Appendix F – Infrastructure Vulnerability and Adaptation Summary Sheets

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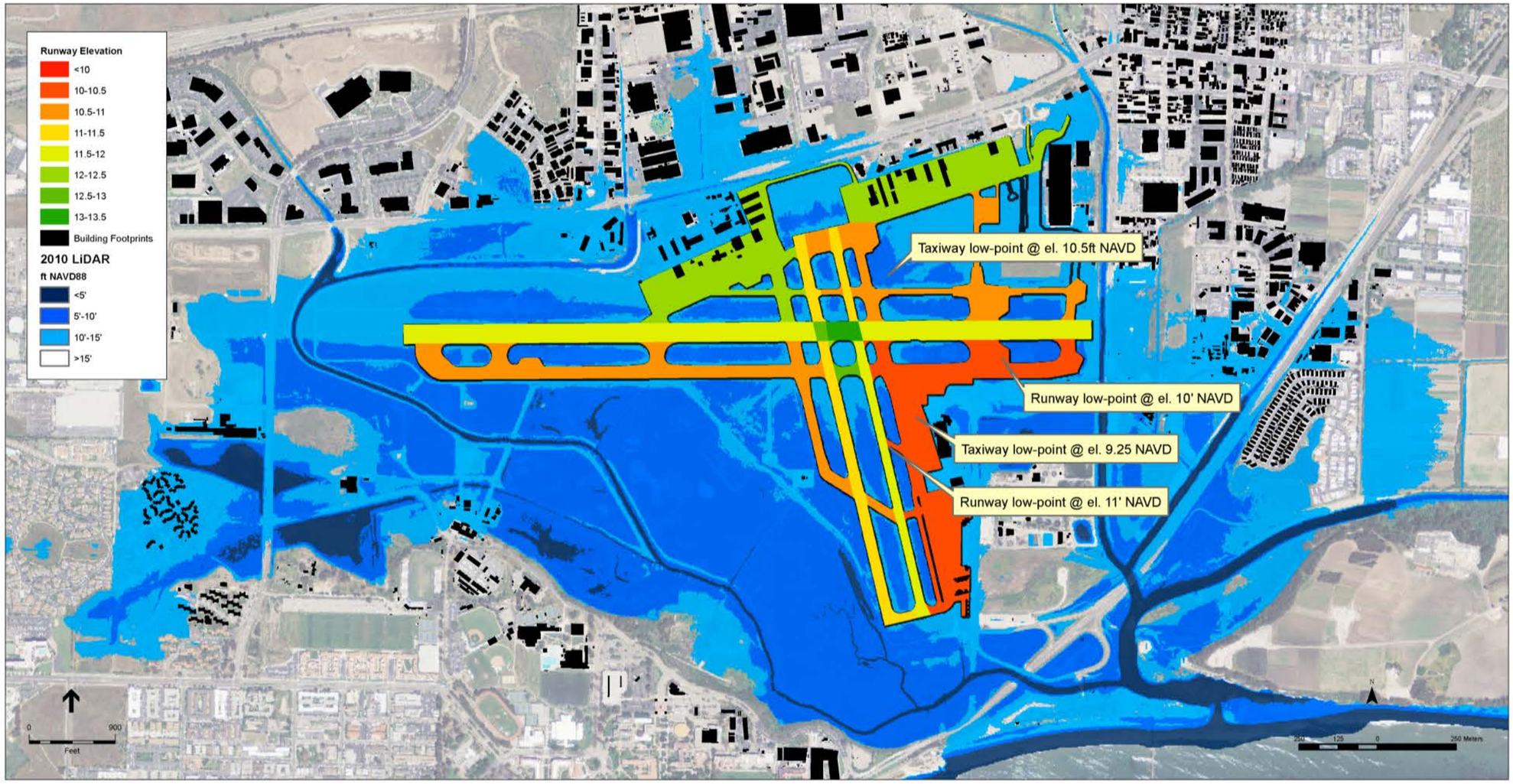
Table SI-1. Santa Barbara Municipal Airport Infrastructure Hazard Summary

<table>
<tr><th>Infrastructure Category</th><th><u>Santa Barbara Municipal Airport (SBA)</u></th></tr>
<tr><td>Location</td><td>The Santa Barbara airport was constructed on landfill within the former footprint of Goleta Slough. The airport property currently occupies the parcel immediately to the north and east of Goleta Slough. The Santa Barbara Municipal Airport (SBA) is a regional domestic airport serving over 700,000 passengers annually.</td></tr>
<tr><td>Types of Hazard</td><td>Tidal inundation – Airport is located in the middle of the tidal slough. Hazard increases with SLR
Fluvial flooding – Elevated risk of fluvial floods during precipitation events when the lagoon mouth is closed.
Local runoff – Accumulation of local runoff due to failure of local storm drainage system may cause ponding on tarmac and taxiways.</td></tr>
<tr><td>Exposure to Hazard</td><td>The Airport is located in the middle of Goleta Slough, protected from tidal inundation by uncertified berms at approximately El. 8.5’. This area experienced flooding during the 1969 and 1995 storm events.</td></tr>
<tr><td>Sensitivity to Hazard</td><td>• Flooding of the runways, taxiways and service buildings through accumulation of local runoff, berm overtopping and backwater through drainage system.
<table>
<tr><th colspan="2">Critical Flood Elevations</th></tr>
<tr><td>Taxiways</td><td>10ft NAVD88</td></tr>
<tr><td>Runways</td><td>11ft NAVD88</td></tr>
<tr><td>Terminals</td><td>13ft NAVD88</td></tr>
</table>
• Bird air-strike hazard (BASH) by waterfowl.
• Loss of access to airport control tower.
• Loss of access or flooding damage to utilities/lights/fuel storage/pipelines.</td></tr>
<tr><td>Vulnerability</td><td>Water levels within the slough exceeding elevation 10.0’ NAVD88 will disrupt normal Airport operations.
Potential flood damage to structures and facilities. Deeper, more frequent flooding leads to greater risk of damage.
Birds striking low flying aircraft pose a major hazard, potentially damaging the aircraft and leading to injuries, death and property damage.</td></tr>
<tr><td>Risk of Changes</td><td>The risk of damage will increase over time with rising sea levels.
<table>
<tr><th colspan="2">Recurrence Interval of Critical Coastal Flood</th></tr>
<tr><td>Taxiways</td><td><50 yrs (no SLR)</td></tr>
<tr><td>Runways</td><td>100 yrs (no SLR)</td></tr>
<tr><td>Terminals</td><td>>100 yrs (no SLR)</td></tr>
</table>
Elevated slough water levels lead to larger waterfowl populations, and increase the frequency of runway, taxiway, and service building flooding.</td></tr>
<tr><td>Potential Adaptation Measures</td><td>• Increase elevation of runway.
• Construct levees and tide gates.
• Manage slough inlet mouth for open conditions.
• Manage waterfowl populations.</td></tr>
</table>

Figure SI-1. Airport Runway Elevations



SOURCE:

LiDAR: NOAA Digital Coasts

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Table SI-2. Santa Barbara Municipal Airport Adaptation Strategy

