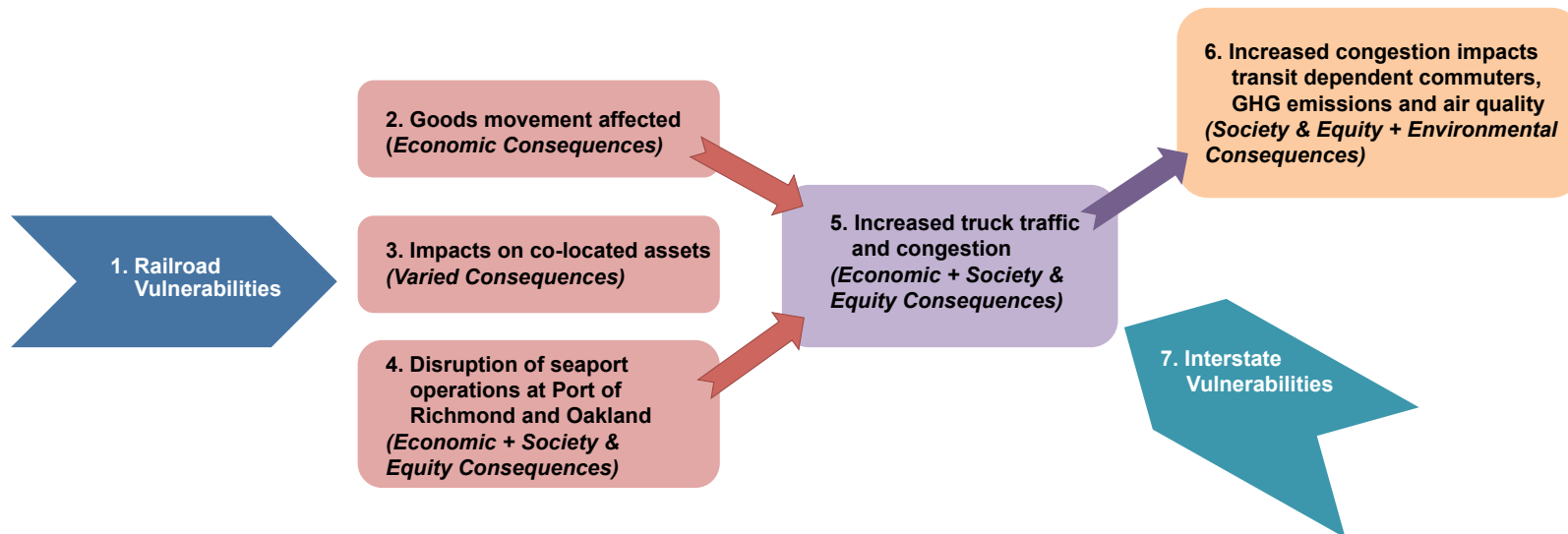
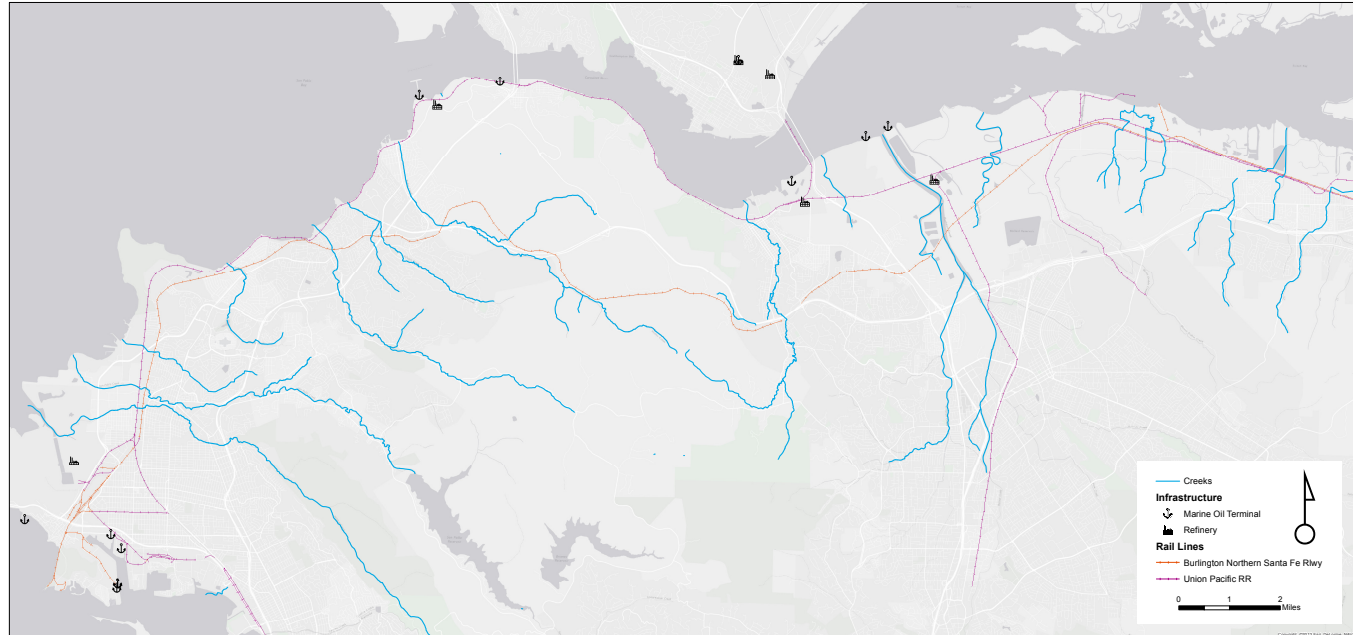


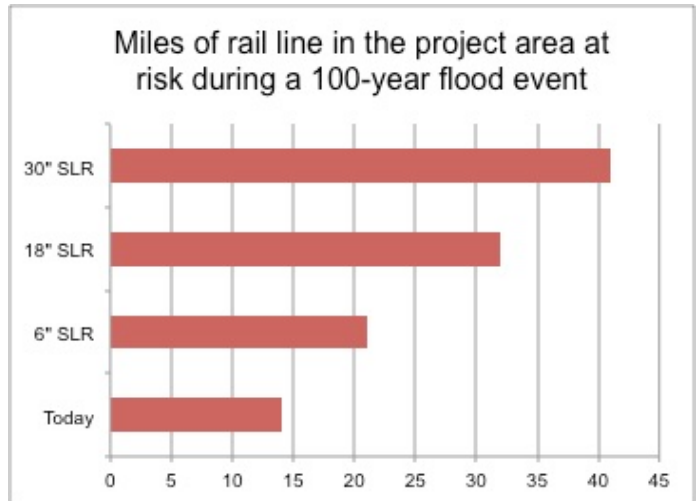
Consequences of Rail Vulnerability

Explore the assets, sectors and vulnerabilities within the county most likely to impact economic activity and goods movement, and consider if local solutions can reduce both local and regional consequences.



