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

June 2, 2022 **Refer to NMFS No:** WCRO-2022-01340

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 Revised San Lorenzo River Lagoon Interim Management Program, Santa Cruz California (Corps File No. 2014-00434)

Dear James Mazza:

Thank you for your letter of June 21, 2021, requesting initiation 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 City of Santa Cruz's (City) Revised San Lorenzo River Lagoon Interim Management Program (Project).

Thank you, also, for your request for consultation pursuant to the essential fish habitat (EFH) provisions in Section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) [16 U.S.C. 1855(b)] for this action.

In the enclosed biological opinion, NMFS concludes the Project is not likely to jeopardize the continued existence of endangered Central California Coast (CCC) coho salmon or threatened CCC steelhead, nor is the Project likely to result in the destruction or adverse modification of critical habitat for CCC coho salmon or CCC steelhead. However, NMFS anticipates take of CCC steelhead and CCC coho salmon will occur. An incidental take statement with non-discretionary terms and conditions is included with the enclosed biological opinion.

Regarding EFH, NMFS has reviewed the proposed project for potential effects and determined that the proposed project would adversely affect EFH for species managed under the Pacific Coast Salmon Fishery Management Plan (FMP), Pacific Coast Groundfish FMP, and Coastal Pelagic Species FMP. However, the anticipated effects are minor, temporary, or localized. Therefore, we have no practical EFH Conservation Recommendations to provide and no EFH Conservation Recommendations are included in this document.

Please contact Joel Casagrande, North-Central Coast Office in Santa Rosa, 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: Gregory Brown, Corps San Francisco District, Gregory.G.Brown@usace.army.mil
Scott Ruble, City of Santa Cruz, SRuble@cityofsantacruz.com
e-file ARN 151422WCR2021SR00118

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

Revised San Lorenzo River Lagoon Interim Management Program
NMFS Consultation Number: WCRO-2022-01340
Action Agency: U. S. Army Corps of Engineers, Regulatory Division, 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?
Central California Coast steelhead (*Oncorhynchus mykiss*)	Threatened	Yes	No	Yes	No
Central California Coast coho salmon (*O. kisutch*)	Endangered	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 Salmon	Yes	No
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: June 2, 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 USC 1531 et seq.), and implementing regulations at 50 CFR 402, as amended.

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 two weeks at the NOAA Library Institutional Repository [https://repository.library.noaa.gov/welcome]. A complete record of this consultation is on file at NMFS' North-Central California Coast Office in Santa Rosa, California.

1.2 Consultation History

On February 24, 2016, NMFS issued its biological opinion (NMFS 2016a) to the U.S. Army Corps of Engineers (Corps) for the City of Santa Cruz's (the City) proposed San Lorenzo River Lagoon Interim Management Program. The initial project included up to two years of sandbar management practices (as described in NMFS 2016a) while the City obtained funds for the fabrication and installation of a head driven culvert system designed to manage dry season water levels in the lagoon. Sandbar management practices were conducted per the biological opinion in 2016 and 2018. Sandbar management practices were implemented in 2019 and 2021 under emergency conditions. The initial design of the culvert system differed in many ways from the currently proposed action, which included annual installation and removal. The City released its request for proposals for the project and received only one that far exceeded the funding available at the time. In addition, the City obtained feedback on this initial culvert design, and subsequently decided to pursue a more permanent structure that would be affixed to San Lorenzo Point.

Between 2018 and 2021, the City developed alternative designs for the culvert system and worked on refining various different sandbar management activities. This included meeting regularly with the resource and regulatory agencies. NMFS provided guidance to the City and their consultants that the new culvert design weir intake on the head driven culvert should include a self-cleaning fish screen. The City and its consultants worked with NMFS on the development of fish screen design throughout 2020 and early 2021.

On June 21, 2021, via email, NMFS received a request for formal consultation from the Corps for the revised Project along with two enclosures, which included a revised biological assessment (HES 2020) and a Sand and Berm Toolkit (City of Santa Cruz 2021). After reviewing the revised biological assessment, NMFS determined the information provided was incomplete. By email on June 23, 2021, NMFS notified the Corps and the City the information received was insufficient to initiate consultation and provided detailed comments on the draft assessment. By August 17, 2021, the Corps and the City had not supplied the necessary information to initiate consultation, at which time NMFS informed the Corps by email that the request was deemed insufficient.

Between June 2021 and March 2022, the Corps, the City, and its consultants, continued communicating at monthly meetings to discuss the status of the revised biological assessment, lagoon conditions and sandbar management strategies, and timelines for construction.

On March 10, 2022, the City's consultant provided NMFS, the Corps and the United States Fish and Wildlife Service (USFWS) a revised biological assessment (HES 2022). This version of the assessment still lacked some necessary information, which was conveyed by NMFS to the Corps, the City, and their consulting team via email on March 23, 2022. Between March 23 and May 13, 2022, the City and their consultants provided NMFS updated information via email. At this time, NMFS determined the information was complete and the consultation was initiated.

1.3 Proposed Federal Action

For ESA consultation, "action" means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies (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 the City under Section 404 of the Clean Water Act (33 U.S.C. § 1344 et seq.) and Section 10 of the Rivers and Harbors Act of 1899, as amended (33 U.S.C. § 403 et seq.) to implement the Revised San Lorenzo Lagoon Interim Management Program (Project) at the mouth of the San Lorenzo River. Some components of the Project would also require permission pursuant to Section 14 of the Rivers and Harbors Act (33 U.S.C. § 408 et seq.) for potential effects to the federal flood control channel immediately upstream of the proposed culvert alignment.

The purpose of the Project is to address localized flooding around the San Lorenzo Lagoon during the dry season. The Project would also reduce public risk to visitors that use the beach, and would improve water quality and habitat in the lagoon by reducing or eliminating the need for intermittent sandbar management by the City that disrupts the ecology of the lagoon. The Project is located at the lower end of the lagoon at Santa Cruz Main Beach (Main Beach), in the City of Santa Cruz, California.

The Project includes two primary elements, the head driven culvert, and sandbar management. Construction of the head driven culvert will take one season (up to three months) and is anticipated to begin in the summer of 2022. The implementation of the sandbar management activities are expected to occur annually (e.g., sand containment berm, priming a breach), or as needed (e.g., temporary outlet channels, low flow breaches, and channel shortening). Water quality monitoring conducted by the City will continue annually but these activities have no effect on species or their habitats. The following sections describe the Project's components as well as construction, operations, and maintenance of the Project.

1.3.1 Head Driven Culvert

1.3.1.1 *Description of the Head Driven Culvert Components*

The head driven culvert consists of three primary components: (1) a junction box, (2) an infiltration gallery, and (3) the horizontal culverts (Figure 1). The purpose of the head driven culvert is to maintain the lagoon's water surface elevation at a desired target of approximately 5.0 feet per the National Geodetic Vertical Datum of 1929 (NGVD 29) after the sandbar has naturally formed. Absent the culvert, the lagoon's water surface elevation would continue to rise and expand with river and tidal inflows, and under most conditions would result in flooding of adjacent properties. The culvert's infiltration gallery is designed to export saltwater from the bottom of the lagoon, which is intended to increase the rate at which the lagoon's water column converts to freshwater, and conceivably, eliminate or reduce density stratification. The head driven culvert will be operated only during the dry season, after the sandbar at the mouth of the river has formed naturally to minimize the need for sandbar management and impacts to fish passage opportunities to and from the lagoon. An operations plan for the culvert was developed by the City in coordination with the resource agencies.

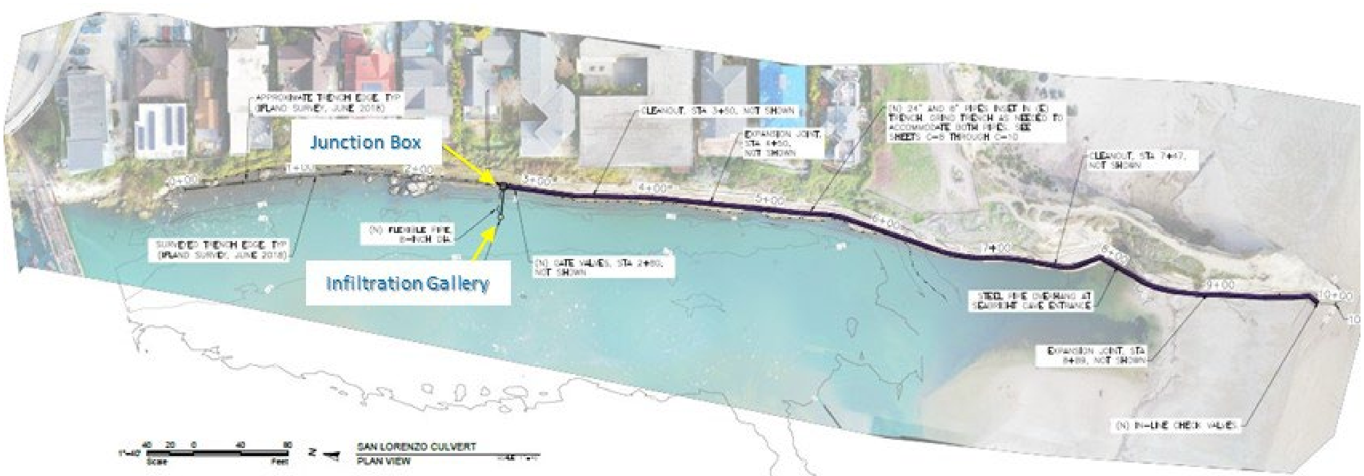

Figure 1. A plan view of the proposed head driven culvert alignment along San Lorenzo Point in the San Lorenzo Lagoon. A portion of the trestle bridge is shown at the far left of the figure with the downstream terminus of the culverts on Main Beach at the right.

Junction Box. The junction box receives inflows from the surface intake weir and the infiltration gallery collector and relays these flows through separate outlet culverts to the ocean (Figure 2). The junction box is a custom fabricated steel cylinder approximately 4 feet in diameter and 4 feet in height that would be anchored in rock along San Lorenzo Point. The junction box includes a weir with adjustable flashboards that would serve as the primary water level regulator once the water surface elevation exceeds 5.0 feet NGVD 29 (HES 2022). Within the junction box, waters will be segregated between those extracted by infiltration and those that overtop the weir structure. The weir can be adjusted to maintain higher or lower elevations in the lagoon, ranging from 5.0 to 7.0 feet NGVD 29 in 0.5-foot increments. The box also provides opportunities for the installation of measuring devices (flow and water quality sondes) necessary to assess the performance of the infiltration gallery collector.

A fish screen will be installed on the intake of the surface weir. The fish screen design consists of two self-cleaning cylinder screens each 24-inch by 30-inch, configured in a “wye” branched assembly (Figure 2). The wedge-wire fish screen maximum mesh size will be 0.25-inch. The screens are self-cleaning via water turbine powered rotation, with fixed brushes on the interior and exterior of the screen. The design of the fish screen has been approved by NMFS and CDFW. The cylinder screens are ISI (Intake Screens, Inc.) products, and have a 12-inch diameter pipe internal to the 24-inch diameter cylinder screen. The dual screen configuration provides for redundancy, allowing for one screen to be shut down while still meeting fish screen criteria. The location of the intake limits exposure to strong river currents owing to its position near the bank and rock ledge. Simple floating boom debris deflectors have not yet been configured but are intended in order to limit floating debris encroaching on the screens.

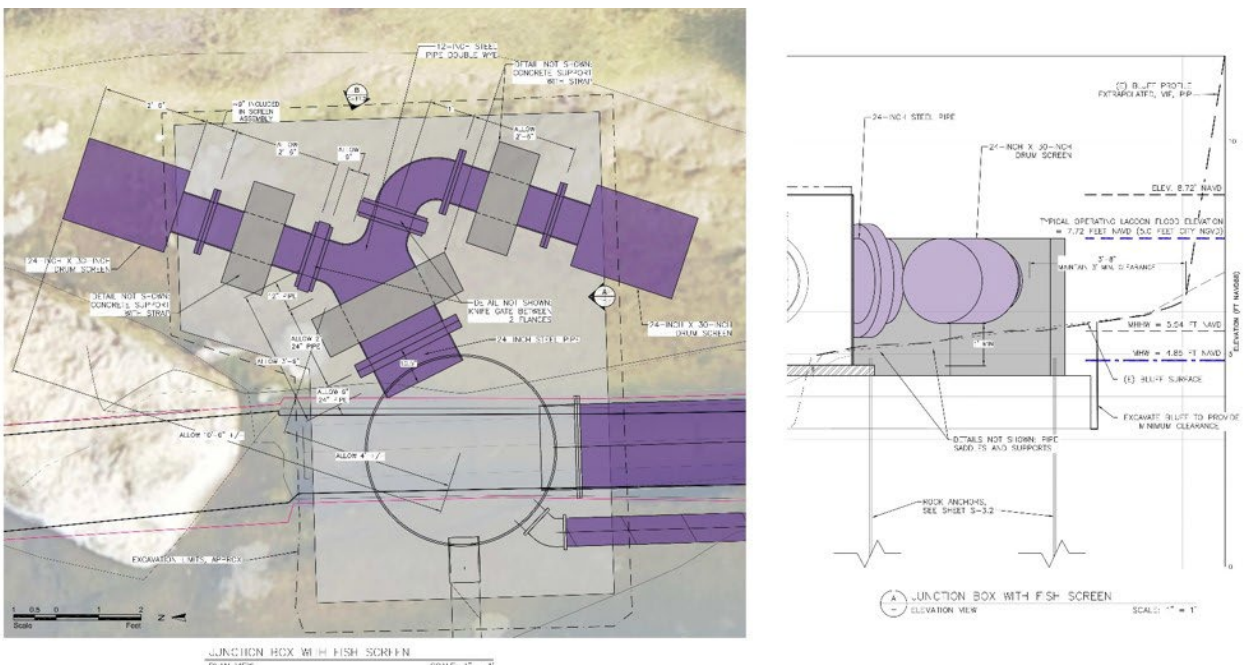

Figure 2. The junction box (circle) with connected dual y-fish screens (top of figure in purple) and the 24- and 8-inch horizontal culverts (right in purple).

Infiltration Gallery. The head driven culvert will include a bottom infiltration galley collector designed to preferentially extract higher salinity water located in the lower part of the water column. This preferential extraction is facilitated by the use of the buried infiltration collector that would draw water through the substrate from a depth below mean lower low water (MLLW) and convey it to the junction box via a connecting pipe (Figure 3).

When the lagoon water surface elevation reaches 3.0 feet NGVD 29, water will start to seep through the porous sand and rock layer, into the bottom of the infiltration collector, flow into the 8-inch pipe connected to the junction box. From there, the extracted water would segregated in the junction box and flow through the dedicated 8-inch horizontal pipe to the ocean outlet. The water from the infiltration gallery is conveyed through a separate 8-inch pipe that is fitted with a separate shutoff valve. As with the 24-inch pipe for the surface weir spill, the shutoff valve in the 8-inch pipe would not be opened until the sandbar has formed. Seepage flows into the infiltration box will be driven by the head difference, therefore, flows into the system will be zero when the lagoon is less than 3.0 feet NGVD 29 and will linearly increase as the water level rises above that elevation.

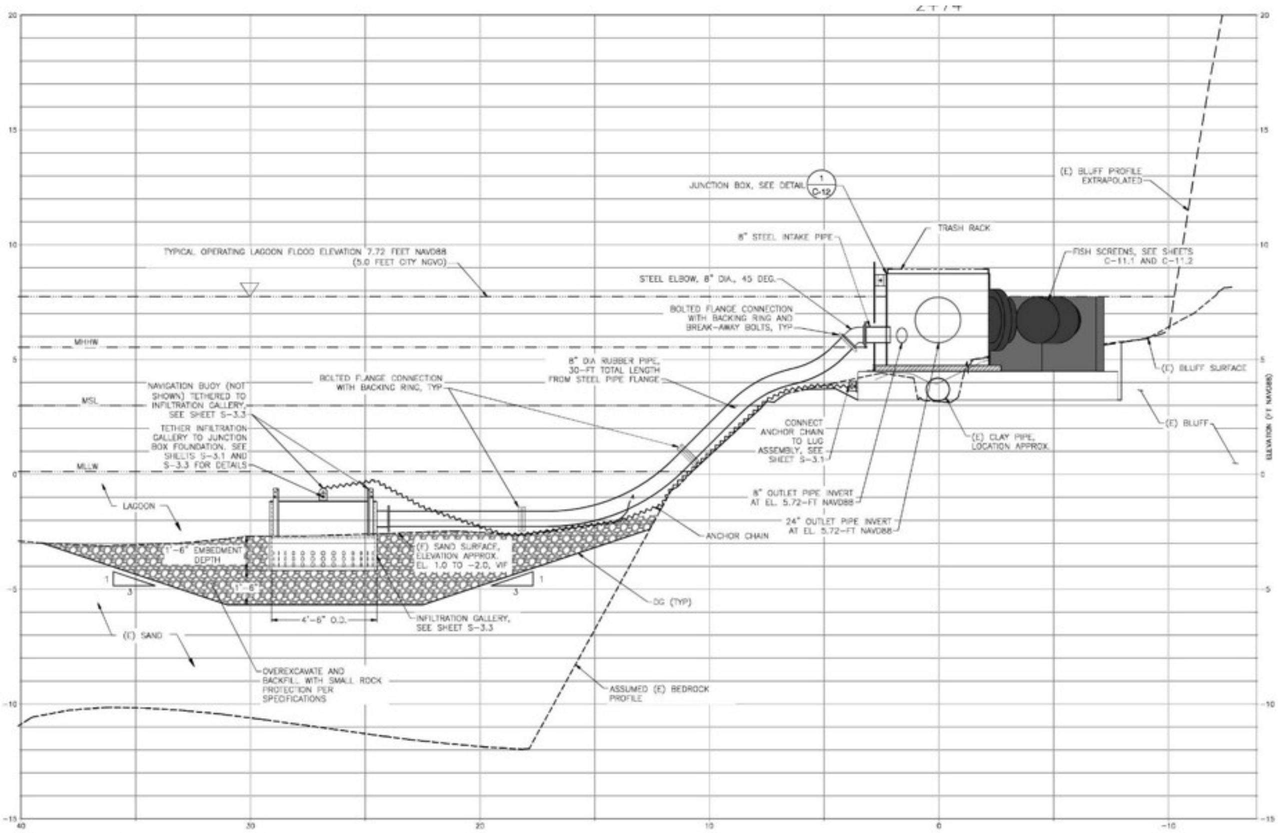

Figure 3. Design drawings of the infiltration gallery positioned on the bottom of the lagoon and connected to the junction box. This view would be looking upstream.

The infiltration collector will consist of a partially perforated galvanized steel structure, located approximately 20 feet west of the junction box and embedded approximately one foot below the ground surface of the lagoon. To limit complete burial and provide adequate infiltration performance, the structure will feature perforations on the side of the box, as well as in the bottom. The use of sub-surface perforations will prevent accidental fish entrainment. An 8-inch diameter by 30-foot-long rubber pipe will connect the infiltration collector to the junction box. The structure will be secured with an anchor chain (e.g., 3-inch galvanized) fastened to the Purisima formation. Approximately 550 square feet of rock material (29 cubic yards) will be placed on top and around the infiltration gallery box. Rock size will be a 2 to 5 inch gradation mixture. In the event that the structure is mobilized during a storm event (drag, debris, impact loads, or a combination thereof), the chain would prevent the system from being washed away, and would facilitate retrieval. The collector is also equipped with an eyelet to facilitate retrieval, cleaning, and re-positioning during routine maintenance cycles (HES 2022).

Culvert Pipes and Outfall. A 24-inch diameter steel pipe will connect the junction box to the outfall along the lower San Lorenzo Point headland and convey waters from the surface weir. An 8-inch diameter steel pipe will convey flows from the infiltration gallery collector via the junction box to the outfall. Both the 8 and 24-inch diameter culvert pipes are equipped with independent knife-gate shutoff valves.

Both pipes will be installed within an abandoned trench excavated in the base of the headland forming the edge of the lagoon. The trench appears to have been used as part of a sewage pipe drain several decades to a century ago, and has long since been abandoned. The trench features a cross-sectional width ranging from 3 to 5 feet along the project alignment. The bottom of the trench includes compacted material, debris, and remnant low-strength grout. For most of the culvert alignment, some excavation of that material will be required to clean-up the trench and facilitate an appropriate grade. Any material that is excavated that is not native Purisima formation will be off-hauled and disposed of. Any native Purisima that is excavated ("trimmed" or "chipped") from the trench, may be left on site for beneficial re-use and placed back into the trench after pipe installation (discussed below in Section 1.3.1.2). The pipes will bridge a short segment of beach adjacent to the Seabright Cave and continue along the lower portion of San Lorenzo Point to the outlet at the base of San Lorenzo Point.

The pipe outfall will consist of a combination of steel pipe sections equipped with an internal tidal check valve. The purpose of the check valve is to prevent seawater (or organisms) from entering the culvert system. The tidal valve is designed to withstand harsh marine conditions, and allow flow to pass through unhinged. The proposed location for the outfall is congruent with the end of San Lorenzo point. The outfall will be securely fastened to the formation using an adequate number of high-strength rock anchors and steel brackets (HES 2022).

1.3.1.2 *Construction of Head Driven Culvert*

Construction of the head driven culvert system is expected to take approximately two to three months with construction planned to begin in summer of 2022. Access to the site will be achieved from the water-side (right bank) using flexi-floats or similar barge systems. The barges will be lifted and placed into the lagoon from the parking lot adjacent to the Santa Cruz Beach Boardwalk (Beach Boardwalk). Equipment and crews will walk on barges from a designated mooring area. Other equipment will be staged at a location along Beach Street west of the Beach Boardwalk with access across Main Beach, and/or on Beach Boardwalk property such as within their fenced corporation yard area. Other equipment could include a drilling device, a backhoe, a spider (4-legged tractor), and possibly, welding devices. The mooring pad will consist of a ramp made of beach sand that is contained by stacked and interlocking concrete blocks. The blocks will extend into a shallow shoreline area of the lagoon, which will temporarily exclude this area as habitat for fish. The installation of the blocks will be done slowly, in a manner that would allow time for any fish to vacate the area. At night, when the barges are not in use, they will be anchored and secured to the mooring area. During construction, equipment will be loaded onto the barges at the mooring area and travel across the lagoon to the culvert work area. The barges (2) will consist of six connectable floating segments.

