

January 14, 2021
Project No. 3372-1L1 *Revised*

Alyce & Brian Johnson
21 Calle Del Onda
Marin County, CA 94970

**RE: LIMITED PRELIMINARY GEOTECHNICAL
FEASIBILITY STUDY,
NEW RESIDENCE,
21 CALLE DEL ONDA,
MARIN COUTY, CALIFORNIA**

Dear Ms. & Mr. Johnson:

We are pleased to present the results of our limited preliminary geotechnical feasibility study for the above-referenced project. The purpose of this feasibility-level study is to evaluate geologic hazards that could potentially impact the proposed new residence and associated improvements, and to provide a summary of conceptual foundation options to support the proposed new residence and associated improvements. As the basis for our study, we reviewed published geologic and hazard maps, reviewed preliminary improvement plans provided by CivicKnit, performed a site reconnaissance to view current site conditions, and reviewed prior geotechnical investigations by our firm for properties in the Stinson Beach area.

If the Design Review and Coastal Development Permit application is approved by the Marin Community Development Agency, a follow-up design level investigation will be required to develop detailed geotechnical design parameters that can be used to design the new residence, garage, and associated improvements. Our follow-up design level investigation would include site-specific seismic cone penetration testing (SCPT), geotechnical analyses, and a geotechnical investigation report.

SITE & PROJECT DESCRIPTION

The 0.36-acre beachfront property is situated at the southeast end of Calle Del Onda in the unincorporated Stinson Beach community of Marin County. The rectangular-shaped property measures approximately 80 feet by 190 feet and is bounded by Calle Del Onda to the northwest, the Pacific Ocean to the southwest, and by developed residential properties to the southeast and northeast. The ground surface across the property slopes relatively gently from the northeast side of the property and the beach up to the central portion of the site. The vacant site is currently vegetated with grasses and ice plant. We understand that a previous residence was formerly situated on the property and was destroyed by fire.

Although plans are preliminary, we understand that the project will consist of constructing a new 1,488 square-foot, two-story residence on the central, northeast side of the site. The residence first floor will be elevated above the existing site grades at an elevation of approximately 20 feet, and will be accessed by a stair and foyer entry located on the



northwest side of the residence. First- and second-level decks are planned on the southeast side of the residence. Additional site improvements will include a detached 288-square foot garage on the northeast side of the residence, a permeable paver patio on the southeast side of the residence, a driveway, patios/walkways, and landscaping. The layout of existing site improvements is shown on the attached Site Plan, Figure 2.

GEOLOGIC & SEISMIC CONDITIONS

Geology

The subject property is located along the southeastern end of a small, narrow peninsula which separates the southeastern end of Bolinas Lagoon from Bolinas Bay and the Pacific Ocean to the southwest. The site elevations vary from 12 to 13 feet (NAVD88) on the northeast side of the property, and 15 to 17 feet in the central northeast portion of the site, to approximately 10 feet and less on the southwest side of the site.

According to the Geologic Map of the Point Reyes National Seashore (J.C. Clark & E.E. Brabb, 1997), the site is located in an area underlain by Holocene-age beach sands (Qs). These deposits generally consist of discontinuous accumulations of well- to moderately-sorted, fine- to coarse-grained loose sands locally interspersed with pebble to boulder sized gravels. The relevant portion of the geologic map is presented on Figure 3, Vicinity Geologic Map.

The Association of Bay Area Governments liquefaction potential mapping of the area (ABAG, 2016) indicates that the site is located in an area considered to have very high liquefaction susceptibility. The ABAG liquefaction susceptibility map is included as Figure 4.

Faulting & Seismicity

The San Francisco Bay Area, which is affected by the San Andreas Fault system, is recognized by geologists and seismologists as one of the most active seismic regions in the United States. In the Bay Area there are four major faults trending in a northwest direction within the San Andreas Fault system, which have generated about 12 earthquakes per century large enough to cause significant structural damage. These faults include the San Andreas, San Gregorio, Hayward, and Calaveras faults. The San Andreas and San Gregorio Faults are located off-shore approximately 0.9 and 1.6 miles southwest of the site, respectively. According to the State of California Special Studies Zones map of the area (Brown, et. al., 1974), the site is not located within a State-defined earthquake fault zone for the San Andreas Fault (see Figure 5). The Hayward and Calaveras Faults are located approximately 17 and 33 miles east of the site, respectively. In addition, according to our attached geologic map, it appears a fault segment has been mapped just east of the main trace of the San Andreas fault and northwest of the site where it abruptly terminates at the northwest end of Bolinas Lagoon (see Figure 3). Some local geologic studies suggest this feature may be an extension of the Golden Gate fault mapped to the southeast and have projected the fault across the lagoon but with a bend farther to the southeast. Based on these projections, it appears that the fault could be potentially located within a few hundred feet of the site, although the exact location of this fault is not precisely understood in the immediate site vicinity. Although not zoned as an active fault; based on its proximity we presume that this fault feature may be associated with the active San Andreas fault at depth and should therefore be considered potentially active.

