



COUNTY OF VENTURA
RESOURCE MANAGEMENT AGENCY | PLANNING DIVISION



VC RESILIENT COASTAL ADAPTATION PROJECT

SEA LEVEL RISE VULNERABILITY ASSESSMENT

APPENDIX A-2. MAP ATLAS AND SECTOR PROFILE RESULTS



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APPENDIX A-2. 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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Public Access, Recreation, and Trails

Overview

Coastal access and recreation in the County of Ventura includes a wide variety of activities such as hiking, beach recreation, surfing, camping, kite surfing, birdwatching, and surf fishing. The County recently amended its Local Coastal Program to include the California Coastal Trail, which consists of existing and planned trail segments that transverse the unincorporated coastline and covers approximately 30 miles. Overall in the unincorporated area, there are 31 beach access points with several miles of vertical access trails, in addition to non-designated street end accessways through much of Silverstrand and Hollywood Beach. The County has two beach parks at Hobson and Faria in the North Coast, and State Parks operates five parks in the unincorporated coastal areas.

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

- Number of vertical coastal accessways
- Length of lateral beach trails
- Length of California Coastal Trail
- Number of Parks

Replacement costs from erosion to the Coastal Trail were estimated at \$170 per foot.

Existing Vulnerabilities

Access: All vertical access points are potentially impacted by erosion and coastal flood hazards that could occur during a 1% annual chance storm. Also, 25% of the lateral access along beaches are susceptible to dune erosion. Tidal inundation affects about 50% of the vertical access trails in the County.

Parks: Under existing conditions, Hobson and Faria County parks, the Rincon Parkway RV campground, Emma Wood State Beach, McGrath State Beach, Point Mugu State Park, Sycamore Cove, Thornhill Broome Beach and Leo Carrillo State Park are all day use and camping recreational facilities that are potentially vulnerable to coastal flooding and erosion. McGrath State Beach has already closed its campground and Thornhill Broome, which routinely faces coastal erosion and flood damages, is being considered for seasonal winter closures.

Coastal Trail: Currently just under 4.7 miles of trail are vulnerable to erosion from a 1% annual chance storm. The estimated cost of replacement is \$4.2 million. 15.3 miles of trail are vulnerable to coastal flooding and 1.5 miles to tidal inundation.



Winter damage to Thornhill-Broom Campsite in Point Mugu State Park

Photo courtesy California State Parks

Projected Vulnerabilities

8 inches by ~2030

Access: All vertical access points may continue to be impacted by erosion and coastal flood hazards during a 1% annual chance storm. 1.5 miles of lateral beach access is susceptible to coastal cliff erosion on the South Coast.

Parks: With additional sea level rise, more of each of the parks is impacted. On the North and Central Coasts, all parks and trails are impacted by storm flooding and erosion. On the South Coast, Point Mugu Rock, Sycamore Cove, Yerba Buena Beach, and Leo Carrillo Beach will be increasingly eroded and except for Sycamore Cove, these beaches may drown.

Coastal Trail: With 8" of SLR, 8.9 miles of trail on the Central and South Coasts are vulnerable to erosion from a 1% annual chance storm. The estimated cost of replacement is \$7.9 million. Also, 16.9 miles of trail are vulnerable to coastal flooding and 1.7 miles are vulnerable to tidal inundation.

16 inches by ~2060

Access: All vertical access points may continue to be impacted by erosion and coastal flood hazards.

Parks: With additional sea level rise, more of each of the parks is impacted.

Coastal Trail: In 2060, 9.1 miles of trail are vulnerable to erosion loss from a 1% annual chance storm. The estimated cost of replacement is \$8.1 million. Over 17 miles of trail are vulnerable to coastal flooding and 1.9 miles to tidal inundation.

58 inches by ~2100

Access: All vertical access points may continue to be impacted by erosion and coastal flood hazards and all of the vertical and lateral access would be impacted with routine tidal inundation.

Parks: With additional sea level rise, all of the remaining parks are either lost or impacted. Nearly all of the day-use facilities at Sycamore Cove are impacted by coastal flooding hazards.

Coastal Trail: In 2100, 9.7 miles of trail are vulnerable to cliff erosion loss, much of this length consists of planned Coastal Trail improvements along PCH on the South Coast. The estimated cost of replacement is \$8.6 million. Nearly 19 miles of trail are also vulnerable to coastal flooding and 6.3 miles to tidal flooding.

Potential Adaptation Strategies

Range of Strategies:

Accommodate – It is possible to elevate parks, trails and campgrounds to accommodate higher flood water levels, and this is currently being considered for McGrath State Beach facilities. Vertical access points can be designed with removable or telescoping elements or constructed in to seawalls and revetments.

Protect – Most of the parks and trails along the North and South Coasts are already armored which include Hobson and Faria County Parks, as well as Rincon Parkway RV campground, and Emma Wood State Beach. The revetments used to protect the parks are up to 70 feet in width, occupying considerable beach area. A “green” protection approach in the North Coast would involve retaining sediment to widen beaches and protect against future coastal and fluvial hazards.

Retreat – Relocate or remove parks from hazardous areas. Coastal access is strongly protected under the California Coastal Act and it will be difficult to find new land for shoreline beach parks without relocating other infrastructure.

Secondary Impacts:

Elevating Coastal Trail segments that are located on roadways would need to be included in a broader adaptation strategy coordinated with transportation authorities.

Findings

Summary

- Annually beaches draw > 3 million visitor days per year and generate an estimated spending of \$112 million.
- Beaches provide ~\$156 million in economic benefits, \$2.3 million in hotel taxes and ~\$1 million in sales taxes.
- Under existing conditions, all the coastal access points and over 50% of the Coastal Trail are vulnerable to coastal erosion and coastal flooding and more than half of the lateral accesses along beaches are already affected by tidal inundation.
- With ~5 feet of SLR, all coastal accesses and all lateral Coastal Trail beaches are vulnerable to coastal erosion, coastal flooding, and tidal inundation.
- Faria and Hobson County Parks may be routinely flooded by large waves requiring seasonal closures.
- Significant portions of the Coastal Trail are at risk to coastal erosion (~30%), tidal inundation (~20%), and coastal flooding (~60%) with ~5 feet of SLR.

Strategy Options

Policy

- Work with State Parks to identify future beach access constraints and seasonal closures for parks.
- Develop a long-range coordinated plan for the Coastal Trail with agencies such as State Parks and Caltrans.

Monitoring

- Monitor depth, extent and frequency of park flooding along frequently impacted areas. Track clean-up and maintenance costs for flooding.

Data gaps

- State park campgrounds, parking lots and trail alignments.

Thresholds:

- A major erosion or coastal flood could temporarily impact vertical and lateral access to coastal Ventura County today.