Railroad Vulnerabilities

Fourteen miles of rail line in the project area is within or passes over the current 100-year floodplain. Seven more miles (or a total of twenty-one miles) may be exposed to a 100-year coastal storm with as little as 6 inches of sea level rise, and a total of forty-one miles may be exposed to a 100-year coastal storm with 30 inches of sea level rise.



Lack of information

- There is insufficient information available on the UP and BNSF rail lines in the project area to thoroughly evaluate the vulnerability of the rail infrastructure.

Governance challenges

- Some segments of rail located on the shoreline serve as the first line of defense against flooding, while some are protected by lands owned by others or levees paid for by the public.

Not built to withstand flooding

- Rail lines are not constructed or maintained to withstand flooding, storm events, wave action or rising groundwater. Track bed, ballast, and embankments will require increased maintenance and could become unsound and fail. The eight tidal creek crossings have varying amounts of freeboard and may be undersized which could cause back ups and overbank flooding.

Functions as an interconnected system and has no redundancy

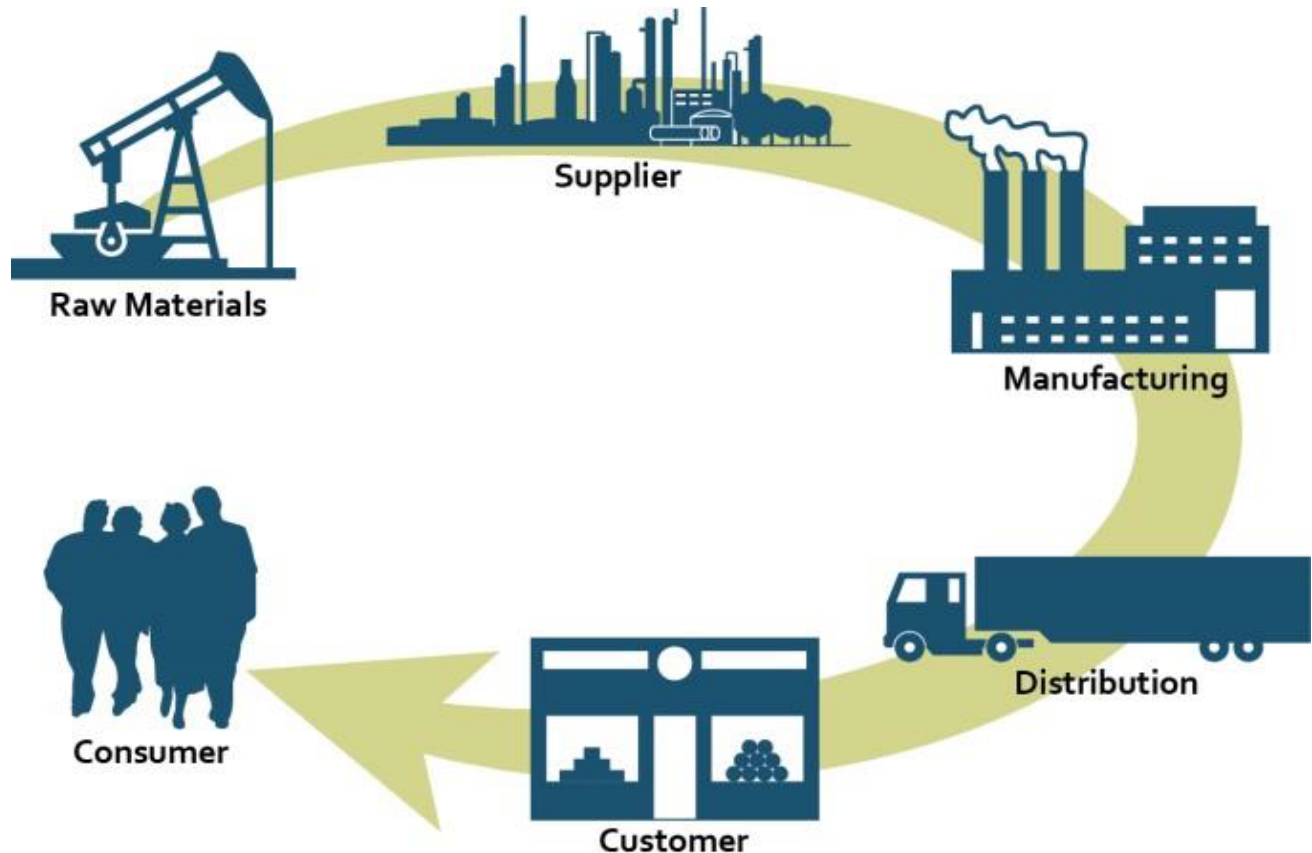
- If any segment of the rail line were disrupted, the entire system would shut down, and there is no redundancy in this rail subdivision that would provide the same goods movement capacity as currently exists.

Railroad disruptions will impact goods movement. *(Economic Consequences)*

Goods movement-dependent industries account for \$490 billion (51%) of the region's output and provide over 1.1 million jobs (32% of regional employment).

Goods moved by rail in the project area include carload commodities (e.g., motorized vehicles and petroleum products other than gasoline or fuel oils) and intermodal shipments (containers moved by ship, rail or truck) with high value manufactured, agricultural and food products.

Regionally, freight train volumes are the highest on the UP Martinez Subdivision, especially between Richmond and Oakland. Freight rail demand is anticipated to grow on the UP Martinez Subdivision, making it the largest freight rail bottleneck in the Bay Area.



Railroad damage or disruption will impact co-located assets and those that rely on the rail line to provide service.

