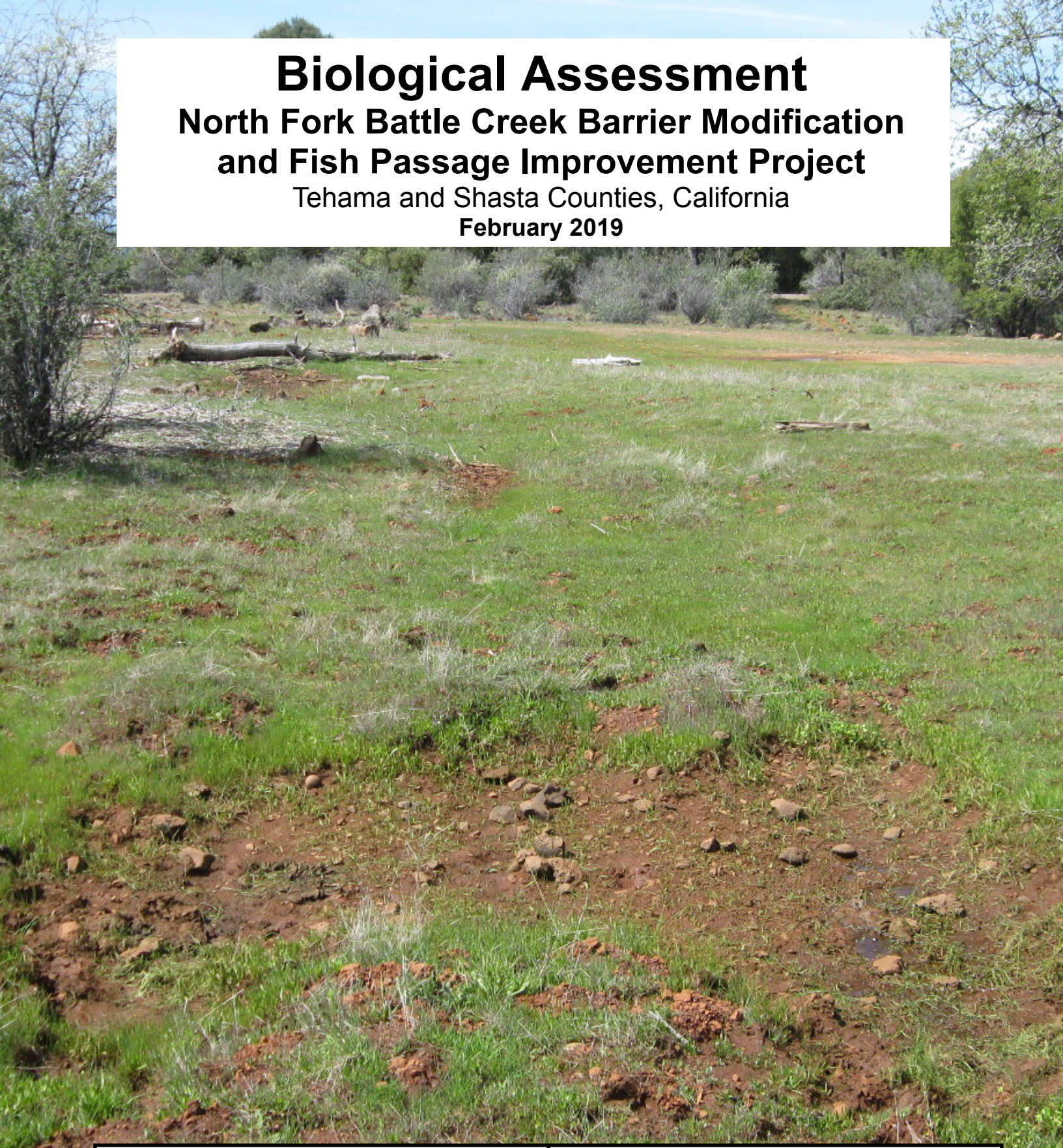
Biological Assessment

North Fork Battle Creek Barrier Modification and Fish Passage Improvement Project

Tehama and Shasta Counties, California

February 2019



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I. INTRODUCTION

The purpose of this Biological Assessment (BA) is to review the North Fork Battle Creek Barrier Modification and Fish Passage Improvement Project (Proposed Action) in sufficient detail to determine if the proposed action may affect fish and wildlife species listed under Section 7 of the Endangered Species Act of 1973, as amended (ESA) [16 U.S.C. 1536 (c)] as Endangered, Threatened, Proposed Endangered or Proposed Threatened; and designated Critical Habitat (CH) for those species. This document was prepared in accordance with the requirement set forth under Section 7 of the ESA.

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Contact Information

The project applicant is the U.S. Fish and Wildlife Service (USFWS). The USFWS is also the lead agency under the National Environmental Policy Act (NEPA). Contact information for the lead agency is listed below:

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Considered Species

The following species and CHs are considered in this document:

Endangered, Threatened or Proposed Species

Slender Orcutt Grass (and its CH)	*(Orcuttia tenuis)*	**Threatened**
Conservancy Fairy Shrimp (and its CH)	(*Branchinecta conservatio)*	**Endangered**
Vernal Pool Fairy Shrimp (and its CH)	*(Branchinecta lynchi)*	**Threatened**
Vernal Pool Tadpole Shrimp (and its CH)	*(Lepidurus packardi)*	**Endangered**
Valley Elderberry Longhorn Beetle (and its CH)	*(Desmocerus californicus dimorphus)*	**Threatened**
Delta Smelt (and its CH)	*(Hypomesus transpacificus)*	**Threatened**
California Red-legged Frog (and its CH)	*(Rana draytonii)*	**Threatened**
Least Bell's Vireo (and its CH)	*(Vireo bellii pusillus)*	**Endangered**
Western Yellow-billed Cuckoo (and its Proposed CH)	*(Coccyzus americanus occidentalis)*	**Threatened**
Gray Wolf (and its CH)	(*Canis lupus*)	**Endangered**

Action Area

The Action Area for the Proposed Action consists of the project boundary along with several combined buffers to account for noise and turbidity (Figure 1). A 0.25-mile buffer was added upstream and downstream of the project boundaries to account for noise, turbidity and other human disturbances during construction. A 150-yard buffer was added along both sides of the access roads and the project boundary to account for noise and other human disturbance activities during construction.

The Action Area is located within Eagle Canyon on North Fork Battle Creek on private lands. Pacific Gas & Electric (PG&E) operates the Eagle Canyon diversion, located within the Action Area, which is used to divert water for hydroelectric power generation into a series of flumes and tunnels that travel through the Action Area. Existing access roads, footpaths and staging areas associated with previous construction activities are located within the Action Area. Access roads are currently used by the landowners for livestock operations and other uses. PG&E frequently uses the south access road and staging area when monitoring and maintaining the Eagle Canyon Dam and flumes.

The Action Area is comprised of gradually sloping upland terraces transitioning to vertical slopes which form the canyon carrying North Fork Battle Creek. Elevations within the Action Area range from 1,490 feet to 1,600 feet above mean sea level. North Fork Battle Creek is a perennial creek flowing from northeast to southwest within the Action Area. According to the California Wildlife-Habitat Relationships classification system, four vegetation communities generally occur within the area: Blue Oak-Foothill Pine, Mixed Chaparral, Montane Hardwood and Riverine (Mayer and Laudenslayer 1988). Soils within the area are generally a stony loam to very rocky loam with rock outcrops forming the canyon walls

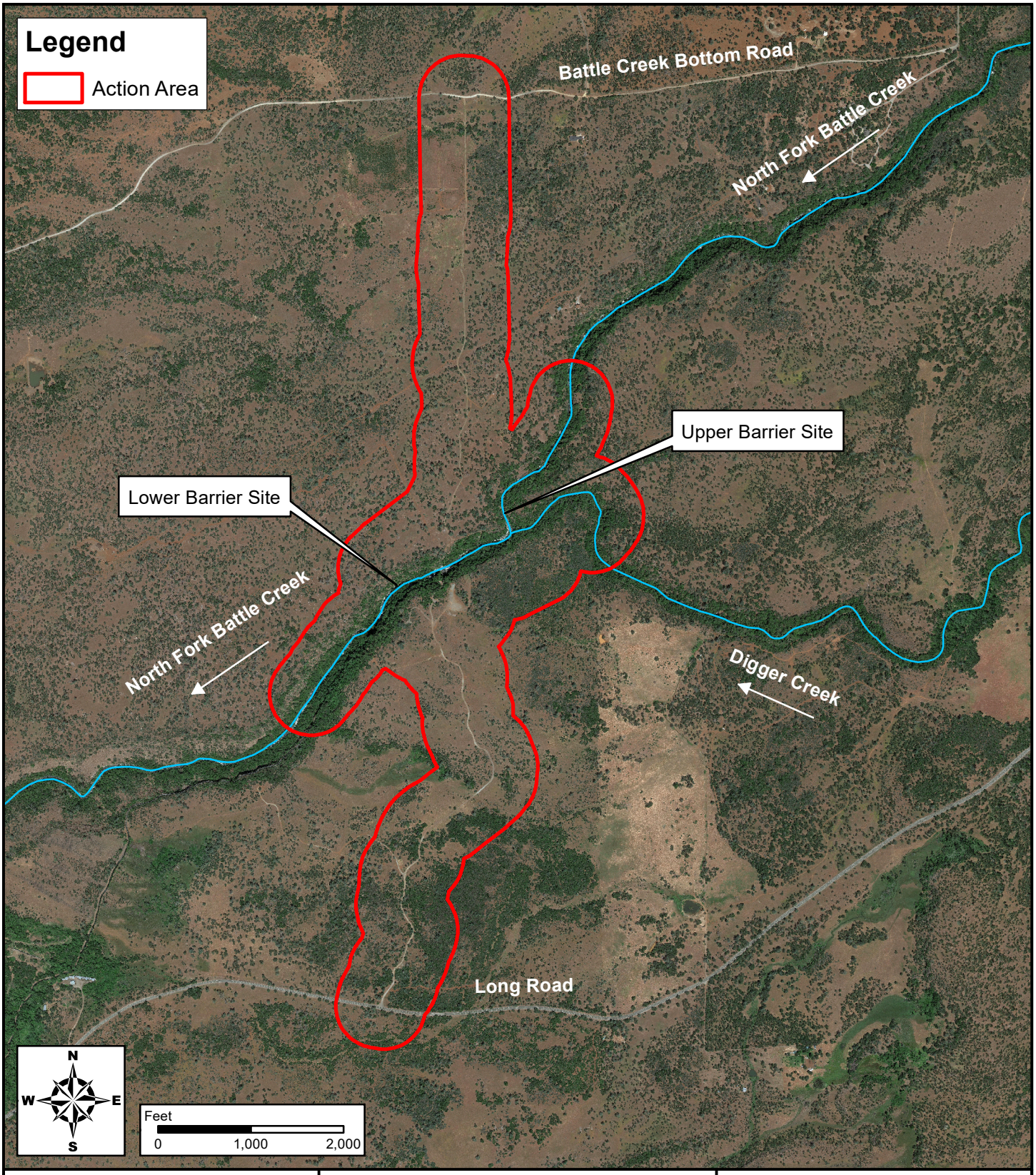

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FIGURE 1

Action Area

PHOTO SOURCE: Google Earth, 5/25/2017

(Tehama Environmental Solutions, Inc. 2018). A groundwater seep wetland and flume system are located along the south canyon slope at the Lower Barrier Site. Isolated seasonal wetlands and ephemeral streams are located along the site access roads and within the upland areas of the site.

Databases Searched for Listed and Proposed Species

A species list (Appendix A) was generated for the project site location using the USFWS Sacramento Fish and Wildlife Office website (U.S. Fish and Wildlife Service 2018). In addition, a records search of the California Natural Diversity Database (CNDDB) (California Department of Fish and Wildlife 2019a) was conducted for the U.S. Geological Survey (USGS) Shingletown 7.5 quadrangle, in which the project is located, to determine if any federally-listed plant or animal species had previously been documented within the project site, Action Area or in the vicinity for the project site.

Species Eliminated from Further Consideration

The following species and / or CHs were eliminated from further discussion in the document based on lack of suitable habitat in, or near the project area or because the project lies outside of the species' known range:

Slender Orcutt grass was eliminated because this species was not detected during botanical surveys conducted for the study area and suitable habitat was deemed lacking (Dittes & Guardino Consulting 2018). The project is not located within the designated slender Orcutt grass CH.

Conservancy fairy shrimp was eliminated because the project is not located within the known range of the species. The project is not located within the designated Conservancy fairy shrimp CH.

Valley elderberry longhorn beetle was eliminated because the project is not located within the known range of the species. The majority of valley elderberry longhorn beetles have been documented below 500 feet in elevation, with some populations occurring in drainages above 500 feet in certain circumstances (U.S. Fish and Wildlife Service 2017). Elevations within the Action Area range from 1,490 feet to 1,600 feet above mean sea level. Given the proximity of the project to the known range of valley elderberry longhorn beetle, the USFWS-Sacramento Valley Division was consulted in July 2018 and it was confirmed that the project is outside the known range of the species (L. Earley pers. comm.). The project is not located within the designated valley elderberry longhorn beetle CH.

Delta smelt was eliminated because the project is not located within the known range of the species. The project is not located within the designated delta smelt CH.

California red-legged frog was eliminated because the project is not located within the current known range of the species. Suitable habitat for the species, consisting of slow-moving or pooled aquatic habitats with overhanging vegetation, is not present within the Action Area (Tehama Environmental Solutions, Inc. 2019). The nearest observation is approximately 29 miles from the project, near Sunflower Gulch and Red Bank Creek in western Tehama County, California. The nearest contemporary recorded observation for this species is located approximately 56 miles south of the project, in Butte County, California. The project is not located within the designated California red-legged frog CH.

Least Bell's vireo was eliminated because the project is not located within the current known range of the species. The project is not located within the designated least Bell's vireo CH.

Western yellow-billed cuckoo was eliminated because the project is not located within the known range of the species. The project is not located within the proposed western yellow-billed cuckoo CH.

Gray wolf was eliminated because this species is not known to breed within, or near the Action Area. The nearest denning site is located over 50 miles away, in western Lassen and northernmost Plumas Counties (California Department of Fish and Wildlife 2019b). The Lassen Pack was first discovered in 2015 and has produced at least two known litters. One male gray wolf (OR-7) was detected in Tehama County in 2011, 2012 and 2013 before returning to Oregon. OR-7 traveled to within three miles of the project in January 2013. Another male (OR-25), roamed through Modoc, Lassen, Shasta and Siskiyou Counties in late 2015 and early 2016 before returning to Oregon. A female (OR-54), crossed the Oregon border into California on January 24 and February 19, 2018, traveled through Siskiyou, Shasta, Tehama, Plumas, Sierra, and Nevada Counties by the end of June 2018, and was still in California as of October 2018. A male wolf (OR-44), traveled from Oregon into Siskiyou County in March 2018 and his last known location was in Siskiyou County in May 2018. Three other uncollared wolves have been observed in northern California in 2017 and / or 2018: CA10F in Siskiyou County, a black wolf in southern Lassen County and a black wolf in northern Lassen / Modoc Counties. Dispersing wolves can travel as far as 600 miles per day (U.S. Fish and Wildlife Service 2016) and have extremely large territories ranging in size from 50 square miles to more than 1,000 square miles (California Department of Fish and Wildlife 2019b). It is extremely unlikely that a wolf pack will establish and / or breed within or near the project site due to the low density of known wolves in California and the large territories wolves use. The project site is outside the known range of the Lassen Pack. The project is not located within the designated gray wolf CH.

Critical Habitat

No designated CHs occur in the Action Area.

II. CONSULTATION TO DATE

The following is a list of the consultation history to date between the USFWS ESA staff and the project applicant or the project applicant's consultants regarding the potential effects of the Proposed Action on the species addressed in this document:

- July 2018: Phone calls between Ms. Laurie Earley of USFWS-RBFWO and Ms. Kellie Berry of USFWS-Sacramento Valley Division regarding the potential of valley elderberry longhorn beetle presence within the project area.
- November 29, 2018: TES requested and received a letter from the USFWS that provided a list of endangered and threatened species that may occur within the project site or be affected by the Proposed Action (Appendix A).
- December 19, 2018: Email from Ms. Earley of USFWS to Mr. Richard Kuyper and Ms. Berry of USFWS-Sacramento Valley Division regarding the project scope and anticipated start of consultation.

III. PROPOSED ACTION

Project Location

The Proposed Action is located on private land within Eagle Canyon on the North Fork Battle Creek and Digger Creek, at approximately 15 stream miles upstream of the confluence of the main stem of Battle Creek and the Sacramento River, west of Manton, in Shasta and Tehama Counties, California (Figure 2). Specifically, the Proposed Action is located in Sections 24, 25, and 36, Township 30 North, Range 1 West, Mount Diablo Base and Meridian; within the 7.5-minute USGS Shingletown quadrangle map (Figure 3) (40°25'26.03"N / -121°55'9.87"W). The Proposed Action occurs in the Hydrologic Unit Code (HUC) USGS Cataloging Unit: 18020153 (Battle Creek). An aerial photo of the project area is included as Figure 4. The project area includes the work areas for two barrier modification sites, the Lower Barrier Site and the Upper Barrier Site, as well as access roads and contractor use areas for equipment staging and stockpiling.

Background

Battle Creek is an important tributary to the Sacramento River, especially for the recovery of three federally listed species of salmonids; endangered Sacramento River winter-run Chinook salmon *(Oncorhynchus tshawytscha),* threatened Central Valley spring-run Chinook salmon, and threatened Central Valley steelhead *(Oncorhynchus mykiss)* (National Marine Fisheries Service et al. 1999). Two natural barriers have been documented on North Fork Battle Creek that prevent salmonid passage (Brown and Newton 2002, Bottaro et al. 2013, Earley 2016): one below Eagle Canyon Dam, herein referred to as the Lower Barrier Site (North Fork Battle Creek stream mile 5.06) and one above the dam, referred to as the Upper Barrier Site (North Fork battle Creek stream mile 5.41). These barriers consist of large boulders that originated from the canyon walls and have formed boulder jumbles in the creek, preventing the passage of salmonids. These barriers need to be physically modified in order to provide salmonids access to upstream high-quality habitat for winter-run and spring-run Chinook and steelhead and moderate-quality habitat for steelhead.

The 1992 Central Valley Project Improvement Act (CVPIA) [Title 34 of Public Law 102-575, Section 3406(b)(1)], authorizes and directs the Secretary of the Department of the Interior (DOI), in consultation with other state and federal agencies, Native American tribes, and affected interests, to develop and implement a program which makes all reasonable effort to at least double natural production of anadromous fish in California's Central Valley rivers and streams. Further, the CVPIA requires that this program give first priority to measures which protect and restore natural channel and riparian habitat values through habitat restoration actions, modifications to Central Valley Project operations, and implementation of the supporting measures mandated by the CVPIA. This directive is implemented through the Anadromous Fish Restoration Program (AFRP) (U.S. Fish and Wildlife Service 2001). The CVPIA established the Central Valley Project Restoration Fund (CVPRF) which consists of donations from any source and revenues provided through payments by Central Valley Project water and power customers. The U.S. Bureau of Reclamation (Reclamation) and the USFWS jointly implement the CVPIA in collaboration with state and local governments.

Thomas R. Payne and Associates (TRPA) mapped partial and complete natural barriers along Battle Creek and identified a potential total barrier below Eagle Canyon Dam (Thomas R. Payne Associates 1991, 1998). TRPA concluded that other barriers downstream of this barrier were all passable at flows greater than 35 cubic feet per second (cfs). The USFWS confirmed the presence of the blockage and also documented that large boulders were present within the first 1,000 feet above the confluence with Digger Creek (Earley 2016). These two barriers sites are the Lower and Upper Barriers associated with the Proposed Action.

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FIGURE 2

Site Vicinity Map

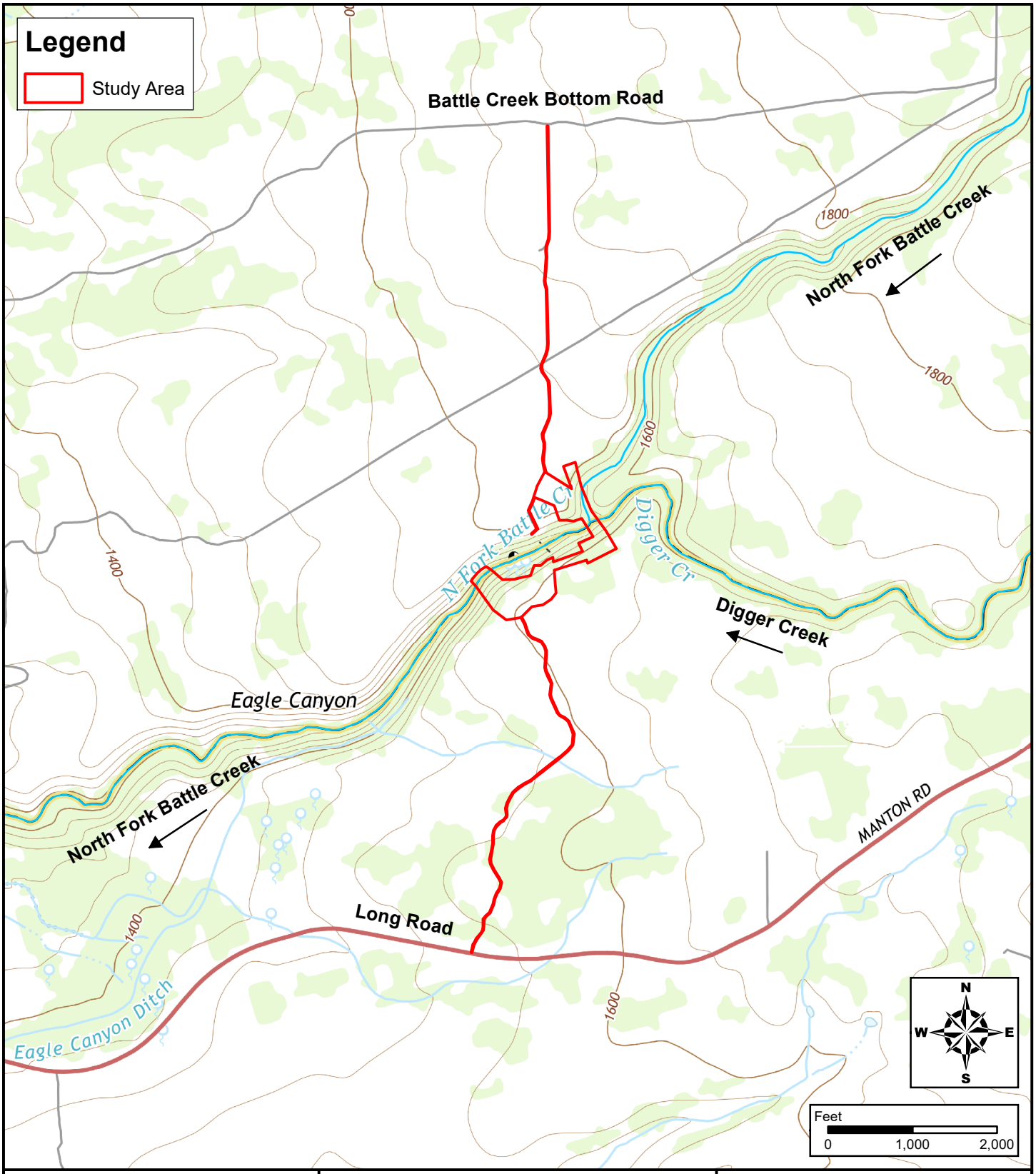

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FIGURE 3

Site Location Map

SOURCE: USGS, 7.5 Minute, California-Tehama Co., SHINGLETOWN QUADRANGLE

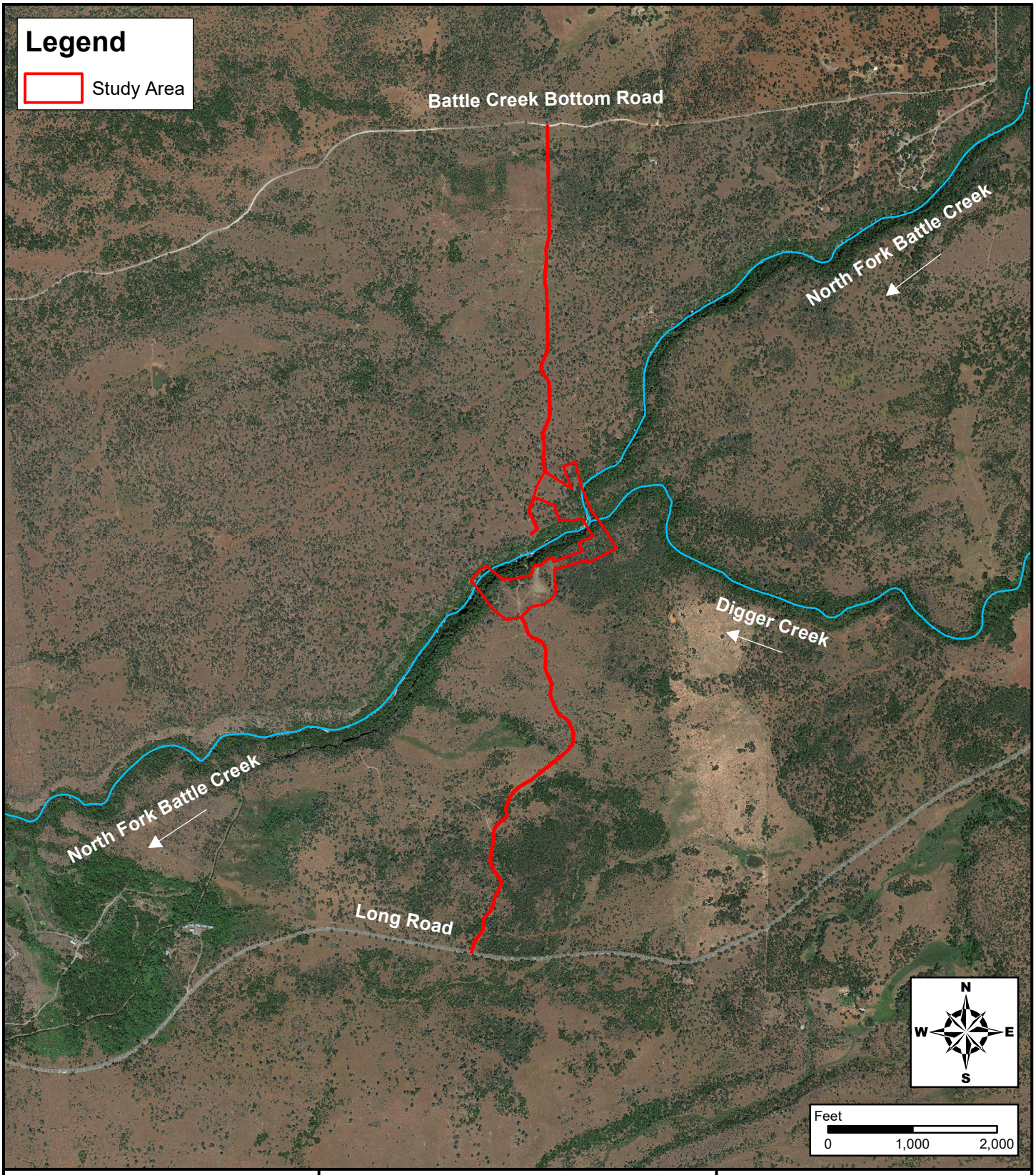

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FIGURE 4

Site Aerial Photo

PHOTO SOURCE: Google Earth, 5/25/2017

In 1999, a memorandum of understanding (MOU) was signed between the National Marine Fisheries Service (NMFS), Reclamation, USFWS, California Department of Fish and Wildlife (CDFW) and PG&E, where parties agreed to pursue what came to be called the Battle Creek Salmon and Steelhead Restoration Project (BCRP). The BCRP is a cooperative, proactive undertaking by the public, interested parties, the Greater Battle Creek Watershed Working Group, state and federal agencies and PG&E to restore the anadromous fishery in the Battle Creek watershed. Upon completion, the BCRP will restore approximately 42 miles of habitat in Battle Creek and an additional six miles of habitat in its tributaries while minimizing the loss of clean and renewable energy produced by the hydroelectric project.

In 2005, a *Final Environmental Impact Statement / Environmental Impact Report* was issued for the BCRP describing impacts associated with specific restoration efforts (Jones and Stokes 2005). The BCRP involves modifications to Battle Creek hydroelectric facilities located on North Fork Battle Creek, South Fork Battle Creek and Baldwin Creek, including removing five diversions dams and constructing fish screens and ladders on three other diversion dams. A powerhouse bypass and trailrace connector was proposed to prevent the mixing of North Fork Battle Creek and South Fork Battle Creek waters. Other elements included protecting a trout hatchery from diseases through the construction of a fish barrier weir; increasing instream flows; dedicating water rights for instream purposes at dam removal sites; and implementing adaptive management to ensure fisheries objectives are met. One of the components of the BCRP was the construction of the Eagle Canyon Diversion Dam Fish Screens and Fish Ladders which was completed in 2012. The Eagle Canyon Diversion Dam is located between the Proposed Action's Lower and Upper Barrier Sites. The Eagle Canyon Fish Ladder will be fully operational upon completion of this Proposed Action.

In 2014, the NMFS released the *Recovery Plan for Evolutionary Significant Units of Sacramento River Winter-run Chinook Salmon, Central Valley Spring-run Chinook Salmon, and Central Valley Steelhead,* which identifies a number of recovery actions for these species, specifically for Battle Creek (National Marine Fisheries Service 2014).

In particular, Action Item Battle Creek (BAC) 1.12 is to:

> *Improve fish passage at natural (rock or wood) fish barriers in the watershed including the ones immediately upstream and downstream of Eagle Canyon, and at the mouth of Digger Creek.*

The Proposed Action is being implemented as a part of this Action Item by the USFWS and the CDFW, in cooperation with the private landowners and the North Fork Battle Creek Barrier Modification and Fish Passage Improvement Project Technical Advisory Committee (TAC) which is comprised of representatives from USFWS, NMFS, CDFW, Central Valley Regional Water Quality Control Board, the U.S. Army Corps of Engineers and several private consulting firms.

In 2015, the CDFW received drought relief funding to complete fish passage evaluations on North Fork Battle Creek, upstream and downstream from Eagle Canyon Dam. Drought relief funding included funding for the preparation of 100 percent designs for the Proposed Action to modify / remove the Lower and Upper Barriers and improve fish passage.

As a part of the March 1, 2016 *Coleman National Fish Hatchery Adaptive Management Plan*, (Cramer Fish Sciences 2016) a full life-cycle modeling was conducted of Chinook salmon and steelhead within the Battle Creek watershed. The results showed that natural barrier passage had the largest observed influence on the equilibrium abundance of winter-run and spring-run Chinook salmon and steelhead in Battle Creek in comparison to other fisheries-related issues.

In February 2017, the *Eagle Canyon Fish Passage Improvements in Battle Creek Lower and Upper Barrier Sites Basis of Design Memorandum* and 100 percent design plans (Michael Love and Associates 2017) were completed for the Proposed Action which provide project goals and objectives, design criteria and decisions, project description, anticipated fish passage conditions, monitoring and maintenance requirements, and limitations and uncertainties. The 100 percent design plans show specific barrier removal and stream enhancements to restore fish passage to the upper limits of North Fork Battle Creek. The Proposed Action will provide access to an additional 4.36 stream miles of high-quality habitat along North Fork Battle Creek for winter-run and spring-run Chinook salmon and steelhead, with an additional 3.64 stream miles of moderate-quality habitat for steelhead.

This Proposed Action is being funded from a combination of sources for the various components of the project. Current funding for environmental regulatory compliance is funded by the USFWS via the CVPIA AFRP. Funding for implementation of the project will likely be from CDFW and other additional funding sources such as the CVPIA AFRP.

Project Purpose

The purpose of the Proposed Action is to modify two natural fish passage barriers on North Fork Battle Creek to allow three federally listed salmonid species access to optimal habitat that will be made available through the BCRP. The two barriers are composed of large boulders and have been documented as complete barriers to upstream salmonid fish migration.

Project Description

The project includes fragmenting and / or removing boulder jumbles and minor regrading of the stream channel. The work will be conducted using a crane at the Lower Barrier Site and a crane or skyline yarding system at the Upper Barrier Site. A detailed discussion of the project may be found in the *Eagle Canyon Fish Passage Improvements in Battle Creek Lower and Upper Barrier Sites Basis of Design Memorandum* (Appendix A) and on the Final Design Plans (Appendix B).

At the Lower Barrier Site approximately 190 cubic yards of selected boulders and bedrock will be removed and two new chutes (the north chute and the south chute) will be created. The north chute is intended to provide a low-flow (35 cfs) passage path for salmonids. At higher flows, the south chute is anticipated to have better passage conditions. It is not anticipated that any new material will be placed in the channel at the Lower Barrier Site. The permanent in-channel modifications total 0.03 acres. After boulder removal, Pool 4 is anticipated to double or triple in width. This increased width will create low velocity areas for fish to recover, approach the primary drop and stage their attempt to move upstream.

At the Upper Barrier Site, approximately 130 linear feet of creek channel will be regraded along the south side of the canyon and five channel spanning rock structures (hydraulic structures) will be installed to control channel grade and water surface profile. Hydraulic structures will include boulder steps and bedrock chutes to create surface drops between two and three feet in height. Each hydraulic structure is designed with three different flow paths, each with specific elevations or specific relationships to the other defined flow path elevations and vertical tolerances. These hydraulic structures will create variable swimming paths and will accommodate a variety of salmonid class sizes. A concrete weir will be constructed to keep water from flowing out of the secondary alignment corridor during low to moderate flows, which will improve flow and fish passage under these flow conditions. Approximately 720 cubic yards of boulders, and potentially some bedrock, will be removed as part of the regrading and barrier removal. Approximately 7 percent (540 cubic yards) of the material removed will be reused in the channel to form the proposed five hydraulic structures. The remainder of the material will be placed in an upland area and / or hauled off-site. There will be a net overall reduction of 180 cubic yards of material at

the Upper Barrier Site as a result of the proposed improvements. The permanent in-channel modifications total 0.10 acres. In addition to removing the boulder barrier, the anticipated modifications should reduce channel velocity and vertical drops while increasing sizes and depths of existing pools and creating some new pools.

Rock will be removed by drilling holes into the boulders and bedrock and then using hydraulic rock splitters or other techniques to break the rock into pieces. No blasting will occur. Scaffolding may need to be constructed to access the boulders. Rock pieces will be lifted up out of the creek canyon using the crane or yarding system and stockpiled in an upland area at the top of the canyon prior to removal from the site. Some rock material will be reused to form the hydraulic structure. A small rubber-tired skid-steer loader may be lowered (if possible) into the dry creek bed to help with the moving and loading of large boulders and rock on to the removal system.

Rock Fall Mitigation (Canyon Stabilization)

Rock fall hazards, mainly consisting of very large blocks of basalt, are located along the canyon at both the Lower and Upper Barrier Sites. These hazards will be assessed and mitigated by either scaling off smaller rocks and / or anchoring in-place larger rocks with bolts. Vegetation may also be cut or removed as a part of this process.

Site Access Roads

Access to the site will be along two existing access roads which may require improvement to accommodate large equipment and material delivery. Improvements to these existing access roads may involve additional rocking within the existing road prism, the construction of designated truck passing areas / turn outs and the replacement of existing culverts.

The existing south access road is currently used by PG&E to access the Eagle Canyon Dam and is rocked in some locations. Seasonal wetlands with potential large branchiopod habitat are located adjacent to the access road. The north access road is also rocked but has not seen as much construction traffic. The contractor may need to add rock to some areas of the access roads in order to support equipment and material delivery. Upon completion of construction, existing access roads will be repaired as necessary. Four existing culverts carrying ephemeral streams under the north access road may become damaged during construction and may need to be replaced prior the end of the project. Some work outside the road prism may be required in order to construct designated truck passing areas / turnouts. These turnouts will be flagged in the field and constructed outside of sensitive resource areas.

If the skyline yarder option is selected by the contractor for removal of boulders at the Upper Barrier Site, a new 430 linear foot gravel access road would need to be constructed through densely vegetated upland habitat dominated by buckbrush *(Ceanothus cuneatus)*. The proposed access road begins at the existing Lower Barrier Site access road / crane access pad and ends at the proposed Upper Barrier Site contractor use area proposed for the yarder system. The access road would be 16-feet wide on scarified and recompacted six inches of subgrade overlaid by woven geotextile fabric and eight inches of compacted crushed aggregate. The access road work will involve the delivery of rock via large 10-wheel or 18-wheel trucks and the placement and spreading of the rock using one or more of the following pieces of equipment available to the contractor: an excavator, grader, front-end loader, skid-steer, backhoe, bulldozer and / or compactor.

Contractor Use Areas

Contractor use areas will be developed to stage equipment and materials. Contractor use areas may also be used for landing pads if the contractor chooses to use a helicopter to deliver materials to the barrier sites. Grading of the contractor use areas would include leveling the ground surface to better facilitate equipment and material storage and to provide for safe worker access to the proposed project site. Gravel

crane pads measuring 30 feet by 30 feet would be constructed within contractor use areas. The approximate limits and locations of contractor use areas and gravel crane pads are shown on the Final Design Plans (Appendix B).

The Lower Barrier West contractor use area is approximately 1.44 acres in size on the south side of North Fork Battle Creek. Approximately 0.17 acres of the use area consists of an existing road and disturbed areas. The area is sparsely to densely vegetated with blue oak *(Quercus douglasii)* gray pine *(Pinus sabiniana)* and buckbrush. A mature gray pine greater than 36-inches in diameter at breast height (dbh) may need to be removed or limbed in order to site the crane and allow crane access to the creek. The crane needs an approximate 0.34 acres along the canyon slope to deliver and remove equipment and materials to, and from the creek. Some vegetation along the canyon slope will need to be selectively trimmed, limbed or removed to provide clearance for the crane operation.

The Lower Barrier East contractor use area is a cleared area on the south side of North Fork Battle Creek currently used by PG&E and is approximately 1.60 acres. The area consists of an existing road and disturbed areas and is generally rocked. The area was previously used for equipment staging and material stockpiling for Eagle Canyon Dam projects and is currently used by PG&E to gain access to the dam for regular maintenance and operation. The area is generally cleared with scattered shrubs, oaks and gray pines located around the perimeter. Seasonal wetlands with potential large branchiopod habitat are located adjacent to, and near the contractor use area. It is anticipated that no vegetation will need to be removed to use this area.

The Upper Barrier contractor use area for the crane option is approximately 1.3 acres and is located in an undisturbed, sparsely to densely vegetated area with scattered blue oak and gray pine on the north side of North Fork Battle Creek. Selective trimming and clearing of vegetation within an approximate 0.7-acre area along the canyon slope will be needed to operate the crane.

The Upper Barrier contractor use area for the skyline yarder option is approximately 1.1 acres and is located in an undisturbed densely vegetated area of buckbrush, oaks and gray pine on the south side of North Fork Battle Creek. Access to the use area is from the Lower Barrier East contractor use area along a proposed, temporary 430 linear foot rock access road. The access road will impact approximately 0.16 acres of upland habitat dominated by buckbrush. Selective trimming and clearing of vegetation within an approximate 1.3-acre area along the canyon slope will be needed to operate the yarder. Improving the contractor use areas will involve the delivery of rock via large 10-wheel or 18-wheel trucks and the placement and spreading of the rock using one or more of the following pieces of equipment available to the contractor: an excavator, grader, front-end loader, skid-steer, backhoe, bulldozer and / or compactor.

It is anticipated that a total of approximately 12 mature trees measuring 36-inch dbh, or greater will need to be removed or trimmed to construct the contractor use areas and to provide creek access for the crane or yarding systems. Additional trees will likely need to be trimmed or removed along the creek bank during construction to remove the boulders.

The contractor will submit a plan for review which shows the limits of the proposed contractor use areas and all vegetation clearing areas. The plan will include areas to be limbed, pruned, topped and cleared. Individual trees to be removed will be identified on the plan and flagged in the field. The plan will include tree species and tree dbh. It is anticipated that the contractor use areas will be more than 0.5 acre in size in order to support equipment and materials and provide truck access when removing boulders and delivering materials and equipment.

Foot Access Paths and Work Decks
Improvements to existing pedestrian access paths and construction of new pedestrian access paths and work decks will be required. Work decks will need to be constructed at the base of the canyon in order to access the large boulders during removal. Work decks will consist of wooden platforms and will be removed upon completion of work. Vegetation limbing and cutting may be required to install the work decks and when improving and constructing pedestrian access paths.

Revegetation
Vegetation to be removed will be restored upon completion of the project, as required. Project revegetation would occur after the project site construction-related activities are completed. A revegetation plan will be prepared prior to final demobilization. Following construction, disturbed vegetated areas would be revegetated in accordance with the revegetation plan. Revegetation would likely occur in the fall or spring following construction and would require access along the existing north and south access roads and staging within the developed contractor use areas. Following revegetation, additional maintenance activities would be required to care for the trees and shrubs planted as a part of the revegetation plan. Work would include irrigation, replanting and non-native plant removal, as needed.

Only minimal wading in water would occur for revegetation and maintenance activities. Personnel would be trained to avoid any impacts to salmonid redds during these activities.

Pre- and Post-Construction Monitoring
Pre- and post-construction monitoring will be required. Activities may include pre-construction biological surveys, as-built surveys, initial post-construction monitoring of hydraulic structures, biological monitoring for salmonid passage success and post-construction site inspection and maintenance. These activities would also require access along the existing north and south access roads and staging within the developed contractor use areas.

Project Schedule
The project schedule is dependent on acquiring implementation funding. It is anticipated that construction will begin in 2020 or 2021, if funding is in place, and continue for two construction seasons. Preliminary work may begin in the fall of 2019 if funding is in place. Construction at the Lower Barrier Site and Upper Barrier Site will occur in separate years. It is anticipated that construction will be completed by 2022. A detailed construction schedule will be prepared prior to the start of construction.

Post-construction revegetation maintenance would occur for approximately three growing seasons following the completion of construction activities at each site. Post-construction monitoring activities would occur for an unknown number of years following construction.

Resource Protection Measures

The project includes a number of Resource Protection Measures (RPMs) which were developed to protect sensitive resources that could be potentially impacted by the project and are hereby incorporated into the project description and plans. The project is designed through spatial and temporal avoidance measures to minimize temporary and permanent impacts to listed species and their habitats. These RPMs and project components are summarized below:

Biological Resources

- **VEGETATION-1:** Disturbance to existing vegetation will be avoided or minimized to the extent possible. Prior to the onset of construction, a vegetation removal plan will be submitted to the USFWS for review and approval.

- **VEGETATION-2:** A revegetation plan will be prepared to replace impacted vegetation by a measure of quantity and quality equal to, or exceeding impacts of the project using appropriate native plant species.
- **VEGETATION-3:** Disturbing streamside woody vegetation that is present within the project area associated with Battle Creek and Digger Creek shall be avoided to the extent possible. For streamside woody vegetation that cannot be avoided, appropriate avoidance and minimization measures will need to be developed during the environmental permit processes with CDFW, NMFS and other regulatory agencies.

  All disturbed streamside woody vegetation shall be revegetated following the completion of construction activities.
- **VEGETATION-4:** Impacts to trees will be avoided to the extent possible. Native trees greater than 16-inch diameter at breast height (dbh) with defects (snags, cavities, leaning toward stream channel, nests, late seral characteristics) and native trees greater than 36-inch dbh will be retained, to the extent possible. Impacts to trees that cannot be avoided will be minimized by limbing rather than cutting vegetation to the ground in order to promote regrowth.
- **VEGETATION-5:** All heavy equipment shall be thoroughly cleaned prior to mobilization onsite to remove any soil, weed seeds and plant parts in order to reduce the importation and spread of invasive exotic plant species.
- **VEGETATION-6:** Only certified weed-free straw shall be used for erosion control or other purposes to reduce the importation and spread of invasive exotic plant species.
- **VEGETATION-7:** An appropriately-timed preconstruction survey will be conducted to identify and map Butte County fritillary plants / colonies within the project area.
- **VEGETATION-8:** To the extent possible, a minimum 30-foot protective buffer will be established around Butte County fritillary plants / colonies that occur on the canyon edges / plateau, which might be subject to impacts relating to vegetation disturbance, equipment and materials staging, equipment operation, and placement of boulders removed from the canyon. Orange plastic barrier fencing will be used to mark the outer boundaries of the minimum 30-foot protective buffer established around each Butte County fritillary subpopulation.
- **VEGETATION-9:** For any proposed access trails extending downslope to the creek, a route will be delineated that will avoid Butte County fritillary plants to the maximum extent possible, and will require the least amount of disturbance to soil and woody vegetation. Plastic flagging and / or plastic orange barrier fencing will be used to define the route and boundaries of allowable pedestrian traffic.
- **VEGETATION-10**: Personnel involved with project implementation will be educated regarding Butte County fritillary and other sensitive botanical resources present. All participants will be made aware of the purpose and locations of the orange plastic barrier fences. Photographs of Butte County fritillary plants, flowers and mature fruits will be provided to all workers who walk or operate machinery / equipment in the project area.
- **VEGETATION-11:** No smoking will be allowed on the construction site or within the project area, for fire prevention purposes.
- **VEGETATION-12:** Road improvement activities shall be conducted in such a manner that disturbances are confined to the already disturbed road prism.
- **VEGETATION-13:** Vehicle traffic will be limited to the existing disturbed road prism. The condition of the road post-project will be coordinated with the landowners and all measures will be taken to return the road to pre-project conditions. Truck passing and parking areas will be

established in areas away from populations of wooly meadowfoam and seasonal wetlands. Truck passing areas will be clearly mapped in the field with high visibility fencing or flagging and all construction personnel will be made aware of the sensitive resources and avoidance measures. Orange barrier fencing will be placed around the seasonal wetlands and wooly meadowfoam populations.

- **FISH-1:** NMFS shall be consulted to 1) develop appropriate Central Valley Steelhead and Central Valley Spring-run Chinook Salmon avoidance and minimization measures, and 2) determine whether an Endangered Species Act Section 7 take permit will be required for the project.
- **FISH-2:** Construction outside of the stream channel could start as early as June 1, and extend to November 30, based upon permits receipt, permit conditions, and / or consultation terms and conditions. For fisheries protection, instream work will occur between July 1 and October 14 at the Upper Barrier Site and between July 1 and September 30 at the Lower Barrier Site. Instream work could start sooner if CDFW, in coordination with NMFS determines that adult spring-run Chinook salmon are no longer present based on environmental conditions, proper installation of an exclusionary weir and real-time passage data. Instream work at the Lower Barrier Site could be extended to October 14, if environmental conditions, which will preclude juvenile steelhead and spring-run Chinook salmon emigration or adult steelhead / fall-run Chinook salmon immigration, are expected to persist. Instream work outside of the above work windows must be approved by CDFW and NMFS on a case-by-case basis with details on how take will be avoided and / or minimized. For work within the channel and banks, fish rescue efforts (herding fish, netting / seining, electrofishing, etc.) will be required prior to the onset of any dewatering of the area. Dewatering will be coordinated with CDFW to ensure that adequate staff are available, and onsite during dewatering efforts.
- **FISH-3:** All construction debris (concrete, metal, etc.) from the fish passage improvement-related construction activities shall be removed from the active stream channel post-construction.
- **FISH-4:** Prior to construction, exclusionary fish netting or other CDFW approved exclusionary structure and / or other mechanism(s) shall be installed upstream and / or downstream of the construction area as determined by CDFW. USFWS, in coordination and consultation with NMFS and CDFW, will ensure that qualified fish biologists are onsite to implement fish rescue operations through the use of herding, seining and / or electrofishing, etc., if necessary. Best professional determination will be used to decide which method(s) of rescue and location of exclusionary structure and / or other mechanism(s) is most appropriate. Biologists will first try to haze and herd fish out of the fish exclusion area. If fish biologists determine that the use of electrofishing is necessary for the efficient and successful removal of fish, USFWS biologists with electrofishing certification will strictly follow the NMFS electrofishing guidelines (National Marine Fisheries Service 2000). The fish rescue team will be comprised of fishery biologists with professional experience using seines and electrofishing equipment.
- **FISH-5:** Adequate erosion and pollution control measures shall be taken to ensure that sediment, turbidity, petroleum products or other harmful chemicals do not enter Battle Creek, wetlands or other aquatic sites as a result of construction activities. Standard Best Management Practices (BMPs) shall be incorporated into the project designs.
- **FISH-6**: BMPs will be developed and implemented to ensure that wet concrete does not enter Battle Creek, wetlands or other aquatic sites during construction.
- **FISH-7:** All water pumps used during construction shall be screened to meet CDFW and NMFS criteria, unless deemed unnecessary by CDFW and NMFS (i.e. if water was being diverted from

an off-channel pool). The refueling of pumps will occur away from the wetted area / channel. If pumps are using fuel, they will be outfitted with a spill kit.

- **FISH-8:** All dewatering and rewatering activities will be conducted slowly, in order to minimize disturbance to fish and will be carefully coordinated with CDFW.
- **FISH-9:** While Pacific lamprey are not expected to occur within the project site, all reasonable measures will be taken to minimize impacts to lamprey, including spending more time at the area as it becomes dewatered (and they are moving out of the mud, chasing the water as it recedes), and possibly electroshocking.
- **WILDLIFE-1:** Any tree removal, vegetation clearing, or the onset of potentially disturbing construction activities shall occur between September 1 and January 1 (outside of the nesting season for raptors with potential to occur within, or in the vicinity of the project site).

  If tree removal, vegetation clearing, or the onset of potentially disturbing construction activities must occur during the nesting season, a raptor nesting survey of the construction area and adjacent suitable habitat shall be conducted by a qualified biologist no more than ten (10) days prior to the initiation of the onset of these activities or as appropriate survey protocols require. If active raptor nests are found to be present, tree removal, vegetation clearing and the onset of potentially disturbing construction activities shall be suspended until a qualified biologist, in consultation with CDFW and / or USFWS can establish an appropriate protective buffer area to minimize impacts to the nesting raptors. No construction activities shall commence within the buffer area until the qualified biologist determines that the young birds have fledged or the nest is no longer active.

  Construction activities shall occur continuously (not including weekends) until the end of the nesting season to discourage raptors from initiating nesting. If construction activities cease for more than ten (10) consecutive days (including weekends), all construction activities shall cease until CDFW can be consulted to determine if a subsequent raptor nesting survey must be performed.
- **WILDLIFE-2:** The USFWS shall be consulted to 1) develop appropriate avoidance and minimization measures, and 2) determine whether an Endangered Species Act Section 7 take permit will be required for the project.

  Project activities shall avoid direct impacts to seasonal wetlands or other large branchiopod (fairy shrimp, tadpole shrimp) habitats.

  High-visibility fencing shall be installed in areas where equipment will be working near any large branchiopod habitat.

  No road grading or road improvements shall be allowed in or, where feasible, near large branchiopod habitats.

  All transporters of potentially hazardous materials (fuel, oil, cement, etc.) will be notified as to the presence of potential large branchiopod habitats, and be required to inspect their vehicles prior to entry and exit of the project site to prevent accidental discharge.

  All vehicular traffic will be restricted to stay within the designated work boundaries. The work boundaries will be flagged or fenced and identified on construction drawings to limit equipment and personnel to the minimum area necessary to perform the project work and minimize impacts to wetland habitat.
- **WILDLIFE-3:** Prior to work in aquatic habitats, water bodies shall be surveyed by a qualified biologist to determine if any western pond turtles are present. If any individuals of these species are found, a qualified and permitted biologist shall determine and implement appropriate

relocation procedures, in coordination with CDFW. The site shall be checked daily by trained construction workers prior to work commencing, including underneath vehicles and equipment that will be used. If special-status species are found, they will be moved by a qualified and permitted biologist to an area of safety out of harm's way.

- **WILDLIFE-4:** Within ten (10) calendar days prior to the onset of potentially disturbing construction activities, a burrowing owl burrow survey of the construction area and adjacent suitable habitat shall be conducted by a qualified biologist. If active burrowing owl burrows are found to be present, the onset of potentially disturbing construction activities shall be suspended until a qualified biologist, in consultation with CDFW, can establish an appropriate protective buffer area to minimize impacts to the roosting birds. No construction activities shall commence within the buffer area until the qualified biologist determines that the burrow is no longer active.

- **WILDLIFE-5:** Any tree removal, vegetation clearing, or the onset of potentially disturbing construction activities shall occur between August 1 and March 1 (outside of the nesting season for grasshopper sparrow, yellow-breasted chat, loggerhead shrike, yellow warbler and other nesting migratory birds. Note: Also see WILDLIFE-1.

  If tree removal, vegetation clearing, or the onset of potentially disturbing construction activities must occur during the nesting season, a nesting survey of the construction area and adjacent suitable habitat shall be conducted by a qualified biologist no more than ten (10) days prior to the initiation of the onset of these activities. If active bird nests are found to be present, tree removal, vegetation clearing and the onset of potentially disturbing construction activities shall be suspended until a qualified biologist, in consultation with CDFW, can establish an appropriate protective buffer area to minimize impacts to the nesting birds. No construction activities shall commence within the buffer area until the qualified biologist determines that the young birds have fledged or the nest is no longer active.

  Construction activities shall occur continuously (not including weekends) until the end of the nesting season to discourage avian species from initiating nesting. If construction activities cease for more than ten (10) consecutive days (including weekends), all construction activities shall cease until CDFW can be consulted to determine if a subsequent nesting bird survey must be performed.

- **WILDLIFE-6:** Prior to any vegetation removal or disturbance to rock cliffs with cracks, a survey shall be conducted by a qualified biologist to ensure that pallid bats, spotted bats or western mastiff bats are not roosting in the area to be removed / disturbed.

  If pallid bats, spotted bats or western mastiff bats are found to be roosting within the area to be removed / disturbed, these activities shall be suspended until a qualified biologist, in consultation with CDFW, can establish appropriate measures to minimize impacts to these species.

