4.3 GEOLOGY AND SOILS

This section analyzes impacts of the proposed project related to geology and soils based on the analyses and conclusions in geotechnical investigations conducted for the Applicant by Haro, Kasunich and Associates Inc. The geotechnical investigations are included in Appendix D-1 of this document and also are available on the City of Santa Cruz website at: http://www.cityofsantacruz.com/departments/planning-and-community-development/environmental-documents.

Public and agency comments related to geology and soils were received during the public scoping period in response to the Notice of Preparation (NOP). Issues raised in these comments include:

- Concern regarding liquefaction, slope stability, and landslide hazards.
- Issues related to building within 10 feet of a 30-percent slope and compliance with City regulations.
- Concern regarding stability of the adjacent off-site drainage.
- Potential for erosion and downstream impacts to the San Lorenzo River and fish species supported in the river.

To the extent that issues identified in public comments involve potentially significant effects on the environment according to the California Environmental Quality Act (CEQA) and/or are raised by responsible agencies, they are identified and addressed within this EIR. Public comments received during the public scoping period are included in Appendix B.

4.3.1 Environmental Setting

Regulatory Setting

State Regulations

The Alquist-Priolo Earthquake Fault Zoning Act was passed by the state of California in 1972 to prevent the construction over active faults of buildings used for human occupancy. The Act requires the State Geologist to establish regulatory zones (known as Earthquake Fault Zones) around the surface traces of active faults and to issue appropriate maps. Local agencies must regulate most development projects within the zones. Before a project can be permitted, cities and counties must require a geologic investigation to demonstrate that proposed buildings will not be constructed over active faults. If an active fault is found, a structure for human occupancy cannot be placed over the trace of the fault and must be set back from the fault (generally 50 feet), although local agencies can be more restrictive than state law requires. There are no state-delineated Alquist-Priolo fault zones in the City of Santa Cruz (City of Santa Cruz, April 2012, DEIR volume).

The Seismic Hazards Mapping Act (SHMA) addresses non-surface fault rupture earthquake hazards, including strong ground-shaking, liquefaction, and seismically-induced landslides. The goal is to mitigate seismic hazards to protect public health and safety. Pursuant to the SHMA, the state Department of Conservation is directed to provide local governments with seismic hazard zone maps that identify areas susceptible to amplified shaking, liquefaction, and earthquake-induced landslides or other ground failures. Site-specific geotechnical hazard investigations are required by SHMA when construction projects fall within these areas. Neither the City of Santa Cruz nor any part of Santa Cruz County is located within a currently designated state-Seismic Hazard Mapping Program zone (California Department of Conservation 2016).

California Building Code. Title 24 of the California Code of Regulations, contains the Building Standards Codes, including Part 2, the California Building Code (CBC), which sets forth minimum requirements for building design and construction. In the context of earthquake hazards, the CBC design standards have a primary objective of ensuring public safety and a secondary goal of minimizing property damage and maintaining function during and following a seismic event. The CBC presents the requirements for geotechnical investigations and prescribes seismic design criteria for various types of structures. The CBC also requires analysis of liquefaction potential, slope-instability, differential settlement, and surface displacement due to faulting or lateral spreading for various categories of construction. Subsection 1803.5.12 establishes seismic design categories and requires that structures in “Seismic Design Categories” D, E or F also evaluate liquefaction potential, assess liquefaction impacts and discuss mitigation measures, such as, but not limited to, ground stabilization, selection of appropriate foundation type and depths, selection of appropriate structural systems or an combination of measures. The City of Santa Cruz is located in Seismic Design categories D-F (City of Santa Cruz, April 2012, DEIR volume).

Local Regulations

The City’s Municipal Code section 24.14.070 requires a site-specific geotechnical investigation for all development, except projects with fewer than four units, in areas identified in the General Plan as having a high liquefaction potential. Section 24.16.060 requires an erosion control plan for projects located within high erosion hazard areas as designated in the General Plan, or for development on slopes greater than 10 percent.

Excavation and grading regulations are addressed in Chapter 18.45 of the City’s Municipal Code. It provides technical regulations for grading and excavation in order to: safeguard life, health, safety, and the public welfare; protect fish and wildlife, riparian corridors and habitats, water supplies, and private and public property; and to protect the environment from the effects of flooding, accelerated erosion, and/or deposition of silt. The ordinance accomplishes this by providing guidelines, regulations, and minimum standards for clearing, excavation, cuts, fills, earth moving, grading operations, water runoff, and sediment control. In addition, the ordinance includes provisions regarding administrative procedures for issuance of permits and approval of plans and inspections during construction and subsequent maintenance.

Section 24.14.060, Erosion Hazard Areas, of Title 24 of the City's Municipal Code requires implementation of an erosion control plan for projects located within, or adjacent to, erosion hazard areas as designated in Maps EQ-6 and EQ-7 in the Environmental Quality Element of the General Plan and for development proposals on slopes in excess of ten percent for all major development proposals and for all development adjacent to streams and wetland areas. The regulations include general provisions regarding site design, implementation of measures during construction to protect exposed soils from erosion, and revegetation. The regulations also require all approved permanent erosion control measures to be installed prior to final Planning Department clearance for occupancy of the development project. For major development proposals, including residential development with four or more units or grading in excess of 1,000 cubic yards, the erosion control plan must be prepared by a registered civil engineer, professional forester, qualified soil scientist or other qualified erosion control specialist.

