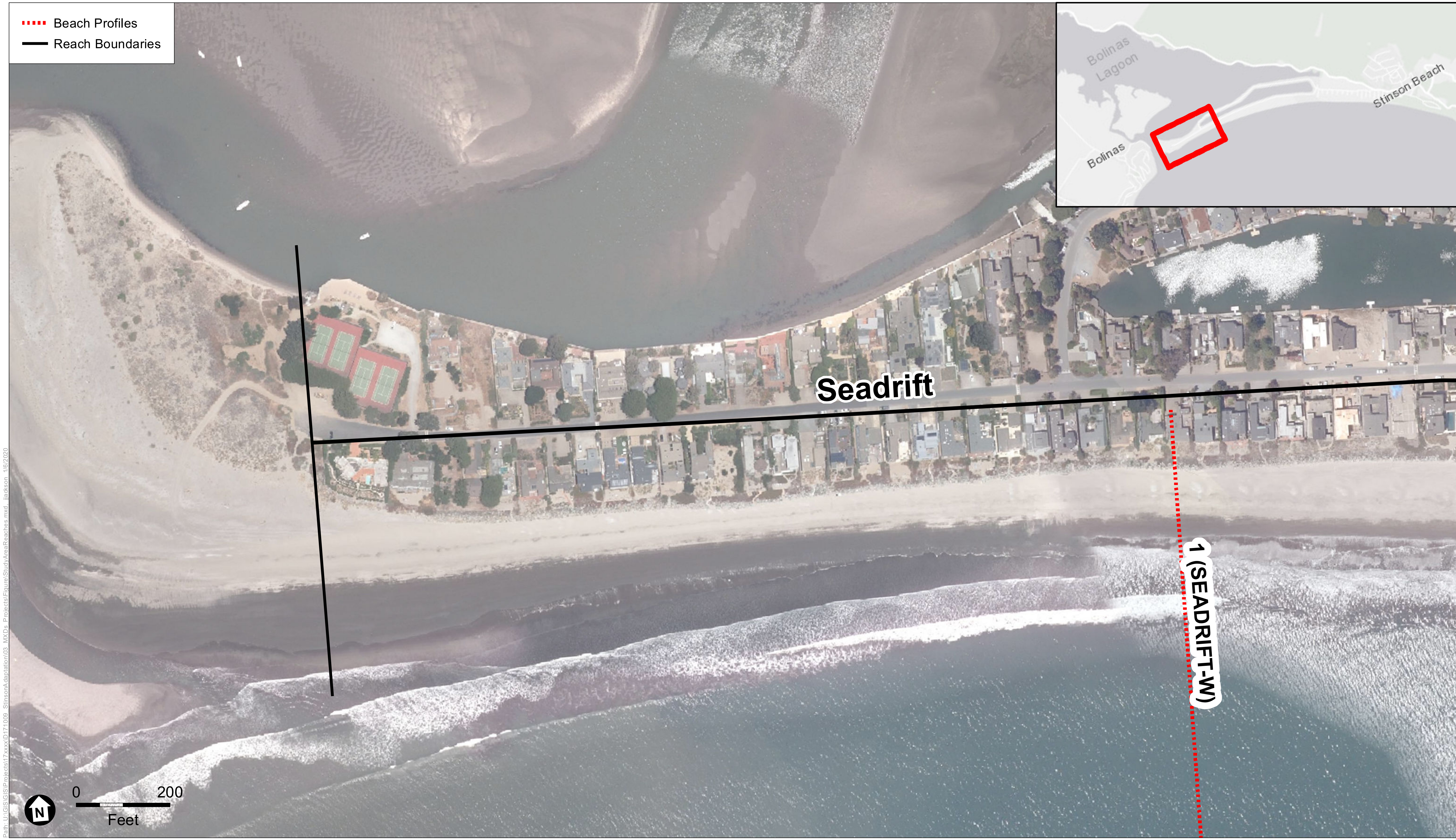



SOURCE: ESA, Marin County 2018 Imagery

Stinson Beach Nature-Based Adaptation Feasibility Study

**Figure A-1**
Study Basemap
Seadrift-West Reach

ESA


SOURCE: ESA, Marin County 2018 Imagery



**Figure A-2**
Study Basemap
Seadrift-Center Reach

ESA


SOURCE: ESA, Marin County 2018 Imagery



**Figure A-3**
Study Basemap
Seadrift-East Reach

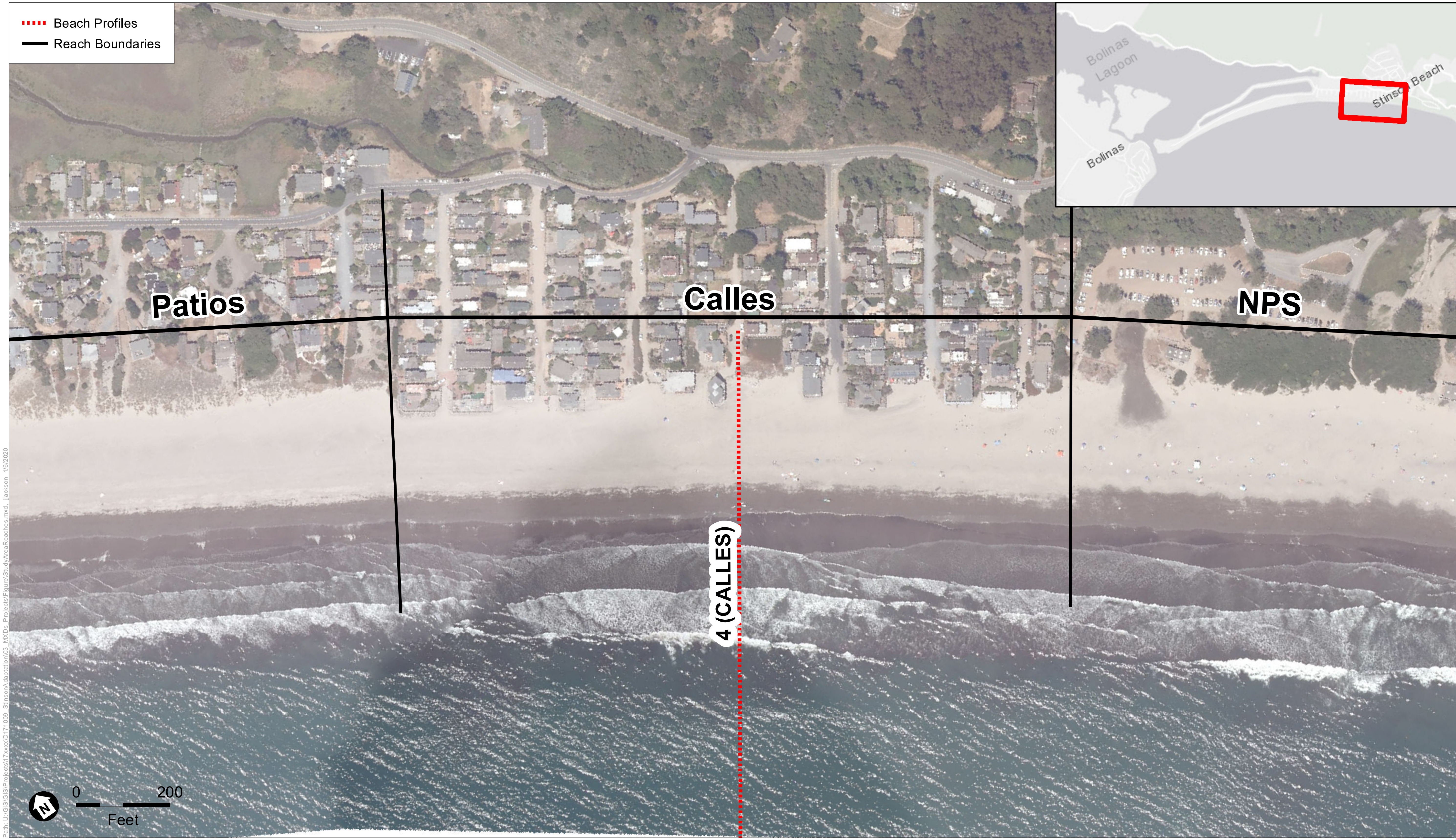
ESA


SOURCE: ESA, Marin County 2018 Imagery

Stinson Beach Nature-Based Adaptation Feasibility Study

**Figure A-4**
Study Basemap
Patios Reach

ESA




SOURCE: ESA, Marin County 2018 Imagery



**Figure A-5**
Study Basemap
Calles Reach

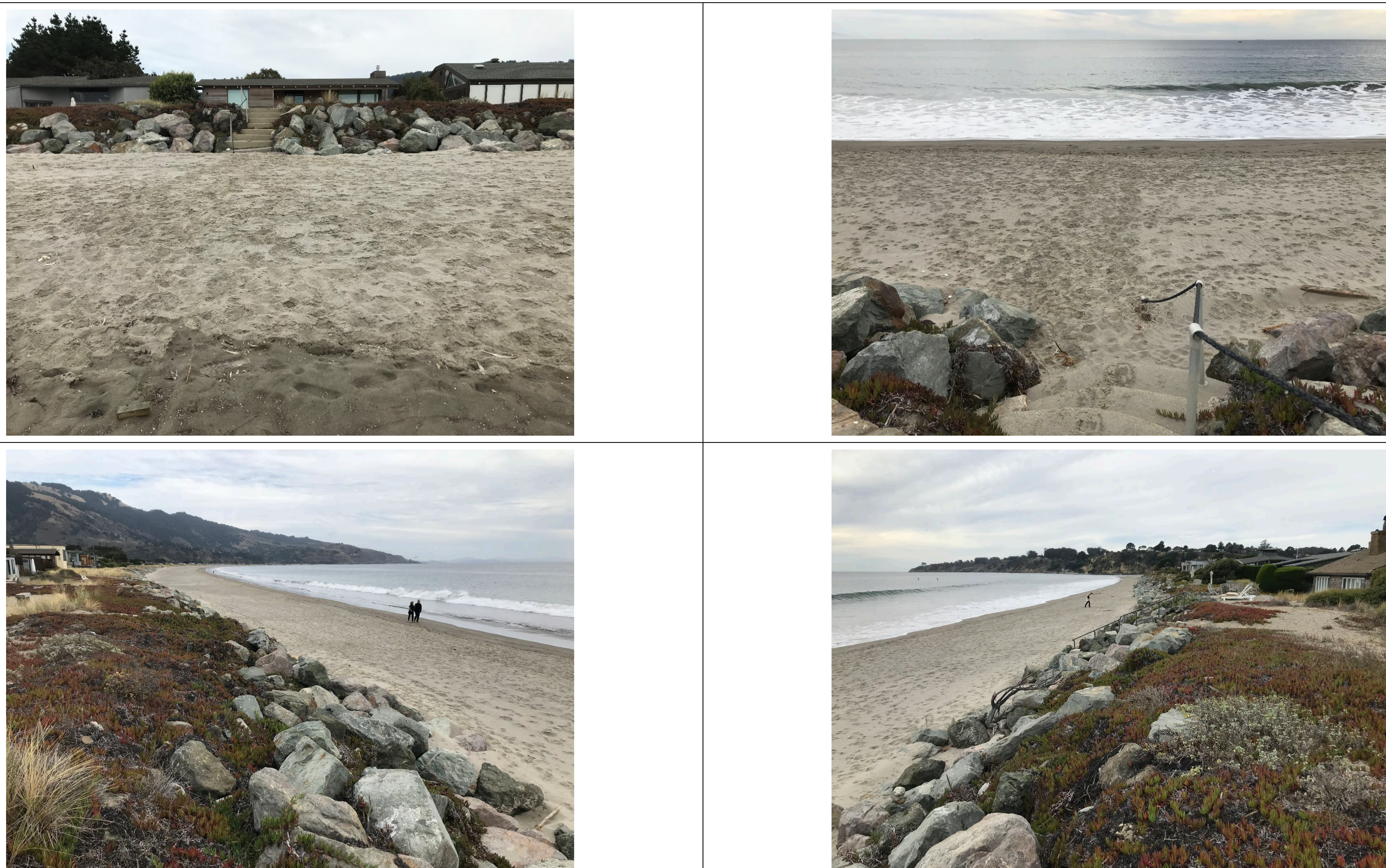
ESA


SOURCE: ESA, Marin County 2018 Imagery

Stinson Beach Nature-Based Adaptation Feasibility Study

**Figure A-6**
Study Basemap
NPS Reach

ESA



SOURCE: ESA



**Figure B-1**
Shoreline Conditions Photos
Seadrift West Profile Location

SOURCE: ESA



**Figure B-2**
Shoreline Conditions Photos
Seadrift East Profile Location

SOURCE: ESA



**Figure B-3**
Shoreline Conditions Photos
Patios Profile Location

SOURCE: ESA

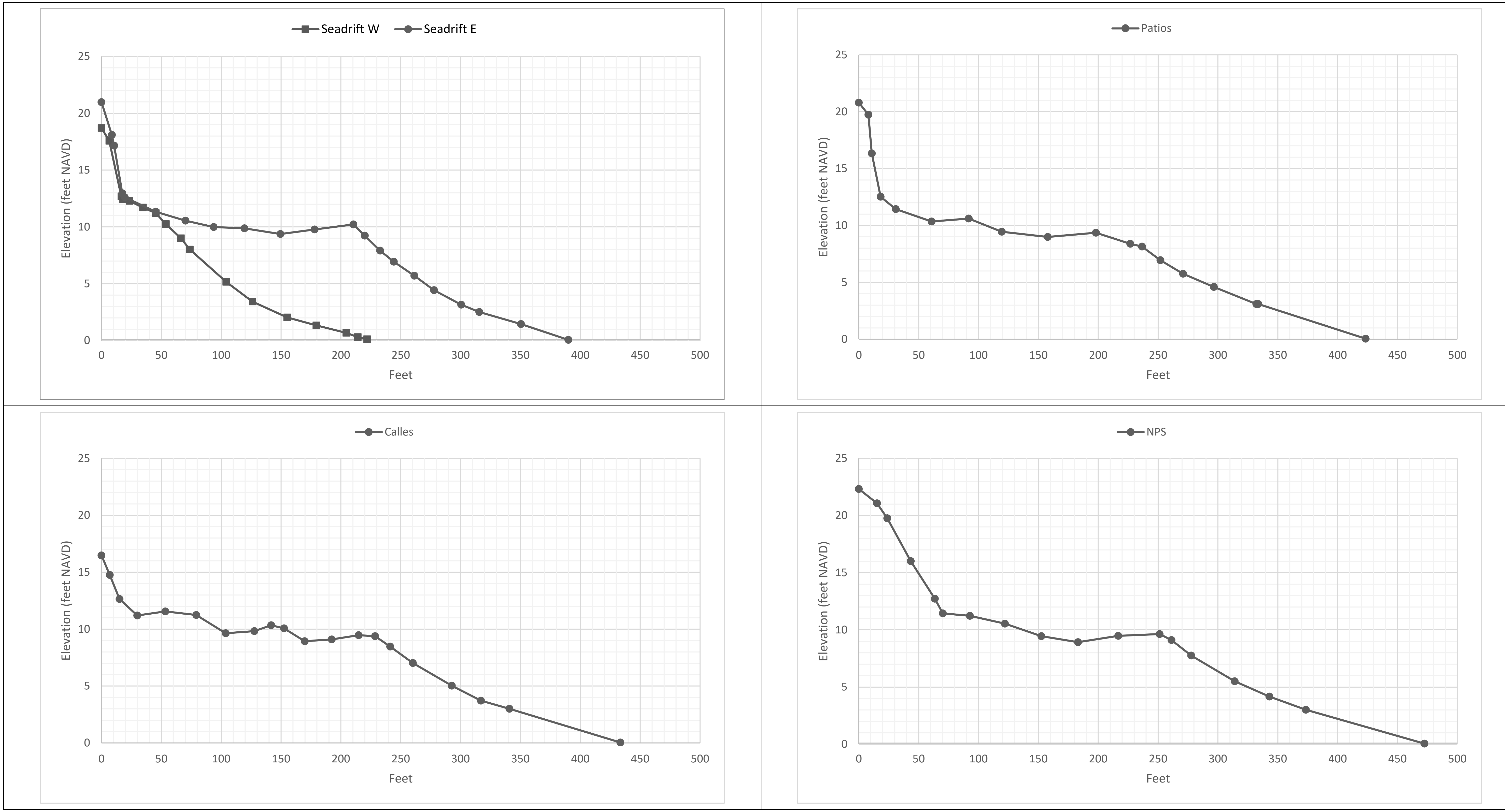
Stinson Beach Nature-Based Adaptation Feasibility Study – 171009.00

**Figure B-4**
Shoreline Conditions Photos
Calles Profile Location

SOURCE: ESA

Stinson Beach Nature-Based Adaptation Feasibility Study – 171009.00

**Figure B-5**
Shoreline Conditions Photos
NPS Profile Location




SOURCE: ESA 2019



**Figure C-1**
Representative Beach Profiles

**Merkel & Associates, Inc.**
5434 Ruffin Road, San Diego, CA 92123
Tel: 858/560-5465 • Fax: 858/560-7779

December 19, 2019
M&A #19-009-01

Mr. James Jackson, PE
Environmental Science Associates, Inc.
550 Kearny Street, Suite 800
San Francisco, CA 94108

**RE: Stinson Beach Site Characterization**

Dear James:

**PURPOSE AND INTRODUCTION**

In support of the Stinson Beach Nature-Based Adaption Feasibility Study (SBNBAFS), Merkel & Associates Inc. (M&A) has been contracted by Environmental Science Associates, Inc. (ESA) to survey and characterize site bathymetry, sediment grain size distribution and habitat conditions along five profiles that span the shoreline from the Bolinas Lagoon inlet to the Stinson Beach Boulders.

## METHODS

Subtidal marine habitat surveys were conducted over an approximately 1,200 acre portion of the nearshore environment of Bolinas Bay (Figure 1). The survey extended along approximately 3.7 miles of the shoreline of Stinson Beach, across the mouth of Bolinas Lagoon to the seabluff at Bolinas. The surveys were conducted on October 16, 2019. The sea state was calm with variable wind chop occurring throughout the day.

Surveys were conducted using interferometric sidescan sonar operating at 468kHz. The sonar system was integrated with a real-time kinematic global positioning system (RTK-GPS) for navigation and heading control, an inertial motion control system, and a sound velocity sensor. These elements enhance vessel position and attitude awareness within the survey system and enhance accuracy of the survey data. The swath width for the survey was set to 50 meters on both the starboard and port channels. Parallel transects were spaced to maximize survey area, thus sacrificing swath overlap between adjoining survey swaths. Transects were navigated along contour parallel swaths until the full survey area was captured in the survey record. Following sonar data collection, data were processed to produce a sonar mosaic image of the seafloor.

The collected data from the sonar included bathymetry and backscatter data. The bathymetric data result from the timing of the return of a sound pulse reflected off the bottom as it is received at multiple locations on the transducer array. The difference in return time to different sensors allows for triangulation of the position of the acoustically reflective surface. Backscatter data creates an acoustic image of the seafloor based on the sound reflectivity of the surveys encountered by transducer generated sound waves. The principal is similar to that used in medical ultrasounds.


**Project Vicinity**

Nature-based Adaptation at Stinson Beach Feasibility Study

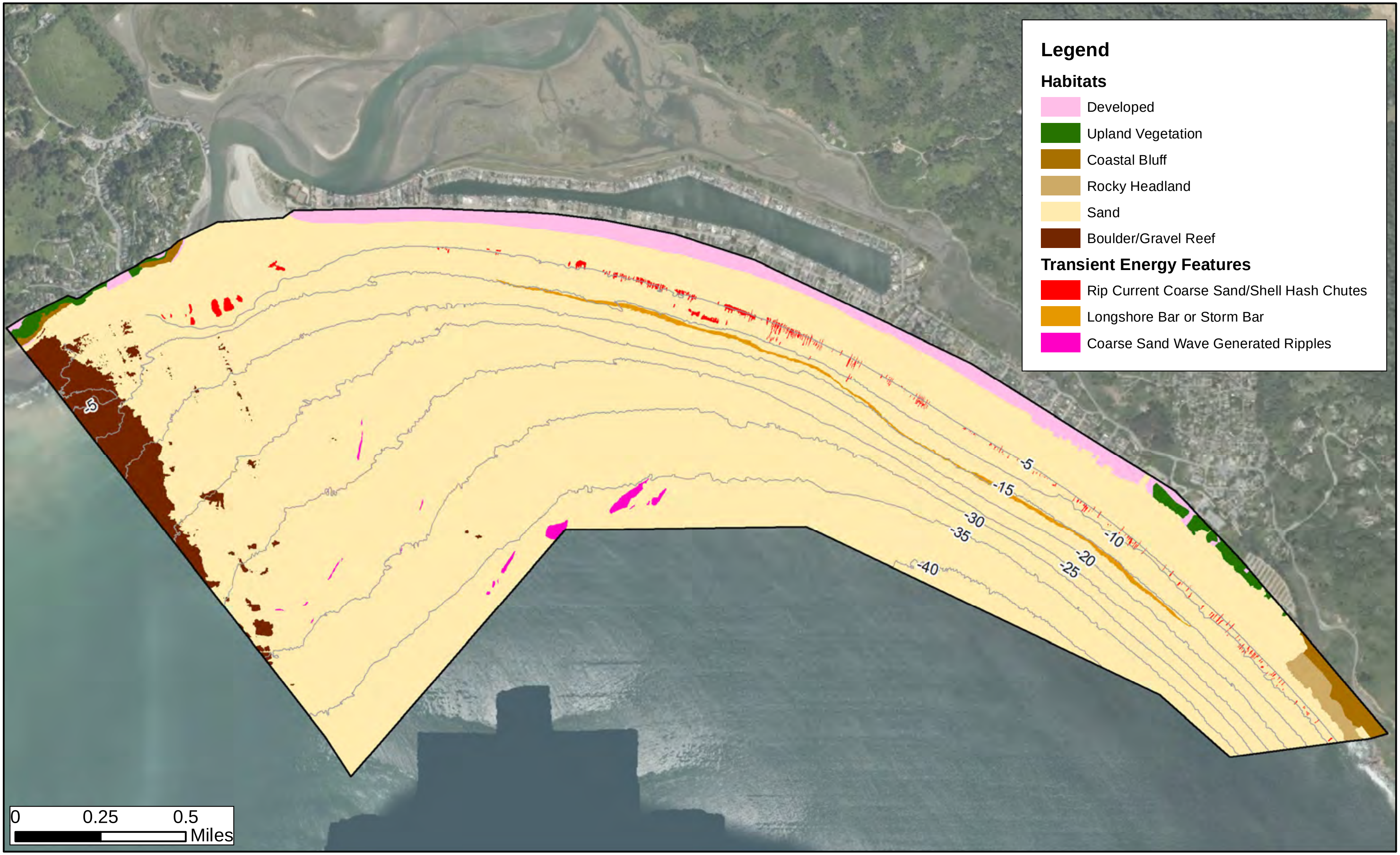
**Figure 1**

The backscatter data were used to determine the distribution of seafloor habitats. The backscatter data are the visual representation of the intensity of the acoustic energy reflected back to the sonar unit from the bottom. Hard objects (e.g., rock) or soft objects containing air filled voids (e.g., kelp pneumatocysts) reflect sound waves with a greater intensity relative to soft bottom (e.g., mud and sand). The angle of the surveyed object relative to the sound wave propagation also determines the intensity of the returned sound signal. Rocky outcroppings with greater complexity (e.g., increased relief) and sand waves have greater variation in terms of high signal intensity mixed with low signal intensity from areas that lie in the acoustic shadows of the reef or on planes facing away from the transducer where reflected energy is principally away from the transducer heads. The backscatter data were processed into a single rectified mosaic image. The registered sonar mosaic was then overlaid on an aerial image of the survey area and reviewed for alignment accuracy. Examples of the mapped features from the acoustic mosaic are illustrated in Appendix 1. Following acoustic surveys, a remotely operated vehicle (ROV) was deployed over some of the habitat features to inspect habitats by video and to collect representative images of the feature conditions. The clarity of imagery was not superior due to increasing surf and wind wave resuspension of sediment in the extreme shallows, diminishing daylight, and generally low visability conditions of Bolinas Bay, and peak ebb conditions of tidal waters leaving Bolinas Lagoon. Marine habitat example photographs are provided in Appendix 2.

Surficial features and marine benthic habitat types were then digitized by a geographic information systems (GIS) specialist with expertise in interpreting sonar data for habitat mapping. The GIS specialist inspected the sonar mosaic and delineated habitats and features using ESRI ArcGIS software. Raw files and interpreted mosaics were reviewed for accuracy by an experienced senior biologist on the project. To provide subtidal habitat feature context along the shoreline, upland habitats along the marine interface were mapped from an August 19, 2018 Google Earth image. The mapping of upland habitat features was completed at a coarse scale in order to provide insight into how the marine features transitioned to the adjacent uplands. This mapping should not be substituted for more focused investigations.

After acoustic surveys were completed, manual sediment grabs were collected using 15 cm shallow cores pushed into the sediment at pre-determined elevations along transects established by ESA. The samples from collected cores were sent to Eurofins Calscience for sediment/grain size analysis. The full laboratory results are provided in Appendix 3.

Following completion of the survey, the bathymetric data were corrected for tidal elevation. The National Oceanic and Atmospheric Administration's measured tides at the two closest gauges, Bolinas Lagoon and San Francisco Golden Gate, was corrected to the geographic position of the boat and used to adjust the survey data. The bathymetric data were then joined together and geographically registered. Contour lines were generated from the registered bathymetric data using the Spatial Analyst extension in ESRI's ArcGIS software for Windows (Figure 2)




N
W E
S

**Habitat Map - October 2019**

Nature-based Adaptation at Stinson Beach Feasibility Study

**Figure 2**

## RESULTS

### Habitat Mapping

The October 2019 survey covered a total of 1,197 acres of acoustically mapped subtidal habitat. Areas not mapped by acoustic means were generally restricted by being too shallow for vessel operation, interference by air entrained in waters of the surf zone, or as a result of being out of the water at the time of the survey. In order to provide seamless habitat coverage across the marine/terrestrial interface, mapping was expanded to include the shoreline margin along the marine habitat mapping area. This expanded the study area to a total of 1,303 acres.

The survey noted five habitat types within the survey area (Table 1 and Figure 2). There were six habitat types mapped by aerial interpretation and acoustic survey. These included upland features and two subtidal marine features including sand bottom and boulder gravel reef. Sand extended from subtidal environments to supratidal environments so this habitat occurred in both terrestrial and marine environments, while the boulder/gravel reef was restricted to subtidal and intertidal environments.

In addition to mapped habitats there were also three transient sand features that were discernable in the acoustic data set. These included longshore or storm bars, rip-current coarse sand/shell hash chutes, and coarse sand wave generated ripples (Table 1, Figure 2). In most habitat mapping programs, extracting these features is not done as they are not indicative of persistent conditions. However, for the present investigation, it was deemed useful to map energy driven conditions as they provide insights into the physical processes affecting this segment of the coastline.

**Table 1. Habitat types delineated in the SBNBAFS 2019 regional habitat survey.**

| Habitat Type | Acres | % Total |
|---|---|---|
| ***Habitat Features*** | | |
| *Developed* | 47.11 | 3.62% |
| *Upland Vegetation* | 8.79 | 0.67% |
| *Coastal Bluff* | 8.34 | 0.64% |
| *Rocky Headland* | 6.21 | 0.48% |
| *Sand* | 1176.85 | 90.34% |
| *Boulder/Gravel Reef* | 38.75 | 2.97% |
| ***Transient Features*** | | |
| *Longshore or Storm Bar* | 7.89 | 0.61% |
| *Rip Current Coarse Sand/Shell Hash Chutes* | 5.65 | 0.43% |
| *Coarse Sand Waves Generated Ripples* | 3.06 | 0.23% |
| Total | 1,302.65 | 100.00% |

Upland habitats mapped are generic features that provide context to the interface area. The marine habitats are described below and example acoustic images are provided in Appendix 1.

***Boulder/Gravel Reef*** – This habitat consists of a gradient of features from large unconsolidated boulders to fine gravels that have been derived from the erosion of the bluff shoreline of Bolinas. The study area does not appear to include much, if any of the bedrock of the larger Duxbury Reef off Duxbury Point that defines the sheltering hooked headland to the west of the study area. However, the material size class of the reef material generally diminishes from south to north along the western margin of the survey area such that gravel and cobble dominates the areas of reef nearest the Bolinas Lagoon mouth and large boulder dominates the area towards Duxbury Reef.

***Sand*** – This habitat feature dominates the subtidal and intertidal landscape of Stinson Beach, occupying more than 90 percent of the total mapped habitat. In general, the sand bottom is a relatively featureless bottom with minor sand rippling in deep water and more pronounced rippling with sharper ridges occurring in shallow water. Sharp ridges in the sand ripples denote more recent development of the features, while smoother ridges occur as the features weather with age. Within the sand habitat there were noted several energy features that could be mapped as discrete elements. While they have been mapped, they are transitory features more indicative of coastal processes influences on the geomorphology of the seafloor than being unique habitat features that are biologically separable from sand bottom over prolonged periods. These features are:

- **Rip Current Coarse Sand/Shell Hash Chutes** – These features form within and immediately below the surf zone as a function of wave drain-out from the shoreline at localized points. The highest concentration of rip current features occurs near Seadrift East about midway down the beach (Figure 2). A second feature that has been classified together with rip current chutes is a scour feature in the ebb bar outside of Bolinas Lagoon. These features are generally developed differently from the archetypical rip current chute in that these are thalwegs of drainage courses on the surface of the ebb bar that tend to concentrate ebb tide energy due to slight depression of the bed form along the channels. These features shift around and will disappear and reform based on many factors influencing the ebb bar.

- **Longshore Bar or Storm Bar** – Along the shore margin at about -10 feet near the more protected western end of Stinson Beach and at about -15 feet towards the more exposed eastern end of the study area there is an narrow and relatively small longshore bar located offshore of the beach. These bars form seasonally and as a result of storm events. They are an unconsolidated transitory feature where beach sand is deposited following erosion from the beach environment and typically occur immediately outside of the surf zone. The bar at Stinson Beach was notably small and non-descript in October 2019.

- **Coarse Sand, Wave Generated Ripples** – These features are not to be confused with widespread minor sand rippling that occurs in shallow waters near shore where the bottom exhibits small and highly transitory rippling due to high frequency wave influence (see Appendix 2). Rather the ripples that are mapped under this energy feature are long-period deeper water features that depict evidence of large storm influence and directionality of storm waves. Appendix 1 provides examples of some of these features. The largest of these features occur below -35 feet and are likely the result of concentrating swell energy by the Duxbury Reef headland. Smaller features also occur in waters between -20 and -30 feet towards the western end of the study area (Figure 2). These are similarly likely the result of swell energy being focused by Duxbury Reef as it enters Bolinas Bay.

**Sediment Grain Size**

Sediment grab samples were collected at 46 locations across a range of depths along previously defined transects (Table 2). From these collections samples were field characterized as to the nature of the sediment. The field characterization consisted of opening each sample after collection and inspecting the material visually and tactilely. Except where samples were notably course or fine, or had larger inclusions, they were identified generically without substantial effort to attach modifiers to major classes of silt, clay, sand, gravel, cobble. The field characterization indicated that material offshore in the study area is predominantly clean sands. Only in deeper waters of the study area was silt a major component of the material. For interest purposes, a sample was collected well outside of the study area at approximately -60 feet. This sample was similarly classified as predominantly sand, albeit silty sand.

**Table 2. Sediment collection and field characterization.**

| Elev. | NPS | Seadrift W | Seadrift E | Patios | Calles | Bolinas | Count |
|---|---|---|---|---|---|---|---|
| 12 | Sand | Sand | Sand | Sand | Sand | | 5 |
| 6 | Sand | Sand | Sand | Sand | Sand | | 5 |
| 3 | Sand | Sand | Sand | Sand | Sand | | 5 |
| 0 | Sand | Sand | Sand | Sand | Sand | | 5 |
| -2 | Sand | | | | | | 1 |
| -6 | Sand | Sand | Sand | Sand | Sand | | 5 |
| -12 | Sand | Sand | Sand | Sand | Sand | Sand/Gravel | 6 |
| -24 | Sand | Silty Sand | Sand | Sand | Sand | Sand | 6 |
| -30 | | Silty Sand | | | | | 1 |
| -36 | Silty Sand | Silty Sand | Sand | Sand | Silty Sand | Sand | 6 |
| -60 | Silty Sand | | | | | | 1 |
| **Count** | 10 | 9 | 8 | 8 | 8 | 3 | **46** |

From the collected samples, ESA selected 25 samples to be further analyzed for sediment grain size to characterize the surface sediments of the beach and nearshore subtidal environment. These samples were well distributed across the beach and elevation range from approximately +12 to -24 feet (Figure 3). Samples were analyzed by Eurofins Calscience as reported on in Appendix 3. Post collection analyses of sampling location and bathymetry from survey data resulted in correction of some sampling elevations that did not fully match intended sample elevations and sampling IDs at the time of collection. For this reason, elevation has been reported in Table 3 along with sample results. Table 3 presents simplified information from the laboratory analysis as the mean grain size and total percent sand for each analyzed location.

Surface Sediments ranged from coarse to medium sand with a generally remarkably high sand fraction and low silt content across all analyzed samples.

**Table 3. Sediment/ grain size analysis**

| ID | Elevation | Latitude | Longitude | Mean Grain Size | % Sand |
|---|---|---|---|---|---|
| **NPS 12** | 12 | 37.89585˚ | -122.63983˚ | 0.250 | 100 |
| **NPS 3** | 3 | 37.895156˚ | -122.640426˚ | 0.395 | 100 |
| **NPS 0** | 0 | 37.89503˚ | -122.64054˚ | 0.849 | 97.47 |
| **NPS -12** | -12 | 37.89415˚ | -122.64129˚ | 0.236 | 100 |
| **NPS -24** | -24 | 37.8931˚ | -122.6422˚ | 0.278 | 100 |
| **Seadrift W 12** | 12 | 37.90674˚ | -122.67239˚ | 0.317 | 100 |
| **Seadrift W 3** | 3 | 37.906427˚ | -122.672402˚ | 0.398 | 98.90 |
| **Seadrift W 0** | -5 | 37.90581˚ | -122.67238˚ | 0.248 | 99.39 |
| **Seadrift W -12** | -16 | 37.90367˚ | -122.67236˚ | 0.445 | 94.57 |
| **Seadrift W -24** | -25 | 37.90055˚ | -122.67233˚ | 0.965 | 78.01 |
| **Seadrift E 12** | 12 | 37.90497˚ | -122.65917˚ | 0.299 | 100 |
| **Seadrift E 3** | 3 | 37.904242˚ | -122.659432˚ | 0.481 | 100 |
| **Seadrift E 0** | 0 | 37.90398˚ | -122.65951˚ | 0.327 | 100 |
| **Seadrift E -12** | -12 | 37.90279˚ | -122.65992˚ | 0.428 | 97.85 |
| **Seadrift E -24** | -24 | 37.90162˚ | -122.66032˚ | 0.278 | 98.68 |
| **Patios 12** | 12 | 37.9016˚ | -122.65035˚ | 0.283 | 100 |
| **Patios 3** | 3 | 37.900877˚ | -122.650836˚ | 0.410 | 100 |
| **Patios 0** | 0 | 37.90084˚ | -122.65088˚ | 0.356 | 100 |
| **Patios -12** | -12 | 37.89976˚ | -122.65162˚ | 0.304 | 100 |
| **Patios -24** | -22 | 37.89869˚ | -122.65236˚ | 0.268 | 99.42 |
| **Calles 12** | 12 | 37.89912˚ | -122.64506˚ | 0.292 | 100 |
| **Calles 3** | 3 | 37.898386˚ | -122.645676˚ | 0.382 | 100 |
| **Calles 0** | 0 | 37.89823˚ | -122.6458˚ | 0.248 | 98.96 |
| **Calles -12** | -13 | 37.89728˚ | -122.64659˚ | 0.274 | 99.10 |
| **Calles -24** | -24 | 37.89633˚ | -122.64738˚ | 0.249 | 98.88 |


**Station Grab Samples**

Nature-based Adaptation at Stinson Beach Feasibility Study

**Figure 3**

Digital habitat mapping information is being provided as ESRI ArcGIS shape files for your use.

Thank you for the opportunity to assist you on this work. If you have any questions regarding the methods or data presented, or need for additional information, please do not hesitate to contact me.

