

CORTE MADERA

Community Profile: Corte Madera

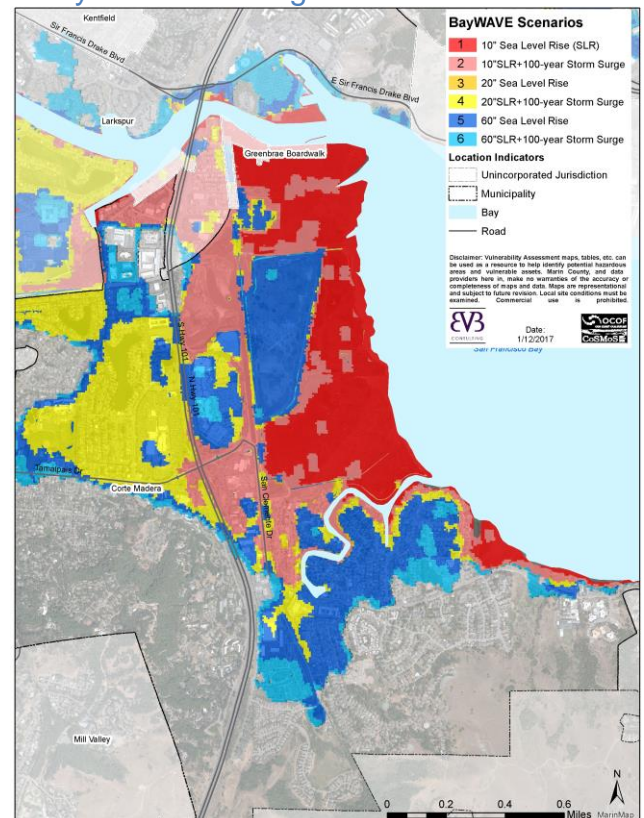
Corte Madera is a primarily residential community with several large commercial areas that take advantage of the highway corridor. These commercial areas serve the entire region and include outdoor malls, auto dealerships, restaurants, and other local business. In the near-term, 230 acres could be exposed to sea level rise. By the long-term, 906 acres could be exposed to sea level rise and 994 acres could be exposed with an additional 100-year storm surge. Key vulnerabilities in Corte Madera include:

- Homes along the tributaries to Corte Madera Creek may be vulnerable in the near-term.
- Commercial areas on Paradise Drive may be vulnerable to sea level rise in the near-term, and storm surges sooner.
- Segments of the 101 could be vulnerable to seasonal storm surges in the near-term, and sea level rise in the medium to long-terms. Access to the community from the US Highway 101 corridor may become increasingly difficult with chronic flooding.
- Marin Country Day School, Marin Montessori, Cove Elementary, and Neil Cummins elementary could be vulnerable across the scenarios.
- Mariner Cove and Marina Village are already susceptible to subsidence and could be vulnerable to sea level rise surface flooding in the near-term.
- Madera Gardens and the Corte Madera Town Center could be vulnerable to the 100-year storm surge in the medium-term, scenario 4, and sea level rise in the long-term, scenario 6.
- Stormwater pump stations could become tidally influenced and overburdened. If the pump station fails or capacity is exceeded, the surrounding neighborhoods could flood.
- Marsh land degradation or loss at the shoreline and Corte Madera Creek tributaries.
- The fire station on Paradise Drive could experience flooding impacts and access issues in the medium-term.
- Police serving the community are headquartered in Larkspur. Flooded roads could increase response times, and at worst, low lying areas become blocked to vehicles.
- California Highway Patrol (CHP) Marin headquarters is vulnerable to subsidence and sea level rise in the medium-term.

IMPACTS AT-A-GLANCE: SCENARIO 6

1,500+ living units	9,500+ people
994 acres exposed	79 commercial parcels
16 miles of roads	
Storm, tidal, and subsidence impacts already occur	Corte Madera Caltrans Central Marin PD Corte Madera Fire CHP Larkspur-Corte Madera School District HOAs Property Owners
\$1.4 billion worth of assessed property value; assets vulnerable; \$1.5 billion in single family market value ¹⁸⁹	

Map 77. Corte Madera Sea Level Rise and 100-year Storm Surge Scenarios



¹⁸⁹ 2016 dollars

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Housing at the end of Lucky Drive. Corte Madera. Credit: Marin County DPW

Vulnerable Assets

Corte Madera's most vulnerable assets in the near-term include commercial and residential south of US Highway 101 and along Corte Madera Creek. In the long-term, flooding could pass through the US Highway 101 corridor, flooding commercial development, and residential west of the highway.

Land

Corte Madera is one of the County's large municipalities and has relatively long length of shoreline that is protected by armoring with development not too far behind in most cases. Corte Madera also features productive tidal marshes that may help preventing major flooding before the medium-term. Note also, that Corte Madera city limits extend well into the upland valleys. However, unlike communities further south, Corte Madera has considerable low-lying areas, especially historic marshes filled for development.

Acres

In the near-term, 230 acres, or eight percent of Corte Madera, could be exposed to tidal flooding and another 200 acres could be exposed to storm surge flooding only. In Medium-term scenario 3, eleven percent of Corte Madera, or about 300 acres could be exposed to sea level rise tidal flooding at MHHW. With the additional 100-year storm surge in scenario 4, twice this area could face nuisance storm-surge flooding. In the long-term more than thirty percent of Corte Madera could be subject to MHHW tidal flooding and 100-year storm surge flooding.

Table 84. Corte Madera Exposed Acres

Scenarios		Acres	
		#	%
Near-term	1	230	8
	2	430	15
Medium-term	3	313	11
	4	640	22
Long-term	5	906	32
	6	994	35

Source: MarinMap, CoSMoS

Table 85. Corte Madera Vulnerable Parcels at MHHW

Scenarios		Parcels	
		#	%
Near-term	1	9	0
	2	201	6
Medium-term	3	68	2
	4	635	17
Long-term	5	1,104	30
	6	1,535	42

Source: MarinMap, CoSMoS

Parcels

Examining how this acreage is divided in to parcels for development and reservation, and what uses are on the land can provide a representation of the human activities that could be vulnerable in Corte Madera. In the near-term, few parcels could be vulnerable to tidal flooding; however, 200 could be vulnerable to 100-year storm surge flooding. In the medium-term, nearly 70 parcels could experience tidal flooding. Several of these are marshes and parklands, though some residential parcels off Lucky Drive could be vulnerable to flooding by this time period. A 100-year storm could flood, almost 20 percent of parcels with bay storm waters. In the long-term, more than 1,100 parcels may be subject to tidal and storm-surge flooding. These parcels constitute one-third of Corte Madera's parcels. With an addition 100-year storm surge, more than 40 percent of Corte Madera could be impacted by flooding. This level of flooding would be devastating to development and property owners.

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Table 86. Corte Madera Vulnerable Parcels by Land Use

Land Use	Scenarios					
	1		3		5	
	Near-term		Medium-term		Long-term	
	#	Ac.	#	Ac.	#	Ac.
Commercial Improved			4	3	70	95
Commercial Unimproved					8	3
Industrial Improved					5	8
Industrial Unimproved					3	5
Residential	3	1	57	28	944	152
Multi-Family Improved					3	1
Single Family Attached			2	25	66	3
Single Family Improved	2	0.6	55	9	871	147
Single Family Unimproved	1	0.4	2	0.4	4	1
Tax Exempt	3	237	4	274	52	472
Exemption Improved	1	3			10	10
Exemption Vacant	2	25	1	3	3	27

Source: MarinMap, CoSMoS

Table 87. Corte Madera Vulnerable Residential and Commercial Parcels

Land Use	Scenario					
	1		3		5	
	Near-term		Medium-term		Long-term	
	#	%	#	%	#	%
Residential	3	0	57	3	944	29
Commercial			4	3	79	66

Source: MarinMap, CoSMoS.

Across land uses, the majority of acreage in the near-term is dedicated to tax exempt lands, which are typically parks and open space, and this case, mostly marshes. Residential is also vulnerable in the Marina Village and Mariners Cove. In the medium-term, commercial parcels along San Clemente Drive could expect tidal impacts in the parking lots. In the long-term, all of the marshes are flooded, as are most of the neighborhoods east of Paradise Drive. These nearly 1,000 parcels account for thirty percent of Corte Madera residential parcels. The eighty parcels that could expect tidal flooding impacts on a regular basis account for seventy percent of commercial parcels in Corte Madera. This is a significant portion of commercial properties in the community. Moreover, these businesses serve as a regional center of commerce serving more than just the Corte Madera community. Several of the businesses also sell high value items, such as cars, furniture, and more. Of note, a few industrial use parcels could face tidal flooding.

Buildings

Buildings on the flatlands of Corte Madera were built on filled in marshes that extend to Kentfield, and are already vulnerable to subsidence. East of U.S> High 101, Mariner Cove is built on fill and is not levee protected. Marina Village is protected to the north by a levee. However, the eastern side of Marina Village is raised by fill and may be susceptible to sea level rise along San Clemente Creek first. Mariners Cove may be susceptible to sea level rise along San Clemente Creek as well. Further east along the roadway are commercial centers that are fronted by marsh lands tempered with an earthen levee used as a trail. These commercial areas, including Aegis Senior Living complex, may be vulnerable across all of the sea level rise scenarios, first impacting the low-lying car dealership area and spreading outwards.

In long-term scenario 5, the area north of US 101 including the Corte Madera Town Center, could also be impacted. While it is plausible this area could be reached by storms in the medium-term, long-term sea level rise could burden the area with regular tidal influences. Water could also impact the area north of the highway from the creek system and channels extending into the city. This area is also impacted by stormwater backups due to tidal influences that would worsen. In fact, this issue may have led to a two week shut down of half of Neil Cummings Elementary School.

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Table 88. Corte Madera Vulnerable Buildings by Scenario

Scenarios		Buildings	
		#	%
Near-term	1	5	0
	2	255	7
Medium-term	3	138	4
	4	804	21
Long-term	5	1,283	33
	6	1,468	38

Source: MarinMap, CoSMoS

Table 89. Corte Madera Vulnerable Buildings Average Flood Depths* at MHHW

Flood Depth (feet)	Scenarios		
	Near-term	Medium-term	Long-term
	1	3	5
0.1-1	1	43	34
1.1-2	4	79	240
2.1-3	0	10	206
3.1-4		1	200
4.1-5		2	240
5.1-6			224
6.1-7			106
7.1- 8			15
8.1-9			1

Source: MarinMap, CoSMoS

*Flood depth data is not available for all exposed areas and assets.

Table 90. Corte Madera Vulnerable Buildings' FEMA Hazus Storm Damage Cost* Estimates in Long-term Scenario 6

Number of Buildings in Scenario 6	1,468
Yellow Tag :Minor Damage \$5,000	\$7,340,000
Orange Tag: Moderate Damage \$17,001+	\$24,957,468
Red Tag-Destroyed Assessed structural value	\$726,321,314

Source: MarinMap, CoSMoS

* 2016 dollars

As seen in Table 88, in the near-term, buildings are not impacted until the 100-year storm surge condition is applied, amounting to 255 buildings. In the medium-term, nearly 140 buildings may be vulnerable to tidal flooding. And more than six hundred more buildings are vulnerable with the 100-year storm surge coincidence. These figures constitute one-fifth of the community's buildings. By scenario 5, nearly 1,300 buildings could expect tidal flooding impacts, and a few hundred more could be damaged from storm surge impacts.

Table 89 indicates how many buildings could fill with one, two, or ten feet of water when flooded due to sea level rise at MHHW. In the near-term, five vulnerable buildings could expect less than or equal to two feet of tide waters. This trend continues for the majority of the buildings in scenario 3 as well. In long-term scenario 5, 500 buildings could be flooded with up to three of saltwater. More than 650 buildings could be flooded with more than three feet and up to six feet of water, and about 125 buildings could be flooded with between six and nine feet of saltwater on a regular basis. These properties would be unusable in their current state.

Table 90 estimates costs using FEMA Hazus post-disaster damage tagging levels for buildings and their contents. These figures are based on scenario 6, the worst case scenario examined in this assessment. This analysis assumes every building experiences the same damage level, such that if all 1,500 buildings are yellow-tagged, up to \$25 million in damages could incur. At the high end, more than \$700 million¹⁹⁰ of structural damages could occur. Reality would likely reflect of mix of these damage levels.

The maps on the following pages illustrate vulnerable buildings by scenario. The areas in the call out circles enable the reader the see areas that are difficult to see on the large scale map. The circles do not indicate that these areas are more vulnerable than others along the shoreline.

¹⁹⁰ 2016 dollars

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Map 78. Corte Madera Vulnerable Buildings

Vulnerable Assets

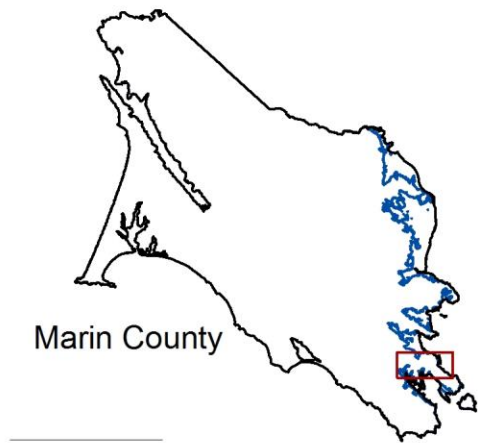
- School
- Emergency Shelter
- Fire Station
- Law Enforcement

Vulnerable Buildings

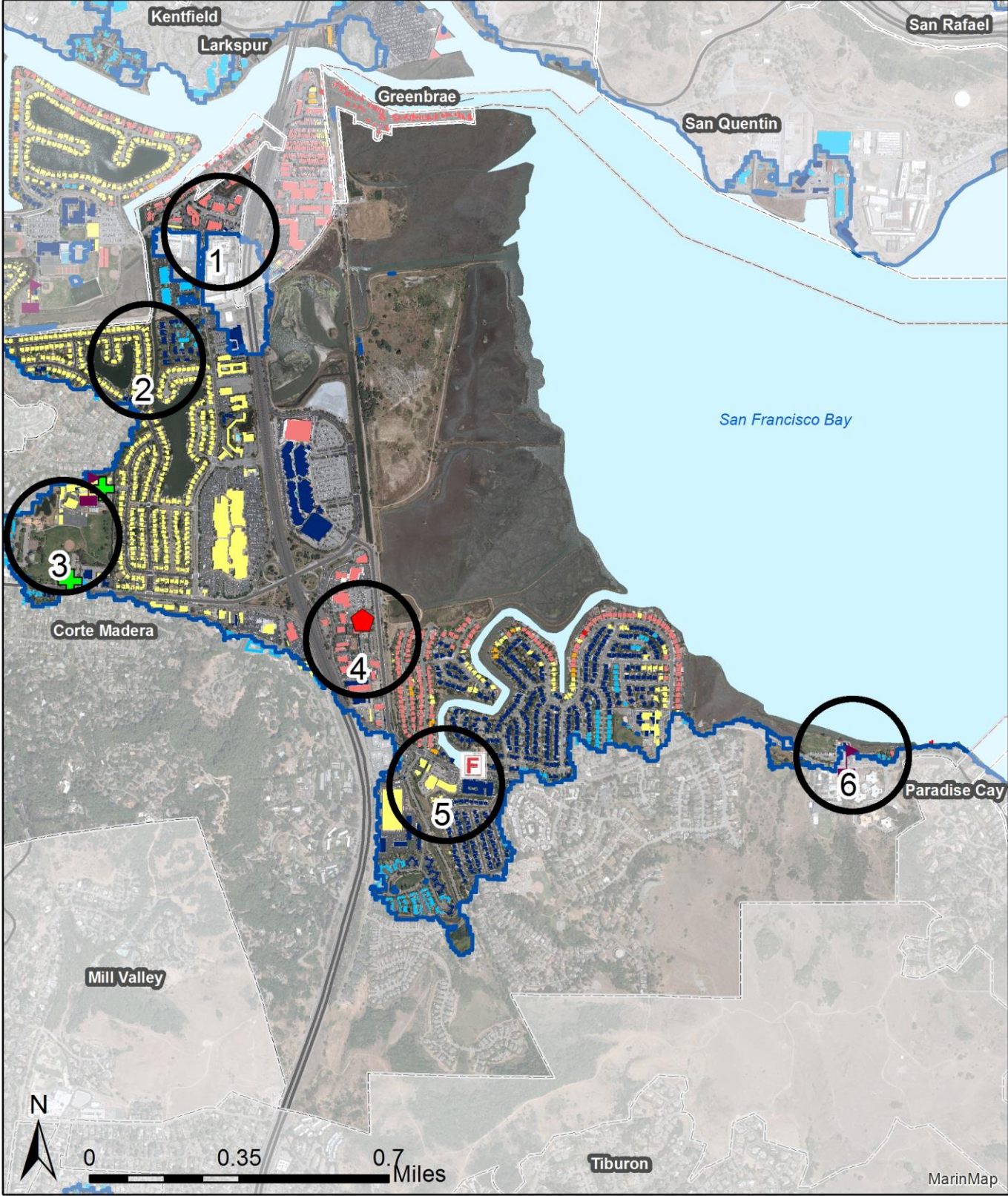
- Scen. 1: 10" Sea Level Rise (SLR)
- Scen. 2: 10" SLR+Storm Surge
- Scen. 3: 20" Sea Level Rise
- Scen. 4: 20"SLR+Storm Surge
- Scen 5: 60" Sea Level Rise
- Scen. 6: 60"SLR+Storm Surge

Location Indicators

- Unincorporated
- Municipality
- Road
- Bay
- Inland Extent: Sea Level @ 60"+100-year Storm



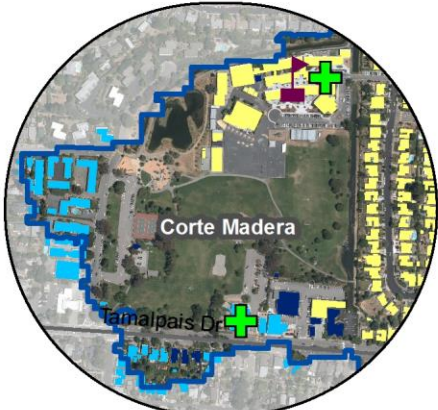
Date:
6/15/2017



1: Lucky Drive



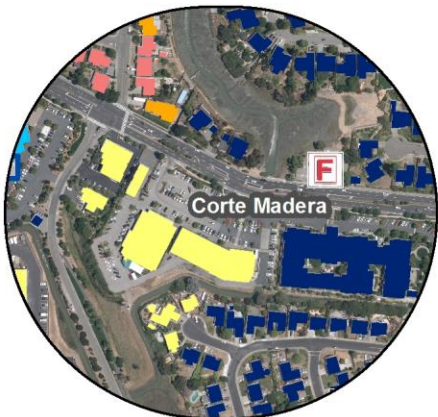
2: Madera Gardens



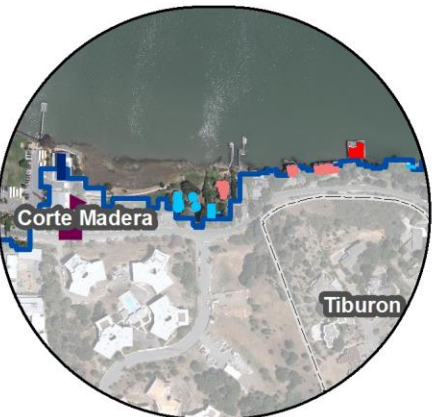
3: Neil Cummins School



4: San Clemente Drive



5: San Clemente Dr.
@ Paradise Dr.



6: Paradise Drive

Disclaimer: Vulnerability Assessment maps, tables, etc. can be used as a resource to help identify potential hazardous areas and vulnerable assets. Marin County, and data providers here in, make no warranties of the accuracy or completeness of maps and data. Maps are representational and subject to future revision. Local site conditions must be examined. Commercial use is prohibited.

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Transportation

Nearly every road west of Highway 101 is vulnerable in the near- to medium-terms with a 100-year storm surge. By scenario 5, all of these roads and tens more on the east side of the US Highway 101 could expect tidal flooding. Several of the roads east of US Highway 101 are already, and will continue to be, vulnerable to subsidence. In addition, due to the orientation of the commercial sites, already stressed parking lots could experience impacts first.

Table 91 lists the vulnerable roads and trails in Corte Madera by onset. In near-term scenario 2, 3 miles of road could experience nuisance storm surge flooding. In medium-term scenario 3, 1 mile of road could experience tidal flooding. In scenario 4, this figure jumps to nine miles. This temporary flooding; however, may not be as problematic as roads that only experience may be able to tolerate short-term saltwater exposure. Finally, in the long-term 14 miles could experience tidal flooding, and two more could experience storm surge flooding. Fourteen miles of road closed down twice a day for several days a month several months of the year would be extremely burdensome for travelers. Especially considering the regional impacts of US Highway 101 flooding where it interchanges with Interstate 580.

Preliminary conversations with Caltrans indicate that Caltrans is well aware of the existing and arising concerns in the County.¹⁹¹ According to Caltrans and the CoSMoS model shows flooding at low spots of US Highway 101 between Corte Madera and San Rafael. These low spots typically benefit from levees and pumps others operate to protect the larger area from flooding. These locations are south of Tamalpais Drive to Nellen Avenue, and from Corte Madera Creek to Lucky Drive.

Transit service along the vulnerable roads could also be compromised. Impacts to transit service could disproportionately impact low-income and Aegis residents. Both Golden Gate Transit and Marin Transit operate in the area. Golden Gate Transit routes 18, 22, 17, 24, 27, 36, 70, 71, 80, and 117 pass through the flooded area at the following stops:

- Paradise Dr. and El Camino Dr.,
- Paradise Dr. and Seawolf Passage,
- Paradise Dr. and Prince Royal Dr.,
- Doherty Dr. and Larkspur Plaza,

- Paradise Dr. and Madera Del Presidio Ave.,
- Paradise Dr. and Harbor Dr.,
- 33 San Clemente Dr.,
- Hwy 101 and Lucky Dr.,
- Hwy 101 and Tamalpais Dr., and
- Hwy 101 and Paradise Dr.

Marin Transit routes 113 and 117 also travel through the flooded areas with stops at:

- Tamal Vista Blvd. and Sandpiper Circle,
- Madera Blvd. and Monona Dr.
- Madera Blvd. and Mohawk Ave.,
- Paradise Dr. and Madera Del Presidio Ave.,
- Paradise Dr. and Harbor Dr.,
- Paradise Dr. and El Camino Dr.,
- Paradise Dr. and Seawolf Passage,
- Paradise Dr. and Robin Dr.,
- 33 San Clemente Drive,
- Tamal Vista Blvd. and Council Crest Dr., and
- Paradise Bus Pads.

Lost or compromised function of these ground transportation features could cut off access to Corte Madera, leading to negative economic impacts for local and regional businesses, emergency vehicle accessibility impacts, residents and commuters dependent on US Highway 101.

Trails along and through the marshes are also vulnerable in the near-term. These paths are typically on or near shoreline armoring. Several miles of bike path and sidewalk along the vulnerable roads are also vulnerable across all scenarios.



Corte Madera Creek at the end of Lucky Drive. Note the low-lying segment of US Highway 101 starts here. Credit. Marin County DPW

¹⁹¹ Sea Level Rise Vulnerability Assessment Interview. Caltrans. April 30, 2015. J. Peterson. D. Fahey. Marin County Development Agency. BVB Consulting LLC.

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The maps on the following pages illustrate vulnerable transportation features. The areas in the call out circles enable the reader the see areas that

are difficult to see on the large scale map. The circles do not indicate that these areas are more vulnerable than others along the shoreline.

Table 91. Corte Madera Vulnerable Transportation Assets

Near-term		Medium-term		Long-term	
Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6
None	3 miles	1 mile	9 miles	14 miles	16 miles
	Hwy 101 ^C Redwood Hwy ^L Paradise Dr ^L Baja Ct ^L Casa Buena Dr ^L Channel Dr ^L Conow St ^L Ebbside Passage ^L Echo Ave ^L Fifer Ave ^L Golden Hind Passage ^L Harbor Dr ^L Lucky Dr ^L Nellen Ave ^L San Clemente Dr ^L Tamal Vista Blvd ^L Tamalpais Dr ^L Yolo St ^L		Roads in scenario 2 Apache Rd ^L Arrowhead Ln ^L Birch Ave ^L Cheyenne Way ^L Chickasaw Ct ^L Council Crest Dr ^L Edgemar Way ^L Hickory Ave ^L Lakeside Dr ^L Madera Blvd ^L Madera del Presidio Dr ^L Meadowsweet Dr ^L Mohave Ct ^L Mohawk Ave ^L Monona Dr ^L Navajo Ln ^L Sanford St ^L Seamast Passage ^L Seminole Ave ^L Tradewind Passage ^L	Roads in scenarios 2 and 4 Diamond Head Passage ^L El Camino Dr ^L Estrada Ln ^L Flying Cloud Course ^L Foremast Cv ^L Granada Dr ^L Key Largo Course ^L Key Largo Cv ^L Lanyard Cv ^L Meadow Creek Dr ^P Morning Star Course ^L Pacific Queen Passage ^L Paloma Dr ^L Prince Royal Dr ^L Prince Royal Passage ^L Sandpiper Cir ^P Sandra Marker Trl ^L Seawolf Passage ^L Simon Ranch Rd ^P Spindrift Passage ^L Staghound Passage ^L Wornum Dr ^{L,C}	Roads in scenarios 2, 4, and 5 Ash Ave ^L Cay Passage ^L Chapman Dr ^L Council Crest Dr ^L Creekside Ct ^P Eastman Ave ^L Hickory Ave ^L Laurel Dr ^L Parkview Cir ^P Pixley Ave ^L Redwood Ave ^L Westward Dr ^L

M = Marin County; C = State of California; L = Local Municipality; P = Private. Source: MarinMap, CoSMoS

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Map 79. Corte Madera Vulnerable Transportation Assets

Vulnerable Assets

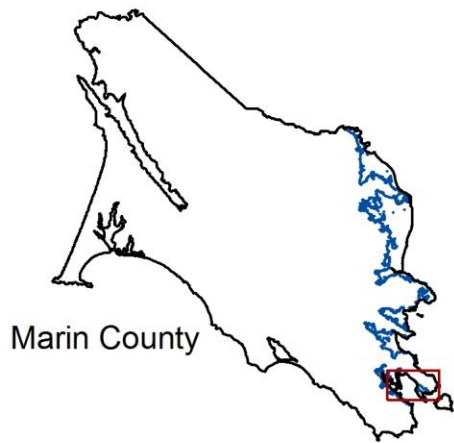
- Bike path
- Bay Trail
- Trail
- MT Bus Stop
- GGT Bus Stop
- Ferry

Vulnerable Roads

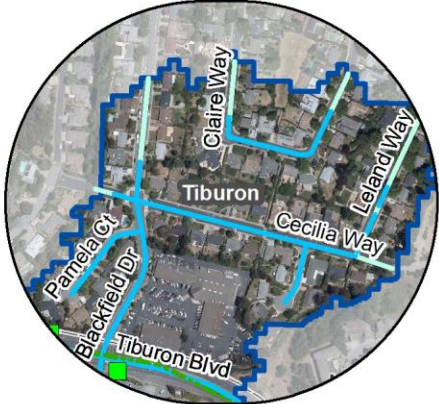
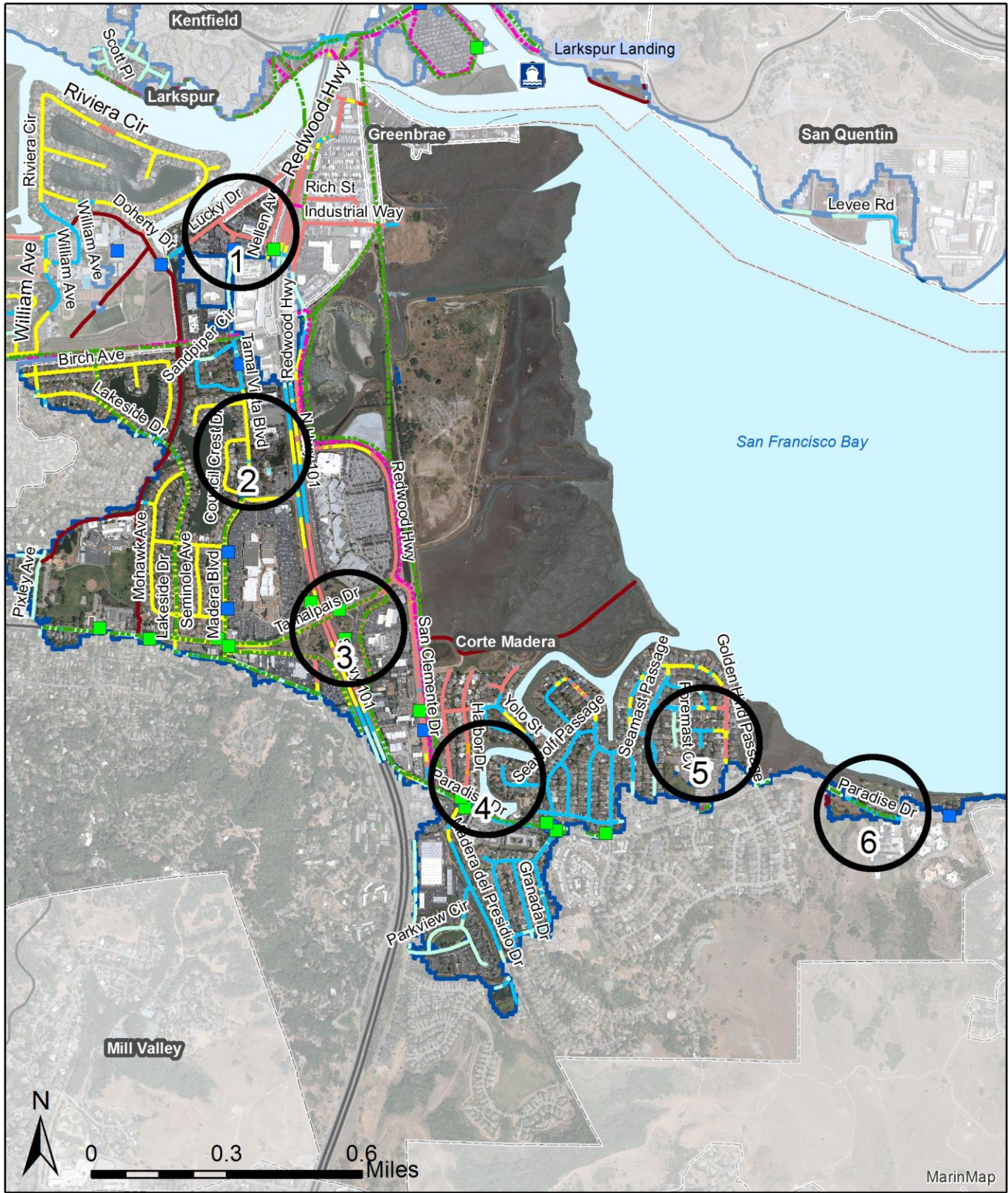
- @10" Sea Level Rise (SLR)
- @10"SLR+ 100-year Storm Surge
- @20" Sea Level Rise
- @20"SLR+ 100-year Storm Surge
- @60" Sea Level Rise
- @60"SLR+ 100-year Storm Surge

Location Indicators

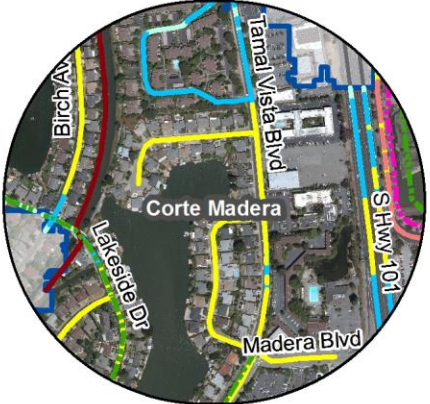
- Unincorporated
- Municipality
- Road
- Bay
- Inland Extent: Sea Level @ 60"+100-year Storm



Date:
6/15/2017



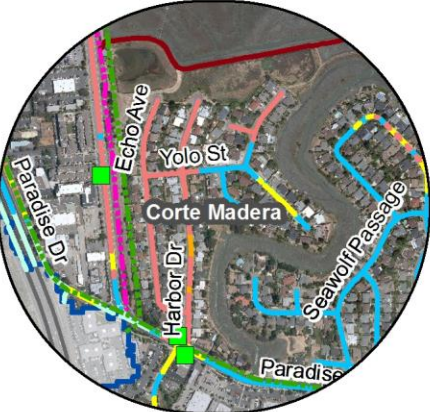
1: Lucky Drive



2: Tamal Vista Blvd.



3: U.S. Hwy. 101



4: San Clemente Dr.
@ Paradise Dr.



5: Mariner's Cove



6: Paradise Drive

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Utilities

Corte Madera's Sanitary District No. 2 will likely face issues common in other shoreline communities in the study area, including:

- Underground pipes face compounding pressure forces from water and the road,
- Road erosion and collapse with underlain pipes,
- Saltwater inflow and infiltration causing inefficiencies in wastewater treatment,
- Continuously subsiding soils or fill, and
- Escalating activity, capacity demands, energy consumption, and wear and tear on pump stations in stormwater and wastewater systems,
- Aging individual site connections for water, sewer, and electrical, and
- Flood waters interrupting access for employees to reach work sites.

In addition, PG&E has a natural gas pipe line along US Highway 101, Paradise Drive, and Madera del Presidio Drive towards Paloma Drive. They also have transmission towers and lines that travel from Larkspur through the hills across the Corte Madera marshes.

Natural Resources

Corte Madera has a rich estuary and marsh system that support robust wildlife populations in the Corte Madera Ecological Reserve, Triangle Marsh, and the lagoon habitats. The marsh lands are extensive and may be able to withstand sea level rise impacts; however, because many sections abut levees, roads, or development, the marshes could get squeezed out in the long-term and turn to mud flats and open water.

The longfin smelt, Ridgway Rail, and Salt Marsh harvest mouse are the listed endangered species recorded in this area. The smelt is listed as threatened on the California species list and a candidate for the federal list. The Ridgway Rail and Harvest mouse are federally listed. The San Pablo Song sparrow, though not listed, is unique to the area and has potential habitat in the exposed area.

The Ridgway's rail is one of the largest rails in North America, very secretive, and primarily lives in salt and brackish marshes. The Corte Madera Ecological Reserve supports one of the densest populations of

Ridgway's rails in the northern San Francisco Bay.¹⁹²

Salt marsh harvest mice are endangered because of habitat loss, fragmentation, and alteration.¹⁹³ These mice are only found in the Bay area, including the marshes of Corte Madera; in the upper half of tidal salt marshes and the adjacent uplands during high tides.¹⁹⁴ Sea level rise would greatly impact this species, especially if the mouse's habitat is trapped by development. If high inundation rates occur in areas without upland habitat then reproduction could be reduced or eliminated.

Lastly, Chinook salmon, an endangered species, young use tidal marshes for cover and the feed as it out-migrates through the estuary. And steelhead trout, a special status species, use tidal marshes and creeks for foraging.¹⁹⁵



Corte Madera Ecological Reserve. Credit: C. Kennard

¹⁹² Goals Project. 2015. *The Baylands and Climate Change: What We Can Do*. Baylands Ecosystem Habitat Goals Science Update 2015 prepared by the San Francisco Bay Area Wetlands Ecosystem Goals Project. California State Coastal Conservancy, Oakland, CA. Pg. 168

¹⁹³ Shellhammer, H. 2000. Salt Marsh Harvest Mouse. Pp. 219 – 228 in Goals Project. 2000. Baylands Ecosystem Species and Community Profiles: Life history and environmental requirements of key plants, fish and wildlife. Prepared by the San Francisco Bay Area Wetlands Ecosystem Goals Project. P. R. Olofson, editor. San Francisco Bay Regional Water Quality Control Board, Oakland, California.

¹⁹⁴ Goals Project. 2015. *The Baylands and Climate Change: What We Can Do*. Appendix 5.1 Salt Marsh Harvest Mouse. Ecosystem Baylands Habitat Goals Science Update 2015 prepared by the San Francisco Bay Area Wetlands Ecosystem Goals Project. California State Coastal Conservancy, Oakland, CA.

¹⁹⁵ Marin Audubon Society. Personal Communication. March 10, 2017.

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Recreation

The Bay Trail (County Route 17), Sandra Marker Trail, Corte Madera/Larkspur Bike Path, marsh land pathways, and private boating infrastructure could be vulnerable to sea level rise in the near-term. Additionally, on street bike paths and sidewalks are also compromised. This would greatly impact bicyclists that ride the Tiburon Peninsula. These activities will likely shift to accommodate the changing circumstances of travel. In addition, the Best Western and Marin Suites could be vulnerable.

Emergency Services

Three emergency shelters in Corte Madera may be vulnerable in scenario 6. Fire Station 13 off of Paradise Drive is vulnerable in the long-term to sea level rise and could experience access impacts even sooner. The Tamalpais Drive fire station just misses exposure under these average high tide scenarios. Access south of the facility could be compromised due to flooding. The police headquarters are technically in Larkspur; however, similar access issues could also arise here. When traveling to Corte Madera, that fastest route from the station is typically using U.S. Highway 101, which could likely be flooded to some degree during high tides under all of the BayWAVE scenarios. This could increase response times, and at worst, prevent responses entirely. Finally, the California Highway Patrol Office is in the exposure zone. To learn more about the site's vulnerabilities see the Emergency Services Profile.

Cultural Resources

Corte Madera's inventoried historic assets are located outside of the flood area.

Table 92 lists these assets and others in order of onset and severity of flooding. A 100-year storm surge would add an additional 1 to 3 feet of water to these properties. Note also, above average high tides could impact more properties than accounted for in this analysis.

A few additional select assets could also be vulnerable in scenario 6 with the additional 100-year storm surge condition. These are:

- Marin Country Day School (emergency shelter),

- Holy Innocents Episcopal (emergency shelter), and
- Marin Lutheran Church (emergency shelter).

All three of these sites are existing emergency shelters that by the end of the century could be at the epicenter of emergency and unable to serve their function.

The maps on the following pages illustrate vulnerable utility, natural resource, recreation, emergency and historic features. The areas in the call out circles enable the reader to see areas that are difficult to see on the large scale map. The circles do not indicate that these areas are more vulnerable than others along the shoreline.

