4.4 GEOLOGY, HYDROLOGY AND WATER QUALITY

This section analyzes impacts of the proposed project related to geotechnical, hydrological and water quality issues based on a review of existing city plans and the engineering report prepared as part of the Wharf Master Plan. This section also draws from the City of Santa Cruz *General Plan 2030* EIR (SCH#2009032007), which was certified on June 26, 2012, regarding background information on regulatory setting and geological and hydrological conditions in the City. The General Plan EIR is incorporated by reference in accordance with section 15150 of the State CEQA Guidelines. Relevant discussions are summarized in subsection 4.4.1. The General Plan EIR is available for review at the City of Santa Cruz Planning and Community Development Department (809 Center Street, Room 101, Santa Cruz, California) during business hours: Monday through Thursday, 7:30 AM to 12 PM and 1 PM to 3 PM. The General Plan EIR is also available online on the City's website at:
http://www.cityofsantacruz.com/Home/Components/BusinessDirectory/BusinessDirectory/102/1775.

Public and agency comments related to hydrology and water quality were received during the public scoping period in response to the Notice of Preparation (NOP). Issues raised in these comments include:

- Explain "strengthening and stabilizing" the Wharf as a result of the expanded walkways and additional pilings and evaluate the overall geotechnical impact of widening the wharf beyond its current configuration.
- Include a technical study to assess the impact of winter storms and wave action on the western (weather-side) lowered walkway with public safety issues and the potential for storm debris to hit restaurant windows due to wave action on the lowered walkway.
- Address the impact of sea level rise and more frequent storms anticipated with climate change, high tides and waves on the western walkway.
- Examine the potential impact to the swell pattern, redirection of wave force, change in the area of wave-force dissipation, and sand movement as a result of installation of additional piles as part of the proposed Wharf (East Promenade) expansion.
- Provide an "ocean current analysis" to assess the viability of securing and stabilizing vessels on the proposed new eastside docks, both large and small.
- Concerns were expressed regarding the treated piles and effects on water quality.
- Include recommendations in Wharf Master Plan for water quality control in the Project Description or as mitigation measures.

To the extent that issues identified in public comments involve potentially significant effects on the environment according to the California Environmental Quality Act (CEQA) and/or are raised by responsible agencies, they are identified and addressed within this EIR. Public comments received during the public scoping period are included in Appendix A.

4.4.1 Environmental Setting

Regulatory Setting

The following overview summarizes key regulations regarding geotechnical, hydrological, and water quality requirements. See the General Plan 2030 EIR (DEIR volume, pages 4.7-1 – 4.7-5), which is incorporated by reference, for further discussion on regulations related to hydrology and water quality. Additional regulatory and permitting requirements are discussed in Chapters 3 and 4.2.

Federal Regulations

The Federal Emergency Management Agency (FEMA) – a former independent agency that became part of the new Department of Homeland Security in March 2003 – is tasked with responding to, planning for, recovering from, and mitigating against disasters. Formed in 1979 under an executive order by President Jimmy Carter to merge many of the separate disaster-related responsibilities of the federal government into one agency, FEMA is responsible for determining flood elevations and floodplain boundaries based on U.S. Army Corps of Engineers studies and approved agencies studies and for coordinating the federal response to floods, earthquakes, hurricanes, and other natural or man-made disasters and providing disaster assistance to states, communities and individuals. FEMA distributes the Flood Insurance Rate Maps (FIRMS), which are used in the National Flood Insurance Program (NFIP). These maps identify the locations of special flood hazard areas (SFHAs), including the 100-year flood zone.

The U.S. Environmental Protection Agency (EPA) is the lead federal agency responsible for water quality management. The Clean Water Act of 1972 (CWA, codified at 33 United States Code Sections 1251-1376) is the primary federal law that regulates the discharge of pollutants to waters of the United States from any point source. Section 401 of the CWA requires water quality certification for any activity, including the construction or operation of a facility, which may result in any discharge into navigable waters. Section 404 of the CWA requires a permit for the discharge of dredged fill material into navigable waters at specified disposal site. In 1987, amendments to the CWA added Section 402(p), which establishes a framework for regulating non-point source stormwater discharges under the National Pollutant Discharge Elimination System (NPDES). Various elements of the CWA address water quality, and they are discussed below.

The Santa Cruz Wharf is located in the Monterey Bay National Marine Sanctuary (MBNMS), and MBNMS staff has indicated that the following prohibitions apply to projects located within the sanctuary for which there are no exceptions.

1. Discharge or deposit of any matter within or into MBNMS.

2. Discharge or deposit from beyond MBNMS any matters that enter and injure sanctuary resources or qualities.

State Regulations

California Building Code. Title 24 of the California Code of Regulations, contains the Building Standards Codes, including Part 2, the California Building Code (CBC), which sets forth minimum requirements for building design and construction. In the context of earthquake hazards, the CBC design standards have a primary objective of ensuring public safety and a secondary goal of minimizing property damage and maintaining function during and following a seismic event. The CBC presents the requirements for geotechnical investigations and prescribes seismic design criteria for various types of structures. The CBC also requires analysis of liquefaction potential, slope-instability, differential settlement, and surface displacement due to faulting or lateral spreading for various categories of construction (City of Santa Cruz, April 2012, DEIR volume).

Stormwater-Water Quality Regulations. The California State Water Resources Control Board (State Board) and the nine Regional Water Quality Control Boards (RWQCB) have the responsibility in California to protect and enhance water quality, both through their designation as the lead agencies in implementing the Section 319 non-point source program of the federal Clean Water Act, and through the state's primary water pollution control legislation, the Porter-Cologne Water Quality Control Act of 1969, codified in Division 7 of the California Water Code). Under the Act, the State must adopt water quality policies, plans, and objectives that protect the State's waters for the use and enjoyment of the people. Such "waters of the State" include streams, groundwater, isolated wetlands, and other bodies of water that are not under federal jurisdiction as "waters of the United States" (under the Clean Water Act). The Act sets forth the obligations of the SWRCB and RWQCBs to adopt and periodically update water quality control plans (Basin Plans). Basin Plans are the regional water quality control plans required by both the CWA and Porter-Cologne Act in which beneficial uses, water quality objectives, and implementation programs are established for each of the nine regions in California. The Act also requires waste dischargers to notify the RWQCBs of their activities through the filing of Reports of Waste Discharge (RWD) and authorizes the SWRCB and RWQCBs to issue and enforce waste discharge requirements (WDRs), National Pollutant Discharge Elimination System (NPDES) permits, Section 401 water quality certifications, or other approvals.

Urban runoff and other "non-point source" discharges are regulated by the 1972 Federal Clean Water Act (CWA), through the National Pollutant Discharge Elimination System (NPDES) permit program that has been implemented in two phases through the California Regional Water Quality Control Boards (RWQCB). Phase I regulations, effective since 1990, require NPDES permits for stormwater discharges for certain specific industrial facilities and construction activities, and for municipalities with a population size greater than 100,000. Phase II regulations expand the NPDES program to include all municipalities with urbanized areas and municipalities with a population size greater than 10,000 and a population density greater than 1,000 persons per square mile.

Phase II regulations also expand the NPDES program to include construction sites of one to five acres (City of Santa Cruz, April 2012, DEIR volume).

