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Basis of Design Report for Buck Gulch Fish Passage Project (Worley Property)

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Cover photo: Existing Culvert over Buck Gulch.

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1 INTRODUCTION

Elizabeth Worley, the owner of APN 220-271-008, contracted Stillwater Sciences to prepare fish passage upgrade designs for a culvert located on Buck Gulch, tributary to Redwood Creek. This Basis of Design (BOD) Report provides justification for the fish passage upgrade design which is included in Appendix A.

2 SITE DESCRIPTION

The project is located to the north of the small town of Briceland, along Buck Gulch which flows into Miller Creek, then Redwood Creek. Redwood Creek enters the South Fork Eel River from the west near the town of Redway in southern Humboldt County. The current crossing structure is estimated to be at least 30 years old. As shown on figure 1, it is a 6-foot diameter corrugated metal culvert with a ~2-foot jump at the outlet. Additionally, rust holes have developed in the bottom of the culvert, and decaying logs are holding up the near-vertical fill slopes around the culvert inlet. The project drains an area of approximately 0.9 square miles and the location is shown on Figure 2.

Figure 1. Project site overview photo.

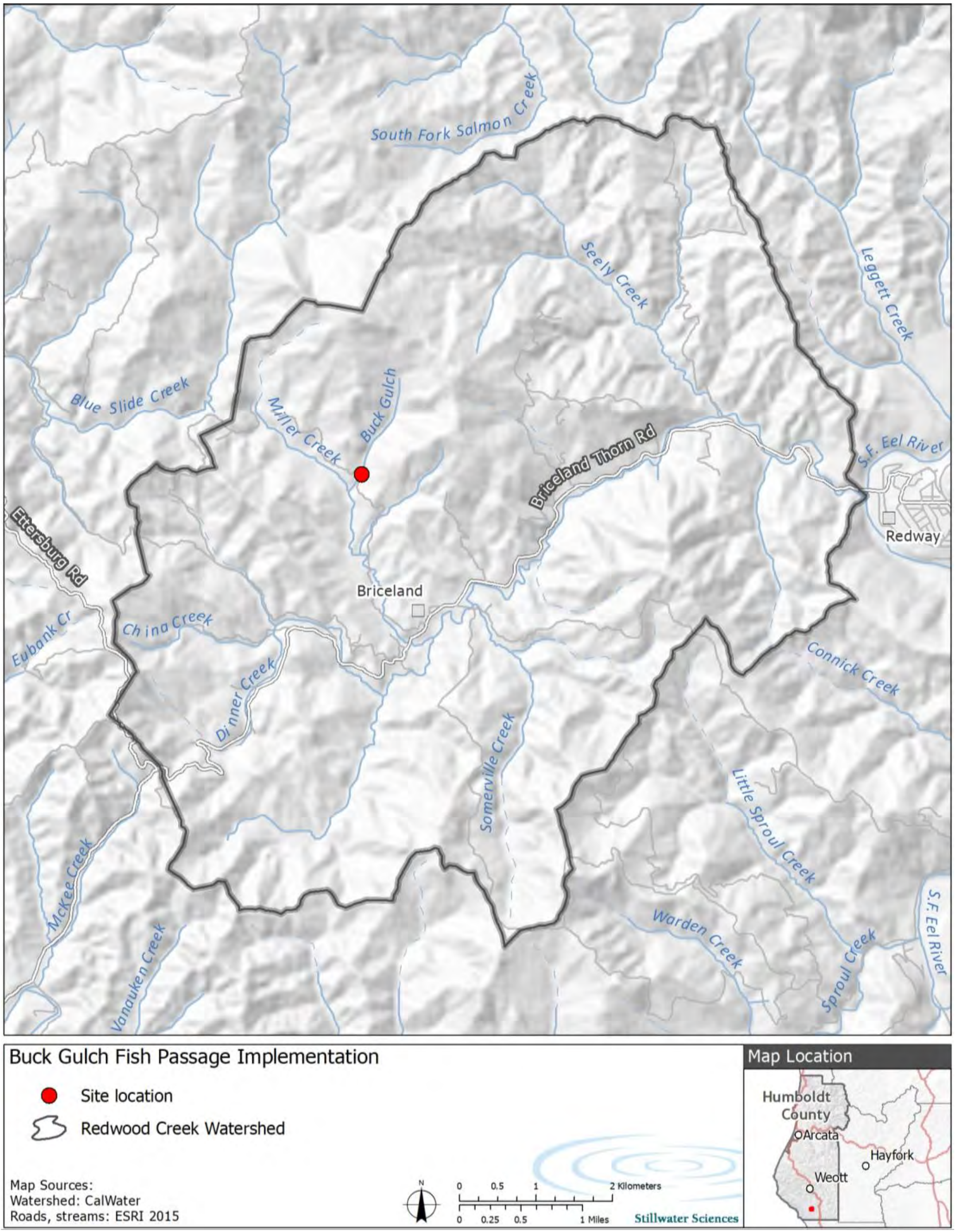

Figure 2. Vicinity map.

3 PROBLEM STATEMENT

As shown in Figure 1 and described above, the current crossing structure does not provide full fish passage due to the jump at the outlet as well as high velocities within the culvert barrel (discussed in more detail in Section 8 below). Additionally, partial and/or catastrophic failure of the crossing is becoming more likely due to ongoing decay in the culvert bottom and logs in the fill slopes. In the summer of 2017, CDFW staff conducted an instream survey of the project vicinity and documented 38 steelhead within the channel reach spanning approximately 2,760 linear feet upstream from the culvert. Based on these findings, CDFW recommended upgrade treatments that provide full fish passage to adult and juvenile salmonids (Scott Monday email communication September 12, 2017).

