5.5 GEOLOGY AND SOILS

This section of the DEIR evaluates the potential for implementation of the Solana Residential Development Project to impact geological and soil resources in the City of Torrance. The analysis in this section is based in part on the following technical report(s):

- *Preliminary Geotechnical Investigation, Proposed Multi-Family Residential Development, Hawthorne Boulevard and Via Valmonte, Torrance, California.* Geocon West, Inc., June 30, 2017.
- *Fault Rupture Hazard Investigation, Proposed Multi-Family Residential Development, Hawthorne Boulevard and Via Valmonte, Torrance, California.* Geocon West, Inc., January 21, 2016.
- *Suggested Contingency Facto for Estimation of Soil Excavation Quantity during Grading Proposed Multi-Family Residential Development Vesting Tentative Tract Map 74148, Lot 1 Hawthorne Boulevard and Via Valmonte Torrance, California.*
- *Paleontological Resources Assessment for the Solana Project, City of Torrance, Los Angeles County, California.* Paleo Solutions, October 5, 2018.

Complete copies of these studies are included in the Technical Appendices to this DEIR (Appendices E1, E2, and E3).

Twenty-eight comments relating to geology and geologic hazards were received in response to the Initial Study (IS)/Notice of Preparation (NOP) circulated for the proposed project, primarily regarding the potential impacts relating to development within the former diatomaceous earth mine, slope stability and soil stability. This Section focuses on the following impacts: landslides, collapsible soils, expansive soils, and paleontological resources. Impacts arising from liquefaction were identified as less than significant in the Initial Study included as Appendix A to this DEIR; but are analyzed in this Section due to relevant findings of the project geotechnical investigation. Soil erosion is analyzed in this DEIR in Section 5.8, Hydrology and Water Quality. Impacts related to rupture of earthquake fault, seismic ground shaking, and usage of septic tanks were determined to be less than significant in the Initial Study included as Appendix A to this DEIR. Existing conditions respecting faulting and earthquakes are summarized below in reference to earthquake-induced landslide impacts.

5.5.1 Environmental Setting

5.5.1.1 REGULATORY SETTING

State

California Alquist-Priolo Earthquake Fault Zoning Act

The Alquist-Priolo Earthquake Fault Zoning Act requires the state geologist to delineate earthquake fault zones along faults that are "sufficiently active" and "well defined." The act requires that cities and counties withhold development permits for a site in an earthquake fault zone until geologic investigations demonstrate that the site is not threatened by surface displacements from future faulting. An active fault is one that has had surface displacement within Holocene Time (the last 11,000 years).Pursuant to this act, structures for human occupancy are not allowed within 50 feet of the trace of an active fault.

Seismic Hazard Mapping Act

The Seismic Hazard Mapping Act (SHMA) was adopted by the state in 1990 to protect the public from the effects of nonsurface fault rupture earthquake hazards, including strong ground shaking, liquefaction, seismically induced landslides, or other ground failure caused by earthquakes. The goal of the act is to minimize loss of life and property by identifying and mitigating seismic hazards. The California Geological Survey prepares seismic hazard zone maps and provides them to local governments; these maps identify areas susceptible to amplified shaking, liquefaction, earthquake-induced landslides, and other ground failures. SHMA requires responsible agencies to only approve projects within seismic hazard zones following a site-specific investigation to determine if the hazard is present, and if so, the inclusion of appropriate mitigation(s). In addition, the SHMA requires real estate sellers and agents at the time of sale to disclose whether a property is within one of the designated seismic hazard zones.

2016 California Building Code

Current law states that every local agency enforcing building regulations, such as cities and counties, must adopt the provisions of the California Building Code (CBC) within 180 days of its publication. The publication date of the CBC is established by the California Building Standards Commission, and the code is updated every three years. It is in Title 24, Part 2, of the California Code of Regulations. The most recent building standard adopted by the legislature and used throughout the state is the 2016 CBC, which took effect on January 1, 2017. Local jurisdictions may add amendments based on local geographic, topographic, or climatic conditions. These codes provide minimum standards to protect property and people by regulating the design and construction of excavations, foundations, building frames, retaining walls, and other building elements to mitigate the effects of seismic shaking and adverse soil conditions. The CBC's provisions for earthquake safety are based on factors such as occupancy type, the types of soil and rock onsite, and the strength of ground motion with a specified probability of occurring at the site. Provisions governing grading are set forth in CBC Appendix D, *Grading*.

California Building Code Section 1802 (Requirements for Geotechnical Investigations)

Requirements for geotechnical investigations for subdivisions requiring tentative and final maps and for other types of structures are in California Health and Safety Code, Sections 17953 to 17955, and in Section 1802 of the CBC. Testing of samples from subsurface investigations is required, such as from borings or test pits. Studies must be done as needed to evaluate slope stability, soil strength, position and adequacy of load-bearing soils, the effect of moisture variation on load-bearing capacity, compressibility, liquefaction, differential settlement, and expansiveness.

City of Torrance

The City of Torrance adopted the 2016 CBC, with local amendments, as Division 8, Chapter 1 of the City's Municipal Code. The City of Torrance's General Plan Safety Element identified requirements for new development to abide by the most recently adopted City and State seismic and geotechnical requirements to protect injury and structural damage due to geologic and seismic hazards. The City established a fault hazard management zone around the traces of the Palos Verdes fault that are considered more recently active. The intention of the fault hazard management zone is to require that geologic investigations, which may include

fault trenching, be performed if conventional structures designed for human occupancy are proposed within the zone (Torrance 2010).

5.5.1.2 EXISTING CONDITIONS

Regional Geologic Setting

The project site is on the northern slopes of the Palos Verdes Hills, the westernmost onshore uplifted area of the Peninsular Ranges Geomorphic Province, a series of mountain ranges separated by northwest-trending valleys. The Palos Verdes Hills are on the southern margin of the Los Angeles Basin, a coastal plain.

Faulting and Seismicity

The Palos Verdes Fault passes approximately 350 feet north of the project site (see Figure 5.5-1, *Local Fault Map*). The segment of the Palos Verdes Fault near the project site is not considered active by the California Geological Survey; as faults that have not moved in 11,000 years are not considered active.

Minor shearing onsite due to either folding of the Palos Verdes Hills or past earthquakes in the region was observed in the San Pedro Sand. The shears are not considered active faults; however, the shears could be subject to displacement during future earthquakes.

Other active faults in the region include the Cabrillo Fault, approximately 1.9 miles to the south, and the Newport-Inglewood Fault approximately 7.5 miles to the northeast (see Figure 5.5-2, *Regional Fault Map*). The Compton Thrust—a fault several miles underground that is not exposed at the surface—underlies most of the City of Torrance including the project site. Several other thrust faults (underground and not expressed at the surface) underlie the Los Angeles Basin.

The project site is not in an Alquist-Priolo Earthquake Fault Zone; however, the site is in a City of Torrance Fault Hazard Management Zone and a site-specific investigation is required to assess the potential for surface fault rupture hazards that may impact the proposed development.

The CBC contains provisions for earthquake safety based on factors including occupancy type, the types of soil and rock onsite, and the strength of ground motion with a specified probability of occurring at the site. The peak ground acceleration onsite with a 2 percent chance of exceedance in 50 years—that is, an average return period of 2,475 years—is 0.72g, where g is the acceleration of gravity. Seismic design parameters pursuant to California Building Code requirements are provided in the geotechnical investigation report (Geocon West 2017).

Project Site

Topography

The southwest part of the site ranges in elevation from approximately 460 feet above mean sea level (amsl) down to approximately 330 feet amsl at the southeast corner of the site. A steep slope remaining from the mining operations, up to 250 feet high, extends across the site generally east west from the southeast corner of the site to the northwest corner. The 5.71acre development area, mostly in the northeast quadrant of the site,

consists of two pads—one approximately 190 to 220 feet amsl and the other approximately 235 to 245 feet amsl. The southeast quadrant of the site gradually slopes eastward toward Hawthorne Boulevard. The northernmost part of the site slopes upward toward single-family homes offsite south of Via Valmonte; that slope is also a mining remnant. Elevations on the northwest site boundary range up to approximately 340 feet amsl (see Figure 4-1, *Topographic Map*).

Geologic Units

Subsurface exploration of the site included 35 borings to depths of up to 120.5 feet below ground surface (bgs).

The site is underlain by the following geologic units mapped on Figure 5.5-3, *Geologic Map*.

Artificial Fill

Artificial fill was encountered to depths between 2 and 80 feet bgs. On the lower pad, the fill is shallowest near the base of the adjacent slopes and increases in thickness towards the central area of the site. On the slopes bounding the proposed development on the northwest (Slope 1) and east-northeast (Slope 2), the fill is approximately 2 to 5.5 feet thick. The artificial fill generally consists of light to dark brown and yellowish-brown sand, silty sand, and clayey sand, with lesser amounts of gravelly sand, sandy silt and clay. The fill contains localized concentrations of concrete, brick, and rock fragments (up to 22 inches in longest dimension) with localized pockets of debris such as wire, PVC pipe, plastic and metal debris. The artificial fill is characterized as slightly moist and loose to medium dense. The fill is the result of backfilling the former mining pit, a process that has been on-going without regulatory agency oversite or permits since the 1960s (Geocon West 2017).

Overburden Soil

Overburden soil was encountered within the upper five feet at the top of the north-facing slope (Slope 3). The overburden soil consists primarily of dry, soft light gray sandy silt with varied amounts of gravel and roots.

Marine Sand

Late Pleistocene age marine sand was encountered below the fill soils (on Slope 2) to a maximum depth of 15 feet. The Pleistocene Epoch extends from about 2.59 million years before present (ybp) to about 11,700 ybp (USGS 2017). The marine sand generally consists of light brown to brown and reddish brown, fine to medium-grained sand, silty sand and sandy silt with lenses of coarse-grained sand and rounded gravel; and is generally massive to horizontally bedded. The marine sand is characterized as dry to slightly moist and loose to dense or firm to hard.