Construction activity on projects that disturb one or more acres of soil must obtain coverage under the State's General Permit for Discharges of Storm Water Associated with Construction Activity (Construction General Permit, 99-08-DWQ). Construction activity subject to this permit includes clearing, grading, and disturbances to the ground such as stockpiling or excavation. The Construction General Permit requires the development and implementation of a Storm Water Pollution Prevention Plan (SWPPP). The SWPPP must list best management practices (BMPs) that the discharger will use to protect stormwater runoff and the placement of those BMPs.

Local Regulations

Stormwater Management Program. The City of Santa Cruz (City) has developed a Storm Water Management Program (SWMP) in order to fulfill the requirements of the Phase II NPDES General Permit for Discharges of Storm Water from Small Municipal Separate Storm Sewer Systems (MS4) (General Permit) and to reduce the amount of pollutants discharged in urban runoff. In compliance with the Phase II regulations, the City's comprehensive SWMP is designed to reduce the discharge of pollutants to the Maximum Extent Practicable (MEP) and to protect water quality (City of Santa Cruz, April 2012, DEIR volume).

In 1998, the City of Santa Cruz adopted an ordinance for "Storm Water and Urban Runoff Pollution Control" (Chapter 16.19 of the city's Municipal Code) as part of its Storm Water Management Program in accordance with the RWQCB's requirements. The ordinance identifies prohibited discharges and required Best Management Practices (BMPs) for construction and new development.

As indicated above, construction activity on projects that disturb one or more acres of soil must obtain coverage under the State's General Permit for Discharges of Storm Water Associated with preparation and implementation of a SWPPP and BMPS to protect water quality during construction. The proposed project would not result in grading and development that would disturb over one acre, and thus, the project would not be subject to preparing a SWPPP. The City's regulatory requirements and BMPs, as detailed in the "Stormwater Best Management Practices Manual" published by the City's Public Works Department, must be implemented.

Municipal Code Requirements. The City's Municipal Code section 24.14.070 requires a site-specific geotechnical investigation for all development, except projects with fewer than four units, in areas identified in the General Plan as having a high liquefaction potential.

The Zoning Ordinance, Title 24 of the Municipal Code, currently contains provisions to ensure that new development is designed and constructed in a manner that limits alteration of drainage patterns, prevents erosion, and minimizes long-term impacts on water quality. Chapter 24.14 – Environmental Resource Management – contains a section on Conservation Regulations that includes general provisions for drainage and erosion controls. Section 24.14.050 requires that a drainage plan be submitted for projects, both large and small, when existing drainage patterns would be altered by new construction. A drainage plan must be submitted and reviewed as part of the project approval. In addition, the ordinance requires that stormwater runoff resulting from project development be minimized.

Geologic and Seismic Hazards

The project site is located in a seismically active region of California and the region is considered to be subject to very intense shaking during a seismic event. The City of Santa Cruz is situated between two major active faults: the San Andreas, approximately 11.5 miles to the northeast, and the San Gregorio, approximately 9 miles to the southwest. There are no active fault zones or risk of fault rupture within the City (SOURCE VII.1b). Therefore, fault rupture through the project site is not anticipated.

The project would be subject to seismic shaking. According to maps developed as part of the City's recently adopted *General Plan 2030* and included in the General Plan and General Plan EIR, the project site is located in an area identified as being subject to liquefaction hazards (City of Santa Cruz, June 2012-page 10-5 and City of Santa Cruz, April 2012, DEIR volume-Figure 4.10-4).

According to the Engineering Report prepared as part of the Wharf Master Plan, the Wharf structure is all timber construction that can be separated into three functional areas: foundation (piles and cap); deck (stringers decking and paving); and superstructure (buildings on top). The Wharf foundation (piles) acts as cantilever elements as the piles transfer all forces (support) into the seafloor by embedment of approximately 20 feet. The piles support vertical loads (weight) by bearing on the pile tip and friction for the length of embedment. The piles resist lateral loads (wave, earthquake, etc.) by embedment into the soil that produce a bending moment within the embedded portion of the pile. Horizontal beams at the south end of the Wharf provide lateral bracing to the piles.

Decking members span across multiple stringers for vertical loads (weight). The entire timber deck assembly is flexible and acts as a unit to spread load to adjacent members, particularly large point loads (such as a truck wheel). For lateral loads, the deck assembly acts as a diaphragm (flexible) to transmit loads across many multiple piles in the foundation (Moffatt & Nichol, 2014).

The Engineering Report included an inspection of all existing wharf piles (approximately 4,450). The piles are the most critical element of the structure as they transmit all loads to the supporting seafloor soils. The inspections indicated that the piles are in good condition overall. Less than five percent of the existing piles require replacement (Moffatt & Nichol, 2014). Notable exceptions are underneath buildings where replacement is difficult with the building structure in place. The report indicates that a major factor contributing to the longevity of the piles has been the practice of using Douglas fir piles treated with preservative (different treatment methods have been used on the existing piles depending on the time period they were installed). Observed damage to the piles is caused by storm waves, floating logs and marine borers. The assessment concluded that the continued replacement of damaged piles will allow the continued functioning of the Wharf well into the future (Ibid.).

The engineering review also included a structural evaluation of the Wharf that assessed the condition of the existing structural members and analysis of their capacity to safely support the imposed loads (weight, waves, earthquake, etc.). The review concluded that the condition of the structure is good due to the quality of original construction and continuous maintenance (Moffatt & Nichol, 2014).

A preliminary analysis of the Wharf performance in a seismic event was included in the Engineering Report. The Wharf is in a seismically active area and has withstood a number of earthquakes during its 100 years in existence. These include the Loma Prieta earthquake in 1989, whose epicenter was approximately five miles from the Wharf. This earthquake caused significant damage to Santa Cruz including damage to the downtown area that required significant reconstruction, however there was no damage to the Wharf as a result of the Loma Prieta Earthquake (Moffatt & Nichol, 2014). The vertical timber pile construction of the Wharf is inherently flexible (Ibid.).

Regional Hydrological Setting

Surface Hydrology

The City of Santa Cruz encompasses approximately 12 square miles between the Monterey Bay and the Santa Cruz Mountains and lies on a narrow coastal plain at the mouth of the San Lorenzo River. A total of 39 miles of watercourses occur within the City (City of Santa Cruz, April 2012, DEIR volume). The San Lorenzo River originates in the Santa Cruz Mountains and is the largest drainage in the region. The river flows southward from the Santa Cruz Mountains, traverses through the center of the City, and forms a major physical feature of the region. The downtown area of the City of Santa Cruz is situated on the floodplain of the lower San Lorenzo River.

The San Lorenzo River drains a 138-square mile watershed, featuring forested and urbanized areas within the City and Santa Cruz County. Within the City limits, the lower San Lorenzo River flows southward from the Sycamore Grove area of Pogonip through the center of Santa Cruz, to Monterey Bay. The lower 2.5 miles (south of Highway 1) are channelized in a levee flood control project developed in cooperation with the U.S. Army Corps of Engineers (ACOE) in the late 1950s (City of Santa Cruz, April 2012, DEIR volume). Significant flood improvements along the river were completed in 2000 as part of the ACOE's San Lorenzo River Flood Control and Environmental Restoration Project. This project raised the river levee heights, provided landscaping, improved the pedestrian/bicycle path on the levee, and rehabilitated three of the four downtown bridges (over the San Lorenzo River) to increase flood flow capacity. The San Lorenzo River discharges into Monterey Bay approximately 4,500 feet south of the Santa Cruz Wharf.

