0.033656	4.92	16.25	22.03	1.01

HEC-RAS Plan: AltF_LCG_Prop_rev001 Profile: Q50

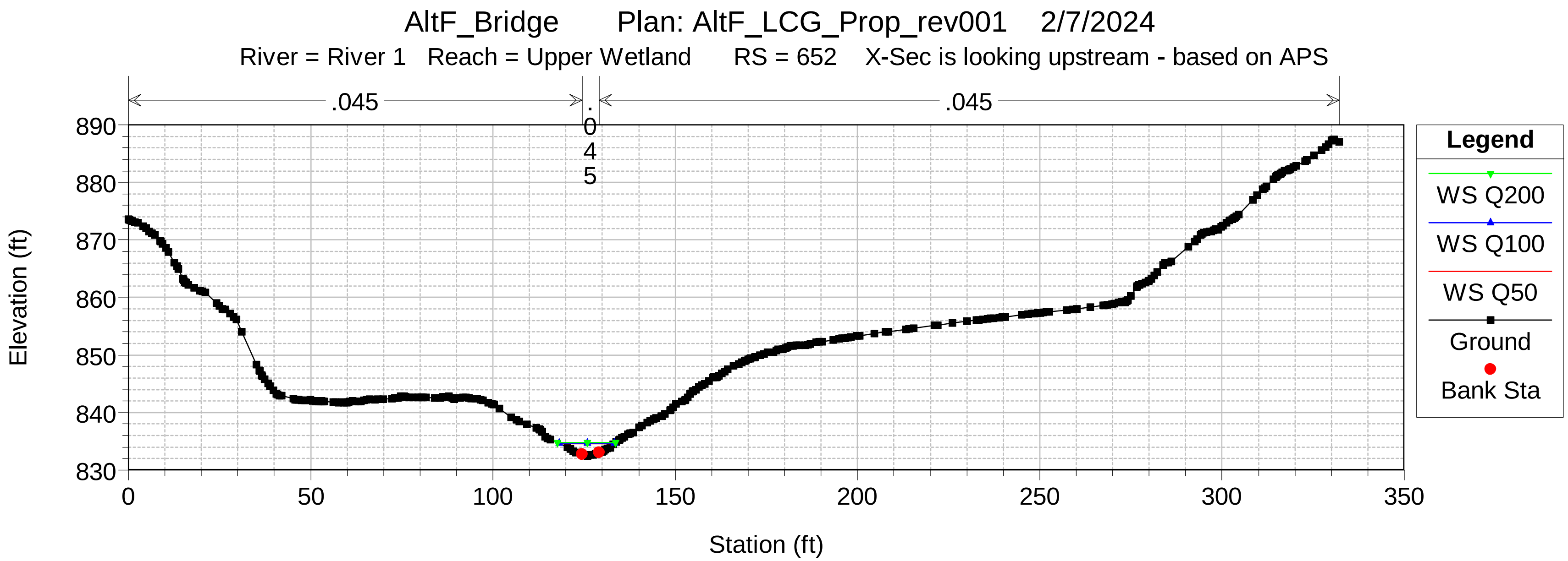
Reach	River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
		(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Upper Wetland	718	60.00	837.70	840.32		840.33	0.000304	0.70	86.73	66.16	0.11
Upper Wetland	684	60.00	839.42	840.09	840.09	840.29	0.041846	3.60	16.68	42.73	1.01
Upper Wetland	652	60.00	832.49	834.56	834.07	834.76	0.006986	4.13	18.09	14.52	0.53
Upper Wetland	645 BR U	60.00	832.49	834.08	834.08	834.56	0.023492	6.21	11.64	12.24	0.93
Upper Wetland	645 BR D	60.00	822.83	824.58	824.06	824.63	0.003235	2.02	36.71	52.69	0.34
Upper Wetland	545	60.00	822.83	824.06	824.06	824.31	0.032813	4.24	15.37	30.77	0.96
Tributary	1029.2	7.00	930.74	931.38	931.38	931.50	0.049921	2.79	2.51	10.58	1.01
Tributary	1029	7.00	901.38	902.09	902.09	902.31	0.043857	3.72	1.88	4.46	1.01
Tributary	909	7.00	847.35	847.91	847.91	848.04	0.046584	2.86	2.45	9.49	0.99
Tributary	537	7.00	841.04	841.76	841.76	841.97	0.044111	3.68	1.90	4.65	1.01
Lower wetland 1	447	70.00	817.19	818.50	818.50	818.90	0.034167	5.06	13.84	17.85	1.01
Lower wetland 1	329	70.00	814.10	815.18	815.18	815.52	0.034748	4.68	14.97	22.07	1.00
Lower wetland 1	278	70.00	806.96	809.63		809.71	0.003376	2.33	30.00	21.51	0.35
Lower wetland 1	222	70.00	805.41	809.63		809.65	0.000380	1.14	61.49	23.88	0.13
Lower wetland 1	209	70.00	805.30	809.42		809.62	0.006427	3.51	19.94	8.70	0.41
Lower wetland 1	169	70.00	806.79	808.54	808.54	809.09	0.031703	5.95	11.76	10.89	1.01
Lower wetland 1	130	70.00	806.23	807.70		807.82	0.006836	2.70	25.97	26.24	0.48
Lower wetland 1	120	70.00	806.24	807.31	807.31	807.66	0.034182	4.76	14.70	21.20	1.01



