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CITY COUNCIL AGENDA REPORT

Meeting Date: December 5, 2024

From: Director of Public Works/City Engineer

Subject: Brisbane Marina Sea Level Rise Memorandums

Receipt and review of these memorandums is exempt from CEQA because it is not a project (CCR Title 14 §15378 (b) (2)).

Community Goal/Result Safe Community

Purpose

Staff will present the findings of two studies on sea level rise that are focused on the impact to the city's marina and its adjacent utilities.

Recommendation

Receive the memorandums and provide direction to staff as deemed necessary and appropriate.

Background

During Council's earlier review of a proposed Siera Point Open Space and Parks Master Plan, Council directed staff to complete studies on the direct impact of sea level rise on marina facilities, to better understand the future relationships between possibly relocated marina facilities and any new open space/park concepts. Those studies, a review of impacts to near shore utilities by EKI and a review of onshore and offshore marina infrastructure by Anchor QEA are complete and will be discussed below.

Also, in July of this year, staff received a conditional award letter for a planning study to address the impact of sea level rise on the Brisbane Lagoon, Sierra Point Parkway, and U.S. Highway 101. Questions and revisions from Caltrans were finalized at the end of October, and the City is awaiting final notice of award and obligation of funds.

The City has attempted to secure additional finding to further understand and plan for sea level rise impacts. In August of 2023 the city's grant writing consultant applied for a federal grant (Promoting Resilient Operations for Transformative, Efficient and Cost Saving Transportation - PROTECT) to study the impact of bayside sea level rise from our north to south city limits, and to develop a resilience improvement plan. This effort received a significant amount of support from OneShoreline staff, and received letters of support from Caltrain, California High Speed Rail, Supervisor Canepa and Senator Becker. Unfortunately, this effort was not awarded. Staff is continuing to work closely with OneShoreline in hopes of participating in a holistic approach to sea level rise with participation from Caltrans and adjoining municipalities.

Discussion

Both attached studies analyzed likely effects of projected sea level rise (SLR) in the years 2030, 2050, 2070 and 2100.

Utilities

The City's water, sewer and storm drain facilities will all be impacted by a 2030 100-year storm surge because of the elevation of their present location (generally under or adjacent to the east shoreline walkway). By 2050, both the storm surge and king tides will cause additional nuisance flooding that will disallow access to the utilities for the duration of the storm surge and during the king tide periods. By 2070, the studies indicate these utilities will most likely be flooded daily.

To continue providing reliable public services to Sierra Point, the water and storm drain lines should be raised to an appropriate elevation well before 2070. Staff recommends planning to relocate the storm drain facilities by 2030, and the water facilities by 2040. A decision on relocating the sewer lines should be made consistent with planning for the marina itself, which is the only user of sewer lines on the south shoreline.

Opinions of probable cost (contingencies included):

Project	**Cost**
Waterline relocation	$3.4M
Storm drain modification **(gravity flow) or** Storm drain modification **(pump stations)**	$6.9M - $4.9M
Sewer system relocation	$4.0M

Marina

Key components of the marina evaluated are the breakwater (the north-south running sea wall), the fishing pier, navigational piles, the piles, floats, gangways and gangway platforms that make up the marina, and the three bathrooms and harbormaster's office that make up the landside structures.

The Anchor QEA memo does not find a need to raise or relocate facilities due to SLR in 2030; however, they note that by this time the facility will be 50 years old and should be replaced. This is a significant "early" cost. (Note that even if these components were not replaced due to age in 2030, they will require replacement in 2050 due to SLR impacts.) Rather than providing a detailed SLR-associated rationale for each of the recommended upgrades, the table below simply provides a chronological outlay of funds needed to keep the marina fully functional.

Opinions of probable cost (contingencies excluded):

"Replace by" Year	Project	Cost
2030	Replace seaside marina components	$46.0M
2050	Raise breakwater **or New breakwater**	$6.4M - $60.0M
2050	Raise navigational piles	$0.3M
2050	Relocate landside structures	$5.8M
2070	Modify fishing pier **or**	$1.2M
2070	Replace fishing pier	$4.0M
2070	Raise gangways to elev. 17' MSL and begin replacement of components that are now 40-years old	$33.0M
2070	Relocate/raise existing landside structures	$2.0M
2100	Relocate yacht club	$3.6M

Suggested Direction for Council to Provide Staff:

- Develop a CIP to modify the existing storm drain infrastructure no later than 2030.
- Develop a plan to relocate the waterline no later than 2050.
- Develop an RFP to create a funding plan for the 2030/2050 anticipated Marina replacements.

Measure of Success

A continuing early planning effort to respond to sea level rise by protecting public infrastructure in the most responsible manner.

Environmental Review

Receipt and review of these memorandums does not need further environmental review under the California Environmental Quality Act (CEQA) as it is general policy and procedure making not applied to a specific instance and therefore it is not a "project" (California Code of Regulations, Title 14, Division 6, Chapter 3, Article 20, §15378 (b) (2)).

Attachments

1. EKI 8/27/24 memo, Sea Level Rise Assessment of Impacts on Wet Utilities at the Brisbane Marina
2. Anchor QEA memo Assessment of Sea Level Rise at Brisbane Marina

R.L. Breault
Randy Breault, Public Works Director

Jeremy Dennis
Jeremy Dennis, City Manager

27 August 2024

MEMORANDUM

To: Randy Breault, P.E. (City of Brisbane)

From: Jonathan Sutter, P.E., Yuqing Gao, and Colin Dixon (EKI)

Subject: **Sea Level Rise Assessment of Impacts on Wet Utilities at the Brisbane Marina** (EKI C40021.00)

EKI Environment and Water, Inc. (EKI) has prepared this memorandum for the City of Brisbane (City) to analyze projected future sea level rise (SLR) impacts on the City's potable water, wastewater, and storm drain infrastructure at the Brisbane Marina (Project Site). To analyze these issues, EKI assessed the marina landside utilities in terms of direct SLR risks (i.e., flooding) and impacts from other infrastructure adaptations as described in the technical memorandum prepared by Anchor QEA (Anchor QEA, 2024). As part of this assessment, EKI identified future wet utility infrastructure improvements and developed corresponding opinions of probable cost (OPCs). For the storm drain system there were two alternatives considered: (1) installing a new raised gravity-based drainage system and (2) installing three new, low-head pump stations to create a partially pressurized system. The corresponding total OPCs for necessary improvements for all utility improvements are estimated to range from $13.3 to $14.3 million in 2024 dollars, depending on the storm drain system alternative.

EKI followed the framework established by Anchor QEA and analyzed the likely effects of projected SLR on each utility in the years 2030, 2050, 2070, and 2100. The landside adaptations recommended by Anchor QEA are described on an incremental basis for each projection horizon. In accordance with that approach, EKI assessed the impacts to the landside utilities and identified to what extent each system would need to be upgraded and replaced for the corresponding SLR planning horizon. However, EKI assumes that the utility improvements would be performed only once and would be constructed at the same time as the improvements identified by Anchor QEA. Therefore, the OPC is based on replacing and upgrading the utilities while planning for the projected SLR in the year 2100.

CURRENT WET UTILITY INFRASTRUCTURE CONDITIONS

Landside utilities within the Project Site include a potable water system, sanitary sewer system, and storm drain system. EKI relied on the City's infrastructure geodatabase and a site inspection to inventory each utility within the Project Site. When describing the location of the utility components, EKI will reference the two critical landside elevations described in the Anchor QEA memorandum: the revetment and the top of slope elevation.

The revetment is an armored slope along the waterfront. On top of the revetment is the shoreline path that runs along the perimeter of the marina, and Anchor QEA estimates this elevation at +9.6 feet (Anchor QEA, 2024). There are four structures on top of the revetment including three bathrooms and the Harbor Master's office. The parking lot servicing the Harbor Master's office is also at this level. The revetment, one bathroom and the parking lot can be seen in Photo 1. There is another slope inland of the revetment, and on top of that slope are two more structures and additional parking lots. This is the top of slope

elevation, and it is estimated to be +15.5 feet (Anchor QEA, 2024). One of the top of slope structures can be seen in the background of Photo 1.

Photo 1: Bathroom on Shoreline Revetment

Potable Water System

As shown on Figure 1, the potable water (PW) system within the Project Site includes a 16-inch diameter high density polyethylene (HDPE) water main running along the revetment. Outside of the Project Site, this water main extends along the north and south revetments and forms the main transmission loop in Sierra Point. A 10-inch diameter HDPE pipe runs through the Marina parking lot and connects to the 16-inch diameter main near the Harbor Master's Office near Dock 2. The system supplies potable water to the four structures along the revetment and to the Sierra Point Yacht Club at the top of slope level. Within the Project Site, in addition to the water service connections and related appurtenances, there are six fire hydrants and two blow-offs.

Sanitary Sewer System

As shown on Figure 2, the sanitary sewer (SS) system within the Project Site includes an 8-inch diameter HDPE gravity sewer and five manholes that collect wastewater from the four structures along the

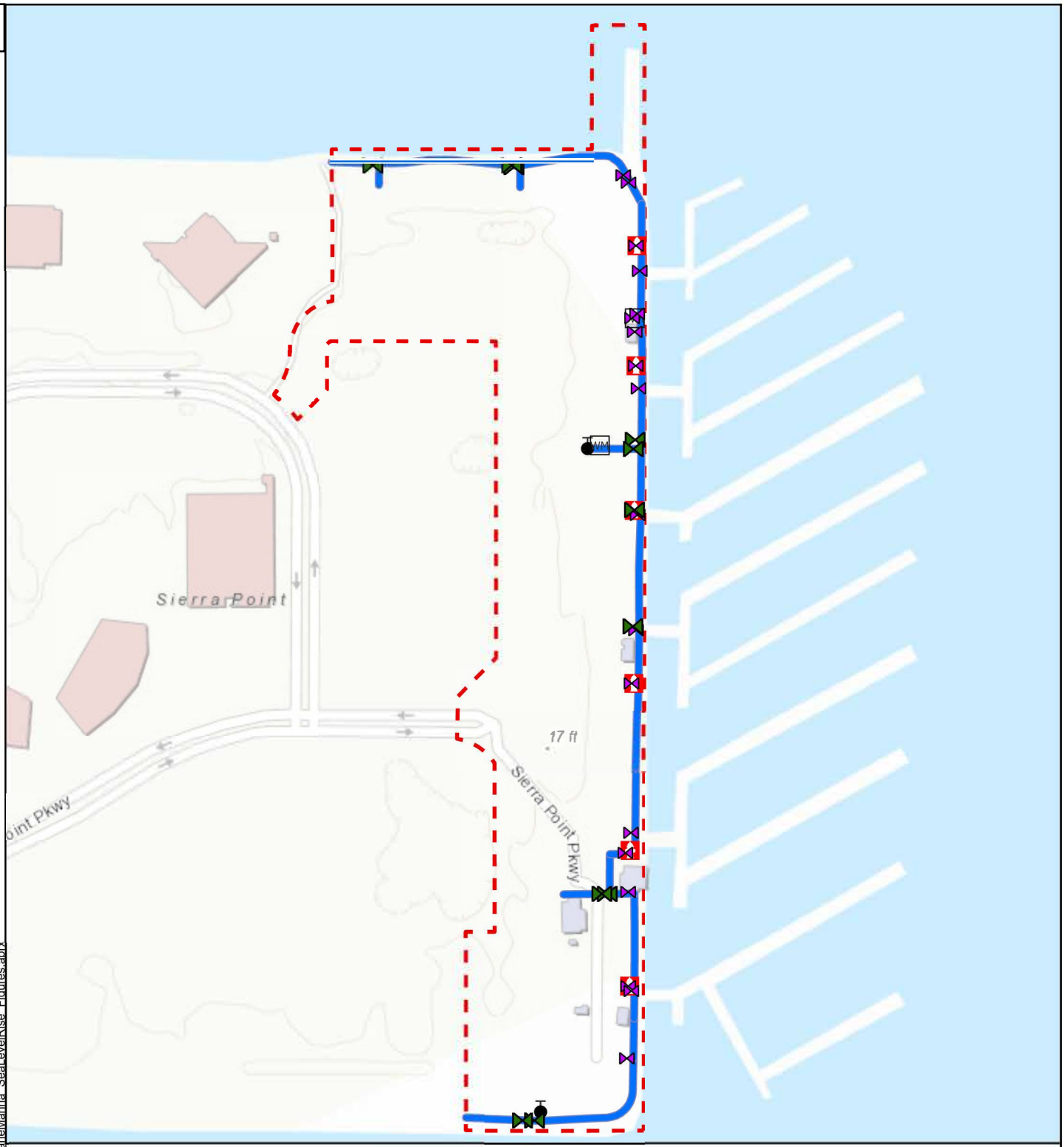
revetment. The gravity main conveys wastewater to Lift Station #1 (also known as the Harbormaster Lift Station), which is located south of the Dock 3 restrooms (see Photo 2). Lift Station #1 pumps the wastewater through a 6-inch asbestos cement pipe (ACP) force main north along the revetment within the Project Site. Outside of the Project Site, the force main continues west along the northern revetment and then south parallel to Highway 101 before discharging back to the gravity system upstream of Lift Station #4.

Photo 2. Harbormaster Lift Station (Lift Station #1)

Storm Drain System

As shown on Figure 3, the storm drain (SD) system within the Project Site serves the Marina, and several nearby parking lots. The system drains stormwater to the Bay via ten outfalls along the revetment. At the time of EKI's site visit, all outfalls were fully submerged and did not appear to have any tide gates installed. An example outfall is shown in Photo 3. The SD system within the Project Site includes 11,310 linear feet (LF) of storm drain pipes, 117 catch basins, and seven manholes (although only one was found during field investigation). A portion of the SD system located outside of the Project Site is included in this assessment because it may need to be modified in response to SLR adaptations and modifications to the Marina outfalls (Figure 3).

