City of Benicia Climate Change Vulnerability and Adaptation Plan

# DRAFT

# Existing Conditions and Stressors Report

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## Project Introduction

The City of Benicia is a waterfront city in the San Francisco Bay Area. As the State's first capital, it is full of history, home to the first West Coast U.S. Army post, host to a railroad car ferry, and numerous other historic sites. Today, Benicia is home to a thriving arts community, beautiful weather and scenic vistas, and a downtown full of charming boutiques and antique shops. In order to maintain its high quality of life, prosperous businesses, productive ecosystems, and vibrant neighborhoods, Benicia is planning for the future.

The City of Benicia acknowledges the risks of increased temperatures, sea level rise, more frequent wildfires, and changes in precipitation that are associated with projected changes in the climate and is taking steps to prepare for and become a more resilient city that can manage the hazards of today as well as those of tomorrow by conducting a Climate Change Vulnerability Assessment and creating an Adaptation Plan. This plan will help Benicia remain a thriving, sustainable city with resilient communities, infrastructure, and services.

This work is funded through a Climate Ready Grant from the California Coastal Conservancy. This grant program seeks to help California's coastal communities prepare for the effects of a changing climate. The project uses this funding to build upon prior and ongoing sustainability efforts within the City. Climate change mitigation has been integrated in the City's operating procedures, and the City now wishes to examine how best to integrate adaptation planning. The City is poised to capitalize on an important window of opportunity to develop adaptation measures that are sustainable, equitable, economically viable, and cost effective. Proactively assessing vulnerability and evaluating adaptation measures is a key step towards building a more resilient city.

This Existing Conditions and Stressors Report collects historical data from a variety of sources in order to outline the current state of Benicia's infrastructure and natural areas, and document how the infrastructure and natural areas have been impacted by weather and natural disasters in the past. This report does *not* account for any potential changes in climate or natural hazards; the impacts of climate change will be considered in the next phase of the

**Key Terms and Concepts**

**Climate change:** Long term changes to the global or regional "average weather" attributed largely to increased levels of atmospheric carbon dioxide produced by the use of fossil fuels.

**Climate variable:** Parameters used to measure and describe climate. For example: temperature, precipitation, wind, storm surge, waves, and relative sea level change.

**Existing stressor:** Cyclical climate variables that may already have or may lead to a climate impact (e.g., high temperatures, heavy rainfall, cyclical variations in temperature over a period of time).

**Climate impact:** The effect that climate has on infrastructure and natural areas.

**Asset category:** A collection of similar community assets . For the purposes of this report – community land use, services and facilities; transportation; Port of Benicia; natural areas; shoreline protection; stormwater and waste water; energy, infrastructure, and pipelines.

project – the vulnerability assessment.

The report follows the following format:

- An overview of the project area
- An overview of the project framework
- Background information on the City of Benicia
- A summary of existing natural hazard stressors
- A topical overview of various asset categories and the historical damage caused by natural hazards. The asset categories include:
    - community land use, services and facilities
    - transportation
    - Port of Benicia
    - natural areas and parks
    - shoreline protection
    - stormwater and waste water
    - energy, infrastructure, and pipelines
- A table of the impact that damage to any given asset category would have on the Benicia economy, environment, equity, and governance.

## Project Area

The map, below, outlines the extent of the Project Area and highlights some of the critical infrastructure and natural areas. The Project Area is located along the City's shoreline, extending from the Benicia State Park in the West to the City's Eastern extent, just past the end of the industrial area (see Figure 1). This area is relatively flat, while outside of the Project Area, the city gains elevation with inland hills.

The shoreline area encompasses a variety of land uses, including natural (e.g., marshes, wetlands, parks, beaches), industrial/commercial, a seaport, and residential areas.

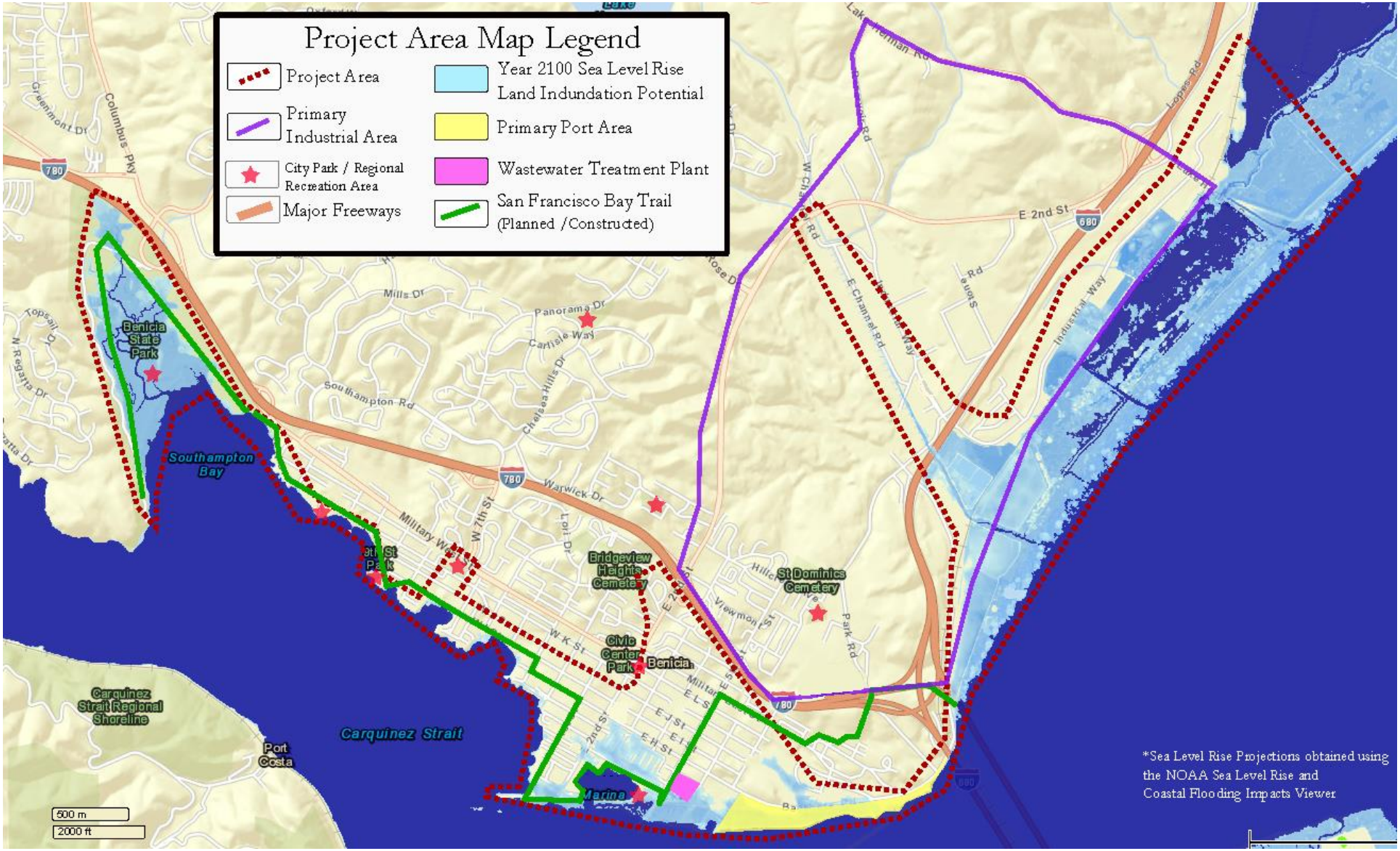


**Figure 1: Project Area Map**

## Framework

From October 2010 through December 2013, the San Francisco Bay Conservation and Development Commission (BCDC), with support from the National Oceanic and Atmospheric Administration Coastal Services Center (NOAA CSC), undertook a first-of-its-kind detailed sea level rise vulnerability assessment project for a sub-section of the San Francisco Bay in Alameda County. This project, named Adapting to Rising Tides (ART), developed and piloted a process for conducting vulnerability assessments by bringing together a broad suite of stakeholders and experts to collectively gain a better understanding of how climate change will affect the ecosystems, infrastructure, and economy of the Bay Area.

The current City of Benicia project is modeled off of this larger ART project and seeks to use the tools and framework developed for the ART project as much as possible. However, due to the differing scales of analysis (city vs. region) and project timeline, the tools will be customized for a local planning effort.

A key element of the ART project that will be replicated here is the focus on four overarching frames of analysis:

- Society and equity
- Economy
- Environment
- Governance

Together, these four foci comprise a sustainability framework that will inform the consideration of adaptation strategies and options, and will help address how Benicia can support a sustainable and prosperous economy while building resilience to climate change.

