

Energy Sector

Refineries, pipelines, electrical power distribution (substations) and generation facilities are energy sector assets analyzed for vulnerability to sea level rise. Energy infrastructure provides electricity and natural gas to homes and businesses, as well as fuel for multiple modes of transportation, both within the project area, and beyond to other parts of the region, state, and nation. Energy sector assets were considered together because these systems share similar vulnerabilities, and their damage or disruption can have wide ranging consequences on day-to-day community function as well as emergency response capacity.

The energy industries and infrastructure discussed in this assessment are regulated by a number of State and Federal agencies. The Department of Transportation's (DOT) Pipeline and Hazardous Materials Safety Administration (PHMSA), through the Office of Pipeline Safety (OPS), is the federal regulatory agency responsible for the oversight of pipeline safety. At the State level, the California Public Utilities Commission (CPUC) regulates electric and gas utilities, as well as some aspects of the telecommunications sector. The State Fire Marshal acts as an agent of PHMSA with respect to pipeline safety, for example requirements such as pipeline coating and burial depth, as well as conducting periodic inspections of transmission pipelines, including surveying pipeline right-of-ways for excavation activities or population encroachment and detection of leaks and threats of corrosion.

Refineries

The primary purpose of an oil refinery is to process crude oil to make petroleum products and other chemicals, including motor fuel and lubricants. These products are then transported to distributors and consumers. All five Bay Area oil refineries are located near the shoreline, four of which are in the project area, because they rely on marine oil terminals. They also depend on many other sectors, including road and rail goods movement corridors, pipelines, power generation and distribution, water supply and wastewater services. Often, refinery operations and associated industries are co-located on adjacent industrial parcels owned by the refinery.

KEY ISSUE STATEMENT

Temporary or permanent disruption of refinery operations, due to on-site flooding or because access to the refinery (roads or rail) is disrupted, would have significant impacts locally, regionally, and statewide. Improving the resilience of refinery operations will require coordination with asset owners and managers that operate on-site as well as those that provide goods and services from off site.

EXPOSURE TO CURRENT AND FUTURE FLOODING

The four refineries in the Contra Costa ART project area are large industrial sites with assets and facilities both along the shoreline and inland. Three of the four refinery have at least a portion of their land area within the existing 100-year floodplain (coastal and/or riverine) and all of the refineries are exposed to as little as one foot of sea level rise. While this result is not surprising based on their shoreline location, site-scale analyses are needed to better understand which if any vulnerable refinery assets or facilities are located on the shoreline or in low lying areas that could be flooded either due to shoreline overtopping or a failure of the stormwater system to drain adequately.

Refinery	City	Current 100-year Flood	Sea Level Rise					
			1'	2'	3'	4'	5'	6'
Tesoro Martinez	Martinez	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Shell Martinez	Martinez	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Conoco Phillips 66	Rodeo	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Chevron's Richmond	Richmond	Yes	Yes	Yes	Yes	Yes	Yes	Yes

ASSET DESCRIPTIONS

Tesoro Martinez Refinery

The Tesoro Martinez Refinery site includes many different types of assets and facilities. In addition to Tesoro's refinery operations the site includes the Amorco (import) and Avon (export) Marine Oil Terminals, as well as seven facilities that are owned and operated by other companies who either own or lease the land where the facility is located. These facilities include a Chevron Products Company bulk fuel terminal; a Monsanto catalyst and chemical manufacturing plant; a Shell Oil Company crude oil pump station and pipeline; a Kinder Morgan refined product pump station and the Santa Fe pipeline; a Foster Wheeler cogeneration plant; an Air Liquide plant where CO₂ and compressed natural gas are manufactured; an Air Products hydrogen gas plant. In addition, Wickland Oil Company and Shore Terminals LLC own and operate pipelines on the refinery site¹.

