

**TOWN OF HIGHLAND BEACH
BEACH RESTORATION FEASIBILITY STUDY
2023**

**Submitted to:
The Town of Highland Beach**

Prepared By:

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EXECUTIVE SUMMARY

The Town of Highland Beach requested that Aptim Environmental & Infrastructure, LLC (APTIM) develop a feasibility report that evaluates options for protecting and restoring the beach within the Town as a follow-up to the feasibility report completed in 2013. The Town has since participated in a joint climate change resiliency study, and the beach and dune system has been subject to episodic erosional stresses caused by waves, tides, and storm surges. The beach is one of the Town's most valuable assets and the Town requested that APTIM evaluate and update options that would protect the beach's natural resources, coastal property, and public health and safety.

APTIM evaluated the Town's 2.84-mile beach. The survey of the shoreline was conducted in August and September 2023 and shoreline data from 1975 to 2008 was reviewed. In summary, the beach in the southern portion of the Town is narrow and the berm is low. The shoreline in the southern section appears to be controlled by three rock outcrops, of which Yamato Rock at the southern extremity is the most prominent. The average shoreline retreat rate at the southern end of Town is -1.8 feet/year though the average shoreline change for the entire section of beach is an advance of 1.2 feet/year. The beach in the northern 1.85 miles of the Town has benefitted from repeated beach nourishments in Delray Beach. The beach in this area is wider, higher and has an established, vegetated dune system.

While the historic shoreline changes are a basis for optimism, the dune toes are eroded, and the berm is low in elevation. This suggests that the beach and dune system is vulnerable to storm surges.

APTIM evaluated several alternatives including a no action alternative, upland sand placement via truck haul, a larger scale beach nourishment project, and installation of coastal structures. It is recommended that a larger scale beach nourishment project be pursued long term. It is further recommended that the dune toes and the dry beaches be nourished to restore the storm protective capacity of the beach and dune system in the near term.

A large-scale beach nourishment project encompasses dredging sand from offshore and placing it along the southern 2 miles of the Town's beach. The cost of construction is estimated at \$14M, assuming a project is constructed in 2024.

Recommendations were reviewed in conjunction with the 2021 Coastal Resilience Partnership Multi-Jurisdictional Climate Change Vulnerability Assessment report.

Limited public beach access will limit availability of County, State or Federal funding. It is recommended that other options be considered to fund a beach nourishment program, such as an Ad Valorem Tax, Erosion Prevention District, or Municipal Service Benefit Unit.

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**TOWN OF HIGHLAND BEACH
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1. INTRODUCTION

The Town of Highland Beach requested that Aptim Environmental & Infrastructure, LLC (APTIM) update the 2013 feasibility report that evaluates options for protecting and restoring the Town's beach. The beach is one of the Town's most valuable assets and the Town requested that APTIM evaluate options that in general would:

1. Maximize protection of the beach's natural resources, coastal property and development, and public health and safety;
2. Maximize the quality of the beach for both human activities and environmental needs;
3. Minimize economic losses that may result from a beach erosion event by being prepared;
4. To efficiently, economically, and responsibly respond to and restore the beach as soon as possible after sustaining any significant beach loss;
5. Minimize the potential negative impacts (visual, audio, environmental, and beach sand loss) of the proposed sand, and;
6. Maximize the potential benefits of any future renourishment activities.

This report is derived from the following engineering and surveying activities:

1. A current beach and dune profile survey.
2. An engineering inspection of the beach and dune conditions both on a regional and individual property basis.
3. An updated comparison of the beach surveys to identify trends in the beach and dune changes.
4. An evaluation of the coastal forcing (winds, waves, storm surge, sea level rise) that affect Highland Beach's coastal zone.
5. An evaluation of engineering alternatives that could be considered by the Town or individual owners.
6. A presentation of funding alternatives for this predominantly private beach.
7. Incorporation of the recommendations from the regional climate change report, as appropriate, to protecting the beach and dune system.

This report will first present the coastal setting within the Town of Highland Beach, discussing the tides, storm events, history of shoreline and volumetric changes, and offshore resources. This will be followed by a general discussion of the current condition of the Town's beach. The next section, Problem Identification and Alternatives, will evaluate various alternatives available to address the beach condition. This discussion will be followed by an outline of the potential funding mechanisms. The last section will contain APTIM's recommendations.

2. COASTAL SETTING

2.1 Beach, Dune, and Surf Zone Terminology

The management of beaches has resulted in a unique set of geographic and geomorphic descriptions of specific features at “the beach”. To assist the reader with understanding of various sections of the report, the following select definitions are provided (Figures 1 and 2). These definitions include a list by Komar, (1976) with additions as necessary.

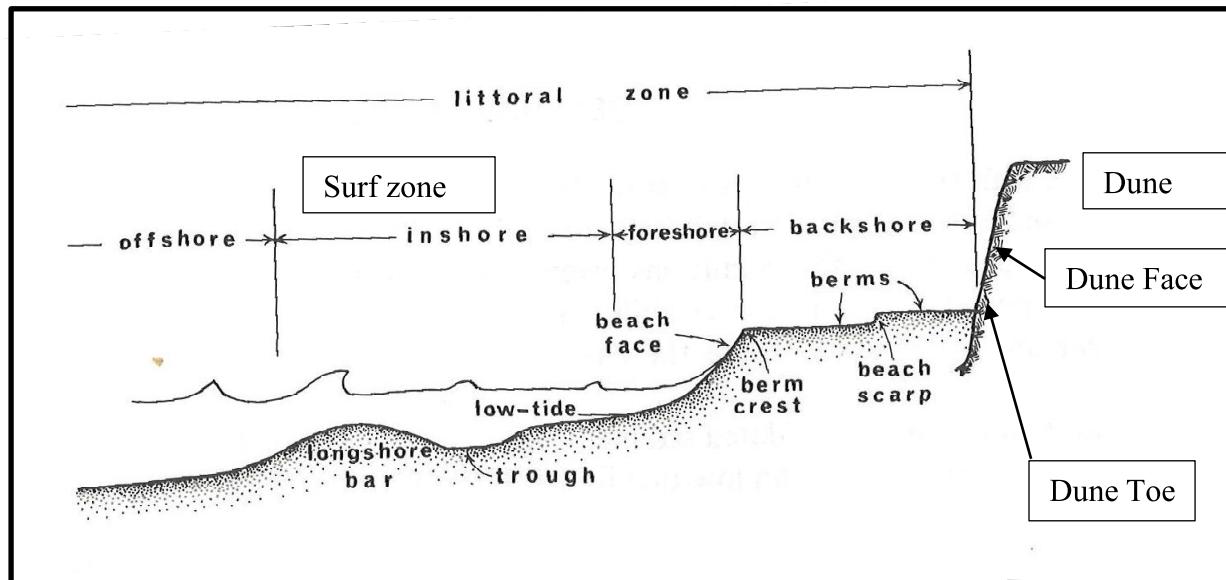


Figure 1. Definition sketch of the nearshore zone, beach, and dune components.

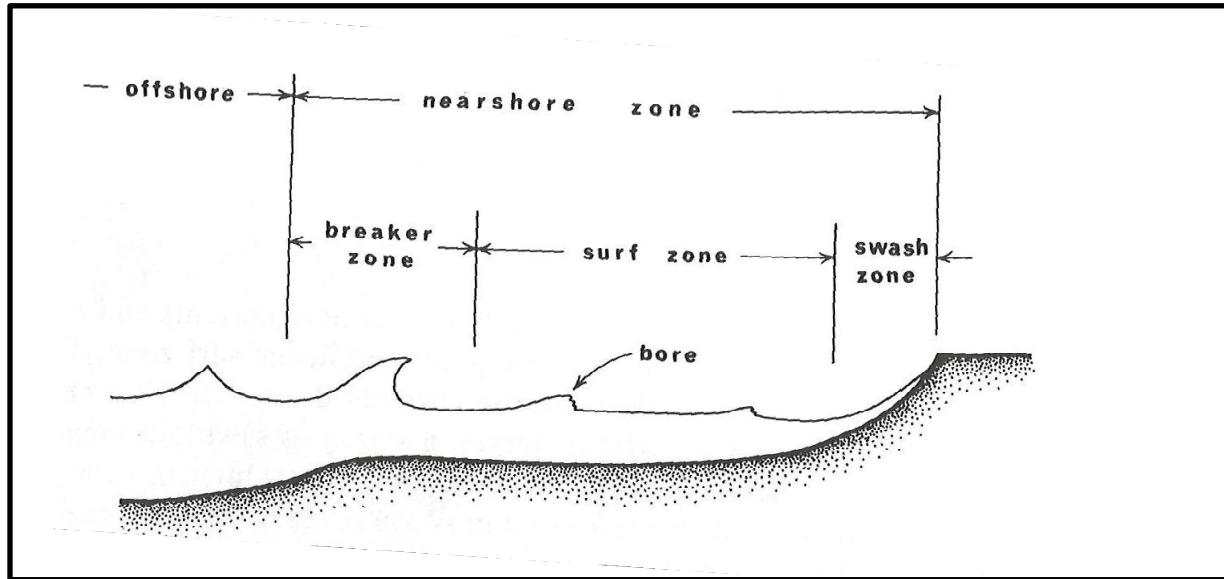


Figure 2. Definition sketch of the nearshore zone focusing on wave and hydrodynamic processes.

Backshore: The zone of the beach profile extending landward from the sloping foreshore to the point of development of vegetation or change in physiography (sea cliff, dune field, and so on).

Beach face: The sloping section of the beach profile below the berm which is normally exposed to the action of the wave swash.

Beach scarp: An almost vertical escarpment notched into the beach profile by wave erosion. Its height is commonly less than a meter, although higher examples are found.

Berm (beach berm): A nearly horizontal portion of the beach or backshore formed by the deposition of sediment by the receding waves. Some beaches have more than one berm, while others have none.

Berm crest (berm edge): The seaward limit of a berm. May be a distinct break in the slope of the beach profile. Sometimes, a location of gradual transition in beach slope.

Breaker zone: The portion of the nearshore region in which the waves arriving from offshore reach instability and break. With very simple uniform waves, such as may be generated in a laboratory wave tank, the zone may be reduced to a breaker line. On a wide, flat beach, secondary breaker zones may occur in which reformed waves break for a second time. May also be referred to as the surf zone.

Depth of closure: A water depth where the net cross shore sediment transport by waves is zero when measured on an annual basis.

Dune: An unconsolidated mound of sand at the landward portion of the beach, that is often deposited by winds. The dune may or may not be vegetated.

Dune toe: The portion of the dune that is usually within 1 to 3 feet (vertically) of the unvegetated beach berm. The dune toe may mimic the slope of the dune or be near vertical as a result of recent erosion.

Dune face: The seaward portion of the dune.

Dune crest: The portion of the dune which is at its highest elevation and is usually horizontally flat. The width of a dune crest can vary significantly.

Fetch: The uninterrupted distance that winds blow across a body of water.

Foreshore: The sloping portion of the beach profile lying between a berm crest (or in the absence of a berm crest, the upper limit of wave swash at high tide) and the low-water mark of the backwash of the wave swash at low tide. This term is often nearly synonymous with the beach face but is commonly more inclusive, containing also some of the flat portion of the beach profile below the beach face.

Inshore: The zone of the beach profile extending seaward from the foreshore to just beyond the breaker zone, or surf zone.

Intertidal: That portion of the beach located in the vicinity of the shoreline between mean high water and mean low water.

Littoral transport: The volume of sand actively moving in the surf zone. May also be referred to as sediment transport.

Longshore bar: A ridge of sand running roughly parallel to the shoreline. It may become exposed at low tide. At times there may be a series of such ridges parallel to one another but at different water depths.

Longshore trough: An elongated depression extending parallel to the shoreline and any longshore bars that are present. There may be a series at different water depths.

Nearshore hardbottom: A ridge of exposed Anastasia formation (limestone) located within the nearshore zone and may extend onto the dry beach. Sections submerged at all tide levels will usually be encrusted with corals, sponges, algae, etc. and form a basis of a shallow water marine ecosystem. The nearshore hardbottoms frequently contain juvenile fish; thus, the hardbottoms functions as part of a larger ecosystem. May be referred locally as reefs.

Offshore: The comparatively flat portion of the beach profile extending seaward from beyond the breaker zone (the inshore) to the edge of the continental shelf. This term is also used to refer to the water and waves seaward of the nearshore zone.

Pioneer zone: That portion of the vegetated dune that is closest to the shoreline. This area is subject to the largest amount of salt spray, and wave impacts. Plants within the pioneer zone are the most salt tolerant and/or hardy. In Palm Beach County, pioneer dune species include, but are not limited to, sea oats, marsh hay cordgrass, and railroad vine, or similar species.

Scarp: A near vertical elevation change within the beach berm or dune that results from wave action, with or with elevated tides.

Shore: The strip of ground bordering any body of water, whether the ground is rock or loose sediment. If it is unconsolidated sediment, then *shore* becomes synonymous with *beach* used in its restricted sense.

Shoreline: The line of demarcation between the water and the exposed beach.

Subtidal: That portion of the beach (profile) that is always submerged, or below mean low water.

Surf zone: The portion of the nearshore region in which the waves arriving from offshore reach instability and break.

Swash zone: The section of the beach where broken waves advance and recede principally as a sheet of water.

Wrack (line): A localized area on the beach where floating vegetative and other debris accumulates. In Palm Beach County, the wrack primarily consists of decaying Sargassum weed, a naturally occurring vegetation in the ocean. The wrack is usually aggregated in a semi-continuous line and is located near the maximum wave uprush during a period of time. Wrack can provide a food source for wading birds.

2.2 Winds

Winds indirectly cause the littoral transport of sand by generating waves. Northeast wind events typically produce the largest waves due to a long, uninterrupted fetch and the duration of the winds. Winds from the east and southeast typically do not create large waves in the project area because of the limited fetch between southeast Florida and the Bahamas, and the limited duration of weather patterns from these directions.

Winds associated with tropical storms may also affect the shoreline. Due to the cyclonic nature of the winds associated with tropical storms and hurricanes, the winds can come from any direction. If the winds are in an onshore direction, a storm surge will be created and in conjunction with the higher waves will cause accelerated erosion of the beach. Figure 3 demonstrates the annual wind data at the Lake Worth Pier collected between May 2022 to April 2023.

The wind data presented in Figure 3 indicates that the predominant directions of winds is from the southeast with a range from due south to slightly north of due east. Winds can come from all

directions. The majority of the winds are less than 20 mph from all directions. Of interest to the beach is the data that suggests that the greatest frequency of winds that are greater than 20 mph are occurring from the northeast quadrant. These winds will generate seas and swells from the northeast across the unlimited Atlantic fetch and will dominate the wave driven sediment transport in a southerly direction. While there are strong winds from the southern direction, these occur over a shorter wave fetch and do not create substantive northerly directed waves.

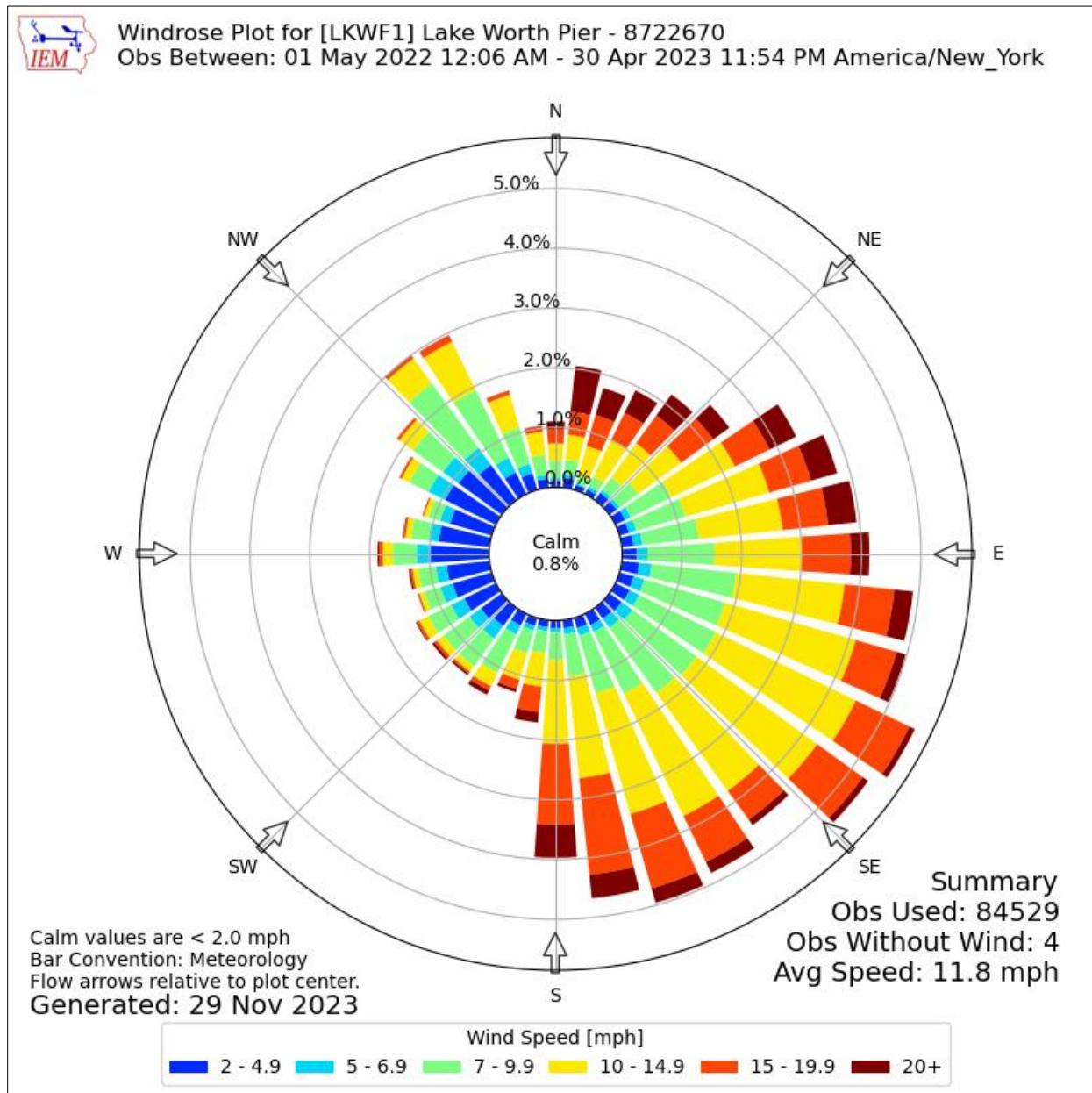


Figure 3. Windrose data collected at Lake Worth Pier (Source: Iowa State University).

2.3 Waves

One of the principal causes of beach erosion is waves breaking on the beach and washing sand into the ocean. This wave induced sediment movement can be in the longshore direction, and the onshore-offshore direction. Due to the general north-south orientation of the Town's shoreline, waves from the east cause little longshore movement of sand. In contrast, waves from the north and northeast cause a net movement of sand to the south, while waves from the south and southeast cause a net movement of sand to the north.

One important factor that contributes to the wave climate observed within the Town of Highland Beach project area is the presence of the Bahama Banks. This geological formation limits the fetch (the length of open water) for eastern, southeastern and some northeastern waves. Since the largest waves affecting the project area (on average) are from the northeast, the annual net movement of sand in Highland Beach (or Palm Beach County) is to the south.

2.3.1 Extreme Wave Analysis for Highland Beach

To assess the potential for waves during rare events to affect Highland Beach, the following analysis of hindcasted wave data was performed. Hindcasted wave data was obtained from the USACE's Wave Information Study (WIS) (<https://wisportal.erdc.dren.mil/#>) at station ST63464 which is located at 26.3333°N, 79.9167 °W, where the estimated water depth is 810 feet. The data set spans from 1980 until 2023 (43 years). To determine the return frequencies of extreme waves, a Peak Over Threshold (POT) analysis was conducted on the data to analyze the peak wave height values. A threshold value was chosen as 6 feet.

The return periods and corresponding wave heights and wave periods were then calculated by fitting extreme value distributions to the POT data obtained. The extreme value curves were fitted to the largest 50 events. The results are shown in Table 1. The data shows that offshore of Highland Beach there are annual events of 13.5 feet waves at 9.4 second periods and that during rarer events the wave heights and periods are much larger. Thus, there are deepwater conditions that pose a general risk to Highland Beach. Conditions at deepwater do not directly reflect conditions at the beach. All waves go through transformation as they propagate onshore, most importantly depth limited breaking. Waves may break and lose energy several times on their approach to the beach. Therefore, the waves that an observer sees at the beach are smaller than the deepwater conditions.

Table 1. Extreme Wave Analysis Offshore of Highland Beach

Return Period (years)	Wave Height H _{mo} (feet)	Wave Period T _p (seconds)
1	13.5	9.4
2	15.7	10.8
5	19.4	12.0
10	22.8	12.9
20	26.4	13.8
25	27.6	14.1

50	31.6	14.9
100	35.8	15.7
200	40.3	16.6
500	43.0	17.1

2.4 Storms

Surges and waves caused by extratropical and tropical storms (including hurricanes) are major threats to the shoreline of Highland Beach. The hurricane season extends from June 1 through November 30. Palm Beach County has averaged 1.0 land-falling tropical storms per 10 nautical miles of shoreline from 1871 to 1973 (USACE, 1987). In recent years, the number of tropical storms affecting the Atlantic and Caribbean waters have been above the long-term historic averages. Whether this is due to climate change or is cyclical will be determined in decades to come.

Extratropical storms that generate waves out of the northeast also have a significant effect on the Town's shoreline. These storms are characterized by strong winds of long duration (several days) that generate swell waves. Northeaster storms typically cause more beach erosion along the coast of Highland Beach than any other event. One recent example is the northeast storm of December 15-17, 2023, which caused significant wave action, and elevated tides for Palm Beach County (and elsewhere).