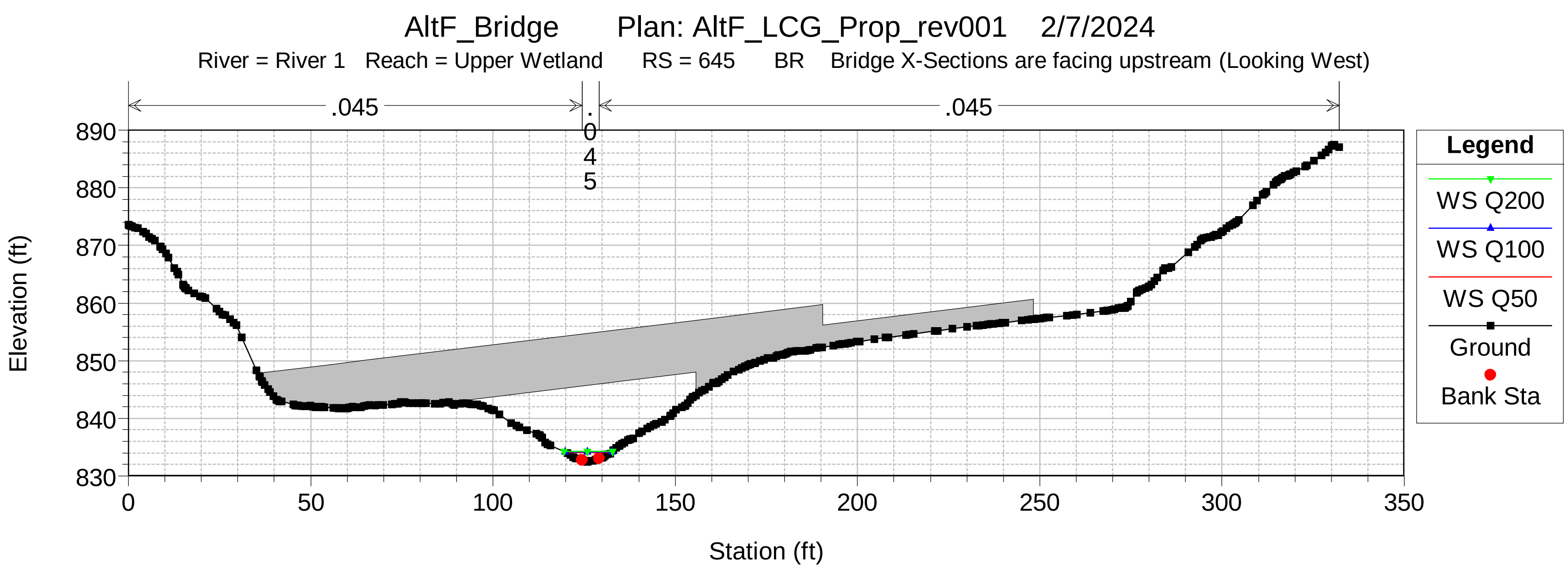
AltF_Bridge Plan: AltF_LCG_Prop_rev001 2/7/2024
River = River 1 Reach = Upper Wetland RS = 718
.045
.045
.045
Elevation (ft)
Station (ft)
Legend
WS Q200
WS Q100
WS Q50
Ground
Bank Sta



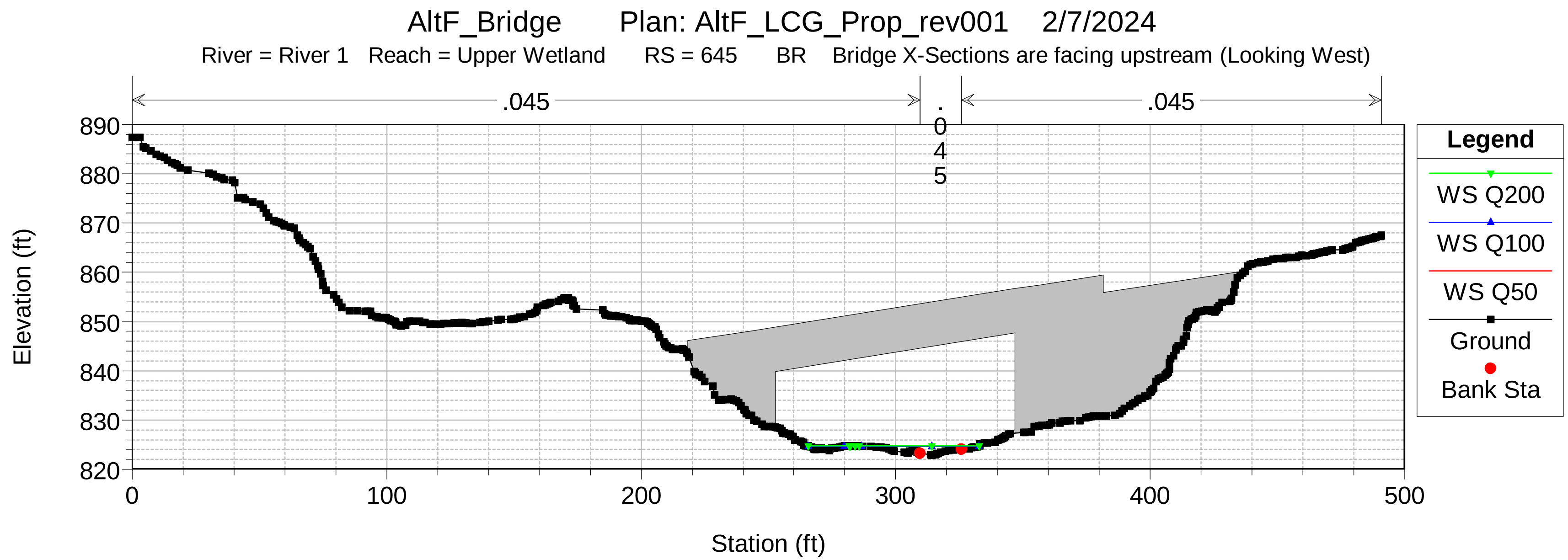
AltF_Bridge Plan: AltF_LCG_Prop_rev001 2/7/2024
River = River 1 Reach = Upper Wetland RS = 684
.045
.045
.045
Elevation (ft)
Station (ft)
Legend
WS Q200
WS Q100
WS Q50
Ground
Bank Sta

