

1 FINAL 30% Design Report
2 Trinity River Channel Rehabilitation Site at
3 Oregon Gulch
4 (River Mile 80.9 to 81.7)
5



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7 May 29, 2018

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17 **Cover photo:** Oblique view of the Oregon Gulch Project Site on the Trinity River, looking downstream. Photo Credit: Ken Decamp, 2013

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94 Purpose and Background

95 This report presents the DRAFT design for the Oregon Gulch channel rehabilitation project (Project). The Project
96 is one of the 47 rehabilitation sites originally identified for construction by the 2000 Environmental Impact
97 Statement / Report (USFWS et. al. 2000) within the restoration reach. The restoration reach of the Trinity River
98 spans 40 miles from Lewiston Dam downstream to the North Fork Trinity River confluence. The Project will
99 function in concert with restoration flow releases across all water year types to support the fundamental goals
100 of the Trinity River Restoration Program.

101 Statutory Mandate

102 In December 2000, the Secretary of the Interior signed a Record of Decision (ROD, USDOI 2000) for the Trinity
103 River Mainstem Fishery Restoration Final Environmental Impact Statement/Report. This decision recognized that
104 restoration and maintenance of the Trinity River’s fishery resources requires rehabilitating the river itself, and
105 restoring the dynamic geomorphic processes that maintain an aquatic ecosystem. Consequently, the ROD
106 included five components to ensure long-term restoration and maintenance of the Trinity River (USDOI 2000).

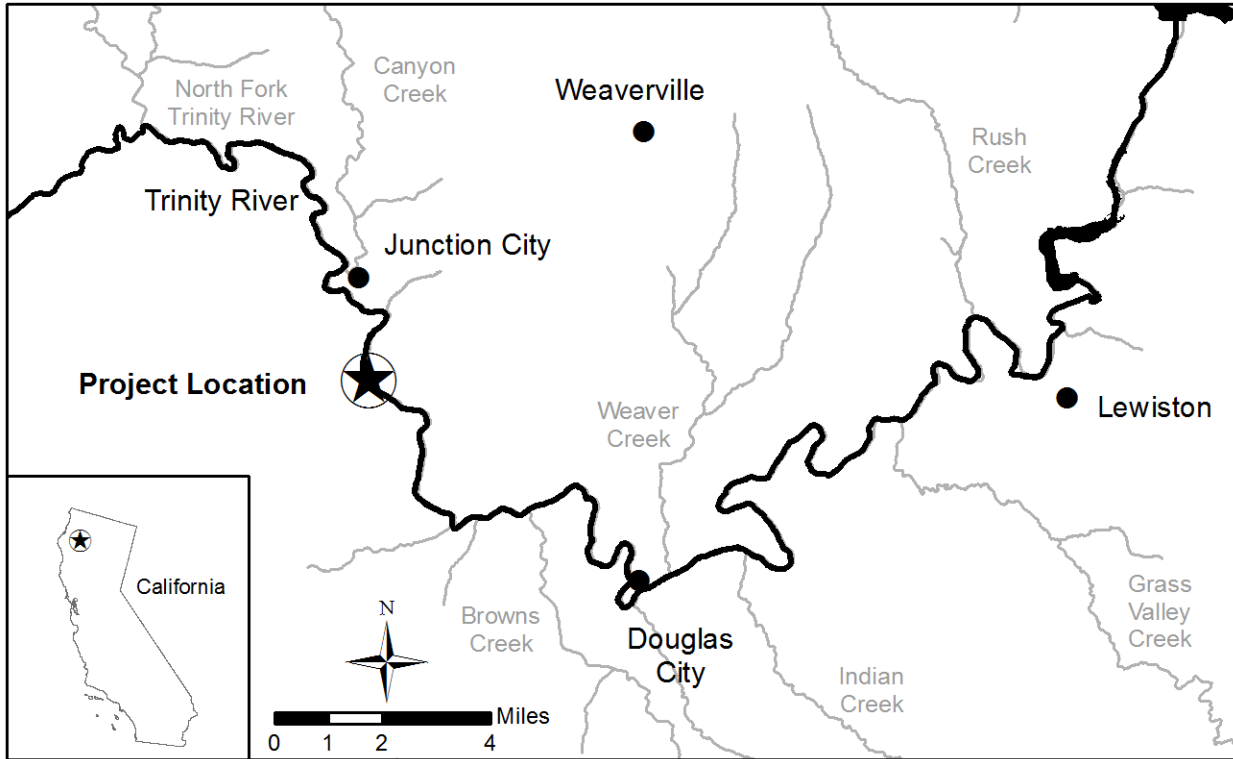
- 107 1. Variable annual in-stream flows ranging from 369,000 acre-feet in critically dry years to 815,000 acre-feet in
108 extremely wet years.
- 109 2. Physical channel rehabilitation including removal of riparian berms and establishment of side channel habitat.
- 110 3. Sediment management, including the supplementation of spawning gravels below Lewiston Dam and reduction in
111 fine sediments which degrade fish habitats.
- 112 4. Watershed restoration projects to reduce fine sediment production in the Trinity Basin and its subsequent delivery
113 to the Trinity River.
- 114 5. Infrastructure improvements or modifications, including rebuilding or fortifying bridges and addressing other
115 structures affected by peak in-stream flow releases provided the ROD.

116 “The ROD represents the culmination of over two decades of efforts aimed at understanding the necessary in-
117 stream flow and physical habitat restoration requirements in order to restore the Trinity River anadromous
118 fishery. Statutory requirements since 1955, based in large part upon the federal governments’ trust obligation to
119 the Hoopa Valley and Yurok Tribes, require the restoration and maintenance of the Trinity River anadromous
120 fishery resources to pre-dam levels. It is clear that restoration must provide for a meaningful fishery, not only for
121 the Tribes, but also for the commercial, sport, and recreational fisherman. These important resources represent
122 both tribal trust and public treasures from which all should benefit – to restore the faith of tribal beneficiaries
123 and to improve the economic well-being of the Trinity Basin and the North Coast as a whole.” (USDOI 2000, page
124 8).

125 Project Location, Ownership, Infrastructure, and Access

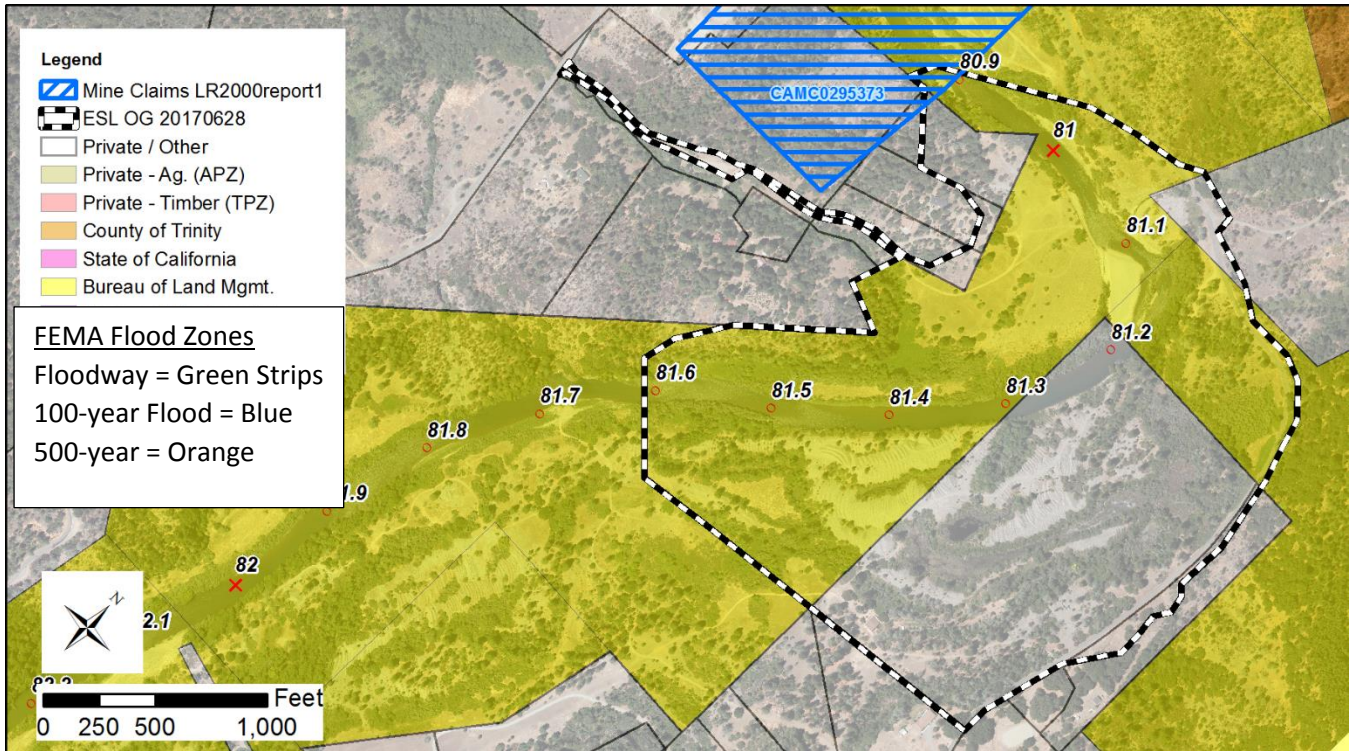
126 The project site is located on the Trinity River in Junction City, California (Figure 1). The project site spans 0.7
127 river miles from RM 80.9 to RM 81.6 (Figure 2). Land ownership is a mix of public land (Bureau of Land
128 Management) and private land. A mining claim is located on a small corner of the project site downstream of
129 RM 80.9. Road access to the site is via one of two private road spurs off of county roads (Figure 3). Different
130 sides of the river are referred to as river right and river left from the perspective of looking in the downstream
131 direction. The river right road access is through Dunmovin Road (private) off of Sky Ranch Road (county). The
132 river left road access is through Sandy Flat Road (private) off of Dutch Creek Road (county). Heavy equipment
133 drive access on Sandy Flat Road will not be allowed. The Federal Emergency Management Agency (FEMA) 100-
134 year flood zone spans the entire valley bottom. No houses are located in the 100-year flood zone but one house

135 is located in the 500-year flood zone immediately adjacent to the 100-year flood zone boundary. Two water
136 supply wells and their power sources are located in the project boundary. Many of the landowners on river left
137 obtain their water directly from Mill Creek, outside of the project boundary. The river flows from left to right on
138 all project figures unless otherwise indicated.



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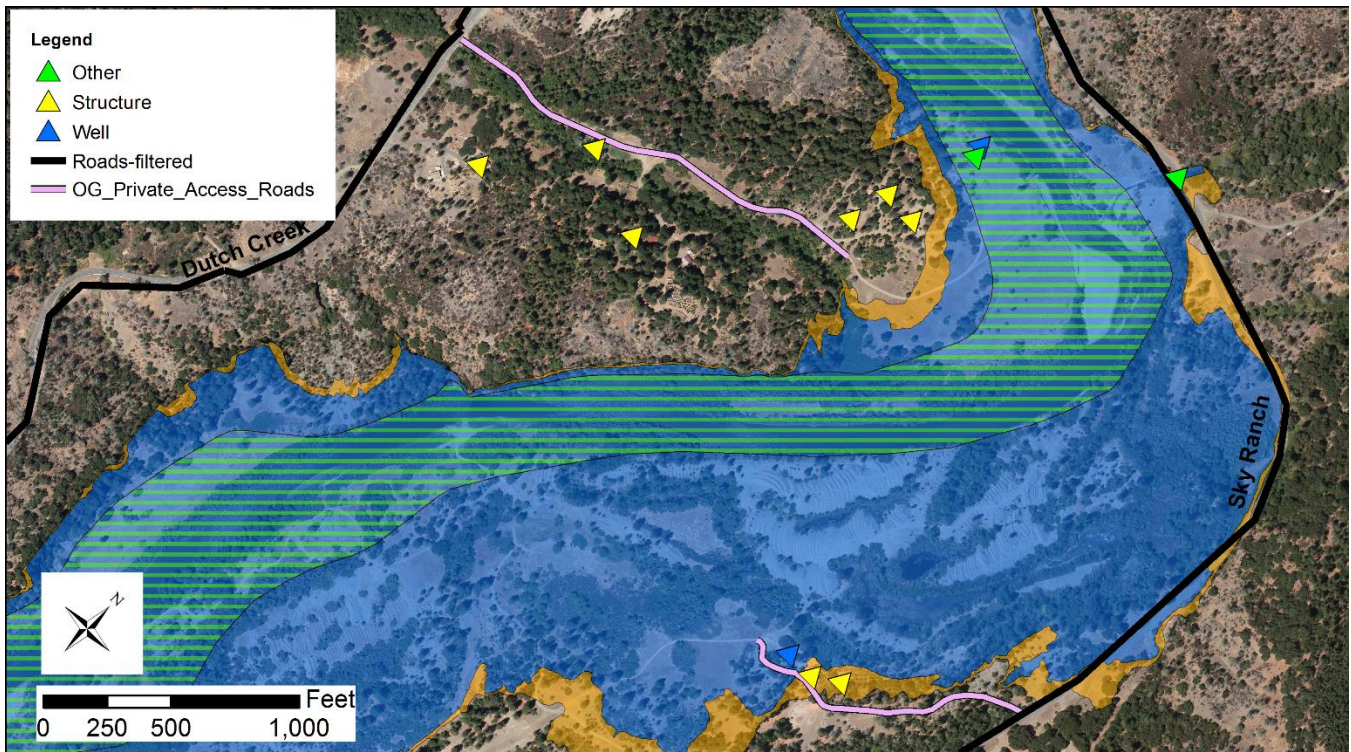
FIGURE 1. PROJECT LOCATION MAP. RIVER FLOW IS RIGHT TO LEFT.



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FIGURE 2: LAND OWNERSHIP, ENVIRONMENTAL STUDY LIMITS, AND MINING CLAIMS

Black dotted line = Environmental Study Limit (project site); Red marks with numbers = River miles.



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FIGURE 3: INFRASTRUCTURE, ACCESS, AND FEMA FLOOD ZONES

147 Hydrology and Water Quality

148 The Trinity River is 290 Km long with a total watershed area of 7,670 Km² and is the largest tributary to the
149 Klamath River. Approximately one quarter of the watershed is located above Lewiston Dam. The watershed is
150 predominately mountainous and forested. The climate is Mediterranean with hot dry summers and cool wet
151 winters. Precipitation averages 75 to 200 cm/year with 80 percent of the precipitation occurring between
152 November and March. The high elevation northern tributaries experience snowmelt dominated hydrology while
153 the southern tributaries are predominately rainfall dominated. The largest magnitude floods on the Trinity River
154 are generated by rain on snow events.

155 Trinity and Lewiston Dams were constructed as part of the Trinity Division of the Central Valley Project. The
156 dams and associated infrastructure create a trans-basin diversion that supplies water from the Trinity River to
157 the Sacramento River in the Central Valley of California. The long-term average annual runoff for the Trinity
158 River above Trinity Dam is 1.25 million acre-feet. Trinity Dam has a storage capacity of 2.4 million acre-feet
159 which is enough to hold 2 full years of inflow. Flow regulation began in 1960 with trans-basins diversions starting
160 in 1963. Flow diversions historically accounted for upwards of 90 percent of the annual inflow to Trinity Dam,
161 virtually eliminated floods, and reduced daily flows to a constant 150 cfs (USFWS and HVT 1999). Flow diversions
162 have gradually been reduced since the early 1980's in response to a variety of environmental legislation. Since
163 2005, flow diversions account for slightly more than half of annual inflow to Trinity Dam. Environmental flow
164 releases to the Trinity River are conducted as part of on-going restoration efforts and account for the remainder
165 of the water. The environmental flow releases include spring high flow releases intended to emulate snowmelt
166 runoff, route sediment downstream, and create a dynamic channel. The magnitude of these high flow releases
167 varies by water year type with the largest being capped at 11,000 cfs (USDOI, 2000). Flow regulation has
168 reduced the modern 2-year event (6,000 cfs) by 60 percent as compared to pre-dam hydrology at the Lewiston
169 streamgage (USFWS and HVT, 1999). The hydrology at the Project site is a mix of dam releases and tributary
170 accretion from several major tributaries.

171 Flow Frequency and Duration

172 The hydrology for the project site was developed using data from the Junction City streamgage (USGS#
173 11526250). The Junction City streamgage is the nearest streamgage to the project location (about 2 miles
174 downstream) and best represents the local hydrology. The Junction City streamgage includes flow contributions
175 from Oregon Gulch, a fourth order stream located in-between the project site and the streamgage. Table 1 lists
176 median flows for the various water year types as computed from the Junction City streamgage. Flows range
177 from 350 cfs (minimum winter baseflow) to 58,810 cfs (FEMA 100-year flood flow). The median normal year
178 flow is 7,150 cfs.

179 The flow duration exceedance probability at the Junction City gage (Table 2) shows the magnitude of flow
180 experienced at the Junction City gage during 300 cfs releases from Lewiston Dam (plus natural tributary
181 accretion) for exceedance probabilities of 90%, 50%, and 10% in Critically Dry, Normal, and Extremely Wet water
182 year types. The flow magnitudes were computed for the time period January 1 to April 30 for the gage period of
183 record (1996 – 2017) for flow durations of 1, 7, 14, and 21 days. The January 1 to April 30 time period
184 corresponds with the early juvenile rearing period during the 300 cfs winter baseflow releases from Lewiston
185 Dam. The 1-day duration flow magnitudes range from a low of 338 cfs (90% exceedance in a critically year) to a
186 high of 5,700 cfs (10% exceedance in an extremely wet water year) with a median of 758 cfs (50% exceedance in
187 a normal water year). The 21-day duration flow magnitudes range from a low of 333 cfs (90% exceedance in a
188 critically year) to a high of 3,476 cfs (10% exceedance in an extremely wet water year) with an average of 666 cfs

189 (50% exceedance in a normal water year). The full flow duration curves for all water year types are shown in
 190 Appendix A and were provided the McBain Associates and the Hoopa Valley Tribe.

191 **TABLE 1: MEDIAN FLOWS BY WATER YEAR UPSTREAM OF THE JUNCTION CITY STREAMGAGE**

Flow (cfs)	Return Interval (years)	Description
350		Minimum winter baseflow
450		Minimum winter baseflow during rearing period
4,800	1.14	Median Dry year net flood frequency ^A
7,150	1.67	Median Normal year net flood frequency ^A
9,000	2.5	Median Wet year net flood frequency ^A
16,850	8.3	Median Ex. Wet year net flood frequency ^A
21,900		Maximum Ex. Wet year ^{A, B}
58,810	100	FEMA 100 year ^C

- 192 A) Source: Hoopa Valley Tribe et al. (2011); table 4.5 net flood frequency for the Junction City streamgage (1996 – 2009); rounded
 193 to nearest 50 cfs. Return intervals are based on approximate probability of a given water year type and are not representative
 194 of a true statistical flood frequency analysis.
 195 B) Similar to the Maximum Fishery Flow (MFF) of 21,736 cfs. The MFF is an 11,000 cfs ROD release conducted in combination with
 196 a 100-year spring-time tributary flood event. The MFF was used by TRRP to identify needed infrastructure improvements.
 197 C) Source: CADWR (2014)

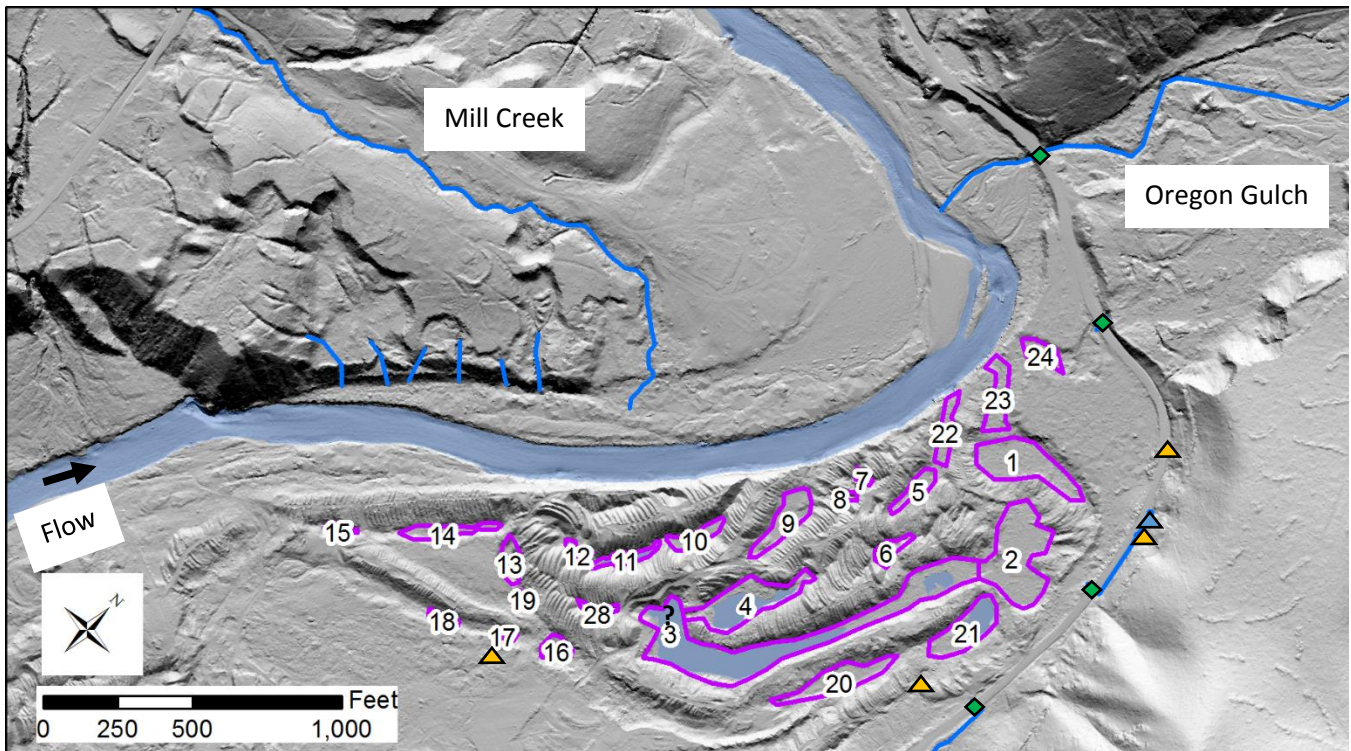
198 **TABLE 2: FLOW DURATION EXCEEDANCE PROBABILITY AT JUNCTION CITY GAGE FROM JANUARY 1 TO APRIL 30 (1996 –**
 199 **2017). FLOW MAGNITUDE VALUES IN THE TABLE ARE IN CFS.**

Duration (days)	Exceedance ->	Extremely Wet Year			Normal Year			Critically Dry Year		
		90%	50%	10%	90%	50%	10%	90%	50%	10%
	1	1,066	1,986	5,700	599	758	1,880	338	456	747
	7	844	1,559	4,369	581	722	1,077	334	425	582
	14	720	1,311	3,930	581	669	825	333	414	498
	21	720	1,132	3,476	580	666	736	333	406	482

200

201 **Local Surface Water and Wetlands**

202 Figure 4 shows the location of perennial and ephemeral creeks, springs, and wetlands. Perennial local surface
 203 water supplies are Oregon Gulch, Mill Creek, and Sky Ranch Road Spring. Oregon Gulch is a fourth order tributary
 204 to the Trinity River and forms a large delta that pushes the mainstem towards the west. Oregon Gulch passes
 205 through a concrete box culvert under Sky Ranch Road that acts as a fish barrier. Mill Creek is a second order
 206 tributary. Upon reaching the valley floor terrace Mill Creek goes subsurface and does not have a surface water
 207 connection to the Trinity River. Two un-named first order creeks are located on the eastern side of the valley.
 208 Sky Ranch Road Spring flows south along Sky Ranch Road for 300 feet before reaching a culvert that passes the
 209 flow under the road and into the Oregon Gulch wetland complex. Two additional culverts on Sky Ranch Road
 210 pass ephemeral flows into the wetland complex.



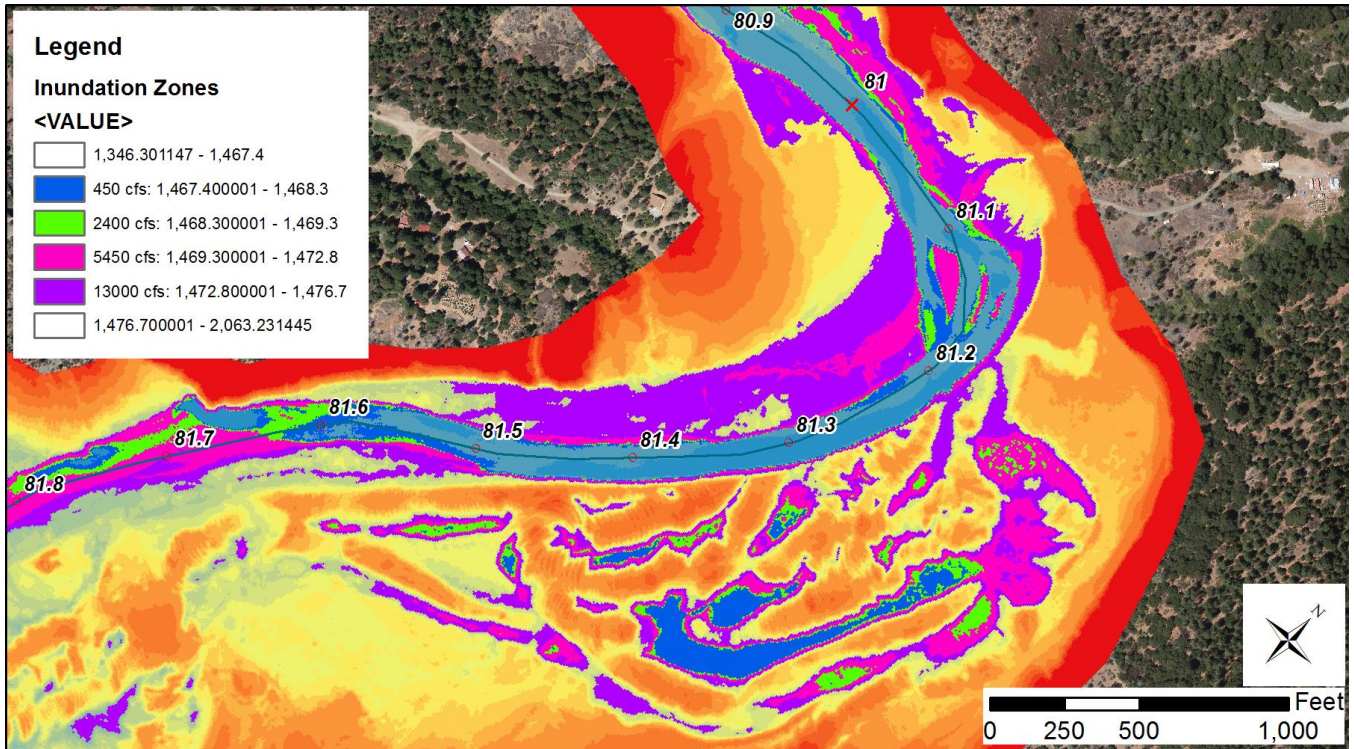
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212 **FIGURE 4: TRIBUTARIES, SPRINGS, AND WETLAND PONDS**

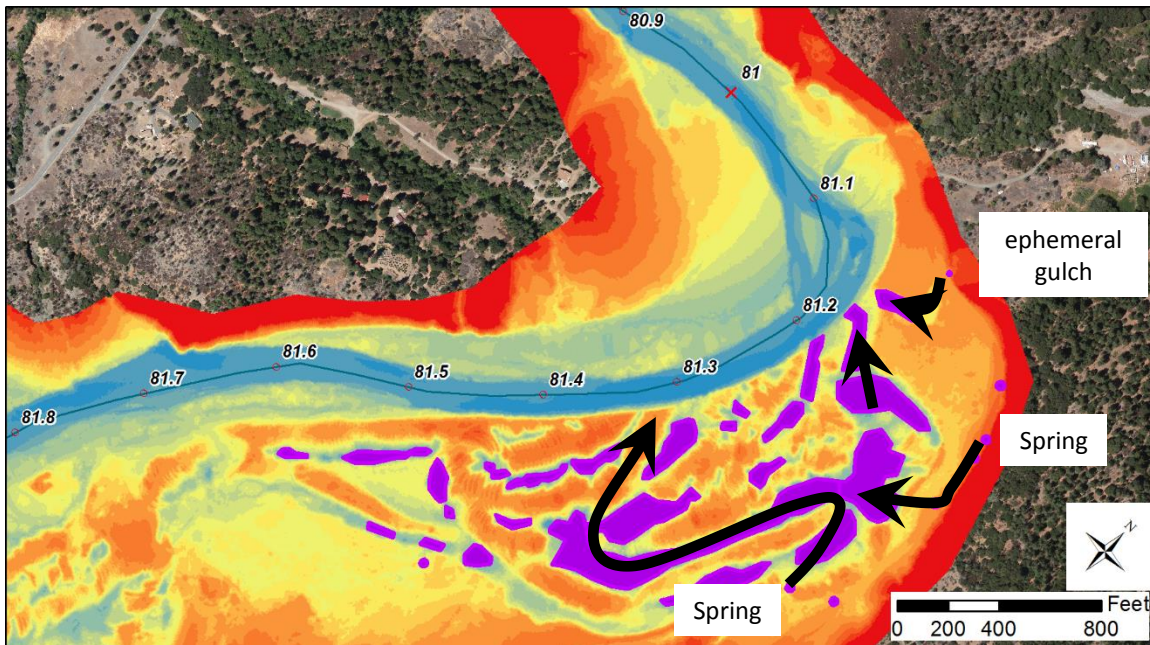
213 *Blue line = creek or drainage; blue triangle = perennial spring; orange triangle = ephemeral spring; green diamond = culvert;*
 214 *question mark = potential spring; magenta polygon = wetland pond (with pond ID #).*

215 Dredger mining created a large complex of wetlands on river right (Figure 4). Monitoring was conducted
 216 throughout the 2017 to determine water levels and infer flow paths through the wetlands (Appendix B). The
 217 water surfaces of the wetlands closely track the water surface of the Trinity River indicating good groundwater
 218 exchange across the valley bottom. Raising mainstem flows cause the wetlands to fill, and falling mainstem flows
 219 cause the wetlands to drain. Figure 5 shows the approximate inundation zones for the wetland ponds for
 220 mainstem flows between 450 cfs and 13,000 cfs. The water surface elevation in the wetlands can vary by up to 9
 221 feet between mainstem flows of 300 cfs and 13,000 cfs. The elevation of the bottom of the wetland relative to
 222 the mainstem water surface elevation during low flows determines whether the wetland is perennial (wetland
 223 bottom elevation below mainstem low flow water surface) or ephemeral (wetland bottom elevation above
 224 mainstem low flow water surface). The wetlands 3, 4, and 11 are perennially inundated and the remainder are
 225 ephemeraly inundated.

226 Wet periods affect the wetlands in two ways. First, baseflows in the mainstem increase, raising the groundwater
 227 water table and inundating more wetlands. Second, ephemeral springs and creeks form on the east side of the
 228 valley that supply additional water to wetlands. The ephemeral water supply from the valley wall creates a
 229 positive drainage from the east valley wall to the mainstem. Figure 6 shows the inferred surface water and
 230 ground water flows paths based on measured water surface elevations during the wet spring of 2017. A beaver
 231 dam is located between ponds 3 and 4. During wet periods when positive drainage from the east valley wall
 232 towards the river exists, the beaver dam causes the water in pond 3 to back up and be 1 foot higher than in
 233 pond 4. During the summer low flow period the beaver dam is dry and has no hydraulic effect (i.e. ponds 3 and 4
 234 are have the same water surface elevation).



235
 236 **FIGURE 5: APPROXIMATE FLOW INUNDATION ZONES**
 237 *Note: Yellow to Red colors indicate 2-foot elevation intervals in detrended topography*



238
 239 **FIGURE 6: INFERRED SURFACE WATER AND GROUNDWATER FLOW PATHS DURING WET PERIODS WITH WATER SUPPLY**
 240 **FROM THE VALLEY WALL**
 241 *Note: Red to yellow colors show 2-foot elevation intervals in the detrended topography; magenta polygons*
 242 *indicate wetland locations; magenta circles indicate springs; black arrows show inferred surface water and*
 243 *groundwater flow paths.*

244 Water Quality

245 Appendix B shows the 2017 water quality monitoring results for water temperature, dissolved oxygen, pH,
246 specific conductance, and mercury.

247 Water Temperature

248 Water temperature is highly local and can change dramatically from point to point. The water temperature
249 needs for salmonids vary by species and life stage. The water temperature of the Trinity River typically ranges
250 from 5 °C to 18 °C, as measured at the Trinity River above North Fork streamgage. Reservoir releases from
251 Trinity Dam have flipped the natural temperature regime making the river warmer in the winter and colder in
252 the summer than would have occurred without the dam. The current temperature regime lacks seasonal
253 variability exhibited by undammed streams in the region.

254 Surface water temperatures were manually measured in shallow water (<1.0 ft) near mid-day to get the hottest
255 water temperatures. The surface water temperature of the wetland ponds typically ranges between 9 °C and 16
256 °C expect for the August measurements. The hottest surface water temperatures were measured in August and
257 ranged from 14.3 °C to 23.4 °C, with all but one measurement below 20.2 °C. Temperature loggers placed in the
258 ponds several feet below the water surface indicate the deeper area of the ponds (below 2 or 3 feet) is
259 thermally stratified and remain cooler than the surface water temperatures. The pond bottom temperatures
260 never exceeded 16 °C. Air temperature is the primary driver of pond water temperature and plays a significant
261 role in river water temperature (along with the reservoir releases). Pond bottom temperatures generally track
262 river temperatures to within a couple °C but experience less diurnal variation.

263 Dissolved Oxygen

264 Dissolved oxygen concentrations are highly localized and can change dramatically from point to point. Dissolved
265 oxygen levels for salmonids are typically considered good when > 6.0 mg/l, fair (3.0 mg/l to 6.0 mg/l), and poor
266 to lethal (<3.0 mg/l). The dissolved oxygen in Trinity River typically ranges from 9 mg/l to 16 mg/l, as measured
267 at the Trinity River above North Fork streamgage. Dissolved oxygen in the wetland ponds is good to fair
268 throughout the winter and spring (Table 3) when water temperatures are cold and the ponds are free of aquatic
269 vegetation. Dissolved oxygen levels generally drop in the summer months as water temperatures rise and thick
270 stands of aquatic vegetation cover the pond and reduce atmospheric oxygen exchange. Depending on location,
271 dissolved oxygen levels can drop precipitously in the summer months to lethal levels (near zero). Dissolved
272 oxygen levels in the open water portion of pond 4 remained good throughout the summer. Pond 4 is the only
273 pond that retains large open water area in the summer that is free of aquatic vegetation and therefore
274 maintained good atmospheric oxygen exchange. The open water in Pond 4 is caused by pond depths that
275 exceed the 6 foot rooting depth of the aquatic vegetation.

276 **TABLE 3: DISSOLVED OXYGEN MEASUREMENT SUMMARY**

Date	# samples	Min DO (mg/L)	Max DO (mg/l)	Notes
2017-04-13	3	6.55	6.96	Samples limited to shallow pond margin areas.
2017-04-28	15	4.74	12.32	Samples limited to shallow pond margin areas.
2017-05-18	15	1.5	6.5	Samples limited to shallow pond margin areas.
2017-08-10	5	0.7	2.5	Samples limited to shallow pond margin areas.
2017-09-28	15	0.1	8.0	Samples in shallow and deep water areas, mostly located away from the channel margins.

277 Mercury

278 Mercury sampling was conducted in March 2018. Results will be included in future versions of this report.

279 Other Water Quality Parameters

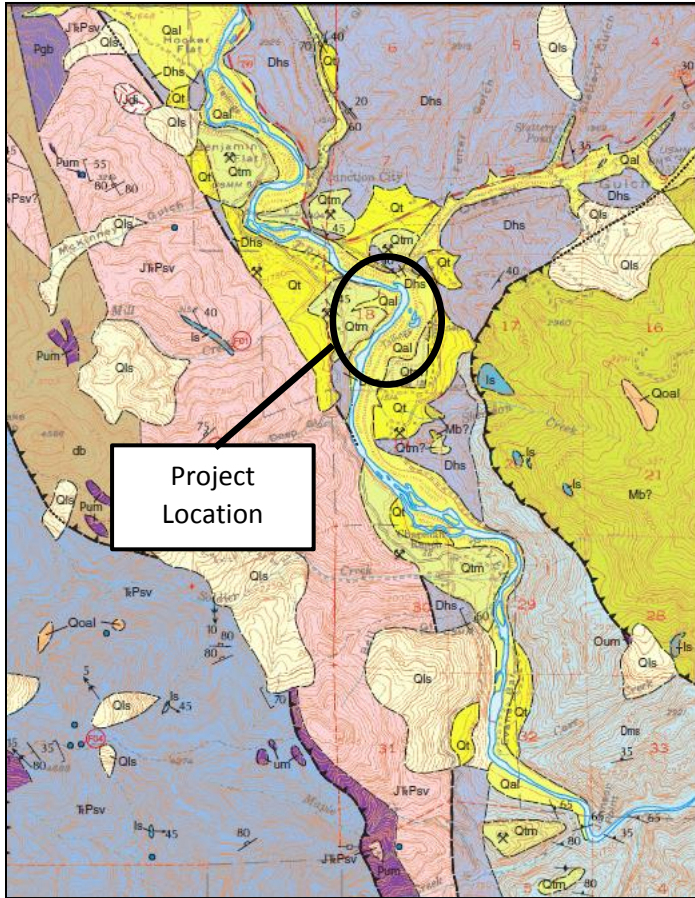
280 Specific conductivity and pH in the surface water was measured on September 28, 2017. The specific
281 conductance of the Trinity River was 119 $\mu\text{s}/\text{cm}$ and the spring on Sky Ranch Road measured 216 $\mu\text{s}/\text{cm}$. The
282 specific conductivity of the wetland ponds was higher than the river and spring and ranged from 478 $\mu\text{s}/\text{cm}$ to
283 823 $\mu\text{s}/\text{cm}$. The pH ranged from 7.4 to 8.7. The wetland ponds all measured pH below 8.0 while the Trinity River
284 and the spring on Sky Ranch Road measured above 8.0.

285 Geology and Geomorphology

286 Geology

287 The Trinity River watershed is located in the southern portion of the Klamath Mountain Province (Irwin, 1994).
288 The Klamath Mountain Province is characterized by a complex series of folded and faulted metamorphic rocks,
289 eastward dipping regional thrust faults, and granite plutons. Regional thrust faults generally define the location
290 of the valley walls on either side of the river corridor (CADWR, 1980). Pleistocene glaciation occurred in the high
291 elevations of several headwater tributaries but stopped short of reaching the mainstem Trinity River (Sharp,
292 1960). Significant placer gold deposits occur throughout the watershed in Quaternary alluvial deposits located in
293 the modern river valleys and adjacent Pleistocene strath terraces, as well as the Weaverville Formation, a fluvial
294 gold bearing formation likely deposited during the Oligocene (Diller, 1902; Anderson, 2008). The valley
295 bottom width at the project site is geologically controlled by faults that form the eastern and western valley
296 walls (Figure 7).

297



298

299 **FIGURE 7: RECONNAISSANCE GEOLOGIC MAP OF THE HAYFORK 15' QUADRANGLE, TRINITY COUNTY, CA. MODIFIED FROM**
 300 **IRWIN (2010). NOTE: SEE IRWIN (2010) FOR MAP AND SYMBOL LEGEND.**

301 [Valley Scale Geomorphology](#)

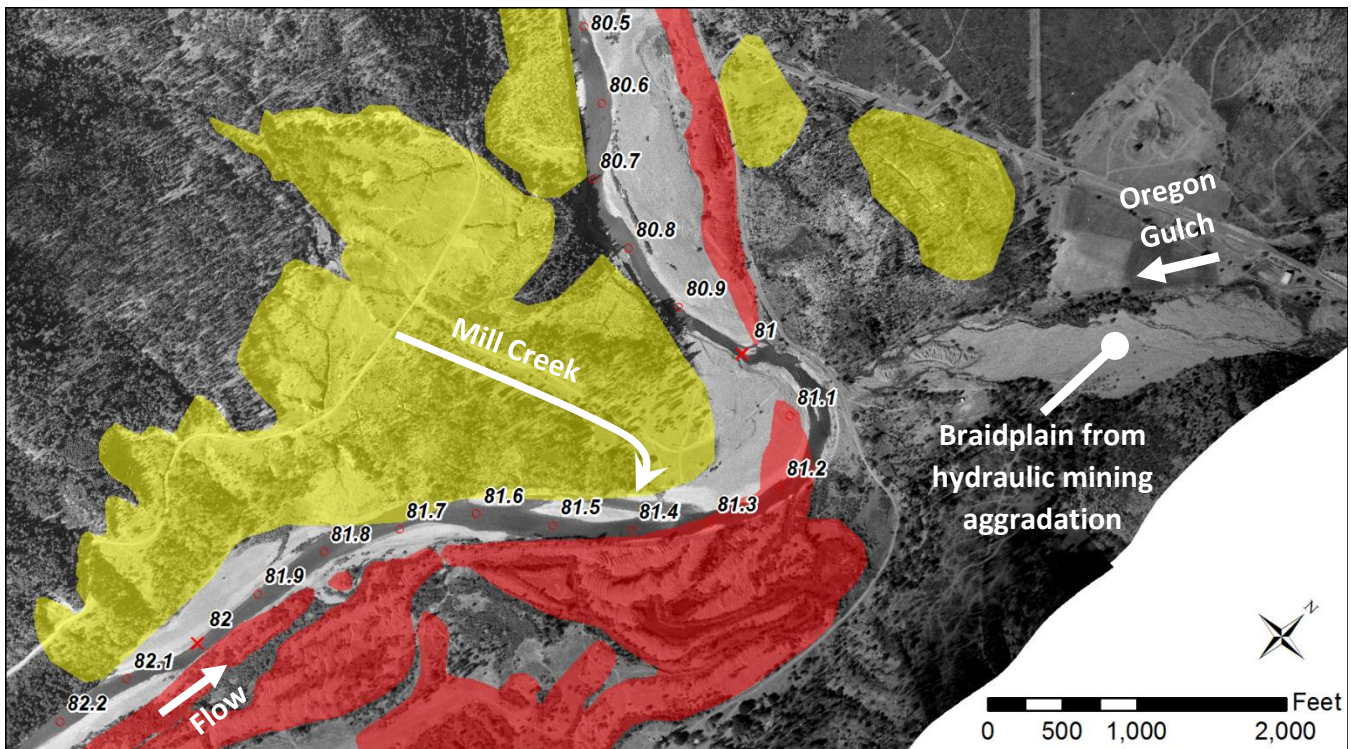
302 The Trinity River is a partially confined, gravel bed river, and is the largest tributary to the Klamath River. The
 303 Trinity River has complex geology and remarkable history of human impacts from mining, logging, and flow
 304 regulation. The local mining impacts near the project site are shown in Figure 8. Extensive hydraulic mining
 305 occurred throughout the Junction City area from the 1860's to the mid 1900's. The sediment discharged from
 306 the hydraulic mines caused significant valley aggradation resulting in a large-scale bulge in the longitudinal
 307 profile of the Trinity River that extends from about Dutch Creek (RM 86.4) to Lime Point (RM 74.6) (Krause et al.
 308 2010). The apex of aggradation occurs at the Oregon Gulch confluence (RM 81.1). The valley aggradation from
 309 hydraulic mining at the Project site is estimated at about 12 feet. The valley aggradation has lowered the valley
 310 slope above the Oregon Gulch confluence (0.0016) by about 25 percent as compared to the overall 40 mile river
 311 slope (0.0022). Extensive dredger mining mechanically mixed and inverted the alluvial material and left remnant
 312 tailings piles (up to 40 feet high) that artificially confine the river. The resulting floodplain and terrace sediments
 313 are coarse grained with poor capillarity.

314 Gaeuman et al. (2016) characterized the morphologic attributes that are common to the entire Junction City
 315 Valley reach (RM 82.85 to 78.08) as follows: The reach occupies a fairly wide alluvial valley bottom (5th widest in
 316 the restoration reach). The valley is generally straight but has a strong curvature at the Oregon Gulch confluence
 317 and near the Dutch Creek Bridge. Incision into the mining sediments and pre-dam bars has produced a canal-like
 318 channel that is largely disconnected from its valley. The valley disconnection creates the smallest measured

319 functional floodplain width despite having one of the largest valley bottom widths in the restoration reach. The
320 paucity of functional floodplains means the riverine ecosystem is largely disconnected from the valley bottom
321 under the modern flow regime. The Trinity River is a straight, plane bedded, single-thread channel with a low
322 sinuosity (near 1.0). Channel morphology is generally simple, except where valley curvature forces the channel
323 to interact with the valley wall. Discriminate analysis using the method described by Eaton et al. (2010) showed
324 that the Trinity River favors a single-threaded channel planform at the project location and is unlikely to develop
325 a multi-thread channel. However, smaller scale flow bifurcations around alluvial bars are possible. Natural
326 reworking of the present terraces will require time spans that exceed those normally considered by resource
327 managers.

328 The Oregon Gulch and Mill Creek watersheds and creek alignments were also dramatically altered by hydraulic
329 mining. Hydraulic mining in Oregon Gulch occurred between 1851 and 1940 and filled the Oregon Gulch valley
330 with a wedge of sediment ranging from 120 feet thick near the headwater to 40 feet near its confluence with
331 the Trinity. Oregon Gulch is slowly incising through the hydraulic mining sediments which provides a high
332 sediment load. The high tributary sediment load and wide mainstem valley allow for Oregon Gulch to produce a
333 large delta that is causing significant lateral migration of the Trinity River. Mill Creek has a small sediment load
334 because it is a much smaller creek and the majority of sediment was washed out by hydraulic mining.

335



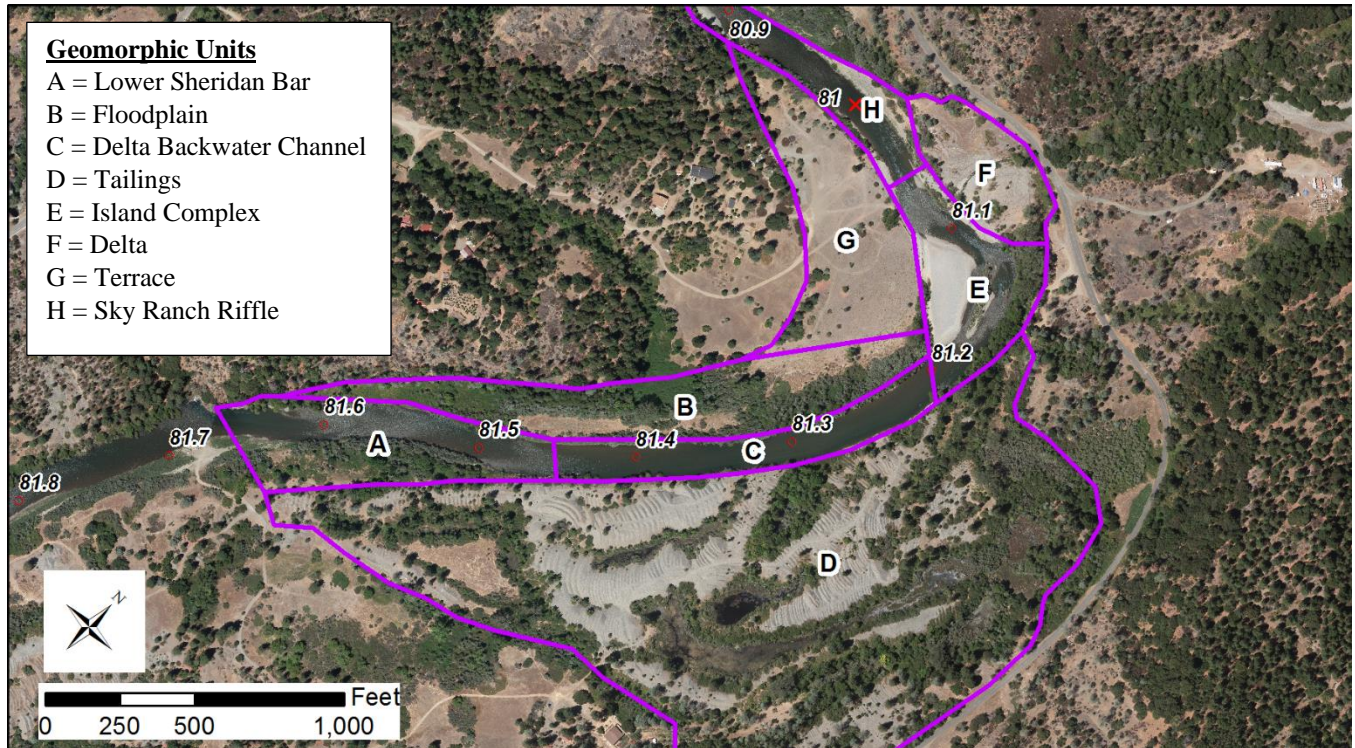
336 **FIGURE 8: LOCAL HYDRAULIC AND DREDGER MINING IMPACTS NEAR THE PROJECT SITE**

337 *Photo year – 1960. Yellow = extent of hydraulic mining; Red = extent of dredger mining 1944-1965*

339

340 [Site Scale Geomorphology](#)

341 Historical mining impacts, large floods, flow regulation, and continued delta building have created the
342 contemporary site geomorphology found today, delineated in Figure 9 and summarized in Table 4.



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FIGURE 9: CONTEMPORARY GEOMORPHIC UNITS

TABLE 4: DESCRIPTION OF CONTEMPORARY GEOMORPHIC UNITS

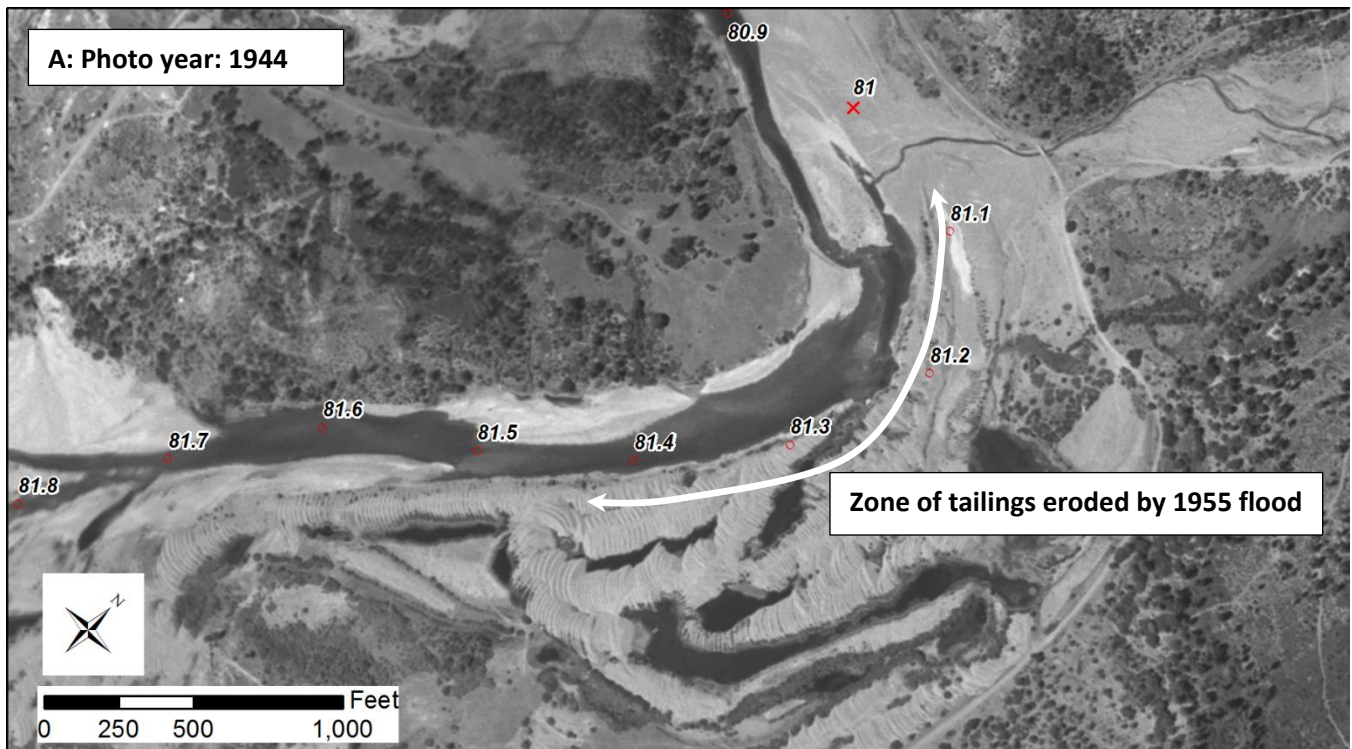
Unit	Name	Description
A	Lower Sheridan Bar	A vegetated bar with a small alcove at the downstream end that periodically fills with sand. Forms a compound riffle downstream of Sheridan Hole that drops 4 vertical feet. The first foot of drop is across a recirculation bar that forms downstream of Sheridan Hole on river left between RM 81.67 and RM 81.6. The recirculation bar is periodically exposed as it changes in response to floods but the riffle remains relatively stable. The stabilized head cut across the remnant pre-dam bar accounts for the remaining 3 feet of drop.
B	Floodplain	Created by a large, pre-dam bar whose chute channel slowly filled in with vegetation and sediment, converting it to a contemporary floodplain and terrace.
C	Delta Backwater Channel	An simple channel with a low slope and a plane bed entrenched between tailings and remnant pre-dam bars and backwatered by the Oregon Gulch delta. The channel is extremely stable vertically and horizontally, indicating it is an efficient sediment transport reach.
D	Tailings	A large dredger tailings field that occupies upwards of 75% of the valley bottom width. The height of the tailings piles ranges from 25 to 35 feet above the river. Large pre-dam floods flattened portions of the tailings piles. Low areas between the tailings have created a large complex of perennial and ephemeral wetlands.
E	Island Complex	A contemporary island complex controlled by the Oregon Gulch delta. The island complex is very dynamic with active deposition and erosion that changes the number of islands and channels.
F	Delta	The delta of Oregon Gulch. The delta was completely evacuated by the 1955 flood. The delta rapidly rebuilt between 1955 and the early 1970's. Delta growth continues today but at a slower pace.
G	Terrace	A large terrace created by the 1955 flood in an area previously occupied by the river. The terrace rises up to 15 feet above the contemporary river and forces the river to the right side of the valley.
H	Sky Ranch Riffle	A steep transition from Oregon Gulch to Sky Ranch through a short narrowing of the valley.

347

348 **Historical Change**

349 Historical change was assessed using aerial photos from 1944 to 2016 (figures in Appendix C) and comparing
350 changes in mapped channel extents before and after large floods (figures in Appendix D). The alignment and
351 planform of the Trinity River prior to the start of the Gold Rush in 1848 is unknown. Active large scale hydraulic
352 mining occurred in Oregon Gulch through 1940, contributing vast amounts of sediment to the Trinity River
353 valley. The 1944 aerial photos provide first available evidence of the channel alignment and planform but were
354 taken after 96 years of intensive hydraulic and dredger mining. In 1944, the Junction City valley had already
355 aggraded by about 12 feet from hydraulic mining sediment inputs and large portions of the valley bottom were
356 cut off by dredger mining. In 1944 the Trinity River was aligned along the left side of the valley downstream of
357 Sheridan Hole (RM 81.7). The river was presumably pushed to the left side of the valley by the extensive dredger
358 mining upstream of Oregon Gulch and by the high tributary sediment loads from hydraulic mining in Oregon
359 Gulch. Large floods had already sheared off portions of the dredge tailings between RM 81.7 and 81.3. Large
360 bars are present near RM 81.5 and RM 81.1 (the old delta head).

361 The 1955 flood caused the largest changes at the project site observed in the historical aerial photo record. The
362 1955 flood peaked at 172,000 cfs (as measured downstream at the Burnt Ranch streamgauge) and was more than
363 twice the size of the next three largest storms on record (1958, 1940, and 1964). The 1955 flood was large
364 enough to flatten large sections of tailings piles between RM 81.4 and RM 81.1 and rearrange the valley (Figure
365 10). Smaller but significant changes occurred in response to floods after 1955 and to flow regulation after 1960.
366 Geomorphic changes between 1944 and 2016 occur in 3 primary response zones: the Delta zone, the Delta
367 Backwater zone, and the Tailings zone.