2.5 Tides

The closest NOAA tide gauge to the project area is located on the Lake Worth Pier. The tides are semi-diurnal (two high and two low tides per day) with a mean tidal range of 2.9 feet. Tidal datums appear in Table 2.

Table 2. Tidal Datums at the Lake Worth Pier

	Elevation (feet, NAVD)
Mean Higher High Water (MHHW)	0.55
Mean High Water (MHW)	0.37
Mean Sea Level (MSL)	-0.97
Mean Low Water (MLW)	-2.35
Mean Lower Low Water (MLLW)	-2.51

Source: NOAA (2023), <https://tidesandcurrents.noaa.gov/datums.html?id=8722670>

2.5.1 King Tides

While the preceding paragraph discusses the expected tides as predicted by NOAA, the South Florida area is experiencing tides (not associated with storms) that are the result of solar and lunar alignments, seasonal variations of the position and inclination of the sun and moon, velocity changes in the flow of the Gulfstream Current located directly offshore, and other minor causes. These (semi) predictable events result in tides that are above traditional predicted tidal elevations. These are often referred to as king tides in the media. King tides can occur in any month, but the combination of individual contributions is

usually maximum in the months of October and November during spring tides (times of new and full moons). For example, measured peak tidal elevations at the Lake Worth Pier occurred on October 1 and October 29, 2023, at elevation 2.4 feet NAVD, and on November 16, 2023, at elevation 2.45 feet NAVD. If these king tides coincide with wind events, significant changes to the beaches can occur.

2.6 Storm Surge

Storm surge refers to elevated tides that are induced by storms. They are influenced by changes in atmospheric pressure and wind stress acting on the ocean. In the surf zone, the breaking of waves causes an increase in the mean water level as well. Two common ways to estimate storm surge is from (1) recurrence intervals of measured total water levels (measured at tide stations) and (2) numerical simulation of hurricanes of known frequencies. These are discussed in the following sections.

2.6.1 Measured Tides

Due to the limited number of tidal gauges along Florida's coast, the extreme water levels return period was derived by NOAA from measured data collected at Virginia Key (Table 3). The gage is located within a sheltered marine environment, so this table excludes the effects of wave setup in the nearshore beach zone which results in underestimating the total water level at the beach for a given return period.

Table 3. Estimated Storm Stage from Tidal Measurements

Return Period (years)	Storm Stage Level (feet, NAVD)
50	3.94
25	3.92
17.5	2.94
12.5	2.69
9	2.67
6	1.95
2	1.71
1	0.97

2.6.2 Numerical Hindcasts of Hurricane Induced Storm Surges

Storm surge is defined as the rise of the sea surface above its astronomical tide level due to storm forces. The increased elevation is attributable to a variety of factors including wave setup, wind shear stress, and atmospheric pressure. Dean et al (1992) estimated the storm surge along Palm Beach County using numerical simulations of landfalling hurricanes (Table 4).

Table 4
Hindcasted Storm Surge Elevations for
Southern Palm Beach County
(After Dean, et al., 1992)

Return period (years)	Combined total storm tide level above NAVD (ft) profile 4 (186-227)
500	13.1
200	11.3
100	10.1
50	8.4
20	6.2
10	4.2
5	1.7

Table 4 shows even a 10-year return period storm will support wave action on top of the existing beach berm in Highland Beach.

2.7 Sea Level Rise

The global sea level has both risen and fallen throughout geological history. Recent trends in local sea level changes can be used as indicators of what will occur in the near future. Experience indicates that as the relative sea level rises, the shoreline will be subjected to increased flooding, shoreline recession, and profile erosion. NOAA has published sea level trends for regions along the United States coasts based on measured yearly mean sea level records. The longest tide gage record in southeast Florida is based in Key West (Figure 4). Based on the Key West tide gage records, NOAA has estimated that sea level is rising along the southeast Florida coast at 2.57 mm/year (NOAA). This is equivalent to 0.84 feet/century.

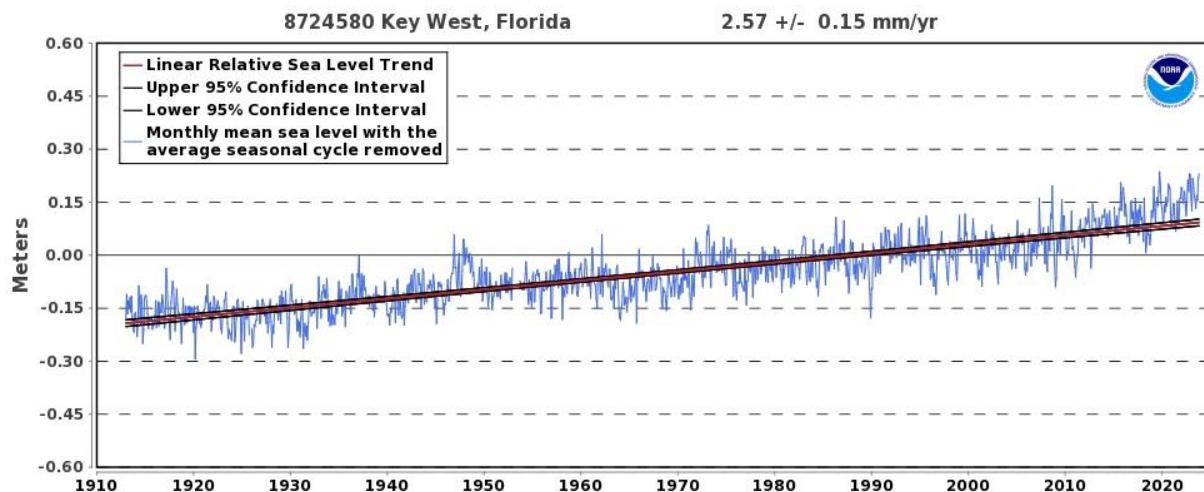


Figure 4. Long term record of sea level rise in Key West, Florida.

The Southeast Florida Climate Change Compact (SFCCC) has reviewed recent trends in measured sea level rise and made recommendations to its members (4 southern counties) that sea level rise may accelerate as shown in Figure 5. Figure 5 shows the relative increase in sea level relative to the year 2000 as a function of future time (years). While the acceleration is small since 2010 (Figure 4), there is a measured short-term trend. The SFCCC has suggested that there are four (4) probable scenarios that may occur in the future (Figure 5). Other scenarios may also occur. The SFCCC has suggested that the use of the NOAA Intermediate High scenario be used for planning purposes for future activities in Southeast Florida.

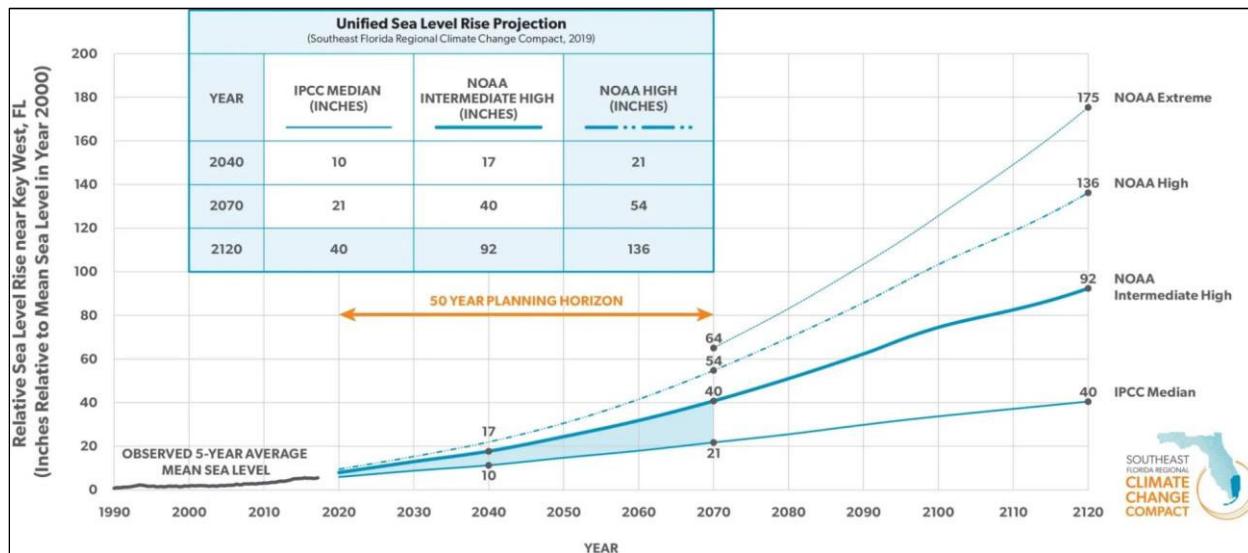


Figure 5. Projection of Sea Level Rise (Source. Southeast Florida Climate Change Compact).

2.7.1 Recessional Effects of Sea Level Rise on Beaches

Bruun (1962) proposed a formula for estimating the rate of shoreline recession based on the local rate of relative sea level rise. This methodology also includes consideration of local topography and bathymetry. Bruun's approach assumes that with a rise in sea level, the beach profile will attempt to re-establish the same bottom depths relative to the previous sea level. As a result, the beach profile shape relative to the mean water level will re-establish itself. If the longshore littoral transport in and out of a given shoreline area is equal, the quantity of material required to re-establish the nearshore slope must be derived from shoreline recession. The effects of sea level rise on the shoreline recession can be approximated using Bruun's (1962) relationship:

$$R = LS / (h+b) \quad [\text{Equation 1}]$$

where R = shoreline recession,
 S = sea level rise,
 b = berm height,
 h = depth of the limit of the active profile,
 L = horizontal distance from the beach to the limit of the active profile.

The annual limit of the depth of the active profile, h , has been estimated using cross-shore beach profiles collected by the State (Appendix A). For Highland Beach, the profiles suggest that the depth limit of the active profile averages –28 feet, NAVD.

The estimate of shoreline recession due to relative sea level rise used –28 feet, NAVD as the depth of closure. The distance, L , from the mean-high-water line (+0.44 feet, NAVD) to the depth of closure is estimated to be 1,500 feet (an average value was calculated from surveys collected along FDEP survey monuments R-191 through R-204). Using a berm height, B , of 7 feet and a linear sea level rise rate of 0.0084 feet/year, the shoreline recession due to sea level rise is calculated to be 0.36 feet/year using Bruun's rule. This relatively small value would be difficult to measure directly in the field.

2.7.2 Flooding and Inundation Effects of Sea Level Rise on Beaches

An increase in sea level will also reduce the appearance of the width of the beach due to higher mean water levels. The data in Figure 4 suggests that mean sea level is approximately 1 foot higher today than it was in 1910 (at the beginning of the Key West tidal record). As many beaches in Palm Beach County have a beach face slope of 1V:10H, the increase in water level has reduced the apparent width of the beach by 10 feet in the last century. Ongoing sea level rise (linear or accelerated) will further reduce the apparent width of the beach.

2.7.3 Future Storm Surges

The estimates of storm surge for recurring storms presented in Table 4 were computed based on a specific tidal elevation (Dean et al., 1992). With increasing time since the 1992 study, the expected value of the storm surge should also increase based on the actual rise in sea level (Figure 4). Increased storm surge elevations will result in increased shoreline recession, beach erosion, and dune impacts.

3. MEASURED BEACH AND DUNE CONDITIONS

This section discusses the historic shoreline changes, and beach and dune volumetric changes within the Town of Highland Beach.

3.1 Data

The Florida Department of Environmental Protection (FDEP) and Palm Beach County have collected beach surveys over the last several decades. An additional survey was performed by APTIM surveyors in August 2023. All of these surveys have been collected at FDEP monuments (or reference points) which are spaced at approximately 1000 feet apart along the sandy shorelines of the State of Florida. The northern limit of the Town of Highland Beach is located approximately 950 feet north of FDEP monument R-191 and 200 feet south of R-190. The southern limit of the Town of Highland Beach is located approximately 175 feet south of FDEP monument R-204.

The earliest available beach profile data set was collected in January 1975 (FDEP, 2013). Other available data sets that included the entire beach profile from the dune crest out to the depth of closure include October 1990, October 2008, and August 2023 surveys.

3.2 Shoreline Change Analysis

A shoreline change analysis was performed using the available survey data (Tables 5 and 6). Table 5 identifies, that over the long term, the beach throughout most of the Town of Highland Beach is advancing in a seaward direction. The average shoreline advance is 1.2 feet/year between January 1975 and August 2023 (Table 6).

The greatest shoreline advancement is occurring at the northern limits where it is influenced by the long-term nourishment of the City of Delray Beach's nourishment program. The effects of the nourishment program are most evident in the January 1975-August 2023 column between R-191 and R-199 (Table 5). South of R-199 there is little influence of the City of Delray Beach's nourishment on the shorelines.

Tables 5 and 6 also show that the beach is advancing inconsistently, with some recessions observed at select profiles in the north, center, and south sections of the Town. While there is the long-term advancement, there are times of recession and locations where shoreline recession has occurred.

Table 5. Shoreline Change Summary

Profile	Shoreline Change (feet)					
	Jan 1975 to Oct 1990	Oct 1990 to Apr 2004	Apr 2004 to Nov 2004	Nov 2004 to Oct 2008	Oct 2008 to Aug 2023	Jan 1975 to Aug 2023
R-191	83.1	5.3	-24.7	53.2	49.7	166.6
R-192	68.1	34.7	-26.6	82.1	-19.0	139.3
R-193	68.0	55.4	-55.2	14.4	34.1	116.7
R-194	49.3	62.5	-79.3	33.4	7.8	73.7
R-195	10.8	49.1	-29.8	22.2	-3.9	48.4
R-196	50.5	-10.0	-15.8	19.0	28.3	72.0
R-197	28.2	13.2	-18.9	5.0	11.5	39.0
R-198	8.4	19.4	-45.8	35.3	2.8	20.1
R-199	-14.9	3.5	2.6	-1.6	22.7	12.3
R-200	-33.7	12.7	-38.6	31.1	21.5	-7.0
R-201	5.9	0.3	-15.3	28.4	-9.8	9.5
R-202	-18.7	1.3	-27.7	24.3	25.5	4.7
T-203	-27.0	24.3	-56.2	26.8	58.4	26.3
R-204	43.0	20.2	-42.2	32.0	27.5	80.5
Average	22.9	20.9	-33.8	29.0	18.4	57.3

Table 6. Annualized Shoreline Change Summary

Profile	Annualized Shoreline Change (feet/year)					Jan 1975 to Aug 2023
	Jan 1975 to Oct 1990	Oct 1990 to Apr 2004	Apr 2004 to Nov 2004	Nov 2004 to Oct 2008	Oct 2008 to Aug 2023	
	Oct 1990	Apr 2004	Nov 2004	Oct 2008	Aug 2023	
R-191	5.3	0.4	-41.2	13.6	3.3	3.5
R-192	4.3	2.6	-44.3	21.1	-1.3	4.7
R-193	4.3	4.1	-92.0	3.7	2.3	2.5
R-194	3.1	4.6	-132.2	8.6	0.5	2.0
R-195	0.7	3.6	-49.7	5.7	-0.3	1.6
R-196	3.2	-0.7	-26.3	4.9	1.9	1.3
R-197	1.8	1.0	-31.5	1.3	0.8	0.8
R-198	0.5	1.4	-76.3	9.1	0.2	0.5
R-199	-0.9	0.3	4.3	-0.4	1.5	-0.3
R-200	-2.1	0.9	-64.3	8.0	1.4	-0.8
R-201	0.4	0.0	-25.5	7.3	-0.7	0.6
R-202	-1.2	0.1	-46.2	6.2	1.7	-0.6
T-203	-1.7	1.8	-93.7	6.9	3.9	-1.0
R-204	2.7	1.5	-70.3	8.2	1.8	1.6
Average	1.5	1.5	-56.4	7.4	1.2	1.2

3.3 Volumetric Change Analysis

While the shoreline can be indicative of the condition of the entire beach profile, a better representation of the beach condition is the volume of sand within the beach profile. For example, natural onshore and offshore movement of sand will occur throughout the year causing the shoreline to move; although the beach can still be in a healthy condition with no volumetric change. A volumetric change analysis from the dune out to -28.0 feet, NAVD (1975 to 2008) and -30 feet NAVD (2008- 2023) describes the total beach profile evolution.

3.3.1 Volume Changes above -30 feet NAVD

Table 7 shows that all of the profiles within the Town of Highland Beach accreted sand between 1975 and 2008. Because only every third profile line was surveyed to -28 feet in 1975, the volumetric changes are aggregated in 3000-foot increments. During this period, the total beach accumulated 2.1M cy.

Table 7. Volumetric Change Summary above -28.0 feet, NAVD

Profile	From	To	Distance between Profiles (feet)	Volumetric Change above -28.0 feet, NAVD (cubic yards)		
				Jan 1975 to Oct 1990	Oct 1990 to Oct 2008	Jan 1975 to Oct 2008
Limit of THB	R-191	955	80,000	88,400	168,400	
R-191	R-192	1,209	101,200	111,900	213,100	
R-192	R-195	2,662	254,900	224,300	479,200	
R-195	R-198	3,300	294,400	242,500	536,900	
R-198	R-201	3,052	228,700	170,800	399,500	
R-201	R-204	3,627	233,100	127,200	360,300	
R-204	Limit of THB	175	8,700	5,100	13,800	
Total		14,980	1,201,000	970,200	2,171,200	

Table 8 shows the volumetric changes between 2008 and 2023 above the -30 feet NAVD contour. While the overall beach accumulated 263,000 cy of sand during this 15-year period, there were small losses of sand within the profiles at the northern end of Town. The largest accumulations were at the south end of the Town. The accumulation of sand between R-203 and R-204 is more influenced by the City of Boca Raton's beach conditions as profile R-204 is south of Yamato Rock which restricts sand movements in both directions. The City nourished their northern beaches in 2010, 2014, and in 2020; thereby contributing to the condition of profile R-204.

Table 8. Volumetric Change Between 2008 and 2023 above -30.0 feet, NAVD

Profile Area	Distance (ft)	Volumetric Changes (cy) DOC
R-191 to R-192	1,208	7,617
R-192 to R-193	1,233	-5,799
R-193 to R-194	778	-2,675
R-194 to R-195	640	-3,901
R-195 to R-196	1,341	7,154
R-196 to R-197	850	10,897
R-197 to R-198	1,107	25,953
R-198 to R-199	1,087	31,024
R-199 to R-200	858	20,069
R-200 to R-201	1,104	13,221
R-201 to R-202	1,157	29,974
R-202 to T-203	1,112	64,713
T-203 to R-204	1,352	64,687
Project Area (R-191 to R-204)	13,827	262,934

Over the long term (Table 7), there is a general trend of greater accretion at the north end of the Town and less accretion at the south end of the Town. This again suggests that the volumetric increase is a function of sand migrating south from the Town from Delray Beach. Delray Beach has placed in excess of 6.25M cubic yards of sand on their beach since 1973, so approximately 1/3 of this volume has moved into the Town of Highland Beach. Examining the beach profiles in Appendix A suggests that the majority of this sediment has stayed in the offshore portion of the profile. While sand in the offshore profile does not provide direct protection of the upland infrastructure, it supports a gradual sloping profile which supports offshore wave breaking and reduced wave energy that reaches the dry beach. Well-nourished offshore beach profiles will assist in stabilizing any sand placed above mean high water by upland property owners.

3.3.2 Volumetric Changes Above Mean High Water

Although the Town's beach has benefited from the accumulation of sediment from the north, the natural offshore transport (during storms, for instance) has not resulted in year-over-year beach berm growth, nor facilitated natural dune build-up. To demonstrate this finding further, a volumetric analysis was performed that showed the beach volumetric gain above mean high water (0.44 feet, NAVD) was only 84,900 cubic yards between 1975 and 2008, which is around 4% of the total volumetric gain. Since 2008, the beach and dune above mean high water has gained 67,000 cubic yards (Table 9). While this represents approximately 26% of the total gain during the same time frame, it represents only 2 cy/ft of beach on average, which should be considered minimal.

Table 9. Volumetric Change Summary Above Mean High Water (+0.44 feet, NAVD)

Profile		Distance between Profiles (feet)	NEW Distance between Profiles (feet)	Volumetric Change above +0.44 feet, NAVD (cubic yards)	
From	To			Jan 1975 to Oct 2008	Oct 2008 to Aug 2023
R-191	R-192	1,209	1,208	41,900	9,795
R-192	R-193	1,238	1,233	19,700	4,973
R-193	R-194	781	778	9,700	2,612
R-194	R-195	643	640	19,100	-1,274
R-195	R-196	1,341	1,341	31,600	71
R-196	R-197	851	850	8,300	1,601
R-197	R-198	1,108	1,107	9,400	7,739
R-198	R-199	1,090	1,087	-3,200	8,467
R-199	R-200	858	858	-8,100	1,690
R-200	R-201	1,105	1,104	-400	-920
R-201	R-202	1,157	1,157	-21,500	-1,192
R-202	T-203	1,111	1,112	-25,600	12,169
T-203	R-204	1,358	1,352	4,000	20,931
Total		13,850	13,827	84,900	66,662

3.4 Environmental Resources

As described in CB&I (2013), there are numerous rock out crops (hardbottom) throughout the Town of Highland Beach. The nearshore hardbottom resources within Highland Beach are part of the Nearshore Ridge Complex (NRC), a combination of shallow colonized pavement and ridges of relatively flat, low-relief carbonate rock (Walker, 2012). Most of the exposed rock is located at the south end of the Town, the most prominent being Yamato Rock.

The NRC potentially serves a variety of ecosystem functions, including settlement and nursery areas, spawning sites, feeding areas, and shelter for hundreds of species of macroalgae, fish and invertebrates such as stony corals and octocorals (Lindeman *et al.*, 2009; Lindeman and Snyder, 1999). The hardbottom resources adjacent to Highland Beach are located in the intertidal and subtidal zones and are subject to high wave energy and constant sand movement. The benthic community is generally dominated by turf algae and macroalgae, with invertebrates including tunicates and sponges. It is characterized by a low-density coral community, predominantly of small colonies of *Siderastrea* spp. (less than 2 cm), a species that dominates the nearshore habitat of south Florida and is considered relatively sediment tolerant (Lirman *et al.*, 2002).