- **WILDLIFE-7:** All vegetation clearing within potential western red bat roosting habitat (woody riparian habitat), shall occur between August 31 and May 1, in order to minimize the likelihood of injuring or killing juvenile bats during the period when they are still unable to fly.

- **WILDLIFE-8:** Potential ringtail denning habitat exists within the project area in the form of hollow trees and rock talus. Prior to construction, a biologist will inspect the project site for signs of denning.

  If ringtails are found to be denning, construction activities will be suspended until a qualified biologist, in consultation with CDFW, can establish appropriate measures to protect ringtail.

- **WILDLIFE-9:** A qualified biologist (biological monitor) shall regularly inspect construction-related activities to ensure that no unnecessary disturbance to special-status species and / or their associated habitats occurs. The biological monitor shall have the authority to stop all activities

that may result in such disturbance until appropriate corrective measures have been completed. The biologist will also be required to report any unauthorized take to CDFW, USFWS and / or NMFS immediately.

- **WILDLIFE-10:** A construction worker education program shall be implemented that includes an explanation of all special-status animal species, identification, avoidance measures, and federal and state laws that protect the species. This shall include, at a minimum, those species listed in the environmental documents.
- **WILDLIFE-11:** Appropriate measures will be used to avoid the spread of aquatic invasive species such as zebra / quagga mussels, New Zealand mudsnails and chytrid fungus to and from the project area according to the current CDFW Aquatic Invasive Species Disinfection / Decontamination Protocols (Northern Region) and the current USFWS Red Bluff Fish and Wildlife Office Anadromous Fish Restoration Program Hazard Analysis Critical Control Point Plan.
- **WILDLIFE-12:** All food-related trash will be disposed of in closed containers and removed from the project area daily during the construction period. Construction personnel will not feed or otherwise attract wildlife to the project area.
- **WILDLIFE-13**: No pets will be allowed within the project area.
- **WETLAND-1:** Project activities will avoid impacts to wetlands and other aquatic habitats to the extent possible.
- **WETLAND-2:** High-visibility fencing will be installed in areas where equipment will be working near any wetlands or other aquatic habitats that are not to be disturbed.
- **WETLAND-3:** Construction crews will be informed about the importance of avoiding sensitive areas, including wetlands.
- **WETLAND-4:** A Clean Water Act Section 404 Permit will be obtained from the U.S. Army Corps of Engineers and a Clean Water Act Section 401 Certification will be obtained from the Central Valley Regional Water Quality Control Board (RWQCB).

Hazardous Materials

- **HAZ-1:** A designated concrete washout area will be located at least 100 feet from any high water mark within adjacent waterways and from any wetlands and will be developed and used following the U.S. EPA Stormwater BMP for a Concrete Washout.
- **HAZ-2:** Measures WATER-3 through WATER-6 associated with potential petroleum product spills will be fully implemented.
- **HAZ-3:** Construction equipment and materials shall not be stored or stockpiled in the creek channel, and shall be stored at least 50 feet from the top of the stream bank or any wetlands or other aquatic sites.

Soils, Geology and Minerals

- **SOIL / GEO / MIN-1:** After ground-disturbing activities are complete, all disturbed areas (outside of the active stream channel) shall be seeded with native plant species and mulched as described in the revegetation plan.
- **SOIL / GEO / MIN-2:** Construction of all project actions shall comply with RWQCB Basin Plan Objectives. Standard BMPs will be incorporated into the project designs and / or the Stormwater Pollution Prevention Plan (SPPPP), if required.
- **SOIL / GEO / MIN-3:** If the total disturbance area is greater than one acre, a Notice of Intent will be submitted to the State Water Resources Control Board to obtain coverage under the

National Pollution Discharge Elimination System General Permit for Discharges of Stormwater Associated with Construction Activity.

- **SOIL / GEO / MIN-4:** Geologic hazards from rock fall will be mitigated by removing (scaling), shotcrete or securing (rock bolts) to potential rock fall or selecting locations for infrastructure away from known or anticipated rock fall hazards.

Hydrology and Water Quality

- **WATER-1:** All construction shall be conducted in the summer / early fall during the low flow period. Any work within the channel and banks, outside of this instream work window must be isolated from flowing water and dewatering will be required.
- **WATER-2:** Monitoring of water turbidity and settleable materials shall be conducted in accordance with the Clean Water Act Section 401 Certification through consultation with the RWQCB.
- **WATER-3:** All equipment and machinery that contains fuel, oil or other petroleum products used during construction related activities shall be checked for petroleum leaks immediately prior to being mobilized to the project site and again each day prior to use.
- **WATER-4:** All equipment refueling and / or maintenance shall take place within a secondary containment structure and, when feasible, a minimum of 100 feet away from Battle Creek, wetlands or other aquatic sites.
- **WATER-5**: An emergency spill kit and absorbent oil booms will be onsite during construction activities.
- **WATER-6:** All equipment operations within the channel and banks of Battle Creek will be required to use readily biodegradable hydraulic oil.
- **WATER-7:** A dewatering permit will be obtained from the RWQCB, if deemed necessary based on the dewatering methods used.
- **WATER-8**: Helicopter delivery of all materials including wet and dry concrete materials, will use a helicopter route that minimizes the length of time spent over open water areas of Battle Creek and will be delivered to the site in sealed protective containers such as intermediate bulk containers (IBCs) designed for containment of dry flowable chemical materials or fluids. Helicopter staging and delivery areas will be isolated from the adjacent upland, wetland and stream areas through use of silt barriers.
- **WATER-9:** Transfer of cement and mixing of concrete will be performed in a containment berm or cell and will occur only during dry weather. Cement stored on site will be in containers or covered at all times. Any equipment to be cleaned of concrete will be washed in / over a sealed protective container. Concrete wash water and any excess concrete will be collected in containers such as flexible or rigid IBCs and removed from the site.
- **WATER-10:** In the event that any concrete materials are spilled onsite, it shall be immediately cleaned up and transferred to an IBC. Any operations resulting in spills will be immediately stopped. Modifications will be made to prevent spills, prior to resuming operations.
- **WATER-11:** Concrete will be placed in dry conditions to the maximum extent feasible. Areas where concrete is to be placed within ten feet of water, will be isolated from the creek with silt and turbidity barriers. If concrete is to be placed underwater, it will be fully contained in formwork extending above the water level and will be installed by tremie methods. Water displaced by the tremie placement will be pumped to a dewatering storage system. Pumping will be used to maintain a positive flow gradient toward the area of work (away from the creek), and pumped water will be discharged to the dewatering storage system.

- **WATER-12:** A water quality protection plan will be prepared by the contractor that includes concrete / cement measures and shall be approved by the project engineer prior to the start of any construction-related activities, including mobilization of materials to the project site.

IV. AFFECTED SPECIES AND EXISTING ENVIRONMENT

Vernal Pool Fairy Shrimp *(Branchinecta lynchi)*

Legal Status

The vernal pool fairy shrimp was listed as Threatened by the USFWS on September 19, 1994 (59 FR 48136). CH was initially designated on August 6, 2003 (68 FR 46684). Changes to the 2003 CH due to economic and non-economic exclusions were designated for four vernal pool crustaceans and 11 vernal pool plants, including vernal pool fairy shrimp, on August 11, 2005 (70 FR 46924). CH was designated for each of the individual 15 vernal pool species on February 10, 2006 (71 FR 7117).

Current and Historical Distribution

At the time of its listing, vernal pool fairy shrimp were known to occur only in California, extending from Tulare County in the south, to Shasta County in the north. In 1998, vernal pool fairy shrimp were discovered in vernal pools in Jackson County, Oregon, in an area north of Medford known as the Agate Desert. Prior to this discovery, the most northerly known location for the species was south of Mount Shasta, California, some 80 miles south of the Agate Desert.

Life History and Habitat Requirements

Vernal pool fairy shrimp occur exclusively in vernal pool and vernal pool-like habitats such as seasonal wetlands that fill with water during fall and winter rains and dry up in spring and summer. Although the species has been collected from larger pools, it generally tends to occur in smaller pools less than 0.05 acres and is typically found in pools with low to moderate salinity or total dissolved solids (U.S. Fish and Wildlife Service 2005). Vernal pool fairy shrimp eggs, or cysts, remain dormant in the soil when the pools are dry and several separate hatches can occur in a single wet season. Adults can reach sexual maturity in as few as 18 days at optimal water temperatures and feed on algae, bacteria, protozoa, rotifers and detritus (U.S. Fish and Wildlife Service 2005).

Reasons for Species Decline

Population declines are attributed to destruction and degradation of vernal pool habitats. Like the other species of vernal pool branchiopods, the number of *B. lynchi* populations have declined primarily because of destruction or degradation of vernal pools through development of urban, suburban, and agricultural projects. In addition to direct habitat loss, vernal pool fairy shrimp populations have declined from a variety of activities that degrade existing vernal pools / swales by altering pool hydrology (water regime). Vernal pool hydrology can be altered by a variety of actions, including the construction of roads, trails, ditches, or canals that can block the flow of water into, or drain water away from, the vernal pool complex.

Recovery Plan Goals

The recovery plan that includes the vernal pool fairy shrimp identifies the overall recovery goals as achieving and protecting, in perpetuity, self-sustaining populations of each species, delisting the 20 federally listed plant and animal species and ensuring the long-term conservation of the 13 species of special concern. Interim goals include stabilizing and protecting populations to prevent further decline of the threatened status for those species listed as endangered.

Current Status in the Project Area

The project site is not located in or near the currently designated CH, but is located within the current known range of the species. A wetland delineation (Tehama Environmental Solutions 2018) mapped all potentially jurisdictional wetlands within the project area (Appendix D – Wetland Delineation Map). Potential habitat is present in seasonal wetlands adjacent to, and near the south access road and contractor use areas. Vernal pool fairy shrimp were not observed within the study area during biological surveys, however full protocol-level surveys were not conducted (Tehama Environmental Solutions, Inc. 2019). Since a full set of protocol-level surveys have not been conducted at the project site, vernal pool fairy shrimp must be assumed to occur in all seasonal wetlands, encompassing approximately 0.09 acres of potential habitat (Appendix D - Wetland Delineation Map).

Vernal Pool Tadpole Shrimp *(Lepidurus packardi)*

Legal Status

The vernal pool tadpole shrimp was listed as Endangered by USFWS on September 19, 1994 (59 FR 48136). CH was initially designated on August 6, 2003 (68 FR 46684). Changes to the 2003 CH due to economic and non-economic exclusions were designated for four vernal pool crustaceans and 11 vernal pool plants, including vernal pool fairy shrimp, on August 11, 2005 (70 FR 46924). CH was designated for each of the individual 15 vernal pool species on February 10, 2006 (71 FR 7117).

Current and Historical Distribution

Historically, vernal pool tadpole shrimp likely evolved in the Central Valley of California, approximately two million years ago (U.S. Fish and Wildlife Service 2005). It is estimated that roughly four million acres of vernal pool habitat existed in the Central Valley during pre-agricultural times and vernal pool tadpole shrimp were likely distributed over most of these vernal pool habitats (U.S. Fish and Wildlife Service 2015).

Currently, vernal pool tadpole shrimp are distributed across the Central Valley of California and in the San Francisco Bay area. With vernal pool habitats in the Central Valley now representing only approximately 25 percent of their former area, remaining habitats are considerably more fragmented and isolated than during historical times and this species is uncommon even where vernal pool habitats occur (U.S. Fish and Wildlife Service 2005). Vernal pool tadpole shrimp are found in Shasta County (Stillwater Plains and near Redding), Butte County (on private land near Chico) and in Tehama County (Vina Plains Preserve, the Dales Lake Ecological Reserve, and on various California Department of Transportation lands). The largest concentration of vernal pool tadpole shrimp occurrences is found on a number of public and private lands in Sacramento County. This species also occurs in Yuba, Placer, Solano, Glenn, Merced, Tulare, Kings, Fresno, Stanislaus and Alameda Counties.

Life History and Habitat Requirements

Vernal pool tadpole shrimp occur in a wide variety of ephemeral habitats and have been collected in pools ranging in size from 6.5 square feet to 88 acres (U.S. Fish and Wildlife Service 2005). Vernal pool tadpole shrimp eggs, or cysts, remain dormant in the soil when the pools are dry and hatch in as few as four days after winter rains fill the vernal habitats (U.S. Fish and Wildlife Service 2005). Adults reach sexual maturity in three to four weeks and females can deposit as many as six clutches of eggs in a single wet season (U.S. Fish and Wildlife Service 2005). They feed on organic debris and living organisms such as fairy shrimp and other invertebrates (U.S. Fish and Wildlife Service 2006).

Reasons for Species Decline
Population declines are attributed to destruction and degradation of vernal pool habitats. Threats also include road improvement projects, urban development, parasitism by flukes *(Trematoda sp.)* and pesticide drift from adjacent farmlands.

Recovery Plan Goals
The recovery plan that includes the vernal pool tadpole shrimp identifies the overall recovery goals as achieving and protecting, in perpetuity, self-sustaining populations of each species, delisting the 20 federally listed plant and animal species and ensuring the long-term conservation of the 13 species of special concern. Interim goals include stabilizing and protecting populations to prevent further decline of the threatened status for those species listed as endangered.

Current Status in the Project Area
The project site is not located in or near the currently designated CH but is located within the current known range of the species. A wetland delineation (Tehama Environmental Solutions 2018) mapped all potentially jurisdictional wetlands within the project area (Appendix D). Potential habitat is present in seasonal wetlands adjacent to the south access road and contractor use areas. Vernal pool tadpole shrimp were not observed within the study area during biological surveys, however full protocol-level surveys were not conducted (Tehama Environmental Solutions, Inc. 2019). Since a full set of protocol-level surveys have not been conducted at the project site, vernal pool tadpole shrimp must be assumed to occur in all seasonal wetlands, encompassing approximately 0.09 acres of potential habitat (Appendix D - Wetland Delineation Map).

V. EFFECTS AND ANALYSIS

Vernal Pool Fairy Shrimp

Direct Effects
According to Section 7 of the ESA and its associated regulations promulgated at 50 Code of Federal Regulations (CFR) Section 401, direct effects occur at or very close to the time of the action. Direct effects are direct or immediate effect of the project on a species or its habitat, whether beneficial or adverse.

Vernal pool fairy shrimp and their cysts may be directly affected when improving the existing south access road and the Lower Barrier East contractor use area. During access road rocking activities and the grading and rocking of the contractor use area, vehicles, equipment or materials may enter adjacent potential large branchiopod habitat and crush vernal pool fairy shrimp adults and cysts that may be present.

Vernal pool fairy shrimp and their cysts may be directly affected during construction when accessing the site. Concrete trucks, flat-bed trailers loaded with large equipment and materials, construction worker vehicles and large tracked equipment (i.e. excavator) will use the access roads and contractor use areas regularly during project construction. When delivering equipment and materials and when driving to the site, vehicles may drive off the access road to temporarily park or pull over to allow other vehicles to pass. These vehicles may inadvertently drive into adjacent potential large branchiopod habitat, crushing vernal pool fairy shrimp adults and cysts that may be present.

Vernal pool fairy shrimp and their cysts may be directly affected during construction while working within the contractor use area. Vehicles may inadvertently park outside the contractor work area

boundaries, entering adjacent potential large branchiopod habitat and crushing vernal pool fairy shrimp adults and cysts that may be present. Contractor deliveries, materials and equipment may be inadvertently stored and stockpiled in adjacent potential large branchiopod habitat.

Vernal pool fairy shrimp and their cysts may be directly affected during construction if stormwater runoff is not properly managed when working during the wet season. Disturbed construction areas and access roads that are not properly stabilized prior to rain events may cause erosion and sedimentation. Uncontrolled drainage may cause a change in drainage patterns, increasing or decreasing surface runoff volumes discharging to potential large branchiopod habitat. Uncontrolled stormwater runoff may discharge directly to adjacent potential large branchiopod habitat, depositing silt in the seasonal wetlands and burying vernal pool fairy shrimp adults and cysts that may be present. Hazardous materials like fuel, oil and grease may be attached to transported sediments or included in uncontrolled stormwater that discharges into seasonal wetlands.

Vernal pool fairy shrimp and their cysts may be directly affected during construction if hazardous materials and cement are not properly contained or managed onsite. Hazardous materials stockpiled adjacent to potential large branchiopod habitat may leak or spill, discharging to adjacent seasonal wetlands and potentially killing vernal pool fairy shrimp adults and cysts that may be present. Cement washout stations located adjacent to seasonal wetlands may leak or spill and cement laden water may discharge to potential large branchiopod habitat. Vehicle and equipment washing and cleaning activities occurring adjacent to potential large branchiopod habitat may result in a discharge of soaps and caustic chemicals to adjacent seasonal wetlands. Leaking oils, grease and fuel from poorly maintained vehicles and equipment may discharge to adjacent potential large branchiopod habitat.

Baseline current conditions consist of year-long, intermittent use of the south access road for ranching operations and by PG&E to access the PG&E Eagle Canyon Dam for maintenance and operations. The south access road and Lower Barrier East contractor use area are partially rocked. Seasonal wetlands located adjacent to the existing south access road prism and near the Lower Barrier East contractor use area are currently subject to siltation, road runoff and potential off-road parking / pull over. Typically, standard pickup trucks and passenger vehicles use the existing south access roads and the Lower Barrier East contractor use area for monitoring and maintaining the Eagle Canyon Fish Ladder and Dam.

The seasonal wetlands located near the Lower Barrier East contractor use area are of relatively poor quality (Appendix E – Site Photos). Several of the seasonal wetlands have a layer of small pea gravel covering the bottom or contain leftover construction materials and / or organic mulch (Tehama Environmental Solutions 2018). Seasonal wetlands SW-2, SW-3, SW-4, SW-5 and SW-6 may have been created and / or have been impacted by recent construction activities associated with former construction staging areas (Tehama Environmental Solutions 2018). Vegetation within the seasonal wetland features tend to be dominated by common species not specific to vernal pool habitat (Tehama Environmental Solutions 2018). In addition to the poor quality of these pools, there are no other natural vernal pools within the Action Area.

During construction, road use is expected to temporarily increase above baseline conditions. In order to avoid impacts to potential branchiopods, all road use and rocking would be limited to the existing road prism. Designated truck passing areas / turnouts (if required) would be located away from potential large branchiopod habitat. No rock or other material would be allowed permanently or temporarily into seasonal wetlands. Additionally, no road grading would be allowed within potential large branchiopod habitat. Construction of the contractor use areas will avoid direct impacts to seasonal wetlands. All potential large branchiopod habitat adjacent to, or near the road and contractor use areas will be fenced and signed with high-visibility protection fencing and signs.

Designated concrete washout area will be located at least 100 feet from potential large branchiopod habitat and will be developed and used following the U.S. EPA Stormwater Best Management Practice (BMP) for a Concrete Washout. All transporters of hazardous materials (fuel, oil, wet concrete etc.) would be required to inspect their vehicles for leaks prior to being mobilized to the project site and again each day prior to use.

Stormwater BMPs will be implemented in accordance with the Stormwater Pollution Prevention Plan. BMPs may include the use of fiber rolls, silt fencing and straw to control runoff, the redirection of uncontrolled stormwater away from potential large branchiopod habitat, the proper storage and maintenance of equipment and vehicles, and the property storage of hazardous materials. Prior to the beginning of a qualifying rain event and at the end of each construction season, exposed soils will be temporarily stabilized and erosion controls will be installed and / or refreshed.

A qualified biologist (biological monitor) will regularly inspect construction-related activities to ensure the protection of potential large branchiopod habitats. The biological monitor will have the authority to stop all activities that may result in habitat disturbance until appropriate corrective measures have been completed. The biological monitor will also be required to report any unauthorized take to CDFW, USFWS and / or NMFS immediately. A construction worker education program will be implemented for all personnel onsite that includes an explanation of all special-status animal species with the potential to occur, including identification, avoidance measures, and federal and state laws that protect the species.

With the above-mentioned avoidance and RPMs in place:

> There is a low likelihood that branchiopod adults and / or cysts would be killed, harmed or harassed during the rocking of the access roads or the rocking and grading_of the contractor use areas. Effects associated with these activities would be short-term, insignificant and not be meaningfully measurable.
>
> There is a low likelihood that branchiopod adults and / or cysts would be killed, harmed or harassed by vehicle traffic or when using the contractor use areas to store and stage equipment and material. Effects associated with these activities would be short-term, insignificant and not be meaningfully measurable.
>
> There is a low likelihood that branchiopod adults and / or cysts would be killed, harmed or harassed from erosion and siltation, the introduction of hazardous materials, or as a result of changes to hydrology. Effects associated with these activities would be short-term, insignificant and not be meaningfully measurable.

Indirect Effects

According to Section 7 of the ESA and its associated regulations promulgated at 50 CFR Section 401, indirect effects are those effects that are caused by, or will result from the proposed action, and are at a later time but still reasonably certain to occur.

Vernal pool fairy shrimp and their cysts may be potentially indirectly impacted after completion of construction as a result of long-term erosion or sedimentation, changes in hydrology or introduction of hazardous materials. These indirect effects have the potential to degrade potential habitat, and could result in vernal pool fairy shrimp mortality.

Disturbed construction areas that are not properly stabilized after construction has ended may result in long-term erosion and sedimentation. Erosion could cause the destruction of potential large branchiopod habitat through the transport and deposition of sediments into seasonal wetlands. Erosion could also cause

changes to drainage patterns and increase runoff volumes discharging to potential large branchiopod habitat. Hazardous materials like fuel, oil and grease may be attached to transported sediments or included in uncontrolled stormwater that discharges to potential large branchiopod habitat.

Changes in hydrology could occur as a result of construction and eventually impact potential large branchiopod habitat. Uncontrolled drainage, erosion and changes to drainage patterns could result in increased surface runoff volumes discharging to potential large branchiopod habitat. Repeated construction use of the south access road may cause soil compaction and the lowering of the access road elevation. Lowering the elevation of the access road may result in the subsequent draining of adjacent potential large branchiopod habitat.

In order to avoid indirect impacts to potential large branchiopod habitat, BMPs will be implemented in accordance with the Stormwater Pollution Prevention Plan upon completion of the project. At the end of each construction season and upon completion of construction, all exposed soils will be stabilized. BMPs may include seeding, and / or mulching exposed soils, the use of fiber rolls, silt fencing and gravel berms to control runoff while the site is being stabilized, and the redirection of new uncontrolled stormwater away from potential large branchiopod habitat.

All hazardous materials used and stored at the site will be completely removed from the Action Area upon construction completion. Any hazardous materials leaks or spills discovered during construction cleanup will be immediately contained and disposed of accordingly. Construction use areas and access roads will be returned to preconstruction conditions such that post-construction runoff patterns are the same as pre-construction runoff patterns. The access road elevations located adjacent to potential large branchiopod habitat shall be consistent with pre-construction conditions so as to avoid dewatering adjacent potential habitat.

Additionally, a biological monitor with authority to stop project work as necessary, would be onsite to regularly inspect construction-related activities, including the final restoration of the access roads and contractor use areas, to ensure that no unnecessary long-term disturbance to potential large branchiopod habitats occur.

With the above-mentioned avoidance and RPMs in place:

> There is a low likelihood that branchiopod adults and / or cysts would be killed, harmed or harassed from erosion and siltation, the introduction of hazardous materials, or as a result of changes to hydrology. Effects associated with these activities would be insignificant and not be meaningfully measurable.

Vernal Pool Tadpole Shrimp

Direct Effects

Direct effects for vernal pool tadpole shrimp are expected to be similar to the direct effects described above for vernal pool fairy shrimp.

Indirect Effects

Indirect effects for vernal pool tadpole shrimp are expected to be similar to the indirect effects described above for vernal pool fairy shrimp.

Interdependent and Interrelated Effects

Interdependent and interrelated factors are those project components that would likely not occur otherwise, if it were not for the project (such as project-related monitoring) or have some connection to the project area that should be considered and / or could have an indirect effect on species in the Action Area. Interrelated projects include the proposed action under consideration and other projects or activities that are part of a larger project and depend on the larger project for their justification. Interdependent projects are projects that have no independent utility apart from the proposed action under consideration.

Pre-construction biological surveys will be required as a part of the project which will result in additional access to the site prior to the start of construction. Access will be minimal and typical via a personal vehicle or on foot.

Post-construction monitoring may include as-built surveys, initial and long-term post-construction monitoring of hydraulic structures and potential adjustment of structures that have moved out of place, biological monitoring for salmonid passage success and post-construction site inspection and maintenance.

Following revegetation, additional maintenance such as irrigation, replanting and non-native plant removal will occur as needed. For approximately three consecutive growing seasons, post-construction maintenance will include the care of trees and shrubs planted as a part of the revegetation plan.

Vehicle access and equipment and materials stockpiling during pre- and post-construction monitoring and maintenance activities would be similar in scale and duration to current ranching activities and PG&E's maintenance and monitoring of the Eagle Canyon Dam and Fish Ladder. Potential adjustment of structures that have moved out of place may require use of a crane and / or yarder system. Personnel accessing the site during pre- and post-construction activities would be trained to avoid any impacts to seasonal wetlands containing potential large branchiopods and would be required to follow the same RPMs discussed in this biological assessment. There are no other interrelated or interdependent actions associated with the Proposed Action.

Cumulative Effects

Cumulative effects are those effects of future non-federal (state, local government, or private) activities on endangered and threatened species or CH that are reasonably certain to occur within the Action Area of the federal activity subject to consultation. Currently, there are no other known future state, tribal, local and private actions reasonably certain to occur within the action area under consideration.

The BCRP involves modifications to Battle Creek hydroelectric facilities located on North Fork Battle Creek, South Fork Battle Creek and Baldwin Creek, including removing five diversions dams and constructing fish screens and ladders on three other diversion dams. The project is being implemented by Reclamation.

A winter-run Chinook salmon reintroduction program was initiated several years ago in Battle Creek involving the annual release of juvenile fish in North Fork Battle Creek, approximately four stream miles downstream of the proposed project. The goal of the program is to reintroduce a self-sustaining winter-run Chinook population into the upper reaches of North Fork Battle Creek. These juvenile releases have been ongoing in an attempt to create an annual pipeline of adults that can potentially colonize Battle Creek when the proposed project is completed. The current plan is to intercept all adult winter-run Chinook at the Coleman National Fish Hatchery, located on the main stem of Battle Creek, approximately 16 stream miles downstream of the proposed project. Once the proposed project has been completed,

making high-quality winter-run Chinook habitat available, the adult fish will be allowed to access the upper reaches of North Fork Battle Creek. This multi-agency project is being implemented by the USFWS.

The cumulative impacts of these projects and the Proposed Action are not anticipated to be negative, and in fact should improve natural resource conditions for federally listed anadromous fish and other native species in the Battle Creek watershed.

Beneficial Effects

The goal of the Proposed Action is to restore upstream passage for adult Chinook salmon and steelhead at the Lower and Upper Barrier Sites on the North Fork Battle Creek. The Proposed Action would not result in beneficial effects to the species analyzed in this document. However, the Proposed Action would contribute to the recovery of several federally listed anadromous fish species and provide ancillary benefits to other wildlife species that utilize anadromous fish as a food source.

VI. ESA EFFECTS DETERMINATION

The following conclusions led to the final determination of effects that the North Fork Battle Creek Barrier Modification and Fish Passage Improvement Project would have on Endangered, Threatened and Proposed species:

1) RPMs and BMPs would be implemented.

2) The project would not result in direct effects to large branchiopod habitat.
The Proposed Action **may affect, but is not likely to adversely affect** vernal pool fairy shrimp and vernal pool tadpole shrimp. Injury and / or mortality to potential large branchiopod adults and / or cysts will be avoided with the implementation of RPMs and BMPs. Effects to vernal pool fairy shrimp and vernal pool tadpole shrimp may occur, however the effects would not be meaningfully measurable or detectable and would never reach the level where a take would occur.

The Proposed Action **would have no effect** on vernal pool fairy shrimp or vernal pool tadpole shrimp CH.

The Proposed Action **would have no effect** on slender Orcutt grass, valley elderberry longhorn beetle, Conservancy fairy shrimp, delta smelt, California red-legged frog, least Bell's vireo, western yellow-billed cuckoo or gray wolf or their CHs.

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VIII. PERSONS CONSULTED

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Mr. Michael Love, P.E., Principal Engineer, Michael Love & Associates, Inc., Arcata, California.

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IX. ACKNOWLEDGEMENTS

We wish to thank Ms. Laurie Early of the USFWS and Mr. Michael Love and Mr. P. Travis James of Michael Love & Associates, Inc. for assistance with the preparation of portions of this document. We wish to thank PG&E, Mr. David Gamon and Ms. April Gage, and the Davis Ranch for providing and / or arranging access to the project site. Funding for this work was provided by the USFWS under the authority of the Central Valley Project Improvement Act through Grant Agreement Award F18AP00099.

APPENDIX A

U.S. Fish and Wildlife Service Species List

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Sacramento Fish And Wildlife Office
Federal Building
2800 Cottage Way, Room W-2605
Sacramento, CA 95825-1846
Phone: (916) 414-6600 Fax: (916) 414-6713

In Reply Refer To: November 29, 2018
Consultation Code: 08ESMF00-2019-SLI-0458
Event Code: 08ESMF00-2019-E-01399
Project Name: North Fork Battle Creek Barrier Modification and Fish Passage Improvement Project

Subject: List of threatened and endangered species that may occur in your proposed project location, and/or may be affected by your proposed project

To Whom It May Concern:

The enclosed species list identifies threatened, endangered, proposed and candidate species, as well as proposed and final designated critical habitat, under the jurisdiction of the U.S. Fish and Wildlife Service (Service) that may occur within the boundary of your proposed project and/or may be affected by your proposed project. The species list fulfills the requirements of the Service under section 7(c) of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 *et seq.*).

Please follow the link below to see if your proposed project has the potential to affect other species or their habitats under the jurisdiction of the National Marine Fisheries Service:

http://www.nwr.noaa.gov/protected_species/species_list/species_lists.html

New information based on updated surveys, changes in the abundance and distribution of species, changed habitat conditions, or other factors could change this list. Please feel free to contact us if you need more current information or assistance regarding the potential impacts to federally proposed, listed, and candidate species and federally designated and proposed critical habitat. Please note that under 50 CFR 402.12(e) of the regulations implementing section 7 of the Act, the accuracy of this species list should be verified after 90 days. This verification can be completed formally or informally as desired. The Service recommends that verification be completed by visiting the ECOS-IPaC website at regular intervals during project planning and implementation for updates to species lists and information. An updated list may be requested through the ECOS-IPaC system by completing the same process used to receive the enclosed list.

The purpose of the Act is to provide a means whereby threatened and endangered species and the ecosystems upon which they depend may be conserved. Under sections 7(a)(1) and 7(a)(2) of the Act and its implementing regulations (50 CFR 402 *et seq.*), Federal agencies are required to utilize their authorities to carry out programs for the conservation of threatened and endangered species and to determine whether projects may affect threatened and endangered species and/or designated critical habitat.

A Biological Assessment is required for construction projects (or other undertakings having similar physical impacts) that are major Federal actions significantly affecting the quality of the human environment as defined in the National Environmental Policy Act (42 U.S.C. 4332(2)(c)). For projects other than major construction activities, the Service suggests that a biological evaluation similar to a Biological Assessment be prepared to determine whether the project may affect listed or proposed species and/or designated or proposed critical habitat. Recommended contents of a Biological Assessment are described at 50 CFR 402.12.

If a Federal agency determines, based on the Biological Assessment or biological evaluation, that listed species and/or designated critical habitat may be affected by the proposed project, the agency is required to consult with the Service pursuant to 50 CFR 402. In addition, the Service recommends that candidate species, proposed species and proposed critical habitat be addressed within the consultation. More information on the regulations and procedures for section 7 consultation, including the role of permit or license applicants, can be found in the "Endangered Species Consultation Handbook" at:

http://www.fws.gov/endangered/esa-library/pdf/TOC-GLOS.PDF

Please be aware that bald and golden eagles are protected under the Bald and Golden Eagle Protection Act (16 U.S.C. 668 *et seq.*), and projects affecting these species may require development of an eagle conservation plan (http://www.fws.gov/windenergy/eagle_guidance.html). Additionally, wind energy projects should follow the wind energy guidelines (http://www.fws.gov/windenergy/) for minimizing impacts to migratory birds and bats.

Guidance for minimizing impacts to migratory birds for projects including communications towers (e.g., cellular, digital television, radio, and emergency broadcast) can be found at: http://www.fws.gov/migratorybirds/CurrentBirdIssues/Hazards/towers/towers.htm; http://www.towerkill.com; and http://www.fws.gov/migratorybirds/CurrentBirdIssues/Hazards/towers/comtow.html.

We appreciate your concern for threatened and endangered species. The Service encourages Federal agencies to include conservation of threatened and endangered species into their project planning to further the purposes of the Act. Please include the Consultation Tracking Number in the header of this letter with any request for consultation or correspondence about your project that you submit to our office.

Attachment(s):

- Official Species List

Official Species List

This list is provided pursuant to Section 7 of the Endangered Species Act, and fulfills the requirement for Federal agencies to "request of the Secretary of the Interior information whether any species which is listed or proposed to be listed may be present in the area of a proposed action".

This species list is provided by:

Sacramento Fish And Wildlife Office
Federal Building
2800 Cottage Way, Room W-2605
Sacramento, CA 95825-1846
(916) 414-6600

Project Summary

Consultation Code: 08ESMF00-2019-SLI-0458

Event Code: 08ESMF00-2019-E-01399

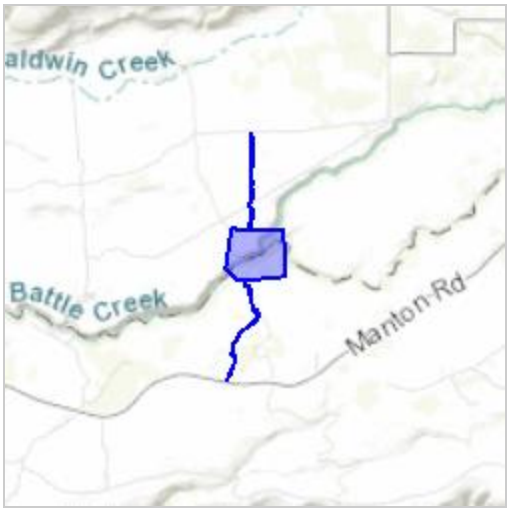
Project Name: North Fork Battle Creek Barrier Modification and Fish Passage Improvement Project

Project Type: Federal Grant / Loan Related

Project Description: The purpose of the project is to improve passage conditions for adult Chinook salmon and steelhead in Battle Creek by removing boulder barriers and restoring flow conditions at the Upper and Lower Barrier Site located south of Manton, CA.

Project Location:

Approximate location of the project can be viewed in Google Maps: https://www.google.com/maps/place/40.42434973047426N121.91813500100517W



Counties: Shasta, CA | Tehama, CA

Endangered Species Act Species

There is a total of 6 threatened, endangered, or candidate species on this species list.

Species on this list should be considered in an effects analysis for your project and could include species that exist in another geographic area. For example, certain fish may appear on the species list because a project could affect downstream species.

IPaC does not display listed species or critical habitats under the sole jurisdiction of NOAA Fisheries[1], as USFWS does not have the authority to speak on behalf of NOAA and the Department of Commerce.

See the "Critical habitats" section below for those critical habitats that lie wholly or partially within your project area under this office's jurisdiction. Please contact the designated FWS office if you have questions.

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1. NOAA Fisheries, also known as the National Marine Fisheries Service (NMFS), is an office of the National Oceanic and Atmospheric Administration within the Department of Commerce.

Amphibians

NAME	STATUS
California Red-legged Frog *Rana draytonii* There is **final** critical habitat for this species. Your location is outside the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/2891	Threatened

Fishes

NAME	STATUS
Delta Smelt *Hypomesus transpacificus* There is **final** critical habitat for this species. Your location is outside the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/321	Threatened

Crustaceans

NAME	STATUS
Conservancy Fairy Shrimp *Branchinecta conservatio* There is **final** critical habitat for this species. Your location is outside the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/8246	Endangered
Vernal Pool Fairy Shrimp *Branchinecta lynchi* There is **final** critical habitat for this species. Your location is outside the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/498	Threatened
Vernal Pool Tadpole Shrimp *Lepidurus packardi* There is **final** critical habitat for this species. Your location is outside the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/2246	Endangered

Flowering Plants

NAME	STATUS
Slender Orcutt Grass *Orcuttia tenuis* There is **final** critical habitat for this species. Your location is outside the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/1063	Threatened

Critical habitats

THERE ARE NO CRITICAL HABITATS WITHIN YOUR PROJECT AREA UNDER THIS OFFICE'S JURISDICTION.

APPENDIX B

Basis of Design Memorandum

Eagle Canyon Fish Passage Improvements in Battle Creek
Lower and Upper Barrier Sites

Basis of Design Memorandum

February 2017

Prepared for:

California Department of Fish and Wildlife
(Agreement Number D1499019)

Prepared by:

Michael Love & Associates
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Eagle Canyon Fish Passage Improvements in Battle Creek, Lower and Upper Barrier Sites

Basis of Design Memorandum

Prepared for:

California Department of Fish and Wildlife
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February 2017

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Attachments

Attachment 1 – 90% Design Drawings

Attachment 2 – Annotated Bibliography of Previous Battle Creek Studies and Reports

Attachment 3 – *Eagle Canyon Fish Passage Improvements; Alternative Analysis Constructability Review Memorandum* **(SRD, 2016a)**

Attachment 4 – *Eagle Canyon Fish Passage Improvements; Alternative Class 4 Estimate Narrative* **(SRD, 2016b)**

Attachment 5 – *Construction Schedule*

1 PURPOSE AND INTRODUCTION

This Basis of Design Memorandum (BODM) is intended to provide a summary of the proposed fish passage improvements at the Lower Barrier Site and Upper Barrier Site in Eagle Canyon on North Fork Battle Creek near Manton, California. This memorandum provides the project goals and objectives, design criteria and decisions, description of the proposed project, anticipated fish passage conditions resulting from the project, anticipated monitoring and maintenance required, and limitations and uncertainties associated with implementation and project performance.

The information presented in this memorandum relies on previously completed work. Repeating information from other documents was minimized but some information is repeated or summarized for convenience. A discussion of previously completed documents is included in Sections 2.2 and 2.3. Descriptions and analysis presented in this BODM are based on the 90% design drawings, which are included as Attachment 1.

The organization of this BODM is as follows:

Section 2 - Background and Setting: Presents the project location, a summary of the work completed previously by others and the Design Team for this project, and a summary of the existing LBS and UBS conditions.

Section 3 - Project Goals, Objectives, and Fish Passage Design Criteria: Describes design considerations and criteria used for this project.

Section 4 - Lower Barrier Site Design: Presents the Lower Barrier Site design, including a description of the design, anticipated fish passage performance, anticipated maintenance requirements, expected design life, recommended post-construction monitoring, and design limitations and uncertainties.

Section 5 - Upper Barrier Site Design: Presents the Upper Barrier Site design, including a description of the design, anticipated fish passage performance, anticipated maintenance requirements, expected design life, recommended post-construction monitoring, and design limitations and uncertainties.

Section 6 - References: Lists reports and publications cited in this document.

2 BACKGROUND AND SETTING

Battle Creek has historically been regarded as a uniquely important watershed because of the abundance and broad diversity of Chinook salmon and steelhead that used the creek. The year-round influence of cold water springs allowed for such diversity to develop, including winter-run Chinook salmon, which are now extirpated from the watershed and in danger of extinction. Hydroelectric facilities, operations, and other human factors likely caused the extirpation of winter-run Chinook from the Battle Creek watershed in the early 1900s (Reynolds et al. 1993).

After many years of planning, there is currently a major fisheries restoration project being completed by many organizations and led by the U.S. Bureau of Reclamation (USBR) on Battle Creek, referred to as *The Battle Creek Salmon and Steelhead Restoration Project* (USBR Restoration Project). Upon its

completion, the goal of the USBR Restoration Project is to reestablish approximately 42 miles of prime salmon and steelhead habitat on Battle Creek, plus an additional six miles on its tributaries.

The California Department of Fish and Wildlife (CDFW) has retained the services of Michael Love & Associates, Inc. (MLA) to design and develop construction ready documents to improve upstream fish passage conditions at two natural fish barriers on North Fork Battle Creek (NFBC): Lower Barrier Site (LBS) and Upper Barrier Site (UBS). This Eagle Canyon Fish Passage Improvement Project (Project) is being completed for CDFW under Agreement Number D1499019.

The following sections present background and setting information pertinent to this memorandum. This includes the project location, summary of previously completed work, and summaries of the existing conditions at both sites.

2.1 Project Location

This project is located within Eagle Canyon, along the border of northern Tehama and southern Shasta counties on North Fork Battle Creek (Figure 2-1). The separation between the Lower Barrier Site (LBS) and Upper Barrier Site (UBS) is approximately 1,200 feet. Eagle Canyon Dam, operated by Pacific Gas & Electric (PG&E), is located at approximately the mid-point between the two project sites. See Attachment 1, Sheet 3, for an additional site location map.

2.2 Previous Work and Relevant Studies by Others

The Battle Creek watershed has been the subject of many previous studies. An annotated bibliography of the previously completed work obtained as part of this project is included in Attachment 2. The following sections further highlight some of the studies.

2.2.1 In-Stream Flow Agreements

In February 1999, the National Marine Fisheries Service (NMFS), U.S. Bureau of Reclamation, U.S. Fish and Wildlife Service (USFWS), California of Department of Fish and Game (CDFG), and Pacific Gas and Electric Company (PG&E) entered into a memorandum of understanding (MOU). The MOU outlined the roles and responsibilities regarding actions to be undertaken as part of the Battle Creek Chinook Salmon and Steelhead Restoration Project. Among other details, the MOU outlined minimum instream flow releases below various diversion dams within the anadromous reaches of North and South Fork of Battle Creek. Table 2-1 presents minimum instream flow releases at North Battle Creek Feeder Dam (Feeder Dam) and Eagle Canyon Dam by month. Figure 2-2 shows the location of these dams relative to the project sites. Currently, PG&E is operating under interim instream flow requirements.

2.2.2 Hydrology Studies and Streamflow Gaging

Figure 2-2 presents an overview of the USBR Restoration Project components with the location of the LBS and UBS indicated. The figure also indicates the location of key dams and flow gaging stations within the watershed that may be discussed in this memorandum. MLA's *Existing Site and Hydraulic Characterization Technical Memorandum* (MLA, 2016b), presents a detailed discussion of project hydrology.

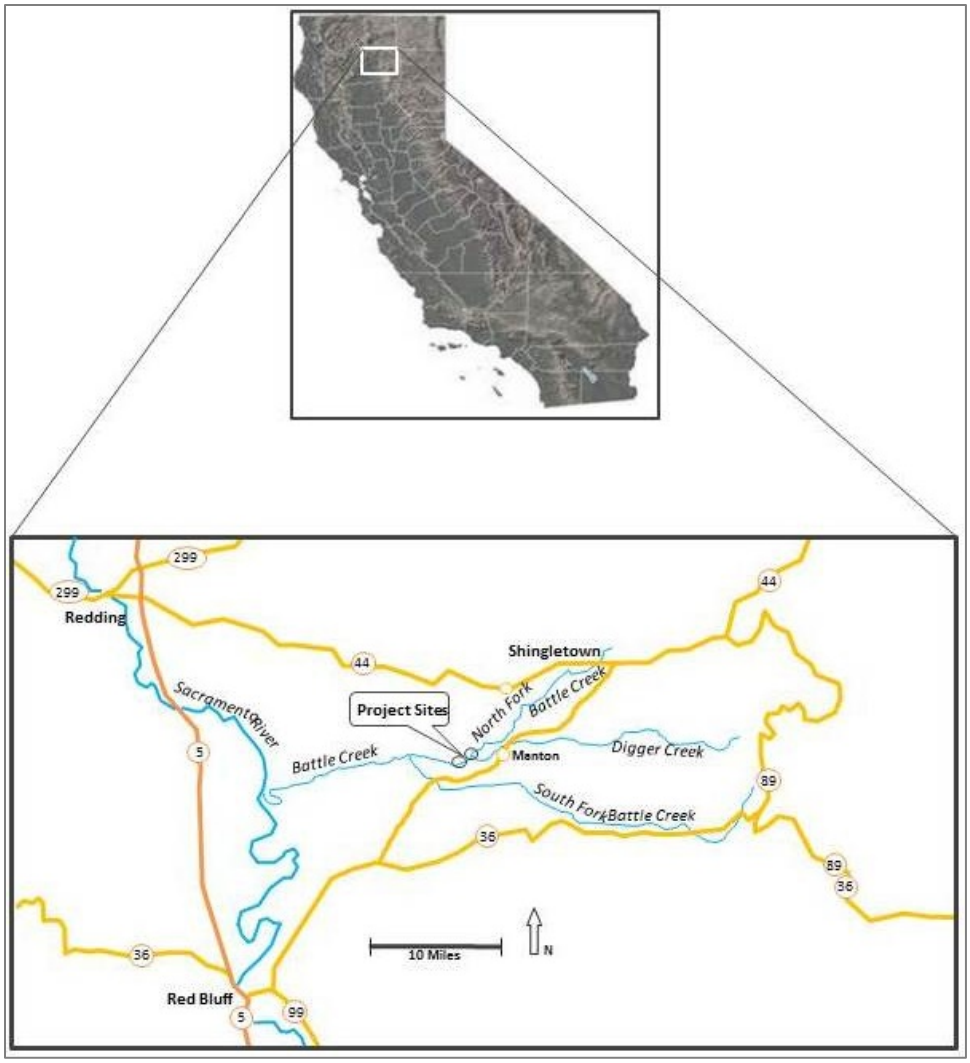


Figure 2-1. Project location map.

Table 2-1. Minimum instream flow releases by month for the Feeder Dam upstream of the UBS and Eagle Canyon Dam upstream of the LBS (from the 1999 MOU).

	Minimum Instream Bypass Flow (cfs)											
Diversion Dam	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Feeder Dam[1]	88	88	67	47	47	47	47	47	47	47	47	88
Eagle Canyon[2]	46	46	46	46	35	35	35	35	35	35	35	46

1. On occasion the release is not attainable due to the quantity of inflow reaching the dam. Additional inflows to the North Battle Creek Feeder reach are occasionally received from the junction box of the Volta 2 Powerhouse Tailrace and Cross-Country Canal a short distance downstream.

2. Eagle Canyon Dam releases reported on this table include releases from Eagle Canyon Springs (the springs located downstream of Eagle Canyon Dam).

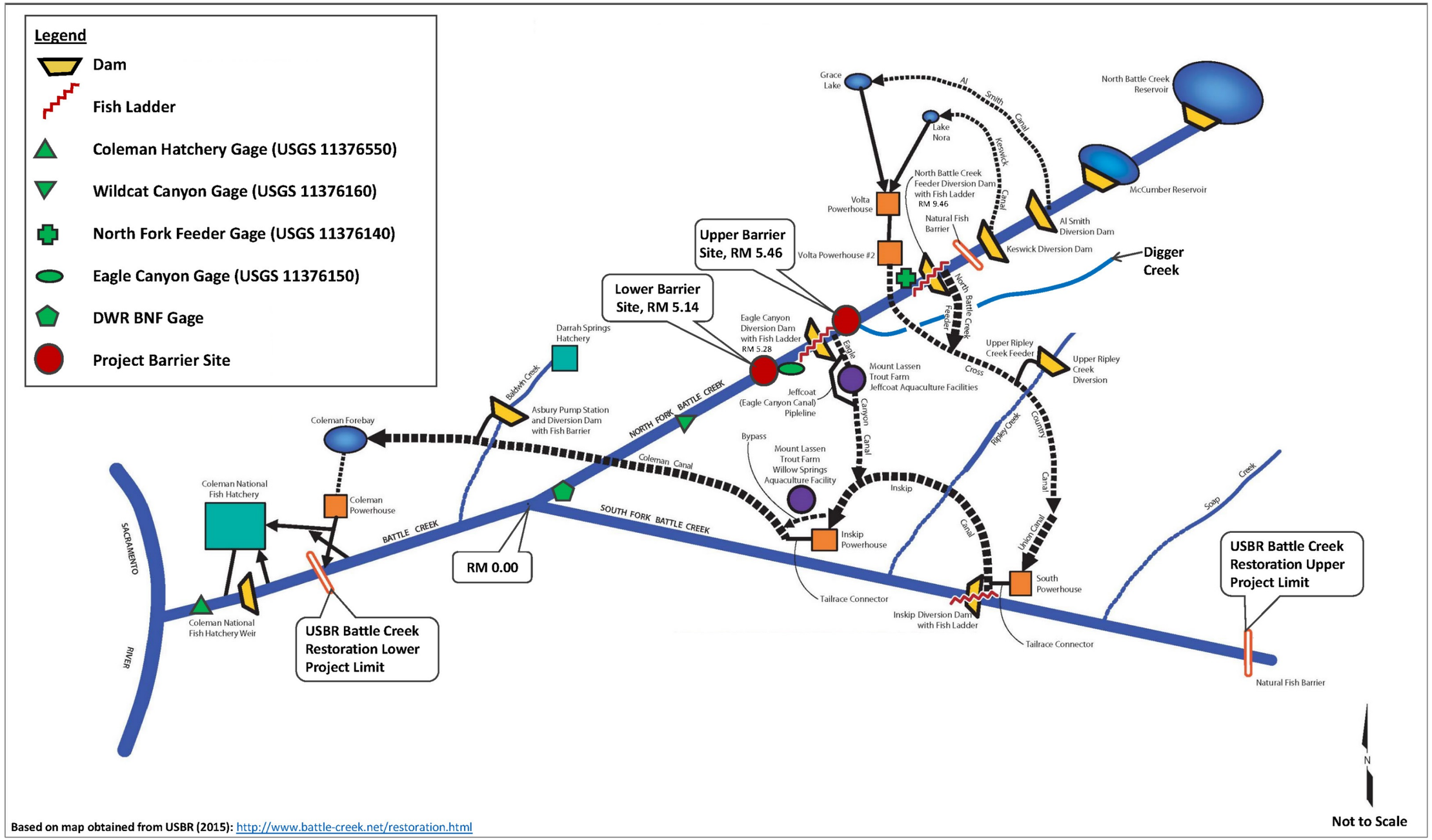


Figure 2-2. Battle Creek Schematic for USBR Restoration Project with this project's site locations and the location of various flow gages indicated.

2.2.3 Fish Passage and Fish Monitoring Studies

There have been several fish passage and fish monitoring studies completed for Battle Creek. The following paragraphs highlight some of these studies. Refer to MLA (2016b) for additional details.

Figure 2-3 presents a map of partial and complete natural barriers identified by Thomas R. Payne and Associates (TRPA, 1998), with the current two project barriers indicated by the red dots. Located between LBS and UBS is Eagle Canyon Dam. TRPA (1998) identified several barriers downstream and upstream of these two barrier sites. In general, they concluded that the barriers downstream of the LBS were all passable at flows greater than 35 cfs. USFWS continues to monitor some of these barriers to determine at what flows passage is feasible. USFWS is also monitoring locations between Eagle Canyon Dam and the UBS.

The UBS is located approximately 600 feet upstream of Eagle Canyon Dam. For reasons unknown, the 1998 TRPA fish passage assessment makes no mention of the UBS. Earley (2014) identified the UBS, referred to as Barrier B. Earley concluded that the UBS was a complete barrier at low and moderate flows, with the potential for an alternative passage route around the barrier at high flows. MLA (2016b), discussed in the following section, concluded that the primary drop is a complete barrier at all flows.

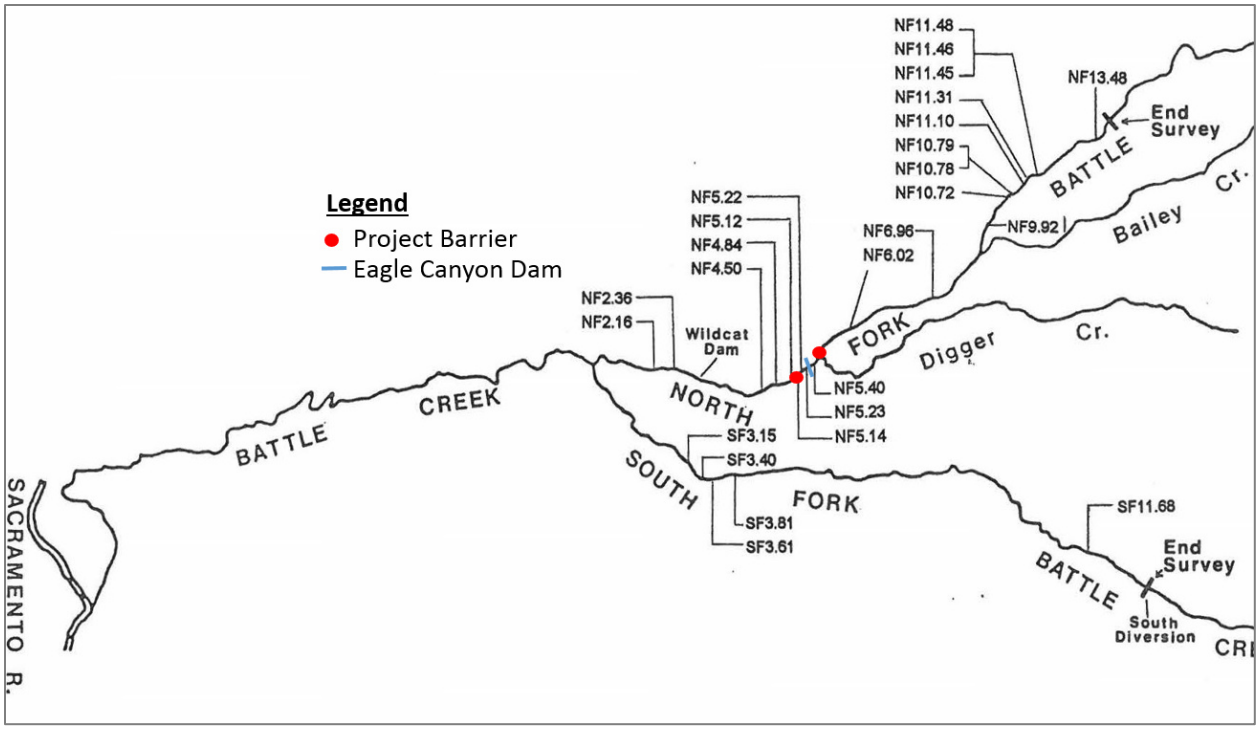


Figure 2-3. Locations of identified barriers (TRPA, 1998) with the current Project's barriers labeled by red dots.