Section 24.14.030, Slope Regulations, of Title 24 of the City's Municipal Code states that no building shall be located on a slope of thirty to fifty percent, or within twenty feet of a thirty to fifty percent slope, unless an exception is granted pursuant to section 24.14.040 or a variance is granted pursuant to section 24.08.810. The Planned Development Permit Chapter of the Municipal Code (Section 24.08.700) allows certain zoning regulations to be varied in an effort to foster development plans which serve public objectives more fully than development plans under conventional zoning regulations. Slope regulations are one of the zoning regulations that can be varied under this permit. The project Applicant has requested a reduction in slope setbacks in accordance with these requirements as two buildings are located within twenty feet of a 30 percent slope.

Study Area

The study area consists of the project site, which is located at the northern edge of the city of Santa Cruz along Ocean Street Extension, northwest of the Ocean Street / Graham Hill Road intersection.

Regional Geologic Setting

The City of Santa Cruz lies on a narrow coastal plain at the mouth of the San Lorenzo River Valley on the northern shore of the Monterey Bay. The coastal plain is bounded landward by the Santa Cruz Mountains, rising to elevations over 2,600 feet. The San Lorenzo River flows southward from the Santa Cruz Mountains and is the largest drainage in the region, with an area of about 106 square miles. The central district of the City of Santa Cruz is situated on the floodplain of the lower San Lorenzo River.

The City of Santa Cruz is situated on the southwestern slope of the central Santa Cruz Mountains, part of the Coast Ranges physiographic province of California. The northwest-southeast structural grain of the Coast Ranges is controlled by a complex of active faults within the San Andreas fault system. The geology of the City and surrounding area displays over 100 million years of geologic history. Rock units in the City are separable into three major groups: granitic intrusive rocks of Late Cretaceous age, pre-Cretaceous metasedimentary rocks, and sedimentary rocks of Tertiary and Quaternary age. The sedimentary rocks overlying the granitic and metamorphic basement, principally the Santa Margarita Sandstone, the Santa Cruz Mudstone, and the Purisima Formation, are younger Tertiary age rocks and, locally, have experienced only gentle uplift and very mild folding (City of Santa Cruz, April 2012, DEIR volume).

Regional Seismicity and Seismic Hazards

The City of Santa Cruz is located in a seismically active region of California. The City of Santa Cruz is situated between two major active faults: the San Andreas, approximately 11.5 miles to the northeast, and the San Gregorio, approximately 10 miles to the southwest. The active or potentially active faults that may affect the region include the San Andreas, Zayante-Vergeles, Monterey Bay-Tularcitos, and San Gregorio fault zones; see Table 4.3-1. There are no active fault zones or risk of fault rupture within the City (City of Santa Cruz, April 2012, DEIR volume).

TABLE 4.3-1: Distances to Local Faults

Fault	Distance from City (miles)	Maximum Expected Earthquake Magnitude (Moment Magnitude)	Approximate Time Between Major Earthquakes (years)
San Gregorio	9.9	7.2	400
Zayante-Vergeles	7.9	7.9	8821
Monterey Bay-Tularcitos	6.5	6.5	2841
San Andreas	11.2	7.9	210

Source: Nolan Associates in City of Santa Cruz General Plan 2030 EIR

Historical earthquakes along the San Andreas fault and its branches have caused substantial seismic shaking in Santa Cruz County in historical time. The two largest historical earthquakes to affect the area were the moment magnitude (Mw) 7.9 San Francisco earthquake of April 18, 1906, and the Mw 6.9 Loma Prieta earthquake of October 17, 1989 (corresponding to Richter magnitudes of 8.3 and 7.1). The San Francisco earthquake caused severe seismic shaking and structural damage to many buildings in the Santa Cruz Mountains. The Loma Prieta earthquake may have caused more intense seismic shaking than the 1906 event in localized areas of the Santa Cruz Mountains, although its regional effects were not as extensive. There were also major earthquakes in northern California along or near the San Andreas fault in 1838, 1865, and possibly 1890 (City of Santa Cruz, April 2012, DEIR volume).

Project Site Conditions

Geologic and Seismic Conditions

The project site is underlain by Santa Margarita sandstone; undifferentiated alluvial deposits are mapped down the slope of the site and undifferentiated terrace deposits are mapped upslope of the site (Haro, Kasunich and Associates, April 2007). The project site is located in a seismically active region of California and the region is considered to be subject to very intense shaking during a seismic event as discussed above. According to maps developed as part of the City's adopted *General Plan 2030* and included in the General Plan EIR, the project site is not located in an area identified as being subject to liquefaction hazards (Figure 4.10-4), is not located within a mapped landslide area (Figure 4.10-3), and contains 30-50+ percent slopes (Figure 4.10-5) (City of Santa Cruz, April 2012, DEIR volume).

