4.7 GEOLOGY AND SOILS

Issues & Supporting Information Sources	Potentially Significant Impact	Less Than Significant With Mitigation Incorporated	Less Than Significant Impact	No Impact
Would the project:				
a. Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:				
i) Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault? Refer to Division of Mines and Geology Special Publication 42.	☐	☐	☒	☐
ii) Strong seismic ground shaking?	☐	☐	☒	☐
iii) Seismic-related ground failure, including liquefaction?	☐	☐	☒	☐
iv) Landslides?	☐	☐	☐	☒
b. Would the project result in substantial soil erosion or the loss of topsoil?	☐	☐	☒	☐
c. Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse?	☐	☐	☒	☐
d. Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994) creating substantial risks to life or property?	☐	☐	☒	☐
e. Have soils incapable of adequately supporting the use of septic tanks or alternative waste water disposal systems, where sewers are not available for the disposal of waste water?	☐	☐	☐	☒

4.7.1 Environmental Setting

4.7.1.1 Overview

Both the Old River and Connection Slough sites are located in Holocene-age (10,000 years B.P. to present day) alluvial fan deposits and dune sands. These deposits extend up to 30 feet below ground surface where they are underlain by older, late-Pleistocene (10,000 to 70,000 years B.P.) alluvial fan deposits and stream terrace deposits (Helley 1997, Wagner et al. 1991). These sedimentary deposits are characterized by soft, water-saturated muds, peat, and loose sands. Local areas may slump and slide. Muds contain expansive clays, and the area is considered to have a high liquefaction potential. The surrounding areas are reclaimed wetlands, which experience amplified lateral and vertical movements that can be damaging to structures. The Project area also is subject to subsidence, the gradual setting or sinking of the earth's surface with little or not horizontal motion. In the Project area, subsidence results from the oxidation of peat on the Delta islands, as well as such factors as anaerobic decomposition, shrinkage, wind erosion, and compaction by farm equipment (Contra Costa County 2005, San Joaquin County 1992).

Seismic hazards are those hazards associated with earthquakes. Neither of the Project sites is in a mapped Alquist-Priolo Special Studies Zone (Contra Costa County 2005, San Joaquin County 1992, CGS 2002). The active seismic source closest to the Project sites is the Midland fault, a thrust fault located approximately 3 miles west of the Old River site. The many active faults in the region include the Tracy-Stockton, Patterson, Calaveras, Hayward, and San Andreas faults (Contra Costa County 2005 and San Joaquin County 1992).

4.7.1.2 Old River Site – Subsurface Conditions

Subsurface exploration completed to date for the Old River site includes two borings in fields on Holland Tract west of the levee, three borings on the crest of the Bacon Island levee, one near the toe of the Bacon Island levee and two in fields beyond the levee. At the Holland Tract side of the Old River channel, the native peat and organic soil extend to about elevation -18 feet in the two borings drilled in the fields west of the levee. Earlier exploration data further north and south of the planned Holland Tract abutment suggests that the base of the peat and organic soil may be near elevation -22 feet. The peat and organic soil is underlain by sand that extends to about elevation -60 feet. For preliminary design, the tule berm is assumed to be composed of peat and organic soil with sand lying below elevation -18 feet. The original channel of Old River is assumed to be a layer of silt or silty sand overlying sand. As the channel becomes shallower approaching the Bacon Island levee, the soils above elevation -15 feet are assumed to be peat and organic soil, with sand below that elevation. At the Bacon Island side of the Old River channel, the peat extends down to about elevation -12 feet and is underlain by sand.

4.7.1.3 Connection Slough Site – Subsurface Conditions

Subsurface exploration completed to date for the Connection Slough site includes four borings on the Bacon Island levee crest, one boring near the levee toe, two borings in the Bacon Island fields south of the levee, and three borings within the southern portion of Connection Slough. Peat and organic soil, together with an underlying 5-foot-thick layer of normally consolidated elastic silt, extend to about elevation -30 to -35 feet in the borings drilled on the Bacon Island levee and in Connection Slough. These soils are underlain by 5 to 10 feet of medium dense sand over 5 to 8 feet of stiff clay. Below the stiff clay are thicker deposits of sands interbedded with silt and clay to the depths explored.

4.7.2 Regulatory Setting

No federal regulations related to geology and soils are applicable to the Project.

