



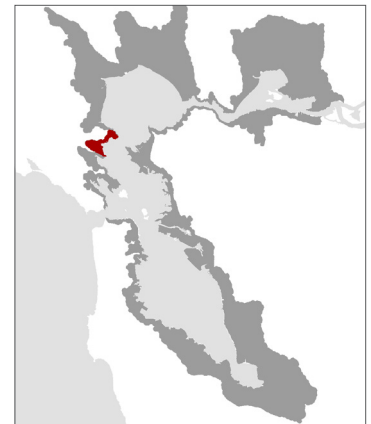
Tiscornia Marsh, San Rafael. Photo courtesy of CA King Tides Project.

## Local Assessments Section B: **SAN RAFAEL** *Operational Landscape Unit*

### JURISDICTIONS WITHIN THIS SECTION

*Marin County*

*San Rafael*



# HOW TO USE THE LOCAL ASSESSMENTS



## WHO IS THIS FOR?

Anyone interested in understanding their local shared vulnerabilities to flooding and sea level rise.

### Local jurisdictions

- Cities
- Counties
- Special Districts
- Utilities Providers

### Stakeholder Groups

- Non-profits/NGOs
- For-profits/Private
- Associations
- Interested Parties

### General Public

- Residents
- State/Regional**
- Caltrans
- MTC/ABAG

## HOW IS IT ORGANIZED?



Local assessments are organized by four regional systems assessed: Transportation, Vulnerable Communities, Priority Development Areas (PDAs), and Priority Conservation Areas (PCAs).

Each part of the local assessment provides varying levels of details at three scales: 1) Operational Landscape Unit (OLU), 2) Individual Descriptions, and 3) Shared Stories of Vulnerabilities in Focus Areas/Areas of Impact. This assessment can be reviewed in whole, or individual parts can be reviewed separately depending on interest and level of detail desired.



## WHAT'S IN THIS ASSESSMENT?

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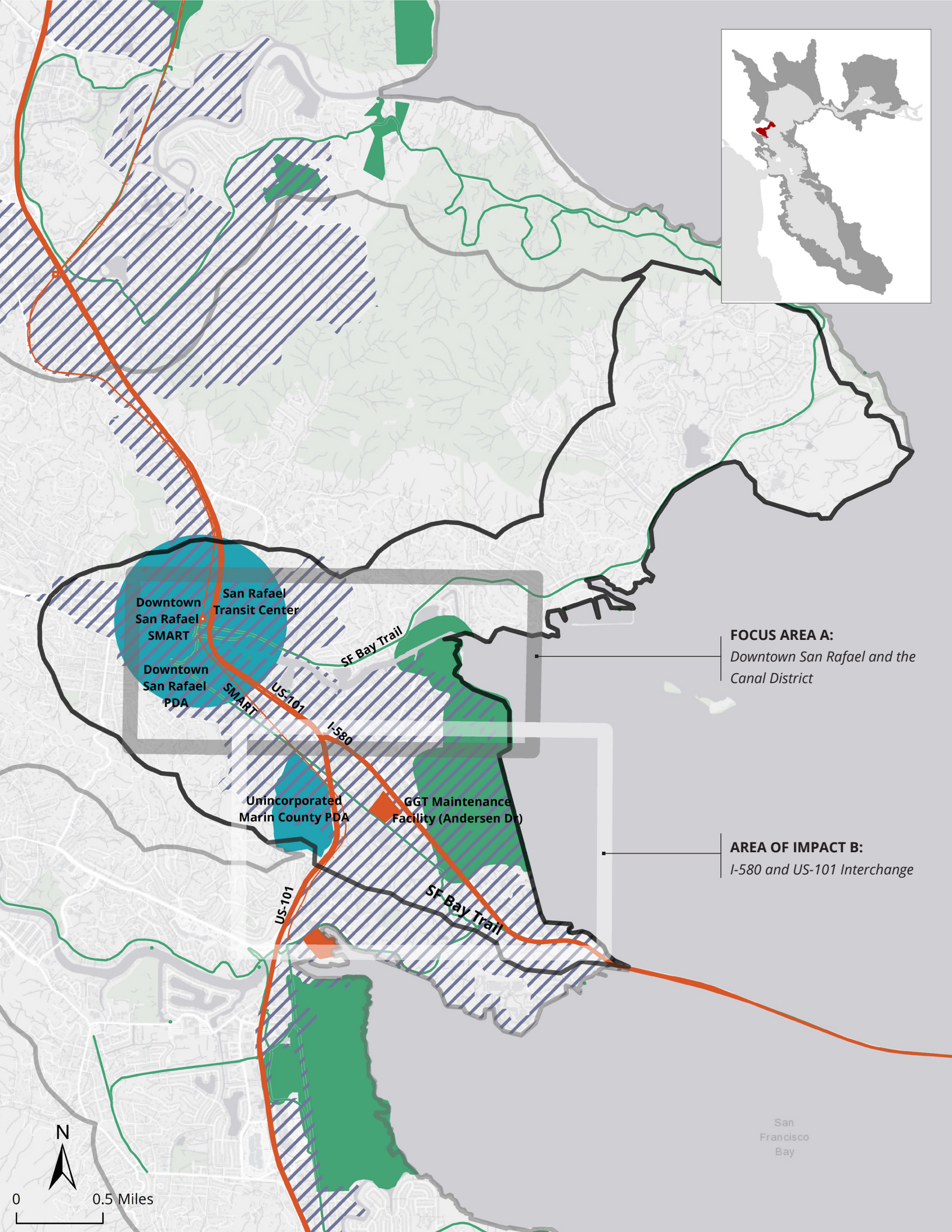
## ***Where are we in the region?***

This OLU encompasses the shoreline of the largest city in Marin County, San Rafael. The city includes an active boating sector, the largest downtown in the county, a university, and the county's largest employers. It is also the largest population center within Marin County, and houses the county's largest population of low-income and limited English proficiency households, particularly within the Canal District.<sup>1</sup> Many of the historic marshes within this area have been filled to allow development. The OLU is characterized by suburban development, industry and infrastructure, and rural/open space. A substantial portion of the development in the area is subject to early flooding via the creeks. This OLU has the highest proportion of people flooded at early water levels of the 30 OLUs throughout the region.



Approximate area of the San Rafael OLU. Map data © 2019 by Google.







# What regional systems are here?

Operational Landscape Unit (OLU) boundaries were used to organize and help identify regionally significant assets that were co-located together (Methodology can be found in ART Bay Area Section 3.0 Local Assessments).

The map on page 4 shows the entire OLU, including all the regional systems present. Colors are used throughout this document to help navigate across these four regional systems. Individual assets that were assessed as part of this local vulnerability assessment are listed in the bullets below and can also be found on the labels on the map (Figure 1b).

## ◀ Figure 1b. MAP OF REGIONAL SYSTEMS AND LIST OF INDIVIDUAL ASSETS ASSESSED WITHIN BELOW:



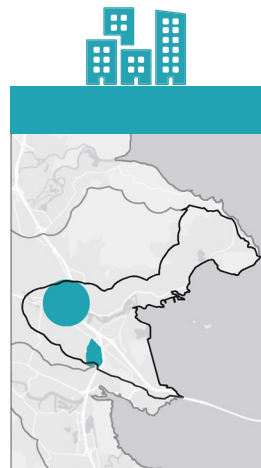
### TRANSPORTATION

- Union Pacific Railroad
- I-580
- US-101
- San Rafael Downtown SMART Station
- San Rafael Transit Center
- Golden Gate Bridge Highway and Transit District Maintenance Yard (Anderson Drive)
- Local Roads



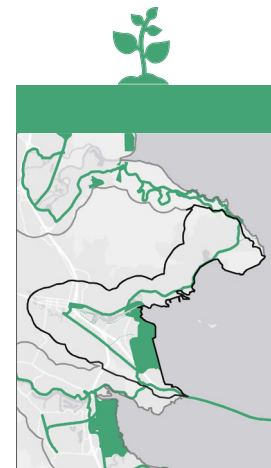
### VULNERABLE COMMUNITIES

- San Rafael Canal District Community



### PRIORITY DEVELOPMENT AREAS (PDAs)

- San Rafael Downtown PDA
- Unincorporated Marin County (California Park) PDA



### PRIORITY CONSERVATION AREAS (PCAs)

- San Francisco Bay Trail PCA
- San Francisco Bay Water Trail PCA
- Central Marin Bayfront, Canalways PCA



## What was assessed?

### TRANSPORTATION



I-580 and US-101 interchange. Map data © 2019 by Google.

**Union Pacific Railroad** • The Union Pacific Railroad (UPRR) is an important heavy freight rail supporting the reliable movement of goods to markets across the Bay Area. In this OLU, the primary use of these rails is for passenger rail service including all Amtrak. Electrical substations that power the light rail are impacted at 36" TWL. VTA maintenance and operations facilities are essential for the daily operation of the VTA system and the River Oaks (96" TWL) and Cerone (108" TWL) Divisions will be susceptible to flooding. VTA also operates bicycle routes (first exposed at 12" TWL) and bus service (first exposed at 12" TWL) with 27.6 million riders as of 2018. VTA also operates an expressway on SR-237 which is exposed at 48" TWL.



**I-580** • Interstate 580 is an 80-mile east-west highway, running from San Rafael to Tracy in the Central Valley. It provides a connection from the Bay Area to the southern San Joaquin Valley and Southern California via Interstate 5. Within this OLU lies the western terminus, at the junction with US-101. I-580 is four lanes within this OLU and has limited redundancy given its direct link to the San Rafael-Richmond Bridge and limited local road alternatives. It is an important commute corridor averaging 84,500 vehicles<sup>2</sup> and 5,458 trucks<sup>3</sup> per day. It passes through a light industrial portion of eastern San Rafael, provides access to San Quentin State Prison, crosses the San Rafael-Richmond Bridge, and enters the City of Richmond in Contra Costa County. Within this OLU, sections of I-580 are completely exposed at 12" TWL between US-101 and the San Rafael Bridge. Significant flooding occurs at 48" TWL, when the freeway is almost completely overtopped.

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**US-101** • US-101 is the primary north-south transportation artery from San Francisco into Marin County and beyond, providing important access to and from this OLU and providing connections to I-580, SR-37, and SR-1. It provides important commuter transportation service for local, regional, and inter-regional automobile and truck traffic, averaging 192,000 vehicles<sup>4</sup> and 7,473 trucks<sup>5</sup> per day. It is also a designated emergency route for the Bay Area.<sup>6</sup> Within this OLU, it is an 8-lane highway and is first exposed at 12" TWL at the intersection of I-580. Significant flooding impacts occur at 36" TWL, when the flooding becomes more extensive south of where the freeway crosses the San Rafael Canal.