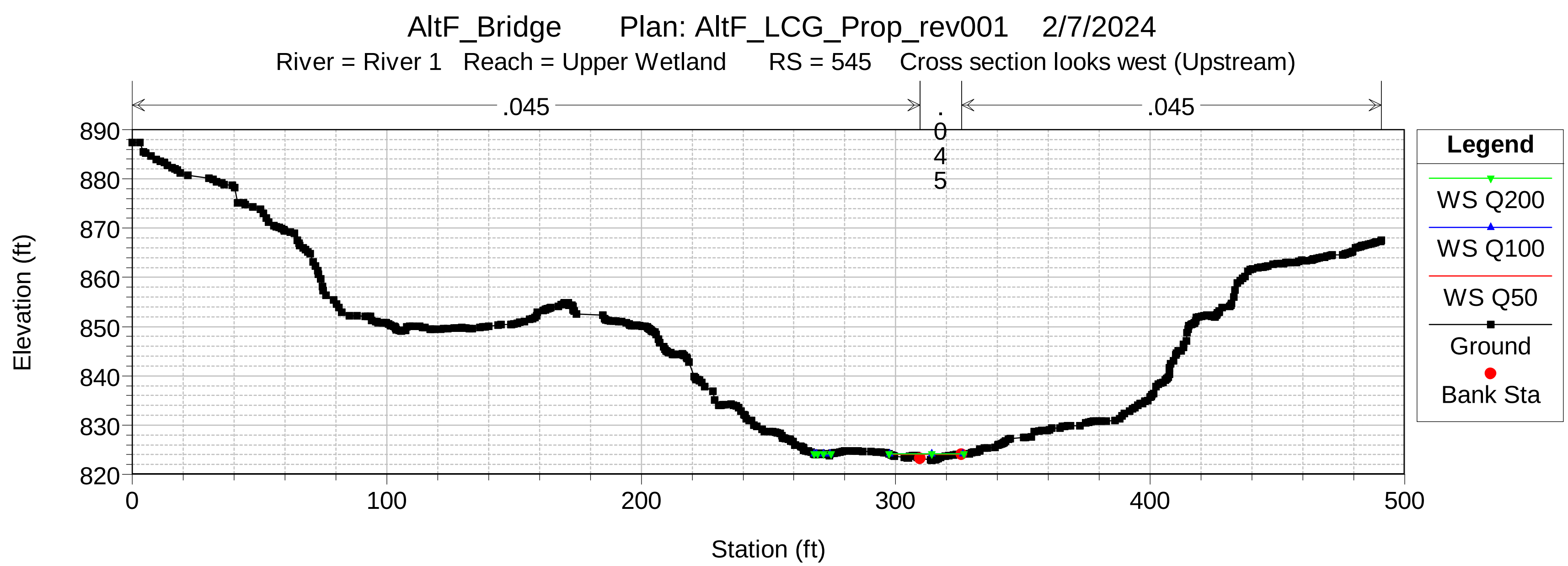


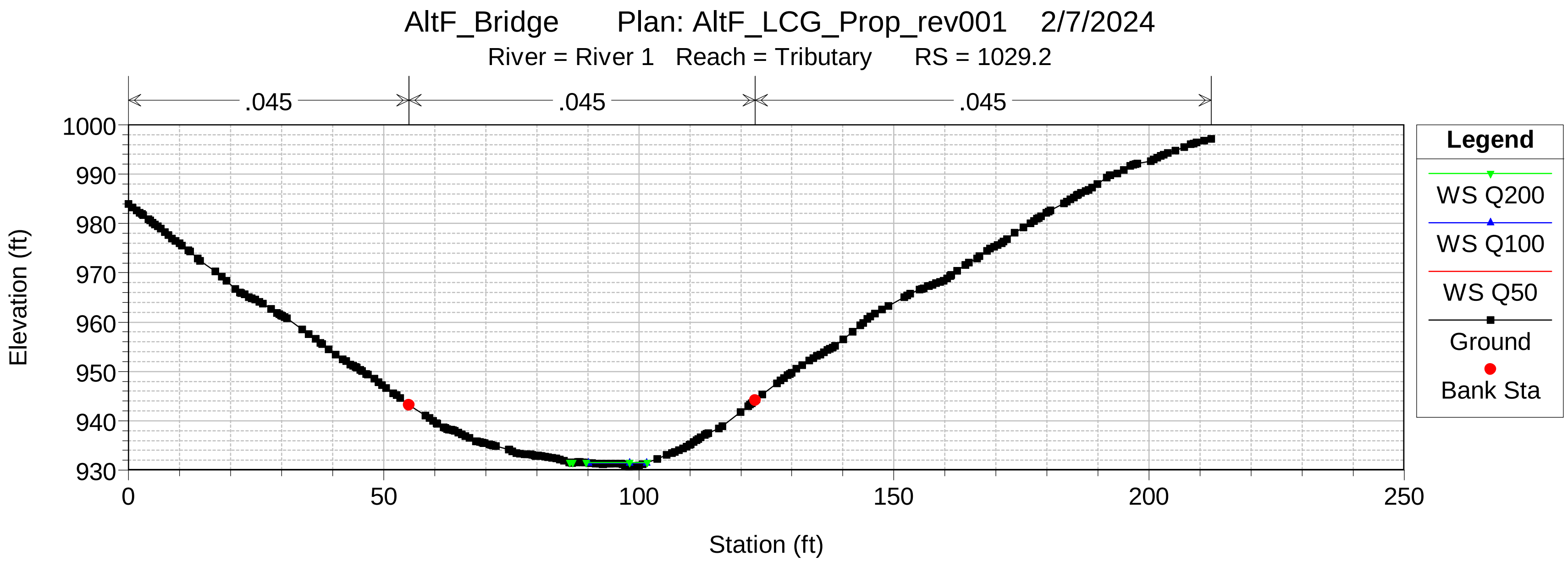
AltF_Bridge Plan: AltF_LCG_Prop_rev001 2/7/2024
River = River 1 Reach = Upper Wetland RS = 652 X-Sec is looking upstream - based on APS
.045
.045
.045
890
880
870
860
850
840
830
Elevation (ft)
0
50
100
150
200
250
300
350
Station (ft)
Legend
WS Q200
WS Q100
WS Q50
Ground
Bank Sta



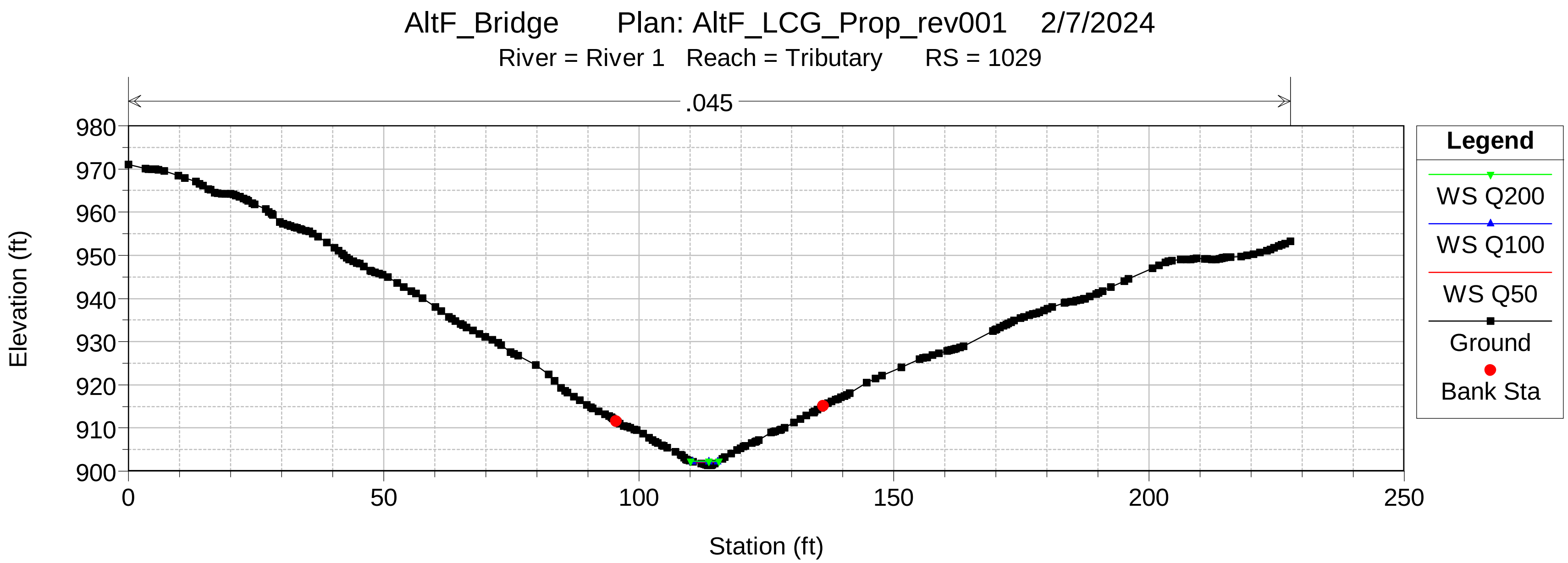
AltF_Bridge Plan: AltF_LCG_Prop_rev001 2/7/2024
River = River 1 Reach = Upper Wetland RS = 645 BR Bridge X-Sections are facing upstream (Looking West)
.045
.045
.045
890
880
870
860
850
840
830
Elevation (ft)
0
50
100
150
200
250
300
350
Station (ft)
Legend
WS Q200
WS Q100
WS Q50
Ground
Bank Sta