Much of this hardbottom is ephemeral in nature but is important for the environmental system and must be considered when evaluating beach restoration alternatives within the Town. There are around 1.2 acres of nearshore hardbottom within the Town.

4. EXISTING BEACH AND DUNE CONDITIONS

Beach observations were conducted in August and September 2023 to document the condition of the visible or dry portion of the beach and dune system. The observations were performed on a property-by-property basis. Details are provided in Appendix B. In the following sections, are descriptions of select areas which were felt to be representative of various sections of Highland Beach.

4.1 2355 to 2545 South Ocean Boulevard

The beach in the northernmost quarter mile of the Town is backed by single family homes (2355 to 2545 South Ocean Boulevard). There is a well-developed, vegetated dune system with the crest elevation of the dune between 13.5 feet and 15 feet NAVD, which is in excess of the 100 year return period storm surge (Table 4). The beach was wide with a berm and a mild foreshore slope; however, at the Delray Beach-Highland Beach municipal boundary, the seaward berm was observed to have a higher elevation, with 20 inches of berm scarp at 2355 South Ocean Boulevard (Photo 1). This scarp diminishes to the south. The dune in this area appears to have 1-2.5 feet of scarp, where the waves have washed up over the berm (Photo 2). Historic wrack lines were observed at the toe of the dune as well as the mid-berm trough. Profile R-191 is representative of this stretch of beach. Profiles comparing the beach condition in October 2008 and August 2023 can be found in Appendix A.



Photo 1. View looking south at the Highland Beach-Delray Beach municipal boundary. The berm has an approximate 20-inch scarp which diminishes to the south.



Photo 2. Eroded dune face with historical wrack lines at the toe of the dune.

4.2 2575 to 3407 South Ocean Boulevard

The next mile of beach (2575 to 3407 South Ocean Boulevard, Townhouses of Highland Beach Condominium to the Clarendon Condominium) is composed primarily of condominiums apart from the Delray Sands serving as the only oceanfront resort in Highland Beach. There is a vegetated dune throughout this area, however it varies from 75 to 100 feet wide in the northern section to 40 feet wide in front of the Ambassadors Condominiums. Most of the dune in this area exhibited scarps or dune face erosion at the base of the vegetation (Photo 3). The beach in front of the vegetated dune varied from 60 to 90 feet. The beach had a berm and relatively flat foreshore slope indicative of a healthy beach profile. However, some minor berm scarps were observed fronting the property of 2575 (Townhouses of Highland Beach) ranging from 6-10 inches across the property. Profiles R-192 (Photos 4 and 5) through R-196 show the historic beach cross-sections in this section of the beach (Photos 6 and 7).



Photo 3. (From right to left) The scarped dune toe in front of Ocean Pines Condo. The scarped dune toe is hidden behind the seagrapes in front of Ocean Dunes Condo.



Photo 4. Southerly view of the beach berm and dune near R-192.



Photo 5. View of the beach berm and dune near R-192 looking north.



Photo 6. View looking south along the beach in front of the Delray Sands.
Note the berm and mild foreshore slope.



Photo 7. View to the north along the beach in front of the Ambassadors South Condo.
Note the scarped dune face and dune toe.

4.3 3419 to 3907 South Ocean Boulevard

The section of beach from 3419 to 3907 South Ocean Boulevard is approximately 0.55 miles long and is mostly composed of single-family homes except for a few condos at the north end (Le Sanctuaire, Villanova, Villas at Highland Beach Ocean Reef Condo, and Ocean Villas Condo). This section also contains the beach club for Toscana and the beach access of the Highland Beach Club. Thus, there is a high recreational value for the beach in this section.

Along this section of the Town's shoreline, sections of the dunes are well vegetated, however, some areas have been undermined at the base of the vegetation and some dune scarping were visible along the shoreline (Photo 8). The elevation of the dune ranges from +15 feet, NAVD to +23 feet, NAVD. Profile R-199 had a lower dune elevation at +12 feet, NAVD, which provides limited protection.



Photo 8. Dune face scarping is resulting in undermining of the dune vegetation¹ in front of 3715 South Ocean Boulevard.

¹ Dune vegetation is often a continuous transition from pioneer species to back dune species. Pioneer species usually includes sea oats, marsh hay cordgrass, and railroad vine, which are best suited to be immediately behind the beach. Back dune species include seagrape, which are shallow rooted, but grow well within Palm Beach County. The presence of seagrape on an eroded dune face or toe may be problematic. While the species will grow in the pioneer zone (Photo 8), it does not utilize a deep root system to handle the fluctuating sand elevations that accompany being at the landward edge of the beach. Further discussion regarding seagrape is included in Appendix C.

4.4 3912 to 4307 South Ocean Boulevard

The section of beach from 3912 South Ocean Boulevard, Regency Highland Club to 4307 South Ocean Boulevard, consists primarily of single-family homes and low-density condominiums (Ocean Place Villas). The Regency Highland Club has a beach access in this reach. The beach is sufficiently wide to provide recreational benefits to the Club's 210 units.

Only two homes do not have a vegetated dune in front of their property (3921 and 4001 South Ocean Boulevard). All the other properties have a vegetated dune though the width and height vary. The beach is slightly wider compared to the 2008 profiles of this area (with the exception of R-201, where the shoreline position has moved landward). Nevertheless, the beach is relatively narrow, the dunes are not sustainable over the long term, and the dunes can be impacted by a major storm event. However, the beach in this section will provide some storm damage protection benefits to the homes under higher frequency, low intensity storms.

Persistent hardbottom first appears in this reach (Photos 9 and 10). In Photo 9, the outcrop in this area acts as a breakwater, holding the sand up on the adjacent property. In Photo 10, the rock outcrop functions more like a low-profile groin with a wider beach on the north side of the outcrop fronting 4201 and a receded shoreline on the south side of the outcrop, fronting Ocean Place Villas.



Photo 9. Looking north, the exposed hardbottom observed in front of the Regency Highland Club and 3907 South Ocean Boulevard.



Photo 10. Looking north, the beach narrows to the south of the outcrop, fronting Ocean Place Villas.

4.5 Ocean Place Estates to the South Town Limit

The 0.62 miles at the south end of the Town extending from the Ocean Place Estates to the Admiral Walk Towers beach access, south of Yamato Rock, consists primarily of single-family homes, townhomes, and low-density condominiums (Parker Highland Condominium). The beach has a sufficient berm and a relatively flat foreshore. There were some areas of exposed hardbottom observed in the swash zone for this stretch.

There are several properties in Ocean Place Estates which exhibited severe scarping of the dunes (Photo 11); however, some properties have recently re-established a planted dune. While the dune erosion is prevalent, there is a buried seawall in front of the homes to provide secondary protection.

The 45 Ocean Condominium is the only property that does not have a vegetated dune in front of their property. The seawall encompassing the property varies in height, with the lowest section of the wall being 6.5-7 feet above the berm. All the other properties in this stretch have a vegetated dune though the width and height vary.

The next stretch of properties located to the north of Yamato Rock, consist of single-family homes, townhomes, and the Parker Highland Condominium. These properties have higher, vegetated dunes, except for the 4515-4519 townhomes, where the dune fronting this property is approximately 3-4 feet lower than the adjacent properties. Although the remaining properties have densely vegetated, high dunes, undermining is occurring at the base of these plants, with ~4-5 feet of scarp in some areas (Photo 12).



Photo 11. The most significant erosion observed in the Ocean Place Estates.



Photo 12. Some properties to the north of Yamato Rock have densely vegetated, high dunes; however, undermining is occurring at the base of these plants, with ~4-5 feet of scarp in some areas north of the stairs.

South of Yamato Rock, the beach is stable and healthy, and the three properties (4713, 4715 and 4801 South Ocean Boulevard) have a 50-foot-wide vegetated dune and an approximate 80 to 100-foot beach in front of the structures (Photo 13). Historically, this section of beach has benefited from the North Boca Raton Beach nourishment projects constructed in 1988, 1998, 2010, 2014, and 2020.

The beach access for the Admiral Walk Towers is at the limits of Highland Beach, with a 100-foot-wide vegetated dune with no structures present on this beach parcel. While the dune is wide in this area, the dune crest is at approximately +10 feet, NAVD (FDEP profile R-204, Appendix A), which is the lowest dune in Highland Beach. The dune crest is at the elevation of 100-year return period storm surge (Photo 14).



Photo 13. View of the beach looking south at Yamato Rock.



Photo 14. West view of the two single family homes and a portion of the Boca Highland Beach Club. Note the elevation of the dune relative to the adjacent Milani Park parcel.

5. PROBLEM IDENTIFICATION AND ALTERNATIVES

The preceding review of historic beach changes suggests that the Town's beaches are performing well overall. They have benefited from the beach nourishment projects constructed in Delray Beach and the City of Boca Raton and the natural north to south transport of sand. This natural movement of sand has widened the beaches at the north end of the Town and resulted in a relatively stable beach in the center of the Town.

The field observation of the beach suggests the following:

- that the berm elevations are lower (than Delray Beach);
- many of the dune toes are scarped;
- there are numerous wrack lines in the vicinity of the toe of the dune, which indicate where the wave uprush limits are occurring in recent timeframes;
- and the nearshore hardbottoms in the south end of the Town act like semi permeable groins-stabilizing sand on the north side and increasing local erosional stresses on the southside.

This alternative picture indicates that the Town's beaches have been subject to episodic storms and erosional events. Coupled with long-term sea-level rise, the occurrence of impacts to the upper dry beach and dune system should be expected to continue to occur and may worsen over the long term. As the beaches are not excessively wide, there is insufficient sand available to transport landward to the dunes as a result of onshore winds. Therefore, any natural onshore/offshore sediment transport cycling that may occur (in Delray Beach, for example), should not be expected to occur in Highland Beach.

To address both short-term and longer-term beach and dune needs, the following options, undertaken by the Town or by individual property owners are available:

5.1 No Action by the Town of Highland Beach

The Town's beaches can be viewed as performing relatively well and no infrastructure is under imminent threat. The No Action alternative is a non-proactive approach to beach and dune management or is an acknowledgment that any Town wide repairs (including engineering and permitting) to the beach and dune can be accomplished post-storm. Individual residents are responsible to respond to any future storm events, and to the long-term effects of sea-level rise on their property. There is no immediate cost to the Town under this alternative. If the current trend in sea-level rise continues, this alternative will become less feasible as storm action will cause more impacts to the beach berm (if present), and the dunes. Permanent impacts to vegetation will occur.

5.2 No Action by Private Residents

The Town's beaches can be viewed as performing relatively well and no infrastructure is under imminent threat. Individual owners may elect to take no action with a low risk of storm impact over the short term. If the current trend in sea-level rise continues, this alternative will become less feasible as storm action will cause more impacts to the beach berm (if present), and the dunes. Permanent impacts to vegetation will occur. A perceived loss of upland property may or will occur. There is no immediate cost to the individual owners under this alternative.

Select properties in the south end of the Town have a history of restoring their dunes due to a combination of storm action, and nearshore rock interruptions of sediment transport. For those properties, this alternative is not recommended.

The two single family homes and the Boca Highland Beach Club at the south end of Town have the lowest dune elevations in the Town. For those properties, this alternative is not recommended.

5.3 Dune Toe Enhancement

The majority of the dunes within the Town exhibit impacts to the seaward toe of the dune (Photos, 2, 3, 6, 7, 8, and 11). These impacts are associated with annual storm events or storms of similar size. If the current trend in sea-level rise continues, these storm and erosion events may become more frequent. To offset the long-term impact from repetitive storm events, a restoration of the toe of the dune could be accomplished with small placements of beach compatible sand (~2 cy/ft)

and vegetative restoration to prevent or reduce windblown sand transport. This could be accomplished on a Town wide or individual property basis. Sand would need to be replaced every few years as storm impacts (continue to) occur. General recommendations for individual properties are provided in Appendix B. Specific vegetation discussions are included in Appendix C.

5.3.1 Regulatory Requirements

Reconstruction of the dunes using sand from upland borrow sources can be permitted as a FDEP field permit. For quantities less than 200 cubic yards, individual property owners can apply for, and be issued a permit by the FDEP's field representative, who is based in West Palm Beach.

Permits for volumes more than 200 cubic yards are issued as a field permit by FDEP staff in Tallahassee. The basic permit requirements are for the sand to be beach compatible.

5.3.2 Post-Storm Regulatory Procedures

Following significant storm events, such as a tropical storm or severe northeaster, the FDEP may issue an Emergency Order. A typical Emergency Order allows the Town to issue permits to individual property owners in lieu of an FDEP permit and allows:

- Activities to secure structures for safety purposes.
- Restoration of a damaged dune system using beach compatible sand.

Emergency orders are usually issued on a Countywide basis and are posted on FDEP's website. Permit conditions and/or restrictions are included in the Emergency Order.

This alternative is the recommended near-term alternative. It can repair damage to the toe of the existing dunes and raise the berm elevation of the dry beach. This alternative is best implemented on a Town wide scale, but individual owners (or groups of adjacent owners) could implement parts of the recommendations to best protect their properties, if the Town elects not to act.

5.3.3 Construction Challenges

Delivering sand to any property within Highland Beach can be challenging due to limited public or private access points (discussed later). Small quantities may be transported via driveways and limited side yards via a bobcat or similar equipment. Some contractors have narrow conveyor belt systems to transport sand over the dune. These can be installed adjacent to houses. If there is no access across an individual property, delivering sand via distant access points and along the beach can be accomplished between November 1 and February 28 (outside of sea turtle nesting season).

Given that dune toe restorations are typically performed on a small scale (up to a dozen truck loads per owner), there is limited impact on the Town's infrastructure or traffic patterns.

5.3.4 Opinion of Probable Construction Cost

The cost of small-scale operations can be estimated at \$100 per linear foot of dune with additional cost due to potential limited access for construction equipment and sand delivery.

5.4 Dune Restoration and Dry Beach Enhancement

As indicated in previous sections, the dune toes have been impacted and the beach berms are lower in elevation than may be prudent considering episodic storm events, king tides, and long-term sea-level trends. A Town wide dune and dry beach restoration and enhancement project could be developed to increase storm damage prevention to upland infrastructure. A minimum dune template would be developed for various sections of the Town that would meet the needs of the upland property owners. It is possible that a proposed dune section would be completely encompassed by the current beach and dune profile such that the project would not need to be constructed at a given location at this time. For programmatic purposes, the minimum recommended dune and dry beach nourishment volume is six (6) cubic yards/foot. This equates to a fill volume of approximately 90,000 cubic yards. For planning purposes, sand would be obtained from inland sand mines and trucked to the project site. The scale of this project would best be accomplished by the Town on behalf of its residents.

There are several advantages to this approach:

- Once engineered and constructed, the Town could apply for FEMA reimbursement to rebuild the dunes if the project was impacted by a large storm event and the County was included in a Federal Emergency Declaration.
- This project would be constructed via truck haul allowing small quantities to be placed in discrete locations.
- By limiting sand placement above mean high water, the effort to obtain a permit is reduced.
- There are no impacts to the riparian rights of the upland property owners. Upland property owners currently own the land to the mean high water, and they would retain this right.

The disadvantages to this approach include:

- Sand would only be placed above mean high water limiting the volume of sand that could be placed and limiting the storm protective value of the nourishment.
- There would be no seaward shift of the shoreline and thus no increase in recreational space along the beach.
- The cost of upland sand placement has a high per cubic yard cost due to the cost of transporting the sand from inland mines to the project site.
- A significant level of coordination will be required by the Town to develop, administer, and maintain the permit.

- Sand placed on the dry beach will be impacted during annual storm events. While contributing to storm protection, some of the sand may erode immediately. There may be negative public comments as a result.
- The project will occur on private property. This will require temporary construction easements to place sand on the beach and to allow construction equipment and labor to work along the beach. A unified effort by the residents to provide easements will be required.

5.4.1 Regulatory Requirements

FDEP permits would be required under 62B-33, F.A.C., or 62b-41, F.A.C. as determined by FDEP staff in Tallahassee based on potential impacts to nearshore hardbottoms. All construction activity would be restricted to occur outside of sea turtle nesting season.

However, in the case of a storm event, the Town would hold a permit to reconstruct the dunes and dry beach in the impacted area. As with beach nourishment designs, the Town holding a permit in hand greatly expedites restoring the dune after a major storm event.

Despite efforts to minimize impacts, there may be perceptions of potential environmental impacts to nearshore hardbottoms. These impacts may require mitigation or substantive design modifications.

5.4.2 Construction Challenges

Delivering sand to any property within Highland Beach can be challenging due to limited public or private access points. If there is no access across an individual property, delivering sand via distant access points and along the beach can be accomplished between November 1 and February 28 (outside of sea turtle nesting season). While there are multiple accessible locations to deliver sand to the beach, most are privately owned, and some have constructability issues for their use during sand delivery. The Town should seek out willing owners to develop sand delivery points within the Town. Otherwise, the Town will need to negotiate use of adjacent municipalities access points, which will likely come with their own conditions for use.

Given the scope of the dune and dry beach nourishment, and the likely requirement to construct the project outside of sea turtle nesting season, limited impacts to Town traffic patterns should be expected.

5.4.3 Probable Construction Cost

For a 90,000 cy dune and dry beach nourishment, the project will be best constructed using truck hauled inland sands. As discussed above, there are limited locations to deliver sand to the beach and will require relative long alongshore haul distances to place the sand. A unit cost of \$45/ton (1.4 tons/cy) will result in a \$5.75M project cost.

5.5 Beach Nourishment Project

CB&I (2013) recommended the following alternative:

A beach nourishment project would likely involve advancing the shoreline seaward by approximately 50 feet as this is a similar design cross section used in Delray Beach and North Boca Raton projects. This would provide greater storm damage reduction and recreational benefits to Highland Beach residents. Delray Beach and North Boca Raton have wider beaches than this to account for their local background erosion rates, but the Town of Highland Beach has a relatively stable beach and would not require this additional fill. The design berm elevation of the Delray Beach and North Boca Raton beach nourishment projects is at +7.5 feet, NAVD and a similar berm crest elevation is proposed for the Town of Highland Beach. The approximate fill volume required to construct this template throughout the entire 2.84 miles of the Town is approximately 1.0M cubic yards.

The beach nourishment would be built wider than the 50-foot design width for constructability purposes. The construction template will erode as sand is shifted offshore. This process might take up to a year, though a large storm would speed the “equilibration” process.

The cost to construct this project in 2024 would be approximately \$14M. This includes a mobilization cost of \$4.0M and a unit cost of \$10.00 per cubic yard. It would be possible to reduce this cost by sharing in the mobilization cost with either Boca Raton or Delray Beach when they construct their next project. The permit for initial construction of such a project is good for five (5) years, providing time to coordinate with your neighboring municipalities.

Some of the advantages of a full beach nourishment project include:

- The project would provide significant storm damage reduction benefits.
- The project would provide additional recreational benefits.
- The Town could apply for FEMA reimbursement to rebuild a portion of the project if the project was impacted by a large storm event and Palm Beach County was included in a Federal Emergency Declaration.
- The unit cost for this type of fill is much lower than a truck haul project.

The disadvantages of a beach nourishment project:

- A nourished beach becomes State land seaward of the pre-construction mean high water line. An Erosion Control Line (ECL) is established as part of the permitting process, which is the mean high-water line prior to construction of the project. This becomes the seaward property line of each upland property owner. Dry beach seaward of the ECL is State owned (public) land. Some upland property owners may object to the loss of one of their riparian rights between the ECL and the mean high-water line.
- There is a high capital outlay for the construction of the project.

5.5.1 Regulatory Considerations

Environmental permits will be required by both FDEP and the U.S. Army Corps of Engineers. Permitting may take at least one (1) year to obtain once a design has been established.

The persistent hardbottom at the south end of Town will present some permitting challenges. While the acreage of impacted nearshore rock is low (approximately 1.2 acres) the permitting agencies may require avoidance of some of this rock (specifically Yamato Rock) or mitigation in the form of an offshore artificial reef. For planning purposes, mitigation costs are nominally \$1M to \$1.5M/acre. Avoiding some of this rock will be difficult to implement or will restrict the nourishment volume greatly such that the effectiveness of any remaining nourishment volume in this avoidance area is reduced.

5.5.2 Sand Source

APTIM (and its legacy firms) has performed considerable offshore sand search investigations for the cities of Boca Raton and Delray Beach and is confident that sufficient sand resources are available directly offshore of the Town of Highland Beach. The USACE (2012) has collected data further north and directly offshore of the Town of Highland Beach. The data confirmed that the same sand feature dredged to construct the North Boca Raton Project extends further into the Town of Highland Beach though a detailed investigation of this potential source still needs to be performed.

5.5.3 Summary

This is the recommended long-term alternative. It ensures that sufficient storm damage protection is present and recreational areas are available throughout the Town. The beach berm design can be increased over the coming decades to address sea level rise.

6. COASTAL STRUCTURES

Coastal structures are appealing because it is assumed that they prevent sand from washing away. In reality, coastal structures simply redistribute sand within a littoral cell. For example, building a groin will hold additional sand on the north (updrift) side of the groin, but that sand will be deprived from the south side of the groin causing an erosional area. This concept is evident in some of the nearshore rock outcrops in the south end of Town (Photo 13). There is no additional sand introduced into the system as is the case with a beach nourishment project. Strategic use of coastal structures is possible in areas that have alternating areas of erosion and accretion. The concept is to reduce the erosion in one area by reducing accretion in another. Strategic use of coastal structures can also be successful if implemented with beach nourishment. Various coastal structures were evaluated within the Town of Highland Beach based on these concepts.

