Draft

AB 691 Sea-Level Rise Assessment

For

Crescent City State Lands

June 27, 2019

Submitted to:

City of Crescent City

377 J Street

Crescent City, CA 95531

Prepared by:

PND Engineers, Inc.

1736 Fourth Avenue S

Seattle, WA 98134

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

ACRONYMS AND ABBREVIATIONS

GHG	Greenhouse Gas
GT	Great Diurnal Tidal Range
IBC	International Building Code
ICPP	United Nations Intergovernmental Panel on Climate Change
LHMP	Local Hazard Mitigation Plan
MHHW	Mean Higher High Water
MLLW	Mean Lower Low Water
NFIP	National Flood Insurance Program
NOAA	National Oceanic and Atmospheric Administration
RCP	Representative Concentration Pathway
SLR	Sea-Level Rise
USACE	United States Army Corps of Engineers

DISCLAIMER: The following Sea-Level Rise Assessment was prepared for the City of Crescent City. All statements are the sole responsibility of PND Engineers, Inc. and do not necessarily reflect the views or policies of the City. This assessment is for planning purposes only. Site-specific evaluations may be needed to confirm or verify information presented herein.

1. Assessment of impacts of sea-level rise

Crescent City is situated on a low-lying portion of the Pacific coast in northern California. Like much of coastal California, the City is vulnerable to extreme coastal events combined with rising seas. Extreme events such as storm surges and tsunamis can and have caused widespread adverse impacts to coastal resources and infrastructure without the addition of higher sea levels. Understanding the effects of sea-level rise (SLR) on the region's coastline when combined with extreme coastal events is critical in allowing the City to identify its most at-risk resources and aid in developing strategies to adapt these resources to changes.

In 1868 Crescent City (City) was granted 194 acres of sovereign lands in trust (Figure 1). The City controls land and tideland properties waterward of the 1948 Ordinary High-Water Mark, bounded by the Redwood Highway to the north, Crescent City Harbor District State Land boundary to the east, Lighthouse Way Breakwater to the south, and Front Street to the north. These granted lands, as amended in 1963, were approved of "for the establishment, improvement, and conduct of a harbor, for the construction, maintenance and operation of wharves, docks, piers, slips, quays and other utilities, structures, facilities, and appliances necessary or convenient for commerce, navigation and fisheries, and for public recreation purposes" (Statutes of California, 1963). As part of its fiduciary duty, the City is required to take reasonable steps to keep control of and preserve the trust lands. As the effects of climate change and sea-level rise (SLR) have the potential to cause a wide range of impacts to trust lands, the City provides the assessment herein to describe how it could address potential effects on critical facilities and resources, per Assembly Bill No. 691.

Figure 1: Crescent City State Land Grant Boundary

a. Inventory vulnerable natural and built resources and facilities

The City's land grant area supports recreational activities, including the Shoreline RV Campground, the City's community pool, a cultural center, and various park related assets. The land grant area also contains the City's wastewater treatment plant. There is one notable natural resource within the boundary: Elk Creek Estuary. This estuary has been highly altered from its natural state by encroaching development, tideland fill, and harbor sedimentation. The City's shoreline in the land grant area is protected against coastal hazards like wave impacts, erosion, and flooding by four manmade breakwaters and one shoreline breakwater groin structure. Of those, only the Lighthouse Way Breakwater is partially within the City's granted land area (Figure 1). The City's granted lands form the eastern edge of the Crescent City Harbor District, which is the only "harbor of refuge" between Humboldt Bay, California, and Coos Bay, Oregon. This shallow-draft harbor supports the U.S. Coast Guard Station Crescent City and patrol boat USCGC Dorado, commercial and sport fishing operations, recreational boating, and maritime and non-fishing related businesses.

A complete inventory of vulnerable built resources that are directly within the boundaries of the City is provided in Table 1. Additionally, the most apparent coastal hazard risks to each recourse is provided.

Table 1: Inventory of Vulnerable Resources in the City's Land Grant Area and Their Coastal Hazard Risks

No.	Critical Facility (count or description)	Resource	Coastal Hazard Risks
1	B Street Pier	Built	Tsunami, inundation, flooding, sea-level rise
2	Beachfront Levee	Built	Tsunami, inundation, flooding, sea-level rise
3	Beachfront Park	Built	Tsunami, inundation, flooding, sea-level rise
4	Cultural Center	Built	Tsunami, inundation, flooding, sea-level rise
5	Elk Creek Estuary	Natural	Tsunami, inundation, flooding, salt water intrusion, sea-level rise
6	Harbor Trail Land	Built	Tsunami, inundation, flooding, sea-level rise
7	Kidtown & Dog Park	Built	Tsunami, inundation, flooding, sea-level rise
8	Lighthouse Way Breakwater*	Built	Tsunami, inundation, flooding, sea-level rise
9	Northcoast Marine Mammal Center*	Built	Tsunami, inundation, flooding, sea-level rise
10	Shoreline RV Campground	Built	Tsunami, inundation, flooding, saltwater intrusion, sea-level rise
11	Swimming Pool	Built	Tsunami, inundation, flooding, saltwater intrusion, sea-level rise
12	Wastewater Treatment Plant	Built	Tsunami, inundation, flooding, saltwater intrusion, sea-level rise

**Asset not owned or maintained by the City.*

b. Impacts and recommendations described in the current state sea-level rise policy guidance

The physical impacts of SLR include inundation, flooding, increasing shoreline erosion, larger tidal prisms, wave heights and wave forces, saltwater intrusion, and changes in sedimentation patterns. In order to manage these impacts and those from extreme events, there are a number of adaption strategies possible. These strategies can include the reactive approach of "do nothing," as it is referred to in the California Coastal Commission SLR Guidance (2018), or proactive approaches such as protection,

accommodation, and/or retreat of resources. A definition and example of each proactive approach is provided below:

> **Protection:** Defend a resource as is, in its current location. Example: Hard or soft shoreline armoring, increasing stiffness of dock piles, and constructing flood gates.
>
> **Accommodation:** Modify existing resources to decrease hazard risks and thus increase their resiliency. Example: elevating structures, retrofitting to increase strength, repositioning boats and ships within a harbor, and dune revegetation for a natural resource such as a beach.
>
> **Retreat:** Relocating or removing existing resources out of hazard areas and limiting new development in that area. Example: permanently relocating a building to higher ground and removing all small boats from a harbor.

The resources and facilities within the City land grant boundary are located in a densely developed coastal area with unique characteristics and constraints for adaptation to SLR. Most of these resources have an expected lifespan beyond 2050 and, therefore, they are not easily or economically relocated in the near term. That being said, non-water-dependent assets and resources can, in theory, be relocated. However, water-dependent assets and resources will need to remain in their current locations. In these cases, accommodation and protection strategies may be more favorable.

c. Consideration of impacts of storms and extreme events

Climate change is predicted to alter storms characteristics by increasing their intensity, frequency, spatial extent, duration, and timing (IPCC, 2014 and National Academies Press, 2016). According to the 2018 Del Norte Local Hazard Mitigation Plan (LHMP), several hazards have been identified to be of highest concern to Crescent City, including tsunamis and earthquakes, followed by severe weather and flooding.[1]

i. Tsunamis

Crescent City has long been known as one of the nation's most susceptible cities to tsunamis. Tsunamis can be produced by earthquakes, landslides, and submarine volcanic explosions. The configuration of the region's coastline and the shape of the ocean floor lend themselves to the formation of these destructive waves on the local section of coastline. In the last eighty years, thirty-nine tsunamis have been detected within Del Norte County. Four of which caused more than $37 million in damage. The worst-case scenario for the County would be a tsunami triggered by a seismic event along the Cascadia subduction zone. Historical records suggest that such a tsunami could produce a wave with heights between fifteen and sixty feet. A wave with those heights is estimated to yield 186,059 tons of debris and cause $1.42 billion in damage, without accounting for secondary impacts (LHMP, 2018). Aside from the tremendous hydraulic force of a tsunami wave, secondary impacts can be devastating. Examples of secondary impacts include floating debris endangering lives and undermining roads, buildings, bulkheads, etc.; trapped flood waters contaminating drinking water; sewer systems and culverts becoming clogged; and power generation facilities being inundated.

[1] While the 2018 LHMP does consider SLR to have a low potential of risk in Crescent City, it is also stated that SLR may "impact economically important assets in coastal areas." SLR will have a higher potential for risk should it increase by four feet (LHMP, 2018).

With near-shore tsunamis, there is generally little warning time for evacuation, leaving more people vulnerable to all of these threats. For the City, the infrastructure of highest concerns would be the Redwood Highway, harbor breakwaters, drainage and utility systems, and the City's wastewater treatment plant (LHMP, 2018). To compound the threat further, higher than average sea levels will create a higher launching point for tsunami waves moving inland. Therefore, the depth and extent of inundation will be greater as the mean sea level surface increases.

ii. Earthquakes

Del Norte County is susceptible to regular earthquake activity, as evidenced by a magnitude 5.5 or greater event every 3.6 years, on average, or the five seismic events between 2000 and 2018. As more than 87% of the homes in Crescent City were built before modern seismic codes were in force, many structures may need seismic retrofits in order to withstand even a moderate earthquake. Within the City, the soft soils (particularly along the shoreline) are considered to be of a type that are most affected by ground shaking, and therefore are most susceptible to liquefaction. Structures on these soils may experience significant structural damage. A large portion of the land grant area is fill created after the 1964 tsunami to provide additional protection to the City from coastal flooding. Fill soils are generally more susceptible to liquefaction unless compaction measures have been taken to densify the soils. However, specific geotechnical data to confirm the extent of liquefaction is not available for this study, and SLR is anticipated to have only a minor impact on this effect. Therefore, it is not considered further.