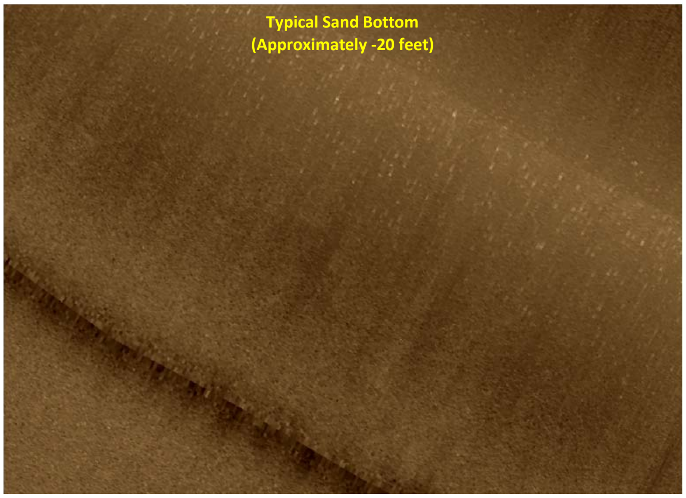
Sincerely,

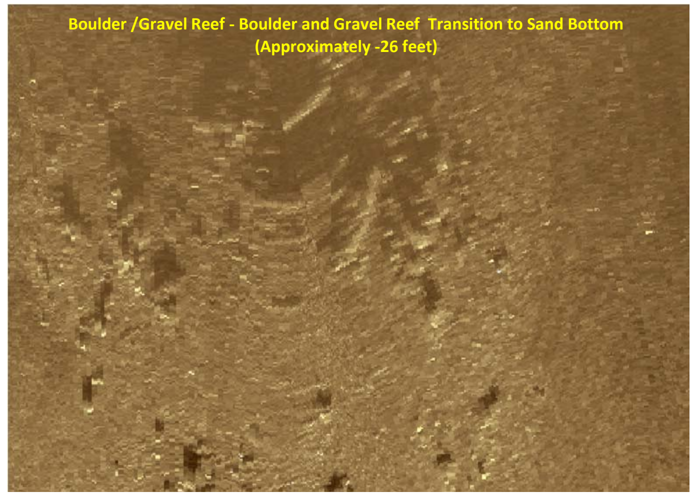
Keith W. Merkel
Principal Consultant

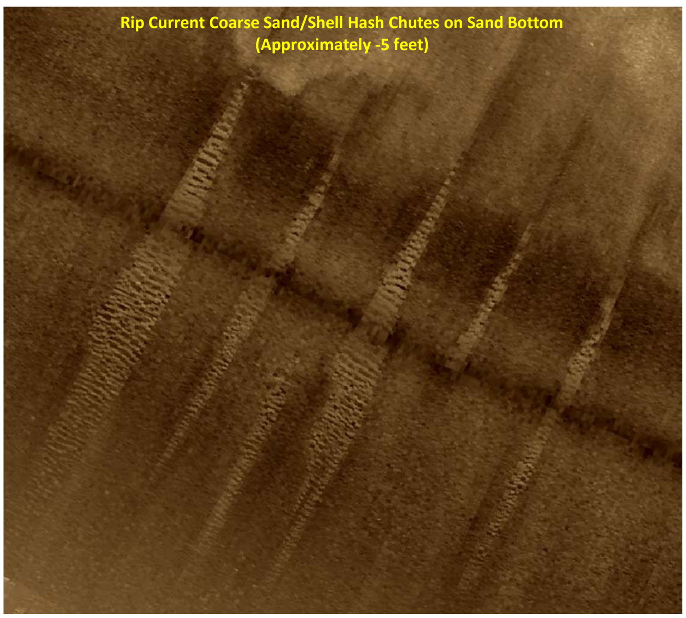
## APPENDIX 1. STINSON BEACH SUBTIAL HABITAT ACOUSTIC IMAGES

**STINSON BEACH MARINE HABITAT EXAMPLES FROM INTERFEROMETRIC SIDESCAN SONAR (OCTOBER 2019)**

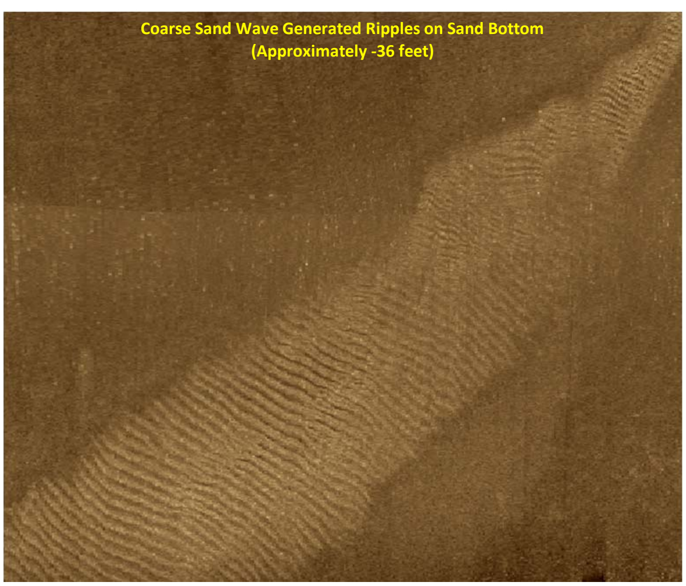
***Merkel & Associates, Inc.***

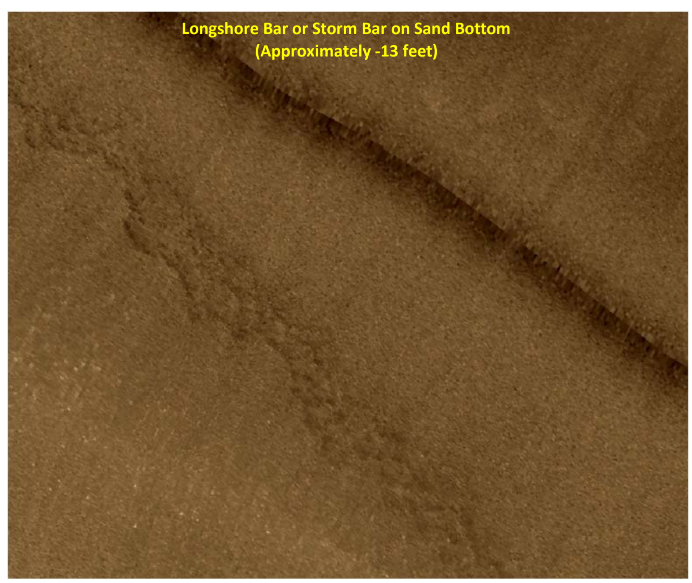






**APPENDIX 2. HABITAT PHOTOS**

**Photo 1. Boulder/Gravel Reef** - Cobble beds at approximately -10 feet near the boulder/gravel reef interfaces with sand bottom.

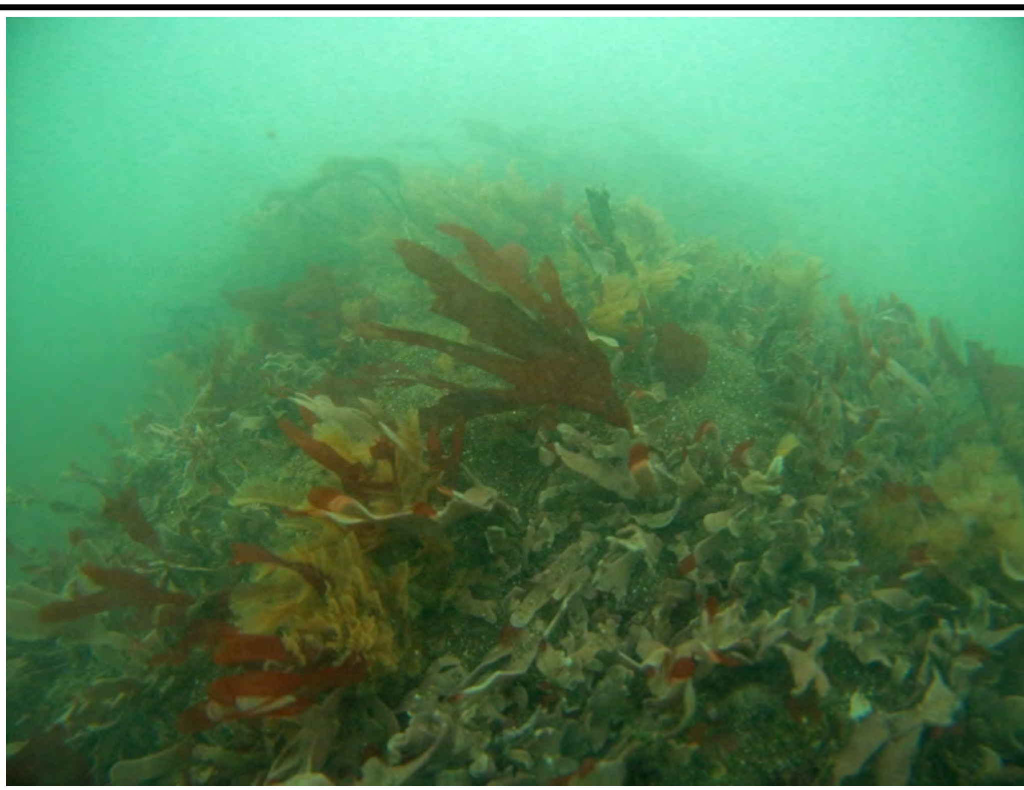


**Photo 2. Boulder/Gravel Reef** - Large boulder reef at approximately -14 feet at the western margin of the study area.

**Photo 3. Boulder/Gravel Reef** - Large boulder reef at approximately -19 feet at sand bottom interface.

**Photo 4. Boulder/Gravel Reef** – Mixed cobble and gravel west of Bolinas Lagoon mouth at approximately -5 feet. Poor image due to high particulates in lagoon outflow.

**Photo 5. Boulder/Gravel Reef** and **Sand** – Interface between boulder reef and sand bottom at approximately -29 feet.

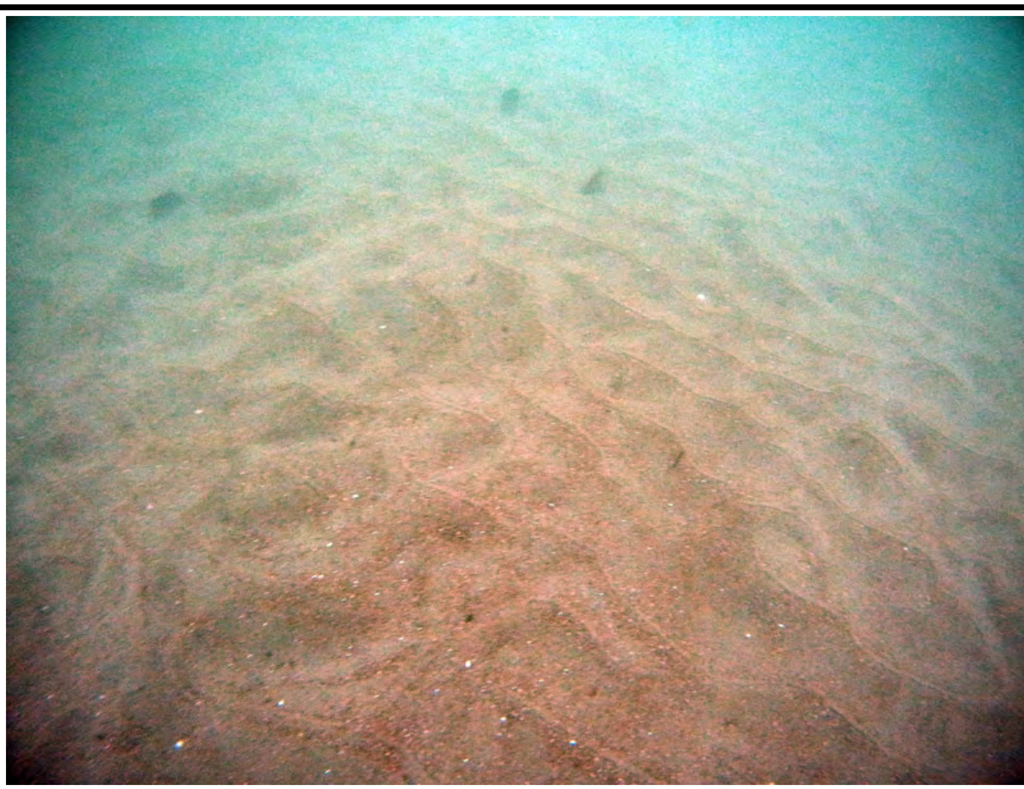


**Photo 6. Sand** – Sand bottom at approximately -9 feet off Patios showing wave influence and sparse sand dollars.

**Photo 7. Sand** – Fine sand bottom at approximately -40 feet between Patios and Calles transects.

**Photo 8. Sand** – Transient rip-current chute with shell hash at approximately -8 feet between Seadrift East and Patios.

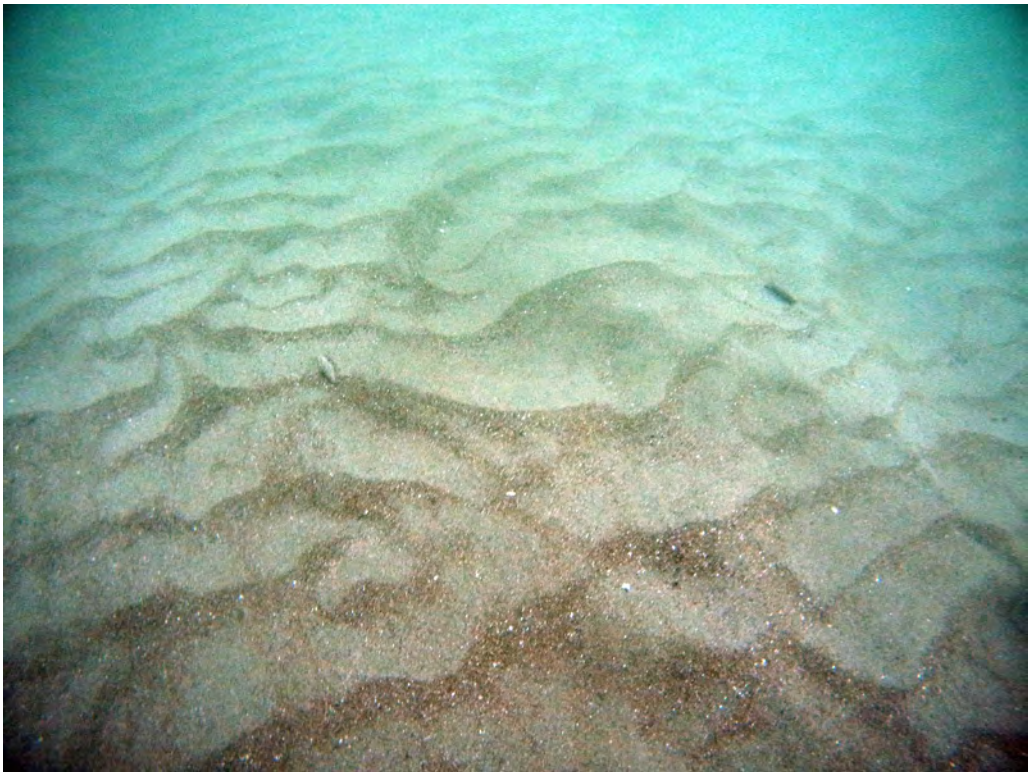


**Photo 9. Sand** - Rippled sand at approximately -5 feet off Bolinas Lagoon mouth

**Photo 10. Sand** – Sand bottom at approximately -11 feet off Seadrift-East transect. Sparse sand dollars are common in offshore shallows.

## APPENDIX 3. EUROFINS CALSCIENCE ANALYTICAL REPORT

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eurofins | Calscience

# ANALYTICAL REPORT

Eurofins Calscience LLC
7440 Lincoln Way
Garden Grove, CA 92841
Tel: (714)895-5494

Laboratory Job ID: 570-13756-1
Client Project/Site: STINSON BEACH 19-009-01

For:
Merkel & Associates
5434 Ruffin Road
San Diego, California 92123

Attn: Kathy Rogers

*Authorized for release by:*
*12/10/2019 9:48:59 PM*

Carla Hollowell, Project Manager I
(714)895-5494
carlahollowell@eurofinsus.com

# Table of Contents

# Definitions/Glossary

Client: Merkel & Associates — Job ID: 570-13756-1

Project/Site: STINSON BEACH 19-009-01

## Glossary

| Abbreviation | These commonly used abbreviations may or may not be present in this report. |
|---|---|
| ¤ | Listed under the "D" column to designate that the result is reported on a dry weight basis |
| %R | Percent Recovery |
| CFL | Contains Free Liquid |
| CNF | Contains No Free Liquid |
| DER | Duplicate Error Ratio (normalized absolute difference) |
| Dil Fac | Dilution Factor |
| DL | Detection Limit (DoD/DOE) |
| DL, RA, RE, IN | Indicates a Dilution, Re-analysis, Re-extraction, or additional Initial metals/anion analysis of the sample |
| DLC | Decision Level Concentration (Radiochemistry) |
| EDL | Estimated Detection Limit (Dioxin) |
| LOD | Limit of Detection (DoD/DOE) |
| LOQ | Limit of Quantitation (DoD/DOE) |
| MDA | Minimum Detectable Activity (Radiochemistry) |
| MDC | Minimum Detectable Concentration (Radiochemistry) |
| MDL | Method Detection Limit |
| ML | Minimum Level (Dioxin) |
| NC | Not Calculated |
| ND | Not Detected at the reporting limit (or MDL or EDL if shown) |
| PQL | Practical Quantitation Limit |
| QC | Quality Control |
| RER | Relative Error Ratio (Radiochemistry) |
| RL | Reporting Limit or Requested Limit (Radiochemistry) |
| RPD | Relative Percent Difference, a measure of the relative difference between two points |
| TEF | Toxicity Equivalent Factor (Dioxin) |
| TEQ | Toxicity Equivalent Quotient (Dioxin) |

# Case Narrative

Client: Merkel & Associates
Project/Site: STINSON BEACH 19-009-01

Job ID: 570-13756-1

## Job ID: 570-13756-1

### Laboratory: Eurofins Calscience LLC

**Narrative**

**Job Narrative**
**570-13756-1**

**Comments**
No additional comments.

**Receipt**
The samples were received on 11/22/2019 7:00 PM; the samples arrived in good condition, properly preserved and, where required, on ice. The temperature of the cooler at receipt was 2.5º C.

**General Chemistry**
No analytical or quality issues were noted, other than those described in the Definitions/Glossary page.

# Client Sample Results

Client: Merkel & Associates
Job ID: 570-13756-1
Project/Site: STINSON BEACH 19-009-01

## Method: D4464 - Particle Size Distribution of Catalytic Material ( Laser light scattering)

**Client Sample ID: NPS +12**
**Lab Sample ID: 570-13756-1**
**Date Collected: 10/16/19 07:00**
**Matrix: Solid**
**Date Received: 11/22/19 19:00**

| Analyte | Result | Qualifier | RL | MDL | Unit | D | Prepared | Analyzed | Dil Fac |
|---|---|---|---|---|---|---|---|---|---|
| Clay(less than 0.00391 mm) | ND | | 0.01 | 0.01 | % | | | 11/26/19 18:01 | 1 |
| **Coarse Sand (0.5mm to 1mm)** | **1.43** | | 0.01 | 0.01 | % | | | 11/26/19 18:01 | 1 |
| **Fine Sand (0.125 to 0.25mm)** | **54.80** | | 0.01 | 0.01 | % | | | 11/26/19 18:01 | 1 |
| Gravel (greater than 2 mm) | ND | | 0.01 | 0.01 | % | | | 11/26/19 18:01 | 1 |
| **Medium Sand (0.25 to 0.5 mm)** | **43.29** | | 0.01 | 0.01 | % | | | 11/26/19 18:01 | 1 |
| Silt (0.00391 to 0.0625mm) | ND | | 0.01 | 0.01 | % | | | 11/26/19 18:01 | 1 |
| Total Silt and Clay (0 to 0.0626mm) | ND | | 0.01 | 0.01 | % | | | 11/26/19 18:01 | 1 |
| Very Coarse Sand (1 to 2mm) | ND | | 0.01 | 0.01 | % | | | 11/26/19 18:01 | 1 |
| **Very Fine Sand (0.0625 to 0.125 mm)** | **0.49** | | 0.01 | 0.01 | % | | | 11/26/19 18:01 | 1 |

**Client Sample ID: NPS +3**
**Lab Sample ID: 570-13756-2**
**Date Collected: 10/16/19 07:10**
**Matrix: Solid**
**Date Received: 11/22/19 19:00**

| Analyte | Result | Qualifier | RL | MDL | Unit | D | Prepared | Analyzed | Dil Fac |
|---|---|---|---|---|---|---|---|---|---|
| Clay(less than 0.00391 mm) | ND | | 0.01 | 0.01 | % | | | 11/26/19 18:11 | 1 |
| **Coarse Sand (0.5mm to 1mm)** | **17.76** | | 0.01 | 0.01 | % | | | 11/26/19 18:11 | 1 |
| **Fine Sand (0.125 to 0.25mm)** | **41.44** | | 0.01 | 0.01 | % | | | 11/26/19 18:11 | 1 |
| Gravel (greater than 2 mm) | ND | | 0.01 | 0.01 | % | | | 11/26/19 18:11 | 1 |
| **Medium Sand (0.25 to 0.5 mm)** | **32.88** | | 0.01 | 0.01 | % | | | 11/26/19 18:11 | 1 |
| Silt (0.00391 to 0.0625mm) | ND | | 0.01 | 0.01 | % | | | 11/26/19 18:11 | 1 |
| Total Silt and Clay (0 to 0.0626mm) | ND | | 0.01 | 0.01 | % | | | 11/26/19 18:11 | 1 |
| **Very Coarse Sand (1 to 2mm)** | **5.87** | | 0.01 | 0.01 | % | | | 11/26/19 18:11 | 1 |
| **Very Fine Sand (0.0625 to 0.125 mm)** | **2.05** | | 0.01 | 0.01 | % | | | 11/26/19 18:11 | 1 |

**Client Sample ID: NPS +0**
**Lab Sample ID: 570-13756-3**
**Date Collected: 10/16/19 07:20**
**Matrix: Solid**
**Date Received: 11/22/19 19:00**

| Analyte | Result | Qualifier | RL | MDL | Unit | D | Prepared | Analyzed | Dil Fac |
|---|---|---|---|---|---|---|---|---|---|
| Clay(less than 0.00391 mm) | ND | | 0.01 | 0.01 | % | | | 11/26/19 18:19 | 1 |
| **Coarse Sand (0.5mm to 1mm)** | **27.74** | | 0.01 | 0.01 | % | | | 11/26/19 18:19 | 1 |
| **Fine Sand (0.125 to 0.25mm)** | **16.27** | | 0.01 | 0.01 | % | | | 11/26/19 18:19 | 1 |
| **Gravel (greater than 2 mm)** | **2.40** | | 0.01 | 0.01 | % | | | 11/26/19 18:19 | 1 |
| **Medium Sand (0.25 to 0.5 mm)** | **21.96** | | 0.01 | 0.01 | % | | | 11/26/19 18:19 | 1 |
| **Silt (0.00391 to 0.0625mm)** | **0.13** | | 0.01 | 0.01 | % | | | 11/26/19 18:19 | 1 |
| **Total Silt and Clay (0 to 0.0626mm)** | **0.13** | | 0.01 | 0.01 | % | | | 11/26/19 18:19 | 1 |
| **Very Coarse Sand (1 to 2mm)** | **30.66** | | 0.01 | 0.01 | % | | | 11/26/19 18:19 | 1 |
| **Very Fine Sand (0.0625 to 0.125 mm)** | **0.86** | | 0.01 | 0.01 | % | | | 11/26/19 18:19 | 1 |

**Client Sample ID: NPS -12**
**Lab Sample ID: 570-13756-4**
**Date Collected: 10/16/19 07:30**
**Matrix: Solid**
**Date Received: 11/22/19 19:00**

| Analyte | Result | Qualifier | RL | MDL | Unit | D | Prepared | Analyzed | Dil Fac |
|---|---|---|---|---|---|---|---|---|---|
| Clay(less than 0.00391 mm) | ND | | 0.01 | 0.01 | % | | | 11/26/19 18:29 | 1 |
| **Coarse Sand (0.5mm to 1mm)** | **2.51** | | 0.01 | 0.01 | % | | | 11/26/19 18:29 | 1 |
| **Fine Sand (0.125 to 0.25mm)** | **62.33** | | 0.01 | 0.01 | % | | | 11/26/19 18:29 | 1 |
| Gravel (greater than 2 mm) | ND | | 0.01 | 0.01 | % | | | 11/26/19 18:29 | 1 |
| **Medium Sand (0.25 to 0.5 mm)** | **30.85** | | 0.01 | 0.01 | % | | | 11/26/19 18:29 | 1 |

## Client Sample Results

Client: Merkel & Associates
Project/Site: STINSON BEACH 19-009-01

Job ID: 570-13756-1

### Method: D4464 - Particle Size Distribution of Catalytic Material ( Laser light scattering) (Continued)

**Client Sample ID: NPS -12**
**Date Collected: 10/16/19 07:30**
**Date Received: 11/22/19 19:00**

**Lab Sample ID: 570-13756-4**
**Matrix: Solid**

| Analyte | Result | Qualifier | RL | MDL | Unit | D | Prepared | Analyzed | Dil Fac |
|---|---|---|---|---|---|---|---|---|---|
| Silt (0.00391 to 0.0625mm) | ND | | 0.01 | 0.01 | % | | | 11/26/19 18:29 | 1 |
| Total Silt and Clay (0 to 0.0626mm) | ND | | 0.01 | 0.01 | % | | | 11/26/19 18:29 | 1 |
| Very Coarse Sand (1 to 2mm) | ND | | 0.01 | 0.01 | % | | | 11/26/19 18:29 | 1 |
| **Very Fine Sand (0.0625 to 0.125 mm)** | **4.31** | | 0.01 | 0.01 | % | | | 11/26/19 18:29 | 1 |

**Client Sample ID: NPS -24**
**Date Collected: 10/16/19 07:50**
**Date Received: 11/22/19 19:00**

**Lab Sample ID: 570-13756-5**
**Matrix: Solid**

| Analyte | Result | Qualifier | RL | MDL | Unit | D | Prepared | Analyzed | Dil Fac |
|---|---|---|---|---|---|---|---|---|---|
| Clay(less than 0.00391 mm) | ND | | 0.01 | 0.01 | % | | | 11/26/19 18:36 | 1 |
| **Coarse Sand (0.5mm to 1mm)** | **6.44** | | 0.01 | 0.01 | % | | | 11/26/19 18:36 | 1 |
| **Fine Sand (0.125 to 0.25mm)** | **48.59** | | 0.01 | 0.01 | % | | | 11/26/19 18:36 | 1 |
| Gravel (greater than 2 mm) | ND | | 0.01 | 0.01 | % | | | 11/26/19 18:36 | 1 |
| **Medium Sand (0.25 to 0.5 mm)** | **42.56** | | 0.01 | 0.01 | % | | | 11/26/19 18:36 | 1 |
| Silt (0.00391 to 0.0625mm) | ND | | 0.01 | 0.01 | % | | | 11/26/19 18:36 | 1 |
| Total Silt and Clay (0 to 0.0626mm) | ND | | 0.01 | 0.01 | % | | | 11/26/19 18:36 | 1 |
| Very Coarse Sand (1 to 2mm) | ND | | 0.01 | 0.01 | % | | | 11/26/19 18:36 | 1 |
| **Very Fine Sand (0.0625 to 0.125 mm)** | **2.41** | | 0.01 | 0.01 | % | | | 11/26/19 18:36 | 1 |

**Client Sample ID: CALLES +12**
**Date Collected: 10/16/19 08:20**
**Date Received: 11/22/19 19:00**

**Lab Sample ID: 570-13756-6**
**Matrix: Solid**

| Analyte | Result | Qualifier | RL | MDL | Unit | D | Prepared | Analyzed | Dil Fac |
|---|---|---|---|---|---|---|---|---|---|
| Clay(less than 0.00391 mm) | ND | | 0.01 | 0.01 | % | | | 11/26/19 18:45 | 1 |
| **Coarse Sand (0.5mm to 1mm)** | **3.53** | | 0.01 | 0.01 | % | | | 11/26/19 18:45 | 1 |
| **Fine Sand (0.125 to 0.25mm)** | **37.84** | | 0.01 | 0.01 | % | | | 11/26/19 18:45 | 1 |
| Gravel (greater than 2 mm) | ND | | 0.01 | 0.01 | % | | | 11/26/19 18:45 | 1 |
| **Medium Sand (0.25 to 0.5 mm)** | **58.29** | | 0.01 | 0.01 | % | | | 11/26/19 18:45 | 1 |
| Silt (0.00391 to 0.0625mm) | ND | | 0.01 | 0.01 | % | | | 11/26/19 18:45 | 1 |
| Total Silt and Clay (0 to 0.0626mm) | ND | | 0.01 | 0.01 | % | | | 11/26/19 18:45 | 1 |
| Very Coarse Sand (1 to 2mm) | ND | | 0.01 | 0.01 | % | | | 11/26/19 18:45 | 1 |
| **Very Fine Sand (0.0625 to 0.125 mm)** | **0.34** | | 0.01 | 0.01 | % | | | 11/26/19 18:45 | 1 |

**Client Sample ID: CALLES +3**
**Date Collected: 10/16/19 08:30**
**Date Received: 11/22/19 19:00**

**Lab Sample ID: 570-13756-7**
**Matrix: Solid**

| Analyte | Result | Qualifier | RL | MDL | Unit | D | Prepared | Analyzed | Dil Fac |
|---|---|---|---|---|---|---|---|---|---|
| Clay(less than 0.00391 mm) | ND | | 0.01 | 0.01 | % | | | 11/26/19 18:52 | 1 |
| **Coarse Sand (0.5mm to 1mm)** | **20.27** | | 0.01 | 0.01 | % | | | 11/26/19 18:52 | 1 |
| **Fine Sand (0.125 to 0.25mm)** | **37.78** | | 0.01 | 0.01 | % | | | 11/26/19 18:52 | 1 |
| Gravel (greater than 2 mm) | ND | | 0.01 | 0.01 | % | | | 11/26/19 18:52 | 1 |
| **Medium Sand (0.25 to 0.5 mm)** | **37.46** | | 0.01 | 0.01 | % | | | 11/26/19 18:52 | 1 |
| Silt (0.00391 to 0.0625mm) | ND | | 0.01 | 0.01 | % | | | 11/26/19 18:52 | 1 |
| Total Silt and Clay (0 to 0.0626mm) | ND | | 0.01 | 0.01 | % | | | 11/26/19 18:52 | 1 |
| **Very Coarse Sand (1 to 2mm)** | **3.04** | | 0.01 | 0.01 | % | | | 11/26/19 18:52 | 1 |
| **Very Fine Sand (0.0625 to 0.125 mm)** | **1.44** | | 0.01 | 0.01 | % | | | 11/26/19 18:52 | 1 |

# Client Sample Results

Client: Merkel & Associates
Project/Site: STINSON BEACH 19-009-01
Job ID: 570-13756-1

## Method: D4464 - Particle Size Distribution of Catalytic Material ( Laser light scattering)

**Client Sample ID: CALLES 0**
**Date Collected: 10/16/19 08:40**
**Date Received: 11/22/19 19:00**
**Lab Sample ID: 570-13756-8**
**Matrix: Solid**

| Analyte | Result | Qualifier | RL | MDL | Unit | D | Prepared | Analyzed | Dil Fac |
|---|---|---|---|---|---|---|---|---|---|
| Clay(less than 0.00391 mm) | 0.41 | | 0.01 | 0.01 | % | | | 11/26/19 18:59 | 1 |
| Coarse Sand (0.5mm to 1mm) | 6.55 | | 0.01 | 0.01 | % | | | 11/26/19 18:59 | 1 |
| Fine Sand (0.125 to 0.25mm) | 61.13 | | 0.01 | 0.01 | % | | | 11/26/19 18:59 | 1 |
| Gravel (greater than 2 mm) | ND | | 0.01 | 0.01 | % | | | 11/26/19 18:59 | 1 |
| Medium Sand (0.25 to 0.5 mm) | 25.16 | | 0.01 | 0.01 | % | | | 11/26/19 18:59 | 1 |
| Silt (0.00391 to 0.0625mm) | 0.64 | | 0.01 | 0.01 | % | | | 11/26/19 18:59 | 1 |
| Total Silt and Clay (0 to 0.0626mm) | 1.04 | | 0.01 | 0.01 | % | | | 11/26/19 18:59 | 1 |
| Very Coarse Sand (1 to 2mm) | 0.09 | | 0.01 | 0.01 | % | | | 11/26/19 18:59 | 1 |
| Very Fine Sand (0.0625 to 0.125 mm) | 6.03 | | 0.01 | 0.01 | % | | | 11/26/19 18:59 | 1 |

**Client Sample ID: CALLES -12**
**Date Collected: 10/16/19 08:50**
**Date Received: 11/22/19 19:00**
**Lab Sample ID: 570-13756-9**
**Matrix: Solid**

| Analyte | Result | Qualifier | RL | MDL | Unit | D | Prepared | Analyzed | Dil Fac |
|---|---|---|---|---|---|---|---|---|---|
| Clay(less than 0.00391 mm) | 0.41 | | 0.01 | 0.01 | % | | | 11/26/19 19:09 | 1 |
| Coarse Sand (0.5mm to 1mm) | 7.89 | | 0.01 | 0.01 | % | | | 11/26/19 19:09 | 1 |
| Fine Sand (0.125 to 0.25mm) | 54.00 | | 0.01 | 0.01 | % | | | 11/26/19 19:09 | 1 |
| Gravel (greater than 2 mm) | ND | | 0.01 | 0.01 | % | | | 11/26/19 19:09 | 1 |
| Medium Sand (0.25 to 0.5 mm) | 34.41 | | 0.01 | 0.01 | % | | | 11/26/19 19:09 | 1 |
| Silt (0.00391 to 0.0625mm) | 0.49 | | 0.01 | 0.01 | % | | | 11/26/19 19:09 | 1 |
| Total Silt and Clay (0 to 0.0626mm) | 0.90 | | 0.01 | 0.01 | % | | | 11/26/19 19:09 | 1 |
| Very Coarse Sand (1 to 2mm) | 0.14 | | 0.01 | 0.01 | % | | | 11/26/19 19:09 | 1 |
| Very Fine Sand (0.0625 to 0.125 mm) | 2.66 | | 0.01 | 0.01 | % | | | 11/26/19 19:09 | 1 |

**Client Sample ID: CALLES -24**
**Date Collected: 10/16/19 09:00**
**Date Received: 11/22/19 19:00**
**Lab Sample ID: 570-13756-10**
**Matrix: Solid**

| Analyte | Result | Qualifier | RL | MDL | Unit | D | Prepared | Analyzed | Dil Fac |
|---|---|---|---|---|---|---|---|---|---|
| Clay(less than 0.00391 mm) | 0.43 | | 0.01 | 0.01 | % | | | 11/26/19 19:18 | 1 |
| Coarse Sand (0.5mm to 1mm) | 4.70 | | 0.01 | 0.01 | % | | | 11/26/19 19:18 | 1 |
| Fine Sand (0.125 to 0.25mm) | 59.87 | | 0.01 | 0.01 | % | | | 11/26/19 19:18 | 1 |
| Gravel (greater than 2 mm) | ND | | 0.01 | 0.01 | % | | | 11/26/19 19:18 | 1 |
| Medium Sand (0.25 to 0.5 mm) | 31.00 | | 0.01 | 0.01 | % | | | 11/26/19 19:18 | 1 |
| Silt (0.00391 to 0.0625mm) | 0.68 | | 0.01 | 0.01 | % | | | 11/26/19 19:18 | 1 |
| Total Silt and Clay (0 to 0.0626mm) | 1.11 | | 0.01 | 0.01 | % | | | 11/26/19 19:18 | 1 |
| Very Coarse Sand (1 to 2mm) | 0.05 | | 0.01 | 0.01 | % | | | 11/26/19 19:18 | 1 |
| Very Fine Sand (0.0625 to 0.125 mm) | 3.26 | | 0.01 | 0.01 | % | | | 11/26/19 19:18 | 1 |

**Client Sample ID: PATIOS +12**
**Date Collected: 10/16/19 09:20**
**Date Received: 11/22/19 19:00**
**Lab Sample ID: 570-13756-11**
**Matrix: Solid**

| Analyte | Result | Qualifier | RL | MDL | Unit | D | Prepared | Analyzed | Dil Fac |
|---|---|---|---|---|---|---|---|---|---|
| Clay(less than 0.00391 mm) | ND | | 0.01 | 0.01 | % | | | 11/26/19 19:48 | 1 |
| Coarse Sand (0.5mm to 1mm) | 1.73 | | 0.01 | 0.01 | % | | | 11/26/19 19:48 | 1 |
| Fine Sand (0.125 to 0.25mm) | 42.32 | | 0.01 | 0.01 | % | | | 11/26/19 19:48 | 1 |
| Gravel (greater than 2 mm) | ND | | 0.01 | 0.01 | % | | | 11/26/19 19:48 | 1 |

# Client Sample Results

Client: Merkel & Associates
Project/Site: STINSON BEACH 19-009-01

Job ID: 570-13756-1

## Method: D4464 - Particle Size Distribution of Catalytic Material ( Laser light scattering) (Continued)

**Client Sample ID: PATIOS +12**
**Date Collected: 10/16/19 09:20**
**Date Received: 11/22/19 19:00**

**Lab Sample ID: 570-13756-11**
**Matrix: Solid**

| Analyte | Result | Qualifier | RL | MDL | Unit | D | Prepared | Analyzed | Dil Fac |
|---|---|---|---|---|---|---|---|---|---|
| **Medium Sand (0.25 to 0.5 mm)** | **55.48** | | 0.01 | 0.01 | % | | | 11/26/19 19:48 | 1 |
| Silt (0.00391 to 0.0625mm) | ND | | 0.01 | 0.01 | % | | | 11/26/19 19:48 | 1 |
| Total Silt and Clay (0 to 0.0626mm) | ND | | 0.01 | 0.01 | % | | | 11/26/19 19:48 | 1 |
| **Very Coarse Sand (1 to 2mm)** | **0.40** | | 0.01 | 0.01 | % | | | 11/26/19 19:48 | 1 |
| **Very Fine Sand (0.0625 to 0.125 mm)** | **0.07** | | 0.01 | 0.01 | % | | | 11/26/19 19:48 | 1 |

**Client Sample ID: PATIOS +3**
**Date Collected: 10/16/19 09:30**
**Date Received: 11/22/19 19:00**

**Lab Sample ID: 570-13756-12**
**Matrix: Solid**

| Analyte | Result | Qualifier | RL | MDL | Unit | D | Prepared | Analyzed | Dil Fac |
|---|---|---|---|---|---|---|---|---|---|
| Clay(less than 0.00391 mm) | ND | | 0.01 | 0.01 | % | | | 11/26/19 20:17 | 1 |
| **Coarse Sand (0.5mm to 1mm)** | **26.36** | | 0.01 | 0.01 | % | | | 11/26/19 20:17 | 1 |
| **Fine Sand (0.125 to 0.25mm)** | **27.79** | | 0.01 | 0.01 | % | | | 11/26/19 20:17 | 1 |
| Gravel (greater than 2 mm) | ND | | 0.01 | 0.01 | % | | | 11/26/19 20:17 | 1 |
| **Medium Sand (0.25 to 0.5 mm)** | **43.21** | | 0.01 | 0.01 | % | | | 11/26/19 20:17 | 1 |
| Silt (0.00391 to 0.0625mm) | ND | | 0.01 | 0.01 | % | | | 11/26/19 20:17 | 1 |
| Total Silt and Clay (0 to 0.0626mm) | ND | | 0.01 | 0.01 | % | | | 11/26/19 20:17 | 1 |
| **Very Coarse Sand (1 to 2mm)** | **2.07** | | 0.01 | 0.01 | % | | | 11/26/19 20:17 | 1 |
| **Very Fine Sand (0.0625 to 0.125 mm)** | **0.57** | | 0.01 | 0.01 | % | | | 11/26/19 20:17 | 1 |

**Client Sample ID: PATIOS 0**
**Date Collected: 10/16/19 09:40**
**Date Received: 11/22/19 19:00**

**Lab Sample ID: 570-13756-13**
**Matrix: Solid**

| Analyte | Result | Qualifier | RL | MDL | Unit | D | Prepared | Analyzed | Dil Fac |
|---|---|---|---|---|---|---|---|---|---|
| Clay(less than 0.00391 mm) | ND | | 0.01 | 0.01 | % | | | 11/26/19 20:26 | 1 |
| **Coarse Sand (0.5mm to 1mm)** | **17.63** | | 0.01 | 0.01 | % | | | 11/26/19 20:26 | 1 |
| **Fine Sand (0.125 to 0.25mm)** | **35.61** | | 0.01 | 0.01 | % | | | 11/26/19 20:26 | 1 |
| Gravel (greater than 2 mm) | ND | | 0.01 | 0.01 | % | | | 11/26/19 20:26 | 1 |
| **Medium Sand (0.25 to 0.5 mm)** | **42.59** | | 0.01 | 0.01 | % | | | 11/26/19 20:26 | 1 |
| Silt (0.00391 to 0.0625mm) | ND | | 0.01 | 0.01 | % | | | 11/26/19 20:26 | 1 |
| Total Silt and Clay (0 to 0.0626mm) | ND | | 0.01 | 0.01 | % | | | 11/26/19 20:26 | 1 |
| **Very Coarse Sand (1 to 2mm)** | **1.63** | | 0.01 | 0.01 | % | | | 11/26/19 20:26 | 1 |
| **Very Fine Sand (0.0625 to 0.125 mm)** | **2.54** | | 0.01 | 0.01 | % | | | 11/26/19 20:26 | 1 |

