MITIGATED NEGATIVE DECLARATION

FOR

SALMONID RESTORATION FEDERATION MARSHALL RANCH STREAMFLOW ENHANCEMENT PROJECT

SCH #2019109088

October 2020

Lead Agency:
County of Humboldt

Lead Agency Contact:
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I. PROJECT SUMMARY

Date: October 2020

Project Title: Marshall Ranch Streamflow Enhancement Project

Lead Agency: County of Humboldt

Lead Agency Contact:
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Current General Plan Designation: County of Humboldt APN 220-061-011-000
- Residential Agriculture (RA)

Current Zoning: County of Humboldt
- Unclassified (U)

Property Owners
And Parcels:

Humboldt County				
Landowner	**Location**	**Parcel #**	**Contact**	**Phone**
Velma V. Marshall Estate	Marshall Ranch, Briceland, CA	220-061-011	David Sanchez	707-223-3946

Project Description:

Note that the project design and this associated Mitigated Negative Declaration (MND) have been revised from the versions that were circulated for public comment from November 1, 2019 to December 2, 2019 based on comments received from California Department of Fish and Wildlife, State Water Resources Control Board Division of Water Rights, and neighboring landowners.

The Salmonid Restoration Federation (SRF) is planning to construct a 15.3-million-gallon off-stream pond on the Marshall Ranch, adjacent to Redwood Creek, a tributary to the South Fork Eel River. The pond is designed to fill with rainwater (~5.5 million gallons) and water pumped from Redwood Creek during the wet season (~9.8 million gallons). This Project seeks to improve habitat for coho salmon (*Oncorhynchus kisutch*) and steelhead (*Oncorhynchus mykiss*) in Redwood Creek, an important salmon bearing tributary, by addressing the limiting factor of low summer streamflows. The pond has been sited and designed to fill during the winter wet season and release most of its stored water directly to Redwood Creek providing increased flows of 50 gallons per minute during the 5-month dry season. It is anticipated that the pond will be nearly drained at the end of each dry season for bull frog management.

A crucial component of the project is the proposed diversion of water from Redwood Creek during the wet season that will be used to fill the off-stream pond. The project team has applied for an Appropriative Water Right with the State Water Board Division of Water Rights (Application A033073). This water rights application has requested a total yearly diversion of 30.85 acre-feet of water to be diverted during the wet season period of December 1 to April 1 with a maximum diversion rate of 220 gallons per minute. The proposed diversion structure via screened intake and pump is shown on the Design Plans in Attachment A (Basis of Design Report). Of the total requested diversion amount, 30.1 acre-feet (~9.8 million gallons) would be dedicated to flow enhancement for the benefit fish and wildlife and 0.75 acre-feet (250,000 gallons) would be dedicated to domestic, stock watering and fire suppression uses which would allow the landowner to forbear diversion during the dry season.

The South Fork Eel River is one of five priority watersheds selected for flow enhancement projects in California by the State Water Resources Control Board (SWRCB) and California Department of Fish and Wildlife (CDFW) as part of the California Water Action Plan effort (SWRCB 2019). Redwood Creek is a critical tributary to the South Fork Eel River (NMFS, 2014) that historically supported coho and chinook salmon (*Oncorhynchus tshawytscha*) and steelhead.

Coho salmon stocks in the South Fork Eel River Watershed may have historically constituted one of the largest populations of the species in California (NMFS, 2014). Sadly, their population has experienced a precipitous decline, with an approximately 1200% reduction observed between the 1930's and 1991 (BLM et al. 1996, Brown and Moyle 1991). Today, the population remains highly depressed, with the National Marine Fisheries Service assigning a moderate risk of extinction to the Southern Oregon and Northern California Evolutionarily Significant Unit (SONCC ESU). This ESU is currently listed as threatened under the federal Endangered Species Act (ESA) and the California Endangered Species Act (CESA).

Numerous factors are responsible for the declines in coho salmon abundance, and many of these limiting factors are also impacting chinook salmon and steelhead, which are also severely depressed in abundance relative to historical population estimates. Land use practices including logging and road systems have greatly increased winter runoff resulting in decreased groundwater storage and lower summer streamflows. Widespread removal of large wood from streams has also decreased groundwater storage through channel incision and loss of floodplain connectivity and resulted in fewer and shallower instream pools that are of insufficient size to withstand drought. Cannabis cultivation has also expanded in the last 15 years, which has resulted in increased water diversions that have affected area watercourses and summer stream flows. Industrial logging practices combined with fire suppression have resulted in overly dense even aged forests with higher evapotranspiration rates which significantly contribute to lower dry season flows. The problems of reduced groundwater storage and increased evapotranspiration are intensified during longer dry seasons which have become the norm during the past decade.

SRF has been conducting low flow monitoring in Redwood Creek during the past eight dry seasons. Flow monitoring results paint a dire picture of dry-season flows with flows in Redwood Creek mainstem typically measuring between 0 and 5 gallons per minute during the driest part of the year in late summer and early fall. Over the last several years, the dry conditions have lasted into November due to the late onset of rainfall.

The proposed Project includes construction of a 15.3 million gallon off-channel pond, associated pipelines, water chiller, and diversion pump station (requiring Appropriative Water Rights), ancillary water storage for domestic use and fire suppression, erosion control structures within intermittent streams, instream habitat enhancement structures along the Redwood Creek mainstem, and solar and micro-hydro energy generation system to offset the long-term energy use of project operations.

The Project would provide significant, measurable benefits in terms of dry season flow enhancement for coho salmon, steelhead, and other aquatic habitat along the 5.5 miles (mi) of Redwood Creek mainstem downstream from the Project. The Project is designed to deliver approximately 50 gallons per minute (GPM) of high-quality water during the five-month dry season, which will be wholly dedicated to instream values including reasonable and beneficial fish and wildlife uses of the water. Quantifiable long-term objectives include increased summer streamflow, enhanced fish and wildlife habitat, and improved water quality. An initial analysis of the reservoir operations show that flow releases are expected to have suitable water temperatures during the standard operating scenarios due to the depth of the pond and water released from the bottom of the pond. However, to address rare occurrences when released water may have elevated temperatures, an on-demand water chiller are proposed in the project design.

The proposed water diversion from Redwood Creek during the wet season will be managed to minimize the impacts to instream resources (i.e. sufficient water will be left instream to meet the need of aquatic habitat and senior diverters). A Draft Water Availability Analyses (WAA) was prepared by Stillwater Sciences and submitted to the State Water Board Division of Water Rights for review with the Appropriative Water Rights Application and also included in Attachment A of this MND as Appendix C of the BOD Report. From the WAA, the preliminary proposed diversion restrictions are intended to minimize impacts to instream resources:

- Minimum bypass flow at the point of diversion = 5 cfs (~2,250 gpm)
- Maximum diversion rate of 5% of total flow (i.e. to achieve desired maximum diversion rate of 220 gpm, flows would need to be 10 cfs (4,500 gpm).

Note that CDFW and SWB are currently working on multiple flow-related studies and analyses focused on Redwood Creek, the results of which are expected to inform the final Water Availability Analyses Report and subsequent permitted diversion schedule/protocols. It is expected that ongoing collaboration between the project team and agency staff will result in agreed upon final diversion requirements which will be defined in the final Appropriative Water Right and Lake and Streambed Alteration Agreement. The goal of the Project is to reduce impacts of the wet-season diversion to less than significant levels while not unnecessarily limiting the project's ability to maximize dry season flow enhancement benefits.

Surrounding Land Uses: The lands surrounding the project consist of private holdings, small family farms, forests used for timber production, and conserved lands owned by federal and state agencies, non- profits, and sustainable forestry landowners. The proposed pond construction site is an ancient fluvial terrace primarily covered by grassland utilized for livestock grazing. The grassland is flanked to the east and west by intermittent drainages hosting corridors of bigleaf maple forest alliance. These drainages are incised and actively eroding, exporting deleterious fine sediment to Redwood Creek. Redwood Creek also exhibits anthropogenic degradation as it is incised and lacks large wood relative to historical conditions (CDFW 2014). Over the last several years, Redwood Creek has experienced completely dry conditions at two of the four mainstem Redwood Creek flow gages downstream from the proposed flow enhancement site (Stillwater Sciences, 2019).

Other Public Agencies Whose Approval Is Required (permits, financing approval, or participation agreement): U.S Army Corps of Engineers, National Marine Fisheries Service, U. S. Fish and Wildlife Service, North Coast Regional Water Quality Control Board, State Water Resources Control Board, California Department of Fish and Wildlife.

Have California Native American tribes traditionally and culturally affiliated with the project area requested consultation pursuant to Public Resources Code section 21080.3.1? If so, is there a plan for consultation that includes, for example, the determination of significance of impacts to tribal cultural resources, procedures regarding confidentiality, etc.?

AB 52 has been requested. As described in detail below, a Cultural Resources Assessment has also been completed for the project site which recommends measures to avoid impacts to cultural resources. Through the Special Permit application process with the Humboldt County Planning Department in which began in July 2019, local tribes have also been notified of the project.

CEQA Requirement:
The Project is subject to the requirements of the California Environmental Quality Act (CEQA). The Lead Agency is the County of Humboldt (County), per CEQA Guidelines Section 21067. The purpose of this Initial Study (IS) is to provide a basis for determining whether to prepare an Environmental Impact Report (EIR) or a Negative Declaration. This Initial Study is intended to satisfy the requirements of CEQA (Public Resources Code, Div 13, Sec 21000-21177) and the State CEQA Guidelines (California Code of Regulations, Title 14, Sec 15000-15387).

CEQA encourages lead agencies and applicants to modify their projects to avoid potentially significant adverse impacts (CEQA Section 20180[c][2] and State CEQA Guidelines Section 15070[b][2]).

Section 15063(d) of the State CEQA Guidelines states that an IS shall contain the following information in brief form:

1) A description of the project including the project location
2) Identification of the environmental setting
3) Identification of environmental effects by use of a checklist, matrix, or other method, provided that entries on a checklist or other form are briefly explained to provide evidence to support the entries
4) Discussion of means to mitigate significant effects identified
5) Examination of whether the project would be consistent with existing zoning, plans, and other applicable land use controls
6) The name of the person or persons who prepared and/or participated in the IS

The Finding: Although the projects may have the potential to cause minor short-term impacts on soil, vegetation, wildlife, water quality, and aquatic life, the measures that shall be incorporated into the project will lessen such impacts to a level that is less than significant (see initial study and environmental impacts checklist).

Basis for the Finding: Based on the initial study, it was determined there would be no significant adverse environmental effects resulting from implementing the proposed project. The project is designed to provide environmental benefit by enhancing and maintaining quality salmonid spawning and rearing habitat in the project area and downstream through augmentation of dry season stream flows.

Humboldt County finds that implementing the proposed projects will have no significant environmental impact. Therefore, this mitigated negative declaration is filed pursuant to the California Environmental Quality Act (CEQA), Public Resources Code § 21080 (c2). This proposed mitigated negative declaration consists of all of the following:

II. PROJECT INTRODUCTION AND BACKGROUND

INTRODUCTION

PROJECT SEQUENCE – PERMITTING, FUNDING AND IMPLEMENTATION

The Project aims to secure implementation funding from the CA Wildlife Conservation Board (WCB) Proposition 1 Streamflow Enhancement Program. The Project may also in the future aim to secure funding from other sources including (but not limited to) State Coastal Conservancy (SCC) Proposition 1, California Department of Fish and Wildlife (CDFW) Fisheries Restoration Grant Program (FRGP), Department of Water Resources (DWR) Proposition 1, and CDFW and WCB Proposition 68 Programs. These projects are subject to review under the California Environmental Quality Act (CEQA) (Pub. Resources Code, § 21000 et seq.).

While the implementation may be funded by different sources over several years, the planning and permitting of the entire Project is currently funded by the WCB Proposition 1 Streamflow Enhancement Program and the documents that follow address the entire Project. This Initial Study and the MND describe and analyze the potential significant impacts of all Project treatments at all sites. Individual restoration activities will require additional environmental permitting from CDFW, State Water Resources Control Board (SWRCB), North Coast Regional Water Quality Control Board (NCRWQCB), and federal agencies. These individual restoration activities will also include monitoring and analysis of outcomes. It is anticipated that the majority of the implementation will occur during the period of June – October 2021, with the potential for some lesser amounts of work to occur in 2022.

PROJECT GOALS AND OBJECTIVES

The primary goal of the Project is to maintain vital salmonid rearing habitat in Redwood Creek through flow augmentation during the dry summer months. Creation and operation of the reservoir has the potential to prevent the drying of stream reaches and resulting salmonid mortality. The reservoir is anticipated to be a valuable management tool that can help improve resiliency of fish stocks to challenging environmental conditions. In addition to flow augmentation, rock weirs and large wood placements will improve fish habitat, and gully stabilization will reduce the delivery of fine sediment to Redwood Creek.

The Project addresses the goals and policies of the County General Plan's Water Resources element including the following:

WR-G2 - Water Resource Habitat. River and stream habitat supporting the recovery and continued viability of wild, native salmonid and other abundant coldwater fish populations supporting a thriving commercial, sport, and tribal fishery.

Relevant project actions: Deliver cool water to Redwood Creek during the summer low flow period, which will improve dry season survivability of juvenile anadromous salmonids.

WR-G9 - Restored Water Quality and Watersheds. All water bodies de-listed and watersheds restored, providing high quality habitat and a full range of beneficial uses and ecosystem services.

Relevant project actions: Redwood Creek currently experiences low flows and warm water temperatures during the summer and early fall months. Cool water flow augmentation from the Project will improve instream habitat quality and anadromous salmonid rearing habitat.

WR-P23 - Watershed and Community Based Efforts. Support the efforts of local community watershed groups to protect, restore, and monitor water resources and work with local groups to ensure decisions and programs take into account local priorities and needs.

Relevant project actions: The Project is a collaboration of the Marshall Ranch, Salmonid Restoration Federation, and state and federal agencies with the goal of restoring cool water flow to Redwood Creek during the summer dry season.

WR-P25 - State and Federal Watershed Initiatives. Support implementation of state and federal watershed initiatives such as the Total Maximum Daily Loads (TMDLs), the North Coast Regional Water Quality Control Board's (NCRWQCB) Watershed Management Initiative, the National Marine Fisheries Services and Department of Fish and Game coho recovery plans and the California Non-Point Source Program Plan.

Relevant project actions: The Project addresses the goals of the California Water Action Plan (SWRCB, 2019), Goal B of the WCB strategic plan (WCB, 2014), Goal 2 of the State Wildlife Action Plan (CDFW, 2015), and host of NOAA Fisheries' recovery actions for coho salmon in the South Fork Eel River. See below for additional detail regarding these goals.

WR-IMP19 - Coordinate and Support Watershed Efforts. Seek funding and work with land and water management agencies, community-based watershed restoration groups, and private property owners to implement programs for maintaining and improving watershed conditions that contribute to improved water quality and supply.

Relevant project actions: The Project is a collaboration of the Marshall Ranch, Salmonid Restoration Federation, and state and federal agencies. Funding for the Project was supplied by funded by the WCB Proposition 1 Streamflow Enhancement Program.

The Project addresses the goals of important statewide plans including the following:

The Project directly addresses the goals of the California Water Action Plan (SWRCB, 2019) and will ensure the restoration of critically important habitat. The Project supports the following actions: 1) Restoration of degraded stream ecosystems to assist in natural water management and improved habitat; 2) Enhancement of water flows in stream systems statewide; 3) Expansion of water storage capacity and improvement of groundwater management; and 4) Management and preparation for dry periods.

The Project addresses Goal B of the WCB strategic plan (WCB, 2014): Work with partners to restore and enhance natural areas, create viable habitat on working lands, manage adaptively, and ensure long-term ecosystem health and strategic direction. It also addresses goal B.1: Invest in projects and landscape areas that help provide resilience in the face of climate change, enhance water resources for fish and wildlife and enhance habitats on working lands. The Project includes a collaborative team of partners, will improve habitat on adjacent sustainable forestry working land, will include adaptive management, and will help ensure long term ecosystem health and resilience to climate change related drought as well as intensified rainfall events.

The Project also aligns with Goal 2 of the State Wildlife Action Plan (CDFW, 2015) – Enhance Ecosystem Conditions, and Goal 3 – Enhance Ecosystem Functions and Processes: Maintain and improve ecological conditions vital for sustaining ecosystems in California. Most specifically, the project improves the hydrologic regime and increases water quantity and availability vital for sustaining ecosystems.

NOAA Fisheries has prioritized a list of recovery actions for coho salmon in the South Fork Eel River Population chapter of their SONCC Recovery Plan (NMFS, 2014). The proposed strategy universal to the top 10 priority actions is listed as "Improve flow timing or volume." Additionally, Redwood Creek is repeatedly identified as a "stream where coho would benefit immediately," and afforded high priority among areas of the South Fork Eel River watershed. While specific action items for this strategy primarily focus on diversion reduction to improve flows, the Project's reservoir surely utilizes the same strategy to accomplish a common goal. Additionally, components of the project do align with specific action items in the recovery plan:

Strategy: Increase Channel Complexity

- SONCC-SFER.2.1.1.2 Place instream structures, guided by assessment results
- SONCC-SFER.2.2.3.1 Identify potential sites to create refugia habitats. Prioritize sites and determine best means to create rearing habitat

Strategy: Decrease water temperature, increase dissolved oxygen

- SONCC-SFER.10.1.48.2 Add LWD, boulders, or sources of structure as guided by assessment to augment habitat at cool water sources

Relevant project actions: Construction of 2 boulder weirs and 4 large wood structures.

Strategy: Reduce delivery of sediment to streams

- SONCC-SFER.8.1.15.3 Upgrade roads, guided by assessment

Relevant project actions: Culvert replacements, installation of drainage features, and surface treatments along the project access road.

The Project will incorporate post-project flow monitoring to measure project benefits and address potential concerns through adaptive management.

Finally, it is SRF's objective to implement this project while not causing a significant adverse effect on the environment or reducing the number or restricting the range of an endangered, threatened, or rare species. To this end, SRF has formed a working group Technical Advisory Committee (TAC) to provide input needed to ensure avoidance of adverse impacts while achieving the project objectives. The TAC will include representatives from the WCB, CDFW, NOAA, SWRCB, and NCRWQCB.

Examples of similar projects:
Specifically, there are several examples analogous to this Project where stored water is used to directly augment dry-season streamflow. Flow releases from two different agricultural ponds and one municipal groundwater well to tributaries of the Russian River in Sonoma County exhibit encouraging results. As described in Ruiz et al. (2019), the project began in 2015 and is ongoing. Data show that flow augmentations in all years from 2015-2018 were able to appreciably

increase wetted habitat, increase stream water dissolved oxygen, and decrease stream water temperature below the stored flow release points. Additionally, releases into Dutch Bill Creek averaging 36 GPM beginning in late August of 2015 were able to cumulatively re-wet more than 2,300 feet of stream channel with effects measurable up to 1.8 miles downstream.

While modest compared to winter flows, these augmentations have the potential to increase pool connectivity and water quality. A foundational hypothesis for this Project, that increased pool connectivity will bolster over-summer salmonid survival, is supported by the work of Obedzinski, Pierce, Horton, and Deitch (2018). Their study found that days of disconnected surface flow showed a strong negative correlation with juvenile coho salmon survival rate in 4 tributaries to the Russian River. Provided this evidence, it is anticipated that the Project's release of approximately 50 GPM into Redwood Creek throughout the dry season can result in significant habitat benefit.

BACKGROUND

Salmonid Restoration Federation (SRF) is a statewide non-profit organization that promotes restoration and recovery of wild salmon populations through education, outreach, and advocacy. Since 2013, SRF has been conducting low-flow monitoring and community outreach in the 26 square-mile Redwood Creek watershed that is a tributary to the South Fork Eel River.

SRF's low-flow monitoring and targeted outreach campaign was initially funded by the Humboldt Area Foundation (HAF) and CDFW. In 2014, SRF received a NCRWQCB 319(h) grant that enabled development of a Quality Assurance Project Plan for the monitoring project that included data loggers to capture continuous flow data. This grant allowed SRF to work with a prominent consulting hydrologist (Randy Klein) who oversaw our monitoring plan, developed discharge rating curves, and wrote a preliminary hydrology report that informed our planning efforts.

In 2015, SRF received a grant from the CDFW's Drought Solicitation that funded our organization to hire Stillwater Sciences to conduct a feasibility study investigating what types of flow enhancement actions were most likely to increase dry season flows within a portion of Redwood Creek and the Miller Creek sub-watershed. The feasibility study resulted in a prioritized list of actions, with the Marshall Ranch site (described herein as the Project) identified as the project with the greatest potential to increase dry-season flows.

A productive partnership between SRF, Stillwater Sciences, the Marshall Ranch and Hicks Law, as well as support from representatives from multiple state agencies including WCB, CDFW, NOAA, NCRWQCB, and SWRCB, has enabled this planning project to move forward expeditiously. Two additional team members have been brought onto the Project to support the planning and design efforts: SHN Engineers and Geologists to provide support for the geotechnical investigation and engineering design of hydraulic appurtenances, and William Rich and Associates to assess cultural resources.

This project will be integrated alongside a conservation easement encompassing the Marshall Ranch ownership managed by California Rangeland Trust. This conservation easement will prevent the subdivision and sale of the majority of the ranch. These restrictions will be especially beneficial in this area, where small subdivisions are frequently used for cannabis cultivation with detrimental impacts to water quality and supply, and fish and wildlife habitat.

SRF currently has three Wildlife Conservation Board streamflow enhancement planning grants including the grant to develop the Marshall Ranch implementation project.

Additionally, SRF's Executive Director, Dana Stolzman, has written a Collaborative Water Management guidebook to assist other coastal watersheds in flow enhancement planning efforts. This resource can be found at http://www.calsalmon.org/sites/default/files/files/CWM_Final_Report.pdf

SRF was also awarded the 2018 Water Quality Stewardship Award from the North Coast Regional Water Quality Control Board for "exemplary work in advancing the science and practice of stream restoration and salmonid protections on the North Coast."

SRF is excited to be the project proponent of the Marshall Ranch planning and implementation project. We believe that our years of work in this critical tributary and our history of working with this outstanding project team will be a valuable asset to see this restoration project to completion.

Project Planning and Design

Over the past two years, the project team has conducted project planning and assessments including topographic surveys, subsurface investigations, biological and cultural resource surveys and reports, pre-project flow monitoring and preparation of 30% and draft and final 65% design plans. Agency and stakeholder input has been sought including a field trip to the project sites.

Project design is based on the best available science and is informed by the California Salmonid Stream Habitat Restoration Manual (Flosi et al. 2010) and Ponds – Planning, Design, Construction (USDA 1997). Additionally, the Project is informed by scientific studies and streamflow enhancement techniques that have been used in the Mattole and Russian River watersheds.

Following development of the draft 65% designs in September 2019, concerns were raised by downslope landowners that the proposed pond and associated grading and infrastructure may not meet the desired level of long-term safety, especially during the rare case of a large rainfall event coupled with a large magnitude earthquake. Based on these concerns, additional analyses have been conducted including further assessment of potential pond failure mechanisms, seismic slope stability analyses under worst-case current and proposed conditions, dam breach analysis, as well as an assessment of long-term operations, maintenance and monitoring costs. Based on these analyses, numerous significant modifications were made to the project design to ensure long term stability of the project:

1) Lowering the pond berm elevation by eight feet which resulted in a grading approach with significantly more excavation into the terrace – note that this design change reduced pond capacity from 16.3 million gallons to the current volume of 15.3 million gallons;
2) Relocation of the pond spillway;
3) Installation of a pond liner, French drain, and subsurface restrictive barrier;
4) Grade control structures in central gully; and
5) Construct a 7.5 KW solar array, micro-hydro turbine, backup battery bank, inverter, grid intertie system and control center building to offset the Project's energy use and provide backup power during outages to maintain operations and monitoring capabilities.

These design modifications are described in detail in the Basis of Design Report included as Attachment A of this MND and discussion in the applicable project impacts sections of this document.

III. ENVIRONMENTAL FACTORS POTENTIALLY AFFECTED:

The environmental factors checked below would be potentially affected by this project, involving at least one impact that is a **"Potentially Significant Impact"** as indicated by the checklist on the following pages.

☐ Aesthetics
☒ Biological Resources
☒ Geology/Soils
☒ Hazards/Hazardous Materials
☒ Hydrology/Water Quality
☐ Recreation
☒ Utilities/Service
☐ Agricultural and Forestry Resources
☒ Cultural Resources
☐ Greenhouse Gas Emissions
☐ Land Use/Planning
☐ Population/Housing
☐ Transportation/Traffic
☒ Mandatory Findings of Significance
☐ Air Quality
☐ Energy
☐ Mineral Resources
☒ Noise
☐ Public Services
☐ Tribal Cultural Resources

An explanation for all checklist responses is included, and all answers take into account the whole action involved, including off-site as well as on-site; cumulative as well as project-level; indirect as well as direct; and construction as well as operational impacts. In the checklist the following definitions are used:

> "**Potentially Significant Impact**" means there is substantial evidence that an effect may be significant.
> "**Potentially Significant Unless Mitigation Incorporated**" means the incorporation of one or more mitigation measures can reduce the effect from potentially significant to a less than significant level.
> "**Less Than Significant Impact**" means that the effect is less than significant and no mitigation is necessary to reduce the impact to a lesser level.
> "**No Impact**" means that the effect does not apply to the Project, or clearly will not impact nor be impacted by the Project.

DETERMINATION: (To be completed by the Lead Agency on the basis of this initial evaluation)

- ☐ I find that the proposed project **could not** have a significant effect on the environment, and a **Negative Declaration** will be prepared.
- ☑ I find that although the proposed project could have a significant effect on the environment, there will not be a significant effect in this case because revisions in the project have been made by or agreed to by the project proponent. A **Mitigated Negative Declaration** will be prepared.
- ☐ I find that the proposed project **may** have a significant effect on the environment, and an **Environmental Impact Report** (EIR) is required.
- ☐ I find that the proposed project **may** have a "potentially significant impact" or "potentially significant unless mitigated" impact on the environment, but at least one effect 1) has been adequately analyzed in an earlier document pursuant to applicable legal standards, and 2) has been addressed by mitigation measures based on the earlier analysis as described on attached sheets. An **Environmental Impact Report** is required, but it must analyze only those effects that remain to be addressed.
- ☐ I find that although the proposed project could have a significant effect on the environment, because all potentially significant effects (a) have been analyzed adequately in an earlier **EIR** or **Negative Declaration** pursuant to applicable standards, and (b) have been avoided or mitigated pursuant to that earlier **EIR** or **Negative Declaration**, including revisions or mitigation measures that are imposed upon the proposed project, nothing further is required.

Joshua Dorris

Signature

10/28/2020

Date

Joshua Dorris, Planner

For Humboldt County Planning and Building Department

EVALUATION OF ENVIRONMENTAL IMPACTS

1) A brief explanation is required for all answers except “No Impact” answers that are adequately supported by the information sources a lead agency cites in the parentheses following each questions. A “No Impact” answer is adequately supported if the referenced information sources show that the impact simply does not apply to projects like the one involved (e.g., the project falls outside a fault rupture zone). A “No Impact” answer should be explained where it is based on project-specific factors as well as general standards (e.g., the project will not expose sensitive receptors to pollutants, based on a project-specific screening analysis).

2) All answers must take account of the whole action involved, including offsite as well as onsite, cumulative as well as project-level, indirect as well as direct, and construction as well as operational impacts.

3) Once the lead agency has determined that a particular physical impact may occur, then the checklist answers must indicate whether the impact is potentially significant, less than significant with mitigation, or less than significant. “Potentially Significant Impact” is appropriate if there is substantial evidence that an effect may be significant. If there are one or more “Potentially Significant Impact” entries when the determination is made, an EIR is required.

4) “Negative Declaration: Less Than Significant With Mitigation Incorporated” applies where the incorporation of mitigation measures has reduced an effect from “Potentially Significant Impact” to a “Less Than Significant Impact.” The lead agency must describe the mitigation measures, and briefly explain how they reduce the effect to a less than significant level (mitigation measures from Section XVII, “Earlier Analyses,” may be cross-referenced).

5) Earlier analyses may be used where, pursuant to the tiering, program EIR, or other CEQA process, an effect has been adequately analyzed in an earlier EIR or negative declaration. Section 15063(c)(3)(D). In this case, a brief discussion should identify the following:

    a) Earlier Analysis Used. Identify and state where they are available for review.

    b) Impacts Adequately Addressed. Identify which effects from the above checklist were within the scope of and adequately analyzed in an earlier document pursuant to applicable legal standards, and state whether such effects were addressed by mitigation measures based on the earlier analysis.

    c) Mitigation Measures. For effects that are “Less Than Significant with Mitigation Measures Incorporated,” describe the mitigation measures which were incorporated or refined from the earlier document and the extent to which they address site-specific conditions for the project.

6) Lead agencies are encouraged to incorporate into the checklist references to information sources for potential impacts (e.g., general plans, zoning ordinances). Reference to a previously prepared or outside document should, where appropriate, include a reference to the page or pages where the statement is substantiated.

7) Supporting Information Sources: A source list should be attached, and other sources used or individuals contacted should be citied in the discussion.

8) This is only a suggested form, and lead agencies are free to use different formats; however, lead agencies should normally address the questions from this checklist that are relevant to a project’s environmental effects in whatever format is selected.

9) The analysis of each issue should identify:

   a) the significance criteria or threshold used to evaluate each question; and
   b) the mitigation measure identified, if any, to reduce the impact to less than significance.

I. AESTHETICS: Except as provided in Public Resources Code Section 21099, would the project:	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
a) Have a substantial adverse effect on a scenic vista?	☐	☐	X	☐
b) Substantially damage scenic resources, including, but not limited to, trees, rock outcroppings, and historic buildings within a state scenic highway?	☐	☐	☐	X
c) In non-urbanized areas, substantially degrade the existing visual character or quality of public views of the site and its surroundings? (Public views are those that are experienced from a publicly accessible vantage point). If the project is in an urbanized area, would the project conflict with applicable zoning and other regulations governing scenic quality?	☐	☐	X	☐
d) Create a new source of substantial light or glare which would adversely affect day or nighttime views in the area?	☐	☐	X	☐

Discussion:

(a) Less Than Significant Impact: The project will not have a significant effect on a scenic vista. Such an impact will not occur because the project will not be readily visible from Briceland Road or any other heavily traveled local roadway. The placement of the small solar array has been designed with consideration of maintaining low visibility and the pond and restoration features will be aesthetically pleasing and will serve to restore to the watershed to a more natural condition with water flowing in Redwood Creek during the dry season offsetting human consumptive use.

(b) No Impact: The project will not damage scenic resources such as trees, rock outcroppings, and historic buildings within a state scenic highway. Such an impact will not occur because the project is not located in the vicinity of a state scenic highway.

(c) Less Than Significant Impact: The project will not substantially degrade the existing visual character or quality public views of the sites and their surroundings because there are no publicly accessible vantage points overlooking the project site. Access to the site is via a private drive and any overlooking locations are within the Marshall Ranch or adjacent private properties. Adjacent neighbors may experience some degraded visual character due to installation of the small solar array and graded berms. However, through careful planning and design, the natural character of the site will be maintained to the greatest extent practical while still achieving the project objectives. Solar array layout has been based on consideration of visual effects and final berm grading will be blended in with natural topographic features. In addition, planting of native trees, shrubs and other vegetation will be performed at all sites where vegetation has been removed or fill has been placed. It is also important to consider that the overall goal of this project is to enhance dry season flows in Redwood Creek which will restore the natural character of a significant portion of the watershed.

(d) Less Than Significant Impact: The project will not create a new source of substantial light which would adversely affect day or nighttime views in the area of the worksites. Such an impact will not occur because the restoration project does not require installation of artificial lighting. It is possible that some glare may be created by the solar panels. However, any receptors of glare created by the solar panels would be expected to occur to the south of the project area based on the southern orientation of the panels. The land to the south of the project is almost entirely large parcels utilized for ranching and timber and there are no residences located to the south of the project. Also, the size of the solar array has been significantly reduced to a ~500 SF footprint in the current project design. Therefore, the project would have a less than significant impact.

II. Agriculture and Forestry Resources. In determining whether impacts to agricultural resources are significant environmental effects, lead agencies may refer to the California Agricultural Land Evaluation and Site Assessment Model (1997) prepared by the California Dept. of Conservation as an optional model to use in assessing impacts on agriculture and farmland. In determining whether impacts to forest resources, including timberland, are significant environmental effects, lead agencies may refer to information compiled by the California Department of Forestry and Fire Protection regarding the state's inventory of forest land, including the Forest and Range Assessment Project and the Forest Legacy Assessment project; and forest carbon measurement methodology provided in Forest Protocols adopted by the California Air Resources Board. Would the project:	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
a) Convert Prime Farmland, Unique Farmland, or Farmland of Statewide Importance (Farmland), as shown on the maps prepared pursuant to the Farmland Mapping and Monitoring Program of the California Resources Agency, to non-agricultural use?				X
b) Conflict with existing zoning for agricultural use, or a Williamson Act contract?				X
c) Conflict with existing zoning for, or cause rezoning of, forest land (as defined in Public Resources Code section 12220(g)), timberland (as defined by Public Resources Code section 4526), or timberland zoned Timberland Production (as defined by Government Code section 51104(g))?				X
d) Result in the loss of forest land or conversion of forest land to non-forest use?				X
e) Involve other changes in the existing environment which, due to their location or nature, could result in conversion of Farmland, to non-agricultural use or conversion of forest land to non-forest use?			X	

Discussion:
The project is located on land that is zoned by Humboldt County as Residential Agriculture and periodically used for grazing livestock. Fish and wildlife management are allowable uses on this zoning.

(a) No Impact: The Farmland Mapping and Monitoring Program has not mapped farmlands in Humboldt County. Therefore, no land in the County is considered Prime Farmland, Unique Farmland, or Farmland of Statewide Importance (Farmland), as shown on the maps prepared pursuant to the FMMP of the California Resources Agency. Therefore, there would be no impact.

(b) No Impact: The project will not conflict with existing zoning for agricultural use or a Williamson Act contract. The project is located on land that is zoned by Humboldt County as Residential Agriculture and periodically used for grazing livestock. Fish and wildlife management (one of the primary purposes of the project) is an allowable use on this zoning. The project parcel is not under a Williamson Act contract, therefore there would be no impact.

(c) No Impact: The project is zoned as Residential Agriculture and as such will not conflict with existing zoning for, or cause rezoning of, forestland, timberland, or timber zoned Timberland Production.

(d) No Impact: No trees will be removed, and no loss or conversion of forest land will occur.

(e) Less Than Significant Impact: The project will not involve other changes in the existing environment, which due to their location or nature, could result in significant conversion of farmland to non-agricultural use. Fisheries habitat restoration actions either are away from, or are compatible with, existing agricultural uses. The proposed reservoir is located in an open grassland and will utilize some of the space that could be used for periodic grazing. However, it represents a very small percentage of the overall ranch ownership. Additionally, the project design will allow for future cattle grazing within portions of the project footprint, (following several years of revegetation) and will also enhance water availability for livestock while reducing livestock impacts to watercourses via fencing.

III. Air Quality. Where available, the significance criteria established by the applicable air quality management or air pollution control district may be relied upon to make the following determinations. Would the project:	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
a) Conflict with or obstruct implementation of the applicable air quality plan?			X	
b) Result in a cumulatively considerable net increase of any criteria pollutant for which the project region is non-attainment under an applicable federal or state ambient air quality standard?			X	
c) Expose sensitive receptors to substantial pollutant concentrations?			X	
d) Result in other emissions (such as those leading to odors) adversely affecting a substantial number of people?				X

Discussion:
Humboldt County is designated as 'in attainment' for all National Ambient Air Quality Standards (NAAQS or federal standards). Humboldt County is designated as 'in attainment' for all California Ambient Air Quality Standards (CAAQS or State standards) pollutants except PM_{10}. The North Coast Unified Air Quality Management District (NCUAQMD) has not formally adopted significance thresholds that would apply to projects such as this. For construction emissions, the NCUAQMD has indicated that construction emissions are not considered regionally significant for projects that will be of relatively short duration (less than one year) (NCUAQMD 2015).

Impacts related to construction dust are considered significant if dust is allowed to leave the site (NCUAQMD 2015). Construction activities are subject to Rule 104 (Prohibitions) Section D (Fugitive Dust Emission). Pursuant to Section D, the handling, transporting, or open storage of materials in such a manner, which allows or may allow unnecessary amounts of particulate matter to become airborne, shall not be permitted. Reasonable precautions shall be taken to prevent particulate matter from becoming airborne, including, but not limited to: 1) covering open bodied trucks when used for transporting materials likely to give rise to airborne dust; and 2) the use of water during the grading of roads or the clearing of land.

(a) Less than significant: The construction portion of the project will last for less than one year (June 1 to November 1). During this period, the project will comply with Rule 104, Section D and cover open body trucks hauling materials off site and use water during the grading of roads, excavation, and land clearing.

(b) Less than significant: Humboldt County is in attainment of all air quality standards, except PM_{10}. The project will comply with Rule 104, Section D and cover open body trucks hauling materials off site and use water during the grading of roads, excavation, and land clearing. Therefore, the project will not result in a cumulatively considerable net increase of any criteria pollutant for which the project region is in non-attainment under applicable federal or state ambient air quality standards.

(c) Less than significant: The project will not expose sensitive receptors to substantial pollutant concentrations. Such an impact will not occur because the project will not increase pollutant concentrations and is designed in part to reduce dependency on fossil fuel generated electricity through the installation of the solar array and micro hydro system to offset the Project's long-term energy use. There is the potential for fugitive dust to travel off site and expose neighbors. However, the project will comply with Rule 104, Section D and cover open body trucks hauling materials off site and use water during the grading of roads, excavation, and land clearing. Therefore, it is not expected that sensitive receptors would be exposed to substantial concentrations of $PM_{10.}$

(d) No Impact: The project will not create other emissions (such as objectionable odors) affecting a substantial number of people.

IV. Biological Resources. Would the project:	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
a) Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special status species in local or regional plans, policies, or regulations, or by the California Department of Fish and Game or U.S. Fish and Wildlife Service?		X		
b) Have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, and regulations or by the California Department of Fish and Game or U.S. Fish and Wildlife Service?		X		
c) Have a substantial adverse effect on federally protected wetlands (including, but not limited to, marsh, vernal pool, coastal, etc.) through direct removal, filling, hydrological interruption, or other means?				X
d) Interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites?		X		
e) Conflict with any local policies or ordinances protecting biological resources, such as a tree preservation policy or ordinance?				X
f) Conflict with the provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other approved local, regional, or state habitat conservation plan?				X

Discussion:

Special-status species are defined in this ISMND as those that are:

- listed as endangered or threatened, rare, or proposed/candidates for listing under the ESA and/or CESA;
- designated by CDFW as a Species of Special Concern;
- have a California Rare Plant Rank (CRPR) of 1, 2, 3 or 4; and/or
- have a state ranking of S1, S2, or S3 (critically imperiled, imperiled, or vulnerable, respectively) on CDFW’s California Sensitive Natural Communities List (CDFW 2018a).

An in-depth review of the project site and surrounding area was conducted using desktop and field reviews (Appendix K of the BOD Report). The desktop review included querying the following resources:

- The U.S. Fish and Wildlife Service (USFWS) online Information for Planning and Consultation (IPaC),
- The California Native Plant Society’s (CNPS) online Inventory of Rare and Endangered Vascular Plants of California,
- CDFW’s California Natural Diversity Database (CNDDB),
- CDFW’s CNDDB northern spotted owl viewer, and

- National Marine Fisheries Service's (NMFS) California Species List Tools database (NMFS 2019).

The desktop review generated a list of special status plant and wildlife species with potential to inhabit the project area (Tables 1 and 2). The field review was conducted on 3 May 2019 and was used to assess habitat for the species on the list, determine their potential to be present, and identify what project-related effects on these species would occur, if any. Please see Appendices F and K of the BOD report in Attachment A for more detailed information.

Table 1. Special status plant species with the potential to be present in or around the Project Area.

Scientific name (common name)	Status (Federal, State, CRPR[1])	Habitat association[2]	Source	Likelihood of occurrence
Astragalus agnicidus (Humboldt County milk-vetch)	None/CE/1B.1	Openings, disturbed areas, and sometimes roadsides in broadleafed upland forest and north coast coniferous forest; 390–2,625 ft. Blooming period: April–September	CNPS, CDFW	**Moderate:** Broadleafed upland and north coast coniferous forest habitats present within Project area. Two occurrences within 5–10 mi of the Project area.
Coptis laciniata (Oregon goldthread)	None/None/4.2	Mesic meadows and seeps and streambanks in north coast coniferous forest; 0–3,280 ft. Blooming period: (February) March–May (September–November)	CNPS, CDFW	**Moderate:** North coast coniferous forest habitat present within Project area. Two occurrences within 5–10 mi of the Project area.
Erythronium oregonum (giant fawn lily)	None/None/2B.2	Sometimes serpentinite, rocky, openings in cismontane woodland and meadows and seeps; 325–3,775 ft. Blooming period: March–June (July)	CNPS, CDFW	**Moderate:** Cismontane woodland habitat present within Project area. No ultramafic soils mapped or observed in Project area. One occurrence is within 5–10 mi of the Project area.
Erythronium revolutum (coast fawn lily)	None/None/2B.2	Mesic, streambanks, bogs and fens, broadleafed upland forest, and north coast coniferous forest; 0–5,250 ft. Blooming period: March–July (August)	CNPS, CDFW	**Moderate:** Broadleafed upland and north coast coniferous forest habitats present within Project area. Two occurrences within 5–10 mi of the Project area.
Gilia capitata subsp. *pacifica* (Pacific gilia)	None/None/1B.2	Coastal bluff scrub, openings in chaparral, coastal prairie, and valley and foothill grassland; 15–	CNPS, CDFW	**Moderate:** Chaparral and valley and foothill grassland habitats present within Project

Scientific name (common name)	Status (Federal, State, CRPR[1])	Habitat association[2]	Source	Likelihood of occurrence
		5,465 ft. Blooming period: April–August		area. Multiple occurrences within 5–10 mi of the Project area.
Montia howellii (Howell's montia)	None/None/2B.2	Vernally mesic, sometimes roadsides in meadows and seeps, north coast coniferous forest, and vernal pools; 0–2,740 ft. Blooming period: (February) March–May	CNPS, CDFW	**Moderate:** North coast coniferous forest habitat present within Project area. Two occurrences within 5–10 mi of the Project area.
Piperia candida (white-flowered rein orchid)	None/None/1B.2	Sometimes serpentinite in broadleafed upland forest, lower montane coniferous forest, and north coast coniferous forest; 95–4,300 ft. Blooming period: (March) May–September	CNPS, CDFW	**Moderate:** Broadleafed upland, lower montane coniferous, and north coast coniferous forest habitats present within Project area. No ultramafic soils mapped or observed in Project area. Multiple occurrences within 1 mi of the Project area.
Usnea longissima (Methuselah's beard lichen)	None/None/4.2	On tree branches, usually on old growth hardwoods and conifers in broadleafed upland forest and north coast coniferous forest; 160–4,790 ft. Blooming period: N/A (lichen)	CNPS, CDFW	**Moderate:** Broadleafed upland and north coast coniferous forest habitats present within Project area. Multiple occurrences within 5–10 mi of the Project area.

Table 2. Special status wildlife species with the potential to be present in or around the Project Area.

Species name	**Status[1] Federal/ State**	**Distribution and habitat associations**	**Location of suitable habitat in Project area**	**Likelihood of occurrence**
Fish				
Oncorhynchus kisutch (Coho salmon – southern Oregon/ northern California coast Evolutionarily Significant Unit)	FT, CH/ST	Spawn in coastal streams and large mainstem rivers (i.e., Klamath/Trinity rivers) in riffles and pool tails-outs and rear in pools ≥ 3 ft deep with overhead cover with high levels oxygen and temperatures between 50–59°F.	Suitable habitat occurs in the South Fork Eel River and Redwood Creek.	**High**: Present in Redwood Creek.
Oncorhynchus tshawytscha (Chinook salmon – California Coastal ESU*)*	FT, CH/None	Wild coastal, spring, and fall-run Chinook found in streams and rivers between Redwood Creek, Humboldt County to the north and the Russian River, Sonoma County to the south.	Suitable habitat occurs in the South Fork Eel River and Redwood Creek.	**High**: Present in Redwood Creek.
Oncorhynchus mykiss (Steelhead – northern California coast Distinct Population Segment)	FT, CH/None	Inhabits small coastal streams to large mainstem rivers with gravel-bottomed, fast-flowing habitat for spawning. However, habitat criteria for different life stages (spawning, fry rearing, juvenile rearing) are can vary significantly.	Suitable habitat occurs in the South Fork Eel River and Redwood Creek.	**High**: Present in Redwood Creek.
Entosphenus tridentatus (Pacific lamprey)	None/SSC	Similar to anadromous salmonids, inhabits coastal streams and rivers with gravel-bottomed, fast-flowing habitat for spawning. Ammocoetes rear in backwater areas with sand, silt, and organic material for 4 to 10 years before migrating to the ocean.	Suitable habitat is present and spawning/rearing occurs in the South Fork Eel River. Spawning and rearing habitat is likely to occur in Redwood Creek.	**High:** Suitable habitat present.

Species name	Status[1] Federal/ State	Distribution and habitat associations	Location of suitable habitat in Project area	Likelihood of occurrence
Amphibians				
Rana boylii (Foothill yellow-legged frog, North Coast Clade)	None/SSC	Associated with partially shaded, shallow streams, and riffles with rocky substrate. Some cobble-sized substrate required for egg laying. Adults move into smaller tributaries after breeding.	Suitable habitat is present and breeding occurs in the South Fork Eel River. Observed in Redwood Creek downstream of Project area.	**High**: Suitable habitat present.
Taricha rivularis (Red-bellied newt)	None/SSC	Ranges from southern Humboldt to Sonoma counties. Found in streams during breeding season. Moist habitats under woody debris, rocks, and animal burrows.	Suitable habitat is present and sightings have occurred in the Mattole River, approximately 5 mi west of the Project area.	**High**: Habitat present in the Project area.
Birds				
Strix occidentalis caurina (Northern spotted owl)	FT/ST	Typically found in large, contiguous stands of mature and old-growth coniferous forest with dense multi-layered structure.	Suitable foraging habitat is present within the Project area. Habitat within the Project area is unsuitable for nesting. The closest activity center is over 1.7 mi to the south-southeast of the Project area.	**Moderate**: Suitable foraging habitat exists in the Project area.
Asio otus (Long-eared owl)	None/SSC	Distributed throughout North America. Recorded in north coast from Bald Hills, Humboldt County to Willits, Mendocino County. In Humboldt County, nest in mixed stands of conifers and oaks with edges and openings such as meadows or prairies.	Suitable nesting and foraging habitat present in the Project area.	**High**: Habitat present in the Project area.
Reptiles				
Emys marmorata (Western pond turtle)	None/SSC	Ponds, marshes, rivers, streams, and irrigation ditches with abundant vegetation, and either rocky or muddy bottoms, in woodland forest and	Suitable habitat occurs in the South Fork Eel River. Ponds that may contain western	**Moderate.** May occur in neighboring ponds.

Species name	Status[1] Federal/ State	Distribution and habitat associations	Location of suitable habitat in Project area	Likelihood of occurrence
		grasslands. Below 6,000 ft elevation. Basking sites are required. Egg-laying sites are located on suitable upland habitats (grassy open fields) up to 1,640 ft from water.	pond turtles are located on neighboring properties.	
Mammals				
Arborimus pomo (Sonoma tree vole)	None/SSC	Associated nearly exclusively with Douglas-fir trees and occasionally grand fir trees within the north coast fog belt between the northern Oregon border and Sonoma County. Eats Douglas-fir needles exclusively.	Early to mid-seral Douglas-fir stands are present adjacent to the Project area, which could provide nesting and foraging habitat.	**High**: Recorded occupying timber stands adjacent to the Project area
Corynorhinus townsendii (Townsend's big-eared bat)	None/SSC, CT	Found throughout California in all but subalpine and alpine habitats. Roosts in cavernous habitats, usually in tunnels, caves, buildings, mines, and basal hollows of trees, but also rock shelters, preferentially close to water. Caves near water's edge are favored. Forages in riparian zone and follows creeks and river drainages on foraging bouts. Feeds primarily on moths. Drinks at stream pools.	Suitable foraging habitat throughout most of the Project area; however, barns, old buildings, and bridges for roosting are not present within the Project area.	**Moderate**: May be present in some of the barns and older structures adjacent to the Project area.
Antrozous pallidus (Pallid bat)	None/SSC	Found throughout California. Roosts in rock crevices, outcrops, cliffs, mines, and caves; trees (underneath exfoliating bark of pine and oak) and in basal hollows; and a variety of vacant and occupied structures (e.g., bridges) or buildings. Roost individually or in small to large colonies (hundreds of individuals). Feeds low to or on the ground in a variety of open habitats, primarily on ground-dwelling arthropods.	Suitable foraging habitat throughout most of the Project area, however, barns, old building, and bridges are not present within the Project area.	**Moderate**: May be present in some of the older structures adjacent to the Survey Area

Species name	Status[1] Federal/ State	Distribution and habitat associations	Location of suitable habitat in Project area	Likelihood of occurrence
		Forages most frequently in riparian zone, in open oak savannah, and open mixed deciduous forest. Drinks at stream pools.		

(a) Less Than Significant with Mitigation Incorporated: The project will not have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special status in local or regional plans, policies, or regulations, or by the California Department of Fish and Wildlife (CDFW), National Oceanic and Atmospheric Administration (NOAA) or U.S. Fish and Wildlife Service (USFWS). All effects will be less than significant with the incorporation of the mitigation measures listed below and in Appendix K of the BOD Report.

Plants

No special-status plant species were observed during the protocol-level botanical survey conducted in the Project area on 4 May 2019 (see Appendix F of BOD Report). In addition, there are no records of special-status plant occurrences within the Project area based on the 2019 CDFW CNDDB queries and collection records in the Consortium of California Herbaria (ucjeps.berkeley.edu/consortium). As such, Project activities will have no impact on known special-status plant populations. However, the following design features are incorporated into the project description and discussed further in Appendix F of BOD Report.

- The Project footprint will be minimized to the extent possible.
- The pond will be positioned to minimize impacts on existing vegetation to the extent possible.
- Ground disturbance and vegetation clearing and/or trimming will be confined to the minimum amount necessary to facilitate Project implementation.
- Heavy equipment and vehicles will use existing access roads to the extent possible.
- Construction materials will be stored in designated staging areas.
- Measures to prevent the spread of invasive weeds and sudden oak death pathogens will be taken, including, where appropriate, inspecting equipment for soil, seeds, and vegetative matter, cleaning equipment, utilizing weed-free materials and native seed mixes for revegetation, and proper disposal of soil and vegetation.
- Disturbed soils areas will be revegetated with native grasses and forbs. Please see the erosion control and revegetation sheet in the project design package.

Fish

Coho and Chinook salmon, steelhead, and Pacific lamprey are special-status fish species known to occur in Redwood Creek within to the Project area. Project-related impacts on these species could result from discharge of sediment from reservoir and infiltration gallery excavation, gully stabilization, instream habitat enhancement, contact with heavy equipment, entrainment into dewatering pumps. and offset well construction.

There would be long-term beneficial effects for fish and habitat resulting from the addition of wood and project water to the stream channel. The increase in wood structures would result in localized scour and help create pool and cover habitat for fish. The input of water during the summer and late fall from the infiltration gallery would increase summer and fall flow in Redwood Creek during the dry season. It is expected that coho salmon and steelhead will benefit from the infusion of cool project water during the summer and fall months. Stabilization of the gullies on the property would reduce sediment input into Redwood Creek and adverse effects on spawning and rearing habitat for fish.

The following measures, and those in Appendix K of the BOD Report, will be employed by the Project to avoid, minimize, or mitigate indirect sediment-related impacts on special-status fish species and their habitat.

BIO-1: The use of cofferdams will contain any turbid water produced during the Project within the work area, thereby avoiding impacts on downstream salmonids. Any turbid water within the confined work areas would be pumped to a receiving site outside the channel or to tanks. Any turbid water within the work area would be allowed to settle prior to removal of the cofferdams, thereby minimizing downstream effects on salmonids.

BIO-2: Discharge of sediment will be controlled and minimized with the implementation of best management practices (BMPs) on all disturbed soils that have the potential to discharge into area watercourses. Applicable BMPs include, but are not limited to, installation of silt fences, straw wattles, and placement of seed-free rice straw. BMPs will be installed at all access points to the work sites, which will minimize the potential for sediment delivery and deleterious effects on salmonids.

BIO-3 - All gully stabilization work will be conducted when the individual sites are dry (i.e. no surface water).

BIO-4: A June 15 – November 1 instream work window will be established to allow time for young-of-the-year salmonids to be very mobile and capable of avoiding injury. The work window will also allow downstream migration of smolts to be completed prior to any Project-related channel disturbance taking place. In addition, the work window coincides with the summer low-flow season during which flow in the creek will be at its summer base flow. Finally, the November 1 date will ensure all work is done prior to the rainy season and arrival of any upstream migrating adult salmonids.

BIO-5: Prior to the initiation of any instream work in areas with surface water, a qualified biologist will survey the site to determine fish presence. The biologist will implement an aquatic species removal and relocation plan to move any fish or amphibians that may be in work sites to suitable habitat downstream. Block nets will be installed to prevent fish from reentering the work area. Any fish remaining in the work area will be captured by hand, dip net, or as a last resort, using a backpack electrofisher. Cofferdams will be constructed in the channel at sites where streamflow is present. Water will then be diverted around the work area.

BIO-6: The Project will follow the Fish Screening Criteria for Salmonids (NMFS 1997), NOAA Restoration Center/Army Corps of Engineers programmatic biological opinion requirements.

Wildlife

<u>Foothill yellow-legged frogs</u>

The reservoir and infiltration gallery construction activities will take place in open meadow areas not utilized by foothill yellow-legged frogs. However, foothill yellow-legged could be affected by proposed activities that would take place within Redwood Creek and at gully stabilization sites.

Impacts on adult, juvenile, or larval frogs could occur through direct contact with heavy equipment or disturbed soil. Adverse impacts could occur from instream structure construction, dewatering of work areas, trampling of larvae during instream operations, contact with heavy equipment, and sediment discharge. The gully stabilization sites are not utilized by foothill yellow-legged frogs for breeding or larval rearing and impact on these life history stages would not occur at these locations.

The Project would result in the development of additional instream habitat, which should benefit foothill yellow-legged frogs by maintaining and potentially expanding the amount of instream habitat available for breeding and larval development in Redwood Creek.

The following mitigation measures, and those Appendix K of the BOD Report, will be employed to avoid or minimize effects on foothill yellow-legged frogs:

BIO-7: An egg mass survey will be conducted in May prior to the construction season to determine if breeding occurs within the Project reaches.

BIO-8: A visual observation survey of the project areas will be conducted within two weeks prior to the start of construction to determine if adult and juvenile foothill yellow-legged frogs are present in the Project area.

BIO-9: If foothill yellow-legged frogs are present, then a qualified CDFW-approved biologist will be present immediately prior to the start of construction to remove any frogs and relocate them in suitable habitat.

BIO-10: The Project manager or qualified designee will conduct daily morning inspections of the area slated for work to determine if amphibians entered the areas overnight. Any individuals will be captured and relocated prior to the start of the day's work.

Red-bellied newt

Adult and juvenile red-bellied newts would likely be occupying terrestrial areas during the operation period and could be affected by heavy equipment that collapses burrows or moves woody debris. Larval newts have the potential to be present in areas that could be affected by instream operations. Mitigation measure BIO 10, those in Appendix K of the BOD Report, and the following will be employed to avoid or minimize the potential for take of red-bellied newt:

BIO-11: Terrestrial woody debris will be left in place to the greatest extent practicable during operations within the riparian areas.

BIO-12: Prior to the initiation of any instream work in areas with surface water, a qualified biologist will survey the site to determine larval newt presence. If red-bellied newts are present, then a qualified CDFW-approved biologist will be present immediately prior to the start of operations to remove any individuals and relocate them in suitable habitat.

The Project will result in the development of additional instream habitat, which should benefit red-bellied newts by maintaining and potentially expanding the amount of instream habitat available for breeding and larval development.

Northern spotted owl

The closest northern spotted owl activity center to the Project is approximately 1.7 mi away from the Project area and recent surveys (i.e., within the last four years) have not documented nesting within this activity center (Appendix K of the BOD Report). Nesting habitat does not occur within the Project area or in the adjacent forest. The Project activities do not include removal of any trees that could provide habitat for owls. Therefore, there will not be any direct impacts on northern spotted owls or their habitat. However, there is the potential for construction-related noise to affect northern spotted owls that may be on adjacent properties or away from the Project area.

The potential for Project construction to indirectly impact nesting northern spotted owls was preliminary evaluated using USFWS (2006) guidelines. Owls can be affected by noise-related, visual, or physical disturbances, such as created by heavy equipment. USFWS (2006) identifies the distance that sound associated with different types of construction equipment is estimated to disturb northern spotted owls during the breeding season, relative to ambient noise levels. Most types of standard construction equipment (e.g., backhoes, bulldozers, construction vehicles, etc.) would require disturbance buffers of 330–1,320 ft from nesting spotted owl activity centers. No Project activities utilizing these types of equipment are expected to occur within 1,320 ft of a northern spotted owl nest. In addition, as stated above, recent surveys have not found nesting northern spotted owls with the closest known activity center (1.7 mi from the Project area). Therefore, project effects on northern spotted owls would be less than significant.

Long-eared owl

Long-eared owls have not been observed within 17 mi of the Project area (Appendix K of the BOD Report). However, this species nests in conifer and oak woodlands that are either open or are adjacent to grasslands, meadows, or shrublands. These habitats exist within the Project area, although no evidence of occupancy was observed during the field survey. Construction activities associated with the Project would not affect nesting or roosting habitat since no trees would be removed. However, potential foraging habitat could be affected due to the construction of the reservoir and infiltration gallery. In addition, construction noise may affect nesting owls.

The construction of the reservoir will result in approximately 6.5 ac of grazed grassland area being permanently converted to open water and associated containment berm features. This conversion could affect the amount of foraging habitat available for long-eared owls. A preliminary estimate of available grasslands in the Briceland area conducted using satellite imagery showed approximately 470 ac of grassland (not including numerous small openings) within a one-mile radius of the Project area. The Project would convert approximately 1.4% of this area to reservoir, a relatively minor impact in consideration of the amount of suitable foraging habitat in the vicinity and the lack of evidence indicating species presence in and around the Project area.

The following conservation measure will be employed to avoid or minimize the potential for impacts on long-eared owls:

BIO-13: A pre-construction nesting bird survey will be conducted during the breeding season and within two weeks of the start of construction. Appropriate buffers will be established around all active nests within the Project area.

Sonoma tree vole

Suitable habitat for Sonoma tree voles is present in the timber stand adjacent to the Project area. The Project will not occur within the forest nor remove any trees; therefore, there will be no impact on this species.

Pallid bat

Suitable habitat for pallid bats is present in the timber stand adjacent to the Project area. The Project will not occur within the forest nor remove any trees or structures that could be occupied by this species; therefore, there will be no impact on pallid bat.

Townsend's big-eared bat

Suitable habitat for Townsend's big-eared bats is present in the timber stand adjacent to the Project area. The Project will not occur within the forest nor remove any trees or structures that could be occupied by this species; therefore, there will be no impact on Townsend's big-eared bat.

Western pond turtles

Redwood Creek, within the Project area has a relatively closed canopy, which would limit the basking opportunities for turtles. In addition, water flow during the summer months is very low or intermittent, which is not the preferred habitat for turtles. In addition, there are no ponds in the Project area that could contain this species. However, there is the potential that turtles could be within the Project area at the start of construction.

The following mitigation measure, along with those in Appendix K of the BOD Report, will be employed to avoid or reduce impacts on western pond turtles to a less than significant level:

BIO-14: Prior to the initiation of any instream work in areas with surface water, a qualified biologist will survey the site to determine turtle presence. The biologist will capture and relocate any turtle that may be in work sites to suitable habitat downstream. Block nets will be installed to prevent turtles from reentering the work area.

Bullfrogs

The construction and operations of the pond has the potential to create habitat for bullfrogs and subsequently impact native species. The following avoidance and minimization measures will be incorporated in the project design, monitoring and maintenance plan. In order to avoid bullfrogs from infesting the project sites the following strategies will be implemented:

a) Landowner and resident education is one of the most important strategies, as people have been known to intentionally introduce bullfrogs to local bodies of water as a source of food.

b) Monitoring of project sites will also be very important as early detection, before populations can get established, is a key component of control. Monitoring will be conducted as per Exhibit A in Appendix K of the BOD Report: Bullfrog Monitoring and Management Plan prepared by CDFW.

c) If needed, the off-channel pond may be drained. David Manthorne, CDFW Senior Environmental Scientist recommends draining of ponds if invasive bullfrogs are present to interrupt their life cycle (CDFW Compliance Guidance). According to research by Doubledee et al, 2007, "*Bullfrogs, Disturbance Regimes, and the Persistence of California Red-Legged Frogs* ", draining of ponds can be effective for bullfrog management if draining occurs at least every 2 years.

d) If annual monitoring shows that bullfrogs are present, active measures will be taken in consultation with CDFW and will follow the methods described in Exhibit A of BOD Appendix K: Bullfrog Monitoring and Management Plan

(b) Less than Significant: The project will not have a substantial adverse effect on any riparian habitat or other sensitive natural communities identified in local or regional plans, policies and regulations, or by CDFW or USFWS.

One sensitive natural community, *Acer macrophyllum* Forest Alliance (S3), was observed within the Project area (Appendix F of the BOD Report). This alliance comprised the riparian forest (also under CDFW preliminary jurisdictional throughout the Project area) adjacent to Redwood Creek and its tributaries in the Project. Some minor disturbance is anticipated within this natural community during the instream habitat enhancement and gully stabilization Project activities. Installation of the off-channel reservoir will not affect this sensitive natural community, as it will replace a portion of the annual/perennial grassland in the Project area. Also, it is expected that the gully stabilization work will provide groundwater storage benefits, which could enhance riparian vegetation in those locations.

Some minor disturbance is expected where proposed instream structures are keyed into the stream banks. Riparian vegetation will be reestablished where construction activities disturb existing plants, and additional native plants will be planted to enhance the riparian vegetation. Mitigation measures to minimize impacts on riparian habitat are found in Appendix K of the BOD Report and include:

BIO-15: Planting of seedlings shall begin after December 1, or when sufficient rainfall has occurred to ensure the best chance of survival of the seedlings, but in no case after April 1.

BIO-16: Any disturbed banks shall be fully restored upon completion of construction. Revegetation shall be done using native species. Planting techniques can include seed casting, hydroseeding, or live planting methods using the techniques in Part XI of the California Salmonid Stream Habitat Restoration Manual.

BIO-17: Disturbed and compacted areas shall be re-vegetated with native plant species. The species shall be comprised of a diverse community structure that mimics the native riparian corridor. Planting ratio shall be 2:1 (two plants to every one removed). Unless otherwise specified, the standard for success is 80 percent survival of plantings or 80 percent ground cover for broadcast planting of seed after a period of 3 years.

BIO-18: To ensure that the spread or introduction of invasive exotic plants shall be avoided to the maximum extent possible, equipment shall be cleaned of all dirt, mud, and plant material prior to entering a work site. When possible, invasive exotic plants at the work site shall be removed. Areas disturbed by project activities will be restored and planted with native plants.

BIO-19: Mulching and seeding shall be done on all exposed soil which may deliver sediment to a stream. Soils exposed by project operations shall be mulched to prevent sediment runoff and transport. Mulches shall be applied so that not less than 90% of the disturbed areas are covered. All mulches, except hydro-mulch, shall be applied in a layer not less than two (2) inches deep. Where feasible, all mulches shall be kneaded or tracked-in with track marks parallel to the contour, and tackified as necessary to prevent excessive movement. All exposed soils and fills, including the downstream face of the road prism adjacent to the outlet of culverts, shall be reseeded with a mix of native grasses common to the area, free from seeds of noxious or invasive weed species, and applied at a rate which will ensure establishment.

BIO-20: If erosion control mats are used in re-vegetation, they shall be made of material that decomposes. Erosion control mats made of nylon plastic, or other non-decomposing material shall not be used.

BIO-21: If riparian vegetation is to be removed with chainsaws, the Permittee shall use saws that operate with vegetable-based bar oil when possible.

(c) No impact: The project will not have a substantial adverse effect on federally protected wetlands as defined by § 404 of the Clean Water Act as there are no USACE jurisdictional wetlands within the project area. Two small state jurisdictional isolated wetlands have been mapped on the parcel but will not be disturbed as the result of any proposed project. The project actions will have either no effect on wetlands or will be beneficial to wetlands.

(d) Less Than Significant Impact with Mitigation Incorporated: The instream construction portion of the project that requires the installation of cofferdams and dewatering of the work area will temporarily affect migration of fish between habitat units. However, this disruption in the ability of fish to migrate will only occur during the brief instream construction period. In addition, the instream part of the project is timed to begin after the downstream salmonid smolt migration has ceased. The project would end prior to the start of the upstream migration season for adult salmonids.

Once completed, the project will result in a substantial improvement in the ability of juvenile fish to migrate between habitat units during the dry season. This is due to the discharge of project water from the pond into Redwood Creek. It is expected that the augmented flow will help maintain a single thread channel and connectivity between habitat units that is currently lacking during dry years. In addition, the project includes the installation of instream habitat structures that are designed to create pool and cover habitat. This will improve the rearing habitat in Redwood Creek. These design features and implementation of the mitigation measures **BIO-4, -5, and -6** described above and in Appendix K of the BOD Report will reduce impacts to a less than significant level.

(e) No Impact: The project will not conflict with any local policies or ordinances protecting biological resources, such as a tree preservation policy or ordinance. Such an impact will not occur because project actions are designed to restore and enhance biological resources. The Humboldt County Streamside Management Area Ordinance requires a Special Permit for all activities within Streamside Management Areas. This project has been submitted to the Humboldt County Planning Department with a Special Permit application as needed to allow for the project activities within the Streamside Management Areas.

(f) No Impact: The project will not conflict with the provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other approved local, regional, or State habitat conservation plan. Such a conflict will not occur because the project restoration actions will not have a significant adverse impact on any species or habitat. Project actions are designed to restore the natural character of the fish and wildlife habitat at the project work sites. The project specifically supports the California Salmon, Steelhead Trout and Anadromous Fisheries Program Act (Fish and Game Code § 6900 et. seq.).

V. Cultural Resources. Would the project:	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
a) Cause a substantial adverse change in the significance of a historical resource as defined in §15064.5?		X		
b) Cause a substantial adverse change in the significance of an archaeological resource pursuant to §15064.5?		X		
c) Disturb any human remains, including those interred outside of formal cemeteries?		X		

Discussion:

(a) Less Than Significant with Mitigation Incorporated: The project will not cause a substantial adverse change in the significance of a historical resource as defined in CEQA Guidelines § 15064.5.

Resources identified during site-specific surveys will be protected before ground-disturbing activities are permitted at a site. Ground disturbance will be required to implement the project at some work sites that have the potential to affect historical resources, this potential impact will be minimized to a less than significant level through implementation of the protective measures presented below and in Appendix E of the BOD Report. As a result, any potentially significant impacts will be avoided or mitigated to below a level of significance.

CR-1: Cultural resources on the site will be protected by the Permittee through implementation of the following protective measures before work can proceed:

a) The site boundary shall be clearly marker during project implementation. Boundary markers such as flagging, stakes, fencing, or other highly visible barrier should be used.

b) The area containing the archaeological site shall be completely excluded from ground disturbing activities. The proposed path of the pond intake pipeline and primary spillway have been rerouted to avoid ground disturbance to the identified sensitive area.

c) Spoils from pond excavation may be placed directly on the existing site surface, however, no grading or scarifying shall be conducted. Heavy equipment shall not enter the site unless atop a sufficient layer of fill, such that the underlying soil is not displaced.
d) All ground-disturbing activities and placement of fill material within the known archaeological site shall be monitored by a professional archaeologist familiar with specific project conditions. A monitoring plan should be developed and used to guide monitoring and discovery protocol.
e) This archaeological site should be continuously monitored after project construction. The landowner or designee should watch for erosion, unauthorized collecting, and other site damages as a result of this site now being identified.
f) In the event additional archaeological material is encountered during project implementation or during future site monitoring efforts, all work shall stop in the area of the find and the discovery protocol initiated as described below in 6).

CR-2: The Permittee shall ensure that the implementation contractor or responsible party is aware of these site-specific conditions, and shall inspect the work site before, during, and after completion of the action item.

CR-3: Inadvertent Discovery of Cultural Resources - If cultural resources are encountered during construction activities, all onsite work shall cease in the immediate area and within a 50-foot buffer of the discovery location. A qualified archaeologist will be retained to evaluate and assess the significance of the discovery, and develop and implement an avoidance or mitigation plan, as appropriate. For discoveries known or likely to be associated with Native American heritage (prehistoric sites and select historic period sites), the tribes listed in Section 6.2 and those that the County has on file shall also be contacted immediately to evaluate the discovery and, in consultation with the project proponent, the County, and consulting archaeologist, develop a treatment plan in any instance where significant impacts cannot be avoided. Prehistoric materials which could be encountered include obsidian and chert debitage or formal tools, grinding implements, (e.g., pestles, handstones, bowl mortars, slabs), locally darkened midden, deposits of shell, faunal remains, and human burials. Historic archaeological discoveries may include nineteenth century building foundations, structural remains, or concentrations of artifacts made of glass, ceramics, metal or other materials found in buried pits, wells or privies.

(b) Less Than Significant with Mitigation Incorporated: The project will not cause a substantial adverse change in the significance of an archaeological resource pursuant to CEQA Guidelines § 15064.5. While ground disturbance will be required to implement the project at some work sites that have the potential to affect archaeological resources, this potential impact will be avoided through implementation of the protective measures described above and presented in Appendices E and K of the BOD Report for all work sites. Resources identified during site-specific surveys will be protected before ground-disturbing activities are permitted at a site and an archeological monitor will be present during excavation in critical areas. As a result, mitigation measures will ensure that any potentially significant impacts are avoided or mitigated to below a level of significance.

(c) Less Than Significant with Mitigation Incorporated: The project is highly unlikely to disturb any human remains, including those interred outside of formal cemeteries. While ground disturbance will be required to implement the project at some work sites that have the potential to affect these resources, this potential impact will be avoided through implementation of the protective measures presented in Appendix E of the BOD Report for all work sites. Resources identified during site-specific surveys will be protected before ground-disturbing activities are permitted at a site and an archeological monitor will be present during excavation in critical areas.

CR-4: Inadvertent Discovery of Human Remains - If human remains are discovered during project construction, work shall stop at the discovery location, within 20 meters (66 feet), and any nearby area reasonably suspected to overlie adjacent human remains (Public Resources Code, Section 7050.5). The county coroner shall be contacted to determine if the cause of death must be investigated. If the coroner determines that the remains are of Native American origin, it is necessary to comply with state laws relating to the disposition of Native American burials, which fall within the jurisdiction of the Native American heritage Commission (NAHC) (Public Resources Code, Section 5097). The coroner will contact the NAHC. The descendants or most likely descendants of the deceased will be contacted, and work shall not resume until they have made a recommendation to the landowner or the person responsible for the excavation work for means of treatment and disposition, with appropriate dignity, of the human remains and any associated grave goods, as provided in Public Resources Code, Section 5097.98.

CR-5: Procedures for treatment of an inadvertent discovery of human remains:

a) Immediately following discovery of known or potential human remains all ground-disturbing activities at the point of discovery shall be halted.

b) No material remains shall be removed from the discovery site, a reasonable exclusion zone shall be cordoned off.

c) The property owner shall be notified and the Permittee Project Manager shall contact the county coroner.

d) The Permittee shall retain the services of a professional archaeologist to immediately examine the find and assist the process.

e) All ground-disturbing construction activities in the discovery site exclusion area shall be suspended.

f) The discovery site shall be secured to protect the remains from desecration or disturbance, with 24-hour surveillance, if prudent.

g) Discovery of Native American remains is a very sensitive issue, and all project personnel shall hold any information about such a discovery in confidence and divulge it only on a need-to-know basis, as determined by the CDFW.

h) The coroner has two working days to examine the remains after being notified. If the remains are Native American, the coroner has 24 hours to notify the NAHC in Sacramento (telephone 916/653-4082).

i) The NAHC is responsible for identifying and immediately notifying the Most Likely Descendant (MLD) of the deceased Native American.

j) The MLD may, with the permission of the landowner, or their representative, inspect the site of the discovered Native American remains and may recommend to the landowner and Permittee means for treating or disposing, with appropriate dignity, the human remains and any associated grave goods. The descendants shall complete their inspection and make recommendations or preferences for treatment with 48 hours of being granted access to the site (Public Resource Code, Section 5097.98(a)). The recommendation may include the scientific removal and non-destructive or destructive analysis of human remains and items associated with Native American burials.

k) Whenever the NAHC is unable to identify a MLD, or the MLD identified fails to make a recommendation, or the landowner or his/her authorized representative rejects the recommendation of the MLD and mediation between the parties by the NAHC fails to provide measures acceptable to the landowner, the landowner or his/her authorized representatives shall re-inter the human remains and associated grave offerings with appropriate dignity on the property in a location not subject to further subsurface disturbance in accordance with Public Resource Code, Section 5097.98(e).

l) Following final treatment measures, the Permittee shall ensure that a report is prepared that describes the circumstances, nature and location of the discovery, its treatment, including results of analysis (if permitted), and final disposition, including a confidential map showing the reburial location. Appended to the report shall be a formal record about the discovery site prepared to current California standards on DPR 523 form(s). Permittee shall ensure that report copies are distributed to the appropriate California Historic Information Center, NAHC, and MLD.

VI. Energy. Would the project:	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
a) Result in potentially significant environmental impact due to wasteful, inefficient, or unnecessary consumption of energy resources, during project construction or operation?				X
b) Conflict with or obstruct a state or local plan for renewable energy or energy efficiency?				X

Discussion:

(a) Less Than Significant: The Project will not result in the wasteful, inefficient, or unnecessary consumption or energy resources during construction or operations. The construction contractors will be using heavy equipment as effectively as possible to reduce fuel and labor costs and generation of greenhouse gasses. In addition, the operation of the Project will utilize a solar array to offset any energy consumption and provide clean energy to the State's electrical grid.

(b) No impact: The Project will not conflict with or obstruct a state or local plan for renewable energy or energy efficiency. The Project includes the installation of a solar array and micro hydro system that will offset the amount of electricity necessary to operate the facility.

VII. Geology and Soils. Would the project:	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
a) Directly or indirectly cause potential substantial adverse effects, including the risk of loss, injury, or death involving:				
i) Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault? Refer to Division of Mines and Geology Special Publication 42.				X
ii) Strong seismic ground shaking?				X
iii) Seismic-related ground failure, including liquefaction?			X	
iv) Landslides?			X	
b) Result in substantial soil erosion or the loss of topsoil?		X		
c) Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse?			X	
d) Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial direct or indirect risks to life or property?			X	
e) Have soils incapable of adequately supporting the use of septic tanks or alternative wastewater disposal systems where sewers are not available for the disposal of wastewater?				X
f) Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature?				X

Discussion:

(a) No Impact and Less Than Significant Impact:

(i) There are no earthquake faults on the project site. The nearest fault (Briceland Fault) is located over 4,000 ft to the northeast and is not considered active (CGS 2018). The project site is not located in an Earthquake Fault Zone (CGS 2018). The nearest active fault is the San Andreas fault, which is approximately 9.5 miles southwest of the project site. Therefore, there would be no impact.

(ii) The project would not result in strong seismic ground shaking or involve construction of features that would be at risk of structural failure due to strong seismic ground shaking. Therefore, there would be no impact.

(iii) The project's geotechnical report (Appendix B of the BOD Report) described that the materials beneath the upper terrace (where pond and solar array will be located) have clay skins and iron and manganese accumulations, and is therefore too old and well cemented to be susceptible to liquefaction. The lower terrace (fill placement location) was described as having a low to moderate potential for liquefaction under sustained ground shaking. Within this portion of the project area, excavated fill from the pond site will be placed and recontoured with gentle slopes that do not pose a substantial adverse risk. No human habitation structures are being proposed on these sites. Therefore, there would be a less than significant impact.

(iv) The geotechnical report stated that the project sites are on planar, generally level ground and that mass wasting is unlikely to affect the areas that would be under construction. Additional recent borings indicated that the subsurface bedrock grades toward a shallower depth downslope from the proposed pond, which would add additional stability. In addition, the pond design contains multiple safety features as described in the BOD Report that would further limit the potential for failure. Finally, long-term monitoring of pond berm stability and groundwater elevations adjacent to the pond will be conducted as part of the project's Operations, Maintenance, and Monitoring Plan to observe project function and any issues will be addressed through adaptive management. Through these actions, there would be a less than significant impact.

(b) Less Than Significant impact With Mitigation Incorporated: The project will not result in substantial soil erosion or the loss of topsoil. Such an impact will not occur because the Project is designed to contribute to an overall reduction in gully erosion. Existing roads will be used to access work sites wherever possible. The potential for substantial soil loss associated with pond construction will be avoided through implementation of the design features and mitigation measures presented in Appendix K of the BOD Report.

GEO-1: Work sites shall be winterized at the end of each day to minimize the eroding of unfinished excavations when significant rains are forecasted. Winterization procedures shall be supervised by a professional trained in erosion control techniques and involve taking necessary measures to minimize erosion on unfinished work surfaces. Winterization includes the following: smoothing unfinished surfaces to allow water to freely drain across them without concentration or ponding; compacting unfinished surfaces where concentrated runoff may flow with an excavator bucket or similar tool, to minimize surface erosion and the formation of rills; and installation of culverts, silt fences, and other erosion control devices where necessary to convey concentrated water across unfinished surfaces, and trap exposed sediment before it leaves the work site.

GEO-2: Effective erosion control measures shall be in-place at all times during construction. Construction shall not begin until all temporary erosion controls (i.e., straw bales or silt fences that are effectively keyed-in) are in place down slope or down stream of project activities within the riparian area. Erosion control measures shall be maintained throughout the construction period. If continued erosion is likely to occur after construction is completed, then appropriate erosion prevention measures shall be implemented and maintained until erosion has subsided.

GEO-3: An adequate supply of erosion control materials (gravel, straw bales, shovels, etc.) shall be maintained onsite to facilitate a quick response to unanticipated storm events or emergencies.

GEO-4: Upon project completion, all exposed soil present in and around the project site shall be stabilized within 7 days. Soils exposed by project operations shall be mulched to prevent sediment runoff and transport. Mulches shall be applied so that not less than 90% of the disturbed areas are covered. All mulches, except hydro-mulch, shall be applied in a layer not less than two (2) inches deep. Where feasible, all mulches shall be kneaded or tracked-in with track marks parallel to the contour, and tackified as necessary to prevent excessive movement. All exposed soils and fills, including the downstream face of the road prism adjacent to the outlet of culverts, shall be reseeded with a mix of native grasses common to the area, free from seeds of noxious or invasive weed species, and applied at a rate which will ensure establishment.

(c) Less Than Significant impact: To minimize the risk of the project interacting with or creating geologic instabilities, geomorphic mapping of the greater project area and a geotechnical investigation of the reservoir location were conducted. Geomorphic mapping identified one dormant, one suspended, and one active landslide area, all of sufficient distance and topographic isolation to pose less than significant hazards to project infrastructure. Grade control structure installation in the east, west, and central tributaries and a bank stabilization structure to be installed in Redwood Creek will serve to enhance geologic stability in the project area. Comprehensive results of the geomorphic and geotechnical investigations as well as Slope Stability Analyses are included in the Basis of Design Report in Attachment A. Additionally, best practices for construction will be maintained, including adherence to detailed compaction specifications as well as construction oversight by senior geotechnical and engineering staff.

(d) Less Than Significant Impact: Expansive soils shrink and swell in response to soil moisture levels and generally have a large clay component. Geomorphic and Geotechnical investigation suggests that there are clay soils onsite that have low to medium plasticity and have a potential for expansion and contraction. This project proposes earthen fills and hydraulic appurtenances that will be designed to withstand soil expansion and contraction. In addition, the engineered fills will have liquid limits of less than 40 and a plasticity index of less than 15. Additionally, the pond design has been modified from a soil liner to a High-density Polyethylene (HDPE) to reduce risks associated with expansive soil. Therefore, the potential for substantial direct or indirect risks to life or property from this project being located on expansive soils is less than significant.

(e) No Impact: The project will not create any sources of wastewater requiring a septic system.

(f) No Impact: There are no unique paleontological resources or sites or unique geologic features in the Project area.

VIII. Greenhouse Gas Emissions. Would the project:	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
a) Generate greenhouse gas emissions, either directly or indirectly, that may have a significant impact on the environment?			X	
b) Conflict with an applicable plan, policy or regulation adopted for the purpose of reducing the emissions of greenhouse gases?				X

Discussion:

(a) Less Than Significant Impact: The project will emit greenhouse gases (GHG) primarily through the burning of fuel to operate vehicles and heavy equipment during the construction phase of the project.

Construction and operational emissions were estimated using the CalEEMod (version 2016.3.2). CalEEMod is a statewide land use emissions computer model designed to provide a uniform platform for government agencies, land use planners, and environmental professionals to quantify potential criteria pollutant and GHG emissions associated with both construction and operation of a variety of land use projects. The model quantifies direct emissions from construction and operations (including vehicle use), as well as indirect emissions, such as GHG emissions from energy use, solid waste disposal, vegetation planting and/or removal, and water use.

The model was developed in collaboration with the air districts in California. Default data (emission factors, trip lengths, meteorology, source inventory, etc.) have been provided by the various California air districts to account for local requirements and conditions. The model is an accurate and comprehensive tool for quantifying air quality impacts from land use projects throughout California. The model can be used for a variety of situations where an air quality analysis is necessary or desirable such as CEQA documents. Input data and full results from CalEEMod is included in Attachment B of this MND.

The North Coast Unified Air Quality Management District (NCUAQMD) has not identified or recommended any GHG standards or thresholds of significance for the evaluation of construction projects. NCUAQMD has issued a rule stating that stationary sources emitting less than 25,000 tons per year of CO2 equivalent are exempt from compliance determination. Utilizing stationary source compliance rules is not recommended for the evaluation of projects subject to CEQA review and therefore we look to other jurisdictions that have developed thresholds, namely other California air districts, to show the emissions associated with this project in a state-wide context. These thresholds are as follows:

- South Coast Air Quality Management District (SCAQMD): SCAQMD's GHG Working Group has proposed a significance screening level of 3,000 metric tons CO2 equivalent (MT CO2e) per year for residential and commercial projects (SCAQMD 2015).
- Bay Area Air Quality Management District (BAAQMD) has adopted a project-level, operational threshold of significance that requires compliance with a qualified GHG reduction strategy or similar plan, maximum annual emissions of 1,100 MT CO2e per year or less, or achievement of a GHG efficiency rate of no more than 4.6 MT CO2e per

service population per year (BAAQMD 2017). BAAQMD has not adopted a project-level threshold of significance for construction-related GHG emissions.
- Sacramento Metro Air Quality Management District (SMAQMD) has adopted construction and operational GHG thresholds of 1,100 MT CO2e per year for land development and construction projects (SMAQMD 2015).

In the absence of NCUAQMD thresholds, the GHG emissions from this project will be compared to the SMAQMD threshold of 1,100 MT CO2e per year for construction emissions. This is because the SMAQMD has updated their guideline to account for the SB 32 2030 targets for GHG emissions. While utilized for comparative purposes, significance of the project's potential impact is ultimately based on its long-term interaction with the state's GHG reduction goals as stated in California Air Resources Board's (CARB) 2017 Scoping Plan.

When considering the project's long-term interaction with the state's GHG reduction goals, it is critical to consider the increasing contribution that wildfires have on California's greenhouse gas emissions. Between January 1, and September 18, 2020, fires in California burned through 3.4 million acres and generated an estimated 91 million MT CO2e, or ~26.8 MT CO2e per acre burned (Alberts 2020). These emissions are 25% more than California's annual emissions from fossil fuels. Considering that wildfires are becoming a major source of GHG emissions, this project will almost certainly result in a net reduction of GHG emissions over the life of the project due to the project objective of providing long-term water supply for fire suppression.

The project would emit GHG emissions during construction from off-road equipment, worker vehicles, and any hauling that may occur. Construction emissions would be generated from the exhaust of equipment, the exhaust of construction hauling trips, and worker commuter trips. The construction phases include site preparation, site grading, and building construction. Based on CalEEMod results, construction of the project will result in emissions of 713 MT CO2e, which is below the SMAQMD construction threshold of 1,100 MT CO2e per year.

The project would emit GHG emissions during long-term operations from energy required to run the pump and water chiller. Based on CalEEMod results, operations of the project will result in emissions of 4 MT CO2e, which is well below the SMAQMD construction threshold of 1,100 MT CO2e per year. Furthermore, this minor amount of GHG emissions emitted during long-term operations will be offset by renewable energy generation through the solar and micro hydro project components.

In summary, GHGs emitted by this proposed project fall below typical state thresholds for construction projects. Additionally, long term GHG emission from fire suppression benefits are likely to far offset the construction GHG emissions. Based on estimated GHG emission from 2020 wildfires in CA (Alberts 2020), 26.8 MT CO2e per acre burned were produced by the fires. Therefore, if the project prevents approximately 27 acres of wildfire, that will offset the construction related GHG emissions. Based on fire history and climatic trends, it is highly likely that this project will help prevent far greater than 27 acres of wildfire over the 50+ year lifespan of the project. Finally, GHG emissions associated with project operations are offset by renewable energy generation. Based on these factors, the project-generated GHG emissions will have a less than significant impact on the environment.

(b) No impact: The project will not conflict with any applicable plan, policy or regulation adopted for the purpose of reducing the emissions of greenhouse gases. GHG emissions in

California are regulated under several state-wide measures, most prominently the California Global Warming Solutions Act of 2006, widely known as Assembly Bill (AB) 32, which requires the CARB to develop and enforce regulations for the reporting and verification of statewide GHG emissions and sets limits on state emissions with a mandate to reduce GHG emissions to 1990 levels by 2020. AB 32 has been followed up by additional legislation and orders mandating efficiency-based thresholds:

- SB 32 requires statewide GHG emissions to 40 percent below 1990 levels by 2030
- B-30-15 provides an interim 2030 goal with the ultimate goal of reducing emissions by 80 percent below 1990 levels by 2050. The B-30-15 interim 2030 emission reduction goal is consistent with SB 32 and represents 'substantial progress' towards the 2050 emissions reduction goal.
- EO S-03-05 directs the state to reduce GHG emissions to 80 percent below 1990 levels by 2050.

Locally, the NCUAQMD maintains air quality conditions in Humboldt County and administers a series of air pollution reduction programs, including open burning permits, grants, permitting of stationary sources, emission inventory and air quality monitoring, and planning and rule development. The NCUAQMD adopted Rule 111 in 2015, which evaluates stationary sources subject to NSR and Title V permitting. Pursuant to Rule 111, stationary sources emitting less than 25,000 tons per year of CO2 equivalent are exempt from compliance determination.

The Humboldt County General Plan commits to concrete actions to further reduce countywide GHG emissions. The County is currently preparing a Climate Action Plan (CAP). Although not yet finalized, the County is suggesting GHG reduction targets of 40 percent below 1990 levels by 2030, and 60 percent below 1990 levels by 2040.

As previously described, this project will generate GHG emissions during the construction phase, but all GHG emissions from long-term operations will be offset by renewable energy generation. Furthermore, the project will provide a dry season water source to combat wildfires in the region which is expected to offset the construction GHG emissions. In summary, this project does not conflict with any plan, policy, or regulation adopted for the purpose of reducing the emissions of greenhouse gases.

IX. Hazards and Hazardous Materials. Would the project:	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
a) Create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials?		X		
b) Create a significant hazard to the public or the environment through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment?		X		
c) Emit hazardous emissions or handle hazardous or acutely hazardous materials, substances, or waste within one-quarter mile of an existing or proposed school?				X
d) Be located on a site which is included on a list of hazardous materials sites complied pursuant to Government Code Section 65962.5 and, as a result, would it create a significant hazard to the public or the environment?				X
e) For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project result in a safety hazard or excessive noise for people residing or working in the project area?				X
f) Impair implementation of, or physically interfere with an adopted emergency response plan or emergency evacuation plan?				X
g) Expose people or structures, either directly or indirectly, to a significant risk of loss, injury or death involving wildland fires?		X		

Discussion:

(a-b) Less Than Significant with Mitigation Incorporated: The project will not create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials. The only hazardous materials that would be used on site are fuels, lube oil, coolant, and hydraulic fluid associated with the routine maintenance and operation of heavy equipment. Any potential significant hazard associated with the accidental release of petroleum and coolant products used with equipment during construction will be minimized through implementation of the mitigation measures below and described in more detail in Appendix K of the BOD Report. As a result, mitigation measures will ensure that any potentially significant impacts are avoided or mitigated to below a level of significance.

HAZ-1: Heavy equipment that will be used in these activities will be in good condition and will be inspected for leakage of coolant and petroleum products and repaired, if necessary, before work is started.

HAZ-2: When operating vehicles in wetted portions of the stream channel, or where wetland vegetation, riparian vegetation, or aquatic organisms may be destroyed, the responsible party shall, at a minimum, do the following:

a) All equipment shall be cleaned to remove external oil, grease, dirt, or mud. Wash sites shall be located in upland locations so that dirty wash water does not flow into the stream channel or adjacent wetlands;
b) Check and maintain on a daily basis any vehicles to prevent leaks of materials that, if introduced to water, could be deleterious to aquatic life, wildlife, or riparian habitat;
c) Take precautions to minimize the number of passes through the stream and to avoid increasing the turbidity of the water to a level that is deleterious to aquatic life; and
d) Allow the work area to rest to allow the water to clear after each individual pass of the vehicle that causes a plume of turbidity above background levels, resuming work only after the stream has reached the original background turbidity levels.

HAZ-3: All equipment operators shall be trained in the procedures to be taken should an accident occur. Prior to the onset of work, the Permittee shall prepare a Spill Prevention/Response plan to help avoid spills and allow a prompt and effective response should an accidental spill occur. All workers shall be informed of the importance of preventing spills. Operators shall have spill clean-up supplies on site and be knowledgeable in their proper deployment.

HAZ-4: All activities performed in or near a stream will have absorbent materials designed for spill containment and cleanup at the activity site for use in case of an accidental spill. In an event of a spill, work shall cease immediately. Clean-up of all spills shall begin immediately. The responsible party shall notify the State Office of Emergency Services at 1-800-852-7550 and the CDFW immediately after any spill occurs and shall consult with the CDFW regarding clean-up procedures.

HAZ-5: All fueling and maintenance of vehicles and other equipment and staging areas shall occur at least 65 feet from any riparian habitat or water body and place fuel absorbent mats under pump while fueling. The USACE and the CDFW will ensure contamination of habitat does not occur during such operations. Prior to the onset of work, the Permittee shall prepare a plan to allow a prompt and effective response to any accidental spills. All workers will be informed of the importance of preventing spills and of the appropriate measures to take should a spill occur.

HAZ-6: Location of staging/storage areas for equipment, materials, fuels, lubricants, and solvents, will be located outside of the streams high water channel and associated riparian area. The number of access routes, number and size of staging areas, and the total area of the work site activity shall be limited to the minimum necessary to complete the restoration action. To avoid contamination of habitat during restoration activities, trash will be contained, removed, and disposed of throughout the project.

HAZ-7: Petroleum products, fresh cement, and other deleterious materials shall not enter the stream channel.

HAZ-8: Stationary equipment such as motors, pumps, generators, compressors, and welders, located within the dry portion of the stream channel or adjacent to the stream, will be positioned over drip-pans.

(c) No Impact: The project will not emit hazardous emissions or handle hazardous or acutely hazardous materials, substances, or waste within one-quarter mile of an existing or proposed school. Such impact is avoided because the project will not create any feature that will emit hazardous substances.

(d) No Impact: The project worksites are not located on any site that is included on a list of hazardous materials sites compiled pursuant to Government Code Section 65962.5**.**

(e) No Impact: No project work site is located within an airport land use plan or within two miles of a public airport or public use airport.

(f) No Impact: The project will not impair implementation of, or physically interfere with, an adopted emergency response plan or emergency evacuation plan. The project has no effect on access. The project will include road upgrades and installation of firefighting infrastructure including hydrants and a pond suitable for helicopter and ground-based water withdrawals.

(g) Less Than Significant with Mitigation Incorporated: The project will not expose people or structures directly or indirectly to a significant risk of loss, injury, or death involving wild land fires. At work sites requiring the use of heavy equipment, there is a small risk of an accidental spark from equipment igniting a fire. Firefighting equipment (bulldozer, excavator, fire extinguishers, and hand tools) will be on site during construction. The project's pond will be suitable and available for use by helicopter or ground-based firefighting efforts. In addition, fire hydrants will be installed to assist in more localized firefighting efforts. The potential for accidental fire will be reduced to a less than significant level through implementation of the project design and mitigation measures presented in Appendix K of the BOD Report.

HAZ-9: All internal combustion engines shall be fitted with spark arrestors.

HAZ-10: The Permittee shall have an appropriate fire extinguisher(s) and firefighting tools (shovel and axe at a minimum) present at all times when there is a risk of fire.

HAZ-11: Vehicles shall not be parked in tall grass or any other location where heat from the exhaust system could ignite a fire.

HAZ-12: The grantee shall follow any additional rules the landowner has for fire prevention.

X. Hydrology and Water Quality. Would the project:	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
a) Violate any water quality standards or waste discharge requirements or otherwise substantially degrade surface or groundwater quality?		X		
b) Substantially deplete groundwater supplies or interfere substantially with groundwater recharge such that the project may impede sustainable groundwater management of the basin?			X	
c) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, in a manner, which would:				
(i) result in substantial erosion or siltation on- or off-site;		X		
(ii) substantially increase the rate or amount of surface runoff in a manner which would result in flooding on- or offsite;			X	
(iii) create or contribute runoff water which would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff; or			X	
(iv) impede or redirect flood flows?			X	
d) In flood hazard, tsunami, or seiche zones, risk release of pollutants due to project inundation?			X	
e) Conflict with or obstruct implementation of a water quality control plan or sustainable groundwater management plan?			X	

Discussion:

(a) Less Than Significant with Mitigation Incorporated: The South Fork Eel River watershed has a total maximum daily load (TMDL) established for water temperature and sediment. There is the potential for minor short-term increase in turbidity during installation of instream structures and pond construction. Additionally, there is the potential for release of water from the pond with higher than desirable temperature levels. The goal of the project is to increase water quantity and improve water quality in the dry season by adding cool water to Redwood Creek from the off-stream pond. The project design includes features designed specifically for this objective including an on-demand water chiller to cool water prior to discharge into Redwood Creek. This cool water discharge would reduce water temperatures in Redwood Creek and not be in conflict with the TMDL.

There is also potential for water quality in Redwood Creek downstream from the project to be adversely affected during the wet season if too much water is diverted out of Redwood Creek to fill the pond. However, this impact will be avoided through close collaboration with regulatory agency staff during the design, permitting, implementation, operations and monitoring phases of the project.

The gully stabilization part of the project would significantly reduce sediment delivery from the project area into Redwood Creek, which could benefit instream habitat. This reduction in sediment delivery would not be in conflict with the TMDL or Basin Plan.

The project area currently experiences periodic grazing by cattle, which results in increased nutrient loads into Redwood Creek during runoff periods. The project will be fenced, which will take some of the existing grazing land out of production, thereby reducing nutrient loading into Redwood Creek. No mitigation necessary for this pollutant.

Short-term increases in turbidity associated with the instream structure installation would be controlled by isolating the project area from flowing water, installing BMPs, and revegetating disturbed surfaces. The design features and mitigation measures **BIO 1-6, GEO 1–4** and **HAZ-1– 8** described above and in Appendix K of the BOD Report, as well as **HYD-1** described below will assure that the project actions are in compliance with water quality standards and that impacts on water quality are avoided or mitigated to below a level of significance.

HYD-1: As required by final CDFW and SWB permit conditions, flow and temperature monitoring results, flow augmentation amounts, and diversion operations will be reported to regulatory agency staff on an annual basis. Based on this data, diversion and flow augmentation operations will be adjusted and optimized as appropriate to protect and enhance downstream aquatic habitat to the greatest extent feasible.

(b) Less Than Significant: The project will not substantially deplete groundwater supplies, interfere substantially with groundwater recharge, or impede sustainable groundwater management in the basin This is because the project site is underlain by nearly impervious shale bedrock, with minimal groundwater recharge potential. In addition, the project is located in an area that was determined to be of low priority by the California Department of Water Resources for the development of a sustainable groundwater management plan. However, there is localized shallow groundwater that is perched on top of the shale bedrock. The project is expected to result in changes to the dynamics of this existing shallow groundwater within the project vicinity because construction of the pond will reduce the ground surface area that recharges the shallow groundwater and, by design, drain groundwater in the vicinity of the pond to increase slope stability. Most of the water stored in the shallow groundwater aquifer drains within a few weeks following significant precipitation based on groundwater modeling results as described in the BOD Report in attachment A. Therefore, there are no groundwater wells or other existing land uses that rely on this shallow aquifer. There is a small amount of moisture that persists during the dry season along the bedrock-soil interface that provides soil moisture to support riparian vegetation within some locations in the project vicinity. The project may result in some minor changes to this dynamic. The project proposes construction of grade control structures in the three tributary drainages adjacent to the project site, which will reduce incision and improve shallow groundwater retention within those portions of the project. It is also important to consider the objective of this project is to provide a significant benefit to 5.5 miles of riparian habitat along Redwood Creek. Furthermore, By incorporating these design features and considering the overall positive effects of the project on a watershed scale, the project impacts on local groundwater will be less than significant.

(c) the project would not substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river.

> **(i) Less Than Significant with Mitigation:** The project would not result in substantial erosion or siltation on- or off-site. Such an impact will not occur because several of the project actions are designed to decrease overall erosion and sediment delivery. The instream boulder and large wood placement in Redwood Creek and rock armor grade control structures in the smaller tributary drainages will alter drainage patterns by slowing incision and erosion. Instream structures proposed in Redwood Creek will produce a local redistribution of bed load, facilitating the deposition of spawning

gravel in riffles and create localized scour to maintain pools for juvenile fish habitat. This local redistribution of bed load will not produce a net increase of erosion. Further, the erosion control mitigation measures (**GEO 1–4**) described in Appendix K of the BOD Report will assure that all project actions, including construction activities, are in compliance with water quality standards, which would reduce impacts to a less than significant level.

(ii) Less Than Significant: The project will not substantially alter the existing drainage pattern of the work sites, or substantially increase the rate or amount of surface runoff in a manner that would result in flooding on- or off-site. The project will capture wet-season runoff in the pond, which would reduce flooding potential. The construction of the proposed pond and associated infrastructure could result in an increased flood risk if the pond suffers a catastrophic failure. However, the project is designed to minimize such a failure by being located on a stable terrace feature, having an armored overflow and downslope berm to direct water away from residences, reduced berm height, and double sealed containment (i.e. gravel layer over pond liner, and clay seal). These design features would reduce the potential for failure and associated downstream flood risk to a less than significant level. In addition, the risk of flooding would be further reduced by other design measures described in Appendix K of the BOD Report.

(iii) Less Than Significant:: The project will not create or contribute runoff water that would exceed the capacity of existing or planned storm-water drainage systems, or provide substantial additional sources of polluted runoff. Overall, the project aims to reduce storm water runoff through capture of wet-season runoff and release it during the dry season to improve instream habitat. In addition, the project will improve the road system and associated drainage facilities to increase its capacity to drain a 100-year runoff event. Finally, the project will install grade control structure in three tributaries, which will increase the retention of groundwater, reduce erosion, and reduce delivery of sediment to Redwood Creek. Therefore, this impact would be less than significant.

(iv) Less Than Significant: The project will not place structures within a 100-year flood hazard area, which would significantly impede or redirect flood flows. The pond is outside of the 100-year floodplain. Instream structures are built to change the direction and velocity of stream flow. However, these structures are designed to affect conditions in the low flow channel and will not impede flood flows. Note that the micro-hydro turbine is installed in the control center building and generates energy from the piped flow release from the reservoir only, so it will not impede or be affected by flood flows.

(d) Less Than Significant: The project is not located in tsunami, or seiche zones. With the exception of the pump intake and instream habitat structures, all of the project components (pond, solar array, control center building, access roads, fencing, etc.) are well outside of the 100-year flood zone. As such, the risk of release of pollutants due to inundation of the project is less than significant.

(e) Less Than significant: The project is in a basin that was determined to be of low priority by the California Department of Water Resources for the development of a sustainable groundwater management plan. Therefore, there is no sustainable groundwater management plan for this basin. The project will not conflict with or obstruct the implementation of a water quality control plan. In fact, the project is in the South Fork Eel River, which is one of five priority watersheds selected for flow enhancement projects in California by the SWRCB and CDFW as part of the California Water Action Plan effort (SWRCB 2019). However, there is a potential for warm water to be discharged from the pond during extreme hot and dry periods. The project design includes the use of an industrial water chiller that would cool water prior to delivery to Redwood Creek. Therefore, the impact would be less than significant.

XI. Land Use and Planning. Would the project:	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
a) Physically divide an established community?				X
b) Cause a significant environmental impact due to a conflict with any land use plan, policy, or regulation adopted for the purpose of avoiding or mitigating an environmental effect?				X

Discussion:

(a) No Impact: The project will not physically divide an established community. This impact will not occur because the project is being entirely conducted on a single property.

(b) No Impact: The activities that compose this project do not conflict with any applicable land use plan, policy, or regulation adopted for the purpose of avoiding or mitigating an environmental effect. Such an impact will not occur because the project's activities are designed to be consistent with the County's General Plan Water Resources element goals and policies WR-G2, WR-G9, WR-P23, WR-P25, and WR-IMP19.

WR-G2 - Water Resource Habitat. River and stream habitat supporting the recovery and continued viability of wild, native salmonid and other abundant coldwater fish populations supporting a thriving commercial, sport, and tribal fishery.

Relevant project actions: Deliver cool water to Redwood Creek during the summer low flow period, which will improve dry season survivability of juvenile anadromous salmonids.

WR-G9 - Restored Water Quality and Watersheds. All water bodies de-listed and watersheds restored, providing high quality habitat and a full range of beneficial uses and ecosystem services.

Relevant project actions: Redwood Creek currently experiences low flows and warm water temperatures during the summer and early fall months. Cool water flow augmentation from the Project will improve instream habitat quality and anadromous salmonid rearing habitat.

WR-P23 - Watershed and Community Based Efforts. Support the efforts of local community watershed groups to protect, restore, and monitor water resources and work with local groups to ensure decisions and programs take into account local priorities and needs.

Relevant project actions: The Project is a collaboration of the Marshall Ranch, Salmonid Restoration Federation, and state and federal agencies with the goal of restoring cool water flow to Redwood Creek during the summer dry season.

WR-P25 - State and Federal Watershed Initiatives. Support implementation of state and federal watershed initiatives such as the Total Maximum Daily Loads (TMDLs), the North Coast Regional Water Quality Control Board's (NCRWQCB) Watershed Management Initiative, the National Marine Fisheries Services and Department of Fish and Game coho recovery plans and the California Non-Point Source Program Plan.

Relevant project actions: The Project addresses the goals of the California Water Action Plan (SWRCB, 2019), Goal B of the WCB strategic plan (WCB, 2014), Goal 2 of the State Wildlife Action

Plan (CDFW, 2015), and host of NOAA Fisheries' recovery actions for coho salmon in the South Fork Eel River. See below for additional detail regarding these goals.

WR-IMP19 - Coordinate and Support Watershed Efforts. Seek funding and work with land and water management agencies, community-based watershed restoration groups, and private property owners to implement programs for maintaining and improving watershed conditions that contribute to improved water quality and supply.

Relevant project actions: The Project is a collaboration of the Marshall Ranch, Salmonid Restoration Federation, and state and federal agencies. Funding for the Project was supplied by funded by the WCB Proposition 1 Streamflow Enhancement Program.

As described on page 9 (Project Goals and Objectives), this project was specifically designed to directly addresses the goals of the California Water Action Plan (SWRCB, 2019) and will ensure the restoration of critically important habitat. The project also addresses Goal B of the WCB strategic plan (WCB, 2014). The Project also aligns with Goal 2 of the State Wildlife Action Plan (CDFW, 2015) – Enhance Ecosystem Conditions, and Goal 3 – Enhance Ecosystem Functions and Processes: Maintain and improve ecological conditions vital for sustaining ecosystems in California. Most specifically, the project improves the hydrologic regime and increases water quantity and availability vital for sustaining ecosystems.

XII. Mineral Resources. Would the project:	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
a) Result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the state?				X
b) Result in the loss of availability of a locally important mineral resource recovery site delineated on a local general plan, specific plan or other land use plan?				X

Discussion:

(a) No Impact: The project will not result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the state. Such an impact will not occur because no valuable mineral resources are known to exist at the project site.

(b) No Impact: The project will not result in the loss of availability of a locally important mineral resource recovery site delineated on a local general plan, specific plan, or other land use plan. Such an impact will not occur because no mineral resource recovery sites occur at the project work sites.

XIII. Noise. Would the project result in:	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
a) Generation of a substantial temporary or permanent increase in ambient noise levels in the vicinity of the project in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies?		X		
b) Generation of excessive ground-borne vibration or ground-borne noise levels?				X
c) For a project located within the vicinity of a private airstrip or an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project expose people residing or working in the project area to excessive noise levels?				X

Discussion:

(a) Less Than Significant with Mitigation Incorporated: The project will not result in significant exposure of persons to, or generation of noise levels in excess of, standards established in the local general plan or noise ordinance, or applicable standards of other agencies. There will be a temporary increase in noise levels at those work sites requiring the use of heavy equipment. It is expected that the highest noise levels would be about 88 dB at 50 ft and would come from bulldozers. However, noise attenuation is expected to be about 7.5 dB per doubling of distance from the source. The nearest residence is approximately 150 ft from the edge of the work area and over 300 ft from the pond excavation site where most of the noise would be produced. Therefore, it is estimated that the noise level received by the nearby residence from work (road and berm construction) at the edge of the work area would be about 77 dB. The noise level at the nearby residence from work conducted at the pond site would be about 70 dB.

The Project will occur on property with a General Plan zoning classification of RA. Fish and wildlife management are conditionally permitted uses on this property. The Project is consistent with General Plan's Noise Element's Goal and Policy N-S7, which states that for the RA designation, the maximum permissible noise level within the zone is 75 dB between the hours of 6 am to 10 pm. The noise expected to be produced by the Project is less than the maximum allowable. In addition, N-S7 also states that an exception (#4) applies when heavy equipment and power tools are used during construction of permitted structures when conforming to the terms of the approved permit. The project will include several mitigation measures to reduce noise impacts to a less than significant level. These mitigation measures include:

NOISE-1: To reduce the possibility of the construction noise and vibrations becoming an annoyance to sensitive receptors near the Project, exterior construction activity shall be confined to the weekday hours of 7:00 am to 7:00 pm or until sunset, whichever is later, and weekend hours of 8:00 am to 6:00 pm or until sunset, whichever is later. No heavy equipment related construction activities shall be allowed on Sundays or holidays.

NOISE-2: The Permittee shall notify sensitive receptors (all property owners within 350 feet) of potential impacts from noise and vibration prior to initiating each construction phase. The notice shall describe construction activities and anticipated noise and/or vibrations from these activities, and the duration and operational hours of construction activities. The notice will also include a contact that sensitive receptors may call to report noise or vibration concerns. The notice will include a request that property owners share the notice with any employee or tenants working within 350 feet of the project site.

NOISE-3: Construction equipment shall be properly maintained and equipped with noise control devices, such as mufflers and shrouds, in accordance with manufacturers' specifications.

Following construction, the project will utilize passive structures that will not generate excessive noise. A pump however, will be used during the wet season to divert water from Redwood Creek to help fill the pond. The pump's sound level is less than 70 dBA. However, the pump will be submerged in water, installed in a cistern, below the redwood creek channel elevation, and will only be running when Redwood Creek has significant flow, so it is unlikely that the pump will be audible to any neighbor, the nearest of which is ~400' away. Additionally, a water chiller may also be operated several days each year. The water chiller has a sound level of 56.2 dBA at 32.8 ft distance from the machine. However, the chiller would be housed in the control center building which will be designed to muffle the sound. The nearest residences are ~500' away from the control center building, so sound levels at the residences are expected to be <40 dBA. While these project components will create an intermittent, long-term increase in ambient noise levels, they are powered by electric motors, will be housed in a control center building/cistern designed to muffle sound, and will likely only be audible to those within the immediate proximity. Based on noise monitoring during initial operation, adaptive management measures will be implemented as described in the Mitigation Measure **Noise-4** below. As such, this operational noise will constitute a less than significant impact.

NOISE-4: During final design, construction, and initial operations, adaptive management actions will be conducted including fine tuning of feature layout and installation of sound barriers to reduce noise level from the pump and chiller to the greatest extent practical.

(b) No Impact: The project will not result in exposure of persons to, or generation of, excessive ground-borne vibration or ground-borne noise levels. Such an impact will not occur because only minor amounts of ground-borne vibration or noise will be generated short-term at those work sites requiring the use of heavy equipment.

(c) No Impact: None of the project work sites are located within two miles of a private airstrip, public airport, or public use airport.

XIV. Population and Housing. Would the project:	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
a) Induce substantial population growth in an area, either directly (e.g., by proposing new homes and/or businesses) or indirectly (e.g., through extension of roads or other infrastructure)?				X
b) Displace substantial numbers of existing people or housing, necessitating the construction of replacement housing elsewhere?				X

Discussion:

(a) No Impact: The project will not induce substantial population growth in an area, either directly or indirectly. Such an impact will not occur because the project will not construct any new homes, businesses, roads, or other human infrastructure.

(b) No Impact: The project will not displace any existing people or housing and will not necessitate the construction of replacement housing elsewhere.

XV. Public Services. Would the project result in substantial adverse physical impacts associated with the provision of new or physically altered governmental facilities, need for new or physically altered governmental facilities, the construction of which could cause significant environmental impacts, in order to maintain acceptable service ratios, response times or other performance objectives for any of the public services:	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
a) Fire protection?				X
b) Police protection?				X
c) Schools?				X
d) Parks?				X
e) Other public facilities?				X

Discussion:

(a-e) No Impact: The project will not have any significant environmental impacts associated with new or physically altered governmental facilities. Issuance of restoration grants to government agencies could, in some cases, lead to minor increases in staffing to complete projects. Such increases will not lead to any significant adverse impacts, because the increases are short term, and no significant construction will be required to accommodate additional staff.

XVI. Recreation.	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
a) Would the project increase the use of existing neighborhood and regional parks or other recreational facilities such that substantial physical deterioration of the facility would occur or be accelerated?				X
b) Does the project include recreational facilities or require the construction or expansion of recreational facilities which might have an adverse physical effect on the environment?				X

Discussion:

(a) No Impact: The project would not increase the use of existing neighborhood and regional parks, or other recreational facilities. Such an impact will not occur because the project actions will restore anadromous fish habitat and do not significantly alter human use or facilities at existing parks or recreational facilities. Overall, the project is expected to increase recreation opportunities by assisting in restoring populations of anadromous fish.

(b) No Impact: The project does not include recreational facilities and does not require the construction or expansion of recreational facilities.

XVII. Tribal Cultural Resources. Would the project cause a substantial adverse change in the significance of a tribal cultural resource, defined in Public Resource Code section 21074 as either a site, feature, place, cultural landscape that is geographically defined in terms of the size and scope of the landscape, sacred place, or object with cultural value to a California Native American tribe, and that is:	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
a) Listed or eligible for listing in the California Register of Historical Resources, or in a local register of historical resources as defined in Public Resource Code section 5020.1(k), or				X
b) A resource determined by the lead agency, in its discretion and supported by substantial evidence, to be significant pursuant to criteria set forth in subdivision (c) of Public Resources Code Section 5024.1. In applying the criteria set forth in subdivision (c) of Public Resource Code Section 5024.1, the lead agency shall consider the significance of the resource to a California Native American tribe.				X

Discussion:

(a) No impact: There are no tribal cultural resources on the project site that are listed or eligible for listing in the California Register of Historical Resources, or in a local register of historical resources as defined in Public Resource Code 5020.1(k).
(b) No impact: There are no resources determined by the lead agency, in its discretion and supported by substantial evidence, to be significant pursuant to criteria set forth in subdivision (c) of Public Resources Code Section 5024.1.

XVIII. Transportation. Would the project:	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
a) Conflict with an applicable plan, ordinance or policy addressing the circulation system including transit, roadway, bicycle and pedestrian facilities?				X
b) Conflict or be inconsistent with CEQA Guidelines section 15064.3, subdivision (b)?			X	
c) Substantially increase hazards due to design features (e.g., sharp curves or dangerous intersections) or incompatible uses (e.g., farm equipment)?				X
d) Result in inadequate emergency access?				X

Discussion:

(a) No Impact: The project will not conflict with any applicable plans, ordinances or policies that address the circulation systems, transit, roadway, bicycle, and pedestrian facilities in or around the project area.

(b) Less than significant: Construction of the proposed project would not directly impact any roadways. During the construction phase, workers and equipment/materials delivery will utilize Briceland/Thorn Road, Redwood Drive, and US 101. However, these trips would be small compared to existing traffic and would not lead to a significant increase in roadway congestion. Long term operations and maintenance requirements are minimal so any long-term traffic volume increase resulting from the project would be negligible. Therefore, the project will not conflict, either individually or cumulatively, with CEQA Guidelines section 15064.3, subdivision (b).

(c) No Impact: The project will upgrade the existing roadway inside the project area to support heavy equipment traffic and drain 100-year flood return interval events at crossings.

(d) No Impact: The project will not result in inadequate emergency access. The proposed improvements to the roadway will allow improved access by emergency fire vehicles that would need access to the pond and associated fire hydrants.

XIV. Utilities and Service Systems. Would the project:	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
a) Require or result in the relocation or construction of new expanded water or wastewater treatment or stormwater drainage, electric power, natural gas, or telecommunications facilities or expansion of existing facilities, the construction or relocation of which could cause significant environmental effects?		X		
b) Have sufficient water supplies available to serve the project and reasonably foreseeable future development during normal, dry and multiple dry years?			X	
c) Result in a determination by the wastewater treatment provider, which serves or may serve the project that it has adequate capacity to serve the project's projected demand in addition to the provider's existing commitments?				X
d) Generate solid waste in excess of State or local standards, or in excess of the capacity of local infrastructure, or otherwise impair the attainment of solid waste reduction goals?				X
e) Comply with federal, state, and local management and reduction statutes and regulations related to solid waste?				X

Discussion:

(a) Less Than Significant with Mitigation Incorporated: : The project does not involve relocation or construction of new expanded water or wastewater treatment or stormwater drainage, natural gas, or telecommunications facilities or expansion of existing facilities. The project will construct a facility to store water during the wet season and release water during the dry season to enhance aquatic habitat, so the project is not expected to cause significant negative environmental impacts. The project also includes construction and operation of small scale solar and micro hydro energy generation which will be tied into the grid. New underground lines will connect the current PG&E service to the solar panels, pump and control center building. Impacts that could occur during installation will be primarily associated with ground disturbance, which will be localized at the trenches where utilities will be buried. Impacts will be reduced to a less than significant level by the installation of erosion control BMPs and revegetation and other mitigation measures (**GEO 1–4**) detailed in the Geology section above

(b) Less Than Significant: The project relies on wet season diversion from Redwood Creek and rainfall to fill the pond. The diversion will require a new Appropriative Water Right, the application for which has been filed with the State Water Resource Control Board (SWRCB). A preliminary Water Availability Analyses has been prepared for the project which shows that sufficient water supplies are available during the wet season to fill the pond. The project does not include any future development that would require any future water supply.

(c) No Impact: The project will not produce wastewater or be served by a wastewater facility.

(d) No Impact: The project will not generate a significant volume of solid waste requiring disposal in a landfill. Any waste generated will be minimal and only occur during construction. No waste will be produced during operations.

(e) No Impact: The project will not violate any federal, state, or local statutes or regulations related to solid waste.

XX. Wildfire: if located in or near state responsibility areas of lands classified as very high fire hazard severity zones, would the project:	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
a) Substantially impair an adopted emergency response plan or emergency evacuation plan?				X
b) Due to slope, prevailing winds, and other factors, exacerbate wildfire risks, and thereby expose project occupants to, pollutant concentrations from a wildfire or the uncontrolled spread of a wildfire?				X
c) Require the installation or maintenance of associated infrastructure (such as roads, fuel breaks, emergency water sources, power lines or other utilities) that may exacerbate fire risk or that may result in temporary or ongoing impacts to the environment?			X	
d) Expose people or structures to significant risks, including downslope or downstream flooding or landslides, as a result of runoff, post-fire slope instability, or drainage changes?				X

(a) No impact: The project will not substantially impair an adopted emergency response plan or emergency evacuation plan. The project includes road upgrades, which will improve emergency response and evacuation on the project property. In addition, the proposed pond and hydrants will provide water necessary for emergency fire responses.

(b) No impact: The project does not propose to construct structures that would be used for human habitation. The project reduces wildfire risk by installing a pond and hydrants that could be used to fight wildfires. The upgrading and construction of access roads will also reduce wildfire risk by providing passive fire breaks should a wildfire initiate.

(c) Less than significant: The project is located in a meadow area and will include the installation and upgrading of access roads, hydrants, pond, and powerlines. The access roads can serve as fire breaks, which would lessen the risk of fire spread over the current condition. The pond and hydrants can be called upon to supply water in the event of a wildfire, which is a significant improvement over the current condition. All new onsite power supply lines will be installed via underground burial and would not increase the risk of wildfire.

(d) Less than significant: The project is located on a flat terrace adjacent to Redwood Creek that is very stable (see geotechnical report) and not prone to landslides. Any potential landslides in the project area would be diverted away from the nearby residence by the proposed berm along the northern property extent.

XXI. Mandatory Findings of Significance.	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
a) Does the project have the potential to degrade the quality of the environment, substantially reduce the habitat of a fish or wildlife species, cause a fish or wildlife population to drop below self-sustaining levels, threaten to eliminate a plant or animal community, substantially reduce the number or restrict the range of a rare or endangered plant or animal or eliminate important examples of the major periods of California history or prehistory?		X		
b) Does the project have impacts that are individually limited, but cumulatively considerable? ("Cumulatively considerable" means that the incremental effects of a project are considerable when viewed in connection with the effects of past projects, the effects of other current projects, and the effects of probable future projects).				X
c) Does the project have environmental effects, which will cause substantial adverse effects on human beings, either directly or indirectly?		X		

Discussion:

(a) Less Than Significant with Mitigation Incorporated: The project does have the potential to degrade the quality of the environment. However, the potential is reduced to a less than significant level by design and through implementing the mitigation measures described above and in Appendix K of the BOD Report. The project shall be implemented in a manner that will avoid short-term adverse impacts to rare plants and animals, and cultural resources during construction. The project activities are designed to improve and restore stream habitat, thereby providing long-term benefits to both anadromous salmonids and other fish and wildlife.

(b) No Impact: The project does not have adverse impacts that are individually limited, but cumulatively considerable. Cumulative adverse impacts will not occur because potential adverse impacts of the project are only minor and temporary in nature and will be mitigated to the fullest extent possible. It is the goal of the project that the beneficial effects of habitat enhancement actions will be cumulative over time and contribute to the recovery of listed anadromous salmonids.

(c) Less Than Significant with Mitigation Incorporated: The project does have the potential to cause substantial adverse effects on human beings. However, the potential is reduced to a less than significant level by design and through implementing the mitigation measures described above and in Appendix K of the BOD Report. Furthermore, measures implemented as part of this project will contribute to significant fire safety improvements for the local community through the construction of the pond and hydrant.

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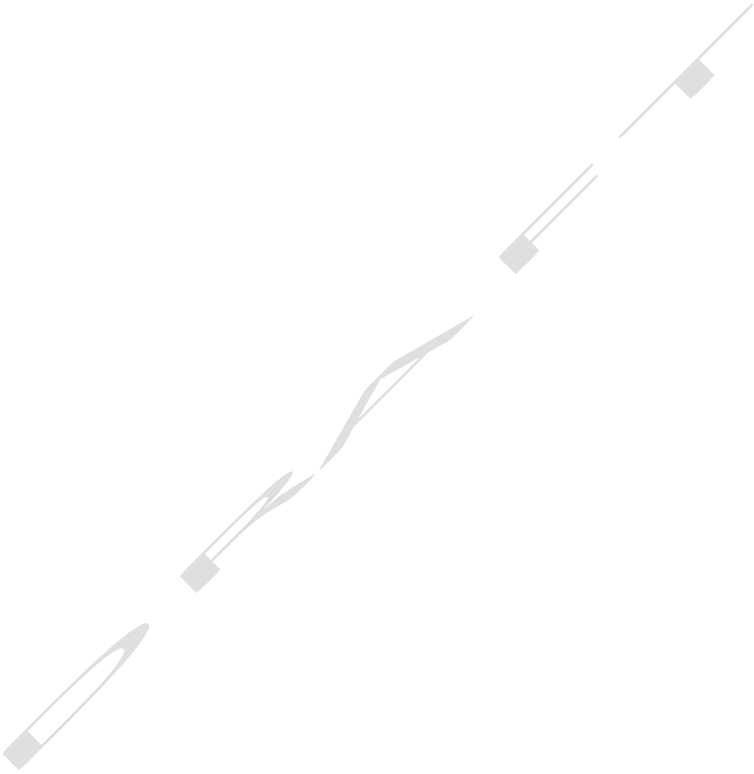
Attachment A

Basis of Design Report

(Stillwater Sciences, September 2020)



SEPTEMBER 2020

Basis of Design Report & Feasibility Analyses for Marshall Ranch Streamflow Enhancement Project

PREPARED FOR

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Suggested citation:
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Cover photo: Location of proposed off-channel pond (top photo) and flow enhancement delivery location to Redwood Creek (bottom photo).

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EXECUTIVE SUMMARY

The primary goal of the Marshall Ranch Flow Enhancement Project (Project) is to augment dry season stream flow in Redwood Creek to significantly improve aquatic habitat conditions. The Salmonid Restoration Federation (SRF) has been monitoring dry season flows in the Redwood Creek watershed over the past seven years. During 2013 through 2018, flows at all gaging stations along Redwood Creek mainstem dropped below 5 gallons per minute for multiple weeks, including long channel reaches where flows ceased completely. Note that 2019 had anomalously high flows mainly due to significant precipitation in May. However, 2020 is proving to be one of the driest years documented with flows dropping precipitously in late July and August to 0 to 5 gpm at all mainstem monitoring stations. These severely low flow conditions are projected to persist for at least a month. Dry stream conditions make it very difficult for salmonids and other native aquatic species to survive. A variety of sources likely contribute to the low-flow conditions including current human consumptive use, climate change (longer dry seasons), and legacy land use impacts (roads and timber harvest).

The Project is being designed to significantly improve these dry-season conditions. A 15.3 million gallon off-channel reservoir is proposed to store winter runoff and release approximately 50 gallons-per-minute of cool clean water into 5.5 miles of Redwood Creek during the 5-month dry season. The released water will have suitable temperatures via release from the bottom of the reservoir and water quality will be maintained by on-demand aeration. This flow input is expected to have a significant and measurable benefit to salmonids and other aquatic habitat in Redwood Creek. The volume of flow augmentation from this single project is expected to be approximately equal to 50% of the estimated human consumptive use within the southwestern half of the Redwood Creek watershed including the Miller Creek, China Creek, Dinner Creek, and Upper Redwood Creek mainstem sub-watersheds (Stillwater Sciences 2017).

Flow augmentation pilot projects in Russian River tributaries including Dutch Bill Creek, Porter Creek, and Green Valley Creek have successfully improved instream aquatic habitat for salmonids during the dry season (RRCWRP 2017, Grantham et. al. 2018, RRCWRP 2019). Specifically, the Porter Creek and Green Valley Creek projects have utilized water stored in agricultural ponds to augment dry season streamflow which has resulting in greater pool connectivity and wetted channel area, as well as significant increases in dissolved oxygen (DO) levels.

A fire suppression component is also being designed into the project. The pond will be accessible for helicopters to dip their buckets and a fire hydrant is also being proposed for access by fire engines during emergencies.

Selection of the Marshall Ranch off-channel pond site has been guided by office- and field-based assessments of a significant portion of the Redwood Creek watershed. Based on these assessments, the proposed pond location is uniquely suited for the project due to the following factors: 1) the project area is comprised of a broad area with gentle topography, 2) the site is not within the Redwood Creek floodplain or within the potential Redwood Creek channel migration corridor, 3) there are no watercourses, wetlands, trees or other sensitive plant species within the proposed pond footprint so environmental impacts are minimized, 4) the pond site is located at an elevation with enough pressure head to deliver the entire pond volume to Redwood Creek by gravity, and 5) the Marshall Ranch LLC (landowner) is fully supportive of the project. However, due to the size of the project and nearby downslope neighbors, a detailed analyses of site conditions, pond design features, and potential failure mechanisms is required.

To support the Project design process, further in-depth analyses of the site and its surroundings were conducted to ensure that the pond will be stable for the long-term. The site is a unique geomorphic feature within the Redwood Creek watershed. As shown on the geomorphic map (Figure 3) it is defined by Spitler (1984) as a Pleistocene fluvial terrace (between 10,000 to 2 million years old). The geotechnical evaluation for the project confirmed this finding with boreholes consisting of hard shale bedrock overlaid by sandy gravel deposits (old sediment from when Redwood Creek was flowing on the terrace approximately 80 ft higher in elevation than the current creek level). On top of the pre-historic creek deposits, 10 to 20 feet of alluvial fan material has been slowly deposited over the last >10,000 years from the upgradient hillslope and small swale. These multiple lines of scientific evidence supporting terrace stability provided the basis for the pond design prepared in September 2019 which accompanied initial CEQA application documents.

In addition to construction of the off-stream pond and associated piping and drainage features, the Draft 65% Plans prepared in September 2019 included treatments to stabilize the two gullies located to the east and west of the proposed pond. Treatment of these gullies is a critical step to ensure long-term stability of the site. Excerpts from the Draft 65% Plans are included in Appendix A.1 to provide documentation for how the project design evolved from the 65% level to the current 90% level.

During the CEQA public comment period, concern was raised by downslope landowners that the proposed pond with associated grading and infrastructure did not sufficiently minimize long-term risk, especially during the rare case of a large rainfall event coupled with a large magnitude earthquake. Based on these concerns, additional analyses have been conducted including further assessment of potential pond failure mechanisms, seismic slope stability analyses under worst-case current and proposed conditions, dam breach analysis, as well as an assessment of long-term operations, maintenance and monitoring costs. Based on these analyses, several significant modifications were made to the project design that will greatly reduce risk and improve longevity of the project:

1) Lowering the pond elevation by eight feet,
2) Relocation of the pond spillways,
3) Installation of a pond liner, french drain, and subsurface restrictive barrier,
4) Grade control structures in central gully, and
5) Install backup energy system to provide capability to operate and monitor project even during power outage.

These design modifications are described further in Section 10.2, and included in the 90% Designs in Appendix A.2.

By incorporating the proposed design modifications described above, the risk of slope instability adversely impacting the downslope landowners is lower than current conditions (without pond), as indicated by slope stability analyses (Appendix H). This is a result of the proposed project significantly lowering the water table within the upper terrace and stabilizing the central gully. A high water table and downcutting of the gully are the primary factors that are driving current erosion along the slope between the downslope landowners and the proposed pond. The pond is set back a significant distance from the slope break. No plausible mechanism for massive pond failure was identified during the slope stability analyses. Furthermore, dam breach analysis shows that even under a worse-case scenario of dam failure, the rock-lined earthen berm constructed between the project and downslope neighbor will direct up to 1,000 cubic feet per second of flow away from their property.

The project team has secured a commitment from the WDH Foundation to provide funding for long-term operations, maintenance, and monitoring. A Water Trust entity will be formed as part of the project to manage and administer these funds via partnership between the Marshall Ranch, SRF, and Stillwater Sciences. The Water Trust would be responsible for the long-term operations, maintenance, and monitoring of the project and is expected to be a long-term catalyst supporting flow enhancement efforts throughout the Redwood Creek watershed.

A key project component that will require significant attention from the project team and agency staff over the coming year is securing an Appropriative Water Right for the project that allows for wet-season diversion from Redwood Creek to optimizes the primary goal of the project: dry season flow enhancement. It is widely agreed upon that there is “available” water in Redwood Creek during the wet season. However, the challenge that faces the project team and regulators is defining an allowable diversion schedule that balances the need to protect instream resources during the wet season while maximizing dry season flow enhancement potential. Stillwater Sciences has prepared a Draft Water Availability Analysis Report (Appendix C). This topic was discussed extensively at the March 2020 TAC meeting with strong recommendations from TAC members that the capacity of the pump in Redwood Creek should be upsized to a maximum flow rate of 220 gallons per minute (gpm) to take better advantage of peak flows during the wet season.

The Project was also discussed at the Redwood Creek Salmon Habitat and Restoration Priorities (SHaRP) meeting held in Arcata in June 2019. The meeting was attended by local restoration practitioners and fisheries staff from CDFW and NOAA. Feedback was overwhelmingly positive in terms of the Project fitting into coho recovery strategies for Redwood Creek. Additionally, the project team looks forward to working closely with CDFW and SWRCB to integrate the Project into existing agency activities in Redwood Creek. Specifically, CDFW has conducted an instream flow study in Redwood Creek and the SWRCB is conducting hydrologic and temperature modeling within the South Fork Eel watershed. It is the project team’s goal to coordinate closely with agency staff as studies are finalized and align the project with these regional initiatives.