(Varied Consequences)

Pipelines owned by Kinder Morgan are located in the UPRR right-of-way, and could be damaged if rail embankments destabilize. The pipelines transport petroleum and if ruptured during a flooding event could damage the surrounding terrestrial environment and the Bay. *(Environment)*

In places where the railroad serves as the **first line of defense** a failure could result in flooding of inland communities, some that are resource and access limited, e.g., Bay Point, Montalvin Manor, Rodeo, Port Costa, Parchester Village. *(Society and Equity)*

Capitol Corridor Joint Powers Authority (CCJPA) provides over **1.7 million customers passenger rail service** between Sacramento and San Jose on the UP Martinez Subdivision. *(Economy + Society & Equity)*

Refineries are at **fixed locations** along the rail line, and temporary or permanent disruption at of the rail terminal would affect the capacity to ship and receive goods, and potentially disrupt refinery operations, impacting local and regional jobs both on site and in the sectors serving the refinery. *(Economy)*

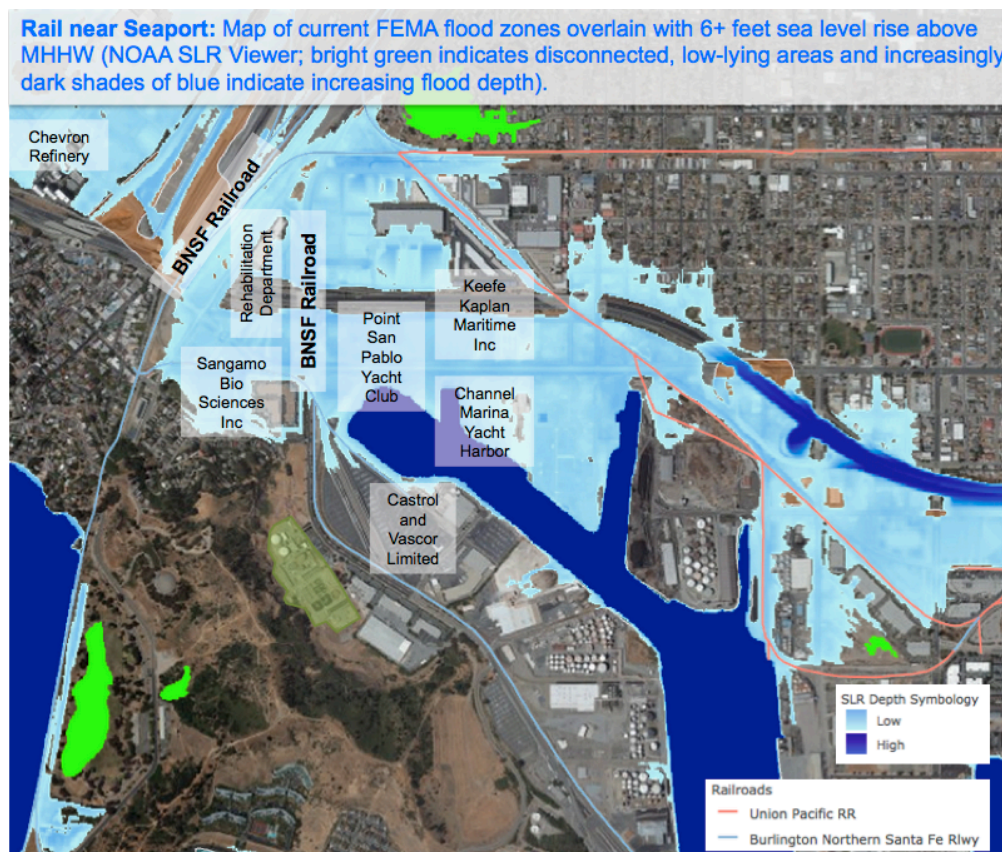


Seaport operations at the Port of Richmond rely on railroad service provided by UPRR, BNSF, and the Richmond Railroad (*Economic + Society & Equity Consequences*)

In 2013 the seaport handled over 1.57 million tons. The seaport also supports employment in a variety of sectors, ranging from directly related jobs such as longshoremen, to rail and truck operators. Overall, there were 1,644 direct jobs from the Bay Area seaports in 2013.

Temporary or permanent disruption of rail lines that serve the seaport would affect the capacity to ship and receive goods, and this could impact the local and regional economy and affect those that work at the seaport or in related industries.

Disruption of the rail to the seaport could result in increased road traffic within the surrounding neighborhoods' local roads and Interstate system. In addition, some of the roads that serve the seaport are vulnerable to flooding and some of the terminals at the seaport have only one road leading in/out and operations would be disrupted if these roads were damaged or closed.



Increased truck traffic that results from freight rail service disruption will have a significant impact on congestion and commuter access to local and regional jobs
(*Economic + Society & Equity Consequences*)

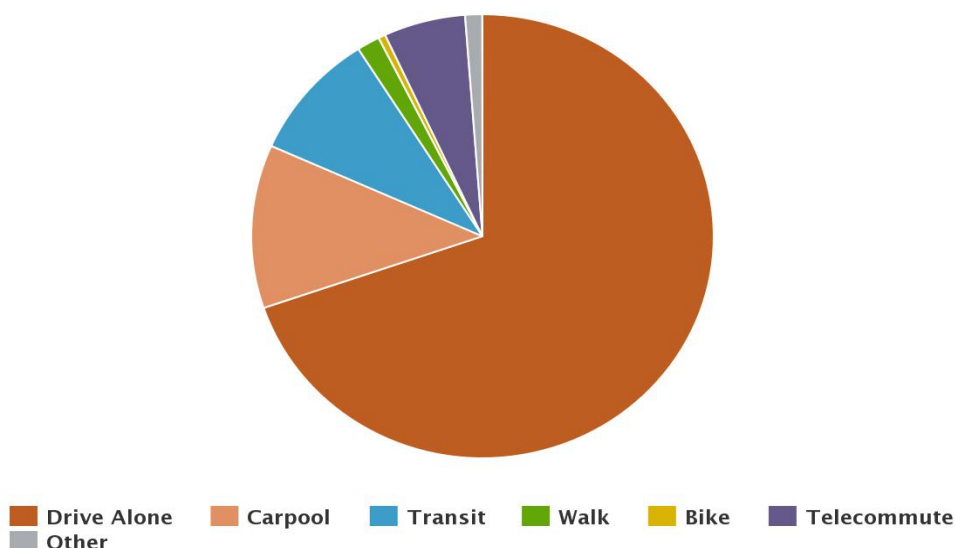
I-80 carries the third-largest truck volume in the Bay Area. As a route of regional importance, with an average of 290,000 vehicles daily, it is already one of the most congested freeways in the region.

I-580 provides access to significant local employment centers and serves as a connection for commuters between the East Bay and San Francisco Peninsula.

I-680 provides access to significant local employment centers, and serves as a connection for commuters from Solano County and San Francisco through the Benicia-Martinez Bridge.

The Richmond Parkway and Central Avenue provide access to local employment centers and serves as a connection for local commuting along the East Bay shoreline.

