



COUNTY OF VENTURA  
RESOURCE MANAGEMENT AGENCY | PLANNING DIVISION



# VC RESILIENT COASTAL ADAPTATION PROJECT

## SEA LEVEL RISE VULNERABILITY ASSESSMENT

### APPENDIX A-1. MAP ATLAS AND SECTOR PROFILE RESULTS



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# APPENDIX A-1. MAP ATLAS & SECTOR PROFILE RESULTS

This Appendix summarizes the effects of 8 inches, 16 inches and 58 inches (about 5 feet) of sea level rise (SLR) on routine monthly high tide inundation and from the potential erosion and flooding impacts caused by a large coastal wave storm (1% annual chance storm). These storms could happen in any given year, however the extent of the damage would not likely occur everywhere across the entire County shoreline from a single event given the different shoreline orientations and wave directions.

Each Sector profile shows the findings and recommendations that can be used to identify vulnerabilities and consider possible solutions and policy directions. Each sector profile, has a set of 3 vulnerability maps (North, Central and South Coast) color coded to the sea level elevation of impacts and a 2-page summary of findings for each of the following resources:

## Sectors in Appendix A-1

- Land Use Parcels and Structures
- Agriculture
- Wastewater
- Stormwater
- Water Supply

## Sectors in Appendix A-2

- Parks, Trails and Coastal Access
- Roads and Parking
- Public Transportation and Bike Routes
- Oil and Gas
- Hazardous Materials
- Critical Services

These sector profiles are intended to summarize the impacts to the key measures of impact for each sector as identified in Section 5. The overview section provides a short summary of the resource sector and any specifics about the analysis as well as identifies the individual measures of impact. The existing conditions and future vulnerabilities sections highlights components of the sector that are potentially at risk today and projected to be at risk in the future sea level rise and tidal inundation, coastal erosion, coastal flooding, and fluvial flood hazards (Section 4.3). Future vulnerabilities and potential impacts are discussed for each sea level rise scenario based on what else becomes vulnerable with that additional amount of sea level rise. The ~5 feet by 2100 sea level rise scenario identifies what else potentially becomes vulnerable, but the text summarizes everything at risk by coastal hazards and ~5 feet of sea level rise. The adaptation section is a relatively simple summary of potential ranges of options of strategies. This adaptation section will evolve as additional workshops and dialogs are held with the City and key stakeholders. Finally, the summary section, identifies key findings, thresholds of significant impacts, and data gaps. Potential next steps suggests future policy directions, and monitoring needs.

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## Overview

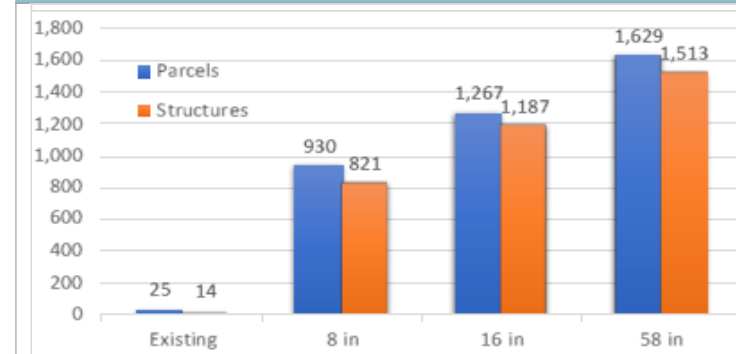
There are 12 land use categories within Ventura County, which were categorized into four distinct land use types for evaluation. Land uses were categorized into (1) residential, (2) commercial, (3) industrial, and (4) visitor serving accommodations. More detail on the methods and results can be found in Sections 4 and 5 of the Report.

Cliff and dune erosion results in a loss of land and structures and coastal flooding causes temporary damages from a large 1% annual chance storm. Monthly high tides inundate at-risk properties (land and structures). Narrow ocean front parcels on the North and South Coast have a Mean High Water boundary, so portions of the parcels are already affected by routine high tides.

The following measures of impacts quantify the impact of coastal hazards and sea level rise (SLR) on land uses and structures:

- **Parcels by land use type**
- **Number of structures**

## Coastal Erosion



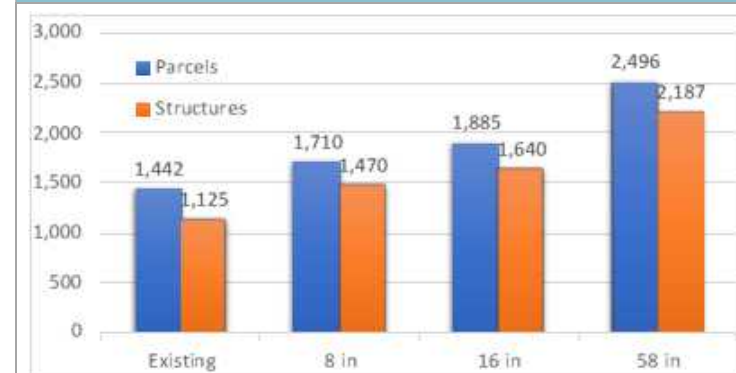
Cliff erosion along the South Coast causes vulnerabilities to residential parcels with 8" of SLR (131 parcels), although some of these could occur today. Beach and dune erosion on the Central Coast shows existing condition impacts to 14 parcels, rising to 619 parcels with 8" of SLR. Erosion affects mainly residential parcels located in Silverstrand and Hollywood Beach. Commercial impacts include businesses along Los Altos St. in Hollywood Beach, along Ocean Dr. in Silverstrand.

Storm Erosion	Existing	8 Inches	16 Inches	58 Inches
North	\$0	\$1,100,000	\$1,200,000	\$1,200,000
Central	\$26,600,000	\$981,100,000	\$1,255,400,000	\$1,480,100,000
South	\$0	\$208,300,000	\$208,300,000	\$208,500,000
<b>Total</b>	<b>\$26,600,000</b>	<b>\$1,190,500,000</b>	<b>\$1,464,900,000</b>	<b>\$1,689,800,000</b>

**ECONOMICS:** South Coast cliff erosion was not calculated for existing conditions, but potential impacts of over \$208 million (\$M) with only 8" of SLR. The Central Coast is already subject to \$26.6M in dune erosion losses (1% annual chance storm) and losses may increase to \$981.1M with 8", \$1.25 billion with 16", and \$1.48 billion with ~5 feet of SLR. The North Coast lacks future erosion projections, potential damages are understated as \$1.2M for structures in Emma Wood State Beach. Failure of existing armoring would cause substantially more property damages.

*Note: North Coast erosion modeling was not conducted and erosion may cause vulnerabilities in this area. The model used for South Coast cliff erosion may have underestimated existing cliff erosion hazards.*

## Coastal Flooding



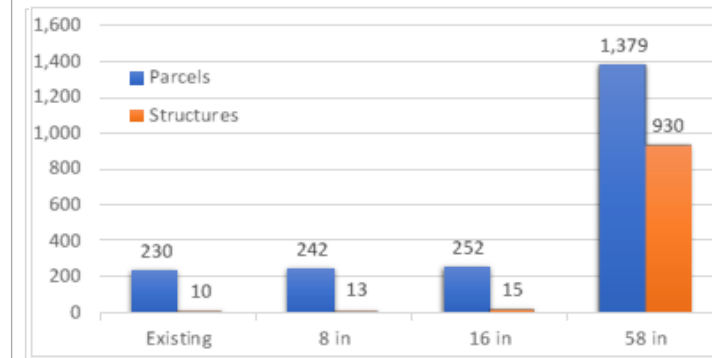
Residential buildings are >95% of vulnerable structures. Half of all parcels exposed to flooding with ~5 feet of SLR are in the Silverstrand and Hollywood Beach neighborhoods. Ten commercial buildings are vulnerable today and 31 may be exposed with ~5 feet of SLR.

**ECONOMICS:** South Coast experiences increasing flood damages over time: \$10M presently, about \$11M with 8" and 16" of SLR and losses increase significantly to \$136.6M with ~5 feet of SLR. The Central Coast is already subject \$120.1M in coastal flooding losses (during a 1% annual chance storm) and losses increase to \$150.7M with 8", \$173.3M with 16", and \$407.3M with ~5 feet of SLR. North Coast coastal flooding currently exposes \$46.8M in property. This estimate increases to \$51.6M with 8", \$55.0M with 16", and 138.2M with ~5 feet of SLR.

Coastal Flooding	Existing	8 Inches	16 Inches	58 Inches
North	\$46,800,000	\$51,600,000	\$55,000,000	\$138,200,000
Central	\$120,100,000	\$150,700,000	\$173,300,000	\$407,300,000
South	\$10,000,000	\$10,800,000	\$11,000,000	\$136,600,000
<b>Total</b>	<b>\$176,900,000</b>	<b>\$213,100,000</b>	<b>\$239,300,000</b>	<b>\$682,100,000</b>

## Tidal Inundation

Currently, 230 oceanfront parcels are at risk of tidal inundation. Between 16" and ~5 feet, impacts escalate by 904 residential structures and 11 commercial buildings.



\$48.5M in property is currently vulnerable. Tidal exposure increases to \$81.1M with 8", \$98M with 16", and \$177.7M with ~5 feet of SLR. The Central Coast is not at risk until ~5 feet of SLR, when \$633.3M in property is exposed. The North Coast has \$22.2M in property exposed currently, increasing to \$23.5M with 8", \$24.9M with 16", and \$70.2M with ~5 feet of SLR.

Tidal Inundation	Existing	8 Inches	16 Inches	58 Inches
North	\$22,200,000	\$23,500,000	\$24,900,000	\$70,200,000
Central	\$0	\$0	\$0	\$633,300,000
South	\$48,500,000	\$81,100,000	\$98,000,000	\$177,700,000
<b>Total</b>	<b>\$70,700,000</b>	<b>\$104,600,000</b>	<b>\$122,900,000</b>	<b>\$881,200,000</b>

## Potential Adaptation Strategies

**Range of Strategies:** Includes "No Action" and cleanup, as well as retreat, accommodate and protection strategies.

**Accommodate** - Includes elevating structures and increasing setbacks. Elevating is expensive if completed as a retrofit, however building code changes would enable elevation to occur overtime with the bulk of the cost placed on developers and private property owners when redeveloping their properties.

**Protect** - Constructing levees and coastal armoring to reduce vulnerabilities is the "gray" protection approach, which has already been implemented in the North Coast. A "green" protection approach likely cost effective in the Central Coast would be to augment sand dunes to protect against future coastal hazards.

**Retreat** - Includes policy and/or regulatory options (e.g. transfer of development, repetitive loss, and rolling easements) as well as voluntary purchase of the vulnerable properties potentially with a lease back option.

**Secondary Impacts:** Retreat strategies have secondary impacts due to the loss of structures, property, and subsequent resulting impacts on the tax base revenues to the County. Gray protection options have been traditionally used with some success in the past, but continued use would result in a loss of beaches over time. Green protection strategies may benefit beaches and homes by maintaining recreational uses, but may not be suitable for high-energy shorelines that erode.

## Findings

### Summary

- Residential parcels make up ~95% of exposed property.
- Coastal erosion poses the highest economic risk to land uses, primarily in Hollywood Beach and Silverstrand.
- Currently \$26.6M in property is at-risk to erosion and \$176.9M is at-risk to flooding from a 1% storm.
- With 8 inches \$1.2 billion in property is at-risk to erosion and \$213M is at-risk to flooding from a 1% storm.
- With ~5 feet of SLR, \$1.7 billion in property is at-risk to erosion and \$682M exposed to coastal flooding.

### Thresholds:

- Coastal erosion impacts substantially more residential property with 8" of SLR (\$26M to \$1.2 billion).
- Tidal inundation impacts escalate between 16" & ~5 feet of SLR, particularly in the Central Coast.

### Strategy Options

#### Policy:

- Consider codifying an increase to base flood elevation or movable foundation standards for new development.
- Develop real estate disclosure requirements to inform homebuyers of the risk of living adjacent to the coast.

#### Projects:

- Develop a phased long-term managed retreat plan.
- Potentially require any abandonment or retreat to remove derelict or threatened structures.

- Develop dune and shoreline management plans.

#### Monitoring:

- Monitor frequency, duration and depth of impacts.