Construction would take place along the Purisima formation. This will include driving rock anchors, or installing other types of fasteners to keep the system components in place. If necessary, future removal of the head driven culvert system, or components thereof, would involve a similar procedure as installation (i.e., barges and equipment). As noted above, installation of the system would require limited clean-up of sections of the existing trench running along the base of the Purisima formation of San Lorenzo Point to remove debris and old grout from the existing trench (Figure 4). An estimated 100 to 200 cubic yards of material will be excavated from the existing trench. This will likely involve chipping away at the sides of the existing trench or removing derelict pipe remnants. The drilling of the rock anchors will also produce additional sediments of native material from the drilled bore holes.

Figure 4. Portions of the existing trench and remnant pieces of the historic pipe within the trench along San Lorenzo Point.

The plans and specifications intentionally give the contractor some flexibility in their pipe alignment methods to accommodate the existing bends and elevation changes in the existing alignment, but direct them to minimize excavation as much as possible. Excavated mudstone is proposed to be used beneficially on site. Uses include: backfill or bedding below the proposed culvert pipes in low areas within the trench, as cover for the pipe by distributing material back onto the pipe after installation providing additional aesthetic screening, or by simply leaving it in place on the bench feature. Additionally, some of the excavated material may be utilized directly across the river to help rebuild/bolster the existing access containment berm and pedestrian beach access walkway (discussed below) where it passes under the trestle bridge and transitions from a paved path at the Beach Boardwalk to a sand path on the beach. This transition needs to be refortified with sand every couple of years, so beneficial reuse of this native material for this purpose will be ideal. Lastly, beneficial reuse eliminates the need to dispose of this material in a landfill, resulting in additional costs, traffic, and emissions impacts associated with the truck trips.

Limited sections of the existing trench still retain short portions of the original old clay pipe. Additionally, there are approximately six or less areas where approximate 2-inch long concrete “plugs” of large aggregate concrete had been poured presumably to hold down the old clay pipe. These non-native clay pipe and concrete materials will be removed and hauled off site for disposal. Estimated material volume is approximately 10 cubic yards.

Construction of the culvert system during the summer of 2022 will require management of the sandbar to maintain an open lagoon with low water surface elevations. Specifically, this will require the use of multiple low flow breaches (described below).

1.3.1.3 *Construction Best Management Practices*

The City proposes to implement several Best Management Practices (BMPs) during installation of the project (HES 2022). These include:

- Contractors must have a supply of fuel and hydraulic fluid spill containment supplies onsite to facilitate a quick response to unanticipated fuel or hydraulic fluid spill emergencies.
- Construction equipment must be checked at the beginning of each workday. If leaks occur during work below top of bank, the contractor must contain the spill and remove the affected soils.
- Staging/storage areas for equipment, materials, fuels, and lubricants, must be located outside of the stream's normal high-water height and above ocean high tide levels. Stationary equipment such as motors, pumps, generators, compressors, located on the beach must be positioned over drip pans.
- Clean-up of all spills must begin immediately. NMFS must be notified immediately of spills into sensitive aquatic resources and must be consulted regarding clean-up procedures.
- All temporary, construction-related material must be removed from the Project area.
- City staff or their qualified designee must provide on-site training for work crews to ensure protection of the stream zone and listed wildlife species. City staff or their qualified designee are empowered to halt construction activities if they determine the Project is resulting in unintended or unanticipated adverse impacts to listed species or their habitats.
- Construction monitoring by qualified environmental personnel will be conducted during all construction operations to ensure no harm or harassment of state and federally protected species such as, tidewater goby, steelhead, and coho salmon occurs during operation of heavy equipment or shovel activities.
- Work activities will be conducted between June and October. Should the City need to conduct activities outside this period, it will notify NMFS to obtain concurrence.
- If the substrate of the lagoon is altered during work activities, it will be graded or otherwise restored to approximate natural conditions after the work is completed.
- The number of access routes, number and size of staging areas, and the total area of the activity will be limited to the minimum necessary to achieve the Project goal. Routes and boundaries will be clearly demarcated and avoid waters of the lagoon.
- The selected contractor also will be responsible for implementation of construction specifications for environmental protection set forth in the City's project bid documents.

1.3.1.4 *Operations*

The following operational measures will be implemented as part of the Project to avoid or minimize potential effects to steelhead, coho salmon, and their critical habitat. The objectives of these measures is to allow the lagoon to maintain an open mouth to the ocean for fish passage between the lagoon and ocean during periods when the lagoon would naturally be open, while avoiding flood damage from high lagoon water surface elevations after a natural sandbar closure.

The head driven culvert has shutoff valves that will allow the City to open and close the culvert system. Final determinations to operate or close the system will be made through coordination with the resource agencies. The weir built within the junction box will have an adjustable flashboard system to manage the water surface elevation when lagoon water overtops into the culvert system.

The City works collaboratively with permitting regulatory and resource agencies in its ongoing management of the lagoon. These agencies include the California Coastal Commission, California Department of Fish and Wildlife (CDFW), Central Coast Regional Water Quality Control Board (CCRWQCB), Corps, NMFS, and the USFWS.

The following operations measures are meant to provide assurance that the objectives stated above will be met. These specific measures will be evaluated during the initial year of operation, and knowledge derived from their application will be incorporated into appropriate changes following the first year of operation. Changes will be approved by the resource agencies.

Specific operations measures[1] are as follows:

1. Both the 24-inch and 8-inch culvert pipes will be fitted with shutoff valves to close the pipes entirely, open them to allow flow from the lagoon, and potentially control the rate at which water is discharged.
2. In the spring and early summer, and when the lagoon mouth at the beach is open, the pipe valves will remain closed as long as the lagoon stage (absent tidal fluctuation) is below the 5.0-foot NGVD 29 overflow weir. When the river mouth at the beach closes, the valve will remain closed until lagoon water surface elevation approaches 5.0 feet. When lagoon stage reaches approximately 4.8 feet and the lagoon remains closed, the infiltration collector valve will be opened to allow release of saline water from deeper levels and the 8-inch culvert outlet valve will be opened. When the lagoon stage reaches 5.0 feet NGVD 29, lagoon water will flow over the junction box weir and enter the 24-inch horizontal culvert. The purpose of this measure is to allow the lagoon to stay open naturally and to reopen naturally after short-term natural closures that are not permanent. This will facilitate fish migration and allow tidal exchange in the lagoon.
3. The lagoon opens in the fall through a combination of erosion of the sandbar through wave action and increase in river flow due to rainfall. Once the lagoon opens, the City will close the culvert system. The City may also close the culvert system in anticipation of rain and a natural breach. In the event of re-closure of the lagoon, the City may re-open the culvert system. Any decision to re-open the culvert will be made after coordination with the resource agencies.
4. The City will not use machinery to open the sandbar. Instead the City will grade a low spot in the sandbar near the San Lorenzo Point in the fall prior to natural opening to guide

[1] These operating procedures may be adjusted in the future as the City and resource agencies become informed on operation performance.

the location of the natural opening.

5. A fish screen will be installed on the junction box at the weir inlet to prevent fish from entering the culvert system as approved by CDFW and NMFS. The screen has been designed to meet CDFW and NMFS fish screening design criteria and will be appropriately maintained to avoid clogging with debris.
6. Lagoon water quality and fish populations will be monitored monthly from June through October using established methods in conjunction with the City's Habitat Conservation Plan monitoring program. Results will be compared to pre-project monitoring results (2004-present). Operation of the culvert system will be re-evaluated if detrimental effects on water quality or fish populations are documented.
7. The City will convene a conference call in May or June (or earlier based on water year conditions) each year to inform interested resource agencies, including the six aforementioned, of lagoon conditions, plans for the season, and operational updates as appropriate. The City shall provide any data that the agencies request regarding operating decisions. Such data may include river flow, lagoon water surface elevation, water quality parameters and photographs.
8. The three fisheries agencies (CDFW, NMFS and USFWS) may instruct the City to open or close the culvert system at any time should those agencies determine that such action is in the best interest of the fish species in the lagoon.
9. Operations measures 2, 3 and 4 may be altered to react to unforeseen conditions as desired and approved by CDFW, NMFS and USFWS.
10. The City's annual sand "containment berm" (described below) may be constructed after May 1 each year. The berm is constructed to prevent extension of the lagoon and its outlet to the west on main beach. Construction shall remain at least 50 feet from the water's edge.

1.3.1.5 *Maintenance*

The following are actions required to operate and maintain the culvert system:

- *Excavate Beach at Outfall*: Sand will be excavated from in front of the culvert outlet to expose the outlet that may become buried by the beach. It is anticipated that excavations will occur within a 50-foot by 30-foot plan footprint, extending up to 8 feet deep (vertical) from the beach berm at 13 feet NAVD 29 to the 24-inch diameter pipe with an invert at about 5 feet NAVD 29. Anticipated sand excavation volumes will range between 35 and 90 cubic yards, depending on beach, ocean and culvert discharge conditions. The excavation may be required approximately once per year, on average, to initiate culvert discharge during the dry season after mouth closure or after a large south swell event greatly increases berm depth.
- *Flush Pipe Interior*: Water will be pumped into the pipes in order to flush marine growth and other detritus (e.g., sand, kelp) out to the ocean. A hose will be connected to one or more of four fittings located at the upstream and downstream ends of the two pipes (around Station 3+25 and 7+75). Water will be pumped at one location at a time, but all four connection locations may be used. The connections will be made by land or water, but most likely water access via a small work barge. The work barge will be mobilized from the west (right) river bank and pushed to the water connections with a small motorized boat. The barge will be anchored with anchor lines and or spuds. The barge

will likely include a metal A-frame to facilitate lifting heavy objects such as the infiltration collector. A water pump will be loaded onto the barge along with water hose. The anticipated barge size is not larger than 20 feet by 40 feet. The flush water may be pumped from the lagoon complying with screening requirements (i.e., NMFS requirements) to prevent entrainment of fish. Pipe flushing depends on the level and type of fouling in the pipe, and may occur on average about once per year.

- *Reposition Infiltration Gallery Collector*: The infiltration gallery collector may be subject to displacement during high river flows and as the result of scour of the sand bed. Repositioning of the infiltration collector in the spring, prior to culvert system operation, will be accomplished via a small work barge (see item 2). The work barge will lift and lower the anchor chain and the infiltration gallery collector along with pipe connecting the gallery to the junction box. The frequency of infiltration collector repositioning is anticipated to be once per year.
- *Operate Valves and Adjust Weir*: When not in operation, valves shall be closed to cut off flow through the pipes. There is one valve on each of the two pipes. Shutting the valves requires attaching a wheel and turning it, and then removing the wheel and storing it off site. Debris lodged at the debris booms will be removed to gain access to the weir. Adjustment of the weir consists of inserting or removing flashboards. Valve and weir adjustments are anticipated twice per year, on average. Access will be by barge, small boat or by foot along the bedrock bench at the base of San Lorenzo Point.
- *Debris Removal at the Junction Box*: Trash, debris, vegetation and other detritus may accumulate over time near or on the junction box, trash rack, and weir opening. These obstructions may reduce the proper operation of the system. Regular inspection and cleanup operations shall be performed frequently to maintain the system within a normal range of operations.

1.3.1.6 *Monitoring*

The City has a well-established monitoring program (2004-present) for the San Lorenzo Lagoon that will be utilized to assess and track water quality and habitat conditions in the lagoon, and to assess the effectiveness of the head driven culvert and any implications of sandbar management activities implemented as part of the Project. This monitoring program includes fisheries, water quality, and hydrologic conditions.

For water quality and hydrology, the existing monitoring includes:

- Two continuous water quality sonde arrays each equipped with surface and bottom data recorders which provide continuous time series of water temperature, conductivity, dissolved oxygen, salinity, and water surface elevation.
- When the sandbar is closed, bi-weekly vertical profile measurements of water quality are measured in 0.4 meter depth increments at seven stations, which provide spatial and temporal information on water column conditions vertically (within water column) and longitudinally throughout the lagoon (2nd Nature 2021).
- Observations of substrate, vegetation, sandbar, and climate conditions are noted during the collection of the bi-weekly vertical water quality profiles.
- Continuous lagoon water surface elevation, river inflow, and ocean wave and tide data are also available.

Due to inherent uncertainties between theoretical performance of the infiltration gallery, and actual performance, a water quality monitoring plan is included as part of the Project. Monitoring would include the deployment of continuous water quality monitoring instruments inside the junction box (e.g., temperature/salinity sondes, flow meters, etc.).

The City also has an established fisheries monitoring program that includes sampling of fishes at multiple sites within the lagoon monthly from June through October (HES 2022). While the fisheries monitoring is not part of the proposed action, the data collected will be used to infer habitat suitability through changes in catch per unit effort and population estimates as well as observations of fish health and condition. The fisheries monitoring is authorized under an existing ESA section 10(a)(1)(A) research permit (Permit #16318-4R).

1.3.2 Sandbar Management

The City has developed a suite of sandbar management activities designed to achieve desired lagoon water surface elevation targets for culvert construction and to avoid flooding and public safety risks while minimizing adverse impacts on lagoon habitat and species. The suite of sandbar management actions are described in the Sand and Berm Management Toolkit (City of Santa Cruz 2021), which has been developed and refined over the past four years with input from the resource agencies. The toolkit includes actions to manage water surface elevations in the lagoon leading up to and during construction of the head driven culvert structure and at various times in the future. It also includes the use of a seasonal sand containment berm on the beach that extends from the Beach Boardwalk to approximately the high tide line. The use of the containment berm is to prevent the lagoon from expanding westward along the beach. The westward expansion of the lagoon results in a beach that forms an isolated peninsula (i.e., parallel to the ocean) which presents a heightened risk to public safety. The berm also provides an access path to the beach from the Beach Boardwalk for emergency response vehicles and personnel.

1.3.2.1 *Low Flow Breaches*

The City proposes to use a low flow breach method that is designed to minimize the outflow velocities and risk of rapid lagoon dewatering. This method uses a small pilot breach channel at a relatively low lagoon water surface elevation (< 6.0 feet NGVD 29) during a rising tide. As the tide rises, the hydraulic gradient decreases while the lagoon waters slowly scour a wider channel. Several hours later, when the tide begins to fall, the lagoon water level has lost much of its hydraulic gradient and the resulting outflow mimics a more natural tidal exchange that avoids a rapid dewatering of the lagoon.

The mobilization process is as follows. The lagoon will be continuously monitored and immediately upon closure of the river mouth, a good tide and swell window will be identified by City staff. As soon as the sandbar closes, the City will notify the resource agencies of the tidal window identified for a low flow breach and to provide other relevant data (e.g., water level, river inflow, images, work plan, etc.). If there is agreement from the agencies, then the action will be implemented.

Following the lowering of lagoon water levels, there may be a couple of isolated ponds that could potentially harbor fish. Any isolated ponds will be connected to the lagoon by using a shovel to create a channel, or biologists will check the isolated ponds and relocate any stranded fish immediately to the lagoon using dip nets.

The City prefers this method of sandbar management over the Temporary Outlet Channel (TOC) methods they used in the past (described below) because it is easier and less expensive to implement, and because it is a more reliable method for achieving desired outcomes while minimizing impacts to the lagoon. Once the head driven culvert is constructed and operational, the use of low flow breaches are most likely to occur in situations where the sandbar has formed in spring or early summer and river inflows exceed the capacity of the culvert system. This is expected to be rare. In this case, the low flow breaches would be used before the lagoon water surface elevation reached 6.0 feet NGVD 29. The City estimates no more than 6 low flow breaches per year.

1.3.2.2 *Temporary Outlet Channels*

Temporary Outlet Channels (TOCs) are designed to reduce the lagoon water surface elevation followed by a mechanical closure. This is done at a range of lagoon elevations by using an excavated channel at an angle across the beach. The pilot channel expands as the lagoon outflow erodes the channel banks. Expansion can be rapid as the beach sand is readily eroded and carried down the channel. The growth and ultimate size of the outflow depends on the length of the channel (and thus its slope) and tidal stage. Outflow can be managed to some degree by using an excavator to place sand into the top of the channel to reduce the head-cutting and stream flow velocities. When the desired water level in the lagoon is reached, the outflow channel is closed by using a bulldozer to push sand into the channel. The mechanical closing of the lagoon is an attempt to minimize the time the lagoon is open and allow freshwater to re-accumulate in the lagoon. If channel head-cutting moves up to the thalweg (deepest part of the river) and available resources (machinery and sand) are insufficient to achieve control or closure then the breach becomes unstoppable resulting in a more complete drainage of the lagoon. The risk of this occurring increases with a higher lagoon water surface elevation leading up to the action. While TOCs are considered a tool to relieve critical flooding, the City strives to avoid using TOCs unless absolutely necessary and does so only in close consultation with the regulatory agencies. This is considered a measure of last resort.

During the implementation of this activity, biologists will be on site to document the potential for fish stranding, and if necessary, to collect and relocate stranded fish into the lagoon using dip nets. Fish would be transported by foot in holding containers (5-gallon buckets or ice chests) supplied with lagoon water and released. The City is seeking authorization to conduct up to two TOCs per calendar year.

1.3.2.3 *Channel Shortening*

This activity is undertaken when the outlet channel forms to the west along Main Beach in front of, or parallel to, the Beach Boardwalk. This activity involves excavating a new outlet channel through the beach berm closer to San Lorenzo Point. The existing long outlet channel would be cut off with sand at its inlet. This activity involves some in-water work when the westward extension is closed off. The use of sand containment berms (described below) in the spring season would reduce the likelihood of needing this activity by preventing the development of a long outlet channel to the west from forming.

In the event that this activity is needed, biologists will attempt to capture and relocate any fish in the portion of the outlet channel targeted for cut off. A block net will be used at the upstream end of the cut off channel. Biologists will use seines or dip nets with appropriately sized mesh for juvenile salmonids to collect any fish in the cut-off channel and relocate them to the lagoon. Fish would be transported by foot in holding containers (5-gallon buckets or ice chests) supplied with lagoon water and released. Once all fish are captured and relocated, sand will be used to isolate the cut off channel. Observations of the cut off channel by fish biologists will continue in order to detect and collect any fish that evade the initial capture and relocation effort.

1.3.2.4 *Priming a Breach*

This action is completed in late summer or fall when the lagoon is closed. The intention is to force the pending outlet channel toward San Lorenzo Point when the lagoon opens in the fall, and to allow the lagoon to open at a lower stage to reduce the risk of flooding (Figure 5). In anticipation of the first rains of the year, the beach berm crest is lowered to approximately 7.0 feet NGVD 29. The City anticipates this activity will be required annually. This activity requires encroachment within 50 feet of the lagoon and the ocean, however, equipment will not enter waters.

Figure 5. Aerial image illustrating the general location of a sand containment berm (without the trestle extension) and the general area where priming or berm trimming would be conducted (City of Santa Cruz 2021).

1.3.2.5 *Sand Berms*

Sand Containment Berm
The City proposes to use a sand containment berm with the intent of preventing the lagoon outflow channel from forming to the west, in front of the Beach Boardwalk, and to ameliorate concerns with beach recreation and public safety. The channel tends to form in this way since the sandbar generally builds higher closer to San Lorenzo Point and lower further westward in front of the Beach Boardwalk. To accomplish this, a 12-foot high sand levee will be constructed from the southeast corner of the Beach Boardwalk retaining wall to the outer edge of the beach (Figure 5). Construction of the berm can take from one to two weeks using a bulldozer and front loader. Sand is taken from dry areas of the beach and no work occurs in the water. Equipment is kept a minimum of 50 feet from the water's edge. The City proposes to conduct this annually.

Sand Berm Extension to Trestle Underpass
This activity allows the City to create an extension of the sand containment berm along the Beach Boardwalk's riverside seawall, such that the sand containment berm (discussed above) connects with the trestle bridge pedestrian underpass. The purpose of this activity is to improve beach access to Main Beach for both the public as well as beach patrol and maintenance vehicles. This extension is constructed in the spring well before water levels in the lagoon are high. No work will occur in any water or within a minimum of 50 feet from the water. Construction of the berm extension uses sand from Main Beach. The berm has tended to remain in place in drier winters and may only need relatively minor maintenance in these cases. As part of this work, the City will also conduct approximately bi-annual maintenance to the transition between the existing paved path under the trestle bridge and the extended sand berm. Maintenance may include re-stacking small boulders to support the transition from asphalt onto the sand. Natural debris such as drift wood may also be incorporated in the transition. Finally, the maintenance of this transition may episodically require importing some small gravel which stabilizes the transition (approximately 10 cubic yards). All work will be finished by replenishing the sand on top.

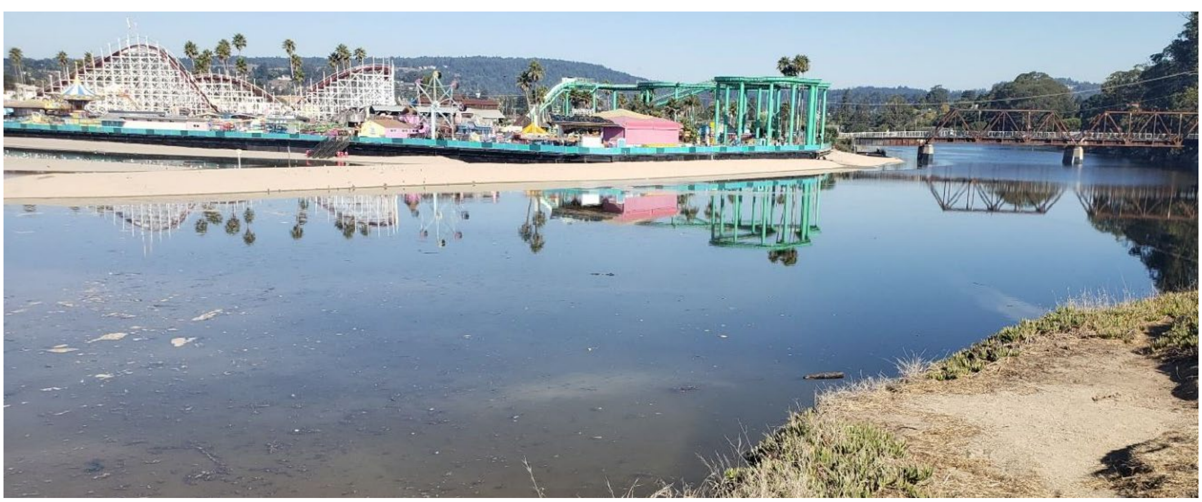

Figure 6. The sand containment berm extension from the corner of the Beach Boardwalk upstream to the railroad trestle bridge. Source: City of Santa Cruz (2021).