Photo 3. Submerged Outfall in the Brisbane Marina



Legend

- Marina_AOI
- SPW_FireHydrant
- SPPW_FlushingBlowoff
- SPPW_ServiceMeter
- SPPW_ServiceValve
- SPPW_SystemValve
- SPPW_WaterMain

Abbreviations

AOI = Area of Interest
PW = Potable Water
SP = Sierra Point

Potable Water System

Sources

1. Base map provided by Esri Online Services, dated July 29, 2024.

Notes

1. All locations are approximate.
2. This map only shows utilities located within the Brisbane Marina AOI.

Brisbane Marina
Brisbane, CA
August 2024
C40021.00
Figure 1

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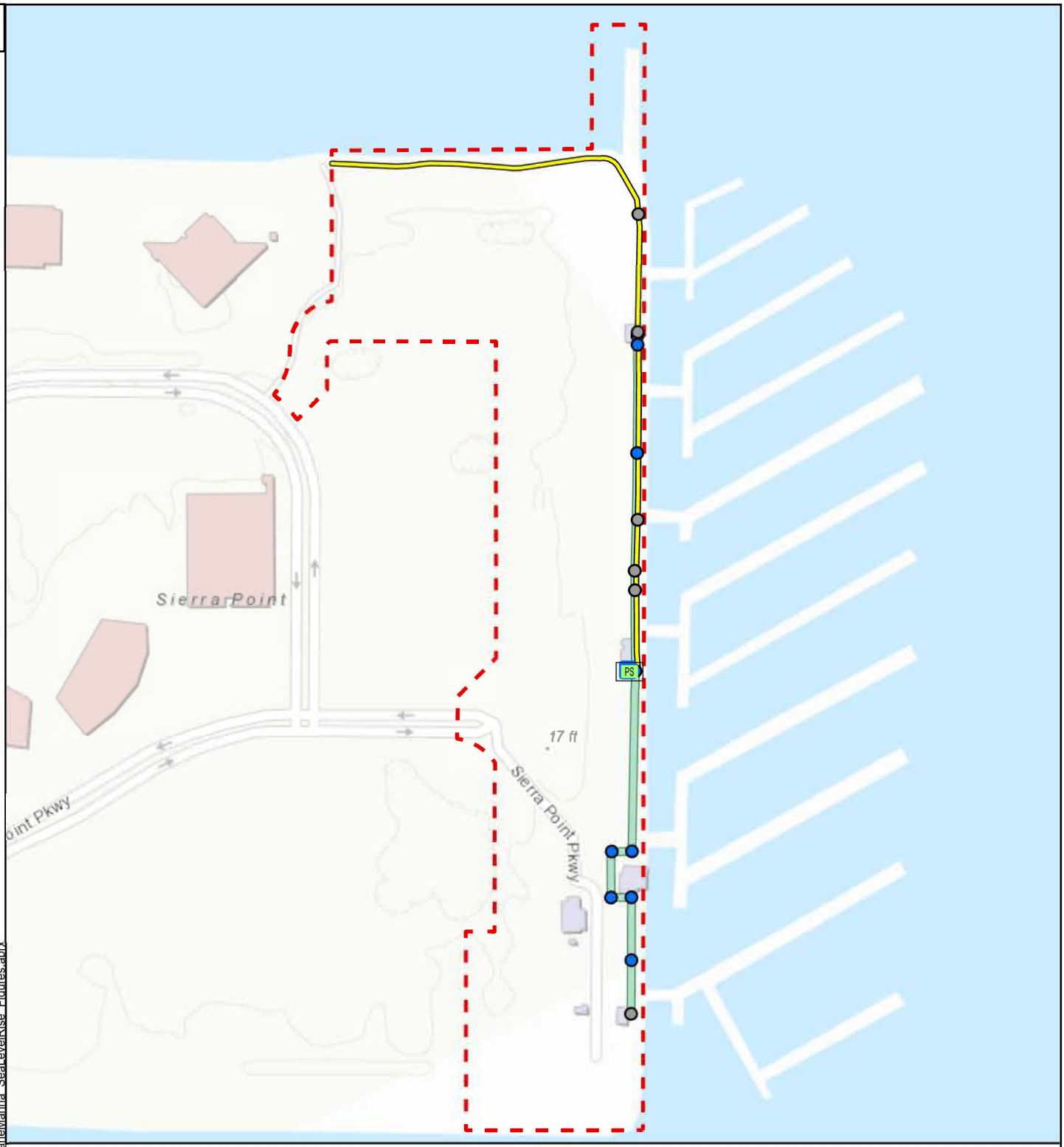

Legend

- Marina_AOI
- SS_LiftStationBoundary
- SS_CO
- SS_MH
- SS_GravityMain
- SS_ForceMain
- SS_LiftStation (PS)

Abbreviations

AOI = Area of Interest
CO = Clean Out
MH = Manhole
SP = Sierra Point
SS = Sanitary Sewer

Sanitary Sewer System

Sources

1. Base map provided by Esri Online Services, dated July 29, 2024.

Notes

1. All locations are approximate.
2. This map only shows utilities located within the Brisbane Marina AOI.

Brisbane Marina
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Figure 2

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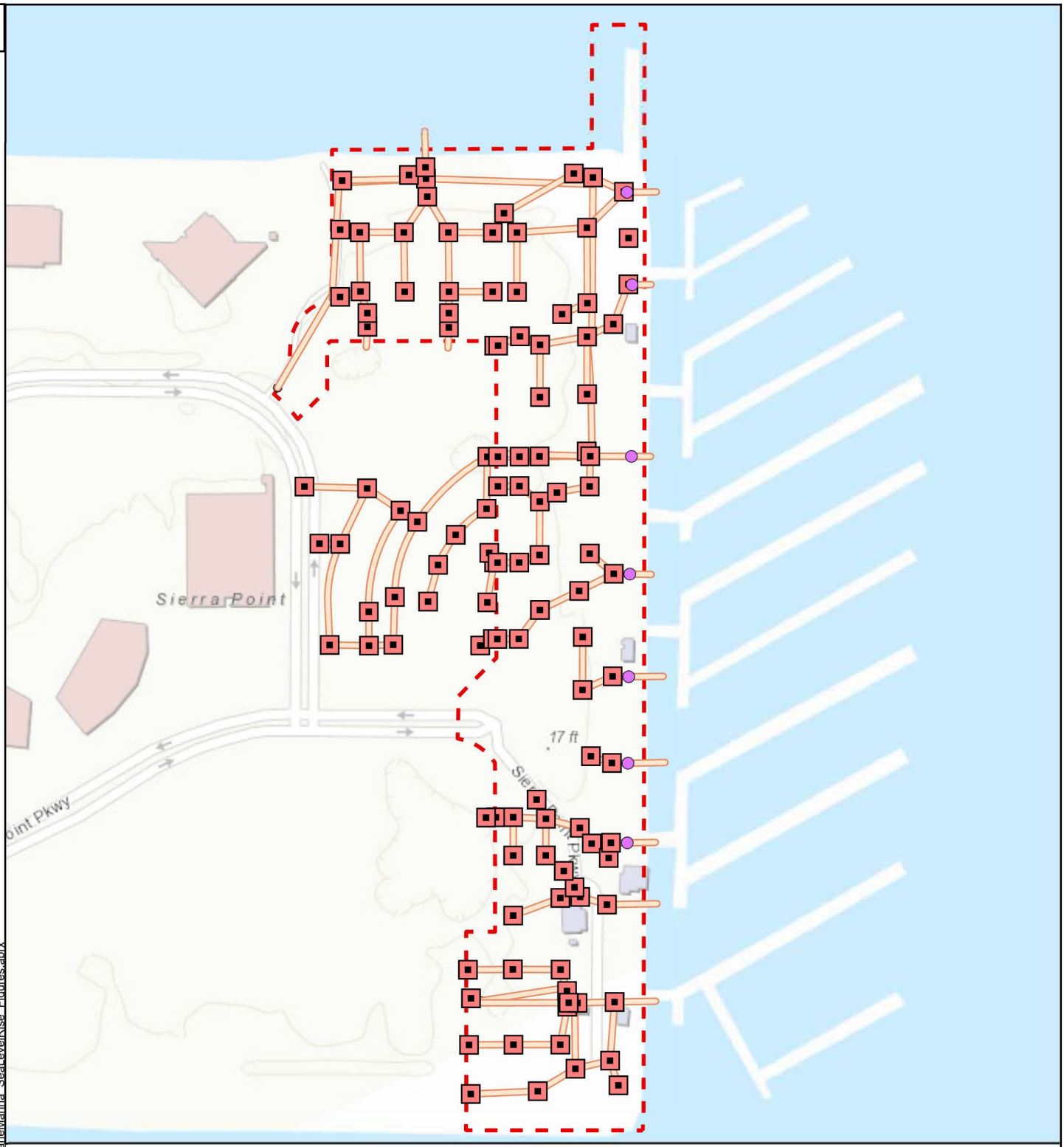

Legend

Marina_AOI
SPSD_CatchBasin
SPSD_Cleanout
SPSD_Manhole
SPSD_Pipe

Abbreviations

AOI = Area of Interest
SD = Storm Drain
SP = Sierra Point

Sources

1. Base map provided by Esri Online Services, dated July 29, 2024.

Notes

1. All locations are approximate.
2. This map shows utilities connected to the 10 storm drain outfalls located within the Brisbane Marina AOI.
3. Storm drain manholes are not verified in field.

Storm Drain System

Brisbane Marina
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Figure 3

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PROJECTED SEA-LEVEL RISE AND IMPACTS TO WET UTILITIES AT THE PROJECT SITE

In March 2023, a presentation to the Brisbane City Council included an exhibit showing mean higher high water (MHHW), king tide, and 100-year storm surge elevations based on SLR projections for the years 2030, 2050, 2070, and 2100 (Figure 4). The San Francisco Bay has two tidal cycles every day, and the MHHW elevation is the average of the daily higher high tide. The MHHW elevation is indicative of the elevation where daily tidal flooding is likely and permanent inundation is possible. At this elevation, rising groundwater is also a larger risk, as long-term rising sea levels can raise the water table in nearshore environments. If groundwater comes in contact with wet utilities, it can increase the rate of corrosion of metal components, make maintenance and repair more difficult, and increase the risk of cross-contamination between the groundwater and the various water systems. King tides are a set of unusually high tides that only happen a few times per year, and this means the impacts of the King tide are more similar to the storm surge. They involve temporary inundation and potential damage from wave action. This can harm structures, disable electrical systems, and increase erosion and soil destabilization.

The Anchor QEA memorandum (Anchor QEA, 2024) analyzes the impacts of SLR on the four structures on the Marina revetment and the two inland structures, which are at the Marina top of slope elevation. The four revetment structures are raised off the ground (Photo 1) and the bottom floor elevation of the structures is estimated at +11 feet. The two top of slope structures have a bottom floor elevation of +15.5 feet. For the 2030 SLR scenario, Anchor QEA does not recommend raising the revetment or top of slope elevation as the storm surge only reaches elevation +10.3 feet and therefore does not impact any of the structures. However, this elevation is higher than the top of the revetment (+9.6 ft), and this means that anything at ground level on the revetment may be at risk from a 100-year storm surge.

In the 2050 SLR scenario, the storm surge (+12.3 feet) threatens the four revetment structures (+11 feet), and the king tide (+10.2 feet) may flood the top of the revetment (+9.6 feet). For that reason, Anchor QEA recommends raising the revetment and the area behind the revetment to +13.3 feet in order to be one foot above the storm surge elevation.

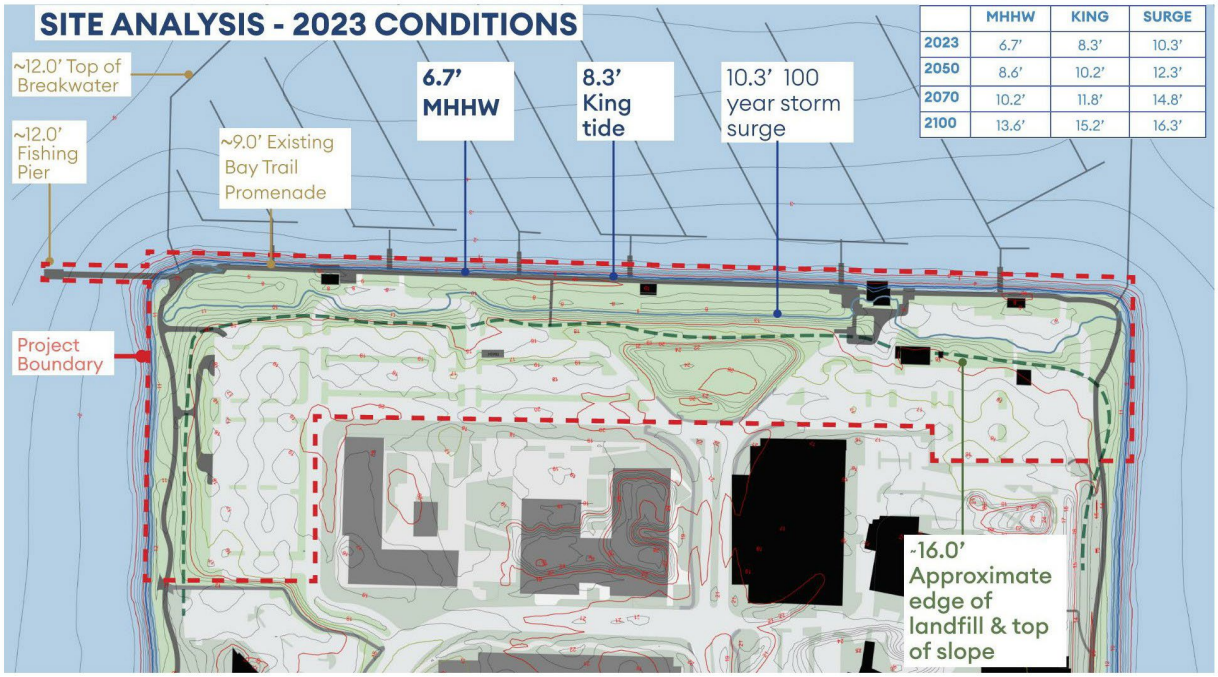
In the 2070 SLR scenario, the MHHW elevation (+10.2 feet) is above the current revetment elevation and therefore anything on the revetment is likely to experience daily flooding. The storm surge elevation is +14.8 feet, which is not yet impacting the top of slope structures. Anchor QEA recommends that the revetment and the area behind the revetment be raised to at least +15.8 feet in order to be one foot above the storm surge elevation.

In the 2100 SLR scenario, the storm surge may reach +16.3 feet, putting the top of slope structures (+15.5 feet) at risk. Planning for 2100 SLR, Anchor QEA recommends that the revetment, the area behind the revetment and the buildings at the top of slope elevation be raised to +17.3 feet.

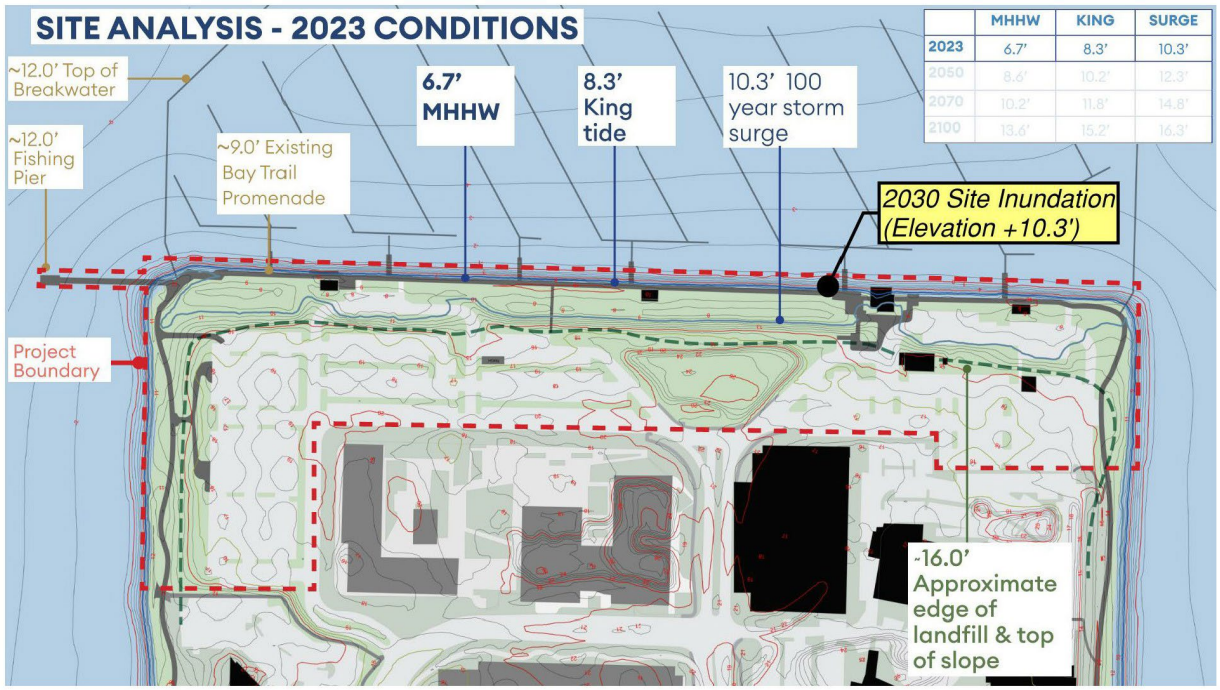
In the sections below, EKI assesses each SLR scenario and its anticipated impacts on the potable water, sanitary sewer, and storm drain systems.

