Design Hydraulic Study

Bridge 09C-0134, Blairsden-Graeagle Road over Middle Fork Feather River

Plumas County

Prepared for:

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December 3, 2013

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Executive Summary

Purpose:	Replace deficient bridge.	
Funding Program:	HBP	
Design Flood:	Standard Design Flood (21100-cfs, 50-year recurrence)	
Clearance for Drift:	3.0-feet	
Design Exception:	None required for flood hydraulic conditions	
Recommendations:	Min. Soffit Elevation –	4353.65-feet (to meet recommendations of Caltrans and FHWA)
	Pier Scour Elevation –	4320.8-feet
	Abutment Scour Elevation –	Abutment 1, 4339-feet Abutment 3, 4346-feet
	Abutment Protection –	Recommended to reduce the long term potential for damage to abutments from bank erosion and bank migration.

Note regarding estimates of potential scour: Potential scour has been estimated using empirical equations presented in FHWA HEC-18. These equations do not consider geotechnical conditions and therefore assume all substrate is erodible. The potential scour estimates identified in this report may be inappropriate if a geotechnical investigation identifies material resistant to erosion at higher elevations.

Preferred Bridge Characteristics:

Soffit Elevation –	4355.24-feet (4.59-ft above Q50, 3.13-ft above Q100)
Overtopping Flood –	31000-cfs, approximately 150-year recurrence
Impact on Flood Risk –	Minor (0.18-foot) increase in water surface elevation during the most probable 100-year flood but no increase in flood risk to structures because no structures are present within the 100-year floodplain.
Impact on Channel –	Preferred bridge is not expected to aggravate channel instability.

Design Hydraulic Study
Blairsden-Graeagle Road over Middle Fork Feather River

INTRODUCTION

Background: This bridge hydraulic analysis has been prepared for the sole purpose of meeting the requirements of 23 CFR §650.115 and §650.117 dealing with bridges, structures, and hydraulics. Although potentially useful for other purposes, this analysis has not been prepared for any other purpose. Reuse of information contained in this report for purposes other than those for which this analysis and report are intended is not endorsed or encouraged by the author and is at the sole risk of the entity reusing information herein contained. Estimates of peak flows for frequent flood peaks (5-year or more frequent), if shown in this report, should not be considered accurate unless an overtopping flood of 5-year or more frequent is identified.

Analyses to meet the requirements of FEMA, the State of California Reclamation Board, low flow environmental or construction concerns and for other purposes may be provided as additional services.

Design Standards: Hydraulic design of the preferred bridge is based on standards recommended by Caltrans (Local Programs Manual - reference 1). Exceptions to these design standards are recommended only if meeting the standard is found to be impractical or unreasonably costly for the proposed project and the exception does not result in an increased risk of damage during floods. Local design standards provided in writing prior to the preparation of the hydraulic analysis have also been considered.

Funding: HBP

Existing Bridge:
Year Constructed – Truss 1910, Approaches 1965
Length – 265.0-feet nominal (261-ft effective)
Clear Width – 14.1-feet
Total Width – 18.0-feet
Skew (hydraulic) – None
Lanes – 1
Speed Limit – Not posted
Load Limit – None
Structure – 6-span steel stringer, 1-span Pratt through truss, 2-spans steel stringer. The existing bridge will not be removed.
Deficiency – Function
Sketch – Figure 1, page 14
Photos 1-4, pages 11, 12

Significance:
Description of Service – Forest resources, alternate route for SR-89
Length of Detour – 2-miles on roads of equal or greater service
Description of Road – Straight, flat

Preferred Bridge: Length – 277.0-feet nominal, 270.0-feet effective hydraulic
Clear Width – 26.0-ft
Total Width – 26.67-ft
Skew (hydraulic) – 10-degrees
Lanes – 2
Speed Limit – Not posted
Load Limit – None
Structure – Two span CIP/PS Concrete Box Girder
Traffic During Construction – Maintained on existing bridge
General Plan – Figure 2, page 15

DESCRIPTION OF BASIN

Geographic Location: Above Blairsden-Graeagle Road, the Middle Fork Feather River drains a small basin on the northern end of the Sierra Nevada Mountain Range.

Receiving Waters: Sacramento River

Characteristics: Area of basin – 711 sq-mi.
Shape – Tenticular rectangle
Highest elevation – 8800-ft Babbitt Peak on the southeast border of basin
Lowest elevation – 4350-ft near bridge
Elevation index – 5.1
Average annual precipitation (basin wide) – 25-in
Aspect – North

Land use: Forest resources. rural residential, small farms and ranches

Vegetation: Conifer forest

Geologic: Topographic features indicate moderate potential for significant landslides capable of causing channel instability and risk to bridge integrity.

Basin: Figure 3, page 16

DESCRIPTION OF STREAM AND SITE

Stream Channel: In the vicinity of Blairsden-Graeagle Road, the Middle Fork Feather River is wide, shallow, and mildly meandering. The channel is confined along the right bank by a hillside. Along the left bank and on the inside of a large bend is a low, wide floodplain with a top elevation near that of the 100-year flood. The Middle Fork Feather River is shown in Photos 5 and 6 (page 13).

Stream Banks: The banks of the Middle Fork Feather River consist of alluvium on the left and colluvium on the right with a moderate cover of grasses, willow, and evergreen trees.

Existing Bridge: The existing Blairsden-Graeagle Road bridge over Middle Fork Feather River is an eight span structure aligned perpendicular to the channel.

Site Topography: Figure 4, page 17

HYDROLOGIC ANALYSIS

Hydrologic Stability: Infrequent floods in Middle Fork Feather River are substantially natural and not significantly influenced by land use activities within the drainage basin.

Flood History: Floods in Middle Fork Feather River have not been known to overtop Blairsden-Graeagle Road.

Number of Methods: Two methods were investigated for estimating potential infrequent flood peak flows in Middle Fork Feather River. These include adjustment (translation) of known flood frequency curves at a proximate streamgage and direct application of the USGS Sierra Region Equations.

Translation Analysis: Approach – Translation analysis consists of estimating the infrequent flood peak flows by comparison with gaged stream or river basins. After identification of representative gaged basins, flood frequency relationships for the gaged basins are determined by plotting annual flood peaks and computing the normal probability Log-Pearson Type III curve fit (reference 7). If the Log-Pearson type III curve fit reasonably represents the plotted data for the less frequent floods, it is considered representative of the gaged basin and used as a basis of comparison. If not, a line of best visual fit may be used as a basis of comparison.

After identifying representative flood-frequency relationships for the gaged basins, candidate flood frequency relationships representing the stream or river at the proposed project site are estimated by adjusting the gaged basin flood frequency relationship to account for differences in characteristics between the gaged basin and the basin above the proposed project. The adjustments are made using the area, elevation and precipitation exponents of the appropriate USGS region equation (reference 8).

Basin Characteristics – Characteristics of gaged basins found to be potentially representative of the basin above the proposed project and having records of adequate length to reasonably identify the infrequent flood peak flows are identified in Table 1.

TABLE 1
Stream and Gaged Basin Characteristics

Basin Description	USGS Gage Number	Area (sq mi)	Average Annual Precip (in)	Elevation Index	Years of Record
Middle Fork Feather River at Blairsden-Graeagle Road	n/a	711	25	5.1	n/a
Middle Fork Feather River near Clio	11392500	686	25	5.1	54

Gaged basin flood frequency curves – Plotted flood frequency data and curves for the gaged basins used in this analysis are shown in Appendix A.

Regional Equations: Approach – The USGS has published a set of regional equations for estimating infrequent flood peak flows in ungaged natural streams and rivers (not affected by lakes, reservoirs, substantial development or substantial reclamation projects) throughout most of California (reference 8). These equations are useful for planning level and rough preliminary estimates of infrequent flood peak flows and corroboration of flood frequency estimates using more detailed procedures. Flood peak flows estimated by these equations should only be relied upon for design if confidence in other methodologies is low and if verified by other methodologies. The empirical equations estimate flood peak flows from basin characteristics including area, elevation index and precipitation. Use of the area, elevation index and precipitation factor exponents of the regional equation for adjustment of flood characteristics from representative long term gaged basins (described in Regional Analysis above) is generally considered to provide a more reliable estimate of infrequent flood peak flows for the ungaged basin.

Flood Peak Flows: Candidate flood frequency relationship – All candidate flood frequency curves derived from regional analysis for the proposed project site are plotted and shown in Appendix A. Estimated 50- and 100-year flood peak flows from all methods investigated are summarized in Table 2.

TABLE 2
Estimated 50- and 100-year Flood Peak Flows

Estimated from	50-Year (cfs)	100-Year (cfs)
Spanish Creek above Blackhawk Creek at Keddie	21100	26900
USGS Sierra Region Equations	24200	32620

Selected flood frequency relationship – The flood frequency relationship estimated from Middle Fork Feather River near Clio has been selected as most appropriate for design of the replacement bridge. The estimate from the USGS Sierra Region Equations was not selected because these

equations are intended to provide a rough estimate of flood peak flows in the Sierra Nevada Mountains when local data is unavailable. The selected flood frequency relationship is shown in Figure 5 (page 18).

Flood of Record: 14900-cfs on February 1, 1963 but a higher peak flow was likely to have been experienced January 1, 1997 after the streamgage was out of service.

HYDRAULIC ANALYSIS

Backwater Model: Backwater program – The Corps of Engineers' HEC-RAS version 4.1.0 backwater program (reference 3) has been selected for modeling hydraulic characteristics representing existing conditions, preliminary bridge configurations and the preferred bridge. This program has been selected because of its long history of use (derived from HEC-2), wide acceptance and great flexibility for evaluating bridge configurations.

Cross-section data – Stream cross-sections and Manning's roughness coefficients upstream and downstream of the proposed project have been assumed constant for all models. Cross-sections used in the backwater models were from a recent ground survey. Locations of cross-sections used in the backwater model are shown on Figure 6 (page 19). Cross-sections have been adjusted for skew as appropriate.

Elevation Datum – NAVD88

Manning's Roughness Coefficients – Mannings Roughness Coefficients for the channel and banks were estimated by observation and comparison with similar channels identified in Roughness Coefficients of Natural Channels (reference 6). Manning's roughness coefficients ranging from 0.035 to 0.040 were used to represent the channel and ranging from 0.040 to 0.045 were used to represent the banks.

Contraction and Expansion Coefficients – Contraction and expansion coefficients of 0.1 and 0.3 respectively were used to represent the natural channel. These were raised to 0.3 and 0.5 respectively in the vicinity of the existing bridge.

Downstream starting water surface elevation assumption – The normal depth method in HEC-RAS was selected for estimating the downstream water surface elevation. A slope of 0.002, estimated from the slope of the stream channel, was used as the starting slope. Four surveyed cross-sections and two interpolated cross-sections were used to isolate the effects of downstream starting water surface elevation assumption from water surface elevations at the bridge.

Existing Bridge: Purpose – The existing condition backwater model has been prepared to identify and document existing hydraulic conditions and to serve as a basis of comparison with which to evaluate preliminary and preferred bridge configurations.

Channel roughness coefficient at bridge – 0.035 to 0.040
Bank roughness coefficient at bridge – 0.040 to 0.045
Contraction coefficient – 0.3 (at bridge)
Expansion coefficient – 0.5 (at bridge)
Bridge modeling method – Energy.
Drift assumption – 2 x actual pier width with 3-foot minimum
Figure 7 (page 20) shows how existing bridge is represented in model.

Model results – Existing flood hydraulic conditions are summarized in Table 3. Existing condition flood profiles and a stage discharge curve at cross-section 2310 are shown in Figures 9 and 10 (pages 22, 23). Summary output tables from the existing condition HEC-RAS backwater model are included in Appendix B.

TABLE 3: Existing Hydraulic Conditions upstream of existing bridge (with drift except as noted)

Flood	Flow (cfs)	Recurrence (years)	W.S. Elevation[1] (feet)	Avg. Channel Velocity[2] (fps)
Standard Design	21100	50	4351.45	11.0
Base	26900	100	4353.39	12.2
Base (no drift)	26900	100	4353.39	11.9
Flood of Record	14900	<25	4349.0±	9.5±
Overtopping Flood	31500	150±	4355.0	13.2±

Notes: 1) At cross-section 2310 located approximately 40-feet upstream of the existing bridge.
2) Highest average channel velocity in vicinity of bridge.

Preliminary Bridges: Backwater models were prepared to represent three candidate bridge configurations. Results from these models were provided to project staff in the form of a preliminary hydraulic analysis report. Using information provided in the preliminary hydraulic analysis report and considering additional factors not related to hydraulic conditions, a bridge configuration was selected as the preferred bridge for final design.

Preferred Bridge: The preferred bridge backwater model has been prepared to identify hydraulic requirements and impacts of the preferred bridge.

Channel roughness coefficient at bridge – 0.035 to 0.040
Overbank roughness coefficient at bridge – 0.040 to 0.045
Contraction coefficient – 0.3 (at bridge)
Expansion coefficient – 0.5 (at bridge)
Bridge modeling method – Energy.
Drift assumption – Pier assumed 11-feet wide (2 x actual pier width)

Figure 8 (page 21) shows how preferred bridge is represented in model.

Model results – Preferred bridge hydraulic conditions are summarized in Table 4. Preferred bridge flood profiles and a stage discharge curve at cross-section 2310 are shown in Figures 9 and 10 (pages 22, 23). Stage discharge curves at cross-sections 2250 for bridge design and 4080 for flood risk assessment are shown in Figures 11 and 12 respectively (pages 24, 25). Summary output tables from the preferred bridge HEC-RAS backwater model are included in Appendix B.

