CivicKnit

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June 4, 2021
Sabrina Cardoza, Senior Planner
Marin County Community Development Agency
3501 Civic Center Drive
San Rafael. CA 94903
RE: 21 Calle del Onda, Stinson Beach CDP Completeness response (Project IDP3049)

Ms. Cardoza,
We are submitting three sets of revised drawings, one digital copy on a thumb drive and this written response to your March 18, 2021 letter requesting additional information to complete our Coastal Development Permit application.

Additional completeness items we have provided include the following:

- A May 13, 2021 Easkoot Creek Hazards Analysis prepared by R.M. Noble & Associates that determined the site will not be impacted by 100-year flooding conditions, including sea level rise modeling done by O'Connor Environmental Inc. for the Marin County Flood District's Stinson Beach Watershed Program Flood Study and Alternative Assessment.
- A new Sheet 12 in our application drawing set that provides a Constraint Map as requested.
- Story poles were erected on the site.
- Modification of Sheet 10 details indicate replacement of low concrete landscape retaining walls and foundations with wood fencing set in sand.
- Modification of Sheet 3 indicates reduction of the concrete septic system protection wall alignment to the minimum perimeter required by Stinson Beach County Water District (SBCWD) for the wastewater permit. In addition, more specific Flood Zone requirements have been added to the sheet.
- Modification of Sheet 8 illustrates that the accessory garage structure will not be constructed on a deep pier foundation.

In addition, the specific coastal hazard analyses requested in the Coastal Commission's March 16, 2021 letter are all provided in the Noble Consultants, Inc. June 22, 2020 update of its Coastal Engineering Analysis that incorporates the 2018 Ocean Protection Council Sea Level Rise Guidance report scenarios, accompanied by a May 6, 2020 CivicKnit letter to SBCWD.

Consistent with LCP Unit 1 Shoreline Protection and Hazards Areas Policy 9, this application includes the following key reports to utilize when evaluating this application:

- **Attachment C:** The 2016 Noble Consultants, Inc. Coastal Engineering Analysis
- **Attachment B:** A Noble Consultants, Inc. June 22, 2020 update of its Coastal Engineering Analysis that incorporates the 2018 Ocean Protection Council Sea Level Rise Guidance report scenarios, accompanying a May 6, 2020 CivicKnit letter to SBCWD
- The SBCWD adopted June 2020 Initial Study/Mitigated Negative Declaration prepared in support of the project's wastewater permit. The report evaluates site aesthetics, biological resources, cultural resources, land use, noise, public services and utilities.

- The January 14, 2021 Limited Preliminary Geotechnical Feasibility Study prepared by Murray Engineers, Inc.
- **Attachment A:** The May 14, 2021 R.M. Noble & Associates letter analyzing flooding hazards from Easkoot Creek.

Based on Preliminary Merit Comments from the County and the Coastal Commission, we offer the following:

TAKINGS ANALYSIS

Since the Coastal Commission may designate the entire site as beach and dune ESHA and it is entirely within two mapped 2018 FIRM coastal flood zones, a Takings Analysis is required to evaluate this permit application. Permit reviews must be balanced under the U.S. and California Constitutions and Coastal Act Section 30010 to prohibit a planning decision from denying or granting a permit in a manner which takes or damages private property without the payment of just compensation.

In 2016, Marin County undertook a Takings Analysis for the Hjorth Residence on Calle del Pradero. The County acknowledged that a strict application of the LCP development policies could result in a regulatory taking and avoided that by performing a Takings Analysis before approving the project. On February 11, 2016, the Ca. Coastal Commission considered an appeal of the Hjorth residence approval. The staff recommended No Substantial Issue and the Commission approved the staff recommendation.

Given that a residence previously existed on this infill property and the owners have continuously paid annual property taxes assessed at a value that assumes development potential, the owners have a reasonable expectation for their modest development to be approved.

The project as proposed does not impact natural coastal resources, coastal views, or public access. It is modest in size, compatible with community character, maintains all required yard and height setbacks and sets considerably further back from the waterfront than neighboring properties.

It retains the natural sand contours, proposes no landscaping in sandy areas and voluntarily offers a 40' wide horizontal public access easement. In addition, the applicant agrees to assume all risks and waive all permitting agencies' liability, and further agrees to record a deed restriction that permits no future shoreline protection and requires removal of the structure at such time as a legally authorized public agency issues an order to do so.

In support of approving the design as proposed, we are offering the following information.

DUNE AND SANDY BEACH PROTECTION

The proposed building design protects the property's sandy beach setting as submitted.

- No grading or landscaping of sandy areas to the east and south of the building is proposed. The shoreline portion of the structure is cantilevered to visibly retain all sandy beach terrain. Over half of the property remains sandy beach with no development proposed. All sandy areas adjacent to existing Calle del Onda vertical public access are retained.
- The owners voluntarily offer to mitigate limited sandy area impacts by recording a 40' wide lateral public easement on dry sand, plus maintaining a minimum 50' open space buffer between the easement and the building.

- The SBCWD adopted Wastewater System Initial Study/Mitigated Negative Declaration (IS/MND) states that the project would not impact habitat for any rare or valuable plant or animal species and the high degree of current human activity on the beach limits future biological value. Low-density residential development on the same sandy soils exists on three sides of the project.
- The building footprint provides greater sandy beach protection than neighboring properties by being located 39' behind the imaginary "string line" across their shoreline face.
- The design is comparably sized with other homes in the surrounding area, resulting in a FAR of only .11 where .30 is permitted. It utilizes a two-story solution to minimize the footprint.
- When compared with the 2016 application for this site, the design reduces the building size by 28% and increases the shoreline setback by an additional 35'.

SEA LEVEL RISE AND EASKOOT CREEK FLOODING HAZARDS

In Stinson Beach, by 2050 nearly 100% of parcels west of Shoreline Highway are vulnerable to flooding due to severe storms and sea level rise.

The project design incorporates recommendations from the substantial analysis of potential hazards, including the following studies:

- The 2016 Noble Consultants, Inc. Coastal Engineering Analysis
- A Noble Consultants, Inc. 2020 update of its Coastal Engineering Analysis that incorporates the 2018 Ocean Protection Council Sea Level Rise Guidance report scenarios, accompanying a May 6, 2020 CivicKnit letter to SBCWD
- A January 14, 2021Limited Preliminary Geotechnical Feasibility Study prepared by Murray Engineers, Inc.
- A May 14, 2021 R.M. Noble & Associates letter analyzing flooding hazards from Easkoot Creek. (Attachment A)

The building is set back 273' from the Mean High High Water (MHHW)line. Noble Associates Coastal Engineering Analysis confirmed that the structures will not increase floodwaters, change their flow or affect neighboring properties.

Based on OPC Guidance and the 2020 Noble Analysis, the lowest structural member will be set at 19.1'NAVD88 to comply with FEMA and County regulations. These engineering analyses also determined that there is a very high likelihood (99.5%) that the wastewater system will not be impacted during a severe storm in 2050, and a 50/50 chance that a 100-year storm would not overtop the septic system in 2070.

The May 13, 2021 Noble & Associates letter (Attachment A) analyzing Easkoot Creek flooding hazards determined that the site will not be not subjected to flooding from that source even as sea level rises over the next 50 years. The 2018 C-SMART Study states, "Due to topography, homes near Easkoot Creek sit approximately 5–10 feet lower than those directly on the beach."

SHORELINE PROTECTION

The 2021 Murray Engineers Geotechnical Feasibility Report presents conceptual level foundation recommendations that will be refined based on field testing, additional soil engineering evaluation and structural design consultation once a conceptual plan has been approved. The study concluded that the proposed new residence will likely need to be supported on rammed piers or similar ground

improvement technology, in order to reduce the potential for liquefaction-induced ground failure impacting the structure.

The project's approved wastewater system is set behind a natural land berm and located over 345' from the Pacific Ocean (MHHW), and over 350' from Easkoot Creek. Regardless, the SBWCD imposed a permit condition requiring a concrete perimeter system protection barrier to further reduce risk of damage during historic storm events. The bottom of the barrier wall will be set at elevation of 9' NAVD88, which is expected to protect the system through 2070. Other than the septic system containment barrier, no permanent armoring is proposed. Based on Coastal Commission comments, the garden fencing and retaining structures have been revised to be constructed solely with shallow wood posts set in sand and eliminated from the beach side driveway approach.

Consistent with LCP Unit 1 Shoreline Protection and Hazards Areas Policy 5, no seawall is proposed for the residence. The owners have agreed to assume the full risks associated with development of their property and to record a deed restriction that permits no future shoreline protection and requires removal of the structure at such time as a legally authorized public agency issues an order to do so.

SEISMIC RISK

As stated in the SBCWD adopted Initial study/Mitigated Negative Declaration, the Association of Bay Area Government's Bay Area Hazards resilience mapping tool indicates that the project site is not located within an Alquist-Priolo fault zone. The nearest such fault zone is approximately 1.3 miles west of the project site. Given that there are no Alquist-Priolo fault zones within the project site, the project site is not considered at risk of surface rupture.