The 2007 geotechnical feasibility investigation report indicates that there are no adverse geotechnical hazards present on the site. Geotechnical hazards are commonly defined as: 1) seismic events, including but not limited to earthquakes, earthquake-induced landslides, liquefaction, subsidence, and tidal flooding damage from earthquake-induced tsunamis and seiches; and 2) non-seismic unstable conditions, including but not limited to landslides, cliff retrenchment, erosion, subsidence, soil creep and shrink/swell conditions; and 3) debris flows and debris avalanches (Haro, Kasunich and Associates, November 2014).

Liquefaction. The geotechnical feasibility investigation prepared for the project in 2007 indicated that the southern third of the project site is potentially subject to liquefaction, although the site is not within a mapped liquefaction area (Haro, Kasunich and Associates, April 2007). Liquefaction in the top 15 feet was identified as a concern in this area where groundwater reaches the surface, and liquefaction below 15 feet was deemed uncertain without further subsurface investigation and quantitative liquefaction analysis of the upper 50 feet of the soil surface. The liquefaction hazard was characterized as low to moderate (Haro, Kasunich and Associates, August 2010). Additional soils borings were conducted in the southern portion of the site in November 2016. The results indicate that the densities of the soil measured in the southern portion of the site are slightly higher, indicating a stronger subsurface soil profile at the southern end of the property. The subsurface soil increased in density and strength with drilling depth. The soil materials encountered consisted of sandy clays and silty sands, a derivative of the Santa Margarita Sandstone. Groundwater was not encountered to depths of 20 feet (Haro, Kasunich and Associates, November 2016).

Landslides. According to a review by a certified engineering geologist, no landslide deposits are shown on the site in published maps; the nearest mapped landslide deposit is approximately 2,000 feet north of the project site (Haro, Kasunich and Associates, November 2014). The review also indicates that no evidence of landsliding on the property is visible on the historical aerial photography dating from 1993 to 2014, and no evidence of recent or historic landsliding was observed on the property during the on-site reconnaissance (Ibid.). At the time of the geotechnical feasibility investigation, there were some signs of erosion on the eastern slope of the project site due to runoff from Graham Hill Road, but there were no signs of deeper and surficial slope instability (Haro, Kasunich and Associates, August 2010). The gully located on the northern portion of the property formed from erosional processes, not as a result of landsliding, and a stormwater drainage pipe discharges into the gully. Storm runoff from Graham Hill Road where it borders the property is controlled by an asphalt curb located along the outer edge of the pavement (Haro, Kasunich and Associates, November 2016).

Soils Conditions

A geotechnical feasibility investigation with report was conducted at the project site in April 2007 prior completion of project plans. The investigation included subsurface soils borings and laboratory testing, however, borings in the southern portion of the site were not taken due to wet soil conditions and limited access for drilling equipment at the time borings were conducted. Three additional exploratory soils borings and laboratory testing were conducted in the southern portion of the site in November 2016. The feasibility investigation included construction aspects related to grading for building pads and access roads, retaining walls, and drainage. A subsequent review of the project grading and drainage plan was completed in February 2010.

The exploratory borings indicate a variety of soil conditions on the project site. Generally, soils on the north side of the site consist of loose to dense, silty sands in the upper two feet, overlying medium dense to very dense silty sands and very stiff to hard non- expansive lean clays with sands and granite cobble (Haro, Kasunich and Associates, April 2007). Soils encountered in northeast portion of the site consist of very stiff to hard, non-expansive lean clay with sand and granite cobble to a depth of eight feet overlying weakly cemented medium dense sand with silt. Soils encountered in the southern portion of the site in the 2007 soils boring consisted of moist to wet loose silty sands or stiff lean clays in the top 15 feet of the soil surface overlying medium dense silty sands (Ibid.). The results of the 2016 soils borings indicate that the subsurface soil conditions are very similar to the subsurface soil conditions encountered in the April 2007 exploratory borings elsewhere on the project; the soil materials encountered consisted of sandy clays and silty sands, a derivative of the Santa Margarita sandstone (Haro, Kasunich and Associates, November 2016). Measured soil densities are slightly higher indicating a stronger subsurface soil profile at the southern end of the property, and the subsurface soil increased in density and strength with drilling depth (Ibid.). Expansive soils were not identified on the project site (Haro, Kasunich and Associates, April 2007). The eastern edge of the project site is comprised of the fill slope that supports Graham Hill Road; no soils borings were performed in this area (Ibid.).

Perched groundwater was encountered at a depth of about three feet below ground surface on portions of the site in 2007. Moist to wet soil conditions were encountered from five to 15 feet below ground surface in the central portion of the site (Haro, Kasunich and Associates, April 2007). Groundwater was not encountered to depths of 20 feet in the borings conducted in November 2016.