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**San Rafael SMART Station and Rail** • Sonoma-Marin Area Rail Transit (SMART) offers passenger rail service in Sonoma and Marin counties. SMART's initial 43 miles of rail corridor includes 10 stations from the Sonoma County Airport to Downtown San Rafael. Future extensions include: Larkspur, which is scheduled to be completed in 2019; Windsor; Healdsburg; and Cloverdale. The full project will provide 70 miles of passenger rail service, connecting SMART passengers with jobs, education centers, retail hubs and housing along the Sonoma-Marin corridor, and a bicycle-pedestrian pathway. North Coast Railroad Authority (NCRA) shares the right of way with SMART and uses this for freight movement.<sup>7</sup> Within this OLU lies the Downtown San Rafael SMART Station located one block from the San Rafael Transit Center, as well as planned extension to the Larkspur Station, which will connect to the Larkspur Ferry Terminal. Within this OLU, the planned Larkspur rail extension is first exposed at 12" TWL and existing rail near San Rafael Station is exposed at 48" TWL.

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**San Rafael Transit Center** • The San Rafael Transit Center is located at 3rd Street and Hetherton Street in downtown San Rafael and houses regional and local transit, taxi, and shuttle connections including the Marin Airporter and shuttles connecting to the Larkspur Ferry Terminal. It includes park and ride lots (owned and operated by Caltrans), a passenger waiting area, public restrooms, customer service, taxi stand, and retail shops. It is owned by Golden Gate Bridge Highway and Transportation District (GGBHTD). Several government agencies are partnering to develop a new and expanded transit center that will provide for the current and future mobility needs of San Rafael and Marin County with the extension of SMART rail.<sup>8</sup> The current transit center is first exposed at 48" TWL.

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**Golden Gate Transit Maintenance Facility (Andersen Drive)** • This facility is owned by the Golden Gate Bridge and Highway Transportation District (GGBHTD) and includes a bus yard, a bus wash, administration buildings, a driver room, a training building, a maintenance building, a body shop, a heavy-duty shop, a warehouse, a fuel island, an employee parking lot, and a Marin Airporter terminal. It serves as the central maintenance facility for Golden Gate Transit buses, which over 9 million customers ride annually.<sup>9</sup> It is located on Andersen Drive south of Bellam Boulevard. It is significantly exposed starting at 12" TWL.

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**Local Roads** • Local roads throughout Downtown San Rafael and the Canal District serve as arterials through San Rafael for individual vehicular transit as well as buses. Roads in Downtown San Rafael (i.e. 2nd St, 3rd St, 4th St, 5th Ave, and Lincoln Ave) are exposed at 48" TWL, while a significant portion of roads in the Canal District (i.e. Kerner Blvd, Bellam Blvd, Francisco Blvd, Canal St) are exposed at 12" TWL.





The Richmond-San Rafael bridge (I-580) looking towards San Rafael from Richmond. Photo by TJ Gehling licensed under CC BY-NC-ND 2.0.

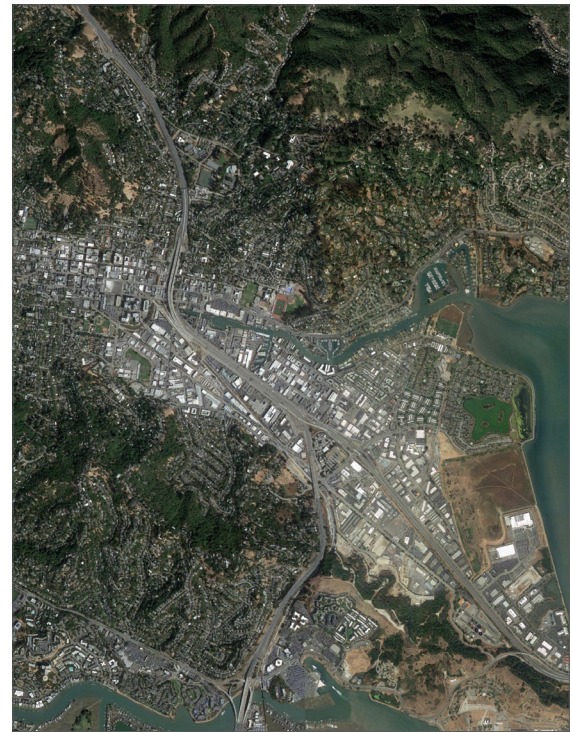
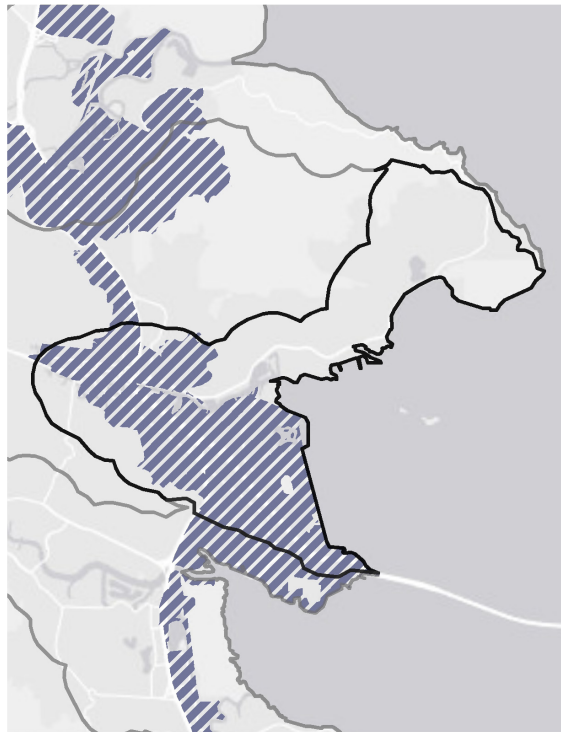


King Tides facing south on N San Pedro Rd, prior to northern China Camp Village State Park entrance, San Rafael. Photo by Stephen Sarhad licensed under CC BY-SA 2.0.





## VULNERABLE COMMUNITIES



The Canal District. Map data © 2019 by Google.

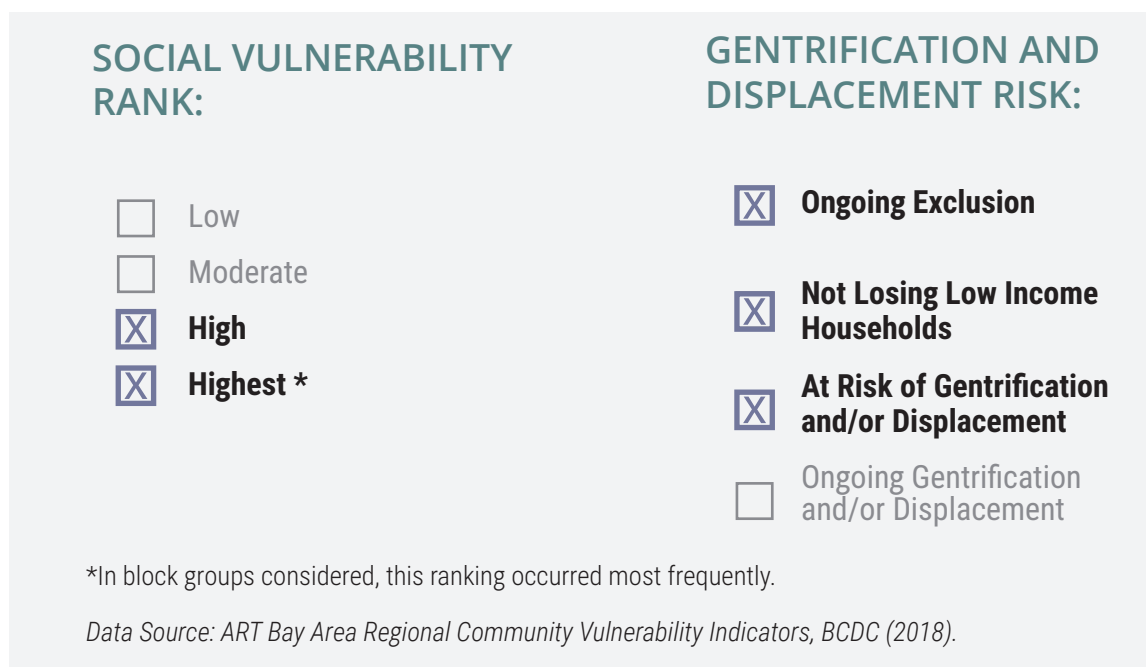
**San Rafael Canal District** • For the purposes of this report, 9 block groups were assigned to a functional community called “San Rafael.” The block groups that were assessed can be referenced in the Appendix. This is a placeholder designation for a set of block groups that have a moderate, high, or highest social vulnerability ranking within the San Rafael area. Before this is used for any planning purposes, this data should be ground-truthed and vetted with the communities considered. Similarly, block groups or communities with a similar vulnerability rank could and likely will have very different needs, considerations, and capacities that are critical to bring into the planning process.