6.1 Groins

Groins are shore perpendicular structures that work by intercepting sand flowing along the shoreline. They generally result in a saw-toothed pattern in the shoreline with sand building up on the north side of the groin (in the case of Town of Highland Beach) and a corresponding recession

in the shoreline on the south side of the groin. The groins are designed such that the downdrift shoreline location meets the design beach goals. They are often constructed in conjunction with a beach nourishment project to mitigate initial downdrift erosion and shoreline retreat (i.e., pre-fill the groin field).

In Highland Beach, the shoreline is quasi uniform and there are no areas that are well suited to the construction of a single groin or a groin field (multiple groins). The beach is currently receiving the downdrift benefits of the Delray Beach nourishment project and the insertion of groins in the northern section of the Town will interrupt the current long-term benefit.

Groins can be constructed of either rubblemound structures which can be pricey, or concrete piles with concrete panels, which can be economically efficient.

6.2 Emergent Offshore Breakwaters

Breakwaters are shore parallel rock structures with crests above the water. They provide protection to the shoreline by waves breaking directly against the structure and providing shelter to the shoreline in its lee. Wave energy is dissipated in the gap due to diffraction of the wave energy. The breakwaters will hold sand behind them at the expense of the sandy beach adjacent to the breakwater. The shoreline then has a cuspatate shape. Given that the shoreline along the Town of Highland Beach is currently relatively stable along the northern half to two thirds, a breakwater field is not a recommended option in this area due to potential changes to the alongshore sediment transport. The application of breakwaters in the southern third of the Town could be considered but must work in concert with the existing nearshore hardbottoms which will be technically challenging to optimize the beach benefits while minimizing environmental impacts. As the erosion in the south part of the Town is localized, and may be episodic, only select breakwaters could possibly be required. Permitting such structures in environmental sensitive area has proven to be difficult.

6.3 Submerged Offshore Breakwaters

A submerged rock breakwater has a crest below mean low water while an emergent breakwater typically has a breakwater crest a few feet above mean high water. The benefit of a submerged structure is that there are fewer concerns with negative impacts to sea turtle nesting. Also, because the structure is submerged it does not have the same aesthetic concerns as an emergent structure.

The drawback of a submerged structure is that it is not nearly as effective as an emergent structure. They have to be much wider than an emergent breakwater to be effective and are similar in cost, if not more expensive. They can be hazardous to boats and will have to be marked with navigation warning signs. Lastly, they have the potential to initiate rip currents between submerged structures because waves break over the structure, but the return flow is restricted by the structure. This flow will then be funneled towards a gap between the structures resulting in a recurrent rip current. For longer, continuous submerged structures, an alongshore current can be created due to wave setup across the structure resulting in an erosional stress on the shoreline. Thus, there are substantive design challenges. There is only one set of submerged offshore breakwaters in the State and their condition is such that the effectiveness has diminished.

Considering the long-term sea-level rise trends and projections, the effectiveness of such a structure will diminish with time resulting in a need for future rehabilitation. This structure is not appropriate for Highland Beach.

6.4 Patented Technologies

There are several “patented technologies” that claim to prevent shoreline erosion and build beaches. These are often marketed as having no downdrift impacts or negative environmental benefits. We caution considering the installation of these “technologies”. The FDEP regularly reviews these claims, requiring a permitting process and peer review of any field tests. We recommend the Town ask the FDEP’s opinion of their performance, if approached.

6.5 Coastal Structures Summary

Coastal structures are not recommended for implementation by the Town given the stable to accretional nature of the shoreline, uniform longshore transport rate, and no definable erosion hot spots. The cost of the structures will exceed the benefit.

Individual property owners may want to consider structures in front of their property in order to expand the dry beach width. We recommend that the Town advise the property owner to investigate this possibility at the property owner’s cost. The Town will be required to provide a finding of consistency with the Town’s Coastal Management Plan as part of the owner’s FDEP permit application process. The individual property owner should submit the engineering design basis to the Town for review prior to the Town providing such a letter. This (APTIM’s) report should not be viewed as a definitive negative response for such applications. As stated previously, strategic use of structures can be beneficial but must be carefully designed and monitored. There is no Town benefit for the installation of coastal structures at this time.

7. FUNDING MECHANISMS

The cost of coastal protection efforts is significant and may strain the Town’s Capital Improvement budget. This section discusses other possible funding sources and mechanisms.

7.1 Federal Funding

Some of the beach nourishment projects around the State of Florida are cost shared by the Federal Government through the U.S. Army Corps of Engineers (USACE). North Boca Raton and Delray Beach are two examples of projects with Federal funding programs. This program includes a complicated design and approval process and requires several years to develop documents to support this funding. The Town is located within the general authorized limits of 1962 Palm Beach County federal authority (House Document 164/87/1), but at present no federal project has been designated due to the lack of public beach access within the Town (USACE, 1987). It is highly unlikely that the Town would successfully obtain Federal funding. If the County were to construct the park at the south end of Town and have sufficient parking on the west side of A1A, Federal funding would still be limited to less than 10% of the total construction cost because of the limited alongshore distance that this public access would provide.

7.2 State Funding

The State of Florida recognizes the benefit of beaches for storm damage protection and supporting the tourism industry. The Beach Management Funding Assistance Program (Chapter 161,F.S., 62B-36, F.A.C.) is funded based on State taxes and administered through the FDEP. The funding for the program is used to support the Department and provide construction funds to eligible projects. The State will cost share up to 50% of the non-Federal cost on eligible beaches. Eligibility is described in the following sections.

First, the State will only fund beaches that are deemed to be “critically eroded”. The Town of Highland Beach is not currently deemed to be a critically eroded shoreline. Given the Town’s history of shoreline advance since 1975, as documented in Section 3 of this report, convincing the FDEP that the shoreline is critically eroded may be challenging.

Second, the State has a beach access requirement for receiving State funds. A “primary beach access”, defined as a beach access with at least 100 public parking places and public restrooms, will allow for funding of a beach project up to $\frac{1}{2}$ mile from the access. A “secondary beach access”, defined as an access that may have public amenities but does not qualify as primary access, will provide for funding based on the number of available public parking places. Given that there are currently no public beach access points within the Town, State funding is not a potential funding source at this time. Construction of the County Park would open the potential for State funding but depending on the type and size of the park, funding would still be limited to the portion of the project within $\frac{1}{2}$ mile of the park.

In summary, it is unlikely that the Town will be successful in securing State funding.

7.3 County Funding

Palm Beach County funds their beach program using a portion of the funds collected through the Tourist Development Tax (or “Bed Tax”). This is a 6% tax on any short-term rental. The County follows the same criteria that the State uses to allocate funds between projects. Again, the lack of current public beach access will thwart any Town request for County funding assistance. If the County Park were to be constructed, funding might still be limited as they use the State’s ranking criteria.

7.4 Town Funding Methods

Given the low probability of receiving Federal, State or County funding, the Town will have to fund any beach and dune initiatives themselves. Several options are available to the Town and are discussed in the following sections. Table 10 shows a range of funding alternatives that the Town could use to raise funds locally for a beach program. Often each local government identifies a funding mechanism that is unique to their Town. Principal methods employed are discussed below.

7.4.1 Ad Valorem Tax

The Town could petition the Board of County Commissioners to levy a separate Ad Valorem tax or to increase the millage rate on all Town property to generate additional revenue to pay for the project. The general revenue approach would have all Town

property owners (regardless of whether they reside on the ocean or elsewhere in Town) pay for the project in proportion to the assessed value of their property. The County would collect the tax and then turn this over to the Town to administer.

Ad Valorem taxes can be pledged as security for a Town issued bond to pay for a beach project. Voter approval would be needed at a referendum for the Town to issue a bond to pay the costs of the project.

7.4.2 Erosion Prevention District

The State Legislature may create a separate beach and shore preservation district. The district would be self-governed by a Board of Directors who are residents in the district. In Longboat Key, taxing is setup such that those properties located west (seaward) of Gulf of Mexico Drive pay 80% of the required funding while those on the east side pay 20%. A similar mechanism could be considered by the Town with those located east of South Ocean Boulevard paying a larger percentage because they have greater benefit due to having ocean front property.

7.4.3 Municipal Services Benefit Unit (MSBU)

MSBU's are authorized by FS 125. A petition by the majority of the property owners to the Board of County Commissioners is required in order to pass an ordinance establishing the MSBU. Public hearings are held to levy the assessment. MSBU's do not require a vote by referendum and involve only property owners. This is beneficial because property owners may visit seasonally and have their voter registration in another State. An MSBU will allow them to be included in the process. Once established, the MSBU has taxing and assessing authority, and bonding and borrowing capability, using assessed property values as security.

Table 10. Alternative Local Funding Mechanisms (from Stevens & Assoc, 1986)

ALTERNATIVE	DESCRIPTION	HOW ESTABLISHED	PROS	CONS
1. Ad Valorem Tax	Uniform Property Tax	Budgetary Process	Existing authority	Non-continuous source; competition w/others; Poor Management
2. Bonding	Selling bonds to create revenue - bond retired by Ad Valorem Tax	Referendum	New revenue covers large initial costs	Non-continuous source; time delays; confined to specific projects; poor tool for management and planning
3. Independent Special Taxing Districts	Independent Gov't established by Legislature to collect property tax for special purpose	By act of Legislature	Continuous source of funds	New government added - not favored by Legislature; voter dependent
4. Dependent Special Taxing District	Ad Valorem tax collected and administered by the County for a special purpose	By act of Legislature	Ability to fund projects	Limited by total County capital of 10 mils subject to political climate
5. Municipal Service Taxing Unit (MSTU)	Property tax of a specific area for service	By petition of property owners; local authority under FS 125	Existing authorization; not project limited	Taxes only in improved area, adjacent property owners
6. Municipal Service Benefit Unit (MSBU)	Special assessments of benefitted properties	Petitions of majority of property owners	Existing authority; no competition with others	Project limited; difficult to establish
7. Erosion Prevention Districts (FS 161)	A dependent taxing district collecting property taxes	Established by ordinance of the County under FS161	Existing authorization; benefit zones can be taxed differently	Included in total County millage cap; politically affected
8. Private Funding	Donations	By mutual agreement	Addresses needs of private property	Not practical for countywide funding
9. Parking Meters and Park Feed	User Fees	Locally initiated	User benefits = pay	Private benefit is not assessed; limited funding
10. Beach Management Districts (Regional)	Larger government spanning a number of Counties with property taxing authority	State Legislature	Stable funding source; larger tax base; not politically motivated	Funds may be disproportionately used

8. IMPLEMENTATION OF REGIONAL CLIMATE CHANGE RECOMMENDATIONS RELATIVE TO THE TOWN'S BEACHES AND DUNES

Appendix 4 of the Coastal Resilience Partnership (CRP, 2021) report on regional climate change outlines a series of Town specific goals to increase the resiliency and sustainability of the Town in the face of climatic change. These goals are broad, and in some cases, lack specific action items for the Town or its individual property owners. This section correlates the previously described beach and dune alternatives with the CRP goals and allows for further consideration of the potential for long term climatic change to influence the Town's beach and dune preservation efforts.

While the CRP's Appendix 4 recommendations address the potential for storm surge (with or without sea level rise) to affect the Town, the impacts and strategies discussed are focused on the effects of storm surge and sea level rise to flood the Town via the Intracoastal Waterway and not directly from the beach and dune system. The majority of the current dune system is sufficiently elevated and wide enough to prevent overtopping of the dunes by expected storm surge and flooding the Town directly from the Atlantic Ocean.

Nevertheless, the Town residents who live along the Ocean are subject to direct storm surge (with or without sea level rise) and its potential effects on the dry beach, and dunes. Storm surge will cause erosion of the dunes which offer protection to upland private infrastructure. The efforts described above to protect the dunes against storm surge and sea level rise are compatible with the general recommendations of Appendix 4 of the CRP vulnerability assessment.

9. SUMMARY AND RECOMMENDATIONS

The beach in the Town of Highland Beach has benefited from the beach nourishment projects in Delray Beach and to a lesser extent Boca Raton. The shoreline has advanced an average of over 1 foot/year since 1975. The beach at the north end of the Town has advanced the most while the beach at the south end of the Town has mildly receded. Overall, the beach is in good condition and does not have an immediate need for a renourishment project.

However, many of the upland properties have suffered minor losses of sand from the dune toes and dune faces. While the shoreline will recover from episodic storm events, upland property owners will have to independently address damage to the dune system because the dunes will not recover naturally in a short period of time.

Two recommendations are provided to the Town:

1. Near Term. Construct a dune toe repair project and/or dry beach nourishment. This will restore the storm protective capacity of the beach and dune system. Maintaining this project will offset the effects of sea level rise. If the Town elects not to pursue the dune toe repair or the dry beach nourishment, individual owners may consider implementing the dune toe repair on a property-by-property basis.

2. Long Term. Construct a beach nourishment project with sand on the dry beach plus sand in the offshore beach profile to protect the upland infrastructure. Beach nourishment projects can take several years to design and permit so this process should be initiated well in advance of need. The nourished beach can offset the effects of long-term sea-level rise.

An initial estimate of the construction cost of a beach nourishment project is \$14M, assuming construction in the winter of 2024. Cost savings could be realized by coordinating construction with either Delray Beach or Boca Raton, which could save some of the dredge mobilization costs.

A local funding plan needs to be developed concurrently with the beach nourishment design and permitting. The Town may wish to consider several funding mechanisms for the project including Ad Valorem taxes, creating an Erosion Prevention District, or creating a Municipal Services Benefit Unit.

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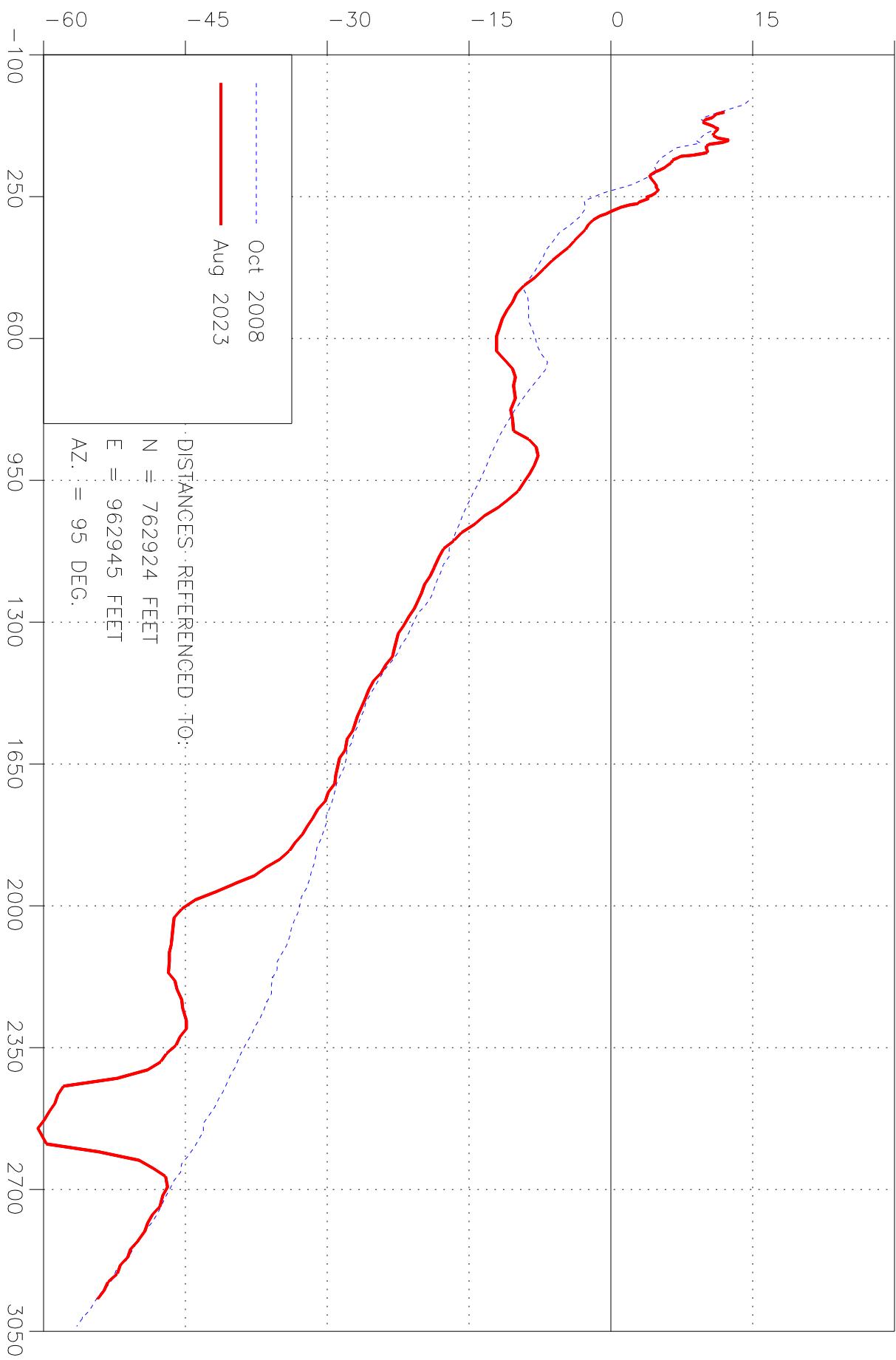
Walker, B. 2012. Spatial analyses of benthic habitats to define coral reef ecosystem regions and potential biogeographic boundaries along a latitudinal gradient. *PLoS ONE* 7(1):1-14.

APPENDIX A
BEACH PROFILE CROSS-SECTIONS

PROFILE LINE: R-191

LOCATION: HIGHLAND BEACH

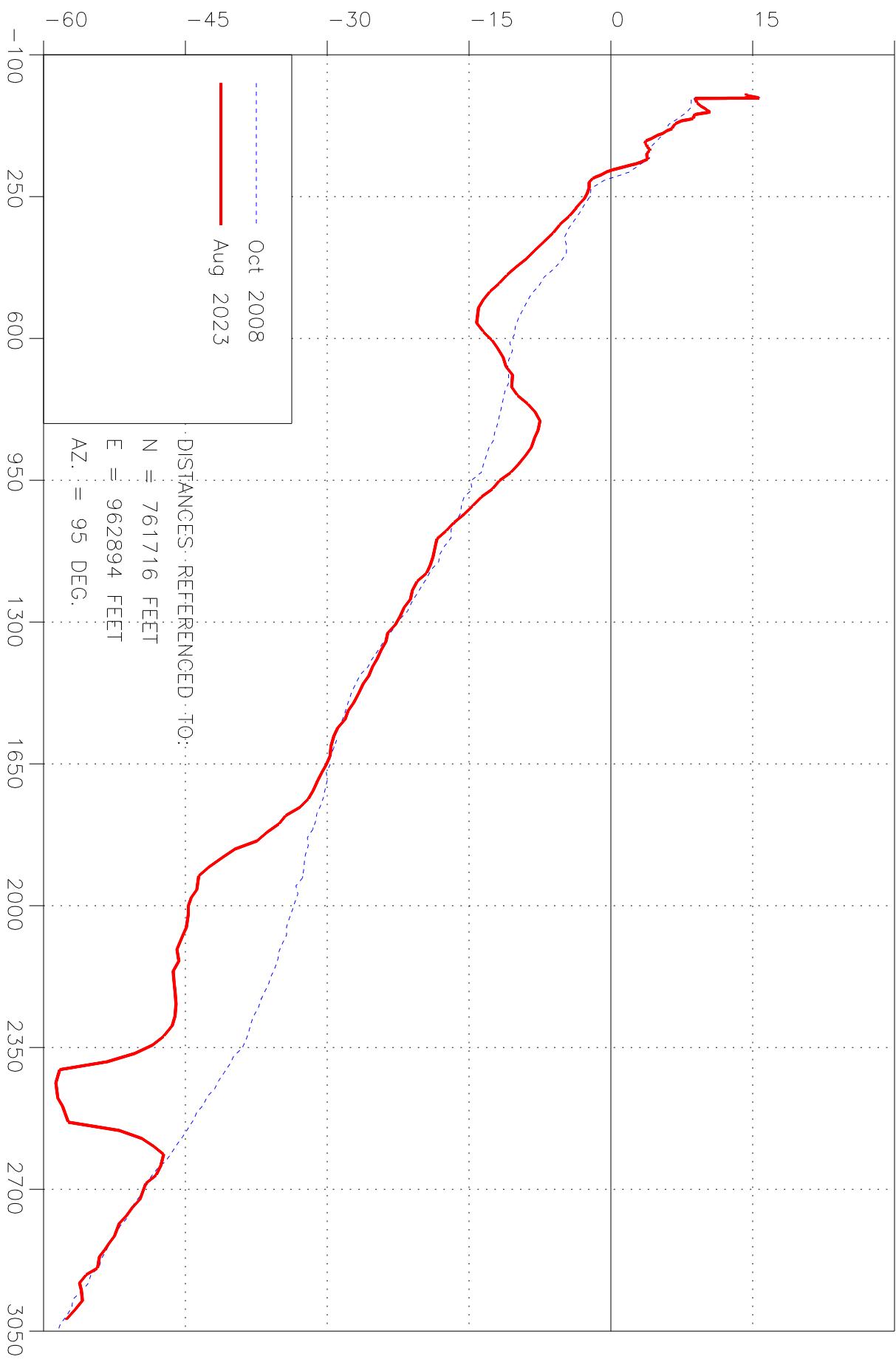
ELEV. (FEET NAVD)