San Pedro Sand

The late Pleistocene age San Pedro Sand underlies the fill on Slope 1, the marine sand on Slope 2, and the proposed building areas on the existing graded pads. The San Pedro Sand ranges from light gray to yellowish brown, fine- to coarse-grained sand that is generally massive to well-bedded, moderately cemented to friable (uncemented) with local gravel-rich beds and some rounded cobbles. The San Pedro Sand is generally massive but locally shows crudely stratified sand beds. The sand is characterized as slightly moist and medium dense to very dense.

Lomita Marl

The mid-Pleistocene age Lomita Marl underlies the San Pedro Sand and is locally exposed on the north-facing slope (Slope 3) along the southern project boundary. The Lomita Marl was not encountered in explorations at the site. However, the Lomita Marl is generally fossiliferous fine-grained sandstone and siltstone that is massive to poorly bedded.

Monterey Formation Bedrock

Sedimentary bedrock of the Valmonte Diatomite member of the Miocene age Monterey Formation was encountered in borings near the southwest site boundary and is exposed on the north-facing slope (Slope 3) along the southern site boundary. The Miocene Epoch extends from approximately 23 million ybp (mybp) to 5.3 mybp (USGS 2010). The Valmonte Diatomite consists of interbedded white diatomaceous siltstone sandstone and brown to yellow brown clayey siltstone. As exposed on Slope 3, the bedrock is predominantly diatomaceous siltstone and sandstone with localized lenses of well-cemented siliceous siltstone, fossiliferous sandstone, and cherty sandstone. The bedrock is thinly bedded with well-developed bedding and ranges from very soft (diatomaceous siltstone and sandstone beds) to medium hard (cherty and siliceous beds). The diatomaceous-rich portion of this formation is reported to be highly porous with low permeability, highly expansive, has poor slope stability, and is not suitable for fill material.

Cross Sections

Two cross sections of subsurface geologic units - one in the west part of the development area (A to A'), and the second in the east part of the development area (B to B') are shown on Figure 5.5-4, *Cross Sections*).

Geologic Hazards

Slope Stability and Landslides

There are no known deep-seated landslides near the site, nor is the site in the path of any known or potential landslides. However, there is a steep north-facing slope (Slope 3) along the southern site boundary. This slope exposes well-bedded diatomaceous siltstone and sandstone of the Valmonte Member of the Monterey Formation and locally some massive to weakly bedded sandstone and siltstone of Pleistocene age Lomita Marl. The slope is in a zone of required investigation for earthquake-induced landslides mapped by the California Geological Survey.

Slopes 1 and 2 (North and Northeast of Lot 1, respectively)

Slopes 1 and 2 range in height from 40 to 80 feet and are inclined at gradients ranging from 1¼:1 to 2:1 (horizontal to vertical). These slopes are underlain by San Pedro Sand and marine sand that are generally homogeneous formations and not considered bedded for the purposes of slope stability evaluation. Stability analyses were conducted for Slope 1 at two locations: cross-section C-C' near the west end of the development area; and cross-section D-D' just east of the midpoint of the slope. Slope 2 would be removed during project development and thus was not analyzed for slope stability.

Slope 3 (South of Lot 1)

Slope 3 ranges from 200 to 250 feet in height. This former quarry slope has been generally graded to a uniform inclination ranging from 48 to 50 degrees (locally up to 60 degrees) and exposes Miocene age sedimentary bedrock of the Monterey Formation. A 50-degree slope is a grade of about 0.84 (horizontal to vertical). The Monterey Formation bedrock is highly fractured and is generally angled in a consistent manner downward to the north. This bedding orientation is favorable with respect to overall stability, generally being inclined more steeply than the slope inclination. Both these conditions are highly stable with respect to overall stability. Also, the bedrock exposed in Slope 3 is soft, highly fractured, and highly weathered. This condition has resulted in areas of continued sloughing and localized rockfalls and some overhanging areas. Areas of debris accumulation (slough) have been designated on the Geologic Map (Figure 5.5-3).

The Monterey Formation bedrock generally consists of siltstone, diatomaceous siltstone and sandstone, and clayey siltstone which are considered relatively impermeable materials and are non-waterbearing. No groundwater or water seepage was observed within the Monterey Formation bedrock. Furthermore, the sloped portion of the site would be dedicated as open space with no appreciable new source of water that could inundate the hillside and thus contribute to slope instability.

Slope Stability Analyses

Three types of slope stability were analyzed: global static stability (relative to gravity; not subject to other forces such as an earthquake); global seismic stability (termed *global pseudo-static stability* in the Geotechnical Investigation Report); and surficial stability. In accordance with the current standard of practice, as outlined in the "Recommended Procedures for Implementation of DMG Special Publication 117, Guidelines for Analyzing and Mitigating Landslide Hazards in California" and "Special Publication 117A, Guidelines for Evaluating and Mitigating Seismic Hazards in California", factors of safety of 1.5 were used for the static and surficial stability analyses, and 1.0 for the seismic analysis. The methods and findings of the stability analyses are described in more detail in the Geotechnical Investigation Report (see Appendix E1 to this DEIR).

Static Slope Stability

The static slope stability analyses were based on strength parameters for each of the geologic units onsite presented in the Preliminary Geotechnical Investigation Report included as Appendix E1 to this DEIR.

Slope 1

The analyses of global static stability for Slope 1 yielded factors of safety of 1.59 at cross-section C-C' and 1.97 at cross-section D-D'; both factors of safety exceed the required minimum 1.5. Therefore, Slope 1 is considered stable regarding global static stability.

Slope 3

Slope 3 was determined to be stable in terms of global static stability. The methods and findings of the stability analyses are described in more detail in the Geotechnical Investigation Report (see Appendix E1 to this DEIR).

Seismic Slope Stability

The maximum horizontal acceleration used in the seismic stability analysis was 0.48g, where g is the acceleration of gravity. The seismic coefficient – representing lateral forces on slopes and on earth-retaining structures – was 0.24g. The analysis was based on a maximum displacement of five centimeters (two inches) where potential failure planes intersect stiff improvements such as structures.

Slope 1

Slope 1 was found to have factors of safety of 1.09 at cross-section C-C' and 1.33 at cross-section D-D', both greater than the required minimum factor of safety of 1.0. Therefore, Slope 1 is considered stable regarding seismic stability.

Slope 3

The slope stability study determined that Slope 3 is considered stable under gross static and pseudo-static conditions.

Surficial Stability

Surface instability includes debris ("slough") falling, and rockfall.

Slope 1

The factors of safety for surficial stability for Slope 1 were approximately 1.0 at cross-section C-C', and 1.04 at cross-section D-D', each lower than the required minimum factor of safety of 1.5.

Slope 3

The analysis determined that rockfalls could occur on Slope 3. As previously indicated, there is a potential for surficial instability consisting of sloughing and/or rockfall. Localized areas of surficial sloughing were observed during Geocon's geologic mapping of Slope 3 as evidenced by slough accumulation at the toe of the slope.

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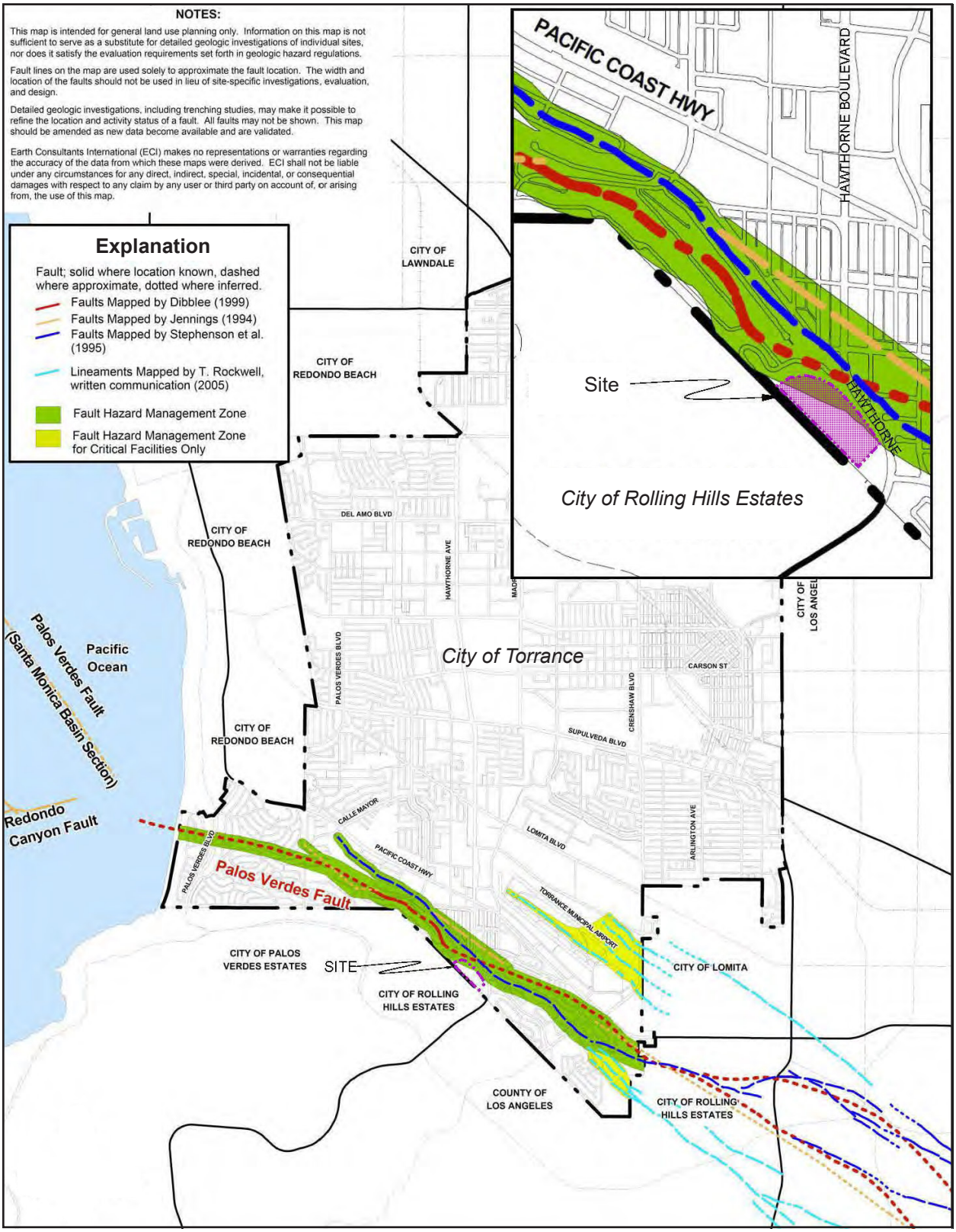
Figure 5.5-1 - Local Fault Map