MARIN COUNTY DEPARTMENT OF PUBLIC WORKS (DPW)

DPW found the application complete for conceptual review while providing comments relate to be provided in conjunction with a building permit application. However, we offer this additional information:

1. The project design meets all required driveway and parking size standards.

2. The project drainage plan is designed to prevent a net increase in storm runoff from the site based on use of permeable paving, subsurface storm water dissipaters and the high percolation rate of the sandy soil.

3. Based on the 2018 Coastal Commission Sea Level Rise Guidance report, the 2020 Noble Coastal Engineering Analysis update established that a 19.1NAVD 88 elevation will comply with FIRM and Ca. Residential Code Sec. R322.2.1(2) requirements.

Sincerely,

Steve Kinsey

ATTACHMENT A

R.M. Noble & Associates

Ronald M. Noble, P.E., President
2420 Mountain Ranch Road
Petaluma, CA 94954
Phone: (415)-246-4595

May 13, 2021

Steve Kinsey
CivicKnit
P.O. Box 81
Forest Knolls, CA 94933

Re: Hazards from Easkoot Creek
21 Calle del Onda, Stinson Beach, CA
Assessor's Parcel No. 195-162-49

Dear Steve:

This letter is an addendum to our Coastal Engineering Analysis dated July 12, 2016 for the subject property, and our updated analysis on April 10, 2020 that reviewed our findings from July 12, 2016 and included wave runup, overtopping and overland wave propagation to determine wave conditions at the project site for the septic system based on the 100-year storm event in the year 2070, including consideration of the effects of SLR.

The purpose of this addendum letter is to consider any potential flooding and inundation impacts from Easkoot Creek, which is on the inland side (northeast side) of the subject property. In analyzing this potential hazard the following studies and information were reviewed:

- Noble's Coastal Engineering Analysis Report dated July 12, 2016
- Noble's updated analysis dated April 10, 2020
- L.A. Stevens & Associates Topographic Map dated 7/24/2015 and updated 8/31/2020
- FEMA Flood Zones in Calles Neighborhood
- CivicKnit's Recent FEMA and California Coastal Commission Guidance Information dated May 6 2020
- Coastal Commission Comment letter of Shoreline Protection and Hazard Areas on all lots in the Calles neighborhood of Stinson Beach dated March 31, 2016
- O'Connor Environmental, Inc.'s Stinson Beach Watershed Program Flood Study and Alternative Assessment dated May 2014

All coastal flooding associated with extreme tides, wave action, erosion, wave runup, wave overtopping, overland wave propagation and inundation, including the potential increase in groundwater have previously been analyzed and approved for the subject property. Therefore,

the comprehensive report prepared by O'Connor Environmental on the impacts from Easkoot Creek were reviewed as it related to flooding hazards to the subject property.

The O'Connor report performed detailed numerical modeling studies for several flooding scenarios of the lower portion of Easkoot Creek, which incuded the Calle del Onda properties. The flooding senarios included the severe December 2005 flood and the projected 100-year flood, including impacts during high tides and SLR. In all the flood maps presented in this report the flooding never reached the subject property. The lowest site grade elevation of the property on its inland side is above +12 feet NAVD88. The reported modeled flood elevation along Calle del Onda during the 2005 flood was 8.6 feet NAVD88, while the modeled 100-year flood was approximately +10 feet NAVD88 at Calle del Onda. Therefore, the site's design flood condition is associated with the previously addressed coastal flooding not from Easkoou Creek.

Sincerely,

R.M. Noble & Associates

Ronald M. Noble, P.E., D.CE, D.PE, D.WRE, Dist.M.ASCE
President

ATTACHMENT B

CivicKnit

P.O. Box 81
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steve@civicknit.com
415.307.1370

May 6, 2020
Ed Schmidt
General Manager
Stinson Beach County Water District
3875 Shoreline Highway / P.O. Box 245
Stinson Beach, CA 94970

RE: Recent FEMA and California Coastal Commission Guidance information

Mr. Schmidt,

At your request, based on comments that the Stinson Beach County Water District (SBCWD)received during the Public Comment period on the Draft Mitigated Negative Declaration prepared by WRA Associates for the 21 Calle del Onda Individual Wastewater System Variance application, I am providing you with this information.

The Water District's request was in response to letters received during the Public Comment period; specifically the January 27, 2020 letter from the U.S. Department of Homeland Security, Floodplain Management and Insurance Branch (FEMA), and the February 13, 2020 letter submitted by the Gulf of the Farallones National Marine Sanctuary (GFNMS).

Per your recommendation, Noble Consultants was re-hired to review their July 12, 2016 Coastal Engineering Analysis for 21 Calle del Onda, Stinson Beach, to obtain their professional judgment of the risks associated with installation of an on-site wastewater system in light of the 2017 revisions to federal Flood Insurance Rate Program (FIRM) maps and the updated 2018 California Coastal Commission (CCC) Sea Level Rise (SLR) Guidance. In addition to performing revised calculations that inform this correspondence, Mr. Ron Noble will be present at the meeting of your Board of Directors to respond to your Board's questions.

In response to the FEMA letter, Noble Consultants has confirmed that the proposed wastewater system will not increase the base flood levels in the surrounding area because of its relatively minor elevated volume relative to the entire Stinson Beach

shoreline where flooding would be occurring. Regarding the revised FIRM maps, Noble Consultants 2016 report used the 2015 Preliminary FIRM Map Extreme Still Water Level (SWL) elevation of +9.1 feet NAVD88, and a current 100 year Base Flood Elevation (BFE) of +15.6 feet, NAVD88. These elevations are identical with the values FEMA ultimately adopted for its 2017 FIRM map of Stinson Beach, resulting in no change to their previous flooding calculations.

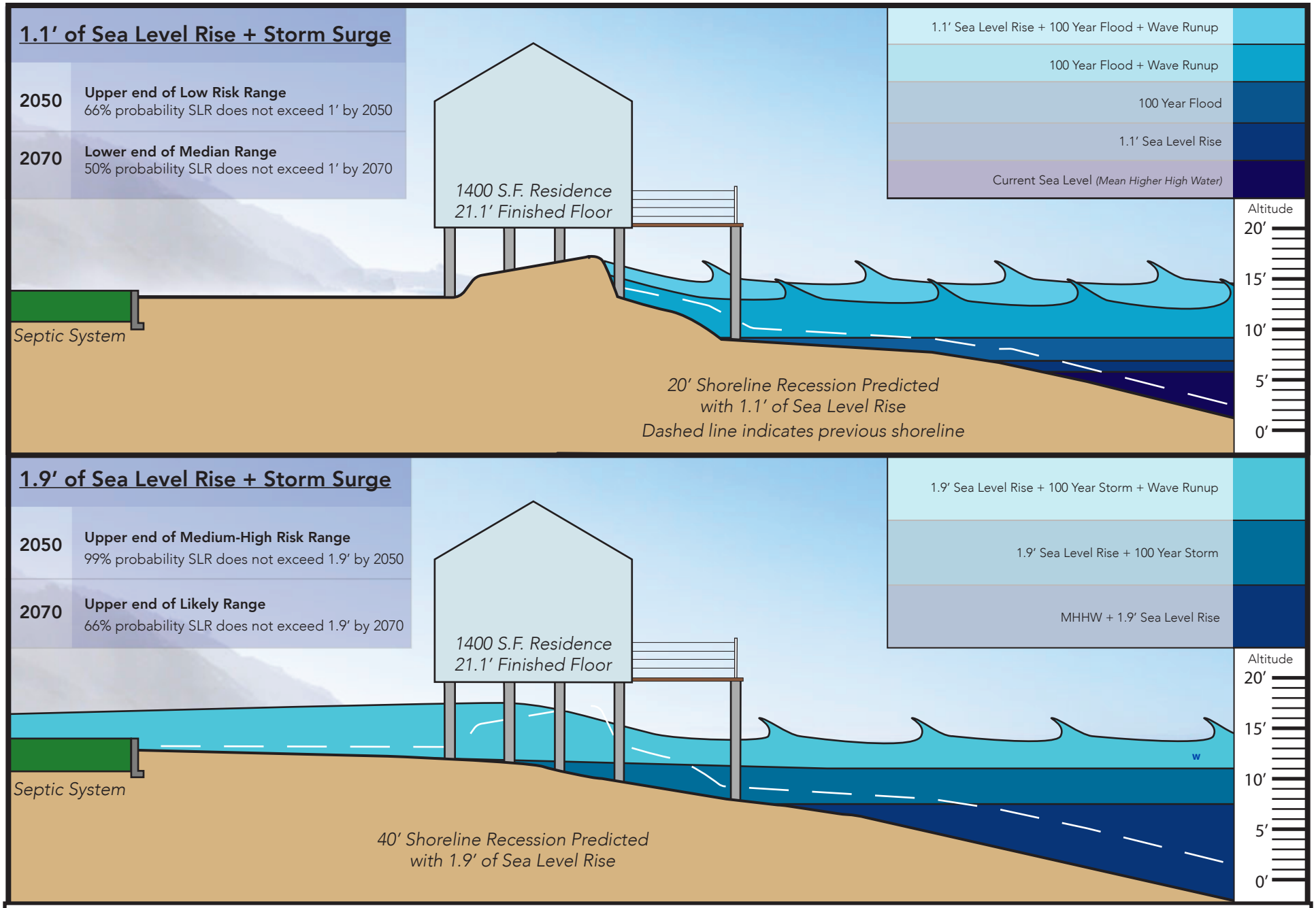
Changing Guidance on Coastal Conditions	
SLR Range in 2066 (2016 estimate)	0.6' - 2.5'
SLR in 2050 (66% likelihood)	0.6'-1.1'
SLR in 2050 (5% likelihood)	1.4'
SLR in 2050 (0.5% likelihood)	1.9'
SLR in 2050 (Extreme scenario)	2.7'
SLR in 2070 (66% likelihood)	0.8' - 1.9'
SLR in 2070 (5% likelihood)	1.9' - 2.4'
SLR in 2070 (0.5% likelihood)	3.5'
SLR in 2070 (Extreme scenario)	5.2'
Shoreline Recession w/ 1.1' SLR	20'
Shoreline Recession w/ 1.9' SLR	40'
Shoreline Recession w/ 3.5' SLR	80'