2.3 Summary of Previous Work Completed by MLA Design Team

Work presented in this memorandum relies on work completed and documented in early documents. Many of these previous documents were included within the appendices of the *Eagle Canyon Fish Passage Improvements in Battle Creek Lower and Upper Barrier Sites: Alternative Analysis Report* (MLA, 2017). Table 2-2 presents the studies completed for this project by the MLA design team.

Table 2-2. A list of previously completed documents completed for this Project by the MLA Design Team.

Associated Task	Document Title	Primary Author	Status	Where Available
Task 2	*Final Eagle Canyon Fish Passage Improvement Project Task 2: Topographic Surveying and Boulder Mapping Results*	Michael Love & Associates, Inc.	Final, May 2016	MLA, 2017, App. E[1]
Task 2	*North Fork Battle Cr Eagle Canyon Survey Report*	GMA Hydrology, Inc.	Final, January 2016	
Task 3	*Engineering Geologic Investigation Technical Memorandum Eagle Canyon Fish Passage Improvement in Battle Creek*	Cotton, Shires and Associates, Inc.	Final, August 2016	MLA, 2017, App. F[1]
Task 4	*Eagle Canyon Fish Passage Improvements in Battle Creek Lower and Upper Barrier Sites: Existing Site and Hydraulic Characterization Technical Memorandum*	Michael Love & Associates, Inc.	Final, October 2016	MLA, 2017, App. G[1]
Task 5	*Eagle Canyon Fish Passage Improvements in Battle Creek Lower and Upper Barrier Sites: Alternative Analysis Report*	Michael Love & Associates, Inc.	Final, January 2017	MLA, 2017
Task 5	*Eagle Canyon Fish Passage Improvements; Alternative Analysis Constructability Review Memorandum*	SR Diversified	Revision 3, October 2016	Attachment 3
Task 5	*Eagle Canyon Fish Passage Improvements; Alternative Class 4 Estimate Narrative*	SR Diversified	November 2016	Attachment 4
1. Indicates the Appendix the document can be found within the *Eagle Canyon Fish Passage Improvements in Battle Creek Lower and Upper Barrier Sites (MLA, 2017)*				

2.3.1 Survey and Mapping

GMA Hydrology's (GMA's) *North Fork Battle Cr Eagle Canyon Survey Report* (GMA, 2016) presents the work completed to develop the base topographic data for the project. This included brining control to the project sites, obtaining LiDAR data, conducting ground base scans, conducting traditional total station surveys, conducting sonar-based bathometric surveys, and obtaining low-elevation aerial photographs of the sites. Survey products included detailed point clouds, surfaces, and meshes for both sites.

MLA's *Final Eagle Canyon Fish Passage Improvement Project Task 2: Topographic Surveying and Boulder Mapping Results Technical Memorandum* (MLA, 2016a) provided the results of the work completed under Task 2 by MLA. This included the labeling of boulders for both sites, mapping hydraulic control for both sites, mapping high and low flow alignments, and delivering all of the electronic information developed by both MLA and GMA.

2.3.2 Engineering Geologic Studies

Cotton, Shires and Associates' (CSA's) *Engineering Geologic Investigation Technical Memorandum Eagle Canyon Fish Passage Improvement in Battle Creek* (CSA, 2016) provided the findings of their engineering geologic investigation. This included a rigorous investigation of the UBS and a qualitative investigation of the LBS.

2.3.3 Characterization of Existing Hydraulic and Fish Passage Conditions Methods

The *Eagle Canyon Fish Passage Improvements in Battle Creek Lower and Upper Barrier Sites: Existing Site and Hydraulic Characterization Technical Memorandum* (MLA, 2016b) summarized the work and findings for characterizing existing conditions. This included field measurements (water level logger, several surveys, and time-lapse cameras) and desktop exercises (rating curves, hydraulic models, and maps) based on the field data and research. A summary of existing fish passage conditions and recommendations for the two sites are presented in Sections 2.4.4 and 2.5.4.

2.3.4 Alternative Analysis

Based on work completed earlier, MLA scoped potential concepts to improve fish passage at the LBS and UBS. From the scoped concepts, two concepts for the LBS and three concepts for the UBS were selected for full alternative development. The concepts and alternatives were presented in *Eagle Canyon Fish Passage Improvements in Battle Creek Lower and Upper Barrier Sites: Alternative Analysis Report* (MLA, 2017). The Report culminated by selecting preferred alternatives for both sites. This BODM presents additional information related to these two preferred alternatives based on the 90% Design Drawings.

2.3.5 Construction Alternative Analysis

Based on the Draft *Eagle Canyon Fish Passage Improvements in Battle Creek Lower and Upper Barrier Sites: Alternative Analysis Report* (Draft Alternative Analysis Report), SR Diversified developed the *Eagle Canyon Fish Passage Improvements Alternative Analysis Constructability Review Memorandum* (SRD, 2016a, Attachment 3). Within this memorandum, SR Diversified conceptually analyzed large equipment access options (helicopter, crane, skyline yarder), foot and small equipment access, water control and water quality control, and rock demolition from a contractor's point of view regarding feasibility and potential issues to overcome. MLA used this information during the development of 65% design documents.

2.3.6 Class 4 Cost Analysis

Based on the Draft Alternative Analysis Report for the Project, SR Diversified developed the *Eagle Canyon Fish Passage Improvements Alternative Class 4 Estimate Narrative* (SRD, 2016b, Attachment 4). SR Diversified was directed to review three large equipment options (helicopter, crane, and skyline yarder) and develop an AACE Class 4 construction cost estimate for the two project sites. Based on the conceptual designs, the three options were found to produce similar construction costs.

2.3.7 Construction Schedule

Based on the 65% drawings and technical specifications, SR Diversified developed a construction schedule. The first schedule developed was for a single construction season. The single construction season provided no float time, requiring everything to proceed on schedule with no unforeseen conditions arising during construction. The single season schedule also required that streamflows be low enough in June to allow installation of a stream diversion. The schedule was viewed as too optimistic, and a two-season construction schedule was developed. The LBS will be constructed the first season and the UBS the second season.

2.4 Lower Barrier Site Summary of Existing Conditions

This section summarizes the LBS layout, geologic hazards, hydrology, and existing fish passage conditions. MLA (2016b) provides a detailed description of the LBS.

2.4.1 LBS Layout

Figure 2-4 and Figure 2-5 presents an aerial image of the LBS and mapped boulder complexes. Figure 2-6 presents the LBS profile. In the first two figures, water flows from right to left. Overall, the LBS is more linear than the UBS with respect to flow direction. Flow at the LBS is concentrated on river right (looking downstream) as it passes from Pool 5, down the primary drop, into Pool 4, through Sieve B [a sieve is a gap under boulders that convey substantial flow], into Pool 3, through Sieve A, into Pool 2, and then finally into Pool 1, which marks the downstream end of the LBS reach. The water surface elevation (WSE) difference between Pools 4 and 5, which encompasses the primary drop, is approximately 8.4 feet under low flow (~35 cfs) conditions. The primary drop is approximately 34.5 feet long.

2.4.2 LBS Geologic Conditions and Hazards

CSA (2016) conducted a qualitative geologic assessment of the LBS and Smelser (2012) conducted a more in-depth characterization of the LBS (in the channel). The two studies provide information helpful to understand the geologic hazards that exist at the LBS.

In general, the LBS is more geologically stable than the UBS but still includes some active toppling. Along the south canyon wall (river left) two very large blocks have a high failure potential and a thinner block or flake also has a high failure potential. These features are above the LBS and located within the Eagle Canyon Basalt layer adjacent to the PG&E footpaths above the LBS. The Eagle Canyon Basalt layer has pervasive, near-vertical cooling joints that result in relatively large bocks that can topple. There are other blocks and columns within this layer near the LBS, but they have a moderate failure potential (could fail within 50 – 100 years).

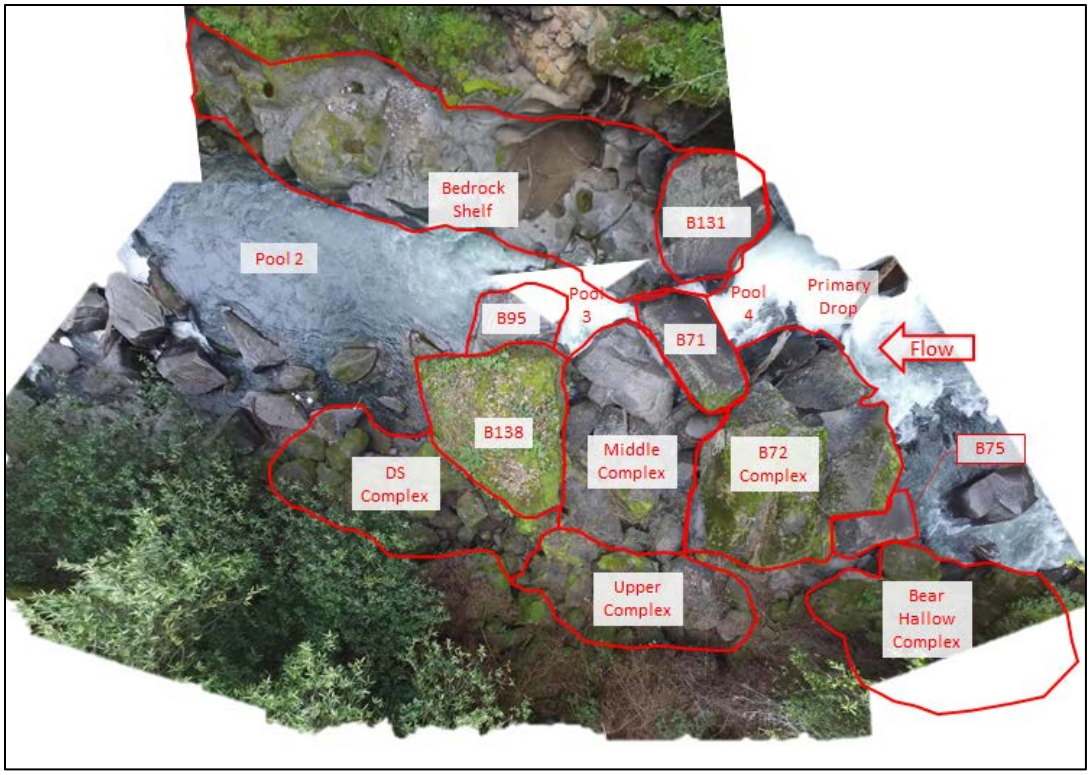


Figure 2-4. Aerial image of the Lower Barrier Site showing mapped boulder complexes.

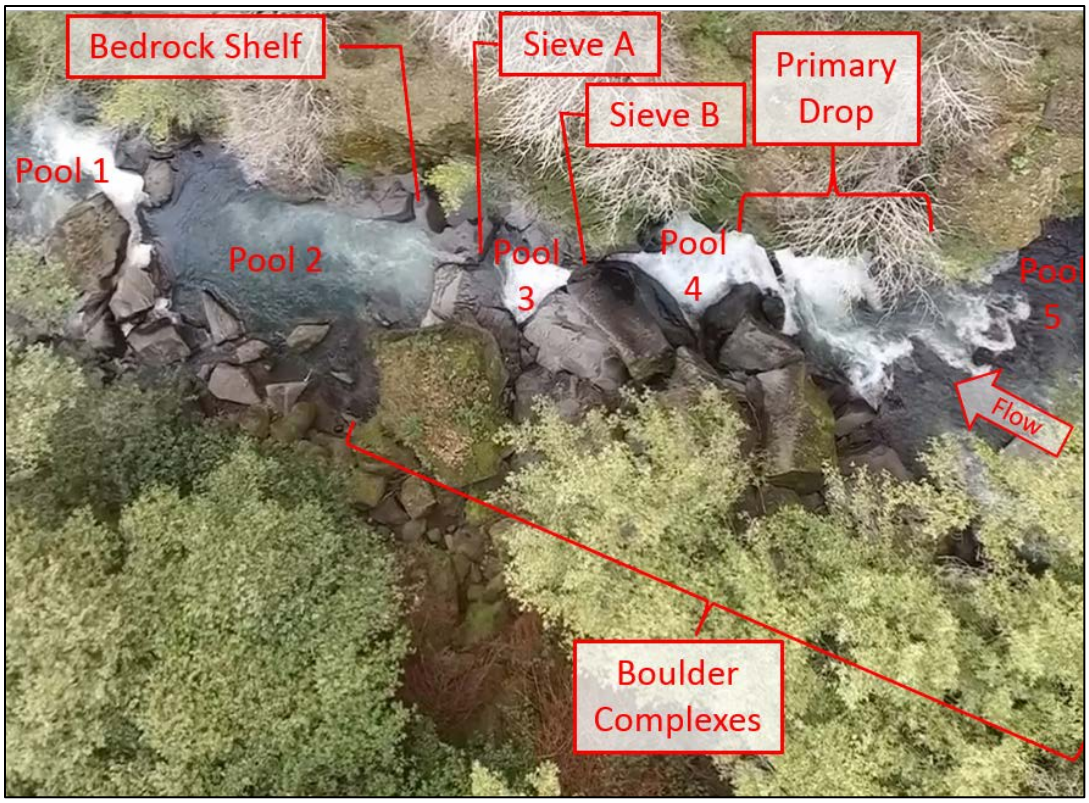


Figure 2-5. Aerial image of the Lower Barrier Site taken on February 10, 2016 at a flow of 120 cfs.

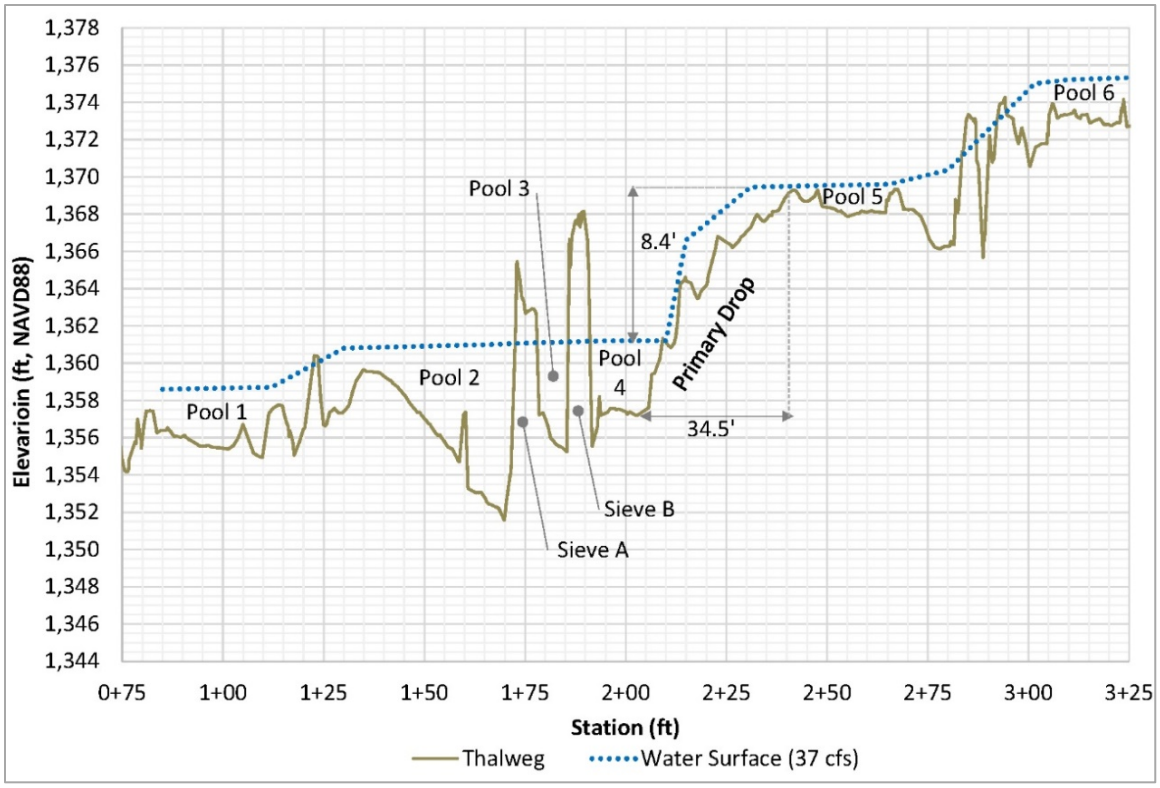


Figure 2-6. Lower Barrier Site channel profile.

CSA could not access the north canyon face due to landowner access permissions, but was able to view the face from PG&E's walkways on the south rim and from aerial photography. The north canyon can be separated into two distinct vertical walls (referred to as upper and lower) with a sloped area between. CSA noted some detached boulders laying on the sloped area with approximately 3 feet diameters and if mobilized, they would potentially tumble into the LBS.

CSA completed field and laboratory tests to quantify the characteristics of the boulders within the channel with respect to hardness. In general, the basalt boulder strength varied from very strong (unconfined compressive strength between 14,500 and 36,250 psi) to extremely strong (unconfined compressive strength greater than 36,000 psi).

2.4.3 LBS Site Hydrology

Peak Flows

Peak flows were estimated from the work completed by USBR (2001). The LBS peak flows are presented in Table 2-3. The flows were derived by scaling the USBR peak flows for Eagle Canyon Dam to the LBS drainage area, which is approximately 188 square miles.

Table 2-3. LBS peak flows for selected return periods.

Return Period (years)	2	2.33	5	10	25	50	100
Flow (cfs)	2,504	2,905	4,407	5,709	7,512	8,914	10,216

Daily Average Flow Duration Curves

Flow duration curves are often used to determine fish passage design flows and evaluate fish passage delays due to low or high flow conditions. The annual 1% exceedance flow is often used in northern California to set the high fish passage design flow for adult anadromous salmonids (CDFG 2002; NMFS 2001).

Figure 2-7 presents flow duration curves (FDCs) constructed for the LBS. The FDC is based on daily average flow records for 16 water years collected at the BNF gage. Flows are scaled to the drainage area of the LBS. In summary, two different approaches were used to develop the FDC. The first is based on the traditional approach, which is a ranking of all of the daily average flow data to determine the exceedance flows. When applying this method, Water Year 2006 was identified as a high-flow outlier, such that eliminating this year decreased the 1% exceedance flow by 32%. Therefore, data from 2006 was excluded from the FDC, resulting in a 1% exceedance flow of 382 cfs.

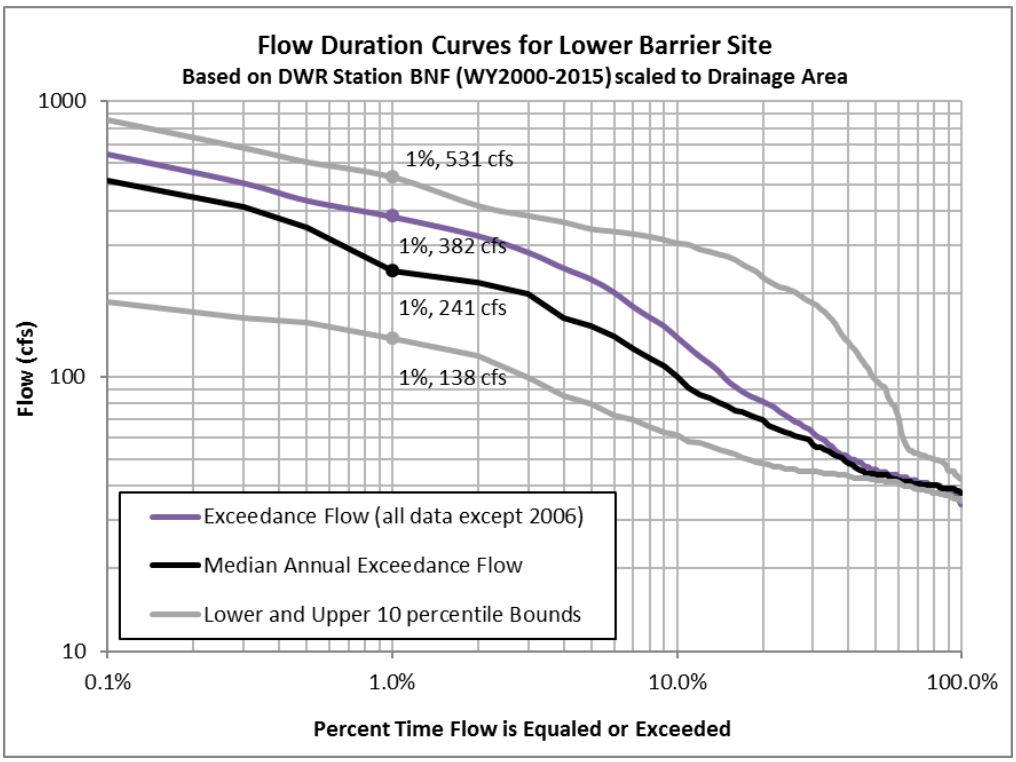


Figure 2-7. Flow duration curves for Lower Barrier Site based on DWR BNF daily average flows, calculated using all data except WY2006 (outlier) and using the median of the annual flow duration curves. For 80% of the water years the annual exceedance flows will fall between the lower and upper curves.

The alternative approach used to create the FDC is based on methods outlined by Vogel and Fennessey (1994). This approach better describes annual variability and allows for calculation of annual statistics and confidence intervals. It involves constructing individual FDCs for each of the 16 water years, and then calculating the median FDC. As seen in Figure 2-7, the median 1% annual exceedance flow is 241 cfs. This means that for half of the water years, from the period of record, the 1% annual exceedance flow was less than 241 cfs and the other half was

a higher. For 80% of the water years, the 1% annual exceedance flow was between 531 cfs and 138 cfs.

2.4.4 LBS Fish Passage Conditions

MLA (2016b) concluded that the primary drop is a complete barrier to migrating salmon and steelhead. The barrier conclusion was based on field observations and two-dimensional hydraulic modeling results. The two-dimensional model results within the primary drop portion of the channel, were compared to swimming speeds based on developed equations (Hunter and Mayor, 1986) for differing fish body size and time to exhaustion for Chinook salmon. The comparison did identify that salmon in good condition could overcome the flow velocity within the primary drop prior to becoming exhausted under certain flow conditions, but the model does not capture the extreme flow turbulence that occurs throughout the primary drop.

Based on several site visits and from time-lapse photography, the turbulence within the primary drop is extreme within the primary drop and Pool 4. Therefore, although the hydraulic model and fish swimming equations may indicate that fish passage is possible, the addition of the extreme turbulence makes the primary drop a complete barrier.

2.5 Upper Barrier Site Summary of Existing Conditions

This section summarizes the UBS layout, geologic hazards, hydrology, and existing fish passage conditions. MLA (2016b) provides a detailed description of the UBS.

2.5.1 UBS Layout

Figure 2-8 presents an aerial image and profile for the UBS. The flow is from left to right. The UBS is more complex than the LBS with respect to both flow paths and boulder arrangements. Upstream of the primary drop, flow moves through Pool 9 and then Pool 8 and then plunges over the primary drop into the shallow and fragmented Pool 7. From Pool 7, depending on flow rate, water moves through one of two sieves. One sieve connects to Pool 6 while the other travels along an unknown path that is believed to exit into Pool 6 just upstream of Pool 5. Pool 6 water, depending on flow rate, primarily flows out along two paths: (1) to Pool 5 along the primary alignment or (2) along the secondary alignment to Pool 3. From Pool 5 water flows into Pool 4. Flow from Pool 4 and Pool 3 meet in Pool 2; Digger Creek flow also enters Pool 2. Finally, flow moves into Pool 1, which is the downstream boundary of the UBS.

In total, thirteen sieves have been identified that convey flow under one or more large boulders. Flow in these sieves can be open-channel or pressurized, depending on streamflow conditions. The sieves complicate the flow description above. For example, several sieves move water from the secondary alignment to the primary alignment. There is also a sieve that moves water from upstream of Pool 5 along an undetermined route under boulders and discharges along the river left of Pool 4.
The primary drop is approximately 12.5 feet long and tall. The face of the drop consists of several large boulders protruding into the flow path. The lower portion of the drop is nearly vertical. The receiving pool below the drop is extremely shallow given the drop height, and a high level of turbulence is generated throughout this area.

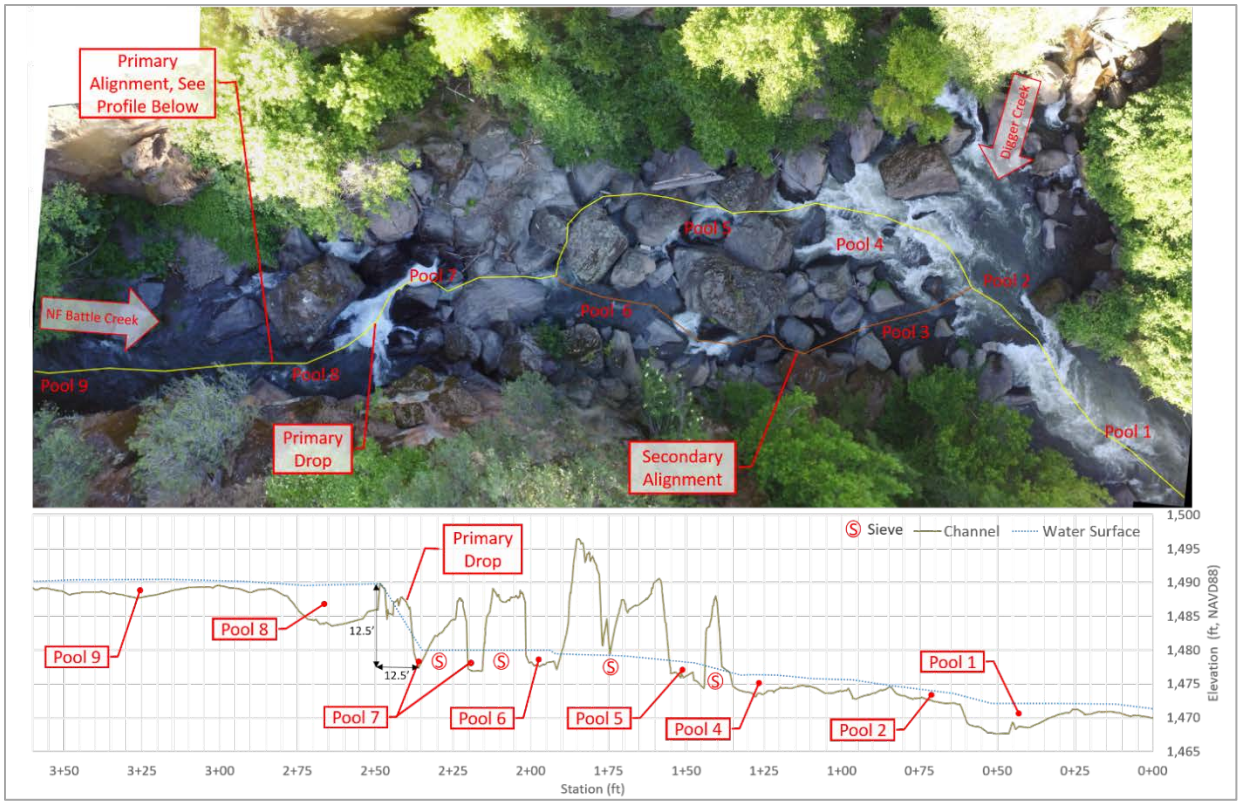


Figure 2-8. Upper Barrier Site overview aerial image and profile. Photograph when flow within NFBC approximately 195 cfs upstream of Digger Creek.

2.5.2 UBS Geologic Conditions and Hazards

CSA (2016) completed a robust geological investigation of the UBS. The UBS is underlain by the Eagle Canyon Basalt formation, which is characterized by a thick-bedded to massive, lightly weathered to fresh, very hard and very strong basalt.

CSA found multiple locations along the canyon walls where rock failure was either high (failure could occur at any time, but likely within 10 years), moderate to high (failure likely within 10 to 50 years), and moderate (failure likely within 50 to 100 years). The locations of the high potential failures were located at different locations along the entire UBS reach and on both sides of the channel. Many of these rockfall hazards consist of extremely large blocks of basalt.

CSA completed field and laboratory tests to quantify the characteristics of the boulders within the channel as well as the canyon walls with respect to hardness and joint characterization. The basalt boulder strength varied from very strong (unconfined compressive strength between 14,500 and 36,250 psi) to extremely strong (unconfined compressive strength greater than 36,000 psi). The rock exposed in both canyon walls is generally non-vascular basalt with a structure that varies from thin (less than 1 foot thick) to massive. The canyon rock is generally fresh to slightly weathered, with fractures that vary from widely spaced (3 feet to 10 feet) to extremely widely spaced (greater than 10 feet).

Rock joints, although infrequent, are moderately continuous (10 feet to 30 feet in length) to highly continuous (30 feet to 100 feet). Joint openings varied from tight to up to 2 inches wide and were generally open ¼ to ½ inch.

2.5.3 UBS Site Hydrology

Peak Flows

Peak flows were estimated from work completed by USBR (2001). The UBS and Digger Creek peak flows associated with specified return periods are presented in Table 2-4. The UBS flows were derived by scaling the USBR peak flows for Feeder Dam to the UBS drainage area, which is approximately 148 square miles. The Digger Creek, with a drainage area of 40 square miles, flows were derived by subtracting Eagle Canyon Dam peak flows from UBS flows. This approach likely underestimates the actual return period flows for Digger Creek, as Digger Creek likely peaks prior to North Fork Battle Creek due to its smaller drainage area. Therefore, the data presented in Table 2-4 should be interpreted as the flow within Digger Creek at the time the UBS' flow is peaking.

Table 2-4. UBS and Digger Creek peak flows for select return periods.

Return Period (year)	2	2.33	5	10	25	50	100
UBS Flow (cfs)	2,332	2,665	4,109	5,331	6,996	8,329	9,551
Digger Creek Flow (cfs)*	168	235	291	369	504	571	649

**Estimated using difference between Eagle Canyon Dam and UBS peak flows.*

Daily Average Flow Duration Curves

To assist with establishing fish passage design flows and evaluating potential low-flow and high-flow passage delays, a flow duration curve (FDC) was constructed (Figure 2-9). The FDC was created using daily average flow records from the DWR gage, BNF, scaled to the drainage area of the UBS. The first approach constructed a FDC using all of the daily average flow data sorted and ranked for the entire period of record, excluding outlier water year 2006 (similar to LBS). This resulted in a 1% exceedance flow of 293 cfs.

The second approach used to develop the FDC was constructed using the same methods described for the LBS (Section 2.4.3) and as presented in MLA (2016b). The median FDC is constructed using the median of the exceedance flows from each annual FDCs from each of the 16 water years. This means that for half of the water years, from the period of record, the 1% annual exceedance flow was less than 182 cfs and the other half was a higher. For 80% of the water years, the 1% annual exceedance flow was between 100 cfs and 410 cfs.

2.5.4 UBS Fish Passage Conditions

Figure 2-10 provides a graphical interpretation of the fish passage conclusions for selected UBS feature. A question mark indicates that a particular bound has not been identified, but the color gradient for that feature indicates when passage may remain suitable (blue) while it moves to less than suitable (white). See MLA (2016b) for additional details.

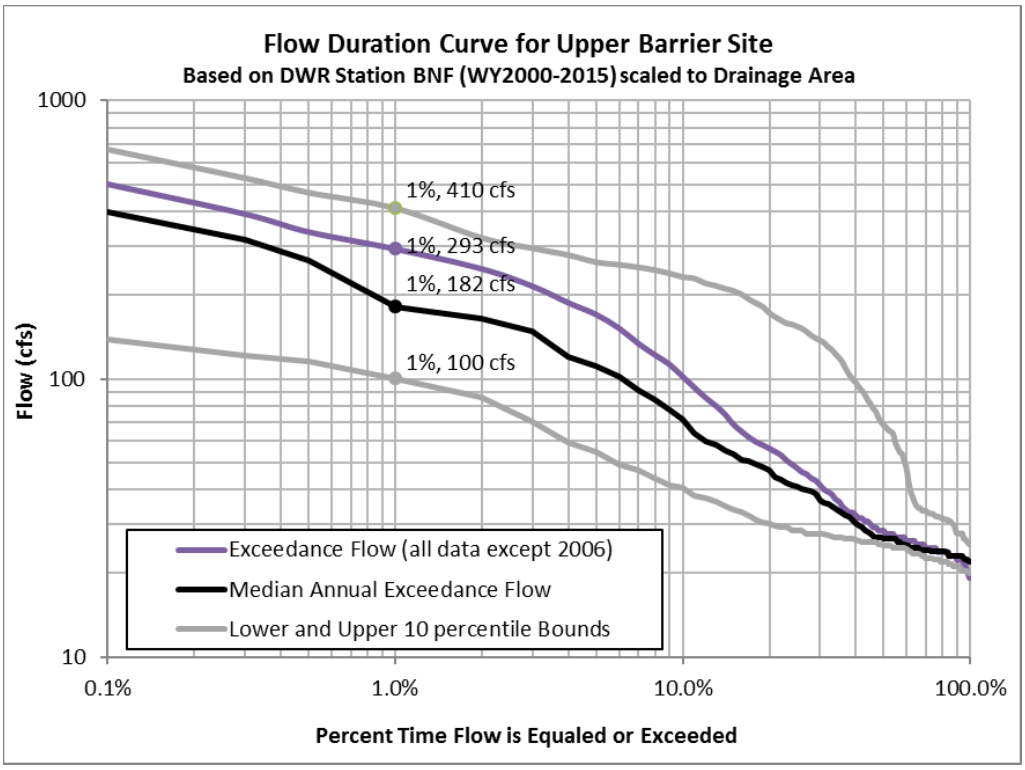


Figure 2-9. Flow duration curves for Upper Barrier Site based on DWR BNF daily average flow record, calculated using all data except WY2006 (outlier) and using the median of each annual flow duration curve. For 80% of the water years the annual exceedance flows will fall between the lower and upper curves.

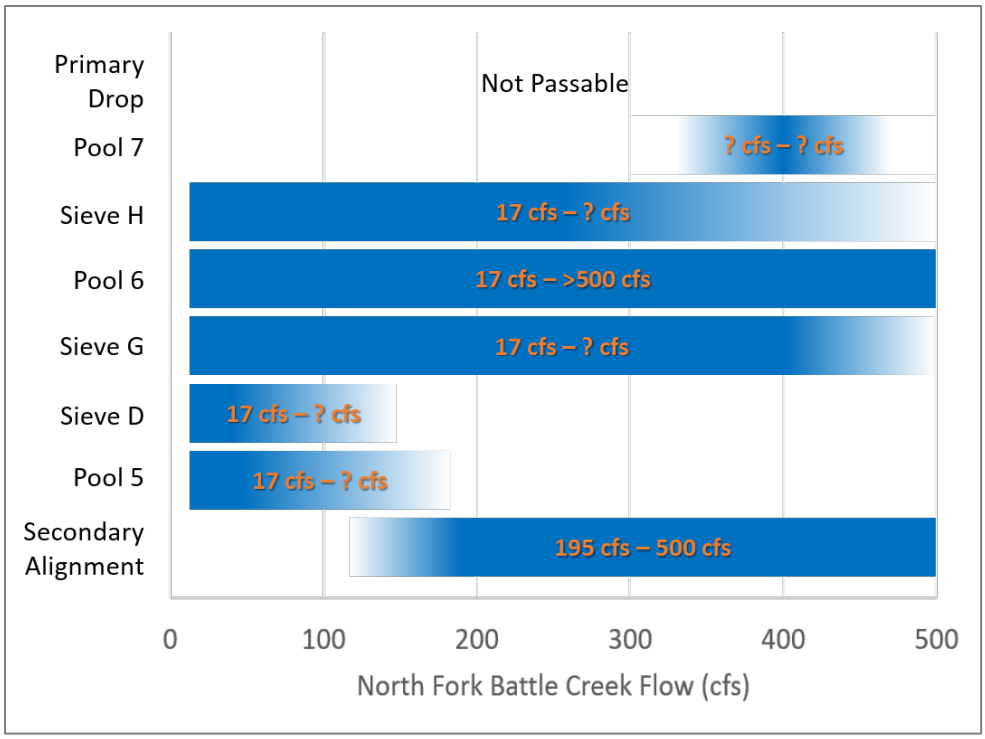


Figure 2-10. UBS fish passage conclusions for selected features (MLA, 2016b: Figure 8-18).

Based on observations, it is our opinion that passage conditions are suitable under most flows up to about 500 cfs for fish to reach Pool 6, although there is some uncertainty with respect to the conditions within Pool 5 and through Sieve D and when the secondary alignment becomes passable. Pool 6 appears to maintain favorable passage/holding conditions up to at least 500 cfs. Sieve H does appear to provide suitable passage conditions up to flows of 300 cfs, but data is lacking to quantify the upper bound for when conditions become less than suitable.

Pool 7 is undefined on both ends of the spectrum with respect to passage conditions. At low to moderate flows, the pool has insufficient depth or remains disconnected into sub-pools separated by large boulders, making in very difficult for a fish to approach the bottom of the primary drop. At higher flows the pool becomes very turbulent which may disorient fish and make holding difficult.

The primary drop appears to be a complete barrier at all flows. Passage improvements should focus passage between Pool 6 and Pool 8, including the primary drop.

3 PROJECT GOALS, OBJECTIVES, AND FISH PASSAGE DESIGN CRITERIA

This section presents the project goal, objectives, fish passage design criteria, and fish passage design flows.

3.1 Project Goal

The project goal is to improve upstream passage for adult Chinook salmon and steelhead at the Lower Barrier Site and Upper Barrier Site located in Eagle Canyon on North Fork Battle Creek near Manton, California.

3.2 Project Objectives

The project objectives are:

- to increase water depth at low fish passage flows,
- to reduce channel velocity,
- to reduce vertical drops,
- to increase existing pools or create new pools,
- to reduce the overall slope of the channel, and
- to create variable swim paths.

3.3 Fish Passage Design Criteria and Design Flows

MLA (2016b) and MLA (2017) include robust discussions with respect to fish passage flows, and findings are summarized here. Initially, CDFW provided high and low fish passage design flows of 1,600 cfs and 35 cfs, respectively. Based on field observations and hydraulic modeling, it appears fish would be unable to migrate upstream at 1,600 cfs due to extreme velocities and turbulence occurring throughout the canyon. Therefore, the high fish passage design flow for the project was changed to the annual 1 percent exceedance flow, which is the current CDFW (CDFG, 2002) and NMFS (2001) high passage design flow criteria for Northern California for adult salmon and steelhead. Based on the flow duration curve constructed using all of the daily average flow data, but excluding outlier water year 2006, this is 382 cfs for the Lower Barrier Site and 293 cfs for the Upper Barrier Site (see Sections 2.4.3 and 2.5.3, respectively). The low

fish passage design flow remains as initially set by CDFW for this project, at 35 cfs for both sites based in part on PG&E minimum instream flow requirements. The fish passage design flows are presented in Table 3-1.

MLA (2016b) and MLA (2017) also present discussions on design criteria for other parameters such as depth, velocity, and drop heights. During the development of those documents, it was not clear if the preferred alternative would be a modification or a technical fishway. Therefore, the criteria discussed included the standard criteria and guidelines from CDFW (CDFG, 2002), NMFS (2001) and NMFS (2011). Because the preferred alternatives for both sites are modifications of natural barriers, the technical fishway criteria are thought to be too stringent and alternative criteria and guidelines based on published swimming abilities of the target fish have been adopted for this project (Table 3-2). The following section presents a general discussion on how these criteria and guidelines were applied to evaluate this project's designs.

Table 3-1. Selected fish passage design flows for the LBS and UBS.

Criteria	Lower Barrier Site	Upper Barrier Site
Low Fish Passage Design Flow	35 cfs	35 cfs
High Fish Passage Design Flow	382 cfs	293 cfs

Table 3-2. General fish passage criteria and guidelines for this project.

Fish Passage Criteria/Guidelines	Value
Minimum Water Depth over a feature[1]	0.5 ft
Minimum Pool Depth	2 ft
Maximum Velocity	See Section 3.4
1. Such as a boulder or chute	

3.4 General Fish Passage Performance Evaluation Method

This section presents a discussion on the methods used to evaluate fish passage performance for the two sites. This analysis followed the same procedures as detailed in Section 4 of MLA (2016b).

Designs for both sites included the development of an SRH-2D hydraulic model to be used for fish passage assessment purposes (as well as design development). Using the hydraulic model results, a fish routing model was developed. The hydraulic model was also used to evaluate other hydraulic conditions.

The intricacies of each SRH-2D model is discussed in each site's relative section below and in MLA (2016b), but in general the model surfaces were developed to mimic the anticipated channel shape after construction is complete. The SRH-2D model provides a detailed simulation of the channel hydraulics covering a wide range of flows, which can in turn be used to evaluate the anticipated fish passage conditions.

A map was developed for each evaluated flow from the SRH-2D model presenting the velocity field where the depth criterion was met. Using the map, a preferred swim route was selected through the velocity field that routed the fish through the lower velocity regions that provided adequate depth (the swim path never moves in a downstream direction). The water velocities at each SRH-2D node along that swim path were then inputted into the fish locomotion and energetics model.

The fish locomotion and energetics model is based on the methods outlined by Castro-Santos (2006) to swim the fish from node to node along a selected route. The approach requires a swim speed equation for the fish, which relates time exhaustion (fatigue) for the fish when swimming at the given speed. The swimming equation used in this analysis was for burst swimming of adult Chinook salmon developed by Hunter and Mayor (1986) based on data from Weaver (1963):

$$\boldsymbol{V_{Burst} = 11.49 L_{TL}^{0.32} t^{-0.5}} \qquad \textbf{Equation 3-1}$$

Where;

V_{Burst} = Fish burst speed (m/s)
L_{TL} = Total fish length (m)
t = time to exhaustion (s); such that 1 s$\leq t \leq$ 30 s

The time required to swim between two nodes is then calculated as a percent of the time to exhaustion at the selected swim speed. The cumulative percent of exhaustion is summed along the route. If the fish is able to swim the entire route without exceeding 100% exhaustion, then passage is successful for that fish.

For this project, the fish locomotion and energetics model swam the fish at a distance-optimizing speed. Between each node the time to exhaustion was optimized, such that the resulting swim speed of the fish minimized the fish's physical exertion, as describe by "percent exhaustion." The analysis was performed for varying sizes of Chinook salmon to determine the smallest fish able to successfully pass through the site.

Additional discussion specific to the LBS and the UBS are included in Sections 4.3.1 and 5.4.1, respectively. The results of the evaluations for the LBS and UBS are presented in Sections 4.3 and 5.4, respectively.

4 LOWER BARRIER SITE PROJECT

The preferred alternative for the Lower Barrier Site was Alternative B, as described in MLA (2017). The following sections present the proposed project for the LBS based on the 90% Design Drawings and Specifications. The 90% Drawings are included as Attachment 1.

4.1 LBS Project Description

The existing LBS primary drop is a narrow chute that drops into the shallow and narrow Pool 4. Boulders on the south bank and the bedrock wall on the north bank constrict both the chute and pool. The constriction creates conditions for extreme turbulence and high velocities

across the entire wetted channel and throughout the water column. The extreme turbulence is likely a primary condition that blocks fish passage.

The LBS design includes removing approximately 190 cubic yards of boulders and a minor amount of bedrock. This involves removing boulders B71, B131, B72 Complex boulders and additional boulders within Pool 4 and the primary drop chute (Figure 4-1, Attachment 1). The rock will be lifted out of the canyon and disposed at the top of the canyon rim or hauled off-site. Removing the large boulders, along with some minor bedrock modification, will widen the primary drop, create multiple pathways for fish to ascend, and widen Pool 4, which will create more pool volume. Reducing the constriction and increasing the pool volume should result in less turbulence, decreased velocity, and additional holding areas for fish.

As part of the boulder removal, the design includes the creation of two new chutes (referred to as the north and south chutes) that extend upstream of Pool 4, see Attachment 1. The north chute is intended to provide a low-flow passage path; at higher flows the south chute is anticipated to have better passage conditions.

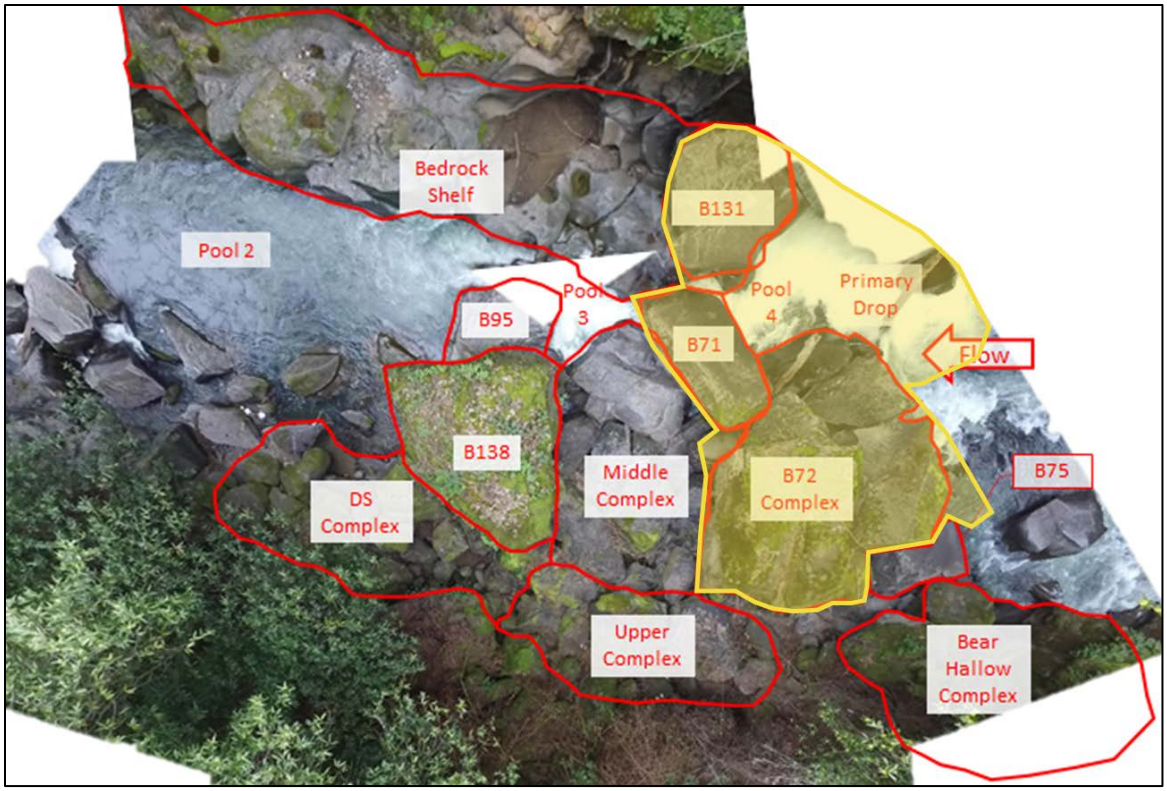


Figure 4-1. LBS Alternative B plan view of rock to be removed (yellow hatching), including B71, B131, B72 Complex boulders and some additional boulders within the Primary Drop and Pool 4.

The north chute is anticipated to be constructed within bedrock. Therefore, it is anticipated that the construction will be able to meet the design dimensions for the chute, as presented in the design drawings (Attachment 1, Sheet 11). The north chute is a trapezoidal channel with a bottom with of approximately 2 feet and a depth of at least 1 foot. The side slopes will vary. The profile includes two grade breaks. The initial slope, extending upstream from Pool 4, is approximately 80% and 8 feet long. Although steep, it is anticipated that this lower section will be backwatered by Pool 4 under most flow conditions. The middle section of the north chute has a slope that is approximately 25% and is approximately 19 feet long. Although this is still steep, passage over similar features downstream of the LBS within Eagle Canyon exist and provide passage. The final section is approximately 11 feet long and has no slope. Field adjustments may be made based on conditions reveled during rock removal.

The south chute is shorter than the north chute but has similar design characteristics. The material comprising the south chute is unknown (boulders verses bedrock), and field adjustments may be required. The general approach is to construct the chute with a minimum 2.5 feet width and with a minimum depth of 1 foot. Like the north chute, there are two profile grade breaks. The downstream section, extending from Pool 4, has a slope of 80% and is approximately 8 feet long. The lower section is anticipated to be backwatered at most flows. The middle section has an approximate slope of 25% and is approximately 8 feet long. The upstream section is approximately 8 feet long and has a 10% slope.

Pool 4 is anticipated to double or triple in width. This increased width will create low-velocity areas for fish to approach the primary drop and stage their attempt to move upstream.

4.2 Construction

Construction techniques are covered in detail in previously completed documents (SRD, 2016a, SRD 2016b, MLA, 2017). For reference, a summary is provided here.

Site access is extremely limited to the LBS. It is assumed that a skyline yarding system or crane (removal system) will be used to deliver materials and equipment to the site and to remove rock from the site. The lifting capabilities of such systems varies, but 8,000 lbs is a conservative estimate.

Prior to beginning the rock removal process, rockfall hazards will be mitigated. This will likely involve scaling off smaller rocks and anchoring in-place, with rock bolts, larger rocks that are at risk of falling during construction. The *Engineering Geologic Investigation Technical Memorandum* (CSA, 2016) provides additional rock stability details.

Rock will be removed by first drilling holes into the boulders and bedrock and then either using hydraulic rock splitters, blasting, or other techniques to break the rock into pieces that are small enough to be lifted by the removal system.

Existing trees in the stream riparian area, along the canyon walls, and up on the canyon rim will need to be removed and/or limbed to accommodate the removal system. This includes trimming the bay trees present along the south bank of Battle Creek at the LBS.

A dewatering system will be installed to bypass streamflow around the worksite. This may not need to be installed until the larger boulders that are outside of the wetted channel are removed. It is assumed that the water bypass will be installed in mid-summer when flows are close to the minimum bypass flow of 35 cfs. Materials for the dewatering system may be brought in by the removal system or by helicopter.

4.3 Anticipated Fish Passage Performance

4.3.1 Methods

A general discussion on the methods used to evaluate potential fish passage performance within the LBS was presented in Section 3.4. As discussed there, a SRH-2D hydraulic model based on the 90% design drawings was developed and executed using a wide range of flows. The LBS model follows the same development procedures as presented in MLA (2016b) and MLA (2017).

Once the model runs were complete, two potential fish passage swim paths were digitized: one swim path followed the north chute and the other followed the south chute. The swim paths were routed through the lowest water velocities while having sufficient depth for passage. A fish routing spreadsheet model was then used to identify the smallest sized Chinook salmon that could swim through the velocity field without becoming exhausted based on the swim speed equations developed by Hunter and Mayor (1986). The results are presented in the next section.

4.3.2 Results

The water surface profiles for flows from 35 cfs (low fish passage design flow) to 382 cfs (high fish passage design flow) for the LBS design are provided in Figure 4-2. To assess the change in flow conditions associated with rock removal, maps of the SRH-2D output were created for existing and proposed conditions for 35 cfs, 120 cfs 250 cfs, 382 cfs, and 1,600 cfs in Figure 4-3 through Figure 4-7. The figures show water velocities when depths are greater than 0.5 feet. The figures show that Pool 4 is substantially widened along the south side of the channel and produces a reverse circulation (back-eddy) flow pattern at all analyzed flows. It also shows that there are multiple pathways fish could use to swim up the primary drop at most flows. At 120 cfs and higher, velocities in the primary drop and flow patterns in Pool 4 suggest that fish will be able to hold in the pool and swim up the south chute while most of the turbulence and high velocities will be on the opposite side of the channel.

Table 4-1 summarizes the hydraulic conditions along the selected fish passage path at each evaluated flow. It also lists the smallest size (length) of Chinook salmon capable of swimming through the velocity field it encounters along the fish passage path.

At the low passage design flow of 35 cfs the north chute provides sufficient depth for passage, while the south chute does not. At all other flows the south chute provides sufficient depth and lower water velocities, making it the preferred passage route. At flows from 35 cfs to 250 cfs, the analysis predicts that even smaller, weaker swimming Chinook salmon could swim through the north chute and south chute, respectively. Based on the spring Chinook length data provide by USFWS for Battle Creek, 90 to 100% of the fish will be able to swim through one of the two chutes at flows between 35 cfs and 250 cfs. At the high passage design flow of

382 cfs, only the larger (top 30 percentile) Chinook salmon are predicted to have the swimming abilities to burst through the velocities in the south chute, while the north chute will be too swift for any fish to pass. This design is considered to provide passage from 35 cfs to 250 cfs, while larger salmon and steelhead will be able to pass at even higher flows.