5. Environmental Analysis



Torrance City Boundary

0 1
Scale (Miles)

Source: Geocon West, Inc., 2016

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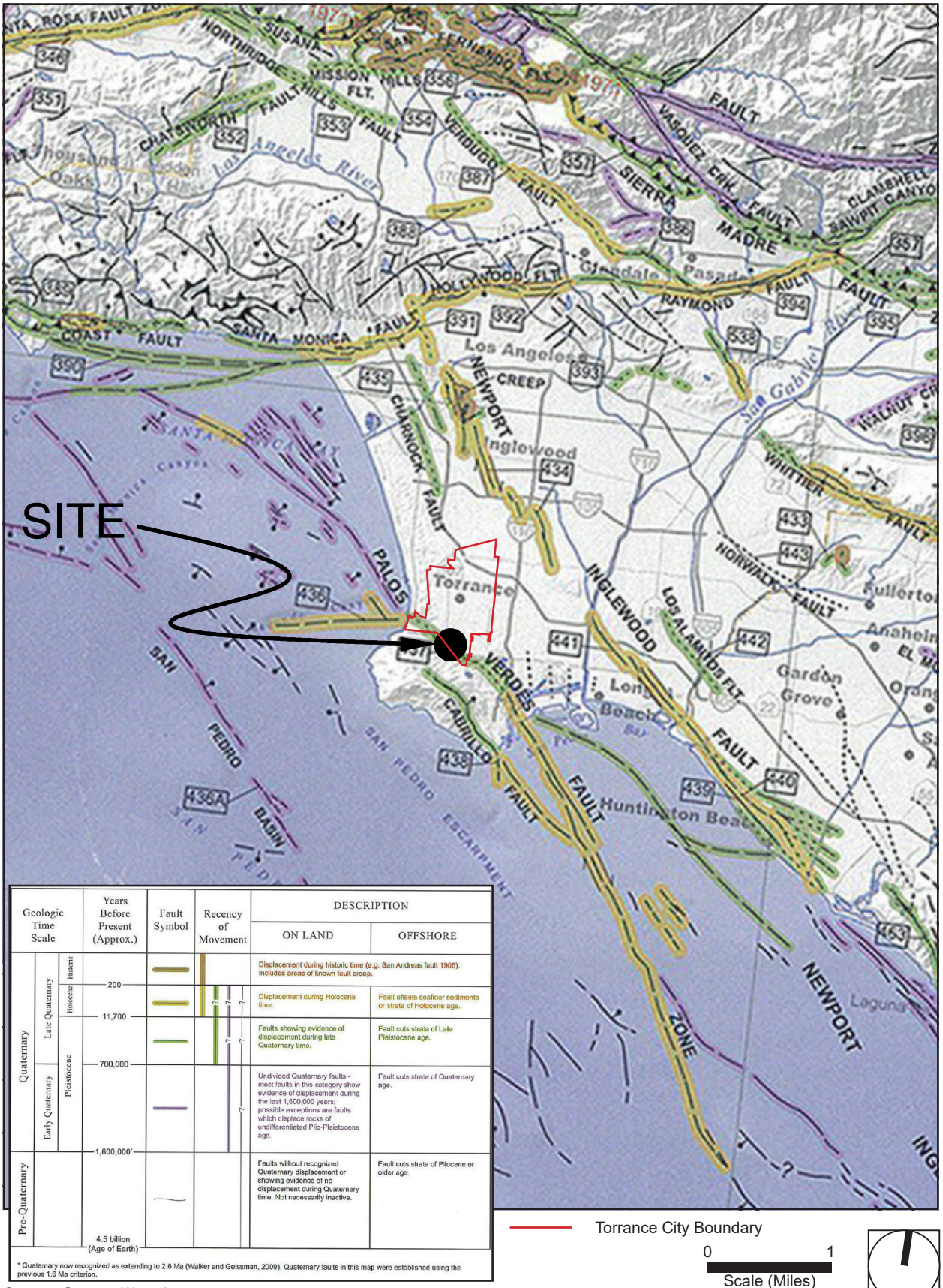
Figure 5.5-2 - Regional Fault Map

5. Environmental Analysis



Geologic Time Scale			Years Before Present (Approx.)	Fault Symbol	Recency of Movement	DESCRIPTION: ON LAND	DESCRIPTION: OFFSHORE
Quaternary	Late Quaternary	Historic				Displacement during historic time (e.g. San Andreas fault 1906). Includes areas of known fault creep.	
		Holocene	200			Displacement during Holocene time.	Fault offsets seafloor sediments or strata of Holocene age.
		Pleistocene	11,700			Faults showing evidence of displacement during late Quaternary time.	Fault cuts strata of Late Pleistocene age.
	Early Quaternary		700,000			Undivided Quaternary faults - most faults in this category show evidence of displacement during the last 1,600,000 years; possible exceptions are faults which displace rocks of undifferentiated Plio-Pleistocene age.	Fault cuts strata of Quaternary age.
Pre-Quaternary			1,600,000*			Faults without recognized Quaternary displacement or showing evidence of no displacement during Quaternary time. Not necessarily inactive.	Fault cuts strata of Pliocene or older age.
			4.5 billion (Age of Earth)				

* Quaternary now recognized as extending to 2.6 Ma (Walker and Geissman, 2009). Quaternary faults in this map were established using the previous 1.6 Ma criterion.

Source: Geocon West, Inc., 2017

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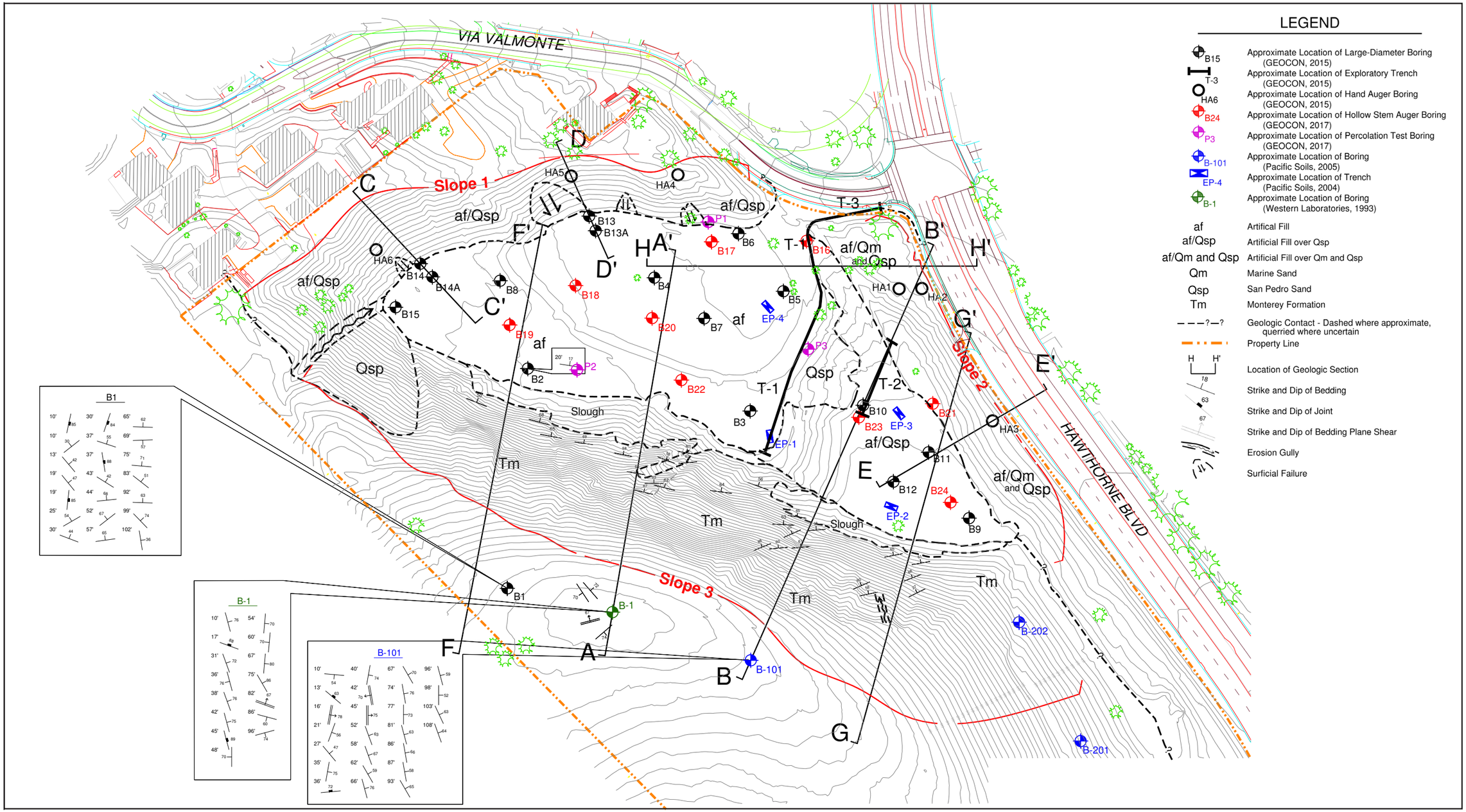
Figure 5.5-3 - Geologic Map
5. Environmental Analysis