4.7.2.1 Alquist-Priolo Earthquake Fault Zoning Act

Under the Alquist-Priolo Earthquake Fault Zoning Act, the State of California defines an active fault as one that exhibits evidence that surface rupture has occurred within the last 11,000 years (i.e., Holocene activity). Under the Act, the state has identified active faults within California and has delineated “earthquake fault zones” along active faults. This act restricts development of structures for human habitation within the earthquake fault zones to reduce the potential for injuries and damage caused by fault rupture.

4.7.2.2 Seismic Hazard Mapping Act

The State of California passed the Seismic Hazard Mapping Act in 1990, following the 1989 Loma-Prieta earthquake. The act was passed to reduce the potential impacts on public health and safety and to minimize property damage caused by earthquakes. The act established a requirement for the identification and mapping of areas prone to the earthquake hazards of liquefaction, earthquake-induced landslides, and amplified ground-shaking. The act requires site-specific geotechnical investigations to identify potential seismic hazards and formulate mitigation measures prior to permitting most developments designed for human occupancy within the Zones of Required Investigation.

4.7.2.3 California Building Code

The 2001 California Building Code (CBC) is based on the 1997 Uniform Building Code, with the addition of more extensive structural seismic provisions. The California Building Code is contained in the CCR Title 24, or the California Building Standards Code, and is a compilation of three types of building standards from three different origins:

- Building standards that have been adopted by state agencies without change from building standards contained in national model codes
- Building standards that have been adopted and adapted from the national model code standards to meet California conditions
- Building standards authorized by the California legislature that constitute extensive additions not covered by the model codes that have been adopted to address particular California concerns

Seismic sources and the procedures used to calculate seismic forces on structures are defined in 24 CCR, Part 2, Volume 2, Chapter 16. The code covers grading and other geotechnical issues, building specifications, and non-building structures.

4.7.2.4 Contra Costa General Plan

The Safety Element of the General Plan includes the following policies:

> 10-20. Any structures permitted in areas of high liquefaction danger shall be sited, designed, and constructed to minimize the dangers from damage due to earthquake-induced liquefaction.

> 10-21. Approvals to allow the construction of public and private development projects in areas of high liquefaction potential shall be contingent on geologic and engineering studies which define and delineate potentially hazardous geologic and/or soils conditions, recommend means of mitigating these adverse conditions, and on proper implementation of the mitigation measures.

4.7.2.5 San Joaquin County General Plan

The San Joaquin County General Plan contains a number of policies associated with identifying geologic hazards and preventing risks from urban development.

4.7.3 Impacts and Mitigation Measures

4.7.3.1 No Project

The No Project alternative would not affect geology and soils because no development would occur.

4.7.3.2 2-Gates Project

Further geotechnical investigation will be performed at both Project sites consisting of explorative land-based borings and monitoring wells at each levee abutment and explorative borings beneath the waterway gate structure from a barge. The borings will explore the thickness and strength of the underlying fill and peat layer, and the thickness, permeability and relative density of the sand formation underlying the peat soil. Monitoring wells along the existing levees will verify the existing groundwater elevations in the sand formations and track groundwater elevation changes that may occur during Project implementation. The field data will be used to refine the design criteria and recommendations for final design and construction, including site-specific levee improvements.

a. Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:

i) Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault? (Refer to California Geological Survey Special Publication 42.)

Less than Significant. Surface ground rupture along faults is generally limited to a linear zone a few yards wide. No active faults are mapped across the Project sites by the California Geological Survey or the USGS, and because the Project sites are not located in an Alquist-Priolo Earthquake Special Study Zone, fault ground rupture is unlikely (San Joaquin 1992, Contra Costa County 2005, CGS 2008).

ii) Strong seismic ground shaking?

Less than Significant. The Project sites are located in modern sediments of the Delta lowlands, are located near seismically active areas, and are highly susceptible to damage from ground shaking and liquefaction (Contra Costa County 2005). Most likely sources of strong ground shaking include the San Andreas, Hayward-Rodgers Creek, Calaveras, Green Valley-Concord, Greenville, Great Valley, and Tracy-Stockton faults.

The current State of California earthquake forecast strategy is based on the concept that earthquake probabilities change over time. The 2007 Working Group on California Earthquake Probabilities produced the Uniform California Earthquake Rupture Forecast, Version 2, or “UCERF” (USGS Open-File Report 2007-1437, http://pubs.usgs.gov/of/2007/1437/). Based on most recent calculations, three of these faults have been determined to have a relatively high probability for one or more earthquakes with a magnitude greater than or equal to 6.7 to occur within the next 30 years. These are the Hayward-Rodgers Creek fault (31 percent probability), Northern San Andreas (21 percent probability) and the Calaveras (7 percent probability) (Working Group on California Earthquake Probabilities 2007). Thus, the gate foundations would be subject to seismic ground shaking associated with a Modified Mercalli Intensity level VII (defined as Very Strong).