Buck Gulch provides some of the most consistent dry season flows within the Redwood Creek watershed (Stillwater Sciences 2017). During severe drought years, Buck Gulch typically has the highest dry-season unit discharge of any of the fourteen monitoring stations maintained by Salmonid Restoration Federation within Redwood Creek (Stillwater Sciences 2017). Therefore, it provides critical summer refuge habitat for salmonids – primarily Steelhead. Considering these factors, this site is a strong candidate for a full fish passage upgrade.

4 GEOLOGY AND TECTONICS

The Redwood Creek watershed is in a tectonically active plate-boundary deformation zone, defined by right-lateral movement along the San Andreas Fault Zone that separates the Pacific plate to the west from the North American plate to the east (Kelsey and Carver 1988). Northward progression of the San Andreas Fault Zone is characterized by lateral shearing and vertical compression due to the major westward turn in the fault zone upon reaching the Mendocino Triple Junction near Cape Mendocino. These primary deformation styles are what create the dominant NNW-SSE trending topographic and structural grain in the region (Kelsey and Carver 1988). The evolution of this regional topographic and structural grain has developed pervasive shearing, fracturing, and faulting throughout the north coast of California.

The Garberville-Briceland fault zone trends NNW-SSE across the watershed (Figure 3) (McLaughlin et al. 2000). The zone consists of multiple named and unnamed fault traces with varying orientations of displacement. Although recent displacement along the fault zone is undifferentiated, it is considered Quaternary in age. The Briceland Fault trace is approximately 3000 feet northeast of the project reaches and the Garberville Fault trace is approximately 3 miles to the northeast (Figure 2).

The Redwood Creek watershed is primarily underlain by the diverse Coastal and Central belts of the Franciscan Complex, the younger marine and non-marine Wildcat Group, and minor amounts of serpentinized peridotite of the Coast Range Ophiolite (Figure 3).

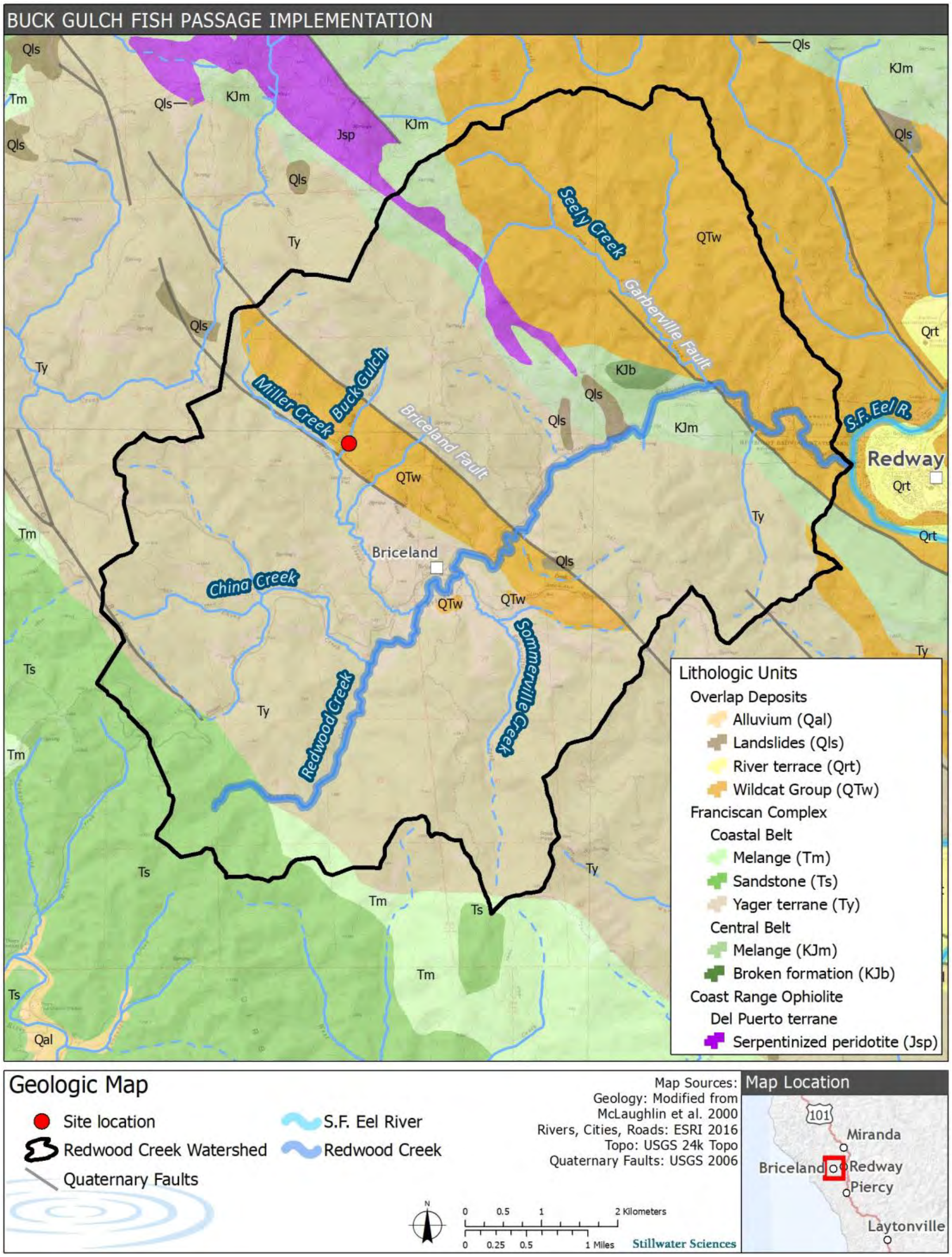

Figure 3. Generalized geologic map of the Redwood Creek watershed and project vicinity.

