UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
West Coast Region
777 Sonoma Avenue, Room 325
Santa Rosa, California 95404-4731

November 14, 2022 **Refer to NMFS No:** WCRO-2022-02081

James Mazza
Regulatory Division Chief
U.S. Army Corps of Engineers, San Francisco District
450 Golden Gate Avenue, 4th Floor, Suite 0134
San Francisco, California 94102-3406

Re: Endangered Species Act Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the Reinitiation of the College Lake Integrated Resources Management Project (Corps File No. SPN-2005-296560) in Santa Cruz County, California

Dear Mr. Mazza:

Thank you for your letter of August 25, 2022, requesting reinitiation of consultation with NOAA's National Marine Fisheries Service (NMFS) pursuant to section 7 of the Endangered Species Act of 1973 (ESA) (16 U.S.C. 1531 et seq.) for the College Lake Integrated Resources Management Project (herein referred to as "Project").

On July 5, 2022, the United States District Court for the Northern District of California issued an order vacating the 2019 regulations adopting changes to 50 CFR part 402 (84 FR 44976, August 27, 2019). As reflected in this document, we are now applying the section 7 regulations that governed prior to adoption of the 2019 regulations. For purposes of this consultation, we considered whether the substantive analysis and its conclusions regarding the effects of the proposed actions articulated in the biological opinion and incidental take statement would be any different under the 2019 regulations. We have determined that our analysis and conclusions would not be any different.

NMFS also reviewed the likely effects of the proposed action on essential fish habitat (EFH), pursuant to section 305(b) of the Magnuson–Stevens Fishery Conservation and Management Act [16 U.S.C. 1855(b)], and concluded that the action would adversely affect the EFH of species managed under the Pacific Coast Groundfish and Coastal Pelagic Species Fishery Management Plans (FMPs). Therefore, we have included the results of that review in Section 3 of this document.

The enclosed biological opinion is based on our review of the proposed Project and describes NMFS' analysis of the effects of the implementation of the Project on threatened South-Central California Coast (S-CCC) steelhead (*Oncorhynchus mykiss*) and their designated critical habitat in accordance with section 7 of the ESA. In the enclosed biological opinion, NMFS concludes the Project is not likely to jeopardize the continued existence of the S-CCC steelhead

Distinct Population Segment (DPS), nor is the Project likely to result in the destruction or adverse modification of designated critical habitat for S-CCC steelhead. However, NMFS anticipates take of S-CCC steelhead is likely to occur as a result of the Project. An incidental take statement with non-discretionary terms and conditions is included with the enclosed biological opinion.

Regarding EFH, NMFS has reviewed the Project for potential effects and determined that the Project will occur within an area identified as EFH for species managed under the Pacific Groundfish and Coastal Pelagic Species FMPs. NMFS has determined the Project will result in adverse effects to EFH due to seasonal changes in the amount of freshwater inflow to the lagoon that may alter water quality and the timing of sandbar formation at the mouth of the Pajaro River. However, the Project has proposed several minimization measures to avoid or minimize potential adverse effects to EFH. Thus, no additional EFH conservation recommendations are provided.

Please contact Joel Casagrande at 707-575-6016, or joel.casagrande@noaa.gov if you have any questions concerning this consultation, or if you require additional information.

Sincerely,

Alecia Van Atta
Assistant Regional Administrator
California Coastal Office

Enclosure

cc: Frances Malamud-Roam, Regulatory Project Manager, Corps, San Francisco District
(Frances.P.Malamud-Roam@usace.army.mil)
Brian Lockwood, General Manager, PV Water (Lockwood@pvwater.org)
e-File ARN 151422WCR2022SR00165

Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response

Reinitiation of the College Lake Integrated Resources Management Project
(Corps File No. SPN-2005-296560)

NMFS Consultation Number: WCRO-2022-02081
Action Agency: U.S. Department of the Army, Corps of Engineers, San Francisco District

Affected Species and NMFS' Determinations:

ESA-Listed Species	Status	Is Action Likely to Adversely Affect Species?	Is Action Likely to Jeopardize the Species?	Is Action Likely to Adversely Affect Critical Habitat?	Is Action Likely to Destroy or Adversely Modify Critical Habitat?
South-Central California Coast steelhead (*Oncorhynchus mykiss*)	Threatened	Yes	No	Yes	No

Essential Fish Habitat and NMFS' Determinations:

Fishery Management Plan That Identifies EFH in the Project Area	Does Action Have an Adverse Effect on EFH?	Are EFH Conservation Recommendations Provided?
Pacific Coast Groundfish	Yes	No
Coastal Pelagic Species	Yes	No

Consultation Conducted By: National Marine Fisheries Service, West Coast Region

Issued By:

Alecia Van Atta
Assistant Regional Administrator
California Coastal Office

Date: November 14, 2022

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1. INTRODUCTION

This Introduction section provides information relevant to the other sections of this document and is incorporated by reference into Sections 2 and 3, below.

1.1. Background

NOAA's National Marine Fisheries Service (NMFS) prepared the biological opinion (opinion) and incidental take statement (ITS) portions of this document in accordance with section 7(b) of the Endangered Species Act (ESA) of 1973 (16 U.S.C. 1531 et seq.), as amended, and implementing regulations at 50 CFR part 402.

We also completed an essential fish habitat (EFH) consultation on the proposed action, in accordance with section 305(b)(2) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) (16 U.S.C. 1801 et seq.) and implementing regulations at 50 CFR 600.

We completed pre-dissemination review of this document using standards for utility, integrity, and objectivity in compliance with applicable guidelines issued under the Data Quality Act (DQA) (section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001, Public Law 106-554). The document will be available within 2 weeks at the NOAA Library Institutional Repository [https://repository.library.noaa.gov/welcome]. A complete record of this consultation is on file at California Coastal NMFS office.

1.2. Consultation History

In 2014, NMFS began providing technical assistance to the Pajaro Valley Water Management Agency (PV Water) for the development of a water supply project at College Lake. This included participation on a technical advisory committee (TAC).

On March 9, 2017, PV Water submitted its Fish Passage Assessment Study Plan for the Project to NMFS and California Department of Fish and Wildlife (CDFW) staff. On March 22, 2017, CDFW emailed PV Water stating NMFS and CDFW had agreed with the proposed methodologies described in the Fish Passage Assessment Study Plan. PV Water, their fisheries consultant, NMFS, and CDFW staff attended a Project site visit on April 12, 2017, and on December 12, 2017, NMFS joined PV Water and its consultants for an additional tour of the College Lake area.

On November 28, 2017, PV Water announced its notice of preparation (NOP) of a project-level Environmental Impact Report for the Project. NMFS submitted its comments on the NOP on January 5, 2018.

On March 6, 2018, NMFS submitted a letter to the State Water Resources Control Board (SWRCB) protesting PV Water's application for a new water right for the Project. In the protest letter, NMFS detailed concerns the execution of a new water right may have on threatened steelhead of the South-Central California Coast (S-CCC) Distinct Population Segment (DPS) and their designated critical habitat, including fish passage constraints.

On February 28, 2019, PV Water and their consultants met with NMFS and CDFW to review the results of the Fish Passage Assessment Study Plan, and to discuss bypass flow recommendations, expected fisheries benefits and other issues related to the Project.

PV Water and its consultants met with NMFS and CDFW on July 8, 2019, to discuss the resolution of issues raised by NMFS and CDFW in their respective protest letters. Between July 2019 and March 2020, NMFS and CDFW worked with PV Water and their consultants on dismissal terms that would address the concerns raised by both NMFS and CDFW. These terms included bypass flow requirements for adult and juvenile steelhead between December 15 and May 31, and commitments for the development and implementation of various monitoring plans (steelhead, invasive species, water quality, and hydrology). With the agreement of these terms, NMFS dismissed its protest of PV Water's application by letter to the SWRCB on March 27, 2020.

On October 22, 2019, CDFW and NMFS biologists and engineering staff attended a site visit of the proposed weir site with PV Water to discuss the project facility designs, local hydrology, and fish screen types.

On December 16, 2019, consultants for PV Water submitted a draft biological assessment to NMFS for review and comment. NMFS submitted comments on the draft assessment on January 17, 2020. A second draft of the assessment was submitted to NMFS for review on March 9, 2020. NMFS responded with comments on the assessment on March 24, 2020.

On June 17, 2020, NMFS' engineer submitted comments to the Project design team via email. An additional conference call between PV Water, their consultants and NMFS staff occurred on November 20, 2020 to review the updated design plans for the proposed weir and fish passage facilities.

On October 2, 2020, the U.S. Army Corps of Engineers (Corps) requested initiation of formal consultation with NMFS' North-Central Coast Office for the proposed Project. A request for consultation was accompanied with a biological assessment (ESA 2020). The Corps submitted a revised request for consultation to NMFS on October 5, 2020, with some clarification on the MSA consultation. Based on the information provided with the request, NMFS initiated consultation on October 19, 2020.

Between October 5, 2020 and February 2021, the Project design team provided additional Project details, including potential changes to construction methods and the alignment of Project facilities. In February 2021, PV Water and their consultants informed NMFS of their need for major revisions to elements of the Project footprint, alignment of facilities, and related construction activities, which would necessitate substantial revisions of the biological assessments for both NMFS and USFWS. Initially, the Corps and NMFS agreed to two consecutive 30-day extensions for the completion of the assessment revisions and the consultation; one extension on February 16, 2021, and another on March 19, 2021. However, by late April 2021, it had become clear from PV Water that the revised project description would not be ready within the extended timeframe. NMFS and Corps agreed to close the consultation until the revised information was ready.

On August 25, 2022, the Corps submitted its request for reinitiation of consultation for the College Lake Integrated Resources Management Project, which was accompanied by a revised biological assessment (ESA 2022a) and a set of revised design drawings. On September 6, 2022, NMFS determined the submitted information was sufficient to reinitiate consultation.

On July 5, 2022, the U.S. District Court for the Northern District of California issued an order vacating the 2019 regulations that were revised or added to 50 CFR part 402 in 2019 ("2019 Regulations," see 84 FR 44976, August 27, 2019) without making a finding on the merits. On September 21, 2022, the U.S. Court of Appeals for the Ninth Circuit granted a temporary stay of the district court's July 5 order. As a result, the 2019 regulations are once again in effect, and we are applying the 2019 regulations here. For purposes of this consultation, we considered whether the substantive analysis and conclusions articulated in the biological opinion and incidental take statement would be any different under the pre-2019 regulations. We have determined that our analysis and conclusions would not be any different.

1.3. Proposed Federal Action

Under the ESA, "action" means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies (see 50 CFR 402.02). For EFH consultation, Federal action means any action authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken by a Federal Agency (50 CFR 600.910).

The Corps proposes to issue a permit to PV Water under Section 404 of the Clean Water Act (33 U.S.C.1344) for the College Lake Integrated Resources Management Project (Project). The purpose of the Project is to develop a new surface water supply and storage resource at College Lake that will help reduce reliance on coastal groundwater pumping and seawater intrusion into the Pajaro Valley Groundwater Basin. Annually, up to 3,000 acre-feet (AF) of surface water would be diverted from College Lake, treated and routed to PV Water's Coastal Distribution System (CDS) where it will be used in lieu of groundwater. The Project is located near the City of Watsonville, in unincorporated Santa Cruz County, California (Figure 1).

College Lake is a natural, shallow depression that receives runoff from the Casserly Creek watershed. The lake has been drained annually by Reclamation District 2049 (RD 2049) for approximately the past 100 years in order to farm the lakebed. An existing weir, pump station and network of earthen ditches in the lakebed are used to facilitate this drainage. A more detailed description of existing conditions and operations is provided in the Environmental Baseline section of this opinion. The Project includes the construction of multiple new facilities including a new regulating weir at the outlet of College Lake equipped with fish passage facilities, an intake pump station adjacent to the lake, the College Lake Pipeline between the lake and coastal service area, and a water treatment plant. The Project also includes operations, maintenance, and various monitoring activities.

1.3.1. Project Components

1.3.1.1. <u>Weir Structure and Intake Pump Station</u>

The Project will include construction of a replacement weir structure and a new diversion and intake pump station to divert surface water from College Lake. The proposed weir structure and intake pump station facility will be located immediately downstream of the existing weir and pump station at the College Lake outlet, which is at the south end of the lake near the location of the existing weir (Figure 1).

Figure 1. The proposed action area (Source: ESA 2022a).

The proposed weir will consist of a reinforced concrete spillway with a mechanically adjustable weir gate, abutment retaining walls on both sides, reinforced concrete aprons on the upstream and downstream ends, and a fish passage structure, or fishway. The weir will be approximately 40 feet wide (the same width as the existing weir), and the adjustable weir crest will be operational through a range of 60.1 to 62.5 feet North American Vertical Datum of 1988 (NAVD88) using one or more pneumatically actuated gates (e.g., Obermeyer Spillway Gates). Additionally, an approximately 60-foot long hardscape (i.e., grouted riprap) transition will span the entire 55-foot wide channel at the upstream and downstream ends of the new weir structure. The riprap transitions will be buried approximately 3 feet and the top of the riprap transition would be flush with the final grade of the channel bottom. The hardscape transition will be buried approximately 3 feet and the top of the transition will be flush with the final grade of the channel bottom.

The fishway has been designed to accommodate bypass flows and fish passage through coordination with NMFS and CDFW. The structure is a pool-style fishway and consists of an entrance pool, a series of four downward opening, vertically adjustable weirs (i.e., vertical lift weir gates) and their associated pools, an exit section, and trash rack.

The proposed adjustable weir gate will be capable of raising the College Lake water surface elevation up to 2.4 feet above the elevation of the existing weir, which will increase the storage in the lake from 1,150 AF at a water surface elevation of 60.1 feet NAVD88 to approximately 1,800 AF at a water surface elevation of 62.5 feet NAVD88.

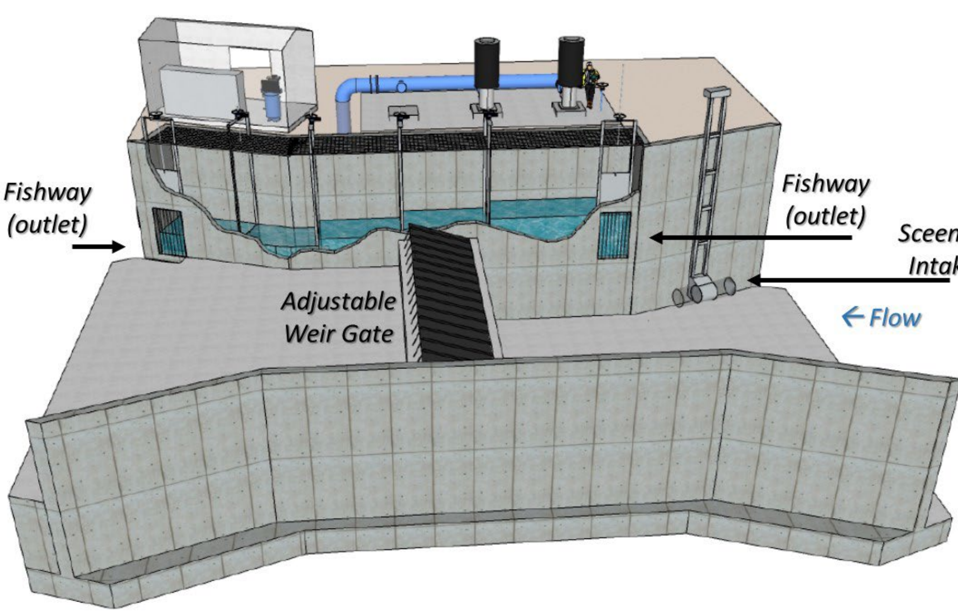


Figure 2. Conceptual design for the proposed weir, intake pump station, and fishway at the outlet of College Lake (Source: cbec 2020).

The intake pump station would pump raw (untreated) water from an intake just upstream of the weir to the proposed water treatment plant (WTP) via a 30-inch diameter intake pipeline with a maximum pumping capacity of 30 cubic feet per second (cfs) (Figure 2). The intake will include a self-cleaning, cylindrical screen designed to comply with NMFS and CDFW screening criteria (Figure 2).

1.3.1.2. College Lake Pipeline

The Project will include construction of an approximately 6-mile-long, 30-inch-diameter pipeline made of high-density polyethylene, or welded steel pipe. The pipeline will extend from the proposed water treatment plant to the City of Watsonville's Recycled Water Facility. The proposed alignment generally follows existing road rights-of-way, and passes through agricultural fields. The pipeline will require crossing several surface features including two crossings of Salsipuedes Creek, a rail line, and state highways.

1.3.1.3. Water Treatment Plant

A water treatment plant (WTP) will be constructed to filter sediment and debris and disinfect the diverted surface water from College Lake. This will occupy approximately 4.3 acres of land along Holohan Road, and will consist of concrete-lined sedimentation basins, drying beds for solids, a filter influent pump station, filtration systems, a sodium hypochlorite disinfection system, and an effluent pump station for local users. Solids coming from the ballasted flocculation/sedimentation process at the WTP will be sent to the sedimentation basins for settling and drying. As the solids settle out of the water, the decant water from solids handling basins will be recycled to the start of the treatment process. Additional moisture from the solids will be removed via evaporation in the solids lagoons prior to off-haul of the solids to a landfill. As a backup to this process, diluted solids could be bled into the Salsipuedes Sanitary District sewer system, which discharges into the City of Watsonville Wastewater Treatment Facility, at flow rates to be approved by the Salsipuedes Sanitary District and the City to not exceed the existing sewer capacity. However, off-hauling of dried solids is assumed for normal process operations.

A potable water well will be constructed on an approximately 300 square foot area of packed dirt east of the WTP and north of an existing house. The well will extract water for use at the WTP (e.g., emergency showers and eyewash stations, lab sink, pump seal water, polymer dilution), the adjacent house that will become a field office for WTP operations, and to provide supplemental water to the CDS, eventually replacing a supplemental well located in the coastal service area. Reducing coastal groundwater production and shifting pumping inland is part of the strategy to eliminate seawater intrusion. The well will be approximately 300 to 400 feet deep and resemble existing wells in the area. Two pumps will extract groundwater and a pipeline will convey the water to the WTP and existing house.

1.3.2. Construction

1.3.2.1. Weir, Intake Pump Station, and Water Treatment Plant

Construction of the proposed weir and intake pump station, and WTP facilities will involve dewatering of the construction site; grading and excavation; installation of sheet piles; erecting concrete structures; installing piping, pumps, electrical and mechanical equipment; and testing and commissioning facilities. The construction of the WTP will occur in upland areas and away from relevant habitats for ESA-listed species.

Construction of the new weir (and removal of the existing weir) will require dewatering of the construction site. PV Water assumes that RD 2049 will continue its current management practices of draining the lake and farming in the lakebed until construction of the proposed Project is complete and operations begin (see Section 2.4 Environmental Baseline). This action by RD 2049 would dewater the majority of the lake leaving only shallow inflow to the lake within the drainage ditches.

Prior to dewatering the ditches, fish will be captured and relocated and then excluded from accessing approximately 300 feet of the main ditch with block nets for the duration of the construction activities. Fish and other wildlife species within the proposed exclusion and dewater zones will be captured by qualified biologists using gear such as backpack electrofishing, seines, and or dip nets. Fish capture and relocation activities are typically restricted to the period of June through October. However, draining of College Lake may have to commence prior to June 1 to ensure the lake is drained prior to the start of construction. If lake draining commences prior to June 1 (as it regularly does under existing conditions), fish relocations would be timed accordingly, and could occur sometime in May.

To isolate the construction area and facilitate dewatering, PV Water proposes to install shoring (interlocking sheet piles) around the entire construction area for the weir. The linear extents of the dewatered reach will be approximately 200 feet. Sheet piles will be installed using a vibratory hammer. The sheet piles are expected to extend approximately 45 feet below and approximately 3 feet above the existing ground surface. A low spot in the lake at the northern limit of the proposed hardscape transition will be excavated to a depth sufficient to accommodate a dewatering pump (estimated to be 4 feet). Water collecting at this point will be pumped around the construction area. Water collected within the construction area (from groundwater or rain water) will also be pumped and discharged in accordance with applicable regulatory requirements to agricultural lands, storm drains, or other waterways. The water will be treated as necessary prior to discharge. Treatment methods may include use of settling tanks or filter bags to allow sediment to settle out of suspension.

Once isolated and dewatered, demolition and removal of the existing weir will commence followed by the construction of the new weir and intake pump station. Construction of the new weir will include erecting concrete structures, installing piping, pumps, electrical and mechanical equipment, and testing facilities.

1.3.2.2. College Lake Pipeline

The College Lake Pipeline will be installed below ground. Methods used for installation of the pipeline will depend on the location. Conventional open-trench techniques will be used for segments through existing roadways and agricultural fields. Crossings of several surface features (e.g., Salsipuedes Creek, railroads, and state highways) will require trenchless methods, primarily jack-and-bore methods.

The proposed pipeline will cross Salsipuedes Creek at two locations. One location is on lower Salsipuedes Creek north of State Route (SR) 129/East Riverside Drive, and the other is in upper Salsipuedes Creek upstream of the Corralitos Creek confluence at the College Road crossing. At the College Road crossing, the pipeline will be installed within the roadbed, or between the roadbed and the existing culvert that passes the creek beneath College Road. At the downstream crossing, the jack-and-bore or micro-tunneling method will be used.

The jack-and-bore method involves the use of a horizontal boring machine, or auger, to drill a hole, and a hydraulic jack to push a casing through the hole under the creek channel. The pipeline is installed in the casing. This process requires the excavation of pits typically 10 feet by 35 feet (depth varies) at opposite ends of the crossing. Soil removed from pits will either be stockpiled and reused, or loaded directly into dump trucks and hauled away for disposal. If existing soil is not adequate for backfilling, then new material will be imported for backfilling. Although jack-and-bore is the preferred trenchless construction method for this crossing, site conditions may necessitate the use of micro-tunneling, a specialized form of pipe jacking where excavation is accomplished using a closed-face pressurized micro-tunnel boring machine. Soil excavated by the head enters an excavation chamber where it is mixed with bentonite slurry and pumped through pipes to the surface where an onsite soil separation plant removes the cuttings from the slurry.

The use of trenchless methods, such as jack-and-bore, present the opportunity for a frac-out to occur. PV Water will require the contractor to retain a licensed geotechnical engineer to develop a Frac-out Contingency Plan. PV Water will submit the Frac-out Contingency Plan to the appropriate resource agencies for review prior to the start of construction of any pipeline segment that will use this trenchless method. PV Water will require the contractor to implement a Frac-out Contingency Plan to ensure that appropriate measures are performed to avoid a frac-out, and if a frac-out were to occur, implement measures to contain, clean-up, and dispose of the slurry.

The pipeline will be installed beneath the Pinto Creek ditch using open trench methods during the dry season. The Pinto Creek drainage ditch does not provide spawning, rearing or migratory habitat for salmonids. Although Pinto Creek is typically dry in the summer, if water is present during construction in Pinto Creek, it is assumed that temporary cofferdams will be installed and that the work area will be dewatered. A typical pipeline trench would be approximately 6.5 feet wide and no more than 8 feet deep. At the Pinto Creek crossing, the work area will be approximately 20 feet wide and the pipeline will be installed at least 5 feet below the bed of the channel. Following installation of the pipe, the channel will be restored to pre-construction conditions.

Once construction is complete, the pipeline will be cleaned and disinfected by flushing with chlorinated water. The flushing water at the outlet end of the pipeline will be collected and treated at the City of Watsonville's Wastewater Treatment Facility.

1.3.2.3. Construction Schedule

Construction is expected to last about 22 months, and will be initiated following the issuance of permits, acquisition of property rights, and completion of design. PV Water anticipates that construction would begin in 2023 and end in 2024. Construction work in Salsipuedes Creek/College Lake will occur during June through October. At the end of this period, work areas will be winterized with no work between November and the end of May. Table 1 shows the current anticipated construction schedule and duration of each activity.

Table 1. Approximate construction schedule and activity duration. From ESA 2022a.

Project Component / Construction Phase	Expected Duration	Estimated Schedule
College Lake Pipeline		
Pipeline Construction	13 months	February 2023 – October 2024
Water Treatment Plant		
Mobilization	1 month	April 2023
Rough Grading	2 months	May 2023 – June 2023
Pile Installation	3 months	June 2023 – August 2023
Concrete Work	12 months	July 2023 – July 2024
Mechanical Equipment Installation	9 months	October 2023 – June 2024
Pre-Commissioning	0.5 month	July 2024
Weir Structure and Intake Pump Station		
Mobilization	2 weeks	May 2023
Clearing and Grubbing	1 week	June 2023
Installation of shoring	3 weeks	June 2023 – July 2023
Dewatering and Excavation	1 week	June 2023 – July 2023
Demolition and removal of existing weir	2 weeks	June 2023 – July 2023
Concrete Work	5 months[1]	July 2023 – November 2023
Removal of shoring	2 weeks	November 2023
Mechanical Equipment Installation	9 months	November 2023 – July 2024
Pre-Commissioning	0.5 month	July 2024
System Commissioning		
Intake and Treatment Process Startup & Testing	1 month	August 2024
Begin Delivery of Treated Water	NA	August 2024 – September 2024
Contractor Demobilization	1 month	October 2024

[1] The construction site would be winterized and no work would occur within the Salsipuedes Creek channel between November 2023 and May 2024. Construction of upland parts of the intake pump station and mechanical equipment installation could occur during this time as they would be out of the creek channel.

1.3.2.4. Construction Avoidance and Minimization Measures

PV Water proposes implementation of various measures to avoid or minimize impacts to steelhead or their designated critical habitat during all Project activities. These are summarized in Section 2.7 of the biological assessment (ESA 2022a). These include measures for staff training, steelhead handling and care, adherence to fish passage and screening criteria, dewatering, erosion control and soil stabilization measures to minimize or avoid water quality impacts, and other general construction best management practices for the protection of water quality and habitats. PV Water will allow all poured concrete to fully dry and cure prior to re-watering the site.

1.3.3. Operations

1.3.3.1. Operations Before and During Construction

As noted previously, PV Water assumes that RD 2049 would continue its current management practices and farming until the Project is completed. Therefore, during construction of the proposed weir structure, water will be pumped from the lakebed in a manner similar to current operations and inflows will be bypassed via a system of temporary pumps and pipeline into Salsipuedes Creek downstream of the construction area.

1.3.3.2. Fish Passage and Bypass Flows

PV Water will bypass Casserly Creek inflows past the weir to avoid disrupting fish passage between College Lake and the Pajaro River. Reach-specific flows for steelhead adult and smolt life stages are as follows:

- *Salsipuedes Creek - Corralitos Creek Confluence to the Pajaro River*. Based on a critical riffle analysis (Haas 2017; Podlech 2019a), this reach is considered passable when the combined flow from Corralitos Creek and College Lake outflow is approximately 21 cfs for adults, and 8 cfs for smolts.
- *Salsipuedes Creek - Proposed Weir Structure to the Corralitos Creek Confluence.* This reach of Salsipuedes Creek does not contain typical riffle habitat and, at times (i.e., during high flow events) receives reverse flow from Corralitos Creek toward College Lake. Fish passage through this reach was evaluated by cbec (2018) using hydraulic modeling to identify flows necessary to meet the same minimum passage depths described above. The analysis concluded that flows of 1.8 cfs and 1.0 cfs from College Lake would provide suitable passage conditions for adults and smolts, respectively.
- *Weir Structure*. Flow rates for passage across the weir will be refined during the design phase of the fish passage structure, but for modeling and evaluation purposes, these rates have been assumed to be the same as the for Salsipuedes Creek between the weir and the Corralitos Creek confluence, or 1.8 cfs and 1.0 cfs for adults and smolts, respectively.