Connections to the Tesoro site are essential to refinery operations. Pipes, pumps, electrical utilities, and other mechanical equipment that connect services and operations are located on site. Transmission lines, roads, interstate roads (i.e. I-680 and Waterfront Road), terminals, pipelines (i.e. Kinder Morgan) and rail (i.e. Union Pacific) connect the

¹ RWQCB Transmittal of Order No.R2-2004-0056 (2004)
http://www.waterboards.ca.gov/sanfranciscobay/board_decisions/adopted_orders/2004/R2-2004-0056.

refinery to services and markets located off site although the Refinery relies mainly on pipe lines for its exports. Although Burlington Northern Santa Fe (BNSF) has a rail line that cuts through the refinery perpendicular to Solano Way and Walnut Creek, it does not service the Refinery. Tesoro receives water from the Contra Costa Water District and is developing a plan to use recycled water from Central Contra Costa Sanitary District. The refinery treats and discharges wastewater to Suisun Bay via a diffusion line under a NPDES permit, while clean stormwater is discharged to Pacheco Slough or Hastings Slough.

A portion of the Tesoro Martinez Refinery is located in the 100-year flood plain, in particular the northern side of the site closest to the Point Edith Wildlife area. Low elevation areas on the site, which may include some wastewater treatment ponds, are vulnerable to flooding. A portion of the Tesoro Martinez Refinery site is low-lying and vulnerable to future coastal storm flooding, and a portion is adjacent to Lower Walnut Creek and could be impacted by future riverine flooding. The site may also be exposed to rising groundwater levels and salinity intrusion as sea levels rise.

Local access to the Tesoro Martinez Refinery from Waterfront Road could be further compromised as sea level rises as low portions of this road flood currently during extreme high tides and the annual King Tide.

Shell Martinez Refinery

The Shell Martinez Refinery site includes refinery operations (e.g., distillation towers, cracking units, cooling towers, storage tanks), a marine oil terminal, a Cogeneration Power Plant (98.5 MW capacity), stormwater treatment (located on the northwest side) and industrial wastewater treatment ponds (located on the east side). Connections on and off the site are essential to the operation of the refinery. Pipes, pumps, electrical utilities, and other mechanical equipment connect services on the refinery site. Transmission lines, roads, interstate roads (i.e. I-680) terminals, pipelines, and rail (UPRR and BNSF) connect the refinery to services and markets located off site.

A portion of the Shell Refinery is located in the 100-year flood plain, and there are low-lying areas near the shoreline and northeastern borders along the Waterbird Regional Preserve. Low elevation areas on the site, which may include some wastewater treatment ponds, are vulnerable to flooding. The east side of Shell Martinez Refinery borders a marsh and is low-lying. Flooding from sea level rise and storm events could expose pipelines, roads (Waterfront Road), rail lines, buildings, and the wastewater treatment plant to potentially corrosive seawater and elevated groundwater levels.

Conoco Phillips 66 Rodeo Refinery

The Conoco Phillips 66 Rodeo Refinery site includes refinery operations (e.g., distillation towers, cracking units, cooling towers, storage tanks), a fuel gas center (remove sulfur compounds from gas), a marine oil terminal, a steam power plant (48 MW capacity), a Carbon Plant with an onsite steam power plant (14.2 MW), hydrogen plants (Unit 110 and Air Liquide Large Industries, which also manufactures energy and steam), stormwater treatment and industrial wastewater treatment plant. Connections on and off the site are essential to the operation of the refinery. Pipes, pumps, electrical utilities, and other mechanical equipment connect services on the refinery site. Transmission lines, roads, interstate roads (i.e. I-80) terminals, pipelines, and rail (UPRR and BNSF) connect the refinery to services and markets located off site.

A small shoreline portion of the Rodeo Refinery is located in the 100-year flood plain and there are areas on site that are low-lying areas and could be flooded if the stormwater drainage system fails. With 6 feet of sea level rise, the wastewater treatment pond is vulnerable to inundation. Although much of the refinery at higher elevations will likely avoid flooding from sea level rise and storm events, pipelines, roads, rail lines, buildings and the wastewater treatment plant that the refinery operations rely on could be exposed to corrosive seawater and elevated groundwater. In addition, the rail line that runs along most of the shoreline may serve as an informal shoreline protection for some of the low-lying portions of the refinery site.