Most commuters in Contra Costa County Drive Alone



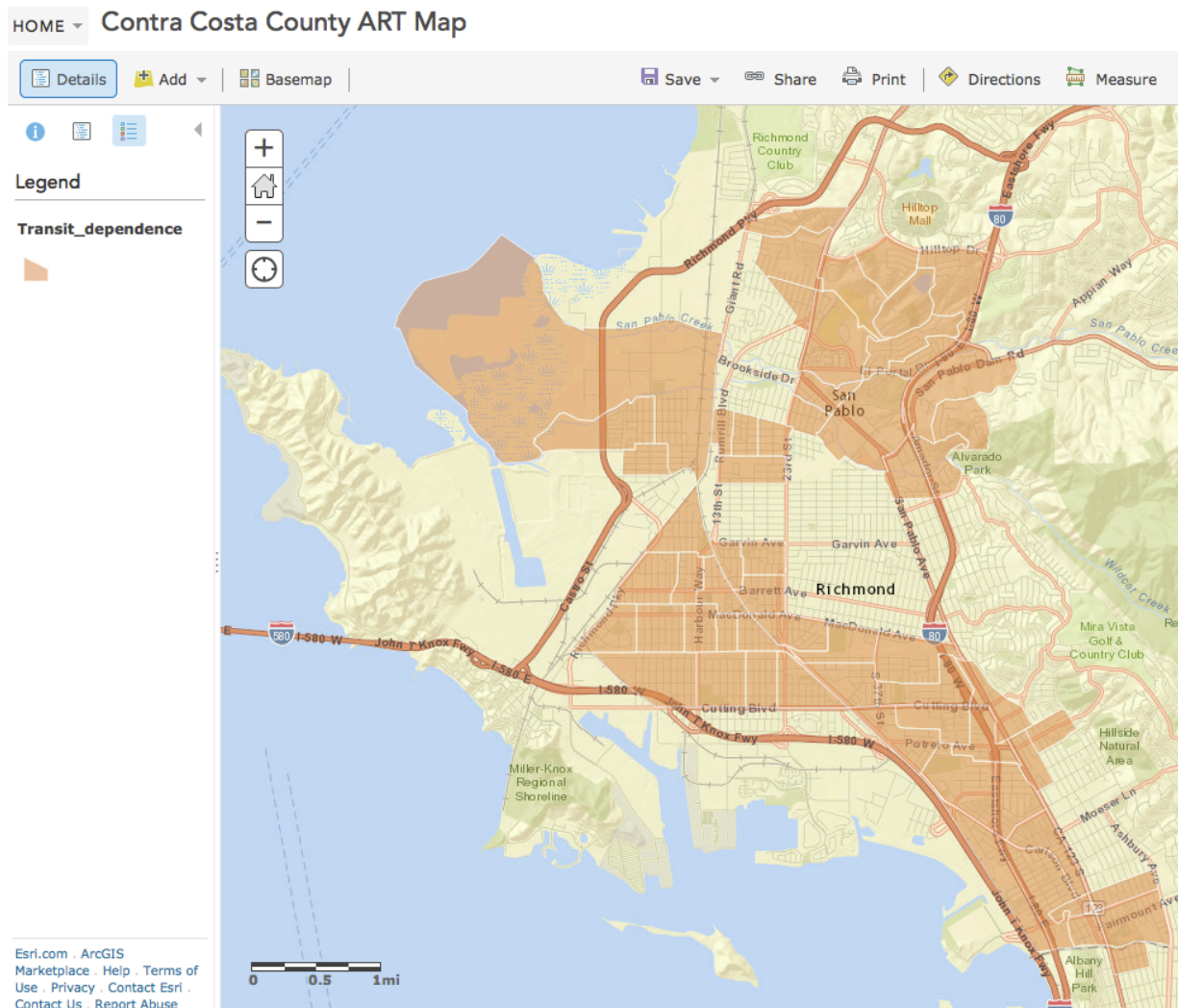
Increased congestion will impact transit dependent commuters and have environmental consequences

(Society & Equity+ Environmental Consequences)

Long-term disruption of freight rail lines that result in more cars and trucks on the road will lead to increase greenhouse gas emissions and impacts to air quality.

There are limited transit operators and limited redundancy in transit routes in the project area. Residents without a vehicle that rely on transit will be vulnerable since rerouted or delayed buses could impact their ability to get to work or obtain necessary services.

Transit dependent neighborhoods in Richmond, measured as block groups where 10% or more of households within a block group are without a vehicle



Interstate Vulnerabilities

I-580

PHYS1: Pavement elevations where I-580 is in close proximity to the Bay (between I-80 and South 51st Avenue) vary from 9.0 feet NGVD at its lowest point by Central Avenue to an average elevation of about 11.0 NGVD. This entire section of highway will be unprotected from sea level rise if not raised.

PHYS2: The below grade and low-lying segment of I-580 from the Cutting Boulevard interchange to the 23rd Street interchange has three pump plants that drain depressed sections of the roadway at the Harbor Way O.C., Meeker Avenue, and at South 23rd Street. A rising groundwater table could impact this segment of I-580 and pavement structural sections could be damaged if the roadbed is constantly saturated.

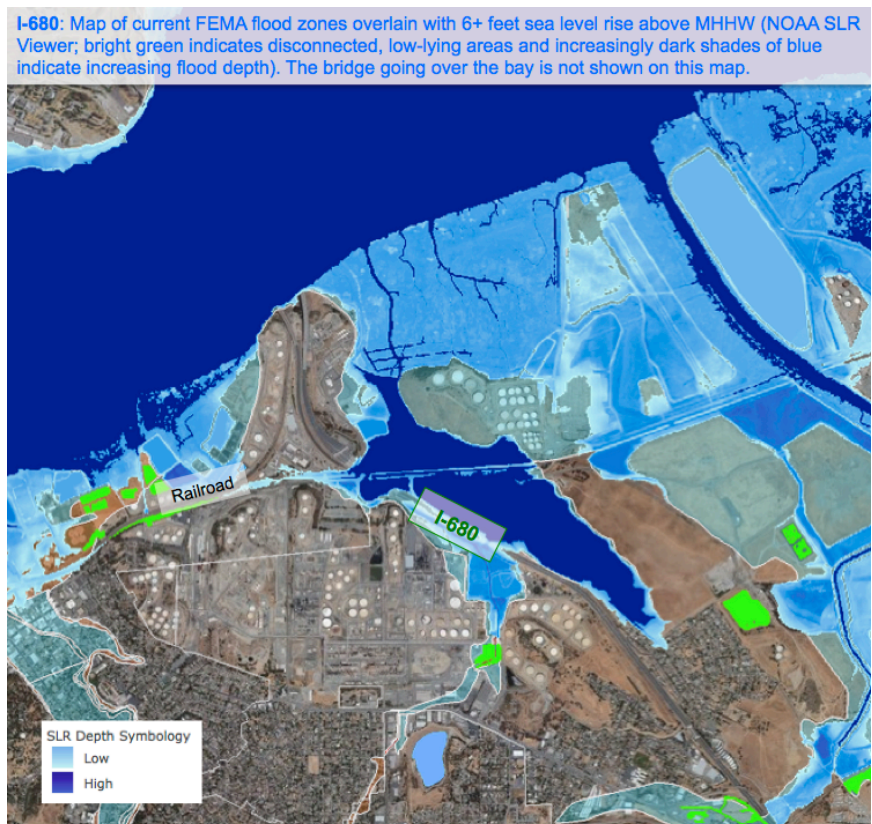
I-80

GOV1: Agency coordination is required to maintain the connections between the interstate and local streets and roads. For example, Contra Costa County maintains the main connectors to I-80 in Crockett.

