

Adapting to Rising Tides



Ground Transportation Vulnerability and Risk Profile

There are significant national, regional and local ground transportation assets within the ART project area. The ground transportation assets analyzed include two toll bridges – the Bay Bridge and the Hayward-San Mateo Bridge; Bay Area Rapid Transit (BART); Interstates 80, 580, 880 and 980; State Routes 92, 61, 185 and 238; passenger and freight rail; the Oakland, Alameda, and Harbor Bay Island Ferry Terminals; AC Transit local and transbay bus routes; arterials, collectors, and local streets; the Webster and Posey Tubes and local bridges to the City of Alameda; the Bay Trail; and rail maintenance yards. People and freight within the San Francisco Bay Area and the State of California depend on the reliability of the ground transportation assets within the project area, which are critical to the public health, safety, and economy of the region and state.

Key Issues

Many of the transportation assets in the ART project area are vulnerable to high tide and storm event flooding. Some assets, such as the Webster and Posey Tubes, are particularly vulnerable because they are largely below current sea level and their openings are at grade. While vehicles that use surface roads, such as private automobiles, buses, and trucks, have some flexibility due to their ability to use alternate routes, these routes lack the capacity serve all of the traffic and heavy congestion would overwhelm most of the region's roadways and interstates. Rail lacks flexibility due to the fixed and interconnected nature of the tracks and a lack of redundancy in the region's rail corridors. The result is that inundation or flood damage to a portion of the rail system would likely affect the entire region. BART and rail stations and ferry terminals and the road access to these facilities are also vulnerable to sea level rise storm event flooding and damage. Underground and at-grade infrastructure such as BART tunnels and roads are also vulnerable to liquefaction, the potential for which is increased by rising groundwater.

Vulnerabilities	Consequences
<p>Timing</p> <ul style="list-style-type: none">• In the near term assets within the BART system that are already exposed to groundwater will face additional flooding and saltwater intrusion due to rising groundwater.• In the near term, the ground transportation network that serves the Oakland International Airport is vulnerable to sea level rise storm event flooding.• In the near term, many of the project area's below grade transportation assets - such as the Webster and Posey Tube - are vulnerable to sea level rise and storm event flooding.• In the near term, the region's heavy rail system will be exposed to sea level rise and storm event flooding, affecting the entire region's passenger and cargo rail network.• Many sections of the Bay Trail will be exposed to sea level rise and storm event flooding in the near term.• Several sections of critical roadway, including parts of I-80, I-880, Airport Drive, and Hegenberger Road, and the Posey and Webster Tubes, will be exposed to storm event flooding with wind waves by mid-century.• Most of the ground transportation assets evaluated in this study (representative roadway sections, BART, rail, and ferry) will be exposed to high tide or storm event flooding by the end of century.	<p>Scale</p> <ul style="list-style-type: none">• Adjoining properties and neighborhoods• Throughout the subregion• Regionwide• Statewide• National <p>People</p> <ul style="list-style-type: none">• Disruptions to ground transportation will affect commuters, whether they use public transportation or private vehicles that rely on vulnerable roads, bridges, or tunnels.• Disruptions to ground transportation could cause problems during emergencies if people are unable to evacuate or reach family members. <p>Economy</p> <ul style="list-style-type: none">• Ground transportation assets in the ART project area are critical to goods movement to and from the seaport and airport, within the subregion, and between the subregion and the rest of the state and country.• Congestion currently costs the region's economy significantly, and the increased congestion resulting from temporary or long term damage to a part of the network would cause this cost to the region to rise.• Workers who rely on vulnerable public transit assets or roads may be unable to get to work, affecting not only their wages but the economy of the region as a whole. <p>Consequences</p>

Vulnerabilities

Physical and Functional Qualities

- Much of the project area's ground transportation infrastructure is at grade; other elements such as tunnels are below grade, with vulnerable entrances or vents at grade.
- Insufficient capacity on alternate routes results in a lack of redundancy for the network when one section or asset is temporarily or permanently damaged or affected by inundation or storm events.
- Water sensitive components critical to BART's operation are at or below grade.
- Rail is fixed, interconnected, and lacks redundancy. If one section of rail in the region is compromised, the whole system will be compromised.
- Rising groundwater increases the risk of liquefaction, which could seriously damage underground assets such as tunnels, and could also cause damage to road surfaces, railroad tracks, and even raised infrastructure if supports are anchored in sediment with high liquefaction potential.
- Even where railroad or BART tracks are not exposed, some maintenance facilities or access to the facilities are at grade and may be compromised, making the system more vulnerable.
- In a few instances, there are communities or facilities that are linked by only one or two accessways. If these accessways were compromised, these communities and facilities may be isolated.
- Some communities lack redundancy in transportation alternatives and a loss or re-routing of a bus route or other transportation service could result in eliminating the ability of those residents to travel.

Management Control

- Multiple agencies are involved in the ownership and management of many of the assets in this category, and coordination among them would be necessary to implement adaptation measures. Additionally, many more agencies and organizations will be affected by the temporary or permanent loss of ground transportation assets and some may be affected by the adaptation response.
- Financing mechanisms for addressing sea level rise and storm event flooding are limited at this time. Ground transportation assets are often expensive, require lengthy environmental review and involve many permitting agencies. Finding strategies that will allow for a quick response will be challenging.

Ecosystem Services

- The exposure of some ground transportation assets could cause an increase in the use of other types of transportation - for example, if the rail system is inoperable, the use of trucks to transport goods may increase, which could result in air or water quality problems.
- The loss of a portion of the transportation network may increase the region's congestion and congestion results in greater emissions and lower fuel efficiency.