Figure 4. The Brisbane Marina Site Inundation Map

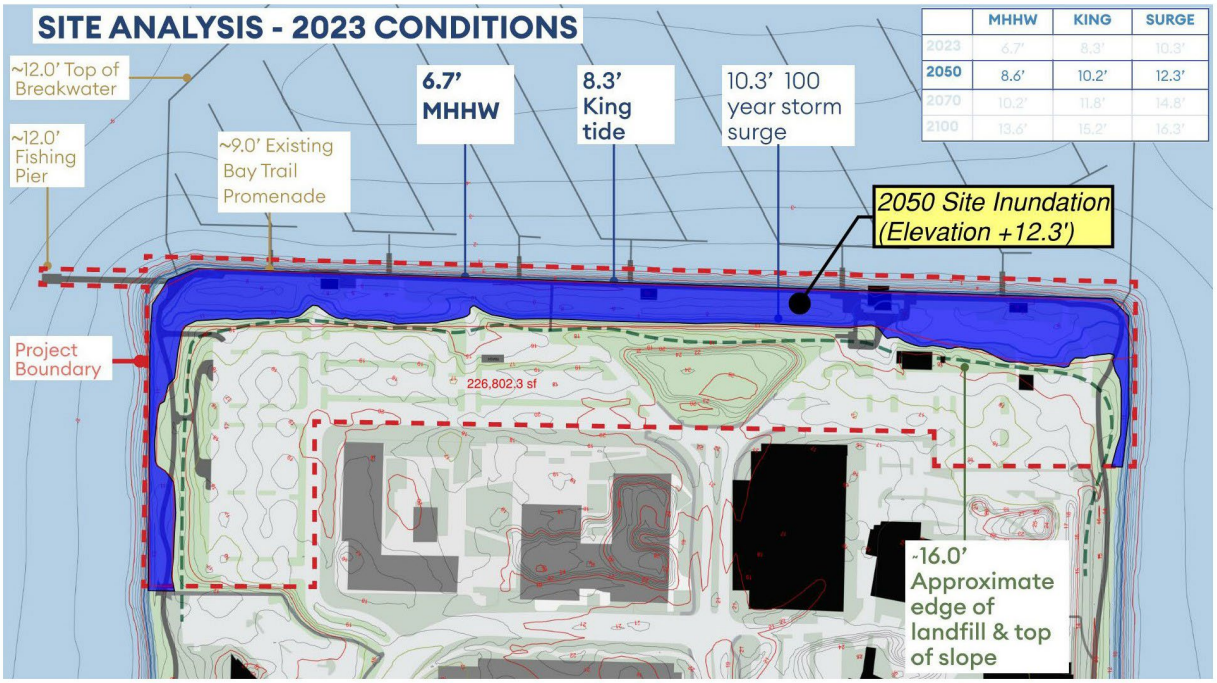
(a) 2023 Conditions



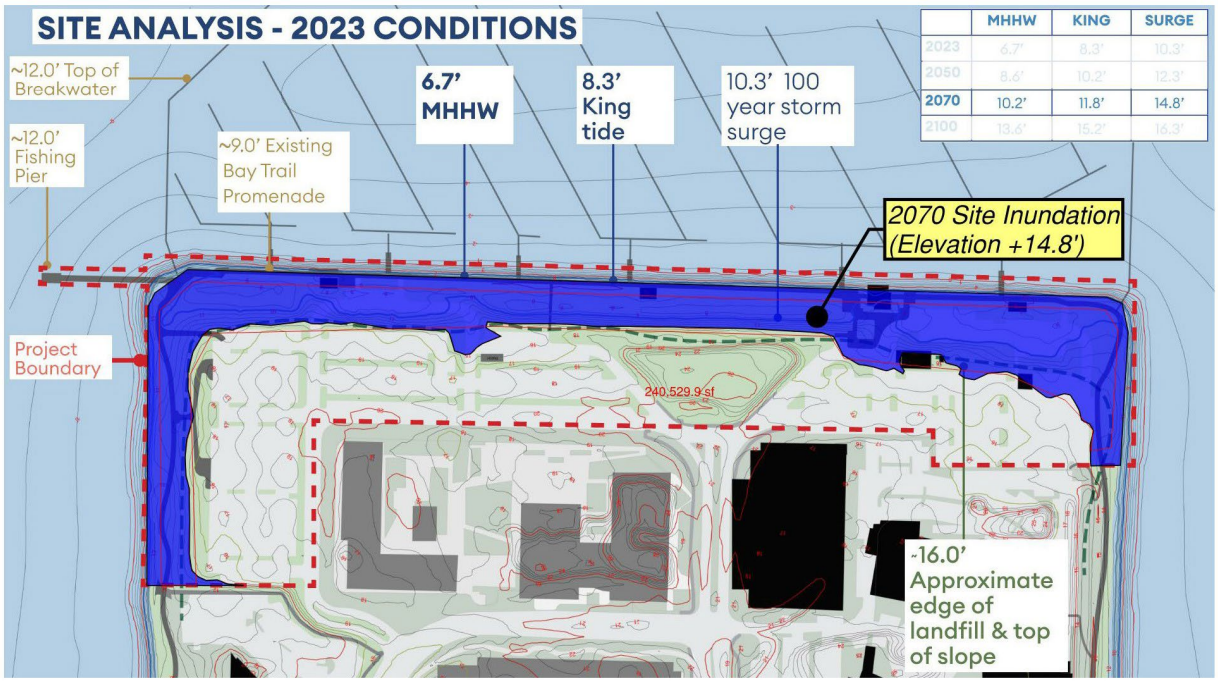
(b) 2030 Site Inundation



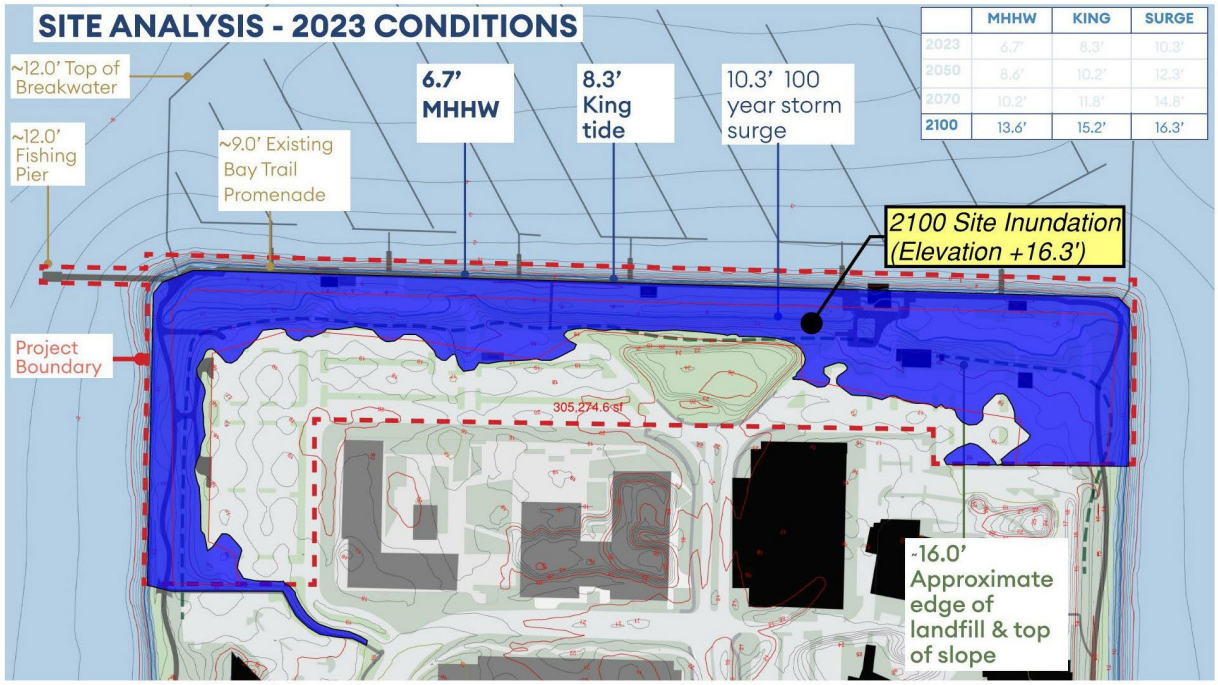
(c) 2050 Site Inundation



(d) 2070 Site Inundation



(e) 2100 Site Inundation



Potable Water System

The water distribution pipes were constructed along the San Francisco Bay Trail and are located at the edge of the pavement along the shoreline. Connected to pipeline are related infrastructure components such as valves, meters, fire hydrants and flushing blow-offs. The facilities are generally at ground level with an elevation of approximately +9.6 feet.

2030 SLR Conditions

The magnitude of SLR by 2030 is relatively small, and the tidal and storm surge elevations for 2030 are essentially equal to the 2023 elevations. In 2030, these PW components are less likely impacted by the daily highest tides (MHHW), but components on the ground surface are at risk of flooding from the 100-year storm surge, which may reach an elevation of +10.3 feet (Figure 5). The underground pipes are not expected to be impacted by the temporary storm surge.

2050 SLR Conditions

The 100-year storm surge may reach an elevation of +12.3 feet, and the daily highest tides will reach an elevation of +8.6 feet (Figure 4c). At their current elevations, the surface components of the PW system would be at risk from the 100-year storm surge but not yet impacted by the daily tides (Figure 5).

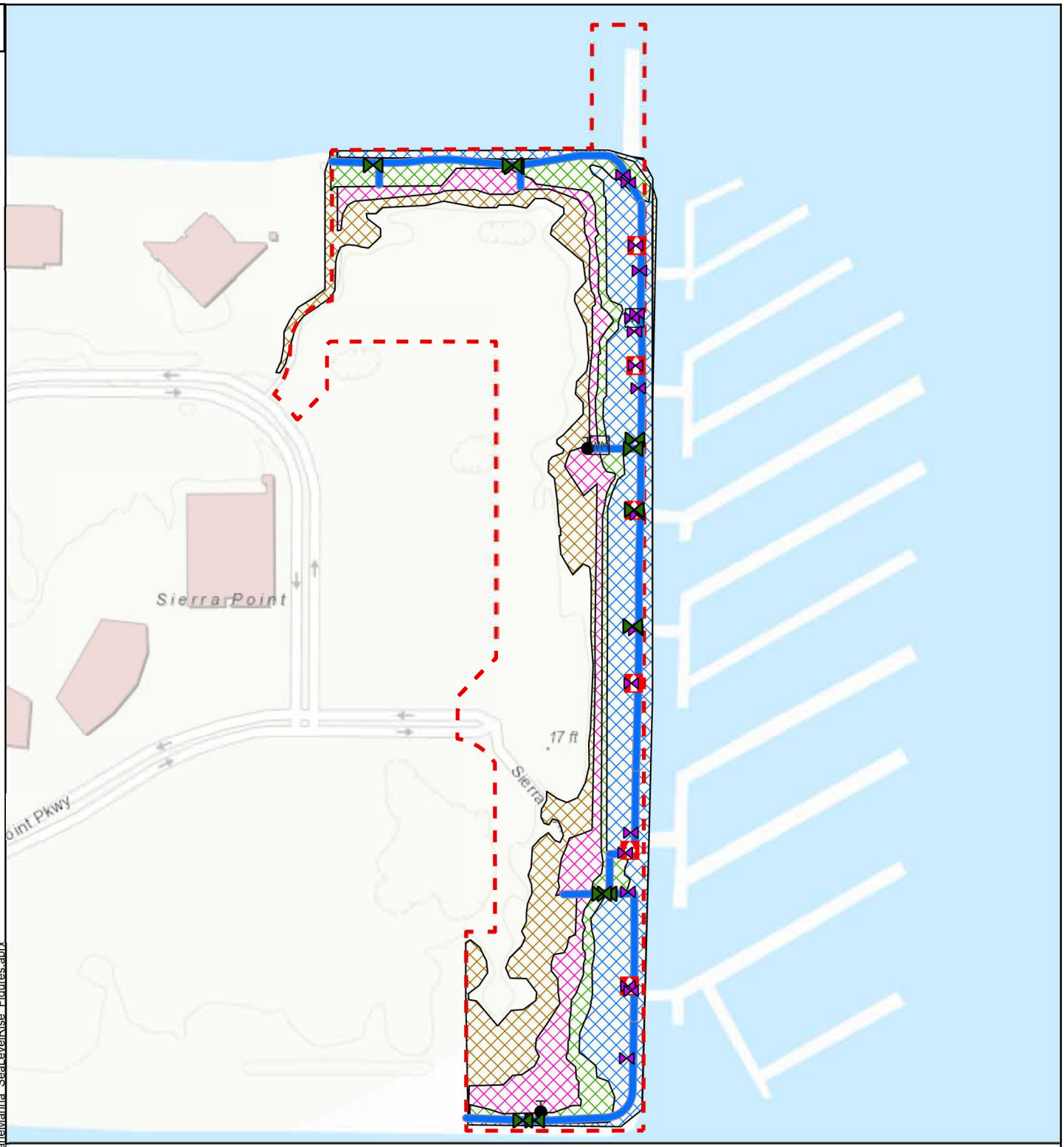
As previously noted, Anchor QEA recommends that the revetment be raised to at least elevation +13.3 feet, by 2050. The landside adaptation is expected to affect the operation of 3,200 feet of water main, 6 fire hydrants, and 6 system valves along the shoreline. It is recommended that the PW utilities be replaced and raised at the same time as the revetment. This is because when the pipes get deeper, they become harder to access for maintenance and repair. Additionally, the pipes are more likely to be submerged below the groundwater table. This is undesirable as the groundwater can cause corrosion of metal components, and any leaks in the pipes can lead to cross-contamination.

2070 SLR Conditions

By 2070, the 100-year storm surge may reach an elevation of +14.8 feet and the daily higher tide will reach +10.2 feet (Figure 4d). At their current elevations, the surface components of the PW system would be at risk from both the 100-year storm surge and the daily higher tides (Figure 5). As described above, the structures on the revetment are also at risk of flooding, and therefore Anchor QEA recommends that the revetment be raised an additional 2.5 feet, to elevation +15.8 feet. As a result, an additional 90 feet of distribution water main may be affected.