Marine Hydrology

The Santa Cruz Wharf is located within the Monterey Bay, which is part of the Monterey Bay National Marine Sanctuary (MBNMS). Generally, the water depth at the end of the Wharf is approximately 26- to 28-feet below MLLW (Moffatt & Nichol, October 2014), although this may vary with shifting ocean bottom sands.

The MBNMS was established and designated in 1992 for the purpose of resource protection, research, education and public use. The MBNMS is the largest of thirteen marine sanctuaries administered by the United States Department of Commerce National Oceanic and Atmospheric Administration (NOAA) and it extends from Marin County to Cambria, encompassing nearly 300 miles of shoreline and 5,322 square miles of ocean, extending an average distance of twenty-five miles from shore. At its deepest point, the MBNMS water depth is 10,663 feet (more than two miles) (Monterey Bay National Marine Sanctuary, 2008).

Water circulation and oceanography in the MBNMS are driven by the California Current System, which mixes cool, lower-salinity subarctic water with warm, saltier equatorial water. The proportion of the two water types in Monterey Bay changes depending on the strength of the various components of the Current System. The predominant ocean-water current direction in the project area is to the west (URS Corporation, May 2013).

There are three distinct oceanographic seasons for Monterey Bay: upwelling[1] season, relaxation season, and winter storm season. The upwelling season typically begins with the spring transition, characterized by strong persistent winds from the northwest and usually occurs between late February or early March and July. It is the start of the annual productivity cycle along northern and central California, and upwelling is driven by winds from the northwest alternates with periods of calm. These winds generally begin to subside by late July, and August through mid-November is the wind relaxation season. During this time, winds are mostly light and variable, and the seas can be calm for one to two weeks at a time. This changes abruptly with the arrival of the first winter storms from the Gulf of Alaska. From late November through early February, winter storms create large waves and strong winds along the coast (NOAA, September 2008).

In Monterey Bay, when upwelling ceases at the end of summer (typically August or September), sea level along the coast and inside Monterey Bay rises and the California Current slows. Sea surface temperatures along the coast may rise markedly. Later in the year (typically November) when winter storms bring occasional strong southerly winds, transport is shoreward, and in places the surface current becomes northerly. This flow is a deep coastal boundary current with a core depth of about 250 meters during spring and summer, and speeds that can be as strong as the surface California Current. Though wind-driven upwelling does not normally occur within

[1] Divergence of water currents or the movement of surface water away from land, leading to upward movement of cold nutrient-rich water from the ocean depths; often associated with great production of fish and fisheries (NOAA, September 2008).

Monterey Bay due to the topographic break of the coastal mountains afforded by the Salinas Valley, some upwelled water may be transported into the Bay from areas to the south of Año Nuevo Island (NOAA, 2008).

Tidal circulation near the Wharf is affected by a combination of open coastal circulation, wave-induced turbulence, and the North Pacific Gyre via the California Current[2]. The prevailing current direction in the shallow, nearshore areas of Santa Cruz is dependent on the circulation pattern within the Monterey Bay and is predominant to the west. Subsurface currents were parallel to shore, and out of the Bay roughly opposite of the wind driven surface flow. Currents are dominated by semi-diurnal and diurnal tidal signals that lag the surface tides by roughly three hours on average. These flows over the course of a tidal cycle are very asymmetric, with the surface flow to the southeast during flooding tide lasting only one-third as long as the flow to the northwest during ebbing tide (Moffatt & Nichol, October 2014).

Stormwater Drainage

The City's storm drain system is comprised of a wide variety of conveyance systems such as underground pipes, small open drainage channels, creeks, and the San Lorenzo River. The system includes numerous storm drain inlets and catch basins throughout the City, and five pump stations that discharge stormwater directly into the San Lorenzo River. In addition, along both the east and west sides of the City, there are stormwater outfalls that discharge onto the beaches or cliffs and into Monterey Bay (City of Santa Cruz, April 2012, DEIR volume).

The Wharf extends into the Monterey Bay and was constructed in 1914. The Wharf deck for road and parking areas is covered with a two inch (nominal) thick asphalt pavement supported by flexible timber decking and framing beneath. The pavement has extensive cracking. There is no existing storm water collection system—except at localized wash-down and trash enclosures--all storm water runoff flows through the deck into the bay (Moffatt & Nichol, October 2014).

Water Quality

Urban development often results in the degradation of water quality due to the introduction of pollutants and erosion due to construction and development. Development and pervious pavement can result in increased runoff and higher velocities in creeks and streams. These

[2] An ocean gyre is a large-scale circular feature, made up of permanent ocean currents that revolve around a central point. Gyres are formed by wind transferring energy to water combined with gravitational forces of the Earth's rotation. There are five major ocean gyres found in the world's oceans: the North Atlantic; South Atlantic; North Pacific; South Pacific and Indian Ocean gyres. Within gyres, waters are relatively constant, remaining stable for long periods instead of circulating around the globe. Gyres have always been areas where large amounts of natural materials, such as driftwood, seeds and pumice, accumulate. In recent decade, plastic has become the overwhelming, unnatural debris in the gyres. Wind and water movement transports trash from land to the ocean where it is carried by ocean currents to the gyres. The MBNMS also receives major influxes of debris due to the North Pacific Gyre (Monterey Bay Aquarium, 2014).

changes can, in turn, cause erosion. Urban pollutants may include toxic metals, hydrocarbons, nutrients, suspended solids, and many other chemicals (City of Santa Cruz, April 2012, DEIR to treat stormwater runoff in compliance with federal and state laws.

The primary pollutants of concern in the City watersheds are sediment and silt and fecal indicator bacteria. The City has targeted these primary pollutants of concern in the SWMP because certain water bodies within the City are listed on the Clean Water Act Section 303(3) list as impaired for these specific pollutants as further discussed below (Ibid.). As previously indicated, the City's SWMP is a comprehensive program to reduce the amount of pollutants discharged in urban runoff and to improve and protect water quality that includes requirements for stormwater treatment in development projects in accordance with the federal state requirements.

The Clean Water Act requires states to identify and prepare a list of water bodies that do not meet water quality objectives, and to establish Total Maximum Daily Loads (TMDL) for each water body to ensure attainment of water quality objectives. The City of Santa Cruz storm drain system (MS4) discharges into four water bodies that are currently on the 303(d) list of impaired water bodies, one of which is the San Lorenzo River. The San Lorenzo River is listed for: sediment, nutrients and pathogens. The City's SWMP addresses the primary pollutants of concern through City measures and BMPs to the Maximum Extent Practicable.

MBNMS is currently updating its 2009 Condition Report which provides an assessment of ecosystem health, status and trends within the Sanctuary. The plan assesses four areas of the sanctuary: estuarine (Elkhorn Slough), nearshore (<30 meters in depth), offshore (>30 meters) and the Davidson Seamount (70 miles offshore, southwest of Monterey). Sanctuary habitats and living resources are reported to be in excellent condition. Overall, in relation to resource health in the vicinity of the Wharf (which extends out to depths of 35 meters), there is improved water quality due to improved sewer infrastructure and non-point source controls (NOAA, 2015).