1 INTRODUCTION

This report provides the basis of design for a large-scale streamflow enhancement project. Current design work is being funded through the California Wildlife Conservation Board’s Streamflow Enhancement Program. The Project will capture and store winter runoff in a 15.3 million gallon off-channel pond and release the stored water into Redwood Creek during the dry season at a rate of approximately 50 gallons per minute. This Project seeks to improve habitat for coho salmon (*Oncorhynchus kisutch*) and steelhead (*Oncorhynchus mykiss*) in Redwood Creek, an important salmon bearing tributary to the South Fork Eel River, by addressing the limiting factor of low summer streamflows. The South Fork Eel River is one of five priority watersheds selected for flow enhancement projects in California by the State Water Resources Control Board (SWRCB) and California Department of Fish and Wildlife (CDFW) as part of the California Water Action Plan effort (SWRCB 2019). Redwood Creek is a critical tributary to the South Fork Eel River that historically supported coho and Chinook salmon (*Oncorhynchus tshawytscha*) and steelhead.

Salmonid Restoration Federation (SRF) is the project lead and Stillwater Sciences is the technical lead with support from SHN Engineers and Geologists (Geotechnical Engineering and Water Conveyance Infrastructure), William Rich and Associates (Cultural Resources), and Hicks Law (Water Rights and Legal Consulting). The project is located on the 2,942-ac Marshall Ranch property near the unincorporated community of Briceland, in Southern Humboldt County, CA (Figure 1). This project was identified as the highest priority flow enhancement project during a feasibility study conducted by SRF and Stillwater Sciences within a portion of Redwood Creek (Stillwater Sciences 2017).

This Basis of Design (BOD) Report presents the preferred design alternative based on field and office-based analyses, as well as general input from the landowner and Technical Advisory Committee (TAC). TAC members for this project include representatives from California Department of Fish and Wildlife (CDFW), and the National Marine Fisheries Service (NMFS), North Coast Regional Water Quality Control Board, and California Wildlife Conservation Board. During the design and review process, project opportunities and constraints were identified and project alternatives were evaluated as described in Section 10 below. The preferred alternative was advanced to the 65% Design level and is included in Appendix A.1. However, based on concerns raised by adjacent landowners pertaining to long-term risks associated with the stability of the project, a second round of design alternatives – specifically focused on improving the stability of the off-channel reservoir – were analyzed and are shown in Appendix A.2.

Recent flow enhancement initiatives in lower Russian River tributaries are analogous to this Project and have displayed that directly augment is one of the most successful approaches to date for enhancing dry-season streamflow. Flow releases from agricultural ponds in Green Valley Creek and Porter Creek have shown resulted in significant instream benefits (Grantham et.al. 2018, RRCWRP 2019). As described in Ruiz et al. (2018) of California Sea Grant, the project began in 2015 and is ongoing. Data show that flow augmentations in all years from 2015-2018 were able to appreciably increase wetted channel habitat, increase dissolved oxygen in the stream water, and decrease water temperature downstream from the flow augmentation release points. For example, releases into Dutch Bill Creek averaging 36 GPM beginning in late August of 2015 and were able to cumulatively re-wet more than 2,300 feet of stream channel with effects measurable up to 1.8 miles downstream.

While modest compared to winter flows, these augmentations have the potential to increase pool connectivity and water quality. A foundational hypothesis for this Project, that increased pool connectivity will bolster over-summer salmonid survival, is strongly supported by the work of Obedzinski et al. (2018). Their study found that days of disconnected surface flow showed a strong negative correlation with juvenile coho salmon survival rate in four tributaries to the Russian River. Provided this evidence, it is anticipated that the Project's release of approximately 50 gallons per minute into Redwood Creek throughout the dry season can result in significant aquatic habitat benefit.

2 PROJECT DESCRIPTION

The primary objective of this project is construction of a 15.3 million gallon off-channel pond designed to deliver approximately 50 gallons per minute of flow augmentation to Redwood Creek during the 5-month dry season to improve instream aquatic habitat. The pond will be filled with wet-season runoff including rainwater catchment and water pumped from Redwood Creek. Other ancillary project components include:

- Instream habitat enhancement features including approximately three large wood structures and two rock weirs in Redwood Creek.
- Gully stabilization treatments including installation of approximately 30 rock armor grade control structures, other rock armoring, and regrading in three Class III drainages.
- Construct a 7.5 KW solar array, micro-hydro turbine, backup battery bank, inverter, grid intertie system and control center building to offset the Project's energy use and provide backup power during outages to maintain operations and monitoring capabilities.
- Installation of emergency fire suppression water supply including one hydrant.
- Upgrading of access roads to and within the project area with drainage features and gravel surfacing to provide year-round access.
- Installation of rainwater catchment tanks with water storage totaling up to approximately 200,000 gallons to supply water for APN 220-061-011 and additional fire suppression for the community. Water tanks may also be topped off via Redwood Creek diversion. Note that this project component is included in CEQA and the Appropriative Water Right application but is not yet designed to the 90%.

3 PROBLEM STATEMENT

Aquatic habitat in Redwood Creek is impaired due to a variety of factors including low dry-season flows, high water temperatures, excessive fine sediment, and lack of habitat complexity (CDFW 2014). There are two fish species with threatened status that are expected to benefit from this project: (1) southern Oregon/northern California coho salmon (*Oncorhynchus kisutch*) (SONCC) which are designated as state and federally threatened and (2) Northern California steelhead (*Oncorhynchus mykiss*) which are federally threatened and are a CDFW species of special concern. Historically, these fish flourished in Redwood Creek. However, rearing habitat for juvenile salmonids has been substantially degraded and the current lack of dry season flow is likely the leading factor. (NMFS and CDFW 2019).

Dry season flows (i.e., June–October) in north coastal California watersheds have decreased over the past half century (Sawaske and Freyberg, 2014; Asarian, 2014) likely due to a combination of changes in climate, land use and associated consumptive water demand, and vegetative cover. In watersheds most impacted by industrial and nonindustrial timber harvest, homesteading, and cannabis cultivation, diminished streamflow is having lethal or sub-lethal effects on juvenile salmon and steelhead and is also negatively impacting sensitive amphibian species (Bauer et al 2015).

Today, remnant fish populations survive in Redwood Creek (NMFS 2014), but despite considerable expenditures in habitat restoration projects (i.e. sediment reduction and placement of large wood habitat structures), many stream reaches don't have sufficient flow to maintain the diminishing populations. This project will address this key limiting factor by storing runoff during the wet season and strategically releasing the stored water to enhance flows in a critical reach of Redwood Creek during the dry season.

The Redwood Creek watershed is located within the South Fork Eel River ESU, which NOAA identifies as a core population vital to the preservation of Southern Oregon Northern California Coast (SONCC) coho salmon (NMFS 2014). The SONCC coho recovery plan indicates the need for "improving flow timing or volume" in each of the first ten action items in the SONCC Coho Recovery Plan (NMFS 2014).

The primary focus of this project is increasing dry season flows in critical reaches of Redwood Creek. Additional project elements will also address several other limiting factors including large wood structures to increase habitat complexity and gully stabilization treatments to reduce fine sediment inputs.

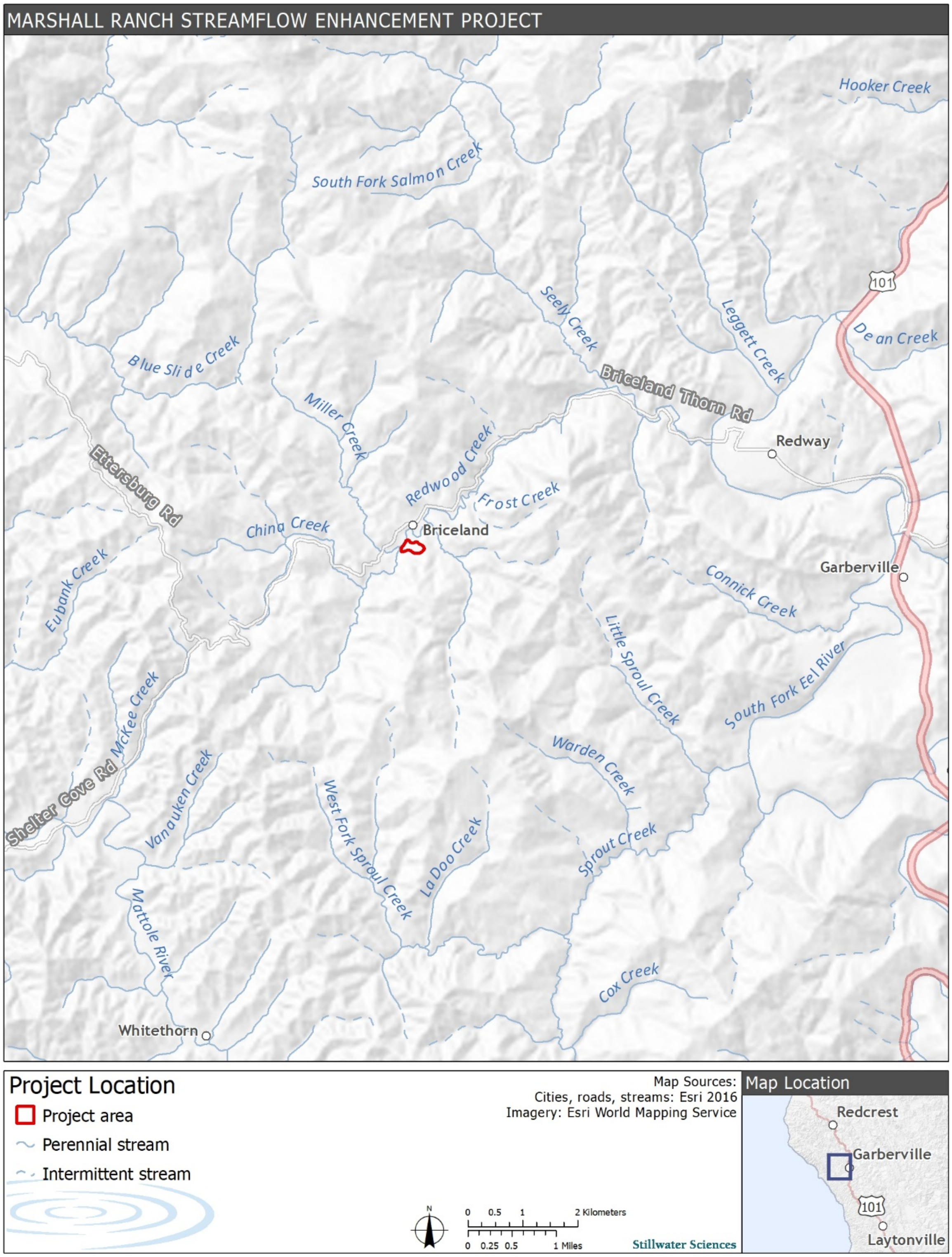


Figure 1. Vicinity map.

4 GEOLOGY AND TECTONICS

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

The Garberville-Briceland fault zone trends NNW-SSE across the watershed (Figure 2) (McLaughlin et al. 2000). The fault zone consists of multiple named and unnamed fault traces with varying orientations of displacement. Although recent displacement along the fault zone is undifferentiated, it is considered Quaternary in age (i.e., active within the last 1.6 million years). The Briceland Fault trace is approximately 4,300 feet northeast of the project site and the Garberville Fault trace is approximately 2.75 miles to the northeast (Figure 2).

The Redwood Creek watershed is primarily underlain by the diverse Coastal and Central belts of the Franciscan Complex, the younger marine and non-marine Wildcat Group, and minor amounts of serpentinized peridotite of the Coast Range Ophiolite (Figure 2). The project site is located along mainstem Redwood Creek between the Miller Creek and Somerville Creek confluences. The site is partially underlain by an isolated exposure of Pliocene-aged moderately consolidated sandstone, argillite, and conglomerate, included by some with the Wildcat Group (McLaughlin et al. 2000). The area surrounding the project site, and most of the Redwood Creek watershed, is underlain by various subunits of the Eocene to Paleocene Yager terrane (Franciscan Complex Coastal Belt), which primarily consists of sheared and highly folded mudstone (McLaughlin et al. 2000). The mudstone includes minor rhythmically interbedded arkosic sandstone and local lenses of conglomerate. This lithology produces terrain with relatively irregular topography lacking a well-incised system of sidehill drainages when compared to other subunits of the Franciscan Complex Coast Belt.

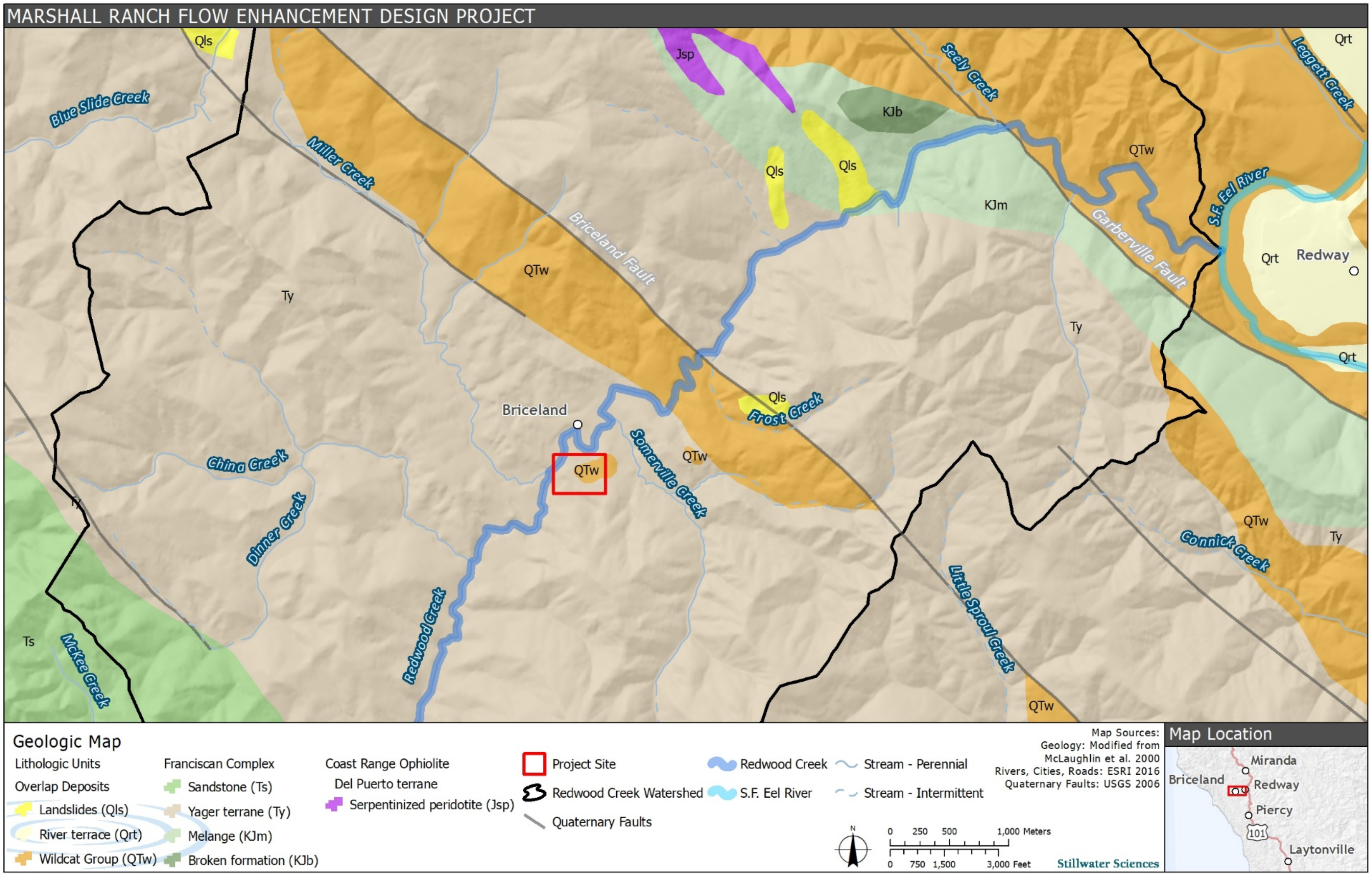


Figure 2. Generalized geologic map of the Redwood Creek watershed and project vicinity.

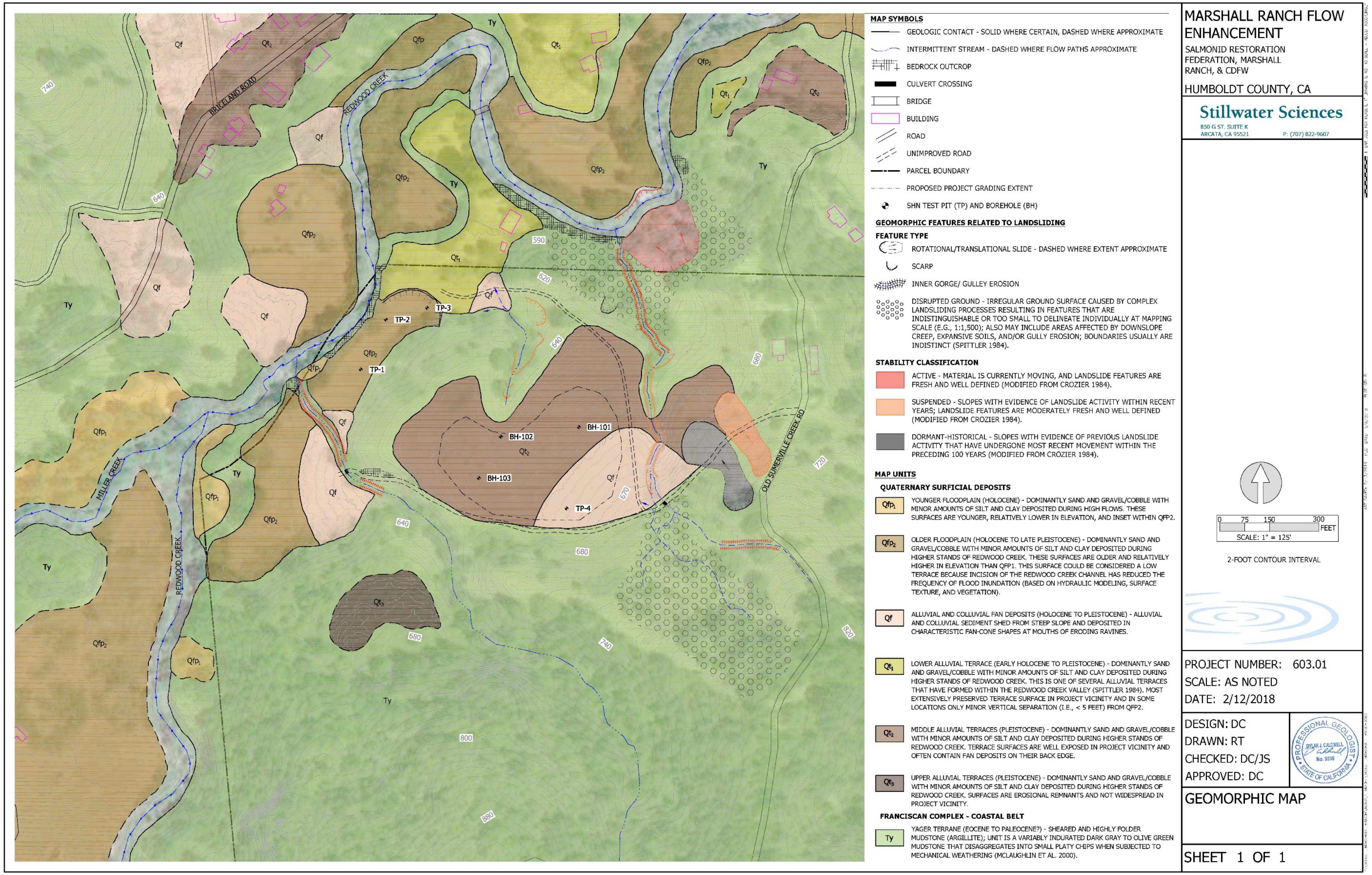
5 GEOMORPHIC ASSESSMENT

A geomorphic assessment was conducted to characterize the existing geomorphology of the project area, assess risks associated with potential hazards, support the opportunities and constraints assessment, and inform project designs. Specifically, the geomorphic assessment included a topographic survey that was integrated with 2007 LiDAR data, review of existing data, and a field assessment. Existing data that were reviewed included geologic mapping (McLaughlin et al. 2000), geomorphic and landslide mapping (Spittler 1984), and historical aerial photographs from 1942, 1947, 1954, 1963, 1965, 1984, 1988, 1996, 2000, 2005, 2009, 2010, 2012, and 2014. A geotechnical investigation was also conducted by SHN Engineers & Geologists and is described below in Section 6.

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

Upper elevations in the Redwood Creek basin are characterized by narrow, steep-walled canyon slopes that are covered by relatively thin soils and dense conifer and hardwood stands and drained by perennial and intermittent streams. At mid-elevations, the steep canyons transition into gently rounded upland ridges supporting grass meadows and shrub and oak woodland vegetation. The valley width greatly expands near Briceland, where Redwood Creek meanders between large elevated terraces (Figure 3). Channel incision in the Redwood Creek basin is likely due to ongoing tectonic uplift related to the nearby Mendocino Triple Junction, extensive anthropogenic land-use practices, and climate change altering hydrologic patterns. The flight of terrace and floodplain surfaces in the project vicinity record over 120 feet of vertical incision of Redwood Creek.

The project site consists of Pleistocene-era fluvial terraces and lower floodplain surfaces adjacent to Redwood Creek, which flows from the southwest to the northeast across the project area (Figure 3). Upland hillslopes border the site to the south and east. The project site is bound by small intermittent streams to the east and west that are tributary to Redwood Creek. These streams are hereinafter referred to as the east-side and west-side tributaries. The northern central edge of the upper terrace has been eroded by a third smaller drainage. Multiple landslide features are located around the project area and are further described in the following sections.



MAP SYMBOLS

GEOLOGIC CONTACT - SOLID WHERE CERTAIN, DASHED WHERE APPROXIMATE

INTERMITTENT STREAM - DASHED WHERE FLOW PATHS APPROXIMATE

BEDROCK OUTCROP

CULVERT CROSSING

BRIDGE

BUILDING

ROAD

UNIMPROVED ROAD

PARCEL BOUNDARY

PROPOSED PROJECT GRADING EXTENT

SHN TEST PIT (TP) AND BOREHOLE (BH)

GEOMORPHIC FEATURES RELATED TO LANDSLIDING

FEATURE TYPE

ROTATIONAL/TRANSLATIONAL SLIDE - DASHED WHERE EXTENT APPROXIMATE

SCARP

INNER GORGE/ GULLEY EROSION

DISRUPTED GROUND - IRREGULAR GROUND SURFACE CAUSED BY COMPLEX LANDSLIDING PROCESSES RESULTING IN FEATURES THAT ARE INDISTINGUISHABLE OR TOO SMALL TO DELINEATE INDIVIDUALLY AT MAPPING SCALE (E.G., 1:1,500); ALSO MAY INCLUDE AREAS AFFECTED BY DOWNSLOPE CREEP, EXPANSIVE SOILS, AND/OR GULLY EROSION; BOUNDARIES USUALLY ARE INDISTINCT (SPITTLER 1984).

STABILITY CLASSIFICATION

ACTIVE - MATERIAL IS CURRENTLY MOVING, AND LANDSLIDE FEATURES ARE FRESH AND WELL DEFINED (MODIFIED FROM CROZIER 1984).

SUSPENDED - SLOPES WITH EVIDENCE OF LANDSLIDE ACTIVITY WITHIN RECENT YEARS; LANDSLIDE FEATURES ARE MODERATELY FRESH AND WELL DEFINED (MODIFIED FROM CROZIER 1984).

DORMANT-HISTORICAL - SLOPES WITH EVIDENCE OF PREVIOUS LANDSLIDE ACTIVITY THAT HAVE UNDERGONE MOST RECENT MOVEMENT WITHIN THE PRECEDING 100 YEARS (MODIFIED FROM CROZIER 1984).

MAP UNITS

QUATERNARY SURFICIAL DEPOSITS

Qfp_1	YOUNGER FLOODPLAIN (HOLOCENE) - DOMINANTLY SAND AND GRAVEL/COBBLE WITH MINOR AMOUNTS OF SILT AND CLAY DEPOSITED DURING HIGH FLOWS. THESE SURFACES ARE YOUNGER, RELATIVELY LOWER IN ELEVATION, AND INSET WITHIN QFP2.
Qfp_2	OLDER FLOODPLAIN (HOLOCENE TO LATE PLEISTOCENE) - DOMINANTLY SAND AND GRAVEL/COBBLE WITH MINOR AMOUNTS OF SILT AND CLAY DEPOSITED DURING HIGHER STANDS OF REDWOOD CREEK. THESE SURFACES ARE OLDER AND RELATIVELY HIGHER IN ELEVATION THAN QFP1. THIS SURFACE COULD BE CONSIDERED A LOW TERRACE BECAUSE INCISION OF THE REDWOOD CREEK CHANNEL HAS REDUCED THE FREQUENCY OF FLOOD INUNDATION (BASED ON HYDRAULIC MODELING, SURFACE TEXTURE, AND VEGETATION).
Qf	ALLUVIAL AND COLLUVIAL FAN DEPOSITS (HOLOCENE TO PLEISTOCENE) - ALLUVIAL AND COLLUVIAL SEDIMENT SHED FROM STEEP SLOPE AND DEPOSITED IN CHARACTERISTIC FAN-CONE SHAPES AT MOUTHS OF ERODING RAVINES.
Qt_1	LOWER ALLUVIAL TERRACE (EARLY HOLOCENE TO PLEISTOCENE) - DOMINANTLY SAND AND GRAVEL/COBBLE WITH MINOR AMOUNTS OF SILT AND CLAY DEPOSITED DURING HIGHER STANDS OF REDWOOD CREEK. THIS IS ONE OF SEVERAL ALLUVIAL TERRACES THAT HAVE FORMED WITHIN THE REDWOOD CREEK VALLEY (SPITTLER 1984). MOST EXTENSIVELY PRESERVED TERRACE SURFACE IN PROJECT VICINITY AND IN SOME LOCATIONS ONLY MINOR VERTICAL SEPARATION (I.E., < 5 FEET) FROM QFP2.
Qt_2	MIDDLE ALLUVIAL TERRACES (PLEISTOCENE) - DOMINANTLY SAND AND GRAVEL/COBBLE WITH MINOR AMOUNTS OF SILT AND CLAY DEPOSITED DURING HIGHER STANDS OF REDWOOD CREEK. TERRACE SURFACES ARE WELL EXPOSED IN PROJECT VICINITY AND OFTEN CONTAIN FAN DEPOSITS ON THEIR BACK EDGE.
Qt_3	UPPER ALLUVIAL TERRACES (PLEISTOCENE) - DOMINANTLY SAND AND GRAVEL/COBBLE WITH MINOR AMOUNTS OF SILT AND CLAY DEPOSITED DURING HIGHER STANDS OF REDWOOD CREEK. SURFACES ARE EROSIONAL REMNANTS AND NOT WIDESPREAD IN PROJECT VICINITY.

FRANCISCAN COMPLEX - COASTAL BELT

Ty	YAGER TERRANE (EOCENE TO PALEOCENE?) - SHEARED AND HIGHLY FOLDER MUDSTONE (ARGILLITE); UNIT IS A VARIABLY INDURATED DARK GRAY TO OLIVE GREEN MUDSTONE THAT DISAGGREGATES INTO SMALL PLATY CHIPS WHEN SUBJECTED TO MECHANICAL WEATHERING (MCLAUGHLIN ET AL. 2000).

MARSHALL RANCH FLOW ENHANCEMENT
SALMONID RESTORATION FEDERATION, MARSHALL RANCH, & CDFW
HUMBOLDT COUNTY, CA

Stillwater Sciences
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ARCATA, CA 95521
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PROJECT NUMBER: 603.01
SCALE: AS NOTED
DATE: 2/12/2018

DESIGN: DC
DRAWN: RT
CHECKED: DC/JS
APPROVED: DC

DYLAN J. CALDWELL
No. 9336

GEOMORPHIC MAP

SHEET 1 OF 1

Figure 3. Geomorphic map.

5.1 Field Assessment

The geomorphic field assessment of the project area consisted of evaluating the site topography and surficial drainage features, logging shallow stratigraphy, and further characterizing features related to landsliding.

5.1.1 Proposed pond and control center building sites

The proposed pond site is on a broad gently sloping Redwood Creek fluvial terrace tread (Qt_2 in Figure 3), approximately 900 feet east-west by 450 feet north-south (Figure 4). The terrace tread, or surface, slopes approximately 5% to the NNW towards Redwood Creek. The terrace has a low-gradient alluvial fan deposited by the east-side tributary on its back edge and upland hillslopes to the south and east. The east-side tributary has eroded a moderately incised channel 6-8 feet deep, which bisects the terrace and fan deposits. The central drainage has eroded the northern edge of the terrace tread and has deposited a small alluvial fan on the adjacent lower terrace (Qt_1) to the north. The pond-site terrace surface is approximately 90 feet higher in elevation than the adjacent Redwood Creek thalweg located approximately 350 feet to the northwest. An unimproved access road travels west from Old Somerville Creek Road along the back edge of the terrace and down toward the floodplain near the Redwood and Miller creek confluence. The east-side tributary passes under the access road through a culvert. Yager terrane argillite bedrock is exposed in a road cut on the terrace riser above the west-side tributary. The terrace tread is vegetated with grass and bushes, with trees around portions of its perimeter.

The proposed control center building site is located on the floodplain surface (Qfp_2 in Figure 3) to the northwest of the pond-site terrace, at the bottom of a steep terrace riser (Figure 5). The floodplain is an elongated, relatively flat surface parallel to Redwood Creek. There is a natural low-point and small gully on the outer edge of the floodplain/top-of-bank between TP-1 and TP-2 in Figure 3. The west-side tributary crosses the floodplain and has deposited an alluvial fan on its back edge. The west-side tributary has eroded a moderate to deeply incised channel, up to 15 feet in some locations, that bisects the fan and floodplain deposits. The floodplain is 18-20 feet above the adjacent Redwood Creek thalweg. The channel bank is steep to vertical with a well-exposed Yager terrane argillite strath surface that extends approximately 450 downstream from the west-side tributary confluence with Redwood Creek (Figure 6). A groundwater spring at the bedrock strath-alluvial fill contact near the natural low-point in the floodplain is the only groundwater seep along the Redwood Creek project reach observed in summer/fall months. The spring is located under a large bay tree (Figure 6), which toppled into the creek channel during the 2018/2019 winter. Remnants of the floodplain surface are expansive and border much of Redwood Creek in the project vicinity. Due to recent incision over the past decades to centuries, the floodplain is infrequently inundated by only the largest flood events (e.g., 100-year recurrence interval) (Stillwater Sciences 2018). The Qfp_2 floodplain on the northwest side of Redwood Creek is 4-6 feet lower in elevation than the proposed infiltration gallery site and would therefore inundate first during a large flood event. The west-side tributary passes under the unimproved access road through a culvert crossing. The floodplain is vegetated with grass and bushes, trees around portions of its back edge, and a narrow and dense riparian corridor along the Redwood Creek channel bank.

Figure 4. Intermediate terrace surface (Qt_2), view looking west across proposed pond site. Incised east-side tributary visible in foreground.

Figure 5. Intermediate floodplain surface (Qfp_2), view looking northeast across proposed cooling gallery site. West-side tributary just out of view to right of photo.

Figure 6. Redwood Creek channel at proposed flow delivery point, adjacent to cooling gallery. Bedrock strath-terrace fill contact well exposed along this reach. Groundwater spring near undercut bay tree is only spring along project reach observed during summer months.

5.1.2 Surficial drainage features

As described above, the project area has three separate surface drainages that have varying impacts to the site. Each of the three drainages are further described below.

5.2.2.1 West-side tributary

The west-side tributary is the largest of the three drainages (approximately 0.05 square miles) in the project area and flows south to north along the western side of the site (Figure 3). The stream originates on the steep forested hillslopes to the south of the project site and flows primarily through a steep bedrock canyon before flowing across an alluvial fan and floodplain where it meets Redwood Creek, just upstream of the proposed infiltration gallery site. Only the downstream extent of the tributary and lower portions of the canyon were investigated as part of the geomorphic assessment, considering this is where potential impacts to the proposed project are most likely.

Upon exiting the canyon and flowing across the alluvial fan, the tributary has incised a moderately deep channel (i.e., less than 10 feet). The channel here is actively eroding and is likely exacerbated by concentrated runoff from the access road upslope. The access road off Old Somerville Creek Road crosses the channel over a double-barrel 8-inch corrugated metal pipe culvert crossing. The channel is not incised at the culvert crossing; however, the culvert outfall has incised a large scour hole approximately 8 feet wide and 10 feet deep (Figure 7). The culvert has likely promoted downstream channel incision and fill under the culvert is resisting the headward propagation of the incision, creating a 10-foot knickpoint in the channel. It is difficult to tell when the crossing was constructed based on the historical aerial photos, although the access road is clearly visible in photos from the 1940's. From the road crossing down to the Redwood Creek confluence, the channel is actively incising with up to 12-15 feet of incision in some locations (Figure 8). Development of the incision along this portion of the tributary is difficult to determine across the aerial photo time-series record due to tree cover, although it appears to have increased following the historic 1964 storm and flood event. A Redwood Creek argillite bedrock strath is exposed in the lowest 50 feet of the tributary channel, and slopes toward Redwood Creek based on the exposure in the tributary cut-banks.

5.2.2.2 Central drainage

The central drainage is small and consists of an eroded gully along the northern edge of the pond-site terrace riser (Figure 9). The drainage collects runoff from the proposed pond site and transports it onto a small alluvial fan and lower terrace surface to the north. The fan and lower terrace surface lack an actual channel but at least two poorly defined flow paths are evident: one to the west and one to the north towards the neighboring parcel. On the main terrace riser, the drainage has eroded a moderately incised gully up to 15 feet deep that exposes argillite bedrock at its base. Groundwater was observed weeping at the bedrock-fill contact during summer/fall months. Several small scarps in the alluvium at the head of the incised gully form 0.5-2-foot knickpoints in the drainage. These knickpoints and other scarps on the eastern flank of the gully appear to have had some recent activity, albeit minor, and don't appear to have had significant movement over the historical photo time-series record.

5.2.2.3 East-side tributary

The east-side tributary flows south to north along the east side of the site (Figure 10). The stream originates on the partially forested hillslope immediately south of the pond footprint and flows across the terrace before descending down the terrace riser to meet Redwood Creek. The entire stream length was investigated as part of the geomorphic assessment.

The stream lacks a well-defined primary channel in its headwater area due to the irregular topography it flows across (see Section 5.1.3 for further discussion). Additionally, a lead-off ditch along Old Somerville Road routes concentrated road-runoff into the drainage and has formed a large actively eroding gully. The multiple flow paths mostly converge at a culvert crossing under the access road. A secondary gully just to the west of the crossing causes some runoff to flow over the road and divert across the pond site. Downstream of the culvert crossing the stream flows across an alluvial fan and terrace tread where it has eroded a moderately incised (6 to 8 foot depth) channel. The over-steepened banks are incising via sloughing and block-toppling. Incision dramatically increases at the scarp near the outer edge of the terrace tread (see Figure 10). This increased incision is likely due to anthropogenic impacts, a natural transition from a gently sloping fan and terrace tread to a steep terrace riser, and landsliding further downstream. The change in incision depth is also controlled by a large in-channel debris pile of tires, scrap metal, and appliances placed by landowners. The lowest portion of the stream flows down a steep hillslope with irregular hummocky topography and a large active landslide (see Section 5.1.3 for further discussion). Incision along the entire stream length noticeably increased following the 1964 storm and flood event, as seen in the 1965 aerial photo.

Figure 7. Approximately 10 feet of channel incision at culvert outlet along west-side tributary. Photo taken just upstream from Figure 8.

Figure 8. Typical channel incision along west-side tributary, just upstream from Redwood Creek confluence.

Figure 9. Scarp on main terrace riser above central drainage.

Figure 10. Typical channel incision along east-side tributary. Block-topple in foreground and sloughing on far bank.

5.1.3 Features related to landsliding

Geomorphic features related to landsliding were investigated using the aerial photo time-series, LiDAR-derived topography and hillshades, and during the field assessment. Landslide features were initially mapped and classified in the office and then further characterized and validated in the field. Landslides were classified based on feature types used by Spittler (1984) for the North Coast Watershed Assessment Program (e.g., translational/rotational slide, earthflow, inner gorge, disrupted ground, etc.). Stability classifications modified from Crozier (1984) were also assigned to each mapped landslide feature and are color-coded in Figure 3.

5.1.4 Summary

Although there are unstable geomorphic features in the vicinity, the Project proposes design features that will increase geomorphic stability within the project vicinity including gully stabilization and reduction of groundwater levels. Furthermore, multiple lines of scientific evidence support the findings that the Pleistocene terrace where the reservoir is proposed has been stable for a minimum of 10,000 years.

Figure 11. Disrupted ground upslope from pond site. Hillslope has remained relatively stable and vegetated over photo time-series record (i.e., since 1942).

6 GEOTECHNICAL INVESTIGATION AND SEISMIC SLOPE STABILITY ANALYSES

SHN Engineers and Geologists conducted the geotechnical investigation for the site. A full Geotechnical Report is included in Appendix B and found the project to be feasible from a geohazard and geotechnical standpoint. Specifically in Section 5.7 the report states that “what low risk is associated with the site has been mitigated through development of an extremely conservative design plan”.

Based on the geotechnical investigation, groundwater well data (see Section 8.5) and the revised pond layout included in Appendix A.2, Stillwater Sciences conducted seismic slope stability analyses along two critical cross sections as described in Appendix H. Based on this analyses, no plausible mechanisms for massive pond failure were identified. Additional geotechnical and geophysical investigations to confirm this finding are scheduled for October and November 2020.

7 TOPOGRAPHIC DATA

7.1 Field Survey

Stillwater staff conducted field surveys using a total station and differential GPS. The primary goals of the field effort were to: (1) survey cross sections along the Redwood Creek channel thalweg at the downslope extent of the proposed site to be used for hydraulic modeling; (2) obtain additional topographic data in areas where project features are proposed; and (3) survey existing features (e.g., buildings, trees, roads, and fences). A differential GPS (approximately 0.4 feet horizontal accuracy and 0.7 feet vertical accuracy) was used to establish survey control points. These control points were used to orient the surveys and relate them to a projected coordinate system so that they could be combined with existing Light Detecting and Ranging (LiDAR) topographic data. All elevations and horizontal positions shown in the plans use the local coordinate system based on these control points.

7.2 Merging Field and LiDAR Data

The field survey data was merged with 2007 LiDAR data from EarthScope Northern California LiDAR project. The first step in merging the topographic data sets was to overlay the new field data on the LiDAR DEMs in AutoCAD Civil3D (CAD) to check for general consistency between the two datasets. Once consistency was confirmed, new ground surfaces were created based on the field-surveyed topography and combined with the LiDAR DEMs to create a new existing ground surface DEM for each project reach. Because the extent of the topo survey was limited to the areas described above, constructing a merged terrain model from the available LiDAR and topo survey data required interpolation and interpretation of ground surface elevations in some areas lacking data and/or resolution. Due to the limited accuracy of the LiDAR data especially in the near-channel portion of the project area, it was used only to provide general topographic context and approximate elevations for areas not characterized with field-based topographic data.

8 HYDROLOGIC ANALYSIS

An assessment of site hydrology has been conducted to inform the alternatives analyses and design process. There are five key components of the hydrologic assessment:

1. Determine key regulatory considerations that influence pond size and the ability to fill pond from surface water diversion;
2. Determining the best approach to fill the pond through a combination of direct rainfall input, sheet flow from the hillside, and diversions from surface water; and
3. Utilize existing flow monitoring data to determine a realistic/desirable flow enhancement benefit that the project can achieve.
4. Assess 100-yr storm flows to provide the basis for project design of instream and near-stream features.
5. Assess groundwater data and how groundwater dynamics are expected to affect the project.

Each of these components are discussed below.

8.1 Regulatory Considerations

There are three primary state agencies that could have jurisdiction over this project. These include:

1. CA Department of Water Resources – Division of Safety of Dams (DSOD) regulates dams above a certain size;
2. CA State Water Resources Control Board (SWRCB) requires an Appropriative Water Right for diverting water from a stream and storing it for more than 30 days; and
3. CA Department of Fish and Wildlife (CDFW) requires a Lake and Streambed Alteration Agreement (LSAA) for installing infrastructure and diverting water from a stream.

8.1.1 DSOD jurisdiction

Jurisdictional dams are dams that are under the regulatory powers of the State of California. A "dam" is any artificial barrier, together with appurtenant works as described in the California Water Code. If the dam height is more than 6 feet and it impounds 50 acre-feet or more of water, or if the dam is 25 feet or higher and impounds more than 15 acre-feet of water, it will be under DSOD jurisdictional oversight, unless it is exempted. The DSOD Jurisdictional Size Chart (Figure 12) summarizes the above criteria. Jurisdictional height of a dam, as determined by DSOD, is the vertical distance measured from the lowest point at the downstream toe of the dam to its maximum storage elevation, which is typically the spillway crest.

There are significant annual reporting requirements and fees associated with jurisdictional dams, so from a long-term operations perspective, falling outside of DSOD is desirable. Therefore, a strong consideration in sizing the pond was to stay below a 25-foot dam height and 15 acre-feet (16.3 million gallons) of water storage.

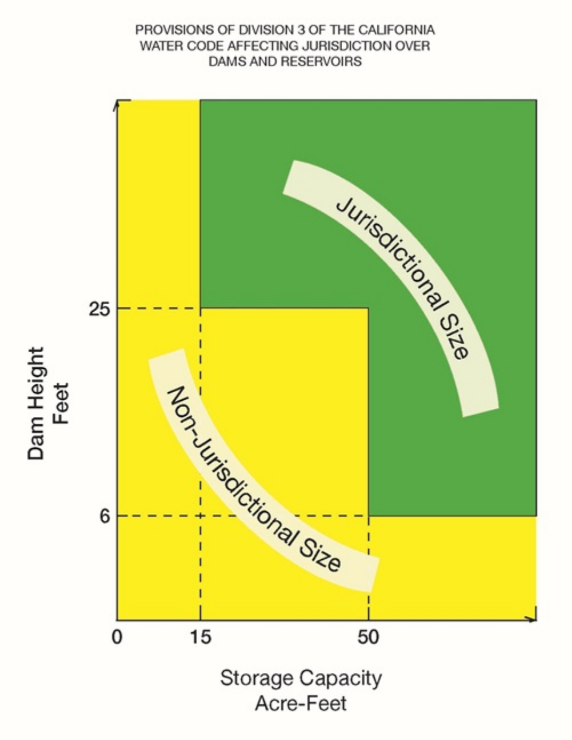

Figure 12. DSOD jurisdictional chart.

8.1.2 SWRCB appropriative water rights

Based on site geometry and the desired project outcome of maximizing flow enhancement inputs, it is not feasible to design this project to capture rainwater and sheet flow only. Therefore, it is anticipated that the Project will require an Appropriative Water Right to divert surface water from a stream and store that water for more than 30 days.

8.1.3 CDFW LSAA

Based on preliminary input from local staff, CDFW is generally supportive of the project. However, based on the project team's experience permitting water diversions on other projects, CDFW is likely to impose limitations on the diversion season and percentage of flow that can be taken from a stream. Based on the expected diversion limitations that CDFW will likely impose, it is likely to be more feasible to divert from larger watercourses during a shorter period to ensure diversion of a smaller percentage of overall streamflow during high flow periods. This concept is discussed further in Section 8.2 below.

8.1.4 Other regulatory requirements

Other permits will be required for the Project but the conditions/stipulations of those permits are not anticipated to govern the project design. These additional permits include:

1. Special Permit from Humboldt County for work within the Streamside Management Areas;
2. Grading and Building Permits from Humboldt County for construction of project infrastructure;
3. 401 Permit from SWRCB for instream work; and

4. 404 Permit from US Army Corps of Engineers.

8.2 Filling the Pond During the Wet Season

Five different sources for filling the pond were analyzed:

1. Direct precipitation falling into the pond;
2. Sheet flow from the hillslope;
3. Surface water diversion from the tributary to the east of the site;
4. Surface water diversion from the tributary to the west of the site; and
5. Surface water diversion from Redwood Creek.

8.2.1 Water availability from upslope sources

To assess the water availability from Sources 1-4 listed above in Section 7.2, the Rational Method (also known as the Rational Formula) was used to calculate expected seasonal runoff. The Rational Formula incorporates a combination of rainfall intensity, drainage area and runoff coefficient to estimate maximum flows and is defined as follows:

$$Q = CIA$$

Where:
Q = Flow Discharge
C = Runoff Coefficient
I = Rainfall Intensity
A = Area

This application of the Rational Method varies from the typical application in that here it is being used to estimate total runoff generated over the entire wet season, so the “annual design rainfall” is substituted for “rainfall intensity” in these calculations.

8.2.2 Expected annual rainfall

Two methods were applied to determine an appropriate annual rainfall to utilize for project design considerations:

1. Local rain gage data compiled by the Mattole Restoration Council (Figure 13); and
2. Annual rainfall for Briceland, CA based on PRISM Climate Group interpolations (Figure 14).

Based on these two data sources, an annual rainfall amount of 48 inches was selected as the design precipitation which represents a dry year with precipitation between the 5th and 10th percentile. This “design precipitation” was selected based on the goal that the project function at capacity during 90% to 95% of precipitation seasons. However, it was also not desirable to limit the project capacity by designing for the most extreme drought years.

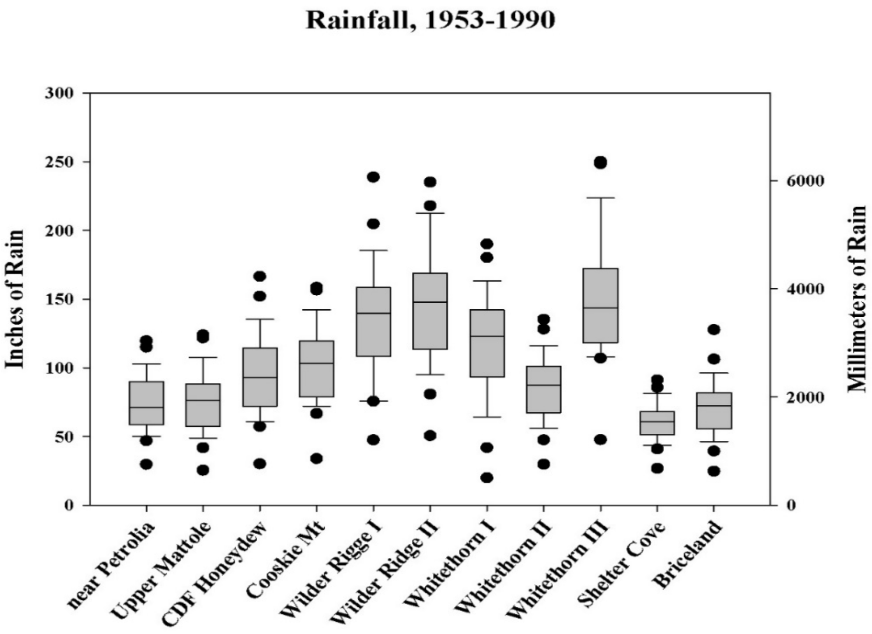

Figure 13. Local rain gage data (Mattole Restoration Council).

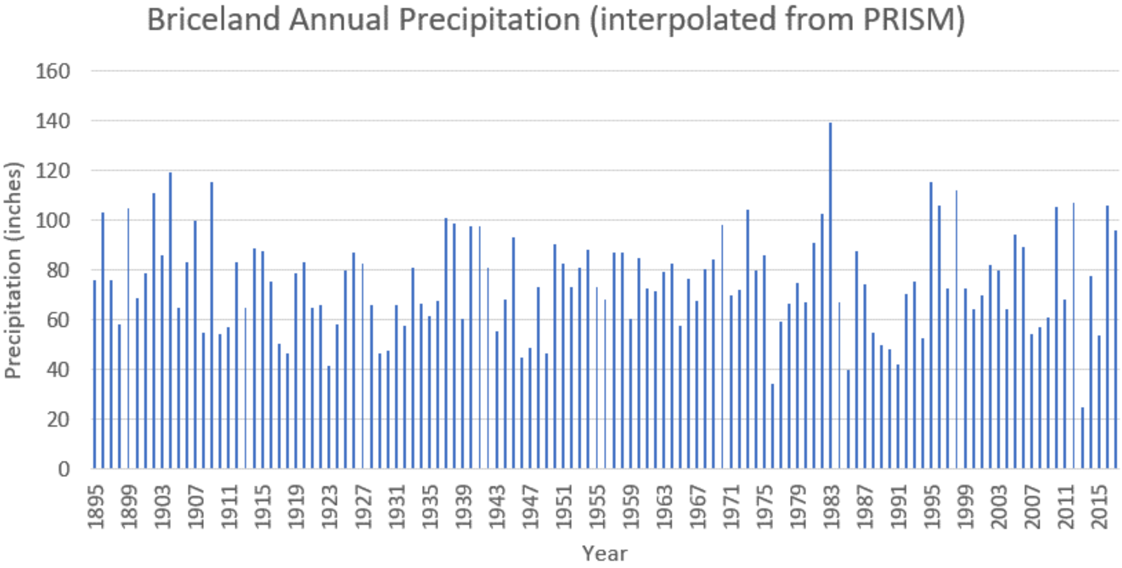

Figure 14. Briceland Annual Precipitation (PRISM).

8.2.3 Calculations

Table 1 below summarizes each of the four potential upslope water sources for the pond and calculates total expected water volume input based on 48 inches of annual precipitation. Note that for the Eastern and Western Tributaries we have reduced the runoff coefficient to 0.2 (from typical 0.4) assuming that a minimum of 50% of the flow would have to be bypassed per expected CDFW LSAA permit conditions.

Table 1. Summary of rational method calculations for upslope water sources.

Source	Area (acres)	Runoff coefficient	Intensity/Annual Precipitation (inches)	Volume (gallons)
Pond (direct precipitation)	4.6	1.0	48	5,984,000
Hillslope sheet-flow	2.5	0.4	48	1,303,315
Diversion from Eastern Tributary	4.0	0.2	48	1,042,652
Diversion from Western Tributary	20.0	0.2	48	5,213,261
Total				**13,543,228**

Based on the results shown in Table 1, the upslope sources only have the capacity to deliver approximately 13.5 million gallons to the pond.

8.2.4 Water availability for diverting from Redwood Creek

Pumping water from Redwood Creek during the wet season was also determined to be a viable option for filling the pond. This source has some advantages in that it will likely be easier to permit due to the small percentage of flow diversion necessary compared to total flow in the creek. A Water Availability Analysis is included in Appendix C. Based on that document, there is sufficient water available in Redwood Creek to pump during the wet season to fill the pond. It is anticipated that up to 100 gallons-per-minute may be pumped during several months of the wet season. Exact diversion schedule will be determined based on regulatory agency conditions and specific stream flows during each year. It is expected that up to approximately 10,000,000 gallons will be pumped from Redwood Creek to fill the pond, which represents less than 0.05% of the average winter runoff at the point of diversion during the period of December 15 to March 31 (see Appendix C). An Appropriative Water Right will be required and has been filed with the SWRCB.

8.3 Existing Flow Data and Expected Flow Enhancement Benefit

SRF has been monitoring dry season flows in Redwood Creek beginning in 2013. Flow monitoring results for station RC-4, located near Redwood Creek's confluence with the south Fork Eel, is shown on Figure 15. As this figure depicts, dry-season flows in Redwood Creek are extremely low with flows at RC-4 dropping below 5 gallons per minute during each of 2013 through 2018 dry seasons (2019 was anomalously high). Flows at all other monitoring stations throughout the watershed follow similar trends with zero flow recorded at the majority of monitoring stations during most years. Based on this data, the proposed project benefit of 50 gallons per minute of flow augmentation provides a substantial and meaningful increase above current dry season base flow. Additionally, water temperatures of the flow releases are anticipated to be suitable for salmonids during most years as described in Appendix J.

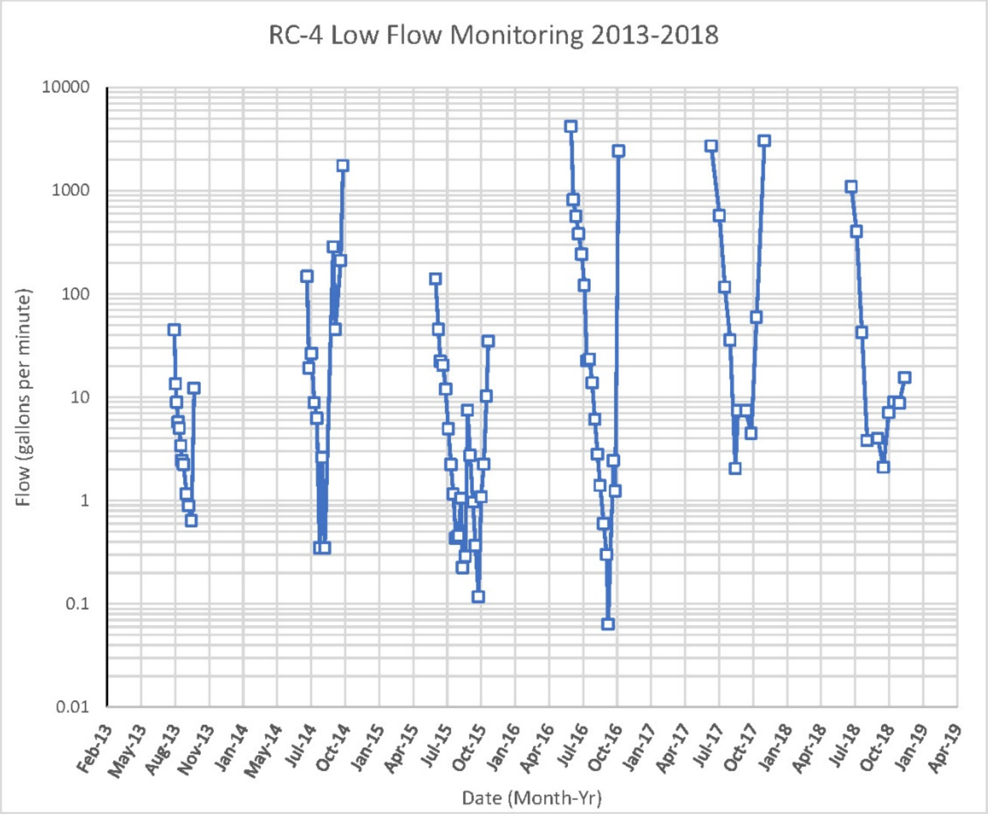

Figure 15. Dry season flow monitoring results for Redwood Creek mainstem near confluence with South Fork Eel.

8.4 100-year Storm Event Analysis

The 100-year storm event analyses utilized Rational Method runoff calculations for the upslope areas and Class III drainages running through and adjacent to the Project as well as more in-depth hydrologic and hydraulic analyses for mainstem Redwood Creek.

8.4.1 100-year storm event rational method calculations

Based on the Rational Formula defined in Section 8.2.1 above, 100-yr discharge was calculated for the pond outfall, eastern tributary, and western tributary. This method is appropriate for determining flow rates for relatively small drainage areas of less than 200 acres according to Cafferata et. al. (2004).

8.4.1.1 Determining storm duration

For the Rational Method analysis, the total area, slope, and longest flow path for each drainage was determined based on field observations and analyses of a USGS topographic map. Based on these values (summarized on Table 2), the "Time to Concentration" was estimated using the Airport Drainage Formula. The "Time to Concentration" is defined as the time it takes runoff to travel along the longest flow path within the contributing watershed and arrive at a site crossing.

Per Cafferata et. al., the "Time to Concentration" can be found with the following Airport Drainage Formula[1]:

$$T_c=((1.8)(1.1–C)(D^{0.5}))/(S^{0.33})$$

Where:

Tc=Time of Concentration (minutes)
C=Runoff Coefficient (dimensionless, 0<C<1.0)
D=Distance (in feet from the point of interest to the point in the watershed from which the time of flow is the greatest)
S = Slope (percent)

Table 2. Summary of time-to-concentration analyses.

Site	Drainage area (ac)	Longest flow path (ft)	Maximum elevation change (ft)	Slope (%)	Time to concentration (min)	100-year intensity (in/hr)
Hillslope draining to pond	2.5	600	80	13	13	3.1
Direct rainfall on pond	4.6	0	0	0	13*	3.1
Eastern Tributary	4.0	700	120	17	13	3.1
Western Tributary	20.0	2500	520	21	23	2.2

* Time to concentration for pond of 13 minutes chosen to match hillslope time to concentration.

8.4.1.2 Precipitation data

The intensity-duration-frequency (IDF) curve used for the Rational Method analysis came from National Oceanic and Atmospheric Administration's National Weather Service Hydrometeorological Design Studies Center Precipitation Frequency Data Server (PFDS).[2] Rainfall intensity was determined from the IDF curves for the 100-year recurrence interval for storm durations equivalent to the "Time to Concentration" for the project sites. The 100-year rainfall intensity from the PFDS for each site is also shown on Table 2.

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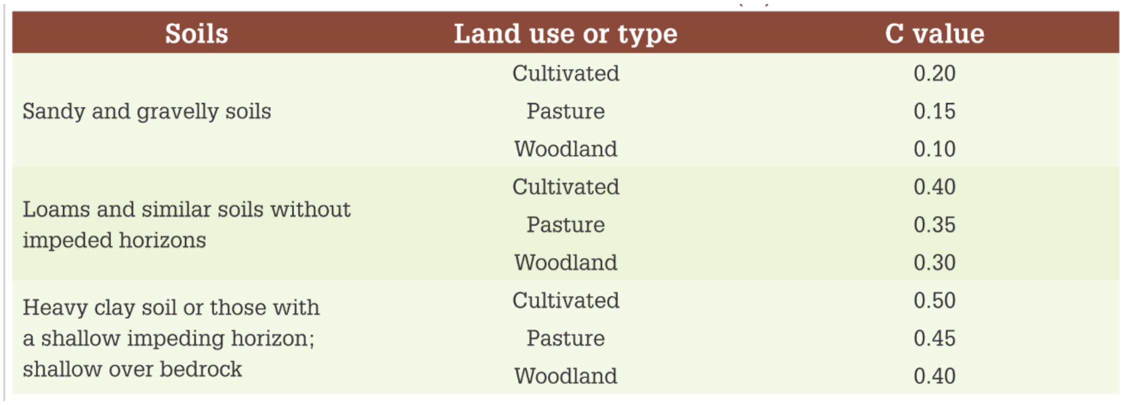
[1] Note that two methods for determining Time to Concentration were described in Cafferata et. al. including (1) the Kirpich formula and (2) the Airport Drainage equation. The Kirpich Formula was developed in 1940 based on precipitation and runoff data from seven rural watersheds in Tennessee with average slopes ranging from 3% to 10%. We believe that the Kirpich Formula does not provide good estimates for Time to Concentrations on steeper northern California watersheds. Additionally, Yee (1994) recommends use of the Airport Drainage equation.

[2] http://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html

8.4.1.3 Runoff coefficients

Cafferata et. al. suggests a runoff coefficient ranging from 0.30 to 0.45, depending on the specific location of the crossing. Per Buxton et. al. (1996), as cited in Cafferata et. al., a runoff coefficient value of 0.4 is recommended for North Coast California specifically. Additionally, a runoff coefficient of 0.4 reflects woodland with heavy clay soil, soil with a shallow impeding horizon, or shallow soil over bedrock per Figure 16 taken from Appendix A, Table A-1 of *The Handbook for Forest, Ranch and Rural Roads* (Weaver et. al. 2015).

For this property, we have used a Runoff Coefficient of 0.4 because the drainage areas consist of mostly woodland with soil with a shallow impeding horizon.



Soils	Land use or type	C value
Sandy and gravelly soils	Cultivated	0.20
	Pasture	0.15
	Woodland	0.10
Loams and similar soils without impeded horizons	Cultivated	0.40
	Pasture	0.35
	Woodland	0.30
Heavy clay soil or those with a shallow impeding horizon; shallow over bedrock	Cultivated	0.50
	Pasture	0.45
	Woodland	0.40

Figure 16. Runoff coefficients (adopted from Appendix A, Table A-1 of the *Handbook for Forest, Ranch and Rural Roads* [2015]).

8.4.1.4 Storm discharges

Discharges from the Rational Method calculations for 100-year storm events are shown on Table 3.

Table 3. 100-year discharges.

Site	100-year discharge (cfs)
Hillslope draining to pond	3
Direct rainfall on pond	14
Eastern Tributary	5
Western Tributary	18

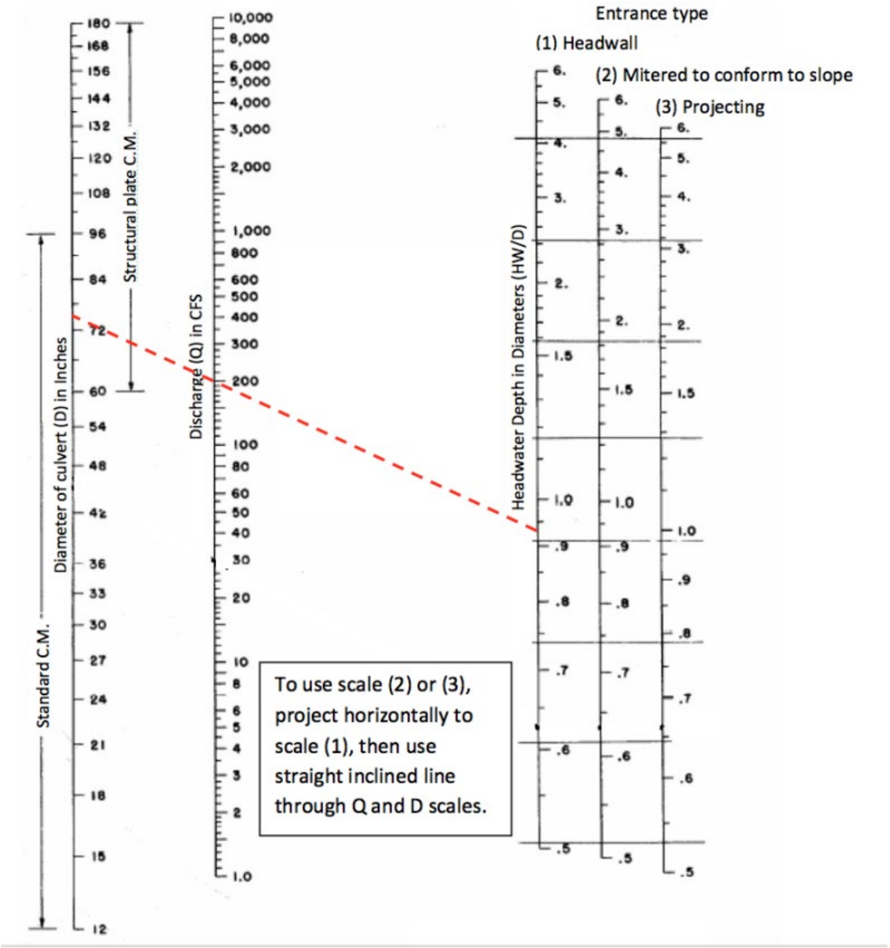
8.4.1.5 Drainage structure sizing

New drainage structures will be needed for the access road to the project which crosses the Eastern Tributary and the pond outlet with runoff generated from both the “hillslope draining to the pond” and the “direct rainfall on the pond”. These culvert crossings are required to carry 100-year discharges and were sized using the FHWA Culvert Capacity Inlet Control Nomograph (Figure A-1 of Weaver et. al. 2015) using an HW/D ratio of 0.67, as shown in Figure 17. Culvert Capacity Inlet Control Nomograph (adopted from Appendix A, Table A-1 of *The Handbook for Forest, Ranch and Rural Roads* [Weaver et. al. 2015]).Figure 17 below. The required culverts for the Eastern Tributary and pond outflow are shown in Table 4. Note that additional hydraulic analyses in HEC-RAS will be conducted for final sizing of the armored pond spillway.

Table 4. Drainage Structure Sizes

Site	100-year discharge (cfs)	Culvert diameter required (inches)
Pond Outflow	17	36
Eastern Tributary	18	24

The rock armored grade control structures proposed for stabilization in the Eastern and Western Tributaries have also been designed to accommodate the 100-yr storm flows listed in Table 3.



To use scale (2) or (3), project horizontally to scale (1), then use straight inclined line through Q and D scales.

Figure 17. Culvert Capacity Inlet Control Nomograph (adopted from Appendix A, Table A-1 of *The Handbook for Forest, Ranch and Rural Roads* [Weaver et. al. 2015]).

8.4.2 Hydrologic and hydraulic overview for Redwood Creek mainstem

To understand the flow dynamics that will act on the instream features proposed in Redwood Creek and to estimate flooding potential at the project site, flow hydraulics were modeled using the U.S. Army Corps of Engineers' (USACE) *Hydrologic Engineering Center's River Analysis*

*System (*HEC-RAS). HEC-RAS is a one-dimensional hydraulic model that is widely used for floodplain mapping and estimating general flow characteristics. This one-dimensional model assumes uniform flow direction and constant velocity distribution within the channel and floodplain portion of each cross section. Flow is modeled based on topography at a channel cross section without considering the effects of channel topography between cross sections. Therefore, it is important that these limitations are closely considered during hydraulic model setup, calibration, and application.

8.4.2.1 Hydrologic data overview

The first step in this hydraulic modeling process is to determine the hydrologic data that will be the principal input to HEC-RAS. The primary hydrologic data sets analyzed for this project were flood frequency flows (also known as recurrence interval flows) which represent higher flows that are expected to occur at a specific frequency (i.e., a 100-year flow would be expected to occur every 100 years on average). These flood frequency flows, especially those from half of “bankfull” to 2-year discharges, are biologically significant because they occur during most winters and are swift enough to flush salmonids out of the system and/or cause mortality if insufficient low-velocity habitat is available at such flows. For this analysis, 1.5-year recurrence interval flows are considered to be synonymous with “bankfull” flows. In addition, it is critical to analyze flows from larger events ranging from 2- to 100-year to determine erosion potential and flooding hazards for adjacent property and infrastructure, as well as the stability of the features being installed under high flow conditions.

Flood frequency discharges for each project reach were determined based on (1) US Geological Survey (USGS) gage data, (2) Federal Emergency Management Agency (FEMA) flood insurance studies, and (3) USGS Streamstats data. Each of these data sources are discussed below.

8.4.2.2 USGS gage data

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

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

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

Where: $b = 0.9$ for 2-year event and $b = 0.87$ for 100-year event

Q_u = Ungauged discharge
Q_g = Gauged discharge
A_u = Ungauged drainage area
A_g = Gauged drainage area.

Results from these calculations are shown in the first row of Table 5.

Table 5. Flood frequency discharge estimates for the Redwood Creek Project Reach.

Discharge location and description:	100-year discharge (CFS)	50-year discharge (CFS)	25-year discharge (CFS)	10-year discharge (CFS)	5-year discharge (CFS)	2-year discharge (CFS)	1.5-year discharge (CFS)
Log-Pearson Analysis based on USGS Gage at Miranda (537 sq mi) adjusted for Drainage Area Difference based on USGS Formula				3,100	2,400	1,400	800
FEMA prorated	3,500	3,400		2,200			
Results from USGS Streamstats for Project Site (10.8 sq mi)	3,850	3,340	2,840	2,170	1,660	930	
Average at project site	**3,700**	**3,400**	**2,840**	**2,500**	**2,000**	**1,200**	**800**

8.4.2.3 FEMA Flood Insurance Studies

FEMA has authored a Flood Insurance Study (FIS) for Humboldt County which includes Redwood Creek (FEMA 2017). The FIS focuses on the area around Redway, downstream of the project reach. The FIS does not provide 100-year flood water surface elevations (WSEs) for the project reach, but does provide a map of estimated 100-year floodplain extents. In addition, FEMA flood discharges for SF Eel River can be prorated by drainage area to estimate flows for the project reach. FEMA predicts flood discharges for 10-, 50-, 100- and 500-year storms.

8.4.2.4 USGS Streamstats data

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

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

8.4.2.5 Discharges

Discharges used in the Redwood Creek hydraulic model are listed in the bottom row of Table 5. These flows have been calculated by averaging the discharges listed in the top two rows of the table. These values have been rounded to two significant digits to reflect the uncertainty of these estimates.

In addition to the flood frequency flows, additional low and moderate flows have also been modeled in HEC-RAS which correspond to winter base flow and a typical late spring/early summer flow. These flows have biological significance for restoration, especially related to spring and summer rearing as well as over-wintering habitat for salmonids. Note that for much of the summer, flows in Redwood Creek drop below 1 cfs (Stillwater 2017). However, due to the level of detail of topographic data gathered as well as hydraulic modeling constraints, there is minimal value-added in modeling flows less than 1 cfs. The low to moderate flows used in the hydraulic model are shown in Table 6. The typical winter discharge was calculated by prorating flows for the project site based on average January, February, and March flows measured at USGS gage #11476500 (SF Eel near Miranda). The typical spring/early summer discharge was calculated by prorating flows for the project site based on average May, June, and July flows measured at USGS gage #11476500 (SF Eel near Miranda).

Table 6. Additional discharge estimates used for the Redwood Creek hydraulic model.

	0.5 bankfull discharge (CFS)	Typical winter discharge (CFS)	Typical late spring/early summer discharge (CFS)
Redwood Creek	400	88	1

8.4.2.6 Existing conditions hydraulic modeling

Existing conditions topography used for the HEC-RAS model was primarily taken from the new topographic data collected by Stillwater Sciences that included the Redwood Creek channel within the project area. This new survey data was combined with LiDAR as previously described. Plan view locations of all HEC-RAS cross-sections are shown on Figure 18. Typically, cross sections are cut perpendicular to the channel thalweg. However, in cases where there is significant channel sinuosity, which is the case for this project, some skewing of the sections is required to properly model the channel and floodplain curvature. Based on sensitivity analyses conducted in HEC-RAS with different cross section placements, it was determined that the slight skewing of the cross sections away from perpendicular does not lead to significant differences in modeled outputs of velocities or flood elevations.

Cross-sections of the channel were cut from the Triangular Irregular Network (TIN) surface in AutoCAD and exported directly to HEC-RAS in order to create the hydraulic model. Manning's "n" roughness values used in HEC-RAS were 0.05 for the channel, based on the HEC-RAS Reference Manual recommendations for a "clean and winding natural stream with some pools, shoals, weeds and stones"; and 0.06 for all banks and floodplains based on a conservative value for "light brush and trees in summer." These values were calibrated based on previous work that Stillwater conducted for a restoration design project just downstream from this project (see discussion below). Flow was modeled in a subcritical regime with a normal depth downstream boundary condition at a slope of 0.0055 held constant for all flow stages.

8.4.2.7 Hydraulic model calibration

The existing conditions HEC-RAS model was calibrated using field-based evidence of 2017 high flow. Based on a review of Water Year 2017 peak flows on Bull Creek, the highest flow event which occurred on January 10, 2017 was approximately a 2-year recurrence interval flood. At Station 17+00, flood debris caught in tree branches was observed at elevations between 464 and 465.5. Based on the positioning of the tree branches where observations were made, it is likely that during high flows they were bent down several feet. The initial HEC-RAS model run predicted 2-year water surface elevations (WSEs) flows of 462.7 feet. To calibrate the model to more accurately match field observations, all Manning's n roughness values were increased by 0.005 which consequently increased the WSE at Station 17+00 to 463.3 feet which closely matches field observations assuming the branches were pushed down several feet.

8.4.2.8 Existing conditions hydraulic model results

The existing average stream channel velocity and mean total shear value results from HEC-RAS for 100-year, 10-year, 2-year, and 1.5-year flows are shown on Table 6. The corresponding WSEs and floodplain extents for these return periods are shown on Figure 18 and Figure 19. A full tabulation of hydraulic model outputs are included in Appendix D. Figure 18 shows the longitudinal profile of the channel invert and WSEs throughout the project area. Note that the Project is located within the upstream extent of the modeled profile between HEC-RAS Stations 3000 and 3500.

Within the project reach, the 100-year flows are almost entirely contained within the channel as shown on Figure 19 due to the generally incised nature of the channel. Therefore, there are no significant constraints in placing fill or constructing infrastructure within adjacent to Redwood Creek. Furthermore, the floodplain terrace to the north of Redwood Creek is significantly lower than the terrace to the south of the creek. Therefore, even if future WSEs were higher than the model results, flooding would extend across the northern floodplain and would not reach the southern terrace where project features are proposed.

The incised and confined nature of the channel will generate high velocities and deep flows that will exert strong forces on proposed instream structures. Therefore, a stability analyses is necessary for the design of proposed instream structures (see Section 12 below).

Table 7. HEC-RAS model outputs for average channel velocity and shear for the modeled project reach.

Flow metrics	Average existing total velocity (feet per second)	Average existing total shear (pounds per square foot)
Spring/Early summer	0.69	0.17
Typical winter	1.31	0.11
0.5 Bankfull	2.29	0.25
1.5-year	3.12	0.42
2-year	3.75	0.56
5-year	4.69	0.78
10-year	5.16	0.89
25-year	5.45	0.95
50-year	5.88	1.06
100-year	6.09	1.12

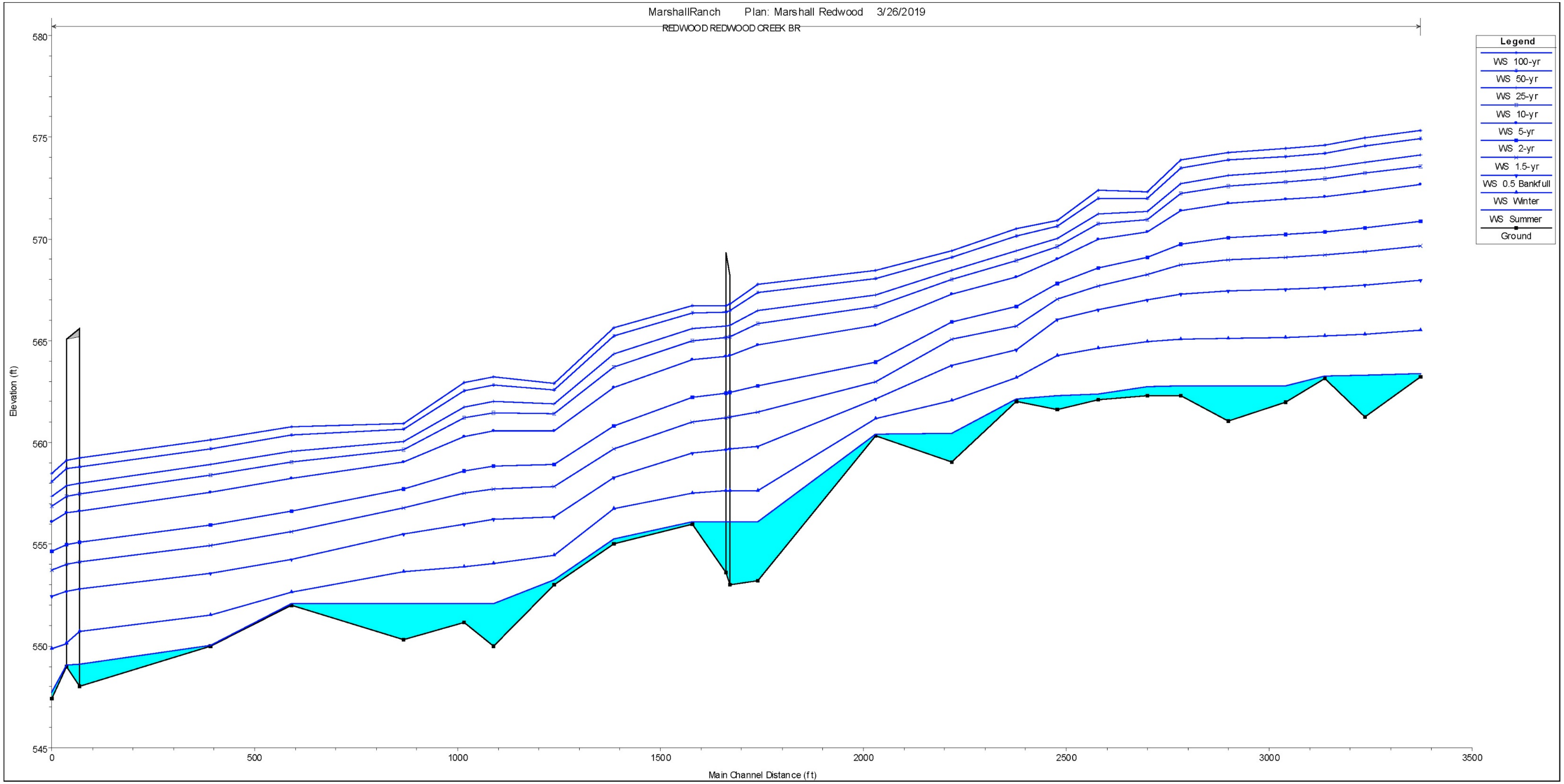


Figure 18. Modeled water surface elevations in the project reach.

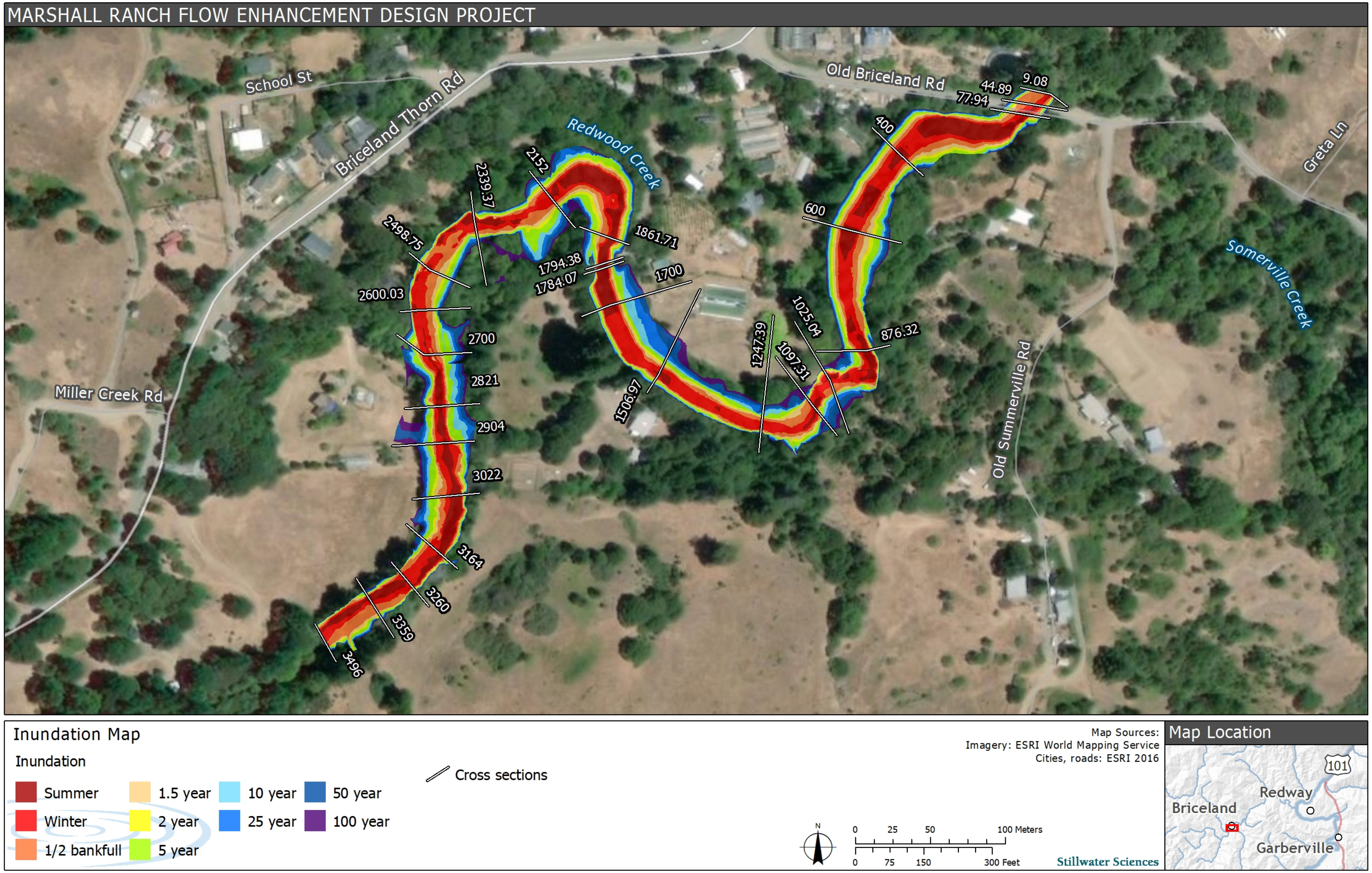


Figure 19. Inundation at various flows within the project reach.

8.4.2.9 Proposed conditions hydraulic modeling results

The proposed features within Redwood Creek are not expected to significantly change hydraulic dynamics so no proposed-conditions modeling has been conducted at this time.

8.5 Groundwater

Groundwater wells were installed in November 2018 inside two of the boreholes (BH-101 and BH-103) and three of the test pits (TP-1, TP-2, and TP-3). Groundwater wells consisted of screened 2-inch diameter PVC pipe with data loggers measuring water elevations at 15 minute intervals. Note that the wells within BH-101 and BH-103 were constructed using standard well installation techniques with a bentonite seal around the top of the well to prevent direct precipitation and ponding around the well head from influencing measured groundwater levels. The wells within TP-1, TP-2, and TP-3 were constructed more coarsely with vertical standpipes stuck into the test pit and backfilled with loose dirt by an excavator bucket (i.e. there was no seal or soil mounding around the well head to reduce pooling and accelerated infiltration during and after significant precipitation events).

Groundwater monitoring results for the five wells are shown on Figure 20. Even with the different installation techniques, the groundwater levels measured within each well follow similar patterns. As expected, the groundwater dynamics at the site are governed by precipitation events with significant rainfall leading to increased groundwater levels within the wells. Within BH-101 and BH-103, during the dry season, the groundwater levels are perched just above the bedrock interface which is consistent with the findings from the geotechnical investigations (note that the bedrock is nearly impervious). Then, during significant rainfall events, the groundwater levels spike.

There was a visible difference between groundwater dynamics at BH-101 compared to BH-103. At BH-101 groundwater was either at the ground surface or within several feet of the ground surface during approximately two months of the 2018/2019 wet season whereas BH-103 just had several groundwater level spikes that neared the ground surface. This is likely due to surface runoff from the Eastern Tributary infiltrating into the terrace upslope from BH-101. Note that these heightened groundwater elevations have implications for slope stability as described in Appendix H.

Groundwater within the lower terrace was also near the ground surface during wet periods. However, based on the current preferred alternative, there may not be a significant amount of infrastructure proposed on the lower terrace. Therefore, the results from the three test pit wells are informative but may not be critical to inform specific design features.

At the second TAC meeting, concerns were raised by agency staff that the project could negatively impact natural groundwater inputs from the project site vicinity through installation of the french drain under the pond. The french drain is designed to drain groundwater from the upper terrace to prevent bubbling under the pond liner and significantly reduce slope stability concerns. As shown by the well data (Figure 20), under existing conditions groundwater is almost entirely drained from the shallow soil layer within two months following significant precipitation events. Furthermore, the underlying shale bedrock is impervious and does not allow for groundwater recharge. Therefore, nearly all groundwater is drained from the site and delivered to Redwood Creek before low flow conditions are reached in the mid to late summer.

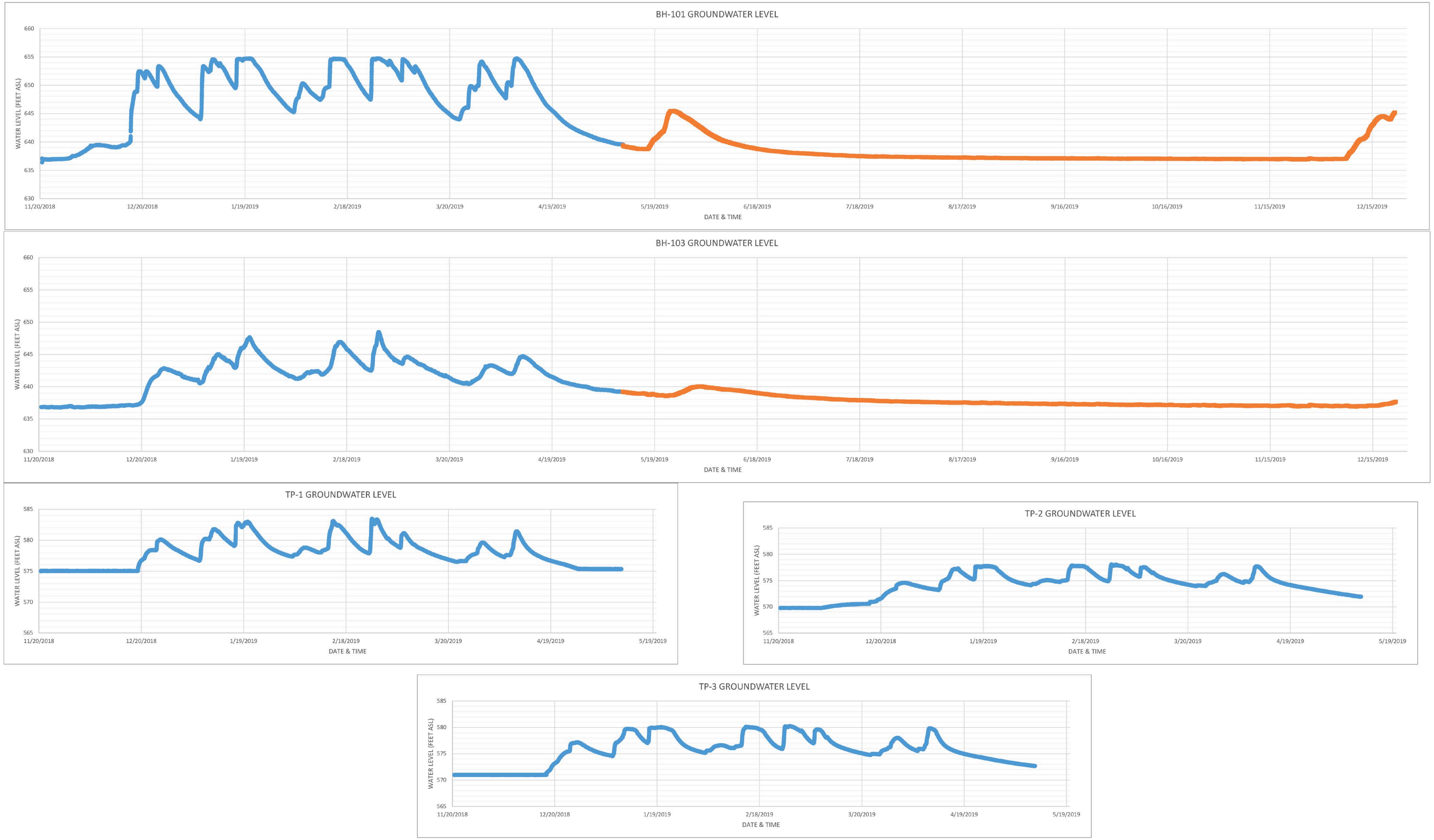


Figure 20. Groundwater monitoring results.

9 ADDITIONAL SITE EVALUATIONS

9.1 Cultural Resources

Findings from a cultural resources study are included in Appendix E. The proposed project design was developed with consideration of cultural resources, so no significant impacts are expected as long as the recommendations in the cultural resources study are followed. A cultural resources construction monitor has been included in the project budget.

9.2 Biological Resources

Findings from a Biological Resources study are included in Appendix F. The proposed project design was developed with the goal of enhancing local aquatic habitat, so no significant impacts are expected as long as the recommendations in the Biological Resource Technical Report are followed.

10 ALTERNATIVES ANALYSES

Based on the results of the multiple analyses described above, the project is feasible. An alternatives analyses was conducted in two phases with an initial phase defining the optimal size and filling/draining mechanisms for the reservoir, and a second phase assessing in more detail specific project design considerations and features that maximize benefits and reduce risk.

10.1 Phase I Analyses

A matrix of proposed project alternatives (Table 8) was developed to compare the flow enhancement benefits resulting from project with various pond sizes and metered versus passive pond outflow approaches.

Table 8. Summary Table of project alternatives.

Pond volume (gals)	Pond volume after evaporation loss (gals)	Flow benefit with mechanized outflow valve, assumes 5-month release time (gpm)	Flow benefit with passive outflow, assumes 5-month release time (gpm)	Comments
6,000,000	4,000,000	19	12	Fills with rainfall only
8,500,000	5,666,667	26	16	Fills with Rainfall, Trib A and hillslope
13,500,000	9,000,000	42	26	Fills with Rainfall, Trib A, Trib B and hillslope
16,300,000	10,866,667	50	31	Maximum capacity to be exempt from DSOD Jurisdiction; needs water pumped from Redwood Creek to fill
21,500,000	14,333,333	66	41	Maximum size based on site conditions and filling capacity based on realistic water sources

Based on this matrix of alternatives the design team selected a 16-million-gallon pond with mechanized outflow capable of delivering 50 gallons per minute of flow to Redwood Creek during a 5-month dry season. Preliminary vetting of this alternative was also conducted at the February 2019 TAC meeting with member of the TAC generally supporting this alternative. The preferred alternative provides a substantial flow benefit of 50 gallons per minute while being generally conservative in utilizing the available topography. This alternative is also exempt from DSOD fees and reporting which will reduce long-term operations and maintenance costs.

This alternative was advanced to the draft 65% design level with excerpts from that design included in Appendix A.1 (Draft 65% Designs Excerpts). Note that based on input from adjacent landowners, further analyses were conducted, and several significant design alternatives were considered through a Phase II alternatives analyses as described below.

10.2 Phase II Analyses

Phase II of the alternatives analyses focused mainly on analyzing specific design alternatives that reduced project risks to the lowest practicable level while increasing functionality and longevity. As listed in the Executive Summary, four new design alternatives were analyzed to increase pond stability and general long-term durability of the project:

1) **Lowering the pond elevation by eight feet.** With this grading approach, approximately 90,000 cubic yards (CY) of earth will be excavated from the terrace and approximately 3000 CY will be used to construct the berm. This will result in a net off-haul of 87,000 CY of earth or ~120,000 tons. With the pond at full capacity (65,000 tons of water), the proposed design will result in a net reduction of weight on the terrace of 55,000 tons. Note that the fill that was previously proposed under the solar arrays has been eliminated. In summary, the current design significantly reduces the soil weight on the existing terrace.
2) **Relocation of the pond spillways.** Based on the lower pond elevation, a rock-lined spillway draining out of the western extent of the pond is now feasible. This new alignment distances the spillway from the adjacent property owners. Also, the change from a culvert spillway (in the previous design phase) to a rock-lined spillway will increase longevity and reduce long-term maintenance costs.
3) **Installation of a pond liner, French drain, and subsurface restrictive barrier.** These design alternatives are being considered to ensure that the project will results in a decrease in groundwater levels downslope from the pond as compared to current groundwater levels. Results of the slope stability analyses showed that a high groundwater table increases risk of slope instability. The previous design iteration included a compacted clay liner on the inside of the pond to control seepage. However, valid concerns were raised about the longevity of that liner with wetting, drying, shrinking and swelling, as well as erosion of the native soil liner over time as the pond was filled and drained every year. Therefore, three significant design modifications for sealing the pond and reducing downslope groundwater are currently being considered: 1) a high grade plastic liner (guarantee of 25 years, life expectancy of 140 years) protected by geotechnical fabric and buried under six inches of gravel, 2) a French drain to collect and drain all groundwater flowing from upslope and under the pond liner, and 3) a subsurface restrictive barrier under the pond berm as a redundant safety feature to prevent downgradient flow of groundwater. Multiple groundwater wells will be installed in the area downslope of the pond to ensure that groundwater levels remain lower than pre-

project conditions. Data recorders measuring groundwater levels will be connected to an online network so that groundwater data can be analyzed and viewed in real time.

4) **Grade control structures in central gully.** Even though the project is likely to significantly reduce runoff rates within the central gully, continued degradation of this gully over time has the potential to slowly erode the terrace where the pond is proposed.
6) **Backup energy system.** Install backup energy system with batteries, inverter, small solar array and micro-hydro to provide capability to operate and monitor project even during power outage.

These alternatives are further described in the 90% Designs included in Appendix A.2. The project team believes that inclusion of these design alternatives will result in a project that minimizes risk and maximizes long-term functionality. Therefore, inclusion of these design revisions is considered to be the "preferred alternative". These design revisions were vetted by the TAC during the March 2020 meeting with generally strong support. Based on additional input from the TAC and heavy equipment contractor who will be conducting the work, several additional minor project features have been added/modified:

1) The proposed pump diversion in Redwood Creek has been upsized from 100 gpm to 220 gpm to allow for higher pump rates during peak winter flows.
2) A small berm and drainage swale have been added to the northeastern extent of the terrace to prevent surface runoff from flowing over the hummocky area which will further reduce the risk of shallow landsliding in this area.

11 PROJECT DESIGN

As described in Section 9, the primary project objective is to construct a 15.3 million gallon and outflow system intended to deliver 50 gallons per minute of flow augmentation to Redwood Creek during the dry season. This system will consist of the following components:

11.1 Main Components of Water Storage and Augmentation System

11.1.1 Pond

Construction of the off-channel pond will include excavation and construction of an earthen berm and spillways built into the natural topography. Construction will include removal of topsoil from the reservoir area. The topsoil will be saved and spread around the reservoir area along with mulch after construction. All excavated material not used to build the berms will be placed and compacted in several designated fill areas as shown on the plans. Two alternatives were analyzed for sealing the pond:

1) Alternative 1: Utilizing existing impervious soil excavated from the site. The pond will be over-excavated followed by layering/compacting of the impervious soil along the inside of the pond to create a natural liner; and
2) <u>Preferred Alternative:</u> Install a plastic pond liner with associated Geotech fabric, gravel, and underdrain as shown on Sheet 6 in Appendix A.2. Note that this alternative is expected to maintain higher water quality in the pond by eliminating the rilling, erosion, and sedimentation that would have resulted from yearly filling of the pond under the Alternative 1 natural clay liner. Based on the Phase II alternatives analyses, this design approach is expected to result in better functionality of the pond both in terms of water quality/quantity and long-term stability.

All critical fill placement will be subject to compaction testing to ensure 90% minimum compaction.

Two alternatives were analyzed for the pond spillway:

1) Alternative 1: Two spillways are proposed as shown on the plans in Appendix A.1. The main spillway will drain via grated concrete inlet riser and 24" diameter corrugated metal culvert transporting overflow down to the lower terrace and emptying into a small cobble-lined channel. The second spillway will be for emergency purposes only and will be a rock-lined spillway that drains into the Eastern Tributary as shown on the design plans. Both spillways will be capable of carrying the 100-yr flows described in Table 4.
2) <u>Preferred Alternative:</u> Based on lowering the elevation of the pond berm by approximate 8 feet (per Phase II alternatives analyses), one rock lined spillway in the northwestern extent of the pond was determined to be feasible. This is a significantly more desirable alternative because it reduces long term maintenance costs associated with a culvert and moves the spillway farther from adjacent landowners. It was determined that no emergency spillway is needed considering that the pond is off-stream and has relatively low outflow discharges even during 100-yr events. However, the proposed berm elevation along the eastern extent of the pond is 1.5 feet lower than the northern pond berm to further reduce risk to adjacent downslope property.

11.1.2 Intake in Redwood Creek

An electrical pump located in a near-channel wet well with screened inlet adjacent to Redwood Creek and associated piping/housing will be utilized to top off the pond (and other smaller storage tanks) as needed. Water will only be diverted from Redwood Creek when flows are high.

11.1.3 Flow enhancement delivery system and industrial water chiller

The primary outflow pipe that delivers water from the pond to Redwood Creek during the summer will be installed via horizontal borehole and have a screened inlet near the bottom of the pond. A valve and flow meter will control the amount of water that is released from the pond.

When the pond gets low and outflow water temperatures begin to warm, water will be directed into an industrial water chiller which will cool the water prior to release to the creek. Initial reservoir drawdown modeling has been conducted and is discussed in Appendix J. That analyses suggests that under standard operating conditions the reservoir is going to be greater than 25 feet deep during the peak of the dry season (August/September) so water should be stratified and temperature concerns should not be an issue considering that water is drawn out of the bottom of the reservoir.

In summary, the analyses indicate that the current pond design will result in flow releases with temperatures suitable for juvenile salmonids throughout the year under a standard management scenario. Under unusual circumstances, however, cooling pond water temperatures may be beneficial, and the industrial water chiller will meet that need.

11.2 Additional Components

There are numerous additional project components that are required to meet the main project objective of flow enhancement as described below.

11.2.1 Solar array and backup energy system

A 7.5 KW solar array, micro-hydro turbine, backup battery bank, inverter, grid intertie system and control center building to offset the Project's energy use and provide backup power during outages to maintain operations and monitoring capabilities. The intention of the system is to offset the electricity used by the pump and chiller. An alarm system will also be installed within the control center building to alert the project team of any system failures.

11.2.2 Gully stabilization treatments

Approximately 30 rock armor grade control structures will be installed to stabilize three actively eroding intermittent drainages adjacent to the Project. In addition to the grade control structures, recently incised portions of the gullies will be filled with compacted soil and several other steeper channel reaches will be armored as shown on the design plans. The gully stabilization features will be installed with a combination of heavy equipment and handwork in several areas that are difficult to access. The gully stabilization features are also expected to offset shallow groundwater draining that results from installation of the french drain under the pond. Specifically, treatments in the western tributary gully will significantly reduce incision rates and slow groundwater discharge.

11.2.3 Large wood and boulder structures in Redwood Creek

Instream habitat enhancement features will be constructed along Redwood Creek mainstem to improve summer rearing habitat for salmonids within the vicinity of the Project and also promote channel stability near the location of flow augmentation delivery and wet-season diversion. This includes the construction of two rock weirs and three large wood habitat enhancement structures.

11.2.4 Access road upgrades

The access roads within the Project vicinity will be improved to provide year-round access for monitoring, operations, and maintenance of all Project components. This will include reshaping and surfacing with gravel and upgrade to three small road/stream crossings.

11.2.5 Additional water storage and fire suppression infrastructure

Additional water storage and delivery systems are included as part of the project to provide domestic use for APN 220-061-011, as well as water supply for emergency fire suppression. Note that these project components are included in project permitting, but implementation may be funded through sources other than WCB.

11.3 Draft 65% Design Engineer's Cost Estimates

Construction cost estimates were made based on the draft 65% designs shown in Appendix A.1. Based on that design, the total project cost was estimated to be approximately $6 million.

11.4 90% Design Engineer's Cost Estimates

The 90% cost estimates are shown on Table 9 and represent costs associated with the project design shown in Appendix A.2. Note that the cost increases between the Draft 65% Designs and 90% Design are the results of the various project modifications described above. Due to the complexity of the Project, a budget contingency is included.

Table 9. Final 90% Design engineer's cost estimate.

No.	Item	Unit Cost	Quantity	Units	Total cost
1	Mobilization	$250,000	1	Lump Sum	$250,000
2	Clearing and Grubbing	$100,000	1	Lump Sum	$100,000
3	Rough Earthwork (cut/fill balanced onsite)	$20	90000	Cubic Yard	$1,800,000
4	Compaction of Pond Berm and Keyway - 10000 CY	$30	10000	Cubic Yard	$300,000
5	Pond Liner installation and materials	$750,000	1	Lump Sum	$750,000
6	Gully Stabilizing Grade Control Structures	$3,000	40	Each	$120,000
7	Additional Gully Armoring (rock placed)	$150	200	Tons	$30,000
8	Gully infill with compacted soil	$25	1500	Cubic Yard	$37,500
9	Dewatering	$40,000	1	Lump Sum	$40,000
10	Instream Large Wood Placed and Anchored	$2,000	8	Each	$16,000
11	Instream Boulders Placed and Anchored (as applicable)	$150	300	Tons	$45,000
12	Pond outflow pipeline materials	$150,000	1	Lump Sum	$150,000
13	Main spillway materials	$100,000	1	Lump Sum	$100,000
14	French drain materials	$200,000	1	Lump Sum	$200,000
15	Water Chiller	$50,000	1	Lump Sum	$50,000
16	Installation of all hydraulic components	$500,000	1	Lump Sum	$500,000
17	Fencing	$100,000	1	Lump Sum	$100,000
18	Solar Array and backup energy system	$100,000	1	Lump Sum	$100,000
19	PG&E Connection	$50,000	1	Lump Sum	$50,000

20	Access road improvements and surfacing	$100,000	1	Lump Sum	$100,000
21	Erosion Control and Revegetation	$80,000	1	Lump Sum	$80,000
22	Post Project Monitoring Equipment (flow and groundwater)	$60,000	1	Lump Sum	$60,000
23	SRF Project Management	$200,000	1	Lump Sum	$200,000
24	Cultural Resources Monitor	$25,000	1	Lump Sum	$25,000
25	Legal and Ranch Oversight	$140,000	1	Lump Sum	$140,000
26	SHN Engineering Oversight	$30,000	1	Lump Sum	$30,000
27	SHN Soils Testing	$15,000	1	Lump Sum	$15,000
28	Stillwater, Engineering, construction oversight, As-builts, Monitoring	$300,000	1	Lump Sum	$300,000
29	10% Contingency	$569,000	1	Lump Sum	$569,000
Total construction cost:					**$6,257,500**

12 STABILITY ANALYSES FOR LARGE WOOD

12.1 Stability Analyses Overview

A Large wood structure stability analysis was used to refine the project design based on the methodology presented in Castro and Sampson (2001). The constants, freebody diagram and equations from Castro and Sampson are included in Appendix G. In summary, this method uses a basic force balance approach in the vertical and horizontal directions to ensure that each wood structure will be stable during a specific flow regime. The calculation process begins with a sum of vertical forces to determine the boulder weight that is necessary to give each structure a factor of safety of 1.5 for buoyancy. Then based on these boulder weights, the factor of safety for momentum is calculated and more boulders are added as necessary to give each structure a momentum (sliding) factor of safety of 2.0 or greater. This stability analyses approach has been reviewed and approved by CDFW Engineer Marcin Whitman for application on several projects in Marin County.

No specific calculations were made for scour or rotational stability because the proposed large wood structures are intended to be dynamic and settle into the bed and banks as scour occurs.

This is achieved by utilizing the combination of boulder ballast, live tree anchoring, and triangular anchoring of the placed large wood to allow for hinging and settlement of the structures if extensive scour occurs. Additionally, the risk of excessive scour and rotational instability will be managed by thorough oversight during construction by the engineer as well as field engineering to fine-tune the wood and boulder installation to insure proper placement.

12.1.1 Stability analyses parameters

Below is a list of assumptions that provide the basis of these calculations:

- Analysis based on maximum velocities at each station from HEC-RAS existing conditions model output. Velocity used in analyses is from adjacent station with highest output velocity.
- All boulders submerged at 100-year flows.
- Rootwad dimensions: 4 ft diameter x 4 ft length with porosity = 0.3.
- Channel bed and banks composed of medium gravel: Friction angle = 40 degrees, which results in coefficient of friction for bed of 0.84 (Castro and Sampson).
- All wood is calculated as dry Douglas Fir: density = 33.7 lb/ft^3 (Castro and Sampson).
- Anchor to live tree is assumed to be equivalent to 4 tons of ballast and 4 tons of momentum-resisting force.
- For flow force calculation on multi-log structures located along a stream bank parallel to flow, calculations may assume a shadow effect (i.e. flow does not act on all logs).
- ϴ (angle from rootwad face to vertical) = 0.

12.1.2 Stability analyses uncertainties and factors of safety

There are several areas of uncertainty associated with this stability analyses as discussed below. However, we are confident that the structures will be relatively stable for the 20-year design life of the wood structures due to the Factors of Safety built into this analysis and the on-site engineering and geomorphic expertise that will guide the final layout of the structures (based on design, installation and monitoring of 50+ similar wood structures by project team). In addition, stability will be guaranteed through proper installation as described in the plans and specifications and guided by technical oversight.

The first area of uncertainty is that average flow velocities through each project reach (determined by HEC-RAS) are used for the stability analyses. In reality, water velocities vary greatly both laterally across the channel cross section and with depth. However, we believe that using average velocities is a conservative estimate because the highest velocities generally occur well away from the channel margins and all the proposed structures are located along the streambanks. However, in some cases, especially along outside bends, velocities along the banks can be as high or higher than velocities in the middle of the channel. In these areas, structures will be designed with greater Factors of Safety for sliding stability (momentum) considering the higher shear forces that may act against them.

A second area of uncertainty is the possibility that the position of the wood structures may adjust due to scour or racking of significant new wood against the structure. Most of the structures are built along the banks with strong anchor points to existing trees or new boulders, and in many cases, the structures have been designed so that the force of the flow will hold them in place (i.e. proposed placement in channel expansion zones). In the case of these structures, minor scour and settling may help the structure stay in place because it will increase resistant forces via wedging. However, some structures may have the potential to rotate if significant scour and racking of additional wood occurs. For structures with significant potential for rotation, it is recommended that anchor boulders be keyed deeply into the channel bed and bank and that the engineer/geologist is onsite for construction to insure proper installation.

A third area of uncertainty is the possibility of contractor error or faulty materials (wood or rock with insufficient strength) leading to failure of one or more of the anchoring connections. As such, we will include a significant amount of redundancy in the anchoring of each structure. To further ensure the quality of anchoring, we strongly recommend that a contractor is selected that has previous experience with implementation of large wood projects. Also, it is recommended that an engineer and/or geologist is onsite during large wood placement and anchoring to insure proper installation.

13 LONG TERM OPERATIONS AND MAINTENANCE

A critical component of the project is to ensure that long-term operations, maintenance, and monitoring activities are conducted appropriately and funded. The project team has secured foundation funding to cover long term operations and maintenance as described in Table 10.

Table 10. Projected Long Term Project Costs (years 1-20 post construction).

	Line Item	Annual Budget	Total Cost
Year 1-3	Marshall Ranch Manager - General oversight of operations (80 hrs/yr)	$8,000	$24,000
	Stillwater Sciences - Engineering support for operations, maintenance, and monitoring (100 hrs/yr)	$15,000	$45,000
	Hicks Law - Legal Services (20 hrs/year)	$6,000	$18,000
	SRF - Annual flow monitoring and general support (160 hrs/year)	$4,800	$14,400
	Public Interest (Water Trust) administrative costs	$5,000	$15,000
	Initial Project Adaptive Management Costs	$15,000	$45,000
	Project Operations Liability Insurance	$35,000	$105,000
	State Licensing & Permit fees	$1,000	$3,000
	Total Cost (years 1-3)	**$89,800**	**$269,400**
Year 4-20	Marshall Ranch Manager - General oversight of operations (40 hrs/yr)	$4,000	$68,000
	Stillwater Sciences - Engineering support for operations, maintenance, and monitoring (32 hrs/yr)	$4,320	$73,440
	Hicks Law - Legal Services (5 hrs/year)	$1,500	$25,500
	SRF - Annual flow monitoring and general support (100 hrs/year)	$4,800	$81,600
	Public Interest (Water Trust) administrative costs	$2,500	$42,500
	Other Operations and Maintenance Costs	$2,500	$42,500
	Specific Equipment Replacement/Repair Costs	$5,000	$85,000
	Ongoing Project Liabilty Insurance	$4,000	$68,000
	State Licensing & Permit fees	$1,000	$17,000
	Total Cost (years 4-20)	**$29,620**	**$503,540**

Note that additional analyses will be conducted to better refine the operations, maintenance, and monitoring plan and costs. The project team anticipates developing a detailed Operations and Maintenance (O&M) Report that will be reviewed and approved by regulatory agency staff prior to the initiation of construction. Costs to conduct in-depth monitoring and adaptive management activities during the first two years of Project operations will be covered through the construction grant as described above. We anticipate working closely with agency staff during the immediate post-project period to optimize project function.

14 RISK AND PROJECT PERFORMANCE ASSESSMENT

There are several areas of potential project risks that have been thoroughly evaluated during the project planning and design process. Project impacts and approaches to minimize those impacts are discussed in Appendix K including design features, proposed mitigation measures, and monitoring and reporting.

A summary of project risks and risk management is summarized below.

14.1 Risk and Management of Pond and Hydraulic Appurtenances Failure

1) Risk: Failure of the earthen fill that constitutes the pond berm is a project risk that could result in damage to downslope property and infrastructure.

   Management: The height of the pond berm has been minimized during the design process by proposing significant excess cut/excavated material in the pond grading approach. Additionally, the berm is gently sloped (3:1 slopes) with engineered compacted fill. At locations where the berm is over 5 feet in height, cobble facing is proposed. Unstable features in the vicinity of the pond including several gullies will be stabilized to reduce the potential for future instabilities in the adjacent landscape. Also, a rock armor-lined earthen berm downslope from the pond is proposed to direct all runoff away from the downslope neighbor's property both under normal runoff conditions and in the extremely unlikely event of pond failure. A dam breach analysis was conducted showing that this berm feature will prevent runoff from directly inundating the neighbor's property even under the worse-case scenario of dam failure with half the pond draining in 17 minutes with a discharge of approximately 1000 cfs. See Appendix I for additional details related to the dam breach analysis. Additionally, ground sensors, groundwater wells and reservoir level measurements will be closely to monitored post-construction to ensure that the pond is functioning as designed. Throughout, the planning, design, construction, and monitoring phases, the Project has and will utilize best professional practices with a team of licensed professionals working together to minimize project risk while maximizing benefits. Secured foundation funding will provide resources for monitoring, operations, and maintenance of the system.

2) Risk: The most common failure mechanism of ponds and reservoirs is the failure of the overflow/spillway system. This can lead to significant erosion and mass wasting and can ultimately cause complete failure of the storage pond if left untreated.

   Management: The project design includes a spillway sized to pass 100-yr storm discharges. The spillway will be constructed with rock armor. The spillway is positioned such that it drains as far away as possible from the nearest neighbor downslope from the project. Secured foundation funding will provide resources for monitoring, operations, and maintenance of the spillway.

3) Risk: Although it would likely not result in catastrophic failure of the Project, there is a risk of failure or malfunction of the flow enhancement piping, flow meter, valves, and cooling gallery.

   Management: The main outflow piping from the pond for flow enhancement will be installed through horizontal bore so it will not be subject to surface hazards. The pipe will daylight at the lower terrace where it will enter a pump house with a series of valves These systems will be constructed with redundancy wherever practicable. Secured foundation funding will provide resources for monitoring, operations, and maintenance of these systems.

14.2 Risks and Management Associated with Instream Structures (Redwood Creek mainstem)

1) Risk: This reach of Redwood Creek within the project area is incised approximately 10- to 15 feet below the adjacent terrace and large flow events (including the 100-year flood) are largely confined within the channel. As such, all proposed work must carefully consider the forces acting on the bed and banks during storm events. Additionally, there are several bridges downstream that could be adversely affected by mobilized large wood.

   Management: To ensure that wood structures are not disarticulated and transported downstream, stability of the structures for a 20-year design life will be insured through the stability analyses described above construction oversight and post-project monitoring by the project engineer and/or geologist. Post-project monitoring should be conducted during the first two winters following significant storm events, and in following years during flow events that exceed those that the new features have previously been exposed to. This monitoring should identify changes in site conditions that may affect functionality and durability (i.e. newly mobilized large wood, new significant scour, or repositioning of an existing structure).

2) Risk: Large wood structures typically have a design life of approximately 20 years due to declining strength related to wood decay, so it is critical to design the project to account for this reality.

   Management: To account for the estimated 20-year design life of the large wood, the boulders are included in each structure will be placed tucked against the bank such that they will continue to provide bank stability and pool complexity even after the wood rots. The incorporation of riparian planting in the design will provide additional riparian wood and root matter that after 20 years will replace the rotten large wood in many cases.

3) Risk: In a future large storm event, sediment delivered to the project reach from upstream sources may change channel morphology in ways that adversely impact the functionality of the proposed structures.

   Management: The addition of large wood and boulder structures within the Project reach are expected to make channel morphology and habitat within the Project area more resilient to potential future geomorphic changes. Furthermore, the Project does not consist of any features that significantly change channel geometry or slope that could be susceptible more susceptible to failure during future large storm events.

14.3 Overall Risks and Management Approaches Associated with Long-term Project Results

1) Risk: Water produced by the project is diverted out of Redwood Creek by downstream water users. Under applicable provisions of California water law, property owners downstream of the project site whose parcels are adjacent to Redwood Creek have the riparian rights to take and use the "natural flow" of the stream for certain limited purposes. Additionally, some downstream property owners may have appropriative rights to divert water.

   Management: Downstream diverters are required by law to report their diversions to CDFW and State Water Resources Control Board (SWRCB) and those agencies have the authority to control the amount and timing of those diversions. The project team is currently conducting broad outreach among property owners and regulatory agency staff (CDFW and SWRCB) to inform all parties about the project and develop a regulatory framework, engage the community, and prepare for monitoring/enforcement activities after the project is constructed. The project team will also provide technical and coordinate grant funding opportunities to assist landowners within critical stream reaches to increase their water storage capacity.

2) Risk: Water quality and temperature produced by the pond is not suitable for aquatic species in downstream channel.

   Management: The project planning process has taken these risks into consideration with the pond and water delivery systems designed such that appropriate temperature and water quality are maintained. The water delivery system will draw water out of the bottom of the pond which will have low temperatures for most of the year. An on-demand circulation system will be installed in the pond to maintain water quality. As necessary, a cooling gallery will be utilized to decrease the temperature of flow releases. Detailed post-project monitoring and adaptive management actions will be utilized to change pond operations as necessary. Furthermore, case studies from Russian River tributaries have shown that similar project greatly improved water quality and specifically dissolved oxygen (RRCWRP 2017, Grantham et. al. 2018, RRCWRP 2019).

3) Risk: Although we know that fish need water to survive, there is some uncertainty regarding how the aquatic habitat will respond to enhanced flows, how to measure and quantify that response, and how to adjust the project flow delivery to maximize aquatic habitat benefit.

   Management: Based on similar projects conducted in Sonoma County in lower Russian River tributaries over the past several years, direct flow augmentation has been very effective in improving downstream aquatic habitat (Ruiz et al. 2018, Obedzinski et al. 2018, RRCWRP 2017, Grantham et. al. 2018, and RRCWRP 2019). However, as this habitat enhancement approach continues to develop, the risk can be addressed by post project monitoring of downstream discharge, temperature, dissolved oxygen levels, fish abundance, and fish health. Based on monitoring results from this and other projects, the Project operations can be adjusted to maximize aquatic habitat benefit.

15 CONCLUSION

Although there are risks associated with this project, the management actions described in Section 14 above reduce project risk to an acceptable level when compared to the expected project benefits. The “no-project alternative” will result in continued degradation of dry-season aquatic habitat in Redwood Creek. Also, this project will significantly improve the community’s resilience to wildfire.

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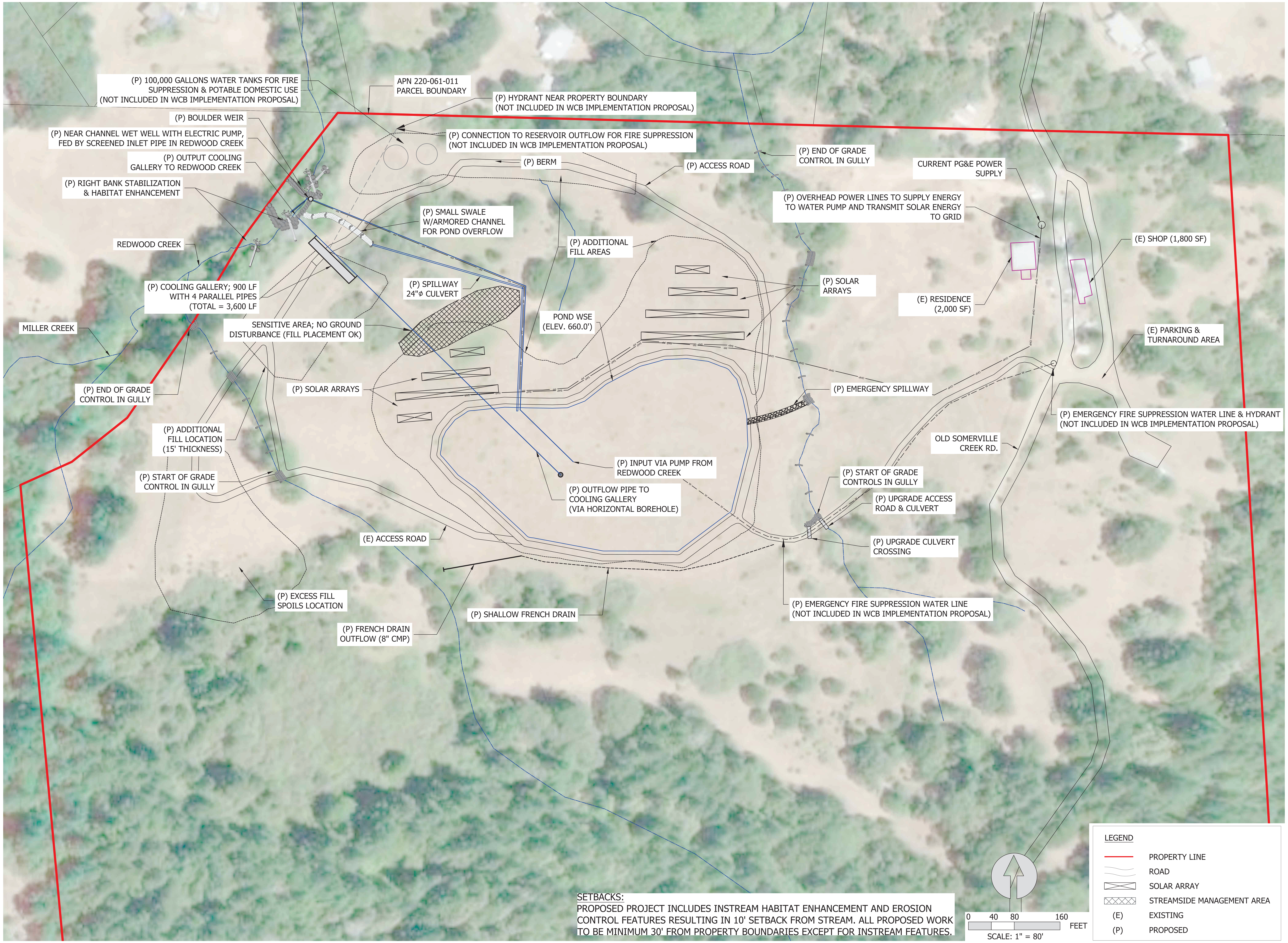
Appendices

Appendix A.1

Excerpts from Draft 65% Design Plans (September 2019)



SETBACKS:
PROPOSED PROJECT INCLUDES INSTREAM HABITAT ENHANCEMENT AND EROSION CONTROL FEATURES RESULTING IN 10' SETBACK FROM STREAM. ALL PROPOSED WORK TO BE MINIMUM 30' FROM PROPERTY BOUNDARIES EXCEPT FOR INSTREAM FEATURES.

LEGEND

—	PROPERTY LINE
═	ROAD
⊠	SOLAR ARRAY
▩	STREAMSIDE MANAGEMENT AREA
(E)	EXISTING
(P)	PROPOSED

MARSHALL RANCH FLOW ENHANCEMENT PROJECT

APN 220-061-011

HUMBOLDT COUNTY, CA

Stillwater Sciences
2855 TELEGRAPH AVENUE, SUITE 400
BERKELEY, CA 94705
P: (510) 848-8098

PROJECT NUMBER: 603.01
SCALE: AS NOTED
DATE: 9/9/2019

DESIGN: JM
DRAWN: CL
CHECKED: JM
APPROVED: JM

JOEL MONSCHKE
No. 79688
9-30-20
EXPIRES

SITE PLAN

SHEET 3 OF 30

IF BAR DOES NOT MEASURE 1" DRAWING IS NOT TO SCALE – ADJUST ACCORDINGLY

LAST SAVED: 9/9/2019 PLOT DATE: 9/9/2019 PLOT STYLE: ----

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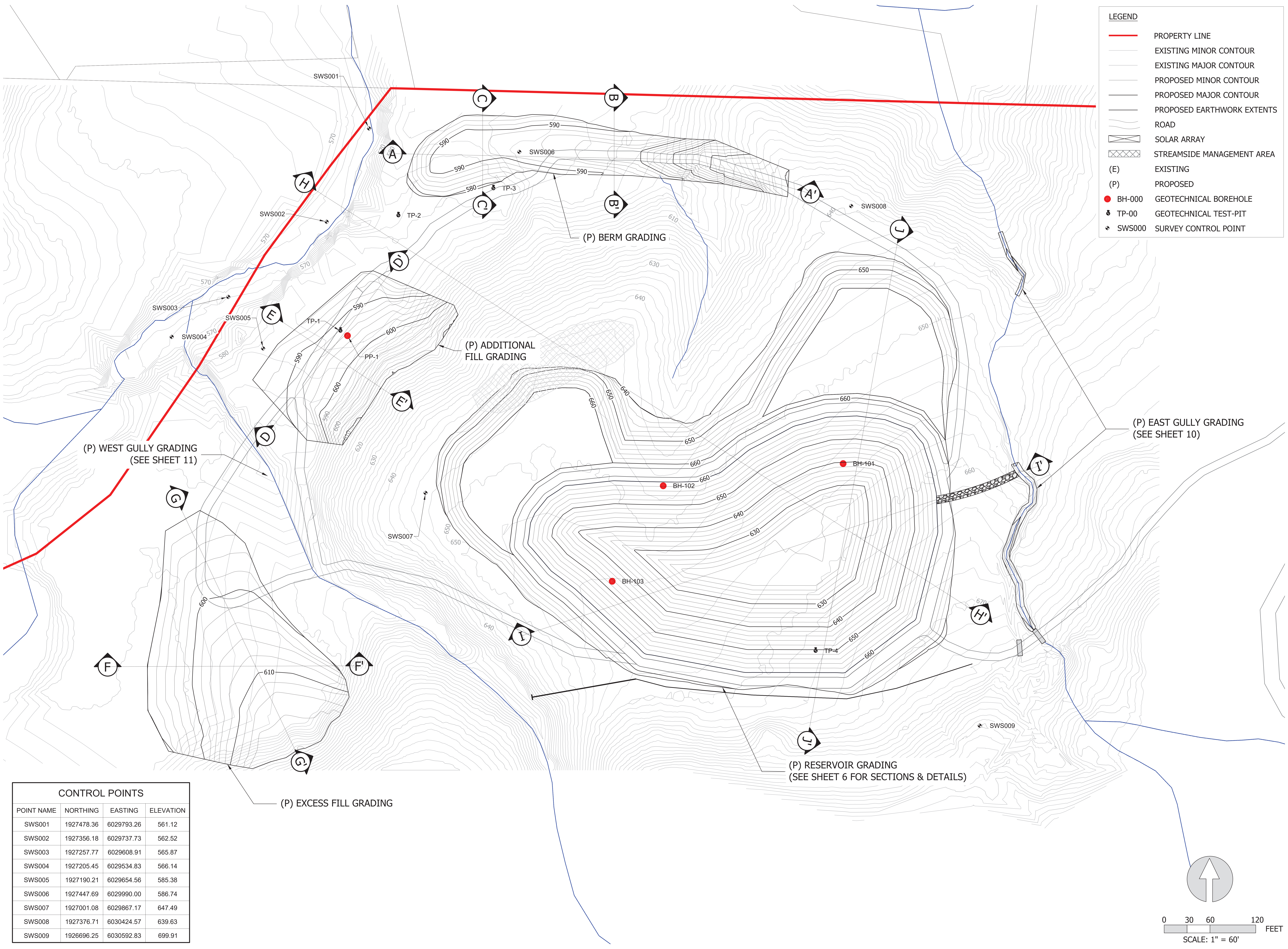

(P) BERM GRADING

(P) ADDITIONAL FILL GRADING

(P) WEST GULLY GRADING (SEE SHEET 11)

(P) EAST GULLY GRADING (SEE SHEET 10)

(P) EXCESS FILL GRADING

(P) RESERVOIR GRADING (SEE SHEET 6 FOR SECTIONS & DETAILS)

LEGEND

	PROPERTY LINE
	EXISTING MINOR CONTOUR
	EXISTING MAJOR CONTOUR
	PROPOSED MINOR CONTOUR
	PROPOSED MAJOR CONTOUR
	PROPOSED EARTHWORK EXTENTS
	ROAD
▭	SOLAR ARRAY
▨	STREAMSIDE MANAGEMENT AREA
(E)	EXISTING
(P)	PROPOSED
● BH-000	GEOTECHNICAL BOREHOLE
TP-00	GEOTECHNICAL TEST-PIT
SWS000	SURVEY CONTROL POINT

CONTROL POINTS

POINT NAME	NORTHING	EASTING	ELEVATION
SWS001	1927478.36	6029793.26	561.12
SWS002	1927356.18	6029737.73	562.52
SWS003	1927257.77	6029608.91	565.87
SWS004	1927205.45	6029534.83	566.14
SWS005	1927190.21	6029654.56	585.38
SWS006	1927447.69	6029990.00	586.74
SWS007	1927001.08	6029867.17	647.49
SWS008	1927376.71	6030424.57	639.63
SWS009	1926696.25	6030592.83	699.91

MARSHALL RANCH FLOW ENHANCEMENT PROJECT

APN 220-061-011

HUMBOLDT COUNTY, CA

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P: (510) 848-8098

PROJECT NUMBER: 603.01
SCALE: AS NOTED
DATE: 9/9/2019

DESIGN: JM
DRAWN: CL
CHECKED: JM
APPROVED: JM

JOEL MONSCHKE
No. 79688
9-30-20
EXPIRES

GRADING PLAN

SHEET 5 OF 30

IF BAR DOES NOT MEASURE 1" DRAWING IS NOT TO SCALE – ADJUST ACCORDINGLY

LAST SAVED: 9/8/2019 PLOT DATE: 9/9/2019 PLOT STYLE: ----

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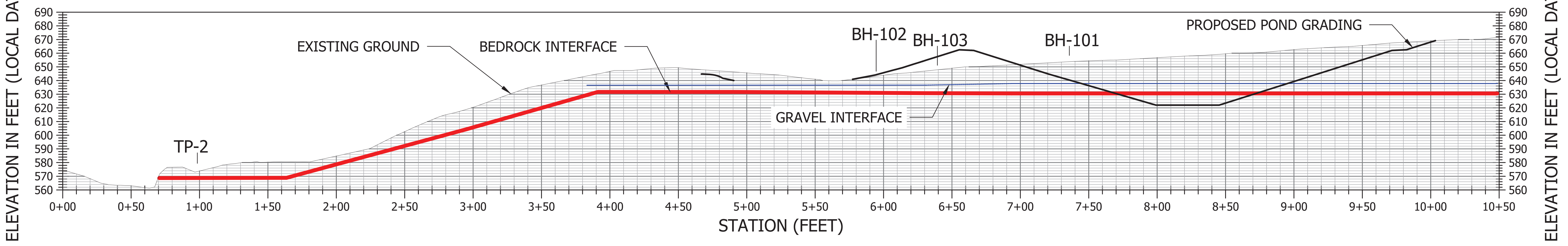
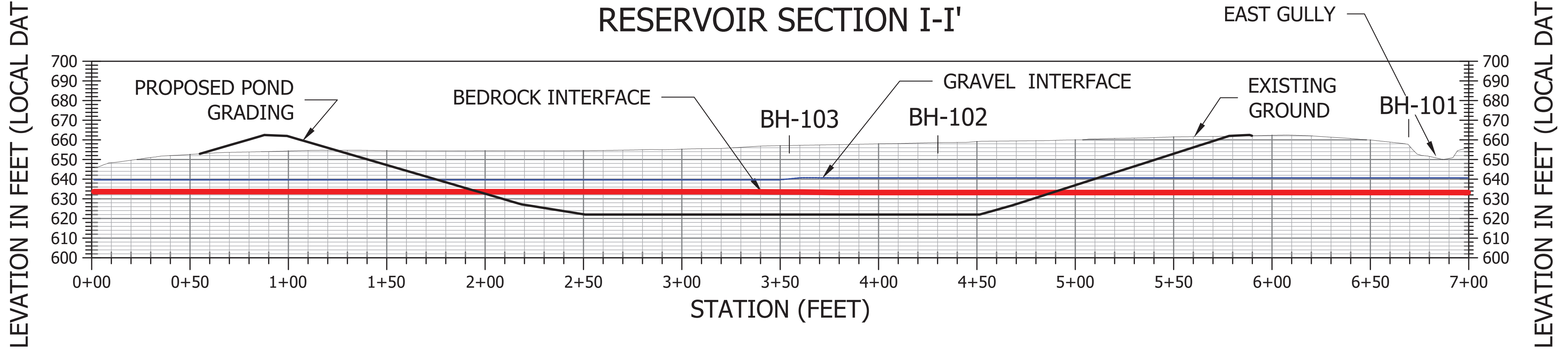
RESERVOIR SECTION H-H'



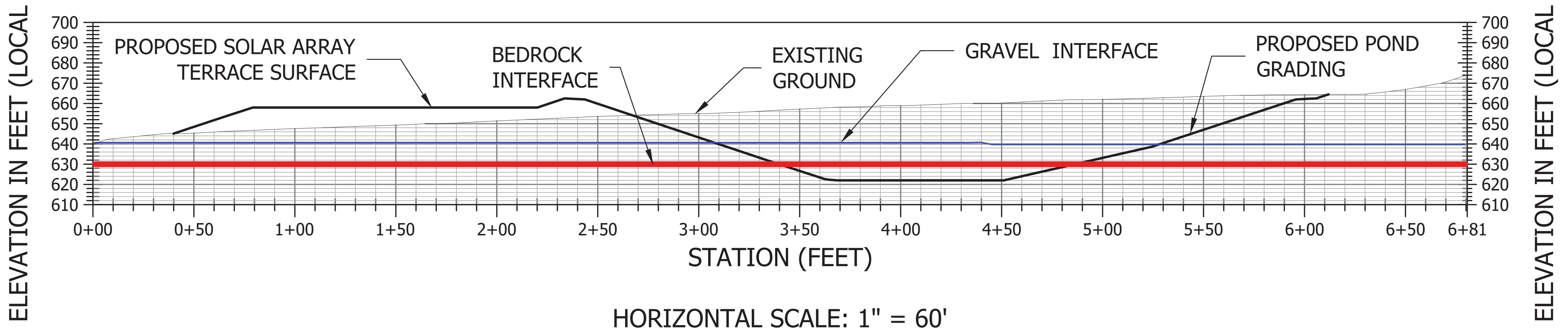
HORIZONTAL SCALE: 1" = 60'
VERTICAL SCALE: 1" = 60'

RESERVOIR SECTION I-I'



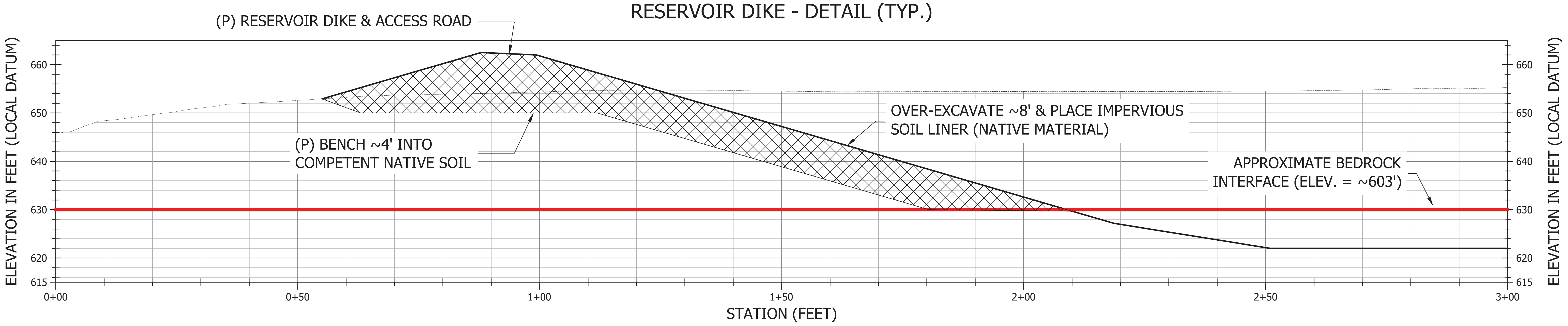
HORIZONTAL SCALE: 1" = 60'
VERTICAL SCALE: 1" = 60'

RESERVOIR SECTION J-J'



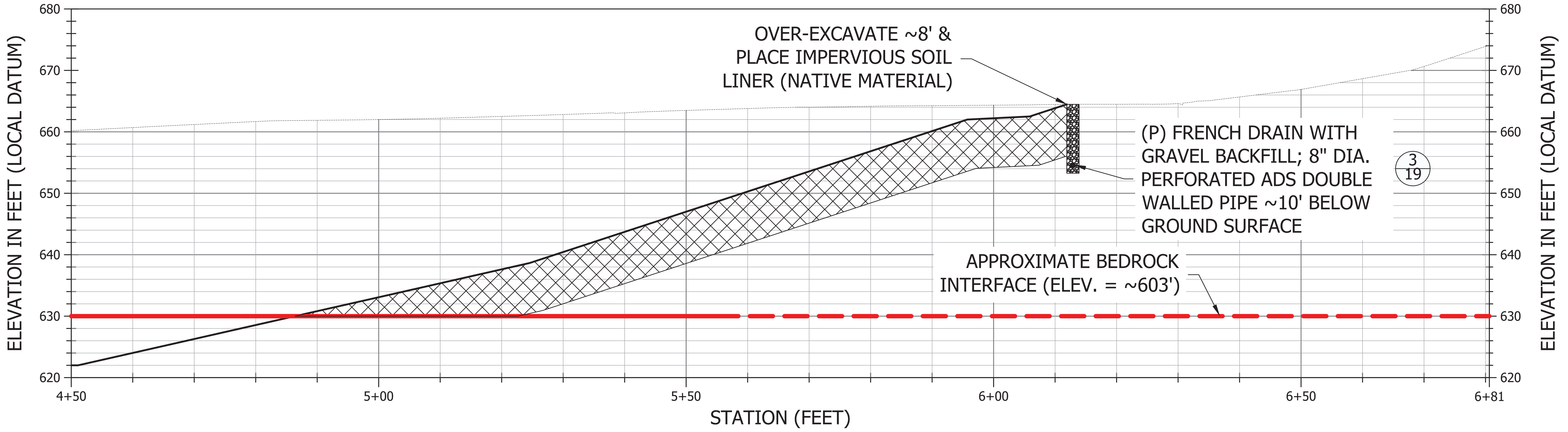
HORIZONTAL SCALE: 1" = 60'
VERTICAL SCALE: 1" = 60'

RESERVOIR DIKE - DETAIL (TYP.)