I-680

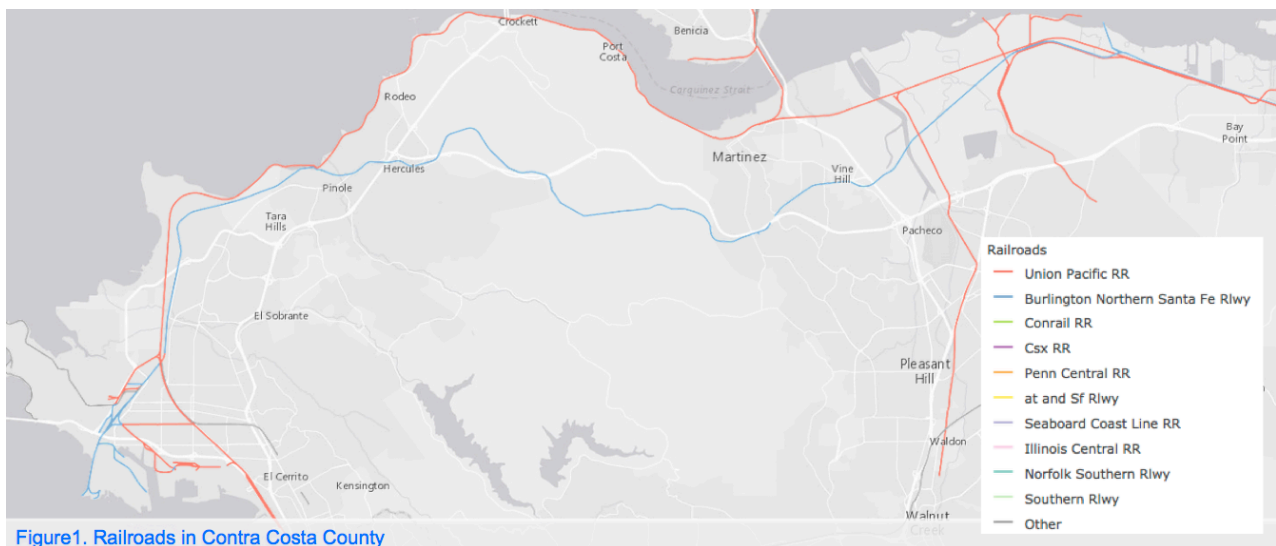
PHYS2: A rising groundwater table could damage the at-grade pavement structural section of this segment of I-680, in particular if the roadbed is constantly saturated.

PHYS4: The capacity of the self-regulating gates at Peyton Slough to contain future extreme water levels is unknown. Caltrans has no plans to protect this reach of I-680 from future sea level rise.



Passenger and Commuter Rail

Asset Description: Since the late 1800s rail has supported goods and commuter movement, serving multiple objectives on a shared track along the San Francisco Bay eastern shoreline, including Contra Costa County. Within the project area, Union Pacific Railroad (UP) owns the right-of-way for the rail line from the County boundary in Richmond, around the coast, and past I-680 (red line in Figure 1).¹ On this rail line (red), Burlington Northern Santa Fe (BNSF) and Richmond Pacific Railroad Corporation have trackage rights, while Amtrak, Capitol Corridor, and San Joaquin have passenger rights.² BNSF owns and operates the rail line from Richmond through Martinez, and UP holds trackage rights that are not currently in use (blue line in Figure 1).³



On average, the UP rail line is used by 50 passenger trains⁴ and 12 freight trains daily, while 20-30 freight trains run on the BNSF owned rail line.⁵ Richmond Pacific Railroad Corporation (RPRC) leases 11 miles of track owned by UP and BNSF, and handles over 22,000 carloads annually.⁶ RPRC “operates on tracks south of Interstate 580, between South 11th Street and Regatta Boulevard in the Richmond Harbor area, on tracks adjacent to I-580 south to Berkeley, and north to Chesley Avenue along the Union Pacific right-of-way, and a section of track between Chesley Avenue and the Chevron yard. RRRC runs two trains with 10 to 20 cars on the northern tracks, and as many as 32 trains with two to 20 cars per day on the southern tracks.”⁷

Goods moved by rail in the project area typically consists of high value manufactured products, agricultural and food products transported from the region’s ports to Northern and Southern California and throughout the Country. “Goods movement-dependent industries in the Bay Area account for \$490 billion (51 percent of total regional output); and provide over 1.1 million jobs (32% percent of total regional employment).”⁸ Rail provides a vital service in the region, supporting economic growth and connecting commuters to regional jobs.

The majority of commuter movement by passenger rail is provided by the Capitol Corridor Joint Powers Authority (CCJPA), which is a partnership among six transit agencies in eight Bay Area counties, and provides service to over 1.7 million customers on the Capitol Corridor route, which connects Sacramento and San Jose.⁹ Other passenger lines that operate on the UP rail line in the project area include the Amtrak Coast Starlight and Amtrak California Zephyr.

Goods and commuter movement rely on a network of fixed, connected railroad assets including the railroad track, signal system, bridges, passenger stations, and maintenance facilities. Ownership and management of railroad assets can be complex since the operators of the commuter and freight trains do not own or manage the rail line or other connected assets. For instance, Capitol Corridor operates most passenger trains but only UP can initiate action on protecting the rail line from flooding.

Key Issue Statement: I Throughout the Contra Costa ART project area, long rail line segments cross existing coastal and riverine floodplains and are at risk of future flooding and storm events. Rail provides critically important goods and commuter movement locally and regionally. In many cases, where the rail line runs along the Bay shoreline it also provides the first line of defense against inland flooding, though effectiveness of that defense is unclear. In addition to securing funding to address long-term flooding vulnerabilities, rail owners must collaborate with other agencies, such as Contra Costa County Flood Control District and rail corridor users such as CCJPA or RPRC, to prepare for and respond to flooding events.