In responding to the GFNMS letter, the effect of the 2018 CCC Sea Level Rise (SLR) Guidance on Noble Consultant's 2016 Coastal Engineering Analysis, the chart to the left demonstrates the differences in potential SLR between the Coastal Commission's 2015 and 2018 Guidance reports. In 2015, the report provided only a potential range of SLR. In 2018, the report also presented a probability of the calculated SLR range occurring in the future.

The Coastal Commission's 2018 report increases the 2070 risks of sea level rise by 6 to 12 inches over its 2015 report. Assuming a 50 year life expectancy, the most conservative 100 year base flood elevation projection would increase from 18.1 feet, NAVD88 to 19.1 feet, NAVD88. This increased potential flood elevation will require the residence's lowest structural members to be no less than 19.1 feet NAVD88 to meet FEMA and Marin County development standards set forth in *Section 23.09.039 - Coastal high hazard areas*, excluding the stairwell leading into the habitable space. As a result the bottom of the home's framing will be 2-6 feet above the existing grade.

The Coastal Commission's most recent sea level rise projections increase the risk that the Calle del Onda wastewater system would be subjected to storm wave runup earlier than previously projected. However, because of the real world uncertainty regarding the actual rate of sea level rise, a precise period before wave action could reach the system cannot be predicted.

Based on the Coastal Commission's 2018 Guidance and Noble Consultants updated calculations, Figure 1 illustrates several potential scenarios that reflect different levels



CivicKnit

Figure 1 – Flood Risk & Sea Level Rise Predictions

5/5/20

of sea level rise and different durations. There is a very high likelihood (99.5%) that 21 Calle del Onda's septic system would not be impacted during a severe storm in 2050, and a 50-50 chance that 100 year storm waves would not overtop the system in 2070.

Figure 1 also illustrates what Noble Consultants predict could occur by 2050 if the unlikely (less than a 1% chance) rate of sea level rise proposed by the Coastal Commission occurs. A 100 year storm could produce wave runup that would overtop the wastewater system by as much as 4.5 feet. In addition, the scouring action could cause the shoreline to recede nearly to the edge of the system. However, the Coastal Commission's projections predict that even in 2070, there is a 66% likelihood that such a level would not be reached .

In the event that sea level rise increases at the higher rates before the useful life of the residence, the Calle del Onda property owner would face several options:

1- Participate in a community-wide wastewater system constructed outside of the flood hazard zone or protected by an alternative neighborhood solution.
2- Seek CCC permission to construct an east-west wave barrier that rises 4.5 feet above ground level and extends 4 feet below grade across their property.
3- Dismantle the development and retreat from the property.

Based on the County of Marin's 2017 C-SMART Sea Level Rise Vulnerability assessment, these options are identical to the choices that over 400 other Stinson Beach property owners will also face as the sea level rises to that height. (Figure 2).

Earlier in 2020, when considering whether to allow a recently repaired septic system to serve an entirely new residence at 11Alameda Patio, the SBCWD did not require a sea level rise analysis. Staff considered the existing sand dune across the property's beach frontage to be adequate to protect the system. However, if a coastal engineering analysis similar to the one required for Calle del Onda had been done, it would have demonstrated that by 2070, storm action, combined with the receding shoreline could also impact that system. (See Figure 2).

In 2015,SBCWD approved a Wastewater System Variance for 48 Calle del Embarcadero. That system is currently vulnerable to inundation from Easkoot Creek, and would face the same or greater impacts from ocean flooding by the year 2070 or sooner. Given that recently approved Wastewater Variances face similar risks from sea level rise over time, equitable consideration and fundamental fairness warrant approval of a Variance for the Calle del Onda property.

Stinson Beach

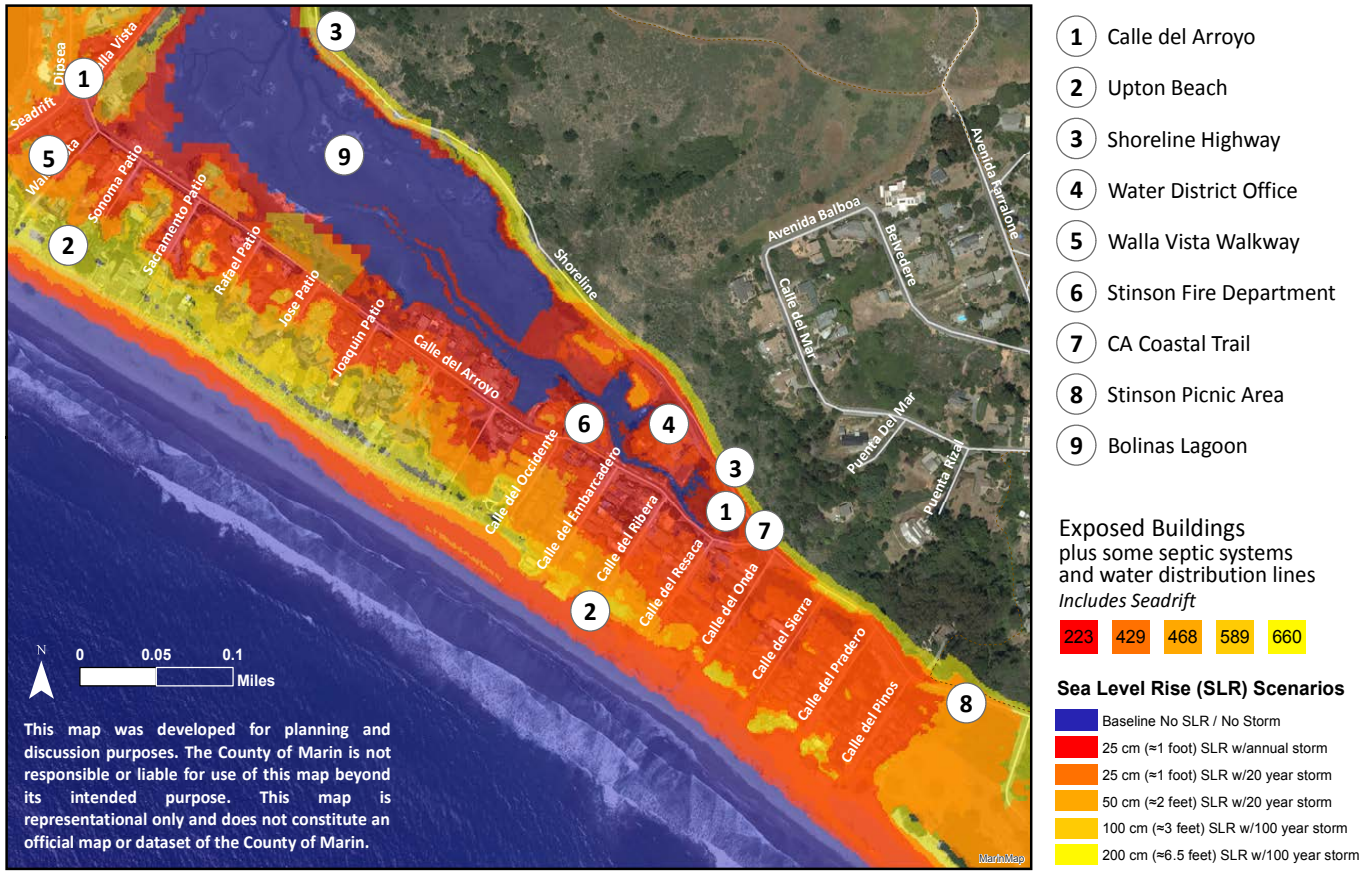


Figure 16. Stinson Beach Exposure Map. Does not include geomorphic change.

