

## Chapter 8. Parks and Recreation Areas

Parks and recreation areas in the ART project area provide a wide variety of services to the public. Resources and activities at these sites include scenic views; walking, running, and biking on paths and trails; nature viewing; interpretive displays; educational facilities and activities; swimming; paddleboating; sailboarding; motorboating; picnicking; playgrounds; family/group event areas and facilities; dog recreation; historic or cultural activities; team sports; and golf.

Parks and recreational areas in the ART project area serve users at three scales:

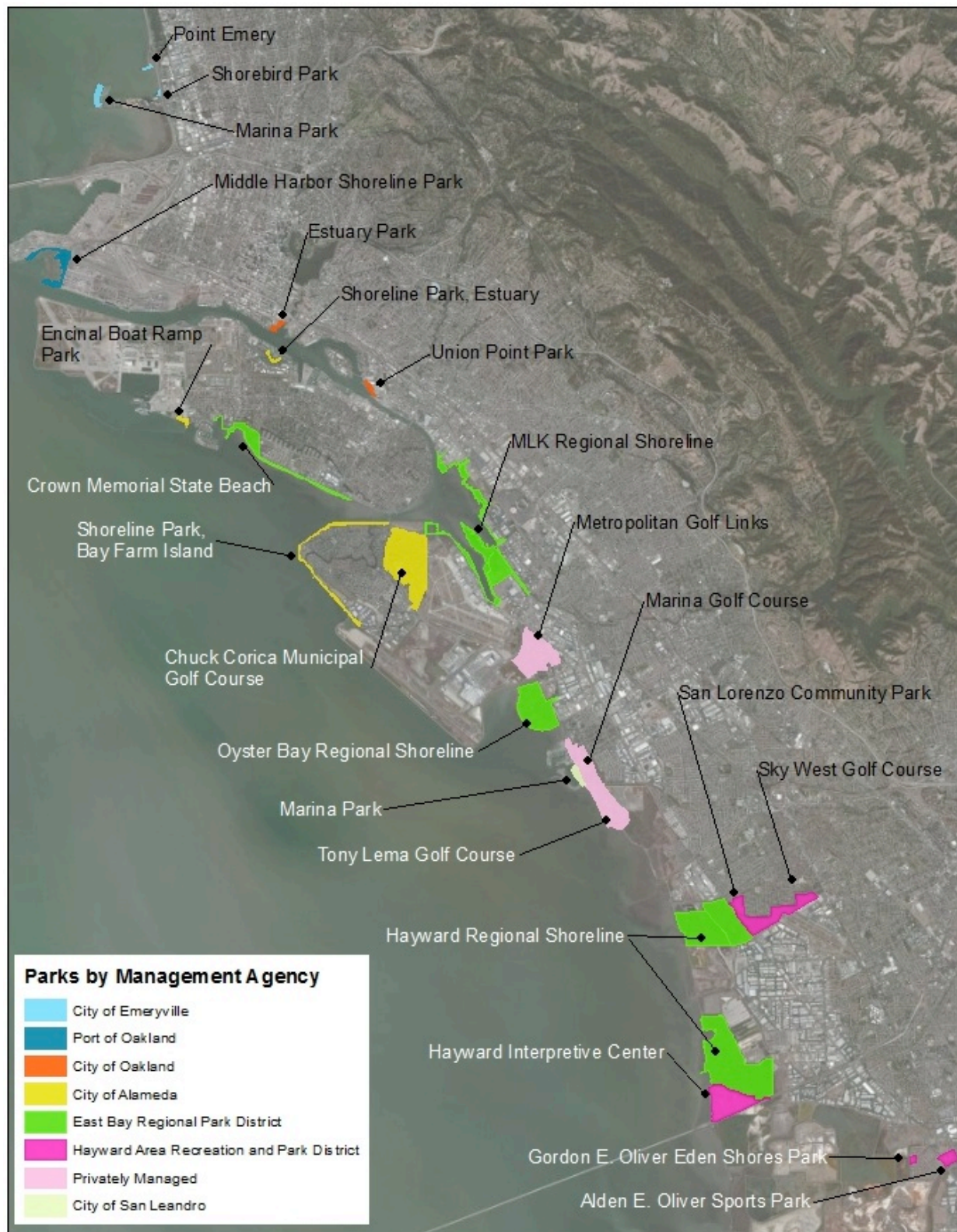
- Regional shoreline areas that attract visitors from the entire Bay Area and beyond;
- Parks or community centers that provide event and sports facilities used primarily by Alameda County residents; and,
- Small shoreline parks that serve a surrounding community or neighborhood.

This section focuses on the vulnerability and risk to 18 parks, 5 golf courses (Figure 1) and the San Francisco Bay Trail in the project area from sea level rise impacts. These sites are representative of the different recreation services and scales of use in the subregion, but are not all-inclusive of parks and recreation areas within the project area. In particular, only a few of the subregion's numerous neighborhood parks are addressed here.

### Exposure

Exposure is the extent to which an asset, in this case a park or golf course, experiences a specific climate impact such as storm event flooding, tidal inundation, or elevated groundwater. The exposure of parks and recreation assets in the ART project area to two sea level rise projections and three Bay water levels was evaluated. The two sea level rise projections, 16 inches (40 cm), and 55 inches (140 cm), correlate approximately to mid- and end-of-century. These two sea level rise scenarios were coupled with three Bay water levels: the new daily high tide, measured as mean higher high water (MHHW), the new 100-year extreme water level, also known as the 100-year stillwater elevation, and the 100-year extreme water level coupled with wind waves, hereafter "storm event with wind waves," or "wind waves." These water levels were selected because they represent a reasonable range of potential Bay conditions that will affect flooding and inundation along the shoreline. For each exposed facility, the average depth of inundation from the daily high tide and storm events was calculated. Whether a facility is exposed to wind waves was evaluated as a simple binary – yes or no. For more information about sea level rise projections and Bay water levels evaluated see Chapters 1 and 2.

For each park and golf course, the extent exposed to each sea level rise projection and Bay water level was determined (see Appendix C). For many of the parks, the total park acreage includes submerged areas. To avoid a gross misrepresentation of the exposure percentages, the analysis was based on the land area of the park. This land area, or footprint, was visually determined and digitized in GIS using aerial imagery in combination with maps that show park boundaries. Therefore the footprint values in Table 1 are approximations, as are the calculated exposure percentages.

**Figure 1.** Park and recreation areas in the ART project area.

Parks with more than 25% of their footprint directly affected by a sea level rise scenario are considered significantly exposed. The selection of this threshold was based on exposure of specific amenities such as trails, buildings, restrooms, picnic tables and other amenities within each park. For most parks, inundation or flooding exposure greater than 25% coincides with exposure of most park amenities. Exceptions to this are noted in the discussion below.

It is important to note that the approach used for the exposure mapping is not appropriate for a dynamic system like a beach. For beaches at Crown Memorial State Beach and Point Emery the analysis relies on the best professional judgment of the park managers about the likely exposure to future sea level rise (based on past events and current situation).

#### Daily high tide inundation

With 16 inches of sea level rise, Hayward Regional Shoreline and the Chuck Corica Golf Course (on Bay Farm Island in Alameda) would be exposed to inundation by the new daily high tide (Column A in Table 1). A large portion of Martin Luther King Jr. Regional Shoreline would also be subject to tidal inundation with 16 inches of sea level rise, but the area exposed is primarily salt marsh habitat and does not include built recreation amenities. Eight parks and two golf courses are significantly exposed to new daily high tides with 55 inches of sea level rise (Column D in Table 1). As sea level rises, exposure to the new high tide could result in a slow yet chronic degradation of assets that cannot accommodate or adjust to new conditions.

#### Storm event flooding and exposure to wind waves

Seven parks and two golf courses would be exposed to storm event flooding with 16 inches of sea level rise. At Crown Memorial State Beach, with less than 20% of the park footprint exposed to storm flooding, critical amenities including the majority of picnic areas and two restrooms would likely be affected (Column B in Table 1). With 55 inches of sea level rise, all but two parks and three golf courses are significantly exposed to storm event flooding. (Column E in Table 1)

In tandem with the extreme water, during storm events there is a greater likelihood of wind waves that can lead to overtopping and erosion of the shoreline and shore protection. During storm events that generate wind waves, areas exposed to the 100-year storm flooding (i.e., Columns B and E in Table 1) would also be exposed to greater flooding depths due to wind waves in these areas. This is because wind-driven waves can elevate Bay water levels significantly, causing overtopping of shore protection by one-half to more than three feet. However, as the wind waves travel inland they tend to dissipate and the additional wind wave-caused flood depths will decrease.

Assets exposed only to wind waves, and not to storm event flooding, could potentially be exposed to shallow flood depths for short durations. With 16 inches of sea level rise, the additional land area exposed to only wind waves is significant for eight parks in the ART project area (Column C in Table 1). With 55 inches of sea level rise, no additional assets are significantly exposed to wind waves only; that is, areas exposed to wind waves are already exposed to 100-year storm flooding.

**Table 1.** Exposure of parks and recreation areas in the ART project area to sea level rise impacts. All facilities exposed to storm event flooding are also within the wind wave zone; the percent in columns C. and F. are exposed *only* to wind waves.