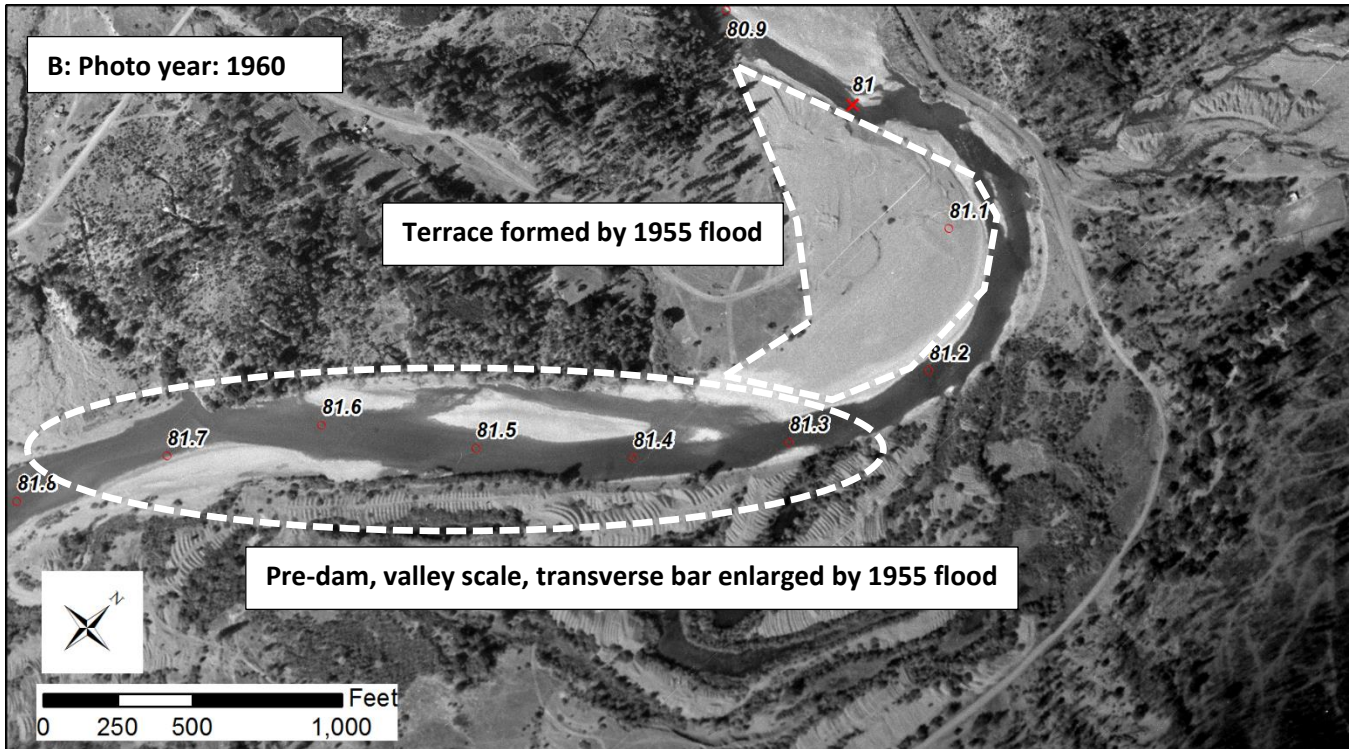


FIGURE 10: PRE-DAM GEOMORPHIC STRUCTURE AND EFFECT OF 1955 FLOOD

Delta Zone Changes 1944 – 2016

The delta zone encompasses the entire valley bottom between RM 80.9 and RM 81.2 (Figure 9; geomorphic units E, F, and G respectively). The 1955 flood caused the river to migrate laterally more than 500 feet and flipped the channel alignment from valley left to valley right (Figure 10). The flood leveled 0.2 miles of tailings piles and evacuated the entire delta of Oregon Gulch. The 1955 flood also created a large terrace that filled the entire valley bend between RM 80.9 and 81.4 that was previously occupied by the Trinity River. This terrace forced the river to remain on valley right. Oregon Gulch rapidly rebuilt a delta between 1960 and 1971 (Appendix C). The delta continued to grow from 1971 to 2016 but at a slower pace. Delta building between 1960 and 2016 pushed the Trinity River more than 200 feet back toward valley left, laterally migrating into the 1955 terrace deposit and causing cut bank erosion. The channel of Oregon Gulch is actively migrating across the delta, typically in the upstream half of the delta (i.e. upstream relative to the Trinity River). The 1960 photo shows evidence of mechanical excavation at the end of the terrace downstream of RM 81.0.

The reformation for the Oregon Gulch delta created an active island complex between RM 81.1 and 81.2; immediately upstream of the delta. The first expression of the island complex is seen in 1971 and grew to full size by 1975. The island complex has remained very active within its 1975 footprint ever since. Local deposition and erosion continue to shift the number of islands, channels, and lateral channel alignment. While the delta and upstream island complex remain laterally active, their location and length from a longitudinal perspective have remained fixed since 1971.

392 Delta Backwater Zone Changes 1944 – 2016

393 The delta backwater zone stretches from Sheridan Hole (RM 81.7) to the upstream end of the island complex
394 (RM 81.2) and includes the lower Sheridan Bar riffle, floodplain, and delta backwater channel (Figure 9;
395 geomorphic units A, B, and C respectively). The river valley is moderately confined between the river left valley
396 wall and river right dredger tailings. The 1955 flood was the formative event which expanded and connected
397 large 1944 bars in this reach to create a valley scale transverse bar downstream of Sheridan Hole (Figure 10).
398 The 1971 photos are the first ones clear enough to delineate the location of the associated riffle, which formed
399 at the lower end of the bar between RM 81.4 and RM 81.3. By 1980 the riffle moved upstream by 0.1 river miles
400 via head cut erosion. The riffle head cut another 0.1 river miles between 1980 and 1990, when riffle head cutting
401 stopped. The modern riffle stretches from Sheridan Hole (RM 81.68) to RM 81.46 and remains fixed in location.
402 The riffle location corresponds with a dredger tailings induced valley constriction that creates a high energy
403 chute that drops 4.3 feet in the FEMA 100-year water surface profile (Figure 11).

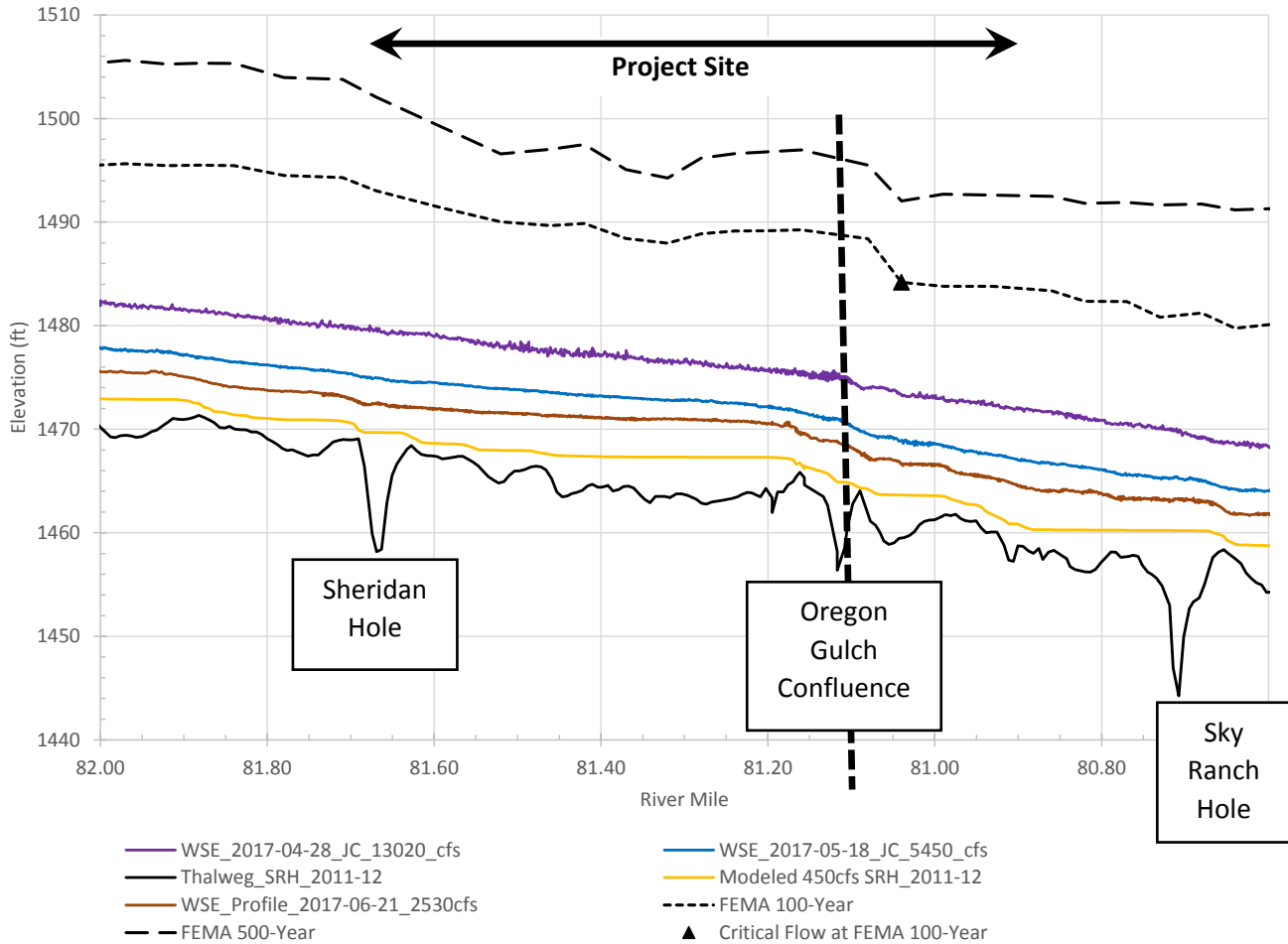
404 In 1960, the lower end of the large pre-dam bar on river left was barren with a large chute channel between RM
405 81.3 and RM 81.6. The lower elevations portions the bar and chute channel began filling in with riparian
406 vegetation after dam construction and flow regulation in 1960. The chute channel remained flowing through
407 1971 but was subsequently choked off by the vegetation and vegetation induced sediment deposition. The
408 former chute channel is now a floodplain. The higher elevations of the bar were unable to support riparian
409 vegetation and remain grassy terraces.

410 Tailings Zone Changes 1944 – 2016

411 The tailings zone is the large field of dredger tailings on valley right between Oregon Gulch delta and Sheridan
412 Hole (Figure 9; geomorphic unit D). A portion of the tailings piles near the channel margin were flattened by
413 large floods prior to 1965 as noted above. The tailing ponds are present in 1944 aerial imagery but were largely
414 devoid of vegetation. The tailings ponds do not change over time except for vegetation growth around the pond
415 margins.

416 Contemporary Geomorphology

417 Valley cross sections are shown in Appendix E. The unconstrained valley bottom width ranges from 600 feet to
418 1,700 feet. Dredger tailings piles occupy up to 75% of that width and eliminate the river's ability to access most
419 of the valley. The river has low sinuosity with river curvature driven largely by valley curvature near the Oregon
420 Gulch confluence. The river is not in direct contact with the valley walls except at the upstream site boundary
421 (Sheridan Hole, RM 81.68) and a bedrock outcrop on river left at RM 80.9. Hydraulic mining caused significant
422 aggradation so the depth to bedrock is anticipated to be at least 10 feet or more. The slope upstream of the
423 Oregon Gulch delta ranges from 0.0012 to 0.0018 to (Figure 11) which represents a reduction of about 20 – 50%
424 as compared to the average river slope of 0.0022 across the entire 40 mile restoration reach. The slope steepens
425 significantly as the river drops 7 feet in the transition from the upstream end of the Oregon Gulch delta (RM
426 81.2) into Sky Ranch (RM 80.9). This large drop is caused by a local valley constriction. The two riffles that form
427 this transition have an overall slope of 0.0039.



428
429
430

FIGURE 11: LONGITUDINAL PROFILE

431 The channel in the Junction City valley reach is shallow with below average bed relief. Gaeuman et al. (2016)
432 evaluated overall channel complexity based on a cluster analysis of various channel parameters including depth
433 variation. This analysis indicated the geomorphic units in the project site are longer than average, and the
434 overall vertical channel complexity (i.e. bed relief) ranges from “very low” to “moderately low”. Exceptions occur
435 in short reaches immediately below Sheridan Hole and near the Oregon Gulch Delta where channel complexity
436 ranges from “high” to “moderately high” respectively. Horizontal complexity is also low.

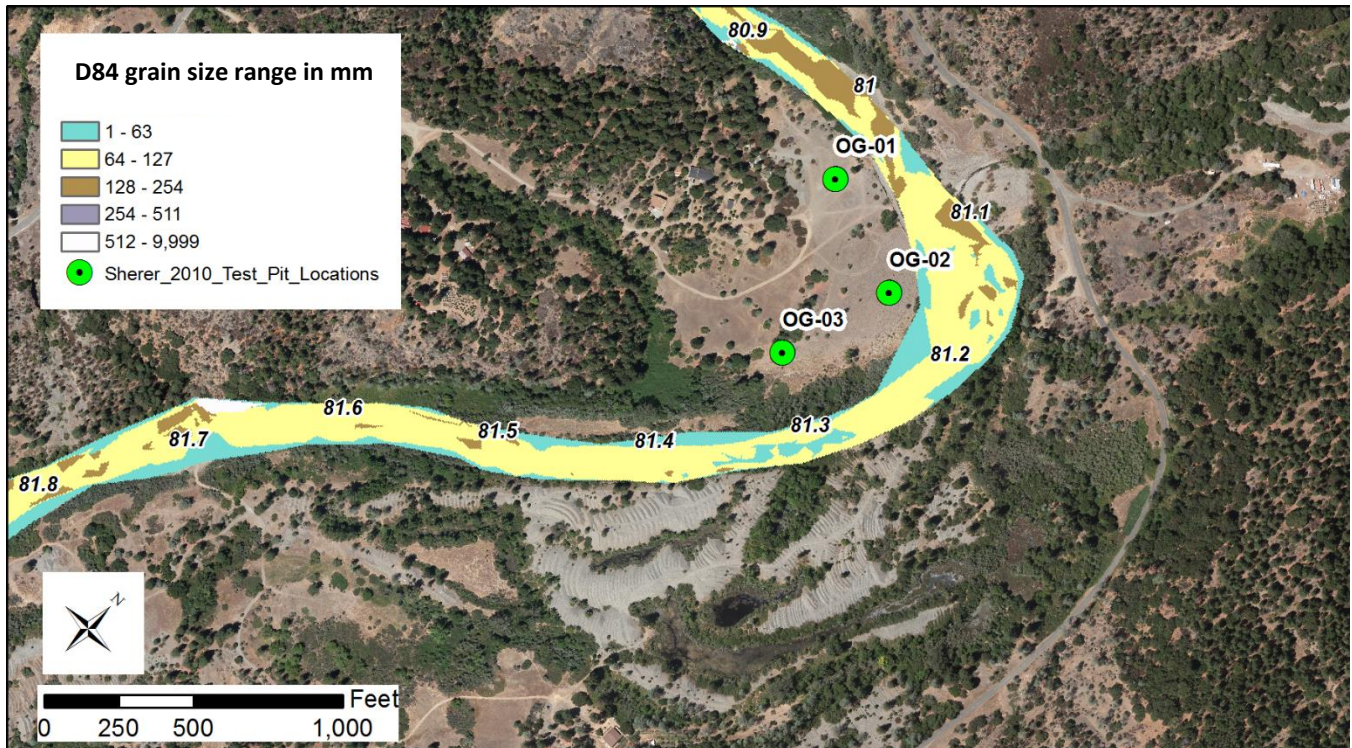
437 Valley Bottom Materials

438 Sherer (2010) visually characterized the sediment deposits of the river left terrace at three test pits (Figure 12).
439 Test pits OG-01 and OG-02 were used to characterize the terrace deposit. The terrace deposit surface is 10 to 15
440 feet above groundwater (elevation 1464.3 ft to 1465.9 ft) and no bedrock was encountered. The terrace deposit
441 consists of poorly graded gravel with sand. The terrace deposits are sometimes overlain with a surface layer (0.7
442 ft thick) of silty sand to sandy silt.

443 Test pit TP-OG-10-03-OW was excavated into a channel bar deposit. A thin (0.5-foot-thick) surficial cover of
444 floodplain overbank deposits consisting of silty sand to sandy silt was encountered. Beneath the surficial
445 deposits to a depth of 7.0 feet, there is an old bar deposit consisting of poorly graded sand with silt, gravel, and

446 cobbles. Between 7.0 and 10.0 feet of depth, there is terrace alluvium consisting of silty sand with gravel and
 447 cobbles. Between 10.0 And 10.5 feet (total depth), very intensely weathered schist bedrock was encountered.
 448 Groundwater was encountered in this pit on top of the bedrock at 10.0 feet (elevation 1464.8 feet). The channel
 449 bar deposit has was estimated to be comprised of approximately 40% spawning size gravel and 60% sand, silts,
 450 and some cobbles.

451 The channel substrate size (D_{84}) between Sheridan Hole and the Oregon Gulch delta is generally less than 128
 452 mm (Figure 12). Below Oregon Gulch the substrate size coarsens (up to a maximum D_{84} of 254 mm) due to the
 453 steeper channel slope and sediment supply from Oregon Gulch.



454
 455 **FIGURE 12: CHANNEL SUBSTRATE MEAN D_{84} SIZE AND TEST PIT LOCATIONS**
 456 *Substrate data collected in 2014 by US Fish and Wildlife Service, Hoopa Valley Tribe, and Yurok Tribe*

457 Large Wood Dynamics

458 Existing wood abundance throughout much of the Project reach is low relative to natural conditions due to
 459 historic impacts from logging, mining, and dam construction (Yurok Tribe Design Group and CH2MHill, 2011).
 460 Wood is often removed from rivers to protect infrastructure such as bridges or pipelines and to facilitate
 461 navigation or recreational use. The Oregon Gulch site overall has very little wood. The island complex at 81.2
 462 RM has been a wood racking and storage area in recent years. In moderate sized rivers such as the Trinity, most
 463 of the natural wood is found in logjams (Cardno Entrix and CH2MHILL, 2011). However, the 2016 high flows
 464 scoured out an entire island and the large wood jam that was being racked by the vegetated island. The
 465 absence of mature vegetation on the island complex now makes it difficult for wood to accumulate anywhere in
 466 the Oregon Gulch site. Also a large buried tree was present for over a decade at 81.45 RM. This too was washed
 467 out during recent high flow events. The only substantial wood presently in the Oregon Gulch site is at the apex
 468 of the bend, at the bottom of the island complex on river right, where the bank is being eroded and trees are

469 collapsing into the channel. Wood densities at the Oregon Gulch site are far less than the recommended 50-60
470 pieces per 100m of river channel (Cardno Entrix and CH2MHILL, 2011).

471 Biological Significance and Use

472 Salmonids

473 Situated in the lower third of the 40 mile project reach, the Oregon Gulch site is used by the bulk of salmonids
474 that are produced in the Upper Trinity. Adult salmonids migrating upstream arrive as early as May (Spring
475 Chinook). Their numbers peak in September and October when the Fall Chinook and steelhead arrive. Some
476 adult steelhead and Coho salmon may continue to use this reach from December through March.

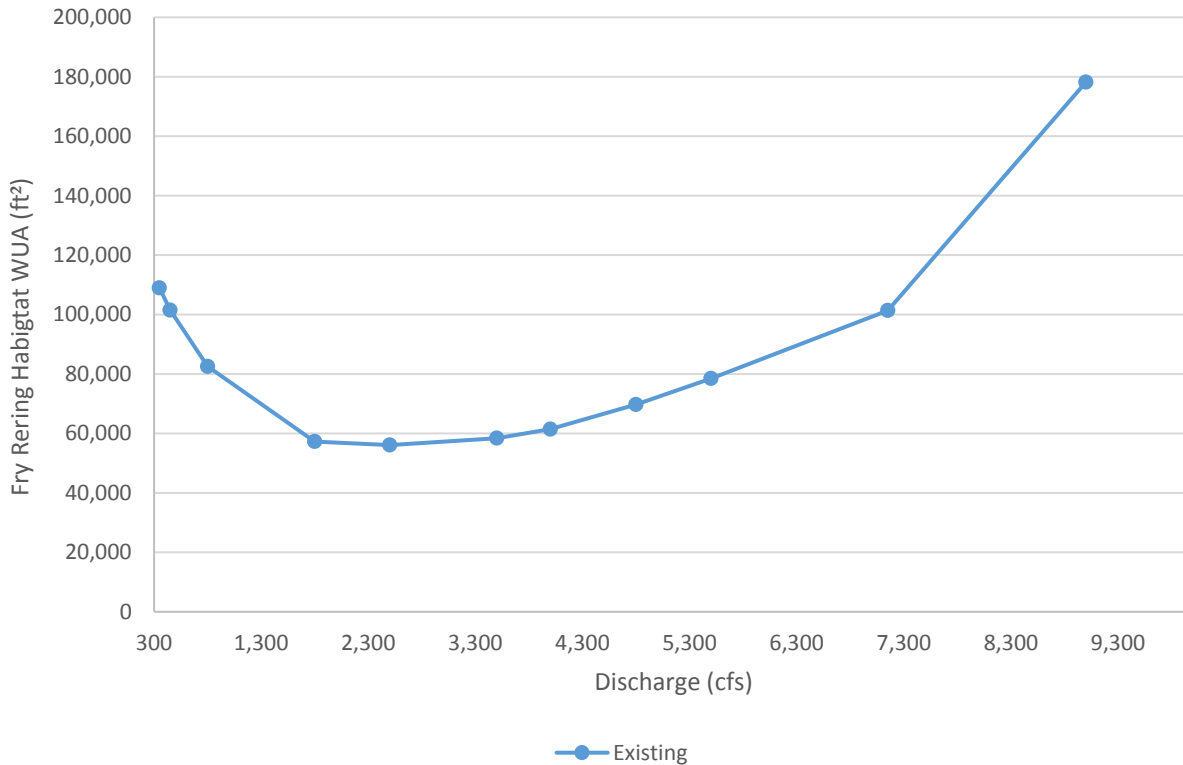
477 Juvenile salmonids begin to emerge from the gravel in January for Spring Chinook. Fall Chinook begin to emerge
478 in late February into April and steelhead appear in late March through May. As mentioned above, a large
479 proportion of the juvenile salmonids that are produced in the Upper Trinity River will rear and migrate through
480 the Oregon Gulch site.

481 Spawning in the Upper Junction City reach of the Trinity River is dominated by native Fall Chinook Salmon. The
482 Sheridan Creek site immediately upstream of Oregon Gulch experiences some of the highest concentration of
483 natural spawners in the 40 mile Project reach. This amplifies the importance of quality rearing habitat directly at
484 the project site (just downstream of Sheridan) across a range of flows.

485 NOAA (2014) identified the Oregon Gulch tributary as having a high intrinsic potential for Coho salmon and
486 ranked removing the fish passage barrier at Sky Ranch Road as a high priority. The Mill Creek tributary has zero
487 intrinsic potential for Coho salmon.

488 Juvenile Rearing Habitat

489 Fry and juvenile rearing habitat was estimated for the Oregon Gulch site using outputs from the SRH-2D
490 hydraulic model results (2016 results, Figure 13). Depth, velocity, and distance to cover was computed for each
491 model cell. Weighted useable area (WUA) was then calculated in the SRH habitat module using habitat
492 equations developed by the Trinity River habitat team. WUA habitat decreases from low flows and does not
493 exceed those values until discharge exceeds 7,500 cfs. The combination of high banks and a terrace on river left
494 and mine tailings on river right confine the channel create some of the poorest rearing habitat observed
495 anywhere in the project reach.



496

497 **FIGURE 13: ESTIMATED FRY CHINOOK WEIGHTED USEABLE AREA AT A RANGE OF FLOWS FOR THE OREGON GULCH DESIGN**
 498 **SITE (2016 EXISTING CONDITIONS).**

499

500 **Salmonid Spawning Habitat**

501 Spawning on the Trinity River usually occurs near hydraulic controls (Perry et al. In revision). Spawning within
 502 the Oregon Gulch site is mostly focused around the upstream and downstream ends of the site where areas of
 503 greater complexity exist (Figure 14). Higher densities of redds are usually observed just below Sheridan Hole at
 504 the top of the site, as well as around the top of the Oregon Gulch delta. The middle of the site (RM 81.4-81.2),
 505 which is a mostly plane bed reach, usually has very low spawning densities. As mentioned earlier, the most
 506 important aspect relating to spawning at Oregon Gulch is the proximity of this site to the Sheridan riffle just
 507 upstream, which experiences some of the highest natural spawning densities in the restoration reach.

508 **Salmonid Adult Holding**

509 No Trinity River specific holding habitat depth criteria for adult Chinook Salmon are available. However, there
 510 are a few sources in the literature that characterize holding habitat for adult Chinook Salmon, though it is
 511 generally understood that “deeper is better”. Raleigh et al. (1986) describe prime adult holding pools in streams
 512 greater than 5m wide (16.4 ft) as those that are greater than 2m in depth (6.6 ft.). Wampler (1986)
 513 characterizes ideal adult holding habitat for adult spring Chinook Salmon in the Wind River of Washington State
 514 as ≥ 14 ft. Moyle (2002) describes adult Spring Chinook selection of pools greater than 6.6 ft deep. It also
 515 appears that other factors like stream aspect, hillshade effects, and overhead cover may influence the quality of
 516 deep water for holding adult Chinook Salmon. With all this in mind, the Oregon Gulch project site currently has
 517 almost no locations where depths exceed 6 feet. Figure 15 shows a detrended terrain model of the site from
 518 data collected in 2016. Arrow #1 points to the deepest area in the Oregon Gulch site that was present during

519 the 2016 survey. That hole was filled in during the 2017 high flows (Townzen, S. pers. Comm). Presently the
520 deepest hole in the Oregon Gulch site for Chinook salmon holding is located at the apex of the bend, at the
521 lower end of the island complex (Arrow #2). The river is scouring a pool there and eroding trees into it, which
522 increase its value for holding habitat.

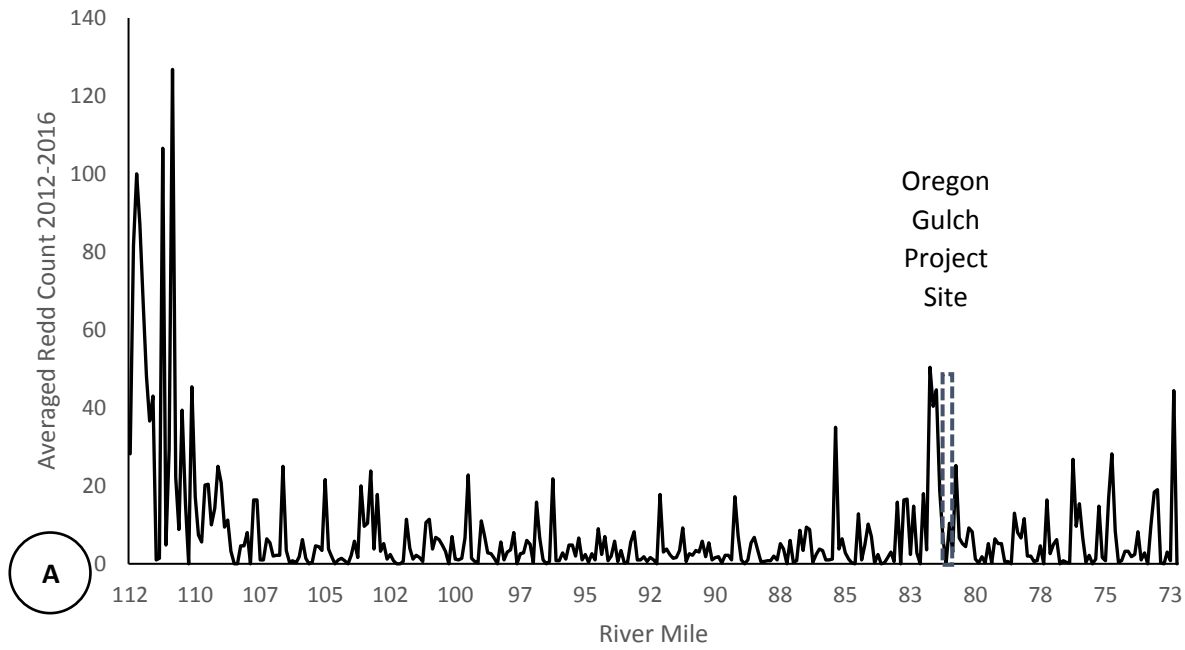
523 Hampton (1997) identified suitable depths for adult steelhead holding as those greater than or equal to 3.5 feet.
524 On the Trinity, steelhead prefer water between 3-8 ft deep, with medium velocities, and large cobbles, boulders
525 or wood that provide velocity cover. Some sort of surface disruption in the form of riffles or bubbles which
526 provide cover from predators is also desirable. Throughout the Oregon Gulch site, there is almost no area that
527 meets this criteria. In some years, a few steelhead were known to hold in the riffle near the top of the site
528 (upstream of RM 81.5), towards the left bank. On river right at RM 81.45, there was a large tree in 6-7 ft of
529 water where a few steelhead and brown trout were found. High flows in 2017 displaced that tree to an
530 unknown location downstream. The majority of the site (RM 81.45-81.2) is a plane bed channel with simple
531 flow characteristics and is highly undesirable habitat for adult salmon or steelhead.

532 In short, the Oregon Gulch site currently exhibits some of the worst rearing habitat across the critical range of
533 flows anywhere in the Project reach and it also has very little adult holding habitat.

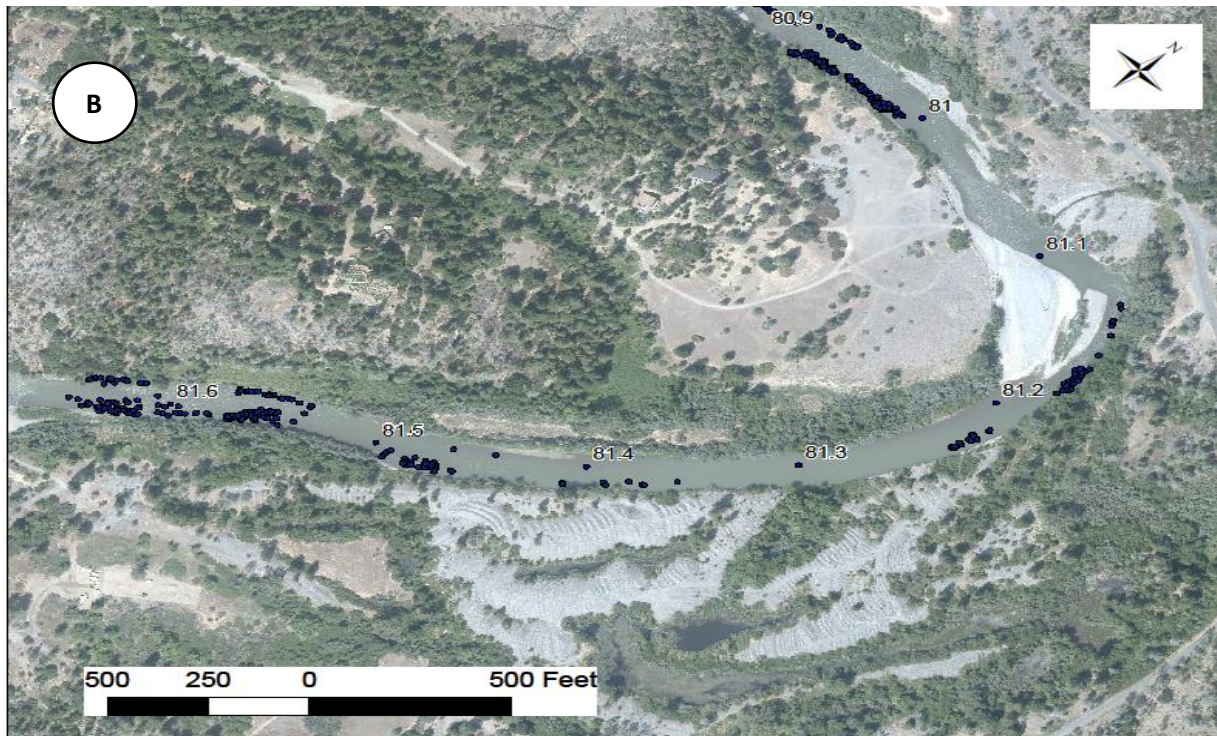
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538

539 **FIGURE 14: FIGURE A) MAINSTEM REDD DISTRIBUTION BETWEEN LEWISTON DAM AND THE NORTH FORK TRINITY RIVER;**

540 **FIGURE B) REDD DISTRIBUTION AT THE OREGON GULCH PROJECT SITE FOR YEARS 2012-2016.**

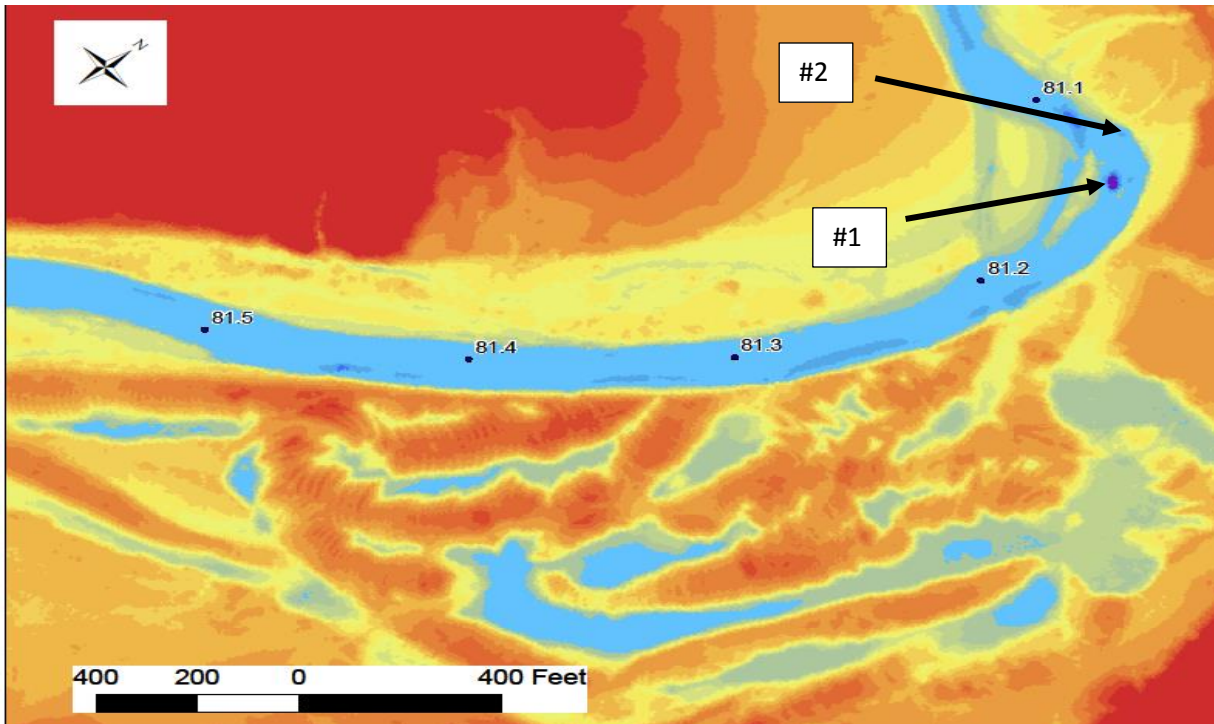


FIGURE 15. MAINSTEM TOPOGRAPHY AT THE OREGON GULCH SITE.

Note: Yellow to Red colors indicate 2-foot elevation intervals in detrended topography. Arrow one indicates a small pool that was filled in during the 2017 high flows. Arrow 2 indicates the deepest pool presently in the site.

Wildlife

Special-Status Wildlife Species

Suitable habitat exists for terrestrial and aquatic special status wildlife (and others) within the Lower Valley ESL. Use of these habitats may change seasonally and surveys need to be conducted to determine current occupation. Past TRRP construction has avoided or minimized potential impacts to species of concern by following limited operating periods (LOPs) which avoid impacts at sensitive life history stages (e.g., breeding and development periods). If these LOPs are observed, mobile life stages are expected to avoid construction equipment so that impacts will be minimal at most. The 2009 Master EIR for channel rehabilitation and sediment management for remaining Phase 1 and Phase 2 sites (NCRWQCB and USBR, 2009) provides more details about special-status wildlife species that occur in the along the mainstem Trinity River between Lewiston dam and the North Fork. The federal Action Agencies and the Cooperating Agencies of the TRRP have reinitiated Section 7 consultation with the regulatory agencies that administer the Endangered Species Act (ESA; e.g., the USFWS and NMFS) to ensure that the current habitat restoration activities, design strategies, and the adaptive management process used for implementing the action remains in compliance with the ESA. Biological Opinions (BOs) which address potential Project impacts to federally listed and proposed species (e.g., SONCC Coho Salmon; N. Spotted Owls) will be developed while current BOs remain in effect.

Foothill yellow-legged frog (*Rana boylei*) and western pond turtle (*Actinemys marmorata*) are the only non-fish, special status aquatic species in the area. Foothill yellow-legged frogs are frequently observed at Oregon Gulch, which may serve as source populations for foothill yellow-legged frogs observed in nearby mainstem locations.

The island complex just upstream of Oregon Gulch has had successful breeding in the past, but generally velocities are too swift and no breeding was observed in 2017 (D. Ashton, pers.comm) and there are no other bars that provide suitable habitat within the Oregon Gulch site. Western pond turtles are frequently observed in the tailings ponds on river right (E. Mattison, pers. comm.).

Riparian and riverine birds are considered special-status species because of their associations with unique and imperiled environments, such as particular types of riparian plant communities. Demographics and abundance of riparian bird communities were monitored in the Trinity River from 2004-2009, including the Oregon Gulch to Canyon Creek reach where this site is located (Miller et al. 2010). Relatively common birds in the reach of river from Oregon Gulch to Canyon Creek include Black-headed Grosbeak (*Pheucticus melanocephalus*), Song Sparrow (*Melospiza melodia*), Tree Swallow (*Tachycineta bicolor*), Yellow-breasted Chat (*Icteria virens*), Yellow Warbler (*Dendroica petechia*), American Dipper (*Cinclus mexicanus*), Belted Kingfisher (*Megaceryle alcyon*), Common Merganser (*Mergus merganser*), Green Heron (*Butorides virescens*), and Spotted Sandpiper (*Actitis macularius*) (Miller et al 2010).

Riparian Vegetation Conditions

Land and vegetation cover type were mapped in 2014 within the 2018 Oregon Gulch site ESL and are shown in Figure 16. Eight percent of the 2018 ESL area was outside of the 2014 Land and vegetation cover type mapping boundary and was unmapped. Using the quantitative definition of vegetation zones from HVT and MA (2015), emergent and mesic vegetation zones occupy the bank 0 to 10 ft above the 450 cfs water surface elevation. Of the 114.3 acres in the ESL, 7.65 acres are less than 3ft above the river (i.e., the emergent zone; 7% of the ESL) and 24.8 acres were between 3 and 10 ft above the river water surface elevation (i.e., the mesic zone; 22% of the ESL). Land and vegetation cover type within the 2018 ESL area was 104.7 acres. Wetland and riparian land cover classes composed 38% and invasive riparian land cover classes composed 3% of the 2018 ESL area (Figure 16). Mature riparian vegetation within the Sheridan Creek site is dominated by narrowleaf willow (14% of the ESL), arroyo willow (8% of the ESL), and red willow (4% of the ESL). Invasive riparian land cover classes were primarily composed of Himalaya berry (3% of the ESL). Tree of Heaven occurs sporadically throughout the site (0.7 acres) and should be prioritized for removal during construction. Over one-quarter of the 2016 ESL area was covered with a combination of disturbance related habitats including yellow star-thistle grasslands (13% of the ESL) and dredger tailings (11.5% of the ESL).

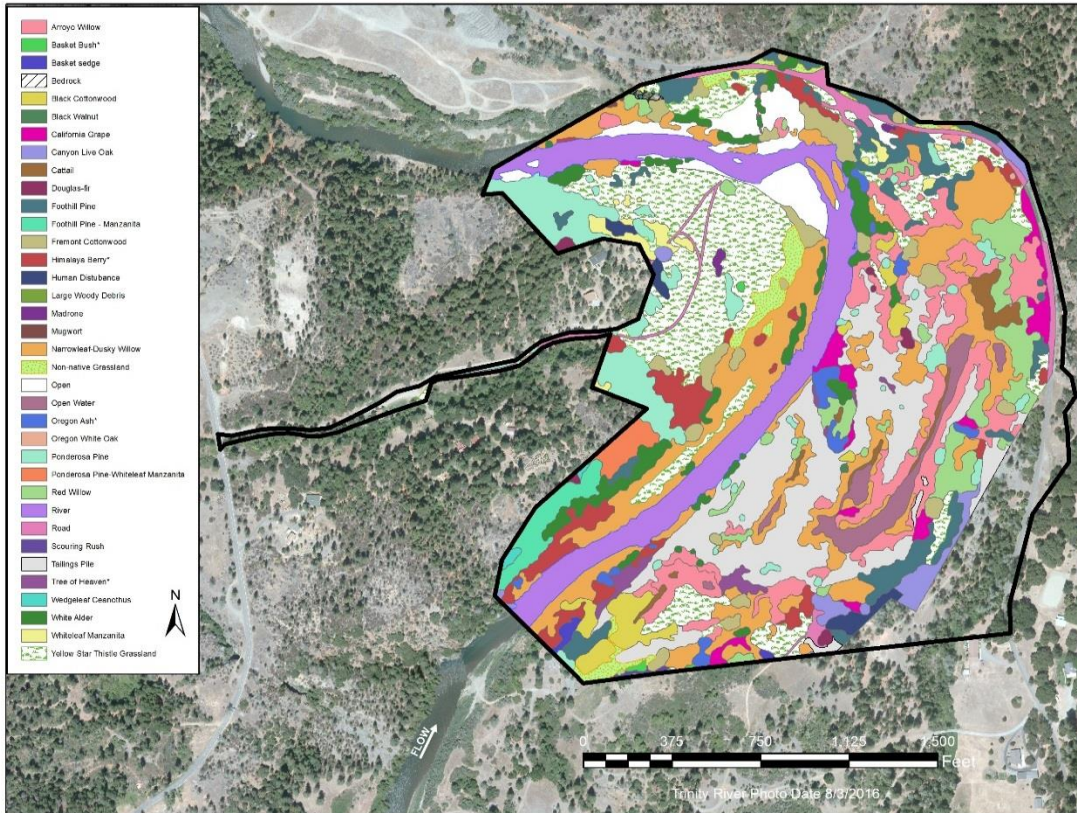


FIGURE 16: LAND AND VEGETATION COVER TYPE MAPPED IN 2014 WITHIN THE 114.3 ACRE PROJECT SITE

Site Constraints and Opportunities

The preceding sections documented how mining impacts, large floods, and flow regulation artificially confined the valley, disconnected the river from its floodplain, and created a simplified and stable river channel through most of the site. The site currently exhibits some of the worst rearing habitat across the critical range of flows anywhere in the restoration reach and it also has very little adult holding habitat. The value of creating rearing habitat at the project site is magnified due its proximity to Sheridan Riffle which has the some of the highest densities of natural spawning in the restoration reach.

Gaeuman et al. (2016) stressed that planform complexity is dependent on an accessible floodplain and recommended the following general approaches for mechanical rehabilitation of the Trinity River:

1. connect the channel to its valley
2. create obstructions
3. use large wood placements at all scales
4. create functional floodplains
5. natural bar morphology and dynamic construction

Gaeuman et al. (2016) provided additional recommendations for the Junction City valley reach (where the Oregon Gulch project is located) as follows: “This reach includes some expansive terrace area that could be converted to complex floodplains over the long term. This should be the ultimate end objective for these reaches. In the short term, rehabilitation in this reach should target floodplain development at a scale

commensurate with current means, increasing channel complexity through local width variations as described previously, and maintaining existing complexity where the channel interacts with its valley walls.” The combination of a wide valley bottom, significant amount of public land, and willing landowners provides a unique opportunity to implement the recommendations of Gaeuman et al. (2016) to make significant and badly needed planform and habitat improvements to the site.

Design Alternatives

Project Objectives

Historical impacts have artificially narrowed the valley bottom, significantly reduced the functional floodplain area, and created a simplified and stable channel geometry (although the delta area remains dynamic). The result is a section of river with extremely poor rearing, spawning, and adult holding habitat and a pronounced dip in rearing habitat capacity between 450 cfs and 8000 cfs. The general project objectives are therefore to increase rearing habitat across all flows, eliminate the rearing habitat dip below bankfull flows, increase the functional floodplain area and increase topographic and hydraulic complexity throughout the site. The project site is located just below the Sheridan Riffle which has the highest density of natural spawning in the restoration reach. It is therefore important to maximize the rearing habitat gains at the project site to enhance growth and survival of the fry produced at the Sheridan Riffle immediately upstream. The detailed project objectives are as follows:

- Physical Objectives
 - Reconnect river with its valley
 - Remove valley constriction between RM 81.67 and RM 81.5
 - Increase functional floodplain area
 - Promote dynamic river processes
 - Increase topographic complexity
 - Reduce wood storage deficit (wood structures and standing inventory)
- Biological Objectives
 - Eliminate the decrease in habitat between low flows and bankfull flow
 - At a minimum, double the rearing habitat capacity across the range of critical habitat flows (350-4,000 cfs) during the Jan-June time period
 - Enhance existing native amphibian habitat
 - Create perennial or seasonal surface water connection to existing and new off-channel water features
- Riparian Objectives
 - Minimize impacts to existing multi-story riparian vegetation and cottonwoods
 - Increase riparian vegetation biomass and abundance in the tree, shrub and herb layer along design features compared to existing conditions
 - Increase the number of trees (especially cottonwood) that could supply logs in excess of 24” to the river,
 - Increase native species richness/abundance on surfaces that will be open and greater than 7 ft above the lowest groundwater of the year

Design Process and Approach

The Trinity River Restoration Program is a multi-agency program. A technical workgroup called the Design Team is comprised of multi-disciplinary program partners that oversee the design process. The Design Team is broken into four smaller subset teams that are assigned a specific project that they oversee the specific design tasks and become the project lead or the designers of record. The four individual designer teams include: Federal, Hoopa Valley Tribe, State of California, and the Yurok Tribe. The designs are reviewed at multiple stages throughout the design process via internal technical review, external technical review (a formal value engineering study), and by the public through the environmental permitting process. The final design deliverables include a design report, design drawings, and Digital Terrain Model (DTM). Design details associated with large wood structures are handled through a separate large wood design report and construction drawings. The Bureau of Reclamation manages the associated environmental permitting process and construction contracting, implementation, and oversight.

The Trinity River Restoration Program design and construction process has evolved over the years to deliver the maximum habitat benefits in the most cost effective manner. As such, the design and construction process on the Trinity differs from a traditional approach in two important ways. First, only the design report and DTM (not construction drawings) are shared with potential construction contractors. The construction drawings provided by the designer to the Bureau of Reclamation are for internal use only and not intended as bid documents. Second, the final DTM does not include micro-habitat features. Micro-habitat features vastly improve the biological benefit of the project but are best designed and constructed in the field under direction of a fisheries biologist once the rough grading to the design DTM has been constructed. These micro-habitat features are typically aimed at making the final construction surface complex and uneven using earthwork, wood, and boulders to create complex topography, inset benches, alcoves, etc. The micro-habitat features enhance the final grade of the project but does not alter the project goals and objectives or the specific hydraulic characteristics of the site.

The 30% Design Alternatives as described below were developed using Digital Terrain Modeling (DTM) through a workflow of both ArcGIS and AutoCAD Civil 3D. The Existing Conditions DTM was derived from surveys and analysis provided through data collected in 2016 by GMA (*GMA Hydrology 2017 and Pryor 2017*). Both Design Alternatives (ALT1/ACD and ALT2/LAM) were “graded” through specific digital modeling tools in AutoCAD using linework and point files to create a three dimensional (3D) digital terrain surface that was later used to analyze and evaluate river hydraulics and Salmon habitat metrics

Conceptual Design Alternatives

In 2010, the Trinity River Restoration Program developed conceptual designs for nine project sites throughout the restoration reach, including two concepts for the Oregon Gulch project site (CH2MHill and Entrix, 2010). The current design process started by reviewing two concepts developed in 2010. From there, the Yurok Design Group took a new approach to the design process and solicited conceptual design input from the other design groups prior developing their own concepts. This was done to ensure the conceptual designs represented input from across the TRRP. The input from the other design groups was developed during individual brainstorm meetings other TRRP design groups. The various brainstorming sessions developed a total of 15 different conceptual ideas. Combining similar design elements reduced the number of brainstorm concepts for consideration to 10, including the original two from 2010 (Appendix F). The 10 brainstorm concepts represent a broad range of philosophies including: a stage zero model option, large amplitude meanders, anastomosing channels, and multiple approaches of incorporating the ponds found in the tailings piles. The 10 concepts were

presented to the TRRP design team on February 1, 2018 for review. The general consensus from the design team was that the site was a good candidate for a “go big” type project to reconnect the river with its valley. The design approaches favored by the design team included: large amplitude meanders, anastomosing channels, maximizing the amount of functional floodplain surfaces (flows < 4,500 cfs) upstream of the delta with an emphasis towards lower surfaces (flows < 2,500 cfs), and reconnecting the existing wetlands with the river. Strategic use of wood jams was favored and adding wood to the Oregon Gulch delta was also suggested. Lastly, the design team agreed that 5 Counties program should be encouraged to reinitiate their effort to replace the Oregon Gulch culvert under Sky Ranch Road to allow fish passage into the tributary but that the fish barrier removal should be kept separate from the proposed mainstem channel rehabilitation project. The design team input on the initial 10 concepts was used to refine number of designs down to two concepts and to move forward to a thirty percent design stage.

Thirty Percent Design Alternatives

The thirty percent designs alternatives adopted the design team recommendations to reconnect the river with its valley and maximize the amount of functional floodplain. Two alternatives were developed for the thirty percent design stage, a large amplitude meander alternative and an anastomosing channel alternative. Both alternatives are described in more detail below. The 30 percent design alternatives have the following in common:

1. The existing geomorphic control at RM 81.2 and associated low valley slope between RM 81.2 and RM 81.6 are maintained. These are desirable features for that promote both meandering and anastomosing channel types.
2. The existing river left terrace downstream of the Oregon Gulch confluence is maintained for following reasons. This high elevation terrace helps maintain the geomorphic control at RM 81.2. Modifying the terrace would require significant earthwork and spoil areas on river left are very limited. Lastly, the habitat gains per unit of excavation are low as compared to areas upstream.
3. RM 81.6 is the upstream boundary for any earthwork to help protect the existing hydraulics of the of Sheridan spawning riffle, Sheridan Hole, and the riffle created by Sheridan Hole (which extends from Sheridan Hole (RM 81.7) to RM 81.6).
4. No fish passage improvements to Mill Creek are planned. The creek does not provide desirable conditions for salmonids (S. Naman, pers.comm.).

Anastomosing Channel (ALT 1) (30% Design)

The anastomosing channel 30% design alternative (ACD) combines the anastomosing concept with the Stage Zero concept. Some large wood jams were also added to the Oregon Gulch delta as recommended during Design Team review of the conceptual designs. Cluer and Thorne (2014) updated channel evolution models to recognize a pre-disturbance (Stage Zero) channel type that is a multi-threaded anastomosing channel with well-connected floodplains and wetlands that provide greater ecological benefits than single thread channels. Restoring rivers to Stage Zero channels is a new restoration approach that has been pioneered in Oregon and Colorado with good success and was a major topic at the 2018 River Restoration Northwest Conference. The Stage Zero approach is suited to low slope areas where valley and floodplain connectivity can be restored to promote longitudinal and lateral sediment deposition. The Oregon Gulch project site is an ideal candidate for a Stage Zero channel restoration approach due to its low slope, wide valley (accessible with tailings removal), and stable geomorphic control near the Oregon Gulch confluence. However, the Trinity differs from many of the project areas in Oregon and Colorado in the necessity to provide safe boating conditions immediately after construction.

A primary concept in the Stage Zero restoration approach is restoring the valley grade across the valley bottom both longitudinally and laterally. A design valley grade of 0.00065 was determined based on a profile analysis that tied into existing water surface elevations at match points of interest (**Error! Reference source not found.**). valley grade design surface was then developed by connecting planar surfaces between valley spanning cross-sections set at the valley grade elevation. All design features are then vertically referenced to the valley design grade.

The anastomosing channel ten percent design alternative is shown in Figure 18. The design uses strategic lowering of the tailings piles to reconnect the river with its valley. The mainstem river is diverted into a new series of anastomosing channels that spread the water broadly across the valley bottom and reconnect the extensive complex of existing wetlands (no-action NA features) currently isolated by the tailings piles.

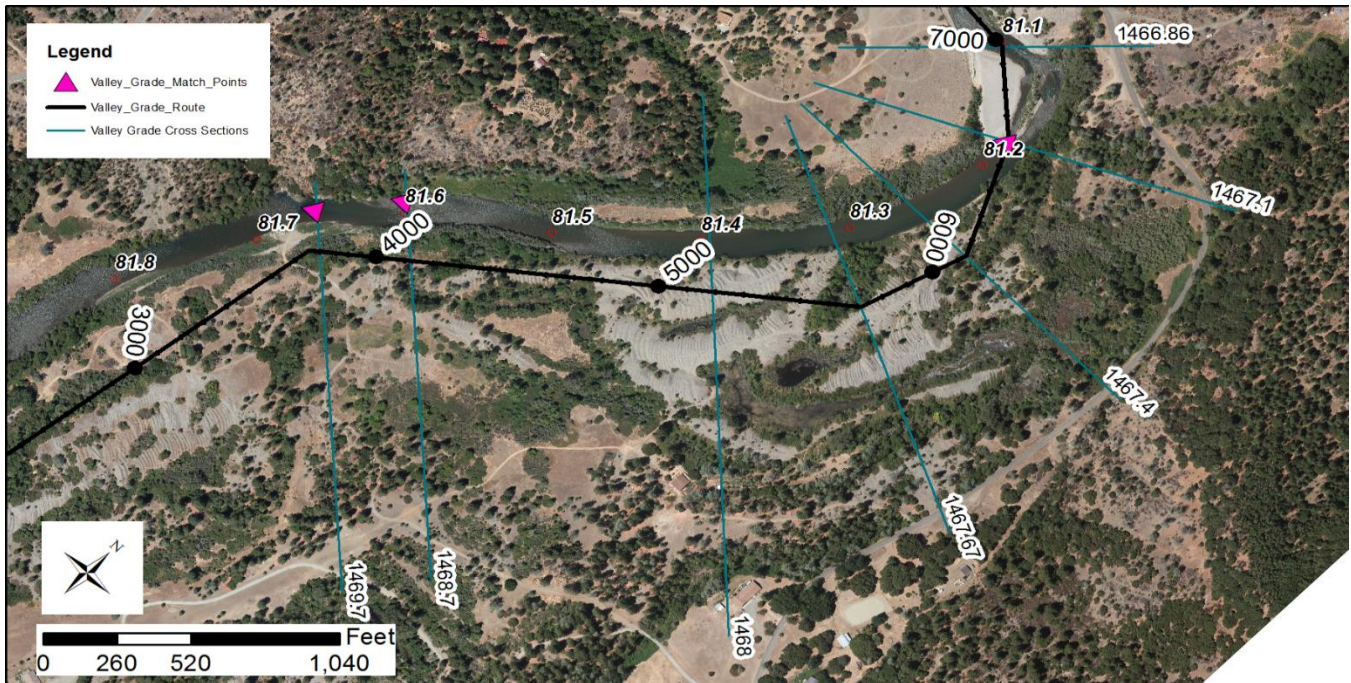


FIGURE 17: VALLEY GRADE LAYOUT

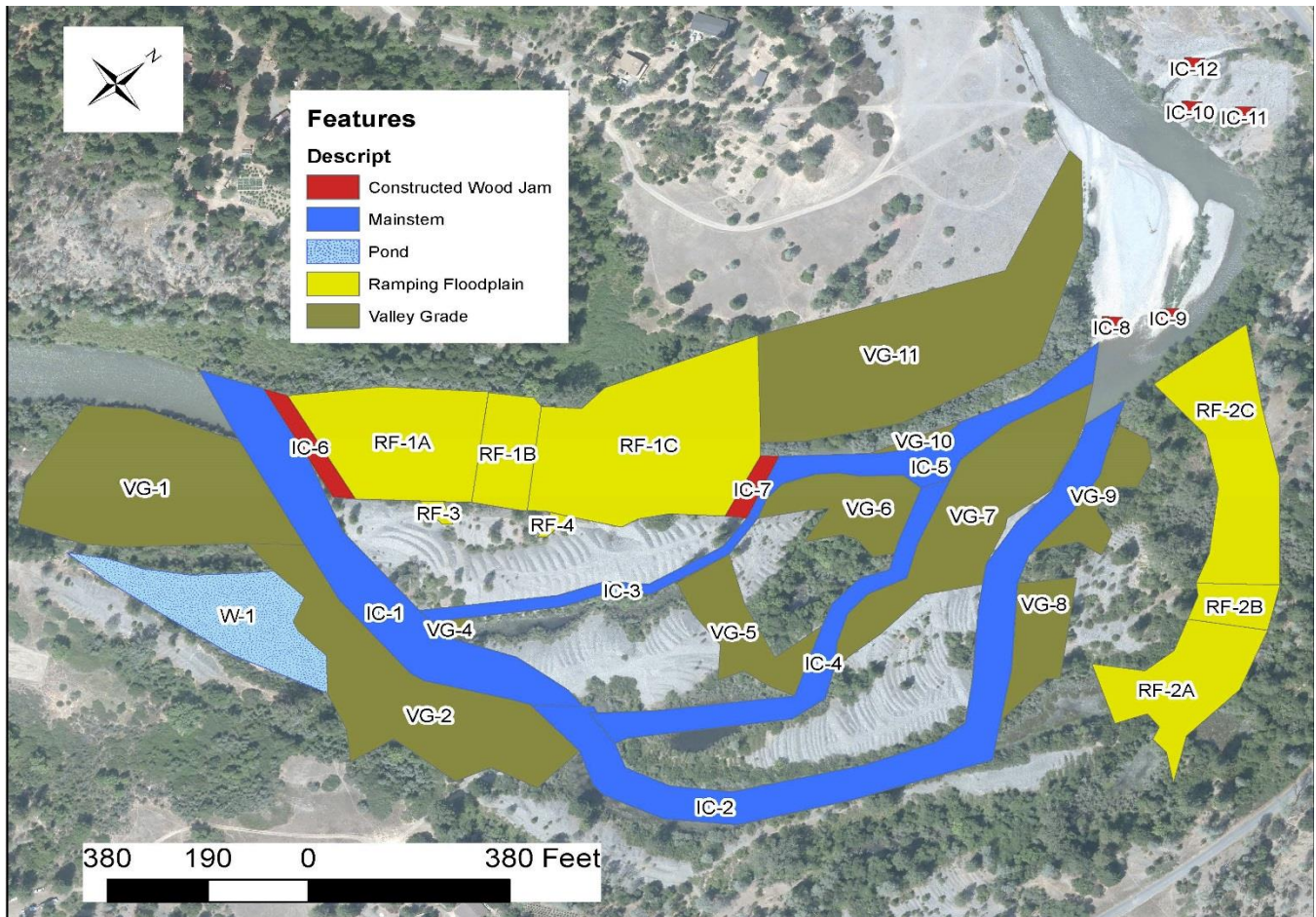


FIGURE 18: ANASTOMOSING CHANNEL (ALT 1) 30% DESIGN ALTERNATIVE

Anastomosing Channels

Description and Purpose: The anastomosing channel network has three primary channels ranging from small (IC3) to medium (IC4) to large (IC2). The channel features are designed to flow within their banks during low flow periods but spill out onto low elevation floodplains set at the valley grade (VG features) and into the surrounding existing wetlands at only slightly higher flows. IC2 is the longest channel, therefore has the lowest slope and is designed to have the most flow post-construction. IC2 will have an average bottom width of about 70 ft and will carry approximately 300 cfs at a total discharge of 450 cfs. IC4 is the second longest channel, and is designed to have an average bottom width of about 40 ft and will convey 125 cfs at a 450 cfs baseflow. IC3 should be considered a side channel. It will have an average bottom width of 20 ft and carry approximately 25 cfs at a 450 cfs baseflow. Portions of IC2 and IC4 will require little to no excavation as they will replace existing ponded features. IC3 will require excavation through tailings, next to an existing pond. The goal is to expand the amount of slow water area while maintaining existing vegetation on at least one bank. IC5 is a return channel for IC3 and IC4. It will occupy the existing mainstem channel but it will be filled in to promote overbank flows onto the low elevation floodplains.