Table 2 lists the minimum lake levels and bypass flows for steelhead adult migration (December 15 through April 30) and smolt migration (May 1 through May 31). Fish bypass releases would begin only when the water surface elevation in College Lake increases to the minimum level where passable conditions for fish would have occurred without a weir in place (i.e., regulated only by the existing channel topography in Salsipuedes Creek). These conditions correspond to a water surface elevation in College Lake that would yield a depth of 0.6 feet at the critical riffle (59.5 feet NAVD88) for the adult steelhead season, and 0.4 feet (59.3 feet NAVD88) for the smolt season (see ESA 2022a).

PV Water anticipates that other future conditions may warrant pumping flows from College Lake into Salsipuedes Creek during the summer and fall. The Project design includes a 30-inch bypass pipeline from the pump station to the downstream side of the proposed weir structure for this purpose. This bypass pipeline could be used to drain College Lake for equipment maintenance or equipment repair, for purposes of predator control, or to prevent water quality issues such as low dissolved oxygen, algal blooms, or other unforeseen issues from developing within the lake. Although PV Water is not presently able to anticipate the frequency of such operations, the bypass pipeline would be operated in compliance with applicable regulatory permit conditions.

Table 2. Proposed seasonal and life stage specific bypass flow and minimum lake elevation requirements for steelhead adults and smolts (ESA 2022a).

Proposed Bypass Flows[1]	Adult Migration		Smolt Outmigration
	December 15 – March 31	April 1 – April 30	May 1 – May 31[2]
Bypass flow between Corralitos-Salsipuedes confluence and Pajaro River	21 cfs	Net inflow when natural flow < 8 cfs; or 8 cfs when natural inflow is ≥ 8 cfs and < 18 cfs; or Net inflow when natural flow is ≥ 18 cfs and < 21 cfs; or 21 cfs when natural inflow is ≥ 21 cfs	8 cfs
Bypass flow at the weir[3] and in Salsipuedes Creek between the weir and Corralitos Creek	1.8 cfs	1.8 cfs	1.0 cfs
Minimum lake elevation	59.5 feet NAVD88	59.5 feet NAVD88	59.3 feet NAVD88

Notes:
cfs = cubic feet per second
NAVD88 = North American Vertical Datum of 1988

1. Instream flow requirements based on critical riffle surveys conducted in 2017 and 2018. Each minimum flow requirement would be the number specified in this table or the flow resulting from bypassing the total inflow into College Lake, whichever is less. Minimum flow between the Corralitos Creek-Salsipuedes Creek confluence and Pajaro River is for the combined flow from Corralitos Creek and College Lake.

2. The smolt outmigration season begins in March, but instream flow requirements for adult steelhead prior to May meet or exceed the smolt requirement and are therefore protective of smolt instream flow needs.

3. The minimum flows may be refined during design phase of the proposed weir and fish passage structure.

1.3.3.3. Proposed Weir Operations

To understand the potential flood impacts of the Project compared to existing conditions, PV Water's consultants conducted two-dimensional modeling of flood dynamics associated with the 10-year and 100-year run-off events (cbec 2018). Based on this analysis, PV Water will manage the proposed adjustable weir to avoid exacerbating flood risk while retaining water from late season precipitation events for subsequent treatment and distribution to irrigators in the Pajaro Valley. The proposed weir will be raised to 62.5 feet NAVD88 following the last anticipated significant storm event of the season. Factors that will affect the timing of the weir adjustment include the lake's water surface elevation and corresponding duration of drawdown, short- and long-term meteorological forecasts, and downstream channel conditions. In the event a significant storm is predicted to occur after the weir has been raised to 62.5 feet NAVD88, PV Water will initiate a pre-storm lowering of the weir from an elevation of 62.5 to 60.1 feet. Based on the results of a follow-up analysis (ESA 2022a Appendix A), lowering of the weir from 62.5 feet to 60.1 feet under existing downstream channel conditions would result in an initial draining rate at the weir of approximately 75 cfs, and this rate would decline quickly (i.e., within one hour) as Salsipuedes Creek below the weir reaches capacity.

1.3.3.4. Water Supply Extractions

Anticipated average annual water diversion rates for the Project range between 1,800 and 2,300 AF, and the annual maximum is 3,000 AF. The intake pipe is designed for a maximum diversion rate of 30 cfs. However, actual diversion rates (daily mean) are expected to be less than 10 cfs. PV Water provided estimated monthly demand based on existing conditions for irrigation water for each modeled water year type (i.e., ranging from very wet to extremely dry). These estimates ranged from 14 to 470 AF.

1.3.4. Maintenance and Monitoring

1.3.4.1. Facilities

Once fully operational, PV Water will periodically conduct routine inspections (e.g., for signs of wear, obstructions, or leakage) and perform maintenance of Project facilities (weir, pump station, WTP, and pipelines). Typical maintenance activities at the weir and intake facilities will include debris removal, cleaning, minor erosion control measures (including replacement of fill in eroded areas), and the replacement of the weir gate. In addition to routine inspections and maintenance activities, there may be a need to conduct unexpected or urgent maintenance activities with an estimated frequency of once every five years.

To the greatest extent feasible, inspections, maintenance, and repairs to the weir and intake structure will be conducted during periods when the lake is drained down in late summer and early fall. However, dewatering of surface or exposed waters surrounding these structures may be necessary at times, particularly for the unexpected maintenance activities. Methods for dewatering may depend on the nature and timing of the maintenance activity, but could include sheet piles driven by vibratory hammer or simply pressed into place by an excavator, or small cofferdams constructed of gravel bags wrapped in plastic sheeting with a bypass pipeline. All methods for isolation and dewatering will require the use of a screened pump. The anticipated frequency of dewatering is not expected to exceed once every five years and would occur at a time of year when water surface elevations in the lake are low and the presence of steelhead is unlikely. Prior to dewatering, attempts to collect and relocate species from the dewatered area will occur following the fish collection methods outlined above in Section 1.3.2.

1.3.4.2. College Lake Water Storage Area

The Project will apply an adaptive management approach to achieve College Lake operation and maintenance objectives. PV Water developed the College Lake Adaptive Management Plan (AMP) as part of the Project permits and other agreements (ESA 2022b). The AMP describes monitoring activities linked to specific goals such as monitoring the status of vegetation growth in the lake bed, hydrology, water quality, and wildlife populations, triggers for taking adaptive management actions, and finally a suite of potential management actions that respond to the monitoring results, such as active vegetation, sediment, and debris removal. Following initial engagement with regulatory agencies, the AMP was developed in conjunction with a series of meetings of the Ad Hoc Adaptive Management Plan Committee (Committee) formed by PV Water to solicit stakeholder input through a transparent and inclusive process. During these meetings, key AMP content was discussed and Committee members provided input and made recommendations. The Committee was supported by PV Water staff and consultants, as well as technical experts in fisheries, terrestrial wildlife, botany and wetlands, and hydrology.

With implementation of the Project, water will be stored in College Lake longer than under existing conditions, which is expected to result in changes to existing land use activities (e.g., lack of tilling and farming in much of the lake bed). PV Water will conduct routine (annual or semi-annual) maintenance activities within the College Lake basin to preserve water storage capacity, avoid exacerbating existing flood hazards, and manage habitat in a manner consistent with requirements established by permits and in accordance with the AMP (ESA 2022b). The Project includes vegetation and sediment maintenance activities. These maintenance activities may occur in the existing ditches and channels within the lake, and upstream of the weir structure. Specific details regarding methods and timing of maintenance activities would be determined once the project has been implemented.

Vegetation. The management of vegetation within the lakebed will be guided by the criteria and triggers defined in the AMP. In general, areas below 59 feet NAVD88 will be managed as open water habitat, with little or no permanent vegetation. To achieve this condition, vegetation management will occur as frequently as once per year during the dry season. Management of vegetation in the dry lakebed will include discing, tilling, trimming, and mowing as necessary. The primary goal of the vegetation management is to limit the establishment of vegetation that could trap sediment and restrict flow and drainage. Vegetation management is not proposed in established willow forested areas on the margins of the lake. Aquatic vegetation in channels (i.e., ditches within the lakebed) may also be removed mechanically using a drag-line and excavator bucket, and in association with sediment and debris removal described below. Debris from vegetation management will be loaded into haul trucks and deposited in a landfill or upland location. Preservation and potential future habitat enhancement in College Lake would also be guided by the criteria and triggers defined in the AMP.

Sediment and Debris. In addition to vegetation, management of sediment and other debris within the lakebed will be guided by the criteria and triggers defined in the AMP. PV Water will remove accumulated sediment and debris from certain areas of College Lake upstream of the weir structure. PV Water will conduct initial geomorphological assessments to confirm the factors in the watershed that influence sediment source, transport, and deposition, and to guide development of effective maintenance activities.

The need for sediment removal will be evaluated annually during routine facility monitoring. Sediment and debris removal will be conducted after the lake is drawn down at the end of the dry season. Removal of sediment will occur when it is determined that sediment accumulations are impeding fish passage, compromising channel capacity, or impairing operation of the weir and intake structure. Other sediment management actions that may be taken include grading of ditch channel banks within the lakebed (e.g., laying back banks) to avoid or minimize bank failure, encourage sediment deposition in areas of the lake away from the weir, and to help minimize stranding of fish during receding water levels. Sediment and debris removed from the lake will be taken to the Buena Vista Landfill for recycling or disposal.

1.3.4.3. Invasive Species Management

PV Water will implement an Invasive Species Management Plan (Podlech 2021a; ESA 2022a Appendix G) to control non-native animal species that compete with and/or pray upon native species such as steelhead. Management methods will include a combination of passive (i.e., periodic lake draining) and active (i.e., capture) control methods, and both methods will occur during late summer or early fall. The draining of the lake will be the result of the drawdown of the lake for water supply in late summer and early fall. Draining of the lake in late summer and early fall will leave only shallow flow in the main drainage ditch of the lake and therefore minimize habitat for non-native fishes. Any surface water left in the lake will be concentrated in the main channel of the lakebed, which will also confine fish and other aquatic species to smaller areas where they can be collected. Methods for fish collection will include backpack electrofishing, seining, and or dip-net. Non-native or invasive species will be euthanized and disposed in accordance with regulatory requirements. Native species (not including juvenile steelhead) will be released at the location they were collected from. Although few if any juvenile steelhead are expected to be present in the lake at this time of year based on anticipated habitat conditions, any observed or captured steelhead will be relocated to the nearest suitable freshwater habitat in appropriate transport containers maintained with cool, well-oxygenated waters. The invasive species monitoring activities will be conducted by a qualified biologist with established experience in fish collection, species identification, handling, and transport. This activity is expected to occur annually, or no less frequent than every three years.

1.3.4.4. Steelhead Monitoring

PV Water has developed a steelhead monitoring plan for the Project in coordination with NMFS and CDFW (Podlech 2022; ESA 2022a Appendix F). The intent of the steelhead monitoring plan is to evaluate the effectiveness of fish passage at the weir, and the effectiveness of the bypass flows for fish passage through Salsipuedes Creek. The steelhead monitoring will also provide additional information on the general status and ecology of steelhead in the Casserly Creek drainage and College Lake. The steelhead monitoring plan includes both active and passive monitoring of steelhead. PV Water has committed to conducting Project effectiveness monitoring for at least five years.

Active monitoring will include capture of steelhead using various methods such as backpack electrofisher, seine, and a downstream migrant, or down-migrant, trap. Capture of steelhead will allow for annual assessments of relative abundance, fish growth, age structure, and an opportunity to tag individual steelhead that can be detected using stationary antennas (i.e., passive monitoring) elsewhere in the watershed. The capture of juvenile steelhead in Casserly Creek, or its tributaries upstream of the lake, will occur in late summer or fall using backpack electrofishing or small seine/dip-nets. In late winter and spring, a downstream migrant trap will be operated in at least 3 of the first 5 years of the Project below College Lake (or the weir), to capture steelhead, determine relative smolt abundance, apply tags to untagged fish, and to recapture fish previously tagged and assess their seasonal growth rates. A relatively small number of post-spawned adults may be captured in the downstream migrant trap during their emigration back to the ocean. Scales may be collected from a subset of the captured individuals to age the fish, assess their growth rates, and to develop estimates of time spent in College Lake.

For tagging, only juvenile steelhead that are of sufficient length (> 65 millimeters (mm) fork length) may be anesthetized using sodium bicarbonate and implanted with a Passive Integrated Transponder (PIT) tag. Two stationary antenna arrays will be installed—one positioned immediately upstream and the other downstream of the weir. These will be used to detect tagged steelhead, determine their swimming direction, timing, and abundance, and to ultimately to assess migration success past/through the weir/fishway. Previously tagged juveniles may be detected by the antennas when they return as adults in subsequent years. The capture, handling and tagging of steelhead will be performed by qualified biologists with established experience implementing these collection methods and procedures. The information collected from the steelhead monitoring plan will be used by PV Water and the resource agencies to evaluate the need for adaptive management of Project operations.

As a component of the steelhead monitoring plan, PV Water will collect hydrologic data to evaluate compliance with bypass flow requirements for steelhead passage. Assessments of hydraulic conditions (fishway chamber depths, leap heights, velocities) will be conducted under a range of flow conditions to ensure the fishway is performing as designed. If necessary, fishway gate controls will be adjusted to meet design passage conditions. PV Water will conduct periodic stream walk assessments of Salsipuedes Creek timed to coincide, to the extent feasible, with streamflow events that are within the range of the established bypass flow targets (i.e., +/- 8 cfs and 21 cfs). Water depths across shallow portions of the streambed (i.e., critical riffles) will be measured and observed conditions will be photo-documented to verify that passage flow needs are being met. Passage efficiency evaluations of the permitted bypass flows in Salsipuedes Creek will be conducted during the first two years following Project initiation and every two years thereafter.

We considered, under the ESA, whether or not the proposed action would cause any other activities and determined that it would not

2. ENDANGERED SPECIES ACT: BIOLOGICAL OPINION AND INCIDENTAL TAKE STATEMENT

The ESA establishes a national program for conserving threatened and endangered species of fish, wildlife, plants, and the habitat upon which they depend. As required by section 7(a)(2) of the ESA, each Federal agency must ensure that its actions are not likely to jeopardize the continued existence of endangered or threatened species, or adversely modify or destroy their designated critical habitat. Per the requirements of the ESA, Federal action agencies consult with NMFS and section 7(b)(3) requires that, at the conclusion of consultation, NMFS provide an opinion stating how the agency's actions would affect listed species and their critical habitats. If incidental take is reasonably certain to occur, section 7(b)(4) requires NMFS to provide an ITS that specifies the impact of any incidental taking and includes reasonable and prudent measures (RPMs) and terms and conditions to minimize such impacts.

2.1. Analytical Approach

This biological opinion includes both a jeopardy analysis and an adverse modification analysis. The jeopardy analysis relies upon the regulatory definition of "jeopardize the continued existence of" a listed species, which is "to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 CFR 402.02). Therefore, the jeopardy analysis considers both survival and recovery of the species.

This biological opinion also relies on the regulatory definition of "destruction or adverse modification," which "means a direct or indirect alteration that appreciably diminishes the value of critical habitat as a whole for the conservation of a listed species" (50 CFR 402.02).

The designation of critical habitat for S-CCC steelhead use the term primary constituent element (PCE) or essential features. The 2016 final rule (81 FR 7414; February 11, 2016) that revised the critical habitat regulations (50 CFR 424) replaced this term with physical or biological features (PBFs). The shift in terminology does not change the approach used in conducting a "destruction or adverse modification" analysis, which is the same regardless of whether the original designation identified PCEs, PBFs, or essential features. In this biological opinion, we use the term PBF to mean PCE or essential feature, as appropriate for the specific critical habitat.

We use the following approach to determine whether a proposed action is likely to jeopardize listed species or destroy or adversely modify critical habitat:

- Evaluate the range-wide status of the species and critical habitat expected to be adversely affected by the proposed action.
- Evaluate the environmental baseline of the species and critical habitat.
- Evaluate the effects of the proposed action on species and their critical habitat using an exposure–response approach.
- Evaluate cumulative effects.
- In the integration and synthesis, add the effects of the action and cumulative effects to the environmental baseline, and, in light of the status of the species and

critical habitat, analyze whether the proposed action is likely to: (1) directly or indirectly reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species; or (2) directly or indirectly result in an alteration that appreciably diminishes the value of critical habitat as a whole for the conservation of a listed species.

- If necessary, suggest a reasonable and prudent alternative to the proposed action.

To conduct the assessment, NMFS examined an extensive amount of information from a variety of sources. Detailed background information on the biology and status of the listed species and critical habitat has been published in a number of documents including peer reviewed scientific journals, primary reference materials, and governmental and non-governmental reports. Additional information regarding the effects of the Project's actions on the listed species in question, their anticipated response to these actions, and the environmental consequences of the actions as a whole was obtained from the aforementioned resources, and others including the College Lake Integrated Resources Management Project Biological Assessment and Essential Fish Habitat Assessment (ESA 2022a).

2.2. Rangewide Status of the Species and Critical Habitat

This opinion examines the status of each species that is likely to be adversely affected by the proposed action. The status is determined by the level of extinction risk that the listed species face, based on parameters considered in documents such as recovery plans, status reviews, and listing decisions. This informs the description of the species' likelihood of both survival and recovery. The species status section also helps to inform the description of the species' "reproduction, numbers, or distribution" for the jeopardy analysis. The opinion also examines the condition of critical habitat throughout the designated area, evaluates the conservation value of the various watersheds and coastal and marine environments that make up the designated area, and discusses the function of the PBFs that are essential for the conservation of the species.

2.2.1. ESA Listed Species and Designated Critical Habitats

This biological opinion analyzes the effects of the Project activities on the S-CCC steelhead DPS, which is listed as threatened under the ESA (71 FR 834, January 5, 2006). The S-CCC steelhead DPS includes coastal populations from the Pajaro River (Santa Cruz County), south to and including Arroyo Grande Creek (San Luis Obispo County). S-CCC steelhead are expected to be present in the action area during Project implementation.

The Pajaro River, Salsipuedes Creek, and Casserly Creek (including its tributaries Green Valley, Banks Canyon, and Gaffey creeks) are designated critical habitat for the S-CCC steelhead DPS (70 FR 52488, September 5, 2005).

2.2.2. Species Description and Life History

Steelhead are anadromous forms of *Oncorhynchus mykiss*, spending some time in both fresh- and saltwater. Juveniles migrate to the ocean where they mature. Adult steelhead return to freshwater rivers and streams to reproduce, or spawn. Unlike Pacific salmon, steelhead are iteroparous, or capable of spawning in multiple years before death (Busby et al. 1996; Moyle 2002). Although one-time spawners are the great majority, Shapovalov and Taft (1954) reported that repeat spawners are relatively numerous (17.2 percent) in central California coastal streams. Eggs (laid in gravel nests called redds), alevins (gravel dwelling hatchlings), fry (juveniles newly emerged from stream gravels), and other juvenile life stages all rear in freshwater until they migrate to the ocean where they reach maturity.

O. mykiss exhibit a variable life history. Coastal *O. mykiss* populations in central and southern California are classified into three principle life history strategies: fluvial-anadromous, lagoon anadromous, and freshwater resident or non-anadromous (Boughton et al. 2007). The anadromous forms of S-CCC steelhead are classified as "winter-run" steelhead because they emigrate from the ocean to their natal streams to spawn annually during the winter; although run times can extend into spring (Moyle 2002). Within the S-CCC steelhead DPS, adults typically enter freshwater between December and April, with peaks occurring in January through March (Wagner 1983; Fukushima and Lesh 1998). It is during this time that streamflow (depth and velocity) are suitable for adults to successfully migrate to and from spawning grounds. The minimum stream depth necessary for successful upstream migration is about 13 centimeters (cm), although short sections with depths less than 13 cm are passable (Thompson 1972). More optimal water velocities for upstream migration are in the range of 40-90 cm/s, with a maximum velocity beyond which upstream migration is not likely to occur of 240 cm/s (Thompson 1972).

Redds are generally located in areas where the hydraulic conditions limit fine sediment accumulations. Reiser and Bjornn (1979) found that gravels of 1.3-11.7 cm in diameter were preferred by steelhead. Survival of embryos is reduced when fines smaller than 6.4 mm comprise 20 to 25 percent of the substrate. This is because, during the incubation period, the intragravel environment must permit a constant flow of water in order to deliver dissolved oxygen to and remove metabolic wastes from the embryos. Studies have shown embryo survival is higher when intragravel velocities exceed 20 cm/hour (Coble 1961; Phillips and Campbell 1961). The number of days required for steelhead eggs to hatch is inversely proportional to water temperature and varies from about 19 days at 15.6˚ degrees (°) Celsius (C) to about 80 days at 5.6°C. Fry typically emerge from the gravel two to three weeks after hatching (Barnhart 1986). Other intragravel parameters such as the organic material in the substrate affect the survival of eggs to fry emergence (Shapovalov and Taft 1954; Everest et al. 1987; Chapman 1988).

Once emerged from the gravel, steelhead fry rear in edgewater habitats along the stream and gradually move into pools and riffles as they grow larger. Cover, sediment, and water quality are important habitat components for juvenile steelhead. Cover in the form of woody debris, rocks, overhanging banks, and other in-water structures provide velocity refuge and a means of avoiding predation (Shirvell 1990; Bjornn and Reiser 1991). Steelhead, however, tend to use riffles and other habitats not strongly associated with cover during summer rearing more than other salmonids. In winter, juvenile steelhead become less active and hide in available cover, including gravel or woody debris. Young steelhead feed on a wide variety of aquatic and terrestrial insects, and emerging fry are sometimes preyed upon by older juveniles. Water temperature can influence the metabolic rate, distribution, abundance, and swimming ability of rearing juvenile steelhead (Barnhart 1986; Bjornn and Reiser 1991; Myrick and Cech 2005). Optimal temperatures for steelhead growth range between 10 and 19°C (Hokanson et al. 1977; Wurtsbaugh and Davis 1977; Myrick and Cech 2005). Fluctuating diurnal water temperatures are also important for the survival and growth of salmonids (Busby et al. 1996).

Although variation occurs, S-CCC juvenile steelhead that exhibit an anadromous life history strategy usually rear in freshwater for 1-2 years (NMFS 2013). S-CCC steelhead smolts emigrate episodically from freshwater in late winter and spring, with peak migrations occurring in April and May (Shapovalov and Taft 1954; Fukushima and Lesh 1998; Ohms and Boughton 2019). Steelhead smolts in California range in size from 120 to 280 mm (fork length) (Shapovalov and Taft 1954; Barnhart 1986). Smolts migrating from the freshwater environment may temporarily utilize the estuarine habitats for saltwater acclimation and feeding prior to entering the ocean.

Juvenile steelhead of the lagoon-anadromous life history rear in lagoons for extended periods (Smith 1990; Boughton et al. 2006; Hayes et al. 2008). Lagoons are a specific type of estuarine habitat where a seasonal impoundment of water develops after a sandbar forms at the mouth of the watershed, temporarily separating the fresh and marine environments (Smith 1990). Like other estuary types, bar-built lagoons can serve as important rearing areas for many fish and invertebrate species—including juvenile steelhead (Simenstad et al. 1982; Smith 1990; Robinson 1993; Martin 1995). Due to the combination of high prey abundance and seasonally warmer temperatures, juvenile steelhead that rear in lagoons have been found to achieve superior growth rates relative to upstream fish of the same cohort, and can therefore disproportionally represent future adult steelhead returns (Bond et al. 2008; Hayes et al. 2008). This is especially important considering that lagoon habitats often represent a fraction of the watershed area. For the S-CCC steelhead DPS, it is hypothesized that the most limiting habitat in terms of availability is over-summer rearing habitat, including functional lagoon habitats (Boughton et al. 2006).

2.2.3. Status of the S-CCC Steelhead DPS

NMFS assesses four population viability1 parameters to discern the status of the listed DPS and to assess a species' ability to survive and recover. These population viability parameters are: abundance, population growth rate, spatial structure, and diversity (McElhany et al. 2000). While there is insufficient data to evaluate these population viability parameters quantitatively, NMFS has used existing information to determine the general condition of the populations in the S-CCC steelhead DPS and factors responsible for the current status of these listed species.

The population viability parameters are used as surrogates for numbers, reproduction, and distribution, which are included in the regulatory definition of "jeopardize the continued existence of" (50 CFR 402.02). For example, abundance, population growth rate, and distribution are surrogates for numbers, reproduction, and distribution, respectively. The fourth parameter, diversity, is related to all three regulatory criteria. Numbers, reproduction, and distribution are all affected when genetic or life history variability is lost or constrained, resulting in reduced population resilience to environmental variation at local or landscape-level scales.

Populations of S-CCC steelhead throughout the DPS have exhibited a long-term, negative trend since at least the mid-1960s when spawning populations were estimated at 17,750 individuals (Good et al. 2005). Available information shows S-CCC steelhead population abundance

[1] NMFS defines a viable salmonid population as "an independent population of any Pacific salmonid (genus *Oncorhynchus*) that has a negligible risk of extinction due to threats from demographic variation, local environmental variation, and genetic diversity changes over a 100- year time frame" (McElhany et al. 2000).

continued to decline from the 1970s to the 1990s (Busby et al. 1996), and more recent data indicate this trend continues (Good et al. 2005). Current S-CCC steelhead run-size estimates in the five largest systems of the DPS (Pajaro River, Salinas River, Carmel River, Little Sur River, and Big Sur River) are likely greatly reduced from 4,750 adults in 1965 (CDFG 1965). More recent estimates for total run-size do not exist for the S-CCC steelhead DPS (Good et al. 2005; Williams et al. 2016) as few comprehensive or population monitoring programs are in place.

Recent analyses conducted by the S-CCC steelhead Technical Review Team (TRT) indicate the S-CCC steelhead DPS consists of 12 discrete sub-populations representing localized groups of interbreeding individuals, and none of these sub-populations currently meet the definition of viable (Boughton et al. 2006; Boughton et al. 2007). Most of these sub-populations are characterized by low population abundance, variable or negative population growth rates, and reduced spatial structure and diversity. The Pajaro River and Salinas River populations are in particularly poor condition (relative to watershed size) and exhibit a greater lack of viability than many of the coastal subpopulations. In the Carmel River there has been a variable but consistent decline in abundance of anadromous adults (Williams et al. 2016; Boughton 2017). The decline is somewhat unexpected because it coincides with a concentrated effort to restore the habitat in the Carmel River and to improve numbers through a rescue/captive rearing operation (Williams et al. 2016). This decline could indicate an increase in S-CCC steelhead DPS extinction risk (Williams et al. 2016).

Although steelhead are present in most streams in the S-CCC DPS (Good et al. 2005), their populations are small, fragmented, and unstable (more subject to stochastic events) (Boughton et al. 2006). In addition, severe habitat degradation and the compromised genetic integrity of some populations pose a serious risk to the survival and recovery of the S-CCC steelhead DPS (Good et al. 2005). NMFS' 2005 status review concluded S-CCC steelhead remain "likely to become endangered in the foreseeable future" (Good et al. 2005). NMFS confirmed the listing of the S-CCC steelhead DPS as threatened under the ESA on January 5, 2006 (January 5, 2006; 71 FR 834).