Figure A6a - Parks, Trails, and Coastal Access: North Coast

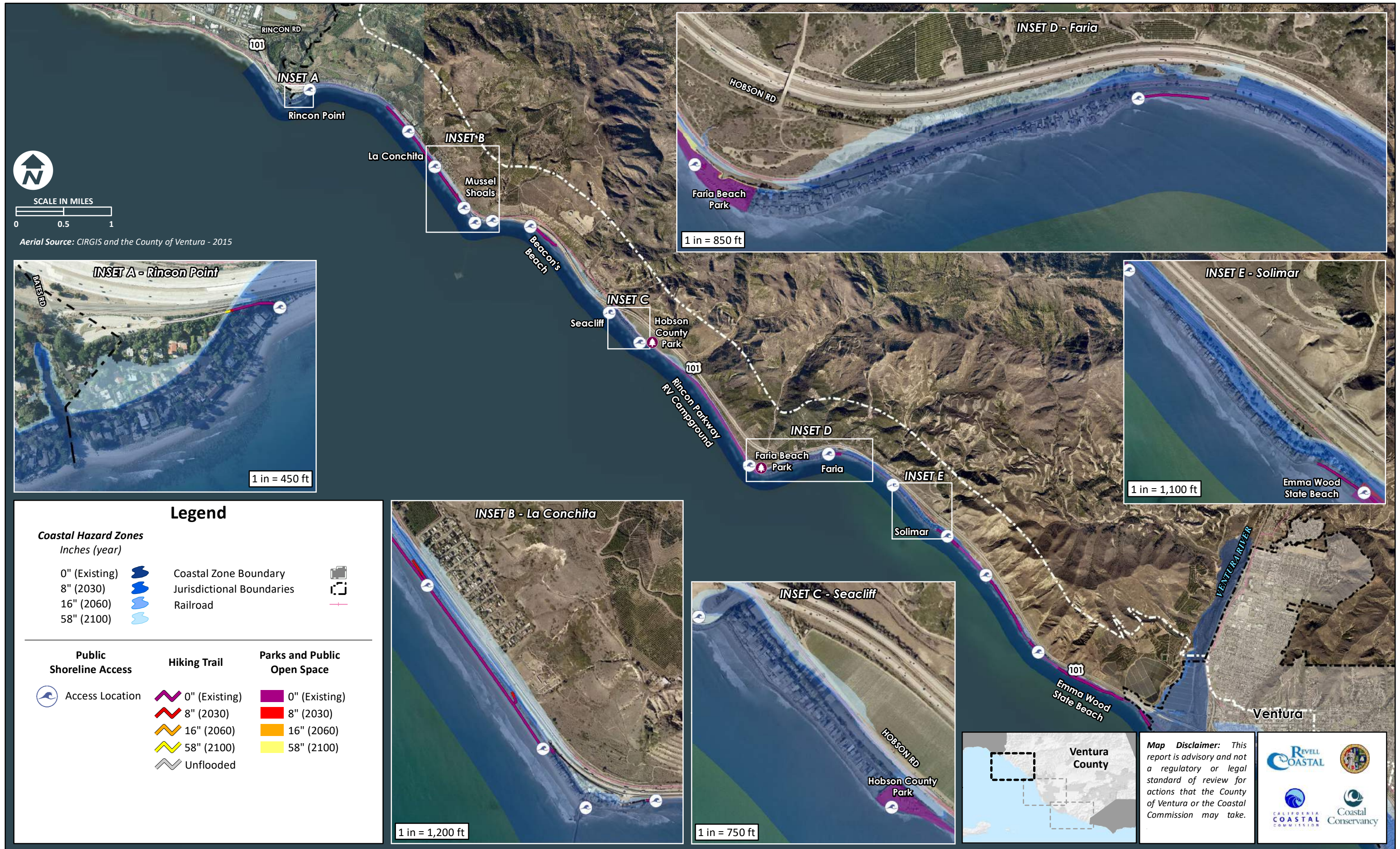


Figure A6b - Parks, Trails, and Coastal Access: Central Coast

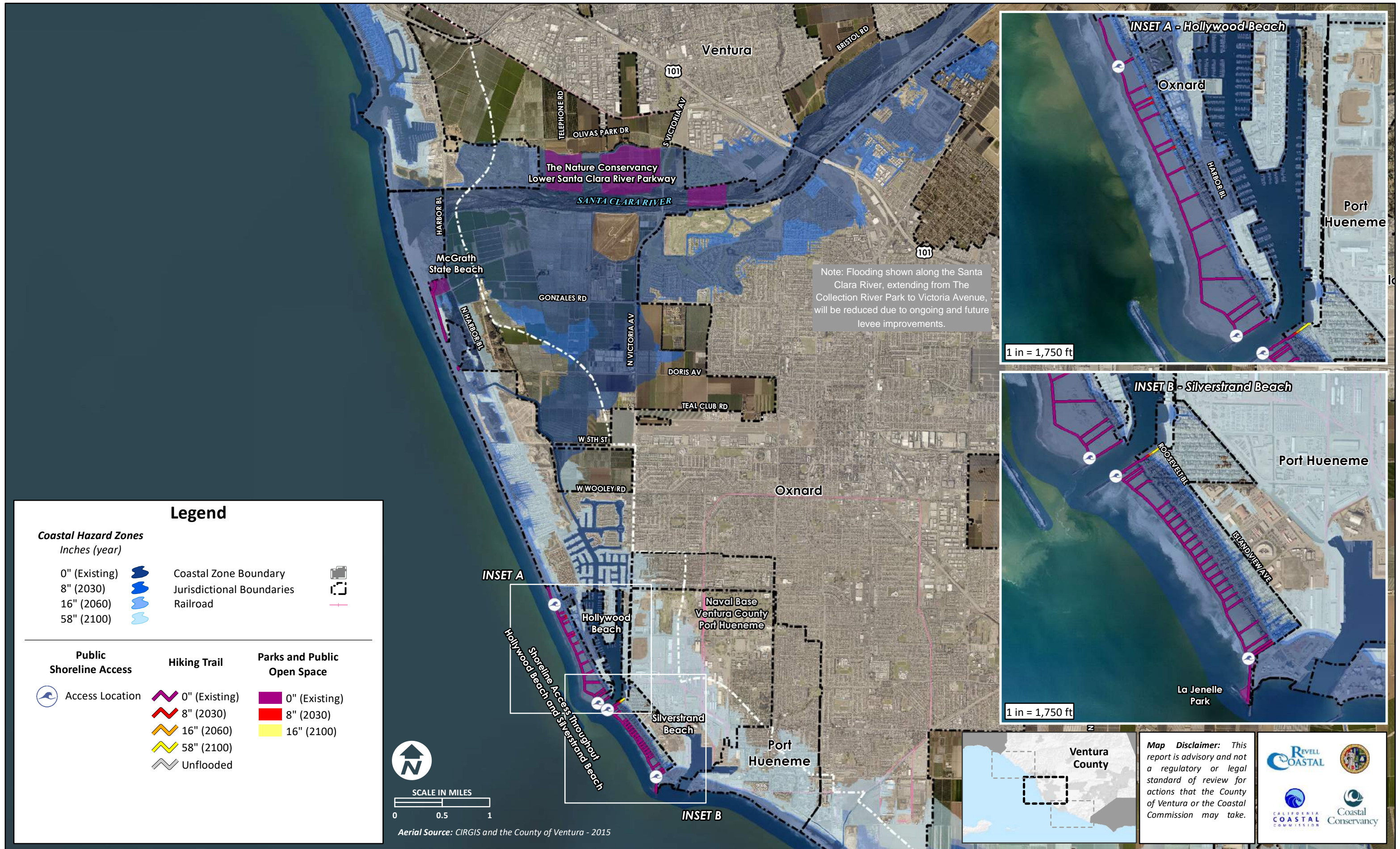
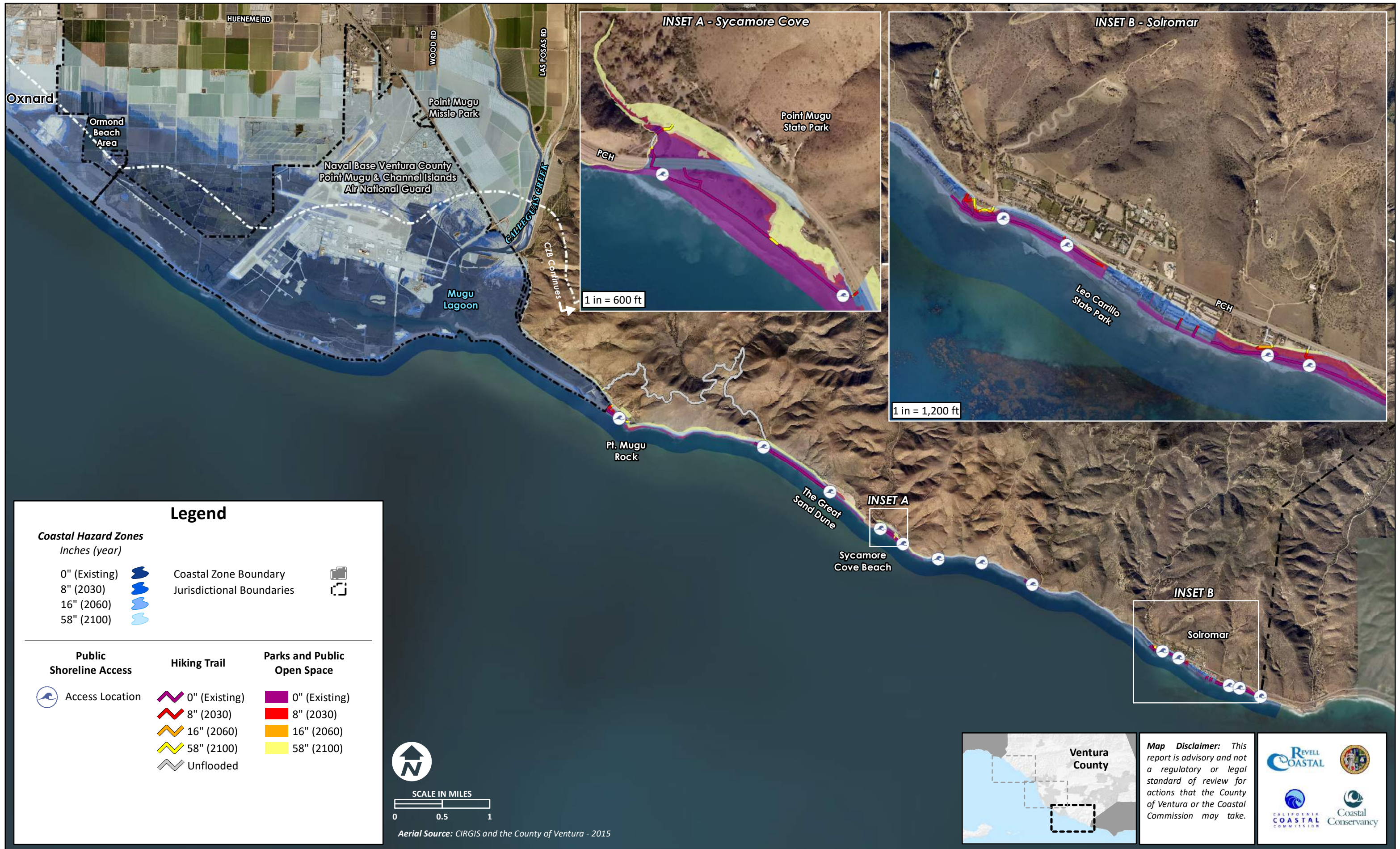


Figure A6c - Parks, Trails, and Coastal Access: South Coast



Overview

The County of Ventura Transportation Department is responsible for the planning, designing, funding, building, operating and maintaining the County road system, with approximately 544 miles of roadway, bridges, drainage and related transportation facilities. Approximately 183 miles of road lie within the County coastal zone and coastal hazard boundary. The responsibility for maintaining these roads lie between Caltrans, primarily for Highway 101 and Pacific Coast Highway (PCH), and the County Transportation Department. Fifteen (15) parking lots are maintained by the County or State Parks that provide coastal access. A failure of the coastal armoring along the North Coast may substantially increase the amount of erosion impacts to roads and parking lots.

To quantify the impact of coastal hazards and sea level rise (SLR) on roads and public transportation, the following measures of impact have been identified:

- **Length of roads (miles), replacement costs from erosion estimated at \$280 per road foot**
- **Number of Parking lots (data not available for all State Parks parking lots)**

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

Existing Vulnerabilities

<p>Tidal Inundation</p> <ul style="list-style-type: none"> • 2.5 miles <p>Coastal Erosion</p> <ul style="list-style-type: none"> • 1.8 miles <p>Coastal Flooding</p> <ul style="list-style-type: none"> • 19.0 miles 	<p><i>Roads:</i> Under current conditions, with a 1% annual chance storm, 19 miles of road are vulnerable to coastal flooding. Much of this is along the Rincon Parkway in the North Coast and along PCH in the South Coast. Tidal inundation may affect portions of roads around the Ventura County Game Preserve during extreme high king tides. Replacement costs for the erosion damages estimated at \$2.7 million.</p> <p><i>Parking:</i> Six parking lots are subject to erosion under existing conditions at Point Mugu, Solromar, and Yerba Buena Beach located in the South Coast and two parking lots on the north side of Channel Islands Harbor at Hollywood Beach. Coastal flooding may impact an additional three parking lots at Faria and Hobson County parks and along the Rincon Parkway.</p>
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Projected Vulnerabilities

8 inches by ~2030

<p>Tidal Inundation</p> <ul style="list-style-type: none"> • 0.7 miles <p>Coastal Erosion</p> <ul style="list-style-type: none"> • 4.9 miles <p>Coastal Flooding</p> <ul style="list-style-type: none"> • 4.6 miles 	<p><i>Roads:</i> With a 1% annual chance storm and 8" of SLR, an additional 4.6 miles of road are vulnerable to coastal flooding. Much of this is along the Rincon Parkway in the North Coast and along PCH in the South Coast. Dune erosion could impact 3.2 miles in Silverstrand and Hollywood Beach, and cliff erosion along the South Coast could damage 1.8 miles of PCH. Tidal inundation may affect additional road portions near the Ventura County Game Preserve during high monthly tides.</p> <p>Replacement costs for the erosion damages estimated at \$7.2 million.</p> <p><i>Parking:</i> No additional parking lots are exposed.</p>
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16 inches by ~2060

<p>Tidal Inundation</p> <ul style="list-style-type: none"> • 0.3 miles <p>Coastal Erosion</p> <ul style="list-style-type: none"> • 4.6 miles <p>Coastal Flooding</p> <ul style="list-style-type: none"> • 4.6 miles 	<p><i>Roads:</i> With a 1% annual chance storm, an additional 4.6 miles of road are vulnerable to coastal flooding. Additional portions of the Rincon Parkway, PCH in the South Coast, and streets at Silverstrand and Hollywood Beach also become more vulnerable. Dune erosion could impact 1.9 miles in Silverstrand and Hollywood Beach and cliff erosion along the South Coast could damage another 2.6 miles of PCH. Tidal inundation may affect additional road portions around the Ventura County Game Preserve and the sod farms during high monthly tides.</p> <p>Replacement costs for the erosion damages were estimated to be \$6.8 million.</p> <p><i>Parking:</i> No additional parking lots are exposed.</p>
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58 inches by ~2100

<p>Tidal Inundation</p> <ul style="list-style-type: none"> • 8.28 miles <p>Coastal Erosion</p> <ul style="list-style-type: none"> • 5.0 miles <p>Coastal Flooding</p> <ul style="list-style-type: none"> • 16.5 miles 	<p><i>Roads:</i> With a 1% annual chance storm, a combined total of 45 miles of road are vulnerable to coastal flooding across coastal Ventura County including almost all of Rincon Parkway and portions of PCH and Highway 101. Dune erosion could impact 8 total miles in Silverstrand and Hollywood Beach and cliff erosion along the South Coast could damage 6 total miles. Tidal inundation impacts increase substantially and periodically affect 12 miles of road across the county, the biggest changes occur at Rincon and Silverstrand.</p> <p><i>Parking:</i> One additional lot near Point Mugu which provides parking for the Chumash trailhead becomes exposed to coastal flooding. A total of 12 County and State Parks parking lots may be vulnerable with ~5 feet of SLR.</p>
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Potential Adaptation Strategies

Range of Strategies:

Accommodate – It is possible to elevate roads to accommodate higher flood water levels. This could be accomplished by elevating segments of road on causeways, or by incrementally elevating the road surface during routine repaving by adding an additional 2-3 inches of asphalt.

Protect – (Green) Contour additional elevation into dunes along the Central Coast, nourish the North Coast Rincon Parkway area with additional cobble. (Gray) Construct and maintain coastal armoring and/or install pumps to flood proof the most vulnerable road segments, such as Harbor Boulevard.

Retreat – Relocate or remove roads from the hazardous areas.

Secondary Impacts:

Retreat strategies may negatively impact traffic and other resources of the County, depending on the realignment. Accommodation strategies may create additional storm water drainage issues. Protection strategies (green) could provide some room for habitat transgression for roads adjacent to wetlands. Gray protection strategies could negatively impact beach and dune habitat transgression as well as escalate maintenance costs.