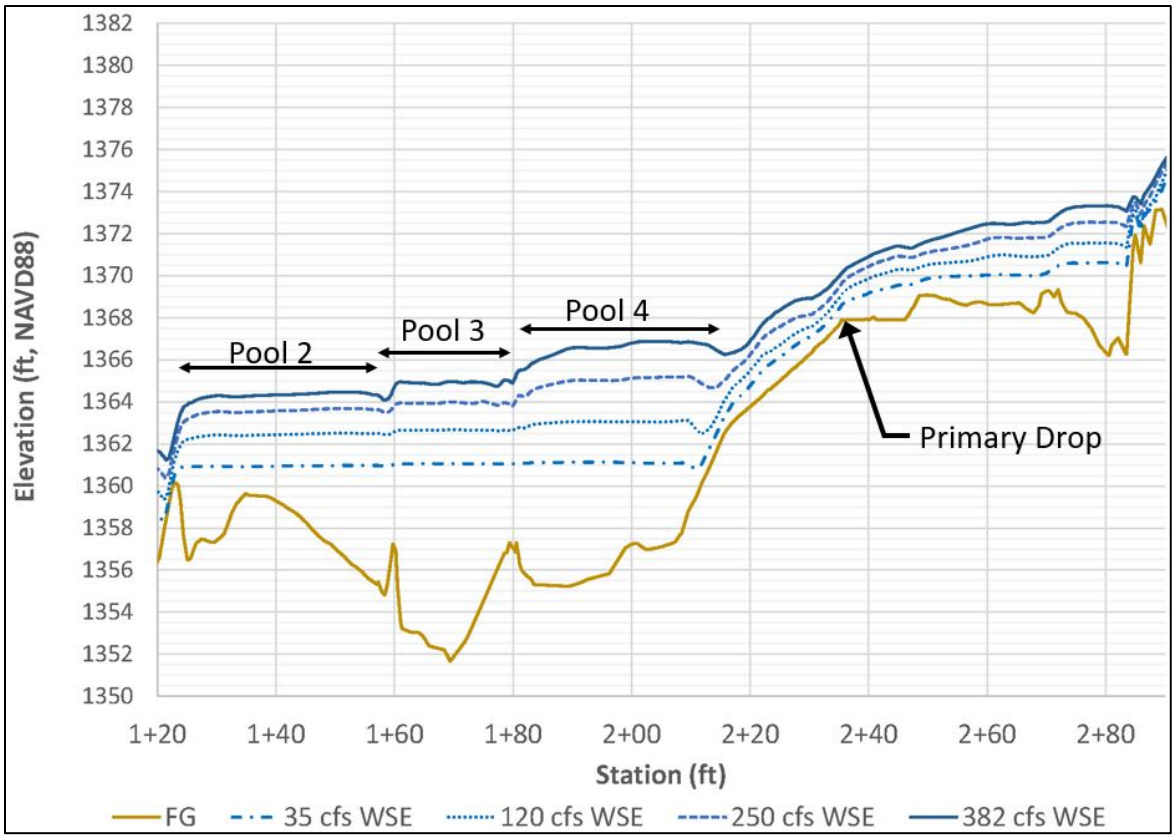
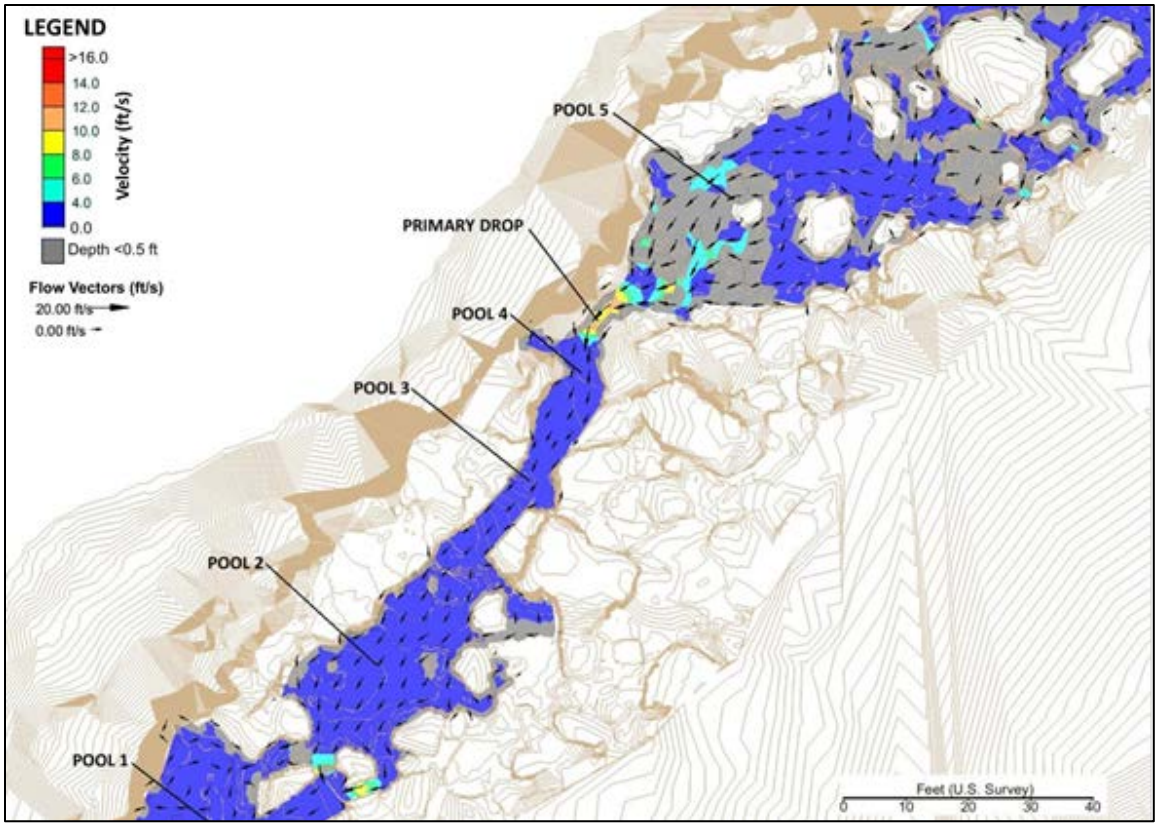
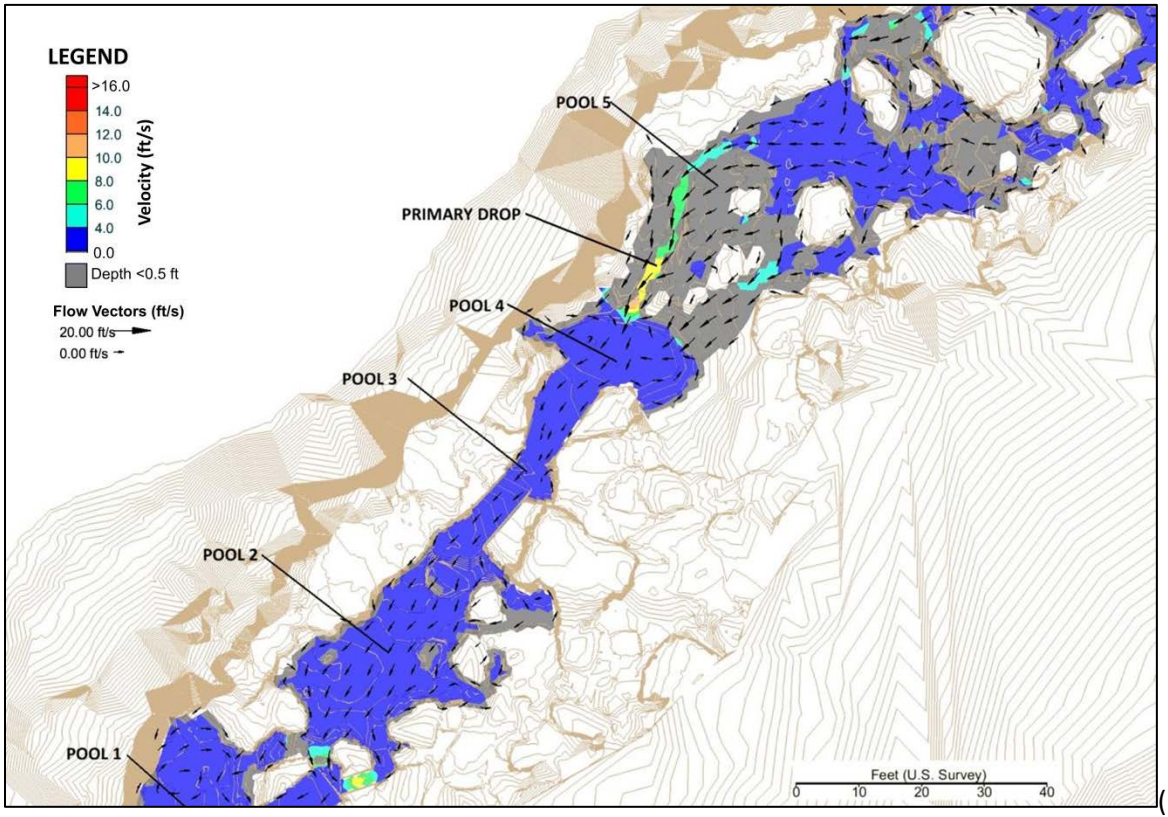


Figure 4-2. LBS water surface profiles for the LBS proposed conditions based on SRH-2D results.

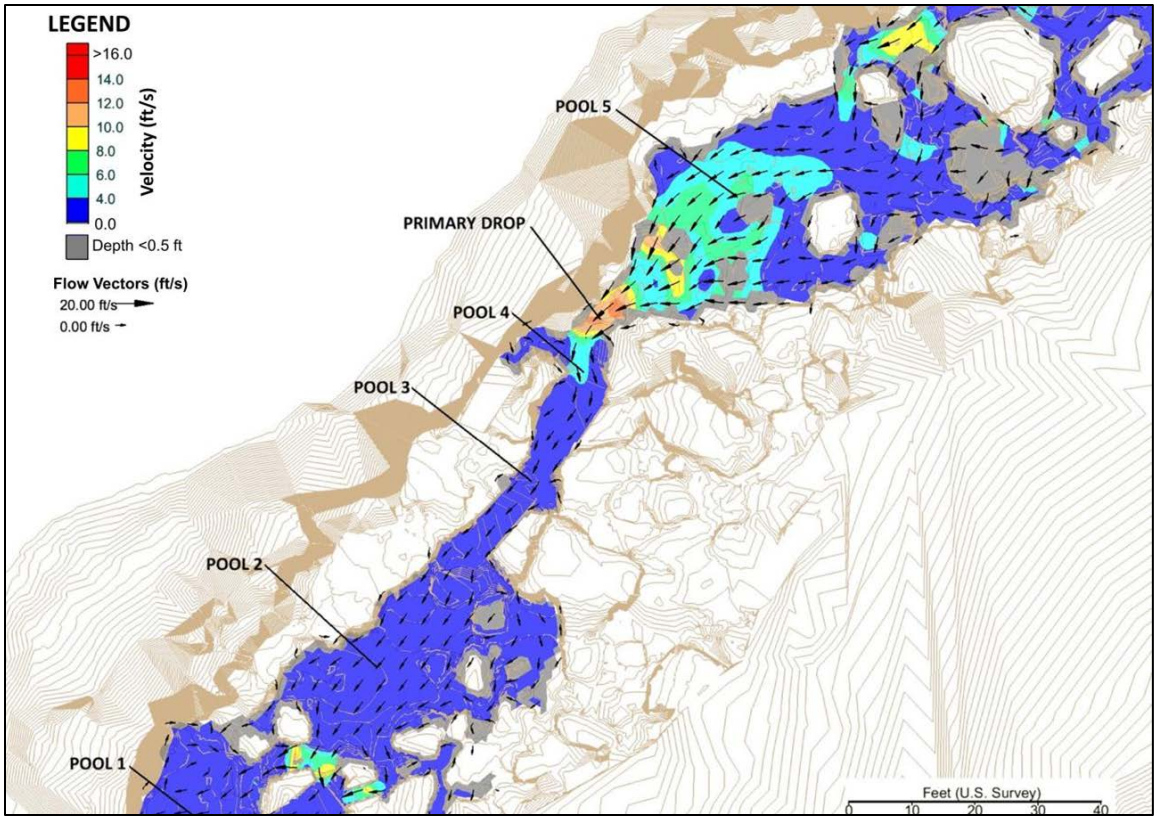


(a)

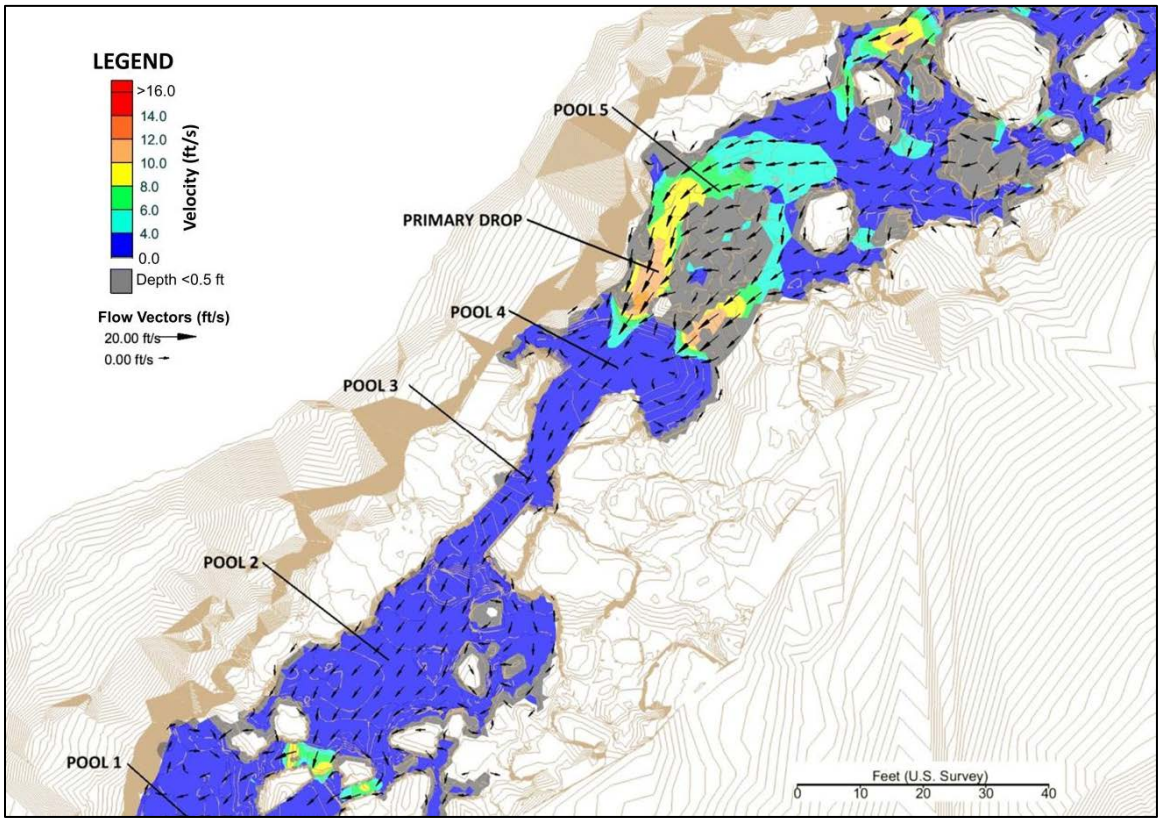


(b)

Figure 4-3. LBS at 35 cfs for (a) existing and (b) proposed conditions.

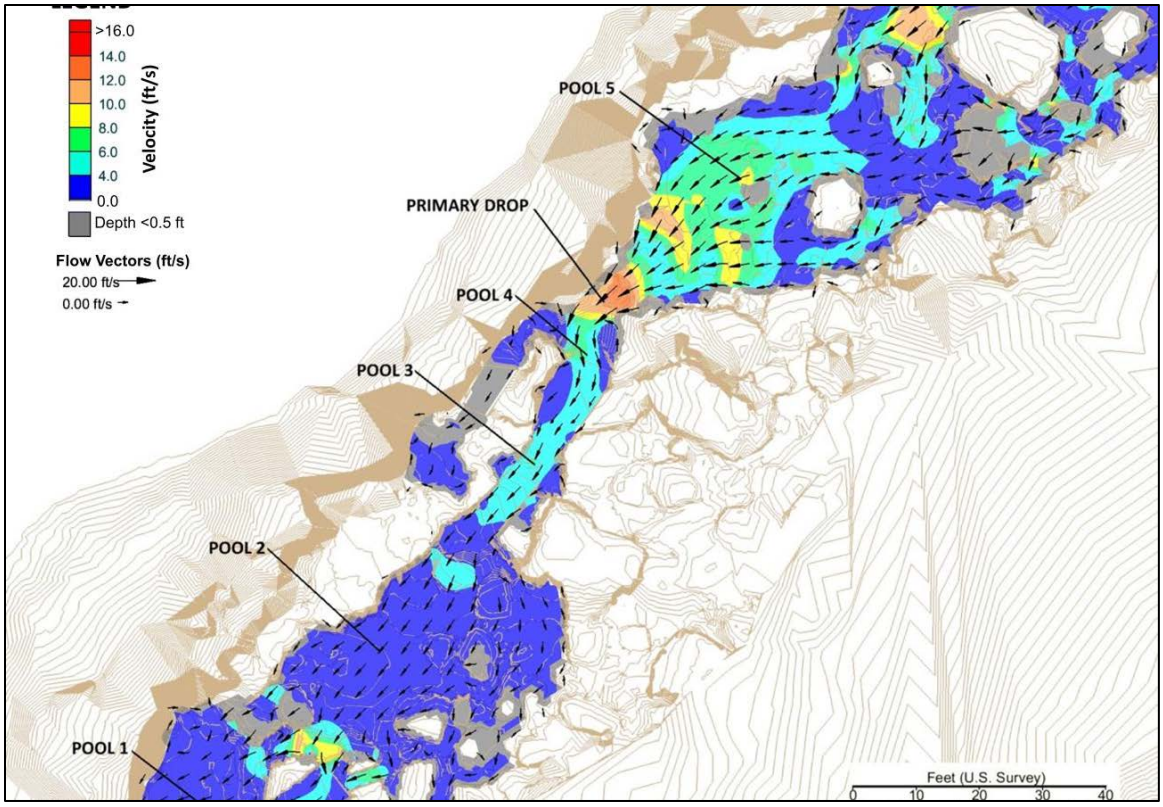


(a)

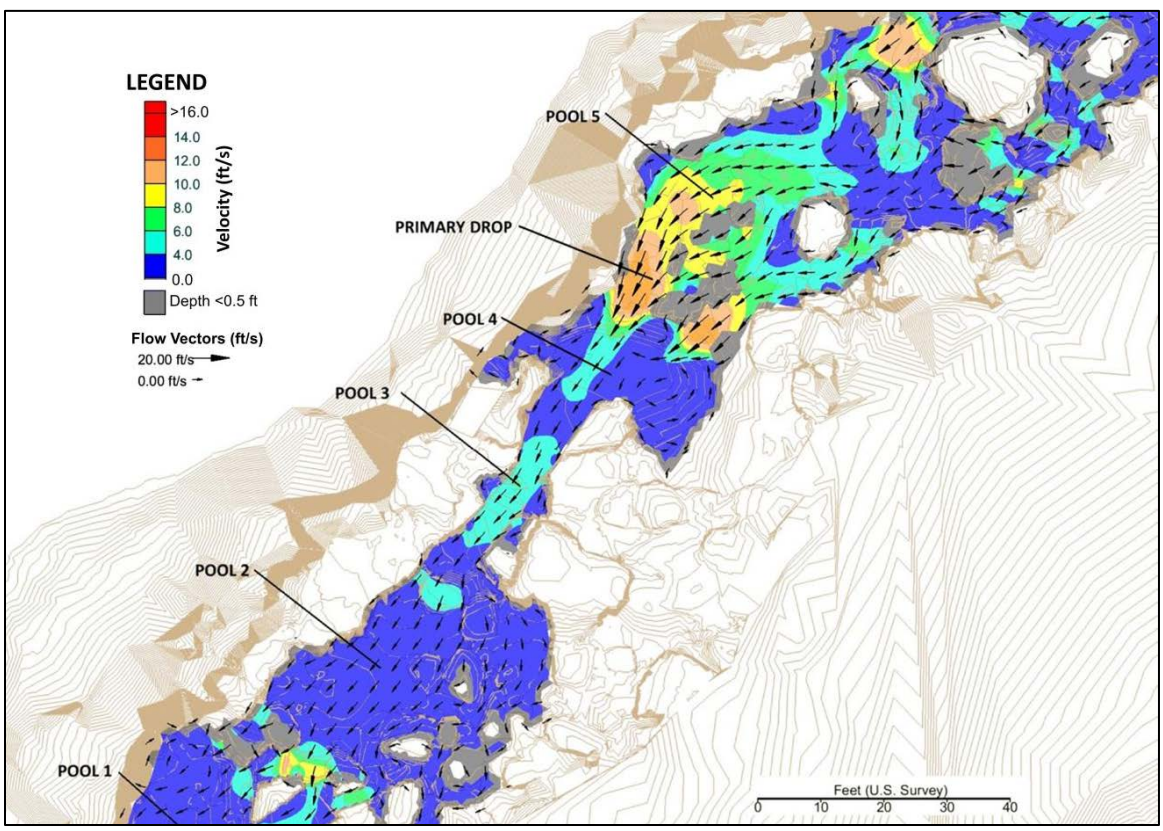


(b)

Figure 4-4. LBS at 120 cfs for (a) existing and (b) proposed conditions.

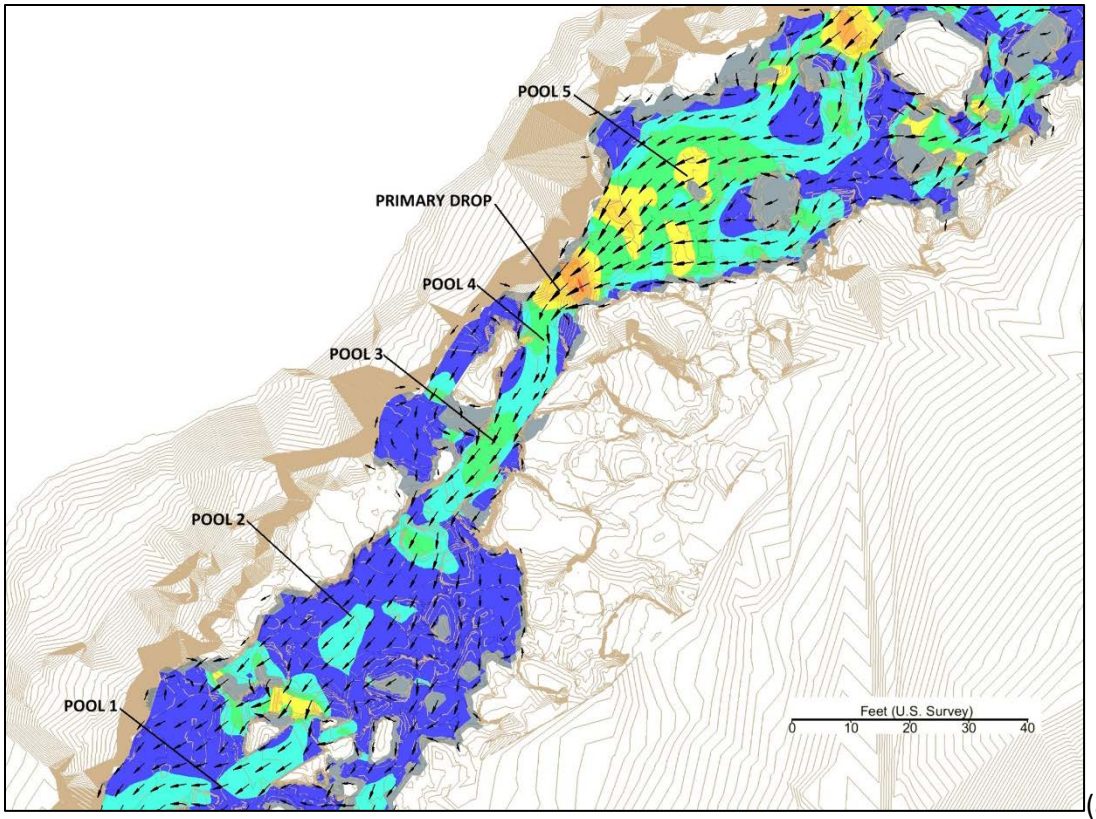


(a)

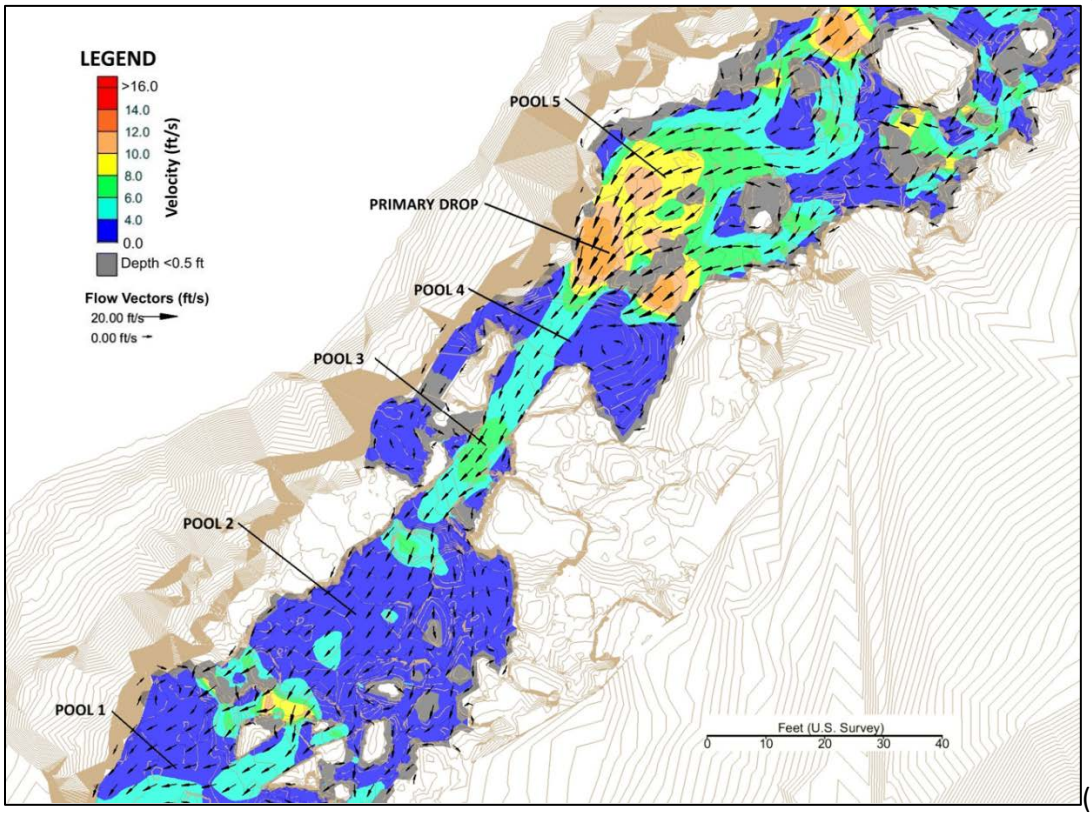


(b)

Figure 4-5. LBS at 250 cfs for (a) existing and (b) proposed conditions.

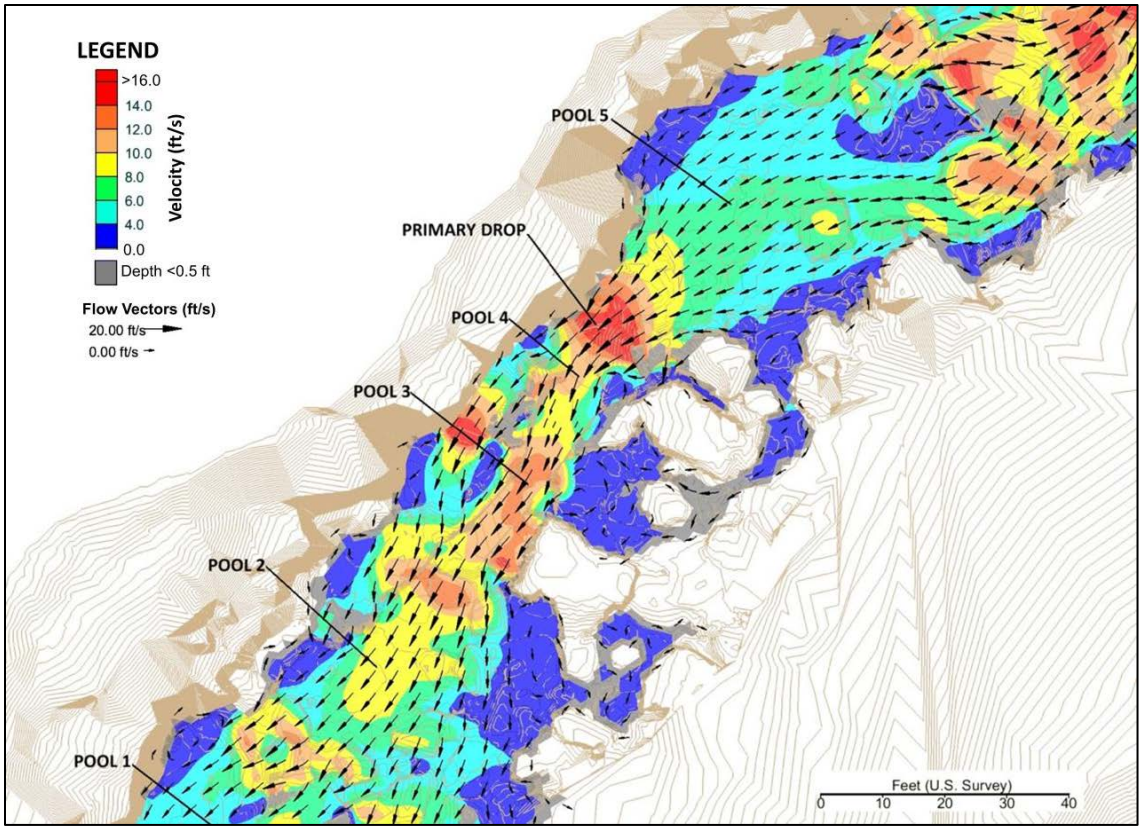


(a)

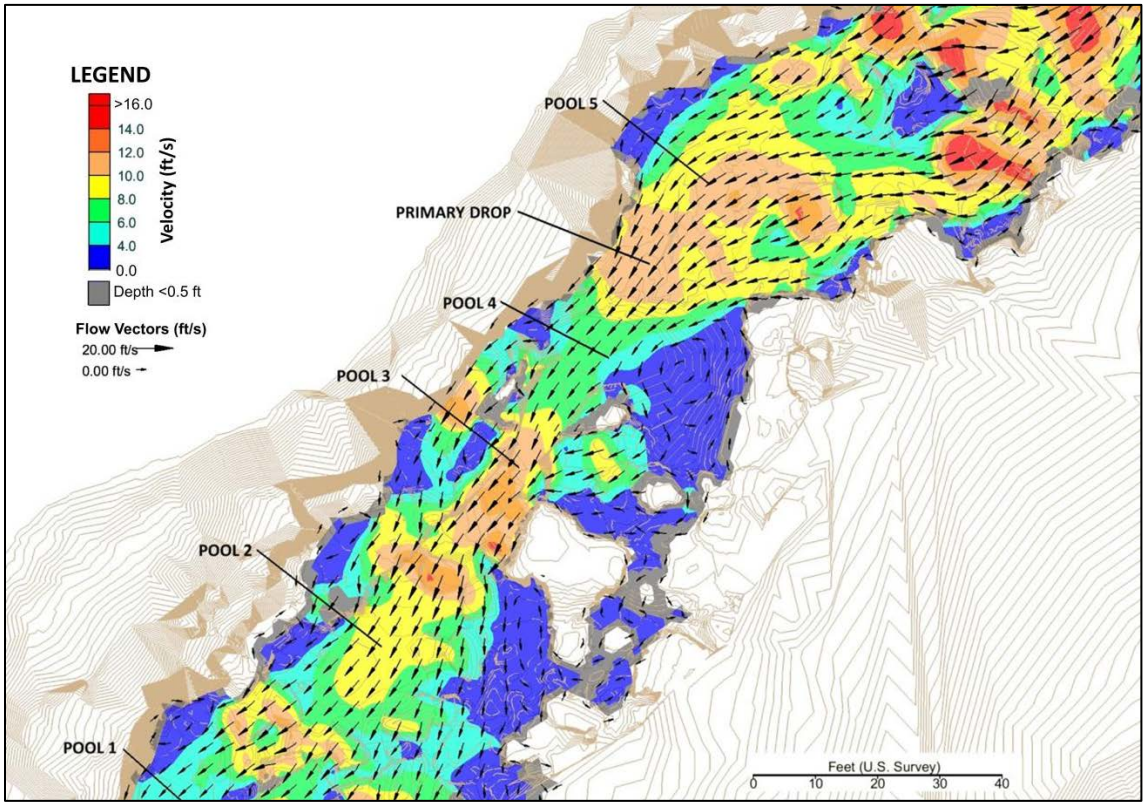


(b)

Figure 4-6. LBS at 382 cfs for (a) existing and (b) proposed conditions.



(a)



(b)

Figure 4-7. LBS at 1,600 cfs for (a) existing and (b) proposed conditions.

Table 4-1. Summary for LBS fish passage hydraulics for existing conditions and proposed conditions. Also provided is the size of Chinook salmon able to swim through the velocities within the primary drop without reaching exhaustion.

Parameter	Flow											
	35 cfs		120 cfs		250 cfs		382 cfs		500 cfs		1,600 cfs	
	Existing Cond.	Prop Cond.[1]	Existing Cond.	Prop Cond.	Existing Cond.	Prop Cond.	Existing Cond.	Prop Cond.	Existing Cond.	Prop Cond.	Existing Cond.	Prop Cond.
Drop Height (ft)[1]	8.0	8.7	7.0	7.4	5.6	6.0	4.6	4.8	3.7	5.1	4.0	4.0
Length of Drop (ft)[1]	31	31	30	30	16	28	16	25	14	20	14	20
Ave. Slope of Water Surface Drop[1]	26%	28%	23%	25%	35%	21%	29%	19%	26%	25%	29%	20%
Average Depth (ft)	1	1.8	1.8	2.7	2.9	3.8	3.6	4.6	4.6	5.4	10.7	9.9
Min. Depth (ft)	0.5	0.5	0.8	0.5	1.5	0.9	1.8	1.1	2.4	1.3	8.58	5.3
Average Velocity (fps)	7.3	5.4	7.7	4.8	7.9	6.0	8.2	6.5	8.4	6.9	10.1	7.9
Max Velocity (fps)	10.9	10.5	12.9	11.0	13.9	12.7	14.3	13.5	14.1	13.7	15.5	9.9
Min Chinook Size for Passing through Velocity Field (cm)	46	55	77	33	87	61	93	79	95	86	>110	>110
Proportion of Chinook Larger than Min Size	98%	93%	38%	100%	10%	90%	5%	30%	3%	13%	0	0

[1] Proposed condition results are for the north chute at 35 cfs. For all other flows, proposed condition results are for the south chute.

4.4 Expected Design Life

The LBS design is anticipated to function as constructed for an indefinite period, which could be for hundreds of years. The exact life expectancy is uncertain and dependent on future rockfall. Rockfall may occur at any time, and can be triggered by strong ground shaking from earthquakes. In most cases, maintenance in the form of rock removal could restore fish passage functionality.

4.5 Anticipated Maintenance Requirements

The LBS design will likely require little to no debris or sediment removal. There is the possibility a large log or other woody debris could become lodged between rocks in an orientation that creates undesirable passage conditions, requiring removal. This has occurred at other locations within North Fork Battle Creek.

Access for inspection and maintenance will be along the south bank of the channel. Improved site access, from the flume catwalk down to the channel, could be installed if desired and acceptable to PG&E. Removal of debris or demolition of rock fallen into the channel needing to be removed will be infrequently but likely need to occur during the low-flow season, after the fish migration period. Therefore, it may be difficult to perform timely maintenance.

The LBS design has a low susceptibility to rockfall hazards. In the event that rocks do fall into the channel after construction, they will likely only cause minor changes to fish passage hydraulics and could even improve passage conditions. There is the potential for very large boulders to fall onto the chute or into the pool, creating undesirable passage conditions that require repair in the form of rock removal.

The LBS is generally not susceptible to damage from boulders that could be mobilized by flow. Flows that mobilize them are likely infrequent and involve extreme depths and velocities. Boulders in transport during these events are expected to pass through the LBS without coming to rest, similar to existing conditions. The design is also not considered susceptible to scour. Field observations of the channel upstream of the project suggest the channel bed is primarily bedrock, with some large boulders. This material is anticipated to be stable and resistant to scour and headcutting, preventing headcutting extending to the next upstream boulder drop.

If a large boulder were to move or fall into the channel reach and create undesirable fish passage conditions, then removal of the boulder will be necessary. Depending on the size, location and orientation of the boulder, several methods could be used to break the rock into small pieces rather than remove it completely. If removal from the canyon is necessary, then large equipment (e.g. crane) will be necessary.

4.6 Recommended Post-Construction Monitoring

4.6.1 As-Built Survey

Immediately following construction, or as construction is finalized, it is recommended that a survey of flow paths and other key channel elements be completed. This will form the basis for follow up surveys. Due to the relatively high flows and dangerous conditions in the channel much of the year, follow up surveys will be conducted during the low flow period. The follow up surveys should focus on the same key flow paths and channel elements and capture any new developments.

4.6.2 Startup Monitoring

Channel adjustments around existing boulders in response to the implemented project is most likely to occur following the first several high-flow events. It is recommended that during the year following construction the site be inspected following each major flow event (> 1,000 cfs) and any changes to the site configuration and flow patterns be noted. In addition to visual inspection, time-lapse cameras should be installed at the LBS to document passage conditions at various flows. This monitoring should be extended if there are only a few high-flow events during the first year, or if channel adjustments are noted.

4.6.3 Biological Monitoring

Monitoring for fish migration through the project site will help indicate whether it is successful. Adult Chinook salmon and steelhead currently reach Pool 2 at the LBS. The monitoring could include field spawning and snorkel surveys upstream and downstream of the LBS to document passage success. Another means to document passage conditions is through implementing a study plan that challenges individual fish to pass through the site. This may involve transport and release of radio-tagged adult Chinook salmon immediately downstream of the site and monitoring their passage attempts. This could be conducted across a range of flows.

4.6.4 Inspection and Maintenance

After the first year, site inspection may occur less frequently, possibly only after the high-flow season. The inspection will be focused on identifying any debris that has accumulated and potentially negatively impacts passage conditions. It will also be used to identify any rockfall or boulder shifting/scour that has changed passage conditions.

4.7 Design Limitations and Uncertainties

The complexity of the LBS and nature of the selected approach for restoring fish passage introduces several notable design limitations and uncertainties for the LBS project. The primary limitation is with respect to the unknown subsurface conditions, boulder interactions related to stability, and presence of bedrock (or lack-of). The design, as presented, is based on the best available data and observations from multiple site visits. The data was captured and site visits occurred during varying flow conditions. Boulders were individually studied and their relationship with adjacent boulders noted, but uncertainty remains with how the boulders will behave once the removal process begins and what additional boulders or bedrock may be exposed once the surface boulders are removed.

For example, during the last site visit to the LBS, of many, a new sieve had formed in a location that had previously appeared comprised of interlocked boulders, cobbles, and gravel. The sieve formed near the upstream end of the south chute, allowing flow to be conveyed under boulder B75, among others. Although this new sieve did not result in a design change, it demonstrates the unpredictable nature of the project site.

Related to the above discussion, the actual final dimensions of Pool 4 after construction may be smaller than shown in the design drawings. This may result for a couple reasons. First, the inter-dependence of indicated boulders to be removed may be significant enough that removal of the boulders cause the south bank to become unstable. There are many boulders outside the approximate limits of grading that have diameters in the tens of feet that should remain in place. Second, the boulders that are indicated to be removed may not go as deep as indicated by the finish

grade contours. This is less of a concern because any in-situ boulder buried under the current boulders could be modified or removed to meet the design intent.

Construction of the two chutes is also related to the unknown subsurface concerns. The north chute is assumed will be constructed within bedrock. If the bedrock is not present, then the chute will need to be constructed through boulders, which may be less stable and require more field adjustments during construction than bedrock. The south channel will be constructed into an unknown material (boulder or bedrock). It is assumed that the chute will be constructed out of boulders, either in-situ or placed. The long-term stability of the chute is uncertain.

Substantial instability in the upstream end of the channel modification could cause upstream channel adjustments in the form of headcutting. Although this is a possibility, it is anticipated that any headcut will be arrested by existing large boulders or bedrock. If a headcut propagates upstream, potential exists for an increase in the water surface drop at the next upstream boulder constriction, potentially degrading passage conditions. If field conditions encountered during construction differ than those assumed in design, field modifications may need to be made.

The design condition hydraulics also cause uncertainty. The hydraulics are complex and subtle differences between the design-condition and the final project configuration could negatively affect fish passage hydraulics, especially turbulence. A lower water level in Pool 4 than anticipated will also require fish to navigate a higher overall water surface drop to reach Pool 5. Care should be taken during construction to avoid excess removal of boulders at the downstream end of Pool 4 to ensure the anticipated backwater from Pool 4 is achieved.

Although these uncertainties exist, the design intent is clear and field-adjustments during construction can mitigate these uncertainties design has addressed them to the extent practical. Additional hydraulic analysis by the fish passage engineer during construction may be needed to characterize resulting conditions associated with contemplated field changes. During construction, it will be essential for the contractor to work directly with the fish passage engineer on a daily basis so that field adjustments can be made that will result in the best project possible.

5 UPPER BARRIER SITE PROJECT

The preferred alternative for the Upper Barrier Site was Alternative C, as described in MLA (2017). The following sections present the proposed project for the UBS based on the 90% Design Drawings and Specifications. The 90% Drawings are included as Attachment 1.

5.1 UBS Project Description

The UBS design is a nature-like channel regrade to improve passage over the existing primary drop. The design objective is to regrade the channel to create hydraulic conditions that are within the swimming and leaping abilities of the target fish at passage design flows.

The regrade and typical boulder arrangements for the UBS design were based on a reference reach approach, which is similar to the stream simulation design approach described in CDFG (2009). For the UBS design, reference reaches within NFBC that have a similar overall slope (10 percent) and are considered suitable for fish passage at some or all migration flows were studied from the ground and using aerial photography techniques. The primary reference reach is located between Eagle Canyon Diversion Dam and Digger Creek. A secondary reference reach a short distance

downstream of the LBS, was also studied. The reference reach observations indicate how hydraulic controlling structures form and remain relatively stable, which becomes the basis for the regrade design. The reference reaches are comprised of boulder steps and cascades.

The UBS design requires the removal of approximately 720 cubic yards of boulder material, and potentially some bedrock (Figure 5-1, Attachment 1 Sheet 20). Most of the rock will be lifted out of the canyon and disposed at the top of the canyon rim or hauled off-site. The remainder of the material will be reused to construct the new regraded channel.

The regraded channel extends approximately 55 feet upstream and downstream of the existing primary drop, is located along the right side of the canyon (looking downstream), and overcomes approximately 11 vertical feet. The overall slope is approximately 10 percent. Five channel-spanning rock structures, herein referred to as hydraulic structures, will control the channel grade and the water surface profile. The hydraulic structures include boulder steps and bedrock chutes, which are similar to reference reach structures. The hydraulic structures create water surface drops between 2 and 3 feet in height. Each hydraulic structure is designed with three different flow paths, each with specific elevations or specific relationships to other defined flow path elevations, including vertical tolerances (Table 5-1 and Attachment 1, Sheets 22 and 23).

The purpose of the different flowline elevations is to create variable swimming paths. As flows increase, some paths may become less favorable for passage while others improve. To ensure that the hydraulic structure functions as designed, each structure must have its voids sealed with smaller material so that water does not pipe through the structure.

There are two design configurations for boulder steps: Type A) boulder constriction and Type B) boulder double slot (Attachment 1, Sheet 24). Type C refers to bedrock chutes. It is important to note that the layout presented within Attachment 1 is considered conceptual. The layout is based on the best information available during design. Much is unknown with respect to the subsurface boulder and bedrock layout. The different hydraulic structure "types" are to be used as a guide to fit field conditions during construction. Regardless of the final plan layout of the hydraulic structures, they must still preform the role of grade and water surface control, and therefore the flowline elevations presented in Table 5-1 still apply.

The Type A and Type B hydraulic structures assume the placement of large rock up to 8,000 lbs, which have diameters between 4 and 5 feet. When feasible, in-situ boulders and bedrock should be used. As seen on Sheet 22 (Attachment 1), the drawings have already indicated several in-situ boulders specifically to remain: boulders B14, B15, B30, B63, and B59. In-situ boulders may need to be modified to help meet the specified flowline elevations and overall design intent.

The Type A hydraulic structure, boulder constrictor, includes placing two properly shaped "constriction" boulders against one another to create a narrow slot that allows a limited amount of flow-through. "Footer" rocks are placed below the constriction boulders, as needed, to limit scour and support the boulders. In many cases, the footer rocks may be in-situ boulders shaped to serve as footers. "Buttress" rocks are placed on the downstream side of the constriction rocks to hold them in place. This hydraulic structure can create two to three feet of drop across it.

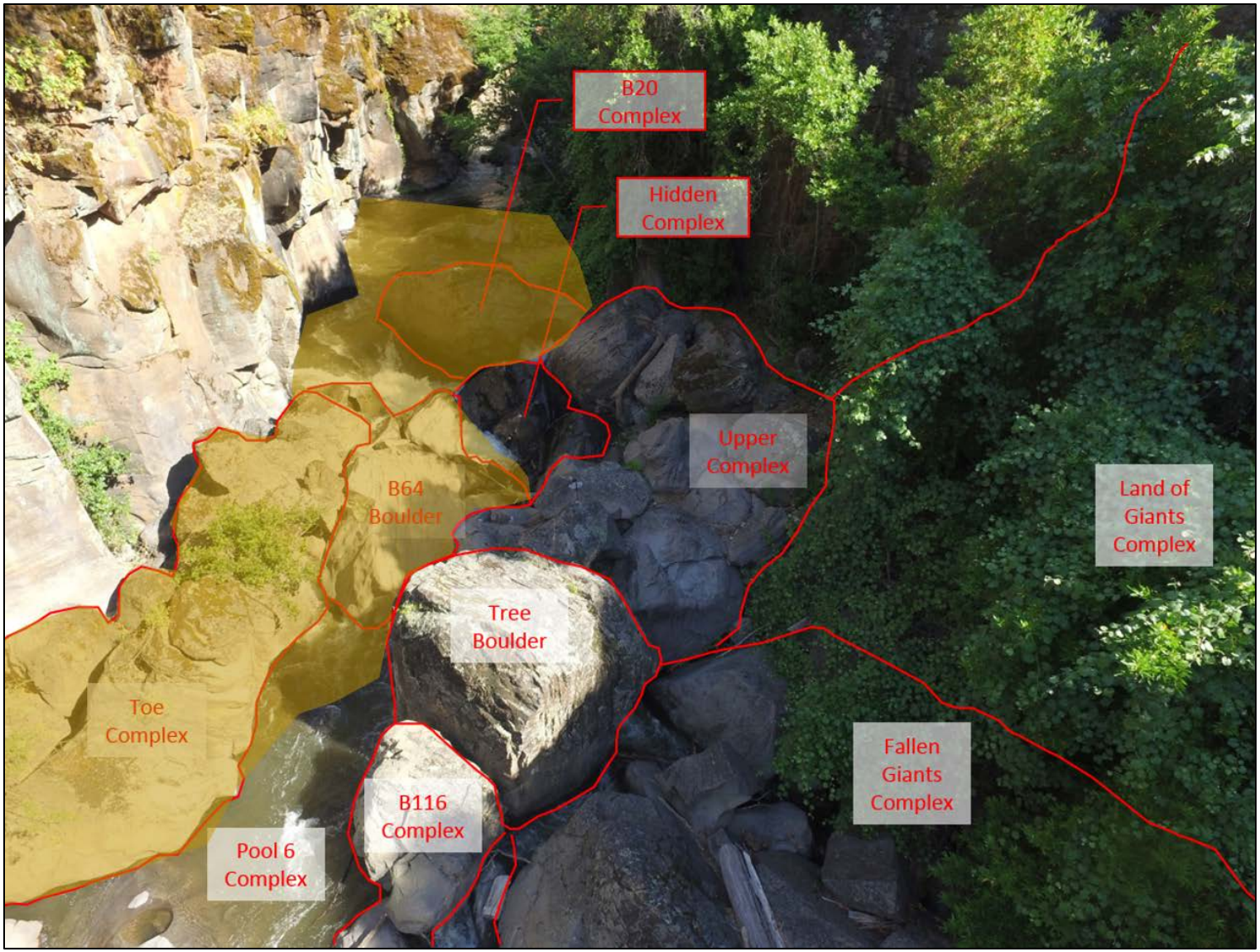


Figure 5-1. UBS boulder and boulder complexes to be removed for regrade. Approximate limits of regrade shaded yellow.

Table 5-1. UBS Hydraulic Structure Layout Table (see Attachment 1, Sheet 22 for Flowline locations).

FLOWLINE (FL) ID	STRUCTURE TYPE	FLOWLINE DESCRIPTION	POOL BOTTOM DOWNSTREAM OF FLOWLINE
HYDRAULIC STRUCTURE 1			
FL1-1	TYPE 'B'	EL 1480.3+/-0.5 FT	MIN 3 FT LOWER THAN FL1-1
FL1-2	TYPE 'A'	1 FT+/-0.5 FT ABOVE FL1-1	MIN 3 FT LOWER THAN FL1-1
FL1-3	TYPE 'A' AGAINST CANYON WALL	1 FT+/-0.5 FT ABOVE FL1-2	MIN 3 FT LOWER THAN FL1-1
HYDRAULIC STRUCTURE 2			
FL2-1	TYPE 'B'	SET BASED ON HYDRAULIC GRADELINE+/-0.5 FT	MIN 3 FT LOWER THAN FL1-1
FL2-2	EXISTING FL, TO REMAIN UNCHANGED	CONTACT BETWEEN B30 AND B36 AT APPROX EL 1483.5 FT	EXISTING POOL TO REMAIN
FL2-3	TYPE 'A' AGAINST CANYON WALL	1 FT+/-0.5 FT ABOVE FL2-2	MIN 3 FT LOWER THAN FL1-3
HYDRAULIC STRUCTURE 3			
FL3-1	TYPE 'C'	SET BASED ON HYDRAULIC GRADELINE+/-0.5 FT, BUT NO GREATER THAN 2.5 FT ABOVE FL2-1	MIN 3 FT LOWER THAN FL2-1
FL3-2	BEDROCK CONDITIONS PERMITTING	1 FT+/-0.5 FT ABOVE FL3-1	MIN 3 FT LOWER THAN FL2-2
FL3-3		1 FT+/-0.5 FT ABOVE FL3-2	MIN 3 FT LOWER THAN FL2-3
HYDRAULIC STRUCTURE 4			
FL4-1	TYPE 'A'	SET BASED ON HYDRAULIC GRADELINE+/-0.5 FT	MIN 3 FT LOWER THAN FL3-1
FL4-2	TYPE 'A'	1 FT+/-0.5 FT ABOVE FL4-1	MIN 3 FT LOWER THAN FL3-1
FL4-3	TYPE 'A'	1 FT+/-0.5 FT ABOVE FL4-2	MIN 3 FT LOWER THAN FL3-3
HYDRAULIC STRUCTURE 5			
FL5-1	TYPE 'A'	SET BASED ON HYDRAULIC GRADELINE+/-0.5 FT	MIN 3 FT LOWER THAN FL4-1
FL5-2	TYPE 'B' (USE IN-SITU BOULDERS AS FEASIBLE)	1 FT+/-0.5 FT ABOVE FL1-1.	MIN 2 FT LOWER THAN FL4-3
FL5-3	TYPE 'B'	1 FT+/-0.5 FT ABOVE FL1-2. DEFINED AT CONTACT BETWEEN B14 AND B15	MIN 2 FT LOWER THAN FL3-3

The Type B hydraulic structure, boulder double slot, is designed with a relatively flat "sill" boulder placed lower than the "keystone" boulders flanking it. A taller "dividing" boulder is placed upstream of the sill boulder to split the flow. As a result, water begins to draw down as it goes around the dividing boulder, before spilling into a receiving pool. This spreads the water surface drop over a longer distance so that fish can leap onto the sill boulder and swim through the remaining water surface drop. The sill boulder creates a 3- to 4-foot wide broad crested weir that creates more hydraulic capacity than the boulder constriction structure. The overall water surface drop across this structure could be up to 3 feet, with the drop spread out as described above. Buttress rocks and footer rocks are also used to give the structure stability.

Below each hydraulic structure flowline, a pool will be constructed. The pool's minimum residual depth will be 2 feet. Additional pool details are presented in Table 5-1.

The Type C hydraulic structure, bedrock chute, will be used in the event that bedrock is encountered with suitable elevations to create the flowlines. The bedrock will be shaped to create multiple chutes each having approximately 2 feet of drop across them. The chute lengths will vary depending on site conditions, but could be as short as 5 feet in length. The flowline elevation of each chute will vary such that there will be low-flow, mid-flow, and high-flow passageways for fish (Table 5-1). A pool will be constructed below the bedrock chutes with a minimum residual depth of 2 feet.

Between the hydraulic structures the channel bed will include large boulders either placed or in-situ. The channel should be rough and additional pools may be necessary.

Pool 6 is located at the downstream end of the channel regrade. Pool 6 was selected as the downstream transition because it is believed that fish can navigate the lower section of the UBS over a wide range of flows, including the fish passage design flows (MLA, 2016b). In addition, Pool 6 is adequate in size and depth to dissipate the flow's energy downstream of the channel regrade and it provides numerous places for fish to hold and stage before swimming upstream. Additionally, during large infrequent flow events (i.e. 1,600 cfs to 100-year flow) Pool 6 backwaters the upstream channel due to boulder constrictions surrounding it. This backwater will reduce the velocities and forces acting on the boulders placed within the regraded reach upstream of Pool 6 (MLA, 2016b).

Pool 9 is located at the upstream end of the channel regrade. Extending the channel regrade further upstream was evaluated but dismissed because it would require the removal of additional large boulders and due to the overall slope of the existing channel, would require a much longer regrade channel reach. Pool 9 provides ample volume for fish to recover after navigating the UBS channel regrade.