**Client Sample ID: PATIOS -12**
**Date Collected: 10/16/19 09:50**
**Date Received: 11/22/19 19:00**

**Lab Sample ID: 570-13756-14**
**Matrix: Solid**

| Analyte | Result | Qualifier | RL | MDL | Unit | D | Prepared | Analyzed | Dil Fac |
|---|---|---|---|---|---|---|---|---|---|
| Clay(less than 0.00391 mm) | ND | | 0.01 | 0.01 | % | | | 11/26/19 20:35 | 1 |
| **Coarse Sand (0.5mm to 1mm)** | **8.40** | | 0.01 | 0.01 | % | | | 11/26/19 20:35 | 1 |
| **Fine Sand (0.125 to 0.25mm)** | **46.52** | | 0.01 | 0.01 | % | | | 11/26/19 20:35 | 1 |
| Gravel (greater than 2 mm) | ND | | 0.01 | 0.01 | % | | | 11/26/19 20:35 | 1 |
| **Medium Sand (0.25 to 0.5 mm)** | **42.58** | | 0.01 | 0.01 | % | | | 11/26/19 20:35 | 1 |
| Silt (0.00391 to 0.0625mm) | ND | | 0.01 | 0.01 | % | | | 11/26/19 20:35 | 1 |
| Total Silt and Clay (0 to 0.0626mm) | ND | | 0.01 | 0.01 | % | | | 11/26/19 20:35 | 1 |
| **Very Coarse Sand (1 to 2mm)** | **1.20** | | 0.01 | 0.01 | % | | | 11/26/19 20:35 | 1 |
| **Very Fine Sand (0.0625 to 0.125 mm)** | **1.30** | | 0.01 | 0.01 | % | | | 11/26/19 20:35 | 1 |

# Client Sample Results

Client: Merkel & Associates
Project/Site: STINSON BEACH 19-009-01
Job ID: 570-13756-1

## Method: D4464 - Particle Size Distribution of Catalytic Material ( Laser light scattering)

**Client Sample ID: PATIOS -24**
**Date Collected: 10/16/19 10:00**
**Date Received: 11/22/19 19:00**
**Lab Sample ID: 570-13756-15**
**Matrix: Solid**

| Analyte | Result | Qualifier | RL | MDL | Unit | D | Prepared | Analyzed | Dil Fac |
|---|---|---|---|---|---|---|---|---|---|
| **Clay(less than 0.00391 mm)** | **0.51** | | 0.01 | 0.01 | % | | | 11/26/19 20:42 | 1 |
| **Coarse Sand (0.5mm to 1mm)** | **6.93** | | 0.01 | 0.01 | % | | | 11/26/19 20:42 | 1 |
| **Fine Sand (0.125 to 0.25mm)** | **58.14** | | 0.01 | 0.01 | % | | | 11/26/19 20:42 | 1 |
| Gravel (greater than 2 mm) | ND | | 0.01 | 0.01 | % | | | 11/26/19 20:42 | 1 |
| **Medium Sand (0.25 to 0.5 mm)** | **27.92** | | 0.01 | 0.01 | % | | | 11/26/19 20:42 | 1 |
| **Silt (0.00391 to 0.0625mm)** | **1.08** | | 0.01 | 0.01 | % | | | 11/26/19 20:42 | 1 |
| **Total Silt and Clay (0 to 0.0626mm)** | **1.59** | | 0.01 | 0.01 | % | | | 11/26/19 20:42 | 1 |
| **Very Coarse Sand (1 to 2mm)** | **1.20** | | 0.01 | 0.01 | % | | | 11/26/19 20:42 | 1 |
| **Very Fine Sand (0.0625 to 0.125 mm)** | **4.23** | | 0.01 | 0.01 | % | | | 11/26/19 20:42 | 1 |

**Client Sample ID: SEADRIFT E +12**
**Date Collected: 10/16/19 10:15**
**Date Received: 11/22/19 19:00**
**Lab Sample ID: 570-13756-16**
**Matrix: Solid**

| Analyte | Result | Qualifier | RL | MDL | Unit | D | Prepared | Analyzed | Dil Fac |
|---|---|---|---|---|---|---|---|---|---|
| Clay(less than 0.00391 mm) | ND | | 0.01 | 0.01 | % | | | 11/26/19 20:48 | 1 |
| **Coarse Sand (0.5mm to 1mm)** | **2.50** | | 0.01 | 0.01 | % | | | 11/26/19 20:48 | 1 |
| **Fine Sand (0.125 to 0.25mm)** | **35.93** | | 0.01 | 0.01 | % | | | 11/26/19 20:48 | 1 |
| Gravel (greater than 2 mm) | ND | | 0.01 | 0.01 | % | | | 11/26/19 20:48 | 1 |
| **Medium Sand (0.25 to 0.5 mm)** | **60.88** | | 0.01 | 0.01 | % | | | 11/26/19 20:48 | 1 |
| Silt (0.00391 to 0.0625mm) | ND | | 0.01 | 0.01 | % | | | 11/26/19 20:48 | 1 |
| Total Silt and Clay (0 to 0.0626mm) | ND | | 0.01 | 0.01 | % | | | 11/26/19 20:48 | 1 |
| **Very Coarse Sand (1 to 2mm)** | **0.68** | | 0.01 | 0.01 | % | | | 11/26/19 20:48 | 1 |
| **Very Fine Sand (0.0625 to 0.125 mm)** | **0.01** | | 0.01 | 0.01 | % | | | 11/26/19 20:48 | 1 |

**Client Sample ID: SEADRIFT E +3**
**Date Collected: 10/16/19 10:25**
**Date Received: 11/22/19 19:00**
**Lab Sample ID: 570-13756-17**
**Matrix: Solid**

| Analyte | Result | Qualifier | RL | MDL | Unit | D | Prepared | Analyzed | Dil Fac |
|---|---|---|---|---|---|---|---|---|---|
| Clay(less than 0.00391 mm) | ND | | 0.01 | 0.01 | % | | | 11/26/19 20:58 | 1 |
| **Coarse Sand (0.5mm to 1mm)** | **30.17** | | 0.01 | 0.01 | % | | | 11/26/19 20:58 | 1 |
| **Fine Sand (0.125 to 0.25mm)** | **22.93** | | 0.01 | 0.01 | % | | | 11/26/19 20:58 | 1 |
| Gravel (greater than 2 mm) | ND | | 0.01 | 0.01 | % | | | 11/26/19 20:58 | 1 |
| **Medium Sand (0.25 to 0.5 mm)** | **39.63** | | 0.01 | 0.01 | % | | | 11/26/19 20:58 | 1 |
| Silt (0.00391 to 0.0625mm) | ND | | 0.01 | 0.01 | % | | | 11/26/19 20:58 | 1 |
| Total Silt and Clay (0 to 0.0626mm) | ND | | 0.01 | 0.01 | % | | | 11/26/19 20:58 | 1 |
| **Very Coarse Sand (1 to 2mm)** | **6.78** | | 0.01 | 0.01 | % | | | 11/26/19 20:58 | 1 |
| **Very Fine Sand (0.0625 to 0.125 mm)** | **0.49** | | 0.01 | 0.01 | % | | | 11/26/19 20:58 | 1 |

**Client Sample ID: SEADRIFT E 0**
**Date Collected: 10/16/19 10:35**
**Date Received: 11/22/19 19:00**
**Lab Sample ID: 570-13756-18**
**Matrix: Solid**

| Analyte | Result | Qualifier | RL | MDL | Unit | D | Prepared | Analyzed | Dil Fac |
|---|---|---|---|---|---|---|---|---|---|
| Clay(less than 0.00391 mm) | ND | | 0.01 | 0.01 | % | | | 11/26/19 21:05 | 1 |
| **Coarse Sand (0.5mm to 1mm)** | **13.60** | | 0.01 | 0.01 | % | | | 11/26/19 21:05 | 1 |
| **Fine Sand (0.125 to 0.25mm)** | **40.10** | | 0.01 | 0.01 | % | | | 11/26/19 21:05 | 1 |
| Gravel (greater than 2 mm) | ND | | 0.01 | 0.01 | % | | | 11/26/19 21:05 | 1 |
| **Medium Sand (0.25 to 0.5 mm)** | **42.51** | | 0.01 | 0.01 | % | | | 11/26/19 21:05 | 1 |

## Client Sample Results

Client: Merkel & Associates
Project/Site: STINSON BEACH 19-009-01

Job ID: 570-13756-1

### Method: D4464 - Particle Size Distribution of Catalytic Material ( Laser light scattering) (Continued)

**Client Sample ID: SEADRIFT E 0**
**Date Collected: 10/16/19 10:35**
**Date Received: 11/22/19 19:00**

**Lab Sample ID: 570-13756-18**
**Matrix: Solid**

| Analyte | Result | Qualifier | RL | MDL | Unit | D | Prepared | Analyzed | Dil Fac |
|---|---|---|---|---|---|---|---|---|---|
| Silt (0.00391 to 0.0625mm) | ND | | 0.01 | 0.01 | % | | | 11/26/19 21:05 | 1 |
| Total Silt and Clay (0 to 0.0626mm) | ND | | 0.01 | 0.01 | % | | | 11/26/19 21:05 | 1 |
| **Very Coarse Sand (1 to 2mm)** | **0.95** | | 0.01 | 0.01 | % | | | 11/26/19 21:05 | 1 |
| **Very Fine Sand (0.0625 to 0.125 mm)** | **2.83** | | 0.01 | 0.01 | % | | | 11/26/19 21:05 | 1 |

**Client Sample ID: SEADRIFT E -12**
**Date Collected: 10/16/19 10:45**
**Date Received: 11/22/19 19:00**

**Lab Sample ID: 570-13756-19**
**Matrix: Solid**

| Analyte | Result | Qualifier | RL | MDL | Unit | D | Prepared | Analyzed | Dil Fac |
|---|---|---|---|---|---|---|---|---|---|
| **Clay(less than 0.00391 mm)** | **0.26** | | 0.01 | 0.01 | % | | | 11/26/19 21:24 | 1 |
| **Coarse Sand (0.5mm to 1mm)** | **16.78** | | 0.01 | 0.01 | % | | | 11/26/19 21:24 | 1 |
| **Fine Sand (0.125 to 0.25mm)** | **31.84** | | 0.01 | 0.01 | % | | | 11/26/19 21:24 | 1 |
| **Gravel (greater than 2 mm)** | **1.50** | | 0.01 | 0.01 | % | | | 11/26/19 21:24 | 1 |
| **Medium Sand (0.25 to 0.5 mm)** | **44.00** | | 0.01 | 0.01 | % | | | 11/26/19 21:24 | 1 |
| **Silt (0.00391 to 0.0625mm)** | **0.40** | | 0.01 | 0.01 | % | | | 11/26/19 21:24 | 1 |
| **Total Silt and Clay (0 to 0.0626mm)** | **0.66** | | 0.01 | 0.01 | % | | | 11/26/19 21:24 | 1 |
| **Very Coarse Sand (1 to 2mm)** | **3.76** | | 0.01 | 0.01 | % | | | 11/26/19 21:24 | 1 |
| **Very Fine Sand (0.0625 to 0.125 mm)** | **1.47** | | 0.01 | 0.01 | % | | | 11/26/19 21:24 | 1 |

**Client Sample ID: SEADRIFT E -24**
**Date Collected: 10/16/19 10:55**
**Date Received: 11/22/19 19:00**

**Lab Sample ID: 570-13756-20**
**Matrix: Solid**

| Analyte | Result | Qualifier | RL | MDL | Unit | D | Prepared | Analyzed | Dil Fac |
|---|---|---|---|---|---|---|---|---|---|
| **Clay(less than 0.00391 mm)** | **0.40** | | 0.01 | 0.01 | % | | | 11/26/19 21:31 | 1 |
| **Coarse Sand (0.5mm to 1mm)** | **8.66** | | 0.01 | 0.01 | % | | | 11/26/19 21:31 | 1 |
| **Fine Sand (0.125 to 0.25mm)** | **52.24** | | 0.01 | 0.01 | % | | | 11/26/19 21:31 | 1 |
| Gravel (greater than 2 mm) | ND | | 0.01 | 0.01 | % | | | 11/26/19 21:31 | 1 |
| **Medium Sand (0.25 to 0.5 mm)** | **31.68** | | 0.01 | 0.01 | % | | | 11/26/19 21:31 | 1 |
| **Silt (0.00391 to 0.0625mm)** | **0.93** | | 0.01 | 0.01 | % | | | 11/26/19 21:31 | 1 |
| **Total Silt and Clay (0 to 0.0626mm)** | **1.32** | | 0.01 | 0.01 | % | | | 11/26/19 21:31 | 1 |
| **Very Coarse Sand (1 to 2mm)** | **0.94** | | 0.01 | 0.01 | % | | | 11/26/19 21:31 | 1 |
| **Very Fine Sand (0.0625 to 0.125 mm)** | **5.16** | | 0.01 | 0.01 | % | | | 11/26/19 21:31 | 1 |

**Client Sample ID: SEADRIFT W +12**
**Date Collected: 10/16/19 11:20**
**Date Received: 11/22/19 19:00**

**Lab Sample ID: 570-13756-21**
**Matrix: Solid**

| Analyte | Result | Qualifier | RL | MDL | Unit | D | Prepared | Analyzed | Dil Fac |
|---|---|---|---|---|---|---|---|---|---|
| Clay(less than 0.00391 mm) | ND | | 0.01 | 0.01 | % | | | 11/27/19 19:30 | 1 |
| **Coarse Sand (0.5mm to 1mm)** | **5.37** | | 0.01 | 0.01 | % | | | 11/27/19 19:30 | 1 |
| **Fine Sand (0.125 to 0.25mm)** | **24.48** | | 0.01 | 0.01 | % | | | 11/27/19 19:30 | 1 |
| Gravel (greater than 2 mm) | ND | | 0.01 | 0.01 | % | | | 11/27/19 19:30 | 1 |
| **Medium Sand (0.25 to 0.5 mm)** | **69.39** | | 0.01 | 0.01 | % | | | 11/27/19 19:30 | 1 |
| Silt (0.00391 to 0.0625mm) | ND | | 0.01 | 0.01 | % | | | 11/27/19 19:30 | 1 |
| Total Silt and Clay (0 to 0.0626mm) | ND | | 0.01 | 0.01 | % | | | 11/27/19 19:30 | 1 |
| Very Coarse Sand (1 to 2mm) | ND | | 0.01 | 0.01 | % | | | 11/27/19 19:30 | 1 |
| **Very Fine Sand (0.0625 to 0.125 mm)** | **0.76** | | 0.01 | 0.01 | % | | | 11/27/19 19:30 | 1 |

# Client Sample Results

Client: Merkel & Associates
Project/Site: STINSON BEACH 19-009-01

Job ID: 570-13756-1

1 2 3 4 5 6 7 8 9 10 11 12

## Method: D4464 - Particle Size Distribution of Catalytic Material ( Laser light scattering)

**Client Sample ID: SEADRIFT W +3**
**Date Collected: 10/16/19 11:30**
**Date Received: 11/22/19 19:00**

**Lab Sample ID: 570-13756-22**
**Matrix: Solid**

| Analyte | Result | Qualifier | RL | MDL | Unit | D | Prepared | Analyzed | Dil Fac |
|---|---|---|---|---|---|---|---|---|---|
| Clay(less than 0.00391 mm) | ND | | 0.01 | 0.01 | % | | | 11/27/19 19:48 | 1 |
| **Coarse Sand (0.5mm to 1mm)** | **8.26** | | 0.01 | 0.01 | % | | | 11/27/19 19:48 | 1 |
| **Fine Sand (0.125 to 0.25mm)** | **48.15** | | 0.01 | 0.01 | % | | | 11/27/19 19:48 | 1 |
| **Gravel (greater than 2 mm)** | **1.10** | | 0.01 | 0.01 | % | | | 11/27/19 19:48 | 1 |
| **Medium Sand (0.25 to 0.5 mm)** | **35.55** | | 0.01 | 0.01 | % | | | 11/27/19 19:48 | 1 |
| Silt (0.00391 to 0.0625mm) | ND | | 0.01 | 0.01 | % | | | 11/27/19 19:48 | 1 |
| Total Silt and Clay (0 to 0.0626mm) | ND | | 0.01 | 0.01 | % | | | 11/27/19 19:48 | 1 |
| **Very Coarse Sand (1 to 2mm)** | **6.06** | | 0.01 | 0.01 | % | | | 11/27/19 19:48 | 1 |
| **Very Fine Sand (0.0625 to 0.125 mm)** | **0.88** | | 0.01 | 0.01 | % | | | 11/27/19 19:48 | 1 |

**Client Sample ID: SEADRIFT W 0**
**Date Collected: 10/16/19 11:40**
**Date Received: 11/22/19 19:00**

**Lab Sample ID: 570-13756-23**
**Matrix: Solid**

| Analyte | Result | Qualifier | RL | MDL | Unit | D | Prepared | Analyzed | Dil Fac |
|---|---|---|---|---|---|---|---|---|---|
| Clay(less than 0.00391 mm) | ND | | 0.01 | 0.01 | % | | | 11/27/19 19:55 | 1 |
| **Coarse Sand (0.5mm to 1mm)** | **3.59** | | 0.01 | 0.01 | % | | | 11/27/19 19:55 | 1 |
| **Fine Sand (0.125 to 0.25mm)** | **52.34** | | 0.01 | 0.01 | % | | | 11/27/19 19:55 | 1 |
| Gravel (greater than 2 mm) | ND | | 0.01 | 0.01 | % | | | 11/27/19 19:55 | 1 |
| **Medium Sand (0.25 to 0.5 mm)** | **36.31** | | 0.01 | 0.01 | % | | | 11/27/19 19:55 | 1 |
| **Silt (0.00391 to 0.0625mm)** | **0.61** | | 0.01 | 0.01 | % | | | 11/27/19 19:55 | 1 |
| **Total Silt and Clay (0 to 0.0626mm)** | **0.61** | | 0.01 | 0.01 | % | | | 11/27/19 19:55 | 1 |
| Very Coarse Sand (1 to 2mm) | ND | | 0.01 | 0.01 | % | | | 11/27/19 19:55 | 1 |
| **Very Fine Sand (0.0625 to 0.125 mm)** | **7.15** | | 0.01 | 0.01 | % | | | 11/27/19 19:55 | 1 |

**Client Sample ID: SEADRIFT W -12**
**Date Collected: 10/16/19 11:50**
**Date Received: 11/22/19 19:00**

**Lab Sample ID: 570-13756-24**
**Matrix: Solid**

| Analyte | Result | Qualifier | RL | MDL | Unit | D | Prepared | Analyzed | Dil Fac |
|---|---|---|---|---|---|---|---|---|---|
| Clay(less than 0.00391 mm) | ND | | 0.01 | 0.01 | % | | | 11/27/19 20:14 | 1 |
| **Coarse Sand (0.5mm to 1mm)** | **8.51** | | 0.01 | 0.01 | % | | | 11/27/19 20:14 | 1 |
| **Fine Sand (0.125 to 0.25mm)** | **44.97** | | 0.01 | 0.01 | % | | | 11/27/19 20:14 | 1 |
| **Gravel (greater than 2 mm)** | **5.16** | | 0.01 | 0.01 | % | | | 11/27/19 20:14 | 1 |
| **Medium Sand (0.25 to 0.5 mm)** | **37.30** | | 0.01 | 0.01 | % | | | 11/27/19 20:14 | 1 |
| **Silt (0.00391 to 0.0625mm)** | **0.27** | | 0.01 | 0.01 | % | | | 11/27/19 20:14 | 1 |
| **Total Silt and Clay (0 to 0.0626mm)** | **0.27** | | 0.01 | 0.01 | % | | | 11/27/19 20:14 | 1 |
| **Very Coarse Sand (1 to 2mm)** | **0.22** | | 0.01 | 0.01 | % | | | 11/27/19 20:14 | 1 |
| **Very Fine Sand (0.0625 to 0.125 mm)** | **3.59** | | 0.01 | 0.01 | % | | | 11/27/19 20:14 | 1 |

**Client Sample ID: SEADRIFT W -24**
**Date Collected: 10/16/19 12:00**
**Date Received: 11/22/19 19:00**

**Lab Sample ID: 570-13756-25**
**Matrix: Solid**

| Analyte | Result | Qualifier | RL | MDL | Unit | D | Prepared | Analyzed | Dil Fac |
|---|---|---|---|---|---|---|---|---|---|
| **Clay(less than 0.00391 mm)** | **0.49** | | 0.01 | 0.01 | % | | | 11/27/19 20:20 | 1 |
| **Coarse Sand (0.5mm to 1mm)** | **4.75** | | 0.01 | 0.01 | % | | | 11/27/19 20:20 | 1 |
| **Fine Sand (0.125 to 0.25mm)** | **37.53** | | 0.01 | 0.01 | % | | | 11/27/19 20:20 | 1 |
| **Gravel (greater than 2 mm)** | **20.24** | | 0.01 | 0.01 | % | | | 11/27/19 20:20 | 1 |

# Client Sample Results

Client: Merkel & Associates
Job ID: 570-13756-1
Project/Site: STINSON BEACH 19-009-01

1 2 3 4 5 6 7 8 9 10 11 12

## Method: D4464 - Particle Size Distribution of Catalytic Material ( Laser light scattering) (Continued)

**Client Sample ID: SEADRIFT W -24**
**Lab Sample ID: 570-13756-25**
**Date Collected: 10/16/19 12:00**
**Matrix: Solid**
**Date Received: 11/22/19 19:00**

| Analyte | Result | Qualifier | RL | MDL | Unit | D | Prepared | Analyzed | Dil Fac |
|---|---|---|---|---|---|---|---|---|---|
| Medium Sand (0.25 to 0.5 mm) | 17.74 | | 0.01 | 0.01 | % | | | 11/27/19 20:20 | 1 |
| Silt (0.00391 to 0.0625mm) | 1.26 | | 0.01 | 0.01 | % | | | 11/27/19 20:20 | 1 |
| Total Silt and Clay (0 to 0.0626mm) | 1.75 | | 0.01 | 0.01 | % | | | 11/27/19 20:20 | 1 |
| Very Coarse Sand (1 to 2mm) | 6.42 | | 0.01 | 0.01 | % | | | 11/27/19 20:20 | 1 |
| Very Fine Sand (0.0625 to 0.125 mm) | 11.56 | | 0.01 | 0.01 | % | | | 11/27/19 20:20 | 1 |

# PARTICLE SIZE SUMMARY

**(ASTM D422 / D4464M)**

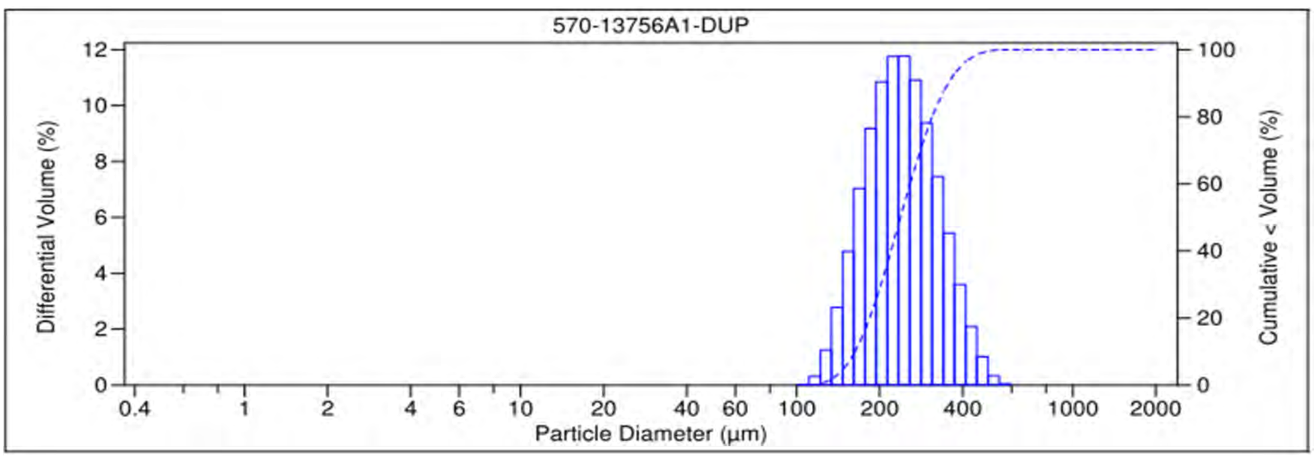
| | | |
|---|---|---|
| Merkel & Associates Inc. | Date Sampled: | 10/16/19 |
| | Date Received: | 11/21/19 |
| | Work Order No: | 570-13756 |
| | Date Analyzed: | 11/26/19 |
| | Method: | ASTM D4464M |

Project: Stinson Beach



| Sample ID | Depth ft | Description | Mean Grain Size mm |
|---|---|---|---|
| NPS +12 | | Fine Sand | 0.250 |

| Particle Size Distribution, wt by percent | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Total Gravel | Very Coarse Sand | Coarse Sand | Medium Sand | Fine Sand | Very Fine Sand | Silt | Clay | Total Silt & Clay |
| 0.00 | 0.00 | 0.34 | 43.49 | 55.51 | 0.67 | 0.00 | 0.00 | 0.00 |




V 3.0

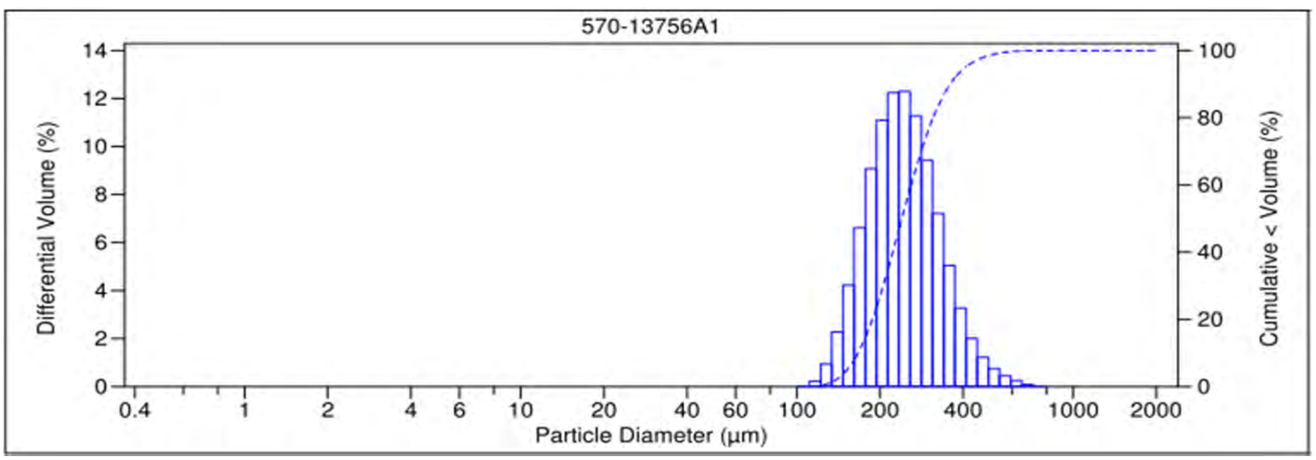
# PARTICLE SIZE SUMMARY

**(ASTM D422 / D4464M)**

| | | |
|---|---|---|
| Merkel & Associates Inc. | Date Sampled: | 10/16/19 |
| | Date Received: | 11/21/19 |
| | Work Order No: | 570-13756 |
| | Date Analyzed: | 11/26/19 |
| | Method: | ASTM D4464M |
| Project: Stinson Beach | | Page 1 of 21 |

| Sample ID | Depth ft | Description | Mean Grain Size mm |
|---|---|---|---|
| NPS +12 | | Medium Sand | 0.255 |

| Particle Size Distribution, wt by percent | | | | | | | | Total Silt & Clay |
|---|---|---|---|---|---|---|---|---|
| Total Gravel | Very Coarse Sand | Coarse Sand | Medium Sand | Fine Sand | Very Fine Sand | Silt | Clay | |
| 0.00 | 0.00 | 1.43 | 43.29 | 54.80 | 0.49 | 0.00 | 0.00 | 0.00 |




V 3.0

# PARTICLE SIZE SUMMARY

**(ASTM D422 / D4464M)**

Merkel & Associates Inc.

| | |
|---|---|
| Date Sampled: | 10/16/19 |
| Date Received: | 11/21/19 |
| Work Order No: | 570-13756 |
| Date Analyzed: | 11/26/19 |
| Method: | ASTM D4464M |

Project: Stinson Beach

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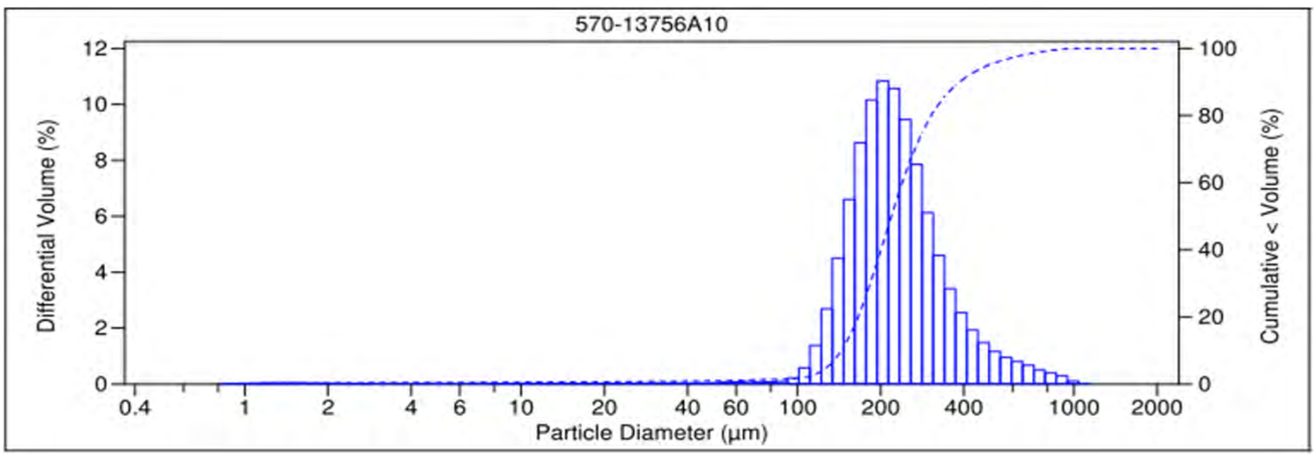
| Sample ID | Depth ft | Description | Mean Grain Size mm |
|---|---|---|---|
| CALLES -24 | | Fine Sand | 0.249 |

| Particle Size Distribution, wt by percent | | | | | | | | Total Silt & Clay |
|---|---|---|---|---|---|---|---|---|
| Total Gravel | Very Coarse Sand | Coarse Sand | Medium Sand | Fine Sand | Very Fine Sand | Silt | Clay | |
| 0.00 | 0.05 | 4.70 | 31.00 | 59.87 | 3.26 | 0.68 | 0.43 | 1.11 |




V 3.0

# PARTICLE SIZE SUMMARY

**(ASTM D422 / D4464M)**

Merkel & Associates Inc.

| | |
|---|---|
| Date Sampled: | 10/16/19 |
| Date Received: | 11/21/19 |
| Work Order No: | 570-13756 |
| Date Analyzed: | 11/26/19 |
| Method: | ASTM D4464M |

Project: Stinson Beach

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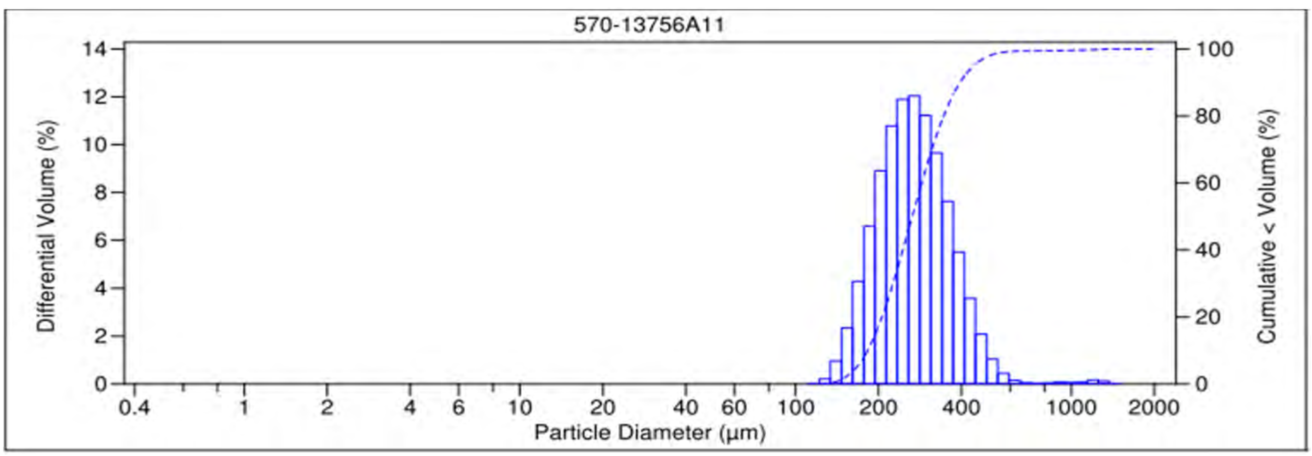
| Sample ID | Depth ft | Description | Mean Grain Size mm |
|---|---|---|---|
| Patios +12 | | Medium Sand | 0.283 |

| Particle Size Distribution, wt by percent | | | | | | | | Total Silt & Clay |
|---|---|---|---|---|---|---|---|---|
| Total Gravel | Very Coarse Sand | Coarse Sand | Medium Sand | Fine Sand | Very Fine Sand | Silt | Clay | |
| 0.00 | 0.40 | 1.73 | 55.48 | 42.32 | 0.07 | 0.00 | 0.00 | 0.00 |




V 3.0

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12

# PARTICLE SIZE SUMMARY

**(ASTM D422 / D4464M)**

Merkel & Associates Inc.