The information contained in this report has been pulled from a variety of sources. Much of the generalized background information is drawn from the ART Existing Conditions Report. The information gleaned from that document has been supplemented with Benicia specific information gathered from:

- Conversations with City staff
- Meetings with:
    - the Technical Advisory Committee (TAC)
    - the Community Advisory Group (CAG) members
- City of Benicia documents
- National databases and resources
- Other online resources (see References)

# Background

## City of Benicia

The City of Benicia is located on the interior of the San Francisco Bay, on the north bank of the Carquinez Strait in Solano County. The city encompasses 15.7 square miles, 12.9 of which are land miles and 2.8 of

which are water miles. This results in an average population density of 1,700 residents per square mile; however, portions of Benicia, such as downtown, are significantly denser.

**Table 1: City of Benicia Demographics**

| | |
|---|---|
| Population | 26,997 |
| Median Income | $88,691 |
| Population Living Below U.S. Poverty Line | 5.5% |
| High School Diploma | 93.8% |
| Bachelor's Degree or Higher | 40.7% |
| Median Age | 43.9 |

*Source: 2010 U.S. Census*

The demographics, presented in Table 1, show that Benicia is a more affluent and highly educated community than the average Bay Area community.

The climate is temperate and Mediterranean, resulting in dry, warm summers and moderate winters. Rainfall averages 19 inches and falls mostly from December through April. The mean annual temperature is 63 degrees with prevailing winds from the west to the southeast.

## General Land Use

Development in the City of Benicia must be consistent with the various adopted plans and policies. The General Plan was adopted in 1999 and guides land use decisions within the City. Between 1999 and 2005, several small changes to the zoning were adopted by Resolution and incorporated into the most recent land use map (see Figure 2).

Following the development of the 1999 General Plan, several specific plans have been developed to present a vision for growth and improvements within specific geographic areas. Current and ongoing specific planning areas include:

- the 2007 Downtown Mixed Use Master Plan (2007)
- the 2009 Draft Arsenal Specific Plan (this plan was never adopted)
- the Urban Waterfront Enhancement and Master Plan (currently under development)

These plans can provide insight into the potential for future development in areas that are at risk to natural hazards and climate change. This possibility will be further explored in a later stage of this project.

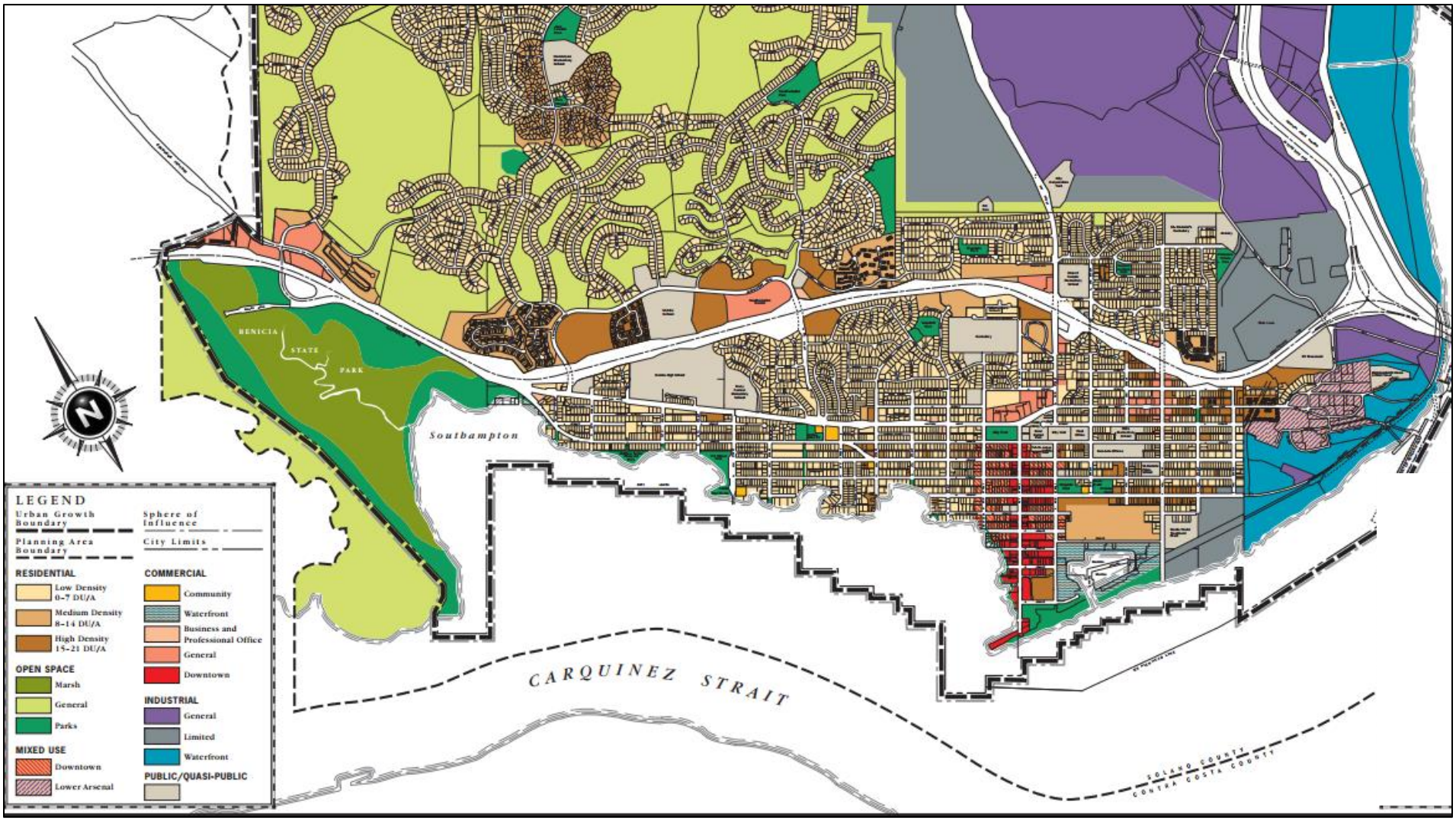


**Figure 2: Figure 2: City of Benicia Land Use Diagram**

## Existing Stressors

Existing weather stressors and the impacts of natural disasters are not as substantial within the Benicia Project Area as they are within some portions of the Bay Area. An overview of major existing hazards (e.g., earthquakes, flooding, landslides, wildfires, drought) are recorded in the 2011 City of Benicia Local Hazard Mitigation Plan Annex and in detailed maps at quake.abag.ca.gov.

### *Earthquakes*

According to the Association of Bay Area Governments, Earthquakes Hazard Program, "Solano County is at risk from many earthquake scenarios. These include Hayward/Rodgers Creek, Green Valley, West Napa, San Andreas, Hunting Creek-Berryessa, and two Great Valley scenarios. The Concord/Green Valley fault is the only known active fault passing within County borders, in the western portion of the county. However, its close proximity to the Hayward Fault, which has the greatest likelihood of rupturing in the next 30 years of all the faults in the Bay Area, combined with moderate to high susceptibility of liquefaction throughout most of the county due to delta soils, leaves Solano County at risk in the next major earthquake. The last major earthquake with an epicenter within Solano County was the Vacaville-Winters earthquake in 1892, estimated to be of magnitude 6.5. It is unknown which fault caused this earthquake."

Table 2 and Figure 3 provide information on earthquake vulnerability and shaking potential within the City. As can be seen in Figure 3, despite not suffering significant damage during the 2014 South Napa Earthquake nor the 1989 Loma Prieta earthquake, the Project Area is subject to significant shaking potential during an earthquake along the **Concord/Green Valley** fault. The specific scenario represented in the figure is a magnitude 6.8 earthquake which the US Geological Survey models to have a 2.7 percent chance of occurring in the next 30 years.

Not all ground in Benicia will experience the same magnitude of shaking during an earthquake due to the different geological materials that make up the City. According to maps produced by ABAG, the shaking amplification is greatest along the Bay due to the deep, loose natural clay (commonly referred to as Bay mud), and the portions of the Bay that were filled to accommodate additional construction. Although filling the Bay has largely been stopped, the existing fill is still utilized for construction and is highly susceptible to settlement and liquefaction (a phenomenon whereby saturated or partially saturated soils lose strength and stiffness and behave like a liquid). There is no comprehensive map of fill locations for the City of Benicia.