Seismologic and geologic experts convened by the U. S. Geological Survey, California Geological Survey, and the Southern California Earthquake Center conclude that there is a 72 percent probability for at least one "large" earthquake of magnitude 6.7 or larger in the Bay Area before the year 2043. The northern portion of the San Andreas fault is estimated to have a 6 percent probability of producing a magnitude 6.7 or larger earthquake by the year 2043 and the Hayward and Calaveras faults are estimated to have a 14 percent and 7 percent probability of producing a similar magnitude earthquake during the same time period (Working Group on California Earthquake Probabilities, 2014).

NEARBY GEOTECHNICAL INVESTIGATIONS

We have performed prior investigations for other beachfront properties with similar geologic settings to the subject site within the Stinson Beach area. A brief summary of these prior investigations follows.

168 Seadrift Road

Our investigation for 168 Seadrift Road pertained to the construction of a new residence, and included a subsurface exploration program consisting of four cone penetration tests and a soil probe in 2013, as well as two seismic cone penetration tests in 2020. The maximum depth explored was approximately 60 feet. The subsurface materials were found to consist predominantly of medium dense to dense clean sands with groundwater encountered at depths of approximately 8 to 10 feet. The measured near-surface shear wave velocities were on the order of 500 ft/sec, and these are less than the value of 710 ft/sec which is the generally accepted limit on soils being susceptible to liquefaction with adverse effects.

In order to strengthen the near-surface soils and help limit the potential for seismic-induced differential settlement and/or lateral spreading to impact the new residence, we recommended the construction be preceded by a near-surface ground improvement program, consisting of rammed aggregate piers or similar technology to a depth of approximately 25 to 30 feet. Following ground improvement, we recommended the new residence foundations be supported either on a relatively rigid grid of footings with a structural slab floor or on a mat foundation. We recommended that foundations be connected to the rammed earth aggregate piers. We concluded that areas of the site located outside of the zone of ground improvement will be susceptible to moderate degrees and likely localized zones of liquefaction-induced total and differential settlement during a large earthquake on the nearby San Andreas fault, a risk that is common to all development in this area.

161 Dipsea Road

Our investigation for 161 Dipsea Road pertained to the construction of additions to an existing residence, as well as the construction of a new semi-detached guest house. As part of our investigation, we advanced three cone penetration tests and one soil probe in 2017 to a maximum depth of approximately 54.5 feet below site grades. The subsurface materials were found to consist predominantly of beach sand, with isolated zones of gravelly sand (up to 2 feet thick) encountered at depth. The sands are predominantly medium dense to very dense below a depth of approximately 5 feet. Loose sand and very thin lenses of medium stiff sandy silt were encountered in the upper approximately 5 feet. Groundwater was interpreted to be approximately 7 feet below site grades.



We concluded that under static conditions, the underlying beach sand deposits will provide moderate bearing capacities capable of supporting the proposed residence additions and semi-detached guest house. However, under seismic loading from a moderate to large earthquake on a nearby fault, based on our investigation the site is subject to liquefaction to a depth of approximately 30 feet, which may result in lateral spreading with potentially severe tilting of foundations and loss of elevation across the site.

Because the 161 Dipsea project was a remodel rather than an entirely new residence and substantial portions of the existing residence were designated to remain, we provided recommendations for supporting the residence additions on continuous spread footings to match the existing foundations, and designed with added rigidity. We recommended the semi-detached guest house be supported on a mat slab with down-turned edges. In addition, we recommended that near-surface ground improvement be considered as a method of strengthening the near-surface soils in order to help limit the potential for seismic-induced differential settlement and/or lateral spreading to impact the remodeled residence and semi-detached guest house.