Source: Geocon West, Inc., 2017

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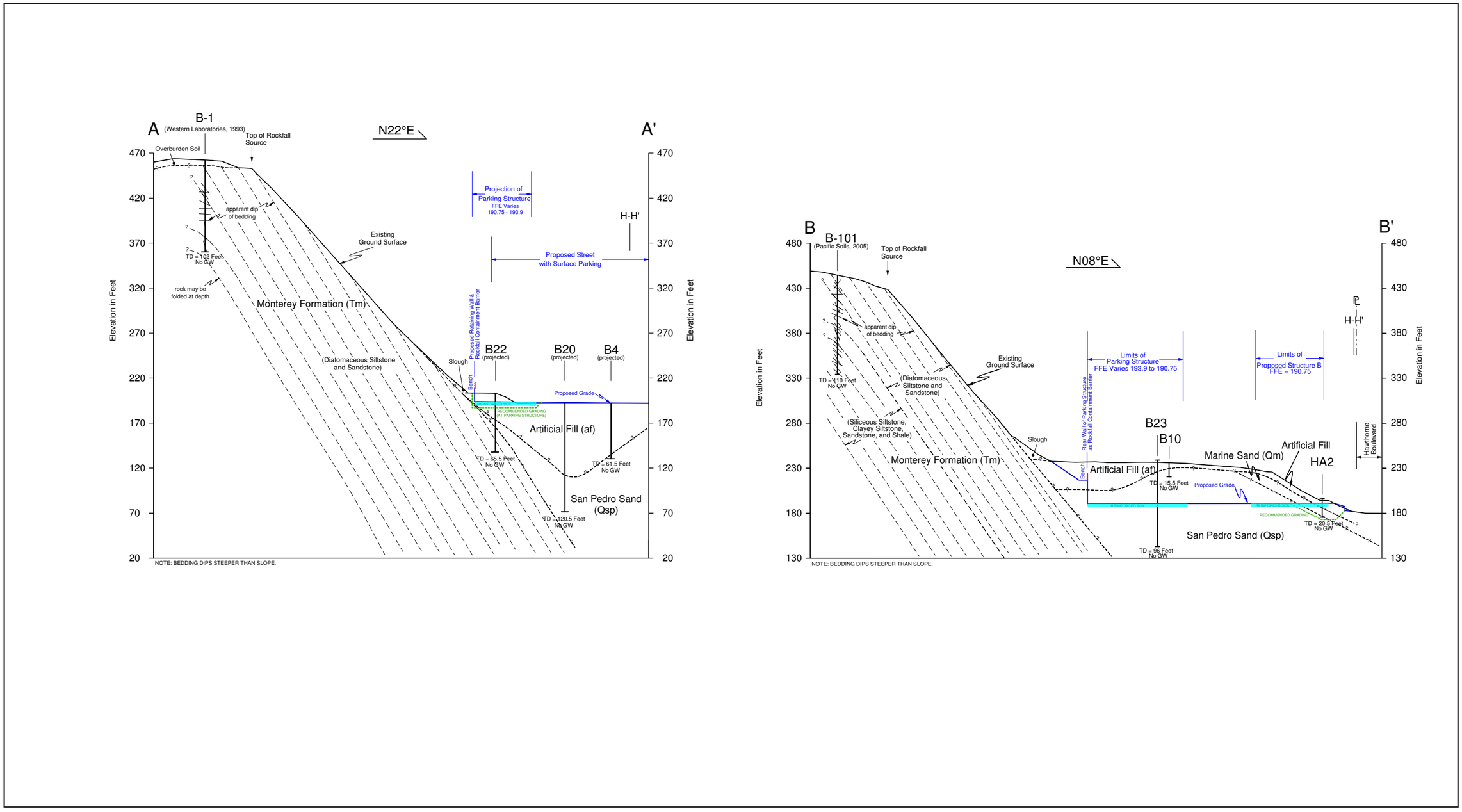
Figure 5.5-4 - Cross_Sections
5. Environmental Analysis



Source: Geocon West, Inc., 2017

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Collapsible Soils

Collapsible soils shrink upon being wetted and/or being subject to a load. Most of the development area is underlain by artificial fill soil used to backfill the former mine pit. The fill soil was found in borings to depths of up to approximately 80feet during the geotechnical investigation and may extend to greater depths. The geotechnical investigation concluded that the fill soil in its existing condition is not suitable for supporting the proposed structures, but is suitable for removal and subsequent reuse as engineered fill.

Expansive Soil

Expansive soils contain substantial amounts of clay that swells when wetted and shrinks when dried; the swelling or shrinking can shift, crack, or break structures built on such soils. The underlying bedrock at the project site is predominantly diatomaceous siltstone and sandstone with localized lenses of siliceous siltstone, fossiliferous sandstone, and cherty sandstone. The bedrock is thinly bedded with well-developed bedding and ranges from very soft (diatomaceous siltstone and sandstone beds) to medium hard (cherty and siliceous beds). The upper few feet of site soils are considered expansive.

Paleontological Resources

The Paleontological Resources Assessment for the project site consisted of a review of technical reports for the project; a paleontological records search by the Natural History Museum of Los Angeles County; a review of online fossil databases; and a reconnaissance field survey.

Diatomaceous siltstone and sandstone, components of the Monterey Formation, is exposed on Slope 3 and was found in borings near the southwest site boundary. Diatomaceous rock contains remains of diatoms, that is, unicellular algae.

Paleontological Records Search Results

One fossil locality has been recorded from within the bounds of the Project area. Fossil locality LACM 4319 was recorded from sediments of the terrestrial Palos Verdes Sand and interfingering marine San Pedro Sand and yielded specimens of fossil camel (Camelidae) associated with great white shark (*Carcharodon* sp.) and requiem shark (*Carcharhinus* sp.).

On the southern slope of the southern ridge within and immediately south of the Project area, fossil locality LACM 5084 yielded specimens of bonito shark (*Isurus* sp.) from either a marine bed of the Palos Verdes Sand or the San Pedro Sand. Additionally, immediately north of the western-most portion of the Project area, fossil locality LACM 4424 yielded a fossil specimen of sanddab fish (*Citharichthys* sp.) from the Palos Verdes Sand and/or San Pedro Sand, and further southeast of the Project area, south of Winlock Road, fossil locality LACM 3265 yielded fossil specimens of mastodon (*Mammut* sp.) and whale (Cetacea) from the Palos Verdes Sand and/or San Pedro Sand.

Online Database Search Results

Within one mile of the Project site, fossil localities in the San Pedro Sand have yielded northern kelp crab (*Pugettia producta*), school shark (*Galeorhinus* sp.), gray whale (*Eschrichtius robustus*), undetermined whale (Cetacea), and ground sloth (*Nothrotherium shastensis*). Within 10 miles of the project site, fossil localities in older alluvium or Palos Verdes Sand have yielded coral (*Caryophyllia californica*), gastropod (*Acanthina* sp.), crab (*Pyromaia tuberculata*), fish (*Alisea grandis*, Osteichthyes), seal (*Mirounga angustirostris* and Pinnipedia), sea lion (*Eumetopias* sp.), dolphin (Delphinidae), whale (Cetacea), tapir (*Tapirus* [*Helicotapirus*] *haysii*), mammoth (*Mammuthus primigenius*), as well as numerous other invertebrate and vertebrate fossil taxa. Fossils discovered in those formations, as well as in the Monterey Formation, farther from the project site are described in the Paleontological Resources Assessment.

Field Survey Results

Shell fragments and intact bivalve and gastropod (snail) fossils were found in the Monterey Formation and San Pedro Sand. Bivalves are marine mollusks with shells consisting of two hinged parts, such as clams. No significant fossil localities or nonsignificant fossil occurrences were recorded.

Potential to Contain Fossils

The Monterey Formation is considered to have very high potential (PFYC 5) to contain fossils; the San Pedro Sand, older alluvium, and Palos Verdes Sand are all considered to have high potential (PFYC 4)to contain fossils.[1]

5.5.2 Thresholds of Significance

Note that the following thresholds have been revised per the CEQA Guidelines Update approved by the California Office of Administrative Law on December 28, 2018. The revisions include relocating former Threshold C-3 respecting paleontological resources and unique geologic features from the Cultural Resources Section to the Geology and Soils Section as Threshold G-6.

According to Appendix G of the CEQA Guidelines, a project would normally have a significant effect on the environment if the project would:

G-1 Directly or indirectly cause 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.)

[1] Based on the results of an assessment of existing data and the field reconnaissance, the paleontological potential of the geologic units underlying the Project area were assessed with the Bureau of Land Management (BLM) Potential Fossil Yield Classification (PFYC) system (BLM, 2008; 2016). The scale for potential to contain fossils used here is a six-point scale ranging from very low potential (1) to very high potential (5), and where 6 designates unknown potential.

ii) Strong seismic ground shaking.

iii) Seismic-related ground failure, including liquefaction.

iv) Landslides.

G-2 Result in substantial soil erosion or the loss of topsoil.

G-3 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.

G-4 Be located on expansive soil, as defined in Table 18-1B of the Uniform building Code (1994), creating substantial direct or indirect risks to life or property.

G-5 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.

G-6 Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature

The Initial Study, included as Appendix A, substantiates that impacts associated with the following thresholds would be less than significant:

- Thresholds G-1.i, G1.ii, G-3 (liquefaction, lateral spreading, and subsidence), and G-5.