5 GEOMORPHOLOGY

Hillslope and stream channel morphologies in the Redwood Creek watershed are similar to those found throughout the western side of the South Fork Eel River basin, due to the prevalence of the underlying Franciscan Coastal Belt terranes. Although there is variability among the terranes, the rock strength in Coastal Belt rocks typically leads to steeper, ridge-and-valley topography with organized drainage networks. Small to large-scale landslides are still common in the basins that drain the Coastal Belt terranes, particularly where sedimentary rocks are less competent and in mélange units.

The channel reach where the Buck Gulch site is located is characterized by narrow, steep-walled canyon slopes that are covered by relatively thin soils and dense conifer and hardwood stands and drained by perennial and intermittent streams. At mid-elevations, the steep canyons transition into gently rounded upland ridges supporting grass meadows and shrub and oak woodland vegetation. Channel incision in Redwood Creek is likely due to ongoing tectonic uplift related to the nearby Mendocino Triple Junction, extensive anthropogenic land-use practices, and climate change altering hydrologic patterns.

The existing 6-foot diameter culvert is undersized which has caused deposition of approximately 2-feet of coarse sediment upstream from the crossing and created a large scour pool downstream as shown on the longitudinal profile on Sheet 2 of the Design Plans in Appendix A. The goal of the project is to install a new structure that is properly sized to convey 100-year flows, allow for fish passage at all life stages, and restore a natural sediment transport regime.

6 TOPOGRAPHIC DATA

Stillwater Sciences conducted a detailed topographic survey of the project site with a total station in January 2018. The survey captured channel thalweg, bottom and top of stream banks, the existing culvert and fill prism, and all trees. The survey extended approximately 300 feet upstream and 180 feet downstream from the crossing. It appears that there is an underground telephone line buried through the project site. Underground Service Alert (USA) should be contacted prior to construction. The Stillwater survey was used to generate a topographic based map with 1-foot contour intervals. Survey grade GPS was not used to set control points, so all elevations and horizontal positions shown in the plans are in a "local coordinate system" based on the control points shown in the Design Plans.

7 PRIMARY PROJECT DESIGN CONSIDERATIONS

The proposed project design was constrained by the factors described below.

1. Directly adjacent to the north of crossing, a driveway intersects the main road which makes installation of a bridge infeasible. Thus, an arch culvert is the proposed upgrade structure.
2. A full oval arch culvert buried into the channel has been chosen as the proposed upgrade structure to address several potential design and construction issues:
    a. Eliminates the need for in-depth geotechnical analyses – the proposed structure will have a bearing area of 972 square feet (54' width by 18' width) and will sit on a minimum 1' thick bed of backing rock (per Design Plans). This will give the

structure sufficient bearing strength irrespective of potential variation in subsurface native soil strength.

   b. Eliminates the need for pouring concrete below grade in rural setting – considering that there is no electrical power at the site, it will be difficult to maintain 24 hours-per-day dewatering for concrete curing process to ensure that downstream habitat is not adversely affected by increased acidity.

3. Due to the relatively confined valley, the only option for channel design is a roughened channel constructed with 4% slopes to match overall project reach gradient and for general consistency with the "stream simulation design process".
4. Due to relatively narrow upstream and downstream valley width, an arch with 18-foot width was the widest structure that could practicably maintain smooth transitions to the adjacent landforms.

Based on these constraints, there was only one clear project alternative which is the 18-foot width full oval arch culvert described in the Plans in Appendix A. The new channel constructed inside the proposed crossing structure will be a rock ramp, two grade control/step pools are proposed upstream and downstream of the proposed arch to provide complexity.

8 HYDROLOGIC AND HYDRAULIC ANALYSIS

8.1 Overview

To understand the flow dynamics at the project site, flow hydraulics were modeled using the U.S. Army Corps of Engineers' (USACE) *Hydrologic Engineering Center's River Analysis System (*HEC-RAS). HEC-RAS is a one-dimensional hydraulic model that is widely used for floodplain mapping and estimating general flow characteristics. This one-dimensional model assumes uniform flow direction and constant velocity distribution within the channel and floodplain portion of each cross section. Flow is modeled based on topography at a channel cross section without considering the effects of channel topography between cross sections. Therefore, it is important that these limitations are closely considered during hydraulic model setup, calibration, and application.

8.2 Hydrologic Data Overview

The first step in this hydraulic modeling process is to determine the hydrologic data that will be the principal input to HEC-RAS. The primary hydrologic data sets analyzed for this project were flood frequency flows (also known as recurrence interval flows) which represent higher flows that are expected to occur at a specific frequency (i.e., a 100-year flow would be expected to occur every 100 years on average). Specifically, for this project, it is important to ensure that the new crossing structure can pass 100-year flows. For this analysis, 1.5-year recurrence interval flows are synonymous with "bankfull" flows.