The City has regularly monitored water quality in the vicinity of the Wharf due to instances of poor water quality adjacent to Cowell Beach. Rigid occlusion material was installed under the Wharf between May and August 2016 and covers the first 25 bents of the Wharf or approximately 375 linear feet south from the bulkhead. The material was installed to prevent birds from perching or roosting in this area. The City has indicated that the water quality has significantly improved since the installation of the barricade. According to data review by City staff, water quality testing in 2017 (after installation of the occlusion material and after heavy winter storms) revealed significantly reduced bacteria averages (Enterococcus and Fecal Coliform) (Babatola, personal communication, December 2017).

During the designation of the Sanctuary in 1992, eight key water quality agencies within the Sanctuary region entered into a Memorandum of Agreement (MOA) to provide an ecosystem-based water quality management process. The agreement led to the development of the Sanctuary's Water Quality Protection Program (WQPP), a partnership of twenty-five federal, state and local agencies, and public and private groups dedicated to protecting and enhancing water quality in the Sanctuary and its watersheds. This partnership of MOA signatories, additional public agencies, non-governmental and private organizations are working as members of the WQPP Committee, which oversaw the development of four action plans entitled: Implementing Solutions to Urban Runoff; Regional Monitoring, Data Access, and Interagency Coordination; Marinas and Boating; and Agriculture and Rural Lands. Since the designation in 1992, runoff and spills along the MBNMS's coastline have periodically resulted in high levels of coliform bacteria being detected in coastal waters, resulting in hundreds of beach closures or warnings annually. This plan was initiated to address the issue of beach closures and will constitute the fifth action plan as part of the WQPP (NOAA, 2008).

Flood Hazards

Flooding and coastal storms present essentially the same risks and are frequently related types of hazards in the City of Santa Cruz. A flood is a natural event for rivers and streams. Coastal storms can cause increases in tidal elevations (called storm surge) wind speed and erosion as well as flooding. Floodplains are lowlands adjacent to rivers, lakes and oceans that are subject to recurring floods (City of Santa Cruz, September 2013).

The City of Santa Cruz Climate Adaptation Plan Update (CAPU) (City of Santa Cruz, 2018) considers flooding and severe coastal storms to be a considerable, potential risk to the city and its residents. Intense, increased rainfall may lead to larger flood flows. Noted in the CAPU are the potential for greater storm surges, wind speeds and resultant coastal erosion. These events are predicted to occur more frequently due to climate change impacts, including the impacts from sea level rise (City of Santa Cruz, 2018).

Flood Hazards

The San Lorenzo River runs through the downtown corridor and the majority of the downtown area is in the San Lorenzo floodplain. Flooding along the coast of Santa Cruz may occur with the simultaneous occurrence of large waves and storm swells during the winter. When storms occur simultaneously with high tides, flood conditions including flooding at the mouth of the San Lorenzo River are exacerbated. The Wharf is not located within a floodplain of a stream, but its location within the bay subjects the facility to costal storms and waves and future sea level rise.

Coastal Storms and Wave Run-up

Studies have found a progressive increase in wave-energy levels in the North Atlantic and North Sea since the 1950s and in the North Pacific since the late 1970s, possibly due to global climate change (Moffatt & Nichol, October 2014). Over the last 15 years, the U.S. west coast has experienced unusually intense wave conditions and the storm frequency and magnitude seem increasing. Although some variations exist, the general trend indicates an increase of average significant wave height and average peak wave period. A study of the California central coast by the U.S. Geological Survey (USGS) observed a trend of significant average wave height increase of

1.4 foot over the past 22 years (Ibid.). The long-term trend also suggests greater storm intensity over the study period. During El Niño months, the mean significant wave height is higher and larger waves are more frequent (30% more frequent than average for waves exceeding 4 meters). In contrast, during La Niña months, their increases are less profound (Ibid.).

The offshore wave climate along central California can be characterized by three dominant modes: the Northern Hemisphere swell, the Southern Hemisphere swell, and local wind-driven seas. The Northern Hemisphere swell typically is generated by typhoons in the North Pacific Ocean off the Aleutian Islands during the winter months (November-March) and can attain deep-water wave heights exceeding 8 m. The Southern Hemisphere swell is generated by storms off New Zealand, Indonesia, or Central and South America during summer months and, although generally it produces smaller waves than the Northern Hemisphere swell, this swell often has very long period (15+ seconds). The local seas typically develop rapidly when low-pressure systems track near central California in the winter months or when strong sea breezes are generated during the spring and summer. Storms with deep-water wave heights in excess of 5 m occur five times a year on average (Moffatt & Nichol, October 2014). The NOAA National Data Buoy Center (NDBC) Buoy 46042 is located approximately 30 miles southwest to the Wharf. It is a deep water buoy with water depth over 6,500 feet.

During spring and fall, the predominant swell directions are from northwest and west-northwest, with slightly more frequent from the northwest. During summer, the predominant swell direction is mainly from the northwest. During winter, a broader band of incoming swells occur between west and northwest, with the most frequent from the west-northwest. Additionally, the winter experiences more frequent storms with swell height exceeding 15 feet 5.5% of the time, followed by the spring and fall with 2.3% and 1.7%, respectively. In contrast, the summer experiences these swell heights less than 0.1% of the time. Similarly, swell period exceeding 15 seconds occurs 19.3%, 12.1%/11.5%, and 8.8% of the time for winter, spring/fall, and summer, respectively (Moffatt & Nichol, October 2014).

Tsunami Hazards

A tsunami is a series of waves generated by an impulsive disturbance in the ocean or in a small, connected body of water. Tsunamis are produced when movement occurs on faults in the ocean floor, usually during very large earthquakes. An earthquake anywhere in the Pacific can cause tsunamis around the entire Pacific basin. Since the Pacific Rim is highly seismically active, tsunamis are not uncommon, although there has been minimal damage and loss of life in Santa Cruz during recorded history (City of Santa Cruz, 2013). However, a tsunami generated by a 9.0 magnitude earthquake in Japan in March 2011 reached Santa Cruz and caused substantial damage to the Santa Cruz Small Craft Harbor.

There are two primary types of tsunami vulnerability in Santa Cruz. The first is a distant source tsunami from elsewhere in the Pacific Ocean. This type of tsunami is capable of causing significant destruction in Santa Cruz. However, this type of tsunami would usually allow time for the Tsunami

Warning System for the Pacific Ocean to warn at risk and threatened coastal areas in time for evacuation (City of Santa Cruz, 2013). The more vulnerable risk to the City of Santa Cruz is a tsunami generated as the result of an earthquake along one of the many earthquake faults in the region. A local source tsunami generated by an earthquake on any of the faults affecting Santa Cruz would arrive just minutes after the initial shock. The lack of warning time from such a nearby event would result in higher causalities than if it were a distant tsunami (Ibid.). The City's mitigation strategy includes continuation of an up-to-date Emergency Operations Plan, an effective public information program and continuing collaborative efforts with the County, other Cities, agencies and community organizations to facilitate collaborative efforts in providing up-to-date tsunami mapping, preparation, information, warning dissemination and education.