**Table 2: Exposure to Earthquakes (acres of urban land)**

| Hazard | 2010 **(acres of urban land)** |
|---|---|
| Earthquake Faulting | 25 |
| Earthquake shaking **(within highest two shaking categories)** | 1,320 |
| Earthquake-Induced Landslides | n/a |

| Hazard | 2010 **(acres of urban land)** |
|---|---|
| Liquefaction **(within moderate, high, or very high liquefaction susceptibility)** | 833 |

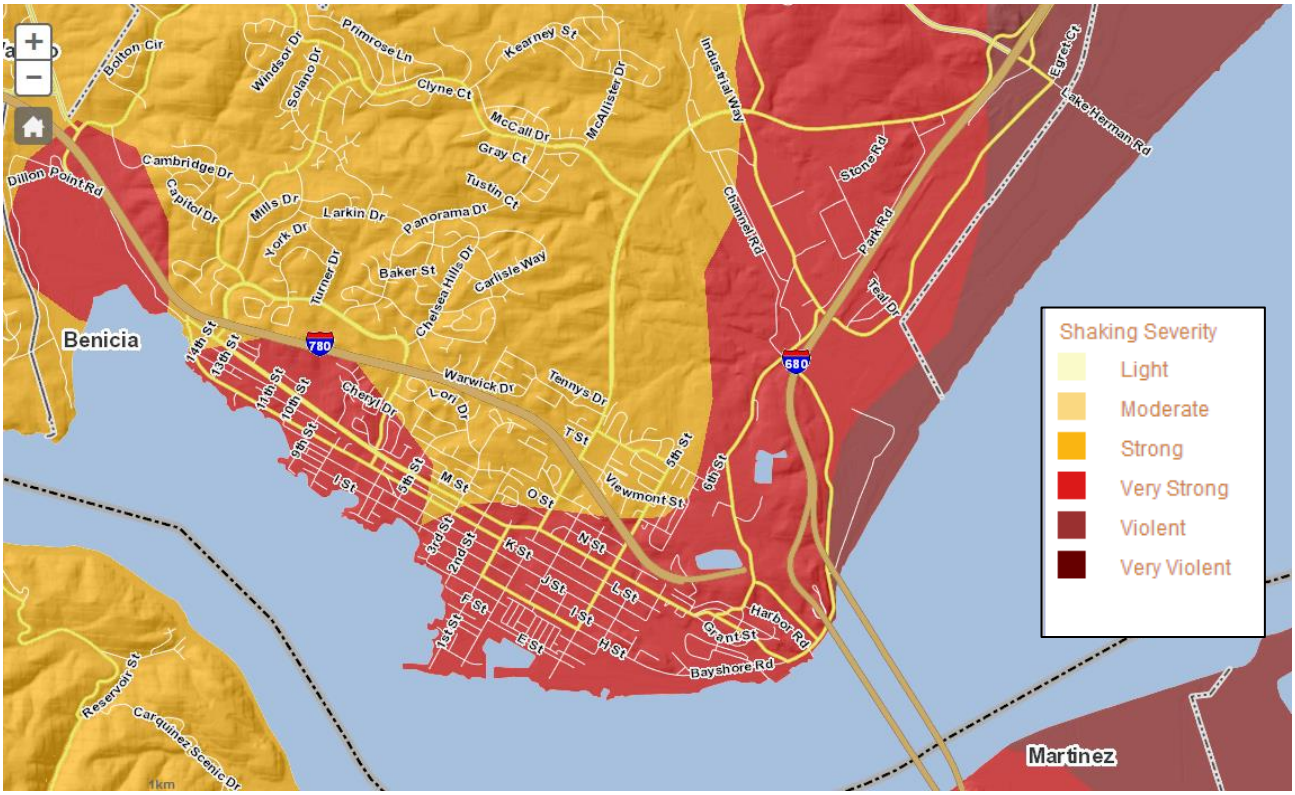


**Figure 3: Concord-Green Valley Earthquake Shaking Severity** ***Source: ABAG Earthquakes and Hazards Program***

## *Subsidence/Settlement*

Settlement occurs when the weight of relatively new buildings or structures compacts the ground beneath it. Subsidence occurs when the ground below a structure cannot support it. This commonly occurs in loose or highly compressible soils such as Bay mud and Bay fill along the Benicia coast.

## *Flooding*

The vast majority of the Project Area consists of low-lying land without any appreciable grade. This constrains the natural drainage systems, some of which have been interrupted by development or eliminated due to Bay fill, and leads to inland back-up of rainfall.

Portions of the City of Benicia are within the Federal Emergency Management Agency (FEMA) 100 year and 500 year flood plain insurance maps. A 100 year flood event has a 1% chance of occurring every year, while a 500 year flood event has a 0.5% chance of occurring every year. FEMA is currently in the processing of updating these maps; however, neither the current nor the future maps take into account

future changes in sea level rise and storm events. Table 3: Exposure to Flooding Hazards  displays the current FEMA flood map risks.

**Table 2: Exposure to Flooding Hazards**

| Hazard | 2010 **(acres of urban land)** |
|---|---|
| Flooding **(within 100 year floodplain)** | 524 |
| Flooding **(within 500 year floodplain)** | 85 |

### *Wildfires*

As can be seen in Figure 4, the majority of the Benicia coastline does not fall within a wildfire hazard zone; most of Benicia's fire vulnerability lays farther inland where temperatures tend to be hotter and there are larger quantities of fuel from dry grasslands. The one exception is near the Benicia-Martinez bridge touchdown where there are some fire risks. Although the prevailing winds blow inland off of the coast, there is still the potential for hazardous air quality days within the Project Area when there are inland fires.

Due to the limited historic impact of fires within the Project Area, the remainder of this report does not include wildfires as an existing stressor.

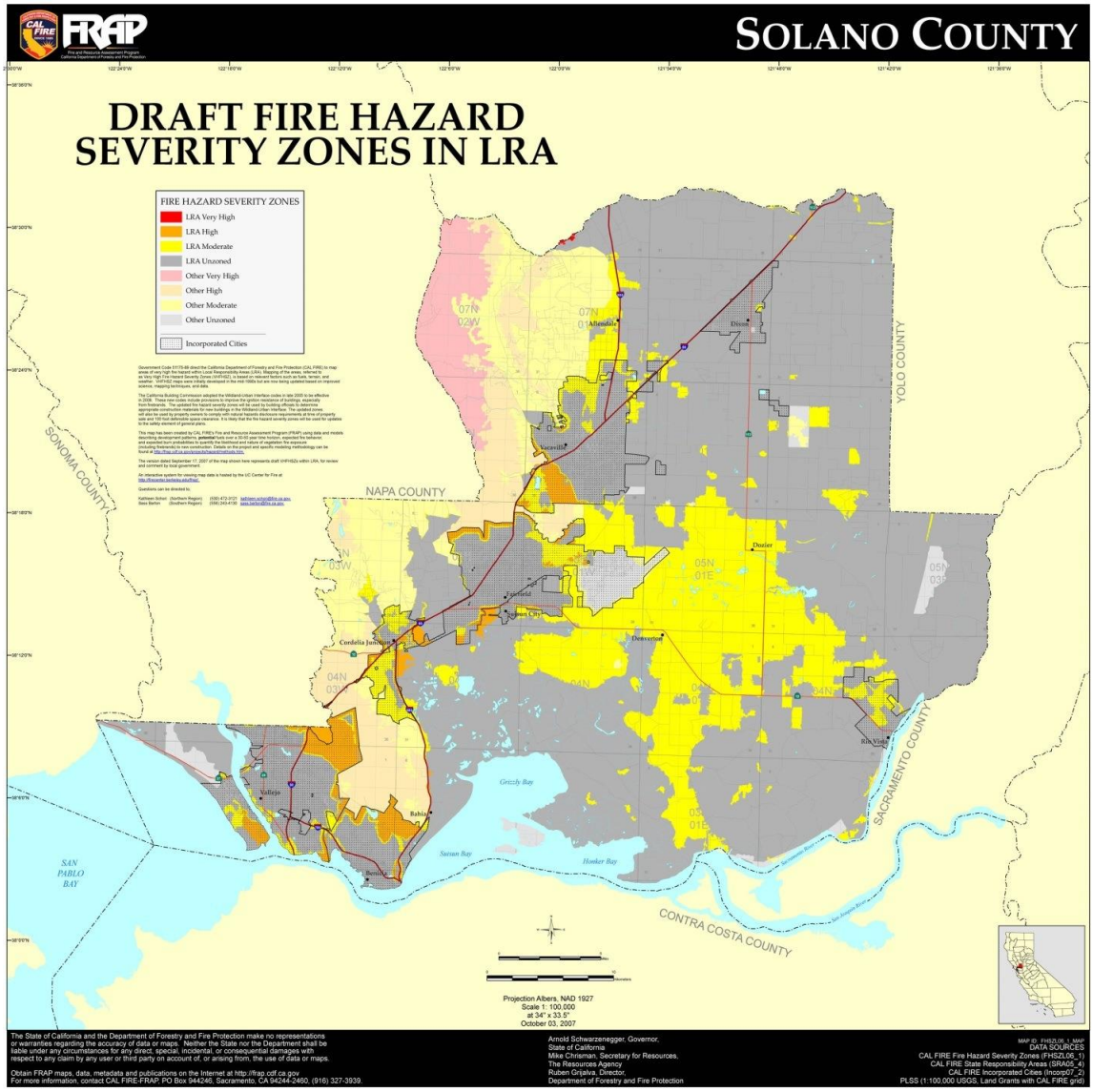


**Figure 4: Fire Hazard Severity Zones.** ***Source: CAL FIRE***

## *Other Hazards*

Other hazards that Benicia identified in their Local Hazard Mitigation Plan include: landslides, wildfire, dam inundation, and drought. Landslides and wildfires are more likely to affect the Benicia hills, inland of the Project Area. Table 4 displays the geographic extent of these hazards.