Flood frequency discharges for the site were determined based on (1) US Geological Survey (USGS) gage data, and (2) USGS Streamstats data. Each of these data sources are discussed below.

8.2.1 USGS gage data

USGS gage #11476500 has recorded annual peak flows in SF Eel River near Miranda for approximately 75 years. For this analysis, peak flow records from October 1939 to September 2016 were used. With these records, Log-Pearson Type III distributions can be used to predict the magnitude of peak flows for specific storm events. Considering the timeframe during which peak flows have been measured, this gage data is particularly accurate in predicting flows for storm events with recurrence intervals of 10 years and less.

Considering that the project reach is not located at the same location as the USGS gages, flows were estimated at each project site using the USGS formula for calculating magnitude and frequency of floods in California:

$Q_u = Q_g(A_u/A_g)^b$

Where: b = 0.9 for 2 year event and b = 0.87 for 100 year event
Q_u = Ungauged discharge
Q_g = Gauged discharge
A_u = Ungauged drainage area
A_g = Gauged drainage area.

Results from these calculations are shown in the first row of Table 1.

8.2.2 USGS Streamstats data

The USGS operates the interactive Streamstats website which can be found at: (http://water.usgs.gov/osw/streamstats/california.html)

This website uses a geographic information system (GIS) and flow regression equations to calculate storm discharges at any point along watercourses. Streamstats provides discharge data for 2-, 5-, 10-, 50- and 100-year storms. Streamstats results at the project site are shown in the third row of Table 1.

Table 1. Flood frequency discharge estimates for the Buck Gulch Project Site.

Discharge location and description:	100-yr discharge (CFS)	10-yr discharge (CFS)	2-yr discharge (CFS)
Log-Pearson Analysis based on USGS Gage at Miranda (537 sq mi) adjusted for project site drainage area (0.9 sq mi) based on USGS Formula	640	370	150
Results from USGS Streamstats for project site (0.9 sq mi)	440	230	90
Average at Project Site	**540**	**300**	**120**

8.3 Additional Discharges

Discharges used in the Buck Gulch hydraulic model are listed in the bottom row of Table 1. These flows have been calculated by averaging the discharges listed in the top two rows of the table. These values have been rounded to two significant digits to reflect the uncertainty of these estimates.

In addition to the flood frequency flows, additional low and moderate flows have also been modeled in HEC-RAS which correspond to exceedance flows. Exceedance flows represent the percent of time per year where flow thresholds are equaled or exceeded. Specifically, for this project, 2% exceedance flows were identified as the highest flows when fish passage is likely to occur and 30% exceedance flows was used for the low-end of adult fish migration representing winter base flow. Additionally, one CFS was modeled to represent a low flow where juvenile passage would be occurring. Again, these flows were calculated based on proration of records from the USGS gage #11476500 (SF Eel near Miranda).

Table 2. Additional discharge estimates used for the Buck Gulch hydraulic model.

	2% Exceedance Flows (CFS)	30% Exceedance Flows (CFS)	Typical late spring/early summer discharge (CFS)
Buck Gulch	48	4	1

8.4 Hydraulic Modeling

8.4.1 Existing conditions hydraulic modeling

Existing conditions topography used for the HEC-RAS model was based on the field-based topographic survey as previously described. The model including eight cross sections as shown in Appendix B. Typically, cross sections are cut perpendicular to the channel thalweg. However, in cases where there is significant channel sinuosity, which is the case for this project, some skewing of the sections is required to properly model the channel and floodplain curvature. Based on sensitivity analyses conducted in HEC-RAS with different cross section placements, it has been determined that the slight skewing of the cross sections away from perpendicular does not lead to significant differences in modeled outputs of velocities or flood elevations.

Cross-sections of the channel were cut from the Triangular Irregular Network (TIN) surface in AutoCAD and exported directly to HEC-RAS in order to create the hydraulic model. Initially, the Manning's n roughness values used in HEC-RAS were .06 for the channel, based on the HEC-RAS Reference Manual conservative recommendations for a "clean and winding natural stream with some pools, shoals, weeds and more stones," and 0.06 for all banks and floodplains based on a conservative value for "light brush and trees in winter." Flow was modeled in a mixed flow regime with a normal depth downstream boundary condition at a slope of 0.04 held constant for all flow stages.

8.4.2 Hydraulic model calibration

The existing conditions HEC-RAS model was calibrated using field-based evidence of 2017 high flow downstream from the culvert. Based on a review of Water Year 2017 peak flows on Bull Creek, the highest flow event which occurred on January 10, 2017 was approximately a 2-year recurrence interval flood. This estimated 2017 peak discharge of approximately 120 CFS resulted in flow depths of 2 to 3 feet throughout the project reach.

8.4.3 Existing conditions hydraulic model results

As shown on Figure 4, the existing culvert does not have capacity to pass 100-year flows and has a ~2-foot jump into the outlet at most flows. Additionally, the 2% exceedance average flow velocity through the culvert is 7.8 feet per second which combined with the jump, provides difficult adult migration conditions. Combined with CDFW survey results and the degraded nature of the crossing as described in Sections 2 and 3 above, this site is a strong candidate for upgrading. Full HEC-RAS output results are included in Appendix B.