PRELIMINARY FINDINGS & OPINIONS

Based on our limited preliminary geotechnical feasibility study, it is our opinion that the proposed development is generally feasible from a geotechnical standpoint, provided the design is preceded by a future site-specific geotechnical investigation involving subsurface exploration and engineering analyses. In our opinion, the primary geotechnical constraints and considerations that will likely affect the design and construction of the proposed development are listed below and discussed in more detail below:

1. Strong to Very Violent Ground Shaking During an Earthquake
2. Liquefaction-Induced Settlement and Lateral Spreading
3. Seismic-Induced Settlement of Surficial Sands Above the Water Table
4. Tsunamis and Seiches
5. Waves, Flooding, Beach Erosion, & Sea Level Rise

1. Strong to Very Violent Ground Shaking– Strong to very violent ground shaking can be expected over the design life of the residence and garage during moderate to large earthquake events. The improvements should be designed in accordance with current earthquake resistant standards, including the 2019 CBC guidelines and design parameters that would be presented in a future design-level report for the project. It should be clearly understood that these guidelines and parameters will not prevent damage to structures; rather they are intended to prevent catastrophic collapse. The project structural engineer should be consulted for additional details relating to an upgraded seismic design.

Based on our review of published geologic maps, although no faults have been mapped across the site, the property is located very close to active faults. It should be noted that while active faults such as the San Andreas fault tend to rupture along previous rupture zones, there exists a potential for the formation of new rupture zones. In addition, there exists a potential for secondary ground deformation, including ground warping and cracking that could impact structures in close proximity to the fault. In our opinion, there is a moderate to high risk that the site could be impacted by secondary ground deformation

during a moderate to large earthquake on this segment of the San Andreas fault, which is inherent to the site location and common to properties similarly situated in the immediate vicinity.

2. Liquefaction & Liquefaction-Induced Lateral Spreading – Based on our experience in the area, we anticipate there to be a relatively high potential for liquefaction, ground displacement, ground lurching, differential settlement and/or lateral spreading as a result of moderate to large seismic events on nearby faults. We anticipate the potential for liquefaction-induced ground failure to impact the proposed improvements can be reduced by supporting the new residence and garage on relatively rigid shallow foundations (such as a rigid grid of footings or mat slab) in combination with ground improvement, or alternatively by using a deep foundation (such as auger cast piles or drilled piers) extending below the liquefiable materials. Regardless of the foundation type used, the owner must be willing to accept that a moderate to high risk associated with these hazards, which is inherent to the property's subsurface conditions and topography, will remain. Liquefaction potential and lateral spreading displacement analysis should be evaluated as part of a future design-level investigation.

3. Seismic-Induced Settlement of Surficial Sands Above the Water Tables – During moderate and large earthquakes, soft or loose, natural or fill soils can become densified and consolidate, often unevenly across a site. Based on our experience in the area, we anticipate that loose surficial sands may be present above the water table at the site, which may be susceptible to some degree of differential compaction. The depth to groundwater and potential presence of surficial loose sands should be evaluated as part of a future design-level geotechnical investigation. If loose surficial sands are encountered above the water table during a future subsurface exploration, we anticipate that near-surface ground improvement will provide adequate mitigation against this potential hazard.

4. Tsunamis and Seiches – A tsunami is a series of long-period waves, typically caused by large-scale seafloor displacements associated with large earthquakes or submarine landslides that effectively transmit energy to the ocean. A seiche is a standing wave that forms in an enclosed body of water, such as a lake, lagoon, or enclosed narrow bay, either as a result of strong ground shaking associated with a seismic event or else as a result of water being displaced due to a mass of soil impacting the standing body of water. In general, low-lying areas near the ocean and harbors are most susceptible to flooding and/or impact-related distress to structures from tsunamis and seiches. Due to its relatively low elevation and immediate proximity to the Pacific Ocean and Bolinas Lagoon, the site is situated in an area that could be subject to flooding and/or impact-related distress as a result of a tsunami. According to the Tsunami Inundation Map For Emergency Planning (CEMA, 2009), included as Figure 6, the site is situated within in a tsunami inundation area that encompasses the beachfront neighborhood surrounding the site as well as the entire Seadrift development, parts of Bolinas, and other areas along the margins of Bolinas Lagoon. Additionally, in our opinion there is a moderately high potential for a seiche to form in the man-made lagoon located on the north side of the Seadrift peninsula, resulting in a large volume of water being displaced out of the artificial lagoon. This water could flow rapidly away from the lagoon and damage anything in its path.