The San Rafael Canal District is home to the largest population center within Marin County and houses extensive multi-family housing units. It is a multilingual community with rich cultural heritage. Six block groups were assessed in the Canal District community. Of these six, five are considered the highest social vulnerability, and one is considered high social vulnerability. This area has the highest population of low-income and limited English proficiency households within the County, which contributes to challenges in accessing critical services in the event of flooding. Residents in this area experience worse health disparities, earn lower incomes, and have lower life expectancies than the county average.<sup>10</sup> In order to holistically address flooding and related risks in the San Rafael Canal District, the Multicultural Center of Marin (formally, the Canal Welcome Center) along with Shore Up Marin are working to build community resilience.<sup>11</sup>

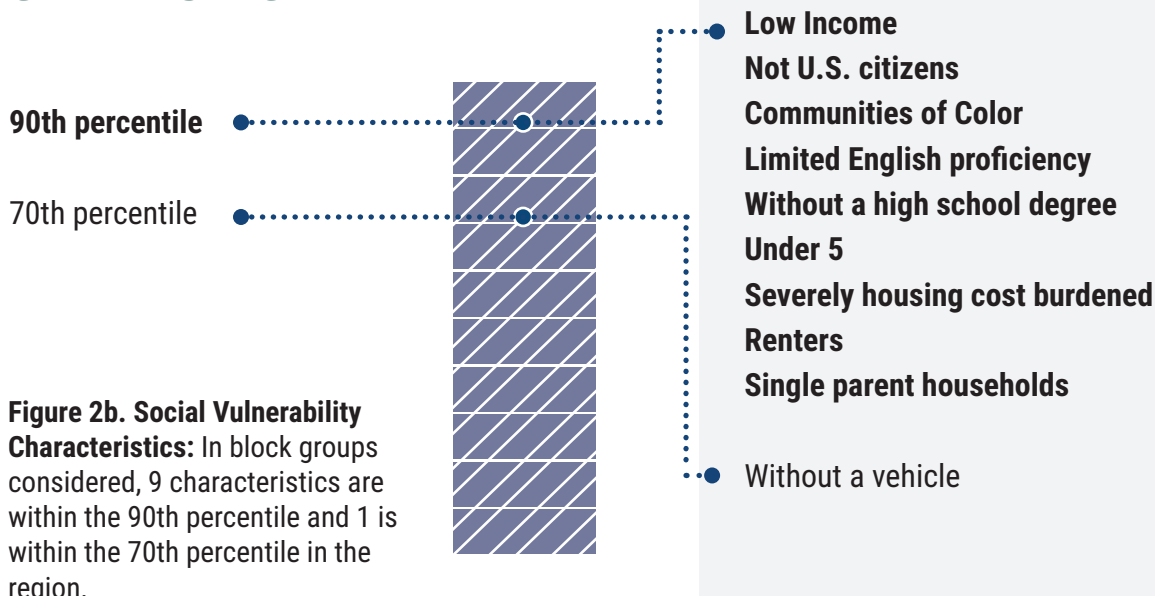


Nine block groups are considered high or highest social vulnerability. Nine social vulnerability characteristics are exhibited in at least one block group in the 90th percentile, with one characteristic in the 70th percentile in the region (Figure 2b).

Many Canal District residents are spending more than a third of their income on rent and in order to afford rents, overcrowding is common. Census tracts in the Canal District are classified as At Risk of Gentrification and/or Displacement, Not Losing Low-income Households, and Ongoing Exclusion.<sup>12</sup>



## SOCIAL VULNERABILITY PERCENTILES IN SAN RAFAEL CANAL DISTRICT





Marina playground during King Tides, San Rafael. Photo courtesy of the CA King Tides Project



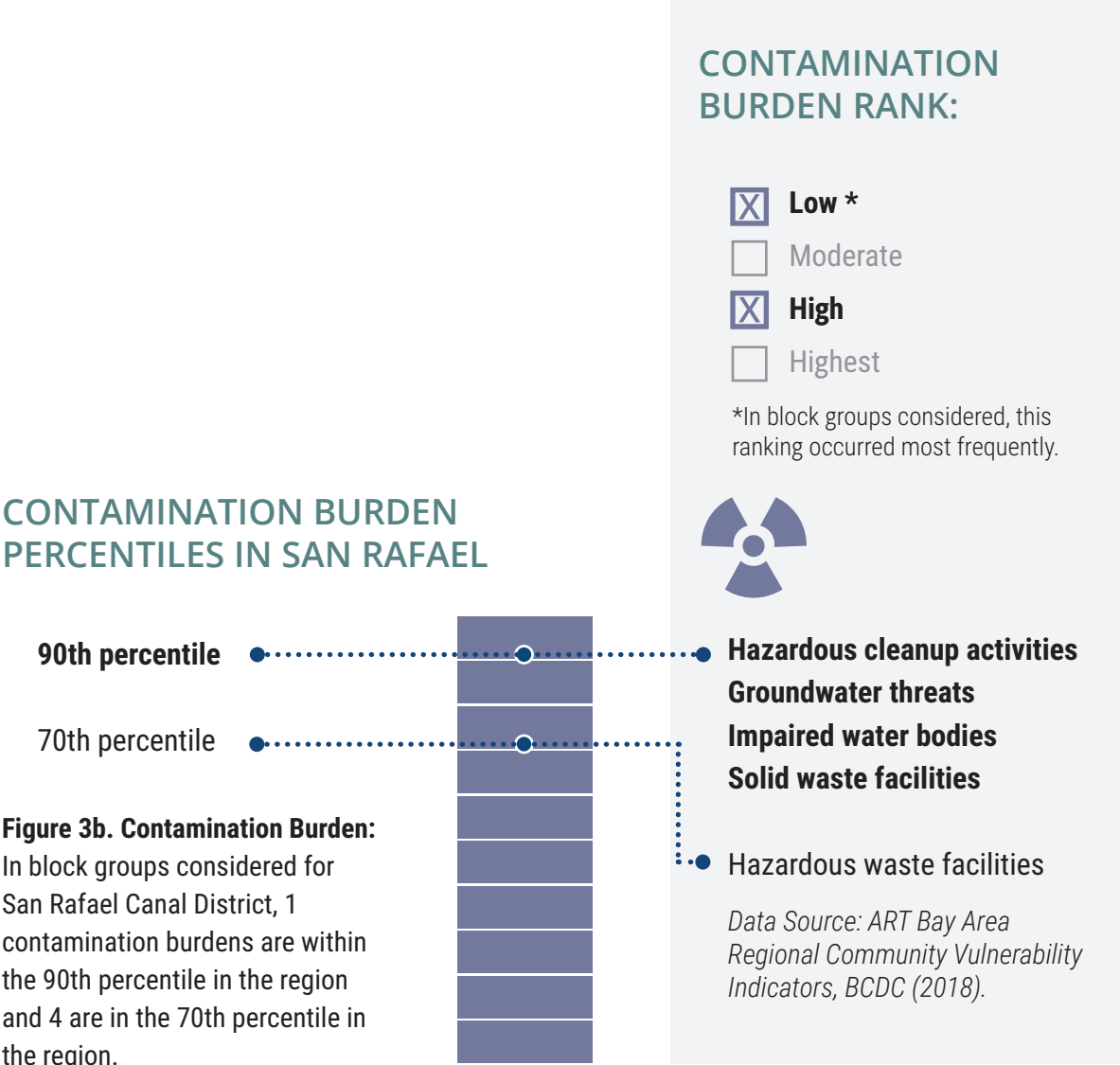
The Canal District. Photo © 2019 by Google.



Contamination burden was assessed only for the block groups included in the functional community groupings. We only looked at areas that have contamination.

The assessed block groups that exhibit social vulnerability are also impacted by a multitude of contamination sources. All of the relevant contamination indicators assessed for the Bay Area are present for these six block groups. Three block groups have high contamination vulnerability, other three have lower contamination vulnerability. Contamination can contribute to negative health outcomes and can be especially harmful as a compounding factor for communities that have existing high social vulnerability.

The following contamination burden is exhibited in at least one block group at in the 90th percentile (Figure 3b). There is one characteristic above the 70th percentile, with four in the 90th percentile, which are bolded.



The block groups considered are first exposed to flooding at 12" TWL (Table 1b). Critical services and facilities that provide community cohesion, medical care, and emergency services will also be impacted by flooding. First exposure of assessed critical facilities begins at 12" TWL.





















Total water levels (TWLs) are used to represent various combinations of temporary and/or permanent flooding that may occur with future sea level rise. Values in the table reflect potential risks to critical facilities in the absence of adaptation planning.

**Table 1b. Critical Services and Facilities:** First exposure of critical services and facilities. Blue bars represent when asset is first exposed to flooding.

An old rowboat in China Camp State Park. Photo by gregorydesantis is licensed under CC BY-NC-ND 2.0



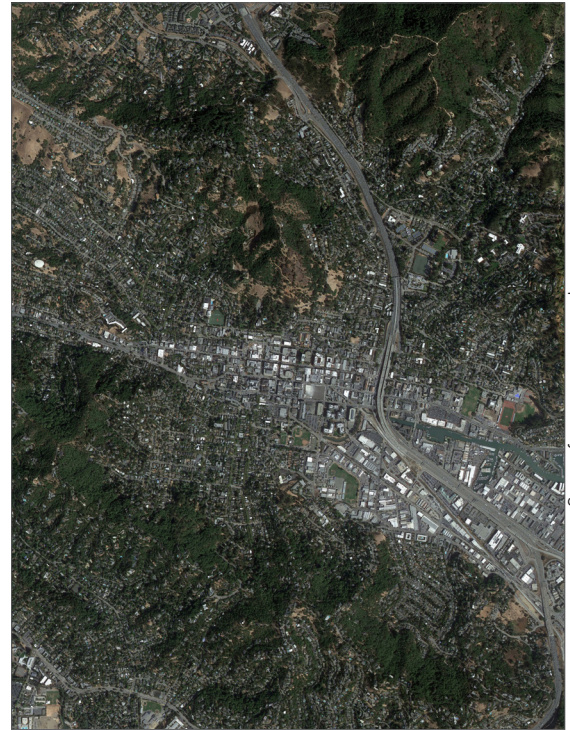
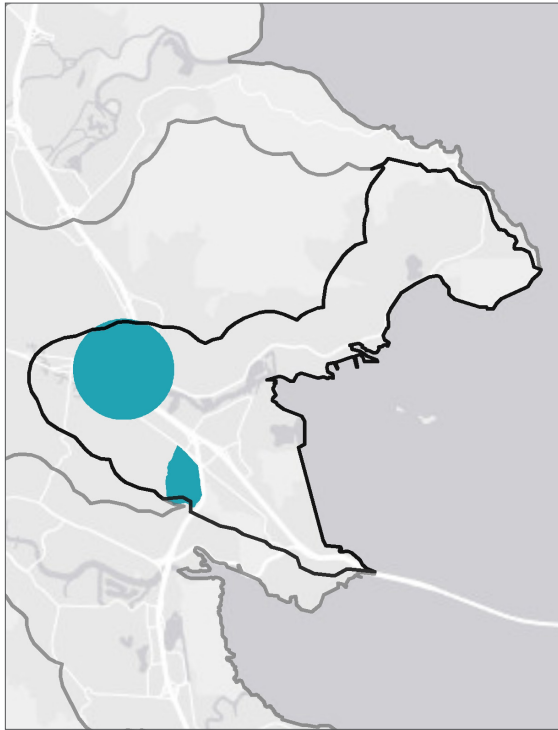
# EXPOSURE OF CRITICAL SERVICES AND FACILITIES IN SAN RAFAEL CANAL DISTRICT

Critical Facilities/Services Impacted		12"	24"	36"	48"	52"	66"	77"	84"	96"	108"
Health Clinics	Marin Community Clinic (Kerner Blvd, San Rafael)										
	Rotacare San Rafael (3rd St, San Rafael)										
	South Marin Health & Wellness Center (S Eliseo Dr, Greenbrae)										
Police and Fire Stations	San Rafael Fire Department Station 4 (Castro Street, San Rafael)										
	San Rafael Fire Department Station 2 (3rd Street, San Rafael)										
Schools	Bahia Vista Elementary School (Bahia Way, San Rafael)										
	Pickleweed Childrens' Center (Canal St, San Rafael)										
	Marin Head Start VLG (Francisco Blvd E, San Rafael)										
	Lagunitas School District (4th Street and Mary Street, San Rafael)										
	Davidson Middle School (Woodland Ave, San Rafael)										
	Enterprise Resource Center (Kerner Blvd, San Rafael)										
	Marin Head Start (Point San Pedro Rd, San Rafael)										
	Lagunitas School District (Lagunitas School Rd, San Geronimo)										
	San Rafael High School (Mission Ave, San Rafael)										
	Parkside Children's Center (Albert Park Ln, San Rafael)										
	San Rafael City Childcare (Albert Park Ln, San Rafael)										
	Madrone High School (Mission Ave, San Rafael)										
	San Rafael High School (3rd St, San Rafael)										
	Laura Dell Elementary Program (Woodland Ave, San Rafael)										
Civic	Albert J. Boro Community Center (Canal St, San Rafael)										





## PRIORITY DEVELOPMENT AREAS (PDAS)



San Rafael Downtown PDA. Map data © 2019 by Google.