TABLE 4: Preferred Bridge Hydraulic Conditions (with drift except as noted)

Flood	Flow (cfs)	Recurrence (years)	W.S. Elevation[1] (feet)	Avg. Channel Velocity[2] (fps)
Standard Design	21100	50	4350.65	10.6
Base	26900	100	4352.11	11.9
Base (no drift, x-sec 2310)	26900	100	4353.57[3]	11.9
Flood of Record	14900	<25	4348.5±	9.0±
Overtopping Flood[4]	31000	150±	4355.0	13.2±

Notes: 1) Except as noted, at cross-section 2250 located approximately 15-feet upstream of the preferred bridge for the purpose of identifying bridge geometric requirements.
2) Average channel velocity approaching bridge assuming existing abutments removed.
3) At cross-section 2310 located approximately 40-feet upstream of the existing bridge for the purpose of comparison with existing hydraulic conditions.

SCOUR AND EROSION

Channel Stability: In the vicinity of Blairsden-Graeagle Road, the Middle Fork Feather River channel appears to be substantially in a state of dynamic equilibrium. The channel may however experience transient aggradation events associated with landslides entering Frazier Creek, a tributary entering Middle Fork Feather River a short distance upstream of the bridge.

Replacement of the existing Blairsden-Graeagle bridge with the preferred bridge is not expected to affect sediment transport and therefore is not expected to aggravate channel instability.

Abutment Local: Abutments of the preferred bridge will not redirect a significant volume of water from the floodplain to the channel during the most probable 100-year flood. Therefore application of the Froehlich Equation in FHWA HEC-18 is precluded. Abutments, however, should be designed considering or protected against potential bank erosion or channel migration. It is not unrealistic to expect up to five feet of additional abutment exposure as a result of bank erosion or channel migration over the expected life of the bridge.

Pier Local: Potential pier scour has been estimated to be 13.2-feet using the limiting pier scour equation presented in FHWA HEC-18.

Contraction Local: The preferred bridge does not constitute a significant contraction of the flood channel.

Total Scour: Total potential scour and potential scour elevations at piers are summarized in Table 5. Scour computations and data are included in Appendix C.

TABLE 5
Total Potential Scour (feet)

Location	Ground Elev.	Degradation (widening)	Contraction Scour	Local Scour	Total Scour	Scour Elev.
Abutment 1	4346	5	0.	0.	5	4339.
Pier 2	4334	0	0.	13.2	13.2	4320.8
Abutment 3	4351	5	0.	0	5	4346.

OTHER CONSIDERATIONS:

Drift: There is a large potential for significant volumes of small to medium size drift (branches to small tree trunks) and a modest potential for large drift (large tree trunks) in Middle Fork Feather River. Drift has been considered in the design of the preferred bridge by providing larger span lengths than the existing bridge and more clearance for drift than the minimum recommended.

Transient Aggradation: In the event of a landslide entering Frazier Creek, it is likely that sediment will fill the active channel of Middle Fork Feather River to a significant degree during the subsequent transient aggradation event. During such events the water surface elevations of moderate recurrence events can well exceed the water surface elevation estimated for the most probable 100-year flood. While it is impossible to predict or assign a recurrence to these events, they are not particularly uncommon and measures can be implemented to minimize damage should such an event occur.

Existing Bridge: The existing bridge will not be removed after construction of the preferred bridge.

FEMA: The preferred bridge is located within a reach of channel that has flood risk mapped by FEMA using approximate study methods. As such, projects may encroach into the floodplain to the extent they result in a 1.0-foot increase in the water surface elevation of the most probable 100-year flood provided the increase does not result in an increased risk of damage

to structures or other negative impacts. The preferred bridge is expected to result in a 0.18-foot increase in water surface elevation during the most probable 100-year flood at and for a short distance upstream of the bridge. No structures are in or adjacent to the channel upstream of Blairsden-Graeagle Road therefore the minor increase in water surface elevation during the most probable 100-year flood does not reflect an increase in the risk of damage to structures. No FEMA applications are believed necessary for the bridge replacement project.

CONCLUSIONS AND RECOMMENDATIONS

Design Flood: Caltrans and FHWA recommend that new and replacement bridges be designed with a minimum soffit elevation equal to the water surface elevation of the most probable 50-year flood (Standard Design Flood) plus appropriate clearance for drift or to the water surface elevation of the most probable 100-year flood (Base Flood) with no clearance for drift, whichever is higher.

Clearance for Drift: The minimum clearance for drift recommended by Caltrans and FHWA for bridges over rivers of 3.0-feet is appropriate at this site.

Design Exception: None required for flood hydraulic conditions

Recommendations: Minimum Soffit Elevation – The minimum soffit elevation of a bridge meeting the recommendations of Caltrans and FHWA is 4353.65-ft. This represents the elevation of the Standard Design Flood plus 3.0-feet of clearance for drift.

Pier Scour Elevation – Pier 2 should be designed considering total potential scour to an elevation of 4320.8-feet.

Abutment Scour Elevation – Abutment 1 should be designed considering or protected against total potential scour to an elevation of 4339-feet. Abutment 2 should be designed considering or protected against total potential scour to an elevation of 4346-feet.

Abutment Protection – Recommended to an elevation 3-feet above the water surface elevation during the most probable 100-year flood or to the top of bank, whichever is higher, to reduce risks of damage during a transient aggradation event and of long term potential for damage to abutments from bank erosion and bank migration.

Note regarding estimates of potential scour: Potential scour has been estimated using empirical equations presented in FHWA HEC-18. These equations do not consider geotechnical conditions and therefore assume all substrate is erodible. The potential scour estimates identified in this report may be inappropriate if a geotechnical investigation identifies material resistant to erosion at higher elevations.

Preferred Bridge Characteristics:

Soffit Elevation –	4355.24-feet (4.59-ft above Q50, 3.13-ft above Q100)
Overtopping Flood –	31000-cfs, approximately 150-year recurrence
Impact on Flood Risk –	Minor (0.18-foot) increase in water surface elevation during the most probable 100-year flood but no increase in flood risk to structures because no structures are present within the 100-year floodplain.
Impact on Channel –	Preferred bridge is not expected to aggravate channel instability.

Photo 1: Looking downstream (north) at Bridge 09C-0134, Blairsden-Graeagle Road over Middle Fork Feather River

Photo 2: Looking upstream (north) at Bridge 09C-0134, Blairsden-Graeagle Road over Middle Fork Feather River

Photo 3: Looking east across Bridge 09C-0134, Blairsden-Graeagle Road over Middle Fork Feather River

Photo 4: Looking west across Bridge 09C-0134, Blairsden-Graeagle Road over Middle Fork Feather River

Photo 5: Looking downstream at Middle Fork Feather River from Bridge 09C-0134, Blairsden-Graeagle Road

Photo 6: Looking upstream at Middle Fork Feather River from Bridge 09C-0134, Blairsden-Graeagle Road

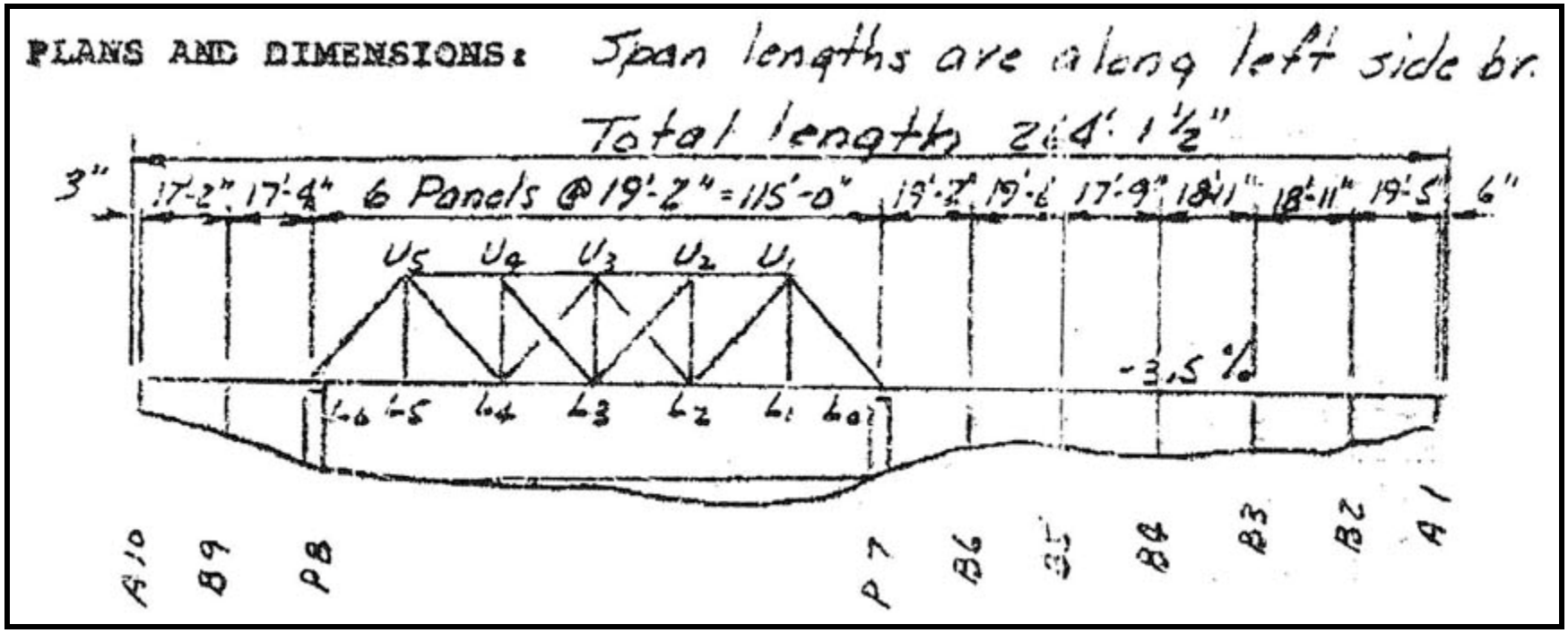
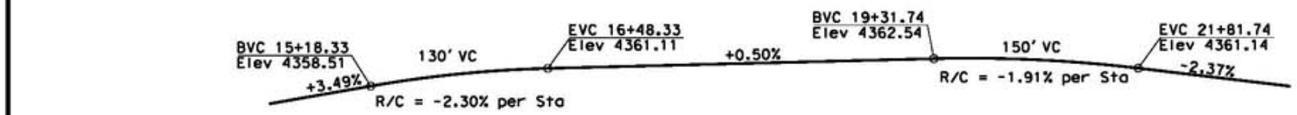
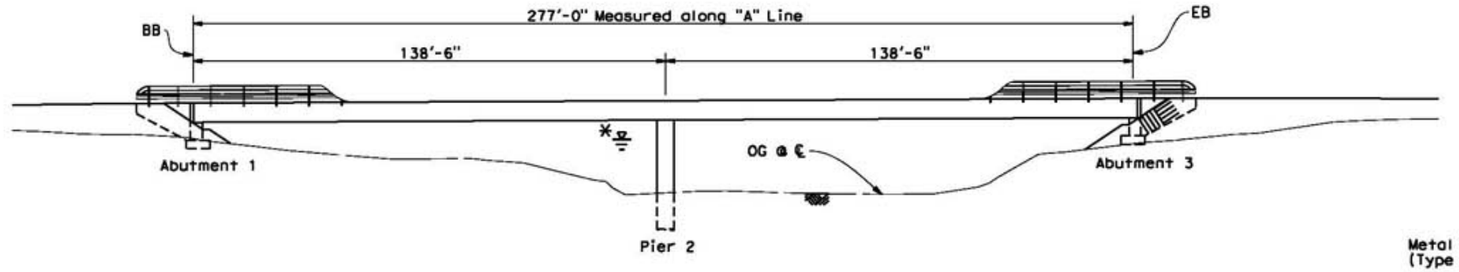


Figure 1: Sketch of Existing Bridge



PROFILE GRADE
No Scale



ELEVATION
1"=20'