In our opinion, the tsunami and seiche hazards present at this site are difficult to quantify and/or mitigate, and the owner must be willing to accept the inherent risk associated with

these hazards due to the site's location. We note that there may be methods of limiting the impact of relatively low-height tsunami waves (i.e. 3 feet or less) on the residence, such as construction of protection walls to dissipate the energy of the wave, or the use of "break-away" walls that yield before wave energy can be transferred to structural support members. Nonetheless, the potential for extensive cosmetic damage and likely also some degree of structural damage to the residence, garage, and associated improvements would remain.

5. Waves, Flooding, Beach Erosion, & Sea Level Rise – Based on our review and site reconnaissance, we note the site is located in close proximity to the ocean. We anticipate the site may be susceptible to impact from long-term sea level rise associated with climate change, as well as damage from storms and associated swell events – especially during high tides occurring while low pressure systems move through the region. We anticipate there to be a long-term potential for waves and flooding to impact the proposed residence and for erosion of the site to occur as a result of seasonal storms which will likely be further accentuated in the future due to climate change. We note that this is more of a planning and coastal engineering challenge that extends to the broader beachfront community, and we defer to others for comment on this matter.

PRELIMINARY RECOMMENDATIONS & FUTURE STUDIES

In our opinion, the proposed new residence and garage will likely need to be supported on rammed earth aggregate piers or similar ground improvement technology, in order to reduce the potential for liquefaction-induced ground failure to impact the structure. The depth of ground improvement should be determined based on a future design-level investigation, and based on our experience will likely need to be on the order of at least 30 feet or more below grade in order to be effective. Although we understand ground improvement has not commonly been part of new construction projects in the area, based on our past evaluations we anticipate that some kind of ground improvement will likely be recommended, to be determined as part of a future design-level investigation. Continuous footing or mat foundations can likely be used to support the new residence and garage, provided they are designed with added rigidity and structurally attached to the rammed earth aggregate piers.

We recommend that design and construction of any site redevelopment project at 21 Calle Del Onda be preceded by a design-level geotechnical investigation, which would involve site-specific subsurface exploration in the form of seismic cone penetration testing, geotechnical engineering analyses to evaluate the potential for liquefaction and liquefaction-induced lateral spreading, and preparation of a geotechnical investigation report that provides detailed geotechnical recommendations for the design and construction of the proposed residence, garage, and associated improvements.

LIMITATIONS

This limited preliminary feasibility study has been prepared for the sole use of Alyce & Brian Johnson, specifically for the proposed residential development on the property located at 21 Calle Del Onda in the Stinson Beach community of unincorporated Marin County, California. The opinions presented above are based on our site reconnaissance, review of published geologic and hazard maps, review of nearby geotechnical investigations by our firm in the Stinson Beach area, and upon local experience and geotechnical engineering judgment. We recommend the proposed development be preceded by a detailed design-level geotechnical investigation, which would include subsurface exploration, laboratory testing, and

supplemental analyses, and may result in modifications to the above preliminary findings, opinions, and recommendations.

Our limited preliminary opinions have been formulated in accordance with generally accepted geotechnical engineering practices that exist in the San Francisco Bay Area at the time this letter was prepared. We make no warranty, expressed or implied.

If you have any questions concerning our limited preliminary feasibility study, please do not hesitate to call.

Sincerely,

MURRAY ENGINEERS, INC

Kristofer T. Korth, P.E.
Senior Engineer



William P. Carter, P.E.
Principal Engineer



Copies: Addressee (email)
CivicKnit (email)
Attn: Steve Kinsey
Attn: Breeze Kinsey

Attachments: Figure 1, Vicinity Map
Figure 2, Site Plan
Figure 3, Vicinity Geologic Map
Figure 4, Liquefaction Susceptibility Map
Figure 5, Vicinity Active Fault Zones Map
Figure 6, Tsunami Inundation Map



Base: USGS Topographic Maps, Bolinas Quadrangle, 7.5-Minute Series, 2015. Approximate Scale: 1 inch = 2,000 feet


	<p>NEW RESIDENCE 21 CALLE DEL ONDA MARIN COUNTY, CALIFORNIA</p>	<p>VICINITY MAP</p>
<p>PROJECT NO. 3372-1L1</p>	<p>JANUARY 2021</p>	<p>FIGURE 1</p>