		16" SLR			55" SLR		
		Daily High Tide	Storm event		Daily High Tide	Storm event	
Parks and Recreation Areas (Listed from North to South in the project area)	Total Land Acres*	% exposed	% exposed	% exposed to wind waves only	% exposed	% exposed	% exposed to wind waves only
1. Point Emery	1.4	6	20	46	36	67	31
2. Shorebird Park	1.1	3	11	14	16	25	47
3. Marina Park, Emeryville	13.2	1	12	34	22	48	38
4. Middle Harbor Shoreline Park (Port View Park)	44.8	1	4	32	6	34	35
5. Estuary Park & Aquatic Ctr	7.2	2	81	17	93	98	0
6. Shoreline Park, Estuary	3.8	2	9	74	19	81	15
7. Union Point Park	6.7	0	1	64	2	60	30
8. Encinal Boat Ramp Park	7.1	3	10	88	12	98	1
9. Crown Memorial Beach	80.1	0	19	50	29	67	21
10. Chuck Corica Municipal Golf Course	314.1	95	98	2	99	100	0
11. Shoreline Park, Bay-Farm Island	38.4	4	19	62	25	76	23
12. Martin Luther King, Jr. Reg. Shoreline	217	42	62	31	77	93	7
13. Metropolitan Golf Links	172.7	0	1	26	13	28	22
14. Oyster Bay Reg. Shoreline	186.8	1	1	2	2	3	6
15. Marina Park, San Leandro	18.8	2	5	68	15	77	13
16. Marina Golf Course	94.5	0	55	32	62	89	10
17. Tony Lema Golf Course	128.8	1	12	15	14	29	19
18. Hayward Reg. Shoreline	791.4	69	96	4	99	100	0
19. San Lorenzo Park	24.3	0	92	7	96	100	0
20. Skywest Golf Course	123.1	0	12	13	15	25	9
21. Hayward Shoreline Interpretive Center	144.7	7	99	1	100	100	0
22. Gordon E. Oliver Eden Shores Park of Hayward	5.6	0	49	51	80	100	0
23. Alden E. Oliver Sports Park of Hayward	26.5	0	0	100	90	100	0
24. San Francisco Bay Trail	Total	105**	3	21	35	32	16
	Class I	80**	2	24	31	33	14
	Class II	24**	4	24	50	29	19

\* Acreage does not include portions of the parks that are submerged, therefore acreages listed in this table do not match the total site acreages for many of the parks and golf courses.

\*\* Class I trails are physically separated from streets and roadways. Class II trails are on-street.

## Sensitivity and Adaptive Capacity

The sensitivity and adaptive capacity of park and recreation assets in the ART project area was assessed for three potential climate impacts that could occur due to sea level rise and storm events. The three climate impacts considered are:

- More frequent or longer duration flooding during storm events
- Permanent or frequent inundation by the daily high tide
- Elevated groundwater levels and saltwater intrusion

Sensitivity is the degree to which an asset or entire system would be physically or functionally impaired if exposed to a climate impact, and adaptive capacity is the ability for an asset or system to accommodate or adjust to a climate impact and maintain or quickly resume its primary function. The sensitivity and adaptive capacity was evaluated for both specific facilities (e.g., a boat launch, an interpretive center, etc.) and universal features such as parking lots, access pathways, and bathrooms.

### Recreational Activities

#### ***Walking, Running, Hiking and Biking***

The designated portions of the Bay Trail along the shoreline provide most of the walking, running, hiking and biking opportunities in the project area. The Bay Trail is also an important commute corridor that provides safe access to jobs and schools for bicyclists. Within most parks, short access paths connect different recreation amenities (e.g., parking lots, restrooms, lawn areas, launch docks, etc). Oyster Bay Regional Shoreline also has long paths that are not part of the Bay Trail.

The sensitivity of trails and paths to tidal inundation, storm flooding, and elevated groundwater varies depending on the trail elevations and locations (e.g., alignment on a levee, in a low-lying area, or along a road), construction materials (e.g., paved, gravel, dirt, etc), connectivity to other trails and transportation routes, and existing conditions. Laura Thompson, Bay Trail Project Manager, notes that the Bay Trail is currently affected by flooding and extreme weather events. For example, a trail segment along a levee in San Leandro was damaged by storm flooding a few years ago and was closed for a period of time for repairs. More frequent storm flooding and/or daily high tide inundation would cause more trail closures and leave lasting damage to trail surfaces and levees. Specifically, pooling can occur on the trails when water overtops the trail or groundwater seeps up through the trail surface. Some trail users might still be able to use a portion of trail that has been compromised by flooding, but this depends on the specific circumstances of the flooding and the user. Factors such as mud and debris, or ponding around a trail in an area where drainage is poor could prevent even the most intrepid pedestrian or biker from passing through. Furthermore, minor pooling or damage to trail surfaces can make segments impassable for persons with limited mobility and trail users in wheelchairs.

The adaptive capacity of trails varies within the project area. Along developed areas of the shoreline in the northern portion of the project area, alternative routes on streets may be available to allow trail users to bypass closed Bay Trail segments. These alternative routes will usually be less safe and less likely to provide a quality recreational experience than the designated Bay Trail, which consists primarily of Class I (off-street, multi-use) trails within the project area. Furthermore, alternative on-street routes might also be unusable due to flooding impacts. Bay Trail segments and other trails through the southern portion of the study area between San Leandro and Highway 92 have relatively few access points and are far removed from parallel transportation routes. Damage to the trails along this stretch of shoreline would



likely necessitate closing large segments of the trail system. Closures such as these will reduce access to nature and wildlife viewing and interpretive signage along the Hayward shoreline. Similarly, impacts to the Bay Trail segments within Martin Luther King Jr. Regional Shoreline would limit these opportunities around San Leandro Bay and Arrowhead Marsh.

The trail segments within regional parks managed by the East Bay Regional Park District and Hayward Area Recreation and Park District could benefit from these agencies' organized park management and their ability to enlist volunteer support for trail cleanup and restoration, which contribute to adaptive capacity. In general, however, the close proximity of recreational trails to the shoreline, and their combined high sensitivity and low capacity to accommodate or adjust to flooding and other impacts make walking, hiking, running and biking activities in the project area very vulnerable to sea level rise.

### ***Passive Recreation and Family and Group Gatherings***

Facilities for passive recreation and family and group activities include picnic tables, barbeques, playgrounds, lawn areas, and event space or facilities for rent. Of the 18 parks assessed in the ART project, twelve have picnic tables and barbeque grills, lawn areas and/or playgrounds (Table 2). Within each of these parks, exposure of these amenities to sea level rise and storm events is closely correlated to the overall exposure of the park's total land acreage shown in Table 1. Among this subset, Estuary Park, Martin Luther King Jr. Regional Shoreline, Gordon E. Oliver Eden Shores Park, and San Lorenzo Park are likely to experience significant flooding of these amenities during a storm event with 16 inches of sea level rise. While this represents relatively few of the parks in the project area, all four are heavily used for passive recreation and family and group events, and the loss of these services could increase demands on other nearby parks that might not be able to accommodate more use. It is likely that parks that already experience flooding issues due to poor drainage, such as San Lorenzo Park, will experience more frequent flooding with much less than 16 inches of sea level rise.

**Table 2.** Passive Recreation Facilities (Parks with higher vulnerability are indicated in orange)

Park	Picnic	Lawn	Playground
Marina Park (Emeryville)	*		
Middle Harbor Shoreline Park	*	*	
Estuary Park		*	
Union Point Park	*	*	*
Crown Memorial State Beach	*	*	
Shoreline Park (Bay Farm Is.)	*	*	
Martin Luther King Jr. Reg. Sh.	*		
Oyster Bay Regional Shoreline	*		
Marina Park (San Leandro)	*	*	*
San Lorenzo Park	*	*	*
Gordon E Oliver Eden Shores Park	*	*	*
Alden E. Oliver Sports Park	*		*

Picnic tables and playgrounds are not likely to be sensitive to occasional flooding and could be used by most visitors as soon as the water recedes. However, persons with limited mobility and wheelchair users are sensitive to minor impacts (e.g., muddy conditions, ponding on trails and in gathering areas), and therefore these facilities may be inaccessible to them for longer periods after flooding events. Lawns and other planted areas are likely to suffer damage from exposure to salt water and will require time to recover or re-vegetate. With repeated Bay flooding, lawn areas and other non-salt tolerant plantings would probably not survive. Managers do not have many options for relocating lawn areas because space at most parks is limited. Despite some of these challenges, passive recreation activities in the project area would be only moderately vulnerable to sea level rise impacts because the amenities that support these activities are

present throughout the park system and, in many cases, resilient to impacts and/or usable when partially impaired.

Space or facilities that can be reserved or rented for gatherings (e.g., classes, weddings, meetings, and parties) are more vulnerable to climate impacts. These facilities are in high demand and, for some parks, provide important revenues. Indoor event spaces located at Estuary Park (Aquatic Center), Martin Luther King Jr. Regional Shoreline, San Lorenzo Park and the Hayward Shoreline Interpretive Center are available for groups to reserve and/or rent. All are likely to be exposed to storm flooding with 16 and 55 inches of sea level rise. This type of flooding would be unlikely to affect the structural integrity of the facilities, but it could cause damage (e.g., water damage to floors) that would make these facilities less desirable or unusable for events. Site managers may be able to take temporary measures to prevent and/or recover from damage (e.g., laying out sandbags or pumping out flood water), which would enable them to avoid or minimize the effects of occasional flooding.

### *Sports Facilities*

Team or field sports facilities include artificial turf and grass playing fields, as well as basketball and tennis courts. In the northern portion of the ART project area a few of the parks have or are adjacent to grass sports fields. Estuary Park has a grass soccer field, and Encinal Boat Ramp Park, Crown Memorial State Beach and Martin Luther King Jr Regional Shoreline are connected recreation areas with grass playing fields and tennis courts. Major sports facilities are clustered at the southern end of the project area at San Lorenzo Park, Gordon E. Oliver Eden Shores Park and Alden E. Oliver Sports Park under the management of the Hayward Area Recreation and Park District (HARD). Managers at HARD have identified poor drainage as an existing cause of flooding during periods of heavy rains. All three parks drain into adjacent marshes or waterways that will have elevated flood levels during storm events with 16 inches of sea level rise. Already, baseball fields at San Lorenzo Park flood when it rains. If grass sports fields are exposed to more frequent flooding, managers will be forced to temporarily close the fields and sports courts while the water drains. At San Lorenzo and Alden Sports Parks, closures would reduce revenues that help support the costs of park maintenance.

With 16 inches of sea level rise, wind waves are likely to overtop flood protection and levees during big storm events, leading to saltwater exposures in these parks as well as the fields along the Alameda and Oakland shorelines, which would cause lasting damage to grass soccer and baseball fields. Under this scenario, the project area could be left with few undamaged soccer or baseball fields. Artificial turf fields and basketball and tennis courts are more resistant to salt water damage, but they might be unusable immediately after storm events due to temporary flooding. All of these impacts would lead to more closures and maintenance and repair costs.