**Table 3: Exposure to Other Hazards**

| Hazard | 2010 **(acres of urban land)** |
|---|---|
| Landslides **(within areas of existing landslides)** | 41 |

| Hazard | 2010 **(acres of urban land)** |
|---|---|
| Wildfire **(subject to high, very high, or extreme wildfire threat)** | 316 |
| Dam Inundation **(within inundation zone)** | 429 |
| Drought | 5,350 |

*Source: City of Benicia Annex to 2010 Association of Bay Area Governments Local Hazard Mitigation Plan*

# Existing Conditions and Stressors

## Community Land Use, Services and Facilities

### Overview

Community land use includes the buildings and infrastructure that make up Benicia's neighborhoods, commercial centers, and communities. This infrastructure supports the social and economic structure of the city.

#### *Residential*

The city's residential areas (which expand outside of the Project Area) include approximately 11,422 housing units (2008-2012 American Community Survey). The majority of Benicia's housing stock is single-family units; however, there are a mix of condos, a mobile home park, apartments, and some limited mixed use space along the waterfront and downtown areas.

The existing housing stock matches the Benicia zoning regulations with the vast majority of the stock consisting of low density development (0-7 Dwelling Units per Acre). Exceptions to this low density residential pattern include the downtown area and the Benicia Industrial Park.

Natural hazard impacts to housing could require temporary emergency response services and long-term rebuilding assistance.

#### *Commercial/Industrial*

The Benicia 2013 Comprehensive Annual Financial Report documents the top city employers (see Table 4). The **Benicia Industrial Park (BIP)** is the largest industrial park in Solano County. It is comprised of 600 businesses, and employs over 7,000 individuals. Additionally, it generates over 60% of Benicia's total sales tax revenue through a large range of business types including: manufacturing, construction, petroleum refining, biotech, and steel fabrication. In particular, the **Valero Benicia Refinery** is the city's top employer and tax payer. The Valero Benicia Refinery produces 10% of the gasoline used in California and 25% of the gasoline used in the San Francisco Bay Area. Approximately 70% of the refinery's product is gasoline; other products include diesel, jet fuel, fuel oil, propane and asphalt. Natural hazard impacts on any of these businesses would impact Benicia's economy.

**Table 4: City of Benicia Principal Employers**

| Employer | No. of Employees | Percentage of Total City Employment |
|---|---|---|
| **Valero** | 500 | 1.9% |
| **Benicia Unified School District** | 375 | 1.4% |
| **Cytosport** | 292 | 1.1% |
| **Dunlop** | 234 | 0.9% |
| **City of Benicia** | 230 | 0.9% |

The **Benicia Arsenal** was originally built as part of a large military reservation and was the primary US Army Ordnance facility on the West Coast. The base was closed by the Army in the early 1960's and given to the City of Benicia which then sold portions to various private parties. The base is now home to a thriving arts, health, food, and entertainment community as well as many industrial businesses. The Arsenal is on the National Historic Registry and is important to Benicia for cultural and historical reasons.

### *Public Facilities*

Critical public facilities within the City of Benicia include seven **schools** (with one, Liberty High School, within the Project Area), one **police station** (within the Project Area and located by Civic Center Park), and two **fire stations** (one of which is on Military Way, within the Project Area). There are no hospitals within the Project Area.

Natural hazard impacts to any of these facilities would limit they city's ability to respond and assist the public following a natural hazard.

## Existing Stressors

### *Settlement*

There are numerous examples of settlement along the Benicia coast line. For example, the **Portside Village** townhomes (116 townhomes in 25 buildings), built in 1999, have experienced settlement and flooding, and have already invested in retrofits to raise and protect their buildings from existing stressors. Although the responsibility for building protection falls on the individual homeowners, the buildings are located on land that is leased from the City which may impact how future adaptation strategies are implemented.

### *Flooding*

In 2005, Benicia experienced a 40-year storm event that coupled extreme high tides with heavy rain. This event led to coastal water overtopping local flood protection structures, flooding downtown, neighboring residential areas, and other portions of the City. According to the national weather service, Benicia received 2.11 inches of rainfall in just one day, and a cumulative 3 inches over the next several days.

Regular flooding of residential areas during high tide and storm events occurs throughout the Project Area. Housing that has historically been impacted by flooding includes: **Portside Village**, other residential and commercial properties surrounding the **Benicia Marina**, the **Rancho Benicia** mobile home park, and some homes along the **300 block of I Street**.

Some residents recall flooding events at Rancho Benicia during extreme tide events that were severe enough to require evacuation via boat. This issue has somewhat been mitigated by changes to the City drainage system. During storm events, the City now diverts water away from Rancho Benicia and over to the **Fitzgerald baseball field.** This practice minimizes flooding in streets and residential areas along **E 2nd Street** and **H Street**.

Along I Street, there used to be a restaurant named **Sam's Harbor** that was regularly inundated during high tide events. This resulted in the eventual closure of the restaurant; however, several homes have now been built on the property. There have been no reports of the homes flooding but they are considered susceptible to flood events.

The homes in older portions of Benicia, closer to downtown and to the east, tend to house **lower income and elderly residents** who require additional assistance during extreme weather events. It is necessary that the community center and other shelters remain open during extreme weather events in order to shelter and care for these residents. There is a **family health center** at the end of Military West that is low lying and susceptible to extreme weather events; however, according to local emergency personnel, there are no major **evacuation facilities** (e.g., shelters), **police, fire stations**, or **safety facilities** that currently experience flooding.

The shoreward portion of the **Benicia Arsenal** is subject to inundation during extreme weather events.

Along **East E Street**, there is a **vacant lot** that could be developed but the property is subject to extreme event inundation and subsidence.

#### *Temperature*

In 2007, Benicia experienced multiple days of over 100°F temperatures. This heat stress damaged transformers and required the opening of **cooling centers**. These high temperatures are currently an infrequent event due to the coastal breezes which lower Benicia's temperature overnight; however, there is a plan in place to respond to these high heat events when they occur.

## Transportation

### Overview

Ground transportation assets in the Project Area are critical for the movement of people and goods. The roads and rails move goods to and from the Port of Benicia and the Industrial Park, within the city, and between the city and the larger San Francisco Bay Area, the rest of the state, and the country.

Benicia is located at the juncture of two major freeways, Interstates 680 and 780. I-680 and 780 provide access to the Bay Area and beyond. I-680 links the city to the four nearby airports:

- Buchanan Field General Aviation Airport
- Oakland International Airport
- Sacramento International Airport
- San Francisco International Airport

Interstate 80 is also accessible from Benicia by traveling five miles west on I-780. The Benicia–Martinez Bridge is part of I-680 and crosses the Carquinez Strait, connecting Benicia and the City of Martinez. The bridge system consists of three parallel bridges: two traffic bridges that carry a total of nine lanes, and a lower Union Pacific Railroad drawbridge that is used by freight trains and Amtrak passenger trains. The vehicle bridges are owned by Caltrans and maintained by Caltrans and the Bay Area Toll Authority (BATA).

The majority of Benicia commuters drive to their places of employment or to the Pleasant Hill or Concord/Martinez BART stations. The City of Benicia is responsible for maintaining the local road network.

Union Pacific Railroad (UP) operates two rail lines that serve the Benicia Industrial Park. UP provides transcontinental "piggyback" services (i.e., transporting loaded truck trailers on flat cars). Also, rail service is provided through siding and tie-ins at company facilities in the Industrial Park, affording direct service to rail cars. Union Pacific, AMPORTS, Valero, and the BIP are looking to bring additional rail traffic into the area.

Solano County Transit (SolTrans) provides public bus transportation services for the City of Benicia and the City of Vallejo. Additionally, SolTrans provides a direct link to several major transit hubs, including: the Vallejo Transit Center, Walnut Creek, the El Cerrito del Norte BART Stations, and the AMTRAK Passenger Rail Service in Martinez, five miles south via I-680.

The San Francisco Bay Trail runs through Benicia (indicated on the Project Area map). The Bay Trail is a planned recreational corridor that, when complete, will encircle San Francisco and San Pablo Bays with a continuous 500-mile network of bicycling and hiking trails. It provides valuable access to recreational opportunities as well as providing a commute alternative for cyclists and connecting numerous public transportation facilities.

## Existing Stressors

Historically, Benicia roads have primarily been impacted by flooding during periods of heavy rain and extreme high tide events. Roadways are also vulnerable to damage during earthquakes and from wildfires.

### *Flooding*

Select roadways along within the City of Benicia currently experience flooding during storm and high tide events. Several TAC and CAG stakeholders have referenced frequent flooding along **E 2nd and E 5th streets**. These roadways are flooded during periods of intense rain and high tide/winds. Neighboring E

1st Street is a core shopping and restaurant area so flooding on E 2nd Street impacts parking and access to these amenities. As mentioned earlier, sections of I Street are also vulnerable to inundation.