PROFILE LINE: R-192

LOCATION: HIGHLAND BEACH

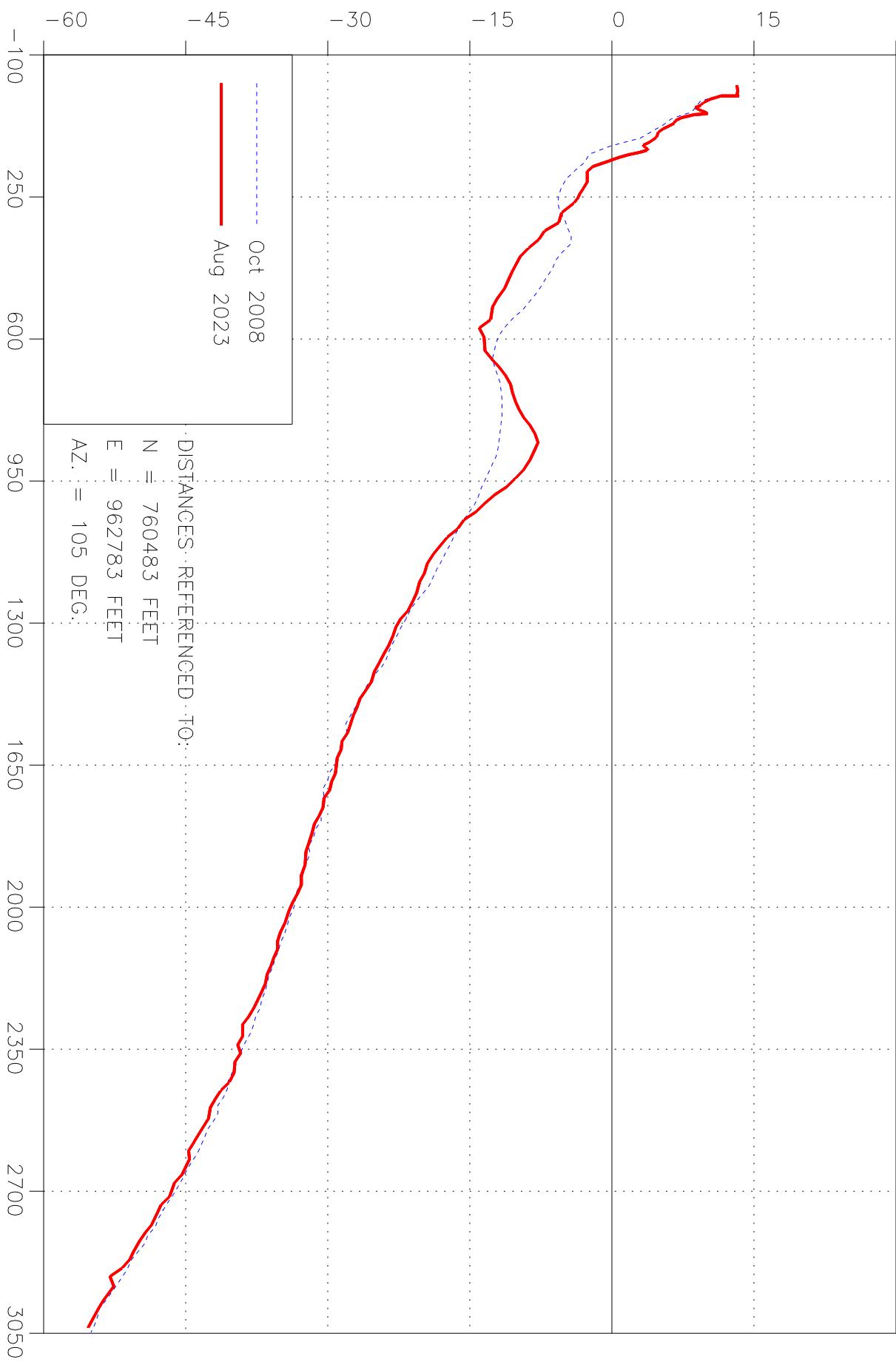
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PROFILE LINE: R-193

LOCATION: HIGHLAND BEACH

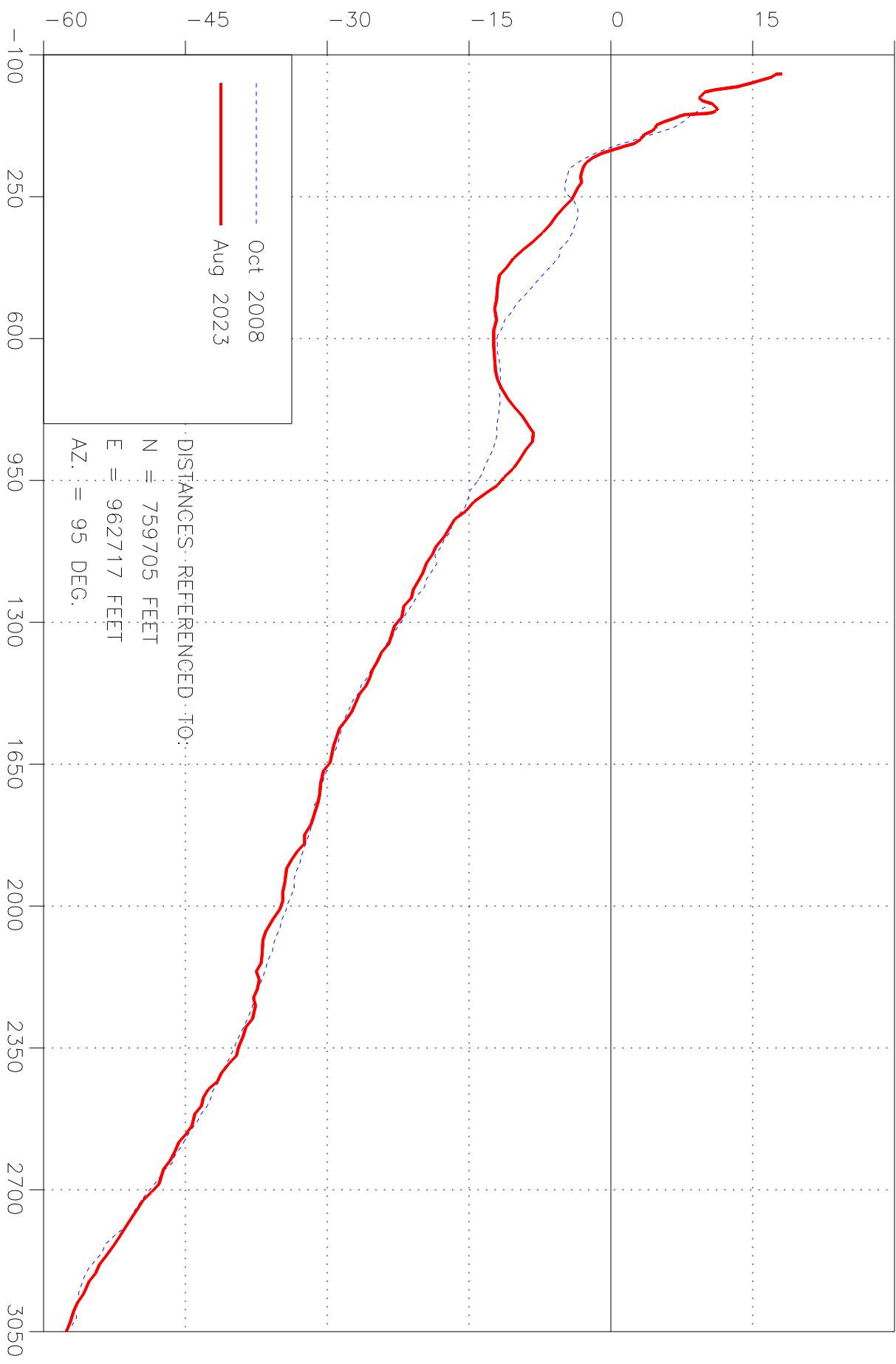
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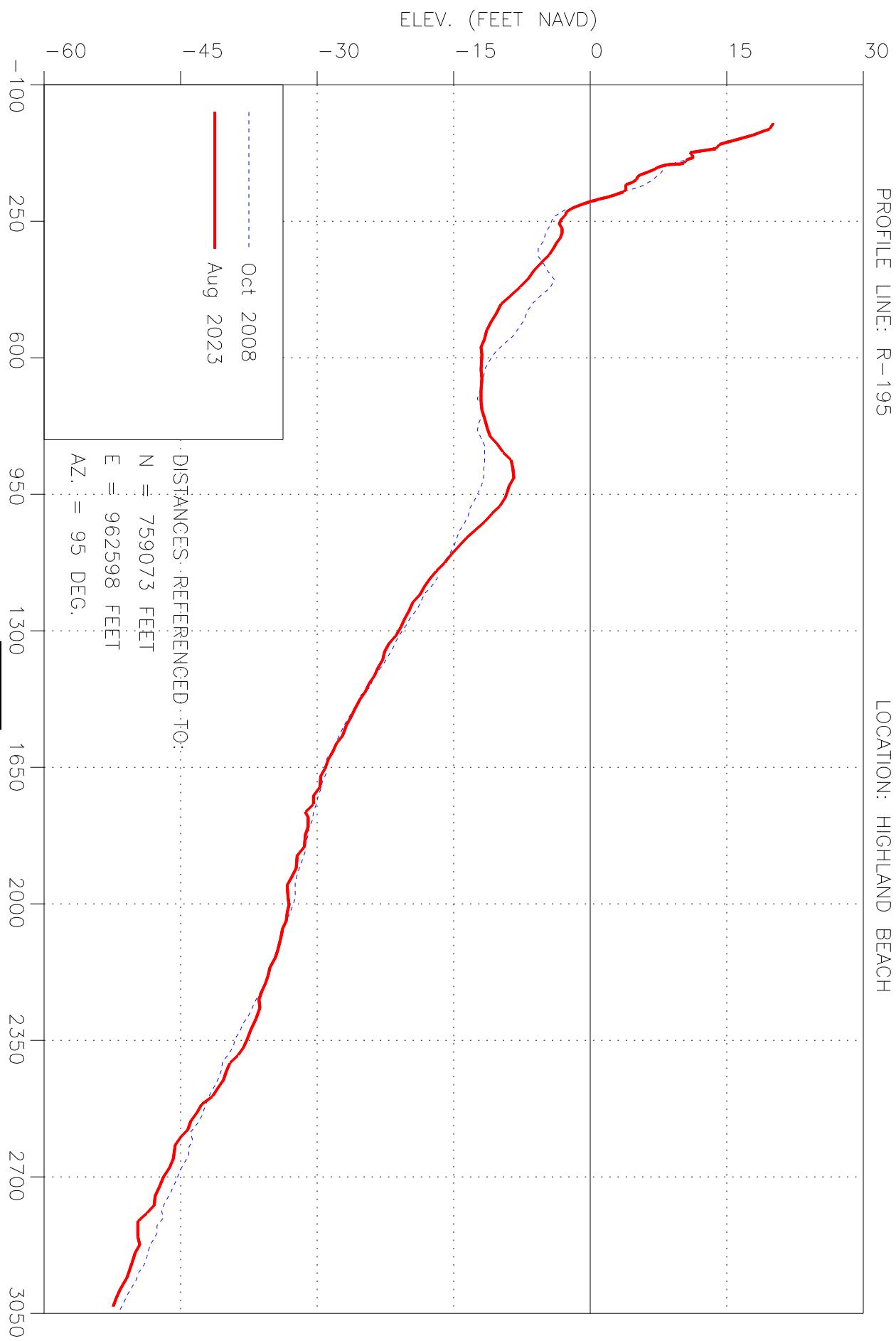


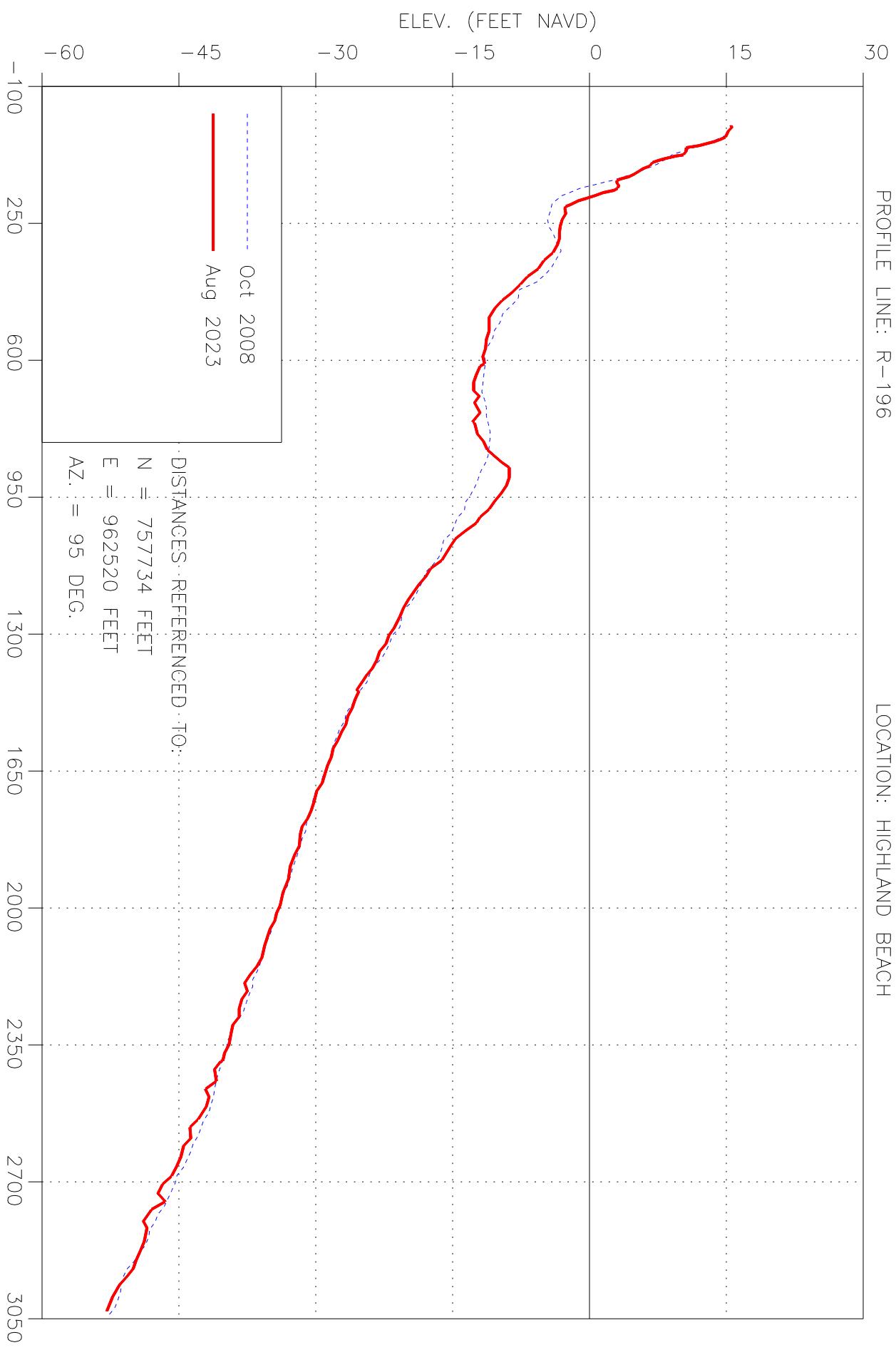
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LOCATION: HIGHLAND BEACH

ELEV. (FEET NAVD)



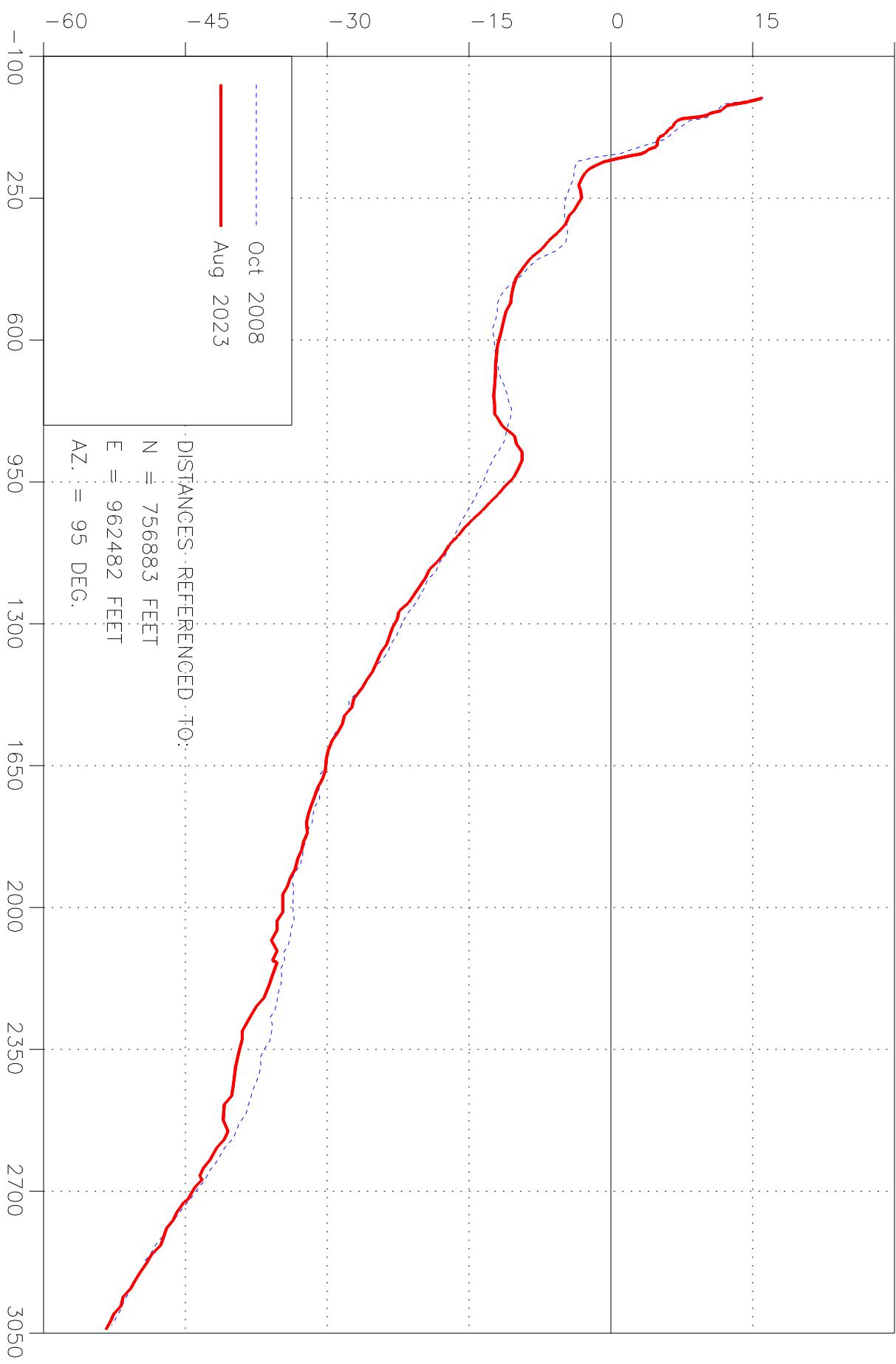




PROFILE LINE: R-197

LOCATION: HIGHLAND BEACH

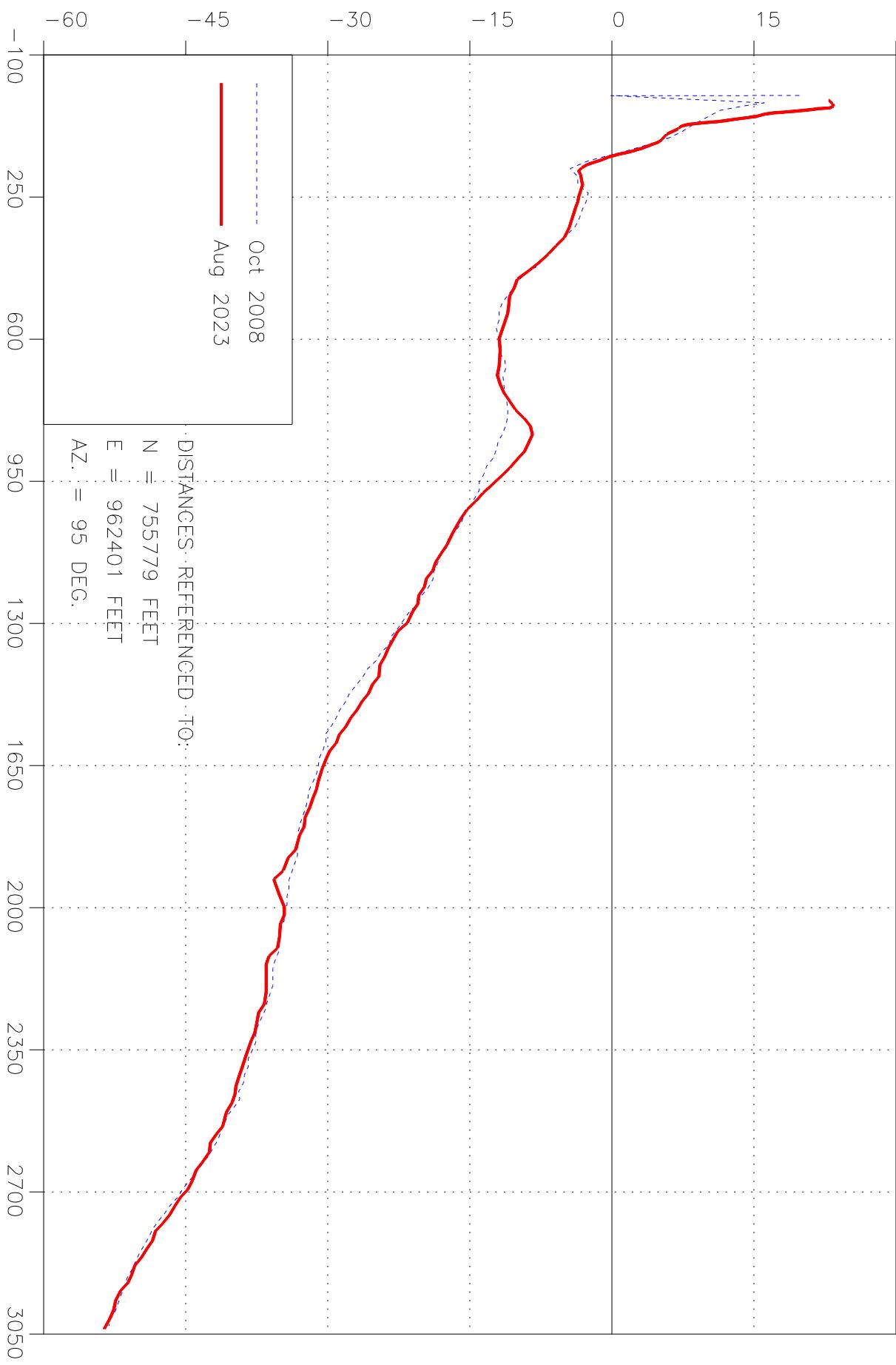
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PROFILE LINE: R-198