Exposure to sea level rise impacts varies dramatically at the five golf courses located in the ART project area. By mid-century, Chuck Corica Golf Course on Bay Farm Island in Alameda could be completely inundated by daily high tide, and over half of the Marina Golf Course (part of the Monarch Bay Golf Complex) in San Leandro could be affected by storm event flooding. In contrast, Metropolitan Golf Links, Tony Lema Golf Course and the Skywest Golf Course are minimally exposed (in acreage percentage) to climate impacts with 16 inches of sea level rise. At 55 inches of sea level rise, storm events are likely to cause significant flooding and exposure to wind waves in these three golf courses. However, substantial portions of each golf course (i.e., greater than 70% of the course footprint) may be unaffected even with end of century sea level rise, offering opportunities to reconfigure the courses to maintain these golfing resources.

Golf courses could be especially sensitive to sea level rise impacts, even at low levels of exposure. Grass that is exposed to saltwater even briefly (e.g., due to storm driven wind waves) may be damaged, requiring significant time and maintenance resources to return the course to a

suitable playing standard. Even if managers can avoid shutting the entire course by closing only the portion(s) under repair, the course may be much less desirable and lose clients. Golfing opportunities for persons with limited mobility will be especially vulnerable because these visitors will have more difficulty using impaired facilities. Furthermore, Marina Golf Course, the only fully accessible par course in the project area, would be significantly affected by storm flooding with 16 inches of sea level rise.

Existing stressors on some of the golf courses are likely to make them more sensitive to sea level rise and storm event impacts within a shorter timeframe. For example, managers currently must close portions of the Skywest course during rainy weather because of flooding caused by poor drainage. Any increase in Bay water levels would exacerbate this issue, leading to more frequent closures, higher maintenance and repair costs, and lost revenues. Most golf courses are expected to be revenue generators, but both Chuck Corica and Skywest golf courses have had operating losses in recent years. The exposure analysis does not address salinity intrusion into groundwater supplies, but these are also likely to affect golf courses (such as the Skywest course) that are irrigated with groundwater pumped on site. Higher groundwater levels could compromise underground irrigation systems, especially valves and controllers.

Overall, existing problems such as poor drainage, as well as high sensitivity of grass turf and other non-salt tolerant plants to salt water exposure suggest that opportunities in the ART project area for certain team sports (i.e., soccer and baseball) and golfing will be highly vulnerable to sea level rise and storm events. Moreover the shrubs and trees that help create the character of these shoreline places may be compromised, affecting the aesthetic qualities that attract the public to the shoreline.

### *Nature and Wildlife Viewing*

The most notable sites for nature and wildlife viewing in the project area are tidal marshes at Elsie Roemer Bird Sanctuary and Crab Cove (at Crown Memorial State Beach), Arrowhead Marsh (at Martin Luther King Jr. Regional Shoreline), Hayward Regional Shoreline and Hayward Shoreline Interpretive Center. At their current elevations, these sites would be exposed to a sea level rise of 16 inches. Sediment accretion in some of the marshes might increase the marsh elevation at a rate commensurate with sea level rise. This outcome depends on current marsh elevation and future availability of sediment. If accretion cannot keep up with the rate of sea level rise, high- and mid-marsh habitats will likely be replaced by low-marsh, mudflats, and sub-tidal areas by the end of the century (Stralberg et al. 2011). This would result in population declines of marsh birds such as Song Sparrows and Marsh Wrens that are of interest to birdwatchers (Veloz et al. 2012). In the meantime, these marshes are likely to remain valuable habitat for shorebirds, and, as such, popular destinations for wildlife enthusiasts.

At Elsie Roemer, Crab Cove and Arrowhead Marsh, which have areas directly subject to tidal action, the types of species that can be seen and the amount of time that they are present will change as the sites experience longer periods of inundation each day. Even in marshes that successfully keep up with sea level rise, the quality of wildlife viewing opportunities may decline as repeated flooding reduces the resilience of these habitats to changes, such as invasive species and erosion.

Although sea level rise and storm events will have direct impacts on inter-tidal habitats, nature and wildlife viewing will be more acutely impaired by sea level rise impacts to the Bay Trail and, in some locations, parking areas. In particular, damage to levee trails that offer some of the best nature and wildlife viewing in the project area will reduce these opportunities for persons with limited mobility. Additionally, higher tides that drown mudflats and marshes or squeeze buffer areas between trails and habitats could cause wildlife to abandon some areas altogether, which would be another indirect effect of sea level rise on wildlife viewing opportunities.



### *Interpretive and Educational Activities*

Parks in the ART project area showcase the natural, historic and cultural resources of the East Bay shoreline. Crab Cove Visitor Center at Crown Memorial State Beach and the Hayward Shoreline Interpretive Center attract thousands of visitors every year for interpretive and educational programs. Neither of these centers is likely to experience significant damage due to storm flooding or daily high tide inundation with 16 inches of sea level rise. However, implementing measures to prevent flood damage (e.g., sandbags) and recover from minor flooding impacts (e.g., water damage to floors) would increase management and maintenance costs and cause unplanned closures. The value of these two centers as interpretive and educational resources is closely linked to their surrounding natural features. Sea level rise impacts that change characteristics of the tidal zone at Crab Cove and the marshes in Hayward, and which limit access to these areas, will directly affect programs that are hosted at these facilities. For example, longer-lasting daily inundation at Crab Cove will limit the availability of a wheelchair-accessible ramp that is used by school groups and members of the public to explore tidepools at low tide. Managers of these facilities have opportunities to adapt interpretive and educational programs to reflect the changing natural resources.

Many of the parks in the project area, such as Hayward Regional Shoreline, have interpretive signage along trails. In contrast with the two interpretive centers discussed above, the sensitivity and adaptive capacity of existing signage is less relevant for understanding how interpretive and educational services are vulnerable to sea level rise and storm events because this signage will need replacing well before mid-century. Again, managers have sufficient opportunity to adapt signage content and placement to changing conditions. Interpretive and educational services in the project area may even benefit from changes associated with sea level rise that offer new ways to capture the interests of and engage with park visitors.

### *Water Sports Access and Facilities*

Public access onto the water for swimming, sailboarding (e.g., windsurfing and kitesurfing), paddleboating (e.g., kayaking, paddleboarding, sculling, outrigger canoeing) or motor boating is available at seven of the parks in the project area (Table 3).

**Table 3.** Water Sports Facilities (Parks with higher vulnerability are indicated in orange)

Park	Swimming	Paddle-boating	Sail-boarding	Motor boating
Point Emery	*	*	*	
Marina Park (Emeryville)		*	*	*
Middle Harbor Shoreline Park		*		
Estuary Park		*		
Encinal Boat Ramp Park		*		*
Crown Memorial State Beach	*	*	*	
Martin Luther King Jr. Reg. Sh.		*		*

Beaches at Point Emery and Crown Memorial State Beach offer opportunities for swimming and wading in the Bay. As noted previously, the exposure mapping approach used in this assessment is not appropriate for dynamic systems such as beaches. Based on the best professional judgment of managers familiar with these parks, both of these sites are likely to be exposed to mid-century high tide inundation and storm event flooding that would erode these beaches. Point Emery is already eroding rapidly and would require significant and expensive shoreline protection improvements to maintain the park's current size. Even with these measures, the beach cannot be maintained with sea level rise.

According to park managers, Crown Memorial State Beach is also eroding, and requires re-nourishment periodically to maintain this very popular beach. (The next re-nourishment is

planned for 2013-2014.) This management practice affords the park some capacity to address sea level rise impacts to the beach because the responsible agencies (i.e., the park manager, East Bay Regional Park District and the two owners, the City of Alameda and California State Parks) have experience with beach nourishment as a management practice at the site. However, the park may be at a disadvantage for receiving immediate attention after a storm event that causes widespread damage because the District does not own the site and might have to give priority to other parks that it owns and manages. At some point it is likely that storm erosion will occur so frequently that costs for re-nourishment become prohibitive. Loss of this unique beach access and the recreational opportunities at Crown Memorial park would be a significant to the Alameda community and the entire Bay Area.

Sailboarding and swimming opportunities in the project area are similarly sensitive to mid-century sea level rise impacts. Point Emery, Marina Park in Emeryville and Crown Memorial State Beach are popular sites for sailboarding due to their uniquely favorable wind conditions and access onto the Bay. As discussed above, the beaches at Point Emery and Crown Memorial from which the sailboarders launch are quite vulnerable to erosion with sea level rise. Impacts that reduce the number of days when visitors can sailboard and paddleboard at Crown Memorial State Beach would also hurt revenues of the rental concession at this site.

The stairs used to launch sailboards at Marina Park are less exposed and sensitive to mid-century flooding than the beaches. However, this location is much less desirable for launching and sailing and, unlike the beaches, can only accommodate one user at a time. Other parks north of the project area offer launch sites for sailboarding that, if resilient to sea level rise impacts, could accommodate some displaced users, but they too might be impaired by storm events. In general, efforts to recover (i.e., to re-open a site) after a flooding event, and plan for ways to extend the “usable life” of these sites for sailboarding will benefit from having an engaged and well-organized user group.

Access onto the Bay for kayaks and similar types of paddleboats is possible in at least six parks. High tide inundation and storm event flooding at mid-century will reduce paddleboating opportunities along this stretch of shoreline. In general, kayakers have the most flexibility among water sports enthusiasts in terms of capacity to use multiple types of launches, boat in various conditions and make use of launch sites that have been partially impaired. However, this is not true for persons with limited mobility or disabilities, who can only safely launch at a site that has been designed to accommodate their needs and is in good functioning condition (including access to the launch itself). Currently the Tidewater Boathouse at the Martin Luther King Jr. Regional Shoreline is the only location with an accessible launch. Other sites such as Crown Memorial State Beach, Estuary Park and additional locations in Martin Luther King Jr. Regional Shoreline provide relatively easy and safe access for launching onto the Bay in a kayak or similar type of paddleboat.