2100 SLR Conditions

By 2100, the 100-year storm surge may reach elevation +16.3 feet, and the daily higher tide will rise to elevation +13.6 feet (Figure 4e). It is recommended that the revetment and the top of slope be raised to elevation +17.3 feet. For the revetment, this represents a 1.5-foot increase from the 2070 recommendation, and for the top of slope it represents a 1.8-foot increase from the current elevation. All PW infrastructure within the Marina Area of Interest (AOI) is recommended to be replaced. The estimated costs of the PW system improvements are shown in Table 2.



Legend

- Storm Surge 2030
- Storm Surge 2050
- Storm Surge 2070
- Storm Surge 2100
- Marina_AOI
- SPW_FireHydrant
- SPPW_FlushingBlowoff
- SPPW_ServiceMeter
- SPPW_ServiceValve
- SPPW_SystemValve
- SPPW_WaterMain

Abbreviations

AOI = Area of Interest
SP = Sierra Point
PW = Potable Water

Sources

1. Inundation area projections provided by Anchor QEA, dated February 2024.
2. Base map provided by Esri Online Services, dated July 29, 2024.

Notes

1. All locations are approximate.
2. This map only shows utilities located within the Brisbane Marina AOI.

Flooding Risk:
Potable Water System

Brisbane Marina
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Figure 5

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Sanitary Sewer Systems

Two sets of sanitary sewer networks are present in the Marina area, including a gravity sewer system and a pressurized sewer system. The sewer pipes run underground beneath the shoreline revetment with associated lift station unit, cleanouts and manholes. Many of these components are at ground level along the revetment, which is approximately at elevation +9.6 feet. However, the lift station housing, which contains its electrical components, is raised off the ground (Photo 2). Therefore, it is recommended that the lift station be replaced at the same time as the other structures on the revetment. The SLR impacts on the SS system are similar to the previously discussed impacts on the PW system (Figure 6). The impacted sewer infrastructure includes 1,500 feet of gravity main, 1,700 feet of forced main, and one lift station. The cost of replacing these systems is shown in Table 2.

Legend

- Storm Surge 2030
- Storm Surge 2050
- Storm Surge 2070
- Storm Surge 2100
- Marina_AOI
- SS_CO
- SS_GravityMain
- SS_LiftStation
- SS_LiftStationBoundary
- SS_MH
- SS_ForceMain

Abbreviations

AOI = Area of Interest
MH = Manhole
SS = Sanitary Sewer
CO = Clean Out
SP = Sierra Point

Sources

1. Inundation area projections provided by Anchor QEA, dated February 2024.
2. Base map provided by Esri Online Services, dated July 29, 2024.

Notes

1. All locations are approximate.
2. This map only shows utilities located within the Brisbane Marina AOI.

Flooding Risk:
Sanitary Sewer System

Brisbane Marina
Brisbane, CA
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Figure 6

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Storm Drain System

Like the other wet utility systems, surface components of the Storm Drain (SD) system, including catch basins and manholes, would be at risk of damage from temporary flooding. However, the storm drain system faces an additional difficulty during large storm surges, because if the catch basins and pipes are inundated during a 100-year storm, this could reduce the system's capacity to drain the stormwater from further uphill. During EKI's visit to the site, it was noted that the SD outfalls were below the water level, indicating that daily tidal fluctuations are already impacting the infrastructure. EKI recommends that in order to maintain the system functionality the outfalls are raised at the same time as the revetment.

Unlike the PW and SS systems, the existing SD network in the Marina is entirely a gravity-based system. Hence, when the outfalls are raised, either some of the upstream pipes will need to also be raised or a system of pumps will need to be installed. EKI evaluated both options and they are presented below.

Gravity Powered System

The first scenario looks at maintaining a gravity-based storm drain system under the different levels of SLR. This involves raising the outfalls along the revetment and raising any pipes behind the outfalls that would no longer maintain a sufficient slope.

2030 SLR Conditions

Similar to the other two systems evaluated above, no major impacts are anticipated by 2030.

2050 SLR Conditions

Raising the revetment will require replacing the SD catch basins and raising the outfall elevations. Raising the outfall elevations will require that some of the uphill SD pipes also be raised in order to maintain a minimum slope. There is incomplete data on the current elevations of the SD pipes, but using the invert elevations from the catch basins, it is possible to estimate which pipe segments will need to be raised. Because the revetment is being raised more than the top-of-slope elevation, the new pipes will likely have a lower slope than before. This means the diameter of the pipes will also need to be increased in order to maintain a similar system capacity. The new pipe diameters shown in the OPC are for cost estimation purposes and are generalized across the system. The new diameters for individual pipes may differ from these estimations depending on factors such as the new watershed area and the exact pipe slope. Assuming the outfalls are raised the same amount as the revetment (3.7 feet), that will require replacing 2,800 feet of SD pipes, 21 catch basins, and one manhole.

2070 SLR Conditions

Assuming the outfalls are raised an additional 2.5 feet above the 2050 recommendation (the same amount as the Revetment), that will require replacing a total of 3,800 feet of SD pipes, 27 catch basins, and one manhole.

2100 SLR Conditions

Assuming the outfalls are raised an additional 1.5 feet above the 2070 recommendation, that will require replacing a total of 6,100 feet of pipe, 52 catch basins and one manhole. The pipes that would need to be

replaced and their new invert elevations are shown on Figure 8. The cost estimates of these upgrades are shown in Table 2.

Ground Cover Analysis

One important consideration with the gravity-based system is whether there will be sufficient ground cover after raising the pipes. For 2100, Anchor QEA (Anchor QEA, 2024) identified +17.3 ft as the minimum elevation for all marina buildings in order to be safely above the 100-yr storm surge. Specifically, they recommend three adaptations: raising the revetment, filling the area behind the revetment and raising the bottom floor of the top of slope buildings. This leaves flexibility in whether the top of slope ground level is raised or if just the buildings are raised off the ground. For analyzing the ground cover over the new pipes, EKI conservatively assumed that the top of slope ground level would not be raised. This means the ground surface inland of the top of slope elevation will remain in its current state, and the shoreside ground surface will be raised to +17.3 ft. EKI calculated the new invert elevations of each pipe, assuming that the layout of the SD system is unchanged, that each pipes needs a minimum 1% slope, and that the outfalls are raised the same amount as the revetment. The outcome is shown on Figure 8, and EKI concluded that all pipes will have a minimum of 2.5 ft of ground cover.

Lift Station Powered System

The alternative to a gravity-based system would be installing new pump stations and creating a partially pressurized SD system. In this scenario most of the SD pipes inland of the revetment would stay unchanged, however, the outfalls would still be raised with the revetment. The benefits of a pumped system are that most of the existing storm drain system would not need to be replaced and the system would be easier to adapt to continually changing environments. For example, if the revetment needs to be raised again after 2100, a gravity-based system may need to be mostly replaced, whereas the pumped system only needs new outfalls, and maybe larger pumps. The drawbacks of the pumped system are that the pumps have a higher operational cost, require more maintenance, and have the risk of failure compared to a gravity system.

Figure 9 presents a conceptual plan for delineating four sub-drainage areas around the Marina, based on current topography and the existing storm drainage network profile. The plan proposes converting three of the sub-drainage areas into partially pressurized SD networks, with one new booster pump stations within each of the three sub-drainage areas. These new pump stations are expected to collect stormwater within their respective sub-drainage areas and discharge it into the bay through new downstream pipes and outfalls. The sub-drainage area between dock 2 and 3 (shown in purple on Figure 9), would maintain its current gravity-based SD networks.

This analysis assumes that the new stormwater pump stations will be designed to convey peak flows within each sub-drainage area during a 10-year design storm, in accordance with criteria set forth in other publicly available storm drainage studies from the San Francisco Bay Area, as well as EKI's engineering experience from similar projects.

The City's 2003 Storm Drainage Master Plan (SDMP) divided the City into distinct watersheds and estimated peak stormwater inflow and runoff volume for each, based on various hydrological factors such as land use, precipitation, and soil conditions. Since the SDMP does not provide projected peak flows for the Marina area, EKI compared its hydrologic parameters with those of other watersheds. It was observed

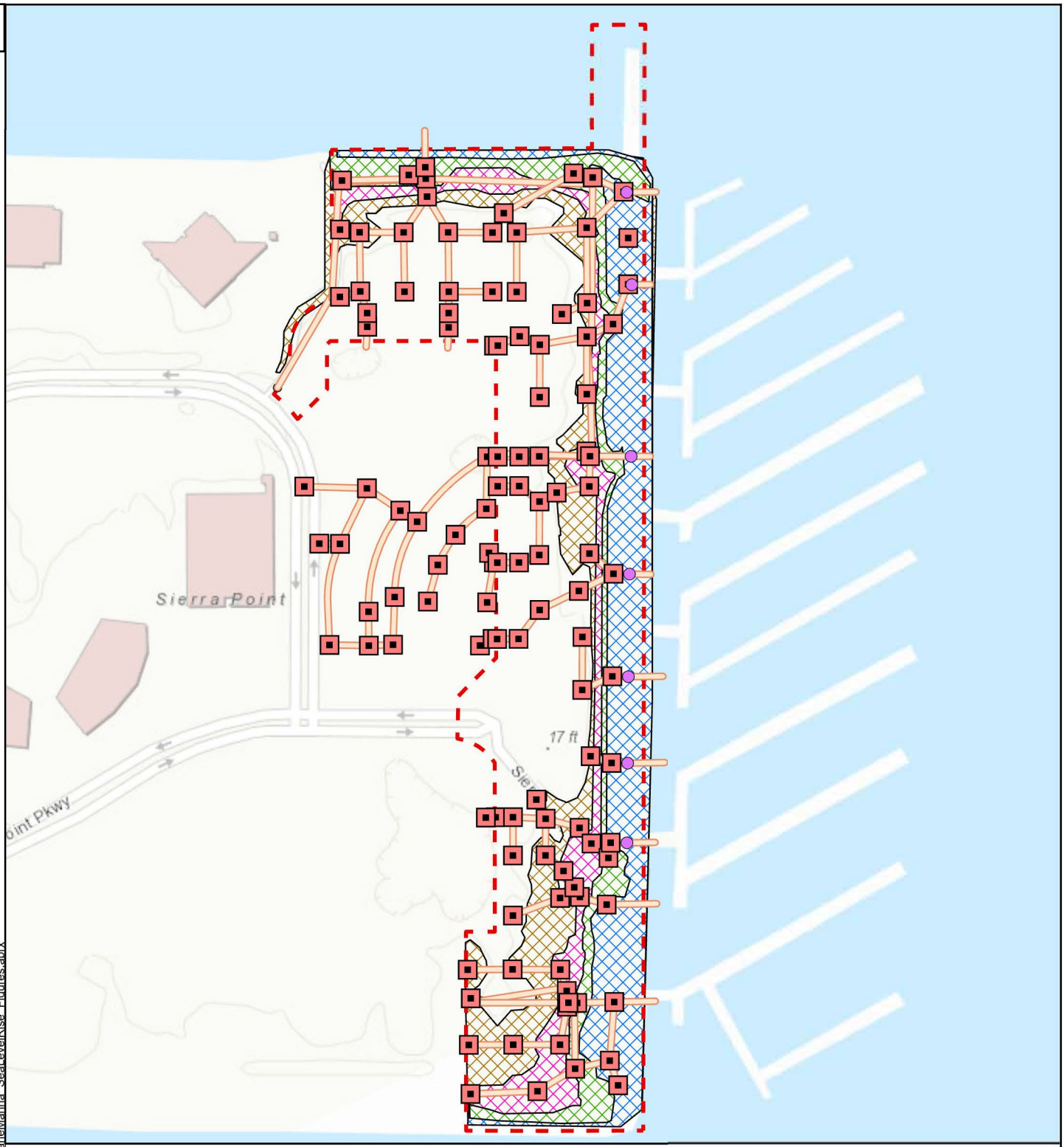
that Watershed 18C at buildout shares similar hydrological conditions with the Sierra Point area (including the Marina). Table 1 summarizes the projected flows for Watershed 18C at buildout, including the factors used for each hydrological parameter in the SDMP, and provides an estimate for the peak stormwater flow in the Marina area. The peak flow of each new pump station's service area during a 10-year design storm are approximately 3,500 gpm, 6,500 gpm, and 4,700 gpm.

Table 1. Estimated Stormwater 10-year Peak Flow in the Marina

Drainage Area	Sub-drainage Area	Area (acres)	Land Use	Imperviousness (%)	10-year Peak Inflow (cfs)	10-year Runoff Volume (AF/24hrs)	Total Peak Flow (gpm)
Sierra Point (Marina)	Future Pump Station 1	5.5	office	75	7.5	0.4	3,400
	Future Pump Station 2	10.5	office	75	14.3	0.5	6,500
	Future Pump Station 3	7	office	75	9.5	2.0	4,700
Watershed 18C		27.2	commercial mixed use (buildout)	80	47.3	7.7	22,900

Abbreviations:
AF = acre-feet cfs = cubic feet per second gpm = gallons per minute hrs = hours
Notes:
(1) Source: Brisbane, 2003.

Based on the estimated peak flows, the new pump stations are expected to have firm pumping capacities of 3,500 gpm, 6,500 gpm, and 4,700 gpm, respectively. Note that these pumping capacity requirements represent high-level estimates and are for planning purposes only. EKI recommends that the City conduct further studies to refine the peak flow calculations and assess the feasibility of implementing such a pumped system.



Legend

- Storm Surge 2030
- Storm Surge 2050
- Storm Surge 2070
- Storm Surge 2100
- Marina_AOI
- SPSD_CatchBasin
- SPSD_Cleanout
- SPSD_Manhole
- SPSD_Pipe

Abbreviations

AOI = Area of Interest
SD = Storm Drain
SP = Sierra Point

Sources

1. Inundation area projections provided by Anchor QEA, dated February 2024.
2. Base map provided by Esri Online Services, dated July 29, 2024.

Notes

1. All locations are approximate.
2. This map shows utilities connected to the 10 storm drain outfalls located within the Brisbane Marina AOI.
3. Storm drain manholes are not verified in field.