The loss of road systems, including disruption of the Redwood Highway, as well as harbor facilities after an earthquake would cause significant impacts to the local economy and may significantly disrupt response and recovery efforts. According to the 2018 LHMP, "citizens are expected to be self-sufficient up to two weeks after a major earthquake without government response agencies, utilities, private-sector services, and infrastructure components." The reason for these seemingly very large amounts of survival supplies simply has to do with access. Responders are not anticipating that they will be able to arrive and care for all County citizens immediately after a devastating earthquake. Residents will be essentially isolated for a period of time. For the City, the secondary impacts to an earthquake include ground subsidence, fires, gas leaks, contamination of water supplies, and power outages.

iii. Severe weather and coastal flooding

Severe weather is defined by the 2018 LHMP as "any dangerous meteorological phenomena with the potential to cause damage, serious social disruption, or loss of human life." This could include prolonged periods of rain, blizzards, thunderstorms, or damaging winds. Flooding is a common secondary hazard of severe weather in the City. The last seven severe storms (six of which were during winter) had a damage assessment of $799,000. It is estimated that a significant number of structures in the City were built before floodplain development regulations were in place. Therefore, these structures may be particularly vulnerable to coastal flood hazards. A 1-percent-annual-chance flood event could produce nearly 80,000 tons of debris (LHMP, 2018). If piers, shoreline, and waterfront facilities cannot reasonably be designed to withstand extreme conditions like coastal flooding, then the structures and

features must be modified to protect against projected coast flooding or accept the consequences of damage and/or failure. As climate change increases the number of severe storms, City facilities and facility operators may also experience more frequent disruptions in the utilities and services they depend on. More resources may need to be directed to response and recovery efforts more often. Additionally, changes in the design of coastal flood protection facilities may be needed as additional SLR stresses are placed on these systems.

d. Consideration of changing shorelines

According to the 2017 FEMA Flood Insurance Study for Del Norte County, coastal flooding near Crescent City is often associated with the simultaneous occurrence of king tides, large waves, and storm surge, especially during the winter. These combined effects produce coastal flooding that causes additional inundation and associated damage due to the simultaneous nature of these events. As these storm events increase in their previously mentioned characteristics, shorelines will be significantly impacted. Beaches in particular are essentially continuous for miles outside the harbor and are highly vulnerable to high-tide flooding without the additional pressures of SLR. When combined with rising sea levels, shorelines will experience a higher initiation point for waves moving inland. Therefore, the depth and extent of flooding will be greater as the mean sea level surface increases. All of the City's beaches outside the land grant are projected to be vulnerable to the combined effects of SLR, with much of the beach expanses condensed by rising tides by 2050. Shorelines within the land grant area were created by fill shortly after the 1964 tsunami and ongoing harbor sedimentation. The entirety of the shoreline is armored with a combination of riprap and concrete rubble. These areas currently protected by shoreline armor are not projected to be vulnerable until 2100, except along Elk Creek and the Shoreline RV Campground, which are expected to be inundated by approximately 2075. Figure 2 depicts areas that are currently exposed to high tide, coastal flooding without the addition of SLR projections or other coastal processes.

Figure 2: High Tide Coastal Flooding Zones

e. Consideration of trends in relative local sea level

Local sea levels are known to display regional variability. The shoreline along Crescent City is rising faster than the current rate of SLR in an occurrence known as tectonic uplift. The land is bowing upward due to the subduction of the Gorda Plate beneath northern California. Quantitatively, the sea level relative to Crescent City's coastline is currently subsiding an average of 0.78 (Figure 3) to 0.8 mm per year (NOAA Tides and Currents, 2018 and Ocean Protection Council, 2018, respectively). However, this overall trend can adjust during periods of oceanographic phenomena such as El Niño Southern Oscillations, causing prolonged increases in water levels of one to two feet, or king tides, which average an increase of two to four feet across California (California Coastal Commission SLR Guidance, 2018). Additionally, local tectonic uplift trends are not likely to be indefinite and SLR may begin to occur at an accelerated rate (NRC 2012). While Crescent City's uplift is winning the race today, it may be outpaced by SLR in the future, or the uplift rate my shift entirely due to a singular seismic event or long-term trend changes. Given this uncertainty, the effects of tectonic uplift trends are ignored in this study.

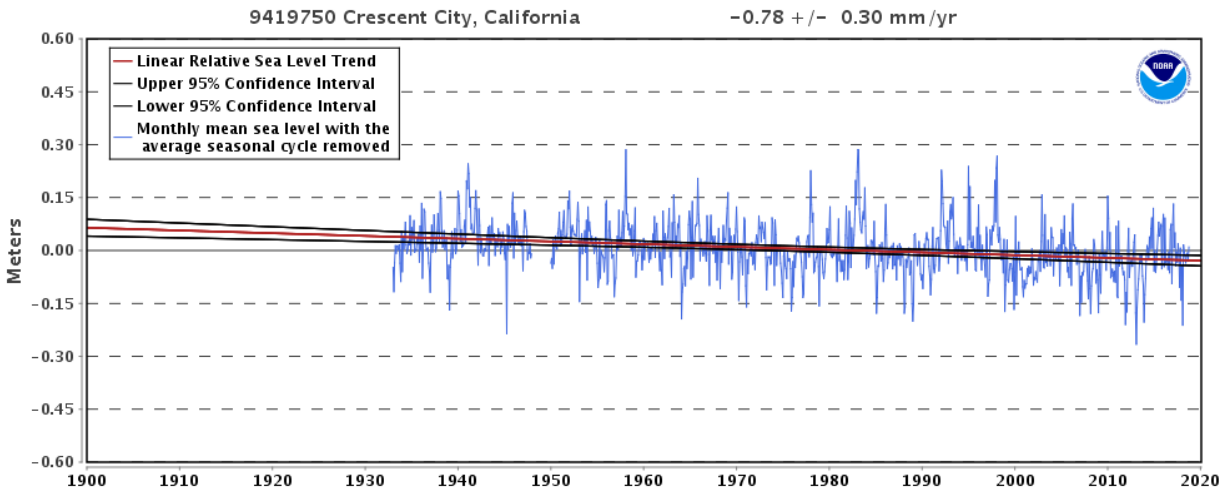


Figure 3: Sea-Level Rise Trend of Crescent City

f. Consideration of impacts to public trust resources and values

i. Public access

Public access is one of the elements that is most at risk from SLR. According to the California Coastal Commission SLR Guidance (2018), accessways could be greatly affected by rising seas. Projected rises in sea level may significantly alter waterfront expanses. A rise of two feet in sea level will encroach on the shoreline, and a rise of six feet will entirely inundate the current non-natural beach expanses, based on the NOAA Sea Level Rise and Coastal Flooding Impacts Viewer with a high level of confidence.[1] Adjacent to the land grant area is a portion of the Redwood Highway that exists along a low-lying area and passes through the 1-percent-annual-chance flood hazard area in present day. This link is critical to City and emergency

[1] The NOAA Sea Level Rise and Coastal Flooding Impacts Viewer determines the tide level based on the great diurnal (GT) tidal range, per the methods of Gill and Schultz (2001). The great diurnal tidal datum is the height difference between the mean higher high water (MHHW) and the mean lower low water (MLLW) tidal datums over a 19-year tidal epoch spanning from 1983 to 2001.

operations. In certain events, portions of the highway may be blocked or damaged by flooding conditions, preventing or limiting access to many areas within the City. As sea levels continue to rise, such flooding conditions may become increasingly more common.

ii. Commerce

The City waterfront in the land grant area is an important component of the City's commerce and is highly vulnerable to future increases in sea levels greater than three feet if adaptation strategies are not considered. The Lighthouse Way Breakwater, in particular, is a major element in the protection structure network that safeguards the harbor. Low-lying roads, the wastewater treatment facility, the Shoreline RV Campground, and stormwater and utility infrastructure are at risk of impaired function due to flooding and saltwater intrusion. According to the 2018 LHMP, the City's finite shoreline areas will experience higher-use levels due to currently planned future development. Such planned improvements should not ignore SLR. While the waterfront land area is protected in the short term from day-to-day coastal hazards, this may not continue well into the 21st Century without community adaption measures taking place.

iii. Recreation

According to the California Coastal Commission SLR Guidance (2018), "beaches, accessways, recreational amenities, and even surfing resources may be dramatically impacted by rising seas." The majority of the City's shoreline and waterfront in the land grant area is utilized for recreational activities and provides a source of revenue and visitor attractions to the City.

Tourism injects significant amounts of money into the local economy annually, mostly from visitors to neighboring Redwood National and State Parks (Economic Development Plans, 2018), and climate change impacts will have a major adverse impact on recreation. As previously stated, SLR could lead to a loss of public access and recreational opportunities due to permanent inundation, episodic flooding, and erosion of beaches, trails, and shoreline. In areas like Crescent City, where beaches are limited in their ability to migrate inland due to development (such as the Redwood Highway and the existing road network), beaches may become narrower, and waterfront recreational areas may disappear completely through inundation even at low tide.

iv. Coastal habitat

The vulnerability of coastal habitat to SLR is the same as its exposure. Unsurprisingly, the natural environment is exposed to all elements during storms and extreme events. Flood events can damage riparian habitat, storm surges can erode beaches and redistribute sediment loads, and rises in sea levels can push these impacts further inland. SLR will greatly alter the amount of present-day coastal habitat, mainly through the flooding of adjacent inland systems up Elk Creek. Inundation in these areas can cause habitat migration over the long term, assuming there is no development hindering this movement. However, such development is abundant in the City, and inundation of low-lying areas leaves coastal habitat more vulnerable to pollutant input. Pollutants in coastal waters can jeopardize the health of all wildlife, even those of economic importance such as salmon, shrimp, tuna, cod, and Dungeness crab. SLR will lead to declines in coastal water quality via inundation of the City's

facilities. This could occur via multiple routes, including the release of untreated wastewater or saltwater intrusion into existing developed areas.

v. Navigability

While navigability was not assessed in the 2018 LHMP, it is anticipated that the navigability of the City and the Redwood Highway will be greatly impacted by SLR. The City's land grant area and shoreline are not used for moorage of large vessels but only small recreational craft. However, flooding of the upland portions of the land grant area may cause more frequent disruptions in the utilities and storm drainage systems, thereby diverting an increasing amount of resources from the City. Coastal flood debris could even block the mouth of Elk Creek and increase flood levels. Navigability will also be catastrophically impacted if the protective breakwaters or levees experience a significant failure or overtopping. Armoring failure or overtopping could occur via SLR, storm surges, tsunamis, or a combination of such events.

vi. Social equity, environmental justice, and the needs of vulnerable communities

The 2018 Ocean Protection Council's Document recommends that adaptation planning and strategies "prioritize social equity, environmental justice and the needs of vulnerable communities." Future consideration of such strategies can provide a more comprehensive and focused planning effort.

Crescent City was founded in 1854 around logging and fishing industries. With the decline of these industries, the resident population has decreased accordingly. Since 2010 the population has dropped by approximately 16%. The 1964 tsunami caused widespread adverse effects to the former thriving downtown commercial shopping district, and the area is said to have "never recovered" (LHMP, 2018). Accordingly, newer commercial development in the City has centered itself around the Redwood Highway as the region shifts to a more tourism-focused economy. Figure 4 depicts present day areas of the City with vulnerabilities to SLR-related hazard preparedness and response based on population densities (Surging Sea Risk Zone Map, 2018). The entirety of the City land grant area shoreline is located within the zone of highest vulnerability for people and businesses from a social and economic perspective. These are the areas considered to be least likely to possess the capacity and resources to prepare and respond to hazards like flooding. A designation of "High Vulnerability" indicates the Crescent City coastal area is within the 20% most vulnerable areas of California. As SLR encroaches on this community, the areas of highest vulnerabilities will only increase. Future consideration of these vulnerabilities is of utmost importance. Engaging communities that will face unequal distribution of SLR-related impacts, such as the fishing and recreational industries, will ensure that adaptation strategies accurately reflect their risk, needs, and priorities.