**San Rafael Downtown PDA** • The San Rafael Downtown PDA is a 340-acre Transit Town Center that covers a 1/2-mile radius around the San Rafael SMART rail station and San Rafael Transit Center. US-101 runs north-south within the PDA.

Guided by the City of San Rafael's Downtown Station Area Plan (SAP), the vision for this PDA is to serve as San Rafael's economic center and to connect the residential neighborhoods that lie to the north, south, east and west to transit connections, shopping, and open space. The plan includes maintaining and enhancing San Rafael's downtown character, providing street and bike/ped improvements to promote transit ridership, and identifying new areas for redevelopment.

Southern portions of the PDA are along Anderson Drive and US-101 are first exposed at 12" TWL. By 48" TWL, flooding crosses into downtown and covers extensive portions of the PDA.

Critical facilities that provide emergency services and utilities may be impacted by flooding (Table 2b). First impacts begin at 36" TWL and increase through 108" TWL.

## CURRENT AND FUTURE HOUSING AND JOBS IN THE SAN RAFAEL DOWNTOWN PDA



### Residential Housing Units

Existing in 2010:	1,633
Projections for 2040:	2,564
Percent Growth:	57%



### Job Spaces

Existing in 2010:	8,719
Projections for 2040:	10,018
Percent Growth:	15%

Data Source: Plan Bay Area 2040, MTC/ABAG (2017).

## EXPOSURE OF CRITICAL FACILITIES IN THE SAN RAFAEL PDA

Critical Facilities/Services Impacted		12"	24"	36"	48"	52"	66"	77"	84"	96"	108"
Police and Fire Stations	San Rafael Fire Department Station 2 (3rd Street, San Rafael)										
	PG&E substation (2nd Street and Lindaro Street, San Rafael)										
Utilities	Lindaro Natural Gas Station (Lindaro Street, San Rafael)										

**Table 2b. Critical Services and Facilities:** First exposure of critical services and facilities. "M" refers to minor impacts or impacts to access roads. Blue bars represent when asset is first exposed to flooding.



**Unincorporated Marin County PDA** • The Unincorporated Marin County PDA encompasses urbanized areas along the 101 Corridor throughout Marin County, specifically land within a half mile of US-101. The Transit Neighborhood PDA actually covers two distinct areas: a portion just south of the Downtown San Rafael PDA in a neighborhood called California Park, and a southern portion on Richardson Bay that includes Marin City. The California Park portion is served by Golden Gate Transit and has access to the Cal Park Hill Pathway, a former railroad right-of-way that now connects downtown San Rafael to Larkspur via bicycle trail.

The California Park neighborhood portion of the PDA consists primarily of suburban residential use, with a portion of mixed use and open space along Woodland Avenue, adjacent to US-101. Some densification and transit connections are envisioned for this neighborhood

At 24" TWL, the entire portion of low-lying land between Woodland Avenue and Auburn Street is flooded via the US-101 underpass.

There are no critical services or utilities that are exposed to flooding in this PDA. There are natural gas pipelines along Rose Street, but they are not exposed to flooding. There is significant exposure of infrastructure located just outside the PDA that impacts the PDA.

*Note: this PDA contains portions within this OLU and the Richardson OLU. This section describes the portion of the PDA within this OLU. The portion in Richardson OLU is described in the Richardson OLU section.*

CURRENT AND FUTURE  
HOUSING AND JOBS IN  
THE MARIN COUNTY  
PDA



Residential  
Housing Units

Existing in 2010:	1,664
Projections for 2040:	1,791
Percent Growth:	8%



Job  
Spaces

Existing in 2010:	8625
Projections for 2040:	739
Percent Growth:	18%

*Data Source: Plan Bay Area  
2040, MTC/ABAG (2017).*

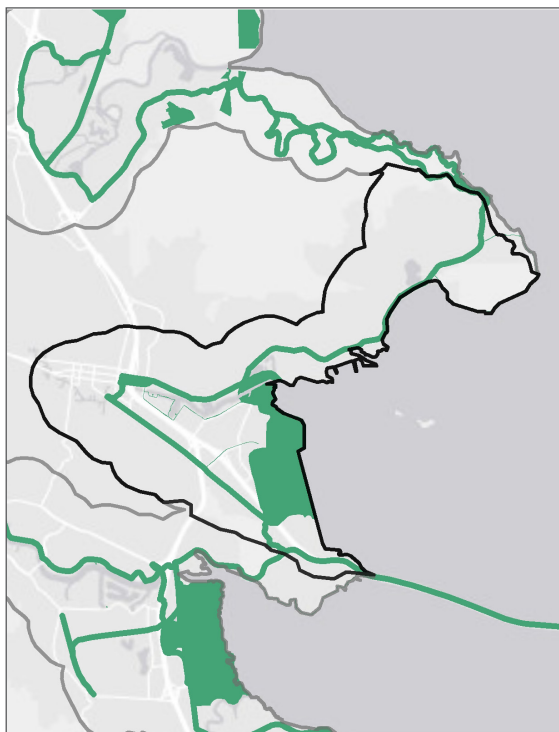


Unincorporated Marin County PDA. Map data © 2019 by Google.





## PRIORITY CONSERVATION AREAS (PCAS)



Baylands PCA. Map data © 2019 by Google

### San Francisco Bay Water Trail PCA

• The San Francisco Bay Area Water Trail is a network of launching and landings sites for non-motorized watercrafts (e.g. kayaks, stand-up paddleboards, wind and kite surf, etc.) around the San Francisco Bay and its major tributaries, including the San Joaquin River, Napa River, and Petaluma River.<sup>13</sup> Within this OLU, there are no Water Trail Designated Trailheads, but there are several existing boat launches eligible to become Trailheads within the San Rafael Canal District. The launches are first exposed at 12" TWL.

### PCA DESIGNATION:

- ☐ Natural Landscapes
- ☐ Agricultural Lands
- ☐ Urban Greening
- ☒ **Regional Recreation**

### FUNCTIONS/BENEFITS:

- **Recreation**
- **Economic Development**
- **Wildlife Habitat**

*Data Source: MTC/ABAG Priority Conservation Areas Program (2017).*



Biking the Richmond-San Rafael bridge (I-580). Photo by TJ Gehling is licensed under CC BY-NC-ND 2.0

## San Francisco Bay Trail PCA •

The San Francisco Bay Trail is a 500-mile regional trail that, upon completion, will circumnavigate the bay. The trail connects people and communities to each other, to parks and open space, to home, work and recreation, and to countless areas of cultural and historic interest. It provides opportunities for health and fitness, increase transportation options, opportunities to observe, learn about, and care for the environment, and provides economic benefits to the region through increased tourism.<sup>14</sup> Within this OLU, the Bay Trail runs immediately adjacent to I-580, US-101, and the shoreline, with planned segments throughout the Canal District. It spans 14.6 miles, with 5.5 miles of existing trail and 9.1 miles of planned trail. The planned trail is mostly along the San Rafael Canal and floods at 12" TWL. The trail provides access to the San Francisco Bay Water Trail. The Bay Trail is first exposed at 12" TWL, with significant flooding impacts at 36" TWL when the majority of the trail within this OLU is flooded.

### PCA DESIGNATION:

- ☒ **Natural Landscapes**
- ☐ Agricultural Lands
- ☐ Urban Greening
- ☐ Regional Recreation

### FUNCTIONS/BENEFITS:

- **Recreation**
- **Community Health**
- **Economic Development**
- **Transportation**
- **Environmental Stewardship**

*Data Source: MTC/ABAG Priority Conservation Areas Program (2017).*



## Central Marin Bayfront, Canalways PCA

• The Central Marin Bayfront, Canalways PCA is 394 acres. The habitat importance of the property is enhanced by its proximity to the pond and wetlands at Spinnaker, an adjacent City-owned pond, as well as wetland habitats further south. It is habitat for large populations of overwintering migratory waterfowl and shorebirds. It is also important for young herons and egrets feeding from their nests on nearby West Marin Island, the largest heron rookery in the bay.

The property is also an important open space, educational and recreational resource along the Jean and John Starkweather Shoreline Park for people from the Canal area of San Rafael, where it is located. The Canal area supports a large multi-cultural population that are frequent users of the park.

The Canalways site is a buffer to protect upstream development against sea level rise. In a natural state, it helps to improve air and water quality and protect public safety by preventing development on seismically unsafe and a flood prone area. The property is a depression on the landscape having been created by leveeing off a portion of the bay.

First flooding occurs at 12" TWL. By 48" TWL 90% of the visited area is inundated.

There are many ecosystem services of the Central Marin Bayfront, Canalways PCA including providing habitat, recreation, and stormwater services of runoff retention, groundwater recharge, and flood water retention (Figure 4b).

## PCA DESIGNATION:

### ☒ Natural Landscapes

☐ Agricultural Lands

☐ Urban Greening

☐ Regional Recreation

## FUNCTIONS/BENEFITS:

- Recreation
- Community Health
- Climate and Resilience

Data Source: MTC/ABAG Priority Conservation Areas Program (2017).