Findings

Summary	Strategy Options
<ul style="list-style-type: none"> • PCH on the South Coast and Rincon Parkway and Highway 101 in North Coast are currently vulnerable. • Erosion could damage 14 miles of roads with ~5 feet of SLR and an estimated replacement cost of \$20.7 million. • Coastal flooding may affect 19 miles of roads now and 45 miles with ~5 feet of SLR including all of Rincon Parkway and portions of Highway 101 and PCH. • 11 County parking lots providing beach access are presently vulnerable to coastal hazards. A total of 12 lots may be affected by coastal flood hazards with ~5 feet of SLR, and six lots may be eroded. <p>Thresholds:</p> <ul style="list-style-type: none"> • Transportation could be substantially impacted today by erosion (1.8 miles) or coastal flooding (19 miles). • With ~5 feet of SLR, tidal inundation affects an additional 8.3 miles of road. <p>Data Gaps:</p> <ul style="list-style-type: none"> • Parking lot data used for State Parks' properties was manually created and may not be precise or complete. 	<p>Policy:</p> <ul style="list-style-type: none"> • Work with Caltrans on PCH to ensure that regional connections remain intact. • Work with State Parks to identify future beach access parking so that there is no net loss of coastal access. • Update the transportation planning documents such as the Strategic Master Plan to identify preferred adaptation strategies to reduce impacts to roads and parking lots. <p>Projects:</p> <ul style="list-style-type: none"> • Elevate or relocate critical roads including Harbor Boulevard and the Rincon Parkway. • Consider amending the County's Capital Improvement Plan to add additional inches of street resurfacing to gain elevation at the pace of sea level rise or greater. • Consider multi-modal transportation such as bike lanes and pedestrian facilities while planning for adaptation. <p>Monitoring:</p> <ul style="list-style-type: none"> • Monitor depth, extent and frequency of road flooding along frequently impacted areas.

Figure A7a - Roads and Parking: North Coast



Figure A7b - Roads and Parking: Central Coast

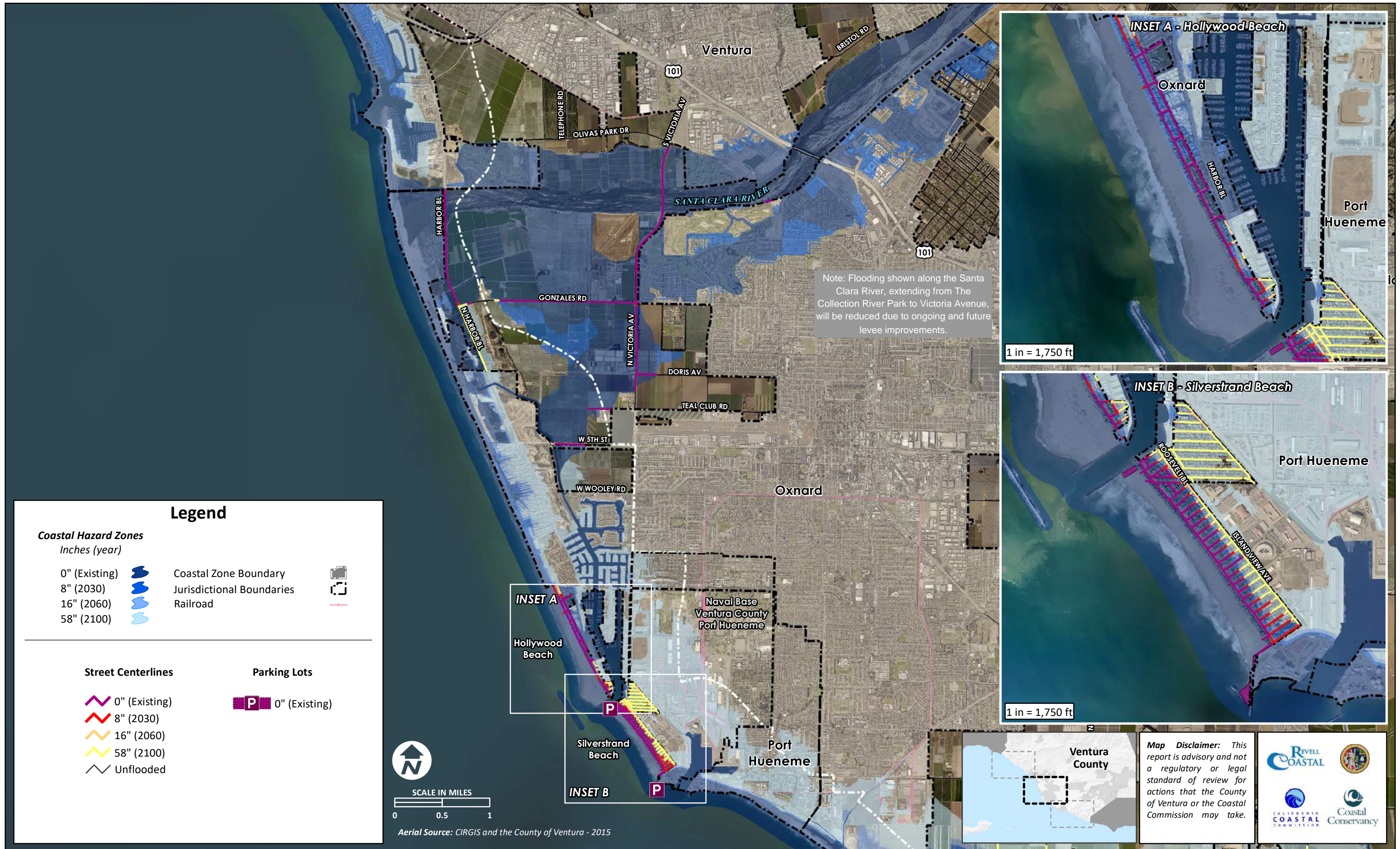
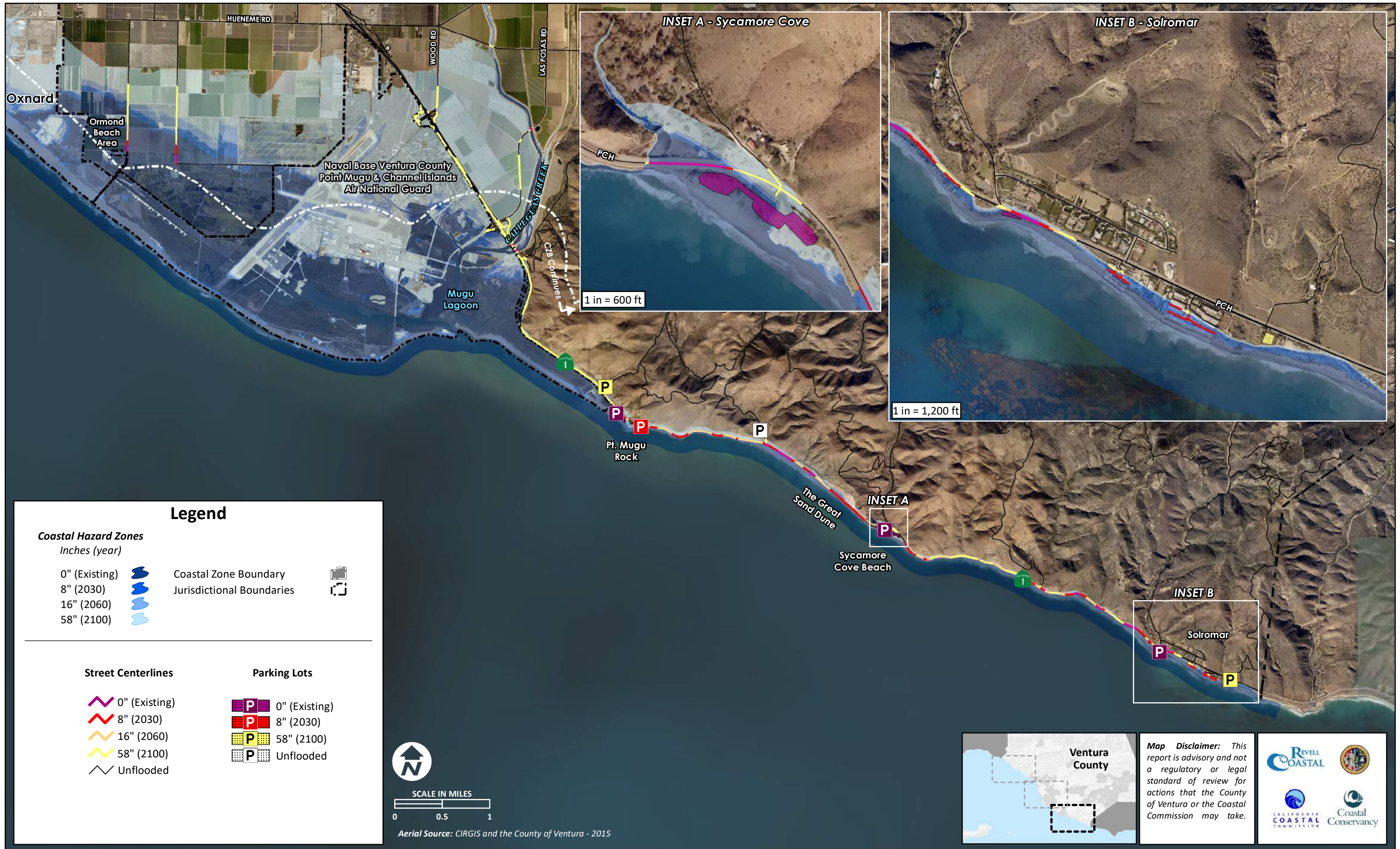


Figure A7c - Roads and Parking: South Coast



Overview & Measures of Impact


Ventura County has approximately five miles of Class 1 bike trails including the recently completed Ralph Fertig Memorial Trail connecting the Beacon’s Beach Area to Rincon Point along Highway 101. Union Pacific Railroad (UPRR) owns and operates the railroad through Ventura County and provides some public use through AMTRAK. The railroad alignment hugs the North Coast coastline and has existed since before the Coastal Act. Episodic erosion has threatened the railroad, which has built emergency revetments for protection. The Coastal Express Bus, operated by VISTA, extends from the City of Ventura to Isla Vista in Santa Barbara County. There are no stops on the North Coast, but the bus route traverses Highway 101. The local bus system, operated by Gold Coast Transit provides no bus routes in the unincorporated coastal zone.

To quantify the impact of coastal hazards and sea level rise (SLR) on roads and public transportation, the following measures of impacts were identified:

- Number of bus stops; bus routes (miles)
- Biking trails (miles)
- Railroad (miles)

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

Existing Vulnerabilities

<p>Coastal Erosion</p> <ul style="list-style-type: none"> • 0.9 miles (bike) • 0.1 miles (rail) <p>Coastal Flooding</p> <ul style="list-style-type: none"> • 5.7 miles (bike) • 3.0 miles (rail) 	<p><i>Bike:</i> The most northern portions of the Ralph Fertig Memorial Trail and Sycamore Cove are exposed to coastal flooding.</p> <p><i>Rail:</i> While no erosion impacts were modeled, the extensive coastal armoring in the area indicates that coastal erosion has already affected much of the North Coast.</p> <p style="text-align: right;"><i>(Photo courtesy of SB Bike Coalition)</i></p>	 <p>Ralph Fertig Memorial Bike Trail</p>
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Projected Vulnerabilities

8 inches by ~2030

<p>Coastal Erosion</p> <ul style="list-style-type: none"> • 0.9 miles (bike) • 0.1 miles (rail) <p>Coastal Flooding</p> <ul style="list-style-type: none"> • 0.6 miles (bike) • 2.6 miles (rail) 	<p><i>Bike:</i> Additional portions of the Ralph Fertig Memorial Trail and Sycamore Cove are exposed to coastal flooding. Coastal erosion could potentially affect the bike lane and sidewalks along Ocean Dr. at Silverstrand Beach.</p> <p><i>Rail:</i> Coastal flooding from a 1% annual chance storm could impact another 2.6 miles of the North Coast rail alignment, bringing the total to 5.6 miles of rail line at risk of storm flooding. Erosion is likely to be an ongoing vulnerability.</p>
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16 inches by ~2060

<p>Coastal Erosion</p> <ul style="list-style-type: none"> • 0.2 miles (rail) <p>Coastal Flooding</p> <ul style="list-style-type: none"> • 0.2 miles (bike) • 1.6 miles (rail) 	<p><i>Bike:</i> Additional portions of the Ralph Fertig Memorial Trail and Sycamore Cove are exposed to coastal flooding. Coastal erosion could potentially affect the bike lane and sidewalks along Ocean Dr. at Silverstrand Beach.</p> <p><i>Rail:</i> Coastal flooding from a 1% annual chance storm could impact the North Coast rail alignment, bringing the total to 7.2 miles of rail line at risk of storm flooding. Erosion is likely to be an ongoing vulnerability.</p>
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58 inches by ~2100

<p>Tidal Inundation</p> <ul style="list-style-type: none"> • 0.9 miles (bike) <p>Coastal Erosion</p> <ul style="list-style-type: none"> • 0.2 miles (rail) <p>Coastal Flooding</p> <ul style="list-style-type: none"> • 3.3 miles (bike) • 3.4 miles (rail) 	<p><i>Bike:</i> Additional portions of the Ralph Fertig Memorial Trail and Sycamore Cove routes are exposed to coastal flooding. Erosion could affect the trail along Silverstrand. With ~5 feet of SLR, 9.9 total miles of bike lanes could be affected by coastal flooding. Tidal inundation begins to affect Silverstrand and lower Oxnard plain near Pt. Mugu.</p> <p><i>Rail:</i> Coastal flooding from a 1% annual chance storm could impact another 3.4 miles of the North Coast rail alignment, bringing the total to 10.6 miles of rail line at risk of storm flooding. Erosion is likely to be an ongoing vulnerability.</p>
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Potential Adaptation Strategies

Range of Strategies:

Accommodate – Elevate roads and bike paths to accommodate higher flood water levels, consider developing additional causeways. Another option would be to add an additional 2-3 inches of asphalt during routine repaving of the roads or bike paths.