AltF_Bridge Plan: AltF_LCG_Prop_rev001 2/7/2024
River = River 1 Reach = Upper Wetland RS = 645 BR Bridge X-Sections are facing upstream (Looking West)
.045
.045
.045
Elevation (ft)
Station (ft)
Legend
WS Q200
WS Q100
WS Q50
Ground
Bank Sta

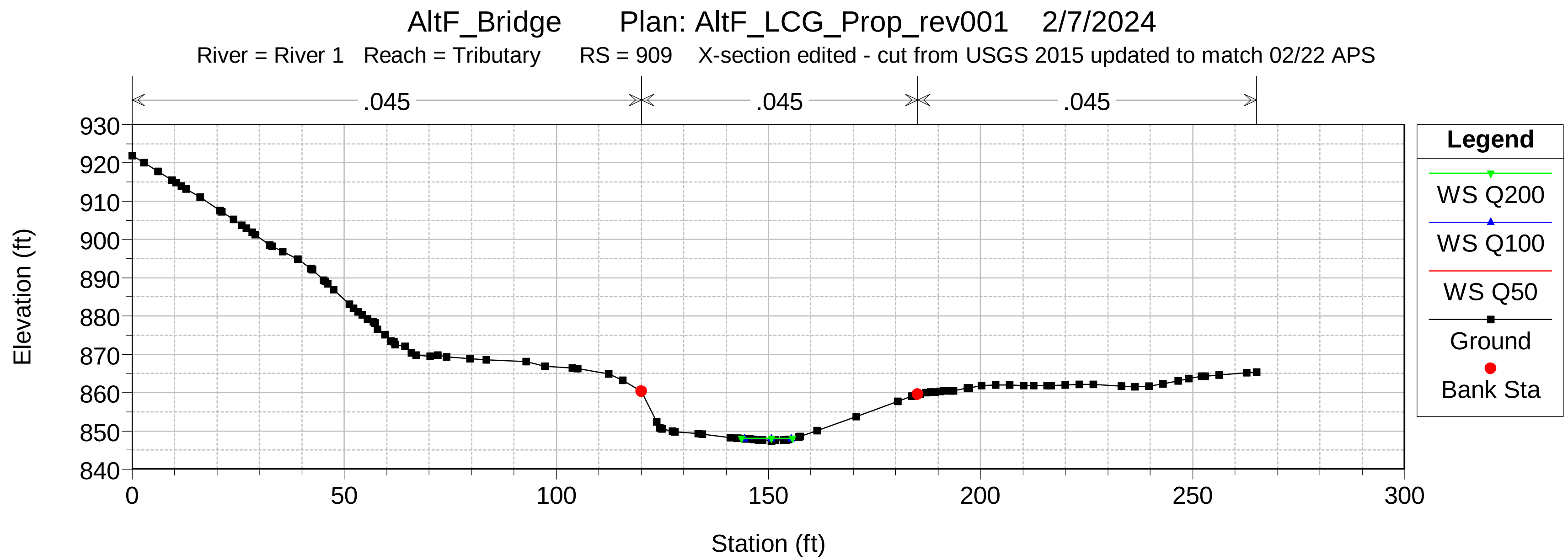

AltF_Bridge Plan: AltF_LCG_Prop_rev001 2/7/2024
River = River 1 Reach = Upper Wetland RS = 545 Cross section looks west (Upstream)
.045
.045
.045
Elevation (ft)
Station (ft)
Legend
WS Q200
WS Q100
WS Q50
Ground
Bank Sta

