9. GEOLOGY AND SOILS

This EIR chapter describes existing conditions and potential project impacts related to soil and geologic conditions, and identifies mitigations for identified potentially significant effects.

9.1 SETTING

9.1.1 Geology and Topography

Regional geology in the City consists of alluvial (stream-related) deposits of Quaternary age (less than two million years old) on the floor of the Refugio Valley, surrounded by marine sedimentary rocks of Miocene age (between five and 23 million years old) in the adjacent uplands. Alluvium in the Refugio Valley varies from about 12 feet in thickness in the southeast portion of the valley to about 80 feet in thickness near the valley mouth. Near San Pablo Bay, a few feet of fine-grained flood plain alluvium cap weak and highly compressible Bay mud deposits. The Bay mud has an estimated thickness of 35 to 40 feet along the western edge of the valley, thinning out in an up-valley direction.

Much of the older valley floor deposits are covered by loose, artificial fill. Fill materials were placed during operation of the Hercules Powder Company and include soils and bedrock excavated from adjacent hillside areas.

Most of Hercules, including the project site, lies within the lower portion of the Refugio Valley, adjacent to San Pablo Bay. The valley floor is fairly level. Most slopes on the uplands surrounding the valley floor are fairly gentle (less than 15 percent), although some slopes are between 15 and 20 percent and exceed 30 percent in very limited areas.[1]

The project site and vicinity encompass a prominent lower-elevation central valley and perimeter hilly area that front San Pablo Bay. The higher-elevation hills in the southern part of the site and vicinity extend up to an approximate elevation of 80 feet above mean sea level (msl). The central area valley has a low elevation of approximately 5 feet above msl.[2] The Hercules General Plan Update EIR identified the southern portion of the project site as an area of potential slope instability and the majority of the rest of the site area underlain by Bay mud.[3]

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[1]ESA, City of Hercules General Plan Land Use and Circulation Elements Update and Redevelopment Plan Amendments Environmental Impact Report, *Volume I: EIR Text*, prepared for the City of Hercules, California, June 9, 1995, page IV.J-1.

[2]ENGEO Incorporated, Preliminary Geotechnical Investigation, Hercules Property Inc. Site, Hercules, California, May 19, 1999, page 4.

[3]ESA, City of Hercules General Plan Land Use and Circulation Elements Update and Redevelopment Plan Amendments Environmental Impact Report, *Volume I: EIR Text*, prepared for the City of Hercules, California, June 9, 1995, Figure IV.J.2.

9.1.2 Soils

As noted above, the Refugio Valley floor is covered with existing fill deposits of variable thickness. These fill deposits overlie natural soil deposits that consist of Quaternary-age unconsolidated to poorly consolidated alluvium, colluvium, and landslide debris. The alluvium in the Refugio Valley consists of organic-rich marine silt and clay deposits locally known as "Young Bay Mud" and/or medium stiff to stiff alluvium and colluvium deposits derived from weathering of bedrock materials along adjacent inland hillsides. The Young Bay Mud typically consists of soft and highly compressible organic-rich soils with interbedded peat.

The rounded foothills along the northeast and southwest perimeters of the project site consist of Miocene-age marine sedimentary units and the Quaternary-age Montezuma Formation (Qmz).[1]

9.1.3 Seismicity and Seismic Hazards

The project site is located in a region of high seismicity. The San Francisco Bay Area, in general, is characterized by large numbers of active strike-slip faults and has been the site of numerous moderate and large magnitude earthquakes. The closest identified active faults to the project site are the Hayward (North), Rodgers Creek, West Napa, and Concord-Green Valley faults, located approximately 4.1 miles west, 9.4 miles north, 10.3 miles north, and 11.6 miles east, respectively.[2]

Three major types of geologic hazards are associated with earthquakes: (1) fault rupture, (2) ground shaking, and (3) ground failure.

(a) Fault Rupture. Ground surface rupture, or fault rupture, is generally associated with earthquakes of magnitude 5.5 and greater. Projects within earthquake fault zones require geologic evaluation to determine if a potential rupture hazard from any fault, whether previously recognized or not, exists.

A preliminary geotechnical exploration for the entire 167-acre Waterfront District prepared by ENGEO, Incorporated, and dated May 19, 1999 (on file with the City Clerk, City Hall, 111 Civic Drive, Hercules), noted that there are no known active faults crossing the Waterfront District and that the district is not within a State-designated Earthquake Fault Zone (see section 9.2.1[a] of this chapter for more detail on State-designated Earthquake Fault Zones). Therefore, the risk of fault rupture at the project site is considered low.[3]

(b) Ground Shaking. Strong ground shaking can be expected during moderate to severe earthquakes in the general region. These strong ground motions could damage structures,

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[1]ENGEO Incorporated, Preliminary Geotechnical Investigation, Hercules Property Inc. Site, Hercules, California, May 19, 1999, page 9.