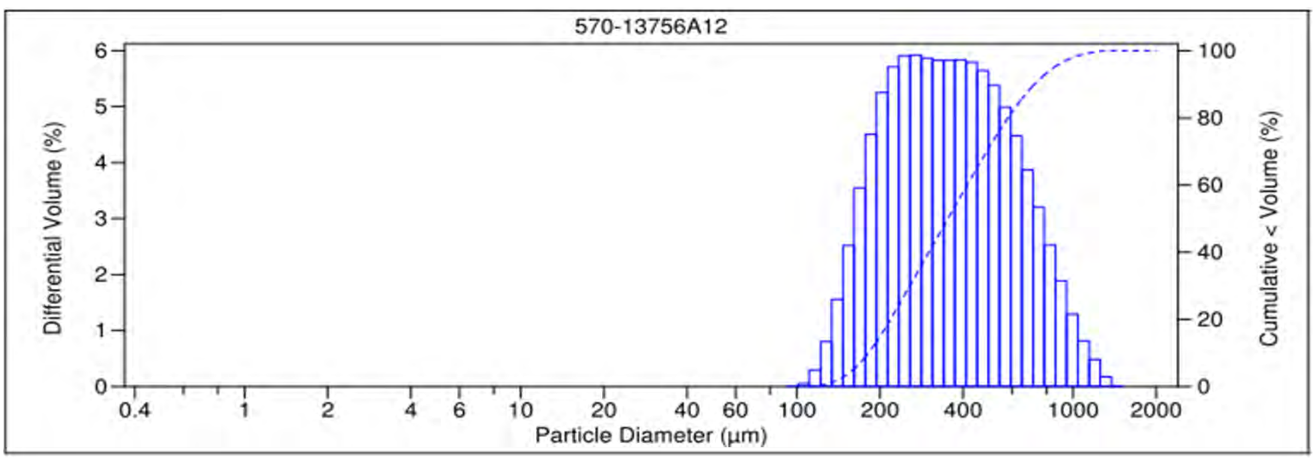
| | |
|---|---|
| Date Sampled: | 10/16/19 |
| Date Received: | 11/21/19 |
| Work Order No: | 570-13756 |
| Date Analyzed: | 11/26/19 |
| Method: | ASTM D4464M |

Project: Stinson Beach



| Sample ID | Depth ft | Description | Mean Grain Size mm |
|---|---|---|---|
| Patios +3 | | Medium Sand | 0.410 |

| Particle Size Distribution, wt by percent | | | | | | | | Total Silt & Clay |
|---|---|---|---|---|---|---|---|---|
| Total Gravel | Very Coarse Sand | Coarse Sand | Medium Sand | Fine Sand | Very Fine Sand | Silt | Clay | |
| 0.00 | 2.07 | 26.36 | 43.21 | 27.79 | 0.57 | 0.00 | 0.00 | 0.00 |




V 3.0

# PARTICLE SIZE SUMMARY

**(ASTM D422 / D4464M)**

Merkel & Associates Inc.

| | |
|---|---|
| Date Sampled: | 10/16/19 |
| Date Received: | 11/21/19 |
| Work Order No: | 570-13756 |
| Date Analyzed: | 11/26/19 |
| Method: | ASTM D4464M |

Project: Stinson Beach

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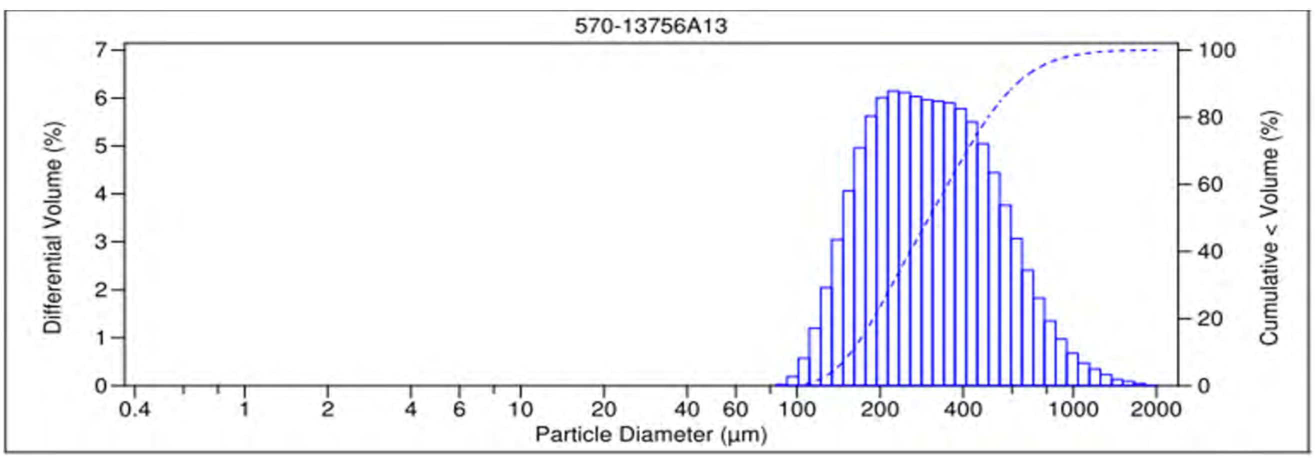
| Sample ID | Depth ft | Description | Mean Grain Size mm |
|---|---|---|---|
| Patios 0 | | Medium Sand | 0.356 |

| Particle Size Distribution, wt by percent | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Total Gravel | Very Coarse Sand | Coarse Sand | Medium Sand | Fine Sand | Very Fine Sand | Silt | Clay | Total Silt & Clay |
| 0.00 | 1.63 | 17.63 | 42.59 | 35.61 | 2.54 | 0.00 | 0.00 | 0.00 |




V 3.0

# PARTICLE SIZE SUMMARY

**(ASTM D422 / D4464M)**

Merkel & Associates Inc.

| | |
|---|---|
| Date Sampled: | 10/16/19 |
| Date Received: | 11/21/19 |
| Work Order No: | 570-13756 |
| Date Analyzed: | 11/26/19 |
| Method: | ASTM D4464M |

Project: Stinson Beach

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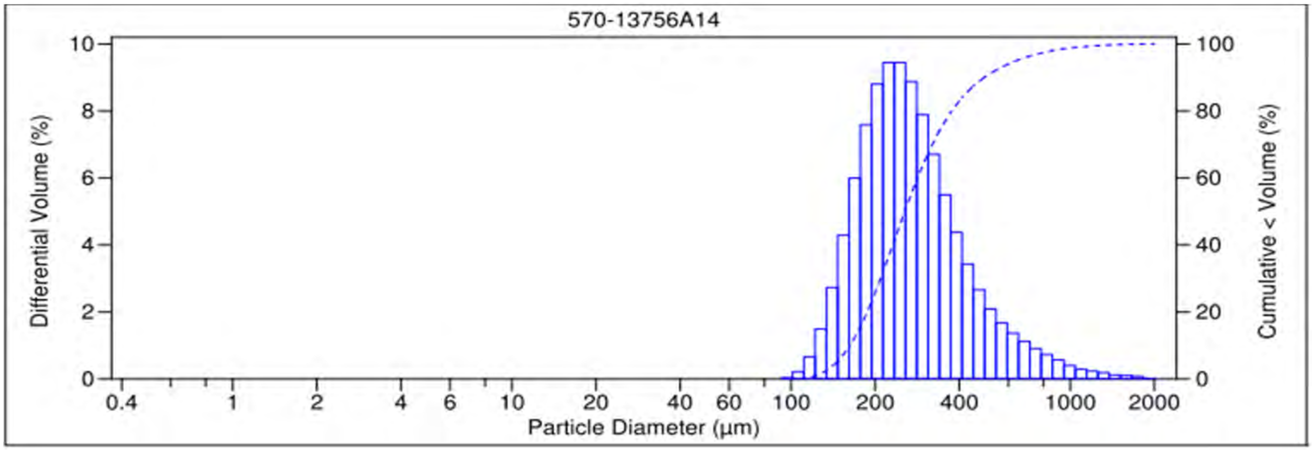
| Sample ID | Depth ft | Description | Mean Grain Size mm |
|---|---|---|---|
| Patios -12 | | Medium Sand | 0.304 |

| Particle Size Distribution, wt by percent | | | | | | | | Total Silt & Clay |
|---|---|---|---|---|---|---|---|---|
| Total Gravel | Very Coarse Sand | Coarse Sand | Medium Sand | Fine Sand | Very Fine Sand | Silt | Clay | |
| 0.00 | 1.20 | 8.40 | 42.58 | 46.52 | 1.30 | 0.00 | 0.00 | 0.00 |




V 3.0

# PARTICLE SIZE SUMMARY

**(ASTM D422 / D4464M)**

| | | |
|---|---|---|
| Merkel & Associates Inc. | Date Sampled: | 10/16/19 |
| | Date Received: | 11/21/19 |
| | Work Order No: | 570-13756 |
| | Date Analyzed: | 11/26/19 |
| | Method: | ASTM D4464M |

Project: Stinson Beach

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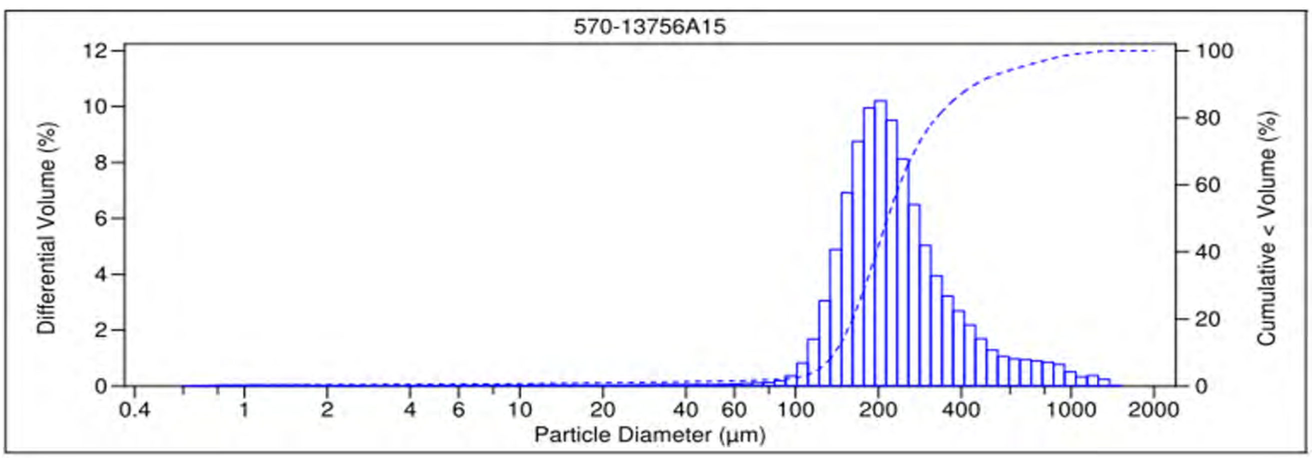
| Sample ID | Depth ft | Description | Mean Grain Size mm |
|---|---|---|---|
| Patios -24 | | Medium Sand | 0.268 |

| Particle Size Distribution, wt by percent | | | | | | | | Total Silt & Clay |
|---|---|---|---|---|---|---|---|---|
| Total Gravel | Very Coarse Sand | Coarse Sand | Medium Sand | Fine Sand | Very Fine Sand | Silt | Clay | |
| 0.00 | 1.20 | 6.93 | 27.92 | 58.14 | 4.23 | 1.08 | 0.51 | 1.59 |




V 3.0

# PARTICLE SIZE SUMMARY

**(ASTM D422 / D4464M)**

| | | |
|---|---|---|
| Merkel & Associates Inc. | Date Sampled: | 10/16/19 |
| | Date Received: | 11/21/19 |
| | Work Order No: | 570-13756 |
| | Date Analyzed: | 11/26/19 |
| | Method: | ASTM D4464M |

Project: Stinson Beach

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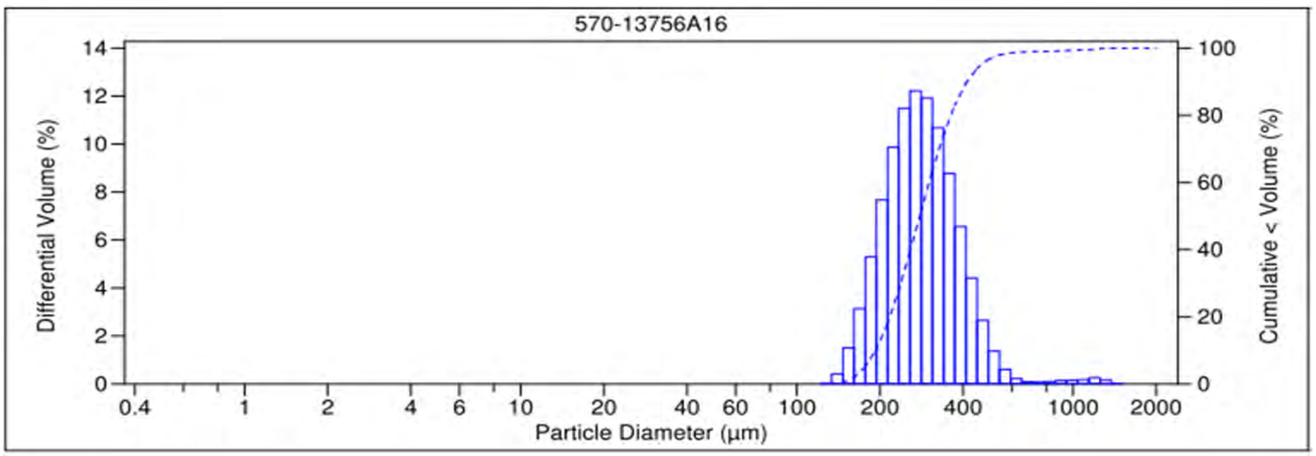
| Sample ID | Depth ft | Description | Mean Grain Size mm |
|---|---|---|---|
| SEADRIFT E +12 | | Medium Sand | 0.299 |

| Particle Size Distribution, wt by percent | | | | | | | | Total Silt & Clay |
|---|---|---|---|---|---|---|---|---|
| Total Gravel | Very Coarse Sand | Coarse Sand | Medium Sand | Fine Sand | Very Fine Sand | Silt | Clay | |
| 0.00 | 0.68 | 2.50 | 60.88 | 35.93 | 0.01 | 0.00 | 0.00 | 0.00 |




V 3.0

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# PARTICLE SIZE SUMMARY

**(ASTM D422 / D4464M)**

Merkel & Associates Inc.

| | |
|---|---|
| Date Sampled: | 10/16/19 |
| Date Received: | 11/21/19 |
| Work Order No: | 570-13756 |
| Date Analyzed: | 11/26/19 |
| Method: | ASTM D4464M |

Project: Stinson Beach

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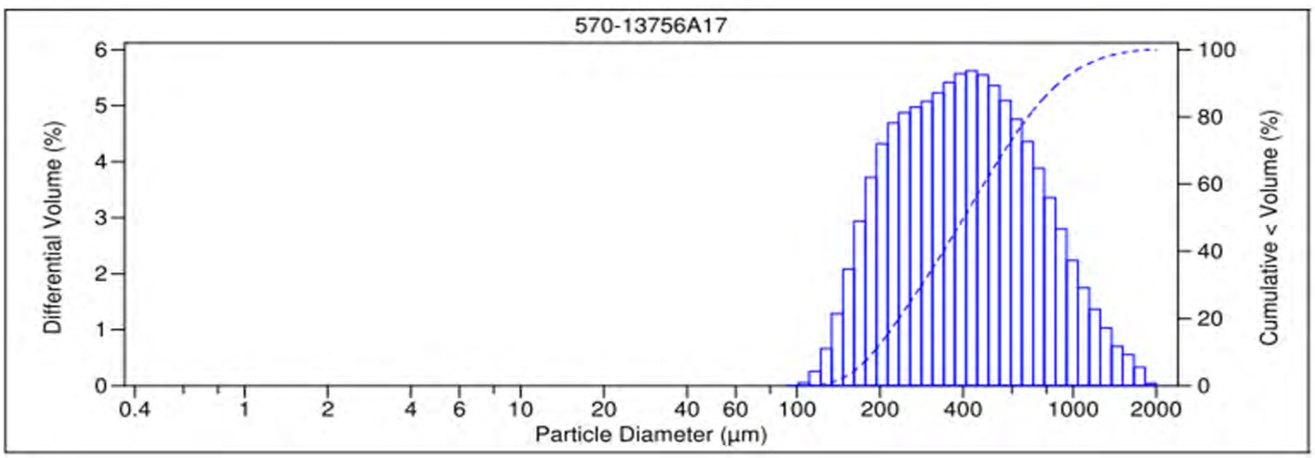
| Sample ID | Depth ft | Description | Mean Grain Size mm |
|---|---|---|---|
| SEADRIFT E +3 | | Medium Sand | 0.481 |

| Particle Size Distribution, wt by percent | | | | | | | | Total Silt & Clay |
|---|---|---|---|---|---|---|---|---|
| Total Gravel | Very Coarse Sand | Coarse Sand | Medium Sand | Fine Sand | Very Fine Sand | Silt | Clay | |
| 0.00 | 6.78 | 30.17 | 39.63 | 22.93 | 0.49 | 0.00 | 0.00 | 0.00 |




V 3.0

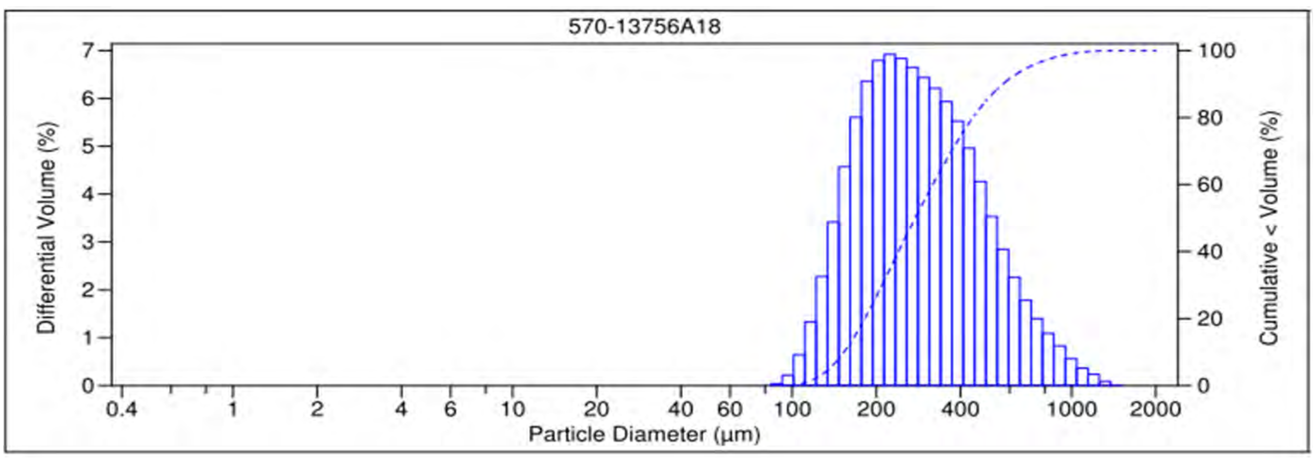
# PARTICLE SIZE SUMMARY

**(ASTM D422 / D4464M)**

| | | | |
|---|---|---|---|
| Merkel & Associates Inc. | | Date Sampled: | 10/16/19 |
| | | Date Received: | 11/21/19 |
| | | Work Order No: | 570-13756 |
| | | Date Analyzed: | 11/26/19 |
| | | Method: | ASTM D4464M |
| Project: | Stinson Beach | | Page 19 of 21 |

| Sample ID | Depth ft | Description | Mean Grain Size mm |
|---|---|---|---|
| SEADRIFT E 0 | | Medium Sand | 0.327 |

| Particle Size Distribution, wt by percent | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Total Gravel | Very Coarse Sand | Coarse Sand | Medium Sand | Fine Sand | Very Fine Sand | Silt | Clay | Total Silt & Clay |
| 0.00 | 0.95 | 13.60 | 42.51 | 40.10 | 2.83 | 0.00 | 0.00 | 0.00 |




V 3.0

# PARTICLE SIZE SUMMARY

**(ASTM D422 / D4464M)**

| | | |
|---|---|---|
| Merkel & Associates Inc. | Date Sampled: | 10/16/19 |
| | Date Received: | 11/21/19 |
| | Work Order No: | 570-13756 |
| | Date Analyzed: | 11/26/19 |
| | Method: | ASTM D4464M |

Project: Stinson Beach

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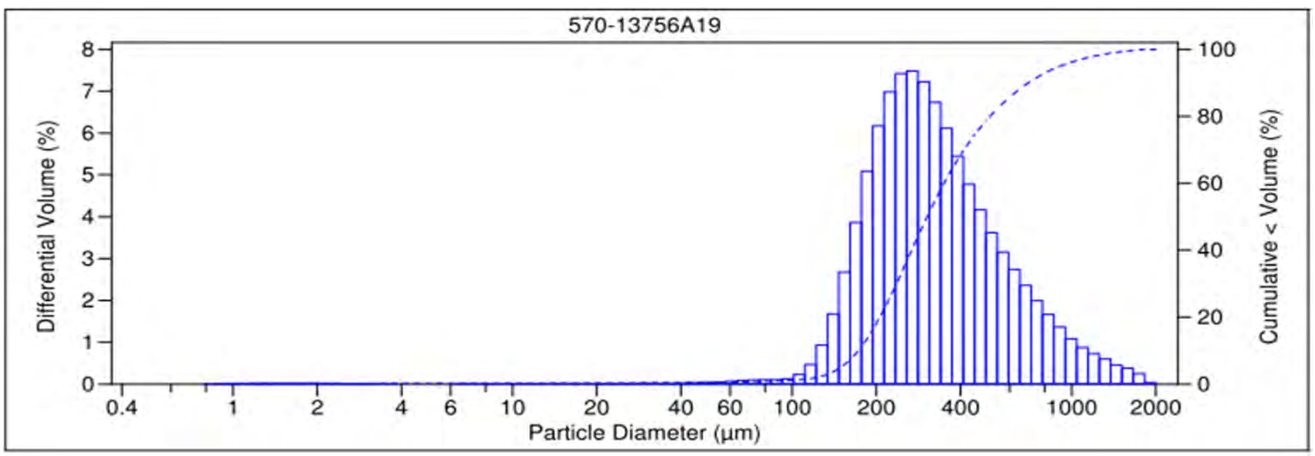
| Sample ID | Depth ft | Description | Mean Grain Size mm |
|---|---|---|---|
| SEADRIFT E -12 | | Medium Sand | 0.428 |

| Particle Size Distribution, wt by percent | | | | | | | | Total Silt & Clay |
|---|---|---|---|---|---|---|---|---|
| Total Gravel | Very Coarse Sand | Coarse Sand | Medium Sand | Fine Sand | Very Fine Sand | Silt | Clay | |
| 1.50 | 3.76 | 16.78 | 44.00 | 31.84 | 1.47 | 0.40 | 0.26 | 0.66 |




V 3.0

# PARTICLE SIZE SUMMARY

**(ASTM D422 / D4464M)**

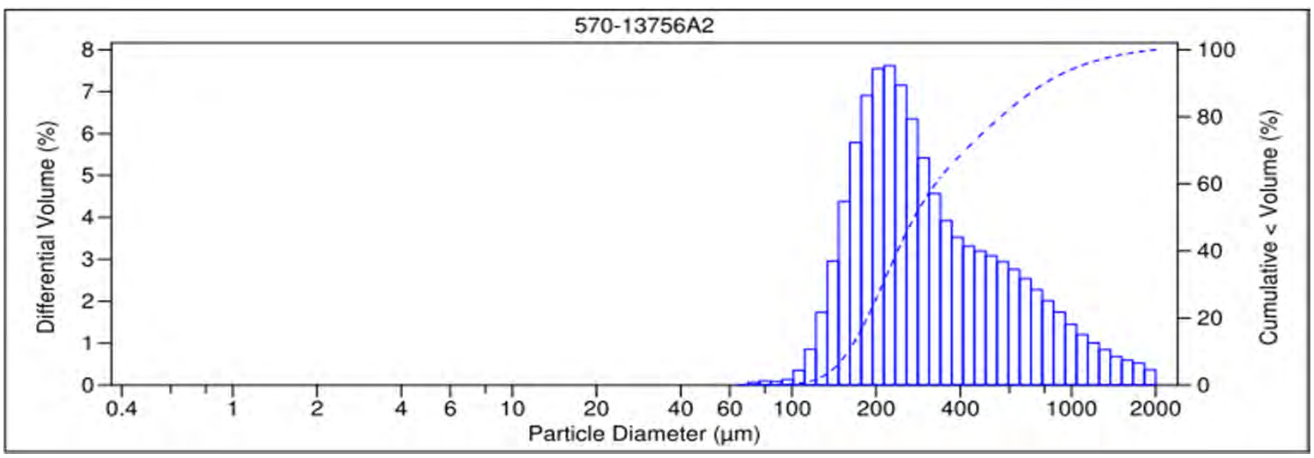
| | | |
|---|---|---|
| Merkel & Associates Inc. | Date Sampled: | 10/16/19 |
| | Date Received: | 11/21/19 |
| | Work Order No: | 570-13756 |
| | Date Analyzed: | 11/26/19 |
| | Method: | ASTM D4464M |

Project: Stinson Beach



| Sample ID | Depth ft | Description | Mean Grain Size mm |
|---|---|---|---|
| NPS +3 | | Medium Sand | 0.395 |

| Particle Size Distribution, wt by percent | | | | | | | | Total Silt & Clay |
|---|---|---|---|---|---|---|---|---|
| Total Gravel | Very Coarse Sand | Coarse Sand | Medium Sand | Fine Sand | Very Fine Sand | Silt | Clay | |
| 0.00 | 5.87 | 17.76 | 32.88 | 41.44 | 2.05 | 0.00 | 0.00 | 0.00 |




V 3.0

# PARTICLE SIZE SUMMARY

**(ASTM D422 / D4464M)**

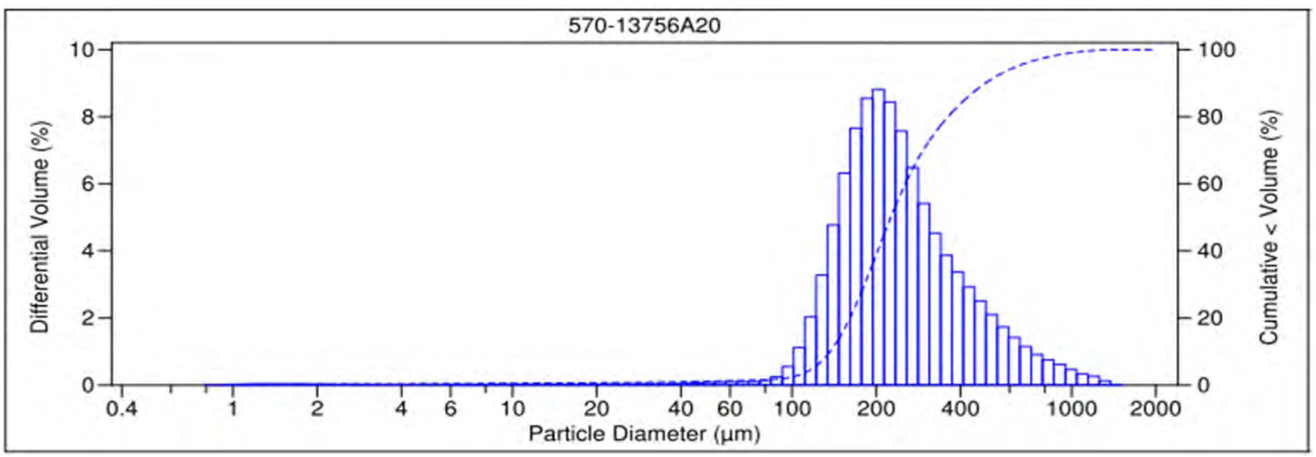
| | | |
|---|---|---|
| Merkel & Associates Inc. | Date Sampled: | 10/16/19 |
| | Date Received: | 11/21/19 |
| | Work Order No: | 570-13756 |
| | Date Analyzed: | 11/26/19 |
| | Method: | ASTM D4464M |

Project: Stinson Beach



| Sample ID | Depth ft | Description | Mean Grain Size mm |
|---|---|---|---|
| SEADRIFT E -24 | | Medium Sand | 0.278 |

| Particle Size Distribution, wt by percent | | | | | | | | Total Silt & Clay |
|---|---|---|---|---|---|---|---|---|
| Total Gravel | Very Coarse Sand | Coarse Sand | Medium Sand | Fine Sand | Very Fine Sand | Silt | Clay | |
| 0.00 | 0.94 | 8.66 | 31.68 | 52.24 | 5.16 | 0.93 | 0.40 | 1.32 |




V 3.0

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# PARTICLE SIZE SUMMARY

**(ASTM D422 / D4464M)**

Merkel & Associates Inc.

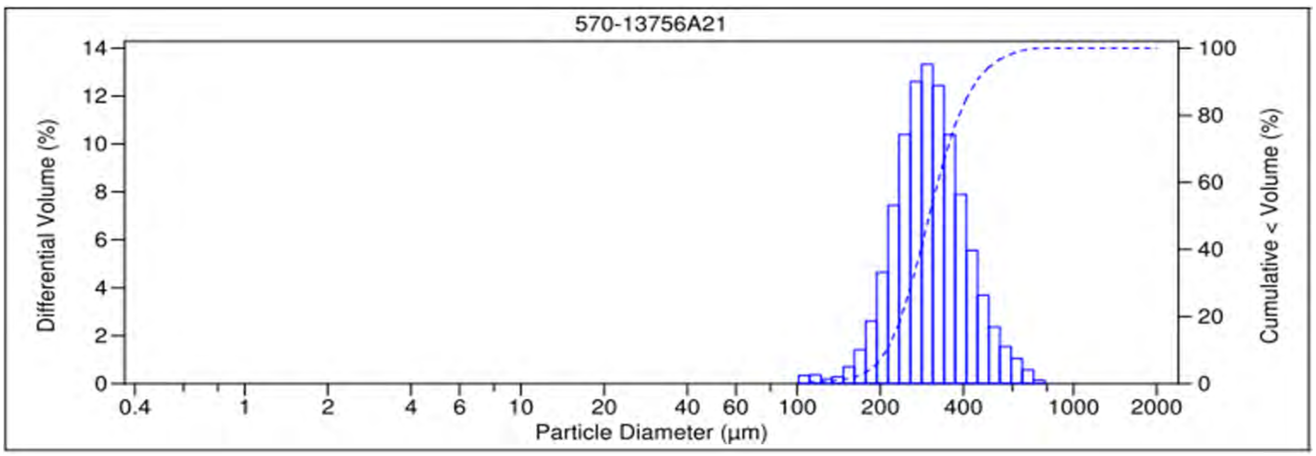
| | |
|---|---|
| Date Sampled: | 10/16/19 |
| Date Received: | 11/21/19 |
| Work Order No: | 570-13756 |
| Date Analyzed: | 11/27/19 |
| Method: | ASTM D4464M |

Project: Stinson Beach

Page 1 of 6

| Sample ID | Depth ft | Description | Mean Grain Size mm |
|---|---|---|---|
| SEADRIFT W +12 | | Medium Sand | 0.317 |

| Particle Size Distribution, wt by percent | | | | | | | | Total Silt & Clay |
|---|---|---|---|---|---|---|---|---|
| Total Gravel | Very Coarse Sand | Coarse Sand | Medium Sand | Fine Sand | Very Fine Sand | Silt | Clay | |
| 0.00 | 0.00 | 5.37 | 69.39 | 24.48 | 0.76 | 0.00 | 0.00 | 0.00 |




V 3.0

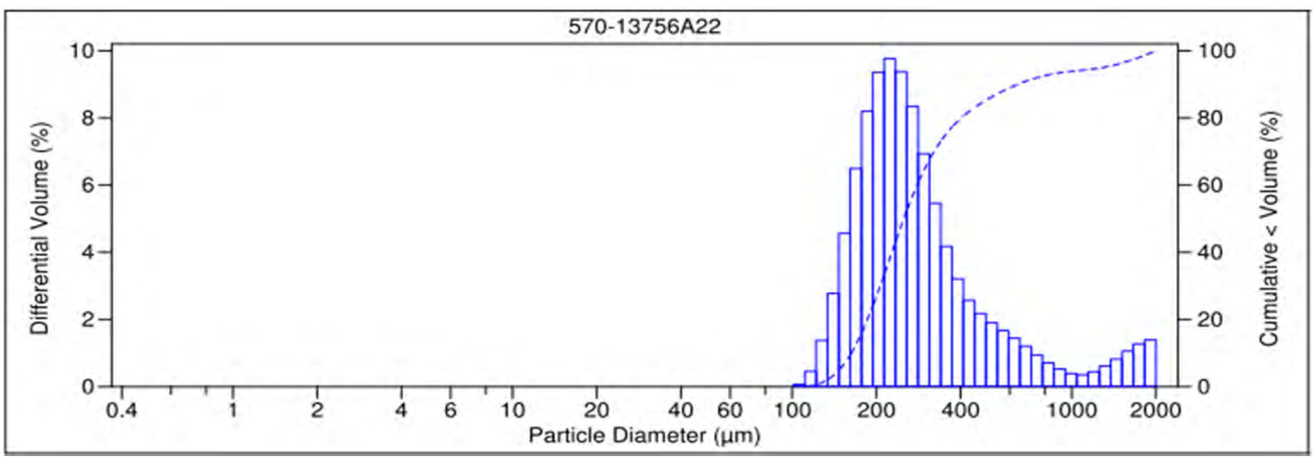
# PARTICLE SIZE SUMMARY

**(ASTM D422 / D4464M)**

| | | |
|---|---|---|
| Merkel & Associates Inc. | Date Sampled: | 10/16/19 |
| | Date Received: | 11/21/19 |
| | Work Order No: | 570-13756 |
| | Date Analyzed: | 11/27/19 |
| | Method: | ASTM D4464M |
| Project: Stinson Beach | | Page 3 of 6 |

| Sample ID | Depth ft | Description | Mean Grain Size mm |
|---|---|---|---|
| SEADRIFT W +3 | | Medium Sand | 0.398 |

| Particle Size Distribution, wt by percent | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Total Gravel | Very Coarse Sand | Coarse Sand | Medium Sand | Fine Sand | Very Fine Sand | Silt | Clay | Total Silt & Clay |
| 1.10 | 6.06 | 8.26 | 35.55 | 48.15 | 0.88 | 0.00 | 0.00 | 0.00 |




V 3.0

# PARTICLE SIZE SUMMARY

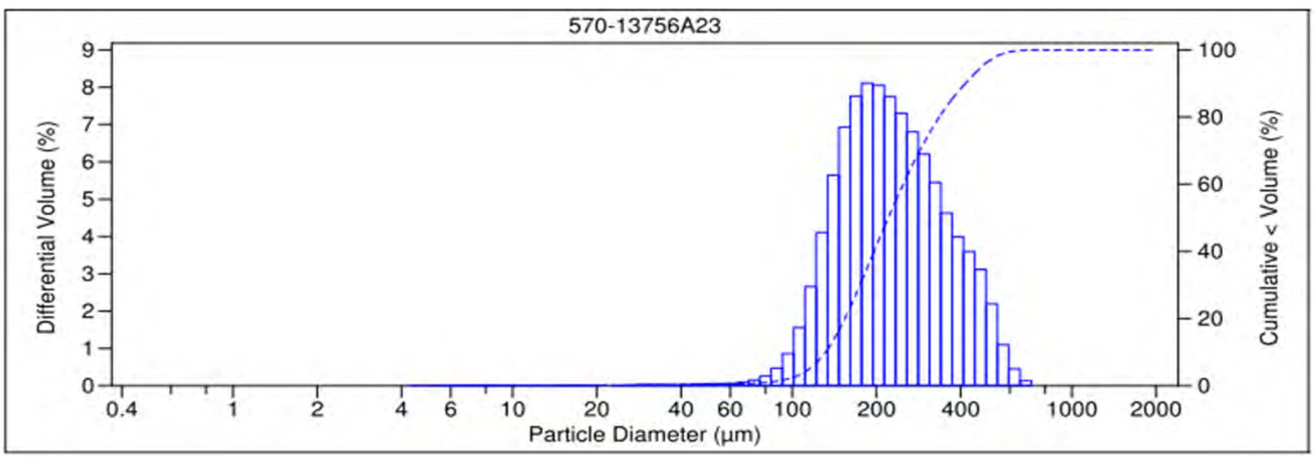
**(ASTM D422 / D4464M)**

| | | |
|---|---|---|
| Merkel & Associates Inc. | Date Sampled: | 10/16/19 |
| | Date Received: | 11/21/19 |
| | Work Order No: | 570-13756 |
| | Date Analyzed: | 11/27/19 |
| | Method: | ASTM D4464M |

Project: Stinson Beach — Page 4 of 6

| Sample ID | Depth ft | Description | Mean Grain Size mm |
|---|---|---|---|
| SEADRIFT W 0 | | Fine Sand | 0.248 |

| Particle Size Distribution, wt by percent | | | | | | | | Total Silt & Clay |
|---|---|---|---|---|---|---|---|---|
| Total Gravel | Very Coarse Sand | Coarse Sand | Medium Sand | Fine Sand | Very Fine Sand | Silt | Clay | |
| 0.00 | 0.00 | 3.59 | 36.31 | 52.34 | 7.15 | 0.61 | 0.00 | 0.61 |




V 3.0

# PARTICLE SIZE SUMMARY

**(ASTM D422 / D4464M)**

Merkel & Associates Inc.

| | |
|---|---|
| Date Sampled: | 10/16/19 |
| Date Received: | 11/21/19 |
| Work Order No: | 570-13756 |
| Date Analyzed: | 11/27/19 |
| Method: | ASTM D4464M |

Project: Stinson Beach

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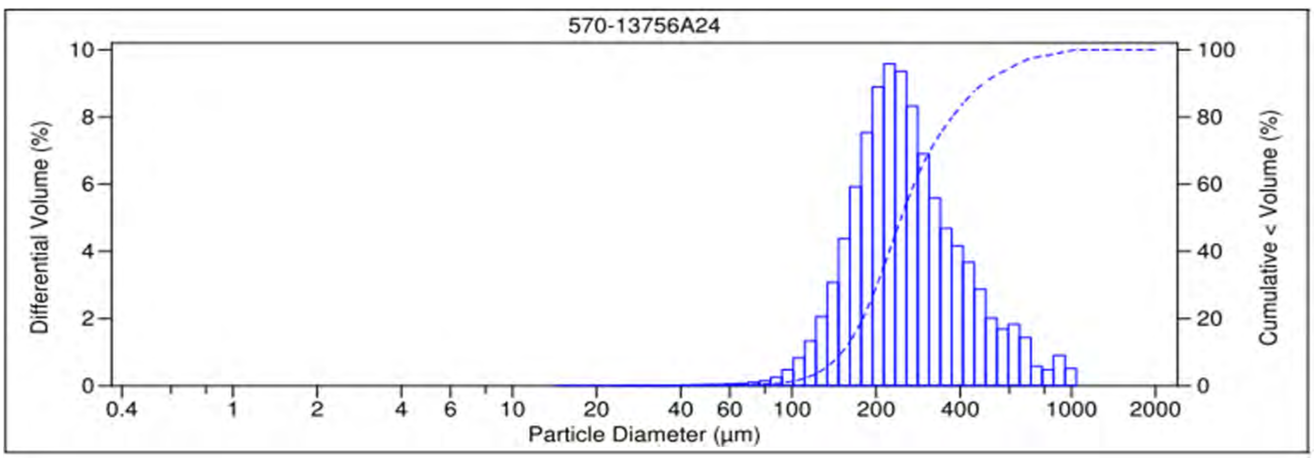
| Sample ID | Depth ft | Description | Mean Grain Size mm |
|---|---|---|---|
| SEADRIFT W -12 | | Medium Sand | 0.445 |

| Particle Size Distribution, wt by percent | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Total Gravel | Very Coarse Sand | Coarse Sand | Medium Sand | Fine Sand | Very Fine Sand | Silt | Clay | Total Silt & Clay |
| 5.16 | 0.22 | 8.51 | 37.30 | 44.97 | 3.59 | 0.27 | 0.00 | 0.27 |




V 3.0

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# PARTICLE SIZE SUMMARY

**(ASTM D422 / D4464M)**

| | | |
|---|---|---|
| Merkel & Associates Inc. | Date Sampled: | 10/16/19 |
| | Date Received: | 11/21/19 |
| | Work Order No: | 570-13756 |
| | Date Analyzed: | 11/27/19 |
| | Method: | ASTM D4464M |

Project: Stinson Beach

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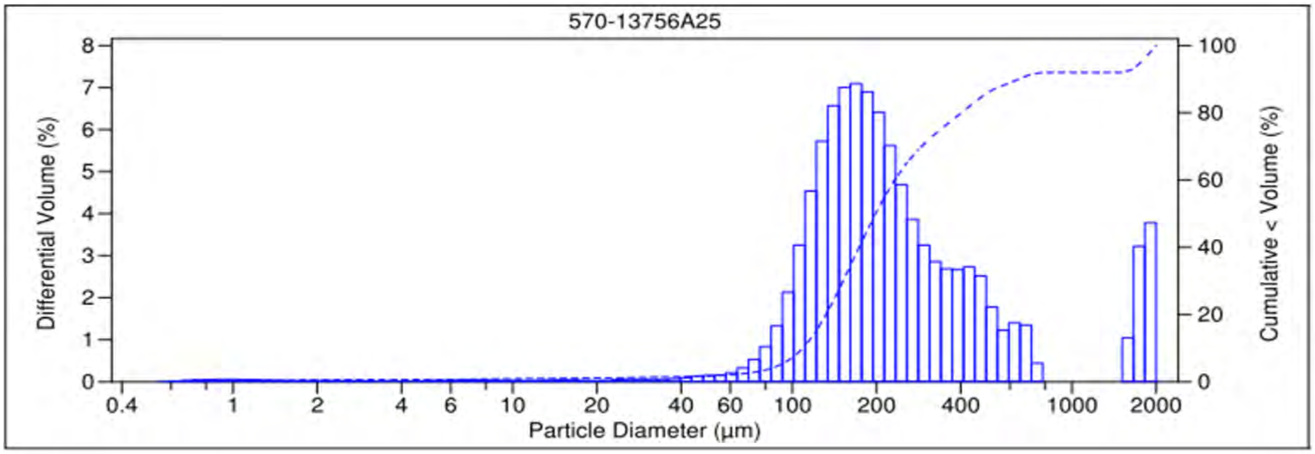
| Sample ID | Depth ft | Description | Mean Grain Size mm |
|---|---|---|---|
| SEADRIFT W -24 | | Coarse Sand | 0.965 |

| Particle Size Distribution, wt by percent | | | | | | | | Total Silt & Clay |
|---|---|---|---|---|---|---|---|---|
| Total Gravel | Very Coarse Sand | Coarse Sand | Medium Sand | Fine Sand | Very Fine Sand | Silt | Clay | |
| 20.24 | 6.42 | 4.75 | 17.74 | 37.53 | 11.56 | 1.26 | 0.49 | 1.75 |




V 3.0

# PARTICLE SIZE SUMMARY

**(ASTM D422 / D4464M)**

Merkel & Associates Inc.

| | |
|---|---|
| Date Sampled: | 10/16/19 |
| Date Received: | 11/21/19 |
| Work Order No: | 570-13756 |
| Date Analyzed: | 11/26/19 |
| Method: | ASTM D4464M |