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
02	PLU	CR	XXXX	XXX	XXX

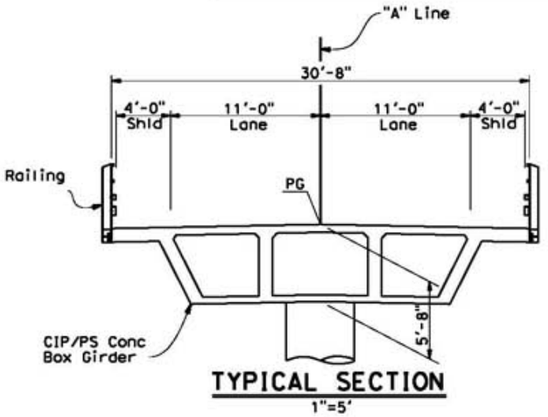
REGISTERED CIVIL ENGINEER — X — DATE

REGISTERED PROFESSIONAL ENGINEER — No. X — Exp. X — CIVIL — STATE OF CALIFORNIA

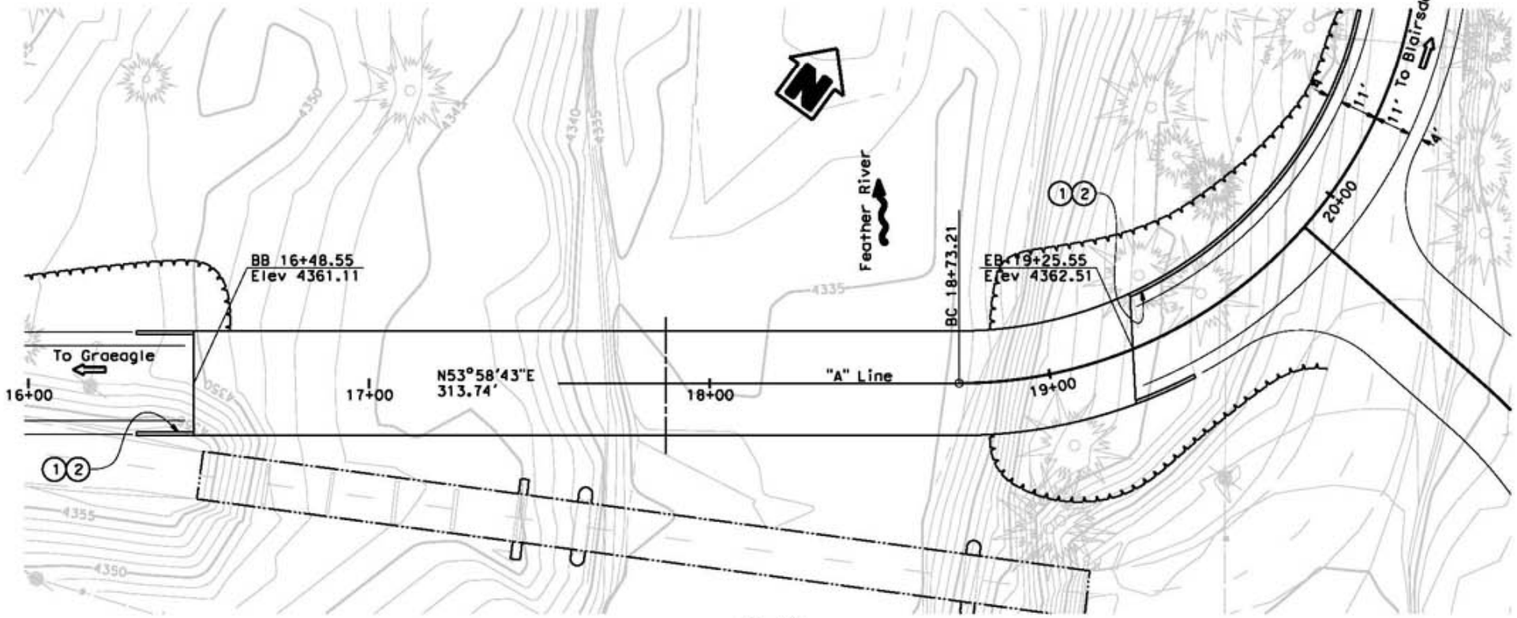
PLANS APPROVAL DATE

The Identity or its officers or agents shall not be responsible for the accuracy or completeness of electronic copies of this plan sheet.

QUINCY ENGINEERING, INC
3247 Ramos Circle
Sacramento, CA 95827 - 2501



TYPICAL SECTION
1"=5'



PLAN
1"=20'

Notes:
1. Paint Bridge "Br No. 09C-XXX "
2. Paint "Blairsde-Groeagle Rood Bridge"
* Highwater elevation
Existing structure

X DESIGN OVERSIGHT	DESIGN	BY D. Mossman	CHECKED X	LOAD & RESISTANCE FACTOR DESIGN	LIVE LOADING: HL93 W/"LOW-BOY"; PERMIT DESIGN VEHICLE	PREPARED FOR THE COUNTY OF PLUMAS DEPARTMENT OF PUBLIC WORKS	X PROJECT ENGINEER
X SIGN OFF DATE	DETAILS	BY D. Mossman	CHECKED X	LAYOUT	BY D. Mossman CHECKED X		BRIDGE NO. X
	QUANTITIES	BY X	CHECKED X	SPECIFICATIONS	BY X PLANS AND SPECS COMPARED X		POST MILES X

ALTERNATIVE No. 1

BLAIRSDEN-GRAEAGLE BRIDGE

GENERAL PLAN

DESIGN GENERAL PLAN SHEET (ENGLISH) (REV.7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: X PROJECT NUMBER & PHASE: X CONTRACT NO.: X

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES 1

SHEET X OF X

FILE => \\Deserver\Engineering\CLIENT\North State Resources\N06-200 Blairsden Groeagle\CAD\N06200a-a-gp01.dgn

USERNAME => _USER_ DATE PLOTTED => 12/6/2011 TIME PLOTTED => 4121144 PM

Figure 2: Preferred Bridge Preliminary General Plan

Figure 3: Middle Fork Feather River Drainage Basin above Blairsden-Graeagle Road

Figure 4: Site Topography

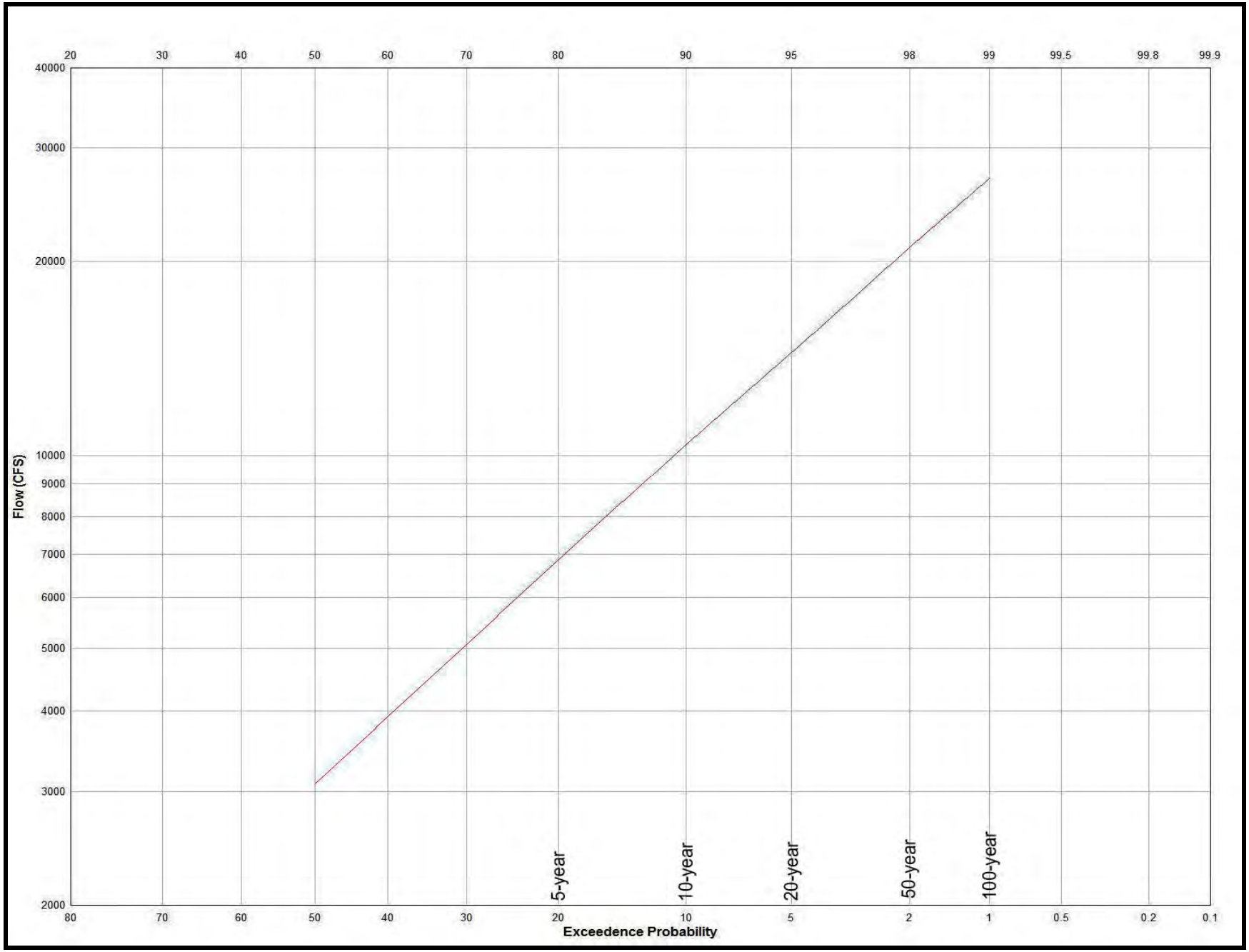


Figure 5: Flood Frequency Curve of Middle Fork Feather River at Blairsden Graeagle Road

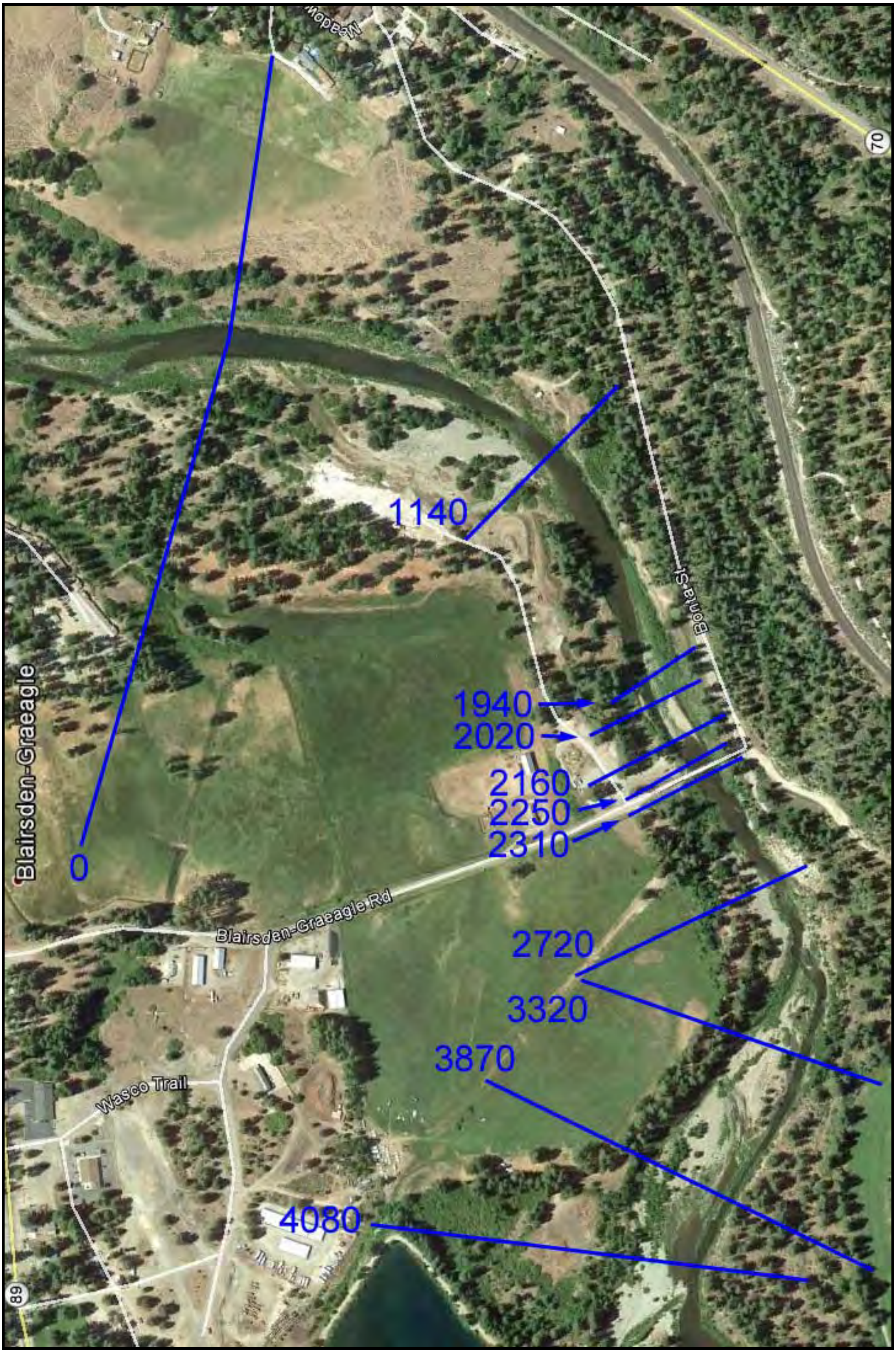


Figure 6: Approximate Locations of Surveyed Cross-sections used in Backwater Model