Figure 2- Marin's C-SMART (Collaboration Sea-level Marin Adaptation Response Team) **Report**

Regarding GFNMS concerns regarding water quality, the proposed system is superior to many of the older gravity systems still in service. In addition, the property's elevation places it above Easkoot Creek's historic floodplain. Marin County Environmental Health Services monitors water quality at Stinson beach from April through October annually. With over 500 existing, active on-site wastewater systems, Stinson Beach's central area is routinely found to have excellent ocean water quality. In recent years, Heal the Bay has awarded the area an A+ grade for the water quality. In extreme storm events, it will be possible for many systems to function sub-optimally, however the Calle del Onda system would not contribute appreciably to the overall water quality reduction at those times, and certainly doesn't warrant being singled out. Finally, the GFNMS statement about a 12 foot tall concrete retaining wall

around the wastewater system perimeter is incorrect, based on an error in the draft WRA Mitigate Negative Declaration that will be corrected by the author.

In summary, neither the 2017 FIRM Maps or the California Coastal Commission 2018 Sea Level Rise Guidance significantly change the 2016 Noble Report findings. In addition, the owners have agreed to limit the size of their residence to the Water District's minimum design capacity. They are prepared to record a deed restriction that commits them and all future property owners to participate in a community wastewater system if one is approved by the community. In addition, once a Wastewater Variance is granted, their single-family residence application to the County of Marin and the Coastal Commission will include a proposed Condition binding any owner to apply for a Coastal Development Permit to remove the structure at such time as the State or County order removal based on an increased level of coastal hazard.

We ask that you proceed immediately to schedule a hearing on this Variance.

Sincerely,

Steve Kinsey

ATTACHMENT C

NOBLE CONSULTANTS, INC.

July 12, 2016

Mr. Craig Nunes
554 View Street
Mountain View, CA 94041

Re: **Coastal Engineering Analysis**
For 21 Calle Del Onda, Stinson Beach, CA
Assessor's Parcel No. 195-162-49

Dear Mr. Nunes:

This letter report presents the results of our coastal engineering analysis for your proposed residence located at 21 Calle del Onda in Stinson Beach (APN: 195-162-49). Our scope of services included data collection & processing, engineering analyses (to include erosion analysis, flood hazard & wave uprush analysis, and mapping of the results), and preparation of a report that documents our analyses and mapping of results. The purpose of this analysis is to respond to the California Coastal Commission letter dated March 31, 2016 regarding "Shoreline Protection and Hazard Areas".

SITE CONDITION

The proposed residence is a new 2,154 square-foot single-family residence with an attached 330 square-foot one-car garage, in addition to new site improvements, including a septic system, driveway and boardwalk, located at 21 Calle Del Onda in Stinson Beach (APN: 195-162-49) as shown in Figure 1. This lot was previously developed with a house, that was destroyed by a fire. A topographic survey was conducted for this project site by L.A. Stevens & Associates, Inc. on July 17, 2015. The topographic survey, overlain with the site plan for the proposed development, is shown in Figure 2. The typical beach profile, which was derived from this July 17, 2015 survey, is shown in Figure 3.

SEA LEVEL RISE

Based on the National Research Council's (NRC) 2012 report[1] on sea level rise (SLR) for the coasts of California, Oregon and Washington, the Coastal and Ocean Working Group of the California Climate Action Team (CO-CAT) developed a SLR guidance[2] to advise California in planning efforts. Using the range of SLR presented in the NRC (2012) report, CO-CAT selected SLR values based on agency and context-specific considerations of risk tolerance and adaptive capacity. These SLR projections were unanimously adopted for use by the California Coastal Commission on August 12, 2015[3]. The SLR predictions for the project site are listed in Table 1.

Table 1. Sea Level Rise Projections

Time Period	By 2030	By 2050	By 2100
Sea Level Rise From 2000	2-12 inches (4-30 cm)	5-24 inches (12-61 cm)	17-66 inches (42-167 cm)

The focus of this study is to ascertain a sea level rise projection of approximately 50 years and determine the impact of SLR on the proposed residence. Using third degree polynomial curves to fit the range of the SLR projections as listed in Table 1, the SLR estimated for various periods is summarized in Table 2. The SLR estimated in the next 50 years (from 2016 to 2066) is 7.5-30.2 inches (0.6-2.5 feet).

Table 2. Sea Level Rise Estimates for Various Periods

Time Period	SLR
2000 - 2016	0.7-5.5 inches
2000 - 2066	8.2-35.7 inches
2000 - 2091	14.5-57.3 inches
In 50 years (2016-2066)	**7.5-30.2 inches (0.6-2.5 feet)**
In 75 years (2016 – 2091)	13.8-51.8 inches (1.2-4.3 feet)

[1] National Research Council (NRC), 2012. Sea-Level Rise for the Coasts of California, Oregon, and Washington: Past, Present, and Future (2012). http://www.nap.edu/catalog.php?record_id=13389.

[2] CO-CAT, 2013.State of California Sea-Level Rise Guidance Document, March 2013 update.

[3] California Coastal Commission, 2015. California Coastal Commission, Sea Level Rise Policy Guidance, unanimously adopted on August 12, 2015.

SHORELINE EROSION IN RESPONSE TO SEA LEVEL RISE

The shoreline recession in response to SLR was estimated using the Bruun Rule (1962)[4] . This theory has been widely applied by the engineering and scientific communities to provide a first approximation of the potential shoreline retreat caused by rising sea levels. Assuming all sand removed from the upper portion of the beach profile is deposited offshore as sea level rises, the Bruun Rule (1962) provides a relationship to estimate shoreline retreat as a function of sea level rise and beach profile characteristics. The Bruun Rule equation is:

$$R = S\frac{W_*}{(h_* + B)}$$

where R is the shoreline recession distance, *S* is the sea level rise, W_* is the horizontal dimension of the active zone of the beach profile, h_* is the depth of closure, and *B* is berm height above the sea level. Using this formula, the shoreline recession distances in response to various SLRs are summarized in Table 3. The shoreline erosion distance in the next 50 years will range between 20 feet to 80 feet, depending on the future SLR. The corresponding eroded beach profiles, compared to the existing (surveyed) profile, are illustrated in Figure 3.

Table 3. Shoreline Recession Distances in Response to Sea Level Rise

Time Period	Sea level rise (feet)	Shoreline recession distance (feet)
In 50 years (2016-2066)	**0.6-2.5**	**20-80**
In 75 years (2016-2091)	1.2-4.3	40-130

CURRENT (2016) COASTAL FLOOD ELEVATION

Currently a base flood elevation (BFE) of 26 feet, NAVD88 is listed in the effective Flood Insurance Rate Map (FIRM) for the proposed residence location. This FIRM was prepared by the Federal Emergency Management Agency (FEMA), with the effective date of May 4, 2009. However, an updated coastal flooding analysis was conducted by FEMA for Marin County in 2015. The results are summarized in the preliminary Flood Insurance Study (FIS)[5] dated July 29, 2015, with an updated preliminary FIRM.

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[4] Bruun, P. (1962), "Sea-level rise as a cause of shore erosion," Journal of Waterways and Harbors Division, Vol. 88 (1-3), 117-130.

[5] FEMA (2015), *Flood Insurance Study, Marin County, California and Incorporated Areas*, Prepared by Federal Emergency Management Agency, Preliminary, July 29, 2015.

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In this updated FIS, storm surge, swell, and locally generated wind waves were modeled on a regional scale using numerical models to deterministically predict water levels and wave conditions for the Pacific Ocean along the coastline of Marin County that is exposed to the open ocean. These data were then used as inputs in a 1-dimensional, transect-based analysis to determine the coastal flooding hazards onshore.

The SHELF model developed by the Scripps Institution of Oceanography was used for the regional surge and wave modeling. This hydrodynamic model included the effects of storm surge, wave effects, and other phenomena such as El Niño and La Niña conditions. The SHELF model produced a hindcast of hourly wave conditions for a 50-year period extending from January 1, 1960 through December 31, 2009. Hourly water levels were obtained from NOAA tide gauges and were paired with the SHELF model waves to analyze the coastal hazards at the shoreline. The frequency and magnitude of storm surge was derived statistically from the 50-year hindcast record.

Tidal elevation data for tide stations along the California coast were obtained from the NOAA's National Ocean Service (NOS). Temporal gaps in the records were filled using an approach that applied the relationships of observed tidal residuals between neighboring gauges to estimate residual components at stations with missing data. Using these correlations and an understanding of the spatial variability of regional storms, the gaps in gauge records were empirically reconstructed to provide a continuous hourly time series of still water levels for the desired period of record at each tide gauge. Once the hourly still water level hindcast was reconstructed for each tide gauge, each tide gauge was assigned the coastal reach for which it was considered to be most representative for the still water levels.

Extreme Still Water Level

Based on the statistical analysis, the extreme still water level (SWL) was computed for various return frequencies, and the results were summarized in Table 11 of the FEMA's (2015) FIS. The SWL at the project site is represented by that determined for the Point Reyes tide gauge. According to this FIS, the 1-percent annual chance (100-year) SWL is +9.1 feet, NAVD88. Based on the National Oceanic and Atmospheric Administration's (NOAA) tidal datums for Point Reyes, the Mean Higher High Water (MHHW) is: +5.74 feet, NAVD88, and the highest observed water level (02/06/1988) is: +8.52 feet, NAVD88. The FEMA's 100-year SWL is approximately 0.6 foot higher than the highest observed water level. To be conservative, the extreme SWL used in this analysis is: +9.1 feet, NAVD88.