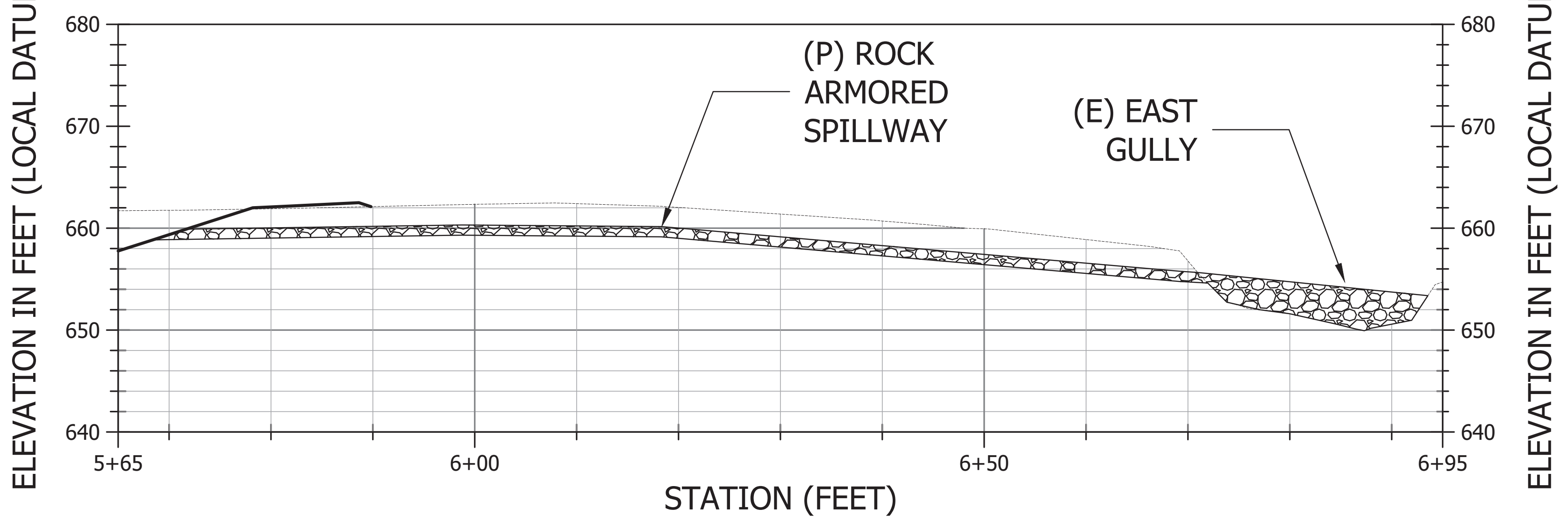
HORIZONTAL SCALE: 1" = 15'
VERTICAL SCALE: 1" = 15'

CUT SLOPE & FRENCH DRAIN - DETAIL (TYP.)



HORIZONTAL SCALE: 1" = 15'
VERTICAL SCALE: 1" = 15'

SPILLWAY - DETAIL (TYP.)



HORIZONTAL SCALE: 1" = 15'
VERTICAL SCALE: 1" = 15'

LEGEND

—	EXISTING GROUND SURFACE
—	PROPOSED GROUND SURFACE

MARSHALL RANCH FLOW
ENHANCEMENT PROJECT
APN 220-061-011

HUMBOLDT COUNTY, CA

Stillwater Sciences
2855 TELEGRAPH AVENUE, SUITE 400
BERKELEY, CA 94705
P: (510) 848-8098

PROJECT NUMBER: 603.01
SCALE: AS NOTED
DATE: 9/9/2019

DESIGN: JM
DRAWN: CL
CHECKED: JM
APPROVED: JM

No. 79688
9-30-20

RESERVOIR SECTIONS & DETAILS

SHEET 6 OF 30

Appendix A.2

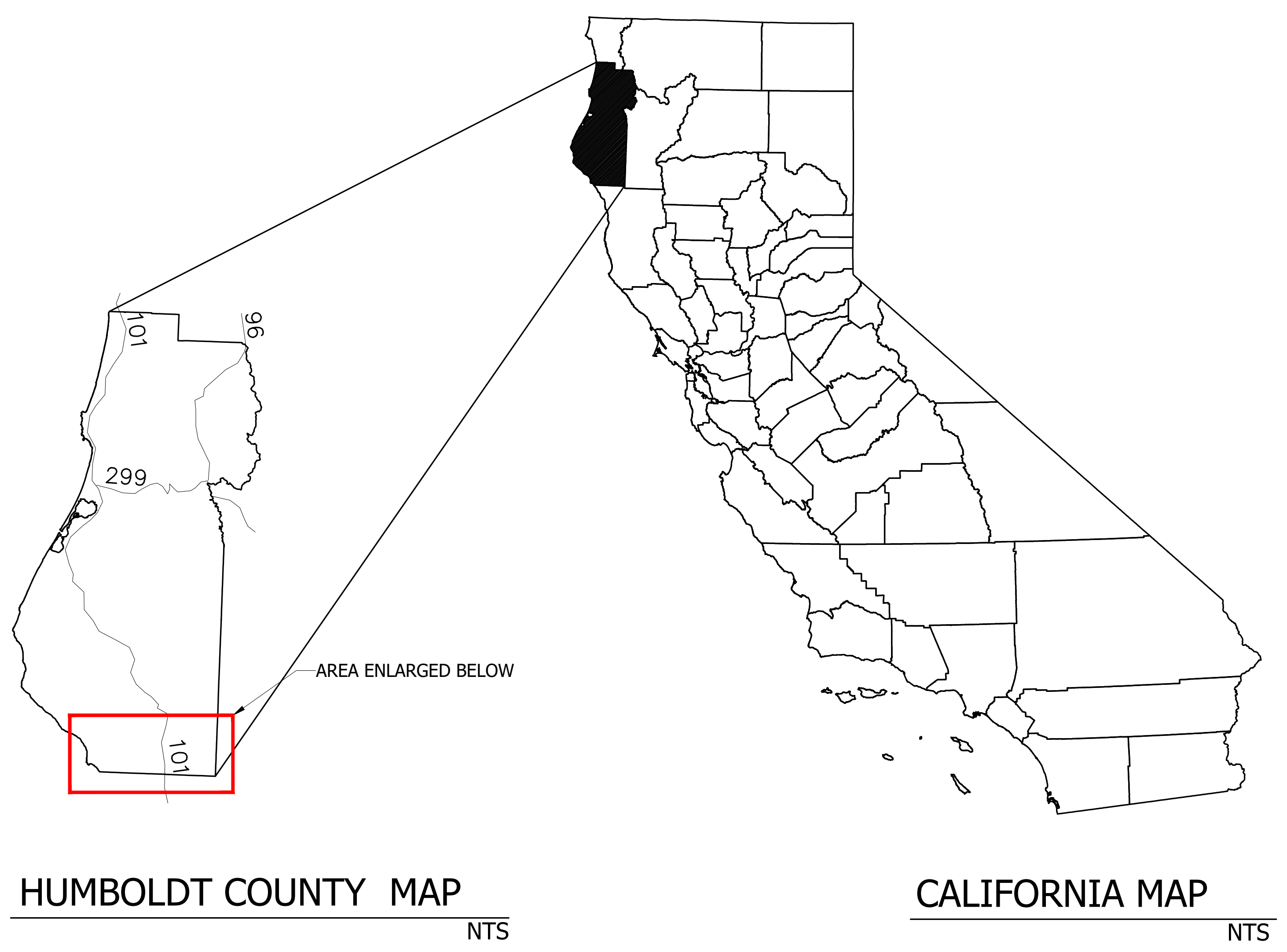
90% Design Plans (September 2020)

MARSHALL RANCH FLOW ENHANCEMENT PROJECT (APN 220-061-011)

90% DESIGN PLANS

HUMBOLDT COUNTY, CA

CALIFORNIA LOCATION MAP



OWNER:

THE MARSHALL RANCH, LLC
VELMA V. MARSHALL ESTATE
5720 OLD BRICELAND ROAD
GARBERVILLE, CA 95542

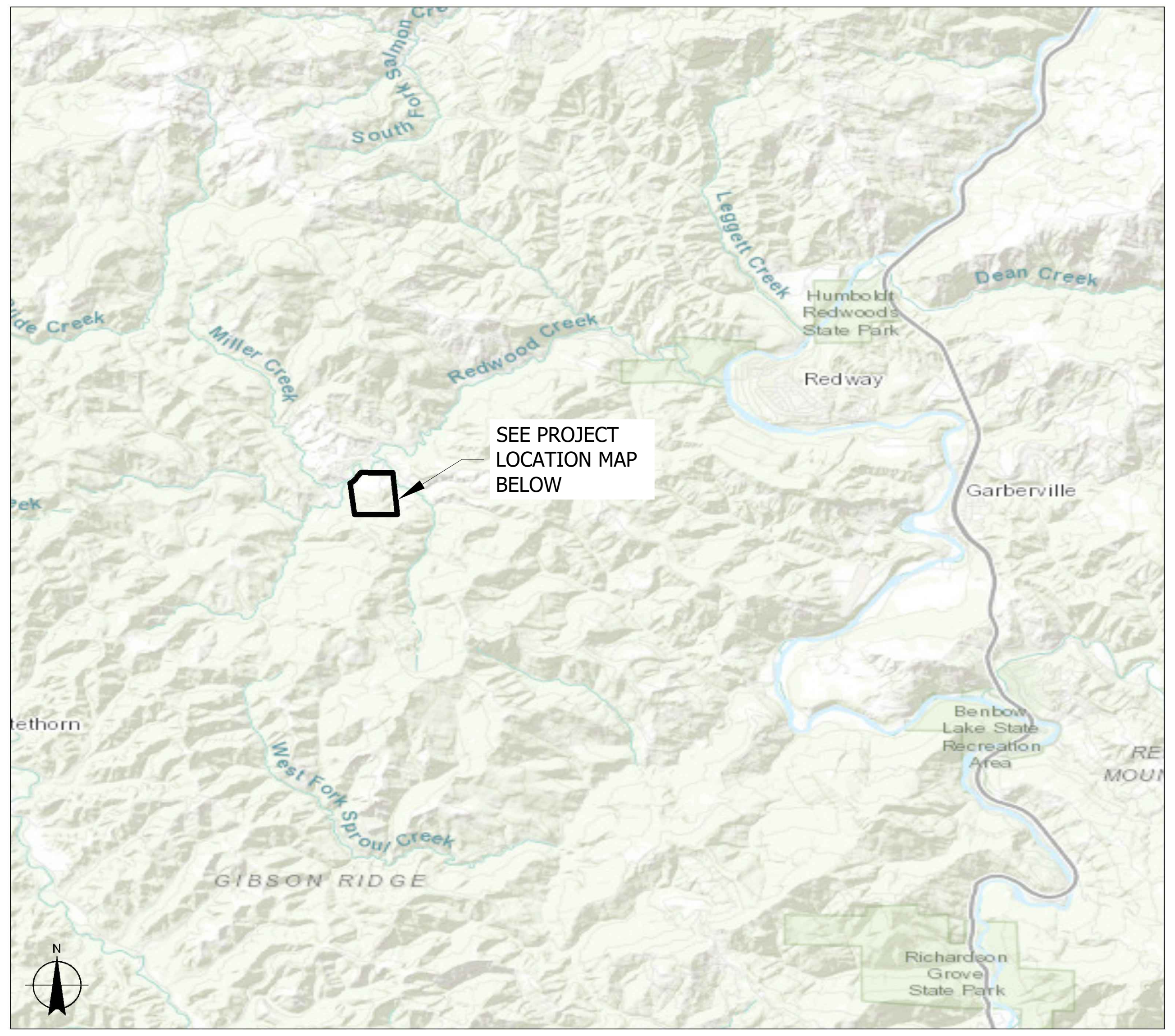
APPLICANT:

SALMONID RESTORATION FEDERATION
425 SNUG ALLEY, UNIT D
EUREKA, CA 95501
SRF@CALSALMON.ORG

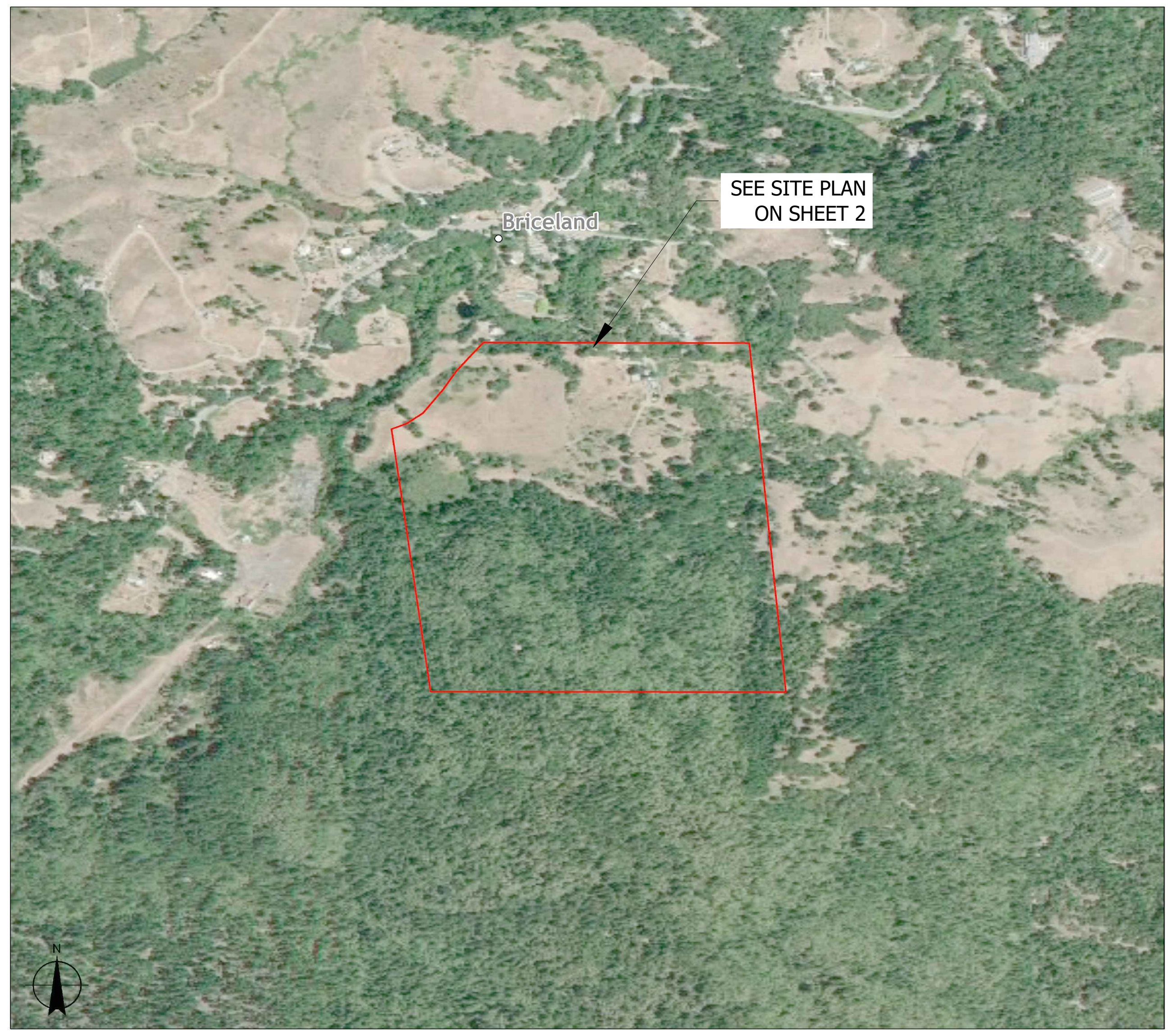
AGENT:

JOEL MONSCHKE PE
STILLWATER SCIENCES
850 G STREET, SUITE K
ARCATA, CA 95521
707-496-7075
JMONSCHKE@STILLWATERSCI.COM

VICINITY MAP



PROJECT LOCATION MAP



PROJECT DESCRIPTION:

CONSTRUCTION OF 15.5 MILLION GALLON OFF-CHANNEL POND & WATER CHILLER DESIGNED TO DELIVER APPROXIMATELY 50 GALLONS PER MINUTE OF FLOW AUGMENTATION TO REDWOOD CREEK DURING THE 5-MONTH DRY SEASON TO IMPROVE INSTREAM AQUATIC HABITAT. POND WILL BE FILLED WITH RAINWATER CATCHMENT AND WATER PUMPED DURING THE WET SEASON FROM A PROPOSED OFFSET WELL ADJACENT TO REDWOOD CREEK (APPROPRIATIVE WATER RIGHT APPLICATION IN PROCESS).

OTHER PROPOSED PROJECT COMPONENTS INCLUDE:

- 7.5 KW SOLAR ARRAY, MICRO-HYDRO TURBINE, BACKUP BATTERY BANK, INVERTER, GRID INTER-TIE SYSTEM & CONTROL CENTER BUILDING.
- INSTREAM HABITAT ENHANCEMENT FEATURES INCLUDING APPROXIMATELY FOUR LARGE WOOD STRUCTURES & TWO ROCK WEIRS IN REDWOOD CREEK.
- GULLY STABILIZATION TREATMENTS INCLUDING INSTALLATION OF APPROXIMATELY 20 ROCK ARMOR GRADE CONTROL STRUCTURES IN THREE CLASS III DRAINAGES.
- UPGRADE ACCESS ROADS TO PROJECT AREA WITH DRAINAGE FEATURES AND GRAVEL SURFACING TO PROVIDE ACCESS YEAR-ROUND.
- INSTALL ONE FIRE HYDRANT

INCLUDED IN CEQA (NOT PART OF WCB PROPOSAL)

INSTALLATION OF WATER CATCHMENT TANKS WITH WATER STORAGE TOTALING UP TO APPROXIMATELY 150,000 GALLONS TO SUPPLY DOMESTIC WATER FOR APN 220-061-011 AND FOR COMMUNITY FIRE SUPPRESSION.

ADDITIONAL NOTES:

1. PARCEL EXTENT TAKEN FROM HUMBOLDT COUNTY GIS AND ASSESSORS PARCEL MAPS; MODIFIED BASED ON FIELD CONDITIONS; APPROXIMATE ONLY.

Sheet List Table

Sheet Number	Sheet Title
1	TITLE SHEET
2	OVERVIEW
3	SITE PLAN
4	SITE PROTECTION, STAGING & TEMPORARY ACCESS
5	GRADING PLAN
6	RESERVOIR SECTIONS & DETAILS
7	FILL PLACEMENT SECTIONS
8	SPILLWAY PLAN & PROFILE
9	REDWOOD CREEK - DEWATERING
10	REDWOOD CREEK - INSTREAM COMPONENTS
11	REDWOOD CREEK - INSTREAM COMPONENTS - PROFILE & SECTIONS
12	EAST GULLY PLAN & PROFILE
13	WEST GULLY PLAN & PROFILE
14	PERMANENT ACCESS ROAD PLAN
15	ELECTRICAL PLAN
16	WATER DISTRIBTUION PLAN
17	FENCING PLAN
18	MONITORING & INSTRUMENTATION PLAN
19	EROSION CONTROL & REVEGETATION
20	DETAILS - 1
21	DETAILS - 2
22	DETAILS - 3

EARTHWORK ESTIMATES:

90,000 CY CUT/FILL BALANCED ON SITE

IMPORT:
- INSTREAM FEATURES & GULLY REPAIR - 400 CY RIPRAP ROCK (BACKING TO 4 TON)
- POND SPILLWAY - 400 CY RIPRAP ROCK (BACKING TO 1/4 TON)
- LOWER BERM FACING - 150 CY RIPRAP ROCK (1/4 TO 1/2 TON)
- UPPER BERM FACING - 350 CY RIPRAP ROCK (BACKING TO 1/4 TON)
- OTHER RIPRAP ROCK - 200 CY VARIOUS SIZES
- FRENCH DRAIN - 1,200 CY DRAIN ROCK
- POND LINER COVERING - 2,500 CY DRAIN ROCK
- ROAD SURFACING - 500 CY
- LARGE WOOD - 6 PIECES

ABBREVIATIONS AND SYMBOLS:

(E)	EXISTING
(P)	PROPOSED

3 — DETAIL # ON SHEET
8 — SHEET #

MARSHALL RANCH FLOW
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DESIGN: JM
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CHECKED: JM
APPROVED: JM

JOEL MONSCHKE
No. 79688
9-30-20
EXPIRES

TITLE SHEET

SHEET 1 OF 22

IF BAR DOES NOT MEASURE 1" DRAWING IS NOT TO SCALE - ADJUST ACCORDINGLY

LAST SAVED: 9/30/2020 PLOT DATE: 9/30/2020 PLOT STYLE: ----

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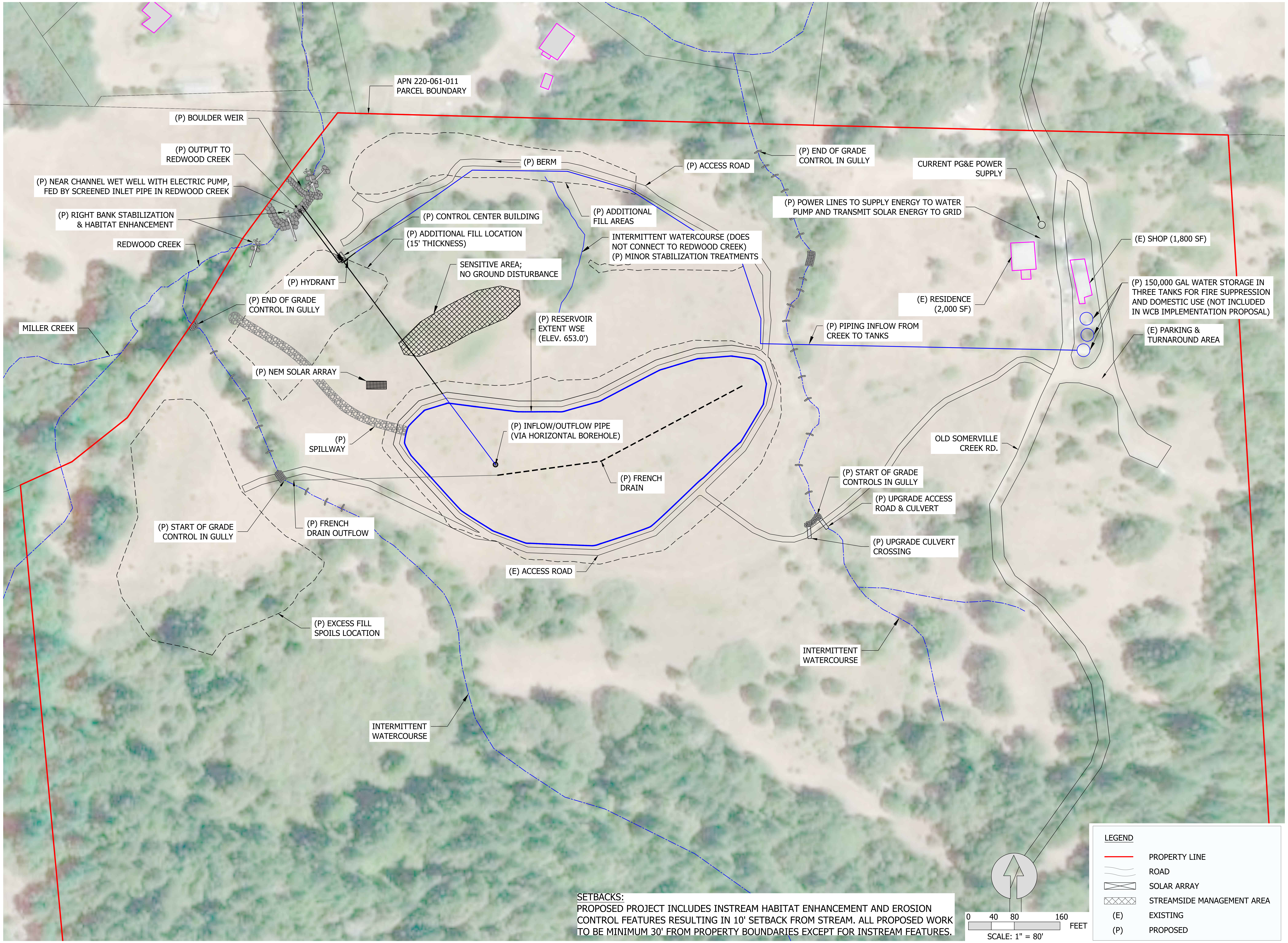
9-30-20
EXPIRES

OVERVIEW

SHEET 2 OF 22



SETBACKS:
PROPOSED PROJECT INCLUDES INSTREAM HABITAT ENHANCEMENT AND EROSION CONTROL FEATURES RESULTING IN 10' SETBACK FROM STREAM. ALL PROPOSED WORK TO BE MINIMUM 30' FROM PROPERTY BOUNDARIES EXCEPT FOR INSTREAM FEATURES.

LEGEND

🟥	PROPERTY LINE
═	ROAD
⊠	SOLAR ARRAY
▨	STREAMSIDE MANAGEMENT AREA
(E)	EXISTING
(P)	PROPOSED

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9-30-20
EXPIRES

SITE PLAN

SHEET 3 OF 22

IF BAR DOES NOT MEASURE 1" DRAWING IS NOT TO SCALE – ADJUST ACCORDINGLY

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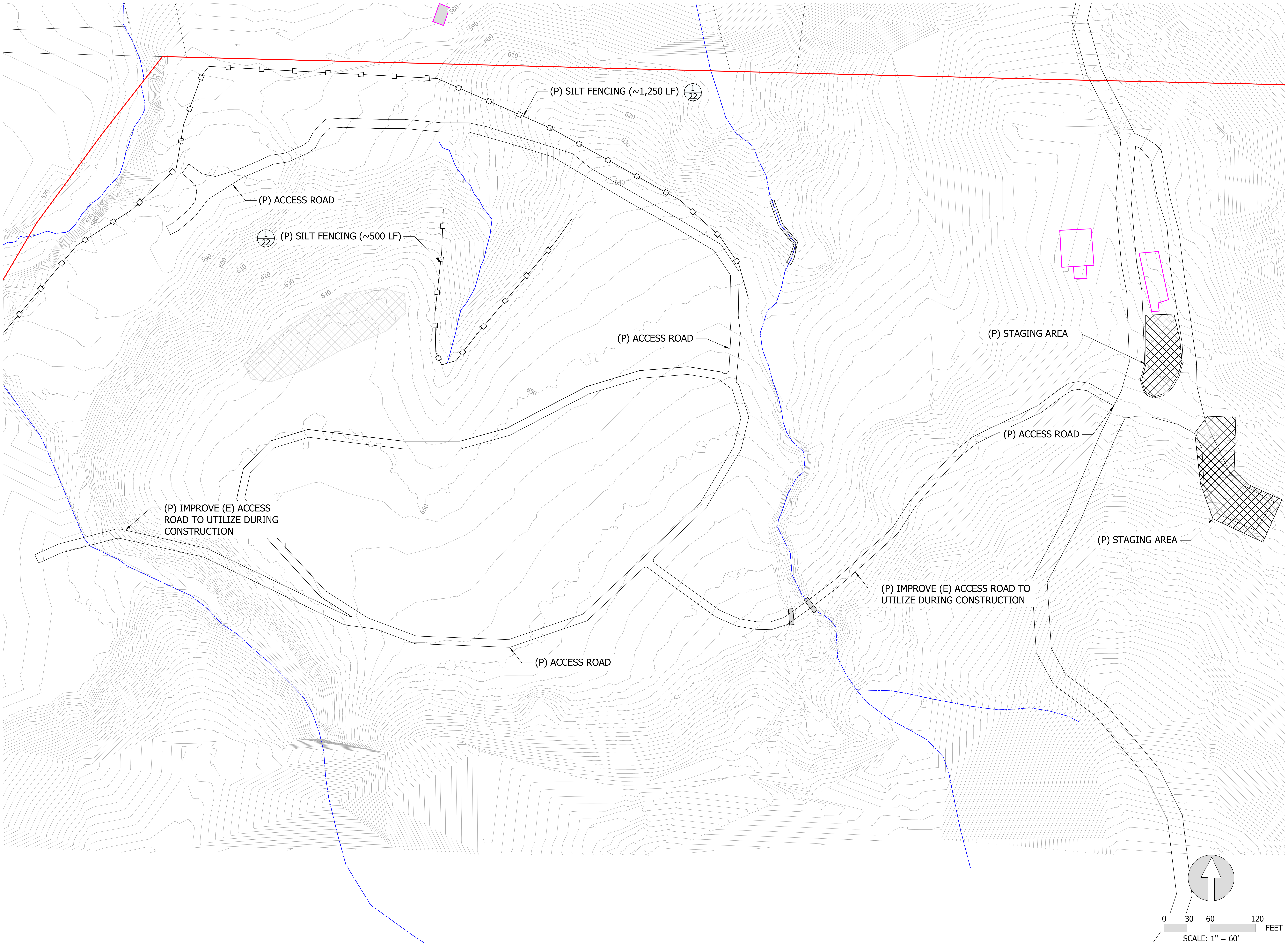

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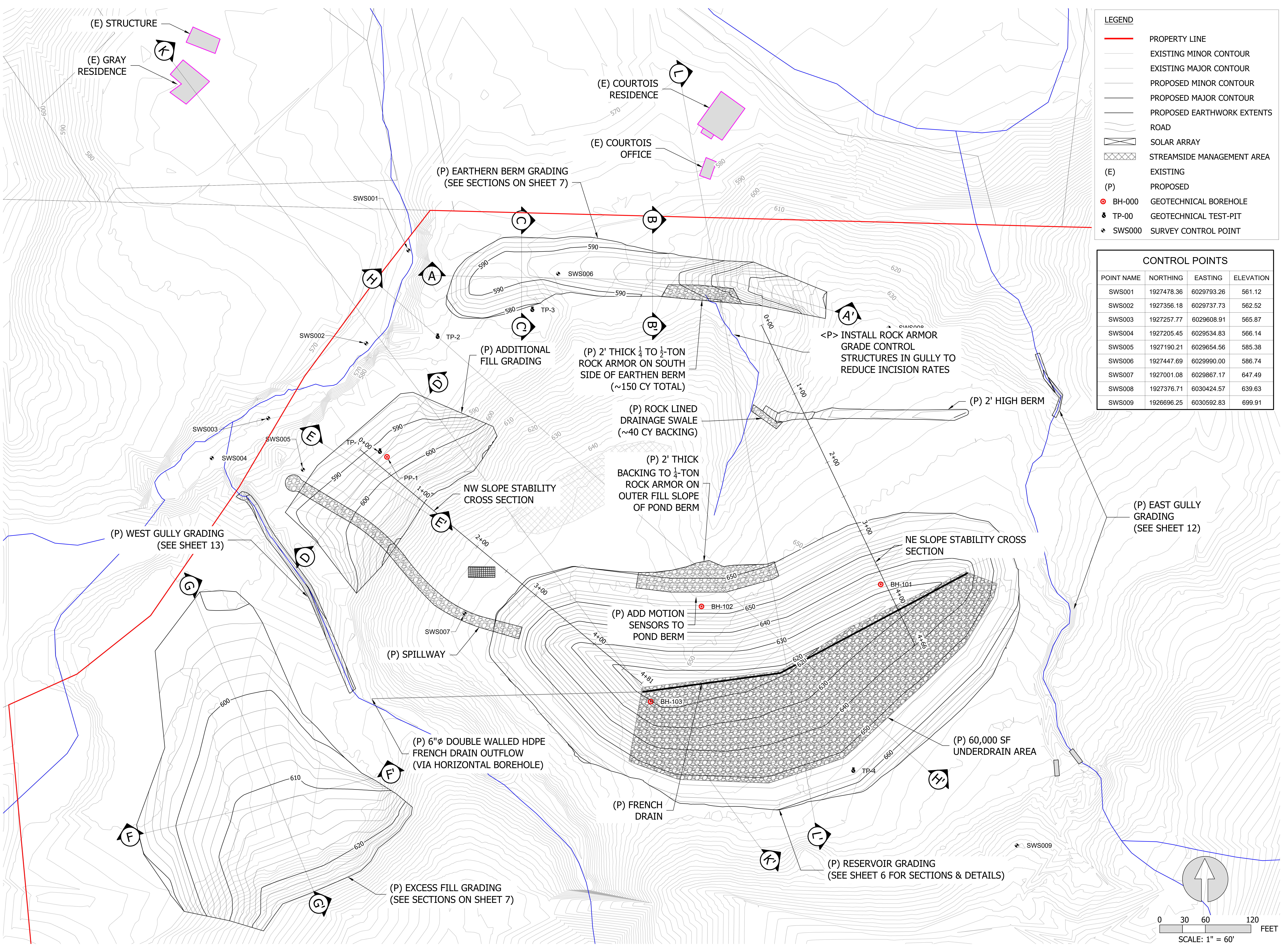
9-30-20
EXPIRES

SITE PROTECTION, STAGING & TEMPORARY ACCESS

SHEET 4 OF 22



LEGEND

PROPERTY LINE	
EXISTING MINOR CONTOUR	
EXISTING MAJOR CONTOUR	
PROPOSED MINOR CONTOUR	
PROPOSED MAJOR CONTOUR	
PROPOSED EARTHWORK EXTENTS	
ROAD	
☒	SOLAR ARRAY
▨	STREAMSIDE MANAGEMENT AREA
(E)	EXISTING
(P)	PROPOSED
◉ BH-000	GEOTECHNICAL BOREHOLE
TP-00	GEOTECHNICAL TEST-PIT
⊕ SWS000	SURVEY CONTROL POINT

CONTROL POINTS

POINT NAME	NORTHING	EASTING	ELEVATION
SWS001	1927478.36	6029793.26	561.12
SWS002	1927356.18	6029737.73	562.52
SWS003	1927257.77	6029608.91	565.87
SWS004	1927205.45	6029534.83	566.14
SWS005	1927190.21	6029654.56	585.38
SWS006	1927447.69	6029990.00	586.74
SWS007	1927001.08	6029867.17	647.49
SWS008	1927376.71	6030424.57	639.63
SWS009	1926696.25	6030592.83	699.91

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9-30-20

GRADING PLAN

SHEET 5 OF 22

IF BAR DOES NOT MEASURE 1" DRAWING IS NOT TO SCALE – ADJUST ACCORDINGLY

LAST SAVED: 9/30/2020 PLOT DATE: 9/30/2020 PLOT STYLE: ----

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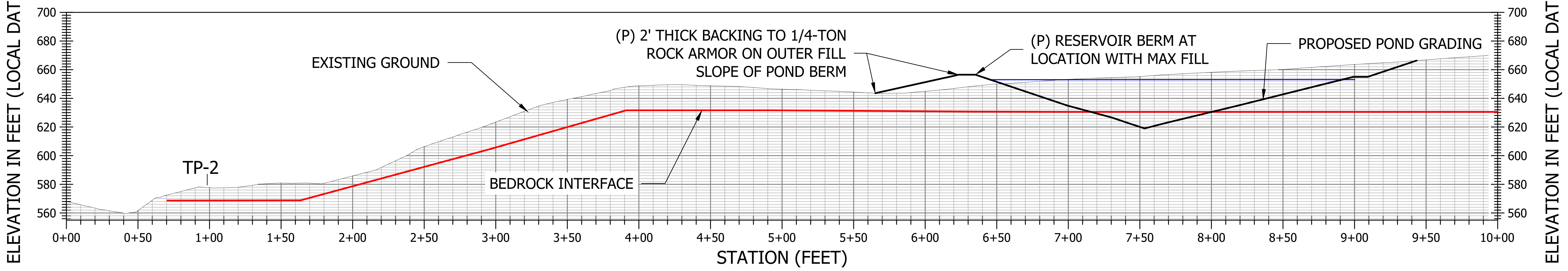
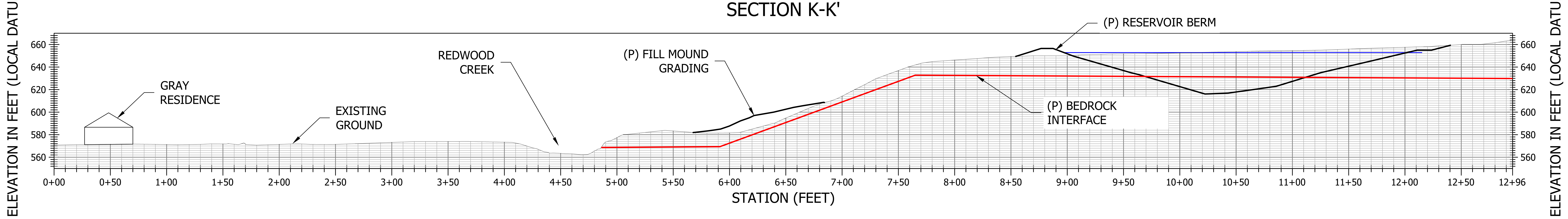
RESERVOIR SECTION H-H'



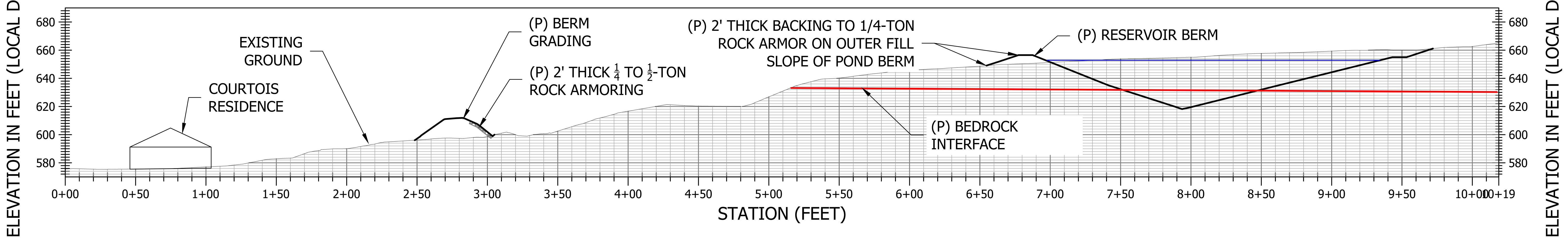
HORIZONTAL SCALE: 1" = 60'
VERTICAL SCALE: 1" = 60'

SECTION K-K'



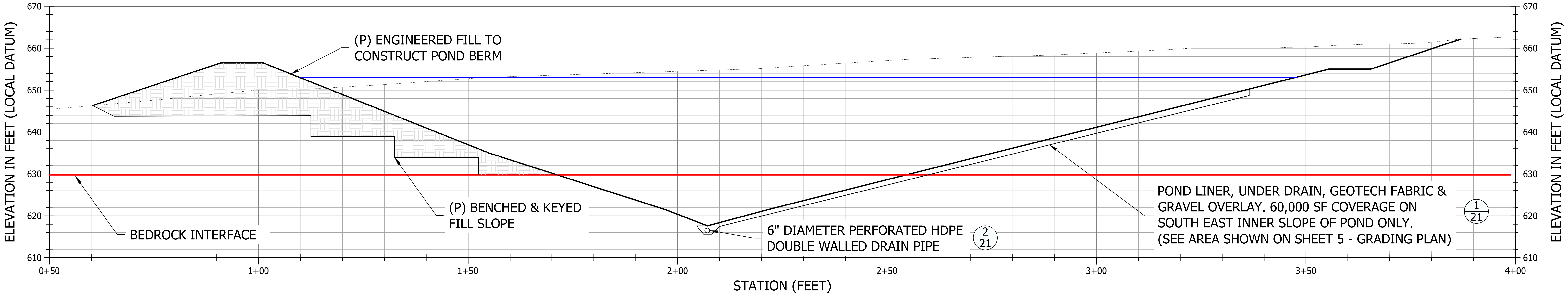
HORIZONTAL SCALE: 1" = 60'
VERTICAL SCALE: 1" = 60'

SECTION L-L'



HORIZONTAL SCALE: 1" = 60'
VERTICAL SCALE: 1" = 60'

FRENCH DRAIN AND SUBSURFACE RESTRICTIVE BARRIER DETAIL (TYP.)



HORIZONTAL SCALE: 1" = 15'
VERTICAL SCALE: 1" = 15'

LEGEND

—	EXISTING GROUND SURFACE
—	PROPOSED GROUND SURFACE

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9-30-20

RESERVOIR SECTIONS & DETAILS

SHEET 6 OF 22

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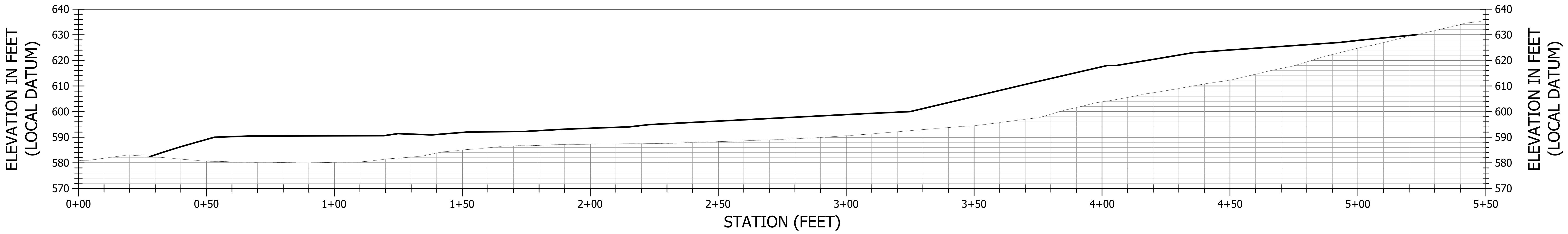
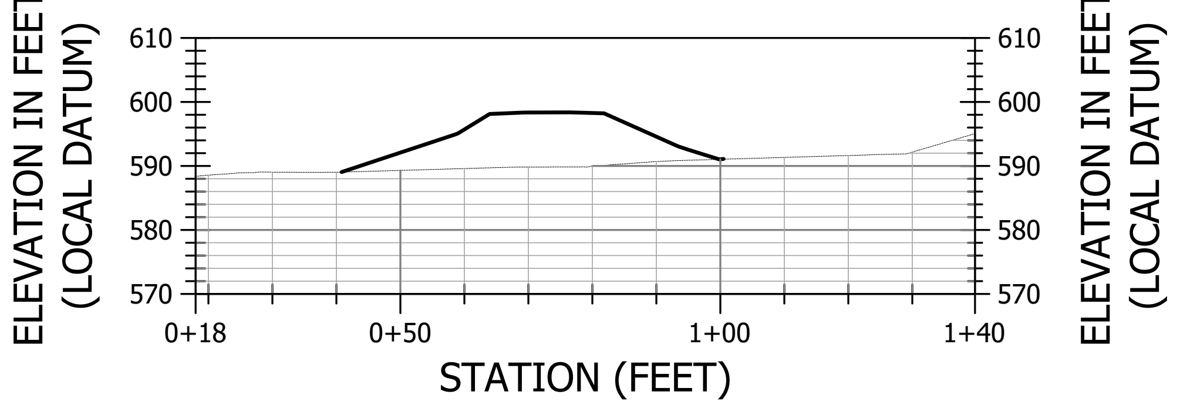
BERM A-A'



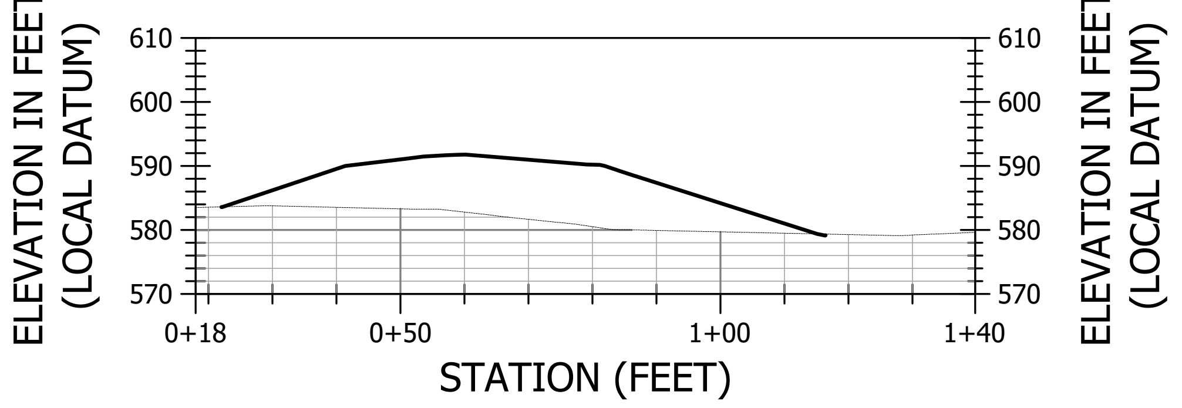
HORIZONTAL SCALE: 1" = 30'
VERTICAL SCALE: 1" = 30'

BERM B-B'



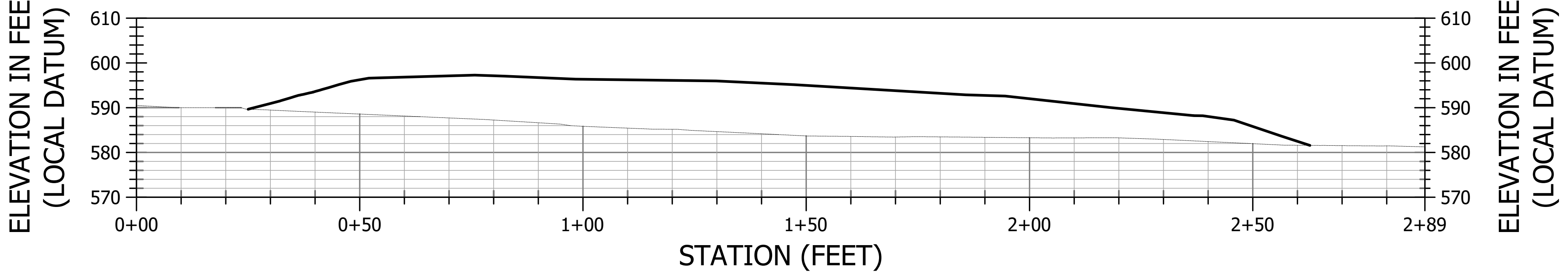
HORIZONTAL SCALE: 1" = 30'
VERTICAL SCALE: 1" = 30'

BERM C-C'



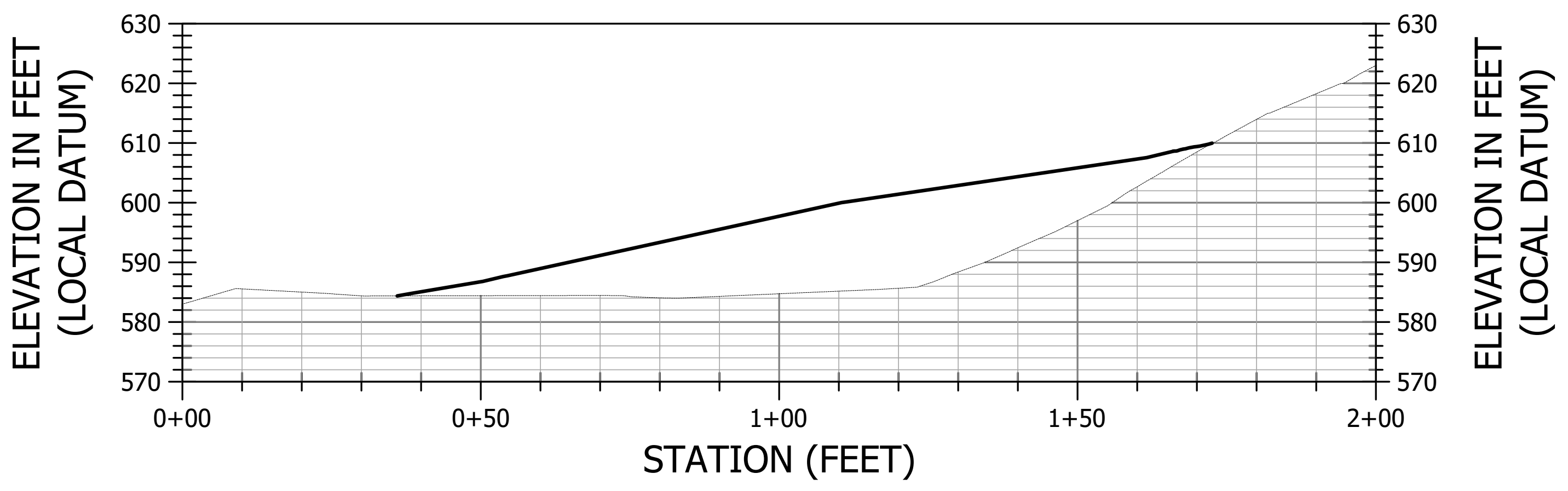
HORIZONTAL SCALE: 1" = 30'
VERTICAL SCALE: 1" = 30'

ADDITIONAL FILL D-D'



HORIZONTAL SCALE: 1" = 30'
VERTICAL SCALE: 1" = 30'

ADDITIONAL FILL E-E'



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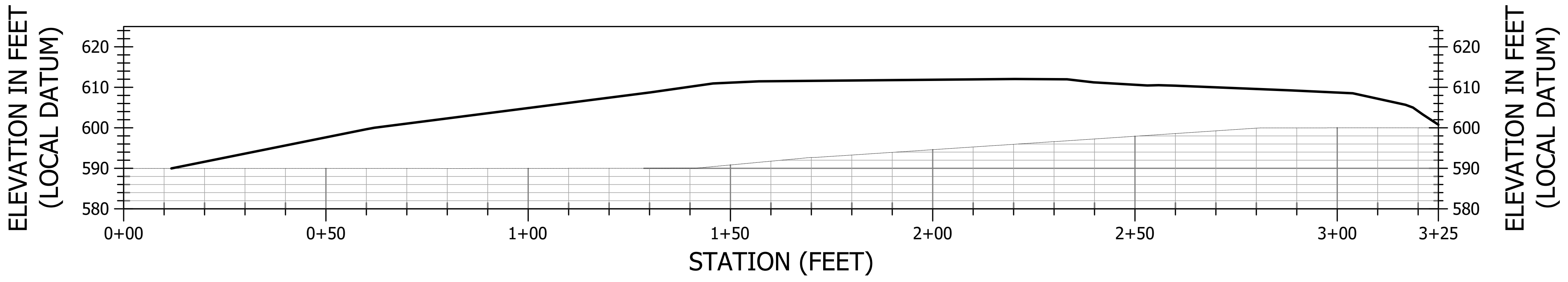
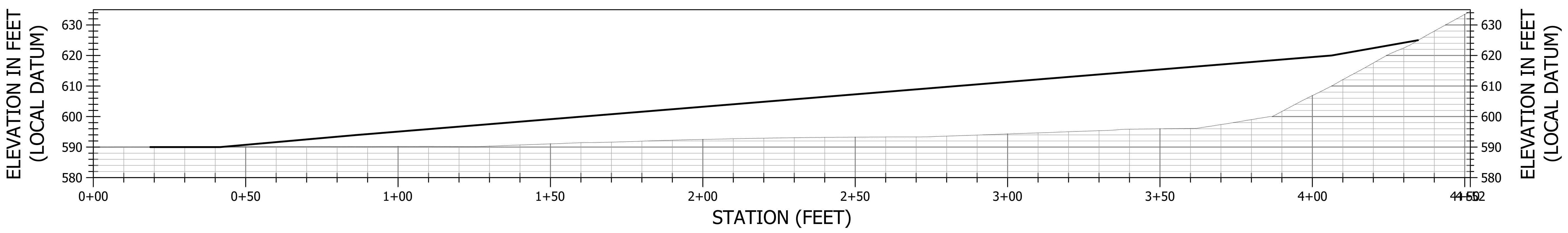
VERTICAL SCALE: 1" = 30'

EXCESS FILL F-F'



HORIZONTAL SCALE: 1" = 30'
VERTICAL SCALE: 1" = 30'

EXCESS FILL G-G'



HORIZONTAL SCALE: 1" = 30'
VERTICAL SCALE: 1" = 30'

LEGEND

── EXISTING GROUND SURFACE
── PROPOSED GROUND SURFACE

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JOEL MONSCHKE
No. 79688
9-30-20

FILL PLACEMENT SECTIONS

SHEET 7 OF 22

IF BAR DOES NOT MEASURE 1" DRAWING IS NOT TO SCALE - ADJUST ACCORDINGLY

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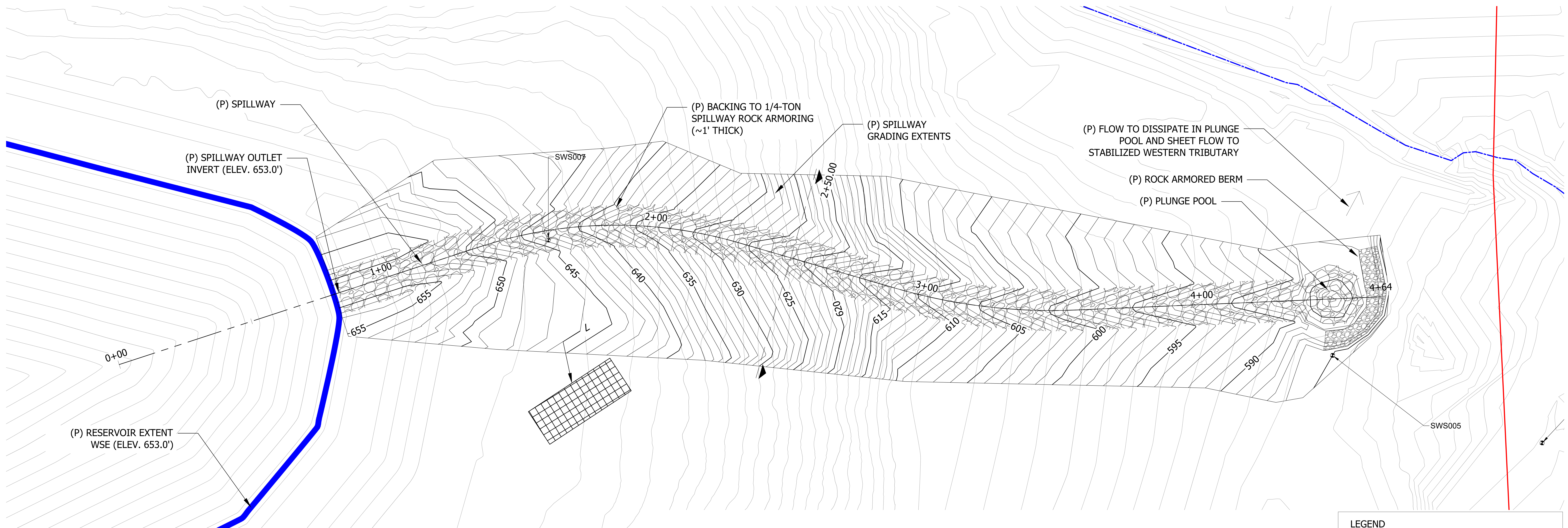
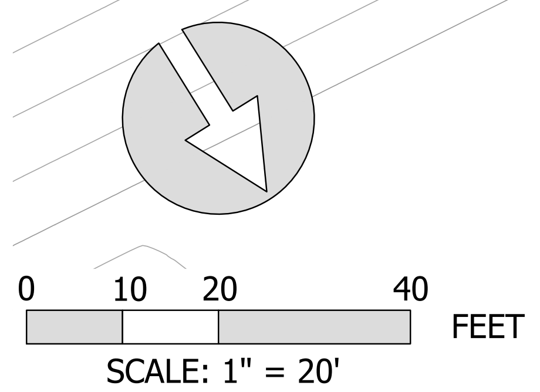
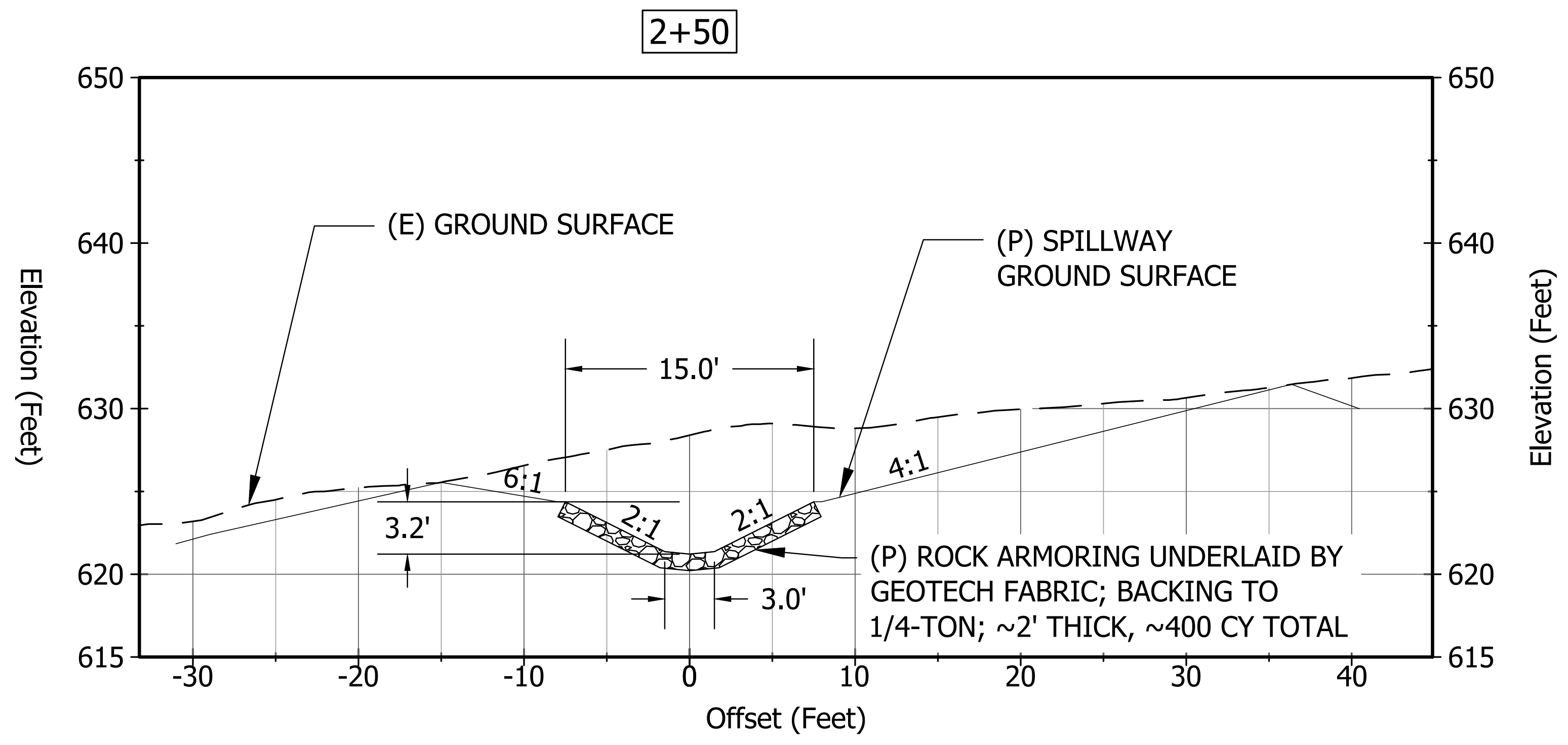


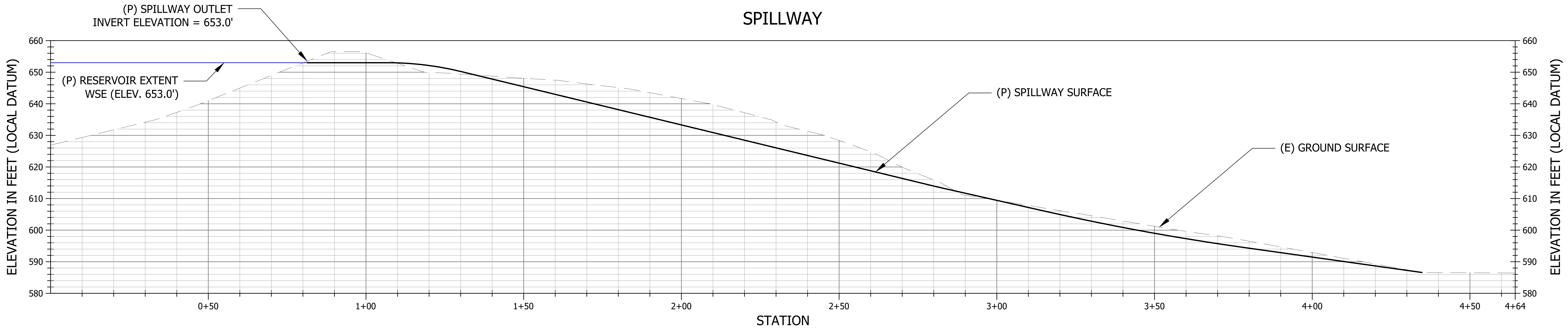




LEGEND

―	PROPERTY LINE
―	EXISTING MINOR CONTOUR
―	EXISTING MAJOR CONTOUR
―	PROPOSED MINOR CONTOUR
―	PROPOSED MAJOR CONTOUR
- - - -	PROPOSED EARTHWORK EXTENTS
═	ROAD
⊠	SOLAR ARRAY
▨	STREAMSIDE MANAGEMENT AREA
(E)	EXISTING
(P)	PROPOSED
⊙ BH-000	GEOTECHNICAL BOREHOLE
TP-00	GEOTECHNICAL TEST-PIT
SWS000	SURVEY CONTROL POINT

SPILLWAY



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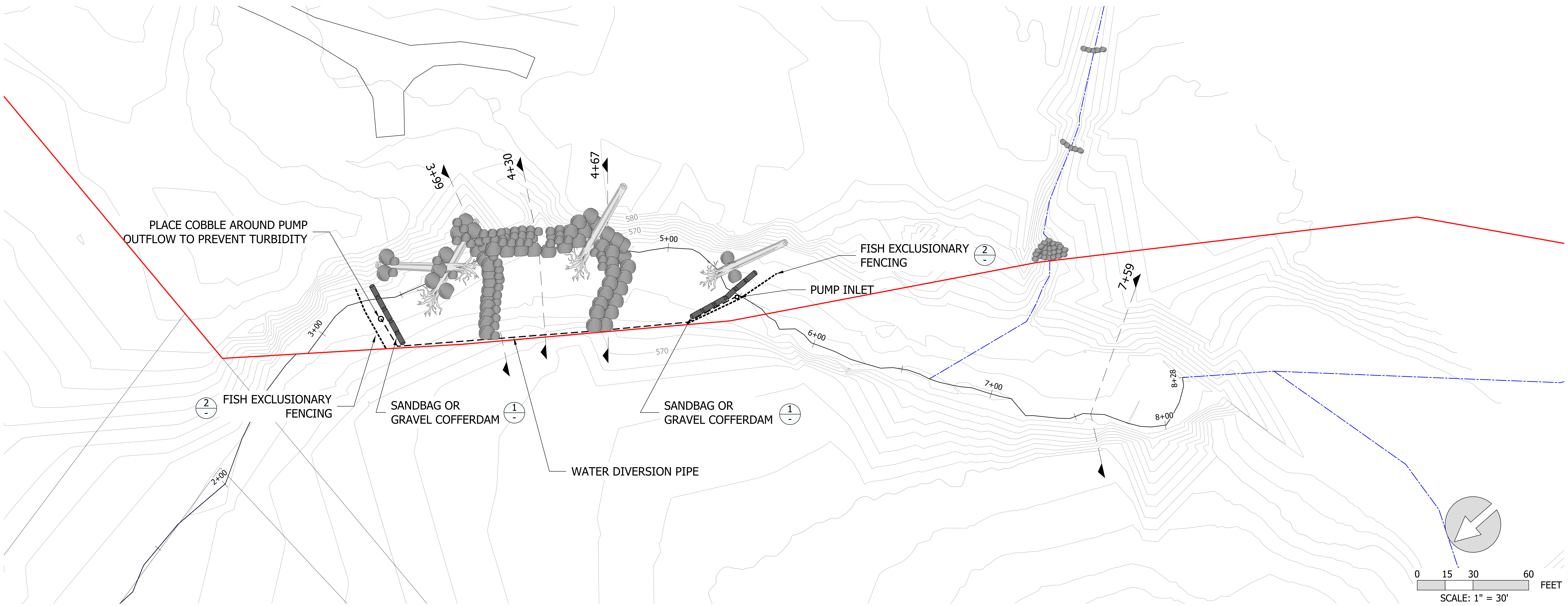
JOEL MONSCHKE
No. 79688
9-30-20
EXPIRES
CIVIL

SPILLWAY PLAN & PROFILE

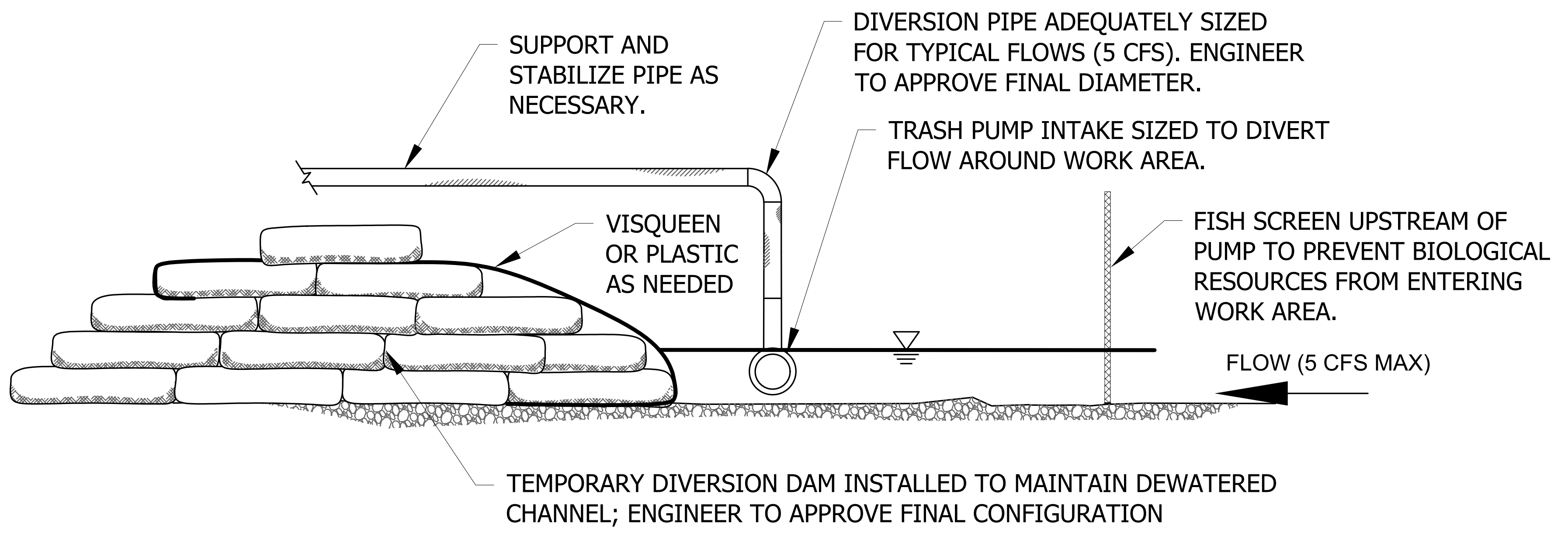
SHEET 8 OF 22



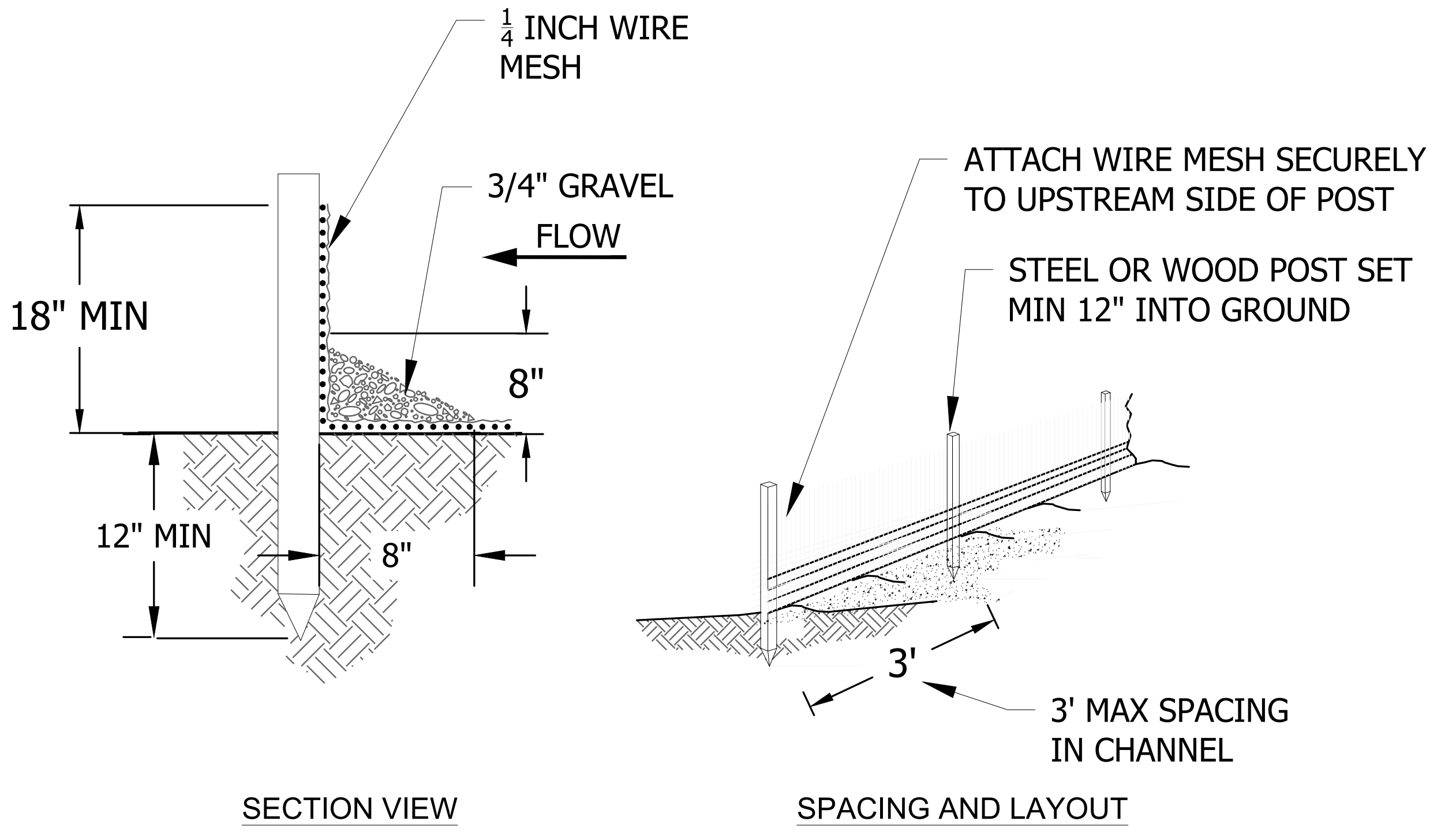
SCALE: 1" = 30'

DEWATERING AND CONSTRUCTION SEQUENCING NOTES:

1. THE ENTIRE LENGTH OF CHANNEL WITHIN THE LIMIT OF WORK SHALL BE ELECTRO-FISHED BY DFW STAFF PRIOR TO ANY CONSTRUCTION ACTIVITY THAT COULD DISTURB THE CHANNEL
2. CONSTRUCT NEW CHANNEL AND ALL FEATURES EXCEPT UPSTREAM AND DOWNSTREAM CONNECTIONS TO EXISTING CHANNEL; DEWATER EXCAVATIONS AS NEEDED DURING CONSTRUCTION TO INSURE THAT NO TURBID WATER RUNS OFF THE SITE
3. CONSTRUCT DOWNSTREAM CONNECTION BETWEEN NEW AND CURRENT CHANNEL; INSTALL TEMPORARY DEWATERING AND BYPASS FLOW SYSTEM AS SHOWN IN THE FIGURE ABOVE
4. CONSTRUCT UPSTREAM CONNECTION BETWEEN NEW AND CURRENT CHANNEL; INSTALL TEMPORARY DEWATERING AND BYPASS FLOW SYSTEM AS SHOWN IN THE FIGURE ABOVE



1 COFFER DAM AND PUMP INTAKE
NTS



SECTION VIEW

SPACING AND LAYOUT

2 FISH EXLUSIONARY FENCING
NTS

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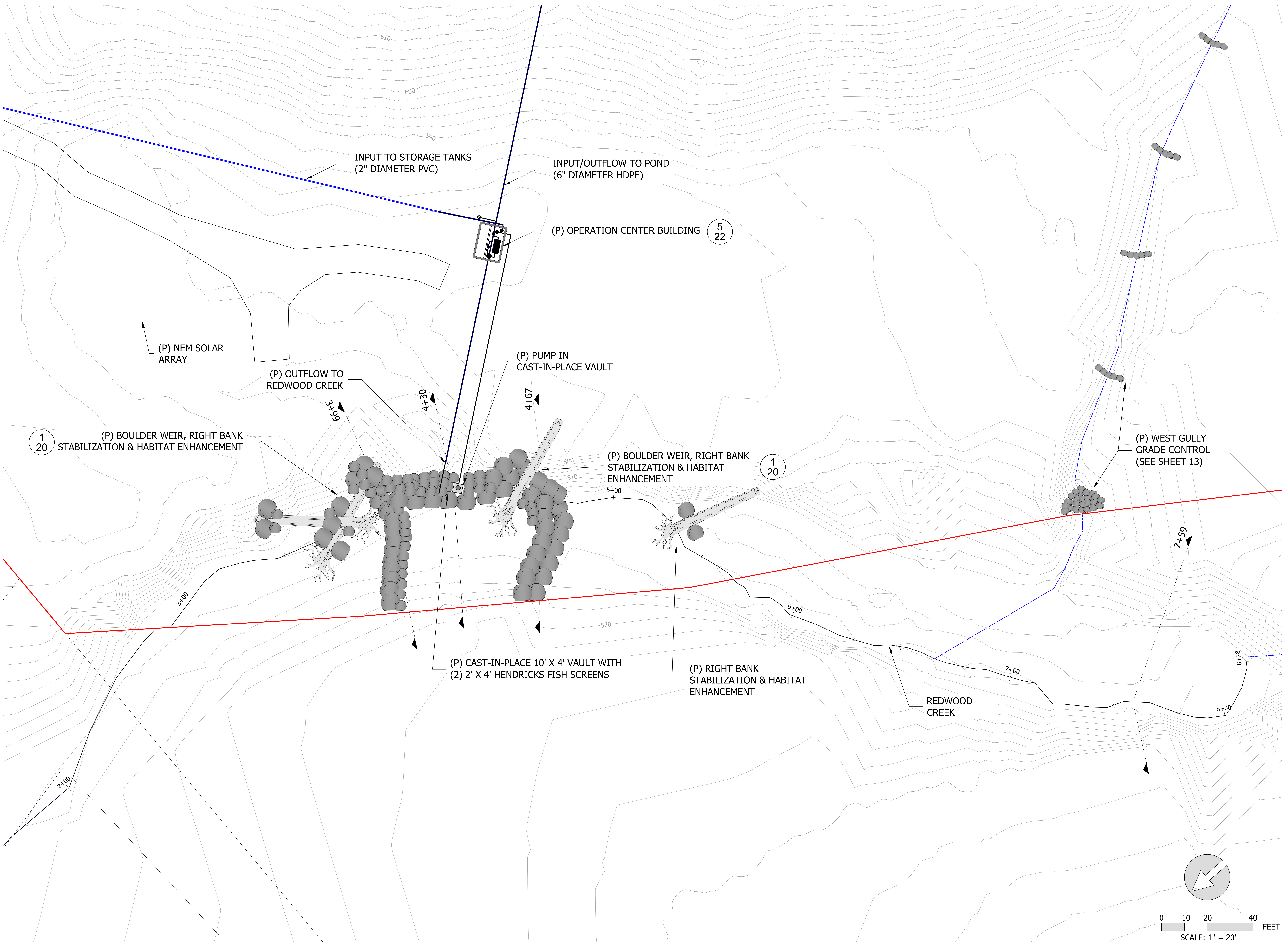
REDWOOD CREEK - DEWATERING

SHEET 9 OF 22

IF BAR DOES NOT MEASURE 1" DRAWING IS NOT TO SCALE – ADJUST ACCORDINGLY

Z:\DATA\603.01_MARSHALLRANCH\ACAD\2_MODEL\603.00_REDWOOD_RECHARGE_RESERVOIR.DWG LAST SAVED: 9/30/2020 PLOT DATE: 9/30/2020 PLOT STYLE: ----



MARSHALL RANCH FLOW ENHANCEMENT PROJECT

APN 220-061-011

HUMBOLDT COUNTY, CA

Stillwater Sciences
2855 TELEGRAPH AVENUE, SUITE 400
BERKELEY, CA 94705
P: (510) 848-8098

PROJECT NUMBER: 603.01
SCALE: AS NOTED
DATE: 8/2/2020

DESIGN: JM
DRAWN: CL
CHECKED: JM
APPROVED: JM

JOEL MONSCHKE
No. 79688
9-30-20
EXPIRES
CIVIL

REDWOOD CREEK - INSTREAM COMPONENTS

SHEET 10 OF 22

IF BAR DOES NOT MEASURE 1" DRAWING IS NOT TO SCALE - ADJUST ACCORDINGLY

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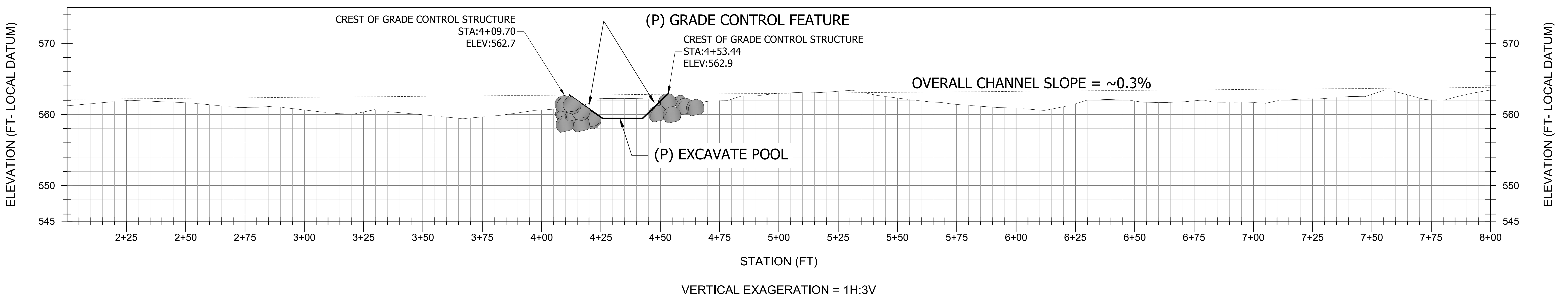
REDWOOD CREEK - ALIGNMENT PROFILE



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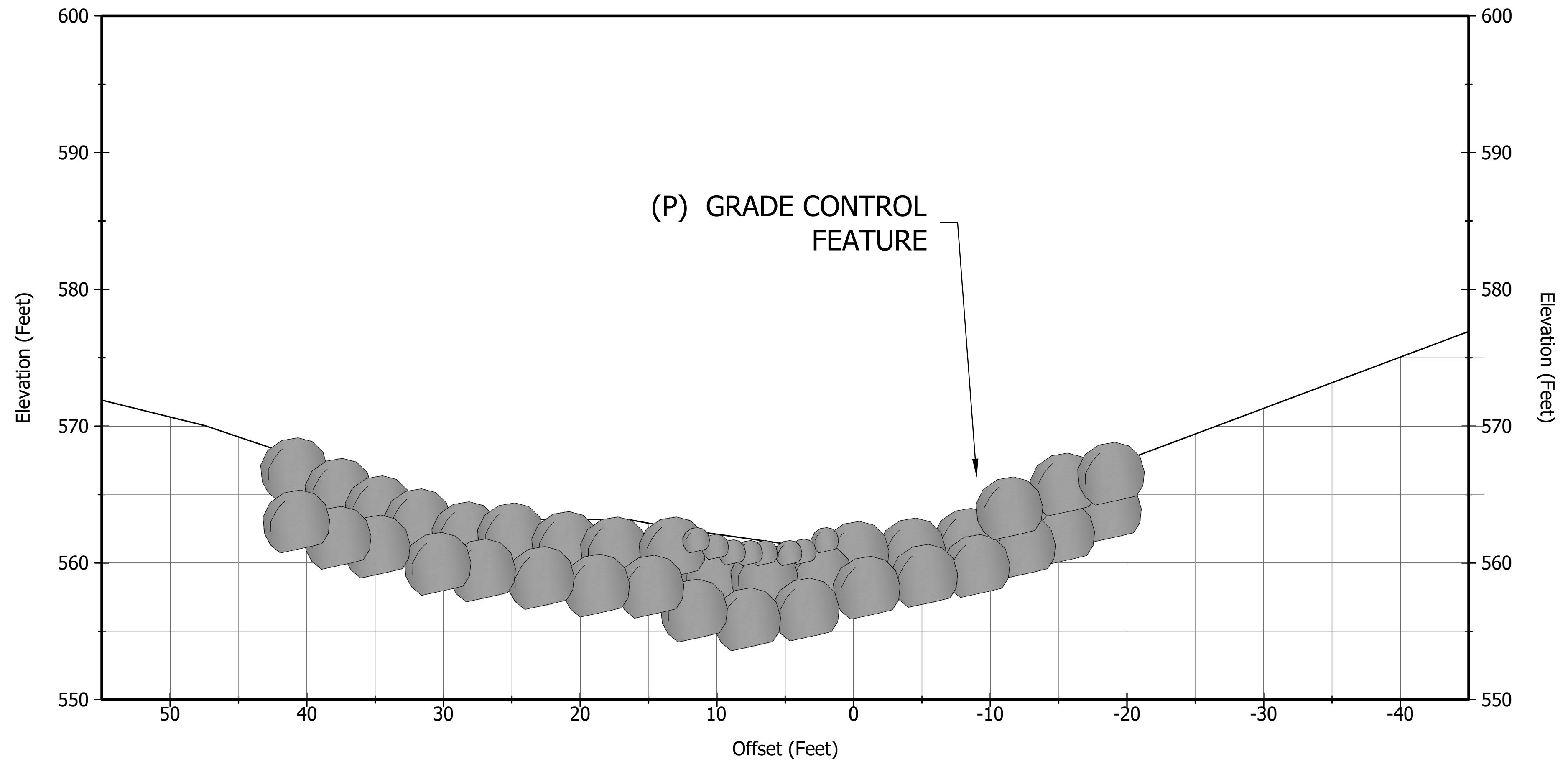
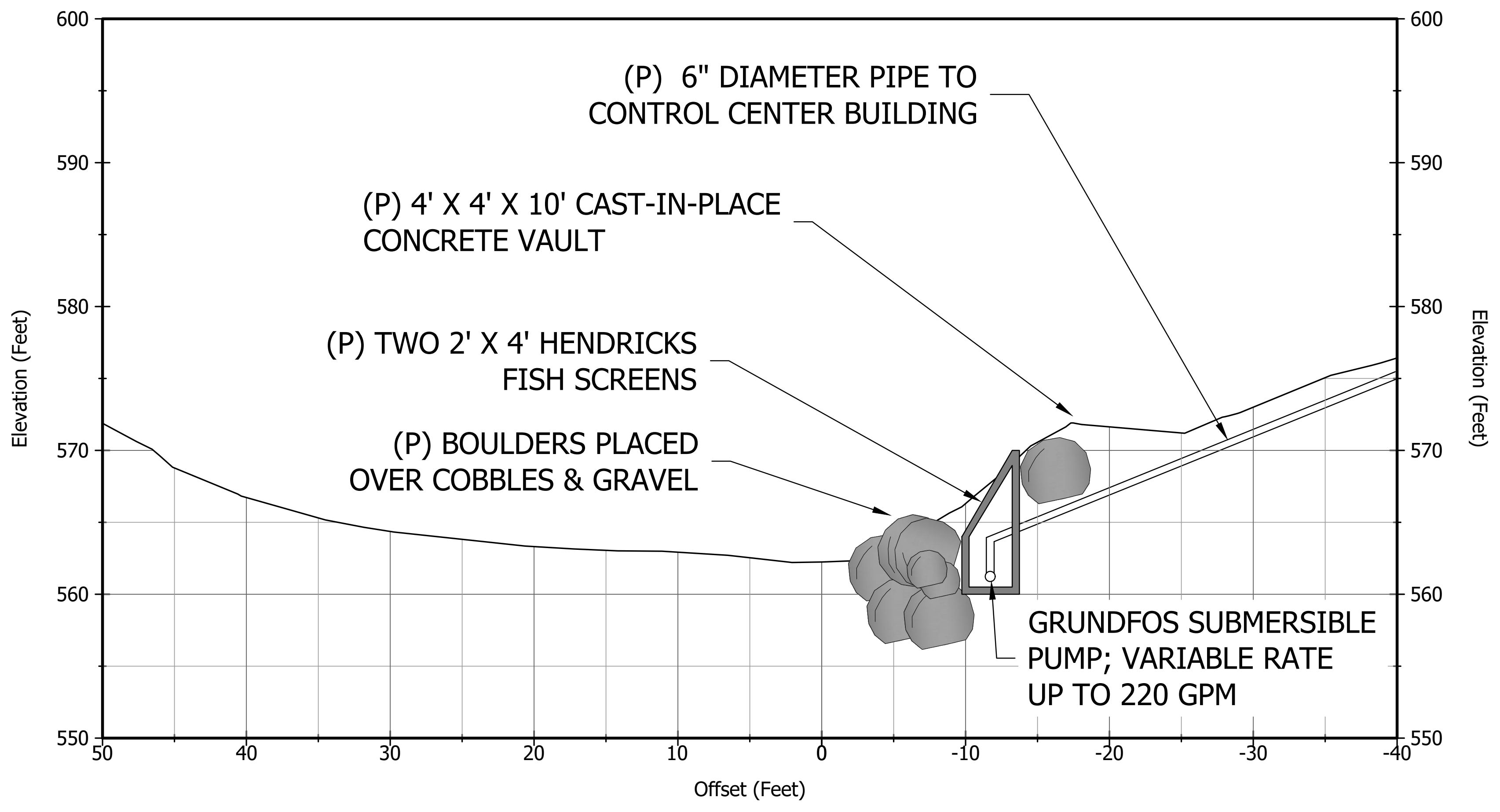


4+30



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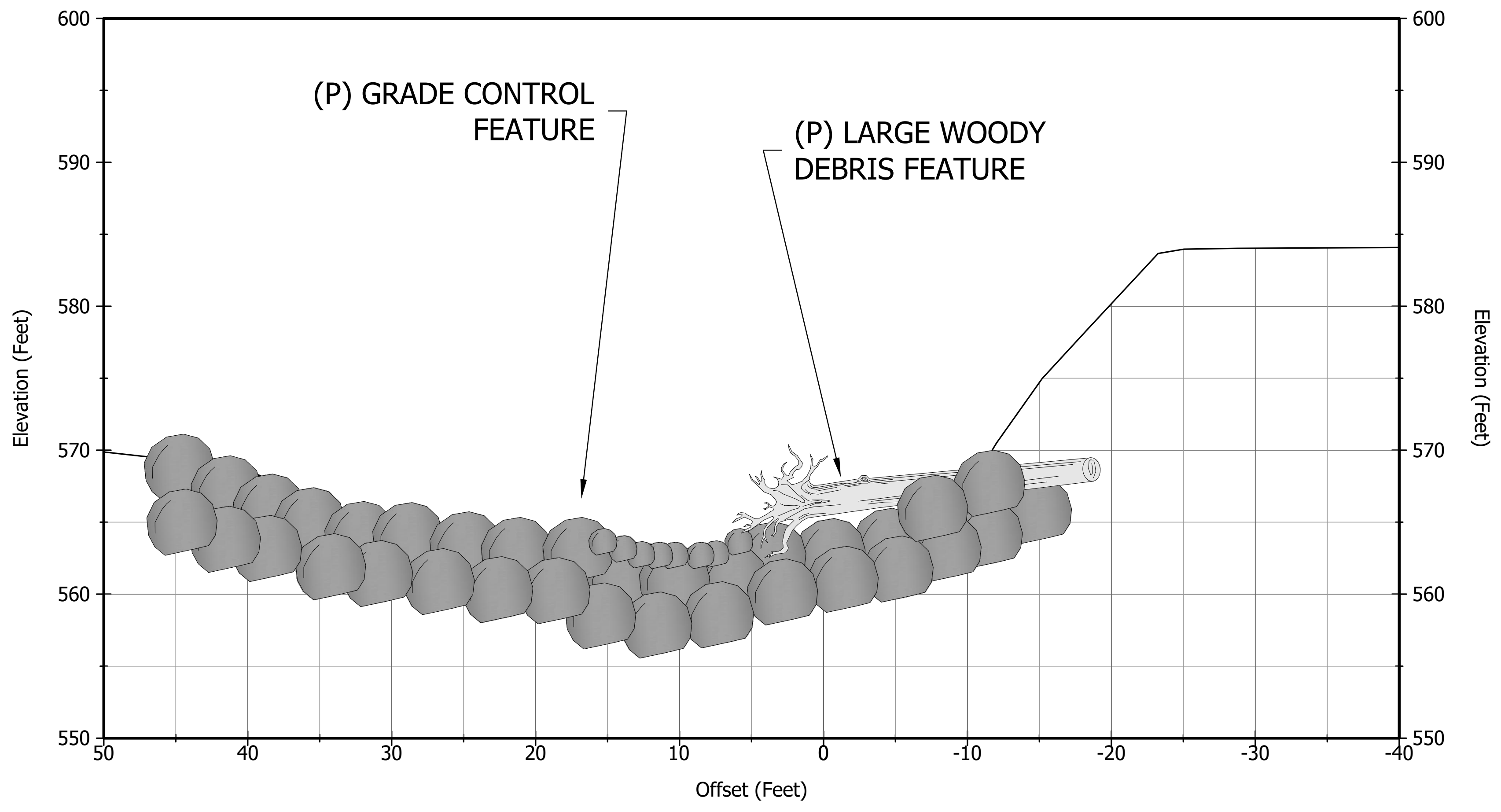

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JOEL MONSCHKE
No. 79688
9-30-20
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CIVIL

REDWOOD CREEK -
INSTREAM COMPONENTS
- PROFILE & SECTIONS

SHEET 11 OF 22

IF BAR DOES NOT MEASURE 1" DRAWING IS NOT TO SCALE – ADJUST ACCORDINGLY

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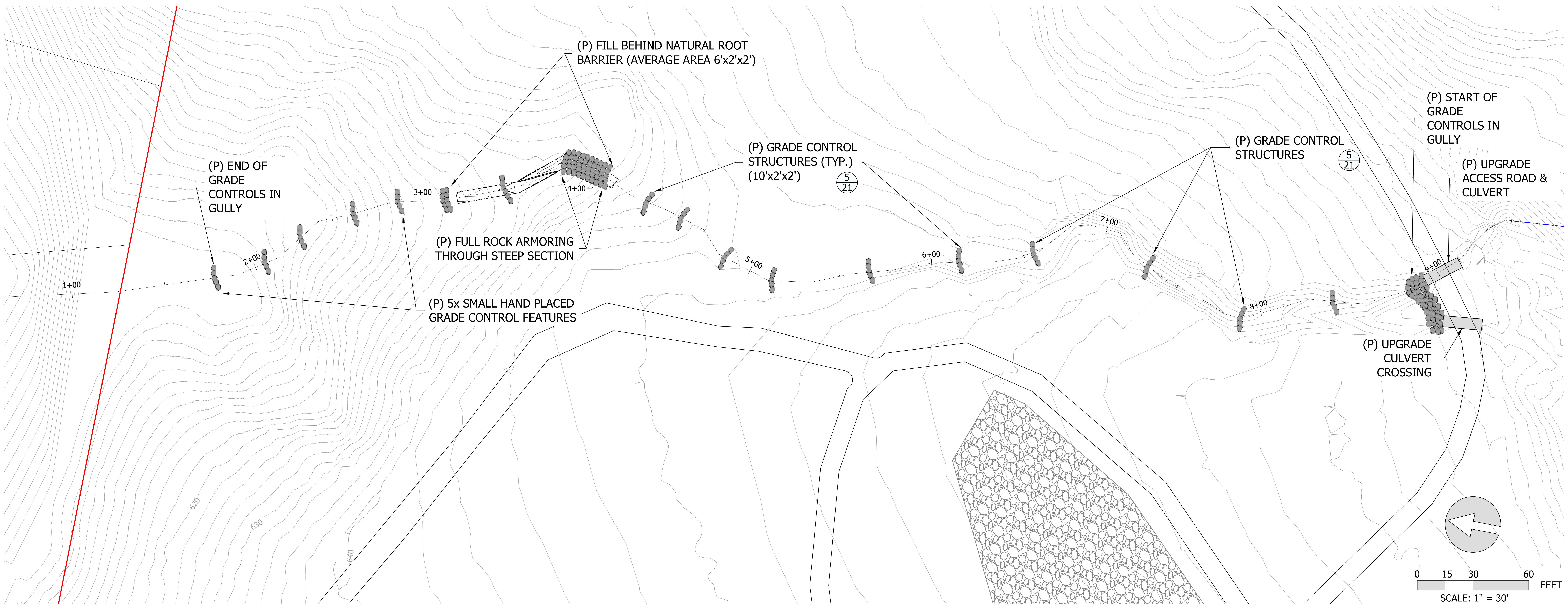
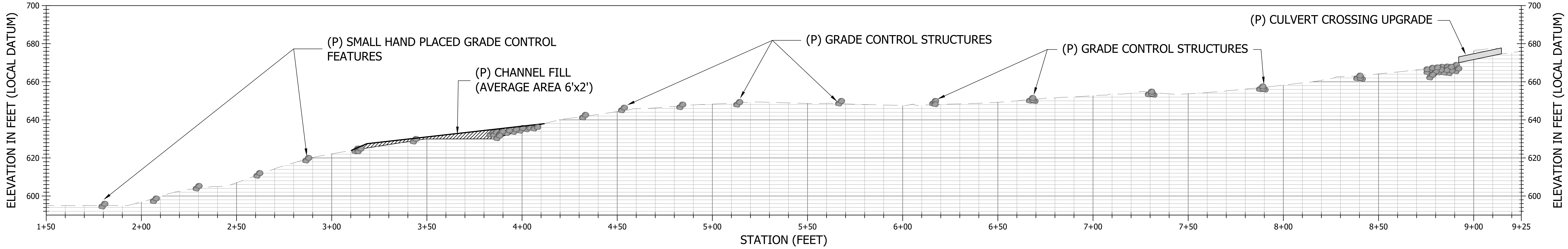


EAST GULLY - ALIGNMENT PROFILE



HORIZONTAL SCALE: 1" = 60'
VERTICAL SCALE: 1" = 60'

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APN 220-061-011

HUMBOLDT COUNTY, CA

Stillwater Sciences
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JOEL MONSCHKE
No. 79688
9-30-20
EXPIRES

EAST GULLY PLAN & PROFILE

SHEET 12 OF 22

IF BAR DOES NOT MEASURE 1" DRAWING IS NOT TO SCALE - ADJUST ACCORDINGLY

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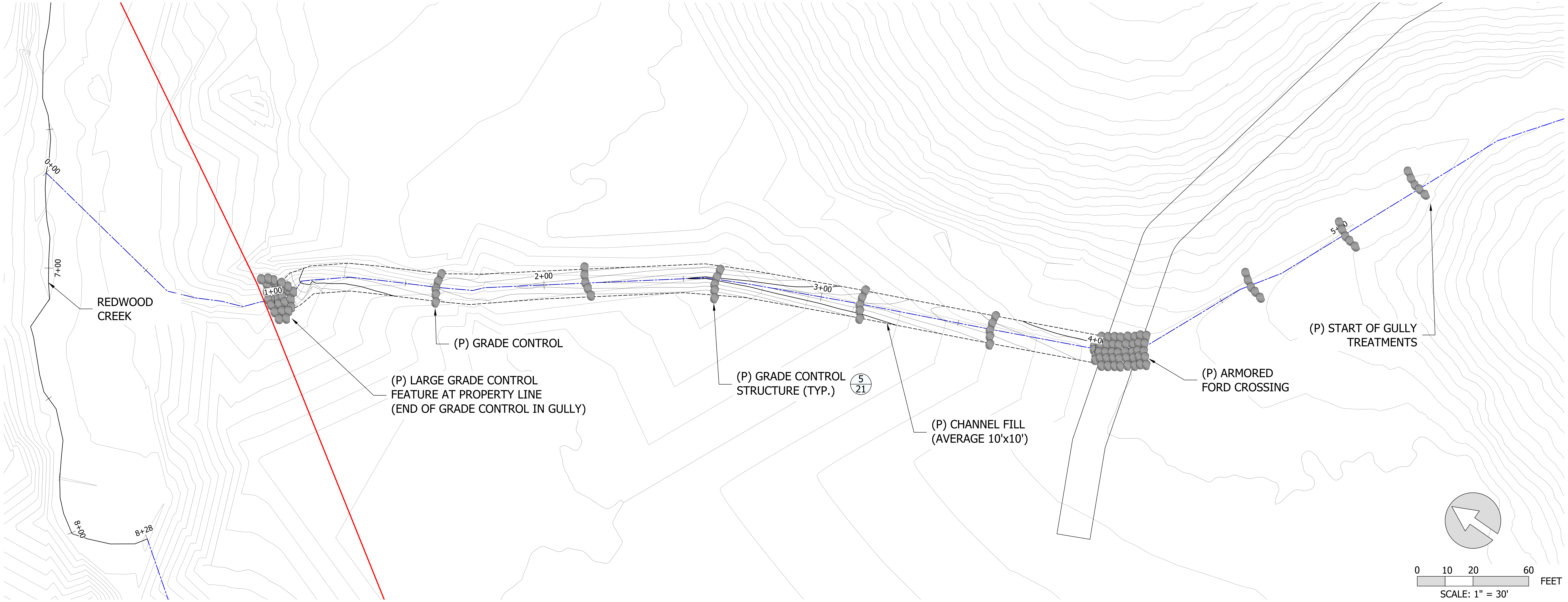
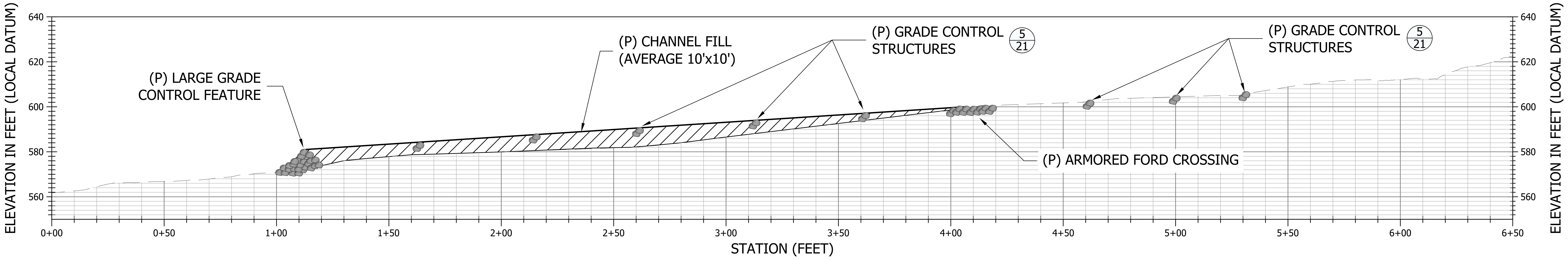


WEST GULLY - ALIGNMENT PROFILE



HORIZONTAL SCALE: 1" = 60'
VERTICAL SCALE: 1" = 60'

MARSHALL RANCH FLOW ENHANCEMENT PROJECT
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JOEL MONSCHKE
No. 79688
9-30-20
EXPIRES

WEST GULLY PLAN & PROFILE

SHEET 13 OF 22

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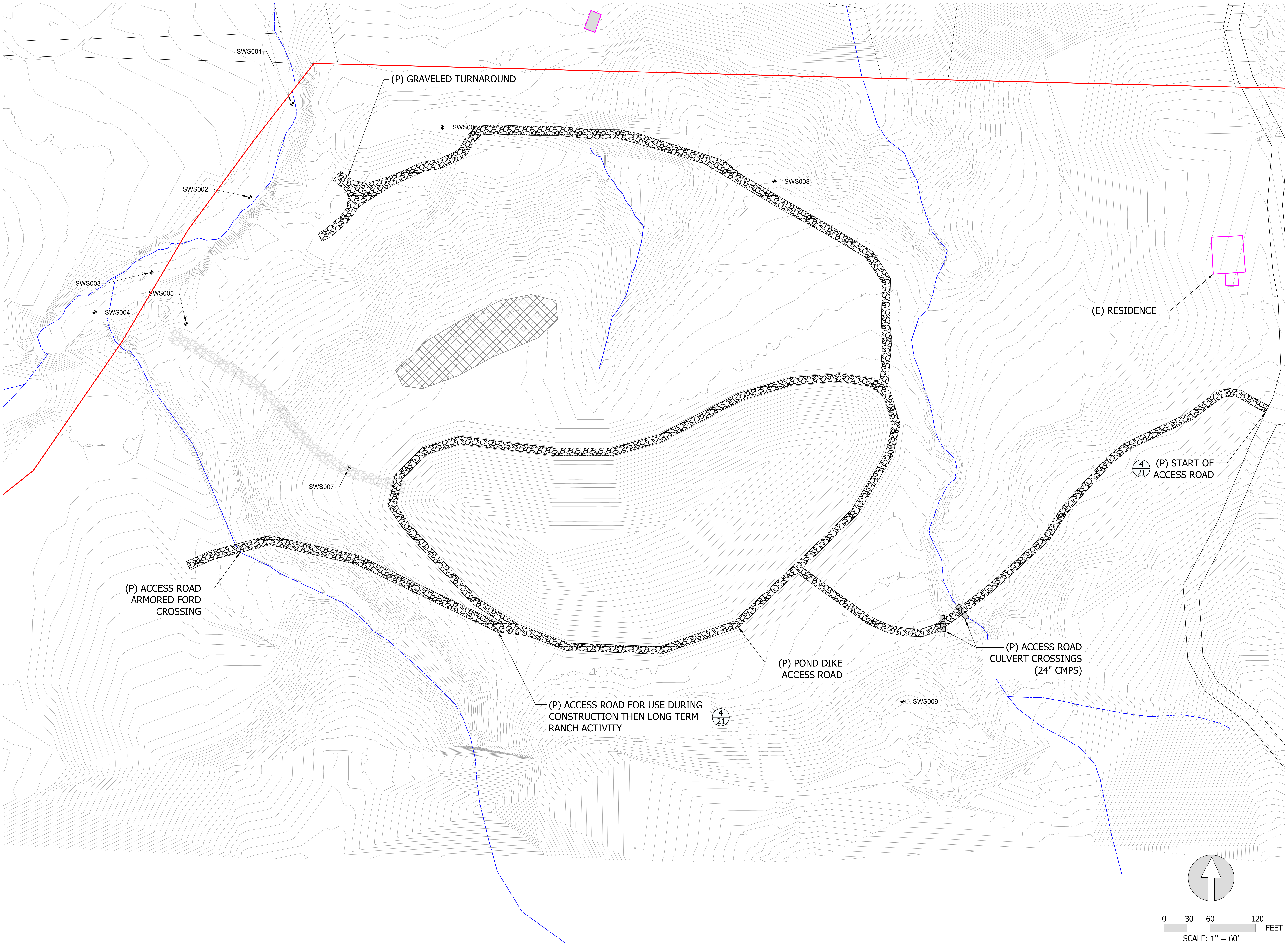

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REGISTERED PROFESSIONAL ENGINEER
JOEL MONSCHKE
No. 79688
9-30-20
EXPIRES
CIVIL
STATE OF CALIFORNIA

PERMANENT ACCESS ROAD PLAN

SHEET 14 OF 22

IF BAR DOES NOT MEASURE 1" DRAWING IS NOT TO SCALE – ADJUST ACCORDINGLY

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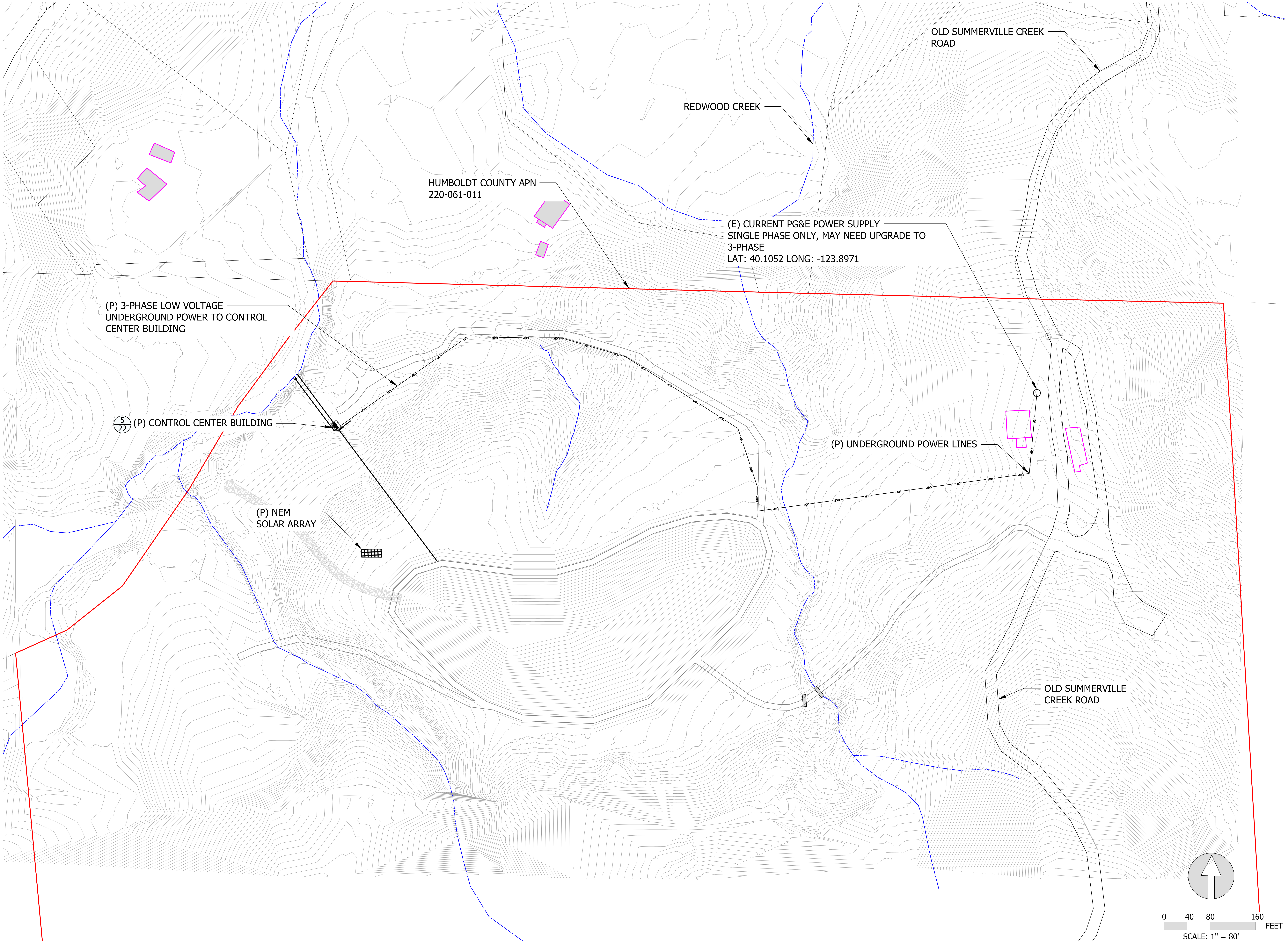

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HUMBOLDT COUNTY, CA

Stillwater Sciences
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JOEL MONSCHKE
No. 79688
9-30-20
EXPIRES

ELECTRICAL PLAN

SHEET 15 OF 22

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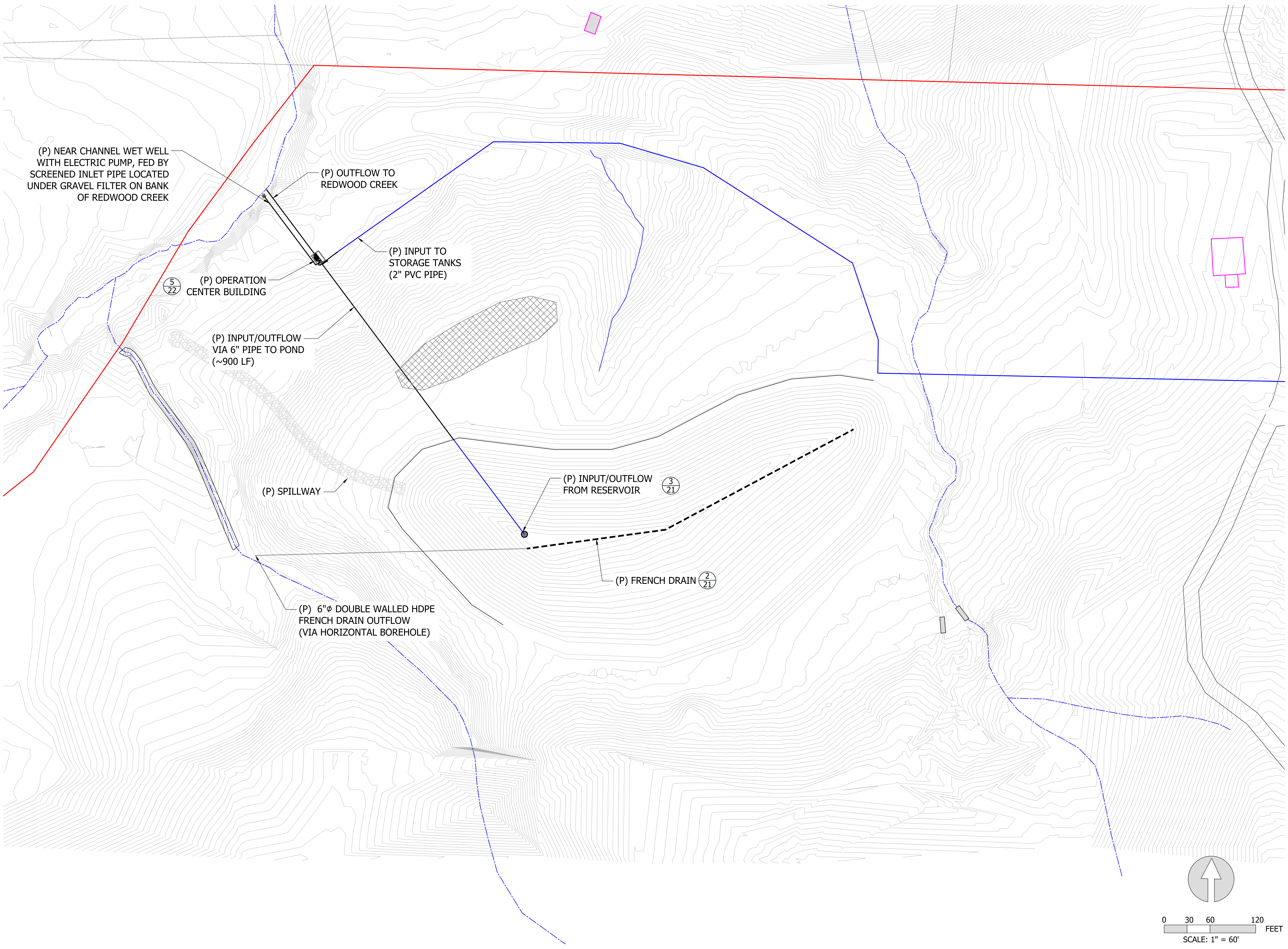

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JOEL MONSCHKE
No. 79688
9-30-20
EXPIRES

WATER INFRASTRUCTURE PLAN

SHEET 16 OF 22

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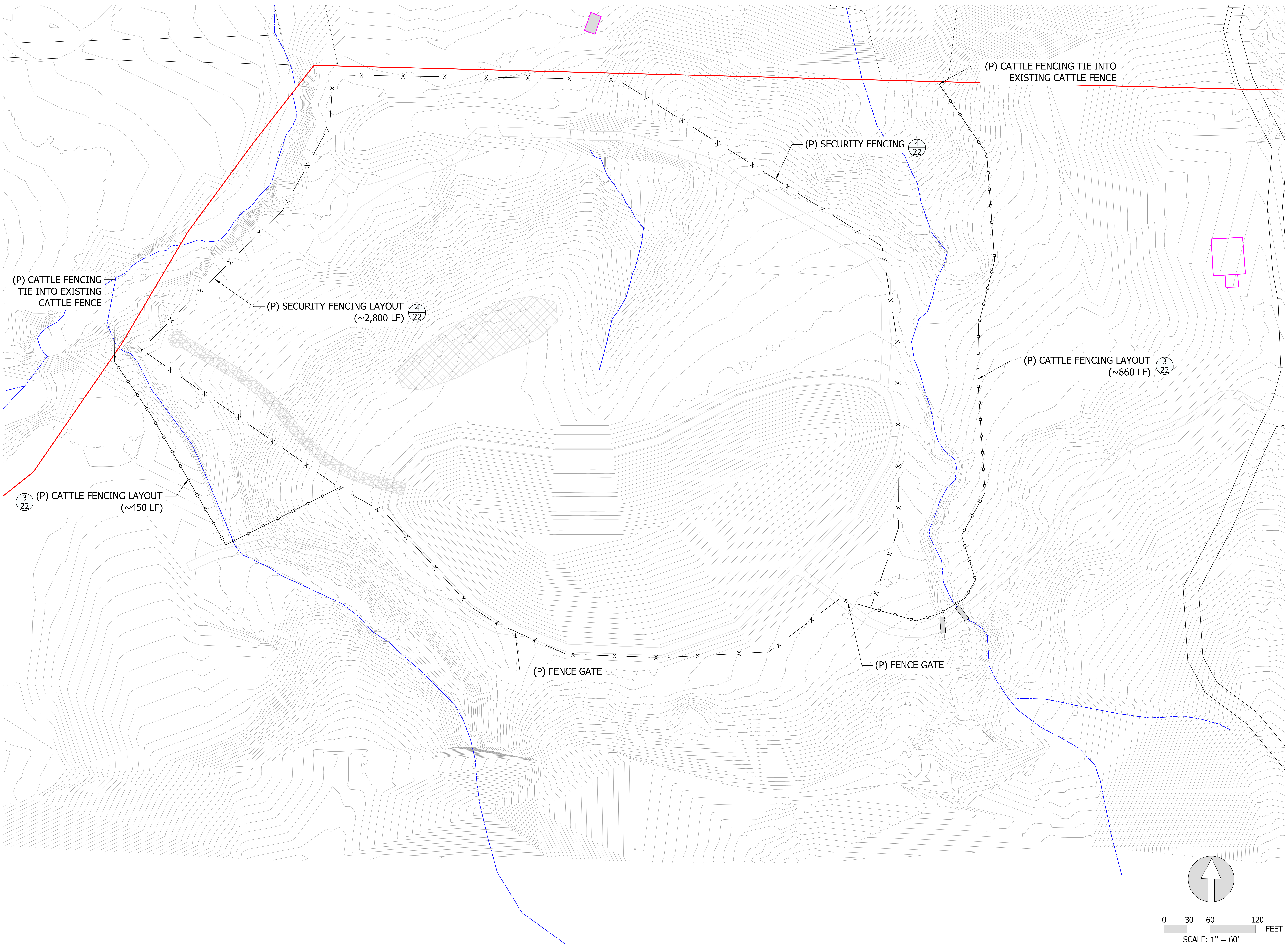

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JOEL MONSCHKE
No. 79688
9-30-20
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CIVIL

FENCING PLAN

SHEET 17 OF 22

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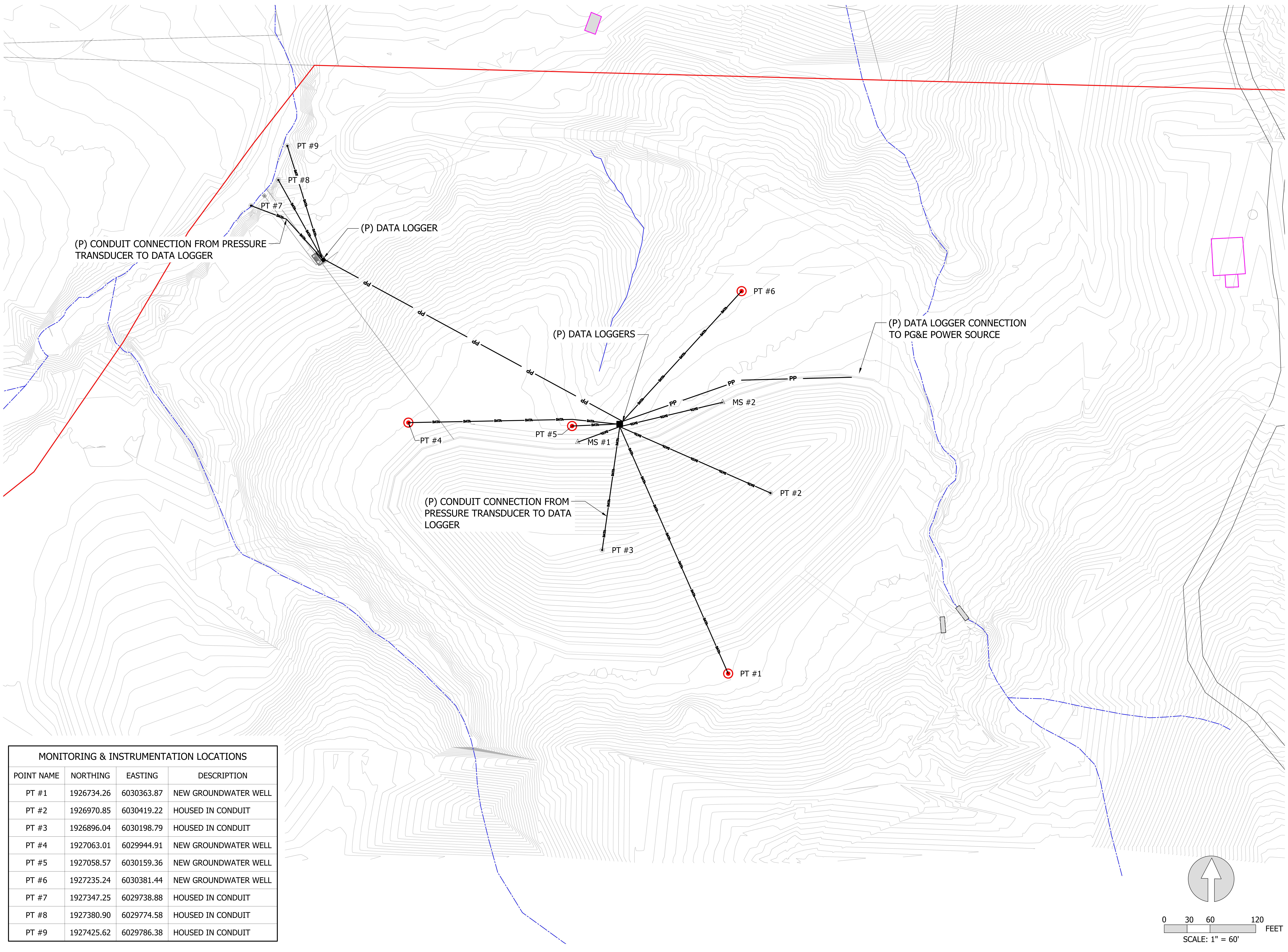

MONITORING & INSTRUMENTATION LOCATIONS			
POINT NAME	NORTHING	EASTING	DESCRIPTION
PT #1	1926734.26	6030363.87	NEW GROUNDWATER WELL
PT #2	1926970.85	6030419.22	HOUSED IN CONDUIT
PT #3	1926896.04	6030198.79	HOUSED IN CONDUIT
PT #4	1927063.01	6029944.91	NEW GROUNDWATER WELL
PT #5	1927058.57	6030159.36	NEW GROUNDWATER WELL
PT #6	1927235.24	6030381.44	NEW GROUNDWATER WELL
PT #7	1927347.25	6029738.88	HOUSED IN CONDUIT
PT #8	1927380.90	6029774.58	HOUSED IN CONDUIT
PT #9	1927425.62	6029786.38	HOUSED IN CONDUIT

MARSHALL RANCH FLOW ENHANCEMENT PROJECT

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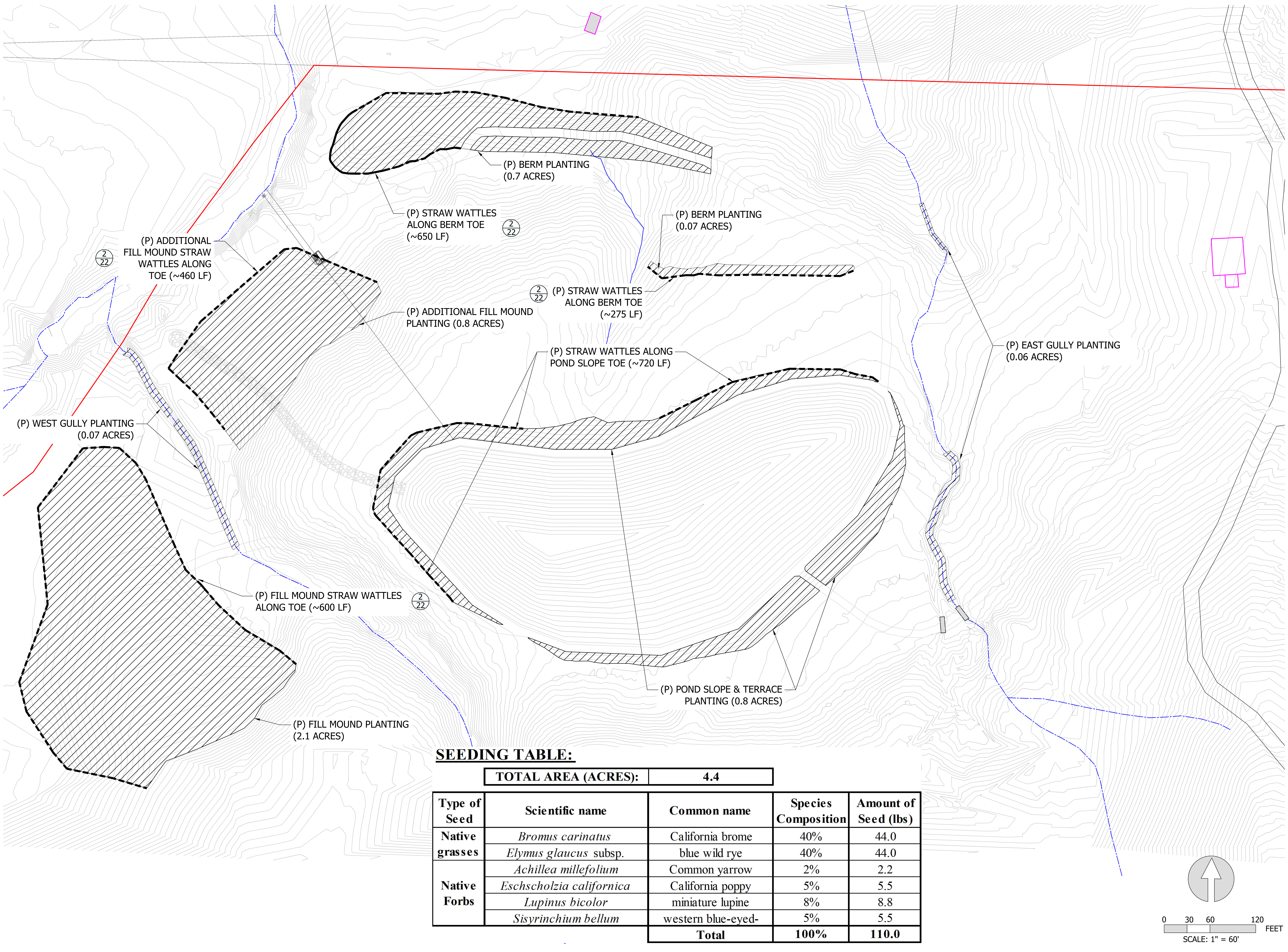
No. 79688
9-30-20
CIVIL

MONITORING & INSTRUMENTATION PLAN

SHEET 18 OF 22

IF BAR DOES NOT MEASURE 1" DRAWING IS NOT TO SCALE



SEEDING TABLE:

TOTAL AREA (ACRES):	4.4

Type of Seed	Scientific name	Common name	Species Composition	Amount of Seed (lbs)
Native grasses	*Bromus carinatus*	California brome	40%	44.0
	Elymus glaucus subsp.	blue wild rye	40%	44.0
Native Forbs	*Achillea millefolium*	Common yarrow	2%	2.2
	Eschscholzia californica	California poppy	5%	5.5
	Lupinus bicolor	miniature lupine	8%	8.8
	Sisyrinchium bellum	western blue-eyed-	5%	5.5
		Total	**100%**	**110.0**

MARSHALL RANCH FLOW
ENHANCEMENT PROJECT
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REGISTERED PROFESSIONAL ENGINEER
JOEL MONSCHKE
No. 79688
9-30-20
EXPIRES
CIVIL
STATE OF CALIFORNIA

EROSION CONTROL &
REVEGETATION

SHEET 19 OF 22

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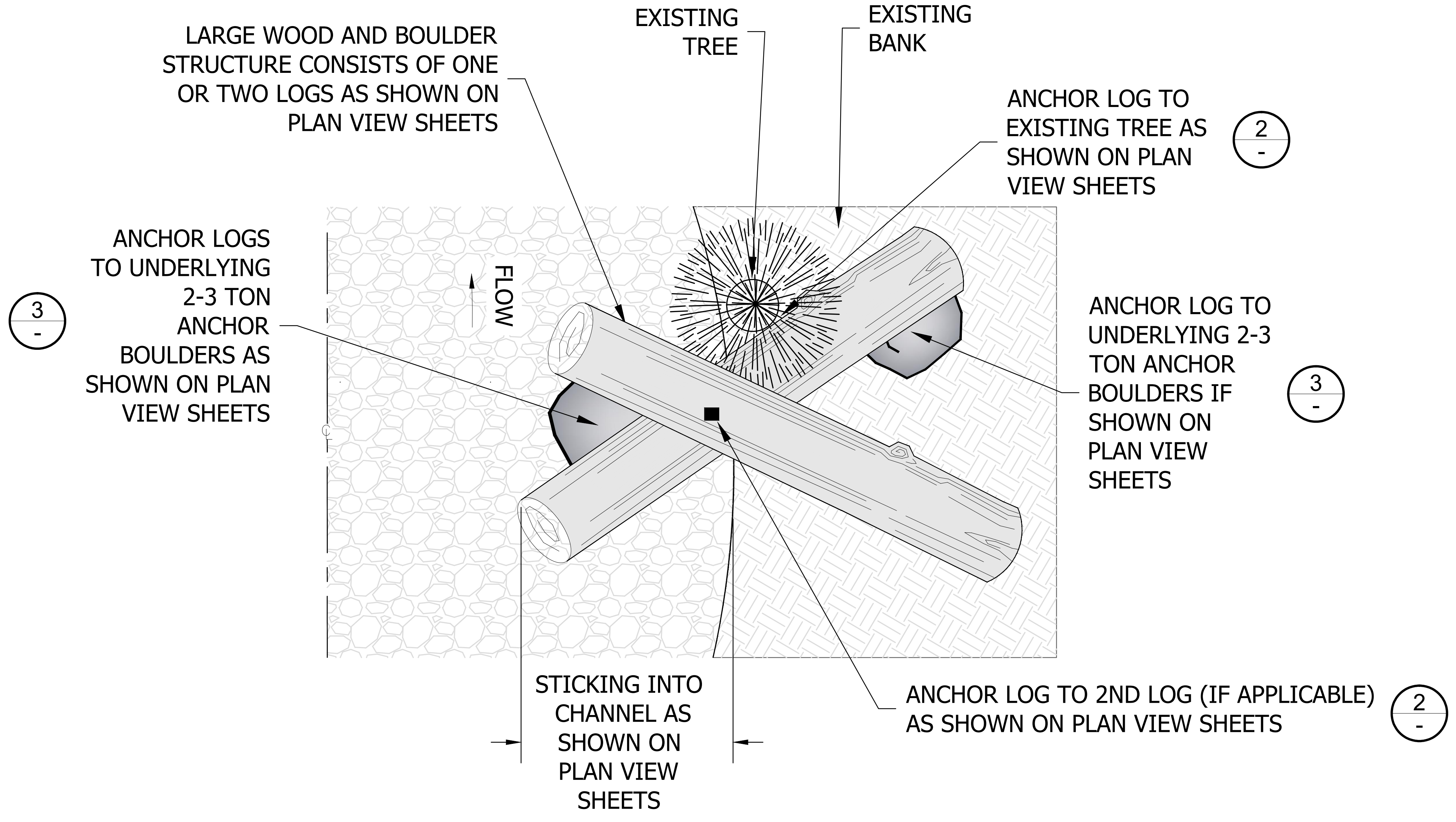
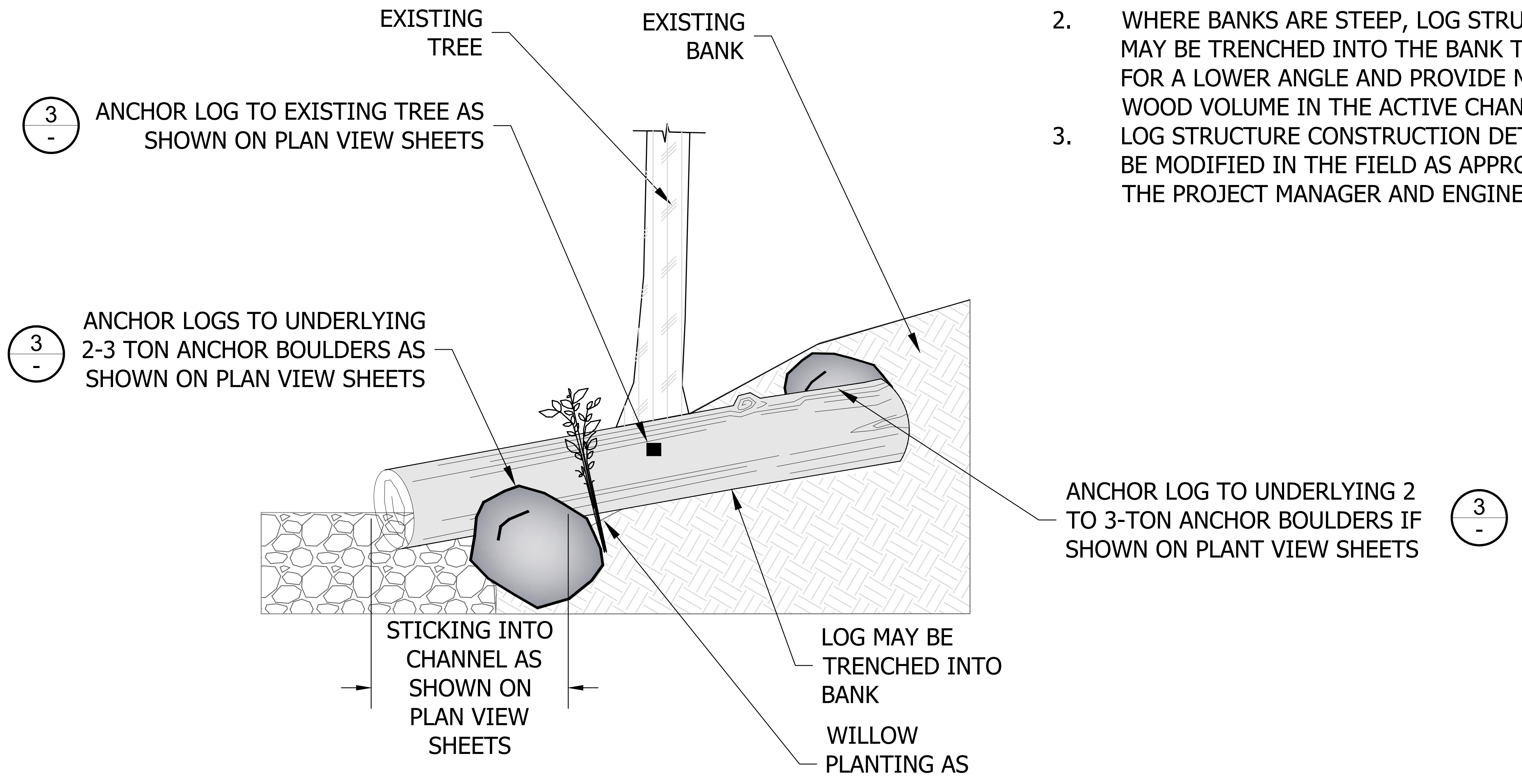


PLAN VIEW



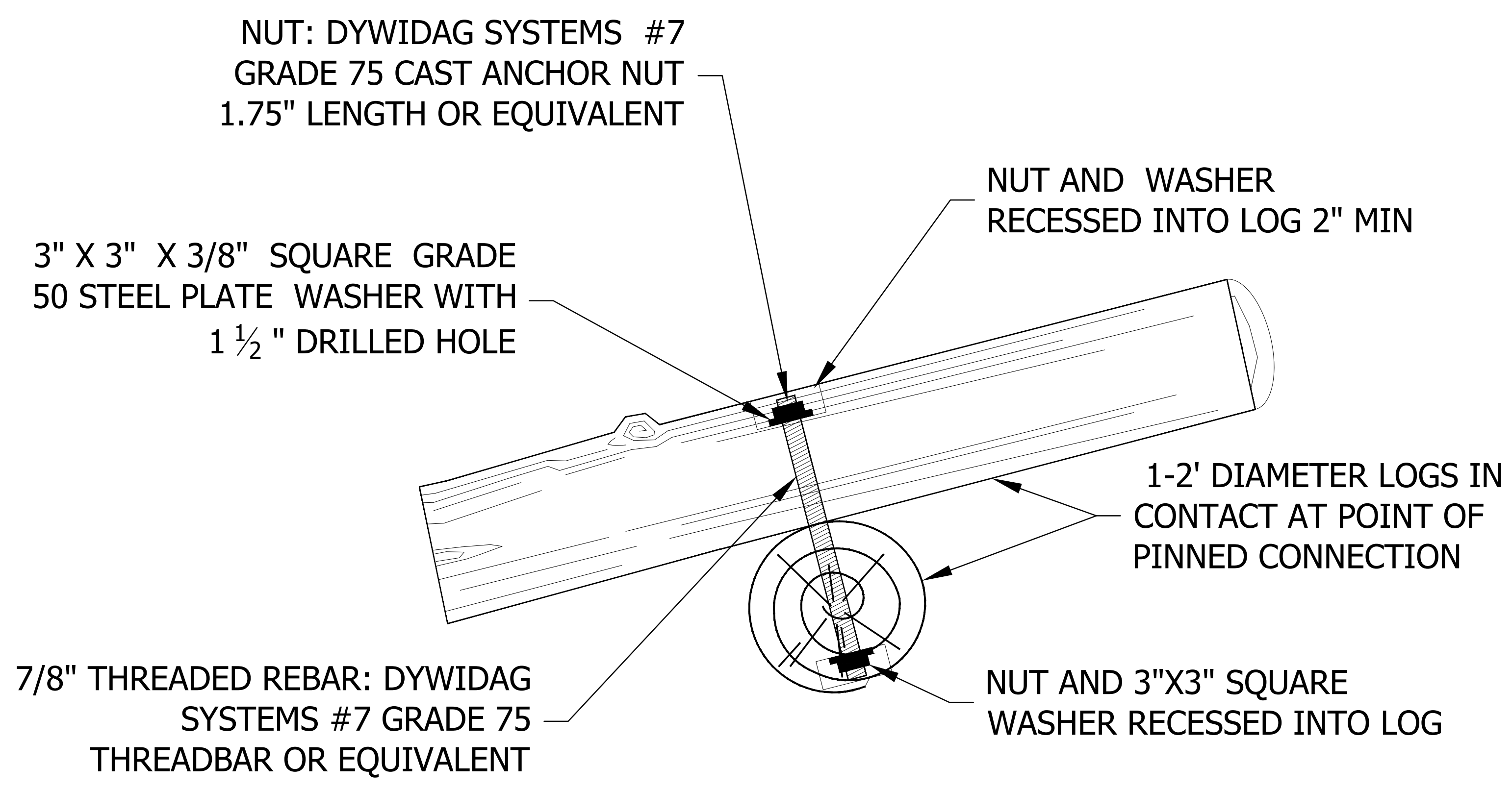
SECTION VIEW

1 1- AND 2-PIECE WOOD STRUCTURE DETAILS

NTS

NOTES:

1. LOG STRUCTURES SHALL BE INSTALLED AS SHOWN ON PLAN VIEW SHEETS
2. WHERE BANKS ARE STEEP, LOG STRUCTURES MAY BE TRENCHED INTO THE BANK TO ALLOW FOR A LOWER ANGLE AND PROVIDE MORE WOOD VOLUME IN THE ACTIVE CHANNEL
3. LOG STRUCTURE CONSTRUCTION DETAILS MAY BE MODIFIED IN THE FIELD AS APPROVED BY THE PROJECT MANAGER AND ENGINEER

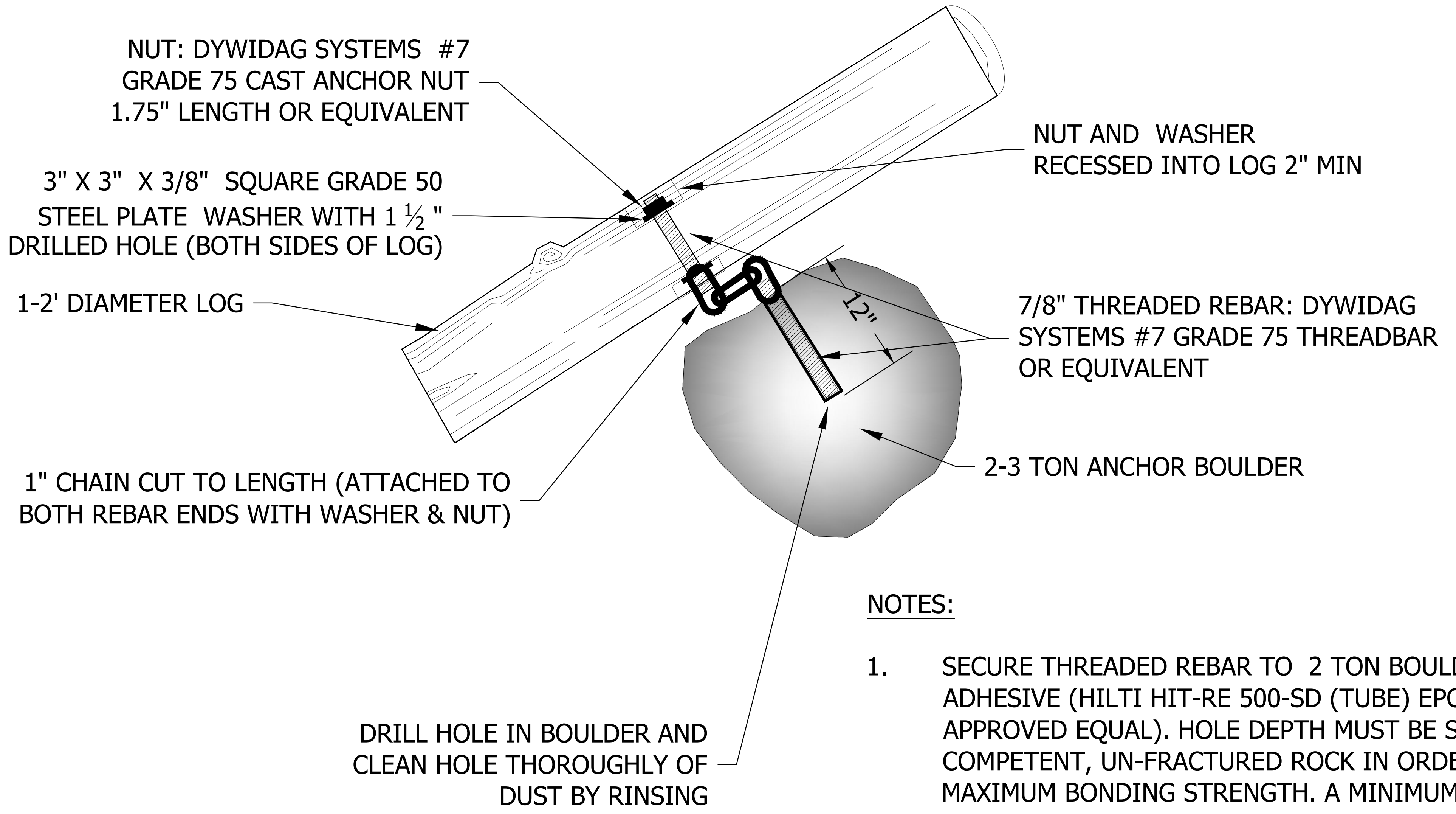


NOTES:

1. NOTCHING NOT REQUIRED ON LIVE TREES TO REDUCE IMPACTS TO TREE HEALTH

2 LOG-LOG OR LOG-TREE ANCHORING

NTS



NOTES:

1. SECURE THREADED REBAR TO 2 TON BOULDER USING EPOXY ADHESIVE (HILTI HIT-RE 500-SD (TUBE) EPOXY CARTRIDGES, OR APPROVED EQUAL). HOLE DEPTH MUST BE SUFFICIENT TO REACH COMPETENT, UN-FRACTURED ROCK IN ORDER TO OBTAIN MAXIMUM BONDING STRENGTH. A MINIMUM OF 12 INCHES IS RECOMMENDED; 1" DIAMOND-TIPPED DRILL (TIGHT FIT).