Flooding Risk: Storm Drain System

Brisbane Marina
Brisbane, CA
August 2024
C40021.00

Figure 7

eki environment & water

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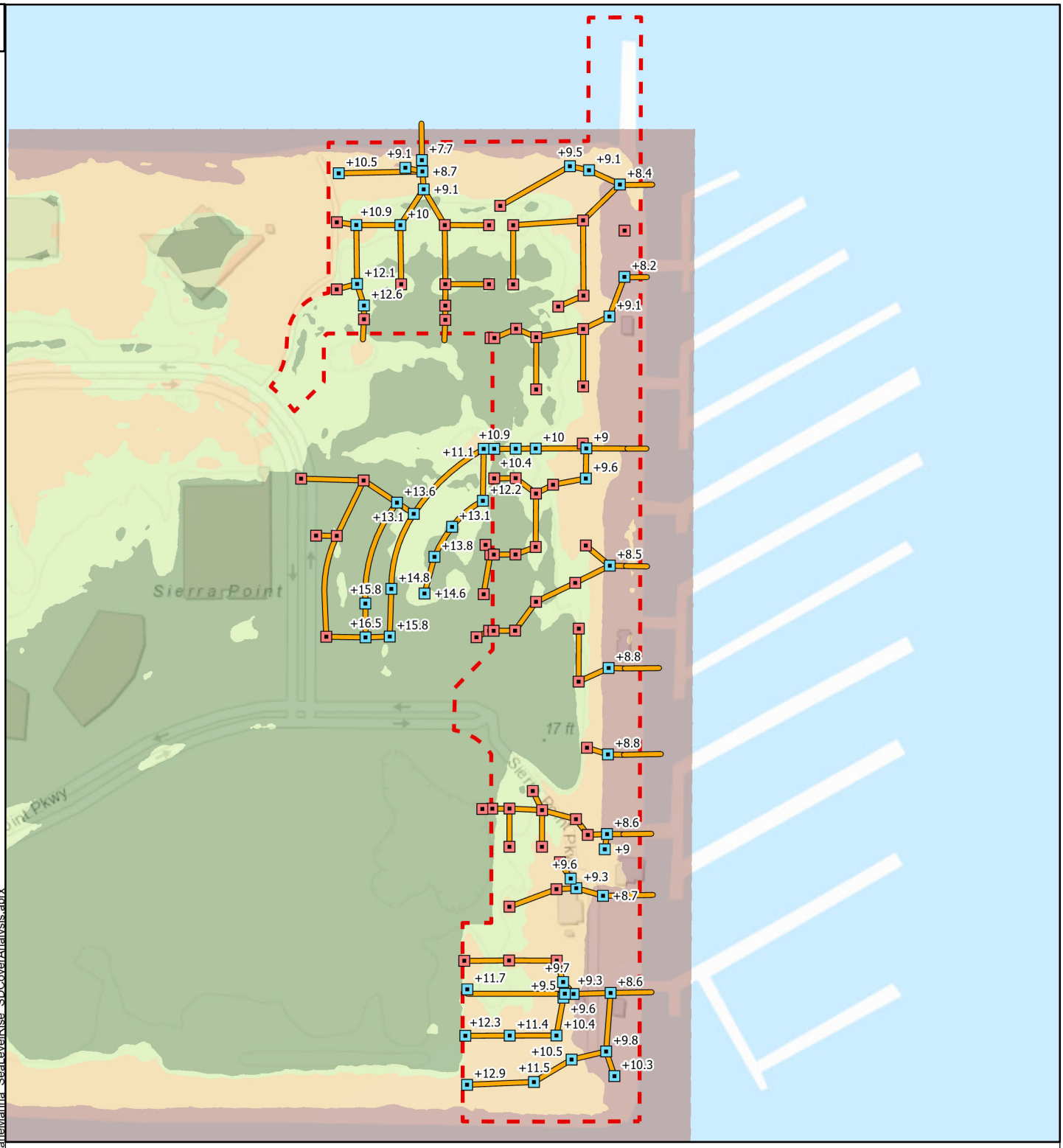

Legend

- Revetment (<=9.6 ft; 17.3 ft by 2100)
- Slope (9.6 - 15.5 ft; 17.3 ft by 2100)
- Top of Slope (15.5 - 17.3 ft)
- Upper Elev (> 17.3 ft)
- Marina_AOI
- SPSD_Pipe
- SPSD_CatchBasin
- SPSD_CatchBasin_Replaced

Abbreviations

AOI = Area of Interest
SD = Storm Drain
SP = Sierra Point

Sources

1. Base Map provided by ESRI Online Services, dated August 14, 2024.

Notes

1. All locations are approximate.
2. This map shows the updated storm drain system planning for 2100 SLR conditions. For pipes that need to be raised, the associated catch basins show the new invert elevations.

Storm Drain System
2100 Raised Pipe Elevations

Brisbane Marina
Brisbane, CA
August, 2024
C40021.00
Figure 8

eki environment & water

C40021.00\Map\Brisbane_Infrastructure_Map\BrisbaneMarina_SeaLevelRise_SDCoverAnalysis.aprx

Legend

- SPSD_LiftStations_New
- SPSD_Pipe
- SPSD_Pipe_New
- SPSD_Pipes_Abandoned
- Marina_AOI
- SPSD_CatchBasin
- SPSD_CatchBasin_New
- SPSD_CatchBasin_Abandoned

Abbreviations

AOI = Area of Interest
SD = Storm Drain
SP = Sierra Point

Sources

1. Base Map provided by ESRI Online Services, dated August 14, 2024.

Notes

1. All locations are approximate.
2. This map shows a conceptualization of an updated storm drain system with four sub-drainage areas and three new pump stations.

Storm Drain System with New Pump Stations

Brisbane Marina
Brisbane, CA
August, 2024
C40021.00
Figure 9

eki environment & water

C:\C40021.00\Map\Brisbane_Infrastructure_Map\BrisbaneMarina_SeaLevelRise_SDCoverAnalysis.aprx

PROPOSED UPGRADES AND OPINION OF PROBABLE COST TO ADDRESS PROJECTED SEA-LEVEL RISE

Descriptions and costs for recommended projects are provided in the sections below. Because this is a planning-level effort, many of the practical constraints that will govern the detailed design and construction of actual infrastructure improvements are unknown at this time, such as:

- Utility interference and relocation;
- Right-of-way and/or easement availability;
- Traffic control requirements;
- Geotechnical and hazardous waste conditions;
- Archaeological discoveries and environmental impacts; and
- Regulatory and permitting requirements.

Utility Improvements

As described in previous sections, the sea-level rise and impact projections were analyzed for different time horizons by Anchor QEA. However, for capital improvement projects budget planning purposes, the utility improvements are evaluated below using the time horizon of the year 2100.

The recommended improvements are described below and itemized improvements for each system are included in Table 2. Note that these are high level recommendations and exact details of the improvements require further evaluations and planning.

Potable Water System

- Cut and cap the existing 16-inch diameter HDPE water main at the existing blow-off located at the southwest corner of the Marina area of interest (AOI) (Figure 1) and near the existing 16-inch x 6-inch Tee located at the northwest corner of the Marina AOI;
- Abandon existing fire hydrants, system valves, blow-off assemblies, service valves, and water meters on and fed by the proposed abandoned 16-inch HDPE water mains (Figure 1);
- Install new 16-inch HDPE water mains running through the existing parking lots and connect to the existing 16-inch HDPE water mains near the north and south limits of the Marina AOI;
- Install new blow-off assemblies, system valves, and fire hydrants; and
- Reconnect or install new service lines and water meters.

Sanitary Sewer System

- Abandon existing gravity sewer pipes, manholes, and cleanouts in the Marina area (Figure 2);
- Cut and cap the existing 6-inch ACP force sewer main in the northwest corner of the Marina AOI (Figure 2);
- Abandon the existing Harbormaster lift station located next to the Dock 3 restroom (Figure 2);

- Install a new lift station with a firm capacity of 220 gallons per minute (gpm)[1] near the existing parking lots and construct associated 6-inch HDPE piping to connect to the existing 6-inch HDPE force sewer main at the northwest limit of the Marina AOI (Figure 2);
- Install new 8-inch polyvinyl chloride (PVC) or HDPE gravity sewer mains and manholes near the existing parking lots in the Marina area; and
- Realign or install new sewer services and cleanouts.

Storm Drain System Scenario 1 – Gravity System

- Abandon existing RCP storm drain pipes, outfalls, manholes, and catch basins in the Marina area (Figure 3); and
- Install new RCP storm drain pipes, outfalls, manholes, and catch basins in the Marina area. The storm drain pipes should be upsized to maintain the current system capacity[2]. Note that the actual slope and capacity of each pipe will vary depending on the final rim and invert elevation of each facility.

Storm Drain System Scenario 2 – Partial Pressurized System with new Stormwater Pump Stations

- Abandon existing RCP storm drain pipes, outfalls, manholes, and catch basins in the Marina area in the vicinity of the revetment (Figure 9);
- Install new RCP storm drain pipes, outfalls, manholes, and catch basins by open trenching in the Marina area between Dock 2 and Dock 3. This will maintain gravity-based discharge to the bay through the new outfalls in this sub-drainage area (Figure 9);
- Install 3 new stormwater pump stations (PSs), new catch basins, and new RCP storm drain pipes to direct flows towards new PSs (Figure 9); and
- Install new RCP storm drain pipes and outfalls downstream from the new PSs to convey water from the PSs and discharge into the bay.

Cost Basis and Opinions of Probable Cost

Table 2 provides unit cost information for the potable water distribution, sanitary sewer collection, and storm drain collection system improvements. Costs have been estimated based on a variety of available information, including:

- Cost estimation guides (e.g. RSMeans)
- Inflation indices, published by the Engineering News Record (ENR)
- Actual cost and bid data from recent similar projects in the San Francisco Bay Area

[1] The size was determined based on the existing Harbormaster Lift Station firm capacity of 200 gpm.
[2] The future slopes are expected to be reduced considering the raise of the revetments described in previous sections.

- Engineering judgement

Table 2 also shows the Opinions of Probable Costs (OPCs) for the conceptual utility improvements resulting from SLR adaptations in the Marina area, which were developed by multiplying the unit costs by the quantities of each type of improvement. The OPCs presented herein are in 2024 dollars based on the ENR Construction Cost Indexes (CCI) for San Francisco of 15,525 and are planning-level Class 5 estimates defined by the American Association of Cost Engineering, which has an accuracy range of -50% to +100%. The OPCs include the construction costs with an additional 60% for contingency and soft costs to account for variability in actual costs, including 25% for construction contingency, 10% for engineering design, 10% for construction management, 10% for general permitting, and 5% for project implementation.

It is expected that the environmental documentation and permitting requirements will be specific to each storm drain system improvement. EKI recommends that the City conduct further studies to confirm the requirements from relevant permitting agencies and to evaluate the projects' qualification for opportunities such as negative declarations.

Table 2. Opinion of Probable Cost

Project: Brisbane Marina Sea Level Rise Analysis
Prepared By: EKI Environment & Water Inc.
Date 27-Aug-24
Proj. No.: EKI C40021.00

Item	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	PRICE
A - Potable Water System					
A1	Cut and Cap Existing 16-inch Main	EA	2	$1,900	$3,800
A2	Valve Abandonment	EA	30	$750	$22,500
A3	Blow-off Assembly Abandonment	EA	2	$750	$1,500
A4	Abandon Existing Fire Hydrants	EA	6	$1,715	$10,290
A5	Install New 16-inch HDPE Water Main	LF	2,800	$660	$1,848,000
A6	Main Connections Tie-ins	EA	2	$10,000	$20,000
A9	Install New 16-inch Butterfly Valves	EA	8	$7,500	$60,000
A10	Install New Fire Hydrant Assembly	EA	6	$15,115	$90,690
A11	Install New Blow-off Assembly	EA	2	$4,750	$9,500
A12	Reconnect Water Services	EA	2	$3,650	$7,300
	Subtotal A - Potable Water System				**$2,096,000**
B - Sanitary Sewer System					
B1	Abandon Existing Sewer Manholes	EA	8	$8,180	$65,440
B2	Abandon Existing 6-inch or 8-inch Gravity Sewer Mains	LF	1,600	$490	$784,000
B3	Install New 6-inch or 8-inch Gravity Sewer Mains via Open Trench	LF	1,520	$360	$547,200
B4	Realign Lateral, via Open Trench	LF	150	$320	$48,000
B5	Replace Existing Lateral from New Sewer Main to New or Existing Cleanout	EA	7	$3,640	$25,480
B6	Abandon Existing Harbormaster Lift Station[2]	LS	1	$75,000	$75,000
B7	Cut and Cap Existing 6-inch Force Sewer Main	EA	2	$150	$300
B8	Install New Sewer Lift Station	LS	1	$402,000	$402,000
B9	Install New Sewer Manhole - Concrete Manhole	EA	8	$11,600	$92,800
B10	6-inch Main Connections Tie-ins	EA	1	$6,550	$6,550
B11	Install New 6-inch HDPE Force Sewer Mains	LF	1,700	$280	$476,000
B12	Install Cleanout at Property Line	EA	7	$870	$6,090
	Subtotal B - Sanitary Sewer System				**$2,529,000**
C - Storm Drain System (Scenario 1)					
C1	Install New 12-inch RCP Strom Drains by Open Trench (<10' deep)	LF	1,920	$360	$691,200
C2	Install New 15-inch RCP Storm Drains by Open Trench (<10' deep)	LF	923	$390	$360,119
C3	Install New 18-inch RCP Strom Drains by Open Trench (<10' deep)	LF	1,380	$420	$579,600
C4	Install New 24-inch RCP Storm Drains by Open Trench (<10' deep)	LF	1,320	$520	$686,400
C5	Install New 27-inch RCP Strom Drains by Open Trench (<10' deep)	LF	80	$600	$48,000
C6	Install New 36-inch RCP Strom Drains by Open Trench (<10' deep)	LF	140	$800	$112,000
C7	Install New 12-inch Catch Basins or Manholes	EA	10	$27,070	$270,700
C8	Install New 15-inch Catch Basins or Manholes	EA	6	$27,070	$162,420
C9	Install New 18-inch Catch Basins or Manholes	EA	18	$27,430	$493,740
C10	Install New 24-inch Catch Basins or Manholes	EA	14	$27,590	$386,260
C11	Install New 27-inch Catch Basins or Manholes	EA	2	$27,770	$55,540
C12	Install New 36-inch Catch Basins or Manholes	EA	3	$28,880	$86,640
C13	Install New Outfalls[3]	EA	9	$40,790	$367,110
	Subtotal C - Storm Drain System (Scenario 1)				**$4,300,000**
D - Storm Drain System (Scenario 2)					
D1	Install New 8-inch RCP Strom Drains by Open Trench (<10' deep)	LF	336	$360	$121,011
D2	Install New 10-inch RCP Strom Drains by Open Trench (<10' deep)	LF	115	$380	$43,845
D3	Install New 12-inch RCP Strom Drains by Open Trench (<10' deep)	LF	782	$390	$304,870
D4	Install New 15-inch RCP Storm Drains by Open Trench (<10' deep)	LF	203	$410	$83,231
D5	Install New 18-inch RCP Strom Drains by Open Trench (<10' deep)	LF	576	$440	$253,645
D6	Install New 21-inch RCP Storm Drains by Open Trench (<10' deep)	LF	123	$490	$60,435
D7	Install New 8-inch Catch Basins or Manholes	EA	3	$19,040	$57,120
D8	Install New 10-inch Catch Basins or Manholes	EA	2	$19,140	$38,280
D9	Install New 12-inch Catch Basins or Manholes	EA	7	$19,240	$134,680
D10	Install New 15-inch Catch Basins or Manholes	EA	2	$19,330	$38,660
D11	Install New 18-inch Catch Basins or Manholes	EA	4	$19,470	$77,880
D12	Install New 21-inch Catch Basins or Manholes	EA	1	$19,630	$19,630
D13	Install New Outfalls[3]	EA	5	$40,790	$203,950
D14	Install New 3,500 gpm Storm Water Pump Station	EA	1	$540,000	$540,000
D15	Install New 4,700 gpm Storm Water Pump Station	EA	1	$720,000	$720,000
D16	Install New 6,500 gpm Storm Water Pump Station	EA	1	$1,000,000	$1,000,000

M.

