4.18 Other Considerations

Other considerations include an analysis of potential sea level risk induced by climate change for the specific Project site. This issue is discussed below.

4.18.1 Climate Change and Sea Level Rise

Topography and Existing Site Conditions

As discussed in Section 4.7, Geology and Soils, the active wastewater outfall line originates at the water effluent treatment (WET) plant and runs west through the Pismo/Oceano dunes for 2.0 miles to the shoreline and then terminates at a seafloor diffuser located 0.5 mile offshore in State Lands lease Public Resources Code (PRC) 1449.1, at a surveyed depth of approximately 38 feet below mean sea level. Inshore portions of the outfall line corridor lie beneath a zone of shallow sand bars and breaking waves (Figure 4.18-1). The nearshore environment features a broad sand beach, which is exposed to the prevailing northwesterly wind and swells (Tenera/Stantec 2023). Active sand dunes between the intertidal zone and the SMR consist of a series of parallel ridges generally aligned perpendicular to the prevailing west-northwesterly winds. The topography of the older dune sands, which comprise the sediments along the eastern portion of the outfall line, generally consists of broad west-northwest trending drainages and intervening broad ridges.

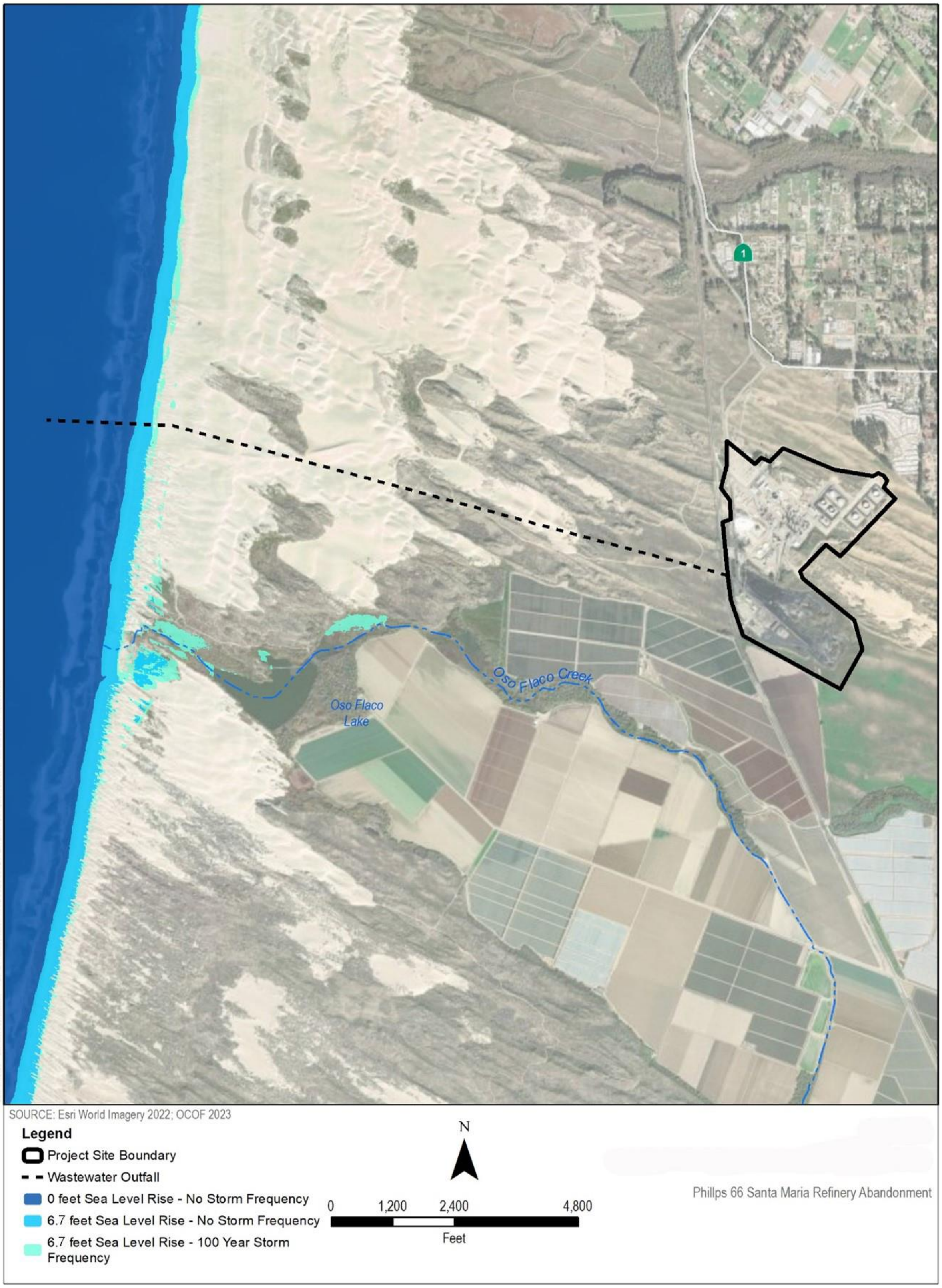
Sea Level Rise Scenarios

The rapid build-up of greenhouse gases (GHGs) from human activity, particularly carbon dioxide but also methane, nitrous oxide, and fluorinated gases, is causing global warming (change of global surface temperatures relative to the baseline period of 1850–1900) and climate disruption (IPCC 2021). Global atmosphere and ocean warming are leading to a complexity of global, regional, and local drivers of sea level rise (SLR). Global mean SLR from glacier mass loss and ocean thermal expansion is accelerating due to increasing rates of ice loss from the Greenland and Antarctic ice sheets (IPCC 2019; Oppenheimer and Glavovic 2019).

The State of California Sea level Rise Guidance (CNRA OPC 2018) (and the related Rising Seas in California: An Update on Sea level Rise Science report) is currently considered by the California Coastal Commission (CCC) and other agencies and organizations to be the best available science on SLR in California. In addition to synthesizing the available research on SLR, these documents highlight scientific evidence that indicates the potential for extreme SLR due to the rapidly accelerating and irreversible ice loss could result in upwards of six to 10 feet of sea level rise (CCC 2021; CNRA OPC 2018). However, these planning documents consider a range of SLR projections due to uncertainty in future GHG emissions.