Wave Runup Elevation

Water level and wave information from the tide gauge analysis and the SHELF model were used in FEMA's (2015) FIS as inputs to the 1-dimensional onshore flood hazard analyses. Wave setup, runup, overtopping, event-based erosion, and overland wave propagation were analyzed, where appropriate, at transects placed along the coastline.

Wave runup was calculated using one of three methods, depending upon the dynamic water level relative to the profile and the shoreline slope. As recommended in FEMA's Pacific Guidelines, the Direct Integration Method (DIM) was used to calculate runup for transects with natural, gently sloping profiles. The Technical Advisory Committee for Water Retaining Structures (TAW) method[6] was used for shorelines with shore protection structures and steeply sloping natural shorelines where the dynamic water level (DWL) exceeded the toe of the structure or bluff. If, for these shorelines, the DWL did not reach the toe of the structure or bluff face, the DIM was used for gently sloping profiles while a modified TAW approach was implemented on steeper shorelines. The Shore Protection Manual method[7] (USACE, 1984) was used to calculate wave runup on vertical walls.

The total runup, including wave setup and incident wave runup, was added to the SWL to determine the total water level (TWL). Annual TWL maxima were selected from the 50-year hindcast (1960-2009). The generalized extreme value statistical distribution was employed to calculate the 1-percent-annual-chance TWL at each transect, and the results are listed in Table 13 of FEMA's (2015) FIS. Based on this table, the total water level (the wave runup elevation or the flood elevation) at the project site (represented by Transect P58) is: +15.6 feet, NAVD88 for the 1% annual chance event. In other words, the 100-year flood elevation, or the Base Flood Elevation (BFE), at the project site is: +15.6 feet, NAVD88.

COASTAL FLOOD ELEVATION IN 50 YEARS (2066)

The wave runup (the vertical distance between the wave runup elevation and the SWL) is mainly a function of the incident wave condition and the beach condition, such as the roughness and the slopes of the beach profile (between the wave breaking point and the wave runup limit). As discussed under the Sea Level Rise section of this letter report, the SLR estimated for the next 50 years (from 2016 to 2066) is approximately 0.6-2.5 feet. For the same offshore wave condition, our analysis indicates that the wave runup virtually shows no difference whether this SLR is

[6] Van der Meer, J.W. (2002), *Wave Run-up and Overtopping at Dikes*, Technical Report. Technical Advisory Committee for Water Retaining Structures (TAW), Delft, The Netherlands.
[7] U. S. Army Corps of Engineers (1984), *Shore Protection Manual*, Volumes 1-3.

considered or not. The wave runup elevation is the still water level (SWL) added to the wave runup. Therefore, the SLR will impact the wave runup elevation mainly by elevating the SWL. Considering a SLR of 0.6-2.5 feet, the 1-percent annual chance (100-year) SWL in 50 years (2066) is approximately 9.7-11.6 feet, NAVD88, and the 1-percent annual chance (100-year) wave runup elevation, or the 100-year flood elevation is approximately 16.2-18.1 feet, NAVD88.

SUMMARY OF COASTAL FLOOD HAZARD

The extreme water levels at the project site are summarized in Table 4. The elevation of the lowest floor's horizontal member is designed at +18.1 feet, NAVD88. This elevation is higher than the 100-year SWL (10.3-13.4 feet, NAVD88) in 75 years (2091), and be above the 100-year flood elevation (16.2-18.1 feet, NAVD88) in 50 years (2066).

Table 4. Water Level (Feet, NAVD88) Summary

Mean Higher High Water (MHHW)	5.74
Highest Observed Water Level (02/06/98)	8.52
100-Year SWL	
Current (2016)	9.1
In 50 years (2066), with SLR = 0.6'- 2.5'	9.7 - 11.6
In 75 years (2091), with SLR = 1.2'- 4.3'	10.3 - 13.4
100-Year Flood Elevation	
Current (2016)	15.6
In 50 years (2066), with SLR = 0.6'- 2.5'	16.2 - 18.1
In 75 years (2091), with SLR = 1.2' - 4.3'	16.8 - 19.9
Elevation of the Lowest Floor's Horizontal Member	18.1

Figure 4 shows the representative beach profiles with the MHHW water lines. Figure 5 shows the beach profiles with the 100-year SWLs. Figure 6 shows the beach profiles with the 100-year flood elevations. Both the current (2016) condition and the condition in 50 years (2066) after considering SLR are shown in these figures. As indicated in Figure 6, part of the ground under the proposed residence will be inundated under the current condition, and part of, or the entire ground under the proposed residence will be inundated in 50 years after considering the future SLR.

Figure 7 shows the map for the current MHHW water line and the variation in range of the future MHHW line in 50 years in relation to the proposed residence. Figure 8 shows the map for the current 100-year SWL water line and the variation in range of the 100-year SWL water line in 50 years. Figure 9 shows the map for the current 100-year flood inundation boundary, and the variation in range of the future inundation boundary in 50 years. As shown in Figure 7, the proposed residence is approximately 240 feet landward of the current MHHW line, and approximately 90 to 210 feet landward from the MHHW line in 50 years. As shown in Figure 9, part of the ground underneath the proposed pile-supported residence will be inundated under the current 100-year storm event, and part of, or the entire ground under the proposed residence will be inundated in 50 years after considering the future SLR. As a reference, Figure 10 shows an enlarged view of the FEMA (2015) Preliminary Flood Insurance Rate Map (FIRM), dated July 29, 2015, for the project site. This FIRM shows a similar coastal flood inundation boundary as the current inundation boundary plotted in Figure 9.

It is noted that the design elevation of the lowest floor's horizontal member is at +18.1 feet, NAVD88. Therefore, the proposed pile-supported residence will withstand the anticipated 100-year flood elevation, or the wave runup elevation, in 50 years (2066), which will be 16.2-18.1 feet, NAVD88 after considering the low and the high SLR projections.

IMPACT OF SEA LEVEL RISE ON GROUNDWATER LEVEL

Sea level rise may elevate the groundwater level in coastal communities. However, this impact will decay as the landward distance from the shoreline increases. The estimated SLR will be 0.6-2.5 feet in the next 50 years. For the most conservative estimate, assuming the groundwater level will elevate at the same magnitude as the future sea level rise, the groundwater rise at the site of the proposed residence will not exceed 0.6-2.5 feet in the next 50 years. A wet weather testing conducted by a wastewater engineer, Troy Pearce, found no groundwater down to 6 feet. Therefore, the future groundwater level will be more than 3.5-5.4 feet under the ground in the next 50 years after considering the high and the low SLR projection.

WAVE ACTION ON SEPTIC SYSTEM

A septic system is proposed on the back side (landward) of the lot. The location of this septic system is shown in Figure 11. It is noted that this septic system is behind (landward of) the sand berm with a top elevation of approximately +17 feet, NAVD88. Under the current condition, the 100-year flood elevation (+15.6 feet, NAVD88) will not overtop this berm. Therefore, the septic system behind this berm will not experience coastal flooding hazard under the current condition. The 100-year flood elevation in 50 years (with SLR) may vary between +16.2 and +18.1 feet, NAVD 88. The sand berm will be overtopped if the flood elevation exceeds the top of the term.

Therefore, it is possible that the septic system will be inundated in 50 years by the water that overtops the berm. However, it will not be directly exposed to wave action from the ocean. In other words, the proposed septic system will not be subjected to coastal flooding under the current condition; however it may be subjected to coastal flooding in 50 years, but virtually without experiencing wave action or wave force.

* * * * *

We appreciate the opportunity to perform this coastal engineering analysis and prepare this report of our results for your proposed new residence at 21 Calle Del Onada in Stinson Beach. Please contact us if you should have any questions regarding our findings.