These impacts will not be addressed in the following analysis. Threshold G-2, soil erosion and loss of topsoil, is addressed in Section 5.8, *Hydrology and Water Quality*, of this DEIR and is not addressed here.

5.5.3 Environmental Impacts

The following impact analysis addresses thresholds of significance for which the Initial Study disclosed potentially significant impacts. The applicable thresholds are identified in brackets after the impact statement.

Impact 5.5-1: Implementation of the Proposed Project could subject residents, visitors and off-site residential uses to landslide hazards. [Threshold G-1.iv]

Impact Analysis:

Slope Stability

There are no known deep-seated landslides near the site, nor is the site in the path of any known or potential landslides. However, a steep north-facing slope (Slope 3) exists along the southern site boundary. This slope exposes well-bedded diatomaceous siltstone and sandstone of the Valmonte Member of the Monterey Formation and locally some massive to weakly bedded calcareous-rich sandstone and siltstone of Pleistocene age Lomita Marl. A review of the State of California Seismic Hazard Zone Map for the Torrance Quadrangle (CDMG, 1999) indicates this slope may have a potential for earthquake-induced landslides. It should be noted that the proposed project would retain Slope 3 in its existing open space state, and no new development would

occur on Slope 3. Surficial stability of slopes 1 and 3 was determined to be lower than the required factor of safety; slope stability analyses are summarized further in Section 5.5.1.2, Existing Conditions, above and are explained further in the Geotechnical Investigation Report (see Appendix E1 to this DEIR).

Four measures for reducing hazards from slope instability to people and structures onsite are recommended in the Geotechnical Investigation Report: setbacks from slopes; rockfall setbacks; retaining walls; and rockfall barriers.

California Building Code Required Setback

The California Building Code (CBC) requires that foundations be sufficiently set back from an ascending or descending slope. The required setback from an ascending slope is 1/2 the height of the ascending slope with a maximum of 15 feet measured horizontally from the exterior face of the structure to the toe of the slope. Where a retaining wall is used, the setback is measured from a projected toe of slope. In lieu of relocating a structure to achieve the setback at the ground surface, foundations may be deepened as necessary to achieve the required setback.

The CBC setback from the development area property line along the south side of the development area next to Slope 3 ranges from approximately 66 feet wide near the west end of Building A to approximately 70 feet wide near the east end of Building A, and from approximately 58 feet wide near the west end of Building C to approximately 32 feet wide near the east end of Building C. The CBC setback along the north side of the development area next to Slope 1 is approximately 24 feet wide near the west end of Building A and approximately 14 feet near the east end of building A (see Figure 3-6, *Site Plan*). Based on the current development plans, the Building Code setbacks will be satisfied for Buildings A, B, and C.

Rockfall Setback

A rockfall setback of 40 horizontal feet, combined with a rockfall catchment area or containment barrier, would be developed along the south side of the development area next to Slope 3. The rockfall setback is narrower than the CBC setback along the south side of Building A; the two setbacks are nearly the same width along the south side of Building C (see Figure 3-6, *Site Plan*). A horizontal setback of 40 feet, when combined with a rockfall catchment area or containment barrier (described below), will be sufficient to retain all potential rockfall.

Retaining Walls/Rockfall Barriers

The site plan includes retaining walls that would extend 11 to 47 feet above grade on the upslope-facing side of the walls. There would be a 7-foot high rockfall barrier wall constructed to the tops of the proposed retaining walls at the base of Slope 3 to mitigate rockfall hazards functioning as a rockfall barrier to stop rolling rocks. Retaining walls would be stabilized with soil nails, that is, metal bars inserted into drilled holes in the slope and then grouted into place.

The part of the rockfall setback upslope from the retaining wall/rockfall barrier would be graded to create a 2.5-foot-wide concrete ditch next to the wall, followed by a nearly level area ("bench") approximately 10 feet

wide to permit access to remove slough. The remaining upslope width of the rockfall setback would be graded to a slope of no more than 2:1 (horizontal: vertical).

The Building Code requires that foundations be sufficiently setback from an ascending or descending slope. The required setback from a descending slope with a steeper than 3:1 and gentler than 1:1 is ⅓ the height of the descending slope with a minimum of 5 feet and a maximum of forty feet measured horizontally from the exterior face of the foundation to the slope face. Where the slope is steeper than 1:1, the slope setback shall be measured from an imaginary line projected at 45 degrees from the toe of the slope upwards. In lieu of relocating a structure to achieve the setback at the ground surface, foundations may be deepened as necessary to achieve the required setback. Based on the latest set of development plans, the Building Code setbacks will be satisfied for Buildings A, B, and C. Retaining Walls and Rockfall Setbacks at Base of Slope 3 (South of Development Area)

South of Building C

The retaining wall/rockfall barrier south of Building C would be approximately 50 feet high total, with the retaining wall extending 47 feet above the finished grade facing the apartment building, and the rockfall barrier extending seven feet above the proposed grade facing the hillside. The retaining wall/barrier would be set back about 11 feet from the exterior wall of the first floor of the building containing a parking garage (see Figure 5.5-5, *Retaining Wall and Rockfall Barrier on Slope 3/Building C*).

Parking Structure (Building D)

On the south side of the parking structure (Building D) the exterior wall of the parking structure would function as both retaining wall and rockfall barrier, and no separate wall or barrier would be built. The hillside slope next to the parking structure wall would be graded as described above (see Figure 5.5-6, *Slope 3/Exterior Parking Structure Wall*).

South of Building A

The retaining wall/rockfall barrier would be about 15.2 feet high, about 13.7 feet of which would be above the finished grade facing the apartment building; and would be set back about 47 feet from the south wall of the Building A (see Figure 5.5-7, *Retaining Wall and Rockfall Barrier on Slope 3/Building A*).

Retaining Walls and Rockfall Setbacks at Base of Slope 1 (North and Northwest of Development Area)

Northwest of Building A

The retaining wall/rockfall barrier would be about 19 feet high – approximately 16 feet of which would be above the finished grade facing the apartment building; and would be set back about 11 feet from the northwest wall of the building (see Figure 5.5-8, *Retaining Wall and Rockfall Barrier on Slope 1/Building A*).

Slope instability hazards would be significant; therefore, a mitigation measure has been provided to reduce such impact to a less than significant level, including the development of setbacks, retaining walls, rockfall barriers, and grading within the rockfall setbacks summarized here and prescribed in further detail in the 2017 Preliminary Geotechnical Investigation report.

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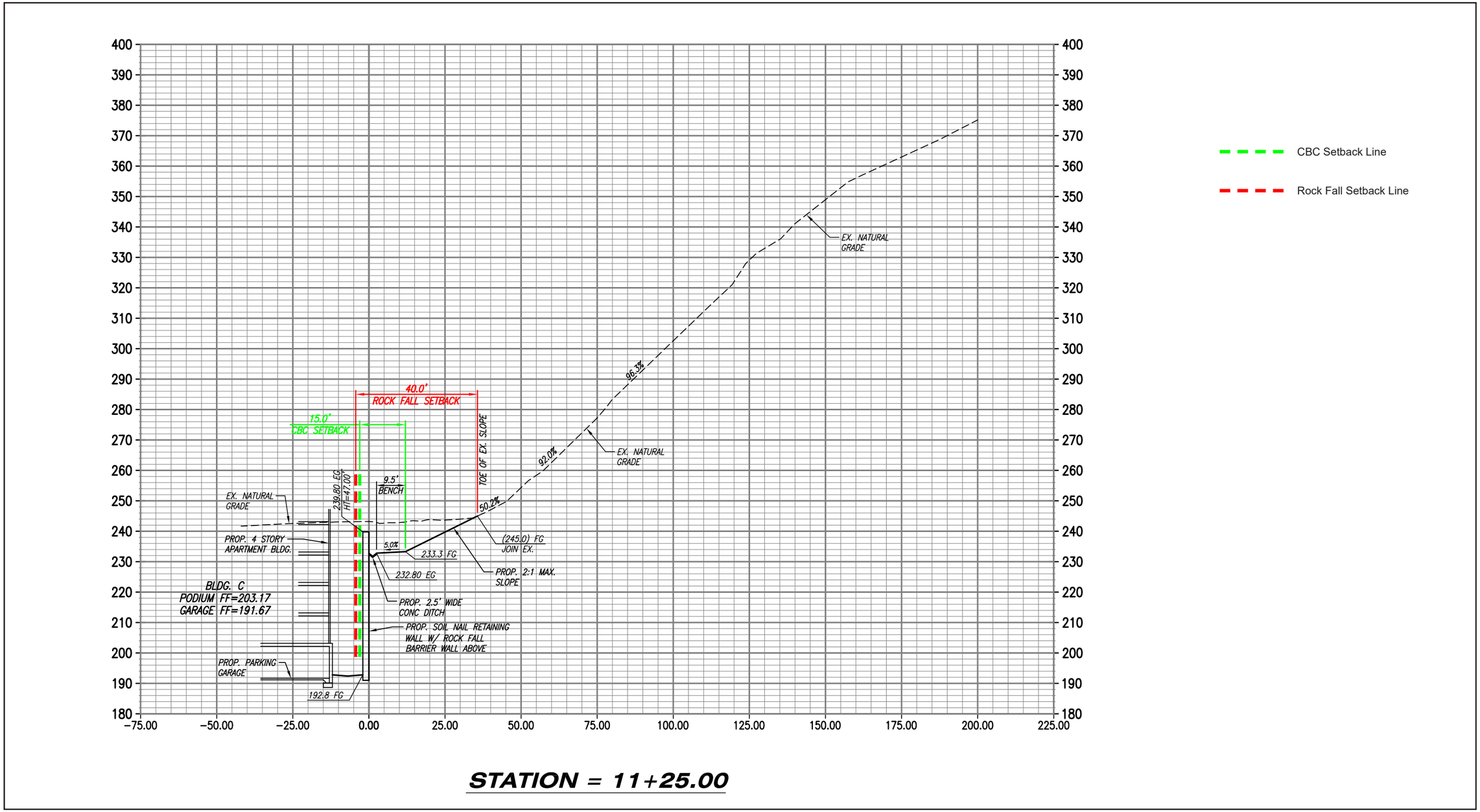
Figure 5.5-5 - Retaining Wall and Rockfall Barrier on Slope 3/Building C

5. Environmental Analysis



Note: The retaining wall and rockfall barrier diagrammed would be next to the south side of Building C in the southeast part of the development area.