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 in the Central Coast would be to augment sand dunes to protect against future coastal hazards.

Retreat – relocate or reroute bike trails and rail lines outside of the vulnerable areas.

Secondary Impacts:

Since most of the existing and planned Class 2 bike lanes are located on Pacific Coast Highway, retreat strategies for bike lanes would need to accompany a broader adaptation strategy for Caltrans roads. Accommodation strategies may create additional demand for stormwater drainage capacity. Dune protection strategies (green) could provide some habitat particularly along the Central Coast. Gray protection strategies could negatively impact beaches, coastal dependent recreation, as well as escalate maintenance costs.

Findings

Summary	Strategy Options
<ul style="list-style-type: none"> • No bus routes or bus stops are susceptible to coastal hazards with ~5 feet of SLR. • At least 11 miles of rail and 9.9 miles of bike trails may be subject to coastal flooding with ~5 feet of SLR. • Coastal erosion may substantially damage rail and bike routes along portions of the North Coast particularly if the existing coastal armoring fails. • Tidal inundation will routinely close about a 0.9 miles of bike path during high tides with ~5 feet of SLR. <p>Thresholds:</p> <ul style="list-style-type: none"> • Significant increases in vulnerability with ~5 feet of SLR as episodic storm impacts become periodic tidal inundation. <p>Data gaps:</p> <ul style="list-style-type: none"> • Erosion to the railroad has already occurred but was not modeled into the future, because the railroad is located inland of major roadways that are armored. 	<p>Policy:</p> <ul style="list-style-type: none"> • Develop alternative bike routes, further inland. • Review the status of the coastal armoring emergency permits in the County. • Coordinate with UPRR and Caltrans on future plans and adaptation strategies. <p>Projects:</p> <ul style="list-style-type: none"> • Amend the County’s Capital Improvement Plan for the bike lanes on Harbor Boulevard, and Caltrans’ Transportation Concept Reports and District System Management Plans to add additional inches to the lift in street resurfacing to gain elevation at the pace of sea level rise or greater than the pace of sea level rise. <p>Monitoring:</p> <p>Monitor depth, extent and frequency of road flooding and erosion along existing alignments. Track clean-up costs.</p>

Figure A8a - Public Transportation and Bike Routes: North

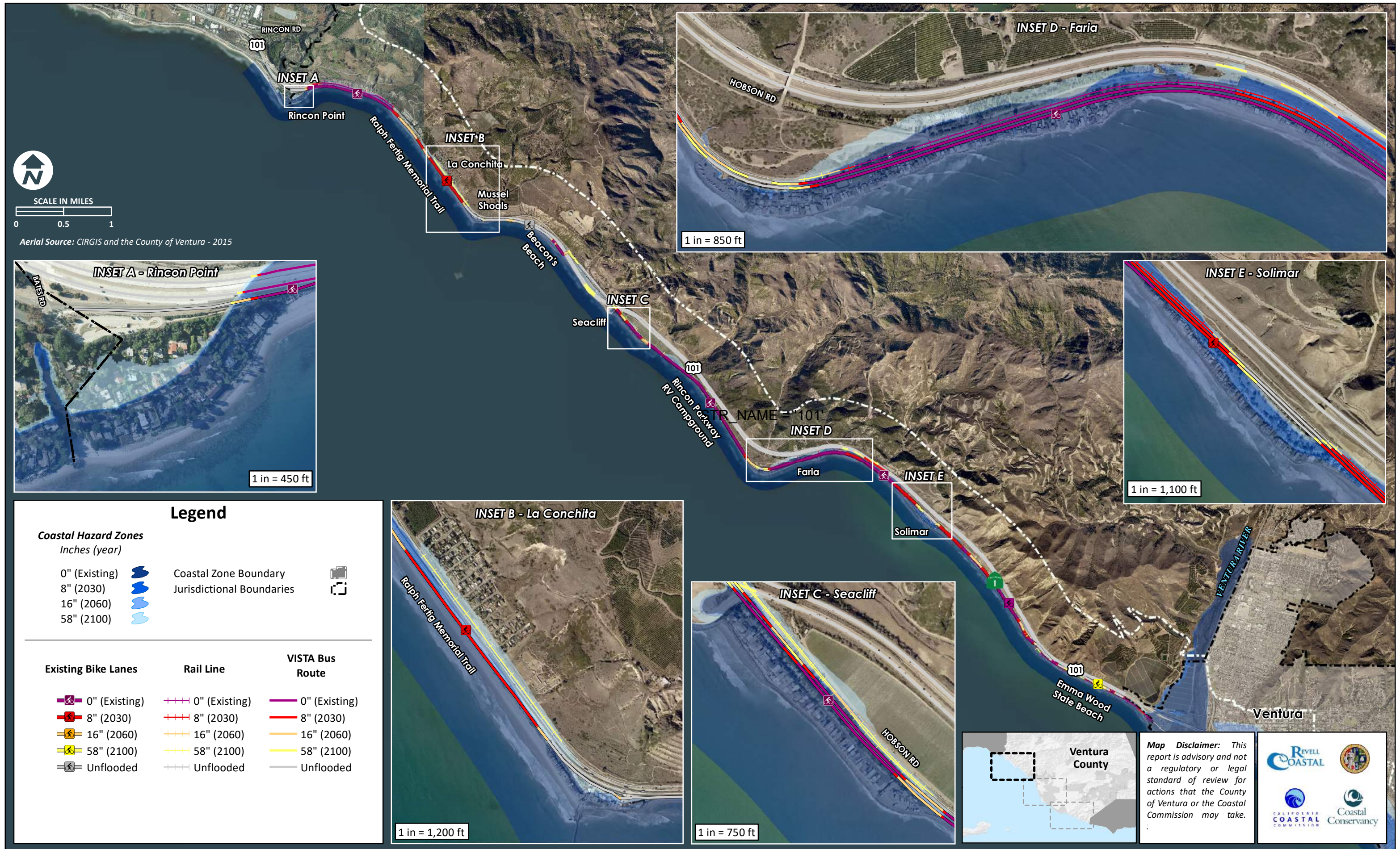


Figure A8b - Public Transportation and Bike Routes: Central

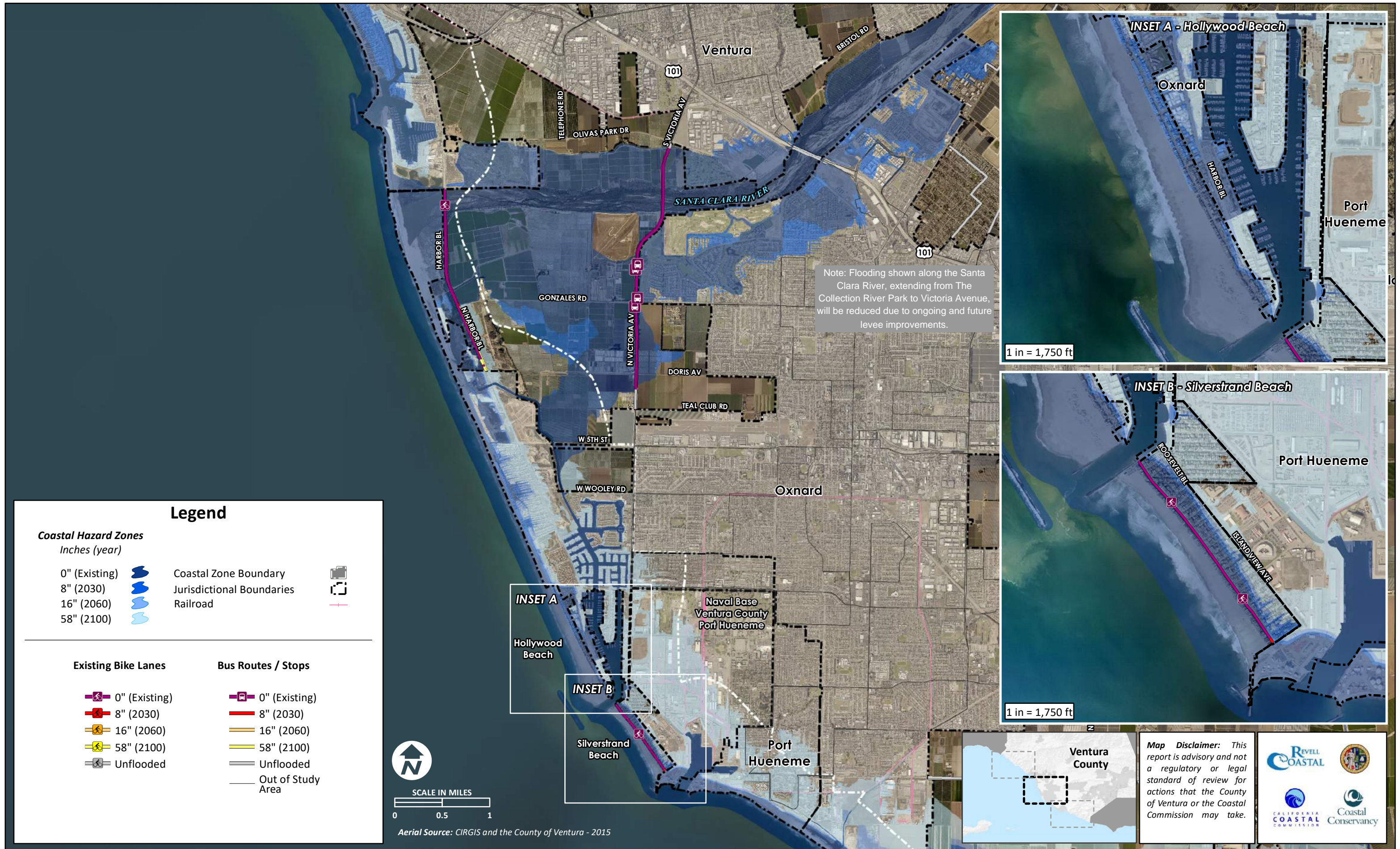
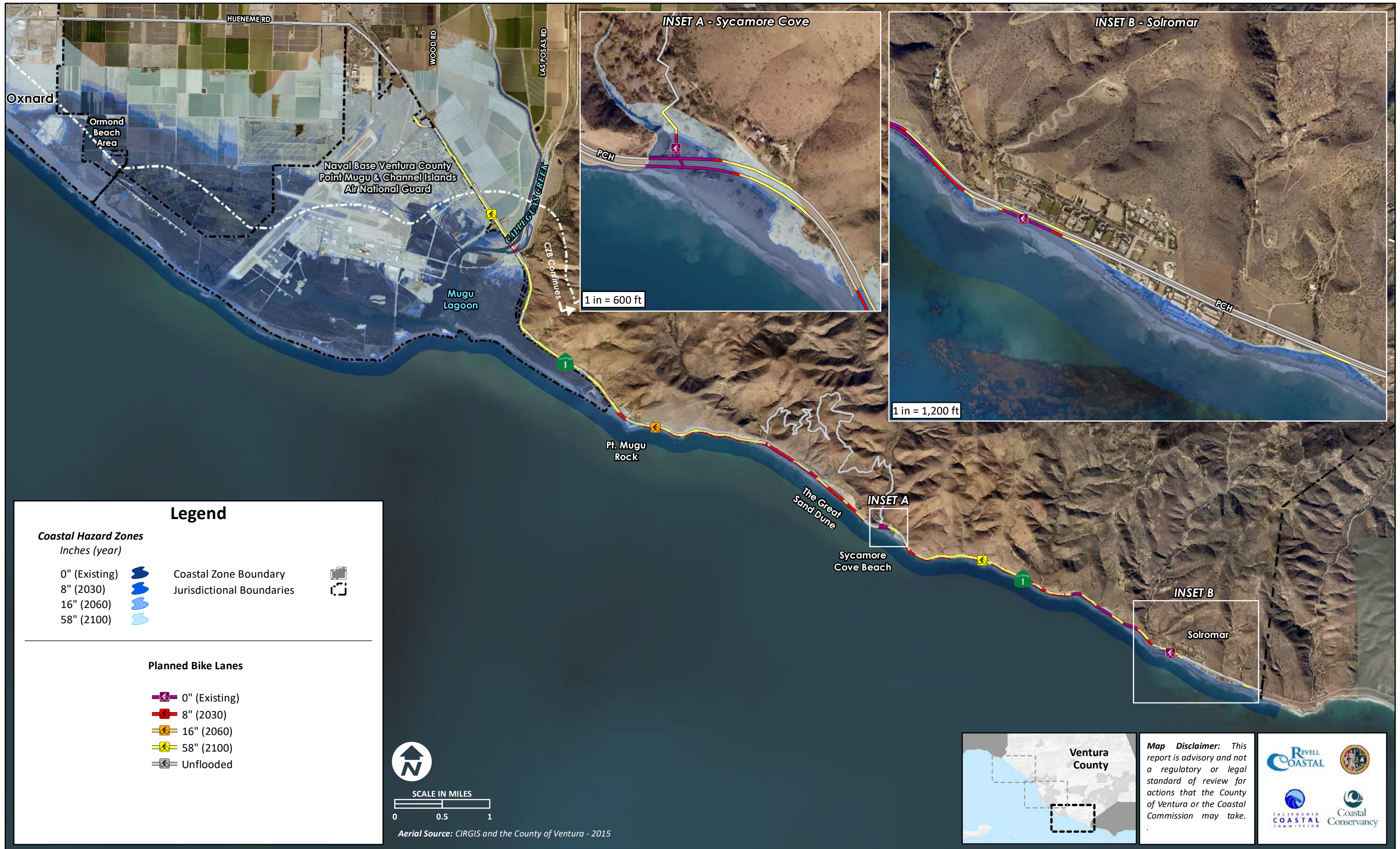