[2]ENGEO Incorporated, Supplemental Geotechnical Recommendations, Hercules Transit Village Block K and Block I, Hercules, California, submitted to the City of Hercules, California, December 17, 2008, page 4.

[3]ENGEO Incorporated, Preliminary Geotechnical Investigation, Hercules Property Inc. Site, Hercules, California, May 19, 1999, pages 9-10.

even if all applicable building regulations are followed. This risk is common to virtually all land development in the greater San Francisco Bay Area.

The extent of hazards from seismic shaking depends on the specifics of the earthquake and the resistance of individual structures. Structures founded on thick, soft soil deposits are more likely to experience more destructive shaking, with higher amplitude and lower frequency, than structures founded on bedrock. In addition, thick, soft soil deposits far from earthquake epicenters may result in seismic accelerations significantly greater than expected in bedrock. Structures not adequately bolted to their foundations have a greater risk of damage than adequately secured structures.

The General Plan Update EIR identified a significant impact related to strong ground shaking within the General Plan Update study area. The EIR specifically identified the Waterfront District as an area that would be expected to receive the strongest local ground shaking because it contains Bay mud. The EIR noted that the Uniform Building Code (UBC) (now referred to as the International Building Code/IBC) requires new development to incorporate seismic safety features. The EIR also cited a number of policies in the General Plan *Safety Element* to help reduce this local ground shaking impact potential, including requirements for detailed studies in lower valley areas with Bay mud and for site planning that considers the potential for differential settlement. In addition, the General Plan EIR included a mitigation requirement calling for site-specific geotechnical investigations for every new discretionary development.[1]

The 1999 ENGEO geotechnical study cited above, and a subsequent applicant-commissioned ENGEO letter dated August 2, 2003, included estimates of peak ground acceleration at the project site during an earthquake of maximum moment magnitude on faults in the project region. These reports indicated that the Hayward Fault, located approximately 4.1 miles from the project site, could have an estimated peak ground acceleration (PGA) of 0.46 (ENGEO, August 2, 2003) at the project site. The 1999 ENGEO report also noted, "based on the presence of significant thicknesses of the Young Bay Mud deposits in the lower lying valley area, amplifications of ground accelerations within the valley area should be anticipated."[2] The 1999 and 2003 ENGEO reports recommended compliance with the UBC (i.e., IBC) requirements at a minimum, plus design of local structures to address the nature of site-specific soil, seismicity, and near-source effects.

(c) Ground Failure. Seismic shaking can also result in ground failure through liquefaction, lateral spreading, ground lurching, seismically induced landsliding, and differential settlement.

(1) Liquefaction. Liquefaction occurs when granular sediments lose cohesion due to vibration and are transformed into a temporary liquid state. This phenomenon typically occurs in saturated, unconsolidated deposits.

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[1]ESA, City of Hercules General Plan Land Use and Circulation Elements Update and Redevelopment Plan Amendments Environmental Impact Report, *Volume I: EIR Text*, prepared for the City of Hercules, California, June 9, 1995, pages IV.J-11 through IV.J-14.

[2]ENGEO Incorporated, Preliminary Geotechnical Investigation, Hercules Property Inc. Site, Hercules, California, May 19, 1999, page 16.

The General Plan Update EIR stated that "Bay mud underlying the western portion of the valley floor is not likely to liquefy, although sand seams occasionally contained within the Bay mud, or fine-grained alluvium or artificial fill on top of the Bay mud, could be susceptible to liquefaction."[1] The 1999 ENGEO report concluded that, based on the material types and densities of granular materials encountered in ENGEO's borings, the risk of liquefaction in the project vicinity was considered low.[2] However, a more recent (December 2008) City-commissioned supplemental geotechnical investigation prepared by ENGEO for a portion of the project site (Blocks K and I) identified potential liquefaction hazards, based on State of California and Association of Bay Area Governments (ABAG) mapping and a computer-based evaluation of liquefaction resistance.[3]

(2) Lateral Spreading. Lateral spreading is the horizontal movement of material adjacent to a steep, unsupported face (i.e., stream bank, cut face, etc.) during liquefaction of underlying deposits. The 1999 ENGEO report concluded that the risk of lateral spreading in the project vicinity would be low, since liquefaction was at that time considered unlikely.[4] The 2008 supplemental ENGEO study found the potential for liquefaction-induced lateral spreading in the project vicinity to be minor based on site-specific conditions on a portion of the project site (Blocks K and I).