The results of the geotechnical feasibility investigation indicate there are no adverse geotechnical hazards that would preclude the development of the proposed project. Primary geotechnical concerns at the project site that were identified in the geotechnical feasibility investigation include strong seismic shaking, slope instability of the fill slope below Graham Hill Road, liquefaction, uniform bearing support for engineered structures and appropriate control of surface runoff and erosion (Haro, Kasunich and Associates, April 2007). The investigation and subsequent reviews outline engineering design measures regarding foundation and retaining wall designs that can be incorporated into project plans that will address these concerns.

According to the Soil Conservation Service *Soil Survey of Santa Cruz* (August 1980) as shown in the City's General Plan EIR, on site soils include primarily two soil classifications: Pfeiffer gravelly sandy loan and Watsonville loam, which are rated as having a high and slight to moderate erosion hazard, respectively. According to maps developed as part of the City's recently adopted *General Plan 2030* and included in the General Plan EIR, the project site is partially located on soils identified as being subject to erosion (Figure 4.10-6).

Existing Slopes

The project site gently slopes east to west from Graham Hill Road to Ocean Street Extension. Slope gradients range from 10 to 15 percent above Ocean Street Extension and 25 to 70 percent downslope of Graham Hill Road (Haro, Kasunich and Associates, April 2007). The existing eastern slopes are inclined at 1:5 (horizontal to vertical) slopes (Haro, Kasunich and Associates, August 2010). At the time of the geotechnical feasibility report was prepared, there were some signs of erosion on the eastern slope due to runoff from Graham Hill Road, but there were no signs of deeper and surficial slope instability (Ibid.). Since then, an asphalt dike has been constructed on the outboard edge of Graham Hill road that diverts runoff away from the eroded areas and has considerably reduced erosion and potential slope instability (Ibid.).

Slope instability was one of the potential geotechnical concerns raised in the preliminary geotechnical feasibility report. Construction of buildings on slopes greater than 25 percent was not recommended without a quantitative slope stability analysis performed by a qualified geotechnical engineer (Haro, Kasunich and Associates, April 2007). The investigation concurred that the proposed retaining wall along the east side of the project is the best solution to buttress the existing fill and accommodate level building pads and would address concern with the potential slope instability of this fill slope.

Observations of the project area over the past 30 years by the project geologist identified at least two episodes of erosion and instability along the outboard shoulder of Graham Hill Road and the slope below. This historical erosion and instability was caused by uncontrolled surface runoff that accumulated along Graham Hill Road during heavy rains and discharged in an uncontrolled manner off the edge of the road pavement. Neither of these episodes occurred on the project site. The location of those problems were related to areas where Graham Hill

Road was poorly designed and lacked design features (such as the asphalt curb at the outer edge of the pavement that is present at the property proposed for development) to prevent problems associated with uncontrolled surface runoff. Graham Hill Road has been repaired and modified over time to direct all road surface drainage away from its outboard edge so that storm water does not spill onto the referenced property (Haro, Kasunich and Associates, November 2014).

4.3.2 Impacts and Mitigation Measures

Thresholds of Significance

In accordance with the California Environmental Quality Act (CEQA), State CEQA Guidelines (including Appendix G), City of Santa Cruz plans, policies, and/or guidelines, and agency and professional standards, a project impact would be considered significant if the project would:

3a Expose people or structures to potential substantial adverse effects including the risk of loss, injury, or death resulting from the rupture of a known earthquake fault, seismic ground-shaking, landslides, or seismic-related ground failure, including liquefaction, which cannot be mitigated through the use of standard engineering design techniques;

3b 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 an on-site or off-site landslide or slope failure/ instability;

3c Result in substantial soil erosion or the loss of topsoil and subsequent sedimentation into local drainage facilities and water bodies; or

3d Be located on an expansive soil, as defined by the Uniform Building Code (1997), or subject to other soil constraints that might result in deformation of foundations or damage to structures, creating substantial risks to life or property.

3e Have soils incapable of adequately supporting the use of septic tanks or alternative wastewater disposal systems where sewers are not available.

Analytical Method

The impact analysis is based on geotechnical and geological reviews conducted by Haro, Kasunich and Associates for the Applicant and consultation with City staff.

Impacts and Mitigation Measures

As described in section 4.3.1 above, the site is not located on expansive soils (3d). As discussed in the Initial Study (see Appendix A), the project will not utilize septic systems (3e). Therefore, the project would not result in impacts related to these thresholds of significance. The following impact analyses address exposure of people or structures to seismic and geologic hazards (3a) and unstable geologic or soils conditions or hazards (3b). Potential soil erosion and effects on water bodies (3c) is addressed in Chapter 4.4, Hydrology & Water Quality.

Impact Geo-1: **Exposure to Seismic Hazards.** The project site will be exposed to strong ground-shaking during a major earthquake on any of the nearby faults, resulting in the exposure of people and/or structures to damage due to strong seismic shaking and potential liquefaction (3a). This is a *potentially significan*t impact.