8.4.4 Proposed conditions hydraulic modeling results

Proposed-conditions hydraulic modeling was conducted by replacing the existing 6-foot diameter culvert with a new 18-foot width aluminum pipe arch structure that is submerged in the channel with to insure a natural-bottomed channel that has the same Manning's "n" value as the rest of the creek channel. The proposed crossing structure details are shown in the Design Plans in Appendix A. Figure 5 shows how the new structure greatly improves crossing functionality in terms of passing 100-year flows and reducing jump height. Additional, the 2% exceedance flow through the culvert is calculated to be 4.1 feet per second.

8.4.4.1 Scour analyses

The Hydraulic Design function in HEC-RAS was utilized to analyze scour of the proposed arch. As shown in the second figure in Appendix B, potential scour depth around the abutments is estimated to be approximately 4.4 feet deep. This is approximately the depth of embedment of the proposed arch culvert so there is minimal risk of undercutting the culvert. Additionally, some lateral scour potential may also occur. The design plans require rock wingwalls feathering the proposed arch culvert inlet into the surrounding topography to protect from scour in this area. Additional rock sizing calculations to prevent bed and armor mobilization are described in Section 9.

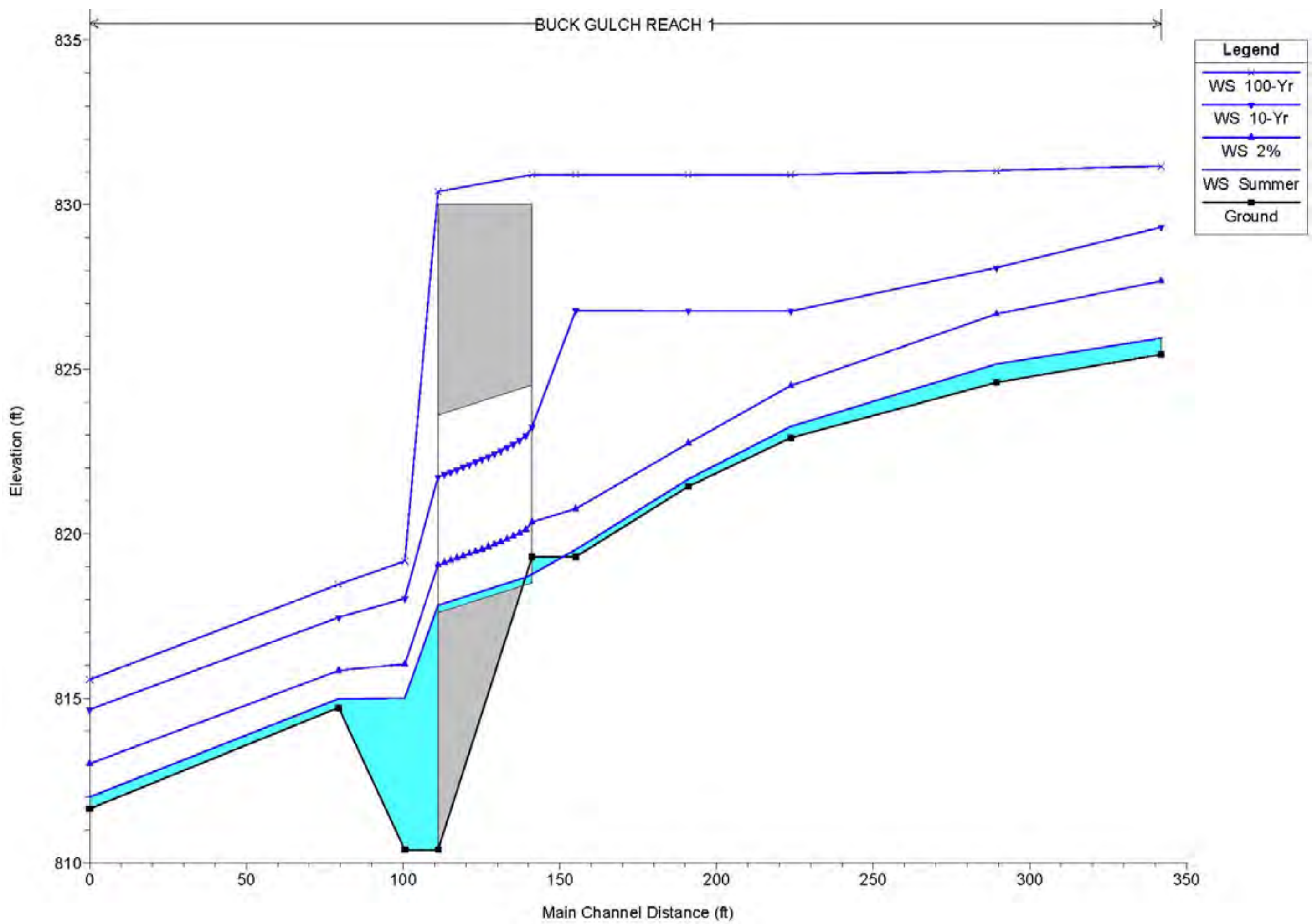

Figure 4. Existing conditions longitudinal profile from HEC-RAS.