Figure A1a - Land Use Parcels and Structures: North Coast

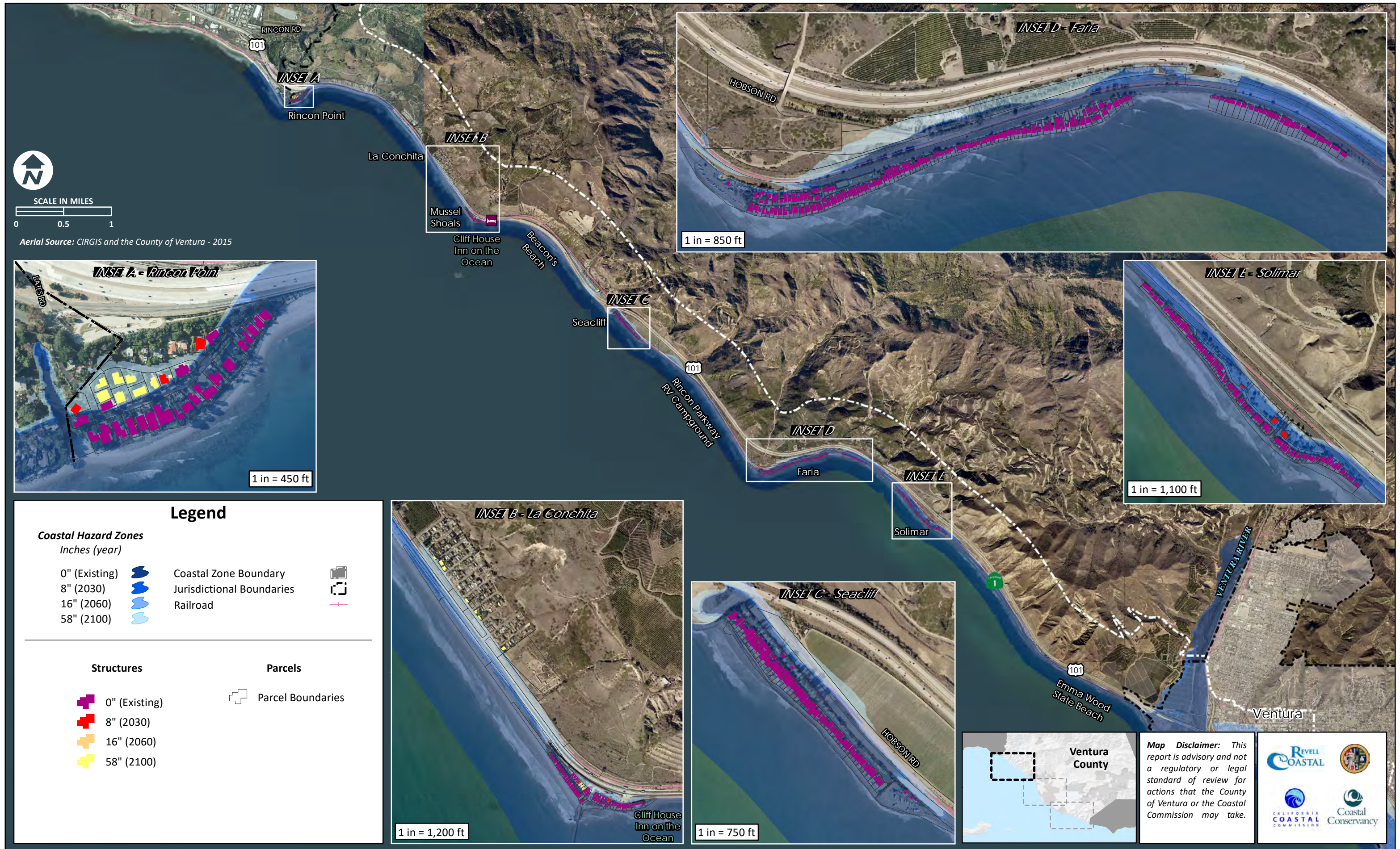
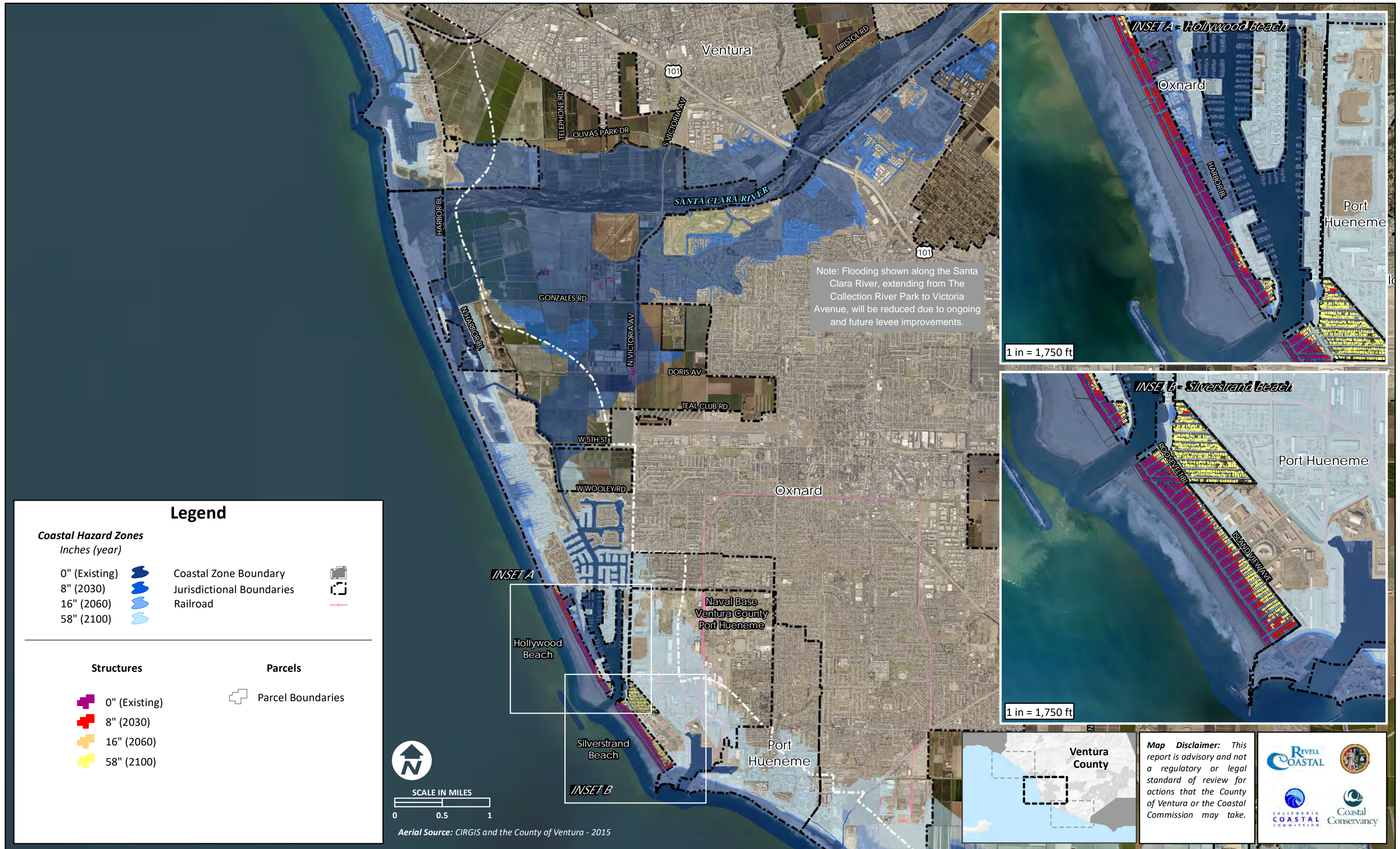
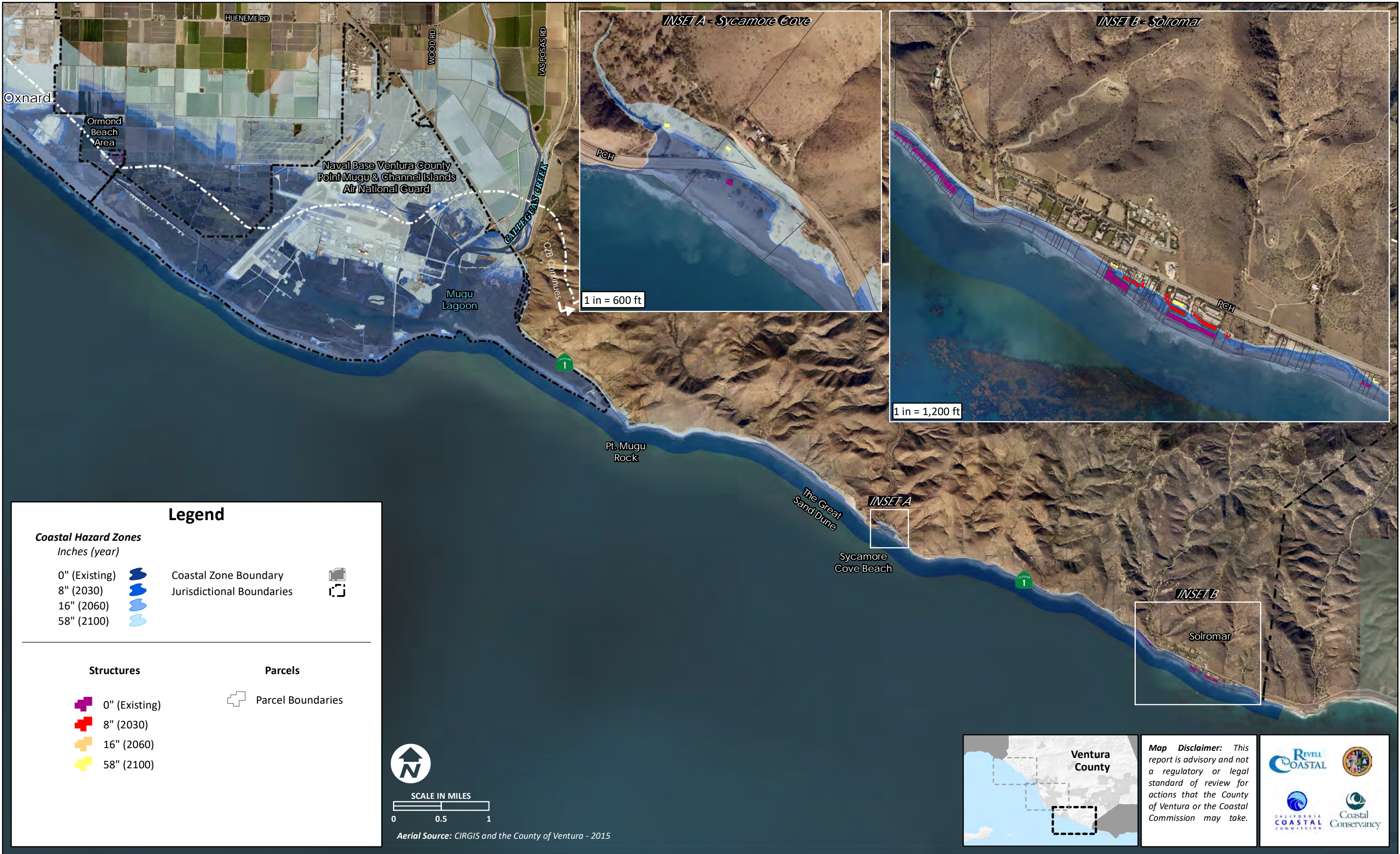


Figure A1b - Land Use Parcels and Structures: Central Coast



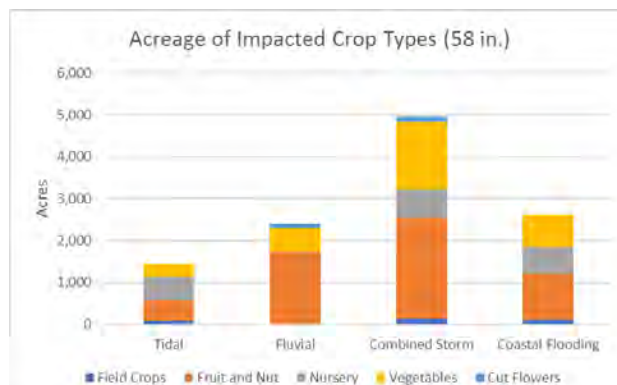
**Figure A1c - Land Use Parcels and Structures: South Coast**





## Overview

Ventura County has approximately 96,000 acres of irrigated farmland and a total acreage in agricultural zoning of nearly 295,000 acres. Some of the top crops grown near the coast in recent years are strawberries, sod, celery and other row crops. The Farmland Monitoring and Mapping Program (FMMP) lands are high-value agricultural soils identified for environmental review purposes under CEQA, with the Farmland Importance categories from highest value downward of Prime, Statewide Importance, Unique, Local Importance, and Grazing Land constituting “agricultural lands.” The estimated value of agricultural land was based on the 2017 Crop & Livestock Report and GIS spatial crop types data. The County has substantial agricultural facilities that may be impacted. For example, Dole has a facility off West Gonzalez Rd. near N. Harbor Blvd., and there are a number of flower nurseries with greenhouses. Impacts to coastal hazards and sea level rise (SLR) on agriculture in coastal areas were quantified by:



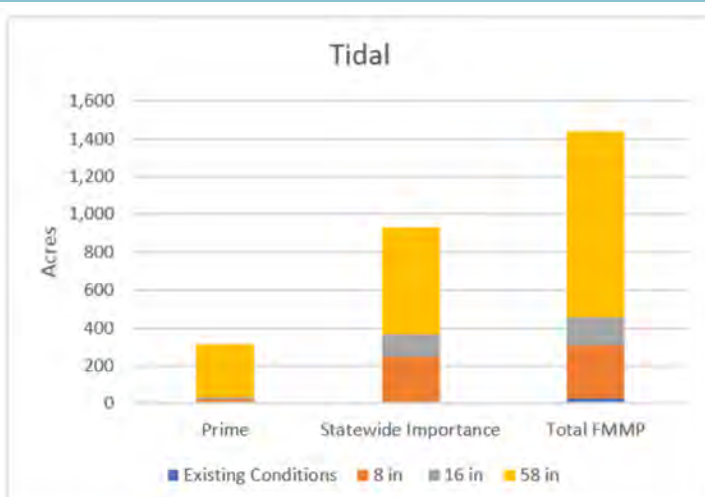
- Acres of Farmland Monitoring and Mapping Program land (FMMP)
- Loss of agricultural productivity from changes in soil salinity based on crop types - \$ Millions (\$M)

## Coastal Erosion and Tidal Inundation

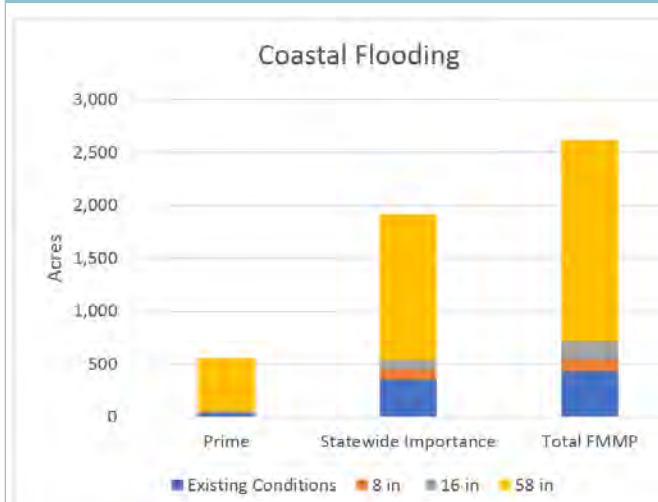
Coastal erosion and tidal inundation are likely to have permanent impacts to agriculture as either a result of the loss of land, or saltwater saturation degrading the soil.

Coastal erosion has minimal impact, and up to seven acres may be exposed to dune erosion with ~5 feet of SLR. Tidal inundation may presently affect 26 acres of FMMP land, 308 acres with 8”, 455 acres with 16”, and 1,440 acres may be impacted with ~5 feet of SLR.

**ECONOMICS:** Losses from erosion now are small (<\$100K), but with ~5 feet of SLR it may affect 7 acres of farmland (<\$500k). However, tidal inundation may impact \$12M of farmland with 8”, \$17M with 16”, and \$51M with ~5 feet of SLR. Assuming a 35% to 75% loss in productivity from tidal inundation compromising soil salinity, crop yields could be reduced by \$4.1M to \$8.7M with 8”, \$5.8M to \$12.4M with 16”, and \$18M to \$38.5M with ~5feet of SLR.



## Coastal Flooding



Coastal storm flooding impacts cause temporary disruption to agricultural operations, but once soil is exposed to saltwater, a shift of crop types away from the highest value crops to lower value ones may be required (e.g. strawberries to celery or grazing). Most impacts from coastal flooding increase between 16” and 58” of SLR with the largest impacts to the FMMP Statewide Importance lands.

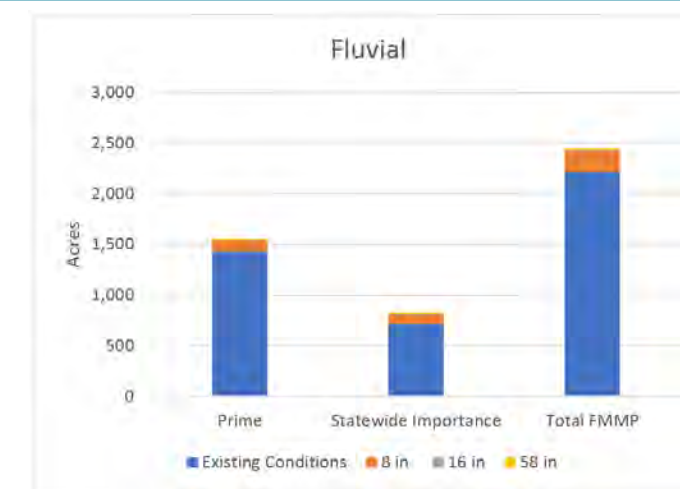
**ECONOMICS:** Coastal flooding could damage \$15.6M in farmland today, rising to \$19.3M with 8 inches, \$23.8M with 16 inches, and \$77.7M with ~5 feet of SLR. Assuming a 15% to 25% loss in productivity losses from coastal floods, crop yields could be reduced by \$11.7M to \$19.4M with ~5feet of SLR and impacts for a 1% annual chance storm.

## Coastal Confluence and Fluvial Flooding

Coastal confluence and fluvial flooding are likely to cause temporary damages and disruption to agriculture, but may serve to improve the quality of the soil by replenishing it with new sediment and reinvigorating some of the soils.

Most fluvial impacts to agriculture occur in the existing floodplains and hazard zones. The SLR influence on fluvial flooding is around 2,430 acres on the Santa Clara River, most of which occurs between existing conditions and 8” of SLR.

**ECONOMICS:** Fluvial flooding economic impacts were not estimated in this report. One significant risk of flooding is potential contamination of farmland.



## Potential Adaptation Strategies

**Range of Strategies:** Includes “No Action” and cleanup, as well as retreat, accommodate and protection strategies.

**Accommodate** - Includes elevating farmhouses and barns. Choose salinity-tolerant crops and explore aquaculture in areas impacted by rising tides. Flood plain easements can compensate farmers for allowing fluvial processes to occur.

**Protect** – Constructing levees and coastal armoring to reduce vulnerabilities is the “gray” protection approach, which has traditionally been implemented along the shoreline and rivers. A “green” protection approach in the Central Coast would be to augment sand dunes or contour horizontal levees to protect against future coastal and fluvial hazards.

**Retreat** - Includes policy and/or regulatory options (e.g. transfer of development and rolling easements) as well as purchase of the vulnerable properties. Retreat options are limited by the absence of large tracts of vacant suitable land.

**Secondary Impacts:** Retreat strategies have secondary impacts due to the loss of agricultural properties and subsequent decline in soil quality. Gray protection options would result in a loss of beaches and soil quality over time. Green protection strategies may benefit agriculture by managing some freshwater flooding that improves soil quality while protecting from seawater intrusion and tidal inundation.

## Findings

### Summary

- Under existing conditions, fluvial hazards could impact over 2,400 acres of high value farmland along the Santa Clara and Ventura Rivers which may add nutrients and top soil, but also pollutants.
- Tidal inundation and erosion may permanently affect >1,400 acres of agricultural lands with ~5 feet of SLR.
- Agriculture faces added challenges from temperature changes and salt water intrusion not analyzed here.
- High value crops like strawberries are sensitive to soil salinity, which will increase with exposure to coastal hazards and SLR, requiring a shift to lower value crops.

### Threshold:

- Between 16” and 58”, coastal flooding and tidal inundation vulnerabilities escalate substantially.

### Strategy Options

#### Policy

- Expand the floodplain easement program.
- Update the Land Conservation Act Program with a focus on areas projected to be tidally inundated.

#### Projects and Monitoring

- Conduct detailed analysis of climate change on specific crops and agricultural lands.
- Potentially require any abandonment or retreat strategies to remove derelict or threatened structures.
- Evaluate the effect of saltwater intrusion into groundwater basins and rising salinity in the irrigation water supply.
- Monitor frequency, duration and depth of flooding and soil salinity at low lying areas around the County.

