



SAMTRANS ADAPTATION AND RESILIENCE PLAN



February 2021



NOTE: Any SamTrans ridership information referenced in this report references pre-COVID-19 data.

EXECUTIVE SUMMARY

Sea levels are rising in the San Francisco Bay, with projections reaching up to 10 feet by the end of century. The California Ocean Protection Council (OPC) now advises California to prepare to be resilient to at least 3.5 feet of sea level rise by 2050 (OPC, 2018; OCP, 2019). This large range of uncertainty makes sea level rise (SLR) challenging to address. When combined with major storm events like a 100-year storm¹ or regular tidal events like the king tide,² flooding onshore caused by SLR can be exacerbated and pushed even farther inland. Heavy rain events can also cause rivers to swell and overflow; for rivers and creeks that drain into San Francisco Bay, these increased flows can meet SLR and storm surge to cause even more severe flooding. In addition, the San Francisco Bay Area is slowly sinking through a phenomenon known as subsidence³, which further amplifies SLR and storm surge concerns.

These climate hazards (SLR, storm surge and fluvial flooding) along with subsidence present major issues for SamTrans' transportation infrastructure and, specifically, for SamTrans' low-lying and coastal bus maintenance facilities: North Base and South Base. North Base, SamTrans' primary operations and maintenance (O&M) facility, is in South San Francisco next to the San Francisco Airport (SFO). South Base is in San Carlos, adjacent to the San Carlos Airport. Both facilities are at risk of climate-change related flooding (temporary) and inundation (permanent).

The San Francisco Bay Area is also vulnerable to heat; because the area has historically experienced moderate temperatures with few extreme swings in highs and lows, communities are insufficiently prepared to manage its effects. Climate change is projected to increase overall average temperatures as well as the number and severity of high and extreme heat events. By 2070, most of San Mateo County will experience at least a 4°F increase in average high temperatures⁴ and the number of projected extreme heat days will more than double compared to 1995 (San Mateo County, 2018).

Each weekday SamTrans makes over 46,000 trips⁵ in San Mateo County through its bus, paratransit and shuttle services. The majority of SamTrans riders are transit-dependent and earn significantly less than the median annual income level in San Mateo County. Affordable public transportation is essential to serving San Mateo County's most vulnerable populations. Loss of bus service or dangerous conditions due to climate change could limit mobility for many of the

¹ A storm that has a 1% chance of occurring in any given year.

² A non-scientific term for a very high tide, which occur when the moon is closest to the Earth.

³ Subsidence is a gradual settling or sudden sinking of the Earth's surface.

⁴ Under a high greenhouse gas (GHG) emissions scenario (RCP 8.5).

⁵ Based on pre-COVID-19 ridership.

County's most vulnerable residents, including people in resource-limited communities or those with functional and access needs.

The SamTrans Adaptation and Resilience Plan (the Plan) identifies SamTrans' vulnerability to SLR, flood and heat-related climate change impacts and presents potential action alternatives to improve resilience. The Plan was developed through the following process, which is guided by the Naval Facilities Engineering Command (NAVFAC) Climate Change Planning Handbook on Installation Adaptation and Resilience (2017):

- Stage I. Conduct Vulnerability Assessments
- Stage II. Identify and Screen Action Alternatives
- Stage III. Evaluate Benefits and Costs of Action Alternatives
- Stage IV. Assemble a Portfolio of Action Alternatives

The SLR and flooding vulnerability assessment focuses on SamTrans' North and South Base facilities, while the heat vulnerability assessment also evaluates the vulnerability of SamTrans' fleet and passengers. The vulnerability assessment focuses on the potential impacts of SLR and associated hazards on SamTrans' assets and services. It considers three aspects of overall vulnerability for both bases: exposure, sensitivity and adaptive capacity, which represent how much an asset is in harm's way from a hazard, how consequential impacts will be and how successfully the asset is able to withstand the impacts.