Figure 4: Social Vulnerability of Crescent City In and Near State Land Grant Area[1]

g. Prioritization of vulnerabilities to be addressed

The City will address SLR-related vulnerabilities in a manner that aligns with its mission statement: "To promote a high quality of leadership, services, and life to our residents, businesses, and visitors by providing the most efficient, innovative and economically sound municipal services, based on our diverse history, culture and unique natural resources." In accordance with these principles, the City is addressing its SLR vulnerabilities by considering the two main environments encompassed within the land grant area and the vulnerabilities specific to these environments. The two main types of environments within the City's State Land Grant Area are:

1) An armored and built-out shoreline area
2) Naturally occurring, but highly altered creek estuary

To date, the City has addressed a number of adaptation strategies and prioritized them in the 2018 LHMP. The proposed actions listed in Table 2 pertain to the inventoried natural and built resources and facilities in the City that are exposed and vulnerable to SLR. These priority strategies will be addressed by the City as funding and resources allow.

[1] The Surging Sea Risk Zone Map defines social vulnerability "as the ability of communities to prepare and respond to hazards like flooding."

Table 2: Adaptation Strategies for Critical Facilities within Crescent City

Adaptation Strategy	Timeline	Est. Cost	Status	Priority
Integrate the hazard mitigation plan into other plans, ordinances and programs that dictate land use decisions in the community, including the General Plan and review of projects within the coastal zone.	Ongoing	Low	In Process	High
Continue to maintain good standing and compliance under the National Flood Insurance Program (NFIP) through implementation of floodplain management programs that, at a minimum, meet the NFIP requirements.	Ongoing	Low	In Process	High
Where appropriate, support retro-fitting, purchase or relocation of structures located in high hazard areas, prioritizing those structures that have experienced repetitive losses and/or are located in high or medium ranked hazard. This includes critical facilities and infrastructure such as, City Hall, water supply infrastructure, storm drains, wastewater infrastructure, and clay sewer lines.	Short-term	High	Pending	Medium
Modify and enhancement of Front Street to reduce road width, plant additional trees, adding hard and soft protection features to protect critical building and infrastructure from coastal flooding and coastal debris	Short-term	High	In Process	High
Retrofit wastewater treatment plant membrane bioreactor to accept backup generator for backup power.	Short-term	Medium	Pending	Medium
Survey FEMA designated A zone to determine base flood elevation Survey and inventory lowest floor elevations of all existing structures (both private and public facilities) in A and X zones, to identify vulnerable structures to target for mitigation.[1]	Short-term	Medium	Pending	High
Conduct coastal bluff stabilization to prevent shoreline retreat and protect public infrastructure.	Short-term	Medium	Pending	Medium
Warehouse and/or relocate critical vehicles, equipment and repair materials outside of identified hazard areas.	Short-term	Medium	Pending	High
Develop a post-disaster action plan that includes grant funding, debris removal and long-term recovery planning components, addressing both public and private assets.	Short-term	Medium	Pending	Medium
Establish a continuity-of-operations plan with phased return to normal operations.	Short-term	Medium	Pending	High
Actively participate in the plan maintenance protocols outlined in Volume 1 of this hazard mitigation plan (LHMP).	Short-term	Low	Pending	High
Identify and pursue strategies to increase adaptive capacity to climate change including but not limited to conducting an analysis of sea-level rise adaptation strategies pursuant to AB 619.	Short-term	Low	In Process	High
Consider participation in the NFIP's Community Rating System program.	Short-term	Low	Pending	High
Upgrade and install additional storm drain lines to relive periodic flooding in downtown Crescent City.	Long-term	Medium	Pending	Medium

[1] *A Zone: "Areas with a 1% annual chance of flooding and a 26% chance of flooding over the life of a 30-year mortgage." The term "X Zone" indicates all other FEMA designated zones (FEMA, 2017).*

2. Maps of 2030, 2050, and 2100 sea-level rise impacts

Probabilistic SLR projections provided in Table 3 are based on the methodologies of Kopp et al., 2014 and Sweet et al., 2017 for the H++ scenario. This assessment has selected the Medium-High Risk Aversion[1] SLR projections, per the recommendations of the 2018 Ocean Protection Council's Risk Decision Framework and 2017 Harbor Improvement Report.[2] However, a range of projections are provided to demonstrate a spectrum of potential scenarios. While the likelihood that SLR will meet or exceed the Medium-High Risk Aversion Projection is low (0.5% probability), this precautionary approach is suitable for the less adaptive, more vulnerable, man-made City resources that will experience medium to high consequences as a result of underestimating SLR.

Table 3: Projected Sea-Level Rise for Crescent City

Time Horizon (1991- 2009 baseline)	Emissions Scenario[1]	2018 Update Probabilistic SLR Projections (Feet)		
		Likely Range	1-In-200 Chance	H++ Scenario
		67% probability SLR is between…	0.5% probability SLR meets or exceeds…	
		Low Risk Aversion	*Medium-High Risk Aversion[2]*	*Extreme Risk Aversion*
2030	High (RCP 8.5)	0.3	0.5	1.2[3]
2050	High (RCP 8.5)	0.7	1.5	3.1[3]
2100	Low (RCP 2.6)	1.5	4.8	9.3
2100	High (RCP 8.5)	2.5	5.9	9.3

[1] A Representative Concentration Pathway (RCP) is a greenhouse gas (GHG) concentration trajectory (IPCC, 2014). IPCC has established four RCPs that are consistent with possible future GHG emission scenarios. This report examines the two extreme scenarios of a low emissions trajectory (RCP 2.6) and a high emissions trajectory (RCP 8.5). RCP 2.6 assumes that GHG concentrations will peak between 2010 and 2020 then substantially decline. This trajectory aims to keep global warming within 2°C of pre-industrial temperatures. RCP 8.5 assumes that there will be no global efforts to constrain emissions and GHG concentrations will increase throughout the 21st century.

[2] Medium-High Risk Aversion SLR Projections are outlined in blue as these will be considered throughout the report.

[3] H++ scenario for North Spit, California which is the nearest projection (geographically) to Crescent City.

Figures 6–8 depict the RCP 8.5 Medium-High Risk Aversion SLR projections for 2030 (0.5 feet), 2050 (1.5 feet), and 2100 (5.9 feet). These figures were created from data on the NOAA Sea Level Rise and Coastal Flooding Impacts Viewer website. Due to limitations of the viewer, projections were rounded up to the nearest foot, and therefore are as follows: 2030 (1 foot), 2050 (2 feet), and 2100 (6 feet). Additionally, these projections do not account for coastal processes such as storm surge or erosion. All water levels are based on the GT datum, per the methods of Gill and Schultz (2001). As there are many unknowns when mapping future conditions, it is important not to focus on the exact extent of inundation, but rather to examine the level of confidence at that location.

[1] According to the State of California Sea-Level Rise Guidance (2018), "risk aversion is the strong inclination to avoid taking risks in the face of uncertainty."

[2] When considering significant infrastructure facilities or assets, the State of California Sea-Level Rise Guidance (2018) advises that additional consideration be given to the more extreme SLR projections and the Harbor Improvement Report (2018) recommends a consideration of a two-foot rise in sea levels by 2050.

Figure 5: Sea-Level Rise of 1 Foot (Projection Year 2030)

Figure 6: Sea-Level Rise of 2 Feet (Projection Year 2050)

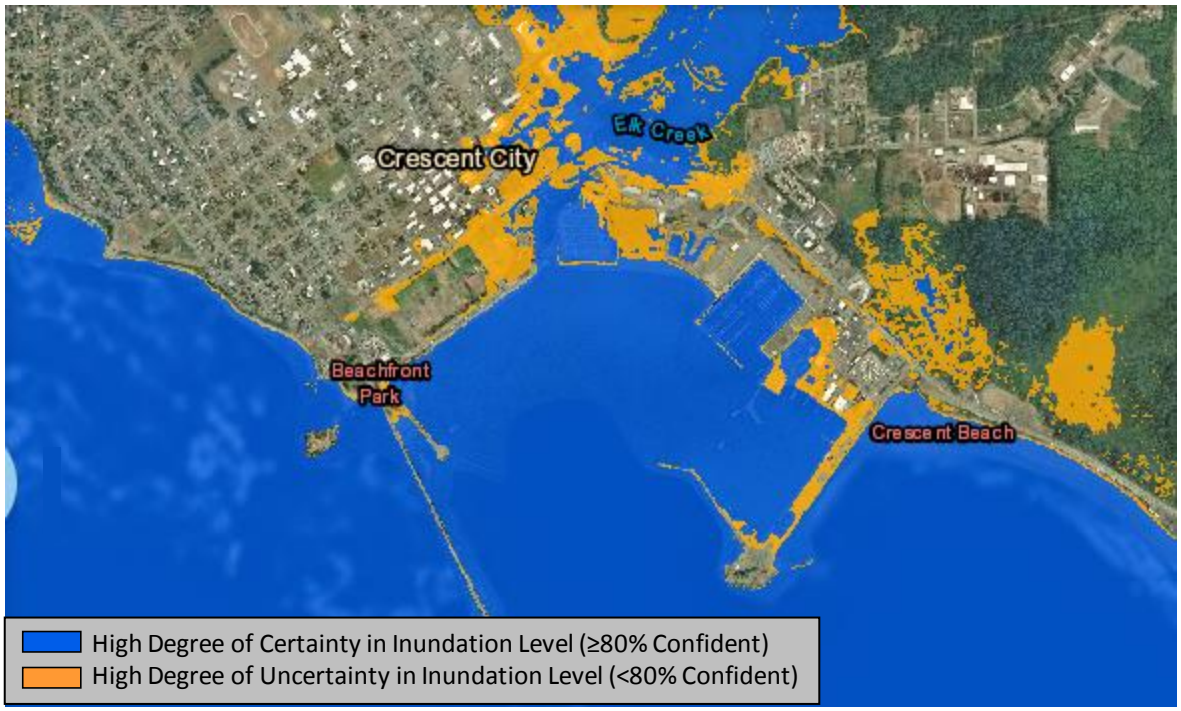


Figure 7: Sea-Level Rise of 6 Feet (Projection Year 2100)

3. Estimate of financial costs of sea-level rise

a. Replacement or repair costs of resources impacted by sea-level rise and climate change

The estimated replacement costs of resources and facilities that could be impacted by SLR and climate change processes are presented in Table 4. Further detail on these valuations is provided in Appendix A - Cost Estimate Details.