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 to 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 provides 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/or an adverse modification analysis. The jeopardy analysis relies upon the regulatory definition of "to jeopardize the continued existence of" a listed species, which is "to engage in an action that 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 the 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 designations of critical habitat for CCC coho salmon and 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 424.12) 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.

The ESA Section 7 implementing regulations define effects of the action using the term "consequences" (50 CFR 402.02). As explained in the preamble to the final rule revising the definition and adding this term (84 FR 44976, 44977; August 27, 2019), that revision does not change the scope of our analysis, and in this opinion we use the terms "effects" and "consequences" interchangeably.

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 rangewide 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.

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 Species Description and Life History

The biological opinion analyses the effects of the federal action on the following federally listed species (Distinct Population Segment [DPS] or Evolutionarily Significant Unit [ESU]) and designated critical habitat:

Endangered Central California Coast (CCC) coho salmon ESU (*Oncorhynchus kisutch*)
Endangered (70 FR 37160; June 28, 2005)
Critical habitat (64 FR 24049; May 5, 1999);

Threatened Central California Coast (CCC) steelhead DPS (*Oncorhynchus mykiss*)
Threatened (71 FR 834, January 5, 2006)
Critical habitat (70 FR 52488, September 2, 2005).

The CCC steelhead DPS includes steelhead in coastal California streams from the Russian River to Aptos Creek, and the drainages of Suisun, San Pablo, and San Francisco Bays eastward to Chipps Island at the confluence of the Sacramento and San Joaquin Rivers. In addition, the DPS includes steelhead from one active artificial propagation program: the Don Clausen Fish Hatchery Program.[2]

The CCC coho salmon ESU includes coho salmon from Punta Gorda in northern California, south to, and including, Aptos Creek in central California, as well as populations in tributaries to San Francisco Bay, excluding the Sacramento-San Joaquin River System. In addition, the ESU includes coho salmon from the following artificial propagation programs: the Russian River Coho Salmon Captive Broodstock Program[3], and the Southern Coho Salmon Captive Broodstock Program.[4]

The action area is within designated critical habitat for CCC steelhead and CCC coho salmon. CCC steelhead critical habitat is designated from the Russian River to Aptos Creek to a lateral extent of ordinary high water in freshwater stream reaches, and to extreme high water in estuarine areas. CCC coho salmon critical habitat is designated to include all river reaches assessable to listed coho salmon from Punta Gorda in northern California south to the San Lorenzo River in central California, and includes two tributaries to San Francisco Bay, Arroyo Corte Madera Del Presidio and Corte Madera Creek. Critical habitat consists of the water, substrate, and adjacent riparian zone of estuarine and riverine reaches (including off-channel habitats).

2.2.1.1 *Steelhead 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 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 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

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[2] Kingfisher Flat Hatchery previously had a small CCC steelhead hatchery program that released steelhead smolts into Scott Creek and the San Lorenzo River. That program was terminated in 2014.

[3] Formerly referred to as the Don Clausen Fish Hatchery Captive Broodstock Program.

[4] Formerly referred to as the Scott Creek/King Fisher Flats Conservation Program and the Scott Creek Captive Broodstock Program.

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 and remove metabolic wastes. 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, CCC juvenile steelhead that exhibit an anadromous life history strategy usually rear in freshwater for 1-2 years (NMFS 2016b). 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. Following their multi-year life-cycle monitoring study of salmonids in Waddell and Scott creeks of Santa Cruz County, Shapovalov and Taft (1954) noted: "It is especially important that at least the lagoons and tidal waters of all coastal streams be closed except during the winter angling season. It is here that young steelhead make their most rapid growth before entering the sea (page 295)."

2.2.1.2 *Coho Salmon Life History*

The life history of the coho salmon in California has been well documented (Shapovalov and Taft 1954; Hassler 1987; Weitkamp et al. 1995). In contrast to the life history patterns of other anadromous salmonids, coho salmon in California generally exhibit a relatively simple three year life cycle. Adult salmon typically begin the immigration from the ocean to their natal streams after heavy late-fall or winter rains breach the sand bars at the mouths of coastal streams (Sandercock 1991). Coho salmon are typically associated with small to moderately-sized coastal streams characterized by heavily forested watersheds; perennially-flowing reaches of cool, high quality water; dense riparian canopy; deep pools with abundant overhead cover; instream cover consisting of large, stable woody debris and undercut banks; and gravel or cobble substrates (Sandercock 1991). Immigration continues into March, generally peaking in December and January, with spawning occurring shortly after arrival at the spawning ground (Shapovalov and Taft 1954).

When in freshwater, optimal habitats for coho salmon include adequate quantities of: (1) deep complex pools formed by large woody debris; (2) adequate quantities of water; (3) cool water temperatures [when maximum weekly average water temperatures exceed 18°C coho salmon are absent from otherwise suitable rearing habitat (Welsh et al. 2001); temperatures between 12-14° C are preferred; and the upper lethal limit is between 25-26°C.]; (4) unimpeded passage to spawning grounds (adults) and back to the ocean (smolts); (5) adequate quantities of clean spawning gravel; and (6) access to floodplains, side channels and low velocity habitat during high flow events. Numerous other requirements exist (i.e., adequate quantities of food, dissolved oxygen, low turbidity, etc.), but in many respects these other needs are generally met when the six freshwater habitat requirements listed above are at a properly functioning condition.

The eggs generally hatch after four to eight weeks, depending on water temperature. Survival and development rates depend, in part, on fine sediment levels within the redd. Under optimum conditions, mortality during this period can be as low as 10 percent; under adverse conditions of high scouring flows or heavy siltation, mortality may be close to 100 percent (Baker and Reynolds 1986). McMahon (1983) found that egg and fry survival drops sharply when fines make up 15 percent or more of the substrate. The newly-hatched fry remain in the redd from two to seven weeks before emerging from the gravel (Shapovalov and Taft 1954). Upon emergence, fry seek out shallow water, usually along stream margins. As they grow, juvenile coho salmon often occupy habitat at the heads of pools, which generally provide an optimum mix of high food availability and good cover with low swimming cost (Nielsen 1992). In the spring, as yearlings, juvenile coho salmon undergo a physiological process, or smoltification, which prepares them for living in the marine environment. Emigration timing is correlated with precipitation events and peak upwelling currents along the coast. Entry into the ocean at this time facilitates more growth and, therefore, greater marine survival (Holtby et al. 1990). Nearly all juvenile coho salmon emigrate to the ocean as yearlings, or age 1+, and spend very little time in the lagoon (Shapovalov and Taft 1954).

2.2.2 Status of the Listed Species

NMFS assesses four population viability[5] parameters to discern the status of the listed ESUs and DPSs and to assess each 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 CCC steelhead DPS, the CCC coho salmon ESU, 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.

2.2.2.1 *CCC Steelhead DPS*

Historically, approximately 70 populations of steelhead existed in the CCC steelhead DPS (Spence et al. 2008; Spence et al. 2012). Many of these populations (about 37) were independent, or potentially independent, meaning they had a high likelihood of surviving for 100 years absent anthropogenic impacts (Bjorkstedt et al. 2005). The remaining populations were dependent upon immigration from nearby CCC steelhead DPS populations to ensure their viability (McElhaney et al. 2000, Bjorkstedt et al. 2005).

While historical and present data on abundance are limited, CCC steelhead numbers are substantially reduced from historical levels. A total of 94,000 adult steelhead were estimated to spawn in the rivers of this DPS in the mid-1960s, including 50,000 fish in the Russian River –the largest population within the DPS (Busby et al. 1996). More recent estimates for the Russian River are on the order of 4,000 fish (NMFS 1997). Abundance estimates for smaller coastal streams in the DPS indicate low but stable levels with recent estimates for several streams (Lagunitas, Waddell, Scott, San Vicente, Pudding, and Caspar creeks) of individual run sizes of 500 fish or less (62 FR 43937; August 18, 1997). Some loss of genetic diversity has been documented and attributed to previous among-basin transfers of stock and local hatchery

[5] 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).

production in interior populations in the Russian River (Bjorkstedt et al. 2005). In San Francisco Bay streams, reduced population sizes and fragmented habitat conditions has likely also depressed genetic diversity in these populations. For more detailed information on trends in CCC steelhead abundance, see Busby et al. 1996; NMFS 1997; Good et al. 2005; Spence et al. 2008; Williams et al. 2011; and Williams et al. 2016.

CCC steelhead long-term population trends suggest a negative growth rate, indicating the DPS may not be viable in the long-term. Populations that historically provided enough steelhead immigrants to support dependent populations may no longer be able to do so, placing dependent populations at increased risk of extirpation. However, because CCC steelhead remain present in most streams throughout the DPS, roughly approximating the known historical range, CCC steelhead likely possess a resilience that has slowed their rate of decline relative to other salmonid species. The 2005 status review concluded that steelhead in the CCC steelhead DPS remain "likely to become endangered in the foreseeable future" (Good et al. 2005). On January 5, 2006, NMFS issued a final determination that the CCC steelhead DPS is a threatened species, as previously listed (71 FR 834).

The most recent status update concludes that steelhead in the 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 CCC steelhead DPS should remain listed as threatened (NMFS 2016c).

2.2.2.2 *CCC Coho Salmon ESU*

Historically, the CCC coho salmon ESU was comprised of approximately 76 coho salmon populations. Most of these were dependent populations that needed immigration from other nearby populations to ensure their long-term survival. Historically, there were 11 functionally independent populations and 1 potentially independent population of CCC coho salmon (Spence et al. 2008, Spence et al. 2012). Most of the populations in the CCC coho salmon ESU are currently doing poorly as a result of low abundance, range constriction, fragmentation, and loss of genetic diversity, as described below.

Brown et al. (1994) estimated that annual spawning numbers of coho salmon in California ranged between 200,000 and 500,000 fish in the 1940s, which declined to 100,000 fish by the 1960s, followed by a further decline to 31,000 fish by 1991. More recent abundance estimates vary from approximately 600 to 5,500 adults (Good et al. 2005). Williams et al. (2011) indicated that CCC coho salmon are likely to continue to decline in number. CCC coho salmon have also experienced acute range restriction and fragmentation. Adams et al. (1999) found that in the mid 1990's coho salmon were present in 51 percent (98 of 191) of the streams where they were historically present, and documented an additional 23 streams within the CCC coho salmon ESaU in which coho salmon were found for which there were no historical records. More recent genetic research has documented reduced genetic diversity within subpopulations of the CCC coho salmon ESU (Bjorkstedt et al. 2005). The influence of hatchery fish on wild stocks has likely also contributed to the lack of diversity through outbreeding depression and disease.

Available data from the few remaining independent populations suggests population abundance continues to decline, and many independent populations that in the past supported the species overall numbers and geographic distributions have been extirpated. This suggests that populations that historically provided support to dependent populations via immigration have not been able to provide enough immigrants for many dependent populations for several decades. The near-term (10-20 years) viability of many of the extant independent CCC coho salmon populations is of serious concern. These populations may not have enough fish to survive additional natural and human caused environmental change.

The CCC coho salmon ESU also includes coho salmon from the following conservation hatchery programs: the Russian River Coho Salmon Captive Broodstock Program at Don Clausen Fish Hatchery in Sonoma County, California, and the smaller Southern Coho Salmon Captive Broodstock Program at Kingfisher Flat Hatchery in the Scott Creek watershed, Santa Cruz County, California. While differing in size and funding, both programs were initiated in 2001 in response to severely depressed coho salmon abundances. Fish are collected from the wild, brought into the hatcheries, genetically tested, and spawned to maximize diversity and prevent inbreeding. In the hatchery, fish are raised to various ages, fed krill, tagged, and released into streams throughout the watersheds. This release strategy allows the fish to imprint on the creek with the aim that they will return to these streams as adults so they can spawn naturally. Juvenile coho salmon and coho salmon smolts have been released into several Russian River tributaries and coastal watersheds in San Mateo and Santa Cruz counties.

None of the five diversity strata defined by Bjorkstedt et al. (2005) currently support viable coho salmon populations. According to Williams et al. (2016), recent surveys suggest CCC coho salmon abundance has improved slightly since 2011 within several independent populations (mainly north of San Francisco bay), although all populations remain well below their high-risk dispensation thresholds identified by Spence et al. (2008). The Russian River and Lagunitas Creek populations are relative strongholds for the species compared to other CCC ESU populations, the former predominantly due to out-planting of hatchery-reared juvenile fish from the Russian River Coho Salmon Captive Broodstock Program. The most recent status review (NMFS 2016c) documents conditions for CCC coho salmon have not improved since the last status review in 2011 (Williams et al. 2016). The overall risk of CCC coho salmon extinction remains high, and the most recent status review reaffirmed the ESU's endangered status (NMFS 2016b). NMFS's recovery plan (NMFS 2012) for the CCC coho salmon ESU identified the major threats to population recovery. These major threats include roads, water diversions and impoundments, and residential development.

2.2.3 Status of CCC Steelhead and CCC Coho Salmon Critical Habitat

PBFs for CCC steelhead critical habitat within freshwater include:

1. Freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation, and larval development;
2. Freshwater rearing sites with:
   a) Water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility;
   b) Water quality and forage supporting juvenile development; and

c) 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;

3. Freshwater 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 CCC steelhead critical habitat within estuarine areas include: areas free of obstruction and excess predation with: water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh- and saltwater; natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels; and juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation.

For CCC coho salmon critical habitat, the following essential habitat types were identified: 1) juvenile summer and winter rearing areas; 2) juvenile migration corridors; 3) areas for growth and development to adulthood; 4) adult migration corridors; and 5) spawning areas (64 FR 24049). Essential features (or PBFs as discussed above) for coho salmon include adequate: (1) substrate, (2) water quality, (3) water quantity, (4) water temperature, (5) water velocity, (6) cover/shelter, (7) food, (8) riparian vegetation, (9) space, and (10) safe passage conditions (64 FR 24049).

The condition of CCC steelhead, and CCC coho salmon critical habitat, specifically its ability to provide for their conservation, has been degraded from conditions known to support viable salmonid populations. NMFS has determined that currently depressed population conditions are, in part, the result of the following human-induced factors affecting critical habitat[6]: logging, urban and agricultural land development, mining, stream channelization, and bank stabilization, dams, wetland loss, and water withdrawals (including unscreened diversions for irrigation). Habitat impacts of concern include altered streambank and channel morphology, elevated water temperature, lost spawning and rearing habitat, habitat fragmentation, impaired gravel and wood recruitment from upstream sources, degraded water quality/quantity, lost riparian vegetation, and increased sediment delivery into streams from upland erosion (Weitkamp et al. 1995; Busby et al. 1996; 64 FR 24049; 70 FR 37160; 70 FR 52488). Based on NMFS familiarity with the landscapes in which these critical habitats occur, these impacts continue to persist today. Widespread diverting of rivers and streams, as well as the pumping of groundwater hydraulically connected to streamflow, has dramatically altered the natural hydrologic cycle in many of the streams within the CCC steelhead DPS and CCC coho ESU which can delay or preclude migration and dewater aquatic habitat. Stream channelization, commonly caused by streambank hardening and stabilization, represents a very high threat to instream and floodplain habitat throughout much of the designated critical habitat for both species, as detailed within the CCC coho salmon and CCC steelhead recovery plans (NMFS 2012 and 2016a, respectively).

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[6] Other factors, such as over fishing and artificial propagation have also contributed to the current population status of these species. All these human induced factors have exacerbated the adverse effects of natural environmental variability from such factors as drought and poor ocean productivity.

Streambank stabilization confines stream channels and precludes natural channel movement, resulting in increased streambed incision, reduced habitat volume and complexity. Overall, the current condition of CCC steelhead and CCC coho salmon critical habitat is degraded, and does not provide the full extent of conservation value necessary for the recovery of the species.

The CZU Lightening Complex started as a series of lightening fires on August 16, 2020 across western Santa Cruz and San Mateo counties (California Department of Forestry and Fire Protection and California Department of Conservation 2020). The fire was fully contained on September 22, 2020, but burned a total of 86,509 acres. Portions of the burned area represented some of the highest quality habitat for salmonids in the Santa Cruz Mountains. In the San Lorenzo River watershed, areas that were burned included the upstream reaches of tributary drainages such as Fall Creek and Bolder Creek. The burn severity was considerably lower than those in coastal watersheds (Cal Fire and CDC 2020). Future winter storms may transport large quantities of ash, debris, and fine sediments into areas downslope from burned areas in the near future.

Recent research identified that toxic runoff from roadways is resulting in the recurrent and rapid mortality of adult coho salmon in the wild (Scholz et al. 2011) and laboratory settings (McIntyre et al. 2018). More recently, laboratory studies have found juvenile coho salmon (Chow et al. 2019) and juvenile steelhead and Chinook salmon (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).

2.2.4 Climate Change

Another factor affecting the rangewide status of CCC steelhead and CCC coho salmon and aquatic habitat at large is climate change. Impacts from global climate change are already occurring in California. For example, average annual air temperatures, heat extremes, and sea level have all increased in California over the last century (Kadir et al. 2013). Snowmelt from the Sierra Nevada has declined (Kadir et al. 2013). However, total annual precipitation amounts have shown no discernable change (Kadir et al. 2013). CCC steelhead and CCC coho salmon may have already experienced some detrimental impacts from climate change. NMFS believes the impacts on listed salmonids to date are likely fairly minor because natural, and local, climate factors likely still drive most of the climatic conditions salmonids experience, and many of these factors have much less influence on salmonid abundance and distribution than human disturbance across the landscape. In addition, CCC steelhead and CCC coho salmon, in the Santa Cruz Mountains, are not dependent on snowmelt driven streams and thus not affected by declining snow packs.

The threat to CCC steelhead and CCC coho salmon 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). Similarly, wildfires are expected to increase in frequency and magnitude (Westerling et al. 2011; Moser et al. 2012).

In the San Francisco Bay region[7], warm temperatures generally occur in July and August, but as climate change takes hold, the occurrences of these events will likely begin in June and could continue to occur in September (Cayan et al. 2012). Climate simulation models project that the San Francisco region will maintain its Mediterranean climate regime, but experience a higher degree of variability of annual precipitation during the next 50 years and years that are drier than the historical annual average during the middle and end of the twenty-first century. The greatest reduction in precipitation is projected to occur in March and April, with the core winter months remaining relatively unchanged (Cayan et al. 2012).

Estuaries 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). 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 (Brewer and Barry 2008; Feely 2004; Osgood 2008; Turley 2008; Abdul-Aziz et al. 2011; Doney et al. 2012). The projections described above are for the mid to late 21st Century. In shorter periods, climate conditions not caused by the human addition of carbon dioxide to the atmosphere are more likely to predominate (Cox and Stephenson 2007; Smith et al. 2007; Santer et al. 2011).

Finally, climate change is also affecting water circulation and temperature patterns in the marine environment. In fall 2014, and again in 2019, a marine heatwave, known as “The Blob”[8], 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.

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 includes approximately 7,600 linear feet of the San Lorenzo Lagoon, which extends from Monterey Bay upstream to the vicinity of Water Street, and approximately 3,220 feet of Branciforte Creek from the San Lorenzo River confluence upstream to the vicinity of Water Street. These areas are

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[7] Both the San Francisco Bay and Monterey Bay regions exhibit similar Mediterranean climate patterns. The action areas are located within the Monterey Bay region.

[8] https://www.fisheries.noaa.gov/feature-story/new-marine-heatwave-emerges-west-coast-resembles-blob

influenced by changes in lagoon stage as modified by the project. The action area encompasses the bed and banks of the river (including a small portion of Branciforte Creek) and lagoon, which consist of levees and associated narrow inboard riparian corridor along the San Lorenzo River, the concrete flood control channel in Branciforte Creek, sand dunes on the main beach adjacent to the lagoon and the Santa Cruz Beach Boardwalk.

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).

2.4.1 Status of Critical Habitat in the Action Area

2.4.1.1 *General Description of the San Lorenzo Lagoon*

The San Lorenzo Lagoon is classified as a bar-built estuary, which forms at the mouth of the San Lorenzo River once a sandbar develops and blocks the river from entering Monterey Bay. The sandbar is part of Santa Cruz Main Beach and extends from San Lorenzo Point west towards the Santa Cruz Wharf. The lagoon extends from the beach upstream to approximately the Water Street Bridge crossing and includes the confluence with Branciforte Creek (Figure 7). The San Lorenzo River and Lagoon are designated critical habitat for CCC steelhead and CCC coho salmon, and support rearing and migration habitats for these species. PBFs include water quality, water quantity, suitable water temperature and salinity conditions, cover/shelter, food, and safe passage conditions.

Depending on the status of the sandbar and degree of tidal exchange, water quality in the lagoon can vary from nearly completely freshwater (prolonged sandbar closure) to nearly full seawater (sandbar is fully open and with high tidal exchange). Under either sandbar condition, water quality in the lagoon differs longitudinally with thicker layers of freshwater upstream and an increasingly thicker saltwater bottom layer farther downstream (Figure 8). Once the sandbar forms, the lagoon's water column begins impounding freshwater inflow from the river and groundwater. Waves, particularly those generated by south swells, can run-up and spill over the sandbar and periodically contribute saltwater to the closed lagoon. When the lagoon is closed and the water surface elevation increases, the greater hydrostatic pressure of the water column forces the bottom saltier layers through the sandbar (i.e., percolation through the sandbar) and into the ocean which promotes a gradual freshening of the lagoon (Figure 8).

Productivity in the lagoon is greatest when the sandbar is closed and the water column has converted to freshwater, or when the water column is mixed by diurnal tidal exchange during periods when the sandbar is open (Figure 8). Productivity declines or is lowest when the sandbar is closed and the water column within the lagoon remains stratified with denser and warmer saltwater at depth and fresher water towards the surface. The stratification reduces, or eliminates, vertical mixing of the water column, and over time this leads to increased water temperatures and a decline in dissolved oxygen concentrations in the lower water column layers. In a closed lagoon, stratification is most common during periods of lower freshwater inflow—mid to late summer and early fall, or briefly soon after bar formation (Smith 1990).