SEA LEVEL RISE FLOODING AND INUNDATION SUMMARY

The SLR vulnerability assessment used existing SLR projection data to evaluate present day flood risk and future flood risk in the years 2050 and 2100. Present day flood risk was evaluated using FEMA 1% flood annual flood chance data, also known as the 100-year flood or base flood. Future scenarios were developed to evaluate SLR risk in 2050 and 2100 with or without considering land subsidence.⁶

The results of this assessment found exposure to mid-century SLR, depending upon the scenario, at both bases. North Base will flood under mid and high-end SLR scenarios and a 100-year storm event by 2050, and its access road is vulnerable to flooding under a current 100-year storm. North Base does not benefit from any existing levee protections, and its facilities could flood under near term SLR and storm conditions. In some scenarios, 100-year storms may begin to cause damage to buildings at North Base within the decade, accounting for land subsidence and SLR.

⁶ Due to the nature of storm surge within the San Francisco Bay and along the west coast, the base flood and SLR evaluation depths take into consideration storm surge as part of the regulatory determination and calculations for SLR projections.

South Base is flat and low-lying; it floods under the high-end 2050 SLR scenario and any of the 2100 scenarios considered for this assessment. South Base is protected from mid-level SLR and storm surge in 2050 due to an existing levee; however, the base could flood under this scenario if a 100-year storm were to overtop Phelps Slough. Further study is needed to understand the likelihood of the slough overtopping in a major precipitation event, as this greatly affects South Base’s overall flood vulnerability. The entire South Base facility is vulnerable to high-end SLR in 2050.

After evaluating the SLR vulnerabilities of both facilities, SamTrans developed a range of different action alternatives to prepare for and improve resilience to the impacts of SLR over the coming century. These alternatives were screened for their benefits, limitations, feasibility and appropriateness, and ten strategies advanced for further evaluation (retained). Retained action alternatives for each base are listed in Table 1.

Table 1. Retained Action Alternatives for North and South Base

North Base	South Base
Construct a horizontal levee around the perimeter of North Base.	Increase the levee height along Steinberger Slough.
Floodproof planned new construction by elevating all utilities and designing the ground level to accommodate flood water.	Excavate/dredge Phelps Slough.
Elevate new building electrical and HVAC systems, moving relevant equipment to roof, adding elevated platforms to house equipment at ground level and/or raising the elevation of the ground where the equipment rests.	Elevate new building electrical and HVAC systems, moving relevant equipment to roof, adding elevated platforms to house equipment at ground level, or raising the elevation of the ground where the equipment rests.
Consider locating BEB charging stations offsite in the future.	Install and modify pump systems downstream of Phelps Slough.
	Install check dams, ponds and infiltration systems in upper watershed to reduce surface runoff and flow going into Phelps Slough to reduce freshwater flood depths.
	Consider locating BEB charging stations offsite in the future.

A lifecycle benefit-cost analysis (LBCA) was conducted for a horizontal levee action alternative for North Base, which would greatly improve the facility’s flood protection from current storm events and near term SLR. This analysis assessed three levee options compared to a “no-action” or baseline scenario. The LBCA demonstrated that there is a clear case for installing suitable flood

protection at North Base. Constructing a levee to protect North Base is projected to save SamTrans significant costs under all SLR scenarios evaluated in this study. However, a regional tide gate solution between South San Francisco and North Base could reduce the length of the levee needed around North Base while also providing protection for several other agencies and properties to the west.

South Base is less vulnerable to future SLR because of the protection provided by the existing Redwood City levee. However, the existing levee would be overtopped under the 2050 high-end SLR scenario. In addition, South Base could be flooded from Phelps Slough overtopping during a storm event in the medium-term. Additional study is needed at the County/regional level to understand the potential fluvial flooding from Phelps Slough. Any solutions to address flooding risk at South Base require regional coordination as SamTrans does not have jurisdiction over the infrastructure that would need to be improved to provide flood protection. Eventually, the Redwood City levee will need to be elevated to continue to provide protection against SLR. This effort would need to be led by Redwood City.