IC6 is a constructed wood feature that will act as a plug to redirect flows into the anastomosing channel network. It will help stabilize the RF-1 ramping floodplain channel transitions. The IC7 constructed wood feature

is intended to prevent head-cutting of the ramping floodplain. It will also provide valuable habitat for juvenile salmonids.

Expected Evolution: Due to the low slope of the Oregon Gulch site, deposition is expected. Expected evolution is discussed further below in the context of hydraulic model analysis.

Assumptions/Uncertainties: The main risk to this design appears to be deposition in the anastomosing channel network. These channels are set deep within the tailings pile, so if this were to result in erosion of the tailings piles, that would be a positive outcome. The primary risk is that deposition in the anastomosing channel network could force the channel to re-establish the current path across RF-1.

Valley Grade Surfaces

Description and Purpose: These low elevation floodplains are designed to overtop at discharges just above winter base flow (350 to 450 cfs), inundating large areas with shallow depths and slow velocities and providing high quality rearing habitat at discharges that occur throughout the critical rearing period. Construction of these surfaces will preserve desirable riparian vegetation wherever possible.

Expected Evolution: We expect fine sediment deposition on the valley grade surfaces and the establishment of riparian vegetation.

Assumptions/Uncertainties: Deposition of gravel in the anastomosing channel network could result in flow paths developing on the valley grade surfaces. This would be considered a positive outcome

Ramping Floodplains

Description and Purpose: Ramping floodplains (RF features) with higher elevation areas (RF-1B and RF-2B) set above the valley grade are meant to steer water and sediment during higher flows into the new anastomosing channel network. They will also serve as good rearing habitat at medium discharges (2,000-6,000 cfs) and provide excellent revegetation opportunities.

Expected Evolution: These features are designed to be depositional, and not scour. Fine sediment deposition is expected across this feature, especially in future years when riparian plantings mature and begin to dominate this landscape.

Assumptions/Uncertainties: The assumption is that the higher elevation ridge and future riparian conditions will prevent the river from avulsing through R1, thereby maintaining river processes in the newly constructed channels.

Wetland Feature

Description and Purpose: W-1 is a deep wetland feature to add depth diversity to the existing network of mostly shallow wetlands. It will inundate at flows of about 450 cfs and will be about 5.5 ft deep.

Expected Evolution: W-1 is not expected to experience significant sediment deposition and should persist.

Assumptions/Uncertainties: Current monitoring has shown close groundwater connectivity between the existing ponds and the river. Rearing conditions for salmonids are expected to remain suitable to optimal throughout the calendar year.

Large Wood Features

Description and Purpose: Construction of two wood features (IC8, IC9) is planned on the mainstem delta, at the downstream end of the project. These structures are projected to increase topographic and vegetative diversity. Recently, the delta area has been losing vegetation to scour and currently only exhibits a single thread channel at low flow (instead of two or three channels in years past). Three more constructed wood features (IC10, IC11 and IC12) are proposed at within the actual delta of Oregon Gulch proper. They share the same objectives as the mainstem features, but at a smaller scale related to the magnitude and frequency of high flows coming from Oregon Gulch.

Expected Evolution: Hydraulic modeling shows increased velocities and shear stresses near the proposed wood jams. They should increase scour along either side of them, and deposition of fines allowing for vegetation to recover behind them.

Assumptions/Uncertainties: Wood racking should occur. Post-construction persistence beyond 5-10 years is uncertain.

Large Amplitude Meander (ALT 2) (30% Design)

The large amplitude meander (LAM) design (Figure 19) was presented as a stand-alone concept to the design team. It was widely agreed upon as a concept to move forward with as one of the alternatives. The LAM design focuses on increasing the sinuosity through the reach by extending the length of the main channel by about 8%. It also features side channel and high flow channel creation through existing tailings ponds as well as extensive tailings lowering to encourage riparian growth.

Meander Complex

Description and Purpose: The meander complex cuts more than 200 ft into the mine tailings located on river right. There are three runs with scour pools (IC1, IC4, IC7) and three bars associated with them (IC2, IC5, IC8). The bars are designed to be low and inundate quickly as flows increase above 450 cfs. Between the three runs are two low gradient constructed riffles (IC3, IC6). Overall the meander sequence will increase sinuosity by about 8% (Sinuosity is dependent on the choice of valley length, which is difficult to define at this site due to the sharp bend at the delta. Using one measure of valley length, sinuosity increases from 1.05 to 1.14). The new alignment is intended to increase shear stress along the outer banks to promote erosion. The IC2 bar has a high flow channel on the back side that is designed to activate at around 2000 cfs. Two constructed wood jams are also designed to complement the meander complex (IC10, IC11). IC10 is located along the outside of the first meander bend below IC1. It will help steer the majority of flows to the right and will not be completely overtopped until 11,000 cfs or higher. IC11 is located along the outside near the downstream end of the last meander. It will help return the majority of flow to the main channel and divert some flows across the lower R3 floodplain. Both jams are positioned to rack natural wood floating downstream. They will have sloping faces (lower on the upstream side) to encourage wood racking and minimize scour.

Expected Evolution: Due to the low slope of the Oregon Gulch site, deposition is expected, particularly on the point bars of the meander bends. Expected evolution is discussed further below in the context of hydraulic model analysis. IC10 and IC 11 are expected to rack wood entering the site from upstream. It is difficult to construct any jam that can persist greater than 10 years, because wood decays rapidly on the Trinity River due to the extreme wetting and drying conditions. If vegetation becomes established, these jam locations may continue to store and shed large wood for years beyond the lifespan of the constructed jams themselves.

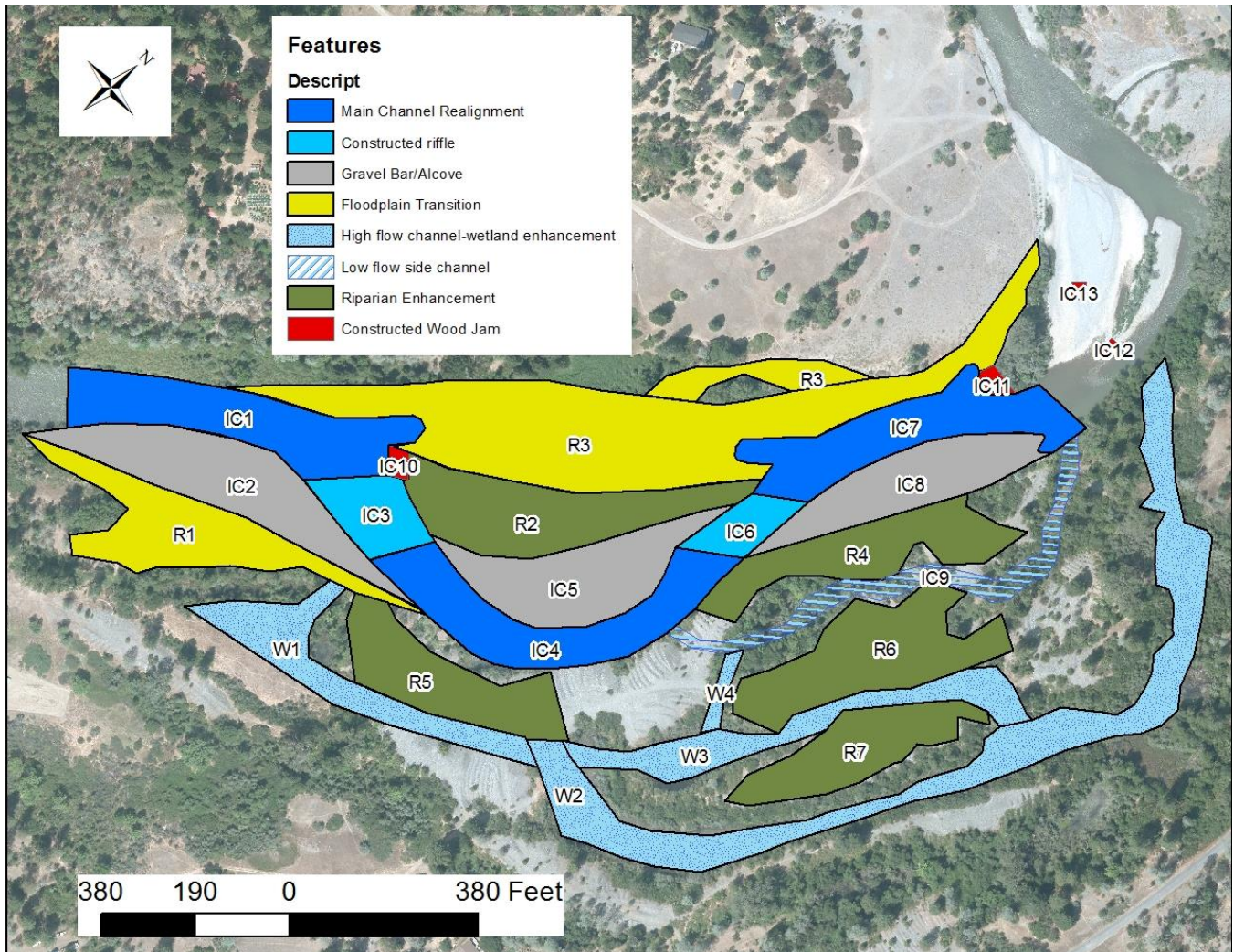


FIGURE 19. LARGE AMPLITUDE MEANDER (ALT 2) 30% DESIGN

Assumptions/Uncertainties: Maintenance of the meander complex depends on features R2 and R3 preventing the river from re-occupying the current flow path. If these features persist, the river will have no choice other than occupying the meander complex. Deposition is likely at multiple sites within the meander complex, which is likely to lead to dynamic and evolving conditions.

River Right Wetland Complex

Description and Purpose: The wetland complex on river right aims to connect multiple ponded areas that are currently isolated between the tailings piles. The R1 floodplain feature is designed to allow water into the wetland complex beginning at around 2,000 cfs. This will create flow through channels in W1, W2 and W3. The existing ponds will require minimal excavation. However, large cuts through the tailings will be required in certain locations. The goal of these wetlands is to create high value rearing habitat year round for salmonids. Fish will be trapped in these ponds when flows are below ~2,000 cfs. Much of these ponded areas are currently

surrounded by high value riparian vegetation. Excavation is intended to occur only within the current ponded areas and in the bare earth tailings piles. Desirable riparian vegetation will be preserved wherever possible.

Expected Evolution: Deposition of fine sediment is always possible in slow velocity environments. These ponds will be excavated to depths over 6 ft deep and are expected to persist for many years. Eventually, certain areas may shallow, or become intermittent, slowly evolving towards a more vegetated condition that only activates at higher flows.

Assumptions/Uncertainties: Current monitoring has shown tight groundwater connectivity between these ponds and the river. Also, there is a high quality perennial spring that enters the W2 pond near the eastern corner of the feature as well as an abundance of beaver activity. Rearing conditions for salmonids are expected to remain suitable to optimal throughout the calendar year.

River Right Low Flow Side Channel

Description and Purpose: A low flow side channel (IC9) is designed for river left. It begins above the IC6 riffle and re-enters 1100 ft downstream below the IC8 bar. It has a slope of 0.08% and is expected to engage at flows as low as 450 cfs. Relatively low velocities are expected throughout much of the range of flows that dominate the period of critical rearing habitat (Jan-May). The alignment routes the channel through multiple ponded areas and several high spots. Similar to the wetland ponds, this feature is lined with red willow, arroyo willow and cottonwood stands. Excavation of the channel will be selective to maximize post construction shade and riparian vegetation.

Expected Evolution: Bank collapse is a possibility where extensive excavation of tailings occur and could clog the low flow side channel. Possible evolution of this feature is discussed further below in the context of hydraulic model analysis.

Assumptions/Uncertainties: Low flow side channels are very hard to maintain for years or decades. Some, inevitably fill in somewhat, but all provide increased rearing habitat across a range of flows compared to pre-construction conditions.

River Right Riparian Enhancements

Description and Purpose: Four areas have been identified (R4, R5, R6, R7) for selective tailings lowering to provide increased riparian benefits and high flow refugia for fish. Currently these areas are a barren landscapes of mine tailings. These surfaces will be lowered to variable elevations (details not yet in design) between 4 and 6+ ft above the 450 cfs water surface elevation to be inundated at flows between 3,500 and 5,000 cfs. Soil or fine sediments will be added to the lowered surface to encourage riparian planting success.

Expected Evolution: Some localized deposition of fine sediments is desirable and anticipated. Riparian forests will grow where barren tailings piles currently exist.

Assumptions/Uncertainties: Three of the four areas being discussed are on private property. The current landowners are extremely supportive of this project and want to see tailings removed and the original valley restored to the maximum extent possible. This is an opportunity that should not be missed. The amount of material to be removed is enormous. New and innovative techniques for construction related activities/schedules will need to be considered to achieve these goals.

River Left Floodplain

Description and Purpose: Floodplain lowering is planned on river left. R3 is designed to wet from the upstream and downstream sides simultaneously while restricting surface flow across it until flows exceed 6,000 cfs. It is intended to provide increased riparian benefit and to provide shallow/slow water refugia for salmonids at flows between 2,000 and 6,000 cfs. The R3 floodplain ties into IC1 on the upstream side. It will have a low flow alcove beside the IC10 log jam and will gently slope up in the downstream direction. The elevation peaks around the mid-point of the floodplain and then begins sloping down again to tie into an alcove below the IC6 riffle. R3 is being designed to be the last feature to overtop at higher discharge, ensuring the majority of flow and energy follow the new meander channel. The R2 riparian enhancement feature is essentially a ridge designed to bifurcate flows between the meander channel and R3 floodplain. R2 is highest on the upstream side, near IC10 to ensure that high flows are steered towards the meander channel.

Expected Evolution: Fine sediment deposition is expected across this feature, especially in future years when riparian plantings mature and begin to dominate this landscape.

Assumptions/Uncertainties: The assumption is that the higher elevation ridge and future riparian conditions will prevent the river from avulsing through R3, thereby maintaining sinuosity and associated river processes in the newly constructed channel.

Downstream Constructed Wood Features

Description and Purpose: Construction of two wood features is planned on the mainstem delta, at the downstream end of the project. These structures are projected to increase topographic and vegetative diversity. Recently, the delta area has been losing vegetation to scour and currently only exhibits a single thread channel at low flow (instead of two or three channels in years past).

Expected Evolution: Hydraulic modeling shows increased velocities and shear stresses near the proposed wood jams. They should increase scour along either side of them, and deposition of fines allowing for vegetation to recover behind them.

Assumptions/Uncertainties: Wood racking should occur. Post-construction persistence beyond 5-10 years is uncertain.

Design Assessment and Performance

Hydraulic Model Description

The TRRP and the Bureau of Reclamation have developed several versions of a two-dimensional, depth-averaged hydraulic model of the Trinity River from Lewiston Dam to the confluence with the North Fork, referred to as the 40 Mile Model. The model development, calibration, and analysis are described in detail by Bradley (2016) and Bradley (2017). The hydraulic model predicts spatial patterns of water depth and velocity and is used to estimate the location, quantity and quality of existing habitat. The model is based on the surveyed topography and bathymetry of the Trinity River, estimates of channel and floodplain roughness, and the outlet water surface elevation for a given discharge. The modeling was conducted using the Bureau of Reclamation's Sedimentation and River Hydraulics model (SRH-2D). SRH-2D solves the depth-integrated, dynamic wave approximation of the Navier-Stokes fluid flow equations with a finite-volume numerical method. More information about SRH-2D can be found at <http://www.usbr.gov/pmts/sediment/model/srh2d/>.

We developed a hydraulic model for the existing conditions and for each of the two design alternatives. A model mesh was created for each of the three models to capture the existing conditions and the features in the design alternatives. The model mesh defines the model domain and discretizes the physical space represented by the model so that the differential equations describing the continuous physical process of fluid flow can be solved numerically between mesh elements. The mesh represents the underlying terrain by assigning elevations to the mesh nodes. The model mesh also defines the spatial resolution of the model. The hydraulic variables computed by the model (water depth and velocity, for example) are spatially averaged over the area represented by each of the mesh elements. Smaller mesh elements average over a smaller area and are therefore better able to represent the slow, shallow water along the channel margins. Smaller mesh elements also represent variations in bed roughness and elevation in more detail. For all three Oregon Gulch models, we used mesh elements in and near the channel that have a modal area of about 8 ft² (4 ft wide by 2 ft long). Mesh elements in floodplain areas and areas well away from the channel are somewhat larger, with a median area of about 20 ft².

The model domain extends from the inlet about 400 ft upstream of Sheridan Hole to the outlet about 1,800 ft downstream of the Oregon Gulch delta, within the bounds of the Sky Ranch site. On river left, the model domain extends well above the river level and includes the large terrace across from the delta. To the east, the model domain extends beyond Sky Ranch road. The model bounds are shown in Figure 20.



FIGURE 20. THE MODEL DOMAIN OUTLINED IN ORANGE. NORTH IS UP.

The bed roughness of existing features was assigned in the same way as for the entire 40 mile model. The following is excerpted from *Bradley* [2018]

SRH-2D represents the friction between the flowing water and the bed and banks of the channel with Manning's roughness coefficient (Manning's n). A value of Manning's n is assigned to each mesh element. The roughness is SRH-2D's primary tuning parameter to adjust the model water surface elevations and velocities to observed values.

The model roughness is based on the physical characteristics of the channel and established relationships between those characteristics and flow resistance. The primary dataset used to develop the channel roughness is the map of the 84th percentile of sediment grain size (D_{84}) within the 2000 cfs flow boundary developed by the Trinity River Habitat Assessment Team in 2014 [*Alvarez et al.*, 2015]. The map of D_{84} was converted to a map of Manning's n according to the following equation from *López and Barragán* [2008] and *García* [2008]

$$n = \frac{C_m(2.8D_{84})^{\frac{1}{6}}}{(8.1\sqrt{g})}$$

where C_m is the unit conversion factor in the Manning equation, equal to 1 for SI units, g is the acceleration of gravity, and D_{84} is in meters. The continuous map of Manning's n was interpolated to the locations of the model mesh element centroids and discretized to 65 unique values between 0.015 and 0.080 by binning into 0.001 wide bins. This step is necessary because SRH-2D limits the number of unique values of Manning's n allowed in a mesh.

The second dataset used in estimating flow resistance is the map of the 2014 riparian vegetation outside of the 450 cfs flow boundary [*HVT and McBain Associates*, 2015]. Aaron Martin and others developed roughness polygon values based on the vegetation type and the floodplain was assigned Manning's n values of 0.025, 0.045, 0.06, or 0.08 based on these polygons.

Design feature roughness was assigned based on the design polygons. Main channel features were assigned $n = 0.035$ and side channels were assigned $n = 0.04$. Lightly vegetated floodplains were assigned $n = 0.025$ and riparian areas were assigned $n = 0.08$. Wood jams were assigned $n = 0.05$. Valley grade features in the anastomosing channel design were assigned $n = 0.03$.

The downstream boundary condition, water surface elevation at the model outlet, was extracted from the latest version of the 40 Mile Model for 14 different flows. The inlet and outlet boundary conditions are summarized in Table 5. The models were run until the discharge across the outlet boundary matched in the inlet flow to within about 2%.

For each of the three models, we computed and examined raster maps of water depth and velocity to assess qualitatively if features are behaving as designed. We also computed total wetted area at each flow and Shields stress maps for two representative grain sizes, 1 mm sand and 50 mm gravel. The Shields stress is

$$\Theta = \frac{\tau}{(\rho_s - \rho)gD}$$

Where τ is the dimensional shears stress computed by SRH-2D, ρ_s and ρ are the densities of sediment (2650 kg/m³) and water, g is gravitational acceleration, and D is a representative grain size. The Shields stress is a non-dimensional shear stress that represents the sediment transport potential in the river. Exact values of the threshold Shields stress for sediment transport vary depending on the study and the river, but are generally in the range of $0.03 < \theta_d < 0.06$. For our purposes, we are interested in the spatial gradients of Shields stress—an area of low Shields stress downstream of an area of high Shields stress may indicate a depositional zone. Areas of uniform high Shields stress indicate the ability to pass sediment of a give size through the area.

We also computed a floodplain connectivity metric following the method described in the Sky Ranch Draft Conceptual Design Report (TRRP Federal Design Group, Feb. 2018). The floodplain connectivity metric is

$$W_j = \left(\frac{1}{L_v}\right) \sum_{i=1}^n P_i A_i$$

Where L_v is the valley length (ft), P_i is the probability of discharge i during the months of February through April, and A_i is the difference between the wetted area at that flow and existing conditions area deeper than 2 ft at 4000 cfs. W_j has dimensions of length and is interpreted as a probability weighted average inundated floodplain width. The floodplain connectivity metric was computed for all flows using probabilities interpolated from Table 3 of the Sky Ranch Draft Conceptual Design Report (TRRP Federal Design Group, Feb. 2018).

Finally, we calculated the amount of habitat in the same manner as for the 40 Mile Model. Bradley (2018) describes habitat calculations as follows:

SRH-2D includes a habitat module, a post-processing option that analyzes the hydraulic results in the context of juvenile salmonid habitat. Among other things, the habitat module classifies each model cell into one of three habitat suitability classes based on thresholds of water depth, water velocity, and distance to cover (e.g., vegetation or in-water features such as large wood). The distance to cover computation requires a shapefile designating cover polygons. The shapefile used in the calculations was derived from the riparian vegetation map used to assign floodplain roughness clipped to the 450 cfs bank lines and the in-water cover map used to assign roughness to in-channel elements such as large wood. In addition to the output of the habitat module, we also evaluated habitat suitability based on continuous habitat suitability curves developed using the methodology described by *Som et al.* [2015]. Each element was assigned a score based on the average of the depth, velocity, and distance to cover score. The score was then weighted by the element area and summed over a particular site on the river to yield a Weighted Useable Area (WUA) that represents the amount of habitat at that site.

TABLE 5. INLET AND OUTLET MODEL BOUNDARY CONDITIONS

Inlet Q (cfs)	Outlet WSE (ft)	Description
350	1460.2	Minimum winter baseflow
450	1460.4	Minimum winter baseflow during rearing period
800	1461.1	
1800	1462.5	
2500	1463.2	
3500	1464.2	
4000	1464.5	
4800	1465.0	Median Dry year net flood frequency ^A

5500	1465.5	
7150	1466.5	Median Normal year net flood frequency ^A
9000	1467.6	Median Wet year net flood frequency ^A
11500	1468.9	
16850	1471.8	Median Ex. Wet year net flood frequency ^A
21900	1474.0	Maximum Ex. Wet year ^{A, B}

A) Source: Channel Rehabilitation Design Guidelines for the Mainstem Trinity River (2011); table 4.5 net flood frequency for the Junction City streamgauge (1996 – 2009); rounded to nearest 50 cfs. B) Similar to the Maximum Fishery Flow (MFF) of 21,736 cfs. The MFF is an 11,000 cfs ROD release conducted in combination with a 100-year spring-time tributary flood event. The MFF was used by TRRP to identify needed infrastructure improvements.

Hydraulic Modeling Results

Water Depth

Analyses of five modeled flows are presented below: 450, 2,500, 5,500, 9,000, and 21,900 cfs. 450 cfs is the minimum winter baseflow during rearing conditions. Flows of 2,500 cfs occur frequently through the winter. Under existing conditions these flows remain confined to bottom of the bankfull channel and increase the velocity causing a habitat dip that reduces the available rearing habitat. 5,500 cfs is the flow for which the ramping floodplain features are designed to engage. 9,000 cfs is the median flow for a wet water year and causes some overbank flooding. 21,900 cfs is the maximum flow expected in an extremely wet year.

Figure 21 through Figure 25 show modeled water depth for the existing conditions (EC) at 450, 2,500, 5,500, 9,000, and 21,900 cfs. The flow is fully confined within the channel at flows up to and including 5,500 cfs, with the exception of some flow through the island complex and behind the left bank gravel bar there (Unit E in Figure 9). At 9,000 cfs (Figure 24), there is some shallow water on the left bank floodplain and the island complex left bank gravel bar is submerged. The tailings piles on the right bank are still fully exposed at 9,000 cfs. Only at 21,900 cfs (Figure 25) is there significant inundation of both the left and right bank floodplains. The periodic fluctuations of modeled water depth visible in the main channel at 21,900 cfs are an indication of a model numerical instability that will be dealt with in the next phase of design process modeling.

Figure 26 through Figure 30 show modeled water depth for the ACD (ALT1) at 450, 2,500, 5,500, 9,000, and 21,900 cfs. All three channels are activated at 450 cfs and all but one of the valley grade surfaces (VG-11) are inundated at this flow, as designed. At 2,500 cfs, the valley grade surfaces are inundated and the RF-2 ramping floodplain surfaces along the right bank are fully engaged and the RF-1 ramping floodplain has begun to flood from both the upstream and downstream ends. At 5,500 cfs, about two-thirds of RF-1 surface is submerged. This surface is fully submerged at 7,150 cfs (not shown). The inundated area continues to increase at 9,000 and 21,900 cfs.

Figure 31 through Figure 35 show the modeled depth results for the LAM (ALT 2) at the same five flows. At 450 cfs, the main channel large amplitude meander carries the bulk of the flow and the right bank low flow side channel, IC9, is flowing. The alcoves at the upstream and downstream ends of R3 are beginning to fill. At 2,500 cfs, the right bank wetland complex has begun to engage and there is a continuous side channel flow path through the wetland complex (W1 and W2). About half of the upstream end of R3 is under shallow water. At 5,500 cfs, the right channel wetland complex is fully engaged and the left bank ramping floodplain (R3) is about to overtop from the upstream end. This surface is fully submerged at 7,150 cfs (not shown). At 9,000 cfs, the riparian surfaces R4 through R7 are fully submerged. They are intended to submerge at flows around 4,500-

5,500 cfs. Changes will be made during the next design phase if we move forward with this design and those features. At 21,900 cfs, all but the highest tailings piles are under water.

Figure 36, Figure 37, and Table 6 summarize the water depth model results. Figure 36 shows the total wetted area at each flow for the three modeled conditions. Both designs increase the wetted area above the existing conditions at every flow and the increase in area is steeper than the existing conditions, which is mostly flat up to flows of about 5,500 cfs. The amount of wetted area in the designs starts to converge at about 9,000 cfs.

In Figure 37, the y-axis of each panel shows the fraction of wetted area less than the depth on the x-axis for each of the three conditions (EC, ACD, and LAM) at the five flows discussed above. Each plot also includes a vertical dashed line that represents the rearing depth threshold for Chinook presmolt (1 m or 3.3 ft). In interpreting the plots, it is important to remember that the values on the y-axis are the fraction of the total wetted below a certain depth. The fractions should be read in the context of the values in Figure 36 to understand the amount of water of a certain depth.

At 450 cfs, the results for all three conditions are similar, with more than ~75% of the wetted area shallower than the rearing depth threshold. At 2,500 cfs the ACD and LAM have water shallower than 3.3 ft over about 50% of the wetted area, while the fraction of area below the threshold depth drops to about 25% for existing conditions. At 5,500 cfs, about 30% of the LAM wetted area is shallower than the depth threshold. The ACD and the EC are similar, with approximately 20% of the wetted area below the depth threshold. However, as shown in Figure 36 the ACD has more than 3 times the wetted area as the EC at this flow. At the 9,000 cfs, the fraction of wetted area shallower than the depth threshold increases for the EC model and remains similar to the 5,500 cfs results for the LAM and the ACD. At the highest flow, 21,900 cfs, about 30% of the EC area is shallower than the threshold depth, while the two designs are similar, with about 20% of the area shallower than the depth threshold. At this flow, the amount of wetted area is about the same for all three conditions, so this may indicate that the existing conditions actually has more shallow water in an absolute sense at 21,900 cfs.

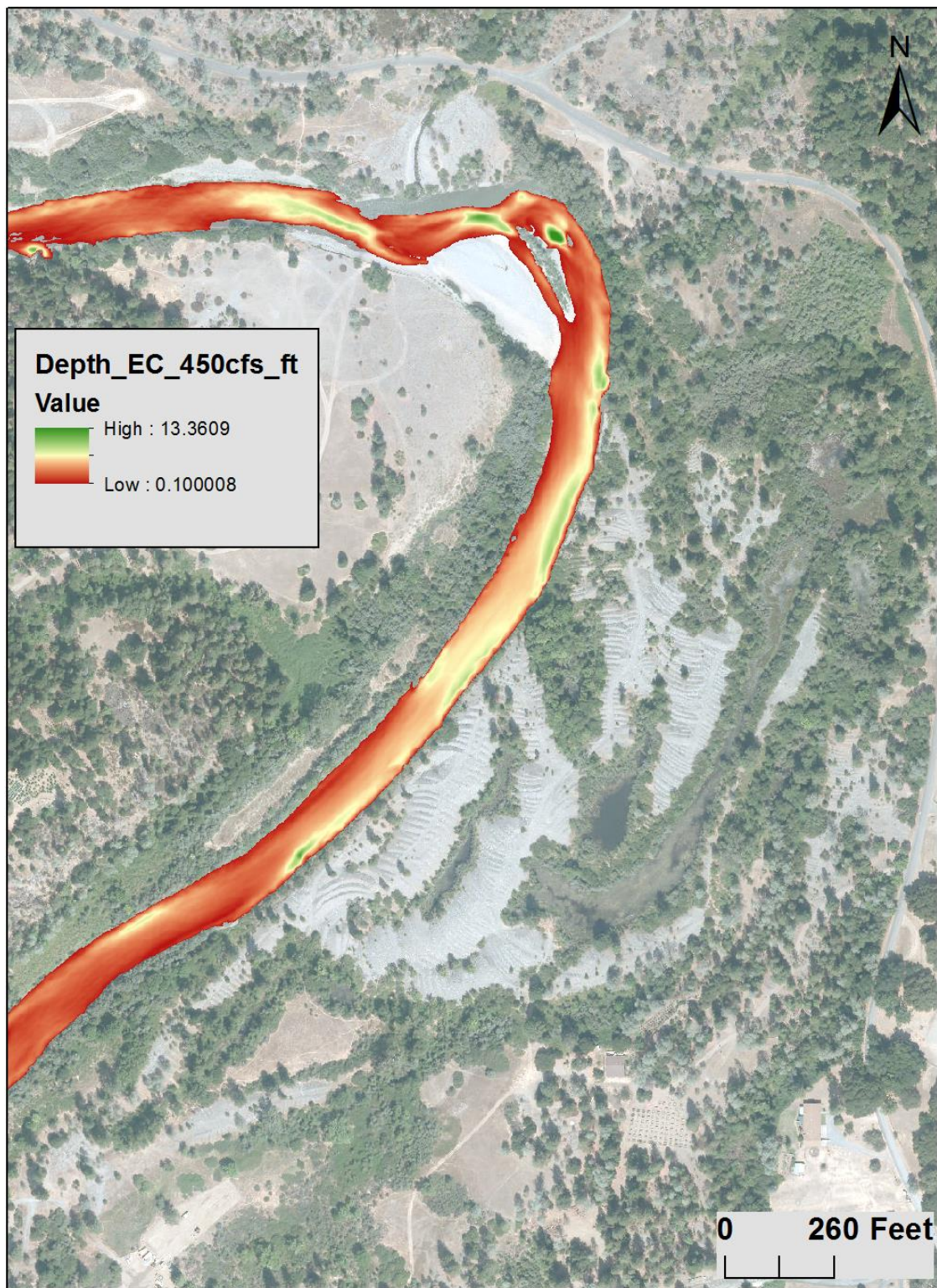


FIGURE 21. EXISTING CONDITIONS MODELED WATER DEPTH AT 450 CFS

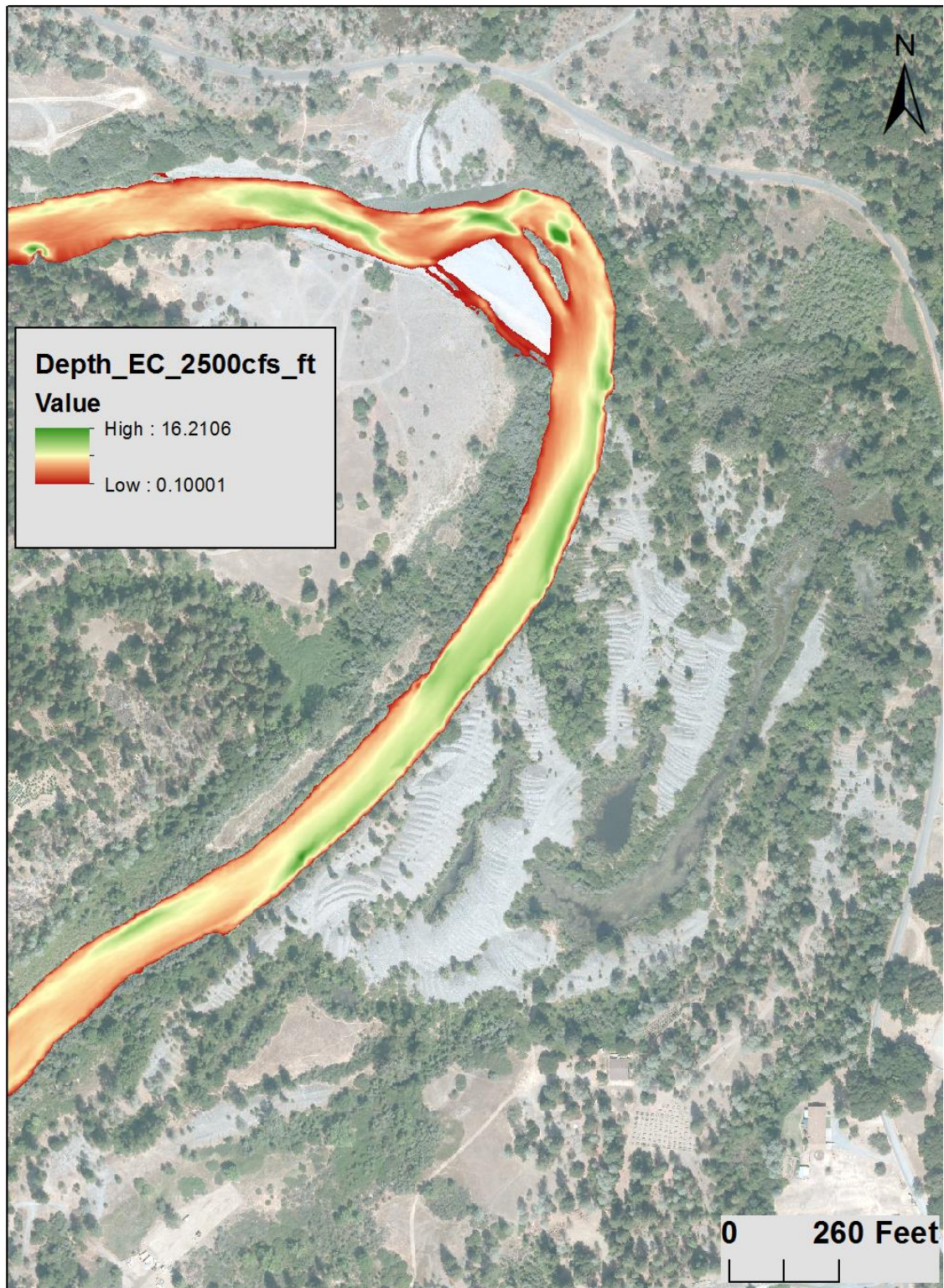


FIGURE 22. EXISTING CONDITIONS MODELED WATER DEPTH AT 2500 CFS

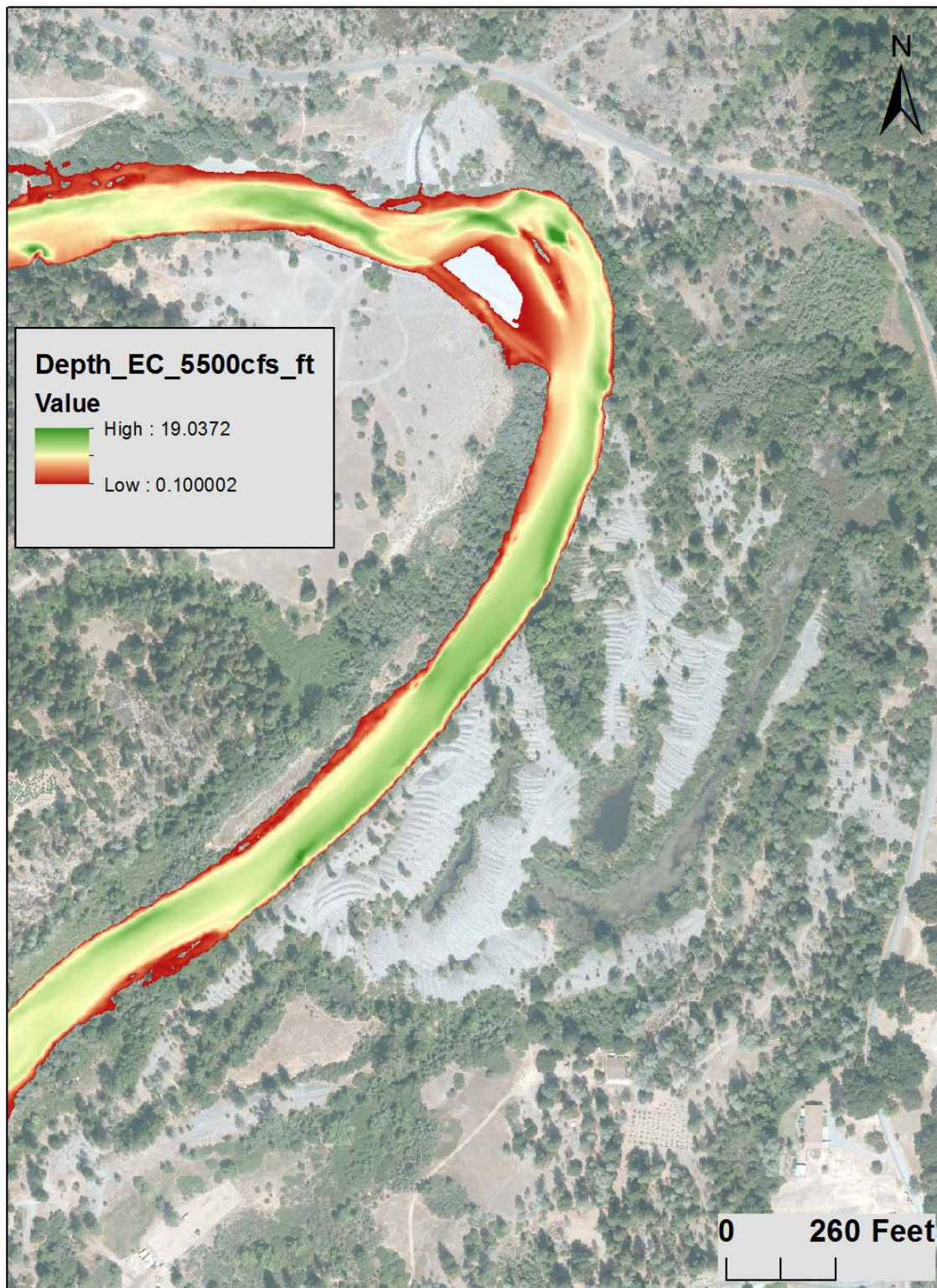


FIGURE 23. EXISTING CONDITIONS MODELED WATER DEPTH AT 2500 CFS

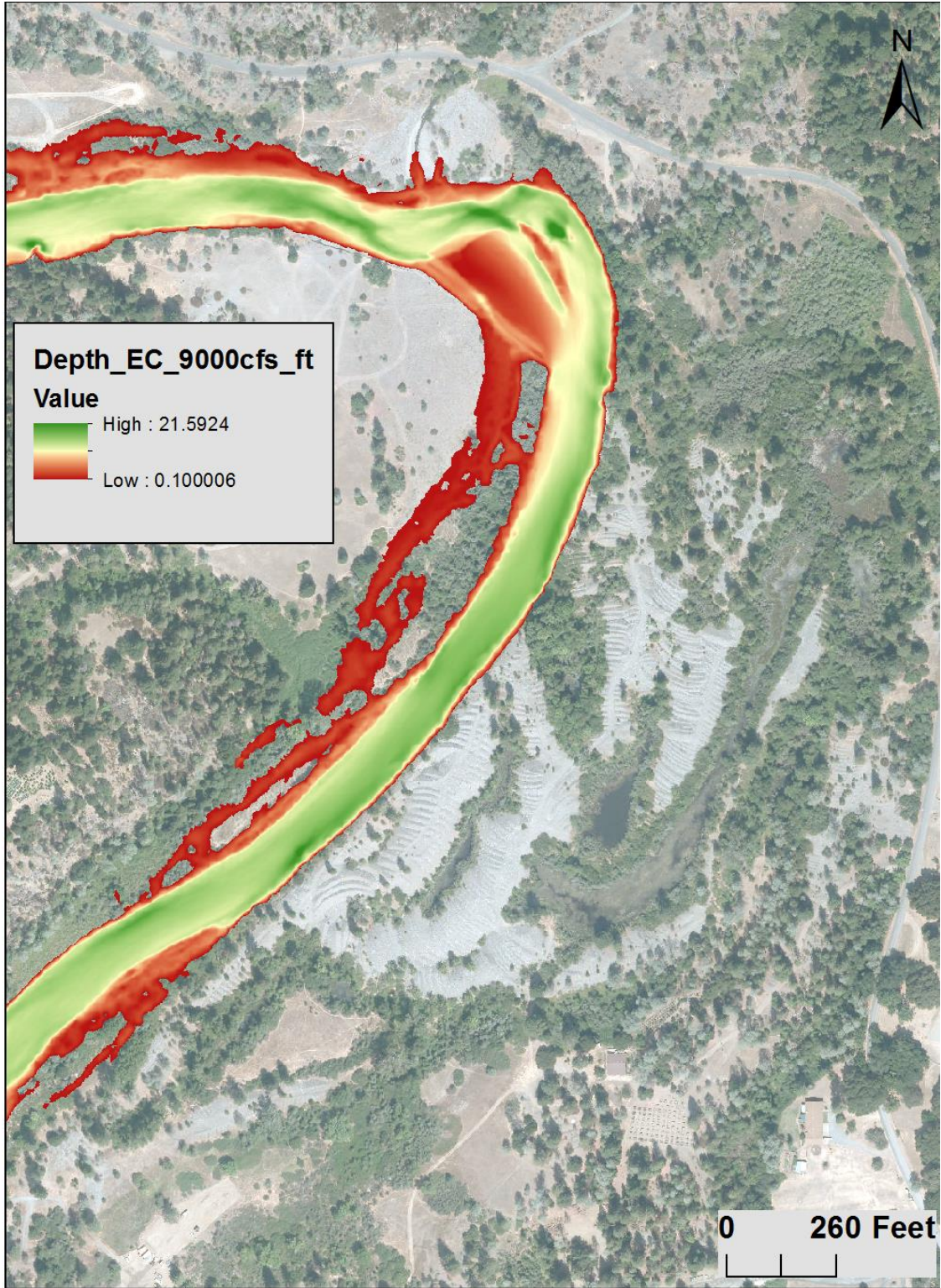


FIGURE 24. EXISTING CONDITIONS MODELED WATER DEPTH AT 9000 CFS

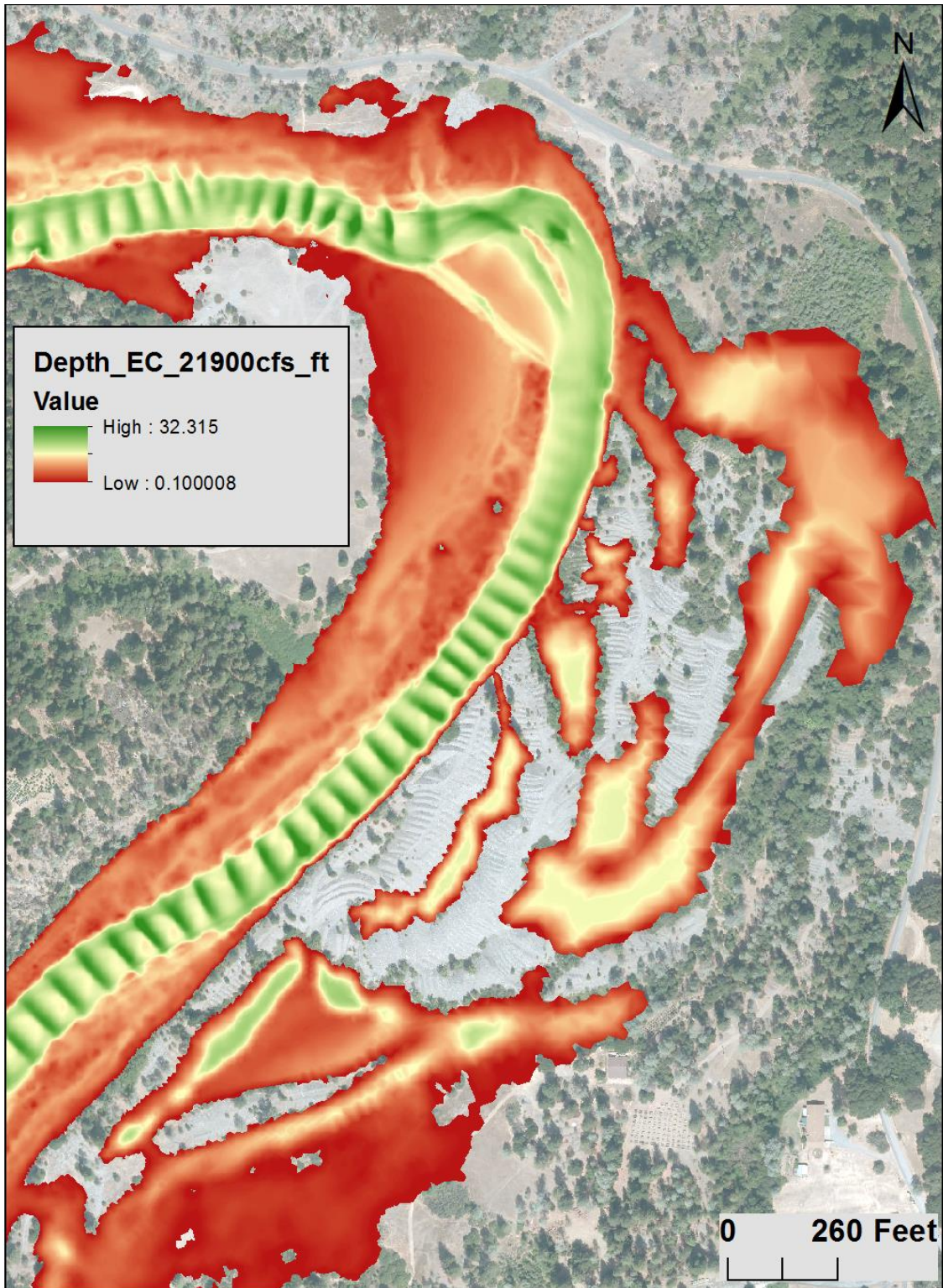


FIGURE 25. EXISTING CONDITIONS MODELED WATER DEPTH AT 21900 CFS. THE PERIODIC VARIATIONS IN DEPTH IN THE MAIN CHANNEL INDICATE NUMERICAL INSTABILITY. THIS MODEL RUN WILL HAVE TO BE RE-DONE WITH A SHORTER TIMESTEP IN THE FUTURE.