Chevron's Richmond Refinery

Chevron's Richmond Refinery site includes refinery operations (e.g., distillation towers, cracking units, cooling towers, storage tanks) a marine oil terminal, a Cogeneration Power Plant (125 MW capacity), stormwater and industrial wastewater treatment ponds, and EBMUD's Richmond Advanced Recycling Expansion. Connections on and off the site are essential to the operation of the refinery. Pipes, pumps, electrical utilities, and other mechanical equipment connect services on the refinery site. Transmission lines, roads, interstate roads (i.e. I-580) terminals, pipelines, and rail (UPRR and BNSF) connect the refinery to services and markets located off site. The refinery's tank farm is located at higher elevation, but the refinery process area and off site connections are located at lower elevation.

Low-lying and shoreline portions of the Chevron Refinery site, in particular along the eastern side of the site, are located in the 100-year floodplain. These areas and adjacent low-lying areas could also be flooded with 2 feet of sea level rise or more. Flooding on the east side of the refinery may impact pipelines, roads, rail lines, buildings, and the wastewater treatment plant, and could expose these assets to potentially corrosive seawater. In addition, elevated groundwater levels may impact existing groundwater containment and extraction systems (groundwater protection system) and may interfere with the refinery's capacity to collect and treat wastewater, groundwater seepage, and stormwater runoff, and consequently discharge these water sources through the existing system of deepwater and perimeter outfalls.

VULNERABILITIES

INFO1: There is limited information about refinery sites or operations, including the different components of the refinery and associated industrial facilities such as the cogeneration or wastewater treatment ponds plants that are often co-located on these sites.

GOV1: The operations and management of refinery sites, the number of agencies that regulate planning and operations, the number of associated facilities, and the reliance on others to provide access and services (i.e. energy, wastewater, rail, marine terminals) will complicate implementing changes necessary to improve resilience to flooding disruptions.

GOV2: Certain facility owners and managers do not have control over the shoreline that may serve as an informal shoreline protection for some of the low-lying portions of their refinery sites.

PHYS1: Facilities and network systems, including onsite wastewater treatment plant, roads, rail/ship terminals, and pipelines that are located in low-lying areas are unlikely to have been constructed to withstand flooding, higher groundwater levels, or salinity.

PHYS2: Pipelines and electrical components connecting the Marine Oil Terminals to land-based refinery facilities may begin to corrode if they are exposed to salt water.

PHYS3: Linear, networked infrastructure such as pipelines and rail lines may be more susceptible to damage during a seismic event if liquefaction potential increases due to higher groundwater. Buried pipelines are vulnerable to groundwater rise and liquefaction, which can cause the pipelines to break.

FUNC1: Refineries rely on power and water to function. Disruption of power, including from onsite cogeneration plants, or damage to wastewater treatment plants may cause refinery operations to slow down or even shut down entirely.

FUNC2: Refineries operate continuously, so the process of safely shutting down requires time and effort. During an emergency, such as an unexpected flood event, there could be far ranging consequences on the economy, environment, and public health if a refinery shuts down with little or no preparation.

FUNC3: Temporary or permanent disruption at ship/rail terminals would affect the capacity to ship and receive goods, and potentially disrupt refinery operations.

CONSEQUENCES

Society and Equity: Slow downs or shut downs of refinery operations could impact local and regional jobs both on site and in the sectors serving the refinery. Flooding of the refinery site could also result in public health impacts if there is an unscheduled disruption in operations that results in the accidental release of pollutants to the air or waters near the facility.

Environment: Contaminants are present on site that could be carried with floodwaters into inland areas, released into the Bay, or migrate into rising groundwater. Most refineries have fire and emergency response teams on-site that could help mitigate impacts during a flood event. If the rail system is disrupted and trucks are used to bring goods to and from the refineries there may be an increase in roadway congestion, impacts on air pollution levels, and increased GHG emissions.