Only two locations, Estuary Park in the Oakland Estuary and Martin Luther King Jr. Regional Shoreline in San Leandro Bay, offer suitably calm conditions and the appropriate launch facilities needed for team rowing, or sculling. Both of these locations are likely to be exposed to storm flooding with 16 inches of sea level rise. The relatively new launch ramps, docks, and boathouse facilities at both sites are designed to accommodate higher tides and are constructed with resistant materials that will help prevent damage and allow the sites to recover quickly from flooding. During a recovery period, the two boating facilities may also benefit from their user groups – rowing teams that rely on the facilities for training – that would presumably have a strong interest in maintaining and restoring functions of the facilities.

Three of the parks addressed in the ART project area have public ramps for launching motorboats: Marina Park in Emeryville, Encinal Boat Ramp Park, and Martin Luther King Jr. Regional Shoreline. Higher daily high tides and flooding from storm events and wind waves

are not likely to cause lasting damage to boat ramps because they are constructed to withstand exposure to Bay water. However, the length and slope of a launch ramp are designed specifically to allow for launching boats that are towed by a vehicle (without causing damage to the boat or vehicle). Depending on the design of the ramp and the site conditions, higher tides that cause longer periods of inundation could decrease the amount of time that the ramp is usable each day. The other public ramps in the project area likely face similar vulnerabilities due to sea level rise.

### ***Fishing***

Recreational fishing is allowed in the Bay with a fishing license from the California Department of Fish and Game. Popular fishing spots at seven fishing piers are found between Emeryville and San Leandro (though not all of these are located within parks). Fishing piers in Shorebird and Marina Parks in Emeryville and Middle Harbor Shoreline Park are unlikely to be exposed to tidal inundation or storm event flooding with 16 inches of sea level rise. In contrast, a loss of access and/or damage to fishing piers in Martin Luther King Jr. Regional Shoreline may occur due to storm event flooding by mid-century.

Depending on the communities that use the piers, the implications of losing access to specific piers will vary. For example, subsistence fishers might rely on having access to one or more piers in the project area and loss of these sites would significantly affect the wellbeing of these users. The project area may have some capacity to accommodate impacts to the fishing piers because fishers can seek out other access points; most parks in the project area allow fishing from the shoreline. Fishing in the ART project area is most likely to be affected by sea level rise impacts to the Bay Trail (which provides access to the shoreline and Bay for fishing) and water quality (e.g., due to sewage spills during periods of high tide and flooding).

### ***Dog Recreation***

Space for dog recreation is in high demand throughout the Bay Area. Of the parks assessed in the ART project, only Marina Park (in San Leandro) and San Lorenzo Park have fenced dog exercise areas; there are two additional dog parks on Alameda Island near Crown Memorial State Beach that are not addressed here. Most parks in the project area allow dogs on leash, with the exceptions of Point Emery, the beach at Crown Memorial, and the area south of Winton Avenue in the Hayward Regional Shoreline, where dogs are prohibited. Loss of designated dog exercise areas could lead to more violations of rules concerning dogs (e.g., leash laws and policies prohibiting dogs) in other park and recreation areas, and crowding in areas where dogs are allowed.

### ***Restrooms***

The ART project exposure analysis shows that with 16 inches of sea level rise, storm event flooding will likely affect half of the approximately 30 restrooms in the parks addressed in this chapter not including restrooms at golf courses. Flooding will lead to more frequent closures and additional repair costs for managing agencies. A few of the parks have portable toilet facilities. Flooding of these types of restrooms could harm water quality by releasing chemicals and human waste into the surrounding environment. Lack of restrooms could be an inconvenience for some visitors, and could deter others from visiting a park at all.

### ***Parking***

Many, if not most, visitors travel by car to the parks in the project area. Parking is essential to their ability to access the various recreation services and amenities provided. With 16 inches of sea level rise, a storm event would cause flooding in parking lots in more than a third of the parks: Marina Park (Emeryville), Crown Memorial State Beach, Martin Luther King Jr. Regional Shoreline, San Lorenzo Park, Gordon E. Oliver Eden Shores Park, Alden E. Oliver Sports Park,

and Hayward Shoreline Interpretive Center. Parking areas in another six parks would potentially be exposed to wind waves during a storm event.

The sensitivity of each park to impacts on parking will depend on multiple factors. If flooding persists (e.g., due to poor drainage) or damages the lot (e.g., due to debris or erosion), parking areas might be closed for extended periods. Park use is usually higher on weekends and holidays, and flooding that affects parking areas during these times would have greater impacts on visitation and potentially on park revenues. Where flooding only partially compromises parking, there might be sufficient accommodation for the demand elsewhere within a park.

Alternatively, nearby on-street parking may allow people to use the park even when the parking area is closed. It is important to note that while these options provide some adaptive capacity, they would probably not address the needs of persons with limited mobility or wheelchair users who would essentially be prevented from accessing recreation services due to the lack of accessible parking spaces. Furthermore, while park managers can implement temporary 'fixes' for parking, they have less flexibility in making fundamental changes that would improve capacity to deal with impacts to parking areas. For example, their options could be limited by lack of funding and very specific requirements in plans and permits for amounts and types of parking in parks. Additionally, some neighborhoods may not allow parking for extended periods of time, and overflow parking could inconvenience residents.

**Table 4.** Summary of Recreational Activity Vulnerability. For recreational activities within each park, the vulnerability to high tide and storm events with 16 and 55 inches of sea level rise is summarized by the following categories: green indicates *no to low* vulnerability; yellow indicates *low to moderate* vulnerability; and red indicates *moderate to high* vulnerability.

Keys for the tables.

<b>Parks and Recreation Areas</b>
1. Point Emery
2. Shorebird Park
3. Marina Park, Emeryville
4. Middle Harbor Shoreline Park
5. Estuary Park & Aquatic Center
6. Shoreline Park, Estuary
7. Union Point Park
8. Encinal Boat Ramp Park
9. Crown Memorial Beach
10. Chuck Corica Municipal Golf Course
11. Shoreline Park, Bay-Farm Island
12. Martin Luther King, Jr. Regional Shoreline
13. Metropolitan Golf Links
14. Oyster Bay Reg. Shoreline
15. Marina Park, San Leandro
16. Marina Golf Course
17. Tony Lema Golf Course
18. Hayward Regional Shoreline
19. San Lorenzo Park
20. Skywest Golf Course
21. Hayward Shoreline Interpretive Center
22. Gordon E. Oliver Eden Shores Park
23. Alden E. Oliver Sports Park

<b>Activity</b>	<b>Icon</b>
walk/run/hike/bike (w)	
passive recreation (pr)	
facilities for groups/events (ge)	
sports fields/courts (sf)	
golf course (gc)	
nature/wildlife viewing (n)	
interpretive/education facilities (ie)	
swimming (s)	
paddleboating (pb)	
rowing (rw)	
sailboarding (sb)	
motorboat launch (mb)	
fishing (f)	
dog recreation (d)	
parking (p)	
restrooms (r)	

**Table 4.** (cont) Summary of Recreational Activity Vulnerability – 16 inches of sea level rise.

<b>16" HIGH TIDE</b>	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
walk / run / hike / bike																							
passive recreation																							
group / event facilities																							
sports fields / courts																							
golf course																							
nature / wildlife viewing																							
interpretation & education																							
swimming																							
paddleboating																							
rowing																							
sailboarding																							
motorboat launch																							
fishing pier																							
dog recreation																							
parking																							
restrooms																							
<b>16" STORM EVENT</b>	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
walk / run / hike / bike																							
passive recreation																							
group / event facilities																							
sports fields / courts																							
golf course																							
nature / wildlife viewing																							
interpretation & education																							
swimming																							
paddleboating																							
rowing																							
sailboarding																							
motorboat launch																							
fishing pier																							
dog recreation																							
parking																							
restrooms																							

**Table 4.** (cont) Summary of Recreational Activity Vulnerability – 55 inches of sea level rise.

55" HIGH TIDE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
walk / run / hike / bike																							
passive recreation																							
group / event facilities																							
sports fields / courts																							
golf course																							
nature / wildlife viewing																							
interpretation & education																							
swimming																							
paddleboating																							
rowing																							
sailboarding																							
motorboat launch																							
fishing pier																							
dog recreation																							
parking																							
restrooms																							
55" STORM EVENT	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
walk / run / hike / bike																							
passive recreation																							
group / event facilities																							
sports fields / courts																							
golf course																							
nature / wildlife viewing																							
interpretation & education																							
swimming																							
paddleboating																							
rowing																							
sailboarding																							
motorboat launch																							
fishing pier																							
dog recreation																							
parking																							
restrooms																							



## Individual Park and Recreation Areas

### ***San Francisco Bay Trail: Segments from Emeryville to Hayward (Association of Bay Area Governments, Bay Trail Project)***

This important recreation asset within the ART project area consists of 74 miles of existing and proposed trail between Emeryville and Hayward, which are part of a larger continuous regional trail system around the edge of San Francisco Bay. Recreational bicyclists, joggers, pedestrians, rollerbladers, people in wheelchairs, commute cyclists, bird watchers, parents with strollers, dog walkers, and many other users are found along the Bay Trail on a daily basis. The physical characteristics of the Bay Trail vary within the ART project area. Depending on its location, the Bay Trail consists of paved paths, dirt trails, bike lanes, sidewalks or signed bike routes. The Bay Trail functions as a shoreline recreational destination, a transportation corridor, and a setting for environmental education. In the ART project area, the Bay Trail links marinas, regional parks, city parks, a major commercial center, residential areas, an ecological reserve, wetlands, industrial areas, two interpretive centers, a boating center, a state beach, an observation tower, an international airport, two ferry terminals, and future access to a toll bridge pathway.

The existing physical and functional condition of the Bay Trail in the project area varies by location. The Bay Trail is maintained by the agency or private property owner responsible for the area where the trail is located. Agencies in the project area include: City of Emeryville, City of Oakland, Port of Oakland, City of Alameda, East Bay Regional Park District, City of San Leandro, Department of Fish and Game, and Hayward Area Recreation and Park District. Many of these jurisdictions are challenged with limited maintenance budgets for parks, open space and trails. Often, trash pick-up and weed abatement are taken care of while long-term maintenance of the trail including sweeping, resurfacing, etc. are typically put off until the trail no longer functions. Private land owners are also responsible for trail maintenance as required by BCDC development permits.