Regional coordination will be critical to addressing SLR vulnerabilities as neither site can be protected in isolation. Multiple action alternatives will be outside of SamTrans’ control and other alternatives, such as installing a levee, will require extensive stakeholder coordination.

HIGH HEAT SUMMARY

Climate change is projected to increase overall average temperatures as well as the number and severity of high heat events in San Mateo County, as shown in Table 2. Some areas within San Mateo County will experience a greater number of high heat days than others. The greatest number of high heat days are expected in San Mateo, Redwood City and parts of south San Mateo County.

Table 2. Projected Temperature Increase

Year	Countywide Temperature Increase	Max High Heat Days Expected ⁷	Average Cooling Degree Days
1995 Baseline	-	13	91.4
2030	1.4 to 2.2°F	21	172.7 (89% increase)
2070	3.8 to 5.0°F	35	709.5 (676% increase)

The high heat vulnerability assessment evaluated heat-related vulnerabilities and adaptation strategies for SamTrans’ North and South Base facilities, fleet and passengers based on heat projections for 2030 and 2070. A range of action alternatives was developed to address the impacts

⁷ For this analysis, we defined high heat days as the number of days per year over 100°F. See section 3.1 for more information.

of high heat events. These alternatives were screened for their benefits, limitations, feasibility and appropriateness. Twelve strategies were retained for further evaluation.

Existing mechanical and passive cooling installed at North and South bases will likely provide sufficient protection from high heat through 2030. However, as average temperatures and the number of high heat days increase, North and South Base may require additional mechanical cooling after 2030. SamTrans should consider future heat projections when upgrading existing HVAC units, which typically have a lifespan of approximately 15 years, and when constructing new facilities.

Based on this analysis, North Base, South Base and SamTrans' bus fleet have limited heat exposure. Because heat risk to facilities and assets is not significant, greater emphasis was placed on mitigating passenger vulnerabilities to high temperatures while waiting for buses.

Increasing temperatures and high heat events put SamTrans' passengers at risk of heat-related health impacts. Public transit users are vulnerable to heat exposure when traveling to and waiting for transit, which can be exacerbated in urban areas by heat island effects and sparse tree canopy. Passenger sensitivity to heat exposure varies based on a number of factors including age, health (particularly pre-existing respiratory or cardiovascular disease), walking distance to a transit stop and wait time.

High temperatures also disproportionately affect disadvantaged communities⁸ that are less likely to have access to a vehicle, more likely to be transit dependent and more likely to reside in areas that experience urban heat island effects. People living in disadvantaged communities may also lack air conditioning at home, or the financial resources to operate air conditioning equipment.

Passenger heat risk was assessed by developing a heat sensitivity score for each census tract within SamTrans' service area to identify high vulnerability zones. Key retained action alternatives to address passenger heat vulnerability include improving shelter and/or shade amenities at SamTrans' bus stops. Approximately 10% of SamTrans' bus stops in San Mateo County have shelters. The majority of the shelters are owned by a third party under a long-term contract for bus shelters featuring advertising (ad shelters), which expires in 2023. The timing of this contract expiration provides an opportunity to incorporate recommendations and/or design specifications into the new contract that provide protections against increasing temperatures. Installing new bus shelters and replacing existing shelters would require coordination and partnership with external stakeholders that own the surrounding property. These action alternatives present an opportunity

⁸ Disadvantaged communities are defined as the top 25% scoring areas from CalEnviroScreen along with other areas with high amounts of pollution and low populations.

for cooperative, collaborative projects with partner agencies, stakeholders and nongovernmental organizations to support shared objectives.

Based on public input collected as by SamTrans, late buses feel four times longer to customers when waiting at a stop without a shelter or bench. In addition, respondents who ride SamTrans monthly or more are most likely to want improved bus stop amenities and features such as real-time information screens and shelters with seating among their top priorities. To address customer concerns and high heat risk, SamTrans could update the existing Bus Stop Guidebook (2013) and develop a bus stop improvement plan that incorporates recommendations from this study. A future bus stop improvement plan could also assist SamTrans in championing improvements at the many bus stops outside of its control.