The most recent status update concludes that steelhead in the S-CCC DPS remains "likely to become endangered in the foreseeable future", as new and additional information available since Williams et al. (2011) does not appear to suggest a change in extinction risk (Williams et al. 2016). In the most recent status review, NMFS concluded that the S-CCC steelhead DPS should remain listed as threatened (NMFS 2016).

2.2.4. Status of Critical Habitat for the S-CCC steelhead DPS

PBFs for S-CCC steelhead critical habitat and their associated essential features within freshwater include:

- Spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation and larval development;
- Rearing sites with:
- water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility;
- water quality and forage supporting juvenile development; and

- natural cover such as shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks;
- Migration corridors free of obstruction and excessive predation with water quantity and quality conditions and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks supporting juvenile and adult mobility and survival.

PBFs for S-CCC steelhead critical habitat within estuarine areas include areas free of obstruction and excessive predation with the following essential features: (1) water quality, water quantity and salinity conditions supporting juvenile and adult physiological transitions between fresh- and saltwater; (2) natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels; and (3) juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation (70 FR 52488).

The condition of S-CCC steelhead critical habitat, specifically its ability to provide for their conservation, has been degraded from conditions known to support viable salmonid populations. NMFS has determined the present depressed population conditions are, in part, the result of the following human-induced factors affecting critical habitat: agriculture, grazing, and mining activities, urbanization, stream channelization, construction of dams and other migration impediments, wetland loss, water resource development including aquifer overdraft, introduction of invasive species, and past recreational harvest. Impacts of concern include alteration of stream bank and channel morphology, alteration of water temperatures, fragmentation of habitat, loss of downstream recruitment of spawning gravels and large woody debris, degradation of water quality and quantity, alteration or loss of riparian vegetation communities, and fish passage constraints (Busby et al. 1996; 70 FR 52488).

Depletion and storage of streamflow have drastically altered the natural hydrologic cycles in many of the streams in the S-CCC steelhead DPS (Good et al. 2005; NMFS 2013). Alteration of streamflow results in migration delays, loss of suitable habitat due to dewatering and blockage, stranding of fish from rapid flow fluctuations, increased water temperatures, and have degraded estuary/lagoon access and function. Overall, the current condition of S-CCC steelhead critical habitat is degraded, and likely cannot provide the conservation value necessary for the recovery of the species absent habitat restoration efforts.

In addition to other water quality contaminants (e.g., pesticides, nutrients), recent research has found that toxic runoff from roadways is resulting in the recurrent and rapid mortality of adult coho salmon in the wild (Scholz et al. 2011; French et al. 2022) and laboratory settings (McIntyre et al. 2018). More recently, laboratory studies have found juvenile coho salmon (*O. kisutch*) (Chow et al. 2019) and juvenile steelhead and Chinook salmon (*O. tshawytscha*) (Brinkmann et al. 2022; McIntyre and Scholz unpublished results 2020) also experience similar patterns of morality resulting from exposure to contaminants in roadway runoff. Studies have identified a degradation product of automobile tires (6PPD-quinone) as the contaminant responsible for this mortality at concentrations of less than one part per billion (Peter et al. 2018; Tian et al. 2020; Brinkmann et al. 2022; Tian et al. 2022). The 6PPD-quinone compound occurs in tires produced by multiple tire manufacturers, and the dust and larger particles worn from tires are ubiquitous on the surface of rural and urban roadways. Storm runoff eventually transports this tire debris into waterways where it can have lethal consequences on salmonids (Feist et al. 2018; Sutton et al. 2019).

NMFS' recovery plan for the S-CCC steelhead DPS (NMFS 2013) describes the key threats and the actions needed to help achieve recovery for populations within each biogeographical population group (BPG). For the Pajaro River and its tributaries (Interior Coast Range BPG), critical recovery actions identified in the plan included:

- development and implementation of operating criteria for the management and protection of ground and surface water extractions to support the life history and habitat requirements of adult and juvenile steelhead;
- removal or modification of passage impediments to provide natural rates of migration for steelhead life stages both upstream and downstream;
- management of instream mining to minimize impacts to migration, spawning and rearing habitat; and
- identify, protect, and where necessary, restore estuarine habitats by providing supplemental water to the estuary and by management of artificial breaching of the river's mouth.

2.2.5. Climate Change

Another factor affecting the range wide status of S-CCC steelhead and aquatic habitat at large is climate change. Recent work by the NMFS Science Centers ranked the relative vulnerability of west-coast salmon and steelhead to climate change. In California, listed coho and Chinook salmon are generally at greater risk (high to very high risk) than listed steelhead (moderate to high risk) (Crozier et al 2019).

Impacts from global climate change are already occurring in California. For example, average annual air temperatures, heat extremes, and sea level increased in California over the last century (Kadir et al. 2013). Snowmelt from the Sierra Nevada has declined (Kadir et al. 2013). Although S-CCC steelhead are not dependent on snowmelt driven streams, they have likely already experienced some detrimental impacts from climate change through lower and more variable stream flows, warmer stream temperatures, and changes in ocean conditions. California experienced well below average precipitation during the 2012-2016 drought, as well as record high surface air temperatures in 2014 and 2015, and record low snowpack in 2015 (Williams et al. 2016). Paleoclimate reconstructions suggest the 2012-2016 drought was the most extreme in the past 500 to 1000 years (Williams et al. 2016). Anomalously high surface temperatures substantially amplified annual water deficits during 2012-2016. California entered another period of drought in 2020. These drought periods are now likely part of a larger drought event (Williams et al. 2022). This recent long-term drought, as well as the increased incidence and magnitude of wildfires in California, have likely been exacerbated by climate change (Diffenbaugh et al. 2015; Williams et al. 2019; Williams 2022).

The threat to S-CCC steelhead from global climate change is expected to increase in the future. Modeling of climate change impacts in California suggests that average summer air temperatures are expected to continue to increase (Lindley et al. 2007; Moser et al. 2012). Heat waves are expected to occur more often, and heat wave temperatures are likely to be higher (Hayhoe et al. 2004; Moser et al. 2012; Kadir et al. 2013). Total precipitation in California may decline and the magnitude and frequency of dry years may increase (Lindley et al. 2007; Schneider 2007; Moser et al. 2012). Increases in wide year-to- year variation in precipitation amounts (droughts and floods) are projected to occur (Swain et al. 2018). Similarly, wildfires are expected to increase in frequency and magnitude (Westerling et al. 2011; Moser et al. 2012). In the last 20 years, the S-CCC DPS has experienced several large wildfires including the Basin Complex Fire (2008 – 162,818 acres), the Soberanes Fire (2016 - 132,100 acres), the Dolan Fire (2020 – 124,924 acres), and the River Fire (2020 – 48,088 acres). These fires have resulted in varying levels of impact to habitats utilized by steelhead. Likely the most significant threat these fires pose are increased landslide and erosion potential, sedimentation of stream channels, loss or degradation of riparian vegetation, and impacts to water quality.

Estuaries, including seasonally closed lagoons, may also experience changes detrimental to salmonids. Estuarine productivity is likely to change based on changes in freshwater flows, nutrient cycling, and sediment amounts (Scavia et al. 2002; Ruggiero et al. 2010). Continued sea level rise (0.42 to 1.67 meters by 2100) is expected to cause sandbars to form farther inland, which can affect the amount of time the lagoon is connected to the ocean (Dalrymlpe et al. 2012; Rich and Keller 2013).

In marine environments, ecosystems and habitats important to juvenile and adult salmonids are likely to experience changes in temperatures, circulation, water chemistry, and food supplies (Feely 2004; Brewer and Barry 2008; Osgood 2008; Turley 2008; Abdul-Aziz et al. 2011; Doney et al. 2012). Some of these changes, including an increased incidence of marine heat waves, are likely already occurring, and are expected to increase (Frolicher, et al. 2018). In fall 2014, and again in 2019, a marine heatwave, known as “The Blob”, formed throughout the northeast Pacific Ocean, which greatly affected water temperature and upwelling from the Bering Sea off Alaska, south to the coastline of Mexico. The marine waters in this region of the ocean are utilized by salmonids for foraging as they mature (Beamish 2018). Although the implications of these events on salmonid populations are not fully understood, they are having considerable adverse consequences to the productivity of these ecosystems and presumably contributing to poor marine survival of salmonids.

In the San Francisco Bay region (and other areas of the central California coast), warm temperatures generally occur in July and August, but with climate change these events will likely begin in June and could continue through September (Cayan et al. 2012). Climate simulation models indicate the San Francisco region will maintain its Mediterranean climate regime for the 21st century; however, these models predict a high degree of variability in annual precipitation through at least 2050, leaving the region susceptible to drought (Cayan et al. 2012). These models of future precipitation suggest that, during the second half of the 21st century in this region, most years will be drier than the historical annual average (1950-1999).

2.3. Action Area

“Action area” means all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR 402.02). The action area consists of the bed and banks of College Lake, upland areas (urban and agricultural) where the intake pumping station, treatment plant, College Lake Pipeline, and staging areas would occur, as well as the projected maximum inundation zone of the lake bed (Figure 3). The action area also includes the waterways influenced by changes in streamflow including Salsipuedes Creek downstream to its confluence with the Pajaro River, and the Pajaro River between the Salsipuedes Creek confluence and the ocean (Figure 1 and Figure 3). The action area will also include sites within Casserly Creek or its tributaries where annual steelhead monitoring will be conducted.

2.4. Environmental Baseline

The "environmental baseline" refers to the condition of the listed species or its designated critical habitat in the action area, without the consequences to the listed species or designated critical habitat caused by the proposed action. The environmental baseline includes the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultations, and the impact of State or private actions which are contemporaneous with the consultation in process. The consequences to listed species or designated critical habitat from ongoing agency activities or existing agency facilities that are not within the agency's discretion to modify are part of the environmental baseline (50 CFR 402.02).

The Project is located within the Pajaro River watershed, which has a drainage area of approximately 1,300 square-miles constituting most of San Benito County and portions of Santa Clara, Santa Cruz, and Monterey counties. The Pajaro Valley is located in the downstream section of the Pajaro River watershed near the coast, and is bordered by the Santa Cruz Mountains to the north and east, the Los Carneros Hills to the south, and Monterey Bay to the west (Figure 1 and Figure 3).

The Pajaro Valley has a Mediterranean climate with relatively cool, wet winters and warm, dry summers. Over 90 percent of annual precipitation falls from November through April. The mean precipitation for the Pajaro Valley ranges from 16 inches near the coast, to more than 40 inches in the Santa Cruz Mountains (ESA 2022a). Land use in the Pajaro Valley is predominantly agriculture with urban centers located in the City of Watsonville and the town of Pajaro. Prominent drainage features include the Pajaro River and its tributary Salsipuedes Creek, which collects runoff from the Corralitos Creek and Casserly Creek subwatersheds.

Approximately 95 percent of the water used in the Pajaro Valley is from groundwater. Since 1953, groundwater overdraft has caused seawater intrusion within the Pajaro Valley Groundwater Basin of up to two and a half miles inland from the coast. As result, in some areas the groundwater is unsuitable for agricultural irrigation and domestic (potable) uses without treatment (ESA 2022a). Because of these conditions, the basin was classified as a critically overdrafted, high priority groundwater basin under California's Sustainable Groundwater Management Act (SGMA) of 2014. The 30-year average annual deficit for the basin is estimated to be approximately 12,100 AF. These conditions are not expected to improve without reductions in coastal groundwater pumping, and the development and delivery of supplemental water supplies.

Figure 3. The majority of the action area and the proposed locations for specific project elements. See also Figure 1. Portions of the action area that are not specifically identified in this map include the sites in Casserly Creek or its tributaries where juvenile steelhead would be collected as part of the steelhead monitoring plan.

2.4.1. Status of S-CCC Steelhead Critical Habitat in the Action Area

2.4.1.1. College Lake

College Lake is a naturally-occurring, shallow depression along the Zayante-Vergeles Fault zone in unincorporated Santa Cruz County approximately one-mile northeast of the Watsonville city limits. The lake receives inflow from Casserly Creek, and its tributaries including Green Valley and Hughes creeks and other small drainages. The drainage from College Lake forms Salsipuedes Creek, which converges with Corralitos Creek approximately 2,000 feet downstream of the lake (Figure 4). Salsipuedes Creek receives an average of approximately 4,700 AF of surface inflow from the watershed above College Lake. Due to the natural topography of the area, there are times when the direction of streamflow in the reach of Salsipuedes Creek between College Lake and the confluence with Corralitos Creek reverses—typically the first storms of the year. Under these conditions, surface flow from Corralitos Creek and the upper portions of Salsipuedes Creek flow towards the lake. The magnitude and direction of streamflow in this reach of Salsipuedes Creek (between the lake and Corralitos Creek) are controlled by several factors including the water surface elevation in College Lake, streamflow in Corralitos and Salsipuedes creeks downstream of the Corralitos Creek confluence, and the elevation of the existing weir at the College Lake outlet. During wet years, spillover from Pinto Lake, a neighboring and natural lake to the west of College Lake, flows through a drainage ditch (called Pinto Creek) into this reach of Salsipuedes Creek between College Lake and the creek's confluence with Corralitos Creek (Figure 4 and Appendix 6.1).

The channel bed elevation downstream of the existing weir is approximately 57 feet NAVD88, and approximately 48 feet NAVD88 in the lake. The water surface elevation of College Lake is 60.1 feet NAVD88 when filled to the top of the existing weir. At this elevation, the maximum depth of the lake is approximately 12 feet (including the ditch), the inundated surface area is approximately 228 acres, and the stored volume is approximately 1,150 AF.

The existing weir and pump station are located at the outlet of College Lake (Figure 4 and Figure 5). During the wet season, the water surface of the lake regularly exceeds the elevation of the existing weir. The purpose of the weir is not to impound water but to prevent water pumped from College Lake into Salsipuedes Creek from flowing back upstream and into the lake. At the initiation of this pumping, the elevation of the weir is raised by approximately 2 feet with sandbags to further prevent pumped water from flowing back into College Lake (Figure 5).

Since at least the early 1920s, the lake has been drained annually to farm the lake bed. Ditches were excavated into the lakebed to facilitate drainage; these ditches persist today (Figure 4 and Figure 5). In 1934, RD 2049 was officially formed and they have continued the annual drainage operations ever since. Pumping of the lake typically begins by mid-March and is usually completed by May or early June. RD 2049 uses two unmetered and unscreened pumps to drain the lake. Once drained, intermittent pumping continues as water accumulates in the ditch (Figure 5). Once drained, it takes about one month to prepare the lakebed soils for planting, so planting normally begins in early July. Most of the crops grown in the lakebed take 60 to 90 days to reach harvest, and therefore crops planted in early July are typically harvested by September or October. The sandbags on the existing weir are usually removed by the end of October, and the lakebed is left fallow through winter and most of spring. Due to the annual draining of the lake and tilling of much of the lakebed soils, the extent of emergent wetland vegetation is sparse.

Riparian vegetation (primarily willow forest) occurs along portions of the lake's margins and at the tributary inlets where farming has been abandoned, including a large area near the Casserly Creek inlet—this parcel is owned by PV Water (Figure 4).

Figure 4. A close up view of College Lake (drained), the location of the existing and proposed weir, and the location of Casserly, Salsipuedes, Pinto, and Corralitos creeks.

Figure 5. The existing weir at College Lake (top and right) and the primary ditch within the center of the lakebed upstream of the weir (bottom left). Source: Joel Casagrande, NMFS, June 2017.

Despite the annual draining, native fishes have been observed in the lake (at least seasonally). In addition to steelhead, native species have included prickly sculpin, hitch, Sacramento pikeminnow, Sacramento sucker, California roach, and threespine stickleback. Non-native fishes observed in the lake include carp, goldfish, fathead minnow, golden shiner, channel catfish, brown bullhead, green sunfish, bluegill, and occasionally, largemouth bass.

The current weir is not equipped with fish passage facilities, therefore downstream fish passage at the weir is blocked whenever the lake's water surface elevation is lower than the crest of the weir, or sandbag extension. Once the sandbags are added to the top of the weir and pumping begins, steelhead passage downstream of the lake is blocked for the remainder of the season (absent an unseasonal storm). Consequently, a large portion of the emigrating steelhead smolts and presumably some kelts are blocked from migrating downstream to the ocean.

The existing weir has less impact on the upstream migration of adult steelhead. During the wet season, and prior to the placement of sandbags and pumping discussed above, water surface elevations immediately downstream of the weir are only up to 1.3 feet lower than the top of the weir whenever contiguous surface flows are present in Salsipuedes Creek. Given the limited difference in water surface elevations, the presence of a deep plunge pool (estimated to be 4+ feet deep) immediately downstream the weir, and the narrow crest of the weir (about 1 foot), adult steelhead are expected to easily migrate upstream under existing conditions any time the weir is overflowing. During and following most storm events, water surface elevations in Salsipuedes Creek and College Lake often exceed the elevation of the existing weir, creating unimpeded passage conditions.

2.4.1.2. Casserly Creek

Casserly Creek and its tributaries, Green Valley Creek and Hughes Creek, drain the western slope of the Santa Cruz Mountains and generally flow south-southwest towards the City of Watsonville (Figure 3). On the valley floor, Casserly Creek flows through a mostly straightened and simplified channel bordered by agricultural fields, and confined by small earthen levees. Riparian vegetation is present along most of the channel but is largely restricted to narrow stands of trees on the banks/levees. During summer and early fall, surface flow into the lake from Casserly Creek is low, warm and consist of a mixture of natural agriculture runoff (Smith 2007; ESA 2022a). Substrate in the creek channel at the lake inlet is dominated by sand and a small amount of gravel. Paulsen Road crosses Casserly Creek and forms the current upstream limit of College Lake. In the upper reaches of Casserly Creek within the Santa Cruz Mountains and foothill reaches, the creek flows through canyons consisting of mixed evergreen forests, dominated by coast redwood. Streamflow is usually present in summer, but may become intermittent during drought years. Pools are shallow and substrate consists of mixed cobble, gravel and sand (Podlech 2021b).

2.4.1.3. Salsipuedes Creek and the Pajaro River

Salsipuedes Creek. Salsipuedes Creek, begins as the drainage of College Lake and continues downstream to the confluence with the Pajaro River (Figure 3). From College Lake to the Corralitos Creek confluence, Salsipuedes Creek is a vegetated, low-gradient and simplified channel with a sandy or mud bottom. Salsipuedes Creek between the Corralitos Creek confluence and the Pajaro River flows within flood control levees constructed by the Corps. The stream banks are generally devoid of mature riparian vegetation due to regular channel maintenance to reduce channel roughness and maintain hydraulic capacity. A narrow strip of mature riparian vegetation is present along approximately one mile of the east bank of Salsipuedes Creek downstream of the Corralitos Creek confluence, but the west bank is entirely devoid of riparian trees upstream of the Highway 129 bridge. A mixed riparian forest is present on both banks of Salsipuedes Creek between the Highway 129 crossing and the Pajaro River (approximately 1,000 feet). The County of Santa Cruz periodically performs maintenance on the levees along Salsipuedes Creek. These activities have included isolated banks stabilization and culvert replacement projects and periodic vegetation maintenance. Throughout Salsipuedes Creek, coarse substrate is scarce and the few riffles present are short and less than 10 feet in length (Smith 2007; Podlech 2019a).

Based on hydrologic modeling of the lake and its tributary inputs (cbec 2014), it is estimated that prior to reclamation of the lake for farming, the evaporation/evapotranspiration from the lake during the dry season was greater than inflows to the lake, thus resulting in a lake disconnected from Salsipuedes Creek in the summer. This is consistent with the name given for the creek, Salsipuedes, which in Spanish translates to “get out while you can”. Presently, dry season surface flow in the mostly unshaded channel of the creek downstream of the Corralitos Creek confluence is intermittent and largely attributed to the artificial pumping from College Lake, agricultural and urban return flows along the creek, and some emerging groundwater closer to the confluence with the Pajaro River. Water pumped from College Lake during summer is warm and very turbid (Smith 2007; ESA 2022a). Salsipuedes Creek is listed on the State Water Control Board (SWRCB)’s list of impaired water bodies under section 303(d) of the Clean Water Act for the following pollutants: dissolved oxygen, *Escherichia coli* (*E. coli*), fecal coliform, nitrate, toxicity, turbidity, and pH (SWRCB 2017).

Pajaro River. From the Salsipuedes Creek confluence, the Pajaro River flows for approximately six miles before discharging to Monterey Bay. The river channel forms the boundary between Santa Cruz and Monterey counties and is contained within flood control levees on the Santa Cruz County side and a mix of levees and coastal bluffs on the Monterey County side. The width of the active channel narrows with distance downstream. Much of the channel is densely vegetated and bordered by levee slopes with minimal vegetation. Streamflow during the summer-fall period is low and heavily influenced by agricultural and urban return flows and emerging groundwater. Water temperatures during the summer are warm, and the substrate is dominated by sand and fine sediments (Smith 2013; ESA 2022a). The Pajaro River (and Pajaro River Estuary) are listed on the SWRCB's list of impaired water bodies under section 303(d) of the Clean Water Act for several pollutants including multiple pesticides, nutrients, metals, turbidity, pH, water temperature, and dissolved oxygen (SWRCB 2017). The channel capacity within the existing flood control levees (constructed in 1949) along much of Salsipuedes Creek and the Pajaro River is insufficient, and therefore flood risk remains a major concern in the area. The County of Santa Cruz performs periodic vegetation and debris maintenance on these benches and the levees. This stretch of the Pajaro River is known to have extensive homeless encampments, debris, and evidence of attempted poaching (Casagrande 2017).

Pajaro River Lagoon. The Pajaro River lagoon is long and narrow, with tidally influenced habitat extending from the river mouth upstream to approximately the Highway 1 Bridge. Approximately half of the lagoon area is bordered by mixed riparian vegetation, which transitions to exclusively emergent and more salt tolerant species. Vegetated shores are narrow and abruptly transition to levees with little or no vegetation. The beach is part of the Pajaro River Mouth Natural Preserve and is bordered by Zmudowski State Beach to the south, both of which are managed by California Department of Parks and Recreation. North of the mouth is the Pajaro River Dunes Colony, a small residential development within the sand dunes immediately west of Watsonville Slough and the lagoon. Watsonville Slough flows behind the beach dunes and joins the lagoon just upstream of the mouth (Figure 1).

In most years, a sandbar forms at the river mouth creating a lagoon. This typically occurs in late summer or early fall. The Habitat Restoration Group (1997) notes the formation of the sandbar is driven primarily by beach-building processes produced by low-energy waves later in summer. Spring and summer freshwater inflows to the estuary are not important factors for sand bar formation for the large estuary because tidal fluctuation through the open sandbar is considerably higher than freshwater inflows. Because the mouth of the lagoon is open through most of the spring and summer, the water column experiences tidal action and is therefore often stratified with saltwater at depth and a thin freshwater lens at the surface. These conditions allow for gradual acclimation to saltwater by emigrating yearling smolts, but are less conducive to rearing younger, juvenile steelhead (Smith 1993a; Habitat Restoration Group 1997). Although rare, the sandbar can form earlier in summer in extreme or consecutive drought years. Under these conditions, the freshwater inflows can gradually reduce the salinity levels in the lagoon and improve rearing conditions for younger steelhead. However, such closures would occur after the tributaries (e.g. Corralitos / Salsipuedes creeks) have disconnected, precluding downstream migration of age-0+ steelhead.

2.4.1.4. Climate Change and the Action Area

The long-term effects of climate change have been described in Section 2.2.5 Global Climate Change. These include potential changes in air temperature and precipitation patterns that may affect steelhead and their critical habitat by changing water quality, streamflow, and steelhead migration opportunities.

The threat to critical habitats for S-CCC steelhead in the action area from climate change is likely going to mirror what is expected for the rest of the central California coastal region. Increases in average air temperatures and prolonged heat waves could increase water temperatures in the action area. Increased variability in annual precipitation is expected to result in more extreme events such as droughts and floods, and thus affect the timing, duration, and magnitude of streamflow. In turn, these changes could reduce the duration and extent of suitable passage windows for migrating steelhead (adult and smolt) through the action area.

In addition to the above, continued sea-level rise is expected to affect sandbar development along the California coast (Rich and Keller 2013), which will undoubtedly have some impact on the function of the Pajaro Lagoon. Sea-level rise would also increase the inland extent of seawater, which would gradually advance estuarine habitats in an upstream direction, particularly within the low-gradient Pajaro River channel.

2.4.2. Status of S-CCC Steelhead in the Action Area

2.4.2.1. College Lake

There is a lack of data regarding the use of College Lake by steelhead for rearing. This is primarily because the lake has been drained annually in late winter or spring for nearly a century. Due to the shallow depths of the lake, limited inflow during the dry season, and the relatively warm summer air and water temperatures, it is presumed the lake would be too warm for successful rearing by juvenile steelhead through the summer. During winter and spring, however, out-migrating juvenile steelhead presumably use the filled lake to forage prior to ocean entry, similar to coastal estuaries (Smith 1990; Bond et al. 2008) or inundated agricultural floodplain habitats (Jeffres et al. 2008; Katz et al. 2017; Holmes et al. 2021).

In an attempt to assess the timing and abundance of smolts migrating through College Lake, a trap was installed immediately downstream of the existing weir between March 19 and April 21, 2011 (Podlech 2011). The intent was to operate the trap throughout the smolt outmigration season; however, the trap was operated only for 12 days due to limited access caused by significant flooding, followed by obvious signs of human tampering of the trap. Over the 12 days, a total of four age-1+ steelhead were captured, of which three were classified as smolts based on their coloration. The lengths of the three smolts were 159, 192, 200 mm fork length, and the fourth steelhead was 135 mm. Scales were collected from the four steelhead and analyzed to determine their age and growth rates. Scales from three of the fish indicated they grew well since their winter annulus (42, 109, and 113 mm), with two of the three fish showing exceptional growth rates. Scales collected from the fourth fish were unreadable. This data, although limited, indicates the lake has the potential to be an important, seasonal rearing habitat for migrating juvenile steelhead.

2.4.2.2. Casserly Creek

Casserly Creek supports a population of S-CCC steelhead. Smith (2007) notes that steelhead smolts and adults were present in Casserly Creek in 1981, 1983, 1992, and 1997. More recently, fall sampling of juvenile steelhead has been conducted at one site in Casserly Creek downstream of Mount Madonna Road, which is about 2.75 miles upstream of the lake (Alley 2018a; Podlech 2019b, Podlech 2021b). This site was recently added to an existing annual monitoring program of several sites in the Corralitos Creek subwatershed and other watersheds within Santa Cruz County. Based on fish densities observed at this site, the production of juvenile steelhead in Casserly Creek has either been consistent with (2017, 2019, and 2020) or substantially greater than (2016) the mean annual densities observed at all other sites in the Corralitos Creek subwatershed (Figure 6). In 2016 (below normal year) and 2017 (wet year), the average density of age-0+ fish represented 86 percent of all steelhead captured (Alley 2018a). In 2019 (wet year), age-0+ fish represented 83 percent of the catch, whereas in 2020 (dry year) age-0+ fish represented only 37 percent of the catch indicating the majority of the juvenile steelhead observed that year were hold over yearlings or older fish (Podlech 2019b, 2020). In 2021, steelhead densities were the lowest observed since monitoring began, however streamflow at the time of sampling was intermittent and reduced to isolated pools (Podlech 2021b).