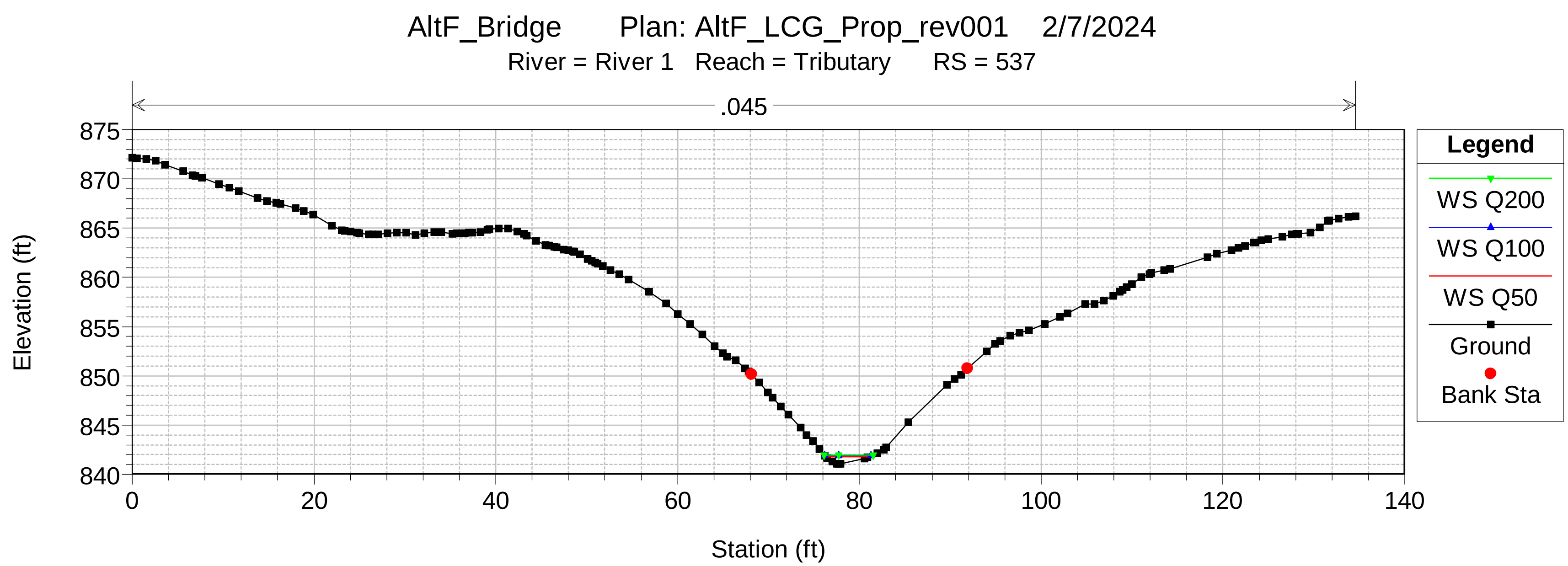


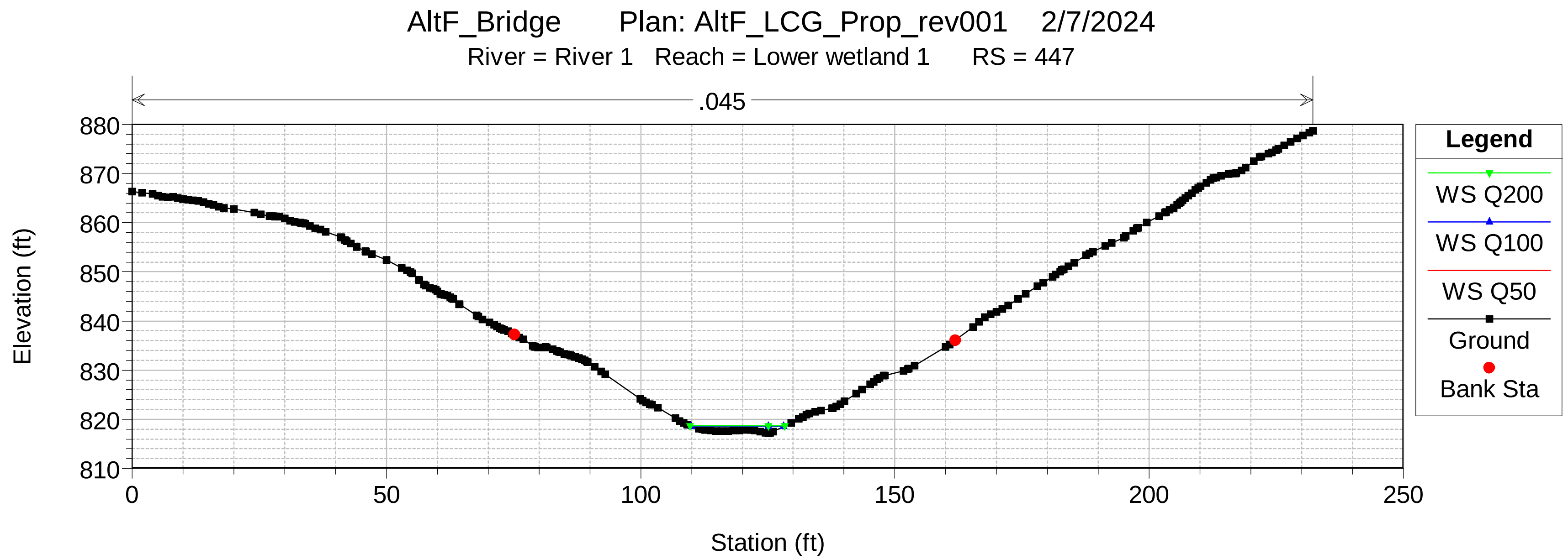
AltF_Bridge Plan: AltF_LCG_Prop_rev001 2/7/2024
River = River 1 Reach = Tributary RS = 1029.2
.045
.045
.045
Elevation (ft)
Station (ft)
Legend
WS Q200
WS Q100
WS Q50
Ground
Bank Sta