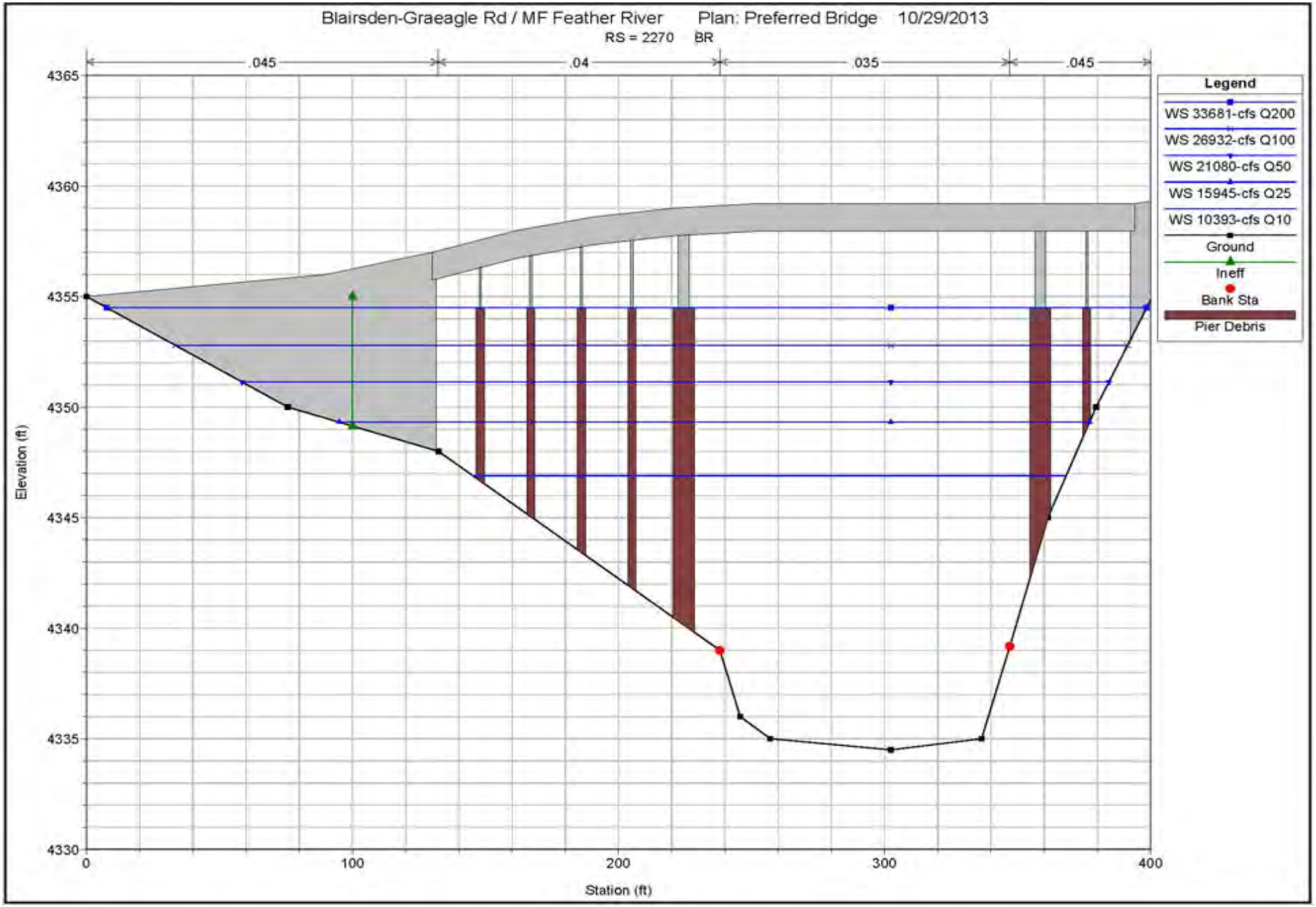


Figure 7: Existing Bridge as Represented in Backwater Model

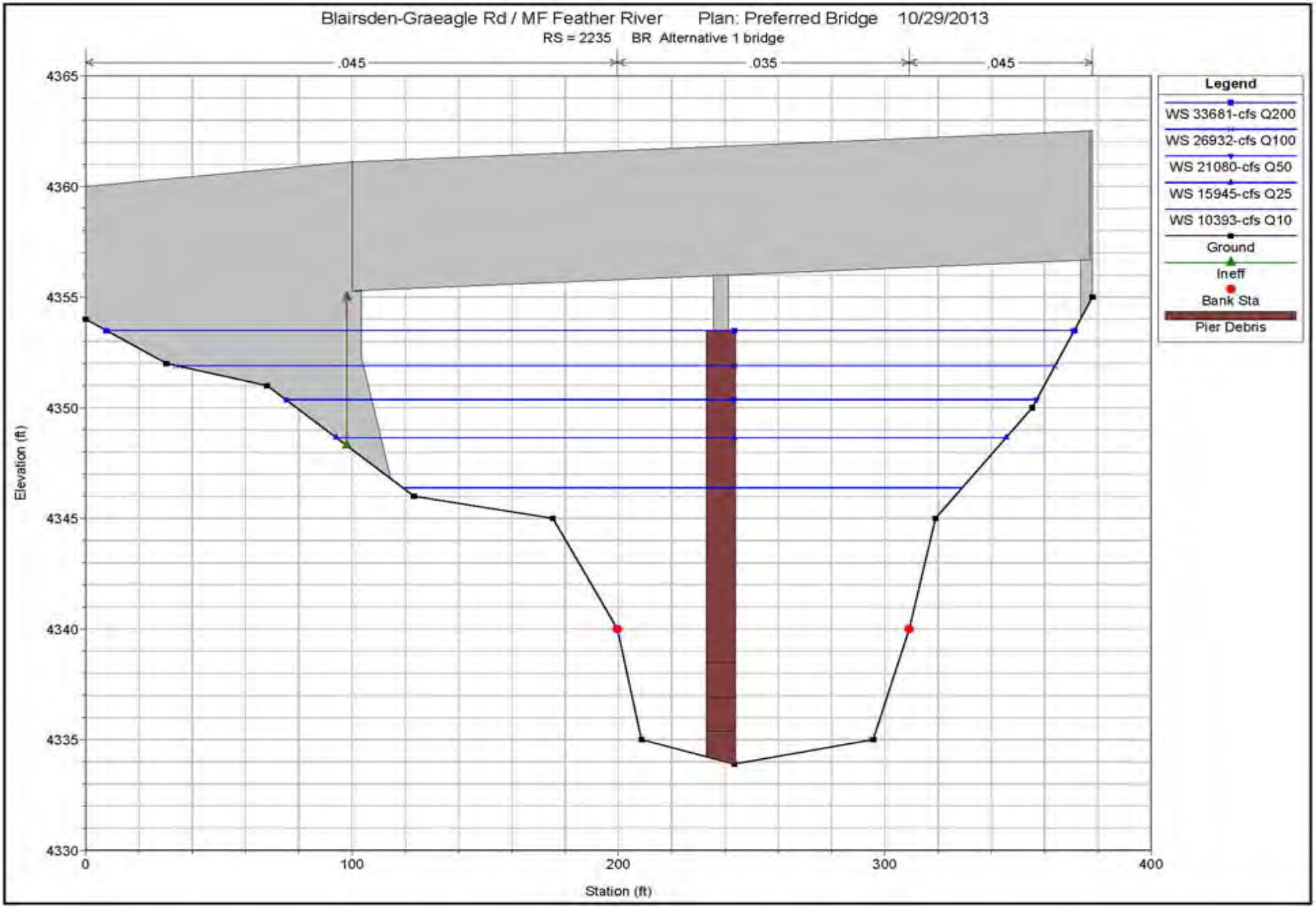


Figure 8: Preferred Bridge as Represented in Backwater Model

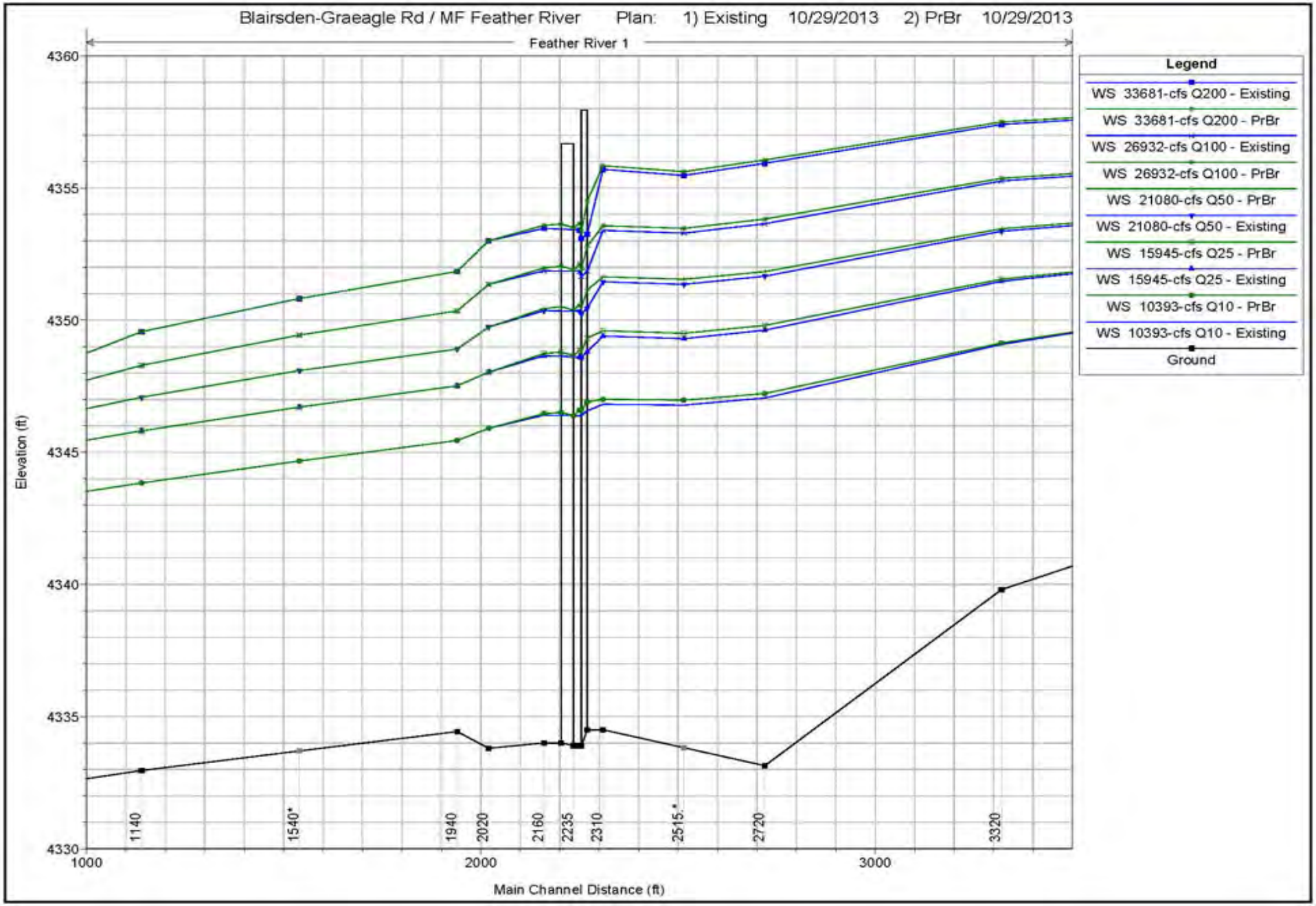


Figure 9: Existing Condition and Preferred Bridge Flood Profiles

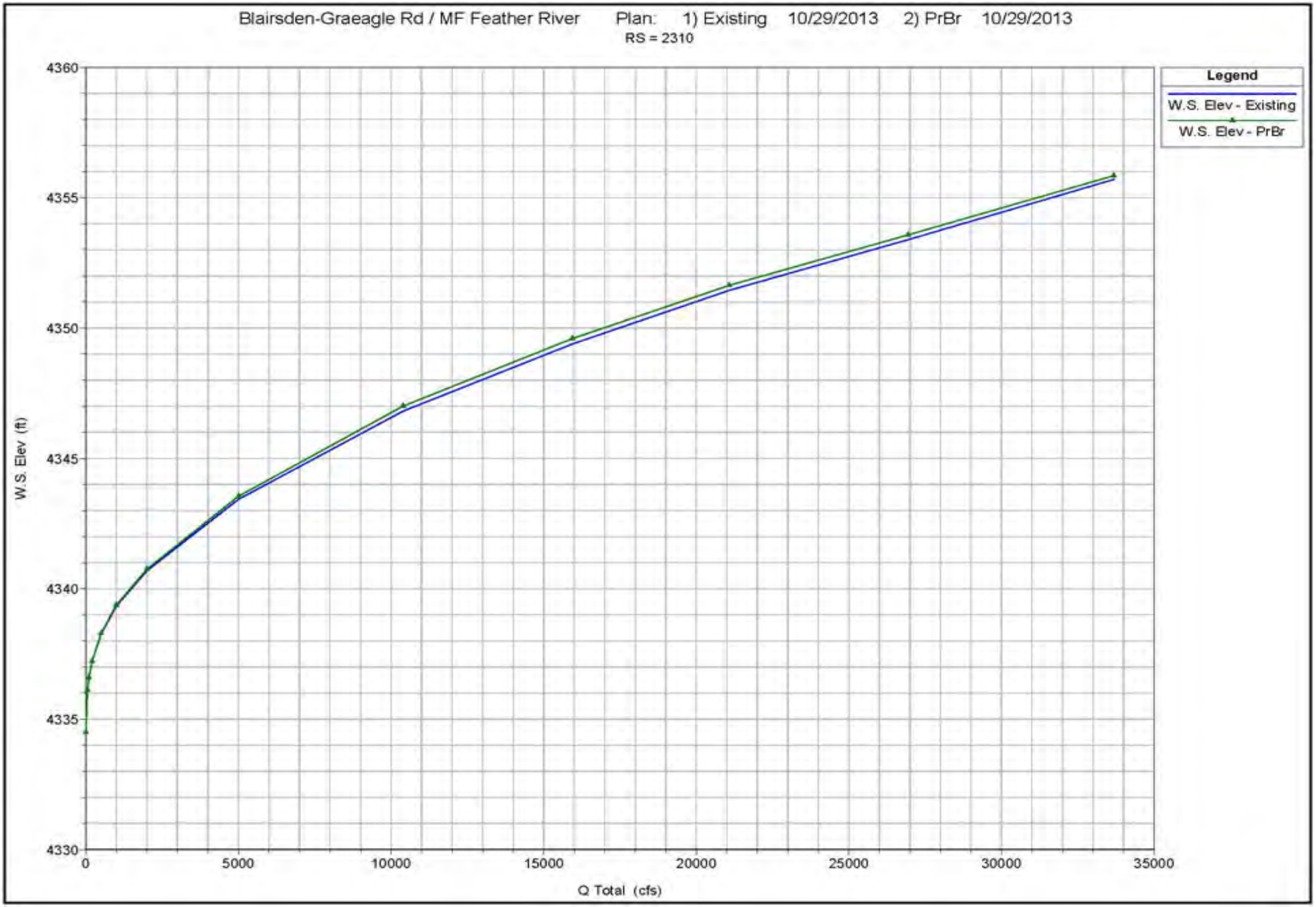


Figure 10: Existing Condition and Preferred Bridge Stage Discharge Curve at Cross-section 2310 *for Flood Risk Assessment*