Rising sea levels are expected to increase storm flooding, coastal erosion, tidal inundation, submergence of nearshore lands, groundwater rise, and seawater intrusion (CCC 2021). The best available science currently offers probabilities of specific sea level projections at various tide gauges that are used to inform planning decisions along the California coast. These probabilities are based on observations, global climate models, and expert opinion. The projections consider different scenarios of GHG emission rates referred to as Representative Concentration Pathways (RCPs), which are named for the associated radiative forcing level, in watts per square meter.

Figure 4.18-1 Sea Level Rise and Storm Frequency



Source: ESRI World Imagery 2022; CNRA OPC 2018

The RCPs range from low emission rates (RCP 2.6) to high emission rates (RCP 8.5), and also include an extreme scenario (H++), which is a single scenario and not a probabilistic projection (CNRA OPC 2018). Before 2050 the differences in SLR projections are minor and do not differentiate much until after 2050. The world is currently on the RCP 8.5 emission trajectory (CNRA OPC 2018).

Sea levels and rates of SLR are also dependent on changes in land elevations which vary across California due to such factors as tectonic activity, subsidence, ocean dynamics, and changes in the Earth's gravitational and rotational fields. To account for vertical land movement associated with tectonic activity and subsidence, localized sea level projections are tied to these local tide gauge data of which there are 12 along the California coast. The Project site is closest to the Port San Luis tide gauge. Table 4.18.1 shows the projected SLR over time under low (RCP 2.6) and high (RCP 8.5) emission rates as well as the extreme rate (H++) scenario that is relevant to the Santa Maria Refinery (SMR) wastewater outfall area, based on the Port San Luis tide gauge data. The first column shows ranges of sea level range for what is considered a likely probability of greater than 66 percent chance to occur, which is considered by the California Natural Resources Agency Ocean Protection Council (CNRA OPC) to be used as guidance for low risk aversion decisions (CNRA OPC 2018). The second column shows the values for what is considered appropriate for medium-high risk aversion decisions with a 0.5 percent probability of occurring. Finally, the last column shows the amount of SLR that is estimated under the extreme rate (H++) scenario, which is generally used for evaluating critical infrastructure or other extreme risk aversion decisions.