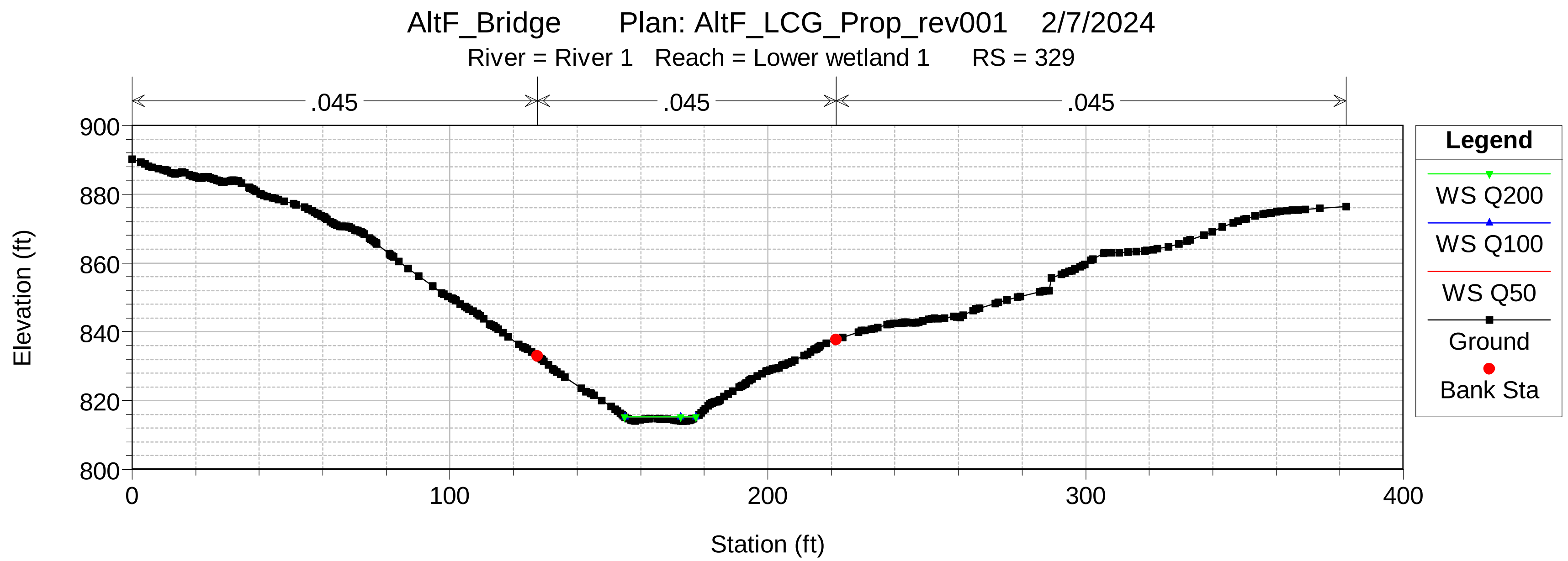


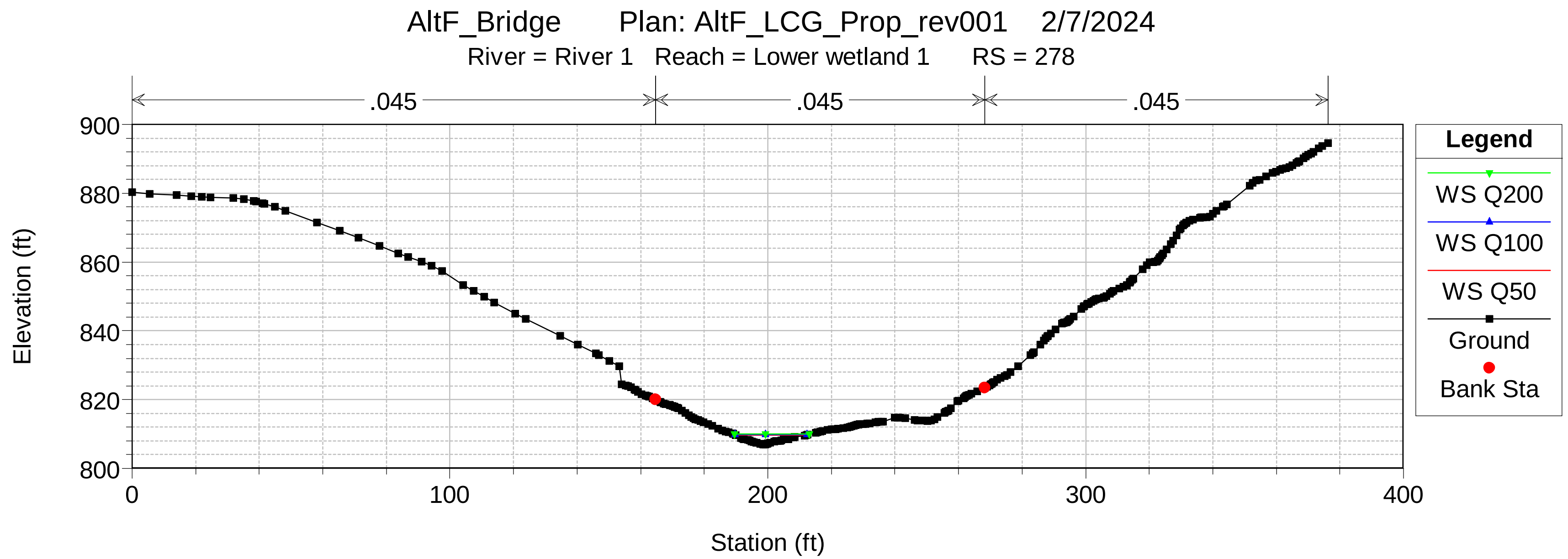
AltF_Bridge Plan: AltF_LCG_Prop_rev001 2/7/2024
River = River 1 Reach = Tributary RS = 1029
.045
Elevation (ft)
Station (ft)
Legend
WS Q200
WS Q100
WS Q50
Ground
Bank Sta

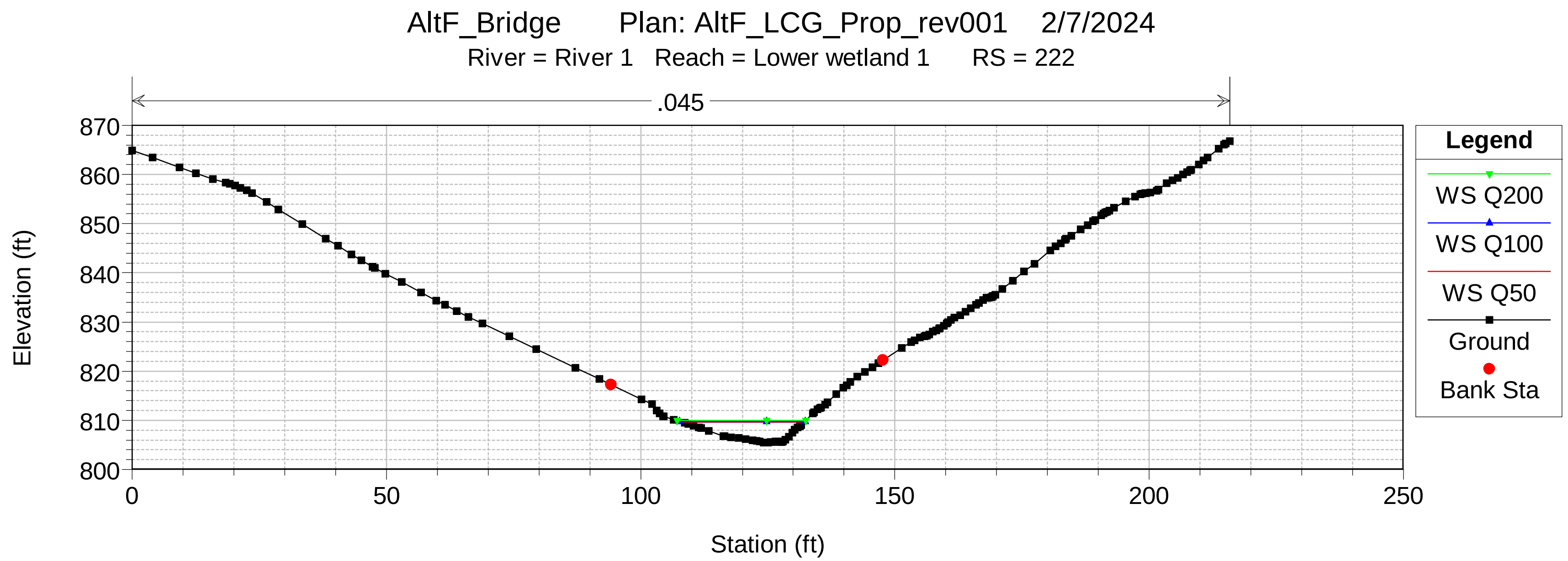

AltF_Bridge Plan: AltF_LCG_Prop_rev001 2/7/2024
River = River 1 Reach = Tributary RS = 909 X-section edited - cut from USGS 2015 updated to match 02/22 APS
.045
.045
.045
Elevation (ft)
930
920
910
900
890
880
870
860
850
840
0
50
100
150
200
250
300
Station (ft)
Legend
WS Q200
WS Q100
WS Q50
Ground
Bank Sta