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Table 92. Example Corte Madera
Vulnerable Assets by Sea Level Rise Onset
and Flooding at MHHW

Asset	Scenarios		
	Near-term	Medium-term	Long-term
	1	3	5
Paradise Dr. commercial	0-1'2"	9"-3'3"	2'-8'4"
Marina Village	0-1'	4'-2'5"	11'-6'
Mariner Cove	0-1'	2"-2'	5'3"
CHP Headquarters	3"	2'4"	6'
Shorebird Marsh		5'3"	10'9"
Bay Trail		0-3'4"	0-8'6"
Madera Gardens.		9"-3'	2'-7'4"
Paradise Drive		0-2'5"	4"-9'
Neil Cummins Elementary		2'5"	6'6"
San Clemente Dr.		1'2"-2'3"	1'9"-7'4'
Tamalpais Dr.		0-2'	2"-7'6"
Corte Madera Town Center		2'	5'
Aegis Senior Living		1'9"	4'7"
Susan Marker Trail			1'2"-7'6"
Cove Elementary		11"	2'3"
The Village at Corte Madera		10"	2'
Higgins Dock			11'10"
Madera Gardens Lagoons			10'4"
Town Park			9'10"
Hwy 101 NB			6"-7'8"
Redwood Hwy.			1'2"-6'8"
Hwy 101 SB off ramp			1'-5'5"
Ring Mountain			3'6"
Skunk Hollow Park			3'
Marin Montessori			1'7"
Corte Madera Ecological Reserve	Floods at existing high tides		

Source: MarinMap, CoSMoS

CORTE MADERA

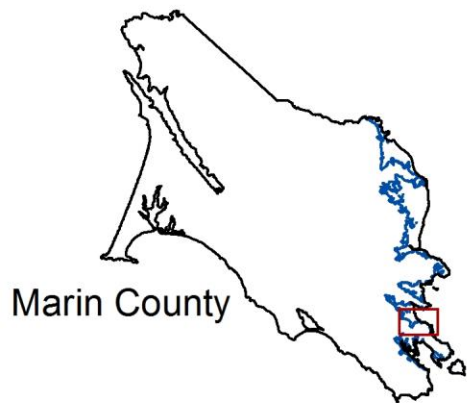
Map 80. Corte Madera Vulnerable Wastewater Utility Assets

Vulnerable Assets

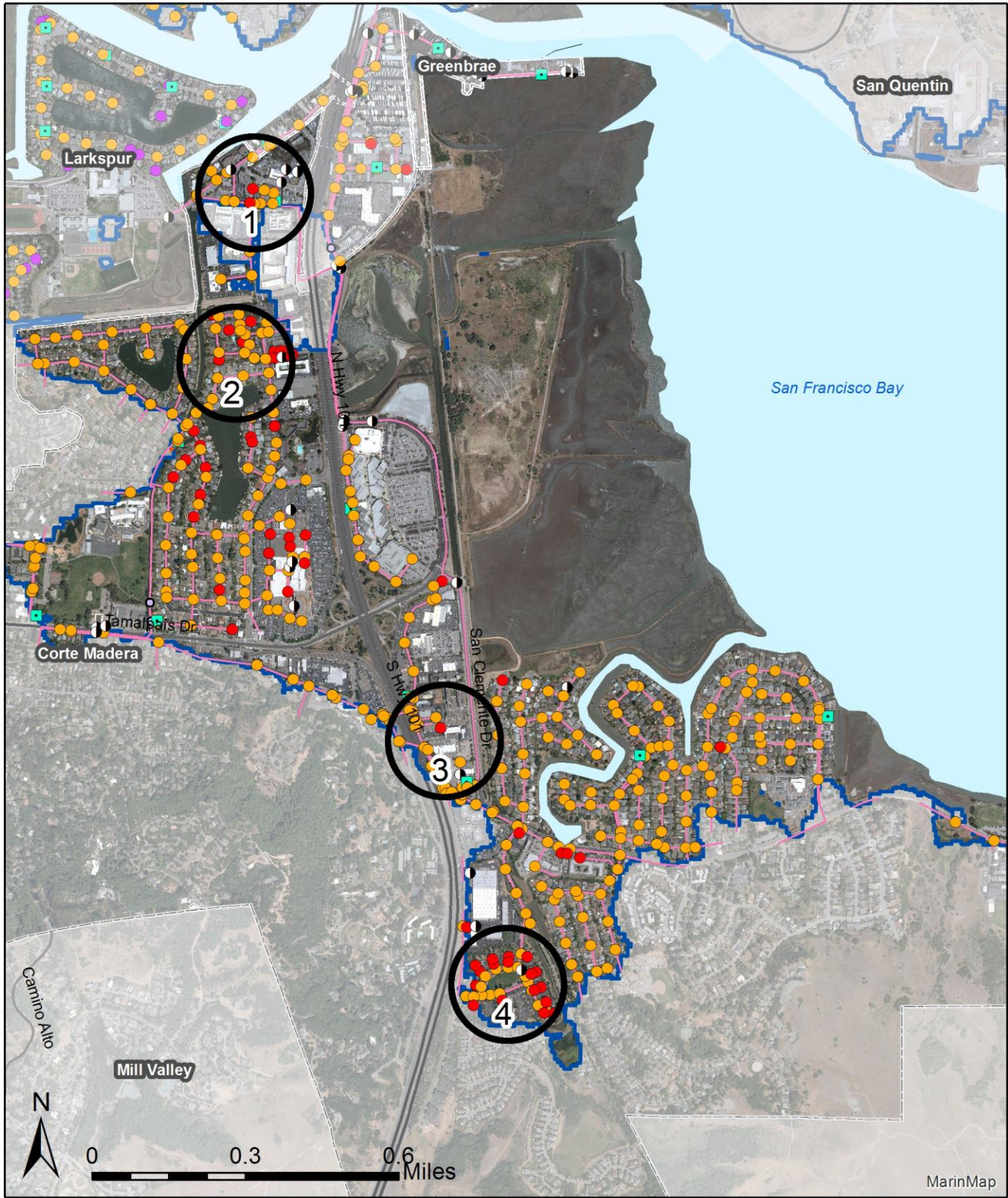
- AP
- Pump Station
- Junction
- Outlet
- Manhole
- Pipe

Location Indicators

- Unincorporated
- Municipality
- Road
- Bay
- ~ Inland Extent: Sea Level @ 60"+100-year Storm Surge



Date:
6/15/2017



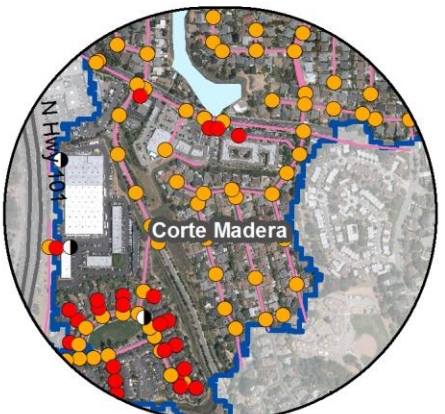
1: Lucky Dr.



2: Madera Gardens



3: San Clemente Drive















4: Madera del Presidio

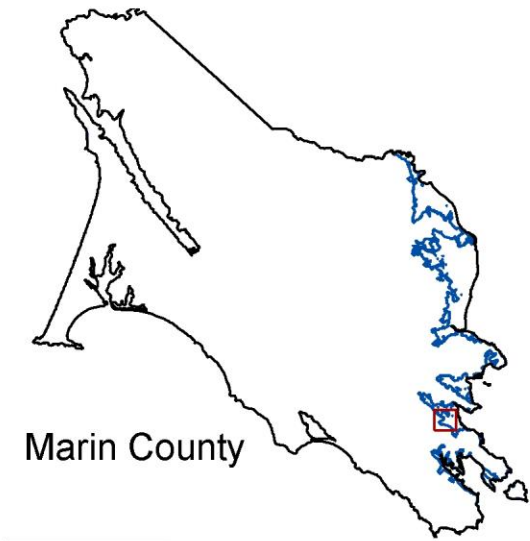
Disclaimer: Vulnerability Assessment maps, tables, etc. can be used as a resource to help identify potential hazardous areas and vulnerable assets. Marin County, and data providers here in, make no warranties of the accuracy or completeness of maps and data. Maps are representational and subject to future revision. Local site conditions must be examined. Commercial use is prohibited.

CORTE MADERA

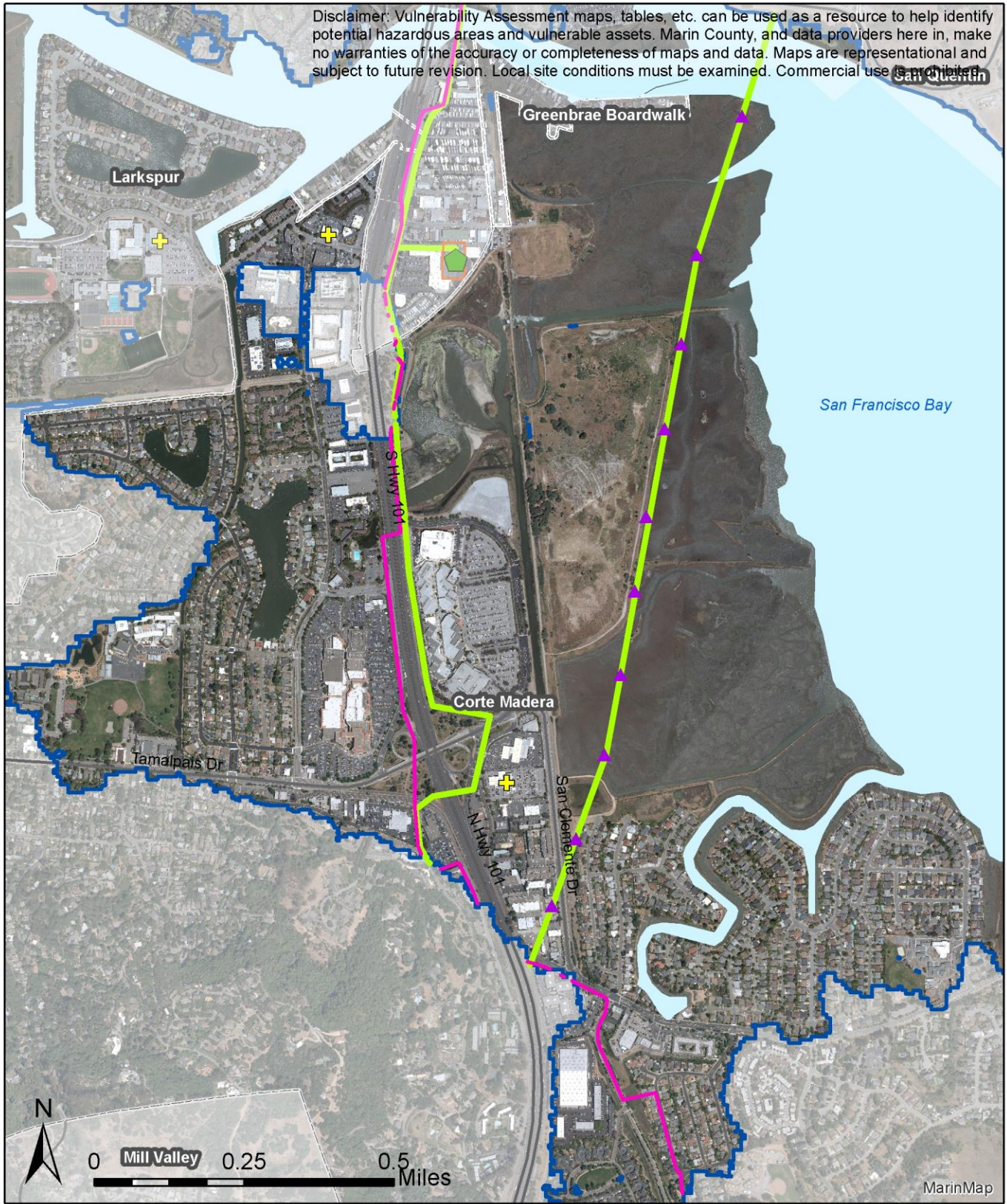
Map 81. Corte Madera Vulnerable Gas and Electric Assets

Vulnerable Assets

-  Solar Installation
- PG&E Assets**
 -  Electric Transmission Lines
 -  Natural Gas Pipeline
 -  Substation
 -  Transmission Tower
 -  PG&E Property
 -  PG&E Buildings
- Location Indicators**
 -  Unincorporated
 -  Municipality
 -  Road
 -  Bay
 -  Inland Extent: Sea Level @ 60"+100-year Storm

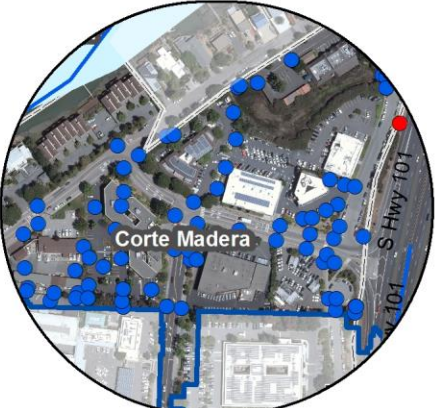
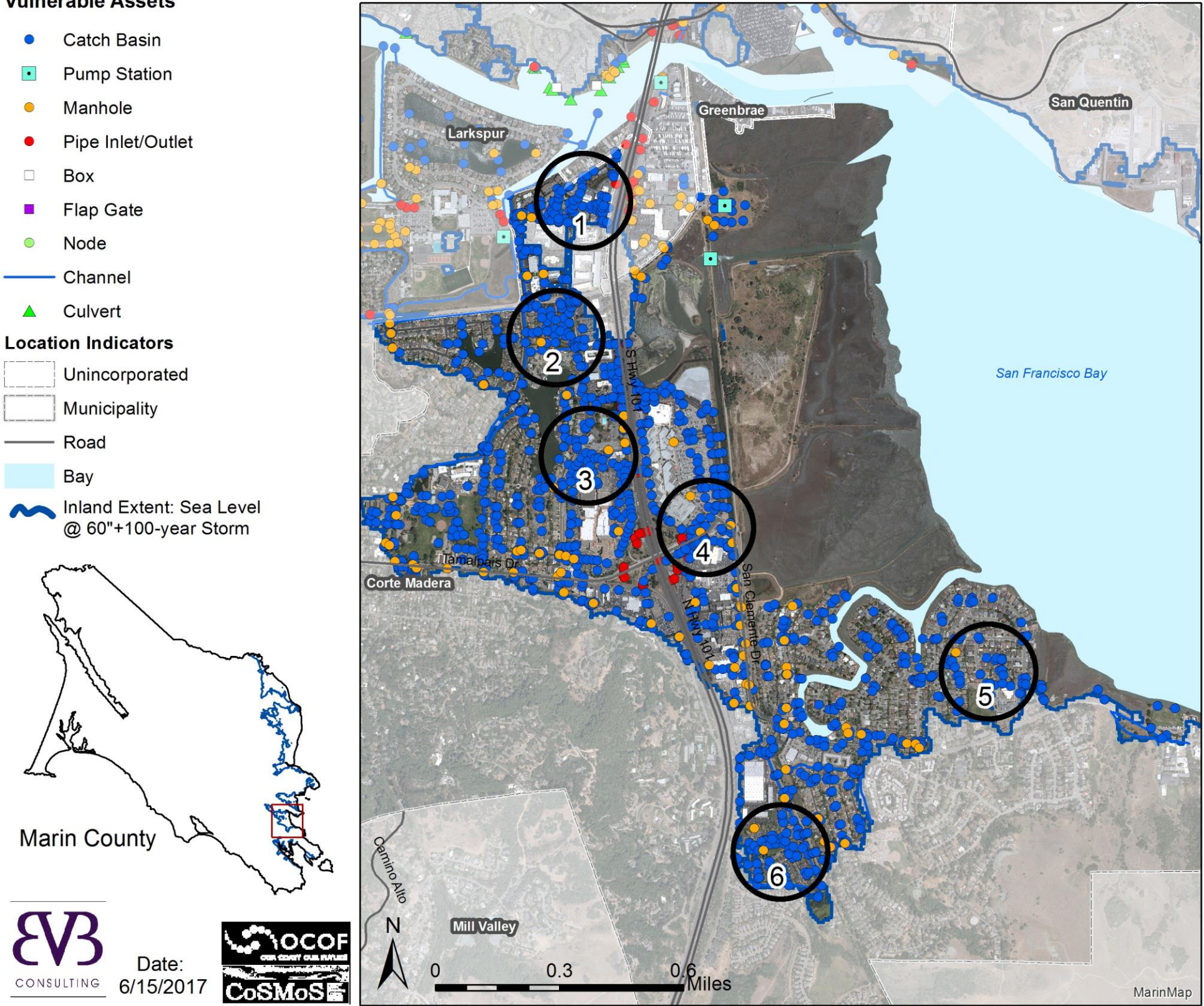


Date:
1/29/2017



CORTE MADERA

Map 82. Corte Madera Vulnerable Stormwater Utility Assets
Vulnerable Assets



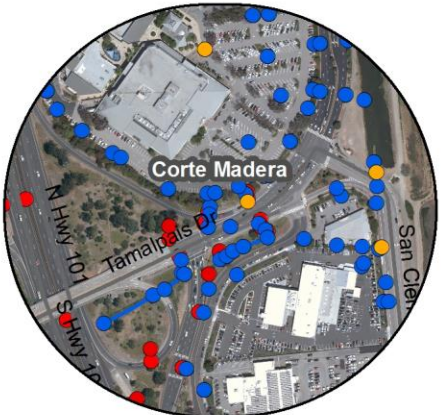
1: Lucky Dr.



2: Northern Madera Gardens



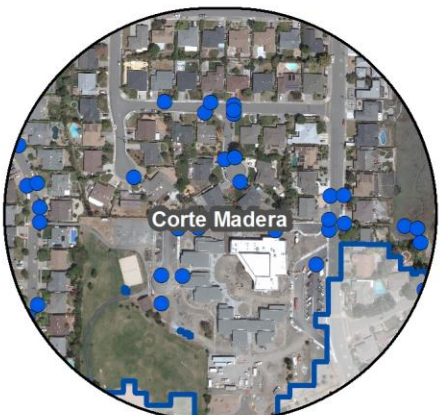
3: Southern Madera Gardens



4: U.S. Hwy. 101 @ Paradise Dr.



5: Meadow Creek



6: Mariner Cove

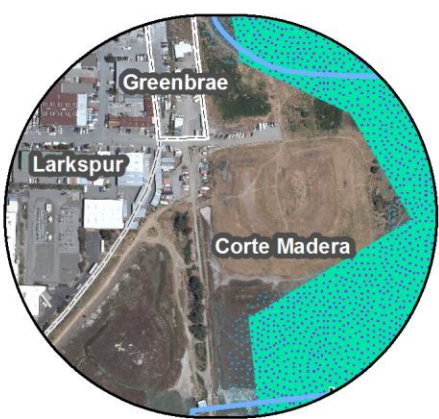
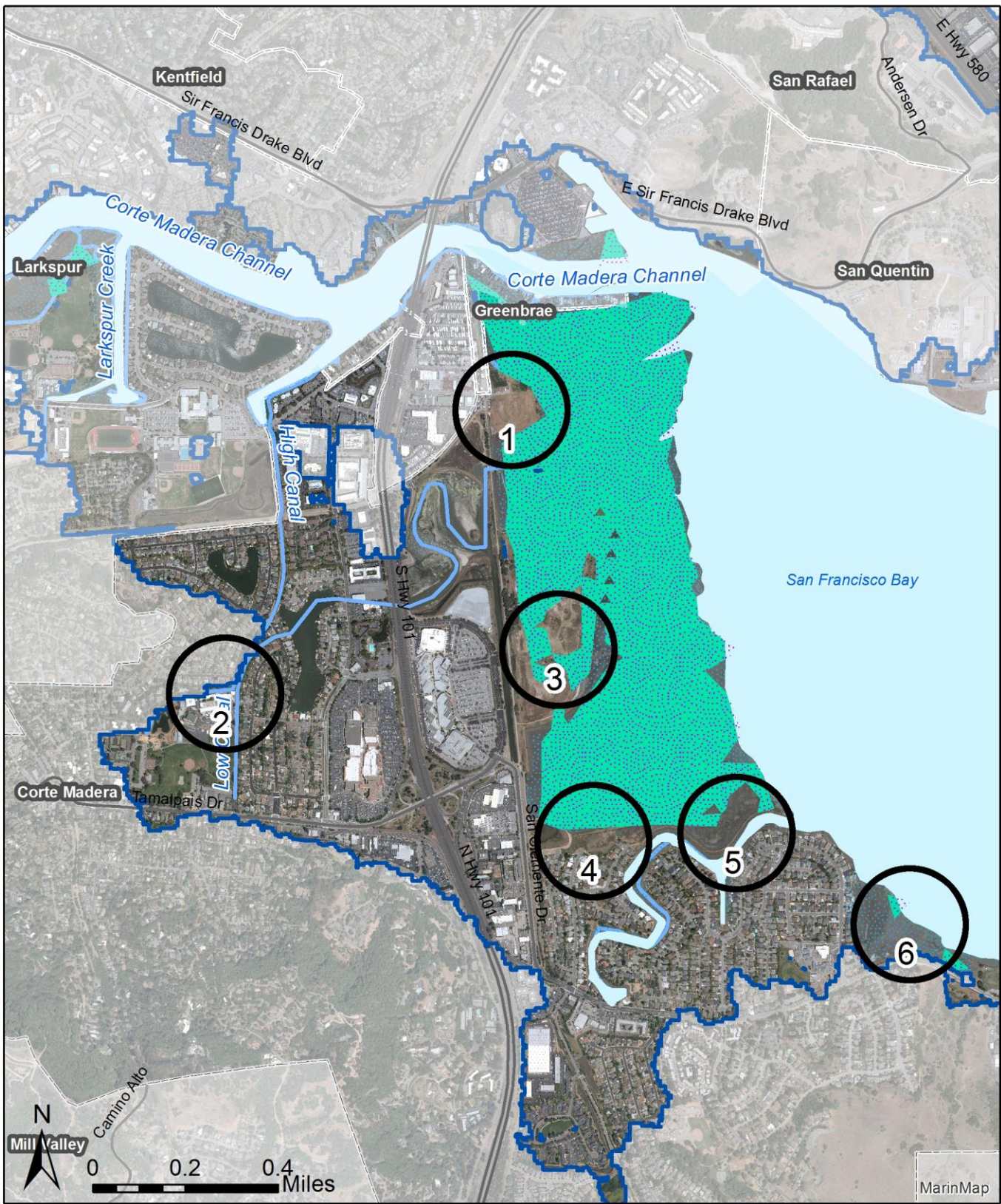
Disclaimer: Vulnerability Assessment maps, tables, etc. can be used as a resource to help identify potential hazardous areas and vulnerable assets. Marin County, and data providers here in, make no warranties of the accuracy or completeness of maps and data. Maps are representational and subject to future revision. Local site conditions must be examined. Commercial use is prohibited.

CORTE MADERA

Map 83. Corte Madera Vulnerable Natural Resource Assets

Vulnerable Assets

- Streams
 - Marsh
 - Estuary
 - Wetland
- Location Indicators**
- Unincorporated
 - Municipality
 - Road
 - Bay
 - Inland Extent: Sea Level @ 60"+100-year Storm



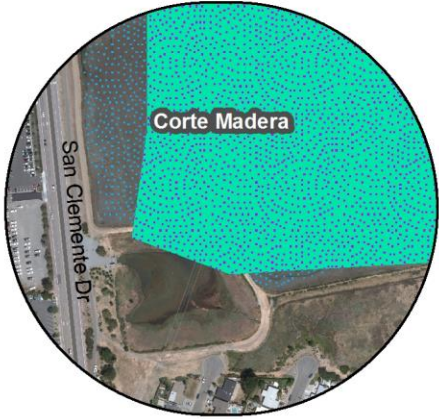
1: Corte Madera Marsh @ Greenbrae Boardwalk



2: Corte Madera Marsh @ The Village



3: High & Low Canals



4: Corte Madera Marsh @ San Clemente Drive

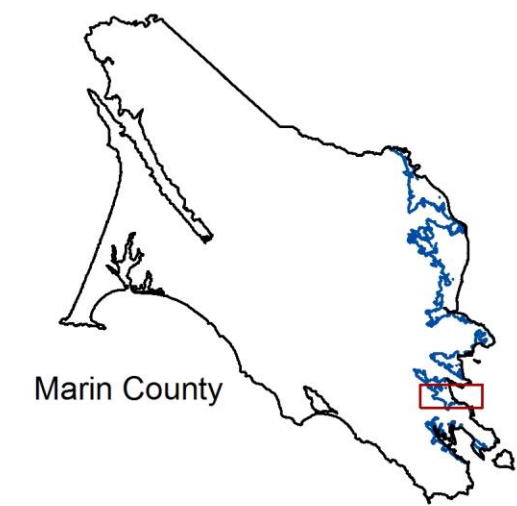


5: San Clemente Creek



6: Triangle Marsh

Disclaimer: Vulnerability Assessment maps, tables, etc. can be used as a resource to help identify potential hazardous areas and vulnerable assets. Marin County, and data providers here in, make no warranties of the accuracy or completeness of maps and data. Maps are representational and subject to future revision. Local site conditions must be examined. Commercial use is prohibited.



Date:
6/15/2017

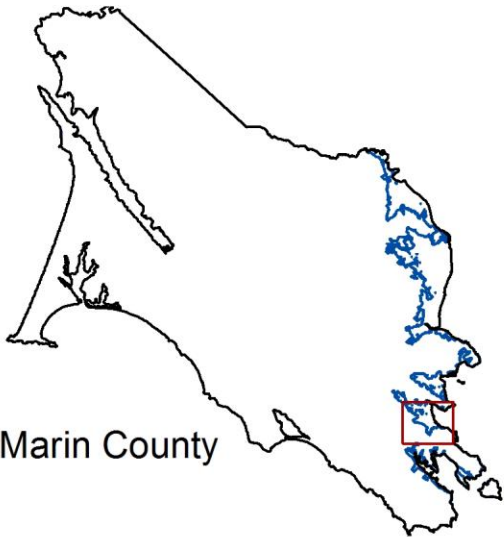


CORTE MADERA

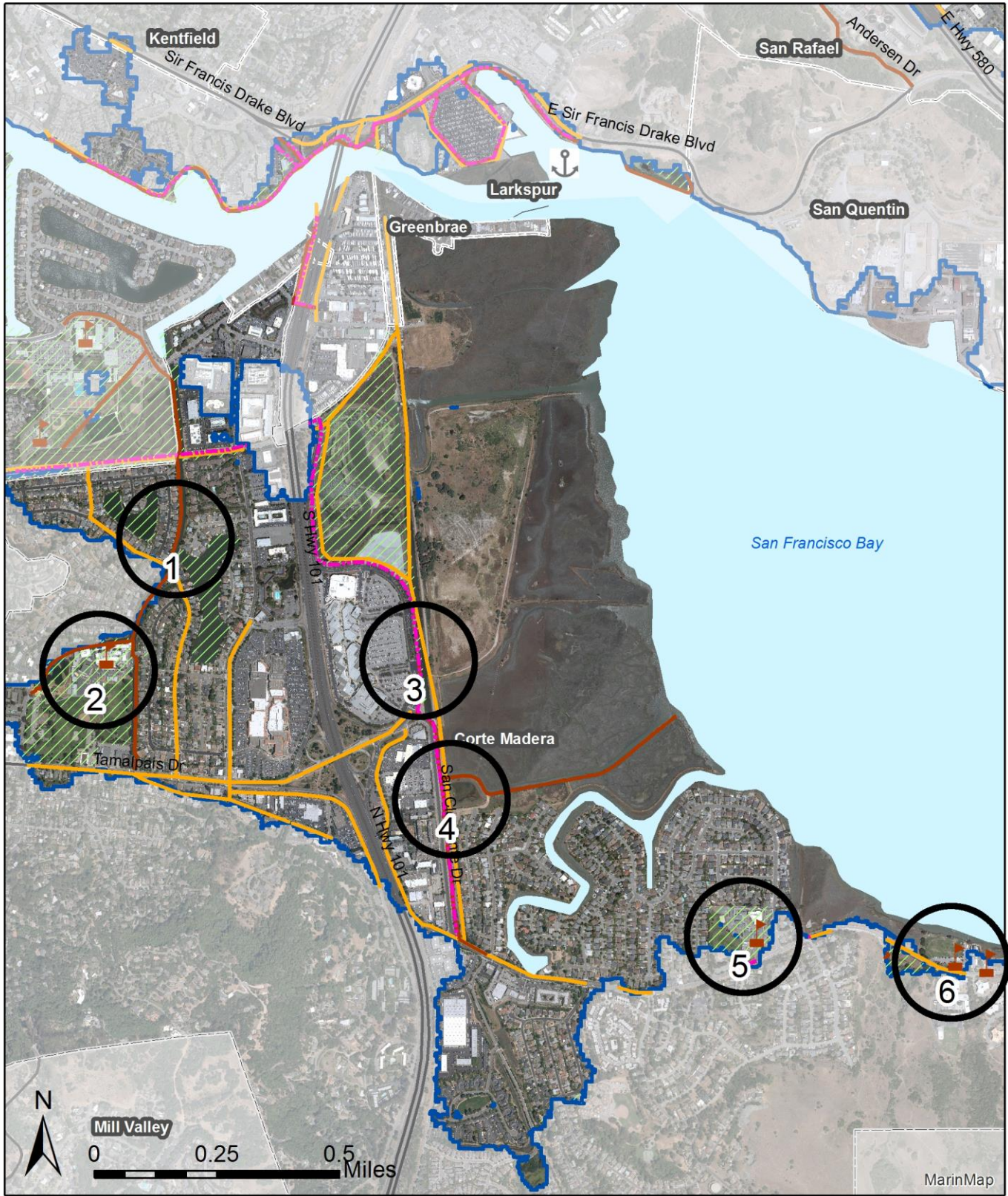
Map 84. Corte Madera Vulnerable Recreation Assets

Vulnerable Assets

- School
 - Bay Trail
 - Trail
 - Bikeway
 - Park
- Location Indicators**
- Unincorporated
 - Municipality
 - Road
 - Bay
 - Inland Extent: Sea Level @ 60"+100-year Storm



Date:
6/15/2017



1: Madera Gardens



2: Corte Madera Town Park



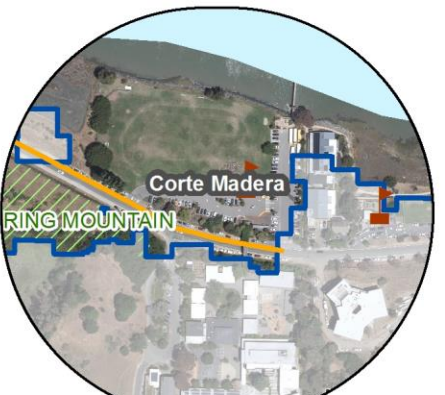
3: Shorebird Marsh



4: San Clemente Dr.



5: San Clemente Park & Cove School



6: Marin Country Day School/ Marin Montessori





Disclaimer: Vulnerability Assessment maps, tables, etc. can be used as a resource to help identify potential hazardous areas and vulnerable assets. Marin County, and data providers here in, make no warranties of the accuracy or completeness of maps and data. Maps are representational and subject to future revision. Local site conditions must be examined. Commercial use is prohibited.

CORTE MADERA

Map 85. Corte Madera Vulnerable Emergency Service Assets

k

Vulnerable Assets

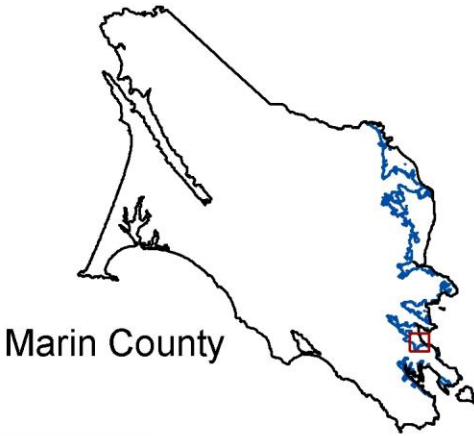
-  Fire Station
-  Emergency Shelter
-  Law Enforcement
-  Medical Facility

Vulnerable Arterials & Highways

-  @ Scen. 1: 10" Sea Level Rise (SLR)
-  @ Scen. 2: 10"SLR+Storm Surge
-  @ Scen. 3: 20"SLR
-  @ Scen. 4: 20"SLR+Storm Surge
-  @ Scen. 5: 60"SLR
-  @ Scen. 6: 60"SLR+Storm Surge

Location Indicators

-  Unincorporated
-  Municipality
-  Road
-  Bay
-  Inland Extent: Sea Level @ 60"+100-year Storm



Date:
2/14/2017



Community Profile: Larkspur

Larkspur borders both sides of Corte Madera Creek, sandwiched between the Town of Corte Madera and Wolfe Grade. The community is characterized by the creek, low-lying public lands, and uplands where downtown and additional hill side housing reside. Key issues include:

- The Golden Gate Bridge District's (GGBHTD) Larkspur hydraulic ferry facility may not be able to withstand near-term high tides, as it can barely withstand existing king tides. The office buildings bordering the water are also vulnerable in the near-term.
- The several hundred thousand gallons of reserve fuel at the ferry facility could be vulnerable in the long-term.
- Housing along Corte Madera Creek canals, sloughs, and lagoons could be vulnerable in the near- to medium-terms, this includes, Boardwalk One, the multi-family units across the canal on Larkspur Plaza, the southern portion of the Heatherwood neighborhood, and some housing west of S. Eliseo Drive. The elevated homes on Boardwalk One may be more adaptable than homes on solid foundations elsewhere.
- Industrial and commercial sites east of US Highway 101 could be vulnerable in the near-term with a storm surge, and to high tides in the medium-term along Redwood Highway.
- All housing west of S. Eliseo Drive could be vulnerable by the long-term to tidal exposure.
- Riviera Circle homes could be vulnerable to sea level rise in the long-term, and storm surges and subsidence sooner.
- The Hillview neighborhood, while already vulnerable to stormwater back-ups, is vulnerable to sea level rise during a 100-year storm surge in the long-term, as is the Edgewater complex and buildings extending up Magnolia Avenue towards Kentfield.
- The Corte Madera/Larkspur Pathway is compromised along Corte Madera Creek.
- Several schools along Doherty Drive could be vulnerable in the medium- to long-term.
- Stormwater infrastructure along the creek could be burdened in the medium- to long-term. Access to and from Larkspur using US Highway 101 already floods during storms. The route is vulnerable to tidal flooding in the long-term.
- The Central Marin Police Department could be surrounded by flood waters.

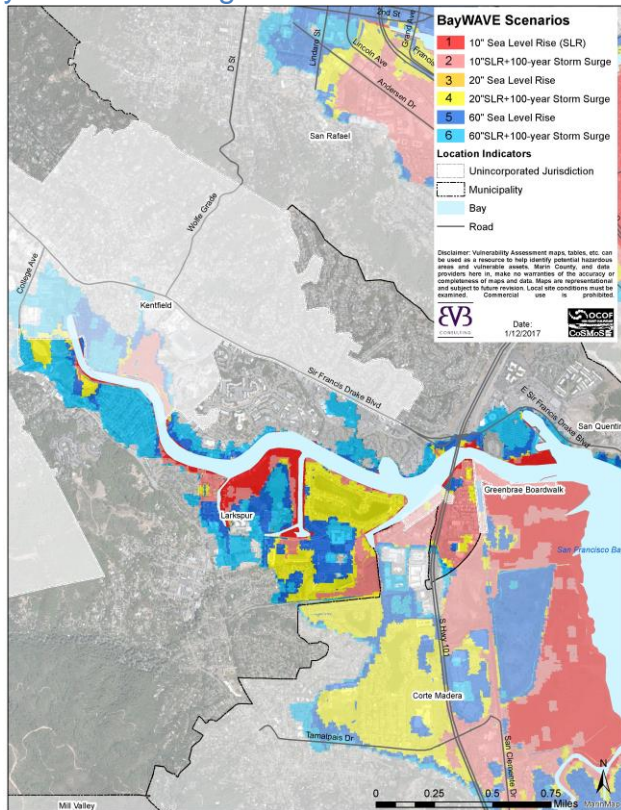
- Piper Park, a historic land fill and current community sports facility, could be vulnerable in the long-term to sea level rise and 100-year storm surge.

IMPACTS AT-A-GLANCE: SCENARIO 6

1,200+ living units	12,000 people
544 acres exposed	27 commercial parcels
8.7 miles of roads	
Storm and tidal impacts already occur	Caltrans Property Owners Tamalpais Union School District GGBHTD
\$2 billion in assessed property value; \$1.2 billion in single-family market value ¹⁹⁶	

¹⁹⁶ 2016 dollars

Map 86. Larkspur Sea Level Rise and 100-year Storm Surge Scenarios



Source: MarinMap, CoSMoS. Credit: BVB Consulting LLC

Vulnerable Assets

Larkspur's most vulnerable assets interface with Corte Madera Creek and its tributaries as they enter San Francisco Bay. Some buildings on the creek already suffer from subsidence issues and have undergone repairs. The low lying area along Doherty Drive could be vulnerable by the long-term, and is highly susceptible to storm surges and stormwater flows.

Land

Much of Larkspur developed flat lands were marshy before the water was channeled and land filled. This area is vulnerable to flooding and subsidence. Larkspur Landing, a critical center for commuting and commerce, could also flood.

Acres

In the near-term, 132 acres, seven percent of Larkspur, could be exposed to tidal flooding. Ten percent of the community could be impacted by an additional 100-year storm surge. About another 100 acres could be exposed to storm surge flooding in medium-term scenario 4. In long-term scenario 5, nearly twenty percent of the community could expect tidal flooding, and 30 percent, or 544 acres, could be exposed with an additional 100-year storm surge. This third of the area of Larkspur is essential to accessing Larkspur, schooling, recreation, and emergency services.

Parcels

This acreage is broken in to parcels for ownership and development purposes. Parcels are also assigned land uses. Examining land uses can provide a representation of what types of human activities could be threatened by sea level rise and stormy seas. Nearly all land uses in the study area could face changing conditions that make their existing use infeasible and are therefore vulnerable. Without intervention, it is unlikely that parcels exposed to tidal flooding could sustain continued use, and even existing tidal marsh habitats could completely transition to mudflats and open water.

In near-term scenario 1 almost 100 acres could face tidal flooding. More than twice that could experience storm surge flooding. Properties experiencing both would have an extremely difficult time recovering from soggy conditions. Around ten percent of Larkspur, or 445, acres, could flood in medium-term scenario 4. In long-term scenario 5, fifteen percent of the community along waterways large and small could experience tidal flooding. With an additional storm surge, one-third of the community could be under saltwater.



1973 Flood on US Highway 101 and fronting marshes. Larkspur. Credit: Marin County DPW

Table 93. Larkspur Exposed Acreage

Scenarios		Acres	
		#	%
Near-term	1	132	7
	2	202	10
Medium-term	3	147	7
	4	299	15
Long-term	5	379	19
	6	544	27

Source: MarinMap, CoSMoS

Table 94. Larkspur Vulnerable Parcels

Scenarios		Parcels	
		#	%
Near-term	1	90	2
	2	246	5
Medium-term	3	121	3
	4	445	10
Long-term	5	687	15
	6	1,216	27

Source: MarinMap, CoSMoS

Table 95. Larkspur Vulnerable Residential and Commercial Parcels

Land Use	Scenarios					
	Near-term		Medium-term		Long-term	
	1		3		5	
	#	%	#	%	#	%
Residential	67	2	99	2	586	15
Commercial			6	4	27	18
Industrial			4	30	12	100

Source: MarinMap, CoSMoS.

Table 96. Larkspur Vulnerable Parcels by Land Use

Land Use	Scenarios					
	1		3		5	
	Near-term		Medium-term		Long-term	
	#	Ac.	#	Ac.	#	Ac.
Commercial Improved			6	10	25	24
Commercial Unimproved					2	0.5
Exemption Improved					21	0.4
Industrial Improved			3	1	10	6
Industrial Unimproved			1	0.1	2	1
Residential	67	21	99	23	586	70
Mobile Home			6	0.03	50	0.3
Multi-Family Improved	6	1	6	1	12	4
Multi-Family Unimproved					1	0.3
Single Family Attached			7	0.1	244	3
Single Family Improved	60	20	69	22	276	62
Single Family Unimproved	1	0.3	2	0.5	2	0.5
Tax Exempt	12	17	15	17	34	84

Source: MarinMap, CoSMoS

LARKSPUR

The three most impacted uses in Larkspur are public land uses, such as schools, parks, and, emergency services, residential, and industrial land uses. Industrial parcels east of US Highway 101 on the shoreline already flood seasonally and could continue to suffer from storms over the next fifteen years. In medium-term scenario 3, the few industrial parcels impacted are one-third of the city's industrial base. By the long-term, all of Larkspurs industrial land could flood tidally at MHHW rendering the properties the very narrow land uses, and not likely the existing uses. Moreover, any industrial products and contaminates from machining or the gas station could input pollutants into the surrounding properties and the Bay waters.

Residential development along Corte Madera Creek could experience tidal flooding in the near- and medium terms. In the long-term, tidal flooding could impact fifteen percent of residential parcels in Larkspur. Multi-family parcels could also see flooding on Larkspur Plaza Drive. Fifty mobile homes, some of Marin's limited affordable housing, could flood tidally at MHHW in the long-term and face storm flooding in the medium-term.

Similar portions of commercial parcels could be vulnerable to tidal flooding as residential, though far less in number and acreage, with 27 parcels and 27 acres flooded in the long-term.