Prior to major land use disturbance, a sandbar formed at the mouth of the San Lorenzo River during the summer dry season (Anonymous 1879). Under these conditions, and depending on the timing of sandbar development, the surface area of the lagoon would expand and flood adjacent wetland and riparian habitats. Beginning in the mid-19th Century, development of the watershed resulted in extensive modifications to the lower river and lagoon areas. Currently, the lower reaches of the San Lorenzo River, including those surrounding the lagoon, are heavily urbanized (Figure 7 and Figure 9). As a result, both the extent and quality of habitat in the lagoon utilized by steelhead and coho salmon have been reduced. This includes the loss of access to its adjacent floodplain and most of its former adjacent wetland/riparian areas (Figure 9). Urbanization within the watershed has had other deleterious impacts on habitats within the river and lagoon including the extent of impervious surfaces, discharge of urban runoff from storm drain systems, and water resource development and use. This has resulted in changes in storm runoff response and an increase in the conveyance of nutrients and other contaminants to the lagoon. These contaminants have contributed to poor water quality conditions at times in the lagoon, including low dissolved oxygen concentrations and harmful algal blooms (PWA and JSA 1989).

The downstream reaches of Branciforte Creek are also heavily urbanized. This portion of the creek has been converted into a narrow, concrete-lined flood control channel. A low-flow notch was more recently added to the center of the channel to improve salmonid fish passage. In its current condition, habitat quality for rearing juvenile salmonids is severely limited in this stretch of the creek, particularly when the lagoon water surface elevation is low. At higher lagoon elevations, the channel becomes inundated with depths up to 3.0 feet or more and juvenile steelhead have been observed in the channel under these conditions (Joel Casagrande, NMFS, personal observation, August 2015). Native riparian and wetland vegetation and natural substrate are very limited within the channel and are occasionally removed for flood control maintenance.

Figure 7. The project action area, showing the lower San Lorenzo River, the lagoon, lower Branciforte Creek, Santa Cruz Beach Boardwalk, Wharf and main beach.

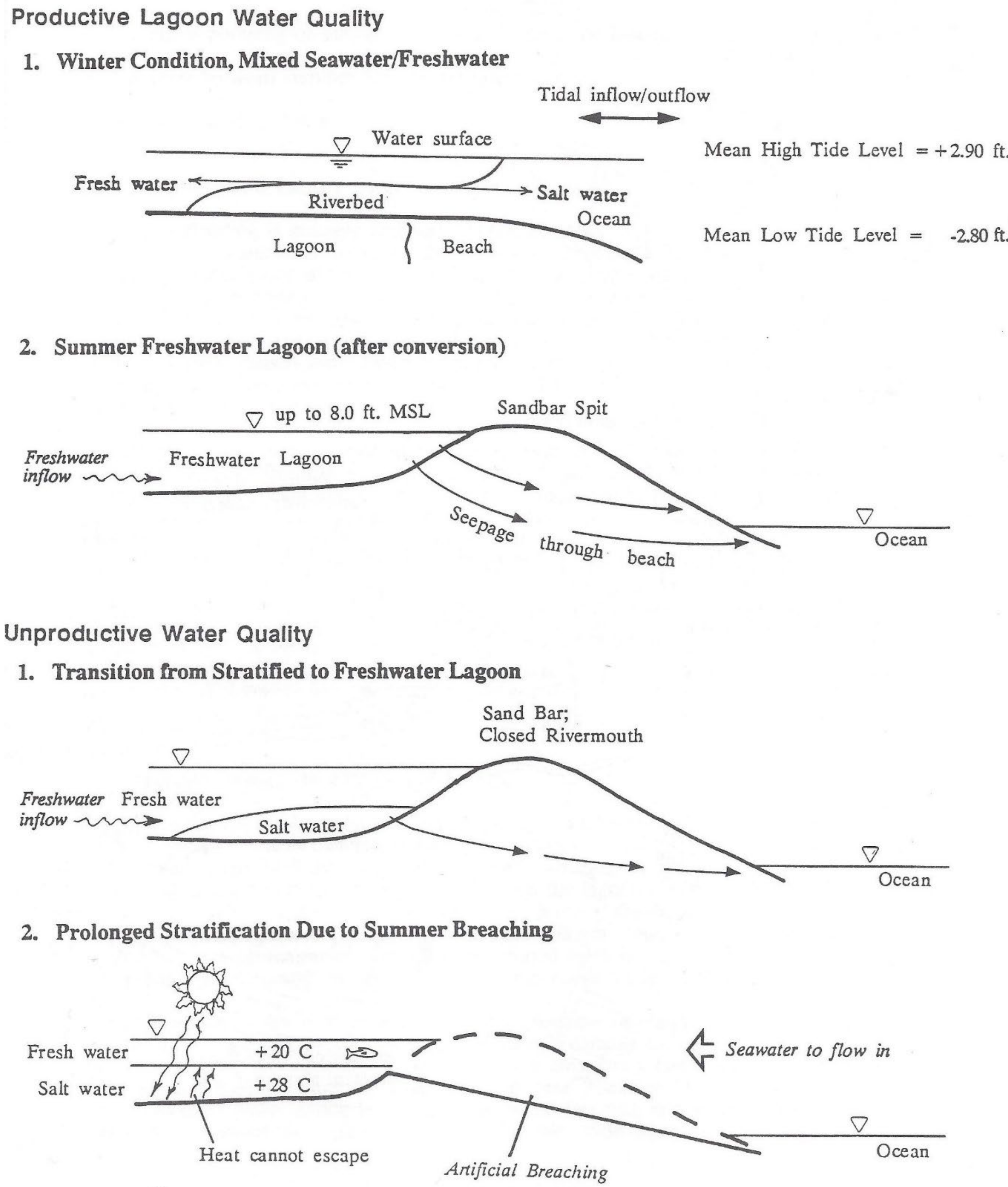


Figure 8. Schematic of lagoon water quality dynamics with an open and closed sandbar. From: PWA and JSA (1989).

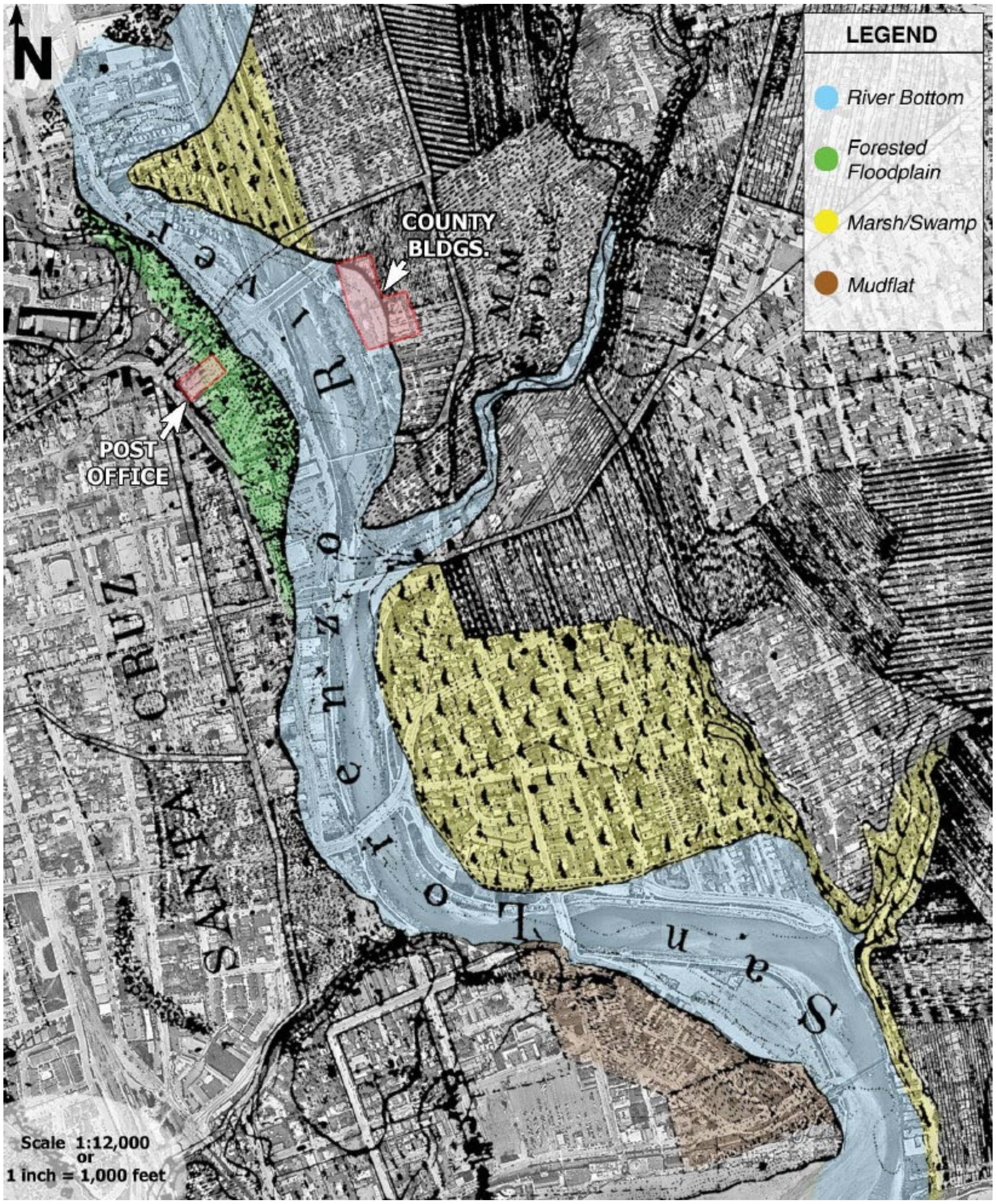


Figure 9. The historic (circa 1854) lower river, lagoon area, and adjacent wetland habitats overlaid on contemporary aerial photograph. Source: SHG et al. 2002.

The lower San Lorenzo River and lagoon are constrained by flood control levees that protect the City from flood. The levees border the river channel from near Highway 1, downstream to the Beach Boardwalk and were constructed by the Corps in 1960 following a devastating flood during the winter of 1955 (PWA and JSA 1989; McMahon 1997; SHG et al. 2002). During the construction of the levees, the lower river channel was straightened, dredged, and nearly all vegetation within the channel was removed. Between 1960 and 1989, the channel was routinely dredged and nearly all vegetation was removed to maximize and maintain flood flow conveyance. Since 1989, dredging and vegetation removal have been more irregular and some riparian vegetation has been allowed to successfully recolonize the upper and middle reaches of the lower river channel (e.g., down to Soquel Avenue Bridge).

Four bridges cross the river/lagoon within the action area, which include (from upstream to downstream) Water Street, Soquel Avenue, Laurel Street, and Riverside Avenue. During the 1990's all four bridges were replaced and raised to meet current seismic standards and to increase flow conveyance. The modifications of these former channel constriction points has contributed to the reduction in the frequency and magnitude of sediment and vegetation removal from the lower river/upper lagoon areas. Between 1999 and 2003, the Corps implemented the San Lorenzo River Flood Control Improvement Project, which included rebuilding and or enlarging the existing levees and floodwalls. Despite these improvements and upgrades to infrastructure, some flood control maintenance activities remain necessary. Sediment and vegetation removal is now more carefully managed and conducted based on site-specific conditions as opposed to complete channel dredging and clearcutting.

Downstream of the Laurel Street Bridge the banks of the river/lagoon are steep, mostly lined with rock (i.e., riprap), and wetland vegetation remains extremely scarce. The Corps constructed a series of pump stations within the levees. These pumps were designed to serve as standby storm water pumps and were not intended to run as continuous water circulating pumps. During periods of high lagoon stage, the pumps must run continuously.

Freshwater inflow to the lagoon is primarily provided by the San Lorenzo River and, to a lesser extent, Branciforte Creek. The City operates a diversion on the San Lorenzo River at Tait Street, located approximately 0.5 miles upstream of the Highway 1 Bridge crossing and less than one mile upstream from the lagoon. The United States Geological Survey (USGS) operates a streamflow gage (11161000 San Lorenzo River at Santa Cruz) just downstream of the Tait Street diversion. Table 1 shows the mean monthly river discharge over 41 years of record at the gage. Although located approximately 1.0 mile upstream of the lagoon, the gage is located downstream of the City diversions and provides an index of river inflow to the lagoon. On average, inflow to the lagoon peaks in February and is lowest in September.

Table 1. Mean monthly river discharge measured at the USGS gage 11161000 in the San Lorenzo River near Santa Cruz.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean monthly discharge (cfs)	309	393	263	153	67	35	19	12	11	16	28	172

The City is currently developing *The City of Santa Cruz Anadromous Salmonid Habitat Conservation Plan* (HCP) for its water supply operations. As part of the HCP, the City has worked with CDFW and NMFS to develop bypass flows for their Tait Street diversion to protect rearing and migratory habitat for steelhead, coho salmon, and other aquatic species in the lower river and lagoon. As of spring 2022, the HCP has not been completed, however, the City has voluntarily implemented the tolling bypass agreements annually beginning in 2016. The minimum bypass flow during dry and critically dry water year types is 8.0 cfs.

The Seaside Company owns and operates the Santa Cruz Beach Boardwalk (Beach Boardwalk), which is located primarily on the leeward side of Main Beach and immediately adjacent to the San Lorenzo Lagoon (Figure 7). Due to the high water table in the low lying areas surrounding the Beach Boardwalk and the low elevation of Boardwalk's infrastructure (-5.0 feet mean sea level), water continually infiltrates the Boardwalk's basement and must be pumped out year round (HES 2015a). This water is discharged onto the beach adjacent to the lagoon. Similarly, low lying areas within the former marshes on the north side of the lagoon (Figure 9) experience flooding when the lagoon's water surface elevation exceeds 5.5 feet NGVD 29. This includes flooding of electrical systems for street and signal lights, residential property, and the flooding of City streets and trails. At these water surface elevations or higher, pumps within the Corps levees along the lagoon must run continuously.

There is a long history of flooding along the San Lorenzo River (PWA and JSA 1989; McMahon 1997). Despite the extensive levee systems, flooding remains a problem and sandbar management has remained necessary (Figure 10). The littoral currents along this portion of Monterey Bay deliver sand from west to east. In 1965, the Santa Cruz Harbor (including its jetties) was constructed south of the river mouth, which has affected the size of the beaches to the north. Sand captured by the jetties in the littoral current has broadened both Seabright Beach to the south of the lagoon and Main Beach (Griggs and Savoy 1985). The accumulation of beach sand has also contributed to the flood potential by maintaining a wider and larger beach dune. To avoid flooding, the sandbar has usually been opened when the lagoon water surface elevation reached or exceeded 5.0 or 6.0 feet NGVD 29.

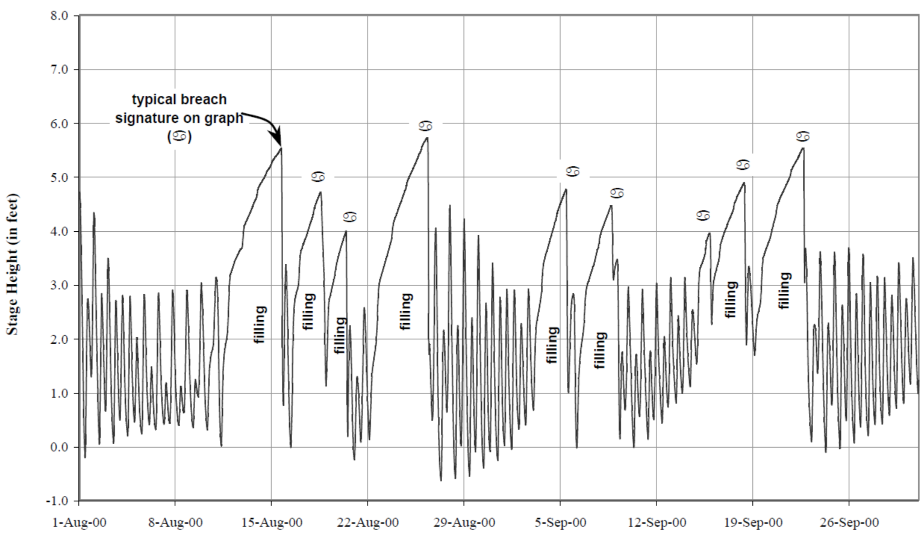
Breaching of the sandbar has been conducted for several decades for multiple reasons including flooding, beach recreation access, and water quality problems. Another concern is the risk to public safety. In summer, Main Beach can have up to ten thousand people present and there have been multiple occurrences of injuries or deaths during an abrupt breach of the river mouth despite the presence of safety personnel.

Breaching the sandbar, particularly during the dry season, can lead to degraded rearing conditions for salmonids in the lagoon (Figure 8). The draining of the lagoon during an uncontrolled breach can adversely affect juvenile salmonids through a sudden loss in volume (i.e., habitat), increase in predation risk, and subsequent changes in water quality; particularly the introduction of saltwater and the release of freshwater. Repeated breaching throughout the dry season disrupts the rearing habitat and prevents the lagoon from completely converting to freshwater. Prior to 2015, mechanical sandbar breaching was implemented to reduce flooding with little or no regard for the impacts on species or their habitat within the lagoon. In addition to mechanical management, it is not uncommon for private individuals to breach the lagoon for various reasons (Figure 10).

The proposed Project is not the first time a culvert system has been considered for dealing with dry season flooding around the lagoon, water quality, and public safety. PWA and JSA (1989) presented a preliminary design of a water control structure along San Lorenzo Point similar to the proposed head driven culvert. The design by PWA and JSA (1989) targeted a maximum lagoon water surface elevation of 4.5 feet mean sea level with bottom ports for the targeted export of saltwater off the bottom.

(a.)

(b.)



(c.)

Figure 10. A mechanical breach of the river mouth on June 23, 1989 (a), an attempt at breaching by members of the public using shovels, August 2019 (b), and a lagoon hydrograph from August and September 2000 showing the frequent breaching at near flood stage (> 5.0 feet). Source: (a) courtesy of Dr. Jerry Smith, (b) courtesy of a private citizen of Santa Cruz, and (c) SHG et al. (2002).

2.4.1.2 *Recent Sandbar Management Actions*

Between 2016 and 2021, the City has implemented several sandbar management actions to reduce flooding and enhance public safety. This has included specific actions described in the Sandbar Toolkit. Some actions were implemented in response to emergency conditions such as levee leaks and heightened public safety concerns, including injury and loss of life. Summaries of these events are provided below.

2016 – The winter of 2015-16 was dry and the fourth consecutive drought year. Mean August discharge at the San Lorenzo River USGS gage near Highway 1 was 9.6 cfs (2ndNature 2017). Two sandbar management actions were conducted by City during the summer and early fall of 2016. The first occurred on August 29, and the second on October 26, 2016. Both management actions were scheduled to coincide with high tides to minimize tidal influence with the lagoon. The August 29 action included the use of a TOC with constructed sand sills in an attempt to minimize the extent of lagoon draining. Both actions resulted in partial drainage of the lagoon. For the first event, water surface elevations remained at or above approximately 3.0 feet NGVD 29, and the lagoon remained open following the second event (Figure 11). No stranded salmonids were observed during or following these management actions.

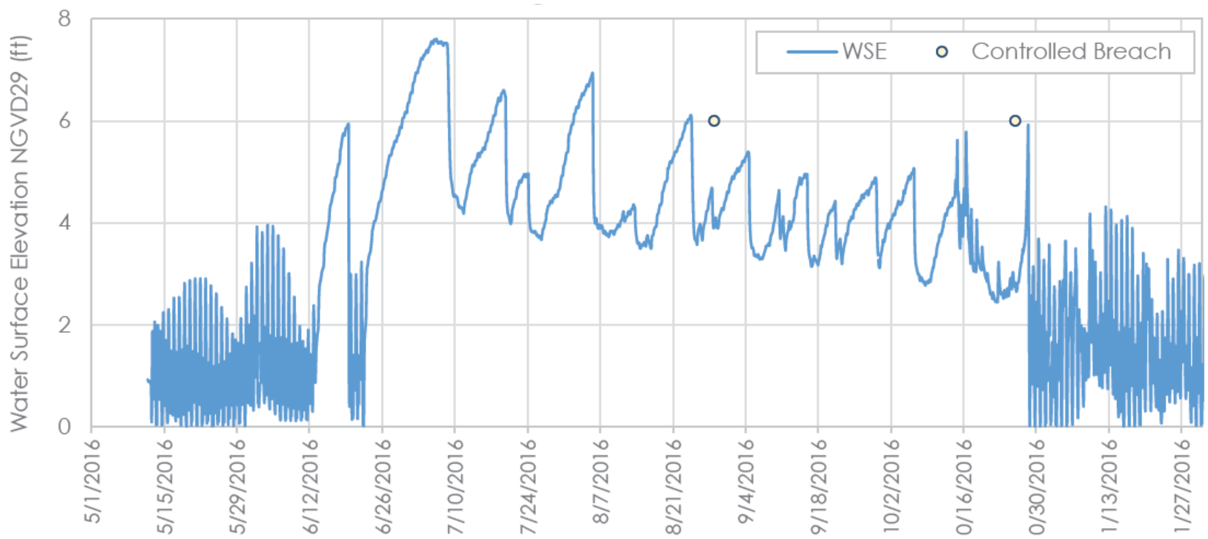


Figure 11. Water surface elevation in the San Lorenzo Lagoon, May through November 2016. From: 2ndNature (2017).

2017 – Unlike the previous four winters, the 2016-17 winter was extremely wet, with a mean August discharge in the lower San Lorenzo River of 27.8 cfs (2[nd] Nature 2018). Due to the high inflow rates, the City did not implement sandbar management actions during 2017. Four brief sandbar closures occurred, which either opened naturally or were opened illegally by public (Figure 12).