## ECOSYSTEM SERVICES OF CENTRAL MARIN BAYFRONT PCA



### Habitats

Depressional Wetlands | 124 acres



### Stormwater

Annual Runoff Retention | 96.7 million gallons

Groundwater Recharge | 2.5 million gallons

Flood Water Retention | 9.2 million gallons



### Recreation

Approximate Visitation Rates | 16 photo user days (PUD)



### Carbon Storage

No soil organic matter quantified. | N/A

**Figure 4b. Ecosystem Services of PCAs.** Statistics on habitats, recreation, carbon storage and stormwater retention in PCAs. *Data by the ART Bay Area Natural Capital Project (2019).*

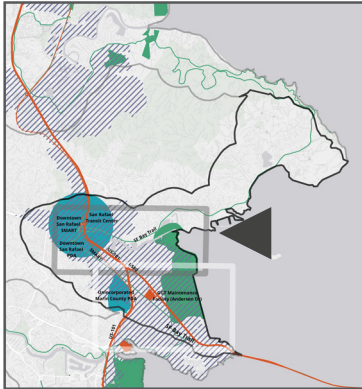


Entrance to the San Rafael Canal. Photo © 2019 by Google.



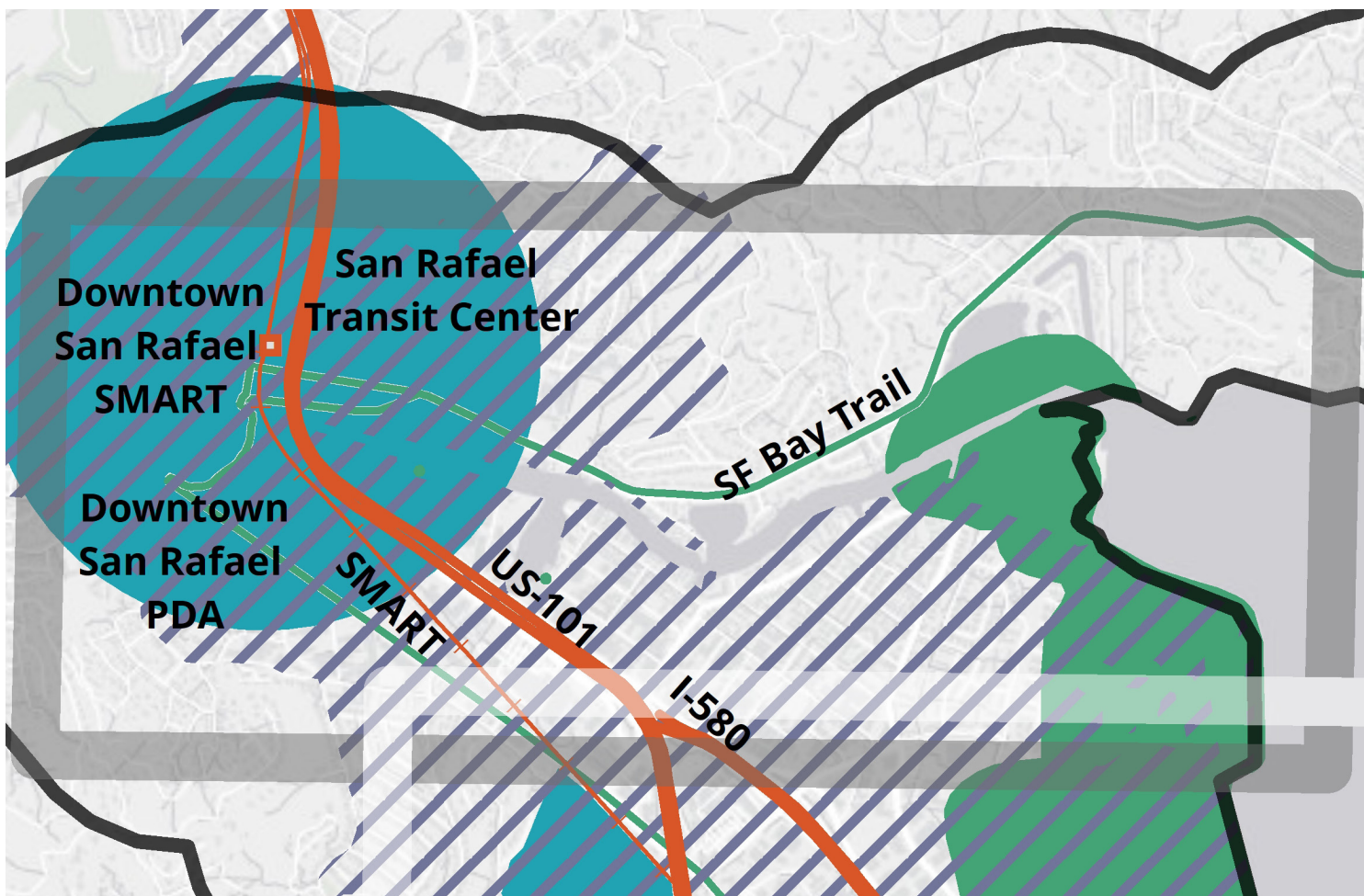
## Focus Area A:

# *Downtown San Rafael and The Canal District*

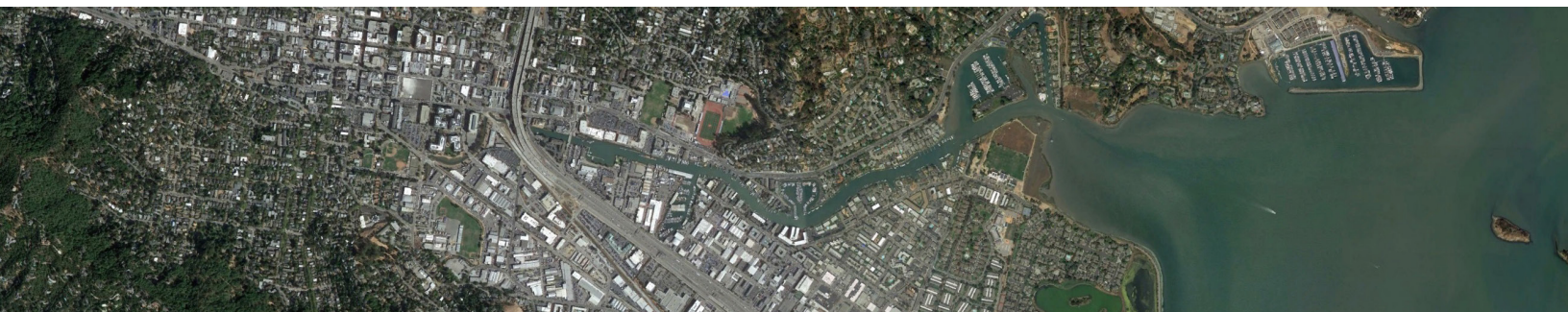


## Location

This Focus Area encompasses Downtown San Rafael and the San Rafael Canal District. It is bounded by Mission Avenue in the north, D Street to the west, and Rice Drive west of US-101 to the south. It also encompasses the Canal District and Kerner Business District portions of San Rafael, bounded by the US-101/I-580 to the west, Kerner Blvd to the south, the San Rafael Canal to the north, and Pickleweed Park/Spinnaker Lagoon to the east. It is roughly 1 square mile (Figure 5b).



**Figure 5b. Top: Identification of where Focus Area is within OLU. Bottom: Map of Focus Area containing regional systems.** Individual assets assessed in this Focus Area are labeled on the map and listed on the following page.



Downtown San Rafael and the Canal District. Map data ©2019 by Google.

## Why shared stories of vulnerability?

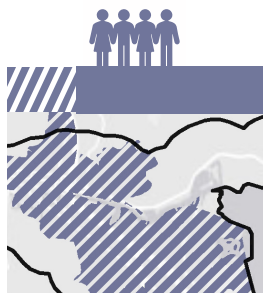
This Focus Area was selected because it contains a variety of regional systems, including numerous transportation routes, a PDA, multiple PCAs, and the San Rafael Canal District. Due to overlap and dependencies among these regional systems in this area, the vulnerabilities of these systems to flooding and sea level rise are discussed together in shared stories of the shoreline, overtopping, and exposure to flooding as water levels rise. The goal of communicating shared vulnerabilities and consequences is to encourage multi-benefit solutions through collaborations and coordination.

### Figure 5b. MAP OF REGIONAL SYSTEMS AND LIST OF INDIVIDUAL ASSETS ASSESSED WITHIN THIS FOCUS AREA LISTED BELOW:



#### TRANSPORTATION

- US-101
- I-580
- San Rafael Downtown SMART
- San Rafael Transit Center
- Local Roads



#### VULNERABLE COMMUNITIES

- San Rafael Canal District Community



#### PRIORITY DEVELOPMENT AREAS (PDAs)

- Downtown San Rafael PDA



#### PRIORITY CONSERVATION AREAS (PCAs)

- San Francisco Bay Water Trail PCA
- San Francisco Bay Trail PCA



# Shoreline today and into the future

## SHORELINE TYPE STORY

### *What is the shoreline made up of now?*

This Focus Area is primarily impacted by flooding from the San Rafael Canal, rather than the Bay shoreline itself. The shoreline of the Canal is predominately embankments, with a small marsh section (with embankments behind) between Lincoln Ave and Lindaro Street.

## SHORELINE DEVELOPMENT STORY

### *How will the shoreline change in the future?*

The Tiscornia Marsh Habitat Restoration and Sea Level Rise Adaptation Project is an ongoing project located adjacent to Pickleweed Park in the Canal District. It is funded by the San Francisco Bay Restoration Authority and aims to improve flood protection for the Canal District. New developments are being built in San Rafael, such as the shoreline homes at The Village in Loch Lomand Marina, which may increase potential future residential flooding.