The freeways are owned and maintained by Caltrans who has not yet been engaged in this project; however, they will be consulted in future phases. Although the **freeways** are elevated through the Project Area, their foundations do experience temporary flooding. Additionally, several TAC and CAG members mentioned seeing extreme high tide events lead to water back-up onto the **I-680** on and off ramps just inland of the industrial area.

CAG members stated that they had experienced periodic flooding along lower East Street and First Street in the lower **Benicia Arsenal**.

Flooding along Sulfur Springs Creek pours over and affects several transportation assets, including:

- access to **Park Street**
- access to **Bayshore**
- the **Bay Trail**

The **Union Pacific rail lines** both reduce and exacerbate flooding issues in Benicia. The lines currently serve as a defense against coastal flooding since the tracks are elevated; however, they occasionally overtop. When there is inland flooding due to precipitation which collects in Sulfur Springs Creek, the UP tracks and vegetation growth within their right of way limits drainage. This causes longer duration flood events. Additionally, the rail bridge across the Carquinez straight is at a very low elevation and is on the National Registry of Historical structures.

### *Other Stressors*

In addition to flooding, roadways are also vulnerable to earthquakes and liquefaction, and wildfires as indicated in Figure 5, below.

**Table 5: Miles of Benicia infrastructure exposed to existing stressors.**
***Source: Benicia 2011 Local Hazard Mitigation Plan Annex***

| Exposure (miles of infrastructure) | | | | | | |
|---|---|---|---|---|---|---|
| **Hazard** | **Roadway** | | **Pipelines** | | **Rail (incl. Amtrak)** | |
| | **2005** | **2010** | **2005** | **2010** | **2005** | **2010** |
| *Total Miles of Infrastructure* | *157* | *153* | *134* | *117* | *16* | *15* |
| Earthquake Shaking (within highest two shaking categories) | 28 | 29 | 26 | 26 | 6 | 7 |
| Liquefaction Susceptibility (within moderate, high, or very high liquefaction susceptibility | 17 | 18 | 16 | 12 | 10 | 7 |
| Liquefaction Hazard (within CGS study zone)[1] | n/a | n/a | n/a | n/a | n/a | n/a |
| Earthquake-Induced Landslides (within CGS study zone)[2] | n/a | n/a | n/a | n/a | n/a | n/a |
| Earthquake Faulting (within CGS zone)[38] | 0 | 0 | 0 | 0 | 0 | 1 |
| Flooding (within 100 year floodplain) | 7 | 5 | 7 | 4 | 4 | 5 |
| Flooding (within 500 year floodplain) | 1 | 2 | 1 | 1 | 0 | 1 |
| Landslides (within areas of existing landslides) | 0 | 1 | 1 | 1 | 0 | 0 |
| Wildfires (subject to high, very high, or extreme wildfire threat) | 15 | 8 | 12 | 4 | 2 | 1 |
| Wildland-Urban Interface Fire Threat | 115 | 111 | 103 | 90 | 7 | 7 |
| Dam Inundation (within inundation zone) | 11 | 10 | 11 | 9 | 3 | 3 |
| Tsunamis[4] | not applicable | | | | | |
| Drought[5] | not applicable | | | | | |

## Port of Benicia

### Overview

The Port of Benicia is critical to the local economy and, due to its location on the coast and adjacent to Sulfur Springs Creek, has experienced many coastal and inland flooding issues.

The port is privately owned and operated by AMPORTS; however, the underlying land is owned by the City of Benicia. AMPORTS lease on the land will sunset in 2032. The Port is located at the southernmost point of Benicia, and is indicated in yellow on the Project Area Map (Figure 1). The port spans 645 acres within the 4,000-acre Benicia Industrial Park, with 140,000 square feet of vehicle processing buildings and a 38-foot deep channel. The 2,400-foot long deepwater pier has the capacity to berth 3 ships, while on-terminal rail access from Union Pacific can potentially utilize 170 railcars. Inland access to and from the port is from I-680, I-780, I-80, and SR-4.

The Port of Benicia is a trading hub with Japan, South Korea, and Australia, and handles neo-bulk and dry bulk cargos. The port is the Northern California hub for domestic distribution of Ford and Chrysler, and Toyota delivers to Northern California solely through the port of Benicia. The Port also exports oil from the Valero Benicia Refinery.

### Existing Stressors

Earthquakes and flooding, due to extreme high tides and inland precipitation, are the main existing stressors to the Port of Benicia.

### *Earthquakes*

The 1989 Loma Prieta Earthquake damaged similar ports, such as the Port of Oakland, which was built on bay fill. The Port of Benicia is also built on fill which significantly increases its liquefaction potential and has resulted in significant local subsidence. A port employee at the TAC meeting estimated that some **buildings** have subsided by as much as 4 feet over the last three decades.

### *Coastal Flooding*

The Port of Benicia currently experiences flooding during extreme high tide and storm events. Significant coastal flooding has been experienced during extreme weather events such as the El Nino years in the 1980's and 1990's. Historically, AMPORTS has used sandbags to fortify their property against coastal flooding and pumps to remove water that infiltrates the Port. In 1986, AMPORTS raised their **levees** by two to three feet in an effort to reduce future flooding events; however, sandbags are still required during extreme weather. Most of today's coastal flooding affects AMPORTS' **Yuba property**, which is immediately west of the main port facilities.

### *Inland Flooding*

Inland flooding during precipitation events infiltrates the Port from **Sulfur Springs Creek**. There is limited natural drainage along this area, in part due to the lack of maintenance and dredging, as well as frequent blockages from **beaver dams**. Additionally, water is concentrated in this area due to runoff from the I-680 Benicia-Martinez Bridge, water discharged from Valero's water treatment plant, and reduced drainage due to vegetation growth along the Union Pacific railroad tracks. AMPORTS current response to flooding events is to fortify their property with sandbags and pump water into the Bay. Their **pumps** are elevated, currently located on top of their levees.

## Natural Areas and Parks

### Overview

Benicia has several parks and natural areas (e.g., wetlands, marsh, beaches). These areas are important to the community for recreation and serve vital ecological benefits.

The Benicia State Recreation Area features marsh, grassy hillsides, and rocky beaches along the Carquinez Strait. The park consists of 2.5 miles of road and bike paths for cyclists, runners and walkers, equestrians, and roller skaters, and an area for recreational fishing.

The Vallejo-Benicia Waterfront is part of the Bay Area Ridge Trail and is open for biking, hiking, and horseback riding. The Benicia portion of the trail runs 3.5 miles east from the State Recreation Area to Benicia Point.

Other parks in the Project Area are the Twelfth Street Park, Ninth Street Park, Willow Park, Civic Center Park, Fitzgerald Park, and the Benicia Marina.

Benicia also has a significant stretch of natural marsh in the west portion of the Project Area, immediately in front of the BIP. These wetlands and the Benicia State Recreation area serve as natural habitats for a range of flora, birds, and other wildlife.

### Existing Stressors

#### *Human Impacts*

The parks are subject to management and budget constraints. Demand for park services, particularly on weekends, can exceed park capacity, lead to heavy use, and traffic congestion. Additionally, tighter budgets have led to deferred preventative maintenance, reduced budgets for maintenance and repairs, and limited operating hours.

Both allowed and prohibited or unmanaged activities in the natural areas within the Project Area can reduce habitat usage by wildlife and cause direct harm to wildlife. These activities include the use of trails adjacent to habitats, intrusion into habitat areas, and littering impact wildlife and their habitats.

Two recent oil spills in the Bay required cleanup along the beaches and shorelines.

#### *Flooding*

Over the past few years, the parks have been affected by severe storms and weather that resulted in flooding, and erosion in the parks.

**Fitzgerald Park** currently serves as a retention area for water during storm events.

The **Benicia Marina** is subject to inundation during extreme high tide events. The dock is a floating dock which provides some protection from tidal changes.

## Shoreline Protection

### Overview

The Benicia shoreline consists of a variety of shoreline protection types which vary from engineered sea walls and revetments to natural features, such as wetlands. This protection buffers Benicia from extreme tide events.

The various types are described below and their general locations along the shoreline are provided in Table 6.