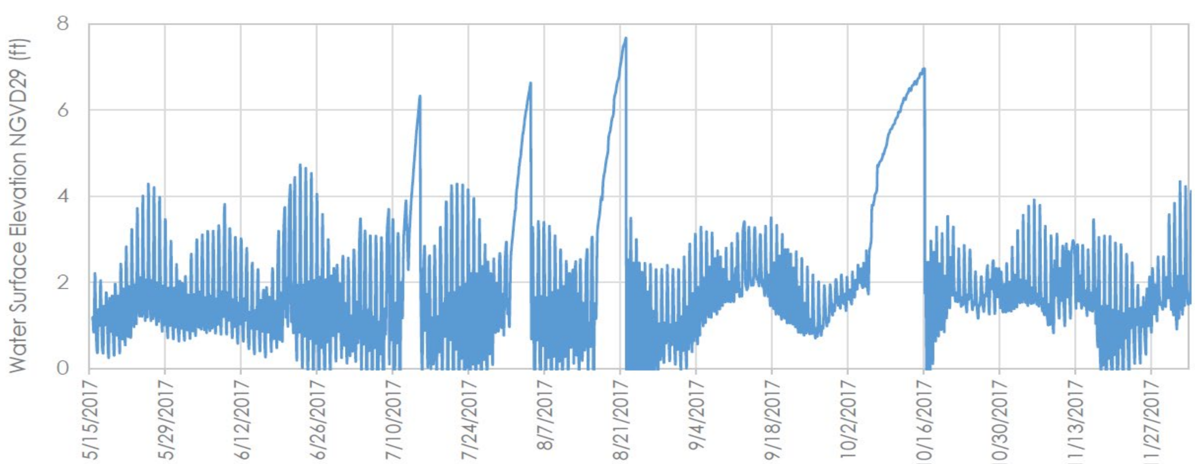


Figure 12. Water surface elevation in the San Lorenzo Lagoon, May through November 2017. From: 2ndNature (2018).

2018 –The winter of 2017-18 was again dry and mean August discharge in the lower San Lorenzo River near Highway 1 was 8.7 cfs (2ndNature 2019). As a result, the sandbar formed earlier and more frequently than 2017. The City implemented two actions during the summer and fall of 2018. The first action occurred on July 18, when the lagoon's water surface elevation reached a height of approximately 7.0 feet NGVD 29. This action was similar to the August 2016 sandbar management action (i.e., use of a TOC and constructed sand sills) only at a much higher water surface elevation. Despite using the same action type, the lagoon's water surface elevation declined to approximately sea-level following implementation (Figure 13). No dead or stranded salmonids were observed. The second action on October 25 involved priming (i.e., grading) the sandbar such that it would allow the lagoon's water surface elevation to rise and breach at a pre-graded elevation. The lagoon's elevation reached approximately 7 feet NGVD 29. The sandbar breached through the primed channel on October 26, and again drained down to approximately sea-level before closing the following day. By October 31 the lagoon water surface elevation was at approximately 5.0 feet NGVD 29 (Figure 13).

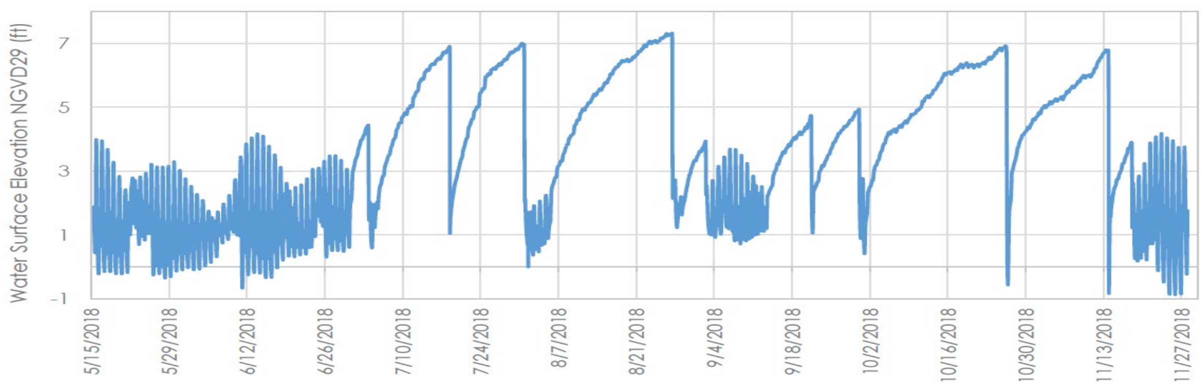


Figure 13. Water surface elevation in the San Lorenzo Lagoon, May through November 2018. From: 2ndNature (2019).

2019 – Like the winter of 2016-17, the winter of 2018-19 was considered above average. Summer river inflow was again high, with a mean August inflow of 21.6 cfs (2ndNature 2020). This kept the lagoon open most of the dry season, with only brief closures. Between June and early September, the few brief closures resulted in breaches that were either natural or the result of illegal breaches by members of the public (Figure 14). In mid-September, the sandbar formed and over nine days the lagoon water surface elevation rose to over 8 feet NGVD 29. As a result of these high elevations, lagoon water began leaking through the levee and flooded residential and City properties. The City was instructed by the Corps to quickly lower the water surface elevation in the lagoon to avoid further deterioration of the levee's integrity and additional flooding. Four sandbar management actions were implemented by the City. City staff used a single shovel to create a trench in the sandbar that resulted in a breach on September 17 (Figure 14). This same action (shovel opening) was repeated on September 27, October 11, and October 28 due to the emergency nature of the levee conditions.

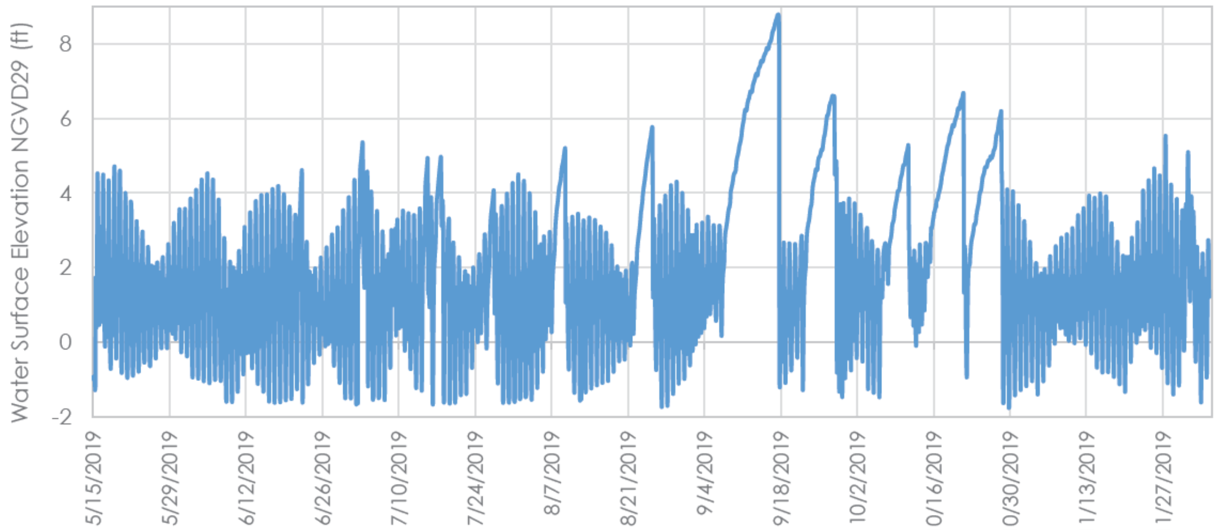


Figure 14. Water surface elevation in the San Lorenzo Lagoon, May through November 2019. From: 2ndNature (2020).

2020 – The winter of 2019-2020 was dry with a mean August river inflow of 9.0 cfs. During the summer through fall period, the City did not implement sandbar management actions. The lagoon outlet channel was similar to 2016, with a long westward channel parallel to the shoreline. The City closed its beaches to the public due to the shelter in place orders related to the Covid-19 pandemic. The longer, westward outlet channel maintained a perched lagoon condition with brief closures opened by natural (or potential illegal) breaches. The lagoon's water surface elevation ranged from 3.0 to 6.5 feet NGVD 29 (Figure 15), but mostly remained between 4.0 and 6.0 feet NGVD 29 (2ndNature 2021). Water quality during this period remained suitable for juvenile salmonid rearing (2ndNature 2021).

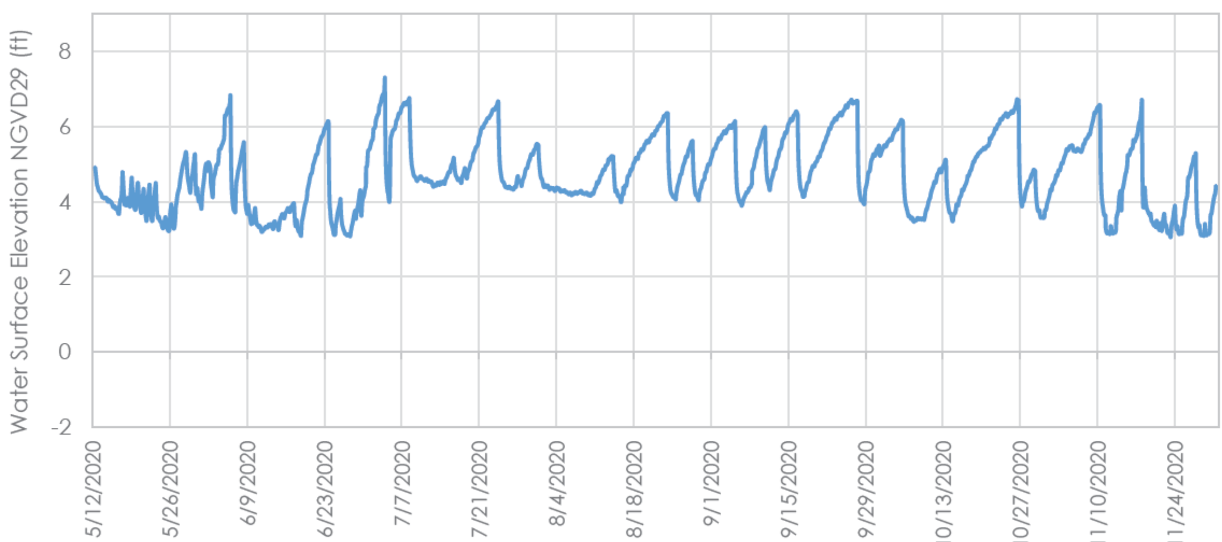


Figure 15. Water surface elevation in the San Lorenzo Lagoon, May through November 2020. From: 2ndNature (2021).

2021 – The winter of 2020-21 was exceptionally dry and the second consecutive drought year. By early May, flow in the lower river was less than 10.0 cfs. The low inflow caused the sandbar to form earlier resulting in the need for frequent sandbar management actions. On May 16, the sandbar breached naturally at a water surface elevation of 6.5 feet NGVD 29. During the breach, two children were entrained into the ocean and an adult drowned while trying to rescue them. Due to the emergency situation and the anticipated large crowds for the Memorial Day weekend, the City implemented an emergency action on May 29, 2021, once the water surface elevation returned to approximately 6.5 feet NGVD 29. The City implemented a "low flow breach" action, which includes the use of a narrow and angled pilot channel that is opened with a high tide. No stranded or dead salmonids were observed; however, large juvenile steelhead or adults were observed swimming back and forth in the outlet channel (Revell 2021). By late June the lagoon water surface elevation reached over 7.0 feet NGVD 29. The high water elevations caused flood damage to private and City properties. Due to the high elevations and anticipated large crowds for the July 4th weekend, the City implemented another emergency low-flow breach on July 1. This time the outlet channel was angled across a high berm towards the west which resulted in a slower lowering of the lagoon's water surface elevation. No stranded or dead salmonids were observed. The sandbar formed within 48 hours and the City implemented a repeat action on July 8. No stranded or dead salmonids were observed; however, an adult steelhead kelt was photographed swimming through the outlet channel and into the ocean (Revell 2021). By July 16, water elevations in the lagoon exceeded 6.0 feet NGVD 29, and the City once again implemented the low-flow breach action on July 16. No stranded or dead salmonids were observed (Revell 2021).

In summary, the City has implemented various different sandbar management actions to limit flooding and public safety risks. Each event was coordinated closely with the resource agencies to minimize or avoid impacts to listed species and water quality. No stranded, injured, or dead steelhead or coho salmon were observed by biological monitors during these past management actions, but adult or large juvenile steelhead were observed volitionally using the outlet channel during two recent management actions in 2021. However, the frequent disturbances, particularly those later in dry season, disrupt rearing habitat quantity by draining a portion of the lagoon, and quality by interrupting the gradual conversion of the lagoon's water column to fresher conditions.

The recovery plans for both the CCC coho salmon ESU (NMFS 2012) and the CCC steelhead DPS (NMFS 2016b), identify specific recovery actions related to estuary management, estuarine habitat enhancement, and public outreach regarding sandbar breaching at the San Lorenzo River. Specific to the proposed Project, NMFS (2016b) identified the following action for the recovery of the CCC steelhead DPS:

- *SLR-CCCS-1.1.4.1* – Develop and implement long-term solutions that reduce the need for artificial sandbar breaching and address flooding concerns at adjacent properties.

NMFS rated this action as Priority 1 (high priority) for the San Lorenzo River steelhead population due to the high utilization of the lagoon by steelhead during the dry season.

NMFS (2012) also identified a similar recovery action for CCC coho salmon:

- *SLR-CCC-1.1.6.1* – Evaluate and implement possible structural improvements to maintain water surface elevations during the summer through the late fall in the lagoon.

NMFS rated this action as Priority 2 (medium priority) because, while important for improving habitat quality in general, CCC coho salmon do not typically utilize closed coastal lagoons for prolonged periods during summer due to high water temperatures. These actions are almost exclusively implemented during summer and early fall.

2.4.1.3 *Climate Change*

The long-term effects of climate change have been presented in Section 2.2.4 Climate Change. These include air temperature and precipitation changes that may affect steelhead and critical habitat by changing water quality, streamflow, lagoon WSE, and steelhead migration opportunities.

The threat to designated critical habitats in the action area from climate change is likely going to mirror what is expected for the rest of Central California. NMFS expects that average summer air temperatures would increase, heat waves would become more extreme, and droughts and wildfire would occur more often (Hayhoe et al. 2004; Lindley et al. 2007; Schneider 2007; Westerling et al. 2011; Moser et al. 2012; Kadir et al. 2013). Many of these changes are likely to further degrade habitat in the action area by reducing streamflow in the lower river, the volume of freshwater in the lagoon during the summer which can impact water quality (water temperatures and dissolved oxygen concentration) in the lagoon. If the timing and the amount of freshwater inflow to the lagoon decline, we can expect longer periods with a shallower and more stratified water column in the lagoon that would reduce habitat suitability for CCC steelhead and CCC coho salmon. However, impacts on freshwater inflow to the lagoon are somewhat buffered by the operation of Loch Lomond Reservoir releases and the City's river bypass requirements near the head of the estuary as part of the HCP, and the proposed culvert system will help to export saltwater and reduce periods of water column stratification.

Such changes to the regional climate could also lead to drier forest conditions and an increased threat of wildfires. As noted above, the CZU Lightening Complex burned 86,509 acres across western Santa Cruz and San Mateo counties, including upstream portions of the San Lorenzo River drainage (e.g., upper portions of the Fall Creek and Boulder Creek tributaries). An increase in frequency of such events within the basin could impact vegetative cover and increase fine sediment and other pollutants to the lagoon, which could have adverse consequences on the PBFs for rearing habitat.

2.4.2 Status of CCC Steelhead in the Action Area

The San Lorenzo River watershed supports one of the largest steelhead populations within the Santa Cruz Mountains Diversity Stratum (NMFS 2016b). This population is functionally independent and likely provides frequent dispersal to nearby smaller coastal populations. Recovery criteria for the San Lorenzo River population of CCC steelhead is a spawner density target of 3,200 (NMFS 2016b).

Complete and consistent annual estimates of adult steelhead escapement to the San Lorenzo River watershed do not exist. Spatially balanced spawning ground surveys conducted as part of California's Coastal Monitoring Program have produced partial estimates of escapement for the winters of 2012-13 to 2014-15 (Table 2). These estimates were made during the recent 2012-2016 drought.

Table 2. Estimates of adult steelhead escapement to the San Lorenzo River watershed during the winters of 2012-13 to 2014-15 as part of the California Monitoring Plan (Jankovitz 2013; Goin 2015; Goin 2016).

Winter	Point Estimate	Low 95% CI	High 95% CI
2012-13	648	0	1,717
2013-14	777	343	1,211
2014-15	188	76	300

Since 2002, Hagar Environmental Sciences (HES) and others have sampled the San Lorenzo Lagoon during the dry season to document juvenile salmonid abundance (HES 2022). Table 3 lists the average steelhead capture per seine haul across sites sampled in the lagoon during the dry season from 2002 and 2021, and Table 4 lists the spring and fall juvenile steelhead mark-recapture population estimates in the lagoon from 2011 to 2020. Steelhead catch per seine haul varies temporally and spatially. Capture is influenced by physical habitat conditions (depth and volume), fish abundance, and water quality. In general, when the sandbar is closed and the lagoon is fuller, depths in parts of the lagoon may exceed the height of the beach seine (8 feet). The larger habitat volume allows fish within the lagoon to disperse more, particularly in response to variable water quality and prey availability. Conversely, when the sandbar is open and the lagoon is at low tide, fish are condensed into a smaller habitat volume with more shallow depths and, therefore, capture can be more efficient.

Since 2002, steelhead capture per unit effort (CPUE) via beach seine has varied among years and months. Years with high CPUE include 2017 and 2019 (both wet years), when freshwater inflow to the lagoon in summer was relatively high and periods of sandbar closure were limited or absent (Table 3). CPUE was also high in 2020, particularly early in the season. Similarly, prior to 2020, the largest population estimates generated from mark-recapture sampling during both the spring and fall sample periods occurred during wet years of 2017 and 2019, when mean August inflow to the lagoon was 27.8 and 21.6 cfs, respectively, and the mouth at the sandbar was almost always open. However, during the dry year of 2020, the lagoon developed an elongated outflow channel, that allowed the lagoon to remain open for most of the summer period, but maintained a perched condition that prevented saltwater from entering the lagoon. As noted above, due to the Covid-19 pandemic, Main Beach was closed to the public in 2020 and, therefore, the elongated outflow channel dissecting main beach was not as much of an issue for public safety. These physical conditions, coupled with a lack of sandbar management, allowed the lagoon to develop a more stable and fresher water column throughout the summer (2nd Nature 2021; HES 2022). Both the CPUE and population estimates for juvenile steelhead that spring and fall were high, suggesting habitat conditions in the lagoon were favorable throughout the year (Table 3 and Table 4). Overall, the trend for early (June) and late (September) steelhead CPUE is increasing, with notable differences following the voluntary implementation of bypass flows per the City's HCP tolling agreement (i.e., 2016 to present).

Table 3. Steelhead catch per unit effort in the San Lorenzo Lagoon June - October of 2002-2021. Data are the average of all sampled sites. Source: HES 2022.

Year	June	July	August	September	October
2002					12.8
2004		21.9		0.1	
2005	8.9	4.6	48.0		15.7
2008	2.6				0.1
2009	0.3			1.0	0.5
2010	8.3	21.5			28.3
2011	13.0				2.5
2012	1.7			14.4	
2013	2.0	8.4		4.7	
2014	1.2	1.1		0.0	
2015	2.6	0.0	0.0		0.0
2016	39.7	1.0	2.0	7.8	
2017	134.4	452.0	272.0	328.5	
2018	23.3	2.5	6.4	6.3	
2019	92.2	53.4	277.7	228.2	
2020	146.1	120.6		31.0	
2021	4.3	6.4			0.3

Table 4. Juvenile steelhead population estimates in the San Lorenzo Lagoon during spring and fall sample periods 2011-2021. Source: HES (2022).

Year	Spring	Fall
2011	501	138
2012	60	714 [1]
2013	207 [2]	No estimate [3]
2014	No estimate [4]	None captured
2015	559 [3]	None captured
2016	2,697	1,331
2017	3,636	>3,636 [5]
2018	2,378	704
2019	7,637 [6]	14,105
2020	26,815	18,720
2021	Not sampled	No estimate [2]

[1] May have been fish entering or leaving lagoon
[2] Low number of marks or recaptures, likely biased
[3] Evidence population not closed, violates assumption of the method
[4] No recaptures
[5] Estimate based on CPUE, mark-recapture estimate not possible, recapture period precluded due to incidental take limitations.
[6] Based on proportion of fish in the catch greater and less than 80 mm FL there would have been an estimated 4,504 *O. mykiss* less than 80 mm FL for a total population of 12,141

To date, the vast majority (>95 percent) of juvenile steelhead captured in the lagoon in the early to mid-summer (June through August) are greater than 60 mm FL (Figure 16). As has been shown in other central California lagoons (Smith 1990; Bond et al. 2008; Jankovitz and Diller 2019), juvenile steelhead that enter the lagoon early in the season grow rapidly due to the highly productive environment.

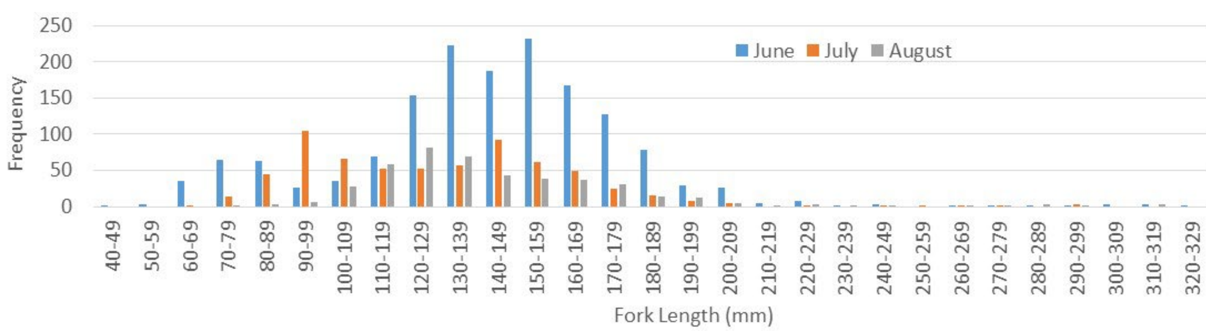


Figure 16. Juvenile steelhead length frequencies captured in the lagoon in June, July, and August 2008-2020. From: Hagar Environmental Sciences.

2.4.3 Status of CCC Coho Salmon in the Action Area

Historically, CCC coho salmon were believed to inhabit all or most of the accessible coastal streams in Santa Cruz County. By the 1960's CCC coho salmon were believed present in seven populations in Santa Cruz County including the San Lorenzo River (Bryant 1994). More recently, observations of coho salmon in the San Lorenzo River watershed have been scarce. One adult, natural origin coho salmon was caught in the Felton Diversion Dam on the San Lorenzo River in the winter of 2012/2013, and a very small number of hatchery-origin adults are occasionally detected (i.e., tag detected) at the Felton Diversion dam tag antenna. Monitoring associated with the Southern Coho Salmon Captive Broodstock Program has confirmed the straying of broodstock program fish into the San Lorenzo River. NOAA's Southwest Fisheries Science Center (SWFSC) operates a passive integrated transponder tag (PIT-tag) antenna array at the Felton Diversion Dam on the San Lorenzo River. Since the winter of 2016-17, a small number of tagged hatchery-origin adults have been detected at the antenna each year (Table 5).

