DRAFT Black Oak Ranch Water Conservation Project
Basis of Design Report





Performed by: Eel River Recovery Project

Funded by: California State Coastal Conservancy Prop 1 Grant (Agreement # 20-076)

November 30, 2022

ACKNOWLEDGEMENTS

This Project is sponsored by the Eel River Recovery Project (ERRP) with resources supplied for planning and permitting by the California State Coastal Conservancy (SCC) from Prop 1 funds. ERRP is very grateful to the firms with which we are subcontracting and their talented staff, including Stillwater Sciences, Village Ecosystems and Thomas Gast Associates Environmental Consultants. We are very thankful for the Black Oak Ranch partners for being willing to participate in forbearance in exchange for enhanced water storage so that Streeter Creek flows can be restored and for their stewardship and conservation of their land. We also wish to acknowledge the Cahto Tribe and thank them for the guidance they are giving us on cultural resource protection and for the traditional ecological knowledge they share.

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Project Information

Date: November 30, 2022

Project Title: Black Oak Ranch Water Conservation Project

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Property Owner

Landowner	Location	Parcel APN #	Contact	Phone
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Background

The Eel River Recovery Project (ERRP) has been a 501c3 non-profit corporation since 2016 (IRS #47-4811332), and its mission includes working with residents on ecological restoration. From 2018 to 2020, we had a pilot project in the Tenmile Creek watershed funded by a California State Coast Conservancy Proposition 1 grant that resulted in the *Tenmile Creek Conservation and Restoration Action Plan* (ERRP 2020). That document envisioned the water conservation project proposed herein. The planning and permitting for water storage infrastructure that will allow forbearance of withdrawal from Streeter Creek and Tenmile Creek is being funded through a second SCC Prop 1 grant, the *Tenmile Creek Water Conservation and Erosion Control Project* (Agreement # 20-076), with the intent of having projects "shovel-ready" when additional grant funds are secured for implementation.

The pilot study of Tenmile Creek included a comparison of flows in Streeter Creek with those of Elder Creek, which is an undisturbed South Fork Eel River tributary to the west, using the U.S. EPA VELMA model (Visualizing Ecosystem Land Management Assessments) (McKane et al. 2014). The default hypothesis related to Streeter Creek flow depletion was that agricultural extraction related to cannabis cultivation was the cause. However, VELMA model runs and flow data collected by TGAEC indicated that flow depletion was the result of increased tree evapotranspiration due to over-stocked stand conditions following post WWII logging, and Douglas fir tree over-topping and replacing oaks. In the long-term, ERRP wants to win CalFire grants to thin the forest of the Streeter Creek watershed because it will likely pay even greater dividends in terms of restoring baseflows. Although there was little water diversion in the upland portion of the Streeter Creek watershed, it was discovered that the largest water users in the basin were an organic farm (Irene's Garden Produce Farm) and youth camp (Camp Winnarainbow) on the Black Oak Ranch, just upstream of the convergence of Streeter Creek and Tenmile Creek (Figure 1). Water from Streeter Creek is used for both farm and camp water supply, and the farm sometimes diverts from Tenmile Creek late in summer in low flow years. The water storage facilities proposed are a 4 million (M) gallon pond to be installed in the field adjacent to the organic farm that will provide water both for the farm and for landscape watering at the camp. New storage tanks installed above the camp will capture 800,000 gallons of potable water for use by campers.

ERRP has studied Streeter Creek since 2018 and documented the presence of steelhead and Chinook salmon juveniles, and coho salmon have historically occurred there. The steelhead juvenile carrying capacity of Streeter Creek varies with flow years. It loses surface flow in severe drought years, but may retain isolated pools fed by sub-surface flow even in years when connections between pools is lost. In wetter years flows stay perennial and support steelhead juveniles through summer and fall (Higgins 2020a, 2022). Also, in higher flow years, cold water upwelling in Tenmile Creek downstream of Streeter Creek creates a refugia for steelhead juvenile and native fish rearing. Therefore, conservation of water by the BOR farm and camp will improve survival of juvenile salmonids and help meet the goals of fish recovery plans (CDFW 2004, NMFS 2014) and water quality plans (U.S. EPA 1999, NCRWQCB 2018).

The BOR has collective ownership through the Black Oak Ranch Limited Partnership and all parcels they own are managed for conservation purposes, including no hunting. BOR has also allowed implementation of numerous fish habitat restoration projects on Tenmile and Streeter creeks. Therefore, the water conservation project proposed here is very much in keeping with the BOR land use ethic.

Project Description

Project Location: The Black Oak Ranch is approximately 5 miles north of Laytonville, California in northern Mendocino County on Highway 101 (Figure 1) and includes parcel APN 01356047 where Irene's Garden Produce Farm and Camp Winnarainbow are located.

Project Summary: The goal of this project is to do design and permitting for water storage that will allow forbearance from dry-season surface water diversions and will enhance summer flow conditions and improve water quality for salmonids in Tenmile and Streeter creeks. This project focuses on increasing water storage capacity on parcel APN 01356047, part of the Black Oak Ranch (BOR). It hosts both an organic farm ("Irene's Garden Produce Farm") and a summer youth camp facility ("Camp Winnarainbow"). Both will forbear from summer water withdrawal after project completion.

Two integrated water storage systems will be developed, a 4 million (M) gallon pond for farm and campground irrigation and 800,000 gallons of tank storage (Figure 2) for drinking water and bathing use by the camp facility that meets State Water Resources Control Board (SWRCB) drinking water standards. Water for the camp facility will be captured both from rainwater and from Streeter Creek in winter following storm events. The water will be stored in steel tanks prior to passing it through the existing treatment facility. The farm and camp landscape do not require such high-quality water, and thus can be stored in a pond.

A seasonal unnamed tributary that crosses BOR near the pond location, as well as rainwater, will be the two main sources of water for the pond. Additional sources include Streeter Creek and groundwater from the sump pump. The farm has historically diverted flow from perennial pools in Tenmile Creek during summer under a riparian water right, and would in the future only withdraw water from this source in winter during years when the intermittent tributary and Streeter Creek did not provide enough water to fill the pond. Redundancy of water sources for the combined system will insure that in case of drought or emergency, there is always a source of water to meet demand, and thus ensure that forbearance requirements are easily met.

Existing Conditions

Site Overview: The Black Oak Ranch is comprised of four parcels totaling more than 600 acres rising from 1500 feet in elevation at the mouth of Streeter Creek to approximately 2000 feet in the hills to the west. Land near the mouth of Streeter Creek where the farm is located is very flat, but the camp parcel has a terrace about 120 feet upslope and to the south. According to Pioneering on Cahto Mountain (Mayo 1974), Black Oak Ranch was owned by the White family in the 1860s and afterward and it was a stage stop on the Humboldt Trail at one time and a hotel was located there. The original water right for the property is dated 1867 and there are accounts of grain and hops having been cultivated there in the 1800s (Mayo 1974). Mean annual rainfall was measured nearby by Vic Weaver from 1998-2021 and the average was 61". Precipitation sometimes falls as snow, but rarely sticks for any length of time.

The flat area occupied by the farm was likely originally native grasslands, but cultivation and grazing has led to a change in flora to mostly non-native grass species and forbs. Smaller meadows in the uplands of BOR also have a history of grazing and have been converted from native to non-native grasses. North facing slopes at higher elevation on BOR were comprised of conifer forests of Ponderosa pine and Douglas fir that were logged after WW II. More of uplands, however, were historically oak woodlands

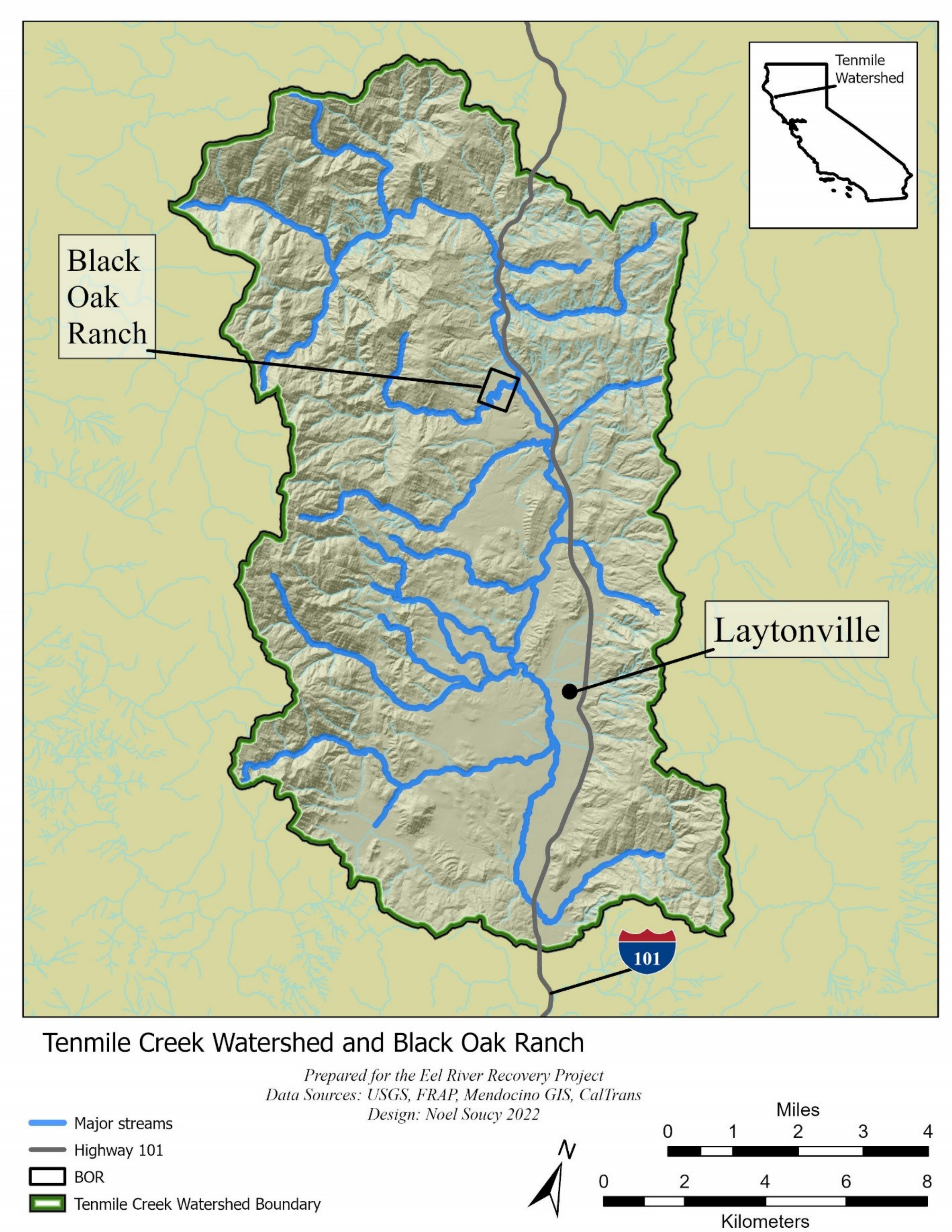


Figure 1: Location of Water Conservation Project, located on Black Oak Ranch. Map by TGAEC.

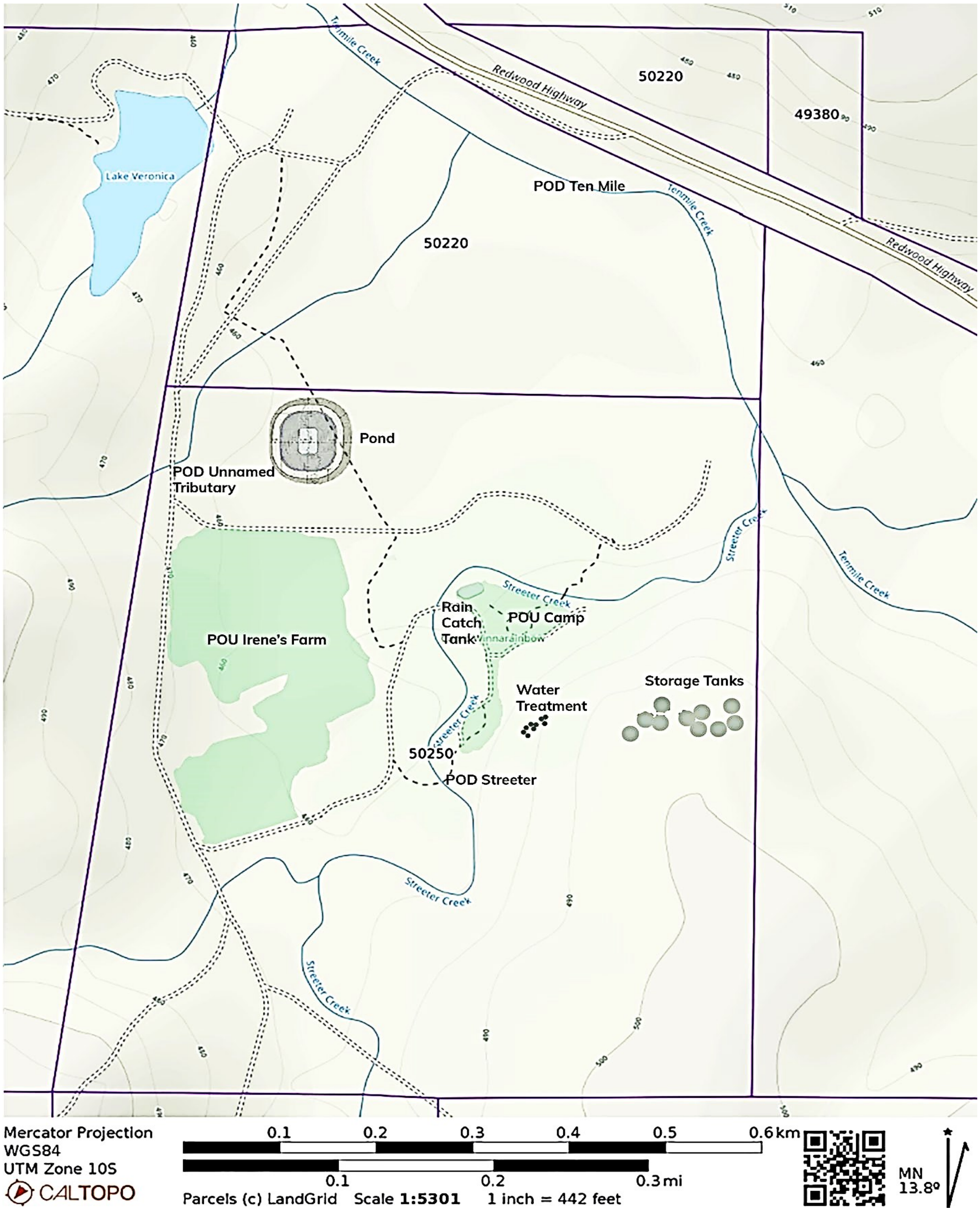


Figure 2: Proposed project layout with points of use (POU) and proposed points of diversion (POD). Map by Anna Birkas, Village Ecosystems.

that are now mixed conifer/hardwood forests as a result of incursion by conifers. Before European settlement, Native Americans used controlled fire to maintain grasslands for foraging animals and oak woodlands for acorn production. The plateau above the camp is a prime example of how conifers can encroach on oak trees and reduce their growth and productivity, eventually leading to their mortality, if there is no intervention.