Table 2. Opinion of Probable Cost

Project: Brisbane Marina Sea Level Rise Analysis
Prepared By: EKI Environment & Water Inc.
Date 27-Aug-24
Proj. No.: EKI C40021.00

Item	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	PRICE
	Subtotal D - Storm Drain System (Scenario 2)				**$3,697,000**
Opinion of Probable Cost for Improvements of Potable Water System, Sanitary Sewer System, and Storm Drain System (Scenario 1)					
	Total Direct Costs[4]				$8,925,000
	Construction Contingency	25%			$2,231,000
	Design, Construction Management, Permitting and Project Implementation[5]	35%			$3,124,000
	TOTAL OPINION OF PROBABLE COST				**$14,280,000**
Opinion of Probable Cost for Improvements of Potable Water System, Sanitary Sewer System, and Storm Drain System (Scenario 2)					
	Total Direct Costs[4]				$8,322,000
	Construction Contingency	25%			$2,081,000
	Design, Construction Management, Permitting and Project Implementation[5]	35%			$2,913,000
	TOTAL OPINION OF PROBABLE COST				**$13,316,000**

Notes

1. Cost estimates were developed by referencing recent bid results for similar projects in the San Francisco Bay Area and are Class 5 estunates and defined by the American Association of Cost Engineering. Costs are presented in July 2024 dollars.
2. Wide variations in actuall abandonment costs are expected due to unknown facility conditions.
3. Wide variations in actual outfall costs are expected.
4. Includes General Conditions, Bonding, and Contractor markups (Overhead & Profit, Contract Administration).
5. Includes mark-ups equal to 35% for design (10%), construction management (10%), general permitting (10%), and project implementation (5%).
6. Cost estimates do not include specific permitting or environmental documentation related cost for Storm Drain system improvements. It's recommened that City to conduct further study for more detailed permitting requirements and costs.
7. Total costs were rounded to the nearest thousand dollars.

For improvements including the storm drain system (scenario 1 – fully gravity system), the total OPC is estimated at approximately $14.3 million in 2024 dollars, including approximately $3.4 million for the potable water system improvements, approximately $4.0 million for the sanitary sewer collection system improvements, and approximately $6.9 million for the storm drain collection system improvements as described above.

For improvements including the storm drain system (scenario 2 – partially pressurized system plus three stormwater pump stations), the total OPC is estimated at approximately $13.3 million in 2024 dollars, including approximately $3.4 million for the potable water system improvements, approximately $4.0 million for the sanitary sewer collection system improvements, and approximately $5.9 million for the storm drain collection system improvements as described above. Note that while this option has a lower capital cost, the ongoing operation and maintenance cost for the pressurized storm drain alternative is anticipated to be higher.

SUMMARY

The landside wet utilities largely exist within or near the revetment along the Marina shoreline. Therefore, it is recommended that the utilities be replaced in accordance with adaptations and improvements made to the revetment. It is recommended that the utilities be replaced in one effort planning for SLR in the year 2100 rather than incrementally.

References

Anchor QEA, 2024. *Draft Memorandum Assessment of Sea Level Rise at Brisbane Marina*.

Brisbane, 2003. *City of Brisbane Storm Drainage Master Plan Final Report, RBF Consulting, dated November 2003.*

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ANCHOR QEA

Memorandum

May 22, 2024

To: Randy Breault, PE

From: Chris Mansour, PE, and Joshua Burnam, MPH, D.Env, Anchor QEA

Re: Memorandum – Assessment of Sea Level Rise at Brisbane Marina

Anchor QEA and EKI Environment and Water are providing separate memoranda to consider how best to analyze future sea level rise (SLR) effects on Brisbane Marina. Anchor QEA has reviewed the March 2, 2023, presentation materials provided by the City of Brisbane and is familiar with Brisbane Marina's (marina's) facilities through past efforts. To best analyze these issues, Anchor QEA proposes a process based on assessing specific key marina assets in terms of short-term (acute) and long-term SLR effects and proposing possible adaptations or solutions for each. A rough order-of-magnitude (ROM) cost estimate (in 2024 dollars) is also provided for suggested engineering solutions (Attachment 1). Costs for dredging have been excluded from this report.

The following features would be assessed:

- Marina docks and piles
- Concrete panel breakwater
- Flooding of the landside and top-of-slope impacts

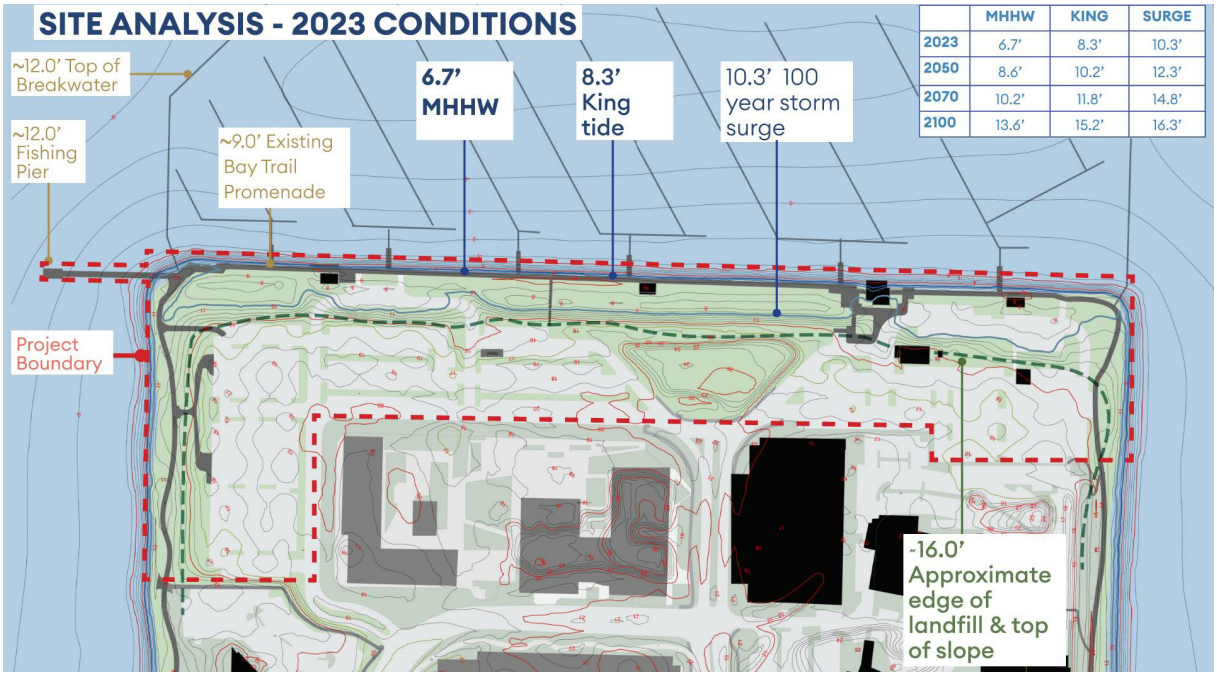
Anchor QEA analyzed for the likely effects of SLR on each key feature in the years 2030, 2050, 2070, and 2100 using the data provided. For each feature, Anchor QEA has proposed potential short- and long-term engineering remedies and evaluated ROM costs as well as key data needs and design steps.

Site Background

In the 1950s and 1960s, the area east of the US 101 freeway known as Sierra Point was constructed as a landfill. From 1980 to 1982, the concrete breakwater was constructed, and the marina was constructed behind the breakwater in 1983.

In March 2023, a presentation to the City Council of Brisbane included an exhibit showing SLR, king tide, and storm surge elevations based on the years of 2023, 2050, 2070, and 2100 (Figure 1). The elevations listed in the presentation for the 2023 mean higher high water elevation of 6.7 feet closely approximates National Oceanic and Atmospheric Administration Tidal Station 9414750, Alameda, California, with a reference datum of mean lower low water (MLLW) equal to 0.0 feet.

Figure 1
March 2023 Presentation Material



2030 Sea Level Rise Case

Breakwater

Original design drawings provided by the City were used as a reference for construction of the breakwater and navigational aids. The top of the concrete breakwater is estimated at elevation +13.4 feet (MLLW). Based on Figure 2, the breakwater will not be submerged during a king tide and storm surge. It is recommended that an inspection of the breakwater be conducted to determine the condition of the wall and that structural calculations be performed to determine whether the breakwater was designed for overtopping. If the breakwater is structurally adequate, the breakwater would not need to be replaced or augmented until 2050 or 2070.

Brisbane Fishing Pier

The fishing pier's walking surface elevation is estimated at +14.5 feet (MLLW). For the 2030 case, where the storm surge is estimated at +10.3 feet, the fishing pier is not in danger of flooding and is above the Federal Emergency Management Agency (FEMA) minimum floor elevation. Therefore, no action is required in 2030.

Navigational Piles

The navigational piles to the southeast of the marina entrance have a top-of-pile elevation estimated to be +20 feet. Top-of-pile elevation should be increased with taller piles starting in 2050, with a future top-of-pile elevation of +25 feet. The top-of-pile elevation should be verified with U.S. Coast Guard (USCG) regulations at the time of design.

Marina

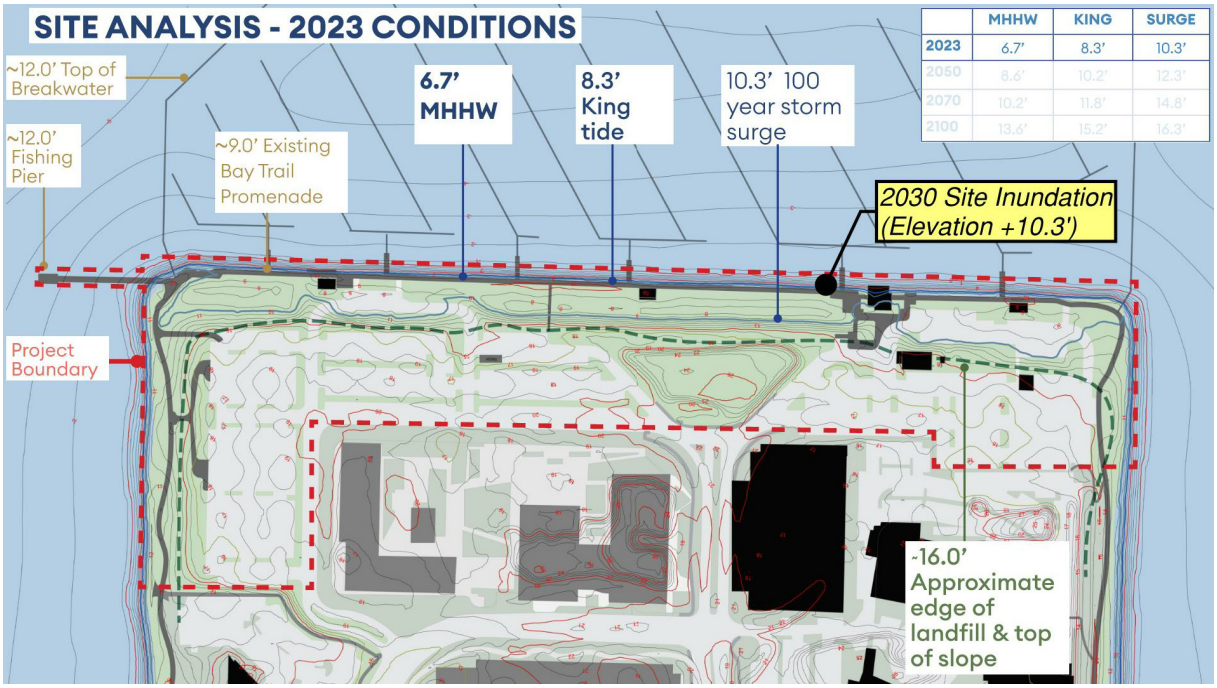
In 2030, the marina will be approximately 50 years old. The concrete floats have reached the end of their service life and should be replaced. The marina comprises 467 piles, 108,500 square feet of floating docks, and six gangway structures.

- **Piles:** The existing piles have a top elevation of +10 feet and were installed in 1982. The piles may have a life expectancy of 80 to 100 years if they are not damaged. With a design life of 80 to 100 years, the piles should be replaced with taller piles by 2050. However, with the replacement of the marina, it may be prudent to replace the piles at the same time (2030). With the anticipated surge height of +16.3 feet (2100) and 2 feet of freeboard of the docks, the replacement piles should be designed with a top elevation of +20 feet.
- **Floats:** The existing concrete floats were constructed in the 1980s. As we have seen in other marinas of this era, the tops of the floats will experience cracking and spalling for the concrete. Replacement of the floats with either concrete or wood decking will be required.
- **Gangways:** The six existing gangways are each 40 feet long. With the expected replacement of the marina, based on Department of Boating and Waterways code, it is anticipated that the new marina will be required to meet Americans with Disabilities Act (ADA) requirements. Therefore, one of the gangways will need to be replaced with an 80-foot-long gangway to meet ADA requirements and provide access to the ADA-designated slips.
- **Gangway Platforms:** Based on the current elevation of +9.6 feet at the gangway platforms floor elevation, the platform floor elevations will need to be raised to place the floor of the platforms above the future king tide elevation. The platforms should be raised to elevation +12 feet by 2030, then to elevation +14 feet by 2050, and to elevation +17 feet by 2070.

Landside

The top of the existing revetment appears to have an elevation of +9.6 feet. There are four structures located in proximity of the revetment and marina. These structures include the three restrooms and the harbor master's office. These structures appear to have a base floor elevation of +11 feet. Two inland structures, the Sierra Point Yacht Club and a single-car storage garage, have a floor elevation estimated at +15.5 feet. Per FEMA guidelines, the minimum floor elevation should be located at least 12 inches above the base flood elevation (surge elevation). For the 2030 case, where the estimated storm surge elevation is +10.3 feet, it appears that all the structures are in no danger of flooding in the short term (Figure 2).

Figure 2
2030 Site Inundation Map



Landside Utilities

To be evaluated under separate cover by EKI.

Estimated Costs

Costs for replacement or modification are provided in Table 1 based on 2024 dollars.

Table 1
2030 Sea Level Rise Case Costs

Element Replaced/Modified	Cost
Breakwater	$0
Fishing Pier	$0
Navigational Piles	$0
Marina	$46,000,000
Landside	$0
Total	**$46,000,000**

2050 Sea Level Rise Case

Breakwater

The top of the concrete breakwater is estimated at elevation +13.4 feet (MLLW). Based on Figure 3, the breakwater will not be submerged during a king tide and storm surge. It is recommended that the concrete breakwater be raised to elevation +20 feet between 2050 and 2070. The raising of the breakwater could be accomplished by replacing the concrete breakwater with a new, taller breakwater; or the breakwater could be raised by constructing atop of the existing breakwater; or the existing breakwater could be augmented by the installation of a new steel sheet pile wall on the bay side of the marina. The design life of the concrete breakwater is estimated to be between 80 and 100 years. Therefore, a new breakwater constructed before 2070 would have a design life to 2170.

Brisbane Fishing Pier

The fishing pier's walking surface elevation is estimated at +14.5 feet (MLLW). For the 2050 case, where the storm surge is estimated at +12.3 feet, the fishing pier is not in danger of flooding and is above the FEMA minimum floor elevation. Therefore, no action is required in 2050. Rasing the pier may be required starting around year 2070.