Juvenile coho salmon were last captured in the San Lorenzo River watershed at two electrofishing sites in Bean Creek, a tributary to Zayante Creek, during fall of 2005. That same year, two juvenile coho salmon were also captured in Zayante Creek near the confluence with Bean Creek (Hagar 2005), and others were observed in Bean Creek during snorkel surveys conducted by NMFS staff (Alley 2019).

Table 5. Number of PIT-tagged coho salmon detected at the Felton Diversion Dam antenna during the winters of 2016-17 through 2019-20. Source: Southwest Fisheries Science Center.

Winter	Number of coho salmon detected
2016-17	1
2017-18	1
2018-19	9
2019-20	2

Within the action area (i.e., the lagoon), juvenile coho salmon have not been captured or observed during the annual sampling described above in section 2.4.2, or during any of the sandbar management actions. In addition to poor abundance or absence in the San Lorenzo River watershed in recent decades, high water temperature in the lagoon during the summer period is thought to be a limiting factor for the presence of juvenile coho salmon in the San Lorenzo River lagoon (NMFS 2012; HES 2022).

Under current conditions, NMFS considers the action area a migratory corridor for coho salmon adults, and as a migratory and temporary growth and saltwater acclimation area for juvenile coho salmon smolts prior to entering the ocean during spring. During the dry winter of 2014, the San Lorenzo River was the first regional stream to open to the ocean (January 24, 2014). Due to the low flow conditions, multiple adult coho salmon and steelhead were observed holding in the lagoon. Efforts to capture these fish by CDFW, NMFS and other partners resulted in 19 coho salmon males (all age-2+ jacks) and 109 steelhead adults. Four of the coho salmon had PIT-tags indicating they were releases from the SCSCBP.

2.4.4 Previous ESA Section 7 Consultations and Section 10(a)(1)(A) Permits in the Action Area

NMFS has completed four formal ESA section 7 consultations on actions implemented within the action area. Each of these anticipated small amounts of incidental take that were unlikely to affect future returns of the listed species, and all were found to not jeopardize the continued existence of CCC steelhead or CCC coho salmon, nor destroy or adversely modify their designated critical habitats. NMFS has also completed one informal consultation within the action area. More information on these consultations is provided in NMFS 2016a.

Activities conducted under the NMFS' ESA Section 10(a)(1)(A) research Permit 16318-4R, issued to Hagar Environmental Science, are expected to continue within the action area. Salmonid monitoring approved under this permit includes juvenile salmonid abundance estimates in local streams and lagoons, including the San Lorenzo Lagoon. Other authorized research permits that overlap the action area include 17292-3R, issued to the NMFS SWFSC Fisheries Ecology Division, and 18012-3R issued to CDFW Region 3. Research under these permits has not been implemented in the action area in recent years. In general, the research activities are closely monitored and require measures to minimize take. NMFS has determined these activities are unlikely to affect future adult returns nor jeopardize the continued existence of the CCC steelhead DPS or CCC coho salmon ESU.

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. 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 50 CFR 402.17(a) and (b).

2.5.1 Disturbance from Barge Movements and Mooring Installation

A temporary mooring area will be constructed on the westward shore of the lagoon near the southeast corner of the Beach Boardwalk. The temporary and localized nature of this activity is not expected to result in injury or harm to salmonids. Although this activity may result in minor behavioral responses (i.e., fish leaving the immediate area), the level of disturbance will be extremely minor and unlikely to contribute to their injury or death during installation. In addition, there is an abundance of habitat in the lagoon that will remain unaffected by these activities the fish can relocate to.

To facilitate construction and maintenance of the culvert system, equipment will be delivered to the culvert alignment from the mooring area and work will be performed from a small floating barge. Each barge is expected to be less than 400 square feet in area, and they will gradually move along (upstream or downstream) the culvert alignment area as work progresses. When crossing the lagoon, the barge will move at a slow rate. While in use as a construction platform, the barges will be temporarily anchored to the lagoon bottom.

The movement of the barges will result in temporary and localized displacement of salmonids, which are expected to swim away from the slow moving barge and seek other areas of the lagoon. The effects of this temporary displacement will be minor. While in some instances, displacement can cause an increase in predation, the barges are equally expected to disrupt (i.e., displace) predators in the lagoon including birds and fish.

2.5.2 Increased Mobilization of Sediments and Other Contaminants

Construction and maintenance activities may result in the increased mobilization of sediments, increased turbidity, and the potential for release of other contaminants (e.g., oils or fuels) into the water column of the lagoon. These activities include work in the existing trench to seat the proposed culvert system, transport of chipped bedrock sediments on barges, placement of the infiltration gallery collector into the lagoon bottom, and maintenance activities.

2.5.2.1 *Turbidity and Sedimentation*

The types of activities described above have been shown to result in temporary increases in sedimentation or turbidity (reviewed in Furniss et al. 1991; Reeves et al. 1991; Spence et al. 1996). Sediment may affect salmonids and other fishes in several ways. High concentrations of suspended sediment can disrupt normal feeding behavior and efficiency (Cordone and Kelly 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 lower dissolved oxygen in the water column, reduce respiratory function, lower disease tolerance, and even 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 may cause salmonids to disperse from established territories (Waters 1995), which can displace fish into less suitable habitat and/or increase competition and predation, decreasing survival.

Work in the trench will include chipping/scraping of natural sediments, remnants of the historic clay pipe and other debris. The remnant pieces of the pipe, grout, and debris will be removed using the barge and disposed of. As described in Section 1.3, the any native bedrock material (Purisima Formation) that is the result of chipping or drilling for anchors may be re-used as bedding along the culvert alignment, transported across the lagoon on barges to be used for the containment berm extension, or disposed of (or a combination of the above). There is potential for small amounts of this material to enter the lagoon and settle to the sandy bottom of the lagoon (i.e., sedimentation). The result of this material entering the lagoon would be extremely minor and indiscernible with respect to impacts on fish behavior, survival, or the abundance of their prey. If reused along the culvert alignment, the placement of these sediments could result in temporary and localized areas of suspended sediment, or turbidity, once rewetted after inundation. During open sandbar conditions, high flow events or tidal exchange could inundate the culvert area and potentially result in localized increases in turbidity from this material. However, under these open-bar conditions, turbidity in the San Lorenzo Lagoon is naturally high from storm runoff generated in the watershed or from tidal disturbance and, therefore, any suspension or scattering of these sediments would be indiscernible from background turbidity levels. Any turbidity plumes are expected to dilute rapidly in the open lagoon and remain on in the immediate vicinity along the bedrock formation. Such conditions are not expected to reach levels that would appreciably affect the health or survival of salmonids in the action area.

Similarly, increases in turbidity from maintenance activities (e.g., repositioning of the infiltration gallery into the lagoon substrate) are expected to quickly dissipate soon after the activity is over and only affect small, localized areas of the lagoon. Regarding critical habitat, the temporary and localized exposure of habitats to increased sedimentation or turbidity is not expected to reach the scale where the physical or biological features of critical habitat will be altered and, therefore, the ability of the critical habitat to support listed species' conservation needs in the action area will be maintained.

2.5.2.2 *Other Contaminants*

As described above, the machinery and barges will be used to facilitate construction of the head driven culvert. Construction and maintenance activities in, over, and near surface waters have the potential to release debris, hydrocarbons, concrete or other adhesives, oils, and similar contaminants into surface waters. If introduced into aquatic habitats, these substances could impair water quality by altering the pH 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 (not possible in the action area) as well as harm the benthic organisms that are a salmonid food source (Eisler 2000). The effects described above for contaminants have the potential to temporarily degrade habitat and harm exposed fish. However, the Project includes avoidance and minimization measures to prevent the introduction of construction debris and contaminants into the action area and measures to respond to spills effectively (HES 2022). As such, conveyance of toxic materials into the action area during Project implementation and maintenance is unlikely to occur and the potential for the Project to degrade critical habitat or harm salmonids is improbable.

2.5.3 Increased Predation Risk

The persistently deeper lagoon during the dry season afforded by the culvert system is expected to reduce predation by avian species (HES 2022). However, actions that will result in the opening of the sandbar (i.e., use of TOCs and low flow breaches) may temporarily lower the water surface elevation and reduce the volume of habitat available to salmonids in the lagoon by as much as approximately 30 percent. The reduced habitat can lead to increased risk of predation of juvenile salmonids, and the breaching can provide an unseasonal opportunity for additional predators, such as striped bass (*Morone saxatilis*), to enter the lagoon from the ocean. Because predation events are extremely difficult to document across time and space, NMFS is unable to quantify the precise number of juvenile salmonids potentially lost to predation. Furthermore, it is impossible to discern the loss to predation caused by the management action versus background rates of predation. Nonetheless, NMFS assumes the occasional implementation of these sandbar management actions will result in the additional loss of a small amount of juvenile salmonids from predation. NMFS assumes most, if not all, of the mortality would be juvenile steelhead because these actions are typically implemented during the dry season at a time of year when coho salmon are unlikely to be present in the lagoon and because of the persistent lack of coho salmon in the lagoon based on past fisheries monitoring.

2.5.4 Fish Stranding

Lagoon breaching or other activities that can rapidly change the water surface elevation increases the risk of fish stranding. Fish stranding, including salmonids, occurs naturally on river floodplains and in complex marsh and backwater habitats. The use of these habitats for foraging or as refuge during high flow events are inherently risky to their survival (Bradford 1997; Sommer et al. 2005; Nagrodski et al. 2012). Nonetheless, to date, no salmonids have been found stranded or dead by biologists during past monitoring of sandbar management activities in the San Lorenzo Lagoon (2015-2021). However, the lagoon is large and not all areas are easily visible or accessible. In other lagoons, observations of juvenile salmonid stranding following a breach (natural or managed) are very rare. When fish strandings have been observed, they are associated with unseasonal breaches (i.e., summer breaches) with limited to no upstream refuge habitat[9], or due to mortality associated with unique poor water quality conditions during a breach (Jankovitz 2018).

For low flow breaches, fish stranding is not expected because these actions are taken at lower water surface elevation soon after sandbar closure and mimic the natural tidal fluctuations.

For TOCs, monitoring of this activity in the past has consistently found zero salmonids stranded. Following the implementation of a TOC in July 2018, biologists observed several large juvenile steelhead volitionally swimming in and out of the outlet channel between the ocean and the lagoon (HES 2022). In NMFS' judgment, the amount of salmonids that may become stranded will be low, if any, and limited to the juvenile life stage. This is based on the strong swimming abilities of salmonids, their preference for utilizing deeper habitats within the lagoon away from shorelines (HES 2022), and because they have evolved utilizing habitats such as estuaries and lagoons that are subject to sudden changes in water depth from floods and natural sandbar breaches. Furthermore, in its current condition, the San Lorenzo Lagoon lacks access to floodplains, complex backwater habitats, and marshes where fish are more likely to become stranded during water fluctuations. NMFS estimates few if any juvenile salmonids will be encountered following a TOC. If stranded fish are encountered and are still alive, the monitoring biologists will use small dip nets to collect the fish and carry them to the lagoon for release. NMFS expects no more 10 juvenile steelhead and 1 juvenile coho salmon will be found stranded alive or dead during each TOC, with no more than two TOCs per year. Those found alive are all expected to survive collection, handling, and release into the lagoon.

2.5.5 Fish Capture/Relocation and Dewatering

For the channel shortening activity, the City or its contracted biologists will attempt to capture and relocate fish from the proposed cut off portion of the channel using seines and or dip nets. Fish capture and relocation activities pose a risk of injury or mortality to rearing juvenile salmonids. Any fish collecting gear, 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 method used, the ambient conditions, the abundance of fish present, and the expertise and experience of the field crew. Since fish relocation activities will be conducted by qualified fisheries biologists, effects to and mortality of juvenile salmonids during capture will be minimized. Based on information from past fish capture and relocation efforts in California, the

[9] https://www.venturariver.org/2010/09/estuary-breach-kills-fish.html

number of injured or killed salmonids from capture and relocation activities is low, typically less than 3 percent of the total number of fish captured.

The implementation of the channel shortening activity will occur during the late spring or summer periods and, therefore, both juvenile steelhead and coho salmon and steelhead kelts may be present. For the channel shortening activity, it is impossible to predict the length of the channel that may be cut off by this activity (if one forms at all) and, therefore, use of density estimates per linear foot is not applicable. Usually flow through the outlet channel is shallow, lacks cover, and is relatively clear, and the area is often heavily used by the public. NMFS expects the amount of salmonids present during this activity will be small. This is based on the above factors as well as the lack of salmonids present during previous use of this activity. As such, no more than 25 juvenile steelhead, 1 adult steelhead, and no more than 3 juvenile coho salmon are expected to be present in the outlet channel segment during this activity. Biologists will use seines and or dip nets to capture fish in the channel. Rates of injury or mortality using these methods is low, and less than other methods such as backpack electrofishing. Therefore, NMFS expects no more than 1 juvenile steelhead and 1 juvenile coho salmon would be injured or killed from capture and handling. Finally, NMFS expects relocated fish will be able to find suitable food and cover in other areas of the lagoon to maintain their fitness and survival.

Once initial capture and relocation efforts are complete, the City or its contracted biologists will use sand to cut off a portion of the existing outlet channel. Streamflow in this section of the outlet channel is expected to decline rapidly thus risking the injury or mortality of salmonids that evade the initial capture and relocation efforts. NMFS expects no more than 1 juvenile steelhead and 1 coho salmon will avoid capture during relocation efforts and be injured or killed as a result of dewatering. NMFS does not expect adult steelhead will die as a result of channel dewatering, as adults, if present, are likely to be easily detected and collected during fish capture activities.

2.5.6 Loss of Benthic Habitat

2.5.6.1 *Head Driven Culvert*

The installation of the head driven culvert will result in permanent effects on critical habitat. The infiltration gallery will be placed within the sandy substrate of the San Lorenzo Lagoon. The gallery structure will be approximately 15 square feet in area and embedded approximately 1-foot into the bed of the lagoon. To help weigh down the gallery and to increase the permeability of water into the buried perforations of the gallery, the sandy substrate surrounding the gallery will be replaced by a mixture of rock consisting of gravels and cobbles (Figure 3). The total area converted to either rock or the gallery structure is expected to be approximately 565 square feet (15 square feet for the gallery and 550 square feet of rock). This equates to approximately 0.05 percent of the total lagoon bottom (measured from the Branciforte Creek confluence downstream to the ocean). Periodic (annual or biannual) maintenance of the gallery, including repositioning and burying of the structure, is expected to occur. This would be achieved using a barge as described above. Replacement of the substrate (from sand to rock) could affect the benthic macroinvertebrate communities in the affected area from taxa that burrow in the soft sandy bottoms to those that attach to rocky surfaces (Robinson 1993; Holmes et al. 2005). In turn, this change in invertebrate community assemblage could affect forage prey availability for juvenile salmonids in the immediate area. However, based on the small size of the affected area relative to the large, unaffected area of the lagoon, the small loss of sandy bottom substrate on the food abundance for juvenile salmonids will be negligible. Also, rock substrates can also support macroinvertebrate taxa that are prey of juvenile salmonids. For example, artificial rock baskets placed in soft-bottom slough channels in the lower Sacramento River were found to be colonized by taxa that included amphipods, which are one of primary prey taxa for juvenile salmonids in coastal lagoons, estuaries, and tidal sloughs, and by chironomids, which are also known prey of juvenile salmonids (Holmes et al. 2005). Based on the above, NMFS does not expect this extremely minor amount of substrate conversion from sand to rock will diminish the value of critical habitat PBFs in the action area, including rearing capacity for juvenile CCC steelhead or CCC coho salmon.

2.5.6.2 *Junction Box and Horizontal Culverts*

Similar to the infiltration gallery, the installation of the junction box and horizontal culverts will result in the permanent loss or alteration of habitat, including impacts to the bedrock shelf, open water habitat (when submerged) and a small portion of the beach dune where the culverts will terminate. The footprint of the junction box is approximately 13 square feet (4-foot diameter cylinder) and will be located in an area of the lagoon immediately adjacent to the bedrock shelf along the left bank of the lagoon. The substrate in this area consists of hard bedrock sandstone. As described above, the steel culverts will traverse the bedrock trench except for the final section where they will pass beneath the beach sand. Replacement of this bedrock area with a hard steel structure would not alter the natural texture or function of the habitat (i.e., hard steel replacing hard bedrock). Considering the total volume of the structures relative to the total volume of habitat in the lagoon, and considering that the hard, steel culverts and junction box will essentially replace hard bedrock, NMFS does not expect this will appreciably alter the substrate quality in the lagoon to an extent that would diminish the PBFs related to rearing and foraging in the lagoon. In addition, the minor loss of open water habitat caused by the installation of the culvert structure, relative to the total volume of open water habitat unaffected by the Project, will not diminish the ability of the habitat to maintain the PBFs for rearing (prey availability and foraging) in the action area.

2.5.6.3 *Mooring*

Installation of the mooring will temporarily exclude a small, shallow area of the lagoon. The area of the lagoon that will be affected by this activity has a sandy substrate and is shallow. This activity will not result in a permanent alteration of the substrate characteristics. Once the mooring area is removed after construction is complete, the affected area of the lagoon is expected to quickly revert to a pre-disturbance condition with a sandy bottom that is subjected to inundation as the lagoon's water surface elevations change. Subsequent exposure to tidal action and river flows will reshape the sand

2.5.6.4 *Barges*

The anchoring of the barges along San Lorenzo Point (or while not in use at the mooring area) will cause localized disturbance to the lagoon substrate and benthos. These small affected areas will be temporary and minor, and will not permanently change the character of the substrate or its topography. The small affected areas are expected to quickly revert back to their pre-disturbance condition once the project is completed. The barges will be small and will not remain in one location long enough to appreciably affect the amount of sunlight reaching the water column or benthos within the action area, or alter the productivity of the lagoon habitat.

Therefore, the use of barges is not expected to permanently affect the ability of the critical habitat to support listed species' conservation needs.

2.5.7 Alterations to Lagoon Habitat from Operation of the Head Drive Culvert

The primary purpose of the head driven culvert is to avoid or reduce flooding of adjacent property while also avoiding sandbar management to the greatest extent possible. Once the sandbar naturally forms for the dry season, the culvert system will be activated to maintain water levels at approximately 5.0 feet NGVD 29. Absent the culvert system or sandbar management, the lagoon's water surface elevation and areal extent would increase creating more potential habitat space until reaching a level where a natural breach occurred. Therefore, the surface weir and infiltration gallery will suppress the maximum amount of habitat to some extent during the dry season.

There are no historic (pre-development), records of the dry season aerial extent and routine maximum water surface elevations of the lagoon for comparison. Also, a considerable portion of the lagoon's upstream habitat and adjacent wetlands that would have been inundated have been permanently lost to urbanization. Since then, there has been a long history of sandbar management and flood control actions, which has perpetuated an unnatural lagoon condition that is more open to tidal action during the dry season. From recent observations, water surface elevations in a closed lagoon have occasionally reached up to 8.0 feet NGVD 29 before sandbar management actions were taken, or the lagoon breached naturally. Under most current conditions the sandbar is breached or breaches naturally prior to exceeding 7.0 feet NGVD 29. Assuming the lagoon could remain closed at a water surface elevation of up to 8.0 feet NGVD 29, the upper reaches of the lagoon in the San Lorenzo River arm would inundate more of the extant riparian vegetation, thereby increasing forage opportunities and habitat complexity for salmonids. In the Branciforte Creek arm, the walls of the creek channel are vertical concrete with no adjacent vegetation to flood and, therefore, only an increase in water depth would be achieved. It is important to note that under current urbanized conditions, maintaining lagoon water surfaces at elevations of 7.0 or 8.0 feet NGVD 29 would be a considerable risk not only for flooding, but also for water quality in the lagoon. At these elevations, the lagoon waters would compromise levees, infiltrate sewer and other buried infrastructure and potentially leach various contaminants into the lagoon.

Maximum water depths in the lagoon during summer could be 1.0 to 3.0 feet shallower due to the culvert's operation, which in general would reduce depth and escape cover from predators. While the habitat at times may be shallower, the consistently deeper lagoon through the dry season without breaching is expected to reduce predation risk. While water depth can be an important form of escape cover for juvenile salmonids, maximizing depth is not always beneficial or necessary for providing or maintaining productive rearing habitat in lagoons. Extensive areas with deep water can trap saltwater, which in turn can make it more difficult to convert the lagoon to freshwater. Moreover, several coastal lagoons in the region have documented highly productive lagoon habitat utilized by juvenile salmonids despite a lack of deep water habitat during summer (Hayes et al. 2008; Alley 2021; Bond et al. 2021; HES 2021). With the water surface elevation at 5.0 feet NGVD 29, the San Lorenzo lagoon would still have extensive areas with depths exceeding 6.0 feet, including some areas exceeding 10.0 feet.

The operation of the head driven culvert system will also affect water quality conditions in the lagoon during the dry season. Once the sandbar forms naturally, operation of the infiltration gallery will begin exporting saltwater as soon as the water surface elevation reaches 3.0 feet NGVD 29, which will facilitate a more rapid transition of the lagoon's water column to freshwater. Instead of repeated breaching events during the dry season that increase opportunities for saltwater to enter the lagoon and the release of freshwater layers from the surface, the operation of the culvert would avoid these disruptions and promote a freshwater conversion. This freshening has been shown to improve water temperatures and dissolved oxygen concentrations, and in turn, improve habitat suitability for a wide range of aquatic species in the lagoon, including juvenile salmonids and their prey.