Adaptation Strategy	Adaptation Measure	Benefits	Drawbacks	SLR Accommodation	Relative Cost	Estimated Lead Time
No Action	**Do Nothing** (*no managed breaches)	No upfront cost.	Future costs due to more frequent airport closure, flood damage.	0ft – Runways flood for multiple days every year under existing conditions if lagoon mouth is closed during winter storm.	N/A	N/A
Management Options	**Breach Inlet** Excavate lagoon inlet channel following closure events as part of planned lagoon management. **Manage Beach Elevation** Breaching to limit height of beach berm	Significant reduction in lagoon water levels. Potential benefits for tidal habitats within lagoon and Slough.	Permitting Requirements. Potential impacts to sensitive/endangered species. Impacts to beach access/recreation.	Potentially Effective for 2-3' SLR. Eventually higher tide levels will cause runways to flood even with inlet mouth open.	Low to Moderate (depending on cost of permitting process)	1 day (emergency breach) 1-5 years (permitted managed breaches)
Management Options	**Sediment Management** Limit removal of sediment from lagoon system through reduced dredging and/or strategic sediment placement.	Potential benefits to habitats, including benefits some sensitive species. Potential reduction in erosion of perimeter berm due to waves during flood events. Uses existing natural resources. Encourages existing physical deposition and accretion processes.	Minimal flood protection. Permitting Requirements. Potential changes to fluvial flood levels. (May require new FEMA mapping) Potential impacts to some sensitive species.	Minimal Benefit. May reduce quantity of fill required to elevate outfield.	Low to Moderate	1-2 years
Relocation	**Elevate Runways Over Time** Increase thickness of runway during regular resurfacing e.g. 6" lifts every 10 yrs.	Costs distributed over time.	Potential to elevate runways is limited by elevation of adjacent infield and overrun areas.	Potentially Effective for 1-2ft SLR. Limited by elevation of adjacent infield and overrun areas.	Low/Moderate (depending on level of fill)	Could be incorporated into existing runway resurfacing. 5-10 year cycle
	Elevate Airfield Apply fill across airfield site, including tarmac, infield and outfield areas.	Greatest potential reduction in flood hazard at Airport. Fill may become available from nearby Devereux Slough site.	May require new FEMA flood mapping. May be subject to strict permitting requirements. Filling of wetlands generally not viewed favorably. Might require temporary closure of airport during grading operations. Subject to availability of fill.	Potentially Effective for 5+ ft of SLR, depending on availability of fill.	High to Very High	1-5 yrs, depending on location and extent of fill placement and permitting requirements
Protect in Place	**Construct Levee** Construct flood control levee around airfield and airport, w/ pumping.	Potentially large reduction in flood hazard.	Would require new FEMA flood mapping. May be subject to strict permitting requirements. Allowable levee height may be limited by flight path/FAA regulations.	Depends on allowable levee height, potentially effective for 4-5ft of SLR.	High to Very High	3 to 10 yrs
Change Uses	**Cease Operation of Airfield**	Elimination of flood hazard.	Santa Barbara Airport is a critical regional transportation link with no similar facility in the region. Closure of the airport could have large adverse impact on local residents and businesses.	Effective for all levels of SLR.	High to Very High	Unknown

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Table SI-3. Commercial, Residential and Airport Buildings Infrastructure Hazard Summary

<table>
<tr><th>Function</th><th><u>Buildings</u></th></tr>
<tr><td>Location</td><td>The region around Goleta Slough is populated by a large number of commercial and residential structures, as well as numerous buildings associated with the airport.</td></tr>
<tr><td>Types of Hazard</td><td>The primary risk to structures within the vicinity of Goleta Slough stems from potential flood damage causes by elevated water levels. Flood levels within Goleta Slough are project to rise due to sea level rise, presenting a potential future flood hazard to structures that are currently outside of the mapped floodplain. Hazards to structures include:
Water damage to building materials and contents
Structural damage due to fast flowing water</td></tr>
<tr><td>Exposure to Hazard</td><td>The buildings most at risk of flooding include the structures immediately adjacent to the airport, several homes and other structures on southwestern edge of the slough, and scattered commercial and residential buildings adjacent to the northern and eastern tributary creeks.</td></tr>
<tr><td>Sensitivity to Hazard</td><td>Increased frequency of flooding of buildings leading to water damage and other flood related damages
Increased wind-wave erosion of levees and banks leading to incremental reduction in level of flood protection and/or increased maintenance costs</td></tr>
<tr><td>Vulnerability</td><td>The severity of damages is dependent on building elevation, depth of flooding, velocities of flow, and the salinity of flood waters, as well as the effectiveness of existing flood protection infrastructure.

The following table summarizes the floor area of structures at risk of flood damage based on the building’s ground floor elevation:<table><tr><th colspan="2">Footprint of Buildings at Risk</th></tr><tr><td>El<10</td><td>90500 sf</td></tr><tr><td>El 10-12.5</td><td>553000</td></tr><tr><td>El 12.5-15</td><td>939000</td></tr></table></td></tr>
<tr><td>Risk of Changes</td><td>The risk of flood damage to buildings will increase over time as sea level rise increases the frequency of extreme high water events within the slough. The specific risk of flooding will vary based on the function of new and future flood control structures, the rate of sea level rise, and the management of the lagoon mouth.</td></tr>
<tr><td>Potential Adaptation Measures</td><td>Elevate structures
Revise construction standards
Revise land-use plan
Construct levees /maintain existing levees
Management of the slough mouth</td></tr>
</table>

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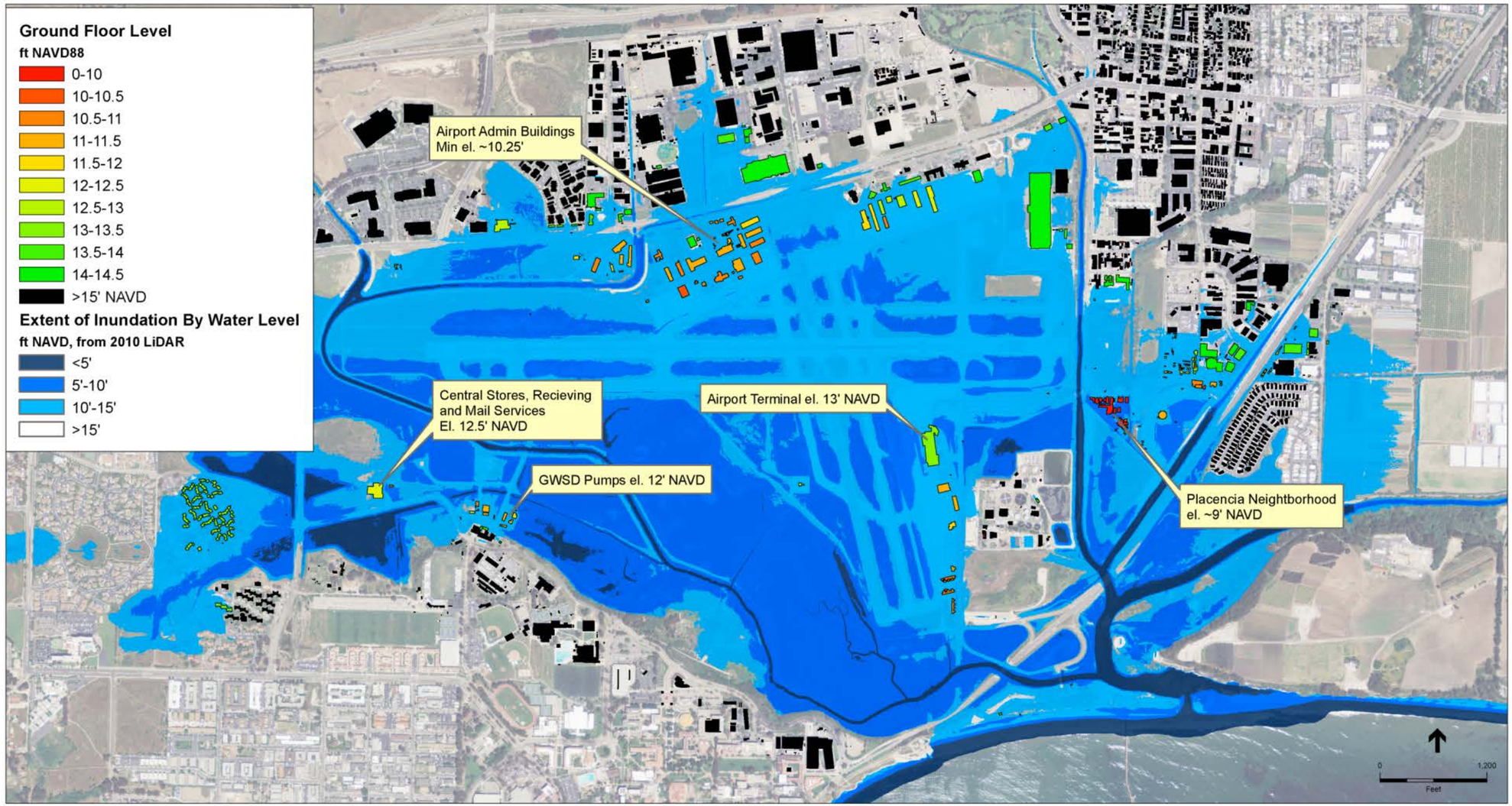
Figure SI-2. Building Ground Floor Elevations near Goleta Slough