(3) Ground Lurching. The term ground lurching refers to the downslope movement of material on a steep slope that does not involve a discrete plane of movement (as occurs in a landslide). Ground lurching is analogous to rapid soil creep, and can affect large areas on a hillslope during a strong earthquake. The 1999 ENGEO study indicated that, while such an occurrence is possible in the Waterfront District in which the project site is located, the associated offset or strain is expected to be minor.[5]

(4) Seismically Induced Landsliding. Seismically induced landslides are triggered by earthquake ground shaking. The risk of this hazard is greatest in the late winter when groundwater levels are highest and hillside colluvium is saturated. The 1999 ENGEO study indicated that this risk is present within the Waterfront District to varying degrees, depending on slope conditions and time of year.[6]

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[1]ESA, City of Hercules General Plan Land Use and Circulation Elements Update and Redevelopment Plan Amendments Environmental Impact Report, *Volume I: EIR Text*, prepared for the City of Hercules, California, June 9, 1995, page IV.J-9.

[2]ENGEO Incorporated, Preliminary Geotechnical Investigation, Hercules Property Inc. Site, Hercules, California, May 19, 1999, page 16.

[3]ENGEO Incorporated, Supplemental Geotechnical Recommendations, Hercules Transit Village Block K and Block I, Hercules, California, submitted to the City of Hercules, California, December 17, 2008, page 7.

[4]ENGEO Incorporated, Preliminary Geotechnical Investigation, Hercules Property Inc. Site, Hercules, California, May 19, 1999, page 16.

[5]ENGEO Incorporated, Preliminary Geotechnical Investigation, Hercules Property Inc. Site, Hercules, California, May 19, 1999, page 16.

[6]ENGEO Incorporated, Preliminary Geotechnical Investigation, Hercules Property Inc. Site, Hercules, California, May 19, 1999, page 16.

(5) Differential Settlement. The General Plan Update EIR noted that differential settlement would be a potential hazard for development over non-engineered fill, alluvium, and/or Bay mud, and on sites containing transition zones between alluvium and bedrock.[1] The Waterfront District contains fills, colluvial deposits, Bay mud, and transitions between alluvium and bedrock.

The 1999 ENGEO report described Young Bay Mud deposits under the Waterfront District that were found to range up to approximately 36 feet in thickness. Young Bay Mud deposits are considered highly susceptible to compression from loads imposed by fill and structures; without mitigation, consolidation of these deposits can be expected to continue for 20 years or longer. The potential for excessive total and differential settlements was described in the report as one of the primary geotechnical concerns for development of the Waterfront District.[2]

9.1.4 Landslide and Erosion Hazards

Landsliding is a form of ground failure involving a relatively rapid downslope movement of a mass of soil, rock, and rock debris. Landslides can cause damage to upslope or downslope structures, roads, utilities, and drainage systems.

As noted earlier, the General Plan Update EIR identified the southern portion of the project site as an area of potential slope instability (slopes greater than 15 percent or areas showing evidence of historic landslides) and the majority of the rest of the site as an area underlain by Bay mud. The General Plan Update EIR also notes that "Bay muds are also susceptible to failure, even when nearly level."[3]

The 1999 ENGEO study identified one landslide on an existing cut slope generally along the south-central border of the current project site. The study indicated that the landslide was upslope of the southern valley margin and appeared to have developed near the transition zone between the Montezuma Formation and Miocene siltstone. The study stated that the landslide "appears to be a surficial landslide involving highly weathered bedrock materials and is estimated to extend to a depth of about 10 to 15 feet below the existing grades."[4]

9.1.5 Shrink-Swell Potential

Shrink-swell potential is the relative change in volume to be expected with changes in moisture content, i.e., the extent to which the soil shrinks as it dries out or swells when it gets wet.

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[1]ESA, City of Hercules General Plan Land Use and Circulation Elements Update and Redevelopment Plan Amendments Environmental Impact Report, *Volume I: EIR Text*, prepared for the City of Hercules, California, June 9, 1995, page IV.J-19.

[2]ENGEO Incorporated, Preliminary Geotechnical Investigation, Hercules Property Inc. Site, Hercules, California, May 19, 1999, pages 18-19.