As discussed previously in this chapter, the Bay Trail is currently affected by flooding and portions of the trail have been temporarily closed or damaged due to extreme weather events. With 16 inches of sea level rise, a majority of the trail in the southern portion of the ART project area (i.e., south of Marina Park in San Leandro) would be affected by storm event flooding. With the notable exception of the Bay Trail around San Leandro Bay (in Martin Luther King Jr. Regional Shoreline), the majority of the trail in the northern portion of the ART project area is unlikely to experience significant impacts with 16 inches of sea level rise. In the longer term, most of the Bay Trail (along with almost all of the parks and golf courses) will be fully inundated or impaired by flooding with 55 inches of sea level rise.

The discussion of trail recreation activities in the previous section addressed the ways in which trails and paths would be sensitive to and have capacity to accommodate sea level rise impacts. Additional considerations for the Bay Trail in particular include the limited availability of funding for improvement, repair and maintenance of existing trails. Most capital funds are limited to new trail construction. Capacity to address impacts may be boosted by organized advocacy groups that support the Bay Trail (i.e., bicycle coalitions). These groups could mobilize, with the assistance of the Bay Trail Project, to push for Bay Trail repairs and improvements needed due to sea level rise. The combination of high sensitivities to impacts and relatively limited adaptive capacity suggest that the Bay Trail in the ART project area is quite vulnerable to future sea level rise.

The consequences of impacts to the Bay Trail could be significant for a variety of reasons. Loss of Bay Trail functionality will result in a disruption of travel to jobs or school for those who commute by bicycle along the Bay Trail. The trail is also a tourist attraction, and closures would




reduce expenditures in adjacent communities. For example, the Bay Trail passes through Jack London Square, serving as the primary promenade along the waterfront. Costs associated with ensuring a safe detour route for bicyclists and pedestrians and for repairing damaged trail segments will also have economic consequences for managing agencies.

Closures of the Bay Trail would result in losses of recreational capacity and shoreline access that are significant at multiple scales. Portions of the Bay Trail in the ART project area are easily accessed by low-income and/or underserved communities and function as their primary recreation destinations. In particular, trail closures will disproportionately affect households that do not own a car and rely on bicycling or walking as primary forms of transportation. Loss of shoreline access via the Bay Trail is a regional concern because the trail is the primary means of access to the largest area of open space in the region – San Francisco Bay. Throughout the project area, the capacity to provide most recreational services would be impaired by disruptions to the Bay Trail (both within and outside of parks). More frequent and costly damage to the Bay Trail will challenge agencies' capacities to maintain the sections of the trail for which they are responsible. Furthermore, responsibility for addressing damage to the Bay Trail could become confusing, and authorization for trail improvements or repairs, which involve several layers of government approval (possibly local, regional and state), could be difficult to accomplish efficiently in order to return the Bay Trail to a functioning status.

### *City of Emeryville (Department of Community Services)*













#### *Point Emery*

Point Emery Park is 1.4 acres with a small beach on its north side. It is a favorite site for accessing the Bay Trail and kiteboarding. The park would benefit from a new accessible path and replacement stairs to the beach. This park is rapidly eroding; more frequent flooding associated with higher Bay waters would accelerate this erosion. Maintaining this park would require expensive shoreline protection, which would not address the loss of the beach. The park is disconnected from inland neighborhoods, and, despite its popularity for kiteboarding, does not receive strong support from this or other user groups. For a key to the table that follows see Table 4 on page 12.

Scenario	Recreational Activity						
16" High Tide							
16" Storm Event							
55" High Tide							
55" Storm Event							

*Shorebird Park*





























Shorebird Park consists of a viewing platform on piers contiguous to the Bay Trail. It includes a beach, a wooden dock with access ramps, and a connection to the Bay Trail. It is 2 acres, some of which is over water. The park is in fair condition, with the boardwalk, handrail, benches, paving, and some landscaping in need of replacement. These features can likely withstand more frequent flooding with minor additional impacts to their condition. However, as sea level continues to rise, Shorebird Park does not have space to be moved or expanded inland, and despite its popularity as a stopping point along the Bay Trail, the park does not have a community group that would be ready to advocate its protection. For a key to the table that follows see Table 4 on page 12.

Scenario	Recreational Activity		
16" High Tide			
16" Storm Event			
55" High Tide			
55" Storm Event			

*Marina Park*

This 13-acre park includes informal grass areas; ramps for windsurfing, motor boats and kayaks; picnic tables with grills; paths; a fire pit; parking; restrooms; and a sewage pumping station. The trails and street in the park are part of a Bay Trail spur. Marina Park is in fair condition. It has new paths and benches, and the grass areas, ramps, parking and rest rooms are in good condition. However, some landscaping needs to be replaced, many of the trees in the park are crowded and unhealthy, and accessible paths are needed to some picnic benches. Due to budget constraints, these improvements have been deferred. The majority of the park is unlikely to be exposed to significant flooding impacts with 16 inches of sea level rise. However, access to the park (along the Bay Trail and road) could be impaired by storm events under this scenario, and wind waves during storm events could potentially damage some paths and grassy areas, the restrooms, and the sewage pumping station. Temporary use of sandbags would help prevent damage to the restrooms and the pumping station.

With 55 inches of sea level rise, more than half of the parking area would be exposed to tidal inundation and storm event flooding and likely suffer damages. This amount of sea level rise would also reduce availability (each day) of the boat ramps due to higher tides. Under the 55 inch scenario, access to Marina Park as a whole would be limited or impossible due to the vulnerability of the road leading to it. Currently the park does not have a "friends of" organization, but it is very popular, has an adjacent residential population, and draws good turnout for annual California Coastal Cleanup events. For a key to the table that follows see Table 4 on page 12.

Scenario	Recreational Activity						
16" High Tide							
16" Storm Event							
55" High Tide*							
55" Storm Event*							

\* Vulnerability ratings do not reflect likely vulnerability of the road that provides access to the park to impacts under these scenarios.

































## Port of Oakland

### Middle Harbor Shoreline Park

Amenities and activities at this 38-acre shoreline park include more than two miles of pathways encircling Middle Harbor Basin; grass turf areas with picnic tables and barbeque pits; multiple restrooms; a sandy beach from which paddleboats can be launched; interpretive signage and maritime historic features (e.g., bollards once used for tying up ships and a viewing tower); nature and birdwatching opportunities; and iconic views of the Bay.

For the most part, facilities at this relatively new park are in very good condition. However, erosion of unpaved paths in the past (due to storm events) has caused enough damage to make them difficult to travel in a wheelchair. This park will likely be minimally affected by tidal inundation or storm event flooding with 16 inches of sea level rise, although wind waves could flood paths and some of the grass turf areas in the park, potentially requiring temporary closures and repairs. Substantially more of the park will be exposed to storm event flooding and wind waves with 55 inches of sea level rise.

These impacts could significantly impair trails and passive recreation amenities (e.g. grassy areas, picnic areas), and could reduce tidal habitat that provides wildlife viewing opportunities. Some of the interpretive features, such as the viewing tower and bollards, may be more resilient to storm event impacts. For a key to the table that follows see Table 4 on page 12.

Scenario	Recreational Activity							
16" High Tide								
16" Storm Event								
55" High Tide								
55" Storm Event								









































## City of Oakland (Office of Parks and Recreation)

### Estuary Park

Estuary Park and the Jack London Aquatic Center comprise a public rowing and visitor center, fishing hub, biking trail, boat launch ramp with boat trailer parking, a small-boat launching ramp, passive recreation, and ball field use facility. The rowing facilities are currently managed by the City of Oakland's Office of Parks and Recreation. However, the city is looking at opportunities for a non-profit organization to take over this role.

A large portion of this 12-acre park could be affected by storm event flooding with 16 inches of sea level rise. The relatively new launch ramps, docks and boathouse facilities at the site are constructed with salt resistant materials that will help prevent damage, and allow these uses of the park to be restored quickly after flooding. In contrast, the grass soccer field would certainly be damaged (or potentially destroyed) by salt water flooding.

















The rowing teams that rely on the facilities for training would likely provide some volunteer work and donations for restoring functions of the facilities if they were to be damaged. Loss of rowing opportunities at this site would affect underserved communities in Oakland. Teams' partnerships with community-based programs provide disadvantaged communities an opportunity to engage and experience these types of recreational activities. For a key to the table that follows see Table 4 on page 12.

Scenario	Recreational Activity									
16" High Tide										
16" Storm Event										
55" High Tide										
55" Storm Event										

#### *Union Point Park*

A small but popular community park on the Oakland Estuary, Union Point Park is an example of green remediation, for which contaminated soils from the site were encapsulated under a large lookout hill that is a signature feature of the park. This seven-acre park also has a restroom, children's play structure and picnic tables. Heavy park use and frequent permitted events, coupled with reduced staffing levels for maintenance (due to budget cuts in the City of Oakland) have impaired the physical condition of the park.









The park would likely experience impacts from wind waves during storm events with a 16 inch sea level rise, but due to its elevation, it is unlikely to be exposed to significant flooding. Even with some flooding, the park would probably recover quickly. The park is tied directly to the City of Oakland's storm drain system to facilitate drainage of excess water, and it is equipped with an underground sump filtration system. Furthermore, the park's design and sturdy structures make it resistant to saltwater damage. With 55 inches of sea level rise, storm event flooding and wind waves will likely affect the majority of the park and amenities, including paths, picnic tables, play structure, lawn areas and restrooms. For a key to the table that follows see Table 4 on page 12.