Lastly, a small concrete weir structure will be built downstream of the regraded channel (Attachment 1, Sheets 25 and 26). The purpose of the weir structure is to keep water from flowing out of the secondary alignment corridor under low to moderate flows. This will improve the flow and fish passage conditions within the secondary alignment corridor under these flow conditions.

5.2 Construction

Construction techniques are covered in detail in previously completed documents (SRD, 2016a, SRD 2016b, MLA, 2017). For reference, a summary is provided here.

Construction at the UBS will be extremely challenging given limited site access and rockfall hazards. It is envisioned that worker site access will be via an improved foot trail down to the site from the western rim of the canyon. Construction access for importing equipment, removing rock, and moving and placing boulders in the channel will be through the use of either a skyline yarding system or a crane (See Attachment 1, Sheets 14 and 15).

A skyline yarding system could be installed with the boom on the western rim downstream of the Digger Creek confluence and the other end anchored to bedrock on the northern canyon wall located upstream of the UBS.

A crane may be used instead of a yarding system, with it placed as close to the western rim as possible. A crane will allow for more maneuverability and control for rock removal and rock placement during construction, which is a key component of the design.

Prior to construction, rockfall hazards will be mitigated using various techniques, including scaling rocks off the cliff and anchoring rocks using rock bolts, as described in the geologic report (CSA, 2016). It is not known if the large block of basalt, referred to in the geologic report as the "wave," will need to be stabilized for construction safety. This block is upstream of the regrade but potentially in the vicinity of a coffer dam for site dewatering.

A streamflow bypass system will need to be installed prior to rock demolition, although some rock may be removed in the dry prior to dewatering to establish a route with suitable grade to lay the pipes. The bypass system will likely include a coffer dam placed upstream of the regraded channel constructed of super-sandbags, a water-filled bladder, or other materials that span the entire canyon wall to wall. The water will be bypassed in a gravity fed pipe around the entire work area. This may require moving the pipe several times during the course of construction. Installation could involve use of a helicopter to bring in the pipe segments and super sandbags.

Rock will be removed by first drilling holes into the boulders and bedrock and then either using hydraulic rock splitters, blasting, or other techniques to break the rock into pieces small enough to be lifted by the removal system.

Once the subgrade is daylighted, it may need to be manipulated to build the hydraulic structures. The hydraulic structures will be built using a combination of moving boulders into position using the yarding or crane system and using existing rock left in-place and potentially split/blasted to the desired size and shape. Rock used to build the structure could be salvaged during the splitting of larger rock during the demolition phase, providing some control as to the size and shape of the boulder. These rocks may be temporarily stockpiled in the canyon or may need to be lifted out and stored above the canyon before being lowered back down and into place.

Building the hydraulic structures will require close coordination between the resident fish passage engineer and the contractor to achieve the desired conditions. It is assumed that the yarding system or crane used for the project will have a minimum lifting capacity of 8,000 lbs, but having a higher lift capacity will provide more flexibility in building the hydraulic structures.

5.3 Stability Analysis of Placed Boulders

MLA (2017) presented a detailed analysis of the stability of the UBS design and concluded that hydraulic conditions within the channel regrade reach are not expected to mobilize the 4- to 5-foot diameter boulders used to construct the hydraulic structures.

The MLA (2017) methods only consider the hydraulic forces necessary to mobilize the boulders forming the structures. Boulder mobility due to collapse of a structure from downstream erosion or impacts from another boulder were not evaluated. Additionally, the methods may underestimate the vertical forces (uplift) associated with the turbulent hydraulics within the regraded channel. Therefore, a conservative approach should be taken to construct the hydraulic structures, and the largest rock that can be practically moved into the desired positions should be used. In addition, boulder shape should be considered; boulders that are more block-like are less prone to rolling and provide more surface area in contact with adjacent rock, and therefore may be more stable.

5.4 Anticipated Fish Passage Performance

5.4.1 Methods

A general discussion on the methods used to evaluate potential fish passage performance within the UBS was presented in Section 3.4. As discussed there, a SRH-2D hydraulic model based on the 90% design drawings was developed and ran using a wide range of flows. The UBS hydraulic model follows the same development procedures as presented in and MLA (2017).

Once the model runs were complete, each flow map was analyzed and a potential fish passage swim path was digitized. The swim paths were routed through the lowest water velocities while having sufficient depth for passage. A fish routing spreadsheet model was then used to identify the smallest sized Chinook salmon that could swim through the velocity field without becoming exhausted based on the swim speed equations developed by Hunter and Mayor (1986).

The primary difference between the LBS approach and the UBS fish routing modeling approach is the inclusion of resting. It is assumed that if a fish reaches a region with a velocity less than or equal to 1.5 body lengths per second (BL/s), then the fish can rest and recover from exhaustion. This is based on work completed by Paulik and DeLacy (1958) and Weaver (1963) in which fish swimming in water moving at 1.5 to 1.8 BL/s did not become exhausted. Therefore, if a fish begins to be exhausted as it navigates a particular feature and reaches an area that has a velocity equal to or less than 1.5 BL/s, then the fish's exhaustion is set back to zero. The model does not include the time it would take for the fish to recover fully before moving further upstream.

The model does not consider the velocity direction. As seen in the next section, eddies form within the project reach. Therefore, there may be instances when a fish is moving in the same direction as the flow as it moves upstream, or the fish could be moving lateral to the primary flow direction. In either case, the magnitude of the velocity is used in the equation. This is a conservative approach because in some cases the fish would use less energy to move a particular distance because it is not swimming against the full magnitude of the velocity. The results of the modeling are presented in the next section.

5.4.2 Results

Unlike the LBS, the UBS's complex layout of boulders and sieves made development of an existing conditions two-dimensional hydraulic model infeasible (MLA, 2016b). Therefore, a pre- and post-construction comparison based on model results cannot be made. MLA (2016b) provides a detailed discussion on existing fish passage conditions, which is summarized in Section 2.5.4 of this memorandum.

Table 5-2 presents a results summary table of the regraded channel hydraulics and fish passage assessment. The table includes average water surface slope, average water depth, minimum water depth, average water velocity, maximum water velocity, minimum Chinook salmon able to navigate the regrade channel, and the portion of Chinook salmon that are larger than the minimum size that navigated the channel based on historic data.

Table 5-2. Summary of UBS fish passage hydraulics and assessment results for the selected swim paths or alignment.

Parameter	Flow				
	35 cfs	120 cfs	293 cfs	500 cfs	1,600 cfs
Average Water Surface Slope	6%	5%	5%	4%	3%
Average Depth (ft)	2.3	3.4	4.6	5.6	10.5
Min. Depth (ft)	0.6	1.0	1.9	1.3	2.1
Average Velocity (fps)	3.3	3.5	4.0	4.2	6.1
Max Velocity (fps)	7.4	7.8	9.0	7.2	9.0
Min Chinook Size for Passing through Velocity Field (cm)	40	40	40	40	NA
Proportion of Chinook Larger than Min Size	100%	100%	100%	100%	NA

Figure 5-2 through Figure 5-5 present a plan and profile view of the SRH-2D hydraulic model results and cumulative fish exhaustion results for 35 cfs (low fish passage design flow), 120 cfs, 293 cfs (high fish passage design flow), and 500 cfs, respectively. On each plan view map, a potential swim path has been selected. The profile shows the water velocity and fish exhaustion along that swim path. In each case, the size of fish analyzed is a 40 cm Chinook salmon. MLA (2016b) showed that a 40 cm fish is just smaller than the smallest Chinook within the recorded data provided by USFWS for spring-run Chinook salmon in Battle Creek. Based on the fish performance evaluation methodology applied to this project, if a 40 cm salmon can navigate the reach, then a larger fish can also navigate the channel. The evaluation shows that a 40 cm can navigate the UBS regraded reach for each analyzed flow.

The selected swim path when the flow is 35 cfs and 120 cfs are nearly identical. Starting at the downstream end, the fish moves up the river left side of the channel and through the most left bedrock chute. Upstream of the bedrock chute, the fish moves laterally to the river right side of the channel and navigates the remainder of the reach on this side of the channel. Results show that the maximum the exhaustion at 35 cfs is 37% and occurs at the downstream end of the reach. Other features do not cause the fish to exceed 20% exhaustion. At 120 cfs, the maximum exhaustion is

49% and occurs near the downstream end of the channel, but the fish experiences a similar exhaustion near Station 45 and several times exceeds 20% exhaustion.

At the high fish passage design flow (293 cfs), the swim path is a similar path as described above. The maximum exhaustion occurs near Station 45, at 85%. The fish regularly exceeds 50% exhaustion but is able to recover between efforts due to slow water between hydraulic structures.

Potential fish passage conditions were evaluated at 500 cfs, which is greater than the high design flow, to see if the regraded channel may still provide hydraulic conditions suitable for passage. According to the approach applied for this project, a 40 cm Chinook can navigate the channel. The maximum exhaustion occurred at the upstream end of the channel, as the fish crosses Pool 9. The velocity within this section of the channel is more a result of the existing boulder configuration at the head of Pool 9 than the configuration of new hydraulic structures. Further, a less direct path across Pool 9 could have been selected, routing the fish through slower water. Regardless, the findings with respect to velocity and its effect on fish are promising.

Figure 5-6 presents the ground and water surface profiles along the selected fish swim path for each analyzed passage flow. The results indicate that the design is working as intended where there are water surface drops across hydraulic structures approximately 2 to 3 feet in height. The depth over all features appears to meet the depth criterion (0.5 ft). The minimum pool depth criterion (2 ft) also appears to be met.

Figure 5-7 presents the results of the SRH-2D model in plan and profile view for 1,600 cfs. Unlike Figure 5-2 through Figure 5-5, no swim path was digitized for this flow because it is believed that fish are not able to reach the regraded channel due to extreme velocities and turbulence occurring immediately downstream, and throughout Eagle Canyon. Instead, the profile shown is along the design alignment. The profile shows the ground and water surface elevations through the regraded reach. As seen, the water surface profile is backwatered from existing downstream controls formed by very large boulders.

The average water surface slope across the regraded channel reach gradually decreases as the flow increases, and the slope is always less than the overall channel bed slope (~10 percent). The average and minimum depth meet design criteria (0.5 ft) for all flows. Although there was not a velocity criterion set for this project, the maximum velocities are well within the short burst capabilities of salmon and steelhead. The maximum velocities occur at hydraulic structures and are short in length. Finally, the minimum Chinook salmon evaluated was 40 cm, which passed through the evaluation reach for flows between 35 cfs and 500 cfs; fish passage was not assessed at the 1,600 cfs flow.

5.5 Expected Design Life

The UBS design is anticipated to function as constructed for an indefinite period. The exact life expectancy is uncertain and dependent on the stability of the constructed hydraulic structures in the regraded channel and future rockfall. If structures break-apart during high flows, this could negatively affect fish passage conditions. Rockfall may occur at any time, and can be triggered by strong ground shaking from earthquakes. In most cases, maintenance in the form of rock removal could restore fish passage functionality.

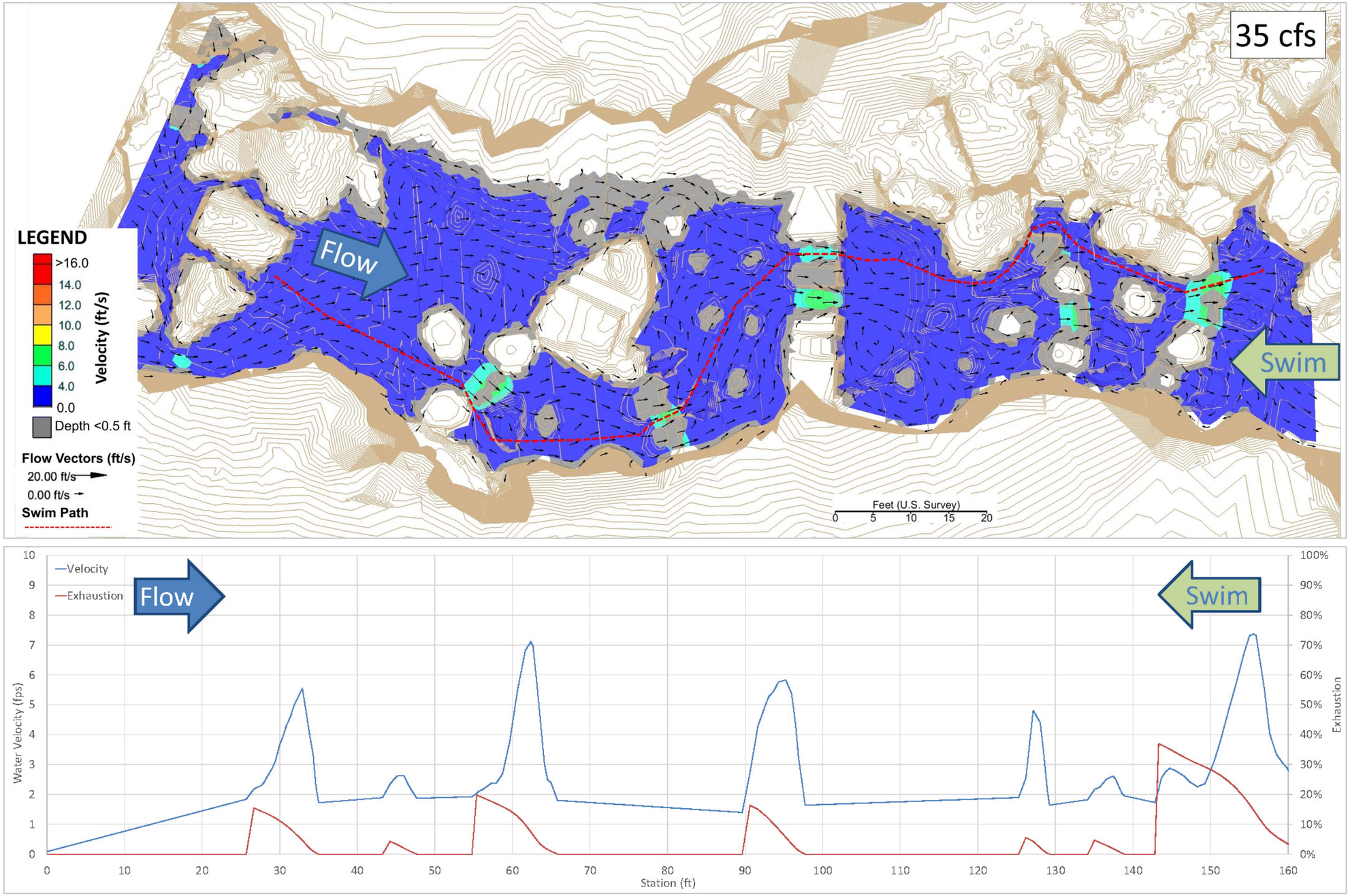


Figure 5-2. Predicted SRH-2D water velocity and fish passage exhaustion results for a 40 cm Chinook salmon at 35 cfs. (a) Plan view (b) Swim path profile.

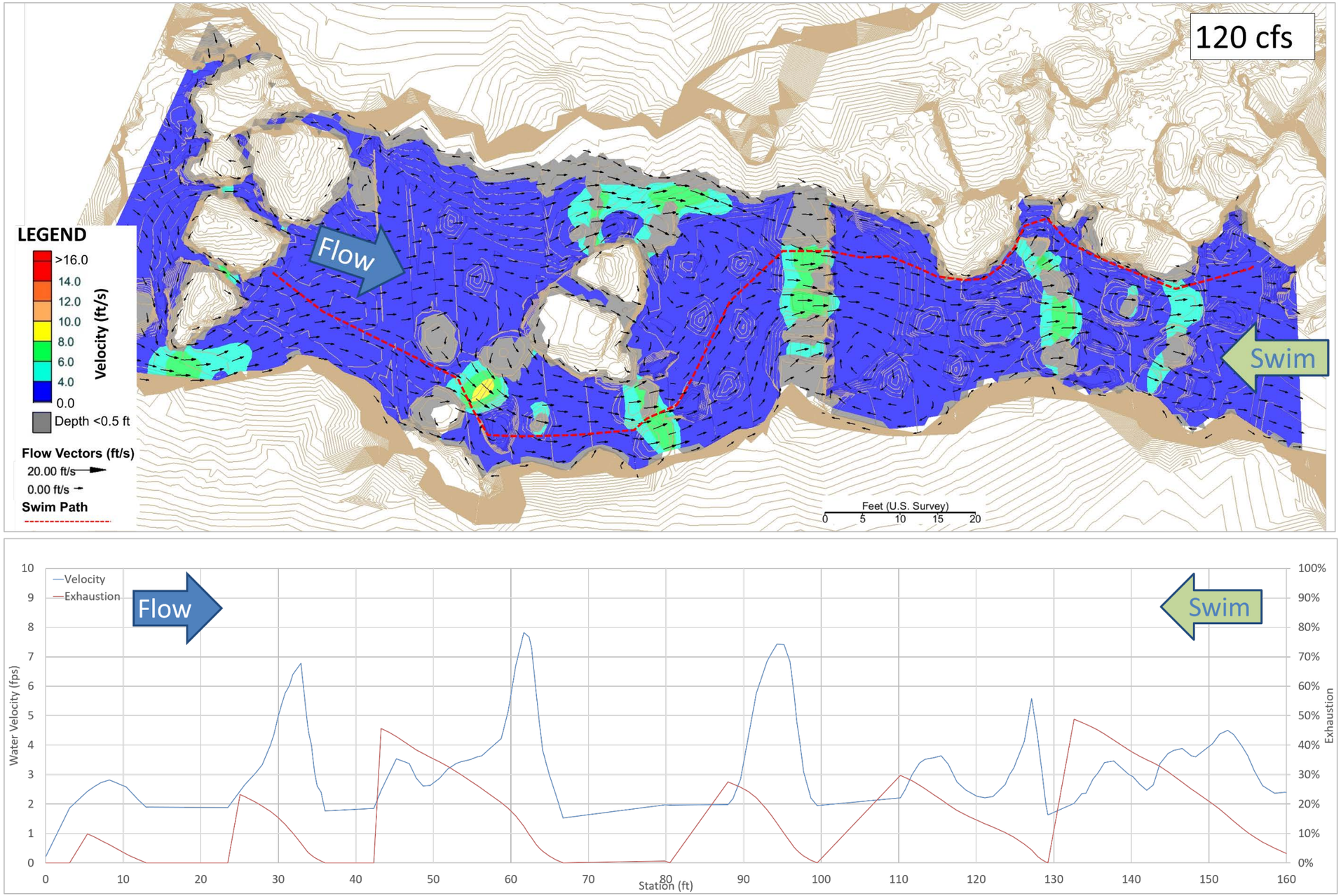
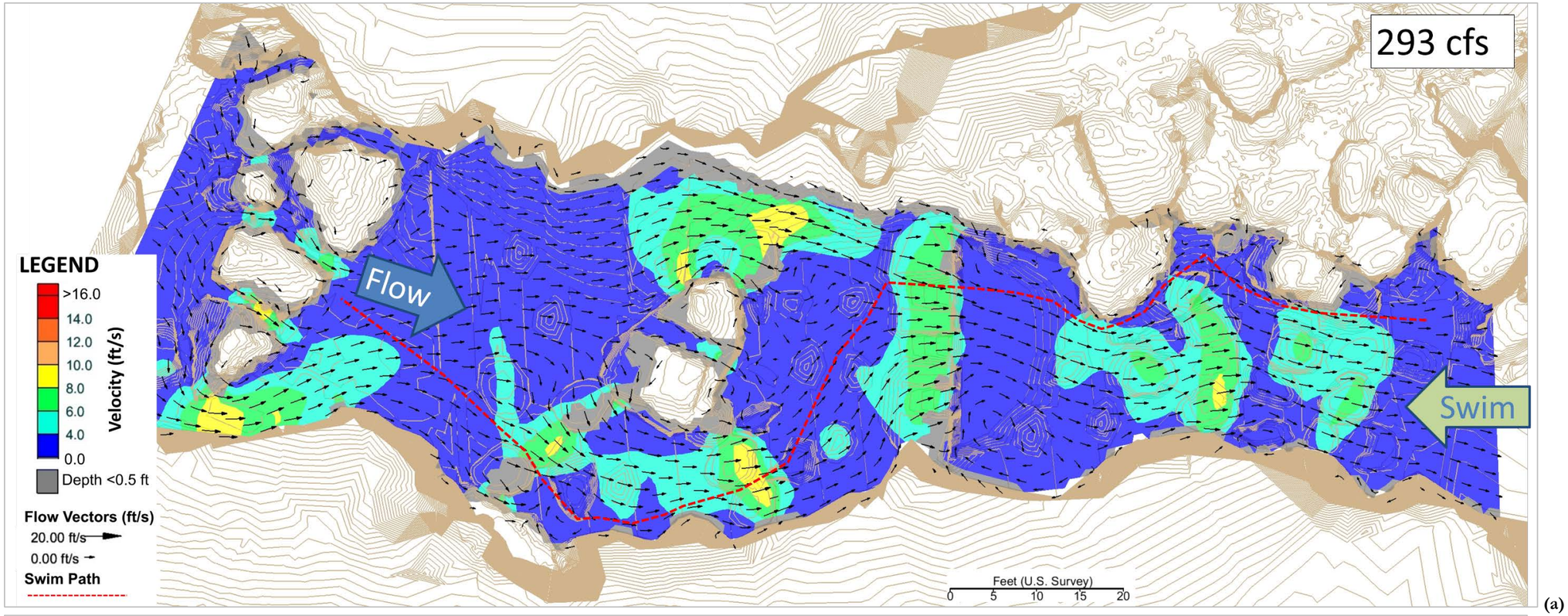
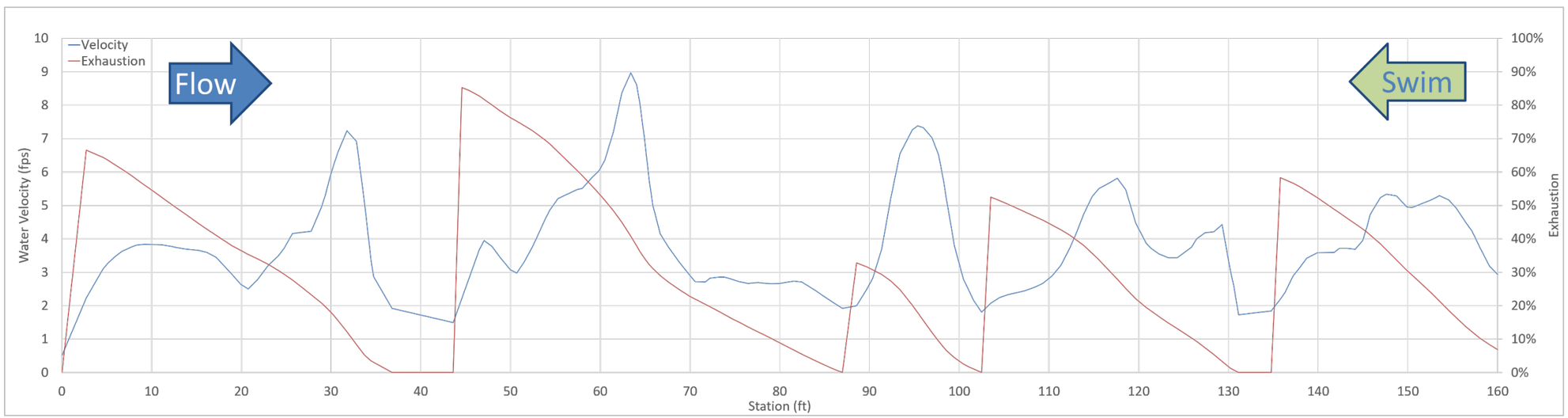


Figure 5-3. Predicted SRH-2D water velocity and fish passage exhaustion results for a 40 cm Chinook salmon at 120 cfs. (a) Plan view (b) Swim path profile.

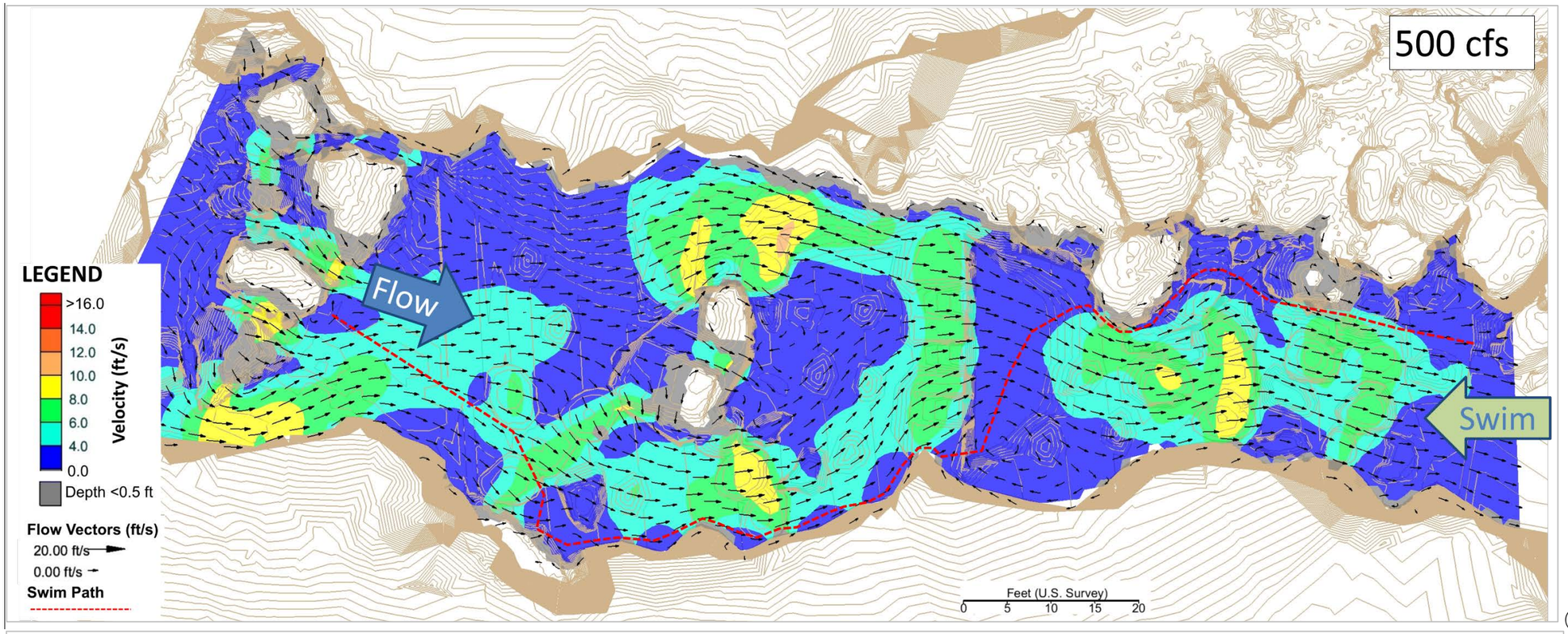


(a)

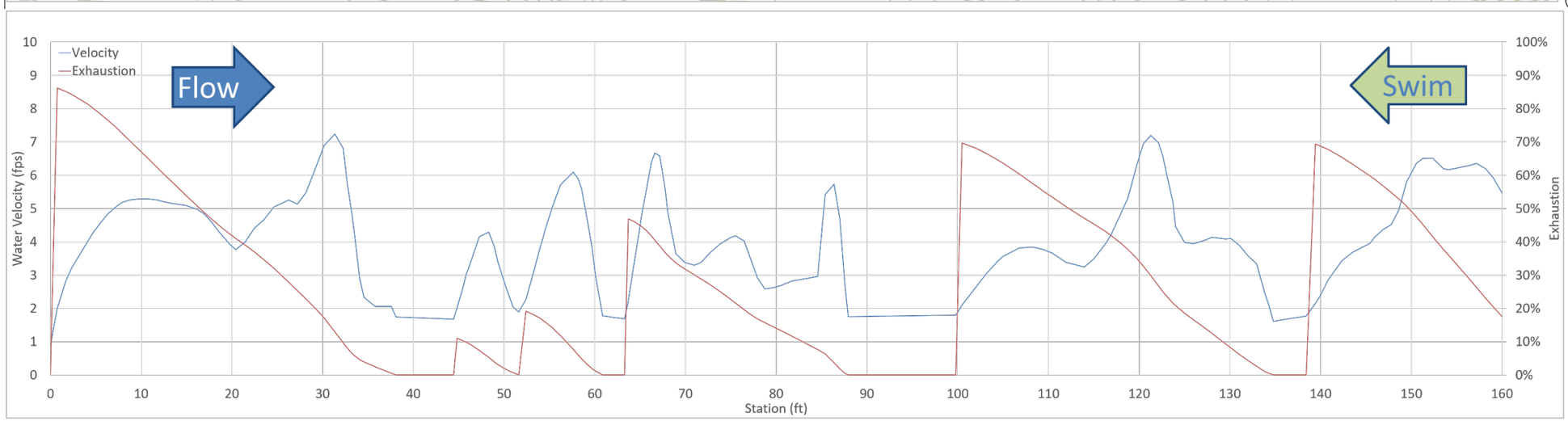


(b)

Figure 5-4. Predicted SRH-2D water velocity and fish passage exhaustion results for a 40 cm Chinook salmon at 293 cfs. (a) Plan view (b) Swim path profile.



(b)



(b)

Figure 5-5. Predicted SRH-2D water velocity and fish passage exhaustion results for a 40 cm Chinook salmon at 500 cfs. (a) Plan view (b) Swim path profile.

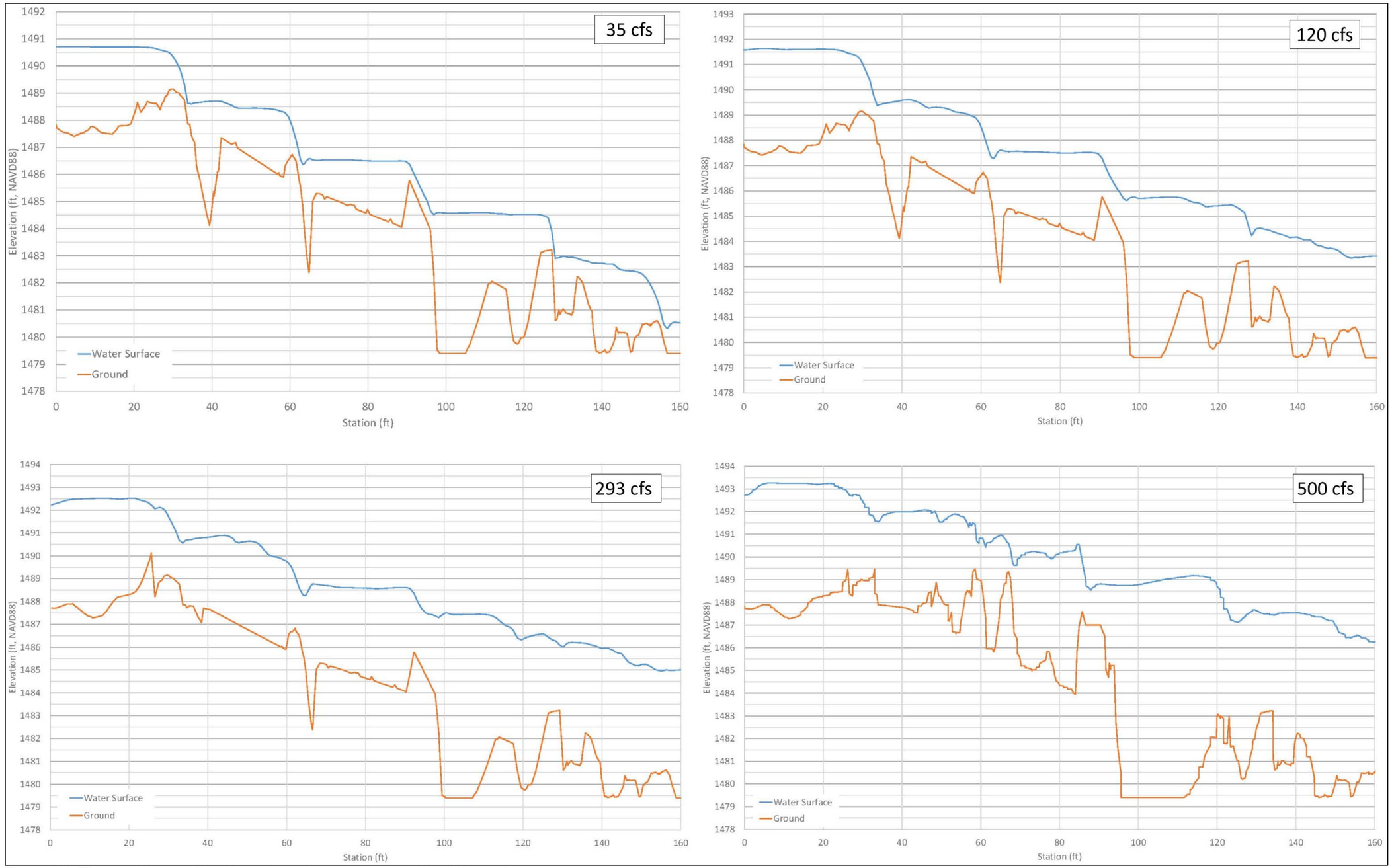


Figure 5-6. Water surface profiles along the swim paths selected for different flows.

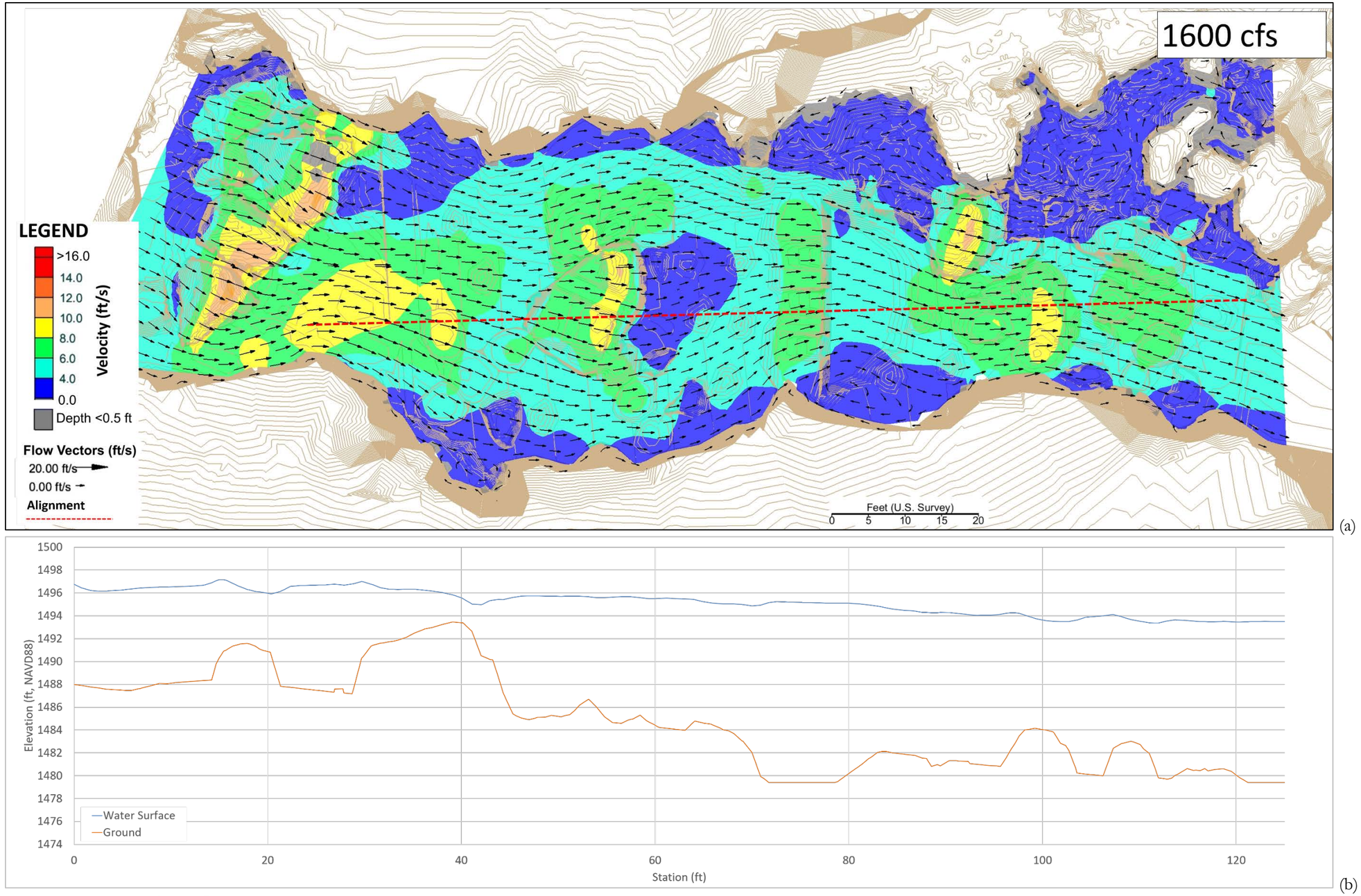


Figure 5-7. Predicted SRH-2D at 1,600 cfs, (a) plan view of velocity (b) ground and water surface profile along alignment.

5.6 Anticipated Maintenance Requirements

The UBS design will likely require little to no debris or sediment removal. There is the possibility that a large log or other woody debris could get jammed between rocks in an orientation that creates undesirable passage conditions, requiring removal. This has occurred at other locations within North Fork Battle Creek. If a log needs to be removed, it could be accomplished by hand crews.

Analyses suggest that the hydraulic structures constructed in the regraded channel will be stable during extreme flows. However, the hydraulic environment is difficult to fully characterize. If the hydraulic structures break apart during high flows and do not reform, then fish passage conditions could degrade, requiring mobilization of a crane or yarding system to reconstruct the hydraulic structures or implement other fish passage improvements.

There is a higher likelihood of rocks falling into the channel at the UBS than at the LBS. In the event that rocks do fall into the channel after construction, they will likely only cause minor changes to fish passage hydraulics and could even improve passage conditions.

The UBS is generally not susceptible to damage from boulders that could be mobilized. Flows that mobilize them are likely infrequent and involve extreme depths and velocities. Boulders in transport during these events will likely pass through the UBS without coming to rest. The design is also not considered susceptible to scour, except in the event that small sieves are formed under boulders due to scour, potentially degrading low-flow passage conditions.

If a large boulder were to move into the channel reach and create undesirable fish passage conditions, then removal of the boulder will be necessary. Depending on the size, location and orientation of the boulder, several methods could be used to break-up the rock rather than remove it completely from the canyon. If removal from the canyon is necessary, then large equipment (e.g. crane) will be necessary. This is not anticipated to occur frequently, if at all.

Access for inspection and maintenance will remain primitive after construction. Improved site access could be installed if desired and approved by the landowner. Other means for inspection could include UAV aerial photography techniques.

5.7 Recommended Post-Construction Monitoring

5.7.1 As-Built Survey

Immediately following construction, or as construction is finalized, it is recommended that a survey of flow paths and other key channel elements be completed. This will form the basis for follow up surveys. Due to the relatively high flows and dangerous conditions in the channel much of the year, follow up surveys should be conducted during the low-flow period. The follow up surveys should focus on the same key flow paths and channel elements and capture any new developments.

5.7.2 Startup Monitoring

Channel adjustments associated with placed and existing boulders is most likely to occur following the first several high-flow events. It is recommended that during the first year following construction the site be inspected following each major flow event (> 1,000 cfs) and any changes to the site configuration and flow patterns be noted. In addition to visual inspection, time-lapse cameras

should be installed at the UBS to document passage conditions at various flows. This monitoring should be extended if there are only a few high-flow events during the first year, or if channel adjustments are noted.

5.7.3 Biological Monitoring

Monitoring for fish migration through the project site will help indicate whether it is successful. The monitoring could include field spawning and snorkel surveys upstream and downstream of the UBS to document passage success. Another means to document passage conditions is through implementing a study plan that challenges individual fish to pass through the site. This may involve transport and release of radio-tagged adult Chinook salmon in Pool 2, downstream of the site and monitoring their passage attempts. This could be conducted across a range of flows.

5.7.4 Inspection and Maintenance

After the first year, site inspection may occur less frequently, possibly only after the high-flow season. The inspection will focus on noting any shifting in boulders forming the hydraulic controls and identifying any debris that has accumulated and potentially negatively impacts passage conditions. It will also be used to identify any rockfall that has changed passage conditions. Establishing photo monitoring points would be useful tool for conducting the inspections.

5.8 Design Limitations and Uncertainties

The complexity of the UBS and nature of the selected approach for restoring fish passage introduces several notable design limitations and uncertainties for the UBS project. The primary limitation is with respect to the unknown subsurface conditions, boulder interactions related to stability, and presence of bedrock (or lack-of). The design, as presented, is based on the best available data and observations from multiple site visits. The data was captured and site visits occurred during varying flow conditions. Boulders were individually studied and their relationship with adjacent boulders noted, but uncertainty remains with how the boulders will behave once the removal process begins and what additional boulders or bedrock may be exposed once the surface boulders are removed.

Several boulders have been specifically identified to remain even though they are within the regrade footprint. In most cases, only a portion of the identified boulder is visible, often only the top. Assumptions were made as to the size of the boulder beyond the visible limits. If these assumptions are proved inaccurate during the construction, then field adjustments will be necessary.

During construction, controlling the placement of large boulders accurately will be very important but uncertainty remains as to whether the equipment can achieve this, in a timely manner. Placement of boulders may require several attempts with a single boulder or several attempts with multiple boulders to get the contact and elevations desired so that the design intent is met.

The stability of the hydraulic structures was mentioned above, but should be reiterated here. The analysis concluded that the large boulders used to construct the structures should remain stable, even under very high flow events, but uncertainty does exist (see Section 5.3). If a structure should fail, the remaining structures, especially the ones upstream, may be in-danger of failing as well.

There is the possibility that at the lowest flows water could leak through the placed boulders around Boulder B63 and drain into the large sieve that connects to Pool 6. This could result in inadequate

flow and depth over the downstream most hydraulic structure. Care will need to be given to seal voids between boulders in this location.

The channel hydraulics are based on a rating curve developed for Pool 6 (downstream boundary condition) constructed through direct observations and surveys. Although we believe the rating curve is based on sound principles, the Pool 6 water surface may not behave as anticipated. Based on hydraulic analysis results, minor fluctuations in the behavior of Pool 6 should be mute but if there is a large shift in the behavior of Pool 6, then there could be consequences for the regraded channel, primarily associated with hydraulic structure stability. A large shift would likely be caused by a large boulder moving downstream of, or near, Pool 6. Although this is assumed to have a low likelihood of occurring, removing the upstream boulders for the project may have unforeseen consequences to the stability of the downstream boulders.

Although these uncertainties exist, the design intent is clear and field-adjustments during construction can mitigate these uncertainties to the extent practical. Additional hydraulic analysis by the fish passage engineer during construction may be needed to characterize resulting conditions associated with contemplated field changes. During construction, it will be essential for the contractor to work directly with the fish passage engineer on a daily basis so that field adjustments can be made that will result in the best project possible.

6 REFERENCES

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APPENDIX C

Final Design Plans

CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE

PLANS FOR CONSTRUCTION OF

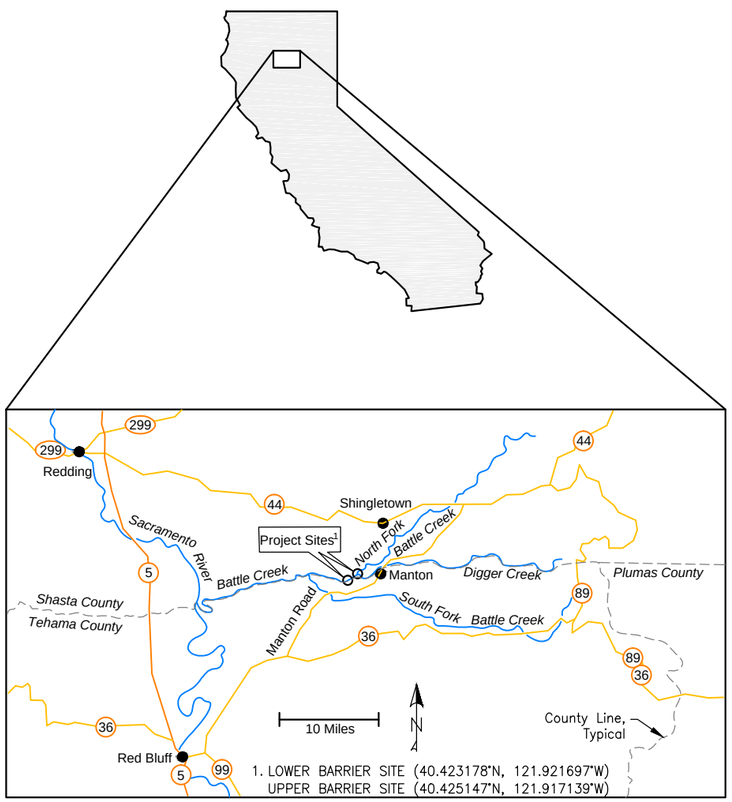
NORTH FORK BATTLE CREEK
EAGLE CANYON FISH PASSAGE IMPROVEMENT
LOWER AND UPPER BARRIER SITES

FEBRUARY 2017

FINAL SUBMITTAL

Prepared For:

CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE
AGREEMENT NUMBER: D1499019



PROJECT LOCATION MAP

APPROVALS

Michael Love and Associates, Inc.

Michael Love, P.E., Principal Engineer

REGISTERED PROFESSIONAL ENGINEER MICHAEL A. LOVE No.71681 CIVIL STATE OF CALIFORNIA

P. Travis James, P.E., Project Engineer

REGISTERED PROFESSIONAL ENGINEER P. TRAVIS JAMES No. C76663 CIVIL STATE OF CALIFORNIA

California Department of Fish and Wildlife

Approved by:

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CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE
NORTH FORK BATTLE CREEK
EAGLE CANYON FISH PASSAGE IMPROVEMENT

PROJECT TITLE SHEET

DATE	FEBRUARY 2017
SUBMITTAL	FINAL
DESIGN	ML, pTJ
DRAWN	pTJ, NN
SHEET	1 of 27

G-1

LEGEND AND SYMBOLS

EXISTING

- FENCE LINE
- 95 — EXISTING CONTOUR AND ELEVATION
- +99.0 — SPOT ELEVATION
- CHANNEL THALWEG OR DRAINAGE
- 1+00 — ALIGNMENT STATIONING (FEET)
- TREE DRIP LINE
- CONTROL POINT/TEMPORARY BENCH MARK
- FLOW DIRECTION
- STUMP
- TREE
- CULVERT
- SIDEWALK
- ROCK SLOPE PROTECTION (RSP)
- SD — STORM DRAIN
- TOP OF BANK
- A — SIEVE (VOID UNDER BOULDERS)
- B65 — INDIVIDUAL BOULDER I.D.
- BOULDER COMPLEX
- FL2-1 — FLOW LINE ID

NEW

- SURVEY CONTROL POINT
- LIMIT OF DISTURBANCE
- FENCE LINE
- 16 — CONTOUR AND ELEVATION
- 16 — SPOT ELEVATION
- 1+00 — STATIONING ALONG ALIGNMENT (FEET)
- CHANNEL THALWEG OR DRAINAGE
- TEMPORARY ISOLATION MEASURE
- SLOPE LINE
- RIPARIAN PLANTING AREA
- STAGING AREA
- LOG/LARGE WOOD STRUCTURE
- WATER SURFACE
- BOULDER OR BEDROCK REMOVAL OR MODIFICATION
- APPROXIMATE VEGETATION REMOVAL LIMITS

ABBREVIATIONS

AKA	ALSO KNOWN AS
APPROX, ~	APPROXIMATELY
BLDR	BOULDER
CA	CALIFORNIA
CGL	CHANNEL GRADE LINE
CL	CENTERLINE
CMP	CORRUGATED METAL PIPE
CO	CONTRACT OWNER
COR	CONTRACT OWNER REPRESENTATIVE
CP	SURVEY CONTROL POINT
CY	CUBIC YARDS
DIA	DIAMETER
DWG	DRAWING
EG	EXISTING GROUND
EL	ELEVATION
(E)	EXISTING
FG	FINISHED GROUND
'	FOOT OR FEET
HDPE	HIGH DENSITY POLYETHYLENE
HGL	HYDRAULIC GRADE LINE
"	INCH
I.D., ID	IDENTIFICATION
LBS	LOWER BARRIER SITE
LOD	LIMIT OF DISTURBANCE
MAX/MIN	MAXIMUM/MINIMUM
(N)	NEW
NF	NORTH FORK
NTS	NOT TO SCALE
OZ	OUNCE
O.C.	ON CENTER
RD	ROAD
SF	SOUTH FORK
STA	STATION
SY	SQUARE YARDS
TBM	TEMPORARY BENCHMARK
TOC	TOP OF CONCRETE
TYP	TYPICAL
UBS	UPPER BARRIER SITE
VEG	VEGETATION
W/	WITH
(1.5:1)	(HORIZONTAL:VERTICAL) SLOPE
%	PERCENT

A — LOCATION AND ORIENTATION OF PHOTOGRAPH

1 / C-1 — SECTION, DETAIL OR TYPICAL NAME (LETTER INDICATES SECTION, NUMBER INDICATES DETAIL OR TYPICAL)

DWG NO. ON WHICH SECTION, TYPICAL, OR DETAIL APPEARS

NOTE: CONTACT ENGINEER FOR ABBREVIATIONS OR SYMBOLS NOT LISTED

GENERAL

Sheet Number	DWG	Sheet Title
1	G-1	PROJECT TITLE SHEET
2	G-2	DRAWING LIST AND LEGEND
3	G-3	EXISTING COND., SHEET INDEX & ACCESS MAP

LOWER BARRIER SITE

Sheet Number	DWG	Sheet Title
4	C-1	CONTRACTOR ACCESS & USE AREA OPTION 1
5	C-2	CONSTRUCTION ACCESS & SITE USE OPTION 2
6	C-3	EAGLE CANYON SECTION
7	C-4	HORIZONTAL AND VERTICAL CONTROL
8	C-5	WATER MANAGMENT PLAN & PROFILE
9	C-6	DEMO PLAN
10	C-7	DEMO PHOTOGRAPHS
11	C-8	DESIGN PLAN, PROFILE, DETAILS, & NOTES
12	C-9	SECTIONS, 1 OF 2
13	C-10	SECTIONS, 2 OF 2

UPPER BARRIER SITE

Sheet Number	DWG	Sheet Title
14	C-11	ACCESS & USE AREA OPTION 1 PLAN
15	C-12	ACCESS & USE AREA OPTION 2 PLAN
16	C-13	ACCESS & USE AREA OPTIONS 1 & 2 SECTIONS
17	C-14	HORIZONTAL AND VERTICAL CONTROL
18	C-15	WATER MANAGEMENT, 1 OF 2
19	C-16	WATER MANAGEMENT, 2 OF 2
20	C-17	DEMO PLAN
21	C-18	DEMO PHOTOGRAPHS
22	C-19	CONCEPTUAL CHANNEL DESIGN PLAN & PROFILE
23	C-20	CHANNEL MODIFICATION NOTES
24	C-21	HYDRAULIC STRUCTURE TYPICALS
25	C-22	WEIR CONSTRUCTION PLAN & PHOTOS
26	C-23	CONCRETE WEIR SECTION & DETAIL

DETAILS

Sheet Number	DWG	Sheet Title
27	C-24	PROJECT DETAILS AND TYPICALS

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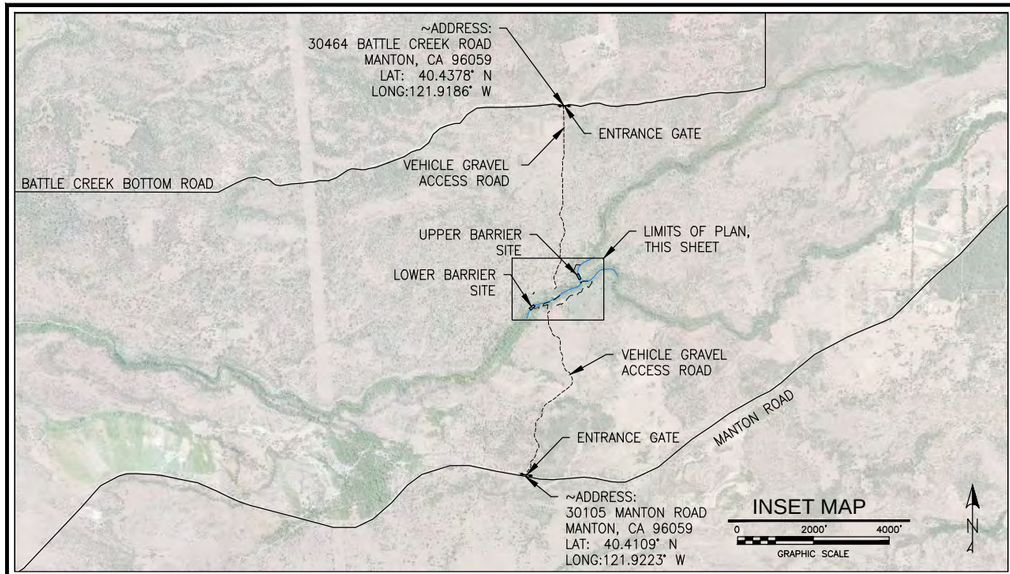
CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE
NORTH FORK BATTLE CREEK
EAGLE CANYON FISH PASSAGE IMPROVEMENT

DRAWING LIST AND LEGEND

DATE	FEBRUARY 2017
SUBMITTAL	FINAL
DESIGN	ML, pTJ
DRAWN	pTJ, NN
SHEET	2 of 27

G-2



NOTES:

1. PERMISSION REQUIRED TO ACCESS BARRIER SITES.
2. ACCESS TO SOUTH RIM MUST FOLLOW PG&E'S ACCESS PROTOCOL, SEE SPECIFICATION 01 14 10 SITE USE
3. KEEP ACCESS CLEAR FOR PG&E
4. KEEP ACCESS CLEAR FOR LANDOWNERS

TO BATTLE CREEK BOTTOM ROAD
VEHICLE GRAVEL ACCESS ROAD
APN # 704260013000
APN # 704260015000
APPROXIMATE NORTH RIM ACCESS TRAIL TO UPPER BARRIER
NORTH FORK BATTLE CREEK
NO VEHICLE ACCESS HAS BEEN ESTABLISHED
UPPER BARRIER SITE, SEE DWG C-19
DIGGER CREEK
ACCESS VIA GATE AT BATTLE CREEK BOTTOM ROAD, KEY PROVIDED TO CONTRACTOR
SCRAMBLE OVER LARGE BOULDERS WITHIN DIGGER CREEK
BEGIN STEEP TRAIL TO DIGGER CREEK
SHASTA COUNTY
GRAVEL VEHICLE ACCESS ROAD
NORTH FORK BATTLE CREEK
EAGLE CANYON DAM
APN # 704260010000
PARCEL BOUNDARY AT CENTER OF CHANNEL, NEITHER PARCEL LINE OR CHANNEL BLUE LINE ARE PRODUCT OF SURVEY
PARCEL LINE FROM COUNTY SHAPEFILE, NOT PRODUCT OF SURVEY, TYP
WORN TRAIL THROUGH BRUSH
APN # 704260016000
TEHAMA COUNTY
CONTRACTOR IS NOT PERMITTED ACCESS TO EAGLE CANYON DAM UNLESS AUTHORIZED BY PG&E IN WRITING
APPROXIMATE SOUTH RIM ACCESS TRAIL TO UPPER BARRIER SITE VIA DIGGER CREEK
LOWER BARRIER SITE
APN # 011020041
APPROXIMATE ACCESS TRAIL TO LOWER BARRIER. REQUIRES PERMISSION FROM PG&E. FOLLOW EXISTING PG&E STAIRS AND CATWALKS TO FLUME, FOLLOW FLUME IN DIRECTION OF FLOW USING CATWALK UNTIL REACHING THE TUNNEL ENTRANCE, THEN CLIMB OFF FLUME AND PROCEED DOWN ROCKS TO CREEK.
APPROXIMATE LOCATION OF (E) PG&E FLUME
VEHICLE GRAVEL ACCESS ROAD
ACCESS VIA GATE AT MANTON ROAD, SEE INSET MAP
TO MANTON ROAD
PLAN
0 80' 160'
GRAPHIC SCALE
N

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EAGLE CANYON FISH PASSAGE IMPROVEMENT

UPPER & LOWER BARRIER SITES
EXISTING COND. SHEET INDEX & ACCESS MAP

DATE	FEBRUARY 2017
SUBMITTAL	FINAL
DESIGN	ML, pTJ
DRAWN	pTJ, NN
SHEET	3 of 27

G-3

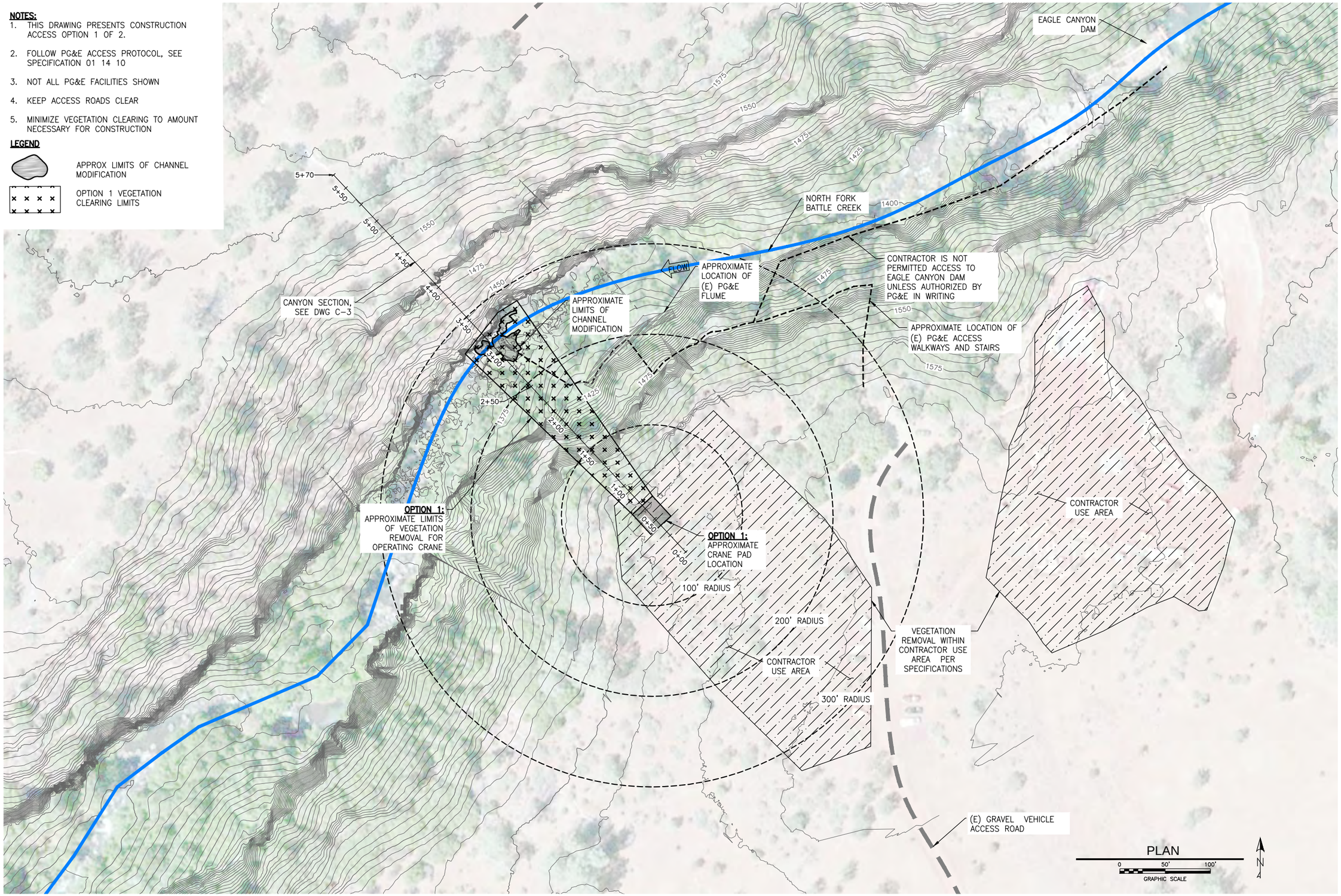
NOTES:

1. THIS DRAWING PRESENTS CONSTRUCTION ACCESS OPTION 1 OF 2.
2. FOLLOW PG&E ACCESS PROTOCOL, SEE SPECIFICATION 01 14 10
3. NOT ALL PG&E FACILITIES SHOWN
4. KEEP ACCESS ROADS CLEAR
5. MINIMIZE VEGETATION CLEARING TO AMOUNT NECESSARY FOR CONSTRUCTION

LEGEND

APPROX LIMITS OF CHANNEL MODIFICATION

OPTION 1 VEGETATION CLEARING LIMITS



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LOWER BARRIER SITE
CONTRACTOR ACCESS & USE AREA OPTION 1

DATE	FEBRUARY 2017
SUBMITTAL	FINAL
DESIGN	ML, pTJ
DRAWN	pTJ, NN
SHEET	4 of 27

C-1

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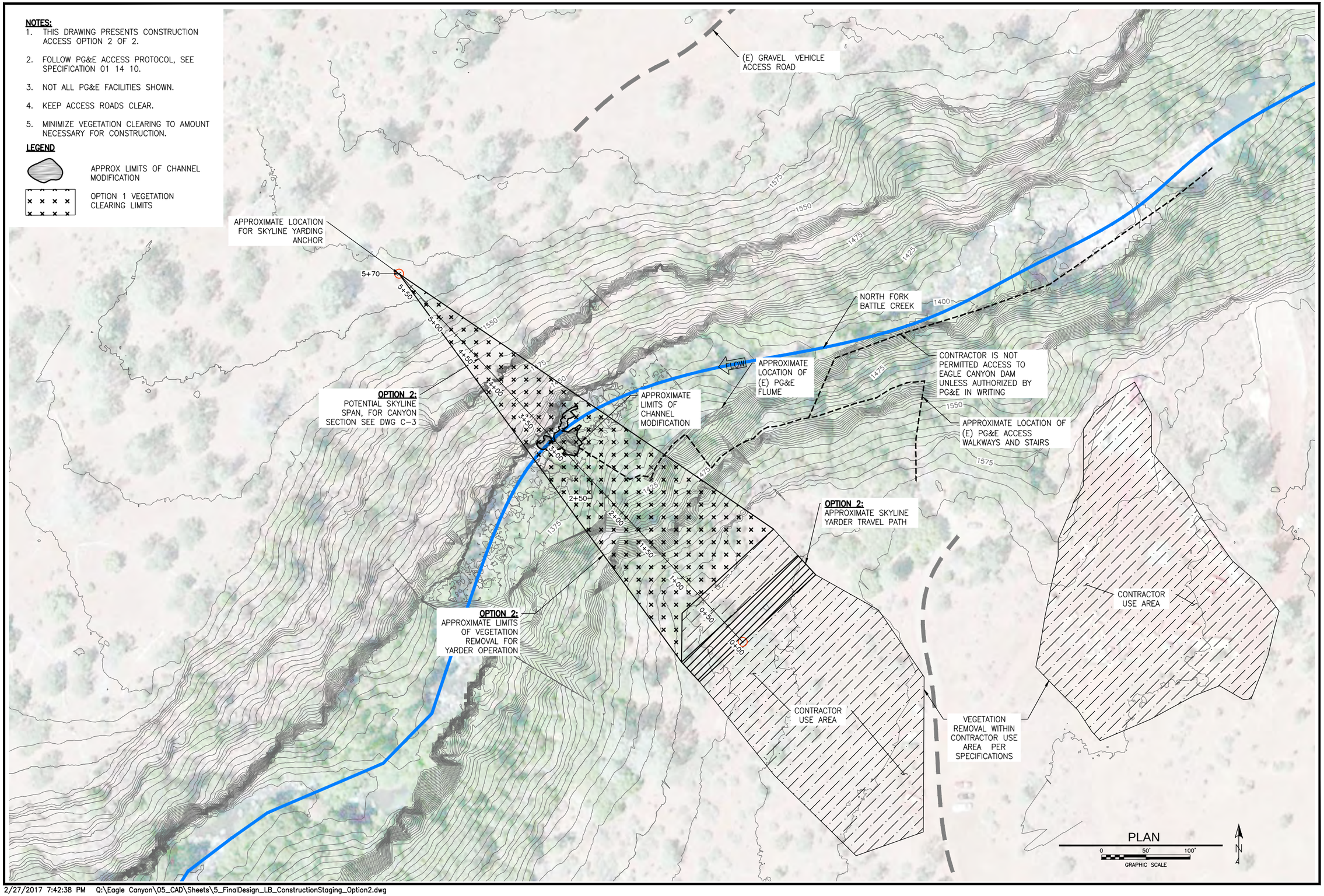
NOTES:

1. THIS DRAWING PRESENTS CONSTRUCTION ACCESS OPTION 2 OF 2.
2. FOLLOW PG&E ACCESS PROTOCOL, SEE SPECIFICATION 01 14 10.
3. NOT ALL PG&E FACILITIES SHOWN.
4. KEEP ACCESS ROADS CLEAR.
5. MINIMIZE VEGETATION CLEARING TO AMOUNT NECESSARY FOR CONSTRUCTION.

LEGEND

APPROX LIMITS OF CHANNEL MODIFICATION

OPTION 1 VEGETATION CLEARING LIMITS



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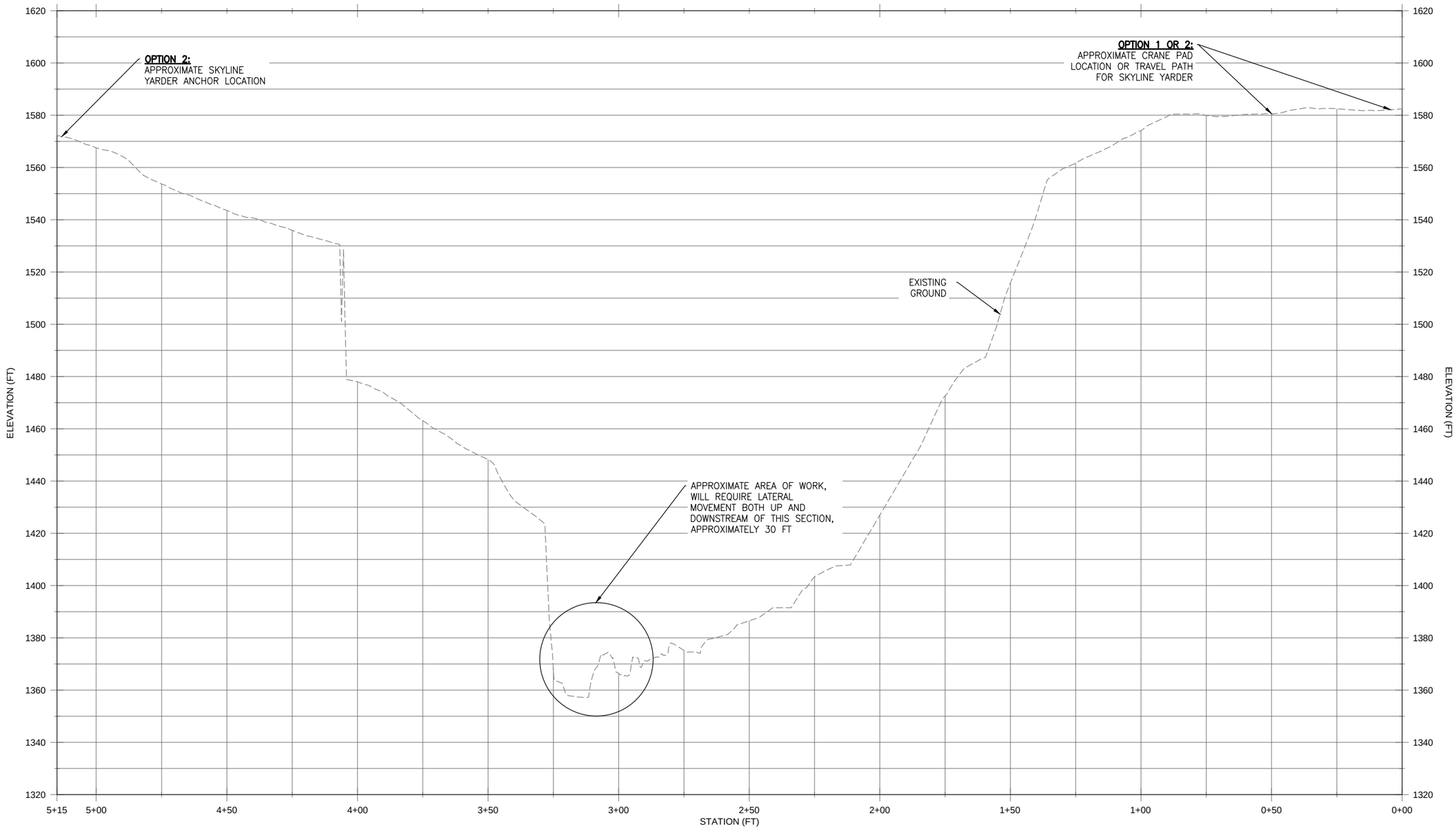
EAGLE CANYON FISH PASSAGE IMPROVEMENT

LOWER BARRIER SITE
CONSTRUCTION ACCESS & SITE USE OPTION 2

DATE	FEBRUARY 2017
SUBMITTAL	FINAL
DESIGN	ML, pTJ
DRAWN	pTJ, NN
SHEET	5 of 27

C-2



CANYON SECTION (LOOKING UPSTREAM)

0 20' 40'
GRAPHIC SCALE

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EAGLE CANYON FISH PASSAGE IMPROVEMENT

LOWER BARRIER SITE
EAGLE CANYON SECTION

DATE	FEBRUARY 2017
SUBMITTAL	FINAL
DESIGN	ML, pTJ
DRAWN	pTJ, NN
SHEET	6 of 27

C-3

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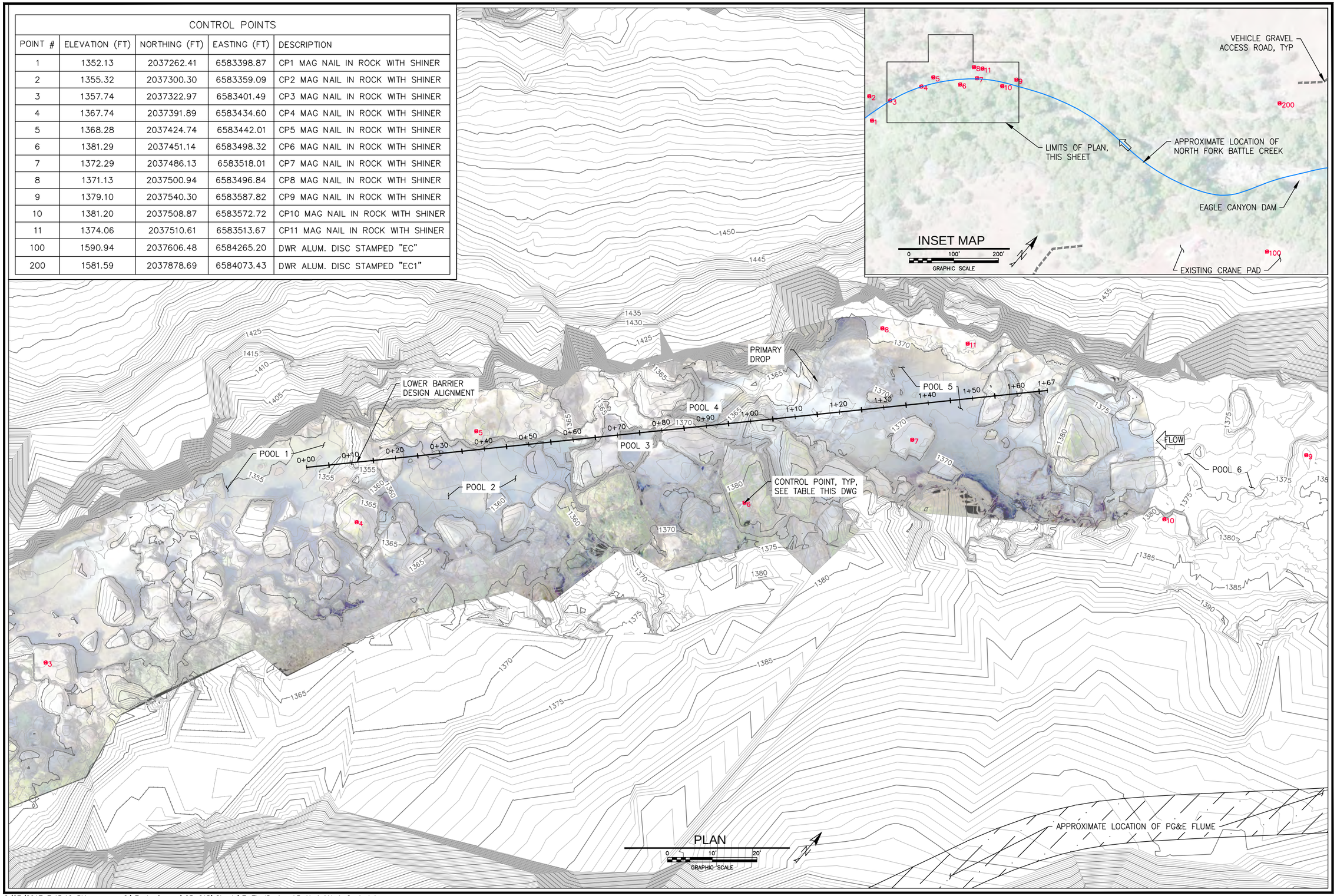
CONTROL POINTS				
POINT #	ELEVATION (FT)	NORTHING (FT)	EASTING (FT)	DESCRIPTION
1	1352.13	2037262.41	6583398.87	CP1 MAG NAIL IN ROCK WITH SHINER
2	1355.32	2037300.30	6583359.09	CP2 MAG NAIL IN ROCK WITH SHINER
3	1357.74	2037322.97	6583401.49	CP3 MAG NAIL IN ROCK WITH SHINER
4	1367.74	2037391.89	6583434.60	CP4 MAG NAIL IN ROCK WITH SHINER
5	1368.28	2037424.74	6583442.01	CP5 MAG NAIL IN ROCK WITH SHINER
6	1381.29	2037451.14	6583498.32	CP6 MAG NAIL IN ROCK WITH SHINER
7	1372.29	2037486.13	6583518.01	CP7 MAG NAIL IN ROCK WITH SHINER
8	1371.13	2037500.94	6583496.84	CP8 MAG NAIL IN ROCK WITH SHINER
9	1379.10	2037540.30	6583587.82	CP9 MAG NAIL IN ROCK WITH SHINER
10	1381.20	2037508.87	6583572.72	CP10 MAG NAIL IN ROCK WITH SHINER
11	1374.06	2037510.61	6583513.67	CP11 MAG NAIL IN ROCK WITH SHINER
100	1590.94	2037606.48	6584265.20	DWR ALUM. DISC STAMPED "EC"
200	1581.59	2037878.69	6584073.43	DWR ALUM. DISC STAMPED "EC1"



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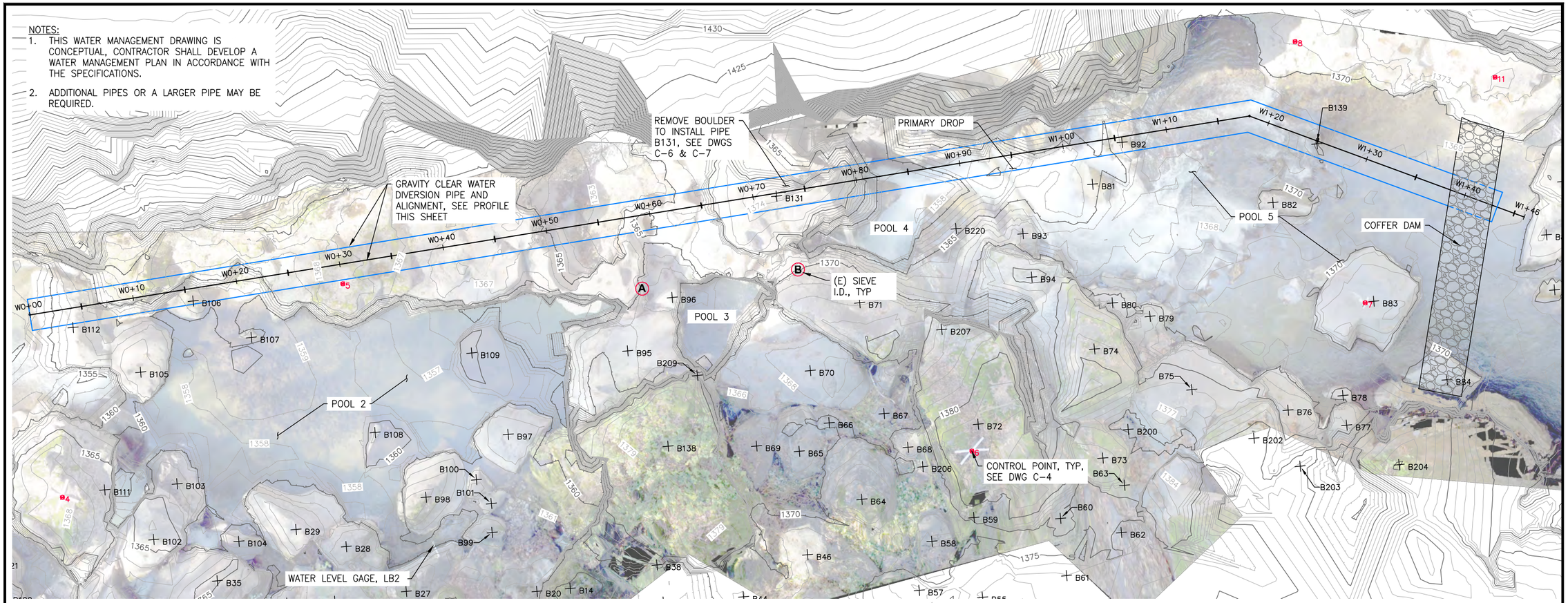
NORTH FORK BATTLE CREEK
EAGLE CANYON FISH PASSAGE IMPROVEMENT

LOWER BARRIER SITE
HORIZONTAL AND VERTICAL CONTROL

DATE	FEBRUARY 2017
SUBMITTAL	FINAL
DESIGN	ML, pTJ
DRAWN	pTJ, NN
SHEET	7 of 27

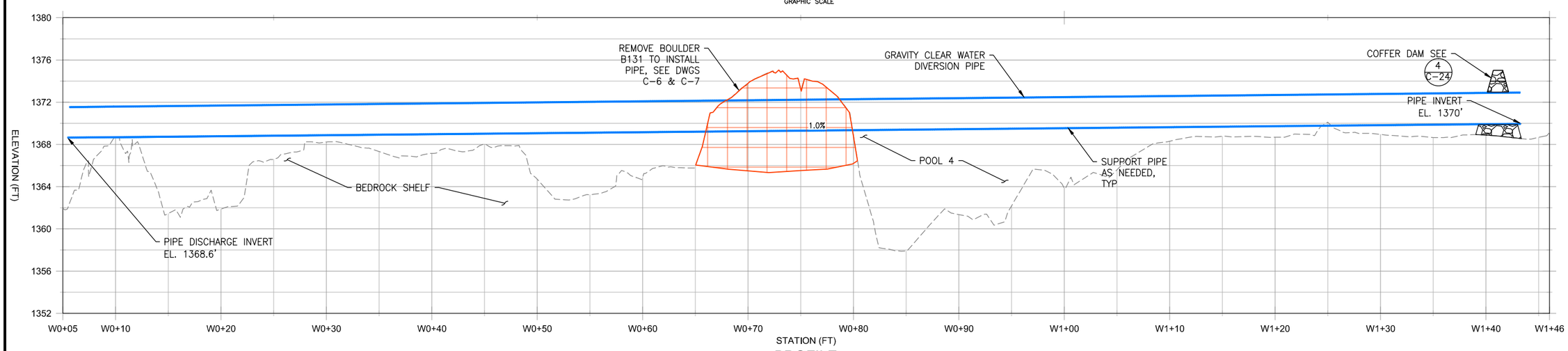
C-4

NOTES:
1. THIS WATER MANAGEMENT DRAWING IS CONCEPTUAL, CONTRACTOR SHALL DEVELOP A WATER MANAGEMENT PLAN IN ACCORDANCE WITH THE SPECIFICATIONS.
2. ADDITIONAL PIPES OR A LARGER PIPE MAY BE REQUIRED.



PLAN

0 5' 10'
GRAPHIC SCALE



PROFILE

0 5' 10'
GRAPHIC SCALE

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CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE
NORTH FORK BATTLE CREEK
EAGLE CANYON FISH PASSAGE IMPROVEMENT

LOWER BARRIER SITE
WATER MANAGMENT PLAN & PROFILE

DATE	FEBRUARY 2017
SUBMITTAL	FINAL
DESIGN	ML, pTJ
DRAWN	pTJ, NN
SHEET	8 of 27

C-5

Complex	Boulder	Axis Dimensions (ft)[3] a	b	c	Volume (CY)[4]	Weight (Ton)[5]
Middle Complex	B208	6.4	3.0	2.0	1.4	3.2
	B68	3.6	3.2	3.0	0.8	1.7
B72 Complex	B72	14.3	10.1	6.6	35.3	78.4
	B221	4.3	3.7	2.9	1.7	3.8
	B208	4.4	4.0	2.7	1.8	3.9
	B59	8.6	4.7	1.7	2.5	5.6
	B207	8.0	3.9	3.2	1.8	4.1
	B74	11.8	6.1	5.0	13.3	29.6
	B73	4.5	3.9	3.9	2.5	5.6
	B79	4.8	3.8	2.2	1.5	3.3
	B80	4.6	6.8	4.2	2.4	5.4
	B94	7.6	7.2	4.8	9.7	21.6
	B93	4.5	4.4	3.2	1.2	2.6
	B220[1]	?	?	?	9.5	21.1
Boulder B131	B131	12.0	11.8	6.0	31.5	69.8
Boulder B71	B71	14.6	10.1	6.2	33.9	75.2
Misc.	B92	5.9	2.8	2.0	0.6	1.4
	B81	5.5	3.0	2.0	1.2	2.7
North Chute Grading[6]	B131	NA	NA	NA	10.0	22.2
South Chute Grading[6]	B71	NA	NA	NA	7.0	15.5
Unseen[2]	NA	NA	NA	NA	17.0	37.7
Estimated volume of rock to be removed: 187 cubic yards, 414 tons						

1 Survey lacks definition for this boulder. Based on photograph review, the boulder is estimated to be similar to B94

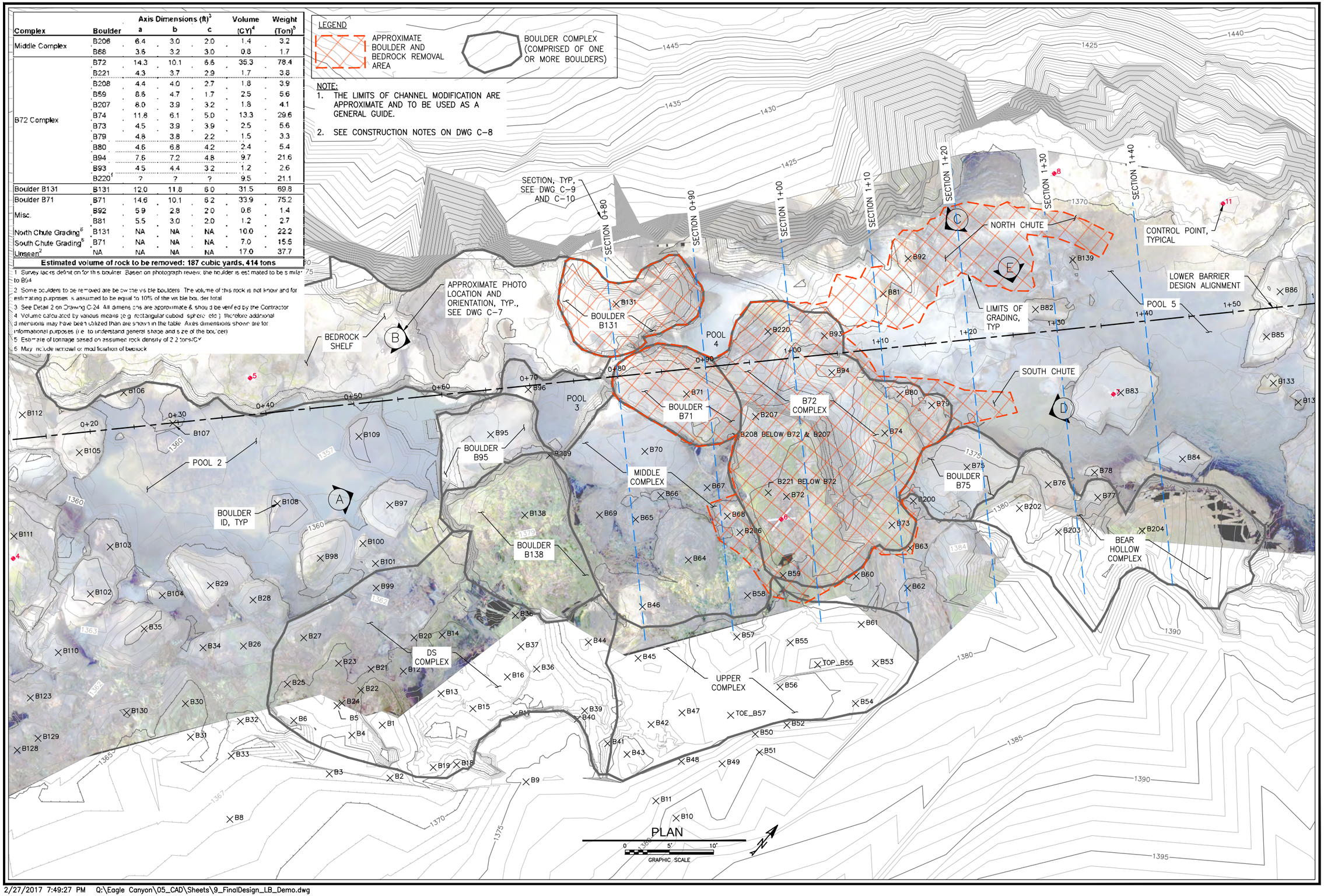
2 Some boulders to be removed are below the visible boulders. The volume of this rock is not known and for estimating purposes is assumed to be equal to 10% of the visible boulder total

3 See Detail 2 on Drawing C-24. All dimensions are approximate & should be verified by the Contractor

4 Volume calculated by various means (e.g. rectangular cuboid, sphere, etc.). Therefore additional dimensions may have been utilized than are shown in the table. Axes dimensions shown are for informational purposes (i.e. to understand general shape and size of the boulder)

5 Estimate of tonnage based on assumed rock density of 2.2 tons/CY

6 May include removal or modification of bedrock



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VERIFY SCALE
THIS BAR IS ONE INCH LONG AT FULL SCALE

CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE
NORTH FORK BATTLE CREEK
EAGLE CANYON FISH PASSAGE IMPROVEMENT

LOWER BARRIER SITE
DEMO PLAN

DATE	FEBRUARY 2017
SUBMITTAL	FINAL
DESIGN	ML, pTJ
DRAWN	pTJ, NN
SHEET	9 of 27

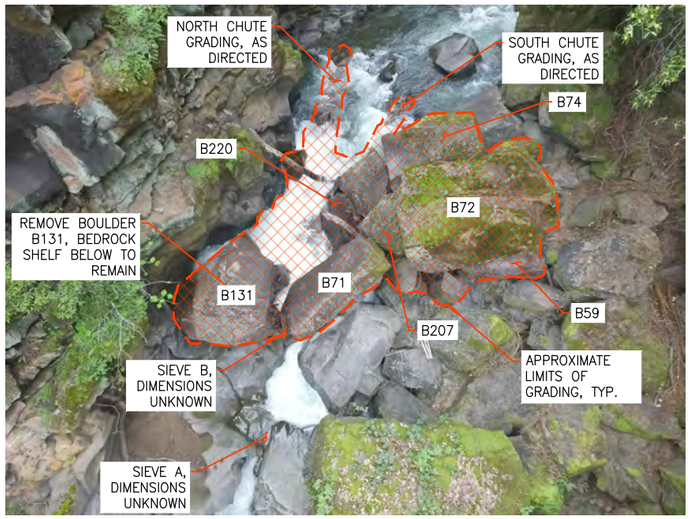
C-6

2/27/2017 7:49:27 PM Q:\Eagle Canyon\05_CAD\Sheets\9_FinalDesign_LB_Demo.dwg

NOTE:
1. THE LIMITS OF CHANNEL MODIFICATION ARE APPROIXMATE AND TO BE USED AS A GENERAL GUIDE.
2. SEE DRAWING C-6 FOR LOCATION WHERE PHOTOGRAPH TAKEN

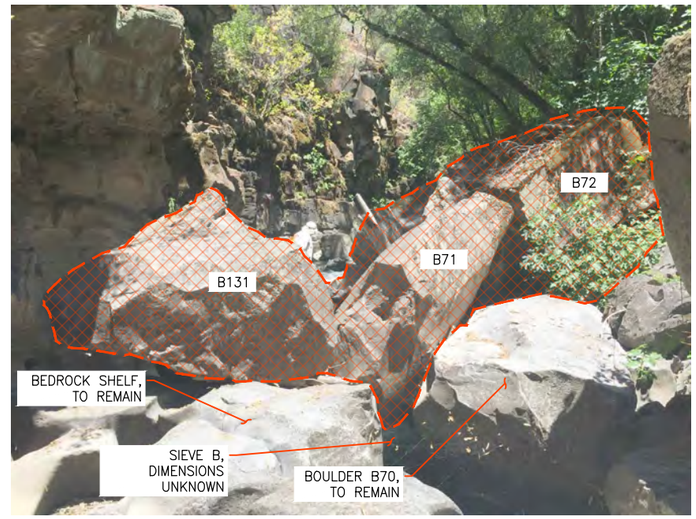
LEGEND

APPROXIMATE LIMITS OF CHANNEL MODIFICATION



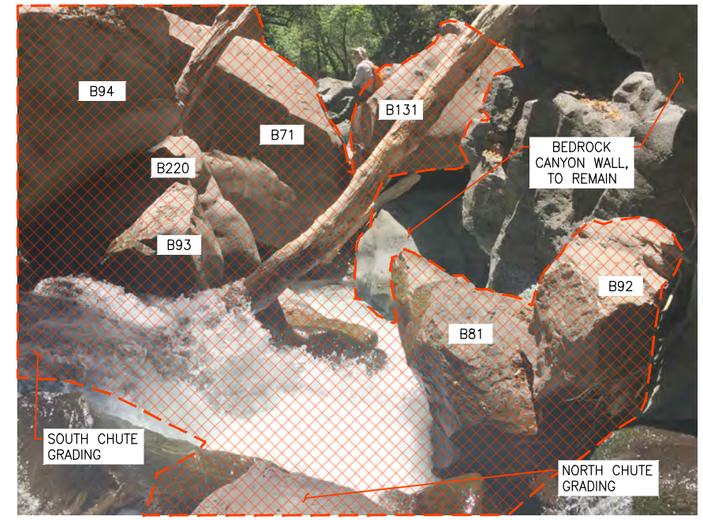
PHOTOGRAPH A

AERIAL, LOOKING UPSTREAM



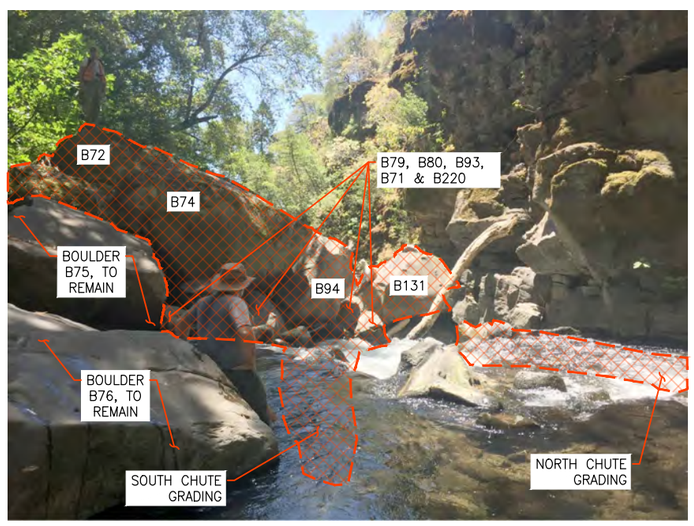
PHOTOGRAPH B

LOOKING UPSTREAM



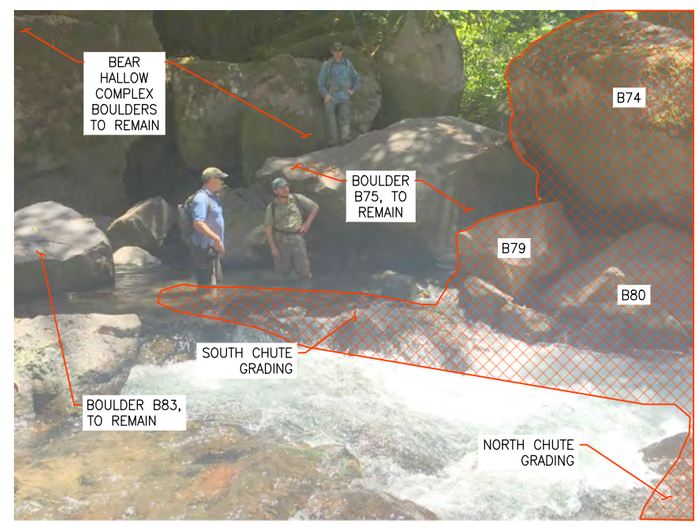
PHOTOGRAPH C

LOOKING DOWNSTREAM



PHOTOGRAPH D

LOOKING DOWNSTREAM



PHOTOGRAPH E

LOOKING TO SOUTH BANK

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VERIFY SCALE
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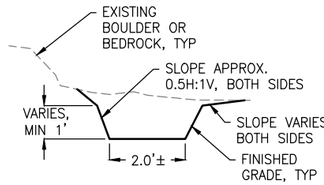
CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE
NORTH FORK BATTLE CREEK
EAGLE CANYON FISH PASSAGE IMPROVEMENT

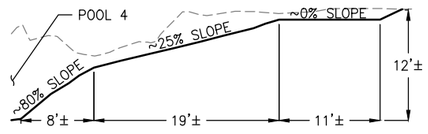
LOWER BARRIER SITE DEMO PHOTOGRAPHS

DATE	FEBRUARY 2017
SUBMITTAL	FINAL
DESIGN	ML, pTJ
DRAWN	pTJ, NN
SHEET	10 of 27

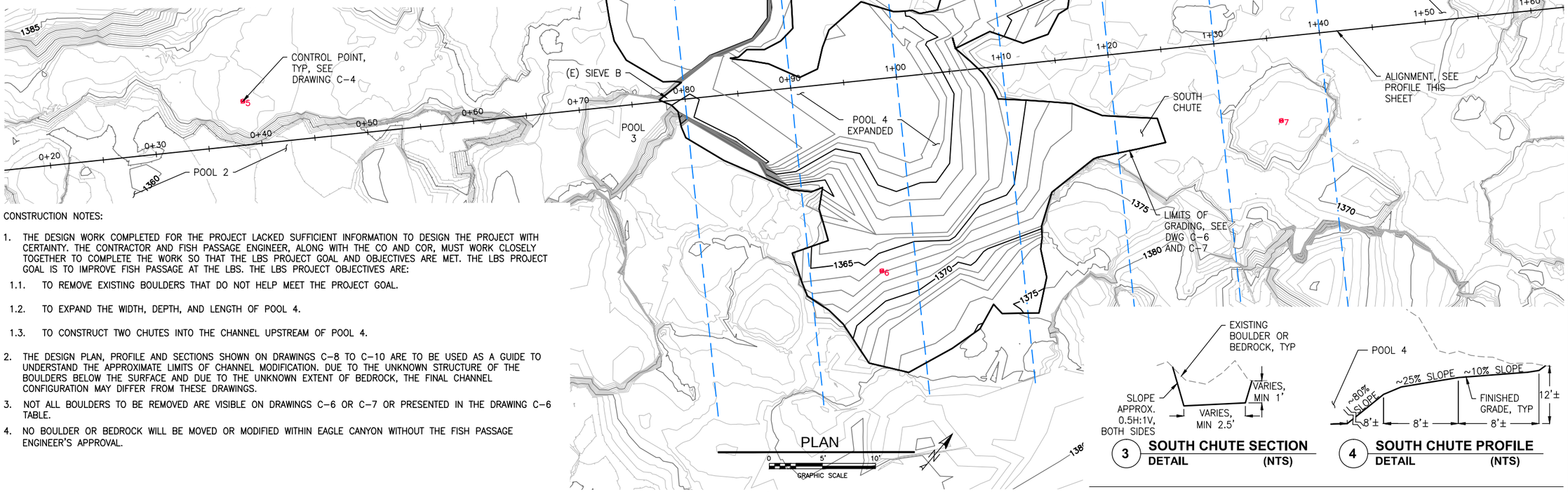
C-7



1 **NORTH CHUTE SECTION**
DETAIL (NTS)



2 **NORTH CHUTE PROFILE**
DETAIL (NTS)

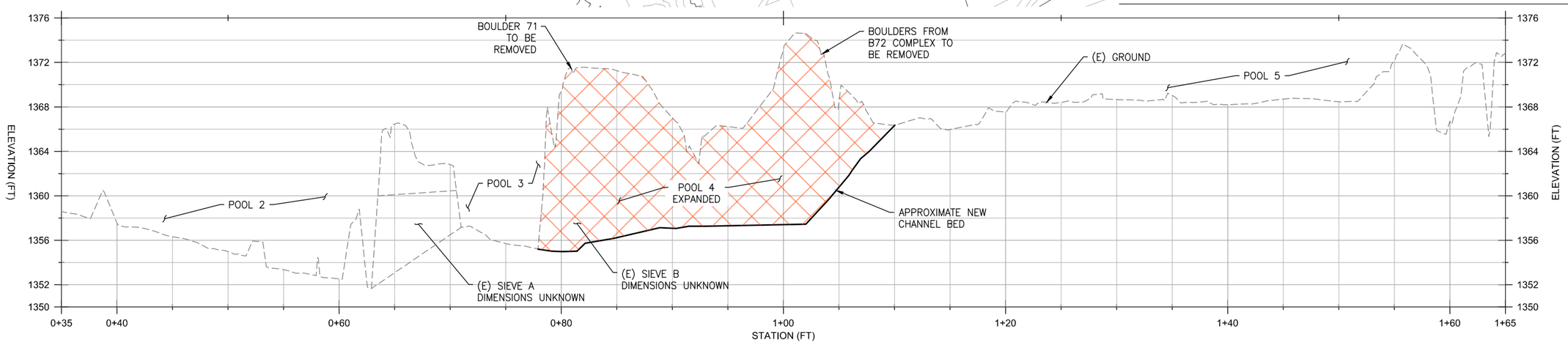


3 **SOUTH CHUTE SECTION**
DETAIL (NTS)

4 **SOUTH CHUTE PROFILE**
DETAIL (NTS)

CONSTRUCTION NOTES:

1. THE DESIGN WORK COMPLETED FOR THE PROJECT LACKED SUFFICIENT INFORMATION TO DESIGN THE PROJECT WITH CERTAINTY. THE CONTRACTOR AND FISH PASSAGE ENGINEER, ALONG WITH THE CO AND COR, MUST WORK CLOSELY TOGETHER TO COMPLETE THE WORK SO THAT THE LBS PROJECT GOAL AND OBJECTIVES ARE MET. THE LBS PROJECT GOAL IS TO IMPROVE FISH PASSAGE AT THE LBS. THE LBS PROJECT OBJECTIVES ARE:
   - 1.1. TO REMOVE EXISTING BOULDERS THAT DO NOT HELP MEET THE PROJECT GOAL.
   - 1.2. TO EXPAND THE WIDTH, DEPTH, AND LENGTH OF POOL 4.
   - 1.3. TO CONSTRUCT TWO CHUTES INTO THE CHANNEL UPSTREAM OF POOL 4.
2. THE DESIGN PLAN, PROFILE AND SECTIONS SHOWN ON DRAWINGS C-8 TO C-10 ARE TO BE USED AS A GUIDE TO UNDERSTAND THE APPROXIMATE LIMITS OF CHANNEL MODIFICATION. DUE TO THE UNKNOWN STRUCTURE OF THE BOULDERS BELOW THE SURFACE AND DUE TO THE UNKNOWN EXTENT OF BEDROCK, THE FINAL CHANNEL CONFIGURATION MAY DIFFER FROM THESE DRAWINGS.
3. NOT ALL BOULDERS TO BE REMOVED ARE VISIBLE ON DRAWINGS C-6 OR C-7 OR PRESENTED IN THE DRAWING C-6 TABLE.
4. NO BOULDER OR BEDROCK WILL BE MOVED OR MODIFIED WITHIN EAGLE CANYON WITHOUT THE FISH PASSAGE ENGINEER'S APPROVAL.