Buildings

Larkspur contains a high number of potentially vulnerable buildings relative to other communities in the study area. In the near-term, forty buildings, two percent of all buildings in Larkspur, could experience tidal flooding. Several hundred buildings could anticipate additional storm surge impacts. In the medium-term, more than 150 buildings could anticipate MHHW tidal flooding, and several hundred more could anticipate impacts during a 100-year storm surge. By long-term scenario 5, 802, or 20 percent of buildings, could experience tidal flooding at MHHW. With the additional 100-year storm surge, 1,160, or 28 percent of buildings could be vulnerable to five feet of sea level rise combined with a 100-year storm surge. A thirty percent loss of buildings would significantly impact Larkspurs ability to recover from disastrous flooding at a community level.

All industrial buildings east of US Highway 101 could experience tidal and storm surge flooding. Housing

along Corte Madera Creek canals, sloughs, and lagoons could be vulnerable in the near- to medium-terms. These properties include Boardwalk One, multi-family units across the canal on Larkspur Plaza, the southern portion of the Heather Garden neighborhood, and some housing west of S. Eliseo Drive. The homes along Boardwalk One are elevated on piers, which may make them more adaptable in the near term. All housing west of S. Eliseo Drive could be vulnerable by the long-term to tidal exposure. Riviera Circle homes could be vulnerable to sea level rise in the long-term, and storm surges and subsidence sooner. The Hillview neighborhood already suffers from stormwater back-ups during high tides. However, from sea level rise alone, this neighborhood could be vulnerable to a 100-year storm surge in the long-term, as could the Edgewater complex and buildings extending up Magnolia Avenue towards Kentfield. Nevertheless, higher high tides would exacerbate stormwater back-ups, and consequently fresh water.

Several schools could face tidal and storm surge flooding. These areas are also already impacted by storm water flooding, which sea level rise will only worsen. Finally, the Central Marin Police Department could be surrounded by flood waters making it difficult for employees to reach and leave the facility.

Buildings in the flooded areas of Larkspur are wood framed structures. Newer buildings are elevated on fill and off the ground, however, homes older than twenty years old may not be. In addition, because many areas were built on filled in marsh, developments, such as the Riviera Circle neighborhood, are also vulnerable to subsidence as underlying soils liquefy.

Table 97. Larkspur Vulnerable Buildings

Scenarios		Buildings	
		#	%
Near-term	1	40	1
	2	382	9
Medium-term	3	165	4
	4	670	16
Long-term	5	802	19
	6	1,160	28

Source: MarinMap, CoSMoS

Table 98. Larkspur Tidal MHHW Flood Depth Estimates for Vulnerable Buildings

Flood Depth (feet)	Scenarios		
	Near-term	Medium-term	Long-term
	1	3	5
0.1-1	17	35	37
1.1-2	17	44	63
2.1-3	22	33	98
3.1-4	1	9	228
4.1-5	0	0	121
5.1-6	1	1	107
6.1-7			31
7.1- 8			15

* Flood depth data is not available for all exposed areas and assets.

Source: MarinMap, CoSMoS

Table 99. Larkspur Vulnerable Buildings FEMA Hazus Storm Damage Cost Estimates in Long-term Scenario 6

Number of Buildings in Scenario 6	1,160
Yellow Tag :Minor Damage \$5,000 minimum	\$5,800,000
Orange Tag: Moderate Damage \$17,001 minimum	\$19,721,160
Red Tag: Destroyed Assessed structural value	\$1,496,649,606

Source: MarinMap, CoSMoS

Table 98 divides the vulnerable buildings by how much tidal saltwater they could flood with, whether it is one, two, or eight feet of saltwater that could come rushing in. In the near- and medium-terms the majority of buildings are flooded with three feet or less of water. In the long-term, more than 450 buildings are vulnerable to more than 3 feet of flooding at MHHW relegating these buildings, unless elevated or protected, unusable.

Table 99 outlines cost estimates using FEMA Hazus tagging levels for damage to buildings and their contents under scenario 6, the worst case scenario analyzed in this assessment. If every vulnerable building were to be destroyed, nearly \$1.5 billion in losses could occur. At yellow tag levels, a minimum of \$5.8 million¹⁹⁷ in damages could occur. Reality would likely reflect a mix of damage levels and monetary figure between these.

The maps on the following pages illustrate vulnerable buildings by scenario. The areas in the call out circles enable the reader to see areas that are difficult to see on the large scale map. The circles do not indicate that these areas are more vulnerable than others along the shoreline.



Cornell Avenue, Hillview Neighborhood, Larkspur during a 2016-2017 winter storm. Credit: A. Fox.

¹⁹⁷ 2016 dollars

Map 87. Larkspur Vulnerable Buildings

Vulnerable Assets

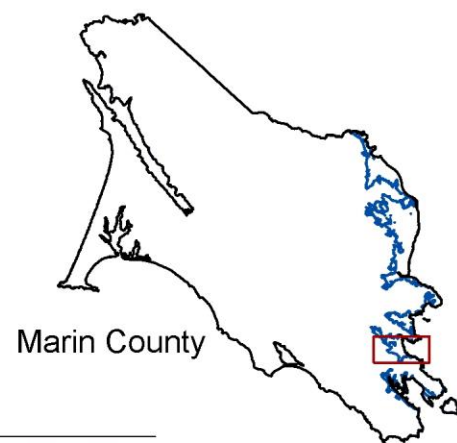
-  School
-  Emergency Shelter
-  Fire Station
-  Law Enforcement

Vulnerable Buildings

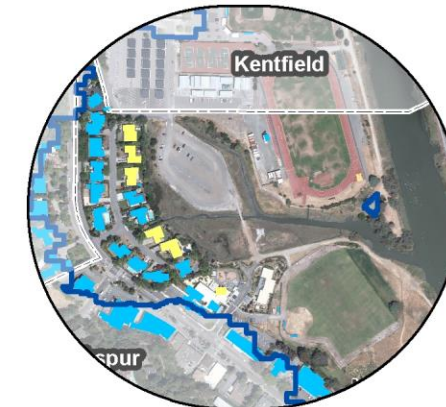
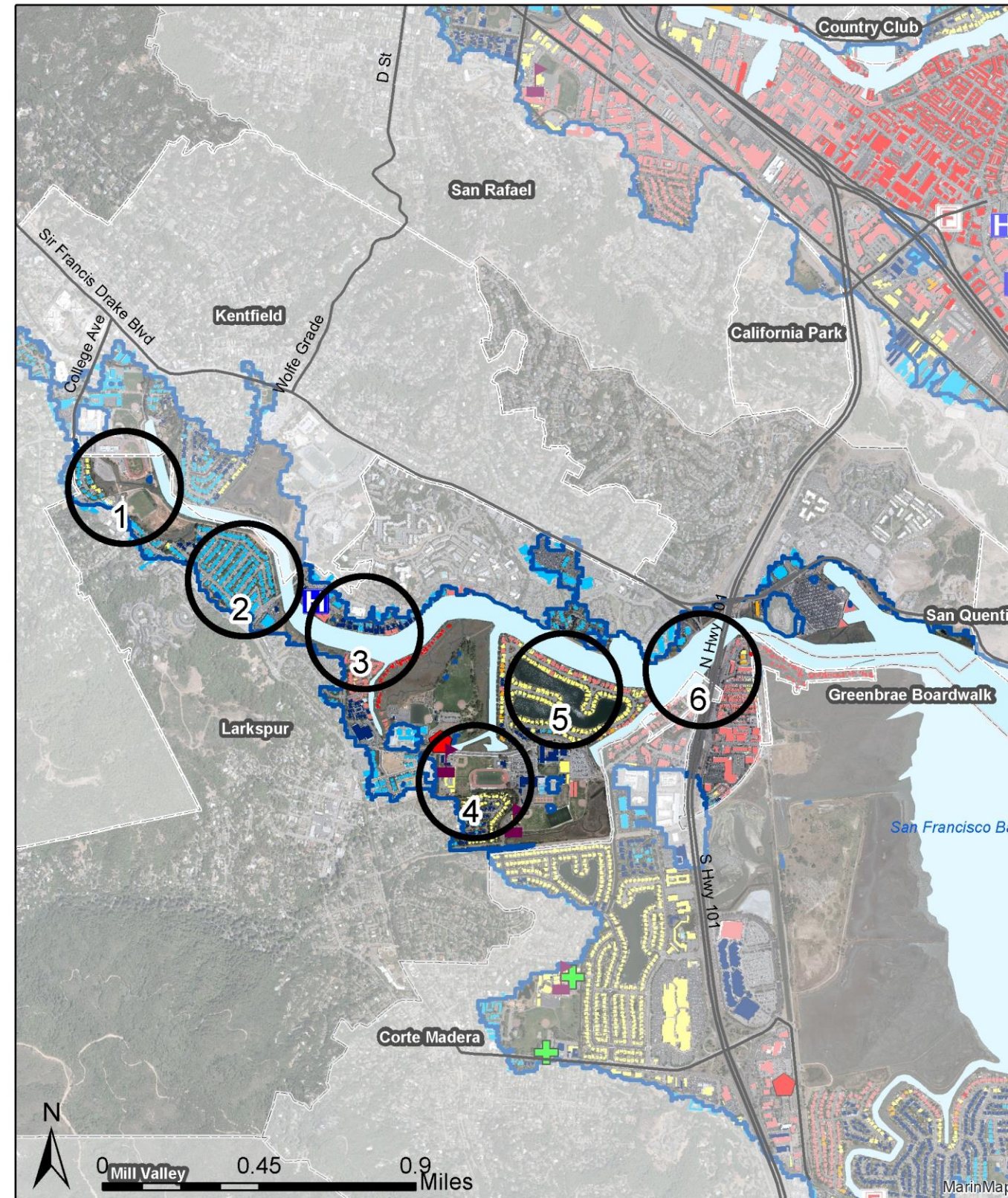
-  Scen. 1: 10" Sea Level Rise (SLR)
-  Scen. 2: 10" SLR+Storm Surge
-  Scen. 3: 20" Sea Level Rise
-  Scen. 4: 20"SLR+Storm Surge
-  Scen 5: 60" Sea Level Rise
-  Scen. 6: 60"SLR+Storm Surge

Location Indicators

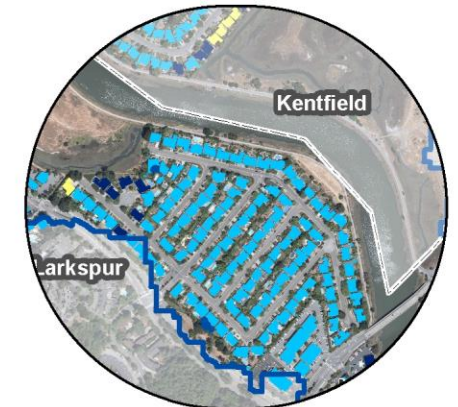
-  Unincorporated
-  Municipality
-  Road
-  Bay
-  Inland Extent: Sea Level @ 60"+100-year Storm



Date:
3/29/2017



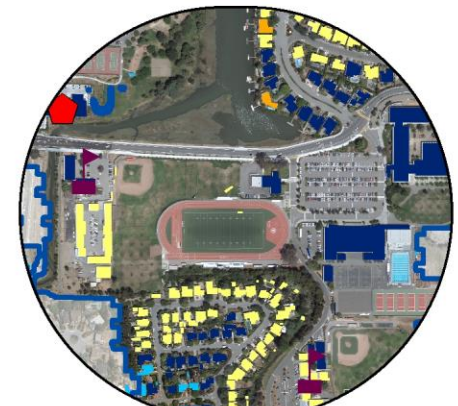
1: Magnolia Ave.
@ College Ave.



2: Creekside Neighborhood



3: S. Eliseo/Boardwalk 1/
Larkspur Plaza Dr.



4: Redwood High School



5: Riviera Circle



6: Industrial east of
U.S. 101

Disclaimer: Vulnerability Assessment maps, tables, etc. can be used as a resource to help identify potential hazardous areas and vulnerable assets. Marin County, and data providers here in, make no warranties of the accuracy or completeness of maps and data. Maps are representational and subject to future revision. Local site conditions must be examined. Commercial use is prohibited.

Transportation

Southerly highway access to Larkspur could be compromised at Lucky Drive and Sir Francis Drake Boulevard U.S. Highway 101 exits. Riviera Circle and Doherty Drive could anticipate storm impacts as early as scenario 2 and tidal flooding by the long-term and medium-term respectively. Floodwaters move up the creek and can reach into the neighborhoods, impacting streets in low elevation areas at Bon Air Road and west of Corte Madera Creek. Bon Air road is a critical route to area hospitals and has experienced flooding as recent as 2017 with up to one and one half feet of water at the Bon Air Bridge. These roads enable commuters, school children, and emergency vehicles to travel to, from, and within the community.

Preliminary conversations with Caltrans indicate that Caltrans is well aware of the existing and arising concerns in the County.¹⁹⁸ According to Caltrans and the CoSMoS model flooding occurs at low spots of US Highway 101 in Larkspur from Corte Madera Creek to Lucky Drive. These low spots typically benefit from levees and pumps others operate to protect the larger area from flooding.

Transit service along Marin Transit routes 17, 29, 113, 117, 119, and 228 and Golden Gate Transit routes 17, 18, 22, 24, 25, 27, 28, 29, 36, 37, 70, 71, 80, and 117 would be compromised if roads are flooded. Impacts to transit service could disproportionately impact low-income and mobility impaired residents. Stops that could be compromised include:

- Bon Air Rd.
- Doherty Dr. and Larkspur Plaza Dr.,
- Lucky Dr. and Riviera Cir.,
- E Sir Francis Drake Blvd. and Larkspur Landing,
- Redwood High School
- Sir Francis Drake Blvd. and McAllister Ave,
- Magnolia Ave. and Dartmouth Dr.,
- Magnolia Ave. and Frances Ave.,
- Magnolia Ave. and Estelle Ave.,
- Larkspur Ferry Terminal,
- Doherty Dr. and Larkspur Plaza,
- Hwy 101 and Lucky Dr., and
- E Sir Francis Drake Blvd. and Larkspur Landing.

The maps on the following pages illustrate vulnerable transportation features. The areas in the call out circles enable the reader the see areas that are difficult to see on the large scale map. The circles do not indicate that these areas are more vulnerable than others along the shoreline.



Golden Gate Ferry and Terminal. Credit: Marin County CDA



Lucky Dr at Doherty Drive. Redwood Highschool at King Tide. Jan. 21, 2015. Credit YESS Program, Redwood High School Students.

¹⁹⁸ Sea Level Rise Vulnerability Assessment Interview. Caltrans. April 30, 2015. J. Peterson. D. Fahey. Marin County Development Agency. BVB Consulting LLC.

Table 100. Larkspur Transportation Routes Vulnerable to Sea Level Rise and a 100-year Storm Surge

Near-term		Medium-term		Long-term	
Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6
0.5 miles	1.5 miles	0.5 miles	4 miles	5 miles	9 miles
Hwy 101 ^C Redwood Hwy ^L Bon Air Rd ^L	Roads in scenario 1 Creeside Dr ^P Doherty Dr ^L Industrial Wy ^{L,P} Larkspur Plaza ^L Rich St ^{L,P} Riviera Cir Dr ^L	Roads in scenarios 1 and 2	Roads in scenarios 1-3 Corte del Coronado ^L Diane Ln ^L Liberty St ^L Midway Rd ^L Tulane Dr ^L Via la Brisa ^L William Ave ^L	Roads in scenarios 1-4 Sir Francis Drake Blvd ^{L,M,C} Camellia Cir ^P Heather Wy ^L Rose Ln ^P S Eliseo Dr ^L Stanford Ct ^L	Roads in scenarios 1-5 Barry Way ^{L,P} College Ave ^{L,M} Cornell Ave ^L Corte del Brayo Real ^L Creek View Cir ^P Cross Creek Pl ^P Dartmouth Dr ^L Elizabeth Cir ^P Estelle Ave ^L Frances Ave ^L Gregory Pl ^P Gretchen Pl ^P Harvard Dr ^L Laderman Ln ^P Larkspur Lndg Cir ^L Lupine Ct ^P Magnolia Ave ^L Murray Ave ^L Orchid Dr ^P Sandy Creek Wy ^P Scott Pl ^P Victoria Wy ^L Yale Ave ^L

M = Marin County; C = State of California; L = Local Municipality; P = Private. Source: MarinMap, CoSMoS

Map 88. Larkspur Vulnerable Transportation Assets

Vulnerable Assets

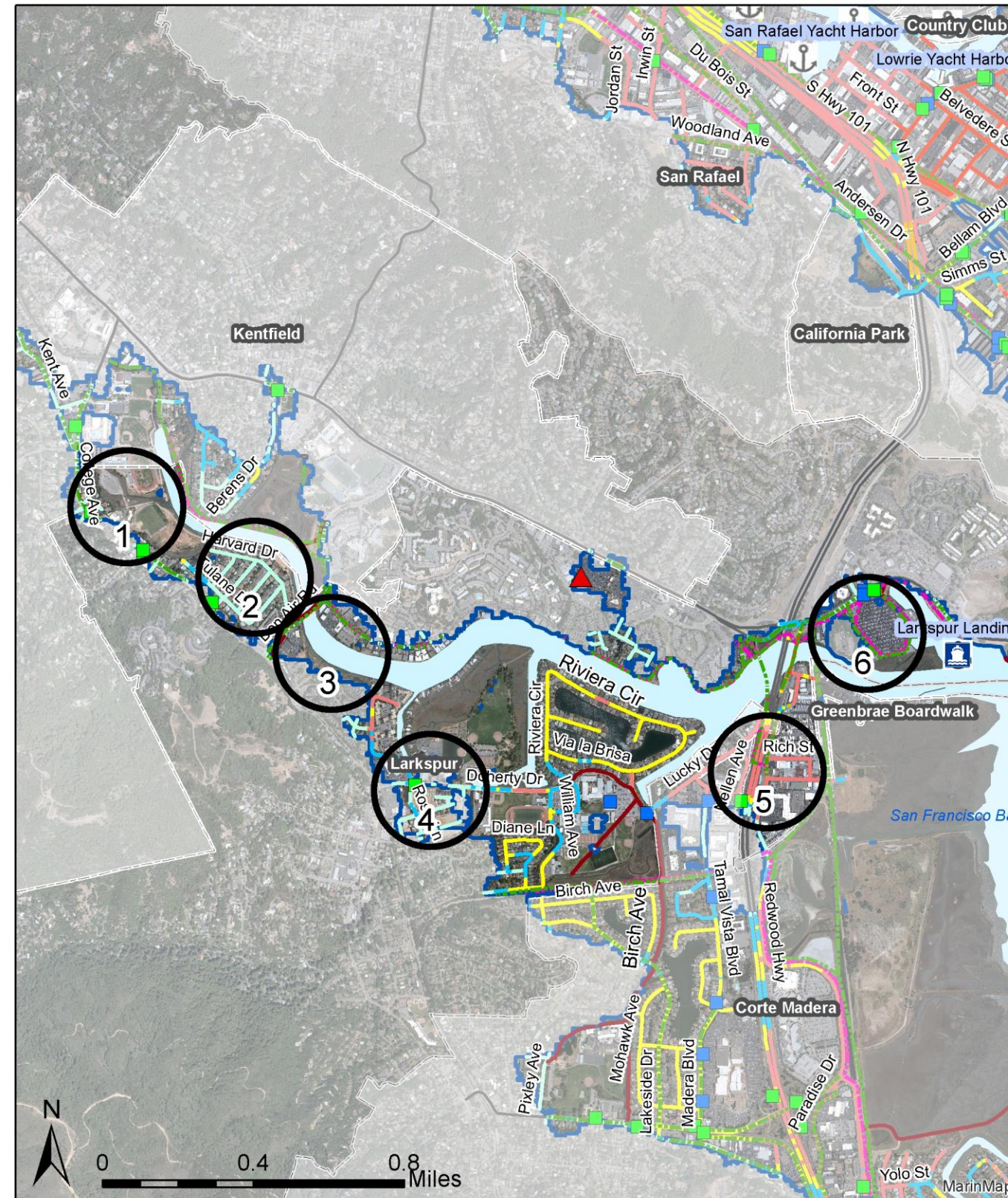
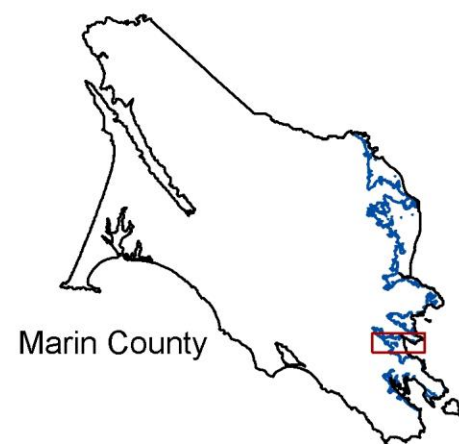
- Park & Ride
- Bike path
- Bay Trail
- Trail
- MT Bus Stop
- GGT Bus Stop
- Ferry

Vulnerable Roads

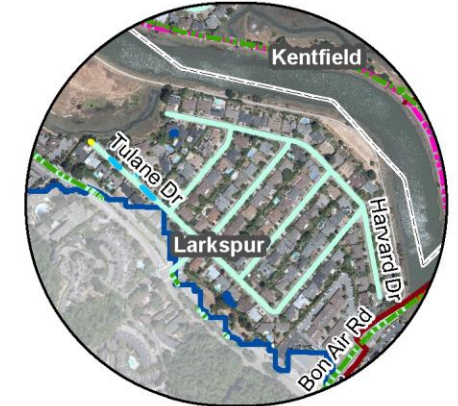
- @10" Sea Level Rise (SLR)
- @10"SLR+ 100-year Storm Surge
- @20" Sea Level Rise
- @20"SLR+ 100-year Storm Surge
- @60" Sea Level Rise
- @60"SLR+ 100-year Storm Surge

Location Indicators

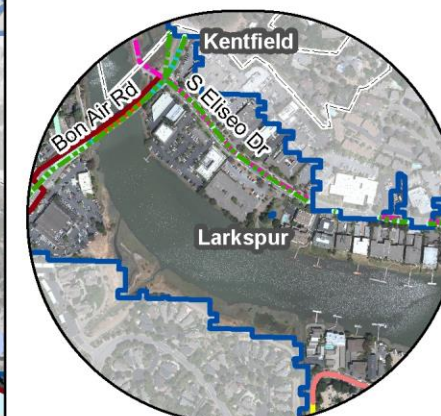
- Unincorporated
- Municipality
- Road
- Bay
- Inland Extent: Sea Level @ 60"+100-year Storm



1: Magnolia Ave. @
College Avenue



2: Hillview Neighborhood



3: Bon Air Rd. @
S. Eliseo Dr.



4: Doherty Dr.



5: U.S. Hwy. 101 @
Corte Madera/Larkspur



6: Larkspur Landing

Disclaimer: Vulnerability Assessment maps, tables, etc. can be used as a resource to help identify potential hazardous areas and vulnerable assets. Marin County, and data providers here in, make no warranties of the accuracy or completeness of maps and data. Maps are representational and subject to future revision. Local site conditions must be examined. Commercial use is prohibited.

Utilities

Larkspur could experience utility issues common in other shoreline communities in the study area, including:

- Underground pipes face compounding pressure forces from water and the road,
- Road erosion and collapse with underlain pipes,
- Saltwater inflow and infiltration causing inefficiencies in wastewater treatment,
- Continuously subsiding soils or fill, and
- Escalating activity, capacity demands, energy consumption, and wear and tear on pump stations in stormwater and wastewater systems,
- Aging individual site connections for water, sewer, and electrical, and
- Flood waters interrupting access for employees to reach work sites.

In addition, PG&E has a natural gas pipe line along US Highway 101 towards San Rafael and a substation bayside of Cost Plus World Market that could be vulnerable during a 100-year storm surge in the long-term, scenario 6, though may be less sensitive if all electrical components are adequately elevated off the ground.

Natural Resources

Marshes lining the Corte Madera Creek are narrow and bordered by development almost entirely, thus vulnerable to sea level rise. These marshes provide extensive habitat for birds, rodents, fish, reptiles, and amphibians. Changes in salinity in the creek and its tributaries may push freshwater and brackish animal and plant species upstream.

Found in Corte Madera, the smelt is listed as threatened on the California species list and a candidate for the federal list. The Ridgway's Rail, tidewater goby, and harvest mouse are federally listed. The white-rayed pentachaeta is an endangered plant species in Corte Madera.

Recreation

The Corte Madera/Larkspur Path is vulnerable in the near-term at creek side segments. Private piers and docks could also be vulnerable. Boat launch sites for kayaking may need to adjust. Piper Park is also vulnerable in the long-term. This park features softball, soccer, and cricket accommodations that

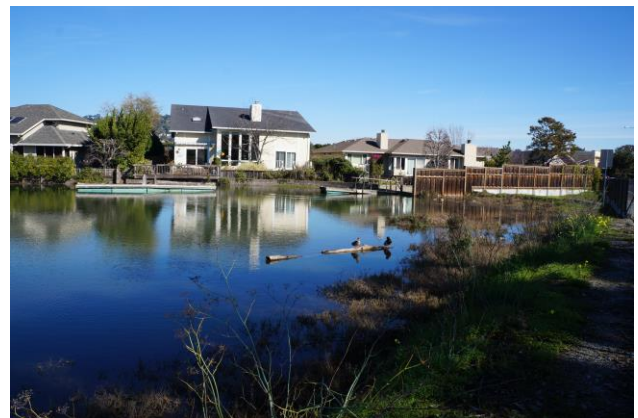
are used regionally. School sites off Doherty Drive used for recreation are vulnerable in the long-term.

Emergency Services

Access through low lying roads is the primary concern for Larkspur residents and businesses that need assistance or transport to Marin General Hospital and other medical facilities in the area. The Central Marin Police Department would become an island as surrounding areas flood. This department also serves Corte Madera and San Anselmo.

Cultural Resources

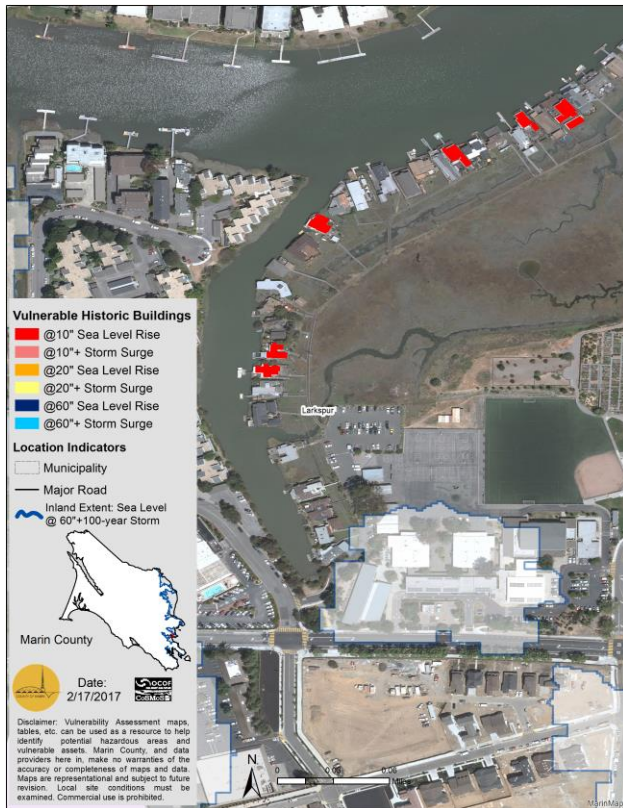
Six vulnerable historic homes along Boardwalk One are the only remaining homes of the four original communities of arks, or houseboats on cement pedestals in water accessed by boardwalks elevated above the marshland. Many of the homes have had alterations and additions compromising the original defining features, though still retain historical character through size, materials, scale, and color.¹⁹⁹



Homes on Riviera Circle at King Tide. Jan. 21, 2015. Credit YESS Program, Redwood High School Students

¹⁹⁹ City of Larkspur. 2005. Historic Resources Survey Re-evaluation

Map 89. Larkspur Vulnerable Cultural Resource Assets



Source: CoSMoS, MarinMap, Larkspur Historic Inventory

Table 101 ranks vulnerable asset by onset and flood depth. A 100-year storm surge would add an additional 1 to 3 feet of water to these properties. Note also, above average high tides could impact more properties than accounted for in this analysis. The Larkspur Plaza shopping center could expect storm surge flooding in the long-term at the southern end of the property. The maps on the following pages illustrate vulnerable utility, natural resource, recreation, emergency and historic features. The areas in the call out circles enable the reader the see areas that are difficult to see on the large scale map. The circles do not indicate that these areas are more vulnerable than others along the shoreline.



Boardwalk One homes on the left and multi-family affordable housing on the right on Marin Lagoon, Larkspur. Credit: Marin County DPW

Table 101. Example Vulnerable Larkspur Assets by Onset and Flooding at MHHW

Asset	Scenarios		
	Near-term 1	Medium-term 3	Long-term 5
Larkspur Landing Beach	Floods at existing high tide		
Boardwalk 1	2'-3"	5'-3'10"	3'2"-6'5"
Piper Park	7'2"	7'11"	10'8"
Bay Trail @ Larkspur Landing	0-5'4"	0-6'	0-8'6"
Cal Park Hill @ Sir Francis Drake Blvd	4'10"	5'3"	8'2"
Edgewater Place marsh	4'4"	5'	8'6"
Remillard Park	2'11"	3'6"	6'2"
Corte Madera Creek Path	0-3"	1"-2'	0-6'9"
Industrial & commercial east of Hwy 101	0-1'9"	0-2'4"	2'2"-6'7"
Hal Brown Park		6'3"	9'2"
Golden Gate Mobile Homes		10"-3'	2'-7'5"
Ferry Terminal		1'-2'6"	2'7"-7'9"
Riviera Circle Homes		3"-2'	7"-5'3"
GGBHTD fuel reserve		1'7"	4'2"
Tamiscal High School		1'7"	2'11"
San Andreas High School		1'5"	3'8"

Asset	Scenarios		
	Near-term	Medium-term	Long-term
	1	3	5
Central Marin Police Department		2'7"	6'9"
Redwood High fields and lots		1'4"	3'4"
Hamilton Park		10"	3'9"
Doherty Dr		0-3"	05'5"
Heatherwood Park			8'2"
Heather Gardens neighborhood			7'
Hwy 101NB @ Lucky Dr			3'6"-5'3"
Redwood Hwy			4'2"-5'2"
Hwy 101SB off ramp @ Sir Francis Drake Blvd			2'3"-5'
Riviera Circle (street)			1'8"-4'9"
Multi-family on Larkspur Plaza Dr.			4'5"
PG&E Substation			4'
Sir Francis Drake Blvd @ Hwy 101			7"-2'9"
Bon Air Landing Park			2'4"
Hillview neighborhood			1'8"
Passport Health			6"
Henry Hall Middle School	Surrounded by saltwater		
Corte Madera Creek	Water resource		
Marin Country Mart	Access issues only		

Source: MarinMap, CoSMoS, Asset Manager Interviews

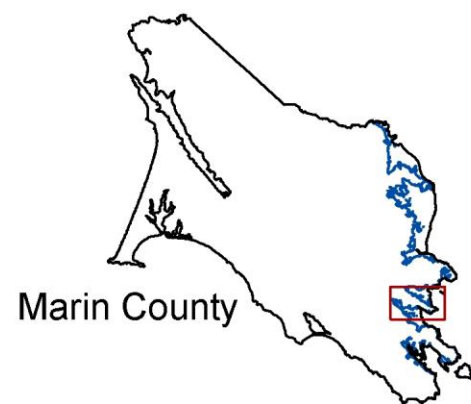
Map 90. Larkspur Vulnerable Wastewater Utility Asset

Vulnerable Assets

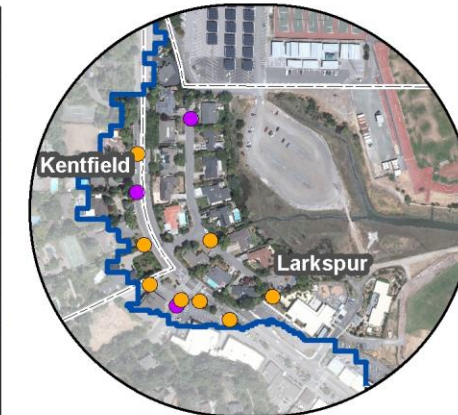
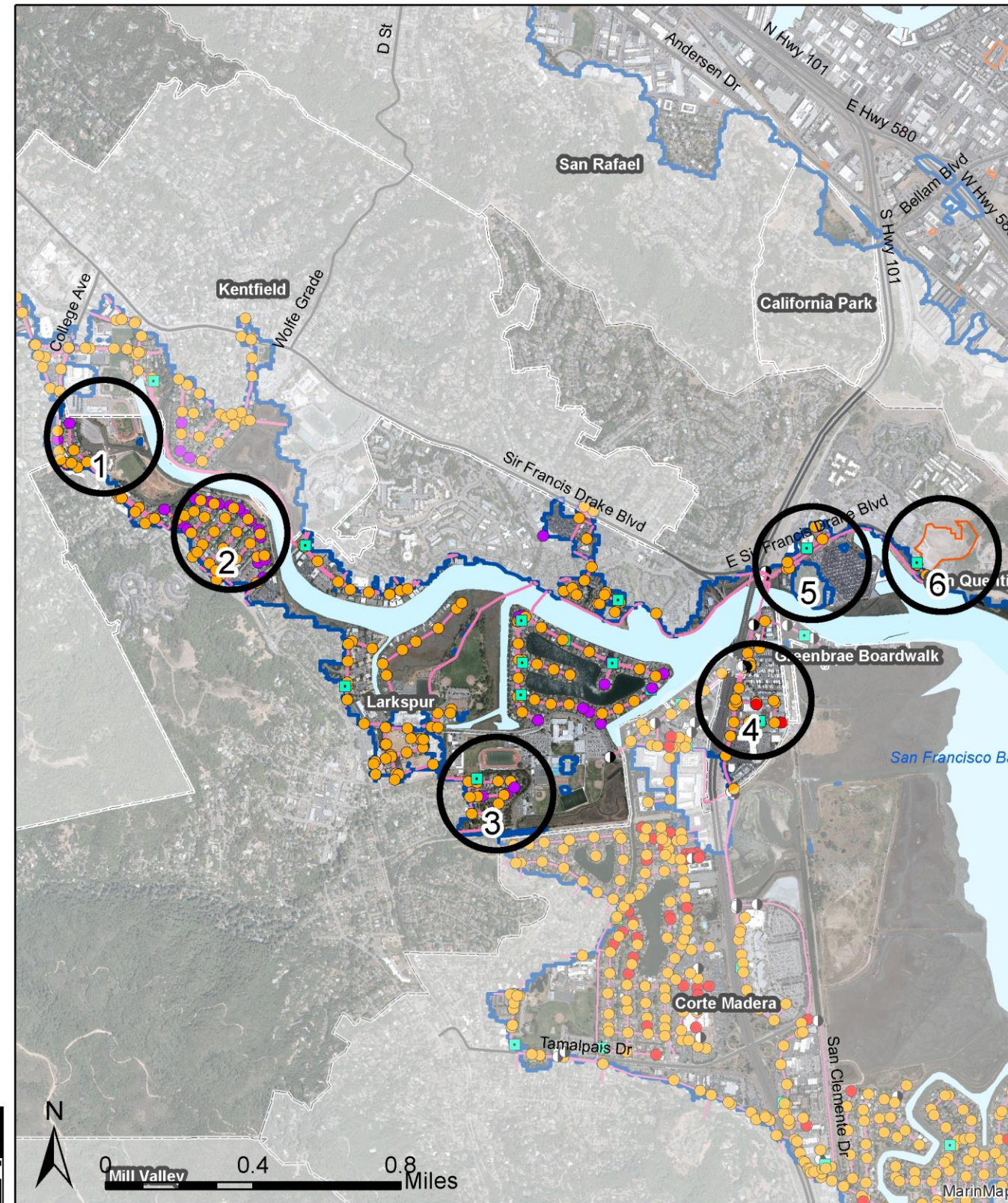
- Manhole
- Pump Station
- Residential Lateral
- Pipe
- Collector
- Junction

Location Indicators

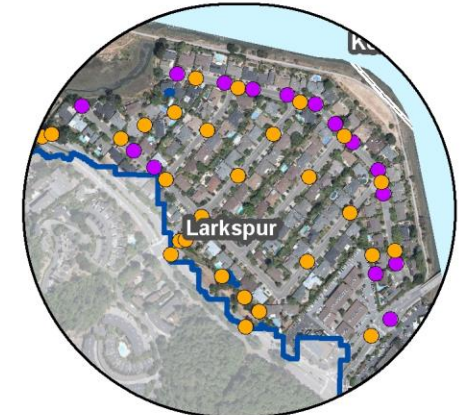
- Unincorporated
- Municipality
- Road
- Bay
- Inland Extent: Sea Level @ 60"+100-year Storm Surge



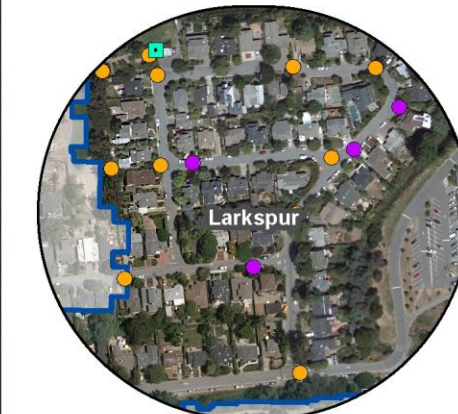
Date:
3/29/2017



1: Magnolia Ave.
@ College Ave.



2: Hillview Neighborhood



3: Heatherwood Neighborhood



4: Redwood Highway
Frontage Rd.



5: Sir Francis Drake Blvd.
@ U.S. Hwy. 101



6: Sir Francis Drake Blvd.
@ Larkspur Landing Cir.

Disclaimer: Vulnerability Assessment maps, tables, etc. can be used as a resource to help identify potential hazardous areas and vulnerable assets. Marin County, and data providers here in, make no warranties of the accuracy or completeness of maps and data. Maps are representational and subject to future revision. Local site conditions must be examined. Commercial use is prohibited.