Table 4: Estimated Replacement Costs of Resources and Facilities

No.	Critical Facilities	Installation Date	Original Cost	Present Day Value(1)
1	B Street Pier[2]	1988	Unknown	$1,700,000
2	Beachfront Levy	1964	Unknown	$1,600,000
3	Beachfront Parks	1901	$1,900,200	$8,000,000
4	Cultural Center	1964	$1,657,400	$8,500,000
5	Elk Creek Estuary	--	--	$1,000,000
6	Harbor Trail Land	2005	$251,600	$400,000
7	Kidtown & Dog Park	1993	$306,700	$500,000
8	Lighthouse Way Breakwater[3]	1922	Unknown	$9,730,000
9	Northcoast Marine Mammal Center[2,4]	1992	Unknown	$1,800,000
10	Shoreline RV Campground	2015	$1,182,000	$1,300,000
11	Swimming Pool	1964	$2,990,200	$6,600,000
12	Wastewater Treatment Plant	1974	$45,389,100	$64,800,000
13	Water/Sewer Underground Utilities	Multiple	--	$4,200,000
14	Roads and Parking Lots	Multiple	--	$3,240,000
	Total			**$113,370,000**

Table Notes:
(1) Unless noted otherwise, present day value based on original construction cost updated to present day value based on 3.2 percent inflation
(2) Present value estimated based on square footage estimate of facility
(3) Asset owned and maintained by USACE
(4) Asset owned and maintained by the Northcoast Marine Mammal Center

b. Non-market values of public trust resources impacted by sea-level rise and climate change

Establishing a dollar value for the ecological conditions, aesthetics, cultural and heritage existence, recreation potential, etc., of the City's highly altered estuary requires consideration of both economic and non-economic impacts of this valued natural feature. The Environmental Protection Agency (EPA) has provided a guidance document (Raheem, 2009) that services to establish the economic value of the ecosystem services provided by estuaries. On the low end, the ecosystem service value of an estuary is $4,627 per acre per year based on the service categories of provisioning of food and water, regulating of climate and erosion, cultural and recreational value, and production and soil formation support attributes. On the high end of values, the estuary is valued at $97,812. For this analysis, an average is taken of the high and low values for the estuary. This value is $68,000 per acre of estuary land per year adjusted for the present value in 2019.

The area of impact to this estuary is not expected to change if the City completes the recommended levee project that is discussed in Section 4a, as the estuary will be on the unprotected side of the levees. For the development of the non-market loss from the changes to the estuary, it was assumed that one acre would change from estuary to shoreline. By 2050 and 2100 the entire five-acre estuary would be impacted by the effects of SLR. The estimated non-market losses based on this value are summarized in Table 5.

Table 5: Non-Market Loss due to SLR impacts to Crescent City's Elk Creek Estuary

Resource Name	Approx. Acreage	2030 Asset Value[1]	2050 Asset Value[2]	2100 Asset Value[2]
Elk Creek Estuary	5	$300,000	$3,300,000	$4,900,000

Table Notes: [1] One acre impacted from SLR by 2030
[2] All five acres impacted from SLR by 2050

c. Consider costs of 2030, 2050, and 2100 high sea-level rise projections with a 100-year storm

A detailed breakdown of the cost of exposed resources and facilities that could be impacted by SLR are summarized in Table 6. When a portion of the asset in question is exposed to SLR, then only a fraction of the functionality of that asset is considered impacted. Further detail is provided in Appendix A - Cost Estimate Details and Appendix B – Breakwater and Levee Quantities Estimate Figures.

Table 6: Estimated Asset Value Exposed to Projected Sea-Level Rise for Years 2030, 2050, & 2100

No.	City Assets within State Land Grant Area	2030 Asset Value[1]	2050 Asset Value[1]	2100 Asset Value[1]
1	B Street Pier	--	--	$1,700,000
2	Beachfront Levees	--	--	$1,600,000
3	Beachfront Park	--	--	$5,300,000
4	Cultural Center	--	--	$8,500,000
5	Elk Creek Estuary	$300,000	$3,300,000	$4,900,000
6	Harbor Trail Land	--	--	$270,000
7	Kidtown & Dog Park	--	--	$500,000
8	Lighthouse Way Breakwater[2]	$970,000	$4,870,000	$9,730,000
9	Northcoast Marine Mammal Center[2]	--	--	--
10	Shoreline RV Campground	--	--	$1,300,000
11	Swimming Pool	--	--	$6,600,000
12	Wastewater Treatment Plant	--	--	--
13	Water/Sewer Underground Utilities	--	--	$2,100,000
14	Roads and Parking Lots	--	--	$1,620,000
	Total	**$1,270,000**	**$8,170,000**	**$44,120,000**

[1] Values based on present day dollars.
[2] Asset not owned or maintained by the City but fall within the State Land Grant Area.

i. Cost of sea-level rise in 2030

Overall, the 2030 SLR projection of 0.5 foot will have minimal impacts on the upland resources and assets in the State Land Grant Area. SLR will expected to encroach on the Elk Creek Estuary and decrease the estuary value at the mouth of Elk Creek in the State Land Grant Area. The value reduction includes protective, productive, and cultural value of this resource along the banks of Elk Creek. Additional City resources will remain protected by the existing shoreline and levees.

Another significant impact to the City's State Land Grant Area is the potential damage to the existing breakwaters protecting the harbor. Breakwaters are subject to coastal processes of waves and storm surge that will be magnified by rising sea levels. While all the breakwaters

would be impacted by SLR, only the Lighthouse Way breakwater is considered since it is the only protective breakwater within the State Land Grant Area. This asset is a protective structure which is federally owned and maintained specifically by the United States Army Corps of Engineers. For the 0.5-foot SLR projection, a 10% repair cost is considered in the future asset impact value.

ii. Cost of sea-level rise in 2050

The 2050 SLR projection of 1.5 feet will encroach on Elk Creek Estuary and decrease the estuary value at the mouth of the creek in the State Land Grant Area. Additional City assets within the State Land Grant Area will remain protected by the existing shoreline and levees. However, the 1.5 feet of SLR will encroach on the embankments and may result in additional scour or shoreline damage during storm and high tide events. The projected SLR will have the largest impact on the existing breakwaters protecting the harbor, and it is anticipated that potential damage may occur to the Lighthouse Way Breakwater. For a 1.5-foot SLR projection, a 50% repair cost is considered in the future asset impact value for this existing protective asset.

Although not specifically quantified in this report, a 1.5-foot SLR will also impact the pedestrian bridge over Elk Creek and the culverts under the Redwood Highway. The culvert provides flow from the City's storm drains and the Redwood Highway connects the City with the industrial area of the Crescent City Harbor, Humboldt County, and access south along the state highway. Also, impacted would be the public access to the lighthouse on Battery Point Island. This lighthouse serves as an attraction to both permanent residents and visitors of Crescent City. The pedestrian bridge, the state highway, the Battery Point Island access are in the near vicinity of the City's State Land Grant area but outside the established Land Grant Boundaries.

iii. Cost of sea-level rise in 2100

The 2100 SLR projection of six feet will directly impact all of the City's assets on the eastern half of the State Land Grant Area. The Elk Creek Estuary will be inundated during much of the tide cycle and the tidal impacts will extend inland along the Elk Creek drainage north of the Redwood Highway and beyond the limits of the State Land Grant Area.

At this projected SLR value, the existing leveed shoreline around the Elk Creek Estuary will be breached and the entire Shoreline RV Campground and eastern side of Beach Front Park will be inundated during high tide events. This inundation would result in significant damage to the existing City assets with these areas and extend the coastal processes of shoreline scour further inshore than the current established shoreline. This scour would also result in a significant increase of harbor siltation and negatively impact vessel navigation. The B Street Pier will also be subject to damage and destruction from the projected 6-foot SLR by year 2100. Fixed piers such as the B Street Pier become subject to larger wave forces, not only on the piles, but also on the deck and utilities under the superstructure. The pier is not designed to resist these wave and uplift forces for higher water levels. By 2100, all of the assets in the inundation zone will be impacted due to SLR and will need to be replaced as shown in Table 6.

The only assets within the State Land Grant Area which would avoid direct impact from a projected 6-foot SLR are the Wastewater Treatment Plant, the Northcoast Marine Mammal

Center, and park area, roads, parking lots, trails, and utilities on the western side of the Land Grant Area above the high-water line. By 2100 for 50 percent of the asset value of the utilities, roadways, and parking lots in the land grant area would be impacted. Also, two-thirds of the asset value of Beachfront Park and the Harbor Trail would be impacted as listed in Table 6.

Outside, but within close proximity to the State Land Grant area, the public access to the Battery Point Island will be cut-off during most of the tide cycle. Additionally, mapping indicates that the pedestrian bridge and the Redwood Highway over Elk Creek will be inundated and impassable at the high-water tide elevation with the projected 6-foot SLR.

Table 6 also incorporates the total asset cost of the Lighthouse Way breakwater, because a rise of 6 feet will overtop and damage the resource during high tides, storms, and storm surge events. A 6-foot SLR would have a significant impact on all of the breakwaters around the Crescent City Harbor and result in large scale changes to the harbor. These assets are outside of the State Land Grant Area and are owned and maintained by other agencies.

d. Anticipated costs and benefits of adaptation/mitigation measures

Table 2 in Section 1g summarizes the priorities to be addressed in response the threat of SLR. As noted in the table, the highest priorities to be addressed are vulnerabilities and adaptation measures that repair critical deficiencies in the existing infrastructures and help the City continue to carry out its core mission.

i. Protection adaptation/mitigation measures

As previously discussed, it is expected that the current levees will not provide sufficient protection for projected SLR by year 2100 due to inundation upstream from the expansion of Elk Creek as sea levels rise 6 feet. Therefore, elevating and armoring the existing levees four vertical feet and extending the levee on east and west sides of Elk Creek is the primary strategy for the City to protect its resources against SLR-related impacts in the land grant area. Estimated costs for protection mitigation and adaption measures are provided in (Table 7). Appendices A, B, and C provide additional details.

Table 7: Estimated Cost for Protective Mitigation/Adaption Measures

No.	Protection Mitigation/Adaptation Measure	Estimated Cost
1	Elevate and extended levee on west side of Elk Creek.	$2,110,000
2	Elevate and extended levee on east side of Elk Creek.	$3,130,000
3	Elevate and strengthen Lighthouse Way Breakwater.[1]	$10,500,000
	Total	**$15,740,000**

[1] *Asset owned and maintained by USACE.*

ii. Accommodation adaptation/mitigation measures

The primary method for accommodating resources for projected rises in sea levels is to replace and elevate the B Street Pier. Given the age of the pier this can be done as the pier reaches the end of its useful life which is expected to occur before 2050.