[3]ESA, City of Hercules General Plan Land Use and Circulation Elements Update and Redevelopment Plan Amendments Environmental Impact Report, *Volume I: EIR Text*, prepared for the City of Hercules, California, June 9, 1995, page IV.J-17.

[4]ENGEO Incorporated, Preliminary Geotechnical Investigation, Hercules Property Inc. Site, Hercules, California, May 19, 1999, page 12 and Figure 2.

Shrinking and swelling of soils cause damage to building foundations, roads, and other structures. The potential extent of shrinking and swelling is influenced by the amount and kind of clay in the soil. A high shrink-swell potential indicates a hazard to maintenance of structures built in, on, or with material having this rating.

The General Plan Update EIR concluded that soils in the Hercules area generally have limitations due to low strength, high shrink-swell potential, and high corrosivity.[1] The 1999 ENGEO study indicated that the Waterfront District has moderately to highly expansive soil (residual soils, colluvium, and landslide debris) that may undergo significant volume changes (swell and compression) when subjected to varying moisture content.[2]

9.2 PERTINENT PLANS AND POLICIES

CEQA requires an EIR to identify the plan and policy setting within which the project is proposed and discuss any inconsistencies between the proposed project and these applicable plans and policies (CEQA Guidelines section 15125[d]). CEQA also indicates that this plan and policy consistency discussion should be limited to the context of evaluation and review of environmental impacts (CEQA Guidelines section 15124[b]).

9.2.1 State Regulations

(a) Alquist-Priolo Earthquake Fault Zoning Act. The Alquist-Priolo Earthquake Fault Zoning Act is the state law that addresses hazards from earthquake fault zones. Its purpose is to mitigate the hazard of surface fault rupture by regulating structures designated for human occupancy near active faults. As required by the Act, the California Geological Survey (CGS) has delineated Earthquake Fault Zones along known active faults in California.

In accordance with the Alquist-Priolo Earthquake Fault Zoning Act, before permitting a proposed project, local agencies must require a geologic investigation that demonstrates that structures for human occupancy will not be constructed across active faults. If an active fault is found during the geologic investigation, all structures designated for human occupancy must be set back from the fault.

As noted earlier, there are no known active faults crossing the Waterfront District, and the district is not within an Earthquake Fault Zone. It is therefore unlikely that the Alquist-Priolo Earthquake Fault Zoning Act would apply to development on the project site.

(b) California Building Standards Code. The State of California provides minimum standards for building design and construction through the California Building Standards Code (Title 24 of the California Code of Regulations). The California Building Standards Code is based on the Uniform Building Code, which has been used widely throughout the United States and has been modified for California conditions with numerous more detailed and/or more stringent requirements. The code specifies standards for geologic and seismic hazards, and includes

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[1] ESA, City of Hercules General Plan Land Use and Circulation Elements Update and Redevelopment Plan Amendments Environmental Impact Report, *Volume I: EIR Text*, prepared for the City of Hercules, California, June 9, 1995, page IV.J-20.

[2] ENGEO Incorporated, Preliminary Geotechnical Investigation, Hercules Property Inc. Site, Hercules, California, May 19, 1999, page 18.

regulations for earthquake-resistant design and construction. The code is periodically updated to reflect latest "state-of-the-art" construction specifications for seismic resistance and other factors.

9.2.2 City of Hercules General Plan

Those objectives, policies, and programs from the Hercules General Plan that are pertinent to consideration of proposed project and its potential geology and soils impacts are listed below. Where any aspect of the proposed project is found in this EIR to be potentially inconsistent with one or more such City-adopted objectives, policies, or programs, a potentially significant environmental impact and one or more associated mitigations has been identified for incorporation into the project to reduce the impact and better implement the General Plan. Otherwise, the proposed project is considered consistent with the objectives, policies, and programs listed below.

The *Safety Element* of the Hercules General Plan contains the following objectives, policies, and programs relevant to consideration of the geology and soils impacts of the proposed project:

- *Consider potential seismic [and] geologic…hazards and introduce adequate safety measures in development plans and proposals.* (Objective 1)
- *…Administration and enforcement of municipal regulations provide positive measures for implementing safety policies.* (Policy 1A)
- *Planned development plans must be prepared and adopted for all new development projects. Safety measures will be incorporated into these planned development plans to provide adequate protection from seismic, geologic, flood and fire hazards.* (Program 1A.1, Item 1)
- *The review and approval of zoning applications, tentative maps and planned development plans shall include consideration of safety policies and standards contained in the General Plan and other area plans.* (Program 1A.1, Item 2)
- *The subdivision, zoning and grading regulations govern the subdivision of land, and the design and construction of site improvements…Seismic, geologic, flood and fire hazards shall be considered in the review and approval of tract maps, grading and improvement plans.* (Program 1A.2, Item 1)
- *The City Council has adopted the Uniform Building Code….The Uniform Building Code provides minimum safety standards by regulating the design, construction, materials use and occupancy of buildings and structures within the City.* (Program 1A.3)
- *Minimize exposure of public facilities and development to seismic hazards.* (Objective 2)
- *Projects proposed for all critical facilities including schools, high-population facilities (such as shopping malls) and industries using or generating significant amounts of hazardous materials within areas subject to very strong earthquake ground shaking or ground failure shall conduct geotechnical studies and structural design evaluations.* (Policy 2B)

- *For development excluding critical facilities and schools, the alternative site feasibility assessment will be an optional requirement of the City (an alternatives site evaluation may be required under CEQA). A rigorous geotechnical evaluation and structural design analyses will be required to ensure that the proposed structures perform adequately in major earthquakes without creating a safety hazard to occupants or people in surrounding areas.* (Program 2B.2)

- *The administration of subdivision and grading ordinances should allow for flexibility in the review and approval of construction plans to permit sound engineering design in the solution of specific geological problems. Site-specific geotechnical investigations shall be required for every new development.* (Policy 2D)

- *Applications for subdivision and development projects shall include site specific geotechnical investigations prepared by a California certified engineering geologist documenting the geotechnical suitability of the site for the proposed development based on soil and underlying substrate conditions; and the measures required to ensure public safety and the protection of property. The following shall be implemented through adoption as conditions of approval for the project:*

  1) *Loose or improperly compacted existing fills and backfills should be excavated from areas to be filled.*

  2) *All areas to be graded should be stripped of vegetation and the top few inches of highly organic topsoil.*

  3) *Organic topsoil should be stripped and stockpiled and used for landscaping.*

  4) *Lower valley areas where bay mud deposits are exposed or are blanketed by shallow thicknesses of poorly compacted fill will require detailed studies prior to site grading.*

  5) *Sidehill "sliver" cuts and fills should be avoided.*

  6) *Special consideration should be given to slope stability in the steep hillside areas. Site new structures away from steep hillsides and the toes of existing landslide surfaces, reducing the potential for damage from landslide movement or burial.*

  7) *Steep sideslopes should be left in their natural condition where possible.*

  8) *Minimize the potential for creating new landslides or reactivating old ones. Setbacks should be determined based on detailed soils investigations in individual cases opposite landslide prone slopes to reduce the potential for slide damage to improvements.*

  9) *Expansive soils should be considered in the design of road pavement sections.*

  10) *Site planning should consider the potential of differential settlement where compressible soils exist, and employ appropriate approaches to reducing the hazard to an acceptable level of risk.*

  11) *Areas underlain by soft bay mud will require further detailed soils investigations.*

12) Slopes should be planted as soon as possible after completion of construction to develop a protective organic mat.

13) Dense pockets of brush and trees located on steep slopes should be left intact where possible to prevent potential landslides.

14) The sides of the stream channel in portions of Refugio Valley should be improved to protect erosion-induced slumping. Care should be taken to maintain the natural appearance of the water-course in the open space areas.

15) Development of the site shall minimize the amount of native soils compacted by construction vehicles and structures, as well as the amount of soil disturbed through grading and excavation. As much as possible, native soils shall be left undisturbed and used for open space and landscaping purposes.

16) Development of the sites shall also maximize the use of pervious materials, including fill, and incorporate proper drainage structures capable of handling anticipated increases in surface runoff.

17) Minimize amount of grading when building on hill sides. No grading shall occur on slopes steeper than 30 percent, and cut slope angles no greater than 33 percent shall be maintained. (Program 2D.1)

- *Applications for subdivision and development projects shall include site specific erosion control and hillside drainage plans, which shall address the following standards. These standards shall be implemented through adoption as conditions of approval for the project.*

  1) The use of silt fencing, sediment trapping basins, runoff diversion devices and hydroseeding of barren slopes shall be required to minimize or prevent erosion impacts.

  2) Grading in the City shall occur with no increase in discharge of sediments to wetlands, Refugio Creek, or San Pablo Bay. (Program 2D.2)

9.2.3 City of Hercules Waterfront District Master Plan (WDMP)

The Waterfront District Master Plan (WDMP) contains no policies or other provisions specifically relevant to geology and soils.