Map 91. Larkspur Vulnerable Gas and Electric Utility Assets

Vulnerable Assets

✚ Solar Installation

PG&E Assets

— Electric Transmission Lines

— Natural Gas Pipeline

◆ Substation

▲ Transmission Tower

□ PG&E Property

■ PG&E Buildings

Location Indicators

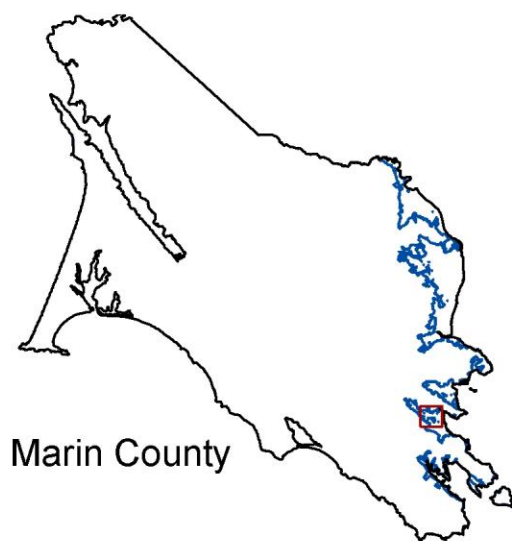
□ Unincorporated

□ Municipality

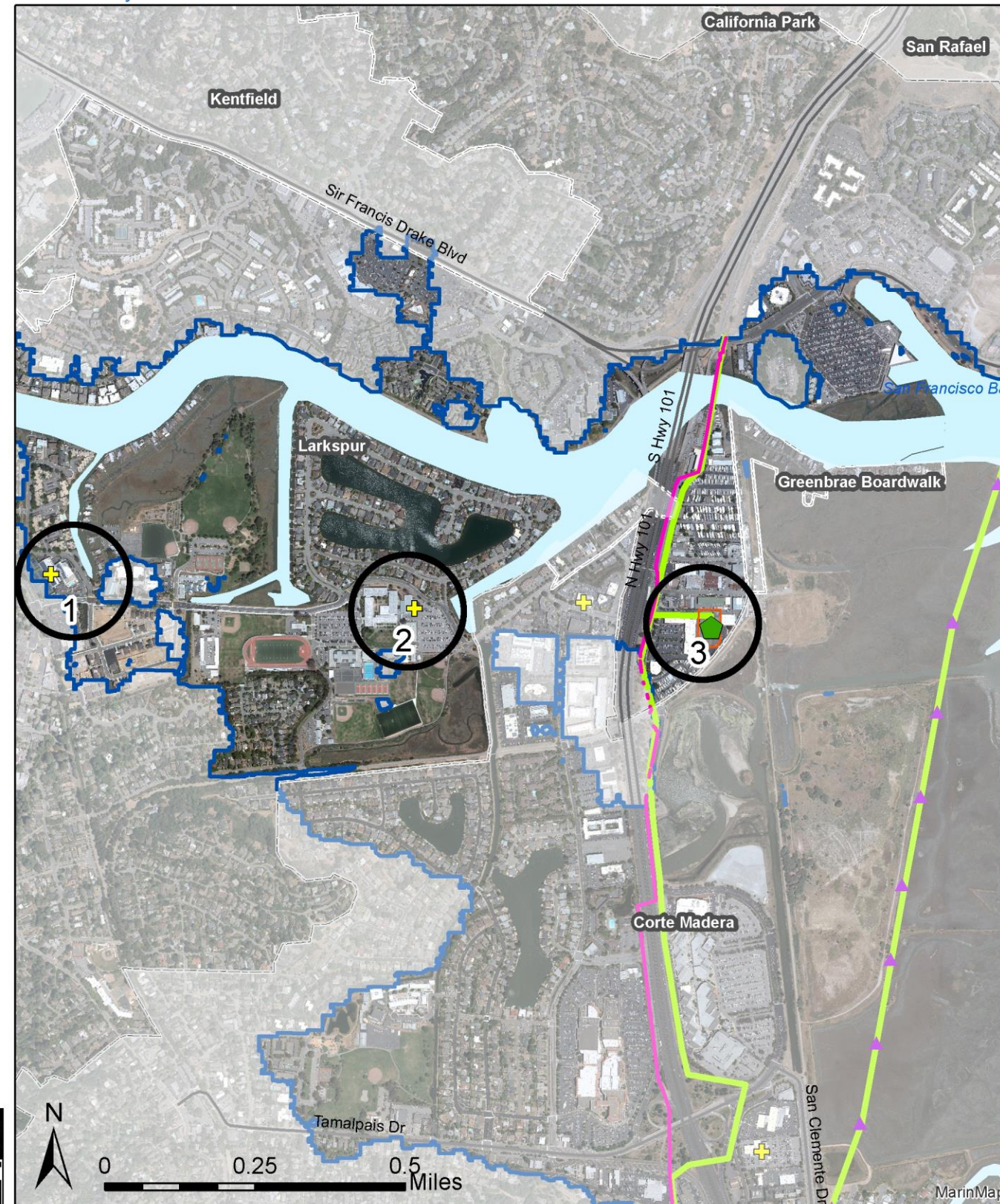
— Road

■ Bay

~ Inland Extent: Sea Level
@ 60"+100-year Storm



Date:
1/29/2017



1: Athletic Club



2: Redwood High School

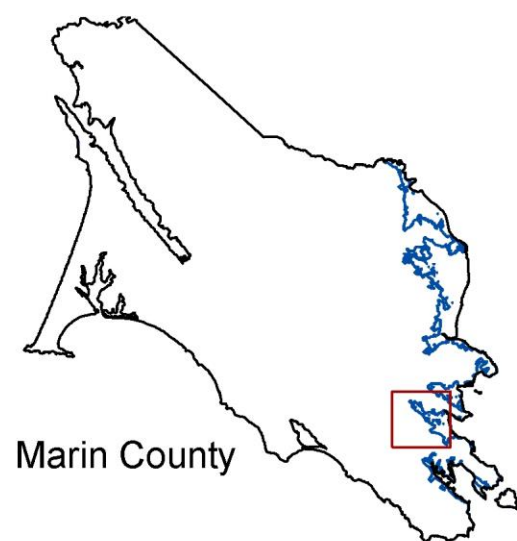


3: PG&E Substation

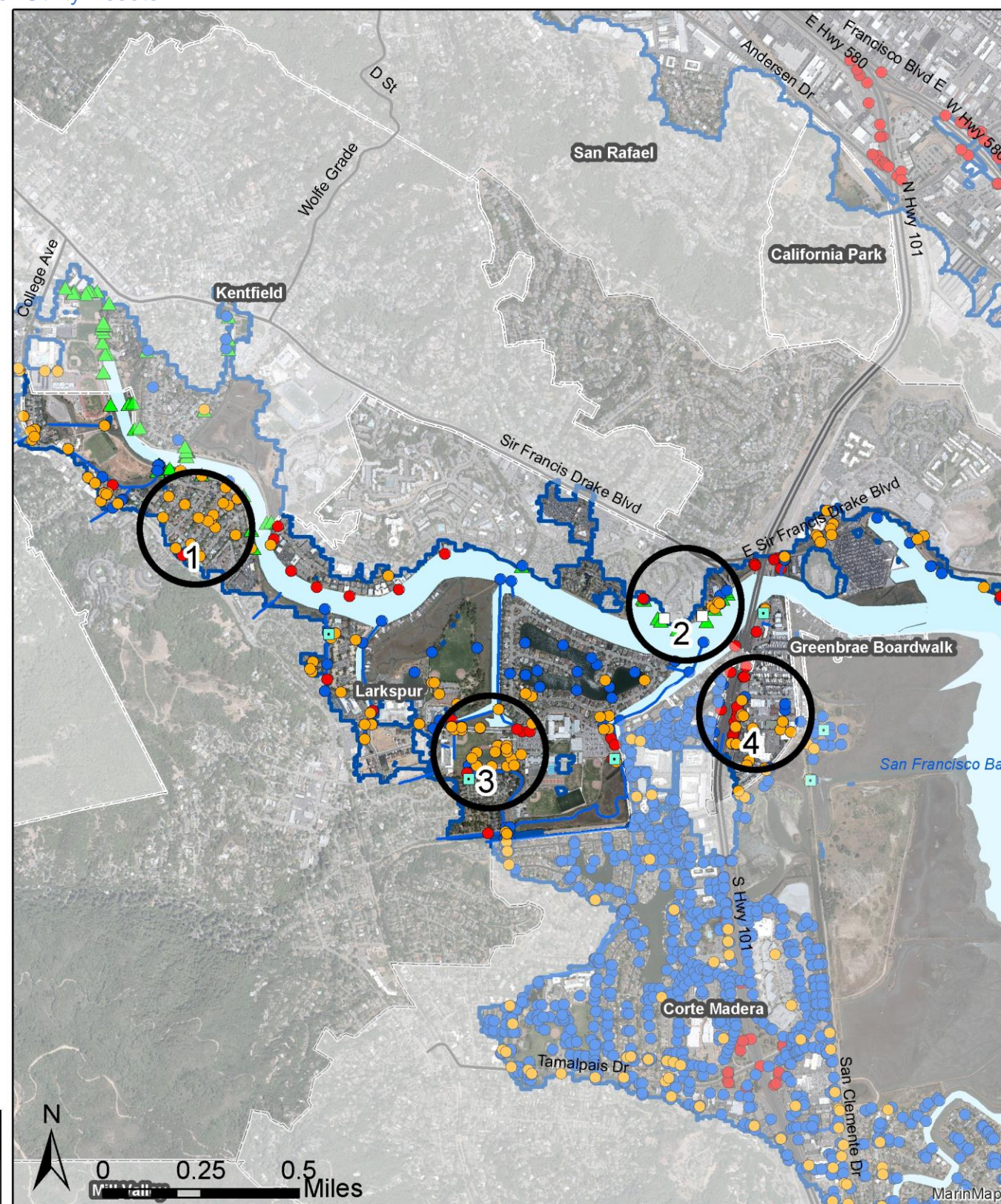
Disclaimer: Vulnerability Assessment maps, tables, etc. can be used as a resource to help identify potential hazardous areas and vulnerable assets. Marin County, and data providers here in, make no warranties of the accuracy or completeness of maps and data. Maps are representational and subject to future revision. Local site conditions must be examined. Commercial use is prohibited.

Map 92. Larkspur Vulnerable Stormwater Utility Assets
Vulnerable Assets

- Catch Basin
 - Pump Station
 - Manhole
 - Pipe Inlet/Outlet
 - Box
 - Flap Gate
 - Node
 - Channel
 - ▲ Culvert
- Location Indicators**
- Unincorporated
 - Municipality
 - Road
 - Bay
 - Inland Extent: Sea Level @ 60"+100-year Storm



Date:
3/29/2017



1: Hillview Neighborhood



2: Bon Air Landing Park



3: Redwood Highschool












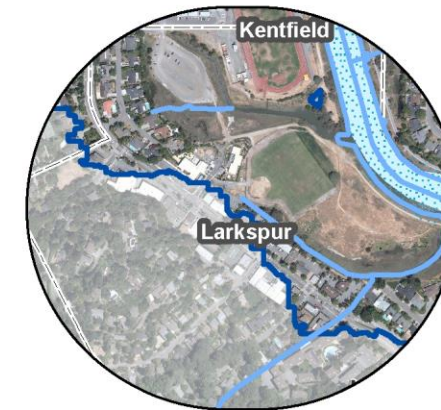
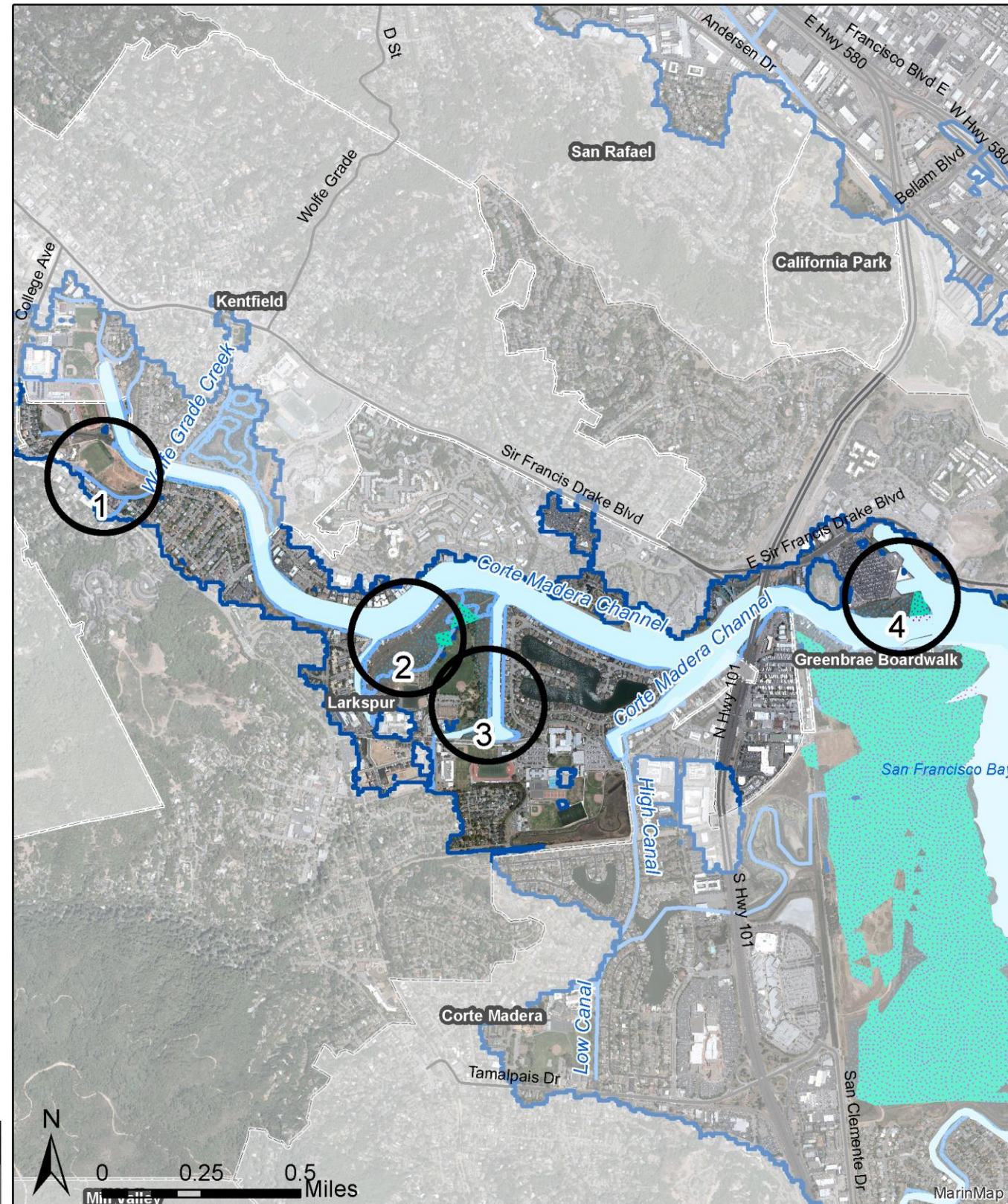
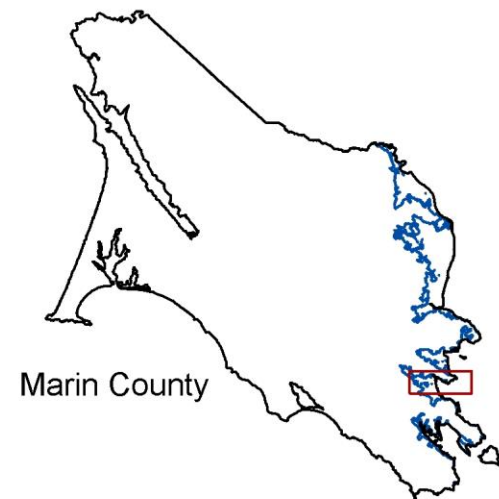
4: U.S. Hwy. 101 Corridor

Disclaimer: Vulnerability Assessment maps, tables, etc. can be used as a resource to help identify potential hazardous areas and vulnerable assets. Marin County, and data providers here in, make no warranties of the accuracy or completeness of maps and data. Maps are representational and subject to future revision. Local site conditions must be examined. Commercial use is prohibited.

Map 93. Larkspur Vulnerable Natural Resource Assets

Vulnerable Assets

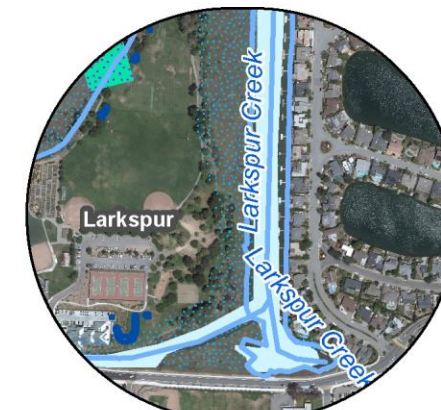
-  Streams
 -  Marsh
 -  Estuary
 -  Wetland
- Location Indicators**
-  Unincorporated
 -  Municipality
 -  Road
 -  Bay
 -  Inland Extent: Sea Level @ 60"+100-year Storm



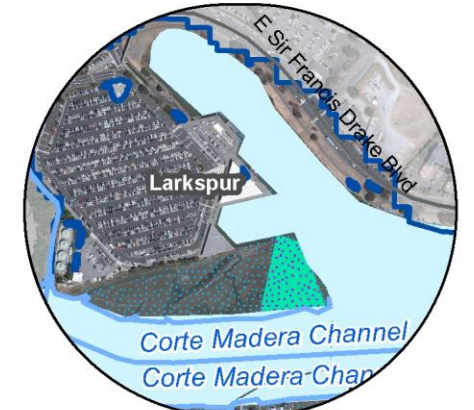
1: Upper Corte Madera Creek



2: Boardwalk One













3: Piper Park

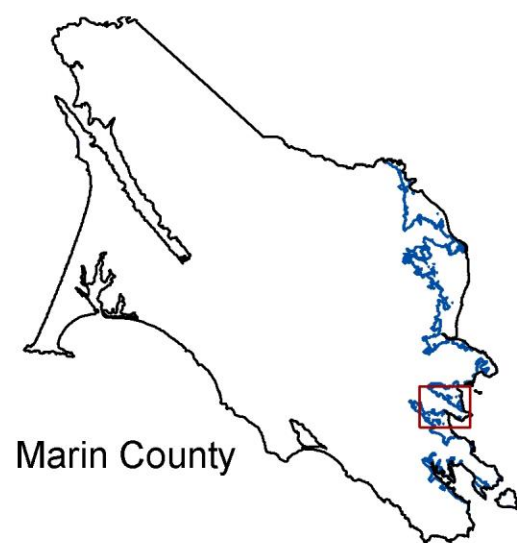


4: Larkspur Landing

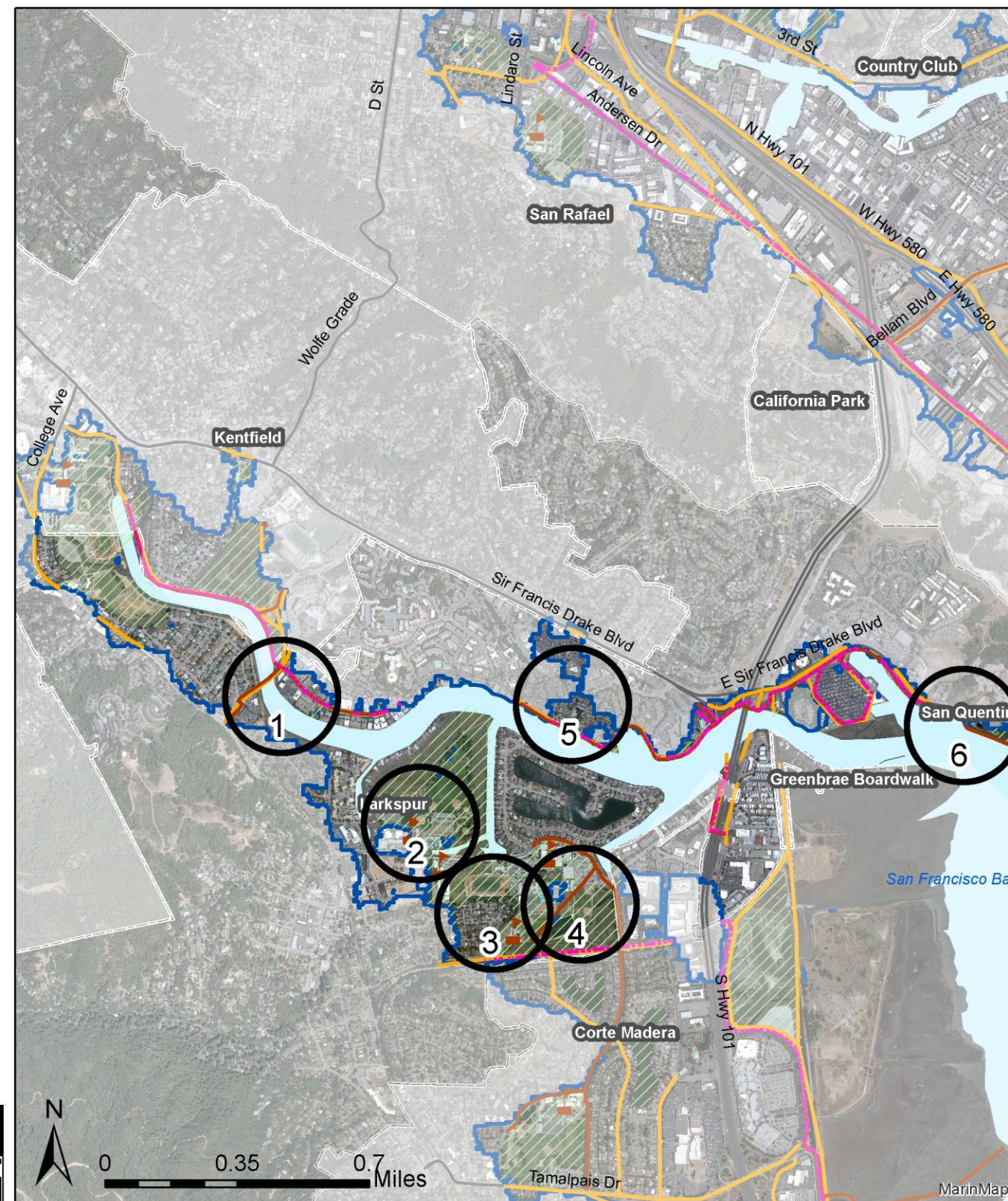
Map 94. Larkspur Vulnerable Recreation Assets

Vulnerable Assets

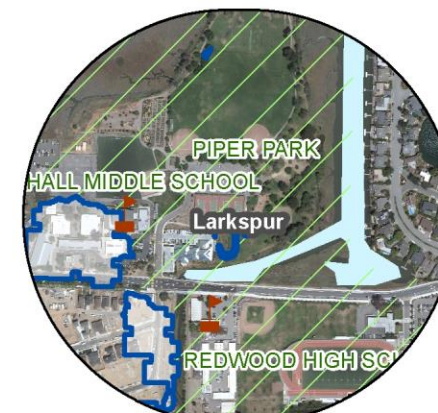
-  School
 -  Bay Trail
 -  Trail
 -  Bikeway
 -  Park
- ## Location Indicators
-  Unincorporated
 -  Municipality
 -  Road
 -  Bay
 -  Inland Extent: Sea Level @ 60"+100-year Storm



Date:
1/25/2017



1: Bon Air Rd.



2: Piper Park
& Schools



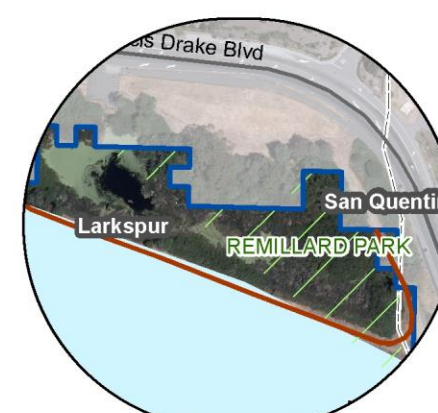
3: San Andreas High School



4: Redwood High School



5: Bon Air Landing Park






6: Remillard Park

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Map 95. Larkspur Vulnerable Emergency Service Assets

Vulnerable Assets

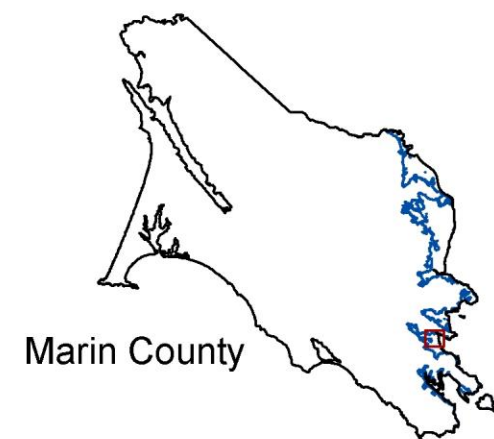
-  Emergency Shelter
-  Law Enforcement
-  Medical Facility

Vulnerable Arterials & Highways

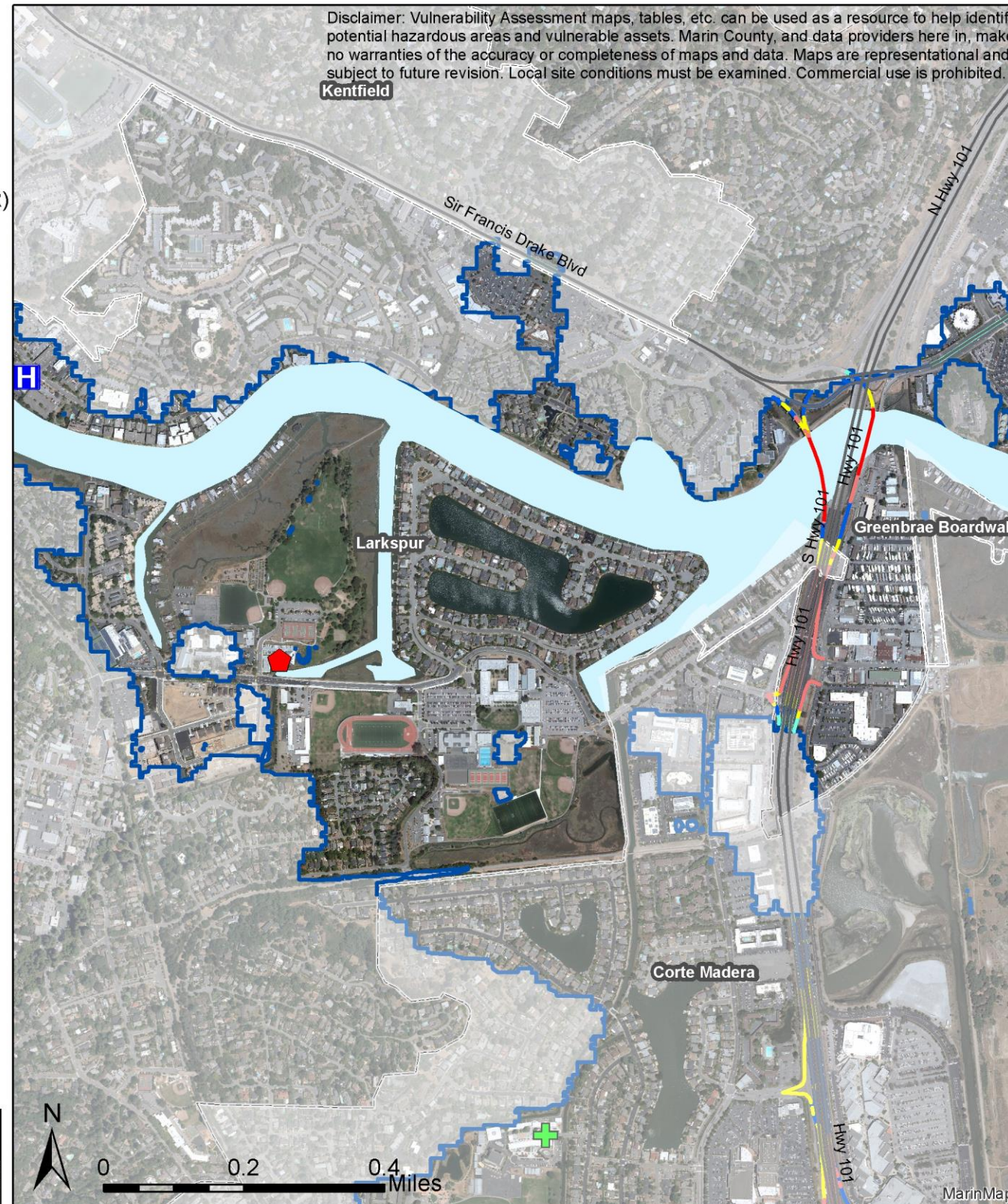
-  @ Scen. 1: 10" Sea Level Rise (SLR)
-  @ Scen. 2: 10"SLR+Storm Surge
-  @ Scen. 3: 20"SLR
-  @ Scen. 4: 20"SLR+Storm Surge
-  @ Scen. 5: 60"SLR
-  @ Scen. 6: 60"SLR+Storm Surge

Location Indicators

-  Unincorporated
-  Municipality
-  Road
-  Bay
-  Inland Extent: Sea Level @ 60"+100-year Storm



Date:
2/14/2017



SAN RAFAEL

Community Profile: San Rafael

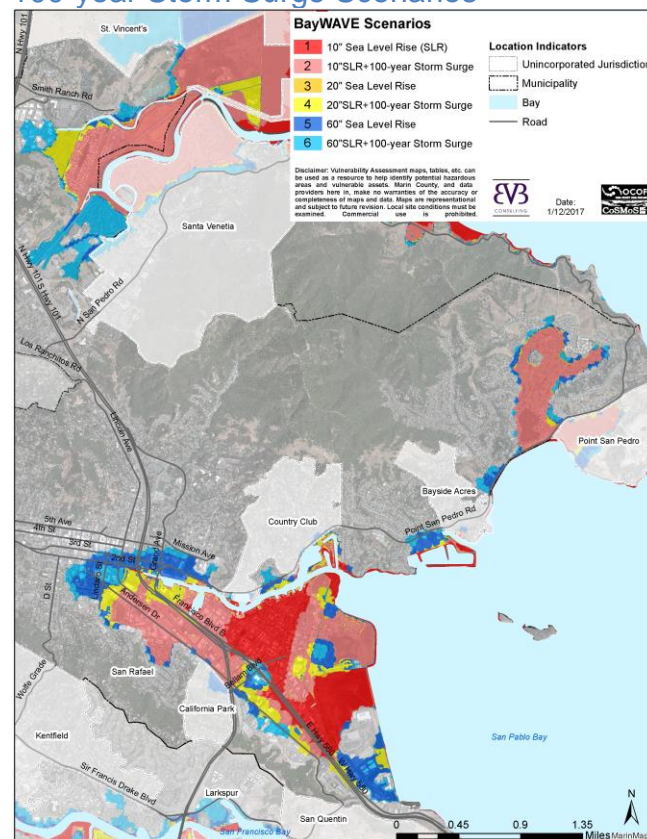
San Rafael is the Marin County seat and largest city. The city features an active boating sector, the largest downtown in the county, a university, and the county's largest employers. San Rafael is home to the largest population in general, and of low-income and limited English proficiency households. These households can be found throughout the city; however a large community exists in the low lying Canal District, the most densely populated area in the county. Compared to the other communities in the study area and the County, San Rafael could experience the most significant impacts, including:

- Flooding in the Canal area and Kerner Business District could compromise extensive multi-family housing, commercial, industrial, and recreational uses.
- US Highway 101 on and off-ramps could anticipate 100-year storm surge flooding in near-term and tidal flooding in the medium-term.
- The San Rafael Transit Center could be vulnerable in the long-term. This could compromise local and regional bus lines, and the new SMART train.
- A significant portion of downtown could face storm surges in the near- and medium-terms and sea level rise in the long-term.
- GGBHTD facilities on Andersen Drive could be vulnerable in the medium-term.
- Several schools including Bahia Vista and Glenwood Elementary, Davidson Middle, and San Rafael High schools could be vulnerable across the BayWAVE scenarios.
- Five historic landfills along the shoreline and one closed brownfield site further inland could be subject to inundation.
- Miles of electrical transmission and natural gas pipelines are in the near-term.
- Marinas and other boating facilities could be vulnerable to sea level rise in the medium- to long-term.
- Peacock Gap homes and golf course could be vulnerable to storms in the near-term and sea level rise in the long-term.
- Marin Lagoon and streets in the Las Gallinas area could begin to see peripheral tidal flooding and storm surge flooding in the near-term, and neighborhood scale flooding by the long-term.
- Fire Station 54 is vulnerable in scenario 1 and two others could have access issues.

IMPACTS AT-A-GLANCE: SCENARIO 6

2,121 acres	58,000 people
4,700+ living units	475 commercial parcels
7.5 road miles	
Storm and tidal impacts already occur	
\$2.6 billion in assessed property value; \$1.7 billion in single-family home market value ²⁰⁰	City of San Rafael San Rafael Sanitation District Property Owners HOAs Caltrans

Map 96. San Rafael Sea Level Rise and 100-year Storm Surge Scenarios



²⁰⁰ 2016 dollars

SAN RAFAEL



San Rafael Canal with the Canal District and Pickleweed Park to the left and several homes and private marinas on the right banks of the canal. Credit: WikiMedia Commons.

Table 102. San Rafael Exposed Acres

Scenarios		Acres	
		#	%
Near-term	1	449	3
	2	1,360	10
Medium-term	3	869	6
	4	1,590	11
Long-term	5	1,856	13
	6	2,121	15

Source: MarinMap, CoSMoS

Vulnerable Assets

San Rafael's vulnerable assets include the entire Canal neighborhood and Kerner Business District, and shoreline development and boating facilities off Point San Pedro Road. In time, the impacts move into downtown San Rafael, Peacock Gap, and Marin Lagoon. Note that recent construction at the Loch Lomond Marina and surrounding properties recently completed projects to elevate the shoreline that are not accounted for in the CoSMoS models 2010 baseline imagery. Thus, flooding and onset predictions here may not be as severe as estimated in this assessment. In addition to sea level rise, subsidence is already a significant issue south of Interstate 580 and U.S. Highway 101, and in Marin Lagoon, where development is built largely on fill atop bay mud. With sea level rise, subsidence rates could increase.

Land

Most of the vulnerable land in San Rafael was built on filled land that used to be tidal marsh or mud. Sea level rise would likely return this area to tidal habitat again without measures to protect existing land uses. With a 100-year storm surge, downtown and further inland areas within the basin of the valley as far back as Gerstle Park.

Acres

In the near-term, 449 acres, or three percent of San Rafael, could be exposed to tidal flooding at MHHW. A 100-year storm surge on top of ten inches of sea level rise, scenario 2, could flood three times as many acres. Outside of the Canal Neighborhood, much of the flooded acreage is marshland. In medium scenario 3, nearly 900 acres could flood tidally at MHHW. In scenario 4, 200 more homes could be impacted by storms surges than in scenario 2, the previous storm surge scenario. By the long-term, 1,856 acres, or roughly 15 percent of San Rafael's area could be exposed to sea level rise, and 2,121 acres could be exposed during an additional 100-year storm surge.

Parcels

San Rafael's acreage is divided in several thousand parcels, any independently owned and developed. Several publically owned parcels could also flood, especially in the near-term. Examining parcels and their uses can provide a look into the human activities that could be flooded out by bay waters.

In the near-term, as seen in [Table 105](#), two percent of parcels could be vulnerable to tidal flooding. With a 100-year storm surge, an additional 136 parcels and 1,438 buildings could experience temporary flooding. These are mostly buildings lining the San Rafael canals and in the low-lying areas west of the canal. The area is characterized by a variety of apartment complexes, light industrial sites, and commercial strip areas that serve the predominantly residents from Central American countries. One single family home subdivision, near Spinnaker Point, not directly at risk until later in the century, however, year round vehicular access may prove challenging before then. Bahia Vista Elementary School, Albert J. Boro Community Center and Pickleweed Park, San Rafael Fire Station 54, and the Marin County Health Innovation campus are some of the potentially impacted public facilities.

SAN RAFAEL

Table 103. San Rafael Vulnerable Residential and Commercial Parcels

Land Use	Scenarios					
	Near-term		Medium-term		Long-term	
	1		3		5	
	#	%	#	%	#	%
Residential	492	3	883	6	1,798	12
Commercial	132	11	234	19	475	40
Industrial	48	17	104	37	170	61

Source: MarinMap, CoSMoS.

Table 104. San Rafael Vulnerable Parcels by Land Uses

Land Use	Scenarios					
	1		3		5	
	Near-term		Medium-term		Long-term	
	#	Ac.	#	Ac.	#	Ac.
Commercial Improved	116	98	213	267	419	527
Commercial Unimproved	16	89	21	108	54	149
Common Area	2	2	3	5	20	26
Industrial Improved	45	21	97	50	153	83
Industrial Unimproved	3	0.6	7	1	17	5
Residential	492	46	883	88	1,798	196
Mobile Home					154	1
Multi-Family Improved	78	34	104	44	136	54
Multi-Family Unimproved	2	0.2	3	0.6	4	1
Single Family Attached	382	5	634	10	1,084	38
Single Family Improved	20	4	127	31	390	76
Single Family Unimproved	8	3	12	3	27	26
Tax Exempt	22	53	57	193	159	530
Exemption Improved	13	6	18	10	22	12
Exemption Unimproved					1	0.5

Source: MarinMap, CoSMoS

And as shown in Table 103, within the vulnerable parcels, three percent of all residential, 11 percent of all commercial, and 17 percent of industrial parcels could face tidal MHHW flooding in the near-term. In medium-term scenario 3, double these figures could anticipate tidal flooding with 883, residential parcels, 234 commercial parcels, and 104 industrial parcels. A significant 20 percent of commercial parcels and almost 40 percent of industrial parcels in San Rafael could be vulnerable to tidal flooding.

In the long-term conditions would worsen, with 40 percent of commercial and 60 percent of industrial parcels could experience tidal flooding. With a 100-year storm surge 75 percent of San Rafael's industrial parcels could flood, and 15 percent of them would only experience storm surge flooding, the remaining could suffer the fates of both tidal and storm flooding combined. Many of these parcels are in the Canal area and Kerner Business District, this area is already highly dependent on storm water pump station to remove stormwater entering the area from the uplands. This force combined with sea level rise would require the pumps to work even harder and become overworked, or worse fail.

While not as large of a portion, 15 percent of residential parcels in San Rafael is nearly 2,000 parcels, many more than other communities in the study area. Moreover, these residential parcels are in the more affordable areas in the city and contain large numbers of low-income renter households. In fact, 34 acres amongst 78 parcels provide multi-family and could be vulnerable to tidal flooding in the near-term. By the end of the century, this figure climbs to 54 acres and 136 parcels. This is especially alarming because many of these parcels contain multiple buildings with multiple living units, thus impacting several hundred, if not thousands of households.

A large number of acres are dedicated to tax exempt land. This land is typically public land, though some parcels belong to non-profit organizations. Parcels that are not dedicated to civic uses are generally parks or open space. Significant portions of open space and marshes make up the San Rafael shoreline that account for the 500 acre figure.

These losses in developable land area are significant to San Rafael, its residents, business owners, and the County as a whole. Continued use of this land would require extensive protection and reinvention.

SAN RAFAEL

Buildings

A majority of privately held parcels contain buildings used for housing, work, entertainment, worship, and commerce. Many public parcels can also contain buildings, especially schools, community centers, and emergency services. Without shelter, many, if not most, of the existing activities on the land would not be feasible. Damages to and destruction of buildings especially several hundred to thousands of buildings at once, would be devastating to the local, regional, and state economy for years afterwards.

In the near-term, as seen in [Table 105](#), two percent of buildings, 410 buildings, in San Rafael could be vulnerable to higher high tides. And With a 100-year storm surge, an additional 1,438 buildings could experience temporary flooding. These are mostly buildings lining the San Rafael canals and in the low-lying areas west of the canal. The area is characterized by a variety of apartment complexes, light industrial sites, and commercial strip areas that serve the predominantly Latino residents. One section, near Spinnaker Point, is a single family home subdivision that is not directly at risk until later in the century, however, year round vehicular access may prove challenging before then. Bahia Vista Elementary School, Albert J. Boro Community Center and Pickleweed Park, San Rafael Fire Station 54, and the Marin County Health Innovation campus are some of the potentially impacted public facilities.

The Kerner business district is vulnerable in the near and medium-terms. Though some portions of the district are protected until after the medium –term because of shoreline armoring, after three feet of sea level rise this area could be saturated at high tides. Note that storm surges could cause temporary impacts as early as scenario 2.

Development is also compromised in the near-term on Irwin, 2nd, and 3rd Streets. This area, known as Montecito, includes gas stations, grocery stores, small offices, and several daily needs businesses. San Rafael High School is located here and could anticipate long-term impacts. In the medium-term, more than 1,000 buildings could be vulnerable to tidal flooding and nearly twice that could be vulnerable under a 100-year storm surge. By the long-term, nearly 2,500 buildings, or 13 percent of all buildings in San Rafael, could face some level of tidal flooding. Under storm surge conditions, 18 percent of buildings in San Rafael, or more than 3,000 buildings could experience storm damage, only 1,200 of which would only suffer storm surge

flooding. Between the medium- and long-terms, ocean waters move further into the valley, crossing the freeway interchanges, flooding out the on and off ramps, reaching the Andersen and Francisco West industrial and commercial areas, downtown, and eventually the Gerstle Park neighborhood.

Table 105. San Rafael Vulnerable Buildings by Scenario

Scenarios		Buildings	
		#	%
Near-term	1	410	2
	2	1,846	10
Medium-term	3	1,088	6
	4	2,097	11
Long-term	5	2,495	13
	6	3,247	18

Source: *MarinMap, CoSMoS*

The Canal Neighborhood population is about 70 percent Central and South American origin and Spanish or native languages are typically spoken at home. Compared to other communities in the study area, Canal residents are younger, families are larger, incomes are lower, and residents are primarily renters.²⁰¹ Almost one-half of residents are housing cost burdened, paying more than 30 percent or more of their income for housing.²⁰² Canal Neighborhood residents own fewer cars and ride transit.²⁰³ These residents are disproportionately vulnerable to sea level rise and some of the first people impacted by sea level rise at their front doors.