Table 4.18.1 Projected Sea Level Rise (in feet) for Port San Luis

Emission Rate and Year	Probabilistic Projections		Extreme Rate (H++ scenario)[a]
	Likely Range (66% probability sea level rise is between…)	1-in-200 Chance (0.5% probability sea level rise meets or exceeds…)	
High Emissions [b] - 2030 High Emissions - 2040 High Emissions - 2050	0.2–0.5 0.4–0.7 0.5–1.0	0.7 1.2 1.8	1.0 1.6 2.6
Low Emissions - 2060 High Emissions - 2060	0.4–1.1 0.6–1.3	2.2 2.5	3.7
Low Emissions - 2070 High Emissions - 2070	0.5–1.3 0.8–1.7	2.9 3.3	5.0
Low Emissions - 2080 High Emissions - 2080	0.6–1.6 1.0–2.1	3.6 4.3	6.4
Low Emissions - 2090 High Emissions - 2090	0.6–1.8 1.1–2.6	4.5 5.3	8.0
Low Emissions - 2100 High Emissions - 2100	0.7–2.1 1.3–3.1	5.4 6.7	9.9
Most of the models do not extend beyond 2100 and as a result the remaining projections below have increased uncertainty.			
Low Emissions - 2110 High Emissions - 2110	0.8–2.1 1.6–3.3	5.0 7.0	11.6
Low Emissions - 2120 High Emissions - 2120	0.8–2.4 1.8–3.7	7.0 8.2	13.8
Low Emissions - 2130	0.9–2.7	8.0	

Table 4.18.1 Projected Sea Level Rise (in feet) for Port San Luis

Emission Rate and Year	Probabilistic Projections		Extreme Rate (H++ scenario)[a]
	Likely Range (66% probability sea level rise is between…)	1-in-200 Chance (0.5% probability sea level rise meets or exceeds…)	
High Emissions - 2130	2.0–4.3	9.6	16.2
Low Emissions - 2140 High Emissions - 2140	0.9–3.0 2.1–4.8	9.2 11.1	 18.7
Low Emissions - 2140 High Emissions - 2140	0.9–3.0 2.1–4.8	9.2 11.1	 18.7
Low Emissions - 2150 High Emissions – 2150	0.9–3.3 2.4–5.4	10.6 12.7	 21.5

Notes: [a] The H++ projection is a single scenario and does not have an associated likelihood of occurrence as do the probabilistic projections.
[b] Prior to 2050, there is not much variance between the low (RCP 2.6) and high (RCP 8.5) projections so only the high is shown.
Source: CNRA OPC 2018

The contribution of thermal expansion (i.e., ocean water volume expanding as ocean water warms) and small glaciers to SLR is relatively well researched, but the effects of climate change on large ice sheets are less understood. In general, SLR is projected to accelerate toward the second half of the century. A contributing factor to SLR is the effects of vertical land movements. In the vicinity of the Project site, there appear to be uplift conditions; however, these are factored into the SLR projections presented in Table 4.18.1 above (Blackwell et al. 2020).

If GHG emissions continue unabated, key glaciological processes could cross thresholds that lead to rapidly accelerating and effectively irreversible ice loss. Aggressive reductions in GHG emissions may substantially reduce but do not eliminate the risk to California from the extreme (H++) sea level rise scenario. Current observations of Antarctic melt rates cannot rule out the potential for extreme sea level rise in the future because the processes that could drive extreme Antarctic Ice Sheet retreat later in the century are different from the processes driving loss now (CNRA OPC 2018).