Geology: According to USGS (1965), most of the Tenmile Creek basin is in the undifferentiated Franciscan and Knoxville formations that are comprised of "consolidated sandstone (graywacke), shale, limestone, chert, greenstone, serpentine, and schist" (TJf). The rocks are marine sedimentary and metasedimentary from the Cretaceous-Jurassic period. Smaller portions of the watershed are composed of sandstone, shale, and minor conglomerate from the Tertiary-Cretaceous period (TK) and younger unconsolidated alluvium from the Quaternary period (Q). Streeter Creek and the unnamed tributary that will be diverted to fill the pond are dominated by Franciscan sedimentary rocks with smaller portions of unconsolidated alluvium (Figure 3). The slope of the farm field where the pond will be located is less than 5% and the top of the terrace above the camp is of similar gradient (Figure 4), which leads to low risk of landsliding from project activities. SHN (2021) recently conducted a geologic analysis for BOR for a bridge construction project. Their geologic map (Figure 5) and key (Figure 6) show that the proposed pond site is located on alluvium from the Holocene era and the tank site is located on older alluvium from the Holocene-Pleistocene era.

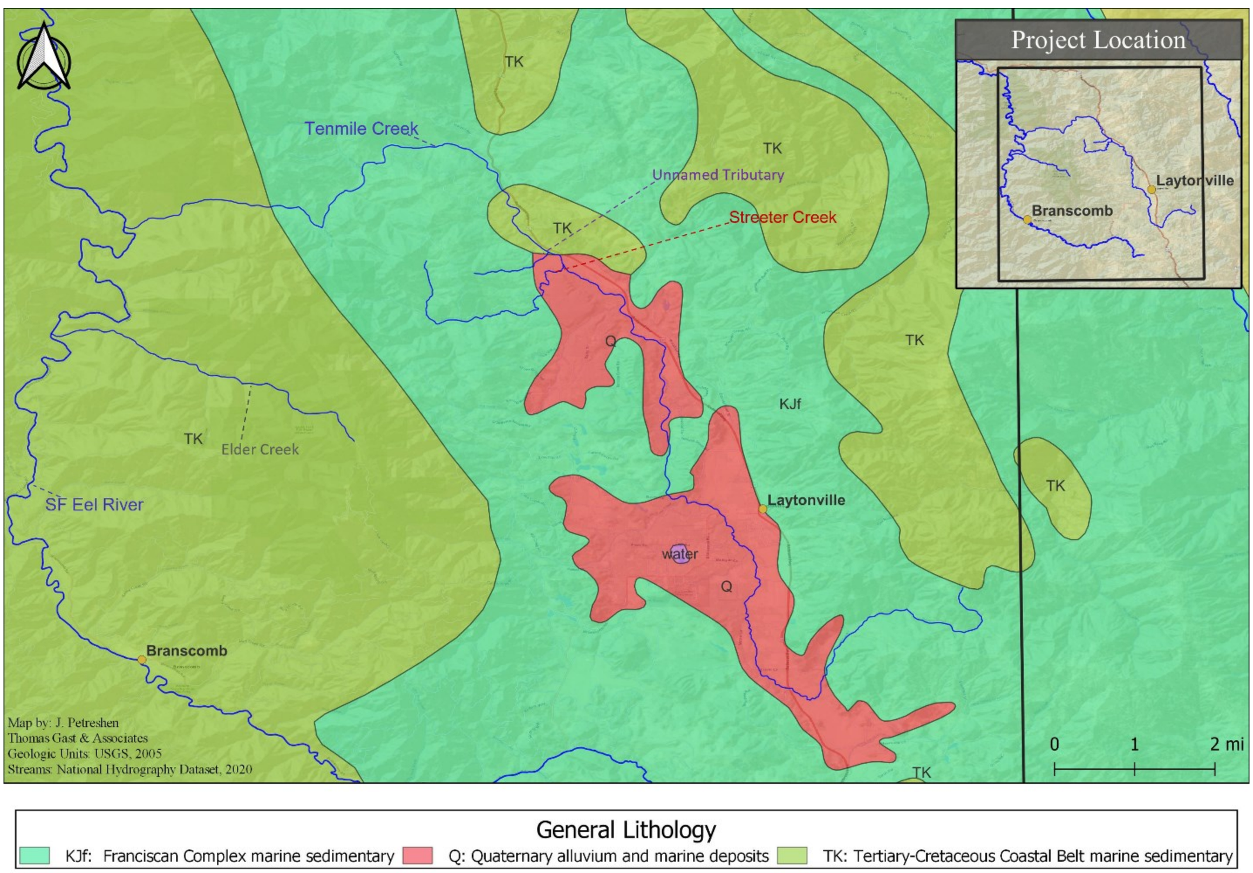


Figure 3: Underlying geology of Tenmile Creek basin, Streeter Creek and the unnamed BOR tributary that will be diverted to fill the pond.

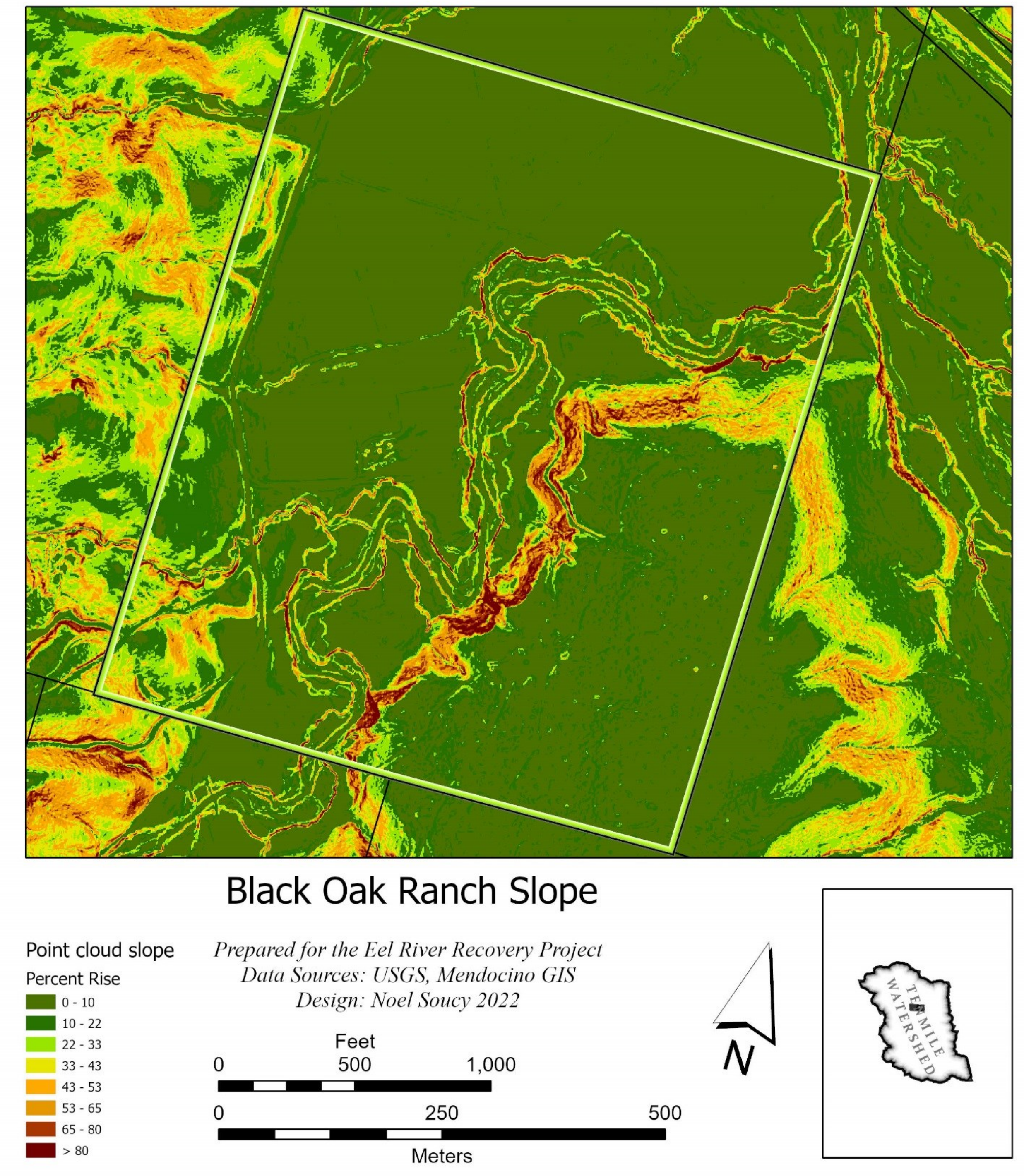


Figure 4. Slope map for BOR pond and tank vicinity.

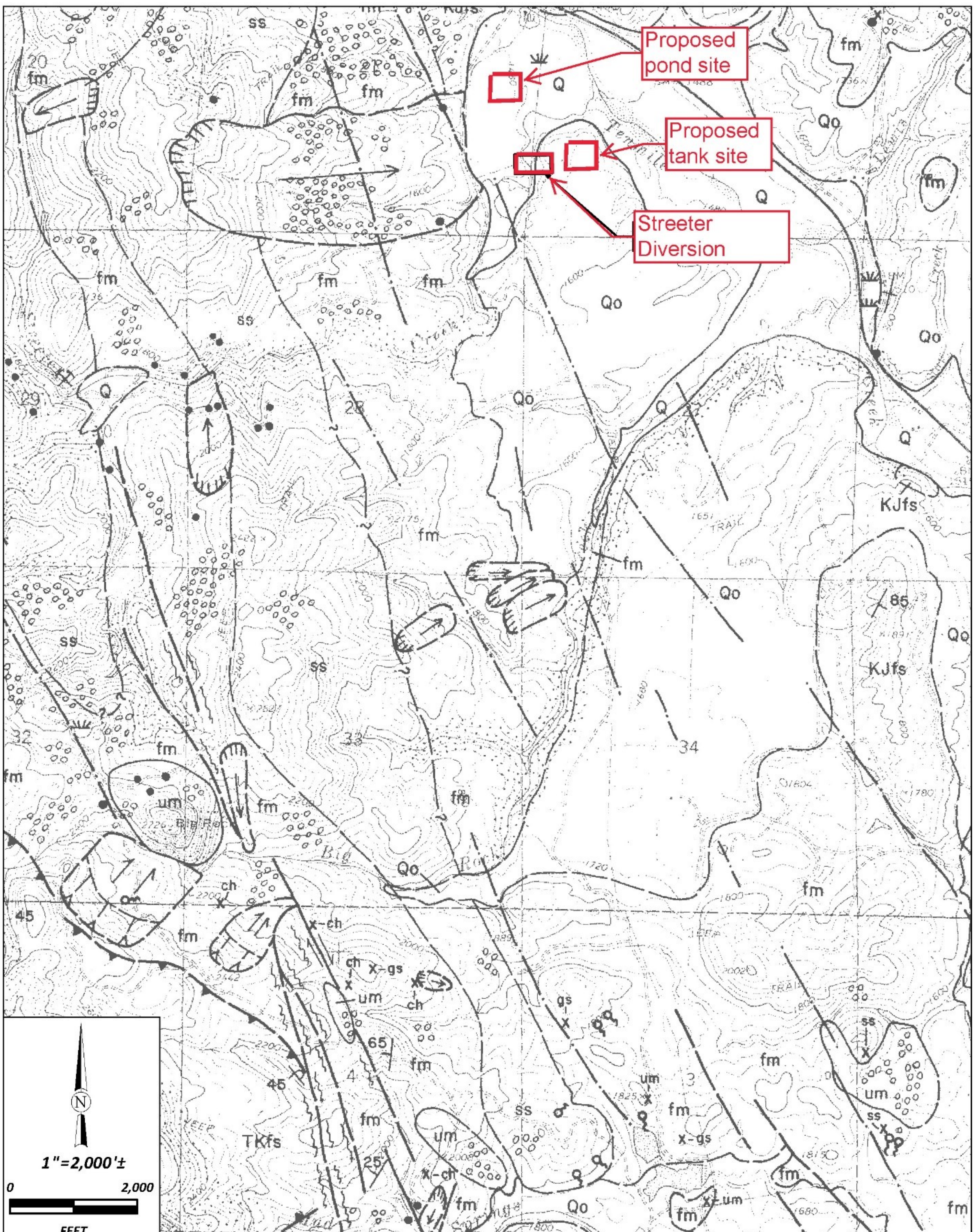
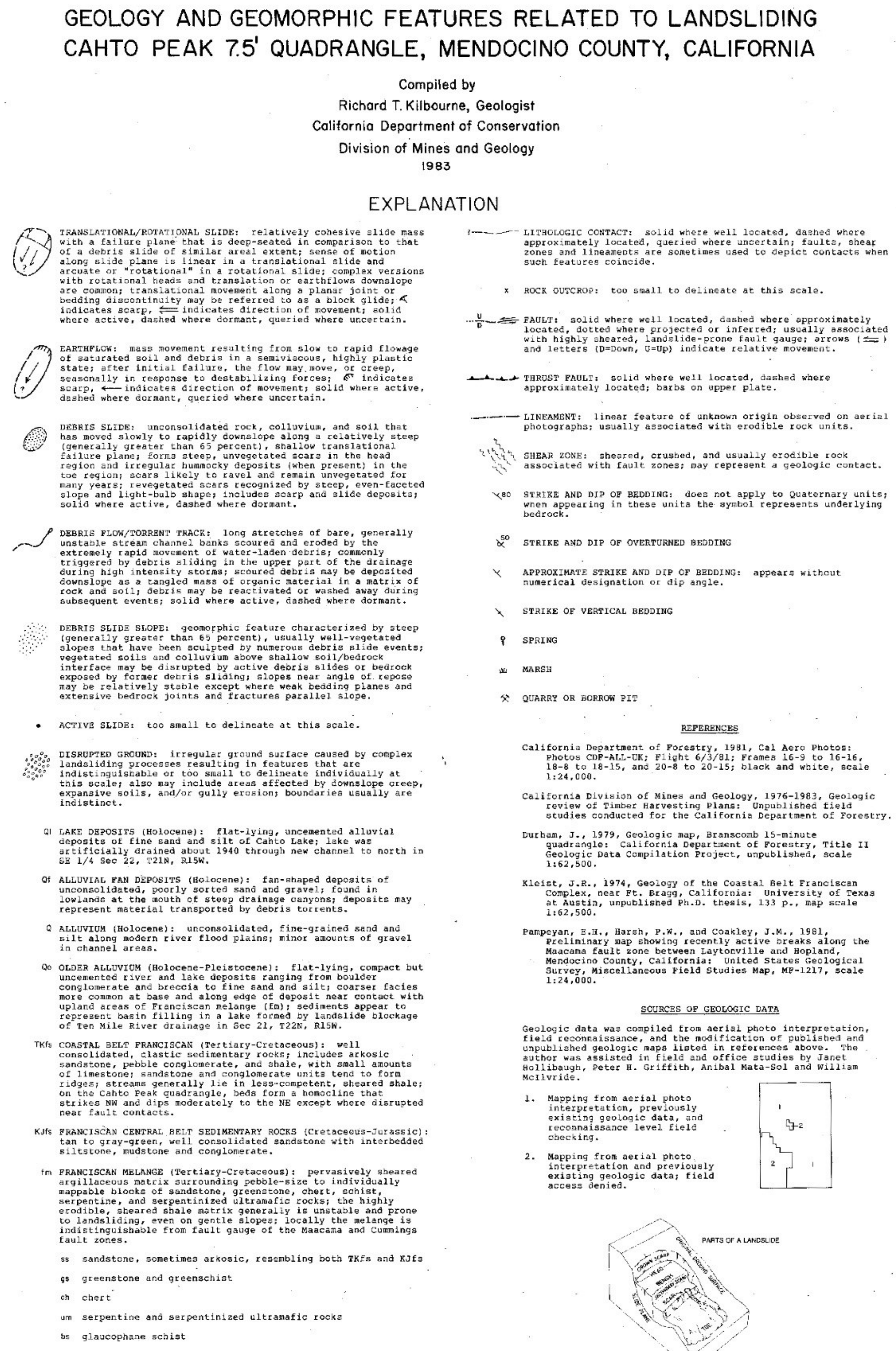