²⁰¹ Census 2010

²⁰² Human Impact Partners. 2013. Healthy Marin Partnership. Community Health Needs Assessment Sub-county Health Indicators.

²⁰³ Census 2010

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Table 106. San Rafael Vulnerable Buildings Tidal Flooding* Estimates at MHHW

Flood Depth (feet)		Scenario		
		Near-term	Medium-term	Long-term
		1	3	5
0.1-1	#	94	143	108
1.1-2	#	143	212	228
2.1-3	#	187	251	346
3.1-4	#	26	206	548
4.1-5	#	3	102	401
5.1-6	#	1	9	360
6.1-7	#		1	215
7.1- 8	#			190
8.1-9	#			26

*Flood depth data is not available for all exposed areas and assets.

Source: MarinMap, CoSMoS

The analysis presented in Table 106 breaks down the vulnerable buildings by how much saltwater could enter the property at MHHW. Storm surges would have one to three feet of additional water and would impact significantly more buildings. In the near and medium-terms most vulnerable buildings in San Rafael experience 6 feet or shallower waters, with the majority experiencing three feet or lower. In the long-term, more than 600 buildings could flood with up to three feet, more than 1,000 buildings could flood with between three and six feet, and more than 400 buildings could be flooded with up to nine feet of saltwater at mean higher high water. Buildings that flood to these extreme on a regular basis are not useable. Even if the building itself is flood proofed, the surrounding land, roads, and utilities would likely be compromised as well, rendering the buildings uninhabitable.

Table 107 shows FEMA Hazus post-disaster estimates for damage to buildings and their contents. If all the buildings vulnerable in scenario 6, the worst case storms urge scenario analyzed in this assessment, experience minor damage a minimum of 16 million in damages could occur. If all for these buildings were to be destroyed, the worst possible outcome, up to \$1.5 billion in assessed structural value vulnerable in scenario 6. Reality would likely reflect a mix of damage levels amounting to monetary values between the high and low figures calculated here.

Table 107. San Rafael Vulnerable Buildings' FEMA Hazus Storm Damage Cost* Estimates in Long-term Scenario 6

Buildings in Scenario 6	3,247
Yellow Tag: Minor Damage \$5,000 minimum	\$16,235,000
Orange Tag: Moderate Damage \$17,001 minimum	\$55,202,247
Red Tag: Destroyed Assessed structural value	\$1,496,065,489

Source: MarinMap, CoSMoS

* 2016 dollars

Buildings in San Rafael are older, and many, especially downtown are unreinforced and could be weakened by flooding. These buildings are primarily mixed-use or commercial. Newer commercial buildings are typically concrete slab tilt-ups or smaller cinder block and stucco buildings. According to a BCDC profile for San Rafael for the Stronger Housing Safer Communities on seismic and flooding safety, most single-family homes in the low-lying areas of San Rafael are one- and two story homes, built in the Victorian era, the earlier part of the 20th century, post-WWII, and newer modern homes. There are also 2-4 unit dwellings, and medium- and large-sized apartment complexes typically of wood construction.²⁰⁴

According to San Rafael asset managers, several critical businesses could be vulnerable to sea level rise. These include: 30 grocery stores from 7-11 to Whole Foods Market, 10 pharmacies, 16 medical clinics, 48 doctor offices, and 29 building supply stores. These businesses either contain critical goods like medications and access to medical and buildings supplies after a major storm or flooding event or house some of the most vulnerable populations in the region.




The maps on the following pages illustrate vulnerable buildings by scenario. The areas in the call out circles enable the reader the see areas that are difficult to see on the large scale map. The circles do not indicate that these areas are more vulnerable than other areas along the shoreline.

²⁰⁴ BCDC. March 2015 Stronger Housing Safer Communities. Strategies for Seismic and Flood Risk. Summary Report. San Rafael Profile: http://resilience.abag.ca.gov/wp-content/documents/housing/San%20Rafael%20Community%20Profile_final_v2.pdf

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Map 97. Southern San Rafael Vulnerable Buildings

Vulnerable Assets

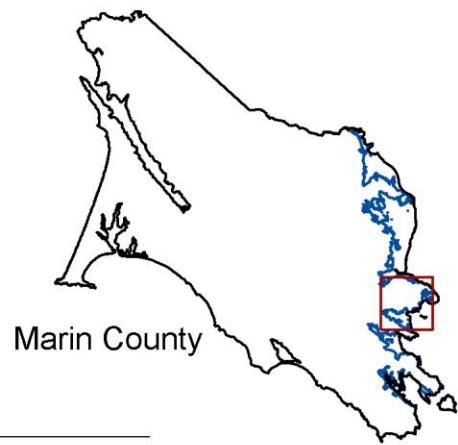
-  School
-  Medical Facility
-  Emergency Shelter
-  Fire Station

Vulnerable Buildings

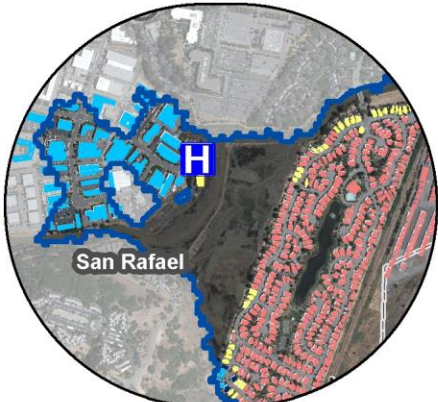
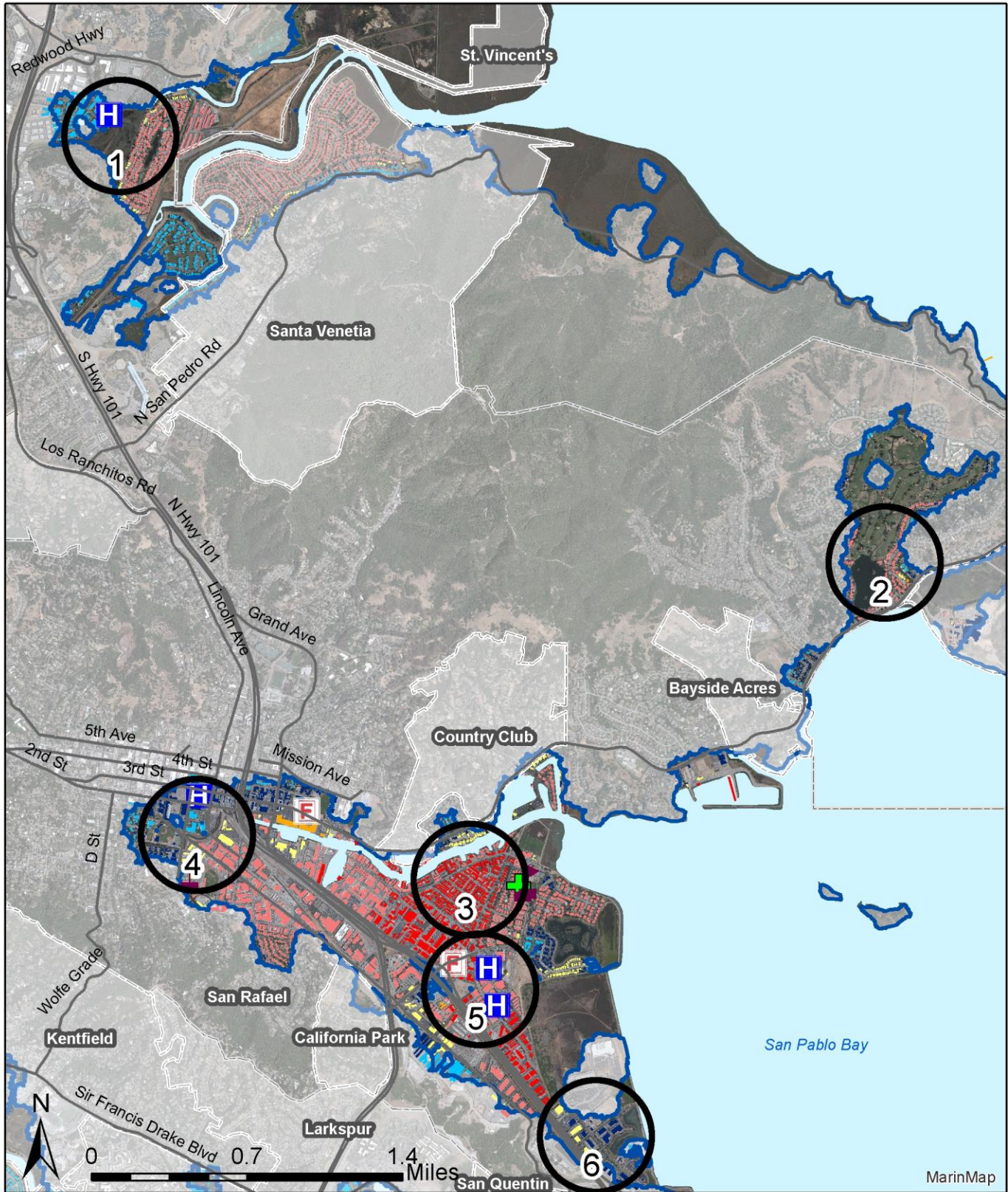
-  Scen. 1: 10" Sea Level Rise (SLR)
-  Scen. 2: 10" SLR+Storm Surge
-  Scen. 3: 20" Sea Level Rise
-  Scen. 4: 20"SLR+Storm Surge
-  Scen 5: 60" Sea Level Rise
-  Scen. 6: 60"SLR+Storm Surge

Location Indicators

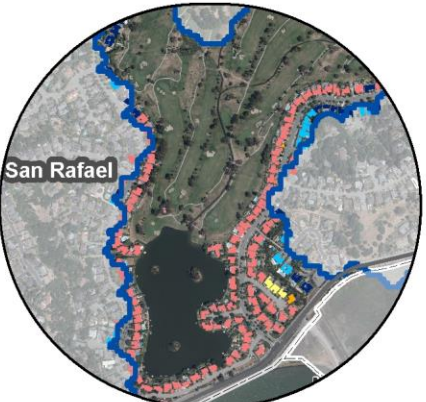
-  Unincorporated
-  Municipality
-  Road
-  Bay
-  Inland Extent: Sea Level @ 60"+100-year Storm



Date:
4/13/2017



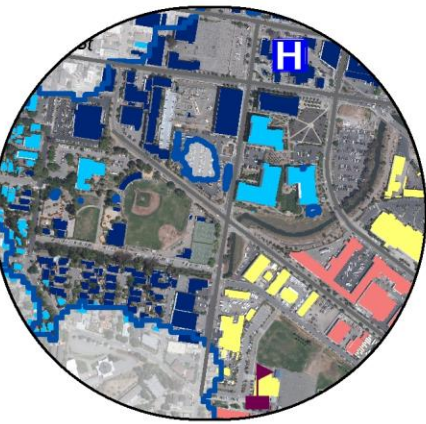
1: Las Gallinas



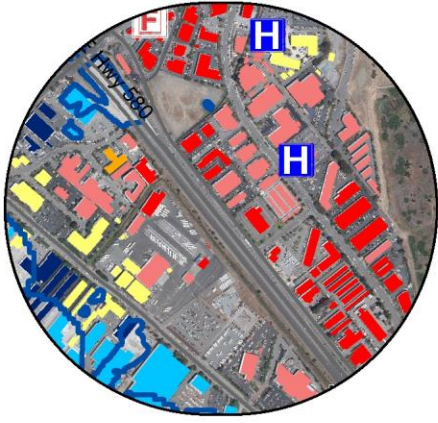
2: Peacock Gap



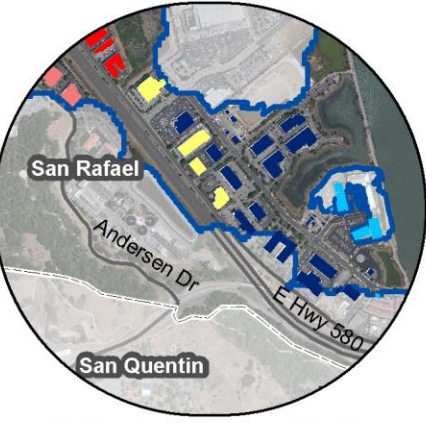
3: Canal Neighborhood



4: Downtown



5: Interstate 580



6: End of Kerner Blvd.

Disclaimer: Vulnerability Assessment maps, tables, etc. can be used as a resource to help identify potential hazardous areas and vulnerable assets. Marin County, and data providers here in, make no warranties of the accuracy or completeness of maps and data. Maps are representational and subject to future revision. Local site conditions must be examined. Commercial use is prohibited.

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A closer examination of places where young children or disabled or older people spend much of their time reveals that nearly 50 vulnerable sites are in the vulnerable area of San Rafael. Thirty-five buildings support childcare facilities. Five buildings house residential care facilities, including:

- Aegis of San Rafael,
- Golden Home Extended Care,
- Miracle Hands Homecare,
- Saint Michael's Extended Care, and
- Schon Hyme Rest Home.

Seven convalescent facilities also house uniquely vulnerable residents. These are:

- All Saints Extended Care, Inc.,
- Country Villa San Rafael,
- Harmony House,
- Kindred Transitional Care and Rehabilitation,
- Pine Ridge Care Center,
- San Rafael Care Center, Inc., and
- San Rafael Healthcare & Wellness Center.

While these facilities may be able to withstand low levels of infrequent flooding, higher levels of water and/or more frequent flooding could be burdensome on these facilities and require relocation. Moreover, these facilities are especially vulnerable to power outages or disruptions to emergency services.

Transportation

Transportation is a major concern for San Rafael and for the entire region. San Rafael serves as a regional transit center, and nearly all routes stop here, including the newly unveiled SMART line. In the near-term, other major roads impacted are Bellam Blvd, Francisco Blvd., East, Kerner Blvd, Grand Ave. and Irwin Street.

Much like with buildings, many of the roads to be flooded first are in, or are major access ways to, the Canal District and north of Interstate 580. Residents in this area tend to live with scarce financial resources and can be especially burdened by disruptions in the transportation system or damages to their vehicles. In addition, those with health or mobility constraints, who do not own a home or car, or are not proficient in the English language, may also be disproportionately burdened by sea level rise and storms. If these residents are displaced, the upheaval and loss would be significant to the

community and the regional economy that depends on their contributions.

Further, this area hosts the majority of light industrial and a major portion commercial uses that depend on the transportation network to reach clients, receive and deliver materials, and receive customers. Moreover, already constrained street parking could be flooded with tidal waters. And repeated exposure to saltwater would damage personal and commercial vehicles. Finally, emergency access for fire, ambulance, and police could be limited at a time residents are most vulnerable. In fact, Fire Station 54 could be directly flooded, damaging equipment and vehicles in the station.

In the medium-term, tidewaters extend under the freeways further into the street grid of downtown and the industrial and commercial Andersen Drive area. While US Highway 101 is generally elevated, on and off ramps at grade could be flooded out along most of its course through the city. Unlike 101; however, Interstate 580 could anticipate surface flooding between the medium- and long-terms. In the long-term, streets and homes in the Gerstle Park neighborhood west of downtown and US Highway 101 could flood when Mahon Creek overflows its banks. While previously impacted by storm surges. Pt. San Pedro Rd. could expect impacts at tidal MHHW by the long-term as well. Roads bayside of Pt. San Pedro Road, such as Mooring Road, could be vulnerable in the near-term.

Preliminary conversations with Caltrans indicate that Caltrans is well aware of the existing and arising concerns in San Rafael.²⁰⁵ According to Caltrans and the CoSMoS model, flooding occurs at low spots of US Highway 101 where it connects with Interstate 580 to the south of San Rafael Harbor. These low spots typically benefit from levees and pumps others operate to protect the larger area from flooding.

Table 108 lists transportation routes that could be vulnerable by scenario and annotates the agency responsible for a road. San Rafael has jurisdiction over the majority of the exposed portion of Pt. San Pedro Road, and the County has jurisdiction bordering the small unincorporated Country Club portions.

²⁰⁵ Sea Level Rise Vulnerability Assessment Interview. Caltrans. April 30, 2015. J. Peterson. D. Fahey. Marin County Development Agency. BVB Consulting LLC.

Table 108. San Rafael Vulnerable Transportation Assets

[illegible]

M = Marin County; C = State of California; L = Local Municipality; P = Private. Source: MarinMap, CoSMoS

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Loch Lomond Marina Club House. Credit: BYB Consulting LLC

Compromises in the road network impact transit services. Nearly every transit service provider travels through the exposed areas in San Rafael. Not only could service be interrupted, the Golden Gate Transit and Marin Airpporter facilities could be compromised as early as scenario 2. Moreover, the San Rafael Transit Center could be vulnerable to tidal flooding in the long-term. Golden Gate Transit routes 17, 22, 23, 27, 28, 29, 35, 36, 40, 42, 44, 49, 70, 71, 80, 99, 101, 117, SR7, 126, and DH could be vulnerable if they roads they travel are flooded. The following bus stops could also be flooded:

- San Rafael Transit Center
- Canal St. and Medway Rd.,
- Canal St. and Novato St.,
- Canal St. and Sonoma St.,
- Second St. and Grand Ave.,
- Third St. and Grand Ave.,
- 445 Francisco Blvd. E,
- 1525 Francisco Blvd. E,
- Irene St. and Francisco Blvd.,
- 3140 Kerner Blvd.,
- Kerner Blvd. and Bahia Way,
- Kerner Blvd. and Canal St.,
- Kerner Blvd. and Fairfax St.,
- Kerner Blvd. and Larkspur St.,
- Medway Rd. and Francisco Blvd., E
- Medway Rd. and Mill St.,
- Andersen Dr. and Jacoby St.,
- 1261, 1011, and 1022 Andersen Dr.,
- Andersen Dr. and Simms St.,
- Andersen Dr. and PG&E,
- Andersen Dr. and Francisco Blvd. W,
- Andersen Dr. and Dubois St.,
- Andersen Dr. and Irwin St., and
- Bellam Blvd. and Lisbon St.,
- Bellam Blvd. and Francisco Blvd. E,

- Bellam Blvd. and I-580 EB On-Ramp
- Francisco Blvd. E and Pelican Way,
- Kerner Blvd. and Shoreline Pkwy.,
- Lindaro St. and Andersen Dr.,
- Lindaro St. and Second St.

Marin Transit routes that could be vulnerable to hazardous road conditions are 23, 29, 35, 36, 228, 233, and 257, with stops at:

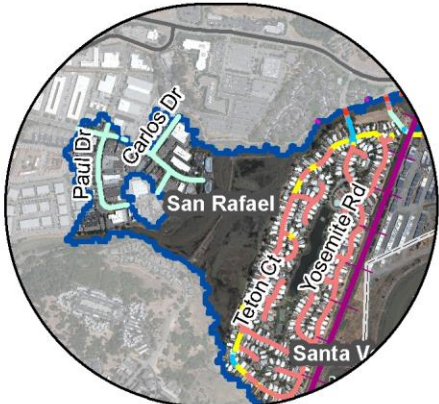
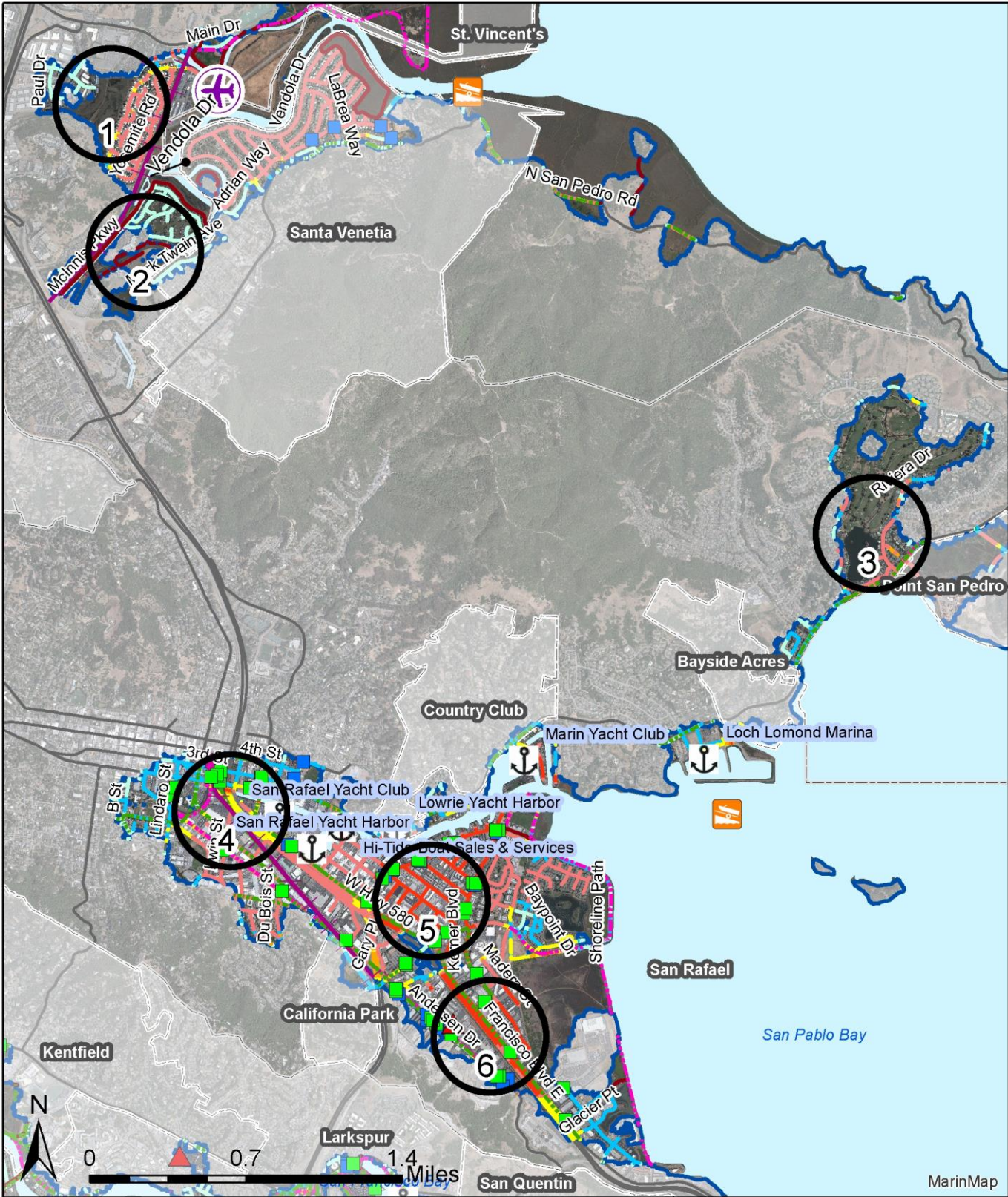
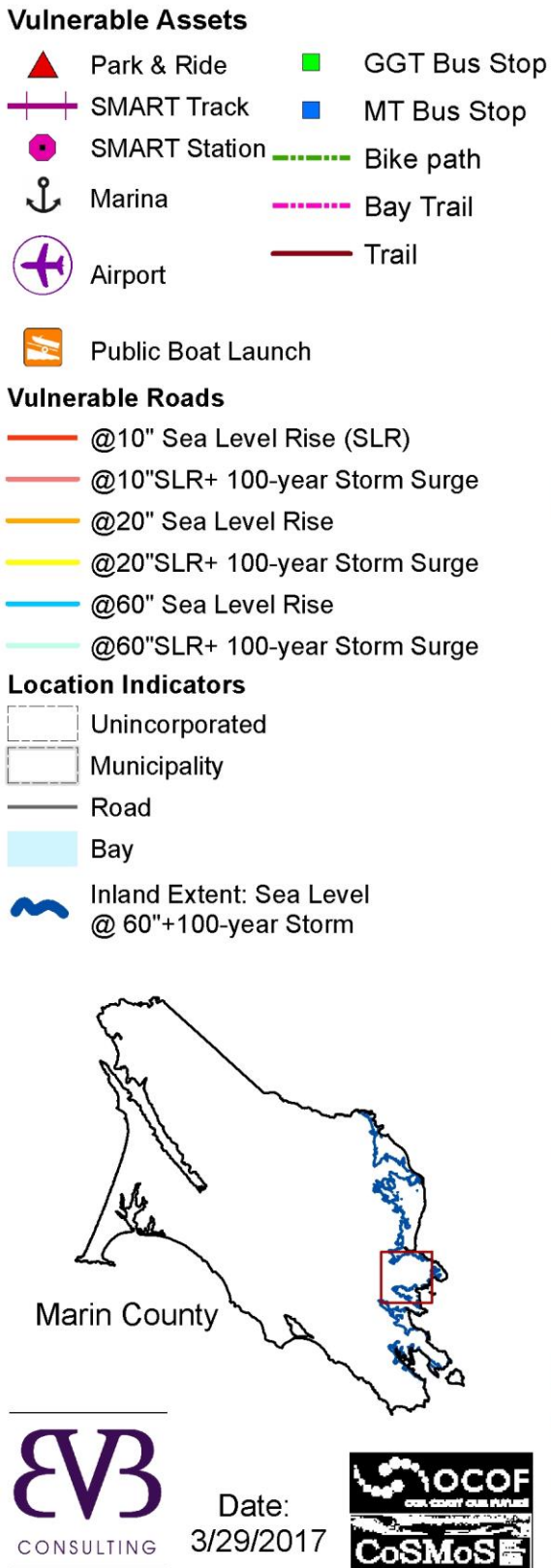
- Third St. and Grand Ave.
- San Rafael Transit Center,
- Second St. and Grand Ave.,
- 887 Andersen Dr.,
- 1011 Andersen Dr.,
- Andersen Dr. and Jacoby St.,
- Andersen Dr. and Simms St.,
- Andersen Dr. P and R Lot,
- Andersen Dr. at Office 1261,
- Andersen Dr. GGBHTD facility
- Andersen Dr. and PG&E Office,
- Medway Rd. and E Francisco Blvd.,
- Medway Rd. and Mill St.,
- E Francisco Blvd. and Bay St.,
- Canal St. and Medway Rd.,
- Canal St. and Novato St.,
- Canal St. and Sonoma St.,
- Kerner Blvd. and Canal St.,
- Kerner Blvd. and Fairfax St.,
- Kerner Blvd. and Bahia Way,
- Kerner Blvd. and Larkspur St.,
- Bellam Blvd. and E. Francisco Blvd., and
- Union St. and Fourth St.

Water transportation is a major contributor the San Rafael's sense of place, commercial activity, and recreation. One of Marin's two ports is located here along with several private marinas that could experience damage from storms and their facilities flooded out if barriers walls are not adequately elevated or pier and dock pilings are not tall enough for the highest high tides. Finally, several miles of trails could be vulnerable to sea level rise including the Bay Trail and Shoreline Path.

The maps on the following pages illustrate vulnerable transportation features. The areas in the call out circles enable the reader the see areas that are difficult to see on the large scale map. The circles do not indicate that these areas are more vulnerable than others along the shoreline.

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Map 98. San Rafael Vulnerable Transportation Assets



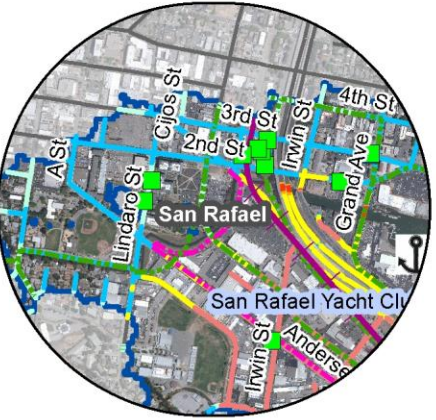
1: Las Gallinas



2: N. San Pedro Rd. @
U.S. Hwy. 101



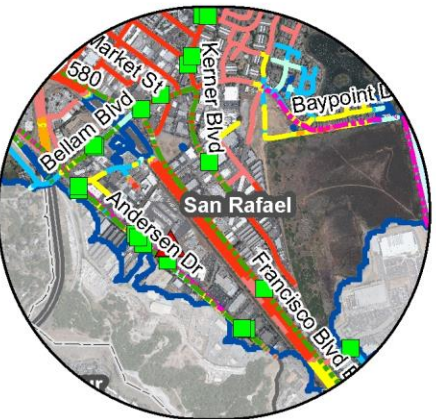
3: Peacock Gap



4: Central San Rafael



5: Canal Neighborhood



6: Interstate 580 corridor

Disclaimer: Vulnerability Assessment maps, tables, etc. can be used as a resource to help identify potential hazardous areas and vulnerable assets. Marin County, and data providers here in, make no warranties of the accuracy or completeness of maps and data. Maps are representational and subject to future revision. Local site conditions must be examined. Commercial use is prohibited.

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Map 99. San Rafael Vulnerable Wastewater Management Assets

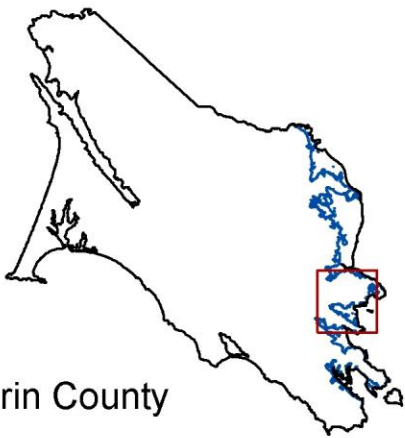
Vulnerable Assets

- Force Main
- Node
- Valve
- Wet Well
- Cap
- Lateral
- Manhole
- Pump Station
- Residential Lateral

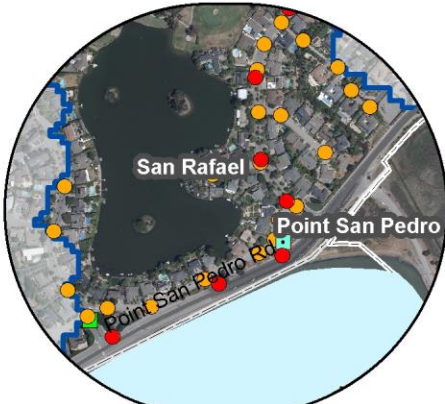
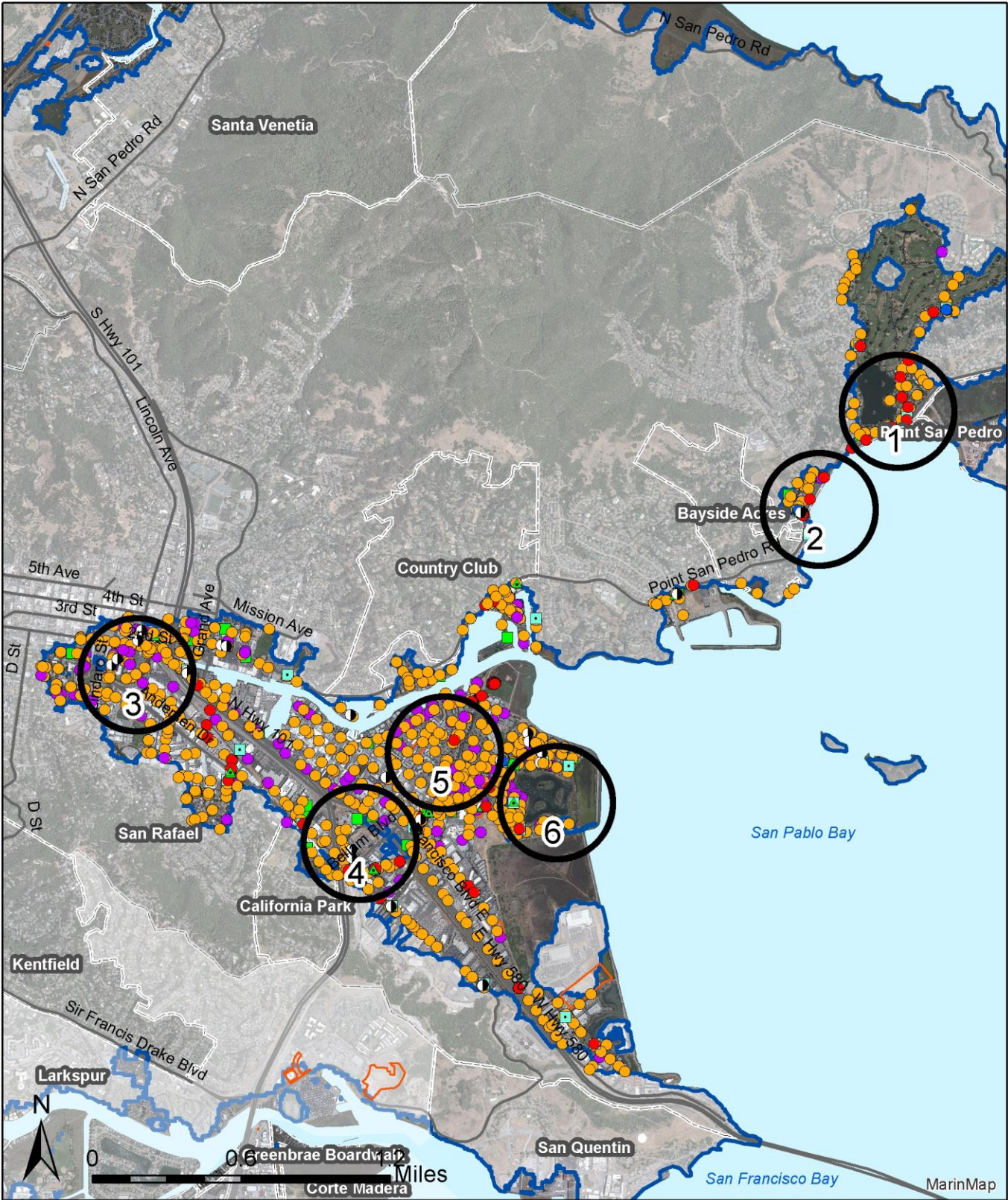
Service District Parcels

Location Indicators

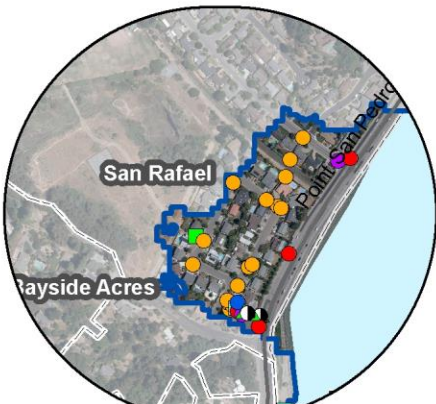
- Unincorporated
- Municipality
- Road
- Bay
- Inland Extent: Sea Level @ 60"+100-year Storm



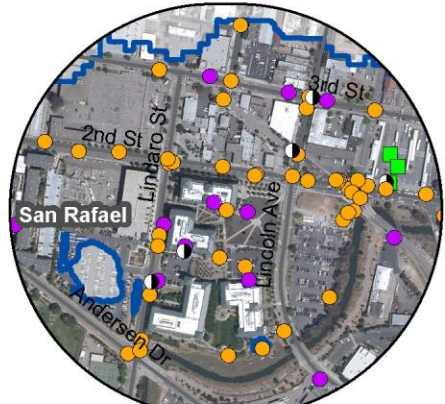
Date:
1/31/2017



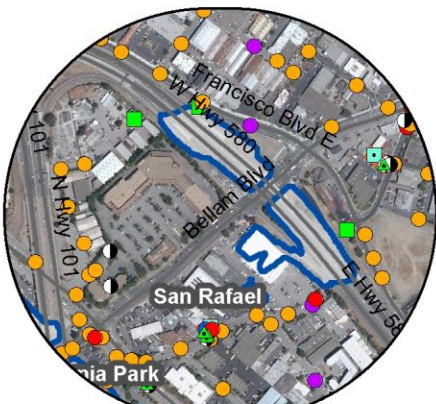
1: Peacock Gap



2: Pt. San Pedro Blvd.



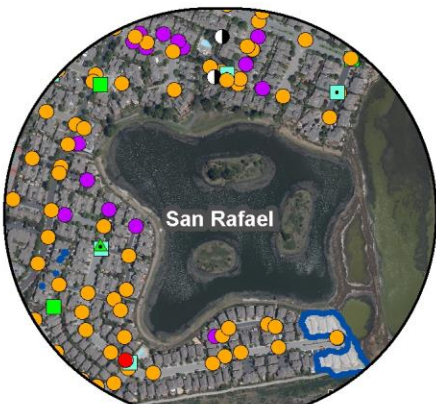
3: Central San Rafael



4: Woodland Ave.



5: Canal Neighborhood



6: Spinnaker Point

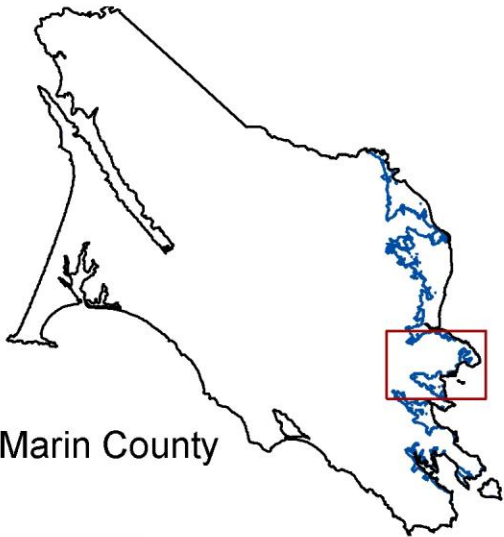
Disclaimer: Vulnerability Assessment maps, tables, etc. can be used as a resource to help identify potential hazardous areas and vulnerable assets. Marin County, and data providers here in, make no warranties of the accuracy or completeness of maps and data. Maps are representational and subject to future revision. Local site conditions must be examined. Commercial use is prohibited.