0 35
Scale (Feet)

Source: Withee Malcolm Architects, 2017

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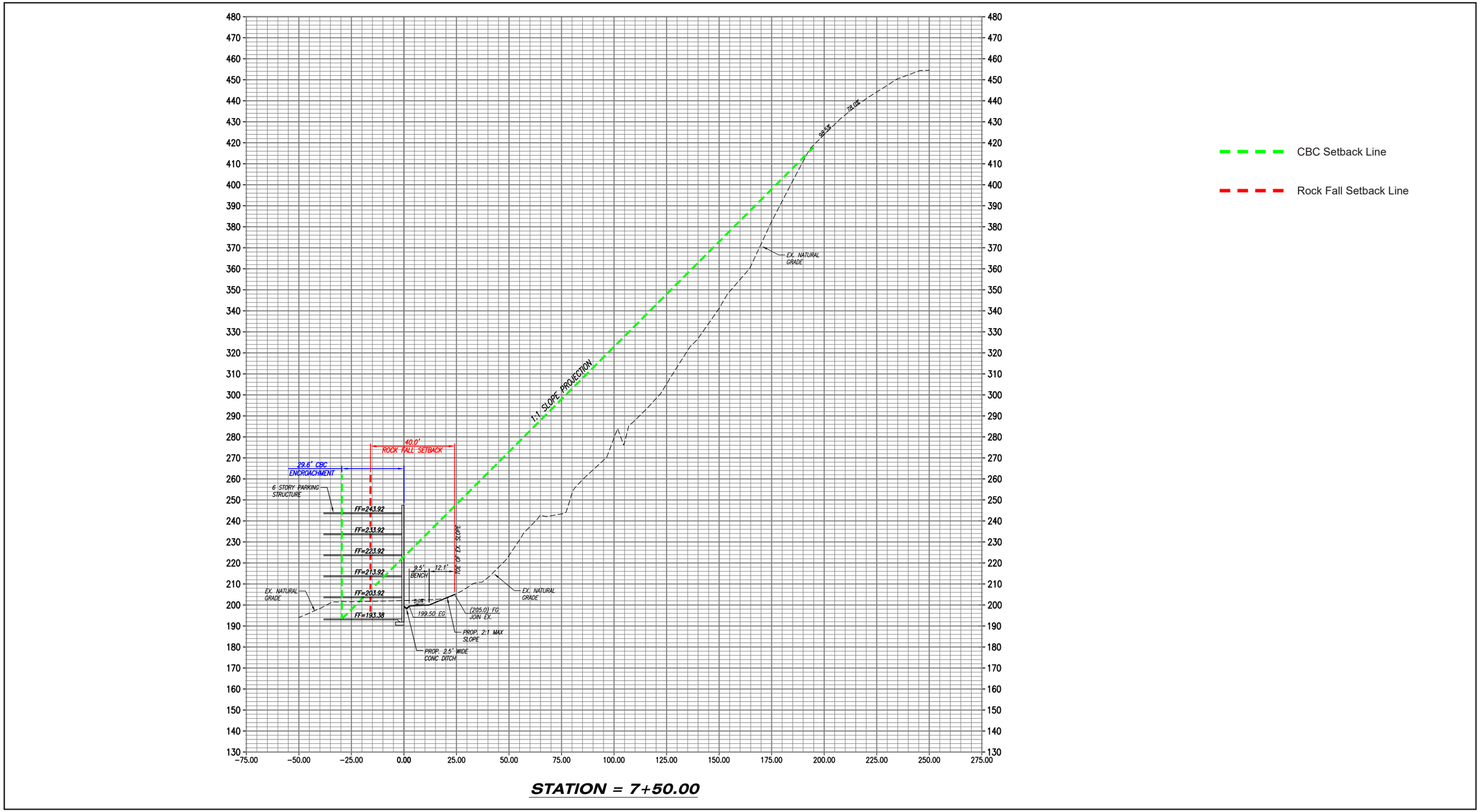
Figure 5.5-6 - Slope 3/Exterior Parking Structure Wall

5. Environmental Analysis



Note: The retaining wall and rockfall barrier diagrammed would be next to the south side of Building C in the southeast part of the development area.

0 50
Scale (Feet)

Source: KHR Associates, 2017

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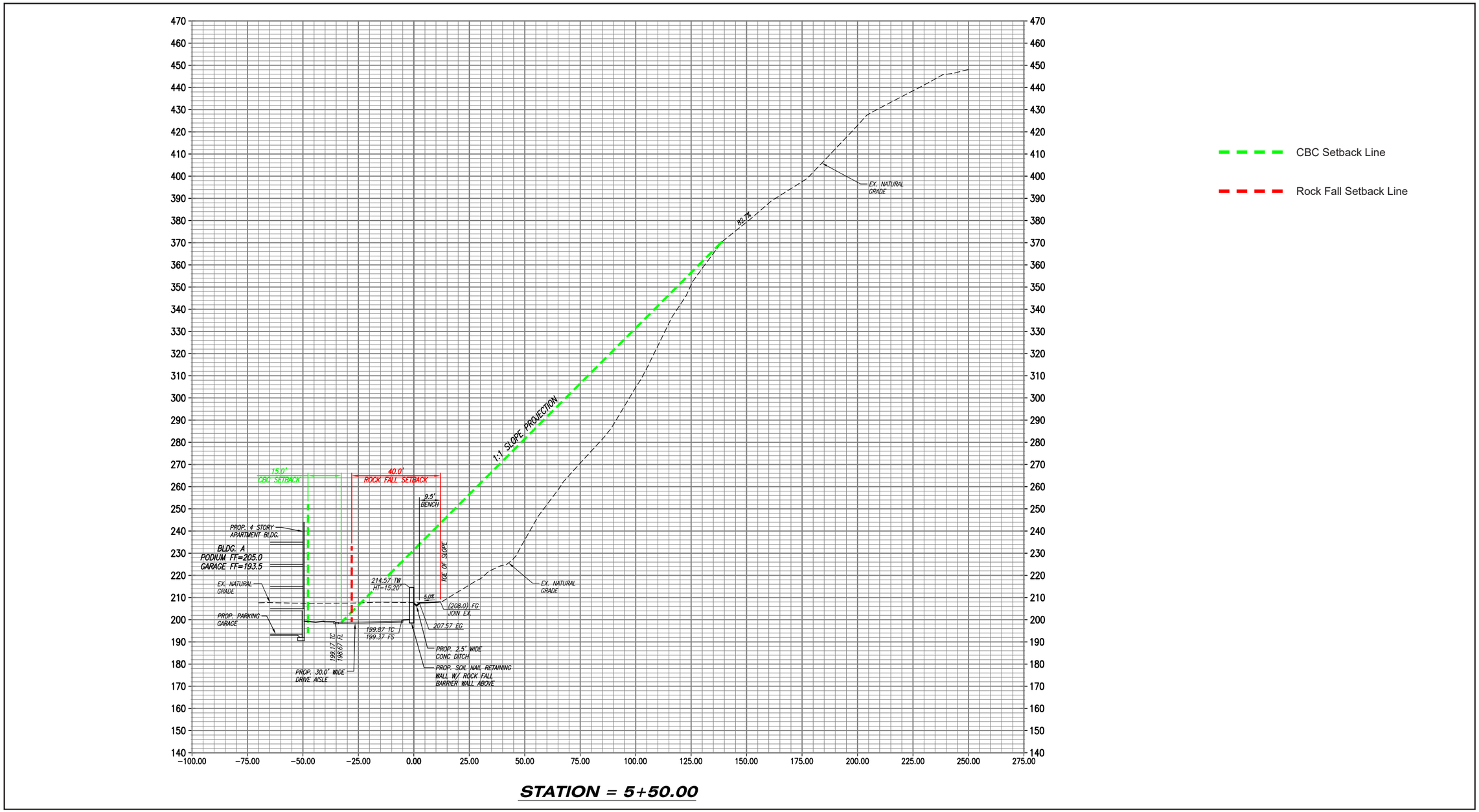
Figure 5.5-7 - Retaining Wall and Rockfall Barrier on Slope 3/Building A



Note: The retaining wall and rockfall barrier diagrammed would be next to the south side of Building C in the southeast part of the development area.