Figure 5. Geology map for Black Oak Ranch vicinity (SHN 2021).



GEOLOGY AND GEOMORPHIC FEATURES RELATED TO LANDSLIDING CAHTO PEAK 7.5' QUADRANGLE, MENDOCINO COUNTY, CALIFORNIA

Compiled by
Richard T. Kilbourne, Geologist
California Department of Conservation
Division of Mines and Geology
1983

EXPLANATION

TRANSLATIONAL/ROTATIONAL SLIDE: relatively cohesive slide mass with a failure plane that is deep-seated in comparison to that of a debris slide of similar areal extent; sense of motion along slide plane is linear in a translational slide and arcuate or "rotational" in a rotational slide; complex versions with rotational heads and translation or earthflows downslope are common; translational movement along a planar joint or bedding discontinuity may be referred to as a block glide; indicates scarp, indicates direction of movement; solid where active, dashed where dormant, queried where uncertain.

EARTHFLOW: mass movement resulting from slow to rapid flowage of saturated soil and debris in a semiviscous, highly plastic state; after initial failure, the flow may move, or creep, seasonally in response to destabilizing forces; indicates scarp, ← indicates direction of movement; solid where active, dashed where dormant, queried where uncertain.

DEBRIS SLIDE: unconsolidated rock, colluvium, and soil that has moved slowly to rapidly downslope along a relatively steep (generally greater than 65 percent), shallow translational failure plane; forms steep, unvegetated scars in the head region and irregular hummocky deposits (when present) in the toe region; scars likely to ravel and remain unvegetated for many years; revegetated scars recognized by steep, even-faceted slope and light-bulb shape; includes scarp and slide deposits; solid where active, dashed where dormant.

DEBRIS FLOW/TORRENT TRACK: long stretches of bare, generally unstable stream channel banks scoured and eroded by the extremely rapid movement of water-laden debris; commonly triggered by debris sliding in the upper part of the drainage during high intensity storms; scoured debris may be deposited downslope as a tangled mass of organic material in a matrix of rock and soil; debris may be reactivated or washed away during subsequent events; solid where active, dashed where dormant.

DEBRIS SLIDE SLOPE: geomorphic feature characterized by steep (generally greater than 65 percent), usually well-vegetated slopes that have been sculpted by numerous debris slide events; vegetated soils and colluvium above shallow soil/bedrock interface may be disrupted by active debris slides or bedrock exposed by former debris sliding; slopes near angle of repose may be relatively stable except where weak bedding planes and extensive bedrock joints and fractures parallel slope.

• ACTIVE SLIDE: too small to delineate at this scale.

DISRUPTED GROUND: irregular ground surface caused by complex landsliding processes resulting in features that are indistinguishable or too small to delineate individually at this scale; also may include areas affected by downslope creep, expansive soils, and/or gully erosion; boundaries usually are indistinct.

Ql LAKE DEPOSITS (Holocene): flat-lying, uncemented alluvial deposits of fine sand and silt of Cahto Lake; lake was artificially drained about 1940 through new channel to north in SE 1/4 Sec 22, T21N, R15W.

Qf ALLUVIAL FAN DEPOSITS (Holocene): fan-shaped deposits of unconsolidated, poorly sorted sand and gravel; found in lowlands at the mouth of steep drainage canyons; deposits may represent material transported by debris torrents.

Q ALLUVIUM (Holocene): unconsolidated, fine-grained sand and silt along modern river flood plains; minor amounts of gravel in channel areas.

Qo OLDER ALLUVIUM (Holocene-Pleistocene): flat-lying, compact but uncemented river and lake deposits ranging from boulder conglomerate and breccia to fine sand and silt; coarser facies more common at base and along edge of deposit near contact with upland areas of Franciscan melange (fm); sediments appear to represent basin filling in a lake formed by landslide blockage of Ten Mile River drainage in Sec 21, T22N, R15W.

TKfs COASTAL BELT FRANCISCAN (Tertiary-Cretaceous): well consolidated, clastic sedimentary rocks; includes arkosic sandstone, pebble conglomerate, and shale, with small amounts of limestone; sandstone and conglomerate units tend to form ridges; streams generally lie in less-competent, sheared shale; on the Cahto Peak quadrangle, beds form a homocline that strikes NW and dips moderately to the NE except where disrupted near fault contacts.

KJfs FRANCISCAN CENTRAL BELT SEDIMENTARY ROCKS (Cretaceous-Jurassic): tan to gray-green, well consolidated sandstone with interbedded siltstone, mudstone and conglomerate.

fm FRANCISCAN MELANGE (Tertiary-Cretaceous): pervasively sheared argillaceous matrix surrounding pebble-size to individually mappable blocks of sandstone, greenstone, chert, schist, serpentine, and serpentinized ultramafic rocks; the highly erodible, sheared shale matrix generally is unstable and prone to landsliding, even on gentle slopes; locally the melange is indistinguishable from fault gauge of the Maacama and Cummings fault zones.

ss sandstone, sometimes arkosic, resembling both TKfs and KJfs

gs greenstone and greenschist

ch chert

um serpentine and serpentinized ultramafic rocks

bs glaucophane schist

LITHOLOGIC CONTACT: solid where well located, dashed where approximately located, queried where uncertain; faults, shear zones and lineaments are sometimes used to depict contacts when such features coincide.

x ROCK OUTCROP: too small to delineate at this scale.

FAULT: solid where well located, dashed where approximately located, dotted where projected or inferred; usually associated with highly sheared, landslide-prone fault gauge; arrows ( ) and letters (D=Down, U=Up) indicate relative movement.

THRUST FAULT: solid where well located, dashed where approximately located; barbs on upper plate.

LINEAMENT: linear feature of unknown origin observed on aerial photographs; usually associated with erodible rock units.

SHEAR ZONE: sheared, crushed, and usually erodible rock associated with fault zones; may represent a geologic contact.

80 STRIKE AND DIP OF BEDDING: does not apply to Quaternary units; when appearing in these units the symbol represents underlying bedrock.

50 STRIKE AND DIP OF OVERTURNED BEDDING

APPROXIMATE STRIKE AND DIP OF BEDDING: appears without numerical designation or dip angle.

STRIKE OF VERTICAL BEDDING

SPRING

MARSH

QUARRY OR BORROW PIT

REFERENCES

California Department of Forestry, 1981, Cal Aero Photos: Photos CDF-ALL-UK; Flight 6/3/81; Frames 16-9 to 16-16, 18-8 to 18-15, and 20-8 to 20-15; black and white, scale 1:24,000.

California Division of Mines and Geology, 1976-1983, Geologic review of Timber Harvesting Plans: Unpublished field studies conducted for the California Department of Forestry.

Durham, J., 1979, Geologic map, Branscomb 15-minute quadrangle: California Department of Forestry, Title II Geologic Data Compilation Project, unpublished, scale 1:62,500.

Kleist, J.R., 1974, Geology of the Coastal Belt Franciscan Complex, near Ft. Bragg, California: University of Texas at Austin, unpublished Ph.D. thesis, 133 p., map scale 1:62,500.

Pampeyan, E.H., Harsh, P.W., and Coakley, J.M., 1981, Preliminary map showing recently active breaks along the Maacama fault zone between Laytonville and Hopland, Mendocino County, California: United States Geological Survey, Miscellaneous Field Studies Map, MF-1217, scale 1:24,000.

SOURCES OF GEOLOGIC DATA

Geologic data was compiled from aerial photo interpretation, field reconnaissance, and the modification of published and unpublished geologic maps listed in references above. The author was assisted in field and office studies by Janet Hollibaugh, Peter H. Griffith, Anibal Mata-Sol and William McIlvride.

1. Mapping from aerial photo interpretation, previously existing geologic data, and reconnaissance level field checking.
2. Mapping from aerial photo interpretation and previously existing geologic data; field access denied.

Figure 6. Geology map legend (SHN 2021).

There is a large earthflow feature mapped to the west of the pond site, but based on field observations this is a very slow-moving feature and the pond site is located greater than 200 feet away from the mapped toe of the slide so this feature poses minimal risk.

A geotechnical report by licensed engineering geologist Chandler Kohen (2022), available as Attachment #1, noted that “the proposed pond is located near the northern margin of the active Maacama North Fault zone and, therefore, potentially subject to strong shaking from future earthquakes.” The California Division of Mines and Geology (1983) found that soils in the vicinity of the proposed pond were derived from recent alluvium that is unconsolidated, often laterally discontinuous river deposits that consist of gravel and sand with inner-fingered silt and clay layers. Kohen (2022) stated that “the main geotechnical constraints that should be considered in the design and construction of the proposed pond include granular site soils, high groundwater” and seismicity. To lower risk of pond failure from these factors, Kohen (2022) recommended that interior and exterior slope grades be limited to 33%, that a high-density polyethylene pond liner be installed under the pond and that and that interior and exterior slope keyways be constructed at low points to limit damage in case of over-filling or seismic shaking Kohler (2022) recommends controlled surface drainage for the pond perimeter to collect surface water for transport to existing natural drainage ways and that such drain-ways have rock energy dissipators and be the channel should have a rock lining. All Kohen’s (Attachment #5) recommendations are integrated into Stillwater’s pond design plans (Attachment #1).

Fish and Aquatic Resources: This Project will increase flow in Streeter Creek, and in a productive reach of Tenmile Creek nearby, and thus improve conditions for native Pacific salmon species listed under the federal Endangered Species Act (ESA), with coho salmon also listed under the California Endangered Species Act (CESA). Steelhead and Chinook and coho salmon all currently or historically utilized Tenmile and Streeter creeks and reaches adjacent to the Project qualify as Critical Habitat under ESA and Essential Fish Habitat (EFH) under the Magnusen Stevens Act. The status of each salmonid population and the condition of their habitat, as well as other native fish, native amphibian species and the western pond turtle that could be present are discussed below. Most of the species would benefit from this Project and none would be harmed. A note on the invasive bullfrog is also included because the pond will need a plan for their control.

<u>Coho Salmon</u>: Coho salmon were once abundant in Tenmile Creek with summer rearing possible in mainstem reaches, some of which now go dry in drought years. National Marine Fisheries Service (Williams et al. 2006) intrinsic potential (IP) habitat maps indicate that Tenmile Creek had more historically suitable habitat than the upper South Fork Eel River, which currently has one of the last functioning Southern Oregon/Northern California coho salmon meta-populations (NMFS 2014). CDFW surveys in the Tenmile Creek watershed in recent years have mostly failed to find coho salmon adults or juveniles.

Data from Cal Trout lower South Fork Eel River DIDSON operation (Metheny 2019, 2020) suggests that the adult coho escapement in 2018 and 2019 was not more than 2000 fish for the whole watershed. Historic Benbow Dam fish ladder counts from 1938 to 1975 averaged 7,705 coho, and prior to the 1955 flood that number was 11,435 fish. ERRP (2020a) had only observed a coho juveniles in the Tenmile Creek watershed inhabiting isolated, stratified pools in Big Rock Creek in 2018. However, coho salmon juveniles were observed at the mouth of Peterson Creek in June 2022 (Figure 7) and found surviving into September in upper Cahto, Mill and Little Case creeks upstream of Streeter Creek. Ocean conditions seem to be favoring coho survival regionally and this strong year class offers a glimmer of hope for their recovery in the Tenmile Creek watershed. While coho have not been documented in Streeter Creek in recent years, they may be present and it is possible that they could be restored and BOR forbearance could play a part in that in conjunction with forest health implementation.