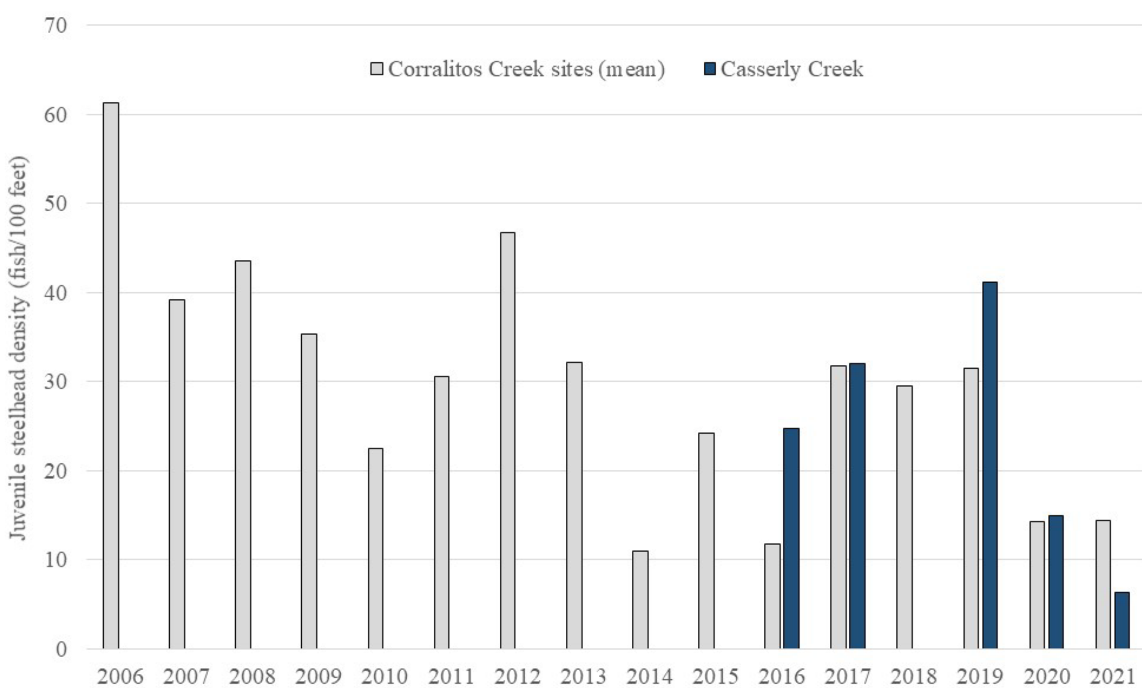


Figure 6. Mean annual juvenile steelhead densities across multiples sites in the Corralitos Creek subwatershed 2006-2021 (median # of sites = 8), and densities observed at the Casserly Creek sample site in 2016-17 and 2019-2021 (Alley 2018a; Podlech 2019b; Podlech 2020; Podlech 2021b).

2.4.2.3. Salsipuedes Creek and the Pajaro River

Salsipuedes Creek is considered a migratory corridor for steelhead to and from spawning habitat in upstream tributaries (i.e., Corralitos, Casserly creeks). However, Smith (2007) notes that adult steelhead have occasionally spawned in the lower-most reaches of Salsipuedes Creek (downstream of Highway 129), where the channel gradient is slightly steeper, the channel is more shaded, and surface flows are more consistent due to emerging groundwater. In June 1973 and 1978, a small number of juvenile steelhead fry were present in Salsipuedes Creek downstream of Highway 129, but were absent later in September of both years. Sampling was conducted at this same site in June of 1974, 1975, 1981, 1982, 1986, 1988, 1991, 1992, and 1995, but no steelhead were observed. At a site upstream of Highway 129 and closer to the Corralitos Creek confluence, no steelhead were capture during summer sampling in any of the aforementioned years (Jerry Smith, personal communication, December 2020). Finally, no steelhead were observed during biological monitoring associated with dewatering and in-channel construction activities at approximately ten storm damage repairs sites throughout Salsipuedes Creek during the summer of 2018 (ESA 2022a).

Within the action area, the non-tidal portion of the Pajaro River does not support spawning or summer rearing habitat (Smith 1993a; Smith 2007). Summer rearing in the Pajaro River is limited by high water temperatures, high turbidity, poor/fine substrate, and low streamflow.

Monitoring of fishes in the Pajaro River lagoon has been limited. In 1991 and 1992, the lagoon was sampled in different months (May through November) using both beach seine and gillnets (Smith 1993a). Steelhead were only found in August of 1991, when three holdover hatchery-released smolts were captured by gillnets. No other steelhead were captured during those months/years. More recently, annual lagoon sampling has been conducted in fall since 2012 by D.W. Alley & Associates. The intent of this sampling is to document the presence, distribution and relative abundance of juvenile steelhead, tidewater goby, and other fish and wildlife as a permit condition for sandbar management activities conducted by the County of Santa Cruz Department of Public Works (Alley 2019). Sampling by beach seine occurs at multiple sites between the sandbar and the Thurwatcher Street Bridge. To date, no steelhead have been captured. The lack of steelhead during fall is not surprising. Smolts entering the lagoon in spring are able to pass through and enter the ocean, and age-0+ juveniles are largely unable to reach the Pajaro River prior to tributary surface flow disconnection. Hence, the Pajaro River lagoon is considered a winter through spring seasonal rearing and acclimation zone for emigrating steelhead smolts prior to ocean entry, and a migratory corridor to and from spawning habitat in the basin.

2.4.3. Previous ESA Section 7 Consultations in the Action Area

NMFS has completed five formal ESA section 7 consultations on actions within the Salsipuedes Creek and Pajaro River portions of the action area. These actions anticipated small amounts of incidental take that were unlikely to affect future S-CCC steelhead returns and all were found to not jeopardize the continued existence of the S-CCC steelhead DPS nor destroy or adversely modify its designated critical habitat. NMFS has also completed three informal ESA consultations for projects in the action area.

Fisheries research and monitoring efforts authorized by NMFS ESA Section 10(a)(1)(A) research and enhancement permits and section 4(d) limits or exceptions could occur in the action area. Currently, the County of Santa Cruz and their designated consultant perform fisheries research and monitoring in the action area including sites in Corralitos Creek and Casserly Creek. Other permitted entities for research and monitoring include CDFW and NOAA's Southwest Fisheries Science Center. However, research or monitoring by these two agencies that would involve take of S-CCC steelhead has not occurred in at least the past 10 years, and we are unaware of any planned research or monitoring activities in the action area. All research and monitoring activities are closely monitored by NMFS and require measures to minimize take. In addition, NMFS has analyzed these activities under section 7 and determined they would not jeopardize the S-CCC steelhead DPS nor adversely modify its designated critical habitat.

2.5. Effects of the Action

Under the ESA, "effects of the action" are all consequences to listed species or critical habitat that are caused by the proposed action, including the consequences of other activities that are caused by the proposed action (see 50 CFR 402.02). A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action (see 50 CFR 402.17). In our analysis, which describes the effects of the proposed action, we considered the factors set forth in 50 CFR 402.17(a) and (b).

The Project is expected to result in effects to steelhead and their critical habitat during construction as well as during future operation, maintenance, and monitoring activities. Construction activities expected to affect steelhead or their habitat include fish capture and relocation, dewatering, and conversion of wetland habitat to hardscape. Effects from operational activities include seasonal changes in water surface elevation in the lake, streamflow exiting the lake, and fish passage opportunities within the action area. Maintenance activities are expected to affect critical habitat during vegetation and sediment maintenance (i.e., removal), dewatering, reduction in invasive species, and potentially steelhead capture and relocation. Finally, monitoring activities will result in take of steelhead through the capture, handling, and tagging of steelhead.

2.5.1. Construction and Maintenance

2.5.1.1. <u>Fish Capture and Relocation</u>

Construction. Construction of the new weir and intake pump station is expected to require dewatering. To minimize or avoid impacts to steelhead, PV Water or its consultants will capture any steelhead within the impacted reach of the channel (approximately 250-300 feet) and relocate them to the nearest suitable habitat based on their life stage. Qualified biologists will use seines, dip-nets, and or backpack electrofishing to capture fish. Captured steelhead will be temporarily held and transported in containers with cool, clean, well-oxygenated water.

For construction of the weir and intake facilities, it is expected that farming in College Lake will continue until the proposed Project is fully constructed. As such, existing management practices (i.e, dewatering of the lake) will be implemented by RD 2049 until construction is complete and the Project is operational. In the event that RD 2049 does not wish to farm the lake the year of construction, PV Water will assume this task. To ensure there is sufficient time to complete in-channel construction during a single dry season, draining of the lake (i.e., dewatering) would begin as early as late April or early May, or after the last significant forecasted storm has passed. Juvenile steelhead are likely to be the predominant life stage present in the lake, with perhaps a small number of kelts. Data to accurately quantify the amount of steelhead expected in the lake during this time are not available. PV Water estimates no more than 200 juvenile steelhead will be present at the time of dewatering the lake for construction. This abundance of fish was derived from the maximum densities of steelhead observed in Casserly Creek during previous sampling (ESA 2022a). Finally, NMFS estimates, based on professional judgement, that up to 3 post-spawned steelhead adults (kelts), may be present in the lake at the time of dewatering.

Maintenance. Maintenance activities will include the inspection and repairs of weir, intake structure, or other project facilities, routine sediment and vegetation maintenance in the lake bed, and the management of invasive species. Maintenance will primarily consist of routine (or annual) activities, however there may also be unforeseen, or unexpected, maintenance needs that arise, such as the need for an urgent repair of one of the facilities.

To the greatest extent feasible, routine facility inspection/repair and vegetation and sediment management activities will be conducted during periods of low water in the lake (i.e., late summer and early fall) when steelhead are less likely to be present. After the lake is drawn down through proposed operations, qualified biologists will sample remnant shallow water habitat within lake for the collection and removal of invasive species and to assess for steelhead presence and relocation needs. At this time, water in the lake would be concentrated into the main ditch channels in the center of the lake. The number of steelhead present is expected to be low, however abundances can vary depending on the time of year and size of the affected area. NMFS expects no more than 100 juveniles and 1 kelt may be present. Any steelhead that are captured will be relocated to suitable habitats, unless it is deemed suitable to return them to the habitat from which they were collected (i.e., assuming no additional sediment or vegetation removal actions are necessary). Vegetation and sediment management activities would occur in areas of the lake already exposed from draw-down of the lake, or in remnant wetted areas (ditches) once the invasive species management activities are complete.

If unexpected maintenance actions are needed at one of the facilities earlier in the year that would require localized dewatering prior to the drawdown of the lake, the area would be isolated with block nets and attempts to capture and relocate species from the isolated area would be made prior to dewatering. The number of steelhead present is expected to be low, however abundances can vary depending on the time of year and size of the affected area. NMFS expects no more than 100 juveniles and 1 kelt may be present.

All fish capture and relocation activities pose a risk of injury or mortality to salmonids. Equipment or gear used to collect fish, whether passive (Hubert 1996) or active (Hayes *et al.* 1996), has some associated risk to fish, including stress, disease transmission, injury, or death. The amount of unintentional injury and mortality attributable to fish capture varies widely, depending on the methods used, the ambient conditions, and the expertise of the field crew. Since fish relocation activities would be conducted by qualified fisheries biologists that will follow agency guidelines and protective measures, effects to, and mortality of, steelhead during capture would be minimized or avoided.

Sites selected for relocating steelhead should have similar water quality as the capture sites and are expected to have adequate habitat available. In some instances, relocated fish may endure short-term stress from crowding at the relocation sites. Relocated fish may have to contend with other fish causing increased competition for available resources such as food and habitat area. Frequent responses to crowding by steelhead include emigration and reduced growth rates (Keeley 2003). Some of the fish released at the relocation sites may choose not to remain in these areas and move to areas that have more vacant habitat and a lower density of steelhead. These types of movements (both upstream and downstream) have been demonstrated by rescued steelhead in other nearby watersheds (Haley Ohms, NMFS SWFSC, personal communication, 2021). As each fish moves, competition remains either localized to a small area or quickly diminishes as fish disperse.

Relocation, or release, sites will be determined at the time of implementation and will consider existing habitat conditions available and the age classes of fish. Depending on the season, steelhead smolts and adults may be relocated to the nearest suitable habitat downstream of the lake where they can volitionally continue their downstream migrations. Juvenile steelhead, such as small parr or fry, will likely be relocated to perennial freshwater habitat upstream of the lake in either Casserly or Corralitos creeks. NMFS does not expect impacts from increased competition would be large enough to impact the survival of individual salmonids based on the small area affected and the relatively small number of individuals likely to be relocated. Once construction activities are completed, juvenile steelhead will have the ability to return to the previously dewatered portion of the action area.

Implementing proposed avoidance and minimization measures is expected to reduce injury and mortality to steelhead during collection, handling, and transport to their release location. A qualified biologist, with experience in fish collection and transport methods, will lead all fish capture and relocation activities. NMFS estimates injury and mortality will not exceed 2 percent of the juvenile steelhead present during collection and relocation activities. If injury and mortality rates during capture and relocation reach maximum levels, then NMFS expects no more than following are expected to be injured or killed as a result of capture and relocation:

- 4 juvenile steelhead during construction;
- 2 juvenile steelhead during routine maintenance activities; and
- 2 juvenile steelhead during unexpected maintenance activities.

If present, NMFS does not expect adult steelhead will die as a result of capture or relocation activities. This expectation is based on the implementation of proposed minimization measures, and because of their size (high detection rate) and their durability while handling.

2.5.1.2. Dewatering

Construction. For construction of the weir and intake facilities, the site will be isolated by sheet pile cofferdams, a streamflow bypass system will be installed, and the channel area within sheet piles will be dewatered. Demolition of the existing weir and construction of the proposed weir would require dewatering of approximately 250-300 linear feet of the main drainage channel within the lakebed and Salsipuedes Creek downstream of the weir. Low summer inflows to

College Lake will be bypassed around the construction site. NMFS estimates no more than two percent of the total number of juvenile steelhead present, or up to four juvenile steelhead, will evade capture and relocation efforts and therefore be exposed to injury or mortality during dewatering for construction of the Project facilities.

Maintenance. For the invasive species management and routine maintenance activities, attempts to capture and relocated any steelhead from the lake will be made. While capture and relocation efforts are expected to encounter the vast majority of the any steelhead present, a small number, or no more than two juvenile steelhead, may evade collection and therefore be exposed to injury or mortality during maintenance activities. For unexpected maintenance activities that are expected to occur only once every five years, dewatering will occur at isolated areas surrounding the facilities as described in Section 1.3.4.1. While capture and relocation efforts are expected to encounter the vast majority of the any steelhead present, a small number, or no more than two juvenile steelhead, may evade collection and therefore be exposed to injury or mortality during maintenance activities.

A qualified biologist, with experience in designing and implementing water diversions and dewatering activities, will be on-site during dewatering operations to monitor placement of temporary cofferdams, capture and handle fish, and to oversee relocation to the nearest suitable habitat. NMFS anticipates only minor temporary changes to streamflow during the installation of the dewatering system. Once the cofferdams and bypass system are installed and operational, streamflow above and below the work areas should be the same as the pre-project conditions. Steelhead that avoid capture in the dewatered reach following relocation efforts may die due to desiccation, thermal stress, or by being crushed by equipment or foot traffic if not found by biologists while water levels within the reach recede. However, the number of steelhead that avoid capture is expected to be low because the habitat is highly simplified with a lack of cover.

After fish capture and relocation efforts, if injury and mortality rates during dewatering reach maximum levels, then NMFS expects no more than following are expected to be injured or killed:

- 4 juvenile steelhead during construction;
- 2 juvenile steelhead during routine maintenance activities; and
- 2 juvenile steelhead during unexpected maintenance activities.

Dewatering operations may affect steelhead by temporarily preventing juvenile salmonids from accessing the area for forage; and dewatering activities may affect the function of critical habitat by reducing forage for juveniles in the dewatered area. Benthic (i.e., bottom dwelling) aquatic macroinvertebrates (salmonid prey) within the dewatered reach will be lost when the lake and channel is dewatered (Cushman 1985). However, effects to aquatic macroinvertebrates resulting from diversions and dewatering will be temporary and rapid recolonization (typically one to two months) of disturbed areas by macroinvertebrates is expected following channel rewatering (Cushman 1985; Thomas 1985; Harvey 1986; Katz et al. 2017). In addition, the loss of macroinvertebrate is not likely to affect steelhead because few, if any, steelhead are expected to occur within the channels of the action area immediately downstream of the dewatered reach. In addition, the fine sediments of the channel typically do not support invertebrate taxa that represent common prey for steelhead and therefore the brief disruption of flow through the ditch within the lake while installing the bypass would have negligible impacts on food abundance outside of the dewatered area.

The temporary loss of wetted habitat in the dewatered channel within the lakebed will not permanently impair the extent or function of designated critical habitat because habitat quality and extent at the site would be returned to pre-project conditions almost immediately after the dewatering system is removed and flow is returned, and because steelhead will no longer be expected in the action area until the lake refills. Based on the small area of impact and temporary nature of the activities, we anticipate the impacts to PBFs for rearing habitat will be minimal and restored quickly after the dewatering systems are removed.

2.5.1.3. Increased Mobilization of Sediment and Other Contaminants

Sediment. Construction and maintenance of Project facilities will result in disturbance to the bed and banks of the lake and creek channel due to equipment access for the installation and removal of dewatering systems, demolition and removal of the existing weir, and the construction of the proposed weir and intake pump station. These types of construction activities have been shown to result in temporary increases in turbidity and areas of channel sedimentation (reviewed in Furniss et al. 1991; Reeves et al. 1991; Spence et al. 1996).

Sediment can affect fish in a variety of ways. High concentrations of suspended sediment can disrupt normal feeding behavior and efficiency (Cordon and Kelley 1961; Bjornn et al. 1977; Berg and Northcote 1985), reduce growth rates (Crouse et al. 1981), and increase plasma cortisol levels (Servizi and Martens 1992). High and prolonged turbidity concentrations can reduce dissolved oxygen in the water column, result in reduced respiratory functions, reduce tolerance to diseases, and can also cause fish mortality (Sigler et al. 1984; Berg and Northcote 1985; Gregory and Northcote 1993; Velagic 1995; Waters 1995). Even small pulses of turbid water can cause salmonids to disperse from established territories (Waters 1995), which can displace fish into less suitable habitat. Increased sedimentation can fill pools thereby reducing the amount of potential cover and habitat available, and smother coarse substrate particles, which can impair macroinvertebrate composition and abundance (Sigler et al. 1984; Alexander and Hansen 1986).

Although the site will be dewatered and fish will be relocated prior to construction, disturbed soils in the construction area may become mobilized when the site is re-watered following construction and during the initial refilling of the lakebed during the wet season. NMFS anticipates these activities could affect steelhead and their critical habitat in the action area in the form of small, short-term increases in turbidity during the first winter storms post-construction. However, distinguishing any increases in turbidity from these isolated disturbances during construction from the overall turbidity originating from the entirety of the Casserly Creek watershed will be difficult and likely inconsequential. NMFS expects any increases in turbidity from the construction activities will be small, temporary in nature, and not expected to reach levels that would adversely affect the survival or migration of steelhead within the action area.

Similarly, sedimentation of the substrate within or nearby the construction site is unlikely to have a measurable impact on the physical habitat quality or the ability for that habitat to provide the primary biological features for steelhead. This is because the substrate within lake naturally consists of fine sediments, and not gravel and cobbles. The threat of smothering coarser substrate that would be used for spawning or that would support macroinvertebrate communities favored by drift feeding salmonids is not possible. As such, isolated areas of sedimentation from construction is not expected to reach a scale where the physical or biological features of critical habitat will be altered. Therefore, the ability of critical habitat to support listed species' conservation needs within the action area will be unchanged.

The College Lake Pipeline will be installed beneath Salsipuedes Creek using HDD methods. HDD has the potential to result in a frac-out, which is when drilling fluids (e.g., a bentonite clay and water slurry) are exposed to the surface of the creek bed. Such events could result in temporary impacts to turbidity and localized areas of sedimentation within the creek bed. These activities will be performed during the summer months when Salsipuedes Creek is not expected to support rearing of juvenile steelhead due to a lack of surface flow or high-water temperatures and turbidity (agricultural or urban return flows). Although a frac-out is not expected to occur, PV Water will prepare a Frac-Out Contingency Plan to address containment and site clean-up should an event occur. Because steelhead are not expected to be present at the location where the pipeline will cross Salsipuedes Creek a potential frac-out during installation of the pipeline beneath the creek will not expose steelhead to harm. The installation of the pipeline beneath Salsipuedes Creek will not change the creek channel morphology and therefore this activity will not alter the PFBs of critical habitat for steelhead migration.

Other Contaminants. Construction and periodic maintenance activities in, over, and near surface water have the potential to release debris, hydrocarbons, concrete/cement, and similar contaminants into surface waters. Potential contaminants that could result from projects like these include wet and dry concrete/cement debris, fuel and lubricant for construction equipment, and various construction materials. If introduced into the aquatic habitats, debris could impair water quality by altering the pH, reducing oxygen concentrations as the debris decompose, or by introducing toxic materials such as hydrocarbons or metals into the aquatic habitat. Oils and similar substances from construction equipment can contain a wide variety of polynuclear aromatic hydrocarbons (PAHs) and metals. PAHs can alter salmonid egg hatching rates and reduce egg survival as well as harm the benthic organisms that are a salmonid food source (Eisler 2000).

The pouring of new concrete may negatively affect water quality by increasing the pH of water in contact with uncured surfaces. The degree to which the curing cement will affect pH of the water decreases over time as the concrete cures. However, during the curing period, the potential changes in pH of water in contact with the curing cement can harm fish through damage to their gills, eyes, and skin, and interfere with a fishes' ability to dispose of metabolic wastes (ammonia) through their gills (Washington Department of Fish and Wildlife 2009).

NMFS does not expect curing concrete at the weir and intake pump station facility will adversely affect water quality or steelhead. The concrete will be poured in a dry environment, and PV Water will allow the concrete to fully cure prior to re-watering the site. Once the lake is full during the following winter, the large amount of water that will come into contact with the concrete is expected to dampen any potential alterations to pH to immeasurable differences due to volumetric dilution, even if steelhead are present while the cement is still precipitating minor amounts of alkali. Therefore, adverse effects to steelhead from new concrete are not expected to occur.

The use of heavy equipment and storage of materials is required for the construction of the proposed facilities. If not properly maintained and stored, contaminants (e.g., fuels, lubricants, hydraulic fluids, concrete) could be introduced into the water system where they can potentially result in temporarily impacts to habitat and harm to exposed steelhead. However, the project includes avoidance and minimization measures to address spills and prevent the introduction of construction debris and contaminants into the action area (ESA 2022a). Due to these measures, conveyance of toxic materials into the action area during project implementation and maintenance is not expected to occur and the potential for the project to degrade critical habitat and harm salmonids is improbable.

2.5.1.4. Underwater Sound

Construction of the weir structure and intake pump station (and potentially for unexpected maintenance actions) will require installation of temporary sheet piles for cofferdams at the upstream and downstream extent of the proposed dewatered reach/area. The sheet piles will be installed with a vibratory hammer.

Pile driving has been shown to have an adverse effect on fish as they react to sounds that are especially strong and/or have intermittent low-frequency sounds (Hastings et al. 1995; 1996; Shin 1995; Popper et al. 2006). Increases in underwater sound levels from pile installation can affect fish in several ways, ranging from alteration of their behavior (i.e., leaving an area), to physical injury (i.e., barotrauma), or mortality. This range of effects depends on several factors including the method of installation (i.e., impact or vibratory hammers), the type of pile (material and size), the distance and location of the fish relative to the pile, the depth of the water and surrounding substrate characteristics, the size and mass of the fish, and the fish's anatomical characteristics. Vibratory pile driving methods produces lower peak sound levels than percussive (impact hammer) pile driving and is often used as an alternative to impact pile driving to avoid or minimize impacts to listed species.

NMFS uses a dual metric acoustic criteria of 206 decibels (dB) referenced to one micropascal (re: 1 μPa) peak sound pressure level (SPL) for any single strike, and a daily cumulative sound exposure level (SEL) of 187 dB re: 1 μPa 2-sec for fish greater than or equal to 2 grams (186 dB for fish less than 2 grams). NMFS also uses a 150-dB root-mean-square pressure (RMS) threshold for sub-injury (i.e., behavioral responses) for fish. There are no established injury criteria for vibratory pile driving for listed species (Caltrans 2015).

Prior to the installation of the sheet piles, fish exclusion nets will be deployed approximately 50 feet upstream and downstream of the proposed dewatered reach. Once the nets are in place, any fish that are within the exclusion zone will be captured and relocated as described above. Therefore, steelhead are not expected to be present within 50 feet of the piles during sheet pile installation. After the sheet piles are in place, the isolated reach will be dewatered as described above. Considering the method of sheet pile installation, the relocation and exclusion of fish from the affected area, the shallow water in the affected area, and the high sound attenuation of soft lake bottom sediments, NMFS expects S-CCC steelhead will not be exposed to harmful underwater sound levels as a result of the Project.

2.5.1.5. Permanent Alteration of Wetland Habitat

The construction of the new weir and intake pumping station will result in permanent alteration of wetland habitat in the lake bed and Salsipuedes Creek channel. The new weir and intake pumping station will permanently covert approximately 0.28 acres of natural bottom habitat to hardscape, either concrete or rock (see Figure 5). Approximately half of this area consists of seasonally inundated wetland consisting of mixed emergent/ruderal areas, farmed wetland areas, and a small amount of riparian forest. The permanent conversion of approximately 0.10 percent of the 228-acre lake bed to hardscape is insignificant and not expected to appreciably diminish the availability or value of critical habitat for steelhead within the action area. As described below, the new weir and future operations will consistently inundate more of the lakebed thereby creating a greater extent of rearing habitat in the lake relative to existing conditions.

2.5.1.6. Vegetation and Sediment Management

Vegetation and sediment removal from College Lake is needed to maintain storage capacity within the lake, and to maintain flow conveyance and fish passage. These maintenance activities would be conducted near the end of the dry season when the lake is drained, or with only shallow streamflow in the bottom of the lake's drainage ditches. Vegetation and sediment removal from areas of the lakebed would not harm steelhead as the lakebed would be dry. In some cases, the use of an excavator bucket or dragline to remove vegetation and or sediment from the drainage channels within the lakebed may be necessary. This will be conducted at a time when habitat conditions (shallow, warm streamflow) are not be expected to support juvenile steelhead, and following invasive species management (and potential steelhead relocation) actions. Therefore, steelhead are not expected to be present during implementation of these management activities.