According to maps developed as part of the *General Plan 2030* and included in the General Plan and General Plan EIR, the Santa Cruz Wharf is located within a tsunami inundation zone, as are most of the downtown and beach areas of Santa Cruz (City of Santa Cruz, June 2012-page 106 and City of Santa Cruz, April 2012, DEIR volume-Figure 4.7-1).

The National Oceanic and Atmospheric Administration operates a tsunami warning system, giving several hours' notice to allow evacuation of threatened areas to prevent injuries. Since the March 2011 Tohuku, Honshu Island tsunami in Japan, the City has worked with the County and other agencies regarding implementation of emergency plans. The City's Hazard Mitigation Plan inventories areas in the City subject to tsunamis and sets forth a mitigation strategy that includes continuation of an up to date Emergency Operations Plan, an effective public information program and continuing collaborative efforts with the County, other Cities, agencies and community organizations to facilitate collaborative efforts in providing up-to-date tsunami mapping, preparation, information, warning dissemination and education.

Sea Level Rise

The rise in global sea level is attributed to the thermal expansion of ocean water and the melting of mountain glaciers and ice sheets around the globe. Although sea level rise is not a new phenomenon, having been a major natural component of coastal change throughout time, the current concern is that with increased global warming and melting of ice sheets on Greenland and West Antarctica, the rate of change may increase. Average global sea level has risen between five to nine inches during the 20th century as reported by the International Panel on Climate Change (IPCC), nearly one-tenth of an inch each year (California EPA, August 2013). Along California's coast, sea level already has risen by an average of seven inches over the last century – three inches at Los Angeles, eight inches at San Francisco, and an estimated six inches at La Jolla near San Diego (Ibid).

Although sea level rise is not a new phenomenon, having been a major natural component of coastal change throughout time, the current concern is that with increased global warming and melting of ice sheets on Greenland and West Antarctica, the rate of change may increase. The "State of California Sea-Level Rise Guidance Document" (March 2013) provides guidance for incorporating sea-level rise projections into planning and projects in California in response to Governor Schwarzenegger's Executive Order S-13-08, issued on November 14, 2008 that directed state agencies to plan for sea level rise and coastal impacts. According to this document[3], sea level rise is projected (using the year 2000 as a baseline) as: 0.13-0.98 feet between 2000 and 2030; 0.39-2.0 feet between 2000-2050; and 1.38-5.48 feet between 2000 and 2100 (see Table 4.4-1). Impacts of sea level rise in California include flooding and inundation, increased coastal erosion, shoreline retreat, changes in sediment supply and movement, and saltwater intrusion to varying degrees along the California coast (California Coastal Commission, August 2015).

TABLE 4.4-1: Sea Level Rise Projections for California

TIME PERIOD	NORTH OF CAPE MENDOCINO	SOUTH OF CAPE MENDOCINO
By 2030	2 – 9 in (-4 – +23 cm)	2 – 12 in (4 – 30 cm)
By 2050	-1 – 19 in (-3 – + 48 cm)	5 – 24 in (12 – 61 cm)
By 2100	4 – 56 in (10 – 143 cm)	17 – 66 in (42 – 167 cm)

SOURCE: National Research Council, 2012 as cited in State of California Sea Level Rise Document, 2013

The Santa Cruz Wharf extends into Monterey Bay, and beach areas have been mapped as being within areas of sea level rise. Rising sea levels, storms of increasing intensity and an alternating series of floods and drought threaten the City of Santa Cruz in the coming decades. With funding from FEMA, the City has prepared a "Climate Adaptation Plan". The objectives of this Plan are to identify and evaluate the potential impacts of climate change on the City, analyze the severity of the hazards that the City faces, and develop potential adaptation responses to reduce the risk and exposure of the City to these hazards. The Santa Cruz Wharf is identified as a critical action item in the City's 2007 Local Hazard Mitigation Plan (City of Satna Cruz, 2007). The potential risks were identified in a "Vulnerability Study", prepared as a collaborative effort between the City's Climate Adaptation Team and University of California (UCSC) scientists. The study identified potential facilities vulnerable to risks of sea level rise, including beaches, West Cliff Drive, the City's wastewater treatment facility and the Santa Cruz Harbor (Griggs, Haddad, January 2011). The study also addressed coastal storm and cliff erosion hazards, as well as the potential for increased precipitation and flooding. Based on this study, the City has developed action items with priorities to respond to specific risks and hazards related to climate change that will build adaptive capacity into policies, programs and infrastructure. Action A-16 in the Climate Adaptation Plan calls for

[3] The State of California supported the preparation of the 2012 National Research Council's Report, *Sea-Level Rise for the Coasts of California, Oregon and Washington: Past, Present, and Future*, which is currently considered the best available science on sea level rise for California (California Coastal Commission, August 2015). This is estimate is current reference by California: a) March 2013-"State of California Sea Level Rise Document"; b) August 2013-"Indicators of Climate Change in California"; and c) August 2015-"California Coastal Sea Level Rise Policy Guidance."

protection and preservation of City buildings, identifying the Wharf and infrastructure as a high priority.

The *Climate Adaptation Plan (CAP) Update 2018-2023*, adopted by the City Council in October 2018, further addresses sea level rise. The CAP Update identifies the Wharf as a critical facility and identifies entrance road to the Wharf as being vulnerable due to coastal erosion hazards by the 2030 Planning Horizon (City of Santa Cruz, 2018).

Two strategies evaluated as part of the CAP Update include the Wharf. Strategy A-7 calls for upgrading or relocating city buildings, the Wharf and infrastructure to protect and prepare for sea level rise, flooding and storm events occurring as a result of climate change. Strategy A-25 calls for protection of visitor-serving venues, including the Wharf. The immediate and projected hazards include coastal erosion, flooding, and sea level rise. Consequentially, the current coastal hazards and projected impacts have prioritized A-7 and A-25 as Very High Priority. The Plan indicates that between 2060 and 2100, climate change will threaten significant portions of coastal areas in Santa Cruz. Decisions regarding what the urban/beach front area will look like in 2100 will need to be made if adaptation is to be strategic and cost effective (City of Santa Cruz, 2018).

4.4.2 Impacts and Mitigation Measures

In accordance with the California Environmental Quality Act (CEQA); State CEQA Guidelines (including Appendix G); City of Santa Cruz plans, policies, and/or guidelines; and agency and professional standards, a project impact would be considered significant if the project would:

GEO-1 Directly or indirectly cause potential substantial adverse effects including the risk of loss, injury, or death involving (i) rupture of a known earthquake fault as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area based on other substantial evidence of a known fault; (ii) strong seismic ground-shaking; (iii) seismic-related ground failure, including liquefaction; or (iv) landslides;

HYD-1 Substantially alter the existing drainage pattern of the site or area, including through alteration of the course of a stream or river or through the addition of impervious surfaces, in a manner which would: (i) result in substantial erosion or siltation on- or off-site; (ii) substantially increase the rate or amount of surface runoff in a manner which would result in flooding on- or offsite; or (iii)_create or contribute runoff water which would exceed the capacity of existing or planned stormwater drainage systems or provide substantial sources of polluted runoff;

HYD-2 Violate any water quality standards or waste discharge requirements or otherwise substantially degrade surface water quality;

HYD-3 Risk release of pollutants due to project inundation in flood hazard, tsunami, or seiche zones; or

HYD-4 Conflict with or obstruct implementation of a water quality control plan or sustainable groundwater management plan.