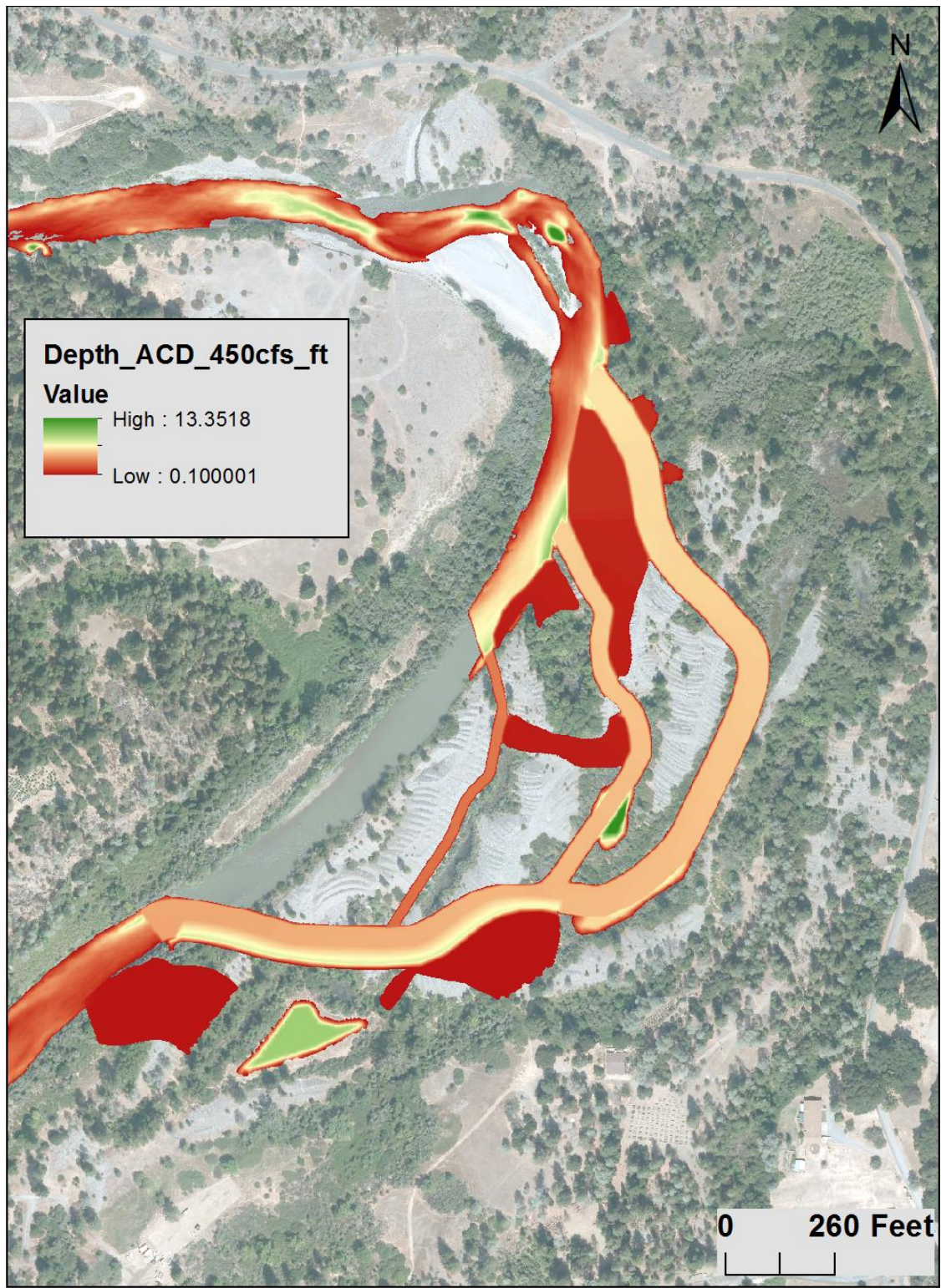


FIGURE 26. ACD (ALT 1) MODELED WATER DEPTH AT 450 CFS

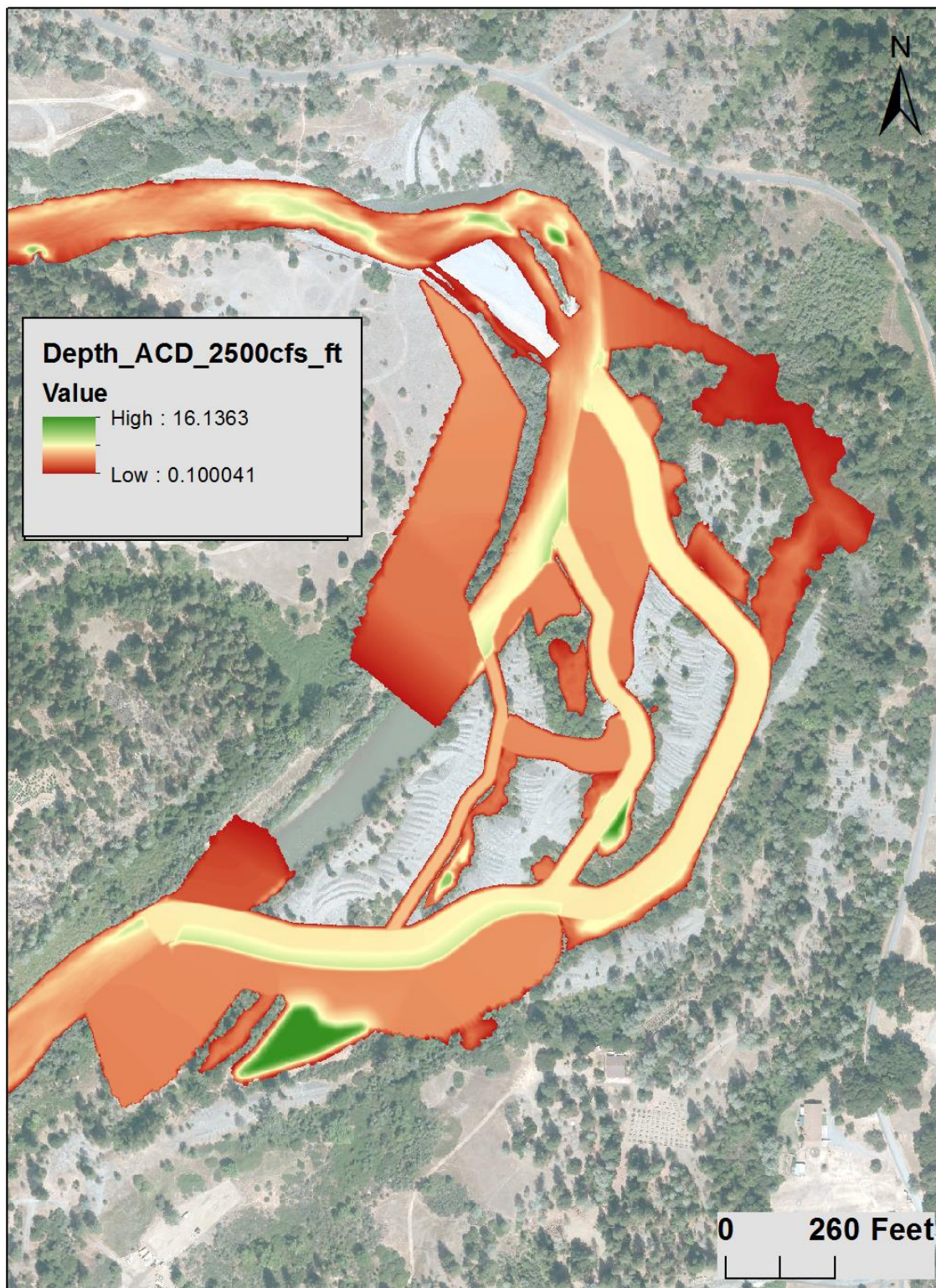


FIGURE 27. ACD (ALT 1) MODELED WATER DEPTH AT 2500 CFS

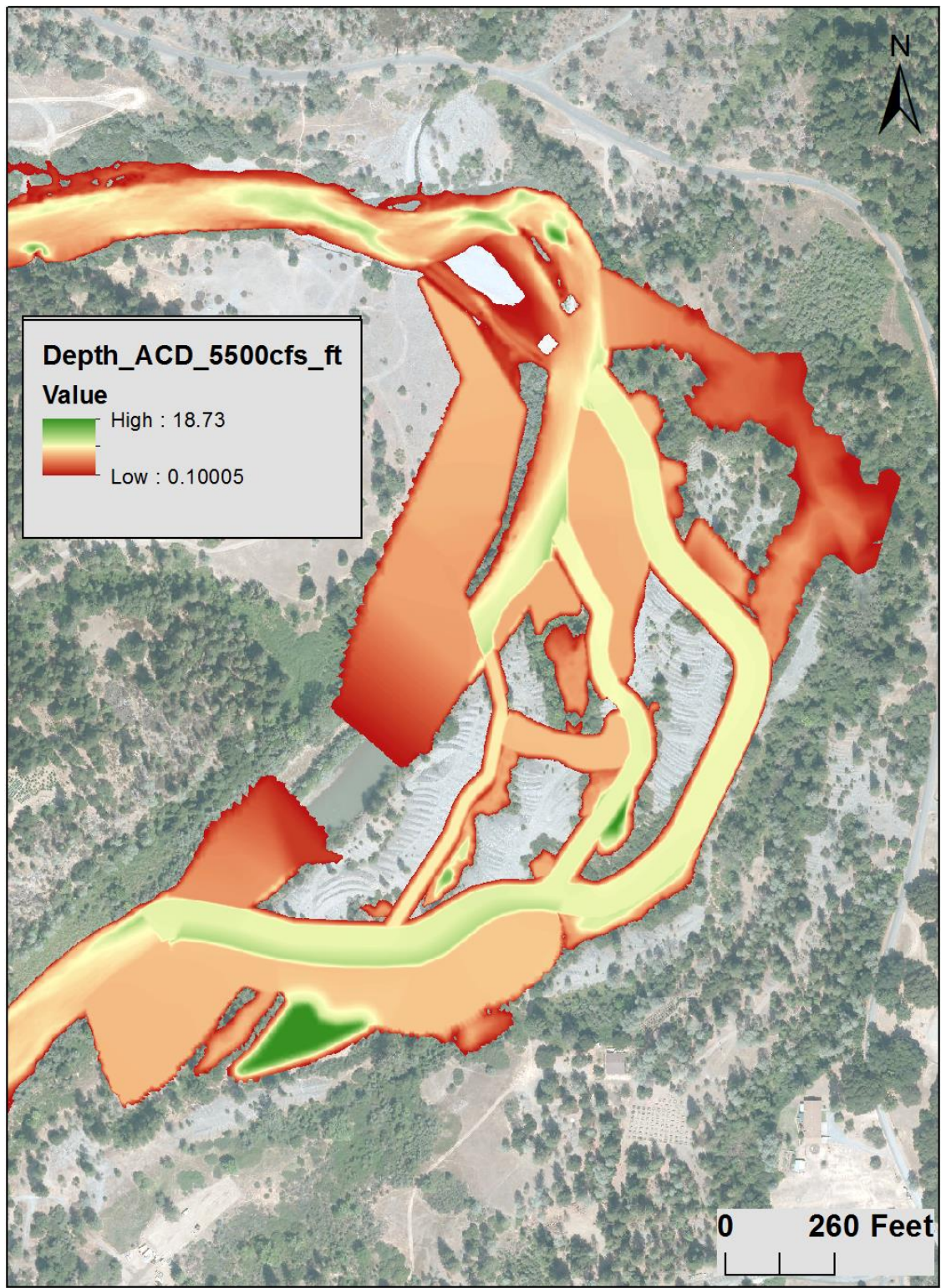


FIGURE 28. ACD (ALT 1) MODELED WATER DEPTH AT 5500 CFS

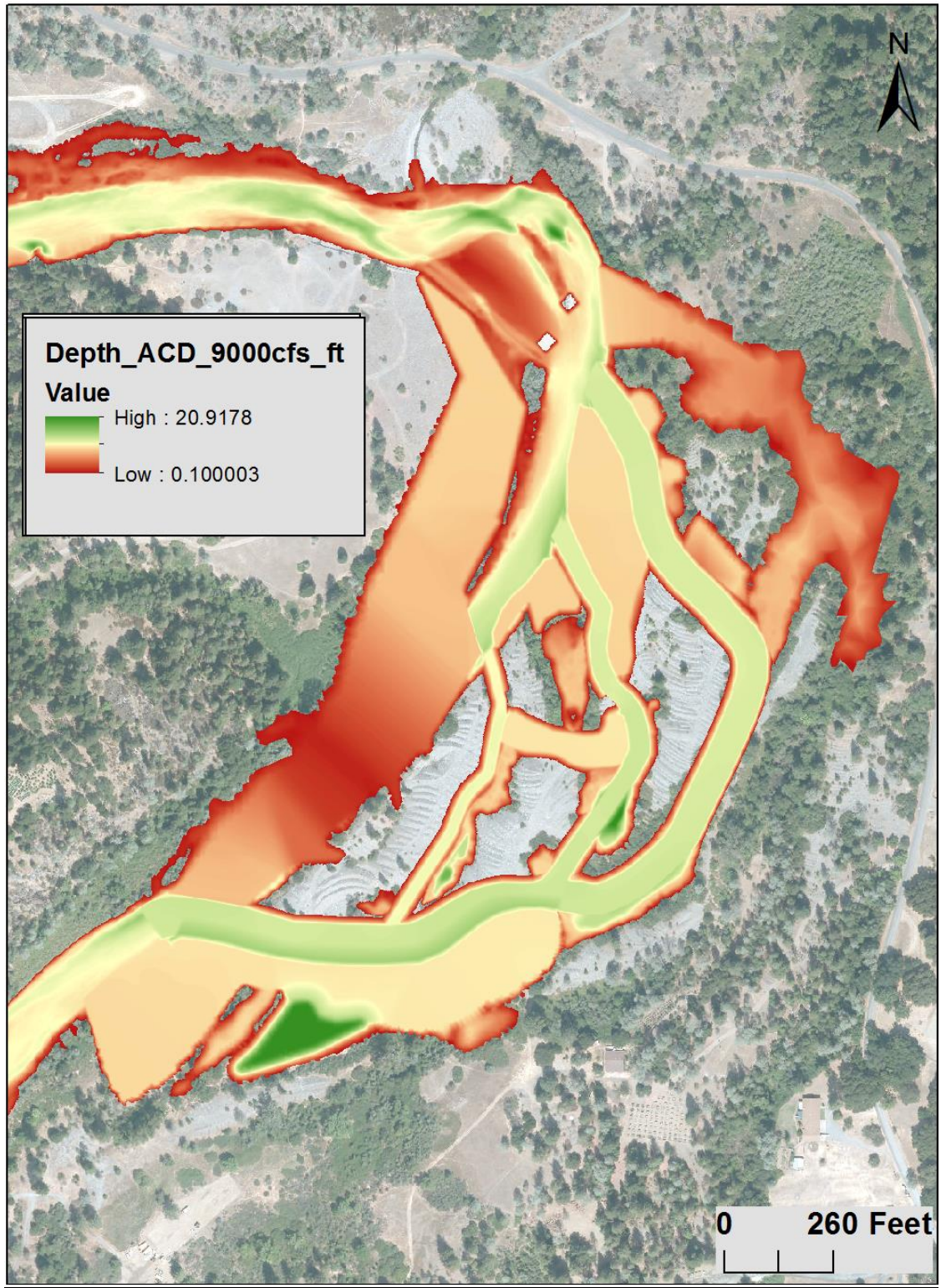


FIGURE 29. ACD (ALT 1) MODELED WATER DEPTH AT 9000 CFS

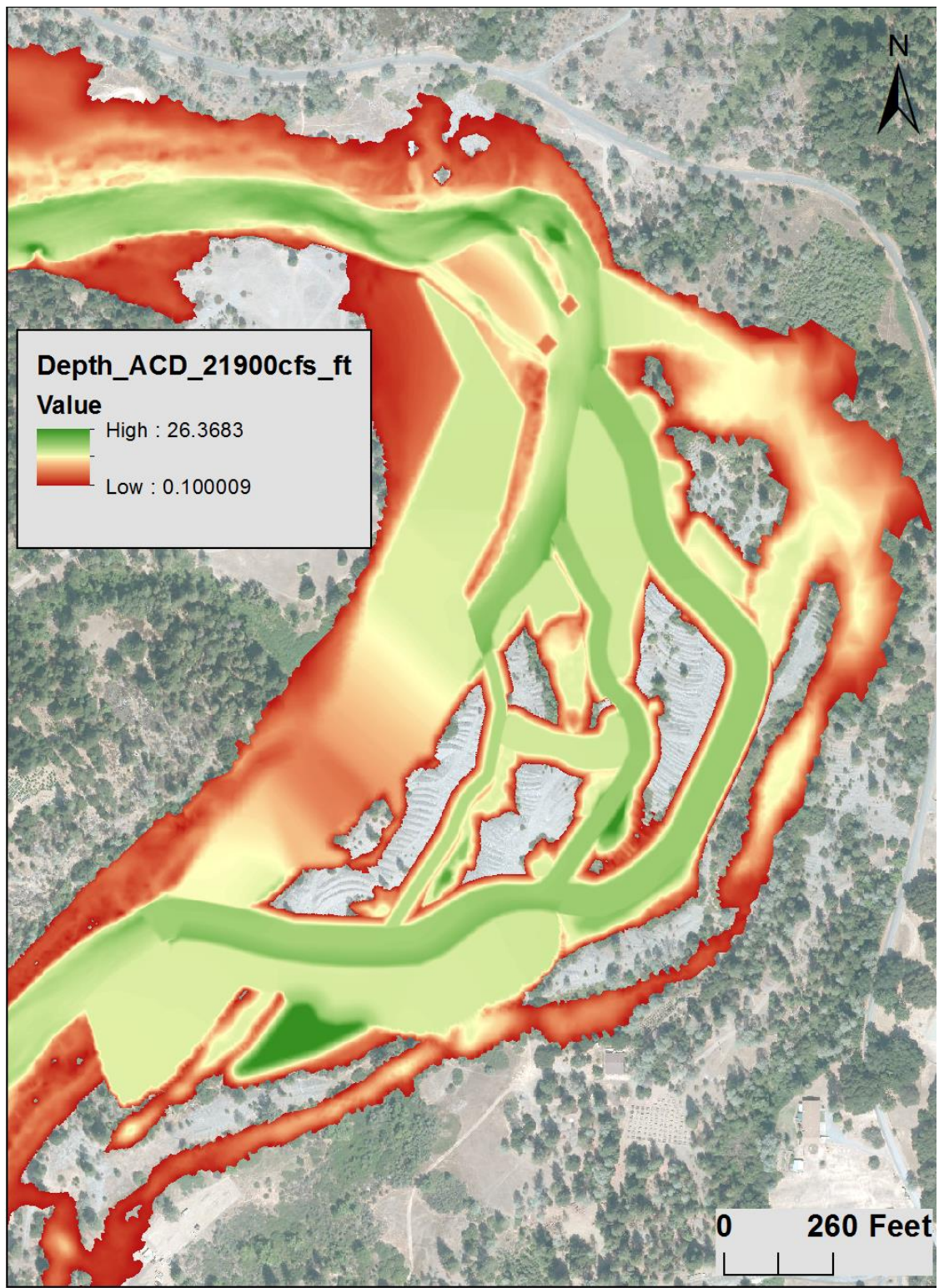


FIGURE 30. ACD (ALT 1) MODELED WATER DEPTH AT 21900 CFS

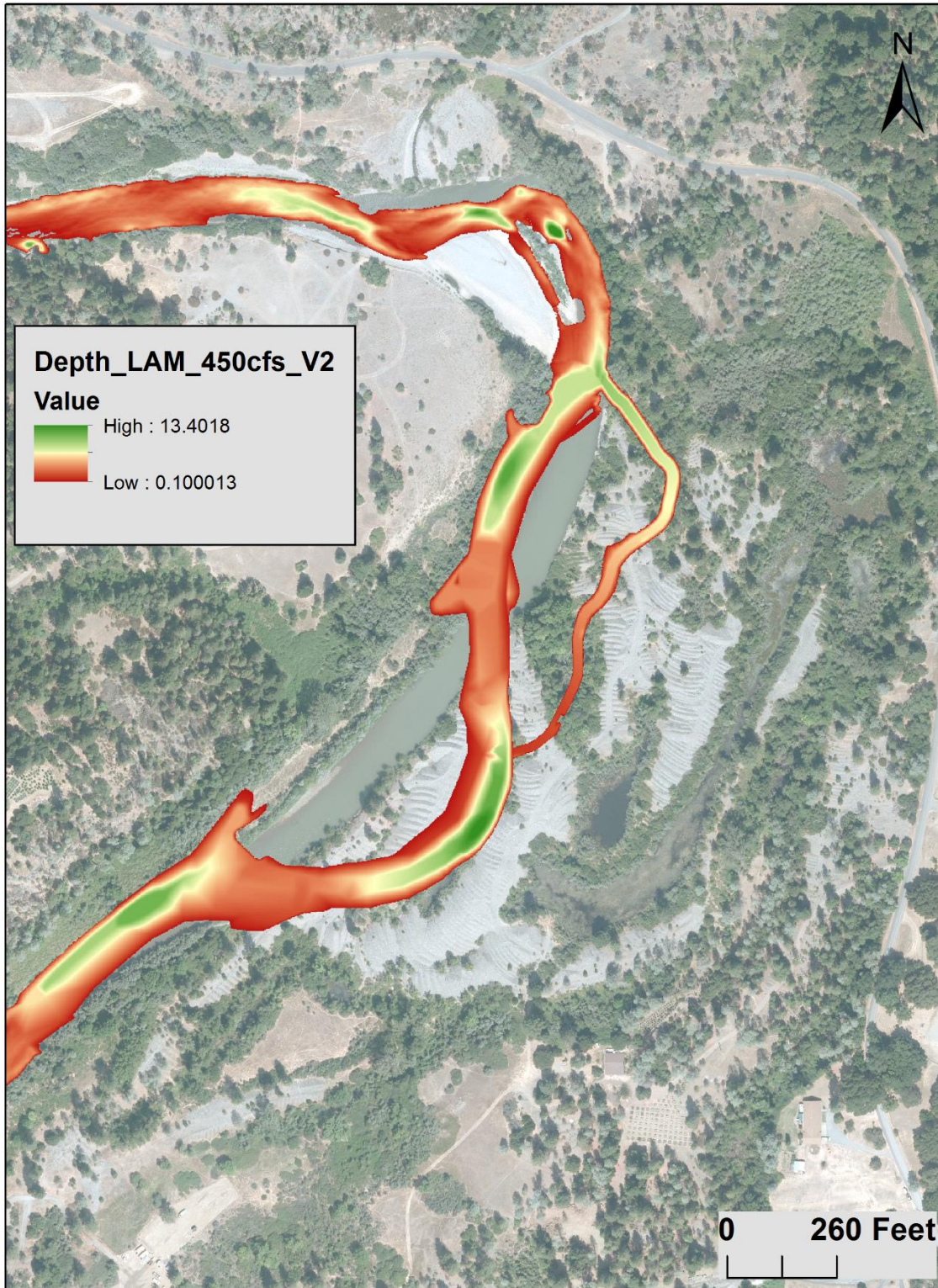


FIGURE 31. LAM (ALT 2) MODELED WATER DEPTH AT 450 CFS

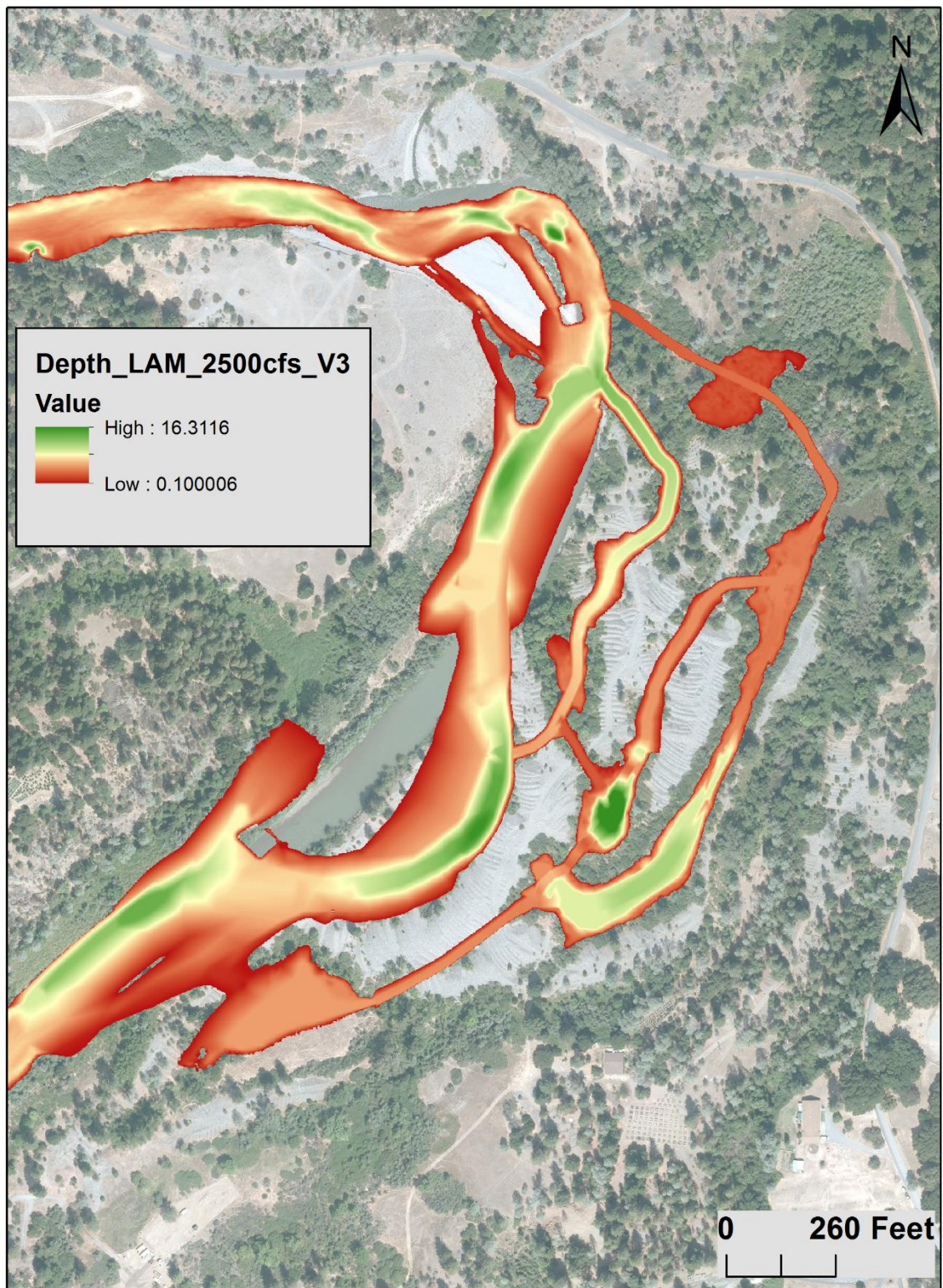


FIGURE 32. LAM (ALT 2) MODELED WATER DEPTH AT 2500 CFS

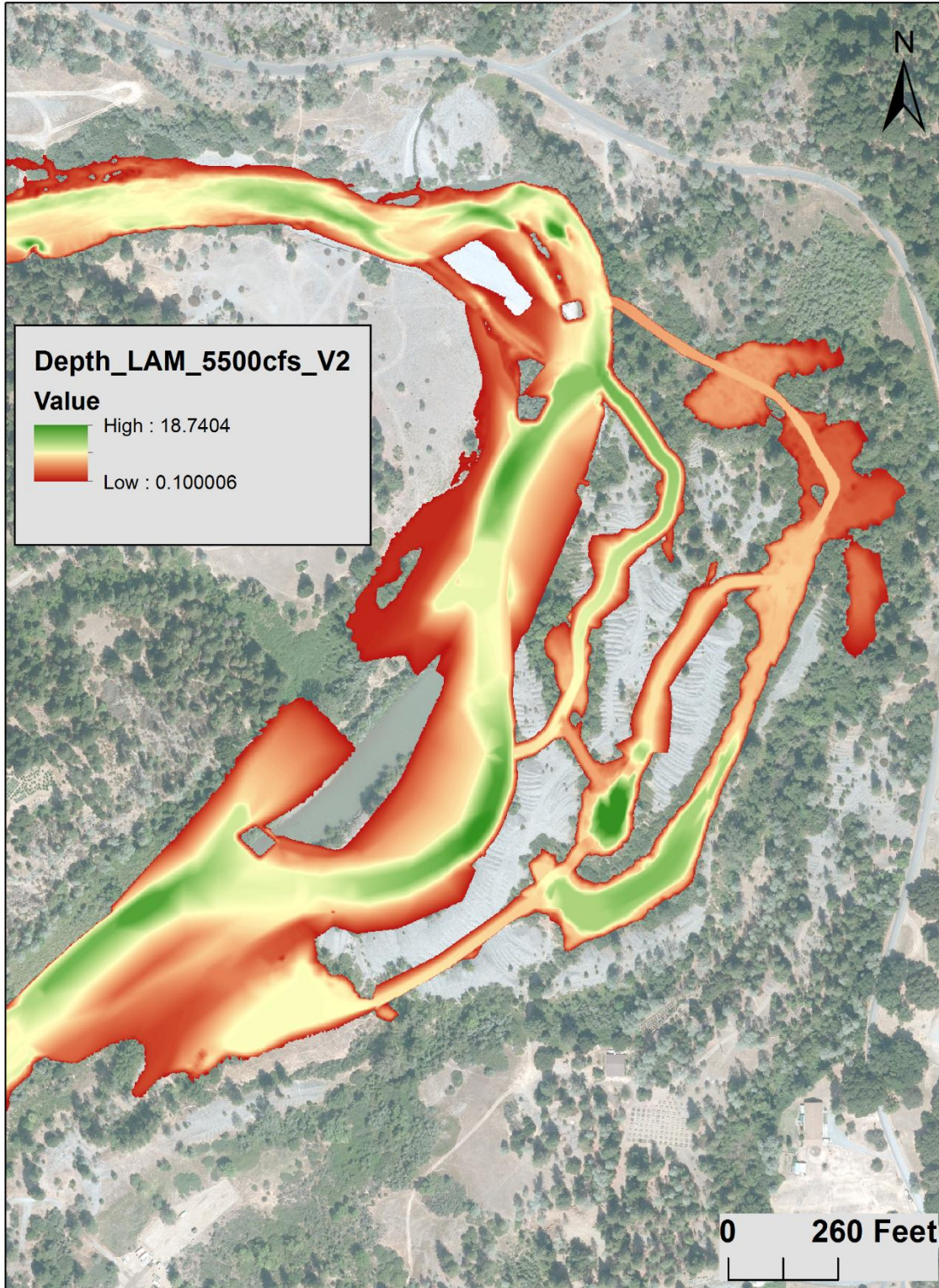


FIGURE 33. LAM (ALT 2) MODELED WATER DEPTH AT 5500 CFS

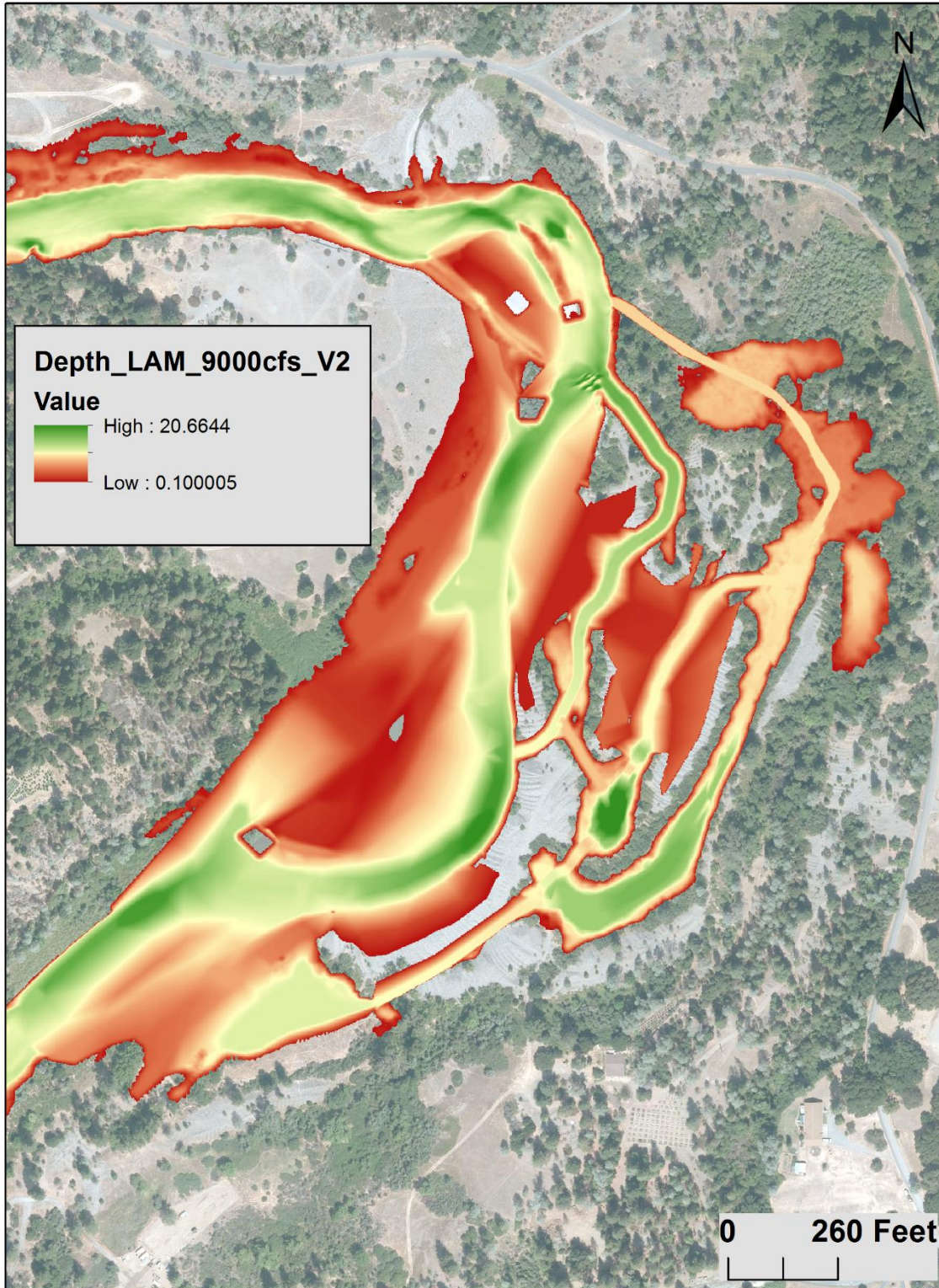


FIGURE 34. LAM (ALT 2) MODELED WATER DEPTH AT 9000 CFS

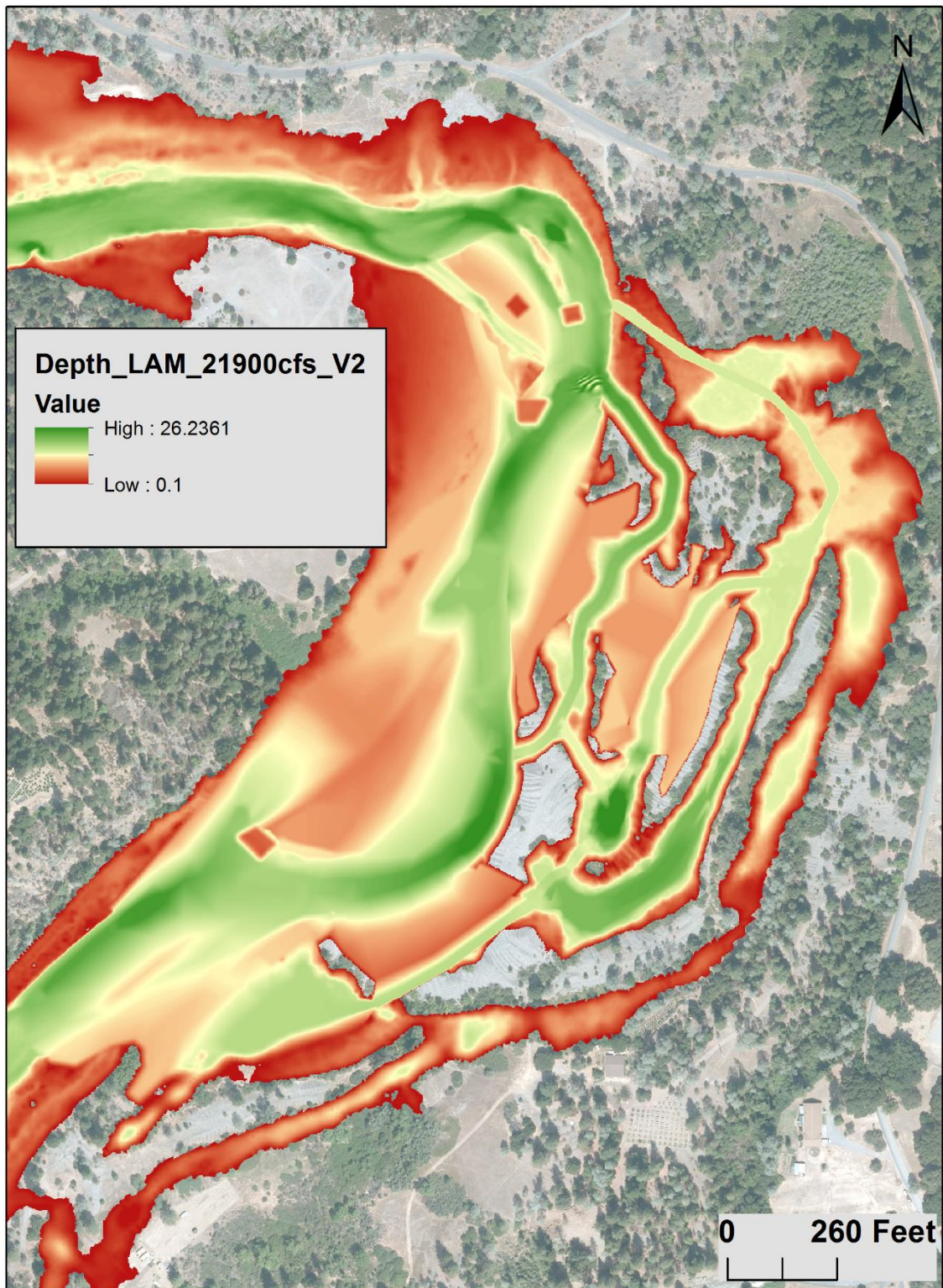


FIGURE 35. LAM (ALT 2) MODELED WATER DEPTH AT 21900 CFS

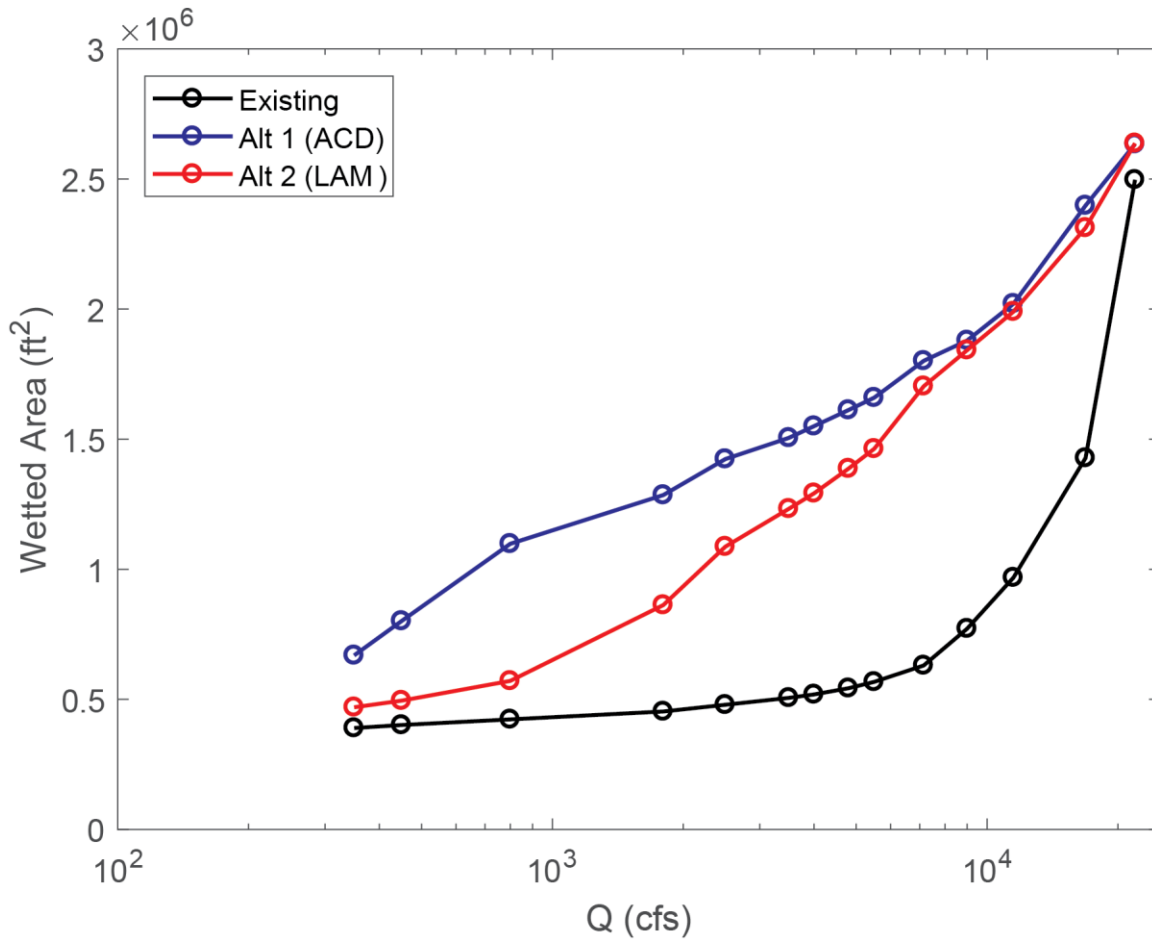


FIGURE 36. THE TOTAL WETTED AREA FOR EACH CONDITION AT EACH MODELED FLOW.

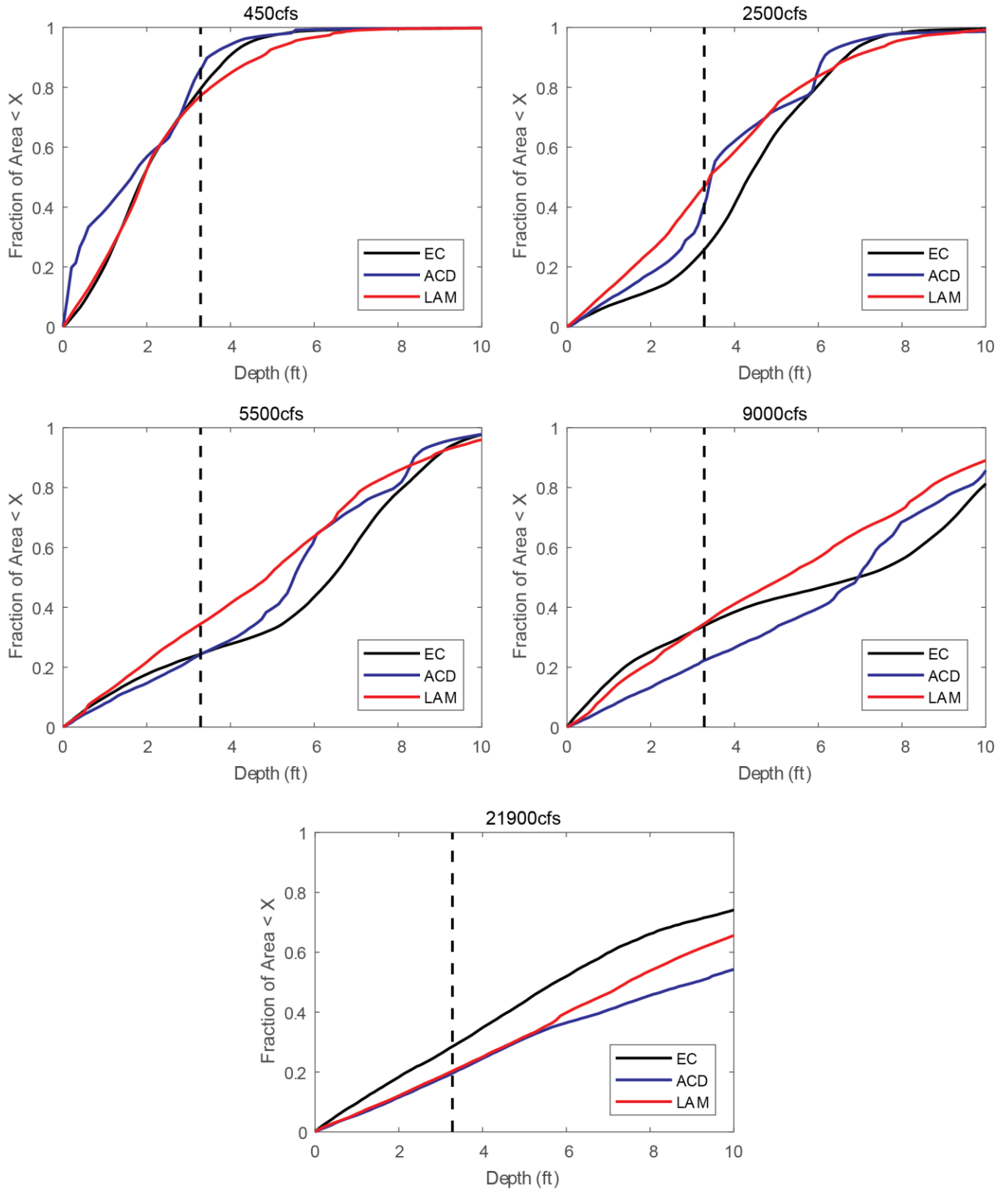


FIGURE 37. AREA DISTRIBUTIONS OF WATER DEPTH FOR THE THREE CONDITIONS AT EACH FLOW. THE VERTICAL DASHED BLACK LINE IS THE REARING DEPTH THRESHOLD FOR CHINOOK PRESMOLT (1 M OR 3.3 FT).

TABLE 6. WETTED AREA ESTIMATES FOR EACH BASED ON SRH HYDRAULIC MODELING. AREA INCREASE FACTOR IS DESIGN AREA / EXISTING AREA.

Flow (cfs)	Existing (ft ²)	Alt 1 – ACD (ft ²)	ACD Area Increase Factor	Alt 2 – LAM (ft ²)	LAM Area Increase Factor
350	389832.8	669128.7	1.7	469630.3	1.2
450	401496.5	801197.6	2.0	495116.6	1.2
800	423067.0	1097853.1	2.6	571019.5	1.3
1800	453426.7	1285303.7	2.8	862530.2	1.9
2500	479286.6	1423544.2	3.0	1086901.3	2.3
3500	505805.2	1505056.7	3.0	1232509.1	2.4
4000	519022.0	1550022.6	3.0	1292016.3	2.5
4800	542804.1	1611937.8	3.0	1386847.4	2.6
5500	567309.7	1659474.9	2.9	1462937.8	2.6
7150	630373.2	1801002.1	2.9	1703362.4	2.7
9000	771863.2	1879209.1	2.4	1842251.3	2.4
11500	967942.4	2020448.4	2.1	1990062.6	2.1
16850	1427605.2	2397922.8	1.7	2312141.3	1.6
21900	2496962.5	2634223.9	1.1	2636969.2	1.1

Shields Stress

Shields stress is rough measure of a river’s sediment transport capacity for a given grain size. Figure 38 shows Shields stress computed for 1 mm sand for the ACD model at 2500 cfs. The figure shows that the Shields stress is uniformly above the transport threshold (plotted in yellow, $\Theta > 0.05$) for all three of the anastomosing channels, indicating that if sand is available for transport from upstream at this flow (and higher flows), the channels in the design should be able to transport it. There is a strong gradient in Shields stress at mid-way through IC-5 (where the color changes from yellow to blue) which could indicate a zone of deposition. This area coincides with a widening of the channel upstream of the junction with IC-4B. Whether this presents a problem will be examined further in the next round of the design process.

Figure 39 shows the Shields stress computed for 50 mm gravel for the ACD model at 9000 cfs. The map indicates that shear stresses are too low (blue) to transport 50 mm gravel across most of the site as designed. This is consistent with the overall expected depositional character of the design. The yellow to blue transition at the upstream end of the model indicates decreasing sediment transport capacity at this flow, which is likely to lead to deposition in IC-1 in the vicinity of the area between the inlets to IC-3 and IC-4 with uncertain results. This could result in the formation of a riffle that would raise water surface elevation at the entrance to IC-3 and increase water velocity at the entrances to IC-4 and IC-2A or it could result in deposition within the smaller channels. This would not necessarily result in plugging of the channels because the water has to go somewhere. The three anastomosing channels are bordered by high tailings pile, so they form the most likely flow path through the side channel complex even if deposition occurs. The risk in this situation is that the channel resumes its current flow path where RF-1 is to be constructed. This risk should be considered further at later stages in the design process. If this outcome can be prevented, widespread deposition within the anastomosing channel complex is likely to lead to very dynamic conditions.

Floodplain Connectivity

The floodplain connectivity metric is a flow duration weighted average floodplain width (described above) averaged over several flows. The computed values for the existing conditions, ACD, and LAM conditions are given in Table 7. Both designs increase floodplain connectivity by huge amounts. The ACD yields a nearly 100-fold increase of W_j over existing conditions. The LAM increase over existing conditions is nearly 30 times.

TABLE 7. THE FLOODPLAIN CONNECTIVITY METRIC W_j COMPUTED FOR EACH CONDITION

Existing Conditions (ft)	Alt 1 – ACD (ft)	Alt 2 – ACD (ft)
3.7	363.0	100.1

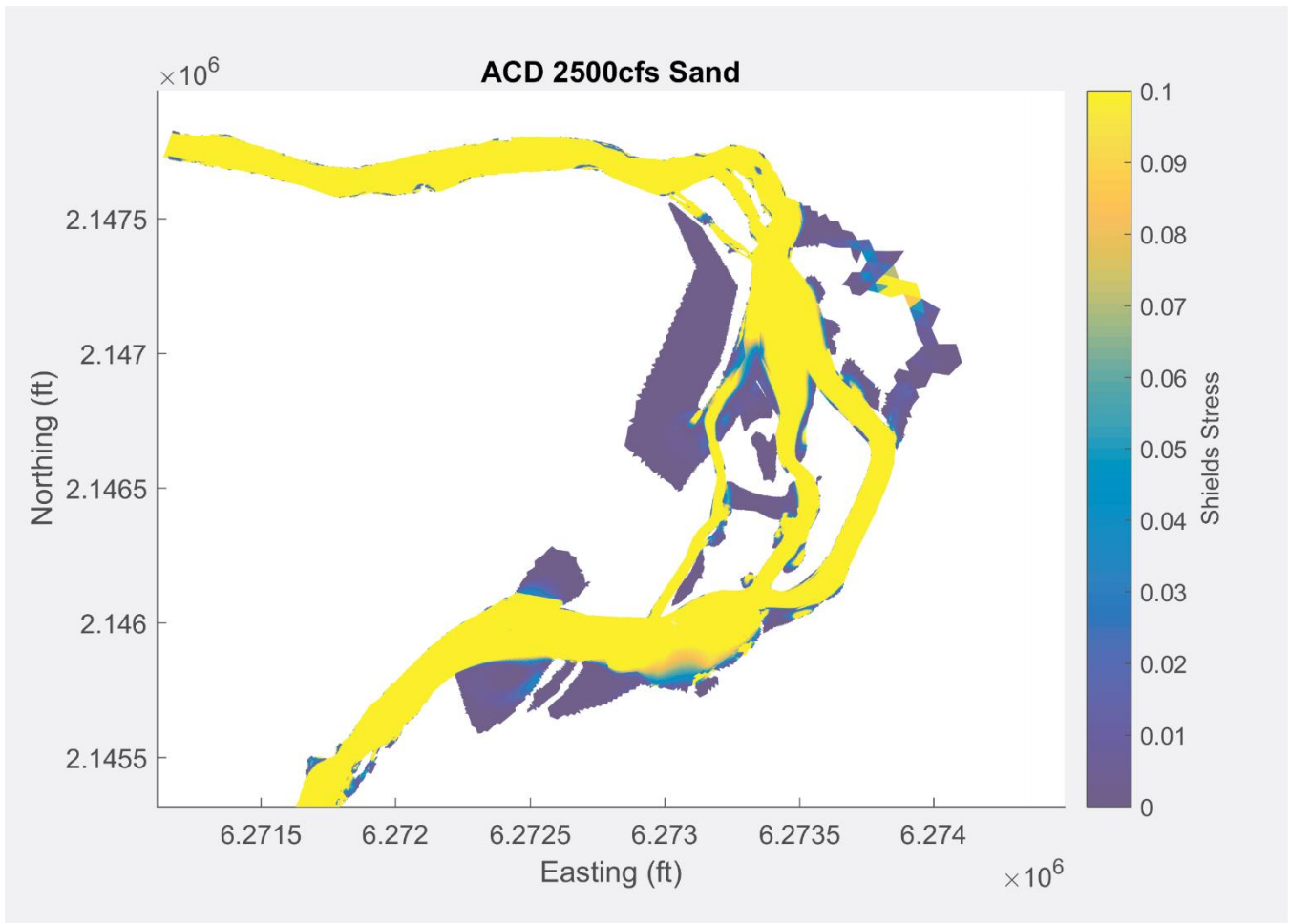


FIGURE 38. ACD MODELED SHIELDS STRESS FOR 1 MM SAND AT 2500 CFS

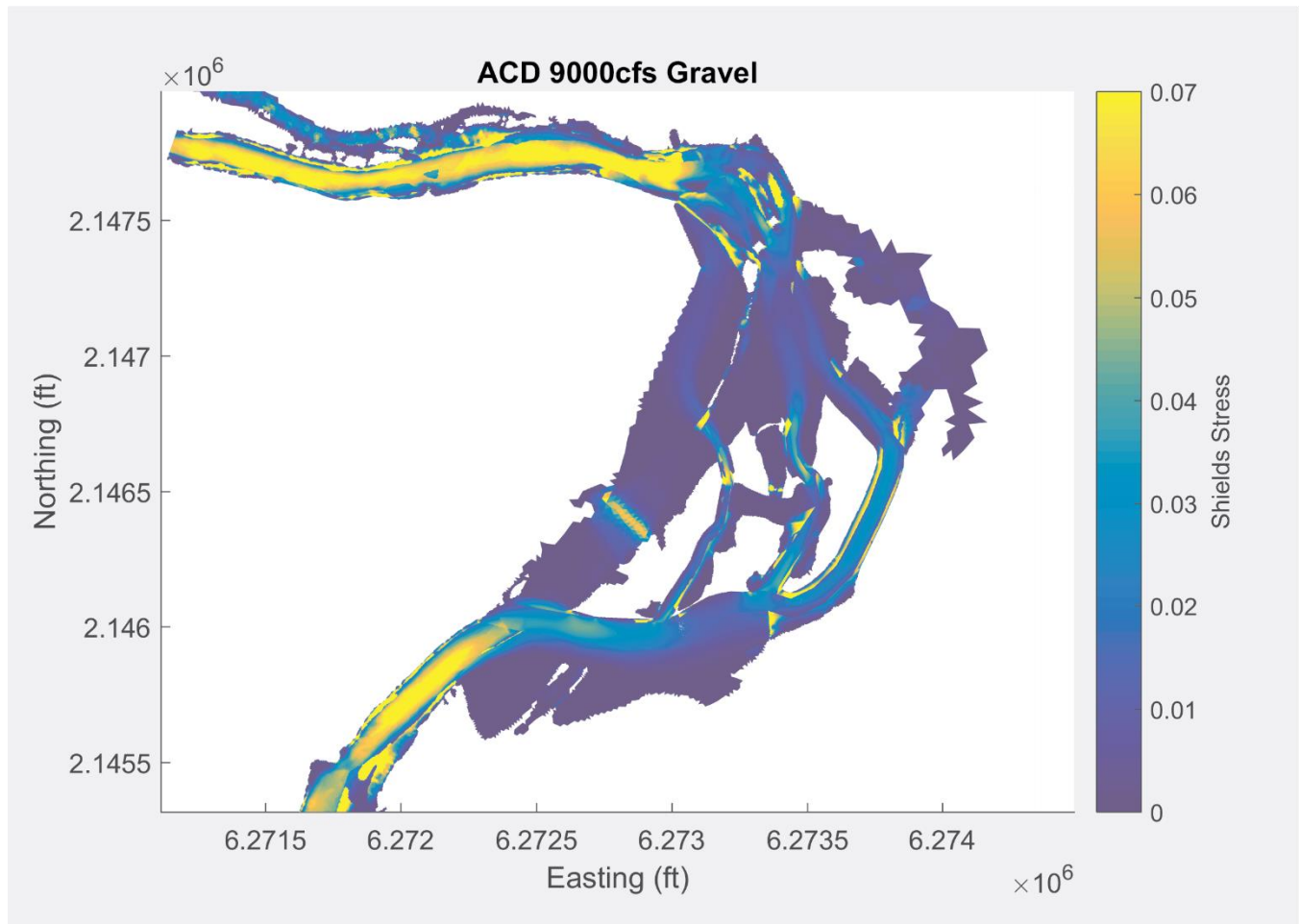


FIGURE 39. ACD MODELED SHIELDS STRESS FOR 50 MM GRAVEL AT 9000 CFS

The computed Shields stress for 1 mm sand at 2500 cfs for the LAM is shown in Figure 40. The Shields stress is well above the transport threshold (yellow) through the main channel and through IC9, indicating that these channels should be capable of transporting sand at this flow and higher flows. Low Shields stresses (blue) in the wetland complex indicate likely deposition. Figure 41 shows the Shields stress map for the LAM for 50 mm gravel at 9000 cfs. The main channel is mostly below or near the gravel transport threshold (the threshold is approximately light blue to greenish yellow, 0.03 – 0.05). IC9 and the wetland complex are mostly below the gravel threshold (darker blues). The predominance of low Shields stresses shown in Figure 41 indicates likely widespread deposition. This is likely to lead to complex, dynamic evolution as long as the river does not resume its present course by re-occupying the areas where R3 and R2 will be constructed. Deposition in the constructed channels could lead to avulsions onto the riparian surfaces (R4 – R7) or into the wetland complex. Deposition on the IC5 gravel bar could push the meander bend IC4 into the tailings piles. Any of these consequences of deposition in which the flow did not re-occupy the current flow path would be considered favorable outcomes.

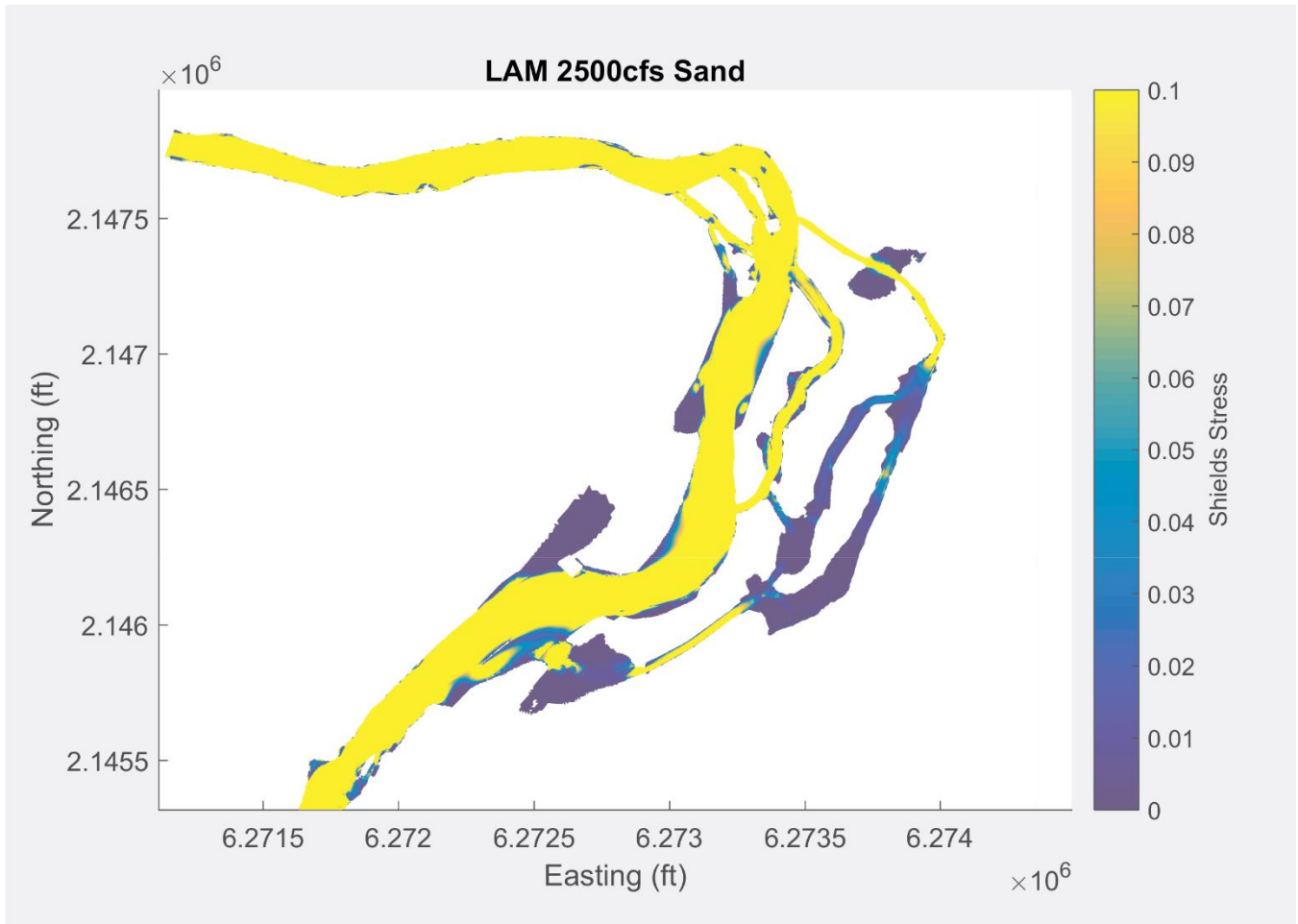


FIGURE 40. LAM MODELED SHIELDS STRESS FOR 1 MM SAND AT 2500 CFS

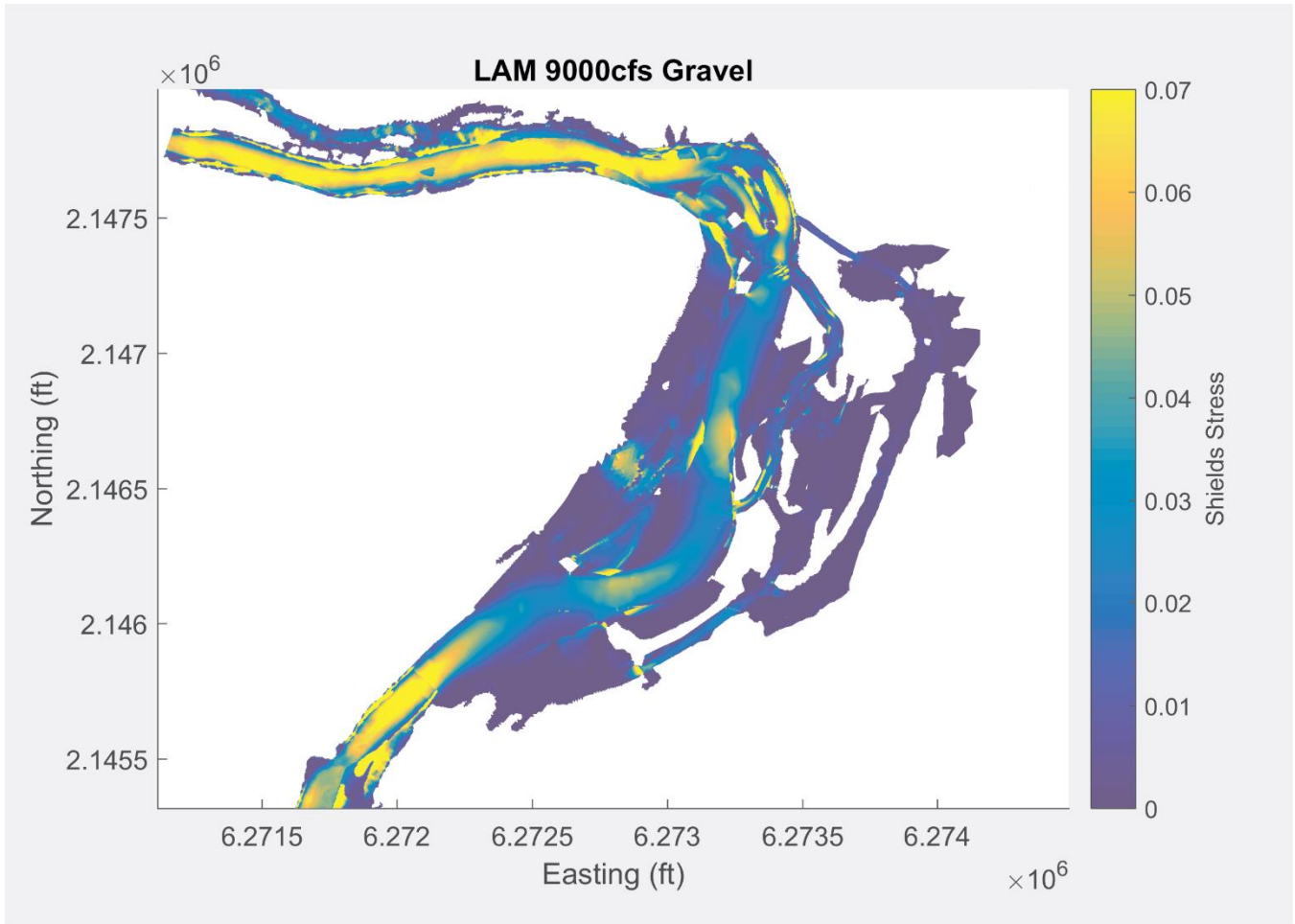


FIGURE 41. LAM MODELED SHIELDS STRESS FOR 50 MM GRAVEL AT 9000 CFS

Salmonid Rearing Habitat Model Results

Existing fry and juvenile rearing habitat was estimated for the Oregon Gulch site using outputs from the SRH-2D hydraulic model results. Depth, velocity, and distance to cover was averaged for each model cell. Weighted useable area (WUA) was calculated in the SRH habitat module using habitat equations developed by the Trinity River habitat team. Design terrains were used for hydraulic and habitat modeling. It is important to note, that due to time constraints, cover was not estimated or incorporated into the design alternative hydraulic runs.

Therefore WUA amounts for design conditions are underestimated.

The results for the two Oregon Gulch existing conditions two 30% design models are shown in Figure 42 and presented in tabular form in Table 8. Both designs increase available habitat across the range of flows up to 16,850 cfs. The ACD more than triples available rearing habitat during typical winter base flows. The largest increases (~700%) occur between 1800 and 4800 cfs. The LAM design demonstrates a ~80% increase in WUA habitat around typical winter baseflows (not including addition of in-water cover). The largest habitat increases occur at flows between 2500 and 5500 cfs (>600%). The existing conditions at Oregon Gulch exhibit one of the worst flow-habitat relationships documented on the Trinity. The habitat dip extends to above 8000 cfs. The two 30% design alternatives remove the dip, though the he ACD performs much better than the LAM between 450-2500 cfs because of the three flowing channels at low flow and multiple surfaces that inundate at 450 cfs.

There are a number of changes/tweaks still to be made to the LAM design surface. Side channel discharge at 450 cfs is estimated to be 25 cfs. 10% of the flow is favored, so this will be adjusted. Also the R4, R5, R6, and R7 riparian enhancement zones do not inundate until about 7150 cfs. These will likely be lowered to ~4500 cfs inundation pending discussions with riparian specialists. If the LAM were chosen as the design to move forward with, opportunities for greater habitat gains between 450 and 1800 cfs will be explored. Potential options include a low flow side channel behind IC2, or increasing conveyance through R-1 to initiate flows through the wetland ponds (W1, W2, W3) at an earlier discharge. Activating the wetland ponds at flows ~800 cfs would create large increases in available habitat during the critical rearing period.