The project site is located in an area of high seismic activity and will be subject to seismic shaking during an earthquake that could expose future structures and people to seismic hazards, particularly seismic shaking and liquefaction. However, adherence to existing regulations and standards, including the CBC and City policies and regulations requiring preparation of geotechnical investigations, would minimize harm to people and structures from adverse geologic events and conditions. Buildings will be required to be designed in accordance with the latest edition of the California Building Code, which sets forth structural design parameters for buildings to withstand seismic shaking without substantial structural damage. Conformance to the CBC as required by state law and the City would ensure the maximum practicable protection available for structures and their associated trenches, excavations and foundations (City of Santa Cruz, April 2012, DEIR volume). Project designs are required to include the application of CBC Seismic Zone 4 standards. The continuation of design review and code enforcement to meet current seismic standards is the primary mitigation strategy to avoid or reduce damage from an earthquake (Ibid.).

A geotechnical feasibility investigation report prepared for the project identified potential for liquefaction in the upper 15 feet of native soils and possibly deeper in the southern portion of the project site (Haro, Kasunich and Associates, April 2007). The geotechnical report recommended further subsurface investigation in this area to screen for liquefaction potential and develop more detailed geotechnical recommendations. Subsequent geotechnical review indicated that the liquefaction potential was deemed low to moderate based on the cohesive nature of the soils in the one soils boring in the southern portion of the site and that engineered designs could be implemented to mitigate effects of liquefaction (Haro, Kasunich and Associates, August 2010). Additional soils borings conducted in the southern portion of the site in November 2016 found that the densities of the soil in the southern portion of the site are slightly higher, indicating a stronger subsurface soil profile at the southern end of the property, and that the subsurface soil increased in density and strength with drilling depth (Haro, Kasunich and Associates, November 2016). The geotechnical engineer further indicated that the conclusions and recommendations of the 2007 geotechnical feasibility investigation and subsequent geotechnical reviews are accurate and appropriate for the entire project site (Ibid.).

The geotechnical feasibility investigation indicates that potential damage to structures resulting from potential liquefaction could be mitigated with use of a foundation design that utilizes piers to penetrate through the liquefiable layers that bear into non-liquefiable soils. With a properly designed pier system, damage to foundations due to liquefaction would be reduced to tolerable levels or eliminated (Haro, Kasunich and Associates, April 2007). If non-liquefiable soils are not encountered at a reasonable depth, it may be more cost effective to “float” structures on an earthen mat with structural slabs or grid foundation systems, although “floating” foundations systems will experience differential settlement over time and may require repair in the future (i.e. re-leveling with injection grouting) (Ibid.). Foundation designs will be included on building plans at the time of submittal for building permit based on the recommendations in the geotechnical investigation and reviews.

A final geotechnical report that outlines site specific design criteria for building foundations systems will be prepared. The geotechnical feasibility investigation has identified potential geotechnical concerns and methods of mitigation through foundation and building designs. The design-level geotechnical study will allow the project structural engineers to calculate and dimension the details of the foundations and retaining walls. For example this will include the details necessary for building permit plan check, such as foundation dimensions and depths, reinforcing steel details, necessary concrete strength, and seismic design details (Haro, Kasunich and Associates, November 2014). Proposed cut and fill grading elevations will be used to specifically evaluate soils at foundation zone elevations and will provide specific mathematical design parameters including but not limited to active earth pressures and seismic surcharge loads in accordance with City and California Building Code requirements.

Mitigation Measures

Implementation of the following mitigation measure will reduce the impact to a less-than-significant level.

MITIGATION GEO-1: Incorporate all recommendations of the project geotechnical investigations and reviews (Haro, Kasunich & Associates, April 2007; February, June, and August 2010; November 2014; and November 2016) in a project design-level geotechnical investigation and incorporate recommendations into final building, grading and drainage plan designs into building plans with additional soils borings as recommended to finalize designs of foundations and retaining wall.

Impact Geo-2: **Slope Stability.** Project development will result in construction on moderate slopes, regrading of the upper slopes, and construction of homes on cut pads, but the project would not cause or result in slope instability. Potential instability of a fill slope below Graham Road will be addressed with the proposed retaining wall along the eastern edge of the site (3b). Thus, this is considered a *less-than-significant impact*.

The project site slopes gently from Graham Road to Ocean Street Extension and about half of the site contains slopes over 15 percent. Slopes greater than 30 percent are confined to the northeastern corner of the site and along Graham Hill Road as shown on Figure 4.3-1, which depicts existing slopes based on an engineered survey of the existing site topography. The site will be graded for building pads and the buildings will be partially stepped up the site. Figure 4.3-2 includes cross sections of the site with the proposed buildings, and Figure 4.3-3 shows the proposed grading plan.

Seven of the proposed buildings (4B, 5B, 6B, 7B, 8B, 9B, and 10B) will be cut into the hillside with the cuts retained by walls which will also support the buildings and which are presumably of concrete masonry unit or reinforced concrete construction (Haro, Kasunich and Associates, February 2010). The geotechnical feasibility investigation recommended that buildings not be constructed on slopes greater than 25 percent without a quantitative slope stability analysis performed by a qualified geotechnical engineer. Portions of the eastern buildings (10B, 9B, 8B, 7B) appear to be situated on slopes at or near 25 percent slopes, but would be protected with the proposed retaining walls. A quantitative slope analysis has not been conducted.