**Table 6: Shoreline Protection Locations**

| Location | Types |
|---|---|
| **Benicia State Park - W. L St.** | Bluff |
| **W. L St. - W 13th St.** | Bluff w/ isolated seawalls and engineered revetments |
| **W. 13th St. - W 9th St.** | Bluff |
| **W. 9th St. - Gull Point Court** | Bluff w/ isolated seawalls and engineered revetments |

| Location | Types |
|---|---|
| **Gull Point court - W. Kuhland Alley** | Engineered revetment |
| **W. Kuhland Alley - E. B St.** | Unprotected shoreline w/ isolated sea walls and non-engineered slope protection |
| **1st St. from E. B St. to the peninsula** | Seawall |
| **1st St. peninsula** | Engineered revetment |
| **1st St. to AMPORT** | Wetlands |
| **Benicia Waste Water Treatment Plant** | Flood wall |
| **AMPORTS** | Engineered revetment small sections unprotected or non-engineered slope protection |
| **AMPORTS – I-680** | Unprotected shoreline w/ isolated sea walls and non-engineered slope protection |

***Engineered Revetments*** - Revetments harden the shoreline, protecting it from waves and strong currents that could cause erosion and land loss. Revetments are generally constructed using three components: an armor layer of larger rock, an underlayer or smaller rock, and an optional filter layer typical comprised of a geotextile. Engineered revetments also have toe of slope protection.

Revetments are primarily designed to protect the shoreline, but they are susceptible to damage from strong currents and wave conditions that occur beyond the "design" event.

Revetments generally require ongoing maintenance. They can be upgraded over time by placing additional armoring sized for increasing wave conditions, the revetment height can be increased, and additional toe protection can be added. Table 6 provides an overview of the location of engineered revetments.

***Seawall*** - A sea wall is a vertical retaining structure designed to protect a shoreline from erosion. Sea walls are design to protect shorelines from wave and current action. The life of the wall will vary with material type, due to corrosion or other damage. Additionally, if portions of the shoreline at the ends of the walls are unprotected they may be susceptible to flanking causing the shoreline behind the wall to slowly erode from the unprotected edges. Over time seawalls may need replacement due to degradation or damage. Table 6 provides an overview of the location of seawalls.

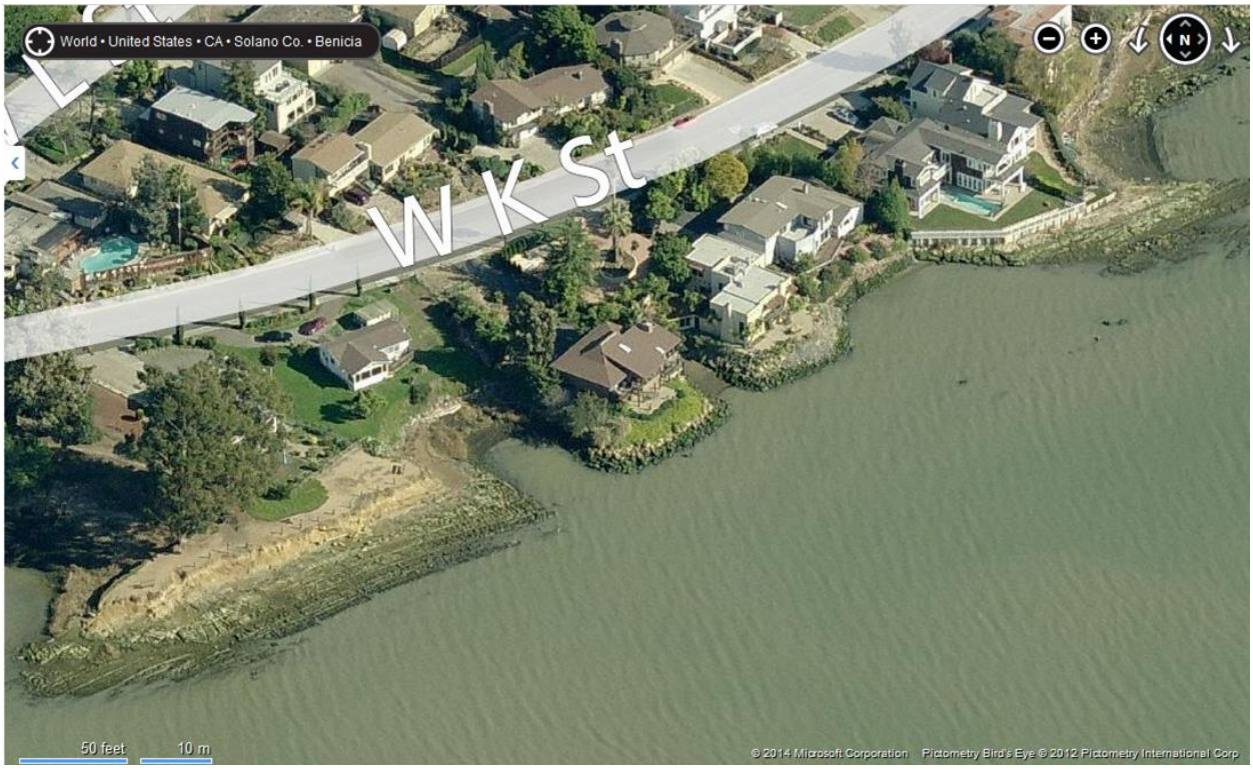


**Figure 5: Unprotected bluff (left), engineered revetments (center), sea wall (right)**

***Non-Engineered Slope Protection*** - Non-engineered slope protection often may look somewhat similar to Engineered Revetments and are often used to protect the toe of bluffs or side slopes exposed to wave and current action. The primary difference between the two is that for non-engineered slope protection rock, concrete debris, rock and other materials are generally placed in an ad hoc manner to address erosion, and typically not in accordance with specific design standards, to ensure it will withstand waves and currents.

Maintenance of non-engineered slope protection is typically reactive, e.g., when erosion, failures or settling are observed. They are susceptible to damage, displacement, and deterioration due to waves and currents as they are often not designed to resist wave action during storm events. Table 6 provides an overview of the location of non-engineered slope protection.


**Figure 6: Non-engineered slope protection (left) and seawall (right)**

***Natural Features Bluff (non-wetland)*** - Much of the Benicia shoreline consists of natural bluff features. These are characterized as tall, steep hill sides. They are made of erosive material subject to wave action as well as erosion due to overland flow. Many of the bluffs exhibit on-going erosion due to wave action at the toe of bluff. In some areas non-engineered slope protection has been added to the toe of slope to slow the process of bluff retreat. Table 6 provides an overview of the location of bluffs.

***Flood Wall*** - A flood wall is a vertical structure designed to protect inland areas from flooding from a 100-year water level. They are designed to meet specific criteria with respect to freeboard (the distance between the top of wall and the 100-year water level), embankment protection, embankment and foundation stability, and settling. Flood walls require ongoing maintenance and their flood protection value depends on the amount of freeboard and the structural stability. Table 6 provides an overview of the location of flood walls.

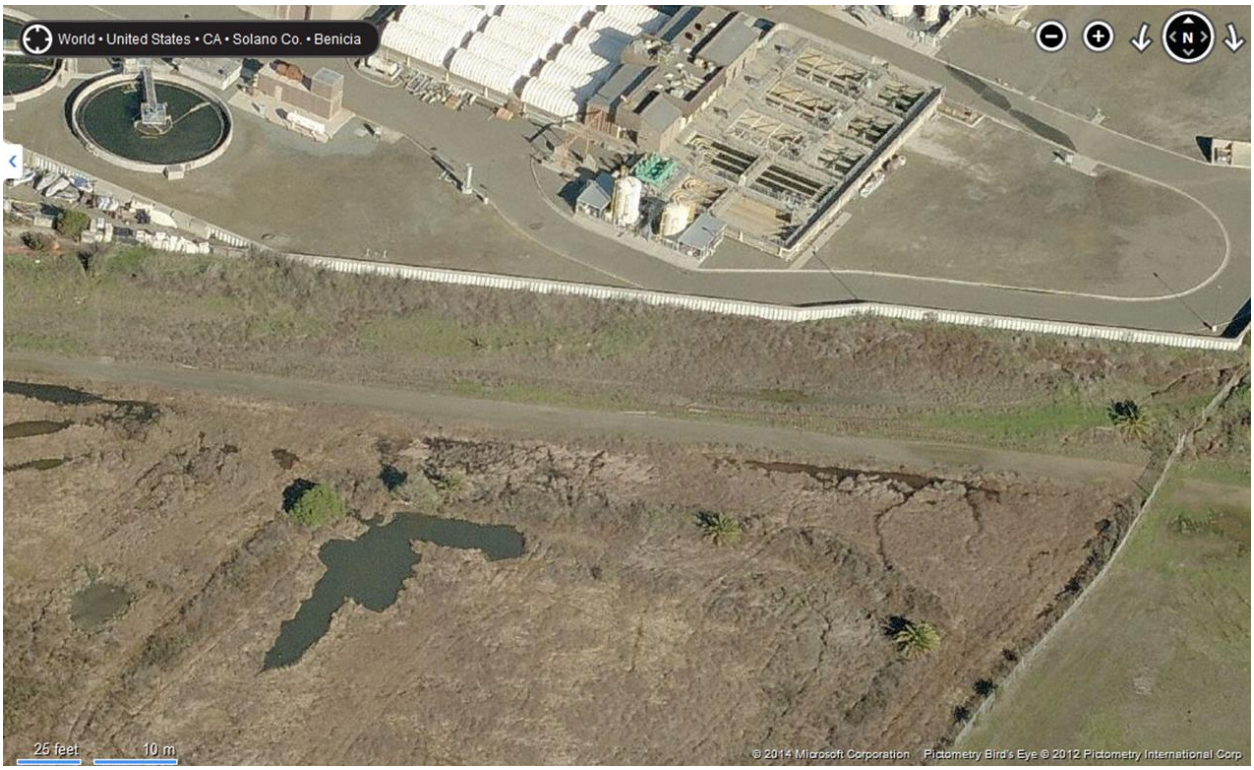


**Figure 7: Flood wall**

## Existing Stressors

### *Human Stressors*

Existing stressors to engineered shoreline protection structures include a lack of resources to conduct necessary maintenance, enhancements, and restorations.