Figure A2a - Agriculture: North Coast

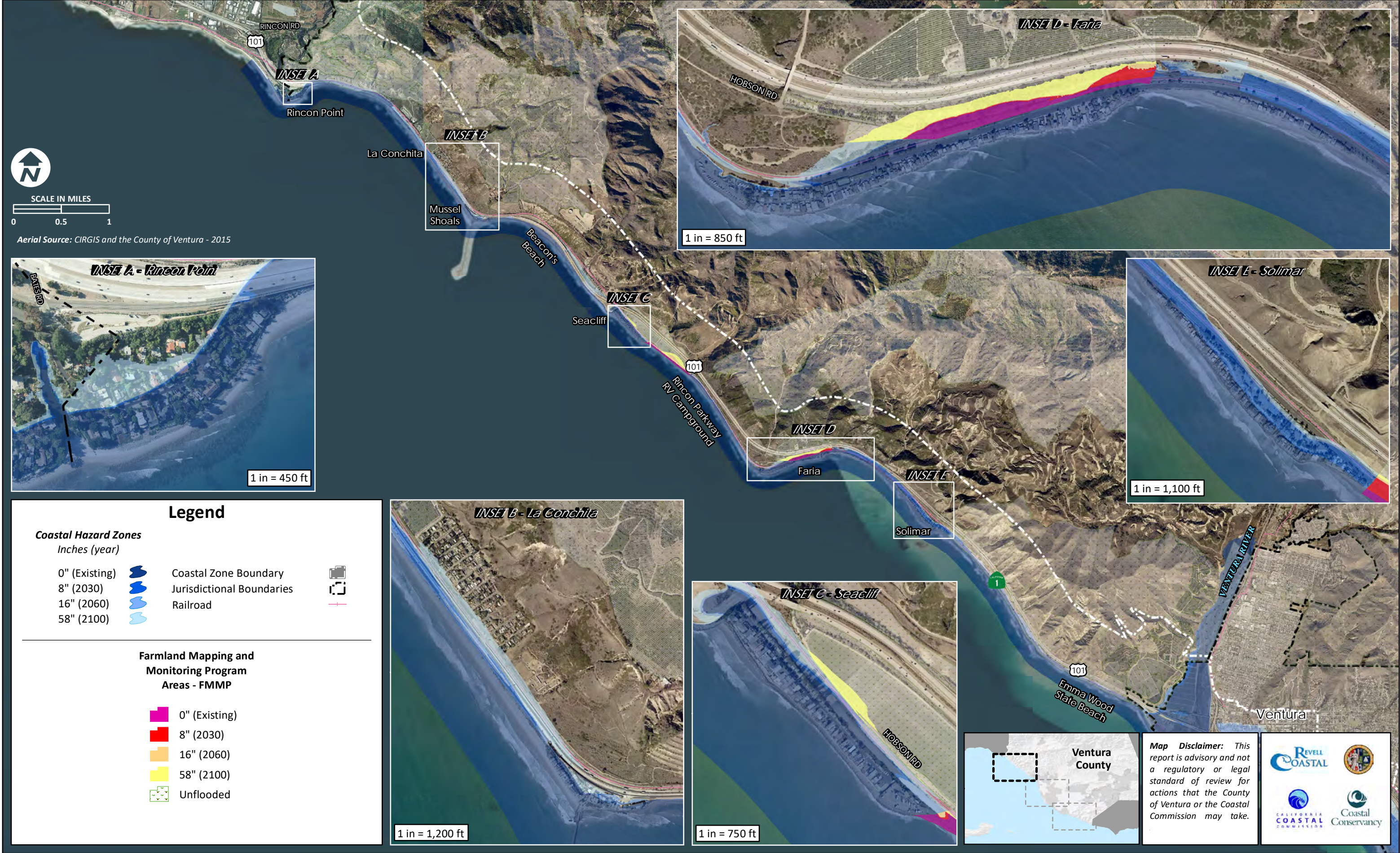


Figure A2b - Agriculture: Central Coast

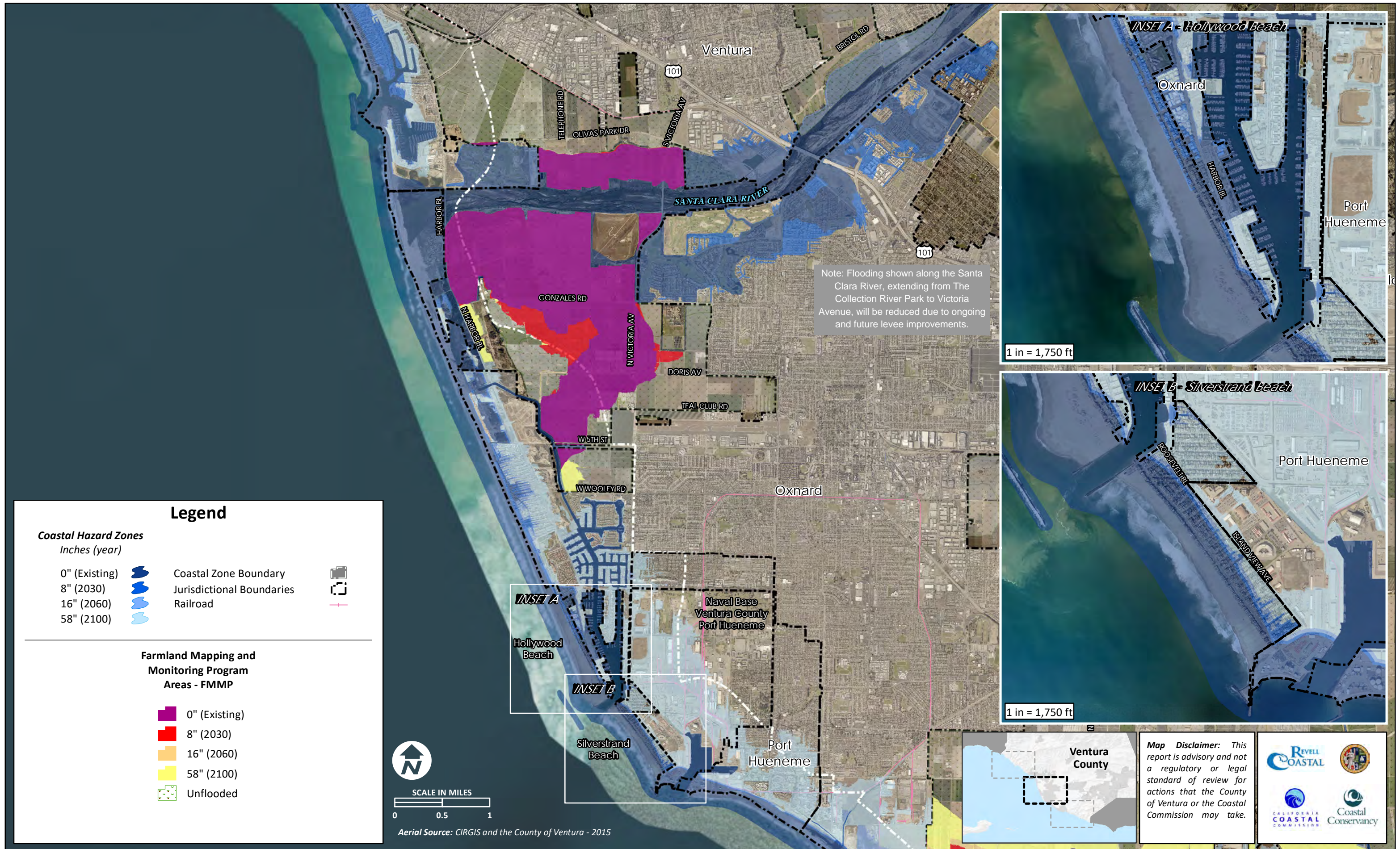
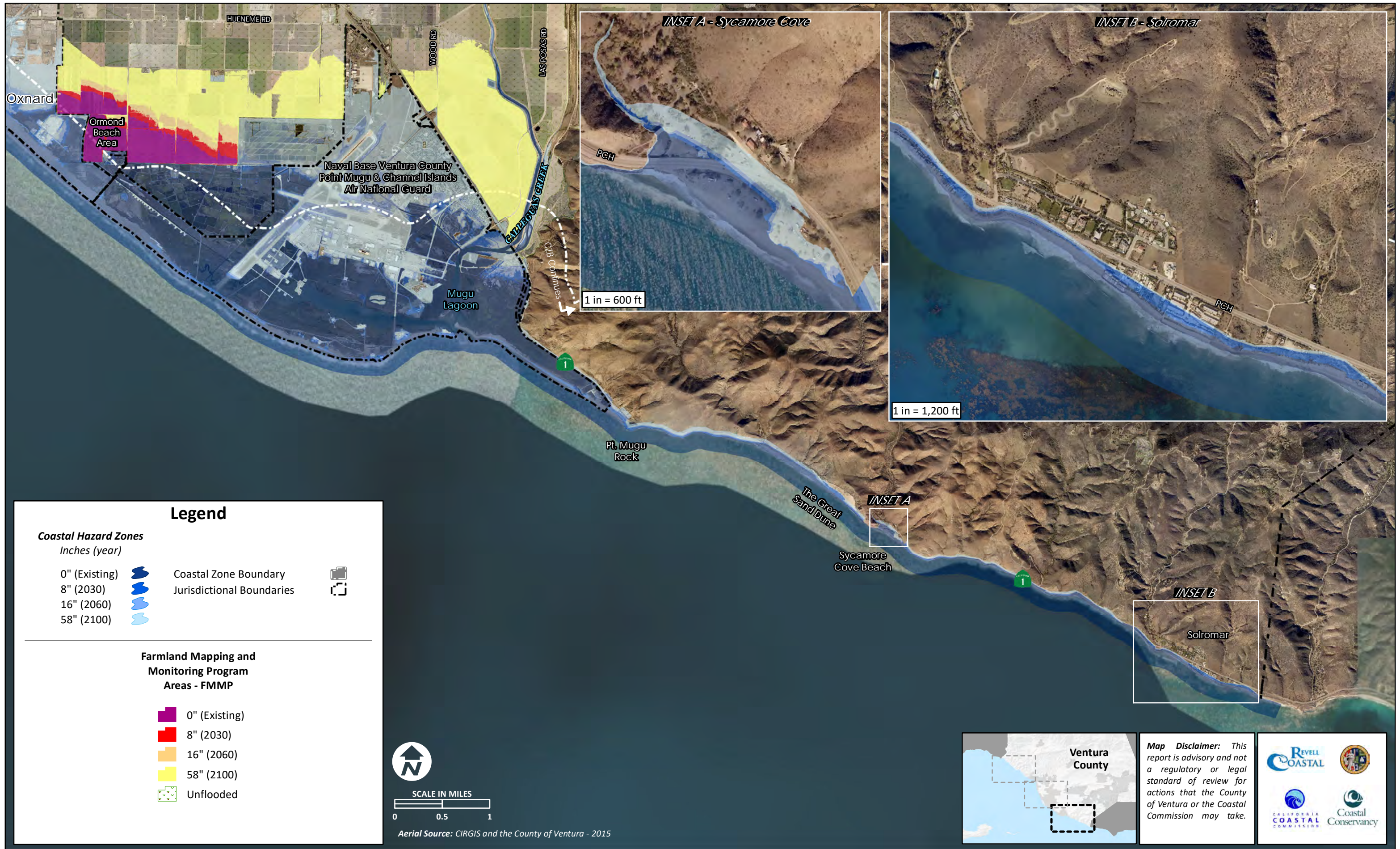


Figure A2c - Agriculture: South Coast



## Overview

The wastewater system is comprised of 17 wastewater districts located throughout the County. The County Water and Sanitation Department oversees the wastewater collection system. Currently, most of the wastewater from the coastal zone is processed at regional wastewater treatment plants, the Ventura Wastewater Treatment Facility (in the City of Ventura), and the Oxnard Wastewater Treatment Plant (in the City of Oxnard). Community Service Area 29 provides service to most of the North Coast, with infrastructure that extends from Mussel Shoals south to the City of Ventura. The North Coast community of La Conchita, as well as buildings in the South Coast, use septic systems, but there is no uniform spatial dataset available to evaluate impacts to septic systems. There is however a public bathroom on septic in Sycamore Cove State Park and a small private wastewater treatment facility associated with the Malibu Bay Club in Solromar (not impacted).

Impacts of coastal hazards and sea level rise (SLR) were quantified using the following measures of impacts:

- Number of pump stations**
- Number of shut off valves**
- Number of manholes**
- Length of pipe (miles)**
- Treatment plants**

*Note: Erosion modeling was not conducted on the North Coast, yet erosion may cause vulnerabilities in this area. Replacement cost of pipes from erosion was estimated to be \$230 per foot.*

## Existing Vulnerabilities

<b>Coastal Flooding</b>	Under existing conditions, there are no impacts from erosion or tidal inundation to the wastewater system, although if existing coastal armoring on the North Coast were to fail, then additional impacts should be expected.
<ul style="list-style-type: none"> <li>• 2 pump stations / 1 valve</li> <li>• 28 manholes</li> <li>• 9.5 miles of pipe</li> </ul>	Coastal flooding may temporarily impact the pump stations at Seacliff and Faria during large wave events ((1% chance annual storm) as well as an emergency shut off valve just south of Faria. Impediments to accessing the shut off valve caused by a large wave event increase the potential for a sewage spill. Nine and a half miles of pipe are susceptible to coastal flood hazards along the Rincon Parkway and at Hollywood Beach.

## Projected Vulnerabilities

### 8 inches by ~2030

<b>Coastal Erosion</b>	Coastal dune erosion could impact 1.5 miles of wastewater pipe in the Central Coast and 21 manholes in the Hollywood Beach neighborhood.
<ul style="list-style-type: none"> <li>• 1.5 miles of pipe</li> <li>• 21 manholes</li> </ul>	Replacement cost of these pipes is estimated on the order of \$1.8 million.
<b>Coastal Flooding</b>	Coastal flooding is projected to impact an additional pump station in Solimar, and an additional 1.8 miles of pipe along the Rincon Parkway and at Hollywood Beach.
<ul style="list-style-type: none"> <li>• 1 pump station</li> <li>• 5 manholes</li> <li>• 1.8 miles of pipe</li> </ul>	

### 16 inches by ~2060

<b>Coastal Erosion</b>	Coastal dune erosion could impact an additional 0.8 miles of wastewater pipe in the Hollywood Beach neighborhood.
<ul style="list-style-type: none"> <li>• 0.8 miles of pipe</li> <li>• 6 manholes</li> </ul>	Replacement cost of these pipes is estimated on the order of \$1.0 million.
<b>Coastal Flooding</b>	Coastal flooding is projected to impact an additional 0.9 miles of pipe and two manholes along the Rincon Parkway, at Silverstrand, and at Hollywood Beach.
<ul style="list-style-type: none"> <li>• 0.9 miles of pipe</li> <li>• 2 manholes</li> </ul>	

### 58 inches by ~2100

<b>Tidal Inundation</b>	Tidal inundation with ~5 feet of SLR may affect a total of 1.7 miles of pipe and limit routine accessibility to the pipe. Twenty six manholes exposed with ~5 feet of SLR may result in substantial salt water inundating and corroding the wastewater system.
<ul style="list-style-type: none"> <li>• 1.7 miles of pipe</li> <li>• 26 manholes</li> </ul>	

### Coastal Erosion

- 1.0 miles of pipe
- 14 manholes

### Coastal Flooding

- 1 pump station
- 19 manholes
- 2.3 miles of pipe

The restroom site at Sycamore Cover Beach may also be inundated.

Dune erosion with ~5 feet of SLR may affect a combined total of 3.3 miles of wastewater pipe in the Central Coast and 41 manholes in Hollywood Beach and Silverstrand. Replacement cost of these pipes is estimated to be ~\$4 million.

Coastal flooding with ~5 feet of SLR may affect a combined total of 14.5 miles of pipe along Rincon Parkway, at Silverstrand, and at Hollywood Beach neighborhoods, as well as potentially impact four pump stations and the bathroom at Sycamore Cove State Park.

## Potential Adaptation Strategies

**Range of Strategies:** A range of strategies include retreat, elevating key vulnerable infrastructure, increasing conveyance and pumping capacity, and completing flood proofing retrofits to protect existing system components.

**Accommodate:** Elevating vulnerable components of pump stations and shut off valves may accommodate some SLR. State Parks could elevate the restroom storage tank or further flood proof the facility at Sycamore Cove.

**Protect:** Complete flood-proofing retrofits to the vulnerable pump stations in order to protect electrical and pump system operations. This may provide a short-term relatively low-cost option to accommodate several feet of SLR. Sealing manholes can reduce the potential for coastal flood waters from overwhelming the sewage system. Coastal armoring (gray), or enhanced sand dunes (green) would provide protection from coastal erosion and flooding.

**Retreat:** Phased relocation of the wastewater infrastructure must be tied to a community wide managed retreat strategy and coordinated with the regional wastewater treatment plants located in neighboring jurisdictions. Erosion and tidal inundation could necessitate retreat strategies, particularly for septic systems and the restroom at Sycamore Cove.