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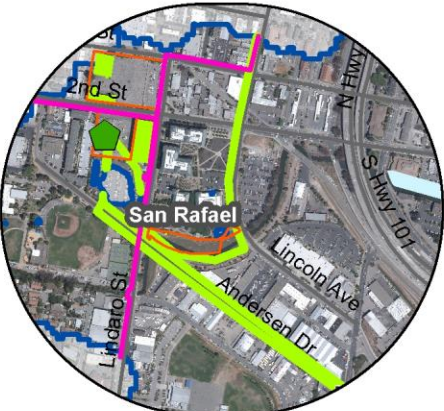
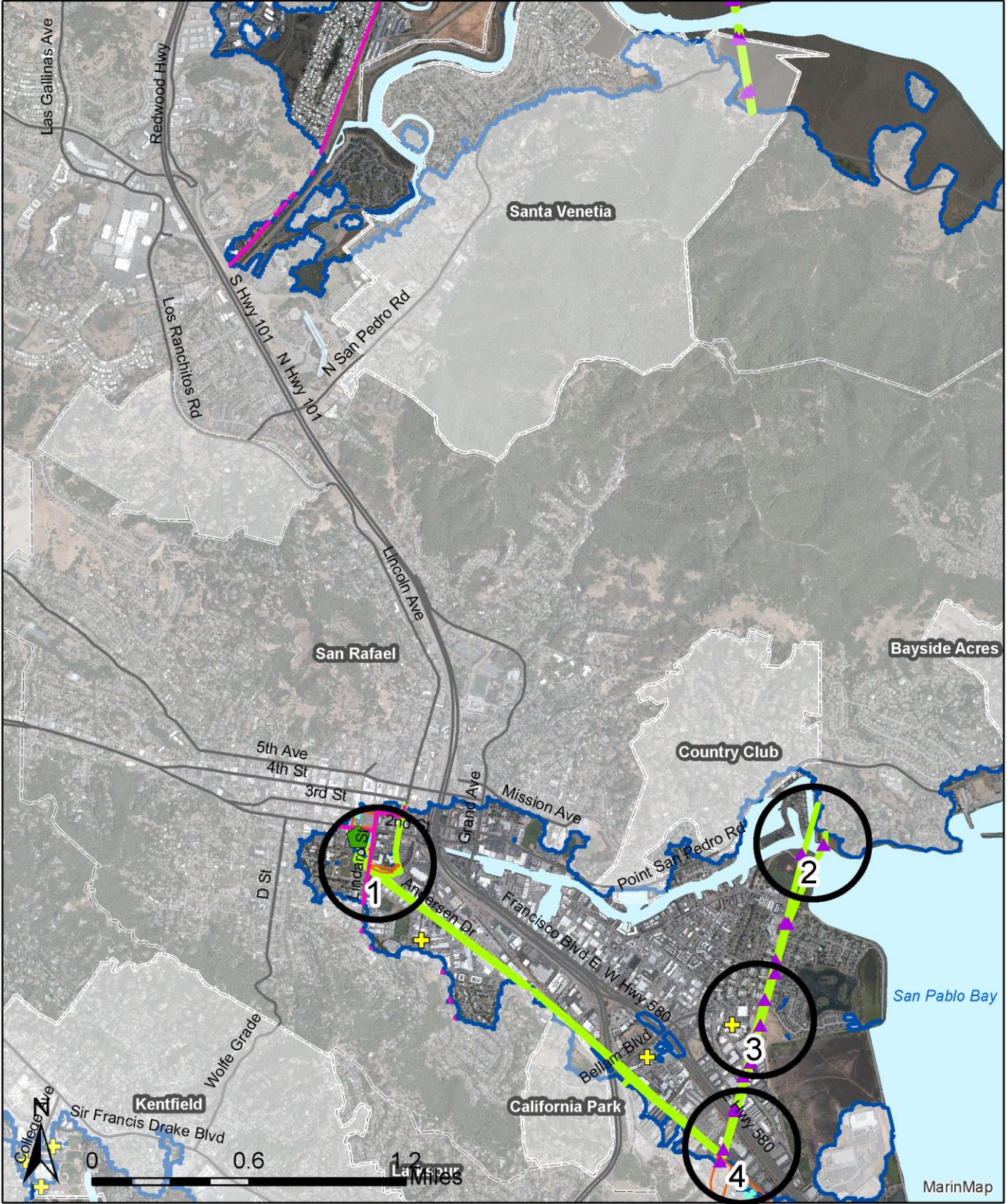
Map 100. San Rafael Vulnerable Gas and Electric Assets

Vulnerable Assets

- Solar Installation
- PG&E Assets**
 - Electric Transmission Lines
 - Natural Gas Pipeline
 - Substation
 - Transmission Tower
 - PG&E Property
 - PG&E Buildings
- Location Indicators**
 - Unincorporated
 - Municipality
 - Road
 - Bay
 - Inland Extent: Sea Level @ 60"+100-year Storm



Date:
1/29/2017



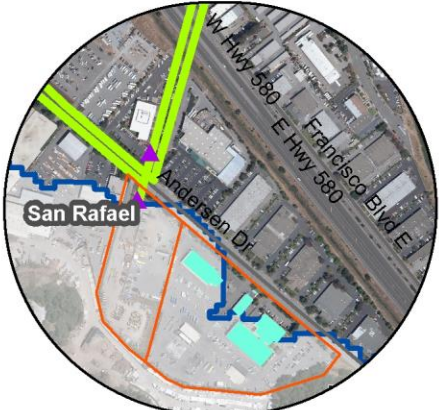
1: Central San Rafael



2: San Rafael Canal



3: Canal Area



4: PG&E Yard & Offices on Andersen Dr.

Disclaimer: Vulnerability Assessment maps, tables, etc. can be used as a resource to help identify potential hazardous areas and vulnerable assets. Marin County, and data providers here in, make no warranties of the accuracy or completeness of maps and data. Maps are representational and subject to future revision. Local site conditions must be examined. Commercial use is prohibited.

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Map 101. San Rafael Vulnerable Stormwater Management Assets

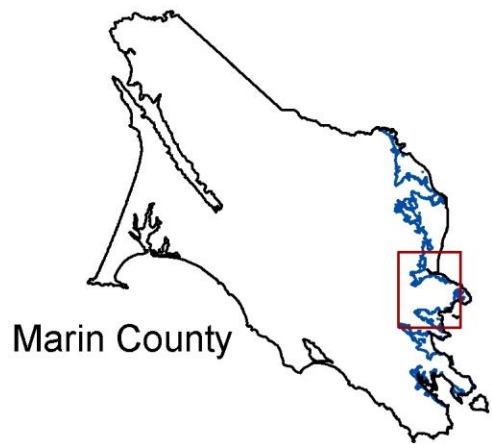
Vulnerable Assets

- ▲ Curb Outlet
- Catch Basin
- Headwall
- Manhole
- Node
- Pipe Inlet/Outlet

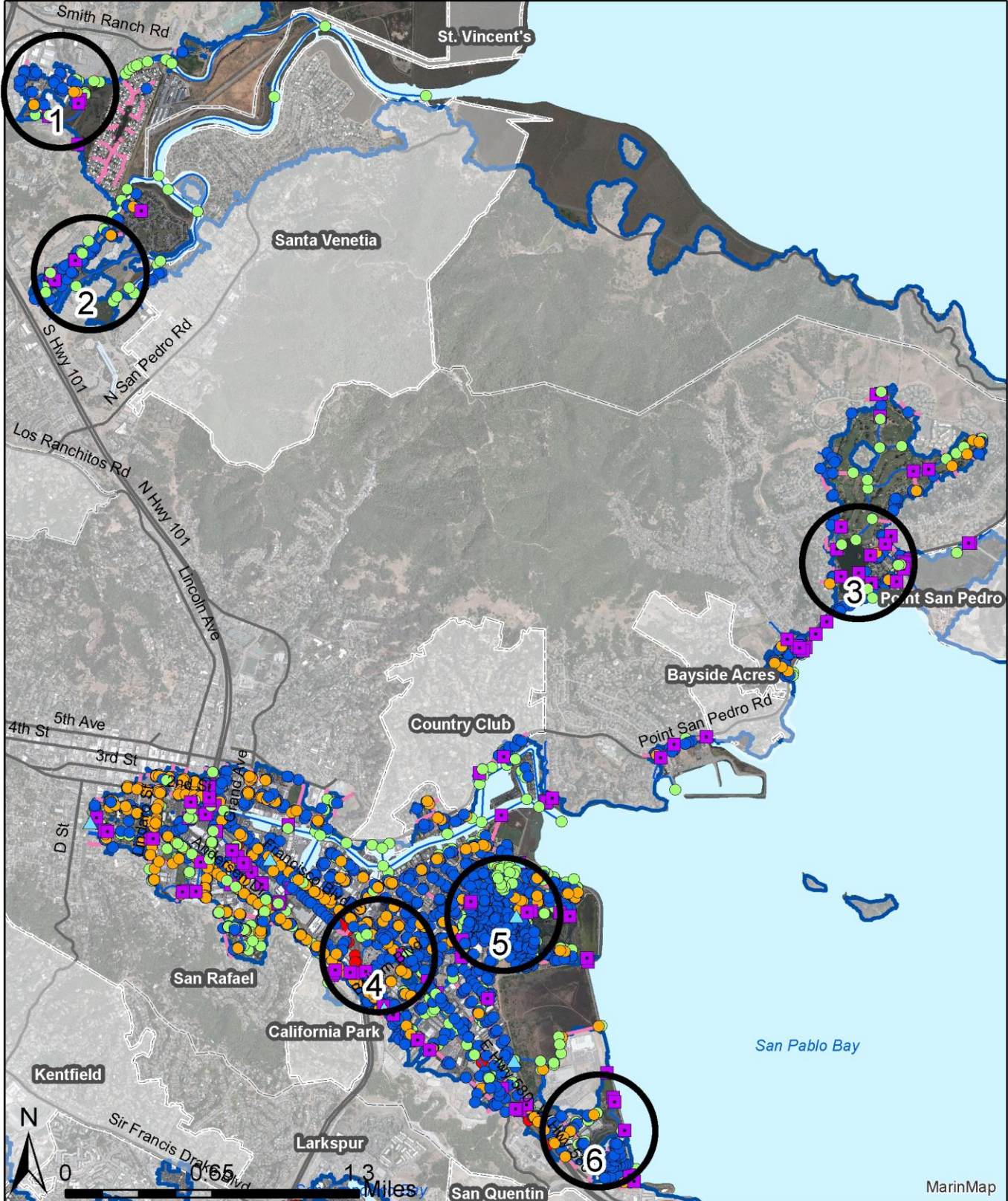
- Channel
- Pipe

Location Indicators

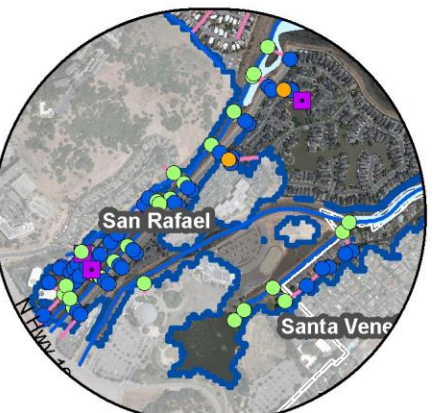
- Unincorporated
- Municipality
- Road
- Bay
- Inland Extent: Sea Level @ 60"+100-year Storm



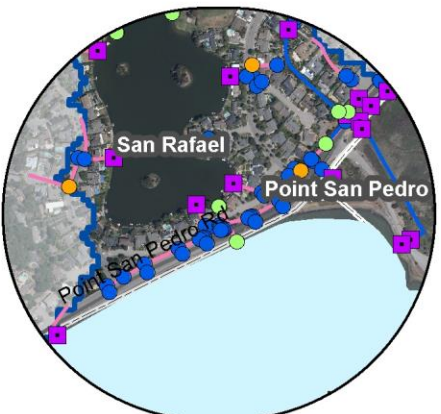
Date: 3/29/2017



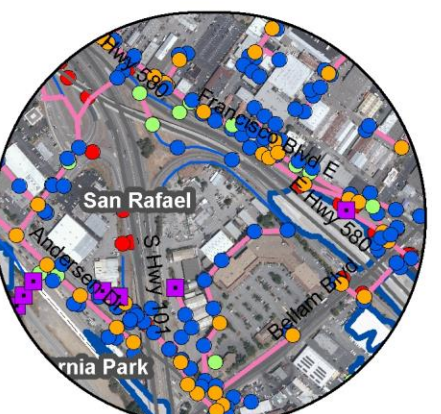
1: Las Gallinas



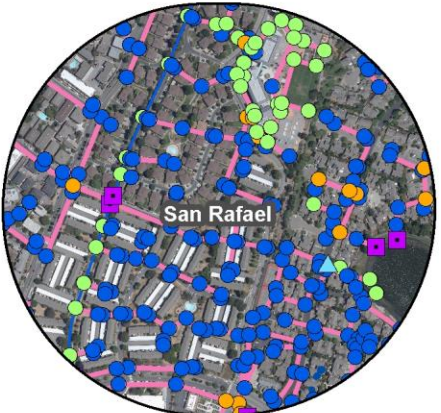
2: Las Gallinas Creek



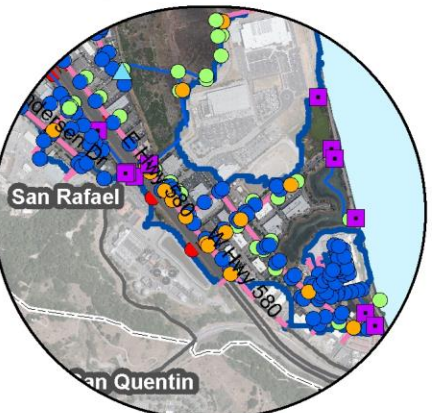
3: Peacock Gap



4: Interstate 580 @ U.S. Hwy. 101



5: Canal Neighborhood



6: Interstate 580 & Kerner Blvd.

Disclaimer: Vulnerability Assessment maps, tables, etc. can be used as a resource to help identify potential hazardous areas and vulnerable assets. Marin County, and data providers here in, make no warranties of the accuracy or completeness of maps and data. Maps are representational and subject to future revision. Local site conditions must be examined. Commercial use is prohibited.

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Utilities

PG&E has significant assets in San Rafael that could be exposed and vulnerable to sea level rise and storm surge impacts. Underground gas pipes could face buoyancy pressures as the water table beneath them rises and pushes them to the surface. The pressure can place bending forces on the pipes, especially where they are held down by roads. Moreover, if a road sheltering a natural gas pipe is damaged enough to rupture the pipes the consequences could be severe. The transmission lines are above ground and could be vulnerable to falling trees and high winds. In addition, posts could become damaged over time, from floating debris, and subsidence. Lastly, the PG&E offices and yard on Andersen Drive could anticipate storm surge impacts in the long-term.

The San Rafael public works building and corporate yard may not experience direct impacts until the long-term with a storm surge, and primarily in the parking lots. However, access to and from the site could be compromised in the long-term due to sea level rise alone. With respect to other utilities, San Rafael is vulnerable to similar issues as other shoreline communities in the study area such as:

- Underground pipes face compounding pressure forces from water and the road,
- Road erosion and collapse with underlain pipes,
- Saltwater inflow and infiltration causing inefficiencies in wastewater treatment,
- Continuously subsiding soils or fill,
- Escalating activity, capacity demands, energy consumption, and wear and tear on San Rafael's stormwater pump stations 50-61, and others in the wastewater collection system,
- Aging individual site connections for water, sewer, and electrical, and
- Flood waters interrupting access for employees to reach work sites.

The maps on the previous pages illustrate vulnerable utility features. The areas in the call out circles enable the reader to see areas that are difficult to see on the large scale map. The circles do not indicate that these areas are more vulnerable than others along the shoreline.

Natural Resources

The shoreline stemming away from the San Rafael Canal hosts significant riparian and tidal marsh

habitats. The diked baylands further south, serve as a storm buffer between urban and tidal areas and contribute to improved water quality trapping and/or removing pollutants from runoff and wastewater. They also act as storage basins for rain runoff and saltwater during high tides.

The dike lands, wetlands, and marshes provide habitat areas for threatened and endangered species; and can serve as possible mitigation areas. Their partial or complete flooding in the winter rainy season provides needed shallow wetland habitat for many species and flocks of migratory ducks and shorebirds.²⁰⁶

Based on the National Inventory of Habitats, several endangered species are known to inhabit these tidal areas including the California Black Rail, Ridgway's Rail, the California Brown Pelican, and the tidewater goby. Other than Brick Yard Beach, San Rafael incorporated has a few beaches that are used for recreation and are not necessarily of habitat value. The Marin Rod and Gun Club beach is also narrow.

Recreation

The San Rafael shoreline and canal are highly active recreation areas. Boating, fishing, biking, and walking the pathways are the most common activities. The marinas are used for boating and could face challenges in the onset of sea level rise. Biking and walking on the streets and trails could be limited to low tides and inaccessible depending on the path's proximity to the existing shoreline.

In the near-term, McNear's Beach, Gallinas Creek, Pickleweed, and Starkweather Shoreline parks could anticipate impacts at the shoreline edges, and in the medium-term, see significant tidal flooding. In the long-term, Albert, Peacock Gap, and Schoen parks could also see tidal flooding. A few hotels, including the Extended Stay America, North Bay Inn, and Motel 6 could also be vulnerable to tidal flooding.

Emergency Services

The San Rafael Fire Department could be directly impacted at the Castro Street Station 54 in the near-term and face access issues at Station 52 and 55 in the medium- and long-terms. In addition, Bahia Vista Elementary and the Albert J. Boro Community

²⁰⁶ San Rafael Community Development Department. Amended and reprinted 2013. San Rafael, CA General Plan 2020: Our Natural Resources.

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Center serve as emergency shelters that could each face up to two feet of flooding by scenario 3. Finally, access on flooded roads would be severely compromised during MHHW and storms.

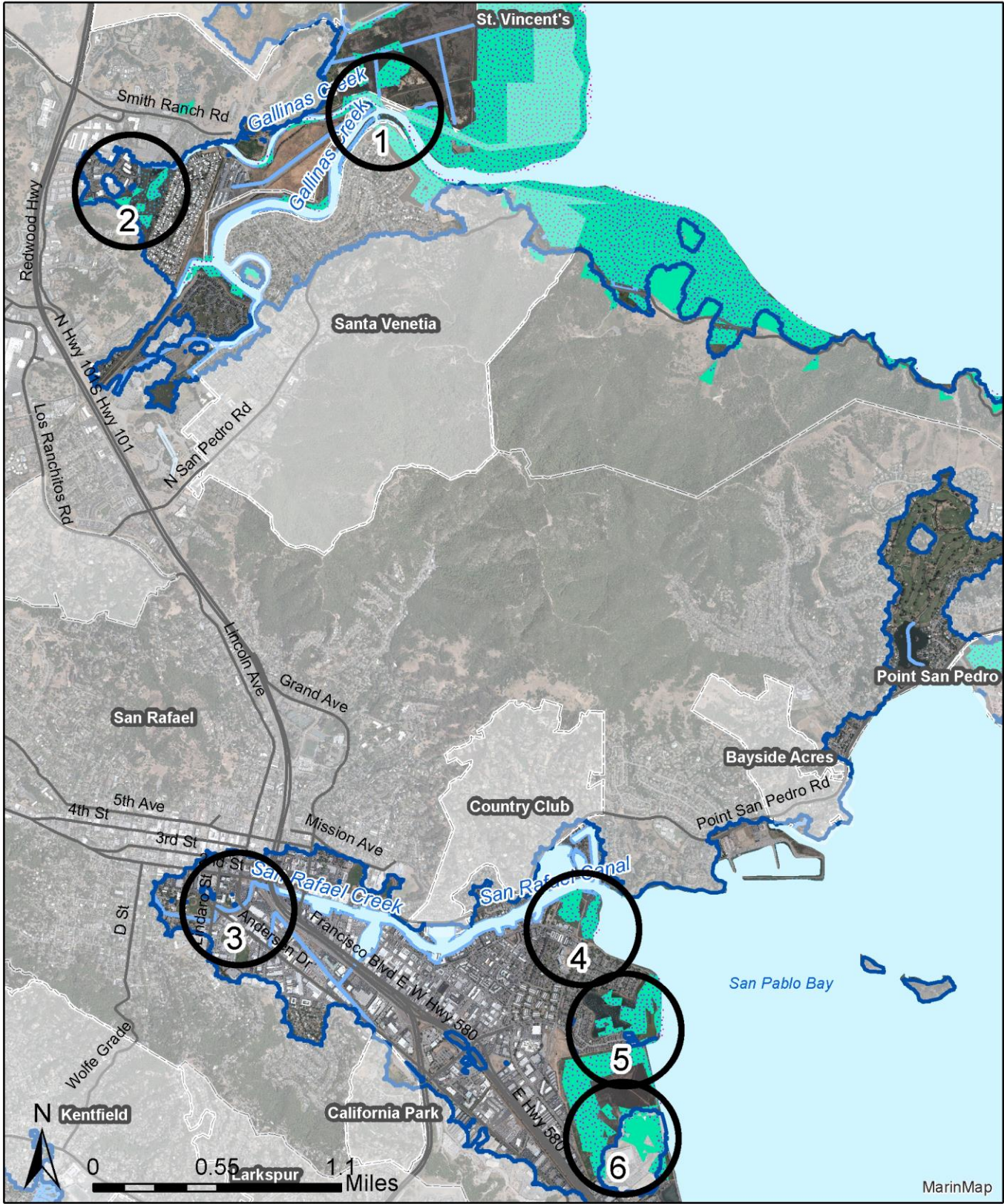
The maps on the following pages illustrate vulnerable natural resource, recreation, emergency and historic features. The areas in the call out circles enable the reader the see areas that are difficult to see on the large scale map. The circles do not indicate that these areas are more vulnerable than others along the shoreline.

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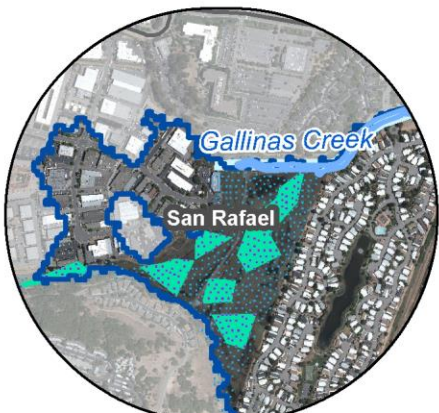
Map 102. San Rafael Vulnerable Natural Resource Assets

Vulnerable Assets

- Streams
 - Marsh
 - Estuary
 - Wetland
- Location Indicators**
- Unincorporated
 - Municipality
 - Road
 - Bay
 - Inland Extent: Sea Level @ 60"+100-year Storm



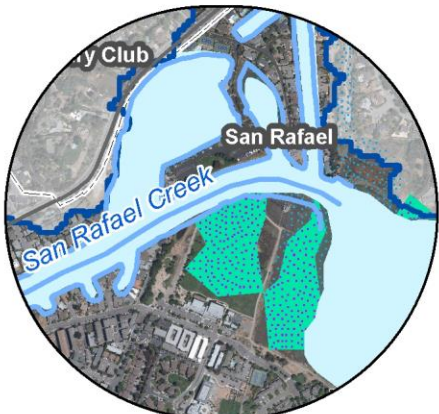
1: Santa Venetia Marsh



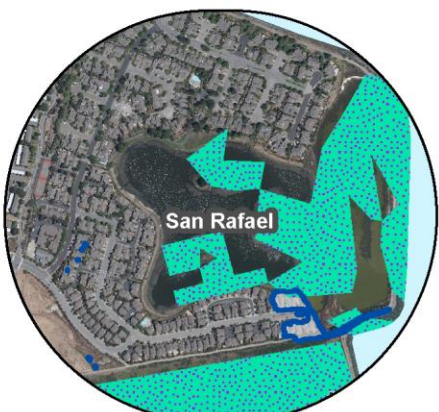
2: Las Gallinas



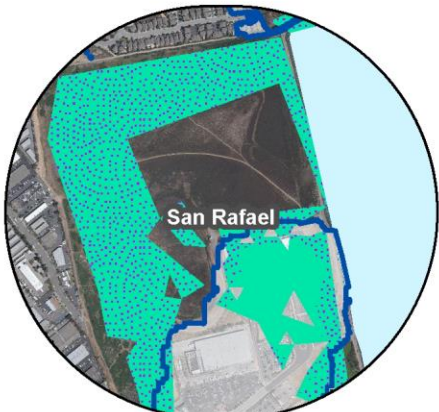
3: San Rafael Creek



4: San Rafael Canal

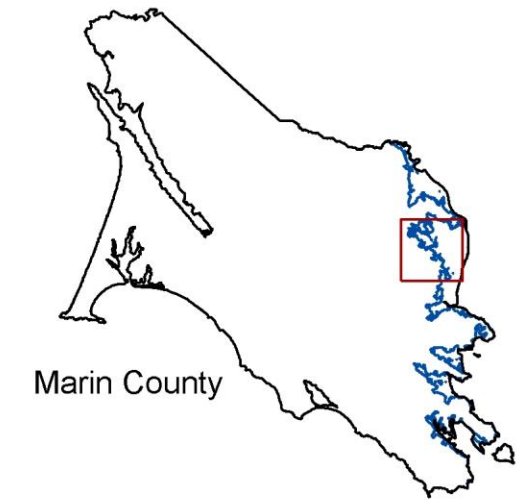


5: MMWD & Bayview Marshes



6: Shoreline Park

Disclaimer: Vulnerability Assessment maps, tables, etc. can be used as a resource to help identify potential hazardous areas and vulnerable assets. Marin County, and data providers here in, make no warranties of the accuracy or completeness of maps and data. Maps are representational and subject to future revision. Local site conditions must be examined. Commercial use is prohibited.



CA Dept. of
Fish &
Wildlife
Date:
3/29/2017

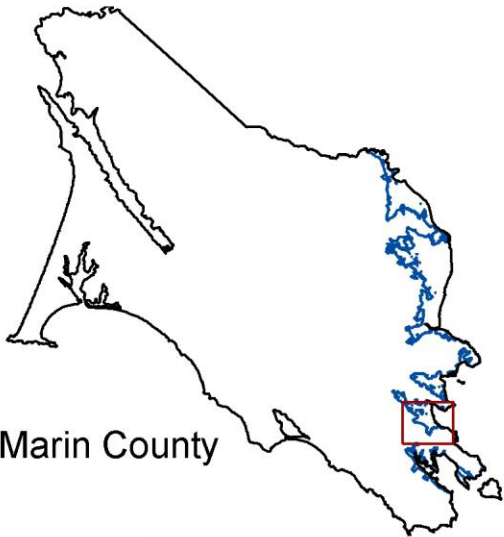


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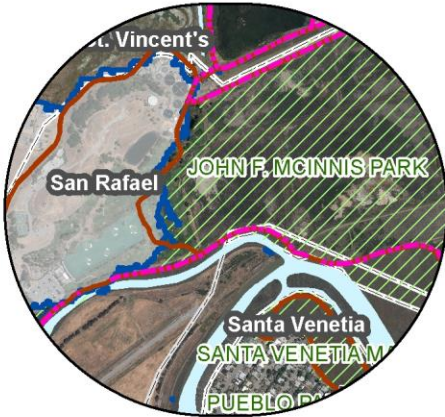
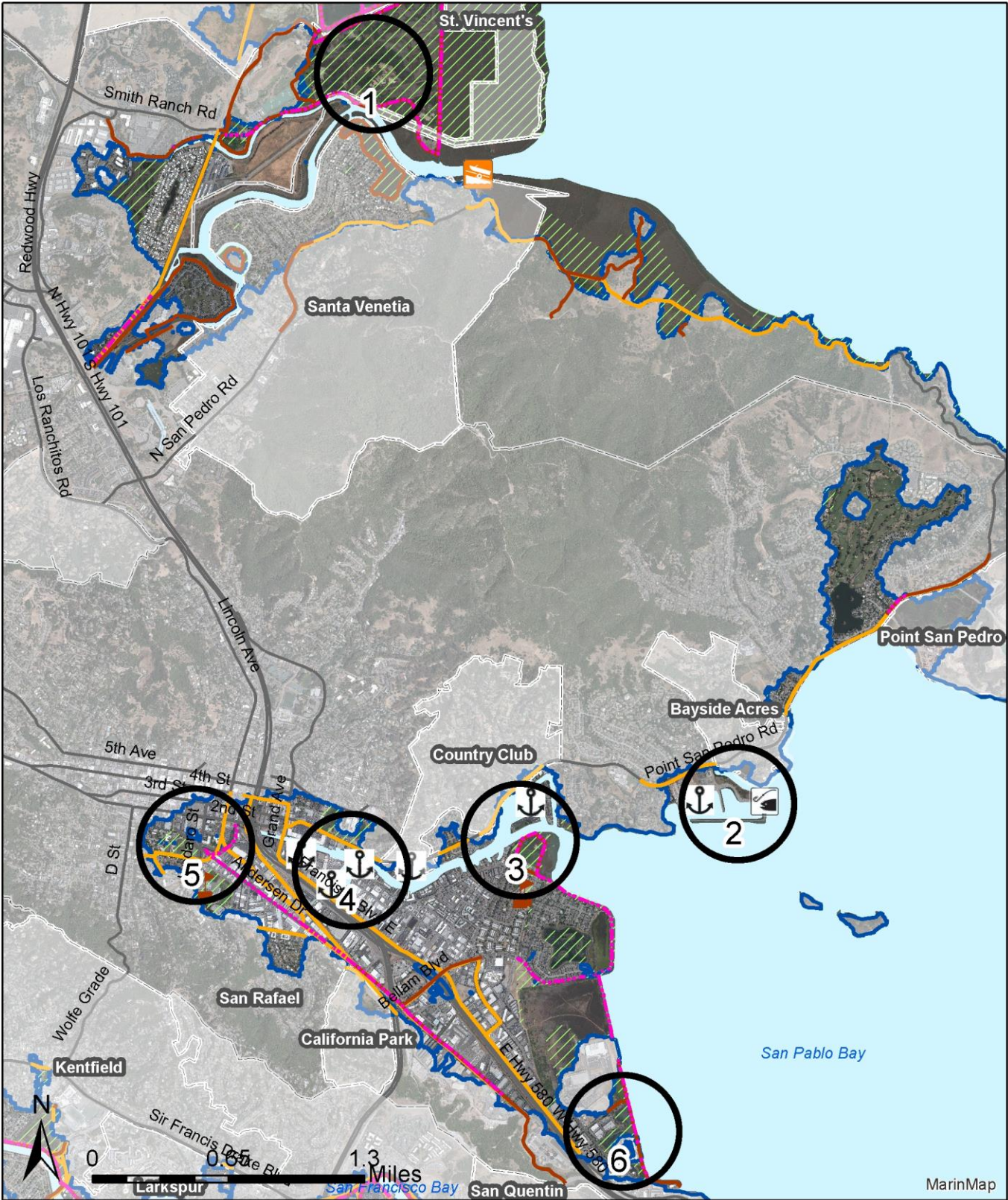
Map 103. San Rafael Vulnerable Recreation Assets

Vulnerable Assets

- School
 - Public Boat Launch
 - Public Fishing Pier
 - Marina
 - Bay Trail
 - Trail
 - Bikeway
 - Park
- Location Indicators**
- Unincorporated
 - Municipality
 - Road
 - Bay
 - Inland Extent: Sea Level @ 60"+100-year Storm



Date:
3/29/2017



1: McInnis Park



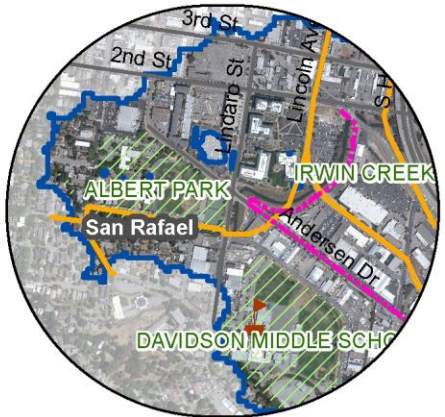
2: Loch Lomond Marina



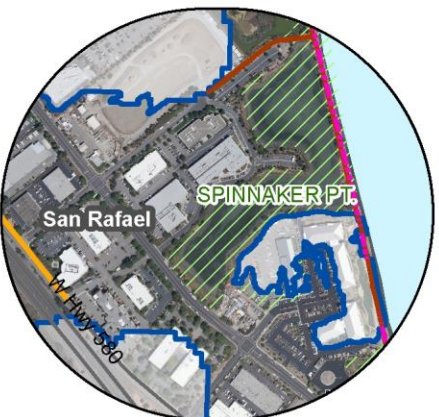
3: Canal Neighborhood



4: San Rafael Canal



5: Gerstle Park Neighborhood






6: Spinnaker Marsh

Disclaimer: Vulnerability Assessment maps, tables, etc. can be used as a resource to help identify potential hazardous areas and vulnerable assets. Marin County, and data providers here in, make no warranties of the accuracy or completeness of maps and data. Maps are representational and subject to future revision. Local site conditions must be examined. Commercial use is prohibited.

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Map 104. San Rafael Vulnerable Emergency Service Assets

Vulnerable Assets

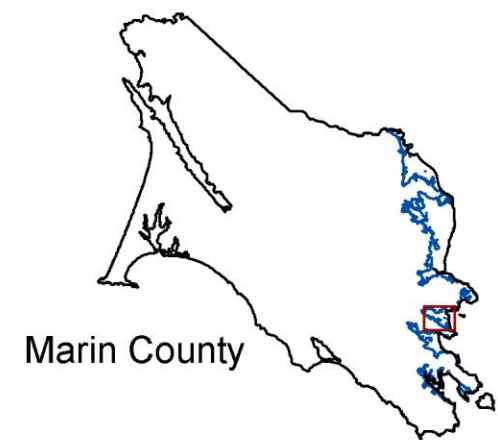
-  Fire Station
-  Medical Facility
-  Emergency Shelter

Vulnerable Arterials & Highways

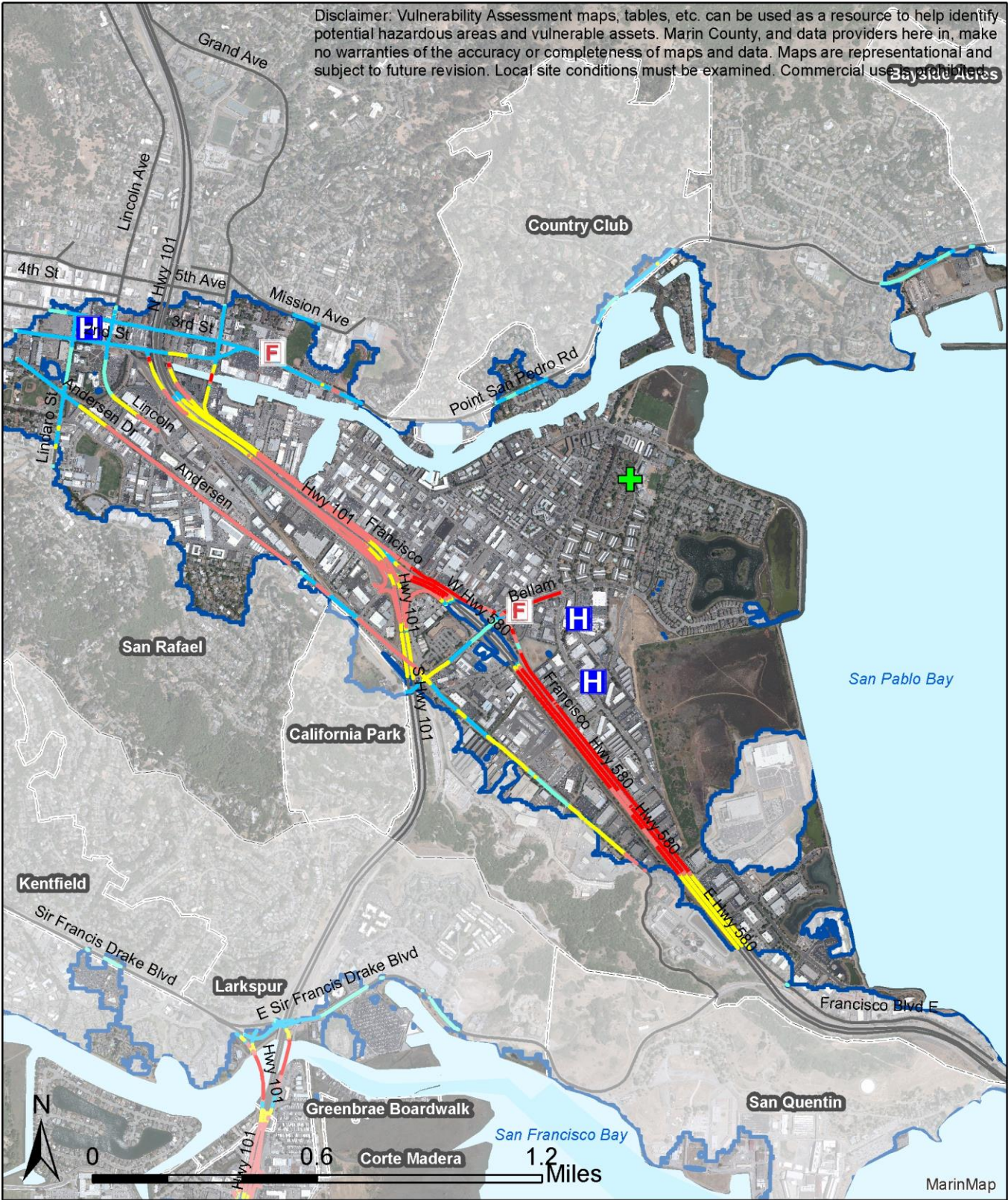
-  @ Scen. 1: 10" Sea Level Rise (SLR)
-  @ Scen. 2: 10"SLR+Storm Surge
-  @ Scen. 3: 20"SLR
-  @ Scen. 4: 20"SLR+Storm Surge
-  @ Scen. 5: 60"SLR
-  @ Scen. 6: 60"SLR+Storm Surge

Location Indicators

-  Unincorporated
-  Municipality
-  Road
-  Bay
-  Inland Extent: Sea Level @ 60"+100-year Storm



Date: 2/14/2017



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Cultural Resources

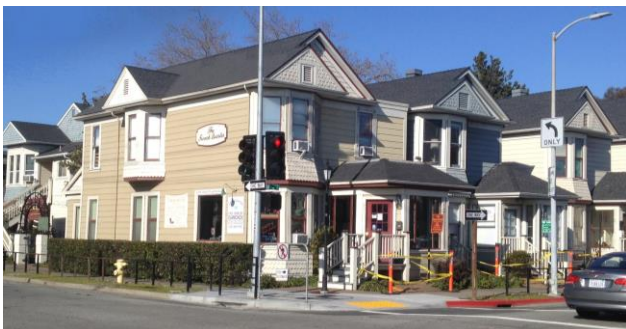
Much like other communities in Marin, San Rafael was once home to Miwok Indians prior to European settlement. San Rafael the home of Mission San Rafael Arcángel (1817), the last mission Spanish missionaries constructed in California. In 1879 the San Francisco and North Pacific Railroad reached San Rafael. The national rail network linked with San Rafael in 1888 leading to increased settlement and economic growth.²⁰⁷

San Rafael's vulnerable historic resources could be vulnerable to both tidal flooding and 100 year storm flooding from San Rafael Creek, generally in close proximity to highway 101. Resources include the Litchfield Sign (local landmark), the French Quarter, 2 potentially historic areas (Ritter Street and Gerstle Park (partial)), and 4 potentially historic structures. Archaeological resources could be present in the exposed area.

Table 109 ranks select vulnerable assets discussed above by onset and maximum flood depth at MHHW. A few public resources that are not likely to suffer tidal flooding under these scenarios, but could suffer during scenario 6, with 100-year storm surge and five feet of sea level rise. These are:

- Glenwood Elem. School,
- Department of Public Works, and
- US Post Office-Bellam Blvd.

Nevertheless, these properties could anticipate difficulties in accessing the site because the roads leading to these sites would be flooded.