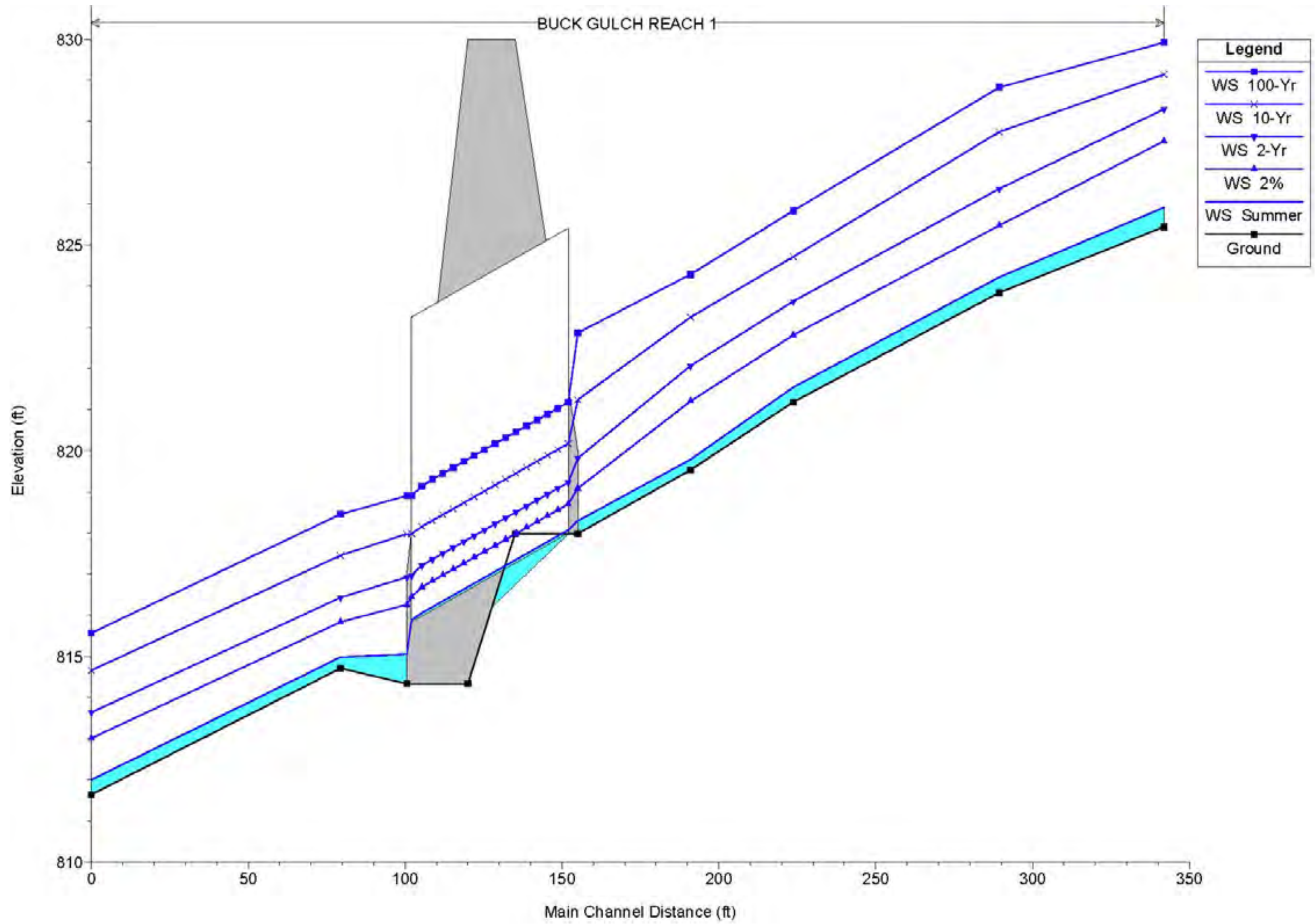

Figure 5. Proposed conditions longitudinal profile from HEC-RAS.

9 DETAILED PROJECT DESIGN

9.1 Channel Design

The project design is shown on the Design Plans in Appendix A.

9.2 Rock Sizing and Placement

Stable rock sizes for the slope protection, steps, and ramps were computed using methods described in DFW 2009. These structures are designed to remain relatively stable at the 100-year flow. All calculations are shown in Appendix C.

9.2.1 Rock slope protection

Minimum rock size for the slope protection was determined using values of 100-year flow depth and velocity obtained from the hydraulic model outputs. An average flow velocity of 7 feet per second was used for the computations. A D50 of 0.2 feet was computed using the FHWA (1989) method. However, based on standard practices of placing large riprap adjacent to bridge and arch culvert abutments to protect road fill, a much larger size class ranging from 2 feet to 5 feet diameter will be used, as listed on Sheet 5 in Appendix A.

9.2.2 Grade control structures

Rock size for the grade control structures was determined using the NRCS (2000) method. A 100-year water surface width of 32 feet, a depth of 3.5 feet and a water surface slope of 5% was obtained from the hydraulic model and used for the computations. A D_{min} of 1.5 feet, a D_{50} of 3.5 feet, and a D_{100} of 7 feet were computed. However, based on experience constructing grade control structures and the difficulty of working with 7-foot boulders, a range of diameters between 2 feet and 5 feet are recommended, as listed on Sheet 5 in Appendix A.

As shown on Sheet 5 in Appendix A, the two large grade control structures extend approximately 8 feet into the bank in an excavated trench. This is based on guidance from DFW 2009 which recommends that key-ins “typically extend at least as far into the banks as the banks are tall, or two foundation rock widths, whichever is greater.”