Scenario	Recreational Activity			
16" High Tide				
16" Storm Event				
55" High Tide				
55" Storm Event				

### *City of Alameda (Recreation and Park Department)*

















#### *Shoreline Park, Estuary*

This 5-acre park on the Oakland Estuary includes 0.7 miles of Bay Trail and a lawn area for passive recreation. The park has little or no exposure to storm event flooding and tidal inundation with 16 inches of sea level rise. With 55 inches of sea level rise, much of the park would be exposed to storm event flooding. The saltwater exposure could damage the Bay Trail and destroy the grass area. For a key to the table that follows see Table 4 on page 12.

Scenario	Recreational Activity	
16" High Tide		
16" Storm Event		
55" High Tide		
55" Storm Event		

#### *Encinal Boat Ramp Park*

The primary recreation feature in this approximately seven-acre park on Bay Farm Island is a motorboat launch. With 16 inches of sea level rise, the entire ramp will be exposed to storm event flooding and wind waves. These impacts are unlikely to cause lasting damage because the ramp is constructed to withstand exposure to Bay water. Only a very small portion (3%) of the entire park area is projected to be affected by higher tides with 16 inches of sea level rise. However, higher tides may decrease the amount of time that the ramp is usable each day. For a key to the table that follows see Table 4 on page 12.

Scenario	Recreational Activity			
16" High Tide				
16" Storm Event				
55" High Tide				
55" Storm Event				

















#### *Shoreline Park, Bay Farm Island*

This 32-acre park forms a narrow band along the northeastern and western edge of Bay Farm Island. A 2.5-mile stretch of Bay Trail, iconic views of the Bay, a fishing pier, lawn areas, and reservable picnic facilities make this a popular park for walking, running and biking, passive recreation, and family / group gatherings. Exposure mapping indicates that the park has low exposure to tidal inundation and storm event flooding with 16 inches of sea level rise, but that wind waves are likely to overtop the riprap shoreline protection around this park. During winter storms Shoreline Park has experienced erosion that would likely worsen with sea level rise. (The city is working with the Army Corps of Engineers to fund a reinforcement project to address this erosion issue.) Temporary flooding due to wind-waves is unlikely to cause lasting damage to the Bay Trail and picnic facilities, but lawn areas may be damaged and, with repeated saltwater exposure, unable to re-grow.

With 55 inches of sea level rise most of the park, along with Bay Farm Island would be severely flooded during a storm event. A high tide with 55 inches of sea level rise would inundate the north shore of the park, which includes a fishing pier, parking and access to the park from a wooden footbridge (owned and maintained by East Bay Regional Park District) across San



Leandro Channel. Water already reaches the bottom of the bridge support beams during extreme high tides. For a key to the table that follows see Table 4 on page 12.

Scenario	Recreational Activity			
16" High Tide				
16" Storm Event				
55" High Tide				
55" Storm Event				

### ***East Bay Regional Park District (EBRPD)***





































#### *Crown Memorial State Beach*

Crown Memorial State Beach on Alameda Island is comprised of approximately 70 acres of sandy beach and 25 acres of landscaped areas. The northern portion of the park is owned by California State Parks and includes the Crab Cove Visitor Center. The long narrow southern part, the beach and trail along Shoreline Drive, is owned by the City of Alameda. East Bay Regional Park District has operating agreements and manages both areas as one park. The State of California and the City of Alameda do not provide funding except for a shared cost for annual beach maintenance. The park's long sandy beach – the largest contiguous beach on San Francisco Bay – is a popular recreational feature. Some flooding impacts are already evident at the park. The rocky point at the northern tip of the park is frequently overtopped with high tides and wind waves; and the lawn outside of the Crab Cove Visitor Center was flooded in January 2006 during an extreme high tide on New Year's Day.

The ART project exposure analysis suggests that while much of the park will not be affected by flooding with 16 inches of sea level rise, more frequent flooding in some portions of the park will reduce access (until flood waters recede) to picnicking facilities, grassy areas, and the beach. Furthermore, storms may cause lasting damage to grassy areas (due to saltwater exposure) and the beach (due to erosion). Higher daily tides will reduce the amount of time that the wheelchair-accessible Tide Ramp is available for use by school groups and members of the public. Elevated groundwater and salt water intrusion could harm trees, grass and other landscaped features. The two main structures at the park – the Crab Cove Visitor Center and the park service yard building – are raised and, due to their construction, would dry out rapidly after a flood event.

As discussed previously in this chapter, the approach to exposure mapping used in this assessment is not appropriate for dynamic systems such as beaches. Managers familiar with the park report that the beach is eroding and would likely be susceptible to greater erosion with higher high tides and flooding with 16 inches of sea level rise. Loss of this unique beach would affect access for swimming, wading, sunbathing, boardsailing and paddleboating, and would be significant loss to the Alameda community and the entire Bay Area. The beach is periodically re-nourished, and this historical practice could expedite future nourishment after storm events that significantly erode the beach.

Sea level rise impacts could challenge the governance of Crown Memorial. With widespread flooding impacts, inter-agency coordination could become strained, and East Bay Regional Park District could be forced to give lower priority to recovery efforts at Crown Memorial as staff is focused on properties that the District owns and manages. For a key to the table that follows see Table 4 on page 12.

Scenario	Recreational Activity								
16" High Tide									
16" Storm Event									
55" High Tide									
55" Storm Event									

### *Martin Luther King Jr. Regional Shoreline*

This popular, 217-acre park, located along the shoreline around San Leandro Bay, offers a diversity of recreation opportunities. Park facilities and activities include 3.7 miles of Bay Trail with six bridges, the Tidewater Boating Center with facilities and launches for rowing and paddleboats, a boat launch ramp, the Shoreline Center (meeting facility), 16 acres of grass turf, nine staging areas providing parking, picnic tables and restrooms, a staff office, the Arrowhead Marsh Overlook ramp and boardwalk, interpretive signage, wildlife viewing opportunities, and three marshes – Arrowhead, New, and Damon – which provide habitat for endangered species. Tidal inundation and storm event flooding with 16 inches of sea level rise is likely to affect much of the park – including many of the park amenities.

In the past, flooding has occurred on lawns and the Bay Trail during extreme weather events that coincided with high tides. High tides (greater than 6 feet) also flood the marshes regularly, and, when combined with surge, can affect the Tidewater Boating Center. Currently, the park assets recover quickly or are not significantly impaired by these impacts. For example, despite regular flooding, the three marshes are not subject to erosion due to the presence of upper tidal plants.

Use of the Bay Trail can be restored quickly once flooding recedes and debris left by storms is removed. With more frequent storm event flooding and/or tidal inundation due to sea level rise, lawn areas might not recover from repeated saltwater exposures. Damage to the Bay Trail, which is paved along most of the shoreline, would be unlikely, but extended closures would be necessary with flooding that persists longer. Longer inundation of the marshes could diminish the survival of endangered clapper rails and salt marsh harvest mice that can only utilize the habitat when the marsh is exposed during low tides. Other shorebirds are also forced to find other refuge areas when the marshes are flooded, and with sea level rise more inundation will reduce opportunities for birdwatching. Sixteen inches of sea level rise will also cause impacts in previously unaffected areas of the park. Storm event flooding might cause temporary closures of many of the parking lots, picnic areas and restrooms. Park managers note that structures like the Tidewater Boating Center, the Shoreline Center and staff offices would take a long time to reopen after flooding.

Some park assets have functional capacity to accommodate higher Bay waters. For example, the Tidewater Boating Center is in good condition and has a dock that rises with the tides and was built for a higher tide than 55 inches. Additionally, restoration of the shoreline and Arrowhead Marsh over the past decade has improved the resilience of these habitats to storm events and high tides. The most significant source of adaptive capacity for the park comes from EBRPD's strong partnerships with organizations that implement restoration, education, and stewardship

programs at the site. Save the Bay and Golden Gate Audubon bring in thousands of volunteers for thousands of hours to plant, maintain, and improve the marshes (e.g., more than 5,000 volunteers worked more than 16,000 volunteer hours in 2011). Most of the educational programs are offered to schools in the underserved areas of Oakland and Alameda County. The Invasive Spartina Project and several agencies provide funding for and implement restoration of the marshes and shoreline while eradicating the *spartina alterniflora* (Atlantic Cord Grass) in the marshes and creeks.

Efforts to improve the park's resilience may be slowed by cumbersome planning and permit processes, as well as the overlap of ownership and jurisdictions along the San Leandro Bay shoreline. Vulnerability of the Martin Luther King Jr. Regional Shoreline also has implications for surrounding areas. Four creeks that run through the park before draining into San Leandro Bay must be free from debris and *spartina alterniflora* in order to convey stormwater that would otherwise flood Oakland communities during high tides and storms. For a key to the table that follows see Table 4 on page 12.

Scenario	Recreational Activity											
16" High Tide												
16" Storm Event												
55" High Tide												
55" Storm Event												

#### Oyster Bay Regional Shoreline

This 190-acre park, located on a former landfill in San Leandro that closed in the 1980's, is still under construction. Some park amenities are already open to the public, including a segment of the Bay Trail along the shore as well as upland trails, picnic tables, a restroom, and a 4-acre grass area. Due to its relatively high elevation, the park is not exposed to much flooding with sea level rise. However, the lower Bay Trail segment along the shoreline might be affected by storm flooding with 55 inches of sea level rise. The impacts would likely be temporary (e.g., closures until flood water recedes and debris is removed) rather than permanent because this portion of the Bay Trail is mostly paved.

Streets surrounding the park could experience sea level rise-related flooding sooner than Oyster Bay Regional Shoreline because they are lower in elevation, and they drain into the adjacent San Leandro Slough and marsh, which might not have capacity for increased flood flows. In turn, this might cause longer-lasting disruptions to access to the park. Higher and more frequent inundation of the adjacent slough and marsh could also diminish the quality of opportunities for wildlife viewing, which is currently a popular activity at the park. To fully convert the landfill to a park over the next few years, EBRPD will be completing grading and landscaping and a new park entrance at Davis Street, with new parking located within the park. Higher Bay water levels are being factored into the design of these improvements to reduce exposure to sea level rise impacts, which enhances adaptive capacity. For a key to the table that follows see Table 4 on page 12.