9.2.4 City of Hercules Grading Ordinance

The City of Hercules grading ordinance (Title 7, Chapter 2 of the Hercules Municipal Code) establishes minimum standards and requirements related to land grading, excavations, and fills, and procedures by which these standards and requirements may be enforced. The ordinance sets forth requirements for grading permits and plans, erosion and sediment control plans, geological reports, and soils reports.

9.3 IMPACTS AND MITIGATION MEASURES

9.3.1 Significance Criteria

Based on the CEQA Guidelines,[1] the proposed project would have a significant adverse impact related to soil or geologic conditions if it would:

(a) expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:

  (1) 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);

  (2) strong seismic ground shaking;

  (3) seismic-related ground failure, including liquefaction; or

  (4) landslides;

(b) 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, creating substantial risks to life or property;

(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;

(f) result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the state; or

(g) result in the loss of availability of a locally important mineral resource recovery site delineated on a local general plan, specific plan, or other land use plan.

Criterion (e) would not apply to the project, since sanitary sewer service would be provided to the project site, and no use of septic tanks or alternative wastewater disposal systems is proposed.

The project would have no impact in relation to criteria (f) and (g), since no significant mineral deposits have been identified in the area according to the Hercules General Plan.

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[1] CEQA Guidelines, Appendix G, Items VI(a-e) and X(a and b).

9.3.2 Future Study and Subsequent Mitigation

Before final mitigation recommendations can be developed for the geotechnical aspects of the project, additional, more detailed studies must be performed to address specific concerns. Accordingly, geotechnical/geologic mitigation requirements identified in subsequent sections of this chapter call for completion of additional, more detailed studies to address specific concerns as individual, site-specific project applications are submitted. Following common practice, the City of Hercules routinely requires such geotechnical/geologic investigations and specifications at phases of development review that follow EIR certification. In particular, Hercules Municipal Code Title 7 (Public Works) details requirements for Encroachments (Chapter 1); Grading, Excavations and Fills (Chapter 2); and Street and Sidewalk Improvements and Conditions, and Underground Utility Requirements (Chapter 3).

There is substantial, reasonable, historic information to support the conclusion that the specific subsequent geotechnical/geologic investigations, inspections, and specific formulations identified in this EIR would adequately mitigate related impacts to less-than-significant levels. A significant record exists demonstrating the effectiveness of such post-EIR-certification design and engineering requirements in mitigating the related soil and geologic impacts of concern identified in this EIR. Under the City's grading permit and building permit provisions, requirements, and regulations, a project cannot be given final approval without reasonable indication of project compliance with these geotechnical/geologic requirements. These common practice requirements and related City inspection and verification procedures prior to project occupancy provide reasonable assurance that a project would incorporate the design and engineering refinements necessary to reduce the impact to a less-than-significant level by either avoiding identified soil and geologic impact areas altogether (i.e., basic project design changes), or by rectifying the impact through conventional engineering and construction procedures (e.g., backfilling) identified throughout the post-EIR investigation and monitoring process.

9.3.3 Impacts and Mitigation Measures

The 1999 ENGEO preliminary geotechnical exploration report (May 19, 1999) and subsequent ENGEO reports (see the footnotes throughout this EIR chapter) contain recommendations for addressing the geotechnical conditions on the project site. However, the 1999 report (page 18) cautions, "Since this study is preliminary, the recommendations included in this report are preliminary in nature and are intended to provide a general example of the typical site development requirements that will be established. These are suitable for project planning purposes. As such, the recommendations should be refined and modified, as deemed appropriate by the geotechnical engineer during project development and preparation of the final...grading plans. During that time, [the geotechnical engineer] may need to perform additional field investigations, settlement analysis, [and] slope stability evaluation, and modify the recommendations contained herein to address the site-specific development plans." The subsequent ENGEO reports include similar disclaimers. Therefore, the ENGEO recommendations noted after the mitigation boxes in this section are intended as typical examples of mitigation for potential geotechnical impacts, not as definitive solutions.

Impact 9-1: Ground Shaking. The proposed project would place new residences, businesses, and infrastructure in a subregion that is expected to experience severe earthquake-induced ground shaking during the useful life of project improvements. This ground movement could cause differential settlement of any poorly consolidated soils, induce ground failure within soils that may be prone to liquefaction, and result in other types of seismically-induced ground failure. These possible project responses to anticipated seismic activity represent a ***potentially significant impact*** (see criteria [a], [c], and [d] in subsection 9.3.1, "Significance Criteria," above).