Flow (cfs)	Existing	Alt 1 - ACD	ACD Area Increase Factor	Alt 2 - LAM	LAM Area Increase Factor
350	122450.2	323592.8	2.6	194589.9	1.6
450	116958.8	368835.1	3.2	196668.9	1.7
800	102254.0	503962.7	4.9	206625.3	2.0
1800	74411.9	508414.7	6.8	331455.6	4.5
2500	68477.8	536615.3	7.8	414502.3	6.1
3500	66126.3	513244.8	7.8	447500.0	6.8
4000	67626.7	514030.1	7.6	460402.3	6.8
4800	74022.7	511203.6	6.9	488561.2	6.6
5500	82175.1	505397.9	6.2	516590.9	6.3
7150	104052.1	522530.3	5.0	600598.9	5.8
9000	179506.2	507246.6	2.8	602152.3	3.4
11500	255460.6	536563.7	2.1	598344.4	2.3
16850	409441.9	661686.8	1.6	642192.0	1.6
21900	939708.1	722072.3	0.8	744242.2	0.8

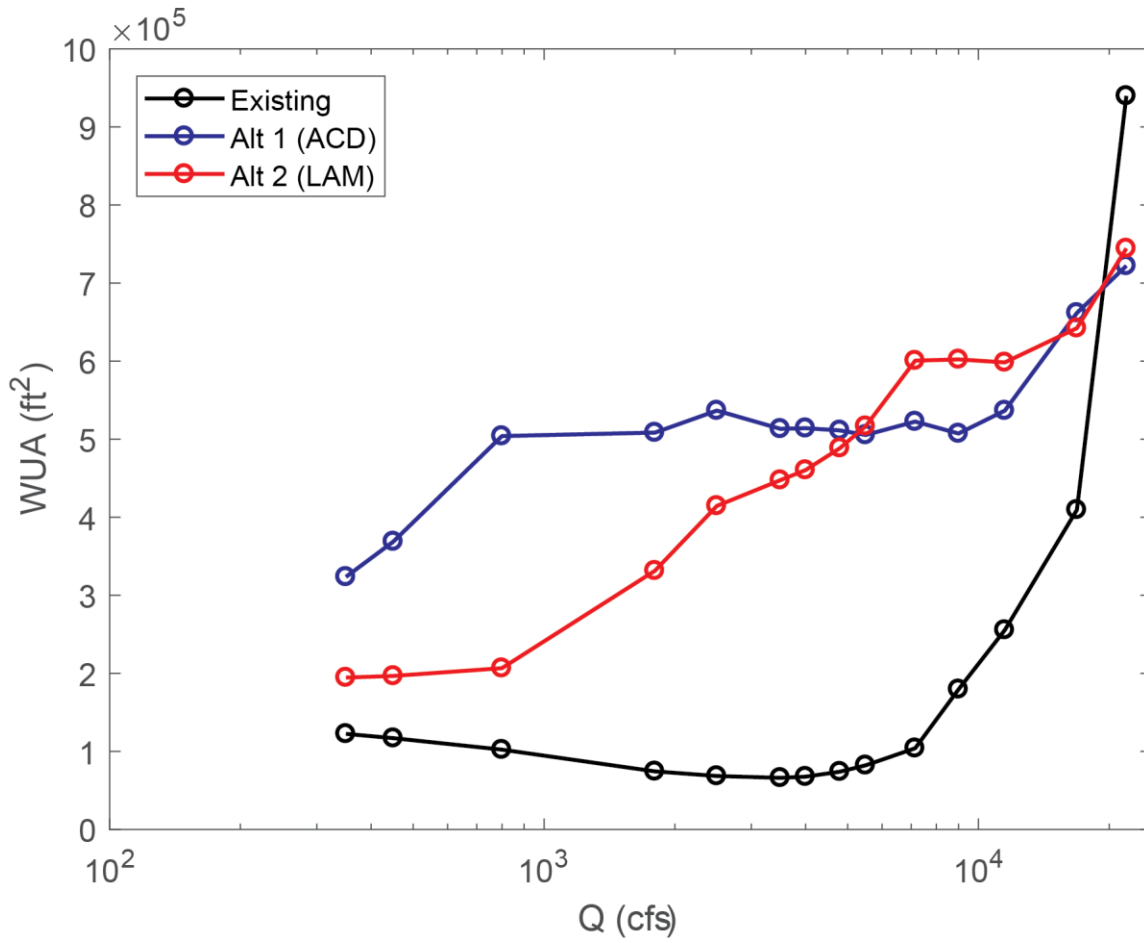


FIGURE 42. WEIGHTED USEABLE AREA (WUA) CALCULATED FOR CHINOOK PRESMOLT PLOTTED FOR EACH MODEL AND DISCHARGE.

TABLE 8. SALMONID PRESMOLT REARING WEIGHTED USABLE AREA ESTIMATES FOR THE ANASTAMOSING CHANNEL (ACD) AND LARGE AMPLITUDE MEANDER (LAM) DESIGNS BASED ON SRH HYDRAULIC MODELING. AREA INCREASE FACTOR IS DESIGN AREA / EXISTING AREA. NOTE: COVER HAS NOT YET BEEN INCLUDED IN THE DESIGN CONDITIONS, THEREFORE WUA FOR DESIGN CONDITIONS IS UNDERESTIMATED.

Flow (cfs)	Existing	Alt 1 - ACD	ACD Area Increase Factor	Alt 2 - LAM	LAM Area Increase Factor
350	122450.2	323592.8	2.6	194589.9	1.6
450	116958.8	368835.1	3.2	196668.9	1.7
800	102254.0	503962.7	4.9	206625.3	2.0
1800	74411.9	508414.7	6.8	331455.6	4.5
2500	68477.8	536615.3	7.8	414502.3	6.1
3500	66126.3	513244.8	7.8	447500.0	6.8
4000	67626.7	514030.1	7.6	460402.3	6.8
4800	74022.7	511203.6	6.9	488561.2	6.6
5500	82175.1	505397.9	6.2	516590.9	6.3
7150	104052.1	522530.3	5.0	600598.9	5.8
9000	179506.2	507246.6	2.8	602152.3	3.4
11500	255460.6	536563.7	2.1	598344.4	2.3
16850	409441.9	661686.8	1.6	642192.0	1.6
21900	939708.1	722072.3	0.8	744242.2	0.8

Engineering Analysis and Level of Effort

Each of the 30% Design Alternatives DTM’s (ALT 1 and ALT 2) surfaces were compared against the Existing Ground DTM surface to evaluate earthwork volume in terms of total cut and fill represented as cubic yards. This engineering analysis is performed using sophisticated software algorithms that compare two surfaces subtracting one from the other to determine the DTM of Difference and is reported as cut/fill quantities. At the 30% conceptual design level, earthwork (cut/fill) volume is used as a metric to determine “Level of Effort” and to evaluate the projects constructability “Costs” without having to use dollars in the equation. Determining an accurate cost of construction at a 30% design level for a river restoration projects can be very problematic and often has a high degree of uncertainty that can cause false positives for management decision makers. Therefore, a group of Designers within the TRRP organization met, discussed this issue, and agreed not to use dollars but rather earthwork volume as the primary metric to determine level of effort. In addition, a unit “Multiplier” was determined for three 4 types of earthwork volume (cut/fill) types to help enhance the level of effort metric to provide a realistic representation of field construction methods. The four multipliers are the following:

- Dry Cut Excavation Unit Multiplier = 1
- Wet Excavation Unit Multiplier = 2
- Dry Fill (Pit Run) Placement Unit Multiplier = 1
- Washed Fill (Processed) Placement Unit Multiplier = 3

The Oregon Gulch 30% Design Alternatives were evaluated using the methodology and metrics described above and the results are presented in the table below:

Alternative Design	Volume Type	Volume Quantity (CY)	Multiplier	Resulting Value
ALT 1 (ACD)	Dry Cut Excavation	346,470 (+)	1	346,470
ALT 1 (ACD)	Wet Cut Excavation	86,617 (+)	2	173,234
ALT 1 (ACD)	Dry Fill (Pit Run)	23,423 (-)	1	23,423
ALT 1 (ACD)	Washed Fill (Processed)	10,038 (-)	3	30,114
	TOTAL (NET) =	399,626		573,241
ALT 2 (LAM)	Dry Cut Excavation	247,252 (+)	1	247,252
ALT 2 (LAM)	Wet Cut Excavation	105,965 (+)	2	211,930
ALT 2 (LAM)	Dry Fill (Pit Run)	30,315 (-)	1	30,315
ALT 2 (LAM)	Washed Fill (Processed)	12,992 (-)	3	38,976
	TOTAL (NET) =	309,910		528,473

End of current version of the draft report. The report will be expanded to include additional information as the design process progresses.

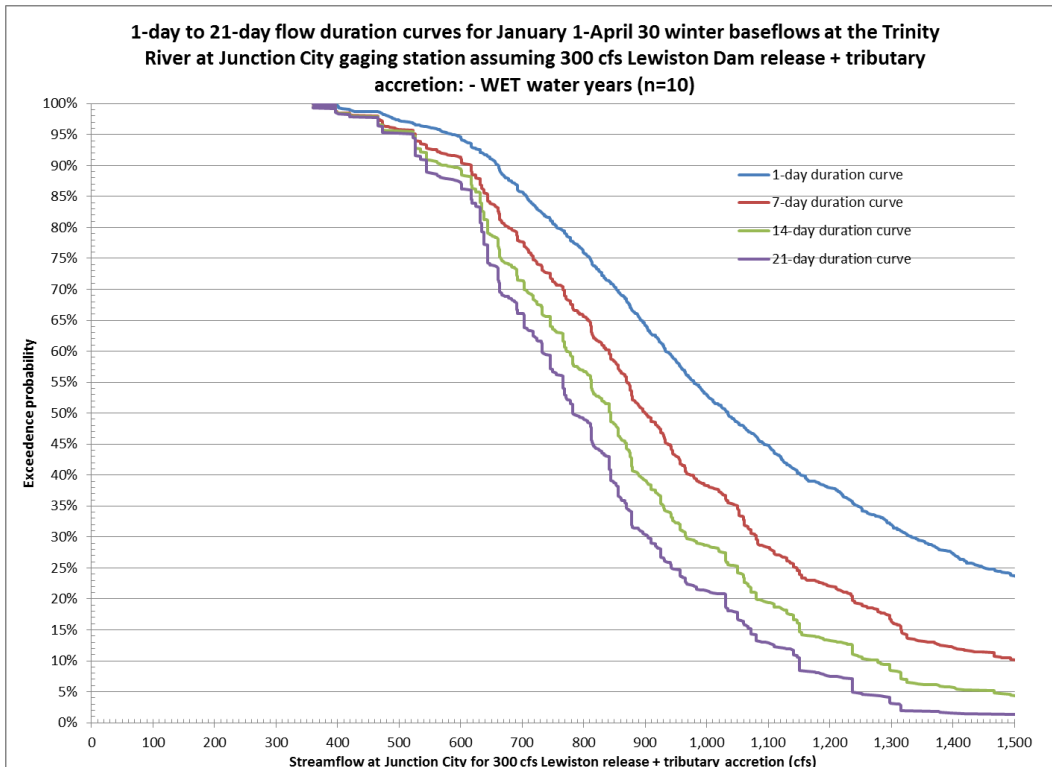
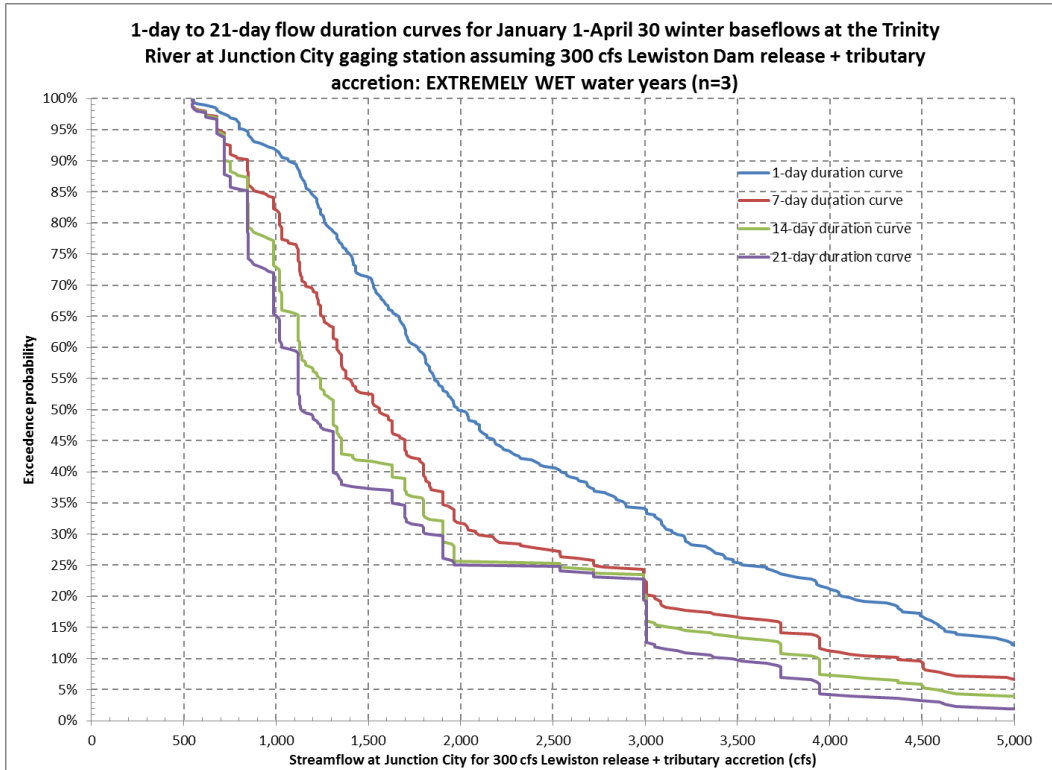
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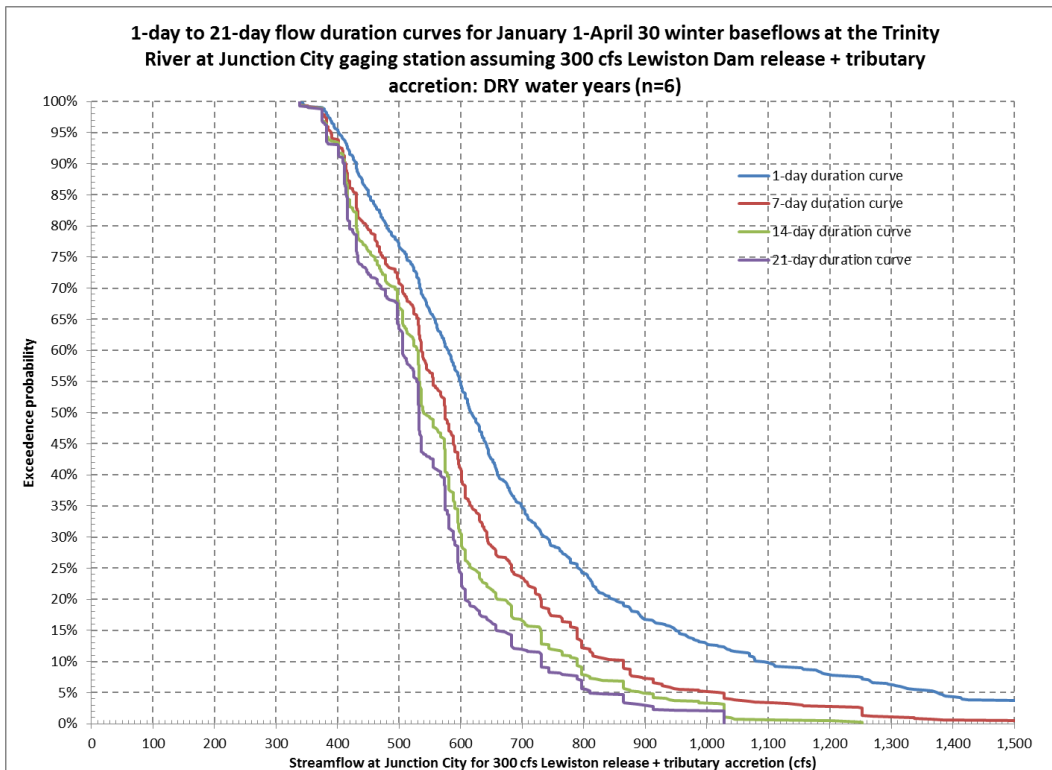
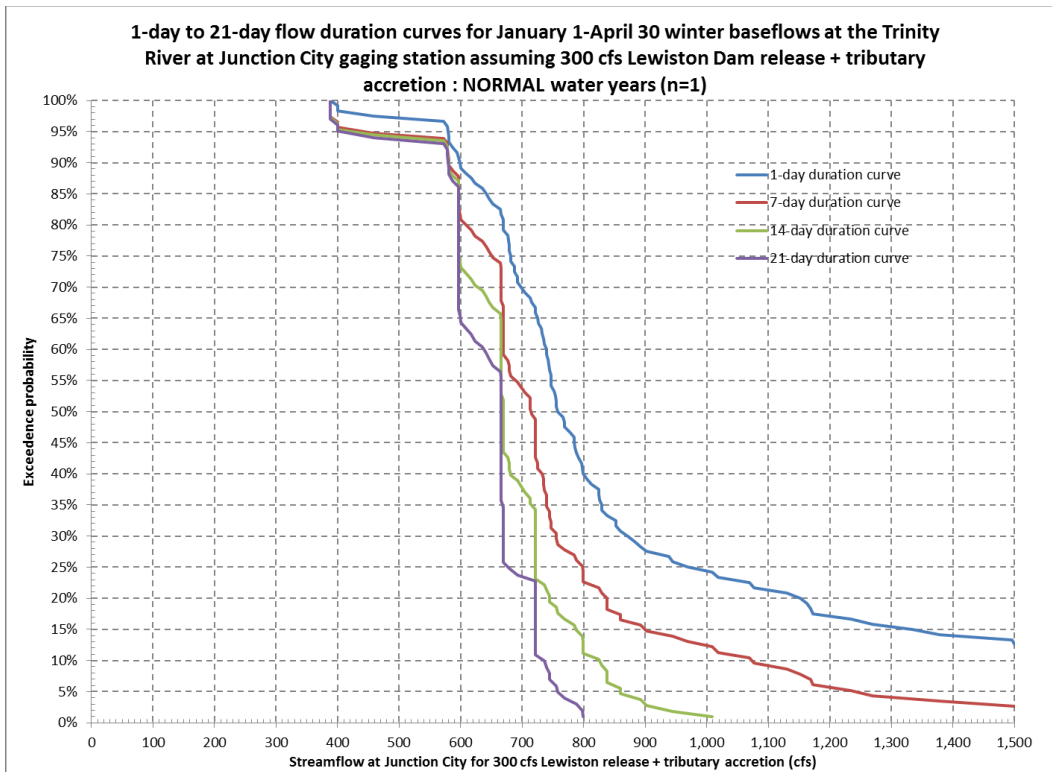
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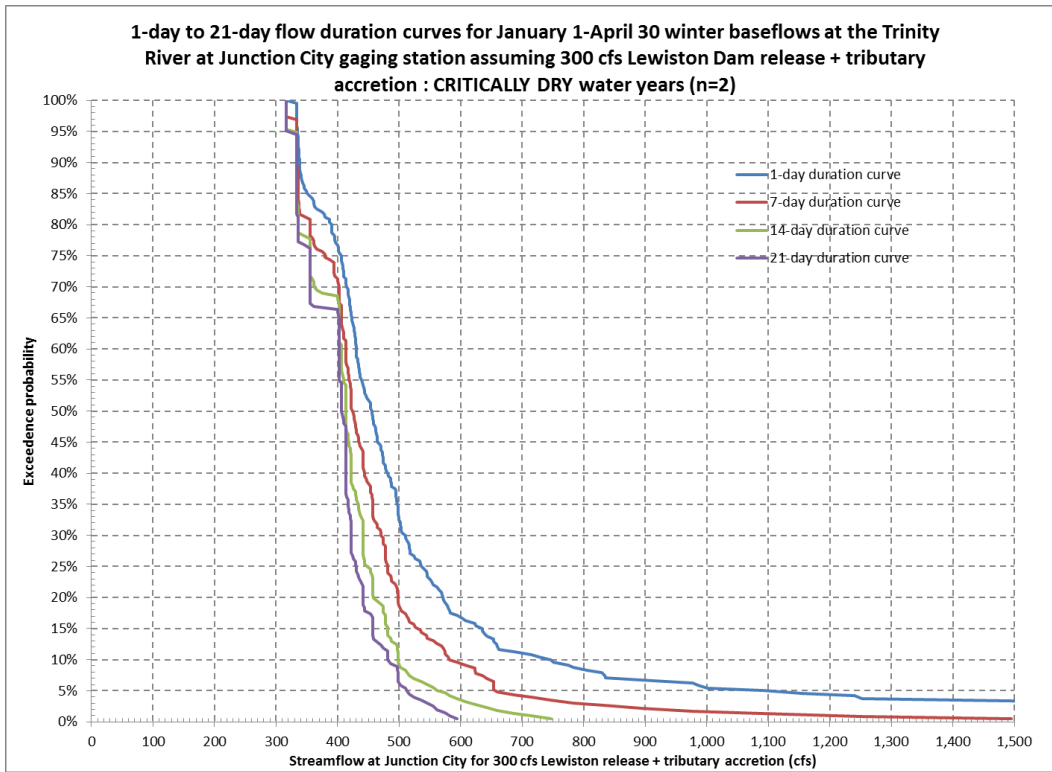
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http://www.westcoast.fisheries.noaa.gov/publications/recovery_planning/salmon_steelhead/domains/southern_oregon_northern_california/SONCC%20Final%20Sept%202014/sonccfinal_ch39_uppertrinityriver.pdf
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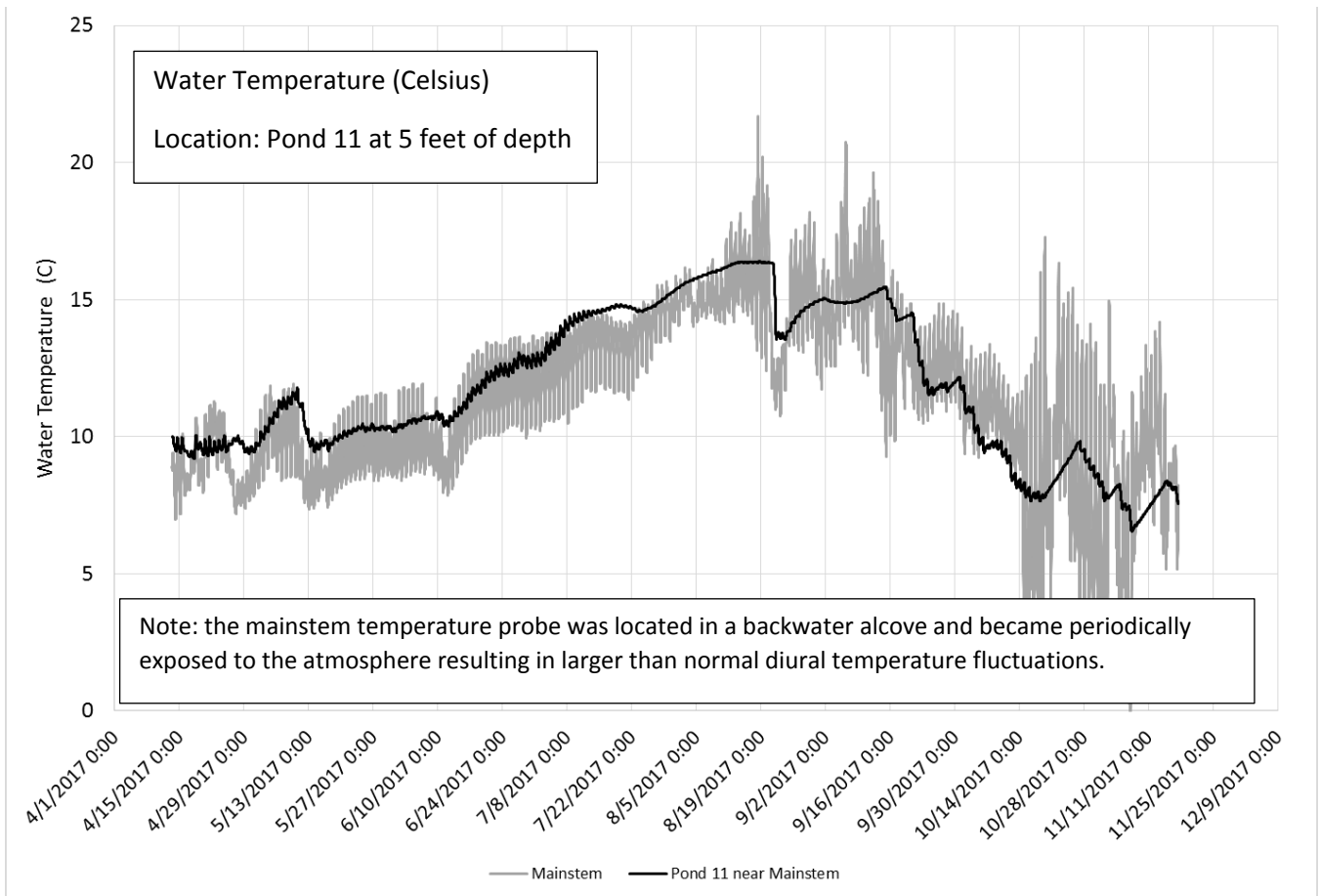
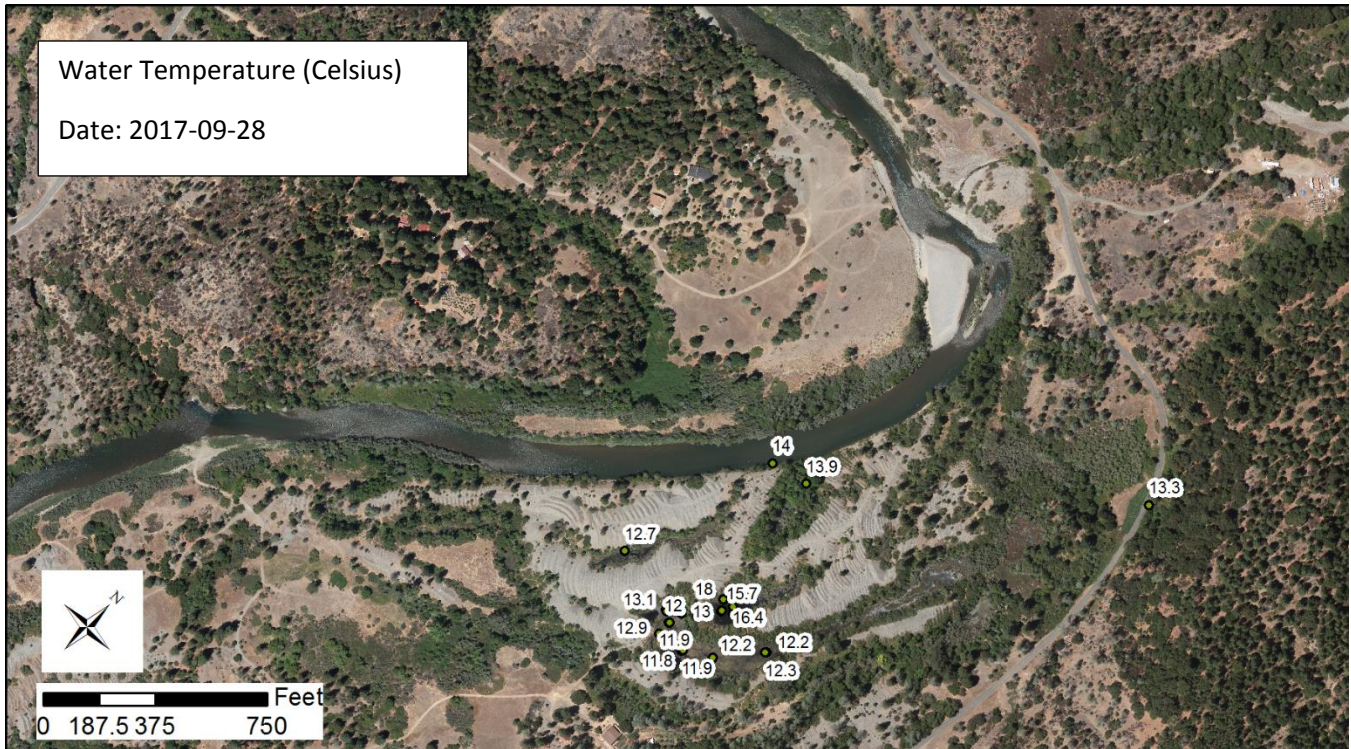
Appendix A: Flow Duration Curves

source: McBain Associates and the Hoopa Valley Tribe



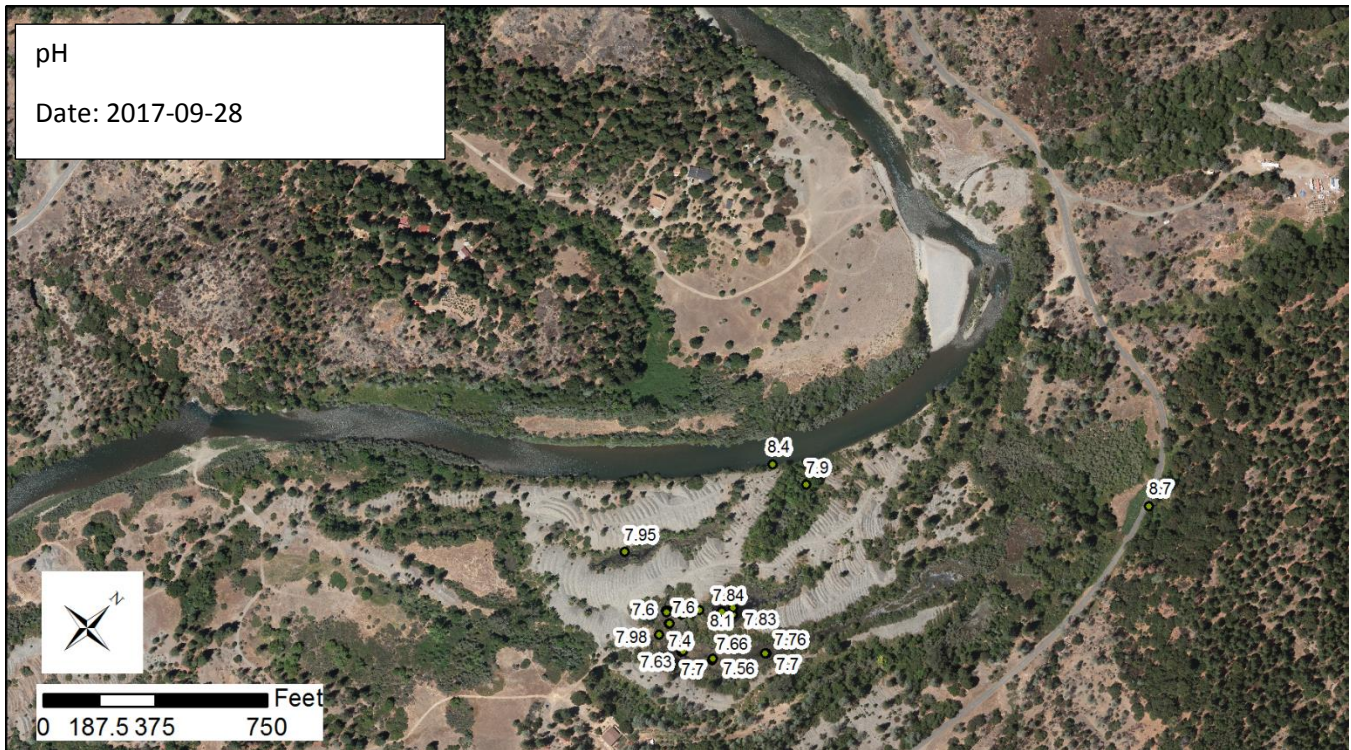






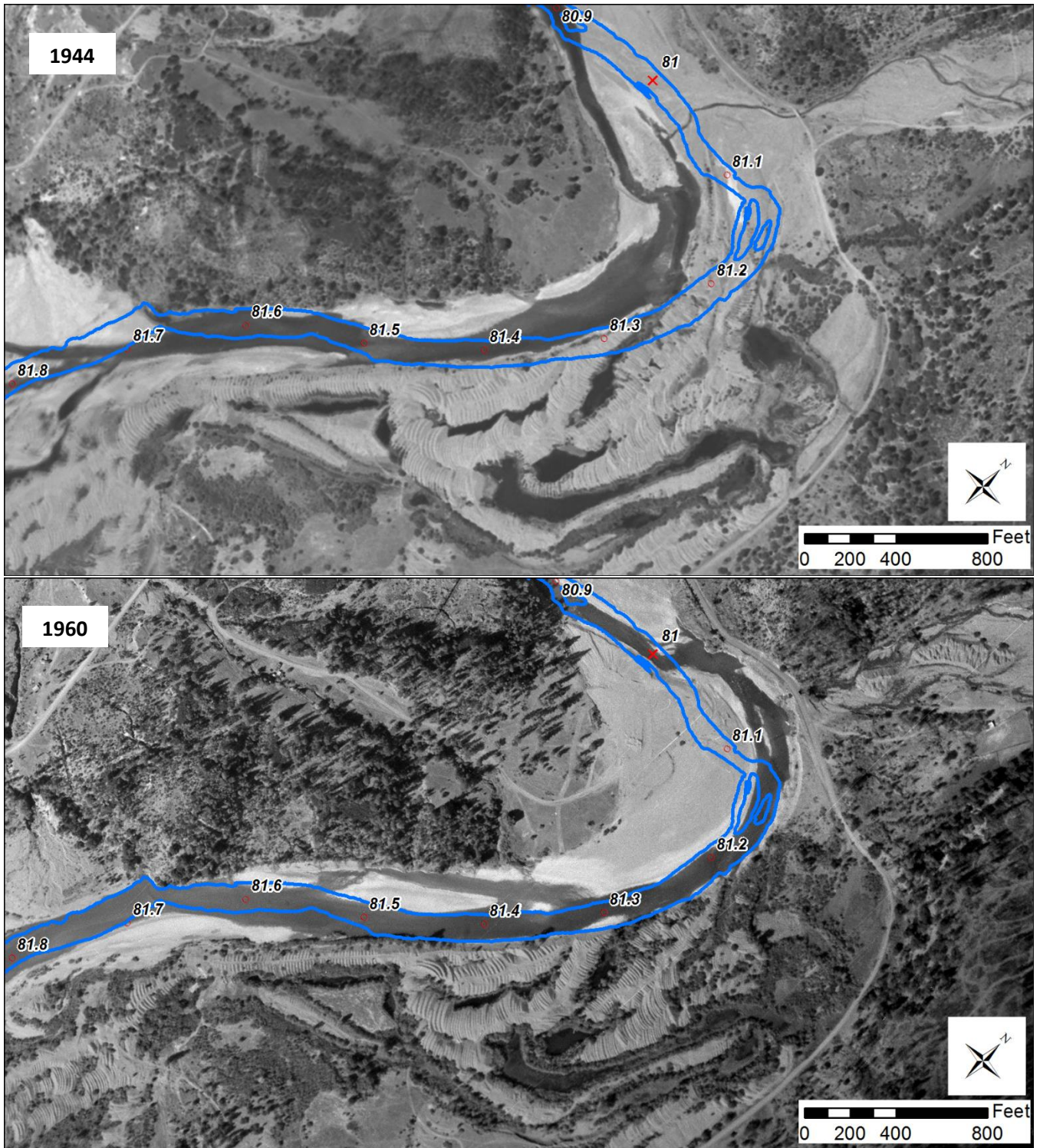


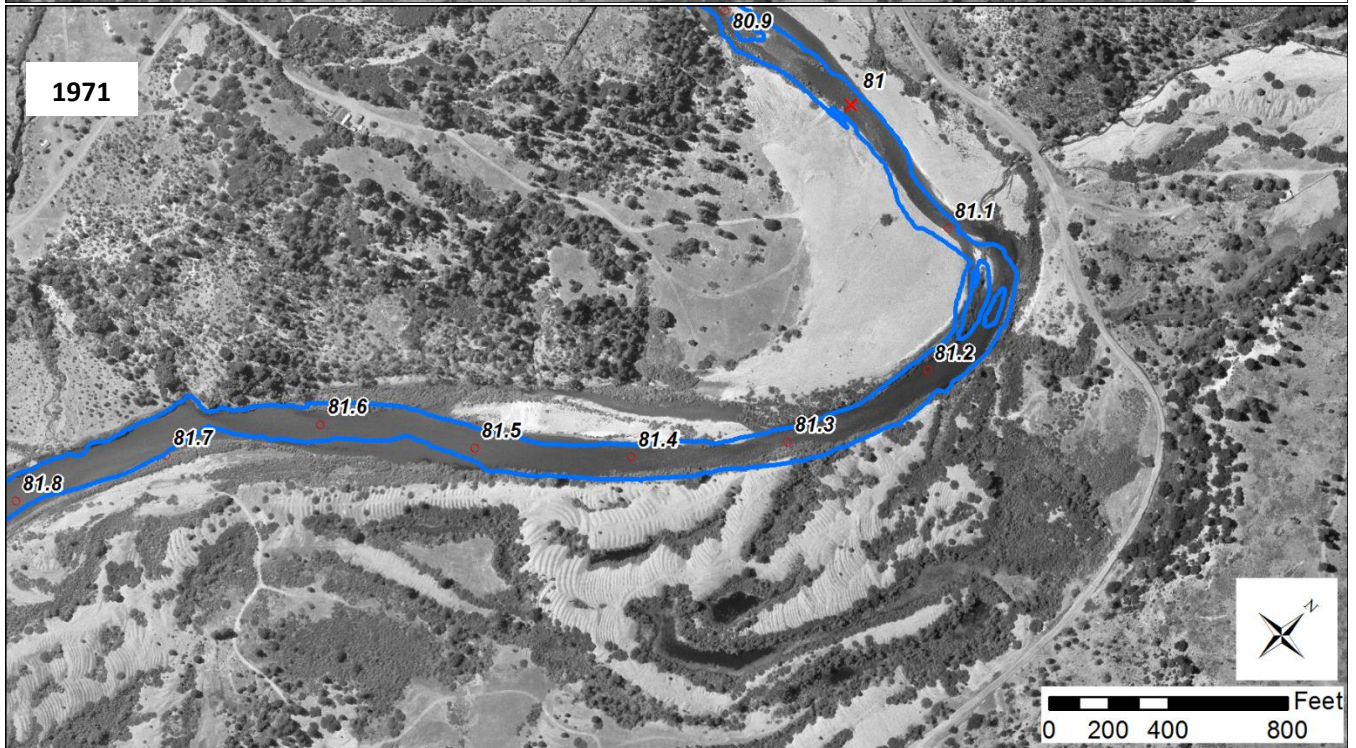
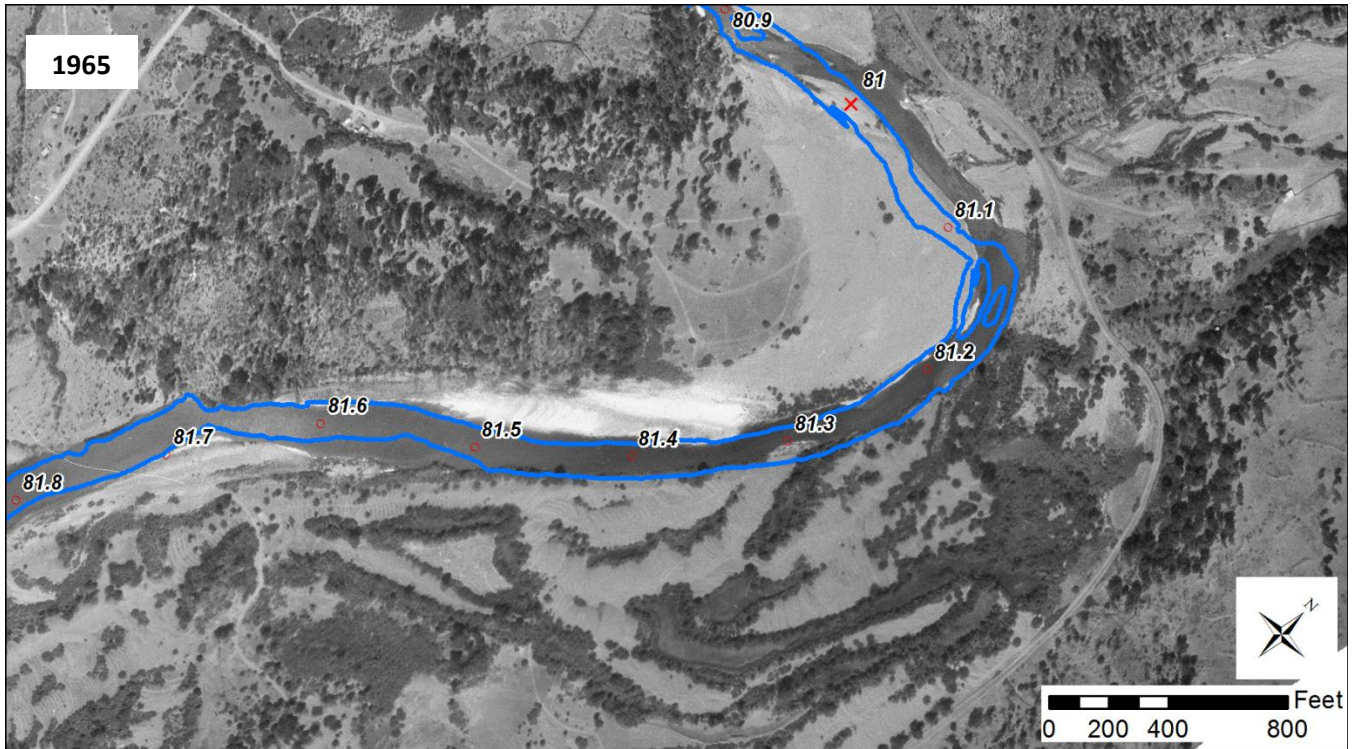
Other Water Quality Monitoring Results

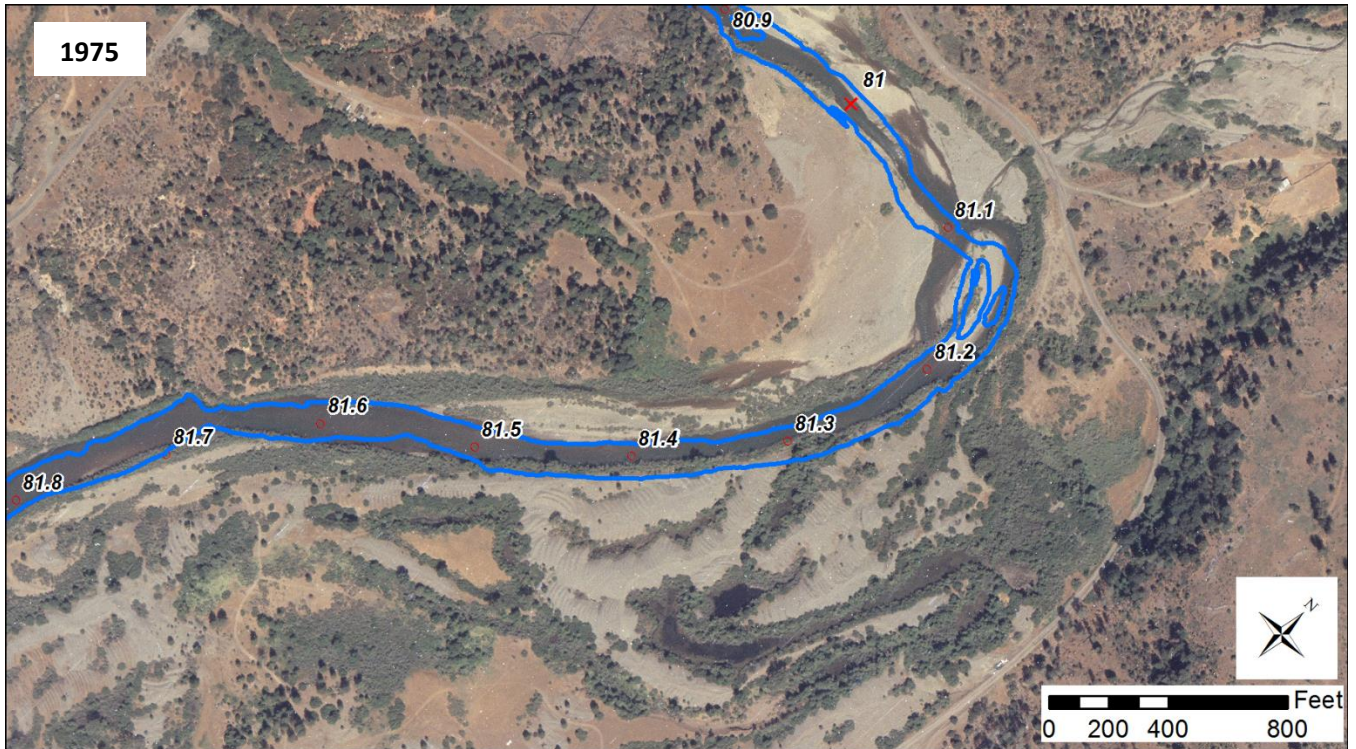


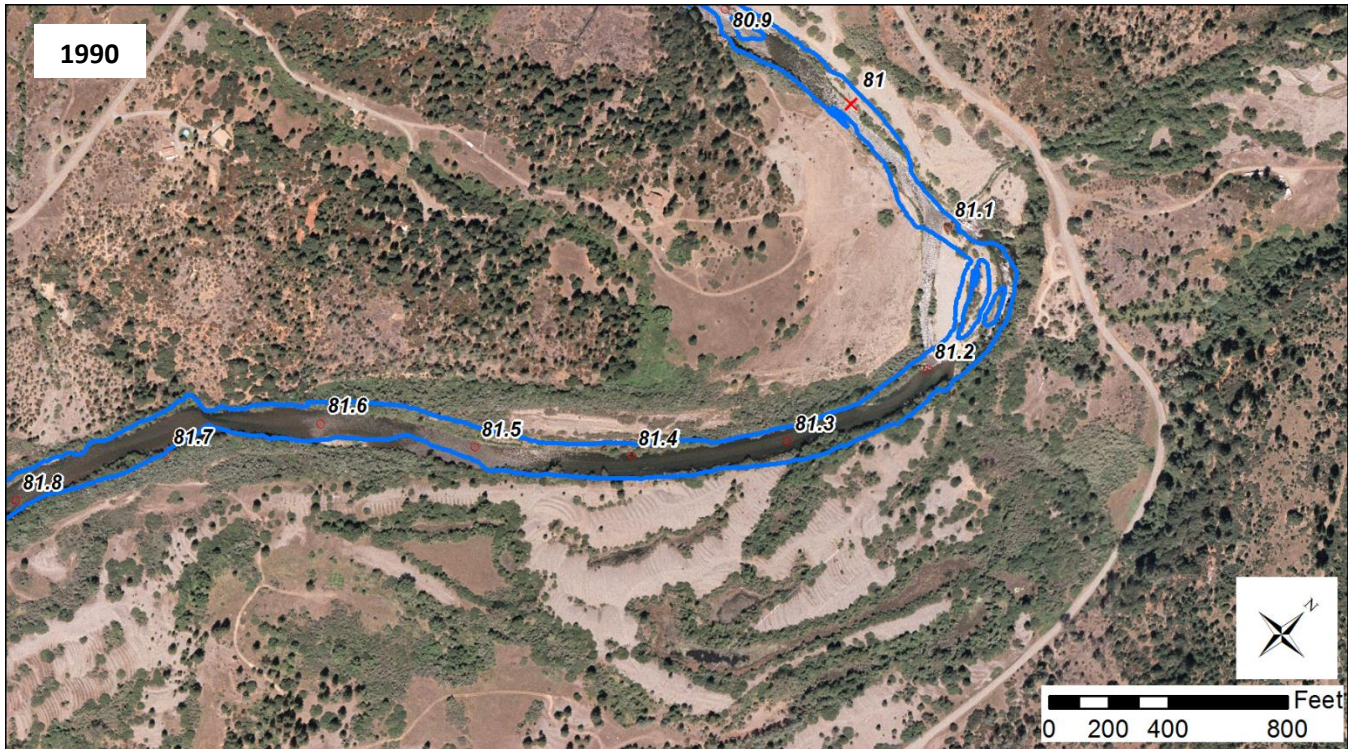
Appendix C Historical Aerial Photos

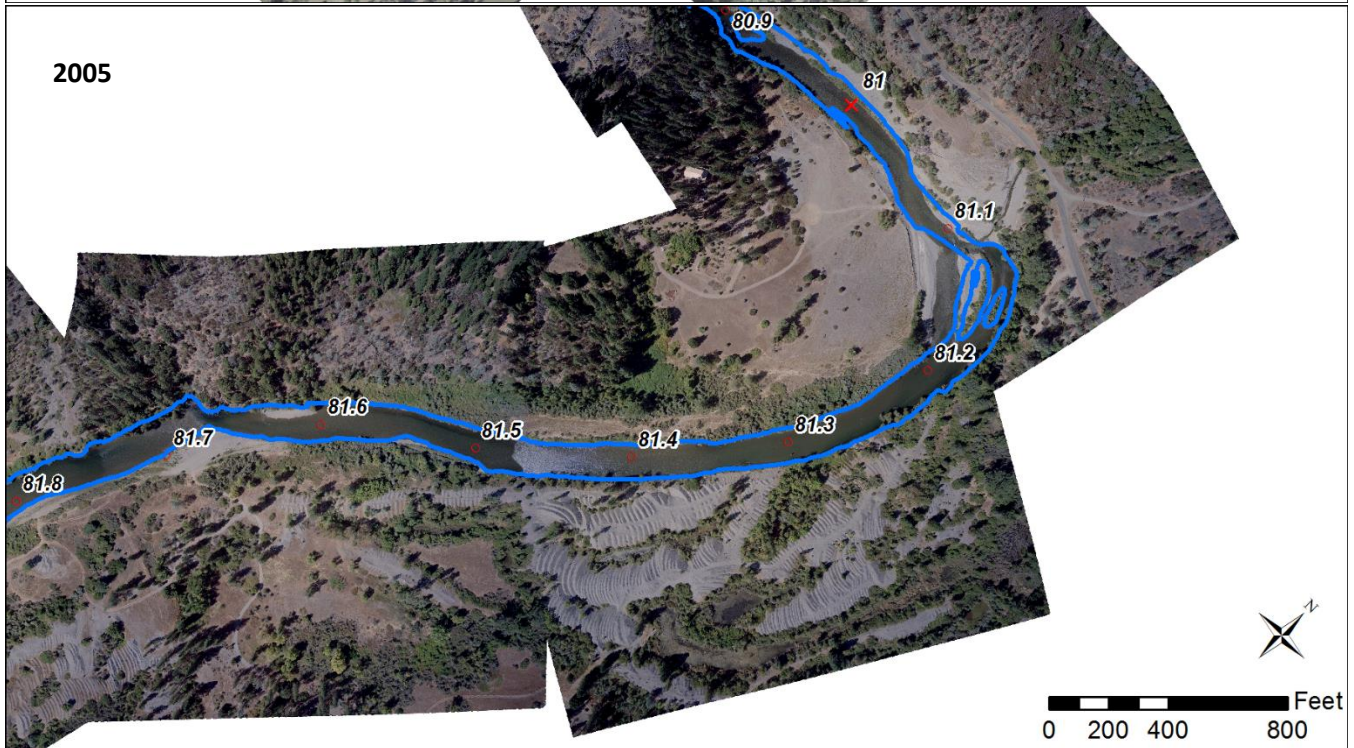
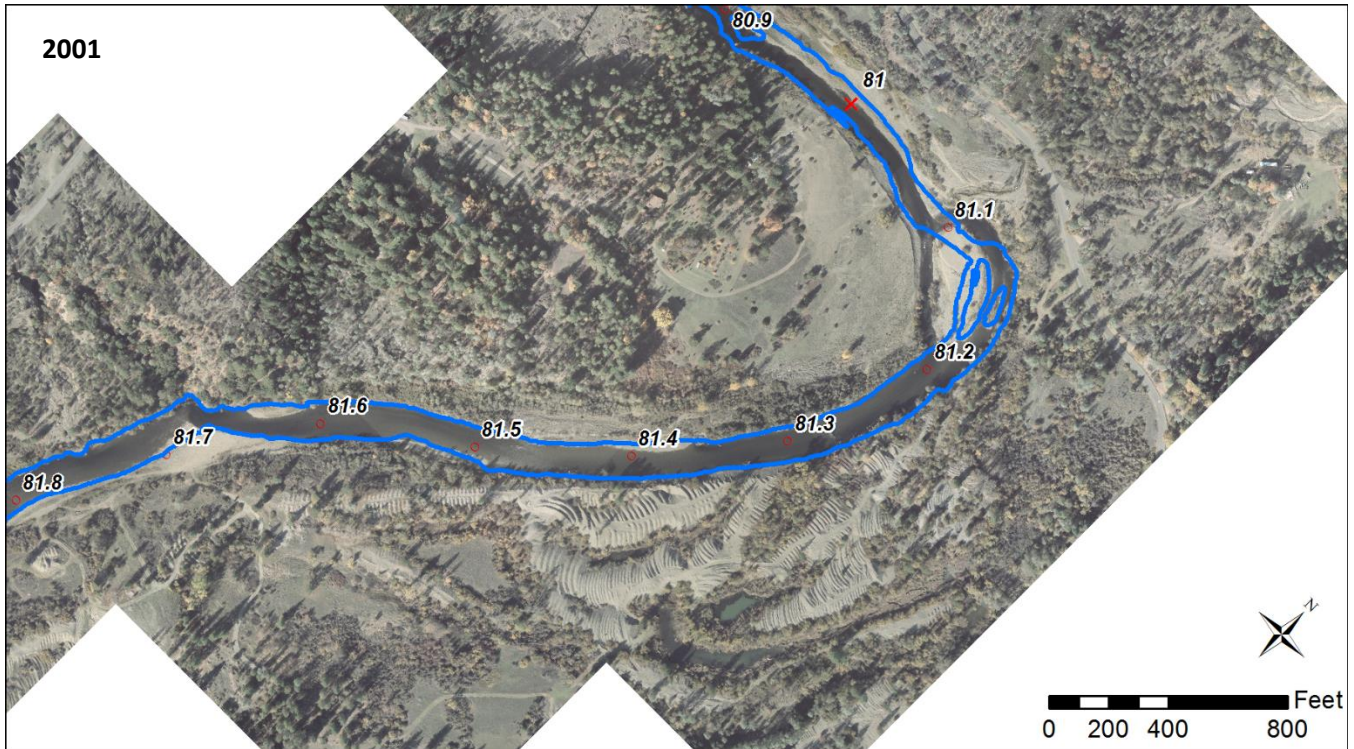
Aerial photos from 1944 to 2016. Blue line shows 2011 low flow inundation boundary from for reference.