Project Site Vulnerabilities

According to the projections from the CNRA OPC in Table 4.18.1 above, the Project site could experience an estimated 0.7 feet to as much as 9.9 feet of SLR by the year 2100. In the guidance for application of the SLR projections, the CNRA OPC recommends first evaluating a project's lifespan as a guide to whether to use SLR projections for only the high emissions scenario (in the case of projects that have lifespan that would end before 2050) or across the range of high- and low-emissions (for projects with lifespans beyond 2050). Considering the Project characteristics, this Project's lifespan would be considered to extend beyond 2050 and is conservatively assumed in this analysis to extend to 2100. The Project does not include any housing component or critical infrastructure and as a result would not be considered a highly vulnerable or critical asset that would warrant a definite inclusion of the extreme scenario (H++), but it is provided here for comparison purposes. The Project would include allowing a non-operating wastewater disposal ocean outfall to remain in-place following abandonment of the SMR and thus is considered a medium risk aversion land use (CNRA OPC 2018; CCC 2018). The following provides the range of low, medium-high, and extreme risk aversion SLR projections for the Project site up to the year 2100, based on the Port San Luis tide gauge data:

- **Low risk aversion projection:** 2.1–3.1 feet
- **Medium-high risk aversion projection:** 5.4–6.7 feet
- **Extreme risk aversion projection:** 9.9 feet

To better understand the potential impacts of this amount of SLR, the modeling efforts that were developed collaboratively between the United States Geological Survey (USGS) Pacific Coastal and Marine Science Center and the Point Blue Conservation Science provide useful tools in their Coastal Storm Modeling System (CoSMoS). Originally launched in 2011, the CoSMoS model first focused on the San Francisco Bay region but was expanded in 2015 and again in 2018 to extend into coastal areas south of the Bay. The CoSMoS tool spans the range of potential sea level and storm conditions from near- to long-term, providing a picture of potential exposure to flooding and erosion hazards under a given scenario. Projections are available for multiple storm scenarios (daily conditions, annual storm, 20-year- and 100-year-return intervals) and under a suite of SLR increments from zero to 9.8 feet (zero to three meters), and an extreme 16.4 feet (five-meter) scenario.

The CoSMoS model projects coastal flooding, shoreline changes (sand beach changes and cliff retreat, where applicable) due to both SLR and coastal storms driven by climate change. The model also projects changes in depth to groundwater as a result of increased SLR and includes all factors that contribute to changes in coastal water levels. Long-term changes in the sea levels are just one of many factors that can be expected to affect coastal water levels as tides, storm surges, waves, river discharges, and seasonal water level fluctuations (e.g., El Niño and La Niña events) can also combine together.

Wave runup is a complex physical coastal process that depends on local water levels, incident wave conditions, and the nature of the beach characteristics (e.g., incline, depth, and presence of shore barriers such as dunes, bluffs, or revetment). Runup heights are dependent on incoming wave characteristics, specifically, wave height, period, and direction, as well as the physical properties of the surf zone and the shore barrier upon which these waves act. As a result, runup is sensitive to many physical properties that can make runup effects vary considerably along short distances of coastline.