**Secondary Impacts:** Vary based on approach and integration of adaptation measures to community adaptation planning. Failure in the system could cause pollution to spill into the ocean or the Santa Clara River and Ormond Beach estuaries. If the wastewater treatment plants in the cities of Ventura and Oxnard are exposed to hazards, the unincorporated areas that are serviced by these plants will be impacted.

## Findings

Summary	Strategy Options
<ul style="list-style-type: none"> <li>• No pump stations, shut off valves or treatment plants are susceptible to coastal erosion or tidal inundation even with ~5 feet of SLR, although impacts may occur if coastal armoring along the North Coast fails.</li> <li>• Two pump stations are currently exposed to flooding, and four pump stations are vulnerable with ~5 feet of SLR.</li> <li>• Nearly 9.5 miles of wastewater pipe are currently exposed to existing flooding hazards, this vulnerability increases with ~5 feet of SLR to 14.5 miles.</li> <li>• Both the wastewater treatment plants in Ventura and Oxnard become exposed to tidal and coastal flooding by ~5 feet of SLR.</li> </ul> <p><b>Thresholds:</b></p> <ul style="list-style-type: none"> <li>• With 8" of SLR, erosion hazards potentially erode 1.5 miles of wastewater pipe. Three pump stations would be vulnerable to coastal flooding.</li> <li>• With ~5 feet of SLR, tidal inundation affects 26 manholes.</li> </ul>	<p><b>Policy:</b></p> <ul style="list-style-type: none"> <li>• Encourage regional dialog about the future location of the sewer network or upgrades to existing treatment plants.</li> <li>• Add policy language to require relocation or avoidance of wastewater hazards to the extent possible.</li> </ul> <p><b>Projects:</b></p> <ul style="list-style-type: none"> <li>• Relocate pipe segments susceptible to coastal erosion. Prioritize sections by timing of impact.</li> <li>• Conduct advanced maintenance to keep lines clear.</li> <li>• Recommend flood proofing the pump stations.</li> <li>• Retrofit manholes to reduce flooding into sewer system.</li> <li>• Work with State Parks to flood-proof the restroom facility at Sycamore Cove.</li> </ul> <p><b>Monitoring:</b></p> <ul style="list-style-type: none"> <li>• Continue to monitor the groundwater levels and salinity levels to understand the impact of both on sewer capacity.</li> </ul> <p><b>Data Gaps:</b></p> <ul style="list-style-type: none"> <li>• Missing data on pipes, connections with treatment plants, and septic systems in South Coast at Solromar, and at La Conchita.</li> </ul>

Figure A3a - Waste Water: North Coast

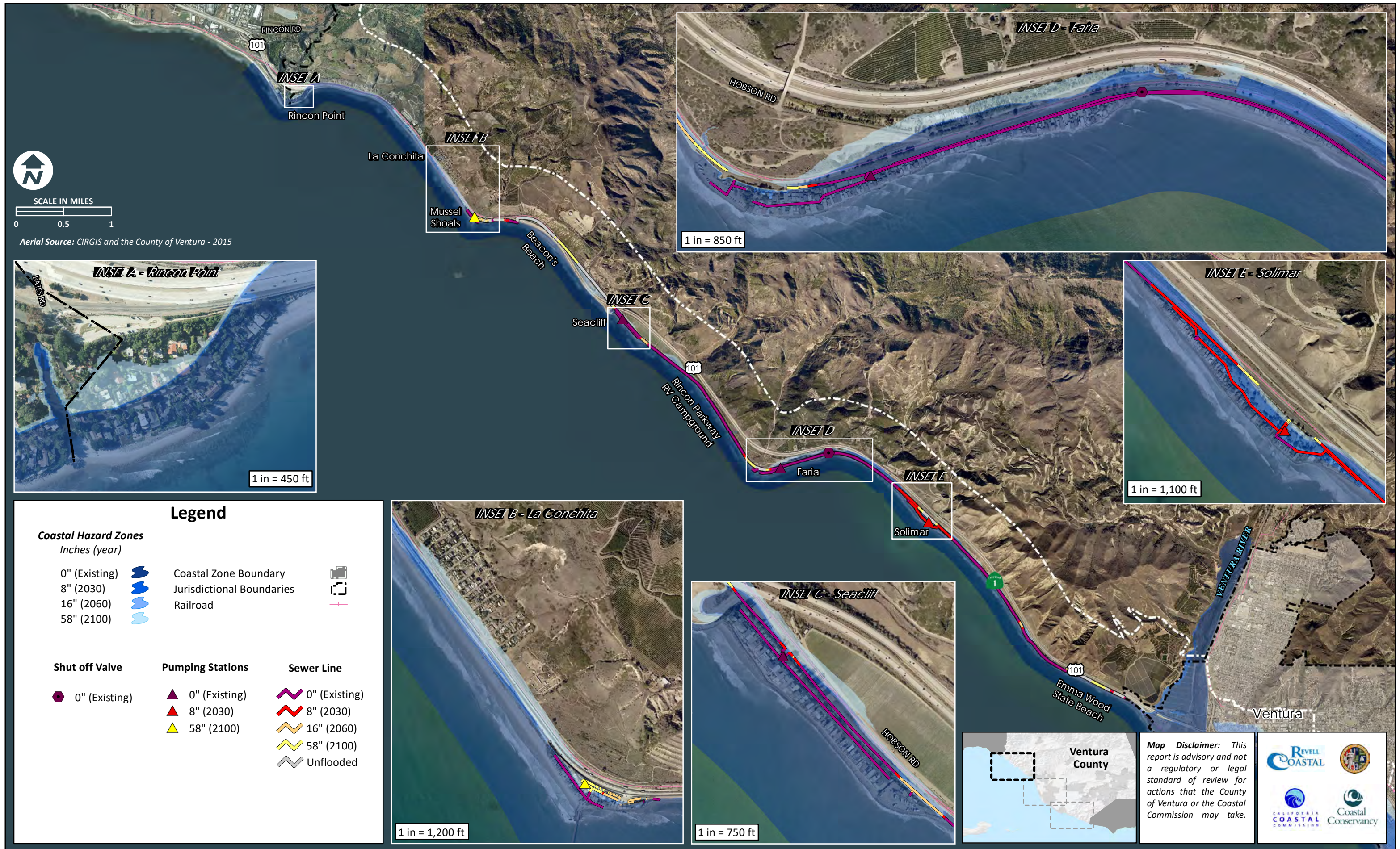


Figure A3b - Waste Water: Central Coast

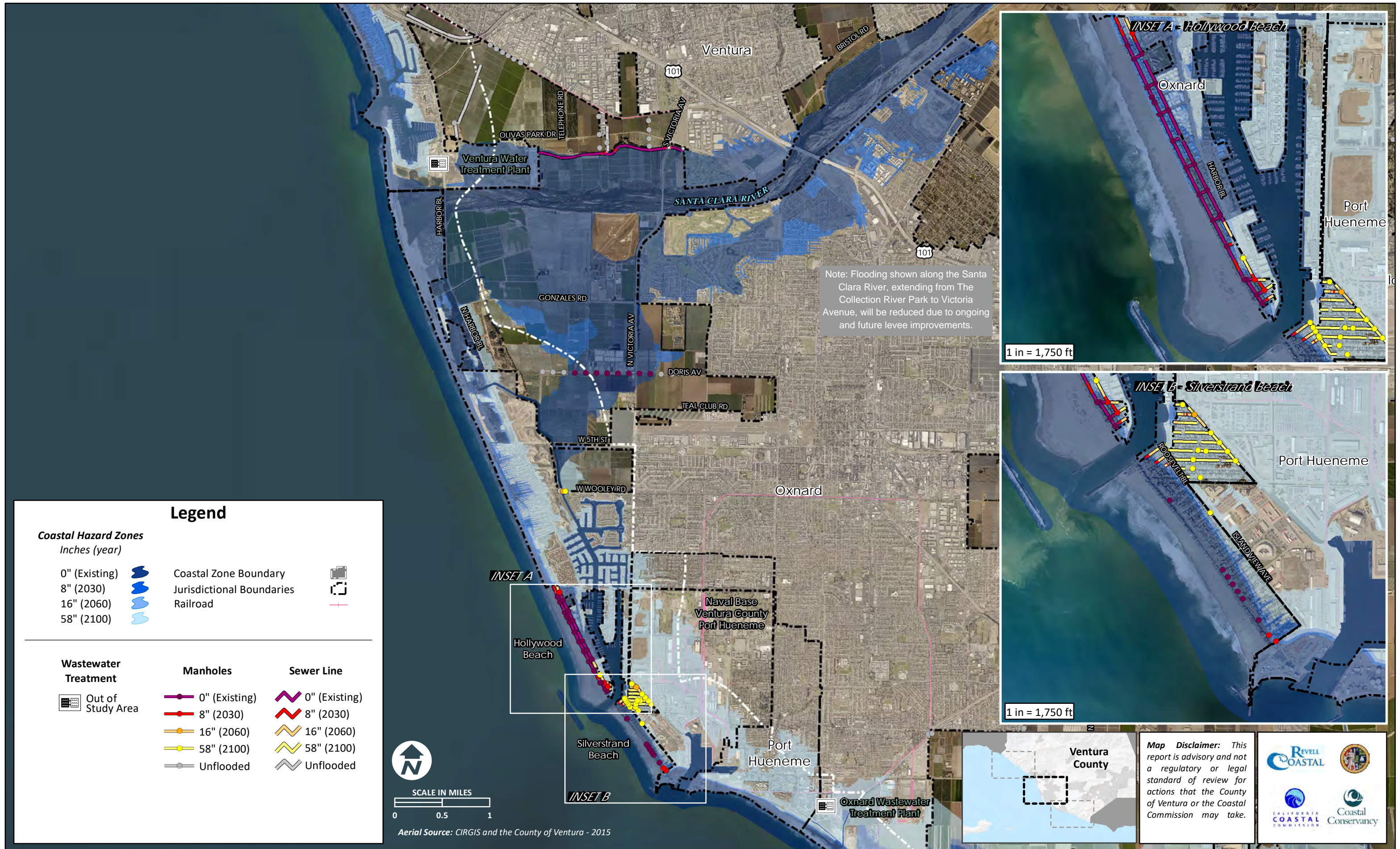
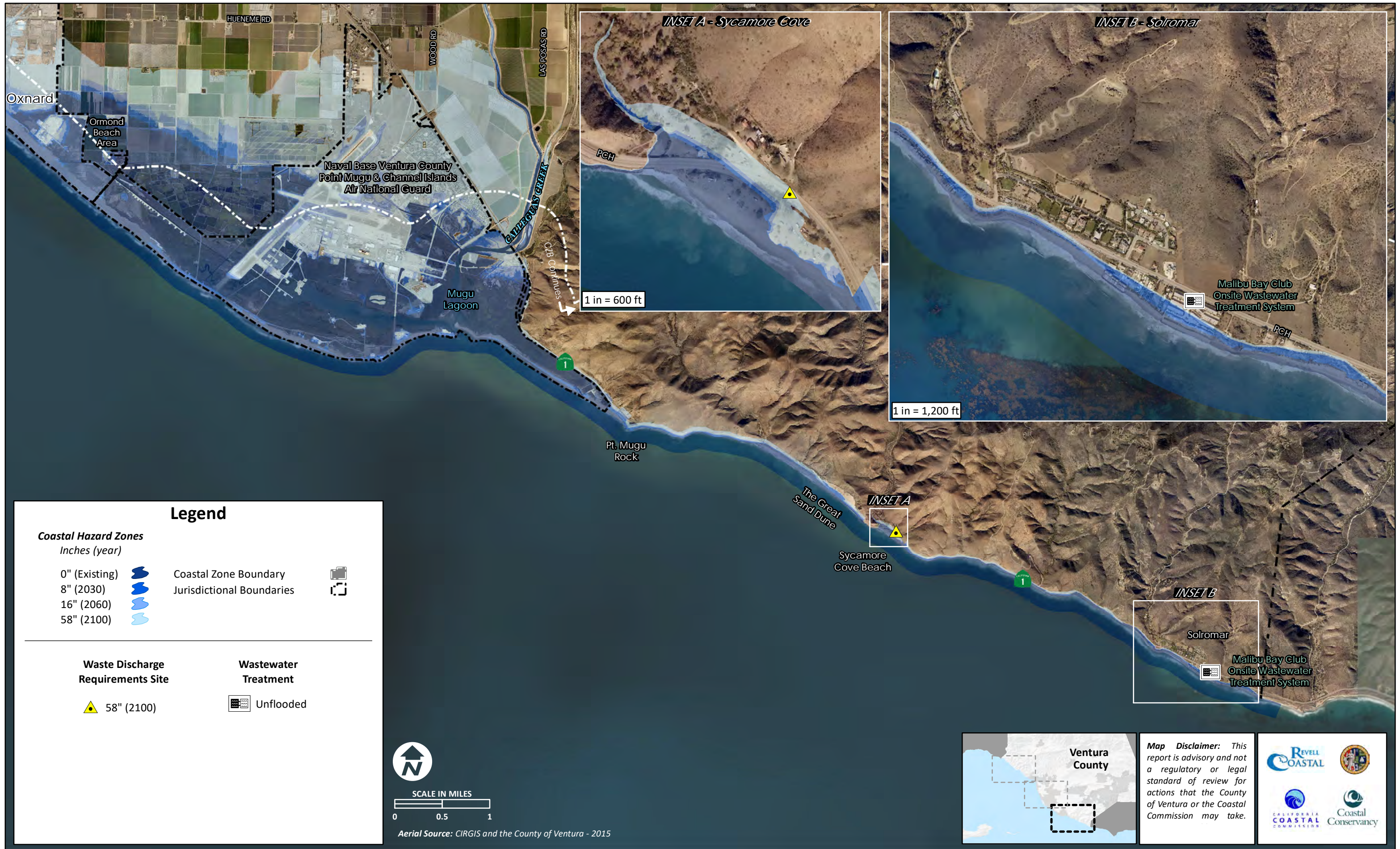