LOCATION: HIGHLAND BEACH

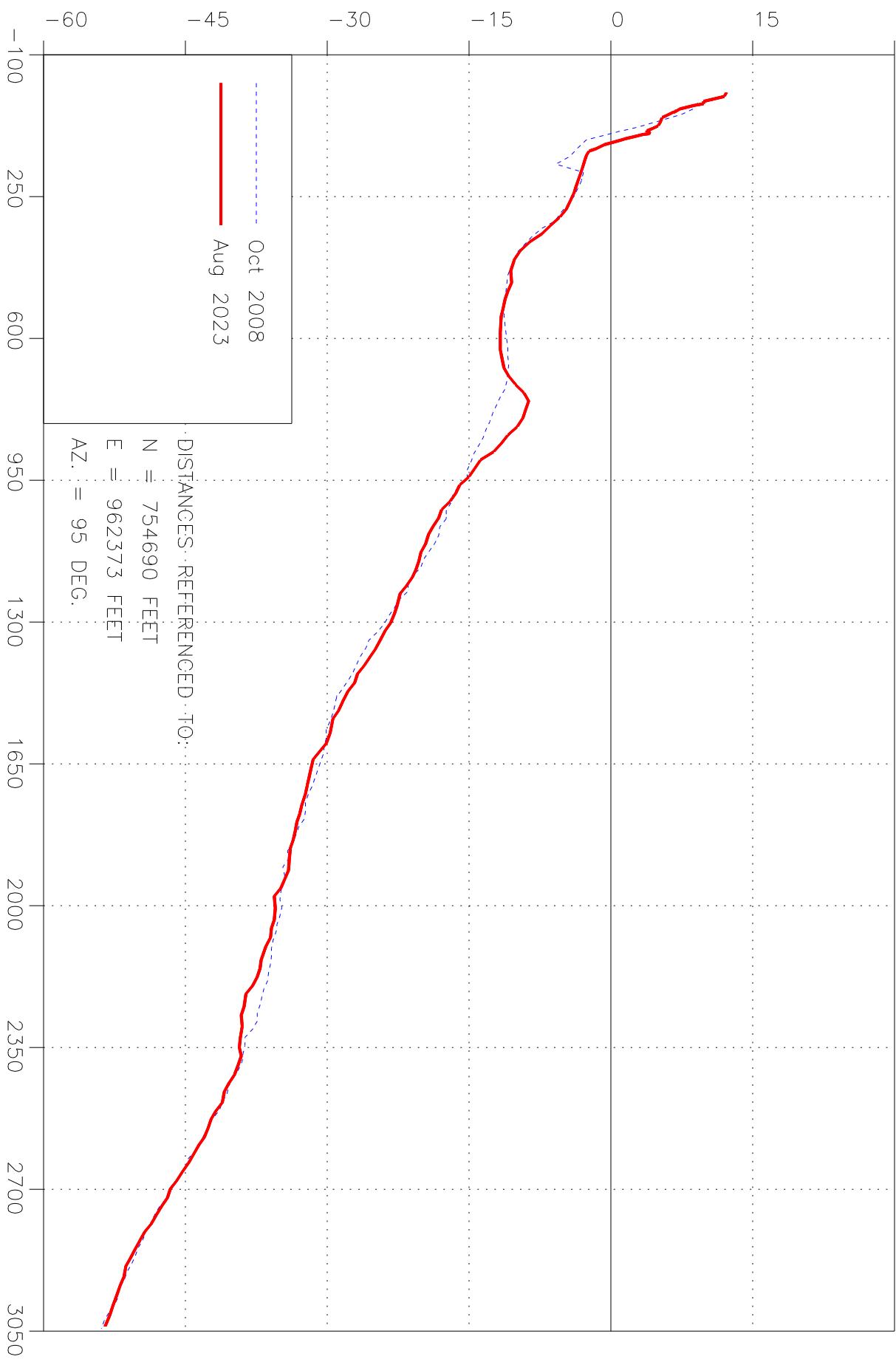
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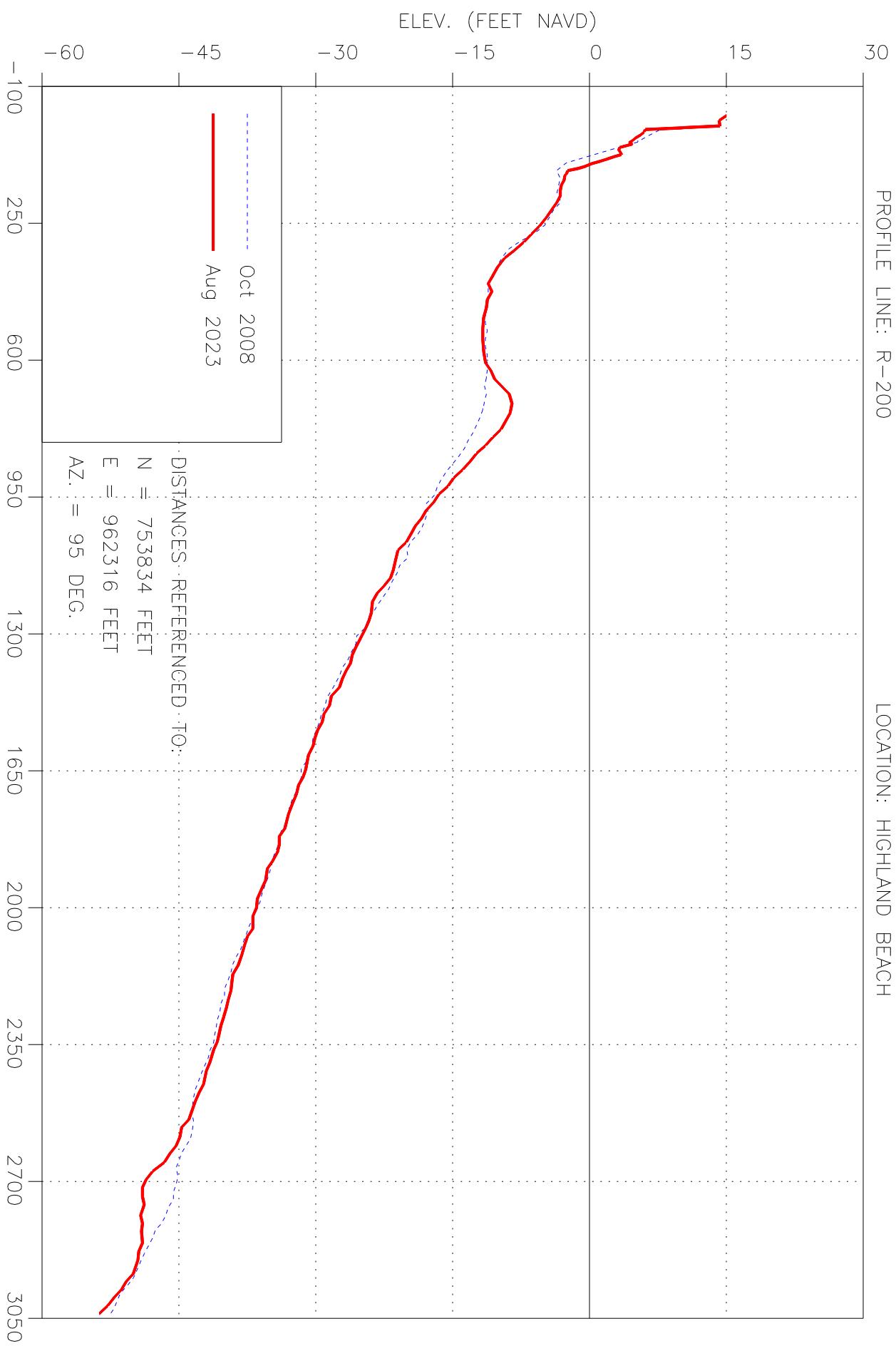


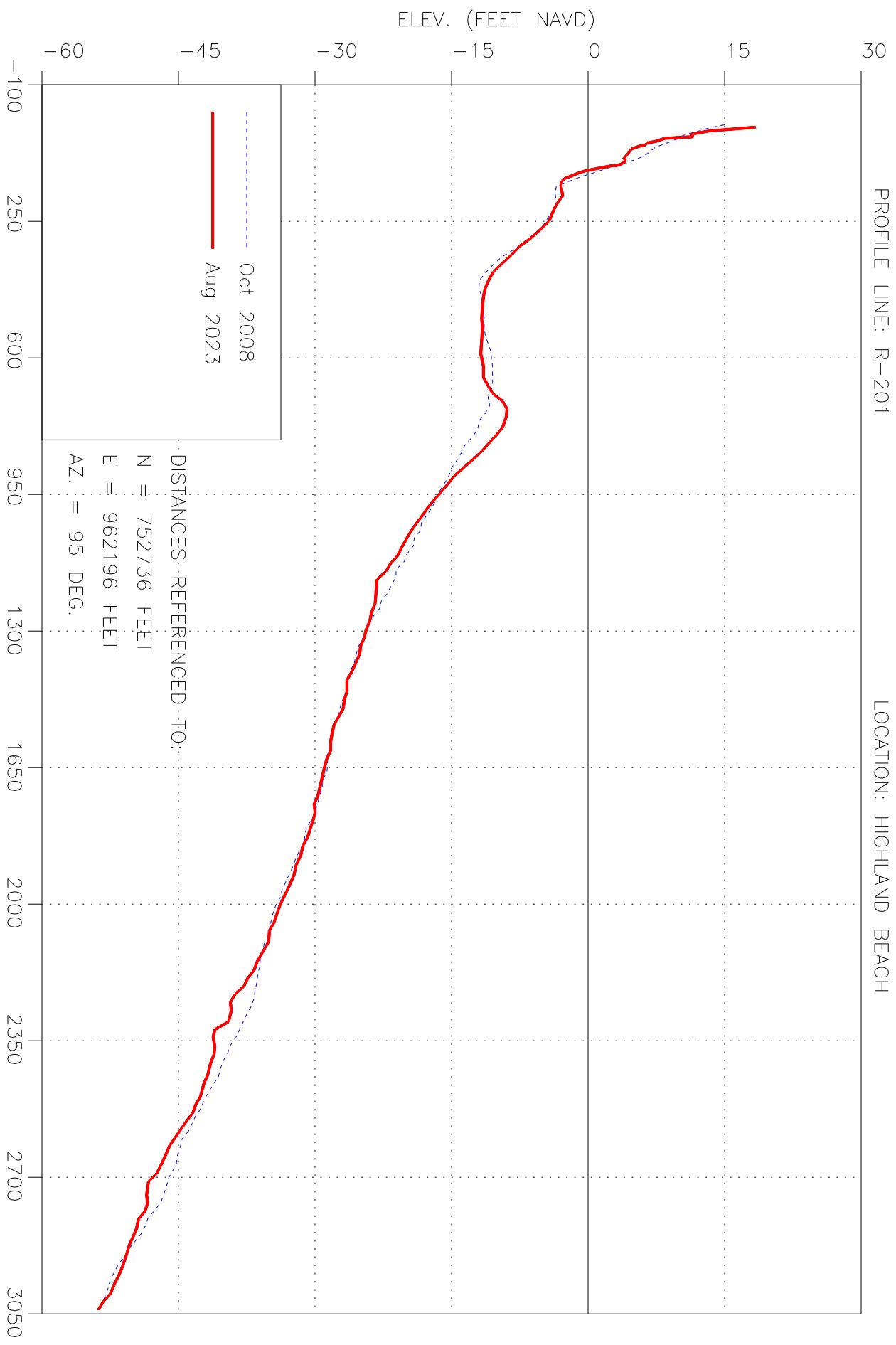
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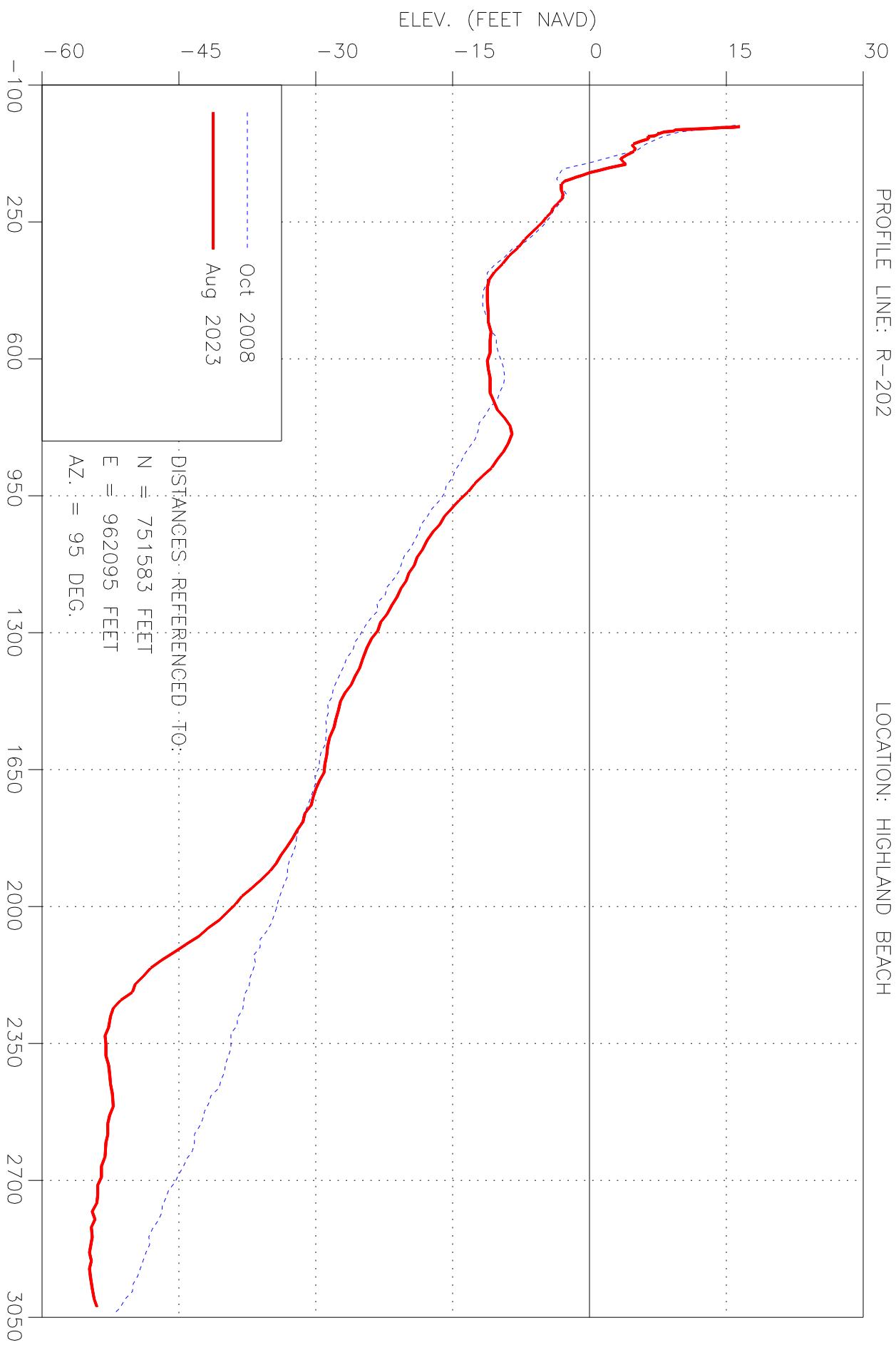
LOCATION: HIGHLAND BEACH

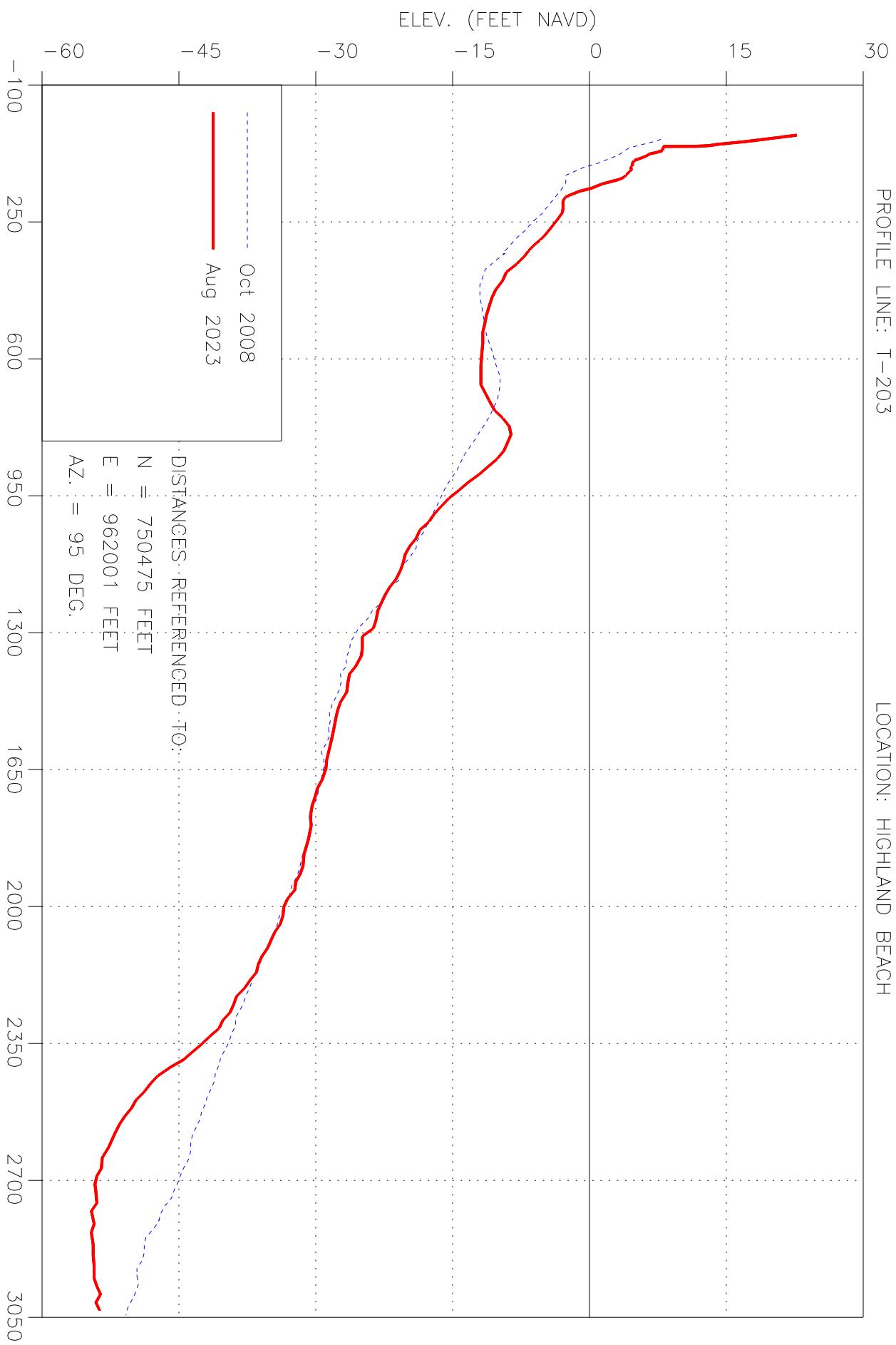
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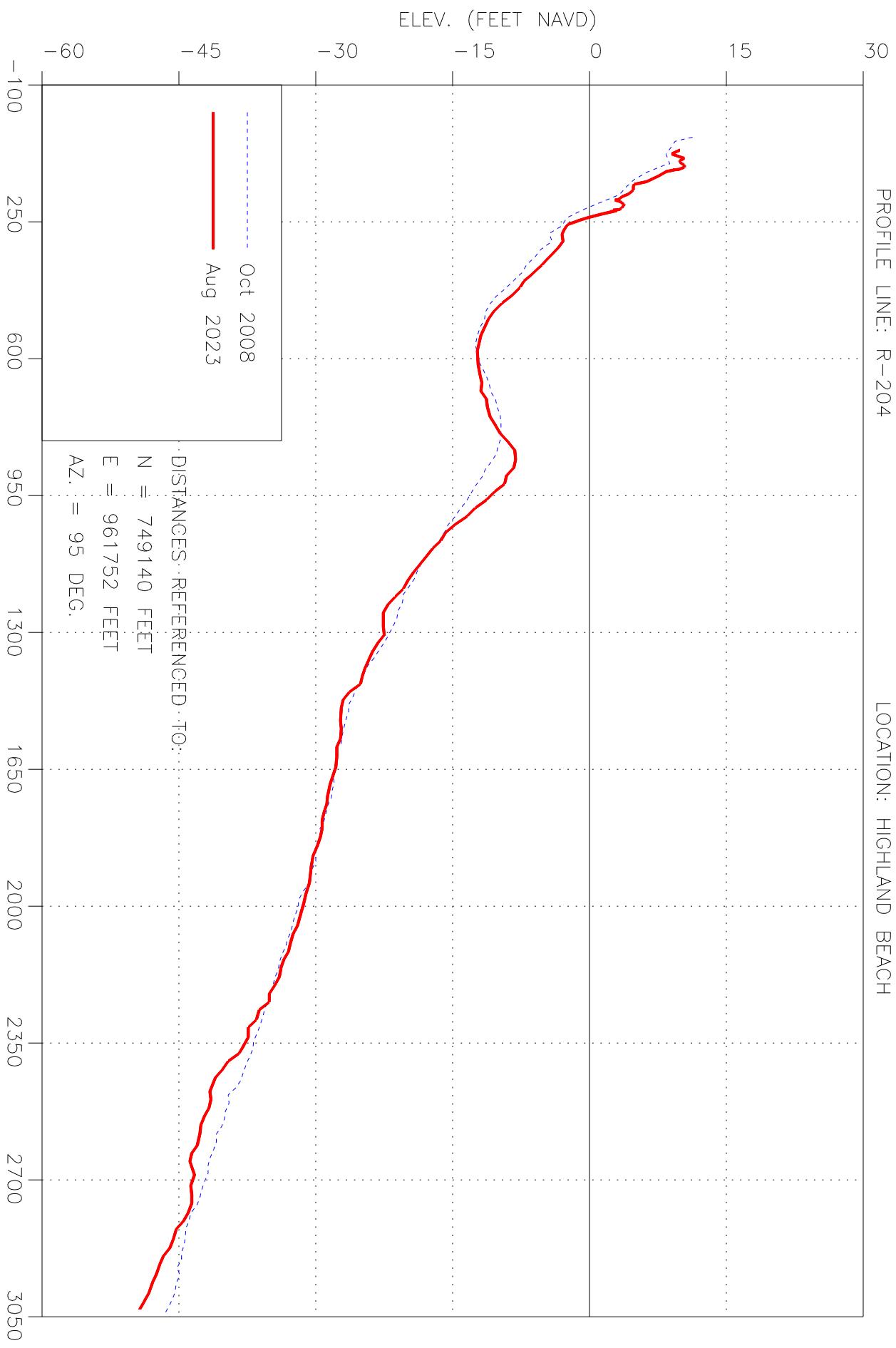