Analytical Method

The following impact analyses are based on review of existing data and studies, including the Engineering Report prepared by Moffatt & Nichol as part of the Wharf Master Plan and other City reports and studies.

Impacts and Mitigation Measures

The following impact analyses address potential geotechnical issues (GEO-1), stormwater drainage (HYD-1), water quality impacts (HYD-2), and exposure to flood or tsunami hazards (HYD-3). The Wharf is not located within a FEMA-mapped floodplain, but exposure to flood hazards as a result of coastal storms and sea level rise is addressed.

The Central Coast Basin Plan (2019) includes water quality standards for Monterey Bay for dissolved oxygen, pH, and radioactivity. The Plan also indicates that the provisions of the State Board's "Water Quality Control Plan for Ocean Waters of California" (Ocean Plan, Appendix A-11) and "Water Quality Control Plan for Control of Temperature in the Coastal and Interstate Waters and Enclosed Bays and Estuaries of California" (Thermal Plan, Appendix A-3 apply to affected ocean waters of the basin. Adoption and implementation of the Wharf Master Plan and subsequent development would not result in discharges to ocean waters or conflicts with the Basin Plan. A sustainable groundwater management plan for the area in which the project is located has not yet been prepared. Therefore, the project would not conflict with adopted water quality or groundwater plans (HYD-4).

Impact GEO-1: **Geologic Hazards.** Adoption and implementation of the Wharf Master Plan and future construction of proposed facilities and improvements would result in exposure of new structural development to seismic hazards. However, with implementation of the recommendations of the Engineering Report prepared as part of the Wharf Master Plan, the project would not directly or indirectly cause potential substantial adverse effects related to seismic or geologic hazards, and the impact would be *less than significant* (GEO-1).

Master Plan

Adoption and implementation of the Wharf Master Plan and future construction of planned improvements and structures would result in: physical expansion of the Wharf to create a pedestrian promenade and a walkway on the west side; construction of three new buildings (Gateway, Events Pavilion and Landmark); and potential intensification of existing buildings and uses on the Wharf. The new facilities would be supported by additional piles as needed for support, and the additional width provided by the East Promenade will also enhance the lateral stability and strength of the Wharf (Roma Design Group, October 2014). The Master Plan provides additional piles and outriggers at the southern end of the Wharf that will provide additional lateral strength.

The Engineering Report concluded that the continued replacement of damaged piles will allow the continued functioning of the Wharf well into the future and that the condition of the wharf structure is good due to the quality of original construction and continuous maintenance (Moffatt & Nichol, October 2014). Implementation of other engineering recommendations would support structural loads with consideration of seismic design factors. These recommendations include, but are not limited to:

- Continued replacement of piles as damaged and installation of additional piles for lateral stability and where required for additions to the Wharf.
- Replacement of deteriorated elements such as stringers, decking and pile caps.
- Provision of design parameters for future facilities.
- Reduce large vehicle access onto the Wharf and limit access to restricted areas.
- Perform design level seismic analyses for structural additions to the Wharf.

Therefore, with the additional piles and lateral support that will be provided as part of the expansion of the Wharf and with implementation of other recommendations outlined in the Engineering Report, the future construction of improvements and structures on the Wharf would not expose people or property to potential substantial adverse impacts.

Near-Term Projects

Entry Gate Relocation. The proposed relocation of the entry gate further onto the Wharf includes a new entrance gate and slight deck expansion that would be supported by additional 12-inch timber piles. The entry will include a gate and sign structure that will be supported by six 14-inch steel piles. The proposed entrance gate will be designed in accordance with engineering recommendations and would not expose people or structures to potential substantial adverse impacts.

East Promenade. Construction of the East Promenade will result in physical expansion of the Wharf by approximately 1.5 acres to the east to create a pedestrian promenade. As indicated above, the additional width provided by the East Promenade will also enhance the lateral stability and strength of the Wharf. The facility will be supported by 525 new 12-inch timber piles and supporting members. The East Promenade structure is designed of similar material and configuration to the existing timber wharf, which provides compatibility and additional lateral strength to the Wharf to withstand waves and other lateral loads (Moffatt & Nichol, October 2014). The Wharf structure acts as a cantilever structure (piles) connected with a diaphragm (deck). By adding piles to the width of the Wharf this increases the stiffness and reduces deflections and stress in the existing piles (Ibid.). As previously indicated, the additional piles and outriggers at the southern end of the Wharf will provide additional lateral strength (Ibid.). The East Promenade is designed to support a pedestrian loading, and in addition, to support emergency fire vehicles. The Engineering Report provides engineering recommendations and design parameters for the East Promenade, including loads for emergency vehicles. Thus, the proposed expansion and new pedestrian promenade will be designed in accordance with engineering recommendations and would not expose people or structures to potential substantial adverse impacts.

Mitigation Measures

No mitigation measures are required as a significant impact has not been identified.

Impact HYD-1: **Stormwater Drainage.** Implementation of the Wharf Master Plan and construction of proposed facilities would result in new structural development with some increase in impervious surfaces, but would not significantly increase runoff volumes or rates, exceed capacities of storm drains or result in erosion or water quality impact (HYD-1). Therefore, the impact would be *less than significant.*

Master Plan

Adoption and implementation of the Wharf Master Plan and future construction of planned improvements would result in expansion of the Wharf's surface area and construction of three new buildings (Gateway, Events Pavilion and Landmark) as well as potential intensification of existing buildings. The buildings would be constructed on mostly impervious paved surfaces, although there are some cracks in the pavement. There are no storm drains that serve the Wharf. The current road surface has no slope and drains through the cracked pavement into the ocean, which causes moisture and accelerates deterioration of the underlying timber structure. The proposed East Promenade and Westside Walkway would result in expansion of the Wharf, but the planned hardwood deck and pervious surfaces would not result in creation of impervious surfaces that would result in an increase in stormwater runoff.

An Engineering Report was prepared as part of the Wharf Master Plan that included review of storm water drainage from the Wharf and provided recommendations for drainage and water quality controls. Since the Wharf is located in the Monterey Bay and there are no downstream storm drain capacity or erosion concerns since runoff from the Wharf goes into the bay, peak flow drainage treatment is not needed. However, treatment for water quality is required for road and parking areas as further described in Impact 4.4-2. The drainage concept for the Wharf is to use pervious surfaces for new walkways and decks that are only for pedestrian use. For new buildings, the roof downspouts would be directed onto vegetated areas or into cisterns/rain barrels for reuse, although some building remodels within the existing footprint would be exempt, i.e., second-story additions that do not increase the building footprint. When repaving road and parking areas, the pavement can be sloped to collect the water into inlets that can treat the runoff through media (carbon filtration) before discharging it into the bay water. A conceptual design is provided in the Wharf Master Plan Engineering Report. As a result of planned stormwater improvements, any increased runoff would not substantially alter the existing drainage pattern of the area or exceed capacity of storm drainage facilities.