Regarding impacts to critical habitat, NMFS expects the proposed maintenance activities within the lake will contribute to increases in turbidity and will limit vegetative cover in the lake when it refills. As water fills the lake and comes into contact with the disturbed soils of the lakebed, turbidity of the water column will initially increase. The general potential effects of increased turbidity or suspended sediment on fish are described in Section 2.5.1.3. NMFS expects any increases in turbidity from rewetting of disturbed sediments on the lake bed or drainage ditches will dissipate soon after the exposed sediments are wetted. After the initial wetting of the exposed sediments, turbidity levels within the lake are expected to decline from this initial increase but may persist due to other factors including wind mixing, turbid inflows, aquatic organisms such as carp feeding on the bottom (Casagrande 2010), and or organic sources. Katz et al. (2017) found that turbidity levels observed within flooded agricultural fields remained elevated due to the suspension of fine sediments during intentional flooding and afterwards during periods of strong wind that mixed the shallow water column. They also found that despite the higher turbidity, juvenile Chinook salmon grew rapidly, particularly those held within enclosures within disced fields.

The goal of the annual vegetation management is to limit the spread and colonization of woody vegetation (primarily willows) within the lakebed and its drainage channels. As noted above in Section 1.3.4.2, the Project does not propose to reduce established willow forest habitat, and the occurrence and extent of other emergent vegetation is already limited by existing farming operations and management. Therefore, the annual removal of young woody vegetation (e.g., willow saplings) and some emergent vegetation will not expose steelhead to new impacts, but will perpetuate the existing extent of vegetation. As demonstrated by Katz et al. (2017) and others, flooded agricultural fields with little or no vegetative cover can provide exceptionally productive seasonal rearing habitat for juvenile salmonids. Per the AMP, vegetation management will be evaluated to assess ways to improve habitat for fishes and other wildlife (e.g., waterfowl) while meeting flood control and water supply objectives. Therefore, any subsequent changes in vegetation management is expected to improve the quality of steelhead critical habitat in the lake.

Based on the above, NMFS does not expect the proposed maintenance activities will result in water quality conditions unlike those that occur under current conditions/operations. The initial filling of the lake will continue to serve as a temporary slack water and detention basin where some of the suspended material generated from upstream and within College Lake will be allowed to settle. Increases in suspended sediment from the proposed maintenance activities are expected to be temporary in nature and not expected to reach levels that would preclude juvenile steelhead from rearing within the lake, or affect their ability to migrate through the action area. Finally, the annual, or semi-annual, removal of early-successional stage vegetation is not expected to diminish the value of critical habitat in the lake or its ability to provide suitable rearing or migration habitat.

2.5.2. Operations

2.5.2.1. Changes in Streamflow and Fish Passage

Fish Passage out of College Lake. The Project will improve fish passage out of (downstream of) College Lake by replacing the existing weir that lacks fish passage facilities (Figure 5) with a new and adjustable weir equipped with a fish passage channel (Figure 2). Under existing operations, once pumping begins and the sandbags are placed on top of the existing weir, the downstream migration of steelhead smolts and kelts is terminated. The existing operations usually begin pumping by late March or early April, and therefore, the pumping operations combined with the impassable weir can prevent a considerable proportion of migrating steelhead from completing their downstream migration past the lake.

For the proposed operations, during periods of high streamflow, the new adjustable weir gate will be lowered and fully submerged, which will allow for unimpeded fish passage in both directions. Following the last large anticipated storm event of the season, the weir gate will be raised to 62.5 feet NAVD88, at which time steelhead adult and smolt passage past the weir will be provided through the fish ladder through May 31.

The proposed diversion intake at the weir structure will be equipped with a self-cleaning fish screen. The screen mesh size will be 1.75 mm with approach velocities of 0.33 feet per second, which meets NMFS' screen criteria for steelhead fry. Therefore, steelhead are not expected to be exposed to entrainment or impingement on the screen while the diversion is in operation.

Fish Passage in Salsipuedes Creek and the Pajaro River. The Project will, at times, result in reduced streamflow exiting College Lake into Salsipuedes Creek and the Pajaro River, with the most pronounced flow reductions occurring in spring and summer (ESA 2022a). The reduction in streamflow is largely due to the elimination of the artificial draining of the lake by RD 2049, but also due to the proposed diversions above the required bypass flow criteria. To ensure operations of the Project would not impact volitional steelhead passage, PV Water worked with NMFS and CDFW to develop bypass flows for adult and smolt passage between December 15 and May 31 (Table 2). Therefore, adherence to the bypass criteria is expected to prevent impacts to steelhead passage from the lake to the Pajaro River during operations.

The change in streamflow described above will also result in changes in streamflow in the lower Pajaro River downstream of the confluence with Salsipuedes Creek. As described above in Section 2.4.1, the lower Pajaro River from the confluence with Salsipuedes Creek downstream to the lagoon (approximately 2.3 river miles), flows in a confined, low-gradient channel with a sand/silt bottom and dense riparian vegetation. This stretch of the Pajaro River is considered a gaining reach, and therefore reductions in streamflow due to percolation in this reach are not expected (Behrens 2019). Streamflow from Salsipuedes Creek that enters the Pajaro River would join existing Pajaro River surface flow from the upper basin and emerging groundwater. Collectively, these flows are expected to maintain conditions for fish passage to the lagoon in the Pajaro River. ESA (2022a) used linear regression of modelled flows to assess the implications of the minimum bypass flows for steelhead passage in the Pajaro River downstream of the Salsipuedes Creek confluence. The analysis ($r^2 = 0.75$) indicated that the 21 cfs minimum adult bypass flow in Salsipuedes Creek corresponded to an estimated flow of 115 cfs (range is 29 to 144 cfs), and the 8 cfs minimum smolt bypass flow corresponded to an estimated flow of 38 cfs (range is 11 to 63 cfs) downstream of the confluence. Based on this analysis, the low flow channel characteristics in the river channel, and the fact that it is a gaining reach, the future implementation of the Project is expected to maintain streamflow conditions suitable for natural rates of steelhead migration in the lower Pajaro River to the lagoon. Therefore, migration PBFs of S-CCC steelhead critical habitat within the action area will not be diminished.

2.5.2.2. <u>Changes in Rearing Habitat in College Lake</u>

Late Fall through Spring. The proposed operations will increase the seasonal availability of rearing habitat in College Lake from late fall through spring. Under the proposed operations, the lake would remain full through at least May 31. The maximum water surface elevation in the lake would also increase from a maximum of 60.1 feet to 62.5 feet, thus inundating more area for longer periods of time relative to present conditions. As a result, the duration and extent of seasonal rearing habitat available to steelhead in the lake will increase, and in turn improve rearing PBFs of S-CCC steelhead critical habitat.

Previous studies of similar lentic habitats, such as coastal lagoons, on-channel ponds, and flooded agricultural fields, have demonstrated the potential for habitats like College Lake to offer exceptional growth opportunities for juvenile salmonids, particularly during winter and spring (Smith 1990; Bond et al. 2008; Jeffres et al. 2008; Podlech 2011; Katz et al. 2017; Holmes et al. 2021), while other studies have shown that increased size of juvenile salmonids at ocean entry greatly increases their marine survival (Holtby et al. 1989; Bond et al. 008). Therefore, if the growth of juvenile steelhead that utilize College Lake is similar to other studies, then the proposed increase in rearing habitat availability within College Lake is expected to improve their marine survival and future adult returns to the Pajaro River watershed (Bond et al. 2008; Osterback et al. 2014).

Summer and Early Fall. Beginning June 1, water would be diverted from storage in College Lake and bypass flow requirements for steelhead passage would end. Extended use of the lake by juvenile steelhead for rearing during summer and early fall is not anticipated (or will be very limited) based on: (1) reduced freshwater inflow and juvenile steelhead access into the lake; (2) the rapid growth of steelhead that use the lake; (3) water temperatures during the summer and early fall; and (4) the physical and hydrologic characteristics of the lake.

Juvenile steelhead that will utilize the lake will be yearlings (age-1) or older fish that enter the lake during storms in late fall, winter, or early spring. Recruitment of more recently emerged age-0 fish in spring and early summer is heavily restricted by low stream flows in Casserly Creek and its tributaries. While Casserly Creek maintains some level of streamflow connection with College Lake during summer—some or all of this being agricultural return flows depending on the water year—by late spring the low flows in the simplified, sandy bed channel limits, or excludes, passage opportunities for age-0 juvenile steelhead (Smith 2007; cbec 2014; ESA 2022a). Juvenile steelhead that enter the lake earlier in the wet season are expected to grow rapidly and leave, as studies have shown that larger juvenile steelhead tend to emigrate earlier than smaller cohorts (Shapovalov and Taft 1954; Smith 1993b; Smith 2022).

Smith (2010) suggested that water temperature conditions in College Lake would quickly deteriorate and become too warm for juvenile steelhead rearing by summer. Unfortunately, there is a lack of data from College Lake regarding seasonal water temperature dynamics prior to the initiation of the existing reclamation practices (i.e., pre-1920s). The limited available data from College Lake and those from an adjacent lake also suggest that water temperatures within College Lake will degrade (i.e., increase) rapidly in late spring and early summer as inflows decline and solar radiation of the shallow lake surface increases. ESA (2022a) notes that water temperature data collected by PV Water at the existing College Lake weir pump station regularly exceed 25℃ in summer, with maximums reaching 28-30℃. However, these are measurements taken in a drained lake. In addition, we reviewed available water temperature data from adjacent Pinto Lake as a surrogate. Pinto Lake has a smaller surface area, but is approximately 2 to 3 meters deeper than College Lake. Figure 7 shows seasonal water column profiles of temperature and dissolved oxygen measured in Pinto Lake by the City of Watsonville (City of Watsonville 2013; Stanfield 2013). Summer water temperatures in the upper 4.0 meters of the water column are greater than 20℃, with most of the water column at approximately 23℃ (Figure 7). Surface water temperatures reached 23℃ by June and as high as 25℃ by August (Figure 7). Because College Lake is shallow (maximum depth approximately 3.0 meters when full) water column stratification is not expected and temperatures measured at the surface are expected to extend to the bottom (i.e., similar to the top 3 meters of the Pinto Lake water column).

Other studies have demonstrated that volitional emigration of juvenile salmonids from flooded agricultural fields is influenced by hydrologic cues and site-specific habitat morphology. Holmes et al. (2021) found that flooded rice fields with an accessible flow inlet and outlet and with added drainage ditches not only enhanced the fish survival but also volitional migration of juvenile Chinook salmon from the fields. In these experiments, the juvenile Chinook salmon remained in the flooded fields long enough to grow rapidly and nearly triple their body mass but were allowed to leave volitionally. The Project will offer a similar setting where College Lake will have inflow from Casserly Creek, particularly during winter and spring, accessible outflow over or through the weir, and a network of ditches to facilitate drainage towards the weir.

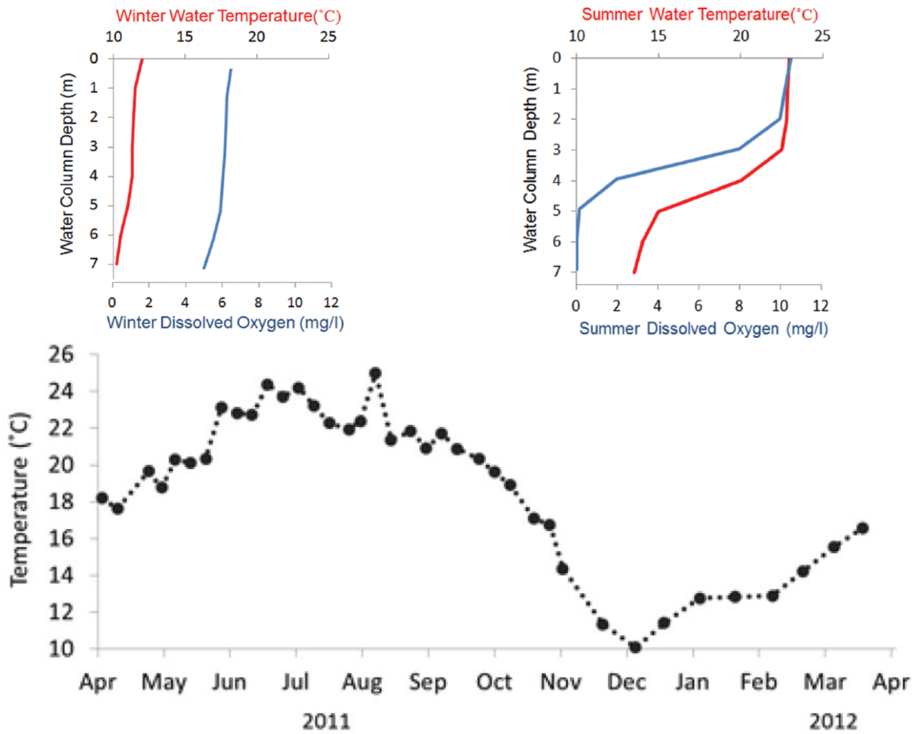


Figure 7. Water column temperatures and dissolved oxygen concentrations in winter and summer measured in Pinto Lake (top graphs), and surface temperatures measured in Pinto Lake (bottom graph) (Source: City of Watsonville 2013).

Any juvenile steelhead in the lake after May 31, when bypass flows would no longer be required, are expected to remain in the lake. Although there are no known physical impediments that would preclude juvenile steelhead from retreating upstream into Casserly Creek, as described above, streamflow in the downstream reaches of Casserly Creek in summer is limited and shallow, which would likely prevent fish passage out of the lake under most conditions. However, portions of the creek channel within the heavily forested area of the lake near the inlet support some deeper and more complex scour pools in the sandy channel that may offer some refuge. These reaches are well shaded and hold water in summer after the lake has largely been drained (Joel Casagrande, NMFS, personal observation, June 2017). Nonetheless, we assume that a small, but unquantifiable, number of juvenile steelhead may become trapped in the lake and injured or killed due to increased predation risk and or the gradually diminished habitat within the lake. However, as described earlier, analysis of the lake's hydrology (cbec 2014) suggests that prior to reclamation for agriculture, the natural summertime inflows were likely exceeded by rates of evaporation and evapotranspiration from the lake, and therefore some juvenile steelhead isolation and mortality in the lake likely occurred as a result of habitat quality decline. This suggests that under natural or unimpaired conditions, the use of College Lake later in spring or summer presented some risk to those individuals.

Regarding critical habitat, the proposed operations are not expected to appreciably alter summer rearing habitat availability as water quality and habitat conditions are not anticipated to be suitable for steelhead rearing even if the lake were left full and not reclaimed. In addition, the drawdown of the lake would not affect the food resources of steelhead downstream of the lake in Salsipuedes Creek, as Salsipuedes Creek does not support steelhead rearing during the dry season. Once the lake refills the following winter, the invertebrate community, particularly the zooplankton community, is expected to return quickly as has been demonstrated in both intentionally flooded agricultural settings and seasonally inundated floodplains (Sommer et al. 2001; Jeffres et al. 2008; Bellmore et al. 2013; Corline et al. 2017; Katz et al. 2017; Holmes et al. 2021). Therefore, the summer to early fall drawdown of the lake is not expected to prevent the lake from providing or maintaining the PBFs related to seasonal rearing habitat for steelhead in College Lake.

2.5.2.3. Changes in Habitat in Salsipuedes Creek and the Lower Pajaro River

Salsipuedes Creek and the lower Pajaro River are migratory corridors for steelhead smolts and adults. The seasonal reductions in streamflow caused by the Project are not expected to change the suitability of Salsipuedes Creek or the lower Pajaro River as rearing habitat for juvenile steelhead. Even with the current artificial pumping of College Lake, streamflow in Salsipuedes Creek during summer is very warm and turbid making it unsuitable for sustained juvenile steelhead rearing in summer. Similarly, the Pajaro River is too warm in summer and not deemed to be suitable rearing habitat during the dry season with or without the proposed Project. Therefore, the Project is not expected to alter rearing or migratory PBFs of S-CCC steelhead critical habitat in Salsipuedes Creek and lower Pajaro River.

2.5.2.4. Changes in the Pajaro River Lagoon

The Project will reduce the amount of freshwater inflow to the Pajaro River lagoon at certain times of the year. This will largely be the result of eliminating the artificial pumping of College Lake in late winter, spring and summer. The reduction in freshwater inflow is expected to have minor impacts on water quality, the timing of sandbar formation, and therefore the potential movement of steelhead between the lagoon and the ocean.

The timing and degree of a sandbar formation is strongly influenced by the amount of fresh and saltwater exchange through a river mouth (Smith 1990; Rich and Keller 2013; Behrens 2019). For most watersheds of the central California coast, sandbar formation generally occurs in late spring or early summer when freshwater inflow and ocean wave energy decline. This pattern occurs for both the Salinas and Carmel rivers to the south (Casagrande et al. 2003), and most other watersheds in Santa Cruz and San Mateo counties (Smith 1990; Hayes et al. 2008). Other natural factors that influence sandbar formation are beach shape, its orientation to prevailing littoral currents, and the morphological characteristics of the river/estuarine channel. As noted in Section 2.4.1, the Pajaro River is atypical in that the sandbar generally remains open during spring and most of the summer, and often closes later in summer, fall or with the first storm of the year (Smith 1993a; Habitat Restoration Group 1997; Alley 2020).

To assess the potential implications of the proposed Project operations on the timing of sandbar formation at the mouth of the Pajaro River, Behrens (2019) used a quantified conceptual model

(QCM) and available hydrologic data from the 2014-2017 water years. The results of the model suggested that the Project would have little effect on the timing of sandbar formation in wet, average, or dry water years, but could potentially cause the sandbar to form as much as 5-6 weeks earlier in below average water year due to the decline in spring freshwater inflow. The biggest contribution to reduced streamflow in spring as a result of the Project would be ending the artificial draining of the lake in late winter or spring, which can produce an additional 22 cfs of inflow to the lagoon for a period of up to 30 days. The QCM also concluded that the operation of the Project would not result in delays in the timing of sandbar breach events in any water year type (Behrens 2019).

With respect to the potential for early sandbar formation, Behrens (2019) notes that the results of the QCM must consider the limited spatial and temporal hydrologic data used as well as some level of uncertainty for other hydrologic inputs to the lagoon. Meanwhile, others have suggested that freshwater inflow is not be the primary influence for sandbar formation at the mouth of the Pajaro River (Smith 1993a; Habitat Restoration Group 1997). Smith (1993a), states that the orientation of the coastline surrounding the river mouth (southwest facing) relative to the littoral sand transport direction limits sand accumulation on the beach at the mouth of the river, and instead promotes the development of a long outflow channel towards the south. The opposite pattern is observed at the Salinas River mouth, where the coastline is oriented more to the northwest and captures sand from the littoral current much more efficiently. Photographs (Table 4; see also Figure 9 and Figure 10 in Appendix 6.2) of the Pajaro River mouth demonstrate the long outlet channel to the south at the mouth of the Pajaro River. Table 4 also includes the daily mean streamflow measured in the Pajaro River at two gages – Chittenden, a long-standing gage located several miles upstream of the Salsipuedes Creek confluence, and Watsonville, a recently installed gage located downstream of the Salsipuedes Creek confluence. The dates of the aerial photos cover a range of water year types, seasons, and the flow values from both gages provide an index of freshwater inflow to the lagoon. Collectively, these data show that the sandbar remained open during a wide range of streamflow conditions, including periods with river flows as low as 1.3 cfs (October 2009), 2.5 cfs (September 2020), and 3.1 cfs (August 2018). This suggests that low freshwater inflow does not necessarily result in a closed lagoon. However, the aforementioned low flow examples are during late summer or fall. If the pumping of the lake in late winter or early spring were to cease with the Project, it very well could result in a closure earlier than under the current artificial condition.

A seasonal reduction of freshwater to the Pajaro Lagoon may result in seasonal changes in water quality within the lagoon, particularly salinity. As described earlier, the vertical and longitudinal salinity patterns throughout the lagoon varies with the tides during periods when the sandbar is open. Because the sandbar is typically open later into the summer, freshwater inflow forms a relatively thin surface layer at the surface of the large lagoon with a thicker and an increasingly saline layer at depth (Smith 1993a; Habitat Restoration Group 1997; Alley 2020). A seasonal reduction in streamflow to the lagoon caused by the Project's operations, particularly in late winter and spring, is not expected to alter this predominant pattern when the mouth of the river is usually open, except for extreme drought years. However, if the sandbar were to form earlier during below average water years due to the Project, the lagoon would impound more freshwater over the extended closed lagoon period. In turn, this would result in a thicker freshwater layer within the lagoon, particularly in its upstream extents, which could improve rearing habitat for steelhead or other fishes. The early sandbar formation would end access to the ocean from the lagoon for steelhead smolts and or kelts. However, in these drier water year types, hydrologic connectivity between the tributary streams (where spawning and rearing occurs) and the lower Pajaro River would be limited to periods during or soon after storms capable of maintaining connections between these habitats. NMFS expects the number of steelhead exposed to an earlier closure will be small, or none, because bar closure would occur during the end of the possible migration window and after the tributary streams to the Pajaro River have either already disconnected or are at low impassable flows. If the sandbar were to form earlier than without the Project, this would represent a shift towards a more natural closure regime, where some proportion of the steelhead are forced to remain in the lagoon for the dry season. As mentioned above, water quality within the lagoon would be improved by early closure, such that sufficient freshwater would be present to support juvenile steelhead rearing and kelt holding until the sandbar opens. This typically occurs at lagoons throughout the California central coast, particularly during below average or dry water years.

Table 3. Pajaro Lagoon sandbar condition from photographs available at Google Earth and the California Coastal Records Project and daily mean streamflow at USGS gages 11590000 (Chittenden) and 11159500 (Watsonville). Gage 11159500 began operating on October 1, 2019.

Date	Sandbar Condition	Pajaro River at Chittenden (cfs)	Date	Sandbar Condition	Pajaro River at Chittenden (cfs)	Pajaro River at Watsonville (cfs)
1993-Jun-11	Open	22.0	2011-May-01	Open	145.0	
2002-Mar-16	Open	75.0	2011-Oct-31	Open	27.0	
2004-Jun-30	Open	11.0	2012-May-05	Open	71.0	
2004-Aug-16	Open	13.0	2013-Apr-15	Open	36.0	
2004-Sep-21	Open	6.2	2013-Oct-04	Closed	1.8	
2005-Oct-07	Open	17.0	2014-Feb-23	Closed	15.0	
2005-Oct-28	Open	22.0	2015-Mar-28	Closed	11.0	
2006-Apr-27	Open	300.0	2015-Sep-11	Closed	0.5	
2006-May-24	Open	100.0	2016-Apr-05	Open	65.0	
2006-Jun-25	Open	30.0	2016-Nov-02	Open	45.0	
2007-May-31	Open	19.0	2017-Sep-01	Open	20.0	
2007-Jul-29	Closed	8.0	2018-May-09	Open	41.0	
2008-Sep-23	Closed	1.8	2018-Aug-09	Open	3.1	
2008-Nov-12	Closed	2.5	2019-Oct-02	Open	3.2	1.5
2009-Mar-18	Open	65.0	2020-Jul-10	Open	10.0	3.2
2009-May-24	Open	14.0	2020-Aug-24	Open	4.6	1.5
2009-Sep-30	Open	1.5	2020-Sep-26	Open	2.5	1.0
2009-Oct-03	Open	1.3	2021-Sep-27	Closed	2.8	0.4
2010-Apr-24	Open	195.0				
2010-Sep-24	Open	18.0				

In summary, the Project is not expected to appreciably affect the timing of sandbar development or breaching under most conditions, and therefore water quality and habitat suitability for steelhead in the lagoon will remain largely unaffected. While the reduction of spring inflow to the lagoon may cause the sandbar to form earlier in some water year types, this outcome is not expected to result in adverse impacts to water quality or rearing habitat, as it would cause more freshwater to accumulate in the lagoon over a longer period. Therefore, NMFS expects the Project will not appreciably alter the PBFs for steelhead rearing habitat in the Pajaro River lagoon. Fish passage through the lagoon will not be affected by the Project. However, the potential for earlier sand formation in some years could restrict the passage of a small number of steelhead from entering the ocean and force them to remain in the lagoon until the following winter. NMFS does not expect this potential shift in sandbar formation timing in select water year types will appreciably affect the lagoon's ability to provide for the conservation and recovery of the S-CCC steelhead DPS.

2.5.3. Steelhead Monitoring

PV Water will implement a steelhead monitoring plan that will evaluate fish passage at the weir and through Salsipuedes Creek to the Pajaro River. The data from this monitoring will also provide information on the use of College Lake by steelhead, including information regarding their residency in the lake and growth rates for a period of 5 years. The monitoring will include the capture, handling, tagging, and release of juvenile steelhead (parr and smolt life stages) and potentially a small number of adults (post-spawned kelts). Methods for collection are expected to include backpack electrofishing and down-migrant trap (e.g., fyke trap).

Steelhead monitoring will occur at two general locations—sites in Casserly Creek or its tributaries upstream of College Lake[2], and (2) in Salsipuedes Creek immediately downstream of College Lake.

For the sites upstream of the lake, backpack electrofishing will be used to collect juvenile steelhead during summer or fall. We estimate no more than 468 juvenile steelhead will be captured, handled and released annually.[3] All captured steelhead will be measured to the nearest millimeter (fork length). A subset of captured juvenile steelhead (no more than 200 per year) ≥ 65 mm fork length may also be anesthetized, weighed, inserted with a PIT-tag, and some may have scales collected to verify age and growth rates. Section 2.5.1 summarizes the general impacts to steelhead from capture by active methods (e.g., electrofishing or seining). NMFS expects no more than two percent of the captured fish (or up to nine juvenile steelhead) will die as a result of being captured, handled, tagged, and released each year.

In addition, PV Water will use a fyke trap in Salsipuedes Creek below the weir to capture emigrating smolts and potentially kelts as they exit College Lake during late winter and spring. NMFS expects no more than 936 juvenile steelhead and 25 kelts[4] will be captured annually. Data for a full season of down-migrant trapping in College Lake do not exist as this activity has only previously been attempted at this location once and for no more than 12 days (Podlech 2011). While more steelhead may move through the lake during spring, the capture of up to 936 fish

[2] Creek sites will likely be in Casserly Creek, but may also include Green Valley Creek or other tributaries.
[3] For the annual estimate, NMFS considered the most recent maximum juvenile steelhead density from Casserly Creek (41 fish per 100 feet) with a 25 percent buffer added to account for potential annual variability in abundance (or 52 fish per 100 feet). Up to three sites will be sampled to ensure enough fish are collected, with each site being up to 300 feet in length.
[4] The estimate of 936 juveniles is based on a doubling of the expected juvenile abundance in the upstream habitats.

would be sufficient to address the data needs for evaluating the Project and to understand the ecology of steelhead use in the lake. To minimize the chance for take exceedance, trapping would occur only certain days each week throughout the late winter and spring periods. The estimate of 25 adult kelts was based on professional judgement and it accounts for variable precipitation and streamflow patterns which could affect their timing of outmigration. All captured steelhead will be handled for measurement and then scanned for an existing PIT-tag. A subset of captured steelhead (no more than 200 per year) ≥ 65 mm fork length may also be anesthetized, weighed, inserted with a PIT-tag, and sampled for scales.

Steelhead may be injured or killed in the trap from flow velocities or debris, and juveniles can be preyed upon by larger salmonids or other predators in the trap. Minimization measures such as frequent checking of traps by qualified biologist are expected to keep mortality to low levels. Traps will be checked in the morning when water temperatures are lower. Fish will only be released once they are fully recovered. In addition, sampling effort can be adjusted (i.e., trap not fished on certain days) to manage capture totals. With the implementation of these measures, we anticipate no more than two percent of the juvenile steelhead captured by trap will be injured or killed each year (or up to 28 juvenile fish annually). We expect no more than 1 adult steelhead will be injured or killed each year as a result of capture in the trap and post capture handling.