A “buttress wall” (retaining wall) is proposed along the eastern edge of the planned structures to retain portions of the cut slopes below Graham Hill road and to accommodate building pads. The wall will be approximately 435 feet in length with a height of approximately eight feet. Cuts for Buildings 7B, 8B, 9B, and 10B will be approximately five feet downslope from this retaining wall. The project geotechnical feasibility investigation concurred that a retaining wall is the best solution to buttress the existing fill slope adjacent to Graham Hill Road and accommodate level building pads and would address concerns with the potential slope instability of this slope (Haro, Kasunich and Associates, April 2007). The retaining wall height should be such that a 2:1 (horizontal to vertical) maximum gradient is achieved for final backfill grades (Ibid.). Where uniform, undisturbed, weakly cemented white sands are exposed at the bottom of the retaining wall a spread footing may be used to support retaining walls. Where the weakly cemented white sands are not exposed at the base of the wall, retaining walls should be supported by piers (Ibid.).

Retaining wall supporting structures should be designed for a surcharge from the buttress wall. The surcharge can be reduced by deepening the footing for the buttress wall, which will result in significantly increased retained heights. Alternately, the walls may be tied back with helical or grouted anchors (Haro, Kasunich and Associates, February 2010). No preliminary borings were drilled in this area so depth of surface soils and density of the underlying bedrock are unknown. If the underlying bedrock is very dense, helical anchors may not be feasible. The geotechnical review recommends additional borings in this area to determine final retaining wall design criteria (Ibid.). Subsequent communications with the geotechnical engineer indicate that it is their professional opinion that there are several foundation options to support the buttress retaining wall (soldier piles, embedded gravity walls), and that the type of foundation that is chosen and designed (based on additional borings) will not change the current layout of the development (Haro, Kasunich and Associates, August 2010).

A portion of the slopes below Graham Hill Road will be regraded, resulting in a less steep slope gradient and buttressed with a retaining wall with a back slope of a more stable gradient of 2:1 (horizontal:vertical) (Haro, Kasunich and Associates, August 2010). It is the professional opinion of the geotechnical engineer that buttressed 2:1 cut slopes into native soils will be stable with drainage and erosion controls (Ibid). The final slopes behind proposed Building 8 will be part of a future slope stability evaluation that will also verify the adequacy of the proposed six-foot setback (Ibid.). If not adequate, the geotechnical engineer anticipates placement of an extended slough wall or a more heavy duty or permanent erosion control blanket over these slopes (Ibid.).

The proposed grading to create level building pads benched up from Ocean Street Extension to the steeper slopes utilizes retaining walls to contain proposed cut slopes that are 5 to 15 feet high. This design significantly increases the overall stability of the site and therefore reduces any potential instability that may occur in the near surface soils (Haro, Kasunich and Associates, November 2014). Based on the proposed layout and a review of the cross sections depicting the retained excavations and level building sites, the geotechnical engineer concluded that slope instability is not a concern relative to development areas addressed in the 2007 geotechnical feasibility report. There are no structures or project improvements proposed on the steeper slopes adjacent Graham Hill Road (Ibid.).

Five buildings are proposed along the eastern edge of the project site (4B, 10B, 9B, 8B, and 7B). The northeastern corner of proposed Building 10B encroaches slightly within a 30 percent or greater slope area. However, this area will be regraded to create 2:1 slopes. Building 9B is approximately 5-15 feet from the edge of slope, and the other buildings are 10-15 feet from the edge of 30 percent slopes. As indicated above, of the geotechnical engineer has indicated that the proposed buttressed 2:1 cut slopes into native soils will be stable, and further concluded that the proposed 5-foot setbacks were adequate (Haro, Kasunich and Associates, August 2010). Review of project setbacks with regards to City policies and regulations is included in Chapter 4.7, Land Use.

Mitigation Measures

Although mitigation measures are not required, Mitigation Measure Geo-1 includes implementation of recommendations of the existing geotechnical investigations and an updated project-level geotechnical investigation that includes additional slope analyses to finalize retaining wall design.

Impact Geo-3: **Soils Constraints.** With implementation of recommendations of the geotechnical feasibility report, development of the project is feasible from a geotechnical standpoint (3b), and impacts related to soil constraints are considered a *less than significant*.

The geotechnical feasibility investigation included construction aspects related to grading for building pads and access roads, retaining walls, and drainage. A subsequent review of the project grading and drainage plan was completed in February 2010, and subsequent soils borings were completed on the southern portion of the site in November 2016.

The primary soils concerns at the site include uniform soil support for foundations, appropriate control of surface runoff and erosion. The preliminary geotechnical report concluded that the proposed residential project is feasible as long as the recommendations in the geotechnical report are applied to the project design (Haro, Kasunich and Associates, April 2007). The investigation assumed construction of one- to three-story, wood frame residential structures. Recommendations are provided for four identified zones on the site that exhibit different soil and subsurface conditions. Some redensification of building pad soils may be required if cuts do not penetrate loose surficial soils. Alternately pier and grade beam foundations may be designed to penetrate loose soils and bear on underlying medium dense sands or hard non-expansive clays.