SOURCE:

Building Footprints: P&S 2010

Elevations: NOAA Digita Coasts Bare Earth LiDAR

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Table SI-4. Structures Adaptation Strategy

Adaptation Strategy	Adaptation Measure	Benefits	Drawbacks	SLR Accommodation	Relative Cost	Estimated Lead Time
No Action	**No Action**	No upfront cost.	Future costs due to more frequent flood damage to structures, increased risk to life and property.	0ft - Placencia St. neighborhood floods during high water events under existing conditions. Airport hangars and maintenance facilities expected to flood regularly with 1-2ft of SLR.	N/A	N/A
Management Options	**Inlet Management** Manage lagoon inlet through breaches or beach shaping to limit the elevation of ponding during lagoon closures.	Significant reduction in lagoon water levels.	Permitting Requirements. Potential impacts to sensitive and endangered species. Impacts to beach access/recreation.	2-3' SLR – Placencia St neighborhood may flood due to high tide elevations even if inlet is open.	Low to Moderate (depending on cost of permitting process)	1 day (emergency breach) 1-5 years (permitted managed breaches)
Relocation	**Elevate Ground Floor Elevations**	Reduce flood hazard to life and property. May allow some continued use of threatened properties.	Disruption of building use during renovation. Limited applicability due to constructability constraints (e.g. building foundation type, accessibility requirements).	SLR accommodation varies by structure, requires site specific assessment. Potential candidates include Airport maintenance facilities.	Medium to High	2-5 years
Protect in Place	**Construct Levee** Construct flood control levees to protect threatened buildings.	Potentially large reduction in flood hazard.	Significant, potentially insurmountable constraints on constructability/engineering feasibility. May require new FEMA flood mapping. May be subject to strict permitting requirements. May create long-term maintenance obligations for county flood control. Allowable levee height near runways may be limited by FAA regulations.	Effectiveness varies by location. Potentially high (3-5ft SLR) for some threatened neighborhoods. (eg. Placencia St.) Less effective in areas without a clearly defensible perimeter (eg. airport maintenance buildings).	High	3 to 10 yrs
Change Uses	**Abandon Threatened Buildings**	Reduce flood hazards to life and property. Expiration of existing leases may present opportunities to phase out use of structures in threatened areas.	Potentially contentious for some properties. More easily implemented for government owned properties. Privately owned properties may require exceptional planning/permitting mechanisms, voluntary participation, or fee simple acquisition.	Potentially effective for all buildings, implementation depends on terms of lease/land ownership.	Low to High, varies with property ownership and available planning mechanisms	3-50yrs

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Table SI-5. Hazardous Material Remediation Sites Infrastructure Hazard Summary

<table>
<tr><th>Function</th><th><u>Hazardous Material Remediation Sites</u></th></tr>
<tr><td>Location</td><td>The California State Water Board has aggregated records of unauthorized chemical waste discharges and spills which require remediation*. Numerous sites have been identified in or adjacent to Goleta Slough at various stages of remediation.</td></tr>
<tr><td>Types of Hazard</td><td>• Mobilization of sub-surface contaminants due to changes in groundwater levels.
• Mobilization of surface contaminants due tidal or fluvial inundation.
• Groundwater and/or surface water contamination due to inundation and/or changing ground water levels.</td></tr>
<tr><td>Exposure to Hazard</td><td>There are 14 sites at various stages of remediation listed within the Goleta Slough Ecosystem Management Plan area, and an additional 43 remediation sites within 0.5 miles of GSEMP area boundary.
<table>
<tr><th>Category</th><th>In GSEMP</th><th>In 0.5 Mile Buffer</th></tr>
<tr><td>Completed</td><td>9 sites</td><td>26</td></tr>
<tr><td>Open</td><td>0</td><td>8</td></tr>
<tr><td>Open - Assessment and Remedial Action</td><td>3</td><td>3</td></tr>
<tr><td>Open - Monitoring or Eligible for Closure</td><td>2</td><td>4</td></tr>
<tr><td>Open - Inactive</td><td>0</td><td>2</td></tr>
</table>
“Open” sites indicate the recent or past observation of surface or groundwater contaminant(s). “Completed” sites indicate the completion of site clean-up and remediation efforts to the satisfaction of the State Water Board.</td></tr>
<tr><td>Sensitivity to Hazard</td><td>• Changing (elevated) ground water levels may mobilize subsurface contaminants, increasing extent of groundwater contamination and possibly also affecting surface water quality.
• Elevated water levels during surface flood events may mobilize surface contaminants. Subsurface contaminants are unlikely to be affected by short-term surface flood events, but may be affected by long-term inundation.</td></tr>
<tr><td>Vulnerability</td><td>The severity of damage varies based on a variety of factors, including the existing extent and concentration of the contaminant(s), the mobility of the contaminant, soil porosity, and groundwater hydraulics. Potential consequences of contaminant mobilization include:
• Expansion of contaminated area
• Exposure of contaminants to surface processes
• Contamination of groundwater wells
• Human health impacts
• Ecological impacts</td></tr>
<tr><td>Risk of Changes</td><td>The risk of damages is expected to increase over time as both sea levels and ground water levels rise.</td></tr>
<tr><td>Potential Adaptation Measures</td><td>• Continued monitoring of remediation sites to assess how changing hydrologic conditions impact contaminant mobilization and transport.
• Enhanced remediation or protection of sites known to pose a significant risk and to be vulnerable to flooding and/or changing hydrologic conditions.</td></tr>
</table>

*These records are available at the GeoTracker database lists http://geotracker.waterboards.ca.gov.