Project: Stinson Beach

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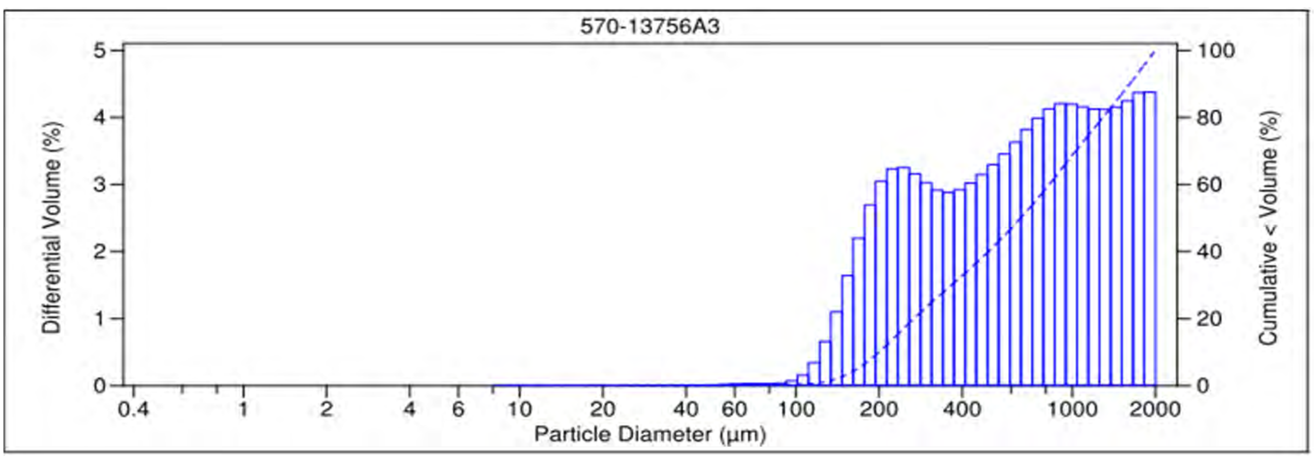
| Sample ID | Depth ft | Description | Mean Grain Size mm |
|---|---|---|---|
| NPS 0 | | Coarse Sand | 0.849 |

| Particle Size Distribution, wt by percent | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Total Gravel | Very Coarse Sand | Coarse Sand | Medium Sand | Fine Sand | Very Fine Sand | Silt | Clay | Total Silt & Clay |
| 2.40 | 30.66 | 27.74 | 21.96 | 16.27 | 0.86 | 0.13 | 0.00 | 0.13 |




V 3.0

# PARTICLE SIZE SUMMARY

**(ASTM D422 / D4464M)**

| | | |
|---|---|---|
| Merkel & Associates Inc. | Date Sampled: | 10/16/19 |
| | Date Received: | 11/21/19 |
| | Work Order No: | 570-13756 |
| | Date Analyzed: | 11/26/19 |
| | Method: | ASTM D4464M |

Project: Stinson Beach

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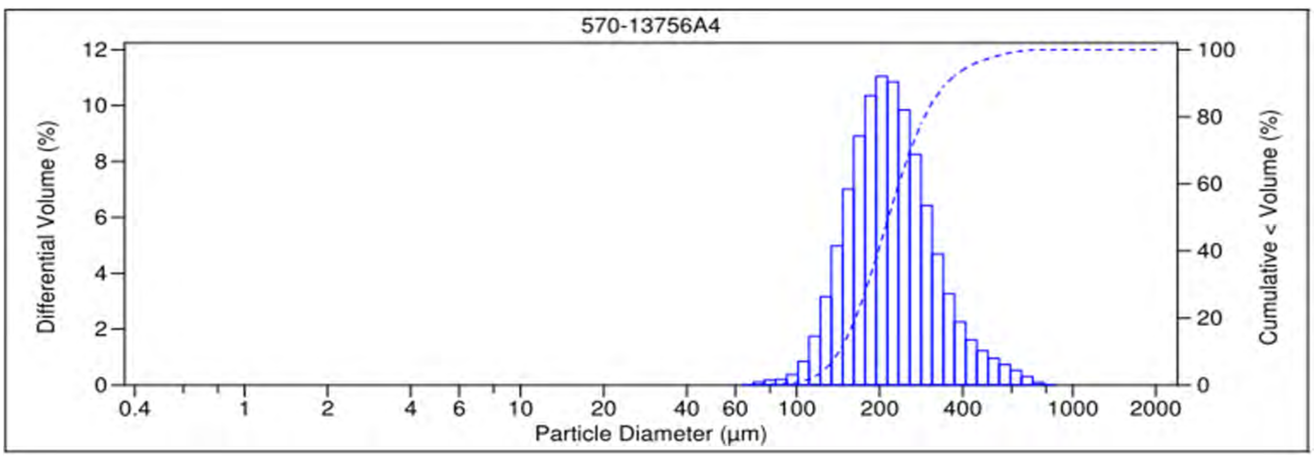
| Sample ID | Depth ft | Description | Mean Grain Size mm |
|---|---|---|---|
| NPS -12 | | Fine Sand | 0.236 |

| Particle Size Distribution, wt by percent | | | | | | | | Total Silt & Clay |
|---|---|---|---|---|---|---|---|---|
| Total Gravel | Very Coarse Sand | Coarse Sand | Medium Sand | Fine Sand | Very Fine Sand | Silt | Clay | |
| 0.00 | 0.00 | 2.51 | 30.85 | 62.33 | 4.31 | 0.00 | 0.00 | 0.00 |




V 3.0

# PARTICLE SIZE SUMMARY

**(ASTM D422 / D4464M)**

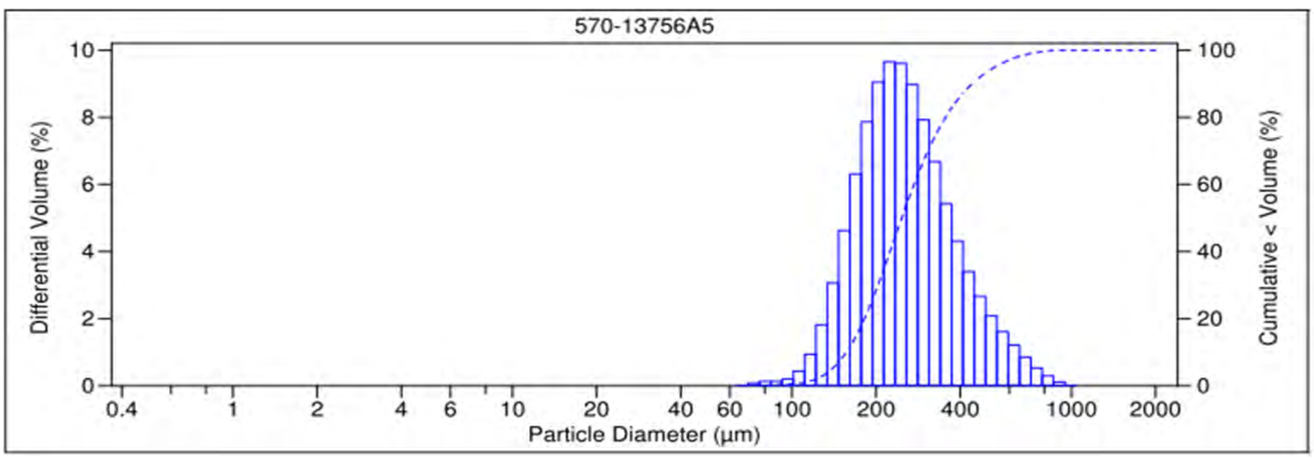
| | | |
|---|---|---|
| Merkel & Associates Inc. | Date Sampled: | 10/16/19 |
| | Date Received: | 11/21/19 |
| | Work Order No: | 570-13756 |
| | Date Analyzed: | 11/26/19 |
| | Method: | ASTM D4464M |

Project: Stinson Beach



| Sample ID | Depth ft | Description | Mean Grain Size mm |
|---|---|---|---|
| NPS -24 | | Medium Sand | 0.278 |

| Particle Size Distribution, wt by percent | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Total Gravel | Very Coarse Sand | Coarse Sand | Medium Sand | Fine Sand | Very Fine Sand | Silt | Clay | Total Silt & Clay |
| 0.00 | 0.00 | 6.44 | 42.56 | 48.59 | 2.41 | 0.00 | 0.00 | 0.00 |




V 3.0

# PARTICLE SIZE SUMMARY

**(ASTM D422 / D4464M)**

Merkel & Associates Inc.

| | |
|---|---|
| Date Sampled: | 10/16/19 |
| Date Received: | 11/21/19 |
| Work Order No: | 570-13756 |
| Date Analyzed: | 11/26/19 |
| Method: | ASTM D4464M |

Project: Stinson Beach

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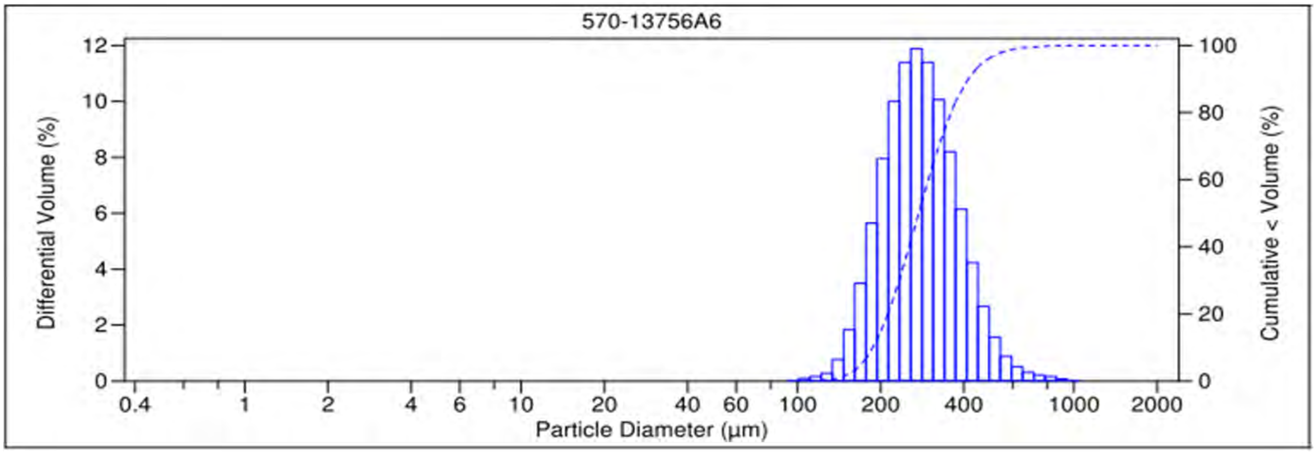
| Sample ID | Depth ft | Description | Mean Grain Size mm |
|---|---|---|---|
| CALLES +12 | | Medium Sand | 0.292 |

| Particle Size Distribution, wt by percent | | | | | | | | Total Silt & Clay |
|---|---|---|---|---|---|---|---|---|
| Total Gravel | Very Coarse Sand | Coarse Sand | Medium Sand | Fine Sand | Very Fine Sand | Silt | Clay | |
| 0.00 | 0.00 | 3.53 | 58.29 | 37.84 | 0.34 | 0.00 | 0.00 | 0.00 |




V 3.0

# PARTICLE SIZE SUMMARY

**(ASTM D422 / D4464M)**

Merkel & Associates Inc.

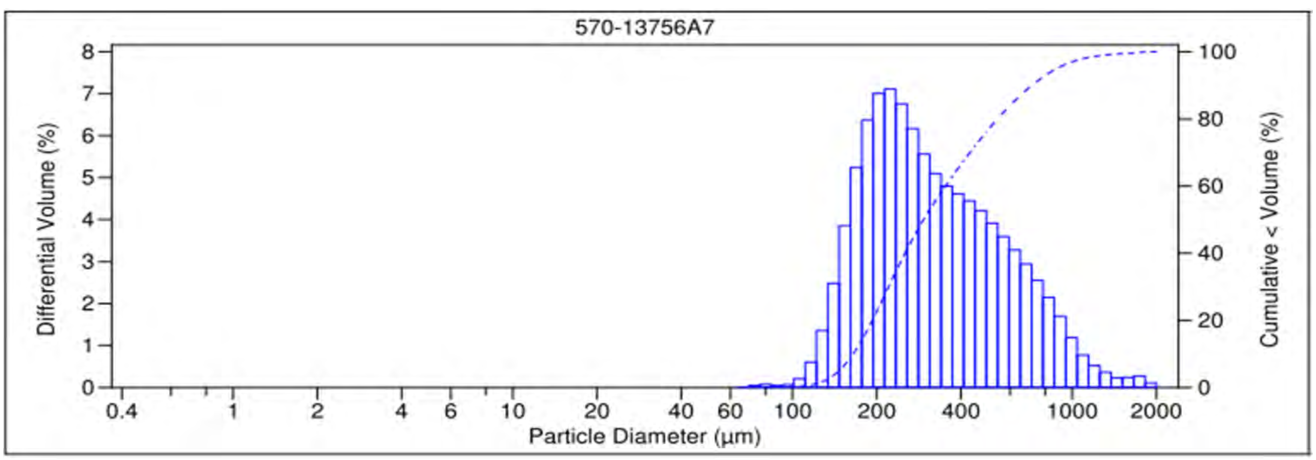
| | |
|---|---|
| Date Sampled: | 10/16/19 |
| Date Received: | 11/21/19 |
| Work Order No: | 570-13756 |
| Date Analyzed: | 11/26/19 |
| Method: | ASTM D4464M |

Project: Stinson Beach



| Sample ID | Depth ft | Description | Mean Grain Size mm |
|---|---|---|---|
| CALLES +3 | | Medium Sand | 0.382 |

| Particle Size Distribution, wt by percent | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Total Gravel | Very Coarse Sand | Coarse Sand | Medium Sand | Fine Sand | Very Fine Sand | Silt | Clay | Total Silt & Clay |
| 0.00 | 3.04 | 20.27 | 37.46 | 37.78 | 1.44 | 0.00 | 0.00 | 0.00 |




V 3.0

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# PARTICLE SIZE SUMMARY

**(ASTM D422 / D4464M)**

Merkel & Associates Inc.

Date Sampled: 10/16/19
Date Received: 11/21/19
Work Order No: 570-13756
Date Analyzed: 11/26/19
Method: ASTM D4464M

Project: Stinson Beach

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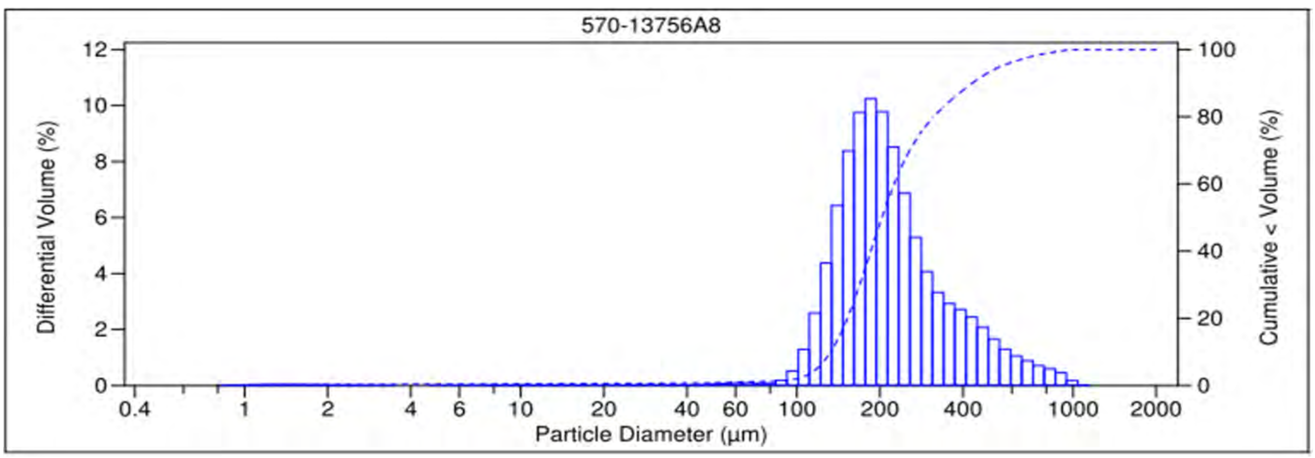
| Sample ID | Depth ft | Description | Mean Grain Size mm |
|---|---|---|---|
| CALLES 0 | | Fine Sand | 0.248 |

| Particle Size Distribution, wt by percent | | | | | | | | Total Silt & Clay |
|---|---|---|---|---|---|---|---|---|
| Total Gravel | Very Coarse Sand | Coarse Sand | Medium Sand | Fine Sand | Very Fine Sand | Silt | Clay | |
| 0.00 | 0.09 | 6.55 | 25.16 | 61.13 | 6.03 | 0.64 | 0.41 | 1.04 |




V 3.0

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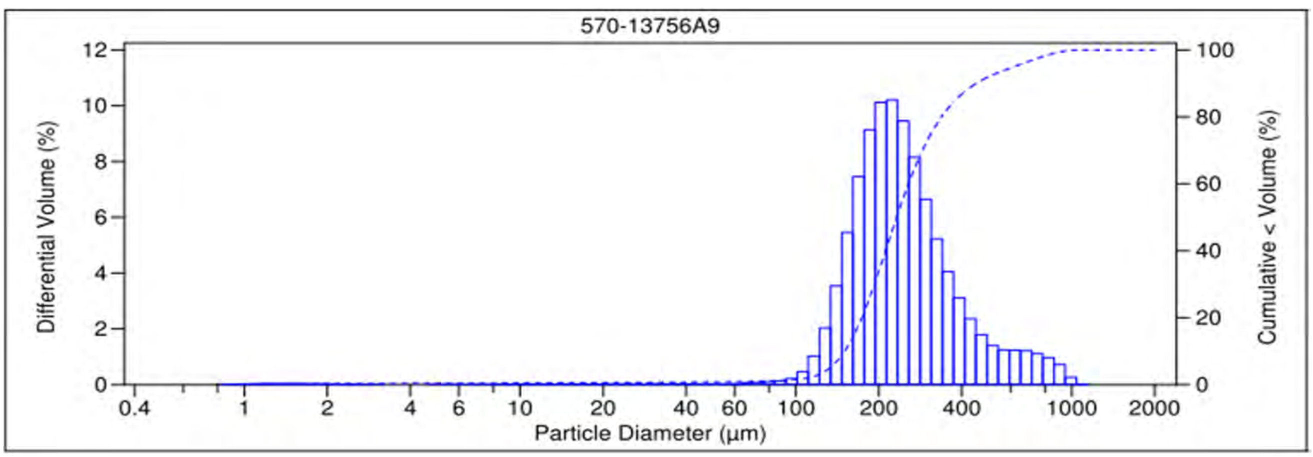
# PARTICLE SIZE SUMMARY

**(ASTM D422 / D4464M)**

| | | |
|---|---|---|
| Merkel & Associates Inc. | Date Sampled: | 10/16/19 |
| | Date Received: | 11/21/19 |
| | Work Order No: | 570-13756 |
| | Date Analyzed: | 11/26/19 |
| | Method: | ASTM D4464M |
| Project: Stinson Beach | | Page 10 of 21 |

| Sample ID | Depth ft | Description | Mean Grain Size mm |
|---|---|---|---|
| CALLES -12 | | Medium Sand | 0.274 |

| Particle Size Distribution, wt by percent | | | | | | | | Total Silt & Clay |
|---|---|---|---|---|---|---|---|---|
| Total Gravel | Very Coarse Sand | Coarse Sand | Medium Sand | Fine Sand | Very Fine Sand | Silt | Clay | |
| 0.00 | 0.14 | 7.89 | 34.41 | 54.00 | 2.66 | 0.49 | 0.41 | 0.90 |




V 3.0

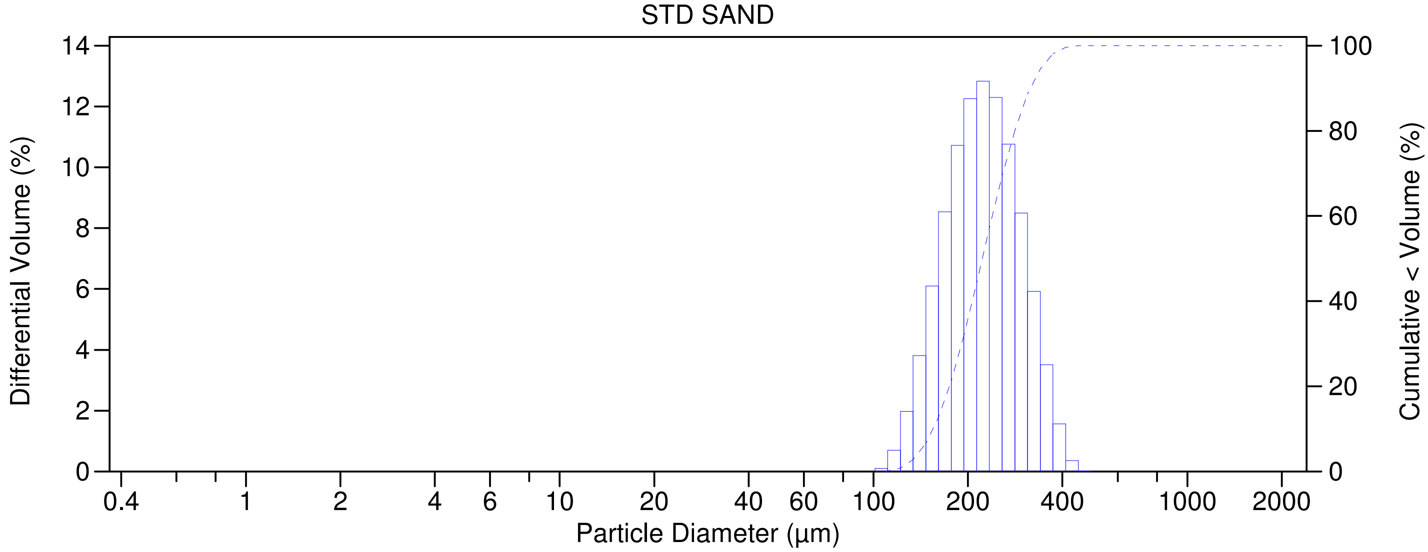
BECKMAN COULTER

LS Particle Size Analyzer





| | |
|---|---|
| File name: | C:\LS13320\STD SAND_26 Nov 2019_21.37.31.$ls<br>STD SAND_26 Nov 2019_21.37.31.$ls |
| File ID: | STD SAND |
| Sample ID: | STD SAND |
| Operator: | 1106 |
| Run number: | 23 |
| | Control Sample |
| Comment 1: | ASTM D4464M , LPSA 1 |
| Comment 2: | 316865 , BATCH#028A |
| Optical model: | Fraunhofer.rf780d |
| Residual: | 3.71% |
| LS 13 320 | Aqueous Liquid Module |
| Start time: | 21:36 26 Nov 2019 — Run length: 60 seconds |
| Pump speed: | 49 |
| Obscuration: | 8% |
| Fluid: | Water |
| Software: | 6.01 — Firmware: 4.00 |




Volume Statistics (Arithmetic) STD SAND_26 Nov 2019_21.37.31.$ls

Calculations from 0.375 µm to 2000 µm

| | | | |
|---|---|---|---|
| Volume: | 100% | | |
| Mean: | 229.8 µm | S.D.: | 61.72 µm |
| Median: | 222.6 µm | Variance: | 3809 $\mu m^2$ |
| Mean/Median ratio: | 1.033 | Skewness: | 0.554 Right skewed |
| Mode: | 223.4 µm | Kurtosis: | -0.087 Platykurtic |

$d_{10}$: 154.8 µm $d_{50}$: 222.6 µm $d_{90}$: 316.7 µm

Folk and Ward Statistics (Phi)

| | | | | | |
|---|---|---|---|---|---|
| Mean: | 2.17 | Median: | 2.17 | Deviation: | 0.40 |
| Skewness: | 0.02 | Kurtosis: | 0.94 | | |

| <5% | <16% | <25% | <40% | <50% | <75% | <84% | <95% |
|---|---|---|---|---|---|---|---|
| 141.3 µm | 167.3 µm | 183.0 µm | 206.7 µm | 222.6 µm | 270.1 µm | 294.7 µm | 344.3 µm |

BECKMAN COULTER

# LS Particle Size Analyzer





| Particle Diameter µm | STD SAND _26 Nov 2019_21.37 .31.$ls Volume % |
|---|---|
| 0.04 | 0 |
| 0.4 | 0 |
| 1.95 | 0 |
| 3.91 | 0 |
| 62.5 | 1.34 |
| 125 | 64.3 |
| 250 | 34.4 |
| 500 | 0 |
| 1000 | 0 |
| 2000 | |

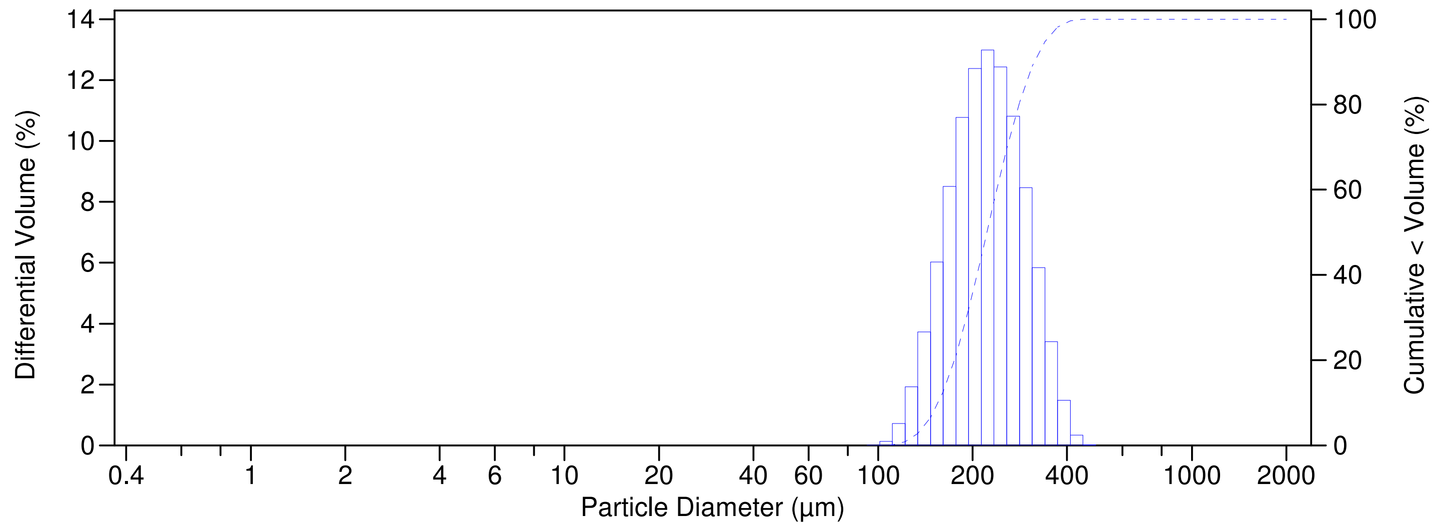
STD SAND_26 Nov 2019_21.37.31.$ls

| Channel Diameter (Lower) µm | Diff. Volume % | Channel Diameter (Lower) µm | Diff. Volume % | Channel Diameter (Lower) µm | Diff. Volume % |
|---|---|---|---|---|---|
| 0.375 | 0 | 24.95 | 0 | 1660 | 0 |
| 0.412 | 0 | 27.39 | 0 | 1822 | 0 |
| 0.452 | 0 | 30.07 | 0 | 2000 | |
| 0.496 | 0 | 33.01 | 0 | | |
| 0.545 | 0 | 36.24 | 0 | | |
| 0.598 | 0 | 39.78 | 0 | | |
| 0.657 | 0 | 43.67 | 0 | | |
| 0.721 | 0 | 47.94 | 0 | | |
| 0.791 | 0 | 52.63 | 0 | | |
| 0.869 | 0 | 57.77 | 0 | | |
| 0.954 | 0 | 63.42 | 0 | | |
| 1.047 | 0 | 69.62 | 0 | | |
| 1.149 | 0 | 76.43 | 0 | | |
| 1.261 | 0 | 83.90 | 0 | | |
| 1.385 | 0 | 92.10 | 0.0031 | | |
| 1.520 | 0 | 101.1 | 0.11 | | |
| 1.669 | 0 | 111.0 | 0.70 | | |
| 1.832 | 0 | 121.8 | 1.98 | | |
| 2.011 | 0 | 133.7 | 3.81 | | |
| 2.208 | 0 | 146.8 | 6.10 | | |
| 2.423 | 0 | 161.2 | 8.53 | | |
| 2.660 | 0 | 176.9 | 10.7 | | |
| 2.920 | 0 | 194.2 | 12.3 | | |
| 3.206 | 0 | 213.2 | 12.8 | | |
| 3.519 | 0 | 234.1 | 12.3 | | |
| 3.863 | 0 | 256.9 | 10.8 | | |
| 4.241 | 0 | 282.1 | 8.50 | | |
| 4.656 | 0 | 309.6 | 5.93 | | |
| 5.111 | 0 | 339.9 | 3.51 | | |
| 5.611 | 0 | 373.1 | 1.56 | | |
| 6.159 | 0 | 409.6 | 0.36 | | |
| 6.761 | 0 | 449.7 | 0.020 | | |
| 7.422 | 0 | 493.6 | 0 | | |
| 8.148 | 0 | 541.9 | 0 | | |
| 8.944 | 0 | 594.9 | 0 | | |
| 9.819 | 0 | 653.0 | 0 | | |
| 10.78 | 0 | 716.9 | 0 | | |
| 11.83 | 0 | 786.9 | 0 | | |
| 12.99 | 0 | 863.9 | 0 | | |
| 14.26 | 0 | 948.3 | 0 | | |
| 15.65 | 0 | 1041 | 0 | | |
| 17.18 | 0 | 1143 | 0 | | |
| 18.86 | 0 | 1255 | 0 | | |
| 20.71 | 0 | 1377 | 0 | | |
| 22.73 | 0 | 1512 | 0 | | |

LS Particle Size Analyzer



| | | | |
|---|---|---|---|
| File name: | C:\LS13320\STD SAND_26 Nov 2019_21.49.53.$ls | | |
| | STD SAND_26 Nov 2019_21.49.53.$ls | | |
| File ID: | STD SAND | | |
| Sample ID: | STD SAND | | |
| Operator: | 1106 | | |
| Run number: | 25 | | |
| | Control Sample | | |
| Comment 1: | ASTM D4464M , LPSA 1 | | |
| Comment 2: | 316865 , BATCH#028A | | |
| Optical model: | Fraunhofer.rf780d | | |
| Residual: | 3.56% | | |
| LS 13 320 | Aqueous Liquid Module | | |
| Start time: | 21:48 26 Nov 2019 | Run length: | 60 seconds |
| Pump speed: | 49 | | |
| Obscuration: | 11% | | |
| Fluid: | Water | | |
| Software: | 6.01 | Firmware: | 4.00 |




Volume Statistics (Arithmetic) STD SAND_26 Nov 2019_21.49.53.$ls

Calculations from 0.375 µm to 2000 µm

| | | | |
|---|---|---|---|
| Volume: | 100% | | |
| Mean: | 229.5 µm | S.D.: | 61.17 µm |
| Median: | 222.5 µm | Variance: | 3742 $\mu m^2$ |
| Mean/Median ratio: | 1.032 | Skewness: | 0.548 Right skewed |
| Mode: | 223.4 µm | Kurtosis: | -0.075 Platykurtic |

$d_{10}$: 155.1 µm  $d_{50}$: 222.5 µm  $d_{90}$: 315.2 µm

Folk and Ward Statistics (Phi)

| | | | | | |
|---|---|---|---|---|---|
| Mean: | 2.17 | Median: | 2.17 | Deviation: | 0.40 |
| Skewness: | 0.02 | Kurtosis: | 0.94 | | |

| <5% | <16% | <25% | <40% | <50% | <75% | <84% | <95% |
|---|---|---|---|---|---|---|---|
| 141.5 µm | 167.6 µm | 183.3 µm | 206.7 µm | 222.5 µm | 269.4 µm | 293.6 µm | 342.3 µm |

BECKMAN COULTER

LS Particle Size Analyzer



| Particle Diameter µm | STD SAND _26 Nov 2019_21.49 .53.$ls Volume % |
|---|---|
| 0.04 | 0 |
| 0.4 | 0 |
| 1.95 | 0 |
| 3.91 | 0 |
| 62.5 | 1.37 |
| 125 | 64.5 |
| 250 | 34.1 |
| 500 | 0 |
| 1000 | 0 |
| 2000 | |

STD SAND_26 Nov 2019_21.49.53.$ls

| Channel Diameter (Lower) µm | Diff. Volume % | Channel Diameter (Lower) µm | Diff. Volume % | Channel Diameter (Lower) µm | Diff. Volume % |
|---|---|---|---|---|---|
| 0.375 | 0 | 24.95 | 0 | 1660 | 0 |
| 0.412 | 0 | 27.39 | 0 | 1822 | 0 |
| 0.452 | 0 | 30.07 | 0 | 2000 | |
| 0.496 | 0 | 33.01 | 0 | | |
| 0.545 | 0 | 36.24 | 0 | | |
| 0.598 | 0 | 39.78 | 0 | | |
| 0.657 | 0 | 43.67 | 0 | | |
| 0.721 | 0 | 47.94 | 0 | | |
| 0.791 | 0 | 52.63 | 0 | | |
| 0.869 | 0 | 57.77 | 0 | | |
| 0.954 | 0 | 63.42 | 0 | | |
| 1.047 | 0 | 69.62 | 0 | | |
| 1.149 | 0 | 76.43 | 0 | | |
| 1.261 | 0 | 83.90 | 0 | | |
| 1.385 | 0 | 92.10 | 0.0058 | | |
| 1.520 | 0 | 101.1 | 0.13 | | |
| 1.669 | 0 | 111.0 | 0.72 | | |
| 1.832 | 0 | 121.8 | 1.93 | | |
| 2.011 | 0 | 133.7 | 3.73 | | |
| 2.208 | 0 | 146.8 | 6.03 | | |
| 2.423 | 0 | 161.2 | 8.51 | | |
| 2.660 | 0 | 176.9 | 10.8 | | |
| 2.920 | 0 | 194.2 | 12.4 | | |
| 3.206 | 0 | 213.2 | 13.0 | | |
| 3.519 | 0 | 234.1 | 12.4 | | |
| 3.863 | 0 | 256.9 | 10.8 | | |
| 4.241 | 0 | 282.1 | 8.47 | | |
| 4.656 | 0 | 309.6 | 5.84 | | |
| 5.111 | 0 | 339.9 | 3.40 | | |
| 5.611 | 0 | 373.1 | 1.48 | | |
| 6.159 | 0 | 409.6 | 0.34 | | |
| 6.761 | 0 | 449.7 | 0.018 | | |
| 7.422 | 0 | 493.6 | 0 | | |
| 8.148 | 0 | 541.9 | 0 | | |
| 8.944 | 0 | 594.9 | 0 | | |
| 9.819 | 0 | 653.0 | 0 | | |
| 10.78 | 0 | 716.9 | 0 | | |
| 11.83 | 0 | 786.9 | 0 | | |
| 12.99 | 0 | 863.9 | 0 | | |
| 14.26 | 0 | 948.3 | 0 | | |
| 15.65 | 0 | 1041 | 0 | | |
| 17.18 | 0 | 1143 | 0 | | |
| 18.86 | 0 | 1255 | 0 | | |
| 20.71 | 0 | 1377 | 0 | | |
| 22.73 | 0 | 1512 | 0 | | |

# QC Sample Results

Client: Merkel & Associates
Project/Site: STINSON BEACH 19-009-01

Job ID: 570-13756-1

## Method: D4464 - Particle Size Distribution of Catalytic Material ( Laser light scattering)

**Lab Sample ID: 570-13756-1 DU**
**Matrix: Solid**
**Analysis Batch: 36327**

**Client Sample ID: NPS +12**
**Prep Type: Total/NA**

| Analyte | Sample Result | Sample Qualifier | DU Result | DU Qualifier | Unit | D | RPD | RPD Limit |
|---|---|---|---|---|---|---|---|---|
| Clay(less than 0.00391 mm) | ND | | ND | | % | | NC | 20 |
| Fine Sand (0.125 to 0.25mm) | 54.80 | | 55.51 | | % | | 1 | 20 |
| Gravel (greater than 2 mm) | ND | | ND | | % | | NC | 20 |
| Medium Sand (0.25 to 0.5 mm) | 43.29 | | 43.49 | | % | | 0.5 | 20 |

# Lab Chronicle

Client: Merkel & Associates　　Job ID: 570-13756-1
Project/Site: STINSON BEACH 19-009-01

**Client Sample ID: NPS +12**　　**Lab Sample ID: 570-13756-1**
**Date Collected: 10/16/19 07:00**　　**Matrix: Solid**
**Date Received: 11/22/19 19:00**

| Prep Type | Batch Type | Batch Method | Run | Dil Factor | Initial Amount | Final Amount | Batch Number | Prepared or Analyzed | Analyst | Lab |
|---|---|---|---|---|---|---|---|---|---|---|
| Total/NA | Analysis | D4464 | | 1 | | | 36327 | 11/26/19 18:01 | C4LT | ECL 1 |
| | Instrument ID: NOEQUIP | | | | | | | | | |

**Client Sample ID: NPS +3**　　**Lab Sample ID: 570-13756-2**
**Date Collected: 10/16/19 07:10**　　**Matrix: Solid**
**Date Received: 11/22/19 19:00**

| Prep Type | Batch Type | Batch Method | Run | Dil Factor | Initial Amount | Final Amount | Batch Number | Prepared or Analyzed | Analyst | Lab |
|---|---|---|---|---|---|---|---|---|---|---|
| Total/NA | Analysis | D4464 | | 1 | | | 36327 | 11/26/19 18:11 | C4LT | ECL 1 |
| | Instrument ID: NOEQUIP | | | | | | | | | |

**Client Sample ID: NPS +0**　　**Lab Sample ID: 570-13756-3**
**Date Collected: 10/16/19 07:20**　　**Matrix: Solid**
**Date Received: 11/22/19 19:00**

| Prep Type | Batch Type | Batch Method | Run | Dil Factor | Initial Amount | Final Amount | Batch Number | Prepared or Analyzed | Analyst | Lab |
|---|---|---|---|---|---|---|---|---|---|---|
| Total/NA | Analysis | D4464 | | 1 | | | 36327 | 11/26/19 18:19 | C4LT | ECL 1 |
| | Instrument ID: NOEQUIP | | | | | | | | | |

**Client Sample ID: NPS -12**　　**Lab Sample ID: 570-13756-4**
**Date Collected: 10/16/19 07:30**　　**Matrix: Solid**
**Date Received: 11/22/19 19:00**

| Prep Type | Batch Type | Batch Method | Run | Dil Factor | Initial Amount | Final Amount | Batch Number | Prepared or Analyzed | Analyst | Lab |
|---|---|---|---|---|---|---|---|---|---|---|
| Total/NA | Analysis | D4464 | | 1 | | | 36327 | 11/26/19 18:29 | C4LT | ECL 1 |
| | Instrument ID: NOEQUIP | | | | | | | | | |

**Client Sample ID: NPS -24**　　**Lab Sample ID: 570-13756-5**
**Date Collected: 10/16/19 07:50**　　**Matrix: Solid**
**Date Received: 11/22/19 19:00**

| Prep Type | Batch Type | Batch Method | Run | Dil Factor | Initial Amount | Final Amount | Batch Number | Prepared or Analyzed | Analyst | Lab |
|---|---|---|---|---|---|---|---|---|---|---|
| Total/NA | Analysis | D4464 | | 1 | | | 36327 | 11/26/19 18:36 | C4LT | ECL 1 |
| | Instrument ID: NOEQUIP | | | | | | | | | |