APPENDIX B
BEACH AND DUNE OBSERVATIONS

Highland Beach - Beachfront Property Evaluation [North-to-South]

Property	Photo	Observation	Dune Condition	Is there rock?	Any visible seawalls?	Recommendations
2355 S Ocean Blvd		<ul style="list-style-type: none"> - Wide beach - Delray gray sands - ~20" berm scarp - Historical wrack line at the toe of the dune - There is a depressed area mid-berm with 2 additional wrack line - Nearshore bar with a 12-18" trough at the low-tide water line. - High tide/wave run-up 	<ul style="list-style-type: none"> - Dune crest elevation is ~3-3.5' above berm elevation - ~2-2.5' of dune scarp, with a 1H:2V seaward slope - Back dune areas have a 2H:1V slope towards the dune crest - Top of dune comprised of panic grass, sea oats; railroad vines at the toe of the scarp line - Seaward dune vegetation thinning/dying at scarp line 	No	No	Restore dune toe with 2cy/ft of sand along east dune toe. Revegetate dune toe with pioneer zone dune vegetation.
2359 S Ocean Blvd		<ul style="list-style-type: none"> - Wide beach - Delray gray sands - ~19" berm scarp - Historical wrack line at the toe of the dune - There is a depressed area mid-berm with 2 additional wrack line - Nearshore bar with a 12-18" trough at the low-tide water line. - High tide/wave run-up 	<ul style="list-style-type: none"> - Dune crest elevation is ~3.5-4' above berm elevation - ~2.5-3' of dune scarp, with a 1H:3V seaward slope - Back dune areas have a 2H:1V slope towards the dune crest - Top of dune comprised of panic grass, sea oats; railroad vines at the toe of the scarp line - Seaward dune vegetation thinning/dying at scarp line 	No	No	Restore dune toe with 2cy/ft of sand along east dune toe. Revegetate dune toe with pioneer zone dune vegetation.
2363 S Ocean Blvd		<ul style="list-style-type: none"> - Wide beach - Delray gray sands - ~18" berm scarp - Historical wrack line at the toe of the dune - There is a depressed area mid-berm with 2 additional wrack line 	<ul style="list-style-type: none"> - Dune crest elevation is ~4-4.5' above berm elevation - ~2.5-3' of dune scarp, with a 1H:3V seaward slope - Back dune areas have a 2H:1V slope towards the dune crest - Top of dune comprised of panic grass, sea oats; railroad vines at the toe of the scarp line - Seaward dune vegetation thinning/dying at scarp line 	No	No	Restore dune toe with 2cy/ft of sand along east dune toe. Revegetate dune toe with pioneer zone dune vegetation.
2365 S Ocean Blvd		<ul style="list-style-type: none"> - Wide beach - Delray gray sands - ~16" berm scarp - Historical wrack line at the toe of the dune - There is a depressed area mid-berm with 2 additional wrack line 	<ul style="list-style-type: none"> - Dune crest elevation is ~4.5-5' above berm elevation - ~2.5-3' of dune scarp, with a 1H:2V seaward slope - Other areas of dune have a 2H:1V slope - Top of dune comprised of panic grass, sea oats; railroad vines at the toe of the scarp line - Seaward dune vegetation thinning/dying at scarp line 	No	No	Restore dune toe with 2cy/ft of sand along east dune toe. Revegetate dune toe with pioneer zone dune vegetation.

1. Seawalls include all types of retaining structures (seawalls, revetments, retaining walls, etc.). Detailed review of property specific plans was not performed.

Highland Beach - Beachfront Property Evaluation [North-to-South]

Property	Photo	Observation	Dune Condition	Is there rock?	Any visible seawalls?	Recommendations
2367 S Ocean Blvd		<ul style="list-style-type: none"> - Wide beach - Deltay gray sands - ~12" berm scarp - Historical wrack line at the toe of the dune - There is a depressed area mid-berm with 2 additional wrack line 	<ul style="list-style-type: none"> - Dune crest elevation is ~3.5-4' above berm elevation - ~2.5-3' of dune scarp with a 1H:2.5V seaward slope - Some seaward vegetated areas of dune scarp have 1H:1V slope (wave run-up) - Other areas of dune have a 2H:1V slope - Top of dune comprised of panic grass, sea oats; railroad vines at the toe of the scarp dune; dense vegetation (sea grape) towards the back of the dune 	No	No	Restore dune toe with 2cy/ft of sand along east dune toe. Revegetate dune toe with pioneer zone dune vegetation.
2375 S Ocean Blvd		<ul style="list-style-type: none"> - Wide beach - Deltay gray sands - ~10" berm scarp - Historical wrack line at the toe of the dune - There is a depressed area mid-berm with 2 additional wrack line 	<ul style="list-style-type: none"> - Dune crest elevation is ~3.5-4' above berm elevation - ~2.5-3' of dune scarp with a 1H:2.5V seaward slope - Some seaward vegetated areas of dune scarp has 1H:1V slope (wave run-up) - Other areas of dune have a 2H:1V slope - Top of dune comprised of panic grass, sea oats; railroad vines at the toe of the scarp dune; dense vegetation (sea grape) towards the back of the dune - Dune vegetation at N property line (near walkway) is thinning/dying on seaward side 	No	No	Restore dune toe with 2cy/ft of sand along east dune toe. Revegetate dune toe with pioneer zone dune vegetation.
2395 S Ocean Blvd		<ul style="list-style-type: none"> - Wide beach - Deltay gray sands - ~4" berm scarp - Historical wrack line at the toe of the dune - There is a depressed area mid-berm with 2 additional wrack line 	<ul style="list-style-type: none"> - Dune crest elevation is ~2.5-3' above berm elevation - ~1.5-2' of dune washout/scarp, with a 2H:1V seaward slope - Vegetation on top of dune crest is thinned out ~10' landward - Top of dune comprised of panic grass, sea oats; railroad vines at the toe of the scarp dune; dense vegetation (sea grape) towards the back of the dune 	No	No	Restore dune toe with 2cy/ft of sand along east dune toe. Revegetate dune toe with pioneer zone dune vegetation.
2425 S Ocean Blvd		<ul style="list-style-type: none"> - Wide beach - Deltay gray sands - berm scarp leveled off - Historical wrack line at the toe of the dune - There is a depressed area mid-berm with 2 additional wrack line 	<ul style="list-style-type: none"> - Dune crest elevation is ~3.5-4' above berm elevation - ~2.5-3' of dune scarp with a 1H:2V seaward slope - Some seaward vegetated areas of dune scarp have 1H:1V slope (wave run-up) - Other areas of dune have a 2H:1V slope - Top of dune comprised of panic grass, sea oats; railroad vines extend to mid-berm; dense vegetation (sea grape) towards the back of the dune - Seaward dune vegetation thinning/dying at scarp line 	No	No	Restore dune toe with 2cy/ft of sand along east dune toe. Revegetate dune toe with pioneer zone dune vegetation.

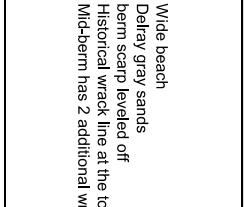
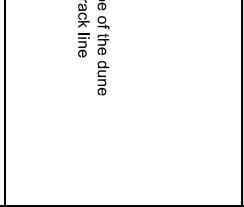
Highland Beach - Beachfront Property Evaluation [North-to-South]

Property	Photo	Observation	Dune Condition	Is there rock?	Any visible seawalls?	Recommendations
2435 S Ocean Blvd		<ul style="list-style-type: none"> Wide beach Delray gray sands berm scarp leveled off Historical wrack line at the toe of the dune Mid-berm has 1 additional wrack line 	<ul style="list-style-type: none"> Dune crest elevation is ~3.5-4' above berm elevation Northern side of the dune higher than southern side ~2-2.5' of dune scarp, with a 1H:2V seaward slope on N property & 1H:1V slope on S property Back dune areas have a 2H:1V slope Top of dune comprised of panic grass, sea oats; railroad vines extend to mid-berm; dense vegetation (sea grape) towards the back of the dune Seaward dune vegetation thinning/dying at scarp line & thinning extends on top of dune crest landward 	No	No	Restore dune toe with 2cy/ft of sand along east dune toe. Revegetate dune to with pioneer zone dune vegetation.
2445 S Ocean Blvd		<ul style="list-style-type: none"> Wide beach Delray gray sands berm scarp leveled off Historical wrack line at the toe of the dune Mid-berm has 1 additional wrack line 	<ul style="list-style-type: none"> Dune crest elevation is ~2.5-3' above berm elevation ~5-1' dune scarp on N property line & ~1.5-2' of dune scarp the rest of the property with a 1H:2V seaward slope Back dune areas have a 2H:1V slope Top of dune comprised of panic grass, sea oats; railroad vines extend to dune toe; dense vegetation towards the back of the dune Seaward dune vegetation thinning/dying at scarp line & thinning extends on top of dune crest landward 	No	No	Restore dune toe with 2cy/ft of sand along east dune toe. Revegetate dune to with pioneer zone dune vegetation.
2455 S Ocean Blvd		<ul style="list-style-type: none"> Wide beach Delray gray sands berm scarp leveled off Historical wrack line at the toe of the dune Mid-berm has 1 additional wrack line 	<ul style="list-style-type: none"> Dune crest elevation is ~2-2.5' above berm elevation Dune's crest appears to be positioned more landward than neighboring properties ~1.5' of dune washout/scarp, with a 2H:1V seaward slope to gradual, 3H:1V slope to the toe Vegetation on top of dune crest is thinned out ~10' landward Top of dune comprised of panic grass & sea oats; railroad vines at the toe of the scarp dune; dense vegetation (sea grape) towards the back of the dune 	No	No	Restore dune toe with 2cy/ft of sand along east dune toe. Revegetate dune to with pioneer zone dune vegetation.
2475 S Ocean Blvd		<ul style="list-style-type: none"> Wide beach Delray gray sands berm scarp leveled off Historical wrack line at the toe of the dune Mid-berm has 2 additional wrack line 	<ul style="list-style-type: none"> Dune crest elevation is ~2-2.5' above berm elevation ~1.5-2' of dune scarp, with a 1H:2V seaward slope Vegetation on top of dune crest is thinned out ~10' landward Other areas of dune have a 2H:1V slope Top of dune comprised of panic grass, sea oats; railroad vines at the toe of the scarp dune; dense vegetation (sea grape) towards the back of the dune Seaward dune vegetation thinning/dying at scarp line 	No	No	Restore dune toe with 2cy/ft of sand along east dune toe. Revegetate dune to with pioneer zone dune vegetation.

Highland Beach - Beachfront Property Evaluation [North-to-South]

Property	Photo	Observation	Dune Condition	Is there rock?	Any visible seawalls?	Recommendations
2525 S Ocean Blvd		<ul style="list-style-type: none"> - Wide beach - Delta gray sands - berm scarp leveled off - Historical wrack line at the toe of the dune - Mid-berm has 1 additional wrack line 	<ul style="list-style-type: none"> - Dune crest elevation is ~2-2.5' above berm elevation - ~1.5-2' of dune scarp, with a 2H:1V seaward slope - Other areas of dune have a 2H:1V slope - Top of dune comprised of panic grass, sea oats; railroad vines at the toe of the scarpd dune; dense vegetation (sea grape) towards the back of the dune - Seaward dune vegetation thinning/dying at scarp line 	No	No	Restore dune toe with 2cy/ft of sand along east dune toe. Revegetate dune toe with pioneer zone dune vegetation.
Townhouses of Highland Beach 2575 S Ocean Blvd		<ul style="list-style-type: none"> - Wide beach - Delta gray sands - berm scarp leveled off - Historical wrack line at the toe of the dune - Mid-berm has additional wrack line 	<ul style="list-style-type: none"> - Dune crest elevation is ~2-2.5' above berm elevation - ~1-1.5' of dune scarp, with a 2H:1V seaward slope - Other areas of dune have a 2H:1V slope - Top of dune comprised of panic grass, sea oats; railroad vines at the toe of the scarpd dune; dense vegetation (sea grape) towards the back of the dune - Seaward dune vegetation thinning/dying at scarp line 	No	No	Restore dune toe with 2cy/ft of sand along east dune toe. Revegetate dune toe with pioneer zone dune vegetation.
2635 S Ocean Blvd		<ul style="list-style-type: none"> - Wide beach - Delta gray sands - berm scarp leveled off - Historical wrack line at the toe of the dune - Mid-berm has additional wrack line 	<ul style="list-style-type: none"> - Dune crest elevation is ~2-2.5' above berm elevation - The dune in front of the N. building is positioned more landward than the dune in front of the S. building; the southern dune falls in line with adjacent northern properties - Dune crest elevation lower in the middle of the property (~2' above berm) compared to the edges - ~1.5-2' of dune washouls/scarp, with a 2H:1V seaward slope - Seaward vegetation up to the dune crest is thinned out. ~5-6' of front dune veg before dense sea grape back dune; especially the south dune - Dune comprised of panic grass, sea oats, sea grape 	No	No	Restore dune toe with 2cy/ft of sand along east dune toe. Revegetate dune toe with pioneer zone dune vegetation.

Highland Beach - Beachfront Property Evaluation [North-to-South]

Property	Photo	Observation	Dune Condition	Is there rock?	Any visible seawalls?	Recommendations
2633 S Ocean Blvd		<ul style="list-style-type: none"> Wide beach Delray gray sands berm scarp leveled off Historical wrack line at the toe of the dune Mid-berm has 2 additional wrack line 	<ul style="list-style-type: none"> Dune crest elevation is ~1.5-2' above berm elevation ~1' of dune scarp, especially around the center of the property, with a 1H:1V seaward slope that gradually become a 3H:1V slope to the toe ~5' washed out vegetation extending into the toe little to no dune vegetation/grasses along south property line Top of dune comprised of panic grass, sea oats, railroad vines at the toe of the scarp dune; dense vegetation (sea grape) towards the back of the dune 	No	No	Restore dune toe with 1cy/ft of sand along east dune toe. Revegetate dune to with pioneer zone dune vegetation.
Carlton House 2701 S Ocean Blvd		<ul style="list-style-type: none"> Wide beach Delray gray sands Berm scarp leveled off Historical wrack line at the toe of the dune Mid-berm has additional wrack line 	<ul style="list-style-type: none"> Dune crest elevation is ~1.1' above berm elevation from north-to-mid property, and is ~2-2.5' from mid-to-south property No dune scarp but rather wave runup to ~2' above the berm, only observed mid-to-south; the northern dune is at a lower elevation and has been washed over, with little/thinned vegetation before back dune 2H:1V seaward slope where vegetation remains than gradually 3H:1V slope to the toe/wrack line North property edge has sea grapes rather than a planted dune Dune comprised of ~5-10' of thinned sea oats before the dense back dune vegetation (sea grape); railroad vines growing in wrack line 	No	No	Restore dune toe with 2cy/ft of sand along east dune toe. Revegetate dune to with pioneer zone dune vegetation. Consider raising the crest elevation of the dune.
Jamaica Manor 2711 S Ocean Blvd		<ul style="list-style-type: none"> Wide beach Delray gray sands Berm scarp leveled off Historical wrack line at the toe of the dune Mid-berm has additional wrack line 	<ul style="list-style-type: none"> Dune crest elevation is ~1.5-2' above berm elevation No dune scarp but rather wave runup to crest of the dune 3H:1V seaward slope where vegetation remains; back dune slope levels off, with a 10H:1V slope to the seawall North property edge has sea grapes rather than a planted dune Dune comprised of ~5-10' of thinned sea oats before the dense back dune vegetation (sea grape); railroad vines growing in wrack line 	No	No	Restore dune toe with 2cy/ft of sand along east dune toe. Revegetate dune to with pioneer zone dune vegetation. Consider raising the crest elevation of the dune.
Villa Magna 2727 S Ocean Blvd		<ul style="list-style-type: none"> Wide beach Delray gray sands Berm scarp leveled off Historical wrack line at the toe of the dune Mid-berm has additional wrack line 	<ul style="list-style-type: none"> Dune crest elevation is ~2' above berm elevation north of steps and ~3' south of step fronting the pool structure North end has wave runup to crest of the dune, extending ~10-15' into the thinned vegetation with a 6H:1V seaward slope in these areas South end has ~2-5' runup/slight scarp with a 3H:1V seaward slope; dying vegetation at scarp line Back dune slope levels off, with a 10H:1V slope to the seawall Dune comprised of ~50' of thinned sea oats before the dense back dune vegetation (sea grape); railroad vines growing in wrack line 	No	Yes. Historical revetment partially buried.	Restore dune toe with 2cy/ft of sand along east dune toe. Revegetate dune to with pioneer zone dune vegetation. Consider raising elevation of dune crest.

Highland Beach - Beachfront Property Evaluation [North-to-South]

Property	Photo	Observation	Dune Condition	Is there rock?	Any visible seawalls?	Recommendations
Delray Sands 2809 S Ocean Blvd		<ul style="list-style-type: none"> - Beach getting thinner - Delray gray sands - Berm scarp leveled off - Historical wrack line at the toe of the dune - Mid-berm has additional wrack line 	<ul style="list-style-type: none"> - Dune crest elevation is ~2-2.5' above berm elevation north of the steps and is ~3-4' south of the steps - North dune has ~2' scarp with a 1H:2V seaward slope and the south dune has ~3' scarp with a 1H:3V slope - Wave runup over parts of the north dune - Areas of thinned/dying vegetation on the seaward slopes - Dune comprised of panic grass, sea oats, with a dense sea grape back dune; the sea grapes along the south end of the property extend seaward to the dune crest 	No	No	Restore dune toe with 2cy/ft of sand along east dune toe. Revegetate dune to with pioneer zone dune vegetation.
Highlands Place 2901 S Ocean Blvd		<ul style="list-style-type: none"> - Beach getting thinner - Delray gray sands - Berm scarp leveled off - Historical wrack line at the toe of the dune - Mid-berm has additional wrack line 	<ul style="list-style-type: none"> - No visible dune fronting the dense Seagrape vegetation at both end of the property; these plantings are ~1' above berm elevation - Dune crest elevation from mid-property is ~2-3' above berm elevation with ~2' scarp with a 1H:1V seaward slope - Wave runup/turtle nests have created depressed parts of seaward dune - Areas of thinned/dying vegetation on the seaward slopes - Dune comprised of sea oats, but is mainly a denser sea grape back dune 	No	Unknown	Restore dune toe with 1cy/ft of sand along east dune toe. Revegetate dune to with pioneer zone dune vegetation.
Wiltshire 2909 S Ocean Blvd		<ul style="list-style-type: none"> - Beach getting thinner - Delray gray sands, traces of Highland shelly brown sands - Berm scarp leveled off - Historical wrack line at the toe of the dune - Mid-berm has additional wrack line 	<ul style="list-style-type: none"> - North dune crest elevation is ~3-3.5' above berm with ~2' scarp - South dune crest elevation is ~3.5-4' above berm with ~3' scarp - Dune has with a 1H:2V seaward slope with thinned/dying vegetation at scarp line - The dune vegetation tapers landward mid property/at walkway compared to the property edges - Dune comprised of sea oats, railroad vines extending to dune's toe wrack line, and sea grapes start on dune crest extending landward. 	No	Yes, ~6' tall	Restore dune toe with 2cy/ft of sand along east dune toe. Revegetate dune to with pioneer zone dune vegetation.
Trafalgar Beach 2917 S Ocean Blvd		<ul style="list-style-type: none"> - Beach getting thinner - Delray gray sands, traces of Highland shelly brown sands - Berm scarp leveled off - Historical wrack line at the toe of the dune - Mid-berm has additional wrack line 	<ul style="list-style-type: none"> - Dune crest elevation is ~2.5-3' above berm elevation with 2H:1V slope for most of the south half of the property - The dune at the north property line is positioned more seaward and has ~2' scarp with a 1H:2V slope; thinned/dying vegetation at scarp line - The dune vegetation tapers landward mid property/at walkway compared to the property edges; wave runup over the dune crest in this area - Dune comprised of sea oats, but is mainly a denser sea grape back dune to the seawall 	No	Yes, ~7-8' tall	Restore dune toe with 2cy/ft of sand along east dune toe. Revegetate dune to with pioneer zone dune vegetation.