Due to the non-uniformity of the native soils, the geotechnical review recommends processing and redensifying the native soils to provide uniform bearing support for new conventional spread footing foundations (Haro, Kasunich and Associates, April 2007). Where slopes are between 15 and 25 percent, a pier and grade beam foundation should be considered, however additional borings should be performed to identify a uniform bearing strata for the piers (Ibid). Drainage controls will be needed next to the foundation due to perched groundwater conditions (Ibid.).

Mitigation Measures

Although mitigation measures are not required, Mitigation Measure Geo-1 includes implementation of recommendations of the existing geotechnical investigations and an updated project-level geotechnical investigation at the time of submittal of building plans. These recommendations include additional soils borings for final foundation and retaining wall design.

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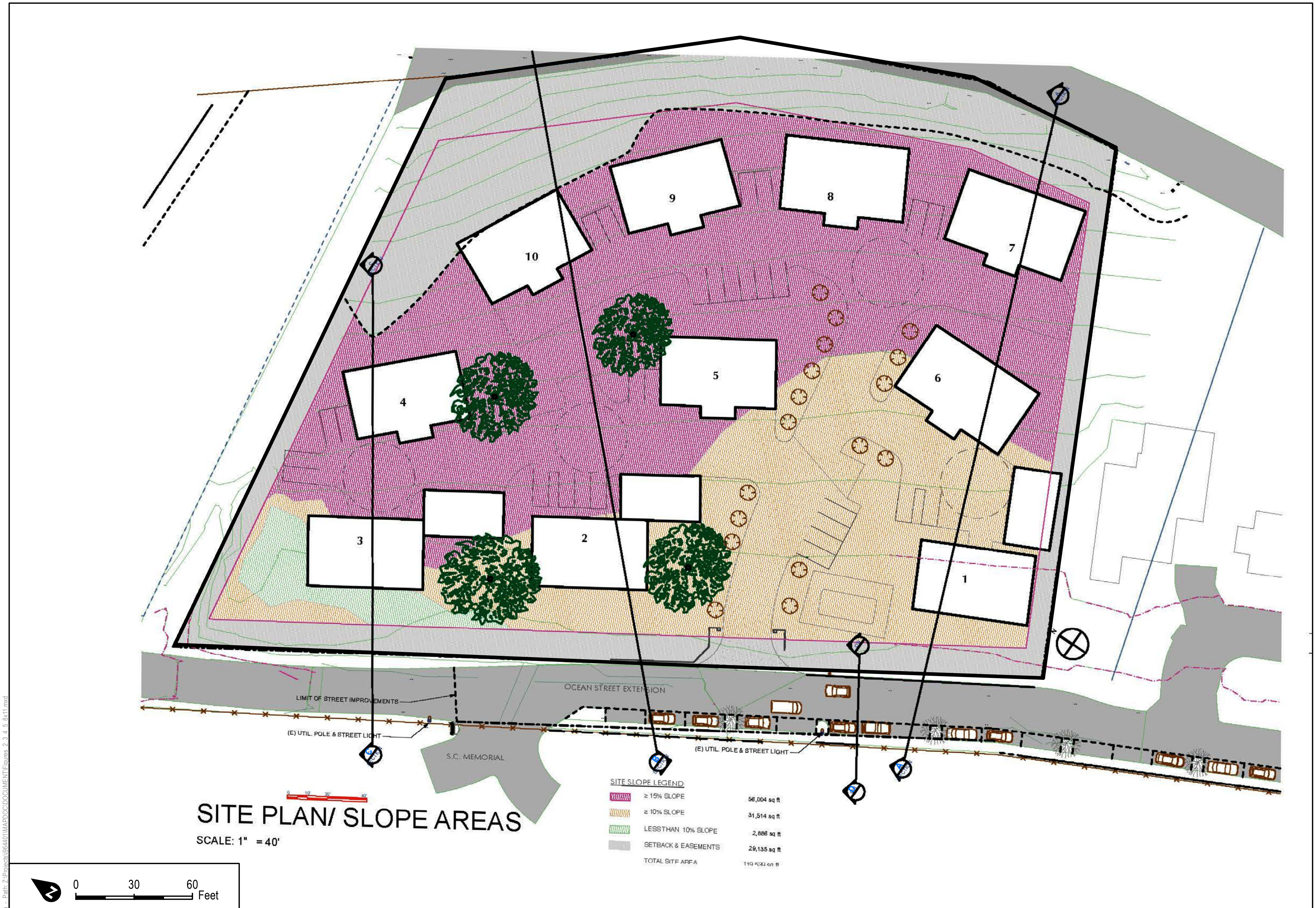