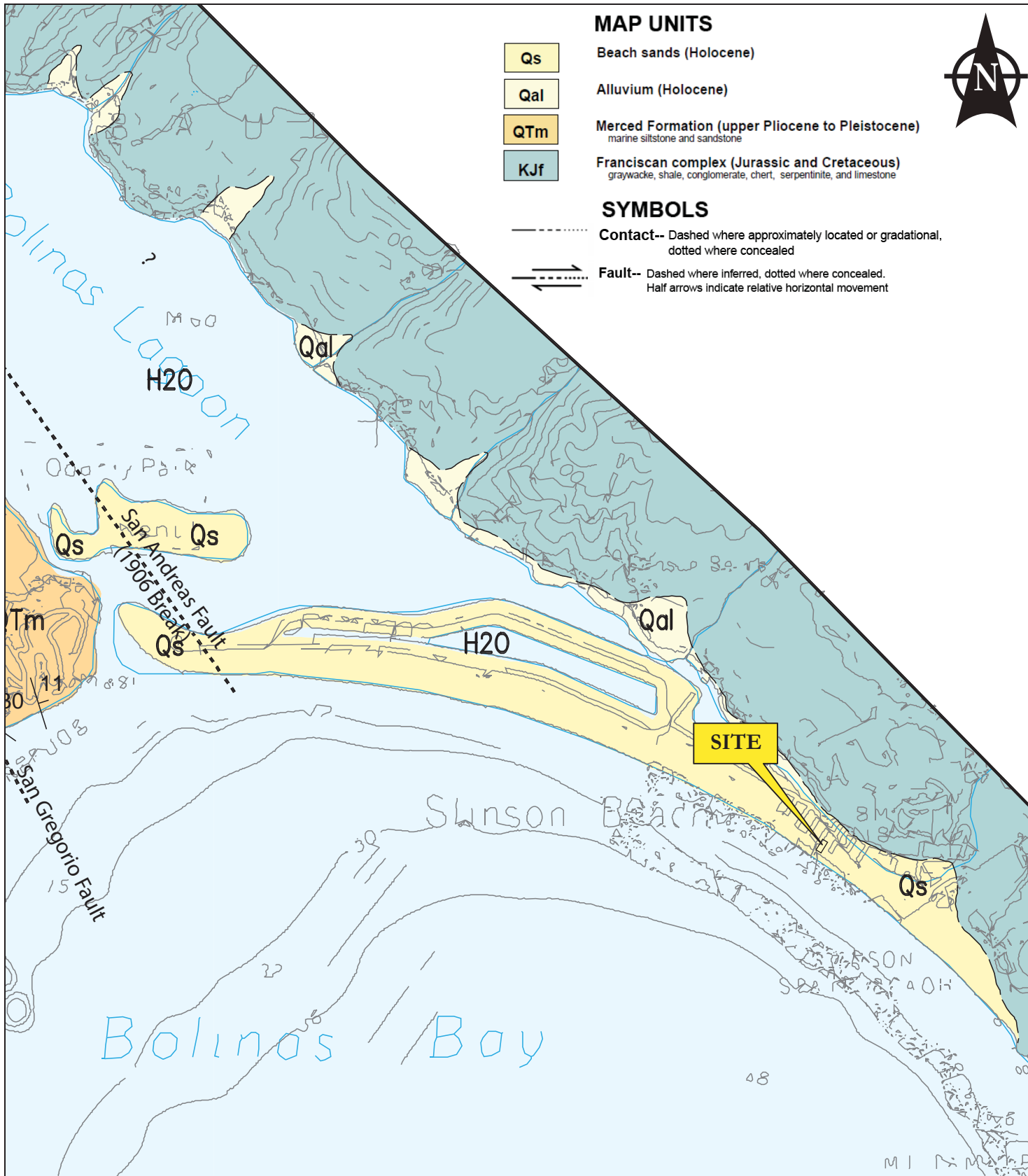


Base: Site Plan by CivicKnit, dated September 10, 2020
 Approximate Scale: 1 inch = 20 feet