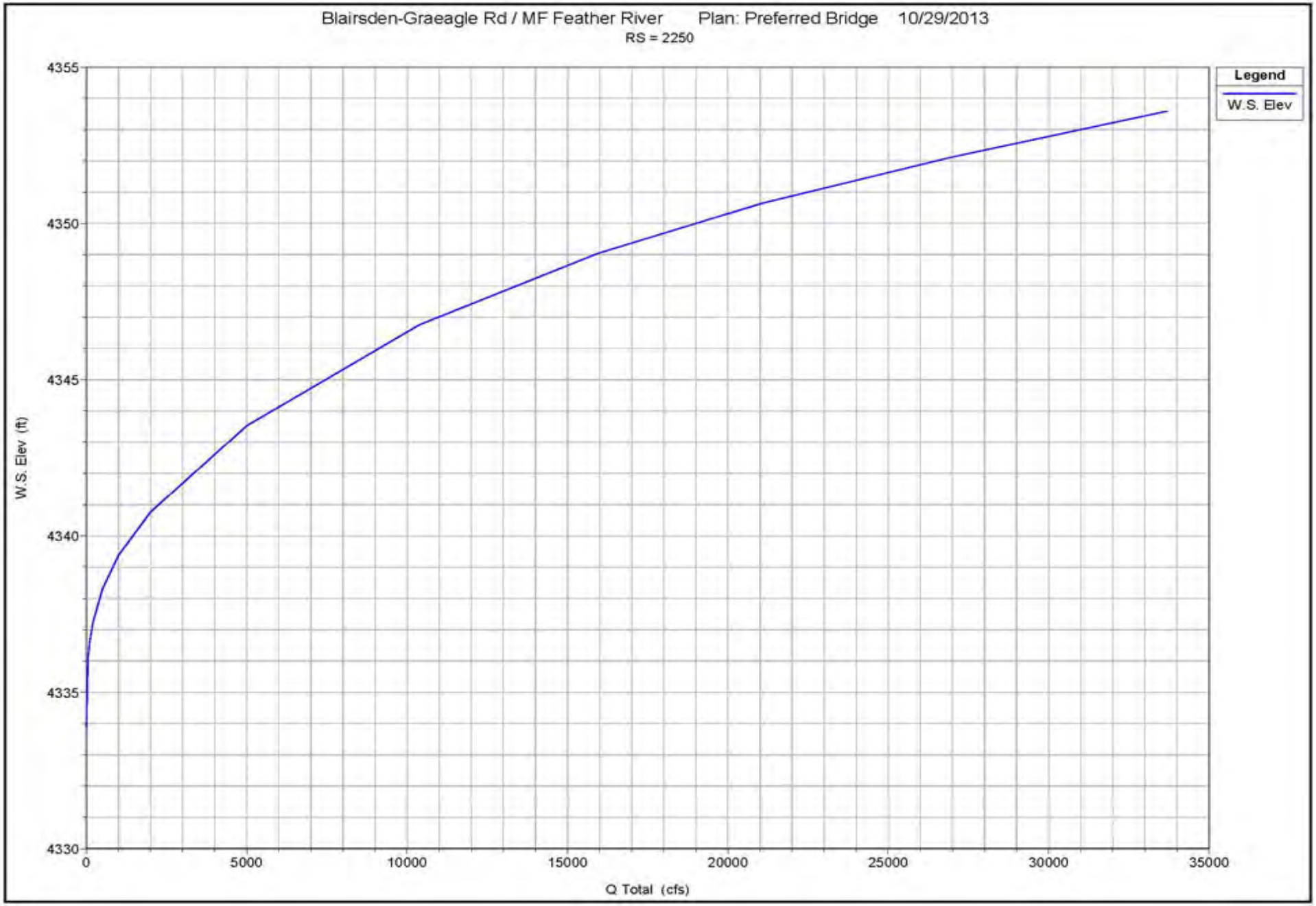


Figure 11: Preferred Bridge Stage Discharge Curve at Cross-section 2250 *for Bridge Design*

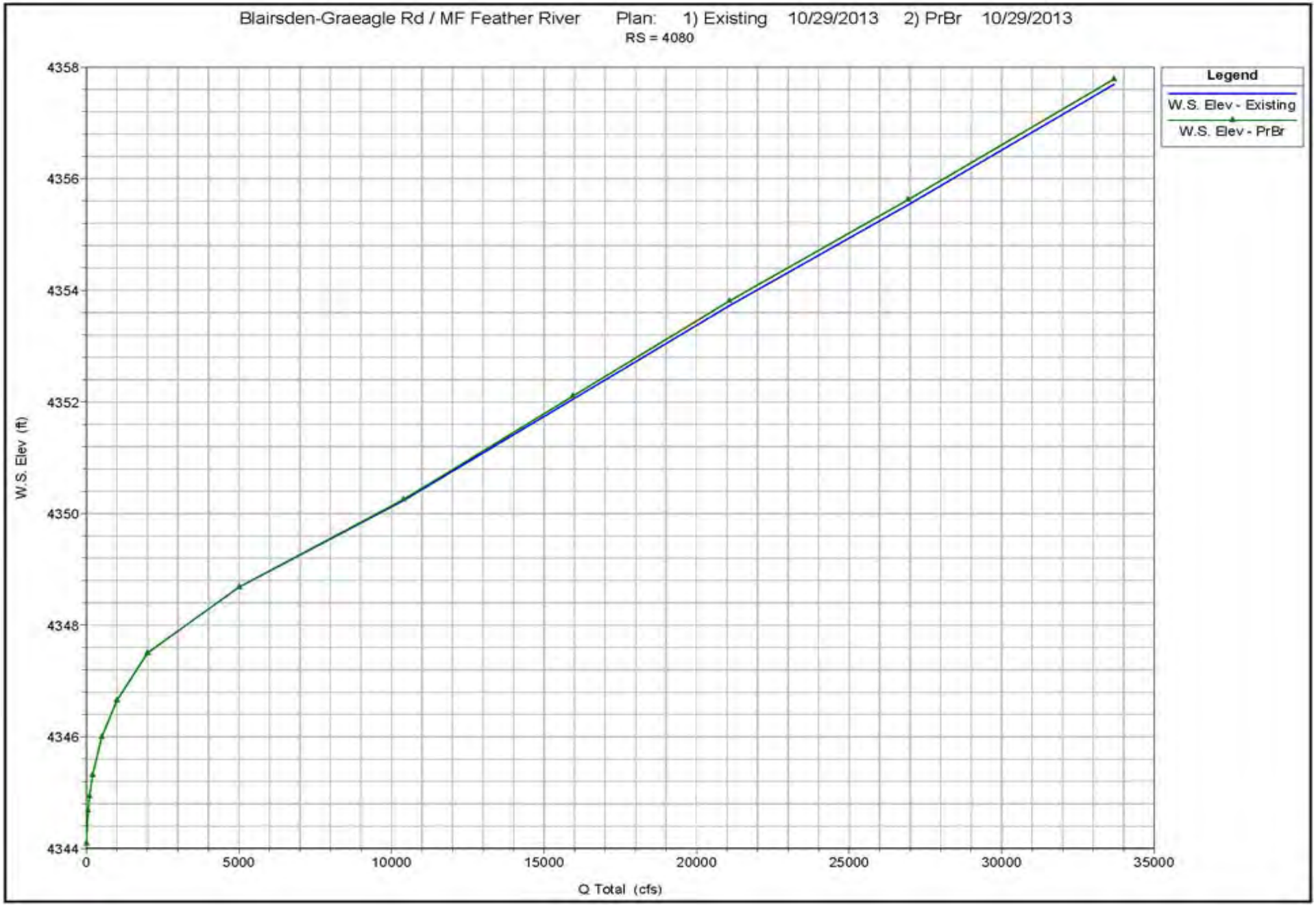


Figure 12: Existing Condition and Preferred Bridge Stage Discharge Curve at Cross-section 4080 (upstream end of model) *for flood risk assessment*