The City will also need to work with USACE, and the Crescent City Harbor District on the potential need to elevate and strengthen the Lighthouse Way Breakwater and other breakwaters around the harbor. These breakwaters serve to protect State Land Grant Area

assets. Damage or destruction of the breakwaters due to SLR coupled with storm surge or a tsunami could have a significant and large-scale impact on the harbor and shoreline of the City.

Additionally, just outside the land grant area, the City should continue to monitor the trends of SLR and consider elevating the pedestrian bridge over Elk Creek and work with Del Norte County and Caltrans to elevate sections of the Redwood Highway if sea-level trends follow the projected modeling. Additional height of these structures can accommodate projected future SLR and thereby maintain pedestrian and vehicle access within the region.

Erosion is also expected to accelerate with SLR along Pebble Beach. The City should continue efforts to protect this vulnerable shoreline through hardening, armoring, and other methods. However, replicating natural processes such as the beach renourishment northwest of the Lighthouse Breakwater using harbor dredging materials should be investigated. Completed beach nourishment projects have been shown to last between three and ten years (Weggel, 1995 as cited by NOAA's Beach Nourishment Programs (2000)). Trembanis and Pilkey (1999), as cited by NOAA's Beach Nourishment Programs (2000), estimated the cost to maintain nourished beaches along developed shorelines for a decade to range from $3.3 million to $17.5 million per mile. Accounting for inflation, these costs increase to $5 million and $26.7 million per mile, respectively (U.S. Inflation, 2019). These amounts are on par with the findings of Parsons et al. (2001), which concludes beach nourishment project costs to be around $15 million per mile.

Careful consideration and verification of SLR trends should be incorporated into any design of future shoreline resources. Estimated costs for accommodation mitigation and adaption measures are provided in (Table 8).

Table 8: Estimated Cost for Accommodation Mitigation/Adaption Measures

No.	Accommodation Mitigation/Adaptation Measure	Estimated Cost
1	Replace and elevate B Street Pier.	$2,000,000
2	Elevate pedestrian bridge over Elk Creek.[1]	$100,000
3	Elevate sections of Redwood Highway over Elk Creek.[2]	$2,500,000
4	Beach Renourishment northwest of Lighthouse Breakwater[1]	$15,000,000
	Total	**$19,600,000**[3]

[1] Asset outside of the State Land Grant Area.
[2] Asset is owned and maintained by Caltrans.
[3] Total based on one mile of beach re-nourishment.

4. Protection and preservation of resources and structures impacted by sea-level rise

a. Addressing vulnerabilities and mitigation/adaptation measures

Proactive solutions to maintain the City's resources and facilities for the next 100 years are likely to encompass a variety of adaption strategies. However, given the existing armored and leveed shoreline it is reasonable to strengthen and protect the existing shoreline rather than retreat assets further inshore.

However, the City may consider relocation of buildings, structures, and utilities that are no longer viable in supporting the City's mission or have reached the end of their useful life. This retreat would serve the

dual purpose of reducing asset exposure from the impacts of SLR and exposure from tsunami inundation. Current building codes (IBC 2018) include tsunami inundation mapping which is more severe along the shoreline than incorporated in previous building codes.

A pragmatic, hybrid approach of protection and accommodation strategies can also be used. This hybrid approach may even diverge over time based on the asset in question, financial resources available by the City and funding sources, and the City's shoreline protection goals. For example, in the short-term; the City could implement redevelopment restrictions in hazard-prone areas or retrofit an asset, such as the B Street Pier; then replace and elevate the pier in the long-term. For older critical assets exposed and vulnerable to SLR, the replacement structures should incorporate provisions for adapting to SLR along with potential tsunami and storm conditions.

A cost-benefit analysis for each inventoried resources or facilities should be evaluated to provide a metrics-based approach to protection and accommodation options. This assessment highlights the need for constructive discussions between City decision makers, tenants, the Crescent City Harbor District, the County, local tribal governments, and State and Federal agencies to establish measures that allocate priorities and reasonable costs.

Table 9 and Figure 9 outline the general adaptation and mitigation strategies for the resources and facilities vulnerable to the impacts of SLR in the land grant area.

Table 9: Adaptation/Mitigation Measures

Adaptation/Mitigation Measure	Strategy	Description or Example
Replace and elevate B Street Pier.	Accommodation	• Use stronger replacement piles to resist damage from increased debris and forces from SLR. • Replace pier at the end of its useful design life to an elevation to above the threat of future sea-level rise.
Elevate and strengthen Lighthouse Way Breakwater.[1]	Accommodation	• Raise rubble-mound breakwater to protect harbor from significant storm and wave events coupled with sea-level rise.
Elevate pedestrian bridge over Elk Creek.[2]	Accommodation	• Raise the bridge and reconstruct abutment structure to an elevation to above the threat of future sea-level rise.
Elevate sections of the Redwood Highway.[2,3]	Accommodation	• Replace highway sections at the end of useful design life to an elevation to above the threat of future sea-level rise.
Elevate, extend, and armor levee on east and west sides of Elk Creek.	Protection	• Raise and extend levees outside the land grant area to protect resources from Elk Creek inundation.
Limit new development in mapped hazard area	Retreat	• Limit new development in zones mapped in the inundation zone unless protection or elevated area can be provided.
Develop and implement a program to capture perishable data after significant events to support future mitigations efforts including the implementation and maintenance of the hazard mitigation plan.	Retreat, Accommodation, and Protection	• Develop and track water surface elevations trends and damage and impact locations from significant events such as tsunamis, storm surge, or king tides.
Develop a debris management plan.	Accommodation	• Develop plan, process, and personnel responsible for removal and disposal of marine debris.
Where appropriate, support retro-fitting, purchase or relocation of structures located in high hazard areas, prioritizing those structures that have experienced repetitive losses and/or are located in high or medium ranked hazard.	Retreat	• Relocation of older buildings and structures in the zone of inundation which no longer support City's mission at a competitive cost.
Beach re-nourishment northwest of Lighthouse Way Breakwater.[2]	Accommodation and Protection	• Investigate the use of harbor dredge material for reuse as beach re-nourishment sand.

[1]*Owned and maintained by USACE.*
[2]*Measure wholly outside the land grant area.*
[3]*Owned and maintained by Caltrans.*

Figure 8: City Adaptation and Mitigation Measures

For further details see Appendix C - Adaptation/Mitigation Measures.

b. Timeframe of implementation of mitigation/adaptation measures

Table 2 in Section 1g includes the timeframe for implementation of each adaption measure. Implementation of each measure is dependent on development of project financing and available grant funding.

c. Monitoring sea-level rise, climate change, and mitigation/adaptation measures

Crescent City participates in NOAA's National Buoy Data Center, which provides observations that help support the understanding and predicting of changes in weather, climate, oceans, and coastlines. The specificity of this data, gathered within the harbor, provides is a valuable tool for the City to correlate SLR and tidal information with impacts on assets within the State Land Grant Area and the City as a whole. This tidal gauge, along with regional gauges, is integral in updating SLR projections and evaluating the interaction between SLR and tectonic uplift. Changes to the rate of tectonic uplift will alter to projections of SLR, and it will be important for the City to stay informed of any changes in these trends.

The City continues to monitor the long-term trends in SLR using the NOAA tidal gauge in the harbor and will continue to monitor changes to existing protective structures. The City will also monitor existing non-protective resources and facilities to evaluate the design life of each, evaluate damage from storm and coastal events, and incorporate SLR adaptation strategies as previously discussed.

d. Regional partnerships to address sea-level rise and climate change vulnerability and resiliency

In light of the 2011 tsunami triggered by the Tohoku earthquake, the City focuses much of its efforts towards disaster preparedness and post-disaster recovery plans. *Prepare Del Norte* hosts an annual Tsunami Preparedness Week during which it tests the Emergency Alert system and educates the public on the local tsunami hazards and how to prepare emergency plans for families.

Given these current partnerships that have been developed for disaster preparedness, the discussion of SLR can be incorporated into regional planning and coordination. Additionally, the City currently relies on the Harbor District's Board of Harbor Commissioners, Del Norte County, the Redwood Coast Tsunami Work Group, the NOAA tidal gauge, and its vast network of businesses, technical consultants, academic institutions, and other public agencies to monitor and address other climate resilience goals. After all, SLR adaption strategies not only benefit the those who benefit from the State Land Grant Area, but also Crescent City and the region as a whole.

5. Summary

SLR-related impacts may threaten the majority of the City's granted sovereign lands and the critical resources and facilities supported by these lands. The strategies and goals presented herein help ensure that the City is taking and will continue to take reasonable steps to monitor, control, and preserve the trust land.

6. References

A.B 691, 2013 Biennium, 2013 Regular Session (Cal. 2013). Accessed via www.leginfo.ca.gov/pub/13-14/bill/asm/ab_0651-0700/ab_691_bill_20131005_chaptered.pdf.

California Coastal Commission. (2018). California Coastal Commission Sea Level Rise Policy Guidance: Interpretative Guidelines for Addressing Sea Level Rise in Local Coastal Programs and Coastal Development Permits. Revised 7 November 2018.

Del Norte County Local Hazard Mitigation Plan. (2018). Operational Area Agency Review Volumes I and II. Prepared by Tetra Tech. Accessed via www.co.del-norte.ca.us/hmp/documents.

Economic Development Plans. (2018). Crescent City Harbor District.

Federal Emergency Management Agency (FEMA). (2017). Flood Insurance Study for Del Norte County, CA. Revised 2017.

Gill, S. and J. Schultz. (2001). Tidal datums and their applications, Special Publication NO. CO-OPS1, NOAA, National Ocean Service Center for Operational Oceanographic Products and Services, 111p, appendix.

IPCC. (2014). Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. Geneva, Switzerland.

Kopp RE, Horton RM, Little CM, Mitrovica JX, Oppenheimer M, Rasmussen DJ, et al. (2014). Probabilistic 21st and 22nd century sea-level projections at a global network of tide gauge sites. Earth's Future. 2:383–406.

National Academies Press. (2016). Attribution of Extreme Weather Events in the Context of Climate Change. National Academies of Sciences, Engineering, and Medicine. Washington, DC: The National Academies Press. doi: 10.17226/21852.

NOAA Sea Level Rise and Coastal Flooding Impacts Viewer. (2018). Accessed via https://coast.noaa.gov/slr/#/layer/slr

NOAA Tides and Currents. (2018) Crescent City, CA - Station ID: 9419750. Access via https://tidesandcurrents.noaa.gov/stationhome.html?id=9419750.