As discussed in subsection 9.1.3 above, the project site may be subject to strong seismic ground shaking and resulting ground failure, which may include liquefaction, lateral spreading, seismically induced landsliding, and differential settlement.

Mitigation 9-1. Consistent with Hercules General Plan *Safety Element* policies 2B and 2D and program 2D.1, the project applicant shall prepare a *detailed, design-level geotechnical investigation* performed by a City-approved licensed engineering geologist or geotechnical engineer. The investigation shall include analysis of project site seismic stability, differential settlement and liquefaction potential, and soil response characteristics with respect to ground acceleration, in accordance with current State requirements. The investigation shall be reviewed by a registered geologist acting on behalf of the City (not by a third-party reviewer retained by the applicant).

The *detailed, design-level geotechnical investigation* shall include the following:

- seismic stability analysis of the existing on-site soil;
- analysis of the potential for excessive total and differential settlements, and detailed results of the ongoing surcharge program and associated monitoring on portions of the project site;
- evaluation of liquefaction potential through the performance of additional cone penetration tests, borings, and/or equivalent methods; and
- determination of site-specific soil response characteristics and maximum credible ground acceleration for an earthquake recurrence interval specified by the City.

Recommendations from the investigation, including appropriate soil stabilization and foundation construction techniques, minimum setbacks around potentially unstable

(continued)

Mitigation 9-1 (continued):

areas, and criteria for the compaction and treatment of on-site fills, shall be incorporated into the final project grading and foundation plans. In general, these recommendations are expected to include the following requirements:

- that all construction comply with the most current edition of the International Building Code;
- that all project structural designs be based on proper estimates by the project geotechnical engineer of peak and maximum repeatable earthquake-induced ground surface accelerations expected to occur on the project site; and
- that excavations be adequately sloped or shored in order to minimize ground movements.

Implementation of these measures to the satisfaction of the City, combined with conformance with standard International Building Code, State of California, City of Hercules, and other applicable regulations, would reduce the potential effects of ground shaking on the project to a ***less-than-significant level***.

For potential ground shaking impacts, the 1999 ENGEO report recommends, at a minimum, application of the International Building Code in coordination with "sound engineering judgment."

Impact 9-2: Landslide, Slope Stability, and Erosion Hazards. The project would allow development in areas that may be subject to substantial landslide, slope stability, and erosion hazards, representing a ***potentially significant impact*** (see criteria [a] through [c] in subsection 9.3.1, "Significance Criteria," above).

As discussed in subsection 9.1.4 above, slopes may be unstable on portions of the project site, including an area along the south-central border of the project site where a landslide was previously identified. Throughout the project site, grading that disrupts, compacts, or overcovers existing soil may cause erosion. In addition, construction of building pads and anticipated development of the Bay Trail segment and associated retaining wall (a shared facility with the ITC project) along the railroad right-of-way could result in unstable slope conditions.

Mitigation 9-2. The *detailed, design-level geotechnical investigation* required by the City under *Mitigation 9-1* herein shall include analysis of landslide, slope stability, and erosion hazards and recommend stabilization measures. The City shall also require preparation of a Preliminary Grading Plan and/or Preliminary Geotechnical Report, prepared by a licensed geotechnical engineer, before approval of project grading permits. The project geotechnical engineer shall determine the extent of any necessary landslide and slope stability remediation and shall direct remediation activities during project construction to ensure that any existing or potential future landslides and unstable slopes are fully stabilized. Mitigation measures (e.g., soil replacement, setbacks, and/or retaining walls, including the Bay Trail retaining wall shared with the ITC project), shall be required if needed to protect against damage that might be caused by slope failure. Such mitigation measures shall comply with the applicable provisions of Hercules General Plan *Safety Element* programs 2D.1 and 2D.2. The investigation shall be reviewed by a registered geologist acting on behalf of the City (not by a third-party reviewer retained by the applicant).

In addition, if the Hercules Bayfront Project proceeds before the ITC project, the project applicant shall ensure that the design of the Bay Trail and its associated retaining wall shall remediate any slope stability hazards identified in the detailed, design-level geotechnical investigation, through a combination of slope reduction, slope protection, and other geotechnical measures (e.g., retaining wall design, cut slopes) to the satisfaction of the City Engineer.

Implementation of these measures to the satisfaction of the City, combined with conformance with standard International Building Code, State of California, City of Hercules, and other applicable regulations, would reduce the potential effects of landsliding and soil erosion on the project to a ***less-than-significant level***.