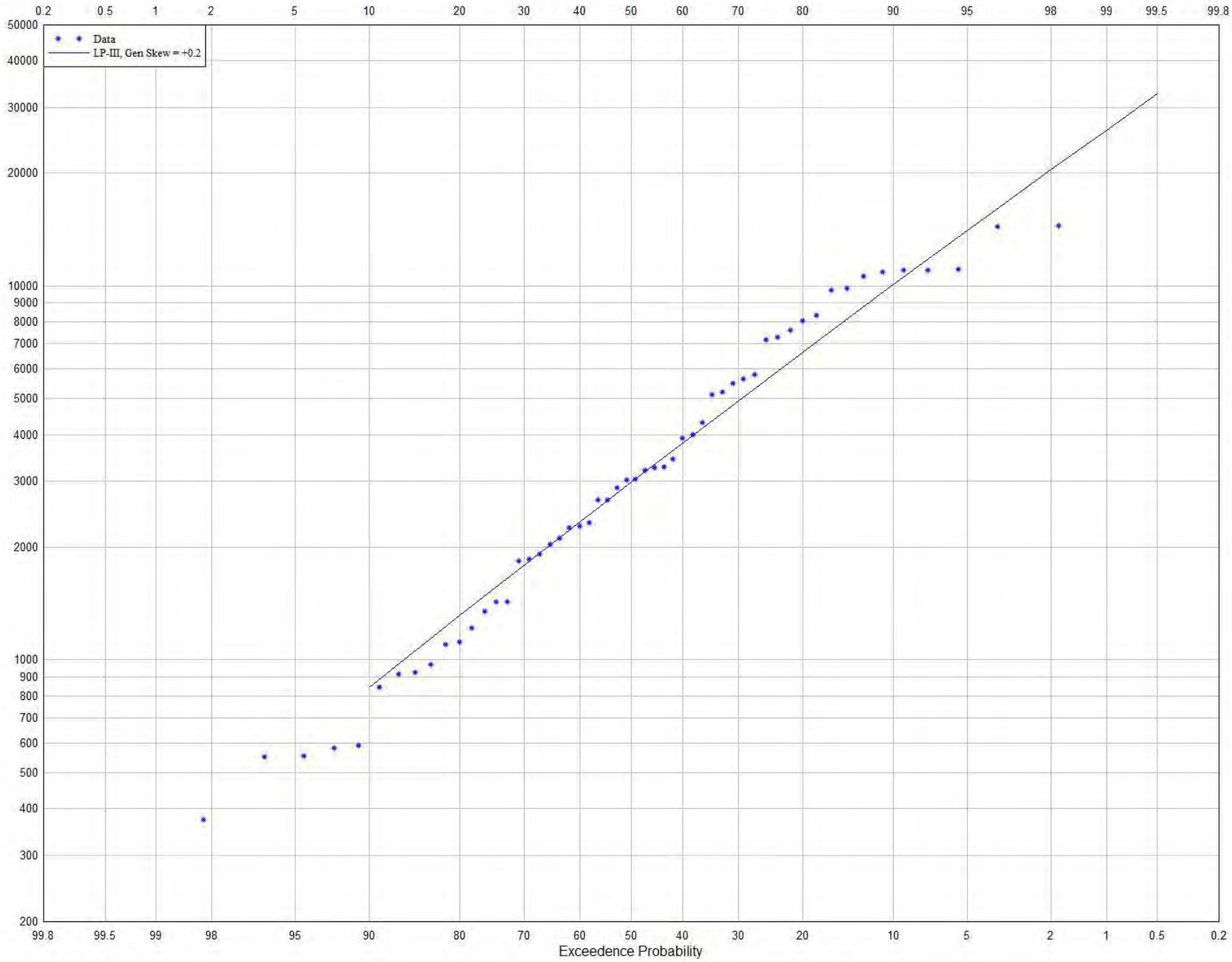
APPENDIX A

Additional Hydrologic Figures

Middle Fork Feather River near Clio

USGS Streamgage 11392500: 54-years, 686-sq mi, 20-in, EI=5.1

Discontinued



APPENDIX B

Additional Hydraulic Data

Backwater Model Summary Output, Existing Condition without Drift

HEC-RAS Plan: Existing River: Feather River Reach: 1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
1	4080	15945-cfs Q25	15945.00	4344.09	4352.05	4351.46	4353.80	0.005978	10.98	1590.63	340.22	0.78
1	4080	21080-cfs Q50	21080.00	4344.09	4353.72		4355.36	0.004196	10.80	2235.07	428.23	0.68
1	4080	26932-cfs Q100	26932.00	4344.09	4355.53		4357.02	0.003023	10.53	3094.11	523.00	0.60
1	4080	33681-cfs Q200	33681.00	4344.09	4357.69		4358.87	0.001975	9.74	4531.94	804.26	0.50
1	3870	15945-cfs Q25	15945.00	4342.53	4352.33		4352.86	0.001508	5.85	2750.31	453.40	0.40
1	3870	21080-cfs Q50	21080.00	4342.53	4354.03		4354.60	0.001232	6.12	3594.96	543.04	0.37
1	3870	26932-cfs Q100	26932.00	4342.53	4355.82		4356.41	0.001011	6.27	4814.87	796.67	0.35
1	3870	33681-cfs Q200	33681.00	4342.53	4357.89		4358.43	0.000759	6.13	6547.95	862.36	0.31
1	3320	15945-cfs Q25	15945.00	4339.80	4351.46		4352.00	0.001617	6.30	2777.41	446.95	0.41
1	3320	21080-cfs Q50	21080.00	4339.80	4353.36		4353.91	0.001256	6.44	3663.14	488.81	0.37
1	3320	26932-cfs Q100	26932.00	4339.80	4355.26		4355.84	0.001043	6.64	4634.60	530.95	0.35
1	3320	33681-cfs Q200	33681.00	4339.80	4357.40		4357.98	0.000859	6.77	5831.43	661.47	0.33
1	2720	15945-cfs Q25	15945.00	4333.14	4349.61		4350.85	0.001982	9.33	2050.38	315.05	0.49
1	2720	21080-cfs Q50	21080.00	4333.14	4351.66		4352.95	0.001745	9.79	2759.33	379.16	0.47
1	2720	26932-cfs Q100	26932.00	4333.14	4353.64		4355.00	0.001593	10.27	3637.17	497.20	0.46
1	2720	33681-cfs Q200	33681.00	4333.14	4355.93		4357.26	0.001378	10.48	4909.38	692.47	0.44
1	2515.*	15945-cfs Q25	15945.00	4333.82	4349.29		4350.48	0.001583	9.14	2112.05	291.99	0.45
1	2515.*	21080-cfs Q50	21080.00	4333.82	4351.35		4352.62	0.001467	9.72	2717.04	296.83	0.44
1	2515.*	26932-cfs Q100	26932.00	4333.82	4353.28		4354.68	0.001423	10.39	3296.41	301.53	0.45
1	2515.*	33681-cfs Q200	33681.00	4333.82	4355.46		4356.97	0.001337	10.92	3966.05	311.33	0.44
1	2310	15945-cfs Q25	15945.00	4334.50	4349.39	4344.17	4350.25	0.000326	8.11	2329.67	284.31	0.38
1	2310	21080-cfs Q50	21080.00	4334.50	4351.44	4345.75	4352.40	0.000316	8.68	2907.95	331.82	0.38
1	2310	26932-cfs Q100	26932.00	4334.50	4353.39	4347.31	4354.47	0.000315	9.30	3470.44	369.43	0.38
1	2310	33681-cfs Q200	33681.00	4334.50	4355.70	4349.16	4356.72	0.000274	9.33	4550.67	400.69	0.36
1	2270		Bridge									
1	2250	15945-cfs Q25	15945.00	4333.90	4348.61	4343.95	4349.99	0.001710	9.84	1936.67	250.78	0.47
1	2250	21080-cfs Q50	21080.00	4333.90	4350.33	4346.28	4351.98	0.001809	10.96	2372.90	281.39	0.49
1	2250	26932-cfs Q100	26932.00	4333.90	4351.84	4348.18	4353.83	0.001975	12.19	2769.84	327.51	0.52
1	2250	33681-cfs Q200	33681.00	4333.90	4353.41	4349.96	4355.74	0.002114	13.39	3191.95	361.90	0.55
1	2160	15945-cfs Q25	15945.00	4334.00	4348.65		4349.66	0.001545	8.27	2142.71	239.00	0.41
1	2160	21080-cfs Q50	21080.00	4334.00	4350.36		4351.64	0.001702	9.44	2575.66	279.83	0.44
1	2160	26932-cfs Q100	26932.00	4334.00	4351.86		4353.46	0.001897	10.64	3048.33	336.96	0.47
1	2160	33681-cfs Q200	33681.00	4334.00	4353.47		4355.32	0.001996	11.63	3622.82	379.88	0.49
1	2020	15945-cfs Q25	15945.00	4333.80	4348.03		4349.36	0.002439	9.71	1856.89	280.35	0.51
1	2020	21080-cfs Q50	21080.00	4333.80	4349.73		4351.32	0.002487	10.77	2377.70	317.62	0.53
1	2020	26932-cfs Q100	26932.00	4333.80	4351.35		4353.14	0.002487	11.65	2909.45	340.93	0.54
1	2020	33681-cfs Q200	33681.00	4333.80	4353.00		4354.99	0.002484	12.51	3496.99	375.09	0.55
1	1940	15945-cfs Q25	15945.00	4334.43	4347.51		4349.11	0.003061	10.63	1698.06	208.53	0.58
1	1940	21080-cfs Q50	21080.00	4334.43	4348.90		4351.04	0.003498	12.32	2003.23	276.54	0.63
1	1940	26932-cfs Q100	26932.00	4334.43	4350.35		4352.83	0.003616	13.50	2408.58	284.56	0.65
1	1940	33681-cfs Q200	33681.00	4334.43	4351.84		4354.67	0.003682	14.60	2840.38	292.87	0.67
1	1540*	15945-cfs Q25	15945.00	4333.70	4346.71	4343.07	4347.97	0.002230	9.19	1881.68	249.26	0.50
1	1540*	21080-cfs Q50	21080.00	4333.70	4348.09	4344.67	4349.71	0.002476	10.51	2228.28	305.83	0.54
1	1540*	26932-cfs Q100	26932.00	4333.70	4349.43	4346.17	4351.44	0.002708	11.80	2587.24	357.97	0.57
1	1540*	33681-cfs Q200	33681.00	4333.70	4350.82	4347.70	4353.24	0.002912	13.07	2978.28	413.24	0.60
1	1140	15945-cfs Q25	15945.00	4332.96	4345.81	4342.38	4347.05	0.002342	8.98	1836.36	286.26	0.52
1	1140	21080-cfs Q50	21080.00	4332.96	4347.08	4343.77	4348.69	0.002598	10.30	2163.29	328.19	0.56
1	1140	26932-cfs Q100	26932.00	4332.96	4348.29	4345.38	4350.32	0.002872	11.64	2493.70	370.77	0.60
1	1140	33681-cfs Q200	33681.00	4332.96	4349.56	4346.82	4352.04	0.003087	12.92	2864.06	415.62	0.63
1	760.*	15945-cfs Q25	15945.00	4332.11	4344.85		4346.17	0.002272	9.39	1880.42	283.26	0.52
1	760.*	21080-cfs Q50	21080.00	4332.11	4345.90		4347.67	0.002724	10.98	2184.70	298.30	0.58
1	760.*	26932-cfs Q100	26932.00	4332.11	4346.76		4349.11	0.003350	12.79	2451.13	319.86	0.65
1	760.*	33681-cfs Q200	33681.00	4332.11	4347.36	4346.22	4350.58	0.004334	15.03	2649.99	337.77	0.74
1	380.*	15945-cfs Q25	15945.00	4331.25	4344.28	4341.28	4345.15	0.002362	7.50	2171.88	336.65	0.50
1	380.*	21080-cfs Q50	21080.00	4331.25	4345.33	4342.52	4346.46	0.002652	8.58	2543.45	379.05	0.54
1	380.*	26932-cfs Q100	26932.00	4331.25	4346.15	4343.63	4347.63	0.003080	9.86	2926.32	653.60	0.59
1	380.*	33681-cfs Q200	33681.00	4331.25	4346.62	4344.67	4348.65	0.003969	11.59	3238.78	901.86	0.68
1	0	15945-cfs Q25	15945.00	4330.38	4343.14	4340.65	4344.29	0.002000	9.79	2609.47	952.42	0.50
1	0	21080-cfs Q50	21080.00	4330.38	4344.40	4341.28	4345.58	0.002001	10.45	3770.62	1506.61	0.50
1	0	26932-cfs Q100	26932.00	4330.38	4345.44	4344.35	4346.60	0.002001	10.99	5225.75	1719.94	0.51
1	0	33681-cfs Q200	33681.00	4330.38	4346.21	4344.37	4347.33	0.002004	11.39	6375.29	1774.91	0.51

Backwater Model Summary Output, Existing Condition with Drift

HEC-RAS Plan: Existing River: Feather River Reach: 1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
1	4080	15945-cfs Q25	15945.00	4344.09	4352.05	4351.46	4353.80	0.005967	10.98	1591.63	340.38	0.78
1	4080	21080-cfs Q50	21080.00	4344.09	4353.73		4355.36	0.004194	10.80	2235.49	428.28	0.68
1	4080	26932-cfs Q100	26932.00	4344.09	4355.53		4357.02	0.003021	10.53	3095.13	523.11	0.60
1	4080	33681-cfs Q200	33681.00	4344.09	4357.69		4358.87	0.001972	9.73	4535.47	804.44	0.50
1	3870	15945-cfs Q25	15945.00	4342.53	4352.33		4352.86	0.001507	5.85	2751.20	453.51	0.40
1	3870	21080-cfs Q50	21080.00	4342.53	4354.03		4354.60	0.001232	6.12	3595.49	543.09	0.37
1	3870	26932-cfs Q100	26932.00	4342.53	4355.82		4356.41	0.001010	6.27	4816.42	796.87	0.35
1	3870	33681-cfs Q200	33681.00	4342.53	4357.90		4358.43	0.000758	6.12	6551.32	862.37	0.31
1	3320	15945-cfs Q25	15945.00	4339.80	4351.47		4352.01	0.001615	6.29	2778.71	447.02	0.41
1	3320	21080-cfs Q50	21080.00	4339.80	4353.36		4353.91	0.001255	6.44	3664.09	488.86	0.37
1	3320	26932-cfs Q100	26932.00	4339.80	4355.27		4355.84	0.001043	6.64	4635.64	530.99	0.35
1	3320	33681-cfs Q200	33681.00	4339.80	4357.40		4357.98	0.000858	6.77	5834.34	662.88	0.33
1	2720	15945-cfs Q25	15945.00	4333.14	4349.62		4350.86	0.001977	9.33	2052.38	315.25	0.49
1	2720	21080-cfs Q50	21080.00	4333.14	4351.66		4352.95	0.001743	9.79	2760.62	379.26	0.47
1	2720	26932-cfs Q100	26932.00	4333.14	4353.64		4355.00	0.001592	10.27	3638.63	497.34	0.46
1	2720	33681-cfs Q200	33681.00	4333.14	4355.93		4357.27	0.001378	10.49	4911.42	694.46	0.44
1	2515.*	15945-cfs Q25	15945.00	4333.82	4349.30		4350.48	0.001579	9.13	2114.19	292.01	0.45
1	2515.*	21080-cfs Q50	21080.00	4333.82	4351.35		4352.62	0.001465	9.71	2718.05	296.84	0.44
1	2515.*	26932-cfs Q100	26932.00	4333.82	4353.29		4354.69	0.001420	10.38	3298.62	301.54	0.45
1	2515.*	33681-cfs Q200	33681.00	4333.82	4355.47		4356.97	0.001335	10.92	3968.02	311.33	0.44
1	2310	15945-cfs Q25	15945.00	4334.50	4349.40	4344.17	4350.26	0.000325	8.10	2331.70	284.55	0.38
1	2310	21080-cfs Q50	21080.00	4334.50	4351.45	4345.75	4352.41	0.000315	8.67	2908.79	331.88	0.38
1	2310	26932-cfs Q100	26932.00	4334.50	4353.39	4347.31	4354.47	0.000315	9.29	3472.59	369.57	0.38
1	2310	33681-cfs Q200	33681.00	4334.50	4355.70	4349.16	4356.72	0.000274	9.33	4553.21	400.69	0.36
1	2270		Bridge									
1	2250	15945-cfs Q25	15945.00	4333.90	4348.61	4343.95	4349.99	0.001710	9.84	1936.67	250.78	0.47
1	2250	21080-cfs Q50	21080.00	4333.90	4350.33	4346.28	4351.98	0.001809	10.96	2372.90	281.39	0.49
1	2250	26932-cfs Q100	26932.00	4333.90	4351.84	4348.18	4353.83	0.001975	12.19	2769.84	327.51	0.52
1	2250	33681-cfs Q200	33681.00	4333.90	4353.41	4349.96	4355.74	0.002114	13.39	3191.95	361.90	0.55
1	2160	15945-cfs Q25	15945.00	4334.00	4348.65		4349.66	0.001545	8.27	2142.71	239.00	0.41
1	2160	21080-cfs Q50	21080.00	4334.00	4350.36		4351.64	0.001702	9.44	2575.66	279.83	0.44
1	2160	26932-cfs Q100	26932.00	4334.00	4351.86		4353.46	0.001897	10.64	3048.33	336.96	0.47
1	2160	33681-cfs Q200	33681.00	4334.00	4353.47		4355.32	0.001996	11.63	3622.82	379.88	0.49
1	2020	15945-cfs Q25	15945.00	4333.80	4348.03		4349.36	0.002439	9.71	1856.89	280.35	0.51
1	2020	21080-cfs Q50	21080.00	4333.80	4349.73		4351.32	0.002487	10.77	2377.70	317.62	0.53
1	2020	26932-cfs Q100	26932.00	4333.80	4351.35		4353.14	0.002487	11.65	2909.45	340.93	0.54
1	2020	33681-cfs Q200	33681.00	4333.80	4353.00		4354.99	0.002484	12.51	3496.99	375.09	0.55
1	1940	15945-cfs Q25	15945.00	4334.43	4347.51		4349.11	0.003061	10.63	1698.06	208.53	0.58
1	1940	21080-cfs Q50	21080.00	4334.43	4348.90		4351.04	0.003498	12.32	2003.23	276.54	0.63
1	1940	26932-cfs Q100	26932.00	4334.43	4350.35		4352.83	0.003616	13.50	2408.58	284.56	0.65
1	1940	33681-cfs Q200	33681.00	4334.43	4351.84		4354.67	0.003682	14.60	2840.38	292.87	0.67
1	1540*	15945-cfs Q25	15945.00	4333.70	4346.71	4343.07	4347.97	0.002230	9.19	1881.68	249.26	0.50
1	1540*	21080-cfs Q50	21080.00	4333.70	4348.09	4344.67	4349.71	0.002476	10.51	2228.28	305.83	0.54
1	1540*	26932-cfs Q100	26932.00	4333.70	4349.43	4346.17	4351.44	0.002708	11.80	2587.24	357.97	0.57
1	1540*	33681-cfs Q200	33681.00	4333.70	4350.82	4347.70	4353.24	0.002912	13.07	2978.28	413.24	0.60
1	1140	15945-cfs Q25	15945.00	4332.96	4345.81	4342.38	4347.05	0.002342	8.98	1836.36	286.26	0.52
1	1140	21080-cfs Q50	21080.00	4332.96	4347.08	4343.77	4348.69	0.002598	10.30	2163.29	328.19	0.56
1	1140	26932-cfs Q100	26932.00	4332.96	4348.29	4345.38	4350.32	0.002872	11.64	2493.70	370.77	0.60
1	1140	33681-cfs Q200	33681.00	4332.96	4349.56	4346.82	4352.04	0.003087	12.92	2864.06	415.62	0.63
1	760.*	15945-cfs Q25	15945.00	4332.11	4344.85		4346.17	0.002272	9.39	1880.42	283.26	0.52
1	760.*	21080-cfs Q50	21080.00	4332.11	4345.90		4347.67	0.002724	10.98	2184.70	298.30	0.58
1	760.*	26932-cfs Q100	26932.00	4332.11	4346.76		4349.11	0.003350	12.79	2451.13	319.86	0.65
1	760.*	33681-cfs Q200	33681.00	4332.11	4347.36	4346.22	4350.58	0.004334	15.03	2649.99	337.77	0.74
1	380.*	15945-cfs Q25	15945.00	4331.25	4344.28	4341.28	4345.15	0.002362	7.50	2171.88	336.65	0.50
1	380.*	21080-cfs Q50	21080.00	4331.25	4345.33	4342.52	4346.46	0.002652	8.58	2543.45	379.05	0.54
1	380.*	26932-cfs Q100	26932.00	4331.25	4346.15	4343.63	4347.63	0.003080	9.86	2926.32	653.60	0.59
1	380.*	33681-cfs Q200	33681.00	4331.25	4346.62	4344.67	4348.65	0.003969	11.59	3238.78	901.86	0.68
1	0	15945-cfs Q25	15945.00	4330.38	4343.14	4340.65	4344.29	0.002000	9.79	2609.47	952.42	0.50
1	0	21080-cfs Q50	21080.00	4330.38	4344.40	4341.28	4345.58	0.002001	10.45	3770.62	1506.61	0.50
1	0	26932-cfs Q100	26932.00	4330.38	4345.44	4344.35	4346.60	0.002001	10.99	5225.75	1719.94	0.51
1	0	33681-cfs Q200	33681.00	4330.38	4346.21	4344.37	4347.33	0.002004	11.39	6375.29	1774.91	0.51