Parsons, George R. and Michael Powell. "Measuring the Cost of Beach Retreat". Coastal Management, 29:91-103, 2001

Raheem, N., J. Talberth, S. Colt, E. Fleishman, P. Swedeen, K. J. Boyle, M. Rudd, R. D. LOPEZ, T. O'Higgins, C. Willer, AND R. M. Boumans. The Economic Value of Coastal Ecosystems in California. U.S. Environmental Protection Agency, Washington, DC, EPA/600/F-09/046, (2009).

State, Territory, and Commonwealth Beach Nourishment Programs. (2000.) National Oceanic & Atmospheric Administration. A National Overview OCRM Program Policy Series. Technical Document No. 00-01.

Statutes of California. (1963). Regular Session 1963 Chapter 1510. Accessed via www.slc.ca.gov/Programs/Granted_Lands/G03_Del_Norte/G03-02_Crescent_City_Harbor_District/S1963_Ch1510%20.pdf.

Surging Seas Risk Zone Map. (2018) Climate Central. Access via https://riskfinder.climatecentral.org/place/crescent-city.ca.us?comparisonType=place&forecastType=NOAA2017_int_p50&impact=Population_highSV&level=4&unit=ft.

Sweet, W.V., R.E. Kopp, C.P. Weaver, J. Obeysekera, R.M. Horton, E.R. Thieler and CZ. (2017). Global and Regional Sea Level Rise Scenarios for the United States.

Trembanis, A.S., and Pilkey, O.H. Comparison of Beach Nourishment Along the US Atlantic, Great Lakes, Gulf of Mexico, and New England Shorelines. Coastal Management. Vol. 27 (1999). Pp. 329-340

Appendix A - Cost Estimate Details

Present Value of City Assets in Land Grant Area Updated for Present Value

Beachfront Park

Consumer Price Index =		3.2%	
Year of Construction =		1964	
Current Year =		2019	
Timeline =		55	years
Original Construction Cost =	$	(1,274,130)	
Present Day Value =			$7,204,388
Rounded =			**$7,200,000**

Cultural Center

Consumer Price Index =		3.2%	
Year of Construction =		1964	
Current Year =		2019	
Timeline =		55	years
Original Construction Cost =	$	(1,447,977)	
Present Day Value =		$8,187,381	
Improvement Description:	Welcome Center		
Year of Construction =		1999	
Current Year =		2019	
Timeline =		20	years
Original Construction Cost =	$	(103,934)	
Present Day Value =		$195,142	
Improvement Description:	Sound sys Cult Ctr		
Year of Construction =		2000	
Current Year =		2019	
Timeline =		19	years
Original Construction Cost =	$	(25,460)	
Present Day Value =		$46,320	
Improvement Description:	Cultural Center Floor		
Year of Construction =		2015	
Current Year =		2019	
Timeline =		4	years
Original Construction Cost =	$	(51,073)	
Present Day Value =		$57,931	
Improvement Description:	Cultural Center Roof		
Year of Construction =		2018	
Current Year =		2019	
Timeline =		1	years
Original Construction Cost =	$	(28,960)	
Present Day Value =		$29,887	
Total Present Value of Cultural Center =			$8,516,661
Rounded =			**$ 8,500,000**

Harbor Trail Land

Consumer Price Index =	3.2%		
Year of Construction =	2005		
Current Year =	2019		
Timeline =	14	years	
Original Construction Cost =	$ (251,614)		
Present Day Value =			$391,067
Rounded =			**$400,000**

Kidtown and Dog Park

Consumer Price Index=	3.2%	
Year of Construction =	1993	
Current Year =	2019	
Timeline =	26	years
Original Construction Cost =	$ (12,400)	
Present Day Value =	$28,125	
Improvement Description:	Kidtown	
Year of Construction =	1999	
Current Year =	2019	
Timeline =	20	years
Original Construction Cost =	$ (124,850)	
Present Day Value =	$234,413	
Improvement Description:	Kidtown	
Year of Construction =	2000	
Current Year =	2019	
Timeline =	19	years
Original Construction Cost =	$ (45,702)	
Present Day Value =	$83,148	
Improvement Description:	Kidtown	
Year of Construction =	2000	
Current Year =	2019	
Timeline =	19	years
Original Construction Cost =	$ (51,496)	
Present Day Value =	$93,689	
Improvement Description:	Parks Restroom	
Year of Construction =	2006	
Current Year =	2019	
Timeline =	13	years
Original Construction Cost =	$ (333,150)	
Present Day Value =	$501,737	

Improvement Description:	Playground Equipment	
Year of Construction =	2006	
Current Year =	2019	
Timeline =	13	years
Original Construction Cost =	$ (39,128)	
Present Day Value =	$58,928	
Improvement Description:	Beachfront Park Access	
Year of Construction =	2018	
Current Year =	2019	
Timeline =	1	years
Original Construction Cost =	$ (292,957)	
Present Day Value =	$302,332	
Improvement Description:	Dog Park	
Year of Construction =	2018	
Current Year =	2019	
Timeline =	1	years
Original Construction Cost =	$ (33,092)	
Present Day Value =	$34,151	

Total Present Value of Cultural Center = $1,336,522

Rounded = **$ 1,300,000**

Shoreline RV Campground

Consumer Price Index =	3.2%	
Year of Construction =	2015	
Current Year =	2019	
Timeline =	4	years
Original Construction Cost =	$ (1,166,859)	
Present Day Value =	$1,323,540	
Improvement Description:	RV Campground Bathroom Remodel	
Year of Construction =	2017	
Current Year =	2019	
Timeline =	2	years
Original Construction Cost =	$ (15,198)	
Present Day Value =	$16,186	

Total Present Value of Cultural Center = $1,339,727

Rounded = **$ 1,300,000**

Swimming Pool

Consumer Price Index =		3.2%	
Year of Construction =		1964	
Current Year =		2019	
Timeline =		55	years
Original Construction Cost =	$	(556,701)	
Present Day Value =		$3,147,787	
Improvement Description:	Main Filter Replacement		
Year of Construction =		1989	
Current Year =		2019	
Timeline =		30	years
Original Construction Cost =	$	(20,407)	
Present Day Value =		$52,501	
Improvement Description:	Pool Energy Conservation Project		
Year of Construction =		1991	
Current Year =		2019	
Timeline =		28	years
Original Construction Cost =	$	(57,062)	
Present Day Value =		$137,841	
Improvement Description:	Water Slide and Water Heater		
Year of Construction =		1999	
Current Year =		2019	
Timeline =		20	years
Original Construction Cost =	$	(110,363)	
Present Day Value =		$207,213	
Improvement Description:	Pool Renovation Project		
Year of Construction =		2004	
Current Year =		2019	
Timeline =		15	years
Original Construction Cost =	$	(74,066)	
Present Day Value =		$118,799	
Improvement Description:	Pool Rehab		
Year of Construction =		2009	
Current Year =		2019	
Timeline =		10	years
Original Construction Cost =	$	(1,714,584)	
Present Day Value =		$2,349,393	
Improvement Description:	Pool Rehab		
Year of Construction =		2012	
Current Year =		2019	
Timeline =		7	years
Original Construction Cost =	$	(301,692)	
Present Day Value =		$376,116	

Improvement Description:	Pool Ext., Roof, Skylines, & Changing Tables	
Year of Construction =	2015	
Current Year =	2019	
Timeline =	4	years
Original Construction Cost =	$ (148,095)	
Present Day Value =	$167,981	
Improvement Description:	ADA Lift for Spa	
Year of Construction =	2017	
Current Year =	2019	
Timeline =	2	years
Original Construction Cost =	$ (7,218)	
Present Day Value =	$7,687	

Total Present Value of Cultural Center = $6,565,319

Rounded = **$ 6,600,000**

WWTP

Consumer Price Index =	3.2%	
Improvement Description:	Prim. Clarif., Sewer Treat., Digester & Boiler	
Year of Construction =	1974	
Current Year =	2019	
Timeline =	45	years
Original Construction Cost =	$ (395,328)	
Present Day Value =	$1,631,338	
Improvement Description:	Sea Wat. Storage, Sewer Treatment, Sec. Clarifier	
Year of Construction =	1978	
Current Year =	2019	
Timeline =	41	years
Original Construction Cost =	$ (810,264)	
Present Day Value =	$2,947,774	
Improvement Description:	Rotating Biol 12 Units	
Year of Construction =	1982	
Current Year =	2019	
Timeline =	37	years
Original Construction Cost =	$ (610,105)	
Present Day Value =	$1,956,831	
Improvement Description:	RBC Dtive Units, Influent Pumps/Ctrls.	
Year of Construction =	1985	
Current Year =	2019	
Timeline =	34	years
Original Construction Cost =	$ (69,715)	
Present Day Value =	$203,440	

Improvement Description:	Chain		
Year of Construction =		1989	
Current Year =		2019	
Timeline =		30	years
Original Construction Cost =	$	(8,553)	
Present Day Value =		$22,004	
Improvement Description:	FmHA: Treatment Plant Imply		
Year of Construction =		1992	
Current Year =		2019	
Timeline =		27	years
Original Construction Cost =	$	(232,700)	
Present Day Value =		$544,689	
Improvement Description:	Belt Press Equip		
Year of Construction =		1993	
Current Year =		2019	
Timeline =		26	years
Original Construction Cost =	$	(326,136)	
Present Day Value =		$739,726	
Improvement Description:	Chain Dr. and Spockets: Secondary		
Year of Construction =		1994	
Current Year =		2019	
Timeline =		25	years
Original Construction Cost =	$	(5,098)	
Present Day Value =		$11,204	
Improvement Description:	Thickener Tank		
Year of Construction =		2000	
Current Year =		2019	
Timeline =		19	years
Original Construction Cost =	$	(27,316)	
Present Day Value =		$49,697	
Improvement Description:	Oufall Line and Pumps		
Year of Construction =		2002	
Current Year =		2019	
Timeline =		17	years
Original Construction Cost =	$	(97,859)	
Present Day Value =		$167,169	
Improvement Description:			
Year of Construction =		2009	
Current Year =		2019	
Timeline =		10	years
Original Construction Cost =	$	(232,700)	
Present Day Value =		$318,855	

Improvement Description:	Site Elec., MBR Tanks, Prim Clarif. Alters., Headworks Screening, Sludge Dewat. Equip., Digester Equip. Rehab	
Year of Construction =	2009	
Current Year =	2019	
Timeline =	10	years
Original Construction Cost =	$ (9,648,000)	
Present Day Value =	$13,220,086	

Improvement Description:	Headworks Recon., MBR Building, Dewat. Build Generator, UV System, Rotary Drum Thickener, Influ. Pumps, MBR Equip.	
Year of Construction =	2010	
Current Year =	2019	
Timeline =	9	years
Original Construction Cost =	$ (15,401,000)	
Present Day Value =	$20,448,723	