Vulnerabilities

INFO1: There is insufficient information available on the rail lines in the project area and beyond to thoroughly evaluate the vulnerability of the rail infrastructure. Maintenance and capital improvement plans are not publicly accessible from rail owners.¹⁰

INFO2: Although funding is earmarked in MTC's Transportation 2013 Plan for a new intermodal transit station in Hercules, no funding appears to be earmarked for sea level rise adaptation.¹¹

GOV1: Planning for sea level rise and storm event impacts is challenging for rail corridor users, given that the rail lines are owned and maintained by private entities, which makes it difficult to coordinate and share information and resources.

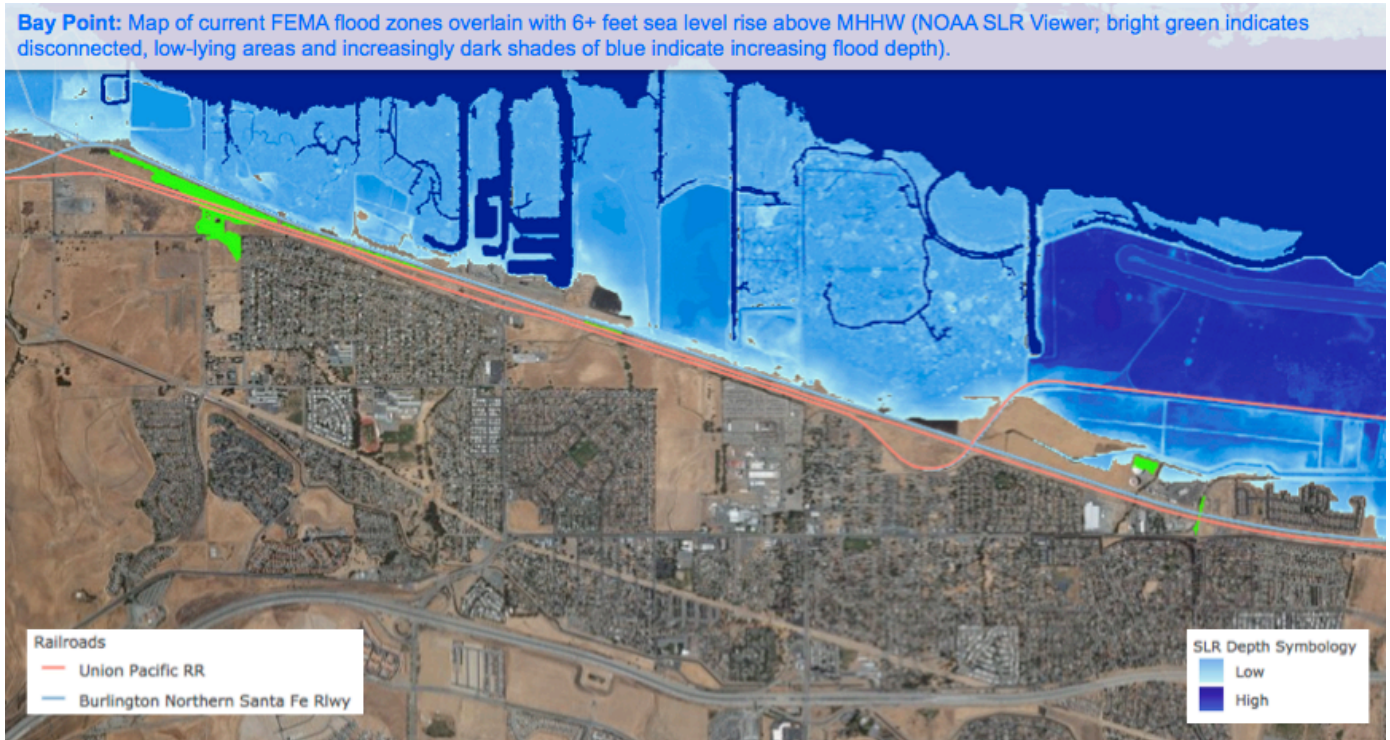
GOV2: Agency coordination is required to maintain passenger rail service including the stations, given the variety of owners and users.

GOV3: A number of entities have permitting authority over railroads; if improvements are necessary to increase resilience, permits from the following agencies could be necessary, which would increase the time needed to implement changes: BCD, USACE (Section 404), RWQCB (401 Certification), USFWS (Biological Opinion), and CDFW (CESA compliance).

GOV4: Some segments of the railroad may be protected by other landowners or levees paid for by the public. In the case of the BNSF tracks near the Richmond Harbor, various industrial corporations abut the railroad tracks.

PHYS1: In the event of an emergency, maintenance and repair may be delayed until a specialized team and custom materials are secured.¹² Multiple disruptions throughout the system may further delay the recovery process.

PHYS2: Some segments of the rail system located along the shoreline could serve as the first line of defense during storm events, however rail (track bed and ballast materials) is not constructed or maintained to prevent inland areas from flooding.



PHYS3: A rising groundwater table could damage the track bed and ballast materials. If constantly saturated, maintenance would need to increase in frequency to avoid structural unsoundness of the rail line structure.¹³

PHYS4: Storm events and wave action have the potential to damage the ballast, embankment, and cause the rail tracks to become structurally unsound.¹⁴

PHYS5: The Martinez station and many segments of rail line throughout the project area are at risk of liquefaction during a seismic event because they are located in areas of susceptible soils, particularly in Rodeo, Hercules, Pinole, San Pablo, and near the I-80/I-580.¹⁵

FUNC1: Power is needed for traffic signal operation and functionality of passenger rail stations; the temporary protocols and backup supplies may not be sufficient during a prolonged outage or during system-wide failures. Power outages pose a safety concerns at signalized intersections and will likely require direct human supervision until power returns.¹⁶

FUNC2: If any segment of the rail line were disrupted, the entire system would shut down. In areas where the rail line is double tracked¹⁷, it is likely that both would be affected in a flooding event.¹⁸

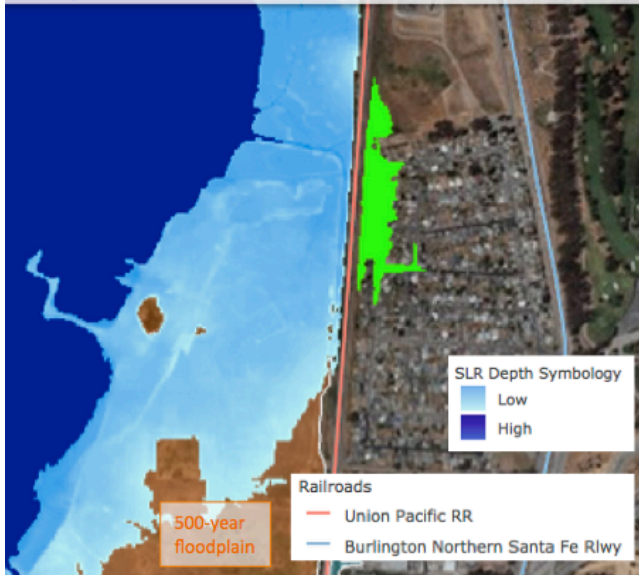
FUNC3: There is no redundancy in the rail system for commuters that would provide the same capacity as currently exists. Commuters could use alternate modes, however I-80 and I-680 could be flooded at the same time as the rail line or may not provide the same level of service, for example, temporary bus service may result in longer commutes and delays.