KEY NOTES

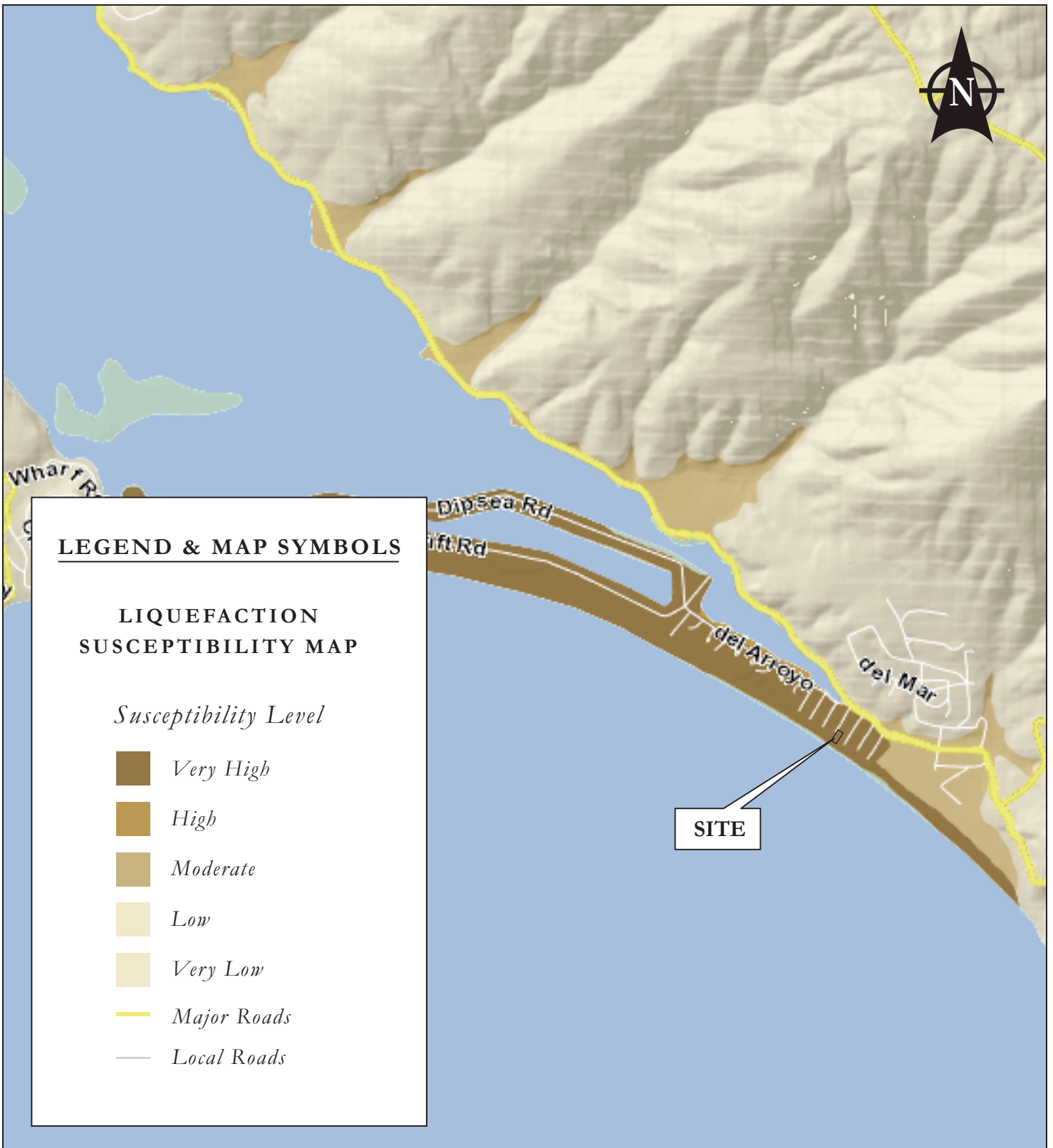
- | | |
|--|--|
| 1 Outline of (N) Two-Story Residence (Shaded) | 6 Area of (N) Deck 1st Floor Deck (Hatched) |
| 2 Area of (N) First Floor (Shaded) | 7 Area of (N) Deck 2nd Floor Deck (Hatched) |
| 3 Area of (N) Second Floor (Cross-Hatched) | 8 Area of (N) Driveway (Stippled) |
| 4 Area of (N) Detached Garage (Shaded) | 9 Area of Proposed Easement (Shaded) |
| 5 Area of (N) Patio (Shaded) | 10 Outline of Property Boundary |