Near-Term Projects

Entry Gate Relocation. The proposed relocation of the entry gate further south onto the Wharf from its current location would expand the Wharf's surface area by approximately 800 square feet. The relocation will provide more efficient accessibility for vehicles entering and exiting the Wharf, but would not affect the number of vehicles accessing the Wharf. Any increased runoff would not substantially alter the existing drainage pattern of the area or exceed capacity of storm drainage facilities.

East Promenade. The proposed East Promenade would expand the Wharf surface area by approximately 1.5 acres and would be devoted to pedestrian use. Runoff would continue to flow into the bay, but there would be no vehicle use in this area that could contribute pollutants to the runoff. Increased runoff would not substantially alter the existing drainage pattern of the area or exceed capacity of storm drainage facilities.

Mitigation Measures

No mitigation measures are required as a significant impact has not been identified.

Impact HYD-2: **Water Quality.** Implementation of the Wharf Master Plan and construction of proposed facilities would result in expansion of the Wharf, but with implementation of stormwater treatment features recommended in the Wharf Master Plan Engineering Report and project-level construction best management practices, future construction of facilities and improvements would not result in a substantial degradation of water quality, although inadvertent discharge of construction debris into marine waters could occur without proper controls (HYD-2). Therefore, the impact would be *potentially significant*.

There are three potential issues affecting water quality as a result of construction of new development and improvements: 1) water quality degradation from stormwater runoff; 2) water quality degradation during construction; and 3) potential water quality issues regarding the type of coating that is on the timber piles. Each will be addressed separately. Since the issues apply to all future development and improvement, the impact is discussed as a whole and not separated between the Master Plan and the two near-term projects.

Stormwater Quality

Stormwater quality treatment is a consideration for roadways due to accumulation of sediments, oils, and grease from vehicles. Water quality treatment is not required for paved pedestrian-only areas or existing building roof areas as vehicles are not in these areas. For new buildings, the Engineering Report recommends that roof downspouts direct roof runoff onto vegetated areas or into cisterns/rain barrels for reuse. New walkways (East Promenade, Westside Walkway) would be constructed with decking boards and gaps to allow for drainage.

As indicated above, the current road surface has no slope and drains through the cracked pavement into the ocean. The Engineering Report indicates that when repaving, the pavement can be sloped to collect the water into inlets that can treat the runoff through media (carbon filtration) before discharge into the bay water. A conceptual design in presented in the Engineering Report. The system would provide a seal over the deck boards to eliminate seepage below and a collection system to allow any trapped water that may collect at the bottom of the asphalt to be drained through a deck “bleeder”. Thus, the recommended paving system will treat stormwater runoff before it is discharged into the Monterey Bay, which does not currently occur (Moffatt & Nichol, October 2014). Structural water quality treatment, such as oil and grease chambers, swirl chambers and media filters also would be feasible water quality treatment tools at the Wharf. With implementation of this system and above measures as recommended in the Engineering Report, surface runoff from paved surfaces with vehicle use would be pre-treated to prevent degradation of the marine waters below the Wharf.

Construction Water Quality

During installation of the pilings, benthic sediments would be temporarily disturbed during installation of the piles, which are estimated to take approximately 15-30 minutes to install per pile. This may result in temporary discharge of sediments into surface waters, which could cause a very minor increase in the water’s turbidity in the immediate vicinity on a temporary basis. Given the limited area of disturbance and short duration, the level of temporary turbidity arising from pile driving would not result in a significant impact on water quality due to the temporary and localized nature of the effect.

The proposed project could inadvertently result in discharge of construction-related contaminants. Discharge or deposit of any matter within or into the MBNMS is prohibited. MBNMS staff have expressed concern regarding potential discharge of debris during construction, such as timbers, nuts, bolts, screws, brackets, etc. from demolition and disassembly operations; sawdust from sawing and drilling of timbers; slag from welding operations; filings from metal cutting operations; discharge of excess caulk, sealants, epoxies, and other joining compounds; discharges of loose debris and garbage; general spills in construction areas; and fuel, oil and hydraulic fluid releases from equipment. Known, potential, and unavoidable discharges need to be carefully mitigated through tailored authorization terms and conditions (e.g. required use of tarps, debris nets, construction diapers, secure storage and spill containment systems).

New and replacement timber piles, beams and decking are treated and cut to size off site before being delivered to the site. Therefore, there is no sawing, welding or sealing of the timber members, which are completed in an offsite factory prior to delivery. Piles are installed into the seafloor with a crane and hammer from the Wharf deck. Beams (caps) are then placed on top of the piles. Once in place, holes are drilled into the pile and beam and connected with a metal plate and bolts using hand tools. Longitudinal beams (stringers) and timber decking are then placed on top of the cap beams and nailed into place using hand tools. Once the Wharf deck is expanded with the East Promenade. Nonetheless, additional measures have been recommended by the Wharf Master Plan engineer to ensure no inadvertent discharge occurs into the Monterey Bay, which would be prohibited.

Additionally, implementation of Best Management Practices required by the City's stormwater management regulations would avoid or minimize impacts to a less-than-significant level that could result during construction of new buildings. Implementation of best management practices required by the City's stormwater ordinance would include measures to protect water quality, such as proper storage, disposal and cleanup of equipment fuels. Construction would not involve grading or excavation, and thus, would not result in erosion-related water quality impacts.

Timber Pile Treatment Effects on Water Quality

The proposed new facilities would require installation of approximately 810 new timber piles in order to support new improvements and/or to increase the lateral stability of the Wharf. Additionally, approximately 225 existing piles will require replacement over time as part of ongoing Wharf maintenance. New and replacement piles would be 12-inch diameter timber (Douglas fir) piles.

The more recently installed replacement timber piles at the Wharf are treated with ACZA (ammoniacal copper zinc arsenate) and coated with a polyurea compound (Moffatt & Nichol, October 2014). ACZA is a wood preservative derived from metal compounds and arsenic that preserve the wood from decay fungi, wood attacking insects, including termites, and marine borers through their toxic properties. These metal-arsenate chemicals are toxic and can produce adverse impacts to aquatic habitat and species when used where they can be leached from pilings into the aquatic environment as fully discussed in section 4.2.2. However, the use of coating on the pile or wrapping piles would prevent leaching of toxic materials in the treated piles from leaching into the bay. Timber piles at the Wharf are sprayed offsite with a polyurea compound that is designed to encapsulate treated timber products to prevent toxins from leaching into the environment and protecting the timber from marine borers, and this coating system has been used for encapsulating AZCA-treated piles without any adverse impacts to water quality. The coating is applied in a controlled factory prior to delivery. The coating provides containment of chemical treatment of the wood piles and provides a barrier to organisms. This type of protection is now in wide usage on treated timbers and has been approved by regulatory agencies throughout California. Some locations include Sterns' Wharf in Santa Barbara, Coast Guard Wharf in Alameda and Trinidad Pier in Humboldt County (Moffatt & Nichol, August 2017). With pile coating, such as that proposed for treated timber piles used at the Wharf, potential leaching into the marine environmental would be avoided. See section 4.2.2 of this Draft EIR for a full discussion.