For potential landslide and erosion hazards, the 1999 ENGEO report recommends that portions of landslides and colluvium not removed in design cuts along slopes should be completely removed and replaced with properly drained engineered fill. The report notes that slope instability can generally be mitigated by proper grading. Please refer to chapter 11, Hydrology and Water Quality, for additional mitigation measures that address soil erosion impacts.

Impact 9-3: Expansive Soil Hazards. The project would allow development in areas that may be subject to substantial hazards from expansive soils, representing a ***potentially significant impact*** (see criterion [d] in subsection 9.3.1, "Significance Criteria," above).

As discussed in subsection 9.1.5 above, the project site is located in an area that has moderately to highly expansive soil (residual soils, colluvium, and landslide debris) that may undergo significant volume changes (swell and compression) when subjected to varying moisture contents.

Mitigation 9-3. The *detailed, design-level geotechnical investigation* required at City discretion under *Mitigation 9-1* shall include analysis of expansive soil hazards and recommend stabilization measures as appropriate. Once grading plans have been developed, the actual use of expansive soils in engineered fill construction shall be further evaluated and the location of primary borrow source areas for fills shall be determined. Additionally, supplemental field and laboratory testing of potential cut materials shall be completed. In addition to observing all cut and fill slope construction, the project geotechnical engineer shall inspect and certify that any expansive soils underlying individual building pads and all roadway subgrades have been either removed or amended in accordance with City-approved construction specifications. If expansive soils are not fully remediated on each lot and in the area of all public and private improvements at the time of site development, the project geotechnical engineer shall make site-specific recommendations for grading, drainage installation, foundation design, the addition of soil amendments, and/or the use of imported, non-expansive fill materials, as may be required to fully mitigate the effects of weak or expansive soils and prevent future damage to project improvements. In addition, since proper drainage, in particular, can improve the performance of expansive soils by significantly reducing their tendency to shrink and swell, deed restrictions shall be imposed to prohibit significant modification of finished lot grades that would adversely affect site drainage.

The recommendations and restrictions identified above shall be reviewed by a City-retained registered geologist and, following his or her approval, be incorporated into a report to be included with each building permit application and with the plans for all public and common area improvements.

Implementation of these measures to the satisfaction of the City, combined with conformance with standard International Building Code, State of California, City of Hercules, and other applicable regulations, would reduce the potential effects of expansive soils to a ***less-than-significant level***.

For potential expansive soil hazards, the 1999 ENGEO report recommends that the soft, compressible portions of these soil deposits be over-excavated, completely removed, and replaced with engineered fill.

Impact 9-4: Groundwater Impacts. Mass grading, construction of cuts and fills, redirection of existing drainage patterns, and installation of landscaping irrigation as part of development allowed by the project, could affect existing patterns of groundwater flow in the area, resulting in slope instabilities that would represent a ***potentially significant impact*** (see criterion [c] in subsection 9.3.1, "Significance Criteria," above).

Unidentified seeps and streams that are buried under fills or exposed in cuts during dry-season construction could surcharge fills, weaken slopes, and oversaturate utility trenches when they reappear during the rainy season. In addition, future overwatering within landscape areas and the redirection of surface runoff onto otherwise stable slopes could cause similar concentrations of groundwater.

Mitigation 9-4. The *detailed, design-level geotechnical investigation* required at City discretion under *Mitigation 9-1* shall include analysis of the effects of grading plans on groundwater flow and recommend any necessary additional slope stabilization measures. Educational materials that discourage overwatering in landscaped areas shall be furnished to all future lot owners and property managers at the time of purchase and periodically thereafter (perhaps by inclusion with water or tax bills), as part of an effort to control groundwater seepage. On-site drainage systems shall be regularly maintained to ensure that storm water runoff is directed away from all slope areas. Implementation of these measures to the satisfaction of the City would reduce this potential effect to a ***less-than-significant level***.

For potential groundwater impacts, the 1999 ENGEO report recommends a temporary dewatering program during trenching and excavation activities.

Cumulative Geology and Soils Impacts. In addition to the project, other development unrelated to the project would continue to occur elsewhere in the city, county, and subregion. Geotechnical impacts related to future development would involve similar hazards associated with site-specific soil conditions, erosion, and ground shaking during earthquakes. The impacts on each site would be specific to that site and its users, and would not be common to or contribute to (or shared with, in an additive sense) the impacts on other sites. In addition, development on each site would be subject to uniform site development and construction standards that are designed to protect public safety. Therefore, cumulative geology and soils impacts would be ***less-than-significant***, and no mitigation measures are required.

Mitigation. No significant cumulative geology or soils impact has been identified; no mitigation is required.