SOURCE: Dennis Diego Architect AIA 2016

DUDEK

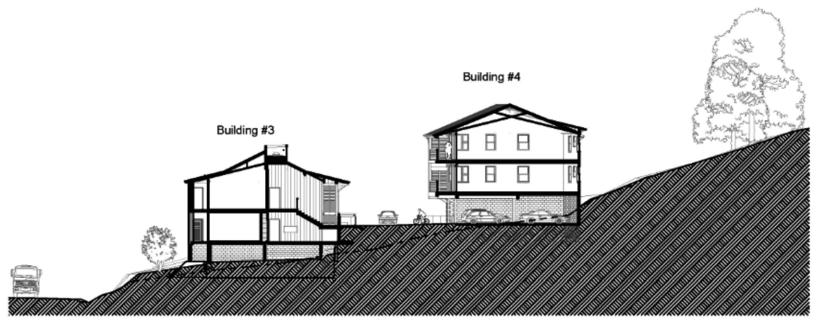
FIGURE 4.3-1

Project Site Slope Map

1930 Ocean Street Extension Residential Project

SITE SECTION A

SITE SECTION B



SITE SECTION C

Not to scale
See 4.3-1 Project Site Slope Map for cross section locations

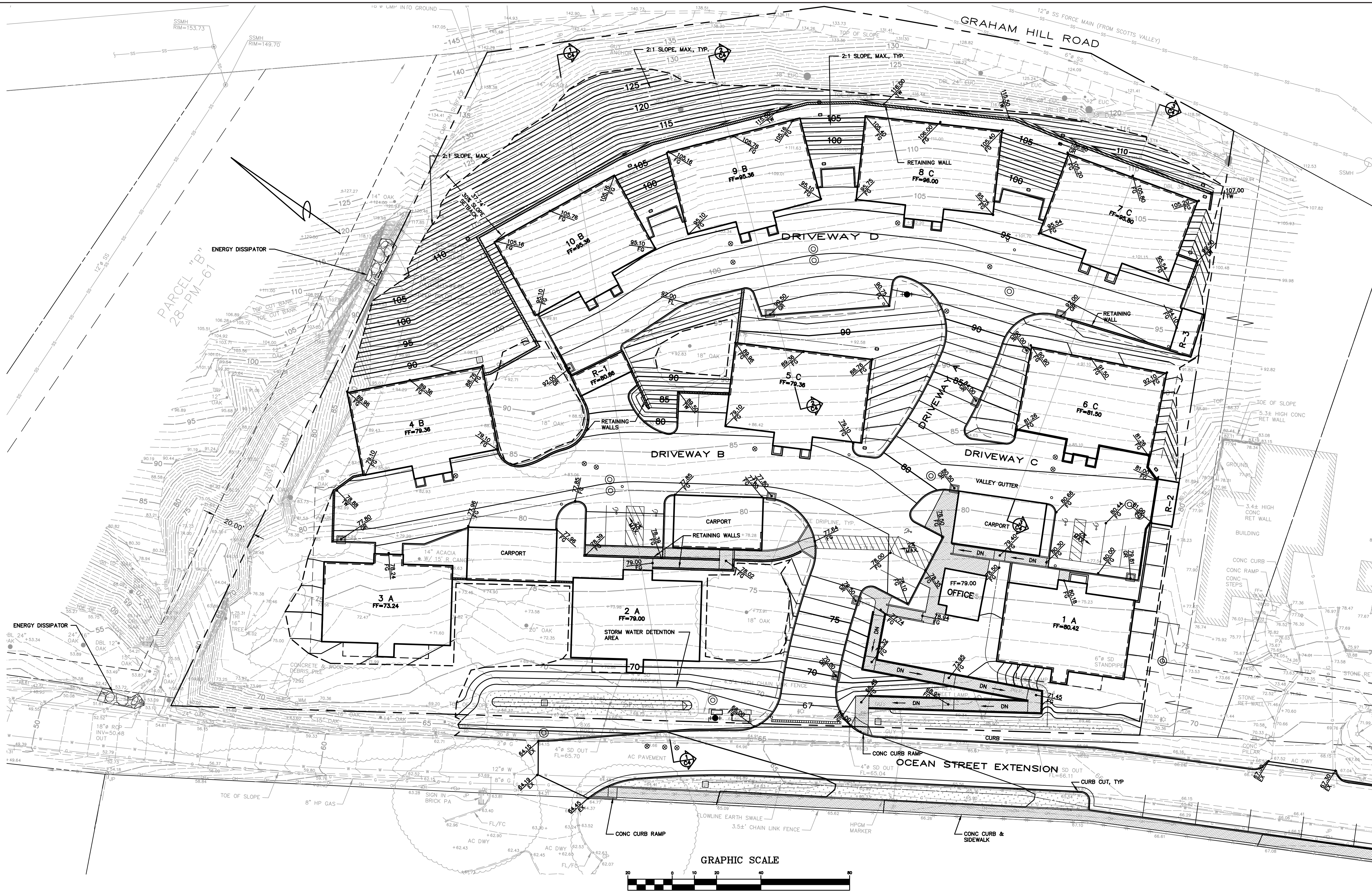
DUDEK

SOURCE: Dennis Diego Architect AIA

FIGURE 4.3-2

Cross Sections

1930 Ocean Street Extension Residential Project



SOURCE: Bowman & Williams (2016)

DUDEK

FIGURE 4.3-3
Proposed Grading Plan

1930 Ocean Street Extension Residential Project