San Rafael's French Quarter Historic District includes Victorian Homes now used for local businesses. Credit: Marin County CDA

²⁰⁷ Wikipedia, San Rafael, California. Last updated December 15, 2016. en.wikipedia.org/wiki/San_Rafael,_California

Table 109. Example San Rafael Vulnerable Assets by Sea Level Rise Onset & Flooding at MHHW

Asset	Scenarios		
	Near-term 1	Medium-term 3	Long-term 5
Canal area Bay Trail & open space	10'3"	11'1"	25'4"
John F. McInnis Park	7'6"	8'6"	10'6"
Starkweather Shoreline Park	5'4"	6'	16'3"
Pickleweed Park	5'	5'8"	8'9"
Hwy 580 EB	0-4'	0-4'10"	4"-7'8"
Kerner Blvd	0-4'	0-4'7"	8"-7'5"
Francisco Blvd E	0-3'10"	0-4'7"	1'-7'5"
Bellam Blvd.	0-3'5"	0-4'	0-7'3"
Canal St.	0-3'4"	1'2"-4'2"	2'-7'11"
Bahia Way	2'-3'3"	2'4"-3'11"	5'2"-6'10"
Hwy 580 W	1"-2'10"	1"-3'7"	1"-6'5"
Bay Trail	0-2'3"	0-3'	0-10'3"
Castro Street Fire Station 54	1'6"	2'7"	6'7"
San Rafael Yacht Harbor	1'2"	4'	10'4"
San Rafael Municipal Harbor	1'	2'	6'
Lowrie Yacht Harbor	9"	3'7"	8'5"
Bahia Vista Elem. School/ Trinity Preschool	8"	2'3"	4'8"
Hi-Tide Boat sales & services	6"	3'4"	8'5"
Marin Yacht Club	1"	1'6"	3'9"
Marin County Health Innovation Campus	1"	1'3"	3'
Beach Park		8'11"	11'10"
Peacock Gap Neighborhood		6'3"	9'

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Asset	Scenarios		
	Near-term	Medium-term	Long-term
	1	3	5
Park			
Grand Avenue		0-6'	7"-9'
Andersen Dr.		0-5'	3"-8"
Francisco Blvd W		0-4'9"	1'8"-9'5"
Peacock Drive		0-4'	9"-6'8"
SMART Rail		1'8"-3'9"	1'2"-6'8"
Loch Lomond Marina		3'7"	9'7"
Peacock Gap Lagoon and Golf Course homes		1"-3'6"	2"-8'9"
San Rafael Airport		3'5"	8'10"
Canal neighborhood		1"-3'	2"-7'8"
Marin Lagoon		5"-2'5"	1'-6'
Hwy 101 NB		0-2'5"	6"-5'3"
Davidson Middle School		2'3"	5'9"
Pt. San Pedro Road		0-2'2"	4"-5'10"
San Rafael Yacht Club		2'2"	5'7"
Hwy 101 SB. Off Ramp		0-2'	1'4"-5'
GGBHTD Headquarters & Bus Depot		1'8"-2'	4'2"-5'
Downtown		1"-1'3"	3"-3'3"
PG&E Office & Yard		1'2"	3'
Pickleweed Park facilities		1'2"	3'
Montecito Plaza		1'	2'3"
Transit Center		11"	2'5"
Marin Community Clinic		10"	3'8"
San Rafael High School		10"	2'
3 rd Street		5"	10"-3'10"
SMART rail			1"-10'3"
Lincoln Avenue			10"-7'4"
Schoen Park			4'2"

Asset	Scenarios		
	Near-term	Medium-term	Long-term
	1	3	5
4 th Street			1'-3'5"
2 nd Street			1'-3'4"
Ritter Clinic			2'10"
Hetherton St.			1'4"-2'4"
Marin County Emergency Services			2'2"
Peacock Lane			1'4"-1'11"
San Rafael Canal	Water resource		
Marin Lagoon	Water resource		

Source: MarinMap, CoSMoS

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Map 105. San Rafael Vulnerable Cultural Resource Assets

Vulnerable Historic Buildings

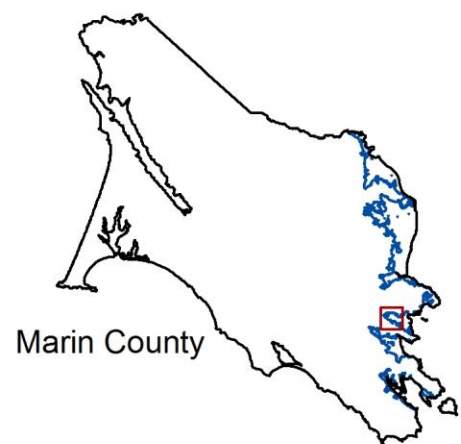
- Scen. 1: 10" Sea Level Rise (SLR)
- Scen. 2: 10" SLR+Storm Surge
- Scen. 3: 20" Sea Level Rise
- Scen. 4: 20" SLR+Storm Surge
- Scen. 5: 60" Sea Level Rise
- Scen. 6: 60" SLR+Storm Surge

Location Indicators

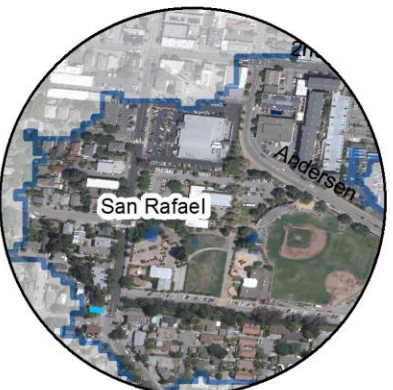
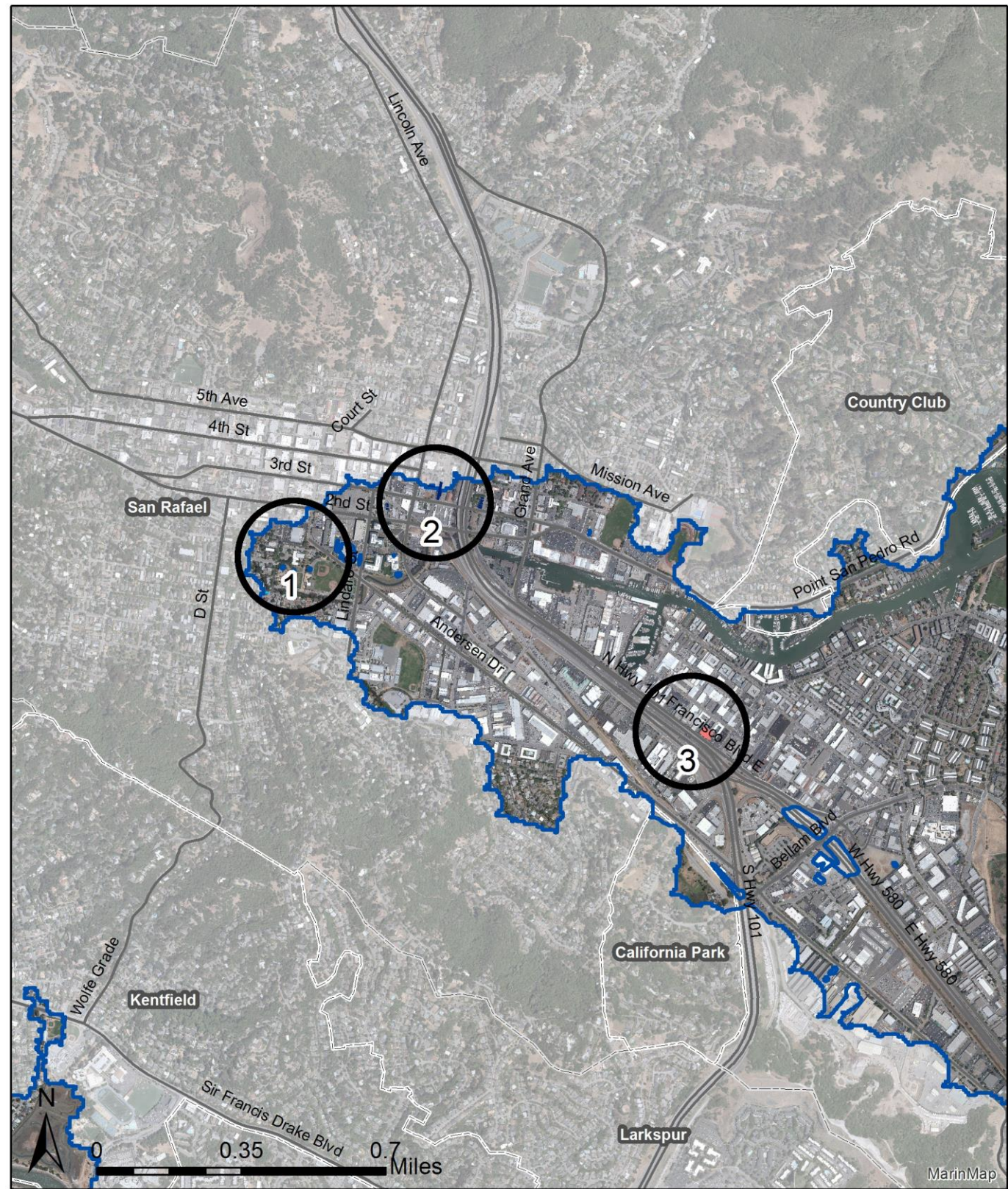
- Municipality
- Major Road
- Inland Extent: Sea Level @ 60"+100-year Storm

Source: Marin Map, CoSMoS, Historic Properties List (San Rafael), San Rafael Historical/architectural Survey. Credit: Marin County CDA

Archaeological resources may be present



Date: 2/17/2017



1: West San Rafael



3: Ritter Street and French Quarter



3: Litchfield Sign

Disclaimer: Vulnerability Assessment maps, tables, etc. can be used as a resource to help identify potential hazardous areas and vulnerable assets. Marin County, and data providers here in, make no warranties of the accuracy or completeness of maps and data. Maps are representational and subject to future revision. Local site conditions must be examined. Commercial use is prohibited.

Community Profile: Novato

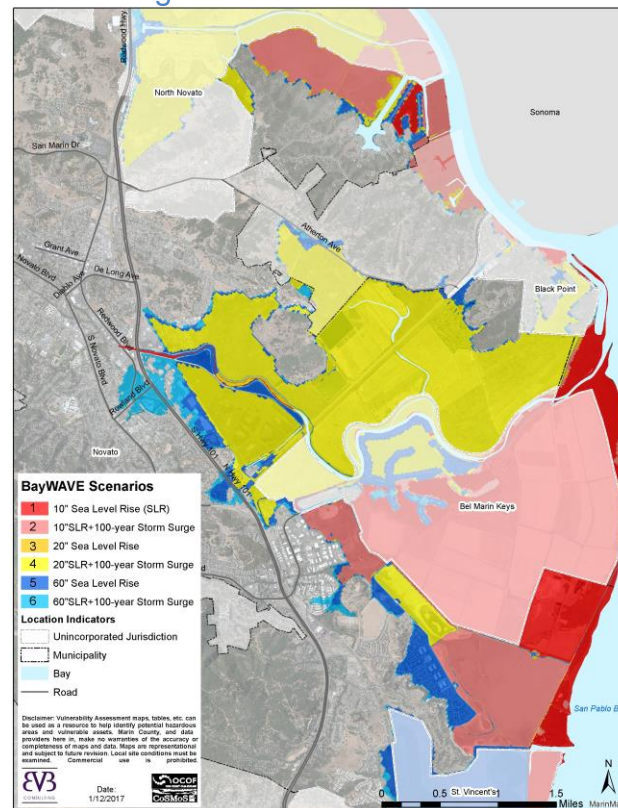
Novato is the second largest city in the county. The community is primarily residential with some large retail areas along the highway corridor. Development is largely inland with a few buildings fronted by tidal marshes and the bay. Much of the community is fronted by unincorporated areas, managed stormwater, agricultural, utility, and marsh lands. These lands could buffer Novato from the bay for several decades, thus, the majority of assets may not experience saltwater flooding until the end of the century. The following are key issues related to Novato sea level rise and a 100-year storm surge:

- The Hamilton neighborhood could anticipate the FEMA certified levee overtopped in the long-term. This would flood hundreds of homes and several professional workspaces.
- The Vintage Oaks Shopping Center could anticipate storm surge impacts in the medium-term and tidal impacts in the long-term. The loading bay would be the first section of the property to flood.
- Development east of U.S. Highway 101 at the Bel Marin Keys and Rowland Boulevards.
- Buildings and marshes in Bahia, along Davidson Drive, and on Olive Ridge are vulnerable to sea level rise.
- State Route 37 to Sonoma and Napa is vulnerable in the near-term in several locations along its route. This road also serves as a bike path and provides access to several publically accessible natural resource assets.
- Tidal and storm surge flooding could impair travel on U.S. Highway 101 in the long-term.
- Sonoma Marin Area Regional Transit rail tracks could be vulnerable in the near-term. Train cars could also be damaged by saltwater exposure.
- The Novato Sanitary District wastewater treatment could expect long-term impacts to several critical buildings.
- The Novato Fire Station 62 is vulnerable in the medium-term, and flooded, in part, in the long-term. In addition, the Fire Protection District and the Novato Professional Fire Fighter's Association office off Rowland Boulevard could be vulnerable in scenario 6.
- Most vulnerable parks are in Hamilton and exposed in the long-term.
- Marsh lands are vulnerable in Hamilton, Deer Island and the surrounding diked baylands, and Bahia.

IMPACTS AT-A-GLANCE: Scenario 6

4,249 acres	51,000+ people
1,100+ living units	78 commercial parcels
17 road miles	
Issues during stormwater and high tide coincidence	City of Novato Novato Fire Department Novato Sanitary District Caltrans Property Owners SMART Marin County DPW North Marin Water District
\$1 billion in assessed property value; more than \$650 million in single-family housing market value ²⁰⁸	

Map 106. Novato Sea Level and 100-year Storm Surge Scenarios



Source: MarinMap, CoSMoS. Credit: BVB Consulting LLC.

²⁰⁸ 2016 dollars

Vulnerable Assets

The most vulnerable assets are the wastewater treatment plant, State Route 37, and Northern Marin Water District. In the long-term, Hamilton could also be vulnerable to the levee overtopping. Due to Novato's inland development, very little of the community is directly impacted. Nevertheless, those dependent on the U.S. Highway 101 corridor will be impacted. In addition, those who use the Novato Sanitary District treatment plant could experience wastewater disruptions.

Land

By land area, Novato is the largest municipality in the County, and relative to its size, a small area, mostly marshes, could be vulnerable to sea level rise. Nevertheless, a considerable number of acres, parcels could flood, compromising their existing land uses and human activities. In addition because of Novato's size and the existence of several smaller communities, complex levee systems, and extensive marsh land, much of the impacted developed land is dispersed into pockets of flooding.

Acres

In near-term scenario 1, 426 acres, or four percent of Novato's land area, could be exposed to sea level rise. An additional 100-year storm surge could flood a total of 1,336 acres, or 14 percent of Novato's land area. This acreage could flood tidally by the medium-term, and more than twice this amount could face storm0-surge flooding. Moving into the long-term scenario 5, all of this land plus 450 more acres could now face tidal influences. This acreage amounts to more than 40 percent of Novato's land area. Even more, 44 percent of the city, or 4,250 acres, could be exposed with an additional 100-year storm surge. By this time, flooding could extend beyond US Highway 101. By this time, marshes could be damaged beyond repair, shoreline armoring could be overtopped, and properties would unusable, some temporarily, others into perpetuity, without adaptive measures.

Parcels

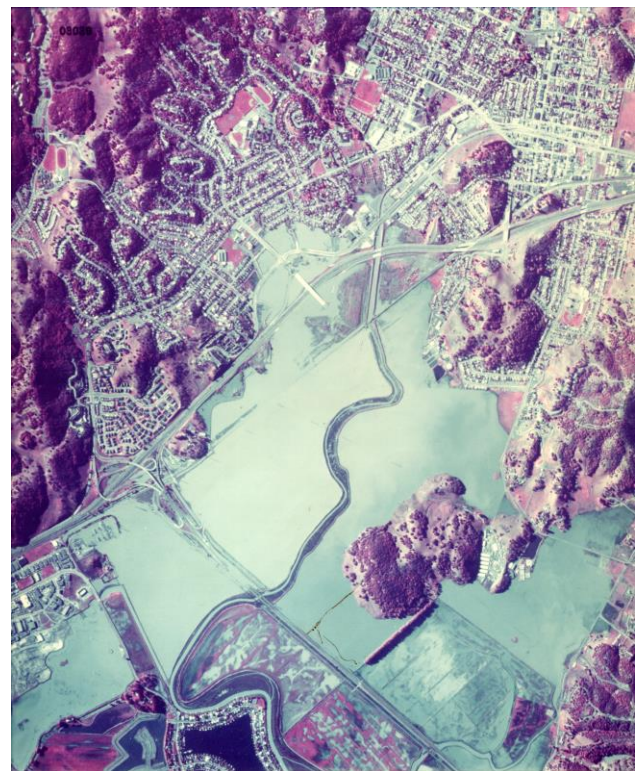
Much of the exposed acreage is vulnerable marsh land that is typically used for public services, such as flood control, or waste water management. Thus, large amounts of acreage are held a few parcels by a few, mostly public, property owners. This holds true through the medium-term, though with a 100-

year storm surge, 55 parcels, still less and one percent of the community's parcels could experience temporary flood conditions. In the long-term, however; bay waters could reach levels high enough to overtop protective armoring. At five feet of sea level rise 800 parcels could flood at MHHW. An additional 3 feet of storm surge waters could flood these 800 properties and an additional 450 properties could experience storm-surge flooding.

Table 110. Novato Vulnerable Acreage

Scenarios		Acres	
		#	%
Near-term	1	426	4
	2	1,336	14
Medium-term	3	1,327	14
	4	3,535	36
Long-term	5	3,998	41
	6	4,249	44

Source: MarinMap, CoSMoS



Historic flood Jan. 4, 1998, Novato. Credit: Unknown

Table 111. Novato Vulnerable Parcels

Scenarios		Parcels	
		#	%
Near-term	1	3	0
	2	7	0
Medium-term	3	6	0
	4	55	0
Long-term	5	800	4
	6	1,256	7

Source: MarinMap, CoSMoS

Table 112. Novato Vulnerable Parcels by Land Use

Land Use	Scenarios					
	1		3		5	
	Near-term		Medium-term		Long-term	
	#	Ac.	#	Ac.	#	Ac.
Commercial Improved					10	37
Commercial Unimproved					6	82
Industrial Improved					8	11
Industrial Unimproved					3	4
Residential					691	59
Single Family Attached					259	8
Single Family Improved					430	51
Single Family Unimproved					2	0.2
Common Area	1	33	1	33	4	67
Tax Exempt	2	82	6	480	62	1,473
Exemption Improved					2	3
Exemption Vacant					4	85

Source: MarinMap, CoSMoS

Table 113. Novato Vulnerable Residential and Commercial Parcels

Land Use	Scenarios					
	Near-term		Medium-term		Long-term	
	1		3		5	
	#	%	#	%	#	%
Residential					691	4
Commercial					16	3
Industrial					11	5

Source: MarinMap, CoSMoS.

In the long-term, impacts go from largely impacting publically owned parcels to impacting commercial, industrial, and residential parcels as well. In the long-term, tidal flooding could impact three percent of commercial, five percent of industrial, and four percent of residential parcels. While only four percent of residential, nearly 700 properties could face tidal flooding on a regular basis. With the 100-year storm surge nearly ten percent of commercial, and more than 20 percent of industrial parcels could face temporary storm surge flooding. Of the vulnerable residential parcels, about 60 developed single family acres could flood tidally.

Buildings

Most developed parcels feature one or more built structures. Most structures, unless already in a flood prone area, are not built to withstand regular or major flooding. The buildings in the exposed area of Novato are relatively newer construction compared to the other communities in the study area. In addition, a relatively small percent of Novato's building stock is vulnerable, topping off at five percent.

In scenarios 1-3, less than 20 buildings could expect tidal impacts. These buildings may be mechanical buildings or small out buildings that exist in or near the marsh lands. In the medium-term with a 100-year storm surge, scenario 4, several buildings at the storage facility in north east Novato could flood. In long-term scenario 5, nearly 700 hundred buildings could flood at MHHW. In scenario 6, with the additional 100-year storm surge, more than 3,000 buildings could flood. This figure amounts to nearly twenty percent of Novato's buildings stock.

Major neighborhoods include Hamilton, Bahia, Olive Ride, Davidson Street, and Los Robles.

Table 115 divides most of the vulnerable buildings by how much water could fill the premises, whether it is one, two, or ten feet of flooding. In the long-term, roughly 100 buildings are flooded with three feet or shallower of water, 30 buildings between three and six feet, and more than 500 buildings could be vulnerable to more than six feet of tide waters. While flooding with several feet of water with the average high tide would be devastating, still, even shallow depths can make a property or home unbearable to live on and difficult to service.

Table 116 shows FEMA Hazus post-disaster estimates of more than \$600 million²⁰⁹ in assessed structural value vulnerable in scenario 6 if all vulnerable buildings were destroyed. If all of the buildings and their contents were damaged at the yellow tag level, \$4 million in damages would be estimated.²¹⁰ Reality would likely reflect a mix of the three damage levels, and a monetary figure between the low and high end figures provided here.

The maps on the following pages illustrate vulnerable buildings by scenario. The areas in the call out circles enable the reader to see areas that are difficult to see on the large scale map. The circles do not indicate that these areas are more vulnerable than others along the shoreline.



Hamilton levee and pathway. Credit: Marin County CDA

Table 114. Novato Vulnerable Buildings

Scenarios		Buildings	
		#	%
Near-term	1	6	0
	2	17	0
Medium-term	3	17	0
	4	56	0
Long-term	5	672	4
	6	3,247	18

Source: MarinMap, CoSMoS

Table 115. Novato Tidal MHHW Flood Depth Estimates for Vulnerable Buildings

Flood Depth (feet)	Scenarios		
	Near-term	Medium-term	Long-term
	1	3	5
0.1-1			54
1.1-2			38
2.1-3			11
3.1-4			13
4.1-5			11
5.1-6			16
6.1-7			23
7.1- 8			25
8.1-9			137
9.1- 10			120
10.1+			207

Source: MarinMap, CoSMoS

Table 116. Novato Vulnerable Buildings FEMA Hazus Damage Cost* Estimates

Buildings in Scenario 6	871
Yellow Tag: Minor Damage \$5,000 minimum	\$4,355,000
Orange Tag: Moderate Damage \$17,001 minimum	\$14,807,871
Red Tag-Destroyed Assessed structural value	\$629,369,009

Source: MarinMap, CoSMoS, FEMA Hazus Model

* 2016 dollars

²⁰⁹ 2016 dollars


²¹⁰ 2016 dollars


Map 107. Novato Vulnerable Buildings

Vulnerable Assets


 Fire Station

Vulnerable Buildings


 Scen. 1: 10" Sea Level Rise (SLR)

 Scen. 2: 10" SLR+Storm Surge

 Scen. 3: 20" Sea Level Rise

 Scen. 4: 20"SLR+Storm Surge

 Scen 5: 60" Sea Level Rise

 Scen. 6: 60"SLR+Storm Surge


Location Indicators

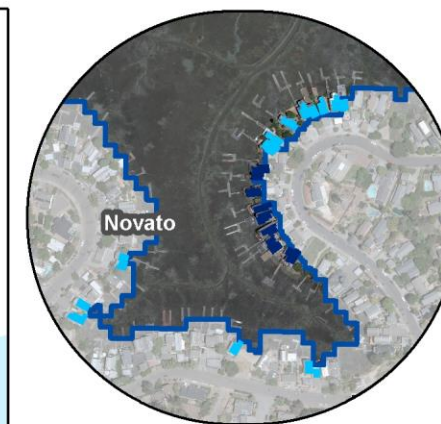
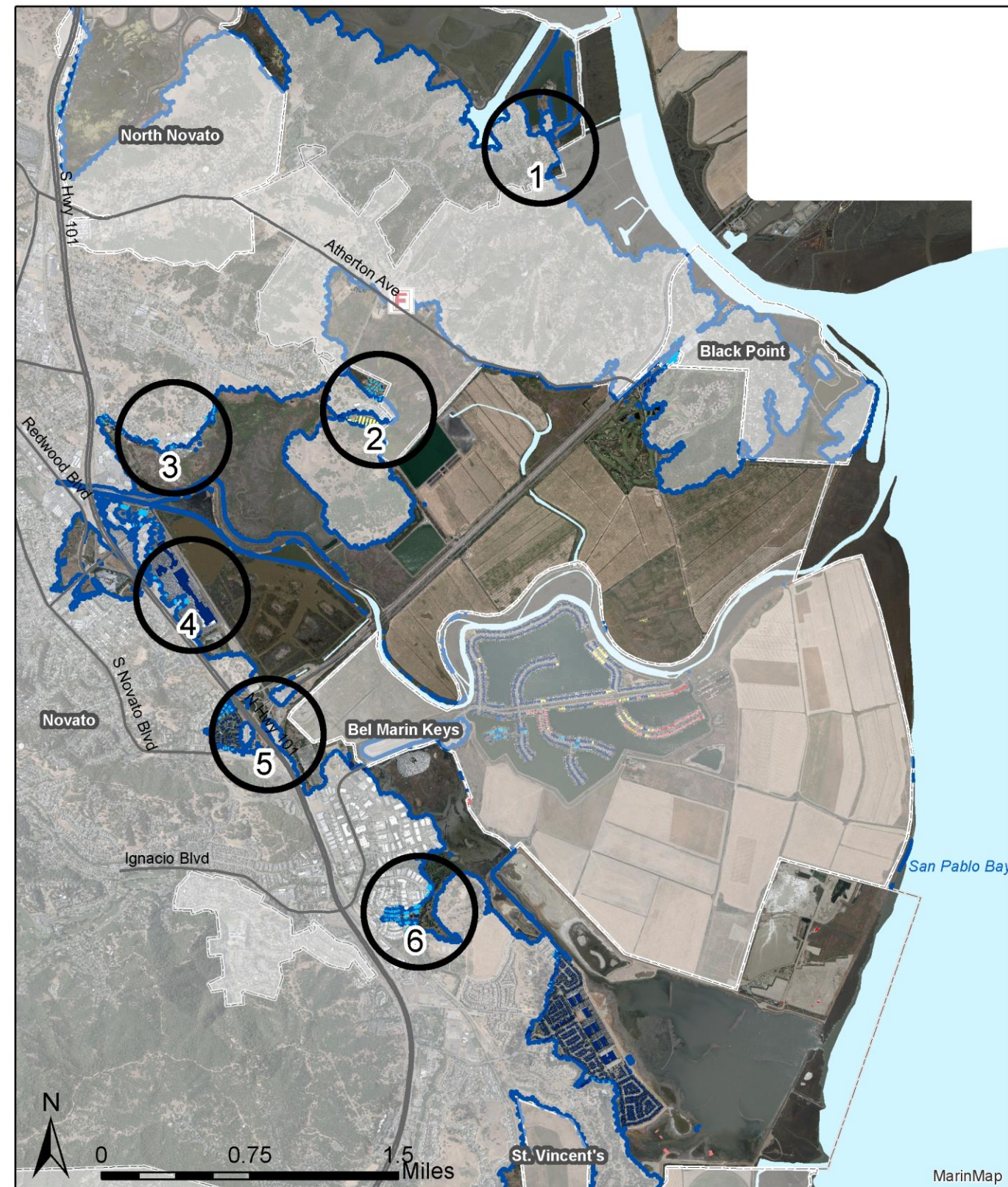
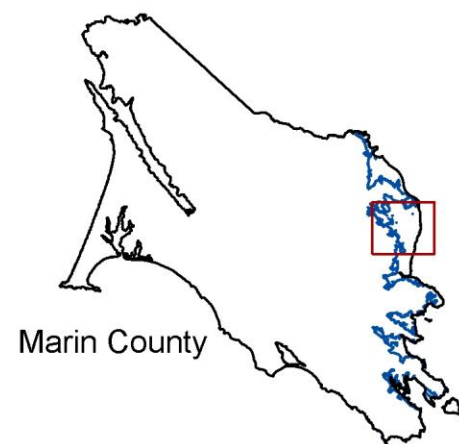
 Unincorporated

 Municipality

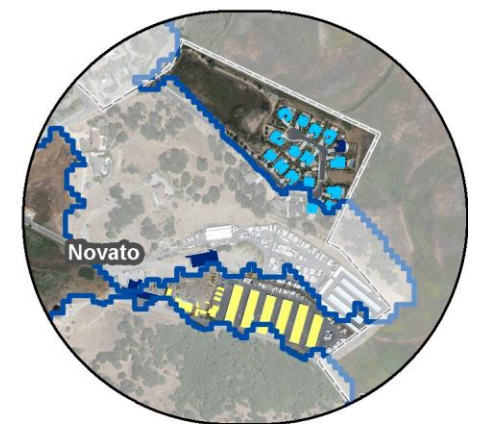
 Road

 Bay

 Inland Extent: Sea Level
@ 60"+100-year Storm



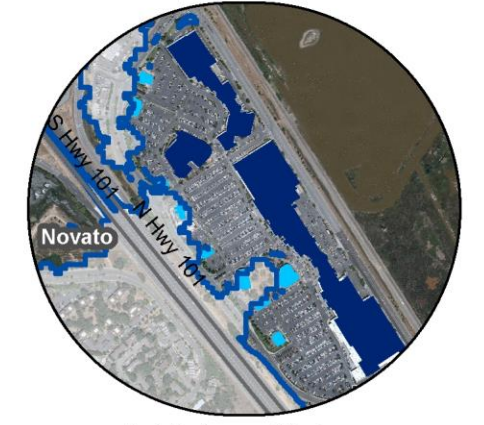
1: Bahia Neighborhood



2: Olive Ridge



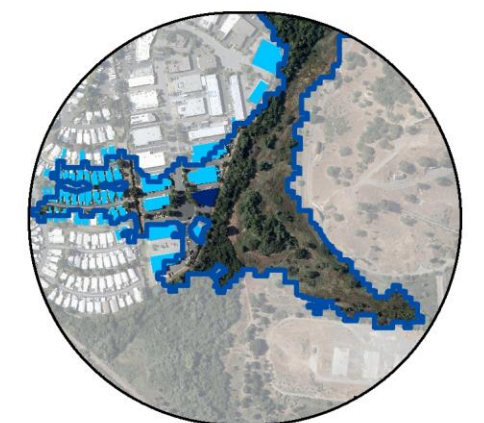
3: Davidson St. Buildings



4: Vintage Oaks
Shopping Center



5: Neighborhood at U.S.
Hwy. 101 @ S. Novato Blvd.



6: Pamoran Rd.

Disclaimer: Vulnerability Assessment maps, tables, etc. can be used as a resource to help identify potential hazardous areas and vulnerable assets. Marin County, and data providers here in, make no warranties of the accuracy or completeness of maps and data. Maps are representational and subject to future revision. Local site conditions must be examined. Commercial use is prohibited.

Transportation

In the near-term, major roadways could be vulnerable to sea level rise including State Routes 101 and 37, Redwood Boulevard, and Rowland Way. A handful of other roads are impacted in the near- and medium-term storm surge scenarios. By scenario 5, a significant number of roads in the low lying areas of the city, including roads on the other side of the Hamilton Levee, could be vulnerable. Examples include: Rowland Boulevard, Bel Marin Keys Boulevard, and Hamilton Parkway. [Table 117](#) lists transportation routes that could be vulnerable by scenario and annotates if the road is managed locally, or by the state or county.

According to Caltrans District 4 managers segments of State Routes 101 and 37 that already experience seasonal flooding that could escalate in frequency and scale due to sea level rise include:

- U.S. Highway 101 at Rowland Boulevard, Novato: This stretch floods, is adjacent to Scottsdale Pond, and a series of ponds, levees, and pumps operated by others protect it.
- U.S. Highway 101 at the 101/37 Interchange, Novato: This vulnerable 3,100-foot stretch is protected by levees and pumps operated by others.
- State Route 37 between Atherton Avenue and U.S. Highway 101: This stretch of State Route 37 is protected by non-engineered levees that have a history of overtopping with combined high tides and Novato Creek flows.

Transit is also impacted in Novato at the intersection of U.S. Highway 101 and Rowland Boulevard. Vulnerable Golden Gate Transit routes are 56, 70, 71, and 80, with stops at:

- Rowland Blvd. Park and Ride, and
- Hwy 101 and Rowland Blvd.

Marin Transit route 251 has vulnerable stops at:

- Rowland Blvd. and Hwy 101 Sb Off-Ramp
- Rowland Blvd. and Redwood Blvd.,
- Rowland Blvd. At Vintage Oaks Entrance,
- Vintage Way at Sleep Train, and
- Vintage Way at Fresh Choice.

Impacts to transit can have disproportionate impacts to households without vehicles and low income household that depend on transit. Persons who work at or use the stores and services provided in this

part of Novato may have to look elsewhere if measures are not taken to adapt to bay flooding. Flooding on the freeway itself could also impede travel to other bus stops that are not vulnerable under these scenarios. Regional travel on cross-county busses would also be impeded for many Novato residents.

The maps on the following pages illustrate vulnerable transportation features. The areas in the call out circles enable the reader the see areas that are difficult to see on the large scale map. The circles do not indicate that these areas are more vulnerable than others along the shoreline.



Rowland Way behind Vintage Oaks Shopping Center. Credit: BVB Consulting LL

Table 117. Novato Vulnerable Transportation Routes

Near-term		Medium-term		Long-term	
Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6
0.1 miles	0.5 miles	0.5 miles	6 miles	15 miles	17 miles
Hwy 101 ^C Hwy 37 ^C Redwood Blvd ^L Rowland Wy ^L	Roads in scenario 1 Burma Rd ^L Perimeter Rd ^L Terminal Rd ^L	Roads in scenario 1	Roads in scenarios 1 and 2 Hamilton Dr ^L Ryan Ave ^L Deer Island Ln ^L Hanna Ranch Rd ^L Marsh Rd ^L Olive Ave ^L Two water Trl	Roads in scenarios 1-4 Rowland Blvd ^L Bel Marin Keys Blvd ^L Hamilton Pkwy ^L Alconbury Wy ^L Alhambra Ct ^L Amelia Dr ^L Arnold Dr ^L Audubon Wy ^L Avocet Ct ^L Caliente Real ^L Club Dr ^L Emerson Ave ^L Ferdinand Way ^L Gann Way ^L Gateway Ct ^L Greenham Ct ^L Hamilton Landing ^L Hangar Ave ^L Hayford Ct ^L Holliday Dr ^L Hospital Dr ^L Inyo Cir ^L Laconheath Ave ^L Lassen Ln ^L Lavenham Rd ^L Los Padres Cir ^L Manuel Dr ^L Maybeck St ^L Mildenhall St ^L Modoc Pl ^L Moore Rd ^L Palm Dr ^L Pizarro Ave ^L Plumas Cir ^L Presidio Dr ^L Renaissance Rd ^L Richardson Rd ^L Richardson Wy ^L Ripley Ln ^L S Palm Dr ^L San Pablo Ave ^L San Pablo Ct ^L Stern Dr ^L Stonetree Ln ^L Tahoe Cir ^L Trinity Dr ^L Vintage Wy ^L Wood Bridge Wy ^L	Roads in scenarios 1-5 Balboa Ct ^L Binford Rd ^L Donna St ^L El Arroyo Pl ^L El Granada Cir ^L Emerson Ave ^L Fairhaven Wy ^L Frosty Ln ^L La Crescenta Cir ^L Lea Dr ^L Leafwood Dr ^L Loleta Ln ^L Louis Dr ^L Palm Dr ^L Pamaron Wy ^L Rush Landing Rd ^L San Pablo Wy ^L Terminal Rd ^L Topaz Dr ^L Toyon Wy ^L Vera Cruz Ave ^L

M = Marin County; C = State of California; L = Local Municipality; P = Private. Source: MarinMap, CoSMoS

Map 108. Novato Vulnerable Transportation Assets

Vulnerable Assets

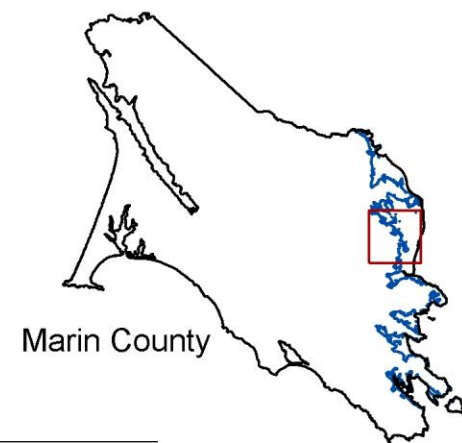
- GGT Bus Stop
- MT Bus Stop
- Bike path
- Bay Trail
- Trail
- SMART Track

Vulnerable Roads

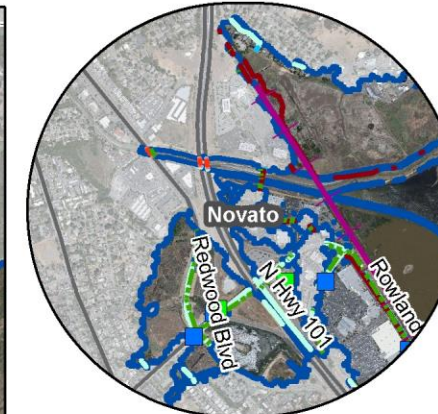
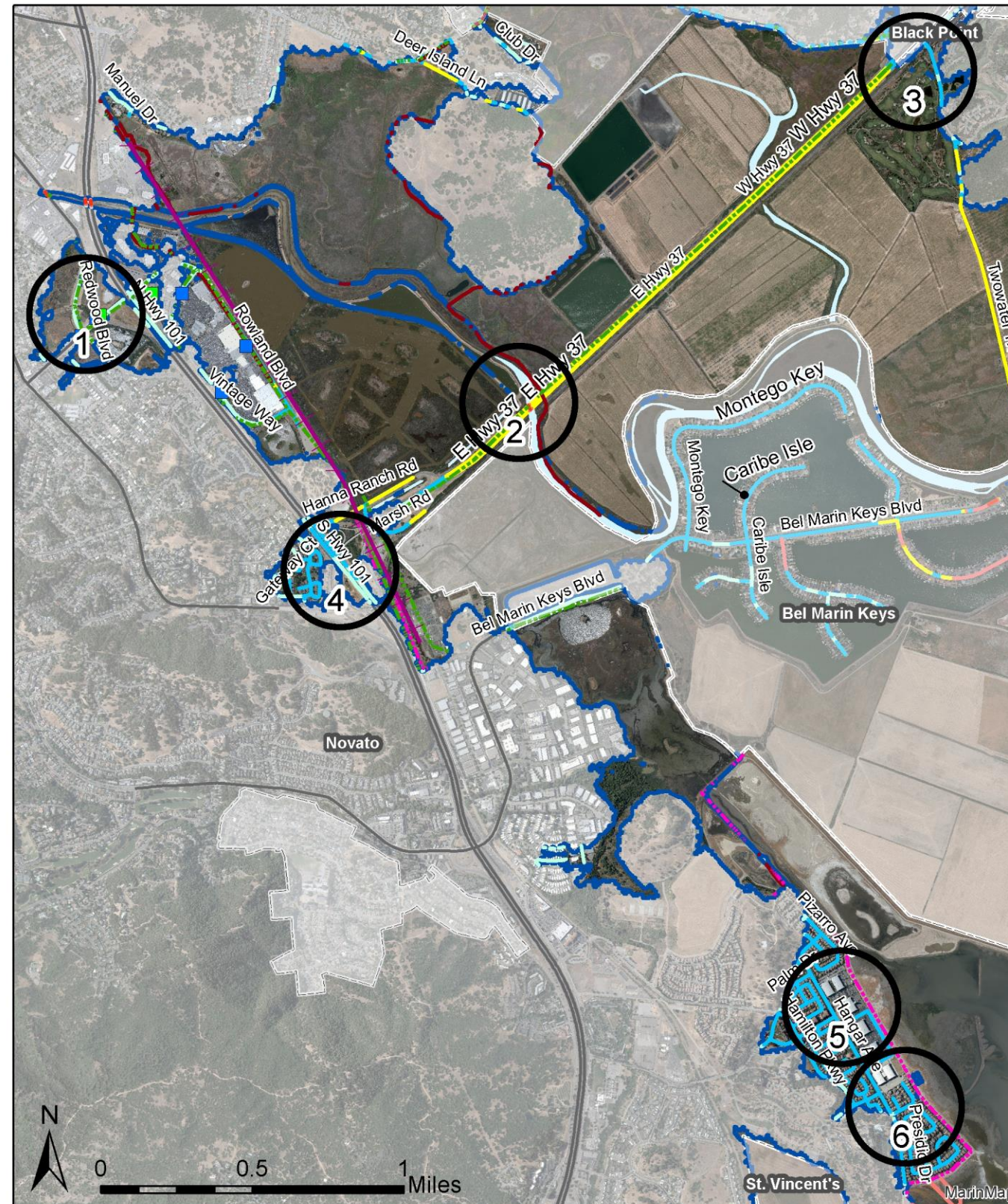
- @10" Sea Level Rise (SLR)
- @10"SLR+ 100-year Storm Surge
- @20" Sea Level Rise
- @20"SLR+ 100-year Storm Surge
- @60" Sea Level Rise
- @60"SLR+ 100-year Storm Surge

Location Indicators

- Unincorporated
- Municipality
- Road
- Bay
- Inland Extent: Sea Level
- @ 60"+100-year Storm



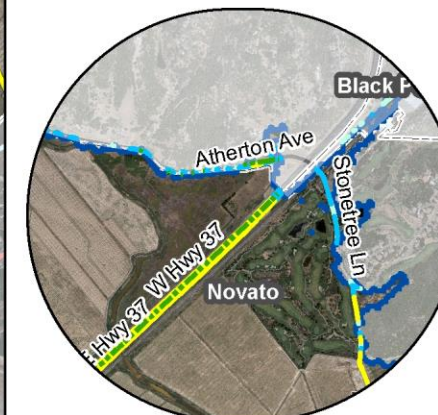
Date:
3/30/2017



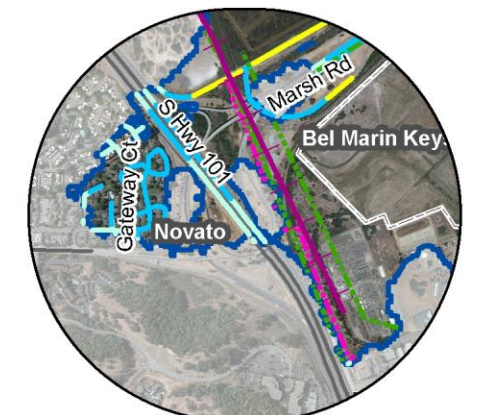
1: U.S. Hwy. 101



2: State Route 37



3: State Route 37
@ Atherton Ave.