9.2.2.1 Rock ramps

Rock sizes for the Engineered Streambed Material (ESM) used for the rock ramps were determined using the ACOE (1994) method based on a slope of 4% and unit discharge of 21.6 cfs/ft. This unit discharge was determined by dividing the total 100-year discharge by the active channel width of 20 feet. A D84 of 1.4 feet and D50 of 0.6 feet were calculated with this method. To be conservative, these size classifications have been increased by approximately 10% to insure stability. Sizing for the ESM is listed on Sheet 5 in Appendix A.

9.3 65% Cost Estimate

65% design level cost estimates for the project are shown on Table 3.

Table 3. 65% engineer's cost estimate for construction.

No.	Item	Unit Cost	Quantity	Units	Total cost
1	Mobilization	$5,000.00	1	Lump Sum	$5,000.00
2	Dewatering	$5,000.00	1	Lump Sum	$5,000.00
3	Grading (cut/take to temporary spoils)	$20.00	500	Cubic Yard	$10,000.00
4	54' length x 18' width x 11' 4" rise Arch Culvert (materials)	$75,000.00	1	Each	$75,000.00
5	Arch Culvert (pre-assembly)	$25,000.00	1	Lump Sum	$25,000.00
6	Backing Rock Placement	$100.00	50	Cubic Yard	$5,000.00
7	Arch Culvert placement	$5,000.00	1	Lump Sum	$5,000.00
8	Grading (fill balanced on site)	$50.00	500	Cubic Yard	$25,000.00
9	Large Wood—Placed and Anchored	$1,500.00	8	Each	$12,000.00
10	Boulders—Placed and Anchored	$150.00	100	Tons	$15,000.00
11	Seeding/mulch/planting	$2,000.00	1	Lump Sum	$2,000.00
12	Permits (DFW 1600)	$3,095.00	1	Lump Sum	$3,095.00
13	Engineering - Bid support, construction oversight, As-builts	$20,000.00	1	Lump Sum	$20,000.00
Total construction cost:					**$207,095.00**

10 RISK ASSESSMENT

Overall, this project greatly reduces the risk of catastrophic road failure and sediment delivery. However, as is the case with any culvert upgrade project, there is the potential that significant sediment and/or debris from an offsite source may deposit within the project reach thereby causing changes to channel morphology that could adversely impact functionality of the proposed structure. However, it is important to note that the new structure is three times as wide as the current structure and the same height, making it significantly more resilient to adapting to potential changes.

A second project risk is that several large wood and boulder structures are proposed for the site to enhance instream habitat upstream and downstream of the culvert. These structures will be anchored to prevent them from moving, but typical large wood structures have a design life of approximately 20 years before the rood becomes rotten, so it is critical to design the project to account for this reality.

10.1 Risk Management

Long-term functionality of the project will be maintained by anchoring all wood structures per CDFW protocols and by closely monitoring the site following large storm events by an engineer/geologist (or other qualified restoration practitioner) to ensure that all components of the project are functioning as designed.

In a broader context of risk assessment, it is also important to consider the risk of the "no-project alternative" which will result in degradation, and lack of fish passage benefit as proposed for this project.

11 IMPLEMENTATION PLAN

11.1 Overview

The 30-foot length by 72-inch-diameter culvert will be replaced with a 54 foot length by 18 foot width by 11-foot 4-inch rise arch culvert. The arch culvert will be supplied by Contech and be placed on a minimum 1 foot thick bedding of backing rock. Riprap will be installed along the streambanks at the culvert inlet and outlet as shown on the plans. The riprap will be placed in a toe trench excavated to a depth of approximately 3' below the channel to eliminate the risk of failure caused by scour. The lower two courses of riprap will be 1- to 2-ton boulders with upper courses consisting of 1/4 ton size class.

The interior of the arch culvert will be filled with native streambed material excavated from the upstream channel and lower portion of the road. Some additional imported cobble and boulders may be imported so that the streambed material matches the specifications on Sheet 5 in Appendix A.

Removal of the existing culvert and fill prism will involve excavation of approximately 500 cubic yards of material which will be reused to rebuild the road prism following installation of the new arch culvert. Material of poor quality that includes decomposed organic matter will be permanently stored on a flat location adjacent to the project site. When fill material is placed for permanent storage, the receiving area will be ripped or decompacted first. Areas chosen for this purpose will be devoid of tree and shrub vegetation. The fill will then be placed in 1-foot lifts and shaped to blend with the surrounding topography with final surface grading designed to reduce runoff concentration as much as possible. Upon completion of the fill, woody debris will be scattered over the surface of the area as mulch.

Road crossing removal may involve some removal of vegetation that has grown in sediment that has been deposited upslope of road prisms. Most of this vegetation will be used as coarse wood mulch on bare soils to reduce surface erosion. Some of the material will be transplanted on-site as one component of the restoration action items. In all cases, disruption of existing vegetation will be minimized.

Culvert replacement requires diverting stream flow around the project site and excavating the existing culvert with heavy equipment. Grade control structures are incorporated into the project design to prevent excessive down-cutting of the stream. All work concerning culvert replacement will be consistent with current DFW and NOAA criteria concerning fish passage. Current NOAA fish passage guidelines can be found on the web at: http://swr.nmfs.noaa.gov/hcd/NMFSSCG.PDF . DFW fish passage guidelines can be found in Part IX of the *California Salmonid Stream Habitat Restoration Manual*, available at http://www.dfg.ca.gov/fish/Resources/HabitatManual.asp.