The water quality dynamics in lagoon observed in 2020 can serve as a surrogate for how we expect the culvert system to improve water quality (see also Section 2.4.1.2). That year, the lagoon's outlet channel made a sharp westward turn parallel to the shore of Main Beach (Figure 17). Although there were brief periods of sandbar closure with frequent natural breaches, the lagoon maintained a perched condition with water surface elevations remaining between mostly 4.0 and 6.0 feet NGVD 29 throughout the dry season (Figure 15). The perched sandbar conditions and long outlet channel prevented ocean waters from continuously entering the lagoon despite having an open mouth for most of this period. Data from water quality monitoring conducted during this period confirmed the restriction of saltwater exchange, and showed the lagoon gradually freshened and maintained suitable water temperature and dissolved oxygen concentrations despite being a drought year (2ndNature 2021). Furthermore, the juvenile steelhead monitoring during the spring and summer sampling periods found some of the highest observed abundances (based on CPUE), which suggests suitable water quality and foraging conditions persisted (Table 3). NMFS expects the culvert system will provide similar conditions to those observed in 2020, where the culvert would "replace" the long outlet channel across the beach and keep the lagoon's water surface elevation at approximately 5.0 feet NGVD 29. The culvert's operations would further enhance these conditions by more rapidly exporting saltwater from the bottom, thus allowing the lagoon's water column to freshen quicker.

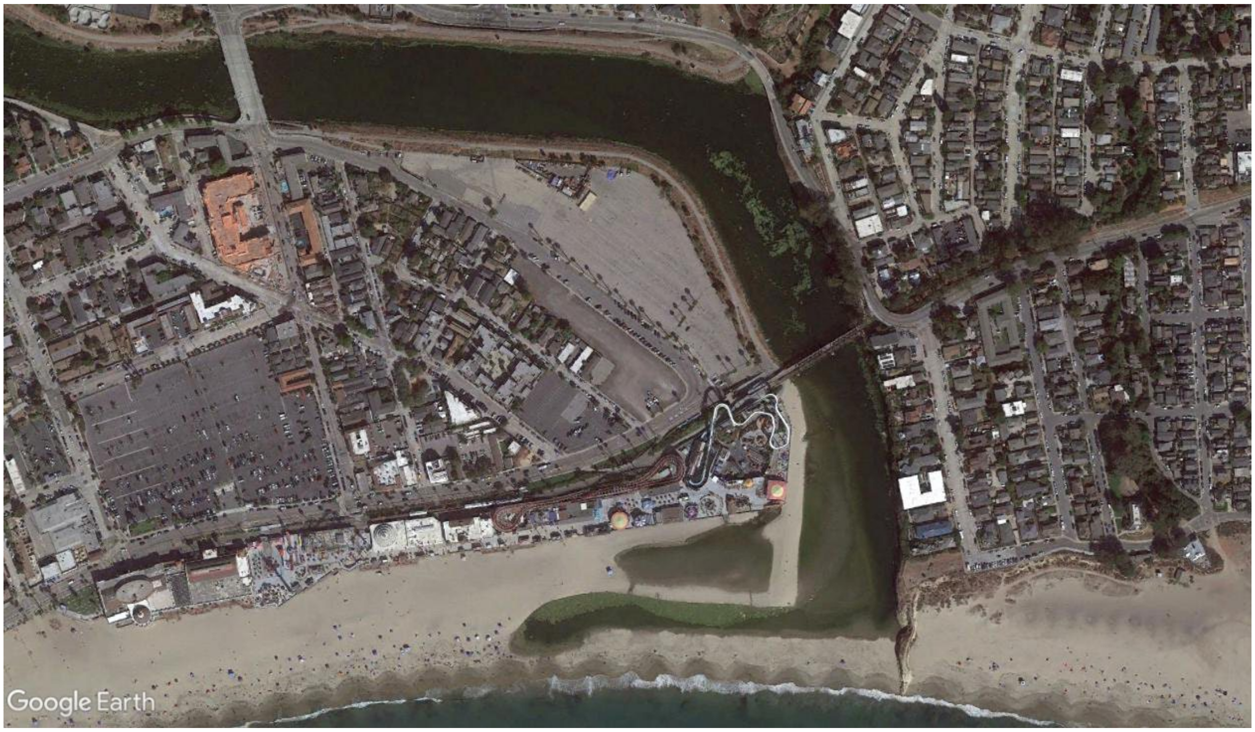


Figure 17. The sandbar and outlet channel at the mouth of the San Lorenzo River on September 26, 2020. Courtesy of Google Earth.

A persistent dry season water surface elevation of 5.0 feet NGVD 29 and more rapid conversion to freshwater is also expected to improve conditions for the establishment of submerged aquatic vegetation in the lagoon, which would be expected to enhance productivity in the lagoon by providing habitat for a more diverse and abundant aquatic invertebrate community (PWA and JSA 1989; Smith 1990; Robinson 1993). HES (2022) suggests that the prolonged closure of the lagoon during the dry season, and conversion to freshwater, could reduce or eliminate the seasonal availability of marine and euryhaline invertebrate prey for juvenile salmonids. The conversion to a closed and freshened lagoon may shift abundances of certain taxa and the lack of tidal influence would eliminate the availability of marine-derived taxa. However, most euryhaline invertebrate taxa that are prey of juvenile salmonids are able to tolerate and become well-established in fresh or brackish water conditions as long as there are not prolonged periods with a stratified water column and anoxia on the bottom. Other coastal lagoons that are closed in summer that convert to freshwater (e.g., Soquel and Scott creeks) have productive invertebrate communities as forage for juvenile salmonids. As such, NMFS expects the invertebrate communities in the San Lorenzo Lagoon may experience a seasonal change by reducing the occurrence of marine-origin invertebrate taxa, but will ultimately support a productive invertebrate community and forage for rearing juvenile salmonids. Based on the above information, NMFS expects the operations of the culvert will result in beneficial effects to habitat quality and stability and will improve the PBFs in the lagoon with respect to rearing.

2.5.8 Alterations to Lagoon Habitat from Sandbar Management Activities

The implementation of the sandbar management activities can result in temporary changes to water quality in the lagoon. The implications and significance of these changes would depend on the type of activity implemented and various environmental conditions, including the condition of the sandbar and outlet channel alignment, river inflow to the lagoon, wave and tide heights, pre-existing water quality conditions in the lagoon prior to management, and the time of year.

2.5.8.1 *Low Flow Breaches*

For the low flow breach method, changes in water quality would be minimized as the decision to breach would be made soon after sandbar closure. By design, the use of low flow breaches would not allow the lagoon to develop a high water surface elevation or a freshened water column and, therefore, would have less dramatic impact on the change of water quality dynamics within the lagoon (Revell 2021). This activity would essentially perpetuate an open tidal condition. While this would limit total habitat space, it would also avoid the development of adverse water quality conditions from prolonged water column stratification. During construction of the culvert system, several low flow breaches are likely to be necessary throughout the summer of 2022. Fisheries monitoring has shown that when the sandbar remains in the mostly open condition (e.g., 2017), water quality (i.e., temperature and dissolved oxygen) remains good, and steelhead abundances, based on CPUE, can be high (Table 3). NMFS expects the implementation of the low flow breaches will limit habitat area in the lagoon to amount available with the tidal cycle, but this change in habitat is not expected to adversely affect the rearing and fish passage PBFs of critical habitat in the lagoon.

2.5.8.2 *Temporary Outlet Channels*

The use of TOCs has the potential to result in much greater impacts to water quality in the lagoon, again depending on their frequency of use and the environmental conditions at the time of use. The past use of this activity has had varied results, including nearly no change to water quality in the lagoon, to full drainage with subsequent periods of stratified water column conditions. The intent of TOCs is to use a constructed channel to drain down the water surface elevation in a controlled manner and then close the channel once the desired water surface elevation is met, but avoid a full drainage and significant water quality change. In all cases, the release of surface layers of the lagoon include the freshest top layers of the water column. The time to recoup the reduction of this freshwater layer would depend on the amount of river inflow and whether the outlet channel allowed saltwater to enter the lagoon during the draining. The risk of an uncontrolled breach increases when there is a high lagoon water surface elevation prior to implementation. The City has indicated they would avoid the use of this activity to the greatest extent possible and instead will rely on low flow breaches prior to reaching a high water surface elevation. Installation of the culvert system will reduce the amount of time needed to restore a fresher water column as the infiltration gallery will target the removal of some of the saltwater. Assuming a worst case scenario, NMFS expects the implementation of the TOCs could result in temporary adverse impacts to rearing habitat PBFs in the lagoon.

2.5.8.3 *Channel Shortening*

The channel shortening activity is not expected to result in changes to water quality in the lagoon as the sandbar would remain open and the new channel outlet would still be angled to limit tidal exchange and facilitate a perched condition. This has been demonstrated in the past. This activity is intended for use during the spring and early summer condition at a time of year when river inflow remains relatively high, the sandbar begins to accumulate, and the outlet channel gradually starts forming westward. The construction and maintenance of the sand containment berm will limit, or exclude, the need for this activity under most conditions.

It is NMFS' judgement that the cut off channel on the beach is not used by salmonids for long-term rearing, but instead for brief periods of migration to and from the lagoon. The loss of this channel segment to dewatering will be replaced by a new and similar outlet channel slightly to the east that is expected to provide the same general habitat conditions and functions as the cut off portion. For these reasons, we expect the function of critical habitat will quickly return to its previous condition within the action area with respect to migration as soon as the new channel is constructed (the same day). Similarly, any loss of juvenile forage habitat in the cut off channel would be negligible as a new and similar channel will be created, and food resources from within the lagoon would remain available to the new outlet channel via drift. Based on the small area of impact and temporary nature of the action, we anticipate the impacts to PBFs for rearing habitat and fish passage will be minimal and restored quickly and will not reach the level that would prevent the ability of the critical habitat to support listed species' conservation needs in the action area.

2.5.8.4 *Sand Berms*

The construction of the containment berm will be done exclusively outside of waters and will entail use of heavy machinery to gather sand from dry areas of the beach to build up the berm. In addition to limiting the development of a long outflow channel, the containment berm may limit the expansion of the ponded lagoon across the beach and in front of the Beach Boardwalk during closed sandbar conditions. When the lagoon spreads out across the beach, it creates additional shallow water habitat. As indicated by HES (2022), steelhead are heavily concentrated in the deeper water habitats of the lagoon where they are less prone to predation by birds. These shallow areas are heavily used by birds (particularly abundant seagulls) and the public. Therefore, excluding the development of this shallow inundated beach habitat by using the containment berm is not expected to appreciably reduce the quantity of rearing space in the lagoon preferred by juvenile salmonids.

The combined use of the containment berm and the culvert system will minimize or avoid repeated habitat disruptions caused by breaching and, therefore, would be a beneficial trade-off with respect to increasing habitat stability and quality within the lagoon. The use of sand containment berms will have negligible adverse effects to the quantity of habitat available in the lagoon but will not reach the level that would prevent the ability of the critical habitat to support listed species' conservation needs in the action area.

2.5.8.5 *Priming a Breach*

To further discourage the formation of an outflow channel westward towards the Beach Boardwalk during winter, the City proposes to implement the 'priming a breach' activity. Specifically, this involves use of machinery during fall to lower (i.e., grade) an area of the sandbar against San Lorenzo Point (Figure 5) down to approximately 7.0 feet NGVD 29 in order to create a pre-determined path for where the sandbar would eventually open once inflows exceed the capacity of the head driven culvert. The implementation of this activity will affect the natural function of critical habitat in the lagoon by dictating the location and characteristics of the outlet channel along the beach and, in some years, when the sandbar may breach. However, this is not expected to appreciably alter the habitat to an extent that would prevent the ability of the critical habitat to support listed species' conservation needs in the action area.

2.5.9 Impacts to Fish Passage Opportunities

2.5.9.1 *Head Driven Culvert*

The operation of the head driven culvert may impact the full range of potential fish passage opportunities to and from the ocean. The City's proposed operations plan stipulates that operation of the culvert will begin only occur after the sandbar has formed naturally and until agreed upon by the resources agencies. Once the operation begins, absent any unseasonal storm event, it would effectively end the ability for the lagoon to self-breach for the remainder of the dry season, precluding fish passage between the lagoon and the ocean until the following wet season. Depending on the timing of this decision, operation of the culvert could truncate the end of the outmigration season for salmonids.

The current management of the lagoon, with repeated sandbar breaching during the dry season, provides salmonids (particularly steelhead) opportunities to migrate to and from the ocean at a time of year when salmonids typically do not have such access. For the central California coast, this dry season management is unique to the San Lorenzo River, as all other coastal streams in the region have sandbars that form and persist during the dry season under most natural conditions (i.e., aside from illegal breaches). As noted previously, historic anecdotes suggest the sandbar at the mouth of San Lorenzo River used to close during the dry season prior to widespread settlement and urbanization (Anonymous 1879). HES (2022) notes the occasional capture of large juvenile steelhead with sea lice in the lagoon immediately following a recent sandbar opening, indicating these fish entered the ocean following a summer breach. The operation of the culvert system would reduce or eliminate these exchanges between the ocean and lagoon from occurring during the summer. The potential loss of any benefits derived from these opportunistic behaviors are unknown and unquantifiable.

The operation of the culvert system may affect the timing of sandbar opening at the onset of the wet season and thus the timing of fish passage to and from the lagoon. The San Lorenzo Lagoon typically breaches for the first time of the wet season between October and early December (2ndNature 2015 – 2021). This window largely occurs prior to the predominant upstream migration window for adult steelhead (January to April) and coho salmon (December to March) in regional watersheds (Shapovalov and Taft 1954; Osterback et al. 2018). Absent the culvert system, the lagoon within the confines of the containment berm would fill more rapidly and induce a breach. However, with the culvert capable of exporting up to approximately 15 cfs, this would slow the rate of lagoon filling and potentially delay sandbar opening. In fall, river inflow to the lagoon typically remains less than 20 cfs unless there is a storm. During these early storm events, river inflow typically rises to above 40 cfs, which is considered sufficient for causing a breach and providing upstream passage in the lower river. The operation of the culvert system can be adaptively managed to avoid altering the timing of first breach in conjunction with the sandbar management activities (e.g., priming a breach). Any potential delays to upstream migration from the lagoon are expected to be rare and will only affect a small fraction of the run for brief durations.

With regard to the natural period of seaward migration for juvenile and adult salmonids (December through June), the operation of the culvert may truncate this window in some years. The City and the resource agencies will strive to minimize this affect using various hydrologic data to make informed decisions for when to begin culvert operations. The sandbar typically forms for good in June or July as river inflows decline and, therefore, NMFS expects the operation of the culvert would limit passage only at the very end of the normal outmigration window. As such, only a small fraction of the total number of salmonid out-migrants would be blocked from entering the ocean. Again, this would be more similar to the natural processes and windows of ocean access expected for coastal streams in the region where sandbar formation naturally interrupts a small portion of all expected out-migrants. For salmonids that are blocked in the lagoon, the culvert system is expected to facilitate suitable water quality conditions and habitat space (described above) to accommodate successful juvenile rearing (Osterback et al. 2018). The project will induce a nature closed lagoon condition, where it is common that a small number of steelhead kelts may be blocked from migrating into the ocean (Shapovalov and Taft 1954). These fish may remain in the lagoon as long as water quality conditions remain suitable, return upstream to cooler riverine habitats, or die in the lagoon. Access upstream to the riverine environment would remain unimpaired by the Project, and past data from detections of PIT-tagged juvenile steelhead at an upstream antenna near Felton has shown some fish, tagged in the lagoon, retreat upstream to the river several kilometers. This upstream retreat behavior has also been documented in other regional streams (Bond et al. 2021). While the Project has the potential to reduce fish passage opportunities, relative to the past management of the lagoon during summer, these minor reductions are not expected to reach levels that would appreciably alter critical habitat to an extent that would impair its ability to provide for the necessary PBFs.

Finally, the junction box intake will have a fish screen that was designed in coordination with NMFS and CDFW to meet fish passage criteria for screened intakes (NMFS 2011). Water intakes can be a major source of potential injury or mortality of fishes (Spencer 1928; Bell 1991). Entrainment, impingement, and delay/predation are the primary contributors to the injury or mortality of juvenile salmonids. Entrainment occurs when fish are drawn into the intake, and impingement occurs when a fish is not able to avoid contact with a screen surface, trash rack, or debris at the intake. This may cause bruising, descaling and other injuries. Impingement, if prolonged, repeated, or occurring at high velocities, also causes direct mortality. Delay at intakes increases predation risk by stressing or disorienting fish and/or by providing habitat for predators. For the junction box intake, the automatic, self-cleaning screens will have a wedged-wire style mesh (0.25 inches) selected for the anticipated sizes and age classes of salmonids in the lagoon. The screen will also meet the criteria of a maximum approach velocity of 0.8 feet per second. Therefore, NMFS does not expect injury or mortality of steelhead or coho salmon from impingement or entrainment at the screened intake. Additionally, because the structure will be located against the bedrock shore of the lagoon, the junction box structure itself will not impair the PBFs related to fish passage.

2.5.9.2 *Priming a Breach and Sand Berms*

Sand management, specifically the use of the beach priming in conjunction with the containment berm, may affect the timing of sandbar breaching in the early part of the wet season. HES (2022) opines this activity, coupled with the sand containment berm, may cause an earlier breach, which could then encourage adult steelhead or coho salmon to enter the lagoon during periods of low inflow conditions and cause delays in their upstream migration if river inflows are insufficient. NMFS does not agree with this opinion. Absent the containment berm and use of priming a breach activities to guide where the breach would occur, the river would normally form an outlet channel farther west down the beach at lower elevations than 7.0 feet NMFS 29. The culvert system can accommodate up to 15 cfs, and the rate of percolation through the sandbar can be an additional 2 to 5 cfs. Past monitoring data show that the lagoon routinely breaches at elevations of 7.0 feet NGVD 29 or less, and with river inflows ranging from 10 cfs or more (2ndNature 2015 – 2021). The target elevation for the priming the beach action is 7.0 feet NGVD 29 and, therefore, this activity would not result in a change from the existing conditions. Even if adult salmonids were to enter the lagoon due to an earlier than normal breach, the large lagoon provides sufficient deep water habitat with cool temperatures for holding until storms generate enough runoff in the watershed to facilitate passage. This project will not affect the timing or magnitude of river inflow to the lagoon. Based on the above, the priming a breach and sand berm activities are not expected to adversely impact the function or quality of designated critical habitat for CCC steelhead or CCC coho salmon with respect to fish passage PBFs.

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 and 402.17(a)]. 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.

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 the environmental baseline (Section 2.4).

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 development and use of water in the watershed. NMFS assumes the rate of such development and water use would be similar to that observed in the last decade.

2.7 Integration and Synthesis

The Integration and Synthesis section is the final step in our 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 action area consists of the lagoon at the mouth of the San Lorenzo River. The San Lorenzo River supports threatened CCC steelhead. NMFS identified the San Lorenzo River as a historically independent population for the CCC steelhead DPS as it is the largest population and watershed within the Santa Cruz Mountains Diversity Stratum (NMFS 2016b). The San Lorenzo River watershed is also known to support endangered CCC coho salmon. NMFS identified the San Lorenzo River as one of two historically independent CCC coho salmon populations within the diversity stratum (NMFS 2012). The San Lorenzo Lagoon is designated critical habitat for both the CCC steelhead DPS and CCC coho salmon ESU.

CCC steelhead and CCC coho salmon have declined from their historic abundances due to the widespread degradation and loss of historic habitats caused by factors including hydrologic modifications (reservoir storage, surface diversions, and groundwater pumping), land use change (urbanization, timber harvest, agriculture, and mining), construction of dams and other migration impediments, channelization and disconnection from floodplains, and the introduction of non-native and invasive species. Coho salmon populations within the diversity stratum have declined substantially over the past several decades and now are only occasionally found in the San Lorenzo River basin—usually the result of straying from hatchery releases.

The Project includes the construction of a head driven culvert system during the dry season of 2022, future maintenance and operations, as well as implementation of various sandbar management activities. The primary objectives of the Project are to reduce flood and public safety risks around the lagoon, reduce the need for sandbar breaching during the dry season, and to improve water quality and habitat stability in the lagoon. The Project will also use various sandbar management activities that will influence the area of the lagoon, the outlet channel alignment, and the duration of sandbar openings. Some of these activities will require attempts to capture and relocate salmonids.

Maintenance of the head driven culvert system is expected to occur annually and will include repositioning of the infiltration gallery within the lagoon bottom, sand excavation on the beach at the culvert outlet, among other small activities. Finally, operations of the head driven culvert will include the manual operation of valves to discharge waters from the lagoon to the ocean. Implementation of these actions will be guided through annual coordination between the City and the resource agencies, and the evaluation of existing conditions.

2.7.1 Summary of Effects to CCC steelhead and CCC coho salmon

In this opinion we analyze the effects of the proposed action based on during one year (season) of construction (including sandbar management), and subsequent years of operations and maintenance of the head driven culvert and sandbar management activities.

2.7.1.1 *Head Driven Culvert*

During construction and future maintenance of the head driven culvert, only minor disturbances to the lagoon are anticipated, which are expected to result in minor and temporary behavioral responses (e.g., fleeing and avoidance of the immediate area) from CCC steelhead and CCC coho salmon. The implementation of proposed minimization measures is expected to render the potential for exposure to water quality impairment during construction and maintenance as improbable and, therefore, no injury or mortality is anticipated from these activities.

The operation of the head driven culvert will largely result in changes to quality and function of habitats in the lagoon (largely described below in Section 2.7.2). This will include changes to dry season water quality, habitat availability and stability, and the timing and duration of fish passage opportunities between the lagoon and the ocean. Regarding fish passage opportunities, the operation of the culvert will begin only after the sandbar has naturally formed in late spring or early summer (June or July). Impacts to fish passage would, therefore, be limited to the end of the out-migration season and most likely only during dry years. We expect this new closed regime will be more similar to other coastal bar-built lagoons in the Central California, and the historic behavior of the Sand Lorenzo Lagoon. With the exception of wet years, the operation of the culvert, in conjunction with the sand containment berm, would reduce or eliminate fish passage opportunities between the lagoon and the ocean during the dry season. For salmonids that are prevented from completing their migration, NMFS expects the improved habitat quality within the lagoon provided by the culvert system will support over-summer rearing for juvenile steelhead and perhaps steelhead kelts. We expect juvenile coho salmon and some steelhead kelts will out-migrate prior to sandbar formation or retreat upstream to the cooler river as water temperatures in the lagoon during summer approach their tolerance levels.

2.7.1.2 *Sandbar Management*

The proposed action includes the use of various sandbar management activities during construction and in the future. The frequency of use of various sandbar management activities will depend on the water year type and the performance of the head driven culvert. Some of the activities are intended to contain the lagoon area, while others will be used to temporarily alter water surface elevations or the alignment of the outlet channel. The effects of these activities on individual steelhead or coho salmon vary. Some activities (use of containment berms, priming a breach) will not occur in waters and, therefore, no injury or mortality is expected. Others (use of channel shortening, temporary outlet channels) have the potential for adverse effects from fish capture, relocation, dewatering, and the increased predation or stranding.