Figure A8c - Public Transportation and Bike Routes: South Coast



Overview

Oil and gas development in the Santa Barbara and Ventura Counties began in the late 1860s. Over 12,000 wells have been drilled into the Ventura Basin. Presently there are ~3,800 active wells in Ventura County. Some of these are operating under permits dating back to the late 1940s, when local oil provided fuel for the Pacific Fleet during World War II. According to the California Division of Oils, Gas and Geothermal Resources, there are 105 active wells within the unincorporated coastal zone, and approximately 363 inactive and capped wells. Little is known about how wells were capped.

Rincon Island, once a major oil and gas processing facility located on the North Coast, is being decommissioned. An additional slant drilling oil facility is located in the West Montalvo Oil Field near McGrath Beach. Minor pipelines connect wells to local storage facilities and connect with major pipelines to transport oil and gas to refineries in Los Angeles. Major pipelines are generally located along the railroad and Highway 101. Nearby oil spills in 1969 (Santa Barbara) and 2015 (minor pipeline rupture near Refugio) have impacted Ventura County beaches. In nearby Summerland, unmarked inactive legacy wells have been leaking for years and have yet to be resolved. Potential fiscal impacts to the County may be in the hundreds of millions of dollars should an oil spill occur.

Impacts of coastal hazards and sea level rise on oil and gas are quantified using the following measures of impact:

- Number of wells (active vs inactive)
- Miles of major pipelines
- Miles of minor pipelines
- Number of facilities

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

Existing Vulnerabilities

<p>Tidal Inundation</p> <ul style="list-style-type: none"> • 2 inactive wells <p>Coastal Flooding</p> <ul style="list-style-type: none"> • 12 inactive wells • 1.9 miles major pipelines • 2.1 miles minor pipelines • 1 Facility <p>Fluvial Flooding</p> <ul style="list-style-type: none"> • 58 inactive wells • 15 active wells 	<p>The two wells exposed to tidal inundation are both inactive, one near Rincon Point, and one near Ormond Beach in the Ventura County Game Preserve. Inactive wells and minor pipelines are exposed to coastal flooding along the North Coast. Coastal flooding also affects major pipelines along Highway 101 and the railroad in the North Coast. Fluvial hazards affect 73 wells (14 active) on the Santa Clara River and one active well on the Ventura River (not shown on the North Coast map extent).</p> <p>For all the historic above-ground infrastructure there remains unknown amounts of below-ground infrastructure along the Santa Barbara and Ventura County coasts. Impacts to oil and gas infrastructure could occur within the county or adjacent jurisdictions with oil spills drifting downcoast and contaminating County beaches.</p> <p>Economics: The biggest potential economic loss is an oil spill, e.g., the recent Refugio oil spill from a minor pipeline cost \$257 million to remediate and could easily happen in Ventura. Twelve wells are already subject to coastal or tidal flooding and an additional 73 are vulnerable to fluvial flooding.</p>
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Projected Vulnerabilities

8 inches by ~2030

<p>Coastal Flooding</p> <ul style="list-style-type: none"> • 3 inactive wells • 1.9 miles major pipelines • 1.5 miles minor pipelines <p>Fluvial Flooding</p> <ul style="list-style-type: none"> • 9 active / 7 inactive wells 	<p>Wells and pipelines exposed to additional coastal flooding are found along the North Coast and near McGrath Beach. Coastal flooding also affects major and minor pipelines along Highway 101 and the railroad on the North Coast. Fluvial flooding along the Santa Clara River may expose additional wells along McGrath State Beach and inland of Harbor Blvd.</p>
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16 inches by ~2060

<p>Coastal Flooding</p> <ul style="list-style-type: none"> • 1.5 miles major pipelines • 0.9 miles minor pipelines 	<p>Coastal flooding continues to potentially impact additional segments of the major and minor pipelines along Highway 101 and the railroad on the North Coast, as well as near the Mandalay Generating Station on the Central Coast.</p>
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58" by ~2100

<p>Tidal Inundation</p> <ul style="list-style-type: none"> • 3 inactive wells <p>Coastal Flooding</p> <ul style="list-style-type: none"> • 17 active / 32 inactive wells • 4.1 miles major pipelines • 1.6 miles minor pipelines 	<p>Tidal inundations are projected to impact 3 inactive wells in and around the Mugu Wetlands and the agricultural fields surrounding Point Mugu Naval Air Weapons Station.</p> <p>Coastal flooding potentially impacts several wells (active and inactive) near the Seacliff Highway 101 offramp to the Rincon Parkway and additionally near McGrath Beach.</p> <p>Coastal flooding from a 1% annual chance storm potentially impacts segments of the major and minor pipelines along the North Coast Highway 101, railroad, and near McGrath Beach on the Central Coast. Seventeen of the 105 currently active wells could be impacted by coastal flooding hazards and 24 active wells by fluvial flooding hazards.</p>
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Potential Adaptation Strategies

Range of Strategies: Oil and gas infrastructure could be relocated, elevated, or protected in place. Regulatory requirements for oil and gas facility adaptation will be contentious and may include State and federal jurisdictions. Generally, oil and gas facilities that are exposed to erosion may need to employ protection or retreat strategies, while facilities that are periodically inundated by tides and flooding could be retrofitted or protected.

Accommodate – For some facilities, it may possible to elevate the equipment and install pumps.

Protect – While coastal erosion has not been projected to directly impact any oil and gas facilities, by ~2100 McGrath State Beach is projected to erode to the edge of the facility near the Mandalay Generating Station and dune erosion facilitates enough coastal flooding to reach many facilities. Maintaining or constructing coastal armoring would be one means to protect these oil and gas resources. A green protection option would be to construct or augment sand dunes to protect the oil and gas infrastructure in the Central Coast.

Retreat – Involves a phased removal to cap, abandon, decommission, and restore facilities. Well casings and onshore support infrastructure may be re-exposed as erosion continues. Permit conditions of approval to require removal would be beneficial.

Secondary Impacts: Delays in any response could result in oil spills and nuisance hazards. Environmental assessments and permitting require substantial lead time and high costs. Elevating may extend the exposure to wave impacts and have escalating maintenance costs. All options could have short-term impacts on sensitive habitats.

Findings

Summary	Strategy Options
<ul style="list-style-type: none"> • Substantial vulnerabilities exist due to current hazards. • No oil and gas infrastructure is exposed to coastal erosion along the Central or South Coasts. • Fluvial hazards create vulnerabilities today and with minor sea level rise (8"). • There is the potential for oil spills from active and inactive wells as well as major and minor pipelines. The costs of remediating a spill could be enormous, and the County could be liable. <p>Thresholds:</p> <ul style="list-style-type: none"> • There is a substantial increase in vulnerabilities after 16" of sea level rise. <p>Data gap:</p> <ul style="list-style-type: none"> • Minor pipeline alignments and details on well caps for inactive wells are not well documented. 	<p>Policy:</p> <ul style="list-style-type: none"> • Coordinate oil and gas responses and share lessons learned with neighboring cities, counties, the CA Fish and Wildlife Office of Spill Prevention and Response, State Lands Commission, and Coast Guard. • Explore the use of bonds or other forms of financial assurance for rapid response to remove damaged wells. • Clarify and streamline the permitting process for remediation of legacy wells. <p>Projects:</p> <ul style="list-style-type: none"> • Upon decommissioning of active sites, ensure the removal of all shore protection, access roads, pipes and other infrastructure. <p>Monitoring:</p> <ul style="list-style-type: none"> • Monitor the State's clean up and removal of Rincon Island facilities for potential impacts to the North Coast.