0 40
Scale (Feet)

Source: KHR Associates, 2017

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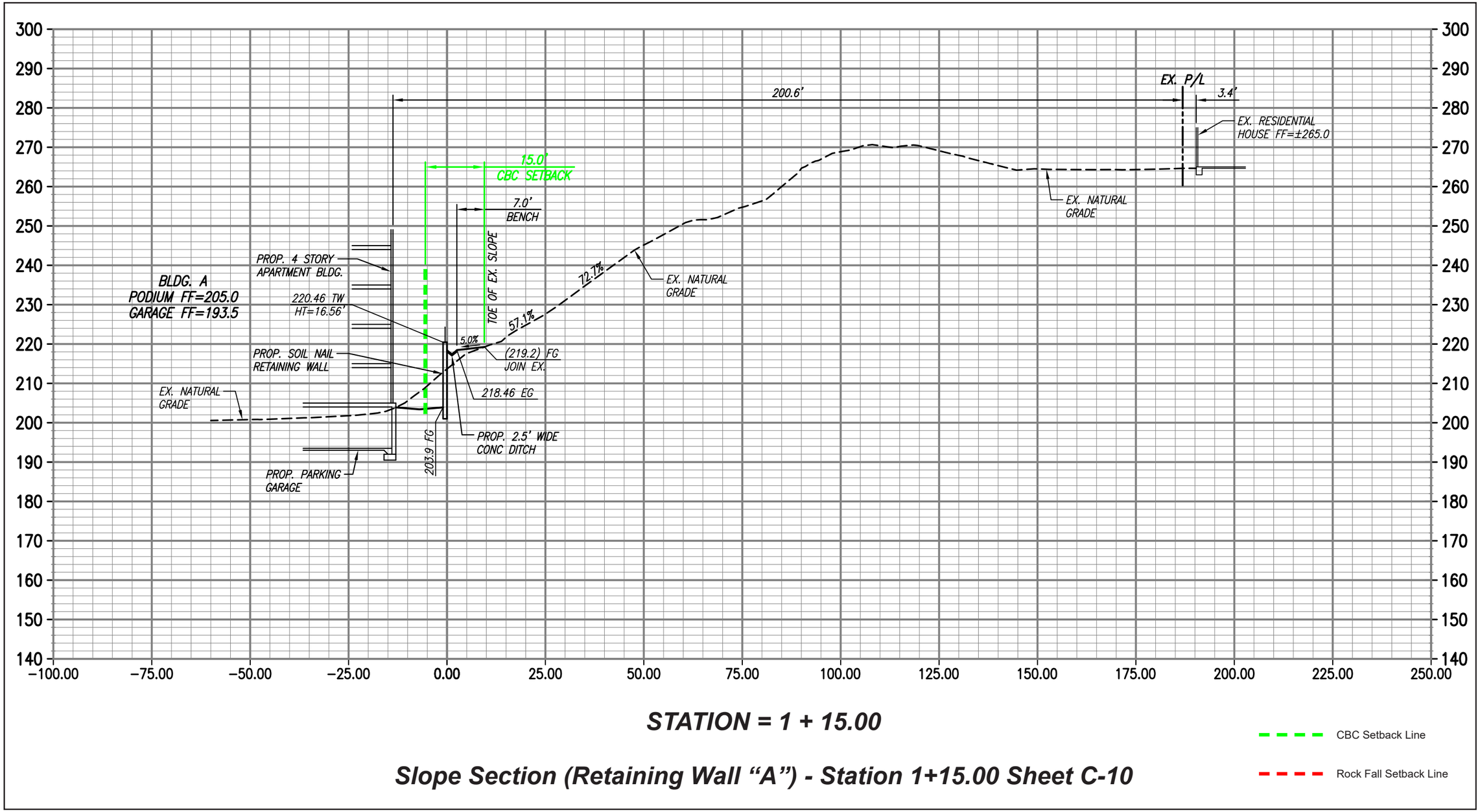
Figure 5.5-8 - Retaining Wall and Rockfall Barrier on Slope 1/Building A



Note: The retaining wall and rockfall barrier diagrammed would be next to the south side of Building C in the southeast part of the development area.

0 50
Scale (Feet)

Source: KHR Associates, 2017

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Impact 5.5-2 Minor shears observed in site sediments could be subject to some slip during a future earthquake. [Threshold G-3]

Impact Analysis: Minor shearing—that is, deformation in rock—onsite due to either folding of the Palos Verdes Hills or past earthquakes in the region was observed in the San Pedro Sand. The shears are not considered active faults; however, the shears could be subject to small slips during future earthquakes. The Preliminary Geotechnical Investigation report contains recommendations for foundation design to minimize hazards from such slips to people and structures (Geocon West 2017). Mitigation measure GEO-1 would ensure the recommendations of the geotechnical report are fully implemented so that impacts would be less than significant.

Impact 5.5-3: Some of the artificial fill soil onsite is unsuitable for supporting the proposed structures. [Threshold G-3]

Impact Analysis: Some of the artificial fill soils onsite were determined to be unsuitable for supporting the proposed structures. The fill soil was placed during unpermitted backfilling of the former mining pit, ongoing since the 1960's. The fill contains localized concentrations of concrete, brick, and rock fragments with localized pockets of debris. Based on the Geocon West geotechnical investigation, Lot 1 would be graded to the following pad elevations:

- Buildings A and B – The finished floor elevation will range from 190.5 to 193.5 feet amsl. Existing artificial fill will be excavated to an elevation of approximately 173 to 177 feet amsl and properly compacted for support of the reinforced engineered fill blanked and proposed foundation.
- Building C – The finished floor elevation will be 191.67 feet amsl. San Pedro Sand is present in this area, requiring removal of this native material to bring elevations to the finished floor elevation. The San Pedro Sand is considered suitable for direct support of the reinforced engineered fill blanket and proposed foundation system.
- Parking Structure – The finished floor elevations vary between 190.75 and 193.9 feet MSL beneath the proposed structure. Both artificial fill and San Pedro Sand are present in this area, therefore existing artificial fill will be excavated to an elevation of approximately 187 feet MSL and properly compacted for support of the reinforced engineered fill blanket, and proposed foundation. Where competent San Pedro Sand is exposed at the excavation bottom, it is considered suitable and will not require excavation to an elevation of 187 feet MSL.

As described above, Lot 1 is not balanced and will require a net export of 119,270 CY of soil. In addition, a 4-foot layer of clean fill will be placed across the entire Lot 1. It is anticipated that this fill material will consist of the competent native materials excavated to obtain the above-referenced pad elevations associated with development activities.

The geotechnical investigation report recommends placement of a layer of engineered fill reinforced with geosynthetic materials as addressed by mitigation measure GEO-1. The Preliminary Geotechnical Investigation report also recommends removal of artificial fill to specific elevations under the sites of the proposed buildings as addressed by mitigation measures GEO-2 through GEO-5. Grading is currently estimated to involve 120,915

cubic yards (CY) of cut and 1,646 CY of fill, resulting in 119,270 CY of soil for export. As such, the additional 10 percent excavation buffer (which would equate to 11,927 CY) specified in the Geocon letter regarding "Suggested Contingency Factor for Estimation of Soil Excavation during Grading" (Geocon 2018b) would be balanced on site and would not be exported off site. Impacts would be less than significant after implementation of mitigation measures identified in this DEIR.

Impact 5.5-4: Shallow soils onsite are considered expansive; thus, project development could cause hazards to people or structures. [Threshold G-4]

Impact Analysis: The upper few feet of site soils are considered expansive based on the underlying bedrock and would therefore need to be removed from under the proposed buildings and other improvements. In addition, as a conservative measure, the recommendations for design of foundations and slabs assume that those improvements would be built on expansive soils even after removal of shallow soils. Implementation of such recommendations included as mitigation measure GEO-6 would minimize consequent hazards to less than significant.

Impact 5.5-5: The proposed project could destroy paleontological resources. There are no unique geological features onsite, and project development would not destroy such a feature. [Threshold G-6]

There are no unique geological features onsite; the slopes onsite are remnants from past mining operations and not natural features.

Native rock and soils on and under the site have very high to high potential to contain fossils; numerous fossil discoveries within 10 miles of the project site are described above in Section 5.5.1.2. However, most of the soils that would be disturbed by project development are artificial fill soils. The preparation and/or engineering of the fill soils before the soils were placed onsite is unknown as permits were not obtained prior to depositing of the artificial fill; however, it is expected that most fossils that may have been in the soils would have been destroyed by preparation, placement, or both. Thus, fill soils are considered to have low sensitivity for fossils. Project development would involve disturbance of some native soils and rock that may contain fossils. Mitigation measure GEO-7 would ensure that any paleontological discovery would be dealt with in a manner as to protect any resource encountered during project implementation. Upon implementation of mitigation, impacts would be less than significant.

5.5.4 Cumulative Impacts

Geologic Hazards

Geology and soils impacts are generally site-specific and do not combine with impacts of other projects to result in cumulative impacts. Other projects proposing certain types of structures, and/or tentative or final maps, would be required to have geotechnical investigations of their project sites conducted. Other projects would be required to comply with provisions of state law and regulations safeguarding against seismic hazards and other geologic hazards, including the CBC, the Alquist-Priolo Earthquake Fault Zoning Act, the Torrance

Fault Hazard Management Zone, and the Seismic Hazard Mapping Act. Cumulative impacts would be less than significant, and project impacts would not be cumulatively considerable.

Paleontological Resources

The area considered for cumulative impacts to paleontological resources is the Palos Verdes Hills plus the southern half of the Los Angeles Basin.[2] The geologic units exposed onsite have produced myriad and very diverse fossil specimens in California, as described in the Paleontological Resources Assessment. Other projects would involve ground disturbance which could destroy fossils. Other projects would be subject to independent CEQA review including assessment of impacts to paleontological resources and implementation of all feasible mitigation measures for any significant impacts identified. Cumulative impacts would therefore be less than significant, and project impacts would not be cumulatively considerable.

5.5.5 Existing Regulations and Standard Conditions

State

- California Public Resources Code Sections 2621 et seq.: Alquist-Priolo Earthquake Fault Zoning Act
- California Public Resources Code Section 2695: Seismic Hazard Mapping Act
- California Code of Regulations Title 24, Part 2: 2013 California Building Code
- California Health and Safety Code Sections 17953-17955: Requirements for Geotechnical Investigations

5.5.6 Level of Significance Before Mitigation

Without mitigation, these impacts would be **potentially significant:**

- **Impact 5.5-1**: Implementation of the Proposed Project could subject residents, and visitors and off-site residential uses could be subject to landslide hazards.
- **Impact 5.5-2** Minor shears observed in site sediments could be subject to slip during an earthquake
- **Impact 5.5-3** Artificial fill soils onsite are unsuitable for supporting the proposed structures.
- **Impact 5.5-4** Expansive shallow soils onsite could cause hazards to people or structures through project development
- **Impact 5.5-5** The proposed project could destroy paleontological resources.