Chinook Salmon: Cal Trout lower South Fork Eel River DIDSON counts in the 2018-2019 and 2019-2020 spawning *seasons* estimated that 3,832 and 2,253 Chinook salmon migrated upstream, respectively (Metheny 2019, 2020). While the Chinook salmon population appeared to be rebounding from 2012 to 2014, the population has dropped to below 10,000 fish since 2018 due to a shift in ocean conditions and low flows during the spawning season (Higgins 2020b). Historic South Fork Eel River Chinook salmon annual runs were documented by fish ladder counts at Benbow Dam that averaged 6,998 between 1938-1975, and 11,435 annually before the 1955 flood. Favorable conditions in WY 2022, including record rainfall in late October 2021, allowed access to the entire Tenmile Creek watershed. Juvenile Chinook were documented feeding in lower Streeter Creek in May 2022 (Figure 8) and also in Cahto Creek and main Tenmile Creek at the Black Oak Ranch and downstream above Grubb Creek. Since Chinook juveniles usually migrate immediately to the estuary, seeing fish lingering and continuing to feed in freshwater likely an indication of a very strong year class. Main Tenmile Creek on the Black Oak Ranch has ideal substrate for Chinook salmon spawning and high densities of spawning fish have been observed and photo and video documented there in some years (Figure 9).

Figure 7. Juvenile coho salmon at the mouth of Peterson Creek. 6/23/22.

Figure 8. Juvenile Chinook at left with steelhead in lower Streeter Creek. 5/26/22.

Steelhead Trout: Data from Cal Trout South Fork Eel River DIDSON operation (Metheny 2019, 2020) suggests that the adult steelhead population was not likely more than 2000 to 3000 adults in the 2018-2019 and 2019-2020 spawning cycles. Benbow Dam counts indicate they were the most abundant Pacific salmon species from 1938 to 1975, with average returns of 11,192 fish, and annual returns averaging 16,544 before the 1955 flood. The standing crop of juvenile steelhead in the Tenmile Creek watershed has often been high in the spring since 2018, but with carrying capacity diminishing with flow later in summer and fall (ERRP 2020, Higgins 2022). Steelhead may spend up to three years in freshwater before ocean entry, with those attaining greater length having better survival to adulthood (Barnhart 1986).

Figure 9. Sub-dominant adult male Chinook over redd in Tenmile Creek at Black Oak Ranch. 11/14/16.

ERRP has observed numerous trout from six to ten inches or greater in length in Tenmile Creek, which strongly suggests a resident, ad-fluvial life history with movement into smaller tributaries to spawn in spring. Resident trout are the same species and may manifest an anadromous life history, if washed to the ocean, and are present in Tenmile Creek and likely utilize Streeter Creek for spawning and rearing.

ERRP documented steelhead successfully rearing through summer in Streeter Creek in 2019 (Figure 10), which was a moderate rainfall. Although Streeter Creek flow disconnected in 2022, steelhead young of the year were observed in isolated pools on BOR. Additionally, in 2019 there was a hyporheic, cold water upwelling in main Tenmile Creek below Streeter Creek that maintained viability for steelhead rearing through summer and fall. Therefore, ecological function of Streeter Creek and Tenmile Creek immediately downstream will be aided by BOR forbearance, thus protecting and enhancing steelhead Critical Habitat and EFH.

Figure 10. Steelhead trout young of the year that survived the summer in lower Streeter Creek in a pool just upstream of Tenmile Creek. 10/17/19.

The upgrade of the Streeter Creek POD will entail dewatering Streeter Creek during construction and a coffer dam will be erected, by-pass pipe installed and any juvenile steelhead at the site will be rescued and relocated. ERRP will consult closely with CDFW and will obtain a NMFS "take permit. A fish rescue and relocation report will be included in the Biological Assessment needed to obtain the 404 permit from the ACOE and a Biological Opinion from NMFS that allows project construction. The Streeter POD design includes adjacent structures with large wood to both buttress the intake system but to add fish habitat complexity with a design as recommended in CDFW (2010).

<u>Pacific lamprey (Entosphenus tridentatus)</u>*:* Listed as a California State Species of Special Concern, Pacific lamprey heavily utilize Tenmile Creek for spawning in years of high abundance and also Streeter Creek. They spawn in gravel similar in size to those preferred by trout and their larvae are known as ammocoetes and they are blind and live in silt and sand on the edges of tributaries, and main trunks of the Eel River, for 5-7 years before entering the ocean. augmenting Streeter Creek and Tenmile Creek flow could improve conditions for larvae.

<u>Sacramento sucker (Catostomus occidentalis)</u>: This native, warmwater adapted species was once common in the Eel River. Predation by the Sacramento pikeminnow since their introduction in 1979 has led to a very depressed sucker population in the South Fork Eel River downstream of Tenmile Creek. In October 2019, native sucker young of the year were observed in the pool downstream of Streeter Creek; therefore, this species would also benefit from BOR forbearance.

Prickly Sculpin (Cottus asper): Sculpin live in the interstitial spaces of the stream bed and attain a maximum length of 6" or less. Prickly sculpin were likely historically present in Streeter Creek, although their present use of the stream has not been documented. Their habitat would also be improved through BOR forbearance.

Yellow-legged Frogs (Rana muscosa): This species is found in Streeter Creek and in Tenmile Creek adjacent, but the proliferation of bullfrogs in the latter poses serious competition for yellow-legged frogs. There is no ESA protected status for this species in northwestern California or in Mendocino County, but in southern California they are listed as Endangered under CESA and as Threatened under ESA in the Sierra Nevada. Additional flow will benefit yellow-legged frogs and there will be no negative impacts from Project construction.

Pacific tree frog (Hyla regilla)*:* The tree frog is ubiquitous, has a black eye stripe, suction cups on toes and sings, which has given rise to one of its common names, the chorus frog. The pond could provide habitat for this species and no aspect of construction will negatively affect them.

Red-legged frog (Rana draytonii): Federally listed under ESA as Threatened, the red-legged frog is not obligately riparian. They often range widely on forest lands and use ponds in upland areas for reproduction, so it is possible they could utilize the pond seasonally.

Western Pond Turtle (Actinemys marmorata): CDFW lists the western pond turtle as a Species of Special concern, but they are abundant in the Eel River watershed and have been observed in Streeter Creek on the BOR. Adults may live up to 70 years and they migrate seasonally from stream side areas in summer to burrows on hillslopes in winter to avoid flood flows. This project will not disturb resident turtles, although they utilize habitat not far upstream of the Streeter Creek POD.

Bullfrog (Lithobates catesbeianus): This invasive species is native to the eastern United States and thrives in ponds in the Tenmile Creek watershed and elsewhere in the Eel River basin. They predate on native frogs and amphibians and may even consume baby ducks or other similar sized prey items. BOR will need a bullfrog control plan and to exert on-going effort to make sure the pond does not become a breeding ground for bullfrogs.

Upland Wildlife: Wildlife habitat on the Black Oak Ranch consists of a mixed deciduous hardwood and conifer forest interspersed with grasslands. There is no suitable habitat for the ESA-listed northern spotted owl or marbled murrelets on the BOR parcels because they lack large, late seral stage conifers. The area where the camp tanks will be installed is an oak forest that has been over-topped by invading Douglas fir trees. BOR has previously thinned fir trees and girdled them to release the oaks, and some fir trees will be harvested to make room for storage tanks and a CalFire three acre exemption permit is being sought. However, there is no threat to either bird species as none of the habitat being disturbed is suitable for nesting, roosting or foraging. The Pacific fisher is listed as threatened under ESA and as a Species of Special Concern by CDFW. Fishers could utilize habitat nearby, but no aspect of the Project would disturb them or have any effect on their prey base.

Botanical Resources: Dr. Kirsten Hill (2021, Attachment #6) did a botanical survey of species in the field where the pond will be constructed in May 2021 and made the following discoveries:

> "The area for the proposed pond on Black Oak Ranch is a dry exposed patch of grassland that contains largely non-native and invasive species of grass. The majority of the grasses present within the patch were Bromus hordeacus and Aira carophyllea. Further away from the entrance road and closer to the dry creek bed was a large patch of Festuca arundinacea. I noticed five single standing native perennial bunch grasses and two Soap Root plant underneath the black oak trees adjacent to the dirt road. These were identified as California Wild Oats and Blue Wild Rye. Interspersed within the dry patch of invasive grasses that were not under the oak trees were some common native annual wildflowers including Eschscholizia californica (California Poppy) and Lupinus bicolor (Lupine) and a few Clarkia purpurea."

Given the long history of agricultural use of the field, it is not surprising that few native species are present. Dr. Hill did a preliminary survey of the terrace above the camp where the storage tanks are to be installed, but did not file a formal report. In a follow up email (Hill 2021a), she stated that species of concern were iris species and mule's ear plants, although neither are present at the site of where the tanks will be placed. Consequently, no adverse impacts on plant species is expected from Project construction.

Cultural Resources: The Cahto Tribe has inhabited the Tenmile Creek watershed since time immemorial according to their cultural history, and they enhanced the productivity of their environment. They are known to have used frequent, low intensity fire to control vegetation, lighting fires in winter or during wet periods that removed competing vegetation in oak woodlands and grasslands. Their practices are now valued as Traditional Ecological Knowledge (TEK) and are now being embraced and adopted by forest health practitioners. Over thousands of years, almost all the area within the Tenmile Creek watershed was traversed and/or utilized, but there is no indication that this project would impact sites of cultural importance given the prior disturbance regimes of agriculture, grazing and logging. However, ERRP has met with the with the Cahto Tribe to discuss any concerns and a site visit is planned with their Tribal Preservation Officer Vernon Wilson.

Hydrologic Analysis

Regulatory Considerations: Based on the initially proposed designs, it was recommended by the SWRCB-Water Rights Division to apply for an Appropriative Water Right (AWR). This water right will include three points of surface water diversion: the existing POD on Streeter Creek, a new POD on the unnamed BOR tributary, and a POD on Tenmile Creek to serve as a back-up water source. In addition to these surface water POD's, it may be recommended to also include groundwater that will be pumped by the sump pump located beneath the pond as another POD. A detailed Water Availability Report (TGAEC 2022) is available as Attachment #3 and is part of the AWR application. Portions of that report are excerpted below.

On a September 13, 2022 field trip to BOR to meet with agencies (Figure 11) and discuss permitting pathways, attorney Matt Clifford of Trout Unlimited, who is a sub-contractor to ERRP on this Project, suggested that the new SWRCB State-wide Restoration Permit for which a recent Programmatic Environmental Impact Report (PEIR) had been completed might be applied. His reasoning was that the construction of augmented water storage was primarily to restore flow to Streeter Creek for the benefit of salmonids, and particularly steelhead.

Figure 11. September 13, 2022 field (l to r) Monty Larson (CDFW), Bob Barsotti, Evan Engber, Martin Mitchell, Irene Engber, Britney Newby (SWRCB NC), Joel Monschke (Stillwater), Anna Birkas (Village Ecosystems), Julia Petreshen (TGAEC), Joe Scriven (MCRCD), Matt Clifford (TU), and Matt McCarthy (SWRCB Sacramento).

In early October, Matt Clifford followed up by arranging a discussion of permitting pathways with CDFW staff members Brad Henderson and Brian Hennes who are part of the Cut the Green Tape program. Invoking the PEIR as a pathway to 401 permitting would entail the SWRCB taking the lead and becoming the formal Lead Agency, a role that ERRP had anticipated would be played by the Mendocino County Resource Conservation District (MCRCD).

CDFW staff said they recognized the potential applicability of the PEIR and said that CDFW would switch its role to that of Responsible Agency, if the SWRCB became the Lead Agency. This means that their agency would concern itself with matters such as stream alteration for the installation of the new diversion works on Streeter Creek, in rescue and relocation of fish at the construction site at the time of dewatering, and setting flow levels and water withdrawal allowed under the BOR forbearance agreement. Under this scenario, CDFW may invoke their new CEQA Statutory Exemption for Restoration Projects (SERP) but require a 1600 permit for the Streeter POD construction.

Following up, Matt Clifford arranged a Zoom meeting with Gil Falcone of the North Coast Regional Water Quality Control Board (NCRWQCB), who was receptive to his arguments and stated that the PEIR might be the appropriate permitting pathway. However, since ERRP is filing an AWR permit and that process can sometimes entail CEQA analysis, Gil recommended that the 401 staff for the SWRCB Water Rights Division (WRD) might be a more appropriate lead for the PEIR process. Gil reached out to Parker Thaler who leads the SWRCB WRD 401 permit process and he expressed interest having his agency invoke the PEIR and to become Lead Agency. A meeting between ERRP staff and contractors is scheduled for December 8, 2022.

The installation of new pump equipment and the re-design of the intake system at the Streeter POD will require stream de-watering using a coffer dam, construction of a by-pass pipe that allows fish to avoid the area of construction, and removal and relocation of steelhead juveniles and other fish species present. ERRP has identified sites where fish could be relocated and will work with CDFW and NMFS on this aspect of the project. In order to obtain a 404 permit from ACOE, NMFS will have to consult, issue a take permit and provide a concurring Biological Opinion. ERRP anticipates creating a Biological Assessment for ACOE and NMFS that would include a section on fish rescue and relocation.

Water Demand: A summary of water use for Irene's Garden Produce Farm and Camp Winnarainbow are provided below, but the Water Supply Report (TGAEC 2022) (Attachment # 3) provides more details.

Farm Water Demand: Irene Engber monitors water extraction from Streeter Creek using a meter and estimates farm water demand at approximately 1 – 1.5 MG per year. She actively implements water conservation measures, especially in drought years, that include planting low water demand crops, rotating crops, and not farming 2 acres due to drought conditions. Additional use includes 500,000 gal annually for an orchard and 200,000 gallons annually for controlling dust on the farm road.

A summary of proposed pond water use is described in Table 1. Approximately 2 MG will be allocated for irrigating the farm, including 500,0000 gallons (0.5 MG) for watering the 178-tree orchard. Approximately 200,000 gallons (0.2 MG) will be allocated for controlling dust on farm roads and another 200,000 gallons (0.2 MG) for irrigating camp grounds. This makes the total water demand supplied by the pond 2.4 M gallons. Additionally, an estimated 30% of the total volume (1.2 MG) will be lost to evaporation and a 10% contingency (0.4 MG), a 4 M gallon pond design is the most appropriate choice.