**Client Sample ID: CALLES +12**　　**Lab Sample ID: 570-13756-6**
**Date Collected: 10/16/19 08:20**　　**Matrix: Solid**
**Date Received: 11/22/19 19:00**

| Prep Type | Batch Type | Batch Method | Run | Dil Factor | Initial Amount | Final Amount | Batch Number | Prepared or Analyzed | Analyst | Lab |
|---|---|---|---|---|---|---|---|---|---|---|
| Total/NA | Analysis | D4464 | | 1 | | | 36327 | 11/26/19 18:45 | C4LT | ECL 1 |
| | Instrument ID: NOEQUIP | | | | | | | | | |

# Lab Chronicle

Client: Merkel & Associates
Job ID: 570-13756-1
Project/Site: STINSON BEACH 19-009-01

## Client Sample ID: CALLES +3
Lab Sample ID: 570-13756-7
Date Collected: 10/16/19 08:30
Matrix: Solid
Date Received: 11/22/19 19:00

| Prep Type | Batch Type | Batch Method | Run | Dil Factor | Initial Amount | Final Amount | Batch Number | Prepared or Analyzed | Analyst | Lab |
|---|---|---|---|---|---|---|---|---|---|---|
| Total/NA | Analysis | D4464 | | 1 | | | 36327 | 11/26/19 18:52 | C4LT | ECL 1 |
| | Instrument ID: NOEQUIP | | | | | | | | | |

## Client Sample ID: CALLES 0
Lab Sample ID: 570-13756-8
Date Collected: 10/16/19 08:40
Matrix: Solid
Date Received: 11/22/19 19:00

| Prep Type | Batch Type | Batch Method | Run | Dil Factor | Initial Amount | Final Amount | Batch Number | Prepared or Analyzed | Analyst | Lab |
|---|---|---|---|---|---|---|---|---|---|---|
| Total/NA | Analysis | D4464 | | 1 | | | 36327 | 11/26/19 18:59 | C4LT | ECL 1 |
| | Instrument ID: NOEQUIP | | | | | | | | | |

## Client Sample ID: CALLES -12
Lab Sample ID: 570-13756-9
Date Collected: 10/16/19 08:50
Matrix: Solid
Date Received: 11/22/19 19:00

| Prep Type | Batch Type | Batch Method | Run | Dil Factor | Initial Amount | Final Amount | Batch Number | Prepared or Analyzed | Analyst | Lab |
|---|---|---|---|---|---|---|---|---|---|---|
| Total/NA | Analysis | D4464 | | 1 | | | 36327 | 11/26/19 19:09 | C4LT | ECL 1 |
| | Instrument ID: NOEQUIP | | | | | | | | | |

## Client Sample ID: CALLES -24
Lab Sample ID: 570-13756-10
Date Collected: 10/16/19 09:00
Matrix: Solid
Date Received: 11/22/19 19:00

| Prep Type | Batch Type | Batch Method | Run | Dil Factor | Initial Amount | Final Amount | Batch Number | Prepared or Analyzed | Analyst | Lab |
|---|---|---|---|---|---|---|---|---|---|---|
| Total/NA | Analysis | D4464 | | 1 | | | 36327 | 11/26/19 19:18 | C4LT | ECL 1 |
| | Instrument ID: NOEQUIP | | | | | | | | | |

## Client Sample ID: PATIOS +12
Lab Sample ID: 570-13756-11
Date Collected: 10/16/19 09:20
Matrix: Solid
Date Received: 11/22/19 19:00

| Prep Type | Batch Type | Batch Method | Run | Dil Factor | Initial Amount | Final Amount | Batch Number | Prepared or Analyzed | Analyst | Lab |
|---|---|---|---|---|---|---|---|---|---|---|
| Total/NA | Analysis | D4464 | | 1 | | | 36327 | 11/26/19 19:48 | C4LT | ECL 1 |
| | Instrument ID: NOEQUIP | | | | | | | | | |

## Client Sample ID: PATIOS +3
Lab Sample ID: 570-13756-12
Date Collected: 10/16/19 09:30
Matrix: Solid
Date Received: 11/22/19 19:00

| Prep Type | Batch Type | Batch Method | Run | Dil Factor | Initial Amount | Final Amount | Batch Number | Prepared or Analyzed | Analyst | Lab |
|---|---|---|---|---|---|---|---|---|---|---|
| Total/NA | Analysis | D4464 | | 1 | | | 36327 | 11/26/19 20:17 | C4LT | ECL 1 |
| | Instrument ID: NOEQUIP | | | | | | | | | |

# Lab Chronicle

Client: Merkel & Associates
Project/Site: STINSON BEACH 19-009-01

Job ID: 570-13756-1

## Client Sample ID: PATIOS 0

Lab Sample ID: 570-13756-13
Date Collected: 10/16/19 09:40
Date Received: 11/22/19 19:00
Matrix: Solid

| Prep Type | Batch Type | Batch Method | Run | Dil Factor | Initial Amount | Final Amount | Batch Number | Prepared or Analyzed | Analyst | Lab |
|---|---|---|---|---|---|---|---|---|---|---|
| Total/NA | Analysis | D4464 | | 1 | | | 36327 | 11/26/19 20:26 | C4LT | ECL 1 |
| | Instrument ID: | NOEQUIP | | | | | | | | |

## Client Sample ID: PATIOS -12

Lab Sample ID: 570-13756-14
Date Collected: 10/16/19 09:50
Date Received: 11/22/19 19:00
Matrix: Solid

| Prep Type | Batch Type | Batch Method | Run | Dil Factor | Initial Amount | Final Amount | Batch Number | Prepared or Analyzed | Analyst | Lab |
|---|---|---|---|---|---|---|---|---|---|---|
| Total/NA | Analysis | D4464 | | 1 | | | 36327 | 11/26/19 20:35 | C4LT | ECL 1 |
| | Instrument ID: | NOEQUIP | | | | | | | | |

## Client Sample ID: PATIOS -24

Lab Sample ID: 570-13756-15
Date Collected: 10/16/19 10:00
Date Received: 11/22/19 19:00
Matrix: Solid

| Prep Type | Batch Type | Batch Method | Run | Dil Factor | Initial Amount | Final Amount | Batch Number | Prepared or Analyzed | Analyst | Lab |
|---|---|---|---|---|---|---|---|---|---|---|
| Total/NA | Analysis | D4464 | | 1 | | | 36327 | 11/26/19 20:42 | C4LT | ECL 1 |
| | Instrument ID: | NOEQUIP | | | | | | | | |

## Client Sample ID: SEADRIFT E +12

Lab Sample ID: 570-13756-16
Date Collected: 10/16/19 10:15
Date Received: 11/22/19 19:00
Matrix: Solid

| Prep Type | Batch Type | Batch Method | Run | Dil Factor | Initial Amount | Final Amount | Batch Number | Prepared or Analyzed | Analyst | Lab |
|---|---|---|---|---|---|---|---|---|---|---|
| Total/NA | Analysis | D4464 | | 1 | | | 36327 | 11/26/19 20:48 | C4LT | ECL 1 |
| | Instrument ID: | NOEQUIP | | | | | | | | |

## Client Sample ID: SEADRIFT E +3

Lab Sample ID: 570-13756-17
Date Collected: 10/16/19 10:25
Date Received: 11/22/19 19:00
Matrix: Solid

| Prep Type | Batch Type | Batch Method | Run | Dil Factor | Initial Amount | Final Amount | Batch Number | Prepared or Analyzed | Analyst | Lab |
|---|---|---|---|---|---|---|---|---|---|---|
| Total/NA | Analysis | D4464 | | 1 | | | 36327 | 11/26/19 20:58 | C4LT | ECL 1 |
| | Instrument ID: | NOEQUIP | | | | | | | | |

## Client Sample ID: SEADRIFT E 0

Lab Sample ID: 570-13756-18
Date Collected: 10/16/19 10:35
Date Received: 11/22/19 19:00
Matrix: Solid

| Prep Type | Batch Type | Batch Method | Run | Dil Factor | Initial Amount | Final Amount | Batch Number | Prepared or Analyzed | Analyst | Lab |
|---|---|---|---|---|---|---|---|---|---|---|
| Total/NA | Analysis | D4464 | | 1 | | | 36327 | 11/26/19 21:05 | C4LT | ECL 1 |
| | Instrument ID: | NOEQUIP | | | | | | | | |

# Lab Chronicle

Client: Merkel & Associates
Job ID: 570-13756-1
Project/Site: STINSON BEACH 19-009-01

## Client Sample ID: SEADRIFT E -12
Lab Sample ID: 570-13756-19
Date Collected: 10/16/19 10:45
Matrix: Solid
Date Received: 11/22/19 19:00

| Prep Type | Batch Type | Batch Method | Run | Dil Factor | Initial Amount | Final Amount | Batch Number | Prepared or Analyzed | Analyst | Lab |
|---|---|---|---|---|---|---|---|---|---|---|
| Total/NA | Analysis | D4464 | | 1 | | | 36327 | 11/26/19 21:24 | C4LT | ECL 1 |
| | Instrument ID: NOEQUIP | | | | | | | | | |

## Client Sample ID: SEADRIFT E -24
Lab Sample ID: 570-13756-20
Date Collected: 10/16/19 10:55
Matrix: Solid
Date Received: 11/22/19 19:00

| Prep Type | Batch Type | Batch Method | Run | Dil Factor | Initial Amount | Final Amount | Batch Number | Prepared or Analyzed | Analyst | Lab |
|---|---|---|---|---|---|---|---|---|---|---|
| Total/NA | Analysis | D4464 | | 1 | | | 36327 | 11/26/19 21:31 | C4LT | ECL 1 |
| | Instrument ID: NOEQUIP | | | | | | | | | |

## Client Sample ID: SEADRIFT W +12
Lab Sample ID: 570-13756-21
Date Collected: 10/16/19 11:20
Matrix: Solid
Date Received: 11/22/19 19:00

| Prep Type | Batch Type | Batch Method | Run | Dil Factor | Initial Amount | Final Amount | Batch Number | Prepared or Analyzed | Analyst | Lab |
|---|---|---|---|---|---|---|---|---|---|---|
| Total/NA | Analysis | D4464 | | 1 | | | 36328 | 11/27/19 19:30 | C4LT | ECL 1 |
| | Instrument ID: NOEQUIP | | | | | | | | | |

## Client Sample ID: SEADRIFT W +3
Lab Sample ID: 570-13756-22
Date Collected: 10/16/19 11:30
Matrix: Solid
Date Received: 11/22/19 19:00

| Prep Type | Batch Type | Batch Method | Run | Dil Factor | Initial Amount | Final Amount | Batch Number | Prepared or Analyzed | Analyst | Lab |
|---|---|---|---|---|---|---|---|---|---|---|
| Total/NA | Analysis | D4464 | | 1 | | | 36328 | 11/27/19 19:48 | C4LT | ECL 1 |
| | Instrument ID: NOEQUIP | | | | | | | | | |

## Client Sample ID: SEADRIFT W 0
Lab Sample ID: 570-13756-23
Date Collected: 10/16/19 11:40
Matrix: Solid
Date Received: 11/22/19 19:00

| Prep Type | Batch Type | Batch Method | Run | Dil Factor | Initial Amount | Final Amount | Batch Number | Prepared or Analyzed | Analyst | Lab |
|---|---|---|---|---|---|---|---|---|---|---|
| Total/NA | Analysis | D4464 | | 1 | | | 36328 | 11/27/19 19:55 | C4LT | ECL 1 |
| | Instrument ID: NOEQUIP | | | | | | | | | |

## Client Sample ID: SEADRIFT W -12
Lab Sample ID: 570-13756-24
Date Collected: 10/16/19 11:50
Matrix: Solid
Date Received: 11/22/19 19:00

| Prep Type | Batch Type | Batch Method | Run | Dil Factor | Initial Amount | Final Amount | Batch Number | Prepared or Analyzed | Analyst | Lab |
|---|---|---|---|---|---|---|---|---|---|---|
| Total/NA | Analysis | D4464 | | 1 | | | 36328 | 11/27/19 20:14 | C4LT | ECL 1 |
| | Instrument ID: NOEQUIP | | | | | | | | | |

# Lab Chronicle

Client: Merkel & Associates
Job ID: 570-13756-1
Project/Site: STINSON BEACH 19-009-01

## Client Sample ID: SEADRIFT W -24
**Lab Sample ID: 570-13756-25**

**Date Collected: 10/16/19 12:00**
**Matrix: Solid**
**Date Received: 11/22/19 19:00**

| Prep Type | Batch Type | Batch Method | Run | Dil Factor | Initial Amount | Final Amount | Batch Number | Prepared or Analyzed | Analyst | Lab |
|---|---|---|---|---|---|---|---|---|---|---|
| Total/NA | Analysis | D4464 | | 1 | | | 36328 | 11/27/19 20:20 | C4LT | ECL 1 |
| | Instrument ID: NOEQUIP | | | | | | | | | |

**Laboratory References:**

ECL 1 = Eurofins Calscience LLC Lincoln, 7440 Lincoln Way, Garden Grove, CA 92841, TEL (714)895-5494

# Accreditation/Certification Summary

Client: Merkel & Associates

Job ID: 570-13756-1

Project/Site: STINSON BEACH 19-009-01



## Laboratory: Eurofins Calscience LLC

All accreditations/certifications held by this laboratory are listed. Not all accreditations/certifications are applicable to this report.

| Authority | Program | Identification Number | Expiration Date |
|---|---|---|---|
| Arizona | State | AZ0781 | 03-13-20 |
| California | SCAQMD LAP | 17LA0919 | 11-30-19 |
| California | State | 2944 | 09-29-20 |
| Hawaii | State | <cert No.> | 07-02-20 |
| Nevada | State | CA00111 | 07-31-20 |
| Oregon | NELAP | CA300001 | 01-29-20 |

# Method Summary

Client: Merkel & Associates
Project/Site: STINSON BEACH 19-009-01

Job ID: 570-13756-1

| Method | Method Description | Protocol | Laboratory |
|---|---|---|---|
| D4464 | Particle Size Distribution of Catalytic Material ( Laser light scattering) | ASTM | ECL 1 |

**Protocol References:**

ASTM = ASTM International

**Laboratory References:**

ECL 1 = Eurofins Calscience LLC Lincoln, 7440 Lincoln Way, Garden Grove, CA 92841, TEL (714)895-5494

## Sample Summary

Client: Merkel & Associates
Job ID: 570-13756-1
Project/Site: STINSON BEACH 19-009-01

| Lab Sample ID | Client Sample ID | Matrix | Collected | Received | Asset ID |
|---|---|---|---|---|---|
| 570-13756-1 | NPS +12 | Solid | 10/16/19 07:00 | 11/22/19 19:00 | |
| 570-13756-2 | NPS +3 | Solid | 10/16/19 07:10 | 11/22/19 19:00 | |
| 570-13756-3 | NPS +0 | Solid | 10/16/19 07:20 | 11/22/19 19:00 | |
| 570-13756-4 | NPS -12 | Solid | 10/16/19 07:30 | 11/22/19 19:00 | |
| 570-13756-5 | NPS -24 | Solid | 10/16/19 07:50 | 11/22/19 19:00 | |
| 570-13756-6 | CALLES +12 | Solid | 10/16/19 08:20 | 11/22/19 19:00 | |
| 570-13756-7 | CALLES +3 | Solid | 10/16/19 08:30 | 11/22/19 19:00 | |
| 570-13756-8 | CALLES 0 | Solid | 10/16/19 08:40 | 11/22/19 19:00 | |
| 570-13756-9 | CALLES -12 | Solid | 10/16/19 08:50 | 11/22/19 19:00 | |
| 570-13756-10 | CALLES -24 | Solid | 10/16/19 09:00 | 11/22/19 19:00 | |
| 570-13756-11 | PATIOS +12 | Solid | 10/16/19 09:20 | 11/22/19 19:00 | |
| 570-13756-12 | PATIOS +3 | Solid | 10/16/19 09:30 | 11/22/19 19:00 | |
| 570-13756-13 | PATIOS 0 | Solid | 10/16/19 09:40 | 11/22/19 19:00 | |
| 570-13756-14 | PATIOS -12 | Solid | 10/16/19 09:50 | 11/22/19 19:00 | |
| 570-13756-15 | PATIOS -24 | Solid | 10/16/19 10:00 | 11/22/19 19:00 | |
| 570-13756-16 | SEADRIFT E +12 | Solid | 10/16/19 10:15 | 11/22/19 19:00 | |
| 570-13756-17 | SEADRIFT E +3 | Solid | 10/16/19 10:25 | 11/22/19 19:00 | |
| 570-13756-18 | SEADRIFT E 0 | Solid | 10/16/19 10:35 | 11/22/19 19:00 | |
| 570-13756-19 | SEADRIFT E -12 | Solid | 10/16/19 10:45 | 11/22/19 19:00 | |
| 570-13756-20 | SEADRIFT E -24 | Solid | 10/16/19 10:55 | 11/22/19 19:00 | |
| 570-13756-21 | SEADRIFT W +12 | Solid | 10/16/19 11:20 | 11/22/19 19:00 | |
| 570-13756-22 | SEADRIFT W +3 | Solid | 10/16/19 11:30 | 11/22/19 19:00 | |
| 570-13756-23 | SEADRIFT W 0 | Solid | 10/16/19 11:40 | 11/22/19 19:00 | |
| 570-13756-24 | SEADRIFT W -12 | Solid | 10/16/19 11:50 | 11/22/19 19:00 | |
| 570-13756-25 | SEADRIFT W -24 | Solid | 10/16/19 12:00 | 11/22/19 19:00 | |

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# CHAIN OF CUSTODY RECORD

570-13756 Chain of Custody

DATE: November 20, 2019

PAGE: 1 OF 3

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LABORATORY CLIENT: Merkel & Associates Inc.

ADDRESS: 5434 Ruffin Rd.

CITY: San Diego STATE: CA ZIP: 92123

TEL: 858-717-2897 E-MAIL: KRogers@merkelinc.com

CLIENT PROJECT NAME / NUMBER: Stinson Beach 19-009-01

P.O. NO.: 19-009-01

PROJECT CONTACT: Kathy Rogers

SAMPLER(S): (PRINT) Jordan Volker

TURNAROUND TIME (Rush surcharges may apply to any TAT not "STANDARD"): ☐ SAME DAY ☐ 24 HR ☐ 48 HR ☐ 72 HR ☐ 5 DAYS ☒ STANDARD

☐ COELT EDF GLOBAL ID: LOG CODE:

SPECIAL INSTRUCTIONS:

## REQUESTED ANALYSES

Please check box or fill in blank as needed.

| LAB USE ONLY | SAMPLE ID | SAMPLING DATE | SAMPLING TIME | MATRIX | NO. OF CONT. | Unpreserved | Preserved | Field Filtered | ☐ TPH(g) ☐ GRO | ☐ TPH(d) ☐ DRO | TPH ☐ C6-C36 ☐ C6-C44 | TPH ____ | BTEX / MTBE ☐ 8260 ☐ ____ | VOCs (8260) | Oxygenates (8260) | Prep (5035) ☐ En Core ☐ Terra Core | SVOCs (8270) | Pesticides (8081) | PCBs (8082) | PAHs ☐ 8270 ☐ 8270 SIM | T22 Metals ☐ 6010/747X ☐ 6020/747X | Cr(VI) ☐ 7196 ☐ 7199 ☐ 218.6 | Grain Size |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | NPS +12 | 10-16-19 | 07:00 | Sediment | 1 | X | | | | | | | | | | | | | | | | | X |
| 2 | NPS +3 | | 07:10 | | 1 | X | | | | | | | | | | | | | | | | | X |
| 3 | NPS 0 | | 07:20 | | 1 | X | | | | | | | | | | | | | | | | | X |
| 4 | NPS -12 | | 07:30 | | 1 | X | | | | | | | | | | | | | | | | | X |
| 5 | NPS -24 | | 07:50 | | 1 | X | | | | | | | | | | | | | | | | | X |
| 6 | Calles +12 | | 08:20 | | 1 | X | | | | | | | | | | | | | | | | | X |
| 7 | Calles +3 | | 08:30 | | 1 | X | | | | | | | | | | | | | | | | | X |
| 8 | Calles 0 | | 08:40 | | 1 | X | | | | | | | | | | | | | | | | | X |
| 9 | Calles -12 | | 08:50 | | 1 | X | | | | | | | | | | | | | | | | | X |
| 10 | Calles -24 | | 09:00 | | 1 | X | | | | | | | | | | | | | | | | | X |

| Relinquished by: (Signature) | Received by: (Signature/Affiliation) | Date: | Time: |
|---|---|---|---|
| [signature] | [signature] EC | 11/21/19 | 10:00 |
| [signature] | [signature] | 11/21/19 | 1900 |
| | | | |

2.0/2.5 5c6

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# CHAIN OF CUSTODY RECORD

WO # / LAB USE ONLY

DATE: November 20, 2019
PAGE: 2 OF 3

LABORATORY CLIENT: Merkel & Associates Inc.
ADDRESS: 5434 Ruffin Rd.
CITY: San Diego STATE: CA ZIP: 92123
TEL: 858-717-2897 E-MAIL: krogers@merkelinc.com

CLIENT PROJECT NAME / NUMBER: Stinson Beach 19-009-01
P.O. NO.: 19-009-01
PROJECT CONTACT: Kathy Rogers
SAMPLER(S): (PRINT) Jordan Volker

TURNAROUND TIME (Rush surcharges may apply to any TAT not "STANDARD"):
☐ SAME DAY ☐ 24 HR ☐ 48 HR ☐ 72 HR ☐ 5 DAYS ☒ STANDARD

☐ COELT EDF GLOBAL ID: LOG CODE:

SPECIAL INSTRUCTIONS:

## REQUESTED ANALYSES

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| LAB USE ONLY | SAMPLE ID | SAMPLING DATE | SAMPLING TIME | MATRIX | NO. OF CONT. | Unpreserved | Preserved | Field Filtered | ☐ TPH(g) ☐ GRO | ☐ TPH(d) ☐ DRO | TPH ☐ C6-C36 ☐ C6-C44 | TPH ___ | BTEX / MTBE ☐ 8260 ☐ ___ | VOCs (8260) | Oxygenates (8260) | Prep (5035) ☐ En Core ☐ Terra Core | SVOCs (8270) | Pesticides (8081) | PCBs (8082) | PAHs ☐ 8270 ☐ 8270 SIM | T22 Metals ☐ 6010/747X ☐ 6020/747X | Cr(VI) ☐ 7196 ☐ 7199 ☐ 218.6 | Grain Size |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 11 | Patios +12 | 10-16-19 | 09:20 | Sediment | 1 | X | | | | | | | | | | | | | | | | | X |
| 12 | Patios +3 | | 09:30 | | 1 | X | | | | | | | | | | | | | | | | | X |
| 13 | Patios Ø | | 09:40 | | 1 | X | | | | | | | | | | | | | | | | | X |
| 14 | Patios -12 | | 09:50 | | 1 | X | | | | | | | | | | | | | | | | | X |
| 15 | Patios -24 | | 10:00 | | 1 | X | | | | | | | | | | | | | | | | | X |
| 16 | Seadrift E +12 | | 10:15 | | 1 | X | | | | | | | | | | | | | | | | | X |
| 17 | Seadrift E +3 | | 10:25 | | 1 | X | | | | | | | | | | | | | | | | | X |
| 18 | Seadrift E Ø | | 10:35 | | 1 | X | | | | | | | | | | | | | | | | | X |
| 19 | Seadrift E -12 | | 10:45 | | 1 | X | | | | | | | | | | | | | | | | | X |
| 20 | Seadrift E -24 | | 10:55 | | 1 | X | | | | | | | | | | | | | | | | | X |

| Relinquished by: (Signature) | Received by: (Signature/Affiliation) | Date: | Time: |
|---|---|---|---|
| [signature] | [signature] | 11/21/19 | 10:00 |
| [signature] | [signature] | 11/21/19 | 1900 |
| | | | |

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# CHAIN OF CUSTODY RECORD

WO # / LAB USE ONLY

DATE: November 20, 2019
PAGE: 3 OF 3

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| LAB USE ONLY | SAMPLE ID | SAMPLING DATE | SAMPLING TIME | MATRIX | NO. OF CONT. | Unpreserved | Preserved | Field Filtered | ☐ TPH(g) ☐ GRO | ☐ TPH(d) ☐ DRO | TPH ☐ C6-C36 ☐ C6-C44 | TPH ___ | BTEX / MTBE ☐ 8260 ☐ ___ | VOCs (8260) | Oxygenates (8260) | Prep (5035) ☐ En Core ☐ Terra Core | SVOCs (8270) | Pesticides (8081) | PCBs (8082) | PAHs ☐ 8270 ☐ 8270 SIM | T22 Metals ☐ 6010/747X ☐ 6020/747X | Cr(VI) ☐ 7196 ☐ 7199 ☐ 218.6 | Grain Size | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 21 | Seadrift W +12 | 10-16-19 | 11:20 | Sediment | 1 | X | | | | | | | | | | | | | | | | | X | | | |
| 22 | Seadrift W +3 | | 11:30 | | 1 | X | | | | | | | | | | | | | | | | | X | | | |
| 23 | Seadrift W 0 | | 11:40 | | 1 | X | | | | | | | | | | | | | | | | | X | | | |
| 24 | Seadrift W -12 | | 11:50 | | 1 | X | | | | | | | | | | | | | | | | | X | | | |
| 25 | Seadrift W -24 | | 12:00 | | 1 | X | | | | | | | | | | | | | | | | | X | | | |
| | | | | | 1 | X | | | | | | | | | | | | | | | | | X | | | |
| | | | | | 1 | X | | | | | | | | | | | | | | | | | X | | | |
| | | | | | 1 | X | | | | | | | | | | | | | | | | | X | | | |
| | | | | | 1 | X | | | | | | | | | | | | | | | | | X | | | |
| | | | | | 1 | X | | | | | | | | | | | | | | | | | X | | | |

| Relinquished by: (Signature) | Received by: (Signature/Affiliation) | Date: | Time: |
|---|---|---|---|
| [signature] | [signature] EC | 11/21/19 | 10:00 |
| [signature] | [signature] EC | 11/21/19 | 1900 |
| | | | |

06/02/14 Revision

# Login Sample Receipt Checklist

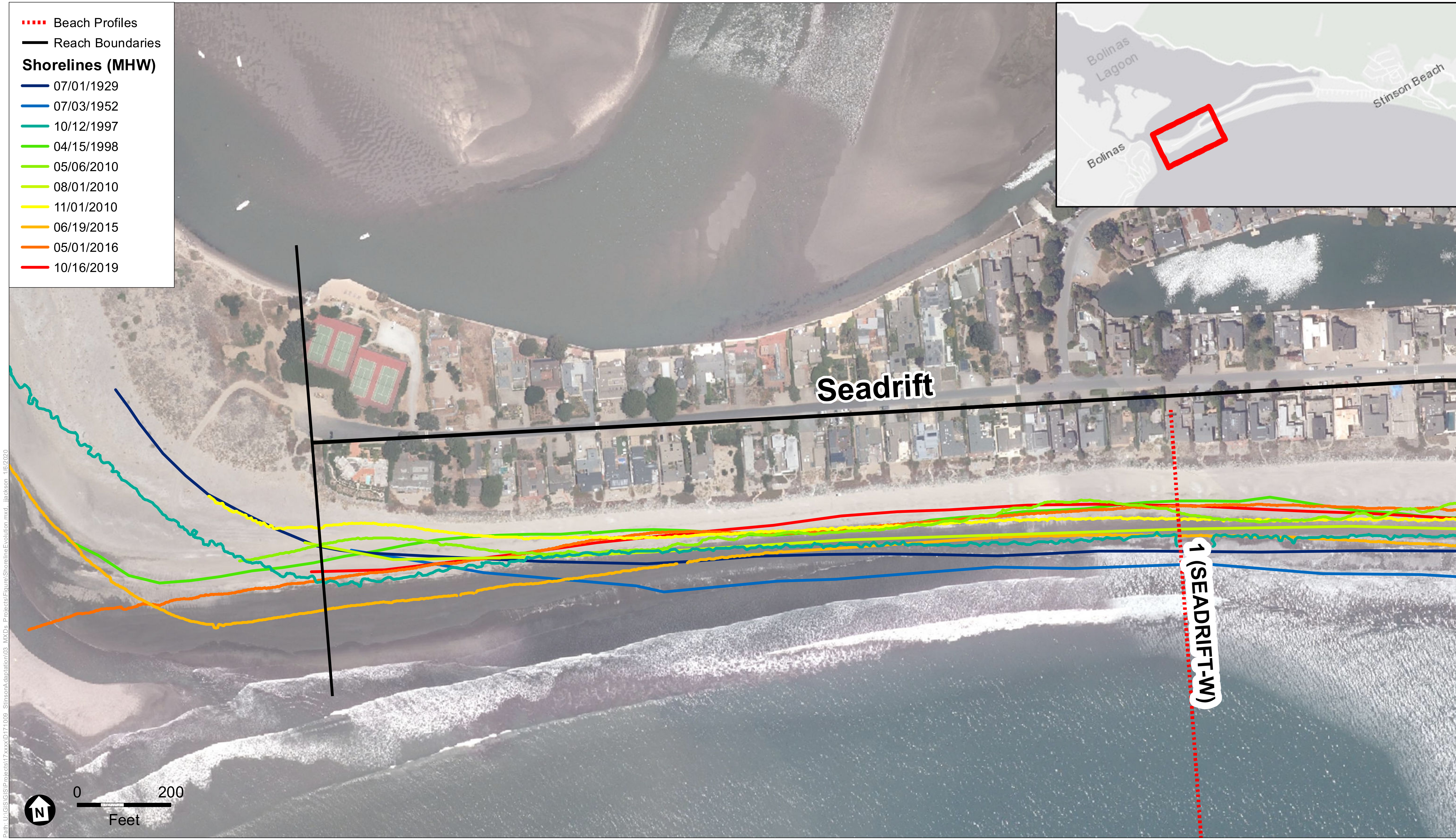
Client: Merkel & Associates

Job Number: 570-13756-1

**Login Number: 13756**
**List Number: 1**
**Creator: Cortez Diaz, Antonio**

**List Source: Eurofins Calscience**

| Question | Answer | Comment |
|---|---|---|
| Radioactivity wasn't checked or is </= background as measured by a survey meter. | N/A | |
| The cooler's custody seal, if present, is intact. | True | |
| Sample custody seals, if present, are intact. | True | |
| The cooler or samples do not appear to have been compromised or tampered with. | True | |
| Samples were received on ice. | True | |
| Cooler Temperature is acceptable. | True | |
| Cooler Temperature is recorded. | True | |
| COC is present. | True | |
| COC is filled out in ink and legible. | True | |
| COC is filled out with all pertinent information. | True | |
| Is the Field Sampler's name present on COC? | True | |
| There are no discrepancies between the containers received and the COC. | True | |
| Samples are received within Holding Time (excluding tests with immediate HTs) | True | |
| Sample containers have legible labels. | True | |
| Containers are not broken or leaking. | True | |
| Sample collection date/times are provided. | True | |
| Appropriate sample containers are used. | True | |
| Sample bottles are completely filled. | True | |
| Sample Preservation Verified. | True | |
| There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs | True | |
| Containers requiring zero headspace have no headspace or bubble is <6mm (1/4"). | True | |
| Multiphasic samples are not present. | True | |
| Samples do not require splitting or compositing. | True | |
| Residual Chlorine Checked. | N/A | |