Improvement Description:	Ops Building, Site Work, MBR Membranes Electrical Equip., Instrumentation	
Year of Construction =	2011	
Current Year =	2019	
Timeline =	8	years
Original Construction Cost =	$ (16,450,902)	
Present Day Value =	$21,165,440	

Improvement Description:	MBR Chemical Storage Containers	
Year of Construction =	2013	
Current Year =	2019	
Timeline =	6	years
Original Construction Cost =	$ (208,500)	
Present Day Value =	$251,875	

Improvement Description:	Headworks Dual Spiral Screen, Aeration Blower	
Year of Construction =	2014	
Current Year =	2019	
Timeline =	5	years
Original Construction Cost =	$ (411,653)	
Present Day Value =	$481,870	

Improvement Description:	Haz. Gas Detec. Sys. WWTP Digest, Cycloblower	
Year of Construction =	2015	
Current Year =	2019	
Timeline =	4	years
Original Construction Cost =	$ (36,768)	
Present Day Value =	$41,705	

Improvement Description:	Airflow and Moisture Seperator	
Year of Construction =	2016	
Current Year =	2019	
Timeline =	3	years
Original Construction Cost =	$ (17,470)	
Present Day Value =	$19,201	
Improvement Description:	Iso. Elec. MCC, Manninf Sample Cab., Elec. Prot. SCADA Reconcil. CIP	
Year of Construction =	2017	
Current Year =	2019	
Timeline =	2	years
Original Construction Cost =	$ (149,260)	
Present Day Value =	$158,965	
Improvement Description:	Process Flow CIP	
Year of Construction =	2018	
Current Year =	2019	
Timeline =	1	years
Original Construction Cost =	$ (21,521)	
Present Day Value =	$22,210	

Total Present Value of WWTP= $64,402,802

Rounded= **$ 64,400,000.00**

Fixed Assets

State Land Grant Assets

User: blacey
Printed: 04/25/19 09:08:49

Asset	Status	Description	Location	Model	Serial	Installed	Life	Orig Cost	Accum Depr	Book Val
10004	Active	Beachfront Park - Front & Howe - 177.5 acres	Other	118-030-18 & 19	118-020-30 & 31	01-01-1901	999	1,274,130.00	-	1,274,130.00
10024	Active	Harbor Trail Land	Other	118-380-30 & 32	118-020-22	03-25-2005	999	251,614.48	-	251,614.48
		Land						**2,780,761.58**	**-**	**2,780,761.58**
10030	Active	Cultural Center	Cultural Center			01-01-1964	50	1,447,977.00	1,447,977.00	-
10039	Active	Welcome Center	Cultural Center			01-01-1999	30	103,933.97	64,847.80	39,086.17
10040	Active	Kidtown	Parks			01-01-1999	30	124,850.48	77,898.28	46,952.20
10041	Active	Kidtown	Parks			01-01-2000	30	45,701.60	26,968.02	18,733.58
10042	Active	Kidtown	Parks			01-01-2000	30	51,496.39	30,387.47	21,108.92
10044	Active	Parks Restroom	Parks			01-01-2006	50	333,150.61	86,346.48	246,804.13
10045	Active	Playground Equipment	Parks			01-01-2006	30	39,128.36	16,535.53	22,592.83
10832	Active	Cultural Center Floor	Cultural Center			09-18-2015	20	51,072.83	7,108.51	43,964.32
10884	Active	Cultural Center Roof	Cultural Center			06-30-2018	20	28,960.00	-	28,960.00
		Structures & Improvements						**5,312,623.79**	**2,957,640.18**	**2,253,973.61**
10062	Active	6 Picnic Tables	Parks			01-01-1993	10	12,400.00	12,400.00	-
10066	Active	Sound sys Cult Ctr	Cultural Center			01-01-2000	10	5,000.00	5,000.00	-
10068	Active	Sound Sys Cult Ctr	Cultural Center			01-01-2000	10	20,460.60	20,460.60	-
10879	Active	ADA lift for spa	Pool	Standard		11-17-2017	10	7,694.38	476.42	7,217.96
		Equipment						**510,714.47**	**427,687.49**	**83,026.98**
10948	Active	Beachfront Park Beach Access - West Howe Drive	Parks			02-08-2018	50	292,957.12	2,295.50	290,661.62
10949	Active	Dog Park	Parks			03-24-2018	20	33,091.50	448.78	32,642.72
		Infrastructure						**2,652,784.35**	**708,445.54**	**1,944,338.81**

10046	Active	Swimming Pool Bldg & etc.	Pool	01-01-1964	40	556,701.00	556,701.00	-
10049	Active	Pool Main Filter-Replace	Pool	01-01-1989	40	20,407.00	15,044.00	5,363.00
10050	Active	Pool Energy Consery Proj	Pool	01-01-1991	40	57,062.00	39,212.92	17,849.08
10051	Active	Water Slide	Pool	01-01-1999	40	105,343.00	60,765.02	44,577.98
10052	Active	Water Heaters for Showers	Pool	01-01-1999	10	5,020.00	5,020.00	-
10053	Active	Pool Renovation Proj	Pool	01-01-2004	40	74,066.00	26,427.51	47,638.49
10054	Active	Swimming Pool Rehab	Pool	01-01-2009	40	1,714,584.00	426,560.44	1,288,023.56
10055	Active	Swimming Pool Rehab	Pool	01-01-2012	20	301,692.00	104,163.14	197,528.86
10056	Active	Swimming Pool Roof and Skylights	Pool	02-03-2015	30	65,741.13	7,495.81	58,245.32
		Structures & Improve - Pool				**2,900,616.13**	**1,241,389.83**	**1,659,226.30**
10090	Active	Changing table	Pool	03-14-2015	8	5,725.00	2,375.18	3,349.82
		Equipment - Pool				**5,725.00**	**2,375.18**	**3,349.82**
10100	Active	Swimming Pool Exterior Improvements	Pool	02-03-2015	50	76,629.29	5,243.42	71,385.87
		Infrastructure				**76,629.29**	**5,243.42**	**71,385.87**
10871	Active	Shoreline RV bathroom remodel	Shoreline RV	04-14-2017	20	15,198.16	922.30	14,275.86
		Structures & Improvements				**15,198.16**	**922.30**	**14,275.86**
10520	Active	RV Park 2015 Renovation	Shoreline RV	06-15-2015	20	1,166,858.74	179,737.84	987,120.90
		Infrastructure				**1,166,858.74**	**179,737.84**	**987,120.90**
10839	Active	SCADA Reconciliation CIP	WWTP	06-30-2017	999	9,998.74	-	9,998.74
10881	Active	Process Flow CIP	WWTP	06-30-2018	999	21,521.25	-	21,521.25
		Construction in Progress				**31,519.99**	**-**	**31,519.99**
10526	Active	Primary Clarifier Building	WWTP	01-01-1974	40	19,472.17	19,472.17	-
10527	Active	Sewer Treatment Mechanical Building	WWTP	01-01-1974	40	40,809.00	40,809.00	-
10528	Active	Digester & Boiler Buildings	WWTP	01-01-1974	40	355,047.00	355,047.00	-
10529	Active	Sea Water Storage Building	WWTP	01-01-1978	40	38,955.00	38,955.00	-
10530	Active	Sewer Treatment - Headworks Bldg	WWTP	01-01-1978	40	189,210.00	189,210.00	-
10531	Active	Sewer Treatment - RBC Unit Bldg	WWTP	01-01-1978	40	263,781.00	263,781.00	-
10532	Active	Secondary Clarifier Bldg	WWTP	01-01-1978	40	318,318.00	318,318.00	-

10534	Active	Chain	WWTP	01-01-1989	40	8,553.00	6,083.61	2,469.39
10535	Active	FmHA: Treatment Plant Imply	WWTP	01-01-1992	40	232,700.00	149,329.30	83,370.70
10536	Active	Chain Dr & Sprockets:Secondary	WWTP	01-01-1994	32	5,098.00	3,781.40	1,316.60
10537	Active	Site Electrical	WWTP	01-01-2009	40	2,230,000.00	402,495.46	1,827,504.54
10538	Active	MBR Tanks	WWTP	01-01-2009	40	3,770,000.00	680,451.97	3,089,548.03
10539	Active	Headworks Reconstruction	WWTP	01-01-2010	40	1,120,000.00	199,537.15	920,462.85
10540	Active	MBR Building	WWTP	01-01-2010	40	8,760,000.00	1,560,665.54	7,199,334.46
10541	Active	Dewatering Building	WWTP	01-01-2010	40	2,810,000.00	500,624.45	2,309,375.55
10542	Active	Operation Building	WWTP	01-01-2011	40	4,401,902.11	774,543.44	3,627,358.67
10543	Active	Site Work	WWTP	01-01-2011	25	5,510,000.00	1,558,036.61	3,951,963.39
10545	Active	Rotating Biol 12 Units	WWTP	01-01-1982	35	651,105.00	651,105.00	-
10546	Active	RBC Drive Units (12)	WWTP	01-01-1985	10	31,310.00	31,310.00	-
10547	Active	Influent Pumps/Controls	WWTP	01-01-1985	20	38,405.00	36,484.25	1,920.75
10549	Active	Thickener Tank	WWTP	01-01-2000	25	27,316.00	19,461.79	7,854.21
10550	Active	Outfall Line & Pumps	WWTP	01-01-2002	20	97,859.00	76,098.49	21,760.51
10551	Active	Primary Clarifier Alterations	WWTP	01-01-2009	40	984,000.00	177,603.38	806,396.62
10552	Active	Headworks Screening	WWTP	01-01-2009	10	236,000.00	215,607.13	20,392.87
10553	Active	Generator	WWTP	01-01-2010	30	408,000.00	97,641.09	310,358.91
10554	Active	UV System	WWTP	01-01-2010	15	400,000.00	199,175.91	200,824.09
10555	Active	Rotary Drum Thickener	WWTP	01-01-2010	10	382,000.00	305,395.43	76,604.57
10556	Active	Influent Pumps	WWTP	01-01-2010	30	581,000.00	139,042.83	441,957.17
10557	Active	MBR Membranes	WWTP	01-01-2011	10	1,913,000.00	1,390,439.07	522,560.93
10559	Active	MBR Chemical Storage Containers	WWTP	01-01-2013	40	208,500.38	26,298.84	182,201.54
10560	Active	Headworks Dual Spiral Screen	WWTP	01-01-2014	20	402,128.61	86,357.76	315,770.85
10865	Active	Isolate Electrical MCC	WWTP	06-30-2017	50	88,241.92	1,769.67	86,472.25
		Structures & Improvements				**39,954,791.67**	**11,126,352.64**	**28,828,439.03**
10544	Active	Hazardous Gas Detector System	WWTP	06-09-2015	5	22,318.59	13,701.48	8,617.11
10561	Active	WWTP Digeste r Belt Press Equipment	WWTP	01-01-1993	20	326,136.00	326,136.00	-
10562	Active	Sludge Dewatering Equipment	WWTP	01-01-2009	15	1,384,000.00	726,804.79	657,195.21
10563	Active	Digester Equipment Rehabilitation	WWTP	01-01-2009	25	1,044,000.00	309,062.74	734,937.26