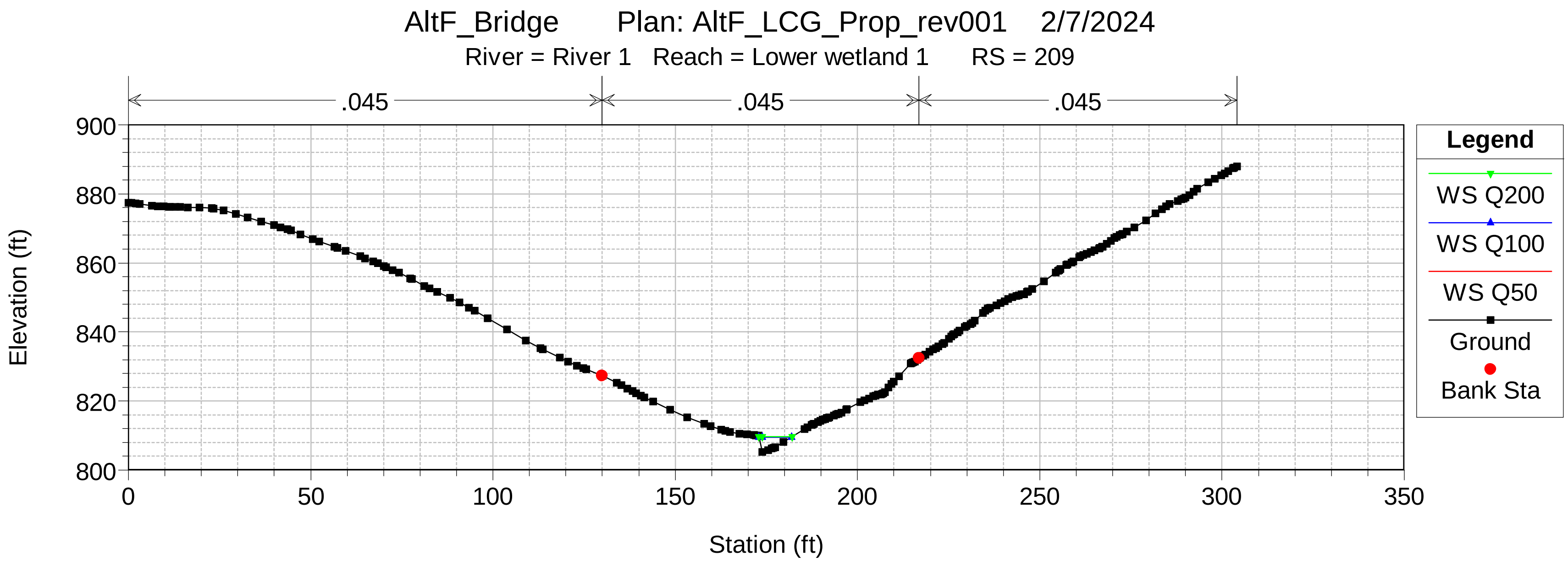

AltF_Bridge Plan: AltF_LCG_Prop_rev001 2/7/2024
River = River 1 Reach = Tributary RS = 537
.045
Elevation (ft)
875
870
865
860
855
850
845
840
0
20
40
60
80
100
120
140
Station (ft)
Legend
WS Q200
WS Q100
WS Q50
Ground
Bank Sta

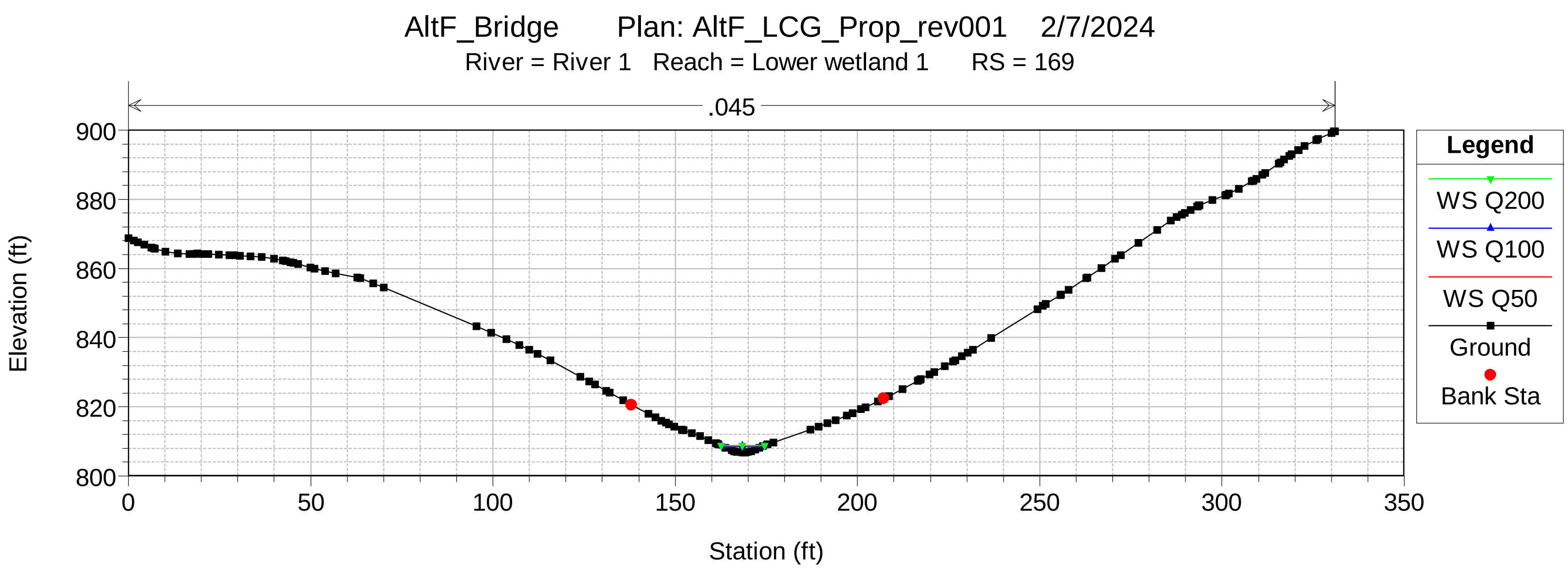

AltF_Bridge Plan: AltF_LCG_Prop_rev001 2/7/2024
River = River 1 Reach = Lower wetland 1 RS = 447
.045
Elevation (ft)
880
870
860
850
840
830
820
810
0
50
100
150
200
250
Station (ft)
Legend
WS Q200
WS Q100
WS Q50
Ground
Bank Sta