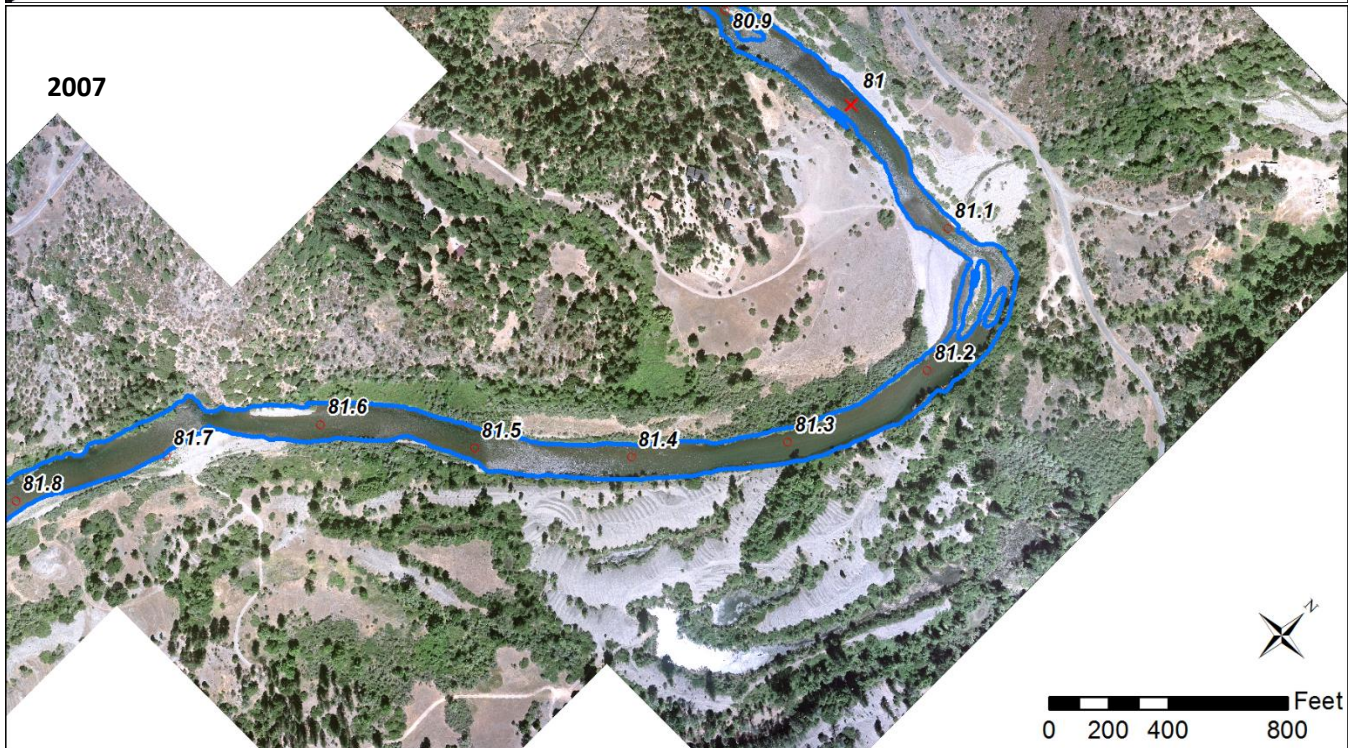
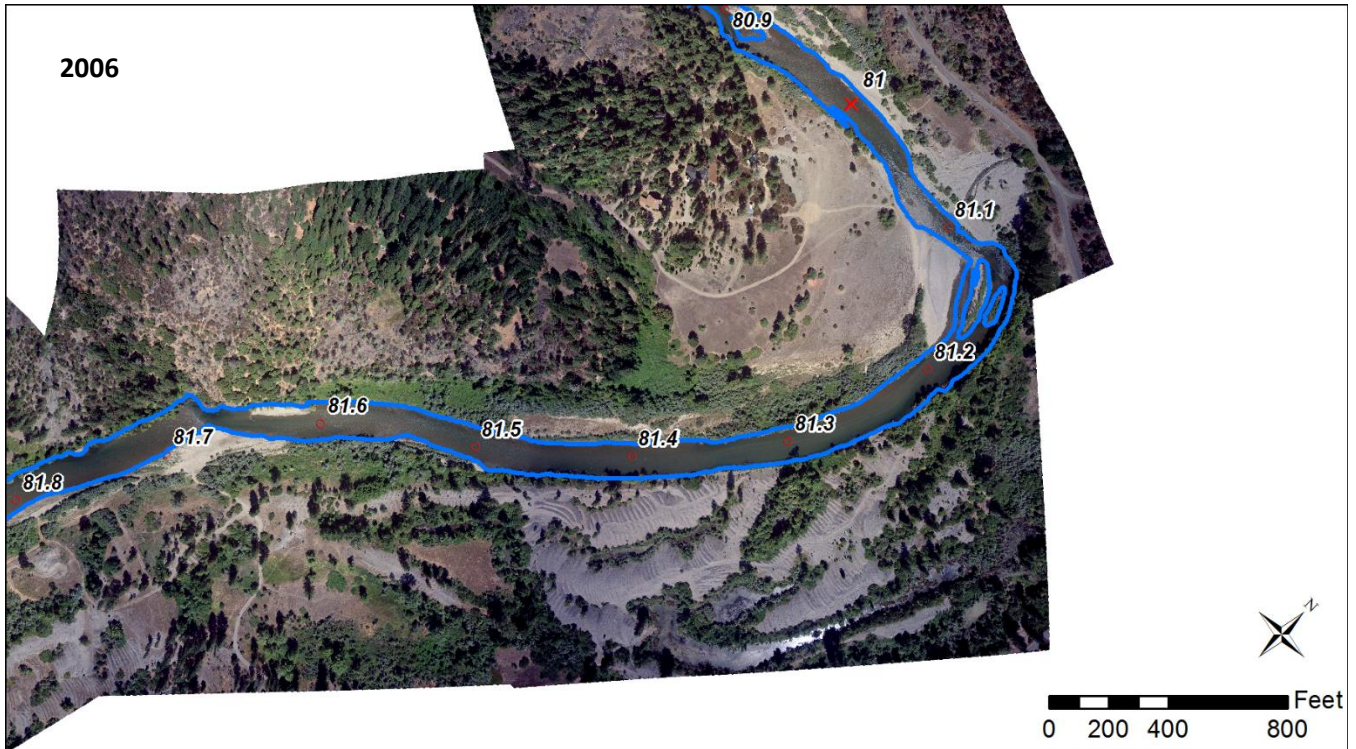


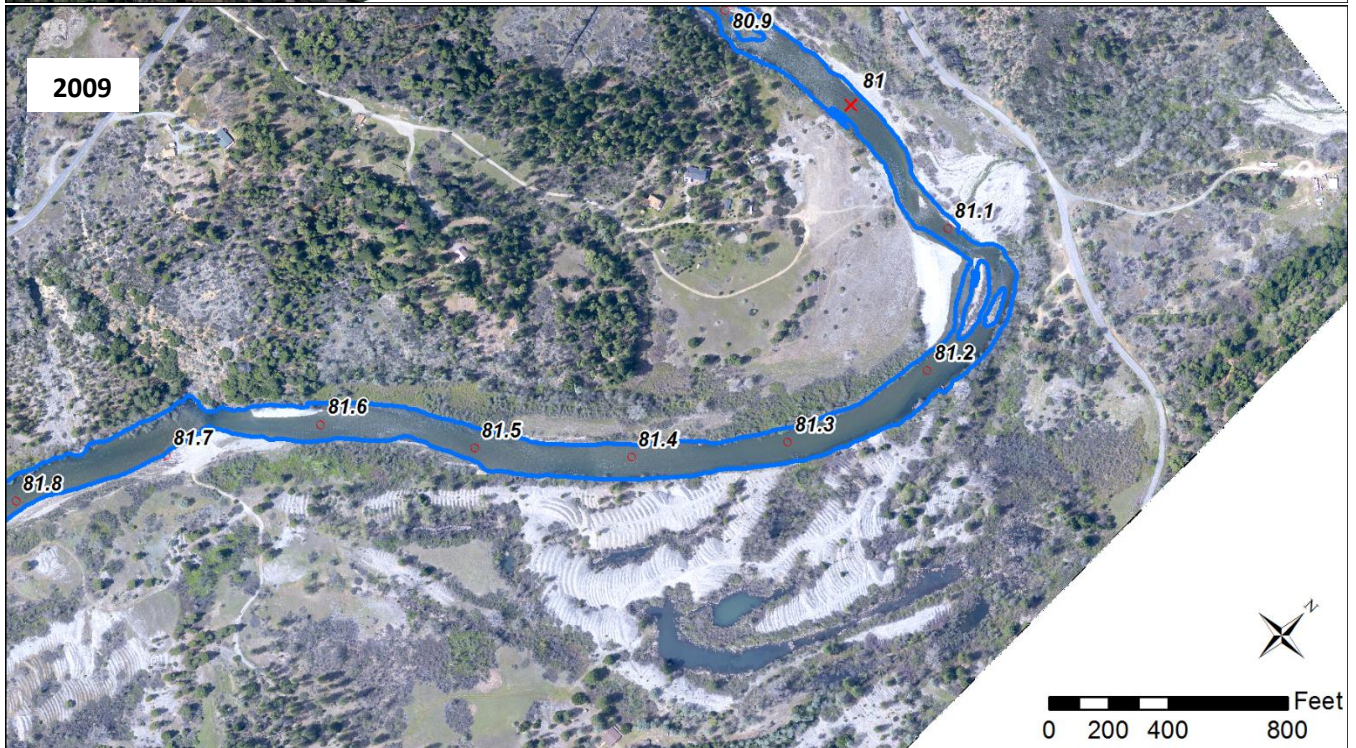
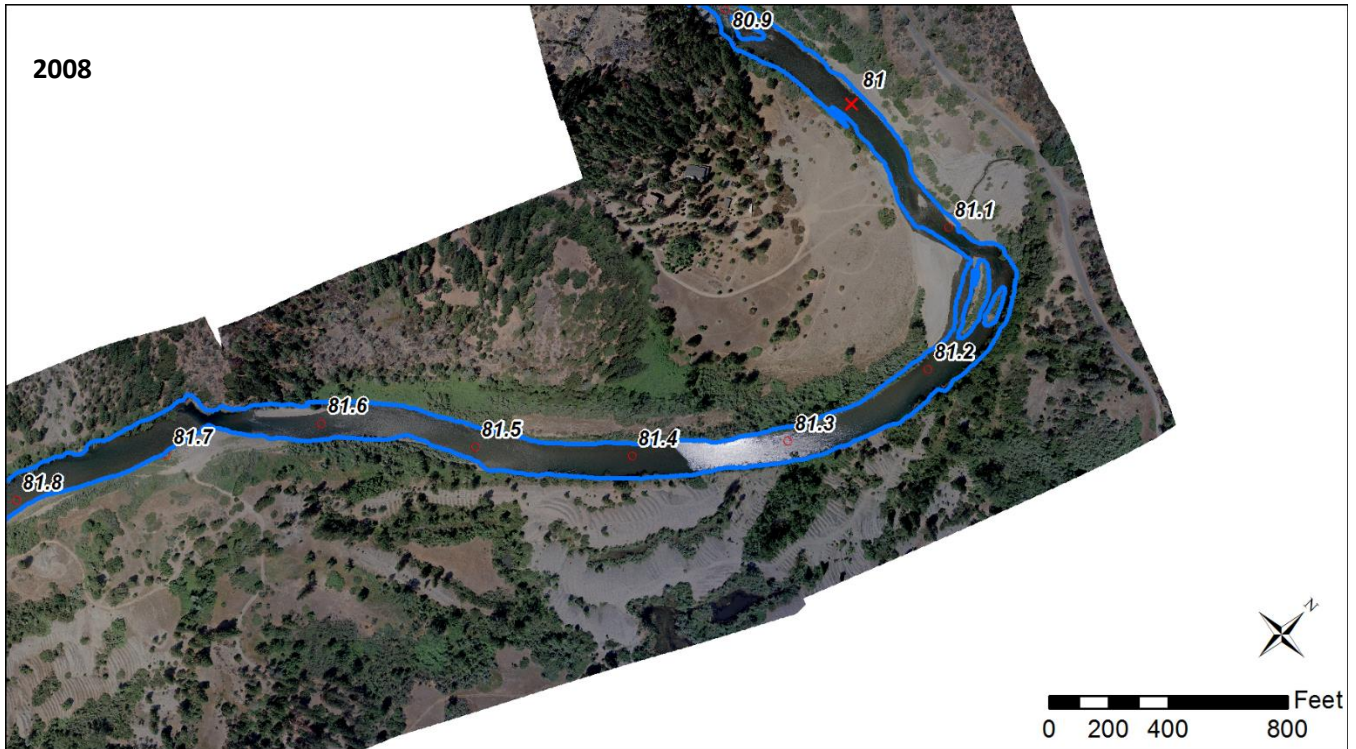




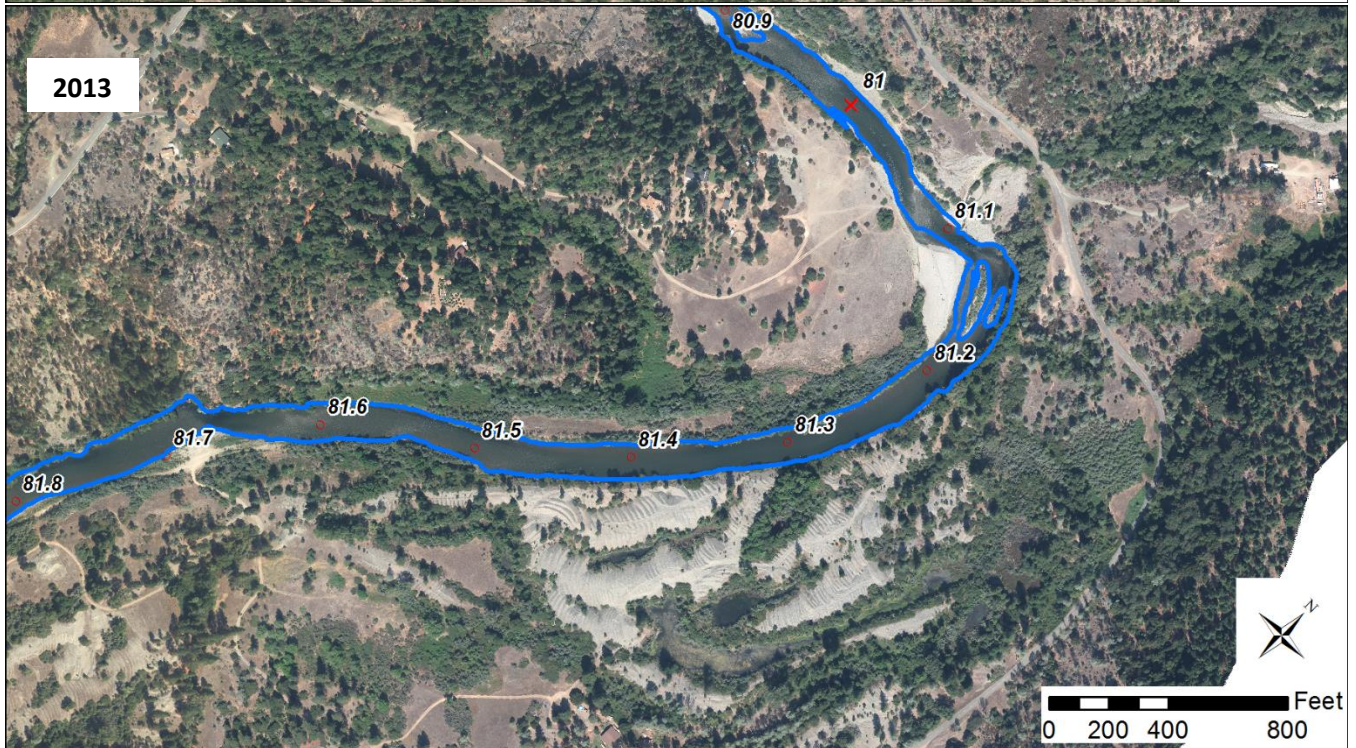


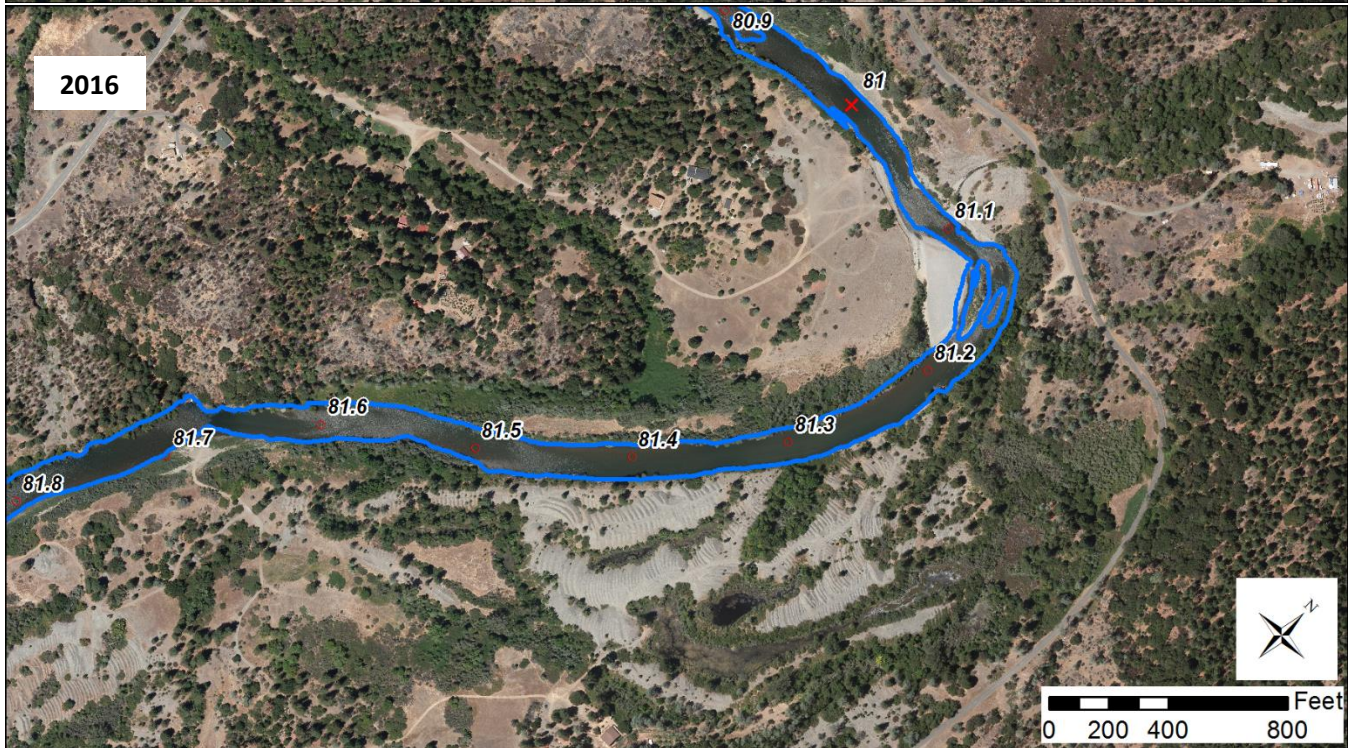




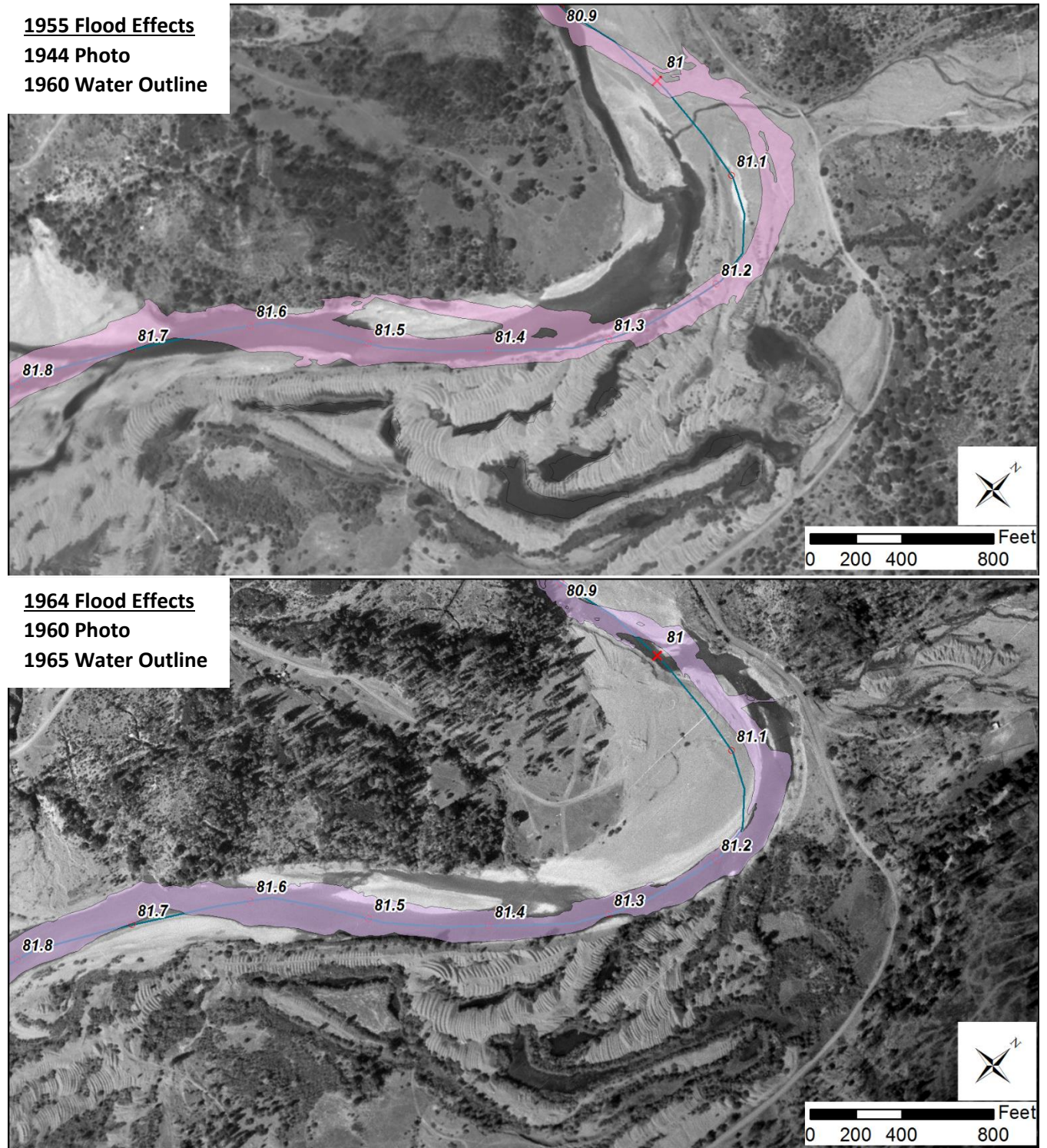


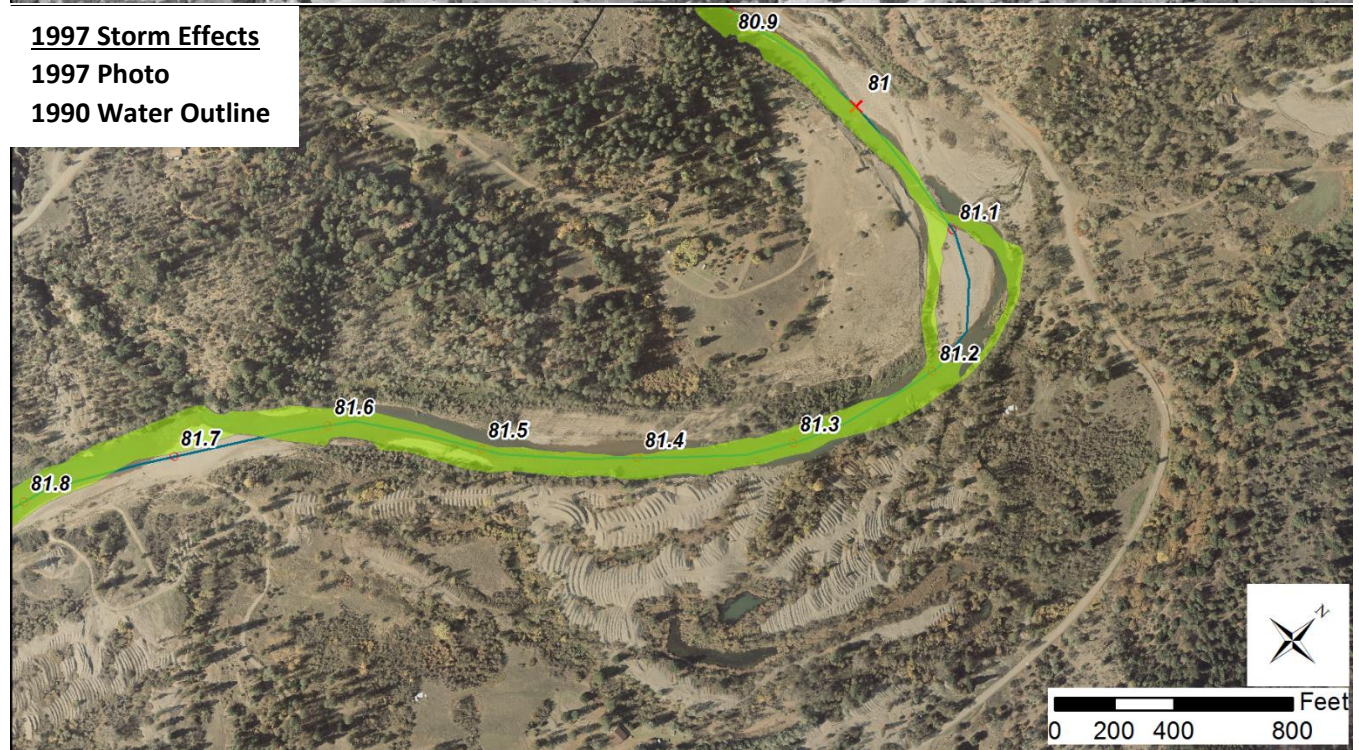


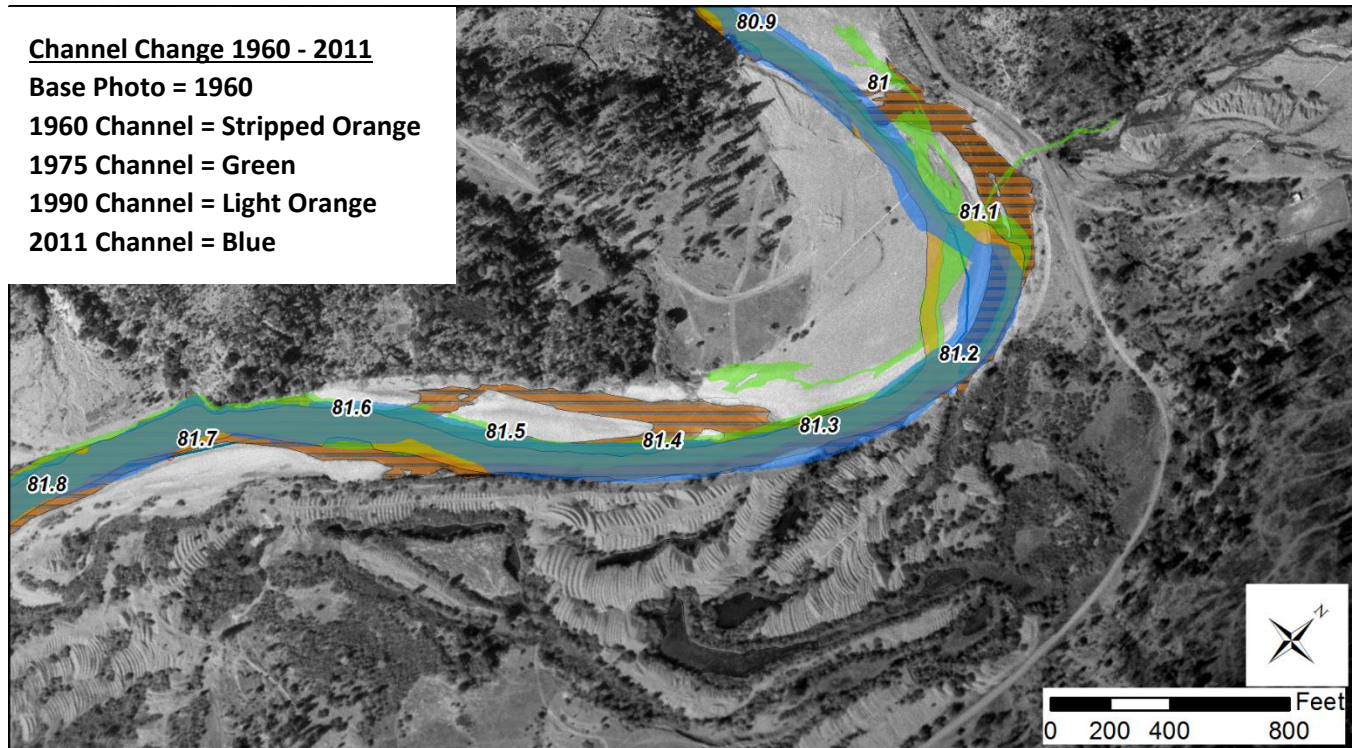
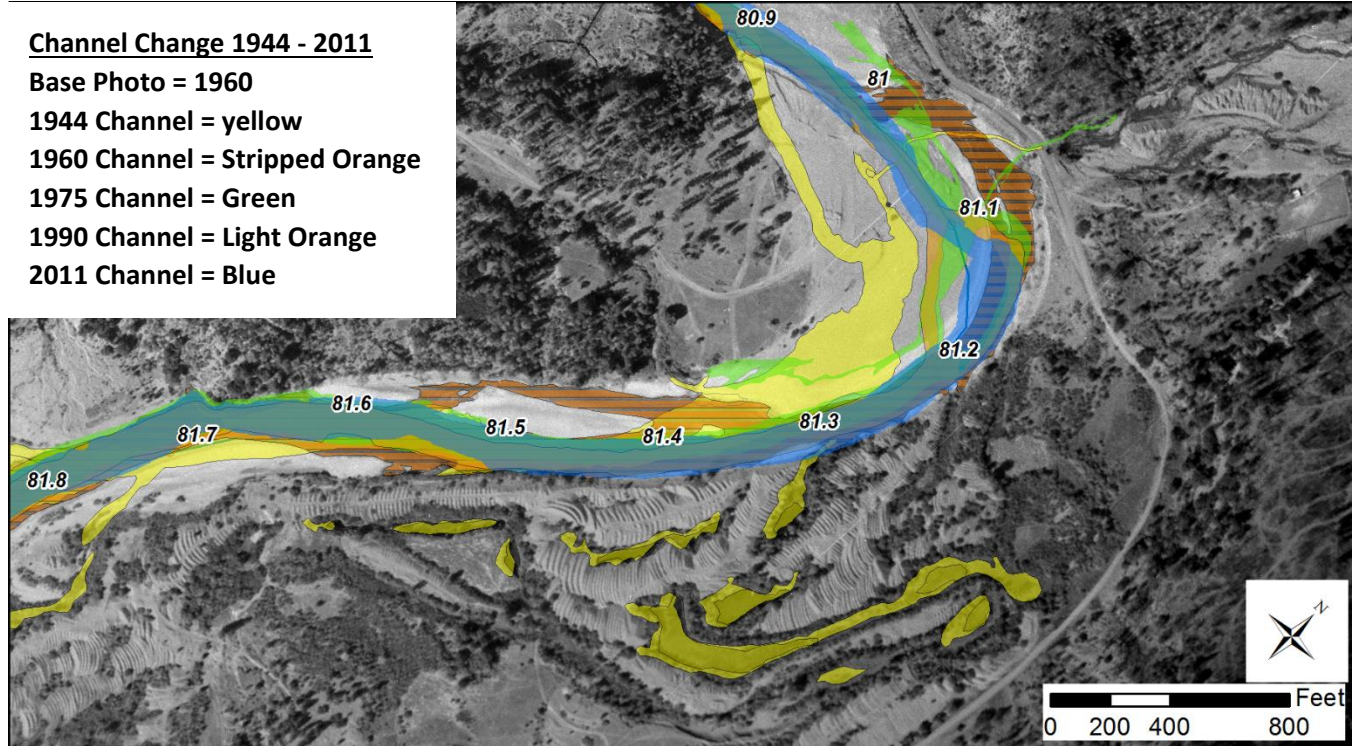




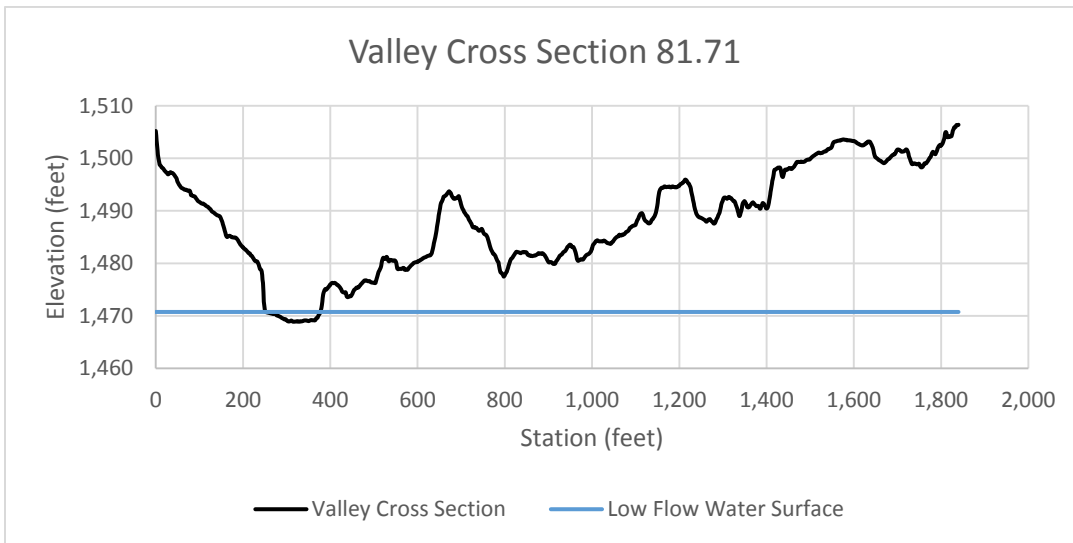
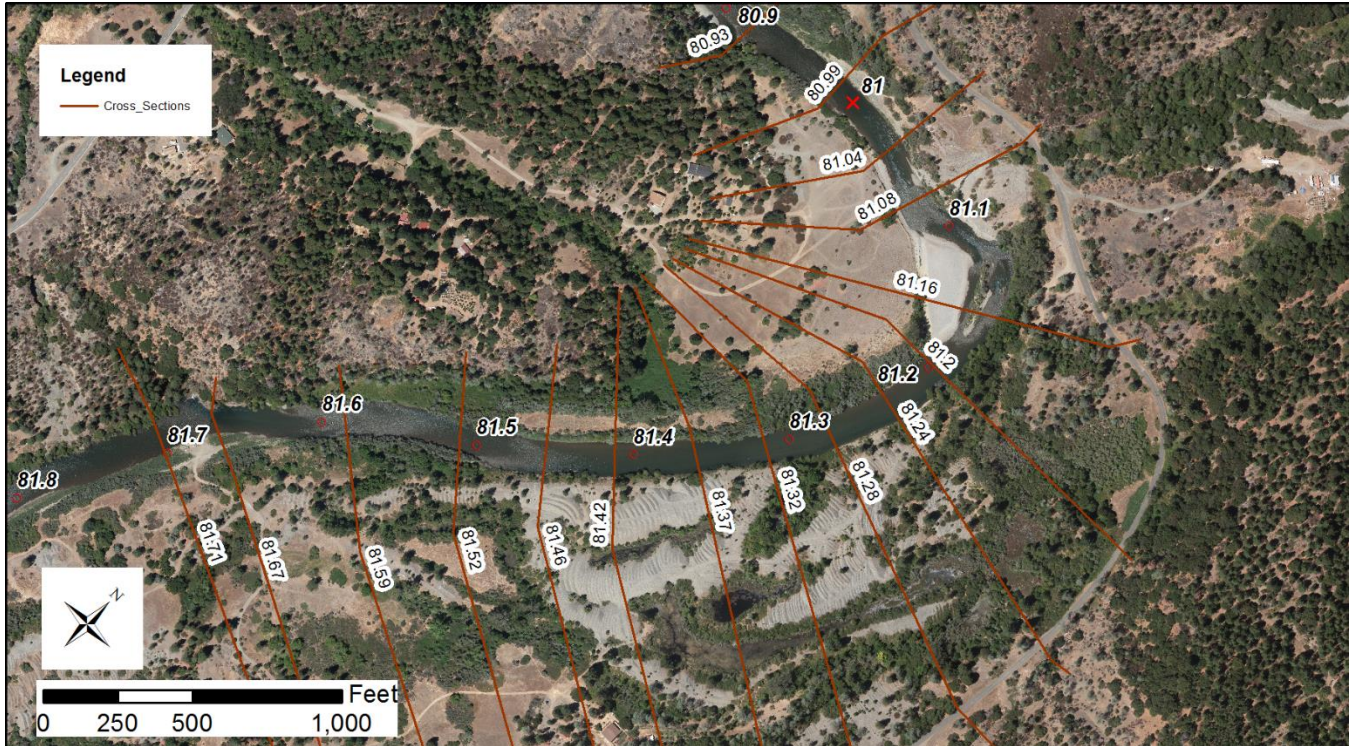
Appendix D: Aerial Photos Showing Channel Planform after Major Floods

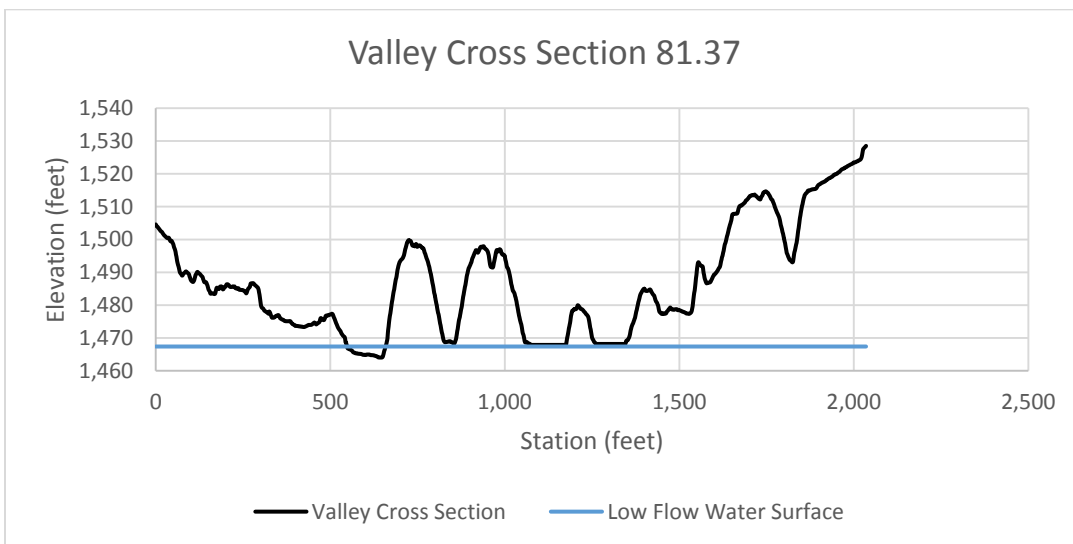
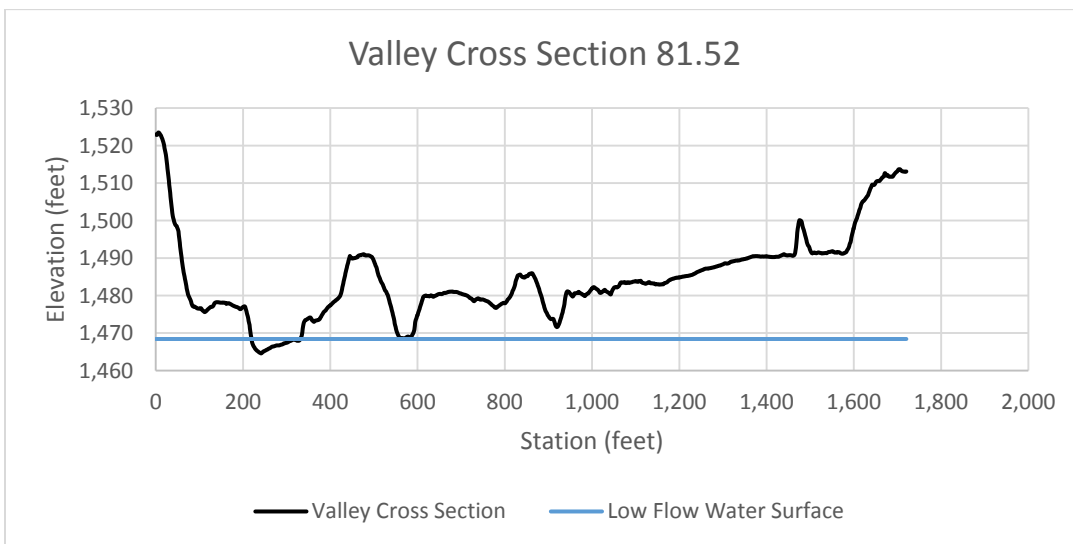
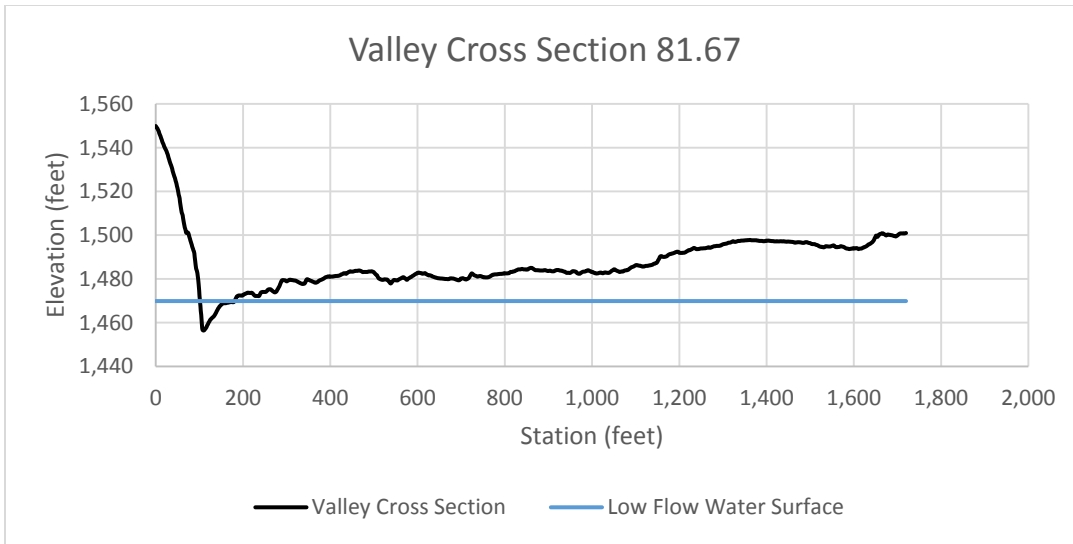


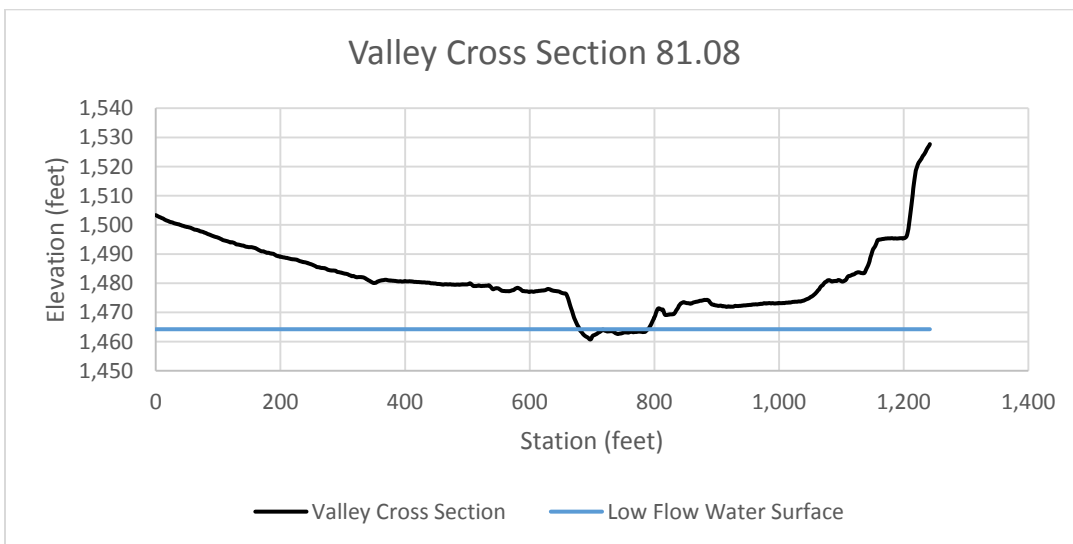
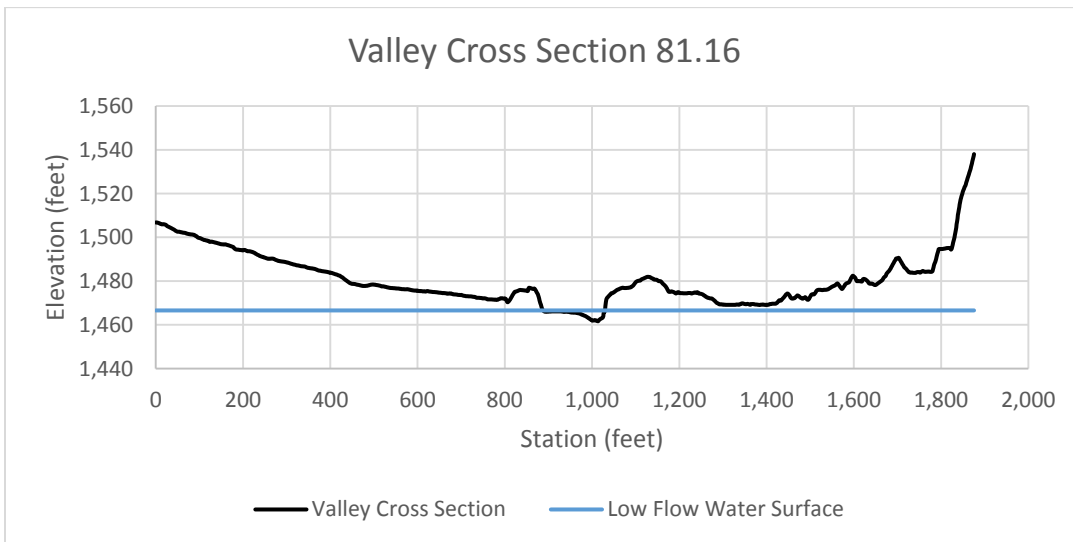
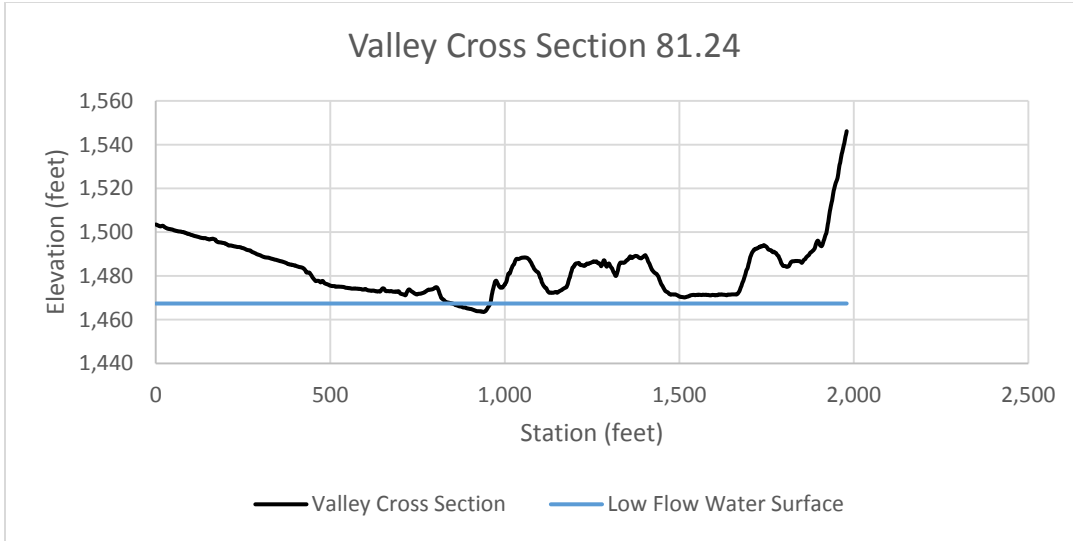