3 LOG-BOULDER ANCHORING

NTS

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JOEL MONSCHKE
No. 79688
9-30-20
EXPIRES

DETAILS - 1

SHEET 20 OF 22

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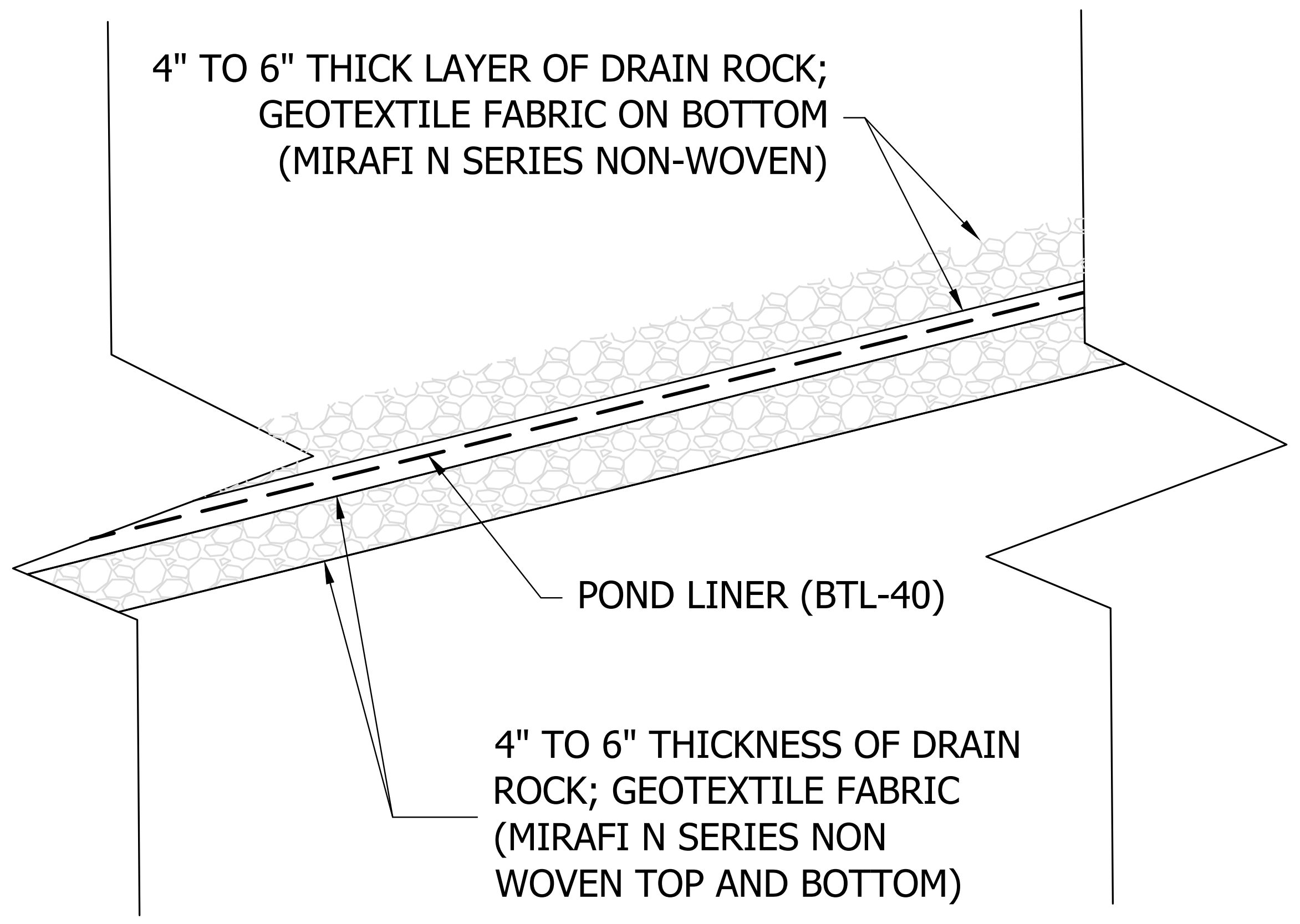
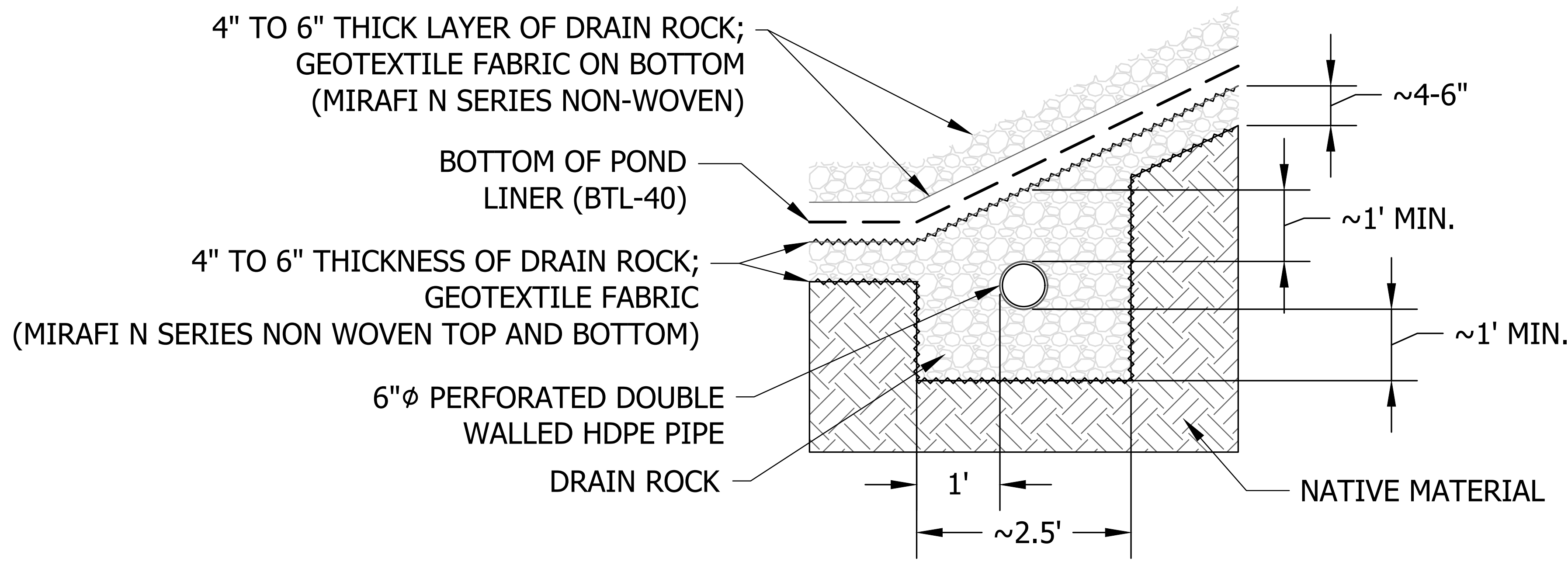


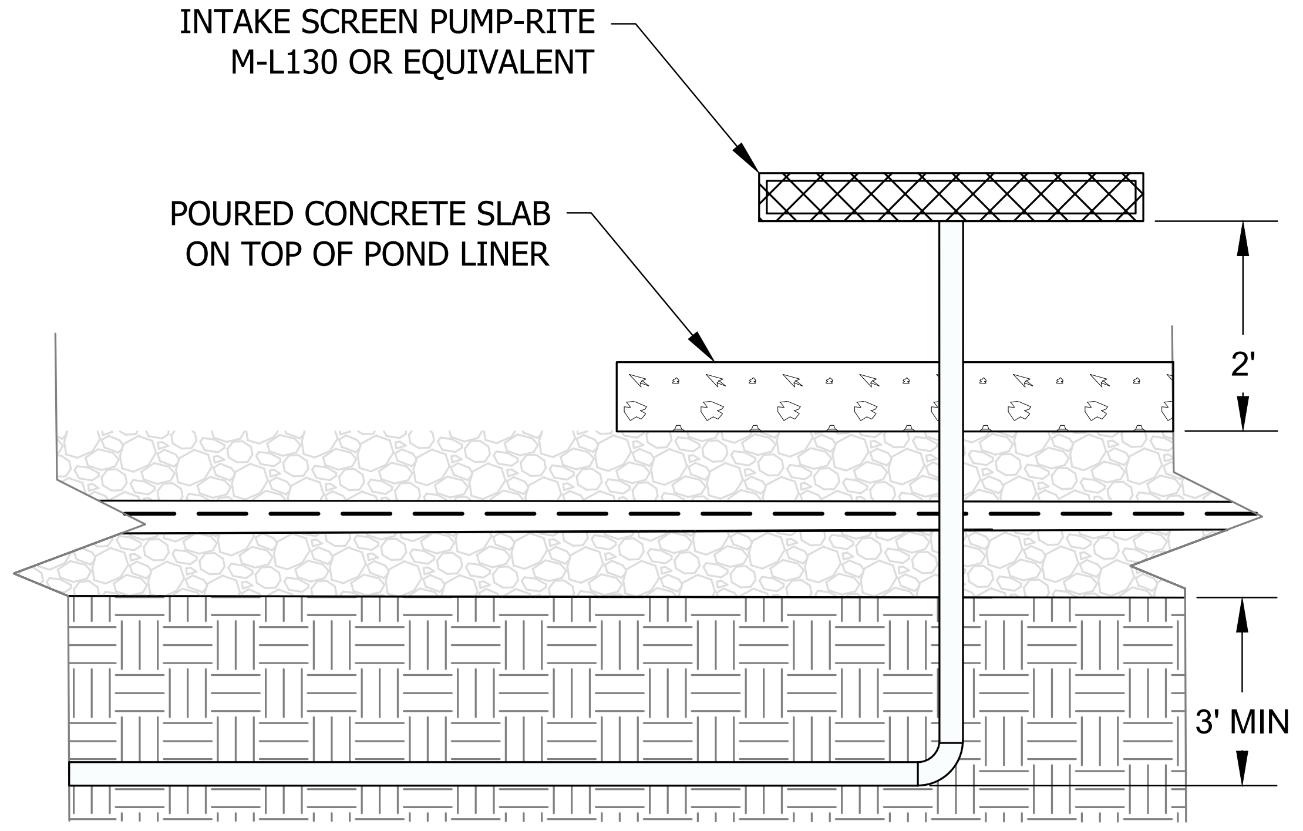
1 **POND LINER DETAIL**

NTS



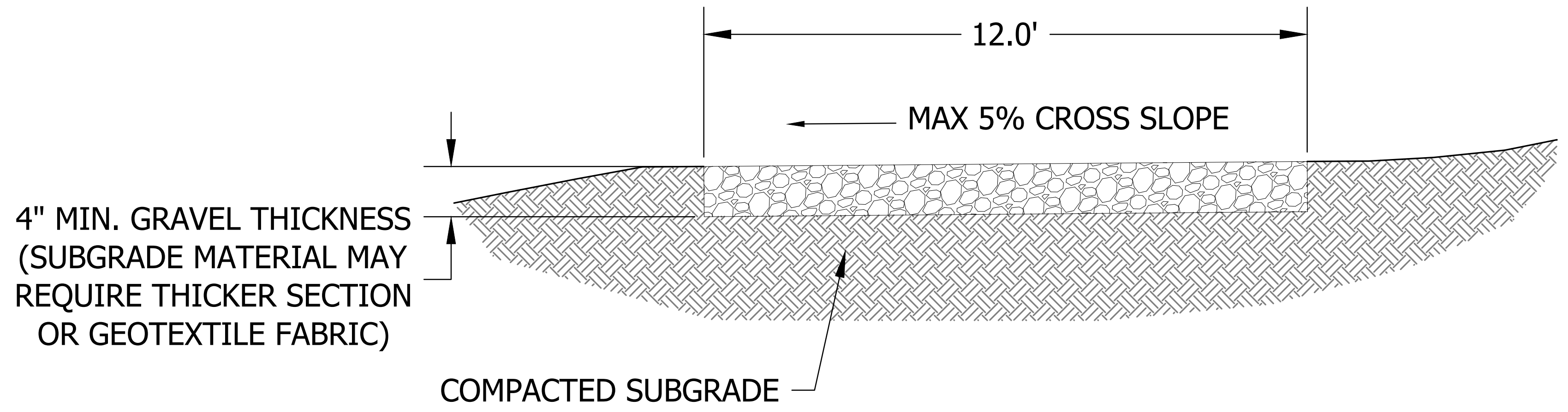
2 **FRENCH DRAIN DETAIL**

NTS



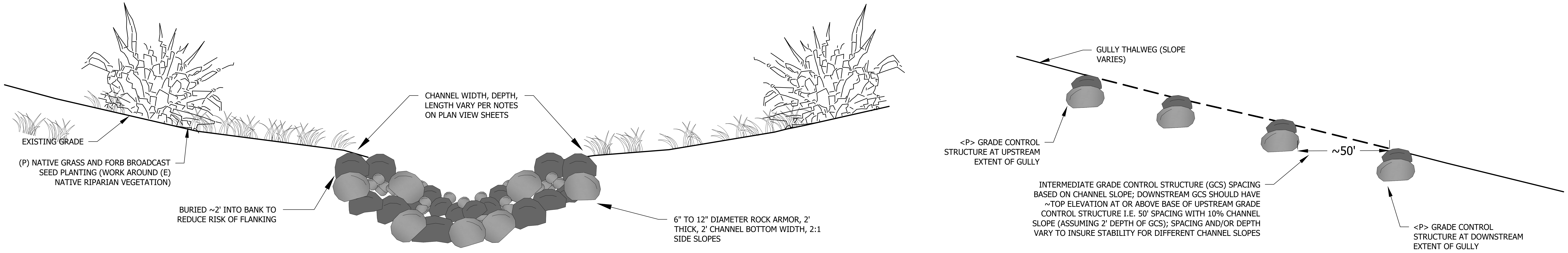
3 **POND INFLOW-OUTFLOW DETAIL**

NTS



4 **GRAVEL ACCESS ROAD**

NTS



GRADE CONTROL - CROSS SECTION

GRADE CONTROL - PROFILE

5 **GRADE CONTROL STRUCTURE**

NTS

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DETAILS - 2

SHEET 21 OF 22

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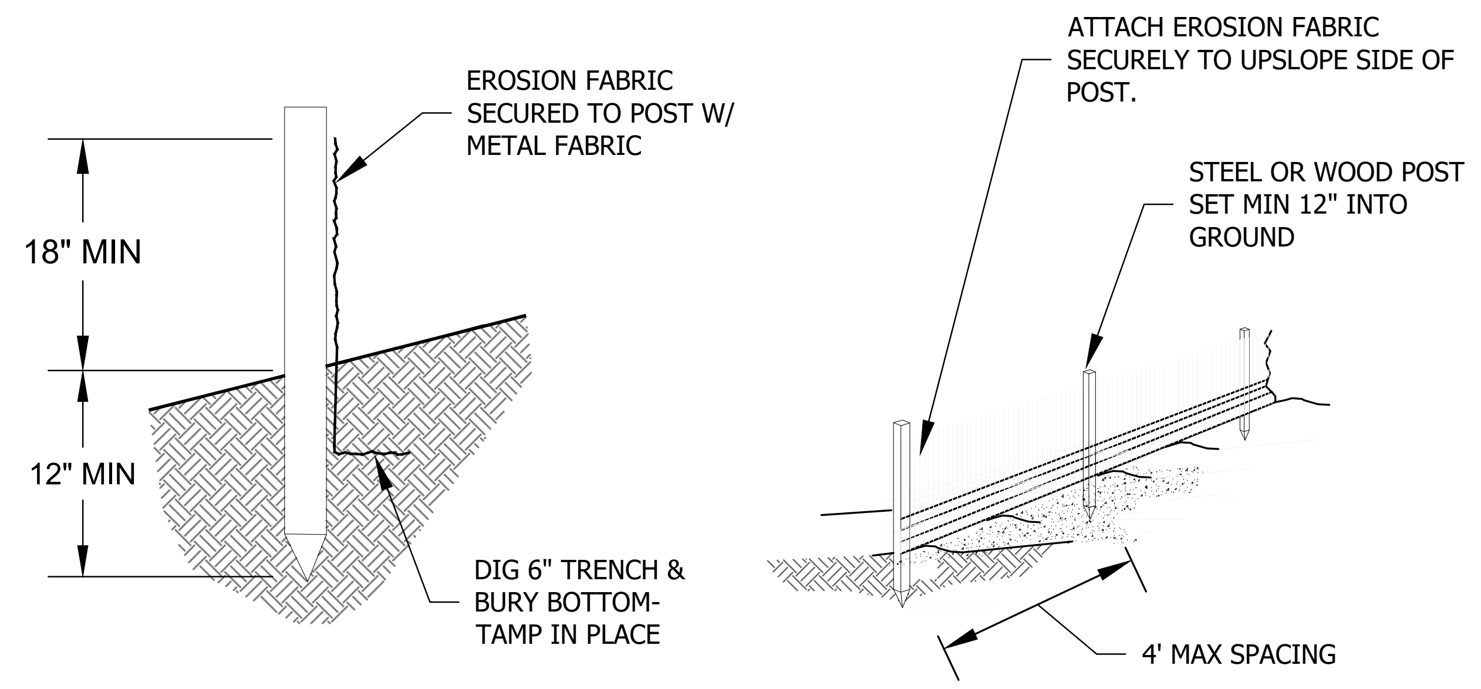
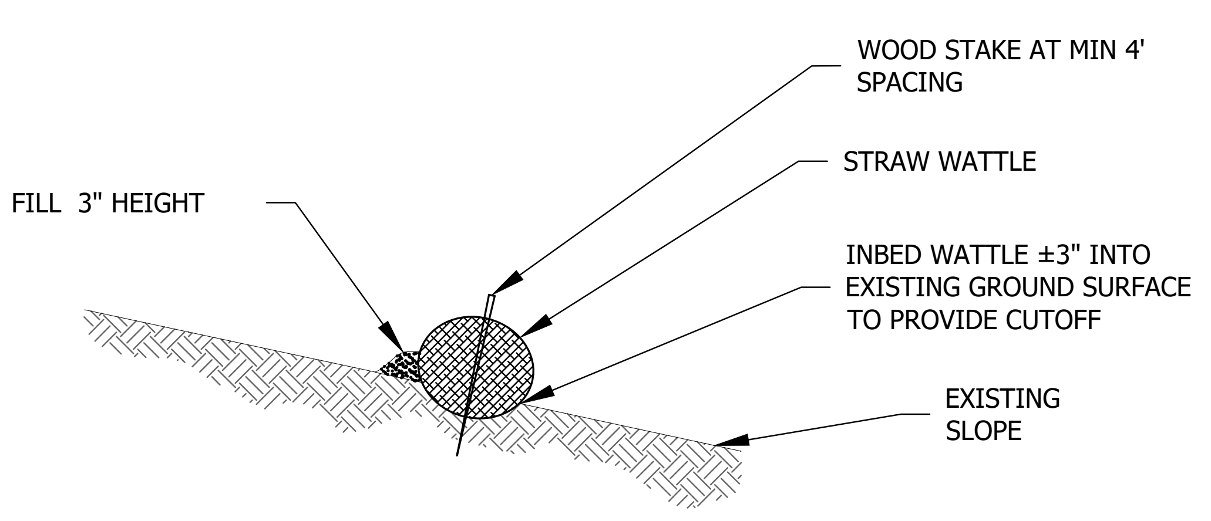


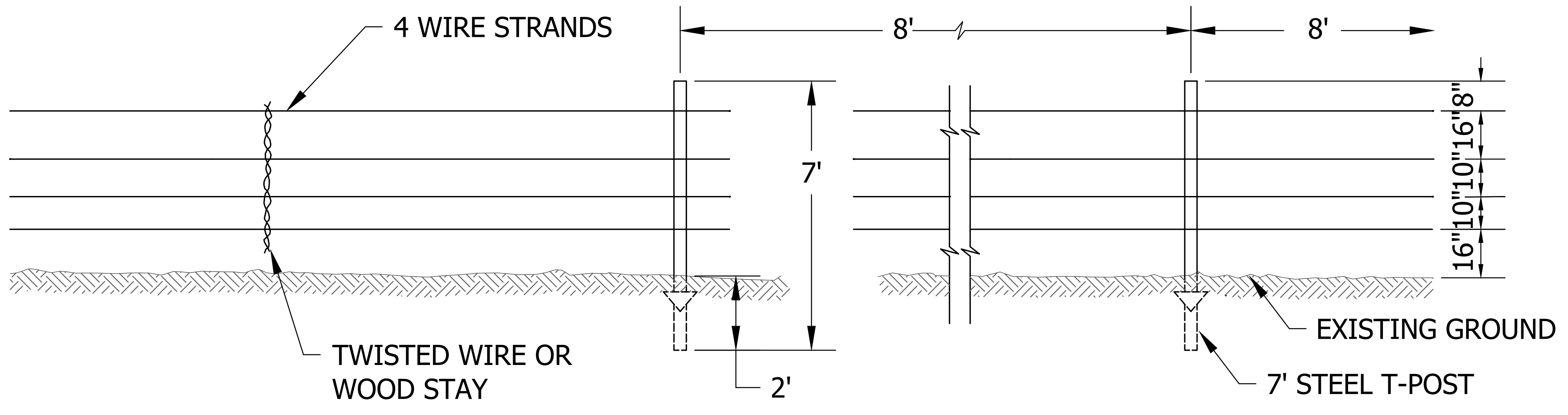
1 SILT FENCING

NTS



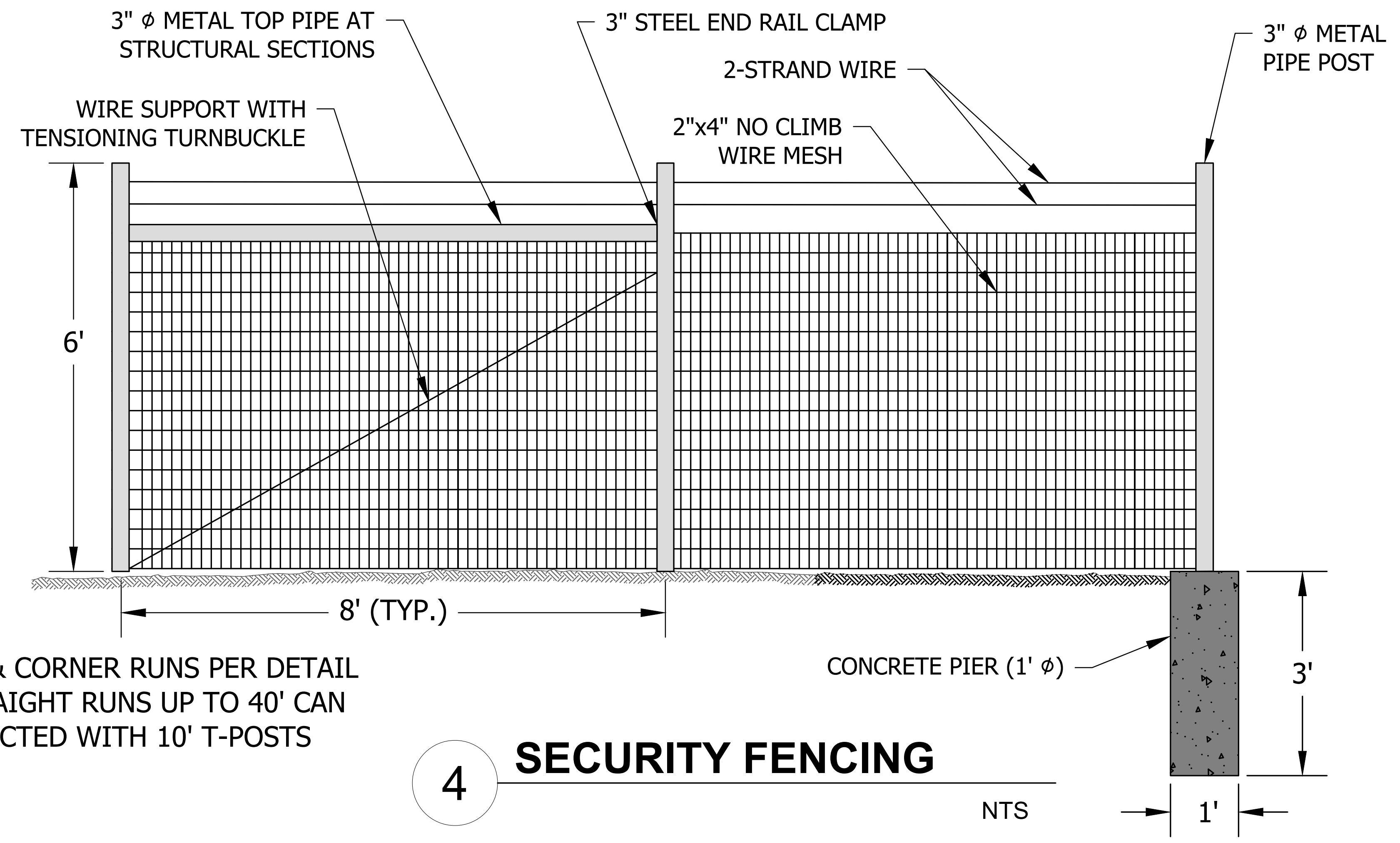
2 STRAW WATTLE

NTS



3 CATTLE FENCING

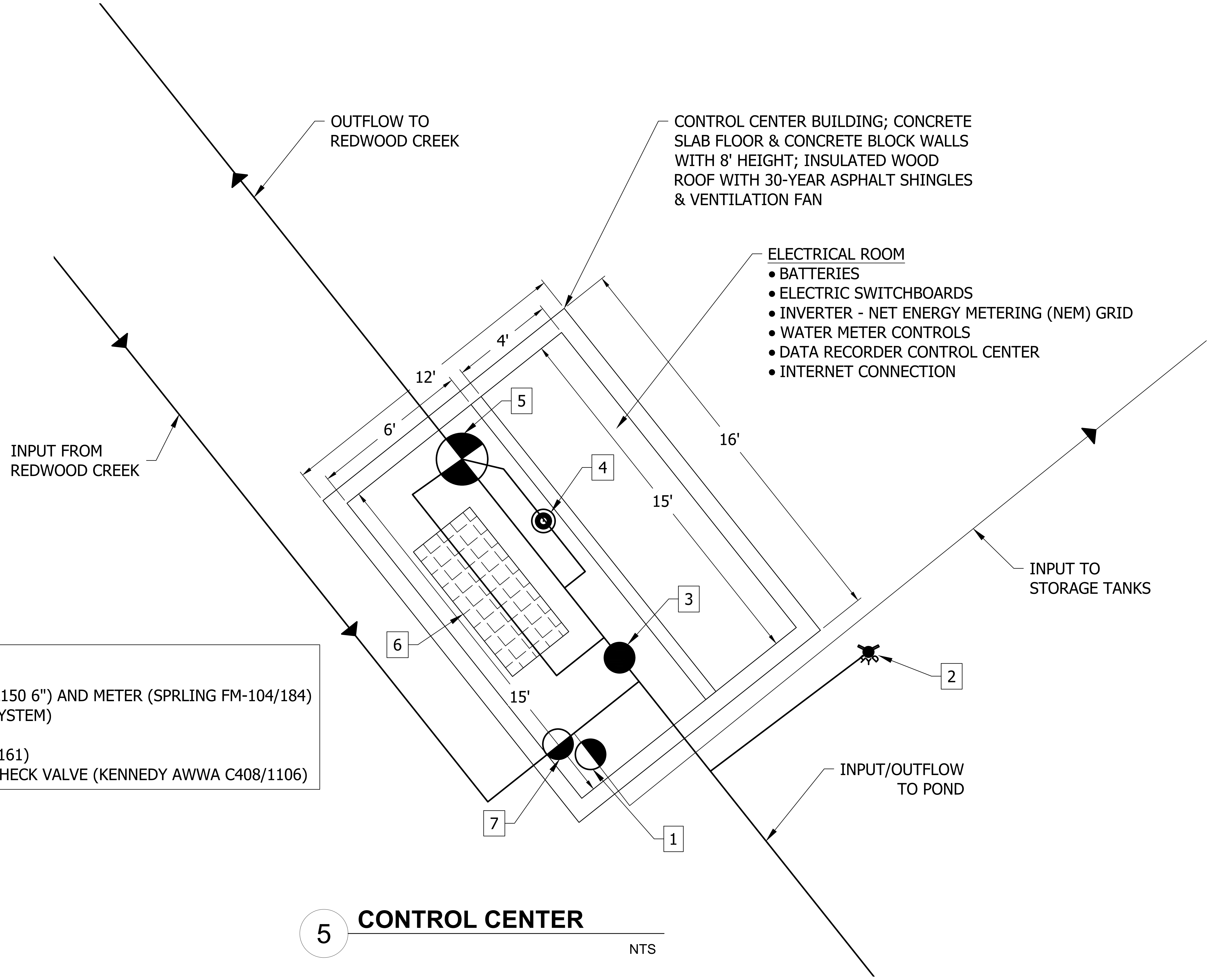
NTS



NOTE: END & CORNER RUNS PER DETAIL ABOVE; STRAIGHT RUNS UP TO 40' CAN BE CONSTRUCTED WITH 10' T-POSTS

4 SECURITY FENCING

NTS



1 - VALVE
2 - FIRE HYDRANT
3 - MAIN OUTFLOW VALVE (KENNEDY MODEL 4500-CL150 6") AND METER (SPRLING FM-104/184)
4 - MICRO-HYDRO TURBINE (CANYON HYDRO M300 SYSTEM)
5 - COLLECTOR CISTERN
6 - INDUSTRIAL WATER CHILLER (TAEEVOTECH-08 1/161)
7 - FLOWMETER (SPARLING FM-104/184) & DOUBLE CHECK VALVE (KENNEDY AWWA C408/1106)

5 CONTROL CENTER

NTS

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JOEL MONSCHKE
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DETAILS - 3

SHEET 22 OF 22

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Appendix B

Geotechnical Investigation Report

Phone: (707) 441-8855 **Email:** info@shn-engr.com **Web:** shn-engr.com
812 W. Wabash Avenue, Eureka, CA 95501-2138

Reference: 018135

September 30, 2020

Dana Stolzman, Executive Director
Salmonid Restoration Federation
425 Snug Alley, Unit D
Eureka, CA 95501

Subject: Geotechnical Investigation Report for a Proposed Water Storage Basin and Associated Infrastructure for Redwood Creek Flow Enhancement, Marshall Ranch, 195 Somerville Road, Briceland, Humboldt County, California; APN 220-061-011– Revision 1

Dana:

This report presents the results of SHN's investigation of geotechnical conditions for a proposed dry season flow enhancement project along Redwood Creek in Briceland, California. The project consists of the development of a 15.3-million-gallon water storage basin and is intended as a habitat improvement project along a critical fish-bearing stream. Our geotechnical investigation was completed primarily to inform the project design team (Stillwater Sciences), and to provide the necessary background information to submit to regulatory agencies or Humboldt County to support permitting for the project. In terms of application to the County for grading and other permits, this report is intended to address all the items on the "Soils Engineering/Engineering Geology Report Checklist" provided on the Humboldt County Planning and Building Department's website (Humboldt County, 2008).

The purpose of our investigation was to evaluate the geotechnical conditions relative to the proposed water storage basin. Our assessment focuses on the geologic suitability of the site (exposure to geohazards and potential to influence site geologic conditions) and general geotechnical conditions (identification of problematic soil conditions, for example). In this report, we provide generic recommendations for site preparation and grading for construction of the storage basin; we understand that detailed engineering plans for the project, including the storage basin, are being prepared by Stillwater Sciences. The recommendations in this report are intended to satisfy the needs of the project and the requirements for obtaining a Humboldt County Building Permit, while maintaining the professional standard of care for this type of work.

1.0 Project Location and Description

We understand the project consists of the construction of a 15.5-million-gallon water storage basin on the property known as the Marshall Ranch, at 195 Somerville Road, in Briceland, Humboldt County, California (Figure 1). Latitude and longitude of the site are 40.104018 °N and -123.899881°W, respectively. The project design was conceptual during our field investigation and has evolved since that time. Our understanding of the current project design is based on 90% design plans provided by Stillwater Sciences, dated July 3, 2020 (Appendix 3). The water storage basin and water chiller are designed to deliver approximately 50 gallons per minute of flow augmentation to Redwood Creek during the 5-month dry season to improve instream aquatic habitat. The storage basin will be filled during the rainy season with direct rainfall (rainwater catchment), as well as with water pumped during the wet season from a proposed point of diversion (POD) in Redwood Creek. Piping between Redwood Creek and the storage basin is part of the project design. Other proposed project components include:

- instream habitat enhancement features including approximately four large wood structures and two rock weirs in Redwood Creek,
- gully stabilization treatments including installation of approximately 20 rock armor grade control structures in three Class III drainages,
- the construction of approximately 7.5 kilowatts (KW) DC solar array, micro-hydro turbine, backup battery bank, inverter, grid intertie system and small control center building, and
- upgrade access roads to project area with drainage features and gravel surfacing to provide access year-round.

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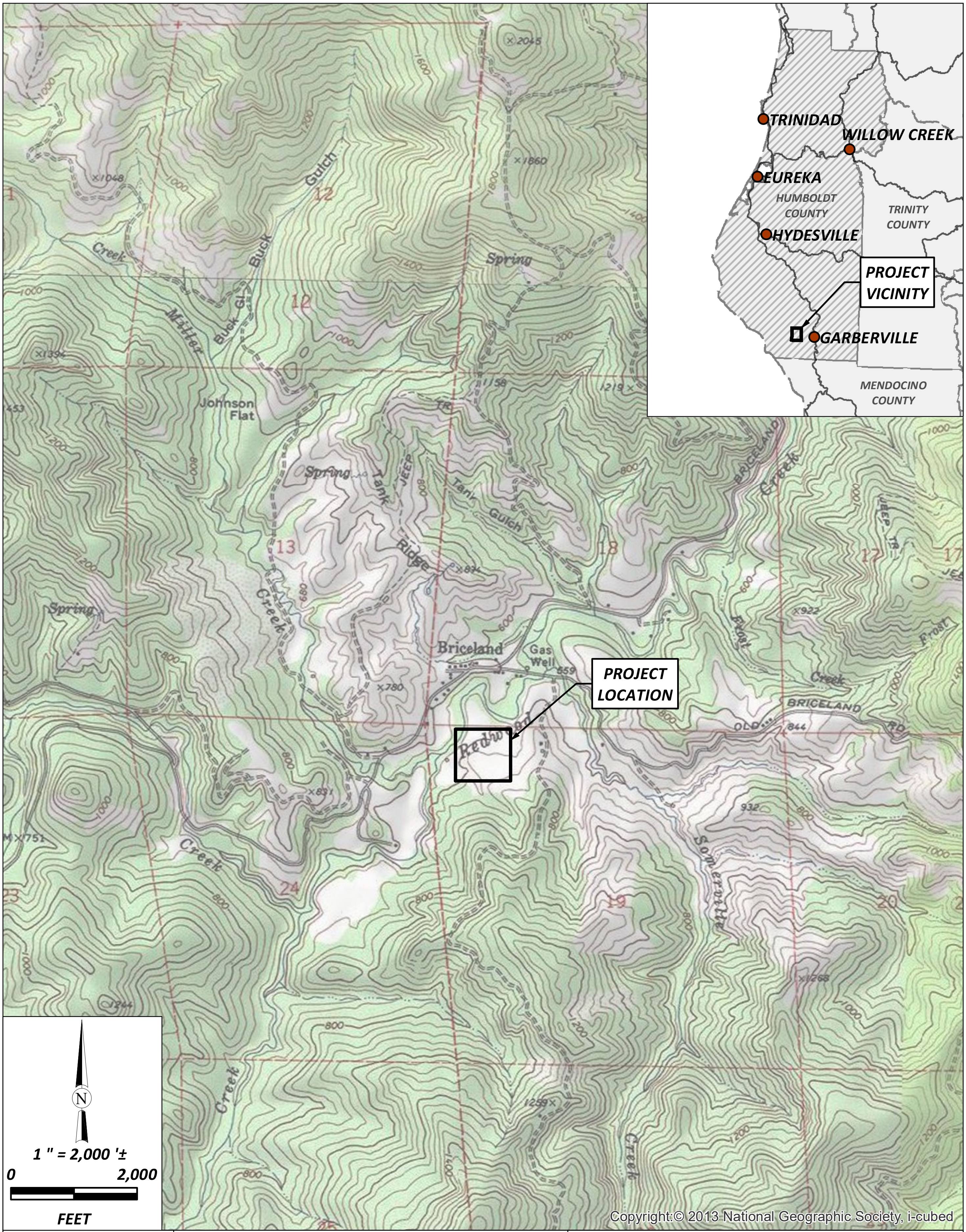

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Briceland, Humboldt County, California

Project Location Map

SHN 018135

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Figure1_ProjectLocationMap

Figure 1

Additionally, three 50,000-gallon water storage tanks are planned to supply domestic water for APN 220-061-011 and community fire suppression. The tanks are part of a future design phase, and therefore, are not taken into consideration for this investigation. Additional geotechnical investigation is needed to determine the final tank location and foundation design.

The solar array will be developed on native ground adjacent to the proposed water storage basin. Details regarding the installation of the solar array (foundation type, for example) are not known at this time. The proposed project elements and exploration locations are shown on Figure 2.

2.0 Scope of Work

The scope of SHN's services included reviewing available geologic and subsurface information, overseeing the advancement of geotechnical borings and excavation of soil test pits, percolation testing, performing laboratory testing on selected soil samples, and providing engineering geology recommendations to aid in project planning, design, and construction.

Specifically, the following information, recommendations, and design criteria are presented in this report:

- description of site terrain and local geology;
- description of soil and groundwater conditions, based on our field exploration, laboratory testing, and review of existing geotechnical information;
- logs of the exploratory geotechnical borings and test pits (Appendix 1) and results of laboratory tests conducted for this investigation (Appendix 2);
- assessment of potential earthquake-related geologic/geotechnical hazards (for example, strong earthquake ground shaking, surface fault rupture, liquefaction, settlement);
- seismic design parameters in accordance with the applicable portions of the 2019 California Building Code (CBC) and American Society of Civil Engineers (ASCE) 7-16 Standard, including site soil classification, seismic design category, and spectral response accelerations;
- recommendations for site improvements, including site and subgrade preparation, fill material, placement and compaction requirements;
- discussion and recommendations for storage basin construction, including strategies to enhance the retention capacity of site soils; and
- recommendations for observation of storage basin construction, materials testing and inspection, and other construction considerations.

3.0 Field Investigation and Lab Testing

Geologists from SHN conducted site visits on August 27 and 28, 2018, to oversee the advancement of three exploratory geotechnical borings (BH-101 through BH-103) and the excavation of four soil test pits (TP-1 through TP-4) and two percolation pits (PP-1 and PP-2). The exploration locations (borings and test pits) were chosen based on the locations of the proposed water storage basin and plumbing infrastructure to assess sub-surface soil and groundwater conditions, and infiltration rates (Figure 2). Our exploration target depths were dictated based on our understanding of the desired depth of the proposed storage basin and related infrastructure at the time of our investigation.

Classifications of the earth materials encountered in the test pits were made during the field investigation in general accordance with the Manual-Visual Classification Method (ASTM-International [ASTM] D 2488). The final boring and test pit logs, presented in Appendix 1, were prepared based on the field logs, examination of samples in the laboratory, and laboratory test results.

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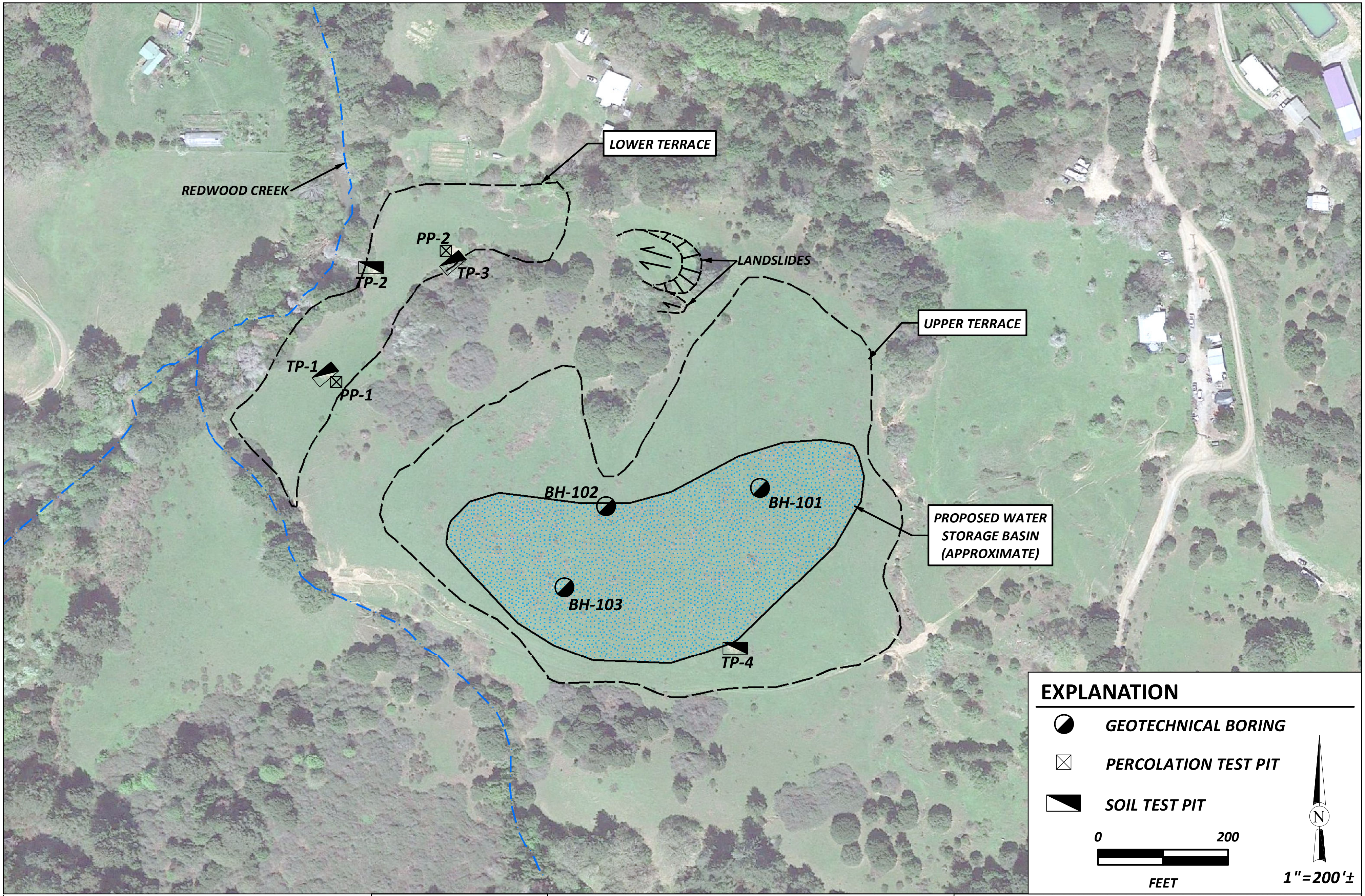

IMAGE SOURCE: GOOGLE EARTH, DATED 4/21/2019

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Briceland, Humboldt County, California

Site Map Showing
Test Locations
SHN 018135

September 2020

Figure2_SiteMap

Figure 2

Selected soil samples were tested in SHN's certified soils-testing laboratory in Eureka, California and Cooper Testing Labs in Palo Alto, California to determine index properties of the subsurface materials. Samples were tested for in-place moisture content and dry density at SHN, and hydraulic conductivity tests (falling head permeability test) were conducted by Cooper Testing Labs. Laboratory test results are presented in Appendix 2.

4.0 Site Conditions

The following sections describe the geologic setting of the site, the site surface and subsurface conditions, and subsurface soil and groundwater conditions encountered at the time of our field exploration.

4.1 Geologic Setting

The proposed project is situated on a pair of adjacent stream terraces east of the confluence of Miller Creek and Redwood Creek in Briceland, California. The site of the proposed 15.5-million-gallon water storage basin is situated on an elevated river terrace approximately 80 feet above the active channel of Redwood Creek ("upper terrace" on Figure 1). The low terrace ("lower terrace" on Figure 1) is approximately 10 feet above the active channel of Redwood Creek. The two terraces are separated by a 60- to 70-foot-high terrace riser with slope gradients of about 40 percent.

Published geologic mapping indicates the upper terrace is a "Holocene- to Pleistocene-age river terrace," and the lower terrace is situated on "Quaternary-age alluvium" (Spittler, 1984). In our opinion, the elevation of the upper terrace above Redwood Creek precludes it being of Holocene age; as such, we interpret this higher geomorphic surface to reflect significant tectonic uplift and to be of late Pleistocene age (or older). The river terrace deposits are described as: "dominantly sand and gravel with minor amounts of silt and clay, deposited during higher stands of major streams and rivers." The alluvium is described as: "unconsolidated sand, gravel and silt, deposited above active channel; in places grades into river terrace deposits." These materials are likely of Holocene age.

Bedrock underlying the site is mapped as Tertiary-age Yager formation (Spittler, 1984). Spittler describes the Yager formation as: "siltstone, sandstone, silty shale, mudstone, and conglomerate; moderately well consolidated; highly sheared in places; silty shale and mudstone often disintegrates by slaking when wetted; sandstone units are generally massive; finer-grained strata are often well bedded." Spittler (1984) has mapped areas of "disrupted ground" on upland slopes to the east and south of the project site. Disrupted ground is described as:

> "Irregular ground surface caused by complex landsliding processes resulting in features that are indistinguishable or too small to delineate individually at the map scale; also may include areas affected by downslope creep, expansive soils, and/or gully erosion; boundaries are usually indistinguishable." (Spittler, 1984)

This vague geomorphic description is commonly applied to prairie ground in Humboldt County, in areas with irregular ground that often reflects erosion or soil creep (as opposed to landsliding).

The site is approximately 4,000 feet southwest of the Briceland fault, which is part of the Garberville-Briceland fault zone. According to Kelsey and Carver (1988), the Garberville-Briceland fault zone is a discontinuous series of north-northwest trending lineaments that extend south-southeast from Bull Creek, through Garberville, to just north of Laytonville. The fault zone can be traced as a 4-kilometer-long, north-northwest trending zone (approximately 200 meters wide) of sag ponds, notched ridges, and aligned springs. The Garberville-Briceland fault zone is not zoned as active by the State of California (CGS, 2018).

4.2 Site Surface and Subsurface Description

Our subsurface explorations were focused at the site of the proposed storage basin. Descriptions of these sites are included below.

4.2.1 Proposed Storage Basin Site

The site of the proposed storage basin is on an elevated river terrace with an average elevation of 660 feet. The surface is gently sloping (approximately 4 percent) to the northwest. A small Class III stream flows across the upper terrace just east of the proposed storage basin site, toward Redwood Creek. This creek flows in a narrow gully across the upper terrace. A stream along the southwest side of the upper terrace flows in a deeply incised channel that forms a steep valley wall slope defining the southwestern edge of the terrace. A small, ephemeral creek originates at a spring in the swale on the terrace riser north of the storage basin. This stream flows across the lower terrace to Redwood Creek. The terrace is generally vegetated with grasses and is bordered by trees.

Test locations for the proposed storage basin include exploratory borings BH-101 through BH-103 and test pit TP-4 (Figure 2). At boring BH-101, we noted 27 feet of alluvium overlying bedrock (see the boring log in Appendix 1). Terrace deposits in this boring consisted of a fining upward sequence grading upward from a gravel lag to upper gravelly silts. Note that the gravel lag deposit at the base of the terrace section is noted on the project plans as the “gravel interface” directly above the bedrock surface. Siltstone/shale bedrock is present below the alluvium to the total depth of 51 feet below ground surface (BGS). This material is hard, breaks into angular chips when drilled, and is highly fractured.

Boring BH-102 encountered 15.5 feet of terrace deposits overlying bedrock. The terrace cover sediments in this boring can also be described as a fining upward sequence, with sandy silt overlying a gravelly lag deposit. Similar bedrock conditions were encountered in this boring relative to other borings, suggesting relatively uniform bedrock conditions beneath the storage basin. We note the comment on the boring log of “hammer bouncing,” referring to the difficulty in advancing the sampler into the bedrock at depth.

Boring BH-103 encountered 20.5 feet of terrace deposits overlying bedrock. A similar fining upward sequence was encountered in this boring. Siltstone/shale bedrock is present beginning at a depth of 20.5 feet to the total depth of 50.5 feet BGS.

Soils encountered in TP-4, located on the uphill portion (back edge) of the terrace, consist of dark brown, medium stiff, silt with sand (ML) and brown, stiff, lean clay with sand (CL) to a depth of 8 feet BGS. We note the fine-grained material in this pit, and infer that the material is, in part, slope wash (colluvium) veneering the alluvium along the back edge of the upper terrace.

We note that the alluvial soils underlying the upper terrace are noted to have clay skins, as well as iron oxide or manganese staining. These are weathering byproducts that reflect the age of this older, uplifted terrace.

Laboratory test results for samples collected from the borings indicate moisture contents that range from 11.8 to 27.4 percent and dry densities that range from 89 to 115 pounds per cubic foot (pcf).

Falling head permeability testing on samples collected from BH-101 and BH-102 revealed hydraulic conductivity of $3x10^{-07}$ centimeters per second (cm/sec), $5x10^{-06}$ cm/sec in BH-101, and $8x10^{-06}$ cm/sec in BH-102. These values suggest low permeability for the alluvial materials in area of the proposed storage basin.

Laboratory test results are presented in Appendix 2.

4.2.2 Lower Terrace Site

The lower terrace is approximately 100 feet east of Redwood Creek with an average elevation of approximately 580 feet. The lower terrace is west of the proposed storage basin site, on a generally planar surface that is gently sloping (less than 5 percent) to the northeast. The site is vegetated with grasses and is bordered by trees.

Test pits, TP-1 through TP-3, were excavated on the lower terrace (Figure 2). Percolation pits PP-1 and PP-2 were excavated adjacent to TP-1 and TP-3, respectively. All the pits exposed alluvial soils, with test pit TP-2 reaching the bedrock abrasion surface beneath the alluvium. Alluvial soils in these pits consisted of interbedded gravels and fine-grained over-bank deposits (silts and clays). These materials are generally loose and non-cemented or mildly cemented.

Falling head permeability testing conducted on a sample collected from TP-3 revealed hydraulic conductivity of $7x10^{-05}$ cm/sec.

Soils encountered in the exploration locations are consistent with the mapped geology for the area; mainly sediments associated with streams and bedrock associated with the Yager formation.

4.2.3 Groundwater

Groundwater was encountered on the upper terrace in BH-101 at a depth of 26 feet BGS, in BH-102 at a depth of 11 feet BGS, and in BH-103 at a depth of 15 feet BGS. In each case, groundwater was perched within about 5 feet of the bedrock surface. Wet zones noted in the underlying bedrock are likely associated with water-bearing bedrock shears. Soil mottling, an indicator of the presence of historical high groundwater conditions, was observed in some of the test locations, at varying depths. On the upper terrace, mottled soils were observed in BH-102 and BH-103 at a depth of 3 feet, and in TP-4 at a depth of 2.5 feet. Groundwater was not encountered in TP-4.

On the lower terrace, mottled soils were observed in TP-1 at a depth of 3 feet. Groundwater was encountered on the lower terrace in TP-2 at a depth of 9 feet BGS and in TP-3 at a depth of 9.5 feet BGS. Groundwater levels can be expected to fluctuate seasonally on the order of several feet in elevation. We anticipate shallow groundwater conditions to occur on the lower terrace during the rainy season.

Stillwater Sciences collected additional groundwater data, subsequent to our field investigation, within wells installed in several boreholes and test pits and results are included in the basin of design report for the project. Based on the proposed excavation depths for the project, groundwater may be encountered during grading and construction for the proposed storage basin and related infrastructure.

4.3 Percolation Tests

Percolation testing was conducted on the lower terrace, adjacent to TP-1 and TP-3, to determine approximate infiltration rates. Percolation testing consisted of digging 12-inch deep by 12-inch wide test holes, at desired test depths. The soils exposed in the test holes were then presoaked for up to an hour prior to testing. Testing consisted of filling the holes with water and recording the rate of drop of the water in inches per minute. Percolation testing in pit PP-1 revealed a percolation rate of 6 minutes per inch at a depth range of 24 to 36 inches BGS. Testing in PP-2 revealed a percolation rate of 10 minutes per inch at a depth range of 18 to 30 inches BGS. These percolation rates are relatively fast and are typical for the soils encountered. Results of the test are included on the test pit logs in Appendix 1.

5.0 Geologic Hazards

Potential geologic/geotechnical hazards common to the local area include seismic ground shaking, surface fault rupture, seismically induced ground deformation (liquefaction, coseismic compaction, and lateral spreading), slope stability and flooding. The assessment of these potential hazards is presented below.

5.1 Seismic Ground Shaking

The project site is in a seismically active area with the potential for strong earthquakes and strong ground shaking. As stated above, the site is west of the Garberville-Briceland fault zone. This fault zone is not considered active by the State of California (CGS, 2018). The site is located approximately 9.5 miles northeast of the northern most extent of the San Andreas fault. Strong seismic ground shaking should be expected during the economic lifespan of the proposed water storage basin. Seismic design parameters are presented below in Section 6.1.

5.2 Surface Fault Rupture

The project site is not located in an Earthquake Fault Zone (CGS, 2018). The nearest active fault is the San Andreas fault, which is approximately 9.5 miles southwest of the project site. The San Andreas fault is a northwest-trending, strike-slip fault. Surface ruptures associated with 1906 San Francisco earthquake were identified at Shelter Cove (Lawson, 1908). The proposed project is situated on surfaces that are gently-sloping and generally planar, which are useful geomorphic surfaces for the interpretation of past fault deformation, if it is present. During our field visit, we did not observe any geomorphic evidence suggesting recent surface rupture.

5.3 Liquefaction

Liquefaction is the sudden loss of soil shear strength due to a rapid increase of soil pore water pressure caused by cyclic loading from a seismic event.

Generally, in order for liquefaction to occur, the following soil conditions are needed:

- Non-plastic granular soils–Sand, silty sand, sandy silt, and some gravels
- A shallow depth to groundwater–Less than 50 feet BGS
- Low relative density soil–Standard penetration test (SPT) blow count ($[N_1]_{60}$) less than 30, usually associated with materials of young geologic age

The adverse effects of liquefaction include localized ground settlement, ground cracking and expulsion of water and sand (sand boils), the partial or complete loss of bearing and confining forces used to support loads, amplification of seismic shaking, and lateral spreading.

Susceptibility to liquefaction decreases with increasing geologic age due to the effects of weathering and the degree of densification, compaction, and/or cementation. Based on the published results of geotechnical testing and post-earthquake studies, the susceptibility of sediments to liquefaction can be directly correlated to the type, origin, and age of the deposits. Geologic materials most susceptible to liquefaction are geologically recent (that is, late Holocene age) sand- and silt-rich deposits, located adjacent to streams, rivers, bays, or ocean shorelines. According to Youd and Hoose (1978), *"*areas especially vulnerable to ground failure have been over steepened slopes, such as streambanks and coastal bluffs, and lowland deposits, principally Holocene flood plain deposits, deltaic deposits, and poorly compacted fills."

Our subsurface investigation revealed the upper terrace to be underlain by stiff to hard non-plastic fine-grained deposits with $(N_1)_{60}$ values that were locally less than 30, and medium dense non-plastic coarse-grained deposits with $(N_1)_{60}$ values that were locally less than 30. Groundwater was encountered on the upper terrace at depths ranging from 11 to 26 feet BGS. If geologically youthful, these materials would be marginally liquefiable under extreme circumstances. As the materials beneath the upper terrace are described as having clay skins and iron and manganese accumulations, it is likely the alluvium on the upper terrace is too old and well cemented to liquefy. We consider that to be a low potential for liquefaction on the upper terrace.

The lower terrace is underlain by medium stiff to stiff plastic fine-grained deposits and medium dense to dense coarse-grained deposits. Groundwater was encountered on the lower terrace in TP-2 at a depth of 9 feet BGS and in TP-3 at a depth of 9.5 feet BGS. These materials are described as loose to mildly cemented, and we interpret their age as being Holocene. As such, we conclude there is a low to moderate potential for liquefaction at the lower terrace under strong, sustained ground shaking.

5.4 Lateral Spreading

Lateral spreading is defined as lateral earth movement of liquefied soils, or competent strata riding on a liquefied soil layer, downslope toward an unsupported slope face (such as a coastal bluff), or an inclined slope face. In general, lateral spreading has been observed on low- to moderate-gradient slopes and has been noted on slopes inclined as flat as one degree.

Due to the age of the alluvial sediments on the upper terrace, and the low potential for liquefaction, there is a low potential for lateral spreading to impact the storage basin. There is a modest potential for lateral spreading on the lower terrace, but it is unlikely to extend to the back edge of the terrace to the area where the majority of plumbing infrastructure is proposed.

5.5 Slope Stability

Disrupted ground is shown on the geologic map (Spittler, 1984) on upland slopes southeast and east of the project site. Aerial imagery shows features (such as, small landslide scars; rills and gullies) that are consistent with the mapped disrupted ground. These localized areas of subtle mass wasting are unlikely to impact the areas under consideration for development here. Both project sites are on planar, generally level ground.

The upper terrace is flanked by descending slopes with gradients up to 40 percent to the northwest and north. A review of aerial imagery shows the northern slope, adjacent to the small spring-fed drainage, has two small landslides. Other shallow slides were observed along gully sidewalls, indicating that slope instability is most common on steep streamside slopes. We did not observe evidence for landsliding on the planar terrace riser, across which the piping for the upper storage basin will extend.

Due to the proximity to nearby active faults and the potential for strong seismic ground shaking to occur at the site, there is moderate potential for localized slumping or small landslides to occur along steep streamside slope. These areas should be avoided to the extent feasible in the project design. It may be prudent for piping to and from the water storage basin to have shut-off valves in case of uncontrolled releases that may occur if the plumbing system is compromised by slope movement or other means.

Using data obtained in the SHN borings, Stillwater Sciences conducted a slope stability analysis titled "Draft Marshall Ranch Dam Break Analysis - Technical Memorandum" in April 2020. Their analysis suggests that the majority of the project area is stable under current and proposed conditions. Supplemental borings are being planned at a future date to further evaluate slope stability at the site. Their analysis is included in Appendix H of the Stillwater Science's Basis of Design Report.

5.6 Flooding

The proposed project is located to the east of Redwood Creek. Both terraces (upper and lower) are located outside the mapped 100-year flood zone. Clearly, the upper terrace is outside the flood zone, and the flooding potential at that elevation is negligible. The lower terrace is 10 feet above the Redwood Creek channel and would be associated with a low potential for flooding under extreme conditions (floods exceeding the 100-year flood level).

5.7 Conclusions Relative to Geologic Hazards

The project appears associated with a low exposure to geologic hazards. What low risk is associated with the site has been mitigated through development of an extremely conservative design plan. The proposed reservoir is designed as a largely below-grade, lined structure with a modest embankment and a large setback from adjacent slopes. The proposed embankment is designed with a low permeability cut-off trench extending into the underlying bedrock in order to reduce lateral groundwater flow through the terrace deposits.

The primary geologic hazards at the site are seismic shaking and landsliding. Seismic shaking is a regional hazard and is regularly mitigated through standard engineering design.

The existing landslide hazard at the site is primarily associated with shallow slumping on the terrace riser below the reservoir site. The risk of impacts associated with this hazard is negligible, due to the large setback from vulnerable slopes and the low permeability of the subsurface materials at the site.

The potential for sliding along the "bedrock interface" (that is, the slightly dipping contact between the bedrock abrasion surface and the overlying terrace deposits) is negligible. The basal part of the section of terrace deposits contacting the bedrock surface is described as a "lag deposit" that will be associated with large clasts with high surface friction. Bedrock beneath the terrace is structurally deformed and is associated with a variety of orientations; it is not forming a smooth planar surface.

6.0 Conclusions and Recommendations

Based on the results of our field and laboratory investigation, it is our opinion the project is feasible from a geohazard and geotechnical standpoint, if our recommendations are implemented during design and construction. The major geotechnical considerations for development of the proposed water storage basin and associated infrastructure include the potential for strong seismic ground shaking and the potential for instability on the moderately-steep slopes on the northwest and north sides of the upper terrace.

6.1 Seismic Design Parameters

Based on the subsurface conditions encountered at our exploration locations, laboratory test results, and our interpretation of soil conditions within 100 feet of the ground surface, we classify the site as a Site Class C consisting of a "Very Dense Soil and Soft Rock" in accordance with Chapter 20 of ASCE 7-16. On this basis, the mapped and design spectral response accelerations were determined using the Structural Engineers Association of California (SEAOC) and California Office of Statewide Health Planning and Development (OSHPD) Seismic Design Maps (Accessed 8/19/20) in conjunction with the site class and the site coordinates for the proposed project. Calculated values for ASCE 7-16 are presented in the following table.

Table 1. ASCE 7-16 Spectral Acceleration Parameters—Redwood Creek Flow Enhancement Project Site (40.104385° N, -123.900039° W)

Parameter	0.2 Second	1 Second
Maximum Considered Earthquake Spectral Acceleration (MCE_R)	$S_S = 1.823$	$S_1 = 0.865$
Site Class	C	
Site amplification factor	$F_a = 1.2$	$F_V = 1.4$
Site-modified spectral acceleration	$S_{MS} = 2.188$	$S_{M1} = 1.211$
Numeric seismic design value	$S_{DS} = 1.458$	$S_{D1} = 0.807$
Seismic Design Category (SDC)	E	
MCE_G peak ground acceleration (PGA)	0.761	
Site amplification factor at PGA (F_{PGA})	1.2	
Site modified peak ground acceleration (PGA_M)	0.913	

6.2 Site Preparation and Grading

We recommend the following basic site preparation and grading:

- As appropriate, notify Underground Service Alert prior to commencing site work.
- Strip and remove all existing vegetation and root systems from areas of proposed development.
- Strip and remove the footprint areas of these developments, plus an additional 5 feet outward.

Additional grading will vary depending on the improvement in question and on the existing topography at the proposed storage basin location. In general, we recommend the following for cut slopes and fill slopes:

- Cut slopes should be no steeper than 2 horizontal to 1 vertical (2H:1V). Cut slopes greater than 5 feet in height should be reviewed by the geotechnical engineer for stability.
- Fill slopes should be no steeper than 2H:1V. Fill slopes greater than 5 feet in height should be reviewed by the geotechnical engineer for stability. All material used to construct fill slopes should meet the engineered fill specifications and compaction requirements outlined below. Where fill is placed on existing slopes steeper than 5H:1V, the fill material should be keyed and benched into competent native soil.

In addition, engineered fill should meet the following requirements:

- Less than 2 percent by dry weight of vegetation and deleterious material
- Liquid limit less than 40
- Plasticity index less than 15

The following installation measures should be followed:

- Moisture-condition the material to near optimum moisture content.
- Place fill in horizontal lifts no greater than 8 inches in uncompacted thickness.
- Compact each lift to at least 90 percent relative compaction[1] before placing the next lift.

Sufficient construction inspection and materials testing should be performed, as determined by the geotechnical engineer, or qualified representative, to confirm the grading is completed in accordance with the design recommendations.

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[1] Relative compaction refers to the in-place dry density of a soil expressed as a percentage of the maximum dry density of the same soil, as determined by the ASTM D1557 Test Method. Optimum moisture content is the water content (percentage by dry weight) corresponding to the maximum dry density.

Also, in general, final grades around the project site should be constructed so that surface water drains away from all improvements. The grade should fall at least 6 inches within the first 10 feet (a 5 percent grade), moving outward from the improvements. Surface runoff should be directed to the nearest project drainage control system and not allowed to storage basin.

6.3 Water Storage Basin Design and Construction

We understand the intent of the upper storage basin is to retain water, using a plastic liner. However, considering the potential for liner failure over time, features are included into the design to reduce the risk of downslope saturation even with liner failure. Hydraulic conductivity tests from materials collected at the site suggest low permeability. The “gravel interface” shown on the project plans would be the stratigraphic interval most likely to facilitate leakage from the storage basin (although we note that the hydraulic conductivity testing on a sample of this material indicated low permeability). Careful design and construction of the storage basin will be critical in ensuring it retains water. Attention is directed to the discussion below regarding a core trench and the need to develop a low permeability core within the embankment.

- The interior and exterior slopes of the engineered fill embankments for the storage basin should be inclined no steeper than 2H:1V.
- The crest of the storage basin embankments should be at least 2 feet above the maximum water level (freeboard) to minimize the potential for breaching during a seismic event.
- The crest of the storage basin embankments should be at least 6 feet wide for embankments less than 10 feet high; taller embankments should have crest widths of at least 10 feet.
- A core trench (equivalent in width to the crest width) should be excavated beneath the axis of dam embankments. The trench should extend at least 2 feet vertically into firm, native soil or rock. This trench should be included regardless of the slope upon which the embankment is built.
- If embankment fills are placed on existing slopes steeper than 5H:1V, then the fill should be benched into firm, native soil a minimum of 2 feet, and the toe should be supported by a keyway. The keyway should be at least 10 feet wide and sloped 2 percent into the slope.
- Finished grading should be designed such that ponding or concentrated runoff is avoided. Where concentrated runoff does occur (such as at storage basin outlets), flow energy should be dissipated by installing rock slope protection (RSP). A permeable, nonwoven geotextile fabric should be placed over the prepared ground surface before installation of any RSP.

For storage basin construction, we recommend the following:

- All earthworks should be performed by an experienced, licensed contractor.
- Strip and remove all existing vegetation and root systems from the footprint of the storage basin, plus an additional 5 feet outward. Note that the footprint area is delineated by the total extent of earthwork to be performed (that is, the perimeter of all cut and fill surfaces).
- During excavation of the design cuts, stockpile the excavated spoils for future use as embankment fill. All embankment fill should be free from woody debris, roots, organics, and rocks retained on the 4-inch sieve. If coarser soils (gravel and/or cobbles) are encountered during excavation and construction, measures should be taken to remove the coarse material. A rock sorter and/or crusher may be required to remove/modify the oversized particles (rocks retained on a 4-inch sieve). Embankment fill should be comprised of greater than 50 percent fine-grained material (silts and clays) to minimize water seepage through the embankment. To the extent feasible, segregate fine-grained materials and blend the remainder of the stockpiled material into a uniform mixture.

  The geotechnical engineer or qualified representative should be present during excavating and stockpiling to ensure the adequacy of the excavated material. If the excavated material is deemed inadequate for use as fill, then an alternate source must be determined (from either a borrow area elsewhere onsite or soil imported from offsite).

  Excess fill spoils to be used as structural fill, intended to support the proposed solar arrays, should be engineered per our recommendations for engineered fill as described above.

- After completion of the design cuts, scarify the upper 12 inches of exposed subgrade soils, moisture-condition to a uniform moisture content of at least 2 percent above optimum, and compact to at least 90 percent relative compaction.
- Place embankment fill materials in horizontal layers no greater than 8 inches in loose thickness, moisture-condition to a uniform moisture content at least 2 percent above optimum, and compact to at least 90 percent relative compaction.
- To enhance the ability of the storage basin to retain water, place the fine-grained, low permeability spoils that were segregated during stockpiling in the center of the embankment to create a low permeability core.
- Immediately following completion of earthwork, exterior slopes should be seeded/planted with suitable erosion-control vegetation (native grass, for example). Trees and large shrubs should not be planted on the embankment.
- Sufficient construction inspection and materials testing should be performed, as determined by the geotechnical engineer or qualified representative, to confirm that the storage basin is constructed in accordance with the design recommendations. At a minimum, the following should be tested for adequate compaction:
  - Scarified and compacted subgrade soils
  - Initial lifts of embankment fill material to verify the contractor’s means and methods
  - Middle lifts of embankment fill material (that is, the lift that is halfway up the total design height of the embankment)
  - Final lifts of embankment fill material

6.4 Storage Basin Spillway

The proposed water storage basin will require the use of an engineered spillway. We understand current environmental regulatory standards require discharge from a storage basin is away from any slopes or watercourses. Discharge shall be directed away from steep slopes. Design and construction of the spillway should follow recommendations for storage basin design and construction presented in Section 6.3 above, namely, “where concentrated runoff occurs, flow energy should be dissipated by installing rock slope protection (RSP). A permeable, nonwoven geotextile fabric should be placed over the prepared ground surface prior to the installation of any RSP.”

7.0 Limitations

This report is based on an investigation of inherently limited scope. The work scope and investigative approach have been tailored to meet the minimum requirements for geotechnical and geologic reporting, while reflecting the low-impact approach of the primary intended uses. Should the intended use for the property change, additional investigation and reporting may be required.

Our conclusions and interpretations are also based on conditions at the time of our work. We cannot preclude changes that may occur in the future that could alter site conditions. This is especially true in Humboldt County, which is located in a dynamic geologic environment subject to large scale, catastrophic events (such as, great earthquakes and large storms).

Lastly, this report applies only to the site described above. Because of the high degree of variability in geology in this region, it is not possible to extrapolate the results described herein to any other site. This report is to be considered in its entirety. No part, section, paragraph, sentence, or phrase is to be quoted, evaluated, or otherwise used without considering its context and relationship to the entire report.

We trust that this report provides the information you need at this time. If you have any questions or require additional information, please contact our office at (707) 441-8855.

Sincerely,

SHN

PAUL SUNDBERG
No. 9723
09/30/2020

Gary D. Simpson
GARY D. SIMPSON
No. 2107
09/30/2020

JOHN H. DAILEY
No. 256
09/30/2020

Paul Sundberg, PG 9723	Gary Simpson, CEG 2107	John H. Dailey, GE 256
Project Geologist	Sr. Engineering Geologist	Sr. Geotechnical Engineer

PRS:GDS:JHD:lms

Appendices:
1. Exploratory Boring and Test Pit Logs
2. Laboratory Results
3. Marshall Ranch Flow Enhancement Project Site Plan

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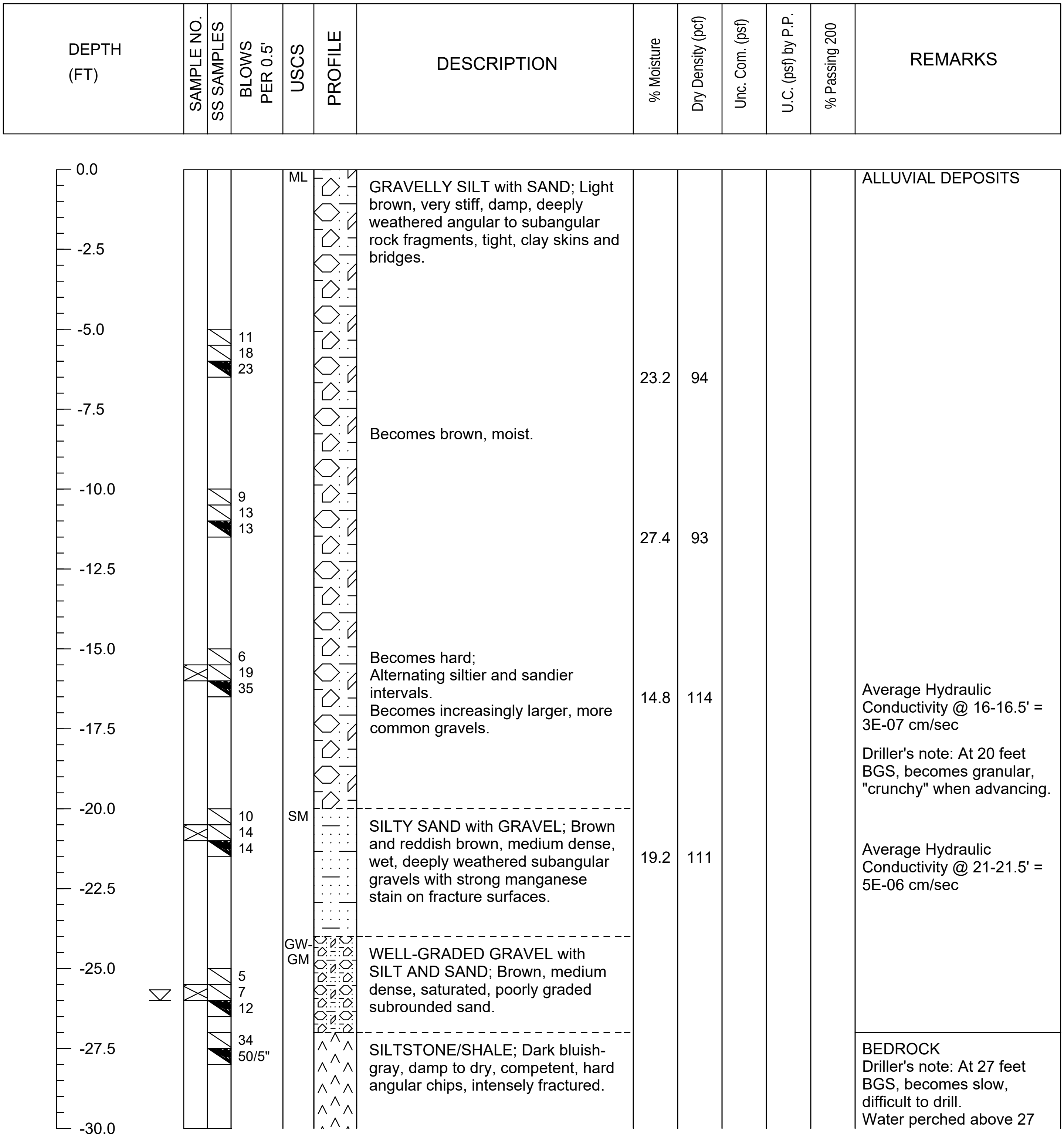
Exploratory Boring and Test Pit Logs

1

PROJECT: Redwood Creek Flow Enhancement Project
LOCATION: Briceland
GROUND SURFACE ELEVATION: 655 Feet
EXCAVATION METHOD: 7" O.D Hollow Stem Auger
LOGGED BY: A. Call

JOB NUMBER: 018135
DATE DRILLED: 8/27/18
TOTAL DEPTH OF BORING: 51.0 Feet BGS
SAMPLER TYPE: Modified Cal Barrel, SPT
Track Mounted Drill Rig

BORING NUMBER **BH-101**



DEPTH (FT)	SAMPLE NO.	SS SAMPLES	BLOWS PER 0.5'	USCS	PROFILE	DESCRIPTION	% Moisture	Dry Density (pcf)	Unc. Com. (psf)	U.C. (psf) by P.P.	% Passing 200	REMARKS
0.0				ML		GRAVELLY SILT with SAND; Light brown, very stiff, damp, deeply weathered angular to subangular rock fragments, tight, clay skins and bridges.						ALLUVIAL DEPOSITS
-2.5												
-5.0			11 18 23				23.2	94				
-7.5						Becomes brown, moist.						
-10.0			9 13 13				27.4	93				
-12.5												
-15.0			6 19 35			Becomes hard; Alternating siltier and sandier intervals. Becomes increasingly larger, more common gravels.	14.8	114				Average Hydraulic Conductivity @ 16-16.5' = 3E-07 cm/sec Driller's note: At 20 feet BGS, becomes granular, "crunchy" when advancing.
-17.5												
-20.0			10 14 14	SM		SILTY SAND with GRAVEL; Brown and reddish brown, medium dense, wet, deeply weathered subangular gravels with strong manganese stain on fracture surfaces.	19.2	111				Average Hydraulic Conductivity @ 21-21.5' = 5E-06 cm/sec
-22.5												
				GW-GM		WELL-GRADED GRAVEL with SILT AND SAND; Brown, medium dense, saturated, poorly graded subrounded sand.						
-25.0			5 7 12									
-27.5			34 50/5"			SILTSTONE/SHALE; Dark bluish-gray, damp to dry, competent, hard angular chips, intensely fractured.						BEDROCK Driller's note: At 27 feet BGS, becomes slow, difficult to drill. Water perched above 27
-30.0												

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

LOG OF BORING

PROJECT: Redwood Creek Flow Enhancement Project
LOCATION: Briceland
GROUND SURFACE ELEVATION: 655 Feet
EXCAVATION METHOD: 7" O.D Hollow Stem Auger
LOGGED BY: A. Call

JOB NUMBER: 018135
DATE DRILLED: 8/27/18
TOTAL DEPTH OF BORING: 51.0 Feet BGS
SAMPLER TYPE: Modified Cal Barrel, SPT
Track Mounted Drill Rig

BORING NUMBER
BH-101

DEPTH (FT)	SAMPLE NO.	SS SAMPLES	BLOWS PER 0.5'	USCS	PROFILE	DESCRIPTION	% Moisture	Dry Density (pcf)	Unc. Com. (psf)	U.C. (psf) by P.P.	% Passing 200	REMARKS
-30.0	☒	☐	21 40 50/6"			SILTSTONE/SHALE; Dark bluish-gray, damp to dry, competent, hard angular chips, intensely fractured.						feet BGS.
-32.5												
-35.0												At 34 feet BGS, cuttings saturated, highly fluid.
-37.5												At 37 feet BGS, cuttings become less fluid. Decreasing moisture in cuttings with depth.
-40.0	☒	☐	37 41 47									
-42.5												
-45.0												
-47.5												
-50.0	☒	☐	36 50/5"									
-52.5						Boring terminated at 51 feet BGS. Installed Peizometer. Screen interval 47.8 feet BGS to 7.8 feet BGS. Blank fro 7.8 feet BGS to surface. #3 sand from bottom of boring to 5 feet BGS. Bentonite from 5 feet BGS to 1.0 feet BGS. Flush mount Christie Box installed at surface. Groundwater encountered at a depth of 26 feet BGS.						
-55.0												
-57.5												

PROJECT: Redwood Creek Flow Enhancement Project
LOCATION: Briceland
GROUND SURFACE ELEVATION: 649 Feet
EXCAVATION METHOD: 7" O.D Hollow Stem Auger
LOGGED BY: A. Call

JOB NUMBER: 018135
DATE DRILLED: 8/28/18
TOTAL DEPTH OF BORING: 51.0 Feet BGS
SAMPLER TYPE: Modified Cal Barrel, SPT
Track Mounted Drill Rig

BORING NUMBER
BH-102

DEPTH (FT)	SAMPLE NO.	SS SAMPLES	BLOWS PER 0.5'	USCS	PROFILE	DESCRIPTION	% Moisture	Dry Density (pcf)	Unc. Com. (psf)	U.C. (psf) by P.P.	% Passing 200	REMARKS
0.0				ML		SILT with SAND; Light brown, stiif, damp to dry, occassional deeply weathered subangular gravel, tight, clay skins and bridges.						ALLUVIAL DEPOSITS
-2.5	☒		7 9 13			Becomes weakly mottled; gray, yellowish brown and brown.	11.3	89				
-5.0			15 21 23			Becomes very stiff Increased clay content; skins and bridges on clast surfaces. Becomes damp.	19.2	101				
-7.5												
-10.0 ▽			12 15 17	GW-GM		WELL-GRADED GRAVEL with SILT AND SAND; Brown, medium dense, wet, subrounded gravel and poorly graded sand, manganese stain on gravel fracture faces, free water observed on ped faces, clay skins and bridges observed on gravels.	15.1 16.7	110 111				Average Hydraulic Conductivity @ 10.5-11' = 8E-06 cm/sec
-12.5												
-15.0	☒		12 24 35			SILTSTONE/SHALE; Dark bluish gray, damp to dry, competent, hard angular chips, intensely fractured.						BEDROCK
-17.5												
-20.0	☒		20 36 50/4"									Hammer bouncing.
-22.5												
-25.0	☒		25 36 50/3"									Hammer bouncing.
-27.5												
-30.0												

PROJECT: Redwood Creek Flow Enhancement Project

LOCATION: Briceland

GROUND SURFACE ELEVATION: 649 Feet

EXCAVATION METHOD: 7" O.D Hollow Stem Auger

LOGGED BY: A. Call

JOB NUMBER: 018135

DATE DRILLED: 8/28/18

TOTAL DEPTH OF BORING: 51.0 Feet BGS

SAMPLER TYPE: Modified Cal Barrel, SPT

Track Mounted Drill Rig

BORING NUMBER
BH-102

DEPTH (FT)	SAMPLE NO.	SS SAMPLES	BLOWS PER 0.5'	USCS	PROFILE	DESCRIPTION	% Moisture	Dry Density (pcf)	Unc. Com. (psf)	U.C. (psf) by P.P.	% Passing 200	REMARKS
-30.0	☒	☐	27 50/5"			SILTSTONE/SHALE; Dark bluish gray, damp to dry, competent, hard angular chips, intensely fractured.						Hammer bouncing.
-32.5												
-35.0												
-37.5												
-40.0	☒	☐	30 42 50/5.5"									Hammer bouncing.
-42.5												
-45.0												
-47.5												
-50.0	☒	☐	29 50/5.5"									Hammer bouncing.
						Boring terminated at a depth of 51 feet. Groundwater encountered at a depth of 11 feet. Borehole backfilled with cuttings.						
-52.5												
-55.0												
-57.5												

LOG OF BORING

PROJECT: Redwood Creek Flow Enhancement Project

LOCATION: Briceland

GROUND SURFACE ELEVATION: 654 Feet

EXCAVATION METHOD: 7" O.D Hollow Stem Auger

LOGGED BY: A. Call

JOB NUMBER: 018135

DATE DRILLED: 8/28/18

TOTAL DEPTH OF BORING: 50.5 Feet BGS

SAMPLER TYPE: Modified Cal Barrel, SPT

Track Mounted Drill Rig

BORING NUMBER
BH-103

DEPTH (FT)	SAMPLE NO.	SS SAMPLES	BLOWS PER 0.5'	USCS	PROFILE	DESCRIPTION	% Moisture	Dry Density (pcf)	Unc. Com. (psf)	U.C. (psf) by P.P.	% Passing 200	REMARKS
0.0				ML		GRAVELLY SILT with SAND; Light brown, very stiff, damp to dry, deeply weathered subrounded gravel, well-graded rounded sand.						ALLUVIAL DEPOSITS
-2.5	☒		10 11 15				16.1	99				
				ML		SANDY SILT; Light yellowish-brown and brown (mottled), very stiff, damp, occasional gravel, iron and manganese oxide stain on parting surfaces.						
-5.0	☒		10 14 14				21.4	97				
-7.5												
-10.0	☒		11 13 20			Becomes slightly clayey, moist, fewer gravels, weak clay skins.	19.5	104				
-12.5				SW-SM		WELL-GRADED SAND with SILT AND GRAVEL; Brown to dark brown, medium dense, wet, deeply weathered subrounded to subangular gravels with manganese stain on fracture faces,						
-15.0 ▽	☒		11 17 18				15.1	115				
-17.5												
-20.0	☒		20 25 31			SILTSTONE/SHALE; Dark bluish-gray, damp to dry, competent, hard angular chips, intensely fractured.						BEDROCK
-22.5												
-25.0												
-27.5												
-30.0												

LOG OF BORING

DEPTH (FT)	SAMPLE NO.	SS SAMPLES	BLOWS PER 0.5'	USCS	PROFILE	DESCRIPTION	% Moisture	Dry Density (pcf)	Unc. Com. (psf)	U.C. (psf) by P.P.	% Passing 200	REMARKS
-30.0	☒	☐	50/6"		^ ^	SILTSTONE/SHALE; Dark bluish-gray, damp to dry, competent, hard angular chips, intensely fractured.						Hammer bouncing. Slow drilling.
-32.5					^ ^							
-35.0					^ ^							
-37.5					^ ^							
-40.0	☒ ☒ ☒	☐ ☐ ☐	14 29 29		^ ^							
-42.5					^ ^							
-45.0					^ ^							
-47.5					^ ^							
-50.0	☒	☐	50/6"		^ ^	Boring terminated at a depth of 50.5 feet BGS. Installed Peizometer. Screen interval 47.5 feet BGS to 7.5 feet BGS. Blank fro 7.5 feet BGS to surface. #3 sand from bottom of boring to 5 feet BGS. Bentonite from 5 feet BGS to 1.0 feet BGS. Flush mount Christie Box installed at surface. Groundwater encountered at a depth of 15 feet BGS.						Hammer bouncing.
-52.5												
-55.0												
-57.5												

PROJECT: Redwood Creek Flow Enhancement Project
LOCATION: Lower Terrace, South
GROUND SURFACE ELEVATION: 585 Feet (Google Earth)
EXCAVATION METHOD: Backhoe
LOGGED BY: PRS

JOB NUMBER: 018135
DATE EXCAVATED: 8/27/2018
TOTAL DEPTH OF TEST PIT: 8 Feet
SAMPLER TYPE: Hand-driven tube

TEST PIT NUMBER
TP-1

DEPTH (FT)	BULK SAMPLES	TUBE SAMPLES	USCS	PROFILE	DESCRIPTION	% Moisture	Dry Density (pcf)	Unc. Com. (psf)	U.C. (psf) by P.P.	% Passing 200	REMARKS
0.0	☒		ML	▤	SANDY SILT; Dark brown, medium stiff, dry to moist, low plasticity, moderate cementation, fine to coarse sub-angular sand, roots.						Observation well OW-1 installed from 0-8' bgs; 5' of screen PVC pipe from 3-8', 5' of blank PVC pipe from 0-3'; 2' of pipe above grade.
-1.0 -2.0	☒	■	SW-SC SC	▨	WELL-GRADED SAND with CLAY AND GRAVEL; Brown, medium dense, dry to moist, weak cementation, non-plastic to low plasticity, fine to coarse sub-rounded to rounded gravel.						
-3.0	☒	■	CL	▨	SANDY LEAN CLAY; Brown, medium stiff to stiff, dry to moist, fine to coarse sub-rounded sand.						Bulk bucket sample from 3-4'
-4.0 -5.0	☒			▨	LEAN CLAY with SAND; Brown, medium stiff to stiff, fine sand, low to medium plasticity, moderate cementation, mottled.						
-6.0 -7.0	☒		SW-SC	▨	WELL-GRADED SAND with CLAY AND GRAVEL; Brown, medium dense, moist, fine to coarse sub-rounded to rounded sand, non-cemented, low plasticity fines.						Bulk bucket and bag sample from 7-8'
-8.0 -9.0 -10.0 -11.0 -12.0 -13.0 -14.0 -15.0					Excavation terminated at a depth of 8 feet. Groundwater not encountered. Installed observation well OW-1 and backfilled with excavated spoils.						

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

LOG OF TEST PIT

PROJECT: Redwood Creek Flow Enhancement Project

LOCATION: Lower Terrace, Central

GROUND SURFACE ELEVATION: 580 Feet (Google Earth)

EXCAVATION METHOD: Backhoe

LOGGED BY: PRS

JOB NUMBER: 018135

DATE EXCAVATED: 8/27/2018

TOTAL DEPTH OF TEST PIT: 11.5 Feet

SAMPLER TYPE: Hand-driven tube

TEST PIT NUMBER
TP-2

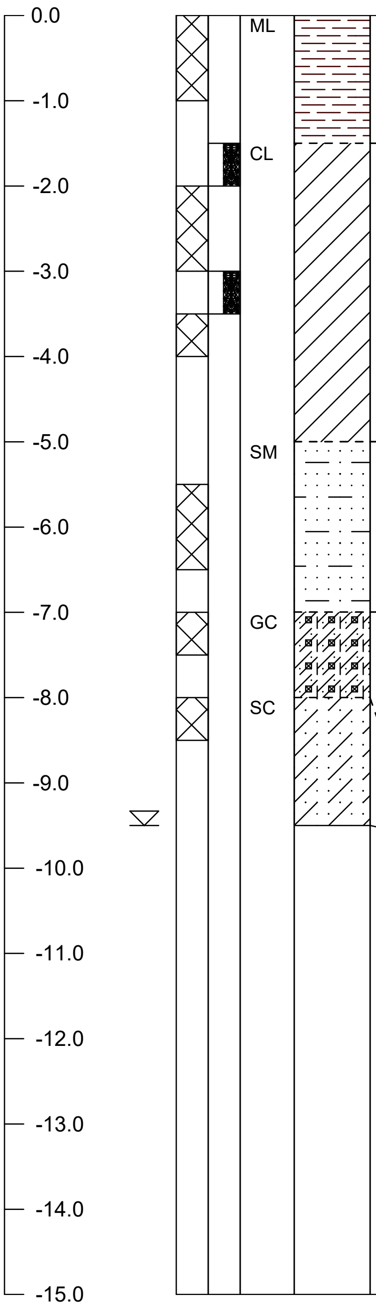
DEPTH (FT)	BULK SAMPLES	TUBE SAMPLES	USCS	PROFILE	DESCRIPTION	% Moisture	Dry Density (pcf)	Unc. Com. (psf)	U.C. (psf) by P.P.	% Passing 200	REMARKS
0.0			ML		SANDY SILT; Brown, medium stiff, moist, moderate cementation.						Observation well OW-2 installed from 0-8' bgs; 5' of screen PVC pipe from 3-8', 5' of blank PVC pipe from 0-3'; 2' of pipe above grade; test pit backfilled to 8 feet to accommodate well installation.
-1.0			SC		SANDY LEAN CLAY; Brown, medium stiff, moist.						
-2.0											
-3.0											
-4.0			SM		SILTY SAND; Dark brown, medium dense, moist, non-cemented.						
-5.0											
-6.0	☒		SW-SM		WELL-GRADED SAND with SILT AND GRAVEL; Brown, medium dense, non-cemented.						Bulk bucket sample from 6-7'
-7.0											
-8.0											
-9.0 ▽					increase in coarse rounded gravel						
-10.0											
-11.0					SILTSTONE; Dark gray (encountered at bottom of test pit in bucket teeth).						
-12.0					Excavation terminated at a depth of 11.5 feet. Groundwater encountered at a depth of 9 feet. Installed observation well OW-2 and backfilled with excavated spoils.						
-13.0											
-14.0											
-15.0											

LOG OF TEST PIT

PROJECT: Redwood Creek Flow Enhancement Project
LOCATION: Lower Terrace, Northeast
GROUND SURFACE ELEVATION: 583 Feet (Google Earth)
EXCAVATION METHOD: Backhoe
LOGGED BY: PRS

JOB NUMBER: 018135
DATE EXCAVATED: 8/27/2018
TOTAL DEPTH OF TEST PIT: 9.5 Feet
SAMPLER TYPE: Hand-driven tube

TEST PIT NUMBER
TP-3



USCS	DESCRIPTION	% Moisture	Dry Density (pcf)	Unc. Com. (psf)	U.C. (psf) by P.P.	% Passing 200	REMARKS
ML	SILT with SAND; Dark brown, medium stiff, dry to moist, moderate cementation, non-plastic to low plasticity.						Observation well OW-3 installed from 0-8' bgs; 5' of screen PVC pipe from 3-8', 5' of blank PVC pipe from 0-3'; 2' of pipe above grade; test pit backfilled to 8 feet to accommodate well installation.
CL	LEAN CLAY with SAND; Brown, medium stiff to stiff, dry to moist, moderate to strong cementation, low plasticity.	15.3	87				Average Hydraulic Conductivity @ 3-3.5' = 7E-05 cm/sec
SM	SILTY SAND; Yellowish-brown, medium dense, moist, weak cementation, low plasticity.						Bulk bucket sample from 5.5-6.5'
GC	CLAYEY GRAVEL with SAND; Brown, medium dense to dense, wet, weak cementation, fine to coarse sub-angular gravel, sub-rounded cobbles.						
SC	CLAYEY SAND; Brownish-gray, medium dense, wet, coarse angular gravel, mottled.						
	Excavation terminated at a depth of 9.5 feet. Groundwater encountered at a depth of 9.5 feet. Installed observation well OW-3 and backfilled with excavated spoils.						

LOG OF TEST PIT

PROJECT: Redwood Creek Flow Enhancement Project

LOCATION: Upper Terrace, South

GROUND SURFACE ELEVATION: 665 Feet (Google Earth)

EXCAVATION METHOD: Backhoe

LOGGED BY: PRS

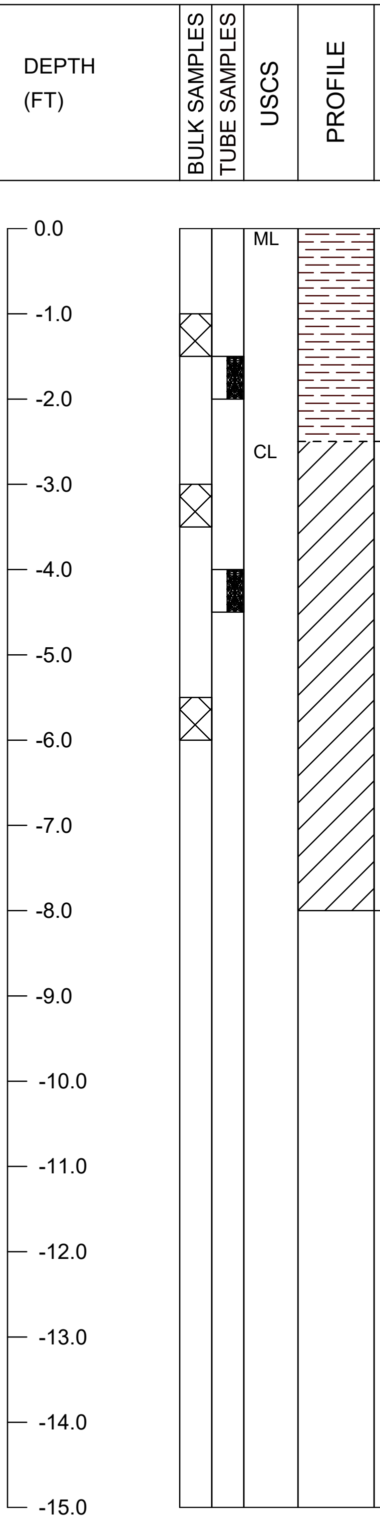
JOB NUMBER: 018135

DATE EXCAVATED: 8/27/2018

TOTAL DEPTH OF TEST PIT: 8 Feet

SAMPLER TYPE: Hand-driven tube

TEST PIT NUMBER
TP-4



USCS	DESCRIPTION	% Moisture	Dry Density (pcf)	Unc. Com. (psf)	U.C. (psf) by P.P.	% Passing 200	REMARKS
ML	SILT with SAND; Dark brown, medium stiff, dry to moist, moderate to strong cementation, non-plastic.						Observation well OW-4 installed from 0-8' bgs; 5' of screen PVC pipe from 3-8', 5' of blank PVC pipe from 0-3'; 2' of pipe above grade.
CL	LEAN CLAY with SAND; Brown, stiff, dry to moist, moderate cementation, low to medium plasticity, mottled.						
	Excavation terminated at a depth of 8 feet. Groundwater not encountered. Installed observation well OW-4 and backfilled with excavated spoils.						

LOG OF TEST PIT

Laboratory Results

2

CONSULTING ENGINEERS & GEOLOGISTS, INC.

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DENSITY BY DRIVE- CYLINDER METHOD (ASTM D2937)

Project Name:	**RCEP Redwood Creek**	**Project Number:**	**018135**
Performed By:	**ESP**	**Date:**	**9/25/2018**
Checked By:	**NAN**	**Date:**	**9/25/2018**
Project Manager:	**GDS**		

Lab Sample Number	18-820	18-821			
Boring Label	**BH-101**	**BH-101**			
Sample Depth (ft)	**6.0-6.5**	**11.0-11.5**			
Diameter of Cylinder, in	2.38	2.41			
Total Length of Cylinder, in.	6.00	6.00			
Length of Empty Cylinder A, in.	0.00	0.00			
Length of Empty Cylinder B, in.	0.85	0.15			
Length of Cylinder Filled, in	5.15	5.85			
Volume of Sample, in^3	22.91	26.69			
Volume of Sample, cc.	375.45	437.30			

Pan #	A2	A3			
Weight of Wet Soil and Pan	787.6	915.4			
Weight of Dry Soil and Pan	655.6	737.1			
Weight of Water	132.0	178.3			
Weight of Pan	87.7	85.4			
Weight of Dry Soil	567.9	651.7			
Percent Moisture	**23.2**	**27.4**			
Dry Density, g/cc	1.51	1.49			
Dry Density, lb/ft^3	**94.4**	**93.0**			

DENSITY BY DRIVE- CYLINDER METHOD (ASTM D2937)

Project Name:	**RCEP Redwood Creek**	**Project Number:**	**018135**
Performed By:	**ESP**	**Date:**	**9/25/2018**
Checked By:	**NAN**	**Date:**	**9/25/2018**
Project Manager:	**GDS**		

Lab Sample Number	18-835	18-837	18-839		
Boring Label	**BH-102**	**BH-102**	**BH-102**		
Sample Depth (ft)	**3.0-3.5**	**6.0-6.5**	**11.0-11.5**		
Diameter of Cylinder, in	2.41	2.40	2.40		
Total Length of Cylinder, in.	6.00	6.00	6.00		
Length of Empty Cylinder A, in.	0.00	0.22	0.00		
Length of Empty Cylinder B, in.	0.55	0.28	0.30		
Length of Cylinder Filled, in	5.45	5.50	5.70		
Volume of Sample, in^3	24.86	24.88	25.79		
Volume of Sample, cc.	407.40	407.73	422.56		

Pan #	A4	A5	A6		
Weight of Wet Soil and Pan	732.5	870.3	967.5		
Weight of Dry Soil and Pan	667.1	744.3	841.5		
Weight of Water	65.4	126.0	126.0		
Weight of Pan	87.9	86.8	87.4		
Weight of Dry Soil	579.2	657.5	754.1		
Percent Moisture	**11.3**	**19.2**	**16.7**		
Dry Density, g/cc	1.42	1.61	1.78		
Dry Density, lb/ft^3	**88.8**	**100.7**	**111.4**		

CONSULTING ENGINEERS & GEOLOGISTS, INC.
812 W. Wabash Eureka, CA 95501-2138 Tel: 707/441-8855 FAX: 707/441-8877 E-mail: shninfo@shn-engr.com

DENSITY BY DRIVE- CYLINDER METHOD (ASTM D2937)

Project Name:	**RCEP Redwood Creek**	**Project Number:**	**018135**
Performed By:	**ESP**	**Date:**	**9/25/2018**
Checked By:	**NAN**	**Date:**	**9/25/2018**
Project Manager:	**GDS**		

Lab Sample Number	18-849	18-851	18-853	18-855	
Boring Label	**BH-103**	**BH-103**	**BH-103**	**BH-103**	
Sample Depth (ft)	**3.0-3.5**	**6.0-6.5**	**11.0-11.5**	**16.0-16.5**	
Diameter of Cylinder, in	2.40	2.41	2.41	2.38	
Total Length of Cylinder, in.	6.00	6.00	6.00	6.00	
Length of Empty Cylinder A, in.	0.40	0.00	0.40	0.00	
Length of Empty Cylinder B, in.	0.28	0.00	0.15	0.33	
Length of Cylinder Filled, in	5.32	6.00	5.45	5.67	
Volume of Sample, in^3	24.07	27.37	24.86	25.22	
Volume of Sample, cc.	394.39	448.51	407.40	413.36	

Pan #	A7	A8	A9	A10	
Weight of Wet Soil and Pan	810.8	934.9	895.2	966.6	
Weight of Dry Soil and Pan	710.5	785.7	763.5	851.5	
Weight of Water	100.3	149.2	131.7	115.1	
Weight of Pan	86.7	87.4	88.2	87.1	
Weight of Dry Soil	623.8	698.3	675.3	764.4	
Percent Moisture	**16.1**	**21.4**	**19.5**	**15.1**	
Dry Density, g/cc	1.58	1.56	1.66	1.85	
Dry Density, lb/ft^3	**98.7**	**97.2**	**103.5**	**115.4**	

COOPER
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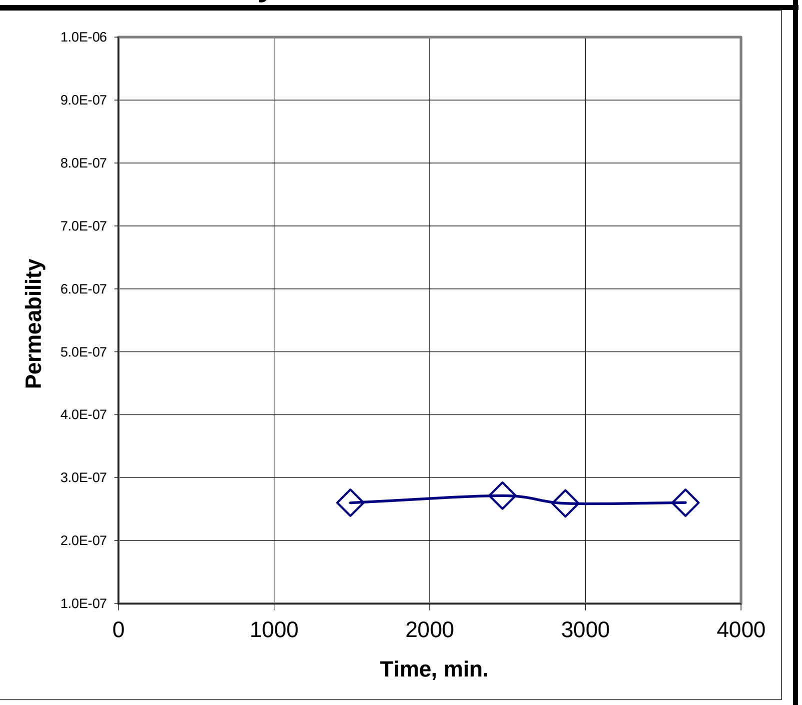
Hydraulic Conductivity
ASTM D 5084
Method C: Falling Head Rising Tailwater

Job No: 054-177 **Boring:** BH-101 **Date:** 10/23/18
Client: SHN Engineers & Geologists **Sample:** **By:** MD/PJ
Project: 018135 **Depth, ft.:** 16-16.5 **Remolded:**
Visual Classification: Yellowish Brown Clayey SAND w/ Gravel (Weathered Rock)

B: = >0.95 **("B" is an indication of saturation)**
Max Hydraulic Gradient: = 17

Max Sample Pressures, psi:			
Cell:	**Bottom**	**Top**	**Avg. Sigma3**
54	49.5	48.5	5

Date	Minutes	Head, (in)	K,cm/sec
10/9/2018	0.00	42.69	**Start of Test**
10/10/2018	1491.00	30.69	2.6E-07
10/11/2018	2468.00	24.69	2.7E-07
10/11/2018	2872.00	22.79	2.6E-07
10/12/2018	3643.00	19.29	2.6E-07



Average Hydraulic Conductivity: **3.E-07** **cm/sec**

Sample Data:	Initial (As-Received)		Final (At-Test)
Height, in	2.52		2.52
Diameter, in	2.42		2.42
Area, in2	4.59		4.60
Volume in3	11.55		11.57
Total Volume, cc	189.3		189.6
Volume Solids, cc	127.8		127.8
Volume Voids, cc	61.4		61.7
Void Ratio	0.5		0.5
Total Porosity, %	32.4		32.6
Air-Filled Porosity (θa),%	5.4		0.3
Water-Filled Porosity (θw),%	27.0		32.3
Saturation, %	83.2		99.2
Specific Gravity	2.70	Assumed	2.70
Wet Weight, gm	396.3		406.4
Dry Weight, gm	345.2		345.2
Tare, gm	0.00		0.00
Moisture, %	14.8		17.7
Wet Bulk Density, pcf	130.7		133.8
Dry Bulk Density, pcf	113.8		113.6
Wet Bulk Dens.ρb, (g/cm^3)	2.09		2.14
Dry Bulk Dens.ρb, (g/cm^3)	1.82		1.82

Remarks:

COOPER TESTING LABORATORY

Hydraulic Conductivity
ASTM D 5084
Method C: Falling Head Rising Tailwater

Job No: 054-177 **Boring:** BH-101 **Date:** 10/23/18
Client: SHN Engineers & Geologists **Sample:** **By:** MD/PJ
Project: 018135 **Depth, ft.:** 21-21.5 **Remolded:**
Visual Classification: Olive Brown Clayey GRAVEL w/ Sand (Weathered Rock)

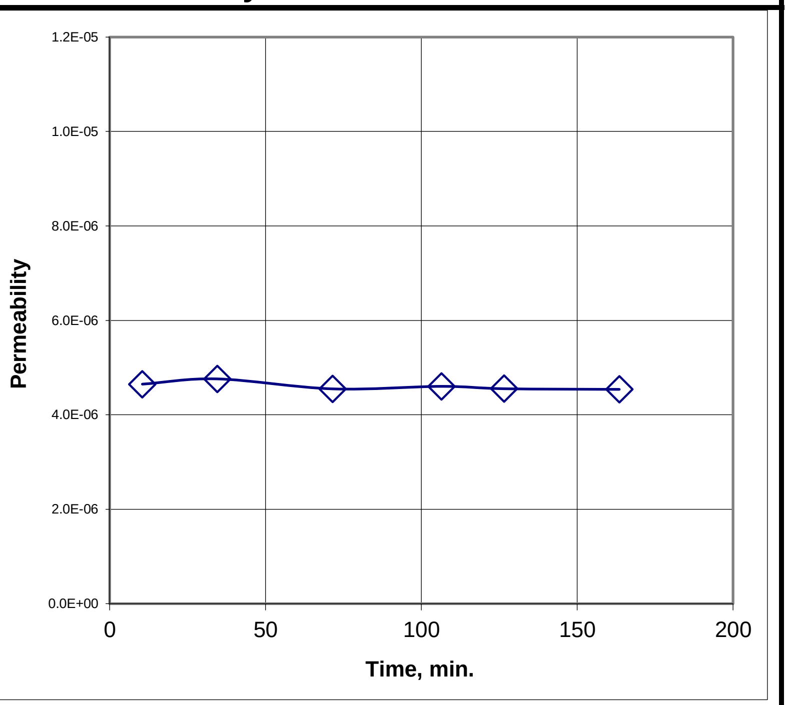
Max Sample Pressures, psi:

Cell:	Bottom	Top	Avg. Sigma3
53.5	49	48	5

B: = >0.95 **("B" is an indication of saturation)**

Max Hydraulic Gradient: = 20

Date	Minutes	Head, (in)	K,cm/sec
10/17/2018	0.00	49.69	**Start of Test**
10/17/2018	10.50	47.69	4.6E-06
10/17/2018	34.50	43.29	4.8E-06
10/17/2018	71.50	37.89	4.5E-06
10/17/2018	106.50	33.09	4.6E-06
10/17/2018	126.50	30.89	4.6E-06
10/17/2018	163.50	27.09	4.5E-06



Average Hydraulic Conductivity: **5.E-06** **cm/sec**

Sample Data:	**Initial (As-Received)**		**Final (At-Test)**
Height, in	2.50		2.47
Diameter, in	2.41		2.43
Area, in2	4.54		4.63
Volume in3	11.35		11.43
Total Volume, cc	186.0		187.3
Volume Solids, cc	122.2		122.2
Volume Voids, cc	63.8		65.1
Void Ratio	0.5		0.5
Total Porosity, %	34.3		34.7
Air-Filled Porosity (θa),%	0.3		1.1
Water-Filled Porosity (θw),%	34.0		33.7
Saturation, %	99.2		96.9
Specific Gravity	2.70	Assumed	2.70
Wet Weight, gm	393.2		393.0
Dry Weight, gm	330.0		330.0
Tare, gm	0.00		0.00
Moisture, %	19.2		19.1
Wet Bulk Density, pcf	131.9		131.0
Dry Bulk Density, pcf	110.7		110.0
Wet Bulk Dens.ρb, (g/cm^3)	2.11		2.10
Dry Bulk Dens.ρb, (g/cm^3)	1.77		1.76

Remarks:

COOPER
TESTING LABORATORY

Hydraulic Conductivity
ASTM D 5084
Method C: Falling Head Rising Tailwater

Job No: 054-177 **Boring:** BH-102 **Date:** 10/23/18
Client: SHN Engineers & Geologists **Sample:** **By:** MD/PJ
Project: 018135 **Depth, ft.:** 10.5-11 **Remolded:**
Visual Classification: Yellowish Brown Clayey SAND w/ Gravel

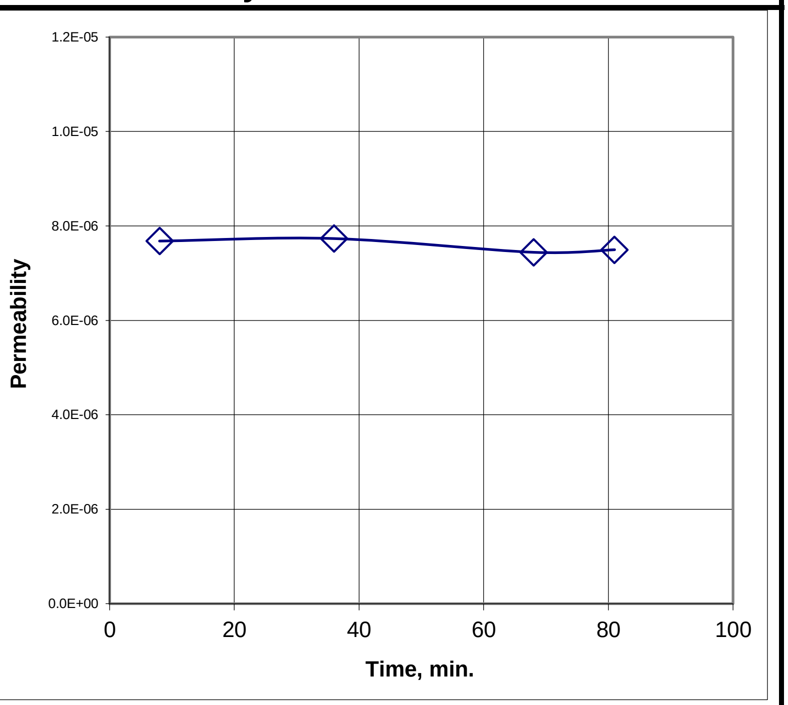
Max Sample Pressures, psi:

Cell:	Bottom	Top	Avg. Sigma3
53.5	49	48	5

B: = >0.95 **("B" is an indication of saturation)**

Max Hydraulic Gradient: = 16

Date	Minutes	Head, (cm)	K,cm/sec
10/17/2018	0.00	97.33	**Start of Test**
10/17/2018	8.00	93.53	7.7E-06
10/17/2018	36.00	81.33	7.7E-06
10/17/2018	68.00	70.33	7.4E-06
10/17/2018	81.00	66.03	7.5E-06



Average Hydraulic Conductivity: **8.E-06** **cm/sec**

Sample Data:	Initial (As-Received)		Final (At-Test)
Height, in	2.51		2.47
Diameter, in	2.40		2.41
Area, in2	4.54		4.56
Volume in3	11.37		11.27
Total Volume, cc	186.4		184.6
Volume Solids, cc	121.9		121.9
Volume Voids, cc	64.5		62.8
Void Ratio	0.5		0.5
Total Porosity, %	34.6		34.0
Air-Filled Porosity (θa),%	7.9		1.4
Water-Filled Porosity (θw),%	26.7		32.6
Saturation, %	77.1		96.0
Specific Gravity	2.70	Assumed	2.70
Wet Weight, gm	378.8		389.3
Dry Weight, gm	329.1		329.1
Tare, gm	0.00		0.00
Moisture, %	15.1		18.3
Wet Bulk Density, pcf	126.8		131.6
Dry Bulk Density, pcf	110.2		111.2
Wet Bulk Dens.ρb, (g/cm^3)	2.03		2.11
Dry Bulk Dens.ρb, (g/cm^3)	1.76		1.78

Remarks:

COOPER TESTING LABORATORY

Hydraulic Conductivity
ASTM D 5084
Method C: Falling Head Rising Tailwater

Job No: 054-177 **Boring:** TP-3 **Date:** 10/23/18
Client: SHN Engineers & Geologists **Sample:** **By:** MD/PJ
Project: 018135 **Depth, ft.:** 3-3.5 **Remolded:**
Visual Classification: Yellowish Brown Sandy SILT (slightly plastic) w/ surface organics/ Sandy CLAY (Silty)

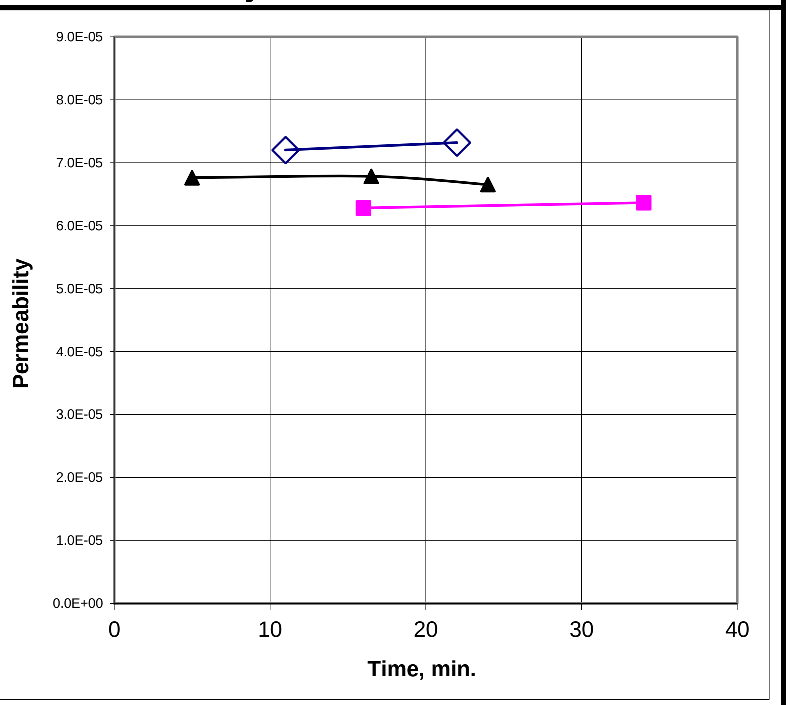
Max Sample Pressures, psi:

Cell:	Bottom	Top	Avg. Sigma3
74	69	69	5

B: = >0.95 **("B" is an indication of saturation)**

Max Hydraulic Gradient: = 3

Date	Minutes	Head, (cm)	K,cm/sec
10/12/2018	0.00	8.20	**Start of Test**
10/12/2018	11.00	5.00	7.2E-05
10/12/2018	22.00	3.00	7.3E-05
10/15/2018	16.00	6.60	6.3E-05
10/15/2018	34.00	3.20	6.4E-05
10/17/2018	5.00	14.00	6.8E-05
10/17/2018	16.50	8.60	6.8E-05
10/17/2018	24.00	6.40	6.7E-05



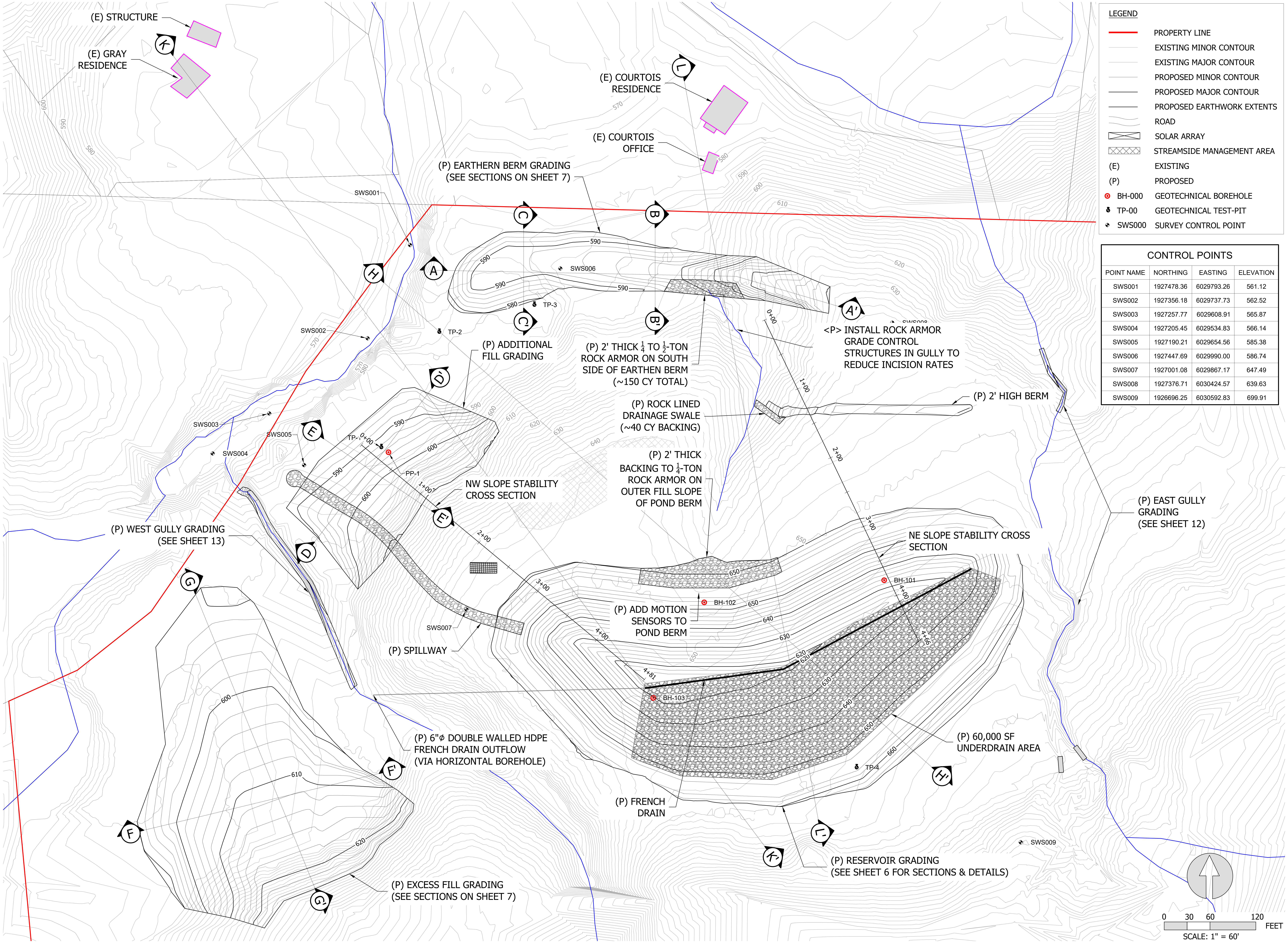
Average Hydraulic Conductivity: **7.E-05** **cm/sec**

Sample Data:	**Initial (As-Received)**		**Final (At-Test)**
Height, in	2.51		2.48
Diameter, in	2.41		2.39
Area, in2	4.55		4.49
Volume in3	11.40		11.13
Total Volume, cc	186.9		182.3
Volume Solids, cc	96.5		96.5
Volume Voids, cc	90.3		85.8
Void Ratio	0.9		0.9
Total Porosity, %	48.3		47.1
Air-Filled Porosity (θa),%	26.9		2.1
Water-Filled Porosity (θw),%	21.4		45.0
Saturation, %	44.3		95.6
Specific Gravity	2.70	Assumed	2.70
Wet Weight, gm	300.6		342.6
Dry Weight, gm	260.6		260.6
Tare, gm	0.00		0.00
Moisture, %	15.3		31.5
Wet Bulk Density, pcf	100.4		117.3
Dry Bulk Density, pcf	87.0		89.2
Wet Bulk Dens.ρb, (g/cm^3)	1.61		1.88
Dry Bulk Dens.ρb, (g/cm^3)	1.39		1.43

Remarks:

Marshall Ranch Flow Enhancement Project Site Plan

3



LEGEND

—	PROPERTY LINE
—	EXISTING MINOR CONTOUR
—	EXISTING MAJOR CONTOUR
—	PROPOSED MINOR CONTOUR
—	PROPOSED MAJOR CONTOUR
—	PROPOSED EARTHWORK EXTENTS
—	ROAD
⊠	SOLAR ARRAY
▨	STREAMSIDE MANAGEMENT AREA
(E)	EXISTING
(P)	PROPOSED
◉ BH-000	GEOTECHNICAL BOREHOLE
♁ TP-00	GEOTECHNICAL TEST-PIT
⊕ SWS000	SURVEY CONTROL POINT

CONTROL POINTS

POINT NAME	NORTHING	EASTING	ELEVATION
SWS001	1927478.36	6029793.26	561.12
SWS002	1927356.18	6029737.73	562.52
SWS003	1927257.77	6029608.91	565.87
SWS004	1927205.45	6029534.83	566.14
SWS005	1927190.21	6029654.56	585.38
SWS006	1927447.69	6029990.00	586.74
SWS007	1927001.08	6029867.17	647.49
SWS008	1927376.71	6030424.57	639.63
SWS009	1926696.25	6030592.83	699.91

MARSHALL RANCH FLOW ENHANCEMENT PROJECT

APN 220-061-011

HUMBOLDT COUNTY, CA

Stillwater Sciences
2855 TELEGRAPH AVENUE, SUITE 400
BERKELEY, CA 94705
P: (510) 848-8098

PROJECT NUMBER: 603.01
SCALE: AS NOTED
DATE: 8/2/2020

DESIGN: JM
DRAWN: CL
CHECKED: JM
APPROVED: JM

JOEL MONSCHKE
No. 79688
9-30-20

GRADING PLAN

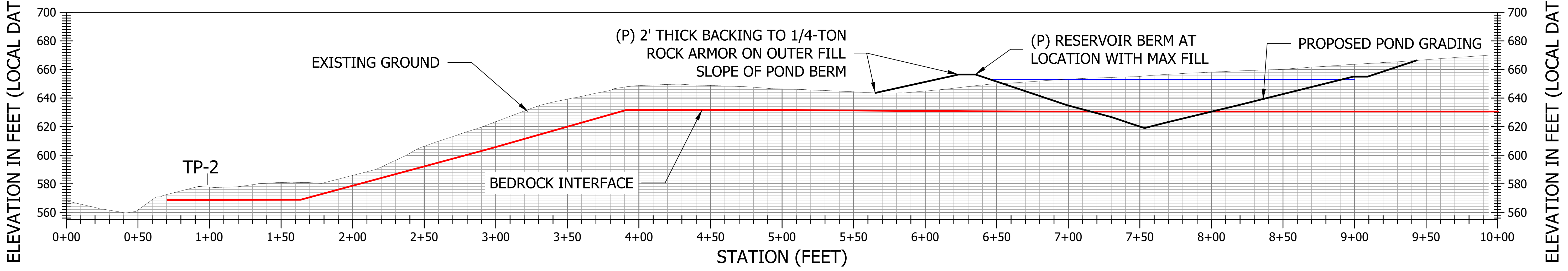
SHEET 5 OF 22

IF BAR DOES NOT MEASURE 1" DRAWING IS NOT TO SCALE - ADJUST ACCORDINGLY

LAST SAVED: 9/30/2020 PLOT DATE: 9/30/2020 PLOT STYLE: ----

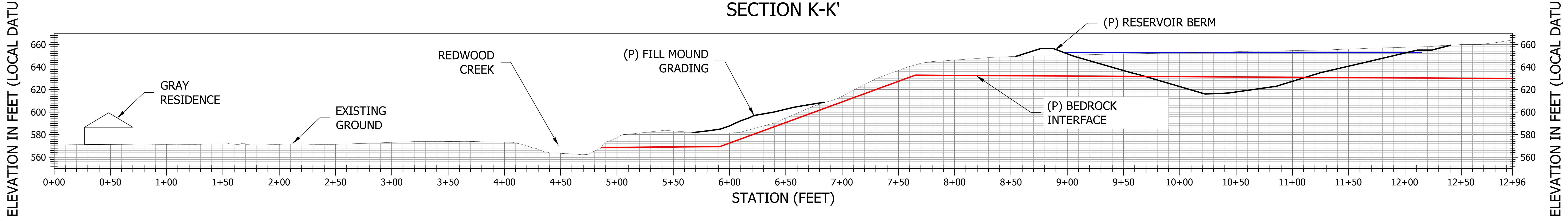
Z:\DATA\603.01_MARSHALLRANCH\ACAD\2_MODEL\603.00_REDWOOD_RECHARGE_RESERVOIR.DWG

RESERVOIR SECTION H-H'



HORIZONTAL SCALE: 1" = 60'
VERTICAL SCALE: 1" = 60'

SECTION K-K'



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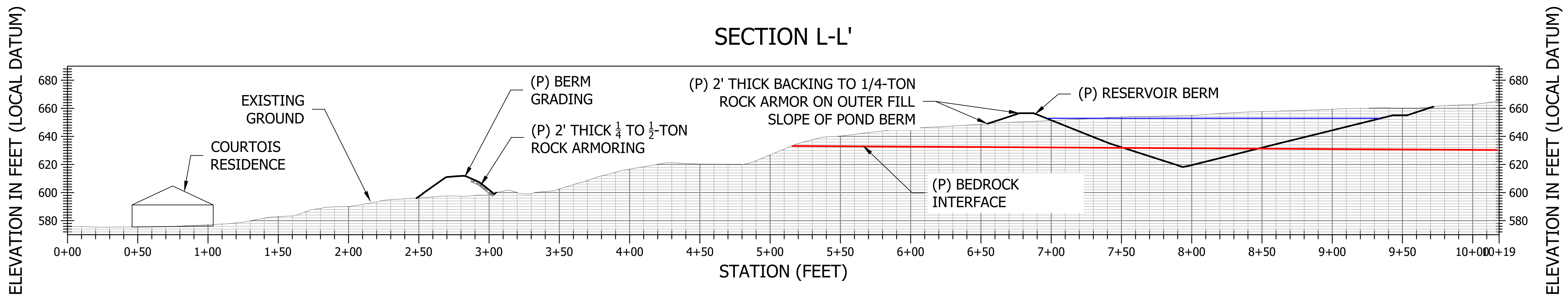
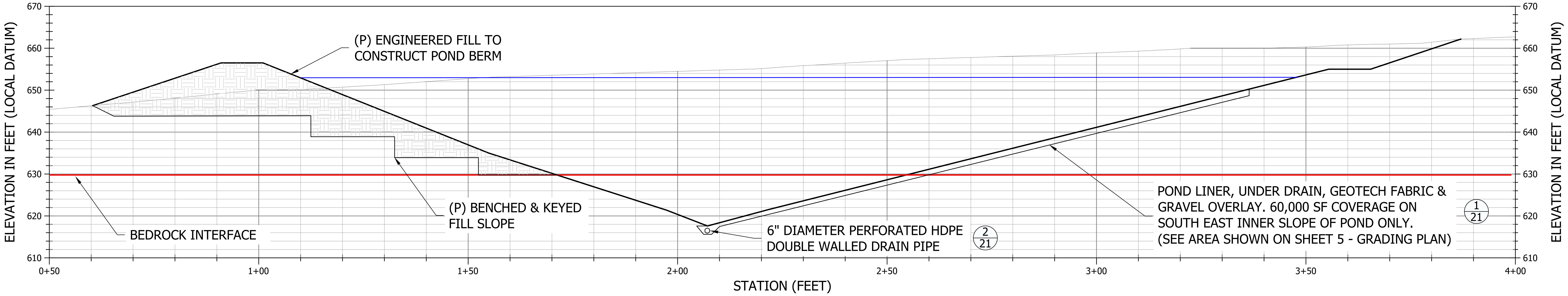
VERTICAL SCALE: 1" = 60'

SECTION L-L'



HORIZONTAL SCALE: 1" = 60'
VERTICAL SCALE: 1" = 60'

FRENCH DRAIN AND SUBSURFACE RESTRICTIVE BARRIER DETAIL (TYP.)