Camp Water Demand: The Camp requires 800,000 gallons of water in the summer for drinking water and showers. Attendees include Camp Winnarainbow that hosts inner-city and rural disadvantaged students who learn about art and nature, and a Women's Herbal Symposium. Current infrastructure includes a SWRCB-approved water treatment facility, from which treated water is pumped to storage tanks above the camp that have a capacity of 30,000 gallons. Due to current limited storage, water is pumped from Streeter Creek approximately weekly, or as needed to meet demand throughout summer.

Table 1: Future Estimated Water use from the proposed 4-MG pond.

Description	**Water Use (gallons)**
Farm Irrigation	1,500,000
Orchard Tree Irrigation (178 trees)	500,000
Dust Control	200,000
Camp Lawn Irrigation	200,000
Evaporation Loss (30% of total volume)	1,200,000
Contingency	400,000
Total Pond Volume	**4,000,000**

Typical summer camp includes 150 students and 24 camp counselors (Figure 12), totaling 174 people/day. With an estimated per person use of 42 gallons per day, a daily total of approximately 7,308 gallons is used. Over a 100 day period of operation, an estimated as 730,800 gallon is utilized by Camp Winnarainbow. Women's Herbal Symposiums are of shorter duration, with two days over four weekends in late spring and late summer, but have more people present than during the summer camp. Estimated use for these events is 7,500 gallons per day for eight days or 60,000 gallons. Total use is then 790,800 gallons and with a 10% contingency equal to 8000 equaling 798,900 gallons or nearly the equivalent of the 800,000 gallons of planned storage. In addition to potable water, the camp requires 200,000 gallons of untreated water for irrigation of the lawn where majority of activities take place that will be supplied directly to the irrigation system from the pond across Streeter Creek.

Figure 12. Camp Winnarainbow counselors on a break coming up Streeter Creek. 6/23/19

The Camp is typically used May 15th through Oct 1, with peak use from June 15th through Sep 1st. Approximately 200,000 gal of untreated water is used for water the camp lawn (where most activities are held). 800,000 gallons of treated water are used for the summer camp potable water. During this recent drought the lawn watering has been reduced as a water conservation effort. A summary of water extracted from Streeter Creek at the permitted point of diversion (POD) (SDU #S015602) from 2011 to 2019 is below as Table 2.

Existing Streamflow Conditions: To better understand water supply and availability, TGAEC (2022) calculated the annual average discharge for Tenmile Creek at the Black Oak Ranch, Streeter Creek and the unnamed tributary on BOR that will be used to supply the pond. Flow calculations for Tenmile Creek are based on U.S. Geologic Survey historic flow records (1955-1973), while the annual discharge of Streeter Creek and the unnamed tributary are calculated using standard drainage area ratios (DAR) utilizing USGS Elder Creek flow data.

Estimated average annual discharge of Tenmile Creek is 176 cfs, while discharge for Streeter Creek and the unnamed tributary are approximately 7 cfs and the Tributary of 0.15 cfs. Observations by Black Oak Ranch residents indicate that the Tributary is an intermittent stream – maintaining streamflow primarily during the winter season and drying during periods of little rainfall. Average discharge values were converted to annual estimated volume output by each stream (Table 3).

Filling Storage During the Wet Season:_The combined system will have three points of diversion (PODs), plus significant input from rainwater and supplemental water from the sump pump under the pond. Redundancy of water sources for the combined system will insure that, in case of drought or emergency, there is always a source of water to meet demand, and thus ensure that forbearance requirements are easily met. The following water sources will be combined to meet the farm and camp need for water supply:

Table 2: Summary of water diversions reported in the annual SDU #S015602 reports from 2011 – 2019

Year	Water Beneficially Used (ac-ft)	Water Beneficially Used (gal)	Water Beneficially Used (MG)
2011	2.06	671,253.06	0.67
2012	1.63	531,137.13	0.53
2013	1.84	599,565.84	0.60
2014	2.31	752,715.81	0.75
2015	1.61	524,620.11	0.52
2016	2.24	729,906.24	0.73
2017	2.06	671,253.06	0.67
2018	7.56	2,463,433.56*	2.46
2019	7.1	2,313,542.10*	2.31
2020	4.92	1603186.92*	1.60
2021	2.45	798334.95*	0.80

* Water for farm use included in 2018 and 2019 reports, but only camp use prior. Camp water use was reduced during COVID years 2020 and 2021.

Table 3. Average annual discharge and corresponding volume outputs for each watershed.

Watershed	Drainage Area (mi^2)	Average Annual Discharge (cfs)	Average Annual Volume Output (MG)	Average Annual Volume Output (ac-ft)
Streeter Creek[1]	4.9	7.23	1,705.6	5,234.3
Tenmile Creek[2]	50.1	176.3	41,590.2	127,635.5
Unnamed Tributary	0.1	0.15	34.7	106.4

[1]Streeter Creek and the Tributary output approximately 5,000 ac-ft and 100 ac-ft per year during drought years, respectively. Tenmile Creek, based on USGS records, delivers an average of 128,000 ac-ft per year.

1. *Rainwater*: Rainwater capture will occur directly into the pond as well as be captured from the camp's Big Top roof and the storage tank roofs.
2. *Streeter Creek POD (existing*). BOR has a SWRCB registered riparian water right for both the farm and camp. This facility will primarily provide water for the camp, but will be equipped to serve as a back-up water source during winter for the pond, if needed.
3. *Unnamed tributary to Tenmile Creek POD (new*): Water from this intermittent creek will be captured at the culvert outlet and will be gravity-fed into the pond. This creek has some connection to Tenmile Creek, but no resident fish life.
4. *Tenmile Creek Facility POD (existing)*: Historic pumping location where water has been extracted for use on Irene's farm when Streeter Creek was low. This facility will also be used as a back-up source of water to fill the pond, if needed during severe drought but only during the wet season as stipulated on forbearance agreement.
5. *Groundwater Sump Pump Under Pond*: The pond will require a sump pump to prevent the pond liner from floating during periods with high groundwater levels. This sump water will be directed back into the pond, acting as a supplemental water source.

Estimated Rainwater Catchment: Precipitation records from the past 20 years, compiled by a nearby landowner Vic Weaver, indicate that the average annual precipitation near Black Oak Ranch is approximately 61 inches (Table 4). Rainwater catchment opportunities include direct precipitation captured by tank roof surfaces, pond, and camp Big Top and shed roof surfaces.

Rainwater Capture for Storage Tanks*:* Table 5 provides data related to the volume of water captured from rainfall by from tank roofs based on eight 100,000-gallon tanks each with a height of 135 inches. The amount of water captured by the tank will be a column of rainwater equal to the annual precipitation that year.

Rainwater Capture by the Pond*:* Approximately one third, or 1.3 M gallons, of the total pond volume can be filled by rainwater catchment during a 40-inch precipitation year or half the pond volume in a 60-inch rainfall year. Estimates for filling use the lower rainfall range because it is the mean precipitation level within one standard deviation from 23 years of local rainfall records. The remaining volume needed to fill the pond would be 2.7 M gallons, coming from the unnamed tributary in most years.

Rainwater Catchment for Camp Big Top: The Big Top at Camp Winnarainbow is a 2000 sq. ft surface with green metal roofing. Pending a water quality test, this will be included, along with the nearby shed with the same type of roof. An estimated 78,000 gallons of water supply can be accessed from this source in an average water year.

Table 4: Precipitation statistics near Black Oak Ranch, averaged from Vic Weaver's rain gauge, determined from 23 years of data (1998 – 2021).

Precipitation Statistic	Value (inches)
Mean	61
Minimum	25.3
Maximum	102.6
Standard Deviation	21

Table 5: Calculations of rainwater captured under varying precipitation conditions (based on a 9' tank height)

Water Source Variation for Different Precipitation Scenarios				
Source	Severe Drought	Low Rain (-1 STDEV)	Average Rain	High Rain (+1 STDEV)
Annual Precipitation (in)	25	40	61	82
Tank Catchment Rain Volume (gal)	158,979	254,366	387,909	521,451
Big Top & Shed Rain Volume (ga	32,164	51,462	78,480	105,498
Stream Volume	688,857	574,171	413,611	253,051
Water need met by Rain	24%	38%	58%	78%

Streeter Creek: The existing diversion point on Streeter Creek (SDU, #S015602) will be used for filling water storage tanks in addition to precipitation. After precipitation inputs during a "drought" year, approximately 574,000 gallons will be required from Streeter Creek (Table 6). This total volume represents 0.04% of the total wet season output by Streeter during a drought year. Streeter Creek will serve as a water source to "top off" the storage tanks after precipitation inputs; therefore, the proposed water diversion season for Streeter Creek is between December 1 and May 15. The average daily output by Streeter over the proposed diversion season is displayed in Figure 13. If we assume water diversion will take place over the course of 31 days, approximately 18,500 gallons will be diverted per day, as represented by the dashed line in Figure 13.

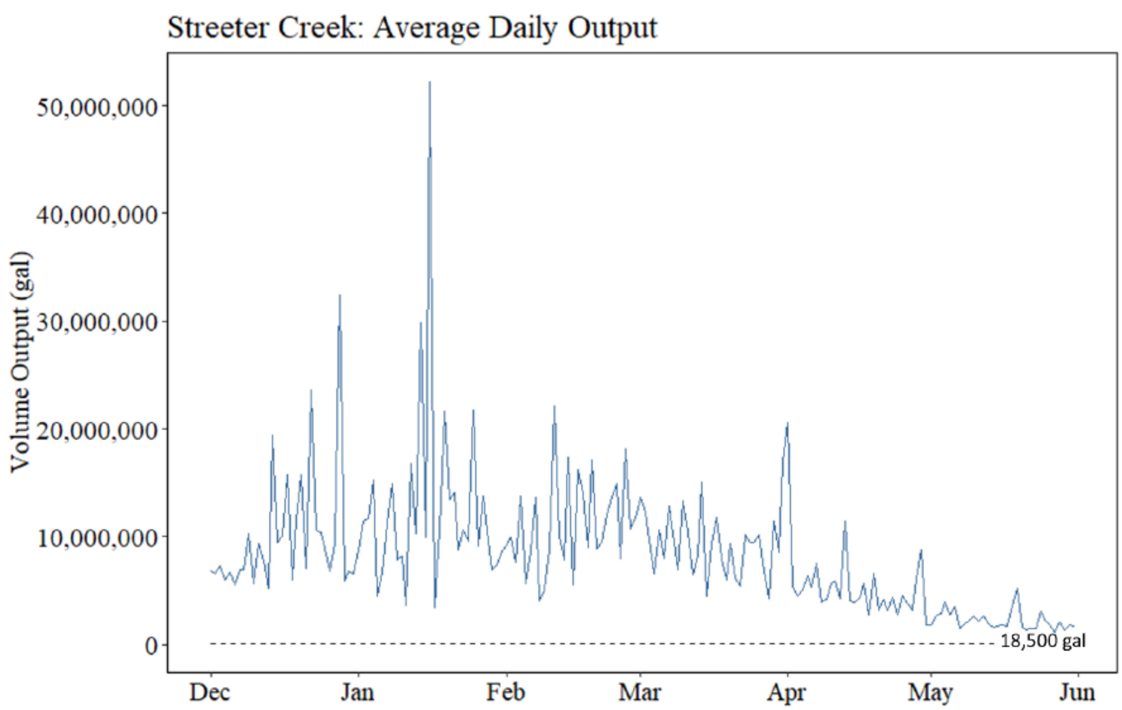


Figure 13: Average daily output from Streeter Creek from December 1 to May 15. Dashed line represents the total volume demand to fill storage tanks (18,500). From TGAEC (2022).

Assuming a daily diversion rate of approximately 18,500 gallons, this comprises between 0.03% and 1.6% of the daily flow output in Streeter Creek during the diversion season under drought conditions. This low percentage of the total daily flow indicates very little impact to both downstream water right holders and aquatic life. Depending on pump rates and varying precipitation conditions, it may take between 6 and 61 days to fill the tanks during an average water year, or between 7 and 72 days during a drought year (Table 6).

Table 6. Calculations of pumping rates describing length of days needed to fill storage tanks after rainwater component for an average precipitation year (61") and a drought year (40").

Average Year (61") — Days Required to Fill Tanks after Rainwater				
Pumping Rate	*5/gal/min*	*10/gal/min*	*20 gal/min*	*50 gal/min*
Days	61	30	15	6
Drought Year (40") — Days Required to Fill Tanks after Rainwater				
Days	72	36	18	7

Unnamed Tributary: The point of diversion from the Unnamed Tributary will be installed near the culvert outlet which passes under the main access road located on project parcel. Diversion from the unnamed tributary to the pond will take place during the period from December 15 to April 30. Flow will be diverted and gravity-fed to the pond, which will reduce long-term pumping costs. Winter peak flow events in this stream typically carry a lot of sediment and water will be withdrawn when peak flows recede and there is less sediment transport. Estimated winter volume outputs from the unnamed tributary are shown in Figure 14, including the amount of water withdrawn for comparison. The target annual diversion volume for the tributary is 2.7 million gallons taken during approximately 31 days at a rate of 60 gpm, as shown in Table 7 below. Overall, the total water demand of 2.7 MG would be 9% of the total wet-season outflow from the Tributary (30 MG) during a drought year.

Tenmile Creek: The Tenmile POD has traditionally been used by Irene Engber to water the Farm during times when Streeter Creek is low or dry. Historically, it has been used for Black Oak Ranch agriculture and is likely one of the original PODs dating back to the 1800s. Currently a small gas pump is temporarily used when needed. Water diversion from Tenmile Creek will be used as a "last resort" to fill the pond and storage tanks after precipitation and primary diversions from the Unnamed Tributary and Streeter Creek have not supplied sufficient water. Therefore, the proposed diversion period for Tenmile Creek is between April 1 and May 15. During the proposed season of diversion from Tenmile Creek (Apr. 1 – May 15), the average monthly output is 1,873 MG. The total demand by pond and storage tanks represents approximately 0.17% of the total output during the proposed diversion period. For complete information, see the Water Availability Report (TGAEC 2022) (Attachment #3).