Economy: Refinery operations disrupted for a significant period of time could result in a loss of jobs at the refinery site and in associated sectors, and potentially impact the regional economy, including higher fuel prices and potentially even fuel shortages.

ASSET SCALE ASSESSMENT FINDINGS

The Tesoro Martinez Refinery was selected as a representative refinery for assessment because refinery staff actively participated in the project working group. Staff shared information about the refinery site and its operations, and provided critical review and feedback on the information gathered to ensure it was as accurate and reflective of existing conditions as was possible. See the Tesoro Martinez Refinery profile sheet summarizing the assessment findings.

Pipelines

Pipelines transport hazardous liquids and gasses, including crude oil, refined, petroleum and natural gas to different locations throughout the region for processing, and then further to other locations and uses. Northern Contra Costa County is the epicenter of refineries and industrial uses in the Bay Area and pipelines, which span the County, are an essential component to the regional economy. The pipeline system serves an area that extends beyond the region as product is often transported throughout Northern California and beyond. Pipelines are usually buried at a depth of 3 to 4 feet and comprised of high-carbon steel, although natural gas distribution systems have been constructed from many different materials including cast iron, steel, copper, and plastic pipe (commonly installed today for gas distribution systems). Natural gas and pipeline systems are owned and operated by many different companies. The location, construction and operation of these systems are generally regulated by federal and state agencies. Many are located in railroad and state road or highway right-of-ways, and some cross natural areas such as marshes and flood control and stream channels.

KEY ISSUE STATEMENT

Buried pipelines are directly and indirectly sensitive to higher groundwater table and salinity intrusion. Exposure to salt water can corrode pipelines that are not protected as specified in federal and state regulations. Rising groundwater levels could increase liquefaction potential leading to additional damage during a seismic event. In the event of flooding, pipelines that are not weighted or anchored may float and become exposed, particularly during prolonged flooding and in marshy or sandy soils. Erosion during storm events could also expose and damage pipelines. Damage to pipelines could result in service disruptions as well as threats to public safety and the environment in the event of an explosion or release of hazardous contents.

EXPOSURE TO CURRENT AND FUTURE FLOODING

There is a total of 276 miles of pipeline within the project area. A total of 55 miles is within the current 100-year floodplain, 12 miles that carry natural gas and 43 that carry hazardous liquids. A total of 51 miles of pipeline is within the area potentially exposed to 6 foot of sea level rise, the majority of which carry hazardous liquids. Due to the type of analysis conducted, the miles of pipeline reported exposed to existing and future flooding may not be unique and likely overlap. Given the shoreline location of many pipelines in the project area, many that are exposed to sea level rise are likely within the existing floodplain.

Miles of Pipeline by Type of Commodity	Current 100-year Flood	Sea Level Rise (cumulative count)					
		1'	2'	3'	4'	5'	6'
Gas*	12	1	2	3	5	6	7
Liquid**	43	11	21	24	28	34	44
Total	55	12	23	28	33	40	51

*Gas = natural gas; **Liquid = crude oil, natural gas liquid, other products

VULNERABILITIES

INFO: Lack of easily accessible information on pipeline material, age, eccentricities, and weld type make it difficult to understand the vulnerabilities of the different pipelines to sea level rise and the consequences that could occur if they are impacted.

GOV: Existing operations and maintenance plans may not be well-coordinated, or adequately shared with emergency responders and other relevant entities. Additionally, the plans may not clearly describe procedures for shutdown and other measures to minimize damages during a storm event. Pipelines are often co-located with other

interconnected infrastructure, like railroads and roads, so governance decisions may require coordination between these agencies, in addition to other stakeholders owning adjacent parcels.

PHYS1: Pipes that are not properly protected are sensitive to corrosion if exposed to saltwater, either by flooded or saltwater intrusion. The material covering some pipelines may be sensitive to corrosion, which could result in direct exposure and potential damage of the pipeline.

PHYS2: Flooded pipelines could float and become exposed if not weighted or anchored. Rising groundwater also increases the risk of liquefaction, which could damage buried pipelines in a seismic event.