HORIZONTAL SCALE: 1" = 15'
VERTICAL SCALE: 1" = 15'

LEGEND

—	EXISTING GROUND SURFACE
—	PROPOSED GROUND SURFACE

MARSHALL RANCH FLOW ENHANCEMENT PROJECT
APN 220-061-011

HUMBOLDT COUNTY, CA

Stillwater Sciences
2855 TELEGRAPH AVENUE, SUITE 400
BERKELEY, CA 94705
P: (510) 848-8098

PROJECT NUMBER: 603.01
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DESIGN: JM
DRAWN: CL
CHECKED: JM
APPROVED: JM

JOEL MONSCHKE
No. 79688
9-30-20
EXPIRES
CIVIL

RESERVOIR SECTIONS & DETAILS

SHEET 6 OF 22

IF BAR DOES NOT MEASURE 1" DRAWING IS NOT TO SCALE – ADJUST ACCORDINGLY

LAST SAVED: 9/30/2020 PLOT DATE: 9/30/2020 PLOT STYLE: ----

Z:\DATA\603.01_MARSHALLRANCH\ACAD\2_MODEL\603.00_REDWOOD_RECHARGE_RESERVOIR.DWG

Appendix C

Draft Water Availability Analysis

DRAFT REPORT ◦ SEPTEMBER 2020

Redwood Creek
Water Availability Analysis Report

PREPARED FOR

Salmonid Restoration Federation
425 Snug Alley, Unit D
Eureka, CA 95501

PREPARED BY

Stillwater Sciences
850 G Street, Suite K
Arcata, CA 95521

Stillwater Sciences

Suggested citation:
Stillwater Sciences. 2020. Redwood Creek Water Availability Analyses Report. Prepared by Stillwater Sciences, Arcata, California for Salmonid Restoration Federation, Eureka, California.

Cover photo: 2018 Redwood Creek dry-season flow conditions near the town of Briceland, July (top photo) and September (bottom photo).

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Tables

Figures

1 INTRODUCTION

This report analyzes water availability in Redwood Creek, tributary to the South Fork Eel. This analyses is being funded through the California Wildlife Conservation Board's Streamflow Enhancement Program. Salmonid Restoration Federation (SRF) is the project proponent and Stillwater Sciences is the technical lead for the project. The South Fork Eel River is one of five priority watersheds selected for flow enhancement projects in California by the State Water Resources Control Board (SWRCB) and California Department of Fish and Wildlife (CDFW) as part of the California Water Action Plan effort (SWRCB 2019). Redwood Creek is a critical tributary to the South Fork Eel River that historically supported coho and Chinook salmon (*Oncorhynchus tshawytscha*) and steelhead.

This water availability analyses comprises a component within an array of actions aimed at improving aquatic habitat in Redwood Creek by addressing the limiting factor of low summer streamflows. The primary purposes of this analyses is two-fold:

1. Provide site-specific water availability information for an Appropriative Water Right that will be filed with the SWRCB for a large-scale flow enhancement project on the Marshall Ranch near the town of Briceland (Stillwater Sciences 2019). The water availability analyses will specifically inform the amount and timing of water that is available for diversion to storage for this project.
2. Provide watershed-wide water availability information to inform watershed-scale planning outreach, data collection and analyses to develop an implementable plan for improving dry season streamflows in Redwood Creek with the ultimate goal of recovery of steelhead and salmon. The water availability analyses will specifically provide information for siting and prioritizing future projects.

This water balance analyzes inflows and outflows from the watershed:

1. Water in: Precipitation
2. Water Out: Streamflow draining into the South Fork Eel River; evapotranspiration; and human use.

Data used for analyses includes flow data collected by the project team in Redwood Creek, USGS gage data, PRISM rainfall data, and Appropriative Water Rights data. It is also important to note that flow enhancement planning work in Redwood Creek is being conducted in close collaboration with work in the Mattole watershed which has a history of flow-related initiatives dating back more than a decade (Trout Unlimited 2013).

2 WATERSHED CHARACTERISTICS

The Redwood Creek watershed comprises 26 square miles of area and approximately 22.4 miles of anadromous stream channel (Figure 1), draining into the South Fork Eel River from the west near the town of Redway. provide habitat to salmonids within Redwood Creek. For the purpose of easing future water availability analyses, Redwood Creek watershed was divided into the following six sub-watersheds shown in Figure 1:

- China Creek
- Upper Redwood Creek

- Miller Creek
- Somerville Creek
- Seely Creek
- Redwood Creek Mainstem

Within Redwood Creek, 80% of the watershed is privately owned residential and ranching parcels with the remaining 20% in timber production. The land was extensively logged in the 1950s–1970s and now suffers from excessive sediment loading. After the logging boom, the land was sub-divided into 40 acre + parcels that were purchased by homesteaders and families participating in the back-to-the-land movement. Currently, the majority of residents live in rural sub-divisions and the primary land use practices include marijuana cultivation, ranching, homesteading, and forestry.

Watershed conditions and water diversions greatly impact coho-bearing creeks. Water diversions, pumping and continually relying on spring water during the dry months of summer are currently affecting water resources. Many parcels that once supported one family now have multiple curtilages and poorly maintained logging roads are now used daily by hundreds of residents contributing to chronic sediment problems.

The population of this rural enclave has nearly tripled since the 1960s and many people have moved here in hopes of capitalizing on the Green Rush. Many residents have increased their water storage for irrigation, light domestic use, and fire safety but they are not necessarily filing their water rights or forbearing from diverting water during the dry season. Climate change, drought, and the cumulative impacts of a multitude of unregulated water diversions will require regulatory compliance, and forbearance incentives.

The Redwood Creek watershed is primarily underlain by the diverse Coastal and Central belts of the Franciscan Complex, the younger marine and non-marine Wildcat Group, and minor amounts of serpentinized peridotite of the Coast Range Ophiolite (Figure 2). Most of the Redwood Creek watershed, is underlain by various subunits of the Eocene to Paleocene Yager terrane (Franciscan Complex Coastal Belt), which primarily consists of sheared and highly folded mudstone (McLaughlin et al. 2000). The mudstone includes minor rhythmically interbedded arkosic sandstone and local lenses of conglomerate. This lithology produces terrain with relatively irregular topography lacking a well-incised system of sidehill drainages when compared to other subunits of the Franciscan Complex Coastal Belt. The mudstone units also typically result in more wet-season runoff and less dry-season base flow than other Coastal Belt units comprised of fractured sandstone.

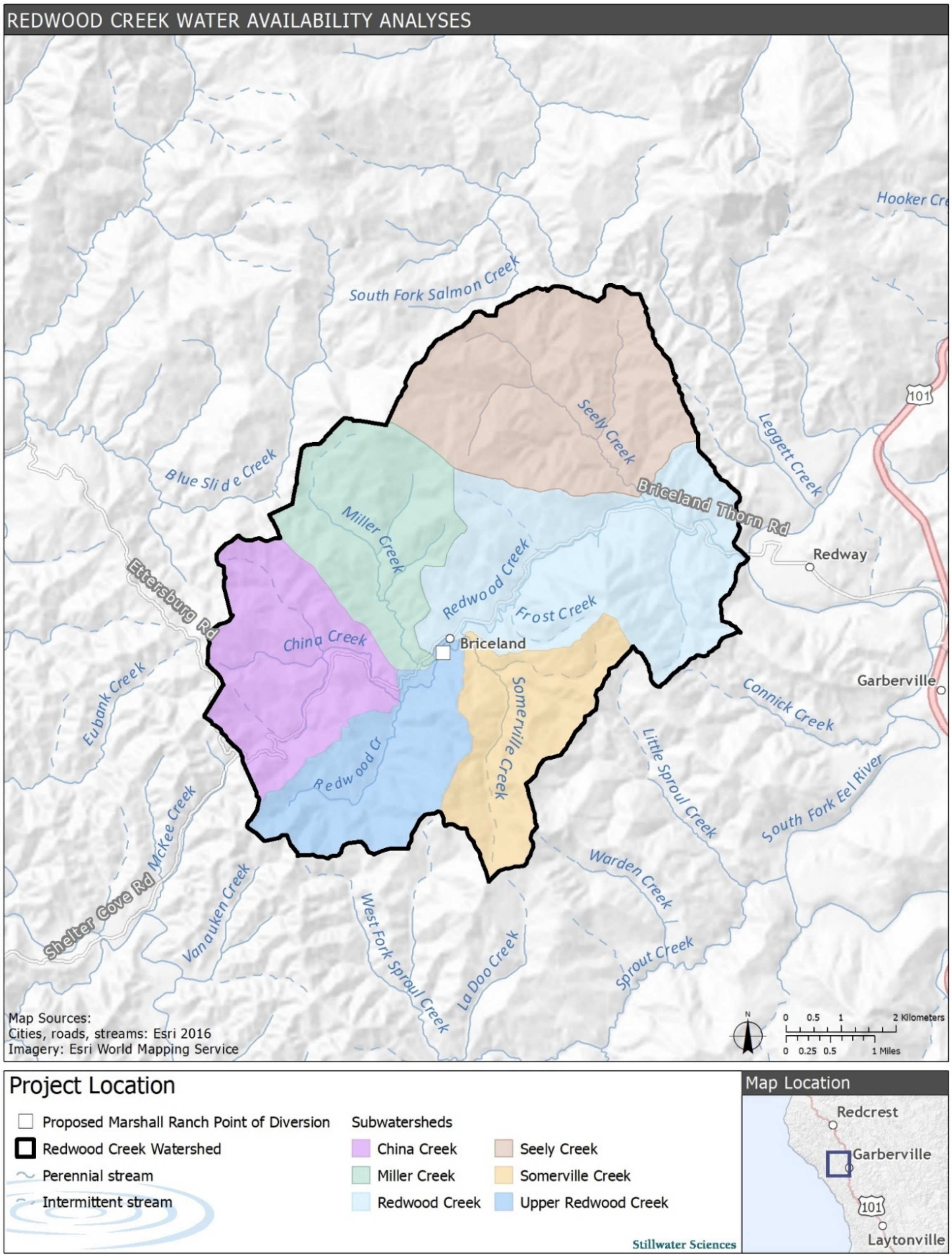

Figure 1. Redwood Creek watershed and sub-watersheds.

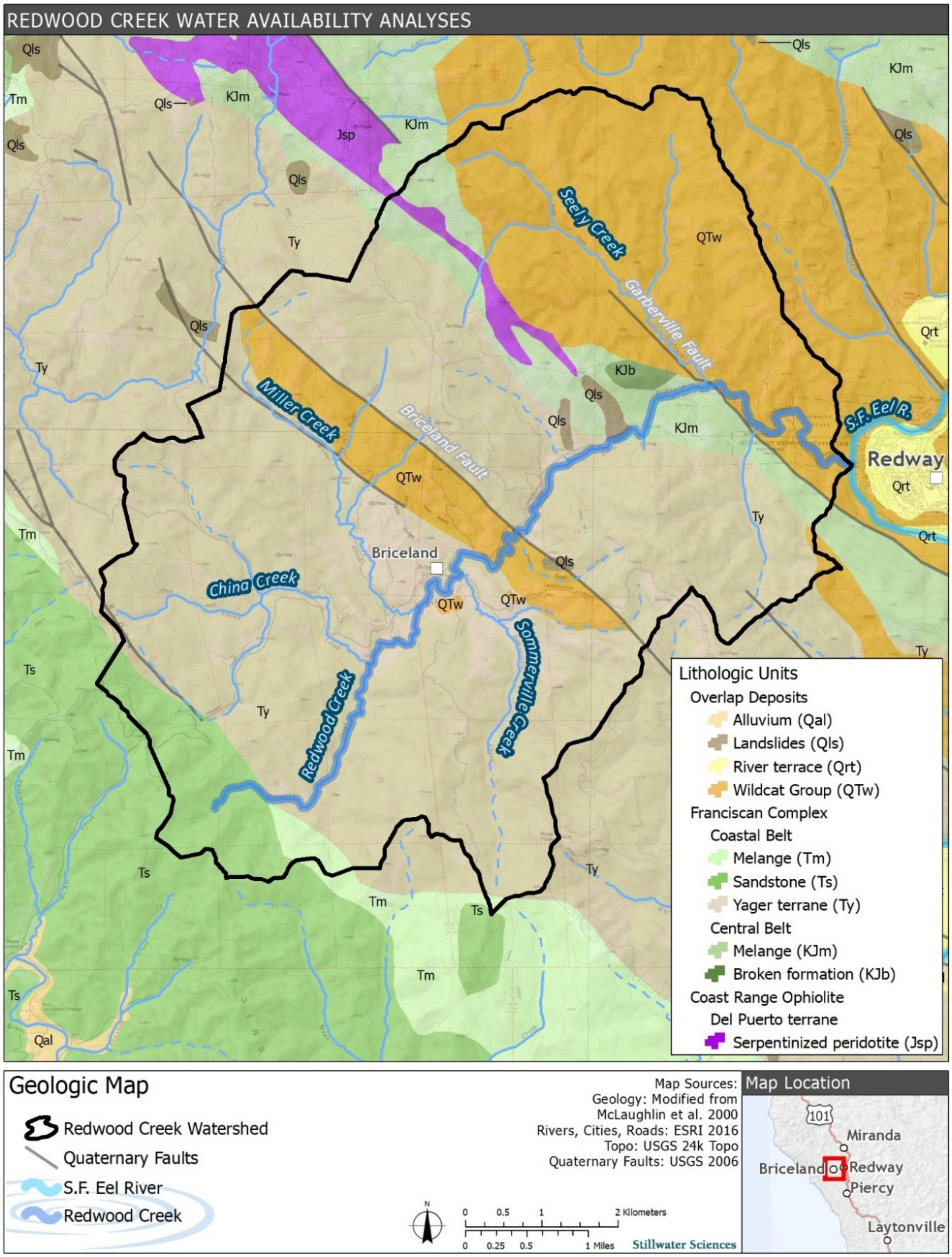

Figure 2. Generalized geologic map of the Redwood Creek watershed.

3 WATER BALANCE

Each of the primary drivers of the Redwood Creek water balance are described in detail below.

3.1 Precipitation

Rainfall data for the watershed was acquired from the Parameter-elevation Regressions on Independent Slopes Model (PRISM) developed the PRISM Climate Group out of Oregon State University. The model generates spatial climate datasets using monitoring data and state-of-the-art climate modeling techniques. Average annual precipitation based of the past 30 years of rainfall monitoring data is shown on Figure 3 and summarized on Table 1. In summary, Redwood Creek receives approximately 69.2 inches of precipitation annually. Typical of the Mediterranean climate, nearly all of this precipitation occurs in the form of rainfall during the winter and spring. The summer and early fall are characterized as warm and dry, with very minimal precipitation.

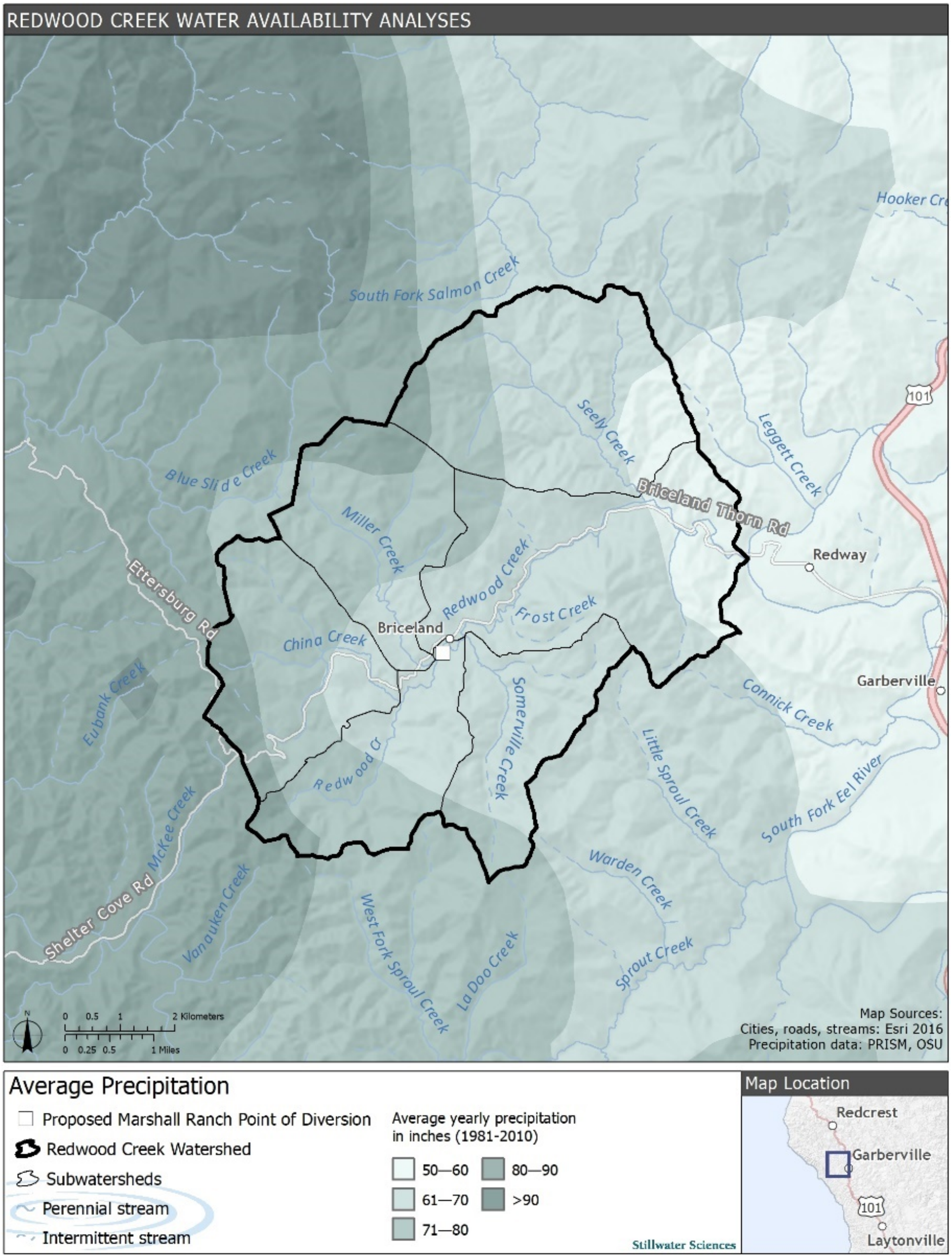

Figure 3. Redwood Creek watershed average annual precipitation.

Table 1. Summary of PRISM precipitation data.

Sub-watershed	Sub-watershed area (mi^2)	Average annual precipitation (inches)	Average annual input volume (ac-ft)
China Creek	3.9	74.9	15,669
Upper Redwood Creek	3.1	72.8	12,174
Miller Creek	3.7	84.1	16,429
Somerville Creek	3.0	67.3	10,846
Seely Creek	5.8	66.3	20,649
Mainstem Redwood Creek	6.4	63.8	21,654
Entire Redwood Creek watershed	25.9	69.2	95,728

3.2 Discharge

There are no flow gages that operate year-round on Redwood Creek, so the best way to determine discharge exiting the watershed during the winter is the proration method as described in the Policy for Maintaining Instream Flows in Northern California Coastal Streams (SWRCB 2014) referred to as "the Policy" hereon. As described in CDFW's Flow Monitoring and Unimpaired Flow Estimation Report for Redwood Creek, Humboldt County (Cowan 2018), the USGS Bull Creek gage near Weott provides a long record of streamflow that can be used to estimate the unimpaired flow in Redwood Creek. Bull Creek is a similar sized watershed located approximately 15 miles north of Redwood Creek. Bull Creek is believed to have remained relatively unimpaired since installation of the USGS gage (Cowan 2018). Results from the average Bull Creek flows (1960 to 2018) prorated to Redwood Creek are shown on Figure 4 as well as Tables 2 and 3.

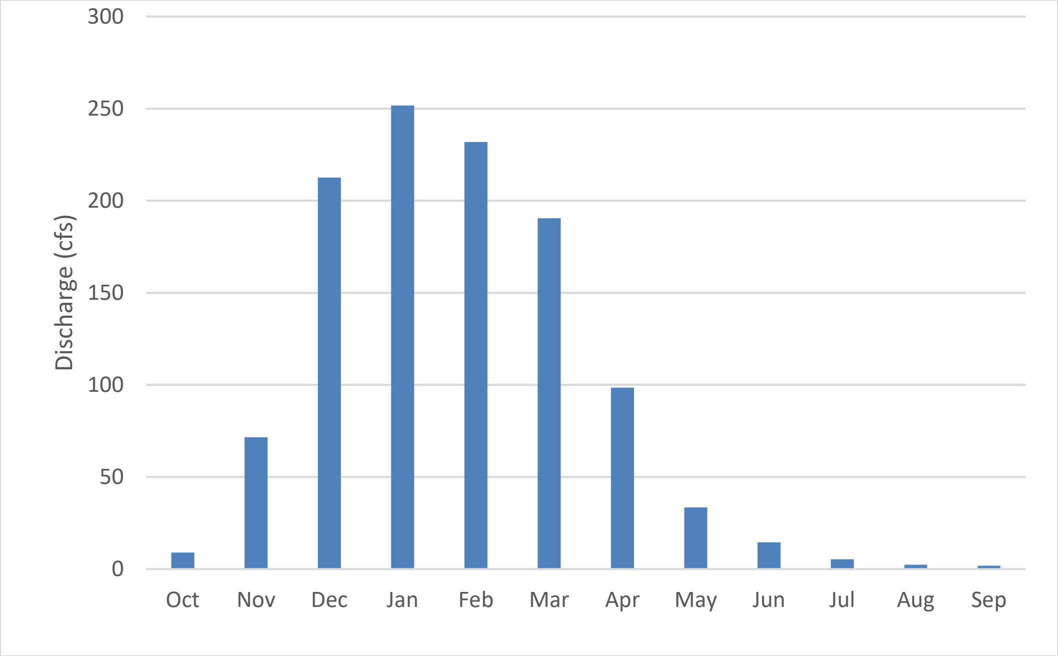

Figure 4. Graph of Redwood Creek average monthly streamflow prorated from Bull Creek gage.

Table 2. Summary of Annual Discharge in Redwood Creek based on proration from Bull Creek gage.

Sub-watershed	Sub-watershed area (mi^2)	Average annual discharge (cfs)	Average annual output volume (ac-ft)
China Creek	3.9	17.0	12,000
Upper Redwood Creek	3.1	13.2	10,000
Miller Creek	3.7	17.8	13,000
Somerville Creek	3.0	11.7	9,000
Seely Creek	5.8	22.4	16,000
Mainstem Redwood Creek	6.4	23.5	17,000
Entire Redwood Creek watershed	25.9	103.7	75,000

Table 3. Summary of wet season flows in Redwood Creek based on proration from Bull Creek gage.

Sub-watershed	Sub-watershed area (mi^2)	Average December output volume (ac-ft)	Average January output volume (ac-ft)	Average February output volume (ac-ft)	Average March output volume (ac-ft)	Average April output volume (ac-ft)
China Creek	3.9	2,387	2,826	2,603	2,069	2,387
Upper Redwood Creek	3.1	1,854	2,195	2,022	1,608	1,854
Miller Creek	3.7	2,502	2,963	2,729	2,170	2,502
Somerville Creek	3.0	1,652	1,956	1,802	1,432	1,652
Seely Creek	5.8	3,145	3,724	3,430	2,727	3,145
Mainstem Redwood Creek	6.4	3,298	3,905	3,597	2,859	3,298
Entire Redwood Creek watershed	25.9	14,580	17,264	15,900	12,641	14,580

As highlighted in Figure 4 as well as Tables 2 and 3 above, there is significant water available in Redwood Creek during the wet season generated by precipitation and extensive runoff. In addition to the wet-season discharge which has been prorated from the Bull Creek USGS gage data, SRF has been monitoring dry season flows in Redwood Creek beginning in 2013. The Redwood Creek gage locations are shown on Figure 5. Flow monitoring results for station RC-4, located near Redwood Creek's confluence with the south Fork Eel River, is shown on Figure 6. As this figure depicts, dry-season flows in Redwood Creek are extremely low with flows at RC-4 dropping below 10 gallons per minute during each of the last six dry seasons. Flows at all other monitoring stations throughout the watershed follow similar trends with zero flow recorded at the majority of monitoring stations during most years. Table 4 shows a comparison of dry-season flow measurements in Redwood Creek versus proration from Bull Creek.

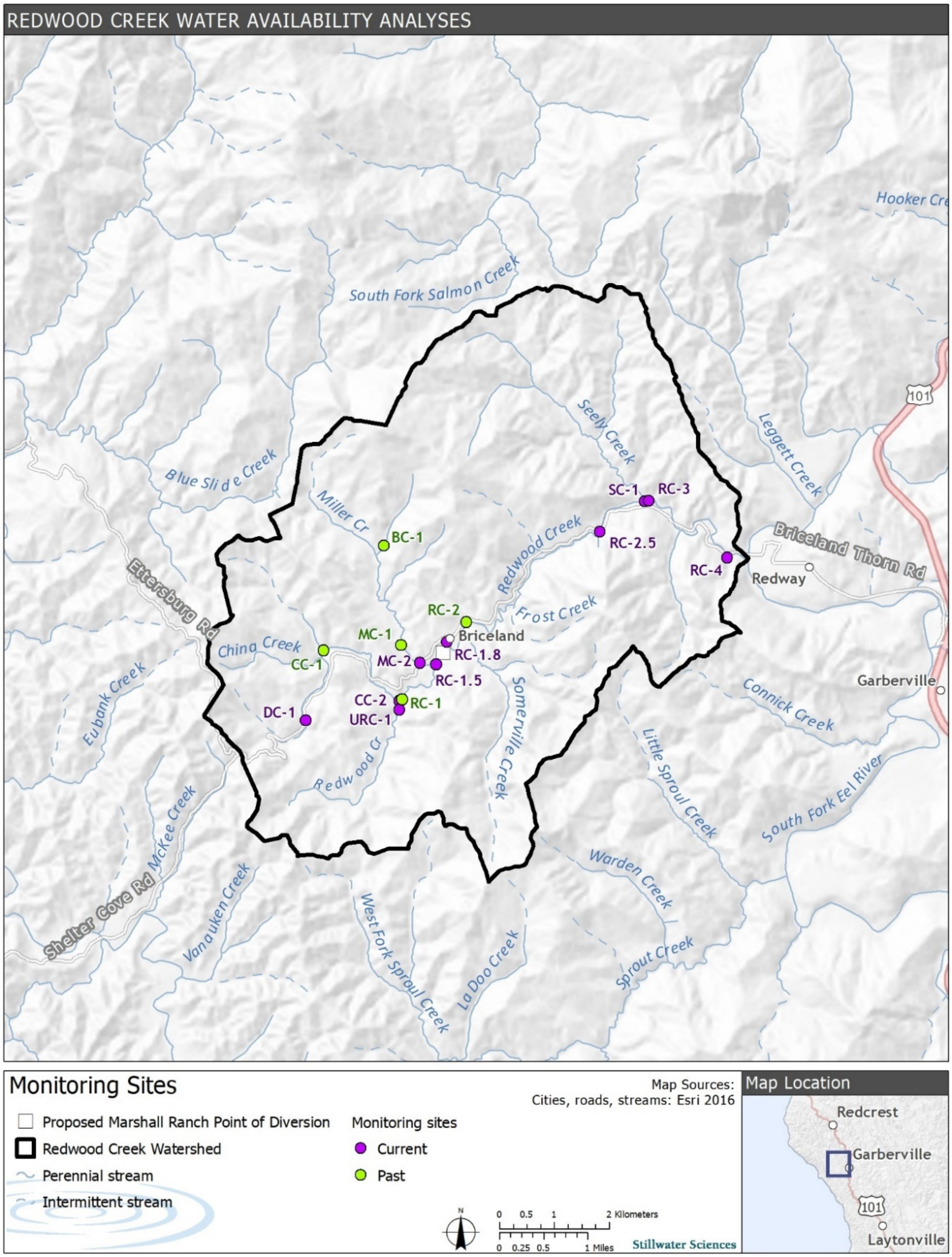

Figure 5. Dry season monitoring stations in Redwood Creek.

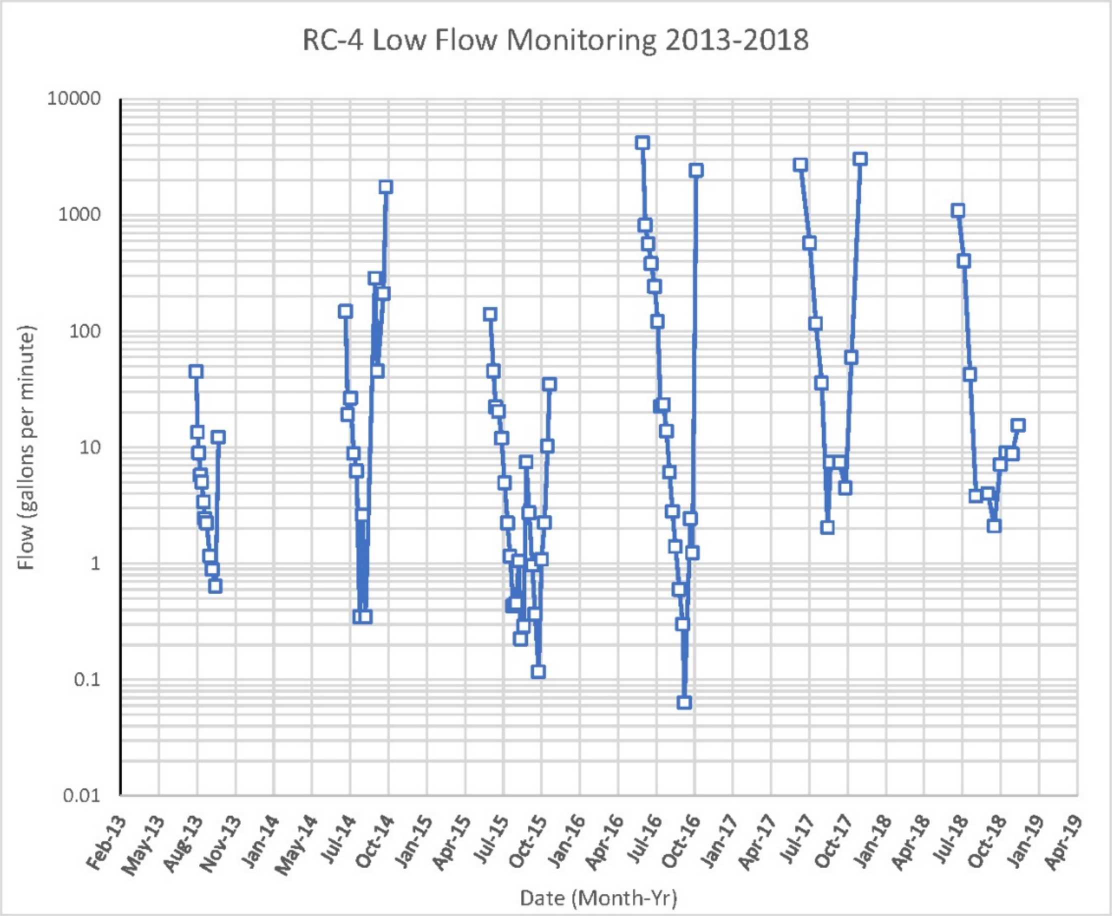

Figure 6. Dry season flow monitoring results for Redwood Creek mainstem near confluence with South Fork Eel.

Table 4. Comparison of dry-season flows measured in Redwood Creek and prorated from Bull Creek.

Sub-watershed	Sub-watershed area (mi^2)	Average July discharge measured (cfs)	Average July discharge prorated (cfs)	Average August discharge measured (cfs)	Average August discharge prorated (cfs)	Average September discharge measured (cfs)	Average September discharge prorated (cfs)
China Creek	3.92	0.20	0.97	0.01	0.44	NA	0.34
Upper Redwood Creek	3.14	0.29	0.76	0.01	0.34	0.00	0.27
Miller Creek	3.66	0.14	1.02	0.00	0.46	NA	0.36
Seely Creek	5.84	0.05	1.28	0.01	0.58	0.00	0.45
Entire Redwood Creek watershed	25.94	0.47	5.95	0.03	2.71	0.01	2.10

The Bull Creek discharge data was used to estimate the Redwood Creek unimpaired hydrograph because of similar watershed characteristics (size, precipitation, location, gradient) and because Bull Creek is believed to be relatively unimpaired since 1988 (Cowan 2018). Water diversions and other impairment likely play a role in the difference between the measured and prorated discharge averages in the summer months. However, other key differences between the watersheds may be factors in the difference including geology. Redwood Creek has more siltstone shale bedrock compared to more sandstone bedrock in Bull Creek that likely supports more robust dry season base flows. Additionally, the measured monthly averages for Redwood Creek were based off only a few measurements and may not accurately represent the monthly average flow, although monitoring results strongly support the overall trend that dry season flows in Redwood Creek are significantly lower than proration calculations would suggest.

3.3 Evapotranspiration

A significant portion of the precipitation in the basin returns to the atmosphere through evaporation or transpiration from vegetation in the watershed. It is difficult to quantify the actual evapotranspiration rates at the watershed scale but the evapotranspiration potential has been estimated by the California Irrigation Management Information System (CIMIS) developed by Department of Water Resources and UC Davis[1]. The group uses weather station data and complex models to delineate reference evapotranspiration zones across California. The reference evapotranspiration rate is the rate at which water evaporates and transpires from a well-watered reference grass crop. According to the map, the Redwood Creek watershed has an average annual reference evapotranspiration of 46.3 inches per year. The actual evapotranspiration rate in Redwood Creek watershed is likely significantly less because it does not have unlimited soil moisture and the vegetation is comprised of conifer forest, oak woodlands, shrublands, grassland and some agriculture.

3.4 Human Water Use

Stillwater Sciences conducted a Flow Enhancement Feasibility Study (Feasibility Study) for a portion of Redwood Creek between 2015 and 2017 (Stillwater Sciences 2017). During that study, human consumptive water use was estimated from a variety of sources as described below. In this report, the approach and data from Stillwater 2017 has been extrapolated out to all of Redwood Creek. It is important to note, that 2016/2017 was the peak of cannabis cultivation and a downswing in consumptive water use related cannabis has likely occurred over the past several years. However, considering that the objective of this report is not to determine precise consumptive use for cannabis, the data from Stillwater 2017 provides sufficient baseline information for the water balance.

As is the case with many rural areas with dispersed water sources and users, quantification of consumptive use is difficult. Considering this difficulty, in the Feasibility Study, Stillwater Sciences used several different approaches to quantify water use, including: (1) landowner responses to a water use survey conducted within the study area by SRF, (2) landowner responses from a survey conducted by Sanctuary Forest in the adjacent Mattole River watershed, (3) information reported in Bauer et al. 2015, and (4) new GIS analyses conducted within the study area that estimated water use based on area of agricultural cultivation determined from aerial imagery. Each approach for estimating water use is described below and summarized on Table 5.

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[1] https://cimis.water.ca.gov/Default.aspx

3.4.1 Landowner responses within the study area

A water use survey was sent to 100 residents within the study area. Response rate was 12%. Based on the 12 responses, average domestic (i.e. household) water use was 102 gallons per day and average irrigation use was 376 gallons per day for a total average water use of 478 gallons per day (Table 5). The low response rate and relatively low resulting estimate of average daily use suggests that many of the larger water users within the study area did not respond, and therefore it may not be appropriate to apply these results more broadly across the entire watershed area. Despite the limited sample size, the survey provided some interesting findings:

- Approximately half of respondents use a spring as their water source for domestic and irrigation water supply.
- Only 1/3 of the respondents have separate domestic and irrigation water systems.
- Half of respondents are currently forbearing for 3 or 4 months.
- Water storage capacity varied widely among respondents.

Table 5. Consumptive water use estimates.

Water use estimate approach	Estimated water use per parcel (gal/day)	Total water use per parcel during 5-month growing season (gal)
1) Redwood Creek water use survey	478	71,700
2) Upper Mattole water use survey	708	106,200
3) CDFW data for Study Area (from Bauer et. al. 2015)	725	108,750
4) Updated GIS analyses of study area	925	138,750

3.4.2 Landowner responses from adjacent watersheds

A water survey of 40 residents in the upper Mattole River resulted in an average estimated water use of 708 gallons per day during the 6-month dry season (Table 5) (Trout Unlimited 2013[2]). Results from this survey are applicable to the Redwood Creek study area considering that the upper Mattole River is located directly adjacent to, and west of the Redwood Creek study area and the Mattole watershed has many of the same physiographic, ecological, and land use characteristics.

3.4.3 Compilation of CDFW data for the Redwood Creek study area

Using the mapping and assumptions of Bauer et al. (2015), Stillwater Sciences estimated cannabis-related water use within the Redwood Creek feasibility study area. The approach involved GIS overlay of the study area boundary and the Bauer et al. (2015) mapping. Estimates of cannabis irrigation on 77 parcels in the study area averaged 425 gallons per day (excludes parcels serviced with water from the Briceland Community Service District). This included approximately 36,000 ft^2 of greenhouse and 2,200 outdoor cannabis plants. When average domestic use of approximately 300 gallons per day per parcel was added, the average water use

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[2] Trout Unlimited. 2013. Mattole River Headwaters Streamflow Improvement Plan.

determined through this method is 725 gallons per day (Table 1). The results of this analysis were generally consistent with results from the upper Mattole River survey.

3.4.4 Updated GIS analyses

Since estimates of water use for cannabis cultivation by Bauer et al. (2015) was based on 2012 aerial imagery, the desktop GIS analyses of water use within the study area was updated based on 2014 aerial imagery. This analyses considered consumptive water use for cannabis cultivation, as well as other land uses (e.g., vegetable gardens and landscaping). Primary results of the analyses include:

- Greenhouse square footage 53,000 (increase of 17,000 square feet from 2012 to 2014)
- Outdoor cannabis plants 2,800 (increase of 600 from 2012 to 2014).
- ~5.6 acres of vegetable gardens, orchards, and vineyards that weren't included in CDFW analyses.

Estimated water use (gallons per day) was then updated using these data and the following assumptions:

- Input from cultivators suggests cannabis plants in greenhouses typically require 3 gallons per day (lower than that estimated by Bauer et al. [2015]).
- Cultivation of outdoor cannabis plants typically requires 6 gallons per day per, a relatively high estimate that accounts for inefficiencies evident in many irrigation systems.
- For other irrigated areas the following formula was used:

(Eto x PF x SF x 0.62) / IE =Gallons of Water per day[3]

Where:

Eto = evapotranspiration factor. Taken from http://www.rainmaster.com/historicET.aspx and using zip code 95553 a value of 0.16 is obtained.

PF = plant factor. Typically, a value of 1.0 is used for lawn 0.80 for water loving shrubs, 0.5 for average water use shrubs, and 0.3 for low water use shrubs (0.5 was used).

SF = irrigated area (square feet).

0.62 = constant.

IE = irrigation efficiency factor. This value compensates for irrigation water that isn't used by the plant. Efficient sprinkler systems with little run-off can have efficiencies of 80%. Drip irrigation systems typically have efficiencies of 90%. (A value of 0.75 was used to account for general leakage and inefficiencies seen in most rural water systems).

Based on these assumptions and calculations, the average water use per parcel was 625 gallons per day for irrigation. Irrigation for cannabis cultivation accounts for 66% and non-cannabis irrigation accounts for 34% of total estimated irrigation use. When domestic use of 300 gallons per day is included, the total estimated water use per parcel increases to 925 gallons per day (Table 5). Over the five-month dry season, this equals 93,750 gallons of irrigation water and 45,000 gallons of domestic water.

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[3] http://www.irrigationtutorials.com/how-to-estimate-water-useage-required-for-an-irrigation-system/

Based on these analyses, 1,000 gallons per day per parcel is a reasonable and conservative estimate for total water use within the feasibility study area (as used in the target flow memorandum).

The analyses from the Feasibility Study was extrapolated out to the rest of the Redwood Creek watershed and utilized to populate the data shown on Table 6.

Table 6. Consumptive water use estimates by sub-watershed.

Sub-watershed	Sub-watershed area (mi^2)	Number of parcels	Total water use per sub-shed during 5-month dry season (ac-ft)*	Total water use during 3.5-month wet season (ac-ft)**	Demand volume (face value) of upstream appropriative water right diversions (af/yr)	% winter flow impairment***
China Creek	3.9	58	26.7	5.6	13.4	0.06%
Upper Redwood Creek	3.1	24	11.0	2.3	0.2	0.01%
Miller Creek	3.7	46	21.2	4.4	6.8	0.04%
Somerville Creek	3.0	18	8.3	1.7	0.3	0.01%
Seely Creek	5.8	61	28.1	5.9	13.3	0.05%
Redwood Creek (mainstem)	6.4	134	61.7	13.0	20.9	0.08%
Entire Redwood Creek Watershed	25.9	341	157.0	33.0	54.8	0.05%

* Based on estimate of 1000 gal/day/parcel over 5-month dry season

** Based on estimate of 300 gal/day/parcel over 3.5-month diversion season

*** Sum of estimated water use during 3.5-month diversion season and appropriative diversion volume as percentage of 3.5-month unimpaired discharge volume (prorated from Bull Cr. Gage).

3.4.5 State Water Board water use reporting data

The State Water Board's EWRIMS website shows all registered water use in Redwood Creek (Figure 7). Human consumptive use water demand is mainly during dry season (Riparian Water Rights) with the exception of Appropriative Water Rights users that fill up storage during the wet season. Water users with Riparian Water Rights typically use very small amounts of water in winter for domestic use only because they are not legally allowed to divert and store water for more than 30 days. A list of all Appropriative Water Rights holders in Redwood Creek is shown on Table 7.

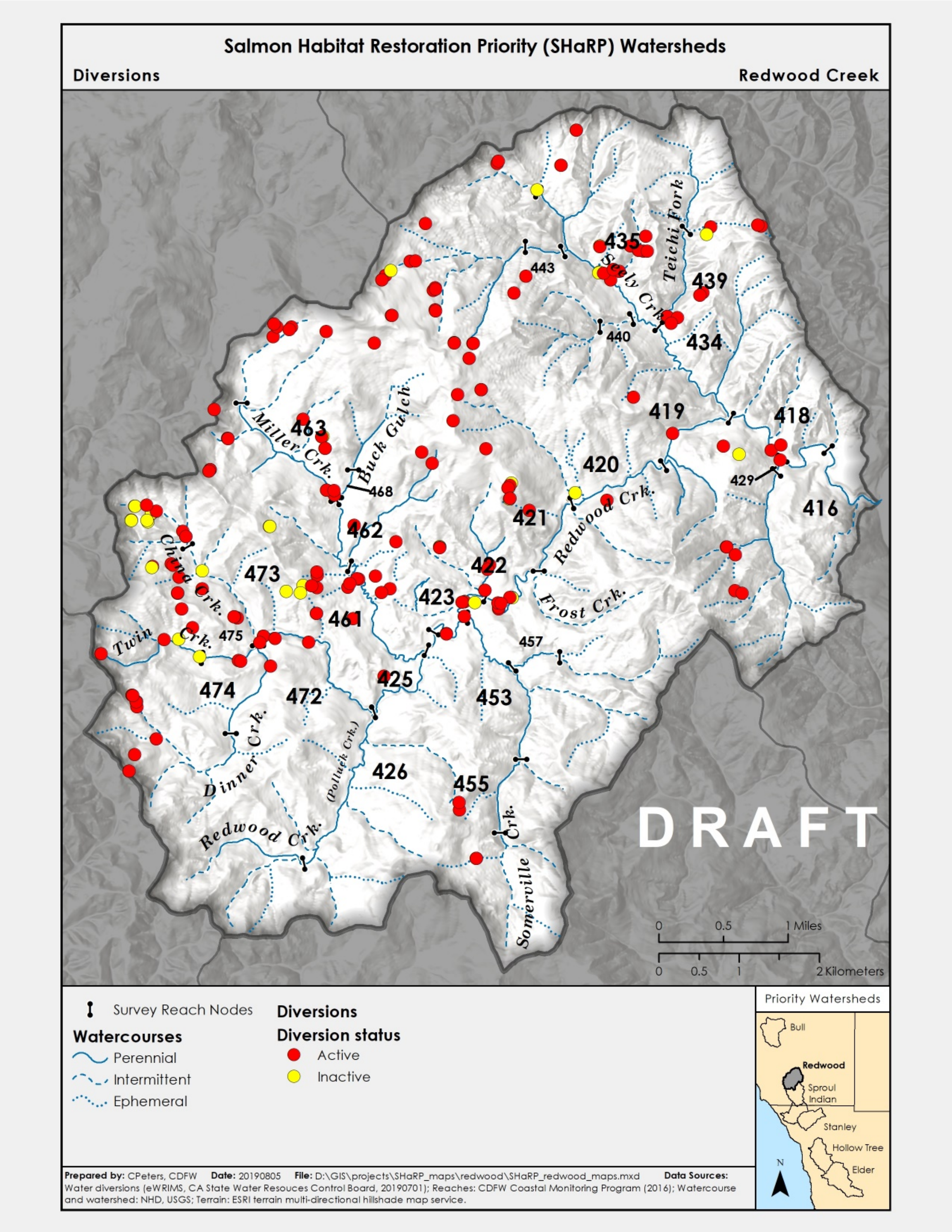
Table 7. List of appropriative water rights.

Application ID	Water right type	Owner	Latitude	Longitude	Source	Face value (ac-Ft)
China Creek Sub-Watershed						
D032319	Registration Domestic	Allyson V. Provisor	40.0905	-123.946	Unnamed Spring	0.13
D032721	Registration Domestic	Frank Canning	40.11697	-123.938	China Creek	0.82
D032176	Registration Domestic	Leonard Anderson	40.1088	-123.939	Unnamed Spring	1.1
H500703	Registration Cannabis	Loren Neufel	40.103	-123.93	China Creek	0.23
H503715	Registration Cannabis	Shannon Martin	40.1106	-123.939	Unnamed Spring	0.61
D032338	Registration Domestic	Charles Butterworth	40.1203	-123.946	Unnamed Spring	0.2
D032600	Registration Domestic	Mir Holmes	40.1034	-123.936	China Creek	0.45
D032339	Registration Domestic	Charles Butterworth	40.11978	-123.943	China Creek	0.32
H502403	Registration Cannabis	Nocona Mendes	40.0983	-123.945	Unnamed Spring	0.55
D032082	Registration Domestic	Charles Liphart	40.1058	-123.927	China Creek	8.07
D032233	Registration Domestic	Robin Downing	40.1084	-123.919	Unnamed Stream	0.2
D032239	Registration Domestic	Jerry Sevier	40.11341	-123.943	China Creek	0.0916
D032873	Registration Domestic	Geraldine Fitzgerald	40.1137	-123.94	Unnamed Spring	0.12
D032428	Registration Domestic	Nocona Mendes	40.09776	-123.945	Unnamed Drainage	0.47
Upper Redwood Creek Sub-Watershed						
H500603	Registration Cannabis	MMF Land VI LLC	40.1063	-123.9	Redwood Creek	0.18
Miller Creek Sub-Watershed						
D032432	Registration Domestic	William Rolff	40.1182	-123.926	Unnamed Stream	0
H504852	Registration Cannabis	Eric Moore	40.11089	-123.909	Unnamed Stream	0.64
D032281	Registration Domestic	Laura Glauberman	40.1283	-123.918	Unnamed Spring	1.4
H504579	Registration Cannabis	Aaron Lieberman	40.1403	-123.923	Unnamed Spring	2.14
D032443	Registration Domestic	George Truett	40.11185	-123.914		1.69
H500861	Registration Cannabis	Elizabeth Worley	40.1223	-123.918	Unnamed Spring	0.46
D032221	Registration Domestic	Dale Harper	40.1116	-123.921	Unnamed Spring	0
D032402	Registration Domestic	Johanna M. Hamel	40.12702	-123.918	Unnamed Spring	0.47

Application ID	Water right type	Owner	Latitude	Longitude	Source	Face value (ac-Ft)
Sommerville Creek Sub-Watershed						
H503686	Registration Cannabis	Garrett Gradin	40.0811	-123.895	Unnamed Spring	0.31
Seely Creek Sub-Watershed						
D032296	Registration Domestic	Hal Hale	40.147	-123.878	Seely Creek	0
H500701	Registration Cannabis	Shanon Taliaferro	40.1422	-123.868	Seely Creek	0.54
D032341	Registration Domestic	Shanon Taliaferro	40.15234	-123.862	Seely Creek	1.04
D032268	Registration Domestic	Charley Custer	40.1471	-123.909	Seely Creek	0
D033045	Registration Domestic	Nancy Johnson	40.1526	-123.855	Unnamed Spring	0.8
H504958	Registration Cannabis	Enoch Tatton	40.14203	-123.908	Unnamed Spring	0.6
D032323	Registration Domestic	Cameron Cleaves	40.1501	-123.874	Leaf Spring	0.33
H500477	Registration Cannabis	Kelsey Beehrle	40.139	-123.899	Unnamed Spring	0.15
D032733	Registration Domestic	Kathleen M Gray	40.1591	-123.884	Yellow Brick Spring	0
D032687	Registration Domestic	Juan Arellano	40.13899	-123.896	Unnamed Spring	0.3
D032342	Registration Domestic	Shanon Taliaferro	40.14221	-123.868	Seely Creek	1.23
D032588	Registration Domestic	Douglas M. Rose	40.139	-123.899		3.5
H500917	Registration Cannabis	Utah Blue	40.1426	-123.902	Unnamed Stream	0.06
D032130	Registration Domestic	Hunter Blackwell	40.1563	-123.887	Seely Creek	1.42
D032744	Registration Domestic	Kathleen M Gray	40.1631	-123.882	Unnamed Spring	0
H503674	Registration Cannabis	Hal Hale	40.14744	-123.876	Unnamed Stream	0.64
H502512	Registration Cannabis	Cameron Cleaves	40.14953	-123.871	Unnamed Spring	0.69
D032295	Registration Domestic	Hal Hale	40.14627	-123.876	Seely Creek	1.33
H500765	Registration Cannabis	Enoch Tatton	40.145	-123.902	Unnamed Spring	0.63
Lower Redwood Creek Sub-Watershed						
D032404	Registration Domestic	Peter Holbrook Living Trust	40.11123	-123.894	Tank Gulch Creek	0.35
H503718	Registration Cannabis	Thomas Hayes	40.1338	-123.895	Unnamed Spring	0.38
H500723	Registration Cannabis	Katherine Wolman	40.1098	-123.892	Redwood Creek	0.18
D032298	Registration Domestic	Cecelia A. Lanman	40.1105	-123.891	Redwood Creek	1.49
H503616	Registration Cannabis	Lisa Deloury	40.1338	-123.895	Unnamed Spring	0.2

Application ID	Water right type	Owner	Latitude	Longitude	Source	Face value (ac-Ft)
D032321	Registration Domestic	Mikal Jakubal	40.1098	-123.896	Redwood Creek	0.23
H500876	Registration Cannabis	Tao Ryce	40.11552	-123.858	Unnamed Stream	0.32
A010198	Appropriative	John R Foster	40.12728	-123.853	Unst	13.4
H503694	Registration Cannabis	John Neill	40.116	-123.901	Unnamed Stream	0.29
D032162	Registration Domestic	Christopher Hinderyckx	40.1268	-123.857	Unnamed Stream	0.7
D032501	Registration Domestic	Cathy Studebaker	40.12279	-123.891	Unnamed Spring	0
D032729	Registration Domestic	John Neill	40.11601	-123.901	Unnamed Spring	0.25
D032407	Registration Domestic	Katherine Wolman	40.1098	-123.892	Redwood Creek	0.41
H501958	Registration Cannabis	Sarah Clarke	40.1279	-123.851	Unnamed Spring	0.13
D032950	Registration Domestic	Cathy Studebaker	40.1216	-123.891	Unnamed Spring	0.61
D032179	Registration Domestic	Michael Labonte	40.1099	-123.897	Unnamed Stream	1.95

A summary of Water Rights data by sub-shed is shown on Table 8.



Prepared by: CPeters, CDFW **Date:** 20190805 **File:** D:\GIS\projects\SHaRP_maps\redwood\SHaRP_redwood_maps.mxd **Data Sources:** Water diversions (eWRIMS, CA State Water Resouces Control Board, 20190701); Reaches: CDFW Coastal Monitoring Program (2016); Watercourse and watershed: NHD, USGS; Terrain: ESRI terrain multi-directional hillshade map service.

Figure 7. Registered Points of Diversion within the Redwood Creek Watershed (figure courtesy of CDFW).

Table 8. Summary of Water Rights by sub-watershed.

Sub-watershed	Sub-watershed area (mi^2)	# riparian water rights	# appropriative water rights	Total volume appropriative water rights (ac-ft)
China Creek	3.9	26	14	13.36
Upper Redwood Creek	3.1	2	1	0.18
Miller Creek	3.7	23	8	6.80
Somerville Creek	3.0	4	1	0.31
Seely Creek	5.8	24	19	13.26
Mainstem Redwood Creek	6.4	21	16	20.89
Entire Redwood Creek watershed	25.9	100	59	54.80

4 WATER AVAILABILITY ANALYSIS FOR REDWOOD CREEK

As described above in this report, due to the Mediterranean climate within Redwood Creek there is extensive runoff from the watershed during the wet season and generally insufficient instream flows to support aquatic habitat and human consumptive use during portions of the dry season. Below, wet season water availability in each of the six tributary areas are further analyzed to spatially define the amount of unappropriated water available during the wet season.

4.1 Water Supply and Diversions in Redwood Creek

The quantity of water instream after appropriated senior water right is summarized in Table 9 below. Overall, appropriated senior water rights represent a very small percentage of wet-season instream flows (<0.1% of total discharge in all sub-watersheds during the Dec 15–Mar 31 period). The season of diversion was assumed to be December 15-March 31 because this is the allowed period for new diversions under the Policy for Maintaining Instream Flows in Northern California Coastal Streams (SWRCB 2014) which has been applied to the neighboring Mattole watershed. However, the SWRCB Instream Flow Policy also allows for site specific studies to extend the allowable season of diversion (SWRCB 2014). This provides a conservative estimate of the percent of discharge impairment because the existing water diversions in Redwood Creek are not necessarily confined to this diversion season.

Table 9. Wet Season Water Impairment by sub-watershed.

Watershed	Area (mi2)	Average precipitation (inches)	Average discharge Dec 15–Mar 31 (cfs), prorated from Bull Cr.	Average outflow from Dec 15–Mar 31 (af/yr), prorated from Bull Cr.	Wet season (Dec 15–Mar 31) demand volume of all upstream diversions (af/yr)	% wet season (Dec 15–Mar 31) flow impairment
China Creek	3.9	74.9	41.7	30163.5	19.0	0.06%
Upper Redwood Creek	3.1	72.8	32.4	23434.4	2.5	0.01%
Miller Creek	3.7	84.1	43.7	31626.2	11.2	0.04%
Somerville Creek	3.0	67.3	28.8	20879.2	2.1	0.01%
Seely Creek	5.8	66.3	54.9	39749.3	19.2	0.05%
Redwood Creek (mainstem)	6.4	63.8	57.6	41684.2	33.8	0.08%
Entire Redwood Creek Watershed	25.9	69.2	254.5	184276.8	87.8	0.05%

Total estimated wet season discharges from 1960 to 2017 are shown on Figure 8. As shown on Tables 9 above, the percentage of unappropriated water supply available during the wet season is high throughout the watershed. Therefore, the potential to cause injury to downstream water users is low, and these analyses should focus on setting diversion criteria that reduce risk to aquatic habitat throughout the watershed. At a minimum, the following criteria should be met:

- No significant diversion when flows are below “non-stressful rearing habitat” target of 0.2 CFS per square mile (Stillwater Sciences 2017).
- Typical wet-season diversion rate should be less than 5% of total flow.

Note that these are general guidelines and should be assessed on a case-by-case basis depending on the location of a proposed point of diversion and the purpose for which the diverted water will be used.

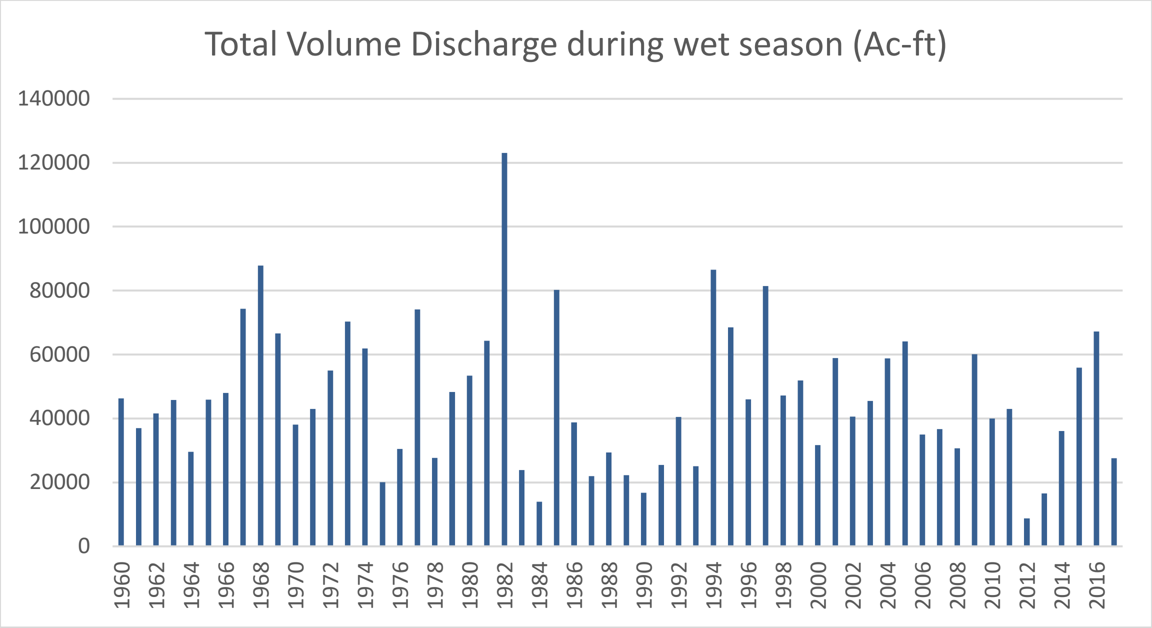


Figure 8. Total wet season unimpaired flow volume for Redwood Creek—1960 to present (prorated from Bull Creek).

5 WATER AVAILABILITY ANALYSIS FOR MARSHALL RANCH

In addition to conducting a water availability analyses for all of Redwood Creek, this technical report presents specific information to support a large-scale flow enhancement project on the Marshall Ranch.

5.1 Project Purpose and Description

The Marshall Ranch Flow Enhancement Project proposes construction of a 16 million gallon off-channel pond and cooling gallery with the primary objective of delivering approximately 50 gallons per minute of flow augmentation to Redwood Creek during the 5-month dry season to improve instream aquatic habitat.

In addition to filling with precipitation that falls on the 4.6 acre pond and 2.5 acre hillslope, it is proposed that the pond will also be filled with water diverted/pumped from Redwood Creek during the wet season. The proposed diversion is rate is 100 gallons per minute with a maximum annual diversion of 10,000,000e gallons. The expected effects of the diversion from Redwood Creek during the wet season and augmentation to Redwood Creek during the dry season are shown in the hydrograph in Figure 9 below. The hydrograph was developed by prorating average daily flows from the Bull Creek gage data to the proposed diversion watershed. As shown in Figure 9, the proposed diversion during the wet season results in a change to the hydrograph that is likely not measurable, while the flow augmentation is significant with downstream flows increasing from 0 to 0.11 cfs (50 gpm).

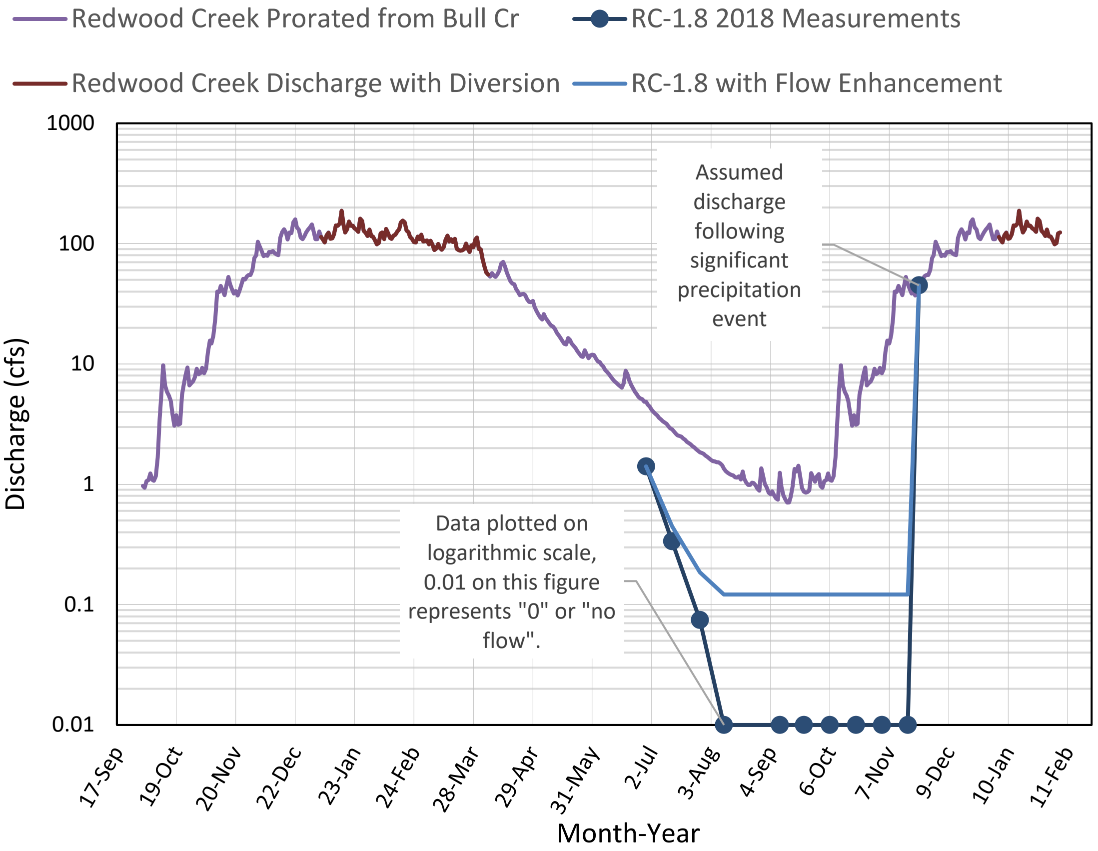


Figure 9. Prorated average “unimpaired” hydrograph with measured low flows and expected effects of diversion and flow enhancement.

5.2 Water Supply Report for Marshall Ranch

The location of the proposed Marshall Ranch diversion is shown on Figure 1. This proposed point of diversion (POD) will draw water from the Miller Creek, China Creek, and Upper Redwood Creek sub-watersheds also shown in Figure 1. Water availability at the proposed POD is shown on Table 10. The first row shows the existing upstream diversions accounting for 0.04% of the total wet season flow. The second row shows the percentages if the proposed diversion is added. Nearly doubling the total appropriative right face value, the new diversion and all existing upstream diversions would amount to less than 0.1% of the unimpaired wet season discharge volume.

5.3 Cumulative Diversion Analysis

There are five active appropriative water rights and six claimed riparian diversions on Redwood Creek downstream from the proposed Marshall Ranch diversion. The active appropriative rights are listed below in Table 11. In total, the downstream diversions amount to 15.66 acre-feet diversion volume per year.

Table 10. Redwood Creek appropriative diversions downstream of proposed diversion application ID.

	Water right type	Owner	Latitude	Longitude	Source	Face value (ac-ft)
H500723	Registration Cannabis	Katherine Wolman	40.1098	-123.892	Redwood Creek	0.18
D032298	Registration Domestic	Cecelia A. Lanman	40.1105	-123.8907	Redwood Creek	1.49
A010198	Appropriative	John R Foster	40.127284	-123.852584	UNST	13.4
H500603	Registration Cannabis	MMF Land Vi Llc	40.1063	-123.8999	Redwood Creek	0.18
D032407	Registration Domestic	Katherine Wolman	40.1098	-123.8924	Redwood Creek	0.41

Although the proposed diversion is not within the SWRCB Instream Flow Policy's jurisdiction, the regionally protective criteria outlined in the Policy provide a useful reference. The Policy states that the maximum cumulative diversion should be 5% of the 1.5-year peak flow. The Policy also outlines a minimum bypass flow equation of 8.8*(mean annual unimpaired flow)*(drainage area)^-0.47 which is 138 cfs at the proposed Marshall Ranch point of diversion. On average, the unimpaired Redwood Creek hydrograph only reaches 138 cfs on 34 days during the year.

In 2019, the project team proposed diversion at lower flows than the SWRCB Policy allows. However, regulatory agency staff provided feedback during the Marshall Ranch 2020 TAC meeting that they would prefer more diversion volume at higher flows. Based on this guidance, the proposed pump for the Redwood Creek diversion has been upsized so that the diversion schedule can generally comply with the SWRCB Policy that allows for diversion of approximately 30 days/year.

However, it is also recommended that the diversion permit conditions are negotiated to provide flexibility during dry years where high flow events are less frequent, because these conditions often coincide with years where dry-season flow enhancement is most needed.

Table 11. Water supply/availability for Marshall Ranch Flow Enhancement Project.

Watershed	Area (mi2)	Average precipitation (inches)	Average discharge Dec 15–Mar 31 (cfs), prorated from Bull Cr.	Average outflow from Dec 15–Mar 31 (af/yr), prorated from Bull Cr.	Wet season (Dec 15–Mar 31) demand volume of all upstream diversions (af/yr)	% wet season flow impairment
Redwood Creek at Marshall Ranch (includes Miller Cr, China Cr, and Upper Redwood Creek subsheds)	10.7	77.3	117.7	85224.2	32.7	0.04%
Redwood Creek at Marshall Ranch with proposed Diversion	10.7	77.3	117.7	85224.2	63.4	0.07%

5.4 Expected Project Benefits

As previously described, this project will deliver ~50 gallons per minute of flow augmentation to Redwood Creek with the purpose of enhancing aquatic. Recent flow enhancement initiatives in lower Russian River tributaries are analogous to this Project and have displayed that directly augment is one of the most successful approaches to date for enhancing dry-season streamflow. Flow releases from three different agricultural ponds in Sonoma County exhibit encouraging results. As described in Ruiz et al. (2019) of California Sea Grant, the project began in 2015 and is ongoing. Data show that flow augmentations in all years from 2015–2018 were able to appreciably increase wetted channel habitat, increase dissolved oxygen in the stream water, and decrease water temperature downstream from the flow augmentation release points. For example, releases into Dutch Bill Creek averaging 36 GPM beginning in late August of 2015 and were able to cumulatively re-wet more than 2,300 feet of stream channel with effects measurable up to 1.8 miles downstream.

While modest compared to winter flows, these augmentations have the potential to increase pool connectivity and water quality. A foundational hypothesis for this Project, that increased pool connectivity will bolster over-summer salmonid survival, is also supported by the work of Obedzinski et al. (2018). Their study found that days of disconnected surface flow showed a strong negative correlation with juvenile coho salmon survival rate in four tributaries to the Russian River. Provided this evidence, it is anticipated that the Project's release of approximately 50 gallons per minute into Redwood Creek throughout the dry season can result in significant aquatic habitat benefit.

6 REFERENCES

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Appendix D

HEC-RAS Hydraulic Model Outputs

HEC-RAS Plan: Marshall River: REDWOOD Reach: REDWOOD CREEK BR

Reach	River Sta	Profile	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Vel Total	Shear LOB	Shear ROB	Shear Total	Flow Area	Top Width	Froude # Chl
			(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(ft/s)	(lb/sq ft)	(lb/sq ft)	(lb/sq ft)	(sq ft)	(ft)	
REDWOOD CREEK BR	3496	Summer	563.39	563.39	563.44	0.059626	1.66	1.66			0.41	0.60	5.44	0.88
REDWOOD CREEK BR	3496	Winter	565.50		565.56	0.003932	1.93	1.93			0.26	45.62	42.64	0.33
REDWOOD CREEK BR	3496	0.5 Bankfull	567.98		568.08	0.001594	2.53	2.53			0.31	158.18	48.22	0.25
REDWOOD CREEK BR	3496	1.5-yr	569.65		569.82	0.001745	3.31	3.31			0.47	241.97	51.69	0.27
REDWOOD CREEK BR	3496	2-yr	570.86		571.10	0.001915	3.93	3.93	0.02		0.62	305.60	53.81	0.29
REDWOOD CREEK BR	3496	5-yr	572.68		573.06	0.002141	4.95	4.91	0.11	0.05	0.84	407.03	58.41	0.32
REDWOOD CREEK BR	3496	10-yr	573.58		574.05	0.002282	5.51	5.42	0.16	0.11	0.95	460.97	61.90	0.34
REDWOOD CREEK BR	3496	25-yr	574.12		574.65	0.002376	5.86	5.73	0.19	0.15	1.02	495.32	64.37	0.35
REDWOOD CREEK BR	3496	50-yr	574.93		575.56	0.002522	6.40	6.19	0.25	0.22	1.15	549.03	67.51	0.36
REDWOOD CREEK BR	3496	100-yr	575.34		576.02	0.002594	6.67	6.42	0.27	0.27	1.22	576.42	68.56	0.37
REDWOOD CREEK BR	3359	Summer	563.32		563.32	0.000002	0.05	0.05			0.00	20.61	17.58	0.01
REDWOOD CREEK BR	3359	Winter	565.33		565.36	0.000735	1.39	1.39			0.10	63.52	25.67	0.16
REDWOOD CREEK BR	3359	0.5 Bankfull	567.74		567.85	0.001774	2.64	2.64			0.34	151.28	45.20	0.25
REDWOOD CREEK BR	3359	1.5-yr	569.37		569.56	0.002121	3.48	3.48			0.54	229.59	51.25	0.29
REDWOOD CREEK BR	3359	2-yr	570.54		570.80	0.002412	4.10	4.10			0.71	292.39	55.80	0.32
REDWOOD CREEK BR	3359	5-yr	572.33		572.72	0.002850	5.02	5.02			1.00	398.75	63.51	0.35
REDWOOD CREEK BR	3359	10-yr	573.23		573.69	0.002909	5.48	5.47	0.04	0.03	1.11	457.06	66.63	0.36
REDWOOD CREEK BR	3359	25-yr	573.77		574.29	0.002931	5.77	5.75	0.08	0.07	1.16	494.04	69.95	0.37
REDWOOD CREEK BR	3359	50-yr	574.58		575.18	0.002985	6.23	6.16	0.17	0.12	1.25	552.27	73.40	0.38
REDWOOD CREEK BR	3359	100-yr	574.98		575.63	0.003016	6.46	6.36	0.22	0.14	1.31	581.85	74.21	0.38
REDWOOD CREEK BR	3260	Summer	563.28	563.28	563.32	0.098481	1.55	1.55			0.42	0.65	9.53	1.05
REDWOOD CREEK BR	3260	Winter	565.24	564.04	565.27	0.001128	1.33	1.33			0.11	66.28	42.23	0.19
REDWOOD CREEK BR	3260	0.5 Bankfull	567.62	565.07	567.70	0.001154	2.29	2.29			0.25	174.73	48.46	0.21
REDWOOD CREEK BR	3260	1.5-yr	569.22	565.92	569.37	0.001458	3.15	3.15			0.42	254.30	50.64	0.25
REDWOOD CREEK BR	3260	2-yr	570.36	566.62	570.59	0.001753	3.84	3.84			0.59	312.83	51.94	0.28
REDWOOD CREEK BR	3260	5-yr	572.09	567.77	572.47	0.002189	4.95	4.95	0.03		0.89	404.44	53.99	0.32
REDWOOD CREEK BR	3260	10-yr	572.95	568.39	573.43	0.002407	5.55	5.54	0.05	0.03	1.06	451.31	54.98	0.34
REDWOOD CREEK BR	3260	25-yr	573.47	568.79	574.01	0.002546	5.94	5.92	0.07	0.05	1.17	479.70	55.57	0.35
REDWOOD CREEK BR	3260	50-yr	574.22	569.39	574.89	0.002776	6.55	6.51	0.09	0.10	1.35	522.05	56.42	0.37
REDWOOD CREEK BR	3260	100-yr	574.59	569.71	575.32	0.002898	6.86	6.81	0.11	0.13	1.45	543.02	63.31	0.38
REDWOOD CREEK BR	3164	Summer	562.79	562.11	562.79	0.000045	0.13	0.13			0.00	7.57	13.61	0.03
REDWOOD CREEK BR	3164	Winter	565.17	563.38	565.19	0.000527	1.06	1.06			0.06	83.37	41.77	0.13
REDWOOD CREEK BR	3164	0.5 Bankfull	567.53	564.54	567.60	0.000895	2.11	2.11			0.20	190.02	48.74	0.19
REDWOOD CREEK BR	3164	1.5-yr	569.10	565.44	569.24	0.001241	2.96	2.95	0.02		0.36	270.77	54.07	0.23
REDWOOD CREEK BR	3164	2-yr	570.23	566.16	570.43	0.001446	3.63	3.58	0.07	0.05	0.46	335.49	60.41	0.26
REDWOOD CREEK BR	3164	5-yr	571.94	567.36	572.27	0.001744	4.68	4.49	0.18	0.09	0.64	445.15	69.90	0.29
REDWOOD CREEK BR	3164	10-yr	572.79	568.01	573.21	0.001899	5.23	4.92	0.25	0.12	0.71	508.18	77.40	0.31
REDWOOD CREEK BR	3164	25-yr	573.31	568.42	573.77	0.002001	5.57	5.17	0.28	0.15	0.76	549.14	82.33	0.32
REDWOOD CREEK BR	3164	50-yr	574.07	569.03	574.62	0.002156	6.10	5.53	0.32	0.20	0.83	615.33	91.14	0.34
REDWOOD CREEK BR	3164	100-yr	574.44	569.36	575.04	0.002238	6.36	5.69	0.33	0.23	0.85	650.60	97.48	0.35
REDWOOD CREEK BR	3022	Summer	562.79		562.79	0.000002	0.04	0.04			0.00	25.10	27.08	0.01
REDWOOD CREEK BR	3022	Winter	565.13		565.14	0.000225	0.83	0.83			0.04	106.27	40.16	0.09
REDWOOD CREEK BR	3022	0.5 Bankfull	567.43		567.48	0.000675	1.88	1.88			0.16	212.55	52.81	0.17
REDWOOD CREEK BR	3022	1.5-yr	568.96		569.07	0.001016	2.69	2.69			0.30	297.76	58.24	0.21
REDWOOD CREEK BR	3022	2-yr	570.06		570.23	0.001270	3.30	3.30	0.00	0.02	0.42	363.77	63.83	0.24
REDWOOD CREEK BR	3022	5-yr	571.75		572.02	0.001495	4.21	4.06	0.11	0.06	0.52	492.67	82.37	0.27
REDWOOD CREEK BR	3022	10-yr	572.60		572.94	0.001597	4.68	4.43	0.17	0.09	0.60	564.84	87.14	0.28
REDWOOD CREEK BR	3022	25-yr	573.11		573.49	0.001667	4.97	4.66	0.21	0.11	0.65	610.08	90.36	0.29
REDWOOD CREEK BR	3022	50-yr	573.87		574.31	0.001781	5.42	4.99	0.26	0.14	0.73	680.74	96.83	0.31
REDWOOD CREEK BR	3022	100-yr	574.24		574.72	0.001836	5.65	5.16	0.28	0.15	0.77	717.42	99.91	0.31
REDWOOD CREEK BR	2904	Summer	562.79		562.79	0.000887	0.35	0.35			0.01	2.83	11.19	0.12
REDWOOD CREEK BR	2904	Winter	565.07		565.09	0.000829	1.28	1.28			0.09	68.80	36.83	0.16
REDWOOD CREEK BR	2904	0.5 Bankfull	567.27		567.37	0.001415	2.48	2.48			0.29	161.17	46.97	0.24
REDWOOD CREEK BR	2904	1.5-yr	568.72		568.91	0.001966	3.42	3.42			0.51	234.11	53.70	0.29
REDWOOD CREEK BR	2904	2-yr	569.76		570.02	0.002385	4.11	4.11			0.71	292.14	58.57	0.32
REDWOOD CREEK BR	2904	5-yr	571.37		571.77	0.002911	5.07	4.95		0.14	0.86	403.65	82.32	0.37
REDWOOD CREEK BR	2904	10-yr	572.22		572.67	0.002991	5.46	5.21	0.04	0.23	0.88	479.70	98.23	0.38
REDWOOD CREEK BR	2904	25-yr	572.73		573.22	0.002929	5.68	5.34	0.09	0.28	0.88	532.32	106.85	0.38
REDWOOD CREEK BR	2904	50-yr	573.49		574.04	0.002860	6.02	5.48	0.15	0.34	0.88	619.89	121.94	0.38
REDWOOD CREEK BR	2904	100-yr	573.87		574.44	0.002830	6.18	5.54	0.17	0.37	0.87	667.73	131.58	0.38
REDWOOD CREEK BR	2821	Summer	562.72		562.72	0.000723	0.29	0.29			0.01	3.44	15.66	0.11
REDWOOD CREEK BR	2821	Winter	564.96		565.00	0.001438	1.72	1.72			0.17	51.05	25.96	0.22
REDWOOD CREEK BR	2821	0.5 Bankfull	566.99		567.19	0.003187	3.56	3.56			0.61	112.40	34.39	0.35
REDWOOD CREEK BR	2821	1.5-yr	568.25		568.64	0.004887	5.04	5.04			1.15	158.75	39.53	0.44
REDWOOD CREEK BR	2821	2-yr	569.08		569.68	0.006174	6.23	6.21	0.13		1.61	193.30	43.33	0.51
REDWOOD CREEK BR	2821	5-yr	570.33		571.34	0.007877	8.09	7.88	0.40	0.13	2.05	253.83	57.66	0.60
REDWOOD CREEK BR	2821	10-yr	570.97		572.20	0.008482	9.00	8.51	0.57	0.33	2.18	293.73	68.01	0.63
REDWOOD CREEK BR	2821	25-yr	571.37		572.74	0.008733	9.52	8.79	0.69	0.44	2.22	322.99	75.73	0.65
REDWOOD CREEK BR	2821	50-yr	571.99		573.55	0.008959	10.22	9.10	0.88	0.62	2.32	373.47	86.36	0.66
REDWOOD CREEK BR	2821	100-yr	572.32	571.02	573.95	0.008962	10.52	9.19	0.97	0.71	2.35	402.66	92.49	0.67
REDWOOD CREEK BR	2700	Summer	562.40		562.44	0.036276	1.75	1.75			0.39	0.57	3.23	0.73
REDWOOD CREEK BR	2700	Winter	564.62		564.71	0.004672	2.38	2.38			0.37	37.04	28.19	0.37
REDWOOD CREEK BR	2700	0.5 Bankfull	566.50		566.69	0.005387	3.51	3.51			0.69	114.08	53.76	0.42
REDWOOD CREEK BR	2700	1.5-yr	567.69		567.98	0.005474	4.32	4.32	0.05		0.92	185.35	66.46	0.45
REDWOOD CREEK BR	2700	2-yr	568.56		568.94	0.005088	4.93	4.85	0.19	0.11	1.00	247.45	75.75	0.45
REDWOOD CREEK BR	2700	5-yr	569.97		570.47	0.004585	5.80	5.42	0.37	0.21	1.00	369.27	102.11	0.45
REDWOOD CREEK BR	2700	10-yr	570.74		571.29	0.004233	6.13	5.51	0.44	0.31	1.01	453.45	115.09	0.45
REDWOOD CREEK BR	2700	25-yr	571.24		571.81	0.004006	6.29	5.54	0.47	0.36	1.01	512.81	123.48	0.44
REDWOOD CREEK BR	2700	50-yr	572.00		572.60	0.003694	6.52	5.56	0.52	0.43	1.01	611.32	135.59	0.43
REDWOOD CREEK BR	2700	100-yr	572.38		573.00	0.003565	6.63	5.56	0.55	0.44	1.00	665.11	144.82	0.43
REDWOOD CREEK BR	2600.03	Summer	562.31		562.31	0.000339	0.27	0.27			0.01	3.69	10.26	0.08
REDWOOD CREEK BR	2600.03	Winter	564.29		564.34	0.002867	1.91	1.91			0.23	46.18	33.58	0.29
REDWOOD CREEK BR	2600.03	0.5 Bankfull	566.04		566.22	0.004087	3.40	3.40			0.61	117.70	46.36	0.38
REDWOOD CREEK BR	2600.03	1.5-yr	567.06		567.41	0.005815	4.79	4.79			1.12	167.06	50.83	0.47
REDWOOD CREEK BR	2600.03	2-yr	567.80		568.33	0.007008	5.82	5.82			1.57	206.04	53.39	0.52
REDWOOD CREEK BR	2600.03	5-yr	569.00		569.84	0.008197	7.37	7.35	0.04	0.20	2.23	272.16	57.51	0.59
REDWOOD CREEK BR	2600.03	10-yr	569.64		570.67	0.008486	8.14	8.07	0.13	0.34	2.50	309.86	60.09	0.61
REDWOOD CREEK BR	2600.03	25-yr	570.04		571.19	0.008653	8.61	8.49	0.20	0.41	2.65	334.50	62.59	0.62
REDWOOD CREEK BR	2600.03	50-yr	570.63		571.98	0.009018	9.35	9.13	0.28	0.53	2.86	372.39	67.23	0.64
REDWOOD CREEK BR	2600.03	100-yr	570.92		572.37	0.009197	9.72	9.43	0.33	0.60	2.96	392.30	69.93	0.66
REDWOOD CREEK BR	2498.75	Summer	562.13	562.13	562.18	0.100173	1.85	1.85			0.55	0.54	6.13	1.10
REDWOOD CREEK BR	2498.75	Winter	563.19	563.19	563.58	0.041405	5.04	5.04			1.97	17.47	22.60	1.01
REDWOOD CREEK BR	2498.75	0.5 Bankfull	564.56	564.56	565.26	0.033806	6.72	6.72			2.88	59.49	42.93	1.01
REDWOOD CREEK BR	2498.75	1.5-yr	565.72		566.40	0.019234	6.60	6.60			2.43	121.21	58.91	0.81

HEC-RAS Plan: Marshall River: REDWOOD Reach: REDWOOD CREEK BR (Continued)

Reach	River Sta	Profile	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Vel Total	Shear LOB	Shear ROB	Shear Total	Flow Area	Top Width	Froude # Chl
			(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(ft/s)	(lb/sq ft)	(lb/sq ft)	(lb/sq ft)	(sq ft)	(ft)	
REDWOOD CREEK BR	2498.75	2-yr	566.70		567.37	0.013049	6.57	6.57			2.19	182.58	66.58	0.70
REDWOOD CREEK BR	2498.75	5-yr	568.15		568.90	0.009882	6.97	6.97			2.23	287.08	77.61	0.64
REDWOOD CREEK BR	2498.75	10-yr	568.92		569.72	0.008837	7.16	7.16			2.26	349.33	83.27	0.62
REDWOOD CREEK BR	2498.75	25-yr	569.41		570.23	0.008303	7.27	7.27			2.28	390.84	86.80	0.60
REDWOOD CREEK BR	2498.75	50-yr	570.14		571.01	0.007407	7.47	7.46	0.06	0.11	2.23	455.74	91.97	0.58
REDWOOD CREEK BR	2498.75	100-yr	570.50		571.40	0.006965	7.58	7.55	0.12	0.19	2.20	489.75	94.37	0.57
REDWOOD CREEK BR	2339.37	Summer	560.45		560.45	0.000004	0.05	0.05			0.00	18.90	20.02	0.01
REDWOOD CREEK BR	2339.37	Winter	562.06		562.09	0.001095	1.33	1.33			0.11	66.04	40.76	0.18
REDWOOD CREEK BR	2339.37	0.5 Bankfull	563.80		563.92	0.002150	2.79	2.79			0.39	143.36	47.59	0.28
REDWOOD CREEK BR	2339.37	1.5-yr	565.08		565.31	0.002887	3.86	3.86			0.68	207.15	52.11	0.34
REDWOOD CREEK BR	2339.37	2-yr	565.93		566.28	0.003635	4.74	4.74			0.98	253.00	55.24	0.39
REDWOOD CREEK BR	2339.37	5-yr	567.27		567.84	0.004383	6.09	6.06	0.10	0.11	1.40	330.03	60.06	0.45
REDWOOD CREEK BR	2339.37	10-yr	568.00		568.70	0.004591	6.74	6.67	0.17	0.22	1.59	374.85	62.59	0.47
REDWOOD CREEK BR	2339.37	25-yr	568.45		569.25	0.004719	7.15	7.02	0.22	0.21	1.64	404.28	67.36	0.48
REDWOOD CREEK BR	2339.37	50-yr	569.10		570.04	0.004985	7.80	7.55	0.30	0.27	1.74	450.57	75.35	0.50
REDWOOD CREEK BR	2339.37	100-yr	569.44		570.44	0.005073	8.09	7.77	0.34	0.36	1.83	476.12	76.85	0.51
REDWOOD CREEK BR	2152	Summer	560.41	560.41	560.44	0.105863	1.40	1.40			0.36	0.71	12.95	1.05
REDWOOD CREEK BR	2152	Winter	561.16	561.16	561.45	0.044085	4.29	4.29			1.57	20.52	35.95	1.00
REDWOOD CREEK BR	2152	0.5 Bankfull	562.15	562.15	562.84	0.033452	6.63	6.63			2.81	60.32	44.47	1.00
REDWOOD CREEK BR	2152	1.5-yr	562.99	562.99	563.97	0.029889	7.94	7.94			3.59	100.72	51.92	1.01
REDWOOD CREEK BR	2152	2-yr	563.93	563.64	564.88	0.020043	7.83	7.83			3.17	153.34	59.74	0.86
REDWOOD CREEK BR	2152	5-yr	565.75		566.62	0.010042	7.50	7.50		0.03	2.50	266.64	65.04	0.65
REDWOOD CREEK BR	2152	10-yr	566.67		567.57	0.007960	7.62	7.49	0.16	0.22	1.98	333.75	81.85	0.60
REDWOOD CREEK BR	2152	25-yr	567.26		568.17	0.006985	7.69	7.37	0.25	0.32	1.74	385.58	94.78	0.57
REDWOOD CREEK BR	2152	50-yr	568.06		569.00	0.006169	7.90	7.25	0.36	0.43	1.55	469.14	114.17	0.55
REDWOOD CREEK BR	2152	100-yr	568.46		569.41	0.005826	7.99	7.17	0.42	0.47	1.49	516.23	123.47	0.54
REDWOOD CREEK BR	1861.71	Summer	556.09		556.09	0.000001	0.04	0.04			0.00	24.98	15.88	0.01
REDWOOD CREEK BR	1861.71	Winter	557.65		557.69	0.001051	1.58	1.58			0.14	55.87	25.03	0.19
REDWOOD CREEK BR	1861.71	0.5 Bankfull	559.81		559.95	0.002546	3.00	3.00			0.45	133.36	44.75	0.31
REDWOOD CREEK BR	1861.71	1.5-yr	561.48		561.70	0.002623	3.70	3.70			0.62	216.09	53.95	0.33
REDWOOD CREEK BR	1861.71	2-yr	562.77		563.04	0.002616	4.14	4.14			0.73	290.09	61.13	0.33
REDWOOD CREEK BR	1861.71	5-yr	564.80		565.14	0.002584	4.67	4.67			0.88	428.52	74.72	0.34
REDWOOD CREEK BR	1861.71	10-yr	565.84		566.22	0.002521	4.91	4.91			0.94	509.26	80.78	0.34
REDWOOD CREEK BR	1861.71	25-yr	566.49		566.89	0.002471	5.04	5.04		0.01	0.97	563.02	85.01	0.34
REDWOOD CREEK BR	1861.71	50-yr	567.36		567.80	0.002386	5.34	5.32	0.03	0.07	0.99	639.37	91.34	0.34
REDWOOD CREEK BR	1861.71	100-yr	567.78		568.24	0.002351	5.49	5.46	0.05	0.10	1.00	678.20	94.38	0.35
REDWOOD CREEK BR	1794.38	Summer	556.09	553.15	556.09	0.000000	0.03	0.03			0.00	37.37	22.49	0.00
REDWOOD CREEK BR	1794.38	Winter	557.62	554.72	557.64	0.000442	1.17	1.17			0.07	75.16	26.62	0.12
REDWOOD CREEK BR	1794.38	0.5 Bankfull	559.67	556.61	559.81	0.001713	2.90	2.90			0.39	138.00	34.36	0.26
REDWOOD CREEK BR	1794.38	1.5-yr	561.26	557.86	561.52	0.002510	4.10	4.10			0.71	195.34	37.74	0.32
REDWOOD CREEK BR	1794.38	2-yr	562.45	558.91	562.83	0.003070	4.96	4.96			1.00	241.72	40.09	0.36
REDWOOD CREEK BR	1794.38	5-yr	564.29	560.41	564.90	0.003892	6.29	6.29			1.51	318.21	43.16	0.41
REDWOOD CREEK BR	1794.38	10-yr	565.20	561.20	565.96	0.004267	6.98	6.97		0.05	1.78	358.48	44.81	0.43
REDWOOD CREEK BR	1794.38	25-yr	565.77	561.69	566.62	0.004513	7.40	7.39		0.08	1.95	384.16	46.11	0.45
REDWOOD CREEK BR	1794.38	50-yr	566.48	562.46	567.52	0.004977	8.17	8.14	0.08	0.13	2.24	417.55	47.89	0.48
REDWOOD CREEK BR	1794.38	100-yr	566.81	562.84	567.95	0.005235	8.58	8.54	0.13	0.16	2.41	433.35	48.59	0.49
REDWOOD CREEK BR	1784.08		Bridge											
REDWOOD CREEK BR	1784.07	Summer	556.09		556.09	0.000001	0.03	0.03			0.00	34.85	23.28	0.00
REDWOOD CREEK BR	1784.07	Winter	557.61		557.64	0.000469	1.18	1.18			0.07	74.59	28.30	0.13
REDWOOD CREEK BR	1784.07	0.5 Bankfull	559.66		559.79	0.001683	2.90	2.90			0.39	137.92	34.04	0.25
REDWOOD CREEK BR	1784.07	1.5-yr	561.23		561.49	0.002528	4.12	4.12			0.72	194.33	37.41	0.32
REDWOOD CREEK BR	1784.07	2-yr	562.41		562.80	0.003122	5.00	5.00			1.02	239.93	39.62	0.36
REDWOOD CREEK BR	1784.07	5-yr	564.23		564.86	0.004019	6.35	6.35			1.55	314.87	42.70	0.41
REDWOOD CREEK BR	1784.07	10-yr	565.14		565.92	0.004521	7.06	7.06			1.87	354.34	44.32	0.44
REDWOOD CREEK BR	1784.07	25-yr	565.70		566.57	0.004846	7.48	7.48			2.08	379.51	45.55	0.46
REDWOOD CREEK BR	1784.07	50-yr	566.40		567.46	0.005468	8.25	8.25	0.07		2.41	412.27	48.26	0.49
REDWOOD CREEK BR	1784.07	100-yr	566.73		567.89	0.005793	8.66	8.64	0.13		2.56	428.14	49.93	0.50
REDWOOD CREEK BR	1700	Summer	556.09	556.03	556.09	0.003493	0.35	0.35			0.02	2.83	31.46	0.21
REDWOOD CREEK BR	1700	Winter	557.52		557.56	0.002104	1.68	1.68			0.18	52.23	37.28	0.25
REDWOOD CREEK BR	1700	0.5 Bankfull	559.47		559.61	0.002558	3.03	3.03			0.46	131.94	44.27	0.31
REDWOOD CREEK BR	1700	1.5-yr	561.03		561.26	0.002797	3.90	3.90			0.68	205.06	49.81	0.34
REDWOOD CREEK BR	1700	2-yr	562.21		562.53	0.002956	4.50	4.50			0.86	266.58	54.07	0.36
REDWOOD CREEK BR	1700	5-yr	564.06		564.51	0.003179	5.37	5.36	0.01		1.12	372.82	62.05	0.38
REDWOOD CREEK BR	1700	10-yr	565.01		565.52	0.003128	5.77	5.66	0.09	0.03	0.98	441.66	83.81	0.39
REDWOOD CREEK BR	1700	25-yr	565.61		566.16	0.003014	5.99	5.73	0.15	0.08	0.92	495.72	96.38	0.39
REDWOOD CREEK BR	1700	50-yr	566.37		567.00	0.003026	6.40	5.91	0.23	0.14	0.94	575.37	110.13	0.39
REDWOOD CREEK BR	1700	100-yr	566.74		567.40	0.003032	6.60	6.01	0.30	0.16	1.00	616.15	111.43	0.40
REDWOOD CREEK BR	1506.97	Summer	555.25		555.26	0.005415	0.68	0.68			0.06	1.48	8.57	0.29
REDWOOD CREEK BR	1506.97	Winter	556.77		556.88	0.006616	2.75	2.75			0.50	31.99	25.93	0.44
REDWOOD CREEK BR	1506.97	0.5 Bankfull	558.29		558.71	0.010216	5.19	5.19			1.45	77.04	32.82	0.60
REDWOOD CREEK BR	1506.97	1.5-yr	559.67		560.29	0.010165	6.32	6.32			1.94	126.58	39.64	0.62
REDWOOD CREEK BR	1506.97	2-yr	560.82		561.55	0.009409	6.84	6.84			2.15	175.35	45.81	0.62
REDWOOD CREEK BR	1506.97	5-yr	562.70		563.54	0.008005	7.37	7.37			2.30	271.54	56.06	0.59
REDWOOD CREEK BR	1506.97	10-yr	563.71		564.59	0.007581	7.55	7.55			2.36	331.16	63.26	0.58
REDWOOD CREEK BR	1506.97	25-yr	564.37		565.26	0.007436	7.56	7.55	0.03	0.05	2.18	376.18	76.81	0.58
REDWOOD CREEK BR	1506.97	50-yr	565.23		566.15	0.006351	7.72	7.40	0.20	0.20	1.53	459.32	115.27	0.55
REDWOOD CREEK BR	1506.97	100-yr	565.66		566.58	0.005880	7.77	7.26	0.32	0.25	1.51	509.44	119.78	0.53
REDWOOD CREEK BR	1247.39	Summer	553.23	553.23	553.29	0.074773	1.95	1.95			0.55	0.51	4.33	1.00
REDWOOD CREEK BR	1247.39	Winter	554.46	554.46	554.87	0.041422	5.15	5.15			2.03	17.08	21.19	1.01
REDWOOD CREEK BR	1247.39	0.5 Bankfull	556.33		556.90	0.014988	6.08	6.08			2.02	65.74	28.75	0.71
REDWOOD CREEK BR	1247.39	1.5-yr	557.82		558.63	0.012495	7.20	7.20			2.49	111.18	32.03	0.68
REDWOOD CREEK BR	1247.39	2-yr	558.90		559.94	0.012462	8.16	8.16			3.00	147.03	34.37	0.70
REDWOOD CREEK BR	1247.39	5-yr	560.56		562.01	0.012984	9.66	9.66			3.90	207.04	37.94	0.73
REDWOOD CREEK BR	1247.39	10-yr	561.41		563.10	0.012685	10.44	10.39	0.20	0.20	3.92	240.61	42.98	0.74
REDWOOD CREEK BR	1247.39	25-yr	561.89		563.76	0.012700	10.98	10.82	0.37	0.32	3.88	262.57	47.75	0.75
REDWOOD CREEK BR	1247.39	50-yr	562.58	561.47	564.74	0.012970	11.84	11.33	0.56	0.48	3.64	300.11	60.45	0.77
REDWOOD CREEK BR	1247.39	100-yr	562.92	561.87	565.21	0.013053	12.24	11.53	0.78	0.57	3.79	320.91	62.61	0.77
REDWOOD CREEK BR	1097.31	Summer	552.09		552.09	0.000002	0.05	0.05			0.00	22.12	18.52	0.01
REDWOOD CREEK BR	1097.31	Winter	554.05		554.07	0.000680	1.17	1.17			0.08	74.95	38.45	0.15
REDWOOD CREEK BR	1097.31	0.5 Bankfull	556.21		556.30	0.001274	2.38	2.38			0.27	167.75	46.63	0.22
REDWOOD CREEK BR	1097.31	1.5-yr	557.71		557.88	0.001741	3.32	3.32			0.48	240.83	50.55	0.27
REDWOOD CREEK BR	1097.31	2-yr	558.82		559.08	0.002070	4.02	4.02			0.66	298.28	52.74	0.30
REDWOOD CREEK BR	1097.31	5-yr	560.56		560.96	0.002549	5.10	5.10			1.00	392.12	55.50	0.34

HEC-RAS Plan: Marshall River: REDWOOD Reach: REDWOOD CREEK BR (Continued)

Reach	River Sta	Profile	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Vel Total	Shear LOB	Shear ROB	Shear Total	Flow Area	Top Width	Froude # Chl
			(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(ft/s)	(lb/sq ft)	(lb/sq ft)	(lb/sq ft)	(sq ft)	(ft)	
REDWOOD CREEK BR	1097.31	10-yr	561.47		561.96	0.002792	5.63	5.63	0.04		1.14	444.15	60.07	0.36
REDWOOD CREEK BR	1097.31	25-yr	562.01		562.56	0.002918	5.97	5.93	0.09	0.01	0.95	478.81	83.70	0.37
REDWOOD CREEK BR	1097.31	50-yr	562.82		563.46	0.003006	6.44	6.15	0.17	0.14	0.98	553.26	97.70	0.38
REDWOOD CREEK BR	1097.31	100-yr	563.22		563.89	0.003033	6.66	6.21	0.11	0.20	0.91	595.95	116.56	0.39
REDWOOD CREEK BR	1025.04	Summer	552.09		552.09	0.000099	0.19	0.19			0.00	5.34	10.32	0.05
REDWOOD CREEK BR	1025.04	Winter	553.89		553.97	0.003817	2.20	2.20			0.31	40.00	29.50	0.33
REDWOOD CREEK BR	1025.04	0.5 Bankfull	556.00		556.15	0.003474	3.09	3.09			0.51	129.32	53.44	0.35
REDWOOD CREEK BR	1025.04	1.5-yr	557.50		557.72	0.002963	3.79	3.79			0.66	211.33	55.82	0.34
REDWOOD CREEK BR	1025.04	2-yr	558.59		558.89	0.002990	4.39	4.39			0.83	273.20	56.90	0.35
REDWOOD CREEK BR	1025.04	5-yr	560.30		560.75	0.003243	5.37	5.37			1.15	372.18	59.23	0.38
REDWOOD CREEK BR	1025.04	10-yr	561.19		561.73	0.003574	5.87	5.87		0.01	1.32	426.16	64.70	0.40
REDWOOD CREEK BR	1025.04	25-yr	561.74		562.33	0.003588	6.16	6.11		0.06	1.23	464.58	76.74	0.40
REDWOOD CREEK BR	1025.04	50-yr	562.55		563.22	0.003602	6.58	6.35	0.05	0.15	1.12	535.35	99.89	0.41
REDWOOD CREEK BR	1025.04	100-yr	562.95		563.65	0.003571	6.77	6.39	0.08	0.18	1.02	579.37	119.23	0.41
REDWOOD CREEK BR	876.32	Summer	552.09		552.09	0.000003	0.05	0.05			0.00	19.38	19.02	0.01
REDWOOD CREEK BR	876.32	Winter	553.65		553.69	0.001064	1.51	1.51			0.13	58.31	28.62	0.19
REDWOOD CREEK BR	876.32	0.5 Bankfull	555.49		555.68	0.002890	3.47	3.47			0.58	115.38	33.46	0.33
REDWOOD CREEK BR	876.32	1.5-yr	556.79		557.18	0.004282	4.96	4.95	0.06		1.03	161.57	38.35	0.41
REDWOOD CREEK BR	876.32	2-yr	557.71		558.29	0.005135	6.14	6.01	0.22	0.10	1.33	199.65	44.44	0.47
REDWOOD CREEK BR	876.32	5-yr	559.06		560.04	0.006495	8.02	7.59	0.56	0.33	1.92	263.52	51.08	0.55
REDWOOD CREEK BR	876.32	10-yr	559.66		560.91	0.007483	9.12	8.44	0.67	0.48	2.21	296.25	57.73	0.59
REDWOOD CREEK BR	876.32	25-yr	560.04		561.47	0.008070	9.79	8.91	0.71	0.59	2.33	318.89	64.03	0.62
REDWOOD CREEK BR	876.32	50-yr	560.64		562.32	0.008695	10.68	9.47	0.92	0.76	2.59	359.07	70.00	0.65
REDWOOD CREEK BR	876.32	100-yr	560.95		562.75	0.008916	11.09	9.70	1.04	0.85	2.71	381.38	72.89	0.67
REDWOOD CREEK BR	600	Summer	552.09		552.09	0.003433	0.33	0.33			0.02	2.99	35.64	0.20
REDWOOD CREEK BR	600	Winter	552.63		552.84	0.030613	3.60	3.60			1.10	24.41	42.18	0.84
REDWOOD CREEK BR	600	0.5 Bankfull	554.25		554.46	0.007390	3.72	3.72			0.81	107.49	60.69	0.49
REDWOOD CREEK BR	600	1.5-yr	555.61		555.86	0.004996	3.98	3.98			0.81	201.17	76.49	0.43
REDWOOD CREEK BR	600	2-yr	556.64		556.91	0.004237	4.20	4.20			0.85	285.61	88.28	0.41
REDWOOD CREEK BR	600	5-yr	558.25		558.56	0.003449	4.52	4.52	0.01	0.03	0.88	442.27	106.76	0.39
REDWOOD CREEK BR	600	10-yr	559.05		559.40	0.003004	4.74	4.70	0.08	0.10	0.85	531.76	116.01	0.37
REDWOOD CREEK BR	600	25-yr	559.56		559.93	0.002784	4.87	4.79	0.11	0.13	0.83	593.00	122.00	0.36
REDWOOD CREEK BR	600	50-yr	560.37		560.76	0.002509	5.06	4.90	0.16	0.18	0.82	694.29	131.38	0.35
REDWOOD CREEK BR	600	100-yr	560.78		561.18	0.002387	5.15	4.94	0.18	0.20	0.81	749.31	136.49	0.35
REDWOOD CREEK BR	400	Summer	550.04	550.04	550.06	0.125815	1.12	1.12			0.27	0.89	25.67	1.06
REDWOOD CREEK BR	400	Winter	551.51		551.56	0.002557	1.75	1.75			0.20	50.35	39.80	0.27
REDWOOD CREEK BR	400	0.5 Bankfull	553.57		553.68	0.002268	2.73	2.73			0.38	146.28	53.53	0.29
REDWOOD CREEK BR	400	1.5-yr	554.94		555.14	0.002631	3.54	3.54			0.58	226.28	62.72	0.33
REDWOOD CREEK BR	400	2-yr	555.96		556.22	0.002861	4.09	4.09			0.74	293.51	69.51	0.35
REDWOOD CREEK BR	400	5-yr	557.56		557.92	0.002955	4.85	4.84	0.03	0.05	0.93	413.04	80.15	0.37
REDWOOD CREEK BR	400	10-yr	558.38		558.81	0.002851	5.24	5.19	0.10	0.12	0.97	481.27	85.56	0.37
REDWOOD CREEK BR	400	25-yr	558.90		559.36	0.002794	5.48	5.39	0.14	0.16	1.00	526.66	88.97	0.37
REDWOOD CREEK BR	400	50-yr	559.70		560.22	0.002716	5.82	5.67	0.20	0.22	1.05	600.14	94.31	0.38
REDWOOD CREEK BR	400	100-yr	560.11		560.66	0.002674	5.99	5.79	0.23	0.25	1.07	639.34	97.05	0.38
REDWOOD CREEK BR	77.94	Summer	549.11	548.11	549.11	0.000014	0.09	0.09			0.00	11.01	14.30	0.02
REDWOOD CREEK BR	77.94	Winter	550.71	549.42	550.76	0.002398	1.83	1.83			0.21	48.19	33.68	0.27
REDWOOD CREEK BR	77.94	0.5 Bankfull	552.80	550.95	552.91	0.002526	2.73	2.72		0.04	0.38	146.79	59.39	0.30
REDWOOD CREEK BR	77.94	1.5-yr	554.13	551.98	554.32	0.002431	3.52	3.46	0.08	0.12	0.51	231.17	67.08	0.32
REDWOOD CREEK BR	77.94	2-yr	555.09	552.63	555.35	0.002519	4.16	4.02	0.15	0.19	0.63	298.33	72.83	0.34
REDWOOD CREEK BR	77.94	5-yr	556.63	553.63	557.03	0.002602	5.11	4.77	0.27	0.31	0.80	418.99	83.06	0.36
REDWOOD CREEK BR	77.94	10-yr	557.47	554.14	557.93	0.002589	5.54	5.10	0.37	0.36	0.89	490.01	86.00	0.37
REDWOOD CREEK BR	77.94	25-yr	558.00	554.50	558.50	0.002575	5.80	5.30	0.43	0.40	0.95	536.02	87.56	0.37
REDWOOD CREEK BR	77.94	50-yr	558.82	555.05	559.37	0.002557	6.18	5.59	0.52	0.45	1.04	608.18	89.90	0.37
REDWOOD CREEK BR	77.94	100-yr	559.23	555.32	559.82	0.002541	6.36	5.73	0.56	0.47	1.08	645.87	91.02	0.38
REDWOOD CREEK BR	44.90		Bridge											
REDWOOD CREEK BR	44.89	Summer	549.07	549.07	549.11	0.085362	1.60	1.60			0.42	0.63	7.93	1.00
REDWOOD CREEK BR	44.89	Winter	550.10	550.10	550.53	0.039276	5.27	5.27			2.07	16.71	19.47	1.00
REDWOOD CREEK BR	44.89	0.5 Bankfull	552.67		552.81	0.003686	3.01	3.01			0.49	133.05	60.25	0.36
REDWOOD CREEK BR	44.89	1.5-yr	554.02		554.23	0.003242	3.67	3.67			0.65	218.26	65.95	0.36
REDWOOD CREEK BR	44.89	2-yr	554.98		555.26	0.003273	4.24	4.24			0.80	283.06	68.69	0.37
REDWOOD CREEK BR	44.89	5-yr	556.53		556.93	0.003231	5.10	5.07	0.07	0.08	0.99	394.17	76.69	0.38
REDWOOD CREEK BR	44.89	10-yr	557.36		557.83	0.003131	5.51	5.44	0.17	0.17	1.07	459.81	79.96	0.39
REDWOOD CREEK BR	44.89	25-yr	557.89		558.40	0.003080	5.77	5.65	0.22	0.22	1.12	502.42	81.88	0.39
REDWOOD CREEK BR	44.89	50-yr	558.70		559.28	0.003016	6.15	5.96	0.28	0.28	1.18	570.14	85.70	0.39
REDWOOD CREEK BR	44.89	100-yr	559.11		559.73	0.002980	6.33	6.10	0.30	0.31	1.21	606.10	87.80	0.39
REDWOOD CREEK BR	9.08	Summer	547.73	547.59	547.74	0.005500	0.74	0.74			0.07	1.36	7.02	0.29
REDWOOD CREEK BR	9.08	Winter	549.86	548.93	550.00	0.005501	2.99	2.99			0.54	29.46	17.23	0.40
REDWOOD CREEK BR	9.08	0.5 Bankfull	552.43	550.85	552.64	0.005501	3.70	3.70			0.75	107.99	46.76	0.43
REDWOOD CREEK BR	9.08	1.5-yr	553.73	552.19	554.06	0.005506	4.61	4.61			1.04	173.46	53.95	0.45
REDWOOD CREEK BR	9.08	2-yr	554.64	552.89	555.09	0.005502	5.37	5.36	0.09	0.05	1.27	223.86	56.49	0.47
REDWOOD CREEK BR	9.08	5-yr	556.09	554.03	556.76	0.005506	6.58	6.50	0.29	0.20	1.62	307.76	60.30	0.49
REDWOOD CREEK BR	9.08	10-yr	556.86	554.58	557.65	0.005502	7.18	7.03	0.38	0.29	1.78	355.48	62.99	0.51
REDWOOD CREEK BR	9.08	25-yr	557.35	554.95	558.22	0.005501	7.55	7.35	0.45	0.35	1.88	386.54	64.74	0.51
REDWOOD CREEK BR	9.08	50-yr	558.09	555.50	559.09	0.005504	8.09	7.80	0.55	0.44	2.03	435.77	67.66	0.52
REDWOOD CREEK BR	9.08	100-yr	558.47	555.80	559.54	0.005505	8.36	8.01	0.53	0.49	2.06	461.87	70.73	0.53

Appendix E

Cultural Resources Report

A Cultural Resources Investigation for the Marshall Ranch Flow Enhancement Project Briceland, Humboldt County, California

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September 2019

CONFIDENTIAL INFORMATION

Archaeological and other heritage resources can be damaged or destroyed through uncontrolled public disclosure of locational information. This document may contain sensitive information regarding the nature and location of archaeological sites that should not be disclosed to unauthorized persons.

Information regarding the location, character or ownership of a historic resource is exempt from the Freedom of Information Act pursuant to 16 U.S.C. 470w-3 (National Historic Preservation Act) and 16 U.S.C. § 470hh (Archaeological Resources Protection Act) and California State Government Code, Section 6254.10.

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Cover photo: View to the northwest of proposed pond location.

1.0 INVESTIGATION SUMMARY

During the summer of 2018, Joel Monschke of Stillwater Sciences requested that William Rich and Associates (WRA) complete a cultural resources survey at a portion of the Marshall Ranch, Assessor Parcel Number (APN) 220-061-011, located in the community of Briceland, southern Humboldt County, California. Mr. Monschke is seeking state grant funding and permitting to improve instream habitat for salmonids and other fish species in Redwood Creek, a tributary of the South Fork Eel River, by installing instream structures in the creek channel, an off-channel water-catchment pond and infiltration gallery which will be designed to supplement summer water-flows in the creek. Additional components of the project include water storage for fire suppression and domestic use, and solar array installation.

The purpose of this investigation is to document whether cultural resources that would qualify under the California Environmental Quality Act (CEQA) as historical resources or tribal cultural resources, are present within the proposed project area. The methods utilized in this investigation included a review of the Northwest Information Center (NWIC) confidential survey and resource records, and other published archaeological and historical literature. Correspondence was conducted with the Native American Heritage Commission (NAHC) and utilized their suggested tribal contact list for this project location. Tribal representatives from the Bear River Band of the Rohnerville Rancheria, the InterTribal Sinkyone Wilderness Council, and the Wailaki Tribe were contacted. The landowner and other knowledgeable individuals were also contacted for historical information about this location. A comprehensive field survey was performed over the entire project area and some adjacent areas, encompassing 27 acres.

According to the NWIC, the proposed project location has not been subject to previous cultural resources studies in the past and no cultural resources are documented. One previous study is noted to have occurred adjacent to the project location (Raskin et al. 2014) and nine additional studies are on file within a ½ mile radius. Four archaeological sites are recorded within this ½-mile buffer around the project property. The closest being "RA 1 – Neufeld Garden Site", approximately 700 feet to the north and described as a small, sparse-density, lithic scatter of chert debitage from toolstone manufacturing and maintenance (Roscoe 2018).

Research indicates that the project area is within the traditional territory of the Wailaki, although most contemporary ethnographic accounts describe this part of southern Humboldt County under the most recent occupation of the "Sinkyone", an extended group of related tribal units which lived in much of the surrounding area on the South Fork Eel River and upper Mattole River. Current ethnographic and historical research indicates the Briceland area was occupied by the To-cho-be keah, an Athabascan-speaking tribal group whose descendants are now affiliated with the Wailaki Tribe, Bear River Band of the Rohnerville Rancheria, InterTribal Sinkyone Wilderness Council, and other communities. The location was historically part of the Frank Stukey land patent of 1891. By 1915 the property was sold to William A. Herman. Mr. Herman's two sons, Bryan and Jesse, managed the property for a long time and continued a livestock operation even after being added to the larger Marshall property in 1970.

Native American coordination was initiated with the NAHC who were asked to provide a list of Native American individuals to contact for this portion of Humboldt County. The Tribal Historic Preservation Officer (THPO) of the Bear River Band of the Rohnerville Rancheria, the Director of the InterTribal Sinkyone Wilderness and the Chairman of the Wailaki Tribe were contacted during the course of this investigation. Landowner Elizabeth Marshall, who is a Wailaki, and her representative David Sanchez participated in the field survey and provided input on the draft report.

A comprehensive field survey of the entire area proposed for project activities was completed by William Rich, M.A., RPA and several research associates over the course of four visits: July 31, August 22 and August 27, 2018 and July 8, 2019. Field conditions were found to be good, with numerous naturally eroding and mechanically graded areas of exposed mineral sediment, as well as, ubiquitous tailings from burrowing rodents. In areas of dense grass, extensive raking and shovel surface scrapes were conducted in an effort to better expose surface mineral soils. These conditions offered ample opportunities to investigate for surface and buried archaeological expression or other cultural resource indicators. On August 27, 2018, Mr. Rich also observed geotechnical backhoe testing seeking to find bedrock on the lower terrace below the proposed pond.

The field survey resulted in the identification of one Native American archaeological site, an isolated groundstone artifact, and a small historic-period refuse deposit in a nearby gully. The archaeological site contains a surface scatter of battered and ground cobble tools and possible fire affected cobbles, which were identified along the northern terrace edge adjacent to proposed project activities. It is assumed that this deposit of artifacts extends below surface considering the relatively flat landform and historical agricultural land uses. This site was documented using California Department of Parks and Recreation (CDPR) 523-series archaeological site record forms under the temporary field-name "WRA 01 – Marshall Site". The resource area is bounded by location of surface artifacts. An isolated cobble handstone with extensive battering and polish was found along an historical road cut near the proposed project area. This artifact appears to have been displaced and is not in-situ. The item was also recorded using the same format under field name "WRA 02 – Marshall Isolate". The historical refuse identified in a nearby drainage gully consists of ranching and residential trash and equipment likely related to the historical residence and other outbuildings to the east of the project area. This site was noted but not formally recorded, as its components do not meet the 50-year threshold for an historical resource.

The archaeological site, field named WRA 01-Marshall Site, appears to be limited to groundstone tools and cooking stones and may be associated with the nearby large live oak trees (*Quercus agrifolia*). Concentrations of groundstone artifacts at this location could imply task-oriented activities with close affiliation to a nearby village or residential base. For these reasons the site appears to qualify as an historical resource pursuant to CEQA 15064.5 (a), significant for its information potential (CRHR Criterion D), and afforded avoidance protection measures during project implementation.

The isolated artifact found along a cut and fill dirt road at the western edge of the terrace appears displaced and was not found with associated artifacts or archaeological features. As an individual item, this artifact would not qualify as an historical resource, pursuant to CEQA 15064.5 (a). Likewise, the domestic and agricultural related refuse found in a nearby gully appears related to the activities of the residence to the east. These materials appear to have been dumped within the last 50 years, likely by the owners or occupants of the house and would not meet the age threshold to qualify as an historical resource, pursuant to CEQA 15064.5 (a).

As currently designed, the WRA 01-Marshall Site lies outside project activities, with the exception of a layer of proposed fill from nearby pond excavation. The proposed outflow pipe to the infiltration gallery will be installed via 4-inch horizontal bore at a depth of 30-40 feet, well below the archaeological site. Adjacent to the eastern edge of the site, two parallel trenches will be excavated for placement of a 4-inch outflow pipe from Redwood Creek and a 24-inch overflow culvert, although the latter may be redesigned for a surface installation.

The following recommendations are designed to provide avoidance and protection strategies for this site during project implementation and into the future. These conditions should be incorporated into project permitting.

1) The site boundary shall be clearly marked during project implementation. Boundary markers such as flagging, stakes, fencing or other highly visible barrier shall be used.
2) The area containing the archaeological site shall be completely excluded from ground disturbing activities.
3) Spoils from pond excavation may be placed directly on the existing site surface, however, no grading or scarifying shall be conducted. Heavy equipment shall not enter the site unless atop a sufficient layer of fill, such that the underlying soil is not displaced.
4) All ground-disturbing activities and placement of fill material within the known archaeological site shall be monitored by a professional archaeologist familiar with specific project conditions. A monitoring plan should be developed and used to guide monitoring and discovery protocol.
5) This archaeological site should be continuously monitored after project construction. The landowner or designee should watch for erosion, unauthorized collecting, and other site damages as a result of this site now being identified.
6) In the event additional archaeological material is encountered during project implementation or during future site monitoring efforts, all work shall stop in the area of the find and the discovery protocol initiated as briefly described in Section 7.1 of this report.