PROFILE
0 5' 10'
GRAPHIC SCALE

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VERIFY SCALE
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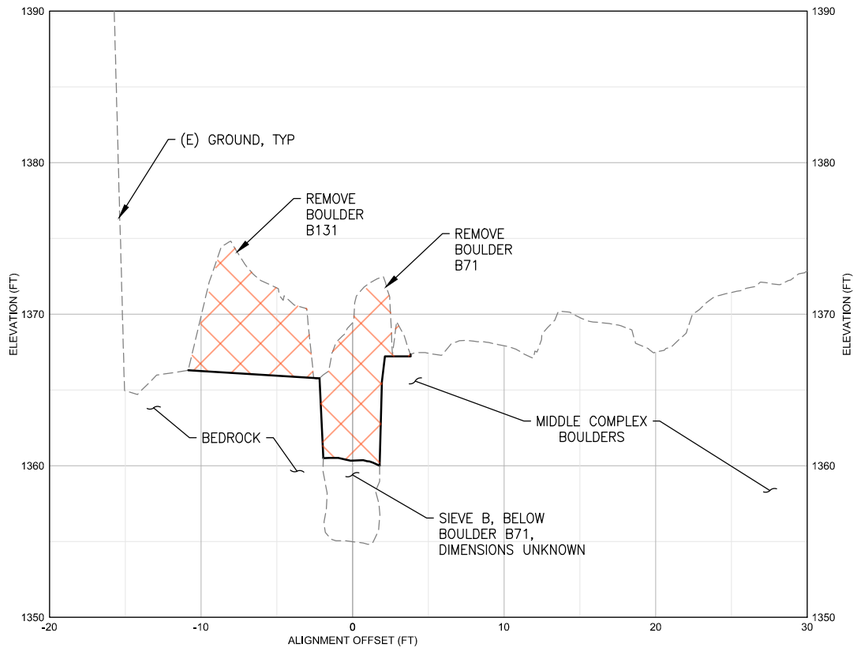
CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE
NORTH FORK BATTLE CREEK
EAGLE CANYON FISH PASSAGE IMPROVEMENT

LOWER BARRIER SITE
DESIGN PLAN, PROFILE, DETAILS, & NOTES

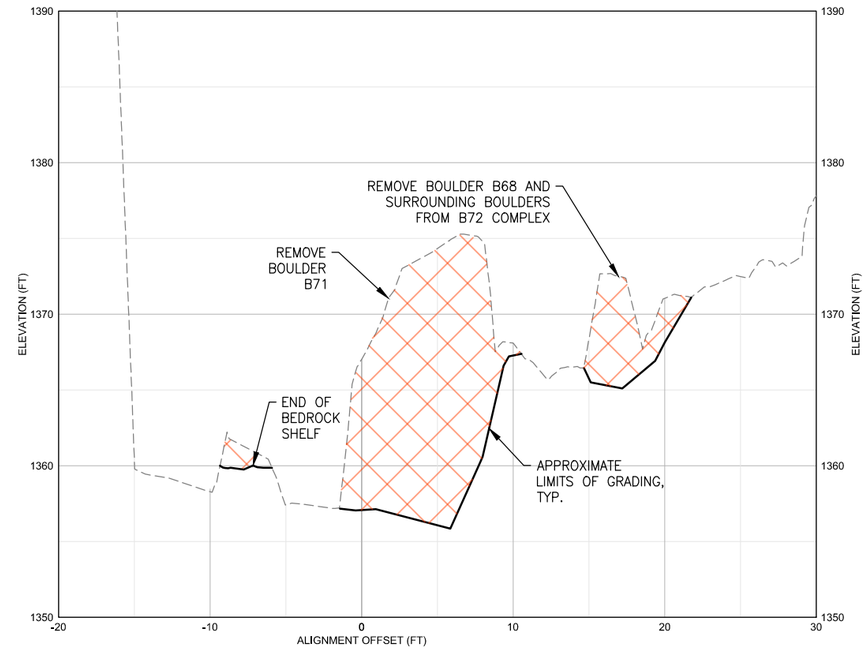
DATE	FEBRUARY 2017
SUBMITTAL	FINAL
DESIGN	ML, pTJ
DRAWN	pTJ, NN
SHEET	11 of 27

C-8



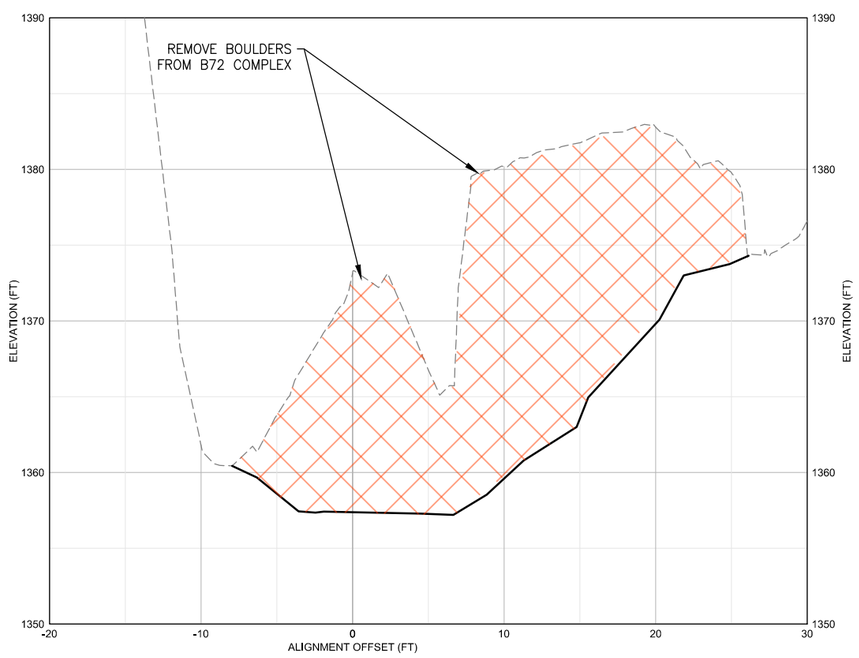
STATION 0+80 (LOOKING UPSTREAM)

0 5' 10'
GRAPHIC SCALE



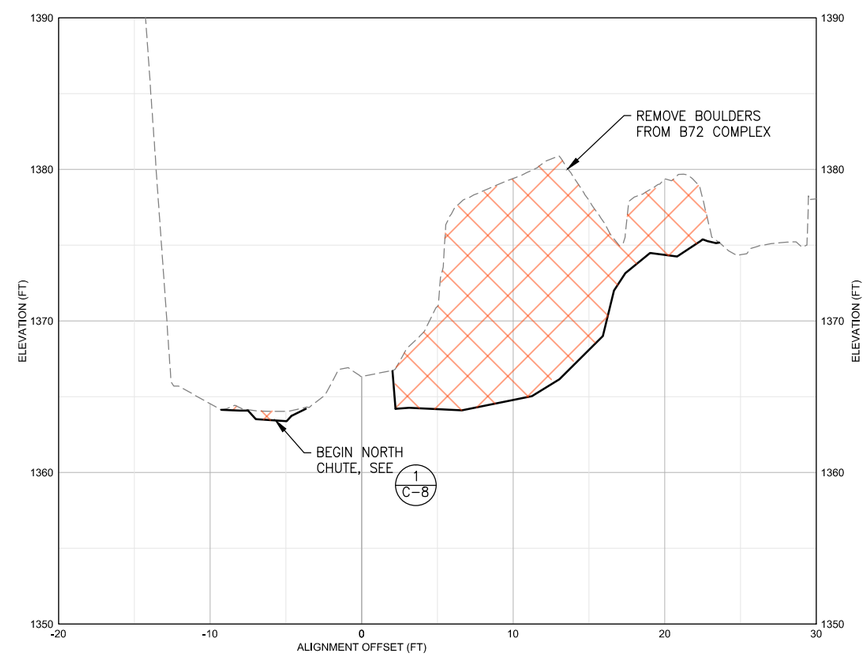
STATION 0+90 (LOOKING UPSTREAM)

0 5' 10'
GRAPHIC SCALE



STATION 1+00 (LOOKING UPSTREAM)

0 5' 10'
GRAPHIC SCALE



STATION 1+10 (LOOKING UPSTREAM)

0 5' 10'
GRAPHIC SCALE

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VERIFY SCALE
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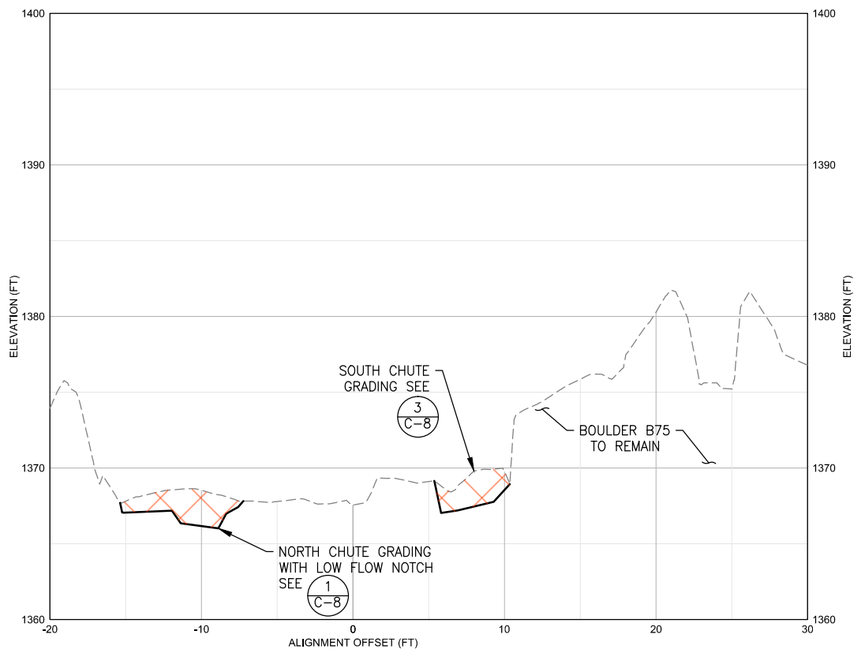
CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE
NORTH FORK BATTLE CREEK
EAGLE CANYON FISH PASSAGE IMPROVEMENT

LOWER BARRIER SITE
SECTIONS, 1 OF 2

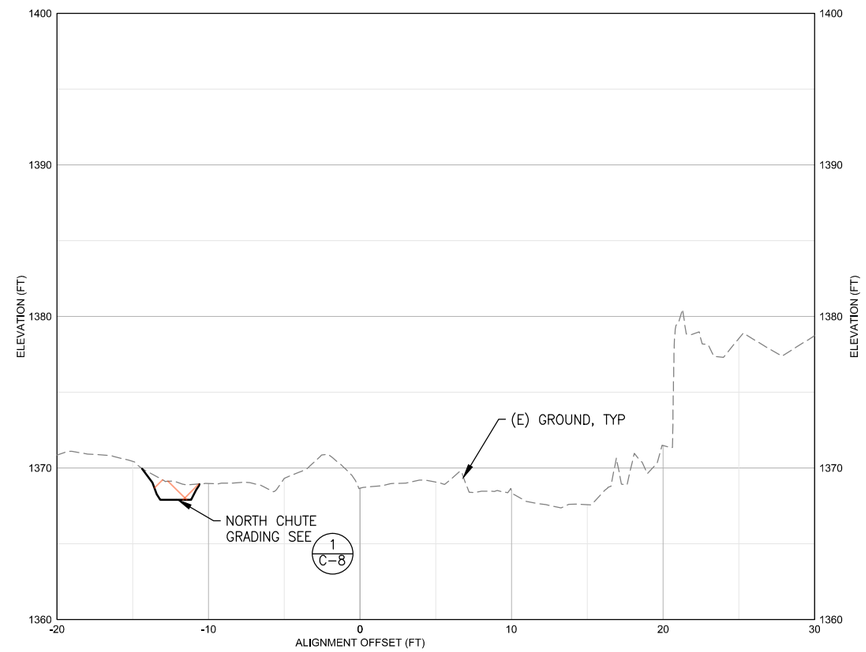
DATE	FEBRUARY 2017
SUBMITTAL	FINAL
DESIGN	ML, pTJ
DRAWN	pTJ, NN
SHEET	12 of 27

C-9



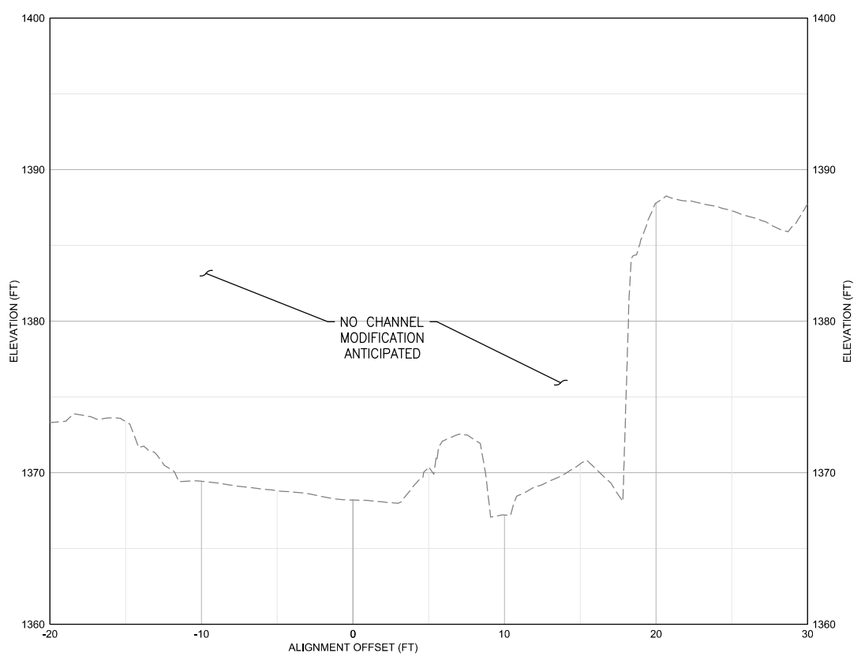
STATION 1+20 (LOOKING UPSTREAM)

0 5' 10'
GRAPHIC SCALE



STATION 1+30 (LOOKING UPSTREAM)

0 5' 10'
GRAPHIC SCALE



STATION 1+40 (LOOKING UPSTREAM)

0 5' 10'
GRAPHIC SCALE

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NORTH FORK BATTLE CREEK
EAGLE CANYON FISH PASSAGE IMPROVEMENT

LOWER BARRIER SITE
SECTIONS, 2 OF 2

DATE	FEBRUARY 2017
SUBMITTAL	FINAL
DESIGN	ML, pTJ
DRAWN	pTJ, NN
SHEET	13 of 27

C-10

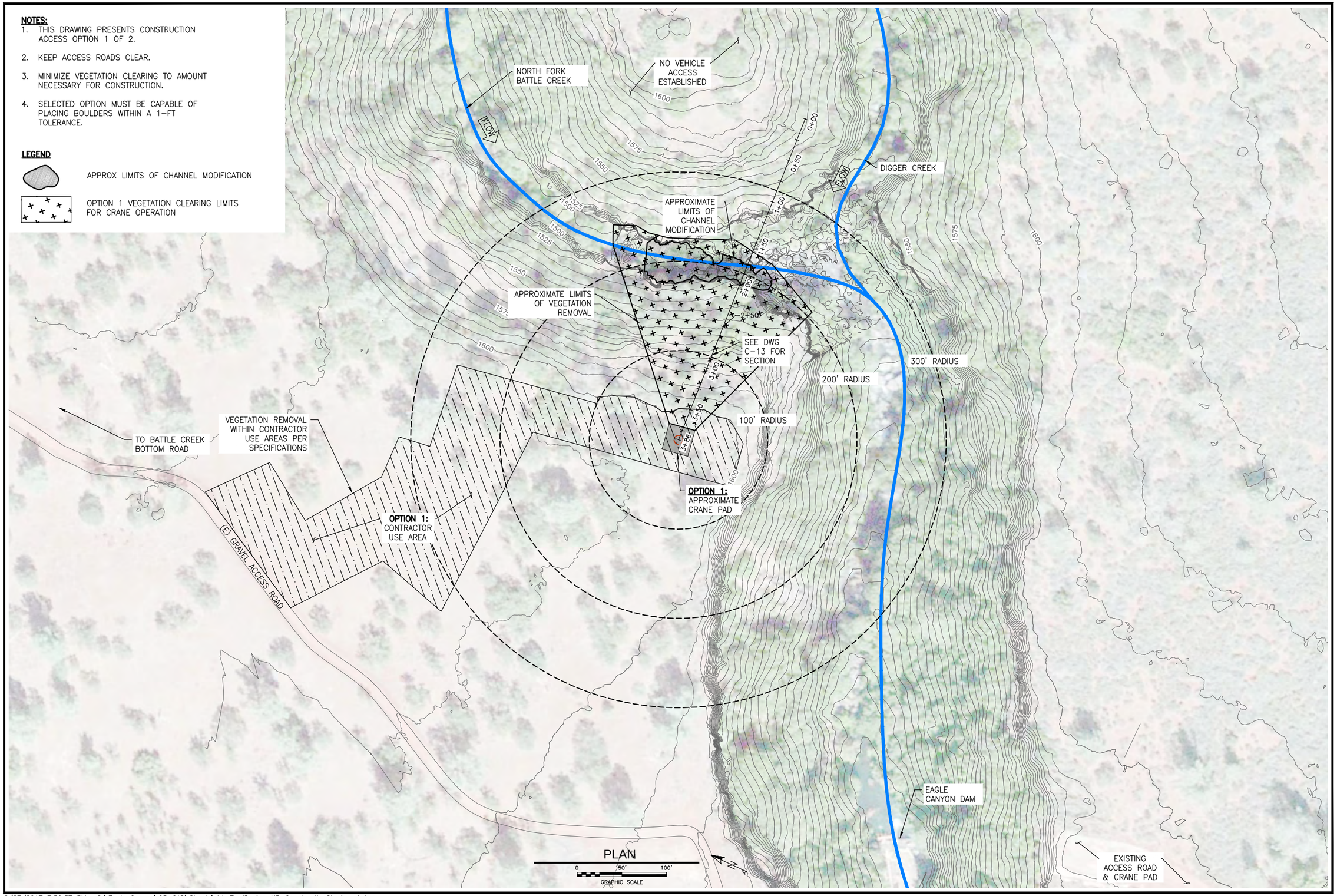
NOTES:

1. THIS DRAWING PRESENTS CONSTRUCTION ACCESS OPTION 1 OF 2.
2. KEEP ACCESS ROADS CLEAR.
3. MINIMIZE VEGETATION CLEARING TO AMOUNT NECESSARY FOR CONSTRUCTION.
4. SELECTED OPTION MUST BE CAPABLE OF PLACING BOULDERS WITHIN A 1-FT TOLERANCE.

LEGEND

APPROX LIMITS OF CHANNEL MODIFICATION

OPTION 1 VEGETATION CLEARING LIMITS FOR CRANE OPERATION



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VERIFY SCALE
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CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE
NORTH FORK BATTLE CREEK
EAGLE CANYON FISH PASSAGE IMPROVEMENT

UPPER BARRIER SITE
ACCESS & USE AREA OPTION 1 PLAN

DATE	FEBRUARY 2017
SUBMITTAL	FINAL
DESIGN	ML, pTJ
DRAWN	pTJ, NN
SHEET	14 of 27

C-11

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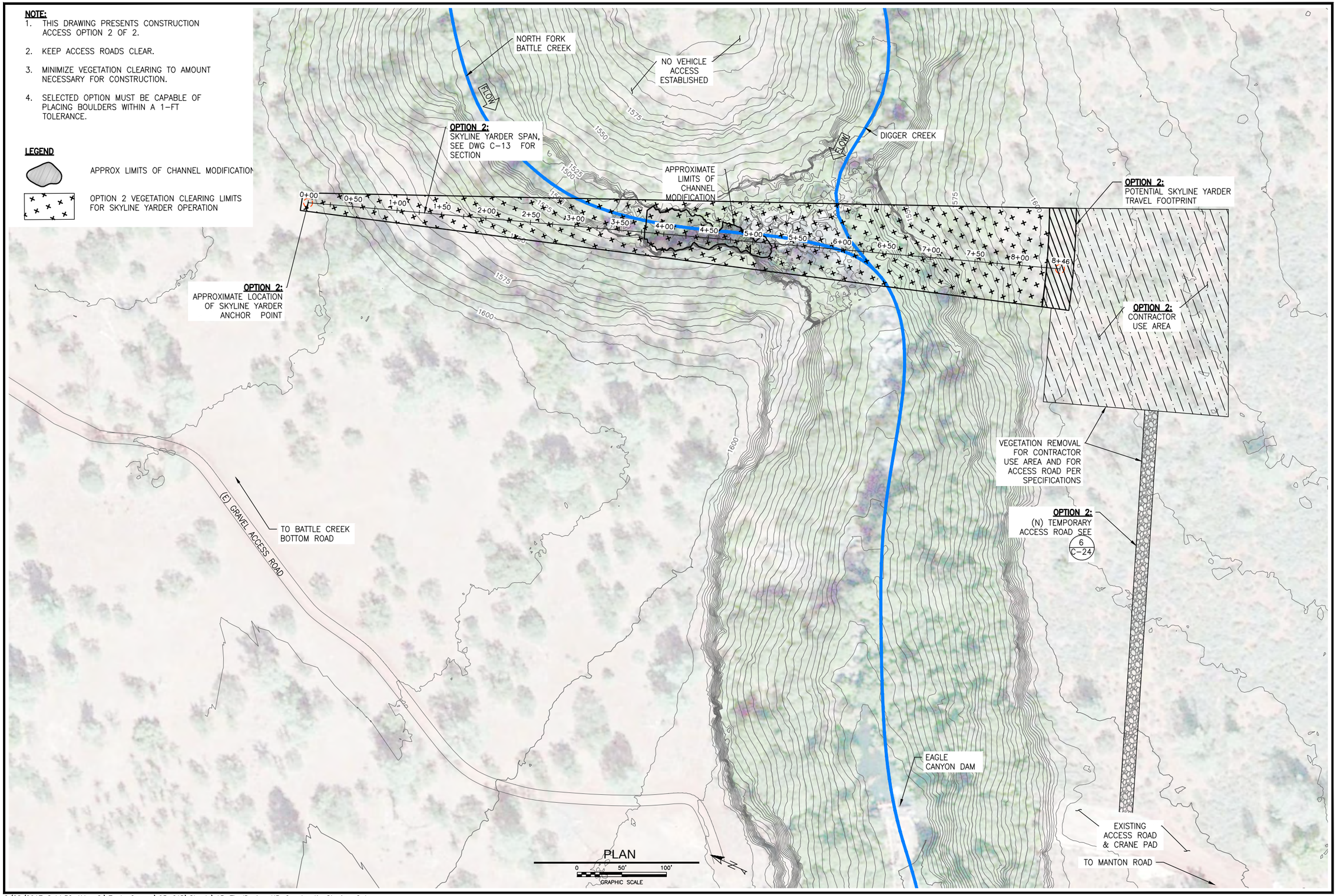
NOTE:

1. THIS DRAWING PRESENTS CONSTRUCTION ACCESS OPTION 2 OF 2.
2. KEEP ACCESS ROADS CLEAR.
3. MINIMIZE VEGETATION CLEARING TO AMOUNT NECESSARY FOR CONSTRUCTION.
4. SELECTED OPTION MUST BE CAPABLE OF PLACING BOULDERS WITHIN A 1-FT TOLERANCE.

LEGEND

APPROX LIMITS OF CHANNEL MODIFICATION

OPTION 2 VEGETATION CLEARING LIMITS FOR SKYLINE YARDER OPERATION



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EAGLE CANYON FISH PASSAGE IMPROVEMENT

UPPER BARRIER SITE
ACCESS & USE AREA OPTION 2 PLAN

DATE	FEBRUARY 2017
SUBMITTAL	FINAL
DESIGN	ML, pTJ
DRAWN	pTJ, NN
SHEET	15 of 27

C-12

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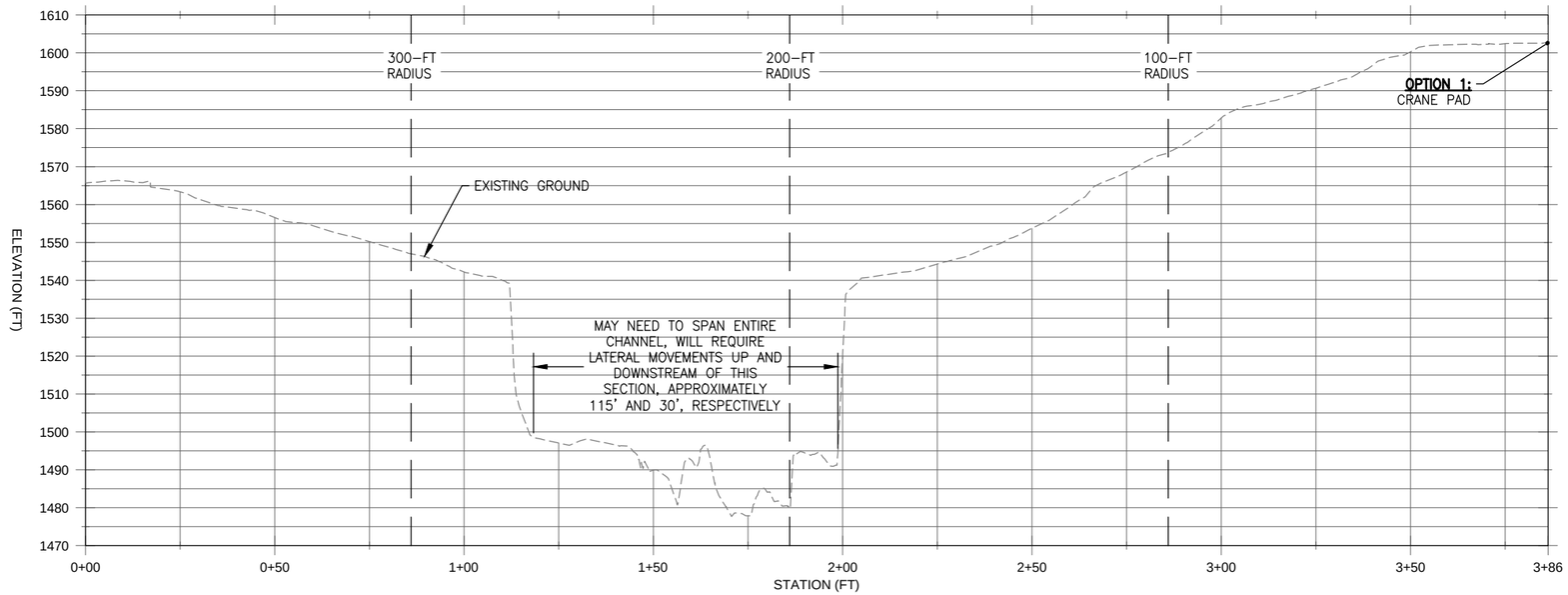
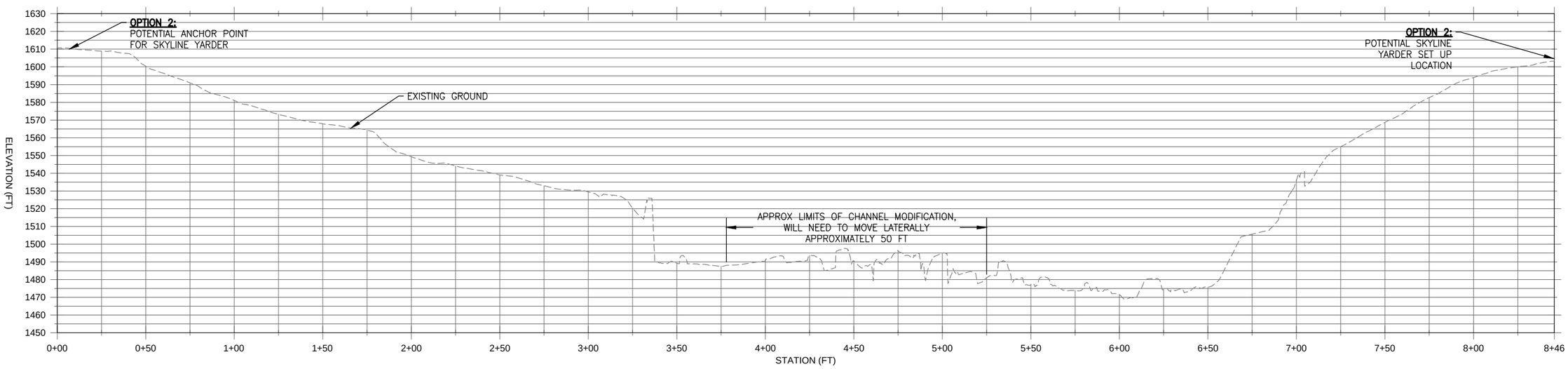


OPTION 1 SECTION

SEE DRAWING C-11 FOR ALIGNMENT

0 20' 40'
GRAPHIC SCALE



OPTION 2 SECTION

SEE DRAWING C-12 FOR ALIGNMENT

0 30' 60'
GRAPHIC SCALE

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VERIFY SCALE
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CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE
NORTH FORK BATTLE CREEK
EAGLE CANYON FISH PASSAGE IMPROVEMENT

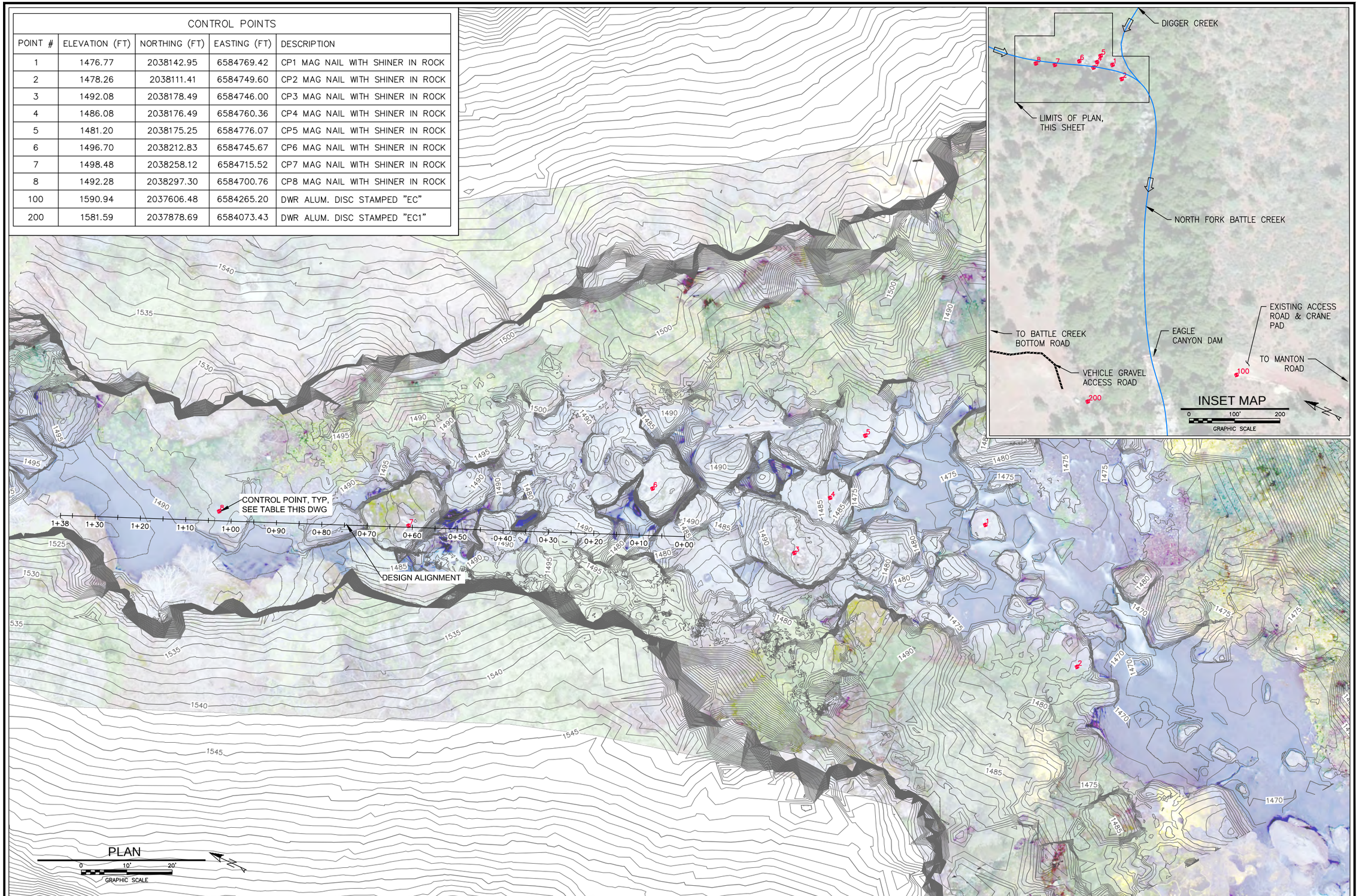
UPPER BARRIER SITE

ACCESS & USE AREA OPTIONS 1 & 2 SECTIONS

DATE	FEBRUARY 2017
SUBMITTAL	FINAL
DESIGN	ML, pTJ
DRAWN	pTJ, NN
SHEET	16 of 27

C-13

CONTROL POINTS				
POINT #	ELEVATION (FT)	NORTHING (FT)	EASTING (FT)	DESCRIPTION
1	1476.77	2038142.95	6584769.42	CP1 MAG NAIL WITH SHINER IN ROCK
2	1478.26	2038111.41	6584749.60	CP2 MAG NAIL WITH SHINER IN ROCK
3	1492.08	2038178.49	6584746.00	CP3 MAG NAIL WITH SHINER IN ROCK
4	1486.08	2038176.49	6584760.36	CP4 MAG NAIL WITH SHINER IN ROCK
5	1481.20	2038175.25	6584776.07	CP5 MAG NAIL WITH SHINER IN ROCK
6	1496.70	2038212.83	6584745.67	CP6 MAG NAIL WITH SHINER IN ROCK
7	1498.48	2038258.12	6584715.52	CP7 MAG NAIL WITH SHINER IN ROCK
8	1492.28	2038297.30	6584700.76	CP8 MAG NAIL WITH SHINER IN ROCK
100	1590.94	2037606.48	6584265.20	DWR ALUM. DISC STAMPED "EC"
200	1581.59	2037878.69	6584073.43	DWR ALUM. DISC STAMPED "EC1"



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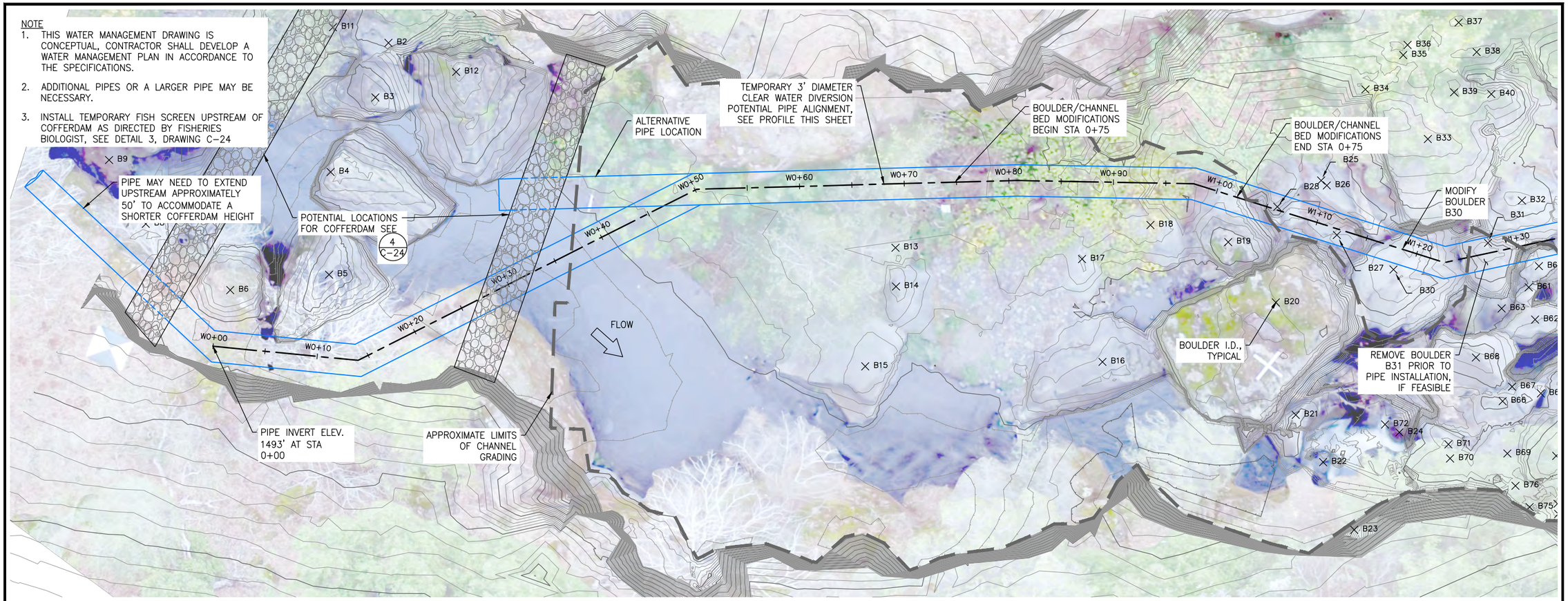
CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE
NORTH FORK BATTLE CREEK
EAGLE CANYON FISH PASSAGE IMPROVEMENT

UPPER BARRIER SITE
HORIZONTAL AND VERTICAL CONTROL

DATE	FEBRUARY 2017
SUBMITTAL	FINAL
DESIGN	ML, pTJ
DRAWN	pTJ, NN
SHEET	17 of 27

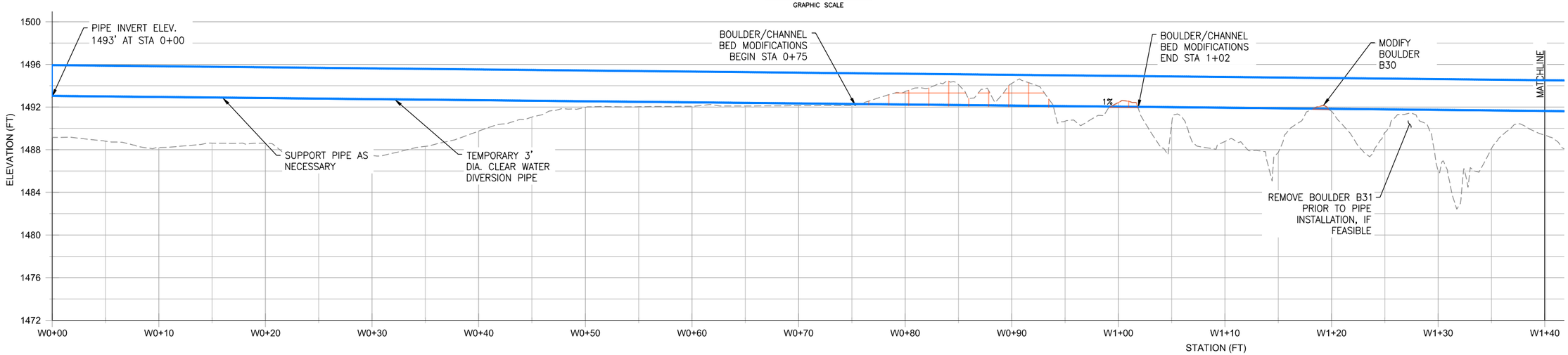
C-14

NOTE
1. THIS WATER MANAGEMENT DRAWING IS CONCEPTUAL, CONTRACTOR SHALL DEVELOP A WATER MANAGEMENT PLAN IN ACCORDANCE TO THE SPECIFICATIONS.
2. ADDITIONAL PIPES OR A LARGER PIPE MAY BE NECESSARY.
3. INSTALL TEMPORARY FISH SCREEN UPSTREAM OF COFFERDAM AS DIRECTED BY FISHERIES BIOLOGIST, SEE DETAIL 3, DRAWING C-24



CONCEPTUAL TEMPORARY PIPE PLAN

0 5' 10'
GRAPHIC SCALE



CONCEPTUAL TEMPORARY PIPE PROFILE

0 5' 10'
GRAPHIC SCALE

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VERIFY SCALE
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CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE
NORTH FORK BATTLE CREEK
EAGLE CANYON FISH PASSAGE IMPROVEMENT

UPPER BARRIER SITE
WATER MANAGEMENT, 1 OF 2

DATE	FEBRUARY 2017
SUBMITTAL	FINAL
DESIGN	ML, pTJ
DRAWN	pTJ, NN
SHEET	18 of 27

C-15

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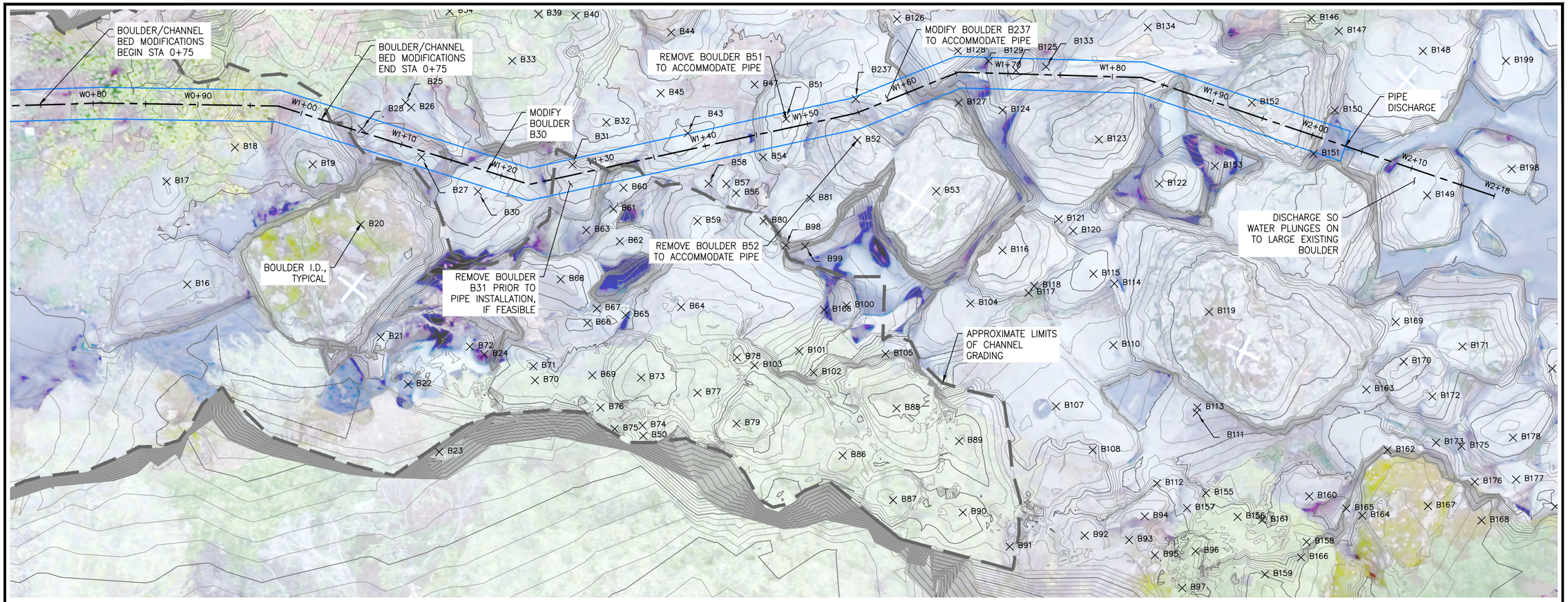
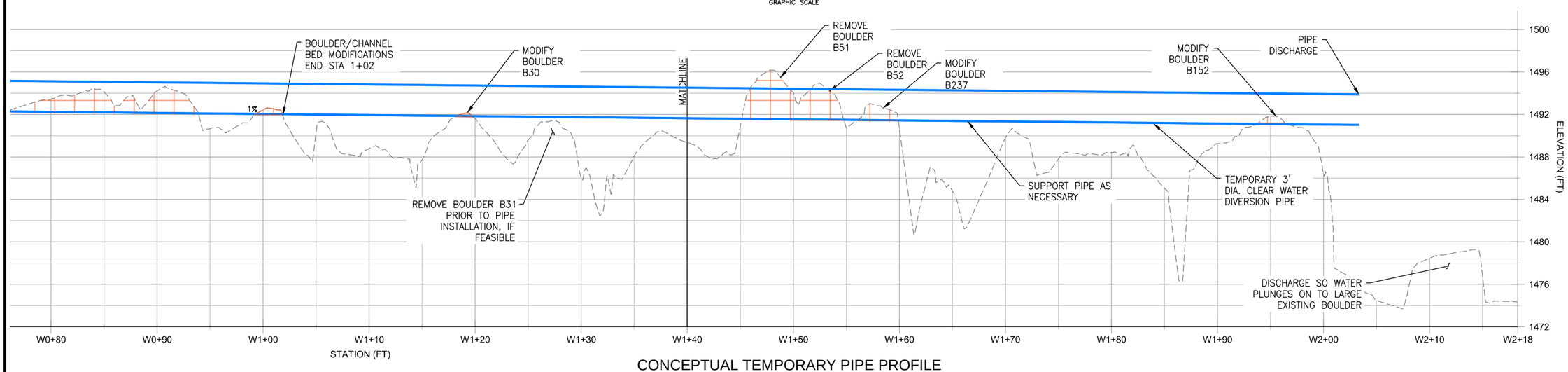


CONCEPTUAL TEMPORARY PIPE PLAN

0 5' 10'
GRAPHIC SCALE



CONCEPTUAL TEMPORARY PIPE PROFILE

0 5' 10'
GRAPHIC SCALE

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Sacramento, CA 95814
http://www.dfg.ca.gov

REGISTERED PROFESSIONAL ENGINEER
MICHAEL A. LOVE
No.71681
CIVIL
STATE OF CALIFORNIA

VERIFY SCALE
THIS BAR IS ONE INCH LONG AT FULL SCALE

CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE
NORTH FORK BATTLE CREEK
EAGLE CANYON FISH PASSAGE IMPROVEMENT

UPPER BARRIER SITE
WATER MANAGEMENT, 2 OF 2

Date	FEBRUARY 2017
Submittal	FINAL
Design	ML, pTJ
Drawn	pTJ, NN
Sheet	19 of 27

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Complex	Boulder	Axis Dimensions (ft)[4] a	b	c	Volume (CY)[5]	Weight (Ton)[5]
B20 Complex	B18[1]	13.6	7.0	8.0	22.1	50.3
	B17[1]	3.4	3.0	3.0	1.1	2.6
	B18[1]	4.2	4.0	4.0	2.5	5.7
	B19	6.2	5.9	3.7	5.0	11.4
	B20	15.9	11.0	9.1	51.4	117.1
Pool 7 Complex	B21[1,2]	6.7	5.5	3.7	5.0	11.5
	B22[1,2]	5.5	4.3	4.1	1.9	4.4
	B24[1]	2.8	2.5	2.3	0.4	1.0
	B72[1]	5.4	5.2	2.3	2.4	5.4
	B61	2.1	2.0	1.0	0.1	0.2
	B62	3.0	3.9	3.5	1.5	3.4
	B64	14.4	8.8	5.4	25.3	57.7
	B65	3.0	2.7	2.7	0.4	0.9
	B66[1]	6.0	2.6	2.3	1.7	3.8
	B67[1]	6.0	4.3	2.4	2.3	5.2
	B68	9.0	6.0	7.0	14.0	31.9
	B69	5.7	3.2	2.4	1.6	3.7
	B70	5.2	4.2	2.1	1.7	3.9
	B71	4.1	3.6	2.0	1.1	2.5
	B73	5.6	4.9	3.8	3.9	8.8
	B74	2.0	1.5	1.0	0.1	0.3
	B75	2.0	1.5	0.8	0.1	0.2
	B76	2.1	2.1	1.9	0.3	0.7
	B80	4.3	3.2	2.4	1.2	2.8
Toe Complex	B77	6.6	5.6	5.0	6.8	15.6
	B78	6.2	2.5	2.5	1.4	3.3
	B79	12.0	8.3	6.0	11.1	25.2
	B86	3.7	3.2	2.1	0.5	1.2
	B87	5.5	4.3	3.8	3.3	7.6
	B88	11.2	7.9	7.1	23.3	53.0
	B89	8.0	6.8	4.8	9.7	22.0
	B90	7.0	3.4	2.5	2.2	5.0
	B101[1]	?	?	?	2.0	4.6
	B102[1]	7.0	4.0	2.3	2.4	5.4
	B103[1]	7.4	6.0	5.0	8.2	18.7

Complex	Boulder	Axis Dimensions (ft)[4] a	b	c	Volume (CY)[5]	Weight (Ton)[5]
Pool 6 Complex	B100[1]	4.0	3.0	3.0	1.3	3.0
	B105	5.5	5.2	4.1	2.6	5.9
Upper Complex	B51	6.1	3.8	5.1	4.4	10.0
	B52	5.7	5.6	5.3	3.3	7.5
	B56[1]	2.4	1.8	1.6	0.3	0.6
	B57[1]	2.0	2.1	2.0	0.3	0.7
	B58[1]	2.0	2.1	2.0	0.3	0.7
	B81[1]	10.0	7.0	5.8	15.0	34.2
Upstream Complex Grading	NA	NA	NA	NA	453	1031
Unseen[3]	NA	NA	NA	NA	18	40
Estimated volume of rock to be removed or modified: 716 cubic yards, 1630 tons						

1. Some of boulder dimensions are not visible (e.g. behind other boulders, under water) and are estimated
2. May be bedrock
3. Some boulders to be removed/moved/modified are located below the visible boulders, primarily beneath the Toe Complex boulders. The volume of this rock is not known and for estimating purposes is assumed to be 75% of the Toe Complex boulder subtotal
4. See Detail 2 on Drawing C-24. All dimensions are approximate & should be verified by the Contractor
5. Volume calculated by various means (e.g. rectangular cuboid, sphere, etc.); therefore additional dimensions may have been utilized than are shown. Axis dimensions are shown are for informational purposes (e.g. to understand general shape and size of the boulder)
6. Weight based on assumed rock density of 2.3 tons/CY

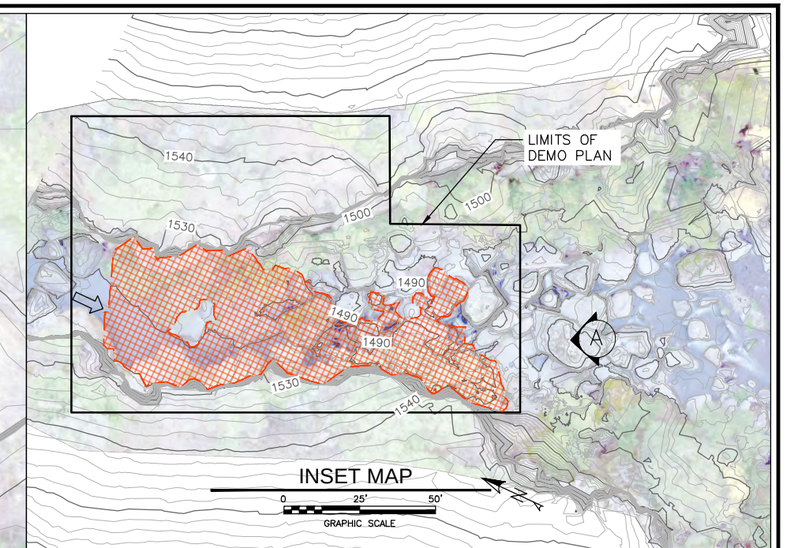
LEGEND

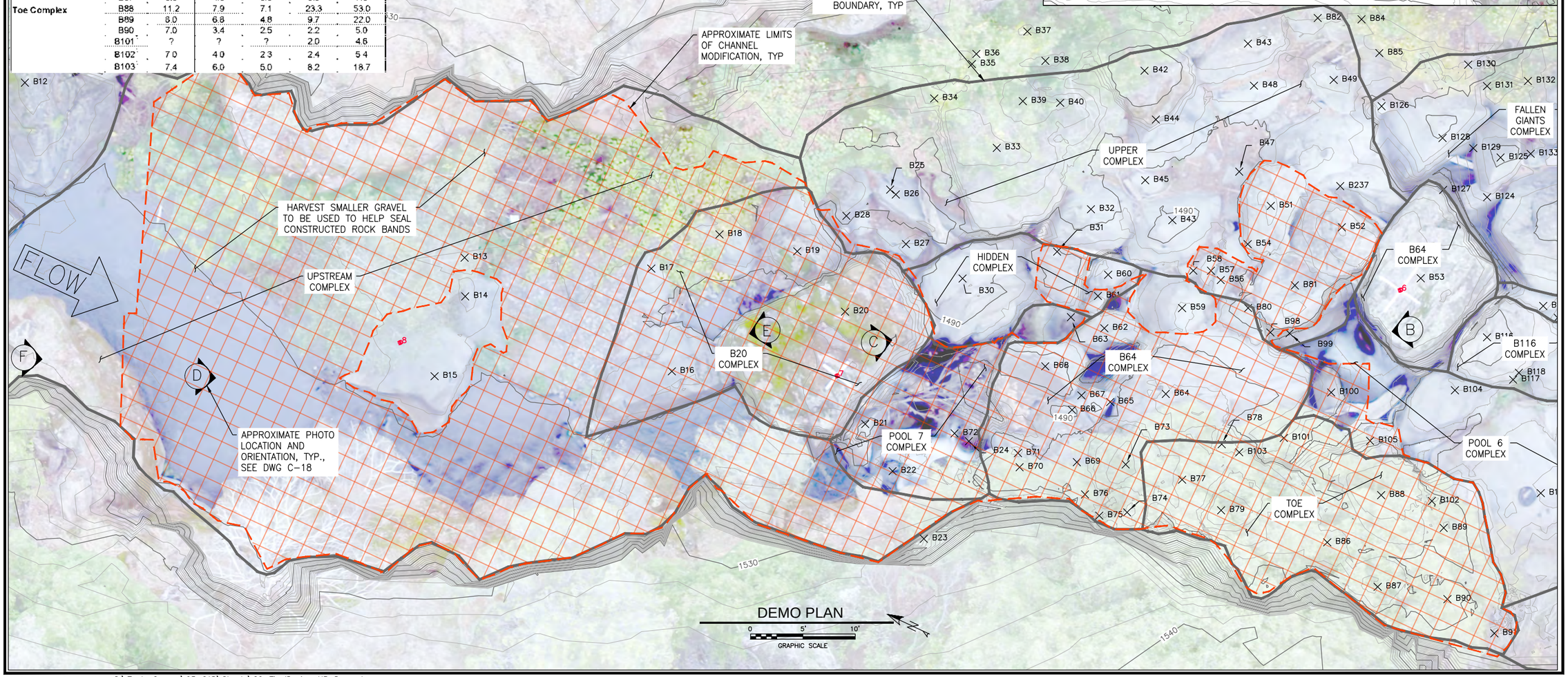
ROCK TO BE REMOVED OR MODIFIED

BOULDER COMPLEX (COMPRISED OF ONE OR MORE BOULDERS)

NOTE:

1. THE LIMITS OF CHANNEL MODIFICATION ARE APPROXIMATE AND TO BE USED AS A GENERAL GUIDE.
2. SEE CONSTRUCTION NOTES ON DWG C-20





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CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE
NORTH FORK BATTLE CREEK
EAGLE CANYON FISH PASSAGE IMPROVEMENT

UPPER BARRIER SITE DEMO PLAN

Date	FEBRUARY 2017
Submittal	FINAL
Design	ML, pTJ
Drawn	pTJ, NN
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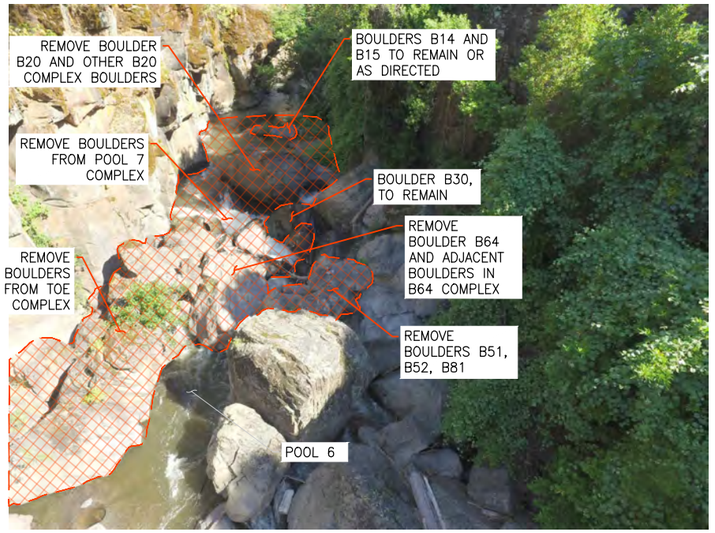
NOTE:
1. THE LIMITS OF CHANNEL MODIFICATION ARE APPROIXMATE AND TO BE USED AS A GENERAL GUIDE.
2. SEE DRAWING C–17 FOR LOCATION AND ORIENTATION OF PHOTOGRAPH.
3. SEE NOTES ON DWG C–21

LEGEND

APPROXIMATE LIMITS OF CHANNEL MODIFICATION



PHOTOGRAPH A

LOOKING UPSTREAM

PHOTOGRAPH B

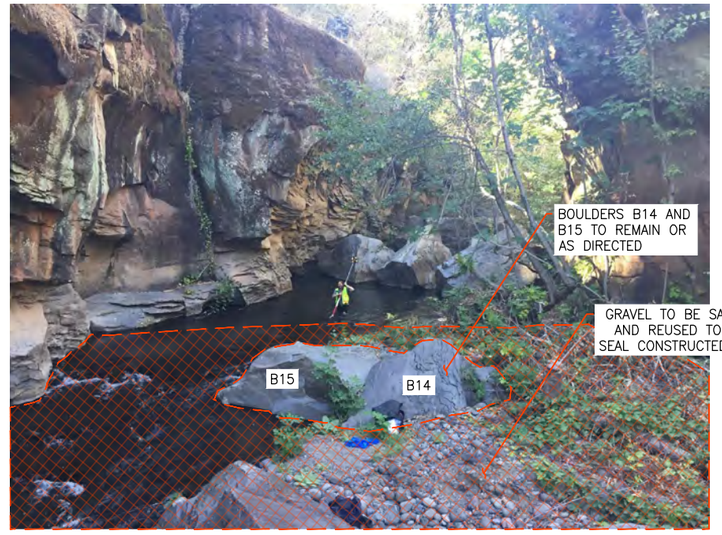
LOOKING UPSTREAM

PHOTOGRAPH C

LOOKING DOWNSTREAM

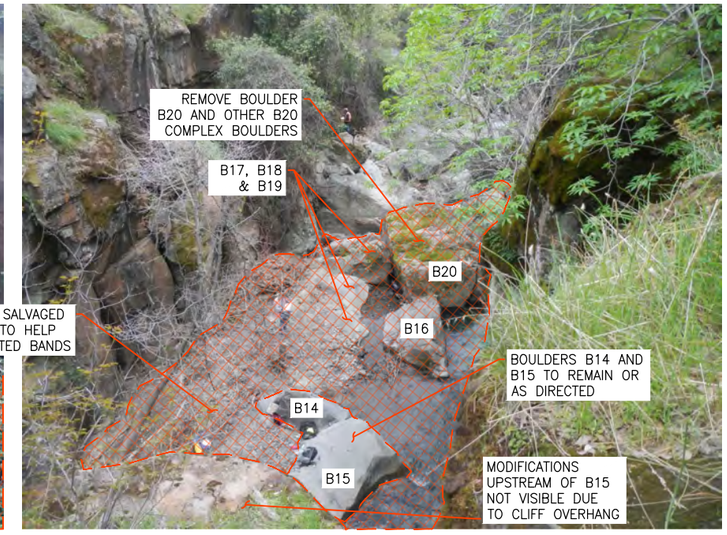
PHOTOGRAPH D

LOOKING DOWNSTREAM



PHOTOGRAPH E

LOOKING UPSTREAM



PHOTOGRAPH F

LOOKING DOWNSTREAM

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EAGLE CANYON FISH PASSAGE IMPROVEMENT

UPPER BARRIER SITE DEMO PHOTOGRAPHS

DATE	FEBRUARY 2017
SUBMITTAL	FINAL
DESIGN	ML, pTJ
DRAWN	pTJ, NN
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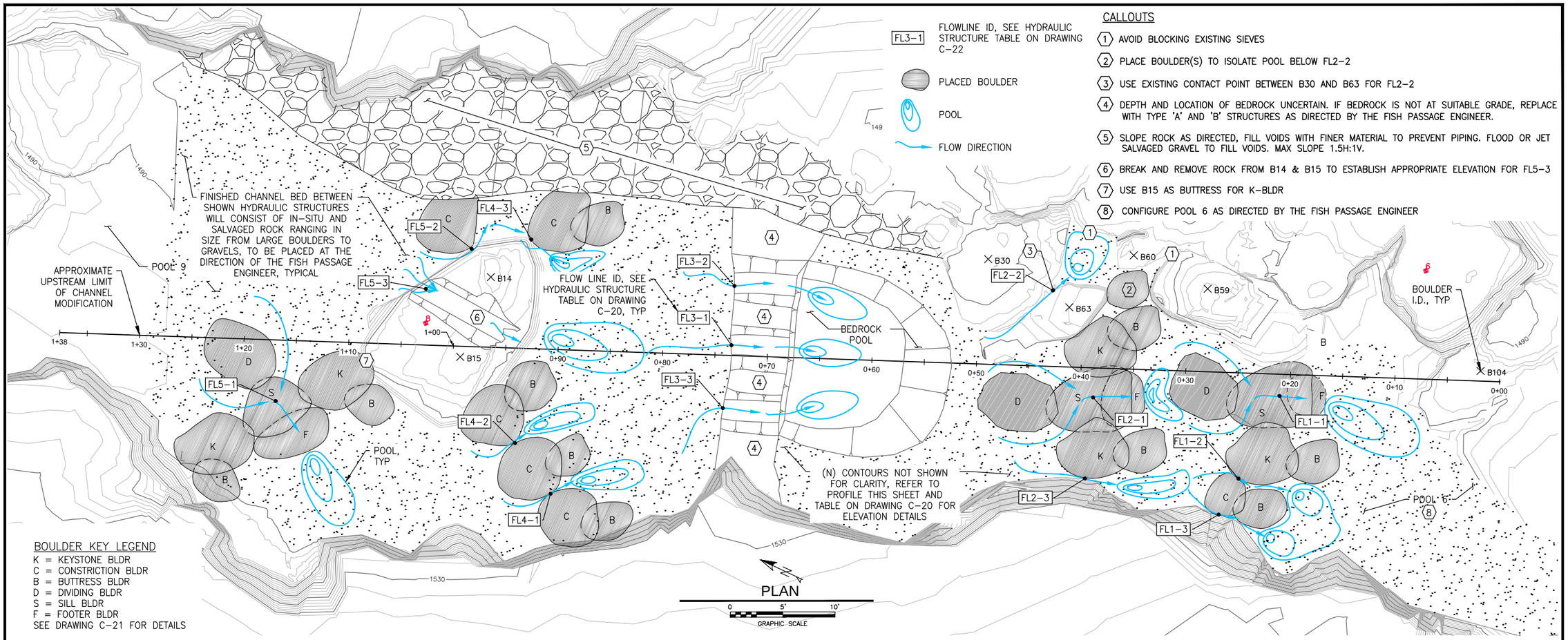

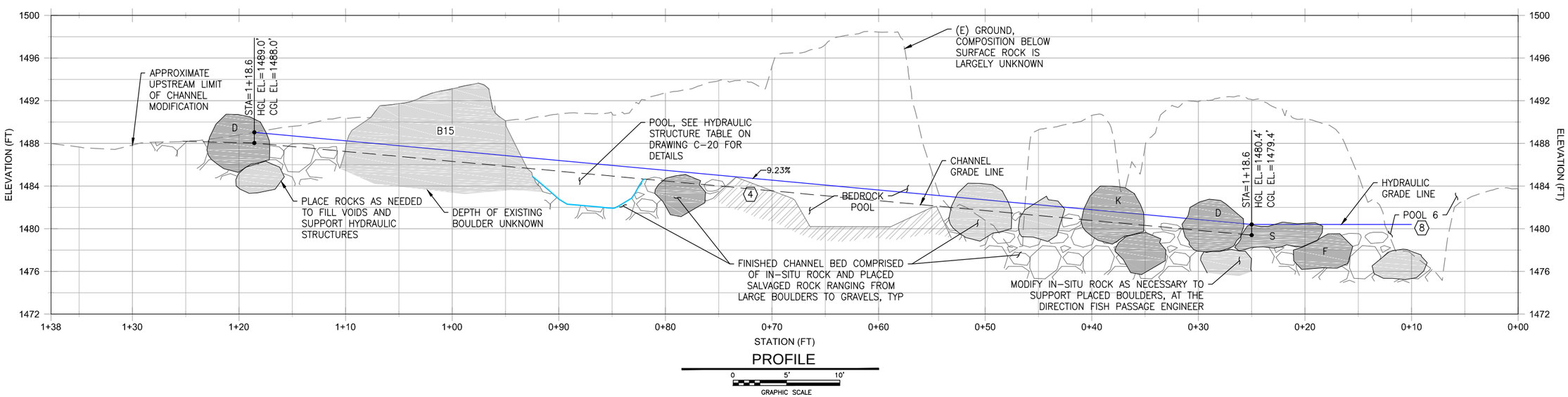

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EAGLE CANYON FISH PASSAGE IMPROVEMENT

UPPER BARRIER SITE
CONCEPTUAL CHANNEL DESIGN PLAN & PROFILE

DATE	FEBRUARY 2017
SUBMITTAL	FINAL
DESIGN	ML, pTJ
DRAWN	pTJ, NN
SHEET	22 of 27

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CONSTRUCTION NOTES:

1. REFER TO SPECIFICATION 31 05 16.
2. THE DESIGN WORK COMPLETED FOR THE PROJECT, ALTHOUGH THOROUGH, LACKED SUFFICIENT INFORMATION TO DESIGN THE PROJECT WITH CERTAINTY. THE CONTRACTOR AND FISH PASSAGE ENGINEER, ALONG WITH THE CO AND COR, MUST WORK CLOSELY TOGETHER TO COMPLETE THE WORK SO THAT THE UBS PROJECT GOAL AND OBJECTIVES ARE MET. THE UBS PROJECT GOAL IS TO IMPROVE FISH PASSAGE AT THE UBS. THE UBS PROJECT OBJECTIVES ARE:

2.1. TO REMOVE EXISTING BOULDERS TO SUPPORT CHANNEL RECONSTRUCTION.

2.2. TO RECONSTRUCT THE CHANNEL USING EXISTING MATERIAL TO CREATE MULTIPLE DROPS OVER BOULDERS AND BEDROCK WITH ADEQUATE POOLS BELOW EACH DROP.