Implanting PIT-tags in juvenile salmonids requires a small surgical procedure including putting fish under anesthesia. The tag is inserted into the body cavity of the fish, immediately anterior of the pelvic girdle. Tagging will take place in the field under suitable ambient conditions, a carefully controlled environment for administering anesthesia, sanitary conditions, and a carefully regulated holding environment where the fish will be allowed to recover from the operation. For adults, anesthesia is not necessary, and the tag is inserted directly into the dorsal sinus cavity using a syringe while the fish is held in a large tote filled with water. PIT-tags implanted in fish of sufficient size have very little effect on their growth, mobility, mortality, or behavior (Prentice et al. 1987; Jenkins and Smith 1990; Prentice et al. 1990; Ombredane et al. 1998; Knudsen et al. 2009). To protect steelhead, individuals >100 mm can receive a 23 mm tag, and those between 65-99 mm can only receive a 12 mm tag. Implanting tags may only be conducted when water temperatures are 18°C or less.

The collection of scales entails using forceps or scraping with a dull knife to remove a small number of scales from above the fish's lateral line and posterior of its dorsal fin. There is very little risk of harm or mortality to juvenile salmonids during scale collection. However, excessive descaling can present a risk to juvenile salmonids because scales, along with associated dermal mucus, are important at protecting the integument of salmonids from abrasion and infection as they make their migrations through fresh and saltwater environments. To protect juvenile steelhead, scales may only be collected when water temperatures are below 21.0° C. Only steelhead that are in good condition and at least 65 mm FL will be sampled for scales. Only a small number of scales will be collected from each fish. With these measures, NMFS does not believe that scale collection will present any additional risk to fish beyond that associated with capture and handling.

In summary, Table 5 displays the annual maximum expected steelhead abundance and incidental mortalities for the various steelhead monitoring activities. For all five years of the proposed steelhead monitoring program, collection and tagging of juvenile steelhead in the upper Casserly Creek watershed will occur annually, whereas down-migrant trapping will only occur in three of the five years. NMFS expects qualified biologists using appropriate minimization measures will maintain incidental mortality to low levels. No more than 37 juvenile steelhead and 1 post-spawned adult are expected to die annually as a result of the steelhead monitoring (or up to 9 juvenile steelhead if only the fall upstream juvenile sampling occurs that year).

Table 4. The annual expected steelhead abundance and unintentional injury or mortality for each monitoring method and associated procedures.

Method (procedures)	Season	Life stage	Number of sites	Distance sampled (feet)	Density (# fish /100 feet)	Expected abundance[1]	Unintentional injury or mortality[2]
electrofishing (PIT-tag; scale collection)	summer-fall (annually)	juvenile	3	300	52	468 (200)	9
down-migrant trap (PIT-tag; scale collection)	spring (3 of 5 years)	juvenile				936 (200)	28
		adult				25 (25)	1
Total (PIT-tag; scale collection)		juvenile				1,400 (400)	37
		adult				25 (25)	1

[1] This is the expected abundance during each monitoring action.
[2] Individual fish that are unintentionally injured or killed are a portion of the fish incidentally taken.

Regarding critical habitat, all of the proposed monitoring activities (e.g., electrofishing, seining, trapping) are minimally intrusive with very little disturbance of creek channels or adjacent riparian zones. These activities will result in short duration foot traffic within isolated areas of the creek channel. The seasonal installation and operation of a trap will have minimal effects on the Salsipuedes Creek channel below the weir, and the channel form and function is expected to quickly return to pre-installation conditions after the removal of the trap. Therefore, none of the proposed monitoring activities will appreciably affect the critical habitat's PBFs for the conservation of the species.

2.6. Cumulative Effects

"Cumulative effects" are those effects of future State or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation [50 CFR 402.02]. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

NMFS does not anticipate any cumulative effects in the action area other than those ongoing actions already described in the Environmental Baseline above. Given current baseline conditions and trends, NMFS does not expect to see significant changes in habitat conditions in the near future due to existing land use and use of water in the action area. NMFS assumes the rate of such development and water use would be similar to that observed in the last decade.

Some continuing non-Federal activities are reasonably certain to contribute to climate effects within the action area. However, it is difficult if not impossible to distinguish between the action area's future environmental conditions caused by global climate change that are properly part of the environmental baseline vs. cumulative effects. Therefore, all relevant future climate-related environmental conditions in the action area are described earlier in the discussion of environmental baseline (Section 2.4).

2.7. Integration and Synthesis

The Integration and Synthesis section is the final step in assessing the risk that the proposed action poses to species and critical habitat. In this section, we add the effects of the action (Section 2.5) to the environmental baseline (Section 2.4) and the cumulative effects (Section 2.6), taking into account the status of the species and critical habitat (Section 2.2), to formulate the agency's biological opinion as to whether the proposed action is likely to: (1) reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing its numbers, reproduction, or distribution; or (2) appreciably diminish the value of designated or proposed critical habitat as a whole for the conservation of the species.

The Pajaro River is a Core 1 (highest priority) population for the recovery of the threatened S-CCC steelhead DPS (NMFS 2013). Although steelhead are present in most streams of the DPS (Good et al. 2005), their populations are significantly less than historical estimates and have become more fragmented, unstable, and vulnerable to stochastic events (Boughton et al. 2006). Most of the approximately 1,251 miles of critical habitat are degraded (70 FR 52488). Severe habitat degradation and the compromised genetic integrity of some populations pose a serious risk to the survival and recovery of the S-CCC steelhead DPS (Good et al. 2005), and therefore the DPS is likely to become endangered in the foreseeable future (Good et al. 2005; 76 FR 76386; Williams et al. 2016; 81 FR 33468).

Steelhead in the S-CCC DPS have declined in large part as a result of land use activities such as agriculture, mining, and urbanization activities which collectively have contributed to the loss, degradation, and fragmentation of habitat (NMFS 2013). Other anthropogenic influences have included the spread of diseases and invasive species, and increased predation rates. Presently, the greatest threats to the S-CCC steelhead DPS populations are the continued degradation of habitats, passage impediments, and both surface and groundwater use (NMFS 2013). Natural environmental variation (floods and droughts) have also periodically reduced or degraded spawning, rearing, and migratory habitats. The DPS has recently experienced one of the worst droughts on record (2012 to 2016), and in 2016 and 2020, several substantial wildfires (Soberanes, Carmel and Dolan fires) burned significant acreage in the Santa Lucia Mountain

Range. The threats from projected climate change, including changes in ocean productivity, are likely to exacerbate the effects of environmental variability on steelhead populations and their freshwater and estuarine habitats in the future. As a result, climate change is now recognized as a new and more serious threat to the recovery of the S-CCC steelhead DPS (Williams et al. 2016).

Based on its size, the Pajaro River is thought to have supported one of the largest steelhead runs in the S-CCC steelhead DPS. Estimates of steelhead adult returns for the entire Pajaro River Watershed (1,500 fish in 1964, 1,000 fish in 1965, and 2,000 fish in 1966) were reported in McEwan and Jackson (1996), but the methodology and data to produce the estimates were not described. Good et al. (2005) estimated the adult steelhead run size in the Pajaro River Watershed to be less than 500 individuals. The decline of steelhead throughout the DPS has been attributed to over-utilization of groundwater, floodplain development, and habitat loss, fragmentation and degradation (NMFS 2013).

The Project will result in both adverse and beneficial effects to S-CCC steelhead and their designated critical habitat. The purpose of the Project is to develop an alternative water supply option for PV Water that will reduce groundwater pumping and the advancement of seawater intrusion. For over 100 years, College Lake has been drained and farmed, which has disrupted steelhead rearing within and migration success through the lake. The Project has been designed, in part, to improve upon the conditions for these two long-standing threats to the steelhead population.

2.7.1. Summary of Effects on S-CCC Steelhead

The Project will result in adverse effects to steelhead during fish capture and relocation for construction and maintenance activities, as well as capture, handling, tagging, and release of steelhead during monitoring activities. NMFS expects the vast majority of encountered steelhead will experience only temporary and minor stress from capture, handling, and transport but will otherwise be unharmed, with only a small number of individuals (two percent or less of those encountered) expected to be injured or killed.

The future operations will largely benefit the conservation and recovery of steelhead in the Pajaro River watershed by allowing for expanded and more consistent use of College Lake for seasonal rearing, and by providing improved fish passage through the lake. The expanded use of College Lake for rearing will allow juvenile steelhead to take advantage of the lake's seasonal productivity, which is expected to enhance their growth rates and marine survival. The operations are also expected to result in the injury of loss of a small number of steelhead. After May 31, passage of steelhead downstream past the lake would not be possible based on the proposed operations. While NMFS expects most steelhead that entered the lake will have left by the end of May, a small amount that do not exit the lake before this date will be forced to stay in the lake or retreat upstream as the lake is gradually drawn down for water supply. If these fish are unable to find suitable refuge in the lake, migrate upstream of the lake, or get collected and relocated during the annual invasive species management surveys, they would be subjected to increased predation or exposure to poor water quality in the declining lake bed.

The potential loss of a small number of juvenile steelhead relative to the number of juveniles produced elsewhere in the watershed is not expected to appreciably diminish the abundance, productivity, diversity, or spatial structure of the Pajaro River steelhead population, nor the recovery potential of the S-CCC steelhead DPS as a whole.

2.7.2. Summary of Effects on Critical Habitat

Casserly Creek, Salsipuedes Creek, and the Pajaro River are designated critical habitat for the S-CCC steelhead DPS. Salsipuedes Creek and the Pajaro River provide PBFs for migration and seasonal rearing, while Casserly Creek provides PBFs for steelhead migration, spawning and seasonal rearing. Throughout the S-CCC steelhead DPS, critical habitat has been impacted by several factors including alterations to surface and groundwater resources, habitat loss or fragmentation due to dams, levees, and land use conversion, and from the introduction and spread of invasive species. Within the action area, the annual reclamation operations at College Lake have occurred for approximately 100 years with little or no regard for the impacts on the steelhead population or the habitat for which they depend. The existing weir is not equipped with fish passage facilities, and therefore once pumping of the lake begins, steelhead migration downstream of the weir is blocked. The proposed weir is will be equipped with passage facilities and the screened intake will ensure steelhead are not impinged or entrained and killed during pumping.

The Project's operations will also affect the hydrology of College Lake, Salsipuedes Creek, and the lower Pajaro River and in turn the PBFs they provide for migration and rearing. The proposed operations will result in seasonal reductions in streamflow within Salsipuedes Creek and the lower sections of the Pajaro River. This reduction is largely attributed to the elimination of the artificial pumping of College Lake during late winter and spring. PV Water has developed bypass flows in accordance with established protocols (Haas 2017) to ensure future operations will not inhibit natural rates of steelhead migration during the migration season (December 15 – May 31). PV Water will evaluate steelhead passage at the new weir and through Salsipuedes Creek and work with NMFS and other agencies to make adaptive changes as needed.

The proposed operations will increase the duration and quality of rearing habitat within College Lake each year. Based on data from College Lake and similar agricultural settings, the habitat provided in College Lake will be productive and provide a unique opportunity for juvenile steelhead to grow rapidly before entering the ocean.

The annual drawdown of College Lake in summer and early fall is not expected to affect rearing habitat quality in College Lake. NMFS expects temperatures throughout the water column of College Lake will be too warm in summer to sustain juvenile steelhead rearing, with or without the Project. Similarly, past monitoring for juvenile steelhead presence in Salsipuedes Creek and the Pajaro River downstream of College Lake has shown these waterbodies consistently do not support suitable rearing habitat during the dry season even with the artificially higher flows provided by the existing reclamation practices. Therefore, the reduction of streamflow in Salsipuedes Creek and the lower Pajaro River during the dry season is not expected to change the suitability of these habitats for rearing.

The construction and future maintenance activities will result in temporary impacts to the lakebed. With the use of minimization measures and considering their localized and temporary nature, the impacts of these activities are unlikely to impair the PBFs for steelhead critical habitat related to rearing and migration. In addition, the construction of the new weir will permanently convert approximately 0.28 acres of mostly earthen drainage ditch and bordering vegetation at the lake outlet to concrete and rock needed for the new weir facility. This, conservatively, equates to approximately 0.10 percent of the entire lake bed and is therefore will not appreciably diminish the value of critical habitat within College Lake or its ability to provide for the conservation of the S-CCC steelhead DPS.

Modeling of the Project's operations on the Pajaro Lagoon suggests there will be no impact on the timing of sandbar development or breaching during wet, average, and dry water years, but with potential earlier closure occurring during below average water years due primarily to the loss of artificially high streamflow from lake pumping. The loss of the artificially high flows in late winter or spring from pumping the lake dry is expected to restore a more normative inflow regime and in turn sandbar dynamics. In all, the Project is not expected to appreciably diminish the value of critical habitat for rearing or fish migration within the Pajaro Lagoon.

Finally, NMFS' recovery plan for the S-CCC steelhead DPS outlined multiple critical recovery actions for the Pajaro River population (NMFS 2013). These included the development and implementation of operating criteria for the management and protection of ground and surface water extractions to support the natural life history and habitat requirements of adult and juvenile steelhead, and the removal or modification of passage impediments to provide natural rates of migration for steelhead life stages. More specifically, the recovery plan identified action Paj-SCCCS-4.2 – "*develop and implement a water management plan for dam operations (e.g., Uvas Dam, College Lake).*" The proposed Project was designed to achieve multiple resource objectives, including the development of an alternative surface water supply, a reduction of groundwater overdraft within Pajaro Valley Groundwater Basin, and the improvement of steelhead rearing habitat availability and migration success.

2.7.3. Climate Change

Future climate change could affect S-CCC steelhead and their designated critical habitat within the action area. Some potential consequences of climate change in the Monterey Bay region are increases in both air and water temperatures, frequency of severe droughts, and changes in the timing and magnitude of storms, their runoff, and dry season streamflow. These projections further highlight the importance of providing suitable streamflow conditions for fish migration and rearing habitat in streams of the S-CCC steelhead DPS.

The Project will not influence the timing or magnitude of freshwater inflow to the lake, but will influence streamflow exiting the lake, particularly during the spring-fall periods. In the future, water that is stored in the lake may experience an earlier onset of warmer temperatures that could impact steelhead rearing habitat quality and perhaps their residency in the lake. However, as described above, juvenile steelhead that utilize College Lake are expected to grow quickly. Since larger juveniles tend to emigrate sooner (Shapovalov and Taft 1954), juveniles that utilize the lake for rearing are expected to have higher survival and therefore this setting may select for this life history strategy. Per the water right for this Project, diversions between December 15 and May 31 scan only occur if the minimum flow bypass criteria for steelhead migration are met. Therefore, with respect to the Project any reductions to streamflow in Casserly or Salsipuedes creeks caused by future climate change would affect water supply for PV Water before impacting steelhead migration. Finally, the minimum bypass flows for smolts and adult passage will be informed by the results of the proposed steelhead and hydrologic monitoring. If this monitoring shows that the bypass flows or weir facilities are inadequate to meet conditions for successful fish passage, then PV Water has agreed to work with NMFS and other resource agencies to develop actions through the AMP to improve upon these conditions. Therefore, any future adaptive actions are expected to provide some level of climate resiliency for S-CCC steelhead and their habitats.

2.8. Conclusion

After reviewing and analyzing the current status of the listed species and critical habitat, the environmental baseline within the action area, the effects of the proposed action, any effects of other activities caused by the proposed action, and cumulative effects, it is NMFS' biological opinion that the proposed action is not likely to jeopardize the continued existence of threatened S-CCC steelhead.

After reviewing and analyzing the current status of the critical habitat, the environmental baseline within the action area, the effects of the proposed action, the effects of other activities caused by the proposed action, and the cumulative effects, it is NMFS' biological opinion that the proposed action is not likely to destroy or adversely modify S-CCC steelhead designated critical habitat.

2.9. Incidental Take Statement

Section 9 of the ESA and Federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without a special exemption. "Take" is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. "Harm" is further defined by regulation to include significant habitat modification or degradation that actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding, or sheltering (50 CFR 222.102). "Harass" is further defined by interim guidance as to "create the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering." "Incidental take" is defined by regulation as takings that result from, but are not the purpose of, carrying out an otherwise lawful activity conducted by the Federal agency or applicant (50 CFR 402.02). Section 7(b)(4) and section 7(o)(2) provide that taking that is incidental to an otherwise lawful agency action is not considered to be prohibited taking under the ESA if that action is performed in compliance with the terms and conditions of this ITS.

2.9.1. Amount or Extent of Take

In the biological opinion, NMFS determined that take is reasonably certain to occur.

Table 6 summarizes the maximum anticipated take by Project activity, location, frequency and life stage. Some of the activities proposed may occur only once (e.g., construction), while others may occur annually as part of the operations and effectiveness monitoring activities. As such, the annual maximum number of steelhead captured and handled for Project activities will vary depending on the activities conducted that year. Capture and relocation for construction will occur only once, whereas operations (annual drawdown) will occur annually, and monitoring activities will vary by type. The expected amount of incidental take of S-CCC steelhead would be exceeded if the amount of fish collected, killed, or injured exceeds the values in Table 6.

In the biological opinion, we describe how the annual operations and drawdown of the lake is likely to cause a small, but unquantifiable, number of steelhead that remain in the lake after May 31 to be injured or killed due to increased risk of predation and declining habitat conditions over the summer and early fall period. NMFS believes the number of individuals trapped in the lake will be small because the habitat conditions in the lake during winter and spring coupled with the facilities and operations will allow for and encourage the vast majority of steelhead that access the lake to volitionally migrate downstream prior to the onset of poor water quality conditions in the lake. However, if monitoring reveals that the abundance of steelhead in the lake during summer is considerably higher than previously considered, then adverse effects and take may increase, and reinitiation of consultation may be needed. See Section 2.11 Reinitiation of Consultation below.

Table 5. Summary of annual expected abundance of steelhead (capture) and unintentional injury or mortality for each Project activity.

Activity	Location	Frequency	Season	Life Stage	Annual Expected Abundance[1]	Annual Unintentional Injury or Mortality[2]
Construction						
collection and dewatering	College Lake	once	late spring	Juvenile	200	8
				Adult	3	0
Routine maintenance and invasive species management						
collection and dewatering	College Lake	annually	summer-fall	juvenile	100	4
	College Lake			adult	1	0
Unexpected maintenance						
collection and dewatering	College Lake	1 in 5 years	any time	juvenile	100	4
	College Lake			adult	1	0
Steelhead monitoring						
backpack electrofisher[3]	watershed	Annually	summer-fall	juvenile	468	9
down-migrant trap	Salsipuedes Creek	3 in 5 years	late winter-spring	juvenile	936	28
				adult	25	1

[1] This is the expected abundance during each dewatering and fish relocation or monitoring event. The number of these events is given in the frequency column.
[2] Individual fish that are unintentionally injured or killed are a portion of the fish incidentally taken.
[3] Collection method may include, or be substituted for, seine nets.

In the biological opinion, we also describe the analyses conducted and protocols used to generate appropriate streamflow bypass levels for juvenile and adult steelhead through College Lake and Salsipuedes Creek. By following the outcomes of these analyses and protocols, the future operation of the Project is not expected to result in the injury or death of steelhead or impair their ability to successfully migrate. However, if monitoring reveals that the bypass flow targets utilized for Project operations are insufficient for successful steelhead migration (e.g., lower or shallower flows), then adverse effects may increase, take may occur, and reinitiation of consultation may be needed. See Section 2.11 Reinitiation of Consultation below.

2.9.2. Effect of the Take

In the biological opinion, NMFS determined that the amount or extent of anticipated take, coupled with other effects of the proposed action, is not likely to result in jeopardy to the species, or the destruction or adverse modification of critical habitat.

2.9.3. Reasonable and Prudent Measures

"Reasonable and prudent measures" are measures that are necessary or appropriate to minimize the impact of the amount or extent of incidental take (50 CFR 402.02).

NMFS believes the following reasonable and prudent measures are necessary and appropriate to minimize take of S-CCC steelhead:

1. Undertake measures to ensure that injury and mortality to steelhead resulting from Project activities is low.
2. Undertake measures to minimize harm on steelhead resulting from Project related impacts to their habitats.
3. Prepare and submit annual reports to describe the status and effects of construction, as well as annual operations, maintenance and monitoring activities.

2.9.4. Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the ESA, the Federal action agency must comply (or must ensure that any applicant complies) with the following terms and conditions. The Corps or PV Water has a continuing duty to monitor the impacts of incidental take and must report the progress of the action and its impact on the species as specified in this ITS (50 CFR 402.14). If the entity to whom a term and condition is directed does not comply with the following terms and conditions, protective coverage for the proposed action would likely lapse.

1. The following terms and conditions implement reasonable and prudent measure 1:

   a. The Corps or PV Water will retain a qualified biologist, or biologists, with expertise in the areas of anadromous salmonid/habitat relationships and experience monitoring and handling salmonids using the methods outlined in the Biological Opinion. The Corps or PV Water will ensure that all biologists working on the Project are qualified to conduct fish collection and handling in a manner that minimizes potential risks to steelhead. All electrofishing will be performed in accordance with NMFS' Guidelines for Electrofishing Waters Containing Salmonids Listed under the Endangered Species Act, June 2000.[5]

   b. The biologist(s) will monitor the construction site during all construction related activities that have potential to affect steelhead. This will include any capture and

[5] https://media.fisheries.noaa.gov/dam-migration/electro2000.pdf

relocation activities, dewatering activities, and sediment and vegetation removal from habitats where steelhead may be present. The biologist(s) will be responsible for handling and, as necessary, relocating steelhead to a predetermined location(s), approved by NMFS. The Corps, PV Water, or their consulting biologists will notify NMFS biologist Joel Casagrande via email at joel.casagrande@noaa.gov or via phone at 707-575-6016 at least one week prior to any capture activities in order to provide an opportunity for NMFS staff to be observe the activities and approve the proposed relocation sites.

c. Steelhead will be handled with extreme care and kept in water to the maximum extent during capture/relocation and monitoring activities. All captured steelhead will be kept in cool, shaded, aerated water protected from noise, jostling, or overcrowding any time they are not in the stream or lake. Steelhead will remain in this water unless being measured, tagged, or released. To avoid predation and to minimize crowding, the biologist(s) will have at least two containers, or live cars, and will segregate smaller steelhead from larger steelhead. Captured steelhead will be returned to the habitat they were collected from (monitoring) or relocated to the nearest appropriate habitat as soon as possible (construction and maintenance). Relocation sites should be similar in nature and must have sufficient habitat space to accommodate the relocated steelhead as well as any existing steelhead present.

d. If any steelhead are found dead or injured, the biologist(s) will contact NMFS biologist, Joel Casagrande, per the above contact information. The purpose of the contact is to review the activities resulting in take, determine if additional protective measures are required, and to ensure appropriate collection and transfer of steelhead mortalities and tissue samples. All steelhead mortalities will be retained. Tissue samples are to be collected from each steelhead mortality per the methods identified in the NMFS Southwest Fisheries Science Center Genetic Repository Protocols (contact the above NMFS staff for directions) and sent to: NOAA Coastal California Genetic Repository; Southwest Fisheries Science Center; 110 McAllister Way; Santa Cruz, California 95060.

e. At least 30 days prior to commencement, an updated fish capture and relocation plan and an updated channel dewatering and flow diversion plan will be sent to the above NMFS contact for review and approval.

2. The following terms and conditions implement reasonable and prudent measure 2:

a. PV Water will allow any NMFS employee(s) or any other person(s) designated by NMFS, to accompany field personnel to visit the Project sites/facilities during any of the activities described in this opinion.

b. Any pumps used to divert live streamflow around planned dewatered work areas will be screened and maintained in good working order at all times. The screening must comply with NMFS' Fish Screening Criteria (NMFS 2022).[6] All pumping must stop immediately should dead steelhead be found at the pump, and the NMFS biologist identified above will be contacted.

c. Vegetation removal will be limited to the minimum necessary to achieve Project goals.

d. Construction equipment used within the lake or Salsipuedes Creek channel will be checked each day prior to work and, as necessary, actions will be taken to prevent and treat all observed fluid leaks. If leaks occur during work, PV Water or their contractors will contain the spill and remove all affected soils per their spill prevention and response plan.

3. The following terms and conditions implement reasonable and prudent measure 3:

a. The Corps or PV Water must prepare and submit annual reports to NMFS for Project activities. The reports must be submitted electronically to NMFS biologist Joel Casagrande at joel.casagrande@noaa.gov by January 31 the following year. Reports prepared for compliance with other agency requirements that contain the information requested below would be acceptable.

i. Annual Construction, Dewatering, and Fish Relocation Reports

The report(s) must include summary descriptions and data regarding:

- dates construction began and was completed;
- methods and results of fish capture/relocation efforts;
- final disposition of all steelhead encountered;
- dewatering methods and activities employed;
- construction progress and, if applicable, what construction remains the following season;
- erosion control or other minimization measures implemented to protect water quality and habitats;
- unforeseen issues encountered during these activities and their potential impacts on steelhead or their habitat;
- steps taken to resolve unforeseen issues; and
- representative photos of dewatered sites, constructed facilities, and any fish exclusion methods.

ii. Hydrologic and Water Quality Monitoring Reports

The report(s) must include summary descriptions and data regarding:

- locations and methods for streamflow, lake elevation, and water quality data collection within the action area;

[6] https://media.fisheries.noaa.gov/2022-08/anadromous-salmonid-passage-design-manual-2022.pdf

- precipitation and streamflow gage data, and lake elevation data for the water year;
- direct measurements of streamflow used to validate recorded gage measurements or for establishing rating curves;
- a summary of bypass flow compliance; and
- water quality data collected by stationary sondes and periodic surface-to-depth profiles in College Lake, as well as tributary inflow sondes.

iii. Annual Maintenance Activity

The report(s) must include summary descriptions and data regarding:

- dates, locations, and type of maintenance activities performed;
- areas affected by the maintenance activities;
- presence and final disposition of any steelhead found and their final disposition;
- photos (representative) of the areas pre- and post-maintenance activities; and
- measures implemented to protect species and designated critical habitats.

iv. Annual Steelhead Monitoring

The report(s) must include summary descriptions and data regarding:

- steelhead monitoring activities implemented;
- numbers and life stages of steelhead capture and released;
- numbers and life stages of steelhead captured, tagged and or sampled for scales and released;
- numbers of steelhead injured or killed;
- PIT-tag detections, their date/time, and corresponding streamflow conditions in Salsipuedes Creek and Corralitos Creek
- results of scale analyses

2.10. Conservation Recommendations

Section 7(a)(1) of the ESA directs Federal agencies to use their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of the threatened and endangered species. Specifically, conservation recommendations are suggestions regarding discretionary measures to minimize or avoid adverse effects of a proposed action on listed species or critical habitat or regarding the development of information (50 CFR 402.02). NMFS offers the following conservation recommendation:

- NMFS encourages the Corps to work with PV Water and other partners to evaluate and, where appropriate and feasible, execute the purchase and retirement of agricultural lands along the lower Pajaro River Lagoon (including lower Watsonville Slough) where it is expected to become increasingly difficult to defend against the future effects of climate change and sea-level rise. The retirement of these lands from agricultural production and their subsequent return to natural habitats would provide some level of climate resiliency for surrounding infrastructure, allow space for estuarine habitat evolution to occur, and would ultimately reduce the demand of freshwater use in PV Water's coastal service area. Such actions could be implemented concurrently with other restoration or planned infrastructure projects (e.g., the Corps' proposed Pajaro River Flood Risk Management Project and the Watsonville Slough Ecosystem Restoration CAP 1135 Project).