It is the opinion of this author that conditions to avoid and monitor, along with implementation of a standard discovery protocol, will result in a project that would not cause a substantial adverse change in the significance of an historical resource and a tribal cultural resource, as defined in CEQA 15064.5 (a) and PRC 21074. Furthermore, it is recommended that the County, as the lead agency for this project, continue good faith consultation with affected tribes regarding tribal cultural resources, the findings of this survey report, proposed protection measures, and participation in field monitoring.

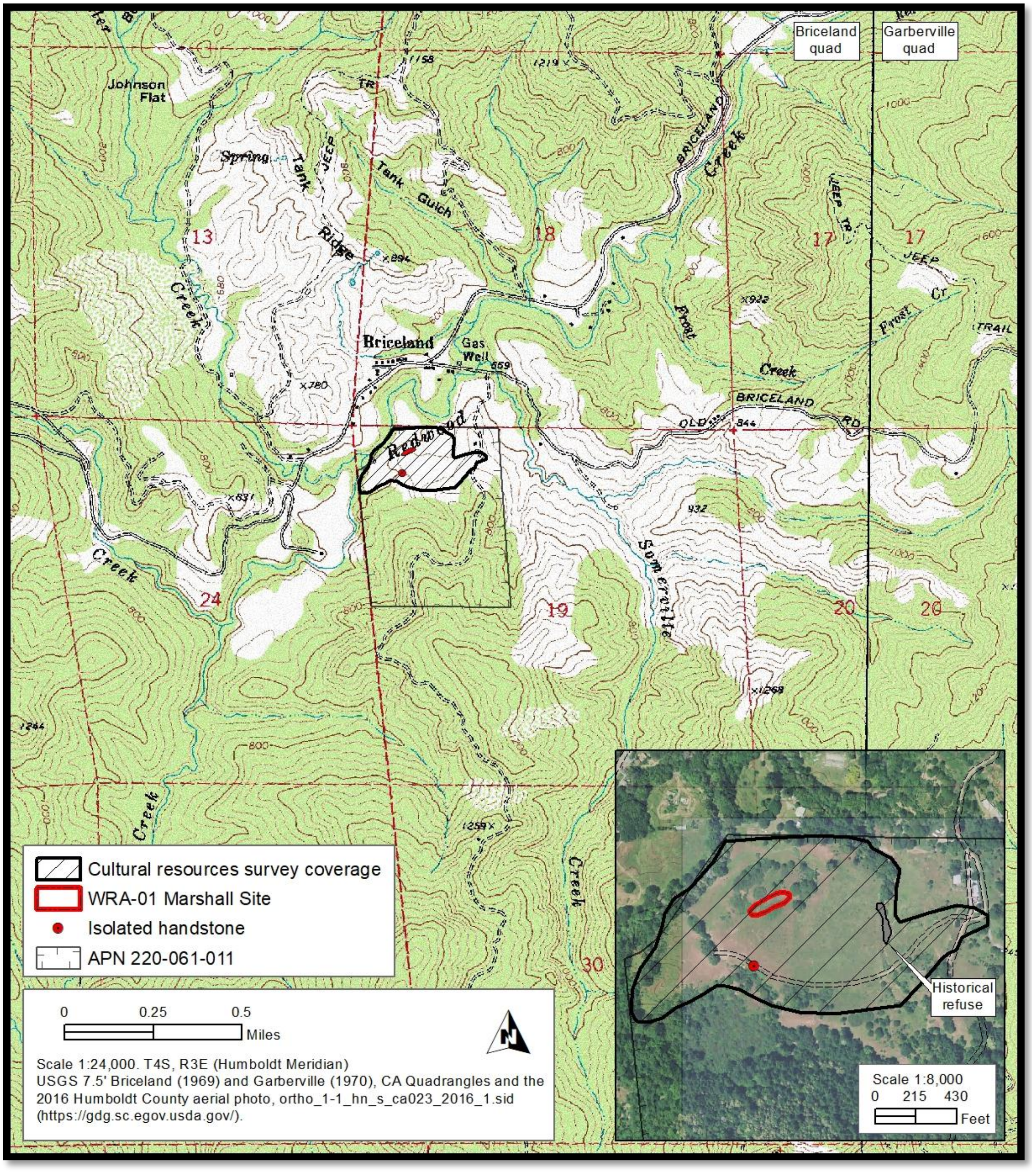
In addition, it is recommended that the findings of this investigation be kept confidential between the permitting/funding agencies, project applicant, tribes and landowner. The location, composition, character and other qualities of the identified archaeological site and any others that may become known are exempt from public disclosure. Project personnel should not be given full knowledge of these conditions other than avoidance of flagged areas. This report should undergo redaction before being made available to unauthorized readers or the public.

2.0 PROJECT DESCRIPTION

This project is generally designed to improve instream spawning and rearing habitat for coho salmon and other salmonids in a section of Redwood Creek, tributary of the South Fork Eel River in southern Humboldt County, California (Figure 1). This will be accomplished by constructing an off-channel water-catchment pond and infiltration gallery, installing instream features in Redwood Creek, and improvements to water transportation infrastructure in Briceland (Appendix A).

Figure 1. Project vicinity map showing location of the Redwood Creek project area near Briceland.

The project area is located in portions of the northwest ¼ of the northwest ¼ of Section 19, Township 4 South, Range 3 East (Humboldt Meridian), as shown on the 7.5’ USGS Topographic Quadrangle Map, Briceland, California (Figure 2).



Scale 1:24,000. T4S, R3E (Humboldt Meridian)
USGS 7.5' Briceland (1969) and Garberville (1970), CA Quadrangles and the 2016 Humboldt County aerial photo, ortho_1-1_hn_s_ca023_2016_1.sid (https://gdg.sc.egov.usda.gov/).

Figure 2. Project location and survey coverage map, showing the location of the identified archaeological site, isolated handstone, and historical refuse.

According to the current project proposal by Stillwater Sciences, the project will include:

> Construction of a 16 million gallon off-channel pond and infiltration gallery designed to deliver approximately 50 gallons per minute of flow augmentation to Redwood Creek during the 5-month dry season to improve instream aquatic habitat. The pond will be filled with rainwater catchment and water will be pumped during the wet season from a proposed offset well adjacent to Redwood Creek (Figure 3).
>
> Other proposed project components include:
>
> - Instream habitat enhancement features including approximately four large wood structures and two rock weirs in Redwood Creek.
> - Gully stabilization treatments including installation of approximately 20 rock armor grade control structures in two Class III drainages.
> - Construct approximately 200 KW solar arrays covering 13,000 SF and associated electrical transmission lines.
> - Installation of rainwater catchment tanks with water storage totaling up to approximately 200,000 gallons to supply potable water for APN 220-061-011 and Briceland Volunteer Fire Department (BVFD). Supply to BVFD on adjacent APNs to be permitted through separate future project. Potable water tanks may also be topped off via Redwood Creek diversion and Appropriative Water Right previously described.
> - Install emergency fire suppression water supply including two hydrants.
> - Upgrade access roads to project area with drainage features and gravel surfacing to provide year-round access.

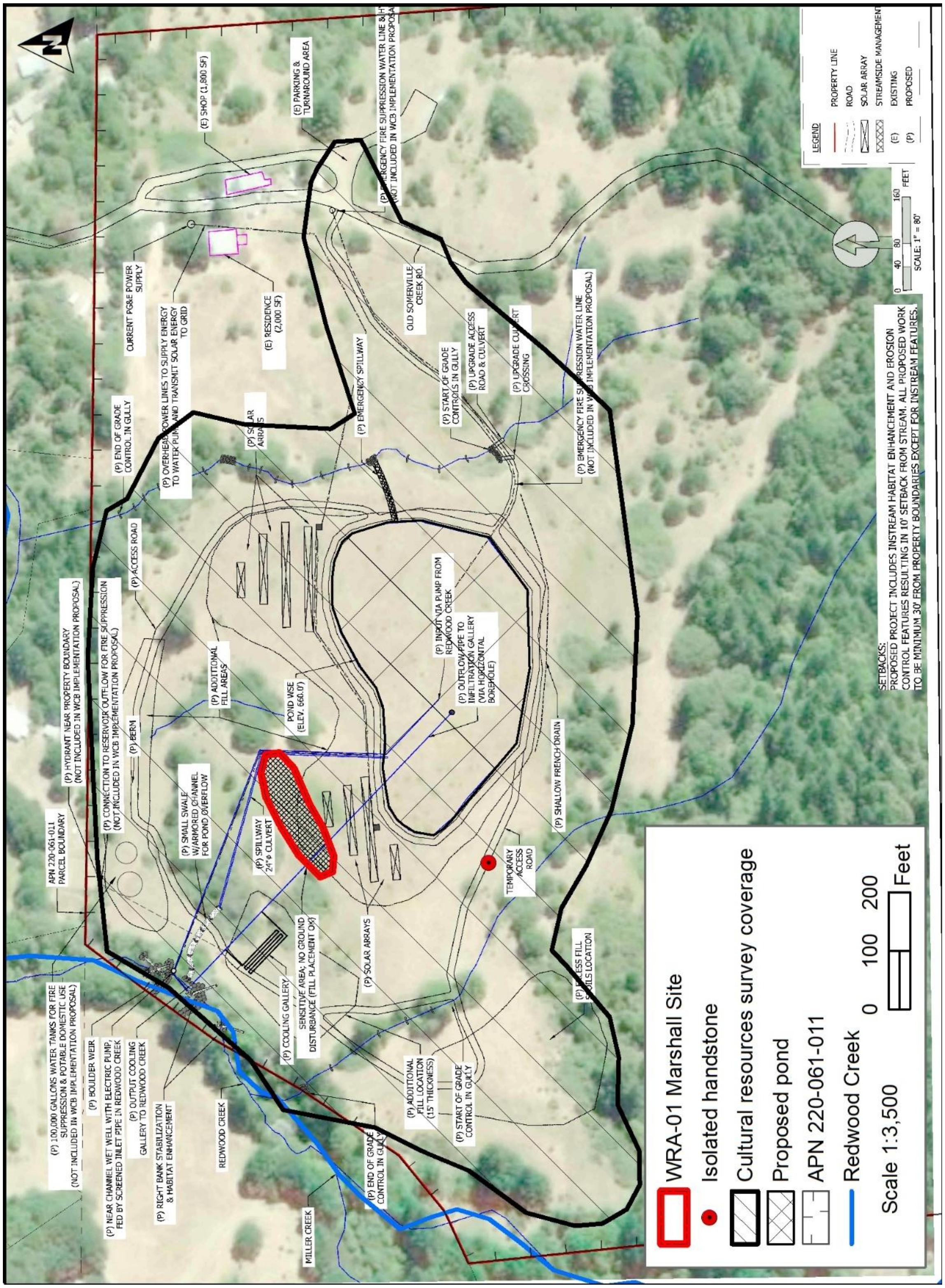


Figure 3. Project design map showing cultural resource survey coverage and findings.

3.0 REGULATORY FRAMEWORK

3.1 California Environmental Quality Act

The California Environmental Quality Act (CEQA), codified in California Public Resources Code (PRC) Sections 21000 et seq., is the principal statute governing the environmental review of projects in the state. CEQA requires that proponents of projects financed or approved by state agencies, assess the project's potential to affect the environment. In accordance with CEQA, a project that may cause a substantial adverse change in the significance of a historical, tribal cultural, or unique archaeological resource is a project that may have a significant effect on the environment (PRC 21084.1, CA AB52 Chapter 532 (2014), and PRC Section 21083.2).

The term "historical resource" is legally defined in California Code of Regulations (CCR), Title 14, Chapter 3, Section 15064.5 (a). Under 14 CCR 15064.5(a)(3), an historical resource is defined as:

(1) A resource listed in, or determined to be eligible by the State Historical Resources Commission, for listing in the California Register of Historical Resources (CRHR) (PRC Section 5024.1).
(2) A resource included in a local register of historical resources, as defined in section 5020.1(k) of the PRC or identified as significant in an historical resource survey meeting the requirements in section 5024.1(g) of the PRC, shall be presumed to be historically or culturally significant. Public agencies must treat any such resource as significant unless the preponderance of evidence demonstrates that it is not historically or culturally significant.
(3) Any object, building, structure, site, area, place, record, or manuscript which a lead agency determines to be historically significant or significant in the architectural, engineering, scientific, economic, agricultural, educational, social, political, military, or cultural annals of California may be considered to be an historical resource, provided the lead agency's determination is supported by substantial evidence in light of the whole record. Generally, a resource shall be considered by the lead agency to be "historically significant" if the resource meets the criteria for listing on the CRHR (PRC Section 5024.1) including the following:

    A. is associated with events that have made a significant contribution to the broad patterns of California’s history and cultural heritage;
    B. is associated with the lives of persons important in our past;
    C. embodies the distinctive characteristics of a type, period, region, or method of construction, represents the work of an important creative individual, or possesses high artistic values; or
    D. has yielded, or may be likely to yield, information important in prehistory or history.

The CRHR also includes resources listed in or formally determined eligible for the listing in the National Register of Historic Places, as well as California State Landmarks and Points of Historical Interest. Resources of local significance that are listed under a local preservation ordinance or are otherwise considered historically significant at a local level, may also be considered eligible for the CRHR. The fact that a resource is not listed in, or determined to be eligible for listing in the CRHR, not included in a local register of historical resources (pursuant to section 5020.1(k) of the PRC), or identified in an historical resources survey (meeting the criteria in section 5024.1(g) of the PRC) does not preclude a lead agency from determining that the resource may be an historical resource as defined in PRC sections 5020.1(j) or 5024.1.

The term "tribal cultural resource" is legally defined in PRC Section 21074:

> (a) “Tribal cultural resources” are either of the following:
>
> > (1) Sites, features, places, cultural landscapes, sacred places, and objects with cultural value to a California Native American tribe that are either of the following:
> >
> > > (A) Included or determined to be eligible for inclusion in the CRHR.
> > >
> > > (B) Included in a local register of historical resources as defined in subdivision (k) of Section 5020.1.
> >
> > (2) A resource determined by the lead agency, in its discretion and supported by substantial evidence, to be significant pursuant to criteria set forth in subdivision (c) of PRC Section 5024.1. In applying the criteria set forth in subdivision (c) of PRC Section 5024.1 for the purposes of this paragraph, the lead agency shall consider the significance of the resource to a California Native American tribe.
>
> (b) A cultural landscape that meets the criteria of subdivision (a) is a tribal cultural resource to the extent that the landscape is geographically defined in terms of the size and scope of the landscape.
>
> (c) A historical resource described in PRC Section 21084.1, a unique archaeological resource as defined in subdivision (g) of PRC Section 21083.2, or a “non-unique archaeological resource” as defined in subdivision (h) of PRC Section 21083.2 may also be a tribal cultural resource if it conforms with the criteria of subdivision (a).

A "unique archaeological resource" is an archaeological artifact, object, or site that meets any of the criteria presented in PRC Section 21083.2(g):

> (g) As used in this section, "unique archaeological resource" means an archaeological artifact, object, or site about which it can be clearly demonstrated that, without merely adding to the current body of knowledge, there is a high probability that it meets any of the following criteria:
>
> > (1) Contains information needed to answer important scientific research questions and that there is a demonstrable public interest in that information.
> > (2) Has a special and particular quality such as being the oldest of its type or the best available example of its type.
> > (3) Is directly associated with a scientifically recognized important prehistoric or historic event or person.

Based on Section 15064.5(b)(2), a project would have a significant adverse effect on historical resources if the project causes a substantial adverse change in the significance of a historical resource. This includes demolishing or altering the physical characteristics of an historical resource that convey its historical significance and that justify its inclusion in, or eligibility for, inclusion in the CRHR or a local historic register, or by disturbing any human remains including those interred outside of formal cemeteries.

Section 15064.5(c) applies to effects on archaeological sites as follows:

> *(1) When a project will impact an archaeological site, a lead agency shall first determine whether the site is an historical resource, as defined in subsection (a).*
>
> *(2) If a lead agency determines that the archaeological site is an historical resource, it shall refer to the provisions of this section and Section 15126.4 of the Guidelines.*

In addition, the CEQA Guidelines (Section 15064.5(c) (3), and (4)) provide tests for significance for archaeological resources, as summarized below:

> *(1) If the site does not meet the criteria [for a historical resource] (a), but does meet the definition of a unique archaeological resource in Section 21083.2 of the Public Resources Code, the site shall be treated in accordance with the provisions of section 21083.2.*
>
> *(2) If an archaeological resource is neither a unique archaeological nor an historical resource, the effects of the project on those resources shall not be considered a significant effect on the environment.*

In addition to meeting one or more of the above criteria, the resources must be at least 50 years of age. A resource less than 50 years of age may qualify if it is exceptionally important to understanding our more recent history.

4.0 ARCHAEOLOGICAL SETTING AND CULTURAL CHRONOLOGY

Recent archaeological studies in the vicinity have broadened the traditional view related to cultural chronology to include paleo-environmental reconstruction (Hildebrandt and Hayes 1983), technology and adaptive responses to the environment (Hildebrandt and Hayes 1983, 1984; Hildebrandt and Swenson 1985; Levulett and Hildebrandt 1987; Whitaker 2005), trade (Hughes 1978; Levulett and Hildebrandt 1987), and the shifting focus from terrestrial to marine resource extraction in the timing of the coastal occupation in Northwest California (Levulett 1985; Whitaker 2005; Tushingham et al. 2016; King et al. 2016).

The seminal work defining early period assemblages in the North Coast Ranges of California was at Pilot Ridge-South Fork Mountain project sponsored by Six Rivers National Forest for logging and road building undertakings (Hildebrandt and Hayes 1983, 1984). Research conducted along the coast of Southern Humboldt include excavations at the mouth of the Mattole River and at Big Flat (Levulett 1985; Whitaker 2005); Spanish Flat and Punta Gorda (Whitaker 2005), and Shelter Cove (Levulett 1985). These studies have provided insight into some of the major environmental and archaeological trends within the region over the past 8000 years.

The initial period of habitation for the King Range seems to have been relatively late, and site occupation continued to be sporadic throughout its history (Levulett and Hildebrandt 1987). This apparent lack of occupation could be explained by the gradual geologic uplift the King Range experiences. The majority of the known archaeological sites along the coast are located within a few meters of sea level. As the King Range is uplifting at an average rate of three meters per thousand years, it follows that they would have been under water three thousand years ago. Much of the currently habitable land along the coast of the King Range would have been submerged until relatively recent times, giving it the appearance of being newly inhabited (Levulett and Hildebrandt 1987). The pre-contact cultural sequence for the region is summarized below.

Paleoindian Period (11,000 to 8,500 B.P.)

A limited number of sites dating from this time period occur in coastal and interior wetlands. Characteristic artifacts of this period include large, lanceolate, concave-base, fluted projectile points, and chipped stone crescents. No evidence exists for the presence of a developed plant food milling technology. Subsistence adaptation is presumed to have been highly mobile hunting and plant gathering within lacustrine or coastal habitats. Exchange between groups presumably took place on an individual, one-to-one basis, with social groups not being heavily dependent upon exchange (Wallace 1978).

Borax Lake Pattern (8,000 to 5,000 B.P.)

The Borax Lake Pattern, characterized as generalized hunting and gathering by small, highly mobile family groups, defines this early period on the Northwest coast (King et al. 2016). Provisional dates of 3000 to 6000 years B.P. were assigned to the Borax Lake Pattern sites at Pilot Ridge based on obsidian hydration data, although radiocarbon dates were not obtained (Hildebrandt and Hayes 1983). Subsequent data based on corrected dates documented by Fitzgerald and Hildebrandt (2001) from carbon found in a soil sample at site CA-HUM-573 on

Pilot Ridge, date the pattern to 7120 +/- 50 radiocarbon years. To date, this is one of the earliest archaeological deposits dated in Northwest California.

The assemblage consists of widestem projectile points, typically made of locally available chert, that are relatively large compared to later period projectile points; handstones, milling slabs, and ovoid and dome scrapers. Borax Lake Pattern sites typically contain a similar array of artifact types, implying each served as a base camp where similar activities took place, and a lack of specialization. Obsidian is poorly represented in the pattern; suggesting exchange networks with obsidian rich areas (southern North Coast Ranges, Northeast California) were not established.

This adaptive pattern corresponded to a significant Xerothermic warming trend that followed the mid-Holocene neoglacial "little ice age", when higher elevations could have been occupied for a longer portion of the year (Hildebrandt and Hayes 1983). Palynological studies demonstrated that the upland environments within the Pilot Ridge survey area had been affected by a mid-Holocene warm period with the result of an upward migration of the oak woodland environment (Hildebrandt and Hayes 1983). Borax Lake Pattern sites have been identified in upland areas on Pilot Ridge and along the Trinity River near Big Bar (Fitzgerald and Hildebrandt 2001; Hildebrandt and Hayes 1983, 1984) and along South Fork Eel River near Piercy (Rich 2017).

Mendocino Pattern (5,000 to 1,500 B.P.)

The middle period within Northwestern California is represented by the Mendocino Pattern, as proposed by Hildebrandt and Hayes (1983, 1984) based on research at Pilot Ridge. The Mendocino Pattern is characterized by smaller projectile point forms than those of the Borax Lake Pattern widestem projectile points (Hildebrandt and Hayes 1983). This adaptive pattern was oriented towards use of low-elevation villages located along salmon-bearing streams near acorn crops and occupied by larger concentrations of people during the winter months. This technological change is hypothetically linked to the advent of storage facilities, particularly for fish and acorns to feed the population during the lean winter months (Binford 1980). It represents an adaptive shift where resources were collected and returned to a permanent settlement area, resulting in a variety of functionally different site types that reflect more specialized activities (Binford 1980). This shift coincided with a significant cooling trend, the Neo-glacial, (approximately 3300 years ago) which particularly affected the resource base of interior Northwest California. The variety and productivity of upland resources declined as species were displaced to lower elevations. Some estimates place altitude-specific life-zones as much as 305 meters lower than they are today (Hildebrandt and Hayes 1983).

Compared to the previous earlier period, Mendocino Pattern sites are marked by a greater variety of generally smaller projectile point forms (Willits Series, Trinity Series, and Oregon Series), distinct unifacial flake tools (McKee uniface), and greater reliance on mortars and pestles (associated with acorn processing) over milling slabs and handstones (Hildebrandt and Hayes 1983; Levulett and Hildebrandt 1987). The McKee uniface was identified and the pattern named during excavations at McKee Flat archaeological site CA-HUM-405 (Bramlette and Fredrickson 1979; Levulett 1978), about five miles west of the current project area. Middle Period components excavated on the high elevation sites in eastern Humboldt County indicate specialized activities, including periodic burning practices. Data from palynological studies support a burning interpretation to maintain open prairies that supported wildlife and vegetal resources (Hildebrandt and Hayes 1983).

Initial use of coastal resources is evident by Mendocino Pattern components investigated at sites located at the mouth of the Mattole River (Levulett and Hildebrandt 1987) and the mouth of Randall Creek (Whitaker 2005). Mendocino Pattern time markers and obsidian hydration data support the finding of a Middle Period component on the northern margin of Humboldt Bay at the Arcata Sports Complex Site (Eidsness 1993). Evidence at these sites indicates that the coastal occupation continued to be sporadic and seasonal through the Middle Period (Hildebrandt and Hayes 1983).

Tuluwat/Augustine Pattern (1500 B.P. to Contact)

Levulett's King Range chronology breaks this next period into the Middle (1500 – 700 B.P.) and Late (700 B.P. to contact) periods (Levulett 1985; Whitaker 2005). The Athabascan speakers, coming from the north, were already adapted to year-round coastal inhabitation, and they brought with them a diverse toolkit. A blending of adaptive traits, referred to as the Tuluwat/Augustine Pattern, was employed by people during these periods. Tuluwat/Augustine Pattern assemblages identified at Shelter Cove and surrounding coastal sites include a variety of small barbed and notched stone arrow points, stone net-weights, and hopper mortar slabs and pestles (Levulett and Hildebrandt 1987).

Activities increased during the Levulett defined Middle and Late Periods in the King Range and on the coast of southern Humboldt County, as evidenced by the appearance of a diversity and abundance of artifact forms. The presence of human burials indicates that certain locations on the coast were occupied residentially, at least sporadically; although the interior riverine and ridge-top ecosystems seem to have been favored during this period. As time went on, the importance of coastal sites increased, as indicated by the gradual appearance and development of midden soils and abundant lithic tools and debris, including imported items indicative of trade. Obsidian blades and beds of obsidian pressure-flakes were recorded in association with burials (Levulett 1985; Levulett and Hildebrandt 1987). Specialized items such as mauls and maul-handles, elk-antler wedges, gorge fish-hooks, grooved abrading stones, composite-toggling harpoons, Tuluwat projectile points, elk-antler spoons and combs, and beads and similar decorative items made from shell and bone appear in numbers. Levulett's 1979 test excavations at sites in Shelter Cove indicated that the deposits appear to be eroded remnants of seasonal food processing stations that were occupied relatively late in time. The deposits consist mostly of shellfish remains, fish and mammal bones, with very few artifacts.

5.0 ETHNOGRAPHIC AND HISTORIC PERIOD OVERVIEW

5.1 Ethnogeography

The debate over the correct name for the indigenous people of Southern Humboldt is a sensitive, controversial, political, and sometimes heated topic. By the time of the arrival of anthropologists in the area, very few people with enough accurate knowledge to serve as sources of reliable information were alive to interview, none of whom were raised in an intact Native culture. All were childhood victims of the genocide period of the early 1860s who survived by being taken into Euro-American families (Norton 1979). What they knew of their culture was largely learned from older people returning from having been taken to reservations by the military or vigilante settlers. According to a man named Briceland Charlie who was interviewed by Pliny Goddard, "The old people used to tell Charlie about places and things when they were on the reservation" (Goddard1908a:1).

When Goddard came to the Southern Humboldt area in September of 1903 to interview the local Native survivors he spoke first with George Burt of the Bull Creek region who told him the name Sin ki ko for the Southfork of the Eel river (Goddard 1908b:216). Later in the same Sinkyone notebook, Briceland Charlie also referred to another Athabascan-speaking group, the Wailaki: "sin-ku-na Blocksburg calls us"; "Says Wailaki everytime for people south and east" (Goddard 1908c:253). In 1908 Goddard wrote "South fork called: siñ kī kōk. People: siñ kīn ne. (George)", referring to the informant George Burt (Goddard 1908d:3449).

Briceland Charlie also told Goddard "nōñ gaL call us siñkyōne (siñ ke nûk / siñ ke ni) We don't call that way" (Goddard 1908c:494). Nevertheless, Goddard wrote "Sinkyone" on the front cover of three out of four of his field Notebooks transcribed in the area; the third one in the series of four was labeled "Sinkene". Briceland Charlie was the informant for the notebook titled Sinkene, just as he was the informant for the other two notebooks titled Sinkyone.

Goddard also wrote a Sinkyone paragraph for Harold Hodge's *Handbook of American Indians North of Mexico*, published in 1910, giving as a tribal name "Shelter Cove Sinkyone" for the southern division of the two Sinkyone linguistic groups. The name sin-ke-kok or sin-ko-ko was a widely known name for the South Fork of the Eel River, but the only use of Sin'-ke-kok-ke'-ah-hahng (people of the Sin-ke-kok) is found describing a band of Kato Natives living on the upper South Fork Eel in Jackson Valley (Baumhoff 1958:166).

In 1902 Alfred Kroeber spent a few days in Southern Humboldt, gathering stories and information from Sally Bell and George Burt that he used in his publication *Sinkyone Tales* (Kroeber 1919). He also wrote a rough draft of an unpublished manuscript found in the Bancroft collection stating:

> The Athabaskans about the South Fork of Eel River called themselves Sinkene. They called the stream about which they lived Sinkiko. The ending –ne of the word Sinkene is therefore the well-known Athabaskan suffix denoting 'people'. The meaning of the first part of both words Sinki- is not known.

After describing the ethnography of the neighboring Wailaki as extending from Blocksburg to Cahto, Kroeber wrote that this Wailaki dialect "is said to be more similar to their own than are the Mattole or the Hupa or the coast dialect…" (Kroeber n.d.:1).

When C. Hart Merriam, a naturalist by profession, came to the Southern Humboldt area slightly over a decade after Goddard he found that two of Goddard's informants Sallie Bell and George Burt did not acknowledge the tribal label "Sinkyone". In his *Ethnogeographic and Ethnosynonymic Data from Northern California Tribes,* Merriam wrote:

> Sinkyone. Name applied by Goddard to tribe on Bull Creek and South Fork Eel River and extending southwest to coast (including the Lo-lahn-kak and To-cho-be ke-ah). Doubtless derived from Sin-ke-kok, the name of the South Fork of the Eel. The Bull Creek Lo-lahn-kak and Briceland To-cho-be ke-ah tell me that there never was any such name as applied to any tribe or band. Goddard may have coined it from Sin-ke-kok, the name of the river (South Fork Eel) .-CHM. Synonymy: Sinkine (Goddard 1907), Sinkyone (Goddard 1910), Sinkyone (Gifford, after Goddard, Cultural Position of Coast Yuki~ Am Anthrop., Vol. 30, No.1, p. 112-115, Jan. 1928). (Merriam 1976:89)

Merriam (ibid:88) also wrote "Sin-ken-ne. Tribe or language, north or northeast of Upper Mattole region, apparently in Elk Mountains (west side) or Rainbow Mountains region. Needs information.-CHM. Lolahnkok name of tribe on or near Elk Ridge (or Rainbow Ridge)."

This begs the question: how truthful is it to use the tribal name "Sinkyone" if Goddard's primary informants did not recognize the label and none of his Southern Humboldt sources shared it with him? A survey of many Northern California tribes would show that there are many tribal names in common usage today, and in the ethnographic literature, that were not the names that the indigenous people called themselves (Golla 2011).

Typical of the disregard for distinguishing groups of Native people, no newspaper article in the late 1880s to early 1920s ever uses a tribal name for any Southern Humboldt Natives. The federal censuses of 1900 and 1910 listing Native people used the completely inadequate and in some cases offensive designations Digger, Mattole, Wailaki, and Eel River tribe.

The idea that the term Wailaki was in common usage locally at this time is confirmed by family members whose relatives knew Sally Bell or Jack Woodman, two sources of Native knowledge who lived into the 1930s. Both Sally Bell and Jack Woodman claimed "Wylackie" tribe on their 1928 California Indian census applications (NARA 1928).

In 1987 Porter and Ferreira interviewed Oliver Mason as part of the Resource Inventory for the Sinkyone Wilderness State Park. In his youth, Mr. Mason had taken fish he caught at Needle Rock to the Bell family at Four Corners, south of Shelter Cove, and listened to Jack Woodman tell him history: "Mr. Mason objected to the term 'Sinkyone' being applied to his ancestors but thought that the terms 'Lolangkok' and 'To-cho-be keah' sound like words from the traditional language". Mr. Mason recommended that they also interview "Della Womack of Briceland, Wailaki descendant of the Briceland and Woods families" (Ferreira 1987:5-6).

Victoria Patterson accessed the many interviews of different tribal Natives concerning the historic use of the Sinkyone Intertribal Wilderness area for the 1989 article “Sinkyone: An Island of Sanity” in *Native News from California*:

> One thing that emerged from the interviews was the close connection between the so-called Sinkyone and the Wailaki, who lived to the east of them. The connection is so close, in fact, that it makes one question whether the Sinkyone were as independent a group as some ethnographers have claimed, or whether they were a coastal branch of the Wailaki. Some of the people interviewed, like Oliver Mason (Wailaki, eighty years old) and Dave Chadburn (Wailaki, eighty seven years old) are directly related to the informants that ethnographers such as G.A. Nomland relied on to describe Sinkyone" culture and who were (erroneously) described as the “last of their tribe." Ellen Sutherland, for example, the full sister of Sally Bell, was the grandmother of both Oliver Mason and Dave Chadburn. (Patterson 1989:4)

At the time of the debate over the renaming of Garberville’s Bear Gulch bridge, Carol Richey wrote a letter to the editor in the Redwood Times:

> We are Wailaki people, not Sinkyone. My Great-great Aunt, Sally Bell, was Wailaki, as was her sisters My Great-Great Grandmother Ellen Sutherland, great great Aunt Jenny Woodman. My father Oliver Mason spent lots of time with his Aunt Sally and uncle Tom Bell out at their four corners home, taking them fresh surf fish, or abalone or deer meat, she told him much about the killings that took the lives of her family, and how she and her sisters survived, she had much dislike for (non- natives) and she would not tell anyone they were sinkyones, when she was so proud of the fact they were Wailaki's and they are still here. She called my dad, whose native name is known by many oldtimers as "Nocky". Full name meaning second son. Dads mother was the late Florence Sutherland, the last of the Sutherland children, she being the youngest of eight, Uncle Enoch Sutherland, the eldest born 1863 and my Grandmother, born 1883. There are many Wailaki people living in the Garberville, Briceland, and surrounding areas. We are not gone, we exist and are proud of it, and we know who we are. When one person can write their thesis, and claim they found a new tribe, and others who are learned believe this. Then I guess we know less? I am so very proud of our cousins, who are working so very hard to allow people to know who we are…. (*Redwood Record* 20 April 2008).

Similarly the late Louis Hoagland wrote that his Wailaki grandfather Alex Frazier had walked the Benbow area with him sharing that it was all Wailaki territory (Personal Communication Elizabeth Marshall and David Sanchez 2019).

Irvin James Wilder was the son of property owner Elizabeth Marshall’s great-great-grandfather Sanford Wilder and great-great grandmother Jenny Piner Wilder who later married George Somerville. In 1940 Irvin Wilder attended a US Senate Subcommittee of the Committee on Indian Affairs “Survey of the Indians in the United States” convention in San Francisco, where he was listed as “Irvin Wilder Wy-la-ckie”. It is clear that the name Sinkyone was not used an identifying tribal name by Goddard’s primary informants Sally Bell, Jack Woodman, Briceland Charlie, or George Burt; though George Burt supplied Goddard with the name Sin-ke-ne for the people living along the Southfork. It is also clear that Wailaki was in common usage in families descended from the indigenous people of the area.

Indigenous groups throughout the region massacred and imprisoned during the 1860s, on the Mendocino Indian Reservation, the Hoopa Indian Reservation and others. The survivors hid and often assimilated with neighboring tribes.

5.2 History

5.2.1 History of Briceland

The Redwood Creek project area is located on a terrace approximately ¼ mile south of the creek, which flows west to east through downtown Briceland. To the immediate east of the property lies Somerville Road, and Somerville Creek which flows from the south to the north. To the west of the project, Miller Creek flows into Redwood Creek from the northwest.

The earliest history of Briceland is not well known. The town is named for John Briceland, who was born in Virginia in 1838 and came across the plains at the age of 18, heading for the California gold fields (Irvine 1915). He soon came to Humboldt County and settled on Elk Ridge, north of the project area, to raise cattle and horses, before finding his way to the Redwood Creek area west of Redway.

In 1876, two adjacent land patents were filed by Daniel Sutherland and William Collier (Fountain 1967). Once the Garberville and Shelter Cove Wagon Road was completed in 1878 by S.F. Taylor's "Oriental brigade" (*Daily Humboldt Times* 12 Sept. 1978), many pack trains passed through the future town site of Briceland, as the inland towns and sheep ranches were now connected to a shipping port at Shelter Cove. A trail was shown on the south side of Redwood Creek in this vicinity on the 1875 government survey map, leading westerly from Garberville, leading on a southwesterly course through the NW ¼ of Section 19 (Surveyor General 1875). In 1884 a traveler coming from Garberville on the Old Briceland Road reported that he first passed the Marshall Ranch, then the Le Sieur Ranch, finally arriving at the Collier ranch which was the site of the Ring Hotel, with Joseph Russell as the proprietor (*Daily Humboldt Standard* 13 May 1884).

According to another account, an early settler by the name of "Jim Filer had a little store here. Mr. Briceland bought him out and continued the mercantile business, enlarging the store and running it for three years, when he sold the store building and goods" (Irvine 1915:1191). Collier also sold out to John C. Briceland: "A few years ago there stood beside a trail between Garberville and Shelter Cove a small log cabin occupied by a gray bearded old gentleman named Collier. This place was bought by Mr. J.C. Briceland who with his family started a hotel and built a store and post office" (*Humboldt Standard* 11 Jan. 1907).

In 1885 Southern Humboldt's most prominent carpenter, George Morgan, began building a new home for John C. Briceland of the Ettersburg (*Daily Humboldt Standard* 21 July 1885). By August, Mr. Briceland was ensconced at his homestead and hotel on Redwood Creek, "where the traveler may enjoy hospitable accommodations and feast his eyes on a lovely landscape which affords a splendid range for sheep and a sufficiency of arable land. Several acres of good, bottom land are now being cleared, which Briceland proposes to plant with fruit trees. Lesieur's ranch, with fat cattle and numerous swine, adjoins Mr. Briceland's on the east" (*Daily Humboldt*

Standard 19 August 1885).

With the August 3rd, 1889 establishment of a Post Office (*Sacramento Daily Record-Union* 4 August 1889) the town name “Briceland” became official, and in early 1901 town plots were surveyed and mapped out by J. Bowden (*Humboldt Times* 16 Apr. 1901). The construction of the Wagner Tan Bark processing plant in 1903 gave a huge boost to the growing tan bark industry and Briceland quickly grew to be the economic and social hub of Southern Humboldt. Tan-oak bark was shipped out of Shelter Cove and other wharves, to leather processing plants in the San Francisco Bay area. The Briceland population surpassed that of Garberville in the 1890s (Vincent 1983:6).

The town of Briceland burnt down on July 14, 1914, with a fire starting in the kitchen of the Briceland Hotel that quickly spread and destroyed nine surrounding buildings, most of which were all connected to the town’s natural gas supply from its source at today’s junction of Old Briceland and Shelter Cove roads (*San Jose Evening News* 14 July 1914). This town well was the first of several oil and gas wells drilled in the area, the last being the very short-lived Dugan Oil Company’s “Velma No. 1” (Stanley 1995:16) located south, and upslope, of the project property.

5.2.2 History of the Project Property

The first land patent for the property was granted on October 1, 1890 to William H. Reynolds, who filed a claim to the NE ¼ of the NW ¼ of Section 19 (BLM 2019a). The following year, on December 1, 1891, Frank Stukey was granted a land patent for the NW ¼ of the NW ¼ of Section 19, identified as Lot 1/Tract 1 (BLM 2019b). The 1898 Lentell Map of Humboldt County shows Stuckey (spelled Stuckey on the map) in ownership of the NW ¼ of the NW ¼, but the NE ¼ of the NW ¼ was then owned by one J. Wilder. Stuckey was still the owner of his ¼-section at the time of the 1911 Denny map, but the East ½ of the NW ¼ has no name affixed.

In 1915, F.H. Stuckey died and was buried in the Briceland cemetery (Hawk 2015). The 1921 Humboldt County atlas shows that William A. Herman owned the project property (Figure 3) (Belcher 1921-1922:3). Mr. Herman served as Justice of the Peace for the Briceland Township in 1921 in addition to his ranching occupation (Jordan 1921:45).

Though Mr. Herman died in 1947 (*Redwood Record* 4 Dec. 1947), the 1949 county atlas shows that the property still bears his name (Metsker 1949:59). His sons Bryan and Jesse took over and managed the property, until selling out to Wes Marshall on December 15, 1970 (Book of Deeds 1069, OR pg 83).

The Herman family used the pasturage on the project property to grow hay and graze livestock. A 1963 aerial photograph of Briceland shows barns just to the west and east of the project site, which were owned by Jesse and Bryan Herman respectively (Figure 4).

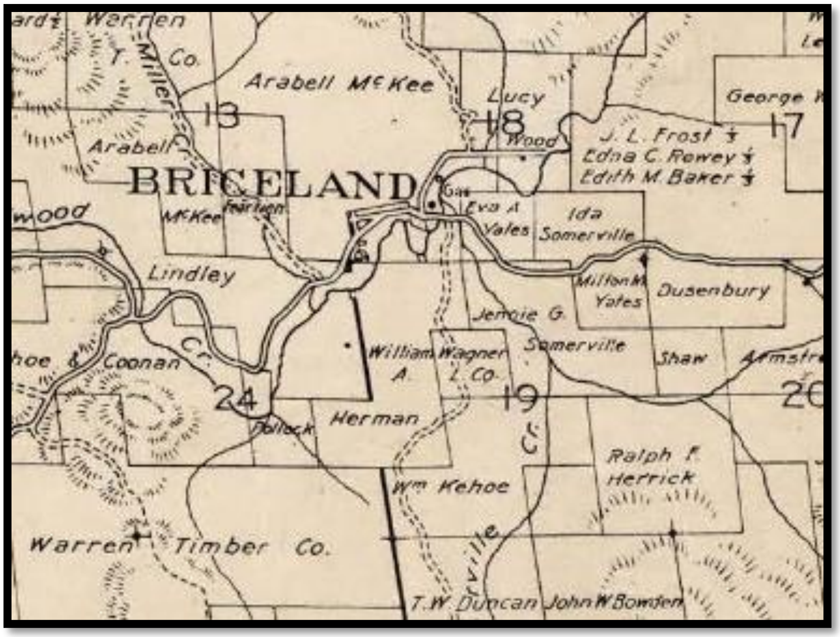


Figure 4. Detail of the 1921 county atlas showing the W.A. Herman property in Section 19, south of Briceland at center.

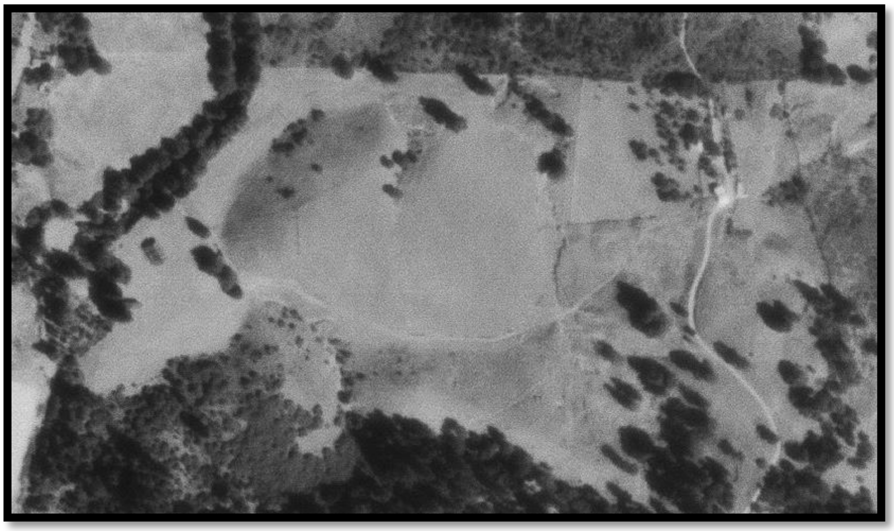


Figure 5. Aerial photo from 1968 of the project area in the grassy meadow at center, with Redwood Creek at upper left and the ranch barn and other structures along the road at upper right.

These structures were also shown on the 1949 USGS 15-minute Garberville quadrangle and the 1969 7.5-minute Briceland quadrangle. Jesse Herman housed a small herd of Angora goats at his barn and Bryan had a herd of Black Angus cattle. The Marshall family purchased the properties from the Herman family in 1970 but continued leasing the property to the Herman family. The project property has largely remained fallow in recent years (Al Karl, personal communication, January 2019).

6.0 INVESTIGATION METHODS AND RESULTS

6.1 Background Archival Research

Background archival research was aimed at obtaining information pertinent to the pre-contact era and historical uses of the project's vicinity to generate specific geographic information about relevant archaeological and historic-era sites. Background research also provided an understanding of the types of cultural resources that were likely to be encountered in the project vicinity. Ethnohistoric research included an examination of historical maps, records and published and unpublished ethnographic documents at the Humboldt County Historical Society, Humboldt State University (HSU) Library, as well as, the author's personal libraries.

Also searched were the directories of the National Register of Historic Places for Humboldt County and the list of determined Eligible Properties, listing for the California Register of Historical Resources, local California Points of Historical Interest, and the listing of the California Historical Landmarks. This research indicated that the project location is not associated with or located near an historic district, historical landmark, locally registered historic resource, or nationally registered historic property.

Northwest Information Center Records Search

Background research for this project included an examination of the confidential archaeological site records and survey reports at the California Historical Resources Information System's regional Northwest Information Center (NWIC) in Rohnert Park, California. On July 25, 2019, Melinda Salisbury B.A. conducted the record search under IC File #18-0175. Following completion of this cultural resources study, a copy of this report will be filed with the NWIC, per the access agreement.

The objectives of the record search were to: 1) review cultural resource survey reports that either included the project area or were conducted within ½ mile of the project area; 2) to review pertinent regional archaeological, ethnographic, and historical overview documents; and 3) determine if cultural or historical resources have been recorded within the project area or within ½ mile of the project area.

The records search at the NWIC revealed that the direct project area has not been included in any previous cultural resources surveys, but that one survey included a portion of the creek channel near the proposed infiltration area (Raskin et al. 2014).

A total of nine previous surveys have been conducted within the ½-mile buffer study area according to the NWIC and one additional survey within this area has not yet been assigned a survey number (Table 1). Cumulatively, these nine previous studies resulted in the identification of four ancestral Native American archaeological sites within the ½ mile buffer. None of these sites are located within the proposed project area or subject property, the closest being approximately 718 feet (219 meters) north on adjacent parcel (Table 2).

Table 1. Previous studies within the project area and the ½ mile buffer.

Survey Number	Title	Author/ Date	Results
S-039836	An Archaeological Survey Report for the Pollack Creek Timber Harvesting Plan, Humboldt County, California	Todd Truesdell 2011	12 archaeological or historical sites were identified, outside of the current ½ mile buffer.
S-041434	A Cultural Resources Investigation of the Proposed Briceland Sediment Reduction and Water Quality Improvement Project, Humboldt County, California, DFG #038 R-1	Jeanette Cooper and James Roscoe 2002	No cultural resources were identified.
S-041764	A Cultural Resources Investigation of the Redwood Creek/Schroeder Property Bank Stabilization Project, Located in Humboldt County, California, DF&G #122-R-1	Greg Collins, Bethany Weber and James Roscoe 2004	No cultural resources were identified.
S-041910	A Cultural Resources Investigation of the Redwood Creek Dam Removal located in Humboldt County, California, California Department of Fish & Game Project #R1-047	Karen Raskin and James Roscoe 2008	No cultural resources were identified.
S-042460	A Cultural Resources Investigation of the Proposed Somerville Creek Restoration Project, Located Near Briceland, Humboldt County, California	Eric Taylor and James Roscoe 1999	No cultural resources were identified.
S-043429	An Archaeological Survey Report for the Marshall Ranch THP, County of Humboldt, California; THP 1-13-029 HUM	Daniel R. Graybil 2012	No cultural resources were identified.
S-046517*	A Cultural Resources Investigation of the California Department of Fish and Wildlife Redwood Creek LWD/Pool Improvement Project #HI-246, Humboldt County, California	Karen Raskin, Nicole Martensen and James Roscoe 2014	The former location of the Schroeder Lumber Mill was noted, but not recorded.
S-048735	A Cultural Resources Investigation of the Miller Creek Sedimentation Reduction and Monitoring Project, located in Humboldt County, California, DF&G #188-R-1	William Rich, Bethany Weber and James Roscoe 2003	No cultural resources were identified.
S-049851	Phase I Cultural Resource Inventory Report for Kan Agribiz, Inc. Commercial Cannabis Permit APN No. 220-252-037	Dimitra Zalavaris-Chase and Thomas Ross 2017	Site P-12-003705 was identified and recorded.
No survey number assigned	A Cultural Resource Investigation Report for a Commercial Cultivation Permit for APN 220-252-034, Briceland, Humboldt County, California	James Roscoe 2018	Site "RA 1 – Neufeld Garden Site" was identified and recorded

* Notes study within a portion of the project area.

Table 2. Cultural resources previously documented within ½ mile of the project area.

Primary # / Trinomial / Name	Description	Author/ Date	Site Location
P-12-000253 / CA-HUM-000233	Ancestral Native American artifact scatter with habitation debris and "arrowheads, scrapers, pestles"	University of California, Archaeological Research Facility n.d.	2,585 feet northwest
P-12-000678 / CA-HUM-000687	Sub-surface lithic scatter exposed by road-cut; anthropogenic soil	Dorothy Stengl and Dave Drennan 1983	1,236 feet north
P-12-003705 / CA-HUM-001703	Sparse-density lithic and groundstone artifact scatter	Dimitra Zalavaris-Chase and Thomas J. Ross 2017	935 feet northeast
"RA 1 – Neufeld Garden Site"	Sparse density lithic scatter	James Roscoe and Matthew Steele 2018	718 feet north

6.2 Correspondence with Native American Tribal Representatives

On February 6, 2019, WRA sent a letter to the Native American Heritage Commission (NAHC) requesting a search of the Sacred Lands Inventory File and a current list of Native Americans who might have knowledge of cultural resources in the project area (Appendix B). The NAHC responded on February 7, 2019 with negative results of the Sacred Lands search and provided a suggested list of Native American individuals to contact for this portion of Humboldt County. The Bear River Band of the Rohnerville Rancheria, InterTribal Sinkyone Wilderness Council, and the Wailaki Tribe were contacted on February 6, 2019. Tribal Historic Preservation Officer Erika Cooper, M.A. responded the same day noting a previously recorded site on an adjacent parcel (Appendix B). No other responses have been received.

Landowner, Elizabeth Marshall and representative David Sanchez were present during several field survey days, and shared their knowledge and history of the area and also provided comments to draft sections of this report. Mr. Sanchez helped to develop the recommended avoidance and monitoring protection measures. With regard to the identified archaeological site, Ms. Marshall indicated that the artifacts would have belonged to her family and that if avoidable, implementation of the proposed project to improve anadromous fish habitat would not result in adverse impacts to this site or other cultural features.

6.3 Survey Methods and Results

Field Investigation Methods and Results

On July 31, August 22 and August 27, 2018 and July 8, 2019, William Rich, M.A., RPA and Research Associate Matthew Cooper conducted a pedestrian field survey of the entire project area, including the areas proposed for construction of the off-channel pond and infiltration gallery, the adjacent reach of Redwood Creek proposed for installation of wood structures and rock armor, the areas proposed for installation of solar arrays, rainwater catchment tanks, and fire hydrants; and the equipment access routes. The field survey included systematic parallel and zig-zag transects over these areas, less than ten meters apart, while visually scanning the ground surface for mineral sediment exposures. On August 27, 2018 William Rich also monitored backhoe test pits being performed on the lower terrace in the location proposed for infiltration (Figure 6). Backhoe testing revealed the lower terrace holds a light brown silty, loam topsoil. Below this the profile enters a zone of increasingly weathered shale bedrock.

Accessibility to mineral sediment was fair throughout the survey area. The direct project area is situated in an open, grassy field, with occasional natural mineral soil exposures, graded and eroded areas, and burrowing rodent tailings providing ample opportunities to investigate for buried archaeological deposits (Figure 7; see also the cover photo). A shovel was used to excavate small holes at regular intervals to aid in this investigation. The field survey encompassed 27 acres (see Figure 2).

Figure 6. View of test pits being conducted to locate bedrock and establish monitoring wells to better understand potential infiltration rate.

Figure 7. View to the northeast of lower terrace at location of proposed pond water infiltration.

The field survey resulted in the identification of a scatter of Native American groundstone artifacts adjacent to the area proposed for pond construction. The site was recorded during this investigation under the field-name “WRA-01 – Marshall Site” on CDPR 523-series archaeological site record forms during this investigation (Appendix C). The location appears to contain a concentration of groundstone artifacts on the surface. Observations include several fragments of netherstone with evidence of use and abrading, to roughen the surface. One handstone was identified with a high degree of polish and battered surfaces. In addition, several broken and discolored cobbles of quartzite were found and interpreted as cooking stones. Despite ample mineral sediment and shovel scrapes, no flaked stone tools or debitage were encountered at this site. The site is situated at the northern edge of a relatively intact alluvial terrace within an open grassland, and scattered large oaks. A site boundary was delineated around the surface artifacts. It seems plausible that the site would be associated with specific activities, related to milling and processing of plant based foods and/or materials. For these reasons the site appears to qualify as an historical resource pursuant to CEQA, significant for its information potential (CRHR Criterion D) as it relates to subsistence strategies, food procurement, and use of the pre-contact landscape around Briceland.

In addition, an isolated handstone was identified in a cut slope adjacent to a historical road. The isolated handstone is an oblong rounded river cobble of sandstone with multiple ground faces, and end battering. It was found approximately 50 feet southwest of the proposed pond construction. The artifact was recorded as an individual item under WRA-02 – Marshall Isolate” on CDPR 523-series archaeological site record forms (Appendix C). The handstone appears in a secondary context due to historical road building leading between the upper and lower terrace. The artifact would not qualify as an historical resource pursuant to CEQA.

A concentration of historic-period refuse was also noted in a nearby gully, just to the east of the proposed pond. This includes building construction materials, rusted metal, a ranch gate, empty 50-gallon drums, bed frames and mattress springs, hogwire and other domestic and ranch refuse. These materials appear to have been dumped within the last 50 years, likely by the owners or occupants of the house about 480 feet to the east and appears moved from its primary context and would not meet the age threshold for an historical resource.

The location of a barn as shown on the 1060 USGS 7.5-minute Briceland quadrangle, about 170 feet southwest of the proposed infiltration gallery, is no longer present. This area was included in the field survey, which did not identify any evidence of a structure at this location.

7.0 CONCLUSIONS AND RECOMMENDATIONS

As currently designed, the WRA 01-Marshall Site lies outside project activities, with the exception of a layer of proposed fill from nearby pond excavation. The proposed outflow pipe to the infiltration gallery will be installed via 4-inch horizontal bore at a depth of 30-40 feet, well below the archaeological site. Adjacent to the eastern edge of the site, two parallel trenches will be excavated for placement of a 4-inch outflow pipe from Redwood Creek, and a 24-inch overflow culvert, although the latter may be redesigned for a surface installation.

The following recommendations are designed to provide avoidance and protection strategies for this site during project implementation and into the future. These conditions should be incorporated into project permitting

1) The site boundary shall be clearly marked during project implementation. Boundary markers such as flagging, stakes, fencing or other highly visible barrier shall be used.
2) The area containing the archaeological site shall be completely excluded from ground disturbing activities.
3) Spoils from pond excavation may be placed directly on the existing site surface, however, no grading or scarifying shall be conducted. Heavy equipment shall not enter the site unless atop a sufficient layer of fill, such that the underlying soil is not displaced.
4) All ground-disturbing activities and placement of fill material within the known archaeological site shall be monitored by a professional archaeologist familiar with specific project conditions. A monitoring plan should be developed and used to guide monitoring and discovery protocol.
5) This archaeological site should be continuously monitored after project construction. The landowner or designee should watch for erosion, unauthorized collecting, and other site damages as a result of this site now being identified.
6) In the event additional archaeological material is encountered during project implementation or during future site monitoring efforts, all work shall stop in the area of the find and the discovery protocol initiated as briefly described in Section 7.1 of this report.

It is the opinion of this author that conditions to avoid and monitor, along with implementation of a standard discovery protocol, will result in a project that would not cause a substantial adverse change in the significance of an historical resource and a tribal cultural resource, as defined in CEQA 15064.5 and PRC 21074. Furthermore, it is recommended that the County, as the lead agency for this project, continue good faith consultation with affected tribes regarding tribal cultural resources, the findings of this survey report, proposed protection measures, and participation in field monitoring.

In addition, it is recommended that the findings of this investigation be kept confidential between the permitting/funding agencies, project applicant, tribes and landowner. The location, composition, character and other qualities of the identified archaeological site and any others that may become known are exempt from public disclosure. Project personnel should not be given full knowledge of these conditions other than avoidance of flagged areas. This report should undergo redaction before being made available to unauthorized readers or the public.

7.1 Protocols for Inadvertent Discoveries

Although discovery of cultural resources during project construction is not anticipated, the following pages offer recommendations to follow in this event. These recommendations are designed to ensure that potential project impacts on inadvertently discovered cultural resources are eliminated or reduced to less than significant levels.

Inadvertent Discovery of Cultural Resources

If cultural resources are encountered during construction activities, all onsite work shall cease in the immediate area and within a 50-foot buffer of the discovery location. A qualified archaeologist will be retained to evaluate and assess the significance of the discovery, and develop and implement an avoidance or mitigation plan, as appropriate. For discoveries known or likely to be associated with Native American heritage (prehistoric sites and select historic period sites), the tribes listed in Section 6.2 and those that the County has on file shall also be contacted immediately to evaluate the discovery and, in consultation with the project proponent, the County, and consulting archaeologist, develop a treatment plan in any instance where significant impacts cannot be avoided. Prehistoric materials which could be encountered include obsidian and chert debitage or formal tools, grinding implements, (e.g., pestles, handstones, bowl mortars, slabs), locally darkened midden, deposits of shell, faunal remains, and human burials. Historic archaeological discoveries may include nineteenth century building foundations, structural remains, or concentrations of artifacts made of glass, ceramics, metal or other materials found in buried pits, wells or privies.

8.0 PROFESSIONAL QUALIFICATIONS

This investigation was completed by William Rich, M.A, RPA. Mr. Rich has over 18 years of professional experience in northwest California and meets the Secretary of Interior's Professional Qualifications Standards for Archaeology (Title 36 Code of Federal Regulations Part 61, and 48 Federal Regulation 44716). Mr. David Heller compiled the information regarding the ethnography and history of the project vicinity. Mr. Matthew Cooper and Ms. Melinda Salisbury, B.A. also aided in various aspects of this investigation.

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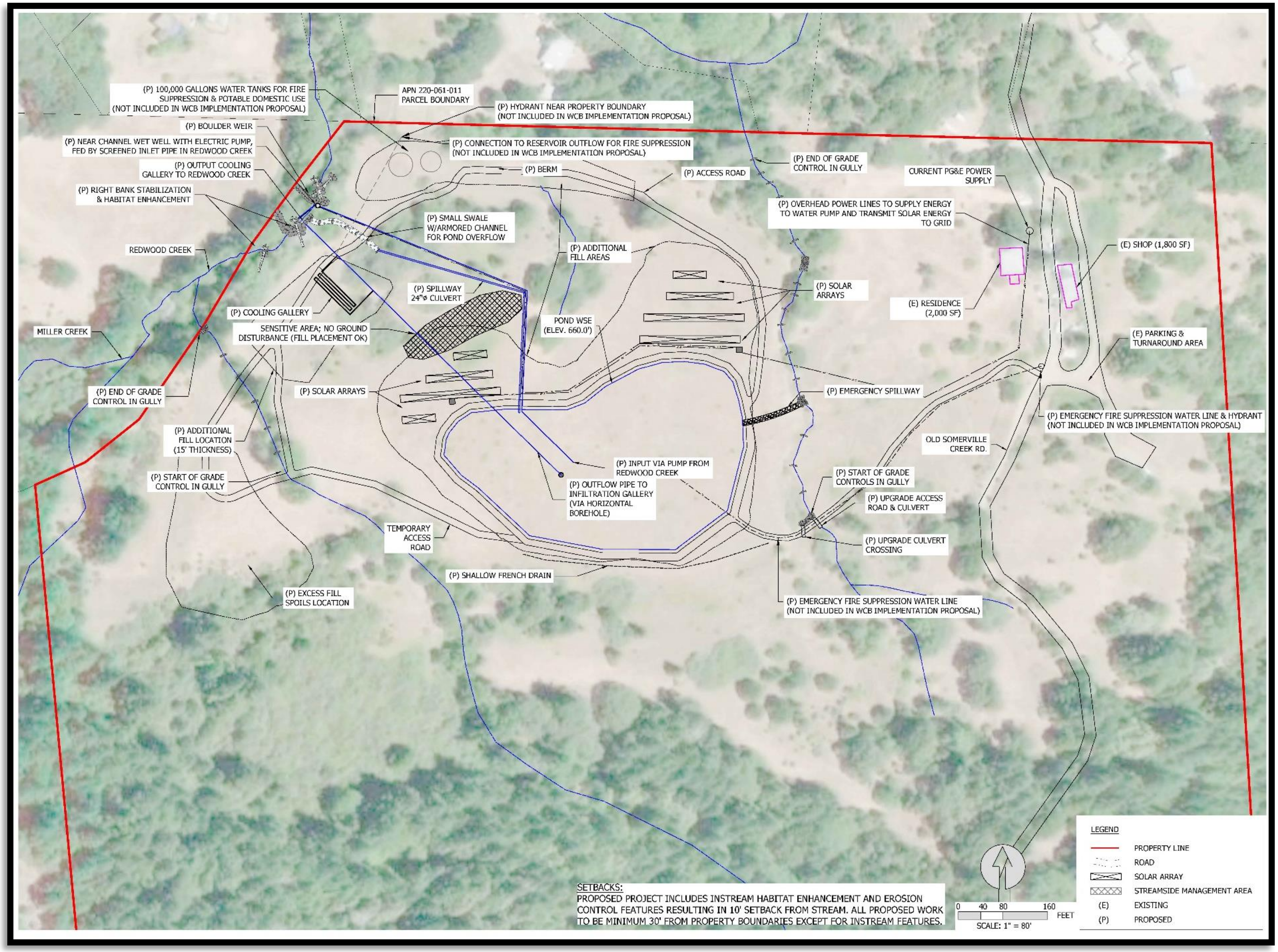
APPENDIX A

Conceptual Design and Project Maps, Marshall Ranch Flow Enhancement Project



SETBACKS:
PROPOSED PROJECT INCLUDES INSTREAM HABITAT ENHANCEMENT AND EROSION CONTROL FEATURES RESULTING IN 10' SETBACK FROM STREAM. ALL PROPOSED WORK TO BE MINIMUM 30' FROM PROPERTY BOUNDARIES EXCEPT FOR INSTREAM FEATURES.

APPENDIX B
Native American Correspondence

DATE: February 6, 2019

TO: Native American Heritage Commission

FROM: William Rich, M.A., RPA

SUBJECT: Sacred Lands Database Search: **Redwood Creek Flow Enhancement (Marshall Ranch) project near Briceland, Humboldt County, CA**

PAGES: 2 (cover and 1 map)

Dear NAHC,

William Rich and Associates have been retained to conduct a cultural resources investigation for the Redwood Creek Flow Enhancement (Marshall Ranch) Project near Briceland, Humboldt County, California. Specifically, the project is located in Section 19, T4S, R3E, as shown on the USGS 7.5' Briceland, CA Topographic Quadrangle. The project area is indicated on the accompanying map.

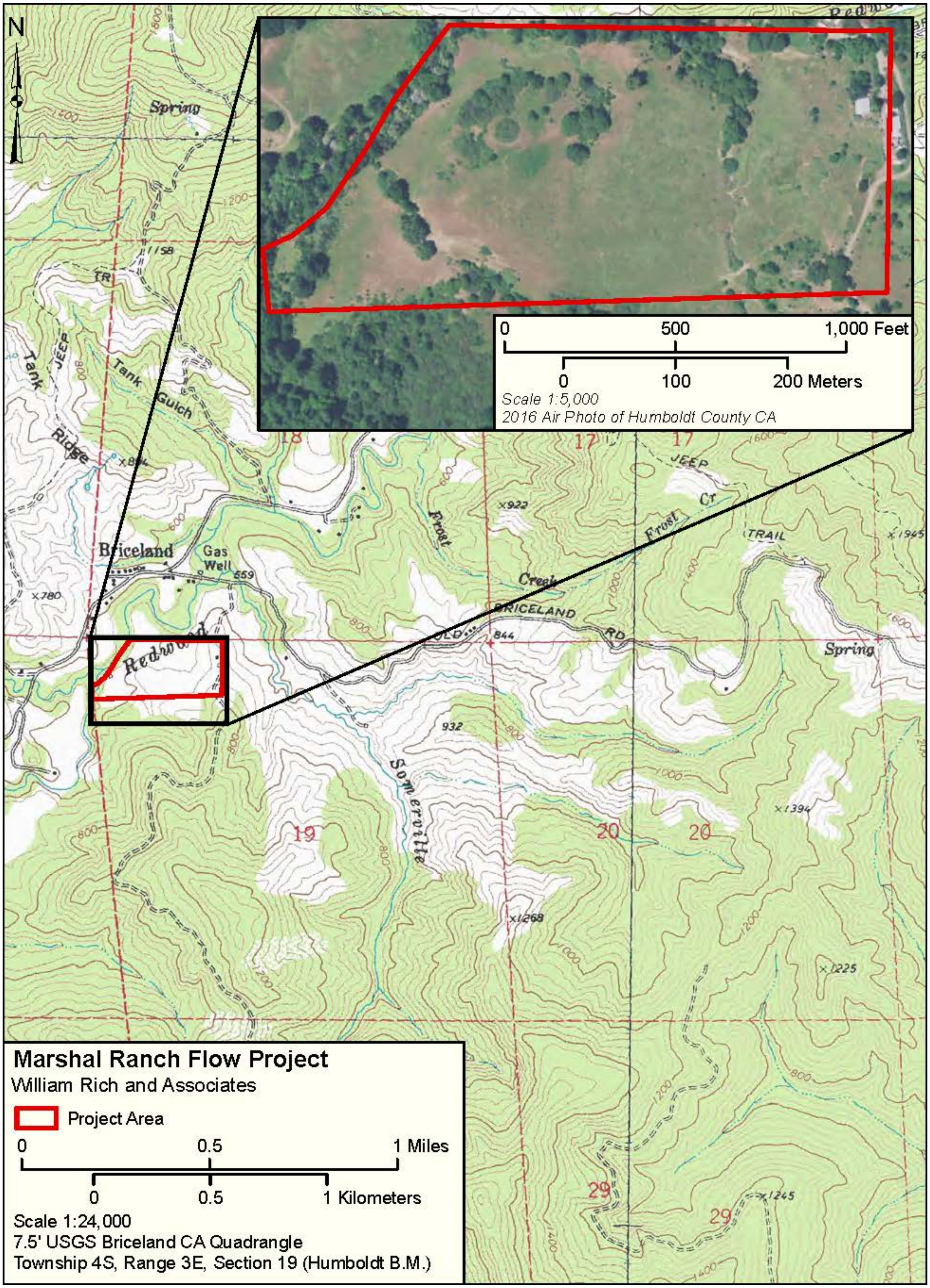
I would greatly appreciate a list of Native American contacts and the results of a search of the sacred lands database for previously identified sites of concern within the project area or a one-half mile radius.

Many thanks in advance for your assistance.

Sincerely,

William C. Rich

William Rich, M.A., RPA
Principal Investigator
William Rich and Associates
P.O. Box 184
Bayside, CA 95524
(707) 834-5347
wcr@williamrichandassociates.com


N
Marshal Ranch Flow Project
William Rich and Associates
Project Area
0
0.5
1 Miles
0
0.5
1 Kilometers
Scale 1:24,000
7.5' USGS Briceland CA Quadrangle
Township 4S, Range 3E, Section 19 (Humboldt B.M.)
0
500
1,000 Feet
0
100
200 Meters
Scale 1:5,000
2016 Air Photo of Humboldt County CA
Spring
Tank Ridge
JEEP TR
Tank Gulch
Briceland
Gas Well
559
Redwood
Frost Creek
Frost Cr
BRICELAND RD
OLD
844
JEEP
TRAIL
Spring
Somerville
932
x922
x1945
x1394
x1268
x1225
x1245
x780
x844
1158
17
18
19
20
29

STATE OF CALIFORNIA **Gavin Newsom, Governor**

NATIVE AMERICAN HERITAGE COMMISSION
Cultural and Environmental Department
1550 Harbor Blvd., Suite 100
West Sacramento, CA 95691
Phone: (916) 373-3710
Email: nahc@nahc.ca.gov
Website: http://www.nahc.ca.gov

February 7, 2019

William Rich
William Rich and Associates

VIA Email to: wcr@williamrichandassociates.com

RE: Redwood Creek Flow Enhancement (Marshall Ranch) Project, near the Community of Briceland; Briceland USGS Quadrangle, Humboldt County

Dear Mr. Rich:

A record search of the Native American Heritage Commission (NAHC) Sacred Lands File (SLF) was completed for the information you have submitted for the above referenced project. The results were negative. However, the absence of specific site information in the SLF does not indicate the absence of cultural resources in any project area. Other sources of cultural resources should also be contacted for information regarding known and recorded sites.

Attached is a list of Native American tribes who may also have knowledge of cultural resources in the project area. This list should provide a starting place in locating areas of potential adverse impact within the proposed project area. I suggest you contact all of those indicated; if they cannot supply information, they might recommend others with specific knowledge. By contacting all those listed, your organization will be better able to respond to claims of failure to consult with the appropriate tribe. If a response has not been received within two weeks of notification, the Commission requests that you follow-up with a telephone call or email to ensure that the project information has been received.

If you receive notification of change of addresses and phone numbers from tribes, please notify the NAHC. With your assistance, we can assure that our lists contain current information. If you have any questions or need additional information, please contact me at my email address: gayle.totton@nahc.ca.gov.

Sincerely,

Gayle Totton

Gayle Totton, B.S., M.A., Ph.D.
Associate Governmental Program Analyst

Attachment

Native American Heritage Commission
Native American Contact List
Humboldt County
2/7/2019

Bear River Band of Rohnerville Rancheria

Erika Cooper, Tribal Historic Preservation Officer	
266 Keisner Road	Mattole
Loleta, CA, 95551	Wiyot
Phone: (707) 733 - 1900	
Fax: (707) 733-1727	
erikacooper@brb-nsn.gov	

Bear River Band of Rohnerville Rancheria

Barry Brenard, Chairperson	
266 Keisner Road	Mattole
Loleta, CA, 95551	Wiyot
Phone: (707) 733 - 1900	
Fax: (707) 733-1727	

Big Lagoon Rancheria

Virgil Moorehead, Chairperson	
P. O. Box 3060	Tolowa
Trinidad, CA, 95570	Yurok
Phone: (707) 826 - 2079	
Fax: (707) 826-1737	
vmoorehead@earthlink.net	

Cher-Ae Heights Indian Community of the Trinidad Rancheria

Garth Sundberg, Chairperson	
P.O. Box 630	Miwok
Trinidad, CA, 95570-0630	Tolowa
Phone: (707) 677 - 0211	Yurok
Fax: (707) 677-3921	
gsundberg@TrinidadRancheria.com	

Hoopa Valley Tribe

Ryan Jackson, Chairperson	
P.O. Box 1348	Hoopa
Hoopa, CA, 95546	
Phone: (530) 625 - 4211	
Fax: (530) 625-4594	

Round Valley Reservation/ Covelo Indian Community

James Russ, President	
77826 Covelo Road	ConCow
Covelo, CA, 95428	Nomlaki
Phone: (707) 983 - 6126	Pit River
Fax: (707) 983-6128	Pomo
tribalcouncil@rvit.org	Wailaki
	Wintun
	Yuki

This list is current only as of the date of this document. Distribution of this list does not relieve any person of statutory responsibility as defined in Section 7050.5 of the Health and Safety Code, Section 5097.94 of the Public Resource Section 5097.98 of the Public Resources Code.

This list is only applicable for contacting local Native Americans with regard to cultural resources assessment for the proposed Redwood Creek Flow Enhancement (Marshall Ranch) Project, Humboldt County.

February 6, 2019

1. Bear River Band of Rohnerville Rancheria –Erika Cooper, THPO
2. InterTribal Sinkyone Wilderness Council –Hawk Rosales, Director
3. Wailaki Tribe - Chairperson

Dear Tribal Representative,

William Rich and Associates is conducting a cultural resources investigation for the **Redwood Creek Flow Enhancement (Marshall Ranch) Project** located near Briceland, in southern Humboldt County, California. This project will construct a 50-million-gallon off-channel pond and groundwater infiltration galleries within Assessor's Parcel Number 220-061-011. The project area is specifically located in Section 19 of Township 4 South, Range 3 East (HB&M) and is shown on the 7.5 USGS Topographic Quadrangle Map, Briceland, California (see attached).

If you have any concerns or would like to share any information that would help identify cultural resources in the project area, feel free to contact me. Any culturally sensitive information that you may disclose to WRA will be held under strict confidentiality and will not be made available to the public. All cultural sites will be documented in accordance to the guidelines established by the State Office of Historic Preservation. A copy of the final report and any completed archaeological site records will be submitted to the California Historical Resources Information System's regional Northwest Information Center.

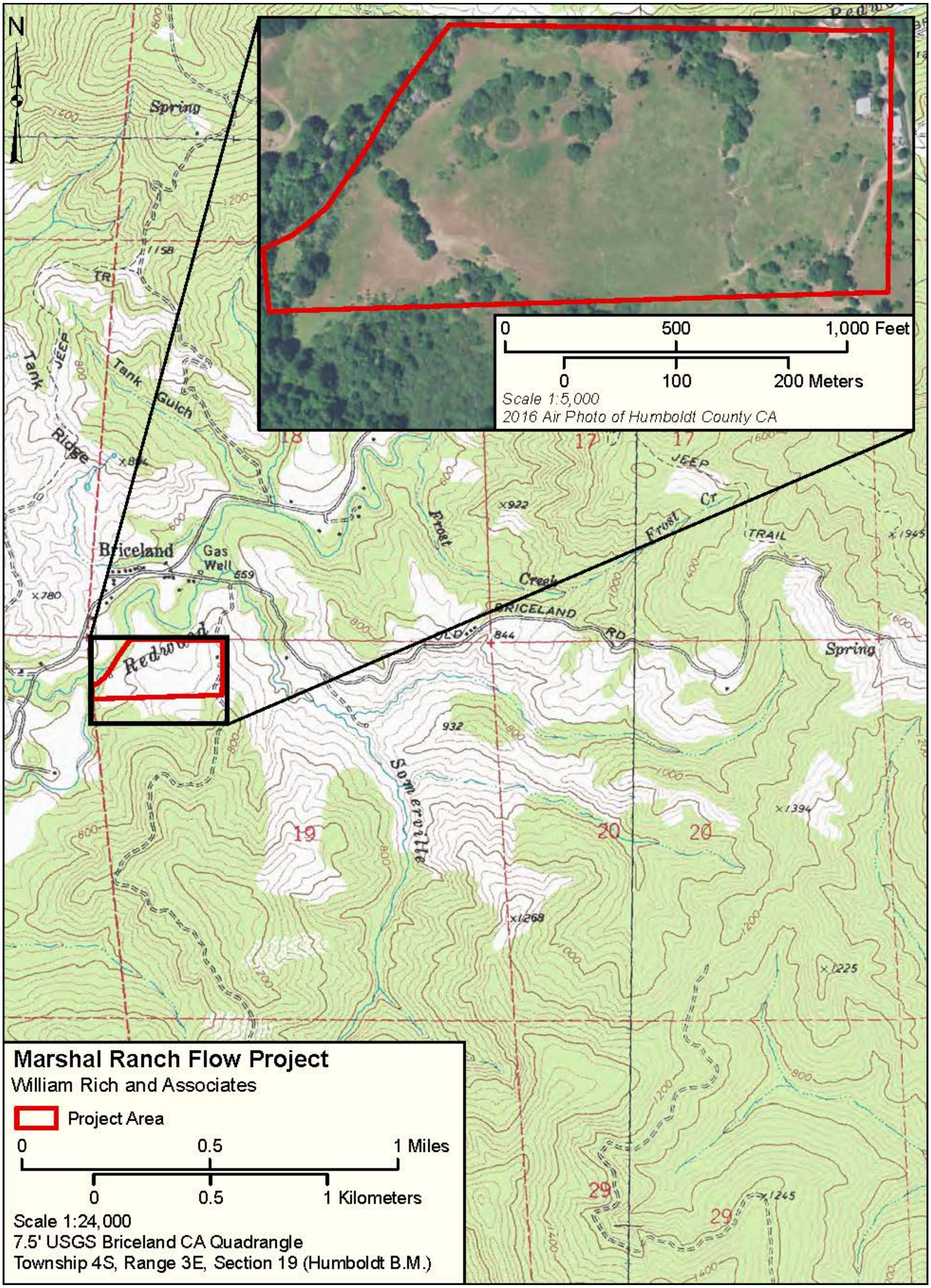
Thank you in advance for your assistance. If you have any information, concerns or questions please contact me at 834-5347 (cell).

Sincerely,

William Rich

William Rich, M.A., RPA
P.O. Box 184
Bayside, CA 95524
wcr@williamrichandassociates.com
(707) 834-5347

Enclosures (2)



Marshal Ranch Flow Project

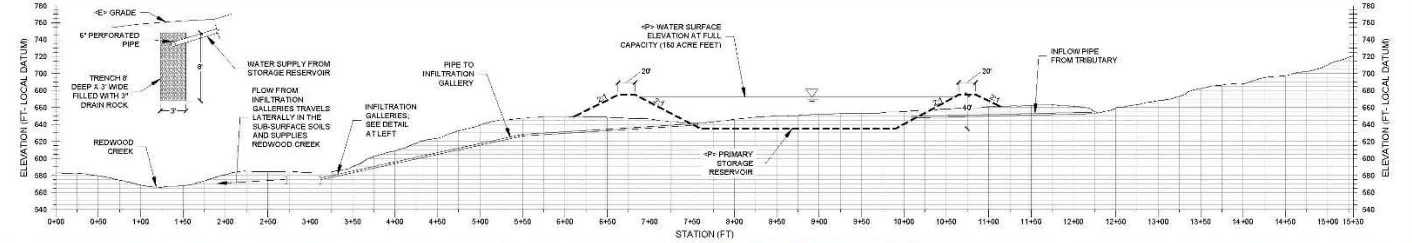
William Rich and Associates

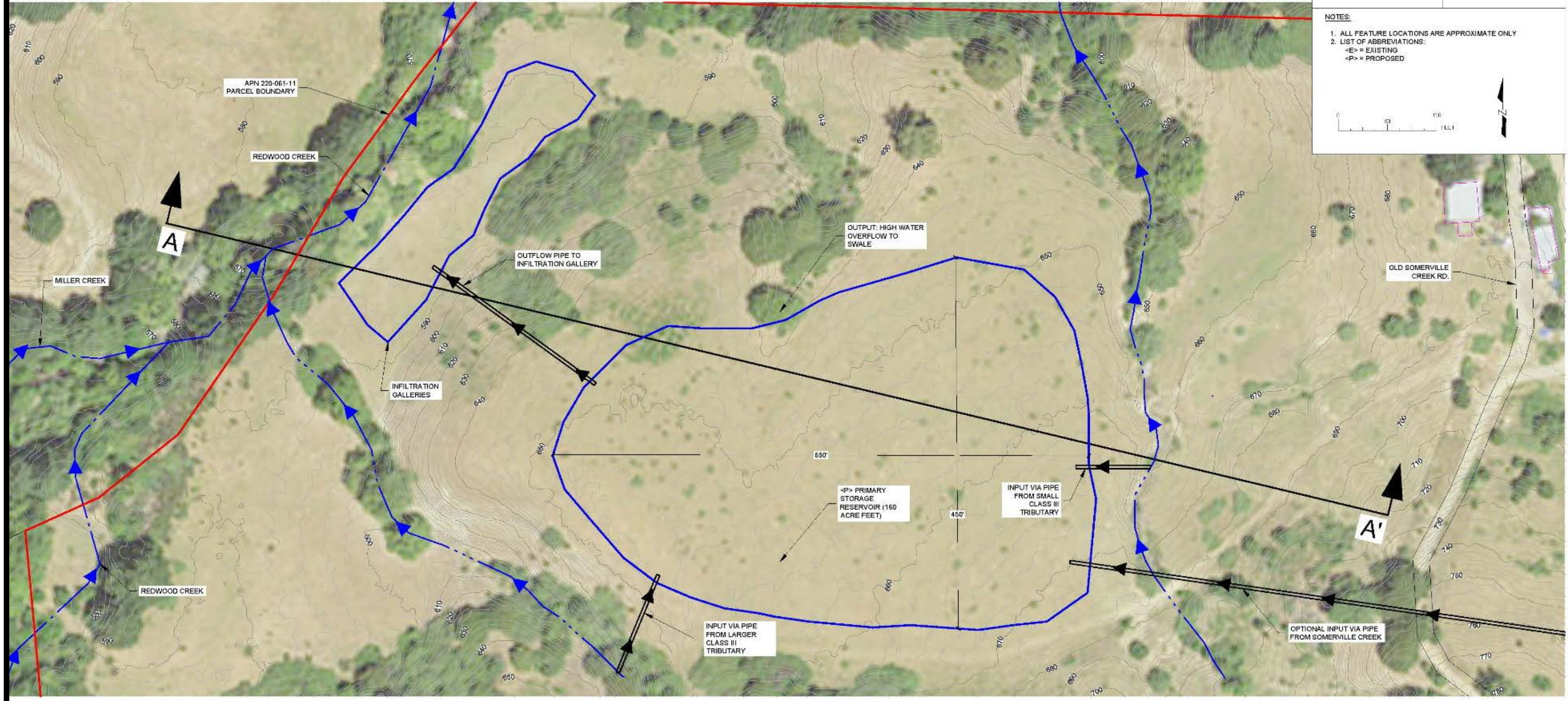
🟥 Project Area

0 0.5 1 Miles

0 0.5 1 Kilometers

Scale 1:24,000
7.5' USGS Briceland CA Quadrangle
Township 4S, Range 3E, Section 19 (Humboldt B.M.)





NOTES:

1. ALL FEATURE LOCATIONS ARE APPROXIMATE ONLY
2. LIST OF ABBREVIATIONS:
   <E> = EXISTING
   <P> = PROPOSED

REDWOOD CREEK FLOW ENHANCEMENT

SALMONID RESTORATION FEDERATION, MARSHALL RANCH, & CDFW
HUMBOLDT COUNTY, CA

Stillwater Sciences
www.stillwatersci.com

Design: JM
Drawn: CL
Checked: JM
Apprd: JM

CONCEPTUAL DESIGN PLAN AND SECTION

Size: D
Project: 603.00
Scale: AS NOTED
Date: 1/13/2017
Sheet: 2 OF 2

William <wcr@williamrichandassociates.com>

Briceland-Marshall Ranch

3 messages

William Rich <wcr@williamrichandassociates.com> Wed, Feb 6, 2019 at 2:26 PM
To: Erika Cooper <erikacooper@brb-nsn.gov>

Hi Erika,

Attached is a letter for you regarding a project WRA is working on near Briceland. the field survey is ongoing at this time.

Please let me know if you have any concerns.

Bill

--
William C. Rich, M.A., RPA
Principal Investigator
William Rich and Associates
Cultural Resource Consultants
P.O. Box 184
Bayside, CA 95524
(707) 834-5347

Visit our website - www.williamrichandassociates.com

WRA_Letter_Marshall Ranch Flow_Briceland.pdf
563K

Erika Cooper <erikacooper@brb-nsn.gov> Wed, Feb 6, 2019 at 3:25 PM
To: William Rich <wcr@williamrichandassociates.com>

Hi Bill,

Thank you for sending this. There is a relatively recently recorded site on the parcel adjacent to this property on the north east corner. I think it should be at the NWIC by now, but if it didn't show up in your records search, let me know.

Erika Cooper, M.A.

Tribal Historic Preservation Officer
Bear River Band of the Rohnerville Rancheria
266 Keisner Road
Loleta, CA 95551
707-733-1900 x233 Office
707-502-5233 Cell
707-733-1727 Fax
erikacooper@brb-nsn.gov

[Quoted text hidden]

William Rich <wcr@williamrichandassociates.com> Wed, Feb 6, 2019 at 4:10 PM
To: Erika Cooper <erikacooper@brb-nsn.gov>

Thanks Erika!

I will confirm with you about that soon.

I'd like to invite you to come out to see this project area. There are positive findings for archaeological materials and I would appreciate your input in designing the avoidance or mitigation measures. The owner, Elizabeth Marshall, is of Wailaki ancestry and enrolled with one, or more, of the Mendocino Tribes. She is a very nice lady it has been a delight to work with her and the ranch manager David Sanchez. Mr. Sanchez also functions with the Mendocino tribes on an official capacity as well. I believe it is with the Confederated Tribes of the Round Valley Reservation.

I'm not yet done with the field survey and we are still working on the background story. We are aware of several archaeological sites in the region and trying to trace some of the local rumors of collecting areas. So far, I've found some groundstone artifacts and a few broken and suspicious cobbles but not any flaked stone debitage. One more visit to go over the area again now that the soils are moist. We are fairly early in the planning of the project and I believe the current design drawings should not be considered final.

Hopefully you will have some time over the next month to make a trip to Briceland.

Bill

[Quoted text hidden]

William <wcr@williamrichandassociates.com>

Letter-Briceland Project

1 message

William Rich <wcr@williamrichandassociates.com>
To: Hawk Rosales <director@sinkyone.org>

Wed, Feb 6, 2019 at 2:29 PM

Hello Hawk,

Please find attached a letter regarding a project I am working on near Briceland.

Thank you!
Bill
--
William C. Rich, M.A., RPA
Principal Investigator
William Rich and Associates
Cultural Resource Consultants
P.O. Box 184
Bayside, CA 95524
(707) 834-5347

Visit our website - www.williamrichandassociates.com

WRA_Letter_Marshall Ranch Flow_Briceland.pdf
563K

APPENDIX C
CONFIDENTIAL Archaeological Site Record:
WRA 01 - Marshall Site
WRA 02- Marshall Isolate

State of California ☐ The Resources Agency
DEPARTMENT OF PARKS AND RECREATION
PRIMARY RECORD

Primary #
HRI #
Trinomial
NRHP Status Code

Other Listings
Review Code Reviewer Date

Page 1 **of** 5 ***Resource Name or #:** WRA-01 Marshall Site
P1. Other Identifier: N/A

***P2. Location:** ■ **Not for Publication** ☐ **Unrestricted**
***a. County** Humboldt **and**
***b. USGS 7.5' Quad** Briceland **Date** 1969 **T** 4S; **R** 3E; NW ¼ **of** NW ¼ **of Sec** 19; Humboldt **B.M.**
c. Address 195 Somerville Road City Briceland Zip 95542
d. UTM: NAD-83, Zone 10N, 423,235 mE/ 4,439,761 mN
e. Other Locational Data: This site is in the northwest quarter of Humboldt APN 220-061-011, south of Redwood Creek and the community of Briceland. From the intersection of Briceland-Thorn Road and Old Briceland Road, proceed easterly on the latter for approximately 800 feet and turn right onto Somerville Road. Drive south for about 1,410 feet and park past the private residence. The site is 290 meters (950 feet) west of the dirt road, along the edge of the break-in-slope.

***P3a. Description:** At this location a scatter of groundstone artifacts and cooking stones were identified. A well used cobble handstone (A1) was identified, as well as, two fragments of cobble netherstone (A2, A3) with a high level of abrading, to roughen the surface. Among other curious cobbles at this site are several broken and discolored quartzite river rocks, interpreted as cooking stones. Despite ample mineral sediment and shovel scrapes, flaked stone tools or debitage were encountered. The site is situated at the northern edge of a relatively intact alluvial terrace within an open grassland, and scattered large oaks. It seems plausible that the site would be associated with specific milling activities, related to processing of plant-based foods and/or other materials. For these reasons the site appears to contain significant potential for information (CRHR Criterion 4) that could be gleaned through archaeology methods related to subsistence strategies, food procurement, and uses of the pre-contact landscape around Briceland and Redwood Creek.

***P3b. Resource Attributes:** AP2. Lithic scatter.

***P4. Resources Present:** ☐ Building ☐ Structure ☐ Object ■ Site ☐ District ☐ Element of District ☐ Other (Isolates, etc.)

P5a.

P5b. Description of Photo: Photo 1. Close-up of groundstone artifact (A2) showing pecked and roughened ventral surface.

***P6. Date Constructed/Age and Source:** ☐ Historic ■ Prehistoric ☐ Both:

***P7. Owner and Address:**
Velma V. Marshall Trust
195 Somerville Road
Garberville, CA 95542

***P8. Recorded by:** William Rich, M.A., RPA P.O. Box 184, Bayside, CA 95524

***P9. Date Recorded:** August 20, 2019

***P10. Survey Type:** Pedestrian survey for a fisheries restoration project

***P11. Report Citation**: William Rich 2019. A Cultural Resources Investigation for the Marshall Ranch Flow Enhancement Project, Briceland, Humboldt County, California

***Attachments:** ☐NONE ■Location Map ■Continuation Sheet ☐Building, Structure, and Object Record ■Archaeological Record ☐District Record ☐Linear Feature Record ☐Milling Station Record ☐Rock Art Record ☐Artifact Record ☐Photograph Record ■ Other (List): 523K: Sketch Map.

State of California ☐ The Resources Agency Primary #
DEPARTMENT OF PARKS AND RECREATION HRI#

ARCHAEOLOGICAL SITE RECORD

Page 2 **of** 5 ***Resource Name or #:** WRA 01 – Marshall Site

***A1. Dimensions:** a. Length: 70 m. (SW-NE) * b. Width: 20m. (NW-SE) (0.3 acres)
Method of Measurement: ☐ Paced ☐ Taped ■ Visual estimate * Other: GIS
Method of Determination: ■ Artifacts ☐ Features ☐ Soil ☐ Vegetation ■ Topography ☐ Cut bank ☐ Animal burrow ☐ Excavation ☐ Property boundary ☐ Other: Site boundary placed generally around identified surface artifacts at edge of terrace.

Reliability of Determination: ■ High ☐ Medium ☐ Low Explain: Mineral soil visibility in the vicinity of the artifact deposit was sufficient to delineate artifact scatter.

Limitations (Check any that apply): ☐ Restricted access ☐ Paved/built over ☐ Site limits incompletely defined
☐ Disturbances ■ Vegetation ☐ Other: Some low grasses obscured mineral soil visibility.

A2. Depth: ☐ None ■ Unknown Method of Determination: No sub-surface investigations were conducted.
***A3. Human Remains:** ☐ Present ☐ Absent ☐ Possible ■ Unknown: None were observed.

***A4. Features:** None observed

***A5. Cultural Constituents:**
A1. Oblong rounded river cobble of sandstone, with polished surfaces and end and central battering. Measures 15.6 x 9.5 x 7 cm (Photo 2). This handstone is complete.

A2. Fragmented netherstone, constructed of a flat river cobble of sandstone, with extensive evidence of pecking on one face. Measures 21 x 13 x 5.5 cm (Photo 1). This fragment composes about 30% of the whole.

A3. Fragmented netherstone constructed from a sandstone cobble (Photo 3). This tool has a high degree of polish in the center of ventral surface with some evidence of battering. This item appears to represent about 50% of the whole. Measures 21 x 18 x 11 cm.

***A6. Were Specimens Collected?** ■ No ☐ Yes

***A7. Site Condition:** ■ Good ☐ Fair ☐ Poor: No disturbances are apparent.

***A8. Nearest Water:** Redwood Creek, tributary of the South Fork Eel River, is about 86 meters northwest of the site.

***A9. Elevation:** 635 feet above sea level.

A10. Environmental Setting: The site is situated in an open, grassy field on the edges of a flat terrace with a northwest-facing aspect, near Redwood Creek. Several large oak trees are present in the vicinity.

A11. Historical Information: Known archaeological sites in the Briceland vicinity include lithic scatters and one are of anthropogenic midden soil.

***A12. Age:** ■ Prehistoric ☐ Protohistoric ☐ 1542-1769 ☐ 1769-1848 ☐ 1848-1880 ☐ 1880-1914 ☐ 1914-1945
☐ Post 1945 ☐ Undetermined

A13. Interpretations: Likely a specific activity site associated with processing seeds or other vegetation.

A14. Remarks: None

A15. References: Rich, William 2019. A Cultural Resources Investigation for the Marshall Ranch Flow Enhancement Project, Briceland, Humboldt County, California.

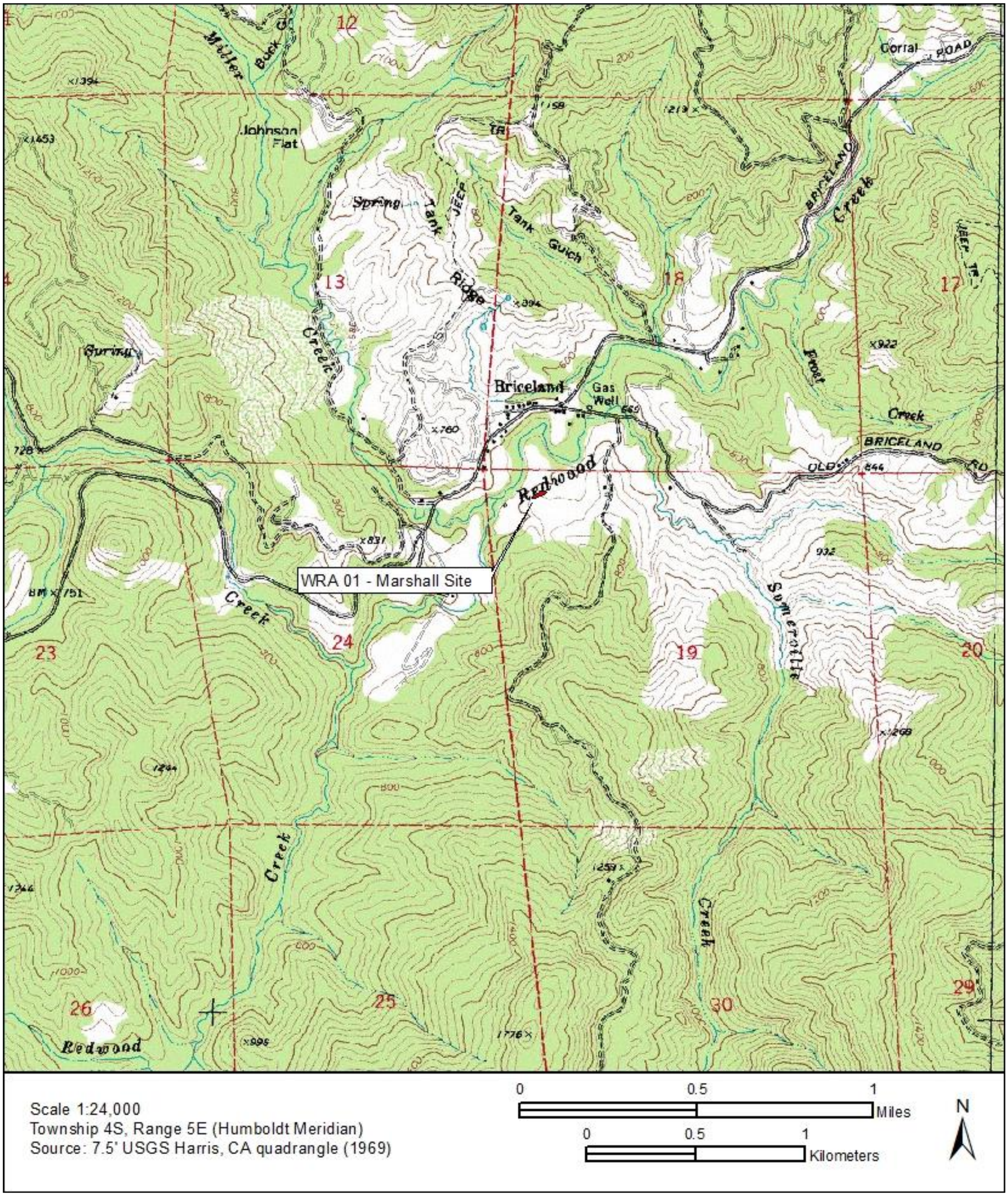
A16. Photographs/Original Media/Negatives Kept at: William Rich and Associates, Cultural Resources Consultants. P.O. Box 184, Bayside, CA 95524.

***A17. Form Prepared by:** William Rich, M.A., RPA Date: August 20, 2019
Affiliation and Address: P.O. Box 184, Bayside, CA 95524

State of California - The Resources Agency
DEPARTMENT OF PARKS AND RECREATION
LOCATION MAP

Primary #
HRI#
Trinomial

Page 3 **of** 5
***Resource Name or #** WRA-01 Marshall Site
***Map Name:** USGS 7.5' Korbel quadrangle
***Scale:** 1:24,000
***Date of map:** 1979



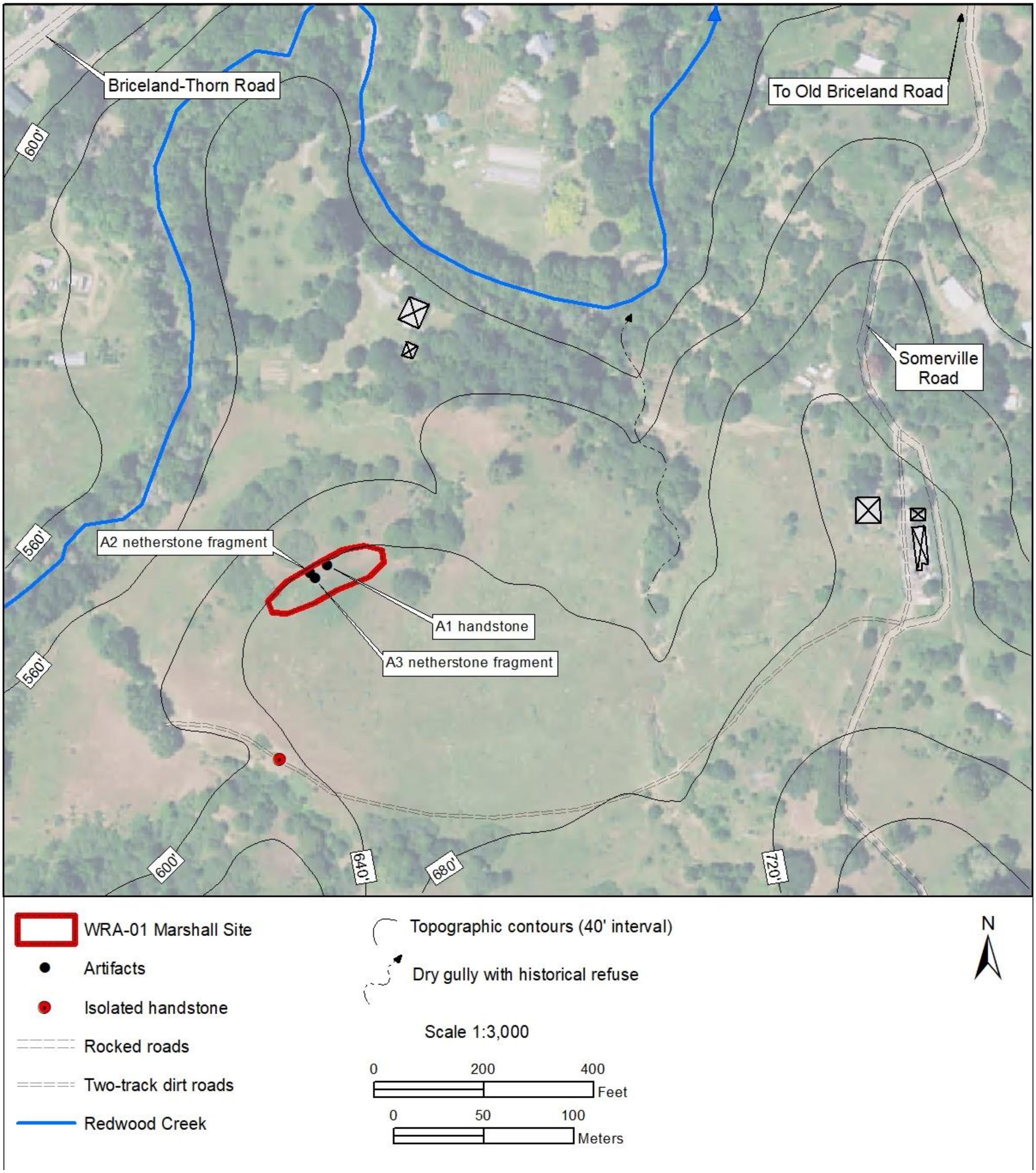
Scale 1:24,000
Township 4S, Range 5E (Humboldt Meridian)
Source: 7.5' USGS Harris, CA quadrangle (1969)

State of California □ The Resources Agency
DEPARTMENT OF PARKS AND RECREATION
SKETCH MAP

Primary #
HRI#
Trinomial

Page 4 **of** 5
***Drawn by:** Matthew Steele, B.A.

***Resource Name or #** WRA-01 Marshall Site
***Date of map:** August 20, 2018



CONTINUATION SHEET

Property Name: WRA 01 - Marshall Site
Page 5 of 5

Photo 2. Artifact A1, handstone.

Photo 3. Artifact A3. Netherstone fragment.

State of California ☐ The Resources Agency
DEPARTMENT OF PARKS AND RECREATION
PRIMARY RECORD

Primary #
HRI #
Trinomial
NRHP Status Code

Other Listings
Review Code Reviewer Date

Page 1 **of** 3 ***Resource Name or #:** WRA-02 Marshall Isolate
P1. Other Identifier: N/A

***P2. Location:** ■ **Not for Publication** ☐ **Unrestricted**
***a. County** Humboldt **and**
***b. USGS 7.5' Quad** Briceland **Date** 1969 **T** 4S; **R** 3E; NW ¼ **of** NW ¼ **of Sec** 19; Humboldt **B.M.**
c. Address 195 Somerville Road City Briceland Zip 95542
d. UTM: NAD-83, Zone 10N, 423,210 mE/ 4,439,658 mN
e. Other Locational Data: This artifact was found in the northwest quarter of Humboldt APN 220-061-011, south of Redwood Creek and the community of Briceland. From the intersection of Briceland-Thorn Road and Old Briceland Road, proceed easterly on the latter for approximately 800 feet and turn right onto Somerville Road. Drive south for about 1,410 feet and turn right, going through the gate, and proceed westerly for about a quarter of a mile (387 meters). The artifact was found in in the north road-cut bank where the road turns towards the north and cuts into the terrace slope heading towards Redwood Creek.

***P3a. Description:** This isolated handstone was found in an old road cut on the western edge of a grassy terrace with a northwest-facing aspect on the south side of Redwood Creek, tributary of the South Fork Eel River in southern Humboldt County. The artifact is a rounded, oblong river cobble of dense sandstone. The artifact exhibits evidence of battering at both distal ends and some ground surfaces on two faces and 18 x 12 x 12 centimeters. Lichen growth indicates the artifact has been exposed on the ground surface for some time and may obscure some evidence of use-wear or modification. An archaeological site consisting of a scatter of ground and battered stones similar to this artifact was identified during this survey, about 81 meters north of this artifact (recorded as WRA-01 – Marshall Site; See Rich 2019).

***P3b. Resource Attributes:** AP16. Other (Isolate tool).
***P4. Resources Present:** ☐ Building ☐ Structure ■ Object ☐ Site ☐ District ☐ Element of District ■ Other (Isolate)

P5b. Description of Photo: Close-up view of handstone artifact.
***P6. Date Constructed/Age and Source:** ☐ Historic ■ Prehistoric ☐ Both: No historic features or artifacts were observed.

P5a. Photograph

***P7. Owner and Address:**
Velma V. Marshall Trust
195 Somerville Road
Garberville, CA 95542

***P8. Recorded by:** William Rich, M.A.,RPA, Cultural Resources Consultants. P.O. Box 184, Bayside, CA 95524.
***P9. Date Recorded:** August 20, 2018
***P10. Survey Type:** Pedestrian survey for a riparian pond construction project

***P11. Report Citation**: William Rich 2019. A Cultural Resources Investigation for the Marshall Ranch Flow Enhancement Project, Briceland, Humboldt County, California.

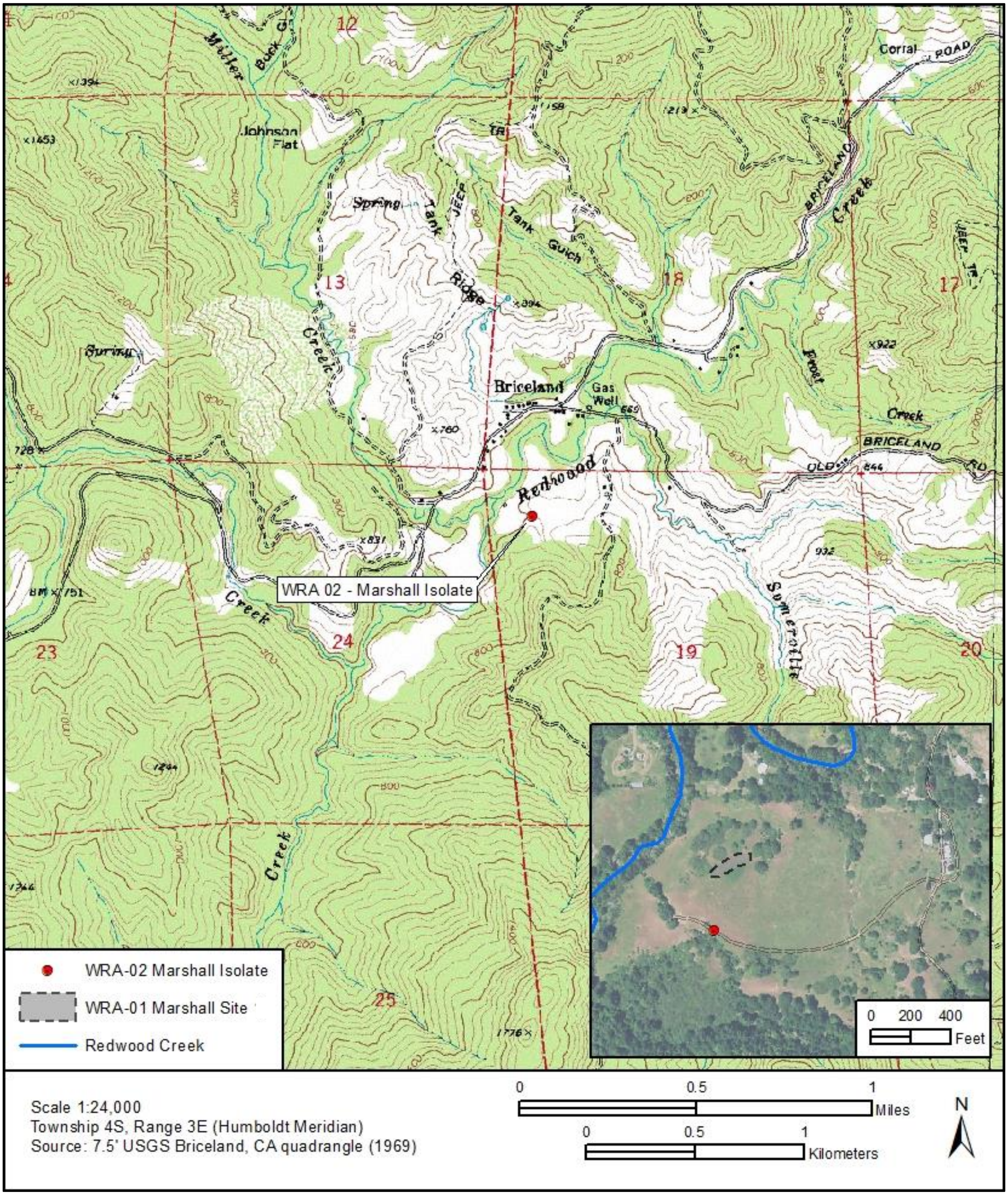
***Attachments:** ☐NONE ■Location Map ■Continuation Sheet ☐Building, Structure, and Object Record ☐Archaeological Record ☐District Record ☐Linear Feature Record ☐Milling Station Record ☐Rock Art Record ☐Artifact Record ☐Photograph Record ☐ Other (List): N/A

State of California - The Resources Agency
DEPARTMENT OF PARKS AND RECREATION

LOCATION MAP

Primary #
HRI#
Trinomial

Page 2 **of** 3
***Resource Name or #** WRA-02 Marshall Isolate
***Map Name:** USGS 7.5' Briceland quadrangle
***Scale:** 1:24,000
***Date of map:** 1969



State of California - The Resources Agency
DEPARTMENT OF PARKS AND RECREATION

Primary#
HRI #
Trinomial

CONTINUATION SHEET

Property Name: WRA 02 - Marshall Isolate
Page 3 of 3

Photos 1 and 2. Isolated handstone (collected by landowner). Scale is in centimeters.

Photo 3. The isolated artifact was found on the left (northeast) side of the dirt road, near the upper-center of this photo.

Appendix F

Biological Resources Technical Report

SEPTEMBER 2020

Biological Resources Technical Report for the Marshall Ranch Streamflow Enhancement Project, Humboldt County, California

PREPARED FOR

Salmonid Restoration Federation
425 Snug Alley, Unit D
Eureka, CA 95501

PREPARED BY

Stillwater Sciences
850 G Street, Suite K
Arcata, CA 95521

Stillwater Sciences

Suggested citation:
Stillwater Sciences. 2020. Biological Resources Technical Report for the Marshall Ranch Streamflow Enhancement Project, Humboldt County, California. Prepared by Stillwater Sciences, Arcata, California for Salmonid Restoration Federation, Eureka, California.

Cover photos: Images of the Marshall Ranch and associated habitat during the biological surveys conducted in May 2019.

Table of Contents

Tables

Figures

Appendices

1 PROJECT BACKGROUND

The Salmonid Restoration Federation (SRF) is planning to construct a 15.3-million-gallon off-stream pond on the Marshall Ranch, adjacent to Redwood Creek, a tributary to the South Fork Eel River. This Project seeks to improve habitat for coho salmon (*Oncorhynchus kisutch*) and steelhead (*Oncorhynchus mykiss*), in Redwood Creek, an important salmon bearing tributary, by addressing the limiting factor of low summer streamflows. The South Fork Eel River is one of five priority watersheds selected for flow enhancement projects in California by the State Water Resources Control Board (SWRCB) and California Department of Fish and Wildlife (CDFW) as part of the California Water Action Plan effort (SWRCB 2019). Redwood Creek is a critical tributary to the South Fork Eel River that historically supported coho and Chinook salmon (*Oncorhynchus tshawytscha*) and steelhead.

Coho salmon have experienced precipitous declines in abundance and are currently listed as threatened under the federal Endangered Species Act (ESA) and the California Endangered Species Act (CESA). Numerous factors are responsible for the declines in coho salmon abundance, and many of these limiting factors are also impacting Chinook salmon and steelhead, which are also severely depressed in abundance relative to historical population estimates. Land use practices including logging and road systems have greatly increased winter run off resulting in decreased groundwater storage capacity and lower summer streamflows. Widespread removal of large wood from streams has also decreased groundwater storage through channel incision and loss of floodplain connectivity and resulted in fewer and shallower instream pools that are of insufficient size to withstand drought. Cannabis cultivation has also expanded in the last 15 years, which has resulted in increased water diversions that have affected area watercourses and summer stream flows. Industrial logging practices combined with fire suppression have resulted in overly dense even aged forests with higher evapotranspiration rates which significantly contribute to lower dry season flows. The problems of reduced groundwater storage and increased evapotranspiration are intensified in a longer dry season. In low flow years, Redwood Creek has experienced dry conditions at two of the four mainstem Redwood Creek flow gages downstream from the proposed flow enhancement site.

The Project would provide significant, measurable benefits in terms of dry season flow enhancement for coho salmon, steelhead, and other aquatic habitat along the 5.5 miles (mi) of Redwood Creek mainstem downstream from the Project. The Project is designed to deliver approximately 50 gallons per minute of high-quality water during the five month dry season, which will be wholly dedicated to instream values including reasonable and beneficial fish and wildlife uses of the water. Quantifiable long-term objectives include increased summer streamflow, enhanced fish and wildlife habitat, and improved water quality.

The Project design is based on the best available science and is informed by the *California Salmonid Stream Habitat Restoration Manual* edition (Flosi et al. 2010), and *Ponds – Planning, Design, Construction* (USDA NRCS 1997). Additionally, the Project is informed by scientific studies and streamflow enhancement techniques that have been used in the Mattole River watershed, California.

1.1 Project Location

The Project is located on a 29.8-acre (ac) area within the 2,942-ac Marshall Ranch property, approximately 3.16 mi east of Redway and just south (0.1 mi) of the unincorporated community of Briceland, Humboldt County, California (Latitude: 40.104256, Longitude: -123.900020) (Figure 1-1). To the west of the Project is Redwood Creek, approximately 5 mi upstream from the confluence of the South Fork Eel River, a tributary to the Eel River and eventually the Pacific Ocean (Figure 1-1). The Project area is in Section 19 of Township 4 South, Range 3 East of the Briceland, U.S. Geological Survey (USGS) 7.5-minute topographic quadrangle. The elevation within the Project area ranges from approximately 570 to 780 feet (ft) above mean sea level. The Project can be accessed from the Briceland Thorn Road after exiting Highway 101 at Redway, California (Figure 1-1).

1.2 Report Purpose and Organization

This biological resource technical report has been developed to describe the special-status and/or sensitive biological resources in or with potential to occur in the Project area (plants, vegetation communities, fish, wildlife, and wetlands and waters) that may be affected by Project construction activities. Potential impacts on biological resources are discussed along with suggested minimization measures to reduce impacts.

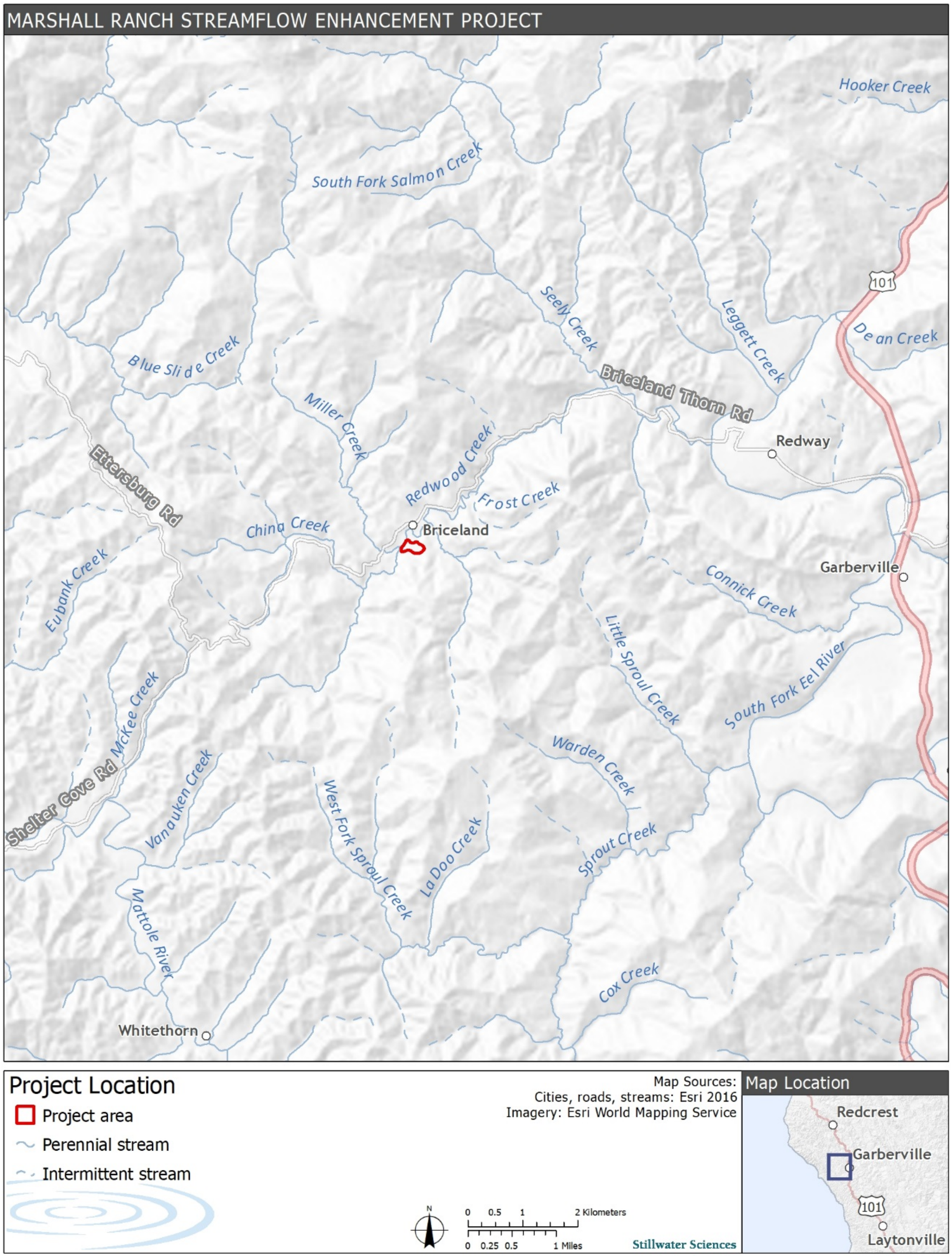


Figure 1-1. Project location.

2 PROJECT DESCRIPTION

The proposed Project includes construction of a 15.3-million-gallon off-channel reservoir, associated pipelines/chiller/pump, ancillary water storage and supply for domestic use and fire suppression, erosion control structures within intermittent streams, instream habitat enhancement structures along Redwood Creek mainstem, and a solar energy generation system to provide long-term operations costs for the Project. Additional Project details are provided below in Section 2.2, Figure 2-1.

2.1 Site Description

The Project will occur on the Marshall Ranch in the Redwood Creek watershed, which is located immediately west of the town of Redway in southern Humboldt County (Figure 1-1).

Redwood Creek is a fish-bearing watercourse that is known to contain coho and Chinook salmon and steelhead. Redwood Creek experiences very low or intermittent flows during the summer and fall, inhibiting habitat for these species.

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

Upper elevations in the Redwood Creek basin are characterized by narrow, steep-walled canyon slopes that are covered by relatively thin soils and dense conifer and hardwood stands and drained by perennial and intermittent streams. At mid-elevations, the steep canyons transition into gently rounded upland ridges supporting grass meadows and shrub and oak woodland vegetation. The valley width greatly expands near Briceland, where Redwood Creek meanders between large elevated terraces. Channel incision in the Redwood Creek basin is likely due to ongoing tectonic uplift related to the nearby Mendocino Triple Junction, extensive anthropogenic land-use practices, and altered hydrologic patterns due to climate change.

The Project site consists of uplifted fluvial terraces and lower floodplain surfaces adjacent to Redwood Creek, which flows from the southwest to the northeast across the Project area. Upland hillslopes border the site to the south and east. The Project site is bound by small intermittent streams to the east and west that are tributaries to Redwood Creek (Figure 1-1).

2.2 Proposed Project

Implementation of the proposed Project will include site preparation, materials procurement and construction of the features described below:

- 15.3 million gallon off-channel pond with approximate maximum dimensions of 500 ft long, 300 ft wide, 40 ft deep, and surrounded by berm 25 ft high. The pond will be filled with rainwater catchment and water diverted from Redwood Creek during the wet season from a proposed offset well (Appropriative Water Right application in process).
- Piping and outflow channels associated with the pond, pump, and water chiller.

- Instream habitat enhancement features including approximately four large wood structures and two rock weirs in Redwood Creek.
- Gully stabilization treatments including installation of approximately 30 rock armor grade control structures in three Class III (intermittent) drainages.
- Construct a 7.5 KW solar array, micro-hydro turbine, backup battery bank, inverter, grid intertie system and control center building to offset the Project's energy use and provide backup power during outages to maintain operations and monitoring capabilities.
- Installation of rainwater catchment tanks with water storage totaling up to approximately 200,000 gallons to supply potable water for APN 220-061-011 and fire suppression.
- Install fire hydrant for emergency fire suppression water supply.
- Upgrade access roads to Project area with drainage features and gravel surfacing to provide year-round access.

2.2.1 Off-channel pond

Construction of the off-channel pond will include excavation and construction of an earthen berm and spillway built into the natural topography. Construction will include removal of topsoil from the reservoir area. The topsoil will be saved and spread around the reservoir area along with mulch after construction. All excavated material not used to build the berms will be placed and compacted in several designated fill areas as shown on the plans. The spillways for the reservoir will be engineered for 100-year storm events and armored with rock cobble or other non-erodible materials.

Materials for the reservoir will include rock for the spillways and weed free straw. Equipment will include heavy equipment for clearing and excavation and a sheepsfoot roller for compacting the berm and sealing the reservoir.

2.2.2 Hydraulic appurtenances (piping, valves, chiller, pump, etc.)

The primary outflow pipe that delivers water from the reservoir to Redwood Creek will be installed via horizontal borehole. A valve will control how much water is released from the reservoir. On on-demand water chiller will be utilized to cool water as needed. An offset cistern will be constructed adjacent to Redwood Creek and fed by a near channel fish screen. An electrical pump and associated piping will be utilized to top off the pond (and other smaller storage tanks) as needed. Water will only be diverted from Redwood Creek when flows are high. Additional hydraulic-related infrastructure includes piping and tanks for fire suppression and domestic use on the property.

2.2.3 Instream habitat enhancement

In association with the diversion structure, instream habitat enhancement features will be constructed to improve summer rearing habitat for salmonids within the vicinity of the Project. This includes the construction of two rock weirs and four large wood habitat enhancement structures. The proposed structures are also intended to promote channel stability along Redwood Creek mainstem within the vicinity of the flow enhancement Project.

2.2.4 Gully stabilization

Approximately 30 rock armor grade control structures will be installed to stabilize three actively eroding intermittent drainages adjacent to the Project. The grade control structures will be installed with an excavator and designed to promote long-term stability of the gully channels.

2.2.5 Solar array and backup energy system

A 7.5 KW solar array, micro-hydro turbine, backup battery bank, inverter, grid intertie system and control center building to offset the Project's energy use and provide backup power during outages to maintain operations and monitoring capabilities. The intention of the system is to offset the electricity used by the pump and chiller.

2.2.6 Access road improvements

The access roads within the Project vicinity will be improved to provide year-round access for monitoring and maintenance of all Project components. This will include reshaping and surfacing with gravel.

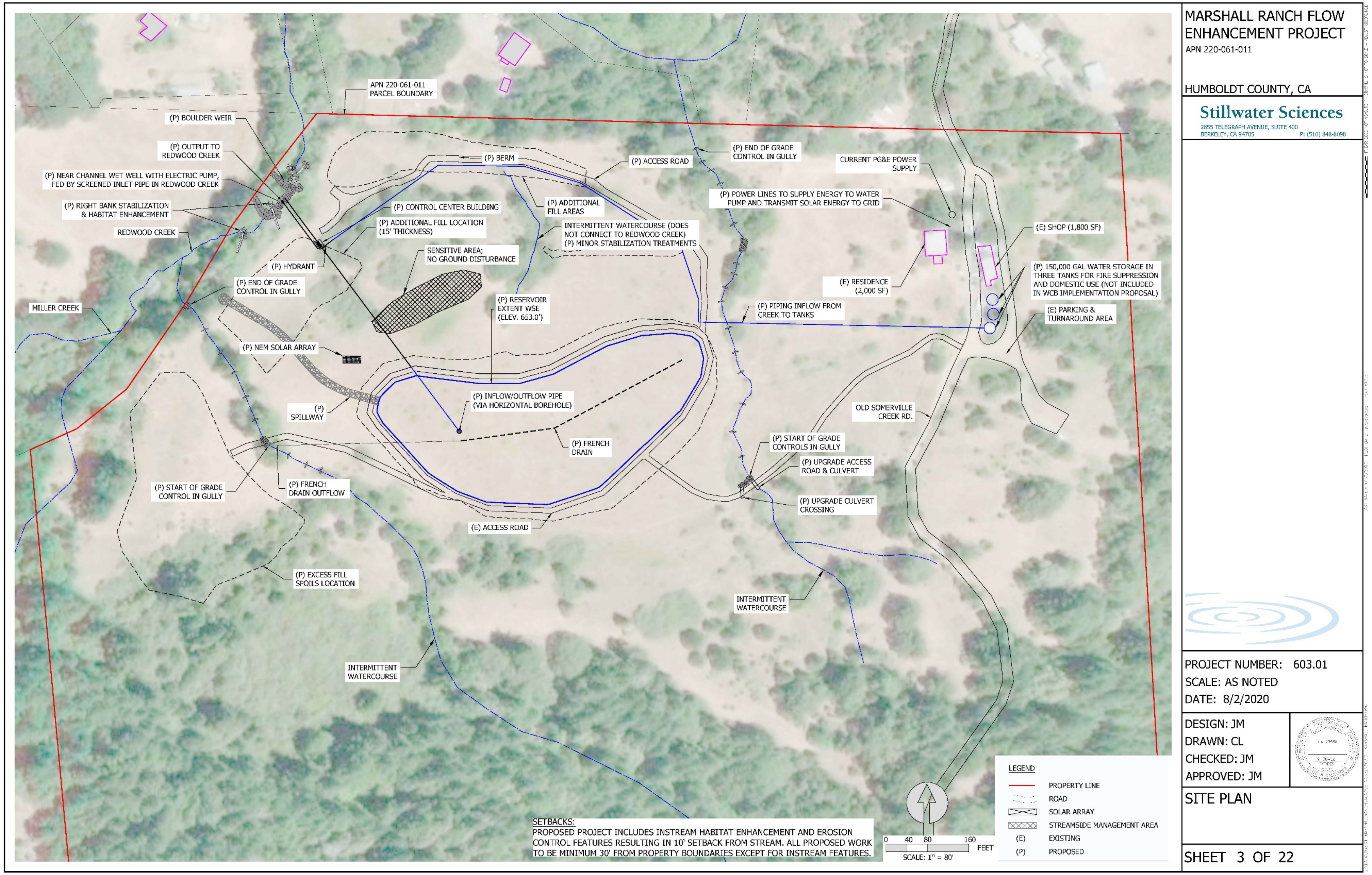


Figure 2-1. Project site plan.

3 VEGETATION ASSESSMENT

A vegetation assessment was conducted on 3 May 2019 concurrent with the early-blooming botanical survey to map vegetation within the approximately 30-ac Project area to the alliance level following classification using the online edition of *A Manual of California Vegetation* (California Native Plant Society [CNPS] 2019a). The resulting vegetation map was used to: (1) determine if any stands are considered special-status natural communities; (2) assess the likelihood of occurrence for special-status species in the Project area; and (3) inform the Project's potential to impact special-status natural communities and species.

Special-status natural communities are defined as those with a state ranking of S1, S2, or S3 (critically imperiled, imperiled, or vulnerable, respectively) on CDFW's *California Sensitive Natural Communities List* (CDFW 2018a).

3.1 Methods

3.1.1 Desktop review

Prior to the vegetation assessment, existing information from the CALVEG geodatabase (USDA Forest Service 2019) and the USGS regional geologic map (McLaughlin et al. 2000) on vegetation and soils in the Project area were reviewed. These data were transposed onto aerial imagery using geographical information systems (GIS) software to create maps for reference in the field.

The CDFW's California Natural Diversity Database (CNDDB) (CDFW 2019a) was queried for the U.S. Geological Survey (USGS) 7.5-minute quadrangle where the Project is located (Briceland), and the surrounding seven quadrangles (Garberville, Honeydew, Shelter Cove, Miranda, Bear Harbor, Piercy, and Ettersburg) (hereinafter Project vicinity) to determine if a special-status natural community was recorded in the Project area. The CNDDB query identified only one special-status natural community, Upland Douglas Fir Forest, in the Project Vicinity.

3.1.2 Field survey

The field survey was conducted by a qualified botanist and ecologist with: (1) experience conducting floristic surveys; (2) knowledge of plant taxonomy and plant community ecology and classification; (3) familiarity with the plant species of the area; and (4) familiarity with appropriate state and federal statutes related to plants and plant collecting. The survey followed the methods of the *CDFW-CNPS Protocol for the Combined Vegetation Rapid Assessment and Relevé Method* (CNPS and CDFW 2018a) and *Protocols for Surveying and Evaluating Impacts to Special-Status Native Plant Populations and Natural Communities* (CDFW 2018b).

Field maps with existing vegetation information from CALVEG (USDA Forest Service 2019) were reviewed and representative locations for each stand type were sampled using the rapid assessment method. Plot size varied based on stand size and access. Dominant vegetation and their plant associates, habitat characteristics (e.g., disturbance, substrates/soils, aspects/slopes), known site history, and overall health of the stand were noted on a *CNPS and CDFW Combined Vegetation Rapid Assessment and Relevé Field Form* (CNPS and CDFW 2018b). If plant identification was not possible in the field, the plants were collected for identification in the laboratory using the "1 in 20" rule (Wagner 1991) or, if a potential special-status plant, according to the botanists' current CDFW plant voucher collection permit guidelines (e.g., not more than five individuals or 2% of the population, whichever is less, for one voucher sheet). Plants were identified following the taxonomy of *Jepson eFlora* (Jepson Flora Project 2019). Visual estimates of cover were noted for each species as well as its size, strata, and height class. Regeneration within sampling locations was also noted. Photographs were taken at each sampling location to document stand characteristics. A field-assessed vegetation alliance was assigned based on dominant and diagnostic species of the stand. Vegetation sampling points were mapped using a handheld sub-meter geographic positioning system (GPS) and stand boundaries within the Project area were delineated onto field maps. The digital data were post-processed and corrected, then incorporated into a geographical information systems (GIS) database. Data on field maps were digitized onto aerial imagery using GIS software.

Each field-assessed vegetation alliance was keyed using the vegetation composition data and the online edition of *A Manual of California Vegetation* (CNPS 2019a) to determine final vegetation alliances. Where applicable, vegetation was characterized and mapped to the finer association level. The finalized vegetation alliance/association names were checked against CDFW's *California Sensitive Natural Communities List* (CDFW 2018a) to determine if any of these types are considered special-status natural communities. These alliances were also used to further assess the likelihood of occurrence for special-status plants in the Project (see Section 4).

3.2 Results

Vegetation alliances observed in the approximately 36-ac Project area are listed in Table 3-1 and presented in Figure 3-1. Developed areas (i.e., residential) totaled 0.7 ac in the Project area. One sensitive vegetation alliance with a state rank of S3 (*Acer macrophyllum* Forest Alliance) was observed in the Project area (Table 3-2). Descriptions of the vegetation cover types are provided in the sub-sections below, along with representative photographs.