Backwater Model Summary Output, Preferred Bridge without Drift

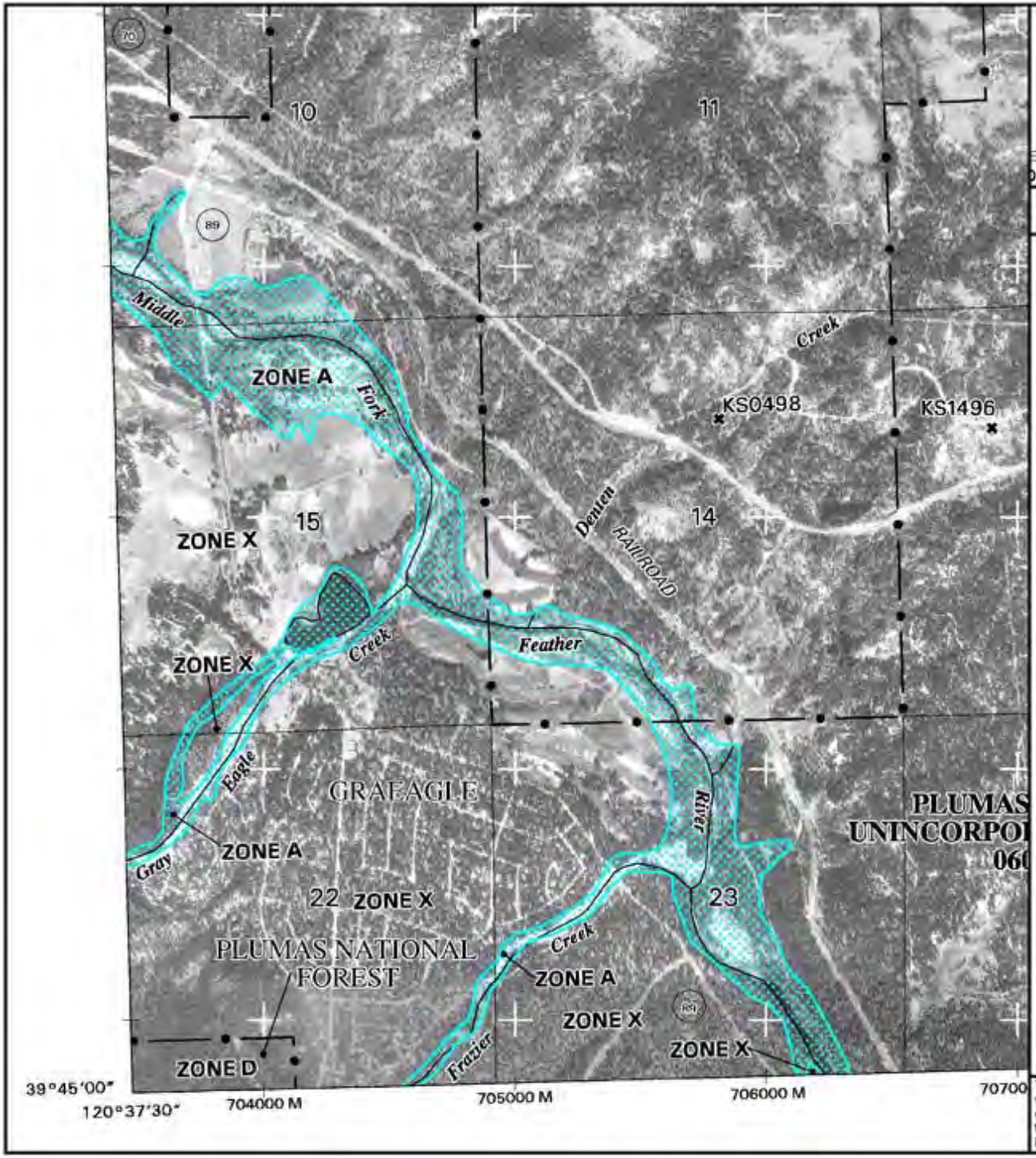
HEC-RAS Plan: PrBr River: Feather River Reach: 1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
1	4080	15945-cfs Q25	15945.00	4344.09	4352.10	4351.46	4353.81	0.005781	10.86	1609.65	343.14	0.77
1	4080	21080-cfs Q50	21080.00	4344.09	4353.81		4355.40	0.004025	10.66	2271.44	432.66	0.67
1	4080	26932-cfs Q100	26932.00	4344.09	4355.62		4357.07	0.002909	10.40	3142.60	527.85	0.59
1	4080	33681-cfs Q200	33681.00	4344.09	4357.78		4358.92	0.001903	9.61	4607.91	808.08	0.49
1	3870	15945-cfs Q25	15945.00	4342.53	4352.38		4352.90	0.001473	5.81	2772.52	455.99	0.39
1	3870	21080-cfs Q50	21080.00	4342.53	4354.10		4354.66	0.001196	6.06	3635.44	550.60	0.37
1	3870	26932-cfs Q100	26932.00	4342.53	4355.90		4356.48	0.000981	6.21	4881.09	798.75	0.34
1	3870	33681-cfs Q200	33681.00	4342.53	4357.98		4358.50	0.000738	6.07	6621.23	862.42	0.30
1	3320	15945-cfs Q25	15945.00	4339.80	4351.55		4352.07	0.001556	6.22	2813.71	448.74	0.40
1	3320	21080-cfs Q50	21080.00	4339.80	4353.46		4354.00	0.001208	6.37	3711.94	491.02	0.37
1	3320	26932-cfs Q100	26932.00	4339.80	4355.36		4355.92	0.001010	6.58	4688.12	533.17	0.35
1	3320	33681-cfs Q200	33681.00	4339.80	4357.49		4358.06	0.000836	6.71	5897.64	716.52	0.32
1	2720	15945-cfs Q25	15945.00	4333.14	4349.80		4350.98	0.001855	9.13	2109.69	320.90	0.48
1	2720	21080-cfs Q50	21080.00	4333.14	4351.83		4353.08	0.001655	9.62	2827.42	388.70	0.46
1	2720	26932-cfs Q100	26932.00	4333.14	4353.82		4355.12	0.001510	10.08	3728.27	505.79	0.45
1	2720	33681-cfs Q200	33681.00	4333.14	4356.06		4357.37	0.001344	10.40	4999.02	721.17	0.44
1	2515.*	15945-cfs Q25	15945.00	4333.82	4349.50		4350.63	0.001476	8.92	2174.12	292.48	0.44
1	2515.*	21080-cfs Q50	21080.00	4333.82	4351.54		4352.76	0.001386	9.53	2775.64	297.31	0.43
1	2515.*	26932-cfs Q100	26932.00	4333.82	4353.47		4354.82	0.001357	10.22	3353.43	301.99	0.44
1	2515.*	33681-cfs Q200	33681.00	4333.82	4355.61		4357.08	0.001294	10.80	4012.26	311.33	0.44
1	2310	15945-cfs Q25	15945.00	4334.50	4349.60	4344.17	4350.42	0.000306	7.93	2386.88	290.90	0.37
1	2310	21080-cfs Q50	21080.00	4334.50	4351.64	4345.75	4352.56	0.000300	8.52	2962.70	335.53	0.37
1	2310	26932-cfs Q100	26932.00	4334.50	4353.57	4347.31	4354.62	0.000302	9.15	3524.60	372.99	0.38
1	2310	33681-cfs Q200	33681.00	4334.50	4355.84	4349.16	4356.84	0.000265	9.22	4608.97	400.69	0.36
1	2270		Bridge									
1	2250	15945-cfs Q25	15945.00	4333.90	4348.86	4343.95	4350.17	0.001584	9.58	1999.06	255.38	0.45
1	2250	21080-cfs Q50	21080.00	4333.90	4350.59	4346.28	4352.15	0.001684	10.69	2439.77	285.41	0.48
1	2250	26932-cfs Q100	26932.00	4333.90	4352.12	4348.18	4354.00	0.001844	11.91	2842.40	336.42	0.51
1	2250	33681-cfs Q200	33681.00	4333.90	4353.66	4349.96	4355.89	0.001997	13.13	3259.35	366.76	0.54
1	2235		Bridge									
1	2160	15945-cfs Q25	15945.00	4334.00	4348.73	4343.29	4349.73	0.001509	8.21	2162.48	240.33	0.40
1	2160	21080-cfs Q50	21080.00	4334.00	4350.43	4344.93	4351.70	0.001669	9.38	2597.96	284.07	0.43
1	2160	26932-cfs Q100	26932.00	4334.00	4351.97	4346.66	4353.51	0.001822	10.48	3069.17	339.75	0.46
1	2160	33681-cfs Q200	33681.00	4334.00	4353.59	4348.18	4355.36	0.001903	11.41	3584.79	383.25	0.48
1	2020	15945-cfs Q25	15945.00	4333.80	4348.03		4349.36	0.002439	9.71	1856.89	280.35	0.51
1	2020	21080-cfs Q50	21080.00	4333.80	4349.73		4351.32	0.002487	10.77	2377.70	317.62	0.53
1	2020	26932-cfs Q100	26932.00	4333.80	4351.35		4353.14	0.002487	11.65	2909.45	340.93	0.54
1	2020	33681-cfs Q200	33681.00	4333.80	4353.00		4354.99	0.002484	12.51	3496.99	375.09	0.55
1	1940	15945-cfs Q25	15945.00	4334.43	4347.51		4349.11	0.003061	10.63	1698.06	208.53	0.58
1	1940	21080-cfs Q50	21080.00	4334.43	4348.90		4351.04	0.003498	12.32	2003.23	276.54	0.63
1	1940	26932-cfs Q100	26932.00	4334.43	4350.35		4352.83	0.003616	13.50	2408.58	284.56	0.65
1	1940	33681-cfs Q200	33681.00	4334.43	4351.84		4354.67	0.003682	14.60	2840.38	292.87	0.67
1	1540*	15945-cfs Q25	15945.00	4333.70	4346.71	4343.07	4347.97	0.002230	9.19	1881.68	249.26	0.50
1	1540*	21080-cfs Q50	21080.00	4333.70	4348.09	4344.67	4349.71	0.002476	10.51	2228.28	305.83	0.54
1	1540*	26932-cfs Q100	26932.00	4333.70	4349.43	4346.17	4351.44	0.002708	11.80	2587.24	357.97	0.57
1	1540*	33681-cfs Q200	33681.00	4333.70	4350.82	4347.70	4353.24	0.002912	13.07	2978.28	413.24	0.60
1	1140	15945-cfs Q25	15945.00	4332.96	4345.81	4342.38	4347.05	0.002342	8.98	1836.36	286.26	0.52
1	1140	21080-cfs Q50	21080.00	4332.96	4347.08	4343.77	4348.69	0.002598	10.30	2163.29	328.19	0.56
1	1140	26932-cfs Q100	26932.00	4332.96	4348.29	4345.38	4350.32	0.002872	11.64	2493.70	370.77	0.60
1	1140	33681-cfs Q200	33681.00	4332.96	4349.56	4346.82	4352.04	0.003087	12.92	2864.06	415.62	0.63
1	760.*	15945-cfs Q25	15945.00	4332.11	4344.85		4346.17	0.002272	9.39	1880.42	283.26	0.52
1	760.*	21080-cfs Q50	21080.00	4332.11	4345.90		4347.67	0.002724	10.98	2184.70	298.30	0.58
1	760.*	26932-cfs Q100	26932.00	4332.11	4346.76		4349.11	0.003350	12.79	2451.13	319.86	0.65
1	760.*	33681-cfs Q200	33681.00	4332.11	4347.36	4346.22	4350.58	0.004334	15.03	2649.99	337.77	0.74
1	380.*	15945-cfs Q25	15945.00	4331.25	4344.28	4341.28	4345.15	0.002362	7.50	2171.88	336.65	0.50
1	380.*	21080-cfs Q50	21080.00	4331.25	4345.33	4342.52	4346.46	0.002652	8.58	2543.27	379.03	0.54
1	380.*	26932-cfs Q100	26932.00	4331.25	4346.15	4343.63	4347.63	0.003080	9.86	2926.32	653.60	0.59
1	380.*	33681-cfs Q200	33681.00	4331.25	4346.62	4344.67	4348.65	0.003969	11.59	3238.78	901.86	0.68
1	0	15945-cfs Q25	15945.00	4330.38	4343.14	4340.65	4344.29	0.002000	9.79	2609.47	952.42	0.50
1	0	21080-cfs Q50	21080.00	4330.38	4344.40	4341.28	4345.58	0.002001	10.45	3770.62	1506.61	0.50
1	0	26932-cfs Q100	26932.00	4330.38	4345.44	4344.35	4346.60	0.002001	10.99	5225.75	1719.94	0.51
1	0	33681-cfs Q200	33681.00	4330.38	4346.21	4344.37	4347.33	0.002004	11.39	6375.29	1774.91	0.51