4: State Route 37 @
U.S. Hwy. 101



5: Northern Hamilton
Neighborhood















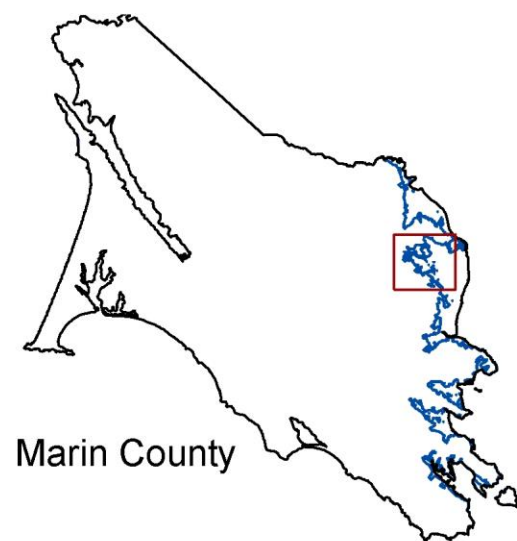
6: Southern Hamilton
Neighborhood

Disclaimer: Vulnerability Assessment maps, tables, etc. can be used as a resource to help identify potential hazardous areas and vulnerable assets. Marin County, and data providers here in, make no warranties of the accuracy or completeness of maps and data. Maps are representational and subject to future revision. Local site conditions must be examined. Commercial use is prohibited.

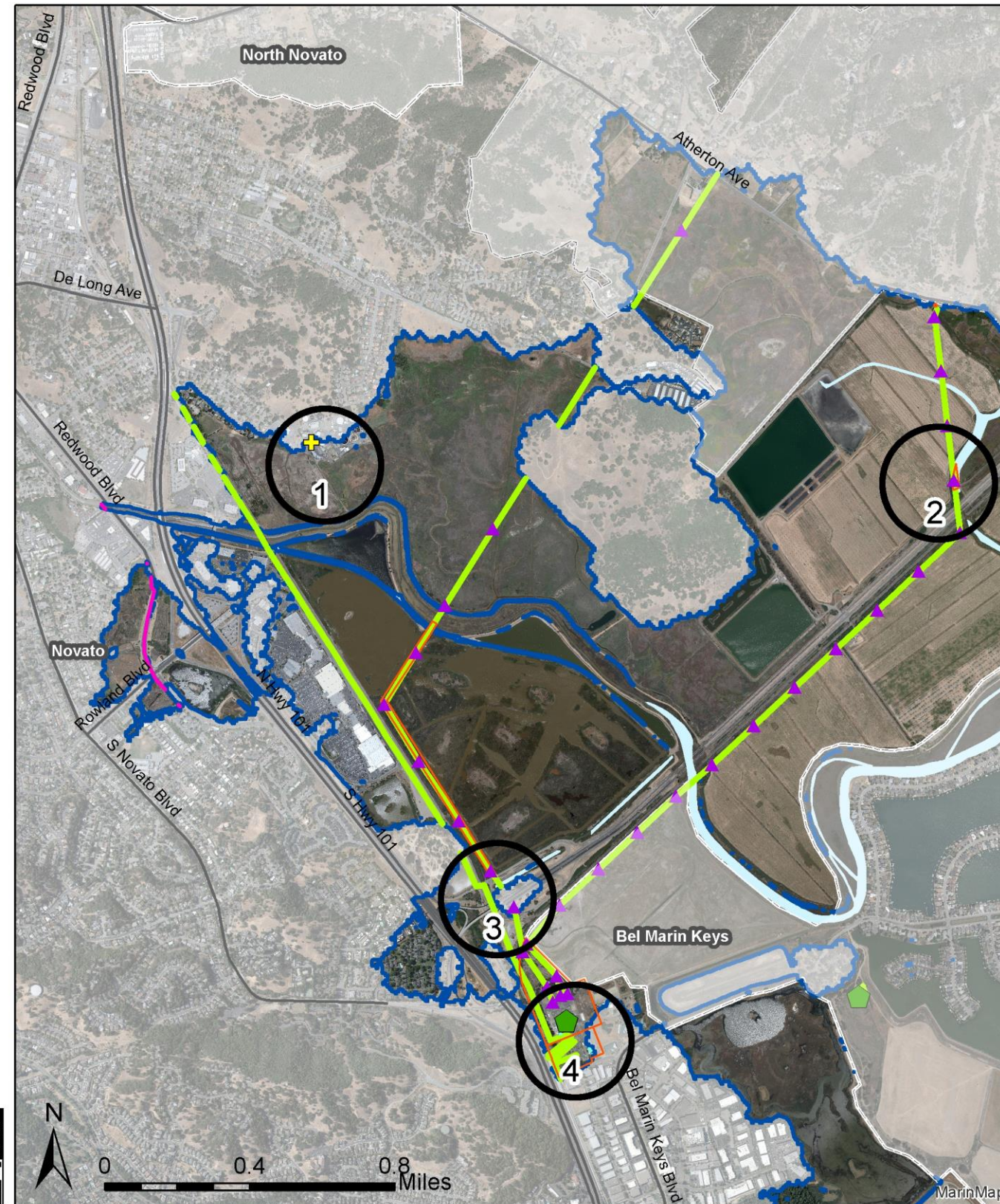
Map 109. Novato Vulnerable Gas & Electric Asset

Vulnerable Assets

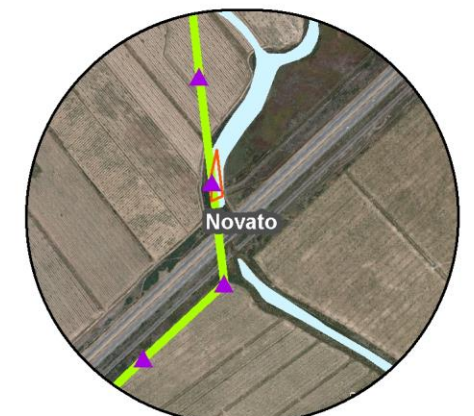
-  Solar Array
- PG&E Assets**
-  Electric Transmission Line
-  Natural Gas Pipeline
-  Substation
-  Transmission Tower
-  PG&E Property
-  PG&E Buildings
- Location Indicators**
-  Unincorporated
-  Municipality
-  Road
-  Bay
-  Inland Extent: Sea Level @ 60"+100-year Storm



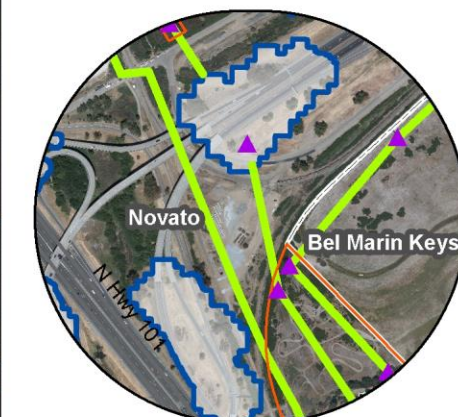
Date:
4/1/2017



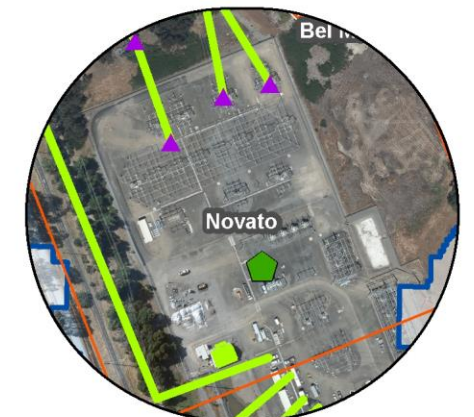
1: Novato Wastewater Treatment Plant



2: State Route 37



3: State Route 37 @ U.S. Hwy. 101



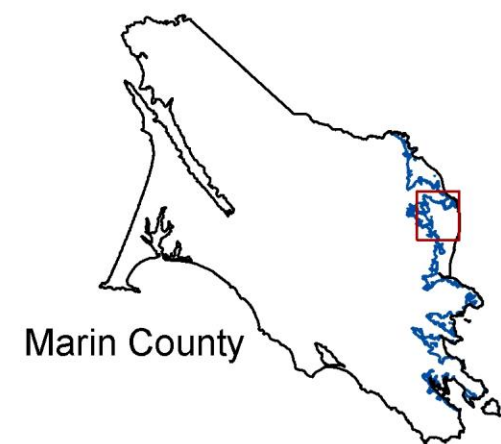
4: PG&E Substation

Disclaimer: Vulnerability Assessment maps, tables, etc. can be used as a resource to help identify potential hazardous areas and vulnerable assets. Marin County, and data providers here in, make no warranties of the accuracy or completeness of maps and data. Maps are representational and subject to future revision. Local site conditions must be examined. Commercial use is prohibited.

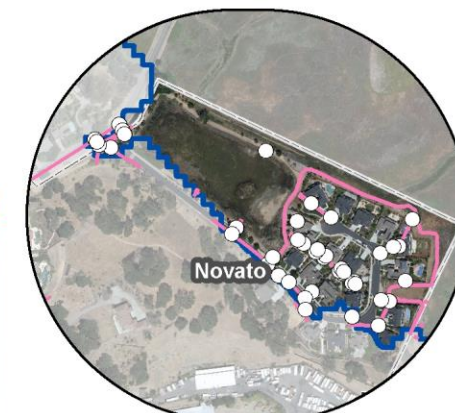
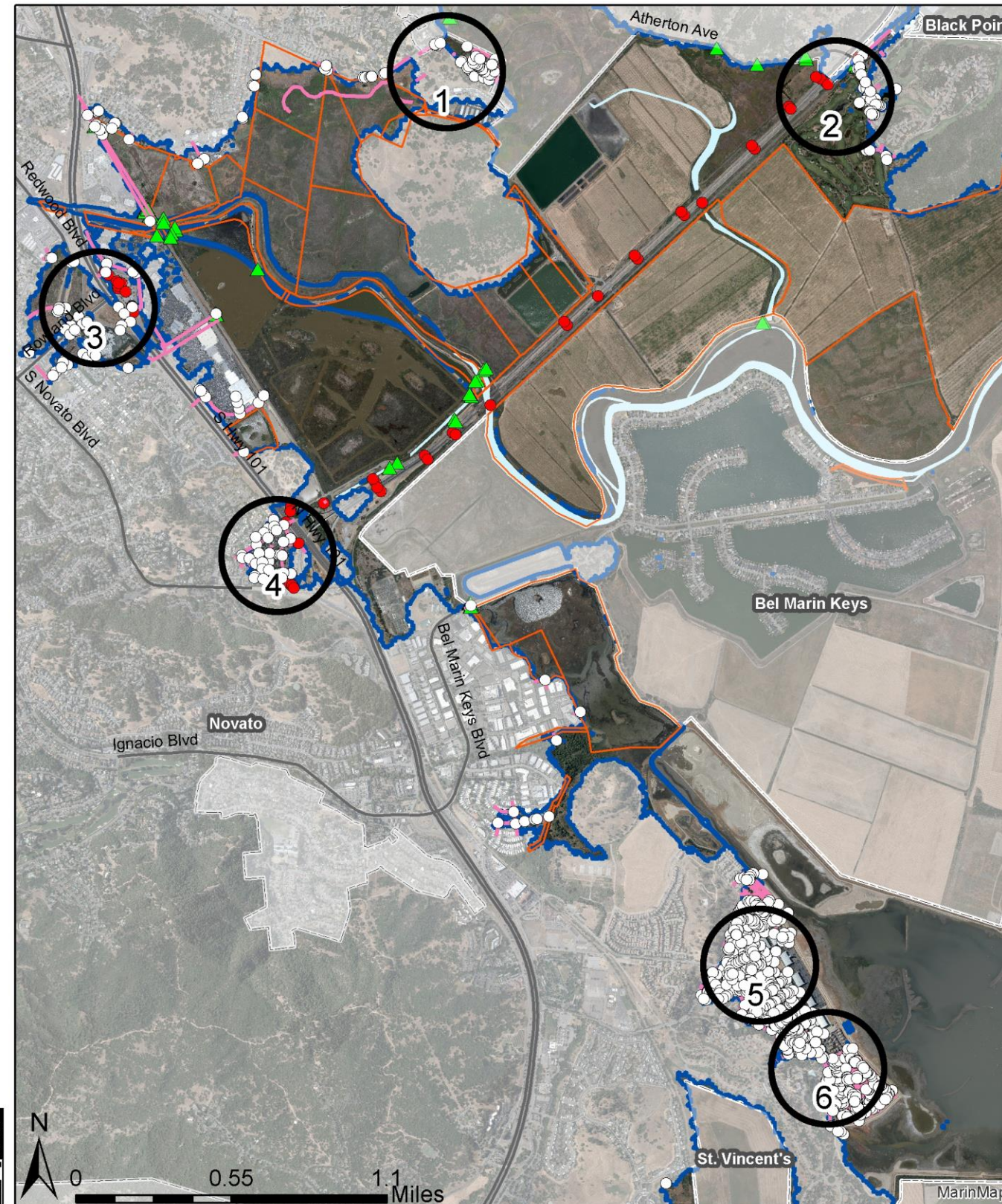
Map 110. Novato Vulnerable Stormwater Assets

Vulnerable Assets

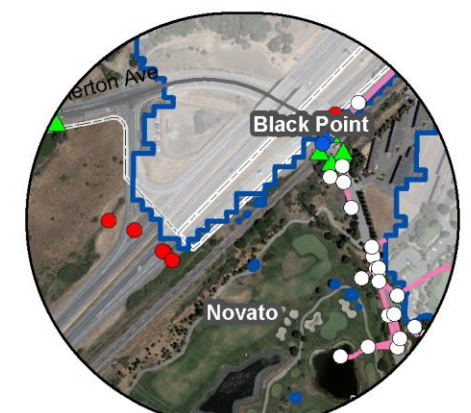
- Unspecified Node
 - ▲ Culvert
 - Pipe Inlet/Outlet
 - Pipe
 - ▭ Flood Control Parcels
- ## Location Indicators
- ▭ Unincorporated
 - ▭ Municipality
 - Road
 - Bay
 - Inland Extent: Sea Level @ 60"+100-year Storm



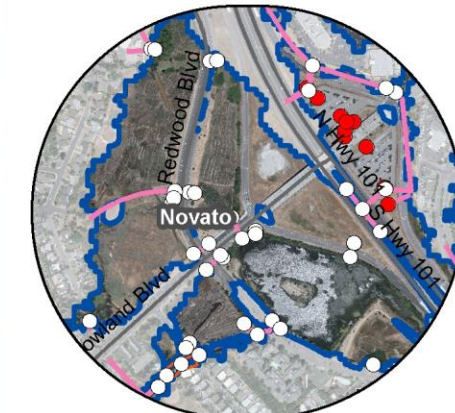
Date:
2/15/2017



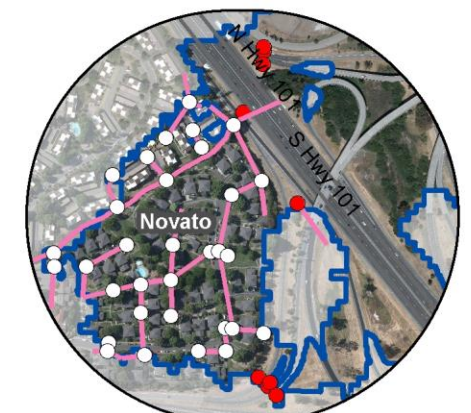
1: State Route 101
@ Rowland Blvd.



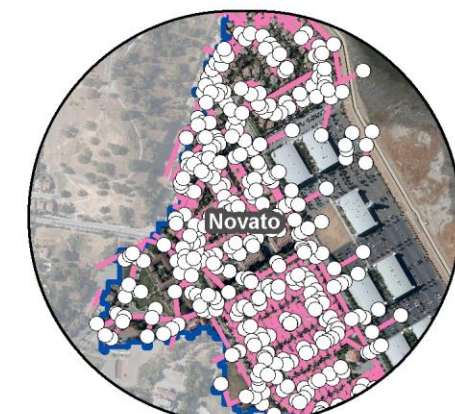
2: State Route 37
@ Atherton Ave.



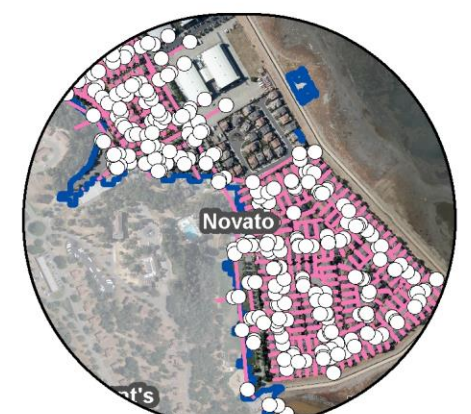
3: State Route 101 @
Rowland Blvd.



4: Lynwood Hill area



5: Northern Hamilton



6: Southern Hamilton

Disclaimer: Vulnerability Assessment maps, tables, etc. can be used as a resource to help identify potential hazardous areas and vulnerable assets. Marin County, and data providers here in, make no warranties of the accuracy or completeness of maps and data. Maps are representational and subject to future revision. Local site conditions must be examined. Commercial use is prohibited.

Utilities

The primary utility issues in Novato are related to the Novato Sanitary District Wastewater Treatment Plant, North Marin Water District (NMWD) office and yard, and the PG&E transmission towers spanning across the Novato marshlands.

The Novato Sanitary District Treatment plant is vulnerable just before 3 feet of sea level rise. By scenario 5, the lower half of the plant is covered by tidal waters. Storm conditions may impact the plant sooner. The water will not likely be high enough to impact the process; however, electrical components may be lower and saltwater corrosion of the tanks and buildings could take a toll over time. Moreover, the highest high tides could reach even further into the facility. To read more about the NSD wastewater treatment plant see the Utilities Profile.

The North Marin Water District is vulnerable to sea level rise, storm surges, and rain events significant enough to back up Rush Creek. Other impacts could include corrosion and contamination of fire water reserves. For other issues related to NMWD see the Utilities Profile.

PG&E transmission towers in Novato's marshlands in Marin County's stormwater diked baylands and Bahia are already showing the effects of subsidence, with leaning towers and taut lines. As sea level rise continues, subsidence will worsen. In addition, the minimum height needed between the towers and the land surface could be flooded, bringing the electrical currents closer to the water.

Finally, Novato is vulnerable to similar issues as other low lying area in the study area such as:

- Underground pipes face compounding pressure forces from water and the road,
- Road erosion and collapse with underlain pipes,
- Saltwater inflow and infiltration causing inefficiencies in wastewater treatment,
- Continuously subsiding soils or fill, and
- Escalating activity, capacity demands, energy consumption, and wear and tear on pump stations in stormwater and wastewater systems,
- Aging individual site connections for water, sewer, and electrical, and
- Flood waters interrupting access for employees to reach work sites.

The maps on the previous pages illustrate vulnerable utility features. The areas in the call out

circles enable the reader to see areas that are difficult to see on the large scale map. The circles do not indicate that these areas are more vulnerable than others along the shoreline.

Working Lands

Most of the vulnerable working lands in Novato are leased out to ranchers for grazing. As this area floods more consistently, less grazing will be possible, and animal waste may enter into the bay when tideswaters retreat.

Natural Resources

Several hundred acres of tidal and stormwater marsh lands could expect higher salinity concentrations and water levels. These occurrences could push marshlands inland where feasible. Scottsdale Marsh, the Bahia shoreline, and Deer Island are habitats that could be impacted.

The longfin smelt, Ridgway's Rail, tidewater goby, Steelhead trout, and salt marsh harvest mouse are the listed species recorded in this area according to the Natural Diversity Database. The smelt is listed as threatened on the California species list and a candidate for the federal list. The Ridgway's Rail, tidewater goby, and harvest mouse are federally listed.

Recreation

Some marsh pathways in the flood control lands could expect impacts in the near-term during average high tides. Most parks impacted in Novato are in the Hamilton area and include:

Scenario 5:

- Bahia Mini Parks
- Future Hamilton Rec Area
- Hamilton Airport Park
- Hamilton Amphitheater Park
- Slade Park
- Hamilton Community Center
- South Hamilton Park

Scenario 6:

- Scottsdale Marsh

In addition, Deer Island Park could become an island at average high tides, as opposed to seasonal high tides and stormwater coincidences.

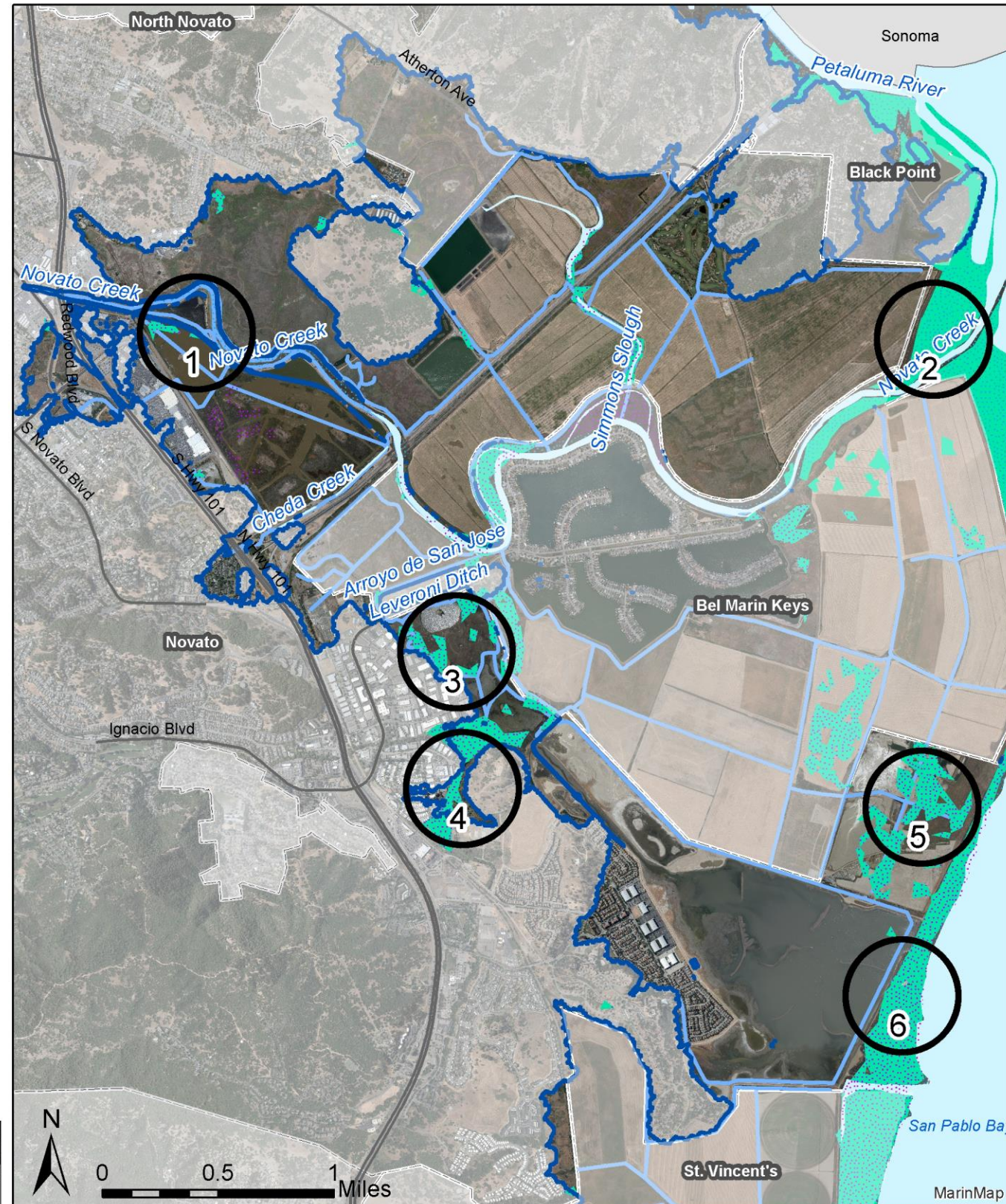
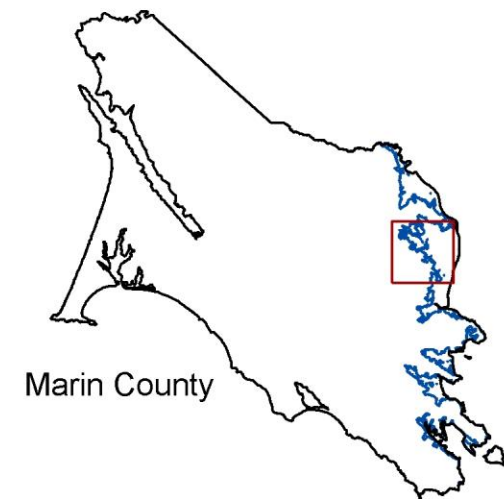
The Bay Trail could expect a high number of low lying segments underwater at MHHW. In addition, segments on the Hamilton levee could be vulnerable in the long-term to flooding and erosion.

The maps on the following pages illustrate vulnerable natural resource, recreation, emergency and historic features. The areas in the call out circles enable the reader to see areas that are difficult to see on the large scale map. The circles do not indicate that these areas are more vulnerable than others along the shoreline.

Map 111. Novato Vulnerable Natural Resource Assets

Vulnerable Assets

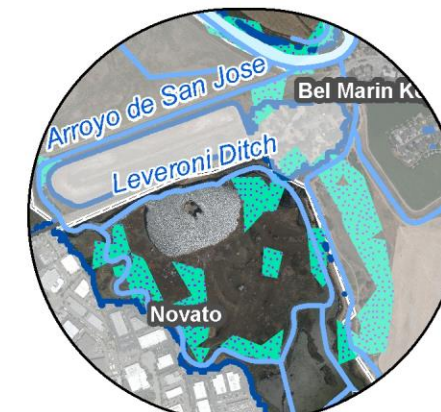
- Streams
 - ▨ Marsh
 - ▨ Estuary
 - ▨ Wetland
- Location Indicators**
- Unincorporated
 - Municipality
 - Road
 - Bay
 - ~ Inland Extent: Sea Level @ 60"+100-year Storm



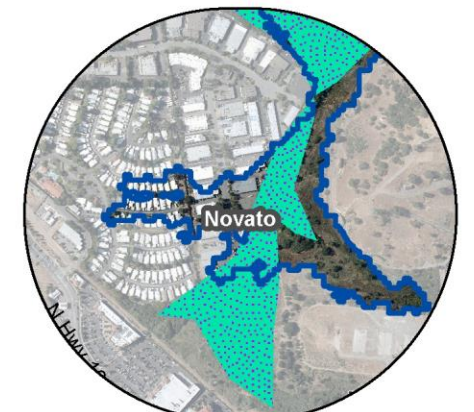
1: Novato Creek



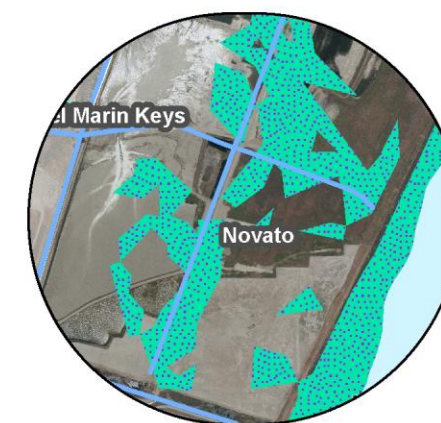
2: Novato Creek Estuary



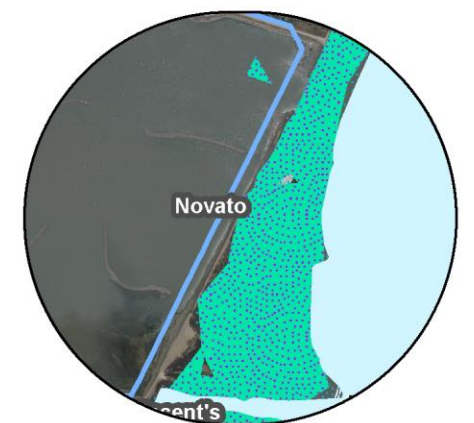
3: Leveroni Ditch



4: Arroyo de San Jose



5: Northern Hamilton Wetlands



6: Southern Hamilton Wetlands

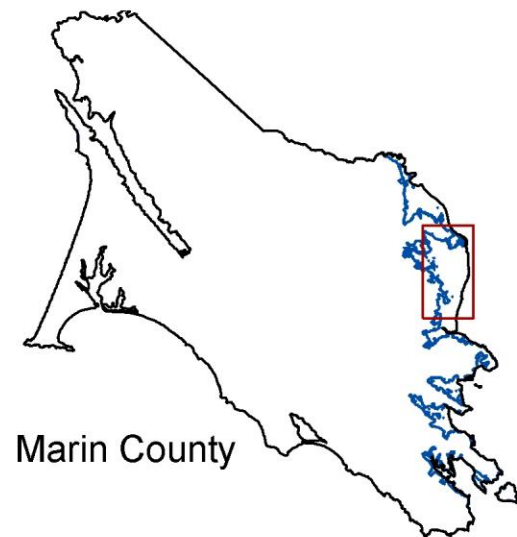
Map 112. Novato Vulnerable Recreation Assets

Vulnerable Assets

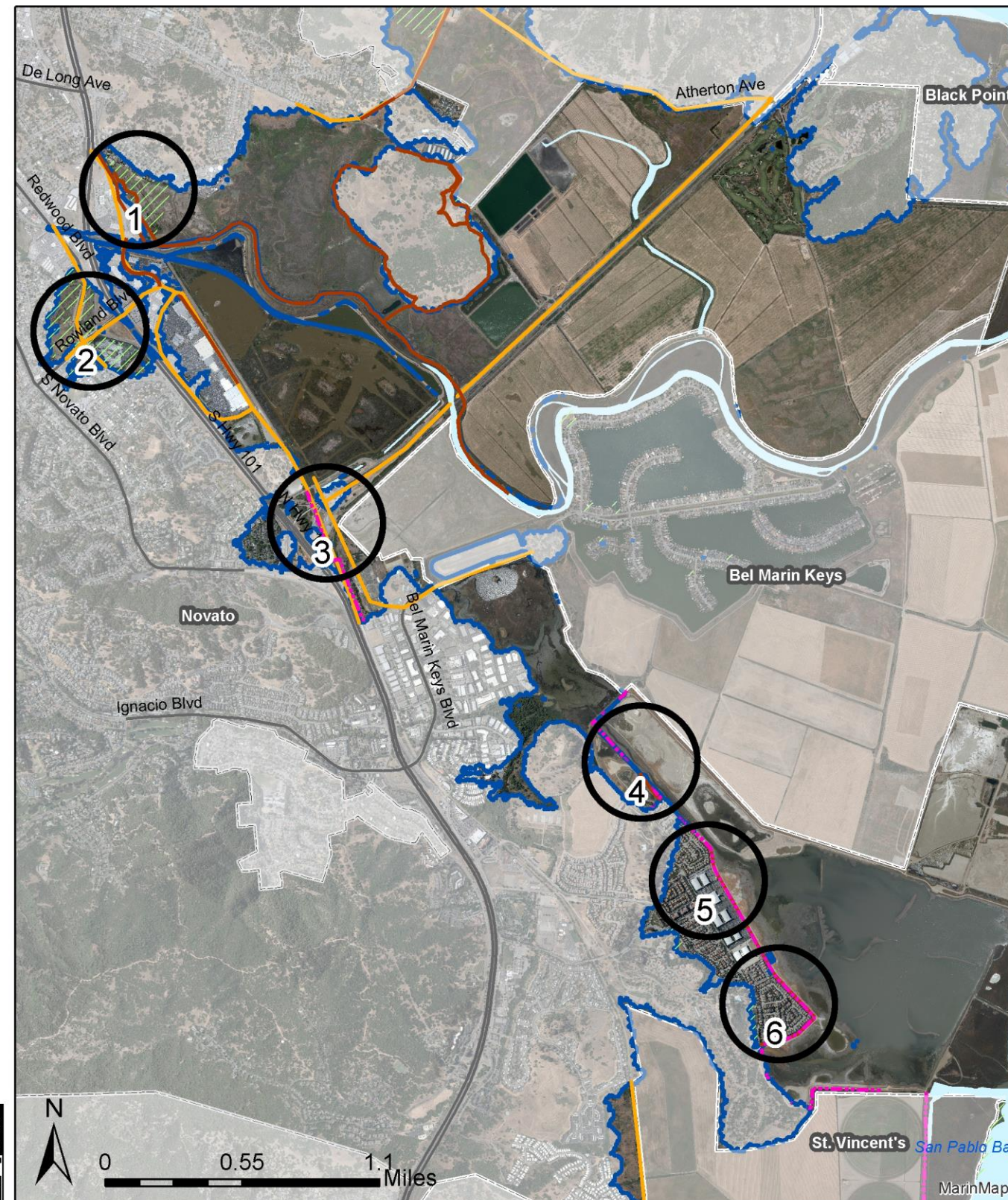
- Bay Trail
- Trail
- Bikeway
- Park

Location Indicators

- Unincorporated
- Municipality
- Road
- Bay
- Inland Extent: Sea Level @ 60"+100-year Storm



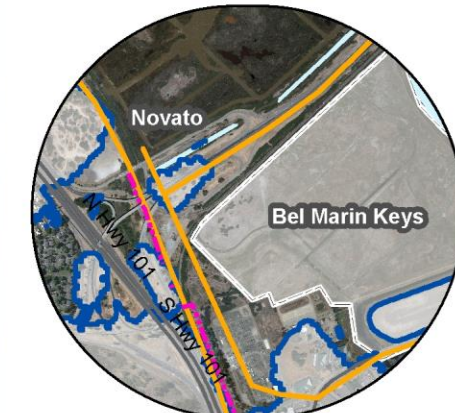
Date: 1/25/2017



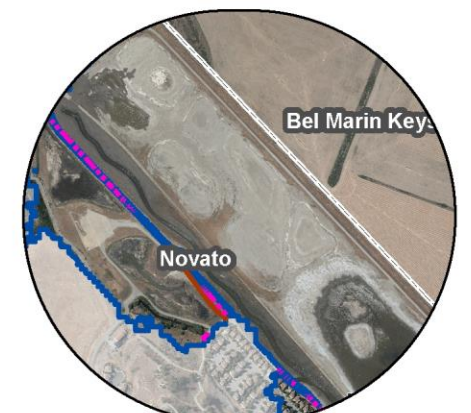
1: Slade Park



2: Scottsdale Marsh



3: State Route 37



4: Upper Hamilton Wetlands



5: Middle Hamilton Levee



6: Lower Hamilton Levee

Disclaimer: Vulnerability Assessment maps, tables, etc. can be used as a resource to help identify potential hazardous areas and vulnerable assets. Marin County, and data providers here in, make no warranties of the accuracy or completeness of maps and data. Maps are representational and subject to future revision. Local site conditions must be examined. Commercial use is prohibited.



SMART Rail Bridge, Novato. Credit: Marin County DPW



Hamilton Field's Headquarters now serves as the Novato Arts center. Credit: Marin County CDA

Emergency Services

In addition to concerns for emergency vehicle access on flooded roads, the Novato Fire Station 62 could expect a high tide average of 5 inches of water in the medium-term and up to a foot of water in the long-term. In addition, the Novato Professional Firefighters Association Office is vulnerable in scenario 6.

Cultural Resources

In the 1930's, the 1,779 acre Hamilton Army Air Field was constructed as headquarters for the 1st Wing of the Air Force, one of only three such bases in the nation.²¹¹ The site was transferred to the US Navy, Army and Coast Guard in 1974, and is now part of Novato. Currently buildings house a variety of residential and commercial uses.

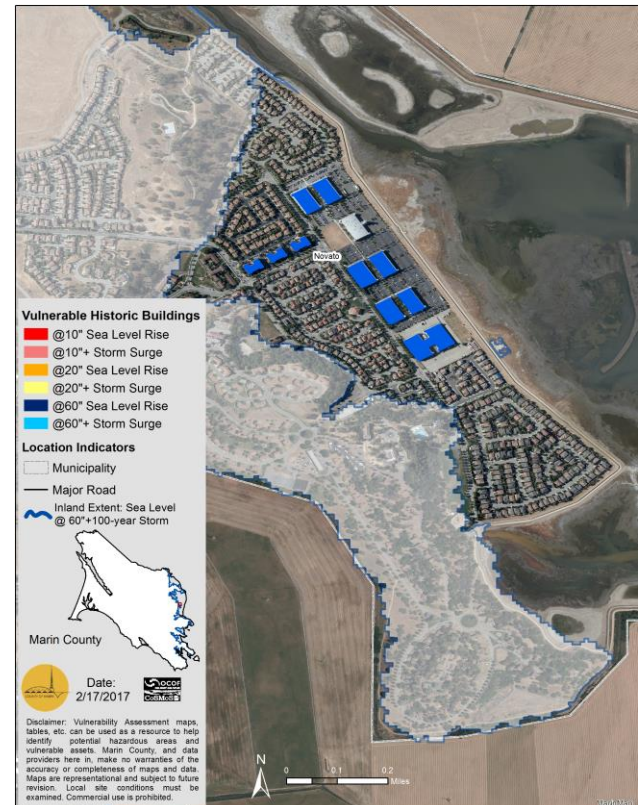
²¹¹ Maniery, M.L., and C.L. Baker. 1998. National Register of Historic Places Registration Form – Hamilton Army Air Field Discontinuous Historic District.

The National Register of Historic Places Registration Form identifies 3 areas of the historic district.²¹² Of the three areas, Area C could be subject to average high tide flood depths of 2'5" to 10'4" by the long-term scenarios. All ten of its contributing resources could flood, including:

- Double hangars- 3 identical H-shaped buildings,
- Air Corps shops and hangar #9,
- Flagpole- 75 foot tall with historic plaque,
- Headquarters building- T-shaped with central two-story section and one-story wings,
- Officers' Barracks- 3 H-shaped 3-story buildings, and
- Electrical transformer vault.

Archaeological sites could be present in the exposure zones.

Map 113. Novato Vulnerable Cultural Resource Assets



Source: CoSMoS, MarinMap, National Register of Historic Places Registration Form – Hamilton Army Air Field Discontinuous Historic District

²¹² Ibid.

Table 118 ranks select vulnerable assets in Novato by onset and flood depth at MHHW. A 100-year storm surge would add an additional 1 to 3 feet of water to these properties. Note also, above average high tides could impact more properties than accounted for in this analysis.

Several assets could be impacted during the storm-surge scenario only, unlike the other that would subject to tidal and storm flooding. These are:

- Novato Corporate Yard,
- Las Robles Mobile Home Park,
- Novato Fire Association office, and
- NMWD administrative office and yard (with stormwater combination).

Table 118. Example Novato Vulnerable Assets by Sea Level Rise Onset and Flooding at MHHW

Asset	Scenario		
	Near-term	Medium-term	Long-term
	1	3	5
Scottsdale Marsh	Flooded at existing high tides		
Hamilton		3'8"-11'6"	9'-29'3"
NSD Wastewater treatment plant		2"-1'7"	5"-4'6"
Bay Trail		0-8"	0-12'7"
Vintage Oaks shopping center		3"-8"	7"-1'8"
Fire Station 62		5"	1'
South Hamilton Park			11'6"
Deer Island			10'10"
Hamilton Pkwy.			4'8"-10'9"
Hamilton Amphitheater Park			10'6"
SMART Rail			0-9'8"
Rush Creek			8'10"
Hwy 37 WB off ramp			2"-8'4"
Slade Park			8'
Hamilton Community Center			8'
Future Hamilton Recreation Area			7'6"
Hwy 37 EB			0-7'
Bahia Mini Parks			6'9"
Rowland Blvd.			0-2'7"
Hwy 101 NB			0-2'
Hwy 101 SB			0-1'9"
NMWD air valves			No data
NMWD fire water reserves			No data
Automated valve connecting NMWD & MMWD			No data
PG&E transmission	In existing marsh areas		

Source: MarinMap, CoSMoS, Asset Manager Interviews