FUNC1: Damage to pipelines could result in service disruptions as well as threats to public safety and the environment in the event of an explosion or release of hazardous contents.

FUNC2: Even if pipelines in the project area are protected, the asset is dependent on all parts of the pipeline network to be in working order. Although many pipeline segments have safety valves to allow for a shut down in an emergency, this process may take some time. Therefore advance warning is necessary if the pipeline is to be safely shut down.

CONSEQUENCES

Society and Equity: Direct societal consequences of pipelines flooding will likely depend on the severity of disruption of fuel and natural gas transport and distribution. However, if damaged pipelines explode or leak there could be health risks to nearby populations.

Environment: Pipelines may carry jet fuel, diesel, and other petroleum products and hazardous materials, which, if released, would harm natural area habitats and sensitive species.

Economy: If the pipelines were disrupted, the movement of goods (fuel, gas, diesel) would either be suspended or transferred to an alternate means of transport. Pipelines are an essential component to refineries, which are a major part of the economy. Therefore interruption of pipeline operations in Contra Costa County could have far reaching economic consequences.

Power Distribution

Substations connect lines within both the transmission and distribution systems and are a critical component of the electricity system. High voltage transmission lines run underground and overhead and carry electricity from where it is generated to substations. Substations transform the power to a lower voltage to be carried by overhead and underground distribution lines to residences and businesses. Substations function together as a system; while the service area of each substation is local, the transmission lines that connect to them are networked.

Of the 33 substations in the project area, 19 are owned and managed by PG&E and 14 are owned by private entities (e.g., Shell Oil Company and others). Substations have expensive and potentially dangerous equipment such as transformers, which change the voltage of electrical current; capacitors, which store energy in an electric field; and voltage regulators, which maintain a constant voltage. Typically, substations are located aboveground in fenced enclosures or are within special-purpose buildings.

KEY ISSUE STATEMENT

Substations provide electricity through a networked grid; if one substation is damaged or disrupted there could be downstream (cascading) consequences even though there is some redundancy within the overall grid. Electricity is critical during an emergency. In addition to enabling communications, electricity is needed to run pumps (stormwater, flood control, wastewater) and maintain emergency response centers and facilities.

EXPOSURE TO CURRENT AND FUTURE FLOODING

Of the 33 substations in the project area eleven substations are exposed to current and/or future flooding, six are located in the 100-year floodplain, and seven are exposed to 4 feet of sea level rise or more. Five of the substations are located in the City of Richmond, four of which are privately owned and one is owned by PG&E. Of the five substations located in the City of Martinez, two are potentially exposed to sea level rise – one of these is owned by PG&E and the other is privately owned. There is one PG&E substation in the City of San Pablo that is within the current floodplain but is not shown to be impacted by sea level rise; however additional studies are needed to understand the potential impact of sea level rise on current coastal and riverine floodplains.

Substation	City	Owner	Current 100-year Flood	Sea Level Rise					
				1'	2'	3'	4'	5'	6'
RICHMOND R	RICHMOND	PG&E						Yes	Yes
STANDARD OIL 1	RICHMOND	OTHER						Yes	Yes
STANDARD OIL 2	RICHMOND	OTHER						Yes	Yes
STANDARD OIL 4	RICHMOND	OTHER							Yes
STANDARD OIL 5	RICHMOND	OTHER	Yes				Yes	Yes	Yes
BROOKSIDE	SAN PABLO	PG&E	Yes						
ALHAMBRA	MARTINEZ	PG&E	Yes						
IMHOFF	MARTINEZ	PG&E	Yes						
URICH	MARTINEZ	PG&E	Yes						
STAUFFER	MARTINEZ	PG&E	Yes					Yes	Yes
URICH	MARTINEZ	OTHER					Yes	Yes	Yes

VULNERABILITIES

INFO: Information was not available regarding the possibilities of load sharing among substations, or if electricity companies plan for or have the operational capacity to load share in the event of shutdowns.

GOV: Existing operations and maintenance plans of power plants and substations may not include well-coordinated shutdown plans to be implemented in the event of an emergency.