		SITE PLAN
NEW RESIDENCE 21 CALLE DEL ONDA MARIN COUNTY, CALIFORNIA		
PROJECT NO. 3372-1L1	JANUARY 2021	FIGURE 2



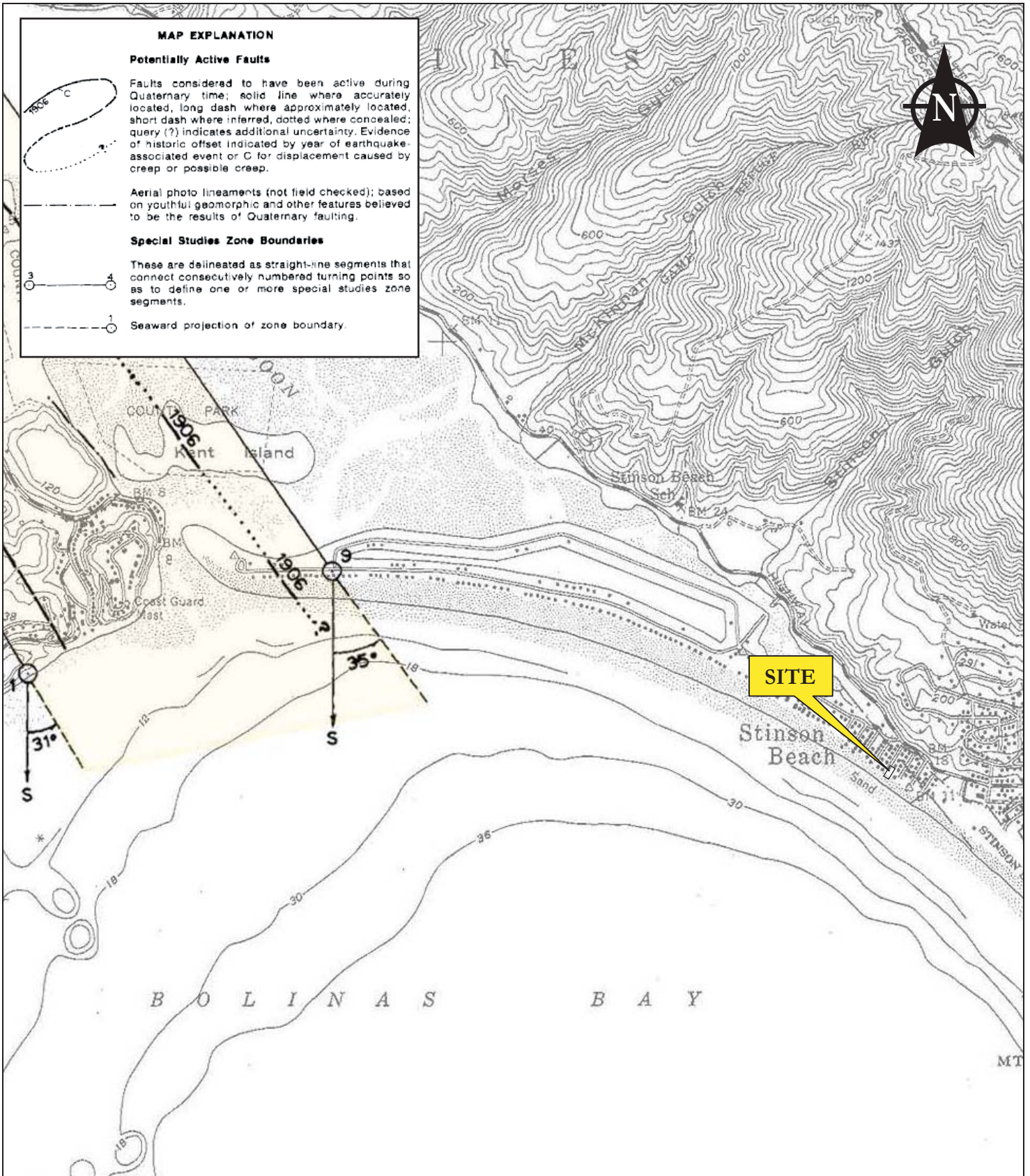
Base: Geology of the Point Reyes National Seashore, J.C. Clark & E.E. Brabb (1997)
 Approximate Scale: 1 inch = 2,000 feet

	NEW RESIDENCE 21 CALLE DEL ONDA MARIN COUNTY, CALIFORNIA		VICINITY GEOLOGY MAP
	PROJECT NO. 3372-1L1	JANUARY 2021	FIGURE 3