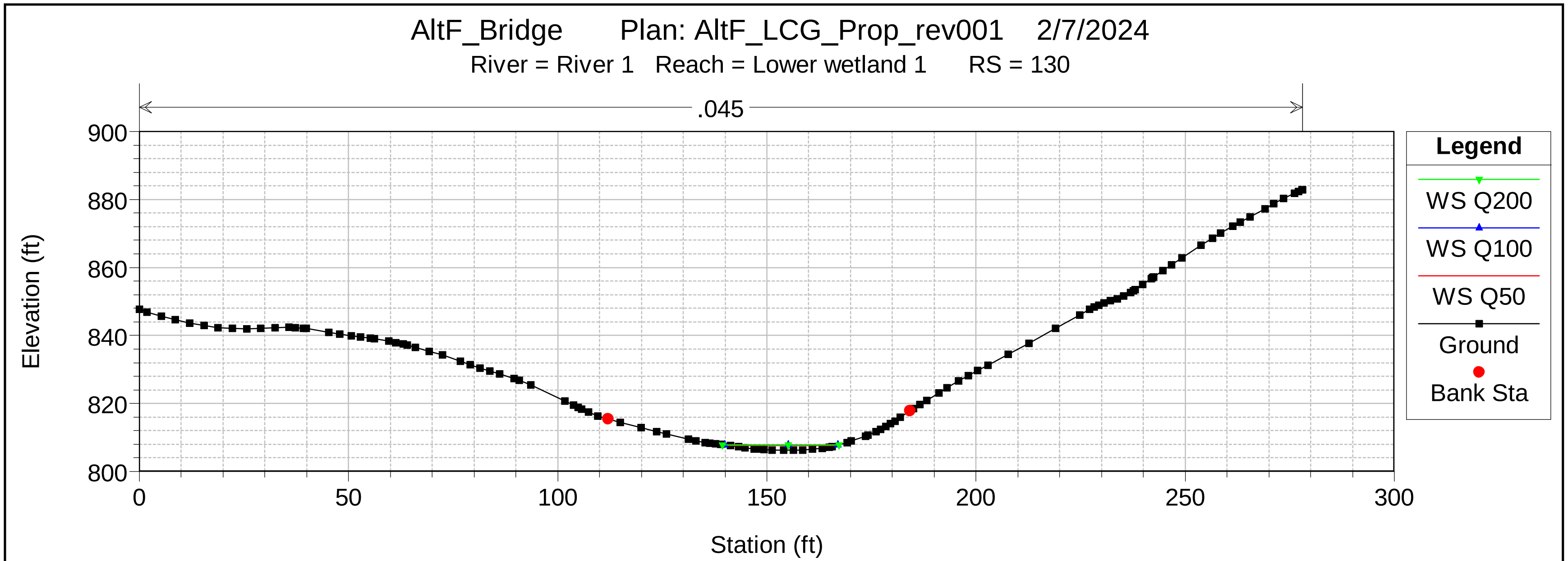

AltF_Bridge Plan: AltF_LCG_Prop_rev001 2/7/2024
River = River 1 Reach = Lower wetland 1 RS = 329
.045
.045
.045
Elevation (ft)
900
880
860
840
820
800
0
100
200
300
400
Station (ft)
Legend
WS Q200
WS Q100
WS Q50
Ground
Bank Sta

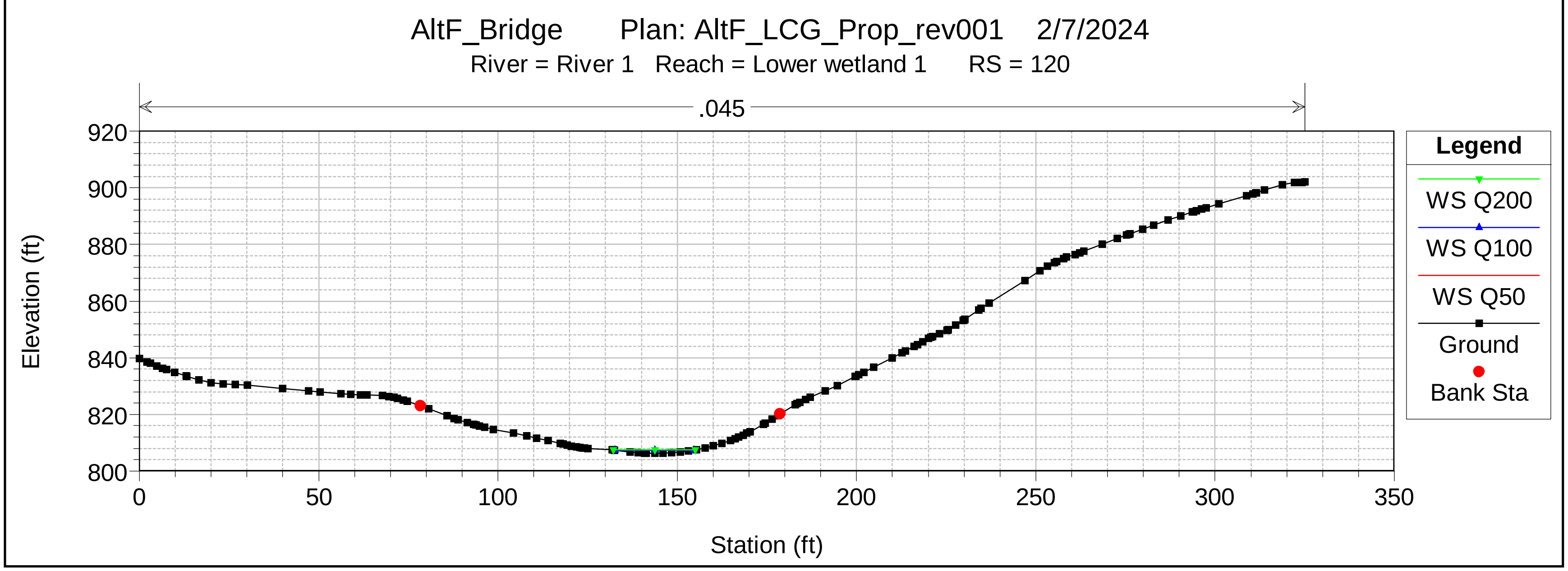

AltF_Bridge Plan: AltF_LCG_Prop_rev001 2/7/2024
River = River 1 Reach = Lower wetland 1 RS = 278
.045
.045
.045
Elevation (ft)
Station (ft)
Legend
WS Q200
WS Q100
WS Q50
Ground
Bank Sta


AltF_Bridge Plan: AltF_LCG_Prop_rev001 2/7/2024
River = River 1 Reach = Lower wetland 1 RS = 222
.045
Elevation (ft)
Station (ft)
Legend
WS Q200
WS Q100
WS Q50
Ground
Bank Sta


AltF_Bridge Plan: AltF_LCG_Prop_rev001 2/7/2024
River = River 1 Reach = Lower wetland 1 RS = 209
.045
.045
.045
Elevation (ft)
Station (ft)
Legend
WS Q200
WS Q100
WS Q50
Ground
Bank Sta


AltF_Bridge Plan: AltF_LCG_Prop_rev001 2/7/2024
River = River 1 Reach = Lower wetland 1 RS = 169
.045
Elevation (ft)
Station (ft)
Legend
WS Q200
WS Q100
WS Q50
Ground
Bank Sta


AltF_Bridge Plan: AltF_LCG_Prop_rev001 2/7/2024
River = River 1 Reach = Lower wetland 1 RS = 130
.045
Elevation (ft)
900
880
860
840
820
800
0
50
100
150
200
250
300
Station (ft)
Legend
WS Q200
WS Q100
WS Q50
Ground
Bank Sta


AltF_Bridge Plan: AltF_LCG_Prop_rev001 2/7/2024
River = River 1 Reach = Lower wetland 1 RS = 120
.045
Elevation (ft)
920
900
880
860
840
820
800
0
50
100
150
200
250
300
350
Station (ft)
Legend
WS Q200
WS Q100
WS Q50
Ground
Bank Sta