Regulatory requirements also create barriers to improving, enhancing, or maintaining structural shorelines. In natural areas throughout the Bay, research is still being conducted to determine if the existing sediment supply is sufficient to maintain the natural accretion rates. Even if it is found to be sufficient, in some locations there is limited or no access to upland areas for inland migration. Large invasive plant and animal species can undermine the integrity of both natural areas and human made structures. Additionally, both natural and human made protections are affected by natural erosion and the subsidence of Bay fill.

### *Coastal Flooding and Erosion*

Engineered shoreline protection along the waterfront is vulnerable to overtopping and is currently subject to erosion and undercutting during storm events.

## Storm Water/Wastewater

### Overview

The storm water and wastewater treatments plants in Benicia are designed to minimize flooding and provide clean water to the city, respectively.

The Wastewater Treatment Plant on E 5th Street was built in 1958 and has been upgraded and expanded several times to continue to serve the community today. The plant is maintained and operated by the Public Works' Wastewater Operations Division. The plant has a permitted dry weather capacity of 4.5 million gallons per day and a short-term hydraulic capacity of 24 million gallons per day.

The sewer system is managed by the City of Benicia's Public Works Department. The collection system consists of 24 lift stations, approximately 150 miles of sewer pipelines, a 3-mile wet weather relief (interceptor) pipeline, and 6 wet weather control structures. The discharge system consists of a 1,100-foot long outfall pipeline and a 150-foot long outfall diffuser pipeline. The system's design and construction standards follow the department's Engineering Design Standards and Standard Plans developed in December 1992 with adopted revisions.

Since 2006, the city implemented a citywide Sanitary Sewer System Management Plan (SSMP) to properly manage, operate, and maintain all parts of the sanitary sewer system to reduce Sewer System Overflows (SSOs). As part of the plan, the department:

- Developed and maintains a map of the sewer system
- Developed a memorandum that describes routine preventative operation and maintenance activities
- Developed a rehabilitation and replacement plan
- Provides regular training to operations and maintenance staff
- Developed equipment and replacement part inventories
- Implemented an outreach program to educate plumbing and sewage contractors about proper practices for preventing blockages in private laterals

The city also developed a Sanitary Sewer Overflow and Backup Response Plan.

The city provides annual reports on the city's Storm Water Management Plan (SWMP), adopted in 2003, which outlines storm water reduction and control measures.

The Valero refinery also operates its own wastewater treatment plant to process water that is used in the refining process, used for cooling, and that falls as rain on the Valero property. The Valero Refinery has installed complex facilities to treat the refinery's wastewater before discharging it into Suisun Bay through an outfall. The wastewater treatment plant includes:

- Surge tanks and retention ponds
- A chemical pre-treatment unit
- Corrugated Plate Separators
- Induced Static Flotation units

- An Activated Sludge unit
- Holding ponds
- An outfall

## Existing Stressors

The Benicia storm water and wastewater system can be stressed due to limited treatment capacity, lack of system redundancy (there is only one municipal waste water treatment plant), and aging infrastructure (the wastewater treatment plant was originally constructed in 1971 but has been regularly maintained and upgraded since that time) that requires ongoing operation and maintenance, and pollutant and organic loading factors.

### *Coastal Flooding*

The Benicia **wastewater treatment plant** staff have already begun assessing vulnerabilities and identifying adaptive responses in their Wastewater System Master Plan. For example, the Benicia wastewater treatment plant is currently surrounded by a sheet piling sea wall, which was constructed as part of the 1998 plant improvements. The 1998 drawings indicate a top sea wall elevation of at least 6 feet above grade, which, when combined with the overall elevation of the plant, would indicate a top wall elevation varying from about 111 to 113 feet above sea level.

The wastewater treatment plant currently pumps all of its discharge water into the Bay. There is a low probability of drainage issues since the system does not rely upon gravity for discharge (they utilize pumps). However, there are **interceptor sewer lines** along the waterfront which may be inundated during a storm event. This level of inundation could overwhelm the wastewater treatment plant and significantly increase the total dissolved solids in the water, making it harder to process.

The wastewater treatment plant at the **Valero Refinery** flooded in the 1990's which lead to a period of illegal wastewater discharge into the Bay. Some water from the Valero wastewater treatment plant is pumped into the Sulfur Springs Creek where it then becomes the responsibility of AMPORTS to pump into the Bay during flooding events.

Due to the limited gravity pull on the storm water system and low water outfalls, there are backups in the storm water system during large storm and high tide events. Along A Street between 1$^{st}$ and E 2$^{nd}$ Street, the **storm drains** are surcharged which leads to flooding due to their inability to drain. At the base of 9$^{th}$ Street, the **outfall** is low and can be inundated during high tide events.

### *Inland Flooding*

During storm events, water can be diverted to avoid significant flooding along critical streets or residential areas. As mentioned earlier, water is frequently diverted from the Rancho Benicia housing area to the Fitzgerald baseball field. Also, water from E 2$^{nd}$ Street and B Street is diverted to an **outfall at W 2$^{nd}$ Street and F Street**, where the outfall is set above the high tide level. That outfall was constructed within the last eight years and still has freeboard during extreme tide events. There is also a large **outfall at 9$^{th}$ Street** that is approximately 30 feet above sea level. In many locations, the existing **storm water**

**pipes** are undersized for the amount of precipitation experienced in large storms which exacerbates the inland flooding issues.

The City currently **dredges along Industrial Ave to the east of E 2nd Street**. This reduces the amount of flooding that occurs during a rainfall event by providing a deeper catchment area.

## Energy Infrastructure and Pipelines

### Overview

Pacific Gas & Electric (PG&E) provides electricity and natural gas to the City of Benicia. PG&E's electricity mix includes:

- 47% natural gas
- 23% nuclear
- 13% renewables
- 17% hydroelectric
- 4% from coal
- 1% other

Due to security issues, PG&E cannot release maps of transformer locations or transmission lines but the company has agreed to actively participate in this project, provide infrastructure locations when possible, and review deliverables. It is also known that they have energy substations along the Carquinez Strait.

According to city officials, Benicia also consumes a significant amount of natural gas. This reliance on natural gas warrants particular attention to the vulnerabilities of energy infrastructure, and pipelines. The specific location of natural gas pipelines is difficult to obtain; however, the U.S. Department of Transportation Pipeline and Hazardous Materials Safety Administration maintains a National Pipeline Mapping System that provides a rough sense of the location of pipelines. This information can be viewed in Figure 9.