Figure A3c - Waste Water: South Coast





## Overview

Ventura County's stormwater system is managed by the Ventura County Watershed Protection District, responsible for stormwater management, flood control, and floodplain management. The stormwater system consists of a series of flood control channels, storm drain inlets and culverts that discharge to the nearest body of water using gravity flow. A substantial storm drain system is near current sea level in the neighborhoods of Silverstrand and Hollywood Beach. Storm drains have historically backed up at several locations in these neighborhoods. Presently, one pump station at Silverstrand diverts stormwater to a wastewater treatment plant for treatment. As sea level rises, portions of the system may not drain during high tides and during more of the tide cycle, which in turn increases flood depths and frequency. Culverts and pipes may also cause ocean water to flow into these neighborhoods.

Impacts of coastal hazards and sea level rise (SLR) on stormwater infrastructure, were quantified by:

- **Number of pumps**
- **Number of storm drain inlets**
- **Number of detention basins**
- **Number of culverts**
- **Length of pipe** (replacement cost from erosion estimated using \$230 per foot)

## Existing Vulnerabilities

<p><b>Tidal Inundation</b></p> <ul style="list-style-type: none"> <li>• 2 basins</li> <li>• 3.2 miles of pipe</li> </ul> <p><b>Coastal Erosion</b></p> <ul style="list-style-type: none"> <li>• 600 feet of pipe</li> </ul> <p><b>Coastal Flooding</b></p> <ul style="list-style-type: none"> <li>• 58 inlets</li> <li>• 8 basins/ 3 pumps</li> <li>• 5.7 miles of pipe</li> </ul>	<p>Tidal inundation may presently impact 3.2 miles of storm drains, and two detention basins located in Faria.</p> <p>Coastal erosion during a 1% annual chance storm may impact 600 feet of pipe in the Hollywood Beach and Silverstrand neighborhoods. Replacement cost of these pipes is estimated at \$140,000.</p> <p>Coastal flooding from a 1% annual chance storm may presently impact 58 storm drain inlets and 5.7 miles of pipes. Two pump stations in Silverstrand and one in Solimar may also be affected during large wave events. Eight detention basins are also potentially impacted at Mussel Shoals and Faria.</p>
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## Projected Vulnerabilities

### 8 inches by ~2030

<p><b>Tidal Inundation</b></p> <ul style="list-style-type: none"> <li>• 0.4 miles of pipe</li> </ul> <p><b>Coastal Erosion</b></p> <ul style="list-style-type: none"> <li>• 42 inlets / 2 pumps</li> <li>• 2 basins</li> <li>• 1.2 miles of pipe</li> </ul> <p><b>Coastal Flooding</b></p> <ul style="list-style-type: none"> <li>• 11 inlets / 1 basin</li> <li>• 0.8 miles of pipe</li> </ul>	<p>Tidal inundation may impact an additional 0.4 miles of storm drains in Hollywood Beach and Silverstrand.</p> <p>Coastal erosion is projected to potentially damage 42 inlets, 2 pumps and 1.2 miles of pipe in the southern portions Hollywood Beach and Silverstrand neighborhoods. In addition to 2 detention basins in Hollywood Beach, one on Sunset Ln. near Las Palmas St., and one on Ocean Dr. near Los Robles St. Replacement cost of these pipes is estimated at \$1.5 million.</p> <p>Coastal flooding from a 1% annual chance storm may impact an additional 11 storm drain inlets and 0.8 miles of pipes in the Hollywood Beach and Silverstrand neighborhoods. One detention basin on Sunset Ln. near Las Palmas St. in Hollywood Beach may be impacted.</p>
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### 16 inches by ~2060

<p><b>Tidal Inundation</b></p> <ul style="list-style-type: none"> <li>• 1 basin</li> <li>• 0.9 miles of pipe</li> </ul> <p><b>Coastal Erosion</b></p> <ul style="list-style-type: none"> <li>• 21 inlets / 2 basins</li> <li>• 0.4 miles of pipe</li> </ul> <p><b>Coastal Flooding</b></p> <ul style="list-style-type: none"> <li>• 9 inlets / 1 basins</li> <li>• 1.4 miles of pipe</li> </ul>	<p>Tidal inundation may impact an additional 0.4 miles of storm drains, and 1 detention basin located at the end of Casper Rd. near the Ventura County Game Preserve.</p> <p>Coastal erosion may damage 21 inlets, 2 basins and additional 0.4 miles of pipe in the Hollywood Beach and Silverstrand neighborhoods.</p> <p>Replacement cost of these pipes is estimated at \$485,000.</p> <p>Coastal flooding from a 1% annual chance storm may impact an additional 9 storm drain inlets and 1.4 miles of pipes in the southern Hollywood Beach and Silverstrand neighborhoods. In addition, one detention basin may also be impacted at McGrath State Beach near the N. Harbor Blvd. Bridge.</p>
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### 58 inches by ~2100

<p><b>Tidal Inundation</b></p> <ul style="list-style-type: none"> <li>• 53 inlets / 2 pumps</li> <li>• 3 basins</li> <li>• 5.4 miles of pipe</li> </ul> <p><b>Coastal Erosion</b></p> <ul style="list-style-type: none"> <li>• 20 inlets</li> <li>• 0.7 miles of pipe</li> </ul> <p><b>Coastal Flooding</b></p> <ul style="list-style-type: none"> <li>• 12 inlets /9 culverts</li> <li>• 8 basins</li> <li>• 3.6 miles of pipe</li> </ul>	<p>Tidal inundation may impact a combined total of 10 miles of storm drains, 2 pumps, and 3 detention basins located near Naval Base Ventura County at the Pt. Mugu Duck Club, the Casper Rd. Ditches north of the Ventura County Game Preserve, and the Mugu Drain adjacent to the Point Mugu Naval Air Weapons Station . This infrastructure was previously impacted by other hazards with less sea level rise.</p> <p>Coastal erosion is projected to potentially damage a combined 83 inlets, 3 basins and 2 pumps and 2.0 miles of pipe across the County.</p> <p>Total replacement cost of these pipes is estimated at \$2.4 million.</p> <p>Coastal flooding from a 1% annual chance storm may impact a combined total of 90 storm drain inlets, 18 basins, 3 pumps, and 12 miles of pipes across the County. Nine culverts which drain La Conchita and around McGrath Lake are projected to be vulnerable with ~5 feet of SLR.</p>
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## Potential Adaptation Strategies

**Range of Strategies:** A range of strategies include retreat, elevating key vulnerable infrastructure, and increasing conveyance and pumping capacity, or flood proofing retrofits to protect existing system components.

**Accommodate:** Increasing the pump capacity, creating detention basins and expanding the size of the conveyance are mid-term solutions, which may accommodate several feet of sea level rise. Floodplain easements can reduce fluvial flooding. In the Central Coast, accommodation efforts must be coordinated with the Harbor Department.

**Protect:** Flood proof retrofits to the vulnerable pump stations to protect electrical and system operations may provide a short term relatively low-cost option to accommodate sea level rise. Consider other infrastructure improvements to divert storm water away from low-lying neighborhoods.

**Retreat:** Phased relocation of the stormwater infrastructure must be tied to a community wide managed retreat strategy.

**Secondary Impacts:** Vary based on approach and integration of adaptation measures to community adaptation planning. Debris accumulation before and during storm events can exacerbate coastal flooding impacts. Additional detention basins could help recharge groundwater aquifers. Stormwater carries hazardous materials and pollutants.

## Findings

Summary	Strategy Options
<ul style="list-style-type: none"> <li>• Increasing tidal inundation poses the largest threat over time due to reduced stormwater conveyance.</li> <li>• Silverstrand &amp; Hollywood Beach are already vulnerable to coastal flooding with a 1% annual chance storm and high tides.</li> <li>• With ~5 feet of SLR, much of the Central Coast gravity-fed system will likely be impacted during routine high tides and may not function effectively on a regular basis.</li> <li>• With ~5 feet of SLR, nine culverts at La Conchita and McGrath Lake may be impacted by coastal flooding.</li> <li>• Erosion threatens 2 miles of pipe with ~5 feet of SLR.</li> </ul> <p><b>Thresholds:</b></p> <ul style="list-style-type: none"> <li>• With 8" of sea level rise, erosion may impact many storm drains in Hollywood Beach and Silverstrand.</li> <li>• With ~5' of SLR, stormwater conveyance from La Conchita and near McGrath Lake may also be impacted.</li> </ul> <p><b>Data gaps:</b></p> <ul style="list-style-type: none"> <li>• No pipes are shown connecting the stormwater pump stations suggesting that data may be missing.</li> </ul>	<p><b>Policy:</b></p> <ul style="list-style-type: none"> <li>• Increase base flood elevation of new development to reduce potential storm water flood impacts.</li> <li>• Revise stormwater policies in the Local Coastal Program, Capital Improvement Plan, and General Plan addressing sea level rise and future decline in conveyance.</li> <li>• Develop a Stormwater Master Plan for Hollywood Beach and Silverstrand.</li> </ul> <p><b>Projects:</b></p> <ul style="list-style-type: none"> <li>• Conduct a stormwater system analysis that examines alternative pump locations, capacity, and expanded conveyance.</li> <li>• Consider adding flap gates after expanding capacity.</li> <li>• Develop stormwater retention basins that allow for reuse or release once tides drop to efficient levels.</li> </ul> <p><b>Monitoring and Maintenance:</b></p> <ul style="list-style-type: none"> <li>• Monitor frequency, duration and depth of stormwater at low lying areas around the County.</li> <li>• Remove debris from inlets and culverts before storms.</li> </ul>