FUNC4: There is no redundancy in the railroad system for goods movement that would provide the same capacity as currently exists. Depending on the location of the disruption, freight could be rerouted however this would result in increased costs and may not accommodate all types of cargo currently moved by rail. In addition, the roadways may not have the capacity needed to move freight in a timely manner.¹⁹

FUNC5: Flooding around the Martinez Station would make it inaccessible to commuters such that passengers would need to travel to the next nearest passenger station in Richmond or use an alternative mode of commute.²⁰

Consequences

Parchester Village: Map of current FEMA flood zones overlain with 6+ feet sea level rise above MHHW (NOAA SLR Viewer; bright green indicates disconnected, low-lying areas and increasingly dark shades of blue indicate increasing flood depth).



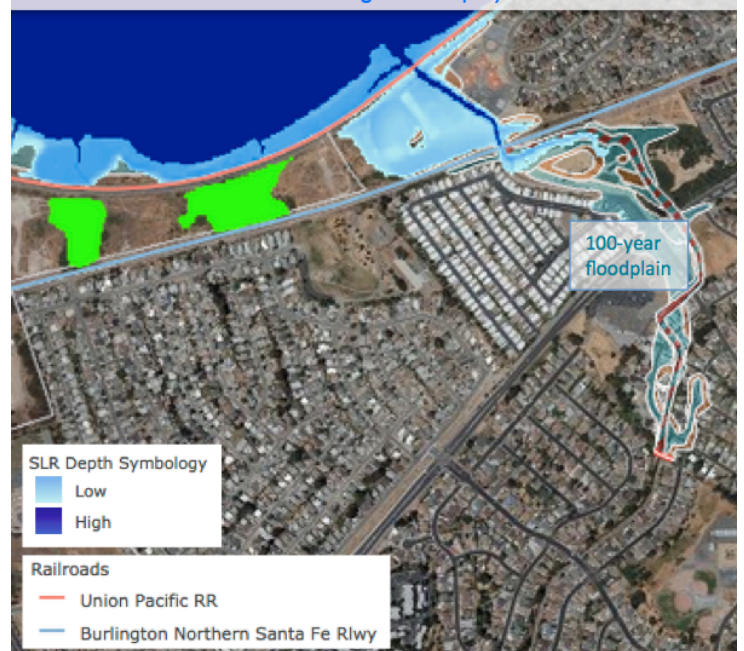
Selby: Map of current FEMA flood zones overlain with 6+ feet sea level rise above MHHW (NOAA SLR Viewer; bright green indicates disconnected, low-lying areas and increasingly dark shades of blue indicate increasing flood depth).



Rodeo: Map of current FEMA flood zones overlain with 6+ feet sea level rise above MHHW (NOAA SLR Viewer; bright green indicates disconnected, low-lying areas and increasingly dark shades of blue indicate increasing flood depth).



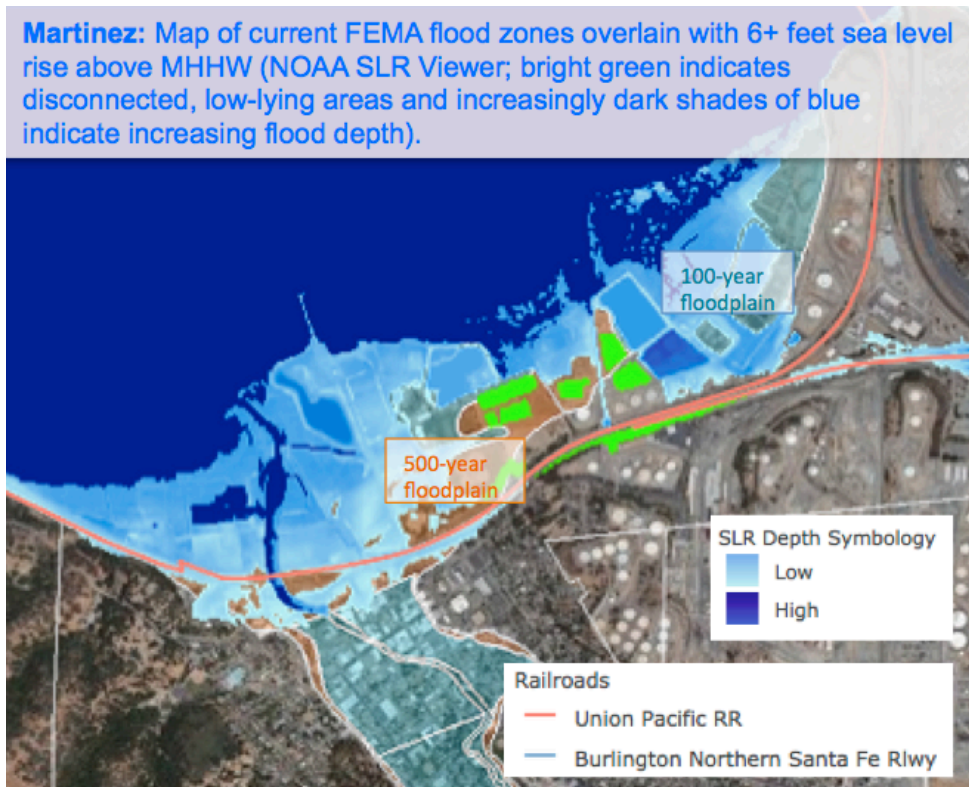
Montalvin Manor: Map of current FEMA flood zones overlain with 6+ feet sea level rise above MHHW (NOAA SLR Viewer; bright green indicates disconnected, low-lying areas and increasingly dark shades of blue indicate increasing flood depth).