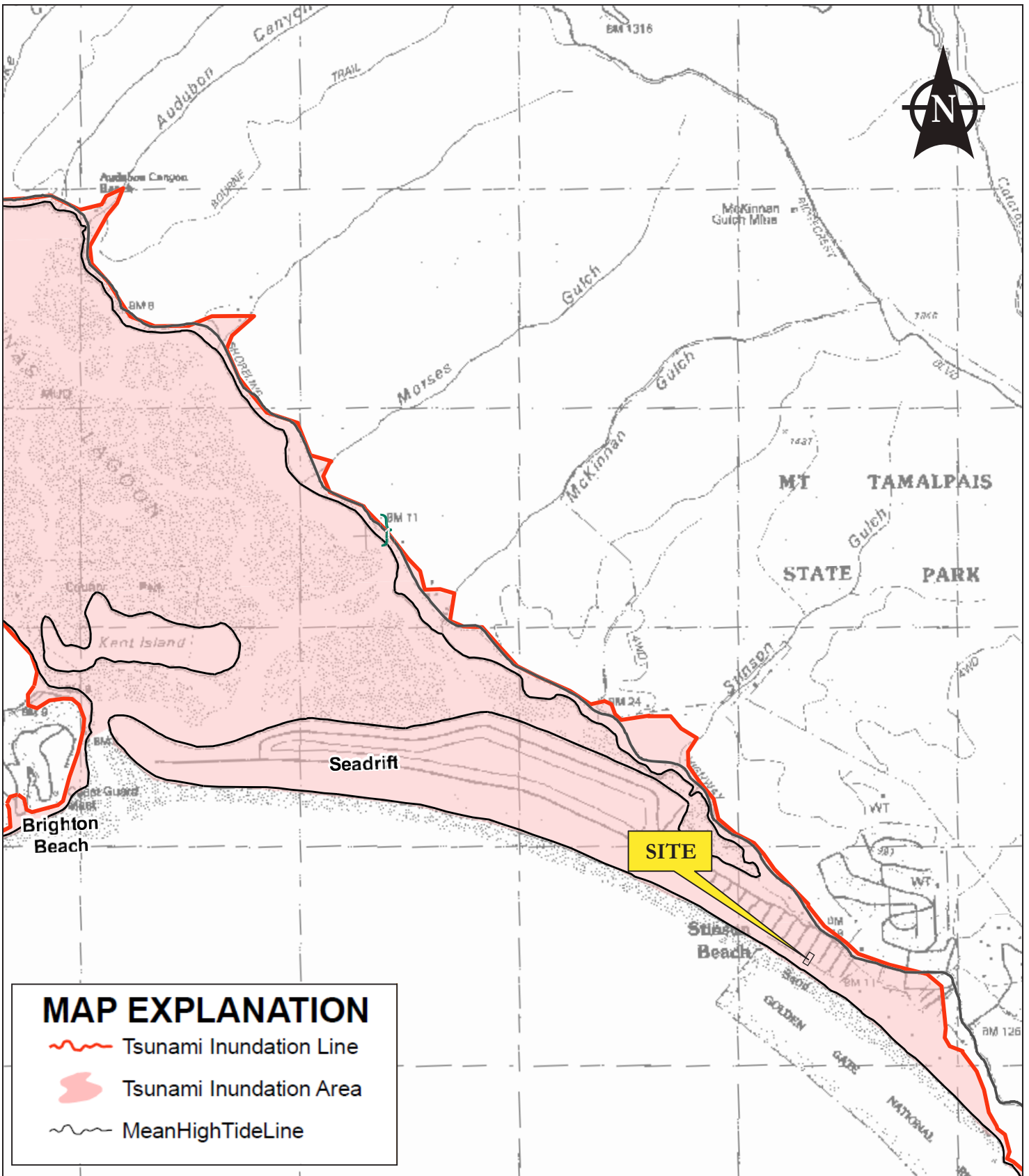
Base: Association of Bay Area Governments, 2016, ABAG Shaking Intensity Maps and Information, <http://gis.abag.ca.gov/website/Hazards/?hlyr=liqSusceptibility>
 Scale: 1 inch = 2,000 feet

	NEW RESIDENCE 21 CALLE DEL ONDA MARIN COUNTY, CALIFORNIA	LIQUEFACTION SUSCEPTIBILITY MAP
	PROJECT NO. 3372-1L1	JANUARY 2021



Base is the State of California Special Studies Zones, Bolinas Quadrangle, 1974. Scale is 1 inch = 2,000 feet

	NEW RESIDENCE 21 CALLE DEL ONDA MARIN COUNTY, CALIFORNIA		VICINITY ACTIVE FAULT ZONES MAP
	PROJECT NO. 3372-1L1	JANUARY 2021	FIGURE 5



Base: Tsunami Inundation Map for Emergency Planning, Bolinas Quadrangle, July 1, 2009, CEMA, CGS, USC.

	NEW RESIDENCE 21 CALLE DEL ONDA MARIN COUNTY, CALIFORNIA		TSUNAMI INUNDATION MAP
	PROJECT NO. 3372-1L1	JANUARY 2021	FIGURE 6