Thus, the gate foundations would be subject to seismic ground shaking associated with a Modified Mercalli Intensity level VII (defined as Very Strong).

Ground motions from seismic activity can be estimated by probabilistic method at specified hazard levels. The intensity of ground shaking depends on the distance from the earthquake epicenter to the site, the magnitude of the earthquake, site soil conditions, and the characteristic of the source. Data contained in the Probabilistic Seismic Hazard Assessment for the State of California Model, 2002 (USGS/CGS 2003), suggest there is a 10 percent probability that the peak horizontal acceleration experienced at the site would range from 0.275g for firm rock to 0.332g for alluvium (where “g” is the acceleration of gravity) in 50 years. According to the California Building Code (CBC) (2001 edition), the site is located in Seismic Zone 4, which implies a minimum horizontal acceleration of 0.4g for use in earthquake-resistant design.

The CBC specifies more stringent design guidelines where a project would be located adjacent to a Class A or B fault as designated by the California Probabilistic Seismic Hazard Maps (USGS/CGS 2003). Hayward-Rodgers fault is a Class A fault (Cao et al. 2003).

Although the facilities could be subject to strong seismic ground shaking, the Project would be required to adhere to the building safety standards specified in the CBC for Seismic Zone 4, which include measures designed to prevent significant structural damage from seismic ground acceleration.

iii) Seismic-related ground failure, including liquefaction?

Less than Significant. Project site soil types include interlayered deposits of loose to dense silty to clayey sands mixed with stiff clays. These factors, combined with a high probability for strong seismic ground shaking, indicate that Project structures could be subject to liquefaction. The Project would be designed in accordance with the recommendations presented in both the predesign and design-level geotechnical engineering investigation reports and would comply with the CBC requirements. Additionally, all earthwork would be monitored by a geotechnical engineer tasked with the responsibility of providing oversight during all excavation, placement of fill, and disposal of materials removed from and deposited on the Project site. Because these features would be incorporated into the Project design, this impact is considered less than significant.

iv) Landslides?

No Impact. The Project sites are not located in or near a landslide hazard area. Therefore, no impact would occur.

b. Result in substantial soil erosion or the loss of topsoil?

Less than Significant. Although the sites are located in an area of relatively flat topography, they are located in a tidal area, thus exposing site soils to the potential for wind erosion. Construction activities would involve some excavating, moving, filling, and temporary stockpiling of soil on the Project site. Grading activities would remove any vegetative cover and expose site soils to erosion via wind and surface water runoff. The Project would be required to implement best management practices (BMPs) as part of its storm water pollution prevention plan (SWPPP), which would prevent substantial soil erosion or the loss of topsoil.

The following standard erosion and sediment control measures and practices would be used during and after construction to ensure that impacts from soil erosion and sedimentation are less than significant:

- Minimize site disturbance
- Perform initial cleanup
- Compact subsurface backfill material
- Leave topsoil in roughened condition
- Construct water bars

- Perform seeding and mulching
- Install erosion control blankets
- Install silt fencing and straw bale dikes
- Conduct daily inspections and periodic maintenance of erosion and sediment control measures

c. Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse?

Less than Significant. The Project sites are located in an area that is subject to lateral spreading, subsidence, and liquefaction. The Project would comply with the recommendations included in the pre-design and design-level geotechnical engineering investigation reports intended to avoid impacts associated with unstable geologic units and soils.

d. Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994, as updated), creating substantial risks to life or property?

Less than Significant. The Project sites are located in an area that contains expansive soils. The Project would comply with the recommendations included in the pre-design and design-level geotechnical engineering investigation reports intended to avoid impacts associated with unstable geologic units and soils.

e. Have soils incapable of adequately supporting the use of septic tanks or alternative wastewater disposal systems where sewers are not available for the disposal of wastewater?

No Impact. The Project does not involve the use of septic tanks or alternative wastewater disposal systems. Therefore, no impact would occur.

4.7.3.3 Cumulative Impacts

Impacts to geology and soils are highly localized; no other projects are located in the immediate vicinity, and no cumulative impacts would occur.