2.11. Reinitiation of Consultation

This concludes formal consultation for the Reinitiation of the College Lake Integrated Resources Management Project.

Under 50 CFR 402.16(a): "Reinitiation of consultation is required and shall be requested by the Federal agency or by the Service where discretionary Federal agency involvement or control over the action has been retained or is authorized by law and: (1) If the amount or extent of taking specified in the incidental take statement is exceeded; (2) If new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not previously considered; (3) If the identified action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in the biological opinion or written concurrence; or (4) If a new species is listed or critical habitat designated that may be affected by the identified action."

For example, reinitiation of consultation may be necessary if:

- The operation of the Project's facilities, including the weir and fish passage gallery, do not perform (i.e., provide adequate fish passage or bypass releases) as intended or described in the above opinion, or
- Hydrological and or biological monitoring reveals that the bypass flows as described in the above opinion do not provide adequate steelhead passage conditions. This would include streamflow connectivity from College Lake to the Pajaro River that is of sufficient magnitude and depth across all riffles.

3. MAGNUSON–STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT ESSENTIAL FISH HABITAT RESPONSE

Section 305(b) of the MSA directs Federal agencies to consult with NMFS on all actions or proposed actions that may adversely affect EFH. Under the MSA, this consultation is intended to promote the conservation of EFH as necessary to support sustainable fisheries and the managed species' contribution to a healthy ecosystem. For the purposes of the MSA, EFH means "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity", and includes the physical, biological, and chemical properties that are used by fish (50 CFR 600.10). Adverse effect means any impact that reduces quality or quantity of EFH, and may include direct or indirect physical, chemical, or biological alteration of the waters or substrate and loss of (or injury to) benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality or quantity of EFH. Adverse effects on EFH may result from actions occurring within EFH or outside of it and may include site-specific or EFH-wide impacts, including individual, cumulative, or synergistic consequences of actions

(50 CFR 600.810). Section 305(b) of the MSA also requires NMFS to recommend measures that can be taken by the action agency to conserve EFH. Such recommendations may include measures to avoid, minimize, mitigate, or otherwise offset the adverse effects of the action on EFH [CFR 600.905(b)].

This analysis is based, in part, on the EFH assessment provided by the Corps and descriptions of EFH for Pacific Coast Groundfish and Coastal Pelagic Species contained in their fishery management plans (FMPs), which are developed by the Pacific Fisheries Management Council (PFMC) and approved by the Secretary of Commerce.

3.1. Essential Fish Habitat Affected by the Project

EFH managed under the Pacific Coast Groundfish FMP (PFMC 2022) and Coastal Pelagic Species FMP (PFMC 1998) may be adversely affected by the Project. EFH will not be impacted by construction, maintenance, or monitoring activities but is likely to be affected by changes in streamflow to the Pajaro River Lagoon (Pajaro Lagoon). The Pajaro Lagoon is known to support species managed under both FMPs (Smith 1993a; Alley 2018b; Alley 2019; Alley 2020). These include:

Pacific Coast Groundfish

- Cabezon (*Scorpaenichthys marmoratus*)
- English Sole (*Parophrys vetulus*)
- Starry Flounder (*Platichthys stellatus*)

Coastal Pelagic Species

- Jacksmelt (*Atherinopsis californiensis*)
- Northern Anchovy (*Engraulis mordax*)
- Pacific Herring (*Clupea pallasii pallasii*)
- Pacific Sardine (*Sardinops sagax*).

The boundary of EFH for the Pacific Coast Groundfish FMP is defined as all waters from the high-water line and the upriver extent of saltwater intrusion[7] in river mouths along the coast from Washington to California, including the Pajaro River. The boundary of EFH for the Coastal Pelagic Species FMP is defined as all marine and estuarine waters from the shoreline along the coasts of California, Oregon, and Washington offshore to the limits of the Exclusive Economic Zone and above the thermocline where sea surface temperatures range between 10°C to 26°C (PFMC 2019).

The Pajaro Lagoon, a type of estuary, is identified as a Habitat Area of Particular Concern (HAPC). HAPCs are considered high priority areas for conservation, management, or research because they are rare, sensitive, stressed by development, or important to ecosystem function. Although these habitats are particularly important for healthy fish populations, other EFH areas that provide suitable habitat functions are also necessary to support and maintain sustainable fisheries and a healthy ecosystem. The HAPC designation does not necessarily mean additional

[7] Defined as defined as upstream and landward to where ocean-derived salts measure less than 0.5 parts per thousand during the period of average annual low flow.

protections or restrictions upon an area, but they help to prioritize and focus conservation efforts. Federal projects that may adversely affect HAPC are more carefully scrutinized during the consultation process.

3.2. Adverse Effects on Essential Fish Habitat

NMFS determined the proposed action, specifically the operations and its impacts on streamflow to the Pajaro Lagoon, would adversely affect EFH for Pacific Coast Groundfish and Coastal Pelagic Species. Species that are managed under the both FMPs use the Pajaro Lagoon for foraging, shelter, and or reproduction. As described in the above biological opinion, the future operation of the Project is expected to reduce the amount of freshwater that enters the lagoon during certain times of year. The change in freshwater inflow to the Pajaro Lagoon may affect the timing and duration of sandbar closure in certain years, which would alter fish movements between the estuary and the ocean, and alter water column salinity dynamics. NMFS expects the sandbar at the mouth of the Pajaro River will remain predominantly in an open state despite the future operation. NMFS also expects that any changes to water quality within the lagoon due to the future operation of the Project will be minor. As described in the above opinion, the reduction in freshwater flow to the lagoon in late winter and spring will largely be attributed to the removal of artificial pumping and draining of College Lake. Collectively, these minor adverse effects are not expected to appreciably diminish the value of the lagoon or its habitat quality for species managed under the Pacific Coast Groundfish FMP or the Coastal Pelagic Species FMP.

3.3. Essential Fish Habitat Conservation Recommendations

Based on information developed in our effects analysis (see preceding biological opinion), NMFS has determined that the proposed action would adversely affect EFH for species managed under the Pacific Coast Groundfish and Coastal Pelagic Species FMPs. Although adverse effects are anticipated as a result of the Project, the proposed minimization and avoidance measures, and best management practices described in the accompanying biological opinion are sufficient to avoid, minimize, and/or mitigate for the anticipated effects. Therefore, no additional EFH Conservation Recommendations are necessary at this time that would otherwise offset the adverse effects to EFH.

3.4. Supplemental Consultation

The Corps must reinitiate EFH consultation with NMFS if the proposed action is substantially revised in a way that may adversely affect EFH, or if new information becomes available that affects the basis for NMFS' EFH Conservation Recommendations [50 CFR 600.920(l)]. This concludes the MSA portion of this consultation.

4. DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

The Data Quality Act (DQA) specifies three components contributing to the quality of a document. They are utility, integrity, and objectivity. This section of the opinion addresses these DQA components, documents compliance with the DQA, and certifies that this opinion has undergone pre-dissemination review.

4.1. Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. The intended users of this opinion are the Corps. Other interested users could include PV Water, State Parks, the California Department of Fish and Wildlife, the U.S. Fish and Wildlife Service, the Central Coast Regional Water Quality Control Board, and the public. Individual copies of this opinion were provided to the Corps and PV Water. The document will be available within 2 weeks at the NOAA Library Institutional Repository [https://repository.library.noaa.gov/welcome]. The format and naming adhere to conventional standards for style.

4.2. Integrity

This consultation was completed on a computer system managed by NMFS in accordance with relevant information technology security policies and standards set out in Appendix III, 'Security of Automated Information Resources,' Office of Management and Budget Circular A-130; the Computer Security Act; and the Government Information Security Reform Act.

4.3. Objectivity

Information Product Category: Natural Resource Plan

Standards: This consultation and supporting documents are clear, concise, complete, and unbiased; and were developed using commonly accepted scientific research methods. They adhere to published standards including the NMFS ESA Consultation Handbook, ESA regulations, 50 CFR 402.01 et seq., and the MSA implementing regulations regarding EFH, 50 CFR part 600.

Best Available Information: This consultation and supporting documents use the best available information, as referenced in the References section. The analyses in this opinion and EFH consultation contain more background on information sources and quality.

Referencing: All supporting materials, information, data and analyses are properly referenced, consistent with standard scientific referencing style.

Review Process: This consultation was drafted by NMFS staff with training in ESA and MSA implementation, and reviewed in accordance with West Coast Region ESA quality control and assurance processes.

5. REFERENCES

70 FR 52488. 2005. Endangered and threatened species; designation of critical habitat for seven evolutionarily significant units of Pacific salmon and steelhead in California. Federal Register 70:52488-52627.

71 FR 834. 2006. Endangered and threatened species: final listing determinations for 10 distinct population segments of West Coast steelhead. Federal Register 71:834-862.

81 FR 7214. 2016. Interagency Cooperation—Endangered Species Act of 1973, as Amended; Definition of Destruction or Adverse Modification of Critical Habitat. Federal Register 71:7214-225.

81 FR 7414. 2016. Listing Endangered and Threatened Species and Designating Critical Habitat; Implementing Changes to the Regulations for Designating Critical Habitat. Federal Register 81:7414-7440.

Abdul-Aziz, O.I., N.J. Mantua, and K.W. Myers. 2011. Potential climate change impacts on thermal habitats of Pacific salmon (*Oncorhynchus spp*.) in the North Pacific Ocean and adjacent seas. Canadian Journal of Fisheries and Aquatic Sciences 68(9):1660-1680.

Alexander, G.R., and E.A. Hansen. 1986. Sand bed load in a brook trout stream. North American Journal of Fisheries Management 6:9-23.

Alley, D.W. 2018a. 2017 Summary Report− Juvenile Steelhead Densities in the San Lorenzo, Soquel, Aptos and Pajaro Watersheds, Santa Cruz County, CA. Prepared for the Santa Cruz County Environmental Health Department. Project # 200-15a. 60 pages.

Alley, D.W. 2018b. Fishery and Water Quality Monitoring of Pajaro River Lagoon in 2018. (Sampling for Tidewater Goby under USFWS Endangered Species Recovery Permit TE-793645-4). Prepared for The Santa Cruz County Flood Control and Water Conservation District Zone 7.

Alley, D.W. 2019. Fishery and Water Quality Monitoring of Pajaro River Lagoon in 2019. (Sampling for Tidewater Goby under USFWS Endangered Species Recovery Permit TE-793645-4). Prepared for The Santa Cruz County Flood Control and Water Conservation District Zone 7.

Alley, D.W. 2020. Fishery and Water Quality Monitoring of Pajaro River Lagoon in 2020. (Sampling for Tidewater Goby under USFWS Endangered Species Recovery Permit TE-793645-4). Prepared for The Santa Cruz County Flood Control and Water Conservation District Zone 7.

Barnhart, R.A. 1986. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (Pacific Southwest), steelhead, United States Fish and Wildlife Service Biological Report 82 (11.60).

Beamish, R.J., editor. 2018. The ocean ecology of Pacific salmon and trout. American Fisheries Society, Bethesda, Maryland.

Behrens, D. 2019. Memorandum: Lagoon Quantified Conceptual Model Memorandum for Pajaro River Lagoon. Prepared for the Pajaro Valley Water Management Agency. Environmental Science Associates. 22 pages.

Bellmore, J.R., C.V. Baxter, K. Martens, and P.J. Connolly. 2013. The floodplain food web mosaic: a study of its importance to salmon and steelhead with implications for their recovery. Ecological Applications 23(1):189-207

Berg, L., and T.G. Northcote. 1985. Changes in territorial, gill-flaring, and feeding behavior in juvenile coho salmon (*Oncorhynchus kisutch*) following short-term pulses of suspended sediment. Canadian Journal of Fisheries and Aquatic Sciences 42:1410-1417.

Bjornn, T.C., M.A. Brusven, M.P. Molnau, J.H. Milligan, R.A. Klamt, E. Chacho, and C. Schaye. 1977. Transport of granitic sediment in streams and its effect on insects and fish. University of Idaho, Forest, Wildlife, and Range Experiment Station, Bulletin 17, Moscow, Idaho.

Bjornn, T.C., and D.W. Reiser. 1991. Habitat requirements of salmonids in streams. Pages 83-138 *in* W.R. Meehan, editor. Influences of Forest and Rangeland Management on Salmonid Fishes and Their Habitats. American Fisheries Society Special Publication 19. American Fisheries Society, Bethesda, Maryland.

Bond, M.H., S.A. Hayes, C.V. Hanson, and R.B. MacFarlane. 2008. Marine survival of steelhead (*Oncorhynchus mykiss*) enhanced by a seasonally closed estuary. Canadian Journal of Fisheries and Aquatic Sciences 65: 2242–2252.

Boughton, D.A., P.B. Adams, E. Anderson, C. Fusaro, E. Keller, E. Kelley, L. Lentsch, J. Nielsen, K. Perry, H. Regan, J. Smith, C. Swift, L. Thompson, and F. Watson. 2006. Steelhead of the South-Central/Southern California Coast: Population Characterization for Recovery Planning. NOAA Technical Memorandum NOAA-TM-NMFS-SWFSC-394. NOAA's National Marine Fisheries Service. Southwest Fisheries Science Center. Santa Cruz, California.

Boughton, D.A., P.B. Adams, E. Anderson, C. Fusaro, E. Keller, E. Kelley, L. Lentsch, J. Nielsen, K. Perry, H. Regan, J. Smith, C. Swift, L. Thompson, and F. Watson. 2007. Viability Criteria for Steelhead of the South-Central and Southern California Coast. NOAA Technical Memorandum NOAA-TM-NMFS-SWFSC-407. NOAA's National Marine Fisheries Service. Southwest Fisheries Science Center. Santa Cruz, California.

Boughton, D.A. 2017. Data Summary – Carmel River steelhead population 2013-2016. NOAA's National Marine Fisheries Service. Southwest Fisheries Science Center. Fisheries Ecology Division. Santa Cruz, California. October 2017. 17 pages.

Brewer, P.G., and J. Barry. 2008. Rising Acidity in the Ocean: The Other CO_2 Problem. Scientific American. October 7, 2008.

Brinkmann, M., D. Montgomery, S. Selinger, J.G.P. Miller, E. Stock, A.J. Alcaraz, J.K. Challis, L. Weber, D. Janz, M. Hecker, and S. Wiseman. 2022. Acute Toxicity of the Tire Rubber-Derived Chemical 6PPD-quinone to Four Fishes of Commercial, Cultural, and Ecological Importance. Environmental Science and Technology Letters 9(4):333-338.

Busby, P.J., T.C. Wainwright, G.J. Bryant, L.J. Lierheimer, R.S. Waples, F.W. Waknitz, and I.V. Largomarsino. 1996. Status review of West Coast steelhead from Washington, Idaho, Oregon, and California. National Marine Fisheries Service, Northwest Fisheries Sceince Center and Southwest Region Protected Resources Division, NOAA Technical Memorandum, NMFS-NWFSC-27.

CDFG (California Department of Fish and Game). 1965. California fish and wildlife plan, Volume I: Summary. 110 p.; Volume II: Fish and Wildlife Plans, 216 p.; Volume III: Supporting Data, 1802 p., available from California Department of Fish and Game, 1416 Ninth St., Sacramento, CA 95814.

Casagrande, J.M. 2017. Uvas Creek Juvenile Steelhead Distribution and Abundance and Adult Observations, 2015. Prepared for the California Department of Fish and Wildlife and the National Marine Fisheries Service. 5 January 2017. 35 p.

Casagrande, J.R. 2010. Aquatic ecology of San Felipe Lake, San Benito County, California. Master’s Thesis. San José State University. 144 pages.

Casagrande, J., and F. Watson. 2003. Hydrology and water quality of the Carmel and Salinas Lagoons, Monterey Bay, California 2002/2003. Report to the Monterey County Water Resources Agency. The Watershed Institute, California State University Monterey Bay, Seaside, California. Report No. WI-2003-14. 128 pages.

Cayan, D., M. Tyree, and S. Iacobellis. 2012. Climate Change Scenarios for the San Francisco Region. Prepared for California Energy Commission. Publication number: CEC-500-2012-042. Scripps Institution of Oceanography, University of California, San Diego.

cbec. 2014. College Lake Multi-Objective Management Project Final Report. Prepared for the Resource Conservation District Santa Cruz County. November 14, 2014.

cbec. 2018. College Lake Integrated Resources Management Project: Hydrologic and Hydraulic Modeling Technical Memorandum. Prepared for Environmental Science Associates. November 2018. 86 pages.

cbec. 2020. College Lake Integrated Resources Management Project: Fishway Hydraulic Design Basis of Design Report and 60% Design Drawings. Prepared for the Pajaro Valley Water Management Agency. October 2020. 149 pages.

Chapman, D.W. 1988. Critical review of variables used to define effects of fines in redds of large salmonids. Transactions of the American Fisheries Society 117(1):1-21.

City of Watsonville. 2013. Pinto Lake Watershed. Implementation Strategies for Restoring Water Quality in Pinto Lake. March 2013. 29 pages.

Coble, D.W. 1961. Influence of water exchange and dissolved oxygen in redds on survival of steelhead trout embryos. Transactions of American Fisheries Society 90:469-474.

Cordone, A.J., and D.W. Kelly. 1961. The influences of inorganic sediment on the aquatic life of streams. California Fish and Game 47:189-228.

Corline, N.J., T. Sommer, C.A. Jeffres, and J. Katz. 2017. Zooplankton ecology and trophic resources for rearing native fish on an agricultural floodplain in the Yolo Bypass California, USA. Watershed Ecology and Management 25:533–545.

Crouse, M.R., C.A. Callahan, K.W. Malueg, and S.E. Dominguez. 1981. Effects of fine sediments on growth of juvenile coho salmon in laboratory streams. Transactions of the American Fisheries Society 110: 281-286.

Crozier L.G., M.M. McClure, T. Beechie, S.J. Bograd, D.A. Boughton, and M. Carr. 2019. Climate vulnerability assessment for Pacific salmon and steelhead in the California Current Large Marine Ecosystem. PLoS ONE 14(7): e0217711. https://doi.org/10.1371/journal.pone.0217711

Cushman, R.M. 1985. Review of ecological effects of rapidly varying flows downstream from hydroelectric facilities. North American Journal of Fisheries Management 5:330-339.

Dalrymple, R.A., L.C. Breaker, B.A. Brooks, D.R. Cayan, G.B. Griggs, W. Han, B.P. Horton, C.L. Hulbe, J.C. Mcwilliams, P.W. Mote, W.T. Pfeffer, D.J. Reed, C.K. Shum, R.A. Holman, A.M. Linn, M. Mcconnell, C.R. Gibbs, and J.R. Ortego. 2012. Sea-level rise for the coasts of California, Oregon, and Washington: past, present, and future. National Research, Council. The National Academies Press, Washington DC.

Diffenbaugh N.S., D.L. Swain, and D. Touma. 2015. Anthropogenic warming has increased drought risk in California. Proceedings of the National Academy of Sciences 12(13):3931-3936.

Doney, S.C., M. Ruckelshaus, J. E. Duffy, J. P. Barry, F. Chan, C. A. English, H. M. Galindo, J. M. Grebmeier, A. B. Hollowed, N. Knowlton, J. Polovina, N. N. Rabalais, W. Sydeman, J., and L. D. Talley. 2012. Climate Change Impacts on Marine Ecosystems. Annual Review of Marine Science 4:11-37.

Eisler, R. 2000. Handbook of Chemical Risk Assessment: Health Hazards to Humans, Plants, and Animals. Volume 1, Metals. Lewis Press. Boca Raton, Florida.

ESA (Environmental Science Associates). 2020. College Lake Integrated Resources Management Project. Biological Assessment and Essential Fish Habitat Assessment. Prepared for the Pajaro Valley Water Management Agency. July 2020. 313 pages.

ESA (Environmental Science Associates). 2022a. College Lake Integrated Resources Management Project. Biological Assessment and Essential Fish Habitat Assessment. Prepared for the Pajaro Valley Water Management Agency. June 2022. 99 pages.

ESA (Environmental Science Associates). 2022b. College Lake Integrated Resources Management Project. Adaptive Management Plan 2022. Prepared for Pajaro Valley Water Management Agency. January 2022. 70 pages.

Everest, F.H., R.L. Beschta, J.C. Schrivener, K.V. Koski, J.R. Sedell, and C.J. Cederholm. 1987. Fine sediment and salmonid production: A paradox. Pages 98-142 *in* E.O. Salo and T.W. Cundy, editors. Streamside Management. Forestry and Fishery Interactions. University of Washington, Institute of Forest Resources. Contribution No. 57.

Feely, R.A., C.L. Sabine, K. Lee, W. Berelson, J. Kleypas, V.J. Fabry, F.J. Millero. 2004. Impact of anthropogenic CO_2 on the $CaCO_3$ system in the oceans. Science 305:362-366.

Feist, B.E., E.R. Buhle, D.H. Baldwin, J.A. Spromberg, S.E. Damm, J.W. Davis, and N.E. Scholz. 2018. Roads to Ruin: Conservation threats to sentinel species across an urban gradient. Ecological Applications 27(8):2382-2396.

French, B.F., D.H. Baldwin, J. Cameron, J. Prat, K. King, J.W. Davis, J.K. McIntyre, and N.L. Scholz. 2022. Urban Roadway Runoff Is Lethal to Juvenile Coho, Steelhead, and Chinook Salmonids, But Not Congeneric Sockeye. Environmental Science and Technology Letters 9(9):733-738.

Frölicher, T.L., E.M. Fischer, and N. Gruber. 2018. Marine heatwaves under global warming. Nature 560:360-377.

Fukushima, L., and E.W. Lesh. 1998. Adult and juvenile anadromous salmonid migration timing in California streams. California Fish and Game 84:133–145.

Furniss, M.J., T.D. Roelofs, and C.S. Lee. 1991. Road construction and maintenance. Pages 297-323 *in* W. R. Meehan, editor. Influences of Forest and Rangeland Management on Salmonid Fishes and Their Habitats. American Fisheries Society Special Publication 19. American Fisheries Society. Bethesda, Maryland.

Good, T.P., R.S. Waples, and P.B. Adams. 2005. Updated status of federally listed ESUs of West Coast salmon and steelhead. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-NWFSC-66.

Gregory, R.S., T.G. Northcote. 1993. Surface, Planktonic, and Benthic Foraging by Juvenile Chinook Salmon (*Oncorhynchus tshawytscha*) in Turbid Laboratory Conditions. Canadian Journal of Fisheries and Aquatic Sciences 50:233-240.

Haas, D. 2017. Standard Operating Procedure for Critical Riffle Analysis for Fish Passage in California. CDFW-IFP-001. California Department of Fish and Wildlife. Instream Flow Program, Sacramento, California. 25 pages.

Habitat Restoration Group. 1997. Fisheries Resources of the Lower Pajaro River and its Tributaries. Appendix G of the Revised Basin Management Plan Draft Environmental Impact Statement. Prepared for Environmental Science Associates. Habitat Restoration Group, Felton, California. 11 pages.

Harvey, B.C. 1986. Effects of suction gold dredging on fish and invertebrates in two California streams. North American Journal of Fisheries Management 6:401-409.

Hayes, D.B., C.P. Ferreri, and W.W. Taylor. 1996. Active fish capture methods. Pages 193-220 *in* B.R. Murphy and D.W. Willis, editors. Fisheries Techniques, 2nd edition. American Fisheries Society, Bethesda, Maryland.

Hayes, S.A., M.H. Bond, C.V. Hanson, E.V. Freund, J.J. Smith, E.C. Anderson, A.J. Amman, and R.B. MacFarlane. 2008. Steelhead Growth in a Small Central California Watershed: Upstream and Estuarine Rearing Patterns. Transactions of the American Fisheries Society 137:114–128.

Hayhoe, K., D. Cayan, C.B. Field, P.C. Frumhoff, E.P. Maurer, N.L. Miller, S.C. Moser, S.H. Schneider, K.N. Cahill, E.E. Cleland, L. Dale, R. Drapek, R.M. Hanemann, L.S. Kalkstein, J. Lenihan, C.K. Lunch, R.P. Neilson, S.C. Sheridan, and J.H. Verville. 2004. Emissions pathways, climate change, and impacts on California. Proceedings of the National Academy of Sciences of the United States of America 101(34):12422-12427.

Hokanson, K.E.F., C.F. Kleiner, and T.W. Thorslund. 1977. Effects of constant temperatures and diel temperature fluctuations on specific growth and mortality rates of juvenile rainbow trout, *Salmo gairdneri*. Journal of the Fisheries Research Board of Canada 34:639-648.

Holmes, E.J., P. Saffarina, A.L. Rypel, M.N. Bell-Tilock, J.V. Katz, and C.A. Jeffres. 2021. Reconciling fish and farms: Methods for managing California rice fields as salmon habitat. PLoS ONE. 16(2): e023768.

Hubert, W.A. 1996. Passive Capture Techniques. Pages 157-192 *in* B.R. Murphy and D.W. Willis, editors. Fisheries Techniques, 2nd edition. American Fisheries Society. Bethesda, Maryland.

Jeffres, C.A., J.J. Opperman, and P.B. Moyle. 2008. Ephemeral floodplain habitats provide best growth conditions for juvenile Chinook salmon in a California river. Environmental Biology of Fishes 83(4):449-458.

Jenkins, W.E. and T.I.J. Smith. 1990. Use of PIT tags to individually identify striped bass and red drum brood stocks. American Fisheries Society Symposium 7:341-345.

Kadir, T., L. Mazur, C. Milanes, K. Randles, and (editors). 2013. Indicators of Climate Change in California. California Environmental Protection Agency, Office of Environmental Health Hazard Assessment.

Katz, J.V.E., C. Jeffres, J.L. Conrad, T.R. Sommer, J. Martinez, S. Brumbaugh, N. Corline, and P.B. Moyle. 2017. Floodplain farm fields provide novel rearing habitat for Chinook salmon. PLoS ONE 12(6).

Keeley, E.R. 2003. An experimental analysis of self-thinning in juvenile steelhead trout. Oikos 102:543-550.

Knudsen, C.M., M.V. Johnston, S.L. Schroder, W.J. Bosch, D.E. Fast, and C.R. Strom. 2009. Effects of passive integrated transponder tags on smolt-to-adult recruit survival, growth, and behavior of hatchery spring Chinook salmon. North American Journal of Fisheries Management 29:658-669.

Lindley, S.T., R.S. Schick, E. Mora, P.B. Adams, J.J. Anderson, S. Greene, C. Hanson, B.P. May, D.R. McEwan, R.B. MacFarlane, C. Swanson, and J.G. Williams. 2007. Framework for assessing viability of threatened and endangered Chinook salmon and steelhead in the Sacramento-San Joaquin Basin. San Francisco Estuary and Watershed Science 5(1):26.

Martin, J.A. 1995. Food habits of some estuarine fishes in a small, seasonal central California lagoon. Master's Thesis. San José State University. 57 pages.