Navigational Piles

The navigational piles to the southeast of the marina entrance should be replaced with taller piles between 2050 and 2070. Top elevation of the navigational piles should be at least +25 feet and should be verified with USCG regulations at the time of design.

Marina:

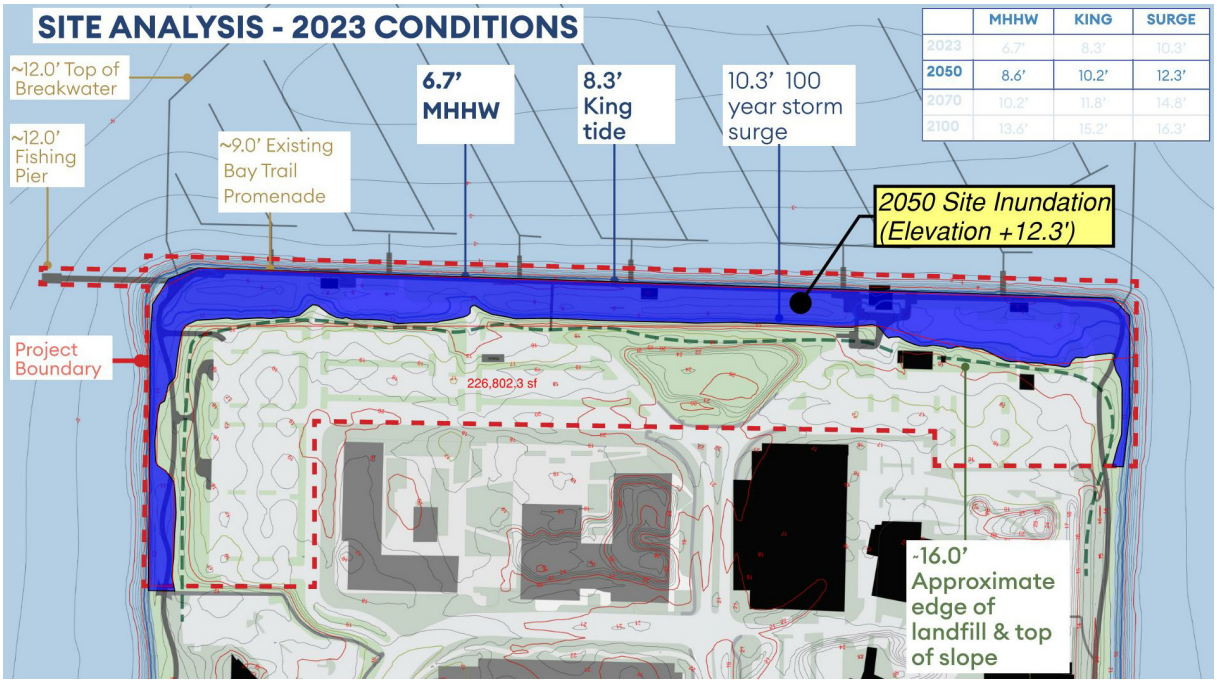
- **Piles:** If not completed in 2030, the piles should be replaced with new, taller piles with the anticipated top elevation of +20 feet by 2050.
- **Floats:** Assuming the marina was replaced in 2030, the replacement marina will be approximately 20 years old in 2050. The concrete floats should have another 30 years of service life remaining.
- **Gangways:** Assuming the marina was replaced in 2030, the replacement gangways will be approximately 20 years old in 2050 and should have 30 years of service life remaining.
- **Gangway Platforms:** The platform should be raised to elevation +14 feet by 2050 and to elevation +17 feet by 2070.

Landside

For the 2050 case, where the estimated storm surge elevation is +12.3 feet, the four structures closest to the water's edge (three restrooms and the harbor master's office) should be raised to an elevation of +13.3 feet minimum and to +17.3 feet ideally. The two landside structures (Sierra Point

Yacht Club and a single-car storage garage) are not in danger of flooding in the short term. Raising the revetment to elevation +13.3 feet and filling the area behind the revetment to elevation +13.3 feet would require an estimated fill of 30,000 cubic yards (cy; Figure 3).

Figure 3
2050 Sea Level Rise Case



Landside Utilities

To be evaluated under separate cover by EKI.

Estimated Costs

Costs for replacement or modification are provided in Table 2 based on 2024 dollars.

Table 2
2050 Sea Level Rise Case Costs

Element Replaced/Modified	Cost
Breakwater	$6,400,000 (modification) to $60,000,000 (complete replacement)
Fishing Pier	$0
Navigational Piles	$300,000
Marina	$0
Landside	$5,800,000
Total	**$12,500,000 to $66,100,000**

2070 Sea Level Rise Case

Breakwater

Assuming the breakwater was reconstructed before 2070, the breakwater should have a life expectancy to 2150 and 2170.

Brisbane Fishing Pier

The fishing pier's walking surface elevation is estimated at +14.5 feet. For the 2070 case, where the storm surge is estimated at +14.8 feet, the fishing pier does not have adequate elevation to be above the storm surge, and the pier will be submerged. It is advised that the pier be replaced with a new pier of sufficient elevation to survive a future storm surge. With an expected service life of 75 years, the pier should be designed for the anticipated storm surge elevation of +16.3 feet plus a 1-foot freeboard, or +17.3 feet.

Option for Non-Replacement

If in the year 2050 to 2070, the piles and pile caps are in good condition, the existing concrete decking could be removed and a new elevated decking installed on a raised pile cap. The span between the pile caps could be constructed of lightweight materials, such as an aluminum gangway or fiberglass members and flooring, to keep the same weight as the existing structure. The intent of this methodology is to keep the existing supporting structure (piles and pile caps) in place and replace only the decking with a decking of equal or lesser weight and thereby not require rebuilding of the supporting pile.

Navigational Piles

Assuming the navigational piles to the southeast of the marina entrance were replaced in 2050, the navigational piles should have a life expectancy extending to 2130 and 2150.

Marina

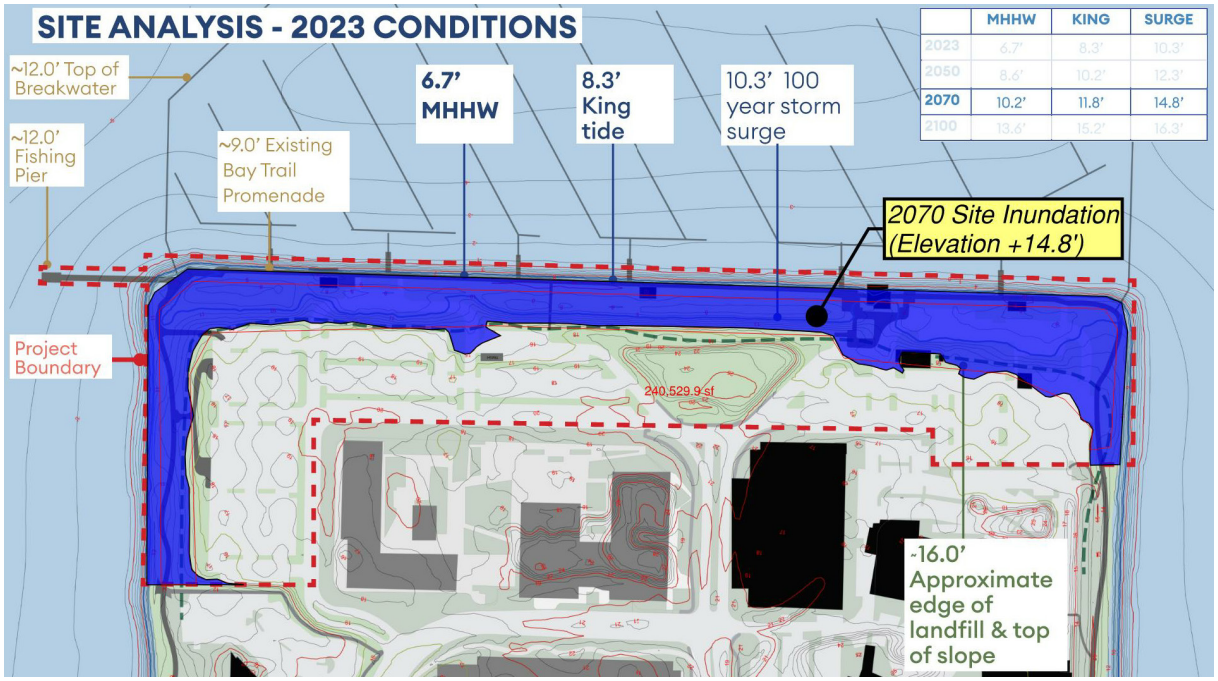
- **Piles:** Assuming the floating dock guide piles were replaced in 2030 or 2050, the piles should have a useful life to 2110 and 2150.
- **Floats:** Assuming the marina was replaced in 2030, the replacement marina will be approximately 40 years old in 2070. The concrete floats should have another 10 years of service life remaining. Replacement of the marina should be anticipated within the next 10 years. Assumed replacement of the marina in 2080.
- **Gangways:** Assuming the marina was replaced in 2030, the replacement gangways will be approximately 40 years old in 2070 and should have 10 years of service life remaining. Replacement of the marina gangways should be anticipated by 2080.

- **Gangway Platforms:** In the 2070 case, the platform should be raised to elevation +17 feet.

Landside

For the 2070 case, where the estimated storm surge elevation is +14.8 feet, the four structures closest to the water's edge (three restrooms and the harbor master's office) should be raised to an elevation of +15.8 feet minimum and to +17.3 feet ideally. The two landside structures (Sierra Point Yacht Club and a single-car storage garage floor with a finished floor elevation estimated at +15.5 feet) are not in danger of flooding in the short term. Raising the revetment to elevation +15.8 feet and filling the area behind the revetment to elevation +15.8 feet would require an estimated fill of 20,000 cy (Figure 4).

Figure 4
2070 Site Inundation Map



Landside Utilities

To be evaluated under separate cover by EKI.

Estimated Costs

Costs for replacement or modification are provided in Table 3 based on 2024 dollars.

Table 3
2070 Sea Level Rise Case Costs

Element Replaced/Modified	Cost
Breakwater	$0
Fishing Pier	$1,200,000 (modification) to $4,000,000 (complete replacement)
Navigational Piles	$0
Marina	$33,000,000
Landside	$2,000,000
Total	**$36,200,000 to $39,000,000**

2100 Sea Level Rise Case

Breakwater

Assuming the breakwater was reconstructed in 2070, the breakwater should have a life expectancy to between years 2150 and 2170.

Brisbane Fishing Pier

Assuming the fishing pier was reconstructed in 2050 to an elevation of +17.3 feet, the fishing pier should have a life expectancy to 2125.

Navigational Piles

Assuming the navigational piles to the southeast of the marina entrance were replaced in 2050, the navigational piles should have a life expectancy extending to between years 2130 and 2150.

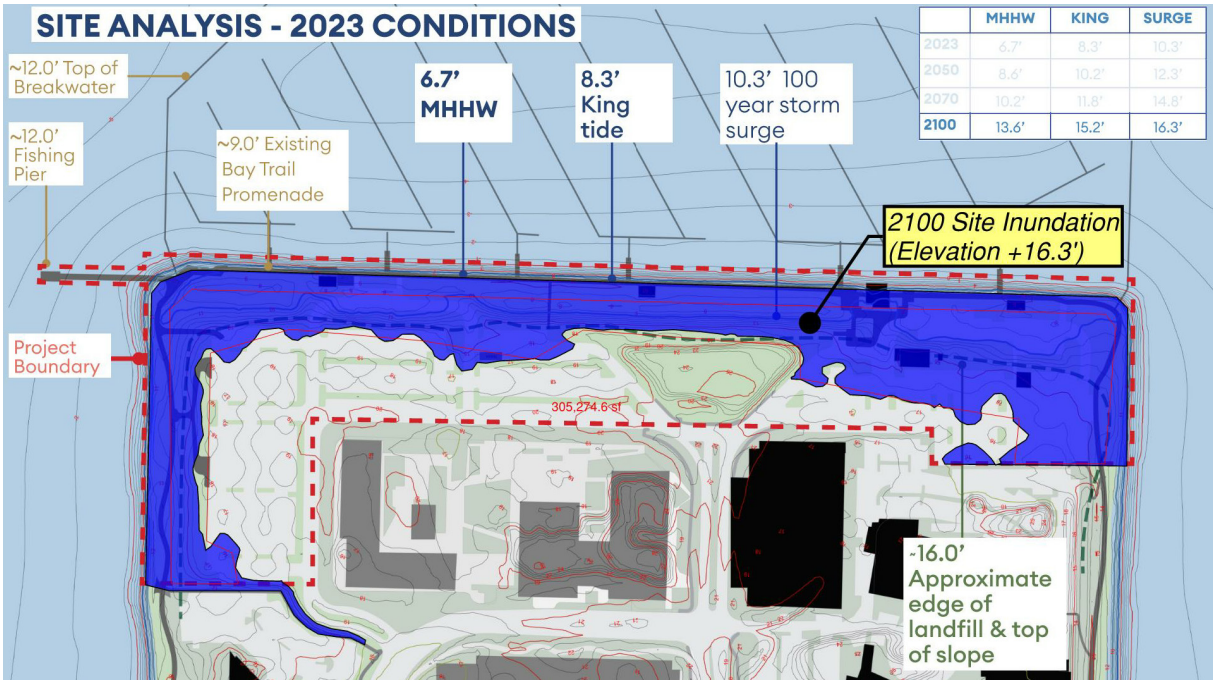
Marina

- **Piles:** Assuming the floating dock guide piles were replaced in 2030 or 2050, the piles should have a useful life to between years 2110 and 2150.
- **Floats:** Assuming the marina was replaced in 2080, the replacement marina will be approximately 20 years old. The concrete floats should have another 30 years of service life remaining.
- **Gangways:** Assuming the marina was replaced in 2080, the replacement gangways will be approximately 20 years old and should have 30 years of service life remaining. (Note that the report anticipated that the marina and piles were replaced in 2030 and 2080.)
- **Gangway Platforms:** Assuming that the gangway platforms were raised in 2070 to elevation +17 feet, the gangway platforms should have a useful life to 2150.

Landside

For the 2100 case, where the estimated storm surge elevation is +16.3 feet, all six structures will need to be raised to an elevation of +17.3 feet minimum. Raising the revetment from elevation +15.8 feet to elevation +17.3 feet and filling the area behind the revetment to an elevation of +17.3 feet and would require an estimated fill of 17,000 cy (Figure 5).

Figure 5
2100 Site Inundation Map



Landside Utilities

To be evaluated under separate cover by EKI.

Estimated Costs

Costs for replacement or modification are provided in Table 4 based on 2024 dollars.

Table 4
2100 Sea Level Rise Case Costs

Element Replaced/Modified	Cost
Breakwater	$0
Fishing Pier	$0
Navigational Piles	$0
Marina	$0
Landside	$3,600,000
Total	**$3,600,000**

Summary

In summary, the marina and piles, the fishing pier, and the breakwater will require replacement or modification as part of required asset management due to the aging of the materials. The required replacements will be designed to accommodate future sea levels.

The landside will require progressive investments over time to accommodate SLR and climate change.