Figure A9a - Oil and Gas: North Coast

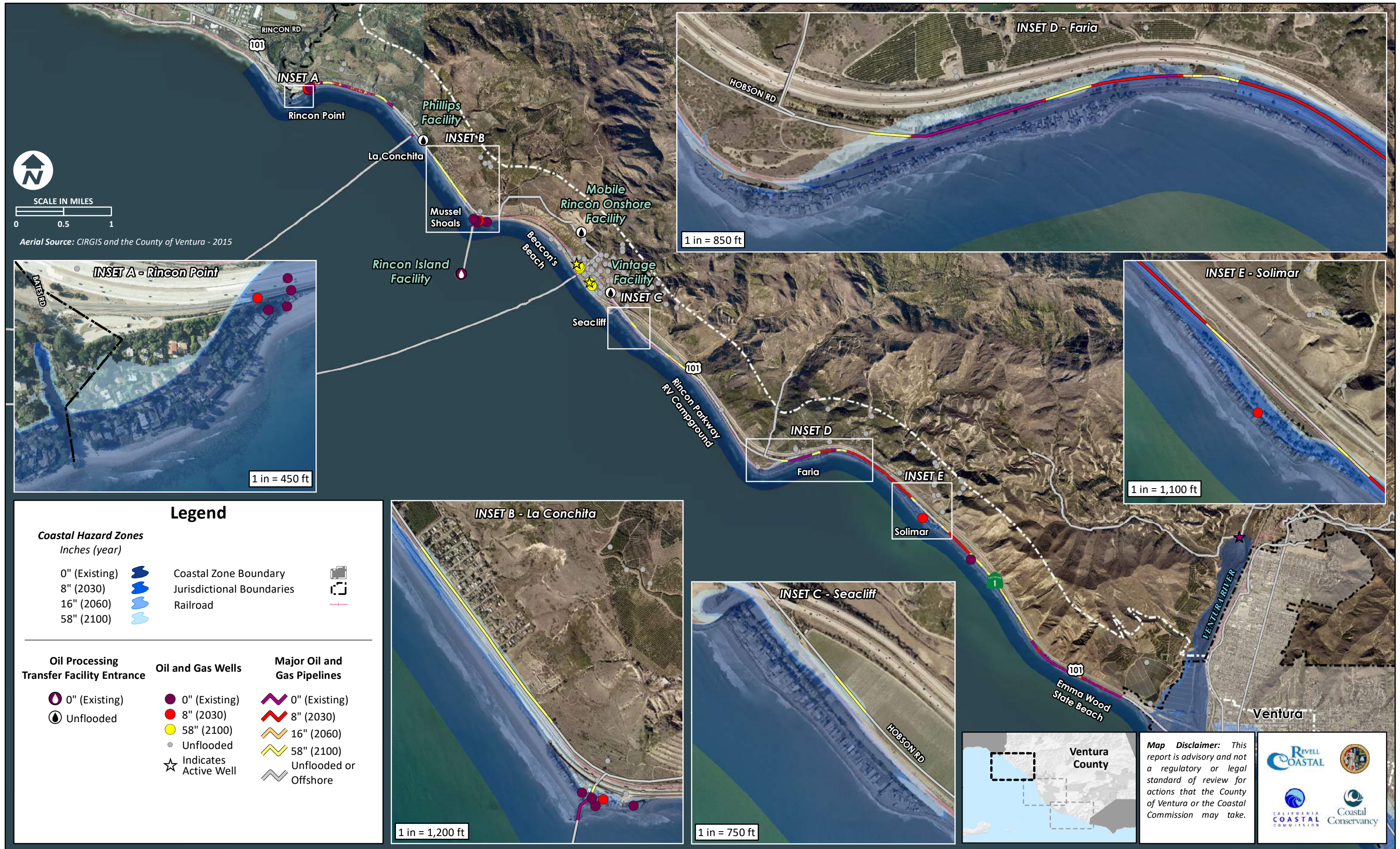


Figure A9b - Oil and Gas: Central Coast

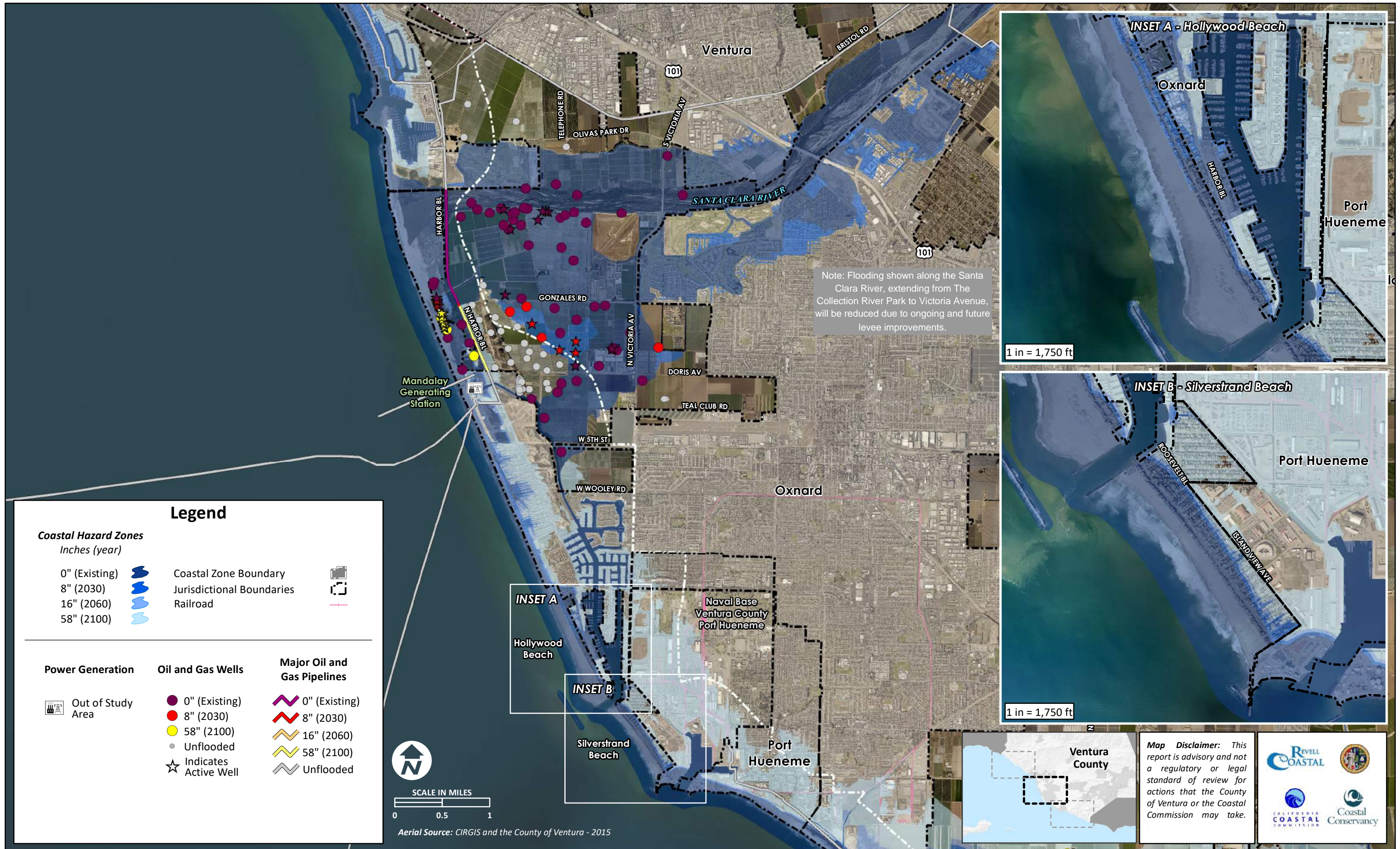
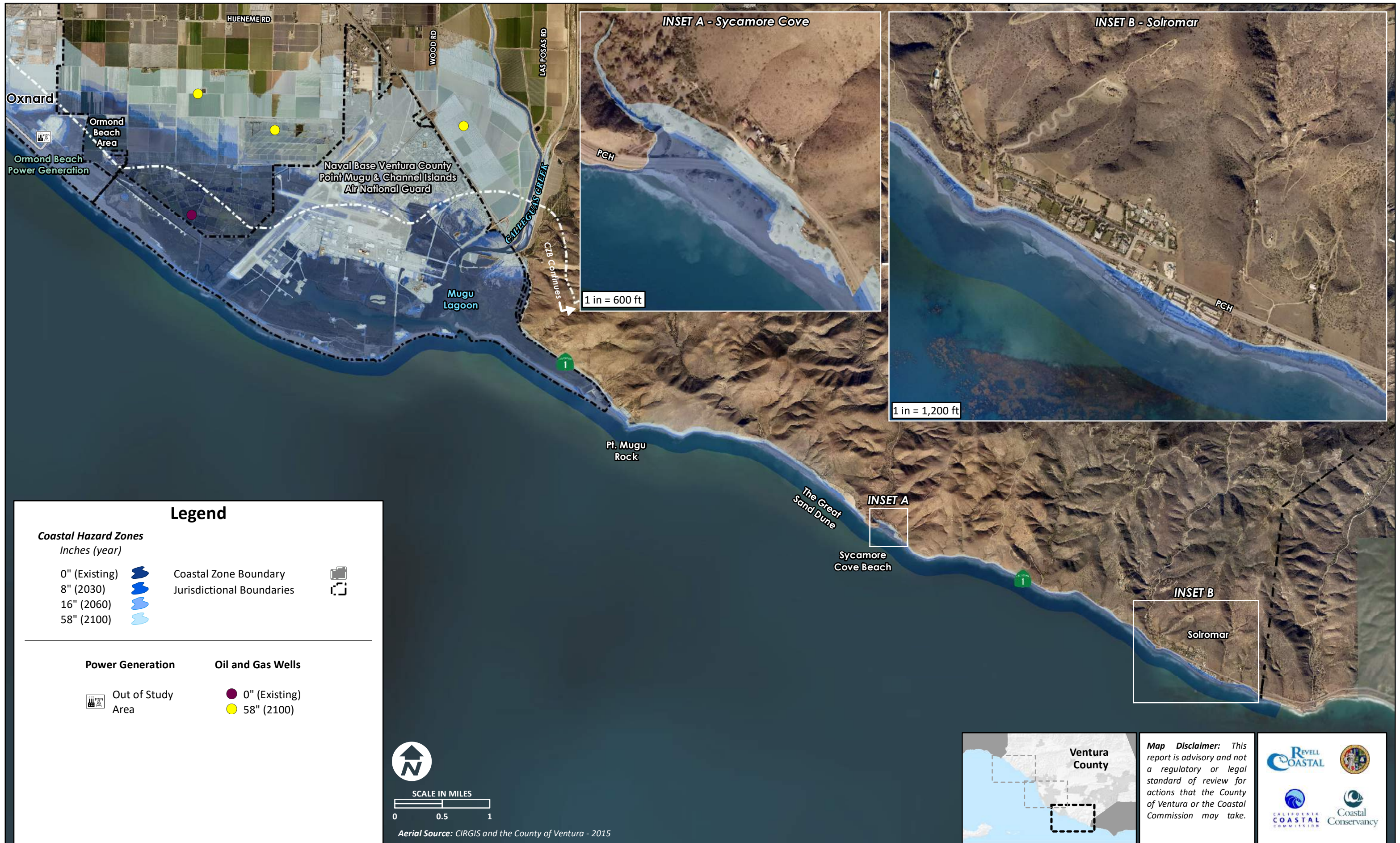


Figure A9c - Oil and Gas: South Coast



Overview

There are two types of hazardous materials evaluated in this Report: businesses that store hazardous materials and sites that have been identified for cleanup remediation.

The Ventura County Environmental Health Division Certified Unified Program Agency (CUPA) provides regulatory oversight for the following six statewide environmental programs: Hazardous Materials Business Plan, Hazardous Waste program, Onsite Hazardous Waste Treatment Permitting, Underground Storage Tank program, Aboveground Petroleum Storage Tank program, and the California Accidental Release Prevention Plan. The implementation of CUPA includes State and Federal laws, as well as County ordinances and policies. CUPA activities also cover hazardous materials emergency response, investigation of illegal disposal of hazardous waste, and public complaints. Compliance is achieved through inspections, educational guidance, and enforcement actions.

A number of state agencies which include the California Environmental Protection Agency, the Office of Emergency Services, Cal Fire, the State Water Board, and the Department of Toxic Substances Control also provide regulatory oversight for hazardous materials and hazardous waste facilities, and, are involved with emergency response and management activities.

The California State Water Resources Control Board monitors waste discharge and leaking underground storage tanks (LUSTs) through their Geotracker web portal which provides a tool to evaluate the potential for contamination to threaten drinking water. The State Water Board actively investigates hazardous spills and works with the owner to clean them (remediate them). The type of chemical and the state (solid, liquid or gas) determines the relative risk of dispersal.

To quantify the impact of coastal hazards and sea level rise (SLR) on hazardous materials, the following measures of impacts have been identified:

Number of active Geotracker sites • **Number of LUSTs** • **Number of CUPA companies**

Existing Vulnerabilities

<p>Coastal Flooding</p> <ul style="list-style-type: none"> • 4 CUPA businesses • 1 Active site <p>Fluvial Flooding</p> <ul style="list-style-type: none"> • 5 CUPA sites 	<p>There are four CUPA businesses potentially exposed to a current 1% annual chance storm. These are an oil and gas related site near Seacliff owned by Pacific Offshore, part of the SoCal natural gas infrastructure just south of Seacliff, and Agromin Organics Recycling Site in Ormond Beach (part in Oxnard, part in County). Five additional CUPA businesses are subject to fluvial flooding in the Santa Clara floodplain.</p>
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Projected Vulnerabilities

8 inches by ~2030

<p>Coastal Flooding</p> <ul style="list-style-type: none"> • 4 CUPA sites 	<p>Coastal flooding may affect four additional CUPA sites including: a Verizon site in La Conchita, some additional SoCal gas infrastructure, some oil and gas infrastructure south of Faria owned by Vintage Production, and a Venoco facility near McGrath State Beach.</p> <div data-bbox="1019 1372 1435 1675" data-label="Image"> </div> <p style="text-align: center;"><i>Agromin compost and mulch processing site</i></p>
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16 inches by ~2060

<p>Tidal Inundation</p> <ul style="list-style-type: none"> • 1 CUPA site 	<p>Tidal inundation may affect the CUPA site at the Agromin Organics Recycling Site near Ormond Beach.</p>
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58" by ~2100

<p>Tidal Inundation</p> <ul style="list-style-type: none"> • 1 active cleanup site <p>Coastal Flooding</p> <ul style="list-style-type: none"> • 4 CUPA sites 	<p>Coastal flooding may affect 13 total CUPA business sites including four additional sites: additional SoCal gas infrastructure, two sites associated with the Southland Sod Farms.</p>
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Potential Adaptation Strategies

Range of Strategies: The majority of impacts to hazardous material storing businesses are potentially avoidable due to a variety of viable adaptation strategies. However, storage tanks must be protected or removed as contaminated soils can be costly to remediate. The adaptation costs are primarily incurred by private businesses or permit holders. However, when contained on a single parcel, the County should incentivize cleanup so that Geotracker sites are remediated before they become a County liability if leaking occurs beyond the parcel boundaries.