Scenario	Recreational Activity				
16" High Tide					
16" Storm Event					
55" High Tide					
55" Storm Event					

### Hayward Regional Shoreline

This large, 1700-acre shoreline park features five miles of unpaved Bay Trail (along the park's outboard levees) and other levee-top trails that connect the shoreline trail from San Leandro to the Hayward Shoreline Interpretive Center (just north of Highway 92). The park is popular for walking, biking, running, bird watching, dog walking, picnicking, fishing, and enjoying scenic views. It also provides opportunities to see three different marshes. Oro Loma Marsh, near the northern end of the shoreline, is a tidal salt-water marsh at its western end, and a seasonal freshwater marsh fed by rainwater at the slightly higher elevations at its eastern end. Cogswell Marsh, near the southern end of the shoreline, was formerly a commercial salt pond that has been restored to tidal salt marsh habitat. Hayward Marsh is also a restored marsh, but it supports a different, more brackish mixture of vegetation because it receives treated freshwater from a nearby wastewater treatment plant (Bay Nature 2012).

Recreational services at the park could be impaired by shoreline access impacts (including the Bay Trail, other levee trails, and parking areas), as well as the wetlands habitats. Currently, high tides, storm flooding, and strong winds occasionally cause waves to overtop outboard levees, leaving the Bay Trail unusable until flooding recedes and debris can be removed, if necessary. Analysis of sea level rise scenarios suggests that with 16 inches of sea level rise, the Hayward Regional Shoreline will experience significant exposure to high tide inundation and storm event flooding. These impacts will exacerbate flooding of the Bay Trail leading to more frequent closures. The Bay Trail within this park is especially susceptible to impairment because disruption of a small portion of trail would likely require closure of a large trail segment.

























Beyond the recreational impacts, more frequent flooding and higher tides will destabilize levees, which are already in need of repair, and potentially cause uncontrolled flows into the marshes, which would also necessitate closure of the park. Further, these impacts could impair the marsh capacity to receive treated wastewater from Union Sanitary District and damage infrastructure such as the PG&E distribution and transmission lines and a railroad line that run through the park. In the event of a disruption to the levees (and Bay Trail), the top priority for park managers is to repair the internal and outboard levees to avoid being in violation of their Regional Water Quality Control Board permit for operation of the Hayward Marsh. Thus, the restoration of recreation activities at the park is linked directly to the condition of the levees and resources available to maintain them. Lack of funding and difficulties obtaining permits have already delayed maintenance and led to levee failure. In contrast to the levees, the marshes are likely to be more resilient to flooding and inundation impacts. Over time, however, longer periods of inundation and changes to the habitat condition will reduce the amount and quality of wildlife watching opportunities. For a key to the table that follows see Table 4 on page 12.

Scenario	Recreational Activity							
16" High Tide								
16" Storm Event								
55" High Tide								
55" Storm Event								

### *City of San Leandro (Department of Recreation and Human Services)*

#### *Marina Park*

Marina Park in San Leandro features approximately 1 mile of paved Bay Trail, picnic and playground facilities, lawn areas, and a sand volleyball court. Very little of this 30-acre park would be exposed to tidal inundation or storm flooding with 16 inches of sea level rise. The sea level rise mapping analysis indicates that a significant portion of the park is exposed to wind waves under this scenario. However, the park is within a protected lagoon, so this impact might not occur. With 55 inches of sea level rise, almost all of the park would be exposed to storm flooding, resulting in park closures and potentially causing significant damage to the Bay Trail, lawn areas, playground facilities, sand volleyball court, and parking area. For a key to the table that follows see Table 4 on page 12.

Scenario	Recreational Activity					
16" High Tide						
16" Storm Event						
55" High Tide						
55" Storm Event						





























### *Hayward Area Recreation and Park District (HARD)*

#### *San Lorenzo Community Park*

This heavily used, 31-acre park is adjacent to marshland on its western property line. The park has three baseball fields, two basketball courts, one turf and two grass soccer fields, a playground, dog park, parking lot, community building (8,236 sq. ft), two exterior restroom/snack bar buildings, and a pond. The property has a number of existing issues including flooding of the western ball fields during heavy rains due to slow drainage into the adjacent marsh, and limited maintenance funding. Sixteen inches of sea level rise will likely cause storm event flooding to occur over much of the park, which will damage and potentially destroy grass areas and landscaping and cause temporary closures of other facilities (e.g., artificial fields, sports courts and buildings). This will reduce revenues from field fees and building rentals, and increase repair and maintenance costs.





Elevated groundwater will damage pavement and building foundations, and saltwater intrusion will have impacts on landscaping and the well water used for irrigation. This park is the only community park in San Lorenzo, which has a very high population of senior citizens that use the community center at the park. Any loss of programs will significantly affect this group because there are no nearby senior centers. Loss of low cost sports or other recreational opportunities will affect low-income residents who may not have the means to travel to distant facilities.

Despite strong community interest in the park, there is little that the managing agency, Hayward Area Recreation and Park District (HARD), can do to raise revenues for adaptive measures. HARD is working to develop a new master plan for the park, which will provide an opportunity to consider and address current and future flooding problems. For a key to the table that follows see Table 4 on page 12.

Scenario	Recreational Activity						
16" High Tide							
16" Storm Event							
55" High Tide							
55" Storm Event							

#### *Sky West Golf Course*

This 125-acre, 18-hole course provides the Hayward area with a public golf course, which has a restaurant, pro shop, a banquet area, and maintenance buildings. With 16 inches of sea level rise, the course would have relatively low exposure to storm event flooding. However, the western portion of the golf course currently floods during heavy rains when water cannot drain rapidly into the adjacent marshlands to the west. This portion of the golf course must be closed several days per year during storm events, and the revenue lost cannot be replaced. Even with a small increase in Bay water levels, this drainage problem will be exacerbated, causing a greater portion of the golf course to be impaired for longer periods of time. The grass turf will also be sensitive to higher groundwater and saltwater intrusion. To better cope with drainage/flooding issues, a dike would need to be built with pumps, or the land would need to be raised, neither of which are low cost solutions. If the impacts preclude opportunities to play 18 holes, it is possible that the course could be redesigned as a 9-hole course, which would allow it to remain open but would significantly reduce revenues. Opportunities to increase revenues are limited because this golf course cannot compete well at higher prices. For a key to the table that follows see Table 4 on page 12.

Scenario	Recreational Activity
16" High Tide	
16" Storm Event	
55" High Tide	
55" Storm Event	

#### *Hayward Shoreline Interpretive Center*

This 4,180 square foot educational and resource center introduces grade school groups and adults to the ecology of San Francisco Bay. The center is not currently affected by storm impacts, and during recent king tide<sup>1</sup> events the center (which is on stilts above the salt marsh) had approximately 6 inches of clearance. Exposure to sea level rise impacts would occur first with storm event flooding. Occasional flooding of the Center could be addressed with temporary corrective measures such as pumping, but more frequent flooding from storm events or high tide inundation would cause structural damage. The building cannot be relocated, though it might be possible to further elevate it, cost permitting, and assuming that access to the facility could be maintained. HARD works closely with the Hayward Shoreline Planning Agency and

<sup>1</sup> A king tide is an extreme high tide event that occurs when the solar and lunar gravitational forces reinforce one another at times of the year when the moon is closest to the earth.























their Citizens' Advisory Committee, which would offer political support for addressing these issues at the center. For a key to the table that follows see Table 4 on page 12.

Scenario	Recreational Activity						
16" High Tide							
16" Storm Event							
55" High Tide							
55" Storm Event							

#### *Gordon E. Oliver Eden Shores Park of Hayward*





















This 5-acre park has three tennis courts, a basketball half-court, a grass soccer field, a parking lot, open grass areas, picnic tables, and a restroom. With 16 inches of sea level rise, wind waves may overtop levees, leading to flooding in the park that would significantly damage the grass areas. Higher groundwater levels and saltwater intrusion could damage landscaping, pavement, and foundations of structures. Poor drainage from the park into the adjacent marsh channel during storm events could be exacerbated by higher Bay water levels. The synthetic court surfaces will be less affected because they can withstand saltwater exposure without experiencing lasting damage, but they would still require time to drain. All of these impacts would lead to more closures and repair costs. In most cases, if the park is only partially impaired by flooding or other impacts, managers would only need to close the affected areas. For a key to the table that follows see Table 4 on page 12.

Scenario	Recreational Activity				
16" High Tide					
16" Storm Event					
55" High Tide					
55" Storm Event					

#### *Alden E. Oliver Sports Park of Hayward*

This 25-acre sports park contains two artificial turf soccer fields, one grass soccer field, four baseball fields, two snack bars/restroom buildings, a play area, picnic area, basketball area, and two parking lots. With 16 inches of sea level rise, storm event flooding and wind waves might overtop levees surrounding this park, leading to flooding that would significantly impair the grass playing fields. Flooding might also occur during heavy rains because the site would not drain well into Alameda Creek when the creek is elevated due to higher Bay water levels. Elevated groundwater as well as saltwater intrusion could damage landscaping, pavement, and foundations of structures. The synthetic turf fields and the sports courts will be less affected because they can withstand saltwater exposure and higher groundwater levels without experiencing lasting damage. However, these playing areas would still require time to drain after flooding.

All of these impacts would lead to more closures and repair costs and reduce income generated by the field fees. As it is, the income for the sports park cannot be increased. In most cases, if the park is only partially impaired by flooding, managers would only need to close the affected areas, allowing them to maintain some revenues during periods of recovery. For a key to the table that follows see Table 4 on page 12.

Scenario	Recreational Activity				
16" High Tide					
16" Storm Event					
55" High Tide					
55" Storm Event					

## Consequences

The potential consequences of the climate impacts are considered for the parks and recreation system as a whole. Consequences are the magnitude of the effects on the economy, society, environment, and governance if an impact occurs. Factors that inform the magnitude of the potential consequences include the severity of the impact on operations and maintenance or capital improvement costs, the size and demographics of the population affected, the types of natural resources affected, and the type, extent, and severity of the effects on humans and the environment.