Utility-related impacts will be discussed by EKI in their report.

Attachment 1
Cost Estimates

Table 1
Anchor QEA
PRELIMINARY COST PROJECTION

Client: City of Brisbane, CA
Project: Sierra Point Marina
Year 2030

Job No.:
Phase : Concept

Prepared By: CTM
Checked By :
1st Provided Date : 4/15/2024

Item #	Description	Qty	Units			Subcontract Cost Unit	Subcontract Cost Amount	TOTAL	
2	**Floating Docks**								**$ 30,700,000**
	Demolition								
	Docks	108500	sf			$ 20	$ 2,170,000	$ 2,170,000	
	Guide piles (Type 1)	467	ea.			$ 3,000	$ 1,401,000	$ 1,401,000	
	Gangways & Platforms	6	ls			$ 20,000	$ 120,000	$ 120,000	
	New Docks & Accessories								
	Fingers & Headwalks	108500	sf			$ 125	$ 13,562,500	$ 13,562,500	
	16" Guide piles	467	ea.			$ 15,000	$ 7,005,000	$ 7,005,000	
	Gangways								
	Standard Gangways (40')	5	ea.			$ 30,600	$ 153,000	$ 153,000	
	ADA Gangway (80')	1	ea.			$ 61,200	$ 61,200	$ 61,200	
	Pile-supported GW Platforms	6	ea.			$ 57,500	$ 345,000	$ 345,000	
	Dock Utilities								
	Electrical per boat, std	580	ea.			$ 6,000	$ 3,480,000	$ 3,480,000	
	Plumbing per boat, incl fire	580	ea.			$ 4,000	$ 2,320,000	$ 2,320,000	
	Sewage Pumpout Facility	1	ea.			$ 40,000	$ 40,000	$ 40,000	

Sub-Total		**$ 30,700,000**
Mobilization/Demobilization (Percent):	4	$ 1,228,000
Water Quality BMPs (Percent):	2.5	$ 767,500
Construction Sub-Total Total:		**$ 32,695,500**
General Contractor OH&P (Percent):	10	$ 3,269,550
Insurance and Bonding (Percent):	1.5	$ 490,433
Construction Total:		**$ 36,455,483**
Soft Costs (Percent):	6.5	$ 1,995,500
Project Total:		**$ 38,450,983**
Contingency (5% Design plus 15% construction):	20	$ 7,690,197
Project Total plus Contingency:		**$ 46,141,179**

Notes:

1. No Escelation in costs. Estimate is in 2024 Dollars.
2. Estimate is accurate within a plus or minimum 10% based on bidding climate at time of bid.
3. Soft costs: 9.5% design/permits: 6.5% construction related
   a. Design: 9%
   b. Permits and Inspection: 1.5%
   c. Construction Observations: 4%
   d. Testing: 1.5%
4. Cost estimate is based on drawings May 2023 Presentation.

This cost estimate is an opinion of construction cost made by the consultant. In providing opinions of construction cost, it is recognized that neither the Client nor the Consultant has control over the costs of labor, equipment, or materials, or over Contractor's methods of determining prices or bidding. This opinion of construction cost is based on the Consultant's reasonable professional judgement and experience and does not constitute a warranty, express or implied, that Contractors' bids or negotiated prices of the Work will not vary from the Client's budget or from any opinion of cost prepared by the Consultant.

Table 2

Anchor QEA

PRELIMINARY COST PROJECTION

Client: City of Brisbane, CA
Project: Sierra Point Marina
Year 2050

Job No.:
Phase : Concept

Prepared By: CTM
Checked By :
1st Provided Date : 4/15/2024

Item #	Description	Qty	Units			Subcontract Cost Unit	Subcontract Cost Amount	TOTAL	
1	**Breakwater**								**$ 4,400,000**
	Option #1: Extend the top of the Existing Breakwater and add Riprap at the toe								
	Demolition: Seawall barge mounted selective demolition of top of wall.	3170	LF			$ 300	$ 951,000	$ 951,000	
	Demolition: loading and hauling	600	LCY			$ 40	$ 24,000	$ 24,000	
	Demolition: Tipping Fees	1000	Tons			$ 100	$ 100,000	$ 100,000	
	Seawall Extension with concrete panels. North and East Sides	855	CY			$ 500	$ 427,521	$ 427,521	
	Seawall Extension with concrete panels. South Side	176	CY			$ 500	$ 87,780	$ 87,780	
	Riprap Placement at toe of Wall, 3`00 LF x 10'W x 5' high.	18400	Tons			$ 150	$ 2,760,000	$ 2,760,000	
	Option #2: Install New Steel Sheet Pile Wall on Bay Side of the existing Breakwater								
	New Steel Sheet Pile Wall PZ40. Add 5% for mobilization	3170	LF			$ 12,500	$ 39,625,000	$ 39,625,000	
	Option #3: Install New Concrete Sheet Pile Wall on Bay Side of the Existing Breakwater								
	Option #3 New Concrete Piles 16" Square. Add 5% for Mobilization	191000	VLF			$ 60	$ 11,460,000	$ 11,460,000	
3	**Landside Improvements**								**$ 3,800,000**
	Demolition								
	Demolition of Restrooms	1500	sf			$ 12	$ 18,000	$ 18,000	
	Demolition of Harbor Master's Office	2750	sf			$ 12	$ 33,000	$ 33,000	
	New Fill								
	Import of Fill 2050	30000	CY			$ 65	$ 1,950,000	$ 1,950,000	
	Buildings								
	2050 Construction of Restrooms 3 @ 500sf	1500	sf			$ 500	$ 750,000	$ 750,000	
	2050 Construciton of Harbor Master's Office	2750	sf			$ 350	$ 962,500	$ 962,500	
5	**Navigational Piles**								**$ 200,000**
	Demolition								
	Guide piles (Type 1)	7	ea.			$ 3,000	$ 21,000	$ 21,000	
	New Navigational Lights and Signage	7	ls			$ 1,200	$ 8,400	$ 8,400	
	New Docks & Accessories								
	New Navigational Lights and Signage	1	LS			$ 50,000	$ 50,000	$ 50,000	
	16" Guide piles	7	ea.			$ 15,000	$ 105,000	$ 105,000	

Option 1			
Sub-Total			**$ 8,400,000**
Mobilization/Demobilization (Percent):	4	$	336,000
Water Quality BMPs (Percent):	2.5	$	210,000
Construction Sub-Total Total:		**$**	**8,946,000**
General Contractor OH&P (Percent):	10	$	894,600
Insurance and Bonding (Percent):	1.5	$	134,190
Construction Total:		**$**	**9,974,790**
Soft Costs (Percent):	6.5	$	546,000
Project Total:		**$**	**10,520,790**
Contingency (5% Design plus 15% construction):	20	$	2,104,158
Project Total plus Contingency:		**$**	**12,624,948**

Option 2			
Sub-Total			**$ 43,625,000**
Mobilization/Demobilization (Percent):	4	$	1,745,000
Water Quality BMPs (Percent):	2.5	$	1,090,625
Construction Sub-Total Total:		**$**	**46,460,625**
General Contractor OH&P (Percent):	10	$	4,646,063
Insurance and Bonding (Percent):	1.5	$	696,909
Construction Total:		**$**	**51,803,597**
Soft Costs (Percent):	6.5	$	2,835,625
Project Total:		**$**	**54,639,222**
Contingency (5% Design plus 15% construction):	20	$	10,927,844
Project Total plus Contingency:		**$**	**65,567,066**

Option 3			
Sub-Total			**$ 15,460,000**
Mobilization/Demobilization (Percent):	4	$	618,400
Water Quality BMPs (Percent):	2.5	$	386,500
Construction Sub-Total Total:		**$**	**16,464,900**
General Contractor OH&P (Percent):	10	$	1,646,490
Insurance and Bonding (Percent):	1.5	$	246,974
Construction Total:		**$**	**18,358,364**
Soft Costs (Percent):	6.5	$	1,004,900
Project Total:		**$**	**19,363,264**
Contingency (5% Design plus 15% construction):	20	$	3,872,653
Project Total plus Contingency:		**$**	**23,235,916**

Notes:

1. No Escelation in costs. Estimate is in 2024 Dollars.
2. Estimate is accurate within a plus or minimum 10% based on bidding climate at time of bid.
3. Soft costs: 9.5% design/permits: 6.5% construction related
   a. Design: 9%
   b. Permits and Inspection: 1.5%
   c. Construction Observations: 4%
   d. Testing: 1.5%
4. Cost estimate is based on drawings May 2023 Presentation.

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Table 3
Anchor QEA
PRELIMINARY COST PROJECTION

Client: City of Brisbane, CA
Project: Sierra Point Marina
Year 2070
Job No.:
Phase : Concept
Prepared By: CTM
Checked By :
1st Provided Date : 4/15/2024

Item #	Description	Qty	Units			Subcontract Cost Unit	Subcontract Cost Amount	TOTAL	
2	**Floating Docks**								**$ 22,000,000**
	Demolition								
	Docks	108500	sf			$ 20	$ 2,170,000	$ 2,170,000	
	Guide piles (Type 1)		ea.			$ 3,000	$ -	$ -	
	Gangways & Platforms	6	ls			$ 20,000	$ 120,000	$ 120,000	
	New Docks & Accessories								
	Fingers & Headwalks	108500	sf			$ 125	$ 13,562,500	$ 13,562,500	
	16" Guide piles		ea.			$ 15,000	$ -	$ -	
	Gangways								
	Standard Gangways (40')	5	ea.			$ 30,600	$ 153,000	$ 153,000	
	ADA Gangway (80')	1	ea.			$ 61,200	$ 61,200	$ 61,200	
	Pile-supported GW Platforms		ea.			$ 57,500	$ -	$ -	
	Dock Utilities								
	Electrical per boat, std	580	ea.			$ 6,000	$ 3,480,000	$ 3,480,000	
	Plumbing per boat, incl fire	580	ea.			$ 4,000	$ 2,320,000	$ 2,320,000	
	Sewage Pumpout Facility	1	ea.			$ 40,000	$ 40,000	$ 40,000	
3	**Landside Improvements**								**$ 1,300,000**
	New Fill								
	Import of Fill 2070	20000	CY			$ 65	$ 1,300,000	$ 1,300,000	
4a	**Fishing Pier (Replacement)**								**$ 2,300,000**
	Demolition								
	Decking	2300	sf			$ 150	$ 345,000	$ 345,000	
	Guide piles (Type 1)	26	ea.			$ 3,000	$ 78,000	$ 78,000	
	Construction								
	Concrete Decking	2300	sf			$ 600	$ 1,380,000	$ 1,380,000	
	Concrete Pile Caps	20	cy			$ 1,248	$ 24,960	$ 24,960	
	16" Guide piles	26	ea.			$ 15,000	$ 390,000	$ 390,000	
4b	**Fishing Pier (Alternative)**								**$ 700,000**
	Demolition								
	Decking	2300	sf			$ 150	$ 345,000	$ 345,000	
	Gangways								
	Standard Gangways (40')	7	ea.			$ 30,600	$ 214,200	$ 214,200	
	Pile-supported GW Platforms	8	ea.			$ 12,500	$ 100,000	$ 100,000	

Sub-Total		**$ 25,600,000**
Mobilization/Demobilization (Percent):	4	$ 1,024,000
Water Quality BMPs (Percent):	2.5	$ 640,000
Construction Sub-Total Total:		**$ 27,264,000**
General Contractor OH&P (Percent):	10	$ 2,726,400
Insurance and Bonding (Percent):	1.5	$ 408,960
Construction Total:		**$ 30,399,360**
Soft Costs (Percent):	6.5	$ 1,664,000
Project Total:		**$ 32,063,360**
Contingency (5% Design plus 15% construction):	20	$ 6,412,672
Project Total plus Contingency:		**$ 38,476,032**

Notes:

1. No Escelation in costs. Estimate is in 2024 Dollars.
2. Estimate is accurate within a plus or minimum 10% based on bidding climate at time of bid.
3. Soft costs: 9.5% design/permits: 6.5% construction related
   a. Design: 9%
   b. Permits and Inspection: 1.5%
   c. Construction Observations: 4%
   d. Testing: 1.5%
4. Cost estimate is based on drawings May 2023 Presentation.

This cost estimate is an opinion of construction cost made by the consultant. In providing opinions of construction cost, it is recognized that neither the Client nor the Consultant has control over the costs of labor, equipment, or materials, or over Contractor's methods of determining prices or bidding. This opinion of construction cost is based on the Consultant's reasonable professional judgement and experience and does not constitute a warranty, express or implied, that Contractors' bids or negotiated prices of the Work will not vary from the Client's budget or from any opinion of cost prepared by the Consultant.

Table 4
Anchor QEA
PRELIMINARY COST PROJECTION

Client: City of Brisbane, CA
Project: Sierra Point Marina
Year 2100

Job No.:
Phase : Concept

Prepared By: CTM
Checked By :
1st Provided Date : 4/15/2024

Item #	Description	Qty	Units			Subcontract Cost Unit	Subcontract Cost Amount	TOTAL	
3	**Landside Improvements**								**$ 2,400,000**
	Demolition								
	Demolition of Yatch Club	2650	sf			$ 12	$ 31,800	$ 31,800	
	Demolition of Yatch Club Storage Facility	1000	sf			$ 12	$ 12,000	$ 12,000	
	New Fill								
	Import of Fill 2100	17000	CY			$ 65	$ 1,105,000	$ 1,105,000	
	Buildings								
	2100 Construciton of Yatch Club	2650	sf			$ 400	$ 1,060,000	$ 1,060,000	
	2100 Construction of Yatch Club Storage Facility	1000	sf			$ 150	$ 150,000	$ 150,000	

Sub-Total		**$ 2,400,000**
Mobilization/Demobilization (Percent):	4	$ 96,000
Water Quality BMPs (Percent):	2.5	$ 60,000
Construction Sub-Total Total:		**$ 2,556,000**
General Contractor OH&P (Percent):	10	$ 255,600
Insurance and Bonding (Percent):	1.5	$ 38,340
Construction Total:		**$ 2,849,940**
Soft Costs (Percent):	6.5	$ 156,000
Project Total:		**$ 3,005,940**
Contingency (5% Design plus 15% construction):	20	$ 601,188
Project Total plus Contingency:		**$ 3,607,128**

Notes:

1. No Escelation in costs. Estimate is in 2024 Dollars.
2. Estimate is accurate within a plus or minimum 10% based on bidding climate at time of bid.
3. Soft costs: 9.5% design/permits: 6.5% construction related
   a. Design: 9%
   b. Permits and Inspection: 1.5%
   c. Construction Observations: 4%
   d. Testing: 1.5%
4. Cost estimate is based on drawings May 2023 Presentation.

This cost estimate is an opinion of construction cost made by the consultant. In providing opinions of construction cost, it is recognized that neither the Client nor the Consultant has control over the costs of labor, equipment, or materials, or over Contractor's methods of determining prices or bidding. This opinion of construction cost is based on the Consultant's reasonable professional judgement and experience and does not constitute a warranty, express or implied, that Contractors' bids or negotiated prices of the Work will not vary from the Client's budget or from any opinion of cost prepared by the Consultant.

File Attachments for Item:

O. Countywide Assignments and Subcommittee Reports