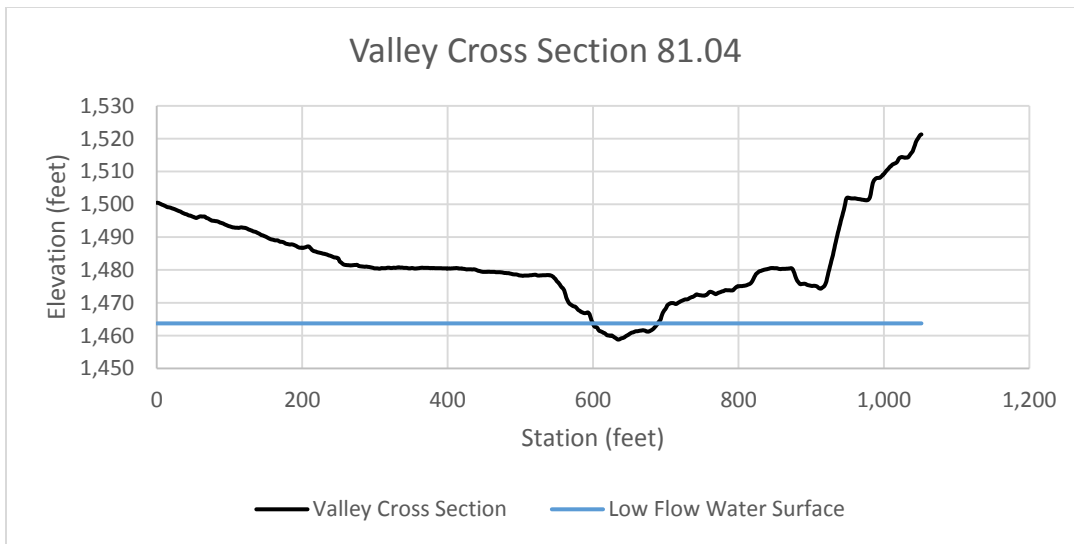


Appendix E: Valley Cross Sections



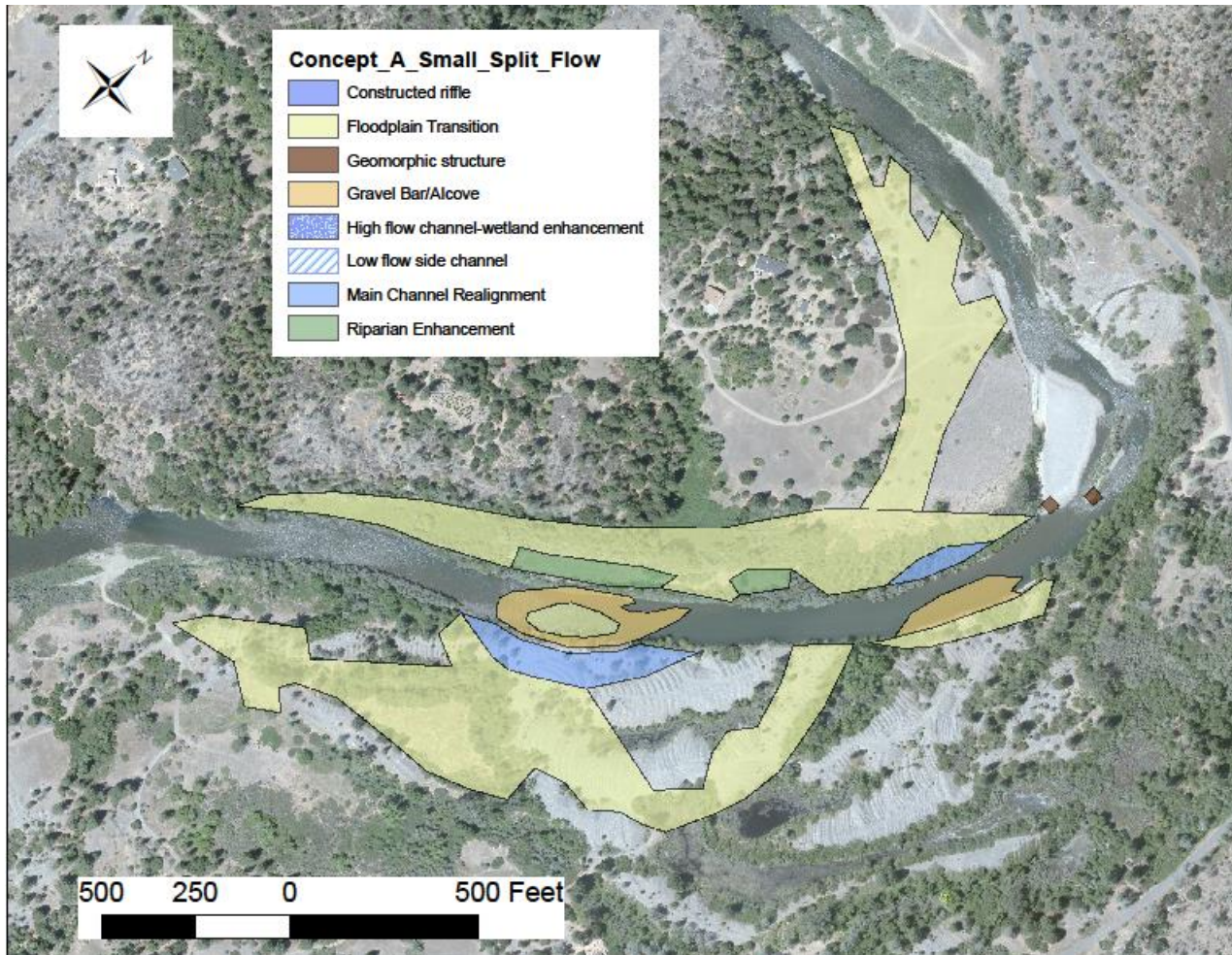




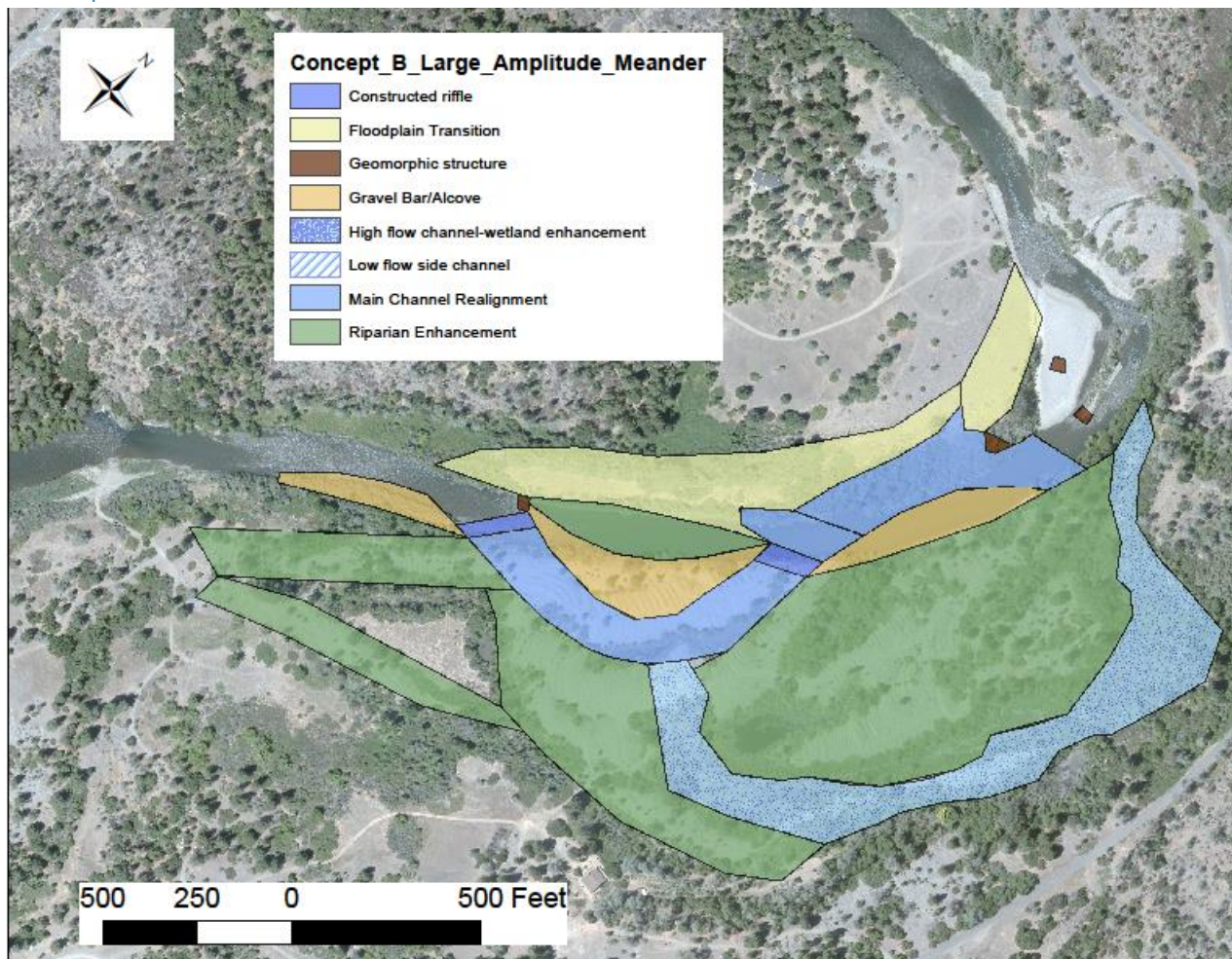


Appendix F: Conceptual Designs

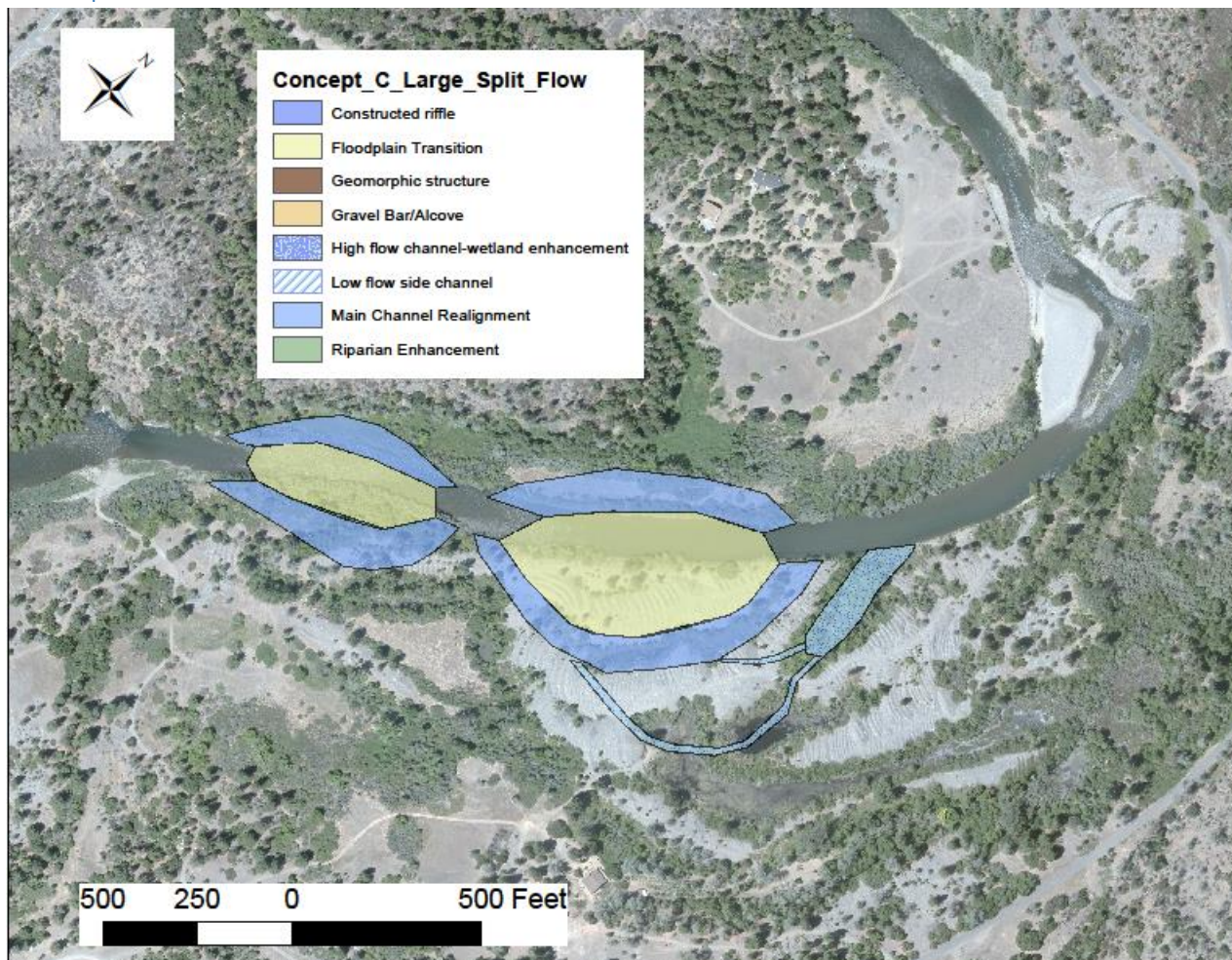
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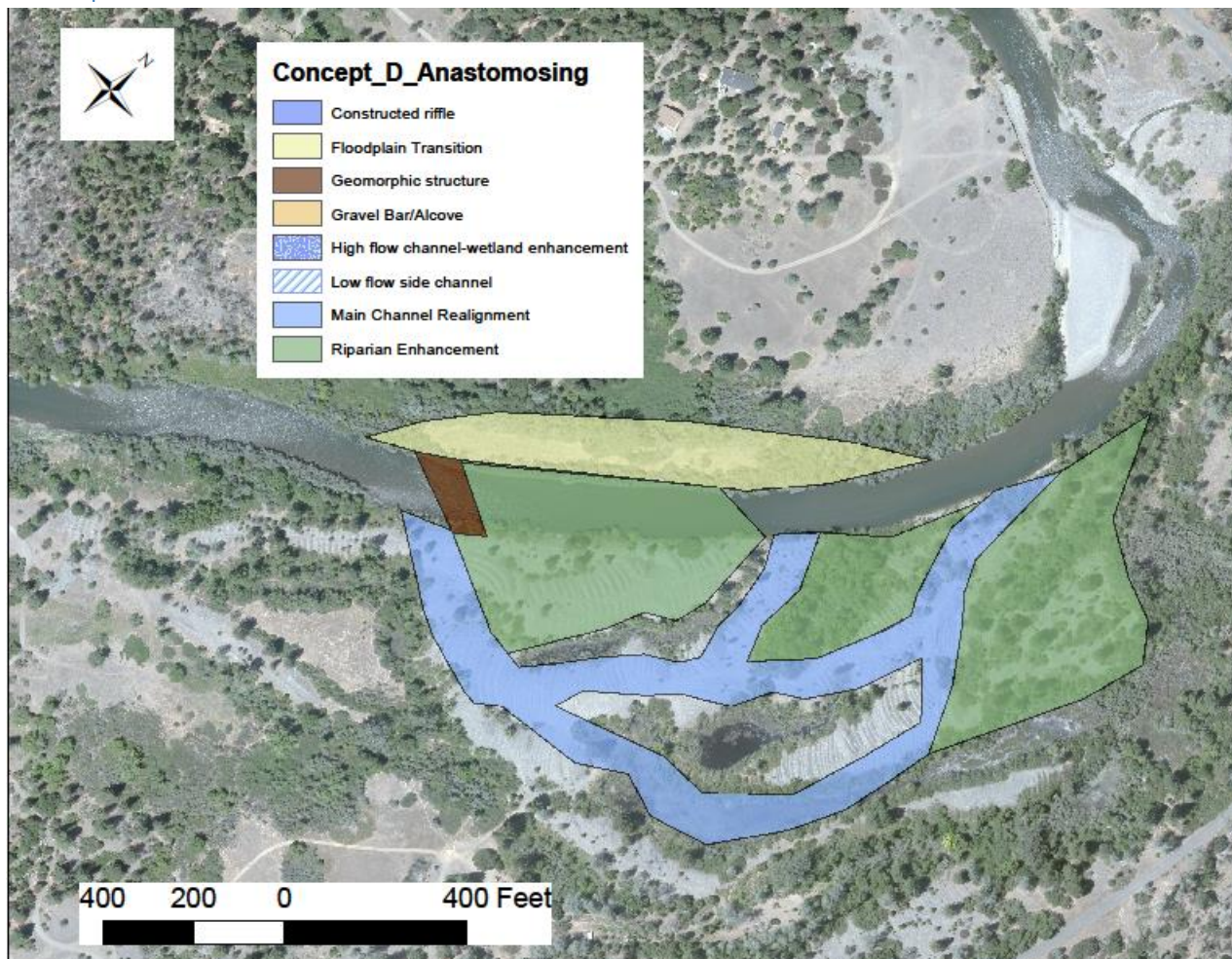
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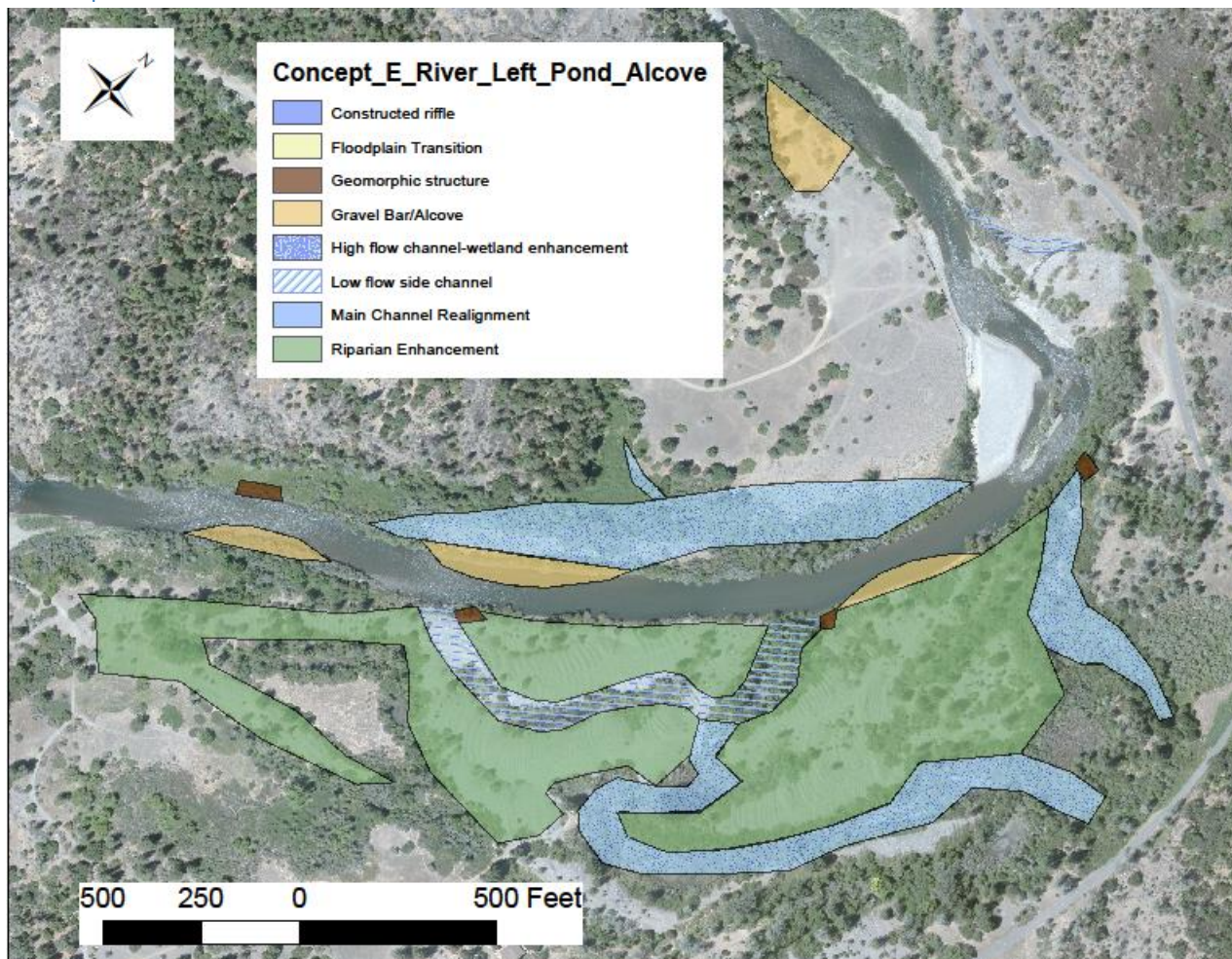
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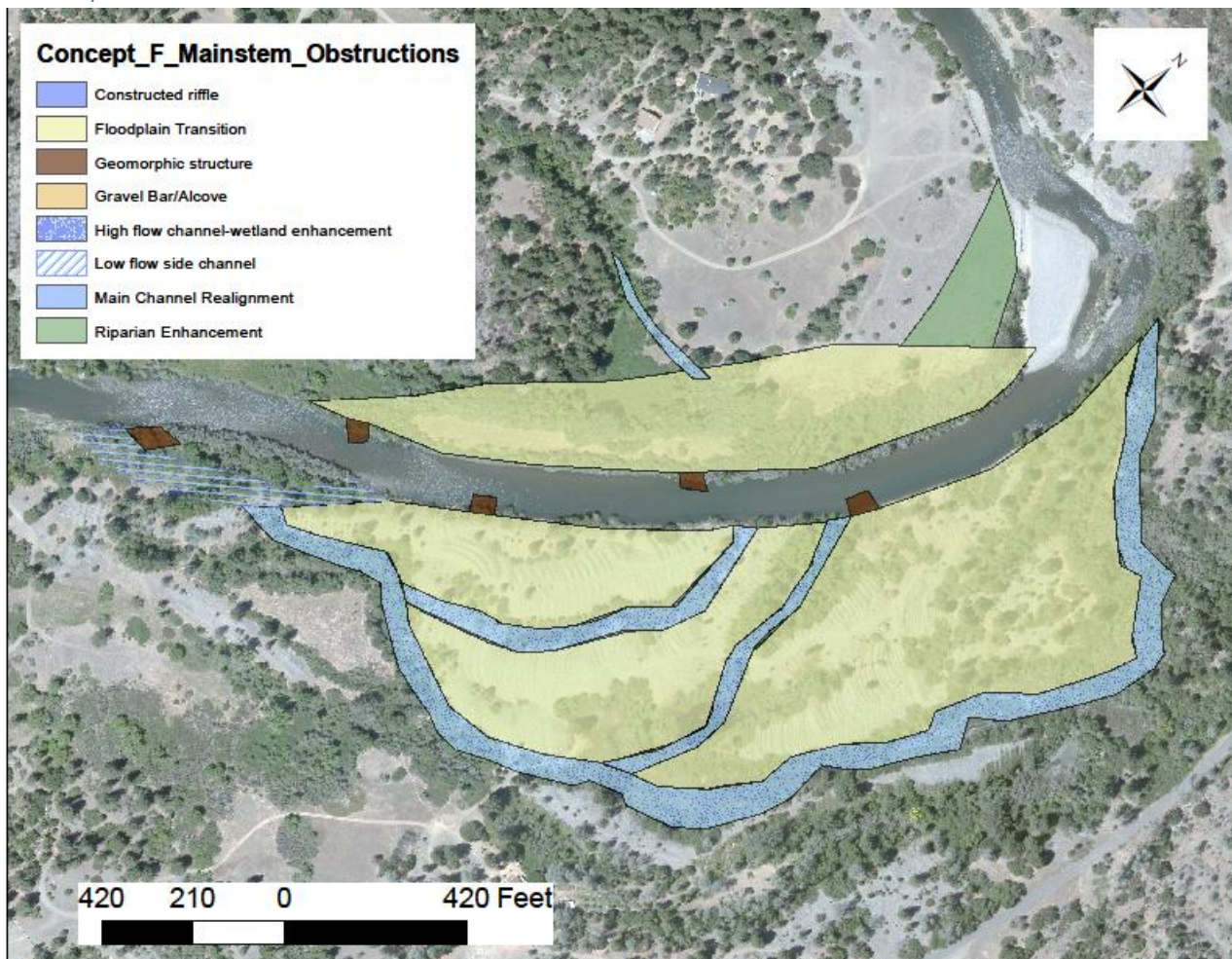
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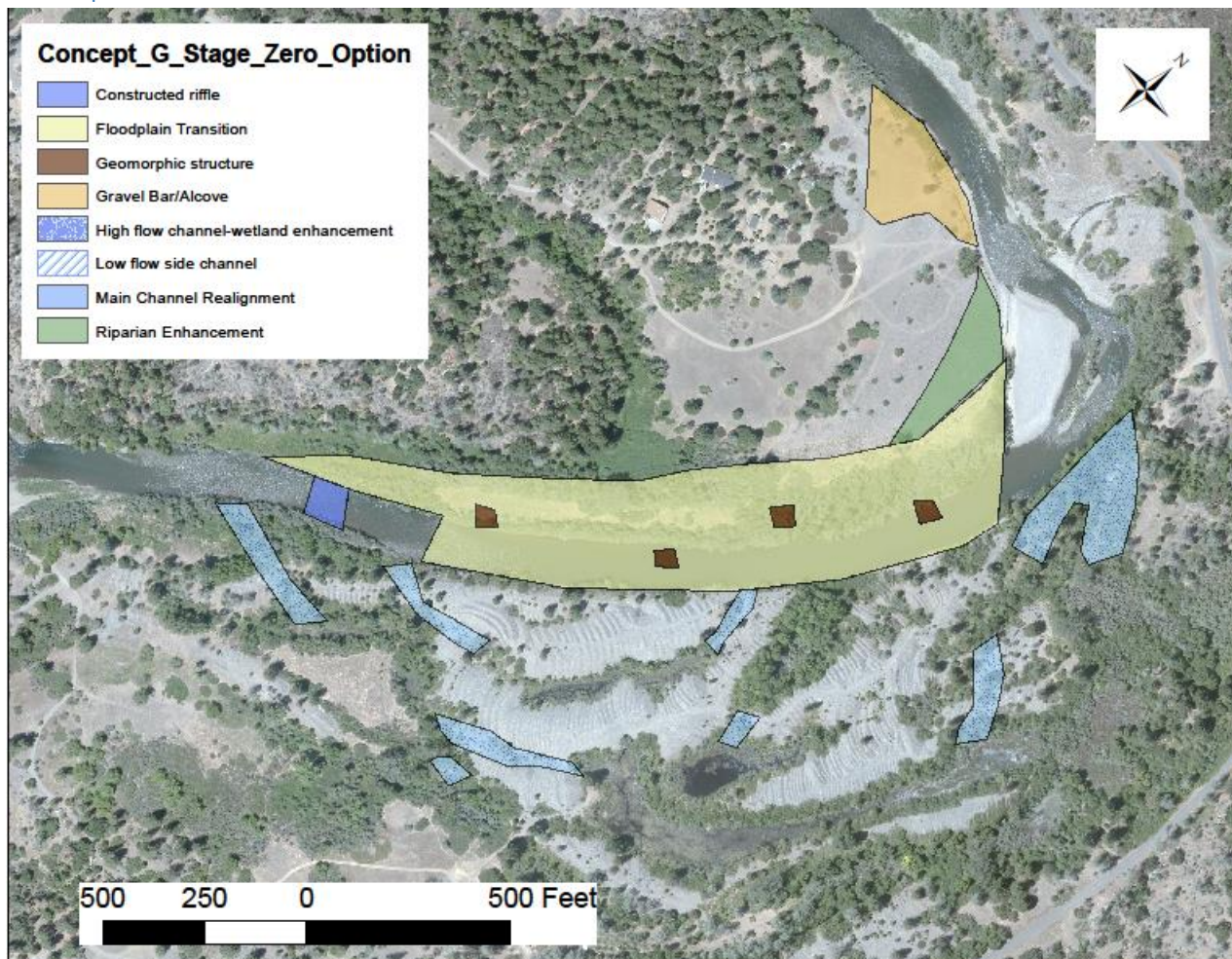
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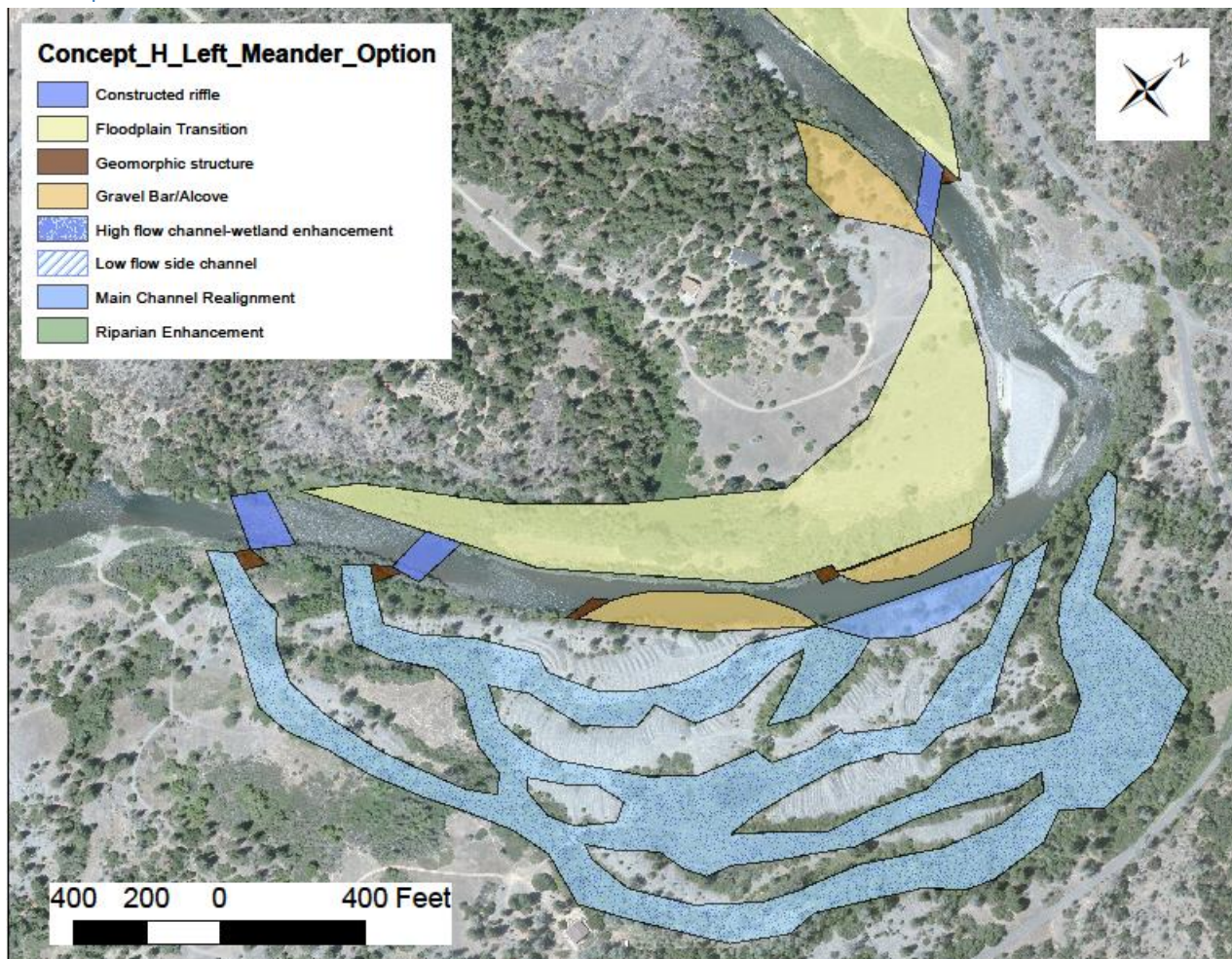
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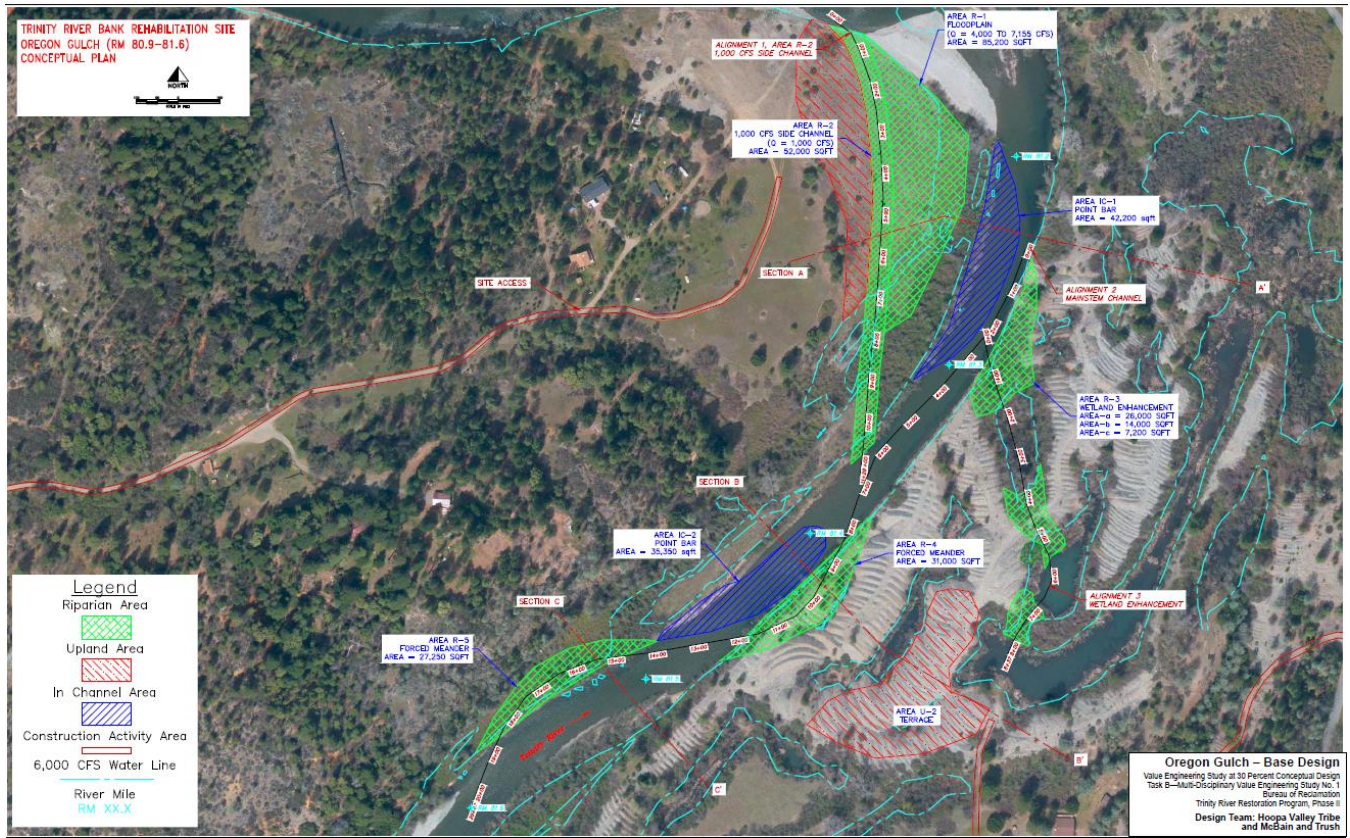
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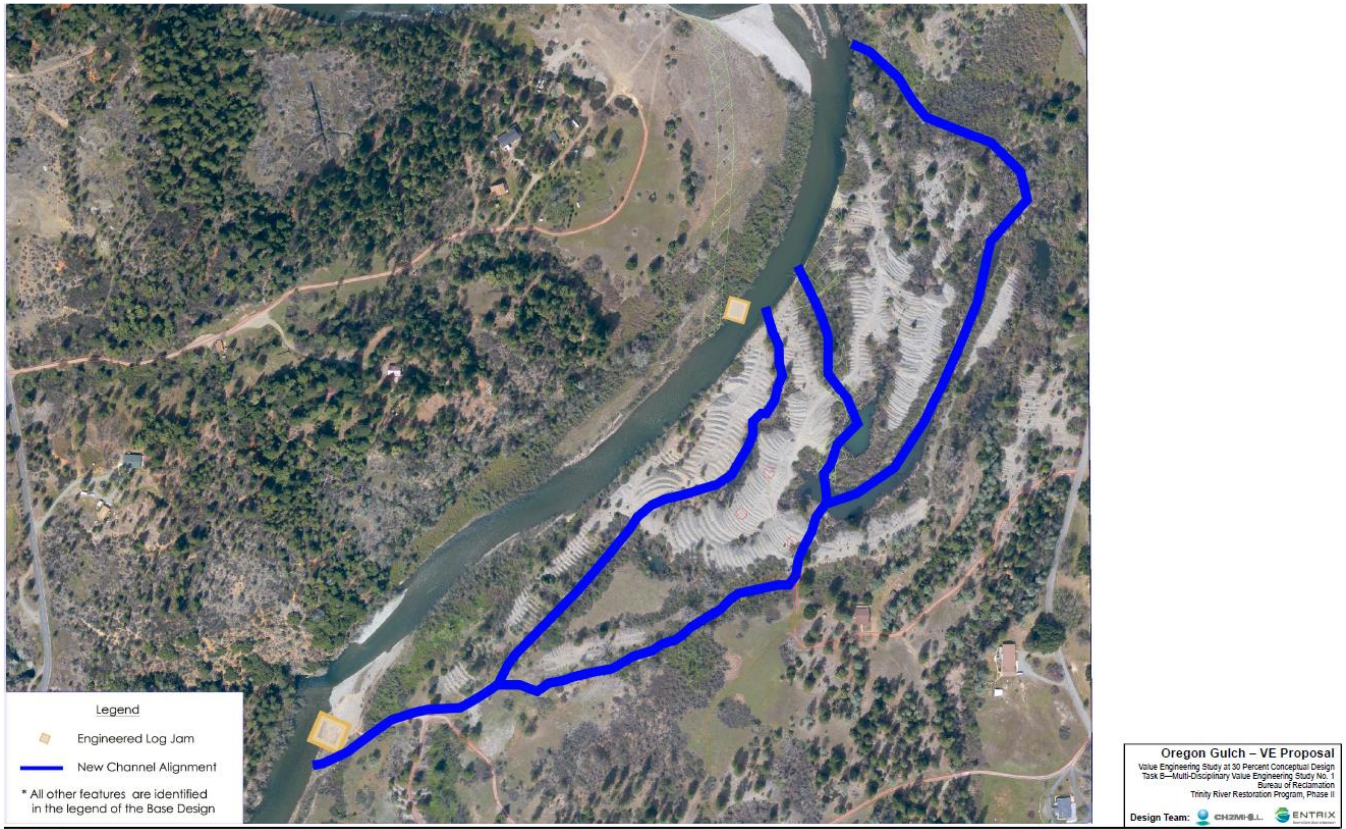
Concept H



Concept I (from HVT 2010)



Concept J (from VE 2010)

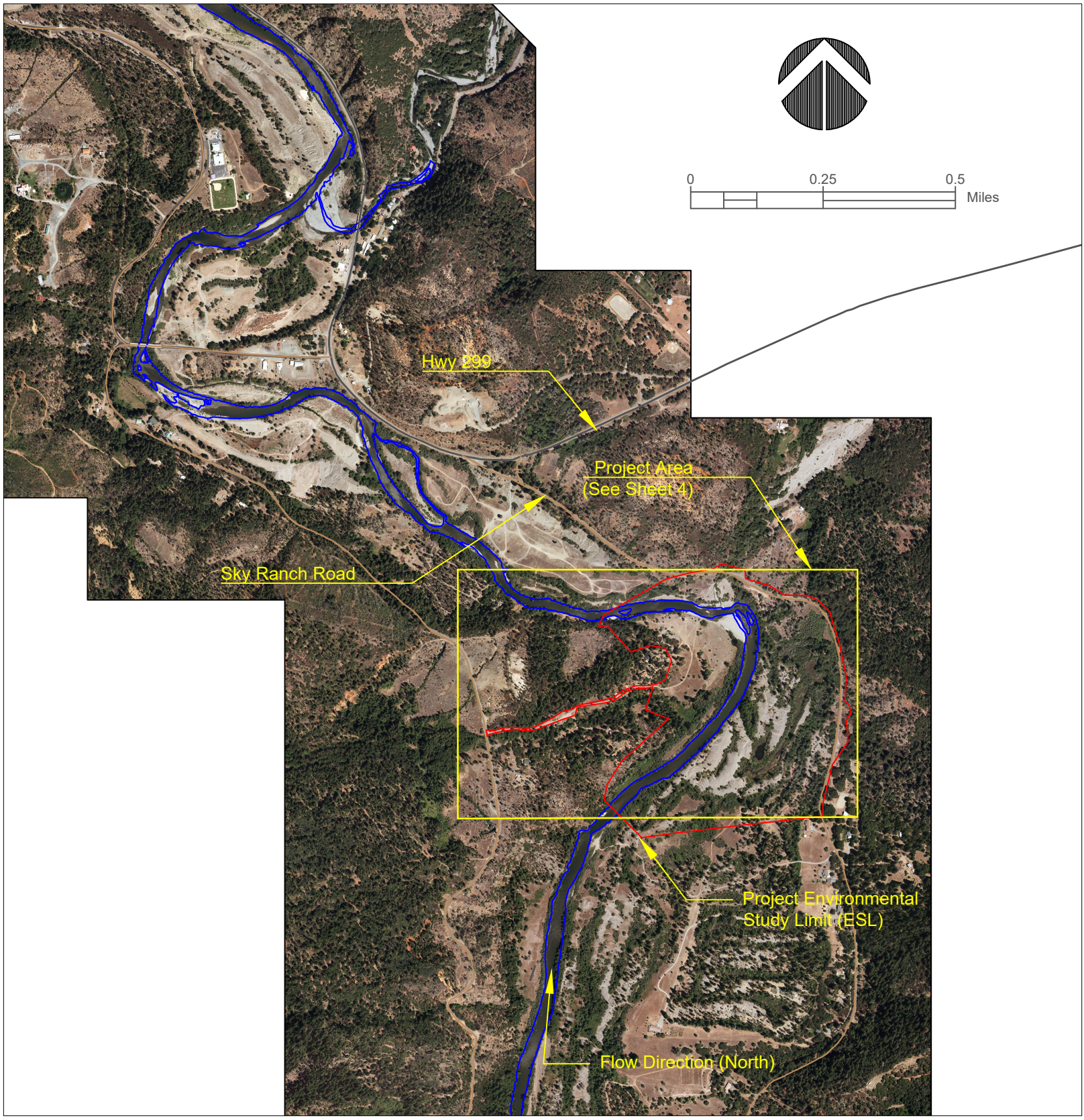
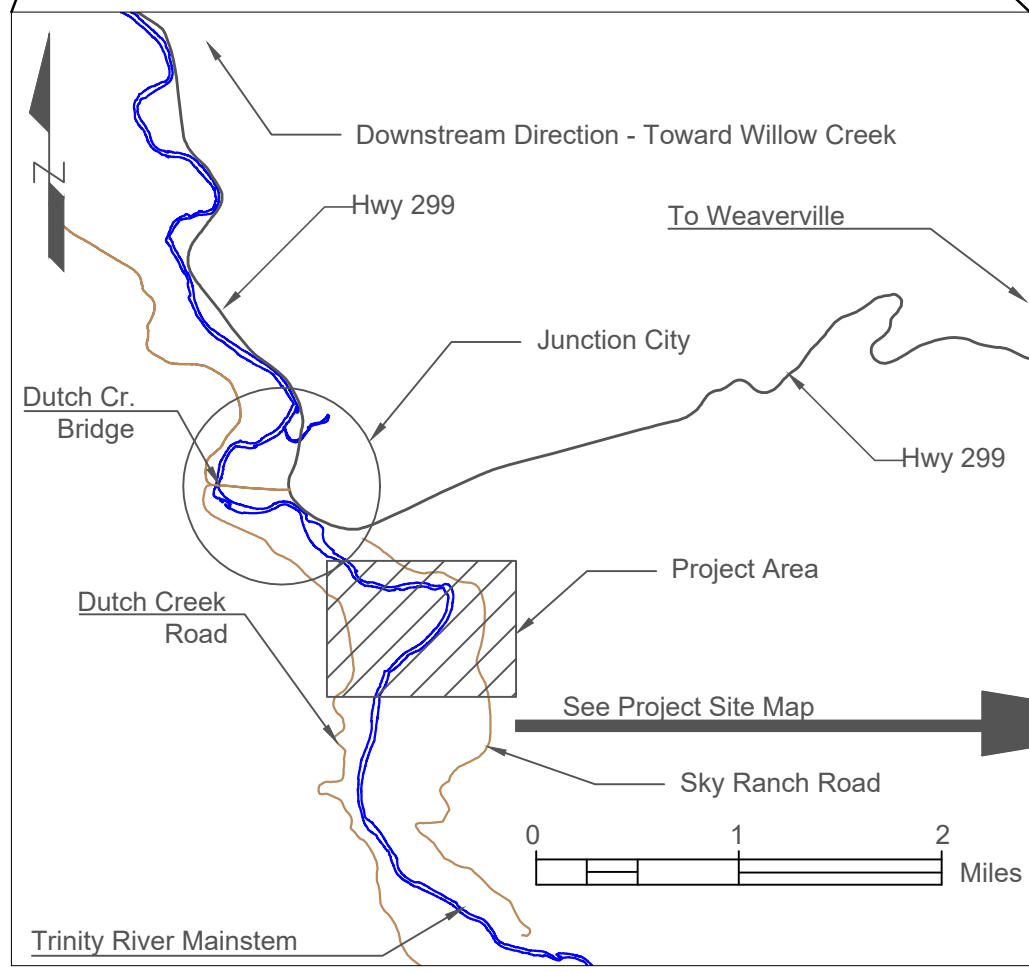


Appendix G: 30 % Design Drawings

OREGON GULCH - 30% DESIGN DRAWINGS - ALTERNATIVE 1 AND 2



Yurok Tribe



Oregon Gulch Channel Rehabilitation Project - 30% Design Drawings
May 29, 2018

TRINITY RIVER RESTORATION PROGRAM

Oregon Gulch 30% Design Drawings - Yurok Tribe

Cover Sheet - Location Map



Yurok Tribe

Drawing Type:

COVER

Drawn By

DJ Bandrowski

Checked By

Aaron Martin

Design Date:

May 29, 2018

Sheet number

1 of 18

Index of Sheets

No.	Sheet Name
1	Cover Sheet - Location Map
2	Sheet Index - Notes - Quantities
3	Planview - Existing Ground - Terrain Surface
4	Planview - Existing Ground - Aerial Photo & 5ft. Contours
5	Planview - Alternative-1 (ALT1) - Terrain Surface
6	Planview - Alternative-1 (ALT1) - Aerial Photo & 5ft. Contours
7	Planview - Alternative-2 (ALT2) - Terrain Surface
8	Planview - Alternative-2 (ALT2) - Aerial Photo & 5ft. Contours
9	Planview - Alternative-1 (ALT1) - Profiles/X-Sections Locations
10	Profiles - Alternative-1 (ALT1) - Profile Sheet 1
11	Profiles - Alternative-1 (ALT1) - Profile Sheet 2
12	X-Sections - Alternative-1 (ALT1) - X-Section Sheet 1
13	X-Sections - Alternative-1 (ALT1) - X-Section Sheet 2
14	Planview - Alternative-2 (ALT2) - Profiles/X-Sections Locations
15	Profiles - Alternative-2 (ALT2) - Profile Sheet 1
16	Profiles - Alternative-2 (ALT2) - Profile Sheet 2
17	X-Sections - Alternative-2 (ALT2) - X-Section Sheet 1
18	X-Sections - Alternative-2 (ALT2) - X-Section Sheet 2

NOTE:

ALTERNATIVE 1 (ALT1) is Also Referenced as the Anastomosing Channel Design or ACD; Therefore: ALT1 = ACD

ALTERNATIVE 2 (ALT2) is Also Referenced as the Large Amplitude Meander or LAM; Therefore: ALT2 = LAM

Quantities

Project Site (Alternative)	Type	Cubic Yards - CY (Cut or Fill)
ALT 1	DRY EXCAVATION	346,470 (CUT)
ALT 1	WET EXCAVATION	86,617 (CUT)
ALT 1	DRY FILL	23,423 (FILL)
ALT 1	WET FILL	10,038 (FILL)
ALT1 - NET VOLUME = 399,626 CY		
ALT 2	DRY EXCAVATION	247,252 (CUT)
ALT 2	WET EXCAVATION	105,965 (CUT)
ALT 2	DRY FILL	30,315 (FILL)
ALT 2	WET FILL	12,992 (FILL)
ALT2 - NET VOLUME = 309,910 CY		

GENERAL NOTES

- These plans are a graphical representation of the work to be performed for the Trinity River Restoration Program, Oregon Gulch Channel Rehabilitation Project Site.
- These Drawings are not intended for construction but are a graphical representation of the project design development.
- References to the right or left bank on these plans are based on a reference point looking downstream.
- All dimensions are shown in feet unless otherwise specified.
- The aerial topographic survey for these plans was prepared by:
Woolpert, Inc. (Orthophotography)
GMA (Terrestrial and Bathymetric Topography)
CA Department of Water Resources. (Site Control)
Date of Existing Ground DTM Development - 2016
- Aerial photographs: April 2015.
- Existing contours within the active channel, tree, and brush areas may not meet 1 ft accuracy and should be considered approximate.
- Survey control points were established by the Department of Water Resources. All subsequent surveys reference these survey control points.
- Horizontal Datum for survey control points is NAD 83, California State Plane Coordinates, Zone 1, Survey Feet.
- Vertical Datum for survey control points is NAVD 88, Survey Feet.
- The government will flag biologically sensitive areas for protection from disturbance prior to construction.
- Grade of finished access roads should not exceed 15%.
- Contractor must reestablish access roads disturbed by construction activities by connecting any new roads to existing roads unless otherwise directed by on-site government representative.
- New access roads constructed by the contractor must be returned to original grade unless a government representative authorizes a new access road to remain in place post-construction.
- Design grade contour interval is 1-foot unless otherwise noted.
- Slopes shown on drawings are in the Horizontal:Vertical format.
- Upper case text in plans denotes features to be constructed.
- Prior to construction, the contractor shall clear and grub vegetation within construction areas only, unless flagged as 'save tree', 'clump planting', or 'large wood' by government.
- The contractor shall develop and maintain all construction access ramps, turnouts, turnarounds, etc., as necessary to haul and place fill as designated.
- Should it appear that the work to be done, is not sufficiently detailed or explained on these plans and attached specifications, the contractor shall contact the government representative who will intern contact the consultant team responsible for the plan preparation, prior to conducting work on that portion of the project.



Yurok Tribe

TRINITY RIVER RESTORATION PROGRAM

Oregon Gulch 30% Design Drawings - Yurok Tribe

Sheet Index - Quantities - Notes



Yurok Tribe

Drawing Type:

INDEX

Drawn By

DJ Bandrowski

Checked By

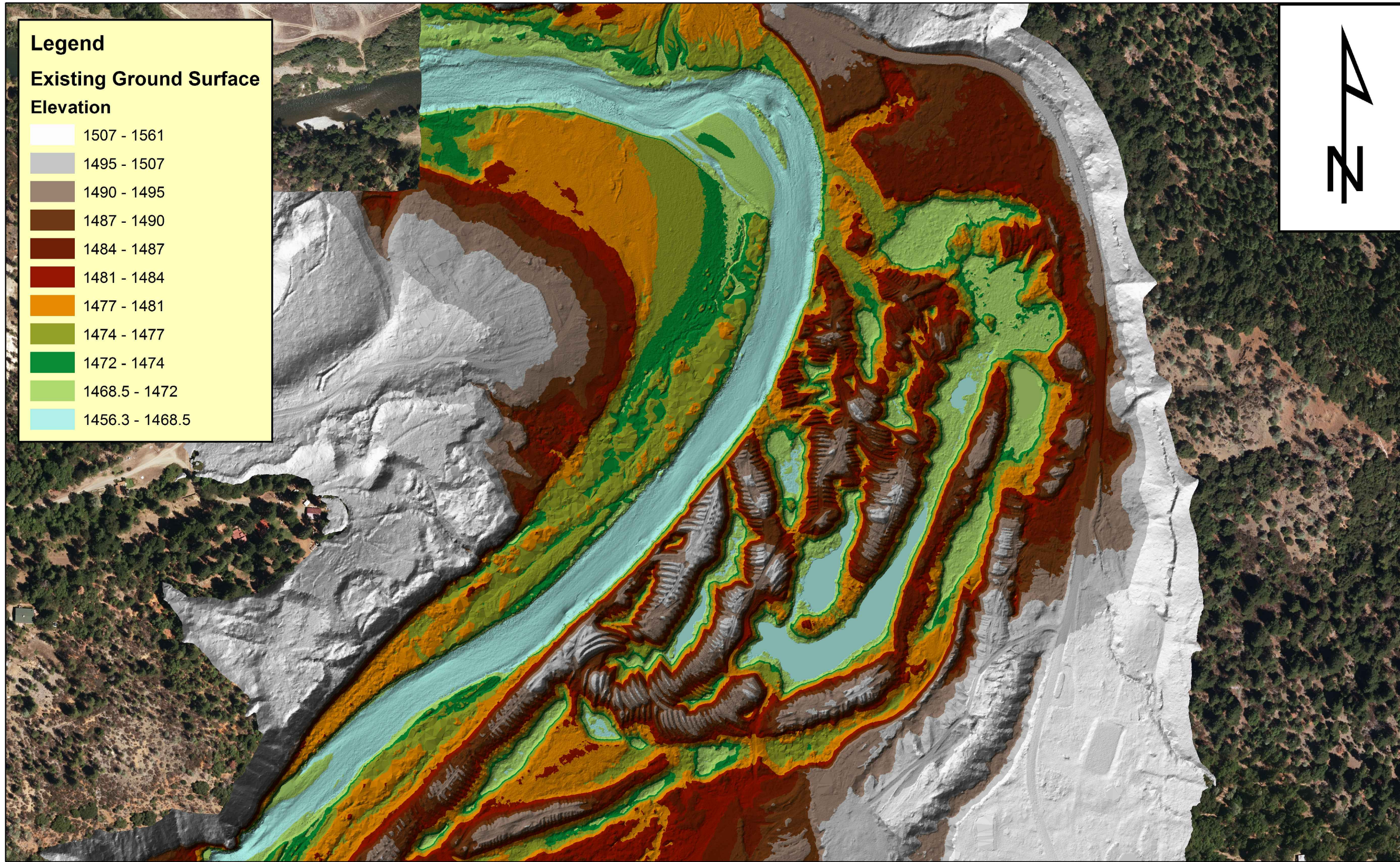
Aaron Martin

Design Date:

May 29, 2018

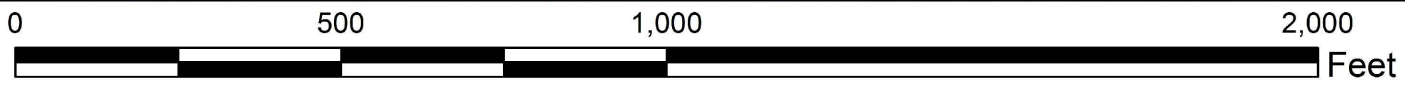
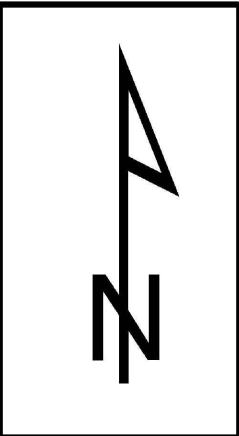
Sheet number

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Legend
Existing Ground Surface Elevation

White	1507 - 1561
Light Gray	1495 - 1507
Medium Gray	1490 - 1495
Brown	1487 - 1490
Dark Brown	1484 - 1487
Red	1481 - 1484
Orange	1477 - 1481
Light Green	1474 - 1477
Green	1472 - 1474
Light Green	1468.5 - 1472
Cyan	1456.3 - 1468.5



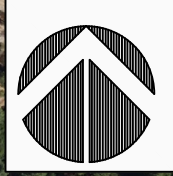
Yurok Tribe

TRINITY RIVER RESTORATION PROGRAM
Oregon Gulch 30% Design Drawings - Yurok Tribe
Planview - Existing Ground - Terrain Surface



Yurok Tribe

Drawing Type:
PLAN
Drawn By
DJ Bandrowski
Checked By
Aaron Martin
Design Date:
May 29, 2018
Sheet number
3 of 18



Environmental Study Limits (ESL)



Yurok Tribe

TRINITY RIVER RESTORATION PROGRAM

Oregon Gulch 30% Design Drawings - Yurok Tribe
Planview - Existing Ground - Aerial Photo & 5ft. Contours



Yurok Tribe

Drawing Type:

PLAN

Drawn By

DJ Bandrowski

Checked By

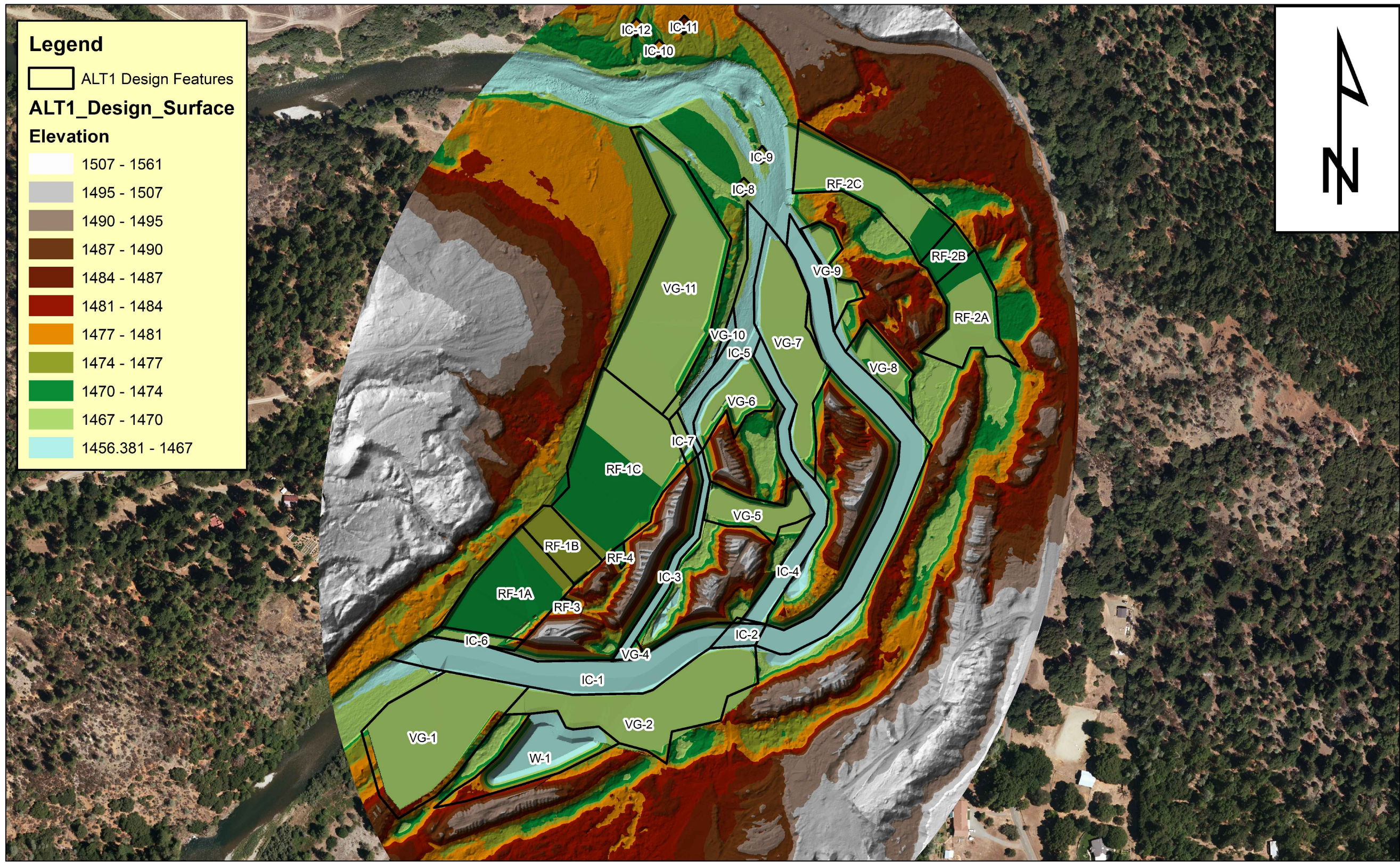
Aaron Martin

Design Date:

May 29, 2018

Sheet number

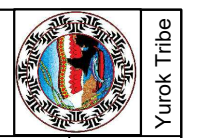
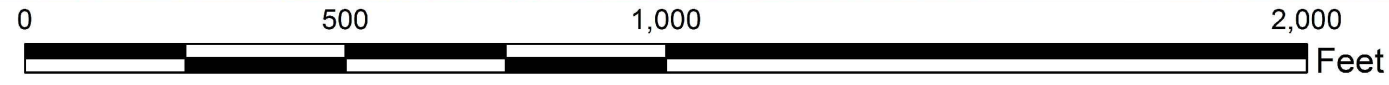
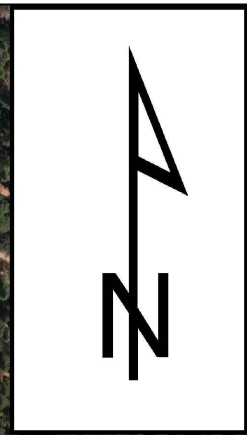
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Legend

ALT1 Design Features
ALT1_Design_Surface
Elevation

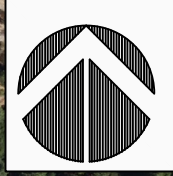
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	1495 - 1507
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	1484 - 1487
	1481 - 1484
	1477 - 1481
	1474 - 1477
	1470 - 1474
	1467 - 1470
	1456.381 - 1467



TRINITY RIVER RESTORATION PROGRAM
 Oregon Gulch 30% Design Drawings - Yurok Tribe
 Planview - ALT 1 - Terrain Surface



Drawing Type:	PLAN
Drawn By	DJ Bandrowski
Checked By	Aaron Martin
Design Date:	May 29, 2018
Sheet number	5 of 18



Environmental Study Limits (ESL)

Design Feature Boundaries



Yurok Tribe

TRINITY RIVER RESTORATION PROGRAM

Oregon Gulch 30% Design Drawings - Yurok Tribe
Planview - ALT1 - Aerial Photo & 5ft. Contours



Yurok Tribe

Drawing Type:

PLAN

Drawn By

DJ Bandrowski

Checked By

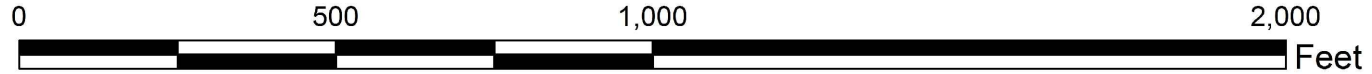
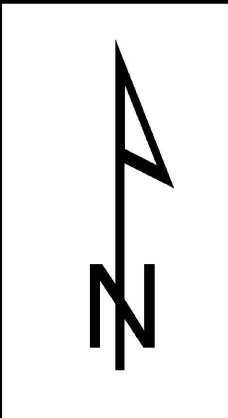
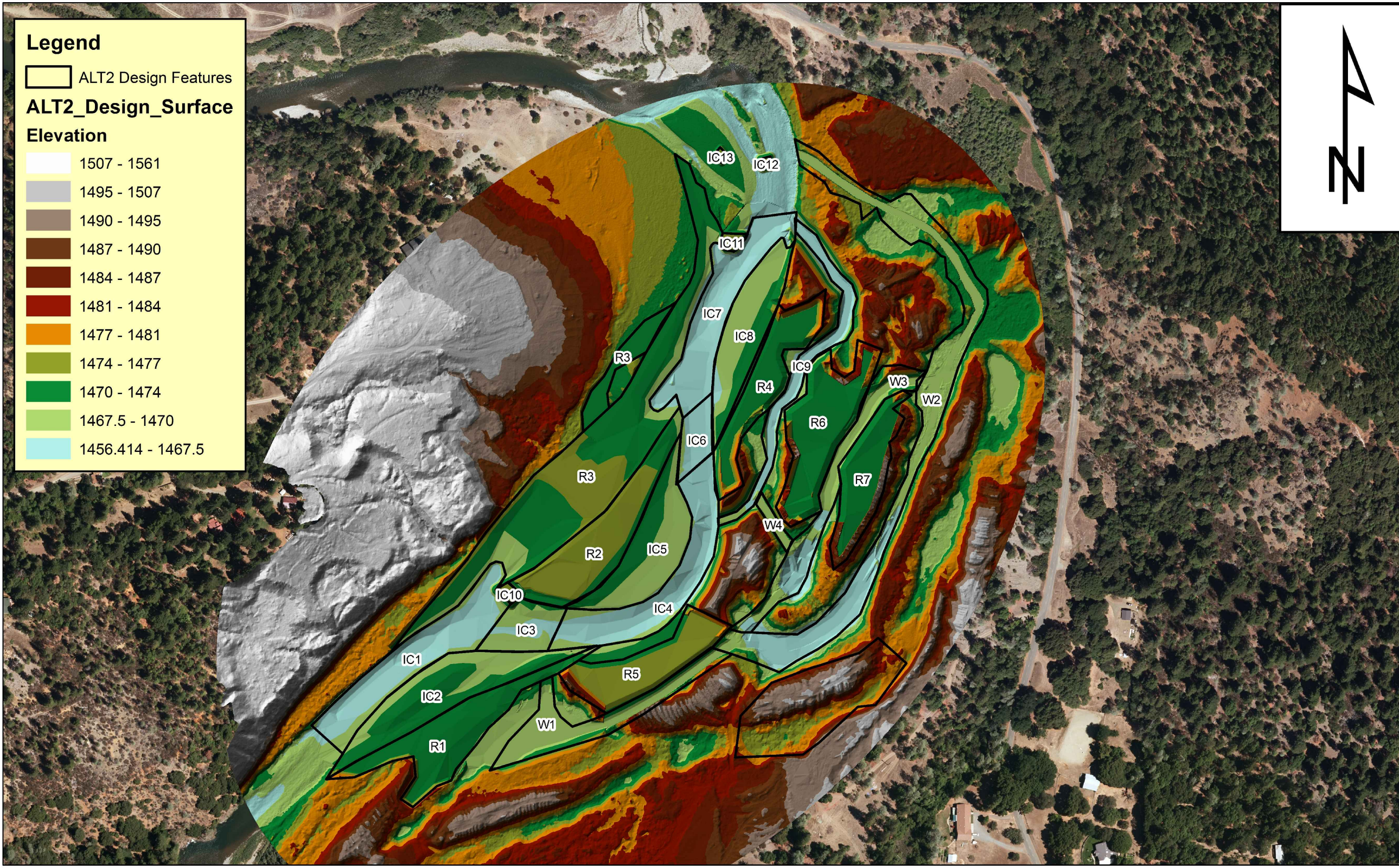
Aaron Martin

Design Date:

May 29, 2018

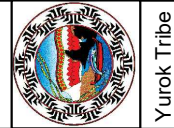
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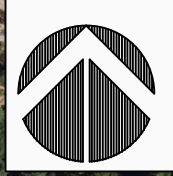
Yurok Tribe

TRINITY RIVER RESTORATION PROGRAM
Oregon Gulch 30% Design Drawings - Yurok Tribe
Planview - ALT 2 - Terrain Surface



Yurok Tribe

Drawing Type:	PLAN
Drawn By	DJ Bandrowski
Checked By	Aaron Martin
Design Date:	May 29, 2018
Sheet number	7 of 18



Yurok Tribe



TRINITY RIVER RESTORATION PROGRAM

Oregon Gulch 30% Design Drawings - Yurok Tribe Planview - ALT2 - Aerial Photo & 5ft. Contours



Yurok Tribe

Drawing Type:

PLAN

Drawn By

DJ Bandrowski

Checked By

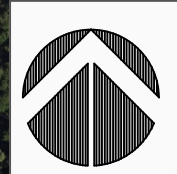
Aaron Martin

Design Date:

May 29, 2018

Sheet number

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Yurok Tribe

TRINITY RIVER RESTORATION PROGRAM

Oregon Gulch 30% Design Drawings - Yurok Tribe Planview - ALT1 - Profile and Cross-Section Locations



Yurok Tribe

Drawing Type:

PLAN

Drawn By

DJ Bandrowski

Checked By

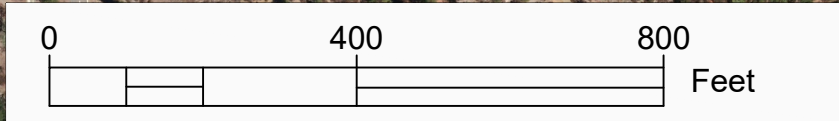
Aaron Martin

Design Date:

May 29, 2018

Sheet number

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Yurok Tribe

TRINITY RIVER RESTORATION PROGRAM

Oregon Gulch 30% Design Drawings - Yurok Tribe

Profile - ALT1 - IC-1 and IC-4 Channel Design



Yurok Tribe

Drawing Type:

PROFILE

Drawn By

DJ Bandrowski

Checked By

Aaron Martin

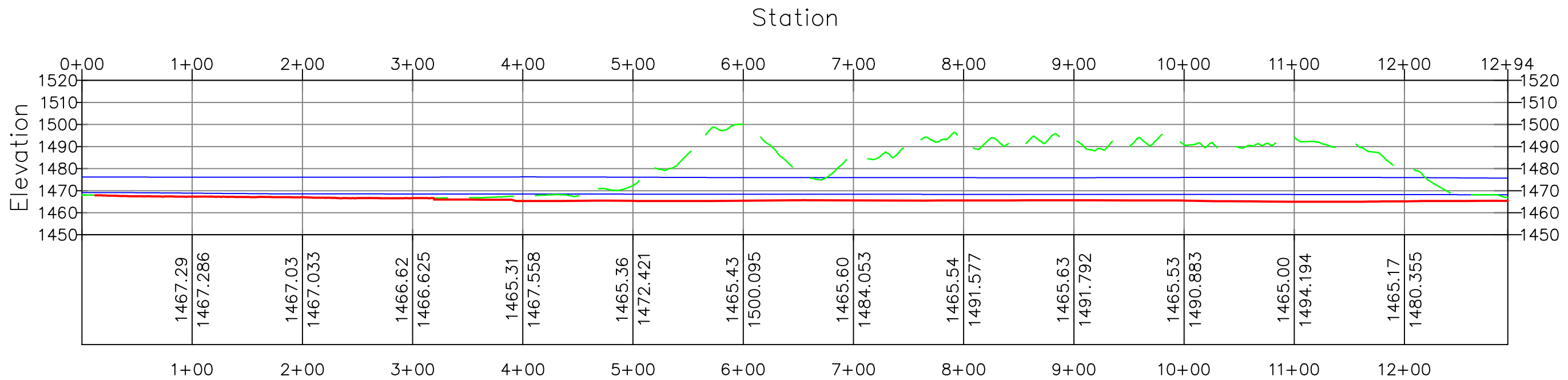
Design Date:

May 29, 2018

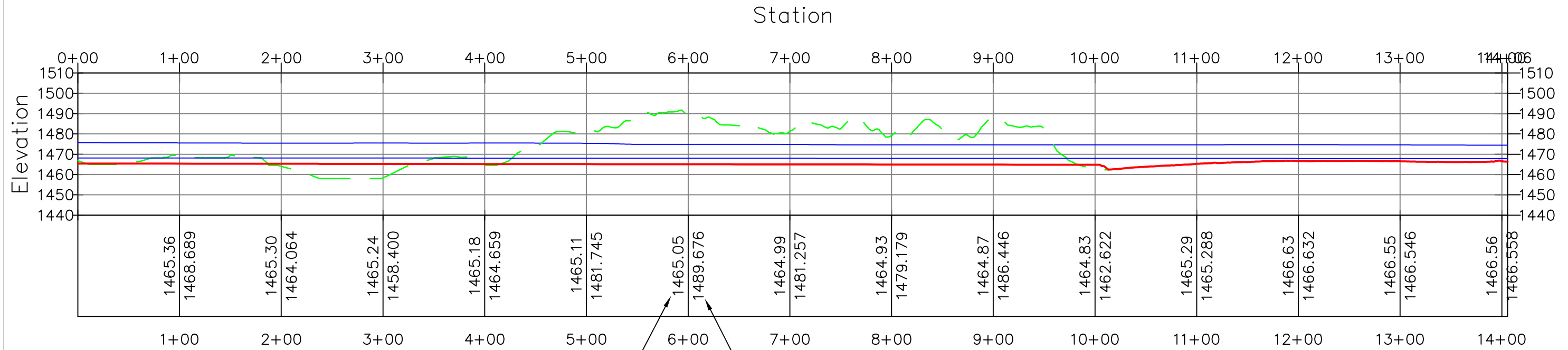
Sheet number

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OG_Alignment_ALT1_IC-1 PROFILE



OG_Alignment_ALT1_IC-4 PROFILE



Design Grade Elevation

Existing Ground Elevation

Legend

- Design Grade
- Existing Ground (2016)
- Design Water Surface (450cfs/9000cfs)



Yurok Tribe

TRINITY RIVER RESTORATION PROGRAM
Oregon Gulch 30% Design Drawings - Yurok Tribe
Profile - ALT1 - IC-2 and IC-3 Channel Design



Yurok Tribe

Drawing Type:

PROFILE

Drawn By

DJ Bandrowski

Checked By

Aaron Martin

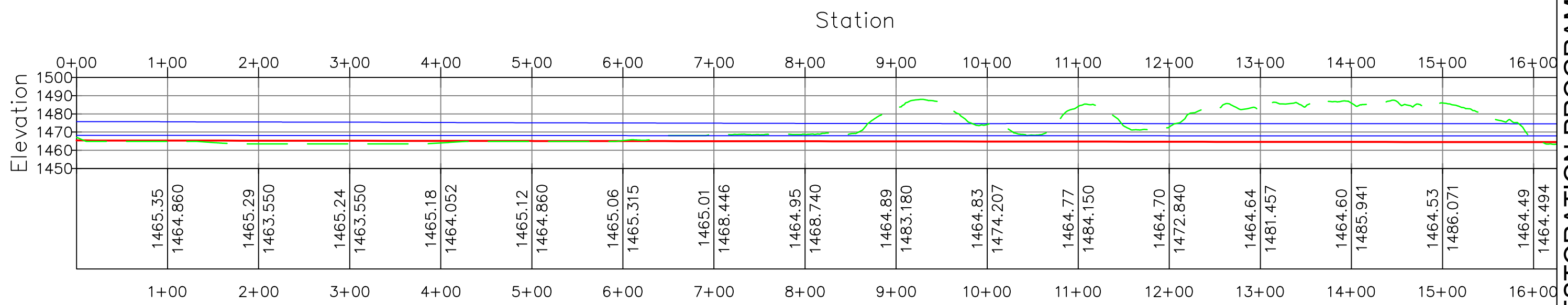
Design Date:

May 29, 2018

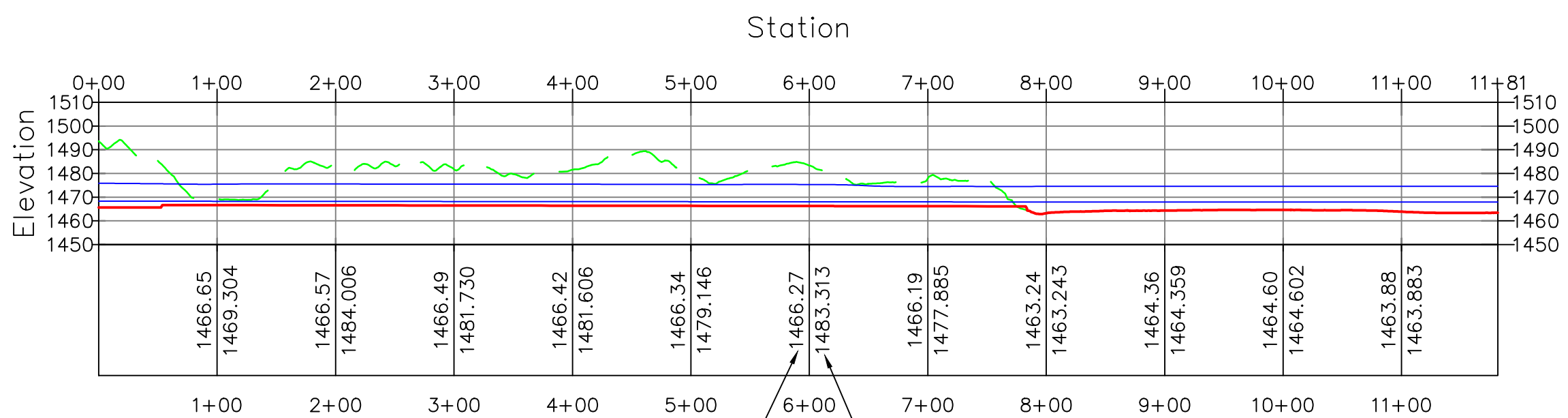
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OG_Alignment_ALT1_IC-2 PROFILE

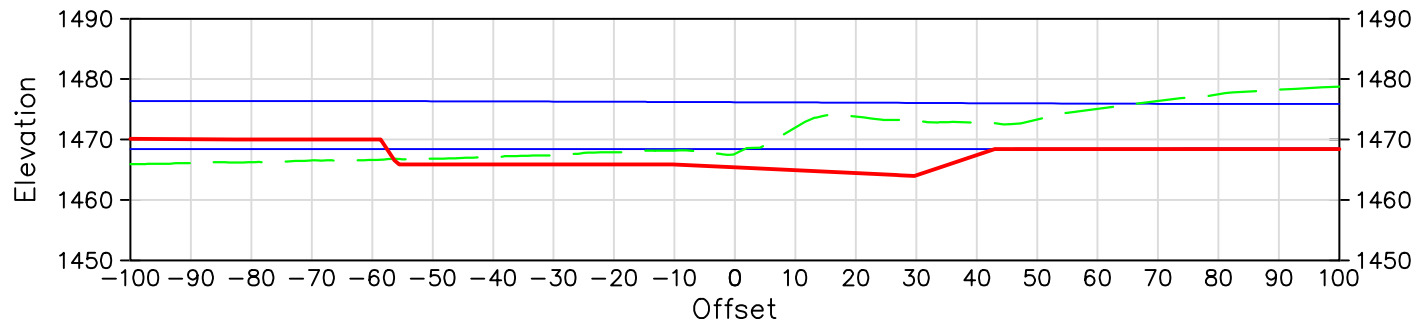


OG_Alignment_ALT1_IC-3 PROFILE

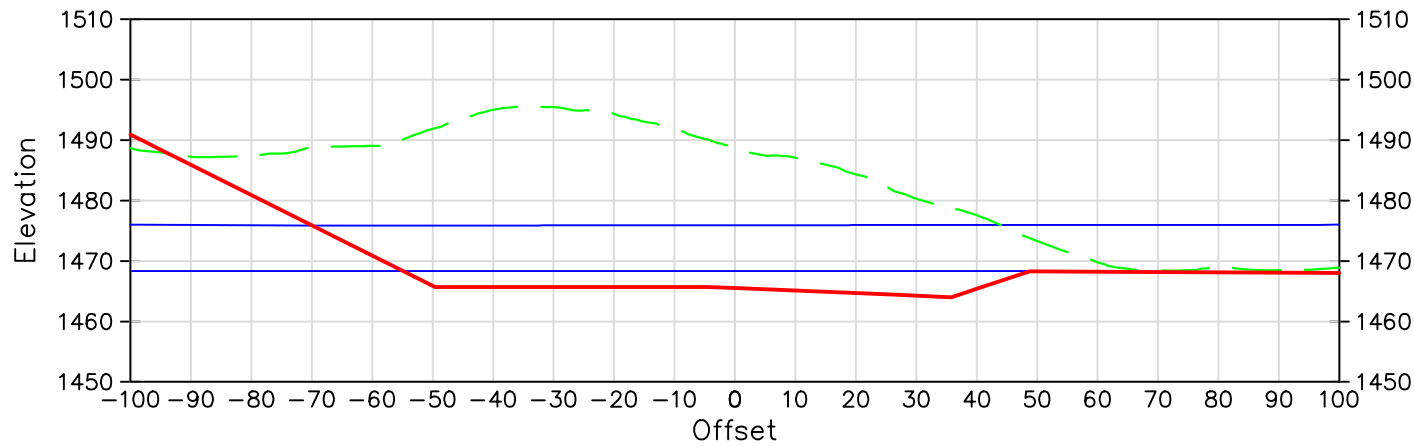


CROSS-SECTION FROM PROFILE IC-1 CHANNEL

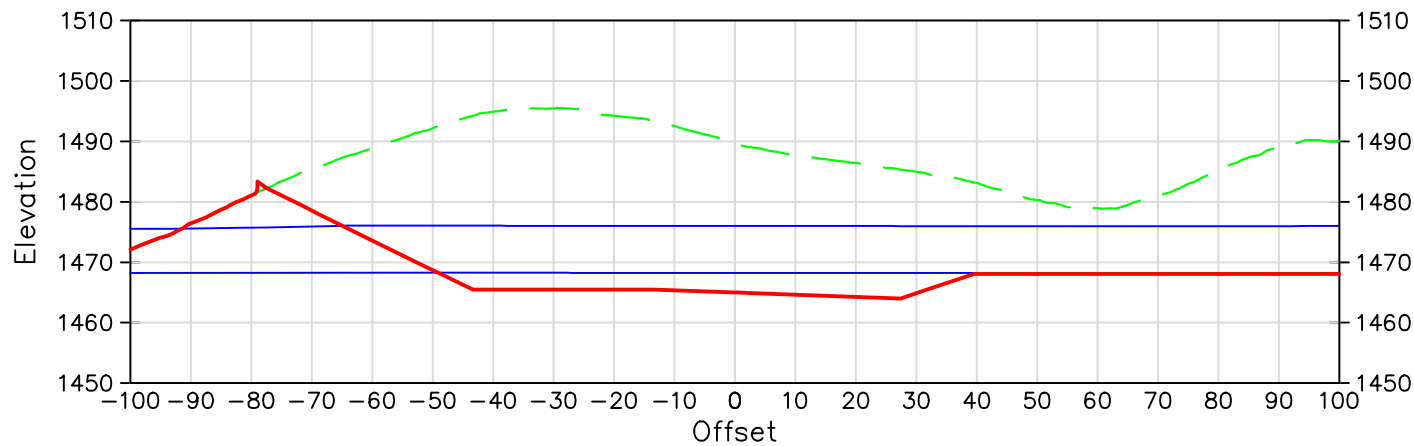
4+49.34



7+50.00



11+37.82

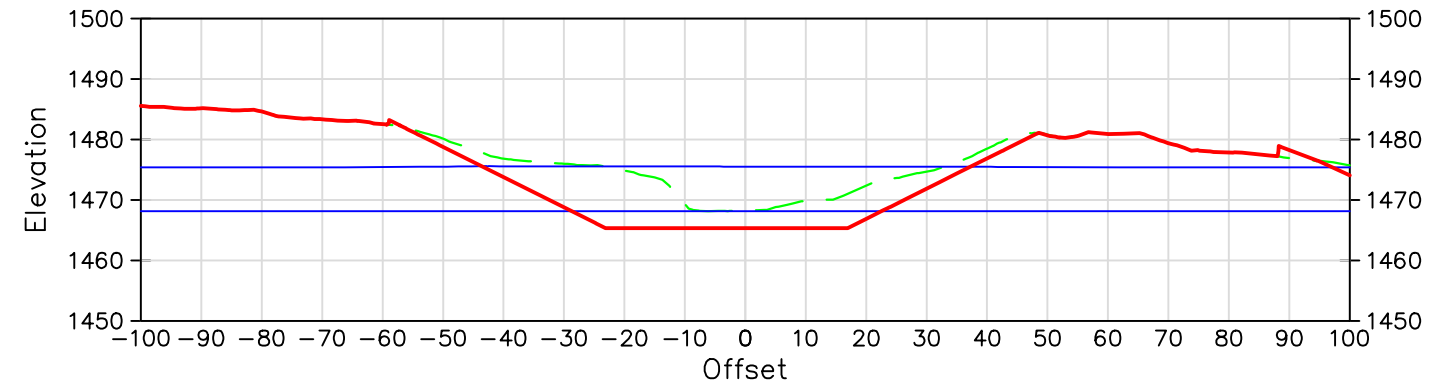


Legend

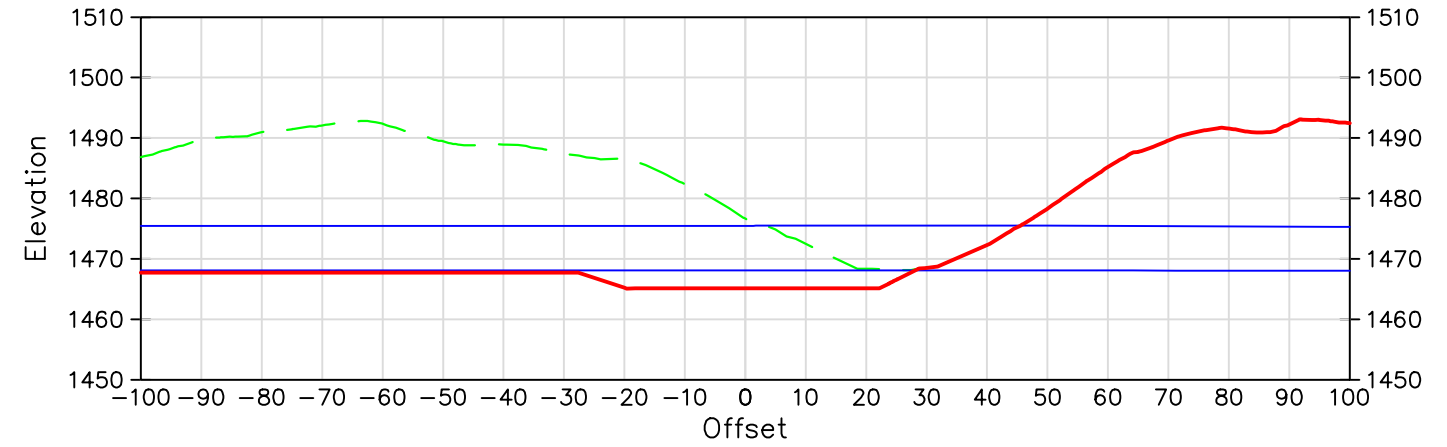
- Design Grade
- - - Existing Ground (2016)
- Design Water Surface (450cfs/9000cfs)

CROSS-SECTION FROM PROFILE IC-4 CHANNEL

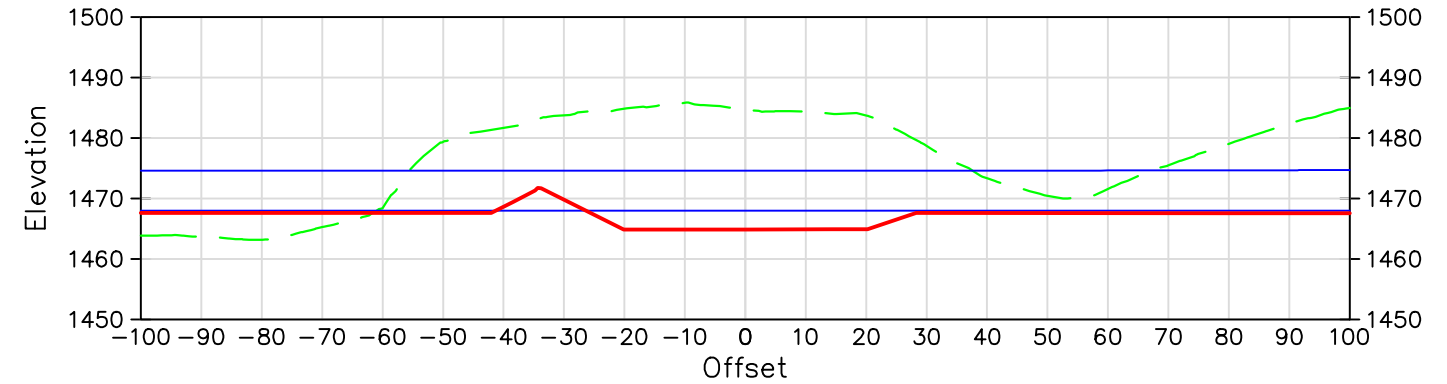
1+37.35



4+58.47



9+13.45



Yurok Tribe

TRINITY RIVER RESTORATION PROGRAM

Oregon Gulch 30% Design Drawings - Yurok Tribe
Cross-Sections - ALT1 - From Profile IC-1 and IC-4



Yurok Tribe

Drawing Type:

X-SECT.

Drawn By

DJ Bandrowski

Checked By

Aaron Martin

Design Date:

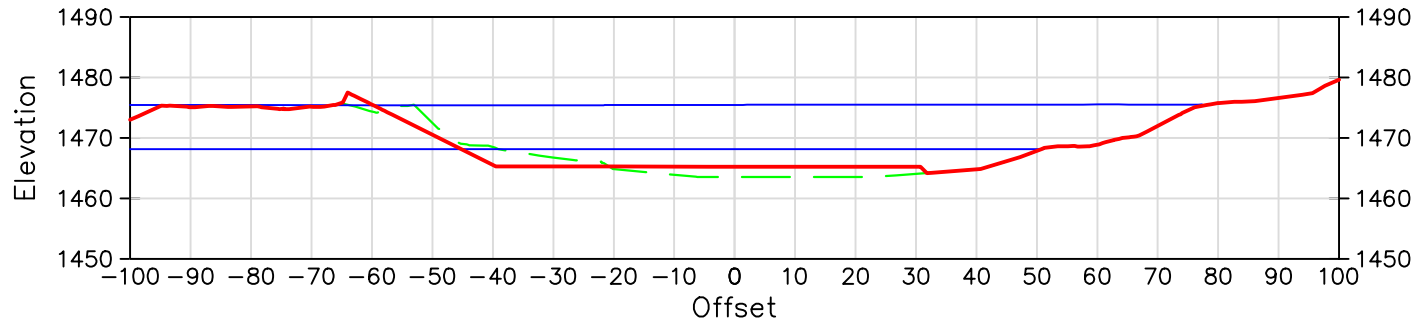
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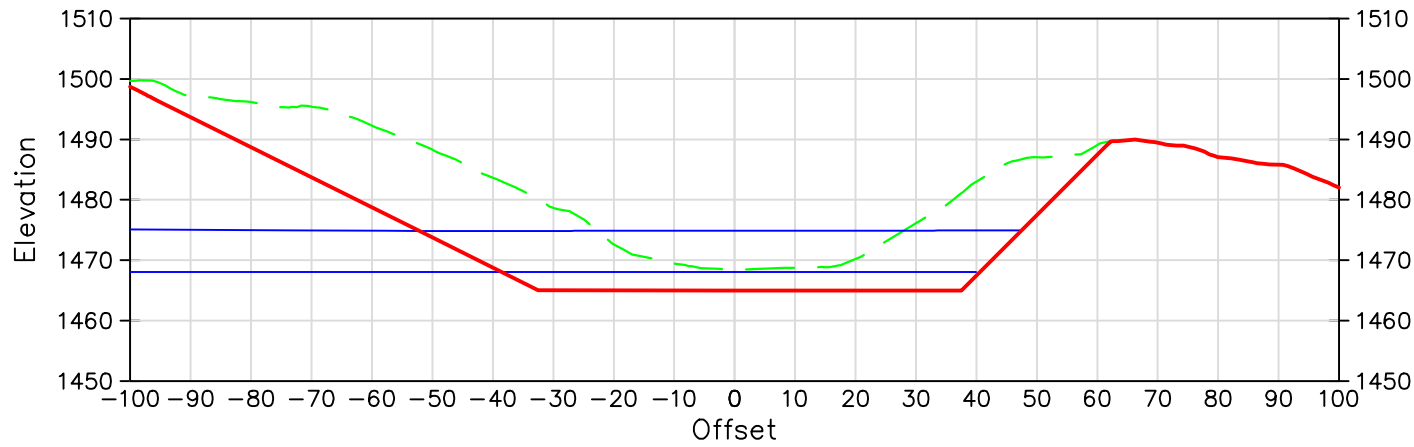
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CROSS-SECTION FROM PROFILE IC-2 CHANNEL

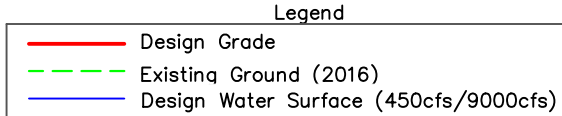
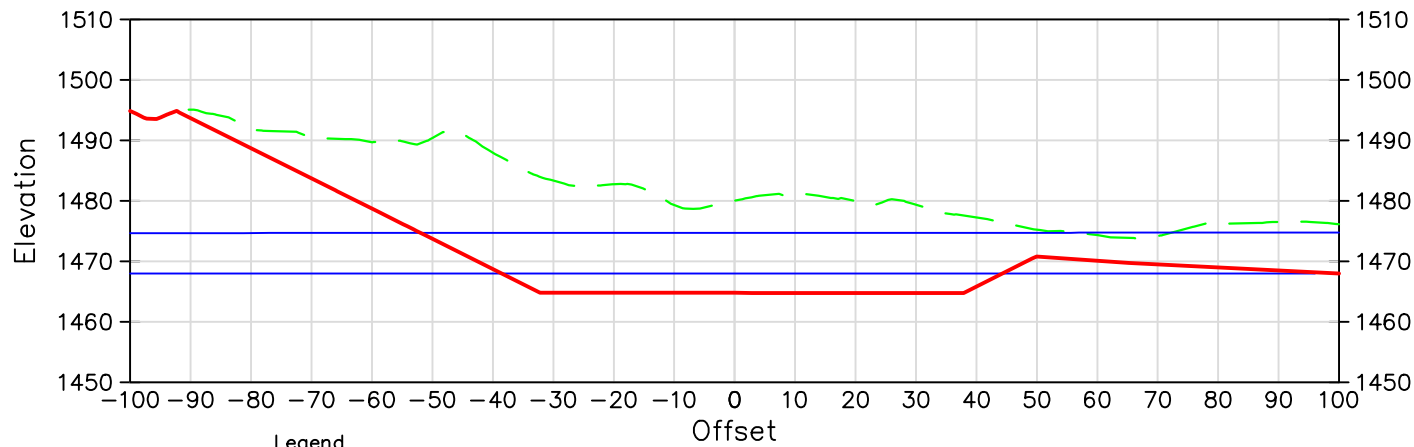
2+86.52



6+99.89

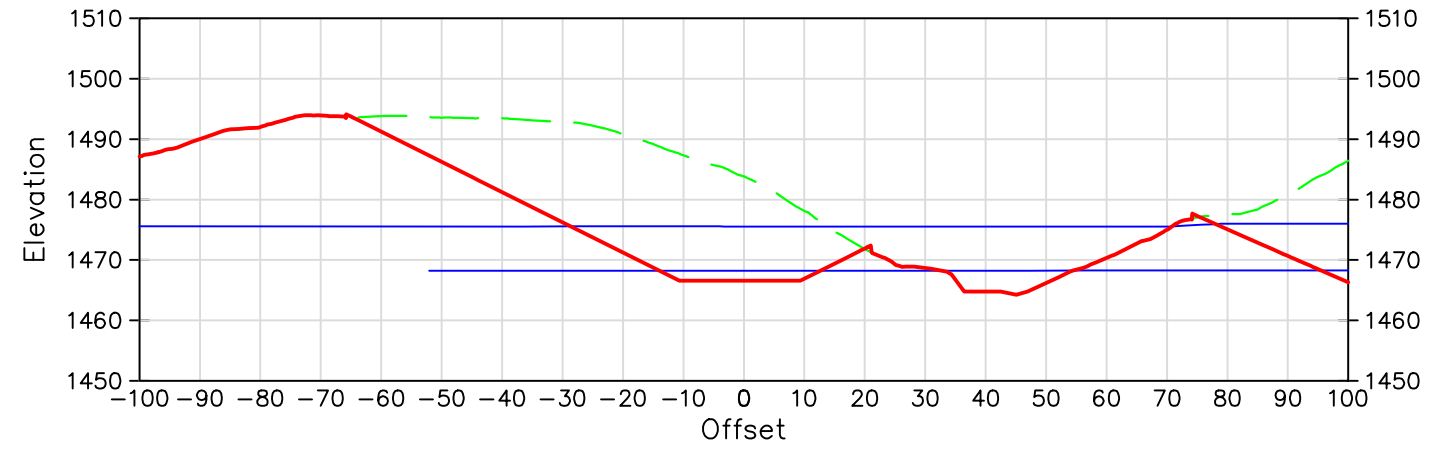


10+84.42

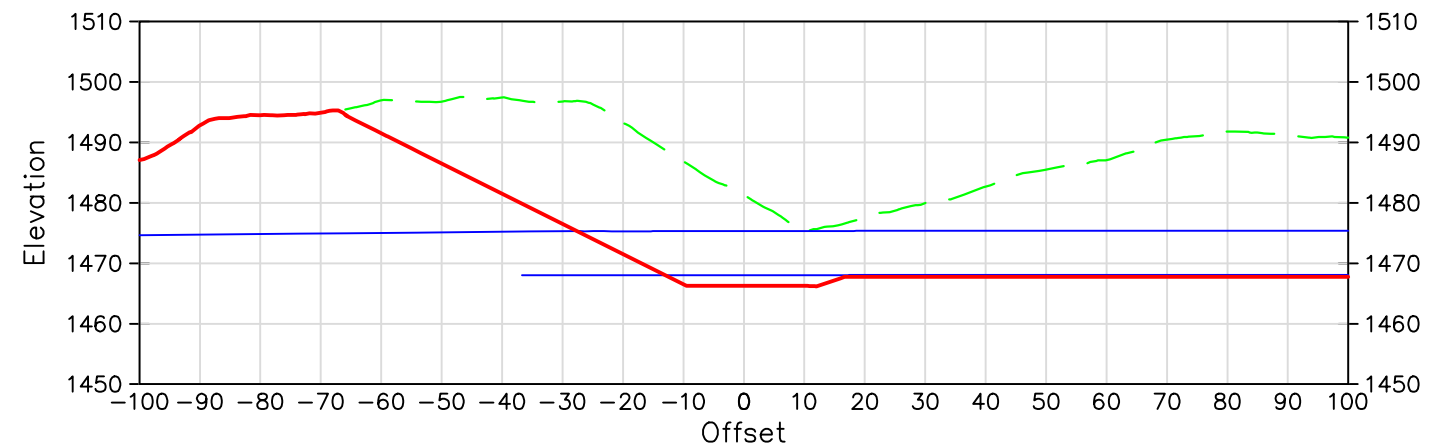


CROSS-SECTION FROM PROFILE IC-3 CHANNEL

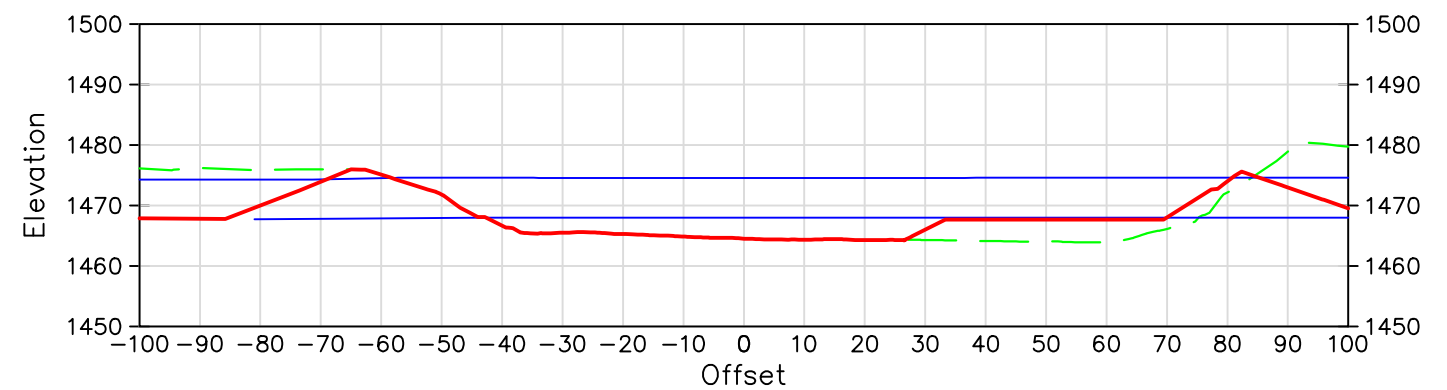
1+98.62



6+09.99



9+32.33



Yurok Tribe

TRINITY RIVER RESTORATION PROGRAM

Oregon Gulch 30% Design Drawings - Yurok Tribe
Cross-Sections - ALT1 - From Profile IC-2 and IC-3



Yurok Tribe

Drawing Type:

X-SECT.

Drawn By

DJ Bandrowski

Checked By

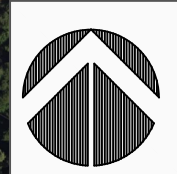
Aaron Martin

Design Date:

May 29, 2018

Sheet number

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Yurok Tribe

TRINITY RIVER RESTORATION PROGRAM
Oregon Gulch 30% Design Drawings - Yurok Tribe
Planview - ALT2- Profile and Cross-Section Locations



Yurok Tribe

Drawing Type:

PLAN

Drawn By

DJ Bandrowski

Checked By

Aaron Martin

Design Date:

May 29, 2018

Sheet number

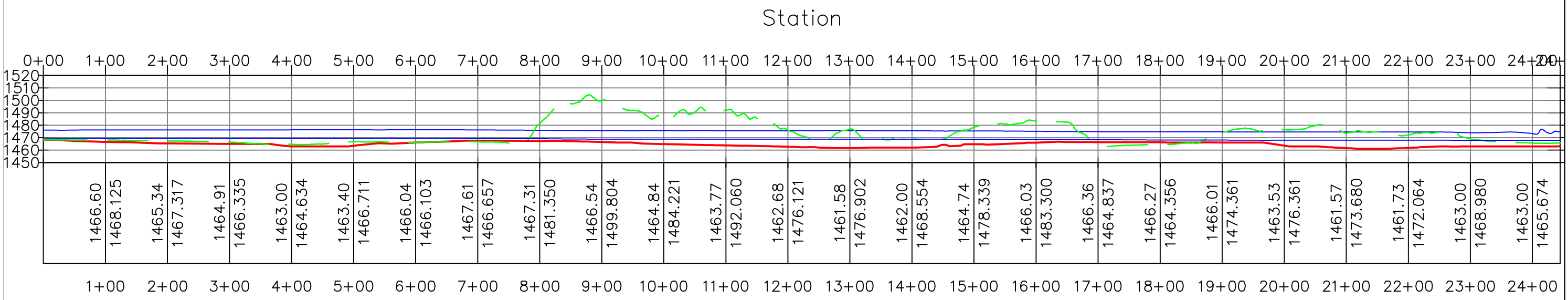
14 of 18



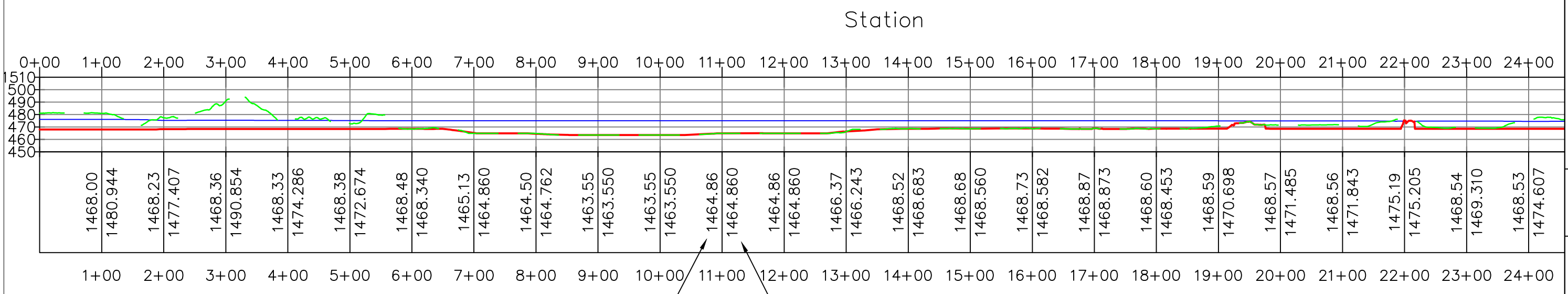


Yurok Tribe

OG_Alignment_ALT2_IC-1 to IC-7 Channel PROFILE



OG_Alignment_ALT2_W-1 and W-2 Channels PROFILE



Design Grade Elevation

Existing Ground Elevation

Legend

- Design Grade
- Existing Ground (2016)
- Design Water Surface (450cfs/9000cfs)

TRINITY RIVER RESTORATION PROGRAM

Oregon Gulch 30% Design Drawings - Yurok Tribe
Profile - ALT2 - IC-1/7 and W1/2 Channel Design



Yurok Tribe

Drawing Type:

PROFILE

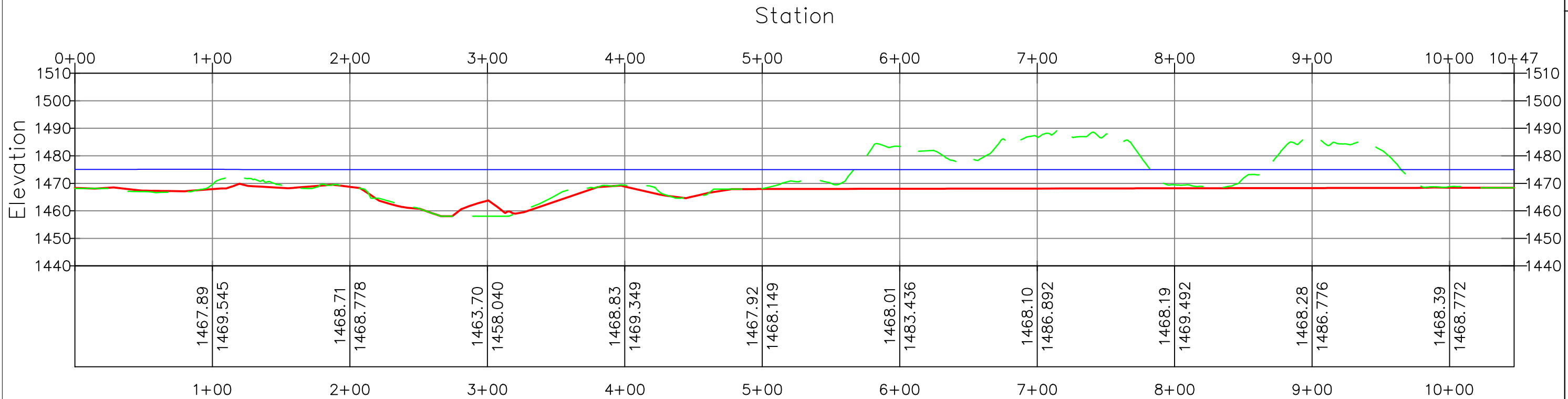
Drawn By
DJ Bandrowski

Checked By
Aaron Martin

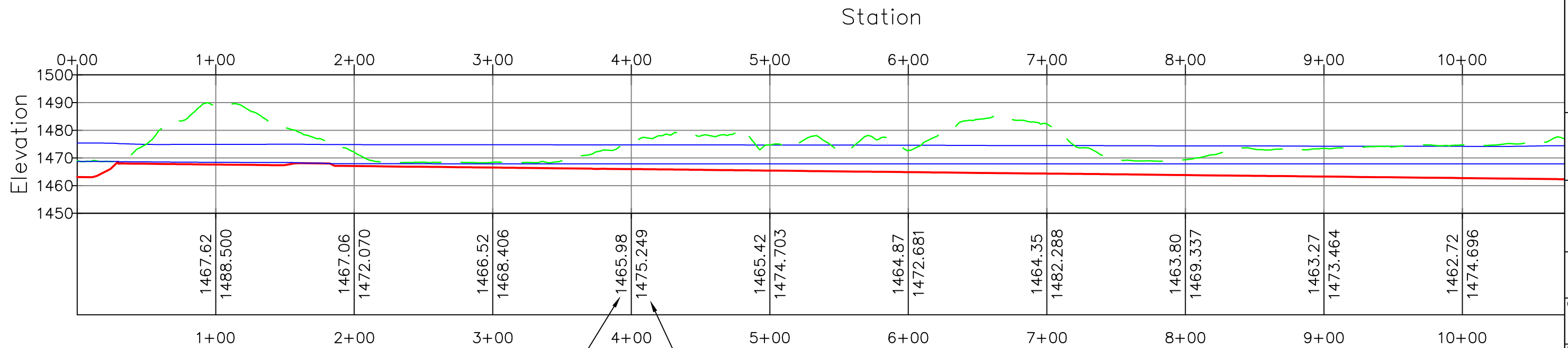
Design Date:
May 29, 2018

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OG_Alignment_ALT2_W-3 Channel PROFILE



OG_Alignment_ALT2_IC-9 Channel PROFILE



Design Grade Elevation

Existing Ground Elevation

Legend

- Design Grade
- Existing Ground (2016)
- Design Water Surface (450cfs/9000cfs)



Yurok Tribe

TRINITY RIVER RESTORATION PROGRAM
 Oregon Gulch 30% Design Drawings - Yurok Tribe
 Profile - ALT2 - W-3 and IC-9 Channel Design



Yurok Tribe

Drawing Type:

PROFILE

Drawn By

DJ Bandrowski

Checked By

Aaron Martin

Design Date:

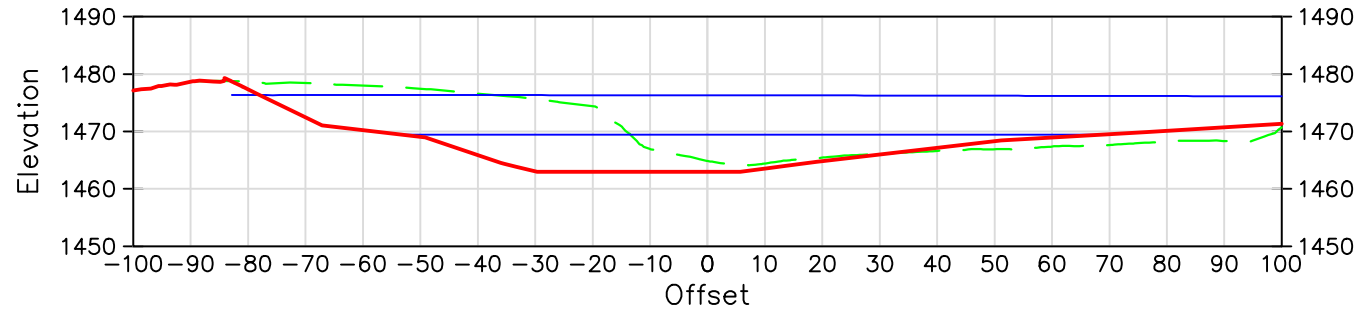
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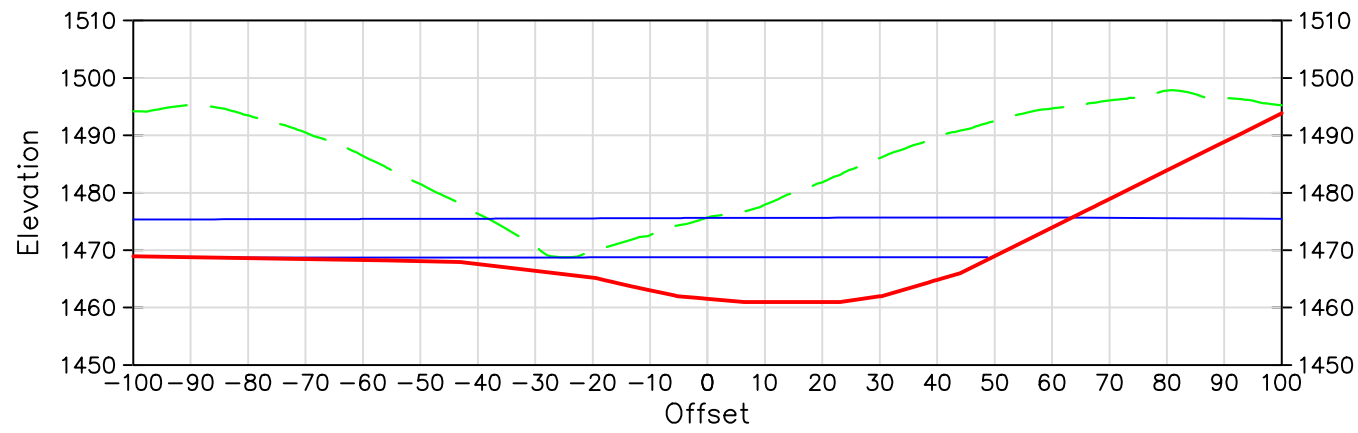
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CROSS-SECTION FROM PROFILE IC-1/3/4/7 CHANNEL

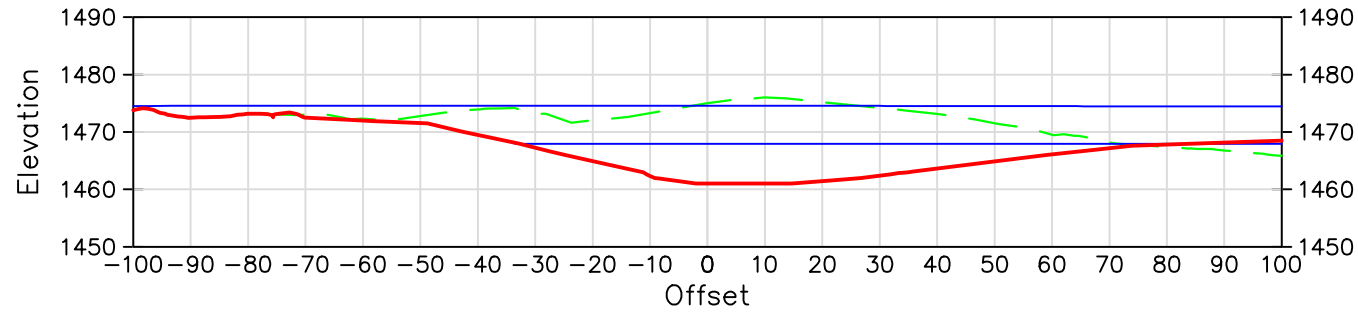
4+49.65



12+88.05



21+51.27

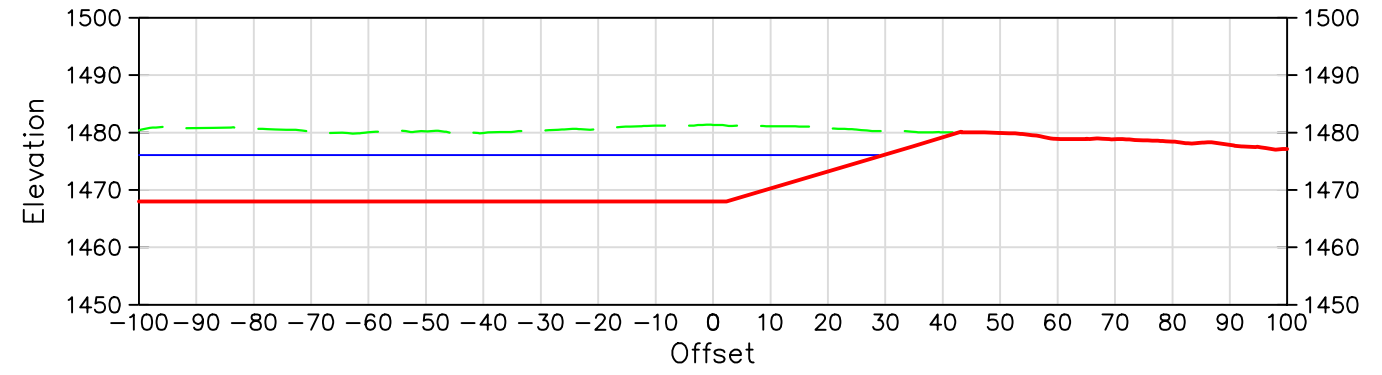


Legend

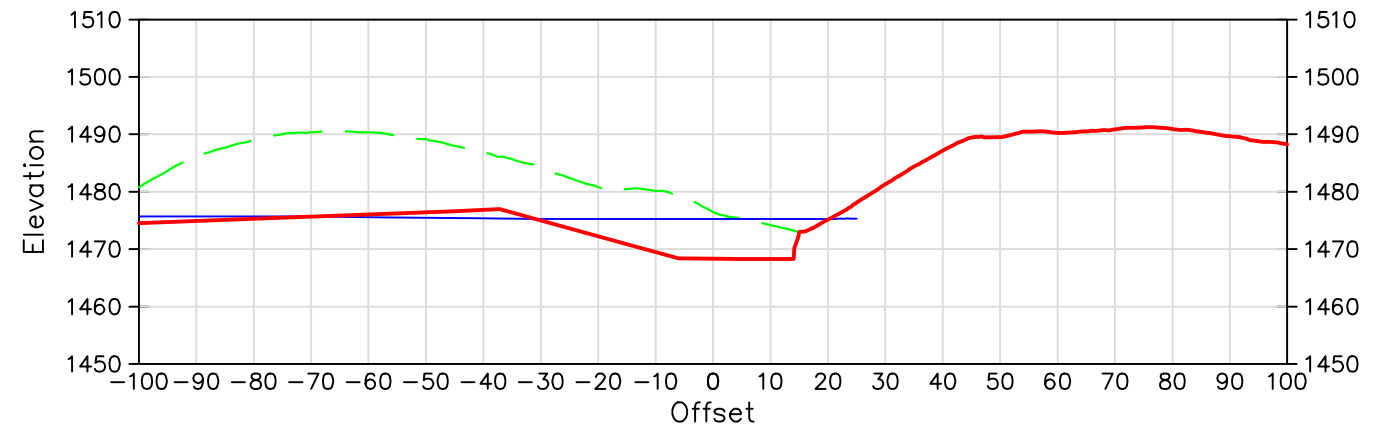
- Design Grade
- - - Existing Ground (2016)
- Design Water Surface (450cfs/9000cfs)

CROSS-SECTION FROM PROFILE W-3/W-4 CHANNEL

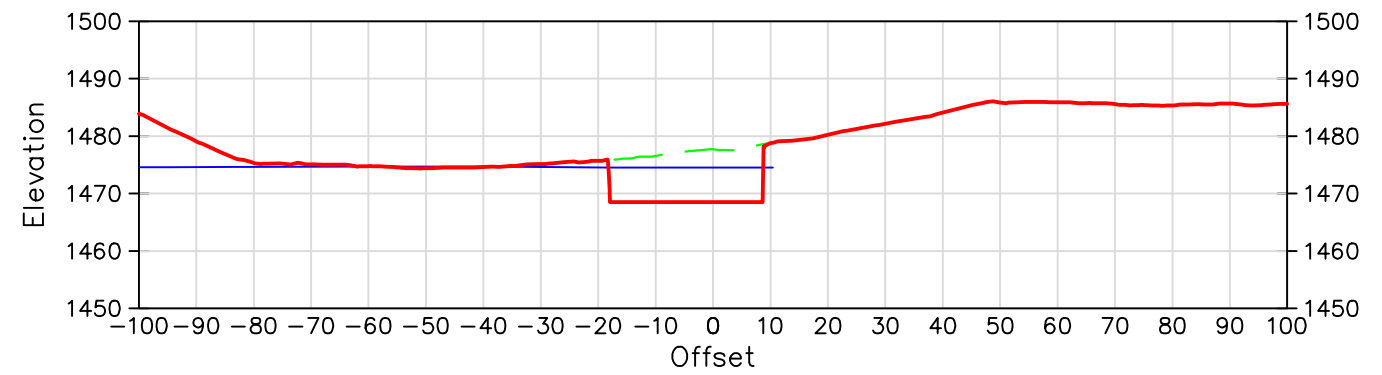
0+15.70



4+16.63



24+35.81



Yurok Tribe

TRINITY RIVER RESTORATION PROGRAM

Oregon Gulch 30% Design Drawings - Yurok Tribe
Cross-Sections - ALT2- From Profile IC-1/7 and W-3/4



Yurok Tribe

Drawing Type:

X-SECT.

Drawn By

DJ Bandrowski

Checked By

Aaron Martin

Design Date:

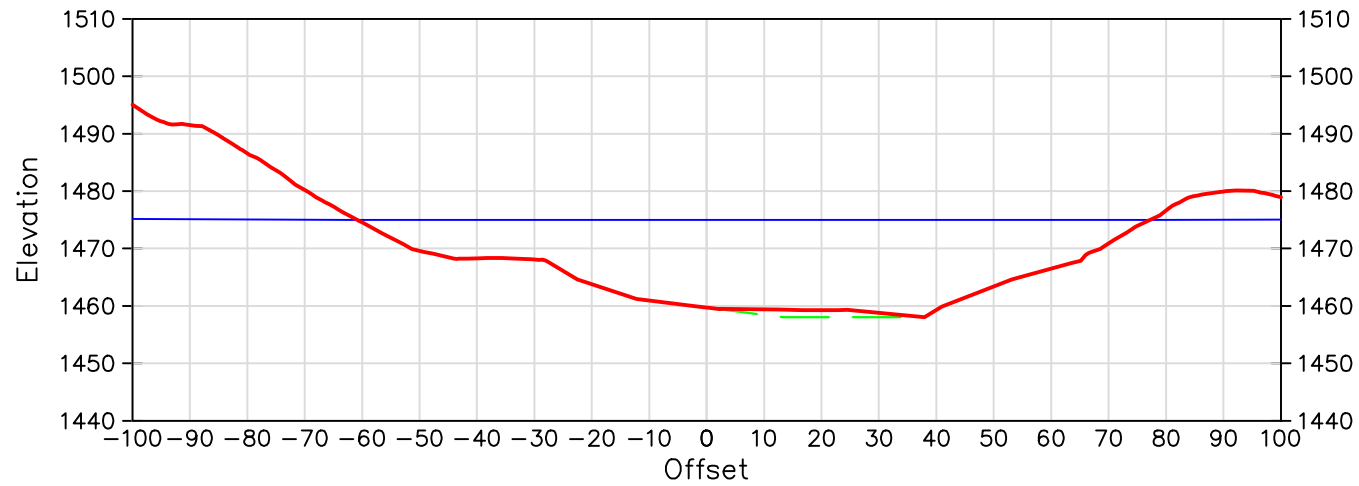
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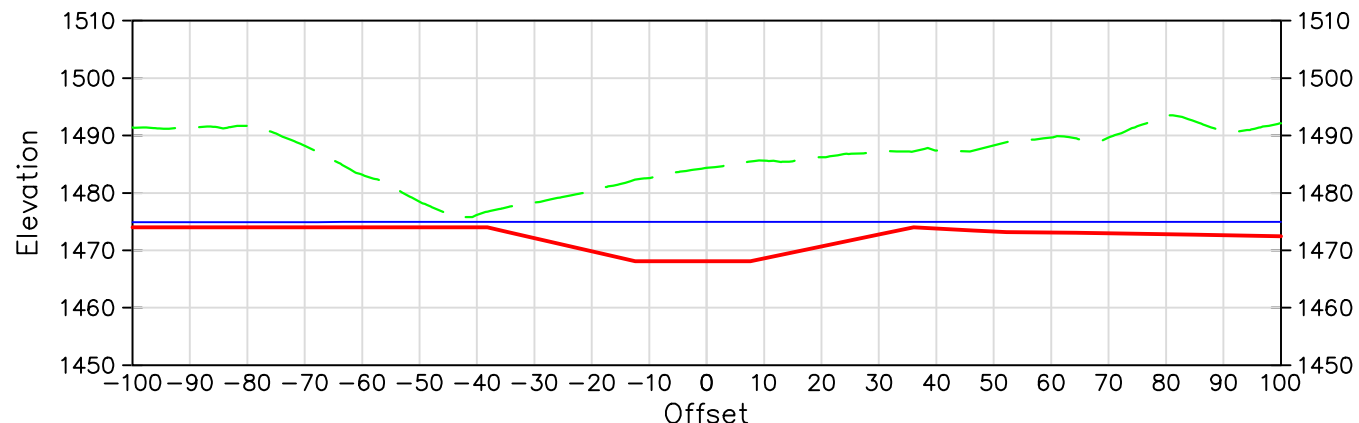
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CROSS-SECTION FROM PROFILE W-3 CHANNEL

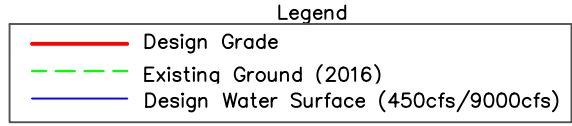
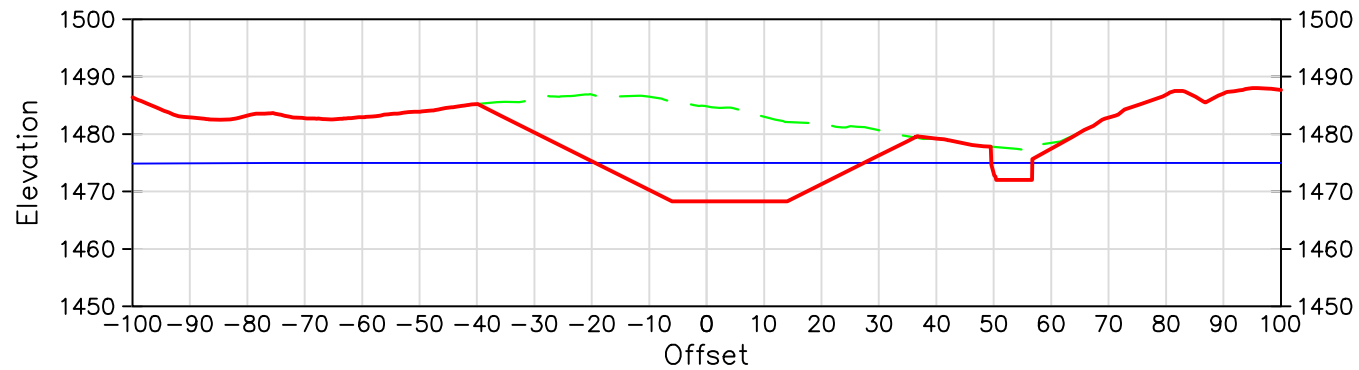
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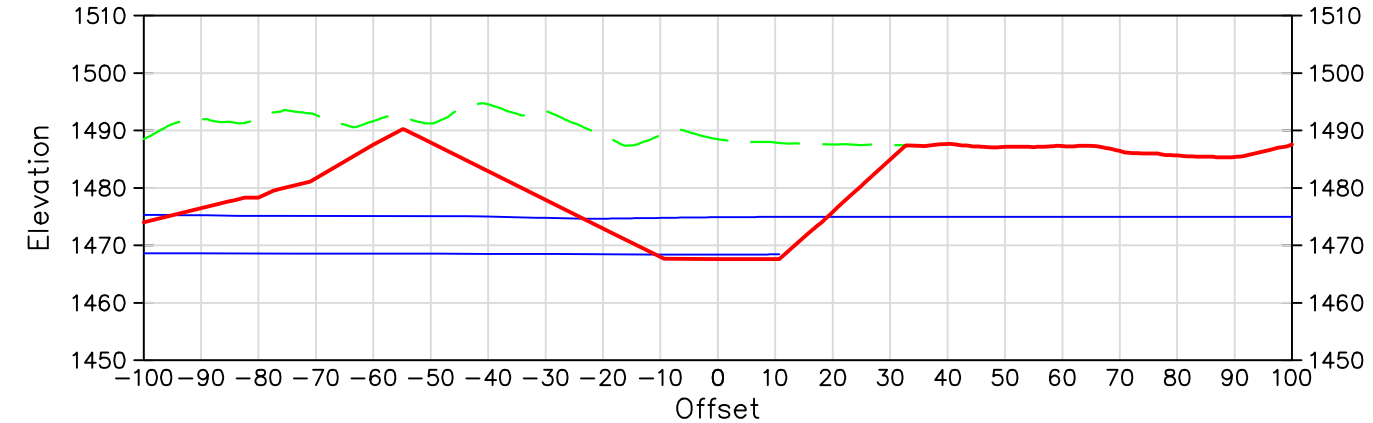


9+34.71

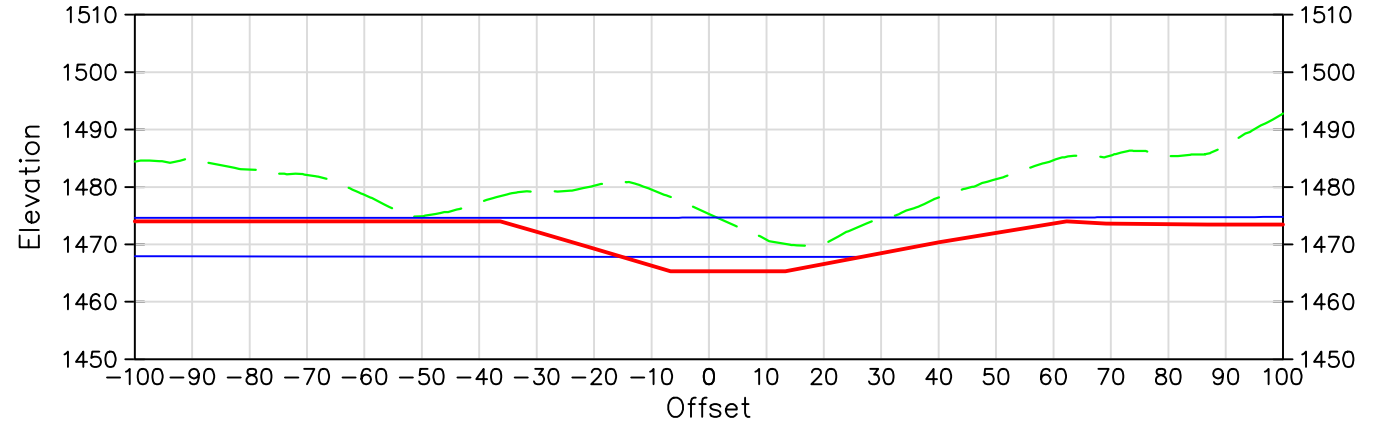


CROSS-SECTION FROM PROFILE IC-9 CHANNEL

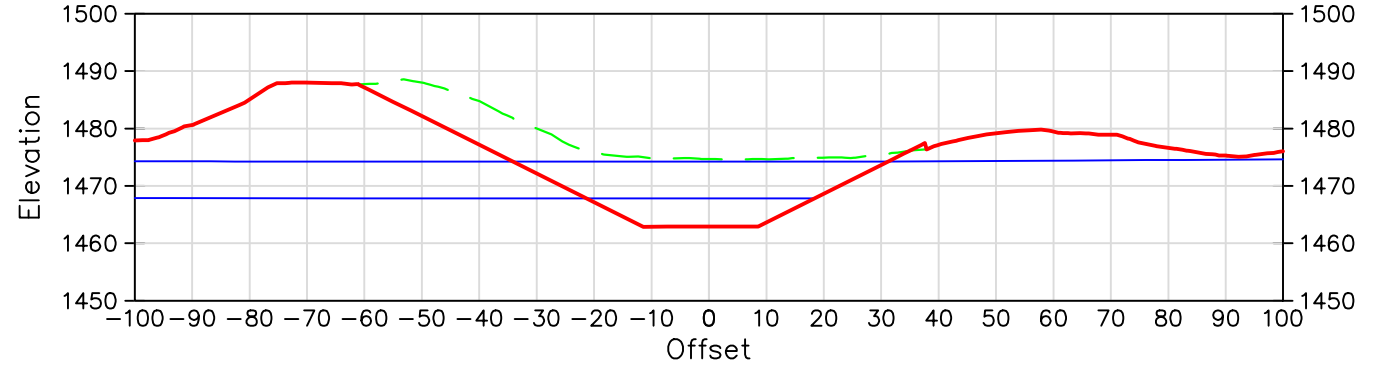
1+00.07



5+20.60



9+63.05



TRINITY RIVER RESTORATION PROGRAM
 Oregon Gulch 30% Design Drawings - Yurok Tribe
 Cross-Sections - ALT2- From Profile IC-1/7 and W-1/2



Drawing Type:

X-SECT.

Drawn By

DJ Bandrowski

Checked By

Aaron Martin

Design Date:

May 29, 2018

Sheet number

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