It is noted that the Draft EIR for the previously proposed Regional Desalination Project reported that offshore components of the seawater intake system could be located in areas that have buried, creosote-treated piles—particularly those intake sites near the existing Municipal Wharf, and construction may disturb buried, creosote-treated piles, which could cause sheening, odors and localized contamination (URS Corporation, May 2013). Five other piers had been constructed in Santa Cruz, and four wharves were built and demolished in the immediate vicinity of the current Santa Cruz Wharf between 1849 and 1922 (Perry, 2012). It is not known whether former wharf piles are buried in the vicinity of the Santa Cruz Wharf. However, implementation of Mitigation Measure HYD-2b would ensure that any contamination or contaminated materials inadvertently discovered or disturbed during construction and installation of new piles would be properly handled and disposed of consistent with state and federal regulations.

Mitigation Measures

Implementation of Mitigation Measures HYD-2a and HYD-2b would reduce potential construction-related impacts to marine water quality to a less-than-significant level.

MITIGATION HYD-2a Implement measures during construction of the Wharf substructure (piles, beams and decking), including but not limited to:

- Install a floating boom can be placed in the water to encompass the work area. Any timber that inadvertently falls into the water will float and be captured by the boom. Any metal (hand tools or bolts) that fall into the water can be retrieved by magnet or diver if necessary.
- The crane that installs the piles and beams shall have its hydraulic system converted for use with vegetable oil so that in the event of a hose failure, no petroleum based substance will contact the water, but rather food grade vegetable oil.
- Any fueling operations of the equipment is conducted on a containment area utilizing plastic sheeting and absorbent pad containment to contain any spills during fueling over the water.

MITIGATION HYD-2b If visual evidence of contamination is observed (e.g., oily sheen) during in-water construction, all work shall stop and appropriate containment measures shall be used to identify the source of the contamination (e.g., buried creosote piles), contain, and/or remove the material; regulatory agencies with authority over the area shall be notified, i.e., the Santa Cruz County Environmental Health Services or Department of Toxic Substances Control. Any hazardous materials needing to be removed shall be handled and disposed of in accordance with the requirements of federal and state regulations.

Impact HYD-3: **Coastal Flood Hazards.** Implementation of the Wharf Master Plan and future construction of proposed facilities would result in new structural development, but would not substantially increase exposure to flood hazards related to coastal storms and sea level rise or result in a risk of release of pollutants due to inundation (HYD-3). This is considered a *less-than-significant impact*.

There are three potential issues affecting flood risks at the Wharf: 1) coastal storm and wave intensity; 2) sea level rise; and 3) a tsunami. Each will be addressed separately. Since the issues apply to all future development and improvement, the impact is discussed as a whole and not separated between the Master Plan and the two near-term projects.

Coastal Storms and Waves

Santa Cruz Wharf was located behind Lighthouse Point for the natural shelter provided at this location. However, this location is on the open coast and subject to inherent forces of the sea. Offshore wave data over an approximate 20-year period (1991-2012) was reviewed as part of the Wharf Master Plan Engineering Study. At the offshore buoy, long-period swells are clearly dominant rather than the short-period seas (Moffatt & Nichole, October 2014). The elevation of Wharf deck (23 ft. MLLW) is sufficient to keep the Wharf deck above all but the infrequent, highest waves which can be up to 20 feet in height (Ibid.).

Studies have found a progressive increase in wave-energy levels in the North Atlantic and North Sea since the 1950s and in the North Pacific since the late 1970s, possibly due to global climate change. Over the last 15 years, the U.S. West Coast has experienced unusually intense wave conditions and the storm frequency and magnitude seem to be increasing (Moffatt & Nichol, October 2014). A study by the U.S. Geological Survey (USGS) 22-year buoy data off the central coast found a trend of significant wave height increased by 2 cm/yr. on average, which is equivalent to an increase of 1.4 feet over the past 22 years. The long-term trend also suggests more storms and greater storm intensity over the study period. During El Niño months, the mean significant wave height is higher and larger waves are more frequent (30% more frequent than average for waves exceeding 4 meters (Ibid.).

The Wharf Master Plan Engineering Study accounts for potential increases in storm intensity, peak waves, and sea level rise. As sea level rises, waves will be closer to the Wharf deck more frequently. Additional piles to widen the Wharf will increase the Wharf's ability to withstand these waves and other lateral forces. The Master Plan also proposes installation of ten outriggers below the stepped edge of the East Promenade, which will extend 25 feet to the east at the elevation and in the same plane of the existing ledgers. The purpose is to provide horizontal bracing, which will increase the stiffness and reduce the sway of the Wharf and provide better resiliency during extreme storms. The outriggers will create a more resilient form, enabling large waves to more readily pass through the structure (Moffatt & Nichol, October 2014). The planned Westside Walkway as called for in the Master Plan will protect the west side of the Wharf and buildings. It can be closed during severe storms and readily repaired if damaged, thus providing a buffer to the main Wharf structure that could sustain greater damage in severe storms if left unprotected. These elements combined with the continued maintenance performed by the Wharf staff will allow the Wharf to continue to resist the forces of the sea (Ibid.). Evacuation of the Wharf during periods of predicted extreme waves also would be implemented as occurred in 1985 and 1998.

The Wharf Master Plan Engineering Report also included a preliminary berthing analysis to determine the optimal location for the construction of a new landing (the South Landing) capable of handling research and visitor-serving vessels up to 100 tons. The Landing has been preliminarily designed however, for a vessel of up to 200 LT (long tons) such as a Coast Guard Marine Protector Class vessel, with a 120 foot length. The Engineering Report provides design recommendations for the South Landing, taking into account expected currents, wave action, winter storms, swell pattern and surrounding ocean conditions.

Furthermore, construction of the East Promenade and additional piles would have no effect on swell patterns or sand movement. The additional piles may result in a minor (1-2%) decrease in wave heights locally at the Main Beach (Porter, personal communication, August 2017). But it would be minor and limited in area.

Sea Level Rise

Because of its location and deck elevation (+23 ft., MLLW), the engineering review conducted as part of the Wharf Master Plan concludes that the Wharf structure should continue to function well into the future (Moffatt & Nichol, October 2014). Review by the City's Climate Action staff indicates that the existing Wharf deck elevation will be above sea levels that currently are projected over the next 100 years based on current sea level rise projections. The proposed East Promenade expansion would be slightly higher than the existing Wharf deck elevation. The Westside Walkway would be slightly lower than the existing deck, but also would be above projected sea level rise levels. The existing approximate 200-foot segment of the Wharf that spans the beach may be subject to greater coastal flooding in the future as a result of sea level rise. However, there are no planned improvements in this location. Thus, implementation of the Master Plan and construction of structures and facilities, including the two near-term projects – the Entry Gate Relocation and East Promenade – would not result in increased exposure to hazards associated to sea level rise.

Tsunamis

The project does not include construction of habitable structures that would expose people or habitable structures to potential tsunami inundation. Implementation of the Wharf Master Plan and future construction of improvements or structures on the existing developed Wharf would not increase or exacerbate tsunami risks, and emergency policies and procedures are place and continue to be updated to address emergency plans in the event of a tsunami.

Mitigation Measures

No mitigation measures are required as a significant impact has not been identified.