Table 3-1. Vegetation alliances and associations observed in the Project area.

Cover types	State status[1]	Total area (ac)
Acer macrophyllum Forest Alliance	S3	5.3
Annual/perennial grassland	None	20.9
Ceanothus incanus Shrubland Alliance	S4	1.2
Pseudotsuga menziesii Forest Alliance	S4	1.8
Quercus spp. Forest Alliance	S4	5.6
Total		**34.9**

[1] State ranks for special-status natural communities:

S3 Vulnerable—Vulnerable in the state due to a restricted range, relatively few populations (often 80 or fewer), recent and widespread declines, or other factors making it vulnerable to extirpation from the state.

S4 Apparently Secure—Uncommon but not rare; some cause for long-term concern due to declines or other factors.

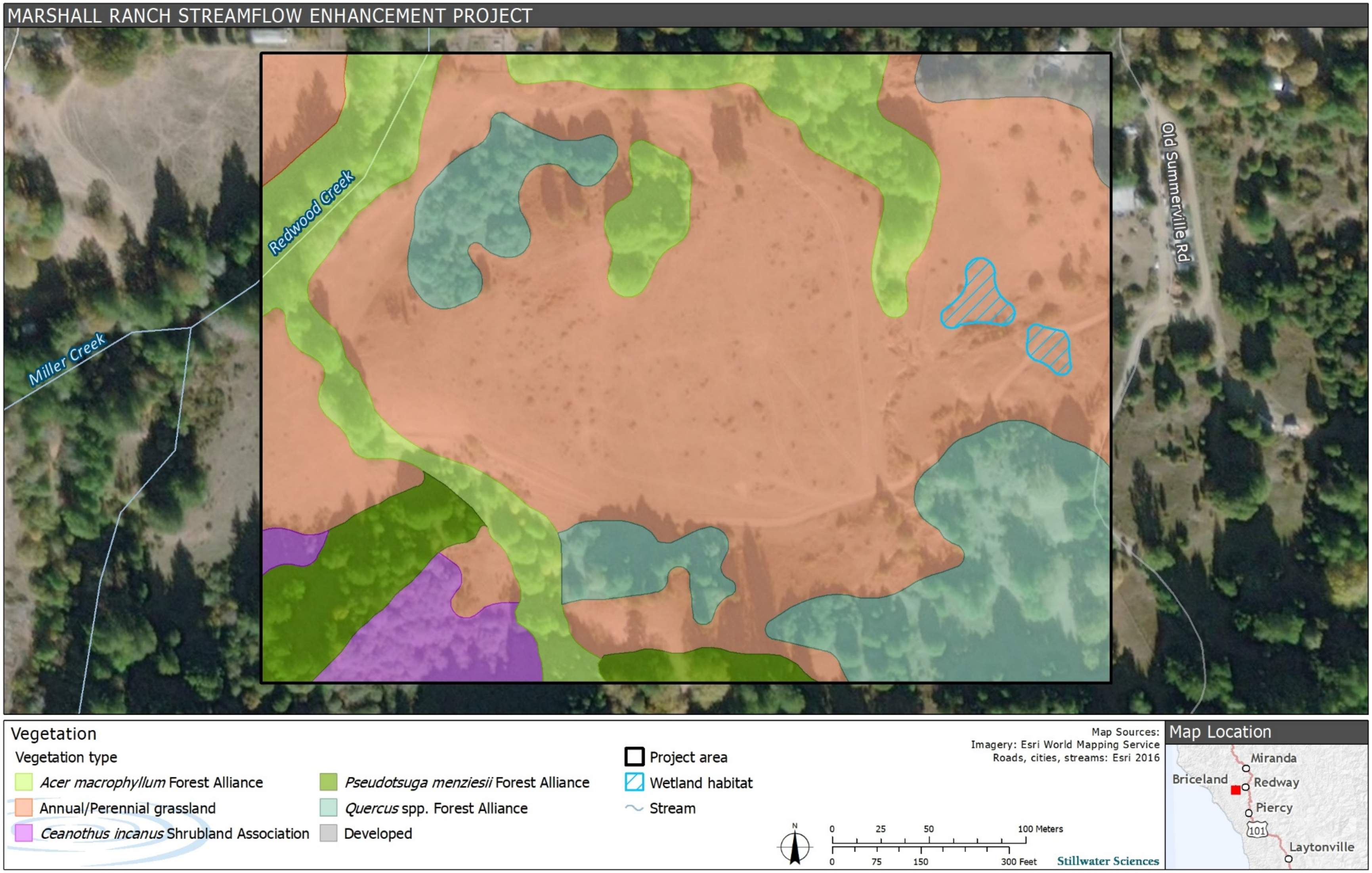


Figure 3-1. Vegetation cover types within the Project area.

3.2.1 *Ceanothus incanus* Shrubland Alliance

The southwestern corner of the Project area contains a dense stand of shrubs predominantly composed by *Ceanothus incanus* (coast whitethorn). Stands of coast whitethorn are described within the *Ceanothus thyrsiflorus* Shrubland Alliance (blue blossom chaparral) (CNPS 2019a) since they are more limited in distribution and are ecologically similar to *Ceanothus thyrsiflorus* (blue blossom) (Klein et al. 2015). Coast whitethorn is dominant in the shrub canopy with low to moderate cover of *Baccharis pilularis* (coyote brush), *Toxicodendron diversilobum* (western poison oak), and *Cytisus scoparius* (Scotch broom). Herbaceous understory was not observed under the dense shrub canopy.

This alliance is associated with chaparral and coastal bluff scrub habitats. The coast whitethorn shrubland association has a total geographic extent of 1.2 ac in the Project area (Table 3-1, Figure 3-1).

3.2.2 *Pseudotsuga menziesii* Forest Alliance

The Douglas-fir Forest Alliance is composed of continuous canopy cover by Douglas-fir (60%) with low cover of *Acer macrophyllum* (big leaf maple) (15%) and black oak (15%). This alliance can occur along all topographical positions and aspects and on varying substrates (CNPS 2019a). In the Project area, this alliance is present on moderate slopes down to the creek bed. Associate tree species in the Project area included *Umbellularia californica* (California bay laurel) and *Arbutus menziesii* (Pacific madrone). The shrub layer varied from open to low cover of *Polystichum munitum* (western swordfern), *Quercus wislizeni* (interior live oak) saplings, and western poison oak. Regenerating tree cover was low (2–5%) comprised of California bay laurel and *Notholithocarpus densiflorus* (tanoak) seedlings and Douglas-fir saplings. Herbaceous species observed throughout this alliance included *Oxalis oregana* (redwood sorrel), *Whipplea modesta* (modest whipplea), *Scoliopus bigelovii* (California fetid adder's-tongue), Viola ocellata (western heart's ease), *Sanicula crassicaulis* (Pacific sanicula), and *Pteridium aquilinum* var. *pubescens* (western bracken fern).

Douglas-fir forest is associated with broadleaved upland forest, north coast coniferous forest, and lower montane coniferous forest habitats. This forest alliance has a total geographic extent of 1.8 ac in the Project area (Table 3-1, Figure 3-1).

3.2.3 *Acer macrophyllum* Forest Alliance

The bigleaf maple forest alliance is composed primarily of bigleaf maple along with Douglas-fir and various hardwoods including black oak, *Salix sitchensis* (Sitka willow), and California bay laurel to form a continuous, sometimes two-tiered canopy bordering Redwood Creek and other waters in the Project area. This alliance is typically located along raised stream terraces, benches, and lower slopes with seeps (CNPS 2019a) and associated with north coast riparian areas in Douglas-fir forest. The shrub layer varied from open to dense cover by western poison oak, western sword fern, *Corylus cornuta* (California hazelnut), and *Rubus parviflorus* (thimbleberry). Herbaceous species varied from sparse to moderate cover and included *Oxalis oregana* (redwood sorrel), modest whipplea, California fetid adder's-tongue, and western bracken fern.

This forest alliance is associated with riparian forest and north coast coniferous forest habitats. It has a total geographic extent of 5.3 ac in the Project area (Table 3-1, Figure 3-1). *Acer macrophyllum* Forest Alliance is a sensitive natural community (S3) on CDFW's *California Sensitive Natural Communities List* (CDFW 2018a).

3.2.1 *Quercus* spp. Forest Alliance

The mixed oak forest alliance is present on the upper slopes on the southern side of the Project area and on the sloped transition between the upper and lower terrace. This forest alliance is composed of a mixture of *Quercus wislizeni* (interior live oak) and *Quercus kelloggii* (black oak) with Douglas-fir, *Arbutus menziesii* (Pacific madrone), and *Notholithocarpus densiflorus* (tanoak) in the upper canopy. The shrub layer varied from moderate to dense cover by western poison oak, coast whitethorn, coyote brush, Scotch broom, and Himalayan blackberry. Herbaceous species cover including western bracken fern and *Lonicera hispidula* (hispid honeysuckle) was low under the oak canopy though this alliance was present within and around annual/perennial grasslands which were dominated by herbaceous species.

The mixed oak forest alliance is associated with cismontane woodland and broadleaved upland forest habitats and has a total geographic extent of 5.6 ac in the Project area (Table 3-1, Figure 3-1).

3.2.2 Annual/perennial grassland

Annual/perennial grasslands in the Project area are managed pastures currently used for livestock grazing. This grassland cover type is best characterized within the Mediterranean California Naturalized Annual and Perennial Grassland Group (Sawyer et al. 2008). This group includes alliances that are primarily composed by nonnative grasses. Grasses observed within areas mapped as grassland included *Bromus hordeaceus* (soft chess), *Anthoxanthum odoratum* (sweet vernal grass), *Aira caryophyllea* (silver hair grass), *Dactylis glomerata* (orchard grass), *Cynosurus echinatus* (bristly dogtail grass), *Elymus glaucus* subsp. *glaucus* (blue wild-rye), *Avena barbata* (slender wild oat), and *Danthonia californica* (California oat grass). Herbaceous vegetation included *Luzula comosa* var. *comosa* (Pacific wood-rush), western bracken fern*, Eschscholzia californica* (California poppy), *Plantago lanceolata* (English plantain), *Juncus patens* (spreading rush), *Juncus bufonis* var. *bufonis* (toad rush), *Hypochaeris radicata* (rough cat's ear), *Rumex acetosella* (sheep sorrel), and *Trifolium* spp. (various clovers). Small patches of *Rubus armeniacus* (Himalayan blackberry), coyote brush, and Scotch broom were observed throughout this alliance. Species dominance varied through the grassland with California oat grass dominating the upper hill slopes and nonnative grasses soft chess and bristly dogtail grass dominating the lower open grazed pasture. Patches of Himalayan blackberry and western bracken fern were observed throughout the flat lower terrace. Two wetland habitats were observed within this cover type, in which *Carex praegracilis* (freeway sedge), *Ranunculus parviflorus* (few-flowered buttercup), *Mentha pulegium* (pennyroyal), *Juncus bufonius* (toad rush), and *Juncus patens* (spreading rush) were prevalent (Figure 3-1).

This grassland cover type is associated with valley and foothill grassland habitat and has a total geographic extent of 20.9 ac in the Project area (Table 3-1, Figure 3-1).

4 SPECIAL-STATUS PLANTS

Special-status plant species are defined as those listed, proposed, or under review as threatened or endangered under the federal ESA and/or CESA; designated as rare under the California Native Plant Protection Act; and/or taxa that meet the criteria for listing as described in Section 15380 of the California Environmental Quality Act (CEQA) Guidelines including species listed on the CDFW's *Special Vascular Plants, Bryophytes, and Lichens List* (CDFW 2018c); that have a California Rare Plant Rank (CRPR) of 1, 2, 3 or 4; and/or that are considered a locally significant species (i.e., rare or uncommon in the county or region).

4.1 Methods

A list of special-status plants that may occur in the Project area was developed by querying the following resources:

- The U.S. Fish and Wildlife Service (USFWS) online *Information for Planning and Consultation* (IPaC) (USFWS 2019a),

- The California Native Plant Society's (CNPS) online *Inventory of Rare and Endangered Vascular Plants of California* (CNPS 2019b), and
- CDFW's CNDDB (CDFW 2019a).

The database queries were based on a search of the Project vicinity (as defined in Section 3.1.1). Appendix A (Table A–1) lists special-status plants identified from the sources described above and provides mapped locations of CNDDB occurrences in the Project vicinity (Appendix A).

The potential for species meeting the above criteria to occur in the Project area was determined by: (1) reviewing the current distribution of each species (i.e., whether it overlaps with the Project area); (2) reviewing the documented occurrence information from the CNDDB; (3) reviewing existing information on vegetation in the CALVEG geodatabase (USDA Forest Service 2019) and soils in the USGS regional geologic map (McLaughlin et al. 2000); (4) comparing the habitat associations of each species with the vegetation alliances and habitat conditions documented in and adjacent to the Project area; and (5) using professional judgement to evaluate habitat quality and the relevance of occurrence data, or lack thereof.

This review and analysis resulted in the following categories of the likelihood for a special-status species to occur in the Project area:

- None: the Project area is outside the species' current distributional or elevation range and/or the species' required habitat is lacking from the Project area (e.g., coastal dunes).
- Low: the species' known distribution or elevation range overlaps with the Project vicinity but not the Project area, and/or the species' required habitat is of very low quality or quantity in the Project area.
- Moderate: the species' known distribution or elevation range overlaps with the Project area and/or the species' required habitat occurs in the Project area.
- High: the species has been documented in the Project area and/or its required habitat occurs in the Project area and is of high quality.

4.2 Results

4.2.1 Desktop review

A total of 29 special-status plant species were documented as occurring within the Project vicinity (Appendix A). Alliances documented during the vegetation assessment (Section 3.2) are associated with the following habitats: valley and foothill grassland, north coast coniferous forest, cismontane woodland, broadleaved upland forest, lower montane coniferous forest, riparian forest and chaparral (Table 4-1). Based on these habitat associations along with landform, soils, and known elevation range within the Project area, 11 special-status plants have low potential to occur (Appendix A) and eight have moderate potential to occur in the Project area (Appendix A and Table 4-1). Of these eight species with moderate potential to occur, none are federally listed, one is listed with the state as endangered, two have a CRPR of 1B (rare, threatened, or endangered in California and elsewhere), three have a CRPR of 2B (rare, threatened, or endangered in California and more common elsewhere), and two have a CRPR of 4 (plants of limited distribution in California, a watch list species) (Table 4-1). Furthermore, only one species, *Piperia candida* (white-flowered rein orchid), has documented occurrences within one mile of the Project area, all others are located 5 to 10 mi from the Project. A spring survey in May was selected to capture the appropriate phenological stage for all species with low and moderate potential to occur in the Project area.

Table 4-1. Special-status plant species with moderate potential to occur in the Project area.

Scientific name (common name)	Status (Federal, State, CRPR[1])	Habitat association[2]	Source	Likelihood of occurrence
Astragalus agnicidus (Humboldt County milk-vetch)	None/CE/1B.1	Openings, disturbed areas, and sometimes roadsides in broadleafed upland forest and north coast coniferous forest; 390–2,625 ft. Blooming period: April–September	CNPS, CDFW	**Moderate:** Broadleafed upland and north coast coniferous forest habitats present within Project area. Two occurrences within 5–10 mi of the Project area.
Coptis laciniata (Oregon goldthread)	None/None/4.2	Mesic meadows and seeps and streambanks in north coast coniferous forest; 0–3,280 ft. Blooming period: (February) March–May (September–November)	CNPS, CDFW	**Moderate:** North coast coniferous forest habitat present within Project area. Two occurrences within 5–10 mi of the Project area.
Erythronium oregonum (giant fawn lily)	None/None/2B.2	Sometimes serpentinite, rocky, openings in cismontane woodland and meadows and seeps; 325–3,775 ft. Blooming period: March–June (July)	CNPS, CDFW	**Moderate:** Cismontane woodland habitat present within Project area. No ultramafic soils mapped or observed in Project area. One occurrence is within 5–10 mi of the Project area.
Erythronium revolutum (coast fawn lily)	None/None/2B.2	Mesic, streambanks, bogs and fens, broadleafed upland forest, and north coast coniferous forest; 0–5,250 ft. Blooming period: March–July (August)	CNPS, CDFW	**Moderate:** Broadleafed upland and north coast coniferous forest habitats present within Project area. Two occurrences within 5–10 mi of the Project area.
Gilia capitata subsp. *pacifica* (Pacific gilia)	None/None/1B.2	Coastal bluff scrub, openings in chaparral, coastal prairie, and valley and foothill grassland; 15–5,465 ft. Blooming period: April–August	CNPS, CDFW	**Moderate:** Chaparral and valley and foothill grassland habitats present within Project area. Multiple occurrences within 5–10 mi of the Project area.
Montia howellii (Howell's montia)	None/None/2B.2	Vernally mesic, sometimes roadsides in meadows and seeps, north coast coniferous forest, and vernal pools; 0–2,740 ft. Blooming period: (February) March–May	CNPS, CDFW	**Moderate:** North coast coniferous forest habitat present within Project area. Two occurrences within 5–10 mi of the Project area.
Piperia candida (white-flowered rein orchid)	None/None/1B.2	Sometimes serpentinite in broadleafed upland forest, lower montane coniferous forest, and north coast coniferous forest; 95–4,300 ft. Blooming period: (March) May–September	CNPS, CDFW	**Moderate:** Broadleafed upland, lower montane coniferous, and north coast coniferous forest habitats present within Project area. No ultramafic soils mapped or observed in Project area. Multiple occurrences within 1 mi of the Project area.

Scientific name (common name)	Status (Federal, State, CRPR[1])	Habitat association[2]	Source	Likelihood of occurrence
Usnea longissima (Methuselah's beard lichen)	None/None/4.2	On tree branches, usually on old growth hardwoods and conifers in broadleafed upland forest and north coast coniferous forest; 160–4,790 ft. Blooming period: N/A (lichen)	CNPS, CDFW	**Moderate:** Broadleafed upland and north coast coniferous forest habitats present within Project area. Multiple occurrences within 5–10 mi of the Project area.

[1] Status:

State:

CE California endangered

California Rare Plant Rank (CRPR):

1B Plants rare, threatened, or endangered in California and elsewhere

2B Plants rare, threatened, or endangered in California, but more common elsewhere

4 Plants of limited distribution, on watchlist

CRPR Threat Ranks:

0.1 Seriously threatened in California (over 80% of occurrences threatened / high degree and immediacy of threat)

0.2 Moderately threatened in California (20–80% occurrences threatened / moderate degree and immediacy of threat)

[2] Months in parentheses are uncommon; N/A = Not applicable

4.2.2 Field survey

No special-status plant species were observed during the 3 May 2019 protocol-level botanical survey conducted in the Project area. A comprehensive list of all plant species observed in the Project area is provided in Appendix B.

5 WETLANDS AND WATERS

Waters and wetlands are under United States Army Corps of Engineers (USACE) jurisdiction pursuant to Section 404 of the Clean Water Act (CWA) regulatory authority and under SWRCB jurisdiction by Section 401 of the CWA. Section 404 of the CWA applies to all waters, including wetlands, that have sufficient nexus to interstate commerce (USACE 1986).

A formal delineation of potential USACE jurisdictional waters or wetlands was not conducted as part of the field assessment; however, a wetland characterization within the Project area was conducted in conjunction with the special-status plant survey performed on 3 May 2019 (Section 4) to provide preliminary information on wetland conditions and assist with Project planning.

5.1 Methods

Results of topographic surveys conducted by Stillwater Sciences were used to characterize watercourses within the Project area. Waters were categorized as perennial (i.e., support water year-round) or seasonal based on the results of the fisheries assessment (Section 6). Connectivity of these waters to traditional navigable waters as defined by the USACE was evaluated in GIS.

Prior to the wetlands assessment, existing information on vegetation, soils, and hydrology for the site was evaluated. Available data from the U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) Web Soil Survey website was reviewed for the Project area and nearby vicinity. Information on potential jurisdictional waters and wetlands in the

Project area and nearby vicinity was obtained from the USFWS National Wetlands Inventory (NWI) online application, *Wetlands Mapper* (USFWS 2019b).

Any potential USACE- and/or state-jurisdictional three-parameter wetland observed in the Project area was drawn onto field maps and later digitized using GIS. Evidence of a three-parameter wetland included the observation of at least two of the following wetland parameters: (1) dominant cover by hydrophytic vegetation (i.e., plants with a wetland indicator status of OBL [obligate], FACW [facultative-wet], or FAC [facultative] in the *Western Mountains, Valleys, and Coast Region* [Lichvar et al. 2016]), (2) wetland hydrology (e.g., saturated soils, standing water), and/or (3) mapped hydric soils. Per the 2001 United States Supreme Court issued decision on *Solid Waste Agency of Northern Cook County v. U.S. Army Corps of Engineers* (SWANCC), any three-parameter wetland not adjacent or abutting a USACE-jurisdictional water of the U.S. does not fall under federal jurisdiction. Instead these isolated three-parameter wetlands are potentially state jurisdictional under the *Porter-Cologne Water Quality Control Act at Water Code section 13000 et seq.* (Porter-Cologne Act) by the Regional Water Quality Control Board (RWQCB).

5.2 Results

Based on thalwegs calculated from topographic survey data, the Project area contains 0.98 ac of potential waters of the U.S. These waters are comprised of Redwood Creek (which flows perennially), two intermittently flowing tributaries to Redwood Creek, and an additional intermittent water that has no clear surface water connection to Redwood Creek (Figure 5-1). Redwood Creek accounts for 0.35 ac of potential waters of the U.S. in the Project area and has an approximate width ranging from 20 ft to 46 ft. Unnamed intermittent waters account for 0.63 ac of potential waters of the U.S. in the Project area; these waters have an average approximate width of 10 ft (Figure 5-1).

Per the USFWS NWI query, Redwood Creek was the only surface water noted in the Project area. Potential waters of the U.S. in the Project area are also considered potential waters of the state by CDFW and SWRCB. Furthermore, riparian vegetation adjacent to waters of the state is interpreted by CDFW as being within the streambed and thereby falls under CDFW jurisdiction (Figure 5-1). Riparian vegetation totals 4.5 ac in the Project area and is associated with the *Acer macrophyllum* Forest Association (Figures 3-1 and 5-1).

Two three-parameter wetlands were also observed in the Project area and totaled 0.20 ac. Standing water observed at both locations indicated a high-water table, a primary indicator for wetland hydrology. Recent bioturbation from livestock was noted at both locations. Tadpoles were observed in areas within the larger wetland (0.19 ac) to the north where standing water was present in hoof punch and one adult tree frog was observed in the smaller wetland (0.01 ac) just downslope of the existing access road (Figure 5-1). Both wetlands are located within the Briceland-Tankridge complex, 15–50% slopes soil map unit. All components within this map unit were not listed as a hydric soil (NRCS 2019). Hydrophytic vegetation was evident in these areas and included freeway sedge (FACW), pennyroyal (OBL), toad rush (FACW), and spreading rush (FACW). No surface water connection to a watercourse was observed and these two isolated wetlands were not considered to be potentially USACE-jurisdictional wetlands; however, they may be considered state-jurisdictional wetlands by the RWQCB (Figure 5-1).

Figure 5-1. Preliminary waters and wetlands within the Project area.

6 SPECIAL-STATUS FISH AND WILDLIFE

6.1 Methods

An assessment of suitable habitat for special-status fish and wildlife was conducted to inform future analysis of the Project's potential to impact such species. Special-status species are defined as those that are:

- listed as endangered or threatened, or are proposed/candidates for listing, under ESA and/or CESA);
- designated by CDFW as a Species of Special Concern

6.1.1 Desktop review

The following biological databases were queried for records of special-status fish and wildlife or critical habitat that have potential to occur in the Project area:

- USFWS species list using the USFWS IPaC portal (USFWS 2019a),
- CDFW's CNDDB (CDFW 2019a),
- CDFW's CNDDB northern spotted owl viewer (CDFW 2019b), and
- National Marine Fisheries Service's (NMFS) *California Species List Tools* database (NMFS 2019).

The CNDDB and USFWS database queries were each based on a search of records within the Project vicinity (see Section 3.1.1). The NMFS database query was based on a query of the Briceland quadrangle. Literature on recent occurrences of special-status species in the region was also consulted to determine which special-status species could occur in the Project area.

6.1.2 Fish and wildlife site assessment

A habitat assessment was conducted on 4 May 2019 to evaluate habitat conditions for special-status fish and wildlife species in the in the Project area. The site visit included a field review of the Project area, general characterization of aquatic and wildlife habitat, and photo documentation. The field survey was conducted in the entire construction zone, along intermittent watercourses and a 450-ft long reach of Redwood Creek, and in an area extending between 450 to 1,200 ft into the forest south of the proposed reservoir area.

6.2 Results

A total of 21 special-status wildlife species were identified from the database queries as having potential to occur in the Project area (Appendix A). Suitable habitat for some of the queried species does not occur in the Project area. Appendix A provides information about queried species without suitable habitat or with a low potential to occur in the Project area and these species are not discussed further in the main body of this document.

There are 12 special-status fish and wildlife species that have a moderate or high potential to occur and/or be affected by Project activities (Table 6-1). These species include Pacific lamprey, which did not appear in the database search results, but are known to occur within the South Fork Eel River in large numbers and likely in Redwood Creek. Each of these species are discussed in further detail in the sections below.

Table 6-1. Special-status fish and wildlife species with moderate to high potential to occur in the Project area.

Species name	Status[1] Federal/ State	Distribution and habitat associations	Location of suitable habitat in Project area	Likelihood of occurrence
Fish				
Oncorhynchus kisutch (Coho salmon – southern Oregon/ northern California coast Evolutionarily Significant Unit)	FT, CH/ST	Spawn in coastal streams and large mainstem rivers (i.e., Klamath/Trinity rivers) in riffles and pool tails-outs and rear in pools ≥ 3 ft deep with overhead cover with high levels oxygen and temperatures between 50–59°F.	Suitable habitat occurs in the South Fork Eel River and Redwood Creek.	**High**: Present in Redwood Creek.
Oncorhynchus tshawytscha (Chinook salmon – California Coastal ESU*)*	FT, CH/None	Wild coastal, spring, and fall-run Chinook found in streams and rivers between Redwood Creek, Humboldt County to the north and the Russian River, Sonoma County to the south.	Suitable habitat occurs in the South Fork Eel River and Redwood Creek.	**High**: Present in Redwood Creek.
Oncorhynchus mykiss (Steelhead – northern California coast Distinct Population Segment)	FT, CH/None	Inhabits small coastal streams to large mainstem rivers with gravel-bottomed, fast-flowing habitat for spawning. However, habitat criteria for different life stages (spawning, fry rearing, juvenile rearing) are can vary significantly.	Suitable habitat occurs in the South Fork Eel River and Redwood Creek.	**High**: Present in Redwood Creek.
Entosphenus tridentatus (Pacific lamprey)	None/SSC	Similar to anadromous salmonids, inhabits coastal streams and rivers with gravel-bottomed, fast-flowing habitat for spawning. Ammocoetes rear in backwater areas with sand, silt, and organic material for 4 to 10 years before migrating to the ocean.	Suitable habitat is present and spawning/rearing occurs in the South Fork Eel River. Spawning and rearing habitat is likely to occur in Redwood Creek.	**High:** Suitable habitat present.

Species name	Status[1] Federal/ State	Distribution and habitat associations	Location of suitable habitat in Project area	Likelihood of occurrence
Amphibians				
Rana boylii (foothill yellow-legged frog)	None/SSC, CT	Associated with partially shaded, shallow streams, and riffles with rocky substrate. Some cobble-sized substrate required for egg laying. Adults move into smaller tributaries after breeding.	Suitable habitat is present and breeding occurs in the South Fork Eel River. Observed in Redwood Creek downstream of Project area.	**High**: Suitable habitat present.
Taricha rivularis (red-bellied newt)	None/SSC	Ranges from southern Humboldt to Sonoma counties. Found in streams during breeding season. Moist habitats under woody debris, rocks, and animal burrows.	Suitable habitat is present and sightings have occurred in the Mattole River, approximately 5 mi west of the Project area.	**High**: Habitat present in the Project area.
Birds				
Strix occidentalis caurina (northern spotted owl)	FT/ST	Typically found in large, contiguous stands of mature and old-growth coniferous forest with dense multi-layered structure.	Suitable foraging habitat is present within the Project area. Habitat within the Project area is unsuitable for nesting. The closest activity center is over 1.7 mi to the south-southeast of the Project area.	**Moderate**: Suitable foraging habitat exists in the Project area.
Asio otus (long-eared owl)	None/SSC	Distributed throughout North America. Recorded in north coast from Bald Hills, Humboldt County to Willits, Mendocino County. In Humboldt County, nest in mixed stands of conifers and oaks with edges and openings such as meadows or prairies.	Suitable nesting and foraging habitat present in the Project area.	**High**: Habitat present in the Project area.
Reptiles				
Emys marmorata (western pond turtle)	None/SSC	Ponds, marshes, rivers, streams, and irrigation ditches with abundant vegetation, and either rocky or muddy bottoms, in woodland forest and grasslands. Below 6,000 ft elevation. Basking sites are required. Egg-laying sites are located on suitable upland habitats (grassy open fields) up to 1,640 ft from water.	Suitable habitat occurs in the South Fork Eel River. Ponds that may contain western pond turtles are located on neighboring properties.	**Moderate.** May occur in neighboring ponds.

Species name	Status[1] Federal/ State	Distribution and habitat associations	Location of suitable habitat in Project area	Likelihood of occurrence
Mammals				
Arborimus pomo (Sonoma tree vole)	None/SSC	Associated nearly exclusively with Douglas-fir trees and occasionally grand fir trees within the north coast fog belt between the northern Oregon border and Sonoma County. Eats Douglas-fir needles exclusively.	Early to mid-seral Douglas-fir stands are present adjacent to the Project area, which could provide nesting and foraging habitat.	**High**: Recorded occupying timber stands adjacent to the Project area
Corynorhinus townsendii (Townsend's big-eared bat)	None/SSC, CT	Found throughout California in all but subalpine and alpine habitats. Roosts in cavernous habitats, usually in tunnels, caves, buildings, mines, and basal hollows of trees, but also rock shelters, preferentially close to water. Caves near water's edge are favored. Forages in riparian zone and follows creeks and river drainages on foraging bouts. Feeds primarily on moths. Drinks at stream pools.	Suitable foraging habitat throughout most of the Project area; however, barns, old buildings, and bridges for roosting are not present within the Project area.	**Moderate**: May be present in some of the barns and older structures adjacent to the Project area.
Antrozous pallidus (pallid bat)	None/SSC	Found throughout California. Roosts in rock crevices, outcrops, cliffs, mines, and caves; trees (underneath exfoliating bark of pine and oak) and in basal hollows; and a variety of vacant and occupied structures (e.g., bridges) or buildings. Roost individually or in small to large colonies (hundreds of individuals). Feeds low to or on the ground in a variety of open habitats, primarily on ground-dwelling arthropods. Forages most frequently in riparian zone, in open oak savannah, and open mixed deciduous forest. Drinks at stream pools.	Suitable foraging habitat throughout most of the Project area, however barns, old building, and bridges are not present within the Project area.	**Moderate**: May be present in some of the older structures adjacent to the Survey Area

[1]Status:

Federal		**State**	
FT	Federal Threatened	ST	Threatened
FC	Federal Candidate	CT	Candidate Threatened
CH	Designated critical habitat within the Project vicinity	SSC	CDFW species of special concern

6.2.1 Fish

Fish-bearing watercourses in the Project area are inhabited by coho and Chinook salmon, steelhead, and Pacific lamprey. Suitable habitat for salmon, steelhead, and lamprey spawning and rearing was observed in Redwood Creek adjacent to the Project area during the field reconnaissance. Gravel in the creek was relatively unembedded and a suitable size for spawning. The pool:riffle:flatwater ratio was approximately 50:15:35 with the pools being between 2–5 ft deep. Brief life history discussions for each species are below.

6.2.1.1 Coho salmon, Southern Oregon/Northern California Coast ESU

The Southern Oregon/Northern California Coast evolutionary significant unit (ESU) for coho salmon is listed as threatened under the federal ESA (NMFS 2005a) and was listed as threatened under the California ESA in 2005. Critical habitat was designated in 1999 between the Mattole River in California and the Elk River in Oregon, inclusive (NMFS 1999a). Critical habitat includes all accessible streams and waters of estuarine areas. Coho salmon are known to spawn and rear in the South Fork Eel River and its tributaries. Upon emergence from the gravels, coho fry seek low-velocity areas along shallow stream margins (Shapovalov and Taft 1954). As they grow, juvenile coho move to deeper habitats, although they continue to prefer low-velocity habitat throughout the rearing period.

Coho salmon adults typically migrate upstream from October through December, and spawn from November through January. Spawning generally occurs in low-gradient stream reaches with gravel and cobble substrates. Females dig nests (redds) in the gravel, and deposit 2,500–5,000 eggs in a sequence of egg pockets, which are fertilized by one or more males (Beacham 1982, Sandercock 1991). Egg development is temperature-dependent, with fry emerging from the gravel in the spring, approximately three to four months after spawning. Upon emergence from the gravels, coho fry seek low-velocity areas along shallow stream margins (Shapovalov and Taft 1954). As they grow, juvenile coho move to deeper habitats, although they continue to prefer low-velocity habitat throughout the rearing period. Juveniles typically spend one to two years rearing in fresh water before outmigrating. Emigration from streams to the estuary and ocean generally takes place from February through June. Coho typically spend two years foraging at sea before returning to their natal streams to spawn.

Suitable habitat for coho salmon spawning and rearing was observed in Redwood Creek adjacent to the Project area during the field reconnaissance. Young-of-the-year coho salmon were observed in Redwood Creek during an instream habitat inventory in 2009 (CDFG 2009).

6.2.1.2 Chinook salmon, California coastal ESU

California coastal Chinook salmon were listed in 1999 as threatened under the federal ESA (NMFS 1999b). The California coastal Chinook salmon ESU extends from the Klamath River (exclusive) south to the Russian River (inclusive). Critical habitat for the species was designated in 2005 (NMFS 2005b) and includes the South Fork Eel River and Redwood Creek.

Chinook salmon in the California coastal ESU exhibit life history characteristics of the fall-run ecotype. In California, most adult fall-run Chinook enter streams from August through November, with peak arrival usually occurring in October and November. Spawning occurs from early October through December. Upon arrival at the spawning grounds, adult females dig shallow depressions or pits in gravel and cobble substrate, deposit eggs in the bottom during the act of spawning, and cover them with additional gravel. Female fall-run Chinook deposit an average of about 5,500 eggs. Egg incubation generally lasts between 40 to 90 days at water temperatures of 42.8 to 53.6°F, and the alevins remain in the gravel for two to three weeks before emerging from the gravel. Fall-run Chinook salmon fry usually begin migrating downstream soon after emergence in February or March, with outmigration continuing into late-July. Chinook spend two or more years at sea before migrating back to their natal streams to spawn.

Suitable habitat for Chinook salmon spawning and rearing was observed in Redwood Creek adjacent to the Project area during the field reconnaissance. Chinook salmon have been identified as being present in Redwood Creek (CWPAP 2014).

6.2.1.3 Steelhead, Northern California Coast DPS

The Northern California Coast steelhead DPS was listed as threatened in 2006 under the federal ESA (NMFS 2006). The Northern California Coast steelhead DPS extends from Redwood Creek in Humboldt County to the Gualala River in Mendocino County (inclusive). Critical habitat for the species was designated in 2005 (NMFS 2005b). Critical habitat includes the South Fork Eel River and its tributaries, including Redwood Creek.

Adult winter steelhead generally begin migrating to spawning areas in October, with the peak migration in December through February. Steelhead spawning occurs in mainstems, tributaries, and intermittent streams in December through May. Spawning occurs in gravel and cobble substrates where the female digs an egg pocket and deposits her eggs, which are fertilized externally by one or more males. Redds typically consist of a series of egg pockets that excavated and subsequently covered during redd construction process. Unlike Chinook and coho salmon, steelhead typically do not remain on the spawning grounds for extended periods to defend the completed redd to reduce the potential for superimposition. Egg development time is inversely proportional to water temperature and varies from about 19 days at 60°F to about 80 days at 42°F. Fry typically emerge from the gravel two to three weeks after hatching. Upon emerging from the gravel, fry move to shallow edgewater habitats to rear, and gradually move into deeper habitats as they grow. During winter, when water temperatures are cold, juveniles are less active and hide in the interstitial spaces between cobbles and bounders. Juvenile steelhead typically rear in fresh water for two to three years prior to migrating downstream to the estuary and ocean. Steelhead spend between six months and three years at sea before returning to their natal streams to spawn. Unlike salmon, steelhead are capable of repeat spawning.

Suitable habitat for steelhead spawning and rearing was observed in Redwood Creek adjacent to the Project area during the field reconnaissance. Young-of-the-year and Age 1+ steelhead were observed in Redwood Creek during an instream habitat inventory in 2009 (CDFG 2009).

6.2.1.4 Pacific lamprey

The Pacific lamprey is a large, widely distributed anadromous species that rears in fresh water before outmigrating to the ocean, where it grows to full size (approximately 16–28 in) prior to returning to freshwater streams to spawn and ultimately die. The species is distributed across the northern margin of the Pacific Ocean, from central Baja California north along the west coast of North America to the Bering Sea in Alaska and off the coast of Japan. Adults migrate into and spawn in a wide range of river systems, from short coastal streams to tributaries of large rivers.

Pacific lampreys typically spawn from March through July depending on water temperatures and local conditions such as seasonal flow regimes (Kan 1975, Brumo et al. 2009, Gunckel et al. 2009). Spawning generally occurs at daily mean water temperatures from 50–64°F, with peak spawning around 57–59°F (Stone 2006, Brumo 2006). Redds are typically constructed by both males and females in gravel and cobble substrates within pool and run tailouts and low gradient riffles into which eggs are deposited (Stone 2006, Brumo et al. 2009, Gunckel et al. 2009).

Hatching occurs following about 15 days of incubation, the egg-sac larval stage spend another 15 days in the redd gravels during which time they absorb the remaining egg sac, until they emerge at night and drift downstream (Brumo 2006). After drifting downstream, the eyeless larvae, known as ammocoetes, settle out of the water column and burrow into fine silt and sand substrates that often contain organic matter. Within the stream network they are generally found in low-velocity, depositional areas such as pools, alcoves, and side channels (Torgensen and Close 2004). Depending on factors influencing growth rates, they rear in these habitats from 4 to 10 years, filter-feeding on algae and detrital matter prior to metamorphosing into the adult form (Pletcher 1963, Moore and Mallatt 1980, van de Wetering 1998). During metamorphosis, Pacific lampreys develop eyes, a suctoral disc, sharp teeth, and more-defined fins (McGree et al. 2008).

After metamorphosis, smolt-like individuals known as macrophthalmia migrate to the ocean—typically in conjunction with high-flow events between fall and spring (van de Wetering 1998, Goodman et al. 2015). In the ocean, Pacific lampreys feed parasitically on a variety of marine fishes (Richards and Beamish 1981, Beamish and Levings 1991, Murauskas et al. 2013). They are thought to remain in the ocean, feeding for approximately 18–40 months before returning to fresh water as sexually immature adults, typically from winter to early summer (Kan 1975, Beamish 1980, Starcevich et al. 2014, Stillwater Sciences and Wiyot Tribe Natural Resources Department 2016).

Pacific lamprey are known to occur in the South Fork Eel River and its tributaries. Redwood Creek has suitable spawning and rearing habitat for this species.

6.2.2 Wildlife

6.2.2.1 Foothill yellow-legged frog

Foothill yellow-legged frog is a California species of special concern and has recently been designated as a candidate for threatened listing under the CESA. Within California, foothill yellow-legged frogs were historically found in the Sierra Nevada foothills, up to elevations of approximately 6,000 ft, and in the Coast Range from the Oregon state border south to the San Gabriel River in southern California (Stebbins 2003). Currently, populations are thought to have disappeared from the southern Sierra Nevada foothills, in areas south of the Transverse ranges, and along the coast south of Monterey County (Jennings and Hayes 1994).

Foothill yellow-legged frogs are typically found in perennial streams or rivers, and intermittent creeks with pools. The species often breeds in open and sunny, low-gradient stream reaches near junctions with tributary streams, due to the proximity of adult overwintering habitat in tributaries and to the presence of boulders and cobbles in these locations. Egg deposition usually occurs in cobble bars or under large boulders in areas of low-velocity flow. Tadpoles show affinity to the oviposition site, remaining in edgewater habitat with substrate interstices, vegetation, and/or detritus for cover. Adults prefer areas with exposed basking sites and cool, shady areas adjacent to the water's edge.

No foothill yellow-legged frogs were observed within or adjacent to the Project area during the field survey in May 2019. Suitable habitat for foothill yellow-legged frog breeding occurs in the South Fork Eel River where the channel widens and the tree canopy opens to allow sun to reach the channel for several hours a day. Although the portion of Redwood Creek in the Project area is more heavily shaded than some section of the South Fork Eel River, suitable breeding and larval rearing habitat for foothill yellow-legged frog is present. In addition, Redwood Creek and its tributaries could be used by adults and juveniles of this species for dispersal in the fall.

6.2.2.2 Red-bellied newt

The red-bellied newt is a California species of special concern. In California, this species is found along the coast from near Bodega, Sonoma County, to near Honeydew, Humboldt County, and inland to Lower Lake and Kelsey Creek, Lake County. It lives in coastal woodlands, especially redwood forests.

Adults are terrestrial and become aquatic when breeding. Terrestrial animals spend the dry summer in moist habitats under woody debris, rocks, in animal burrows. Adults forage on the forest floor for a variety of invertebrates. Adults move toward streams in late February at the start of the breeding season, which extends into May. This species avoids ponds or lakes. Females lay eggs under rocks or attached to submerged roots in rocky streams and rivers with moderate to fast flow. Incubation lasts between two weeks to one month. Larval development to metamorphosis occurs over four to six months, after which they emerge from the streams and occupy terrestrial habitat. Juveniles spend most of their time underground and are not active on the surface until near sexual maturity, which occurs at about four to six years of age.

This species was not observed during the field survey in May 2019, however suitable aquatic and terrestrial habitat is present within or adjacent to Redwood Creek.

6.2.2.3 Northern spotted owl

The northern spotted owl is federally and state-listed as threatened. Critical habitat has been designated for this species, but it is not present within or adjacent to the Project area. Northern spotted owls are uncommon year-round residents in the northern California coastal ranges from Marin County north, as well as within the Cascade Range in northern California, southeast to the Pit River in Shasta County below 7,600 ft (Harris 1993, Gutiérrez et al. 1995, USFWS 2010). South of Burney in the southern Cascade Range and Sierra Nevada, the northern spotted owl is replaced by the California spotted owl (*Strix occidentalis occidentalis*) (Gutiérrez et al. 1995).

Northern spotted owls are typically associated with complex mature or old-growth stands dominated by conifers, particularly redwoods with hardwood understories (Pious 1994, USFWS 2011). Roosting sites are characterized by dense canopy cover dominated by large-diameter trees (i.e., greater than 30-in diameter at breast height [dbh]), multiple canopy layers, and north-facing slopes, often in cool shady areas (Gutiérrez et al. 1995, Courtney et al. 2004). Nests tend to be found in tree or snag cavities, on platforms (e.g., abandoned raptor or raven nests, squirrel nests, mistletoe brooms, or debris accumulations), or on broken-top snags (Zeiner et al. 1990a). Northern spotted owls are generally monogamous, forming long-term pair bonds that often last for life (Courtney et al. 2004). In late February or early March, pairs begin roosting in cavities, the tops of broken trees, or abandoned nests; nesting is followed by peak breeding in April and May (Zeiner et al. 1990a, Gutiérrez et al. 1995, Courtney et al. 2004). Northern spotted owls generally lay a single clutch of one to four eggs (Gutiérrez et al. 1995). A pair may use the same nesting location for several years, although breeding may not occur every year (Zeiner et al. 1990a).

Primary prey items for northern spotted owls are small mammals, but birds and insects are also taken (Forsman et al. 1984, Zeiner et al. 1990a). Foraging habitats vary more than roosting and nesting habitats, but are similarly characterized by high canopy closure and complex structure (Thomas et al. 1990). Open areas are also important foraging areas in northern California, as the abundance and diversity of prey is higher in early successional habitats (Folliard et al. 2000). Spotted owls are likely to forage in stands that are young enough to contain an abundance of prey, such as woodrats, but are old enough to allow the owls to fly under the canopy (Thome et al. 1999).

Suitable nesting habitat for northern spotted owl is not present in or adjacent to the Project area; however, species may forage in the area. The forest to the south of the Project area is dominated by a dense stand of 12- to 24-inch dbh Douglas-fir with a lesser amount of hardwoods. No evidence (pellets, nests, whitewash on trees or forest floor, etc.) of owl nesting or occupancy was observed in this area and the trees within it are not suitable for nesting. The nearest activity center (HUM0580) for this species is located approximately 1.7 mi to the southwest and the last recorded observation at this activity center was of a male in 2015 (CDFW 2019b).

6.2.2.4 Long-eared owl

The long-eared owl is considered a species of special concern in California. It occurs and breeds the length and breadth of the state east of the northern humid coastal region and from sea level to 7000 ft (Shuford and Gardali 2008). The species is considered to be "common" to "abundant locally" (Shuford and Gardali 2008). Surveys for the Humboldt County breeding bird atlas found long-eared owls in 11 scattered blocks in the southern half of the county, mainly in the interior (Hunter et al. 2005, as cited in Shuford and Gardali 2008). Prior records for the region representing possible breeding birds extend from Bald Hills, Humboldt County, south to Willits, Mendocino County (Harris 2005, as cited in Shuford and Gardali 2008).

Long-eared owls nests in conifer, oak, riparian, pinyon-juniper, and desert woodlands that are either open or are adjacent to grasslands, meadows, or shrublands. Key habitat components are some dense cover for nesting and roosting, suitable nest platforms, and open foraging areas. In Humboldt County, the owls apparently nest in mixed stands of conifers and oaks with edges and openings such as meadows or prairies (Hunter et al. 2005, as cited in Shuford and Gardali 2008).

Although no evidence (pellets, nests, whitewash on trees or forest floor, etc.) of owl nesting or occupancy was observed during the field survey, the Project area contains suitable nesting and foraging habitat for long-eared owls. The closest sighting occurred in Humboldt Redwoods State Park at Bull Creek, approximately 17.5 mi north of the Project area. However, observation records may be relatively scarce due to the nocturnal habitat of the species.

6.2.2.5 Sonoma tree vole

The Sonoma tree vole is a candidate for state listing as threatened. In California, the Sonoma tree vole is restricted to coastal forests in the humid fog belt from Sonoma County north to the Klamath mountains (Williams 1986, Jameson and Peeters 2004, Adam and Hayes 1998). Distribution of Sonoma tree voles in many parts of their range is patchy (Hall 1981), but this species can be locally common (Williams 1986).

The Sonoma tree vole is a nocturnal rodent that is active year-round (Zeiner et al. 1990b). This species lives, nests, and feeds within the forest canopy, though males are rarely terrestrial (Williams 1986). The home range usually consists of one or more trees (Brown 1985, as cited in

Carey 1991). Both sexes construct nests of Douglas-fir needles, typically located 6–18 m (20–60 ft) above the ground in branches or against trunks of Douglas-fir trees (Williams 1986). In cases where nests were found in species other than Douglas-fir, grand fir, and redwood, nests were on branches interlocking with branches of Douglas-fir. Breeding occurs throughout the year, peaking from February through September. The young are weaned at 30–40 days (Zeiner et al. 1990b). The diet of the red tree vole consists of needles, buds, and the tender bark of twigs of Douglas-fir, western hemlock, grand fir, and Bishop pine (Williams 1986, Wooster 1996). Needle resin ducts are removed before the remaining part is eaten. Young needles may be consumed entirely (Harris 1990). Tree voles obtain water from food or by licking dew or rainwater from coniferous trees (Maser 1965). Where present, tree voles are a common component of spotted owl diets (Forsman et al. 2004).

In Mendocino County, nests have occasionally been located on open ridge tops and in previously heavily logged and/or grazed areas (Wooster 1996). The predominant tree species used by Sonoma tree voles is Douglas-fir, with larger trees able to support colonies of tree voles (Meiselman 1987, Carey 1991, Wooster 1996, Thompson and Diller 2002, Jones 2003). Based on a study by Thompson and Diller (2002), tree voles are hypothesized to start colonizing in tree stands as young as around 20 years old. Density of active vole nests increases significantly as stands mature beyond 20 years old (Thompson and Diller 2002). Tree voles have also been documented nesting in tanoak, presumably due to its common occurrence in many Douglas-fir stands (Thompson and Diller 2002).

Although a stand search for nests and resin ducts (discarded after feeding on fir needles and used for nesting material) did not yield evidence of occupancy by this species, suitable habitat for Sonoma Tree vole is present in the Douglas-fir-dominated forest south of the Project area.

6.2.2.6 Townsend's big-eared bat

Townsend's big-eared bat is a candidate for state listing as threatened and a California species of special concern. This species occurs throughout California and is associated with caves and structures in a variety of habitats from deserts to coastal scrub to montane forests. Townsend's big-eared bats have been documented from sea level to 10,800 ft, although in California maternity roosts appear to be confined to elevations below 5,900 ft (Pierson and Fellers 1998, Sherwin and Piaggio 2005).

This cavity-dwelling species roosts and hibernates in caves (commonly limestone or basaltic lava), mines, buildings, bridges (with a cave-like understructure), rock crevices, tunnels, basal hollows in large trees, and cave-like attics (Pierson and Fellers 1998, Pierson and Rainey 2007, Pierson et al. 2001, Pierson and Rainey 1996, Sherwin et al. 2000, Sherwin and Piaggio 2005). Townsend's big-eared bats breed in both transitory migratory sites and hibernacula between September or October and February (CDFW 2013). The maternity season extends from 1 March through 31 October, with colonies forming between March and June and breaking up by September or October (CDFW 2013). Maternity colonies and winter hibernacula (found in caves, tunnels, mines, and buildings [Zeiner et al. 1990b]) are particularly sensitive to disturbance. This species could be directly impacted by removal or disturbance of maternal roosts (e.g., trees, abandoned buildings) during the breeding season (March–October).

Townsend's big-eared bat is a moth specialist with over 90% of its diet composed of lepidopterans. Foraging habitat associations include edge habitats along streams, adjacent to and within a variety of wooded habitats. These bats often travel large distances while foraging, including movements of over 93 mi during a single evening (Sherwin et al. 2000). Evidence of large foraging distances and large home ranges has also been documented in California (Pierson and Rainey 1996).

Snags and large trees may be important roosts for this species. In northwestern California, Fellers and Pierson (2002, as cited in Woodruff and Ferguson 2005) documented individual Townsend's bats using tree hollows created by fire or rot in very large redwood (*Sequoia sempervirens*) and California bay trees (*Umbellularia californica*). A nursery colony was found using the basal hollows of large redwood trees in northwestern California (Mazurek 2004, as cited in Woodruff and Ferguson 2005) and in Muir Woods National Monument near San Francisco (Heady and Frick 2001, as cited in Woodruff and Ferguson 2005).

There is limited roosting habitat for Townsend's big-eared bat in the Project area (i.e., no caves, buildings, or bridges); however the species has the potential to roost in cavities present in older madrone and oak trees south of the Project area. Foraging habitat for Townsend's big-eared bat is present in the Project area.

6.2.2.7 Pallid bat

Pallid bat is a California species of special concern. This species occurs year-round in California. Pallid bats are associated with a variety of habitats from desert to coastal regions. At low- to mid-elevations, they are particularly associated with oak habitat (oak savannah, black oak, and oak grasslands) (Pierson and Rainey 2002). In natural settings, day and night roosts are in rock crevices and cliffs, but can also be found in trees (underneath exfoliating bark of pine and oak and in hollows) and caves (Sherwin and Rambaldini 2005, Hermanson and O'Shea 1983, Pierson et al. 2001, Pierson and Rainey 1996). However, in more urban settings (e.g., Central Valley and western Sierran foothills), day and night roosts are frequently associated with human structures such as abandoned buildings, old mine workings, and bridges (Sherwin and Rambaldini 2005, Pierson and Rainey 1996, Pierson et al. 2001). Overwintering roosts require relatively cool and stable temperatures out of direct sunlight. Pallid bats primarily forage in open spaces away from water. They can feed on the ground, on vegetation, and in the air by using a 'wing-cupping' method that forces the prey to the ground (Sherwin and Rambaldini 2005). Their generalist diet consists primarily of large ground-dwelling or slow flying insects and arachnids (Zeiner et al. 1990b), but can also include scorpions (pallid bats are immune to the sting), small rodents, and lizards.

The Project area does not contain tunnels, caves, or mines for roosting; however, suitable roosting habitat for the species occurs within the forest south of the Project area. Suitable foraging habitat for pallid bat occurs throughout the Project area.

6.2.2.8 Western pond turtle

Western pond turtle is a California species of special concern. In California, this species is found from the Oregon border along the Pacific Coast Ranges to the Mexican border, and west of the crest of the Cascades and Sierras.

Western pond turtles inhabit fresh or brackish water characterized by areas of deep water, low flow velocities, moderate amounts of riparian vegetation, warm water and/or ample basking sites, and underwater cover elements, such as large woody debris and rocks (Jennings and Hayes 1994). Along major rivers, western pond turtles are often concentrated in side channel and backwater areas. Turtles may move to off-channel habitats, such as oxbows, during periods of high flows (Holland 1994). Although adults are habitat generalists, hatchlings and juveniles require specialized habitat for survival through their first few years. Hatchlings spend much of their time feeding in shallow water with dense submerged or short emergent vegetation (Jennings and Hayes 1994). Although an aquatic reptile, western pond turtles require upland habitats for basking, overwintering, and nesting, typically within 0.6 mi of aquatic habitats (Holland 1994).

Western pond turtle eggs are typically laid in June and July, though they may be laid throughout the year (Holland 1994, Reese 1996). Egg-laying sites vary from sandy shoreline to forest soil types, though are generally located in grassy meadows, away from trees and shrubs (Holland 1994), with canopy cover commonly less than about 10% (Reese 1996). Young hatch in late fall or overwinter in the nest and emerge in early spring.

Western pond turtles are known to occupy the South Fork Eel River. However, Redwood Creek, adjacent to the Project area has a relatively closed canopy, which would limit the basking opportunities for turtles. In addition, water flow during the summer months is very low or intermittent, which is not the preferred habitat for turtles. However, suitable habitat occurs in ponds on adjacent properties and there is moderate potential for the species to occupy the Project area on at least a seasonal basis.

7 POTENTIAL EFFECTS AND MINIMIZATION MEASURES

7.1 Special-status Plants and Sensitive Natural Communities

No special-status plant species were observed during the protocol-level botanical survey conducted in the Project area on 4 May 2019. In addition, there are no records of special-status plant occurrences within the Project area based on the 2019 CDFW CNDDB queries (Section 4.1) (CDFW 2019a) and collection records in the Consortium of California Herbaria (ucjeps.berkeley.edu/consortium). As such, Project activities will have no impact on known special-status plant populations.

One sensitive natural community, *Acer macrophyllum* Forest Alliance (S3), was observed within the Project area. This alliance comprised the riparian forest (also under CDFW preliminary jurisdictional throughout the Project area) adjacent to Redwood Creek and its tributaries in the Project. Some disturbance is anticipated within this natural community during the instream habitat enhancement and gully stabilization Project activities. Installation of the off-channel reservoir will not affect this sensitive natural community, as it will replace a portion of the annual/perennial grassland in the Project area.

The following minimization measures will be implemented to reduce potential impacts on sensitive natural communities during Project activities:

- The Project footprint will be minimized to the extent possible.
- Ground disturbance and vegetation clearing and/or trimming will be confined to the minimum amount necessary to facilitate Project implementation.
- Heavy equipment and vehicles will use existing access roads to the extent possible.
- Construction materials will be stored in designated staging areas.
- Measures to prevent the spread of invasive weeds and sudden oak death pathogens will be taken, including, where appropriate, inspecting equipment for soil, seeds, and vegetative matter, cleaning equipment, utilizing weed-free materials and native seed mixes for revegetation, and proper disposal of soil and vegetation. Prior to entering and leaving the

work site, workers will remove all seeds, plant parts, leaves, and woody debris (e.g., branches, chips, bark) from clothing, vehicles, and equipment.

7.2 Wetlands and Waters

Construction activities associated with the proposed streamflow enhancement Project have the potential to affect preliminary waters of the U.S. and CDFW riparian zones as some of the work will take place within the active stream channel. The access road and other Project components will avoid all isolated wetlands within the Project area thus, the Project will not affect potential state-jurisdictional isolated wetlands. The following minimization measures are will be implemented to minimize any potential negative impacts on these waters and avoid impacting waters outside of the Project footprint:

- The Project footprint will be minimized to the extent possible.
- Isolated wetlands in the Project area will be flagged and avoided during all construction activities.
- Heavy equipment and vehicles will use existing access roads to the extent possible.
- Work will be conducted during the dry season to the extent possible.
- Construction materials will be stored in designated staging areas.
- The following erosion, sediment, material stockpile, and dust control best management practices will be employed on-site:
    - Locate temporary storage areas away from vehicular traffic
    - Locate stockpiles a minimum of 50 feet away from concentrated flows of storm water, drainage courses, and inlets
    - Protect all stockpiles from storm water run-on using a temporary perimeter sediment barrier such silt fences, compost socks, or sandbag barriers.
    - Keep stockpiles covered or protected with soil stabilization measures to avoid direct contact with precipitation and to minimize sediment discharge.
    - Implement wind erosion control practices as appropriate on all stockpiled material.
- All construction equipment will be well maintained to prevent leaks of fuels, lubricants, or other fluids and extreme caution will be used when handling chemicals (fuel, hydraulic fluid, etc.). Service and refueling procedures will not be conducted where there is potential for fuel spills to seep or wash into wetlands or waters. Appropriate materials will be on-site to prevent and manage any spills.

7.3 Special-status Fish and Wildlife

7.3.1 Fish

Coho and Chinook salmon, steelhead, and Pacific lamprey are special-status fish species known to occur in Redwood Creek within to the Project area. Indirect Project-related impacts on these species could result from discharge of sediment from reservoir and infiltration gallery excavation, gully stabilization, instream habitat enhancement, and offset well and Ranney-type collector construction. In addition, installation of the habitat enhancements and offset well/collector system could have direct impacts on special-status fish species that could be in the construction footprint. However, long-term beneficial impacts would accrue coho salmon, steelhead, and lamprey from water entering Redwood Creek from reservoir/infiltration gallery inputs. Benefits for juvenile

Chinook salmon would be limited since they typically migrate to the ocean prior to the planned water deliveries to the Redwood Creek associated with the Project.

The following measures will be employed by the Project to avoid, minimize, or mitigate indirect sediment-related impacts on special-status fish species and their habitat.

- The use of cofferdams will contain any turbid water produced during the Project within the work area, thereby avoiding impacts on downstream salmonids. Any turbid water within the confined work areas would be pumped to a receiving site outside the channel or to frak tanks. Any turbid water within the work area would be allowed to settle prior to removal of the cofferdams, thereby minimizing downstream effects on salmonids.
- Discharge of sediment will be controlled and minimized with the implementation of best management practices (BMPs) on all disturbed soils that have the potential to discharge into area watercourses. Applicable BMPs include, but are not limited to, installation of silt fences, straw wattles, and placement of seed-free rice straw. BMPs will be installed at all access points to the work sites, which will minimize the potential for sediment delivery and deleterious effects on salmonids.
- All gully stabilization work will be conducted when the individual sites are dry (i.e. no surface water).

There is the potential for instream Project activities to directly impact salmonid species through contact with heavy equipment and entrainment into dewatering pumps. To minimize the potential for injury or mortality of fish, the following measures will be applied:

- A 15 July–15 October instream work window will be established to allow time for young-of-the-year salmonids to be very mobile and capable of avoiding injury. The work window will also allow downstream migration of smolts to be completed prior to any Project-related channel disturbance taking place. In addition, the work window coincides with the summer low-flow season during which flow in the creek will be at its summer base flow. Finally, the 15 October date will insure all work is done prior to the rainy season and arrival of any upstream migrating adult salmonids.
- Prior to the initiation of any instream work in areas with surface water, a qualified biologist will survey the site to determine fish presence. The biologist will herd or relocate any fish that may be in work sites to suitable habitat downstream. Block nets will be installed to prevent fish from reentering the work area. Any fish remaining in the work area will be captured by hand, dip net, or as a last resort, using a backpack electrofisher. Cofferdams will be constructed in the channel at sites where streamflow is present. Pumps will then be installed outside of the stream channel to divert water around the work area.
- The Project will follow the Fish Screening Criteria for Salmonids (NMFS 1997), NOAA Restoration Center/Army Corps of Engineers programmatic biological opinion requirements.

There is also the potential for accidental release of hydrocarbons into Redwood Creek during construction operations. The following measures will be implemented to minimize the accidental release of hydrocarbons.

- All fueling and servicing of heavy equipment will occur at least 100 ft from any watercourse.
- Spill kits will be on-site in case of an accidental release of fuels, lube oil, or hydraulic fluids from equipment.

There would be long-term beneficial effects resulting from the addition of wood to the stream channel. The increase in wood and construction of channel-spanning post-assisted check dams would result in localized reductions in high flow velocities, allowing for sorting and deposition of bed load materials.

Critical habitat for listed salmonids species would also benefit in the short and long-term. The wood would help create debris jams, increase habitat complexity, stabilize floodplains, create off-channel habitat, improve winter and summer habitat conditions, create scour pools, and increase cover for juvenile and adult salmonids. The input of water during the summer and late fall from the infiltration gallery would increase summer and fall flow in Redwood Creek during the dry season. Stabilization of the gullies on the property would reduce sediment input into Redwood Creek and adverse effects on spawning and rearing habitat for fish.

7.3.2 Wildlife

7.3.2.1 Foothill yellow-legged frog

The reservoir and infiltration gallery construction activities will take place in open meadow areas not utilized by foothill yellow-legged frogs. However, foothill yellow-legged could be affected by proposed activities that would take place within Redwood Creek and at gully stabilization sites. Impacts on adult, juvenile, or larval frogs could occur through direct contact with heavy equipment or disturbed soil. Adverse impacts could occur from instream structure construction, dewatering of work areas, trampling of larvae during instream operations, contact with heavy equipment, and sediment discharge. The gully stabilization sites are not utilized by foothill yellow-legged frogs for breeding or larval rearing and impact on these life history stages would not occur at these locations.

The Project would result in the development of additional instream habitat, which should benefit foothill yellow-legged frogs by maintaining and potentially expanding the amount of instream habitat available for breeding and larval development in Redwood Creek.

The following species-specific conservation measures will be employed to avoid or minimize the potential for impacts on foothill yellow-legged frogs:

- An egg mass survey will be conducted in May prior to the operations season to determine if breeding occurs within the Project reaches.
- A visual observation survey of the Project areas will be conducted within two weeks prior to the start of operations to determine if adult and juvenile foothill yellow-legged frogs are present in the Project area.
- If foothill yellow-legged frogs are present, then a qualified CDFW-approved biologist will be present immediately prior to the start of operations to remove any frogs and relocate them to suitable habitat.
- The Project manager or qualified designee will conduct daily morning inspections of the area slated for work to determine if foothill yellow-legged frogs entered the areas overnight. Any individuals will be captured and relocated by a CDFW-approved biologist prior to the start of the construction work for the day.
- The Project will apply for an incidental take permit or other appropriate take authorization as deemed necessary by CDFW if foothill yellow-legged frogs are present within the Project area and they either remain a candidate for listing or are listed as threatened under CESA.

The following additional general conservation measures will be employed to further avoid or minimize the potential impacts on foothill yellow-legged frogs:

- All gully stabilization work will be conducted when the individual sites are dry (i.e. no surface water).
- All fueling and servicing of heavy equipment will occur at least 100 ft from any watercourse.
- Spill kits will be on-site in case of an accidental release of fuels, lube oil, or hydraulic fluids from equipment.

7.3.2.2 Red-bellied newt

Adult and juvenile red-bellied newts have the potential to be present in terrestrial portions of the Project area during the planned construction period and could be affected by heavy equipment that collapses burrows or moves woody debris. Larval newts have the potential to be present in aquatic portions of the Project area and could be affected by instream operations.

The following conservation measures will be employed to avoid or minimize the potential for impacts on red-bellied newt:

- Terrestrial woody debris will be left in place to the greatest extent practicable during operations within the riparian areas.
- The Project manager or qualified designee will conduct daily morning inspections of the area slated for work to determine if adult newts are present on the ground surface. Any adult newts will be captured and relocated to suitable habitat outside of the Project area by a CDFW-approved biologist prior to the start of construction for the day.
- Prior to the initiation of any instream work in areas with surface water, a qualified biologist will survey the site to determine larval newt presence. If larval red-bellied newts are present, then a CDFW-approved biologist will relocate them to suitable habitat outside the Project area prior to the start of construction for the day.

The Project will result in additional dry season flows in Redwood Creek, which would benefit red-bellied newts by maintaining or improving instream habitat available for this species.

7.3.2.3 Northern spotted owls

The closest northern spotted owl activity center to the Project is approximately 1.7 mi away from the Project area and recent surveys (i.e., within the last four years) have not documented nesting within this activity center. Nesting habitat does not occur within the Project area or in the adjacent forest. The Project activities do not include removal of any trees that could provide habitat for owls. Therefore, there will not be any direct impacts on northern spotted owls or their habitat. However, there is the potential for construction-related noise to affect northern spotted owls that may be on adjacent properties or away from the Project area.

The potential for Project construction to indirectly impact nesting northern spotted owls was preliminary evaluated using USFWS (2006) guidelines. Owls can be affected by noise-related, visual, or physical disturbances, such as created by heavy equipment. USFWS (2006) identifies the distance that sound associated with different types of construction equipment is estimated to disturb northern spotted owls during the breeding season, relative to ambient noise levels. Most types of standard construction equipment (e.g., backhoes, bulldozers, construction vehicles, etc.) would require disturbance buffers of 330–1,320 ft from nesting spotted owl activity centers. No Project activities utilizing these types of equipment are expected to occur within 1,320 ft of a northern spotted owl nest. In addition, as stated above, recent surveys have not found nesting northern spotted owls with the closest known activity center (1.7 mi from the Project area). Therefore, northern spotted owls are unlikely to be indirectly affected by the Project.

7.3.2.4 Long-eared owl

Long-eared owls have not been observed within 17 mi of the Project area. However, this species nests in conifer and oak woodlands that are either open or are adjacent to grasslands, meadows, or shrublands. These habitats exist within the Project area, although no evidence of occupancy was observed during the field survey. Construction activities associated with the Project would not affect nesting or roosting habitat since no trees would be removed. However, potential foraging habitat could be affected due to the construction of the reservoir and infiltration gallery. In addition, construction noise may affect nesting owls.

Construction of the infiltration gallery would be a temporary impact since the area would revegetate after completion. The construction of the reservoir will result in approximately 6.5 ac of grazed grassland area being permanently converted to open water and associated containment berm features. This conversion could affect the amount of foraging habitat available for long-eared owls. A preliminary estimate of available grasslands in the Briceland area conducted using satellite imagery showed approximately 470 ac of grassland (not including numerous small openings) within a one-mile radius of the Project area. The Project would convert approximately 1.4% of this area to reservoir, a relatively minor impact in consideration of the amount of suitable foraging habitat in the vicinity and the lack of evidence indicating species presence in and around the Project area.

The following conservation measure will be employed to avoid or minimize the potential for impacts on long-eared owls:

- A pre-construction nesting bird survey will be conducted during the breeding season and within two weeks of the start of construction. Appropriate buffers will be established around all active nests within the Project area.

7.3.2.5 Sonoma tree vole

Suitable habitat for Sonoma tree voles is present in the timber stand adjacent to the Project area. The Project will not occur within the forest nor remove any trees; therefore, there will be no impact on this species.

7.3.2.6 Pallid bat

Suitable habitat for pallid bats is present in the timber stand adjacent to the Project area. The Project will not occur within the forest nor remove any trees or structures that could be occupied by this species; therefore, there will be no impact on pallid bat.

7.3.2.7 Townsend’s big-eared bat

Suitable habitat for Townsend’s big-eared bats is present in the timber stand adjacent to the Project area. The Project will not occur within the forest nor remove any trees or structures that could be occupied by this species; therefore, there will be no impact on Townsend's big-eared bat.

7.3.2.8 Western pond turtles

Redwood Creek, within the Project area has a relatively closed canopy, which would limit the basking opportunities for turtles. In addition, water flow during the summer months is very low or intermittent, which is not the preferred habitat for turtles. In addition, no ponds are located in the Project area that could contain this species. However, there is the potential that turtles could be within the Project area at the start of construction.

The following conservation measure will be employed to avoid or minimize impacts on western pond turtles:

- Prior to the initiation of any instream work in areas with surface water, a qualified biologist will survey the site to determine turtle presence. The biologist will capture and relocate any turtle that may be in work sites to suitable habitat downstream. Block nets will be installed to prevent turtles from reentering the work area.

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Appendices

Appendix A

Scoping List of CNDDB Special-Status Plant and Wildlife Species in the Project Vicinity

Table A-1. Comprehensive scoping list of special-status plants in the Project vicinity.

Scientific name (common name)	Lifeform	Status (Federal, State, CRPR[1])	Habitat associations and blooming period[2]	Source	Likelihood of occurrence
Antennaria suffrutescens (evergreen everlasting)	perennial stoloniferous herb	None/None/4.3	Serpentine in lower montane coniferous forest; 1,640–5,250 ft. Blooming period: January–July	CNPS	**None**: Project area is outside of the known elevation range.
Astragalus agnicidus (Humboldt County milk-vetch)	perennial herb	None/CE/1B.1	Openings, disturbed areas, and sometimes roadsides in broadleafed upland forest and north coast coniferous forest; 390–2,625 ft. Blooming period: April–September	CNPS, CDFW	**Moderate:** Broadleafed upland and north coast coniferous forest habitats present within Project area. Two occurrences within 5–10 mi of the Project area.
Calamagrostis bolanderi (Bolander's reed grass)	perennial rhizomatous herb	None/None/4.2	Mesic bogs and fens, broadleafed upland forest, closed-cone coniferous forest, coastal scrub, mesic meadows and seeps, freshwater marshes and swamps, and north coast coniferous forest; 0–1,495 ft. Blooming period: May–August	CNPS	**Low:** Broadleafed upland forest habitat present within Project area. No occurrences within 10 mi of the Project.
Calamagrostis foliosa (leafy reed grass)	perennial herb	None/CR/4.2	Rocky coastal bluff scrub and north coast coniferous forest; 0–4,005 ft. Blooming period: May–September	CNPS, CDFW	**None:** No suitable habitat present within the Project area.
Castilleja litoralis (Oregon coast paintbrush)	perennial herb (hemiparasitic)	None/None/2B.2	Sandy coastal bluff scrub, coastal dunes, and coastal scrub; 45–330 ft. Blooming period: June	CNPS, CDFW	**None**: Project area is outside of the known elevation range.
Castilleja mendocinensis (Mendocino Coast paintbrush)	perennial herb (hemiparasitic)	None/None/1B.2	Coastal bluff scrub, closed-cone coniferous forest, coastal dunes, coastal prairie, and coastal scrub; 0–525 ft. Blooming period: April–August	CNPS, CDFW	**None**: Project area is outside of the known elevation range.
Ceanothus gloriosus var. *exaltatus* (glory brush)	perennial evergreen shrub	None/None/4.3	Chaparral; 95–2,000 ft. Blooming period: March–June (August)	CNPS	**Low:** Chaparral habitat present within Project area. No occurrences within 10 mi of the Project.
Clarkia amoena subsp. *whitneyi* (Whitney's farewell-to-spring)	annual herb	None/None/1B.1	Coastal bluff scrub and coastal scrub; 30–330 ft. Blooming period: June–August	CNPS, CDFW	**None**: Project area is outside of the known elevation range.

Scientific name (common name)	Lifeform	Status (Federal, State, CRPR[1])	Habitat associations and blooming period[2]	Source	Likelihood of occurrence
Coptis laciniata (Oregon goldthread)	perennial rhizomatous herb	None/None/4.2	Mesic meadows and seeps and streambanks in north coast coniferous forest; 0–3,280 ft. Blooming period: (February) March–May (September–November)	CNPS, CDFW	**Moderate:** North coast coniferous forest habitat present within Project area. Two occurrences within 5–10 mi of the Project area.
Epilobium septentrionale (Humboldt County fuchsia)	perennial herb	None/None/4.3	Sandy or rocky areas in broadleafed upland forest and north coast coniferous forest; 145–5,905 ft. Blooming period: July–September	CNPS	**None:** No suitable habitat present within the Project area.
Erigeron biolettii (streamside daisy)	perennial herb	None/None/3	Rocky, mesic areas in broadleafed upland forest, cismontane woodland, and north coast coniferous forest; 95–3,610 ft. Blooming period: June–October	CNPS	**None:** No suitable habitat present within the Project area.
Erythronium oregonum (giant fawn lily)	perennial herb	None/None/2B.2	Sometimes serpentinite, rocky, openings in cismontane woodland and meadows and seeps; 325–3,775 ft. Blooming period: March–June (July)	CNPS, CDFW	**Moderate:** Cismontane woodland habitat present within Project area. No ultramafic soils mapped or observed in Project area. One occurrence is within 5–10 mi of the Project area.
Erythronium revolutum (coast fawn lily)	perennial bulbiferous herb	None/None/2B.2	Mesic, streambanks, bogs and fens, broadleafed upland forest, and north coast coniferous forest; 0–5,250 ft. Blooming period: March–July (August)	CNPS, CDFW	**Moderate:** Broadleafed upland and north coast coniferous forest habitats present within Project area. Two occurrences within 5–10 mi of the Project area.
Gilia capitata subsp. *pacifica* (Pacific gilia)	annual herb	None/None/1B.2	Coastal bluff scrub, openings in chaparral, coastal prairie, and valley and foothill grassland; 15–5,465 ft. Blooming period: April–August	CNPS, CDFW	**Moderate:** Chaparral and valley and foothill grassland habitats present within Project area. Multiple occurrences within 5–10 mi of the Project area.
Kopsiopsis hookeri (small groundcone)	perennial rhizomatous herb (parasitic)	None/None/2B.3	North coast coniferous forest; 295–2,905 ft. Blooming period: April–August	CNPS, CDFW	**Low:** North coast coniferous forest habitat present within Project area. No occurrences within 10 mi of the Project.

Scientific name (common name)	Lifeform	Status (Federal, State, CRPR[1])	Habitat associations and blooming period[2]	Source	Likelihood of occurrence
Lasthenia burkei (Burke's goldfields)	annual herb	FE/CE/1B.1	Mesic meadows and seeps and vernal pools; 45–1,970 ft. Blooming period: April–June	USFWS	**None:** No suitable habitat present within the Project area.
Lasthenia californica subsp. *macrantha* (perennial goldfields)	perennial herb	None/None/1B.2	Coastal bluff scrub, coastal dunes, and coastal scrub; 15–1,705 ft. Blooming period: January–November	CNPS, CDFW	**None:** No suitable habitat present within the Project area.
Lasthenia conjugens (Contra Costa goldfields)	annual herb	FE/None/1B.1	Mesic cismontane woodland, alkaline playas, valley and foothill grassland, and vernal pools; 0–1,540 ft. Blooming period: March–June	USFWS	**Low:** Cismontane woodland habitat present within Project area. No occurrences within 10 mi of the Project.
Lathyrus palustris (marsh pea)	perennial herb	None/None/2B.2	Mesic bogs and fens, coastal prairie, coastal scrub, lower montane coniferous forest, marshes and swamps, and north coast coniferous forest; 0–330 ft. Blooming period: March–August	CNPS, CDFW	**None**: Project area is outside of the known elevation range.
Lilium rubescens (redwood lily)	perennial bulbiferous herb	None/None/4.2	Sometimes serpentinite, sometimes roadsides, broadleafed upland forest, chaparral, lower montane coniferous forest, north coast coniferous forest, and upper montane coniferous forest; 95–6,265 ft. Blooming period: April–August (September)	CNPS	**Low:** Broadleafed upland forest, lower montane coniferous forest, chaparral, and north coast coniferous forest habitats present within Project area. No ultramafic soils mapped or observed in Project area. No occurrences within 10 mi of the Project.
Listera cordata (heart-leaved twayblade)	perennial herb	None/None/4.2	Bogs and fens, lower montane coniferous forest, and north coast coniferous forest; 15–4,495 ft. Blooming period: February–July	CNPS	**Low:** North coast coniferous and lower montane coniferous forest habitats present within Project area. No occurrences within 10 mi of the Project.
Micranthes marshallii (Marshall's saxifrage)	perennial rhizomatous herb	None/None/4.3	Rocky streambanks and riparian forest; 295–6,990 ft. Blooming period: March–August	CNPS	**Low:** Riparian forest habitat present within Project area. No occurrences within 10 mi of the Project.

Scientific name (common name)	Lifeform	Status (Federal, State, CRPR[1])	Habitat associations and blooming period[2]	Source	Likelihood of occurrence
Mitellastra caulescens (leafy-stemmed mitrewort)	perennial rhizomatous herb	None/None/4.2	Mesic, sometimes roadsides broadleafed upland forest, lower montane coniferous forest, meadows and seeps, and north coast coniferous forest; 15–5,575 ft. Blooming period: (March) April–October	CNPS, CDFW	**Low:** Broadleafed upland, lower montane coniferous, and north coast coniferous forest habitats present within Project area. No occurrences within 10 mi of the Project.
Montia howellii (Howell's montia)	annual herb	None/None/2B.2	Vernally mesic, sometimes roadsides in meadows and seeps, north coast coniferous forest, and vernal pools; 0–2,740 ft. Blooming period: (February) March–May	CNPS, CDFW	**Moderate:** North coast coniferous forest habitat present within Project area. Two occurrences within 5–10 mi of the Project area.
Piperia candida (white-flowered rein orchid)	perennial herb	None/None/1B.2	Sometimes serpentinite in broadleafed upland forest, lower montane coniferous forest, and north coast coniferous forest; 95–4,300 ft. Blooming period: (March) May–September	CNPS, CDFW	**Moderate:** Broadleafed upland, lower montane coniferous, and north coast coniferous forest habitats present within Project area. No ultramafic soils mapped or observed in Project area. Multiple occurrences within 1 mi of the Project area.
Pityopus californicus (California pinefoot)	perennial herb (achlorophyllous)	None/None/4.2	Mesic broadleafed upland forest, lower montane coniferous forest, north coast coniferous forest, and upper montane coniferous forest; 45–7,300 ft. Blooming period: (March–April) May–August	CNPS	**Low:** Broadleafed upland, lower montane coniferous, and north coast coniferous forest habitats present within Project area. No occurrences within 10 mi of the Project.
Sidalcea malachroides (maple-leaved checkerbloom)	perennial herb	None/None/4.2	Often in disturbed areas in broadleafed upland forest, coastal prairie, coastal scrub, north coast coniferous forest, and riparian woodland; 0–2,395 ft. Blooming period: (March) April–August	CNPS, CDFW	**Low:** Broadleafed upland forest, riparian woodland, and north coast coniferous forest habitats present within Project area. No occurrences within 10 mi of the Project.

Scientific name (common name)	Lifeform	Status (Federal, State, CRPR[1])	Habitat associations and blooming period[2]	Source	Likelihood of occurrence
Trifolium amoenum (two-fork clover)	annual herb	FE/None/1B.1	Coastal bluff scrub and sometimes serpentinite in valley and foothill grassland; 15–1,360 ft. Blooming period: April–June	USFWS	**Low:** Valley and foothill grassland habitat present within Project area. No ultramafic soils mapped or observed in Project area. No occurrences within 10 mi of the Project.
Usnea longissima (Methuselah's beard lichen)	fruticose lichen (epiphytic)	None/None/4.2	On tree branches, usually on old growth hardwoods and conifers in broadleafed upland forest and north coast coniferous forest; 160–4,790 ft. Blooming period: N/A (lichen)	CNPS, CDFW	**Moderate:** Broadleafed upland and north coast coniferous forest habitats present within Project area. Multiple occurrences within 5–10 mi of the Project area.

[1] Status:

Federal:		**State:**	
FE	Federally endangered	CE	California endangered
		CR	California rare

California Rare Plant Rank (CRPR):

1B	Plants rare, threatened, or endangered in California and elsewhere
2B	Plants rare, threatened, or endangered in California, but more common elsewhere
4	Plants of limited distribution, on watchlist

CRPR Threat Ranks:

0.1	Seriously threatened in California (over 80% of occurrences threatened / high degree and immediacy of threat)
0.2	Moderately threatened in California (20–80% occurrences threatened / moderate degree and immediacy of threat)
0.3	Not very threatened in California (less than 20% of occurrences threatened / low degree and immediacy of threat or no current threats known)

[2] Months in parentheses are uncommon; N/A = Not applicable

Table A-2. Comprehensive scoping list of special-status fish and wildlife in the Project vicinity.

Scientific name (common name)	Status[1] (Federal/ State)	Distribution and habitat associations	Location of suitable habitat	Likelihood of occurrence in the Project area
Fish				
Oncorhynchus kisutch (coho salmon - southern Oregon / northern California ESU)	FT, CH/ST	Oregon border to Punta Gorda, California. Spawn in coastal streams and large mainstem rivers in riffles and pool tails-outs and rear in pools >3 ft deep with overhead cover with high levels oxygen and temperatures of 50–59°F.	Suitable habitat occurs in the South Fork Eel River and associated tributaries.	**High**: Present in the Project area.
Oncorhynchus kisutch (coho salmon -Central California Coast ESU)	FE, CH/SE	Punta Gorda, California south to Aptos Creek in Santa Cruz County. Spawn in coastal streams and large mainstem rivers in riffles and pool tails-outs and rear in pools >3 ft deep with overhead cover with high levels oxygen and temperatures of 50–59°F.	Suitable habitat is present in the South Fork Eel River but is unlikely to be occupied since the species range ends at Punta Gorda.	**None:** Outside of species range.
Oncorhynchus mykiss (steelhead trout – Northern California DPS)	FT, CH/None	Inhabits small coastal streams to large mainstem rivers with gravel-bottomed, fast-flowing habitat for spawning. However, habitat criteria for different life stages (spawning, fry rearing, juvenile rearing) are can vary significantly.	Suitable habitat occurs in the South Fork Eel River and associated tributaries.	**High**: Present in the Project area.
Oncorhynchus tshawytscha (Chinook salmon – California Coastal ESU*)*	FT, CH/None	Wild coastal, spring, and fall-run Chinook found in streams and rivers between Redwood Creek, Humboldt County to the north and the Russian River, Sonoma County to the south.	Suitable habitat occurs in the South Fork Eel River and associated tributaries.	**High**: Present in the Project area.

Scientific name (common name)	**Status^1 (Federal/ State)**	**Distribution and habitat associations**	**Location of suitable habitat**	**Likelihood of occurrence in the Project area**
Entosphenus tridentatus (Pacific lamprey)	None/SSC	Similar to anadromous salmonids, inhabits coastal streams and rivers with gravel-bottomed, fast-flowing habitat for spawning. Ammocoetes rear in backwater areas with sand, silt, and organic material for 4 to 10 years before migrating to the ocean.	Suitable habitat is present and spawning/rearing occurs in the South Fork Eel River. Spawning and rearing habitat is likely to occur in Redwood Creek.	**High:** Suitable habitat present.
Eucyclogobius newberryi (Tidewater goby)	FE/SSC	Tillas Slough (mouth of the Smith River, Del Norte County) to Agua Hedionda Lagoon (northern San Diego County)	Coastal lagoons and the uppermost zone of brackish large estuaries; prefer sandy substrate for spawning, but can be found on silt and rocky mud substrates; can occur in water up to 4 m (15 ft) in lagoons and within a wide range of salinity (0–42 parts per thousand)	**None:** Habitat not suitable
Amphibians				
Ascaphus truei (Pacific tailed frog)	None/SSC	Associated with high-gradient, perennial and montane streams in hardwood conifer, redwood, Douglas-fir, and ponderosa pine habitats. Tadpoles require water temperatures below 59°F.	Suitable habitat may occur in high gradient watercourses adjacent to the Project area, but not within the Project area.	**Low:** No habitat present.
Rana boylii (foothill yellow-legged frog)	None/ SSC, SCT	Associated with partially shaded, shallow streams, and riffles with rocky substrate. Some cobble-sized substrate required for egg laying.	Suitable habitat occurs in the South Fork Eel River and associated tributaries.	**High**: Likely to be present in Redwood Creek and tributaries adjacent to the Project area.
Rhyacotriton variegatus (southern torrent salamander)	None/SSC	Coastal redwood, Douglas-fir, mixed conifer, montane riparian and montane hardwood-conifer habitats. Seeps and small streams in coastal redwood, Douglas-fir, mixed conifer, montane riparian, and montane hardwood-conifer habitats. Seeps and springs need to be relatively unembedded with fine sediment.	Suitable habitat occurs in high-gradient gravelly seeps and springs within redwood and montane riparian habitat types adjacent to, but not within the Project area.	**Low**: High-gradient seeps are not present in the Project area.

Scientific name (common name)	Status[1] (Federal/ State)	Distribution and habitat associations	Location of suitable habitat	Likelihood of occurrence in the Project area
Taricha rivularis (red-bellied newt)	None/SSC	Ranges from southern Humboldt to Sonoma counties. Found in streams during breeding season. Moist habitats under woody debris, rocks, and animal burrows.	Suitable habitat is present and sightings have occurred in the Mattole River, approximately 5 mi west of the Project area.	**High**: Habitat present in the Project area.
Birds				
Brachyramphus marmoratus (marbled murrelet)	FT,CH/SE	Associated with mature conifers (i.e., redwood and Douglas-fir) for nesting. During the breeding season, may be present 6–8 mi inland.	No suitable habitat within or adjacent to the Project area.	**None**: No suitable habitat
Strix occidentalis caurina (Northern spotted owl)	FE/ST	Typically found in large, contiguous stands of mature and old-growth coniferous forest with dense multi-layered structure.	Suitable foraging habitat is present within the Project area. Habitat within the Project area is unsuitable for nesting. The closest activity center is over 1.7 mi to the south-southeast of the Project area.	**Moderate**: Suitable foraging habitat exists in the Project area.
Asio otus (Long-eared owl)	None/SSC	Distributed throughout North America. Recorded in north coast from Bald Hills, Humboldt County to Willits, Mendocino County. In Humboldt County, the owls apparently nest in mixed stands of conifers and oaks with edges and openings such as meadows or prairies.	Suitable nesting and foraging habitat present in the Project area.	**High**: Habitat present in the Project area.

Scientific name (common name)	Status[1] (Federal/ State)	Distribution and habitat associations	Location of suitable habitat	Likelihood of occurrence in the Project area
Haliaeetus leucocephalus (Bald eagle)	None/SE	Distributed throughout North America. Found at lakes, reservoirs, rivers, and some rangelands and coastal wetlands. Build large stick nests in the upper canopy of the largest trees in the area.	Suitable foraging habitat is present in the South Fork Eel River. Redwood Creek is unsuitable for foraging.	**Low.** No habitat present.
Empidonax traillii brewsteri (Little willow flycatcher)	None/SE	Typically breeds in wet meadows and montane riparian habitats (with a significant shrub component within or near a taller overstory) from 2,000-8,000 ft in elevation from Tulare County north, along the western side of the Sierra Nevada and Cascades. Common spring (mid-May to early June) and particularly fall (mid-August to early September) migrant in riparian habitats at lower elevations, including the north coast of California.	The nearest recorded sighting of this species was along the South Fork Eel River near Miranda in June 2000. Multi-storied riparian forest or woodland (e.g., alder, cottonwood, willow) habitat is not present in the Project area.	**Low**: Suitable habitat not present.
Charadrius alexandrinus nivosus (Western snowy plover)	FT/None	Nests on barren to sparsely vegetated dune-backed beaches, barrier beaches, and salt-evaporation ponds, infrequently on bluff-backed beaches.	No ocean beaches or open large gravel bars are located within or adjacent to the Project area	**None**: No suitable habitat
Phoebastria (Diomedea) albatrus (Short-tailed Albatross)	FE/None	Pacific Ocean (nests in Japan)	Feeds in north Pacific Ocean.	**None**: Habitat not suitable

Scientific name (common name)	Status[1] (Federal/ State)	Distribution and habitat associations	Location of suitable habitat	Likelihood of occurrence in the Project area
Coccyzus americanus (Yellow-billed Cuckoo)	FT/SE	Breeds in limited portions of the Sacramento River and the South Fork Kern River; small populations may nest in Butte, Yuba, Sutter, San Bernardino, Riverside, Inyo, Los Angeles, and Imperial counties	Summer resident of valley foothill and desert riparian habitats; nests in open woodland with clearings and low, dense, scrubby vegetation. The nearest recorded sighting of this species was in the Eel River delta area.	**None**: Habitat not suitable
Reptiles				
Emys marmorata (Western pond turtle)	None/SSC	Ponds, marshes, rivers, streams, and irrigation ditches with abundant vegetation, and either rocky or muddy bottoms, in woodland forest and grasslands. Below 6,000 ft elevation. Basking sites are required. Egg-laying sites are located on suitable upland habitats (grassy open fields) up to 1,640 ft from water.	Suitable habitat occurs in the South Fork Eel River. Ponds that may contain western pond turtles are located on neighboring properties.	**Moderate**. May occur in neighboring ponds.
Mammals				
Arborimus pomo (Sonoma tree vole)	None/SSC	Associated nearly exclusively with Douglas-fir trees and occasionally grand fir trees within the north coast fog belt between the northern Oregon border and Sonoma County. Eats Douglas-fir needles exclusively.	Small patches of Douglas-fir are present within the Project area.	**High**: Recorded occupying timber stands adjacent to the Project area
Pekania pennanti (Pacific fisher – West Coast DPS/Northern California ESU)	FC/SSC	Associated with dense advanced-successional conifer forests, with complex forest structure and high percent canopy closure; den in hollow trees and snags.	Habitat in most of the Project area does not correspond to the dense advanced-successional forest this species prefers. Nearest recorded sighting is approximately 10 mi to the southeast near Cooks Valley.	**Low**. Suitable habitat not present.
Corynorhinus townsendii (Townsend's big-eared bat)	None/SSC, CT	Found throughout California in all but subalpine and alpine habitats. Roosts in cavernous habitats, usually in tunnels,	Suitable foraging habitat throughout most of the Project area; however, barns, old buildings, and bridges for	**Moderate**: May be present in some of the barns and older structures

Scientific name (common name)	Status[1] (Federal/ State)	Distribution and habitat associations	Location of suitable habitat	Likelihood of occurrence in the Project area
		caves, buildings, mines, and basal hollows of trees, but also rock shelters, preferentially close to water. Caves near water's edge are favored. Forages in riparian zone and follows creeks and river drainages on foraging bouts. Feeds primarily on moths. Drinks at stream pools.	roosting are not present within the Project area.	adjacent to the Project area.
Antrozous pallidus (Pallid bat)	None/SSC	Found throughout California. Roosts in rock crevices, outcrops, cliffs, mines, and caves; trees (underneath exfoliating bark of pine and oak) and in basal hollows; and a variety of vacant and occupied structures (e.g., bridges) or buildings. Roost individually or in small to large colonies (hundreds of individuals). Feeds low to or on the ground in a variety of open habitats, primarily on ground-dwelling arthropods. Forages most frequently in riparian zone, in open oak savannah, and open mixed deciduous forest. Drinks at stream pools.	Suitable foraging habitat throughout most of the Survey Area, however barns, old building, and bridges are not present within the Survey Area.	**Moderate**: May be present in some of the older structures adjacent to the Survey Area

[1] Status:

Federal

FE	Federal endangered
FT	Federal threatened
FCT	Federal candidate threatened
CH	Critical habitat designated within the Project vicinity

State

SE	Endangered
ST	Threatened
SCT	State candidate threatened
SSC	CDFW species of special concern

Appendix B

List of Plant Species Observed in the Project Area

Table B-1. Plant species observed during the May 3, 2019 botanical survey.

Scientific name (common name)	**Family**	**Native status**	**Cal-IPC rating**	**WMVC wetland indicator status[1]**
Acer macrophyllum (big-leaf maple)	Sapindaceae	native	None	FACU
Acmispon americanus var. *americanus* (American bird's-foot-trefoil)	Fabaceae	native	None	FACU
Aira caryophyllea (silver hair grass)	Poaceae	naturalized	None	FACU
Anthoxanthum odoratum (sweet vernal grass)	Poaceae	naturalized	Limited	FACU
Arbutus menziesii (Pacific madrone)	Ericaceae	native	None	Not Listed—UPL
Arctostaphylos glandulosa subsp. *glandulosa* (glandular manzanita)	Ericaceae	native	None	Not Listed—UPL
Avena barbata (slender wild oat)	Poaceae	naturalized	Moderate	Not Listed—UPL
Baccharis pilularis (coyote brush)	Asteraceae	native	None	Not Listed—UPL
Bellis perennis (English daisy)	Asteraceae	naturalized	None	Not Listed—UPL
Briza maxima (rattlesnake grass)	Poaceae	naturalized	Limited	Not Listed—UPL
Bromus carinatus (California brome)	Poaceae	native	None	Not Listed—UPL
Bromus diandrus (ripgut grass)	Poaceae	naturalized	Moderate	Not Listed—UPL
Bromus hordeaceus (soft chess)	Poaceae	naturalized	Limited	FACU
Callitriche heterophylla (variable-leaved water starwort)	Plantaginaceae	native	None	OBL
Calocedrus decurrens (California incense-cedar)	Cupressaceae	native	None	Not Listed—UPL
Carduus pycnocephalus subsp. *pycnocephalus* (Italian thistle)	Asteraceae	naturalized	Moderate	Not Listed—UPL
Carex praegracilis (freeway sedge)	Cyperaceae	native	None	FACW
Ceanothus incanus (coast whitethorn)	Rhamnaceae	native	None	Not Listed—UPL

Scientific name (common name)	**Family**	**Native status**	**Cal-IPC rating**	**WMVC wetland indicator status[1]**
Cerastium glomeratum (sticky mouse-ear chickweed)	Caryophyllaceae	naturalized	None	FACU
Cirsium vulgare (bull thistle)	Asteraceae	naturalized	Moderate	FACU
Clinopodium douglasii (yerba buena)	Lamiaceae	native	None	FACU
Clintonia andrewsiana (Andrews's clintonia)	Liliaceae	native	None	Not Listed—UPL
Corylus cornuta subsp. *californica* (California hazel)	Betulaceae	native	None	FACU
Cynosurus echinatus (bristly dogtail grass)	Poaceae	naturalized	Moderate	Not Listed—UPL
Cytisus scoparius (Scotch broom)	Fabaceae	naturalized	High	Not Listed—UPL
Dactylis glomerata (orchard grass)	Poaceae	naturalized	Limited	FACU
Danthonia californica (California oat grass)	Poaceae	native	None	FAC
Daucus carota (Queen Anne's lace)	Apiaceae	naturalized	None	FACU
Elymus glaucus subsp. *glaucus* (glaucous wild rye)	Poaceae	native	None	FACU
Epilobium ciliatum (ciliate willowherb)	Onagraceae	native	None	FACW
Erodium botrys (long-beaked filaree)	Geraniaceae	naturalized	None	FACU
Eschscholzia californica (California poppy)	Papaveraceae	native	None	Not Listed—UPL
Festuca bromoides (brome fescue)	Poaceae	naturalized	None	FAC
Fragaria vesca (wood strawberry)	Rosaceae	native	None	FACU
Fraxinus latifolia (Oregon ash)	Oleaceae	native	None	FACW
Galium aparine (goose grass)	Rubiaceae	native	None	FACU
Geranium dissectum (dissected geranium)	Geraniaceae	naturalized	Limited	Not Listed—UPL
Glyceria ×occidentalis (western manna grass)	Poaceae	naturalized	None	Not Listed—UPL

Scientific name (common name)	**Family**	**Native status**	**Cal-IPC rating**	**WMVC wetland indicator status[1]**
Hypericum perforatum subsp. *perforatum* (klamathweed)	Hypericaceae	naturalized	Limited	Not Listed—UPL
Hypochaeris radicata (rough cat's-ear)	Asteraceae	naturalized	Moderate	FACU
Iris purdyi (Purdy's iris)	Iridaceae	native	None	Not Listed—UPL
Juncus bufonius var. *bufonius* (common toad rush)	Juncaceae	native	None	Not Listed—UPL
Juncus patens (spreading rush)	Juncaceae	native	None	FACW
Leontodon saxatilis (hairy hawkbit)	Asteraceae	naturalized	None	FACU
Leptosiphon bicolor (bicolored leptosiphon)	Polemoniaceae	native	None	FACU
Linum bienne (pale flax)	Linaceae	naturalized	None	Not Listed—UPL
Lonicera hispidula (hispid honeysuckle)	Caprifoliaceae	native	None	FACU
Lupinus bicolor (miniature lupine)	Fabaceae	native	None	Not Listed—UPL
Luzula comosa var. *comosa* (Pacific wood-rush)	Juncaceae	native	None	Not Listed—UPL
Lysimachia arvensis (scarlet pimpernel)	Myrsinaceae	naturalized	None	Not Listed—UPL
Lythrum hyssopifolia (hyssop-leaved lythrum)	Lythraceae	naturalized	Moderate	Not Listed—UPL
Mentha pulegium (pennyroyal)	Lamiaceae	naturalized	Moderate	OBL
Myosotis discolor (changing forget-me-not)	Boraginaceae	naturalized	None	FAC
Oxalis oregana (redwood sorrel)	Oxalidaceae	native	None	FACU
Plantago lanceolata (English plantain)	Plantaginaceae	naturalized	Limited	FACU
Plectritis congesta subsp. *congesta* (sea blush)	Valerianaceae	native	None	FACU
Poa pratensis subsp. *pratensis* (Kentucky blue grass)	Poaceae	naturalized	Limited	FAC

Scientific name (common name)	**Family**	**Native status**	**Cal-IPC rating**	**WMVC wetland indicator status[1]**
Polystichum munitum (western sword fern)	Dryopteridaceae	native	None	FACU
Prunella vulgaris (common selfheal)	Lamiaceae	native	None	FACU
Prunus sp. (domestic prunus)	Rosaceae		None	Not Listed—UPL
Pseudotsuga menziesii var. *menziesii* (Douglas-fir)	Pinaceae	native	None	FACU
Pteridium aquilinum var. *pubescens* (western bracken fern)	Dennstaedtiaceae	native	None	FACU
Quercus garryana (Oregon oak)	Fagaceae	native	None	FACU
Quercus kelloggii (California black oak)	Fagaceae	native	None	Not Listed—UPL
Quercus wislizeni (interior live oak)	Fagaceae	native	None	Not Listed—UPL
Ranunculus parviflorus (few-flowered buttercup)	Ranunculaceae	naturalized	None	FACU
Rosa nutkana subsp. *nutkana* (Nootka rose)	Rosaceae	native	None	FAC
Rubus armeniacus (Himalayan blackberry)	Rosaceae	naturalized	High	FAC
Rubus laciniatus (cutleaf blackberry)	Rosaceae	naturalized	None	FACU
Rubus parviflorus (thimbleberry)	Rosaceae	native	None	FACU
Rumex acetosella (sheep sorrel)	Polygonaceae	naturalized	Moderate	FACU
Rumex crispus (curly dock)	Polygonaceae	naturalized	Limited	FAC
Salix sitchensis (Sitka willow)	Salicaceae	native	None	FACW
Sanicula crassicaulis (Pacific sanicula)	Apiaceae	native	None	Not Listed—UPL
Scirpus microcarpus (small-fruited bulrush)	Cyperaceae	native	None	OBL
Scoliopus bigelovii (California fetid adder's-tongue)	Liliaceae	native	None	Not Listed—UPL

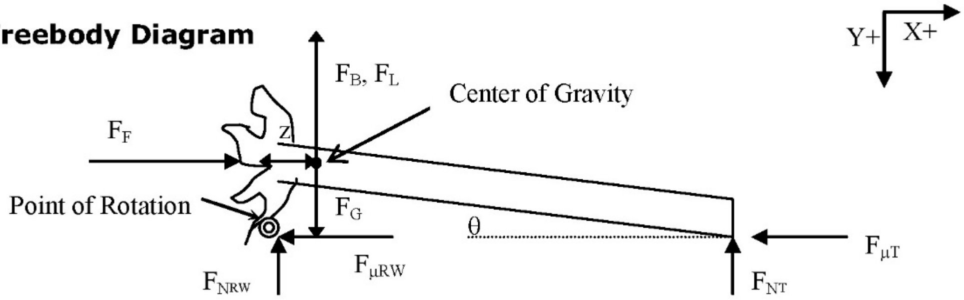
Scientific name (common name)	Family	Native status	Cal-IPC rating	WMVC wetland indicator status[1]
Stachys sp. (hedge-nettle)	Lamiaceae		None	Not Listed—UPL
Toxicodendron diversilobum (western poison oak)	Anacardiaceae	native	None	FAC
Trifolium dubium (little hop clover)	Fabaceae	naturalized	None	FACU
Trifolium subterraneum (subterranean clover)	Fabaceae	naturalized	None	Not Listed—UPL
Umbellularia californica (California bay-laurel)	Lauraceae	native	None	FAC
Vaccinium ovatum (California huckleberry)	Ericaceae	native	None	FACU
Veronica sp. (speedwell)	Plantaginaceae		None	Not Listed—UPL
Vicia americana subsp. *americana* (American vetch)	Fabaceae	native	None	FAC
Vicia hassei (slender vetch)	Fabaceae	native	None	Not Listed—UPL
Viola ocellata (western heart's ease)	Violaceae	native	None	Not Listed—UPL
Whipplea modesta (modest whipplea)	Hydrangeaceae	native	None	Not Listed—UPL

[1] Wetland indicator status (Lichvar et al. 2012 and 2016):
OBL (Obligate Wetland Plants)—Almost always occur in wetlands.
FACW (Facultative Wetland Plants)—Usually occur in wetlands, but may occur in non-wetlands.
FAC (Facultative Wetland Plants)—Occur in wetlands and non-wetlands.
FACU (Facultative Upland Plants)—Usually occur in non-wetlands, but may occur in wetlands.
UPL (Upland Plants)—Almost never occur in wetlands
Not Listed – UPL (Upland Plants)—Plant species not listed in the *2016 National Wetland Plant List* were considered upland (UPL) species.

Appendix G

Wood Stability Analyses

Figure 1: Freebody Diagram



Required Calculations

Force Balance / Momentum

$\Sigma Fy = 0$, $F_F (\sin \theta) + F_G = F_B + F_L + F_{NT} + F_{NRW}$

$\Sigma Fx = 0$, $F_F (\cos \theta) = F_{\mu RW} + F_{\mu T}$

$\Sigma Mo = 0$, $F_{NT} (L_T \cos\theta + z) + F_B z + F_L z = (F_G + B_R)z + F_F (2/3 \, d_w)$

Geometric Calculations and Forces

$\mu_{BED} = \tan \phi$

$\theta = \tan^{-1} ((½D_{RW})/(L_T))$

$z = (½ D_{RW}) \sin \theta$

$\forall_{RW} = (\pi (D_{RW})^2)/4) L_{RW} (1-\eta_P)$

$\forall_T = (\pi (D_T/2)^2) L_T$

$\forall_{Tsub} = (d_w/\sin\theta)(\pi r^2)$

$A_{Rwsub} = (A_{RW})(P_{sub})$

$\forall_{Rwsub} = A_{RWsub} L_{RW}$

$F_G = (\forall_T + \forall_{RW}) \rho_T$

$F_B = (\forall_{Tsub} + \forall_{RWsub}) \rho_w$

STOP, CHECK FS_B

$F_F = (v^2/2g) A_{RWsub} \rho_w C_D$

$F_L = (v^2/2g) (\forall_T + \forall_{RW}) \rho_w C_L$

$FS_B = F_G/F_B$

If $FS_B < 1.5$, add required ballast (B_R) to obtain $FS_B = 1.5$ before continuing calculations

$FS_B = (F_G + B_R)/F_B$

$B_R = ((FS_B)(F_B)) - F_G$

Sum of Moments and Factors of Safety

1. ΣFy, $F_F (\sin \theta) + (F_G + B_R) = F_B + F_L + F_{NT} + F_{NRW}$
2. ΣMo, $F_{NT} (L_T \cos\theta + z) + F_B z + F_L z = (F_G + B_R) z + F_F (2/3 \, d_w)$

Solve Equation 2. for F_{NT}, substitute into Equation 1. Solve for F_{NRW}

3. $F_{\mu T} = F_{NT} \mu_{BED}$ 4. $F_{\mu RW} = F_{NRW} \mu_{BED}$

$FS_M = (F_{\mu T} + F_{\mu RW}) / (F_F (\cos \theta))$

$FS_B = ((F_G + B_R) + F_F (\sin \theta)) / (F_B + F_L)$

Notation and Constants

F_B = force due to buoyancy

F_G = force due to gravity

F_F = force due to flow

F_μ = force due to friction between LW and bed

F_L = force due to lift

F_N = force normal to LW at the tip and the rootwad

Subscripts T and RW refer to the tree and rootwad respectively

ρ_T = density of the tree — See Table 2

ρ_W = density of water = 62.4 $\#/ft^3$

S_g = Specific Gravity

Water = 1.0

Rock (average for quartz) = 2.65

g = acceleration due to gravity = 32.2 ft/s^2

B_R = ballast required (submerged weight) = #

v = velocity of flowing water = ft/s

d_w = depth of water = ft

η_P = porosity

θ = angle from rootwad face to vertical = degrees

ϕ = internal angle of friction for bed material (*See Table 1*) = degrees

μ_{BED} = coefficient of friction for bed material

z = distance in the x direction from the center of gravity to the point of interest = ft

L_T = length of the tree = ft

D_T = diameter of the tree = ft

L_{RW} = thickness of the rootwad = ft

D_{RW} = diameter of the rootwad = ft

$\forall$ = volume = ft^3

A = area = ft^2

P_{sub} = proportion submerged (from Figure 2)

Subscripts T, RW, and BD refer to tree, rootwad, and boulder respectively. *Subscript SUB refers to the submerged values.*

C_D = coefficient of fluid drag

C_{DT} = 0.3

C_{DRW} = 1.2

C_{DBD} = 0.2

C_L = coefficient of lift for large roughness element = 0.18

FS_B = factor of safety – buoyancy

FS_M = factor of safety -- momentum

C_D and C_L values derived from: D'Aoust and Millar, 1999

Appendix H

Seismic Slope Stability Analyses

Stillwater Sciences

850 G Street, Suite K, Arcata, CA 95521
phone 707.822.9607 fax 707.822.9607

TECHNICAL MEMORANDUM

DATE:	September 30, 2020
TO:	Salmonid Restoration Federation
FROM:	Joel Monschke PE, Dylan Caldwell PG, Jay Stallman PG, Chris Lyle
SUBJECT:	Draft Marshall Slope Stability Analysis

Slope stability is a potential geologic hazard at the project site. Due to the diverse geology and topography in the region, slope stability at a particular site is highly variable and dependent on specific site conditions. Stillwater Sciences evaluated potential slope stability hazards across the pond embankment footprint on the upper terrace as well as the hillslopes of the terrace riser that descend toward Redwood Creek. Quantitative slope stability analyses were conducted to evaluate the stability of the site under existing and proposed project conditions, for both static and dynamic (i.e., with seismic loading) conditions. The analyses were conducted in *Slide2 2018* slope stability analysis software which assesses the stability of a slope by comparing the forces resisting failure to the forces driving failure. The ratio of the two forces is defined as a "factor of safety" and is reported as an F value. In a stable slope, the forces resisting failure exceed the driving forces and the resultant F value is greater than 1.0. When the two forces are equal or when driving forces exceed resisting forces, F is less than or equal to 1.0 and slope displacement is likely to occur under that loading condition. The higher the F value is above 1.0, the greater the likelihood that the slope is stable.

Therefore, when conducting slope stability analyses it is important to look at both the factor of safety and the ground displacement that is expected to occur during a loading scenario – if the factor of safety is less than or equal to 1.0.

Most sloping topography will incur minor displacement in a large earthquake event. Therefore, for seismic loading conditions, a determination of the ability of the design structure to withstand the resulting displacement is more relevant for assessing stability and risk as opposed to looking at the factor of safety alone.

This slope stability analysis utilizes geometry obtained from LiDAR and supplemented with field-based total station topographic survey data collected by Stillwater in 2018. Site stratigraphy was based on the subsurface boreholes and test pits excavated during SHN's geotechnical investigation and onsite observations made by Stillwater geologists. Soil and bedrock parameters are based on 1) laboratory results from material testing of subsurface samples collected by SHN,

2) published values (Hunt 2005[1] and NavFac DM-7.2[2]), and 3) professional judgement. Soil parameters are summarized in Table 1 and Table 2.

Stability was analyzed along two slope cross sections. The locations of these cross sections are shown on the plan view of the 90% Design Plans and labeled as the "NE Slope Stability Cross Section" and "NW Slope Stability Cross Section" respectively. Earlier iterations of this slope stability analyses focused on the steeper portions of the slope significantly down-gradient from the proposed pond berm. However, through analyses of those results and consultation with SHN staff (geotechnical consultant) it was determined that the pond berm was set back a sufficient distance from the steeper slopes such that any anticipated shallow instability along those slopes would not affect pond berm stability. Therefore, this analysis focuses specifically on potential failure planes that intersect the pond berm.

Table 1. Soil and bedrock parameters for northwest (NW) section

Material	Dry unit weight (lb/ft^3)	Saturated unit weight (lb/ft^3)	Cohesion* (lb/ft^2)	Internal angle of friction, phi (degrees)
Engineered/compacted native fill – sandy silt (ML)	120	130	1600 and 800	32
Gravelly silt w/ sand (ML)	99	105	190	32
Sandy silt (ML)	100	118	420	28
Lean clay (CL)	87	100	270	20
Sand w/ silt & gravel (SW-SM)	115	125	380	32
Bedrock (BRX) – Yager terrane	160	165	50,000	30

*Cohesion for engineered fill 1600 lb/ft^2 for static conditions and 800 lb/ft^2 for dynamic conditions.

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[1] Hunt, R. E. 2005. Geotechnical Engineering Investigation Handbook. 2nd Edition. Taylor & Francis Group. ISBN 9780849321825

[2] Naval Facilities Engineering Command 1986. Foundations & Earth Structures. Design Manual 7.02.

Table 2. Soil and bedrock parameters for northeast (NE) section

Material	Dry unit weight (lb/ft^3)	Saturated unit weight (lb/ft^3)	Cohesion* (lb/ft^2)	Internal angle of friction, phi (degrees)
Engineered/compacted native – sandy silt (ML)	120	130	1600 and 800	32
Gravelly silt w/ sand-disturbed/loose (ML)	80	100	100	32
Gravelly silt w/ sand (ML)	99	105	190	32
Silty sand w/ gravel (SM)	111	119	420	33
Gravel w/ silt & sand (GW-GM)	125	138	100	35
Bedrock (BRX) – Yager terrane	160	165	50,000	30

*Cohesion for engineered fill 1600 lb/ft^2 for static conditions and 800 lb/ft^2 for dynamic conditions.

Modeled groundwater levels are based on groundwater data collected from wells installed in the upper and lower terrace during SHN's geotechnical investigation (see groundwater well results in Figure 20 of BOD Report). By placing the water table at or just below the ground surface the models account for "worst-case" conditions when the ground is completely, or nearly completely saturated. Note that for the NE cross section this condition occurred for approximately two months during the 2018/2019 wet season.

We anticipate that under proposed project conditions, the groundwater elevation will be significantly lower based on the mitigating measures built into the revised project design that include 1) lining the pond with an impermeable liner, 2) installing a dewatering French drain along the upslope extent of the pond, and 3) installing a impervious clay barrier under the pond dike. However, for this analysis we have assumed a worst-case scenario of groundwater levels at the ground surface.

Potential failure surfaces were initially modeled using the Bishop Simplified method for static conditions and it was determined that the proposed pond site was very stable under static loading for both existing and proposed conditions (See Figures 1-4) with $F > 5$ in all cases.

For seismic slope stability analysis (dynamic conditions), a peak horizontal ground acceleration of 0.58 g ($S_{DS}/2.5$) was used based on recommendations in SHN's Geotechnical Investigation Report, CBC Sections 1613 and 1803, and ASCE 7 Section 11.8.3. Through the Bishop Simplified method, this resulted in factors of safety less than or equal to zero. Therefore, further seismic analyses were conducted using Newmark analyses which predicts displacements for a given seismic event.

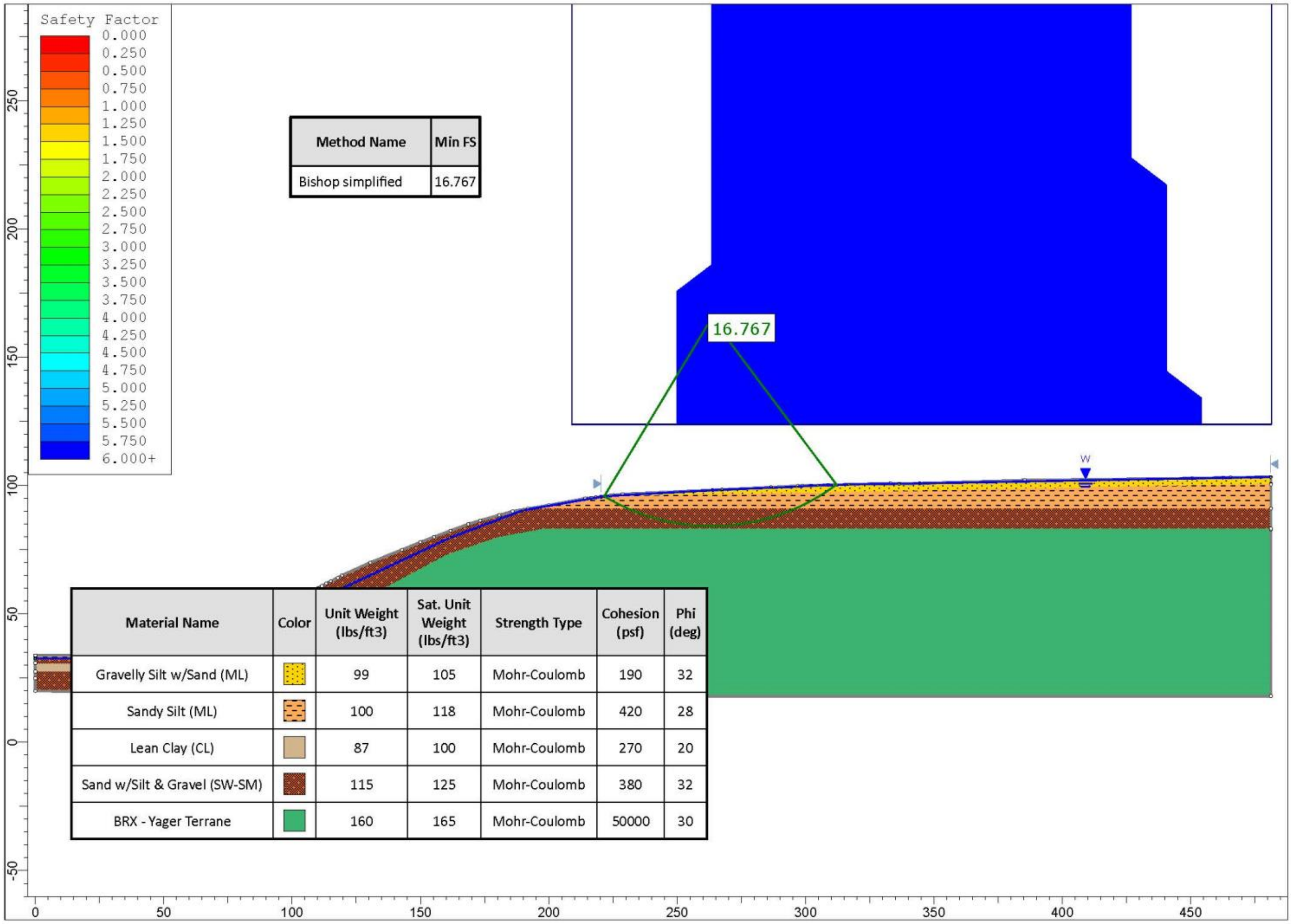
Newmark analysis was run on the NE Cross Section only considering that it is more sloped than the NW Cross Section. Using a simulated earthquake with a Peak Ground Acceleration that was slightly larger than the "Site Modified Peak Ground Acceleration" defined in SHN's Geotechnical Report, a maximum displacement of 0.3 inches at the pond berm is expected (see

Figures 5). An additional model runs was conducted by scaling up the earthquake by two times resulting in displacements of 2.2 inches respectively (Figures 6). Note that a conservative groundwater level at the ground surface was assumed for all of these model runs.

The initial slope stability analyses results were compared to observations of landform and understanding of the geomorphic evolution of the site. At locations where there is field evidence that slopes have been stable for centuries and the slope stability analyses produces a high factor of safety, the field observations validate the model results. Similarly, at locations where there is evidence of instability, the model results are assessed, and model inputs and assumptions are calibrated as needed to produce results that reflect existing field observations.

Our initial results suggest that the majority of the project area is stable under current conditions. Furthermore, the proposed pond berm does not result in instability under proposed static conditions.

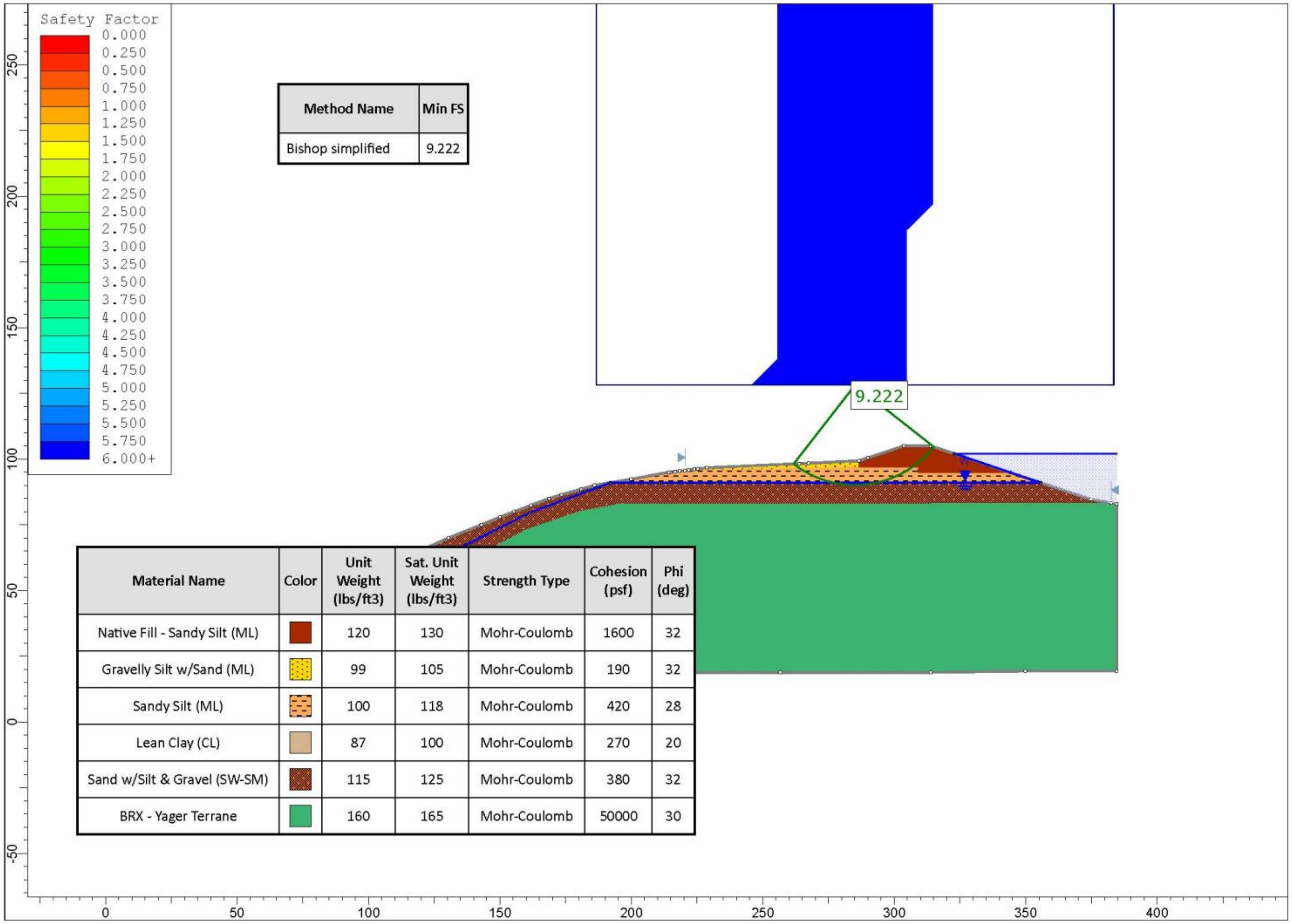
Under dynamic loading conditions, there is potential for ground displacements of several inches depending on the magnitude of earthquake. The proposed pond is constructed with an earthen berm and HDPE liner which can withstand this level of ground displacement without failure. Additional geotechnical investigations will also be conducted in October and November 2020 to better define the extent and elevation of the bedrock surface and refine subsurface soil properties. Following that investigation, this slope stability analyses will be revisited with technical review by SHN’s licensed engineering geologists and geotechnical engineer and UC Berkeley GeoSystems Engineering department faculty.



Method Name	Min FS
Bishop simplified	16.767

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Gravelly Silt w/Sand (ML)	🟨	99	105	Mohr-Coulomb	190	32
Sandy Silt (ML)	🟧	100	118	Mohr-Coulomb	420	28
Lean Clay (CL)	🟫	87	100	Mohr-Coulomb	270	20
Sand w/Silt & Gravel (SW-SM)	🟫	115	125	Mohr-Coulomb	380	32
BRX - Yager Terrane	🟩	160	165	Mohr-Coulomb	50000	30

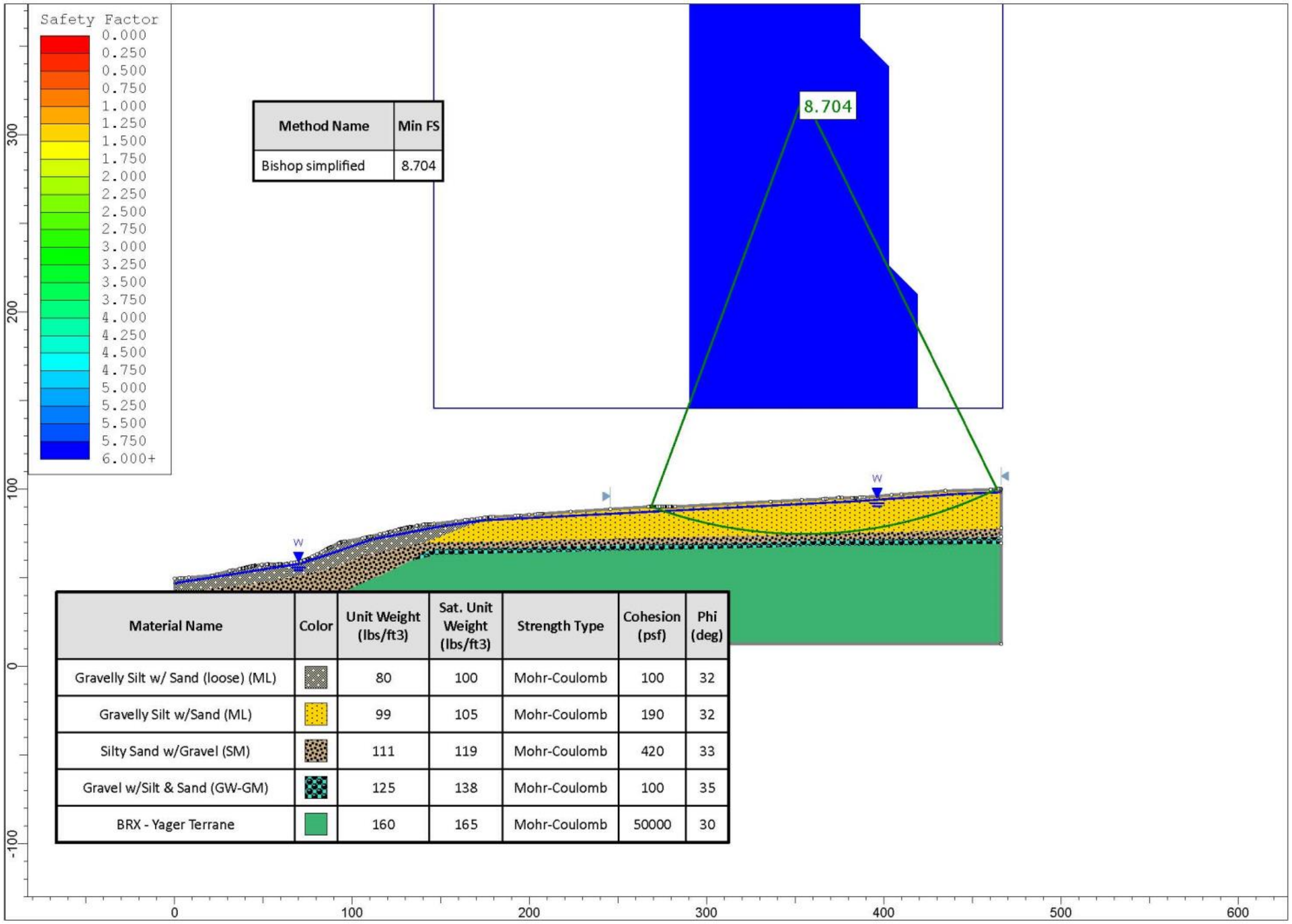
Figure 1. Slope stability analysis results for static existing conditions on the northwest (NW) section. Only critical failure surface (minimum F value) shown.



Method Name	Min FS
Bishop simplified	9.222

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Native Fill - Sandy Silt (ML)	🟥	120	130	Mohr-Coulomb	1600	32
Gravelly Silt w/Sand (ML)	🟨	99	105	Mohr-Coulomb	190	32
Sandy Silt (ML)	🟧	100	118	Mohr-Coulomb	420	28
Lean Clay (CL)	🟫	87	100	Mohr-Coulomb	270	20
Sand w/Silt & Gravel (SW-SM)	🟫	115	125	Mohr-Coulomb	380	32
BRX - Yager Terrane	🟩	160	165	Mohr-Coulomb	50000	30

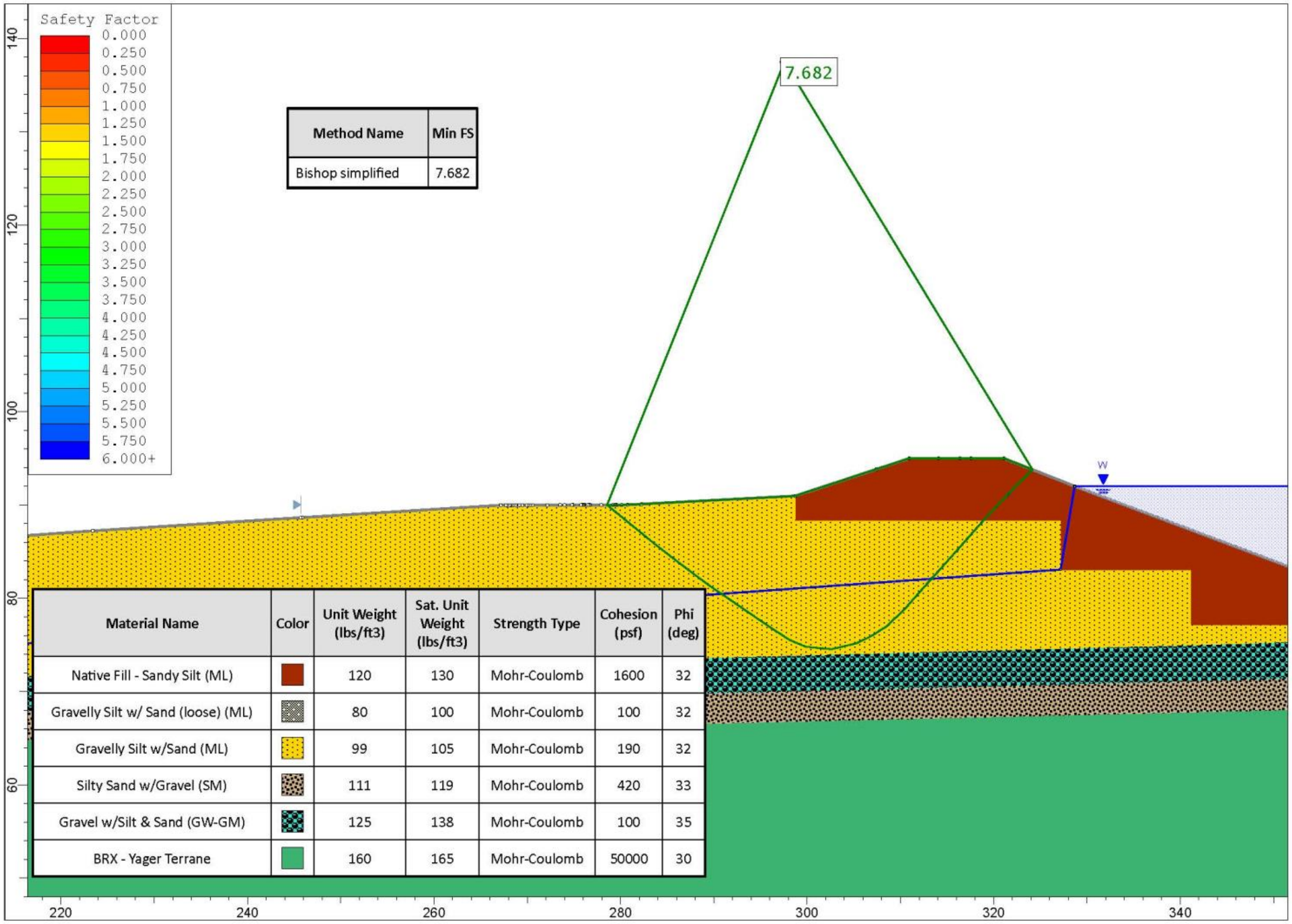
Figure 2. Slope stability analysis results for static proposed conditions on the northwest (NW) section. Only critical failure surface (minimum F value) shown.