The major potential shoreline changes include:

- **The Tiscornia Marsh Habitat Restoration and Sea Level Rise Adaptation Project**
- **Shoreline homes at The Village**



Ship in the canal. Photo by Beatrice Murch is licensed under CC BY-SA 2.0



# Current and future flooding risk

## OVERTOPPING STORY

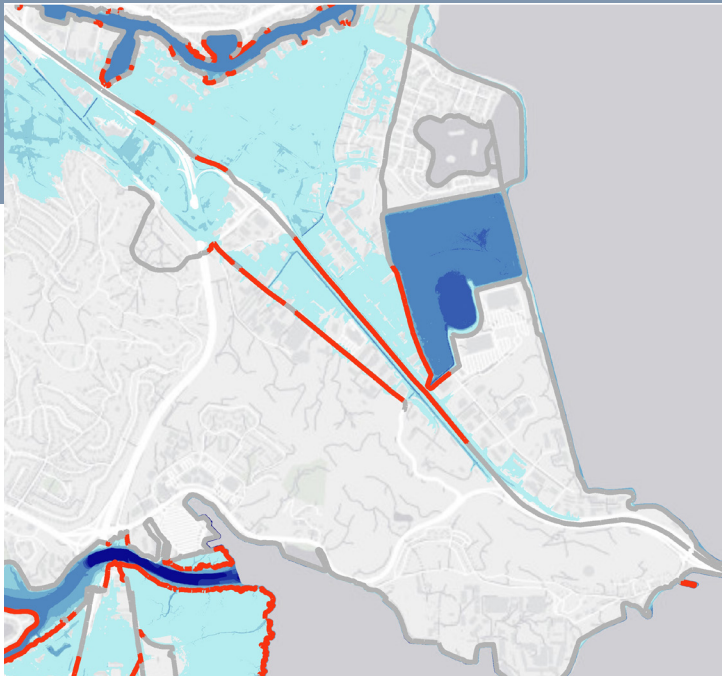
### *Where is water coming over the shoreline?*

Much of the Canal District and Downtown San Rafael is below sea level<sup>15</sup>. At 12" TWL, several embankments along the southern shore of the San Rafael Canal are overtopped (Figure 6b) including between US-101 and Grand Avenue, at the end of Bay Street, shoreline along the Harbor Center Marina between Bay Street and Harbor Street, segments in the 500 and 400 blocks of Canal Street, at the intersection of Canal Court and Canal Street, the inlet immediately east of Portofino Street, and inlets east and west of Lido Lane. At 24" TWL, overtopping expands throughout these sections of the canal. By 36" TWL, the vast majority of the canal's embankments are overtopped as well as embankments in the downtown area along San Rafael Creek from the US-101 (east) and Albert Park (west). By 48" TWL the entire southern shoreline of the canal is overtopped.

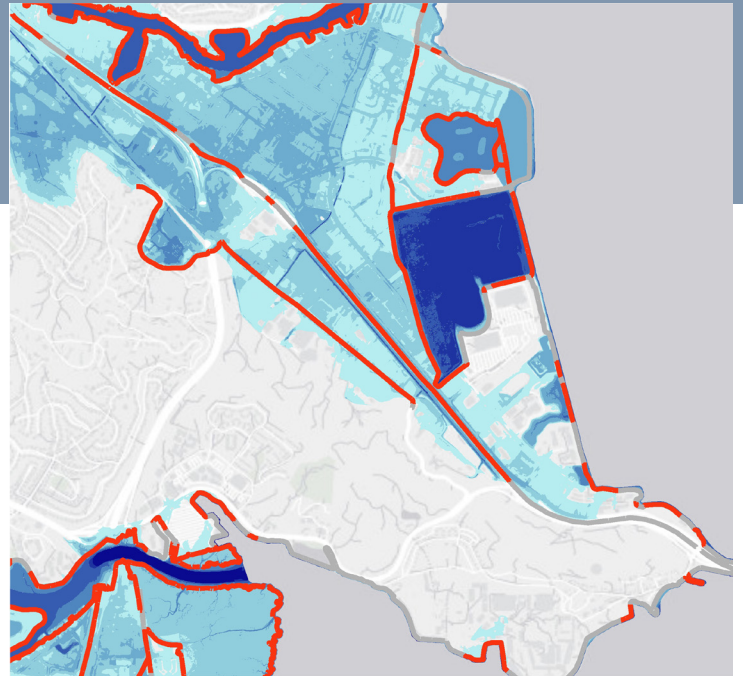
## FLOODING EXPOSURE STORY

### *Where does flooding occur?*

At 12" TWL, the majority of the Canal District is exposed from east of Kerner Boulevard to Bay Street in the west, down through the US-101 (Figure 7b). This exposes Bay Trail, Water Trail, population blocks with the highest social vulnerability and high contamination vulnerability, US-101, I-580, portions of the Downtown San Rafael PDA, local roads (Kerner Boulevard, Bellam Street, other small arterials), three low income housing buildings, and San Rafael Fire Department Station 4. Also, at 12" TWL parts of downtown south of San Rafael Creek and west of US-101 are exposed, including James B Davidson Middle School, population blocks with the highest social vulnerability and high contamination vulnerability, transmission lines along Andersen Drive, and the Bay Trail. This flooding comes from the San Rafael Canal. The Albert J. Boro community center is also exposed at 12" TWL. At 36" TWL, some flooding crosses to the north side of San Rafael Creek into Albert Park and Downtown San Rafael. At 48" TWL, the entire Canal District is fully inundated, and inundation expands into downtown between 2<sup>nd</sup> Street and 4<sup>th</sup> Street. This exposes the SMART Station, the San Rafael Transit Center, a substation at 2<sup>nd</sup> Street and Lindaro Street, and natural gas pipelines. At 66" TWL, the South Marin Health & Wellness Center is flooded. By 84" TWL, the majority of Downtown San Rafael is completely inundated.



12" TWL



48" TWL

## OVERTOPPING AND FLOODING ▲

**Figure 6b. Two total water levels selected that demonstrate first overtopping and/or significant flooding thresholds.** Visit the Bay Shoreline Flood Explorer ([explorer.adaptingtorisingtides.org](http://explorer.adaptingtorisingtides.org)) to see more TWLs.

- No overtopping
- Overtopping
- Shallower depth of flooding
- Deeper depth of flooding

## FIRST FLOODING OF REGIONAL SYSTEMS ASSESSED

Regional Systems Impacted	12"	24"	36"	48"	52"	66"	77"	84"	96"	108"
Bay Trail PCA										
Water Trail PCA										
I-580										
Local Roads										
San Rafael Canal District Community										
Downtown San Rafael PDA										
US-101										
San Rafael Transit Center										
San Rafael SMART Station										

**Figure 7b. First exposure of regional systems.** Individual assets within the four regional systems in this area are shown and colored bars represent when each asset is first exposed to flooding impacts.



# Shared vulnerabilities to flooding

## SHARED VULNERABILITY STORIES

Vulnerability assessments were conducted on individual assets and then shared vulnerabilities were identified for regional systems within each focus area. The vulnerability statements below reflect shared stories of vulnerability. Our goal is to emphasize the interconnections among and across local systems, and encourage shared multi-benefits adaptation solutions.

### 1. Regional Utilities



This area houses important energy generation and transmission infrastructure, including transmission lines, a substation, and natural gas pipelines. The transmission lines, natural gas pipelines and electrical conduits that run throughout the Downtown San Rafael PDA are underneath the pavement and were not built for waterlogged environments. Since there is no underground system to pump floodwaters away from infrastructure, water at any entry point in either of the water or electrical utility systems could affect these utility infrastructure assets. Electrical transmission lines and pipelines function as interconnected systems such that even if utilities in one area are protected, all parts of the regional network must be in working order to maintain system wide function. Loss of power could also disrupt emergency services, such as fire stations, police stations, and hospitals.

### 2. Vulnerable Communities



The San Rafael Canal District is the most densely populated area of the county and provides housing and services, including schools, community centers, and emergency services, to the largest population of vulnerable residents in the County, including a homeless population. Vulnerable populations are severely limited in their ability to prepare for, respond to and recover from flood events. It is also a center of commercial and light industrial use. This district is below sea level and already experiences flooding. Sea level rise will only put housing, commercial and industrial centers, recreational uses and transportation infrastructure at higher risk. These vulnerabilities will be exacerbated due to subsidence.



View from Pickleweed Park. Photo by HPapendick is licensed under CC BY 2.0

### 3. Regional Transportation

Downtown San Rafael serves as a regional bus and rail transit hub through the San Rafael Transit Center and San Rafael SMART Station, both of which are vulnerable to flooding. Many local roads leading to the Transit Center also flood, limiting access to regional services as well as limiting the ability to reroute buses. Additionally, redundant nearby regional transportation options, including US-101 and I-580, also flood, limiting their redundant function. Lack of regional transportation options severely limit goods and commuter movement as well as impacts regional emergency response plans. Planning in this area will require significant coordinated decision making between the owners, managers, and service providers that function in this area.





# Shared consequences to flooding

## SHARED CONSEQUENCE STORIES

This section translates shared vulnerability statements into stories of shared consequences. The ART program considers consequences through frames of sustainability: Society and Equity, the Economy and the Environment.



**Society and Equity** • Flooding of the Canal District will result in significant hardships due to damage or loss of personal property and disconnection from jobs, schools, and community services and ties. Individuals and households that are disadvantaged or underserved experience disproportionate hardships both during and after a flood event. Displaced residents may not have access to equivalent or affordable replacement housing near the jobs, schools, services, and facilities they rely on. Even temporary relocation of residents can sever long-standing neighborhood relationships, disrupting the social network that imparts collective strength and resilience. Floodwaters can leave mold, mud, waste, and other toxics behind in residences and structures; residents who are unable to move, temporarily relocate, or adequately repair their home after a flood are more vulnerable to these impacts. Contaminated sites pose a risk to public health if on-site contaminants are released to surrounding surface or groundwater. Flooding may exacerbate gentrification and displacement already occurring within the Focus Area.



**Economy** • Disruptions to local roads, major highways, and transit centers and damage to energy services due to flooding will have a significant impact on the economy. These impacts include inability to get to work, impacts on goods movement, increased costs due to delay in emergency services, and many more. Community members immediately affected may bear the cost of replacing or repairing belongings and homes, the cost of temporary housing or permanent relocation, increased insurance costs, and dislocation from jobs, schools and other services. The broader community of taxpayers may also bear some of the expense of rebuilding even if they do not themselves live in affected areas. Long-term evacuations could result in the permanent relocation of residents, employees, or entire business sectors outside of the Canal District, with associated economic consequences for the neighborhood, residents and employers that remain. A release of contaminants from closed or active sites could strain local emergency resources and could result in high cleanup and recovery costs. Loss of job centers in Downtown San Rafael and key Marin County facilities in the San Rafael area will have economic impacts that reach beyond the Focus Area and city itself.



**Environment** • Floodwaters that pass through Canal District neighborhoods may pick up and carry hazardous materials that can impair water quality and habitats critical to biodiversity. There could be significant water quality impacts if contaminants are released from contaminated sites into the adjacent natural areas that support a variety of species and habitats.



The Canal District. Photo ©2019 by Google.