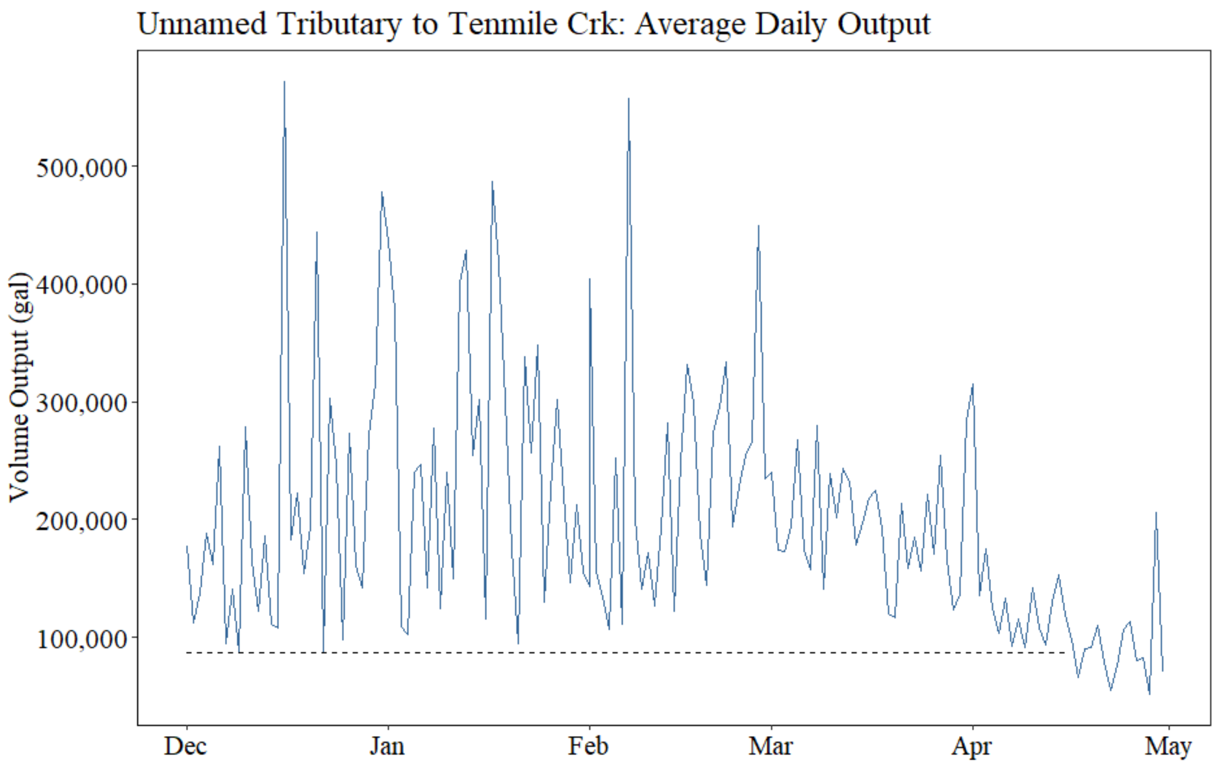


Figure 14: Average daily volume (gal) flowing through Unnamed Tributary to Tenmile Creek. Data were prorated using 55 years of Elder Creek USGS records and assume a 40" precipitation year to simulate drought conditions. Dashed line represents approximate daily diversion rate (86,700 gallons) between Dec. 1 and April 15.

Table 7: Annual diversion goal and resulting minimum desired diversion flow rate.

Annual Diversion Target	2,700,000	Gallons
Number of Days/Year with Full Diversion Flow	31	Days
Diversion Rate/Day	87,120	GPD
Diversion Rate/Hour	3,630	GPH
Average Diversion Rate/Minute	60.5	GPM

Table 8: Water demand by Black Oak Ranch as portion of total wet season output in Tenmile Creek, including the cumulative demand when considering appropriated water in Tenmile.

Demand Type	**Demand Volume (MG)**	**Wet-Season Output**	**Black Oak Ranch: Demand as Portion of Total**	**Appropriated Water (MG)**	**Cumulative Demand as Percentage of Wet-Season Output**
Pond	2.7	-	0.007%	-	0.936%
Storage Tanks	0.5	-	0.001%	-	0.930%
Total	3.2	36,745	0.009%	341.3	0.937%

Groundwater Pump: Given the presence of a variable and generally shallow groundwater (GW) table, the depth of the pond was minimized. However, even adopting that measure to the full feasible extent cannot remove the possibility that the groundwater table may be elevated above the water surface elevation within the pond during some portions of the year. This circumstance, whereby GW levels outside the pond exceed the water surface elevations within the pond, may lead to the liner billowing and associated maintenance issues. To mitigate this operational risk, a dedicated GW dewatering and return pump system is proposed.

Although the primary purpose of the pump is to minimize impacts to the pond liner, it will also be a source to fill the pond. However, the total anticipated inputs from groundwater are unknown at this time so the approach described herein is to fill the pond with rain and surface water diversions, and the groundwater will be supplemental. If the groundwater inputs turn out to be significant, less surface water diversion will be necessary.

Calculating the 100-Year Flood Event for Pond Spillway Sizing: Peak flow estimates have specific recurrence intervals, or frequencies (e.g., a 100-year peak flow has a 1% chance of occurring any year, or once in 100 years, on average). It is critical to analyze flows from a 100-year recurrence interval flood event to determine adequate sizing for the pond's proposed spillway. The 100-year storm event analyses utilize Rational Method runoff calculations for the catchment region of the pond and surrounding berm crest. The Rational Formula is

Q = CIA, where:
Q = Flow Discharge
C = Runoff Coefficient
I = Rainfall Intensity
A = Area

During a 100-year storm event the pond and berm will see the full effect of incidental precipitation and runoff collecting in their collective catchment area, the creek will also be flowing at a rate consistent with a 100-year storm; however, the diversion piping will be designed to inherently limit the flow rate through the line. As discussed in detail below, the gravity diversion supply line routing water into the pond will have a maximum physical flow rate of ~81gpm (~0.18cfs). Based on the Rational Formula, the 100-yr discharge was calculated for the entire pond and berm. For this project, we have adopted an effective Runoff Coefficient of 0.95 to generally capture the blended coefficients of 1.0 for the ponded surface (~1.3 acres), and the relatively smaller region of surrounding berm crest (~0.7acres) at 0.85. To develop an estimate of a peak design flow at the pond's spillway, the 0.18 cfs maximum feasible diversion inflow was adopted as the incoming flow from the unnamed tributary and combined with the estimates of peak runoff generated by the pond and surrounding berm derived through application of the Rational Method.

<u>Determining Storm Duration</u>: 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, the "Time to Concentration" (Tc) 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 feature or "point of concentration".

The contributing region of runoff that would potentially produce runoff over the spillway is small, compact, and predominately ponded water surface; therefore, the value of Tc was assumed to be 5 minutes. This "Time to Concentration" can be calculated following the methods of Per Cafferata et. al. (2004) and the formula:

Tc=((1.8)(1.1–C)(D0.5))/(S0.33)

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)

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). 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 site.

The 100-year rainfall intensity from the PFDS for each site is shown in Table 9. Determining the peak flow associated with the 100-year storm runoff, through the application of the Time of Concentration and Rational Methods, as described above, indicates that a maximum of 11.35cfs is anticipated over the spillway. See Spillway Sizing and Design in Project Design Section below.

Table 9. Summary of Time to Concentration Analysis.

Site	**Area (ac)**	**Cover Coefficient (C)**	**Long Flow path (ft)**	**Max Elevation Change (ft)**	**Slope (%)**	**Time to Concentration (min)**	**100-year (in/hr.)**	**100-year Discharge (cfs)**
Ponded extent and surrounding berms	2.0	0.95	50	1	2.0	5	5.8	11.4 (includes 0.18cfs from max diversion)

Project Design

Pond: This section should be reviewed in conjunction with the Black Oak Ranch Pond and Diversion Project Design – 100% Final Design (Stillwater 2022) that can be found as Attachment #1. A 4-MG pond is proposed for construction to serve as the main source of water storage and supply for Irene's Garden Produce Farm. A geotechnical investigation (Attachment #4) conducted at the proposed pond site indicated the presence of groundwater at 10 feet below the surface, and the pond will be deeper than that. Therefore, as discussed above installation of a groundwater sump pump return line will be required to prevent pond liner from "floating". This will also provide another option for filling the pond, as groundwater pumped by the sump pump will be directed back into the pond.

Construction of the pond will include excavation and placement of an earthen berm and rock armored spillway. 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 critical fill placement will be subject to compaction testing to ensure 90% minimum compaction. The creation of the pond basin is anticipated to generate 13,300 cy of earthen spoils, all of which are anticipated to be reused in the construction of the berm, so the project grading on a whole is anticipated to be net-zero and not require import or export of fill materials. The pond's berm will feature 3:1 (Horizontal: Vertical) side slopes and the crest of the earthen berm is anticipated to be 24-feet wide at its top with a ~2% cross slope to the inside. All recommendations of Kohen (Attachment # 4) have been integrated into the design.

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 Department of Safety of Dams (DSOD) jurisdictional oversight, unless it is exempted. The DSOD Jurisdictional Size Chart (Figure 15) 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. This project falls well below the DSOD jurisdictional threshold considering its max dam height of 12 feet and volume of 12.3 acre feet (4 MG).

Based on the alluvial soils present at the site as described in the geotechnical report, a High Density Polyethylene (HDPE) liner is required to hold water in the pond. Non-woven geotextile fabric and gravel topping will be utilized to protect the liner. The pond has a rock-lined spillways sized for the 100-yr storm discharge as described above and shown on the design plans.

The proposed pond will have a rock-lined spillway sized for the 100-yr storm discharge with a dedicated receiving and infiltration basin located 30-feet away from the northeast corner of the berm's toe, as shown on the design plans (Attachment #1). Given the above results of rational method (11.2cfs), and combining it with the maximum physical flow rate that is feasible through the diversion line (0.18cfs), the effective 100-year design flow rate for the spillway can be determined as 11.4cfs.

To ensure the spillway has adequate capacity for the anticipated 100-year design flow rate, water velocities across the crest will be kept under 1ft/sec across the crest. Therefore, the trapezoidal cross-sectional dimensions of the spillway will be at least 8-feet wide at its base, with 2:1 side slopes (H:V),

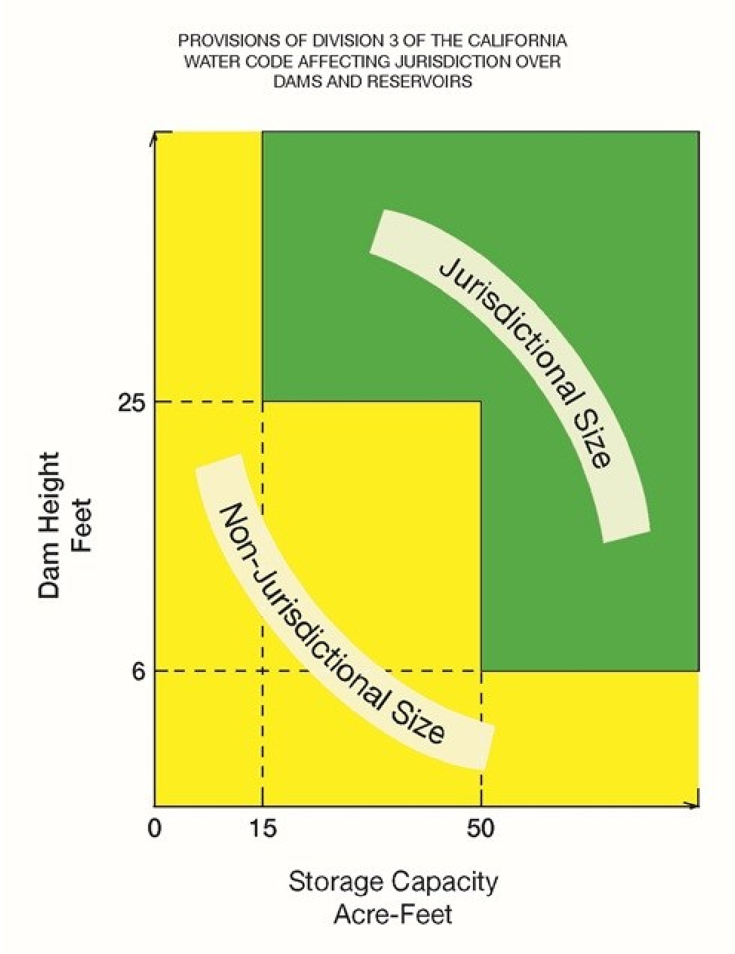


Figure 15. DSOD jurisdictional chart.

and given the 3ft of freeboard present around the earthen dam; the spillway will be 20ft wide at its top. Given these dimensions, the maximum flow of 11.35cfs, and desire to limit the flow velocity across the berm crest to the extent feasible; a maximum flow depth of 1.5ft is anticipated. This flow depth is approximately halfway up the trapezoidal spillway channel provided.

Groundwater Pump at Pond: As shown on the design plan set, an ~9-inch-thick gravel bed layer, wrapped in non-woven filter fabric, is included as a lens below the liner. Additionally, the bottom of the pond, and gravel lens below, are cross-sloped (less than 0.5%) to be lowest in the southeast corner of the pond; thereby effectively intercepting and concentrating groundwater under the pond to a single collection point. To promote this draining and concentrating process, a perforated collection pipe will be run for approximately 100-feet along the lowest eastern edge of the pond. The proposed 4-inch diameter perforated drain will be set to intercept and convey water longitudinally to the edge of the gravel bed below the pond's southeast corner. Just within the gravel bed the perforated piping system will transition to a solid wall pipe of equal type and diameter. This line will continue under gravity flow to a collection sump below the proposed pump house approximately 125-feet to the south.

The collection sump chamber will be composed of a 20-foot long, 2.5-foot diameter (30-inch), HDPE pipe affixed with a watertight cap and set vertically into the ground to create a vertical storage chamber. The proposed GW interception and drain line will outlet into the side of this vertical wet well approximately 5-feet above the chamber's invert. The bottom of the sump chamber will be outfitted with floats that activate the pump when water within the sump reaches the 1487.40-foot elevation, nearly at the bottom of the pond liner; and deactivate the pump when water levels are within 1-foot of the bottom of the sump chamber, the 1483.30-foot elevation. This will provide a variable storage capacity of up to 150 gallons.

The GW return line pump is proposed to be an electric 3/4 horsepower shallow well jet pump with at least 25-ft of suction head capability and at least 35-feet of additional head at a flow rate of approximately 7gpm and discharge pressure of around 30PSI. The Little Giant JP-075-C, model # 558275, will provide satisfactory performance for the indicated criteria; all the specifications and manuals for the selected pump have been included in Attachment #1.