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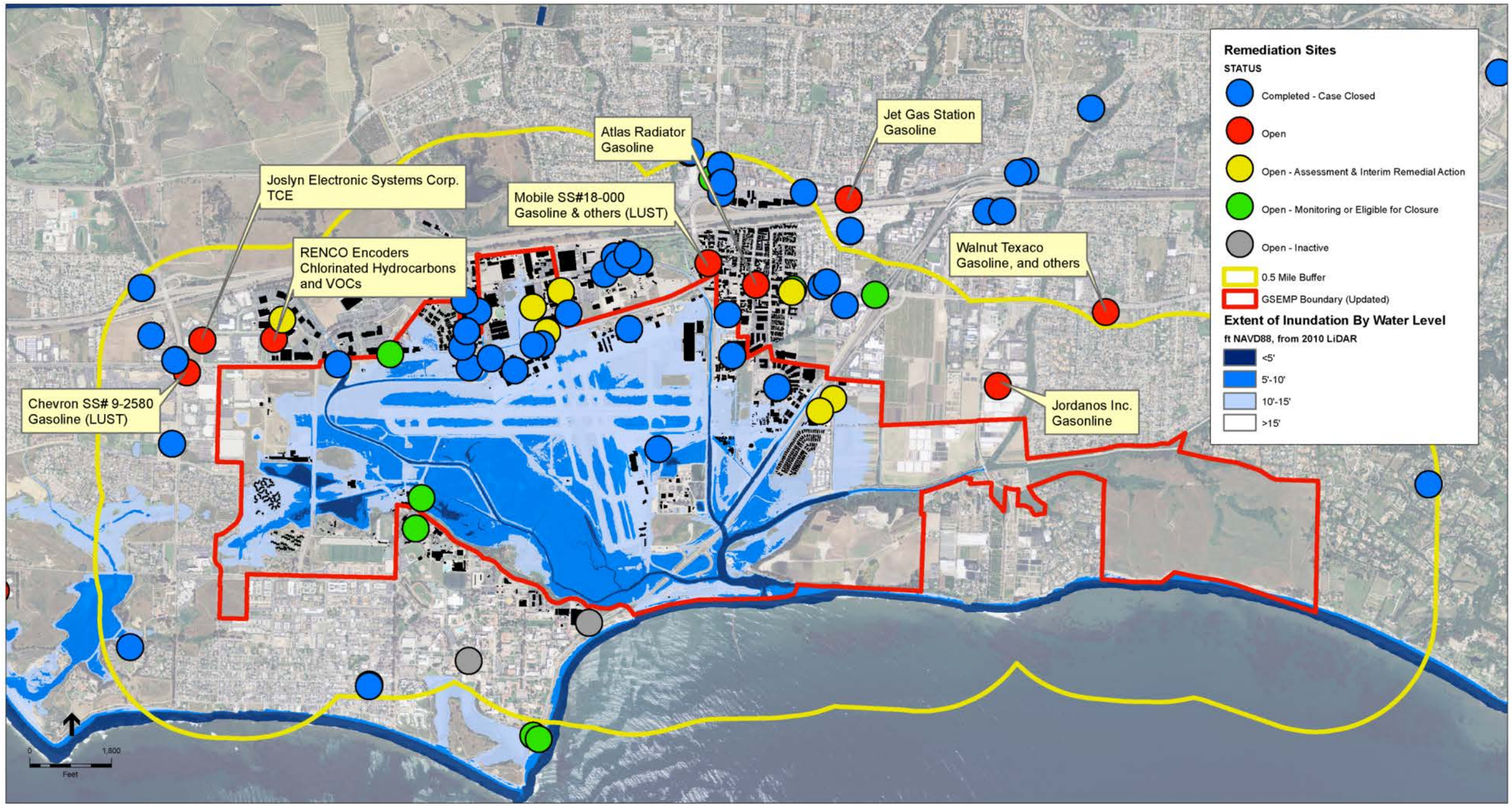
Figure SI-3. Remediation Sites near Goleta Slough



SOURCE:

Remediation Sites: Geotracker, Acessed November 2013

LiDAR: NOAA Digital Coasts

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Table SI-6. Hazardous Materials Business Plans Hazard Summary

Function	Hazardous Materials Business Plans
Location	Businesses which use significant quantities of regulated materials are required to file Hazardous Materials Business Plans (HMBPs) with local regulators. The Santa Barbara Fire District records the locations of all businesses with filed HMBPs for the Goleta/Santa Barbara area. These records show that there are numerous businesses within the vicinity of Goleta Slough which have filed HMBPs.
Types of Hazard	Varies depending on specific hazardous material present and method of storage. Businesses which handle or store hazardous materials are obligated to do so in a safe and responsible manner that minimizes the risk of spill or accidental release. Proper handling and storage practices should greatly reduce the risk of spill or release during the normal course of events, however local businesses may not anticipate elevated flood waters when devising their hazmat storage plans.
Exposure to Hazard	There are 625 business locations that have filed HMBPs for addresses within 0.5 miles of the Goleta Slough study area.
Sensitivity to Hazard	Elevated lagoon water levels are expected to lead to higher flood elevations, potentially increasing the flood risk to structures used for the storage of hazardous materials. The increased flood risk may increase the likelihood of an accidental hazardous material release, depending on the storage facility location, material type, and storage configuration. Hazardous materials which are water-soluble or which react with water, materials which are stored in non-waterproof containers, and materials which are stored in buildings which have an elevated risk of flood damage are expected to have the greatest risk of accidental release during a flood event. An accidental release of hazardous materials may lead to the: • Mobilization of hazardous materials in surface water • Mobilization of hazardous materials in groundwater • Airborne/Aerosol release of hazardous materials
Vulnerability	The severity of an accidental hazardous materials release varies based on the specific hazardous material(s) that is present, the quantity that is mobilized due to the release, and the likelihood of exposure based on the extent of contamination. Accidental releases of hazardous materials may lead to contamination of • Surface water & groundwater • Low-level atmosphere • Soils Such a release may expose humans and wildlife to toxic, corrosive or otherwise harmful materials. The consequences of exposure can vary greatly depending on the hazardous material, the mode and duration of exposure, and the dosage received.
Risk of Changes	The risk of flooding due to rising sea levels and fluvial flood events is expected to increase over time. The risk of damaging hazardous materials release due to flooding varies based on material type and storage configuration.
Potential Adaptation Measures	• Education and outreach to encourage/promote safe HazMat storage practices in areas with elevated flood risk. • Planning/Land-use restrictions on HazMat storage in areas susceptible to elevated flood risk.

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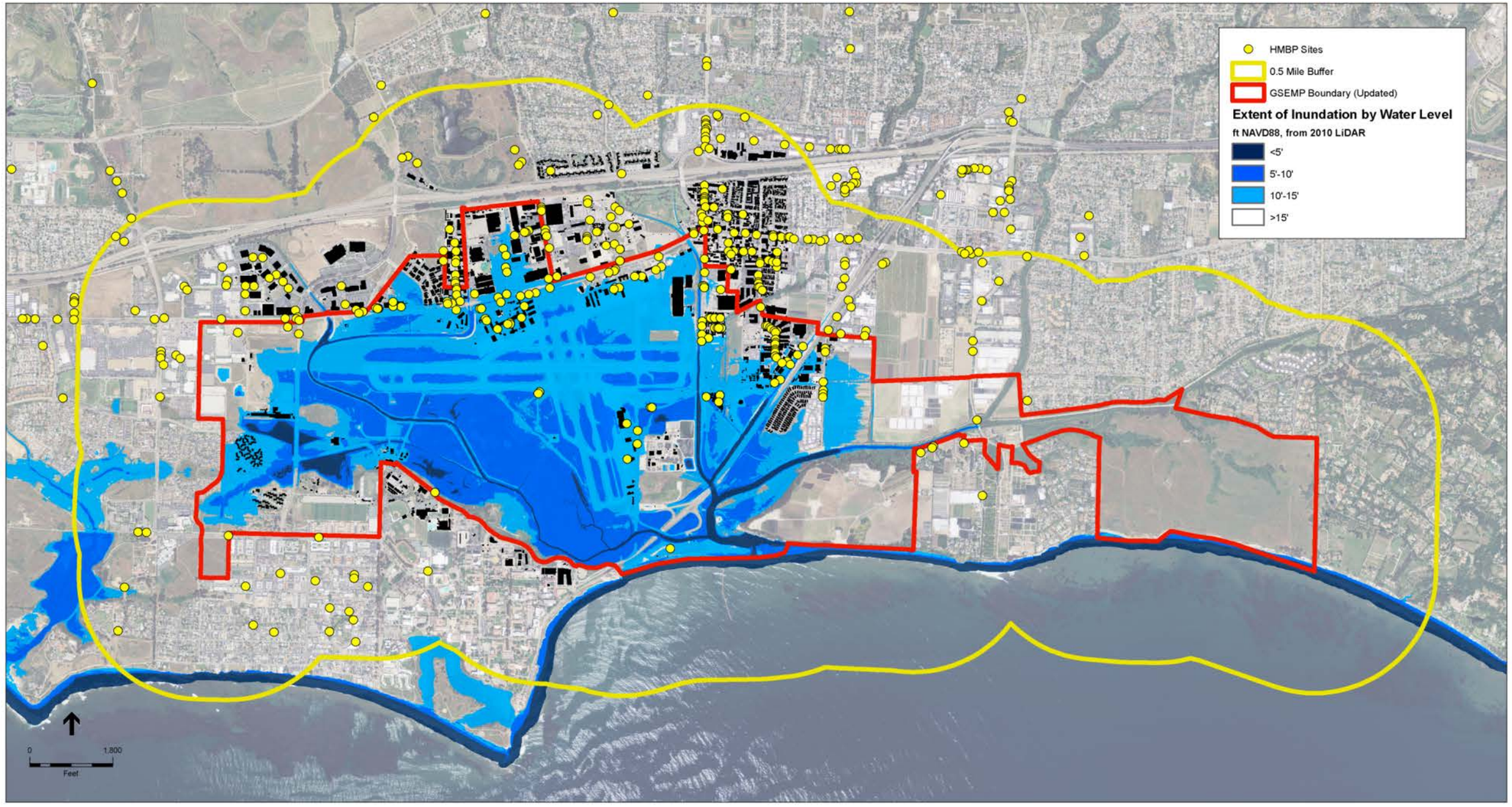
Figure SI-4. Filed Hazardous Materials Business Plans near Goleta Slough