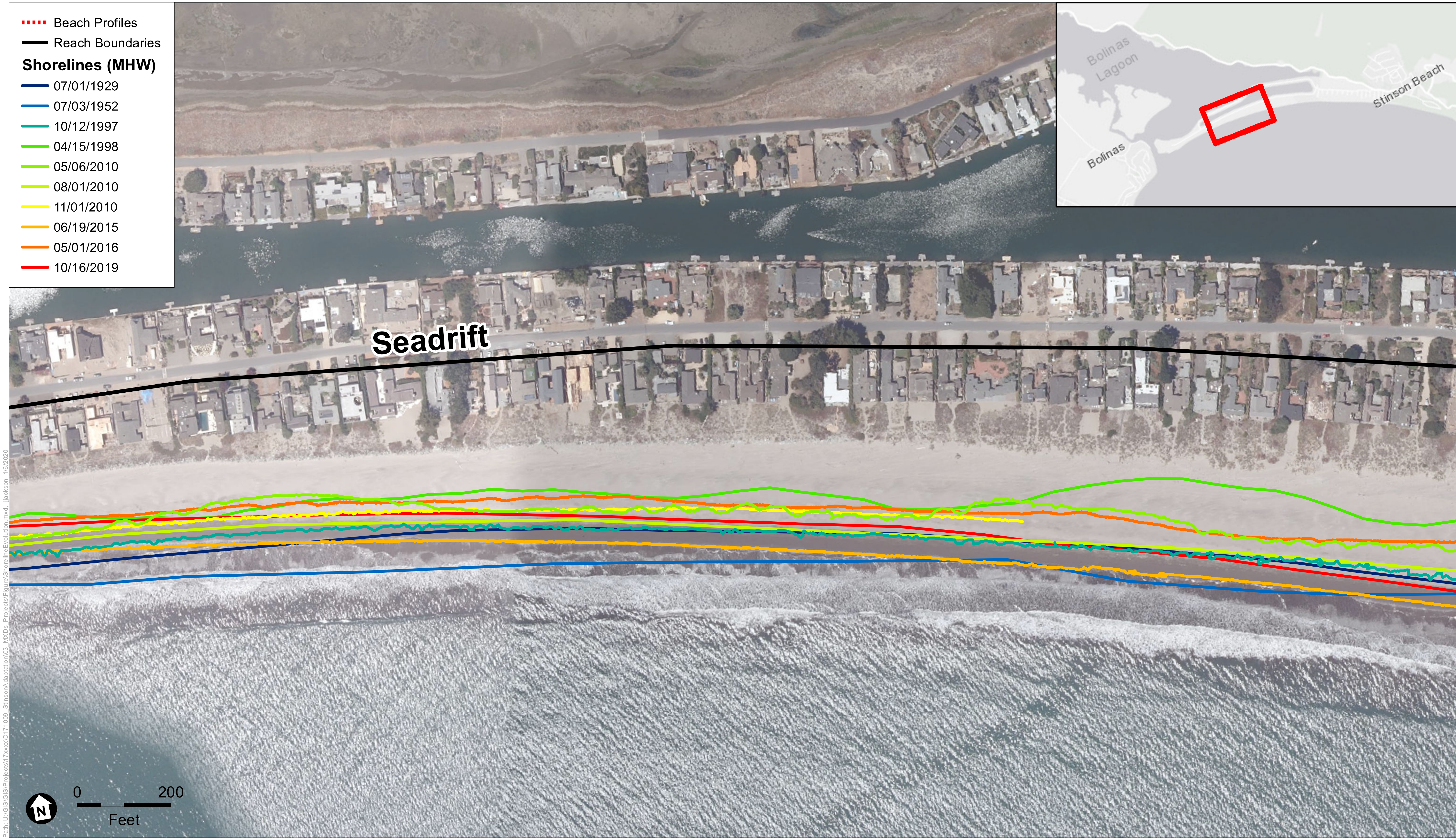



SOURCE: ESA, Marin County 2018 Imagery



**Figure E-1**
Shoreline Evolution Map
Seadrift-West Reach

ESA




SOURCE: ESA, Marin County 2018 Imagery



**Figure E-2**
Shoreline Evolution Map
Seadrift-Center Reach

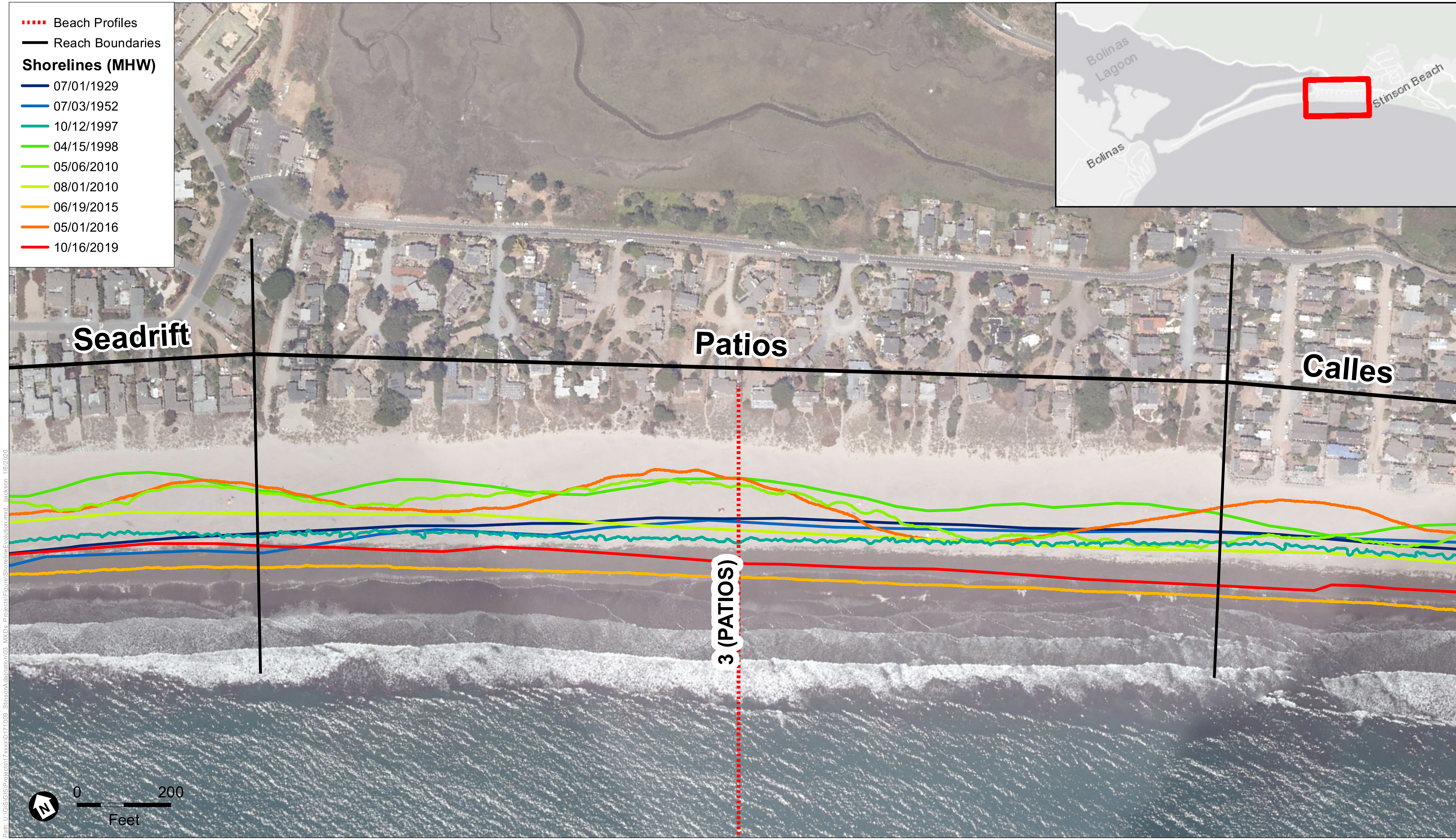
ESA


SOURCE: ESA, Marin County 2018 Imagery



**Figure E-3**
Shoreline Evolution Map
Seadrift-East Reach

ESA

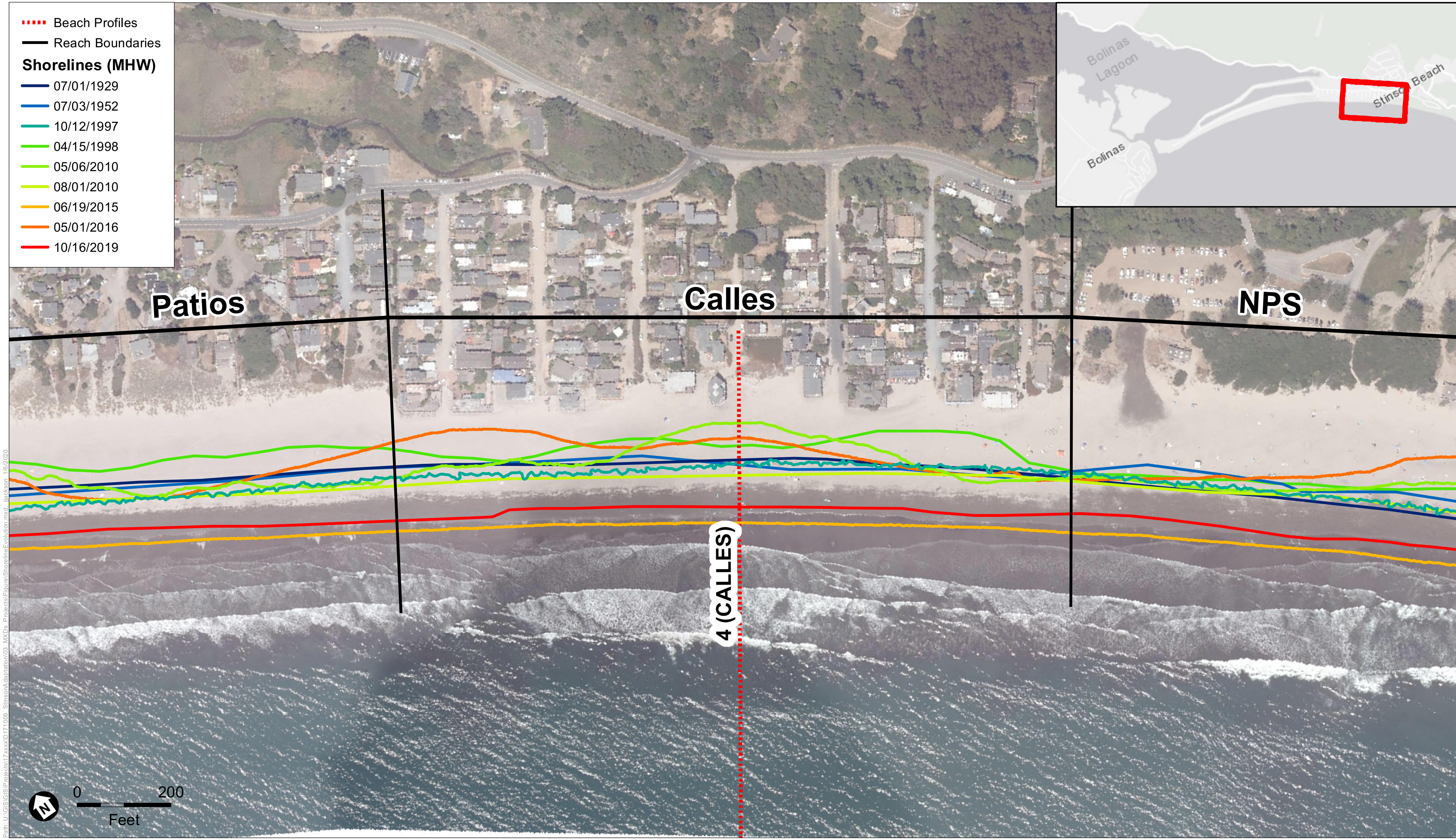



SOURCE: ESA, Marin County 2018 Imagery



**Figure E-4**
Shoreline Evolution Map
Patios Reach

ESA

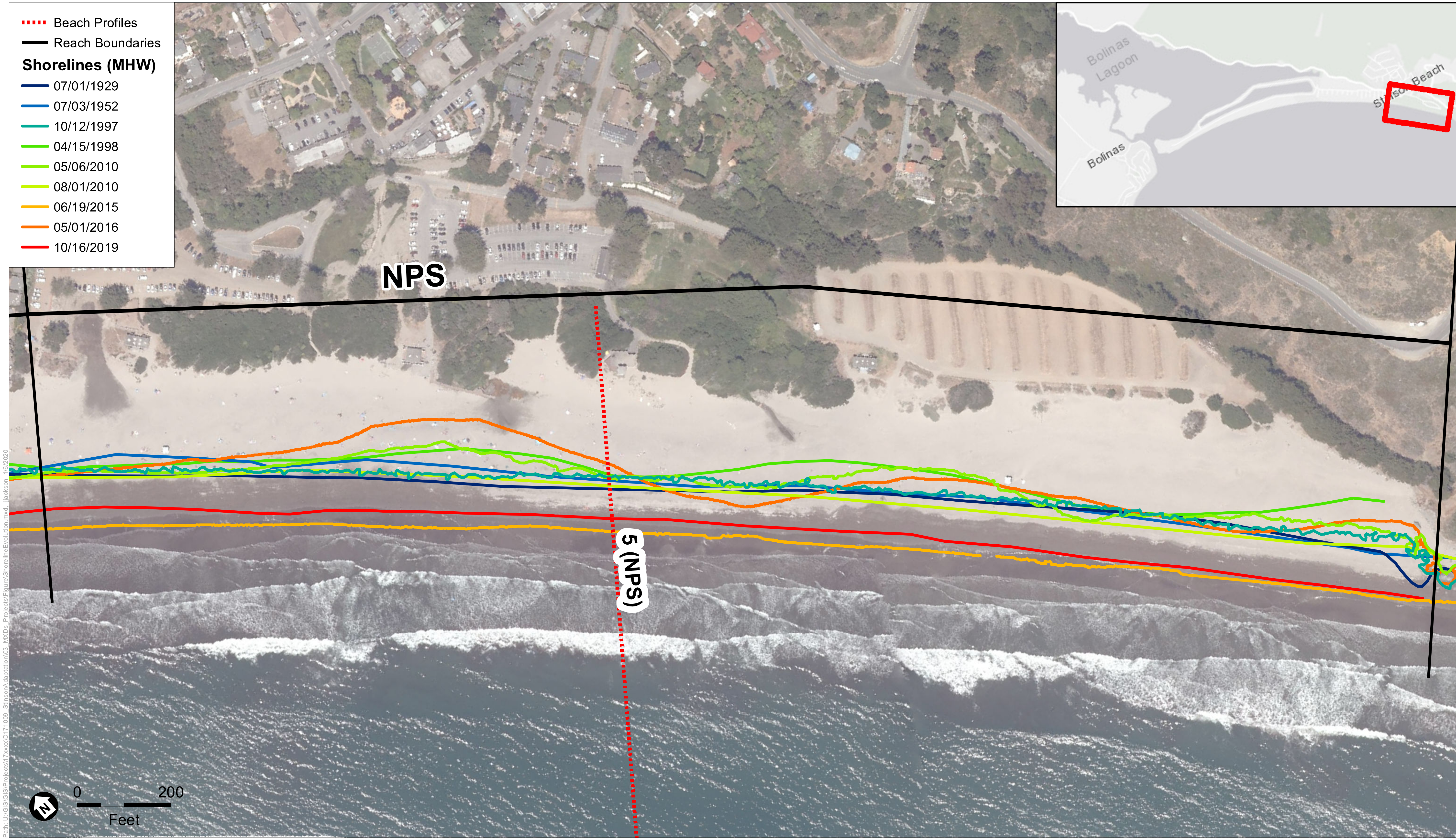



SOURCE: ESA, Marin County 2018 Imagery



**Figure E-5**
Shoreline Evolution Map
Calles Reach

ESA

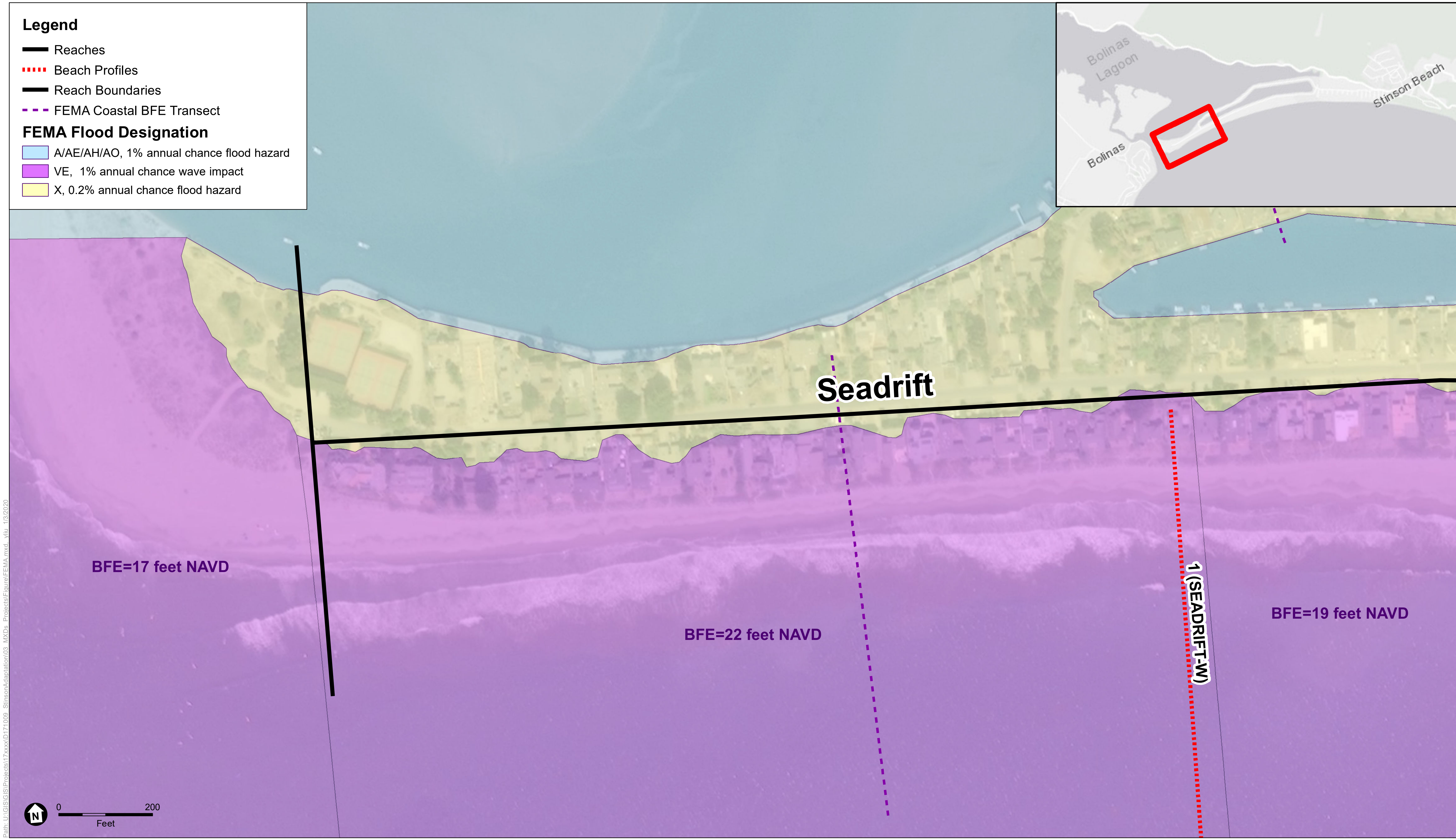



SOURCE: ESA, Marin County 2018 Imagery



**Figure E-6**
Shoreline Evolution Map
NPS Reach

ESA

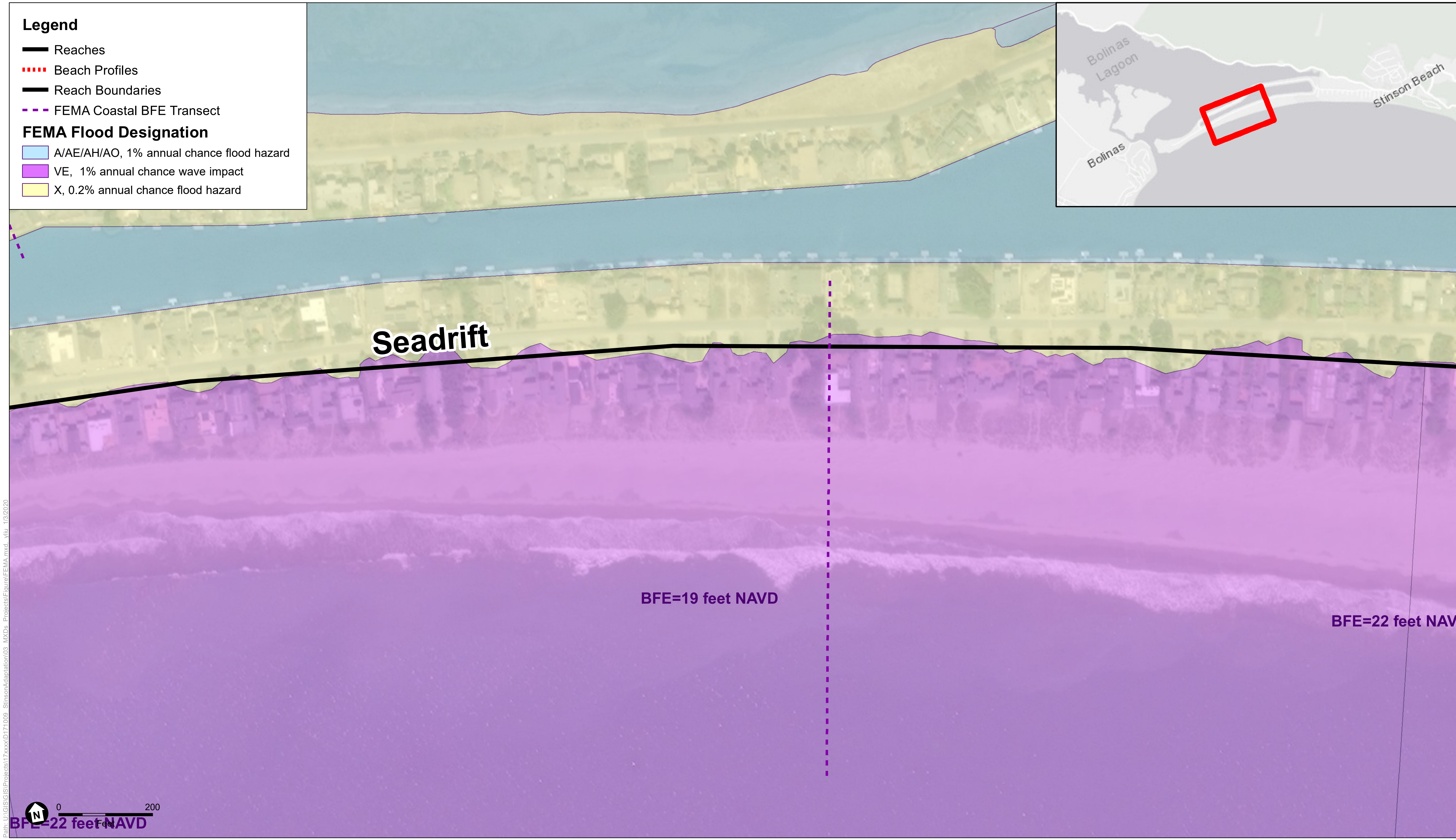



SOURCE: FEMA

Stinson Beach Nature-Based Adaptation Feasibility Study

**Figure F-1**
FEMA Digital Flood Insurance Rate Map (DFIRM)
Seadrift-West Reach

ESA

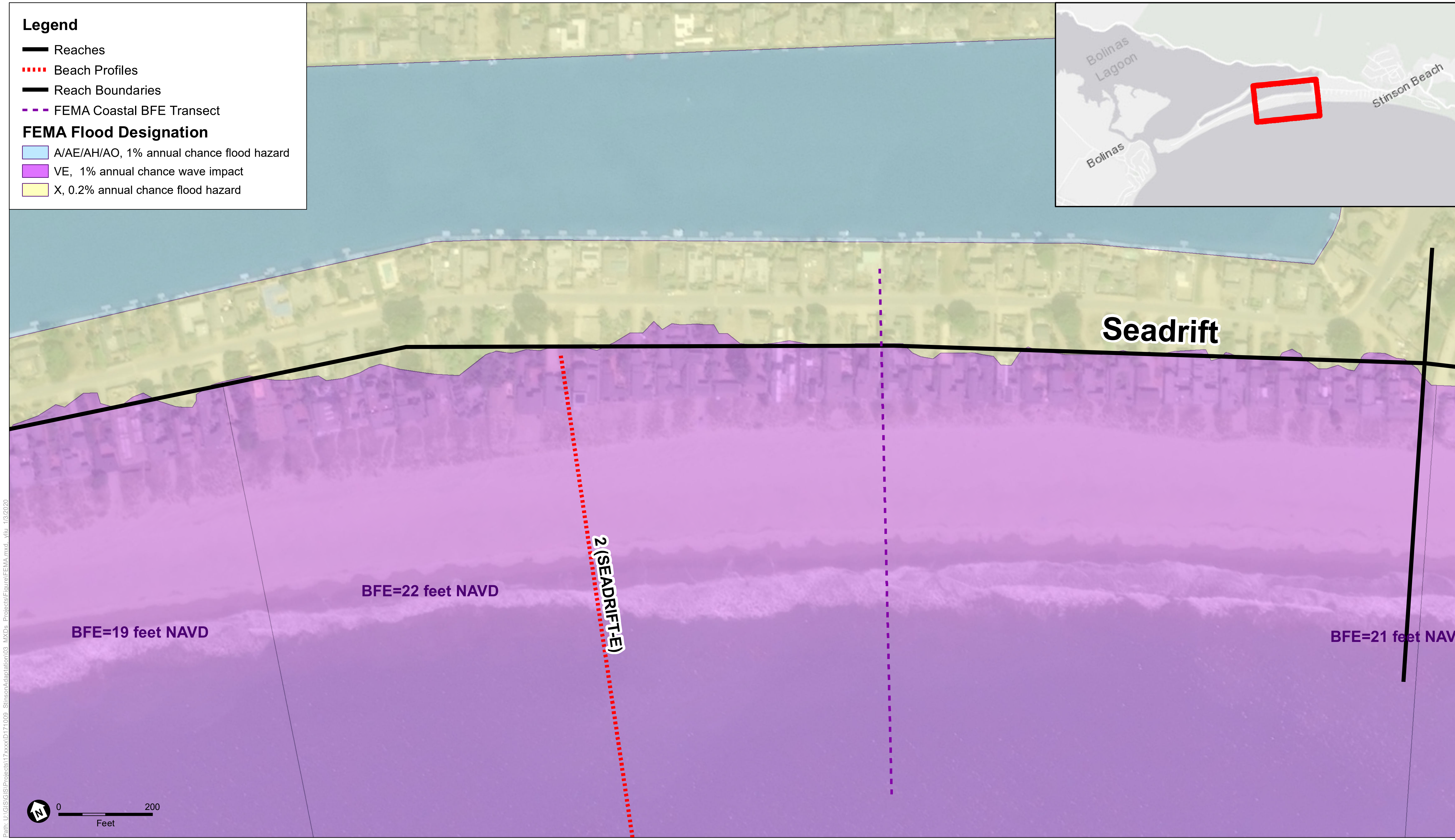



SOURCE: FEMA

Stinson Beach Nature-Based Adaptation Feasibility Study

**Figure F-2**
FEMA Digital Flood Insurance Rate Map (DFIRM)
Seadrift-Center Reach

ESA

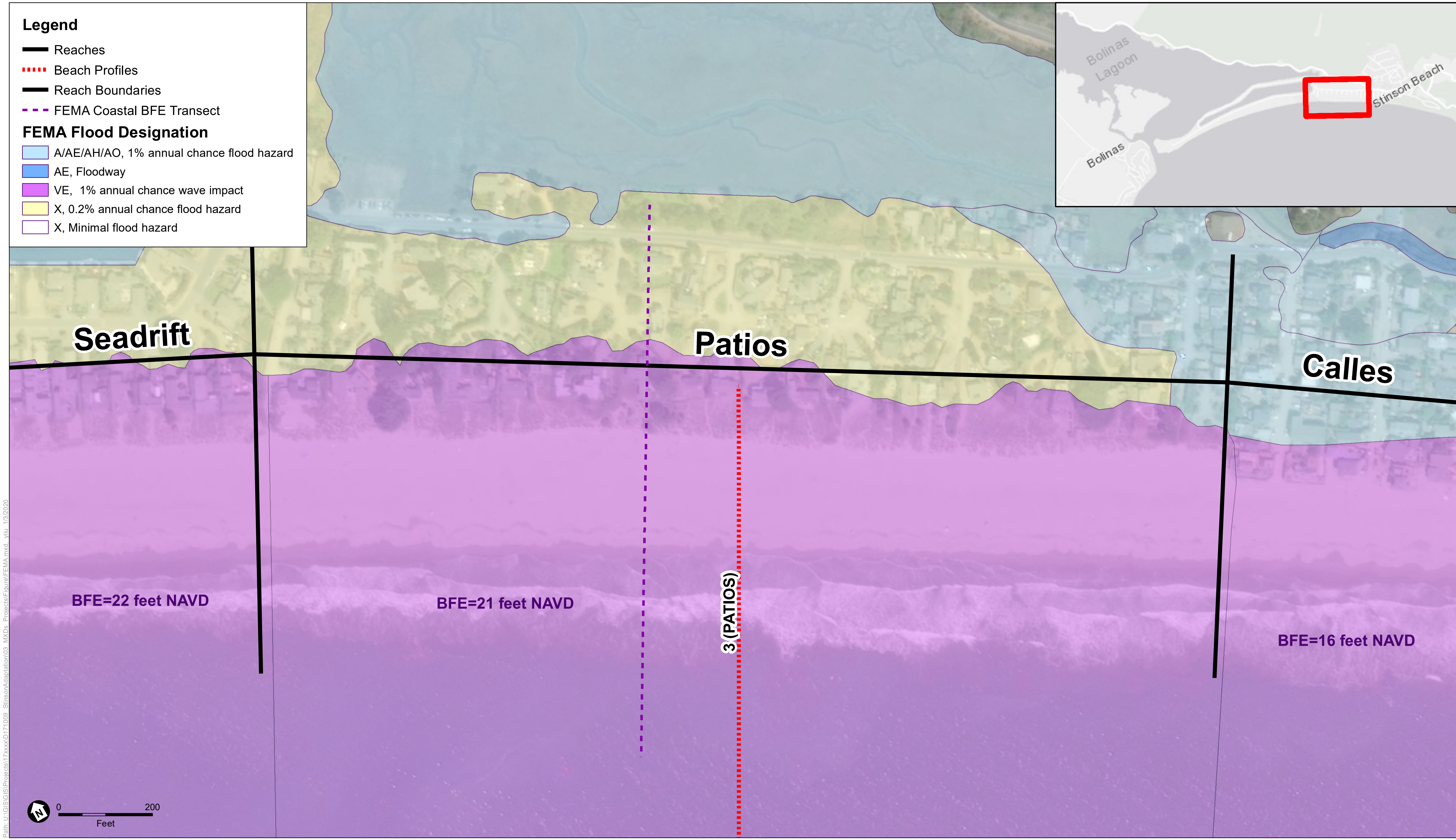



SOURCE: FEMA

Stinson Beach Nature-Based Adaptation Feasibility Study

**Figure F-3**
FEMA Digital Flood Insurance Rate Map (DFIRM)
Seadrift-East Reach

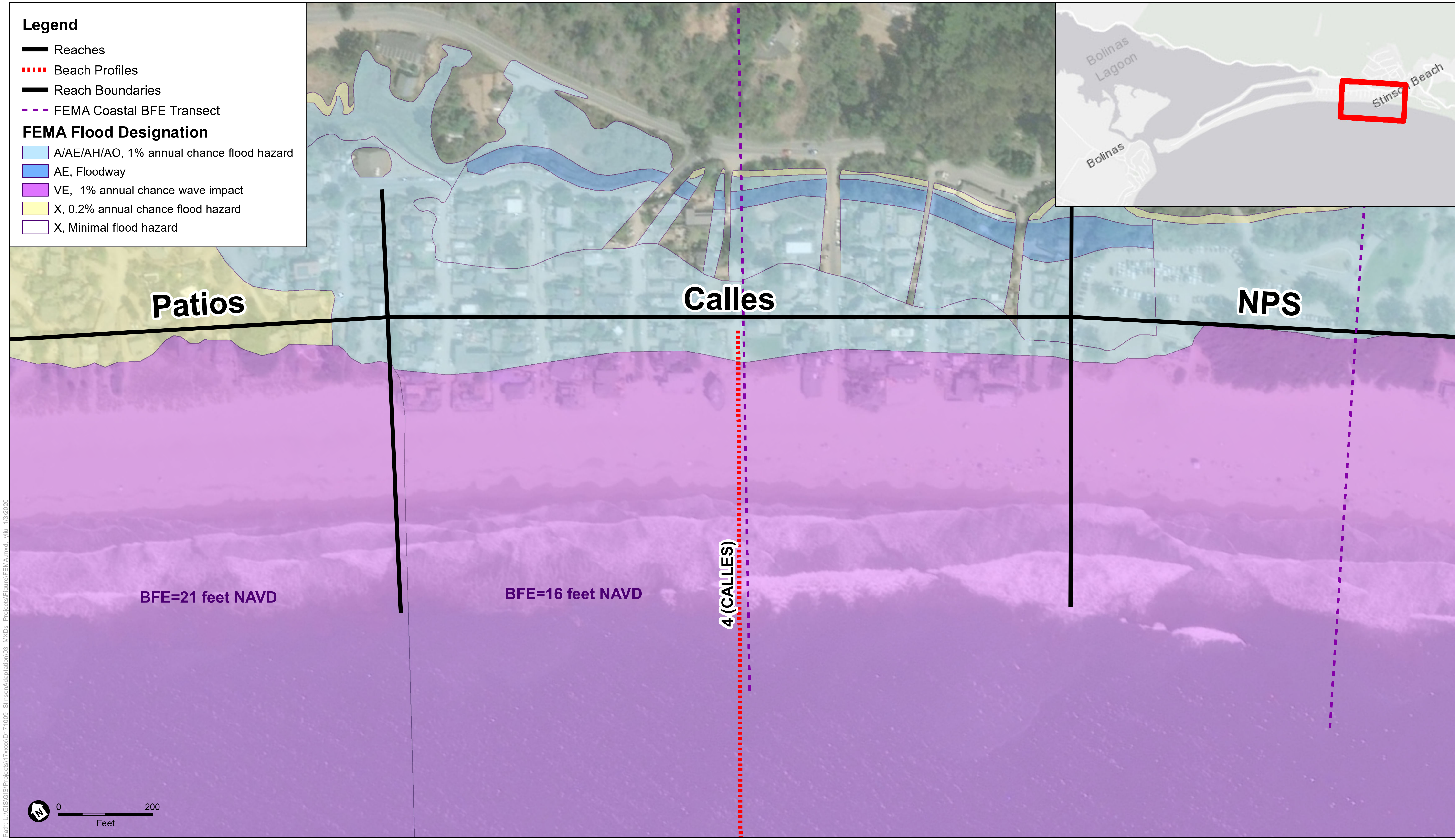
ESA




SOURCE: FEMA

Stinson Beach Nature-Based Adaptation Feasibility Study

**Figure F-4**
FEMA Digital Flood Insurance Rate Map (DFIRM)
Patios Reach

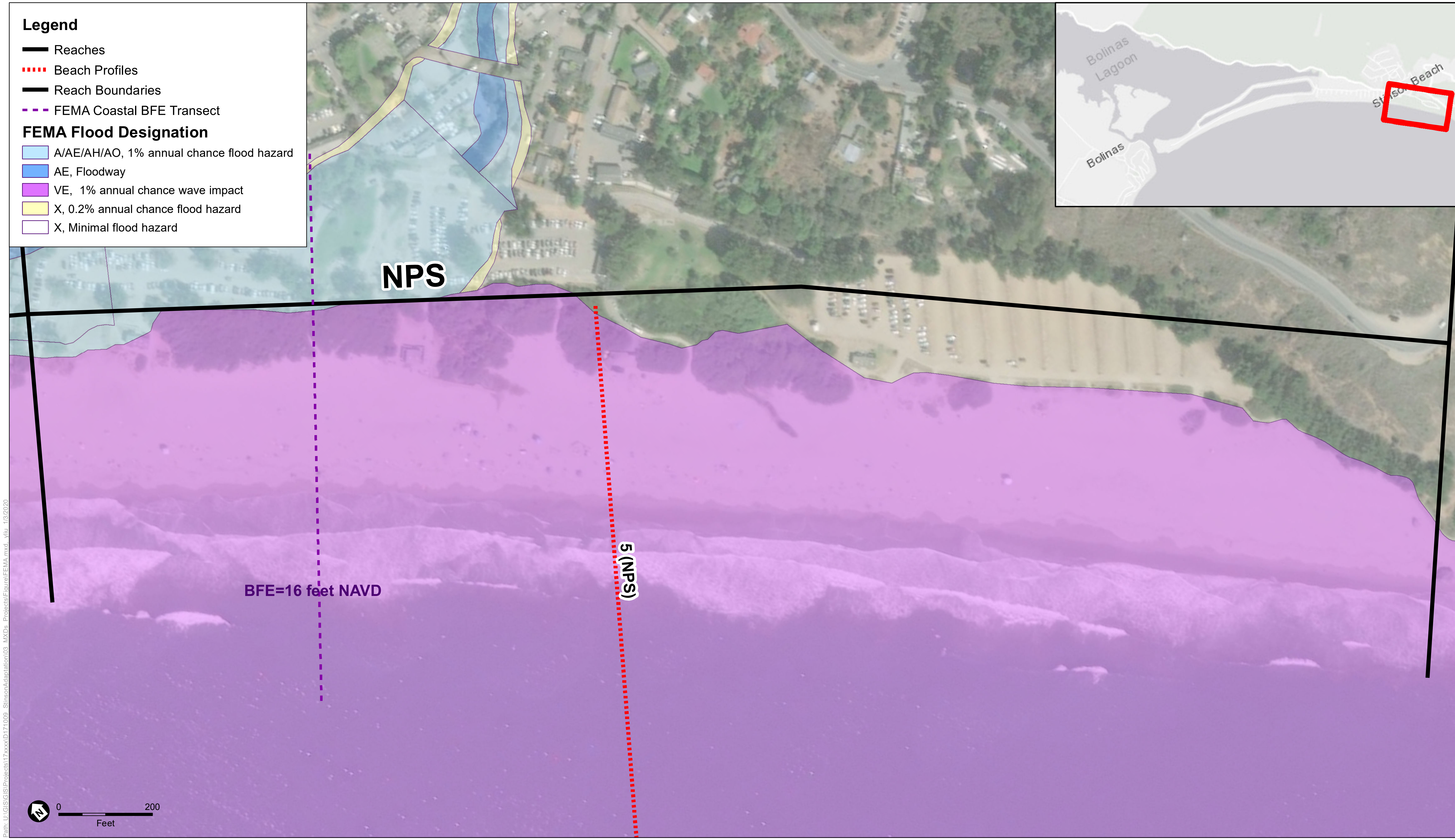



SOURCE: FEMA



**Figure F-5**
FEMA Digital Flood Insurance Rate Map (DFIRM)
Calles Reach

ESA




SOURCE: FEMA

Stinson Beach Nature-Based Adaptation Feasibility Study

**Figure F-6**
FEMA Digital Flood Insurance Rate Map (DFIRM)
NPS Reach

ESA


SOURCE: USGS and OCOF.

Note: Flood extents correspond to existing sea level.

ESA

Stinson Beach Nature-Based Adaptation Feasibility Study

**Figure G-1**
Our Coast Our Future (OCOF) 100-year Coastal Flood Hazard
Seadrift-West Reach

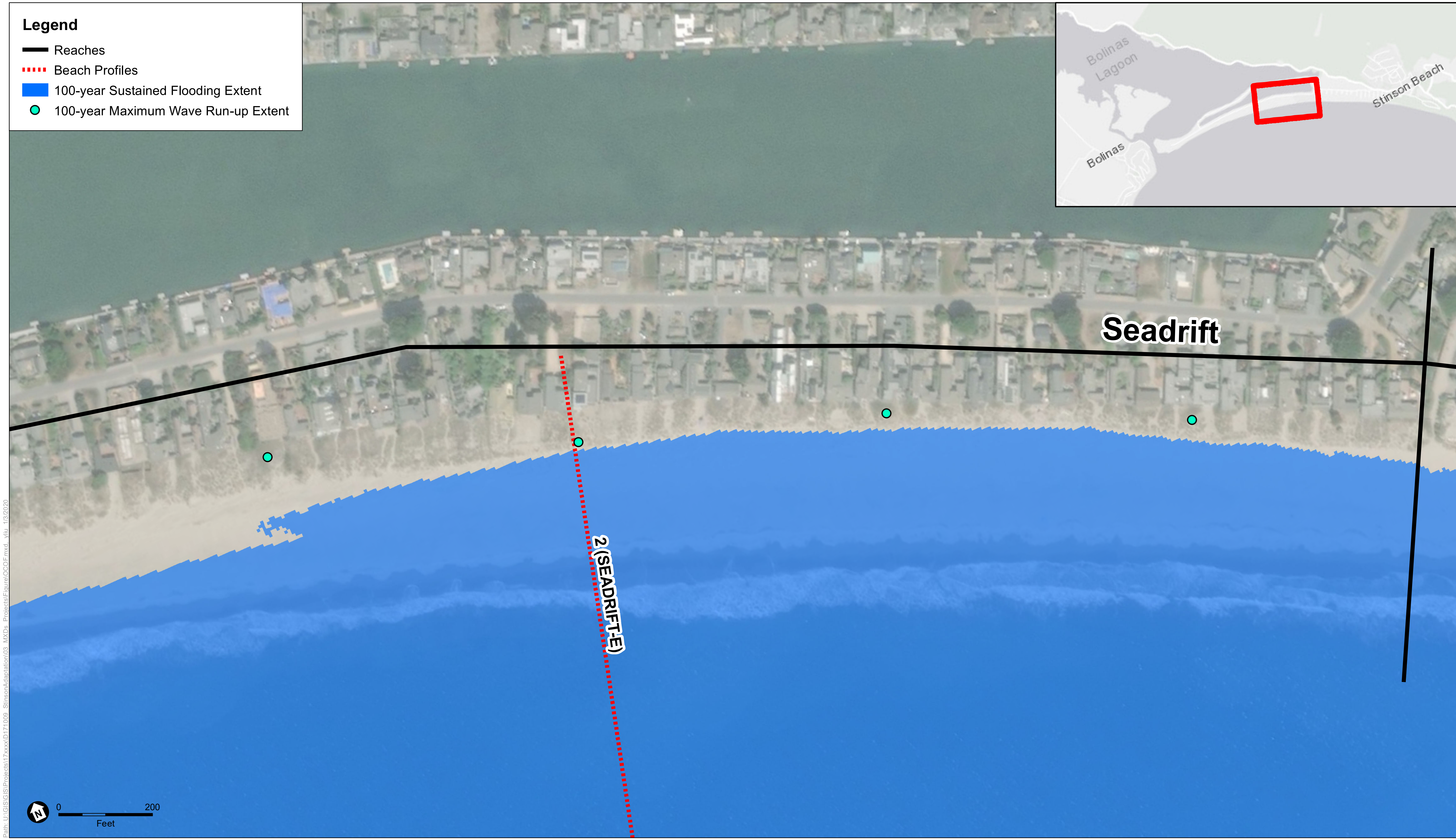

SOURCE: USGS and OCOF.

Note: Flood extents correspond to existing sea level.

ESA

Stinson Beach Nature-Based Adaptation Feasibility Study

**Figure G-2**
Our Coast Our Future (OCOF) 100-year Coastal Flood Hazard
Seadrift-Center Reach



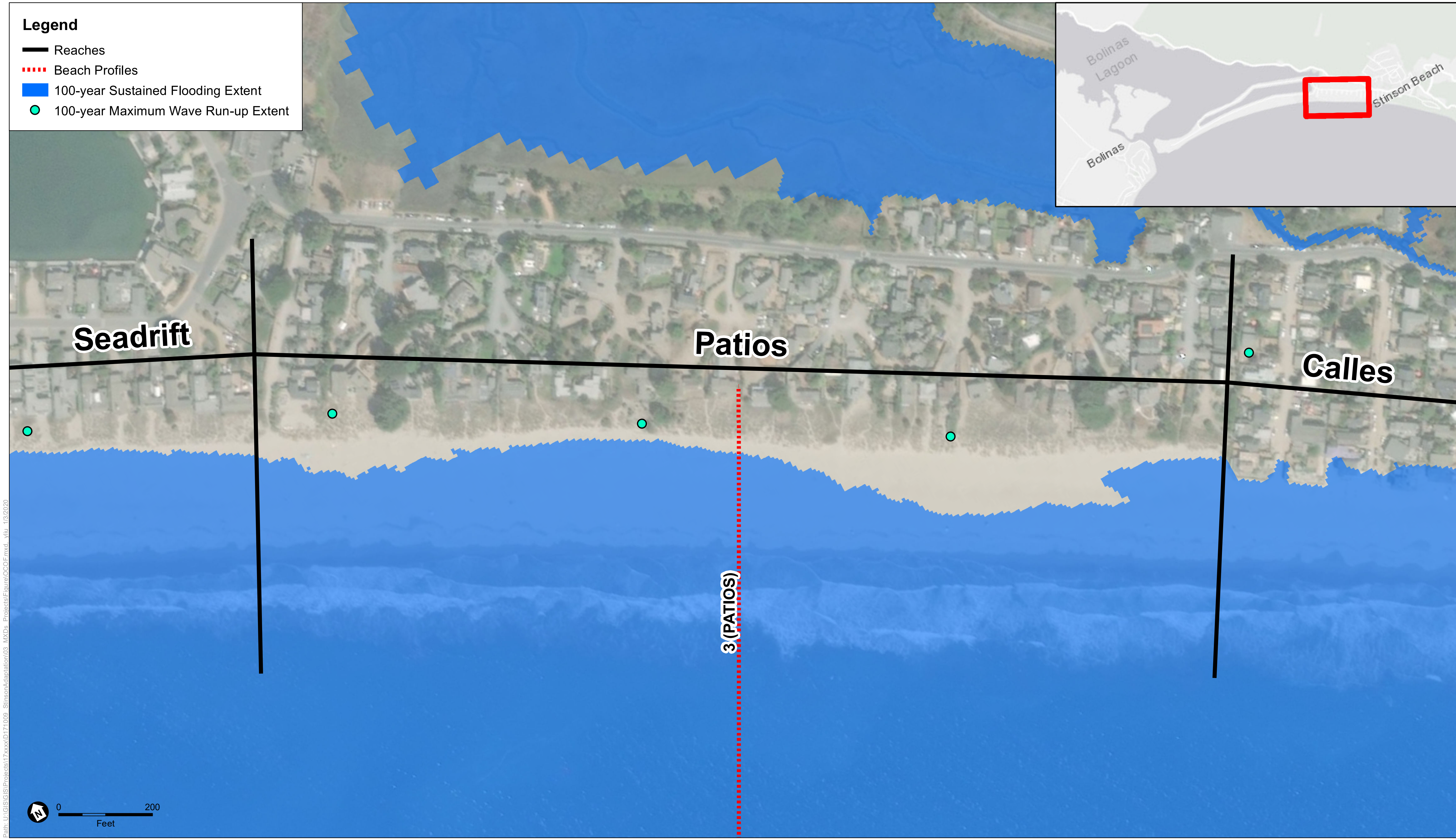

SOURCE: USGS and OCOF.