2.3. TO CONSTRUCT EACH HYDRAULIC STRUCTURE PER THE DESIGN ELEVATIONS WITHIN THE ALLOWED TOLERANCES.

2.4. TO CONSTRUCT EACH HYDRAULIC STRUCTURE SO THAT EACH BOULDER PLACED RESTS AGAINST ADJACENT BOULDERS OR BEDROCK TO COUNTERACT GRAVITATIONAL AND HYDRAULIC FORCES.

3. THE CONCEPTUAL DESIGN DRAWING (DRAWING C–19) IS TO BE USED AS A GUIDE TO AID IN THE CONSTRUCTION OF THE CHANNEL. DUE TO THE UNKNOWN STRUCTURE OF THE BOULDERS AND BEDROCK BELOW THE SURFACE AND DUE TO THE UNKNOWN SHAPE AND SIZE OF THE EXISTING BOULDERS AFTER THEY HAVE BEEN MODIFIED, THE FINISHED CHANNEL MAY DIFFER FROM THE CONCEPTUAL DRAWING.
4. NOT ALL BOULDERS TO BE REMOVED, MOVED, OR MODIFIED ARE VISIBLE ON DRAWINGS C–17 OR C–18 OR PRESENTED IN THE DRAWING C–17 TABLE.
5. NO BOULDER OR BEDROCK WILL BE MOVED OR MODIFIED WITHIN EAGLE CANYON WITHOUT THE FISH PASSAGE ENGINEER'S APPROVAL.
6. THE CONTRACTOR SHALL AVOID DISTURBING THE EXISTING CHANNEL BELOW THE CHANNEL GRADE LINE. USE EXISTING IN–SITU BOULDERS AND OTHER ROCK FOR THE FINISHED CHANNEL AS MUCH AS PRACTICAL.
7. WHERE OVER EXCAVATION OCCURS THE CONTRACTOR MUST, AFTER PLACING LARGER ROCK, MUST FILL VOIDS AND SEAL THE FINISHED CHANNEL TO PREVENT WATER FROM GOING SUBSURFACE.
8. BOULDERS MAY REQUIRE MODIFICATION TO MOVE. MODIFICATION WILL BE CONDUCTED SO THAT THE RESULTING BOULDER FRAGMENTS REMAIN AS LARGE AS POSSIBLE WHILE STILL ALLOWING THE FRAGMENT TO BE MOVED AS NECESSARY, UNLESS OTHERWISE APPROVED BY THE FISH PASSAGE ENGINEER.
9. ALTHOUGH BEDROCK IS SHOWN ON DRAWING C–19, BEDROCK MAY NOT BE ENCOUNTERED.
10. THE CONTRACTOR MAY NEED TO MOVE BOULDERS TO A TEMPORARY STAGING LOCATION WHILE PREPARING THE SUBGRADE FOR THE FINAL BOULDER PLACEMENT IN THE CONSTRUCTED CHANNEL.
11. COLLECT AND STOCKPILE GRAVELS AND OTHER SMALLER ROCKS FOR USE IN RECONSTRUCTING THE CHANNEL.
12. SEPERATE STOCKPILED ROCK MATERIAL BY SIZE, THE EXTENT PRACTICAL.
13. EACH BOULDER WITHIN A HYDRAULIC STRUCTURE WILL BE IN CONTACT WITH ADJACENT BOULDERS WITH AT LEAST THREE (3) POINTS OF CONTACT.
14. EACH BOULDER WITHIN A HYDRAULIC STRUCTURE WILL BE PLACED SO THAT IT IS STABLE AND RESISTANT TO FORCES ACTING ON IT IN A DOWNSTREAM DIRECTION.
15. EACH HYDRAULIC STRUCTURE MUST BE BACKFILLED WITH NATIVE MATERIALS TO FILL VOIDS AND HYDRAULICALLY SEAL THE STRUCTURE, SO THAT WATER POOLS UPSTREAM OF THE STRUCTURE. THE FISH PASSAGE ENGINEER WILL REQUIRE THE CONTRACTOR TO SHOW THAT THE STRUCTURE IS SEALED BY ADDING WATER.
16. EACH HYDRAULIC STRUCTURE WILL BE CONSTRUCTED, WITHIN THE PERMITTED TOLERANCES, TO THE RELATIVE ELEVATIONS SHOWN IN THE HYDRAULIC STRUCTURE LAYOUT TABLE, THIS SHEET.
17. AVOID DISTURBING A HYDRAULIC STRUCTURE ONCE IT HAS BEEN INSTALLED.
18. THE FISH PASSAGE ENGINEER RESERVES THE RIGHT TO MODIFY THE HYDRAULIC STRUCTURE TABLE AT ANY TIME.
19. THE CONTRACTOR NEEDS TO PROVIDE MEANS TO ACCURATELY PLACE BOULDERS AT ANY LOCATION WITHIN THE PROJECT'S CHANNEL MODIFICATION AREA.
20. THE CONTRACTOR NEEDS TO PROVIDE MEANS TO ROTATE A BOULDER WHILE SUSPENDED SO A BOULDER MAY BE PLACED IN AN APPROPRIATE ORIENTATION.
21. POOLS SHALL BE CONSTRUCTED INTO THE CHANNEL BED DOWNSTREAM OF EACH FLOW LINE.
22. ADDITIONAL POOLS MAY BE CREATED BASED ON FIELD CONDITIONS.
23. THE CONTRACTOR MAY NEED TO REPOSITION BOULDERS AFTER PLACEMENT.
24. THE CONTRACTOR MAY NEED TO MODIFY EXISTING IN–SITU BOULDERS.
25. PORTIONS OF IN–SITU BOULDERS MAY NEED TO BE REMOVED TO MEET FINISHED GRADE, CREATE SUITABLE SUBGRADE FOR PLACEMENT OF BOULDERS IN HYDRAULIC STRUCTURES OR TO CREATE DESIRED FLOWLINES.
26. THE SURFACE OF THE FINISHED CHANNEL BED SHALL BE ROUGH WITH SOME BOULDERS PROTRUDING ABOVE THE CHANNEL GRADE LINE.

UPPER BARRIER HYDRAULIC STRUCTURE LAYOUT TABLE

FLOWLINE (FL) ID	ROCK STRUCTURE TYPE	FLOWLINE DESCRIPTION	POOL BOTTOM DOWNSTREAM OF FLOWLINE
HYDRAULIC STRUCTURE 1			
FL1-1	TYPE 'B'	EL 1480.3+/-0.5 FT	MIN 3 FT LOWER THAN FL1-1
FL1-2	TYPE 'A'	1 FT+/-0.5 FT ABOVE FL1-1	MIN 3 FT LOWER THAN FL1-1
FL1-3	TYPE 'A' AGAINST CANYON WALL	1 FT+/-0.5 FT ABOVE FL1-2	MIN 3 FT LOWER THAN FL1-1
HYDRAULIC STRUCTURE 2			
FL2-1	TYPE B	SET BASED ON HYDRAULIC GRADELINE+/-0.5 FT	MIN 3 FT LOWER THAN FL1-1
FL2-2	EXISTING FL, TO REMAIN UNCHANGED	CONTACT BETWEEN B30 AND B36 AT APPROX EL 1483.5 FT	EXISTING POOL TO REMAIN
FL2-3	TYPE 'A' AGAINST CANYON WALL	1 FT+/-0.5 FT ABOVE FL2-2	MIN 3 FT LOWER THAN FL1-3
HYDRAULIC STRUCTURE 3			
FL3-1	TYPE 'C'	SET BASED ON HYDRAULIC GRADELINE+/-0.5 FT, BUT NO GREATER THAN 2.5 FT ABOVE FL2-1	MIN 3 FT LOWER THAN FL2-1
FL3-2	BEDROCK CONDITIONS PERMITTING	1 FT+/-0.5 FT ABOVE FL3-1	MIN 3 FT LOWER THAN FL2-2
FL3-3		1 FT+/-0.5 FT ABOVE FL3-2	MIN 3 FT LOWER THAN FL2-3
HYDRAULIC STRUCTURE 4			
FL4-1	TYPE 'A'	SET BASED ON HYDRAULIC GRADELINE+/-0.5 FT	MIN 3 FT LOWER THAN FL3-1
FL4-2	TYPE 'A'	1 FT+/-0.5 FT ABOVE FL4-1	MIN 3 FT LOWER THAN FL3-1
FL4-3	TYPE 'A'	1 FT+/-0.5 FT ABOVE FL4-2	MIN 3 FT LOWER THAN FL3-3
HYDRAULIC STRUCTURE 5			
FL5-1	TYPE 'A'	SET BASED ON HYDRAULIC GRADELINE+/-0.5 FT	MIN 3 FT LOWER THAN FL4-1
FL5-2	TYPE 'B' (USE IN-SITU BOULDERS AS FEASIBLE	1 FT+/-0.5 FT ABOVE FL1-1.	MIN 2 FT LOWER THAN FL4-3
FL5-3	TYPE 'B'	1 FT+/-0.5 FT ABOVE FL1-2. DEFINED AT CONTACT BETWEEN B14 AND B15	MIN 2 FT LOWER THAN FL3-3

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NORTH FORK BATTLE CREEK
EAGLE CANYON FISH PASSAGE IMPROVEMENT

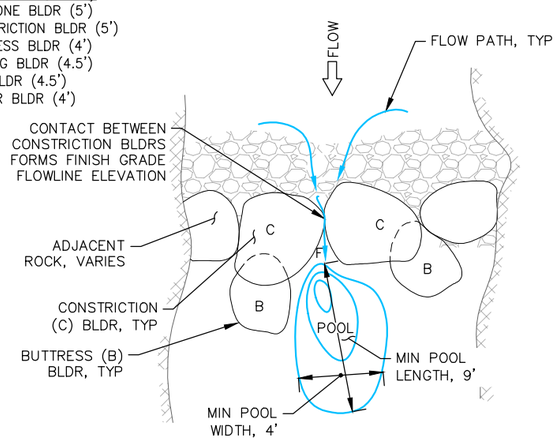
UPPER BARRIER SITE
CHANNEL MODIFICATION NOTES

DATE	FEBRUARY 2017
SUBMITTAL	FINAL
DESIGN	ML, pTJ
DRAWN	pTJ, NN
SHEET	23 of 27

C-20

BOULDER KEY LEGEND
(MIN BLDR B-AXIS, SEE DETAIL 2, DWG C-24)

K = KEYSTONE BLDR (5')
C = CONSTRICTION BLDR (5')
B = BUTTRESS BLDR (4')
D = DIVIDING BLDR (4.5')
S = SILL BLDR (4.5')
F = FOOTER BLDR (4')



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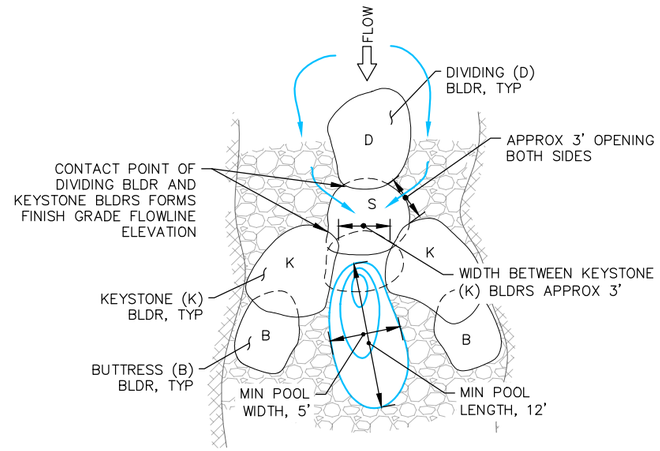

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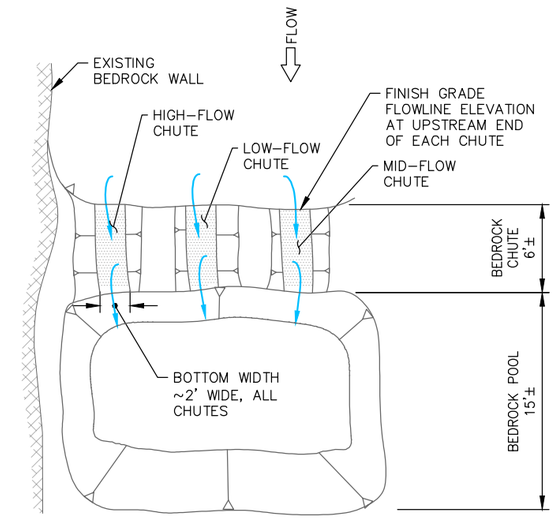

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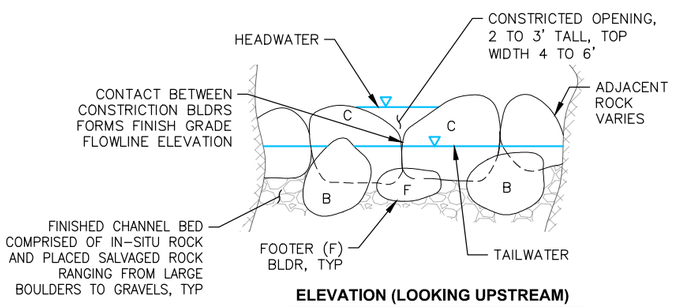
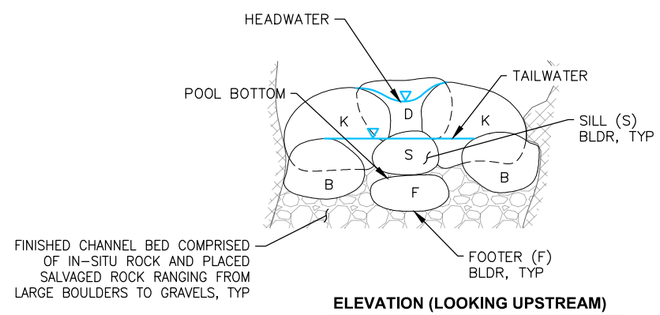


ELEVATION (LOOKING UPSTREAM)



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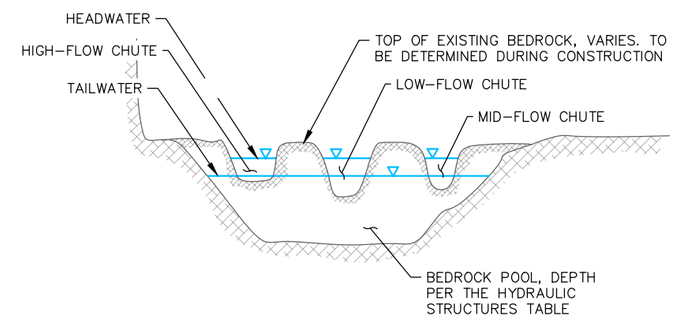
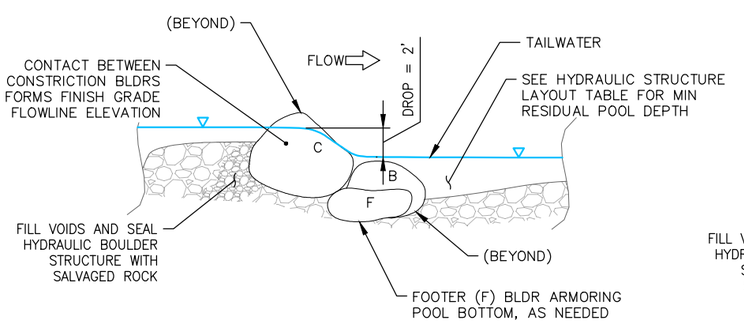
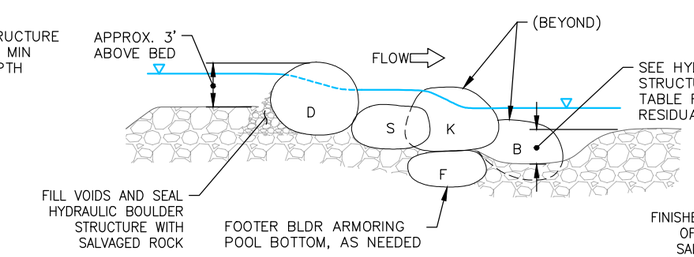


ELEVATION (LOOKING UPSTREAM)



CENTERLINE PROFILE



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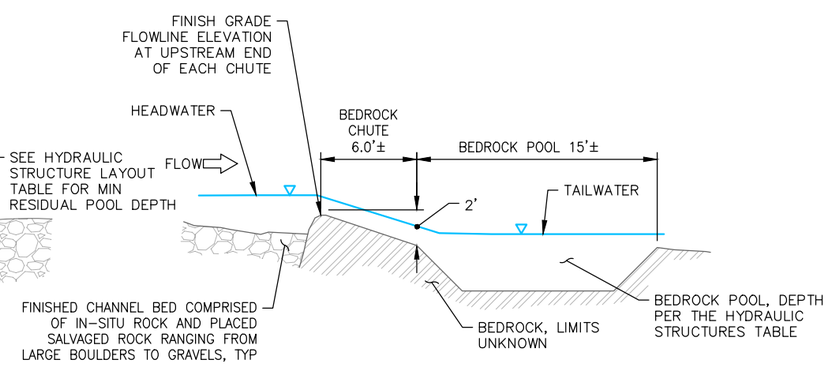

CHUTE PROFILE

1 TYPE 'A' HYDRAULIC STRUCTURE BOULDER CONSTRICTION
TYPICAL (NTS)

2 TYPE 'B' HYDRAULIC STRUCTURE BOULDER DOUBLE SLOT
TYPICAL (NTS)

3 TYPE 'C' HYDRAULIC STRUCTURE BEDROCK CHUTES AND POOLS
TYPICAL (NTS)

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UPPER BARRIER SITE
HYDRAULIC STRUCTURE TYPICALS

DATE	FEBRUARY 2017
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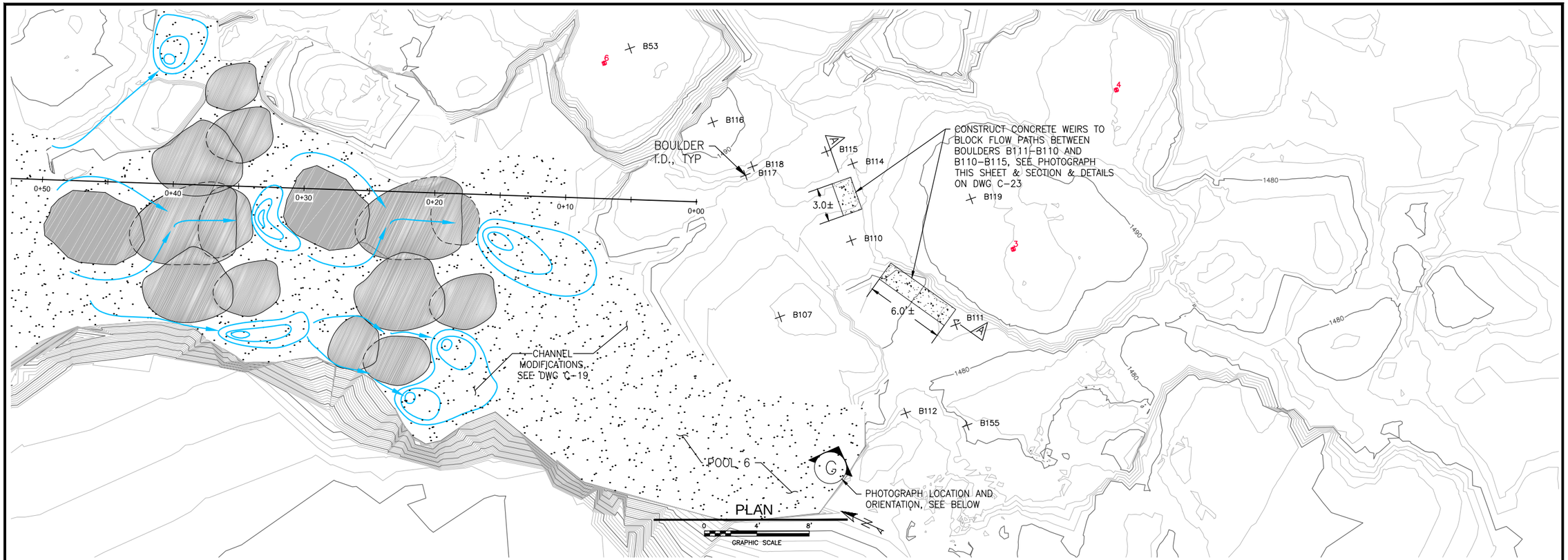
SHEET	24 of 27

C-21



PHOTOGRAPH G EXISTING CONDITIONS

NOT TO SCALE

PHOTOGRAPH G EXISTING CONDITIONS WITH (N) WEIR

NOT TO SCALE

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Sacramento, CA 95814
http://www.dfg.ca.gov

REGISTERED PROFESSIONAL ENGINEER
MICHAEL A. LOVE
No.71681
CIVIL
STATE OF CALIFORNIA

VERIFY SCALE
THIS BAR IS ONE INCH LONG AT FULL SCALE

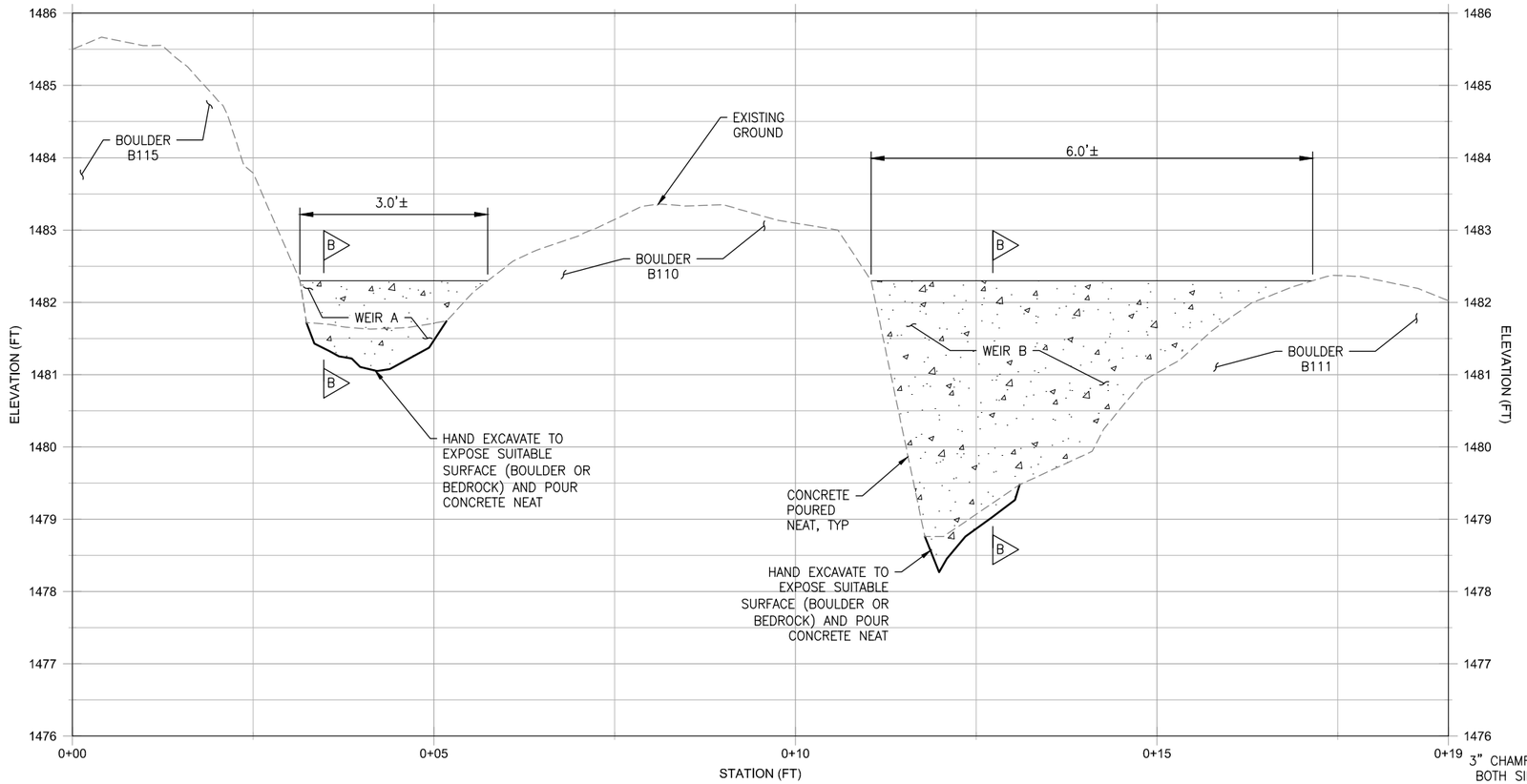
CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE
NORTH FORK BATTLE CREEK
EAGLE CANYON FISH PASSAGE IMPROVEMENT

UPPER BARRIER SITE
WEIR CONSTRUCTION PLAN & PHOTOS

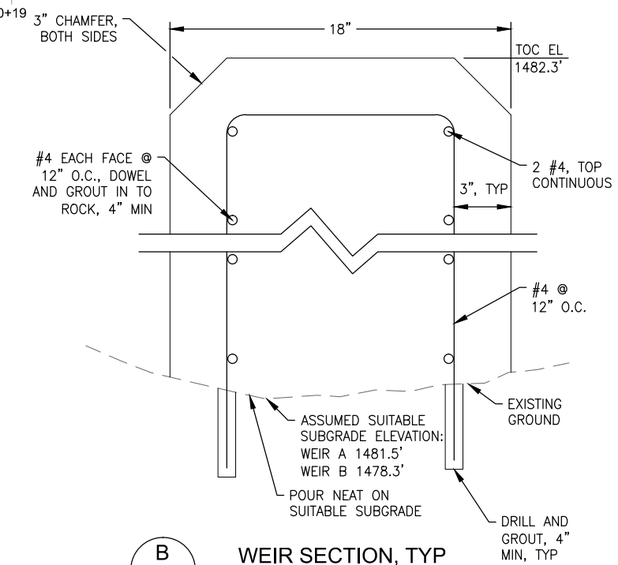
DATE	FEBRUARY 2017
SUBMITTAL	FINAL
DESIGN	ML, pTJ
DRAWN	pTJ, NN
SHEET	25 of 27

C-22

11/22/2016 10:42:21 AM Q:\Eagle Canyon\05_CAD\Sheets\25_FinalDesign_UB_WierConstruction.dwg



A
C-22
WEIR SECTION
0 1' 2'
GRAPHIC SCALE



B
-
WEIR SECTION, TYP
0 4' 8'
GRAPHIC SCALE

PHOTOGRAPH G EXISTING CONDITIONS

NOT TO SCALE

PHOTOGRAPH G EXISTING CONDITIONS WITH (N) WEIR

NOT TO SCALE

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NORTH FORK BATTLE CREEK
EAGLE CANYON FISH PASSAGE IMPROVEMENT

UPPER BARRIER SITE
CONCRETE WEIR SECTION & DETAIL

DATE	FEBRUARY 2017
SUBMITTAL	FINAL
DESIGN	ML, pTJ
DRAWN	pTJ, NN
SHEET	26 of 27

C-23

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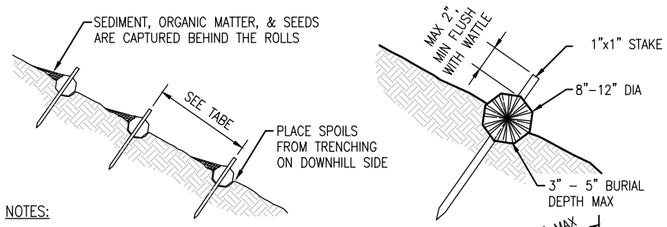
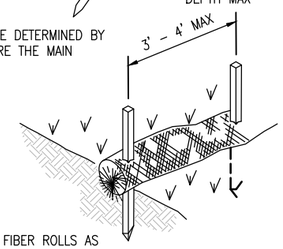


NOTES:

1. VERTICAL SPACING FOR SLOPE INSTALLATION SHOULD BE DETERMINED BY SITE CONDITIONS: SLOPE STEEPNESS AND SOIL TYPE ARE THE MAIN FACTORS. A GOOD RULE OF THUMB IS:

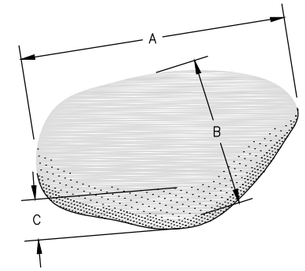
1:1 SLOPES (100%)	=	10 FEET APART
2:1 SLOPES (50%)	=	20 FEET APART
3:1 SLOPES (33%)	=	30 FEET APART
4:1 SLOPES (25%)	=	40 FEET APART

2. ADJACENT ROLLS SHALL TIGHTLY ABUT, DO NOT OVERLAP ROLLS.
3. USE BIODEGRADABLE NETTING, OR REMOVE & REPLACE FIBER ROLLS AS SOON AS STRAW FILLING BEGINS TO DEGRADE
4. REFER TO MANUFACTURERS INSTALLATION INSTRUCTIONS FOR TYPE 2 INSTALLATION USING ROPE AND STAKES
5. WHEN CALLED FOR IN DRAWINGS, STRAW WATTLE IS TO BE SECURELY ATTACHED TO BASE OF TEMPORARY SECURITY FENCING OR STAKED JUST INSIDE SECURITY FENCING AT SPACING CALLED FOR IN SKETCH ABOVE. STRAW WATTLE IS TO BE PLACED ON INSIDE OF FENCE TO MINIMIZE PUBLIC TAMPERING.

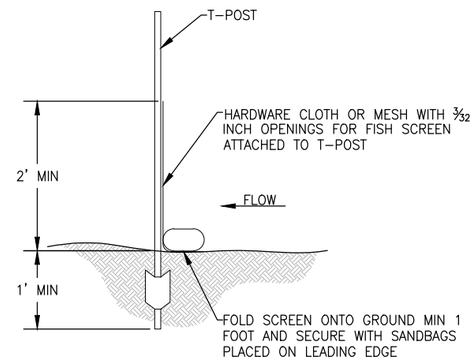


1 STRAW WATTLE
DETAIL, NTS

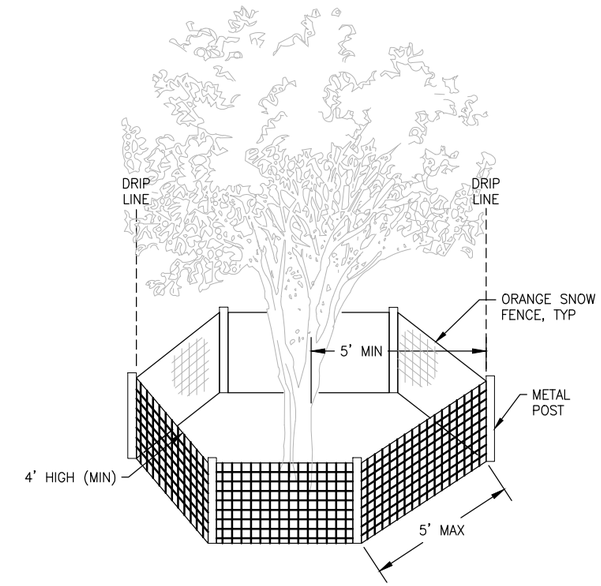
ROCK MEASUREMENT
A LONG AXIS
B INTERMEDIATE AXIS
C SHORT AXIS



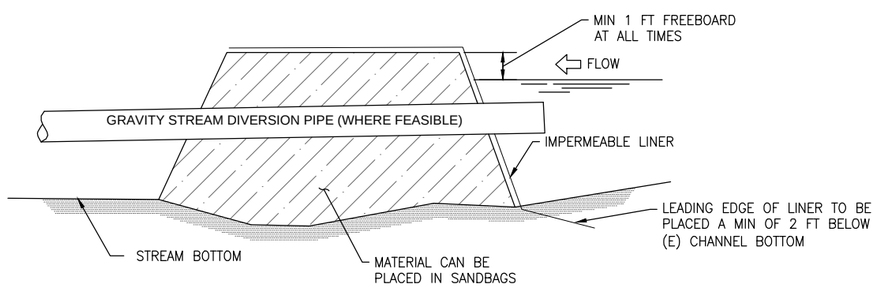
2 BOULDER AXIS
DETAIL, NTS



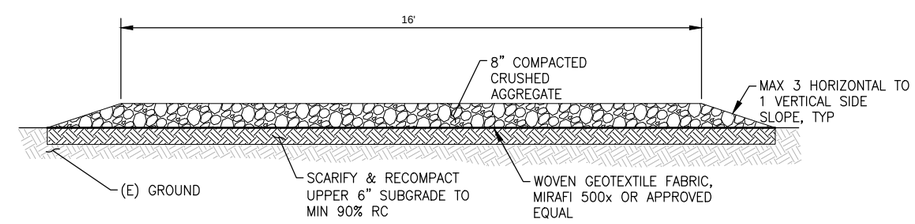
3 TEMPORARY FISH SCREEN
NTS



5 TEMPORARY VEGETATION FENCING
NTS



4 **TEMPORARY COFFERDAM**
TYPICAL PROFILE (NTS)



6 GRAVEL ACCESS ROAD SECTION
NTS

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NORTH FORK BATTLE CREEK
EAGLE CANYON FISH PASSAGE IMPROVEMENT

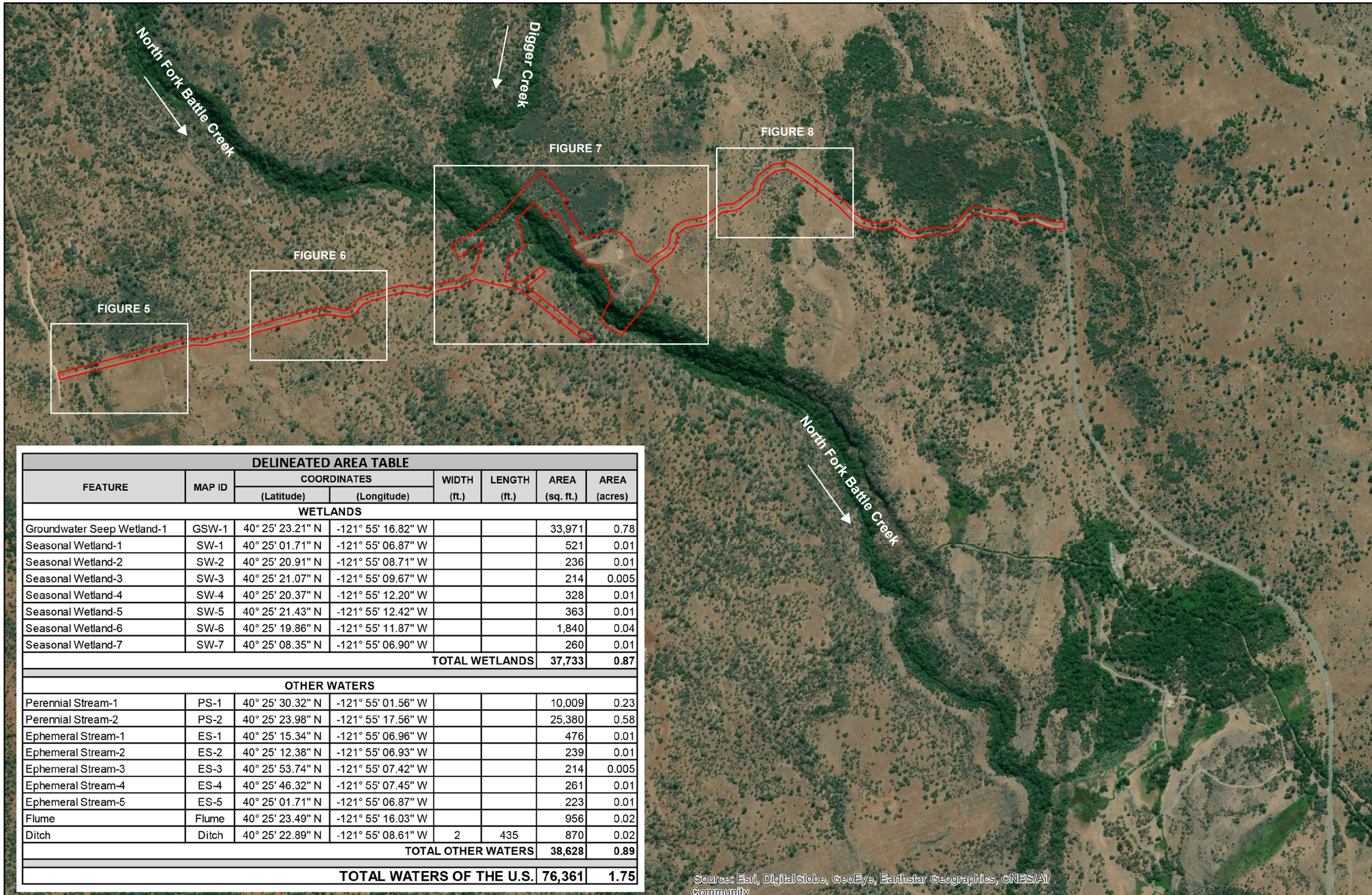
UPPER AND LOWER BARRIER SITES
PROJECT DETAILS AND TYPICALS

DATE	FEBRUARY 2017
SUBMITTAL	FINAL
DESIGN	ML, pTJ
DRAWN	pTJ, NN
SHEET	27 of 27

C-24

APPENDIX D

Wetland Delineation Maps



DELINEATED AREA TABLE

FEATURE	MAP ID	COORDINATES (Latitude)	COORDINATES (Longitude)	WIDTH (ft.)	LENGTH (ft.)	AREA (sq. ft.)	AREA (acres)
WETLANDS							
Groundwater Seep Wetland-1	GSW-1	40° 25' 23.21" N	-121° 55' 16.82" W			33,971	0.78
Seasonal Wetland-1	SW-1	40° 25' 01.71" N	-121° 55' 06.87" W			521	0.01
Seasonal Wetland-2	SW-2	40° 25' 20.91" N	-121° 55' 08.71" W			236	0.01
Seasonal Wetland-3	SW-3	40° 25' 21.07" N	-121° 55' 09.67" W			214	0.005
Seasonal Wetland-4	SW-4	40° 25' 20.37" N	-121° 55' 12.20" W			328	0.01
Seasonal Wetland-5	SW-5	40° 25' 21.43" N	-121° 55' 12.42" W			363	0.01
Seasonal Wetland-6	SW-6	40° 25' 19.86" N	-121° 55' 11.87" W			1,840	0.04
Seasonal Wetland-7	SW-7	40° 25' 08.35" N	-121° 55' 06.90" W			260	0.01
					TOTAL WETLANDS	**37,733**	**0.87**
OTHER WATERS							
Perennial Stream-1	PS-1	40° 25' 30.32" N	-121° 55' 01.56" W			10,009	0.23
Perennial Stream-2	PS-2	40° 25' 23.98" N	-121° 55' 17.56" W			25,380	0.58
Ephemeral Stream-1	ES-1	40° 25' 15.34" N	-121° 55' 06.96" W			476	0.01
Ephemeral Stream-2	ES-2	40° 25' 12.38" N	-121° 55' 06.93" W			239	0.01
Ephemeral Stream-3	ES-3	40° 25' 53.74" N	-121° 55' 07.42" W			214	0.005
Ephemeral Stream-4	ES-4	40° 25' 46.32" N	-121° 55' 07.45" W			261	0.01
Ephemeral Stream-5	ES-5	40° 25' 01.71" N	-121° 55' 06.87" W			223	0.01
Flume	Flume	40° 25' 23.49" N	-121° 55' 16.03" W			956	0.02
Ditch	Ditch	40° 25' 22.89" N	-121° 55' 08.61" W	2	435	870	0.02
					TOTAL OTHER WATERS	**38,628**	**0.89**
					TOTAL WATERS OF THE U.S.	**76,361**	**1.75**

Legend

Study Area (34.7 acres)

Preliminary Delineation Map Overview

FIGURE 4

DELINEATION

Jeff Souza
Lorin Mills
Brandon Vidrio
Tehama Environmental Solutions, Inc.

John Dittes
Dittes and Guardino Consulting

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DEPARTMENT OF THE INTERIOR

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Delineation of Waters of the U.S.

North Fork Battle Creek Barrier Modification and Fish Passage Improvement Project

Shasta and Tehama Counties, California

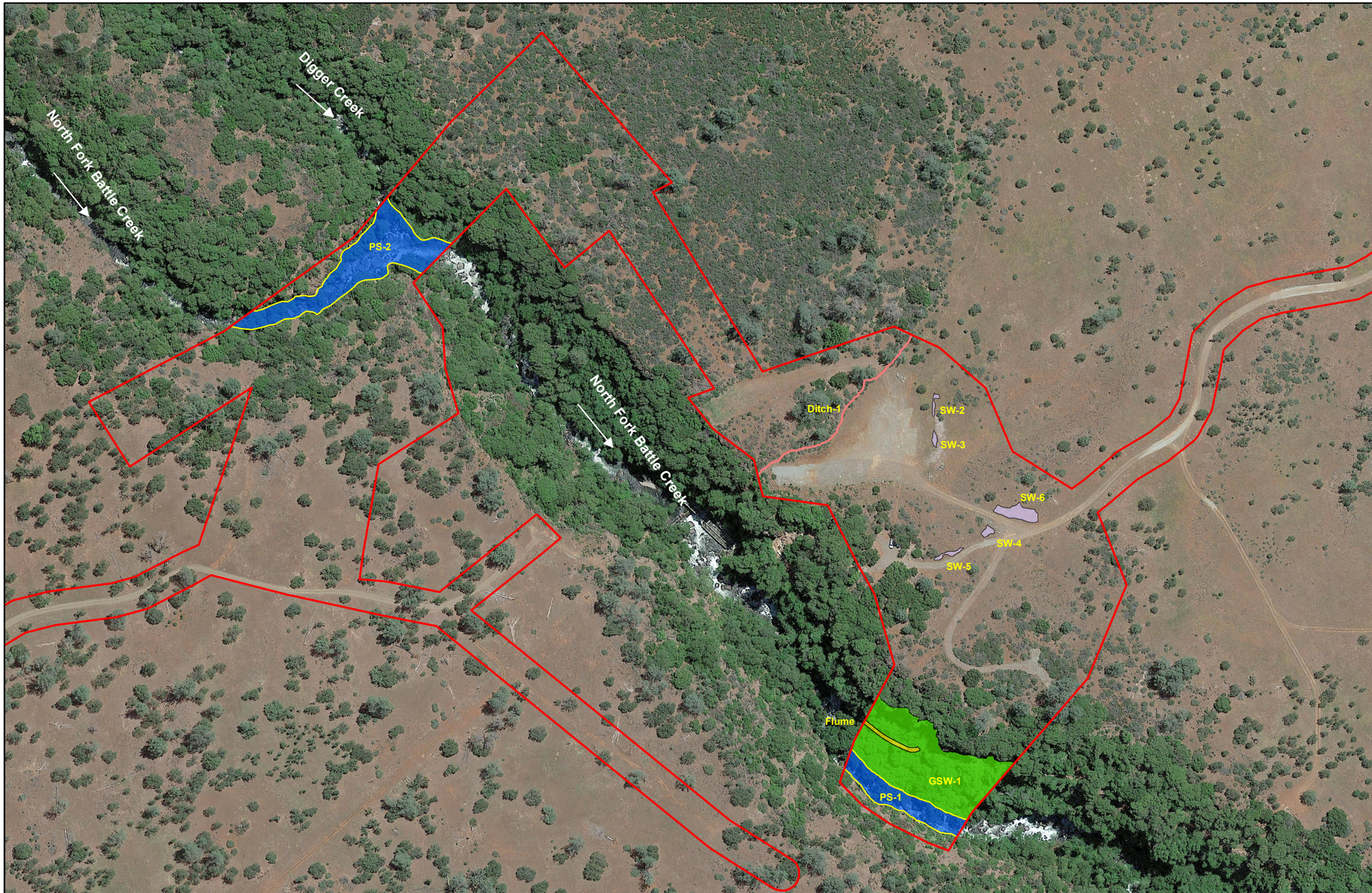
SCALE

0 1,000 2,000 Feet

1 in = 1,000 ft (11" X 17" paper)

October 2018

NOTE: DELINEATION SHOULD BE CONSIDERED PRELIMINARY UNTIL VERIFIED BY THE U.S. ARMY CORPS OF ENGINEERS



Legend

- Study Area (34.7 acres)
- Perennial Stream
- Seasonal Wetland
- Ephemeral Stream
- Groundwater Seep Wetland
- Flume
- Culvert
- OHWM Data Sheet Cross Section
- Ditch
- OHWM
- Data Points

Preliminary Delineation Map

FIGURE 7

DELINEATION

Jeff Souza
Lorin Mills
Brandon Vidrio
Tehama Environmental Solutions, Inc.

John Dittes
Dittes and Guardino Consulting

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North Fork Battle Creek Barrier Modification and Fish Passage Improvement Project

Shasta and Tehama Counties, California

SCALE

0 200 400 Feet

1 in = 200 ft (11" X 17" paper)

October 2018

NOTE: DELINEATION SHOULD BE CONSIDERED PRELIMINARY UNTIL VERIFIED BY THE U.S. ARMY CORPS OF ENGINEERS PHOTO SOURCE: Google Earth, 5/24/2017

Legend

- Study Area (34.7 acres)
- Perennial Stream
- Seasonal Wetland
- Ephemeral Stream
- Groundwater Seep Wetland
- Flume
- Culvert
- OHWM Data Sheet Cross Section
- Ditch
- OHWM
- Data Points

Preliminary Delineation Map

FIGURE 8

DELINEATION

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Lorin Mills
Brandon Vidrio
Tehama Environmental Solutions, Inc.

John Dittes
Dittes and Guardino Consulting

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Delineation of Waters of the U.S.

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Shasta and Tehama Counties, California

SCALE

0 100 200 Feet

1 in = 100 ft (11" X 17" paper)

October 2018

NOTE: DELINEATION SHOULD BE CONSIDERED PRELIMINARY UNTIL VERIFIED BY THE U.S. ARMY CORPS OF ENGINEERS PHOTO SOURCE: Google Earth, 5/24/2017

APPENDIX E

Site Photos

Photo 1. View of Seasonal Wetland feature SW-1, adjacent to the south access road, looking east. Photo date: April 1, 2018.

Photo 2. View of Seasonal Wetland feature SW-2, with SW-3 in the background (surveyor), near the Lower Barrier East contractor use area, looking west. The pink flags represent the delineated wetland boundary. Photo date: June 20, 2018.

Photo 3. View of Seasonal Wetland feature SW-4, adjacent to the south access road, looking north. Photo date: April 1, 2018.

Photo 4. View of Seasonal Wetland feature SW-5, adjacent to the south access road, looking north. The pink flags represent the delineated wetland boundary. Photo date: June 20, 2018.

Photo 5. View of Seasonal Wetland feature SW-6, adjacent to the south access road, looking north. Photo date: April 1, 2018.

Photo 6. View of Seasonal Wetland feature SW-7, adjacent to the south access road, looking south. The pink flags represent the delineated wetland boundary. Photo date: June 20, 2018.