SOURCE:

HMBPs: Santa Barbara Fire Dept.

LiDAR: NOAA Digital Coasts

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Table SI-7. Hazardous Materials and Remediation Sites Adaptation Strategy

Adaptation Strategy	Adaptation Measure	Benefits	Drawbacks	Sea Level Rise Accommodation	Relative Cost	Estimated Lead Time
No Action	Continue to enforce applicable regulations (EPA, CEPA, OSHA and others)	Low Cost	May require increased levels of monitoring and enforcement and or reopening of closed cases as SLR alters groundwater hydrology.	N/A	Low	N/A
Management Options	**Inlet Management** Manage lagoon inlet through breaches or beach shaping to limit the elevation of ponding during lagoon closures.	Significant reduction in lagoon water levels.	Permitting Requirements. Potential impacts to sensitive and endangered species. Impacts to beach access/recreation.	Unknown; vulnerability of existing hazmat and remediation sites depends on specific storage configuration and elevations of hazardous materials, such analysis is beyond the scope of this study.	Low to Moderate (depending on cost of permitting process)	1 day (emergency breach) 1-5years (permitted managed breaches)
Relocation	**Incentivize the relocation** Use permitting mechanisms to incentivize relocation of businesses which use Hazardous Materials to areas outside of the coastal flood hazard zone.	Reduced risk of chemical release during flood events.	Potential opposition from existing businesses. Need for local businesses to relocate. Difficulty finding suitable alternative locations for displaced businesses.	5'+ Removing Hazardous Materials from coastal flood hazard zone would greatly reduce rise of accidental release.	Unknown	2-10 years
Protect in Place	Install levees or other flood protection structures to reduce the extent of the coastal flood hazard zone.	High level of flood protection. Reduced risk of flood related release of hazardous materials.	High cost, including cost of land acquisition for the installation of new flood protection structures and the cost of maintenance.	5'+ Flood control structures which reduce the extent of the flood hazard zone would greatly reduce rise of accidental release.	High-Very High	5-10 years

Note:
Details about specific storage measures and elevations of hazardous materials were not available for this analysis. The evaluation of vulnerability of specific Hazardous Materials storage and use sites is beyond the scope of this study. Additional study is required to properly evaluate the potential impacts of Sea Level Rise on Hazardous Materials used in industrial and commercial processes and on existing toxic spill sites and to develop appropriate material handling and storage guidelines for the use of hazardous materials in coastal flood hazards zones.

We recommend that the appropriate regulatory agencies consider the expected increase in flood hazard due to sea level rise when evaluating the use and storage of hazardous materials in areas that may be exposed to coastal flooding.

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Table SI-8. Roads and Highways Infrastructure Hazard Summary

Function	**Roads and Highways**
Location	Several major transportation corridors pass through or adjacent to the Goleta Slough Management Area. • Highway US101/CA1 is the largest highway in the region, passing north-south through the city of Goleta about 1.5 miles inland. Highway US101/CA1 provides a critical transportation link for Central California. • State Route 217 serves as the main surface connector between US101/CA1, the Santa Barbara Airport, and UCSB. • There are also numerous smaller surface streets in the area including South Fairview Ave, Mesa Road, South Los Carneros Road and Hollister Ave which provide access to local businesses and residences.
Types of Hazard	Disruption of traffic flow due to flooding of low-lying roads and highways Damage to existing roadways and related infrastructure due to scour and erosion of embankments, footings and other structural/geotechnical elements.
Exposure to Hazard	The roads and highways most at risk of flooding are: • Intersection of Los Carneros Rd and Mesa Rd (el 9.2) • South Fairview Ave near the airport terminal (el 10.0) and at approach to Hwy 217 (el. 11.2) • Hollister Ave (el 11.8) • Parking areas and access roads near the airport administration buildings and at the housing development on Mesa Rd west of Los Carneros Rd. • Low-lying access roads adjacent to tributary creeks.
Sensitivity to Hazard	Elevated water levels within Goleta Slough under project SLR conditions are expected to increase the frequency of flood events in areas neighboring the slough. Consequences of flooding include: • Standing water on road surfaces preventing safe vehicle passage. • Potential damage to road grading and pavement surface due to scour and buoyancy effects.
Vulnerability	The severity of damage varies based on the depth and duration of flooding, as well as the velocity of flood waters. Flood waters above the road surface elevation may • Disrupt access pathways critical for the provision of emergency services. • Disrupt of transportation links to local businesses, residences, and municipal infrastructure. In addition, flood waters below the road surface elevation may still present an increased risk of damaging scour and erosion to embankments and road subgrades, which may lead to structural damage to the roadway.
Risk of Changes	The frequency of disruptive/damaging flooding is expected to increase with rising lagoon water levels and with changes to fluvial flood frequency. The future flood risk will be strongly influenced by the future lagoon mouth management regime.
Potential Adaptation Measures	• Manage lagoon mouth to minimize risk of high flood elevations. • Increase levee elevations and/or build new levees. • Raise road elevations. • Revise transportation plans to route traffic away from low-lying access corridors.