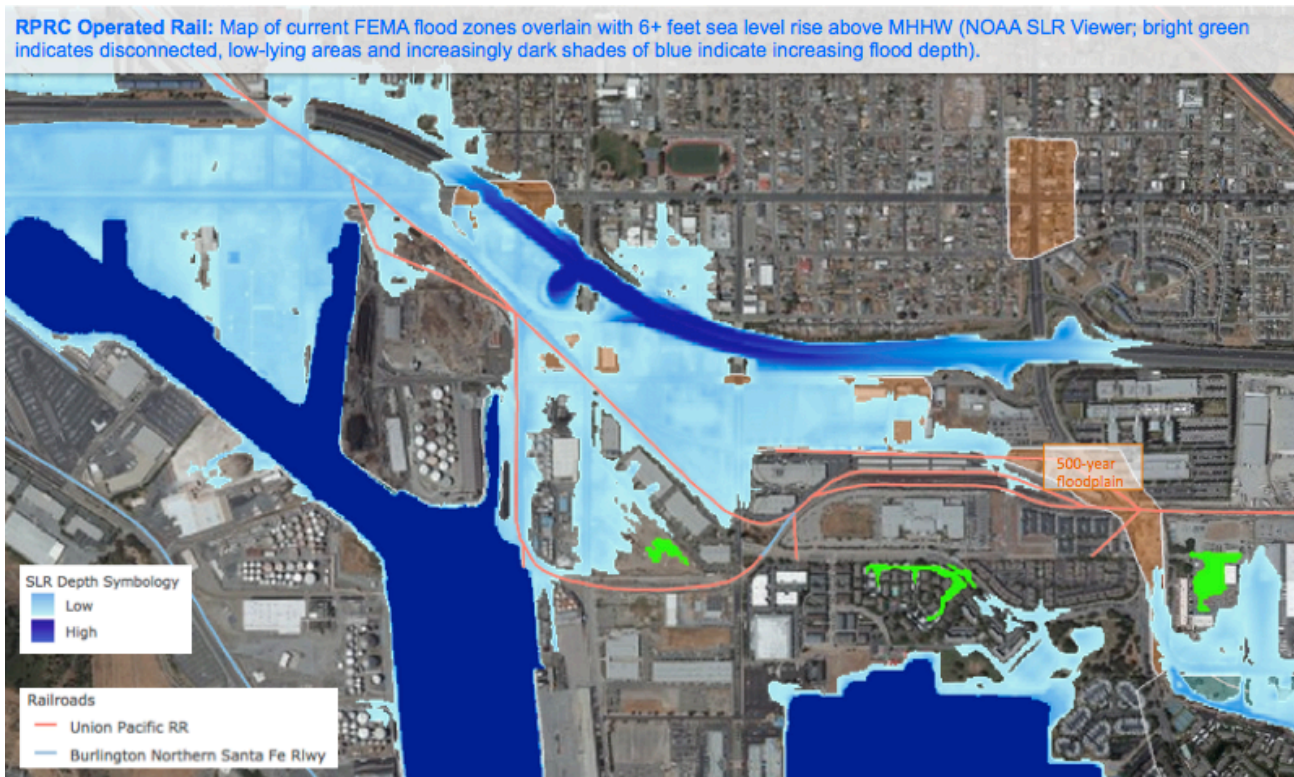


Society and Equity: Disruption of the railroad would have an effect on commuters, goods movement, the economy and the region as a whole. Everyone sharing the road would spend more time in traffic and less time with their friends and families. Commuters would have to spend more money to use their personal vehicles. Additionally, in places where the railroad serves as the first line of defense, a failure of the railroad would result in flooding of the community.

Environment: Long-term disruption would lead to more cars and trucks on the road, which would increase greenhouse gas emissions. Pipelines owned by Kinder Morgan are located under the UP right-of-way, which could be damaged if the embankment is destabilized. The pipelines transport petroleum and if ruptured during a flooding event, would result in a highly mobile spill that can cause great damage to the surrounding terrestrial environment and the Bay.²¹

Economy: The railroads provide a key service moving agricultural, automotive, chemical, industrial, and other goods from the region's seaports to local and national markets. Given the interconnected nature of the rail and lack of redundancy, a disruption on any segment could have significant impacts on the economy. The Surface Transportation Board classifies the BNSF and UP railroads as Class 1, which means that the annual operating revenue for each is over \$433.2 million.²² Similarly, commuter movement is an important asset for the region; Capitol Corridor alone generates \$170 million in economic activity.²³





¹ http://www.mtc.ca.gov/planning/rail/downloads/tech_memos/4a_Conditions.pdf

² Ibid, 11.

³ Ibid, 14.

⁴ Qian, S. Email Communication 7/29/15

⁵ <http://www.wcctac.org/wp-content/uploads/2009/03/FINAL-REPORT-wBART.pdf>

⁶ <http://www.levinterminal.com/facilities-and-services/rail-services/>

⁷ Richmond General Plan. Element 4- Circulation.

<http://www.ci.richmond.ca.us/DocumentCenter/Home/View/8810>

⁸ http://files.mtc.ca.gov/pdf/rgm/Task2D_Importance_of_Goods_Movement.pdf

⁹ Allison, Jim., et. al., (2014). Railroad Infrastructure: Planning for Sea Level Rise

¹⁰ Qian, S. Sea Level Rise Vulnerability Assessment. CCJPA.

¹¹ http://www.mtc.ca.gov/planning/2035_plan/FINAL/6_Appendix_1-Projects_Final.pdf

¹² Qian, S. Sea Level Rise Vulnerability Assessment. CCJPA.

¹³ Qian, S. Sea Level Rise Vulnerability Assessment. CCJPA.

¹⁴ Qian, S. Sea Level Rise Vulnerability Assessment. CCJPA.

¹⁵ Qian, S. Sea Level Rise Vulnerability Assessment. CCJPA.

¹⁶ Qian, S. Sea Level Rise Vulnerability Assessment. CCJPA.

¹⁷ http://www.mtc.ca.gov/planning/rail/downloads/tech_memos/4a_Conditions.pdf, 11

¹⁸ Qian, S. Sea Level Rise Vulnerability Assessment. CCJPA.

¹⁹ Qian, S. Sea Level Rise Vulnerability Assessment. CCJPA.

²⁰ Qian, S. Sea Level Rise Vulnerability Assessment. CCJPA.

²¹ Qian, S. Sea Level Rise Vulnerability Assessment. CCJPA.

²² California Department of Transportation. (March, 2014). San Francisco Bay Area Freight Mobility Study. Final Report. Cambridge Systematics, Inc.

http://www.dot.ca.gov/hq/tpp/offices/ogm/regional_level/FR3_SFBAFMS_Final_Report.pdf

²³ http://www.capitolcorridor.org/included/docs/ccjpa/Cause_for_Celebration2011.pdf