Accommodate – For businesses, there are relatively low-cost options to store materials in a more flood-proof manner by elevating, or floodproofing the facilities or components.

Protect – Adaptation strategies that reduce the exposure of the contaminants would include coastal armoring or potentially some kind of cobble berm. A horizontal levee around the CUPA sites in the Ormond Beach area integrated into the potential restoration design may provide protection.

Retreat – Businesses could avoid leakage by relocating away from the coastline.

Secondary Impacts: Failure of any strategy could result in substantial cleanup impacts if spills occur. Typical cleanup/remediation costs for storage tanks range from \$125,000 (no groundwater leakage) to \$1.5 million or more (groundwater leakage). The type of chemical and the state (solid, liquid or gas) determines the type of approach that may be preferable.

Findings

Summary	Strategy Options
<ul style="list-style-type: none"> • There are no hazardous material vulnerabilities from coastal erosion in the Central or South Coasts with up to ~5 feet of SLR. • Thirteen total CUPA businesses could be impacted by coastal flooding. • Thresholds: • With ~5 feet of SLR the active cleanup site near Seacliff could be exposed to tidal inundation spreading the contaminants much farther. • With 16" of SLR the Agromin Organics Site will be consistently impacted by tidal inundation. <p>Data gaps:</p> <ul style="list-style-type: none"> • The CUPA data and LUST data does not have good spatial reference information and needs to be improved. 	<p>Policy:</p> <ul style="list-style-type: none"> • Improve the storage of hazardous materials. • Work with utility and telecommunications companies to develop standards for floodproofing, podiums, or require alternatives analysis to relocate key infrastructure and avoid future hazards. <p>Projects:</p> <ul style="list-style-type: none"> • Improve the geospatial accuracy of CUPA and LUST data. <p>Monitoring:</p> <ul style="list-style-type: none"> • Continue to monitor CUPA businesses for compliance with hazardous material storage standards.

Figure A10a - Hazardous Materials: North Coast

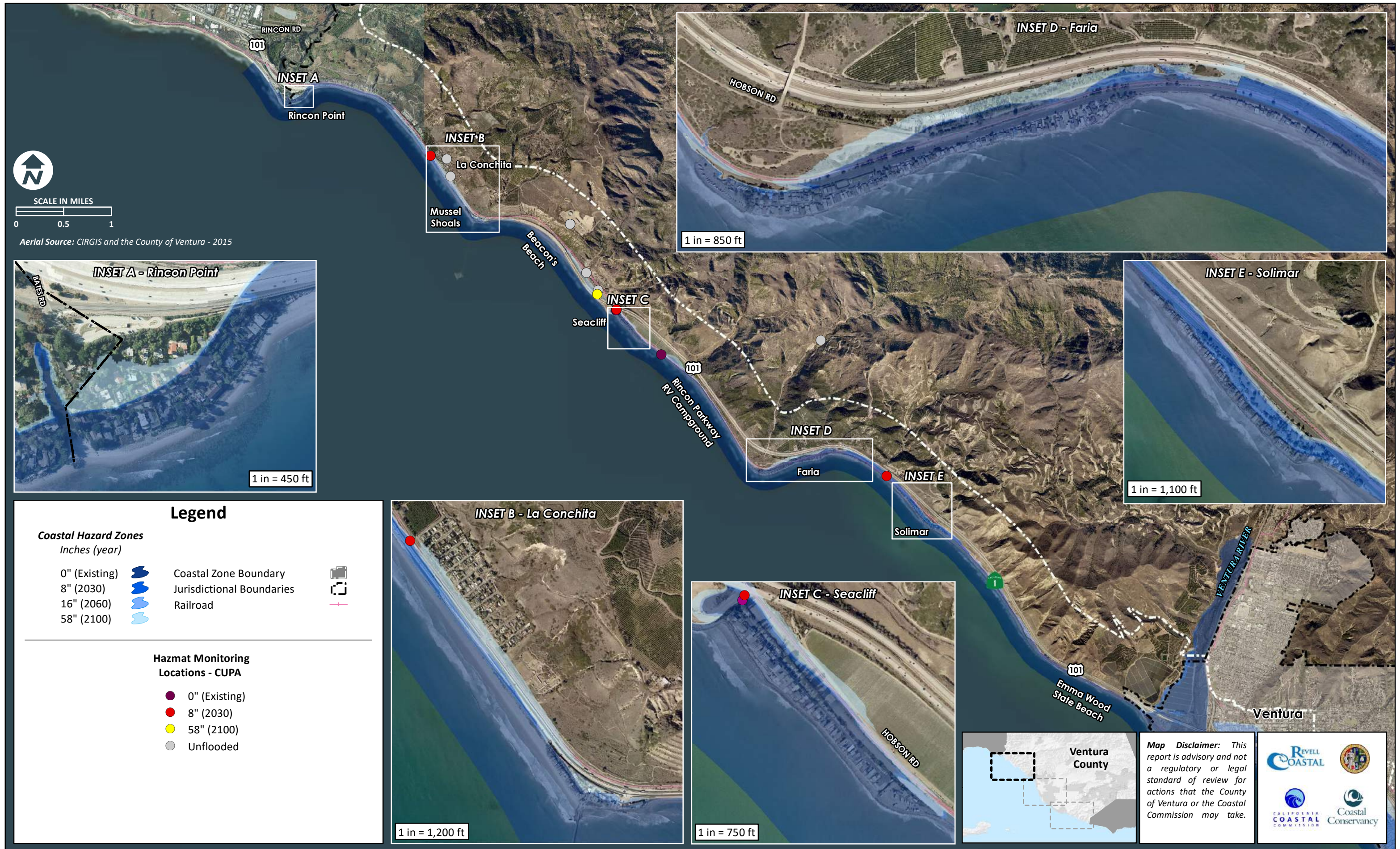


Figure A10b - Hazardous Materials: Central Coast

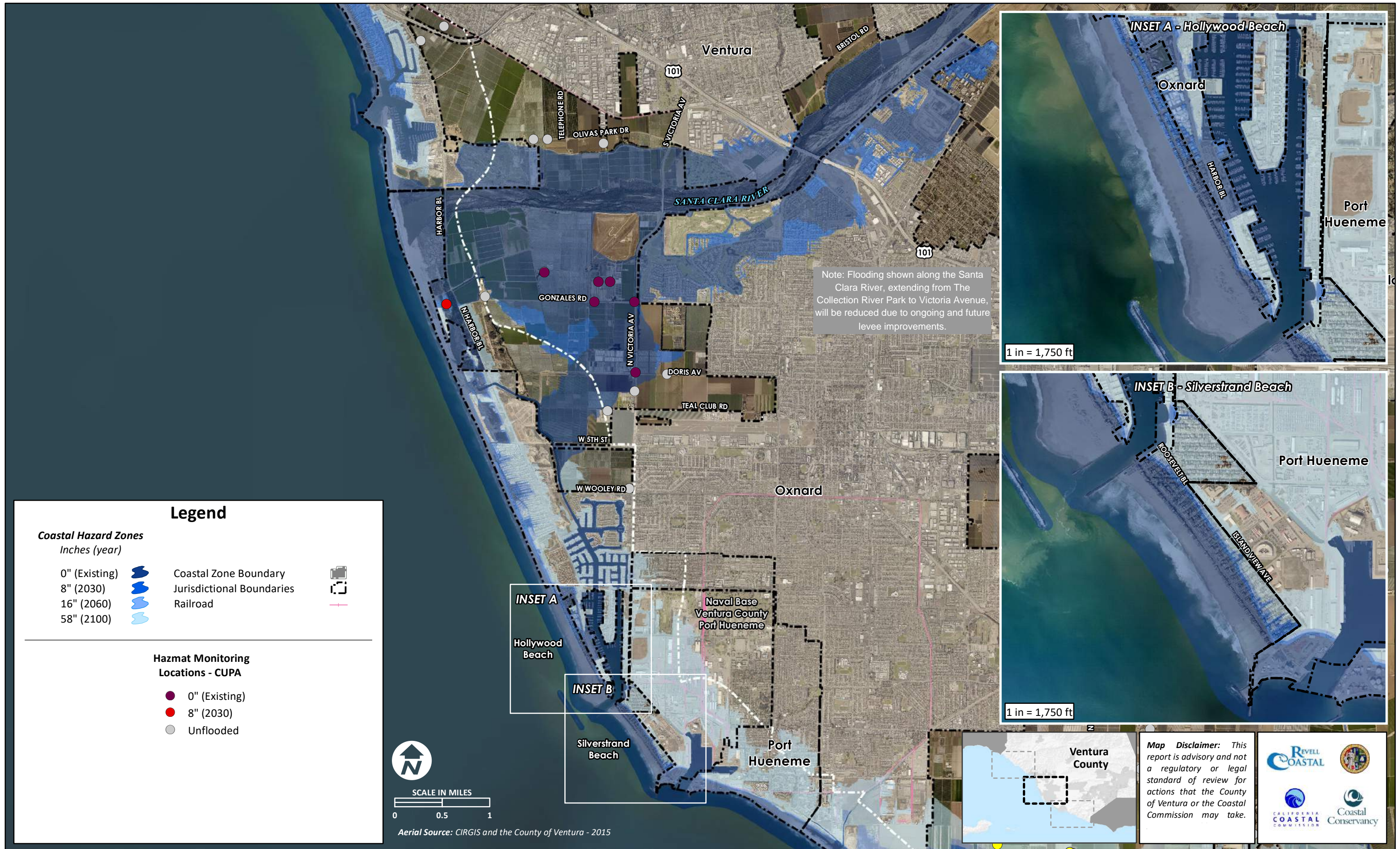
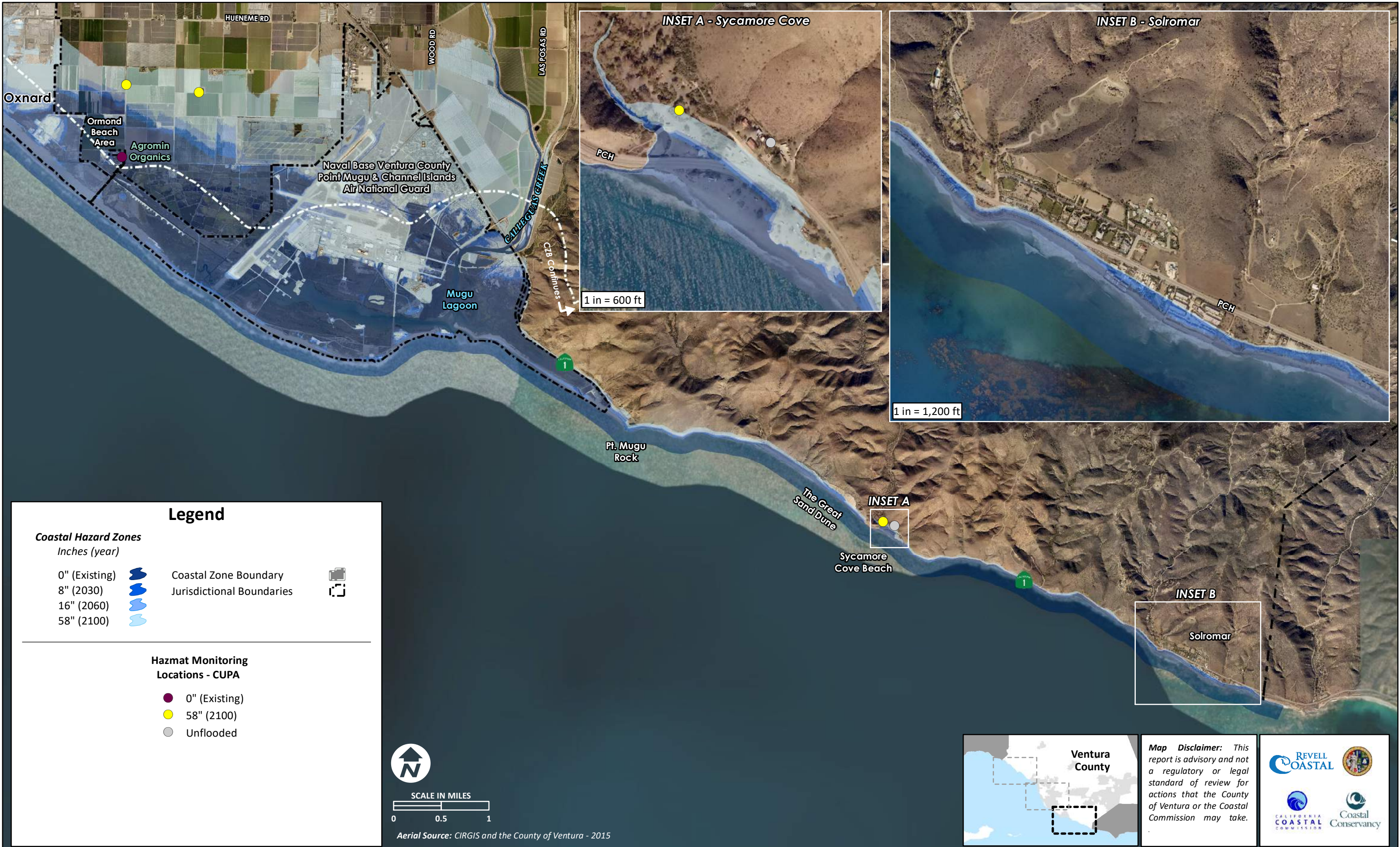