10564	Active	MBR Equipment	WWTP		01-01-2010	15	1,340,000.00	667,239.29	672,760.71
10565	Active	Electrical Equipment	WWTP		01-01-2011	40	3,350,000.00	589,454.39	2,760,545.61
10566	Active	Instrumentation	WWTP		01-01-2011	25	1,276,000.00	360,808.48	915,191.52
10567	Active	Aeration Blower	WWTP		12-11-2014	5	9,523.72	6,789.05	2,734.67
10745	Active	Cycloblower	WWTP	S48067	11-10-2015	5	14,448.60	7,624.31	6,824.29
10747	Active	Airflow and Moisture Separator	WWTP		05-31-2016	10	17,469.83	3,642.43	13,827.40
10837	Active	Manning Sample Cabinet	WWTP		06-30-2017	5	7,802.76	1,564.83	6,237.93
10866	Active	Electrical Protection	WWTP		02-17-2017	10	43,216.06	5,908.26	37,307.80
		Equipment					**8,933,146.26**	**3,024,577.00**	**5,908,569.26**
10593	Active	New Sewer Line To Ocean	Sewer System		01-01-2007	40	2,502,331.70	690,869.39	1,811,462.31
		Infrastructure					**9,955,265.71**	**3,781,686.95**	**6,173,578.76**

Appendix A: Crescent City Protection Cost Estimate Table

Item No.	Element	Unit	Quantity	Unit Cost	Amount	Total
1	Raise the Waterfront Levee (West Side)					**$ 2,110,000**
1a	Water Front Levee Fill (West Side)	CY	26000	$ 35.00	$ 910,000	
1b	Water Front Levee Armor Rock (West Side)	CY	12000	$ 100.00	$ 1,200,000	
2	Raise the Waterfront Levee (East Side)	CY				**$ 3,130,000**
2a	Water Front Levee Fill (East Side)	CY	38000	$ 35.00	$ 1,330,000	
2b	Water Front Levee Armor Rock (East Side)	CY	18000	$ 100.00	$ 1,800,000	
3	Raise/Strengthen Lighthouse Way Breakwater*	CY	105000	$ 100	$ 10,500,000	**$ 10,500,000**

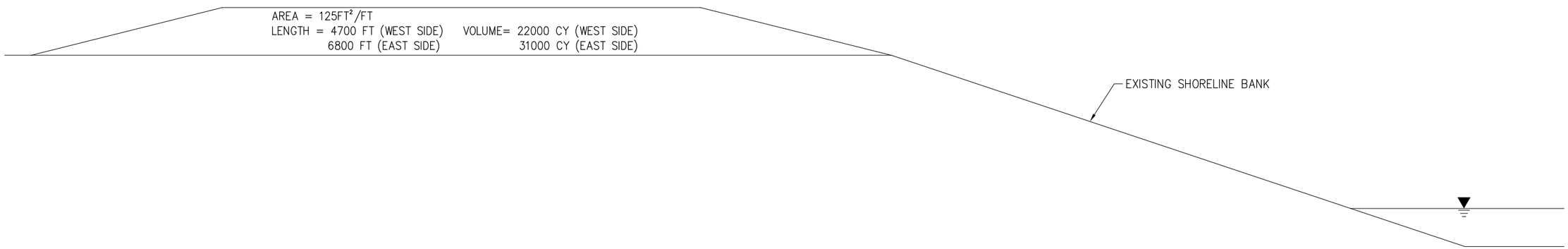
* Note: Lighthouse Way Breakwater Owner and Maintained by USACE

Appendix A: Crescent City Accomodation Asset Cost Estimate Table

Item No.	Element	Unit	Quantity	Unit Cost[1]	Amount
1	Replace and elevation B Street Pier	SQ.FT	11500	$ 170	$ 2,000,000
2	Elevate Pedestrian Bridge over Elk Creek	LUMP SUM	1	$ 100,000	$ 100,000
3	Replace and Elevevation Section of State Highway 101 over Elk Creek	SQ.FT	12500	$ 200.00	$ 2,500,000
4	Beach renourishment northwest of Lighthouse Way Breakwater.	MILE	1	$ 15,000,000.00	$ 15,000,000

Notes: (1) Unit cost of pier based on historic PND construction costs for light duty piers. Bridge construction cost based on comparative bridge costs from Caltrans (2015)

Appendix B – Breakwater and Levee Quantities Estimate Figures



EXISTING SHORELINE LEVEE SECTION

FOR ESTIMATE ONLY

P N D ENGINEERS, INC.
1736 Fourth Avenue S., Suite A
Seattle, Washington 98134
P: 206.624.1387
www.pndengineers.com

REVISIONS

REV	DATE	DESCRIPTION

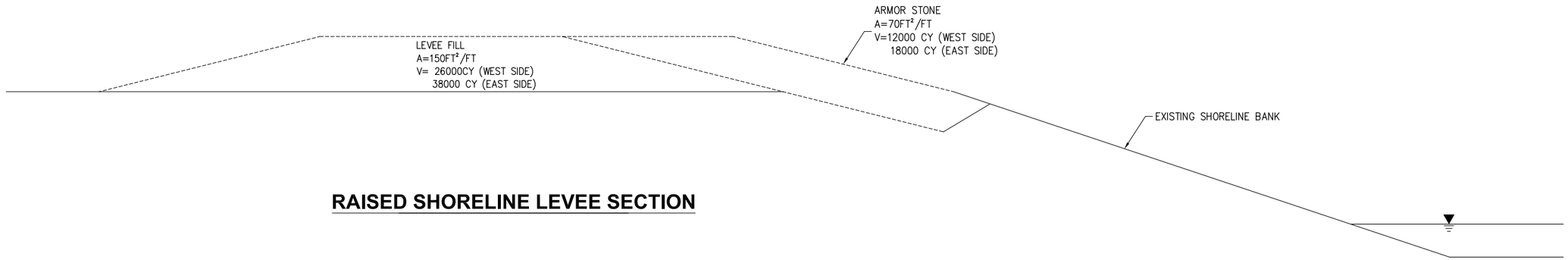
PROJECT: **CRESCENT CITY HARBOR DISTRICT SEA-LEVEL RISE ASSESSMENT**

TITLE: **ASSET ASSESSMENT AND ESTIMATE**

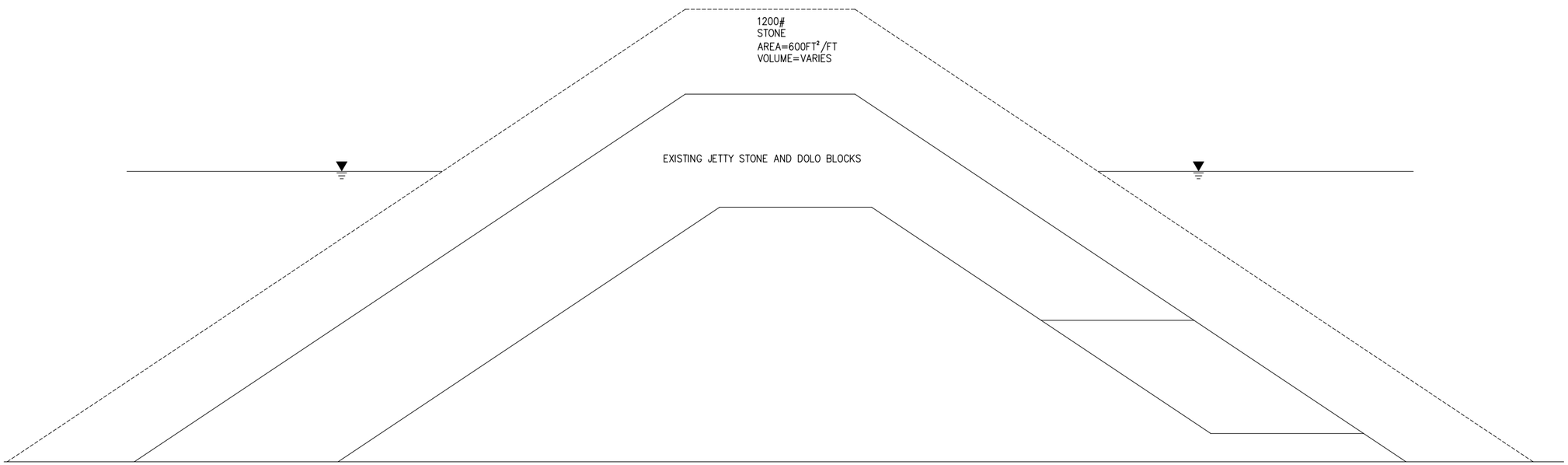
DESIGNED BY:		PROJECT NO:	184062.01
DRAWN BY:	RJ	DATE:	MAY 2019
CHECKED BY:		SCALE:	NTS

SHEET NO: 1 OF 2

03/13/09
XXX



RAISED SHORELINE LEVEE SECTION



RAISED LIGHTHOUSE WAY JETTY SECTION

FOR ESTIMATE ONLY

P N D ENGINEERS, INC.
1736 Fourth Avenue S., Suite A
Seattle, Washington 98134
P: 206.624.1387
www.pndengineers.com

REVISIONS

REV	DATE	DESCRIPTION

PROJECT: **CRESCENT CITY HARBOR DISTRICT SEA-LEVEL RISE ASSESSMENT**

TITLE: **PROTECTIVE MEASURES ESTIMATE**

DESIGNED BY:		PROJECT NO:	184062.01
DRAWN BY:	RJ	DATE:	MAY 2019
CHECKED BY:		SCALE:	NTS

SHEET NO: 2 OF 2

03/13/09
XXX

Appendix C - Adaptation/Mitigation Measures


ELEVATE AND EXTEND LEVEE ON WEST SIDE OF ELK CREEK
ELEVATE AND EXTEND LEVEE ON EAST SIDE OF ELK CREEK
ELEVATE REDWOOD HWY OVER ELK CREEK*
ELEVATE PEDESTRIAN BRIDGE OVER ELK CREEK
CRESCENT CITY HARBOR DISTRICT OUTSIDE OF STATE LAND GRANT AREA
REPLACE AND ELEVATE B STREET PIER
STATE LAND GRANT BOUNDARY
RAISE AND STRENGTHEN LIGHT HOUSE WAY BREAKWATER**
*Owned and maintained by CALTRANS
**Owned and maintained by USACE