McClure, M.M., M. Alexander, D. Borggaard, D. Boughton, L. Crozier, R. Griffis, J.C. Jorgensen, S.T. Lindley, J. Nye, M.J. Rowland, E.E. Seney, A. Snover, C. Toole, and V. Anhk. 2013. Incorporating climate science in applications of the US endangered species act for aquatic species. Conservation Biology 27(6):1222-33.

McEwan, D., and T.A. Jackson. 1996. Steelhead restoration and management plan for California. California Department of Fish and Game, Inland Fisheries Division, Sacramento.

McIntyre, J.K., J.L. Lundin, J.R. Cameron, M.I. Chow, J.W. Davis, J.P. Incardona, and N.L. Scholz. 2018. Interspecies variation in the susceptibility of adult Pacific salmon to toxic urban stormwater runoff. Environmental Pollution 238:196-203.

Moser, S., J. Ekstrom, and G. Franco. 2012. Our Changing Climate 2012: Vulnerability & Adaptation to the Increasing Risks from Climate Change in California. A Summary Report on the Third Assessment from the California Climate Change Center.

Moyle, P.B. 2002. Inland fishes of California. University of California Press, Berekely and Los Angeles, California.

Myrick, C., and J.J. Cech, Jr. 2005. Effects of Temperature on the Growth, Food Consumption, and Thermal Tolerance of Age-0 Nimbus-Strain Steelhead. North American Journal of Aquaculture 67:324-330.

NMFS (National Marine Fisheries Service). 2013. South-Central California Coast Steelhead Recovery Plan, West Coast Region, California Coastal Area Office, Long Beach, California.

NMFS (National Marine Fisheries Service). 2016. 5-Year Review: Summary and Evaluation of South-Central California Coast Steelhead Distinct Population Segment. National Marine Fisheries Service. West Coast Region. California Coastal Office. Santa Rosa, California.

NMFS (National Marine Fisheries Service). 2022. NOAA Fisheries West Coast Region Anadromous Salmonid Passage Design Manual, NMFS, WCR, Portland, Oregon.

Ohms, H.A., and D.A. Boughton. 2019. Carmel River steelhead fishery report – 2019. Prepared for California-American Water Company. Prepared by NOAA National Marine Fisheries Service Southwest Fisheries Science Center and University of California Santa Cruz Institute of Marine Science. Santa Cruz, California. 44 pages.

Ombredane, D., J. Bagliniere, and F. Marchland. 1998. The effects of Passive Integrated Transponder tags on survival and growth of juvenile brown trout (*Salmo trutta L.*) and their use for studying movement in a small river. Hydrobiologia 372:99-106.

Osgood, K.E. 2008. Climate Impacts on U.S. Living Marine Resources: National Marine Fisheries Service Concerns, Activities and Needs. National Oceanic and Atmospheric Administration, National Marine Fisheries Service. NOAA Technical Memorandum NMFS-F/SPO-89.

Osterback, A.M.K., D.M. Frechette, S.A. Hayes, M.H. Bond, S.A. Shaffer, and J.W. Moore. 2014. Linking individual size and wild and hatchery ancestry to survival and predation risk of threatened steelhead (*Oncorhynchus mykiss*). Canadian Journal of Fisheries and Aquatic Sciences 71:1877-1887.

PFMC (Pacific Fishery Management Council). 1998. Description and identification of essential fish habitat for the Coastal Pelagic Species Fishery Management Plan. Appendix D to Amendment 8 to the Coastal Pelagic Species Fishery Management Plan. Pacific Fishery Management Council, Portland, Oregon.

PFMC (Pacific Fishery Management Council). 2022. Pacific Coast Groundfish Fishery Management Plan for the California, Oregon, and Washington Groundfish Fishery. August 2022. Pacific Fishery Management Council, Portland, Oregon.

Peter, K.T., Z. Tian, C. Wu, P. Lin, S. White, B. Du, J.K. McIntyre, N.L. Scholz, and E.P. Kolodziej. 2018. Using high-resolution mass spectrometry to identify organic contaminants linked to urban stormwater mortality syndrome in coho salmon. Environmental Science and Technology 52:10317-10327

Phillips, R.W., and H.J. Campbell. 1961. The embryonic survival of coho salmon and steelhead trout as influenced by some environmental conditions in gravel beds. Pages 60-73 in 14th annual report to Pacific Marine Fisheries Commission. Portland, Oregon.

Podlech, M. 2011. College Lake Smolt Outmigration Study, Spring 2011. Prepared for the Resources Conservation District of Santa Cruz County. 12 pages.

Podlech, M. 2019a. College Lake Integrated Resources Management Project. Fish Passage Assessment. Prepared for Environmental Science Associates. March 2019. 15 pages.

Podlech, M. 2019a. 2019 Juvenile steelhead densities in the Corralitos Creek and Casserly Creek Watersheds. Prepared for City of Watsonville and the Pajaro Valley Water Management Agency. 28 pages.

Podlech, M. 2020. 2020 Juvenile steelhead densities in the Corralitos Creek and Casserly Creek Watersheds. Prepared for City of Watsonville and the Pajaro Valley Water Management Agency. 30 pages.

Podlech, M. 2021. 2021a. Final Invasive Species Management Plan for College Lake Integrated Resources Management Project. Prepared for Pajaro Valley Water Management Agency. June 2021. 16 pages.

Podlech, M. 2021. 2021b. Juvenile steelhead densities in the Corralitos Creek and Casserly Creek Watersheds. Prepared for City of Watsonville and the Pajaro Valley Water Management Agency. 31 pages.

Podlech, M. 2022. Steelhead Monitoring Plan for College Lake Integrated Resources Management Project. Prepared for Pajaro Valley Water Management Agency. February 2022. 19 pages.

Prentice, E.F., T.A. Flagg, and C.S. McCutcheon. 1987. A study to determine the biological feasibility of a new fish tagging system, 1986-1987. Bonneville Power Administration, Portland, Oregon.

Prentice, E.F., T.A. Flagg, and C.S. McCutcheon. 1990. Feasibility of using implantable passive integrated transponder (PIT) tags in salmonids. American Fisheries Society Symposium 7: 317-322.

Reeves, G.H., J.D. Hall, T.D. Roelofs, T.L. Hickman, and C.O. Baker. 1991. Rehabilitating and modifying stream habitats. Pages 519-557 *in* W.R. Meehan, editor. Influences of Forest and Rangeland Management on Salmonid Fishes and their Habitats. American Fisheries Society Special Publication 19. American Fisheries Society. Bethesda, Maryland.

Reiser, D.W., and T.C. Bjornn. 1979. Habitat Requirements of Anadromous Salmonids. *In*: Meehan, W.R., Technical Editor. Influence of Forest and Rangeland Management on Anadromous Fish Habitat in the Western United States and Canada. United States Department of Agriculture, Forest Service GTR PNW-96. 54 pages.

Rich, A., and E.A. Keller. 2013. A hydrologic and geomorphic model of estuary breaching and closure. Geomorphology. 191:67-74.

Robinson, M.A. 1993. The distribution and abundance of benthic and epibenthic macroinvertebrates in a small, seasonal Central California Lagoon. Master's Thesis, San José State University. 77 pages.

Ruggiero, P., C.A. Brown, P.D. Komar, J.C. Allan, D.A. Reusser, H. Lee, S.S. Rumrill, P. Corcoran, H. Baron, H. Moritz, and J. Saarinen. 2010. Impacts of climate change on Oregon's coasts and estuaries. Pages 241-256 *in* K.D. Dellow and P.W. Mote, editors. Oregon Climate Assessment Report, College of Oceanic and Atmospheric Sciences, Oregon State University, Corvallis, Oregon.

Scavia, D., J.C. Field, B.F. Boesch, R.W. Buddemeier, V. Burkett, D.R. Cayan, M. Fogarty, M. A. Harwell, R.W. Howarth, C. Mason, D.J. Reed, T.C. Royer, A.H. Sallenger, and J.G. Titus. 2002. Climate change impacts on U.S. coastal and marine ecosystems. Estuaries 25(2):149-164.

Schneider, S.H. 2007. The unique risks to California from human-induced climate change. May 22, 2007. Environmental Protection Agency.

Scholz, N.L., M.S. Myers, S.G. McCarthy, J.S. Labenia, J.K. McIntyre, G.M. Ylitalo, L.D. Rhodes, C.A. Laetz, C.M. Stehr, B.L. French, B. McMillan, D. Wilson, L. Reed, K.D. Lynch, S. Damm, J.W. Davis, and T.K. Collier. 2011. Recurrent die-offs of adult coho salmon returning to spawn in Puget Sound lowland urban streams. PLoS One 6(12):e29013.

Servizi, J.A., and D.W. Martens. 1992. Sublethal responses of coho salmon (*Oncorhynchus kisutch*) to suspended sediments. Canadian Journal of Fisheries and Aquatic Sciences 49:1389-1395.

Shapovalov, L., and A.C. Taft. 1954. The life histories of the steelhead rainbow trout (*Salmo gairdneri gairdneri*) and silver salmon (*Oncorhynchus kisutch*) with special reference to Waddell Creek, California, and recommendations regarding their management. Fish Bulletin 98.

Shirvell, C. 1990. Role of instream rootwads as juvenile coho salmon (*Oncorhynchus kisutch*) and steelhead trout (*O. mykiss*) cover habitat under varying streamflows. Canadian Journal of Fisheries and Aquatic Sciences 47(5):852-861.

Sigler, J.W., T.C. Bjornn, and F.H. Everest. 1984. Effects of chronic turbidity on density and growth of steelheads and coho salmon. Transactions of the American Fisheries Society 113:142-150.

Simenstad, C.A., K.L. Fresh, and E.O. Salo. 1982. The role of Puget Sound and Washington coastal estuaries in the life history of Pacific salmon: an unappreciated function. Pages 343-364 *in* V.S. Kennedy, editor. Estuarine comparisons. Academic Press, New York.

Smith, J.J. 1990. The effects of sandbar formation and inflows on aquatic habitat and fish utilization in Pescadero, San Gregorio, Waddell, and Pomponio creek estuary/lagoon systems, 1985-1989. Prepared for California Department of Parks and Recreation. Report Interagency Agreement 84-04-324, San José State University.

Smith, J.J. 1993a. Pajaro River Lagoon Management Plan: Technical Appendix A: Aquatic Habitat and Fisheries. The Habitat Restoration Group. 17 pages.

Smith, J.J. 1993b. Drought effects on steelhead density, growth and potential smolt production. Presented at Western Division of the American Fisheries Society Conference. Sacramento, California, July 1993.

Smith, J.J. 2007. Steelhead distribution and ecology in the lower Pajaro River System (with reach descriptions and limiting factor identifications). Department of Biological Sciences, San José State University. 15 July 2007. 28 pages.

Smith, J.J. 2010. Fisheries Issues Associated with the Present and Potential Future Operation of the College Lake Complex (Pajaro River Watershed). Department of Biological Sciences, San José State University. 27 March 2008; revised 30 November 2010. 5 pages.

Smith, J.J. 2022. Pescadero Lagoon Fish Scales Analysis 2022. April, May, and June. Prepared for the California Department of Fish and Wildlife. 9 pages.

Sommer, T.R., M.L. Nobriga, W.C. Harrell, W. Batham, and W.J. Kimmerer. 2001. Floodplain rearing of juvenile chinook salmon: evidence of enhanced growth and survival. Canadian Journal of Fisheries and Aquatic Sciences 58:325-333.

Spence, B., G. Lomnicky, R. Hughes, and R. Novitzki. 1996. An ecosystem approach to salmonid conservation. TR-4501-96-6057. Technical Environmental Research Services Corp., Corvallis, Oregon. 356 pages.

Stanfield, E.R. 2013. Environmental Factors Associated with Toxic Cyanobacteria in Pinto Lake, a Coastal Lake in the Monterey Bay Area. Master's Thesis. California State University Monterey Bay.

SWRCB (State Water Resources Control Board). 2017. Final California 2014 and 2016 Integrated Report (303(d) List/305(b) Report) Supporting Information. https://www.waterboards.ca.gov/water_issues/programs/tmdl/2014_16state_ir_reports/table_of_contents.shtml

Sutton, R., A. Franz, A. Gilbreath, D. Lin, L. Miller, M. Sedlak, A. Wong, R. Holleman, K. Munno, X. Zhu, and C. Rochman. 2019. Understanding microplastic levels, pathways, and transport in the San Francisco Bay Region, SFEI-ASC Publication #950. 402 pages.

Swain, D.L., B. Langenbrunner, J.D. Neelin, and A. Hall. 2018. Increasing precipitation volatility in twenty-first-century California. Nature Climate Change 8:427-433.

Thomas, V.G. 1985. Experimentally determined impacts of a small, suction gold dredge on a Montana stream. North American Journal of Fisheries Management 5:480-488.

Thompson, K.E. 1972. Determining streamflows for fish life. Pages 31-50 *in* Proceedings of the Pacific Northwest River Basins Commission Instream Flow Requirement Workshop, March 15-16, 1972. Portland, Oregon.

Tian, Z., H. Zhao, K. T. Peter, M. Gonzalez, J. Wetzel, C. Wu, X, Hu, J. Prat, E. Mudrock, R. Hettinger, A.E. Cortina, R.G. Biswas, F.V.C. Kock, R. Soong, A. Jenne, B. Du, F. Hou, H. He, R. Lundeen, A. Gilbreath, R. Sutton, N.L. Scholz, J.W. Davis, M.C. Dodd, A. Simpson, J.K. McIntyre, and E.P. Kolodziej. 2020. A ubiquitous tire rubber-derived chemical induces acute mortality in coho salmon. Science 371(6525):185-189.

Tian, Z., M. Gonzalez, C.A. Rideout, H.N. Zhao, X. Hu, J. Wetzel, E. Mudrock, C.A. James, J.K. McIntyre, and E.P. Kolodziej. 2022. 6PPD-Quinone: Revised Toxicity Assessment and Quantification with a Commercial Standard. Environmental Science and Technology Letters 9(2):140-146.

Turley, C. 2008. Impacts of changing ocean chemistry in a high-CO_2 world. Mineralogical Magazine 72(1):359-362.

Velagic, E. 1995. Turbidity study: a literature review. Prepared for Delta planning branch, California Department of Water Resources by Centers for Water and Wildland Resources, University of California, Davis.

Wagner, C.H. 1983. Study of Upstream and Downstream Migrant Steelhead Passage Facilities for the Los Padres Project and New San Clemente Project, Report prepared for the Monterey Peninsula Water Management District.

Washington Department of Fish and Wildlife. 2009. Compiled White Papers for Hydraulic Project Approval HCP. Section 7.6 Direct and Indirect Effects: Water Quality Modifications. 66 pages.

Waters, T.F. 1995. Sediment in Streams: Sources, Biological Effects, and Control. American Fisheries Society Monograph 7.

Westerling, A.L., B.P. Bryant, H. K. Preisler, T.P. Holmes, H.G. Hidalgo, T. Das, and S.R. Shrestha. 2011. Climate change and growth scenarios for California wildfire. Climatic Change 109:(Suppl 1) S445–S463.

Williams, A.P., J.T. Abatzoglou, A. Gershunov, J. Guzman-Morales, D.A. Bishop, J.K. Balch, and D.P. Lettenmaier. 2019. Observed Impacts of Anthropogenic Climate Change on Wildfire in California. Earth's Future 7:892–910.

Williams, A.P., B.I. Cook, and J.E. Smerdon. 2022. Rapid intensification of the emerging southwestern North American megadrought in 2020–2021. Nature Climate Change 12:232–234.

Williams, T.H., S.T. Lindley, B.C. Spence, and D.A. Boughton. 2011. Status Review Update for Pacific Salmon and Steelhead Listed Under the Endangered Species Act: Southwest. 20 May 2011, update to 5 January 2011 Report to Southwest Region National Marine Fisheries Service from Southwest Fisheries Science Center, Fisheries Ecology Division.

Williams, T.H., B.C. Spence, D.A. Boughton, R.C. Johnson, L. Crozier, N. Mantua, M. O'Farrell, and S. T. Lindley. 2016. Viability Assessment for Pacific salmon and steelhead listed under the Endangered Species Act: Southwest, 2 February 2016 Report to National Marine Fisheries Service – West Coast Region from Southwest Fisheries Science Center, Fisheries Ecology Division 110 Shaffer Road, Santa Cruz, California 95060.

Wurtsbaugh, W.A., and G.E. Davis. 1977. Effects of temperature and ration level on the growth and food conversion efficiency of *Salmo gairdneri*, Richardson. Journal of Fish Biology 11:87-98.

6. APPENDICES

6.1. Aerial Photos of College Lake: 1948-2020

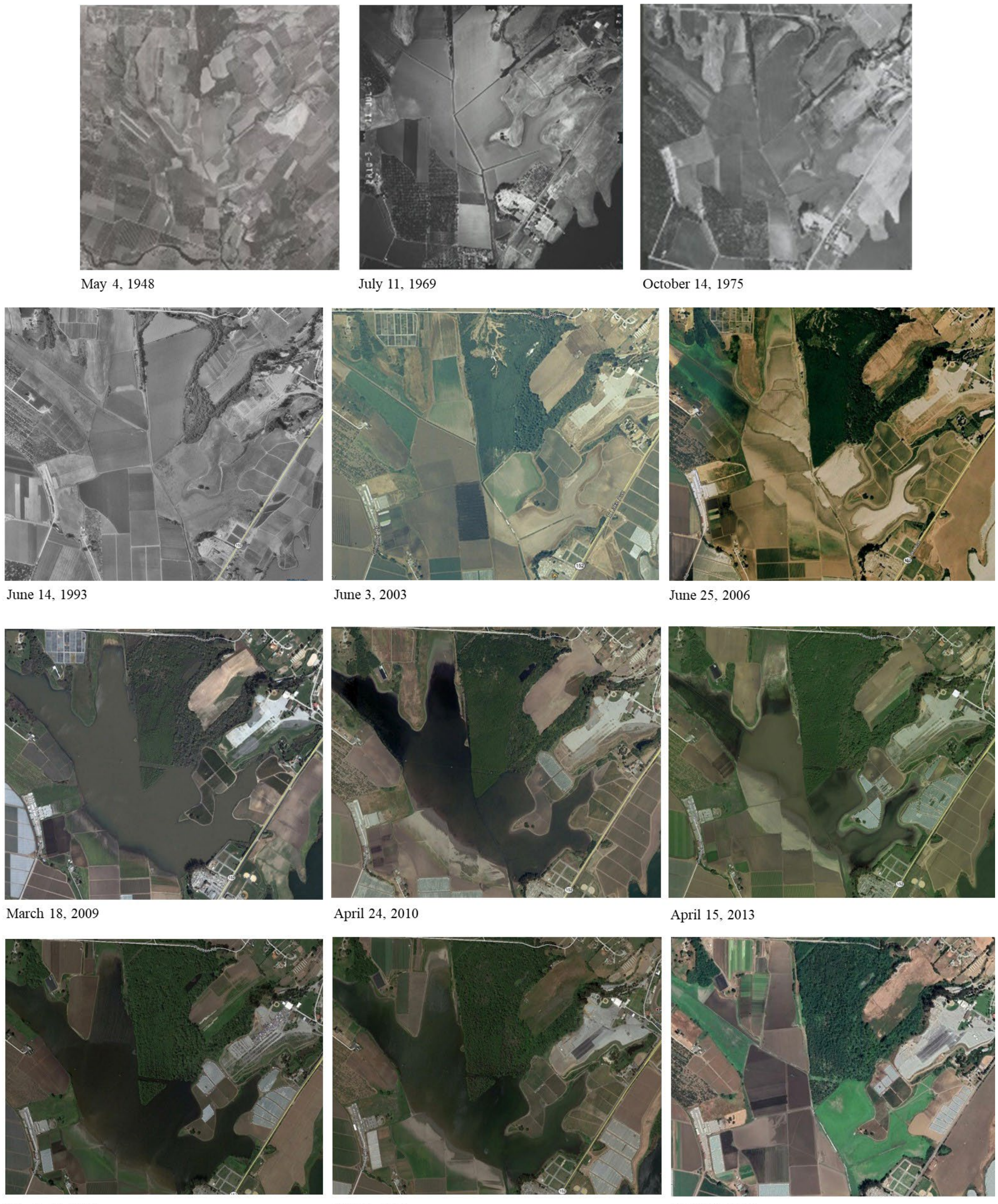


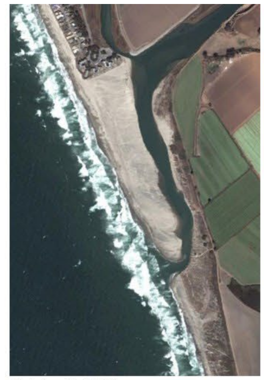
Figure 8. Aerial images of College Lake. Source: University of California Santa Cruz (1948-1975); Google Earth (1993-2020).

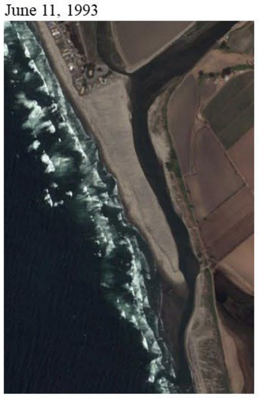
6.2. Aerial Photos of the Lower Pajaro Lagoon: 1993-2021


June 11, 1993

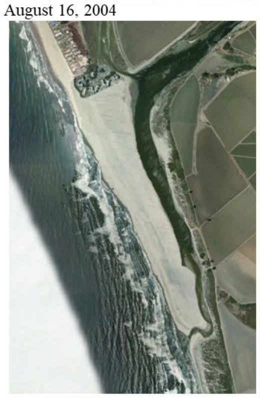

June 30, 2004

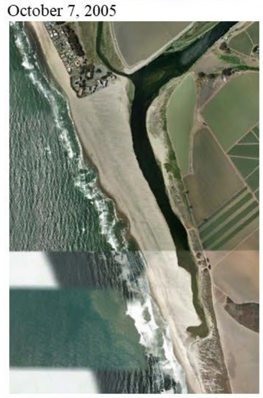

August 16, 2004


October 7, 2005


May 24, 2006

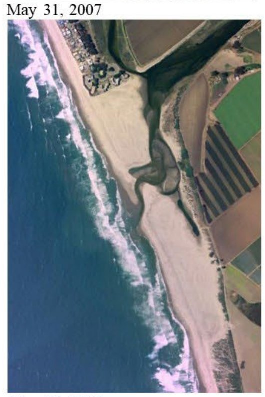

June 25, 2006


May 31, 2007


July 29, 2007


November 12, 2008


March 18, 2009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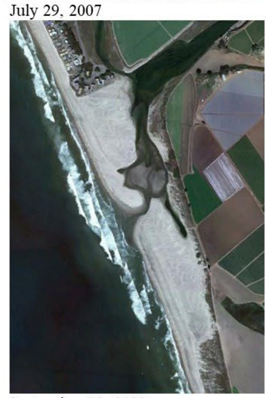
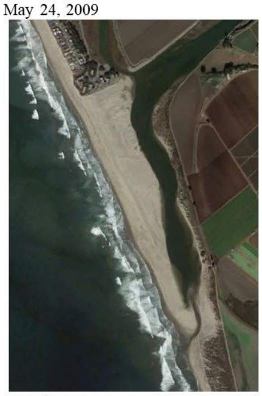

September 30, 2009


April 24, 2010


May 1, 2011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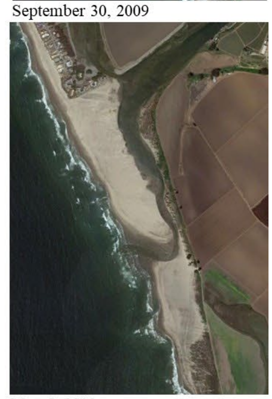
May 5, 2012

Figure 9. Aerial photos of the Lower Pajaro Lagoon courtesy of Google Earth.

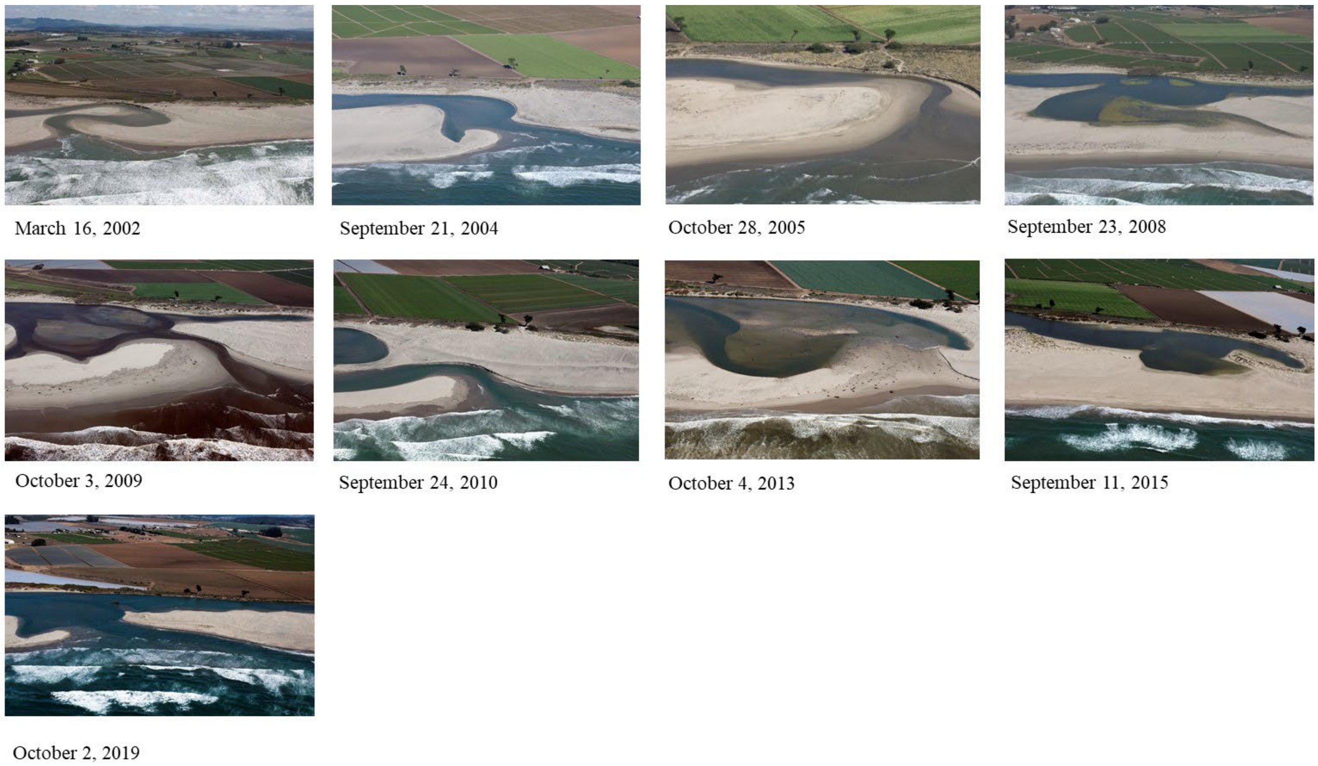

Figure 10. Oblique aerial photos of the Lower Pajaro Lagoon courtesy of Kenneth and Gabrielle Adelman, The California Coastal Record Project.