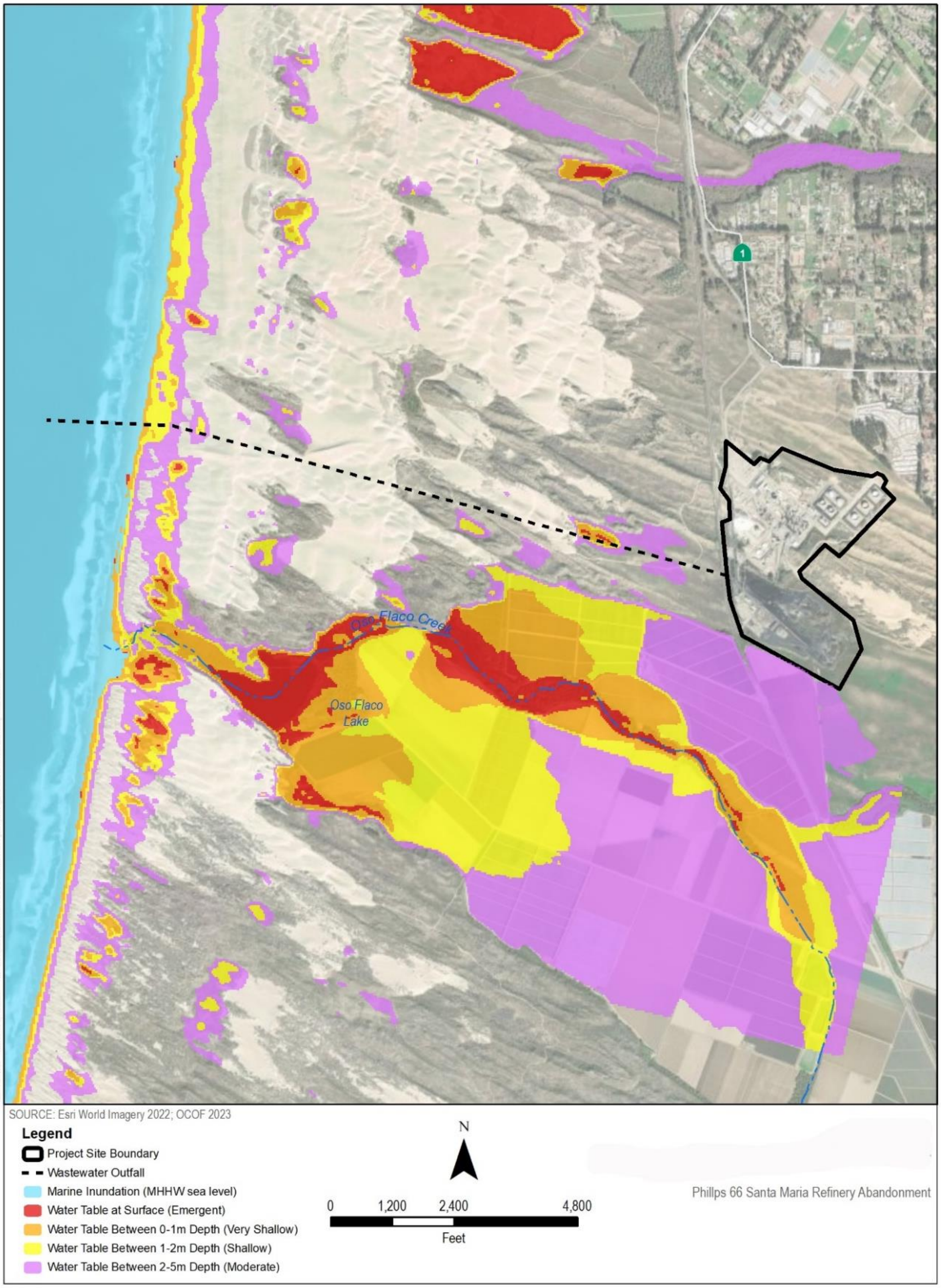
Project Site SLR Impacts

Based on the CoSMoS model, Figure 4.18-1 shows the baseline for the Project area, with no SLR and no storm frequency, and then with 6.7 feet (2.1 meters) SLR, both with and without a 100-year storm event. This SLR of 6.7 feet (2.1 meters) represents maximum emissions for a medium-risk aversion scenario, which has a 0.5 percent chance probability that SLR will be exceeded in the year 2100. Because the wastewater outfall pipeline traverses a wide, sandy beach and intertidal zone with no sea cliff or structures along the coastline, a SLR of 6.7 feet would not result in consequential changes to the shoreline area. In the vicinity of the wastewater outfall, the shoreline would migrate inland approximately up to the current dune line, which is gradual (not steep). No coastal flooding would occur beyond the intertidal zone, including under the 100-year storm event. SLR would result in accretion (i.e., addition) of sand over the outfall in the location of the existing intertidal zone; however, the area of wave scour would migrate inland, potentially exposing the outfall during large storm events. The existing sand dunes provide additional overburden sands and thus would minimize the potential for exposure; however, outfall exposure and associated damage cannot be ruled out over the long term.