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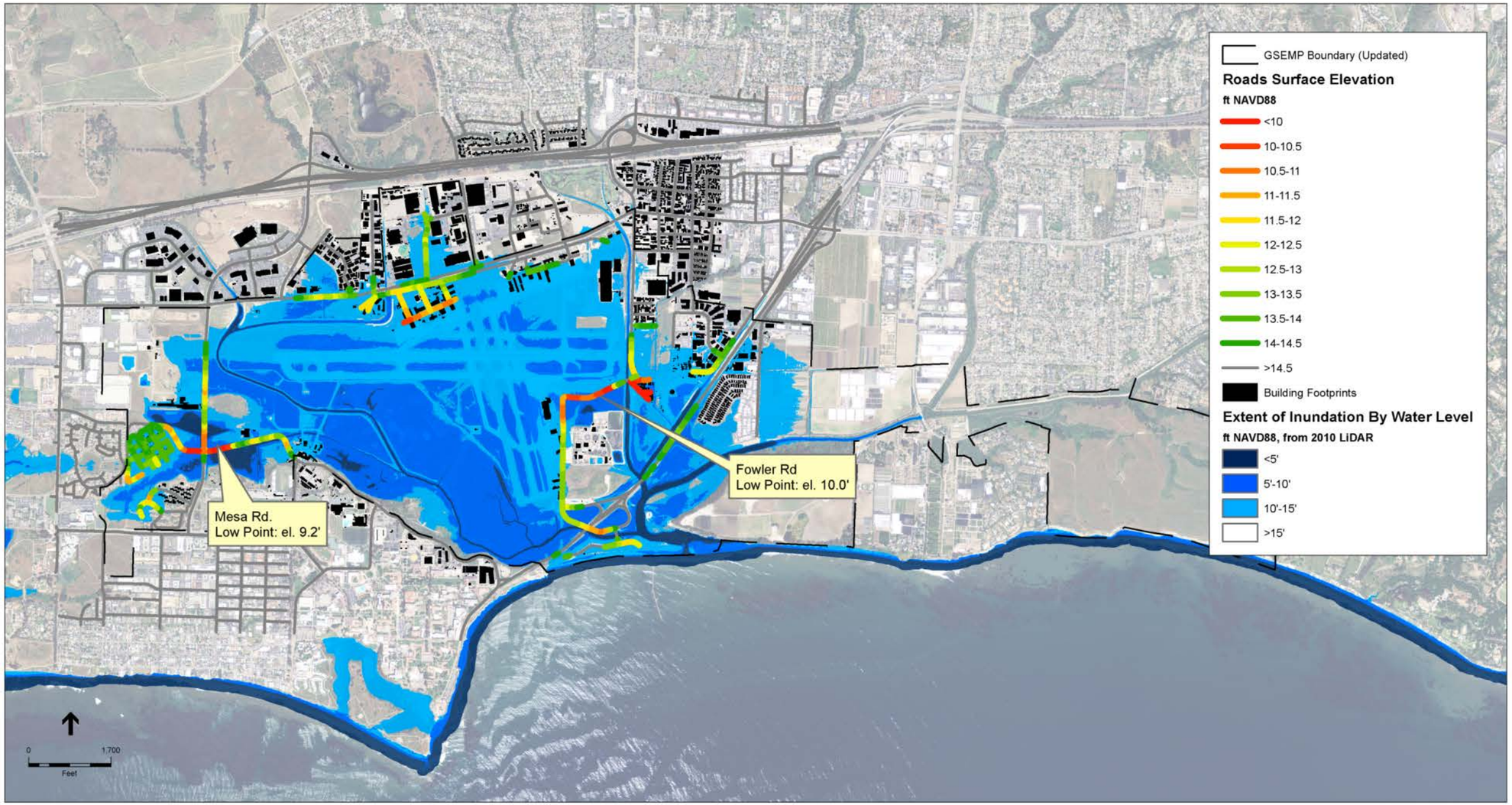
Figure SI-5. Critical Flood Elevations of Roads and Highways near Goleta Sloug



SOURCE:

LiDAR - NOAA Digital Coasts

Roads - Santa Barbara County

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Table SI-9. Roads and Highways Adaptation Strategy

Adaptation Strategy	Adaptation Measure	Benefits	Drawbacks	Effectiveness	Relative Cost	Estimated Lead Time
No Action	**No Action**	No upfront cost.	Increased costs due to more frequent road closures and potential flood damage. Increased risk to life and property.	Mesa Road, Fowler Road, and other low-lying roads and parking areas are likely to experience regular flooding under existing conditions.	N/A	N/A
Management Options	**Inlet Management** Manage lagoon inlet through breaches or beach shaping to limit the elevation of ponding during lagoon closures.	Considerable reduction in flood extents.	Considerable permitting challenges. Potential impacts to threatened and endangered species.	Occasional flooding of Mesa road with 1-2 ft of SLR, Fowler road with 2-3 ft of SLR, Hollister road with 4-5 ft of SLR.	Low to Moderate (depending on cost of permitting process)	1 day (emergency breach) 1-5 years (permitted managed breaches)
Management Options	**Elevate Road Surface Elevations During Regular Repaving** Apply thicker lifts of paving material as part of regular road maintenance to gradually increase road surface elevation for low-lying transit corridors.	Reduce flood hazard. Opportunities to minimize costs by coordinating with planned resurfacing and other improvements.	Capacity to elevate road surface is limited by stability of subgrade and adjacent slopes. Capacity to keep pace with sea level rise depends on actual rate of rise. Subject to availability of fill material. Constructability constraints including adjacent/connecting roads and utilities sharing road corridor.	Potential accommodation for 1-4ft of SLR. Smaller increases in road surface elevation are most feasible, but offer limited long-term protection. Larger elevation increases provide increased protection but will face greater constructability constraints.	Medium to High Varies with road elevation, corridor geometry and maximum feasible lift size	2-10 years Can be incorporated into existing capital improvement plans.
Relocation	**Abandon Threatened Roads and Construct or Improve Alternate Access Corridors**	Reduce flood hazard and long term maintenance costs. Opportunities to remove barriers to tidal connectivity and habitat continuity through constructions of causeways or bridges.	Alternative access corridors will need to be identified. Potentially contentious with affected residents and business owners.	Potentially effective for 5+ ft of SLR, assuming safe alternative transportation corridors exist or can be constructed.	High	10-50yrs
Protect in Place	**Construct Levee** Construct flood control levee around threatened roads. **Construct Causeway** Elevated road structures may allow continued use of existing road alignments. **Slope Contouring** Re-grade wetland transition slopes.	Potentially large reduction in flood hazard. Causeways may allow for increase tidal connectivity and habitat continuity. Contoured wetland transition slopes may provide wave dissipation, increase sediment accumulation and habitat benefits.	Significant, potentially insurmountable constraints on constructability/engineering feasibility. Cost, including future maintenance costs. Difficult permitting process for grading work done on existing wetland areas.	Depends on feasible levee height, potentially effective for 4-5ft of SLR.	High to Very High	3 to 10 years
Change Uses	(no alternate uses were identified)	-	-	-	-	-

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Table SI-10. Sanitary Sewer and Water Treatment Infrastructure Hazard Summary

Function	Sanitary Sewer and Water Treatment
Location	Sanitary sewer pipes, pumping stations and treatment plants are essential to the function of the municipal sewer system. • The Goleta Sanitary District treatment plant is located on Mescalitan Island, to the East of the airport terminal. The treatment plant serves both the Goleta Sanitary District and Goleta West Sanitary District. • The Goleta West Sanitary District pumping station is located at the western end of the slough. • There are numerous sewer pipes in the neighboring areas. There is a critical force sewer main which travels from the Goleta West Sanitary District pump station, across the slough, under the airport, and to the sewer treatment plant. • The Goleta Sanitary District treatment plant outfall pipe crosses the slough near the highway 217 bridge, passes under the beach and discharges approximately 6000 ft offshore.
Types of Hazard	• Tidal and/or fluvial flooding of critical sewer utility facilities, including pumps and treatment facilities. • Increased ground water levels leading to unanticipated buoyant forces on buried pipelines.
Exposure to Hazard	The GWSD Pumping station is immediately adjacent to slough. Critical flood elevation @ pumping well: 12.5ft NAVD The Goleta Sanitary District treatment plant is on Mescalitan Island to the southwest of the airport. Critical flood elevation to overtop treatment ponds: 17.3 ft NAVD Critical access road elevation: 12 ft NAVD
Sensitivity to Hazard	• Increased risk of flooding/inundation of critical infrastructure (pumps, utilities), disrupting operations and potentially damaging equipment. • Rising surface waters may limit access to facilities and pipelines for maintenance and operations. • Rising ground water levels may place unanticipated buoyancy forces on buried pipelines, potentially leading to leaks and/or pipe failure. Current maintenance staff does not anticipate significant problems due to buoyancy, however observation and monitoring is recommended to verify pipe stability under rising sea levels.
Vulnerability	• Both the Goleta West pumping station and the Goleta Sanitary District treatment plant, as well as the force main adjacent to the airport and the GSD outfall are critical to the function of the sanitary sewer system in the region. • The Goleta West pumping station may experience more frequent damaging flooding with rising sea levels. • The Goleta Sanitary District may become temporarily inaccessible due to flooding of key access roads. • The failure of local collection pipes may cause disruption of sewer function to localized areas of service. • Failure of municipal sanitary sewer system may lead to discharge of untreated sewage, presenting risks to human health and habitat.
Risk of Changes	The risk to the sewer utilities within the vicinity of Goleta Slough is expected to increase with sea level rise and rising ground waters.
Potential Adaptation Measures	• Construction of levees to protect key infrastructure, such as the GWSD pump station. • Increasing the elevation and/or relocating vulnerable infrastructure. • Protection or increasing the elevation of critical access corridors. • Placement of additional ballast on buried pipes.