PHYS1: The equipment in substations is sensitive to water. Salt water, in particular, may cause corrosion, especially if the plant or station has not been shut down in advance of flooding. Below ground electrical or mechanical equipment may be sensitive to groundwater intrusion.

PHYS2: Structures and equipment may be damaged during a seismic event especially in areas susceptible to liquefaction, which may become more extensive as groundwater rises.

FUNC: Substations are part of the electricity grid, and if one substation goes out, electricity can usually be rerouted through another substation to its customers. However, if several substations go out, the service could be interrupted and resulting in downstream consequences.

CONSEQUENCES

Society and Equity: Disruptions to substations could result in loss of power, with consequences for residents and those who work in the affected areas. Substations contain hazardous materials that could harm people and contaminate their property if released into floodwaters.

Environment: Substations contain hazardous materials that could harm the health of wetland habitats and sensitive species if floodwaters carry them into the Bay or nearshore areas.

Economy: The disruption of power could result in business closures, with corresponding losses in productivity, revenues, and income.

Power Generation

Of the nine power-generating facilities within the project area only the Crockett Cogeneration Plant is a significant power producing plant. Other smaller power-generating facilities serve specific industrial sites, such as two landfill gas operated systems in the project area. The Crockett Cogeneration Plant operates a natural gas fired cogeneration plant with 240 MW capacity. The plant sells energy to Pacific Gas and Electric Company (PG&E) and steam to the California and Hawaiian Sugar Company (C&H Sugar Company).

KEY ISSUE STATEMENT

Power in the project area is provided mainly by PG&E, which has a network of power plants one of which is the Crockett Cogeneration Plant. Having a network of power plants provides a more resilient system. However, ensuring uninterrupted electricity requires protecting the entire network, including transmission lines and substations connecting the power that is generated to customers. The C&H Company is located directly adjacent to the plant, and relies on this plant for electricity to support goods processing. A shut down of Crockett Cogeneration Plant would not only disrupt C&H operations, but would also impact the PG&E power grid and would be economically costly to repair and bring back on line.

EXPOSURE TO CURRENT AND FUTURE FLOODING

The portion of the Crockett Cogeneration Plant that is located within the 100-year floodplain will also be exposed to 1-2 feet of sea level rise. With 3-4 feet of sea level rise low lying areas further from the shoreline will be exposed to flooding, and with 5-6 feet of sea level rise the entire plant, and the adjacent C&H Sugar Company site will be flooded.

VULNERABILITIES

INFO: There is a lack of detailed, easily accessible, and well-coordinated information about the ownership, location, and condition of energy infrastructure, which is needed for site- and asset-specific vulnerability and risk assessments.

PHYS: Many mechanical and electrical components of utility infrastructure are vulnerable to flooding and rising groundwater levels. In the event of storm-related flooding, equipment at power plants could be damaged by water – particularly saltwater, which causes corrosion – as well as by mud or debris carried by floodwaters. If flooding damages power plants, equipment may have to be replaced, resulting in a lengthy recovery period.

PHYS: Power plants can be shut down to prevent major damage from floodwaters, such as corrosion to transformers, capacitors, switches and other equipment. However, as proper shutdown takes time, advance warning that a flood event may occur is necessary to avoid damages.

FUNC: Existing operations, maintenance, and emergency response plans and procedures for utility infrastructure may be inadequate to address contingencies associated with storm events.

CONSEQUENCES

Society and Equity: If power plants must be shut down or are damaged at a time of peak demand, or when reserve sources are needed, the insufficient power generation could affect the entire region.

Environment: Power plants and supporting infrastructure contain hazardous materials that could harm the health of wetland habitats and sensitive species if carried by floodwaters into the Bay or near shore areas.

Economy: The Crockett Cogeneration Plant provides energy to the PG&E grid and supports local economy. Temporary or permanent disruptions could affect local businesses and the community. C&H Company, in particular, is dependent on the plant for steam, and may face fiscal consequences if the plant is off line for a significant amount of time.