In addition, as illustrated in Figure 4.18-2, current depth to groundwater is one to two meters in the intertidal area, two to five meters in the proximal (near the shoreline) dune areas, and locally as shallow as zero to one meter in the back-dune area west of the SMR. A SLR of 6.7 feet would result in migration of the shallow groundwater (i.e., one to two meters) inland such that increased areas of shallow groundwater (i.e., one to two meters) would be present in the proximal dune areas and very shallow (zero to one meter) to emergent groundwater would be present in the back-dune area. Increased exposure of the wastewater outfall to saline groundwater could result in degradation of the pipeline over the long term.

As described in Section 4.7, Geology and Soils, although the wastewater outfall would be subject to potential exposure and degradation over the long term (through 2100), geology and soils impacts would only be considered significant in the event that the wastewater outfall results in soil erosion, topographic changes, loss of topsoil, or unstable soil conditions as a result of the Project. Unlike a seawall or rock revetment, which can cause a loss of beach sand and narrowing of the beach due to wave energy reflection, the presence of a single 12-inch- to 14-inch-diameter wastewater outfall would not result in adverse impacts to natural beach sand replenishment and sand migration processes. If exposed, pipeline exposure would likely occur during periods of high surf, high tides, and associated intense wave scour during the winter months. Conversely, the pipeline may be covered during the summer months when swells are generally smaller at Pismo Beach and sand accretion generally occurs along the shoreline. Regardless of the amount of pipeline exposure due to wave scour, because the outfall would not cause or exacerbate the potential for such geologic impacts to occur, impacts would be less than significant.

Figure 4.18-2 Sea Level Rise and Rising Groundwater



Source: ESRI World Imagery 2022; CNRA OPC 2018

4.18.2 References

Blackwell, EM, M. Shirzaei, C. Ohja, and S. Werth. 2020. Tracking California's Sinking Coast from Space: Implications for Relative Sea level Rise, Science Advances Vol 6, Issue 31, July 31, 2020. Available at: https://www.science.org/doi/10.1126/sciadv.aba4551. Accessed July 21, 2023.

California Coastal Commission (CCC). 2018. California Coastal Commission Sea Level Rise Policy Guidance, Final Adopted Science Update, Chapter 6, Addressing Sea Level Rise in Coastal Development Permits. Available at: https://documents.coastal.ca.gov/assets/slr/guidance/2018/0_Full_2018AdoptedSLRGuidanceUpdate.pdf. Accessed July 21, 2023.

CCC. 2021. Critical Infrastructure at Risk, Sea Level Rise Planning Guidance for California's Coastal Zone, August 2021. Available at: https://documents.coastal.ca.gov/assets/slr/SLR%20Guidance_Critical%20Infrastructure_8.16.21_FINAL_FullPDF.pdf. Accessed July 21, 2023.

California Natural Resources Agency Ocean Protection Council (CNRA OPC). 2018. State of California, Sea level Rise Guidance, 2018 Update, 2018. Available at: https://www.opc.ca.gov/webmaster/ftp/pdf/agenda_items/20180314/Item3_Exhibit-A_OPC_SLR_Guidance-rd3.pdf. Accessed July 21, 2023.

Intergovernmental Panel on Climate Change (IPCC). 2019. Special Report on the Ocean and Cryosphere in a Changing Climate. Available at: https://www.ipcc.ch/srocc/. Accessed July 21, 2023.

IPCC. 2021. Climate Change 2021: The Physical Science Basis, Working Group I contribution to the Sixth Assessment Report, August 6, 2021. Available at: https://www.ipcc.ch/report/ar6/wg1/. Accessed July 21, 2023.

Oppenheimer, M. and B.C. Glavovic. 2019. Sea Level Rise and Implications for Low-Lying Islands, Coasts and Communities. In: IPCC Special Report on the Ocean and Cryosphere in a Changing Climate. Available at: https://www.ipcc.ch/site/assets/uploads/sites/3/2019/11/08_SROCC_Ch04_FINAL.pdf. Accessed July 21, 2023.

Tenera Environmental Services/Stantec Consulting Services (Tenera/Stantec). 2023. Phillips 66 Company Santa Maria Refinery Offshore Outfall Line and Diffuser, 2022 Annual Dive Inspection and Observations. Prepared for Phillips 66 Santa Maria Refinery.