Figure A10c - Hazardous Materials: South Coast



Legend

Coastal Hazard Zones
Inches (year)

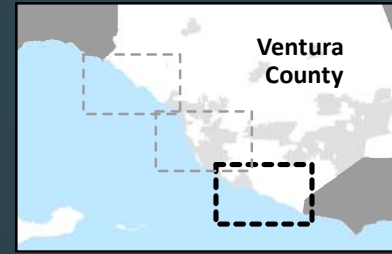
0" (Existing)		Coastal Zone Boundary	
8" (2030)		Jurisdictional Boundaries	
16" (2060)			
58" (2100)			

Hazmat Monitoring Locations - CUPA

	0" (Existing)
	58" (2100)
	Unflooded



Aerial Source: CIRGIS and the County of Ventura - 2015



Map Disclaimer: This report is advisory and not a regulatory or legal standard of review for actions that the County of Ventura or the Coastal Commission may take.



Overview

Critical facilities include those that support emergency operations and disaster response. This analysis includes emergency responders such as fire and sheriff facilities. Tsunami evacuation routes are included. Additionally, secondary facilities have been assessed that would serve to support operations or as evacuation centers. These facilities include medical facilities, schools, government facilities, and communication towers. Communication towers may function when exposed to coastal flooding depending on electrical components but have been identified as a potentially vulnerable resource. To quantify the impact of coastal hazards and sea level rise (SLR) on critical facilities, the following measures of impacts have been identified:

- Number of fire and police stations
- Number of medical facilities
- Miles of evacuation routes
- Number of government facilities
- Number of communication towers
- Number of schools

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

Existing Vulnerabilities

<p>Coastal Flooding</p> <ul style="list-style-type: none"> • 1 school / 6 towers • 2.1 miles of evac. routes 	<p>No critical facilities are exposed to tidal inundation or erosion under existing hazards.</p> <p>Coastal flooding during a 1% annual chance storm could impact Hollywood Beach Elementary School. Up to 2.1 miles of evacuation routes on Highway 101 near Rincon Point on the North Coast and Pacific Coast Highway (PCH) along the South Coast. Six total communication towers may be subject to coastal flooding: four towers along the Rincon Parkway south of Faria, one in Hollywood by the Sea, and one near Point Mugu.</p>
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Projected Vulnerabilities

8 inches by ~2030

<p>Coastal Erosion</p> <ul style="list-style-type: none"> • 1 tower • 0.9 miles of evac. routes <p>Coastal Flooding</p> <ul style="list-style-type: none"> • 1 tower • 1.2 miles of evac. routes 	<p>Coastal cliff erosion could impact 0.9 miles of evacuation route along Highway 101 near La Conchita on the North Coast, and PCH in the South Coast. A communications tower at Point Mugu is also projected to be vulnerable.</p> <p>Coastal flooding is projected to impact an additional 1.2 miles of evacuation routes, and an additional communication tower near Emma Wood State Beach Park.</p>
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16 inches by ~2060

<p>Coastal Erosion</p> <ul style="list-style-type: none"> • 1 school • 1.7 miles of evac. routes <p>Coastal Flooding</p> <ul style="list-style-type: none"> • 1 tower • 1.1 miles of evac. routes 	<p>Coastal dune erosion could begin to impact Hollywood Beach Elementary School. Coastal cliff erosion could impact an additional 1.7 miles of along PCH in the South Coast.</p> <p>Coastal flooding affects an additional tower at Point Mugu and an additional 1.1 miles of evacuation routes along Highway 101 near La Conchita and Mussel Shoals.</p>
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58 inches by ~2100

<p>Tidal Inundation</p> <ul style="list-style-type: none"> • 1 fire station / 1 govt. facility • 0.4 miles of evac. routes <p>Coastal Erosion</p> <ul style="list-style-type: none"> • 3 towers • 2.2 miles of evac. routes <p>Coastal Flooding</p> <ul style="list-style-type: none"> • 1 fire station / 1 govt. facility • 6 towers • 4.7 miles of evac. routes 	<p>Tidal inundation may affect a total of 0.4 miles of evacuation routes, two towers and a Channel Islands Community Service District building during routinely high tides.</p> <p>Dune and cliff erosion accelerated by ~5 feet of SLR may impact a total of 4.7 miles of evacuation routes along Highway 101 and PCH as well as in Silverstrand.</p> <p>Coastal flooding is projected to affect a combined total of 9.1 miles of evacuation routes along Highway 101, PCH, and in Silverstrand. Six additional communication towers near Mussel Shoals, Mugu Lagoon, and Solromar are impacted for a combined total of 14 towers with ~5 feet of SLR. Finally, Ventura County Fire Station #25 near Seacliff and the Channel Islands Community Service District building in Silverstrand are projected to be exposed to coastal flooding.</p>
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Potential Adaptation Strategies

Range of Strategies:

Accommodate – It is possible to elevate buildings and communication towers to accommodate higher flood water levels or examine additional setbacks for new buildings and supporting infrastructure. Poles and anchors supporting towers could be required to use more salt tolerant metals or anchors.

Protect – Coastal armoring (gray), or enhanced sand dunes (green) would provide protection from coastal erosion and flooding.

Retreat – relocate or remove critical facilities and communication towers from the hazardous areas. If feasible, reroute the evacuation routes susceptible to existing and future coastal hazards.

Secondary Impacts:

Retreat strategies may negatively impact Hollywood Elementary School and displace residents and children attending the school. Accommodation strategies that involve elevating structures could be extremely costly depending on the types of structural foundation needed. Elevating communications facilities that are located in scenic areas would increase aesthetic impacts. Green protection strategies could provide some room for dune habitat transgression for roads adjacent to wetlands. Gray protection strategies could negatively impact beach and recreational opportunities as well as have escalating maintenance costs.

Findings

Summary

- No medical facilities or sheriff stations are impacted by coastal hazards with up to ~5 feet of SLR. Ventura County Fire station #56 at Solromar would also not be affected.
- Hollywood Elementary School, Ventura County Fire Station #25, and a Channel Islands Community Service District building are vulnerable to coastal hazards with ~5 feet of SLR. The fire station is estimated to cost \$6.5 million to replace.
- 9.1 miles of evacuation routes could be impacted during coastal flood events and 4.7 miles may be eroded with ~5 feet of SLR.

Thresholds:

- Hollywood Beach Elementary School is vulnerable to coastal flooding now, and with 8" of SLR may become exposed to coastal erosion damages.
- There are significant increases in vulnerability to the Fire station #25 on the North Coast and the Channel Islands Community Service District building in Silverstrand becomes exposed to tidal inundation and coastal flooding with ~5 feet of SLR.



Strategy Options

Policy:

- Evaluate alternative facility locations, especially those facilities affected by tidal inundation or erosion.
- Include language in policy updates to consider sea level rise and flood hazards in the renewal of any future communication tower leases.

Projects:

- Continue to work on alternative evacuation routes for geographically isolated communities such Silverstrand and Solromar.

- Evaluate population demographics exposed.

- Update sea level rise hazards in the Multi-Hazard Mitigation Plan.

Monitoring:

- Monitor extents, depths and frequency of inundation at the school.



Figure A11a - Critical Services: North Coast



Figure A11b - Critical Services: Central Coast

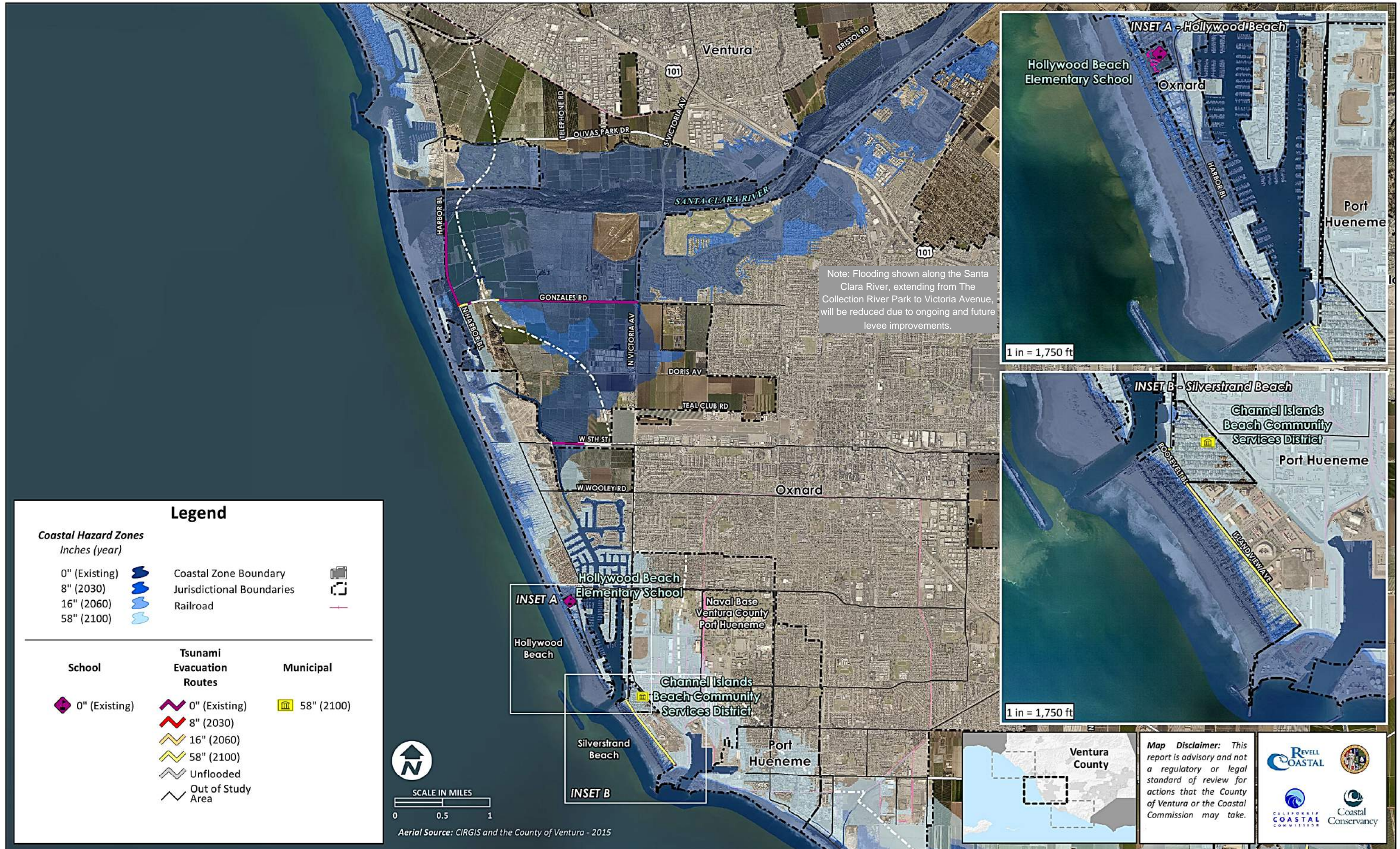


Figure A11c - Critical Services: South Coast