Over time, sea level rise impacts will lead to significant negative consequences for many of the recreational services provided by parks and golf courses in the ART project area. Storm event flooding associated with 16 inches of sea level rise is likely to cause the majority of disruptions to these services. With 55 inches of sea level rise, recreational services in parks around San Leandro Bay and along the Hayward shoreline will be completely lost due to impacts of high tide inundation and storm events.

## Economy

Economic consequences of these impacts identified by park managers include large increases in maintenance and repair costs; loss of revenues during closures; high costs of possible adaptive strategies (e.g., new shoreline protection and retrofits to structures); and loss of jobs if parks are shut down. Additionally, Bay Trail closures would disrupt travel to jobs and schools. Economic consequences of sea level rise in any one park within the project area are unlikely to be significant to the region. However, the cumulative costs of added maintenance and repair, expensive retrofits, and lost revenues and jobs throughout the project area will take their toll on local and regional economic growth if parks are no longer able to effectively contribute to improving the quality of life and aesthetic characteristics of the area, and attracting businesses and generating jobs.

A valuation analysis for eight of the parks in the project area provides an additional indication of the economic consequences of the loss of parks and recreation areas. The eight parks studied were (1) Crown Memorial State Beach, (2) Hayward Regional Shoreline, (3) Martin Luther King, Jr. Regional Shoreline, (4) Oyster Bay Regional Shoreline, (5) Estuary Park (including the Jack London Aquatic Center), (6) Union Point Park, (7) Marina Park (in San Leandro), and (8) the Hayward Shoreline Interpretive Center and trails. The value of the total loss of these eight parks, including all amenities and uses, at mid-century is almost \$190 million (in today's dollars). This value takes into account the replacement costs for major structures (e.g. an interpretive center, a boathouse), the loss of revenues (e.g. from field rentals), and the value of

loss of recreational activities. It is likely that the actual value would be greater; this analysis does not take into account the costs to replace all park infrastructure (e.g. roads, parking areas, picnic facilities, etc.) and conservative approach was used in estimating the value of recreation activities. (Refer to the appendices for the full report and methods used in this valuation analysis.)

### Society

Reduced opportunities for recreational services across many parks for underserved populations (e.g., persons with disabilities, seniors, and low-income residents), as well as disruptions to specific parks that serve the needs of these populations, could have significant societal consequences. Bay Trail manager Laura Thompson points out “closures to the Bay Trail would disproportionately affect households that do not own a car and rely on bicycling and walking as primary forms of transportation.” A recurring issue is the disproportionate impairment of access and recreation opportunities for persons with limited mobility and wheelchair users. These park visitors are much less likely than other user groups to be able to use trails, boat launches, parking areas, and picnic and other facilities that are partially impaired by flooding. Within any one park, this issue might not be significant, but the cumulative effect is that persons with limited mobility will have much less access to the shoreline and recreational services.

Disruptions to San Lorenzo Park illustrate how impacts to a specific park can have critical societal consequences. Karl Zabel, an operations supervisor with the Hayward Area Recreation and Park District notes, “[s]torm flooding/inundation will have a large impact on the recreational opportunities, since this is the only community-sized park in San Lorenzo. San Lorenzo has one of the highest senior citizen populations. This population uses many of the senior programs at the Community Center and any loss of programs will impact this population since there are no nearby Senior Centers. The population of San Lorenzo has a number of underserved residents that will be impacted if low cost sports or other recreational opportunities are lost, since this population does not always have the means to travel to distant facilities.”

Consequences of park closures could also be serious for low-income residents living near parks who rely on these free, easily accessed sites for family gatherings, weekend recreation, and sports activities. Similarly, popular educational and stewardship programs at Martin Luther King Jr. Regional Shoreline are primarily offered to schools in the underserved areas of Oakland and Alameda County. The communities that use these parks and participate in these programs are unlikely to have other, similar opportunities to recreate near, learn about, and connect with the Bay.

Marina Park in Emeryville serves as another example. The sewage pump station on the peninsula serves both the park and the marina, which is believed to be home to low-income, live-aboard tenants whose boats do not all have toilets on board. Flooding damage to the pump station would leave these residents without access to proper sanitation, causing public health issues at the park and marina.

A 2006 analysis of recreation demand by BCDC staff suggests that demand for Bay Area water-oriented recreation has grown and will continue to grow due to factors such as population growth, an aging population, and an increase in ethnic diversity (BCDC 2006). Already, specific communities within the project area, such as the Fruitvale neighborhood in Oakland, are underserved in terms of access to parks. These conditions – existing unmet needs and growing demand for recreation – suggest that cumulative loss of shoreline access and recreation opportunities due to closures of multiple parks in the project area would have significant societal consequences. This overarching consequence is somewhat muted because when

exposed to impacts with 16 inches of sea level rise, most parks will be able to remain open even if they are partially impaired, except during periods of recovery from storm events. However, with 55 inches of sea level rise, all but one park and two golf courses would be unlikely to continue to function, meaning that they would not provide recreational services to any users.

### Environment

The environmental consequences of sea level rise impacts vary depending on the park setting and recreational services. Crown Memorial State Beach, Martin Luther King Jr. Regional Shoreline, and the Hayward Regional Shoreline and Interpretive Center each provide opportunities for interpretation, education, and wildlife and nature viewing that are unique and regionally significant, and they serve to protect the regionally significant environmental resources (e.g., endangered species, fragile habitats, and ecosystem services) at each site. Clearly, loss of these habitats and species would have significant environmental consequences. Though it is less obvious, disruption of the recreational services at these parks would also have a significant environmental consequence. Engaging Bay Area residents through interpretation, education, and wildlife and nature viewing is essential for building awareness and support for environmental protection. In more developed portions of the project area that do not support significant natural resources, impacts to parks and recreation areas will have fewer consequences for the environment.

### Governance

With 16 inches of sea level rise, it is possible that almost all parks addressed in the ART project assessment will have some exposure to storm event flooding. This is a drastic increase in flooding exposure compared with current conditions, and it will have significant governance consequences. The likelihood is very high that after storm events, managing agencies will regularly be faced with extensive damage to multiple parks that they operate. Agencies will have to prioritize recovery efforts, and as Anne Rockwell, Shoreline Unit Manager for the East Regional Park District, notes, this may strain relationships between agencies that co-own and/or manage a park if priorities for recovery differ. Sea level rise impacts may change the management needs at some parks (e.g., towards an approach that focuses on disaster preparedness and response); to accommodate such shifts in management demands, agencies might need to hire differently trained staff and reallocate funds. As agencies try to adjust to new conditions in the parks, they may have difficulties obtaining permits for adaptive management strategies that are not addressed in existing environmental and building regulations and policies. Even if these issues related to management responsibilities and priorities do not emerge as serious challenges, the dramatic increase in required maintenance and repair will have significant consequences for the agencies' capacity to continue to provide recreation services in the project area. This expense could also affect their ability to maintain services in other parks in their service area outside of the project area.

## **Key Findings**

The park and recreation facilities and services within the subregion include beaches, grassy areas, picnic areas, playing fields, local and regional trails (including the Bay Trail), golf courses, wildlife viewing areas, fishing areas, boat docks, passive recreation areas, and interpretive centers. The most common activities within these recreation facilities include walking, biking, passive recreation, and dog recreation. Overall, park and recreation facilities and services are moderately vulnerable to storm event flooding with 16 inches of sea level rise, and very vulnerable to the daily high tide with 55 inches of sea level rise.

Few of the parks and recreation facilities are exposed to the daily high tide with 16 inches of sea level rise, with the exception of wildlife viewing. Some of the tidal marshes will likely be submerged for longer periods of time by the daily high tide with 16 inches of sea level rise, and

this will reduce opportunities for wildlife viewing. The number of park and recreation facilities and services that may be exposed to 16 inches of sea level rise increases with storm event flooding. These include the recreation areas around San Leandro Bay, along the Hayward shoreline, the beaches at Crown Memorial State Beach in the City of Alameda, Point Emery in Emeryville, and parking and restrooms in half of the parks within the subregion. Additionally, a majority of the shoreline trails, paths within parks, picnic areas, beaches, grassy areas, and other landscaped features that support the most common activities at the park sites will be exposed to storm event flooding with 16 inches of sea level rise.

The majority of parks and recreation facilities, including golf courses within the subregion, will be exposed to high tide inundation and storm event flooding with 55 inches of sea level rise. Only a few parks, including Middle Harbor Shoreline Park in the City of Oakland and Marina Park in San Leandro would retain their recreation functions with 55 inches of sea level rise.

The recreation uses and services that are most sensitive to the effects of sea level rise and storm event flooding include trails designed for people with limited mobility, unpaved trails close to the shoreline, the beaches at Crown Memorial State Beach, and grassy areas. People with limited mobility will find it more difficult to move through and detour around inundated and storm damaged areas. Unpaved trails located close to the shoreline will be subject to erosion, flooding, and storm damage that may wash away portions of the trail. Grassy areas are highly sensitive to salt water and many have poor drainage. The beaches at Crown Memorial State Beach are already eroding and require replenishment. Climate impacts such as sea level rise coupled with a storm event will likely increase and accelerate this loss.

Some of the functional roles that shoreline parks and recreation areas serve in the subregion may be replicated at other park sites. Inland parks and recreation sites may provide some of the same functions such as playing fields, jogging trails, passive recreation, and picnic areas. Other functions, however – such as swimming, wading, boardsailing, paddleboating, aquatic wildlife viewing, and shoreline interpretation – are uniquely tied to the shoreline and would not be available within the subregion if lost or significantly damaged due to tidal inundation and storm event flooding. Additionally, the loss of any of these shoreline parks would increase the crowding and overuse that is already experienced at some parks.

The adaptive capacity within the subregion will vary depending upon the characteristics of each site and its recreational activities. For trails and pathways, maintenance and operations – including temporary closures and re-routings – may be possible even with storm event flooding and 16 inches of sea level rise. For some of the most sensitive uses and recreation sites, such as access for people with limited mobility and wildlife viewing, adaptive capacity may be low even at 16 inches of sea level rise, especially with storm event flooding. With 55 inches of sea level rise, particularly with storm event flooding, the adaptive capacity for most recreation sites and uses will not be sufficient to maintain park facilities and functions.

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