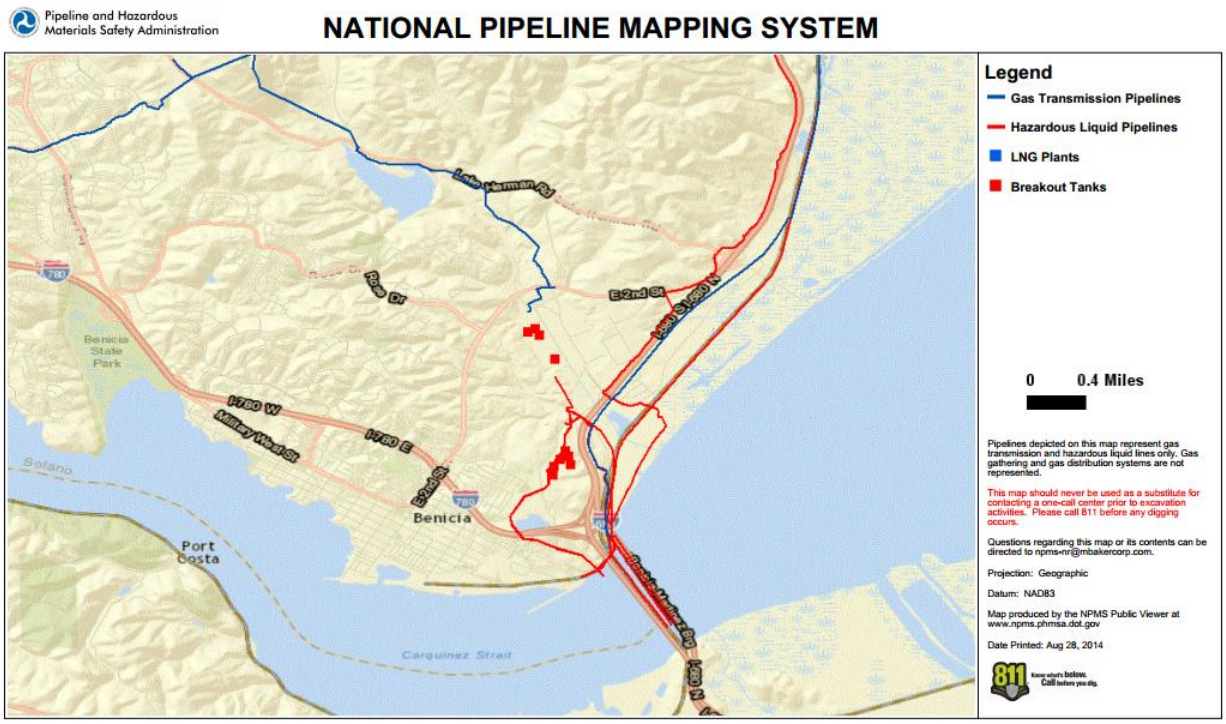


**Figure 8: Benicia Pipelines and Tanks**

Valero owns and operates a refinery (see Figure 10 and the Breakout Tanks in Figure 9) that produces California regulation-compliant gasoline, as well as asphalt, jet fuel, diesel, and propane. Valero plans to obtain additional crude oil for its refinery by rail, for which a Draft Environmental Impact Report has been released.


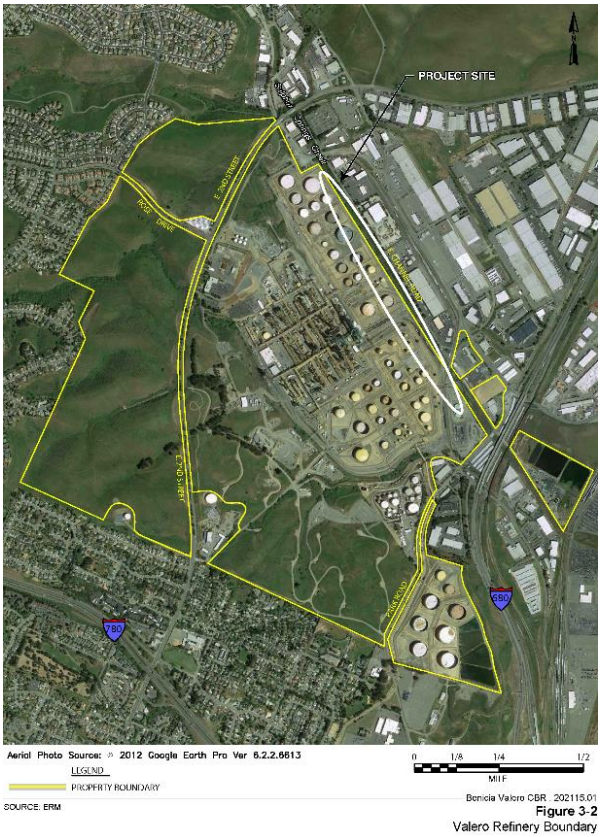


**Figure 9: Valero Refinery Location**

The 2010 City of Benicia Hazard Mitigation Plan Annex identified 117 miles of pipeline in Benicia as being exposed to the following stressors:

- 26 miles vulnerable to earthquake shaking
- 12 miles vulnerable to liquefaction susceptibility
- 4 miles vulnerable to flooding (within the 100-year floodplain)
- 1 mile vulnerable to landslides
- 90 miles vulnerable to the wildfire wildland-urban interface
- 9 miles vulnerable to dam inundation
- More generally, changes in natural gas demand could require changes to pipeline infrastructure

Energy transmission infrastructure is also vulnerable to earthquakes, wildfires, floods, and landslides.

PG&E is conducting an internal vulnerability assessment and emergency management plan which is slated to be completed in 2015. High heat has led to blackouts and brownouts in California due to the increased energy load from air conditioning and the increased stress on transmission wires. PG&E also maintains high voltage boxes underground that may be susceptible to flooding events. Additionally, transmission lines are vulnerable to wildfires that occur outside of the Project Area since the lines run for a significant distance.

## Impacts on Economy, Equity, Environment, and Governance

Table 6 provides an overview of the impacts the existing stressors will impose on the Benicia economy, equity, environment, and governance.

Table 7: Economy, Equity, Environment, Governance Impacts

| Sector | Impacts to the Economy | Impacts to Equity | Impacts to the Environment | Impacts to Governance |
|---|---|---|---|---|
| **Transportation** | • Congestion costs:<br>  ○ reducing travelers productive time<br>  ○ increasing fuel consumption and vehicle operating costs<br>  ○ increasing air pollution<br>  ○ delaying shipments of goods<br>• Congestion increases following temporary or long term damage to a part of the network.<br>• Residents rely on transportation assets to get to work<br>• Impacts to roadway access could limit tourism | • Commuters both into and out of Benicia rely on the transportation network<br>• Events that limit roadway access to Vallejo and the Vallejo Ferry will impact commuters' ability to reach their workplaces.<br>• During emergencies, people may be unable to evacuate or reach emergency services and family members. | | • Transportation operation involves a range of agencies:<br>  ○ STA<br>  ○ MTC<br>  ○ Caltrans<br>  ○ Soltrans<br>• These agencies currently coordinate on many topics, including emergency management, but they will need to conduct more comprehensive planning to address additional stressors. |
| **Port of Benicia** | • Although the Port is exempt from paying property taxes to the City of Benicia, it is still a major driver of economic growth and a source of employment.<br>• The Port is part of the Benicia Industrial Park (BIP), which houses the majority of Benicia's large employers.<br>• Existing stressors such as earthquakes and flooding can put jobs and economic output at risk | • Diesel emissions negatively affect local air quality by emitting criteria air pollutants.<br>• As of 2005, the ocean-going vessels had the largest impacts on local air quality.<br>• The Port of Benicia has been involved in the Bay Area Green Ports Initiative since 2007. | See the equity impacts. | |

| Sector | Impacts to the Economy | Impacts to Equity | Impacts to the Environment | Impacts to Governance |
|---|---|---|---|---|
| **Natural Areas and Parks** | • Parks and recreation assets contribute to quality of life, which helps drive local and regional economic growth by attracting business and generating jobs and income for residents.<br>• In some cases, property values of homes adjacent to parks and trails are enhanced due to views and access. | • Parks and recreation assets provide direct health and education benefits and contribute to quality of life.<br>• Other benefits include services to underserved communities and transportation resources from trails. | • The natural areas provide habitats for plants and animals in the Project Area.<br>• Preservation of these resources provides ecosystem services such as erosion control, waste treatment, and nutrient recycling. | • Due to state and local funding shortfalls, the ability to manage recreational resources to their fullest public value is limited. |
| **Shoreline Protection** | • Around the Bay Area, many natural shoreline areas have seen significant financial investment in restoration and maintenance. | • Engineered shoreline protection often benefits low-income communities that would be most devastated by rising water levels.<br>• Accordingly, existing stressors threaten to disproportionally impact the most vulnerable citizens by degrading shoreline protections. | | Engineered shoreline protection structures are regulated by the following federal, state, and regional agencies:<br>• U.S. Army Corps of Engineers<br>• U.S. Fish and Wildlife Service<br>• Federal Emergency Management Agency<br>• U.S. Environmental Protection Agency<br>• San Francisco Bay Conservation and Development Commission<br>• California State Lands Commission |

| Sector | Impacts to the Economy | Impacts to Equity | Impacts to the Environment | Impacts to Governance |
|---|---|---|---|---|
| **Storm Water/ Wastewater** | • Flooding or wastewater limitations would disrupt local business activities which could lower business revenues and employee returns. | • Older neighborhoods are home to low-income communities.<br>• The infrastructure in these neighborhoods is more susceptible to leaking and breaking, and may not be designed to handle additional storm water, which increases the likelihood and risks of flooding. | • Untreated storm water runoff can be a source of pollutants such as sediment, toxic chemicals, and industrial waste. | • Public funding for public infrastructure improvements will remain challenging. |
| **Energy Infrastructure and Pipeline** | • The Valero refinery is an important economic engine in Benicia, employing 500 workers.<br>• Existing stressors that disrupt energy services could negatively affect economic output in the region due to the required closure of businesses and services and the loss of perishable goods. | • Citizens living adjacent to energy infrastructure would be disproportionately impacted by an accidental release or spill of natural gas and/or power outages. | • The siting of new infrastructure has the potential to impact and degrade the local environment.<br>• At a larger scale, energy infrastructure, such as pipelines, could negatively impact the environment in the case of a large release or spill. | • While the federal government regulates infrastructure and pipelines, local governments maintain jurisdiction over general plans and zoning requirements, and can thus manage siting of specific projects.<br>• Local governments can also work with their utility company to increase the safety of its residents near utility infrastructure. |

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