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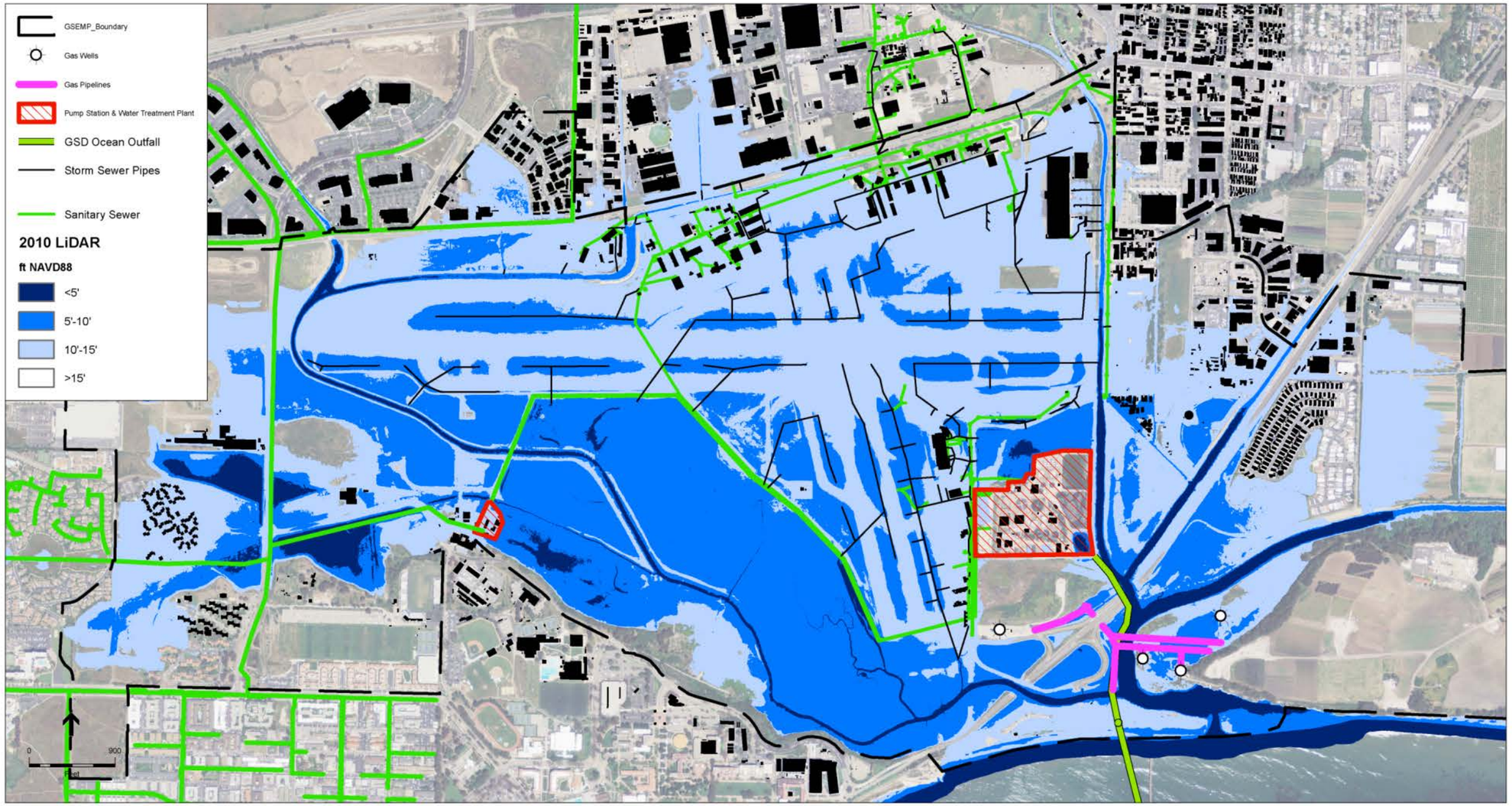
Figure SI-6. Storm and Sanitary Sewer Pipes near Goleta Slough



SOURCE:

Pipe Alignments - Goleta Sanitary District; Pennfield &Smith

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Table SI-11. Sanitary Sewer and Water Treatment Adaptation Strategy

Adaptation Strategy		Benefits	Drawbacks	Sea Level Rise Accommodation	Relative Cost	Estimated Lead Time
No Action	**Do Nothing (*no inlet management)**	No upfront cost.	Flooding and potential for sewage releases from manholes in low-lying Placencia neighborhood.	0ft Regular (annual) flooding will likely result in releases from existing sewer infrastructure in low-lying areas.	N/A	none
Management Options	**Inlet Management** Manage lagoon inlet through breaches or beach shaping to limit the elevation of ponding during lagoon closures.	Significant reduction in flood levels.	Permitting Requirements. Potential impacts to sensitive and endangered species. Impacts to beach access/recreation.	2-3' – Placencia neighborhood floods 5' – GWSD pump station floods	Low to Moderate (depending on cost of permitting process)	1 day (emergency breach) 1-5 years (permitted managed breaches)
Relocation	**Relocate sewer infrastructure in low-lying areas** **Relocate GWSD pump station**	Potentially significant reduction in vulnerable infrastructure.	Options for relocation constrained by need to tie in to existing sewer line alignments. Feasible options for relocation may be limited by land ownership and/or easements.	5'+	Medium to High (sewer pipes) High to Very High (Pump Station)	5-10 years
Protect in Place	**Install water-tight manholes and/or levees similar to those on Mesa Road**	Significant decrease in likelihood of stormwater infiltration into system and accidental sewage spills.	High cost. Potentially increased difficulty of maintenance.	5'+ Substantially reduces the risk of sewage spill due to flooding of low-lying manholes.	Low - Moderate	2-5 years
	Construct flood walls or levees to protect GWSD pump station	Reduction of flood risk to pump station.	Levees or flood walls would require regular inspection and maintenance. Requires engineering evaluation to determine feasibility.	5+ Expense increases with desired level flood protection.	Moderate	
Change Uses	**Change Placencia neighborhood to land use that does not require sewer service.** (it is not feasible to stop sewer service for the Goleta West Sanitary District.)	Reduction of flood risk and elimination of risk of sewage spill.	Potential conflicts with existing tenants/land owners. May require fee simple acquisition or voluntary participation. Loss of services. Difficulty identifying suitable replacement locations for existing tenants.	5+ Would eliminate hazard at Placencia neighborhood.	High	10-50 years

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Table SI-12. Storm Drains and Sewers Infrastructure Hazard Summary