Note: Flood extents correspond to existing sea level.

ESA

Stinson Beach Nature-Based Adaptation Feasibility Study

**Figure G-3**
Our Coast Our Future (OCOF) 100-year Coastal Flood Hazard
Seadrift-East Reach



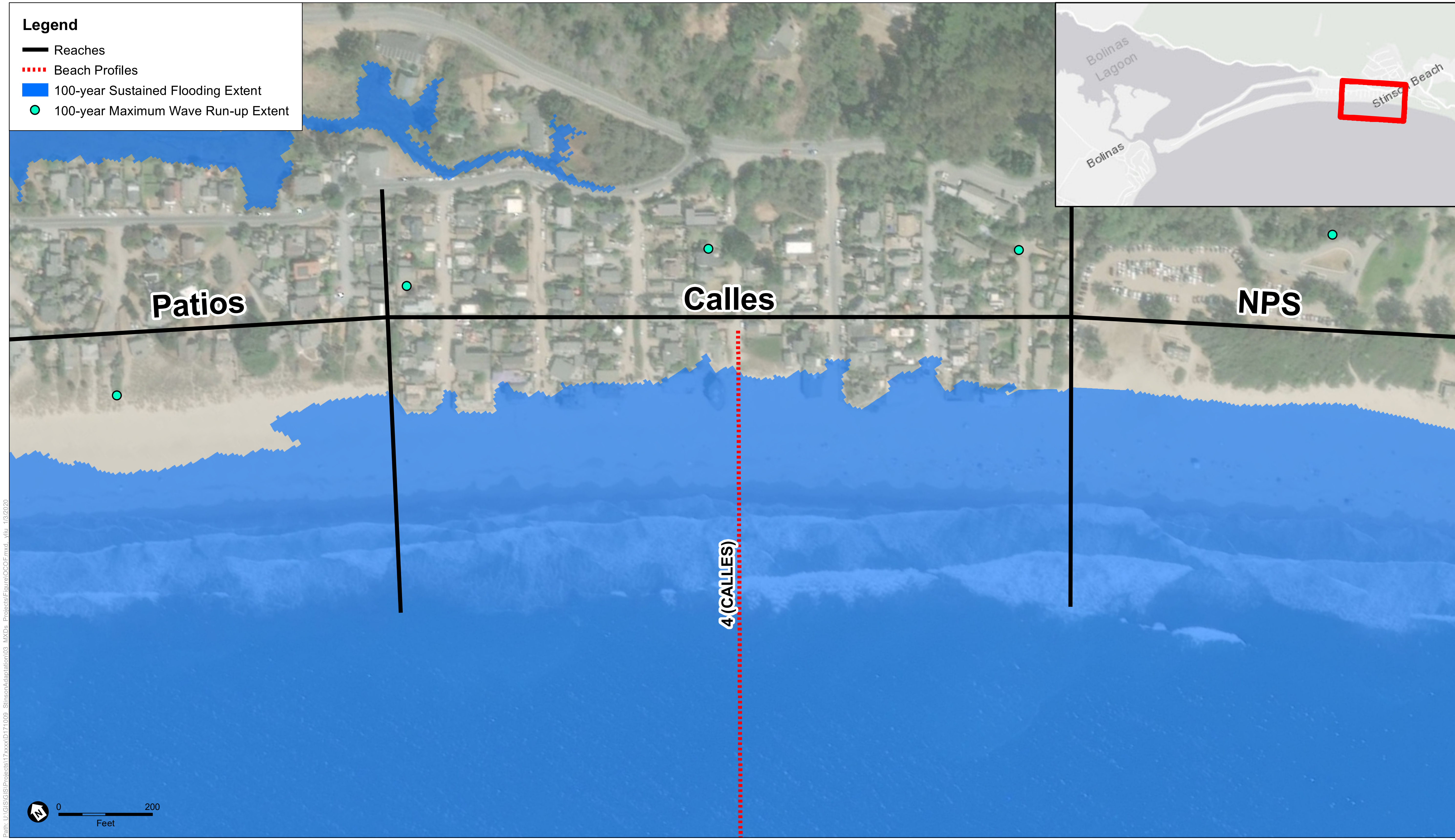

SOURCE: USGS and OCOF.

Note: Flood extents correspond to existing sea level.

ESA

Stinson Beach Nature-Based Adaptation Feasibility Study

**Figure G-4**
Our Coast Our Future (OCOF) 100-year Coastal Flood Hazard
Patios Reach



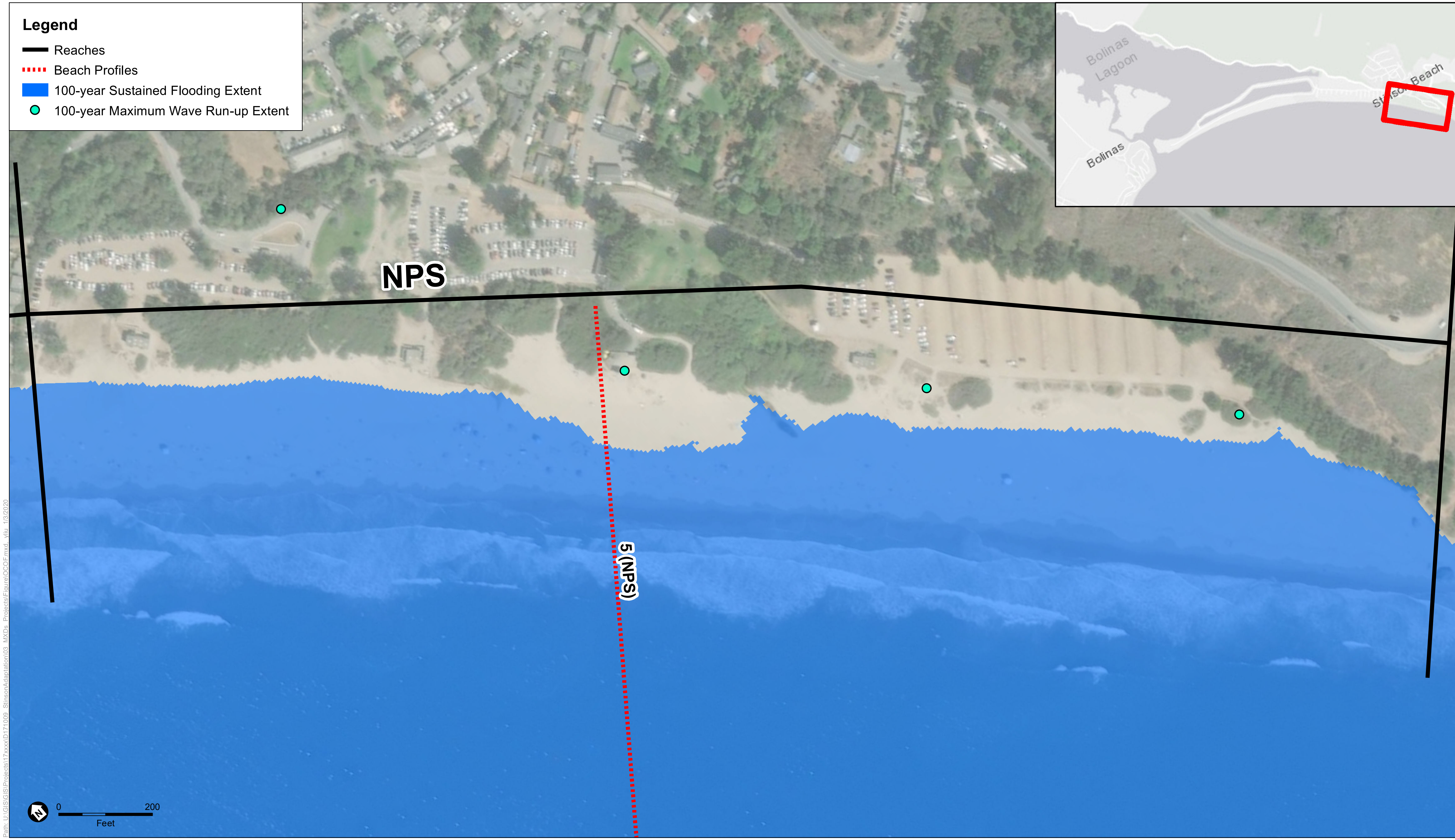

SOURCE: USGS and OCOF.

Note: Flood extents correspond to existing sea level.

ESA

Stinson Beach Nature-Based Adaptation Feasibility Study

**Figure G-5**
Our Coast Our Future (OCOF) 100-year Coastal Flood Hazard
Calles Reach




SOURCE: USGS and OCOF.

Note: Flood extents correspond to existing sea level.



**Figure G-6**
Our Coast Our Future (OCOF) 100-year Coastal Flood Hazard
NPS Reach

ESA

550 Kearny Street
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San Francisco, CA 94108
415.896.5900 phone
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esassoc.com

Stinson Beach Nature-Based Adaptation Feasibility Study Memorandum 1: Existing Conditions

# Appendix H

| | |
|---|---|
| date | May 21, 2020 |
| to | Stinson Beach Nature-Based Adaptation Feasibility Study |
| from | ESA |
| subject | Longshore Sediment Transport Analysis |

## Summary

Longshore sediment transport (LST) potential at Stinson Beach was studied to inform the overall feasibility of nature-based adaptation measures. LST influences shoreline erosion rates and can be used as an indicator of the potential longevity of natural infrastructure on the Pacific shore at Stinson and the potential impacts that natural features may have on adjacent coastal areas. For example, sediment exchange and sedimentation at the Bolinas Lagoon mouth can impact boating access. Thus sand placement to widen the beach at Seadrift could lead to increased sedimentation at the lagoon mouth.

ESA performed a preliminary assessment of Longshore Sediment Transport (LST) rates for Stinson Beach. The analysis includes the use of the nearshore waves estimated for this study described on an ocean wave assessment and accepted methodologies and formulas to estimate the LST potential. The LST potential along the Stinson shoreline was estimated as the average annual (cubic yards per year) determined from 11 years of wave data (2007 to 2017). The calculated rates are referring to as potential as an indication of the transport capacity of the wave (i.e., the transport rate if sediment supply is not a limiting factor).

Results indicate that the potential net LST rate under current conditions is 230k cy/year on average moving northwest and 120k to 350k cy/year on average moving southeast for all the other reaches. Uncertainties in estimating LST include the effects of wave breaking and turbulence, the mechanics of sediment suspension and deposition of beach material, the accuracy of the wave breaking direction, and the limitations of analysis methods to represent the complexity of physical sediment transport processes. The actual rates of longshore sand transport are likely lower, and closer to the rates computed by the van Rijn equations (explained below).

## Beach Parameters

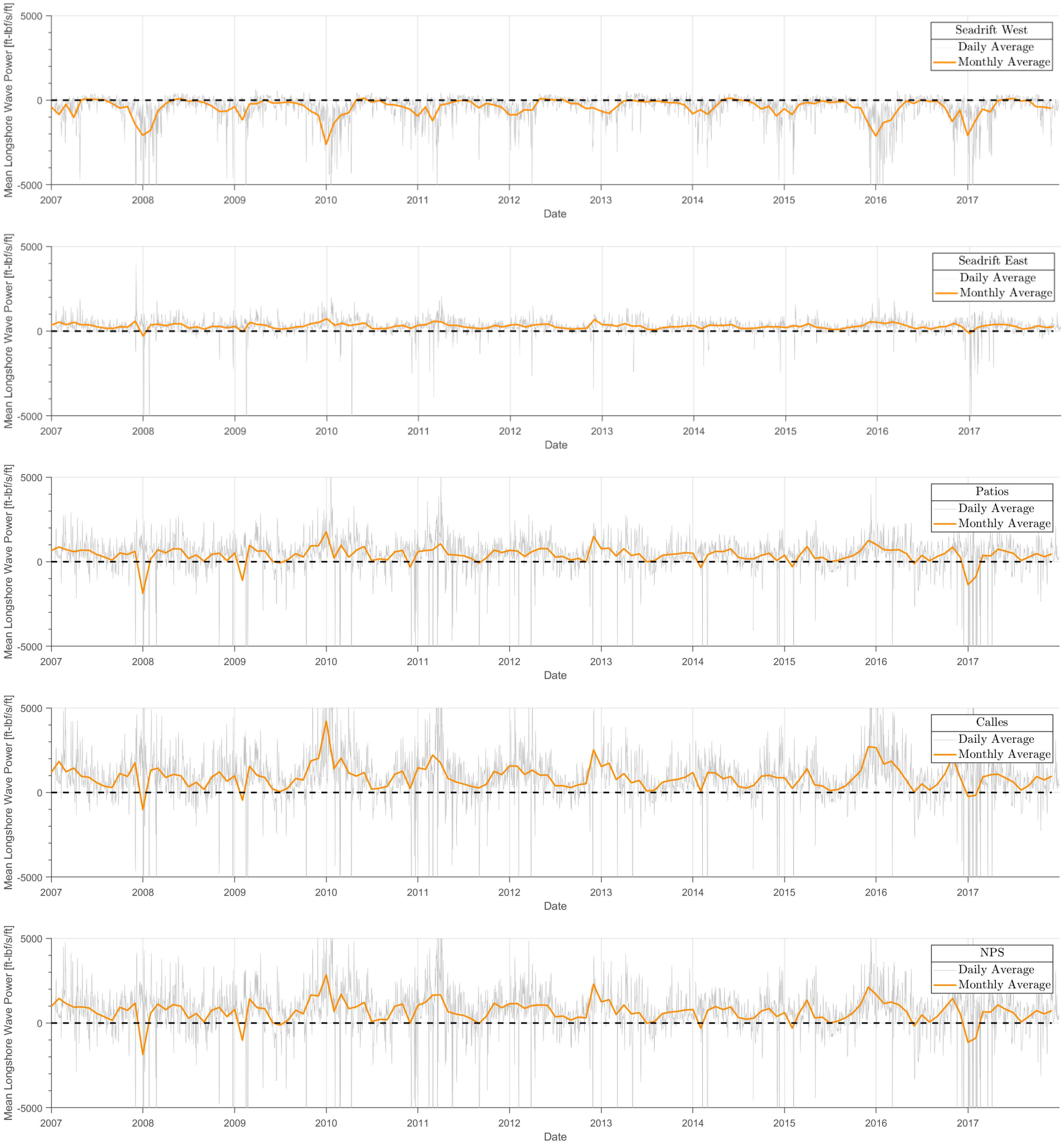
Beach parameters used to estimate LST potential are summarized in Table I-1 for each reach. The shore normal angle for each reach was estimated using the shoreline change analysis tool from USGS (USGS, 2020). The beach slope was measured from the MLLW water elevation to the MHHW water elevation for each beach profile for winter conditions when most LST occurs. The sediment size D50 used is the average D50 for all the samples for each reach.

**TABLE I-1 BEACH PARAMETERS USED IN LST ANALYSIS**

| Reach | Shorenormal (deg) | Slope | D50 (mm) |
|---|---|---|---|
| Seadrift West | 184 | 1:40 | 0.5 |
| Seadrift East | 198 | 1:42 | 0.4 |
| Patios | 211 | 1:41 | 0.3 |
| Calles | 214 | 1:41 | 0.3 |
| NPS | 221 | 1:40 | 0.4 |

## Wave Power

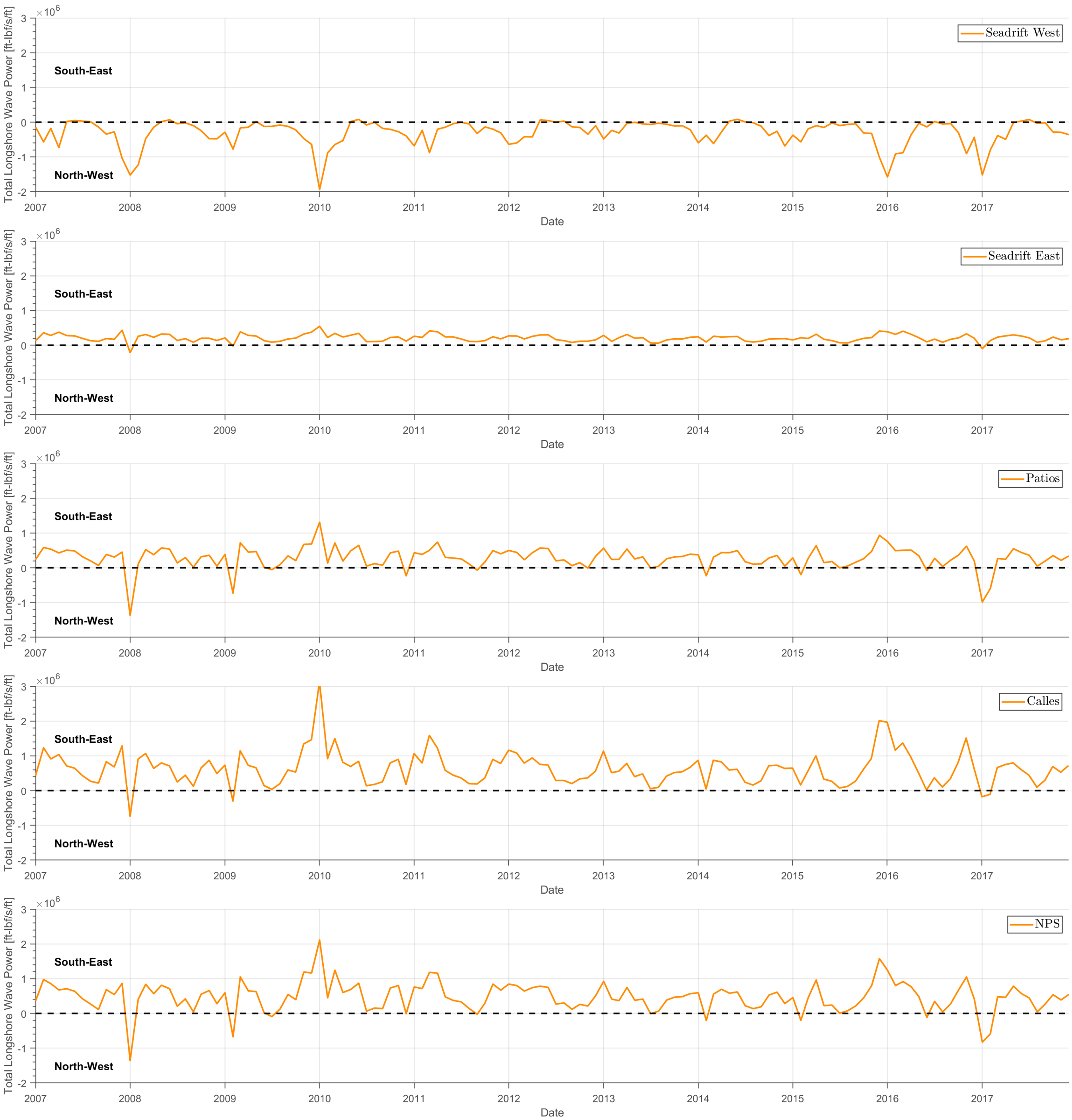
Sediment transport is closely correlated with wave power, **P** (in units of ft-lbf/s/ft of crest length), where **P** is calculated as: $\boldsymbol{P = \frac{\gamma g H^2 T}{32\pi}}$ and $\boldsymbol{\gamma}$ is the unit weight of sea water (64.1 lbf/ft3), **g** is the acceleration of gravity (32.2 ft/s2), **H** is the root-mean-square (rms) wave height (ft), and **T** is wave period (s). The directionality of the wave power known as the Longshore Component of Wave Power, $\mathbf{P_L}$ (ft-lbf/s/ft), where $\mathbf{P_L}$ is calculated as $\boldsymbol{P_L = P sin\alpha cos\alpha}$ and $\boldsymbol{\alpha}$ is the wave angle relative to the shore normal angle. The longshore component of wave power gives us an estimate of the directionality and wave energy variability on the nearshore. Figure I-1 shows the mean longshore wave power as a daily and monthly average for the whole nearshore wave record for each of the Stinson Beach Reaches, and Figure I-2 shows the total longshore wave power per month. The Seadrift West reach shows that the daily and monthly longshore wave power is always negative (northwest direction) as well as the total longshore wave power. The record shows seasonal changes from relative calm in the summer to increase in wave energy on the winter and fall and recorded strong events in 2008, 2010, 2016, and 2017. The Seadrift East shows a change of direction to the southeast (positive) for the monthly average and the total longshore power, however, the daily average shows direction changes (sometimes called “reversals”) and has a weaker net transport direction. Patios, Calles and NPS reaches show a higher variability on the daily average direction but with a stronger signal to the southeast direction. With the Calles reach showing the higher exposure to longshore wave power to the southeast. These three reaches change direction during winter events in 2008, 2009, and 2017.




SOURCE: NOAA 2020, CDIP 2020, NDBC, 2020

Stinson Beach Adaptation / D171009.00

**Figure I-1**
Mean Longshore Wave Power




Stinson Beach Adaptation / D171009.00

SOURCE: NOAA 2020, CDIP 2020, NDBC, 2020

**Figure I-2**
Total Longshore Wave Power

# Potential Longshore Sediment Transport Estimates

The potential LST was estimated using the 11-years (2007-2017) of nearshore waves for each reach described on Appendix H. By simulating sediment transport over a long period, overall trends in potential sediment transport rate and direction can be deduced.

The LST is a function of wave height, wave period, wave direction relative to the shoreline, beach slope, and particle size. Wave linear theory, Snell's law (assuming parallel depth contours) and Goda, 2010 equations were used to estimate the wave height and wave angle at breaking The recorded water levels from the tide station at Point Reyes (NOAA, ID 9415020), the shore normal angle of the beach reaches at Stinson beach and the sediment size characteristics at each reach were used to estimate the LST at each reach. Due to the complexity and difficulty of estimating LST, ESA applied a range of standard empirical methods (USACE 1984, 2002, Kamphius 1991, Mil-Homens et al 2013 and van Rijn 2014). The methods used are summarized in table I-2.

**TABLE I-2**
**LST METHODS**

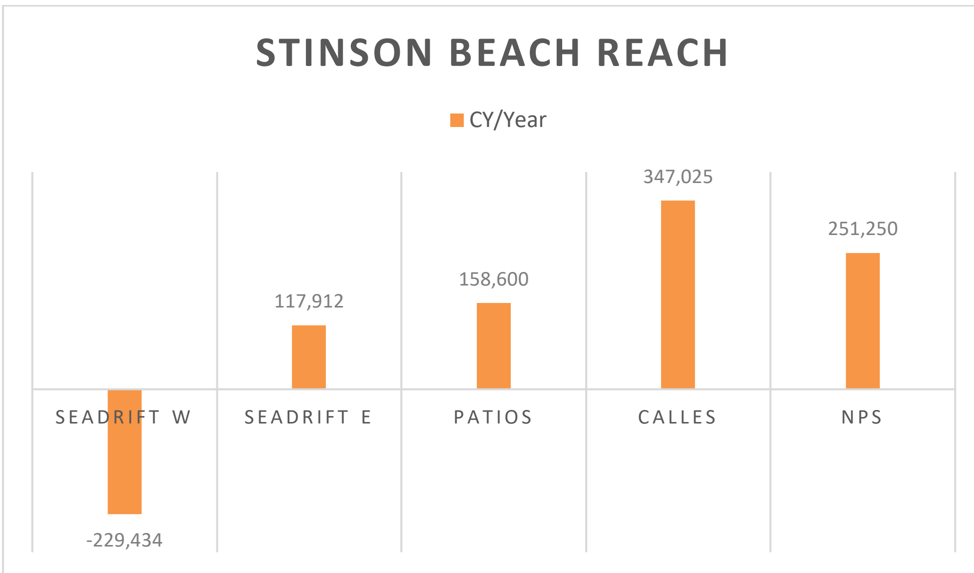
| Method | Short Description |
|---|---|
| CERC | CERC equation (USACE 1984, 2002) has been calibrated using field data from sand beaches. The formula does not take into account for particle size and beach slope. |
| Kamp | Kamphuis equation (Kamphuis, 1991) introduced the effect of particle size and slope on LST. |
| Kamp2 | Modified Kamphuis equation (Mil-Homens et al 2013) is a reevaluation of the Kamphuis formula based on a larger data set and re-calibrated to better account for a large range of sediment size and beach slope. |
| Van Rijn | Van Rijn equation (van Rijn, 2014) establish new coefficients for wave, grain size, and beach slope and takes into account the sea and swell effects. |

LST estimates for each reach and for each method are summarize on Table I-3. Using a sign convention with positive values indicate sediment transport to the southeast and negative values indicate transport in the northwest direction.

**TABLE I-3 LONGSHORE SEDIMENT TRANSPORT ESTIMATES BY REACH (CY/YEAR)**

| Reach | CERC | Kamp | Kamp2 | Van Rijin | Average |
|---|---|---|---|---|---|
| Seadrift West | -227,300 | -325,343 | -237,093 | -128,000 | -229,434 |
| Seadrift East | 115,135 | 178,094 | 131,081 | 47,339 | 117,912 |
| Patios | 133,400 | 248,600 | 209,600 | 42,800 | 158,600 |
| Calles | 360,200 | 457,800 | 376,600 | 193,500 | 347,025 |
| NPS | 259,500 | 352,600 | 282,900 | 110,000 | 251,250 |

Results show the direction of sediment transport on the Seadrift West reach is to the northwest with values ranging from -128,000 cy/year to -325,000 cy/year and with an average of -229,000 cy/year. The reaches to the east of Seadrift west all show sediment transport moving to the southeast, with smaller values at Seadrift East and Seadrift West and increasing transport on Calles and NPS reaches. Figure I-3 shows the average LST estimate from all the methods used for each reach. The figure shows an increase of sediment transport from Seadrift East to Calles reach and reducing transport at the end of Stinson Beach on the NPS reach.




SOURCE: NOAA 2020, CDIP 2020, NDBC, 2020

Stinson Beach Adaptation / D171009.00

**Figure I-3**
Average LST Estimate at Stinson Beach

## Sensitivity of LST Estimates

The wave and hydrodynamic modeling results described herein are considered reliable and utilize industry-standard methods and models. Estimating longshore sediment transport modeling is inherently uncertain; therefore, different methods were applied to better understand trends, directions and range of LST estimates.

Uncertainties in estimating LST includes;

- Uncertainty on predicting and properly estimating wave breaking and turbulence
- Poorly understood mechanics processes of suspension and deposition of beach material
- Accuracy of the wave breaking direction, a small change of a few degrees on the wave breaking direction has a large effect on the estimate of the total longshore transport over a long period of time.

- Limitations on the methods used to truly represent the complexity of physical sediment transport process.

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# Appendix I - Shorebirds
# Prepared for ESA by Point Blue Conservation Science

## Ecology of Pacific Coast Sandy Beach Shorebirds

Pacific Coast sandy beaches provide important habitat for shorebirds for migration and wintering and also provide breeding habitat for a few species. Sandy beaches are physically shaped by the prevailing wave climate, resulting in differences in beach slope and width, significant breaker height, sand grain size and other physical characteristics. Taken together, these characteristics comprise the morphodynamic state of a beach (Defeo et al 2009). The morphodynamic state of a beach strongly influences the macroinvertebrate community; flatter beaches with wider surf zones and smaller sand grain size support a greater abundance and diversity of macroinvertebrates whereas steeper beaches with narrow surf zones and larger sand grain size have lower macroinvertebrate abundance and diversity (Mclachlan and Dorvlo 2005, Defeo et al. 2009).

In addition to physical characteristics, Pacific Coast sandy beach food webs also are influenced by trophic subsidies from beach-cast macroalgal wrack (Pacific giant kelp *Macrocystis pyrifera*, bull kelp *Nereocystis luetkeana,* and others) which influence the abundance of beach invertebrates (e.g., *Talitrid* amphipods, *Coeleptera* beetles, *Diptera* flies; Dugan et al. 2003). Consequently, because shorebirds are predators of sandy beach invertebrates, beaches with physical and/or biological characteristics that support greater prey abundance and diversity also support greater abundance and diversity of shorebirds (Dugan et al. 2003, Neuman et al. 2008, Nielsen et al. 2013, Lafferty et al. 2013, Nielsen et al. 2017). On sandy beaches, the two most abundant shorebird groups have different foraging strategies. Members of the sandpiper family (*Scolopacidae*) are tactile foragers that probe within the sandy substrate for their primary prey, mole crabs (*Emerita analoga*) and *Excirolana* isopods (Connors et al. 1981, Brown 1996). Members of the plover family (*Charadriidae*) use visual cues to identify and seize their primary prey, surface dwelling invertebrates such as amphipods, flies, beetles and polychaetes (Page et al. 2009, Dugan et al. 2003).

## Shorebird Occurrence and Beach Ecology in the Stinson Beach Region

The best available information on the ecological relationships between shorebird occurrence and sandy beach characteristics in the Stinson Beach region comes from the North-Central Marine Protected Area baseline characterization, conducted in 2010 and 2011 (Nielsen et al. 2013). In this study, the physical environment at 17 beaches in the region (San Mateo through Sonoma Counties) was characterized. In addition, more detailed studies of the occurrence of beach-cast wrack and shorebirds were conducted at 10 of the 17 beaches. Because Stinson Beach was not included in the more detailed assessment, the information presented here comes from the closest adjacent beaches in the region that were included, Limantour Beach and Drakes Beach, or from the MPA baseline region at large (henceforth "the region"). However, it should be noted that, unlike Limantour and Drakes Beaches, most of the Stinson Beach backshore is developed and the beach is heavily used by humans, reducing the quality of the sandy beach habitat at Stinson for shorebirds. Another important factor affecting patterns of shorebird occurrence at Stinson is the very close proximity of Bolinas Lagoon, a 445 hectare seasonal estuary, which supports a large diversity and abundance of migratory and wintering shorebirds (Stenzel and Page 2018).

### Shorebird Abundance and Species Richness

Shorebird abundance on sandy beaches in the region peaks in spring and fall, coinciding with migration periods (Nielsen et al. 2013). The most abundant species on sandy beaches in the region are Sanderling, Marbled Godwit and Willet (see Table 1 for species names and mean monthly abundance $km^{-1}$). Sanderling alone account for more than 50% of all shorebird numbers and this numerical dominance by Sanderling is consistent with other studies of sandy beaches in California (Hubbard and Dugan 2003, Neuman et al. 2005, Neuman et al. 2008, Nielsen et al. 2017). The highest maximum and mean densities of shorebirds $km^{-1}$ in the region occurred at nearby Drakes and Limantour beaches (maxima of 125-153 shorebirds $km^{-1}$, mean of 25-39 $km^{-1}$, respectively; Nielsen et al. 2013).

Table 1. The ten most abundant sandy beach shorebird species[1] in the North-Central MPA baseline study region (adapted from Nielsen et al. 2013)

| Common name | Latin name | Mean monthly abundance $km^{-1}$ |
|---|---|---|
| Sanderling | *Calidris alba* | 11.4 |
| Marbled Godwit | *Limosa fedoa* | 3.2 |
| Willet | *Catoptrophorous semipalmatus* | 1.6 |
| Western Snowy Plover | *Charadrius nivosus nivosus* | 1.0 |
| Killdeer | *Charadrius vociferus* | 0.8 |
| Whimbrel | *Numenius phaeopus* | 0.6 |
| Black Oystercatcher | *Haematopus bachmani* | 0.5 |
| Black Turnstone | *Arenaria melanocephala* | 0.3 |
| Semipalmated Plover | *Charadrius semipalmatus* | 0.2 |
| Black-bellied Plover | *Pluvialis squatarola* | 0.2 |
| All Shorebird Species | | 20.1 |

[1] The other species observed included Ruddy Turnstone (*Arenaria interpres*), Western Sandpiper (*Calidris mauri*), Spotted Sandpiper (*Actitis macularia*), and Surfbird (*Aphriza virgata*)

In the region, Nielsen et al. (2013) recorded 14 species of shorebirds (Table 1) and overall species richness was linked to habitat heterogeneity, specifically presence of rocky outcrops) and proximity to wetlands. Two of the most abundant and widespread species on Pacific Coast sandy beaches, Sanderling and Whimbrel, typically occur in much lower numbers in intertidal wetlands (Page et al. 1999, Colwell and Sundeen 2000, Hubbard and Dugan 2003, Neuman et al. 2005, Neuman et al. 2008, Lafferty et al. 2013). However, Sanderling and Whimbrel are locally abundant in the intertidal wetlands of nearby Bolinas Lagoon (Stenzel and Page 2018, Point Blue unpubl. data). A small number of surveys conducted on Stinson Beach over the past decade for the Pacific Flyway Shorebird Survey indicate that Sanderling and Whimbrel are less common there than would be expected based on regional MPA data and patterns at other California beaches (Point Blue unpubl. data), probably due to high levels of human-caused disturbance. Surprisingly, the Long-billed Curlew (*Numenius americanus*) was absent from the shorebird species occurring in the region during the MPA baseline characterization (Nielsen et al. 2013) and it should be noted that this species occurs at Stinson Beach (Point Blue unpubl. data).

### Ecological Relationships with Beach Characteristics

The physical characteristics of Stinson Beach, and Limantour and Drakes beaches measured by Nielsen et al (2013) are similar; all three sites are morphodynamically intermediate, with a significant breaker height of ~1m, relatively small sand grain size (<260 microns), a slope of ~5%, and a wide overall size (>80m). At Limantour and Drakes beaches, eelgrass (*Zostera*) is the dominant type of beach-cast wrack in terms of percent cover but *Macrocystis*, *Nereocystis*, and *Postelsia* are more numerically abundant and these species are favored over eelgrass by *Talitrid* amphipods (Nielsen et al. 2013).

In the region at large, shorebird abundance is correlated with abundance and species richness of macroinvertebrates and macroinvertebrate biomass and diversity is highest at Limantour and Drakes beaches (Nielsen et al. 2013). Thus it is not surprising that the highest numbers of shorebirds $km^{-1}$ in the region also occurs at these beaches. Based on the similarity between the physical characteristics of Stinson Beach and Limantour and Drakes beaches, the patterns of shorebird occurrence at these nearby beaches can be used as a general baseline estimate for Stinson Beach. However, the reduced habitat quality at Stinson resulting from development and high levels of human use must also be taken into account.

### Shorebird Nesting

Shorebird species that nest on sandy beaches in the region and are likely to nest along Stinson Beach or at the lagoon side of the north spit of Stinson Beach are the federally threatened Western Snowy Plover and the Killdeer. Both species are sparsely distributed on beaches in the region and they are less abundant than other sandy beach shorebird species (Nielsen et al. 2013). There is a small nesting population of Snowy Plovers (<60) at nearby Point Reyes National Seashore, where nesting occurs primarily on the north and south sections of the Great Beach (Press et al. 2019). Plovers have nested at Limantour Beach since at least the 1970s (Point Blue unpubl. data) and have nested in some but not all of the past five years (Lau and Press 2019). At Stinson Beach, Snowy Plovers have nested at the northern tip of the spit in two of the past three years (one nest in 2017, two nests in 2018) and along the Seadrift section in 2013 (Point Blue unpubl. data). Historically, Snowy Plovers have occasionally nested on the sandy southern shore of Kent Island within Bolinas Lagoon (Point Blue unpubl. data).

## Local, Regional and Pacific Coast Context

In addition to the physical and biological factors mentioned above, many other factors influence shorebird abundance and distribution on Pacific Coast sandy beaches, including tidal state and landscape features. For example, proximity to wetlands has been shown to influence shorebird abundance and species richness on other Pacific Coast beaches (Colwell and Sundeen 2000, Neuman et al. 2008, Lafferty et al. 2013). Stinson Beach is adjacent to Bolinas Lagoon and this proximity likely influences both species diversity and overall abundance of shorebirds using the beach. Tidal state strongly influences patterns of shorebird behavior and habitat use in estuarine and wetland systems, with most shorebirds foraging on mudflats at low tides when prey availability peaks. On sandy beaches the influence of tide on patterns of occurrence, behavior, and habitat use is less well-studied and the findings are inconsistent among studies. At least one study reports higher abundance at low tide (Neuman et al. 2008) while several others report mixed effects (interactions or correlations with other variables) or no influence of tide (Colwell and Sundeen 2000, Hubbard and Dugan 2003, Neuman et al. 2005, Lafferty et al. 2013). The few studies that have examined behavior of shorebirds on sandy beaches have found that most shorebirds present at low tide are foraging (Brown 1996, Thomas et al. 2003, Neuman et al. 2005).

Human intervention has negatively impacted the physical landforms and the quality of sandy beach ecosystems (Schlacher et al. 2014). Landform changes have been caused by resource extraction (i.e., sand mining), manipulation of sediment supplies (e.g., damming of rivers, dredging), development of human infrastructure such as roads and housing, and shoreline hardening that prevents natural processes from occurring and reduces biodiversity of sandy beach fauna (Schlacher et al. 2007, Dugan et al. 2017). Habitat quality of sandy beach ecosystems has been further reduced by high-intensity recreation, such as off-highway vehicle use, encroachment of non-native vegetation and direct impacts from human-caused recreational disturbance. Although human-caused disturbance has not been shown to affect large-scale spatial patterns of shorebird distribution on sandy beaches (Neuman et al. 2008, Lafferty et al. 2013), the direct impacts of human disturbance cause a number of significant negative effects to shorebirds, including reduced foraging rates (Thomas et al. 2003), lower productivity (Ruhlen et al. 2003) and lower survival (Gibson et al. 2018). These effects, in particular reduced annual survival, have potential to cause population-level consequences for shorebirds. In addition to direct effects, there is evidence that human-caused disturbance can limit local site use by shorebirds on heavily impacted sandy beaches (Neuman et al. 2005, Nielsen et al. 2013) and that human trampling of beaches causes reductions in the critical prey resources that shorebirds are dependent upon (Schlacher et al. 2016). Stinson Beach has high levels of recreational use resulting in a high level of foot traffic and the physical landform has been altered to include areas of hardened and developed shoreline. These human-caused alterations of the landscape have likely reduced the quality of the sandy beach habitat for shorebirds.

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