Sincerely,

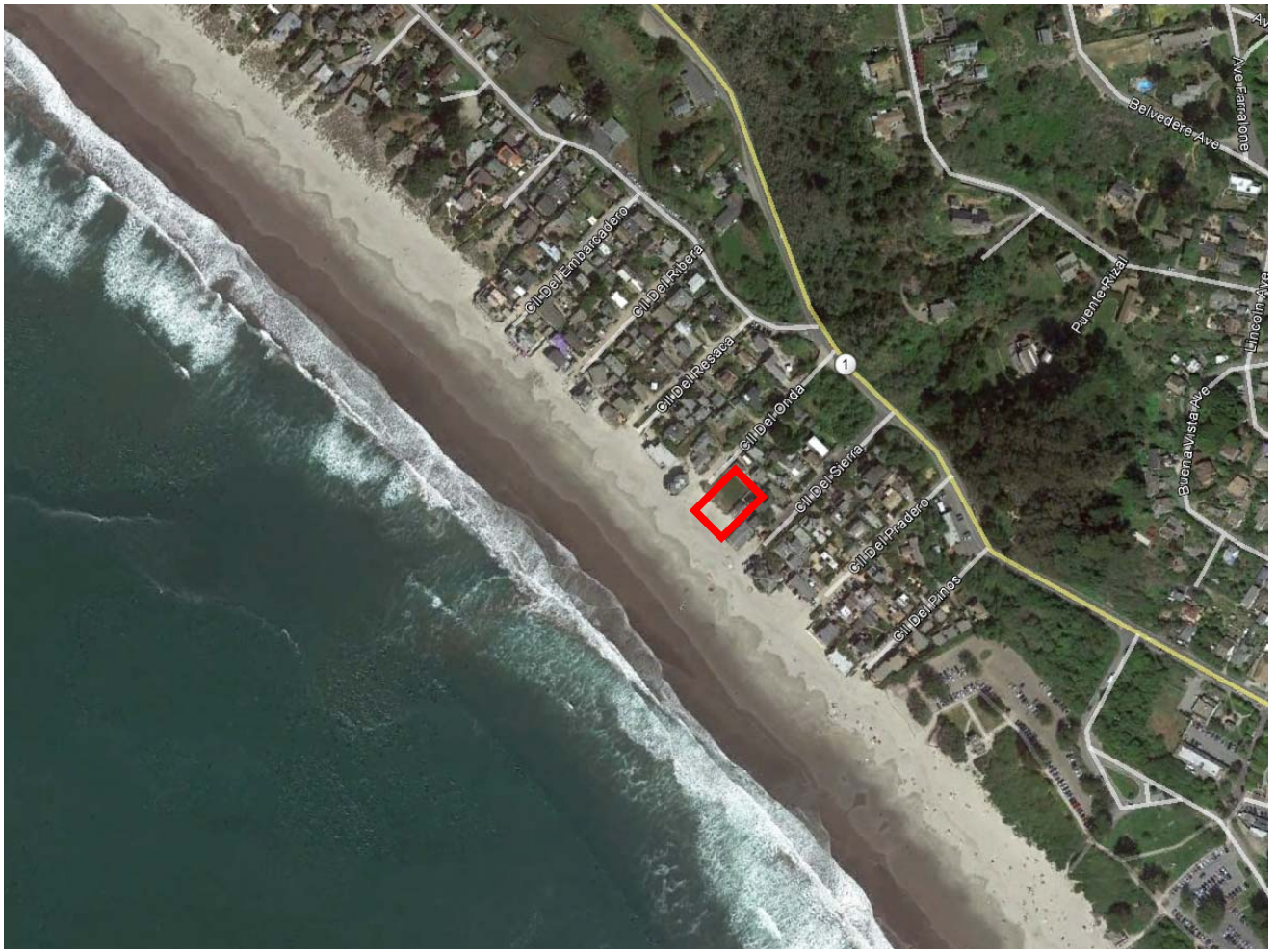
NOBLE CONSULTANTS, INC.

Ronald M. Noble, P.E., D.CE, D.PE, D.WRE
President

Wenkai Qin, Ph.D., P.E., D.CE
Manager, Coastal/Water Resources Analysis

RMN/ WQ

Attachments: (Figures 1 through 11)



Source: Google Earth

Figure 1. Location of Proposed Development (Red Box)