Figure A4a - Stormwater: North Coast

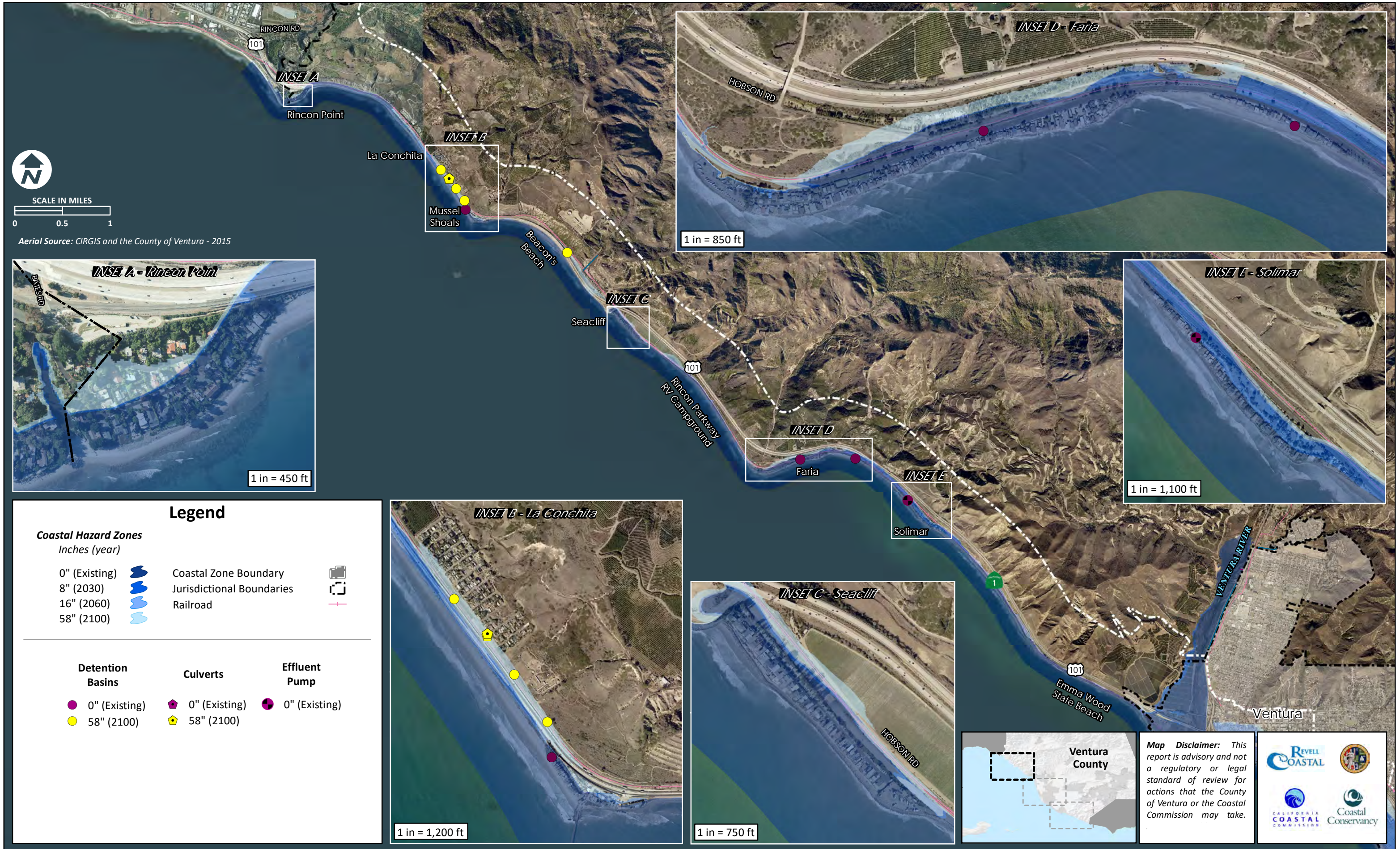


Figure A4b - Stormwater: Central Coast

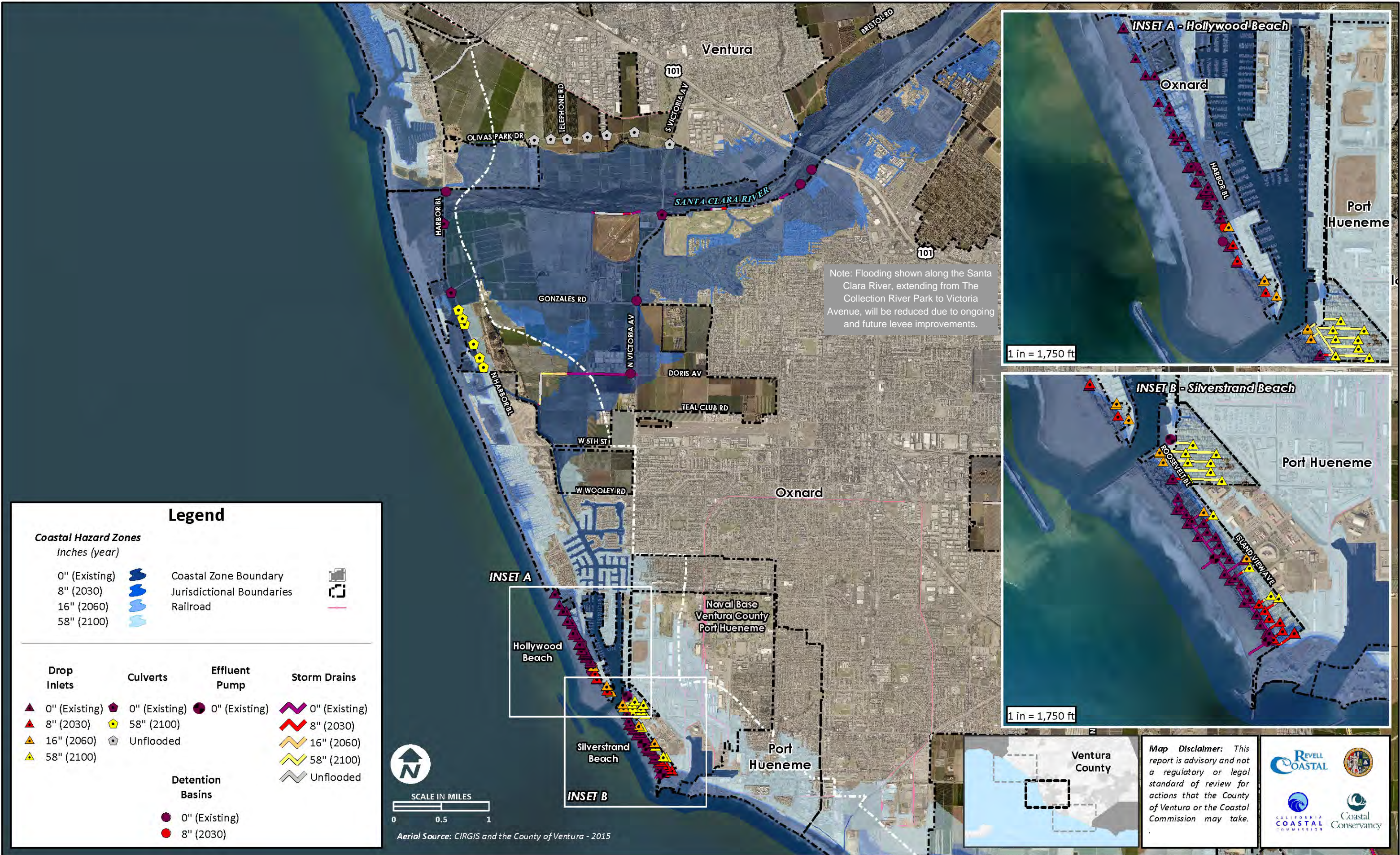
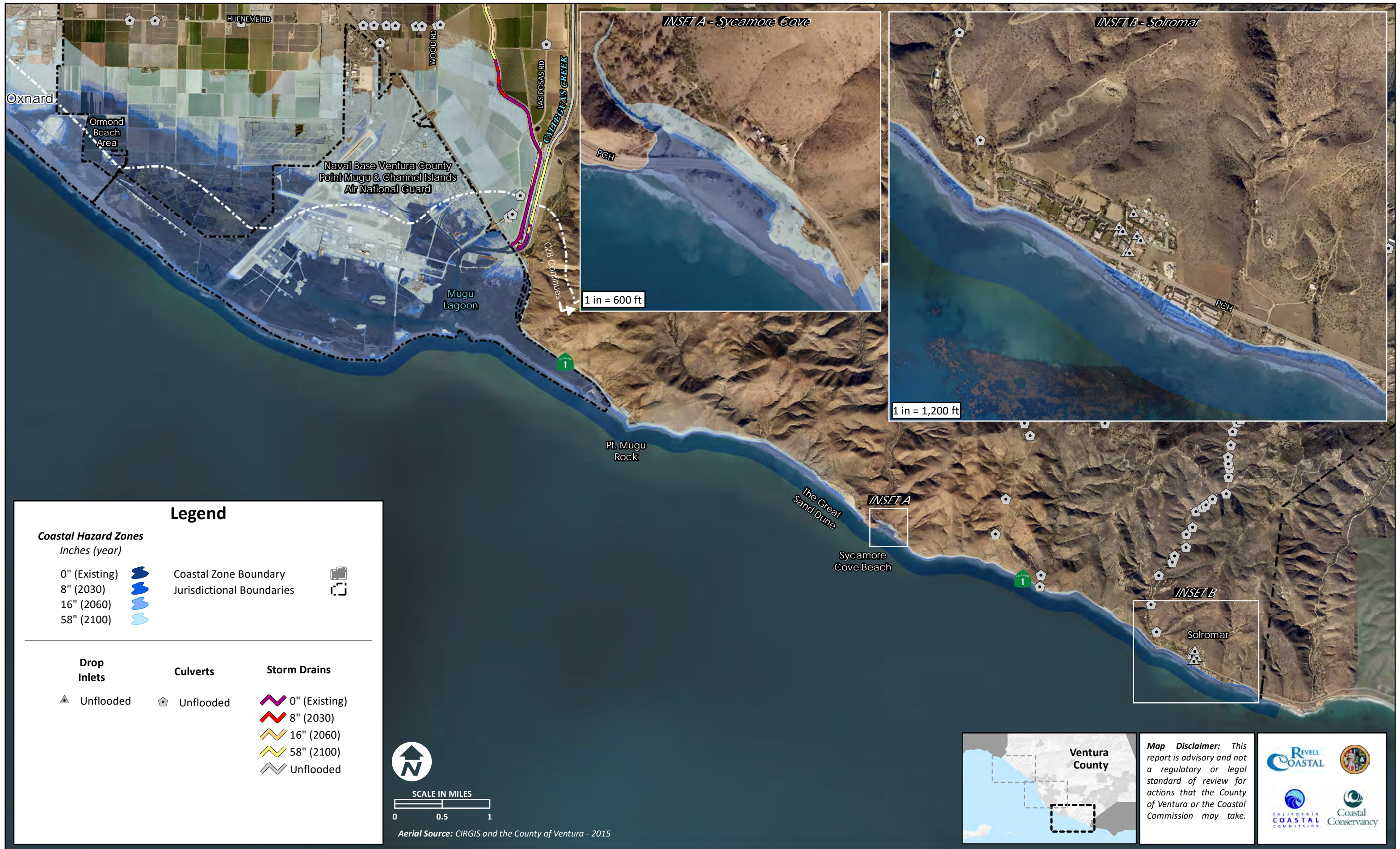


Figure A4c - Stormwater: South Coast



## Overview

The County’s coastal water supply system is managed by three water districts: Casitas Municipal District supplies water to the North Coast, United Water Conservation District supplies water to the Central Coast, and Calleguas Municipal District supplies water to the South Coast. Total annual water demand for cities and farms within Ventura County is about 445,000 acre feet with about 56% being used for agriculture. Most of the water supply comes from groundwater basins, but also from surface water primarily diverted from the Santa Clara and Ventura Rivers, imported state water, and recycled water. There are many water supply initiatives and local groundwater sustainability agencies that are coordinated through the Integrated Regional Watershed Management Plan and the Sustainable Groundwater Management Act. Higher average temperatures could increase evapotranspiration causing an increase in water use and crop irrigation. The focus of this water supply analysis is solely on supply infrastructure exposure to existing and future coastal hazards. Impacts of coastal hazards and sea level rise (SLR) on water supply infrastructure, were quantified by:

- **Length of pipes (feet)**
- **Number of wells**
- **Number of lift stations**

While the coastal flooding analysis shows that some pipes are vulnerable, if they are buried or elevated, periodic flooding may not be a problem unless there is a need to access the pipes for maintenance or system management. Replacement costs of pipes from erosion was estimated using \$230 per foot.

*Note: Erosion modeling was not conducted on the North Coast and erosion may cause vulnerabilities in this area.*

## Existing Vulnerabilities

<p><b>Coastal Flooding</b></p> <ul style="list-style-type: none"> <li>• 2 pump stations</li> <li>• 5 wells</li> <li>• 2.9 miles of pipe</li> </ul>	<p>There are no vulnerabilities to water supply infrastructure from either tides or coastal erosion under existing conditions during a 1% annual chance storm.</p> <p>Coastal flooding impacts two pump stations located in the Hollywood Beach area. In addition, four water supply wells are impacted in the Ventura River Valley (located outside of the map extant), and one well is vulnerable in the Ormond Beach area. Some 2.9 miles of water distribution pipe are also vulnerable along the North Coast around Rincon, Mussel Shoals, Seacliff and the Faria Beach Colony. Small exposure to coastal flooding occurs around Solromar in the South County.</p>
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## Projected Vulnerabilities

### 8 inches by ~2030

<p><b>Coastal Erosion</b></p> <ul style="list-style-type: none"> <li>• 1 pump station</li> <li>• 1621 feet of pipe</li> </ul> <p><b>Coastal Flooding</b></p> <ul style="list-style-type: none"> <li>• 1 well</li> <li>• 0.9 miles of pipe</li> </ul>	<p>Coastal erosion may threaten over 1,600 feet of water supply pipe which may cause disruptions along the Solromar community. One pump station in the Hollywood Beach neighborhood becomes susceptible to erosion. Replacement costs of the pipe was estimated at \$375,000.</p> <p>Coastal flooding may impact an additional groundwater well in the Ormond Beach area and an additional 0.9 miles of pipeline in the North Coast Faria Beach Colony and Solimar neighborhoods and some additional sections in the South Coast Solromar neighborhood.</p>
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### 16 inches by ~2060