Implementation of the channel shortening activity will dewater a portion of the existing outlet channel once a new channel is opened closer to the main lagoon embayment. Although past implementation of this activity is limited, no salmonids were observed by biologists. However, NMFS believes it is possible that a small number of salmonids can be present during future implementation of this activity. Therefore, up to 25 juvenile steelhead, 1 adult steelhead and 3 juvenile coho salmon may be present and require capture and relocation. Anticipated injury or mortality from capture and relocation is expected to be three percent (or less) of the fish present, and injury or mortality expected from dewatering is expected to be two percent (or less) of the fish present prior to relocation and dewatering. Therefore, NMFS expects no more than 2 juvenile steelhead and 2 juvenile coho salmon may be injured or killed as a result of capture/relocation/dewatering.

The use of the temporary outlet channels (TOC) activity is expected to be rare as the City favors using a low flow breach approach to manage lagoon water surface elevations and the head driven culvert will minimize the need for opening the sandbar. As described above in the opinion, low flow breaches are not expected to result in the injury or loss of salmonids. TOC's, however, have the potential for a more dramatic effect on the rate the lagoon volume changes and, therefore, potential injury of death of salmonids. Based on past performance of TOCs, NMFS anticipates at most a small, but unquantifiable, number of juvenile steelhead and coho salmon may be injured or killed as result of increased rates of predation and possibly stranding. For stranding, biologists monitoring the area during each event may encounter a small number of fish with no more than 10 juvenile steelhead and 1 juvenile coho salmon per event (live or dead). All live fish encountered are expected to remain unharmed from collection with dip nets and release into the lagoon. This small loss of juvenile steelhead and coho salmon (if present in the lagoon at the time of implementation) will not reach levels that would affect future adult returns due to the relatively large number of juveniles in the lagoon and watershed unaffected by the Project.

Overall, the project will result in the loss of a small amount of salmonids. NMFS believes this loss will not diminish the abundance, productivity, diversity, or spatial structure of the San Lorenzo River population of CCC steelhead or CCC coho salmon.

2.7.2 Summary of Effects on Critical Habitats

The San Lorenzo Lagoon contains critical habitat for the CCC steelhead DPS and CCC coho salmon ESU. In our adverse modification analysis, we consider the condition of critical habitat, the potential effects of the Project on critical habitat, and whether or not those effects are expected to diminish the value of critical habitat for the conservation and recovery of CCC steelhead or CCC coho salmon.

Critical habitat for the CCC steelhead DPS and CCC coho salmon ESU has been impaired. While conditions vary, critical habitat has been impaired by habitat loss, alteration and fragmentation, surface and groundwater extraction, and land use conversion. Both watershed-wide factors and action area-specific factors affect critical habitat in the action area which limit habitat quality and extent.

In the recovery plan for CCC steelhead (NMFS 2016b), NMFS determined summer rearing habitat for juvenile steelhead in the San Lorenzo Lagoon was poor due to historic loss of habitat extent and due to the current management that relies on repeated sandbar breaching. As noted in Section 2.4 Environmental Baseline, NMFS has identified specific recovery actions aimed at improving habitat conditions in the lagoon by reducing or eliminating the need for sandbar management and by maintaining a lagoon with a persistently higher water surface elevation during the dry season (NMFS 2012; NMFS 2016b). The City has worked closely with the regulatory agencies to develop the proposed Project, which is expected to result in substantial progress towards addressing this issue.

2.7.2.1 *Head Driven Culvert*

The construction and future maintenance of the head driven culvert is reasonably certain to result in temporary adverse effects which include impacts to water quality (turbidity), disturbance to the bed and banks from the construction of the temporary mooring area, disturbance to the water column from the use of a barge in the lagoon for construction, and disturbance to the lagoon bottom for the installation and future maintenance at the infiltration gallery. These impacts will affect only small, localized areas within the larger lagoon which are expected to recover soon after the activity stops.

The operation of the head driven culvert will affect critical habitat during the dry season. The operation of the culvert will suppress the total amount of potential habitat in the lagoon by keeping the water elevations at a fixed maximum height. While this limits the extent of habitat, the habitat stability it provides is expected to improve during the dry season by maintaining a consistent water surface elevation, avoiding, or substantially minimizing, the need for repeated sandbar management, and by improving water quality conditions at this critical time of year.

The operation of the culvert will not begin until the sandbar forms naturally but may reduce subsequent openings later in summer, which would induce a natural closed lagoon condition in the dry season. A small proportion of steelhead and coho outmigrants [juvenile steelhead and coho salmon and steelhead adults (kelts)] will reside in the lagoon or lower river until the sandbar opens again in the fall. The water quality and stable habitat benefits of the culvert are expected to maintain suitable rearing habitat in the lagoon for juvenile steelhead and, therefore, juvenile steelhead that do not have the opportunity to out-migrate are expected to remain in the lagoon or retreat upstream to the river. Late emigrating kelts that are unable to enter the ocean will have the option to stay in the lagoon or retreat upstream to cooler temperatures in the river. It is NMFS' judgment that the operation of the culvert system, in conjunction with particular sandbar management activities, will not affect the timing of sandbar opening in fall.

2.7.2.2 *Sandbar Management*

While the future use of the head driven culvert is expected to substantially reduce the need for sandbar management during the dry season, ongoing flood and public safety risks will require some sandbar management activities to continue. These activities are expected to result in effects to critical habitat including the extent of lagoon habitat.

To facilitate construction of the head driven culvert during the summer of 2022, the lagoon will need to remain in an open state. To achieve this, the City proposes to use re-occurring low flow breaches as soon as the sandbar closes. The use of the low flow breach method is expected to continue an open lagoon condition where the lagoon is subject to tidal influences. Under these conditions, water quality in the lagoon, is expected to remain suitable for rearing (Figure 8). In future years, after culvert system is operable, the use of the low flow breach method will be limited to the late spring or early summer period (if necessary) until the sandbar closes for the season and the culvert begins operating.

The use of TOCs is expected to be rare. This would occur if hydrologic conditions resulted in an abruptly closed sandbar and high lagoon water levels that exceeded the capacity of the culvert system. If used, a TOC has the potential to result in a rapid and more substantial change in lagoon habitat. The future use of this activity is expected to be rare, not repeated throughout the dry season, and will be followed by use of the head driven culvert to export saltwater.

In some years, the lagoon outlet channel to the ocean naturally develops a long channel parallel to and inland from the shoreline. This condition, while conducive for supporting a productive lagoon environment, presents a serious risk to public safety and property. To ameliorate this risk, the City will conduct channel shorting activities that include cutting a new, angled outlet channel closer to the main lagoon embayment. While this activity reduces habitat extent by shortening the natural outlet channel, it has been shown to prevent significant changes in water quality and habitat suitability in the lagoon. This activity would only be necessary if the proposed sand containment berm failed or was not constructed yet that season. Therefore, the use of this activity is also expected to be rare and its duration of effects on the lagoon would be relatively brief once the sandbar closed for the season and the culvert became operational.

The remaining sandbar activities proposed, including the sand containment berm (plus extension) and priming a breach, are expected to affect the extent of the lagoon and potentially minor changes to the timing of sandbar closure and opening. The containment berm will prevent the lagoon and its outlet channel from expanding westward across the beach. This would eliminate areas of the beach that would provide shallow habitat that is unlikely to be used by steelhead or coho salmon as rearing habitat. Both activities will influence the condition of the sandbar which, in turn, can influence fish passage (migration) opportunities between the ocean and the lagoon. As described above, the containment berm may result in the sandbar forming earlier due to higher rates of sand build-up on the eastern end of the beach. This activity was used in 2019 (a wet year) and didn't change the timing of sandbar closure (2ndNature 2020). The use of the prime a breach activity will include constructing a pilot channel to facilitate a breach at an elevation of 7.0 feet NGVD 29, which is consistent with or higher than the elevation of most breaches at the beginning of the wet season.

Overall, the Project will have minor and temporary impacts on critical habitat in the action area. These effects are not expected to diminish the value of critical habitat for the conservation and recovery of CCC steelhead or CCC coho salmon.

2.7.3 Climate Change

Future climate change could affect CCC steelhead and CCC coho salmon and their designated critical habitats within the action area. Some potential consequences of climate change in the Monterey Bay region are increases in both air and water temperatures, and changes in the timing and magnitude of storms, their runoff, and dry season streamflow. These projections further highlight the importance of providing improved conditions in all habitats utilized by CCC steelhead DPS and CCC coho salmon ESU for rearing and during their migrations, including coastal lagoons.

Despite past habitat loss and ongoing flood management actions, the San Lorenzo Lagoon remains a large and sometimes productive habitat. Studies have shown the lagoon is still used extensively by CCC steelhead during the dry season for rearing. For CCC coho salmon, although rare in the watershed, we assume they use the estuary during winter and spring migrations and for temporary rearing in spring. Currently, the presence of productive rearing habitat in the lagoon during the dry season is inconsistent due to a several factors including repeated sandbar management for flood control. Restoration actions that improve the productivity and resiliency of coastal estuaries are becoming increasingly important in the face of climate change. In addition to being highly productive, properly functioning lagoons may become increasingly important refugia for juvenile salmonid rearing as surface flows in local streams becomes less reliable. In the San Lorenzo River, the City has developed and implemented river bypass flows to the lagoon as part of its HCP. These flows, coupled with the proposed action, are expected to provide productive and more reliable rearing environments for juvenile salmonids to use throughout the year.

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, 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 jeopardize the continued existence of the CCC steelhead DPS, nor destroy or adversely modify their designated critical habitat.

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, 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 jeopardize the continued existence CCC coho salmon, nor destroy or adversely modify their 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, we analyzed the effects of the Project, including construction, maintenance, and operation activities related to head driven culvert and the implementation of sandbar management activities.

Construction of the head driven culvert and its periodic maintenance and operations are expected to result only in minor and temporary behavioral responses in the immediate vicinity of the implemented activities. The operation of the culvert will reduce summer and fall fish passage opportunities between the lagoon and the ocean by eliminating the need for seasonal management. This is expected to block a small fraction of the emigrating smolts and late kelts, and these fish will either remain in the lagoon or retreat upstream into the river environment. Some sandbar management activities, such as installation of containment berms and beach priming, are not expected to result in take of CCC steelhead or CCC coho salmon.

For other sandbar management activities, take, resulting in the injury or mortality of salmonids is reasonably certain to occur. Table 6 summarizes the maximum anticipated take by Project activity and frequency.

Table 6. Summary of potential take by species and life stage per activity and its frequency of use.

Activity	Annual Frequency	Life Stage	CCC steelhead Expected Abundance[1]	CCC steelhead Unintentional injury or mortality[2]	CCC coho salmon Expected Abundance[1]	CCC coho salmon Unintentional injury or mortality[2]
Channel Shortening						
capture / handling / dewatering	1	juvenile	25	2	3	2
		adult	1	0	0	0
Temporary Outlet Channel						
capture / handling or found dead	2	juvenile	10	10	1	1
Annual Total		juvenile	46	22	5	4
		adult	1	0	0	0

[1] This is the expected abundance during each 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. All stranded fish observed have the potential to be found dead.

During each channel shortening activity, it is NMFS' judgement that take of up to 25 juvenile steelhead, 3 juvenile coho salmon and 1 adult steelhead kelt may occur. Biologists will attempt to capture and relocate these fish to suitable habitats prior to channel dewatering (Table 6). Of these, up to 2 juvenile steelhead and 2 juvenile coho salmon may be injured or killed from capture, relocation, and dewatering activities during each channel shortening activity (Table 6).

The use of a temporary outlet channel will be rare, but if implemented, would be reasonably certain to result in a small amount of take due to increased predation or stranding. A specific amount of take is impossible to estimate due to the large lagoon area (i.e., detection), the annual variability of the amount of fish of each species in the lagoon at the time of implementation, and because predation would occur underwater and, therefore, not be observed. Biologists may encounter up to 10 juvenile steelhead and 1 juvenile coho salmon either dead or alive during each event for a maximum of two events per year. Fish that are alive at the time of detection are expected to remain uninjured from capture and immediate release into the lagoon.

The expected amount of incidental take will be exceeded if the amount of fish collected, killed, or injured exceeds the amounts described above.

Take may also be exceeded if any of the following were to occur:

- The head driven if the culvert does not perform as designed. This would include:
  - If the culvert system does not maintain an elevation of 5.0 feet NGVD 29 or higher while in operation;
  - If water quality data reveals the head driven culvert does not export saltwater through the infiltration gallery as intended;
  - If the proposed fish screen results in any salmonid injury or mortality;
  - If more than 2 temporary outlet channels are implemented annually; and
  - If more than 1 channel shortening activity is implemented annually (unless species take levels above for this activity have not been exceeded).

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 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 juvenile CCC steelhead and juvenile CCC coho salmon:

1. Undertake measures to ensure that injury and mortality to salmonids resulting from fish capture and relocation and dewatering activities is low;
2. Undertake measures to minimize harm to salmonids from the project through degradation of aquatic habitat;
3. Continue regular coordination with the resource agencies on the operation of the head driven culvert, implementation of sandbar management activities, and the development of any adaptive management approaches; and
4. Prepare and submit plans and reports regarding implementation of sandbar management, fish capture and relocation, dewatering, construction and maintenance activities, as well as lagoon water quality and fisheries monitoring.

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, the City, or any contractor 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. Corps, the City, or any contractor will allow NMFS staff, or any other person

designated by NMFS, to accompany field personnel to visit the Project sites during activities described in this opinion.

b. Corps, the City, or any contractor will retain qualitied biologists with expertise in the area of anadromous salmonid biology, including handling, collecting, and relocating salmonids; salmonid/habitat relationships, including estuaries; and biological monitoring of salmonids. All fisheries biologists working on this Project will be qualified to conduct fish collections in a manner that minimizes all potential risks to ESA-listed salmonids.
c. Corps, the City, or any contractor will ensure that a biologist(s) monitors the action area during the implementation of sandbar management activities to ensure that any adverse effects to salmonids are minimized or avoided. The biologist will be on site during all sandbar management activities to capture, handle, and safely relocate salmonids to an appropriate location in the lagoon. The biologist(s) will notify NMFS staff at joel.casagrande@noaa.gov, or at 707-575-6016, one week prior to activities that may involve fish capture and handling in order to provide an opportunity for NMFS staff to observe the activities. During fish relocation activities the fisheries biologist(s) shall contact NMFS staff at the above number, if injury or mortality of federally listed salmonids occurs.
d. Salmonids will be handled with extreme care and kept in water to the maximum extent possible during rescue activities. All captured fish will be kept in cool, shaded, aerated water protected from excessive noise, jostling, or overcrowding any time they are not in the stream, and fish will not be removed from this water except when released. To avoid predation, the biologist(s) will have at least two containers and segregate young-of-year from larger age classes and other potential aquatic predators. Captured salmonids will be relocated, as soon as possible, to a suitable instream location in the lagoon in which suitable habitat conditions are present to allow for adequate survival of transported fish and fish already present.
e. If any steelhead or salmon are found dead or injured, the biological monitor will contact NMFS staff at joel.casagrande@noaa.gov or at 707-575-6016. The purpose of the contact is to review the activities resulting in take, determine if additional protective measures are required, and ensure appropriate collection and transfer of salmonid mortalities and tissue samples. All salmonid mortalities will be retained. Tissue samples are to be acquired from each mortality per the methods identified in the NMFS Southwest Fisheries Science Center Genetic Repository protocols (contact the above NMFS office at the phone number provided).

2. The following terms and conditions implement reasonable and prudent measure 2:
    a. Corps, the City, or any contractor will allow any NMFS staff or any other person(s) designated by NMFS to accompany field personnel to visit the project site during activities described in this opinion.
    b. To ensure that the Project is built as designed and contractors adhere to construction best management practices, the City will ensure monitoring will be performed during construction by qualified individuals. Monitors will be knowledgeable of the Project designs, construction minimization measures, and the needs of native fish, including steelhead and coho salmon. Monitoring will be

performed daily. The monitor(s) will work in close coordination with Project management personnel, the Project design team, and the construction crew to ensure that the Project is built as designed.

c. Construction equipment used within the lagoon will be checked each day prior to work within waters. This check will occur at appropriate staging areas.
d. The City must ensure their proposed water quality instruments for the head driven culvert are accurate and maintained in good working order. This will require routine calibration to ensure accurate data are collected and that any instrument errors or other issues that would affect the accuracy of the reported water quality shall be resolved as soon as possible.

3. The following terms and conditions implement reasonable and prudent measure 3:
    a. Agency Coordination – The City shall continue regular coordination with the resource agencies, including NMFS, to discuss culvert operations, implementation of sandbar management activities, and the development of potential adaptive management actions to further minimize impacts and to maximize habitat quality and extent in the lagoon.
        i. The City will meet with interested resource agencies no less than twice per year to discuss the above topics.

4. The following terms and conditions implement reasonable and prudent measure 4:
    a. Reporting – The City must prepare and submit annual reports to NMFS for Project activities as outlined below. The reports must be submitted electronically to NMFS biologist Joel Casagrande at joel.casagrande@noaa.gov by March 31 the following year. Reports prepared for compliance with other agency requirements that contain the information requested below would be acceptable.

       The report must contain, at minimum, the following information:
        i. Construction and Maintenance related activities – The report(s) must include the dates construction began and was completed (including individual sandbar management activities); a discussion of any fish collection and relocation activities performed; a discussion of any unanticipated effects or unanticipated levels of effects on salmonids, including a description of any and all measures taken to minimize those unanticipated effects and a statement as to whether or not the unanticipated effects had any effect on ESA-listed fish; the number of salmonids collected and relocated, the number of salmonids killed or injured; and photographs taken before, during, and each activity.
        ii. Operations related activities – The report(s) must include a description of the period of record, data types collected, summary of results, summary of any unforeseen issues and steps taken to address these issues, and reference photos of lagoon habitat and streamflow conditions throughout the reporting period. Specifically, the report(s) must provide document and describe whether the head driven culvert performed as intended, including continuous data on lagoon water surface elevation, river inflow, water temperature, salinity, and dissolved oxygen data collected

throughout the lagoon during the period of record (including from instruments installed within the head driven culvert), and fisheries monitoring results.

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 has the following conservation recommendation:

Past urbanization and levee construction have reduced or altered the diversity and complexity of wetland habitats within the San Lorenzo Lagoon. In addition to the proposed action, the Corps and the City should continue exploring additional opportunities to increase habitat complexity and diversity within the lagoon. This may include the installation and maintenance of large wood features, and increasing the abundance of emergent and submerged aquatic vegetation. Where appropriate, take the necessary steps towards implementing these actions.

2.11 Reinitiation of Consultation

This concludes formal consultation for the Revised San Lorenzo River Lagoon Interim Management Program.

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 incidental taking specified in the ITS 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 monitoring reveals any of the following:

- The culvert does not export saltwater to a degree that reduces water column stratification;
- Once the culvert is in operation for the season, it fails to maintain a lagoon water surface elevation of 5.0 feet NGVD or higher, or it requires repeated sandbar management activities; and
- If low flow breaches result in adverse water quality conditions that result in observed take of steelhead or coho salmon.

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 Salmonids, Pacific Coast Groundfish, and Coastal Pelagic Species, contained in the fishery management plans (FMPs) 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 Salmon FMP (PFMC 2014), Pacific Coast Groundfish (PFMC 2020), and Coastal Pelagic Species (PFMC 2019) would be adversely affected by the Project.

The Project's action area is located in an estuary, which is one of the Habitat Areas of Particular Concern (HAPCs) for coho salmon managed within the Pacific Coast Salmon FMP (PFMC 2014) and for Pacific Coast Groundfish FMP (PFMC 2020).

Summer and fall fish surveys in the San Lorenzo lagoon have recorded the presence of Pacific sardine and northern anchovy, which are species managed under the Coastal Pelagic Species FMP. These surveys have also recorded the presence of starry flounder, which is managed under the Pacific Groundfish FMP (HES 2015b; HES 2019). The abundance of these species has consistently been low, or absent. Seasonally closed lagoons can be productive nursery environments for juvenile fishes managed under these FMPs. However, the intermittent connectivity with the ocean may limit the access to and productivity of the San Lorenzo Lagoon relative to more open and permanently tidal estuary habitats.

Coho salmon have not been captured during the summer and fall sampling efforts in the lagoon (2002-2021) (HES 2021). However, a small number of adults occasionally return to the San Lorenzo River. Adults use the lagoon for migration any juveniles produced by returning adults must pass through the lagoon during their emigration. Juveniles presumably would utilize the lagoon temporarily as forage and saltwater acclimation habitat during winter and spring.

3.2 Adverse Effects on Essential Fish Habitat

NMFS determined the Project would adversely affect EFH for Pacific Coast Salmon, Pacific Coast Groundfish and Coastal Pelagic Species. The potential adverse effects of the Project on EFH have been described in the preceding biological opinion and include changes to the persistence of sandbar closure during the dry season, temporary and minor impacts to water quality during construction, and localized benthic disturbance from the installation and permanent presence of the head driven culvert. As described in the biological opinion above, construction related impacts to water quality and the lagoon benthic habitat are anticipated to be temporary and minor and will only affect small, localized areas within the lagoon. Permanent adverse impacts will include the conversion benthic habitat (565 square feet) for the installation of the infiltration gallery, as well as a reduction in the tidal connectivity during the summer months.

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 Salmon, 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. In addition, the operation of the head driven culvert is intended to reduce the need for frequent sandbar breaches and allow the lagoon to stay closed more during the dry season. The infiltration gallery component of the culvert structure will also help to improve water quality conditions in the lagoon (i.e., density stratification) by targeting the removal of bottom saltwater quicker after sandbar closure. 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 City of Santa Cruz, CDFW, USFWS, Central Coast Regional Water Quality Control Board, Coastal Commission, and other local stakeholders. Individual copies of this opinion were provided to the Corps and the City. 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

2ndNature. 2015. San Lorenzo and Laguna Lagoon Annual Water Quality 2014, Santa Cruz, California. Summary. Prepared for the City of Santa Cruz Water Department. June 2015. 66 pages.

2ndNature. 2016. San Lorenzo and Laguna Lagoons 2015 Water Quality Summary, Santa Cruz, California. Prepared for the City of Santa Cruz Water Department. June 2017. 55 pages.

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