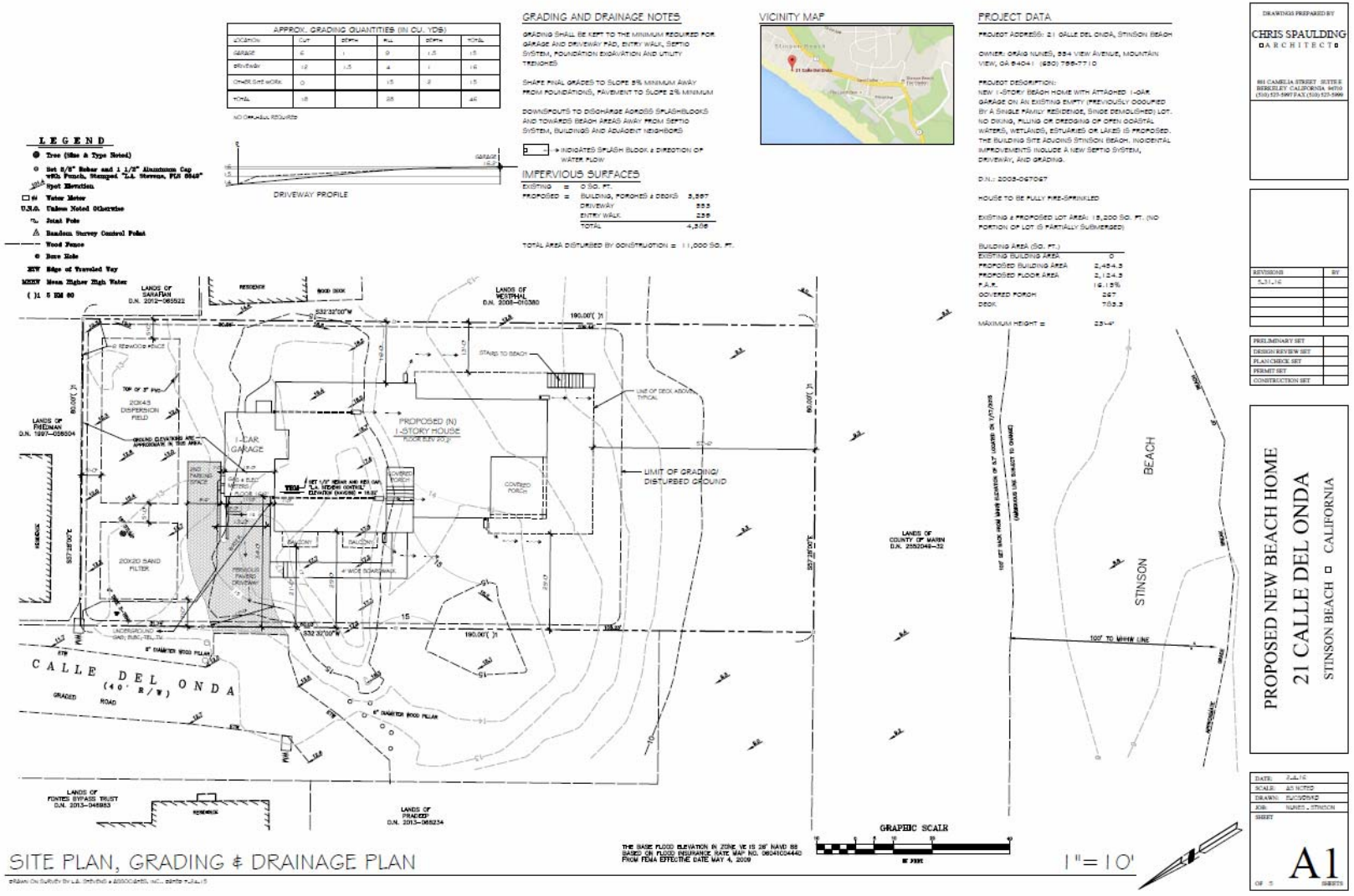


Figure 2. Topographic Survey Overlain with Site Plan for Proposed Development

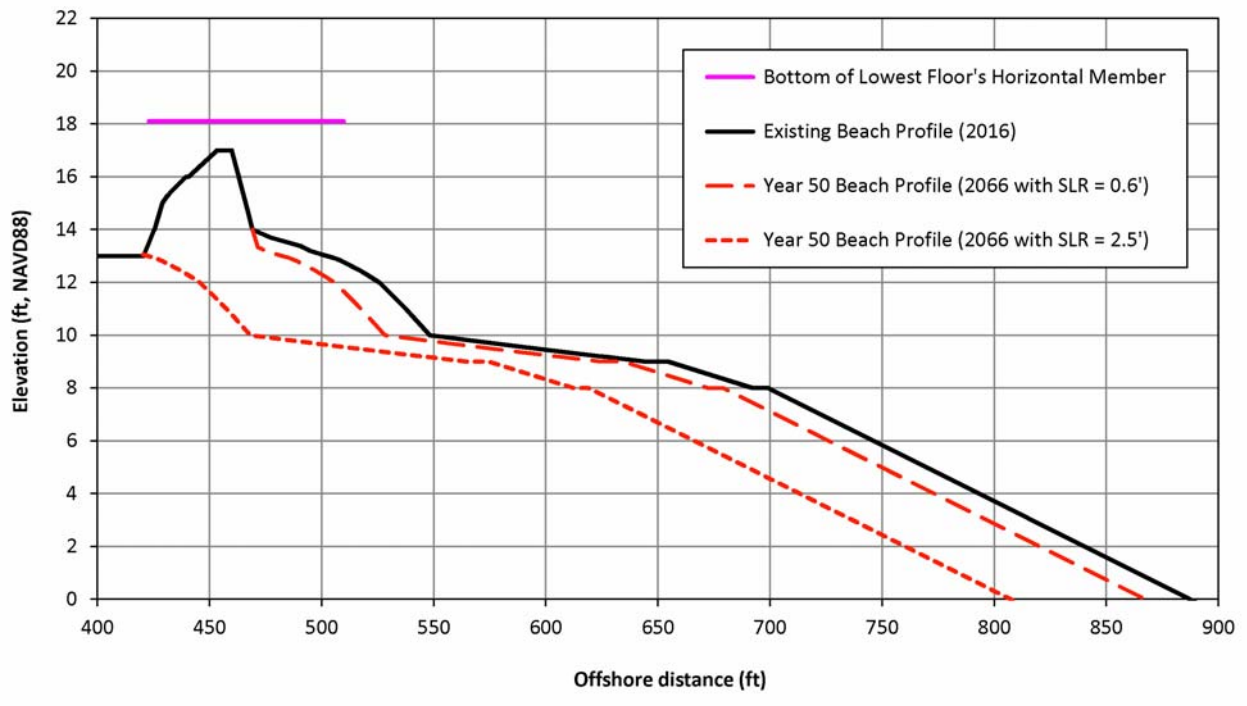


Figure 3. Eroded Beach Profile in Response to Sea Level Rise

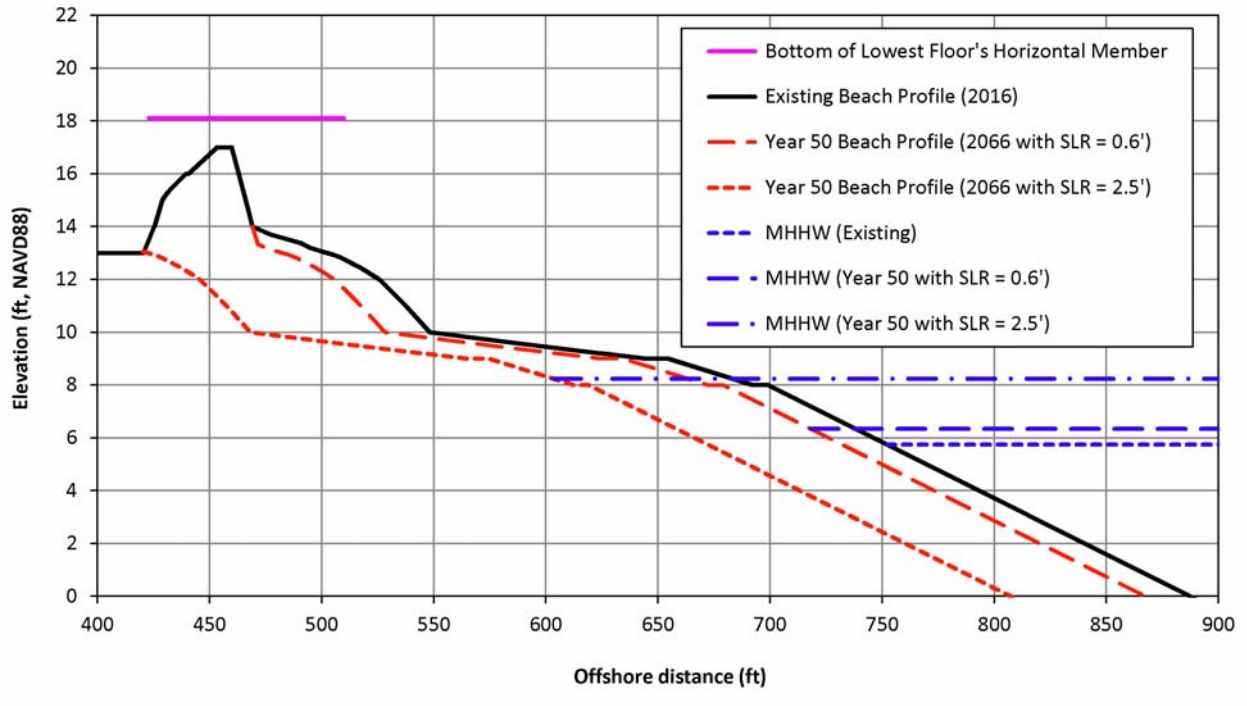


Figure 4. Mean Higher High Water (MHHW) Level

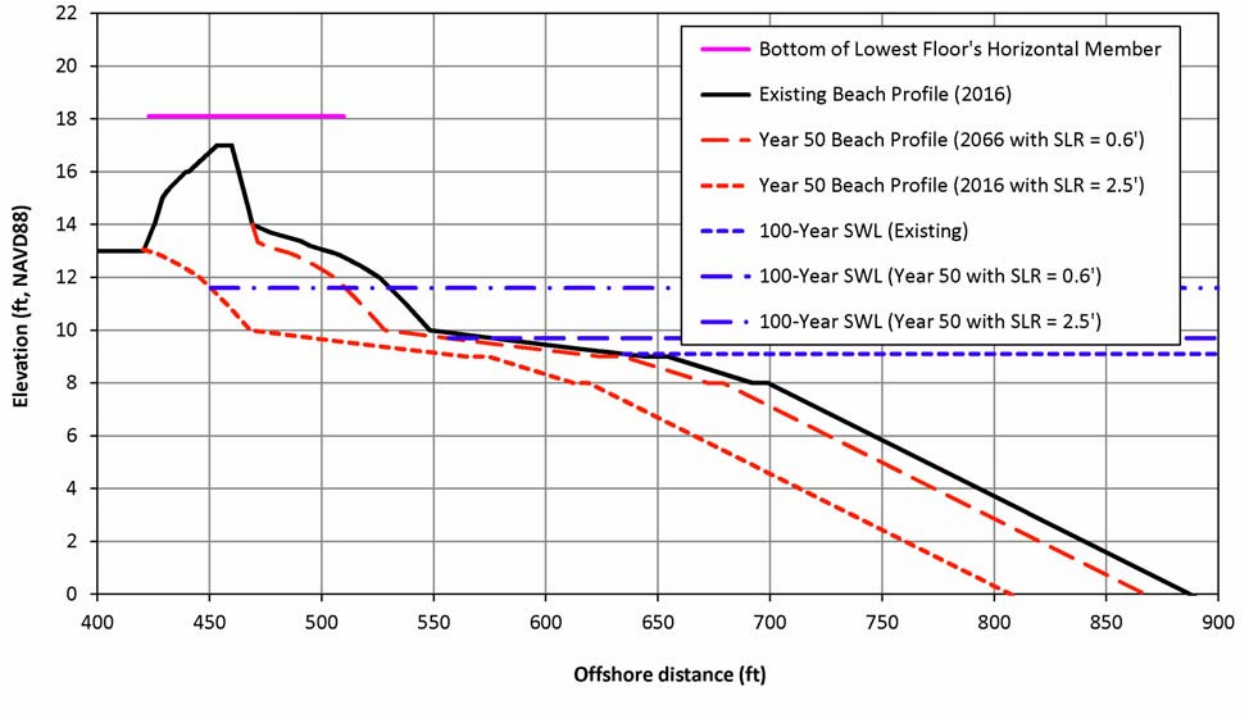


Figure 5. 100-Year Still Water Level

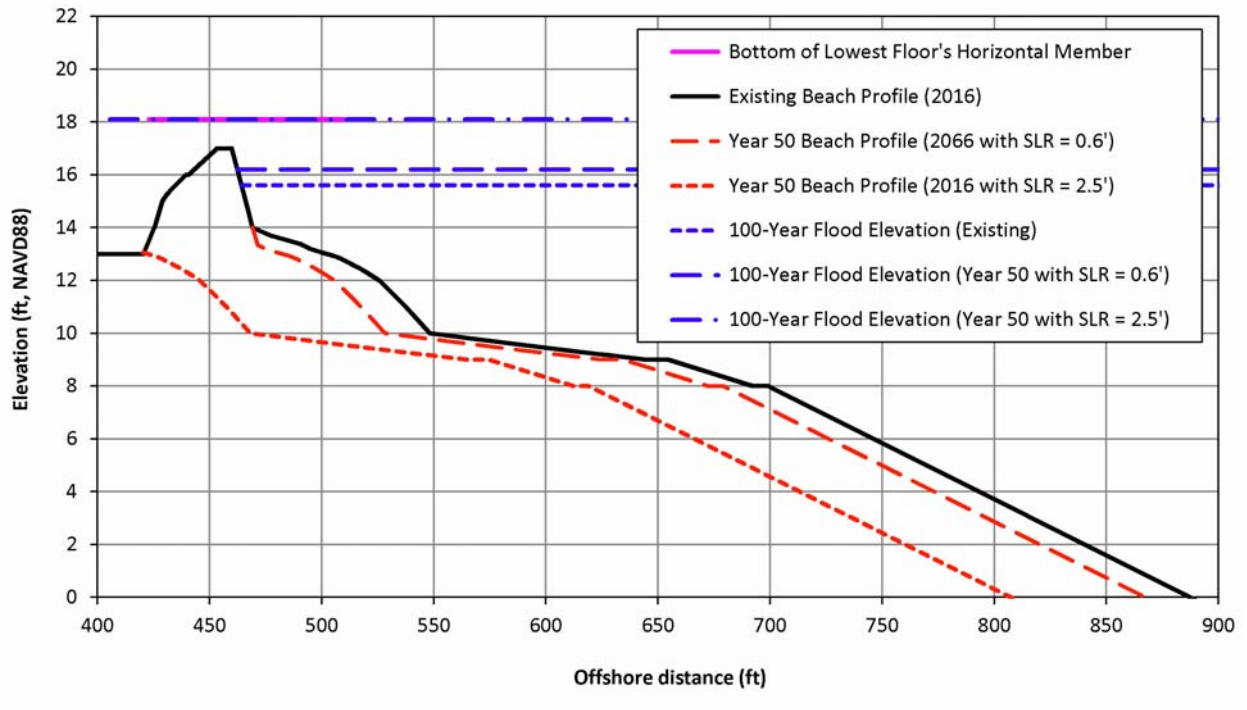


Figure 6. 100-Year Flood Elevation (Wave Runup Elevation)