11.2 Erosion Control

The following erosion control measures will be taken during project construction to mitigate during and post-project adverse impacts on instream habitat:

1. Project work within the wetted stream shall be limited to the period between June 15 and November 1, or the first significant fall rainfall. This is to take advantage of low stream flows and to avoid the spawning and egg/alevin incubation period of salmon and steelhead. Whenever possible, the work period at individual sites shall be further limited to entirely avoid periods when salmonids are present (for example, in a seasonal creek, work will be confined to the period when the stream is dry).
2. No heavy equipment shall operate in the live stream, except as may be necessary to construct coffer dams to divert stream flow and isolate the work site.
3. Work must be performed in isolation from the flowing stream. If there is any flow when the work is done, the operator shall construct coffer dams upstream and downstream of the excavation site and divert all flow from upstream of the upstream dam to downstream of the downstream dam. The coffer dams may be constructed with clean river gravel or sand bags, and may be sealed with sheet plastic. Sand bags and any sheet plastic shall be removed from the stream upon project completion. Clean river gravel may be left in the stream, but the coffer dams must be breached to return the stream flow to its natural channel.
4. For minor actions, where the disturbance to construct coffer dams to isolate the work site would be greater than to complete the action (for example, placement of a single boulder cluster), measures will be put in place immediately downstream of the work site to capture suspended sediment. This may include installation of silt catchment fences across the stream, or placement of a filter berm of clean river gravel. Silt fences and other non-native materials will be removed from the stream following completion of the activity. Gravel berms may be left in place after breaching, provided they do not impede the stream flow.
5. If it is necessary to divert flow around the work site, either by pump or by gravity flow, the suction end of the intake pipe shall be fitted with fish screens meeting DFG and NOAA criteria to prevent entrainment or impingement of small fish. Any turbid water pumped from the work site itself to maintain it in a dewatered state shall be disposed of in an upland location where it will not drain directly into any stream channel.
6. Any disturbed banks shall be fully restored upon completion of construction. Revegetation shall be done using native species. Planting techniques can include seed casting, hydroseeding, or live planting methods using the techniques in Part XI of the *California Salmonid Stream Habitat Restoration Manual*.

7. Suitable large woody debris removed from fish passage barriers that is not used for habitat enhancement, shall be left within the riparian zone so as to provide a source for future recruitment of wood into the stream.
8. Measures shall be taken to minimize harm and mortality to listed salmonids resulting from fish relocation and dewatering activities:
   i. Fish relocation and dewatering activities shall only occur between June 15 and November 1 of each year.
   ii. DFG shall minimize the amount of wetted stream channel that is dewatered at each individual project site to the fullest extent possible.
   iii. All electrofishing shall be performed by a qualified fisheries biologist and conducted according to the National Marine Fisheries Service *Guidelines for Electrofishing Waters Containing Salmonids Listed Under the Endangered Species Act*, June 2000.
9. If for some reason these mitigation measures cannot be implemented, or the project actions proposed at a specific work site cannot be modified to prevent or avoid potential impacts to anadromous salmonids or their habitat, then activity at that work site will be discontinued.

11.3 Oversight and Permitting

The landowner or project proponent will hire a Civil Engineer or other licensed professional trained in this type of project to oversee implementation. Heavy equipment work should be sub-contracted to a licensed contractor with experienced in restoration and specifically fish passage projects. Project implementation is expected to take place in August 2019.

Department of Fish and Wildlife (CDFW) will be the lead agency for CEQA. The project will be covered under CDFW's regional general permit which includes the 404 Certification (US Army Corps of Engineers), 401 Certification (CA State Water Board). The landowner will apply for the CDFW 1600 Permit.

12 MONITORING PLAN

Extensive on-site monitoring will be performed throughout the construction phase as well as post-implementation. During implementation, activities are carefully monitored to make sure plans are followed and that the correct materials and techniques are used so that the objectives of the activities are met while protecting the environment. Pre, post and monitoring photos will be taken from set photo point monuments. The project site will be monitored during the first winter storm events and monitoring photos will be compared to post-project photos to ensure that excessive channel adjustment is not taking place.

A post construction survey shall be completed just after construction that includes a survey of bridge placement and channel components. Permanent benchmarks will be established that can be used for a minimum of five years. The final project reports should contain "as-built" design drawings signed and stamped by the engineer as well as pre- and post-photographs.

The next phase of post-activity monitoring is designed to assess the effectiveness of project work types and should occur within one to three years after an action item is complete. DFW will randomly select ten percent of the action items within each project work type for evaluation. This evaluation shall be recorded on standard project evaluation forms developed by California Department of Fish and Wildlife as described in the *California Salmonid Stream Habitat*

Restoration Manual, Part VIII, Project Monitoring and Evaluation, or using new monitoring procedures developed under a DFW grant. Effectiveness monitoring addresses the physical response associated with an activity, such responses are generally more easily measured and interpreted. Biological response data especially that for anadromous fish, is more difficult to collect and interpret. Reliable assessment of anadromous salmonid response to habitat improvement prescriptions generally require many years of trend data. DFW intends to address the biological response to habitat improvement through a coastal salmonid population monitoring plan which is currently under development in association with the National Oceanic Atmospheric Administration.

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