Function	Storm Drains and Sewers
Location	Municipal storm drain systems serve the communities adjacent to Goleta Slough. Several of these drain pipes discharge into Goleta Slough via gravity drainage. The Santa Barbara airport uses a network of storm drains and pipes to convey runoff from the runways and taxiways into Goleta Slough. Drain pipes are connected to Goleta Slough via culverts and tide gates, which prevent the inland flow of slough water during high tides but allowing storm water to drain during low tides.
Types of Hazard	• Failure of these storm drain systems may lead to flooding at upstream storm drain inlets. • Overbank flooding of drainage channels.
Exposure to Hazard	Storm drain systems are directly connected to Goleta Slough along the perimeter of the airport as well as along the San Jose and Carneros Creek channels.
Sensitivity to Hazard	• Blockage of inlets or outlets. Tide gates are particularly susceptible to blockage due to high downstream water levels. • Backwater effects due to downstream flow blockage or constrictions. • Insufficient capacity for (potentially) increased rainfall.
Vulnerability	Failure of storm drainage system may cause flooding and property damage, and an increased risk to public health and habitats.
Risk of Changes	The risk of damage increased with more intense precipitation events and rising lagoon water levels. The risk of damage is projected to increase over time with rising sea levels. The risk of damage is greatest for drainage networks serving low-lying areas which may be subject to backflow due to insufficient storm water discharge and retention under future elevated slough water levels.
Potential Adaptation Measures	• Construction of new storm water retention capacity • Adoption/Update of BMPs to improve upstream infiltration and stormwater retention for new construction in nearby and upstream areas. • Channel maintenance to prevent flow obstruction • Maintenance of tide gates to prevent blockage and backflow • Installation of pumps to manage excess storm water runoff

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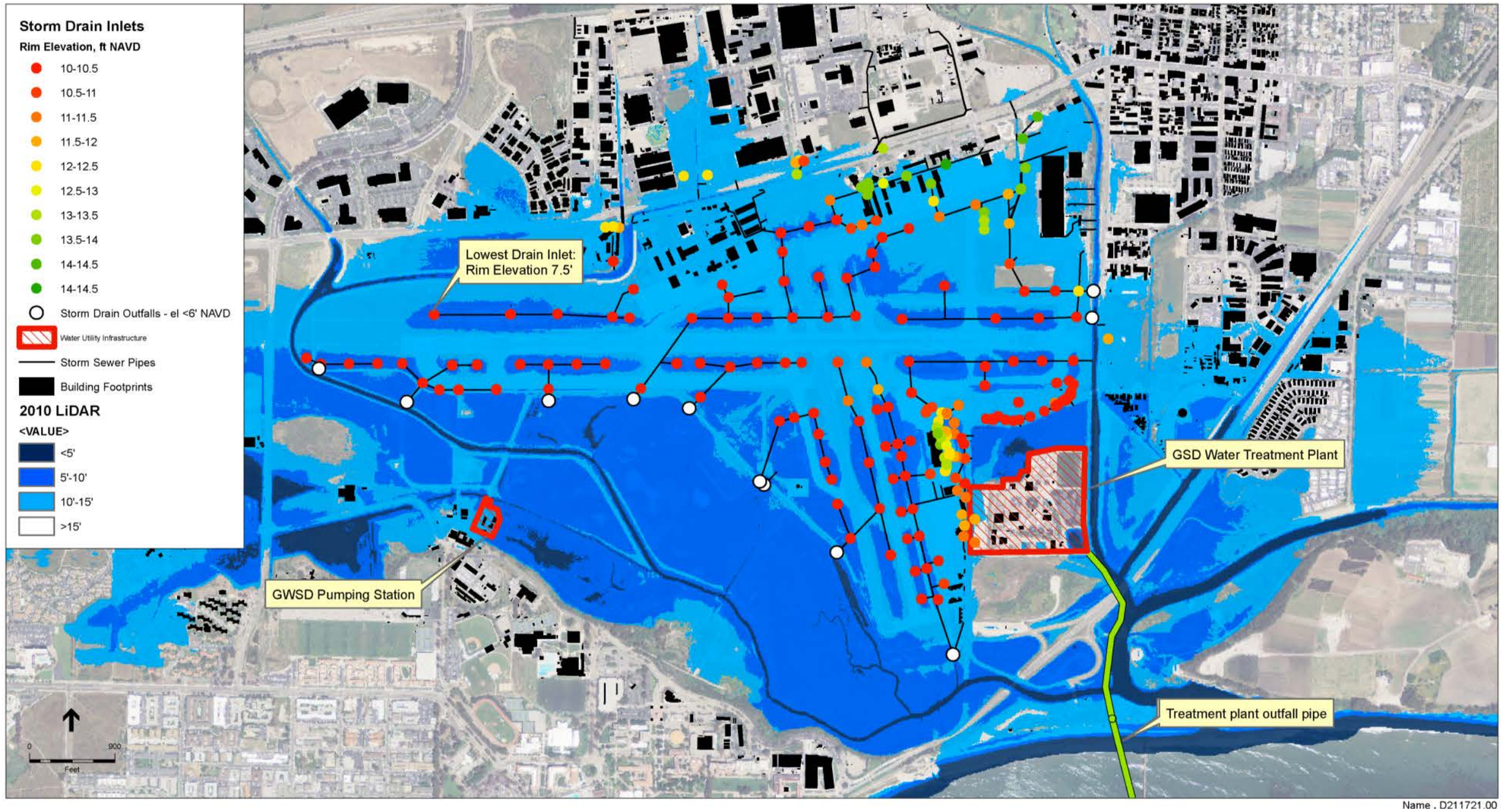
Figure SI-7. Water Utilities and Storm Sewer near Goleta Sloug



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Pipe and Inlet/Outfall Locations - Pennfield & Smith; Goleta Sanitary District

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Table SI-13. Storm Drains and Sewers Adaptation Strategy

Adaptation Strategy	Adaptation Measure	Benefits	Drawbacks	Sea Level Rise Accommodation	Relative Cost	Estimated Lead Time
No Action	**Do Nothing** (no artificial lagoon mouth breaches)	No upfront cost	Future operations and maintenance costs due to more frequent flood damages to structures and increased risk to life and property.	0ft – Storm drains in Placencia St. neighborhood flood during high water events under existing conditions. Storm drains on airport infield may drain poorly when lagoon water levels are >5.0'.	N/A	N/A
Management Options	**Inlet Management** Manage lagoon inlet through breaches or beach shaping to limit the elevation of ponding during lagoon closures.	Significant reduction in lagoon water levels.	Permitting Requirements. Potential impacts to sensitive and endangered species. Impacts to beach access/recreation.	1ft Storm drain system becomes less effective when lagoon water levels exceed 6.0'. During open inlet conditions, drainage reduced during high tides.	Low to Moderate (depending on cost of permitting process)	1 day (emergency breach) 1-5 years (permitted managed breaches)
Management Options	**Install pumps or siphons to drain infield during rainfall events with high lagoon water levels**	Allows system to manage some level of storm water runoff during high lagoon water level events.	Increased operations, maintenances and equipment storage/rental costs. Potential complications associated with discharge or permitting associated with tying into ocean outfall pipe from Sanitary district.	~2 ft (with Inlet and Beach Management) The storm drain system will fail if the taxiways flood due to elevated lagoon water levels.	Low-Medium	1 week (Temporary pumps) 1 year (permanent pumps)
Relocation	N/A – Airfield requires storm drainage system, no relocation possible without relocating airfield.	-N/A	-	-	-	-
Protect in Place	**Construct new levees and add additional storm water retention capacity.** May be combined with pump systems as	Allows for accommodation of larger amounts of rainfall and longer duration of elevated lagoon water levels before storm drain capacity is exceeded.	Cost of installation. Disruption of airfield operations during construction. Potential permitting requirements for new levee construction. Feasibility of new levee construction may be limited due to geometric constraints presented by existing roadways, buildings and runways.	>5' (if combined with inlet management and pump system)	High – Very High	5-10 years
Change Uses	N/A – Cannot change usage of storm drains without changing usage of airfield.	-	-	-	-	-