Figure 7. Existing and Future Mean Higher High Water (MHHW) Lines

Figure 8. Existing and Future 100-Year Still Water Level Lines

Figure 9. Existing and Future 100-Year Flood Inundation Boundaries

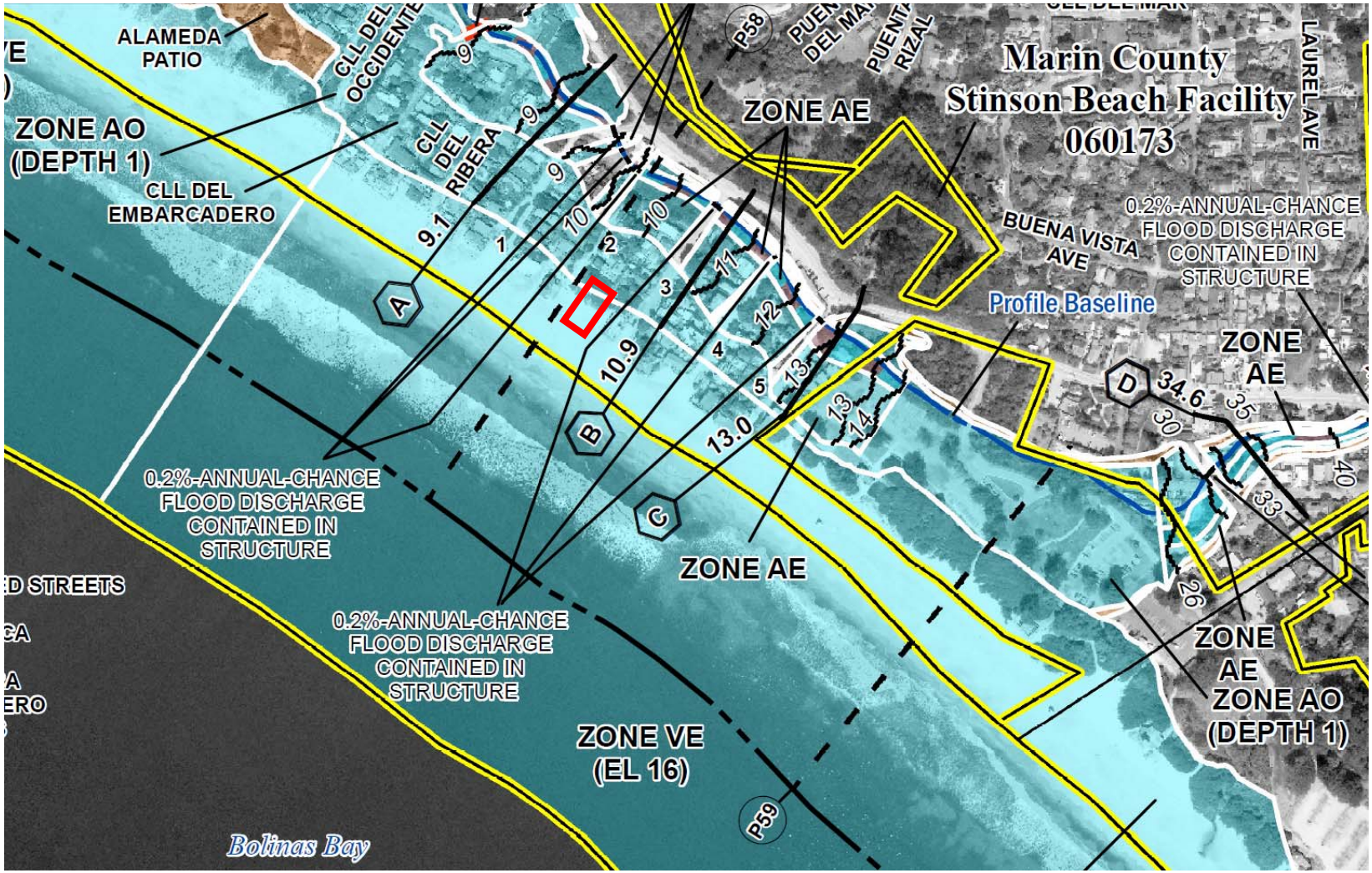


Figure 10. Enlarged View of FEMA (2015) Preliminary Flood Insurance Rate Map (July 29,2015) for Project Site (Red Box)

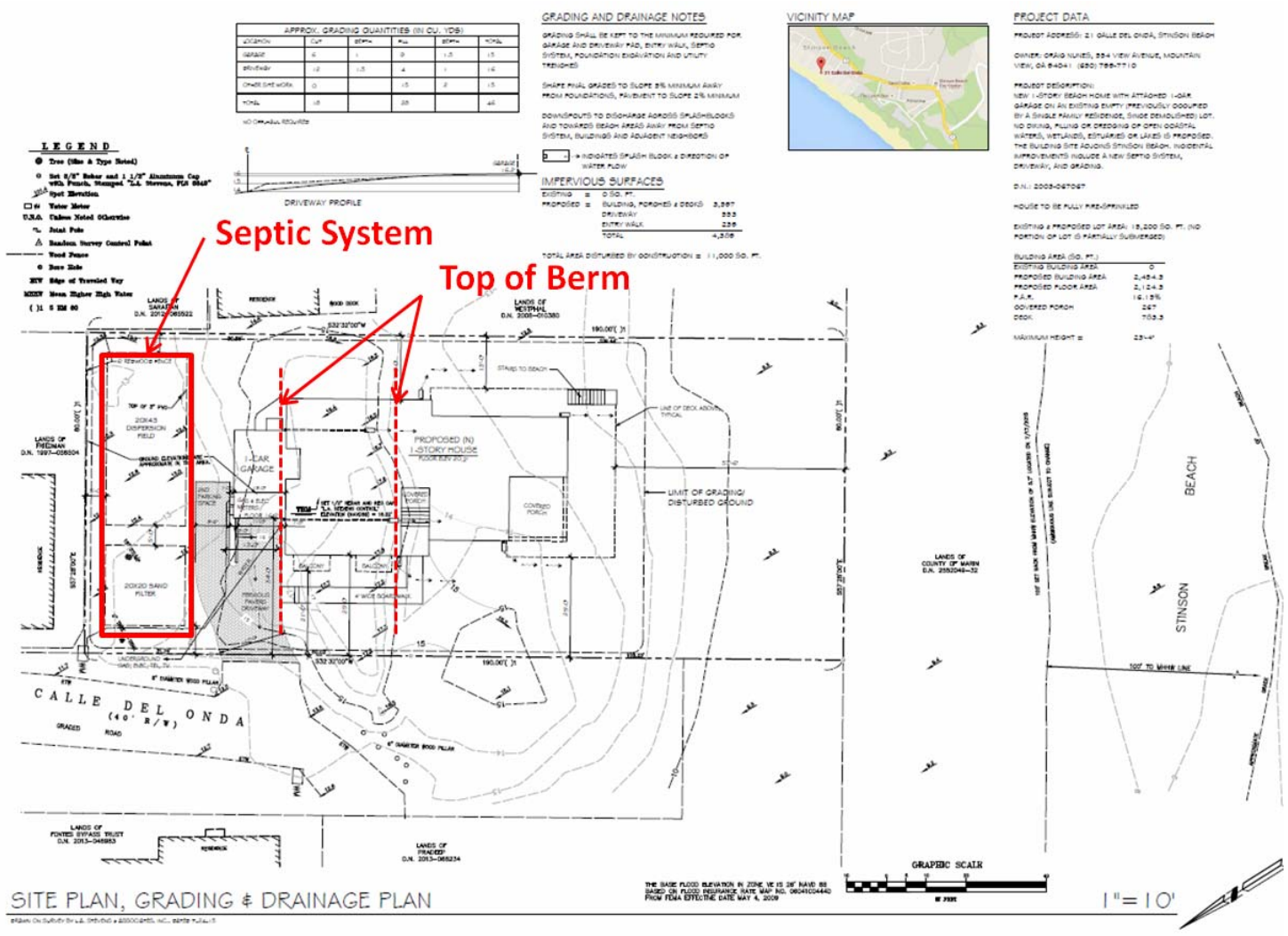


Figure 11. Location of Proposed Septic System Location with Relation to Sand Berm