5.5.7 Mitigation Measures

Impact 5.5-1 and 5.5-2

GEO-1 The proposed project shall be constructed in accordance with the geotechnical engineering recommendations as presented in the *Preliminary Geotechnical Investigation, Proposed Multi-Family Residential Development, Hawthorne Boulevard and Via Valmonte, Torrance, California.* Geocon West,

[2] The northern half of the Los Angeles Basin is excluded from this region because it includes the La Brea Tar Pits, one of the richest localities for ice-age fossils in the world, and tar pits are not characteristic of the project region.

Inc., June 30, 2017, as well as any subsequent documents, including responses to City comments. These recommendations address site preparation, excavation, fill placement and compaction, foundation design, and site drainage, among other topics, as summarized below (full recommendations are included in Appendix E1).

The proposed structures shall be supported on a layer of engineered fill reinforced with geosynthetic materials in order to provide a ductile sublayer that can accommodate earthquake-induced ground displacement and minimize transfer of the displacements to the structures. Artificial fill may be re-used as engineered fill subject to compliance with grading recommendations in the geotechnical investigation report, including but not limited to:

Pockets of trash and debris may be encountered within the deeper artificial fill. If encountered, the trash and debris should be exported from the site and should not be mixed with the fill soils. Generation of oversized material (greater than 8 inches) should be anticipated. Rocks larger than 8 inches but less than 4 feet in maximum dimension may be incorporated into the engineered fill. Placement of oversized material (larger than 8 inches) shall be limited to the area measured at least 15 feet horizontally from the nearest slope face and 10 feet below finish grade or 3 feet below the deepest utility, whichever is deeper. It is recommended that where non-building areas are available, placement of oversized material should be performed in these areas. All materials utilized as engineered fill should be well-blended to create a uniform fill material prior to placement and compaction within each building pad area or slope construction. Soils must be placed uniformly and at equal thickness at the direction of the Geotechnical Engineer (a representative of Geocon West, Inc.).

Grading should commence with the removal of all existing vegetation and existing improvements from the area to be graded. All existing underground improvements planned for removal should be completely excavated and the resulting depressions properly backfilled in accordance with the procedures described herein. Deleterious debris such as wood and root structures should be exported from the site and should not be mixed with the fill soils. Asphalt and concrete should not be mixed with the fill soils unless approved by the Geotechnical Engineer. All existing underground improvements planned for removal should be completely excavated and the resulting depressions properly backfilled in accordance with the procedures described herein.

During grading operations, the Geotechnical Engineer (a representative of Geocon) should be onsite to observe that soil and geologic conditions do not differ significantly from those expected. If conditions are found to be variable, modification to the grading recommendations described herein should be implemented based on onsite observations. This may include deeper excavations to remove artificial fill or unsuitable soils, or reducing excavations where competent soil is encountered at shallower depths than anticipated.

The structures shall be decoupled from the reinforced engineered fill blanket through the placement of a double layer of polyolefin sheets sandwiched between layers of clean sand,

placed immediately below the mat foundation.[3] The preliminary design includes a four-foot blanket of engineered fill with geogrid reinforcement at one-foot intervals; the thickness and number of geogrid layers to be refined during final project design. Geogrids are typically made of plastic; they can be in the form of a grid or a fabric. This procedure should be continued until four layers of geosynthetic reinforcement and 4 feet of engineered fill have been placed. The double layer of polyolefin sheets sandwiched between layers of clean sand should be placed immediately above the reinforced engineered fill blanket and immediately below the mat foundation. The geosynthetic reinforcement should extend laterally a minimum distance of 5 feet beyond the building footprint areas. Mitigation shall follow recommendations set forth in the 2017 Revised Geotechnical Investigation report.

Impact 5.5-3

The proposed project shall be constructed in accordance with the geotechnical engineering recommendations as presented in the *Preliminary Geotechnical Investigation, Proposed Multi-Family Residential Development, Hawthorne Boulevard and Via Valmonte, Torrance, California.* Geocon West, Inc., June 30, 2017, as well as any subsequent documents, including responses to City comments. These recommendations address site preparation, excavation, fill placement and compaction, foundation design, and site drainage, among other topics, as summarized below (full recommendations are included in Appendix E1).

The following mitigation measures would address the geotechnical investigation's recommendations to remove artificial fill soils to appropriate depths to adequately support the proposed structures. The following specified depths are draft measurements subject to change pending final design parameters. Equivalent depths to support final project plans may be adapted and approved by the site soils engineer pending further investigation and final design.

GEO-2 **Building A:** Artificial fill should be removed to 177 feet amsl. Competent San Pedro Sand above 177 feet elevation amsl would not require excavation. The finished floor elevation would be 193.5 feet amsl, 16.5 feet above the recommended removal depth. Mitigation shall follow recommendations set forth in the 2017 Revised Geotechnical Investigation report.

GEO-3 **Building B:** Artificial fill should be removed to 173 feet amsl. Competent marine sand or San Pedro Sand above 173 feet amsl would not require removal. The finished floor elevation would be 190.5 feet amsl, 17.5 feet above the recommended removal depth. Mitigation shall follow recommendations set forth in the 2017 Revised Geotechnical Investigation report.

GEO-4 **Building C**: San Pedro Sand – considered suitable for supporting the proposed building – is expected to be exposed at the pad subgrade, which would be at approximately 185 feet amsl. The finished floor would be 191.67 feet amsl, or about 6.67 feet above the subgrade. Mitigation shall follow recommendations set forth in the 2017 Revised Geotechnical Investigation report.

[3] Polyolefins include several common types of plastics, including polyethylene and polypropylene.

GEO-5 **Parking Structure:** It is expected that artificial fill and San Pedro Sand would be exposed at the pad subgrade. It is recommended that artificial fill be removed to an elevation of about 187 feet amsl; San Pedro Sand would not require removal. The finished floor would be approximately 193 ft amsl at least 6 feet above the recommended removal depth. Mitigation shall follow recommendations set forth in the 2017 Revised Geotechnical Investigation report.

Impact 5.5-4

GEO-6 The proposed project shall be constructed in accordance with the geotechnical engineering recommendations as presented in the *Preliminary Geotechnical Investigation, Proposed Multi-Family Residential Development, Hawthorne Boulevard and Via Valmonte, Torrance, California.* Geocon West, Inc., June 30, 2017, as well as any subsequent documents, including responses to City comments. These recommendations address site preparation, excavation, fill placement and compaction, foundation design, and site drainage, among other topics, as summarized below (full recommendations are included in Appendix E1).

Project grading would comply with recommendations of the geotechnical investigation (Geocon West 2017) to remove the upper few feet of expansive soils, and foundations and slabs shall be designed to be built upon expansive soils following the removal of shallow soils. The limits of existing fill and/or soft soil removal will be verified by the Geocon representative during site grading activities. During grading operations, the Geotechnical Engineer (a representative of Geocon) should be onsite to observe that soil and geologic conditions do not differ significantly from those expected. Mitigation shall follow recommendations set forth in the 2017 Revised Geotechnical Investigation report.

Impact 5.5-5

GEO-7 The project applicant shall retain a qualified paleontologist to monitor ground-disturbing activities in native San Pedro Sand, Lomita Marl, and Monterey Formation rock. The qualified paleontologist shall be present during the pre-grading meeting to discuss paleontological sensitivity and to assess whether scientifically important fossils could be encountered. The paleontologist shall determine, based on consultation with the City, when monitoring of grading activities is needed based on the onsite soils and final grading plans. Mitigation shall follow recommendations set forth in the 2017 Revised Geotechnical Investigation report.

All paleontological work to assess and/or recover a potential resource at the project site shall be conducted under the direction of the qualified paleontologist and follow the standard protocols of the Natural History Museum of Los Angeles County. If any fossil remains are uncovered during earth-moving activities, all heavy equipment shall be diverted at least 50 feet from the fossil site until the monitor has had an opportunity to examine the remains and determines that earthmoving can resume. The extent of land area that is prohibited from disturbance shall be at the discretion of the paleontological monitor. Samples of San Pedro Sand, Lomita Marl, and Monterey Formation rock shall be collected as necessary for

processing and shall be examined for very small vertebrate fossils. The paleontologist shall prepare a report of the results of any findings following accepted professional practice and submit the report for review by the City of Torrance Planning Division. Mitigation shall follow recommendations set forth in the 2017 Revised Geotechnical Investigation report.

5.5.8 Level of Significance After Mitigation

Impact 5.5-1

With implementation of GEO-1, the measures outlined regarding fill soils to address slope instability hazards would ensure that impacts would be less than significant.

Impact 5.5-2

With implementation of GEO-1, the measures outlined regarding fill soils to address minor shears observed in site sediments that could be subject to slip during an earthquake would ensure that impacts would be less than significant.

Impact 5.5-3

With implementation of GEO-2 through GEO-5, in addition to GEO-1, project implementation would remove artificial fill soils to appropriate depths to adequately support the proposed structures to depths specified or equivalent by the recommendation of the site soils engineer. Impacts would be less than significant.

Impact 5.5-4

With implementation of GEO-6, the removal of surface soils and adhering to expansive soil design considerations would ensure that expansive shallow soils onsite would not cause hazards to people or structures through project development. Impacts would be less than significant.

Impact 5.5-5

With implementation of GEO-7, monitoring for paleontological resources during grading and project implementation would ensure that the proposed project would not impact paleontological resources. Impacts would be less than significant.

Upon implementation of the proposed mitigation measures, impacts to geological resources would be less than significant.

5.5.9 References

Geocon West, Inc. 2016, January 21.Fault Rupture Hazard Investigation, Proposed Multi-Family Residential Development, Hawthorne Boulevard and Via Valmonte, Torrance, California.

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