<p><b>Tidal Inundation</b></p> <ul style="list-style-type: none"> <li>• 5 wells</li> </ul> <p><b>Coastal Erosion</b></p> <ul style="list-style-type: none"> <li>• 1 pump station</li> <li>• 500 feet of pipe</li> </ul> <p><b>Coastal Flooding</b></p> <ul style="list-style-type: none"> <li>• 3 wells</li> <li>• 0.4 miles of pipe</li> </ul>	<p>Tidal inundation may routinely affect five wells located in the Ormond Beach area.</p> <p>Coastal erosion may impact one of the pump stations in the Hollywood Beach neighborhood and an additional ~500 feet of pipeline in the Solromar neighborhood. Replacement costs of the pipe was estimated at \$115,000.</p> <p>Coastal flooding is projected to impact three additional groundwater supply wells located in the Ormond Beach Area and an additional 0.4 miles of water supply pipeline in the communities of Faria Beach Colony, Mussel Shoals, and Seacliff.</p>
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### 58 inches by ~2100

<p><b>Tidal Inundation</b></p> <ul style="list-style-type: none"> <li>• 2 pump stations</li> <li>• 750 feet of pipe</li> </ul> <p><b>Coastal Erosion</b></p> <ul style="list-style-type: none"> <li>• 1 pump station</li> <li>• 1611 feet of pipe</li> </ul> <p><b>Coastal Flooding</b></p> <ul style="list-style-type: none"> <li>• 2 pump stations</li> <li>• 1.7 miles of pipe</li> <li>• 23 wells</li> </ul>	<p>Tidal inundation may routinely affect two pump stations in Hollywood Beach and 750 feet of pipe.</p> <p>Coastal erosion may impact another pump station in the Silverstrand and an additional ~1600 feet of pipeline in Solromar. Total replacement costs of pipes is estimated at \$860,000.</p> <p>Coastal flooding is projected to impact two additional pump stations, one in Silverstrand and the other near Wooley Road and Harbor Boulevard as well as an additional 1.7 miles of water supply pipeline in the communities of Rincon, La Conchita, Seacliff, Mussel Shoals, and Faria Beach Colony. An additional 23 groundwater supply wells may be impacted by coastal flooding located primarily in the Ormond Beach and Calleguas creek area, but also supply wells at Oil Piers, Rincon Parkway, Silverstrand, and inland of North Harbor Blvd. near McGrath State Beach.</p>
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## Potential Adaptation Strategies

**Range of Strategies:** Adaptation strategies that are implemented over the coming decades could include infrastructure changes to improve water supply reliability and storage capability, as well as increased conservation efforts and availability of recycled water. Regional supply should be coordinated with other jurisdictions.

**Accommodate** – Elevate or seal pump stations, add emergency control valves at strategic locations.

**Protect** – Constructing levees and coastal armoring to reduce vulnerabilities is the “gray” protection approach, which has already been implemented on the North and South Coasts of the county. A “green” protection approach likely more cost effective in the Central Coast would be to augment sand dunes or contour horizontal levees to protect against future coastal hazards.

**Retreat** – Relocate distribution pipelines away from erosion hazard areas; and consider future locations of pump stations and wells to avoid coastal hazards.

**Secondary Impacts:**

Retreat strategies have secondary impacts due to the loss of structures and property and subsequent resulting impacts on the tax base revenues to the County. Gray protection options would result in a loss of beaches over time. Green protection strategies may benefit beaches and homes by maintaining recreational uses.

## Findings

Summary	Strategy Options
<ul style="list-style-type: none"> <li>• With ~5 feet of SLR, coastal hazards could impact at least 32 wells and four pump stations.</li> <li>• While many of the metered connection pipelines near on the North Coast and South Coast are vulnerable, the main water supply pipeline is not vulnerable because they are inland with gravity flow down to the coast.</li> <li>• Supply wells in the Ormond Beach Area are especially vulnerable to future coastal flood and tidal hazards. Several of these well locations are also in current areas of seawater intrusion.</li> </ul> <p><b>Thresholds:</b></p> <ul style="list-style-type: none"> <li>• Significant increases in vulnerabilities at ~5 feet of SLR.</li> </ul> <p><b>Data gap:</b></p> <ul style="list-style-type: none"> <li>• More detailed pipe locations from the United Water Conservation District and Calleguas Municipal District.</li> <li>• Fire hydrants and control valve data were not available.</li> </ul>	<p><b>Policy:</b></p> <ul style="list-style-type: none"> <li>• Improve policies to promote water conservation and increase reclaimed water use and availability.</li> <li>• Coordinate with local water districts and relevant County departments to adapt the system to future demands and include climate change policies in the Integrated Regional Watershed Management Plan.</li> <li>• Ensure adequate long-term water supplies for the lifetime and intended use of development.</li> <li>• Restrict development of new wells in vulnerable areas.</li> </ul> <p><b>Projects:</b></p> <ul style="list-style-type: none"> <li>• New projects and maintenance on water supply infrastructure should include features for SLR adaptation.</li> </ul> <p><b>Monitoring:</b></p> <ul style="list-style-type: none"> <li>• Continue to monitor groundwater wells and aquifers for seawater intrusion.</li> </ul>

**Figure A5a - Water Supply: North Coast**

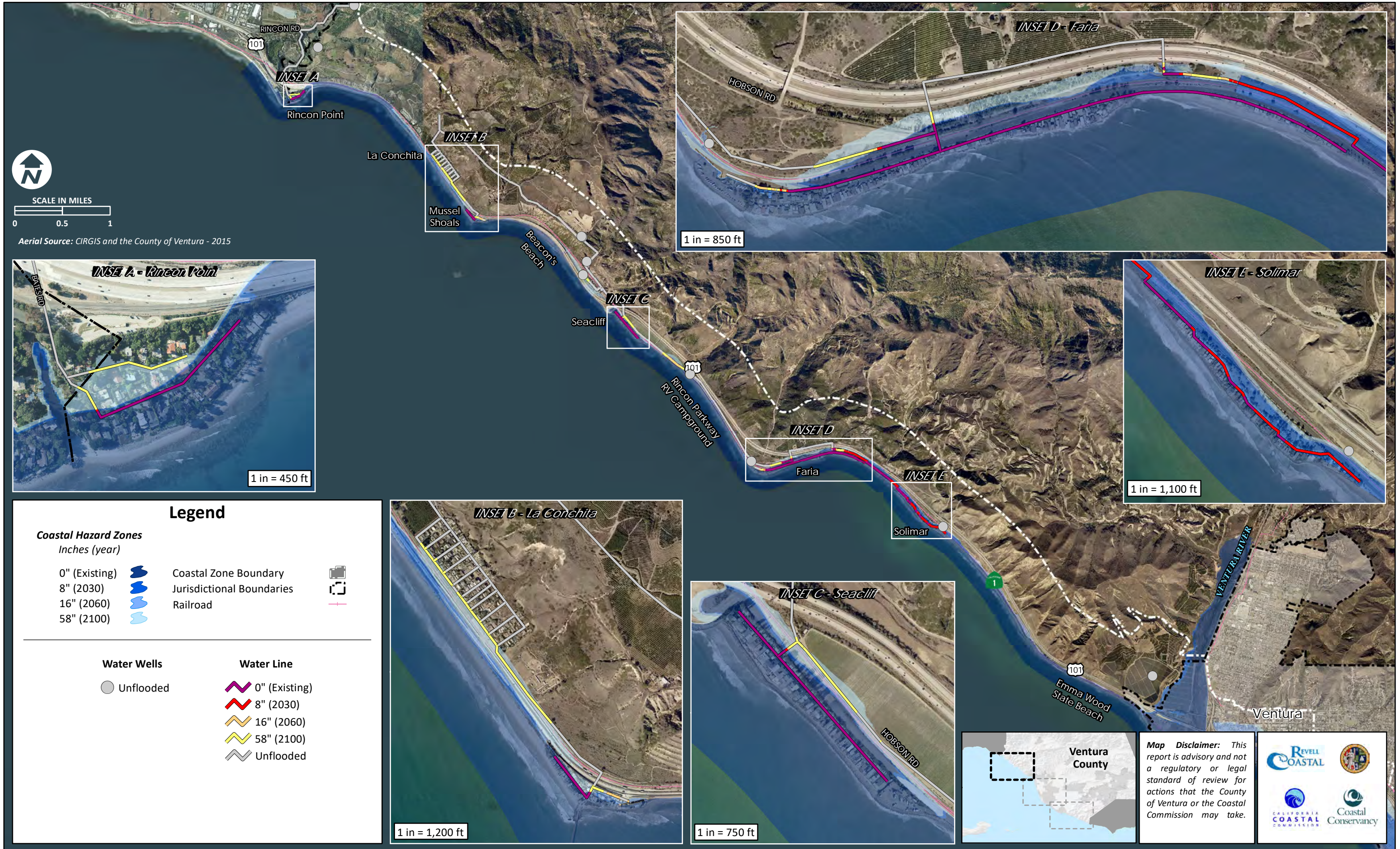


Figure A5b - Water Supply: Central Coast

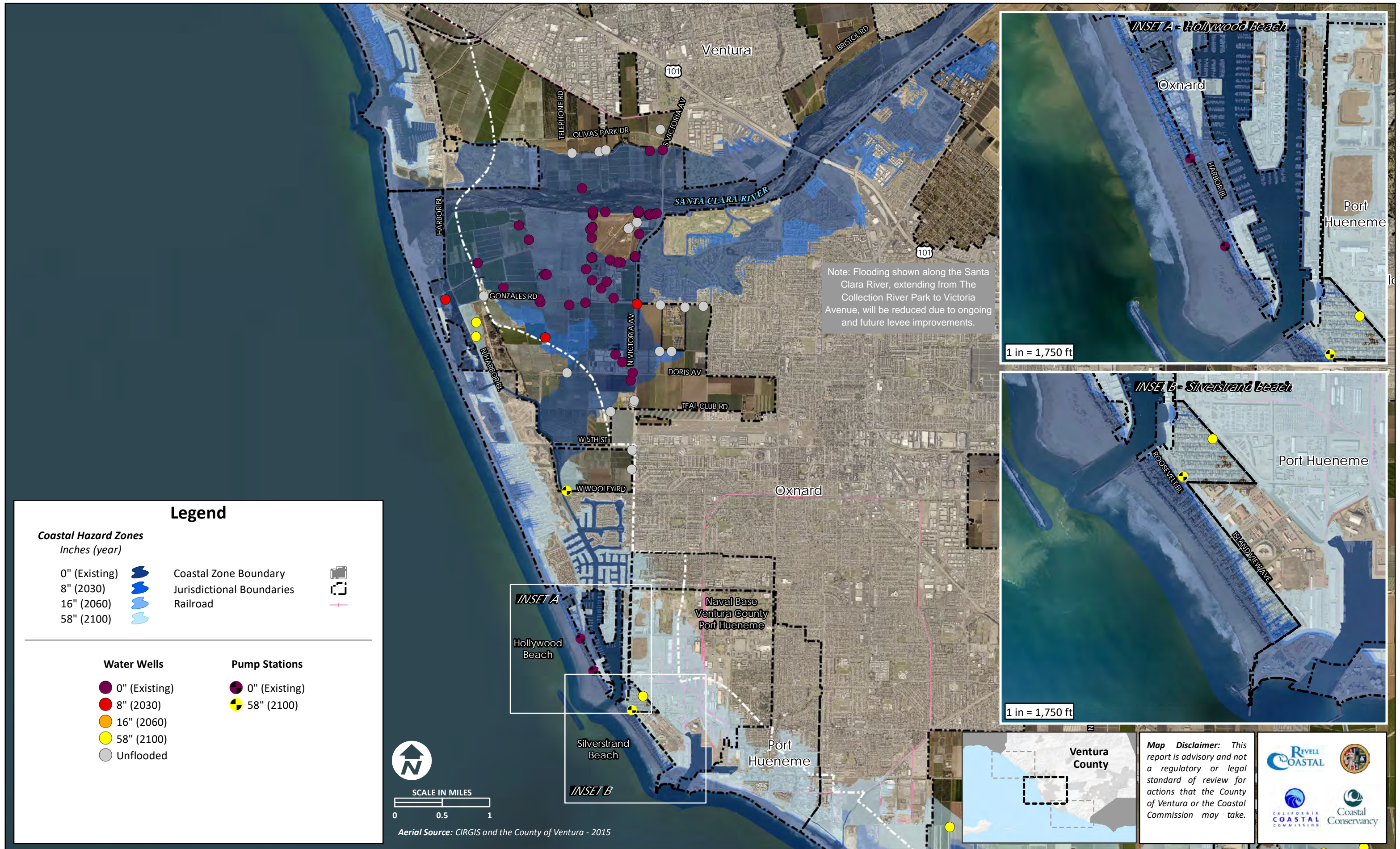


Figure A5c - Water Supply: South Coast