# Advancing adaptation solutions

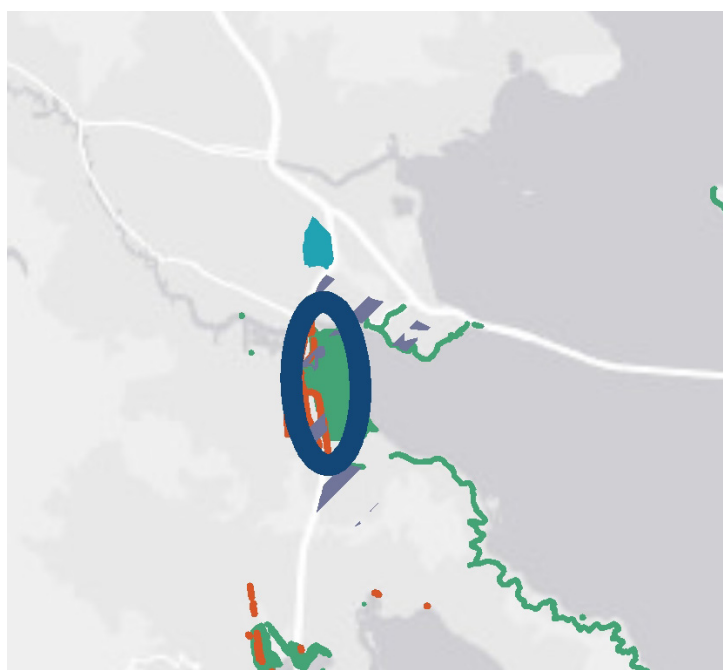
## FITTING INTO REGIONAL STORY

### *How are local areas contributing to Regional Hot Spots?*

The regional scale analysis of ART Bay Area identified clusters of highest consequences around the region, called “Regional Hot Spots.” These areas include places that contain the top five highest consequences in the region for 1) any transportation asset and 2) either a PDA or PCA, and 3) the presence of a vulnerable community block group at any given water level.

Datasets were identified for each regional system to provide a measure of consequence to quantify impacts in the event of flooding. A full list of consequences used for each regional system can be found in Chapter 2.1 Regional Hot Spots.

### Regional Hot Spot at 12” TWL



- Regional Hot Spot
- Transportation Infrastructure
- Vulnerable Community
- PDA
- PCA

#### **Figure 8b. Downtown San Rafael Canal District Hot Spot:**

From 12” TWL to 24” TWL, this Focus Area contains clusters of assets that have among the highest consequences of flooding in the region.

The Downtown San Rafael Canal District is a Regional Hot Spot, meaning it contains a cluster of assets that have among the highest consequences of flooding in the region.

It becomes a Regional Hot Spot starting at 12” TWL, but falls off at 24” TWLs (Figure 8b).

The San Rafael cluster is driven by multiple transportation assets, including CA-101, I-580, the SMART train and the Bay Trail; the Downtown San Rafael PDA, which experiences high impacts to 2010 job spaces and 2040 residential units as well as job spaces, and percent growth of residential units; and by block groups experiencing social vulnerability as well as contamination.

San Rafael no longer appears as a regional cluster at 24” TWL, despite worsening impacts within that cluster; local vulnerability and consequences are still critical, but as other assets get wet, higher regional consequences occur elsewhere.

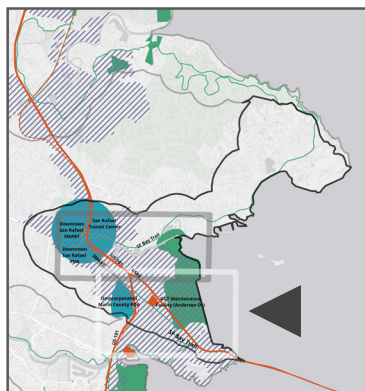
Chapter 4 Regional Adaptation provides adaptation responses for regional issues.



San Rafael looking south. Photo by Michael Estigoy is licensed under CC BY-NC-ND 2.0

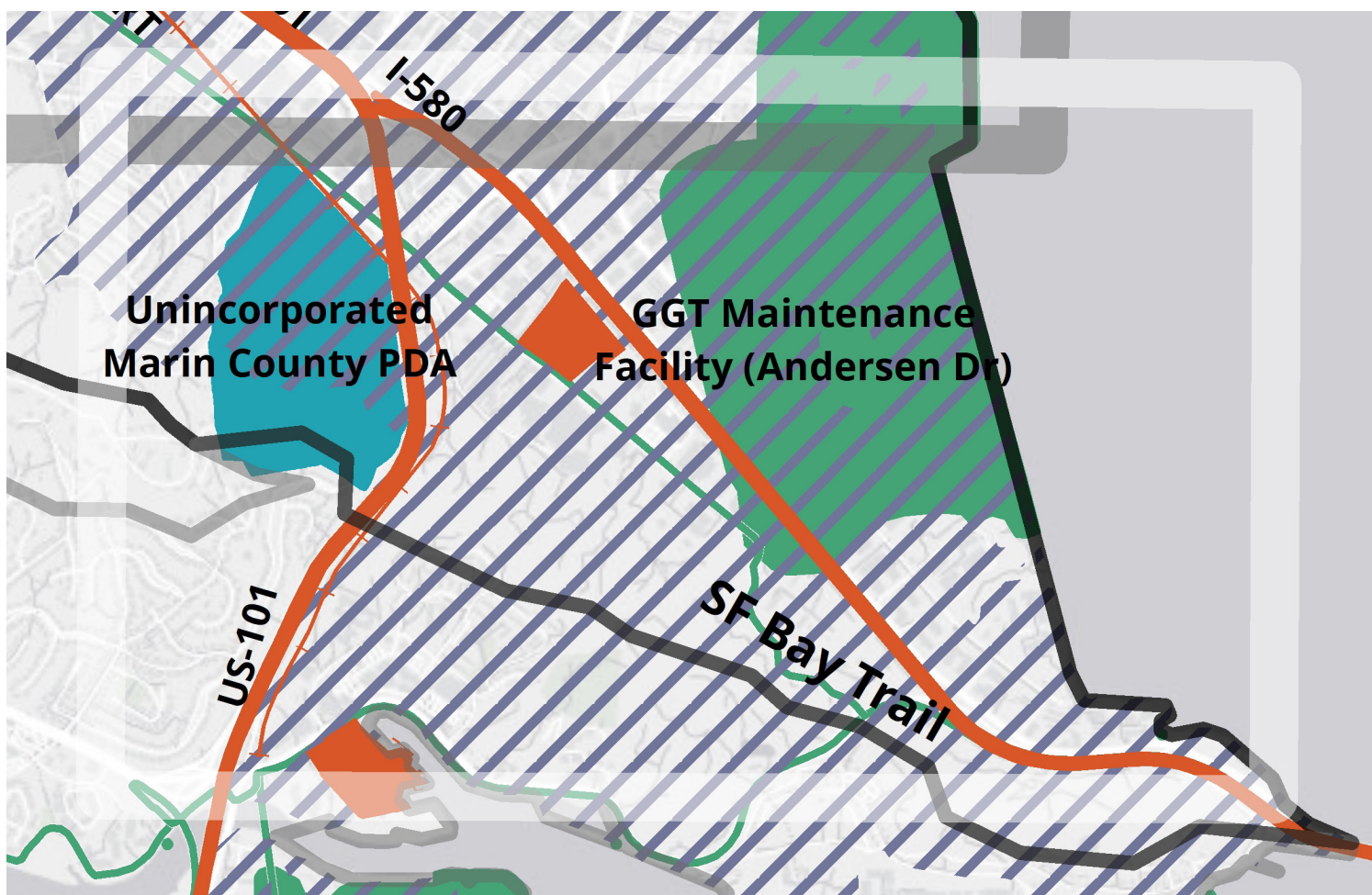


# Area of Impact B: *I-580 and US-101 Interchange*



## Location

This Area of Impact is focused around the I-580 and US-101 interchange and surrounding area (Figure 9b).



**Figure 9b. Top: Identification of where Area of Impact is within OLU. Bottom: Map of Area of Impact containing regional systems.** Individual assets assessed in this Area of Impact are labeled on the map and listed on the following page.

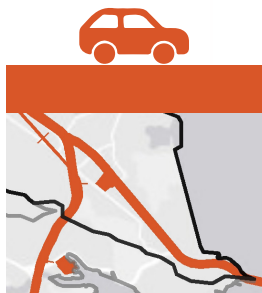


I-580 and US-101 interchange. Map data ©2019 by Google.

## Why shared stories of vulnerability?

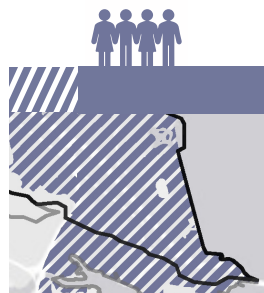
This Area of Impact was selected because it contains a variety of regional systems, including a PDA, a PCA, and multiple regional transportation systems. Due to overlap and dependencies among these regional systems in this area, the vulnerabilities of these systems to flooding and sea level rise are discussed together in shared stories of the shoreline, overtopping, and exposure to flooding as water levels rise. The goal of communicating shared vulnerabilities and consequences is to encourage multi-benefit solutions through collaborations and coordination.

### Figure 9b. MAP OF REGIONAL SYSTEMS AND LIST OF INDIVIDUAL ASSETS ASSESSED WITHIN THIS AREA OF IMPACT LISTED BELOW:



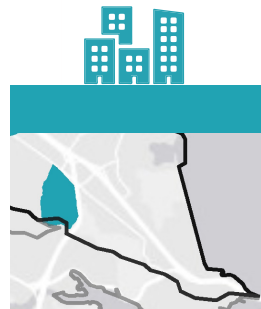
#### TRANSPORTATION

- I-580
- US-101
- Golden Gate Bridge and Highway Transit District Maintenance Yard (Andersen Dr)
- Local Roads



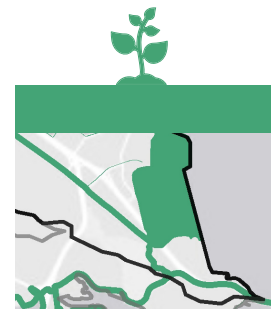
#### VULNERABLE COMMUNITIES

- N/A



#### PRIORITY DEVELOPMENT AREAS (PDAs)

- Unincorporated Marin County PDA



#### PRIORITY CONSERVATION AREAS (PCAs)

- San Francisco Bay Trail PCA



# Shoreline today and into the future

## SHORELINE TYPE STORY

### *What is the shoreline made up of now?*

In this area shoreline berms are present along much of the shoreline, which constitute the first line of flood defense. I-580 itself serves as additional shoreline protection east of the Golden Gate Bridge and Highway Transit District (GGBHTD) maintenance yard. There are additional berms along Andersen Drive itself.

## SHORELINE DEVELOPMENT STORY

### *How will the shoreline change in the future?*

San Rafael has been actively acquiring a band of open space along the Bay. Baypoint Lagoons was a recent development constructed near the mouth of the canal on San Pablo Bay.