Positioned in the pump house on existing grade, this pump will be activated by a high-float switch and draw with suction from the sump. This will require a maximum of 20-feet of suction head, with some minor losses assumed in the 1.5-inch diameter suction inlet line. A screened inlet to the suction line should be included approximately 4-inches above the bottom of the sump chamber; this will ensure at least 8-inches of line length is always submerged. A one-way-check valve should also be included within the lowest 1.5 foot of the suction line. Set to ensure that flow can pass up into the line, but not out of the bottom of the suction line when the pump shuts off.

The pump will pump water collected in the sump up and over the berm, and discharge within the pond, near the bottom. The outlet of the GW return pump line should provide an energy dissipating or flow dispersal feature on its outlet. Similarly, to the suction line, this discharge line should be outfitted with a one-way-check-valve that allows discharge out, but does not let inflow back into the discharge line. As long as the ponded water surface remains above this check valve, this will ensure air dies not become entrapped within the discharge line which will diminish performance. Lastly, just below the one-way check valve a "T" fitting should be installed in the GW return line so that the Street Diversion line can be plumbed into and fill the pond if desired or necessary; a one-way check valve should be included on this line to allow diverted water from Streeter into the pond.

The indicated pump is anticipated to run under these conditions at an effective pump rate of around 7gpm, with internal line pressure around 30PSI. At this rate the 150-gallon capacity sump chamber is anticipated to empty in around 20 minutes, allowing groundwater inflows at approximately 3.5gpm to concentrate in the gravel lens for the other 40 minutes. This provides a reasonable duration for pump runtime given initiation of a cycle, and a reasonable inflow rate for collection and conveyance of intercepted groundwater into the sump chamber. Power for this pump single phase pump system (115/230V) will be provided from the proposed joint trench that runs up to the office located near the Farm's orchard. The office is the current service drop location for power supply to the site and will provide a convenient hookup and supply for the proposed ground water return line pump.

Given the sump chamber will be watertight and exclude the surrounding groundwater table to a depth of up to 12-feet; resulting in approximately 3,800lbs of buoyant uplift force. To ensure these vertical forces are adequately restrained, the pump house foundation slab will be used as ballast. Adopting a factor of safety of 1.5 indicates that ~5,700lbs of concrete should be used in the pump house slab

(~1.5cyds). Assuming a pump house with a square 8-foot footprint that equates to a slab of at least 8" thick; other configurations of equal mass are acceptable.

Irrigation Pump at Pond: Within the proposed pump house containing the groundwater return pump, there will also be a separate pump system dedicated to drawing water from the pond and delivering it to two separate locations on site. The first location is the Irene's Farm and orchard adjacent to the pond, and the second location is the sprinkler system at the camp across Streeter Creek. The same pump will provide these sources of supply water at separate times and plumbing manifolds will control where the pump's outflow goes. While the intention is to supply water to either one of these locations at separate times, as reviewed in detail below, the proposed pumping system could maintain the desired 40PSI line pressure at higher flow rates, so the design of the manifold, and associated plumbing lines, should account for the possibility that the pump can run both systems simultaneously.

This proposed pumping system will be used to run existing sprinkler and irrigation systems at the indicated locations and needs to deliver a minimum of 10 to 12 gallons per minute while maintaining a consistent line pressure of at least 40psi. This dedicated irrigation pump should have at least 20-feet of suction head capacity and up to 125-feet of additional head capacity at the desired 40 psi. The single phase, 2 horsepower, Goulds GT Irri-gator self-priming centrifugal pump, Model number GT20, has been selected for this application, and is anticipated to delivery up to 50 gpm with 20 feet of suction head and 40psi line pressure, given this is 4 to 5 times larger than the flow rate of the existing system, the possibility of running up to 50 gpm at 40psi should be considered on an operational level. Additionally, an adjustable pressure regulator should be installed on the supply line, near the pump, so that a maximum pressure of around 50 psi can be maintained in the line. Running this more powerful pump into an irrigation system with a historically fixed max outflow of 10 gpm, will drive the line pressure up near its max operational pressure of 125 psi; potentially causing damage to historical piping system components. Inclusion of a pressure reducer will mitigate this risk.

Power for this 2-horsepower electric single phase pump system (115/230V) will be provided from the proposed joint trench that runs up to the office located near the farm's orchard. The office is the current service drop location for power supply to the site. Power for the groundwater return line pump and this irrigation pump will be placed in the same joint trench as the various outgoing water supply lines.

The dedicated irrigation pump will draw from the bottom of the pond through a 1.5-inch diameter suction line, up and over the pond berm and then on to the respective irrigation systems through a 2" supply line located in the same joint trench that extends to the office. The 1.5-inch diameter suction inlet line should feature a screened inlet within 1-foot of the bottom of the pond. Approximately 8" above the screened inlet there should be a one-way-check-valve positioned to ensure water can enter the line, but not drain out under gravity; assuming that the pond elevation does not go below the inlet point, this will ensure air does not get into the pumping system. Additionally, there should be one-way-check-valve installed near the pump on the 2" discharge supply line to ensure water can only travel away from the pump and all back pressure in the lines heading up to the sprinkler systems are contained within the line and not continually placed on the pump seals.

In the case of the orchard/farm supply line, it will end and tie-in to the existing irrigation system near the camp office. A one-way-check-valve should also be installed near the terminus of the 2" supply line to ensure the sprinkler system remains primed with minimal air entrapment.

While a manifold for piping and a redundant piping line can be included in the trench to supply the orchard and the lawn sprinkler system separately directly from the pump; as an alternative, a single 2" supply line can deliver water to the orchard, a T-fitting with closure and one-way-check-valves on the both discharge ends, could achieve the same function and reduce the overall piping need while also permitting the dual operation of both irrigation systems.

The supply water line for the lawn sprinkler system at the camp, (either fed from the pump directly, or split off the supply line near the office) will continue up the joint trench, to the bridge, across the creek upstream of the camp, and then down, to tie-into the existing lawn irrigation system at the central camp house. The end of this 2-inch supply line should also be outfitted with a one-way check valve near the tie-in point to minimize any potential air entrapment.

Discussion of the diversion-works on the unnamed tributary that will route water to the pond is in Diversions section below.

Tanks: Design drawings are available as Attachment #2, Tank and Camp Water Supply Design (Village Ecosystems 2022). In order to facilitate Camp Winnarainbow forbearance from use of stream water during the summer season, a water storage and rainwater capture system will be developed. Eight to ten 80,000-gallon to100,000-gallon capacity steel tanks will be installed, which have rainwater catchment integrated into their tops. The tanks will be installed on a flat plateau above the camp and a CalFire less than 3-acre conversion permit will be obtained to allow clearing of Douglas fir trees there. Tank elevations will slightly vary and subtle grading may be required at each tank location.

Prior to construction, bids for detailed tank design and cost will be solicited from tank companies. Depending on the company that gets the bid, some of the construction details may vary. All tank bids will meet the above demands, as well as the following requirements:

- 8-10 tank of 80,000 to 100,000 gallons will be purchased and installed.
- Tanks will be made of corrugated steel.
- The tanks will have a 30 mil polyethylene or PVC liner approved for drinking water storage.
- Foundations will be designed for seismic activity as per California Building Code.
- Roof rainwater catchment system will also be from materials safe for potable water use.
- Roof design will be sufficiently strong to hold and discharge a snow load.
- Tanks will have a total combined roof catchment area of at least 10,200 square feet.
- Bids with thicker steel used in construction will be valued over thinner wall options.

Tank foundations will be constructed by a local concrete contractor based on tank company designs and in keeping with seismic safety guidelines.

The tanks will receive water directly from their rooves, as well as from a combined 2" PVC input line from the Streeter Creek pump. Water from the Pavilion Big Top will also be delivered to storage tanks through this line. The line will split and enter the top of every tank. Except for the highest tank, all tanks will have a mechanical float switch so that, once full, no additional water is delivered. The highest (most easterly) tank will have an electric float switch (120/240V) to stop the pump at Streeter Creek and/or for the Big Top rain catchment system, when the tanks are full.

There will be a 2" shared discharge line with a valve at each tank. A flush valve in this discharge line will go east just below the lowest tank. The discharge line will feed the existing treatment facility that will be moved to the top of the hill. A pre-treatment option with ozone is included in the drawings in case SWRCB Drinking Water Division requires additional treatment. However they may have specific requirements depending on monitoring results, and thus this treatment facility stands in place for whatever they may require. It also may not be needed at all.

<u>Drinking Water Treatment</u>: The existing BOR drinking water treatment facility, a regulated public water facility, will be moved to the top of the hill by the existing tanks that now store treated water. Initial communications with Zachary Rounds from the SWRCB drinking water division suggests that the system will probably not require additional treatment, however monitoring of the new source will be required and if a contaminant is found, or e-coli levels are elevated over current levels, then additional treatment may be required. This project includes addressing those potential issues, with options like a pre-treatment tank with ozone, a reverse osmosis system, and tank circulation. Our design plans include the installation of a 10,000 to 20,000 gallon pre-treatment tank with ozone, in case it is determined that this should be included. This additional pre-treatment tank is optional and need only be constructed if SWRCB division of water rights requires it.

<u>Big Top Rainwater Catchment System</u>: The camp has a covered roof area where people can be in the shade, referred to as the Big Top. Nearby is a small, open shed. Both have green metal roofs typically suitable for potable water. Pending the drinking water analysis from the rooftops, the water will be captured from both roof tops into a 500 gallon tank and pumped uphill to the main storage tanks. This will be a potable water source, so all components must meet NSF/ANSI 61 standards.

The Big Top and shed will both need new gutters. Rain catchment from the shed will be a dry system, while from the Big Top it will be a wet system. At the Big Top the water will flow from the gutter to a screen, such as a Leafeater, that filters out leaves and keeps out mosquitos. From the leafeater it will go into 3" UV resistant PVC pipe that runs down the post of the Big Top on either side. These 3" pipes will connect underground and run to the 500 gallon tank next to the shed. The rainwater caught from the shed roof will go into a leafeater and then directly into a 3" UV resistant PVC pipe and directly into the top of the tank. The tank will have a 3" overflow with gravel or small rock at the outlet. A 2 to 5gpm pump will pump water from the tank to the Streeter POD facility where it will join the pipeline running up to the storage tanks.

<u>Piping and Electrical Infrastructure</u>: The piping and electrical infrastructure will run through a trench that connects the pond, storage tanks, Streeter pump, big top pump, irrigation systems, and treatment facility. The electrical drop at the camp office on the east side of the Farm can serve both sides of the system. The pond could have the option of instead acquiring a separate drop from PG&E from the lines that run near it, and if deemed more cost effective at the time of construction. At this time our team is choosing the existing drop for its simplicity, despite the 800' run. Piping and electrical can go in the same trench throughout the system. Specific piping and electrical details are on the plans (Attachments #1 and #2).)

Diversions: The three sources of water considered by this Project are Streeter Creek, the unnamed tributary and Tenmile Creek. The former two are discussed below, while the Tenmile Creek diversion is not. No modification of the Tenmile Creek POD is proposed herein and instead BOR will pump water under its riparian water right as it has in the past. This option will only be exercised when unnamed tributary and Streeter Creek flows fail to fill pond. Extraction would take place in winter as allowed by forbearance agreement.

Streeter Creek: The Streeter POD will be used to supplement rainwater and may be used during drought conditions to supply the pond. The majority of the 800,000 gallons of water needed to fill the tanks will come from their rooves and rainwater catchment, with Streeter Creek expected to supply 43% of stored potable water. The Streeter POD will augment the pond only in years when the unnamed tributary flow and other sources like rainfall and the sump pump do not supply the 4 MG needed. The infrastructure of this POD will consist of a concrete box imbedded in the bank of Streeter creek, with a 9" pipe leading to a wet well where two submersible pumps, a 30gpm and a 10gpm, will transmit water either uphill to the tanks, or across the bridge and through the field to the pond (see Attachment #2). The improved pump system at the Streeter Creek BOD will be buttressed using a strategic amount of large rock with large wood interbedded (Figure 16) similar to designs recommended in CDFW (2010).

Figure 16. Intake system at Streeter Creek POD that will include fish habitat enhancement structures. By Stillwater Sciences (2022).

The 10gpm pump will only pump to the storage tanks, while the 30gpm pump will be able to pump to either the pond or the tanks. The pumps' electrical connections near the POD can be elevated on a post at least 4' above ground level so that connections are not ever inundated by floodwater. A float switch from the uppermost tank will trigger pumps to stop pumping when the tanks are full. A bypass switch will turn off the circuit such that ponds can be filled when the tanks are also already full. This switch and circuitry may be housed in the existing shed that now houses the treatment facility after the treatment facility is moved to a new location next to the tanks for reasons of energy efficiency).

Unnamed Tributary: The Unnamed Tributary runs from east to west in a field just north of the Farm. It passes through a 36" pipe under the main BOR gravel access road. After passing under the road, it's mildly degraded channel meanders through the field. Large riparian trees exist in the upper reaches, while the lower reaches are dominated by grass and blackberry. The POD will be placed just east of the road at the culvert outlet. The culvert outlet currently exhibits a vertical drop into a scour pool. To minimize disturbance, and the physical extent of work, a 4-ft wide Coanda type screened inlet box will be placed below, and to the side of the culvert outlet as it currently exists. The screened box will be embedded within an armored rock layer that will generally be used to fill soften and protect the scour pool and new infrastructure.

This Coanda box will be positioned to intercept varying flows and will feature a valve that can be operated to allow intercepted flows into the piping system and pond. The intercepted flows at the Coanda box will be piped to a valve box via a 4-inch diameter glued PVC line. A control valve will be inserted into the diversion line at a point just outside the channel. Minimum bypass flows (to be determined at a later date) will be achieved through both positioning of the box to only capture a portion of the culvert outflow, and installation of the control valve providing diverted flows to the pond.

The diversion piping line will continue a downward slope of 1.7% for 400 feet. The longitudinal slope of this gravity diversion line is governed by the necessity to maintain minimum cover over the diversion line itself; therefore, the diversion line falls more steeply than needed to discharge at the pond surface elevation of 1503.6-ft. when the diversion line reaches the western edge of the berm, it will slope up to discharge near the surface elevation of the pond. This configuration produces an overall net slope, from the invert of the Coanda box to the invert of the 4-inch line discharging at the pond surface, of 0.64%.