Method Name	Min FS
Bishop simplified	8.704

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Gravelly Silt w/ Sand (loose) (ML)	▨	80	100	Mohr-Coulomb	100	32
Gravelly Silt w/Sand (ML)	🟨	99	105	Mohr-Coulomb	190	32
Silty Sand w/Gravel (SM)	🟫	111	119	Mohr-Coulomb	420	33
Gravel w/Silt & Sand (GW-GM)	▩	125	138	Mohr-Coulomb	100	35
BRX - Yager Terrane	🟩	160	165	Mohr-Coulomb	50000	30

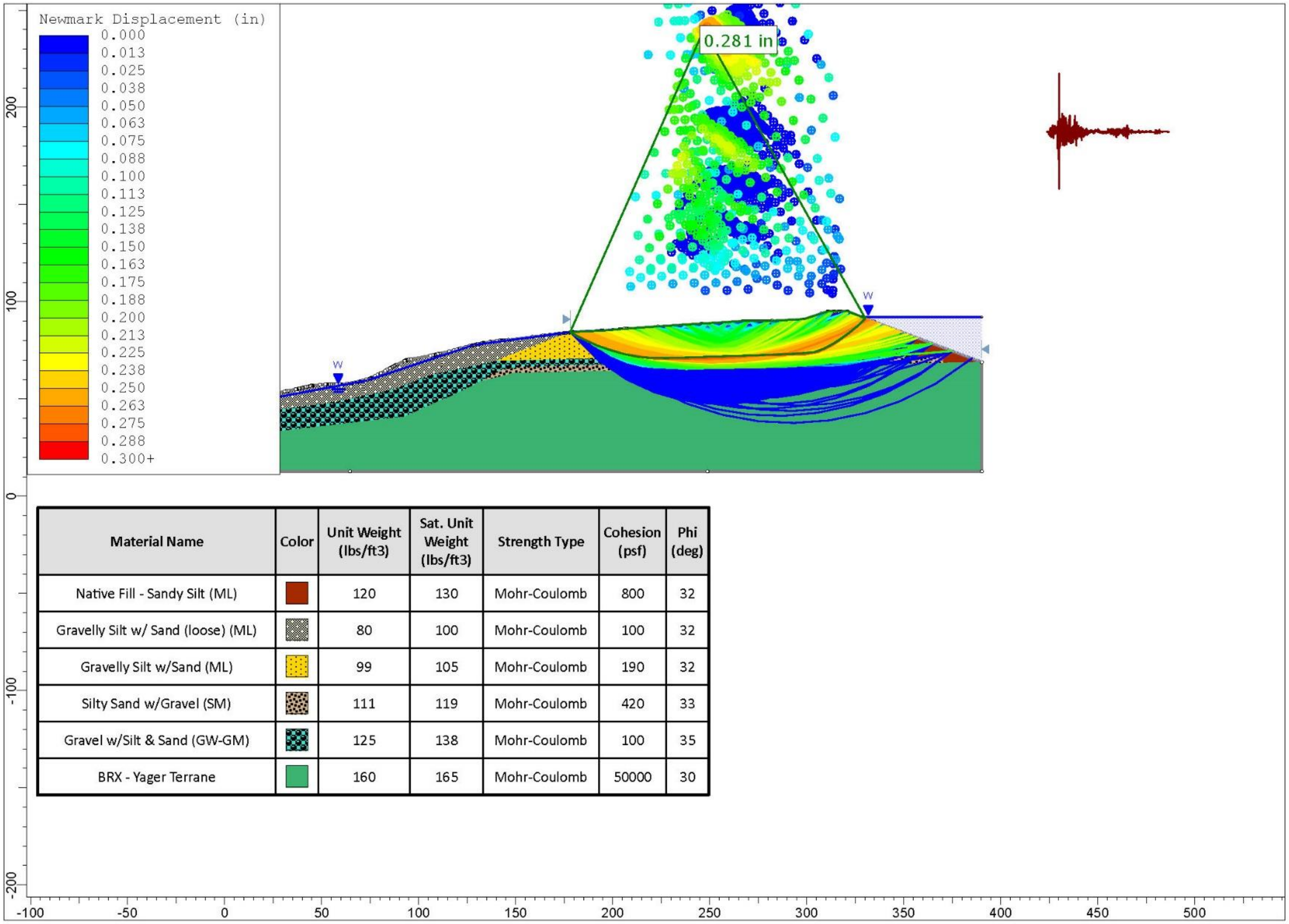
Figure 3. Slope stability analysis results for static existing conditions on the northeast (NE) section. Only critical failure surface (minimum F value) shown.



Method Name	Min FS
Bishop simplified	7.682

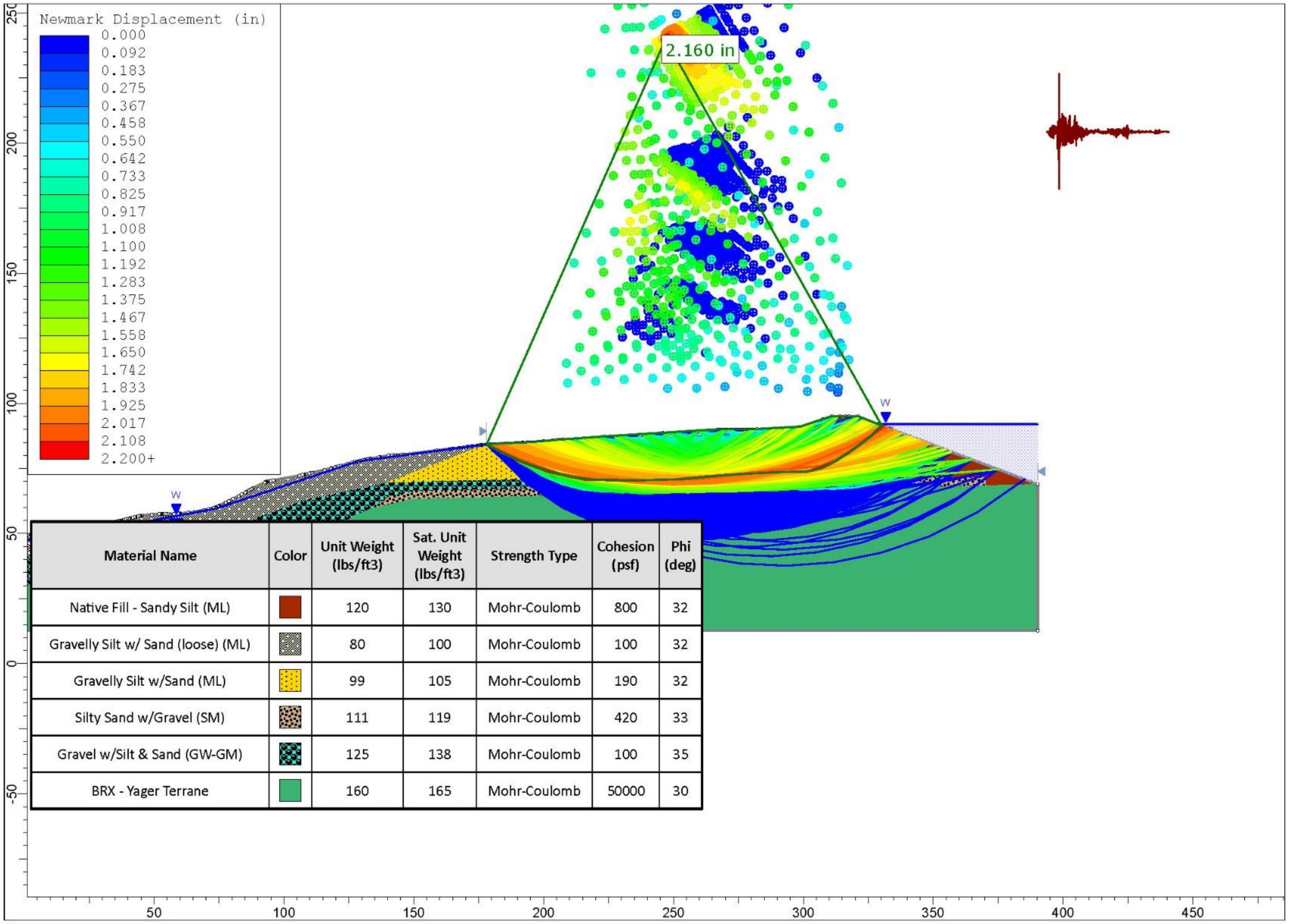
Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Native Fill - Sandy Silt (ML)	🟫	120	130	Mohr-Coulomb	1600	32
Gravelly Silt w/ Sand (loose) (ML)	▨	80	100	Mohr-Coulomb	100	32
Gravelly Silt w/Sand (ML)	🟨	99	105	Mohr-Coulomb	190	32
Silty Sand w/Gravel (SM)	▨	111	119	Mohr-Coulomb	420	33
Gravel w/Silt & Sand (GW-GM)	▨	125	138	Mohr-Coulomb	100	35
BRX - Yager Terrane	🟩	160	165	Mohr-Coulomb	50000	30

Figure 4. Slope stability analysis results for static proposed conditions on the northeast (NE) section. Only critical failure surface (minimum F value) shown.



Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Native Fill - Sandy Silt (ML)	🟥	120	130	Mohr-Coulomb	800	32
Gravelly Silt w/ Sand (loose) (ML)	▨	80	100	Mohr-Coulomb	100	32
Gravelly Silt w/Sand (ML)	🟨	99	105	Mohr-Coulomb	190	32
Silty Sand w/Gravel (SM)	▨	111	119	Mohr-Coulomb	420	33
Gravel w/Silt & Sand (GW-GM)	▨	125	138	Mohr-Coulomb	100	35
BRX - Yager Terrane	🟩	160	165	Mohr-Coulomb	50000	30

Figure 5. Newmark analysis results for dynamic proposed conditions on the northeast (NE) section for anticipated design earthquake. Maximum displacement surface shown in inches.



Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Native Fill - Sandy Silt (ML)	🟫	120	130	Mohr-Coulomb	800	32
Gravelly Silt w/ Sand (loose) (ML)	▨	80	100	Mohr-Coulomb	100	32
Gravelly Silt w/Sand (ML)	🟨	99	105	Mohr-Coulomb	190	32
Silty Sand w/Gravel (SM)	▨	111	119	Mohr-Coulomb	420	33
Gravel w/Silt & Sand (GW-GM)	▨	125	138	Mohr-Coulomb	100	35
BRX - Yager Terrane	🟩	160	165	Mohr-Coulomb	50000	30

Figure 6. Newmark analysis results for dynamic proposed conditions on the northeast (NE) section for anticipated design earthquake scaled by a factor of two. Maximum displacement surface shown in inches.

Appendix I

Dam Breach Analysis

Stillwater Sciences

850 G Street, Suite K, Arcata, CA 95521
phone 707.822.9607 fax 707.822.9607

TECHNICAL MEMORANDUM

DATE: April 1, 2020
TO: Salmonid Restoration Federation
FROM: Joel Monschke PE, Chris Lyle
SUBJECT: Draft Marshall Ranch Dam Breach Analysis

Stillwater Sciences conducted a dam breach analysis to simulate the downslope effects of the extremely unlikely event of catastrophic dam failure. This analysis included the following two steps. First, peak discharge of the breach hydrograph was calculated based on the approach and equations listed in the USDA's NRCS Earth Dams and Reservoirs Technical Release Number 60 (TR-60). Second, the peak discharges were routed downslope using the U.S. Army Corps of Engineers' (USACE) *Hydrologic Engineering Center's River Analysis System (*HEC-RAS).

Peak Discharge Calculations

USDA's TR-60 defines a set of formulas used to calculate peak dam breach discharges based on physical characteristics of a dam. The variables in the equations are defined below with the units of each variable in parentheses:

Q_{max} = peak breach discharge (ft^3/sec)
B_r = breach factor (acres)
V_s = reservoir storage at the time of failure (acre-ft)
H_w = depth of water at the dam at the time of failure (ft)
A = cross-sectional area of embankment at the assumed location of breach (ft^2)
T = theoretical breach width at the water surface elevation corresponding to the depth H_w (ft)
L = width of the valley at the water elevation corresponding to the depth H_w (ft)

Consider that the vast majority (>95%) of grading to construct the proposed reservoir is excavation into the existing terrace, H_w was defined as the maximum water surface elevation (WSE) above the toe of the berm (Figure 1) which is approximately 10 feet. Note that the WSE above the existing ground surface is significantly lower than 10 feet for the majority of the berm, so using H_w = 10 feet is conservative. The reservoir storage area (V_s) used for the dam breach analyses was 7.9 million gallons (24.2 acre-ft), representing the pond volume encompassing the top ten feet of the water column. The cross-sectional area of the embankment (A) at its highest location was calculated to be 680 ft^2. Additional variables are described below in Table 1.

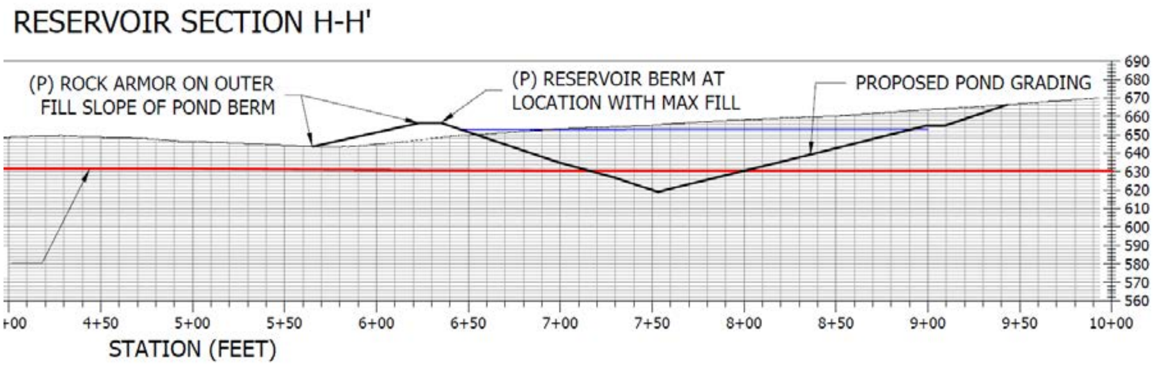


Figure 1. Depiction of maximum water surface elevation above the toe of the berm, figure cropped from Final 65% Plans Sheet 6.

Based on these physical variables, peak breach hydrographs were calculated using the equations listed in TR-60 for dams with H_w < 103 ft as shown in Table 1. The maximum dam breach discharge was calculated to be 1,012 cfs which would drain the top 10 feet of the reservoir (7.9 million gallons) in approximately 17 minutes.

Table 1. Summary of dam breach parameters and results

Variables	**Value**	**Description**
H_w (ft)	10	depth of water at the dam at the time of failure
Vs (acre-ft)	24.2	Reservoir storage at the time of failure
A (sq-ft)	680	Cross sectional area of embankment at the assumed breach
B_r (acres)	0.36	Breach Factor
T (ft)	350	Theoretical breach width
L (ft)	600	Valley width
Q_1 (cfs)	1012	Minimum discharge for H_w<103 ft (USDA TR-60)
Q_2 (cfs)	273	Discharge from standard formula for H_w<103 ft (USDA TR-60)
Duration (mins)	17	Based on Q_1

Flow Routing

The maximum dam breach discharge of 1,012 cfs was routed through the proposed downslope topography utilizing 2-Dimensional (2-D) hydraulic modeling in HEC-RAS. The focus of this analysis was to determine the direct effects to the adjacent downslope property. The proposed graded berm feature was included in this analysis. Note that this dam breach flow routing analysis was intended to assess results of dam breach between the reservoir and Redwood Creek only. The inundation extent resulting from the simulated dam breach is shown on Figure 2. Note that the proposed berm along the property boundary effectively directs all flow away from the downslope property (APN 220-252-018).

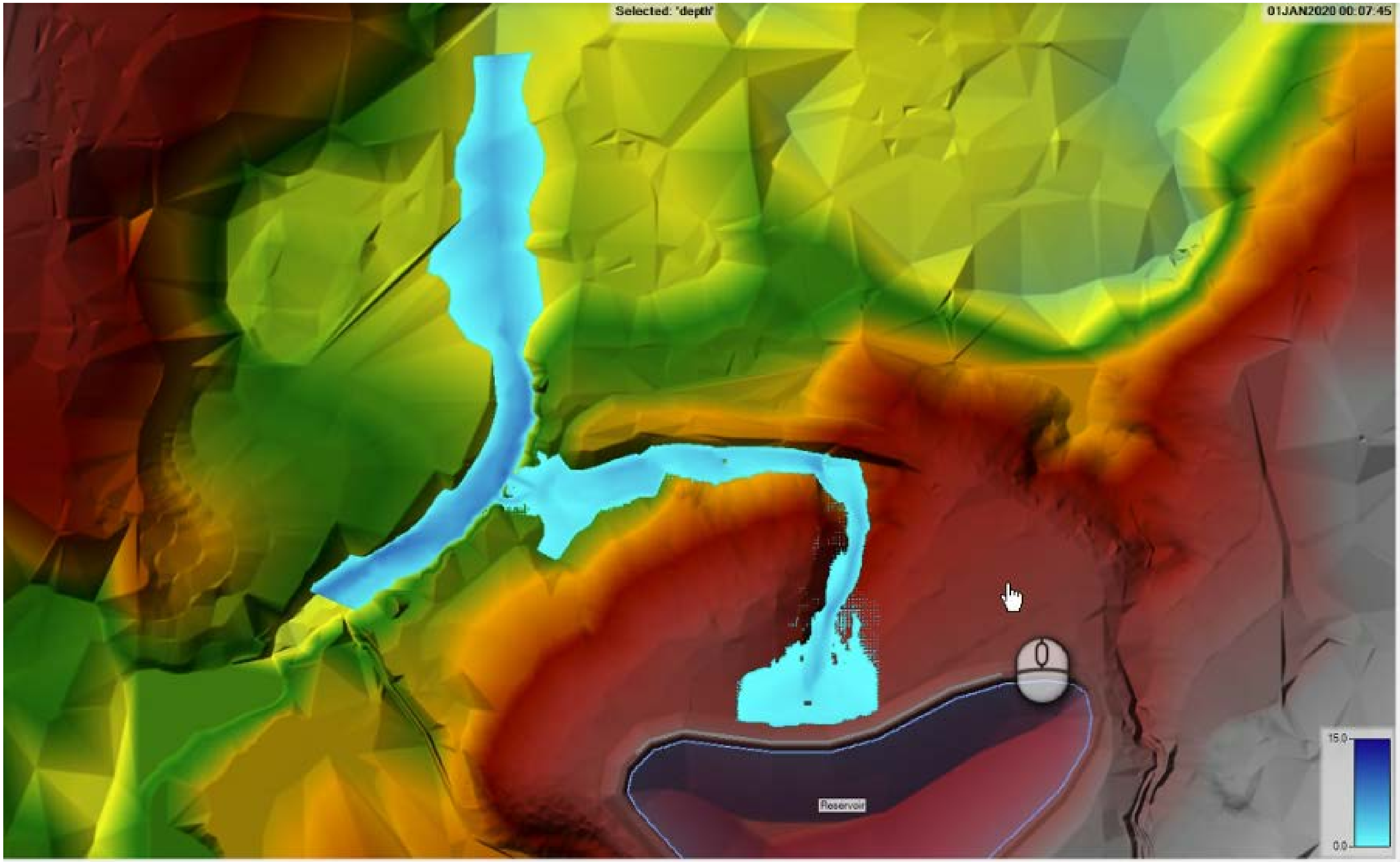


Figure 2. Simulated inundation extents resulting from calculated maximum dam breach discharge.

Additional detailed information about flow characteristics in the vicinity of the berm is shown in Figures 3 and 4 below. Within the reach shown on Figure 3, average water depth is 3.1 feet, and average velocity is 14.3 ft/sec. These simulated flow velocities are high, supporting the need for rock slope protection along the berm to prevent erosion – as proposed in the Final 65% Designs. The proposed berm has approximately 4 feet of freeboard between the water surface and the top of the berm ensuring that the structure could handle higher flow volumes and/or some accumulation of sediment and debris while still passing the necessary flows. Note that the potential for significant erosion of the berm is reduced due to the relatively short duration of the breach discharge (17 minutes).

Note that this analysis assumed that flows in Redwood Creek mainstem were low at the time of dam breach. If the dam breach were to occur at the same time as peak 100-yr flows in Redwood Creek, it could lead to some increased flood risk along Redwood Creek mainstem. However, the likelihood of all factors coinciding to create a worst-case flooding scenario along Redwood Creek is extremely low. The expected additional flooding that could result from this rare scenario would likely be shallow and low velocity floodplain inundation.

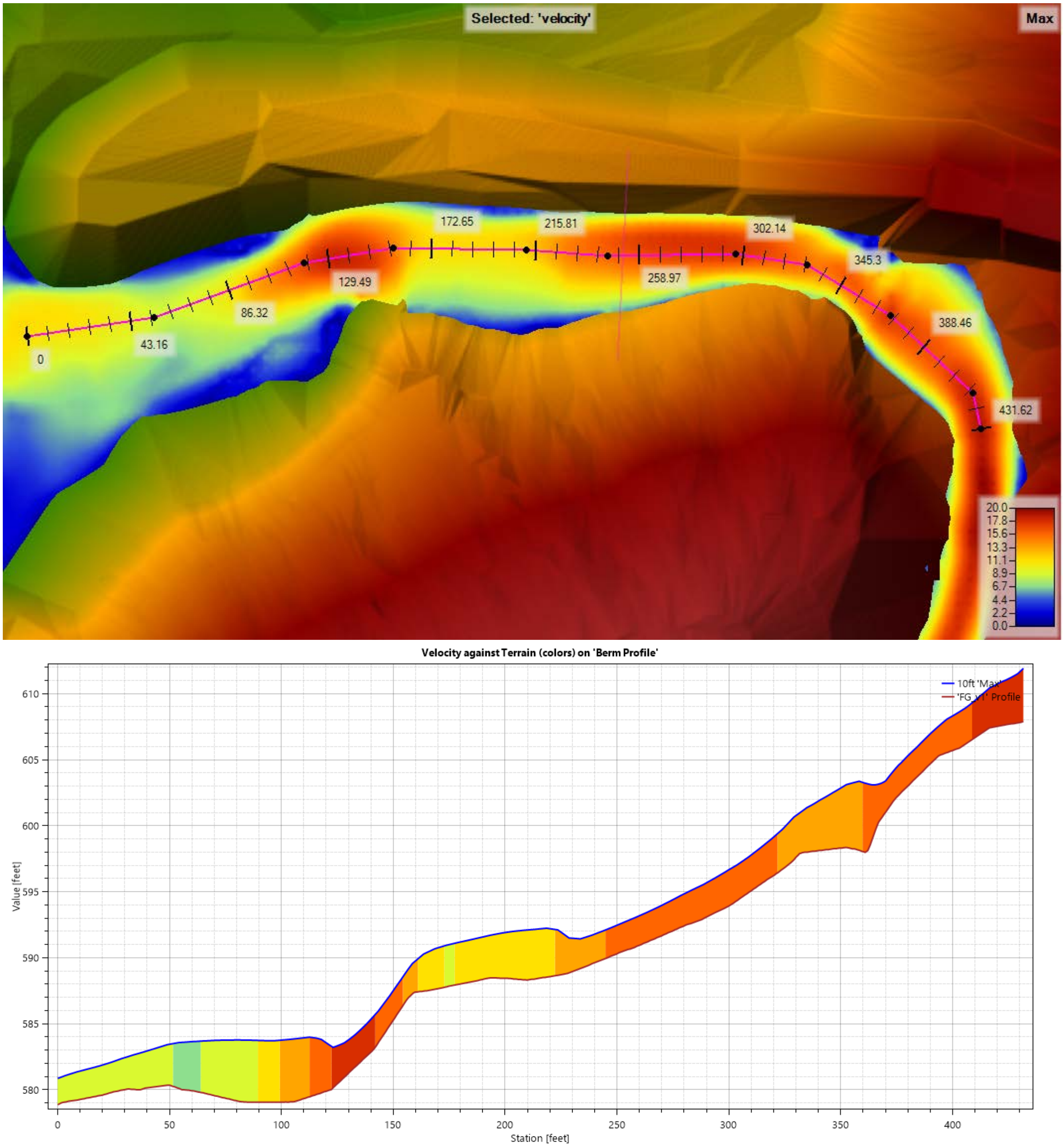


Figure 3. Plan view and longitudinal profile showing flow velocities (in ft/s per colored legend on middle-right of figure) and flow depth (blue line on bottom portion of figure).

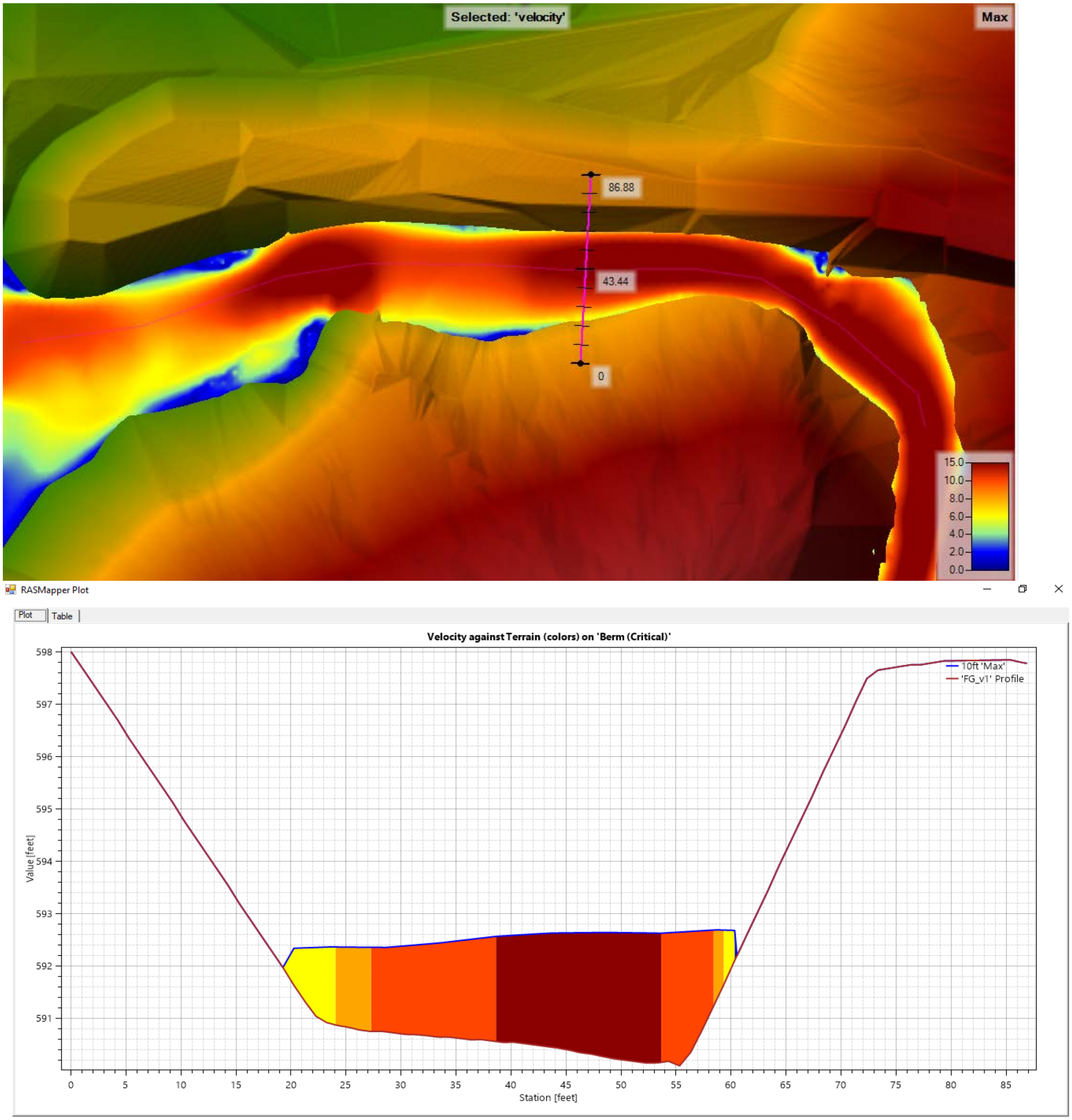


Figure 3. Plan view and one channel cross section showing flow velocities (in ft/s per colored legend on middle-right of figure) and flow depth (blue line on bottom portion of figure).

Appendix J

Pond Operation and Temperature Analysis

Stillwater Sciences

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TECHNICAL MEMORANDUM

DATE: May 21, 2020
TO: Salmonid Restoration Federation
FROM: Joel Monschke PE, Jay Stallman PG, Chris Lyle
SUBJECT: Preliminary Marshall Ranch Pond Operations and Water Temperature Analysis

Stillwater Sciences conducted an analysis of annual pond operations to determine the likelihood and extent to which flow releases from the proposed Marshall Ranch project could have elevated water temperatures and result in negative effects on salmonids.

1 POND VOLUME CALCULATIONS

The first step of the analysis was to determine the physical characteristics of the proposed pond in AutoCAD Civil3D. For each pond depth ranging from 0 to 37 feet, the volume and surface area were calculated. Results are summarized in Table 1. Based on this data, rating curve formulas were developed in Excel for depth-volume and depth-surface area relationships.

Next, evapotranspiration (ET) for the pond site was determined using calculations from the Western Regional Climate Center's Eel River Camp[1]. The Eel River Camp is located approximately 4.6 miles northeast of the Marshall Ranch project site. ET is calculated using the Penman equation based on physical site conditions including solar radiation, wind speed, temperature and humidity. For this analysis, we used the total 2019 monthly ET rates to calculate an average daily ET for each month as summarized in Table 2. Note that 2019 monthly ET rates were compared to previous years and although there are variations between years of +/- approximately one inch per month, the 2019 monthly totals provide a good representation of expected dry season ET rates.

Based on the data listed in Tables 1 and 2, a spreadsheet was developed in Excel that calculates pond volume, water surface area, evaporation and depth based on a beginning pond volume and the amount of water released from the pond each week. Table 3 describes an annual simulation of pond conditions under a standard management scenario. This scenario assumes the following:

- The pond is topped off on April 15 at 15.3 million gallon capacity with no additional inputs from precipitation or diversion after that date. As described in Section 8.2 of the Marshall Ranch Basis of Design Report, the pond will fill with approximately 7.3 million gallons from direct rainfall into the pond and surface runoff from the upslope 2.5 acre hillside (based on 48 inches of annual precipitation). This would require an additional 8 million gallons to be pumped from Redwood Creek during the wet season to fill the pond

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[1] Available online at https://raws.dri.edu/cgi-bin/rawMAIN.pl?caCEEC

to full capacity. With the proposed pump rate of 220 gallons per minute (gpm), 25 days of pumping would be required. This scenario should fill the pond to capacity except for during the most severe drought years when the pond may not be filled, or diversion protocols may need to be adjusted to reach full pond capacity. Note that the project team is currently working with CDFW and SWB to permit the diversion infrastructure and operations.

- Flow releases begin on July 1st at a constant rate of 50 gpm (504,000 gallons per week) and end on December 1. Note that flow releases through the end of November will likely not be needed in most years. However, recent climatic trends in both 2018 and 2019 resulted in very dry conditions in October and November during which time aquatic habitat in some reaches of Redwood Creek mainstem would have likely benefited greatly from additional flow releases during these months. Therefore, it is prudent to allow for an operational approach that provides pond capacity to support flow releases through the end of November. However, during the late season, flow releases could likely be scaled back significantly or turned off completely based on specific conditions during each individual year.

Based on this standard management scenario, approximately 1.1 million gallons will be left in the pond on December 2nd after the flow release stops.

2 IMPLICATIONS FOR WATER TEMPERATURE

Based on assessments of reservoir temperature dynamics that Stillwater Sciences has conducted for other projects located in similar Mediterranean climates in California, it is anticipated that the warm water layer on top of the pond would be no more than 15 to 20 feet thick at the end of the summer (September). Note that this assumption will be verified through water temperature monitoring at a nearby pond site during the 2020 dry season. The cool water layer at the bottom of the pond is expected to have a temperature within the range of 52 to 57 degrees Fahrenheit (11 to 14 degrees Celsius) which is the shallow groundwater temperature for the northern CA coastal region per the EPA's Ecosystem Research online map[2]. Note that this temperature range is consistent with instream water temperatures data collected by Salmonid Restoration Federation in Redwood Creek from continuous data loggers. Specifically, in 2018 at monitoring site RC1.8 (Redwood Creek mainstem just downstream from the Marshall Ranch project) the water temperatures measured by the data logger in the disconnected pool ranged from 52 to 58 degrees Fahrenheit when flows were entirely hyporheic.

Note that the outflow pipe from the pond to Redwood Creek will be drawing water from the bottom of the pond. Based on the standard reservoir operating scenario shown in Table 3, water depths in September range from 25 to 28 feet. Therefore, it is expected that the temperature of flow released during the critical late summer weeks under the standard operating scenario will be suitable for juvenile salmonids[3].

Pond depth continues to drop throughout the fall. As day length shortens and air temperatures cool, however, the temperature and thickness of the warm water layer at the top of the pond diminishes. Even at the end of October, the pond remains 20 feet deep. Under the standard

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[2] Available online at https://www3.epa.gov/ceampubl/learn2model/part-two/onsite/ex/jne_henrys_map.html.

[3] U.S. Environmental Protection Agency. 2003. EPA Region 10 Guidance for Pacific Northwest State and Tribal Temperature Water Quality Standards. EPA 910-B-03-002. Region 10 Office of Water, Seattle, WA

operating scenario shown on Table 3, water temperatures of the flow release are therefore expected to remain suitable for salmonids throughout the year.

Under unusual circumstances (e.g., severe drought years with insufficient rainfall to fill the pond, extensive water draws for fighting wildfire, and October heat storms), pond water temperature conditions may be warmer than simulated under the standard operating scenario. Under these infrequent circumstances, cooling of the pond water and/or flow release could significantly benefit salmonids in Redwood Creek. Although the cooling gallery (i.e., buried pipe) included in the 65% Design Plans is intended to help cool the flow release throughout the year, other options are being explored that could be used to cool the pond water on-demand during unusual circumstances. Industrial water chillers, for example, are engineered with a specific cooling capacity that may be more effective and offer more control than the cooling gallery approach. An industrial chiller is expected to be significantly less expensive to install than a cooling gallery, with the capacity to deliver the same resulting decrease in water temperature. Although an industrial chiller would require an additional electricity demand, the infrequent use of the equipment during unusual circumstances would limit the impact to long term operational costs. Covering the pond with plastic balls to reduce evaporation rate and lower water temperature is also an option that has been explored although it is not the preferred alternative at this time due to aesthetic and management concerns.

3 CONCLUSIONS AND NEXT STEPS

In summary, the analyses included herein indicate that the current pond design will result in flow releases with temperatures suitable for juvenile salmonids throughout the year under a standard management scenario. Under unusual circumstances, however, cooling pond water temperatures may be beneficial, and design approaches are being explored to meet that need.

Temperature monitoring of nearby ponds will be conducted during the summer of 2020 to help validate the assumptions of water stratification depths described above. The project team also plans to integrate project outcomes with the hydrologic and temperature modeling work funded by the State Water Board to assess the likely water temperature implications of the flow releases on Redwood Creek.

Additionally, based on this analysis there will be operational flexibility to release more than 50 gpm during some weeks in the early- and mid-dry season and it is anticipated that an adaptive and collaborative management approach will be needed to maximize yearly project function.

Table 1. Pond volume and surface area for all depths.

Water Surface Elevation (ft)	Water Depth (ft)	Pond Surface Area (ft^2)	Pond Volume (gal)
616	0	2501	15314
617	1	3541	37801
618	2	4746	68689
619	3	6141	109301
620	4	7765	161194
621	5	9616	226080
622	6	11697	305669
623	7	14006	401673
624	8	16534	515767
625	9	19223	649385
626	10	22065	803695
627	11	25058	979829
628	12	28199	1178910
629	13	31488	1402041
630	14	34914	1650290
631	15	38445	1924568
632	16	42079	2225646
633	17	45814	2554287
634	18	49650	2911251
635	19	53589	3297298
636	20	57335	3712103
637	21	61120	4155080
638	22	64943	4626514
639	23	68803	5126689
640	24	72702	5655889
641	25	76639	6214399
642	26	80614	6802505
643	27	84627	7420490
644	28	88679	8068640
645	29	92768	8747240
646	30	96895	9456574
647	31	101061	10196928
648	32	105265	10968585
649	33	109506	11771832
650	34	113786	12606952
651	35	118104	13474231
652	36	122460	14373947
653	37	126854	15306406

Table 2. Monthly ET rates at the Eel River Camp Weather Station.

Year	Month	Days in the Month	Total ET for Month (inches)	Daily Average ET (inches)
2019	April	30	4.67	0.156
2019	May	31	6.1	0.197
2019	June	30	8.01	0.267
2019	July	31	8.47	0.273
2019	August	31	7.96	0.257
2019	September	30	5.31	0.177
2019	October	31	3.64	0.117
2019	November	30	1.93	0.064

Table 3. Annual simulation of pond conditions under standard a management scenario.

Date	Pond Volume (gal)	Discharge Rate during the following week (gpm)	Discharge Volume during following week (gal)	Water Surface Area (sq ft)	Evaporation Loss over following week (gal)	Water Depth in pond (ft)
15-Apr	15306406	0	0	132815	90213	37
22-Apr	15216193	0	0	132578	90052	37
29-Apr	15126141	0	0	132335	89887	37
6-May	15036255	0	0	132087	113410	37
13-May	14922844	0	0	131766	113134	37
20-May	14809710	0	0	131436	112851	36
27-May	14696859	0	0	131098	112561	36
3-Jun	14584298	0	0	130752	152329	36
10-Jun	14431969	0	0	130269	151766	36
17-Jun	14280203	0	0	129771	151186	36
24-Jun	14129016	0	0	129259	150590	36
1-Jul	13978426	50	504000	128732	153474	36
8-Jul	13320953	50	504000	126244	150507	35
15-Jul	12666446	50	504000	123460	147188	34
22-Jul	12015258	50	504000	120387	143524	33
29-Jul	11367734	50	504000	117030	139522	33
5-Aug	10724212	50	504000	113396	127050	32
12-Aug	10093162	50	504000	109546	122736	31
19-Aug	9466426	50	504000	105440	118136	30
26-Aug	8844290	50	504000	101087	113258	29
2-Sep	8227032	50	504000	96494	74524	28
9-Sep	7648507	50	504000	91942	71009	27
16-Sep	7073498	50	504000	87181	67332	26
23-Sep	6502166	50	504000	82216	63497	25
30-Sep	5934669	50	504000	77054	59510	25
7-Oct	5371159	50	504000	71700	36735	23
14-Oct	4830423	50	504000	66349	33993	22
21-Oct	4292430	50	504000	60817	31159	21
28-Oct	3757271	50	504000	55110	28235	20
4-Nov	3225035	50	504000	49230	13819	19
11-Nov	2707216	50	504000	43315	12159	17
18-Nov	2191057	50	504000	37229	10451	16
25-Nov	1676606	50	504000	30973	8695	14
2-Dec	1163911	0	0	24551	0	12
Total			11088000		3054494	

Appendix K

Design Features, Mitigation Measures & Monitoring Program

DESIGN FEATURES, MITIGATION MEASURES & MONITORING PROGRAM FOR THE MARSHALL RANCH STREAMFLOW ENHANCEMENT PROJECT

1 ADMINISTRATIVE MEASURES

Permittee shall meet each administrative requirement described below.

1.1 Documentation at Project Site.

Salmonid Restoration Federation (SRF) shall make the Agreement, any extensions and amendments to the Agreement, and all related notification materials and California Environmental Quality Act (CEQA) documents, readily available at the project site at all times and shall be presented to CDFW personnel, or personnel from another state, federal, or local agency upon request.

1.2 Providing Agreement to Persons at Project Site.

SRF shall provide copies of the Agreement and any extensions and amendments to the Agreement to all persons who will be working on the project at the project site on behalf of Permittee, including but not limited to contractors, subcontractors, inspectors, and monitors.

1.3 Notification of Conflicting Provisions.

SRF shall notify regulatory agencies if SRF determines or learns that a provision in the Agreement might conflict with a provision imposed on the project by another local, state, or federal agency.

1.4 Project Site Entry.

SRF and landowner will allow access to the project site for regulatory authorities provided they provide 24 hours advance notice and allow project permittee, or representative, to be present.

2 PROJECT DESIGN AND MITIGATION MEASURES

Project design and mitigation measures are identified below for each environmental checklist items contained in the Initial Study/Mitigated Negative Declaration (ISMND). In many cases, conservation measures have been incorporated into the project design and are therefore, not considered mitigation measures. Mitigation measures that have been included in the Project's ISMND are identified below using an abbreviated checklist item title and number (e.g. BIO-1). Mitigation measures were incorporated into the ISMND for those checklist items described below where an answer of Less Than Significant with Mitigation Incorporated was given. The Permittee is responsible for ensuring the general and specific mitigation measures are implemented.

2.1 Aesthetics

2.1.1 Design features

- All final grading to be inspected by engineer and revegetation specialist to ensure that it meets specifications including that graded features are blended into natural landscape and

also avoid over compaction of surficial soils to allow for vigorous growth of native vegetation.
- Natural vegetation barriers will be incorporated into the final project design to improve project aesthetics and minimize impacts.

2.1.2 Mitigation measures

- None

2.2 Agriculture and Forestry Resources

No specific design features or mitigation measures are required to minimize impacts.

2.3 Air Quality

2.3.1 Design features

- All bare mineral soils and excavation areas will be watered during construction activities to minimize the potential for fugitive dust production.
- The construction portion of the project will last for less than one year (June 1 to November 1). During this period, the project will comply with Rule 104, Section D and cover open body trucks hauling materials off site and use water during the grading of roads, excavation, and land clearing.

2.3.2 Mitigation measures

- None

2.4 Biological Resources

A biological resources technical report has been prepared by Stillwater Sciences to describe the special-status and/or sensitive biological resources (plants, vegetation communities, fish, wildlife, and wetlands and waters) in or with potential to occur in the Project area that may be affected by Project construction activities. This report titled "Biological Resources Technical Report for the Marshall Ranch Flow Enhancement Project, Humboldt County, CA", has been used to inform the sections below with regard to specific species of concern within the Project area.

2.4.1 Design features

- The project team will work closely with California Department of Fish and Wildlife (CDFW) and the California State Water Resources Control Board Division of Water Rights (SWRCB) to develop final approved diversion protocols for the project that limit impacts to aquatic resources during the wet season flow diversion period. This will be conducted through the CDFW's Lake and Streambed Alteration Agreement (LSAA) and the SWRCB's Appropriative Water Rights application processes. Over the past several months, project designs have been revised to include a larger pump and piping that facilitate a diversion of up to 220 gpm that will allow the project to divert more water during peak flows in Redwood Creek, thereby reducing the impacts of the diversion when flows are lower. Through ongoing discussions and final permit and water rights negotiations with CDFW and SWRCB, a Final Water Availability Analyses (WAA) will be developed that describes a mutually agreed upon scientific basis for flow diversion protocols. Information in the final WAA will provide the basis for development of the project’s Operations Plan that defines pumping schedule and rates based on site specific discharge rates in Redwood Creek with the intent of protecting aquatic resources related to flow diversion to the maximum extent practical.

- The project team will work closely with CDFW and NOAA to develop final approved flow release protocols for the project that maximize the benefits to aquatic resources during the dry season and reduce negative impacts of the flow releases. Over the past several months, a preliminary assessment of flow release schedule and temperature has been conducted and over the coming months this analysis will be further refined to inform final project design. A water chiller will be installed to address concerns with higher than optimal flow release temperatures that may occur during rare occasions. Yearly flow release rates and schedules will be based on specific hydrologic conditions during each year and finalized through a collaborative adaptive management process with CDFW and NOAA staff. The project’s Operations Plan will define general procedures for the flow releases with the intent of enhancing aquatic resources in Redwood Creek to the maximum extent possible.
- The project’s Operations Plan will be revised as needed after project construction through adaptive management and in close collaboration with CDFW, SWRCB and NOAA staff. This will be based on ongoing monitoring of downstream flow and habitat characteristics. Monitoring will occur at a minimum over the first 30 years of project operations with the most robust monitoring occurring over the first 3 years after construction. The Operations Plan will be developed with the intention to fill the reservoir with the minimum impact possible to aquatic resources and release flows to enhance aquatic habitat to the maximum extent possible.
- Aquatic species relocation plan. Prior to dewatering a construction site, fish and amphibian species shall be captured and relocated by CDFW personnel (or designated agents). The following measures shall be taken to minimize harm and mortality to listed salmonids resulting from fish relocation and dewatering activities:
    - Fish relocation and dewatering activities shall only occur between June 15 and November 1 of each year.
    - Fish relocation shall be performed by a qualified fisheries biologist, with all necessary State and Federal permits. Captured fish shall be moved to the nearest appropriate site outside of the work area. A record shall be maintained of all fish rescued and moved. The record shall include the date of capture and relocation, the method of capture, the location of the relocation site in relation to the project site, and the number and species of fish captured and relocated. The record shall be provided to CDFW within two weeks of the completion of the work season or project, whichever comes first.
    - Prior to capturing fish, the most appropriate release location(s) shall be determined. These would have water temperatures similar to the capture location and ample habitat area for dispersal.
    - A block net will be installed at the upstream end of the work area to keep fish from entering from above.
    - If a single thread channel with surface flow is present, fish would initially be hazed downstream using beach seines and dip nets. A block net would then be installed at the downstream end of the work area to keep fish from reentering. At least three sweeps will be conducted to deplete the area of fish as best as possible without handling.

  - Once sweeping in completed, the cofferdam and flow bypass would be installed. Pumping of the work area could then commence.
  - Any remaining fish would become concentrated in deep locations and would be removed using dipnets, seining, or hand capture as water depth continues to decrease.
  - Electrofishing would only occur as a last resort. If deemed necessary, electrofishing shall be conducted by properly trained personnel following NOAA Guidelines for Electrofishing Waters Containing Salmonids Listed under the Endangered Species Act, June 2000.
  - Handling of salmonids shall be minimized. However, when handling is necessary, always wet hands or nets prior to touching fish.
  - Temporarily hold fish in cool, shaded, aerated water in a container with a lid. Provide aeration with a battery-powered external bubbler. Protect fish from jostling and noise and do not remove fish from this container until time of release.
  - Air and water temperatures shall be measured periodically. A thermometer shall be placed in holding containers and, if necessary, periodically conduct partial water changes to maintain a stable water temperature. If water temperature reaches or exceeds 18°C, fish shall be released and rescue operations ceased.
  - Overcrowding in containers shall be avoided by having at least two containers and segregating young-of-year (YOY) fish from larger age-classes to avoid predation. Larger amphibians, such as Pacific giant salamanders, shall be placed in the container with larger fish. If fish are abundant, the capturing of fish and amphibians shall cease periodically and shall be released at the predetermined locations.
  - Anesthetization or measuring fish shall be avoided.
  - If feasible, initial fish relocation efforts shall be performed several days prior to the start of construction. This provides the fisheries biologist an opportunity to return to the work area and perform additional electrofishing passes immediately prior to construction. In many instances, additional fish will be captured that eluded the previous day's efforts.
  - If mortality during relocation exceeds three percent, capturing efforts shall be stopped and the appropriate agencies shall be contacted immediately.
  - In regions of California with high summer temperatures, relocation activities shall be performed in the morning when the temperatures are cooler.
  - The Permittee shall minimize the amount of wetted stream channel that is dewatered at each individual project site to the fullest extent possible.
  - Additional measures to minimize injury and mortality of salmonids during fish relocation and dewatering activities shall be implemented as described in Part IX, pages 52 and 53 of the California Salmonid Stream Habitat Restoration Manual.
  - If these measures cannot be implemented, or the project actions proposed at a specific work site cannot be modified to prevent or avoid potential impacts to anadromous salmonids or their habitat, then activity at that work site shall be discontinued.
- The construction and operations of the pond has the potential to create habitat for bullfrogs and subsequently impact native species. The following avoidance and minimization measures will be incorporated in the project design, monitoring and

maintenance plan. In order to avoid bullfrogs from infesting the project sites the following strategies will be implemented:

- Landowner and resident education is one of the most important strategies, as people have been known to intentionally introduce bullfrogs to local bodies of water as a source of food.
- Monitoring of project sites will also be very important as early detection, before populations can get established, is a key component of control. Monitoring will be conducted as per Appendix K of the BOD Report: Bullfrog Monitoring and Management Plan prepared by CDFW.
- If needed, the off-channel pond may be drained. David Manthorne, CDFW Senior Environmental Scientist recommends draining of ponds if invasive bullfrogs are present to interrupt their life cycle (CDFW Compliance Guidance). According to research by Doubledee et al, 2007, "*Bullfrogs*, *Disturbance Regimes*, *and the Persistence of California Red-Legged Frogs ",* draining of ponds can be effective for bullfrog management if draining occurs at least every 2 years.
- If annual monitoring shows that bullfrogs are present, active measures will be taken in consultation with CDFW and will follow the methods described in Exhibit A: Bullfrog Monitoring and Management Plan

2.4.1.1 Plants

- The Project footprint will be minimized to the extent possible.
- The pond will be positioned to minimize impacts on existing vegetation to the extent possible.
- Ground disturbance and vegetation clearing and/or trimming will be confined to the minimum amount necessary to facilitate Project implementation.
- Heavy equipment and vehicles will use existing access roads to the extent possible.
- Construction materials will be stored in designated staging areas.
- Measures to prevent the spread of invasive weeds and sudden oak death pathogens will be taken, including, where appropriate, inspecting equipment for soil, seeds, and vegetative matter, cleaning equipment, utilizing weed-free materials and native seed mixes for revegetation, and proper disposal of soil and vegetation.

2.4.2 Mitigation measures

BIO-1: The use of cofferdams will contain any turbid water produced during the Project within the work area, thereby avoiding impacts on downstream salmonids. Any turbid water within the confined work areas would be pumped to a receiving site outside the channel or to frak tanks. Any turbid water within the work area would be allowed to settle prior to removal of the cofferdams, thereby minimizing downstream effects on salmonids.

BIO-2: Discharge of sediment will be controlled and minimized with the implementation of best management practices (BMPs) on all disturbed soils that have the potential to discharge into area watercourses. Applicable BMPs include, but are not limited to, installation of silt fences, straw wattles, and placement of seed-free rice straw. BMPs will be installed at all access points to the work sites, which will minimize the potential for sediment delivery and deleterious effects on salmonids.

BIO-3: All gully stabilization work will be conducted when the individual sites are dry (i.e. no surface water).

BIO-4: A June 15 – November 1 instream work window will be established to allow time for young-of-the-year salmonids to be very mobile and capable of avoiding injury. The work window will also allow downstream migration of smolts to be completed prior to any Project-related channel disturbance taking place. In addition, the work window coincides with the summer low-flow season during which flow in the creek will be at its summer base flow. Finally, the November 1 date will ensure all work is done prior to the rainy season and arrival of any upstream migrating adult salmonids.

BIO-5: Prior to the initiation of any instream work in areas with surface water, a qualified biologist will survey the site to determine fish presence. The biologist will herd or relocate any fish that may be in work sites to suitable habitat downstream. Block nets will be installed to prevent fish from reentering the work area. Any fish remaining in the work area will be captured by hand, dip net, or as a last resort, using a backpack electrofisher. Cofferdams will be constructed in the channel at sites where streamflow is present. Water will then be diverted around the work area.

BIO-6: The Project will follow the Fish Screening Criteria for Salmonids (NMFS 1997), NOAA Restoration Center/Army Corps of Engineers programmatic biological opinion requirements.

BIO-7: A foothill yellow-legged frog egg mass survey will be conducted in May prior to the operations season to determine if breeding occurs within the Project reaches.

BIO-8: A visual observation survey of the project areas will be conducted within three days to two weeks prior to the start of operations to determine if adult and juvenile foothill yellow-legged frogs are present in the Project area.

BIO-9: If foothill yellow-legged frogs are present, then a qualified CDFW-approved biologist will be present immediately prior to the start of operations to remove any frogs and relocate them in suitable habitat.

BIO-10: The Project manager or qualified designee will conduct daily morning inspections of the area slated for work to determine if amphibians entered the areas overnight. Any individuals will be captured and relocated prior to the start of the day’s work.

BIO-11: Terrestrial woody debris will be left in place to the greatest extent practicable during operations within the riparian areas.

BIO-12: Prior to the initiation of any instream work in areas with surface water, a qualified biologist will survey the site to determine larval newt presence. If red-bellied newts are present, then a qualified CDFW-approved biologist will be present immediately prior to the start of operations to remove any individuals and relocate them in suitable habitat.

BIO-13: A pre-construction nesting bird survey will be conducted during the breeding season and within two weeks of the start of construction. Appropriate buffers will be established around all active nests within the Project area.

BIO-14: Prior to the initiation of any instream work in areas with surface water, a qualified biologist will survey the site to determine turtle presence. The biologist will capture and relocate any turtle that may be in work sites to suitable habitat downstream. Block nets will be installed to prevent turtles from reentering the work area.

BIO-15: Planting of seedlings shall begin after December 1, or when sufficient rainfall has occurred to ensure the best chance of survival of the seedlings, but in no case after April 1.

BIO-16: Any disturbed banks shall be fully restored upon completion of construction. Revegetation shall be done using native species. Planting techniques can include seed casting, hydroseeding, or live planting methods using the techniques in Part XI of the California Salmonid Stream Habitat Restoration Manual.

BIO-17: Disturbed and compacted areas shall be re-vegetated with native plant species. The species shall be comprised of a diverse community structure that mimics the native riparian corridor. Planting ratio shall be 2:1 (two plants to every one removed). Unless otherwise specified, the standard for success is 80 percent survival of plantings or 80 percent ground cover for broadcast planting of seed after a period of 3 years.

BIO-18: To ensure that the spread or introduction of invasive exotic plants shall be avoided to the maximum extent possible, equipment shall be cleaned of all dirt, mud, and plant material prior to entering a work site. When possible, invasive exotic plants at the work site shall be removed. Areas disturbed by project activities will be restored and planted with native plants.

BIO-19: Mulching and seeding shall be done on all exposed soil which may deliver sediment to a stream. Soils exposed by project operations shall be mulched to prevent sediment runoff and transport. Mulches shall be applied so that not less than 90% of the disturbed areas are covered. All mulches, except hydro-mulch, shall be applied in a layer not less than two (2) inches deep. Where feasible, all mulches shall be kneaded or tracked-in with track marks parallel to the contour, and tackified as necessary to prevent excessive movement. All exposed soils and fills, including the downstream face of the road prism adjacent to the outlet of culverts, shall be reseeded with a mix of native grasses common to the area, free from seeds of noxious or invasive weed species, and applied at a rate which will ensure establishment.

BIO-20: If erosion control mats are used in re-vegetation, they shall be made of material that decomposes. Erosion control mats made of nylon plastic, or other non-decomposing material shall not be used.

BIO-21: If riparian vegetation is to be removed with chainsaws, the Permittee shall use saws that operate with vegetable-based bar oil when possible.

2.5 Cultural Resources

2.5.1 Design features

The project design has been developed to avoid culturally sensitive areas.

2.5.2 Mitigation measures

An archaeological assessment (Appendix C) and tribal group consultation have indicated that cultural resources are present within a portion of the project site. Potential for inadvertent impacts at all sites will be avoided through implementation of the following mitigation measures:

CR-1: Cultural and/or paleontological resources on the site will be protected by the Permittee through implementation of the following protective measures before work can proceed:

- The site boundary shall be clearly marker during project implementation. Boundary markers such as flagging, stakes, fencing, or other highly visible barrier should be used.
- The area containing the archaeological site shall be completely excluded from ground disturbing activities. The proposed path of the pond intake pipeline and primary spillway have been rerouted to avoid ground disturbance to the identified sensitive area.
- Spoils from pond excavation may be placed directly on the existing site surface, however, no grading or scarifying shall be conducted. Heavy equipment shall not enter the site unless atop a sufficient layer of fill, such that the underlying soil is not displaced.

- All ground-disturbing activities and placement of fill material within the known archaeological site shall be monitored by a professional archaeologist familiar with specific project conditions. A monitoring plan should be developed and used to guide monitoring and discovery protocol.
- This archaeological site should be continuously monitored after project construction. The landowner or designee should watch for erosion, unauthorized collecting, and other site damages as a result of this site now being identified.
- In the event additional archaeological material is encountered during project implementation or during future site monitoring efforts, all work shall stop in the area of the find and the discovery protocol initiated as described below in CR-3.

CR-2: The Permittee shall ensure that the implementation contractor or responsible party is aware of these site-specific conditions, and shall inspect the work site before, during, and after completion of the action item.

CR-3: Inadvertent Discovery of Cultural Resources - If cultural resources are encountered during construction activities, all onsite work shall cease in the immediate area and within a 50-foot buffer of the discovery location. A qualified archaeologist will be retained to evaluate and assess the significance of the discovery, and develop and implement an avoidance or mitigation plan, as appropriate. For discoveries known or likely to be associated with Native American heritage (prehistoric sites and select historic period sites), the tribes listed in Section 6.2 and those that the County has on file shall also be contacted immediately to evaluate the discovery and, in consultation with the project proponent, the County, and consulting archaeologist, develop a treatment plan in any instance where significant impacts cannot be avoided. Prehistoric materials which could be encountered include obsidian and chert debitage or formal tools, grinding implements, (e.g., pestles, handstones, bowl mortars, slabs), locally darkened midden, deposits of shell, faunal remains, and human burials. Historic archaeological discoveries may include nineteenth century building foundations, structural remains, or concentrations of artifacts made of glass, ceramics, metal or other materials found in buried pits, wells or privies.

CR-4: Inadvertent Discovery of Human Remains - If human remains are discovered during project construction, work shall stop at the discovery location, within 20 meters (66 feet), and any nearby area reasonably suspected to overlie adjacent human remains (Public Resources Code, Section 7050.5). The county coroner shall be contacted to determine if the cause of death must be investigated. If the coroner determines that the remains are of Native American origin, it is necessary to comply with state laws relating to the disposition of Native American burials, which fall within the jurisdiction of the Native American heritage Commission (NAHC) (Public Resources Code, Section 5097). The coroner will contact the NAHC. The descendants or most likely descendants of the deceased will be contacted, and work shall not resume until they have made a recommendation to the landowner or the person responsible for the excavation work for means of treatment and disposition, with appropriate dignity, of the human remains and any associated grave goods, as provided in Public Resources Code, Section 5097.98.

CR-5: Procedures for treatment of an inadvertent discovery of human remains:

a) Immediately following discovery of known or potential human remains all ground-disturbing activities at the point of discovery shall be halted.
b) No material remains shall be removed from the discovery site, a reasonable exclusion zone shall be cordoned off.

c) The property owner shall be notified and the Permittee Project Manager shall contact the county coroner.
d) The Permittee shall retain the services of a professional archaeologist to immediately examine the find and assist the process.
e) All ground-disturbing construction activities in the discovery site exclusion area shall be suspended.
f) The discovery site shall be secured to protect the remains from desecration or disturbance, with 24-hour surveillance, if prudent.
g) Discovery of Native American remains is a very sensitive issue, and all project personnel shall hold any information about such a discovery in confidence and divulge it only on a need-to-know basis, as determined by the CDFW.
h) The coroner has two working days to examine the remains after being notified. If the remains are Native American, the coroner has 24 hours to notify the NAHC in Sacramento (telephone 916/653-4082).
i) The NAHC is responsible for identifying and immediately notifying the Most Likely Descendant (MLD) of the deceased Native American.
j) The MLD may, with the permission of the landowner, or their representative, inspect the site of the discovered Native American remains and may recommend to the landowner and Permittee means for treating or disposing, with appropriate dignity, the human remains and any associated grave goods. The descendants shall complete their inspection and make recommendations or preferences for treatment with 48 hours of being granted access to the site (Public Resource Code, Section 5097.98(a)). The recommendation may include the scientific removal and non-destructive or destructive analysis of human remains and items associated with Native American burials.
k) Whenever the NAHC is unable to identify a MLD, or the MLD identified fails to make a recommendation, or the landowner or his/her authorized representative rejects the recommendation of the MLD and mediation between the parties by the NAHC fails to provide measures acceptable to the landowner, the landowner or his/her authorized representatives shall re-inter the human remains and associated grave offerings with appropriate dignity on the property in a location not subject to further subsurface disturbance in accordance with Public Resource Code, Section 5097.98(e).
l) Following final treatment measures, the Permittee shall ensure that a report is prepared that describes the circumstances, nature and location of the discovery, its treatment, including results of analysis (if permitted), and final disposition, including a confidential map showing the reburial location. Appended to the report shall be a formal record about the discovery site prepared to current California standards on DPR 523 form(s). Permittee shall ensure that report copies are distributed to the appropriate California Historic Information Center, NAHC, and MLD.
m) The Permittee shall report any previously unknown historic, archeological, and paleontological remains discovered at a project location to the USACE as required in the RGP.
n) If it becomes impossible to implement the project at a work site without disturbing cultural or paleontological resources, then activity at that work site shall be discontinued.

2.6 Energy

No specific design features or mitigation measures are required to minimize impacts.

2.7 Geology and Soils

Implementation of the streamflow enhancement project is expected to contribute to an overall reduction in stormwater runoff and associated erosion at the project site. The following design features and mitigation measures will ensure that impacts on geology and soils are less than significant.

2.7.1 Design features, Construction Oversight and Monitoring

- The project design has incorporated numerous features to reduce the potential for landsliding and other risks associated with geology and soils:
    - Pond liner made of long-lasting High-density Polyethylene (HDPE) and covered with gravel will reduce the risk of a clay liner breaking down over time due to erosion and expansive soils. This will prevent undesirable increases in groundwater levels thereby reducing the risk of landslides.
    - French drain under the pond will drain water from the pond site and downslope terrace improving stability.
    - The pond berm will be founded on bedrock.
    - Drainage berm installed downslope from the pond will divert surface flow away from the hummocky area.
    - Gully treatments will significantly reduce gully incision rates that over long time periods could destabilize portions of the site. Grade control structures will be utilized to control channel scour, sediment routing, and headwall cutting.
    - Crossing upgrades will return runoff to more natural pathways and reduce the risk of overtopping during large storm events.
    - Foundation funding has been secured to cover long-term operations, monitoring, and maintenance.
    - Data recorders/sensors will monitor pond water levels, groundwater levels, and will detect movement in the pond berm and relay that data to an alarm system.
    - Backup power supply will provide power to data recorders, sensors, valves and internet in the case of a power outage.
- Additionally, a long-term Operations, Monitoring and Maintenance Plan will be developed that describes yearly project operations and monitoring and the individuals/organizations responsible for each item. Specifically, Stillwater Sciences licensed geologist and engineer will be responsible for annual inspections of the project features. Additionally, Stillwater will be responsible for continuous monitoring of groundwater well data loggers and dam motion sensors to ensure that the project is functioning as designed and no issues arise that would lead to increased risk of landslides.
- A highly experienced licensed contractor – McCullough Construction – is on the project team and will be constructing the project. Licensed professionals from Stillwater Sciences and SHN Engineers and Geologists will be onsite and closely involved during construction activities to ensure that the project is constructed as designed and any

necessary field engineering arising from changing site conditions are addressed professionally based on best available science and engineering/geotechnical techniques.

- Stillwater Sciences' licensed geologist and engineer will be responsible for post-construction inspections of the project features and will be responsible for continuous monitoring of groundwater well data loggers and dam motion sensors to ensure that the project is functioning as designed and no issues arise that would lead to increased risk of geologic instability.

2.7.2 Mitigation measures

GEO-1: Work sites shall be winterized at the end of each day to minimize the eroding of unfinished excavations when significant rains are forecasted. Winterization procedures shall be supervised by a professional trained in erosion control techniques and involve taking necessary measures to minimize erosion on unfinished work surfaces. Winterization includes the following: smoothing unfinished surfaces to allow water to freely drain across them without concentration or ponding; compacting unfinished surfaces where concentrated runoff may flow with an excavator bucket or similar tool, to minimize surface erosion and the formation of rills; and installation of culverts, silt fences, and other erosion control devices where necessary to convey concentrated water across unfinished surfaces, and trap exposed sediment before it leaves the work site.

GEO-2: Effective erosion control measures shall be in-place at all times during construction. Construction within the 5-year flood plain shall not begin until all temporary erosion controls (i.e., straw bales or silt fences that are effectively keyed-in) are in place down slope or down stream of project activities within the riparian area. Erosion control measures shall be maintained throughout the construction period. If continued erosion is likely to occur after construction is completed, then appropriate erosion prevention measures shall be implemented and maintained until erosion has subsided.

GEO-3: An adequate supply of erosion control materials (gravel, straw bales, shovels, etc.) shall be maintained onsite to facilitate a quick response to unanticipated storm events or emergencies.

GEO-4: Upon project completion, all exposed soil present in and around the project site shall be stabilized within 7 days. Soils exposed by project operations shall be mulched to prevent sediment runoff and transport. Mulches shall be applied so that not less than 90% of the disturbed areas are covered. All mulches, except hydro-mulch, shall be applied in a layer not less than two (2) inches deep. Where feasible, all mulches shall be kneaded or tracked-in with track marks parallel to the contour, and tackified as necessary to prevent excessive movement. All exposed soils and fills, including the downstream face of the road prism adjacent to the outlet of culverts, shall be reseeded with a mix of native grasses common to the area, free from seeds of noxious or invasive weed species, and applied at a rate which will ensure establishment.

2.8 Greenhouse Gas Emissions

No specific mitigation measures are required. Installation and operation of the solar array and micro hydro system will offset the ongoing energy use of project operations. Long term fire suppression benefits of the project are expected to offset greenhouse gas emissions associated with construction.

2.9 Hazards and Hazardous Materials

No hazardous materials will be transported to the project site other than fuel, hydraulic fluid, lube oil, and coolant for the heavy equipment that will be used during construction. The following design features and mitigation measures will ensure that impacts relating to hazards and hazardous materials are less than significant.

2.9.1 Design features

Outside of the construction period, the project would not generate or involve use of any hazardous materials.

2.9.2 Mitigation measures

HAZ-1: Heavy equipment that will be used in these activities will be in good condition and will be inspected for leakage of coolant and petroleum products and repaired, if necessary, before work is started.

HAZ-2: When operating vehicles in wetted portions of the stream channel, or where wetland vegetation, riparian vegetation, or aquatic organisms may be destroyed, the responsible party shall, at a minimum, do the following:

- All equipment shall be cleaned to remove external oil, grease, dirt, or mud. Wash sites shall be located in upland locations so that dirty wash water does not flow into the stream channel or adjacent wetlands;
- Check and maintain on a daily basis any vehicles to prevent leaks of materials that, if introduced to water, could be deleterious to aquatic life, wildlife, or riparian habitat;
- Take precautions to minimize the number of passes through the stream and to avoid increasing the turbidity of the water to a level that is deleterious to aquatic life; and
- Allow the work area to rest to allow the water to clear after each individual pass of the vehicle that causes a plume of turbidity above background levels, resuming work only after the stream has reached the original background turbidity levels.

HAZ-3: All equipment operators shall be trained in the procedures to be taken should an accident occur. Prior to the onset of work, the Permittee shall prepare a Spill Prevention/Response plan to help avoid spills and allow a prompt and effective response should an accidental spill occur. All workers shall be informed of the importance of preventing spills. Operators shall have spill clean-up supplies on site and be knowledgeable in their proper deployment.

HAZ-4: All activities performed in or near a stream will have absorbent materials designed for spill containment and cleanup at the activity site for use in case of an accidental spill. In an event of a spill, work shall cease immediately. Clean-up of all spills shall begin immediately. The responsible party shall notify the State Office of Emergency Services at 1-800-852-7550 and the CDFW immediately after any spill occurs and shall consult with the CDFW regarding clean-up procedures.

HAZ-5: All fueling and maintenance of vehicles and other equipment and staging areas shall occur at least 65 feet from any riparian habitat or water body and place fuel absorbent mats under pump while fueling. The USACE and the CDFW will ensure contamination of habitat does not occur during such operations. Prior to the onset of work, the Permittee shall prepare a plan to allow a prompt and effective response to any accidental spills. All workers will be informed of the importance of preventing spills and of the appropriate measures to take should a spill occur.

HAZ-6: Location of staging/storage areas for equipment, materials, fuels, lubricants, and solvents, will be located outside of the streams high water channel and associated riparian area. The number of access routes, number and size of staging areas, and the total area of the work site activity shall be limited to the minimum necessary to complete the restoration action. To avoid contamination of habitat during restoration activities, trash will be contained, removed, and disposed of throughout the project.

HAZ-7: Petroleum products, fresh cement, and other deleterious materials shall not enter the stream channel.

HAZ-8: Stationary equipment such as motors, pumps, generators, compressors, and welders, located within the dry portion of the stream channel or adjacent to the stream, will be positioned over drip-pans.

HAZ-9: All internal combustion engines shall be fitted with spark arrestors.

HAZ-10: The Permittee shall have an appropriate fire extinguisher(s) and firefighting tools (shovel and axe at a minimum) present at all times when there is a risk of fire.

HAZ-11: Vehicles shall not be parked in tall grass or any other location where heat from the exhaust system could ignite a fire.

HAZ-12: The grantee shall follow any additional rules the landowner has for fire prevention.

2.10 Hydrology and Water Quality

Short-term increases in turbidity associated with the instream structure installation would be controlled by isolating the project area from flowing water, installing BMPs, and revegetating disturbed surfaces. The design features and mitigation measures **BIO 1-6, GEO 1–4** and **HAZ-1–8** described above, as well as **HYD-1** described below will assure that the project actions are in compliance with water quality standards and that impacts on water quality are avoided or mitigated to below a level of significance.

2.10.1 Design features, Construction Oversight, and Monitoring

- Before instream work proceeds, turbidity control measures will be in place.
- Any wastewater from construction area shall be discharged to an upland location where it will not drain sediment-laden water back to stream channel.
- To control erosion during and after project implementation, the Permittee shall implement best management practices, as identified by the appropriate Regional Water Quality Control Board.

- Sediment-laden water caused by construction activity shall be filtered before it leaves the right-of-way or enters the stream network or an aquatic resource area. Silt fences or other detention methods shall be installed as close as possible to culvert outlets to reduce the amount of sediment entering aquatic systems.
- Diversions to fill storage facilities during the winter and spring months shall be made pursuant to the appropriate type of water right and filed with the SWRCB. CDFW will review the appropriation of water to ensure fish and wildlife resources are protected. The following preliminary conditions are proposed for surface water diversions and shall be revised as appropriate through consultation and permit condition negotiation with CDFW and SWB:
  - Seasonal Restriction: No pumping is allowed when stream flow drops below a threshold of ~5 cfs (to be determined by CDFW and SWRCB) except as permitted by CDFW in the event of an emergency.
  - Bypass Flows: Pumping withdrawal rates shall not exceed 5% of stream flow and pumping will typically not be allowed at flows lower than 5 cfs
- CDFW and SWB shall be granted access to inspect the pump system. Access is limited to the portion of the landowner's real property where the pump is located and those additional portions of the real property which must be traversed to gain access to the pump site. Landowners shall be given reasonable notice and any necessary arrangements will be made prior to requested access including a mutually-agreed-upon time and date. Notice may be given by mail or by telephone with the landowner or an authorized representative of the landowner. The landowner shall agree to cooperate in good faith to accommodate CDFW and SWB access.
- Off-channel pond will be constructed to minimize erosion through engineering of berms and spillways to carry 100-year flows and withstand seismic force.
- Dry season flow releases shall have sufficiently low temperature and nutrient levels to provide high quality rearing habitat for juvenile salmonids. This shall be achieved through the project features described in Design Plans in Appendix A.2 of the Basis of Design Report including the outflow at the bottom of the pond, water chiller, floating circulator, and fence excluding livestock from the pond. Water quality will be maintained during the life of the project through implementation of the Operations, Monitoring and Maintenance Plan that will be developed for the project and will define yearly project operations, monitoring and maintenance the individuals/organizations responsible for each action.
- Implementation of the streamflow enhancement project is expected to contribute to an overall reduction in stormwater runoff and associated flooding and mudflow risk as described above and in the Basis of Design Report for the project. To further reduce the risk of flooding resulting from dam failure, an earthen and rock armored berm is proposed between the project and the nearest downslope neighbor which has been designed to deflect flows of at least 1,000 cubic feet per second (cfs) during the worst case dam breach scenario.

2.10.2 Mitigation measures

HYD-1: As required by final CDFW and SWB permit conditions, flow and temperature monitoring results, flow augmentation amounts, and diversion operations will be reported to regulatory agency staff on an annual basis. Based on this data, diversion and flow augmentation operations will be adjusted and optimized as appropriate to protect and enhance downstream aquatic habitat to the greatest extent feasible.

2.11 Land Use and Planning

No specific design features or mitigation measures are required to minimize impacts.

2.12 Mineral Resources

No specific design features or mitigation measures are required to minimize impacts.

2.13 Noise

2.13.1 Design features

The project will utilize passive structures that will not generate excessive noise. A pump however, will be used during the wet season to divert water from Redwood Creek to help fill the pond. The pump will be installed in a wet well adjacent to the channel and will only run approximately 30 days per year when stream flows are high. Additionally, a water chiller may also be operated several days a year but will be housed in a utility building to reduce noise levels. While these project components will create an intermittent, long-term increase in ambient noise levels, they are powered by electric motors, will be housed in a wet well/utility building, and will likely only be audible to those within the immediate proximity. As such, this operational noise will constitute a less than significant impact.

2.13.2 Mitigation Measures

NOISE 1: To reduce the possibility of the construction noise and vibrations becoming an annoyance to sensitive receptors near the Project, exterior construction activity shall be confined to the weekday hours of 7:00 am to 7:00 pm or until sunset, whichever is later, and weekend hours of 8:00 am to 6:00 pm or until sunset, whichever is later. No heavy equipment related construction activities shall be allowed on Sundays or holidays.

NOISE 2: The Permittee shall notify sensitive receptors (all property owners within 350 feet) of potential impacts from noise and vibration prior to initiating each construction phase. The notice shall describe construction activities and anticipated noise and/or vibrations from these activities, and the duration and operational hours of construction activities. The notice will also include a contact that sensitive receptors may call to report noise or vibration concerns. The notice will include a request that property owners share the notice with any employee or tenants working within 350 feet of the project site.

NOISE 3: Construction equipment shall be properly maintained and equipped with noise control devices, such as mufflers and shrouds, in accordance with manufacturers' specifications.

2.14 Population and Housing

No specific design features or mitigation measures are required to minimize impacts.

2.15 Public Services

No specific design features or mitigation measures are required to minimize impacts.

2.16 Recreation

No specific design features or mitigation measures are required to minimize impacts.

2.17 Tribal Cultural Resources

No specific design features or mitigation measures are required to minimize impacts.

2.18 Transportation

No specific design features or mitigation measures are required to minimize impacts.

2.19 Utilities and Service Systems

The project will construct a facility to store water during the wet season and release water during the dry season to enhance aquatic habitat, so the project is not expected to cause significant negative environmental impacts. The project also includes construction and operation of small solar and micro-hydro energy generation to offset power use of the project. The facility will be tied into the grid via a Net Energy Metering (NEM) connection.

2.19.1 Design features

Underground lines will also run between the solar panels, control center building, and pump before connecting to the existing PG&E service. Impacts that could occur during installation will be primarily associated with ground disturbance, which will be localized along the trenches where utilities will be buried.

2.19.2 Mitigation Measures

Impacts will be reduced to a less than significant level by the installation of erosion control BMPs and revegetation and other mitigation measures (**GEO 1–4**) detailed in the Geology section above.

2.20 Wildfire

The project is located in a meadow area and will include the installation and upgrading of access roads, hydrants, pond, and buried underground electrical lines.

2.20.1 Design features

The access roads can serve as fire breaks, which would lessen the risk of fire spread over the current condition. The pond and hydrants can be called upon to supply water in the unlikely event of a wildfire, which is a significant improvement over the current condition. The powerlines leading from the current PG&E service to the control center building and associated infrastructure will be underground and would not increase the risk of wildfire.

2.20.2 Mitigation Measures

No specific mitigation measures are required to minimize impacts.

3 MONITORING AND REPORTING

The Project will be funded through agency and foundation grants that include effectiveness monitoring and reporting. Additionally, agency–specific permits will be obtained prior to implementation and the Project will comply with all state, federal and county regulations. The permittee shall implement the following measures to ensure that the treatments at all Project sites will minimize take of listed salmonids, monitor and report take of listed salmonids, and to obtain specific information to account for the effects and benefits of the Project.

1) The Permittee shall notify all agencies (CDFW, Humboldt County, NCRWQCB, USACE, NOAA, and USFWS) prior to the commencement of work based on the conditions listed in the agency-specific permit.
2) The Permittee Project Manager shall inspect the work site before, during, and after completion of each action item, to ensure that all necessary mitigation measures to avoid impacts are properly implemented.
3) The Permittee shall perform implementation monitoring immediately after each project feature is completed to ensure that projects are completed as designed.
4) The Permittee shall perform effectiveness/validation monitoring for the project.
5) Current monitoring forms and instructions used by CDFW for the implementation monitoring and effectiveness monitoring are found in the California Salmonid Stream Habitat Restoration Manual. Additional monitoring protocols for groundwater and streamflow currently not included in the manual but developed by the Permittee, CDFW, and consultants will also be used.
6) The Permittee shall provide reports to all agencies, (CDFW, Humboldt County, NCRWQCB, SWRCB, USACE, NOAA, and USFWS) based on requirements of the agency-specific permits obtained for the project.
7) The Permittee shall monitor and maintain the structures or work conducted at a given site as per the requirements of agency- specific permits and funding obtained for the project.

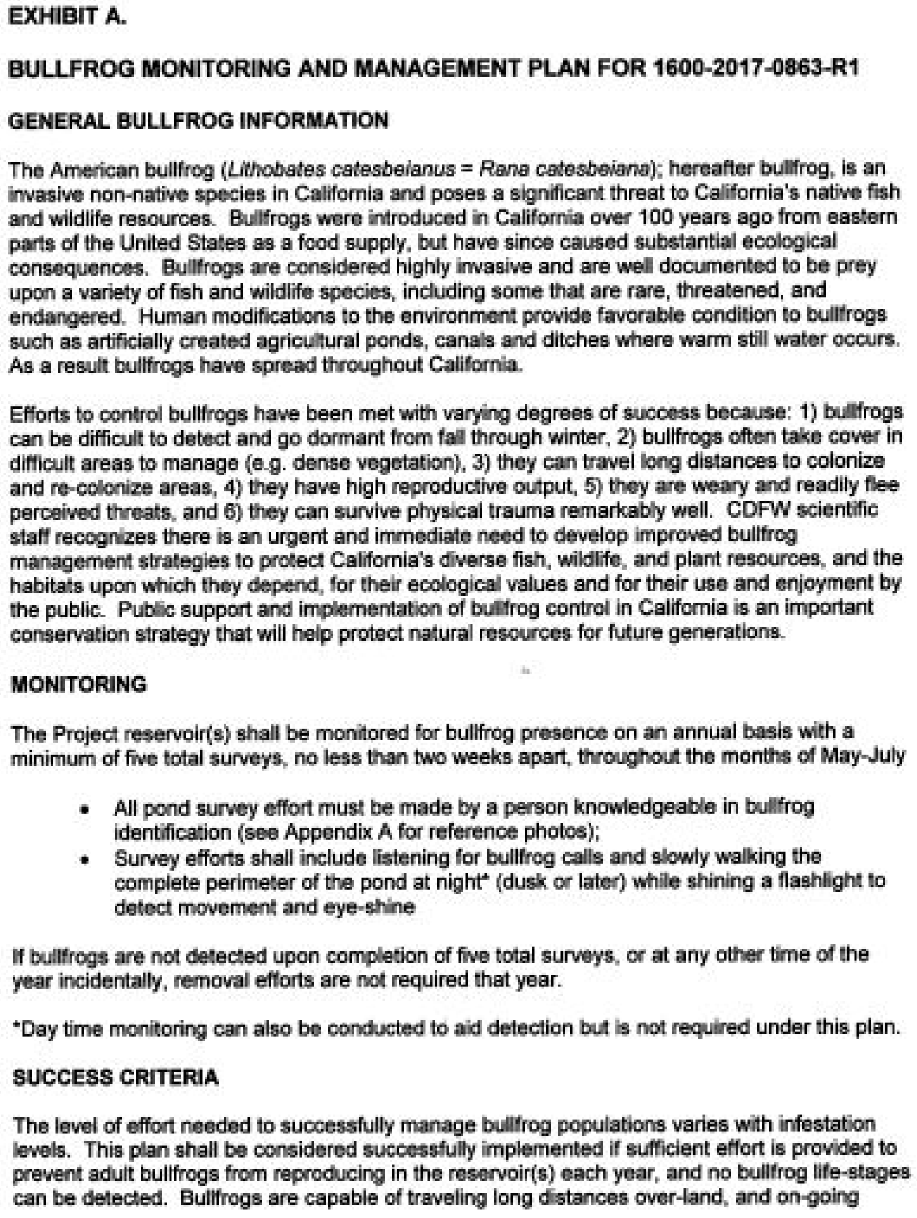


EXHIBIT A.

BULLFROG MONITORING AND MANAGEMENT PLAN FOR 1600-2017-0863-R1

GENERAL BULLFROG INFORMATION

The American bullfrog (*Lithobates catesbeianus* = *Rana catesbeiana*); hereafter bullfrog, is an invasive non-native species in California and poses a significant threat to California's native fish and wildlife resources. Bullfrogs were introduced in California over 100 years ago from eastern parts of the United States as a food supply, but have since caused substantial ecological consequences. Bullfrogs are considered highly invasive and are well documented to be prey upon a variety of fish and wildlife species, including some that are rare, threatened, and endangered. Human modifications to the environment provide favorable condition to bullfrogs such as artificially created agricultural ponds, canals and ditches where warm still water occurs. As a result bullfrogs have spread throughout California.

Efforts to control bullfrogs have been met with varying degrees of success because: 1) bullfrogs can be difficult to detect and go dormant from fall through winter, 2) bullfrogs often take cover in difficult areas to manage (e.g. dense vegetation), 3) they can travel long distances to colonize and re-colonize areas, 4) they have high reproductive output, 5) they are weary and readily flee perceived threats, and 6) they can survive physical trauma remarkably well. CDFW scientific staff recognizes there is an urgent and immediate need to develop improved bullfrog management strategies to protect California's diverse fish, wildlife, and plant resources, and the habitats upon which they depend, for their ecological values and for their use and enjoyment by the public. Public support and implementation of bullfrog control in California is an important conservation strategy that will help protect natural resources for future generations.

MONITORING

The Project reservoir(s) shall be monitored for bullfrog presence on an annual basis with a minimum of five total surveys, no less than two weeks apart, throughout the months of May-July

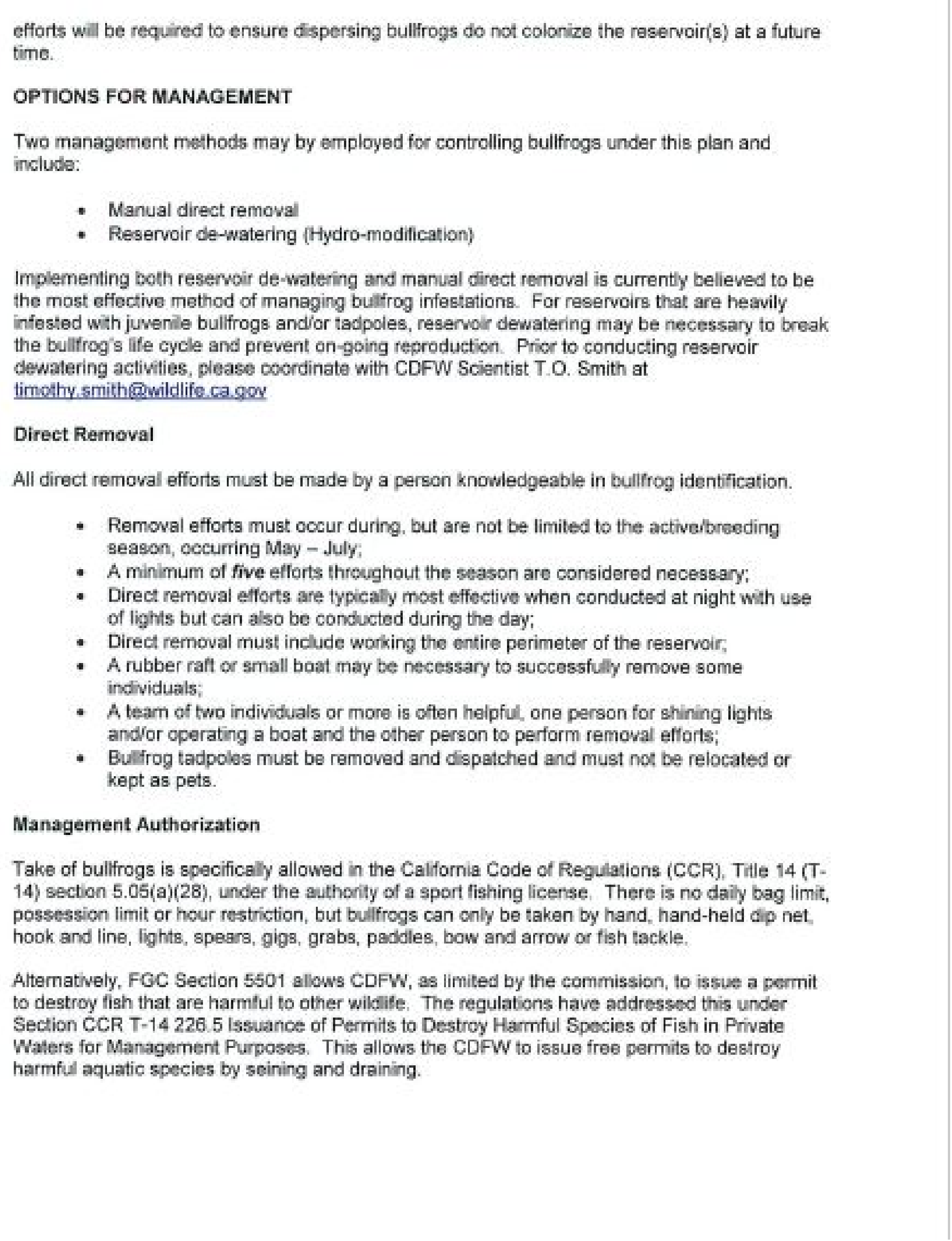
- All pond survey effort must be made by a person knowledgeable in bullfrog identification (see Appendix A for reference photos);
- Survey efforts shall include listening for bullfrog calls and slowly walking the complete perimeter of the pond at night* (dusk or later) while shining a flashlight to detect movement and eye-shine

If bullfrogs are not detected upon completion of five total surveys, or at any other time of the year incidentally, removal efforts are not required that year.

*Day time monitoring can also be conducted to aid detection but is not required under this plan.

SUCCESS CRITERIA

The level of effort needed to successfully manage bullfrog populations varies with infestation levels. This plan shall be considered successfully implemented if sufficient effort is provided to prevent adult bullfrogs from reproducing in the reservoir(s) each year, and no bullfrog life-stages can be detected. Bullfrogs are capable of traveling long distances over-land, and on-going



efforts will be required to ensure dispersing bullfrogs do not colonize the reservoir(s) at a future time.

OPTIONS FOR MANAGEMENT

Two management methods may by employed for controlling bullfrogs under this plan and include:

- Manual direct removal
- Reservoir de-watering (Hydro-modification)

Implementing both reservoir de-watering and manual direct removal is currently believed to be the most effective method of managing bullfrog infestations. For reservoirs that are heavily infested with juvenile bullfrogs and/or tadpoles, reservoir dewatering may be necessary to break the bullfrog's life cycle and prevent on-going reproduction. Prior to conducting reservoir dewatering activities, please coordinate with CDFW Scientist T.O. Smith at timothy.smith@wildlife.ca.gov

Direct Removal

All direct removal efforts must be made by a person knowledgeable in bullfrog identification.

- Removal efforts must occur during, but are not be limited to the active/breeding season, occurring May – July;
- A minimum of ***five*** efforts throughout the season are considered necessary;
- Direct removal efforts are typically most effective when conducted at night with use of lights but can also be conducted during the day;
- Direct removal must include working the entire perimeter of the reservoir;
- A rubber raft or small boat may be necessary to successfully remove some individuals;
- A team of two individuals or more is often helpful, one person for shining lights and/or operating a boat and the other person to perform removal efforts;
- Bullfrog tadpoles must be removed and dispatched and must not be relocated or kept as pets.

Management Authorization

Take of bullfrogs is specifically allowed in the California Code of Regulations (CCR), Title 14 (T-14) section 5.05(a)(28), under the authority of a sport fishing license. There is no daily bag limit, possession limit or hour restriction, but bullfrogs can only be taken by hand, hand-held dip net, hook and line, lights, spears, gigs, grabs, paddles, bow and arrow or fish tackle.

Alternatively, FGC Section 5501 allows CDFW, as limited by the commission, to issue a permit to destroy fish that are harmful to other wildlife. The regulations have addressed this under Section CCR T-14 226.5 Issuance of Permits to Destroy Harmful Species of Fish in Private Waters for Management Purposes. This allows the CDFW to issue free permits to destroy harmful aquatic species by seining and draining.

Pond Dewatering

Pond dewatering may be appropriate if the reservoir can be successfully dewatered without adversely affecting stream resources. Careful planning and coordination with CDFW, is necessary to ensure potential impacts to stream resources can be addressed, prior to commencing with pond draining. Discharge of polluted water to waters of the state may require permitting from other agencies with permitting authority, such as the Regional Water Quality Control Board.

In general, bullfrog tadpoles require two years to develop into frogs, whereas native amphibians only require one year. Therefore, draining a reservoir every year is intended to interrupt bullfrog tadpole development, dramatically decrease bullfrog populations and allow for reduced efforts as a measure of adaptive management. Typically in Northern California, reservoir draining should occur in September through October to avoid impacts to sensitive native amphibian and fishery resources. While draining occurs, direct removal efforts should be employed as described above if possible.

REPORTING

A written log shall be kept of monitoring and management efforts and shall be provided to CDFW **each year** by December 31. The written log shall include: 1) date and time of each monitoring and management effort, 2) approximate number of each bullfrog life stage detected and/or removed per effort, and 3) amount of time spent for each monitoring and management effort.

APPENDIX A. BULLFROG REFERENCE PHOTOS

This is a photo of a Bullfrog tadpole. (Photo taken by Mike van Hattem).

The photos shown in this Appendix demonstrate a medium sized adult bullfrog that was removed from Ten Mile Creek, Mendocino County. Note the bullfrog has a large tympanum, (circular ear drum shown with an arrow) and **does not** have distinct ridges along its back (dorsolateral folds). Photo taken by Wes Stokes.

The bullfrog has somewhat distinct mottling and **the underside of the bullfrogs hind legs are not shaded pink or red.**

Attachment B

Project Emissions Background Documentation

(CalEEMod)

Marshall Ranch Flow Enhancement

Humboldt County, Annual

1.0 Project Characteristics

1.1 Land Usage

Land Uses	Size	Metric	Lot Acreage	Floor Surface Area	Population
Recreational Swimming Pool	140.00	1000sqft	3.21	140,000.00	0

1.2 Other Project Characteristics

Urbanization	Rural	**Wind Speed (m/s)**	2.2	**Precipitation Freq (Days)**	103
Climate Zone	1			**Operational Year**	2022
Utility Company	Pacific Gas & Electric Company				
CO2 Intensity (lb/MWhr)	641.35	**CH4 Intensity (lb/MWhr)**	0.029	**N2O Intensity (lb/MWhr)**	0.006

1.3 User Entered Comments & Non-Default Data

Project Characteristics -

Land Use - This project does not fit the pre-defined land use types or subtypes so the nearest possible landuse was selected - recreational swimming pool.

Grading -

Construction Phase - Modified construction start time so all work will occur in one year. Modified proportion of grading vs proportion of building to better align with this project type. Overlapped grading and building phases to match reality of likely construction sequencing. Minimized days of paving and architectural coating because this project only involves a minor amount of those tasks.

Off-road Equipment - Modifed equipment to match equipment that will be used for this project.

Off-road Equipment - Modified equipment based on what will be used for this project.

Off-road Equipment - Modifed equipment to match equipment that will be used for this project.

Off-road Equipment - Modifed equipment to match equipment that will be used for this project.

Off-road Equipment -

Off-road Equipment -

Stationary Sources - Emergency Generators and Fire Pumps - For this analyses, diesel fire pump substituted for electric pump with similar horsepower; Assumes pump runs 30 days/year.

Road Dust -

Water And Wastewater - Energy used for pumping and cooling water entered seperately.

Solid Waste - Project will generate minimal solid waste.

Stationary Sources - User Defined -

Stationary Sources - Process Boilers - For this analyses, diesel boiler substituted for electric water chiller with similar energy usage; Assumes that it runs 7 days/year.

Land Use Change -

Energy Mitigation -

Vehicle Trips - There is no actual recreation at this pool.

Table Name	Column Name	Default Value	New Value
tblConstructionPhase	NumDays	8.00	181.00
tblConstructionPhase	NumDays	230.00	67.00
tblConstructionPhase	NumDays	18.00	1.00
tblConstructionPhase	NumDays	18.00	1.00

tblConstructionPhase	PhaseEndDate	2/16/2021	10/15/2021
tblConstructionPhase	PhaseEndDate	1/4/2022	10/15/2021
tblConstructionPhase	PhaseEndDate	1/28/2022	10/16/2021
tblConstructionPhase	PhaseEndDate	2/23/2022	10/18/2021
tblConstructionPhase	PhaseStartDate	2/17/2021	7/15/2021
tblConstructionPhase	PhaseStartDate	1/5/2022	10/15/2021
tblConstructionPhase	PhaseStartDate	1/29/2022	10/17/2021
tblGrading	AcresOfGrading	90.50	4.00
tblGrading	AcresOfGrading	7.50	0.00
tblOffRoadEquipment	HorsePower	84.00	81.00
tblOffRoadEquipment	HorsePower	212.00	247.00
tblOffRoadEquipment	HorsePower	212.00	247.00
tblOffRoadEquipment	HorsePower	158.00	97.00
tblOffRoadEquipment	LoadFactor	0.74	0.73
tblOffRoadEquipment	LoadFactor	0.43	0.40
tblOffRoadEquipment	LoadFactor	0.43	0.40
tblOffRoadEquipment	LoadFactor	0.38	0.37
tblOffRoadEquipment	LoadFactor	0.50	0.50
tblOffRoadEquipment	OffRoadEquipmentType	Concrete/Industrial Saws	Generator Sets
tblOffRoadEquipment	OffRoadEquipmentType	Rubber Tired Dozers	Crawler Tractors
tblOffRoadEquipment	OffRoadEquipmentType	Rubber Tired Dozers	Crawler Tractors
tblOffRoadEquipment	OffRoadEquipmentType	Tractors/Loaders/Backhoes	Excavators
tblOffRoadEquipment	OffRoadEquipmentType		Off-Highway Trucks
tblOffRoadEquipment	OffRoadEquipmentType		Bore/Drill Rigs
tblProjectCharacteristics	UrbanizationLevel	Urban	Rural
tblSolidWaste	LandfillCaptureGasFlare	94.00	0.00
tblSolidWaste	LandfillNoGasCapture	6.00	0.00

tblSolidWaste	SolidWasteGenerationRate	798.00	1.00
tblStationaryBoilersUse	AnnualHeatInput	0.00	24.02
tblStationaryBoilersUse	BoilerRatingValue	0.00	1.43
tblStationaryBoilersUse	DailyHeatInput	0.00	0.07
tblStationaryBoilersUse	NumberOfEquipment	0.00	1.00
tblStationaryGeneratorsPumpsEF	CH4_EF	0.07	0.07
tblStationaryGeneratorsPumpsEF	ROG_EF	2.2480e-003	2.2477e-003
tblStationaryGeneratorsPumpsUse	HorsePowerValue	0.00	7.50
tblStationaryGeneratorsPumpsUse	HoursPerDay	0.00	2.00
tblStationaryGeneratorsPumpsUse	HoursPerYear	0.00	720.00
tblStationaryGeneratorsPumpsUse	NumberOfEquipment	0.00	1.00
tblTripsAndVMT	HaulingTripNumber	0.00	625.00
tblTripsAndVMT	WorkerTripNumber	23.00	15.00
tblTripsAndVMT	WorkerTripNumber	35.00	18.00
tblVehicleTrips	ST_TR	9.10	0.00
tblVehicleTrips	SU_TR	13.60	0.00
tblVehicleTrips	WD_TR	33.82	0.00
tblWater	IndoorWaterUseRate	8,280,040.17	0.00
tblWater	OutdoorWaterUseRate	5,074,863.33	0.00

2.0 Emissions Summary

2.1 Overall Construction

Unmitigated Construction

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Year	tons/yr										MT/yr					
2021	0.5062	4.7807	3.4721	8.0300e-003	0.6498	0.2078	0.8576	0.3401	0.1921	0.5322	0.0000	708.1022	708.1022	0.1967	0.0000	713.0190
Maximum	**0.5062**	**4.7807**	**3.4721**	**8.0300e-003**	**0.6498**	**0.2078**	**0.8576**	**0.3401**	**0.1921**	**0.5322**	**0.0000**	**708.1022**	**708.1022**	**0.1967**	**0.0000**	**713.0190**

Mitigated Construction

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Year	tons/yr										MT/yr					
2021	0.5062	4.7807	3.4720	8.0300e-003	0.6498	0.2078	0.8576	0.3401	0.1921	0.5322	0.0000	708.1014	708.1014	0.1967	0.0000	713.0183
Maximum	**0.5062**	**4.7807**	**3.4720**	**8.0300e-003**	**0.6498**	**0.2078**	**0.8576**	**0.3401**	**0.1921**	**0.5322**	**0.0000**	**708.1014**	**708.1014**	**0.1967**	**0.0000**	**713.0183**

	ROG	**NOx**	**CO**	**SO2**	**Fugitive PM10**	**Exhaust PM10**	**PM10 Total**	**Fugitive PM2.5**	**Exhaust PM2.5**	**PM2.5 Total**	**Bio- CO2**	**NBio-CO2**	**Total CO2**	**CH4**	**N20**	**CO2e**
Percent Reduction	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

Quarter	Start Date	End Date	Maximum Unmitigated ROG + NOX (tons/quarter)	Maximum Mitigated ROG + NOX (tons/quarter)
1	**1-1-2021**	**3-31-2021**	1.5314	1.5314
2	**4-1-2021**	**6-30-2021**	1.3076	1.3076
3	**7-1-2021**	**9-30-2021**	2.0627	2.0627
		Highest	2.0627	2.0627

2.2 Overall Operational

Unmitigated Operational

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Area	1.1300e-003	1.0000e-005	1.2900e-003	0.0000		0.0000	0.0000		0.0000	0.0000	0.0000	2.5000e-003	2.5000e-003	1.0000e-005	0.0000	2.6700e-003
Energy	0.0000	0.0000	0.0000	0.0000		0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Mobile	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Stationary	4.1600e-003	0.0222	0.0248	4.0000e-005		1.3000e-003	1.3000e-003		1.2400e-003	1.2400e-003	0.0000	3.8648	3.8648	2.9000e-004	0.0000	3.8720
Waste						0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Water						0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Total	**5.2900e-003**	**0.0222**	**0.0261**	**4.0000e-005**	**0.0000**	**1.3000e-003**	**1.3000e-003**	**0.0000**	**1.2400e-003**	**1.2400e-003**	**0.0000**	**3.8673**	**3.8673**	**3.0000e-004**	**0.0000**	**3.8747**

2.2 Overall Operational

Mitigated Operational

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Area	1.1300e-003	1.0000e-005	1.2900e-003	0.0000		0.0000	0.0000		0.0000	0.0000	0.0000	2.5000e-003	2.5000e-003	1.0000e-005	0.0000	2.6700e-003
Energy	0.0000	0.0000	0.0000	0.0000		0.0000	0.0000		0.0000	0.0000	0.0000	-3.7819	-3.7819	-0.0002	0.0000	-3.7967
Mobile	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Stationary	4.1600e-003	0.0222	0.0248	4.0000e-005		1.3000e-003	1.3000e-003		1.2400e-003	1.2400e-003	0.0000	3.8648	3.8648	2.9000e-004	0.0000	3.8720
Waste						0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Water						0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Total	**5.2900e-003**	**0.0222**	**0.0261**	**4.0000e-005**	**0.0000**	**1.3000e-003**	**1.3000e-003**	**0.0000**	**1.2400e-003**	**1.2400e-003**	**0.0000**	**0.0855**	**0.0855**	**1.3000e-004**	**0.0000**	**0.0780**

	ROG	**NOx**	**CO**	**SO2**	**Fugitive PM10**	**Exhaust PM10**	**PM10 Total**	**Fugitive PM2.5**	**Exhaust PM2.5**	**PM2.5 Total**	**Bio- CO2**	**NBio-CO2**	**Total CO2**	**CH4**	**N20**	**CO2e**
Percent Reduction	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**97.79**	**97.79**	**56.67**	**0.00**	**97.99**

2.3 Vegetation

Vegetation

	CO2e
Category	MT
Vegetation Land Change	-17.2400
Total	**-17.2400**

3.0 Construction Detail

Construction Phase

Phase Number	Phase Name	Phase Type	Start Date	End Date	Num Days Week	Num Days	Phase Description
1	Demolition	Demolition	1/1/2021	1/28/2021	5	20	
2	Site Preparation	Site Preparation	1/29/2021	2/4/2021	5	5	
3	Grading	Grading	2/5/2021	10/15/2021	5	181	
4	Building Construction	Building Construction	7/15/2021	10/15/2021	5	67	
5	Paving	Paving	10/15/2021	10/16/2021	5	1	
6	Architectural Coating	Architectural Coating	10/17/2021	10/18/2021	5	1	

Acres of Grading (Site Preparation Phase): 0

Acres of Grading (Grading Phase): 4

Acres of Paving: 0

Residential Indoor: 0; Residential Outdoor: 0; Non-Residential Indoor: 300; Non-Residential Outdoor: 100; Striped Parking Area: 0 (Architectural Coating – sqft)

OffRoad Equipment

Phase Name	Offroad Equipment Type	Amount	Usage Hours	Horse Power	Load Factor
Demolition	Generator Sets	1	8.00	81	0.73
Demolition	Crawler Tractors	2	8.00	247	0.40
Demolition	Excavators	3	8.00	158	0.38
Grading	Excavators	1	8.00	158	0.38
Site Preparation	Crawler Tractors	3	8.00	247	0.40
Site Preparation	Excavators	4	8.00	97	0.37
Grading	Graders	1	8.00	187	0.41
Grading	Rubber Tired Dozers	1	8.00	247	0.40
Grading	Tractors/Loaders/Backhoes	3	8.00	97	0.37
Building Construction	Cranes	1	7.00	231	0.29
Building Construction	Forklifts	3	8.00	89	0.20
Building Construction	Generator Sets	1	8.00	84	0.74
Building Construction	Tractors/Loaders/Backhoes	3	7.00	97	0.37
Building Construction	Welders	1	8.00	46	0.45
Paving	Cement and Mortar Mixers	2	6.00	9	0.56
Paving	Pavers	1	8.00	130	0.42
Paving	Paving Equipment	2	6.00	132	0.36
Paving	Rollers	2	6.00	80	0.38
Paving	Tractors/Loaders/Backhoes	1	8.00	97	0.37
Architectural Coating	Air Compressors	1	6.00	78	0.48
Grading	Off-Highway Trucks	2	8.00	402	0.38
Building Construction	Bore/Drill Rigs	1	8.00	221	0.50
Demolition	Concrete/Industrial Saws	1	8.00	81	0.73
Demolition	Rubber Tired Dozers	2	8.00	247	0.40
Site Preparation	Rubber Tired Dozers	3	8.00	247	0.40
Site Preparation	Tractors/Loaders/Backhoes	4	8.00	97	0.37

Trips and VMT

Phase Name	Offroad Equipment Count	Worker Trip Number	Vendor Trip Number	Hauling Trip Number	Worker Trip Length	Vendor Trip Length	Hauling Trip Length	Worker Vehicle Class	Vendor Vehicle Class	Hauling Vehicle Class
Demolition	9	15.00	0.00	0.00	16.80	6.60	20.00	LD_Mix	HDT_Mix	HHDT
Site Preparation	14	18.00	0.00	0.00	16.80	6.60	20.00	LD_Mix	HDT_Mix	HHDT
Grading	8	20.00	0.00	625.00	16.80	6.60	20.00	LD_Mix	HDT_Mix	HHDT
Building Construction	10	59.00	23.00	0.00	16.80	6.60	20.00	LD_Mix	HDT_Mix	HHDT
Paving	8	20.00	0.00	0.00	16.80	6.60	20.00	LD_Mix	HDT_Mix	HHDT
Architectural Coating	1	12.00	0.00	0.00	16.80	6.60	20.00	LD_Mix	HDT_Mix	HHDT

3.1 Mitigation Measures Construction

3.2 Demolition - 2021

Unmitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Off-Road	0.0470	0.4956	0.3035	6.2000e-004		0.0228	0.0228		0.0212	0.0212	0.0000	54.3293	54.3293	0.0147	0.0000	54.6963
Total	**0.0470**	**0.4956**	**0.3035**	**6.2000e-004**		**0.0228**	**0.0228**		**0.0212**	**0.0212**	**0.0000**	**54.3293**	**54.3293**	**0.0147**	**0.0000**	**54.6963**

3.2 Demolition - 2021

Unmitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Hauling	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Vendor	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Worker	1.6700e-003	1.5000e-003	0.0118	2.0000e-005	1.8000e-003	2.0000e-005	1.8200e-003	4.8000e-004	2.0000e-005	4.9000e-004	0.0000	1.6014	1.6014	1.0000e-004	0.0000	1.6040
Total	**1.6700e-003**	**1.5000e-003**	**0.0118**	**2.0000e-005**	**1.8000e-003**	**2.0000e-005**	**1.8200e-003**	**4.8000e-004**	**2.0000e-005**	**4.9000e-004**	**0.0000**	**1.6014**	**1.6014**	**1.0000e-004**	**0.0000**	**1.6040**

Mitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Off-Road	0.0470	0.4956	0.3035	6.2000e-004		0.0228	0.0228		0.0212	0.0212	0.0000	54.3293	54.3293	0.0147	0.0000	54.6963
Total	**0.0470**	**0.4956**	**0.3035**	**6.2000e-004**		**0.0228**	**0.0228**		**0.0212**	**0.0212**	**0.0000**	**54.3293**	**54.3293**	**0.0147**	**0.0000**	**54.6963**

3.2 Demolition - 2021

Mitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category						tons/yr								MT/yr		
Hauling	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Vendor	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Worker	1.6700e-003	1.5000e-003	0.0118	2.0000e-005	1.8000e-003	2.0000e-005	1.8200e-003	4.8000e-004	2.0000e-005	4.9000e-004	0.0000	1.6014	1.6014	1.0000e-004	0.0000	1.6040
Total	**1.6700e-003**	**1.5000e-003**	**0.0118**	**2.0000e-005**	**1.8000e-003**	**2.0000e-005**	**1.8200e-003**	**4.8000e-004**	**2.0000e-005**	**4.9000e-004**	**0.0000**	**1.6014**	**1.6014**	**1.0000e-004**	**0.0000**	**1.6040**

3.3 Site Preparation - 2021

Unmitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category						tons/yr								MT/yr		
Fugitive Dust					0.0452	0.0000	0.0452	0.0248	0.0000	0.0248	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Off-Road	0.0159	0.1759	0.0948	1.9000e-004		8.2600e-003	8.2600e-003		7.6000e-003	7.6000e-003	0.0000	16.6522	16.6522	5.3900e-003	0.0000	16.7868
Total	**0.0159**	**0.1759**	**0.0948**	**1.9000e-004**	**0.0452**	**8.2600e-003**	**0.0534**	**0.0248**	**7.6000e-003**	**0.0324**	**0.0000**	**16.6522**	**16.6522**	**5.3900e-003**	**0.0000**	**16.7868**

3.3 Site Preparation - 2021

Unmitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Hauling	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Vendor	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Worker	5.0000e-004	4.5000e-004	3.5300e-003	1.0000e-005	5.4000e-004	1.0000e-005	5.4000e-004	1.4000e-004	0.0000	1.5000e-004	0.0000	0.4804	0.4804	3.0000e-005	0.0000	0.4812
Total	**5.0000e-004**	**4.5000e-004**	**3.5300e-003**	**1.0000e-005**	**5.4000e-004**	**1.0000e-005**	**5.4000e-004**	**1.4000e-004**	**0.0000**	**1.5000e-004**	**0.0000**	**0.4804**	**0.4804**	**3.0000e-005**	**0.0000**	**0.4812**

Mitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Fugitive Dust					0.0452	0.0000	0.0452	0.0248	0.0000	0.0248	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Off-Road	0.0159	0.1759	0.0948	1.9000e-004		8.2600e-003	8.2600e-003		7.6000e-003	7.6000e-003	0.0000	16.6521	16.6521	5.3900e-003	0.0000	16.7868
Total	**0.0159**	**0.1759**	**0.0948**	**1.9000e-004**	**0.0452**	**8.2600e-003**	**0.0534**	**0.0248**	**7.6000e-003**	**0.0324**	**0.0000**	**16.6521**	**16.6521**	**5.3900e-003**	**0.0000**	**16.7868**

3.3 Site Preparation - 2021

Mitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Hauling	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Vendor	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Worker	5.0000e-004	4.5000e-004	3.5300e-003	1.0000e-005	5.4000e-004	1.0000e-005	5.4000e-004	1.4000e-004	0.0000	1.5000e-004	0.0000	0.4804	0.4804	3.0000e-005	0.0000	0.4812
Total	**5.0000e-004**	**4.5000e-004**	**3.5300e-003**	**1.0000e-005**	**5.4000e-004**	**1.0000e-005**	**5.4000e-004**	**1.4000e-004**	**0.0000**	**1.5000e-004**	**0.0000**	**0.4804**	**0.4804**	**3.0000e-005**	**0.0000**	**0.4812**

3.4 Grading - 2021

Unmitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Fugitive Dust					0.5471	0.0000	0.5471	0.2998	0.0000	0.2998	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Off-Road	0.3169	3.1913	2.0875	5.0700e-003		0.1399	0.1399		0.1287	0.1287	0.0000	445.7200	445.7200	0.1442	0.0000	449.3239
Total	**0.3169**	**3.1913**	**2.0875**	**5.0700e-003**	**0.5471**	**0.1399**	**0.6870**	**0.2998**	**0.1287**	**0.4285**	**0.0000**	**445.7200**	**445.7200**	**0.1442**	**0.0000**	**449.3239**

3.4 Grading - 2021

Unmitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Hauling	2.7900e-003	0.0953	0.0155	2.5000e-004	5.1400e-003	4.3000e-004	5.5700e-003	1.4100e-003	4.2000e-004	1.8300e-003	0.0000	23.5520	23.5520	7.2000e-004	0.0000	23.5700
Vendor	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Worker	0.0202	0.0181	0.1422	2.1000e-004	0.0217	2.0000e-004	0.0219	5.7800e-003	1.9000e-004	5.9700e-003	0.0000	19.3236	19.3236	1.2600e-003	0.0000	19.3550
Total	**0.0230**	**0.1134**	**0.1577**	**4.6000e-004**	**0.0268**	**6.3000e-004**	**0.0275**	**7.1900e-003**	**6.1000e-004**	**7.8000e-003**	**0.0000**	**42.8756**	**42.8756**	**1.9800e-003**	**0.0000**	**42.9249**

Mitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Fugitive Dust					0.5471	0.0000	0.5471	0.2998	0.0000	0.2998	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Off-Road	0.3169	3.1913	2.0875	5.0700e-003		0.1399	0.1399		0.1287	0.1287	0.0000	445.7195	445.7195	0.1442	0.0000	449.3233
Total	**0.3169**	**3.1913**	**2.0875**	**5.0700e-003**	**0.5471**	**0.1399**	**0.6870**	**0.2998**	**0.1287**	**0.4285**	**0.0000**	**445.7195**	**445.7195**	**0.1442**	**0.0000**	**449.3233**

3.4 Grading - 2021

Mitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Hauling	2.7900e-003	0.0953	0.0155	2.5000e-004	5.1400e-003	4.3000e-004	5.5700e-003	1.4100e-003	4.2000e-004	1.8300e-003	0.0000	23.5520	23.5520	7.2000e-004	0.0000	23.5700
Vendor	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Worker	0.0202	0.0181	0.1422	2.1000e-004	0.0217	2.0000e-004	0.0219	5.7800e-003	1.9000e-004	5.9700e-003	0.0000	19.3236	19.3236	1.2600e-003	0.0000	19.3550
Total	**0.0230**	**0.1134**	**0.1577**	**4.6000e-004**	**0.0268**	**6.3000e-004**	**0.0275**	**7.1900e-003**	**6.1000e-004**	**7.8000e-003**	**0.0000**	**42.8756**	**42.8756**	**1.9800e-003**	**0.0000**	**42.9249**

3.5 Building Construction - 2021

Unmitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Off-Road	0.0724	0.6857	0.6251	1.2200e-003		0.0352	0.0352		0.0330	0.0330	0.0000	105.4553	105.4553	0.0277	0.0000	106.1486
Total	**0.0724**	**0.6857**	**0.6251**	**1.2200e-003**		**0.0352**	**0.0352**		**0.0330**	**0.0330**	**0.0000**	**105.4553**	**105.4553**	**0.0277**	**0.0000**	**106.1486**

3.5 Building Construction - 2021

Unmitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Hauling	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Vendor	3.5600e-003	0.0907	0.0247	2.0000e-004	4.4700e-003	3.7000e-004	4.8400e-003	1.3000e-003	3.5000e-004	1.6500e-003	0.0000	18.7699	18.7699	9.7000e-004	0.0000	18.7940
Worker	0.0221	0.0198	0.1552	2.3000e-004	0.0237	2.2000e-004	0.0239	6.3100e-003	2.0000e-004	6.5200e-003	0.0000	21.1011	21.1011	1.3700e-003	0.0000	21.1354
Total	**0.0256**	**0.1105**	**0.1799**	**4.3000e-004**	**0.0282**	**5.9000e-004**	**0.0288**	**7.6100e-003**	**5.5000e-004**	**8.1700e-003**	**0.0000**	**39.8710**	**39.8710**	**2.3400e-003**	**0.0000**	**39.9294**

Mitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Off-Road	0.0724	0.6857	0.6251	1.2200e-003		0.0352	0.0352		0.0330	0.0330	0.0000	105.4552	105.4552	0.0277	0.0000	106.1484
Total	**0.0724**	**0.6857**	**0.6251**	**1.2200e-003**		**0.0352**	**0.0352**		**0.0330**	**0.0330**	**0.0000**	**105.4552**	**105.4552**	**0.0277**	**0.0000**	**106.1484**

3.5 Building Construction - 2021

Mitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Hauling	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Vendor	3.5600e-003	0.0907	0.0247	2.0000e-004	4.4700e-003	3.7000e-004	4.8400e-003	1.3000e-003	3.5000e-004	1.6500e-003	0.0000	18.7699	18.7699	9.7000e-004	0.0000	18.7940
Worker	0.0221	0.0198	0.1552	2.3000e-004	0.0237	2.2000e-004	0.0239	6.3100e-003	2.0000e-004	6.5200e-003	0.0000	21.1011	21.1011	1.3700e-003	0.0000	21.1354
Total	**0.0256**	**0.1105**	**0.1799**	**4.3000e-004**	**0.0282**	**5.9000e-004**	**0.0288**	**7.6100e-003**	**5.5000e-004**	**8.1700e-003**	**0.0000**	**39.8710**	**39.8710**	**2.3400e-003**	**0.0000**	**39.9294**

3.6 Paving - 2021

Unmitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Off-Road	5.5000e-004	5.4200e-003	6.1300e-003	1.0000e-005		2.9000e-004	2.9000e-004		2.7000e-004	2.7000e-004	0.0000	0.8185	0.8185	2.6000e-004	0.0000	0.8250
Paving	0.0000					0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Total	**5.5000e-004**	**5.4200e-003**	**6.1300e-003**	**1.0000e-005**		**2.9000e-004**	**2.9000e-004**		**2.7000e-004**	**2.7000e-004**	**0.0000**	**0.8185**	**0.8185**	**2.6000e-004**	**0.0000**	**0.8250**

3.6 Paving - 2021

Unmitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Hauling	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Vendor	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Worker	1.1000e-004	1.0000e-004	7.9000e-004	0.0000	1.2000e-004	0.0000	1.2000e-004	3.0000e-005	0.0000	3.0000e-005	0.0000	0.1068	0.1068	1.0000e-005	0.0000	0.1069
Total	**1.1000e-004**	**1.0000e-004**	**7.9000e-004**	**0.0000**	**1.2000e-004**	**0.0000**	**1.2000e-004**	**3.0000e-005**	**0.0000**	**3.0000e-005**	**0.0000**	**0.1068**	**0.1068**	**1.0000e-005**	**0.0000**	**0.1069**

Mitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Off-Road	5.5000e-004	5.4200e-003	6.1300e-003	1.0000e-005		2.9000e-004	2.9000e-004		2.7000e-004	2.7000e-004	0.0000	0.8185	0.8185	2.6000e-004	0.0000	0.8250
Paving	0.0000					0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Total	**5.5000e-004**	**5.4200e-003**	**6.1300e-003**	**1.0000e-005**		**2.9000e-004**	**2.9000e-004**		**2.7000e-004**	**2.7000e-004**	**0.0000**	**0.8185**	**0.8185**	**2.6000e-004**	**0.0000**	**0.8250**

3.6 Paving - 2021

Mitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Hauling	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Vendor	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Worker	1.1000e-004	1.0000e-004	7.9000e-004	0.0000	1.2000e-004	0.0000	1.2000e-004	3.0000e-005	0.0000	3.0000e-005	0.0000	0.1068	0.1068	1.0000e-005	0.0000	0.1069
Total	**1.1000e-004**	**1.0000e-004**	**7.9000e-004**	**0.0000**	**1.2000e-004**	**0.0000**	**1.2000e-004**	**3.0000e-005**	**0.0000**	**3.0000e-005**	**0.0000**	**0.1068**	**0.1068**	**1.0000e-005**	**0.0000**	**0.1069**

3.7 Architectural Coating - 2021

Unmitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Archit. Coating	2.3200e-003					0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Off-Road	1.1000e-004	7.6000e-004	9.1000e-004	0.0000		5.0000e-005	5.0000e-005		5.0000e-005	5.0000e-005	0.0000	0.1277	0.1277	1.0000e-005	0.0000	0.1279
Total	**2.4300e-003**	**7.6000e-004**	**9.1000e-004**	**0.0000**		**5.0000e-005**	**5.0000e-005**		**5.0000e-005**	**5.0000e-005**	**0.0000**	**0.1277**	**0.1277**	**1.0000e-005**	**0.0000**	**0.1279**

3.7 Architectural Coating - 2021

Unmitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Hauling	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Vendor	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Worker	7.0000e-005	6.0000e-005	4.7000e-004	0.0000	7.0000e-005	0.0000	7.0000e-005	2.0000e-005	0.0000	2.0000e-005	0.0000	0.0641	0.0641	0.0000	0.0000	0.0642
Total	**7.0000e-005**	**6.0000e-005**	**4.7000e-004**	**0.0000**	**7.0000e-005**	**0.0000**	**7.0000e-005**	**2.0000e-005**	**0.0000**	**2.0000e-005**	**0.0000**	**0.0641**	**0.0641**	**0.0000**	**0.0000**	**0.0642**

Mitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Archit. Coating	2.3200e-003					0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Off-Road	1.1000e-004	7.6000e-004	9.1000e-004	0.0000		5.0000e-005	5.0000e-005		5.0000e-005	5.0000e-005	0.0000	0.1277	0.1277	1.0000e-005	0.0000	0.1279
Total	**2.4300e-003**	**7.6000e-004**	**9.1000e-004**	**0.0000**		**5.0000e-005**	**5.0000e-005**		**5.0000e-005**	**5.0000e-005**	**0.0000**	**0.1277**	**0.1277**	**1.0000e-005**	**0.0000**	**0.1279**

3.7 Architectural Coating - 2021

Mitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Hauling	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Vendor	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Worker	7.0000e-005	6.0000e-005	4.7000e-004	0.0000	7.0000e-005	0.0000	7.0000e-005	2.0000e-005	0.0000	2.0000e-005	0.0000	0.0641	0.0641	0.0000	0.0000	0.0642
Total	**7.0000e-005**	**6.0000e-005**	**4.7000e-004**	**0.0000**	**7.0000e-005**	**0.0000**	**7.0000e-005**	**2.0000e-005**	**0.0000**	**2.0000e-005**	**0.0000**	**0.0641**	**0.0641**	**0.0000**	**0.0000**	**0.0642**

4.0 Operational Detail - Mobile

4.1 Mitigation Measures Mobile

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Mitigated	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Unmitigated	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

4.2 Trip Summary Information

	Average Daily Trip Rate			Unmitigated	Mitigated
Land Use	Weekday	Saturday	Sunday	Annual VMT	Annual VMT
Recreational Swimming Pool	0.00	0.00	0.00		
Total	0.00	0.00	0.00		

4.3 Trip Type Information

	Miles			Trip %			Trip Purpose %		
Land Use	H-W or C-W	H-S or C-C	H-O or C-NW	H-W or C-W	H-S or C-C	H-O or C-NW	Primary	Diverted	Pass-by
Recreational Swimming Pool	14.70	6.60	6.60	33.00	48.00	19.00	52	39	9

4.4 Fleet Mix

Land Use	LDA	LDT1	LDT2	MDV	LHD1	LHD2	MHD	HHD	OBUS	UBUS	MCY	SBUS	MH
Recreational Swimming Pool	0.489041	0.045286	0.209606	0.134980	0.040724	0.006674	0.014654	0.046205	0.003398	0.001529	0.005553	0.001505	0.000846

5.0 Energy Detail

Historical Energy Use: N

5.1 Mitigation Measures Energy

Kilowatt Hours of Renewable Electricity Generated

Percent of Electricity Use Generated with Renewable Energy

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Electricity Mitigated						0.0000	0.0000		0.0000	0.0000	0.0000	-3.7819	-3.7819	-0.0002	0.0000	-3.7967
Electricity Unmitigated						0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
NaturalGas Mitigated	0.0000	0.0000	0.0000	0.0000		0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
NaturalGas Unmitigated	0.0000	0.0000	0.0000	0.0000		0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

5.2 Energy by Land Use - NaturalGas

Unmitigated

	NaturalGas Use	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Land Use	kBTU/yr	tons/yr										MT/yr					
Recreational Swimming Pool	0	0.0000	0.0000	0.0000	0.0000		0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Total		**0.0000**	**0.0000**	**0.0000**	**0.0000**		**0.0000**	**0.0000**		**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**

Mitigated

	NaturalGas Use	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Land Use	kBTU/yr	tons/yr										MT/yr					
Recreational Swimming Pool	0	0.0000	0.0000	0.0000	0.0000		0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Total		**0.0000**	**0.0000**	**0.0000**	**0.0000**		**0.0000**	**0.0000**		**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**

5.3 Energy by Land Use - Electricity

Unmitigated

	Electricity Use	Total CO2	CH4	N2O	CO2e
Land Use	kWh/yr	MT/yr			
Recreational Swimming Pool	0	0.0000	0.0000	0.0000	0.0000
Total		**0.0000**	**0.0000**	**0.0000**	**0.0000**

Mitigated

	Electricity Use	Total CO2	CH4	N2O	CO2e
Land Use	kWh/yr	MT/yr			
Recreational Swimming Pool	-13000	-3.7819	-0.0002	0.0000	-3.7967
Total		**-3.7819**	**-0.0002**	**0.0000**	**-3.7967**

6.0 Area Detail

6.1 Mitigation Measures Area

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Mitigated	1.1300e-003	1.0000e-005	1.2900e-003	0.0000		0.0000	0.0000		0.0000	0.0000	0.0000	2.5000e-003	2.5000e-003	1.0000e-005	0.0000	2.6700e-003
Unmitigated	1.1300e-003	1.0000e-005	1.2900e-003	0.0000		0.0000	0.0000		0.0000	0.0000	0.0000	2.5000e-003	2.5000e-003	1.0000e-005	0.0000	2.6700e-003

6.2 Area by SubCategory

Unmitigated

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
SubCategory	tons/yr										MT/yr					
Architectural Coating	2.3000e-004					0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Consumer Products	7.8000e-004					0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Landscaping	1.2000e-004	1.0000e-005	1.2900e-003	0.0000		0.0000	0.0000		0.0000	0.0000	0.0000	2.5000e-003	2.5000e-003	1.0000e-005	0.0000	2.6700e-003
Total	**1.1300e-003**	**1.0000e-005**	**1.2900e-003**	**0.0000**		**0.0000**	**0.0000**		**0.0000**	**0.0000**	**0.0000**	**2.5000e-003**	**2.5000e-003**	**1.0000e-005**	**0.0000**	**2.6700e-003**

6.2 Area by SubCategory

Mitigated

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
SubCategory	tons/yr										MT/yr					
Architectural Coating	2.3000e-004					0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Consumer Products	7.8000e-004					0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Landscaping	1.2000e-004	1.0000e-005	1.2900e-003	0.0000		0.0000	0.0000		0.0000	0.0000	0.0000	2.5000e-003	2.5000e-003	1.0000e-005	0.0000	2.6700e-003
Total	**1.1300e-003**	**1.0000e-005**	**1.2900e-003**	**0.0000**		**0.0000**	**0.0000**		**0.0000**	**0.0000**	**0.0000**	**2.5000e-003**	**2.5000e-003**	**1.0000e-005**	**0.0000**	**2.6700e-003**

7.0 Water Detail

7.1 Mitigation Measures Water

	Total CO2	CH4	N2O	CO2e
Category	MT/yr			
Mitigated	0.0000	0.0000	0.0000	0.0000
Unmitigated	0.0000	0.0000	0.0000	0.0000

7.2 Water by Land Use

Unmitigated

	Indoor/Outdoor Use	Total CO2	CH4	N2O	CO2e
Land Use	Mgal	MT/yr			
Recreational Swimming Pool	0 / 0	0.0000	0.0000	0.0000	0.0000
Total		**0.0000**	**0.0000**	**0.0000**	**0.0000**

7.2 Water by Land Use

Mitigated

	Indoor/Outdoor Use	Total CO2	CH4	N2O	CO2e
Land Use	Mgal	MT/yr			
Recreational Swimming Pool	0 / 0	0.0000	0.0000	0.0000	0.0000
Total		**0.0000**	**0.0000**	**0.0000**	**0.0000**

8.0 Waste Detail

8.1 Mitigation Measures Waste

Category/Year

	Total CO2	CH4	N2O	CO2e
	MT/yr			
Mitigated	0.0000	0.0000	0.0000	0.0000
Unmitigated	0.0000	0.0000	0.0000	0.0000

8.2 Waste by Land Use

Unmitigated

	Waste Disposed	Total CO2	CH4	N2O	CO2e
Land Use	tons	MT/yr			
Recreational Swimming Pool	1	0.0000	0.0000	0.0000	0.0000
Total		**0.0000**	**0.0000**	**0.0000**	**0.0000**

Mitigated

	Waste Disposed	Total CO2	CH4	N2O	CO2e
Land Use	tons	MT/yr			
Recreational Swimming Pool	1	0.0000	0.0000	0.0000	0.0000
Total		**0.0000**	**0.0000**	**0.0000**	**0.0000**

9.0 Operational Offroad

Equipment Type	Number	Hours/Day	Days/Year	Horse Power	Load Factor	Fuel Type

10.0 Stationary Equipment

Fire Pumps and Emergency Generators

Equipment Type	Number	Hours/Day	Hours/Year	Horse Power	Load Factor	Fuel Type
Fire Pump	1	2	720	7.5	0.73	Diesel

Boilers

Equipment Type	Number	Heat Input/Day	Heat Input/Year	Boiler Rating	Fuel Type
Boiler	1	0.07	24.02	1.43	Diesel

User Defined Equipment

Equipment Type	Number

10.1 Stationary Sources

Unmitigated/Mitigated

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Equipment Type	tons/yr										MT/yr					
Boiler - Diesel (0 - 9999 MMBTU)	3.0000e-005	6.2000e-004	4.3000e-004	2.0000e-005		9.0000e-005	9.0000e-005		2.0000e-005	2.0000e-005	0.0000	1.9456	1.9456	2.0000e-005	0.0000	1.9460
Fire Pump - Diesel (0 - 11 HP)	4.1300e-003	0.0216	0.0243	2.0000e-005		1.2200e-003	1.2200e-003		1.2200e-003	1.2200e-003	0.0000	1.9192	1.9192	2.7000e-004	0.0000	1.9259
Total	**4.1600e-003**	**0.0222**	**0.0248**	**4.0000e-005**		**1.3100e-003**	**1.3100e-003**		**1.2400e-003**	**1.2400e-003**	**0.0000**	**3.8648**	**3.8648**	**2.9000e-004**	**0.0000**	**3.8720**

11.0 Vegetation

	Total CO2	CH4	N2O	CO2e
Category	MT			
Unmitigated	-17.2400	0.0000	0.0000	-17.2400

11.1 Vegetation Land Change

Vegetation Type

	Initial/Final	Total CO2	CH4	N2O	CO2e
	Acres	MT			
Grassland	20 / 16	-17.2400	0.0000	0.0000	-17.2400
Total		**-17.2400**	**0.0000**	**0.0000**	**-17.2400**