The major potential shoreline changes include:

- **Baypoint Lagoons**



Shoreline near Bayside Park in San Rafael. Photo by HPapendick is licensed under CC BY 2.0



US-101 exit in Downtown San Rafael. Photo by HPapendick is licensed under CC BY 2.0



# Current and future flooding risk

## OVERTOPPING STORY

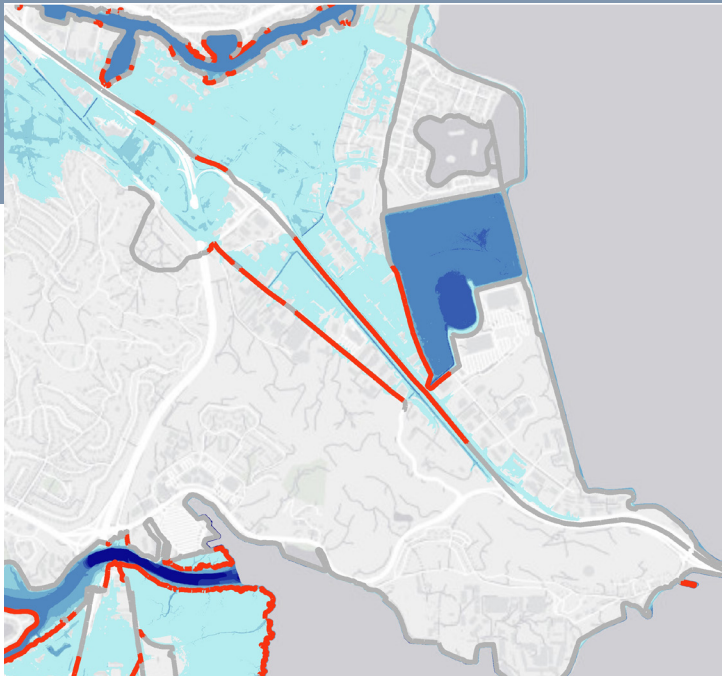
### *Where is water coming over the shoreline?*

At 12" TWL, large segments of berms east of Kerner Boulevard and along Andersen Boulevard are overtopped. I-580 is also overtopped within the impact area (Figure 10b). Overtopping increases with increasing water levels.

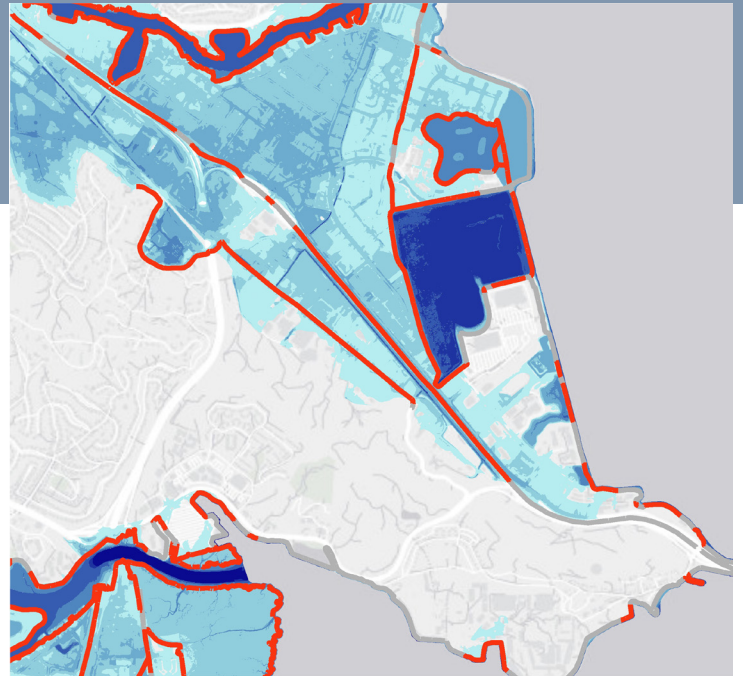
## FLOODING EXPOSURE STORY

### *Where does flooding occur?*

At 12" TWL, I-580, The GGBHTD maintenance yard, US-101, and the Bay Trail are flooded (Figure 11b). The Unincorporated Marin County PDA (California Park neighborhood) is in a low-lying disconnected area at 12" TWL and the key access road of Bellam Blvd. is flooded. Flooding enters the PDA at 24" TWL from the east, and access is cut off. Flooding increases with water levels.



12" TWL



48" TWL

## OVERTOPPING AND FLOODING ▲

**Figure 10b. Two total water levels selected that demonstrate first overtopping and/or significant flooding thresholds.** Visit the Bay Shoreline Flood Explorer ([explorer.adaptingtorisingtides.org](http://explorer.adaptingtorisingtides.org)) to see more TWLs.

- No overtopping
- Overtopping
- Shallower depth of flooding
- Deeper depth of flooding

## FIRST FLOODING OF REGIONAL SYSTEMS ASSESSED

Regional Systems Impacted	12"	24"	36"	48"	52"	66"	77"	84"	96"	108"
San Francisco Bay Trail PCA										
US-101										
I-580										
Local Roads										
GGBHTD Maintenance Yard										
Unincorporated Marin County PDA										

**Figure 11b. First exposure of regional systems.** Individual assets within the four regional systems in this area are shown and colored bars represent when each asset is first exposed to flooding impacts.



# Shared vulnerabilities to flooding

## SHARED VULNERABILITY STORIES

Vulnerability assessments were conducted on individual assets and then shared vulnerabilities were identified for regional systems within each focus area. The vulnerability statements below reflect shared stories of vulnerability. Our goal is to emphasize the interconnections among and across local systems, and encourage shared multi-benefits adaptation solutions.



### 1. Future Growth

The Unincorporated Marin County PDA (California Park) is slated for new job and housing growth, but transportation into the PDA is severely limited by flooding. Bellam Boulevard serves as the main access route to the Unincorporated Marin County (California Park) PDA with no redundancy, and floods early. This community also faces high contamination vulnerability from groundwater, which would be mobilized during flooding. Finally, managing future growth, displacement, access and equity will require coordination, community input and careful planning. Additionally, access to the rest of the region is limited due to flooding at I-580 and US-101.



### 2. Regional Transportation

The US-101 and I-580 provides critical regional transportation to the Bay Area. Both highways are vulnerable to flooding at low water levels. US-101 is the primary north-south transportation artery, providing important access to and from San Rafael and providing connections to I-580, SR-37, and SR-1. It is designated as part of the Strategic Highway Network (STRAHNET), meaning it is critical to the Department of Defense's domestic operations. I-580 has limited redundancy given its direct link to the San-Rafael Richmond Bridge and limited local road alternatives. If exposed to flooding, saltwater may cause corrosion of the reinforcing in concrete structures that support I-580. Additionally, the underpasses of these highways are critical for connecting bike and pedestrian access, which would need to remain intact for any adaptation measures. Implementation will require coordination at the local and regional scale, significant funding, and preemptive planning to avoid critical highway disruption.

# Shared consequences to flooding

## SHARED CONSEQUENCE STORIES

This section translates shared vulnerability statements into stories of shared consequences. The ART program considers consequences through frames of sustainability: Society and Equity, the Economy and the Environment.



**Society and Equity** • Flooding of US-101 and I-580 in this area will have a disproportionate impact on the ability for populations in neighboring socially vulnerable block groups, including those within the Unincorporated Marin County PDA, to and from job centers throughout the region. Mobilization of contaminants through flooding may also negatively impact society.



**Economy** • Flooding of I-580 and US-101 will have major economic consequences as it carries thousands of people every day to and from employment centers throughout the region. The lack of redundancy makes these impacts more severe to commuters who will have to take longer routes, likely leading to traffic congestion and increase vehicle miles traveled which will lead to increased greenhouse gas emissions. In addition, interruption of GGBHTD transit due to the flooding of its central maintenance yard will have economic impacts due to disruption of transit services ability for workers to get to job centers in the greater Bay Area.



**Environment** • Floodwaters that pass through this area may pick up and carry hazardous materials that can impair water quality and habitats critical to biodiversity. There could be significant water quality impacts if contaminants are released from contaminated sites into the adjacent natural areas that support a variety of species and habitats.





The Richmond-San Rafael Bridge (I-580). Photo by TJ Gehling is licensed under CC BY-NC-ND 2.0

## Endnotes

- 1 United States Census Bureau, "2010 Census (California)," 2011.
- 2 Caltrans, "2016 Vehicle Volumes (AADT)," 2016, <http://www.dot.ca.gov/trafficops/census/volumes2017/Route505-980.html>.
- 3 Caltrans, "2016 Truck Volumes (AADTT)," 2016, [http://www.dot.ca.gov/trafficops/census/docs/2016\\_aadt\\_truck.pdf](http://www.dot.ca.gov/trafficops/census/docs/2016_aadt_truck.pdf).
- 4 Caltrans.
- 5 Caltrans.
- 6 "Lifeline Routes."
- 7 "North Coast Railroad Authority," 2010, <http://www.marinconservationleague.org/about-us/40-successes/advocacy/202-ncra.html>.
- 8 Prepared by Bill Guerin, "San Rafael City Council Agenda Report: Downtown Gateway - Permanent Transit Center" (City of San Rafael, November 20, 2017), [http://cityofsanrafael.granicus.com/MetaViewer.php?view\\_id=38&event\\_id=869&meta\\_id=114179](http://cityofsanrafael.granicus.com/MetaViewer.php?view_id=38&event_id=869&meta_id=114179).
- 9 Golden Gate Bridge, Highway and Transportation District, "Golden Gate Bridge, Highway and Transportation District Short-Range Transit Plan, Fiscal Years 2008-2017," February 12, 2008, <http://goldengatetransit.org/services/documents/SRTP-Chapter1.pdf>.
- 10 "San Rafael's Community" (Shore Up Marin, 2019), <http://www.shoreupmarin.org/canal-community.html>.
- 11 "San Rafael's Community."
- 12 "Mapping Displacement and Gentrification in the San Francisco Bay Area" (UC Berkeley Urban Displacement Project, n.d.), <https://www.urbandisplacement.org/map/w>.
- 13 "San Francisco Bay Area Water Trail."
- 14 "San Francisco Bay Trail – A 500-Mile Trail Around the Bay."
- 15 European Space Agency, "Bay Area Displacement," European Space Agency, accessed August 29, 2019, [https://www.esa.int/spaceinimages/Images/2016/11/Bay\\_Area\\_displacement](https://www.esa.int/spaceinimages/Images/2016/11/Bay_Area_displacement).