To ensure the diversion line can supply water to the pond at the minimum desired flow rate of 60gpm, under unassisted gravity flow, the supply line was sized using the Hazen-Williams equation for determining fluid flow parameters of water within piping and our temperature ranges. Assuming the diversion supply line is constructed of PVC piping, then a roughness coefficient of 150 is appropriate. As shown in the design plan set of Appendix X, there is 2.56 feet of fall provided within the supply line; from the invert to of the supply line leaving the Coanda inlet box, to the invert of the diversion piping discharging at the pond, overall hydraulic loss for the system is estimated to be 0.56-feet; therefore, a net elevation drop of ~2-feet remains to induce gravity flow. Under these conditions 0.18cfs (81gpm) can be anticipated to flow at 2.2 feet-per-second through the 4-inch diameter plastic diversion line. This flow regime should provide ample supply of slow-moving water into the pond with minimal pressure build up or hydraulic losses.

To ensure the diversion line does not leak into the dam when the diversion flow is "lifted" back to the pond surface, the piping system is recommended to be constructed of glued PVC pipe that can demonstrate completion of a 24-hour pressure test. In addition to the control valve near the inlet of the diversion line, an air-valve should be installed at the highest point in the piping system to ensure entrapped air is efficiently vacated. To ensure nothing can enter the piping system, a one-way check valve near the outlet is recommended.

Cost of Construction

Construction costs for different elements of the project can be found below as Tables 10-13.

Table 10. Pond and unnamed tributary diversion construction cost estimates.

Item	Unit Cost	Quantity	Units	Total cost
Mobilization	$20,000	1	Lump Sum	$20,000
Topsoil Removal	$10,000	1	Lump Sum	$10,000
Rough Earthwork (cut/fill balanced onsite)	$15	14,000	Cubic Yard	$210,000
Pond Liners installation and materials	$190,000	1	Lump Sum	$190,000
Diversion box and pond inflow piping system	$20,000	1	Lump Sum	$20,000
Pond outflow pipeline materials and installation	$75,000	1	Lump Sum	$75,000
Spillway	$12,000	1	Lump Sum	$12,000
Groundwater Return sump and pump system	$55,000	1	Lump Sum	$55,000
Fencing	$12,000	1	Lump Sum	$12,000
Erosion Control and Revegetation	$12,000	1	Lump Sum	$12,000
Engineering Oversight during construction & compaction testing (?)	$35,000	1	Lump Sum	$35,000
15% Contingency	$97,650	1	Lump Sum	$97,650
				$748,650

Table 11. Shared Pond and Tank Infrastructure, Streeter Diversion, Electrical

Item	Unit Cost	Quantity	Units	Total cost
Mobilization	$5,000	1	Lump Sum	$5,000
Trenching	$10,000	1	Lump Sum	$10,000
Earthwork cut and place wet well	$8,000	1	Lump Sum	$8,000
Concrete Diversion Gallery & Wet well connect	$18,000	1	Lump Sum	$18,000
Pump and Installation, piping manifold, valves	$16,000	1	Lump Sum	$16,000
Electrical lines, pump connections, switches	$40,000	1	Lump Sum	$40,000
PVC pipe to pond and tanks	$30,000	1	Lump Sum	$30,000
Erosion Control and Revegetation	$2,000	1	Lump Sum	$2,000
Engineering Oversight during construction	$5,000	1	Lump Sum	$5,000
15% Contingency	$20,100.00	1	Lump Sum	$20,100
Total construction cost:				**$154,100**

Table 12. Rainwater Catchment and Storage Tank Infrastructure

Item	Unit Cost	Quantity	Units	Total cost
Mobilization	$20,000	1	Lump Sum	$20,000
Topsoil removal and tree clearing	$22,000	1	Lump Sum	$22,000
Foundation installation	$23,000	9	Lump Sum	$207,000
Steel Tanks plus engineering for seismic and foundation	$150,000	9	Lump Sum	$1,350,000
Pavilion Rain Catch, Pump, Gutters, Tank, etc.	$25,000	1	Lump Sum	$25,000
Electrical	$35,000	1	Lump Sum	$35,000
Piping	$25,000	1	Lump Sum	$25,000
Erosion Control and Revegetation	$2,000	1	Lump Sum	$2,000
Engineering Oversight during construction	$20,000	1	Lump Sum	$20,000
15% Contingency	$48,300.00	1	Lump Sum	$48,300
				$1,754,300

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Table 13. Additional Probable Costs

Pre-treatment Option	$50,000	1	Lump Sum	$50,000
Moving Existing Treatment System	$40,000	1	Lump Sum	$40,000
Total Additional Probable Costs				**$90,000**

Total Shared and Tank and Probable Costs	**$1,998,400**
Total Construction Costs*	**$2,747,050**

Alternatives Analysis

During project planning and preliminary design phase, the project team explored the alternative to construct a larger 10 MG pond that could be used for direct flow augmentation to Streeter Creek late in summer for the benefit of salmonids. There was plenty of room for the larger foot print of the pond, but several factors lead to the 4 MG pond design currently being advanced. Challenges in filling the larger pond were greater and long-term operation and maintenance would be much higher, especially related to summer flow releases back to Streeter Creek in summer. Agencies also raised questions about whether water in the pond would be of appropriate temperature and quality to support juvenile steelhead and whether the amount and duration of augmentation would be significant enough to make an ecological difference in their survival. Kohen (2022a) also noted that seismic risk and potential failure of the larger pond was greater. Based on these constraints, the project team, landowners, and agency staff agreed that the pond designed proposed herein is the preferred alternative.

Monitoring and Maintenance

The water storage systems are designed and constructed with high quality materials with the goal of being as maintenance free as possible for the first 25 years of operations. However, the landowner will be responsible for standard operations and maintenance (O&M) which includes filling the tanks and ponds during the wet season and performing standard yearly maintenance.

ERRP and TGAEC will work with the landowner to provide guidance to inform the diversion season based on flow gage data. TGAEC will continue to monitor streamflow in Streeter Creek for a minimum of two years after project construction and inform BOR by email and phone regarding the diversion schedule and restrictions.

Compliance monitoring by ERRP will include a minimum of one site visit and one phone contact per year. Spring monitoring will occur by phone and ensure that water system maintenance has occurred, all conservation systems are in place for the low flow months, and that tanks are properly topped off prior to the dry season. Fall monitoring will include a site visit to determine if objectives are being met by reviewing water meter records. Spot monitoring during the dry season will also be an option.

Anticipated emergencies include leaks or other equipment failures. All systems will be outfitted with leak safety devices; however, emergencies could still occur. Leaks will be handled by providing replacement water or managing a safe refilling plan. Adaptive management will help refine the seasonal water management program for maximum compliance and workability.

References

Barnhart, R. A. 1986. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (Pacific Southwest)--steelhead. U.S. Fish Wildl. Serv. Biol. Rep. 82(11.60). U.S. Army Corps of Engineers, TR EL-82-4. 26 pp.

California Department of Fish and Wildlife. 2004. Recovery Strategy for California Coho Salmon. Report to the California Fish and Game Commission. February 2004. CDFW, Sacramento, CA. 594 p.

California Department of Fish and Wildlife. 2010. California Salmonid Stream Habitat Restoration Manual. Fourth Edition. Volume I. California Department of Fish and Game. Inland Fisheries Division. 495 pp.

Cafferata, P., T. Spittler, M. Wopat, G. Bundros, and S. Flanagan. 2004. Designing watercourse crossings for passage of 100-year flood flows, wood, and sediment, California Department of Forestry and Fire Protection, Sacramento, California.
http://www.fire.ca.gov/ResourceManagement/PDF/100yr32links.pdf

California Division of Mines and Geology (CDMG). 1983. Summary Report: Fault Evaluation Program, 1981-1982 Area – Northern Coast Ranges Region, California, Open File Report 83-10, California Department of Conservation Division of Mines and Geology (DMG), 1983.

Department of Water Resources (DWR), 2020. Draft Handbook for Water Budget Development: With or Without Models. Online at https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Groundwater-Management/Data-and-Tools/Files/Water-Budget-Handbook.pdf, accessed 11-15-2022.

Eel River Recovery Project. 2020. Tenmile Creek Conservation and Restoration Action Plan. Completed for California State Coastal Conservancy Prop 1 grant. ERRP, P.O. Box 214, Loleta, Ca. 77 p.

Gotvald, A.J., Barth, N.A., Veilleux, A.G., and Parrett, Charles, 2012, Methods for determining magnitude and frequency of floods in California, based on data through water year 2006: U.S. Geological Survey Scientific Investigations Report 2012–5113, 38 p., 1 pl.

Higgins, P.T. 2015. Eel River Recovery Project Fall Chinook Salmon 2014-2015 Citizen Monitoring. Performed under contract to the Trees Foundation for the Eel River Recovery Project with funding from Patagonia, the Salmon Restoration Association, and the Humboldt and Mendocino Redwood Companies. ERRP, Arcata, CA. 25 p.

Higgins, P.T. 2020a. Progress Report #18 for the Tenmile Creek Conservation and Restoration Pilot Project. Published February 2, 2020. Performed for the Eel River Recovery Project and the California State Coastal Conservancy (Agreement # 20-076). ERRP, P.O. Box 214, Loleta, CA 95551. 15 p.

Higgins, P.T. 2020b. Eel River Fall Chinook 2019–2020 Run Declines Due to Variable Ocean Conditions. Forest and River News, Winter Edition 2020. Performed for ERRP, Loleta, CA. 3 p.

Higgins, P.T. 2022. Tenmile Creek Water Temperature, Fish Community and Flow Summary Report Water Years 2020-2021. Published February 28, 2022. Performed for the Eel River Recovery Project and the California State Coastal Conservancy (Agreement # 20-076). ERRP, P.O. Box 214, Loleta, CA 95551. 40 p.

Hill, Kirsten. 2022. Black Oak Ranch Pond Location Botanical Survey Report. Performed under contract to ERRP for SCC Prop 1 grant (Agreement # 20-076). Workplace Chemistry, Santa Cruz, CA. 3 p.

Kilbourne, R.T, 1983, Geology and Geomorphic Features Related to Landsliding, Cahto Peak 7.5 Minute Quadrangle, Mendocino County, California.

Kohen, C. 2022a. Geotechnical Investigation Report for a Proposed Pond at the Black Oak Ranch in Laytonville, California. Performed under contract to ERRP for SCC Prop 1 grant (Agreement # 20-076). Chandler Kohen Consulting, Cloverdale, CA. 15 p..

Kohen, C. 2022b. Camp Winnarainbow Water Tanks at Black Oak Ranch in Laytonville, CA. Performed under contract to ERRP for SCC Prop 1 grant (Agreement # 20-076). Chandler Kohen Consulting, Cloverdale, CA. 3 p.

Mann, M.P., Rizzardo, J., Satowski, R., 2004. Evaluation of Methods Used for Estimating Selected Streamflow Statistics, and Flood Frequency and Magnitude, for Small Basins in North Coastal California (U.S. Geological Survey Scientific Investigations Report No. 2004–5068).

Mayo, K. 1974. Pioneering in the Shadow of Cahto Mountain. First Centennial Edition 1874-1974. Laytonville, CA. 143 p.

McKane, R.B, A. Brookes, K. Djang, M. Stieglitz, A.G. Abdelnour, F. Pan, J.J. Halama, P. Pettus, and D. Phillps. 2014. VELMA Version 2.0 - User Manual and Technical Documentation. U.S. Environmental Protection Agency, Corvallis, OR. 180 p.

Metheny, M. 2019. Adult Salmonid SONAR Monitoring Program - South Fork Eel River, Tributary to Eel River Field Note. January 25, 2019. Prepared for Cal Trout and funded by the California Department of Fish and Wildlife. 6 p

Metheny, M. 2020. Adult Salmonid Sonar Monitoring Program South Fork Eel River, Tributary to Eel River. Memo of August 3, 2020. Prepared for Cal Trout and funded by the California Department of Fish and Wildlife. 6 p

National Marine Fisheries Service. 2014. Final Recovery Plan for the Southern Oregon/Northern California Coast Evolutionarily Significant Unit of Coho Salmon (Oncorhynchus kisutch). NMFS, Arcata, CA. 1841 p.

North Coast Regional Water Quality Control Board. 2018. Water Quality Control Plan for North Coast Region (Basin Plan). June 2018 Revision. NCRWQCB, Santa Rosa, CA. 203 p.

SHN. 2021. Geotechnical Investigation and Report, Proposed Black Oak Ranch Railcar Bridge, May 27, 2021. SHN, Eureka, CA.

Stillwater Sciences. 2022. Black Oak Ranch Pond and Diversion Project Design – 100% Final Design, Mendocino County, CA. Performed for the Eel River Recovery Project. Funded by California Coastal Conservancy Prop 1 grant (Agreement # 20-076). Stillwater Sciences, Arcata, CA. 18 p.

Thomas Gast Associates Environmental Consultants. 2022. Water Availability Analysis: Streeter Creek, Unnamed Tributary to Tenmile Creek, Tenmile Creek. Performed for the Eel River Recovery Project. Funded by California Coastal Conservancy Prop 1 grant (Agreement # 20-076). TGAEC, Arcata, CA. 30 p.

U.S. Environmental Protection Agency (US EPA). 1999. Final report: South Fork Eel River Total Maximum Daily Loads for Sediment and Temperature. Region IX. Water Division. San Francisco, CA.

Village Ecosystems. 2022. Tank and Camp Water Supply Design. Performed for the Eel River Recovery Project. Funded by California Coastal Conservancy Prop 1 grant (Agreement # 20-076). VE, Ukiah, CA. 6p.

Waananen, A. O., and J. R. Crippen. 1977. Magnitude and frequency of floods in California. U.S. Geological Survey. Water Resources Investigation 77-21.

Williams, T.H., E.P. Bjorkstedt, W.G. Duffy, D. Hillemeier, G. Kautsky, T.E. Lisle, M. McCain, M. Rode, R.G. Szerlong, R.S. Schick, M.N. Goslin and A. Agrawal. 2006. Historical population structure of coho salmon in the southern Oregon/northern California evolutionarily significant unit. NOAA-TM-NMFS-SWFSC-390. NMFS, Southwest Fisheries Science Center, Santa Cruz, CA. 85 p.