Backwater Model Summary Output, Preferred Bridge with Drift

HEC-RAS Plan: PrBr River: Feather River Reach: 1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
1	4080	15945-cfs Q25	15945.00	4344.09	4352.15		4353.83	0.005629	10.77	1624.95	345.47	0.76
1	4080	21080-cfs Q50	21080.00	4344.09	4353.83		4355.41	0.003986	10.62	2280.11	433.71	0.66
1	4080	26932-cfs Q100	26932.00	4344.09	4355.62		4357.07	0.002914	10.40	3140.80	527.67	0.59
1	4080	33681-cfs Q200	33681.00	4344.09	4357.75		4358.91	0.001924	9.65	4585.43	806.96	0.49
1	3870	15945-cfs Q25	15945.00	4342.53	4352.42		4352.94	0.001444	5.77	2790.82	458.10	0.39
1	3870	21080-cfs Q50	21080.00	4342.53	4354.12		4354.68	0.001187	6.05	3645.43	554.75	0.36
1	3870	26932-cfs Q100	26932.00	4342.53	4355.90		4356.47	0.000982	6.22	4879.14	798.69	0.34
1	3870	33681-cfs Q200	33681.00	4342.53	4357.95		4358.48	0.000744	6.09	6599.75	862.40	0.31
1	3320	15945-cfs Q25	15945.00	4339.80	4351.61		4352.12	0.001510	6.16	2842.45	450.16	0.40
1	3320	21080-cfs Q50	21080.00	4339.80	4353.48		4354.02	0.001198	6.35	3723.45	491.54	0.37
1	3320	26932-cfs Q100	26932.00	4339.80	4355.36		4355.92	0.001011	6.58	4686.30	533.10	0.35
1	3320	33681-cfs Q200	33681.00	4339.80	4357.46		4358.04	0.000843	6.73	5877.29	696.23	0.33
1	2720	15945-cfs Q25	15945.00	4333.14	4349.94		4351.08	0.001768	8.98	2153.85	325.19	0.47
1	2720	21080-cfs Q50	21080.00	4333.14	4351.87		4353.11	0.001636	9.58	2843.04	391.50	0.46
1	2720	26932-cfs Q100	26932.00	4333.14	4353.82		4355.12	0.001513	10.08	3725.06	505.49	0.45
1	2720	33681-cfs Q200	33681.00	4333.14	4356.01		4357.33	0.001359	10.44	4967.46	715.11	0.44
1	2515.*	15945-cfs Q25	15945.00	4333.82	4349.66		4350.74	0.001404	8.77	2219.27	292.83	0.43
1	2515.*	21080-cfs Q50	21080.00	4333.82	4351.59		4352.80	0.001369	9.49	2789.15	297.42	0.43
1	2515.*	26932-cfs Q100	26932.00	4333.82	4353.47		4354.82	0.001359	10.23	3351.66	301.97	0.44
1	2515.*	33681-cfs Q200	33681.00	4333.82	4355.57		4357.05	0.001306	10.84	3998.88	311.33	0.44
1	2310	15945-cfs Q25	15945.00	4334.50	4349.74	4344.17	4350.54	0.000293	7.80	2428.32	295.66	0.36
1	2310	21080-cfs Q50	21080.00	4334.50	4351.68	4345.75	4352.60	0.000297	8.48	2975.29	336.38	0.37
1	2310	26932-cfs Q100	26932.00	4334.50	4353.56	4347.31	4354.61	0.000302	9.16	3522.87	372.88	0.38
1	2310	33681-cfs Q200	33681.00	4334.50	4355.80	4349.16	4356.80	0.000268	9.25	4592.34	400.69	0.36
1	2270		Bridge									
1	2250	15945-cfs Q25	15945.00	4333.90	4349.04	4343.95	4350.29	0.001501	9.41	2043.68	258.65	0.44
1	2250	21080-cfs Q50	21080.00	4333.90	4350.65	4346.28	4352.19	0.001658	10.63	2454.63	286.30	0.48
1	2250	26932-cfs Q100	26932.00	4333.90	4352.11	4348.18	4353.99	0.001848	11.92	2839.92	336.23	0.51
1	2250	33681-cfs Q200	33681.00	4333.90	4353.59	4349.96	4355.85	0.002030	13.21	3239.70	365.34	0.54
1	2235		Bridge									
1	2160	15945-cfs Q25	15945.00	4334.00	4348.73	4343.29	4349.73	0.001509	8.21	2162.48	240.33	0.40
1	2160	21080-cfs Q50	21080.00	4334.00	4350.43	4344.93	4351.70	0.001669	9.38	2597.96	284.07	0.43
1	2160	26932-cfs Q100	26932.00	4334.00	4351.97	4346.66	4353.51	0.001822	10.48	3069.17	339.75	0.46
1	2160	33681-cfs Q200	33681.00	4334.00	4353.59	4348.18	4355.36	0.001903	11.41	3584.79	383.25	0.48
1	2020	15945-cfs Q25	15945.00	4333.80	4348.03		4349.36	0.002439	9.71	1856.89	280.35	0.51
1	2020	21080-cfs Q50	21080.00	4333.80	4349.73		4351.32	0.002487	10.77	2377.70	317.62	0.53
1	2020	26932-cfs Q100	26932.00	4333.80	4351.35		4353.14	0.002487	11.65	2909.45	340.93	0.54
1	2020	33681-cfs Q200	33681.00	4333.80	4353.00		4354.99	0.002484	12.51	3496.99	375.09	0.55
1	1940	15945-cfs Q25	15945.00	4334.43	4347.51		4349.11	0.003061	10.63	1698.06	208.53	0.58
1	1940	21080-cfs Q50	21080.00	4334.43	4348.90		4351.04	0.003498	12.32	2003.23	276.54	0.63
1	1940	26932-cfs Q100	26932.00	4334.43	4350.35		4352.83	0.003616	13.50	2408.58	284.56	0.65
1	1940	33681-cfs Q200	33681.00	4334.43	4351.84		4354.67	0.003682	14.60	2840.38	292.87	0.67
1	1540*	15945-cfs Q25	15945.00	4333.70	4346.71	4343.07	4347.97	0.002230	9.19	1881.68	249.26	0.50
1	1540*	21080-cfs Q50	21080.00	4333.70	4348.09	4344.67	4349.71	0.002476	10.51	2228.28	305.83	0.54
1	1540*	26932-cfs Q100	26932.00	4333.70	4349.43	4346.17	4351.44	0.002708	11.80	2587.24	357.97	0.57
1	1540*	33681-cfs Q200	33681.00	4333.70	4350.82	4347.70	4353.24	0.002912	13.07	2978.28	413.24	0.60
1	1140	15945-cfs Q25	15945.00	4332.96	4345.81	4342.38	4347.05	0.002342	8.98	1836.36	286.26	0.52
1	1140	21080-cfs Q50	21080.00	4332.96	4347.08	4343.77	4348.69	0.002598	10.30	2163.29	328.19	0.56
1	1140	26932-cfs Q100	26932.00	4332.96	4348.29	4345.38	4350.32	0.002872	11.64	2493.70	370.77	0.60
1	1140	33681-cfs Q200	33681.00	4332.96	4349.56	4346.82	4352.04	0.003087	12.92	2864.06	415.62	0.63
1	760.*	15945-cfs Q25	15945.00	4332.11	4344.85		4346.17	0.002272	9.39	1880.42	283.26	0.52
1	760.*	21080-cfs Q50	21080.00	4332.11	4345.90		4347.67	0.002724	10.98	2184.70	298.30	0.58
1	760.*	26932-cfs Q100	26932.00	4332.11	4346.76		4349.11	0.003350	12.79	2451.13	319.86	0.65
1	760.*	33681-cfs Q200	33681.00	4332.11	4347.36	4346.22	4350.58	0.004334	15.03	2649.99	337.77	0.74
1	380.*	15945-cfs Q25	15945.00	4331.25	4344.28	4341.28	4345.15	0.002362	7.50	2171.88	336.65	0.50
1	380.*	21080-cfs Q50	21080.00	4331.25	4345.33	4342.52	4346.46	0.002652	8.58	2543.45	379.05	0.54
1	380.*	26932-cfs Q100	26932.00	4331.25	4346.15	4343.63	4347.63	0.003080	9.86	2926.32	653.60	0.59
1	380.*	33681-cfs Q200	33681.00	4331.25	4346.62	4344.67	4348.65	0.003969	11.59	3238.78	901.86	0.68
1	0	15945-cfs Q25	15945.00	4330.38	4343.14	4340.65	4344.29	0.002000	9.79	2609.47	952.42	0.50
1	0	21080-cfs Q50	21080.00	4330.38	4344.40	4341.28	4345.58	0.002001	10.45	3770.62	1506.61	0.50
1	0	26932-cfs Q100	26932.00	4330.38	4345.44	4344.35	4346.60	0.002001	10.99	5225.75	1719.94	0.51
1	0	33681-cfs Q200	33681.00	4330.38	4346.21	4344.37	4347.33	0.002004	11.39	6375.29	1774.91	0.51



MAP SCALE 1" = 2000'

1000 0 2000 4000 FEET

00 0 600 1200 MET

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 1300E

FIRM

FLOOD INSURANCE RATE MAP

PLUMAS COUNTY,
CALIFORNIA AND
INCORPORATED AREAS

PANEL 1300 OF 1650

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
PLUMAS COUNTY, UNINCORPORATED AREAS	060044	1300	E

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

MAP NUMBER
06063C1300E

EFFECTIVE DATE:
MARCH 2, 2005

Federal Emergency Management Agency

APPENDIX C

Scour Calculations

Potential Pier Scour Using CSU Equation, 100 - Year flood
Blairsden-Graeagle Road over Middle Fork Feather River, November 4, 2013

Ys = Depth of potential scour, Ft.

K1 = 1.0 Nose shape coefficient, round

Theta = 0 Angle between direction of flow and pier, degrees

Length of pier = 5.5 Ft

K2 = 1.00 Angle coefficient

K3 = 1.1 Bed condition coefficient

a = Pier Width, assume 5.5 Ft

Y1 = 18.0 Ft, Maximum depth expected in front of pier, 100 - Year flood.

V1 = 12.0 FPS, Maximum velocity in front of pier, 100 - Year flood.

Fr1 = Froude Number in front of pier

Fr1 = V1/[(g x Y1)^(1/2)] = 0.498

Ys/Y1 = 2.0 x K1 x K2 x K3 x [(a/Y1)^0.65] x Fr1^0.43 = 0.75

Ys = Y1 x (Ys/Y1) = 13.6 Ft.

NOTE: For Fr1 values less than 0.8 the value of Ys/a is not recommended to exceed 2.4.

Ys = 2.4 x a = 13.2 Ft.

APPENDIX D

References

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