Highland Beach - Beachfront Property Evaluation [North-to-South]

Property	Photo	Observation	Dune Condition	Is there rock?	Any visible seawalls?	Recommendations
Highland Towers 2021 S Ocean Blvd		<ul style="list-style-type: none"> - Beach getting thinner - Delray gray sands, traces of Highland shelly brown sands - Berm scarp leveled off - Historical wrack line at the toe of the dune - Mid-berm has additional wrack line - wrack lines are closer together at this property 	<ul style="list-style-type: none"> - Dune crest elevation is ~2-5' above berm elevation - Dune has ~2' scarp with a 1H:1V slope, thinned/dying vegetation at scarp line - The north dune crest has been washed over (wave runup) - Dune comprised of ~15-20' of panic grass and sea oats fronting the dense back dune vegetation (sea grape) 	No	Yes. ~7' tall	Restore dune toe with 2cy/ft of sand along east dune toe. Revegetate dune toe with pioneer zone dune vegetation.
Ocean Pines 3009 S Ocean Blvd		<ul style="list-style-type: none"> - Beach getting thinner - Delray gray sands, traces of Highland shelly brown sands - Berm scarp leveled off - Historical wrack line at the toe of the dune - Mid-berm has additional wrack line - Nearshore sand bar is ~40' from waterline 	<ul style="list-style-type: none"> - North dune crest elevation is ~2-2.5' above berm with ~1.5-2' scarp - South dune crest elevation is ~3-3.5' above berm with ~3' scarp - Dune has with a 1H:1V seaward slope with thinned/dying vegetation at scarp line - Back dune has 2H:1V landward slope - The dune vegetation tapers landward from north to south - Dune comprised of sea oats, fronting a denser back dune (sea grapes) start on dune crest extending landward. 	No	Yes. ~6' tall	Restore dune toe with 2cy/ft of sand along east dune toe. Revegetate dune toe with pioneer zone dune vegetation.
Ocean Dunes 3015 S Ocean Blvd		<ul style="list-style-type: none"> - Beach getting thinner - Delray gray sands, traces of Highland shelly brown sands - Berm scarp leveled off - Historical wrack line at the toe of the dune - Mid-berm has additional wrack line 	<ul style="list-style-type: none"> - Dune crest elevation is ~3.5' above berm elevation - Dune has ~3' scarp with a 1H:3V slope - Dune comprised of sea oats, fronting a denser back dune (sea grapes) - Barely any dune fronting the sea grape vegetation - The dune crest has been washed over (wave runup) exposing the base of the sea grape - Dune has thinned/dying vegetation at scarp line 	No	Unknown	Restore dune toe with 2cy/ft of sand along east dune toe. Revegetate dune toe with pioneer zone dune vegetation.
Penthouse Towers 3101 S Ocean Blvd		<ul style="list-style-type: none"> - Beach getting thinner - Delray gray sands, traces of Highland shelly brown sands - Berm scarp leveled off - Historical wrack line at the toe of the dune - Mid-berm has additional wrack line 	<ul style="list-style-type: none"> - Sea grape vegetation on seaward side of the dune - Dune crest elevation is ~2' above berm elevation with a 2H:1V slope where veg remains - Dune has ~1.5-2' scarp exposes the base of the sea grape - The dune vegetation thins tapering landward mid-property/at walkway compared to the property edges - Some areas mid-property have been washed over (wave runup) 	No	Yes. ~3.5-4' tall	Restore dune toe with 2cy/ft of sand along east dune toe. Revegetate dune toe with pioneer zone dune vegetation.

Highland Beach - Beachfront Property Evaluation [North-to-South]

Property	Photo	Observation	Dune Condition	Is there rock?	Any visible seawalls?	Recommendations
Ocean Terrace N 3115 S Ocean Blvd		<ul style="list-style-type: none"> - Beach getting thinner - Delray gray sands, traces of Highland shelly brown sands - Berm scarp leveled off - Historical wrack line at the toe of the dune - Mid-berm has additional wrack line 	<ul style="list-style-type: none"> - Sea grape vegetation present to seaward dune toe - Dune crest elevation is ~2.5' above berm elevation at the north/south ends of the property and is ~2.5' above the berm mid-property - Dune has ~1.5-2' scarp, exposes the base of the sea grape line - Dune has with a 1H:2V seaward slope with thinned/dying vegetation at scarp line - Wave runup/wave nests have created depressed parts the exposed dune - Dune comprised of mainly of denser sea grape and beach naupaka, and some sea oats where some fronting dune is present 	No	No	Restore dune toe with 2cy/ft of sand along east dune toe. Revegetate dune to with pioneer zone dune vegetation.
Beach Walk E 3201 S Ocean Blvd		<ul style="list-style-type: none"> - Beach getting thinner - Delray gray sands, traces of Highland shelly brown sands - Berm scarp leveled off - Historical wrack line at the toe of the dune - Mid-berm has additional wrack line 	<ul style="list-style-type: none"> - Dune crest elevation is ~2.5-3' above berm elevation - Dune has ~1.5-2' scarp with a 1H:2V slope, thinned/dying vegetation at scarp line - Sea grape vegetation extends to dune toe, base of plants exposed at scarp line - The north dune crest has been washed over (wave runup) - Erosion around steps/walkway locations - Dune comprised of mainly of denser sea grape and beach naupaka, and some sea oats where some fronting dune is present; some railroad vines in wrack line 	No	No	Restore dune toe with 2cy/ft of sand along east dune toe. Revegetate dune to with pioneer zone dune vegetation.
Villa Mare 3211 S Ocean Blvd		<ul style="list-style-type: none"> - Beach getting thinner - Delray gray sands, traces of Highland shelly brown sands - Berm scarp leveled off - Historical wrack line at the toe of the dune - Mid-berm has additional wrack line 	<ul style="list-style-type: none"> - Dune crest elevation is ~3' above berm elevation with ~2.5' scarp and a 1H:2V slope - Dune comprised of mainly of denser sea grape and beach naupaka, and some sea oats where some dune toe is present - Dune has thinned/dying vegetation at scarp line, exposing base of sea grape/naupaka vegetation - South dune, near steps, has been washed over (wave runup), exposed base of vegetation is positioned ~6' landward compared to rest of dune 	No	No	Restore dune toe with 2cy/ft of sand along east dune toe. Revegetate dune to with pioneer zone dune vegetation.
Ambassadors V - North 3221 S Ocean Blvd		<ul style="list-style-type: none"> - Beach getting thinner - Delray gray sands, traces of Highland shelly brown sands - Berm scarp leveled off - Historical wrack line at mid-berm 	<ul style="list-style-type: none"> - Dune crest elevation is ~3' above berm elevation at edges of property with ~2.5' scarp/runup to base of vegetation - Dune crest elevation is ~3.5-4' above berm at mid dune (fronting pool area) with ~2.5' scarp and a 1H:2V slope - ~25-30' of dune vegetation fronting seawall, which thins out in front of the buildings - Dune comprised of mainly of sea oats and beach naupaka, with some palm trees - Dune has thinned/dying vegetation at scarp line, exposing base of sea grape/naupaka vegetation 	No	Yes, ~5' tall	Restore dune toe with 2cy/ft of sand along east dune toe. Revegetate dune to with pioneer zone dune vegetation.

Highland Beach - Beachfront Property Evaluation [North-to-South]

Property	Photo	Observation	Dune Condition	Is there rock?	Any visible seawalls?	Recommendations
Ambassadors V - South 3221 S Ocean Blvd		<p>Coronado at Highland Beach Ocean Club 3321 S Ocean Blvd</p> <ul style="list-style-type: none"> - Beach getting thinner - Delray gray sands, traces of Highland shelly brown sands - Berm scarp leveled off - Historical wrack line at the toe of the dune - Mid-berm has additional wrack line 	<ul style="list-style-type: none"> - North dune crest elevation is ~3.54' above berm elevation with ~2.5' scarp/runup to base of vegetation - Mid-property dune crest elevation is ~1' above berm, appears to have been washed over has a wide flat dune crest - South dune crest elevation at 2.5' above berm elevation with a 1H:2V slope; scarp of 2' at base of sea grape - Dune comprised of mainly of sea oats, sea grape, and beach naupaka, with some palm trees - Dune has thinned/dying vegetation at scarp line, exposing base of sea grape/naupaka vegetation 	No	Yes. ~5' tall	Restore dune toe with 2cy/ft of sand along east dune toe. Revegetate dune toe with pioneer zone dune vegetation.
Ridge O 3401 S Ocean Blvd		<ul style="list-style-type: none"> - Beach getting thinner - Delray gray sands, traces of Highland shelly brown sands - Berm scarp leveled off - Historical wrack line at the toe of the dune - Mid-berm has additional wrack line 	<ul style="list-style-type: none"> - Dune crest elevation is ~2-3.5' above berm elevation with ~2.5' scarp/runup to base of vegetation and a 1H:2V slope - No fronting dune to the north - Dune comprised of mainly of sea oats, sea grapes, beach naupaka, and snake grass, ~20' wide - Dune has thinned/dying vegetation at scarp line, exposing base of vegetation 	No	No	Restore dune toe with 2cy/ft of sand along east dune toe. Revegetate dune toe with pioneer zone dune vegetation.
Clarendon Condominium 3407 S Ocean Blvd		<ul style="list-style-type: none"> - Beach getting thinner - Delray gray sands, traces of Highland shelly brown sands - Berm scarp leveled off - Historical wrack line at the toe of the dune - Mid-berm has additional wrack line 	<ul style="list-style-type: none"> - Dune crest elevation is ~2-2.5' above berm elevation - ~1.5'-2' scarp/runup to base of vegetation and a 1H:2V slope - Top of dune comprised of sea oats and sea grape ~50' wide - Dune has thinned/dying vegetation at scarp line 	No	No	Restore dune toe with 2cy/ft of sand along east dune toe. Revegetate dune toe with pioneer zone dune vegetation.
				No (for building). Yes (for tennis/pool structure);	Restore dune toe with 2cy/ft of sand along east dune toe. Revegetate dune toe with pioneer zone dune vegetation. ~20' tall	

Highland Beach - Beachfront Property Evaluation [North-to-South]

Property	Photo	Observation	Dune Condition	Is there rock?	Any visible seawalls?	Recommendations
3419 S Ocean Blvd		<ul style="list-style-type: none"> - Beach getting thinner - Delray grey sands, traces of Highland shelly brown sands - Berm scarp leveled off - Historical wrack line at the toe of the dune - Mid-berm has additional wrack line 	<ul style="list-style-type: none"> - Dune crest elevation is ~3' above berm elevation under sea grape vegetation - ~2' scarp/runup to base of vegetation and a 1H:2V slope - No dune fronting the dense vegetation - Top of dune comprised of dense sea grape/naupaka, with some sea oats - Dune has thinned/dying vegetation at scarp line 	No	No	<p>Restore dune toe with 2cy/ft of sand along east dune toe.</p> <p>Revegetate dune toe with pioneer zone dune vegetation. Consider reducing seagrape and replacing it with pioneer dune vegetation.</p>
Le Sanctuaire O 3425 S Ocean Blvd		<ul style="list-style-type: none"> - Beach getting thinner - Delray grey sands, traces of Highland shelly brown sands - Berm scarp leveled off - Historical wrack line at the toe of the dune - Mid-berm has additional wrack line 	<ul style="list-style-type: none"> - Dune crest elevation is ~3' above berm elevation under sea grape vegetation - ~2.5' scarp/runup to base of vegetation and a 1H:2V slope - Dune positioned more landward in front of building - No dune fronting the dense vegetation - Top of dune comprised of dense sea grape/naupaka, with some sea oats - Dune has thinned/dying vegetation at scarp line 	No	No	<p>Restore dune toe with 2cy/ft of sand along east dune toe.</p> <p>Revegetate dune toe with pioneer zone dune vegetation. Consider reducing seagrape and replacing it with pioneer dune vegetation.</p>
Villa Nova 3505 S Ocean Blvd		<ul style="list-style-type: none"> - Beach getting thinner - Delray grey sands, traces of Highland shelly brown sands - Berm scarp leveled off - Historical wrack line at the toe of the dune - Mid-berm has additional wrack line 	<ul style="list-style-type: none"> - Dune crest elevation is ~2.5-3' above berm elevation under sea grape vegetation - ~2.5' scarp/runup to base of vegetation and a 1H:2V slope - No dune fronting the dense vegetation - Top of dune comprised of dense sea grape/naupaka with some sea oats - Dune has thinned/dying vegetation at scarp line - Dune veg width tapers landward from north to south 	No	No	<p>Restore dune toe with 2cy/ft of sand along east dune toe.</p> <p>Revegetate dune toe with pioneer zone dune vegetation. Consider reducing seagrape and replacing it with pioneer dune vegetation.</p>

Highland Beach - Beachfront Property Evaluation [North-to-South]

Property	Photo	Observation	Dune Condition	Is there rock?	Any visible seawalls?	Recommendations
Villas at Highland Beach 3511 S Ocean Blvd		<ul style="list-style-type: none"> - Beach getting thinner - Delfay gray sands, traces of Highland shelly brown sands - Berm scarp leveled off - Historical wrack line at the toe of the dune - Mid-berm has additional wrack line 	<ul style="list-style-type: none"> - Dune crest elevation is ~2-2.5' above berm elevation with ~1.5-2' of dune scarp, and a 2H:1V seaward slope - The back dune slopes up to ~8' in elevation - Top of dune comprised of panic grass, sea oats and naupaka; manicured garden hedge at ~25' from front of dune - Dune has thinned/dying vegetation at scarp line 	No	No	Restore dune toe with 2cy/ft of sand along east dune toe. Revegetate dune toe with pioneer zone dune vegetation.
3515 S Ocean Blvd		<ul style="list-style-type: none"> - Beach getting thinner - Delfay gray sands, traces of Highland shelly brown sands - Berm scarp leveled off - Historical wrack line at the toe of the dune - Mid-berm has additional wrack line 	<ul style="list-style-type: none"> - Dune elevation is ~2.5' above berm elevation with ~1.5-2' of dune scarp/wave runup, and a 2H:1V seaward slope - The back dune slopes up to ~6-6.5' in elevation - Top of dune comprised of panic grass and sea oats; sea grape hedge fronting the gazebo ~30' from front of dune - Dune has thinned/dying vegetation at scarp line 	No	No	Restore dune toe with 2cy/ft of sand along east dune toe. Revegetate dune toe with pioneer zone dune vegetation. Consider reducing seagrape and replacing it with pioneer dune vegetation.
3519 S Ocean Blvd		<ul style="list-style-type: none"> - Beach getting thinner - Delfay gray sands, traces of Highland shelly brown sands - Berm scarp leveled off - Historical wrack line at the toe of the dune - Mid-berm has additional wrack line 	<ul style="list-style-type: none"> - Dune crest elevation is ~3' above berm elevation with ~2.5' scarp/runup to base of vegetation and a 1H:2V slope - Not much fronting dune remains - Dune comprised of mainly of sparse sea oats fronting the sea grapes; some cactus plants along south property line - Dune has thinned/dying vegetation at scarp line, exposing base of vegetation 	No	No	Restore dune toe with 2cy/ft of sand along east dune toe. Revegetate dune toe with pioneer zone dune vegetation.
3521 S Ocean Blvd		<ul style="list-style-type: none"> - Berm scarp leveled off - Delfay gray sands, traces of Highland shelly brown sands - Historical wrack line at the toe of the dune - Mid-berm has additional wrack line 	<ul style="list-style-type: none"> - Dune crest elevation is ~2.5' above berm elevation on north side of property with ~1.5' scarp/runup to base of vegetation (dense cactus plants) - Dune crest elevation is ~2' above berm to the south with ~1.5-2' scarp, especially around base of pine tree - Not much fronting dune exists - Dune comprised of mainly of sparse sea oats and grasses, fronting the denser back dune comprised of sea grapes; some cactus plants along north property line - Dune has thinned/dying vegetation at scarp line, exposing base of seaward vegetation 	No	No	Restore dune toe with 2cy/ft of sand along east dune toe. Revegetate dune toe with pioneer zone dune vegetation. Remove pine tree (exotic).

Highland Beach - Beachfront Property Evaluation [North-to-South]

Property	Photo	Observation	Dune Condition	Is there rock?	Any visible seawalls?	Recommendations
Ocean Reef 3525 S Ocean Blvd		<ul style="list-style-type: none"> - Berm scarp leveled off - Delray gray sands, traces of Highland shelly brown sands - Historical wrack line at the toe of the dune - Mid-berm has additional wrack line 	<ul style="list-style-type: none"> - Dune crest elevation is ~2.5' above berm elevation with ~2.5 scarp/runup primarily in the center of the property - The seaward dune has a 2H:1V slope where vegetation remains, and a 3H:1V slope back to ~5' in elevation - Dune comprised of sparse sea oats mid-property, with denser sea grape vegetation along the property edges, and the back dune - Several turtle nests fronting the dune 	No	No	Restore dune toe with 2cy/ft of sand along east dune toe. Revegetate dune toe with pioneer zone dune vegetation.
Highland Beach Club (access)		<ul style="list-style-type: none"> - Only consists of an overwalk staircase from the road to the beach 	<ul style="list-style-type: none"> - Dune appears to have 3' scarp/wave run-up under the steps 	No	No	Restore dune toe with 2cy/ft of sand along east dune toe. Revegetate dune toe with pioneer zone dune vegetation.
3567 S Ocean Blvd		<ul style="list-style-type: none"> - Berm scarp leveled off - Historical wrack line at the toe of the dune - Mid-berm has additional wrack line - Delray gray and Highland brown sands 	<ul style="list-style-type: none"> - Dune crest elevation is ~2.5-3' above berm elevation with ~2.5 scarp/runup primarily around steps - The seaward dune has a 1H:1V slope up to crest, and a 3H:1V slope back to ~5' in elevation - Dune comprised of naupaka and sea grape veg, that is exposed and scraped at the base 	No	No	Restore dune toe with 1cy/ft of sand along east dune toe. Revegetate dune toe with pioneer zone dune vegetation.
3569 S Ocean Blvd		<ul style="list-style-type: none"> - Berm scarp leveled off - Historical wrack line at the toe of the dune - Mid-berm has additional wrack line - Delray gray and Highland brown sands 	<ul style="list-style-type: none"> - Dune crest elevation is ~2.5-3' above berm elevation with ~2.5 scarp/runup primarily north of the steps; ~1.5 scarp/runup mid-south property - The seaward dune has a 1H:1V slope up to crest, and a 3H:1V slope back to ~5' in elevation - Dune comprised of dense cactus and sea grape vegetation, that is exposed and scraped at the base - The vegetation to the north of the steps currently sits ~5' landward of the south vegetation 	No	No	Restore dune toe with 2cy/ft of sand along east dune toe. Revegetate dune toe with pioneer zone dune vegetation. Remove sea grape and installing naupaka and installing pioneer zone vegetation.

Highland Beach - Beachfront Property Evaluation [North-to-South]

Property	Photo	Observation	Dune Condition	Is there rock?	Any visible seawalls?	Recommendations
3571 S Ocean Blvd		<ul style="list-style-type: none"> - Berm scarp leveled off - Historical wrack line at the toe of the dune - Mid-berm has additional wrack line - Delray gray and Highland brown sands 	<ul style="list-style-type: none"> - Dune crest elevation is ~2.5-3' above berm elevation with ~2.5' scarp/runup to dune crest - The seaward dune has a 1H:1V slope up to crest, and a 3H:1V slope back to ~5' in elevation - Dune comprised of sea oats, naupaka and sea grape vegetation, that is exposed and scraped at the base - Tall dense back dune 	No	No	Restore dune toe with 1cy/ft of sand along east dune toe. Revegetate dune toe with pioneer zone dune vegetation.
3573 S Ocean Blvd		<ul style="list-style-type: none"> - Berm scarp leveled off - Historical wrack line at the toe of the dune - Mid-berm has additional wrack line - Delray gray and Highland brown sands 	<ul style="list-style-type: none"> - Dune crest elevation is ~1.5-2' above berm elevation with ~1.5' scarp/runup: most of the front dune is gone - The seaward dune has a 1H:1V slope up to crest, and a 3H:1V slope back to ~8' in elevation - Dune comprised of sparse sea oats of the front dune and dense sea grape vegetation, that is exposed and scraped ~1.5' at the base - The sea grape vegetation to the north of the steps currently extends more seaward out to dune toe, although scraped at base 	No	No	Restore dune toe with 1cy/ft of sand along east dune toe. Revegetate dune toe with pioneer zone dune vegetation.
3575 S Ocean Blvd		<ul style="list-style-type: none"> - Berm scarp leveled off - Historical wrack line at the toe of the dune extending to mid-berm - Delray gray and Highland brown sands - The beach is starting to get more narrow 	<ul style="list-style-type: none"> - Dune crest elevation is ~1.5-2' above berm elevation with ~1.5' scarp/runup: most of the front dune is gone - The seaward dune has a 1H:1V slope up to crest, and a 2H:1V back slope - Dune comprised of sparse sea oats of the front dune and dense sea grape vegetation, that is exposed and scraped ~1.5' at the base - Sea grapes along south property are ~10' landward and front dune has flattened, with a 4H:1V slope fronting the 	No	No	Restore dune toe with 1cy/ft of sand along east dune toe. Revegetate dune toe with pioneer zone dune vegetation. Consider removing sea grape and installing pioneer zone vegetation.
3615 S Ocean Blvd		<ul style="list-style-type: none"> - Berm scarp leveled off - Historical wrack line at the toe of the dune extending to mid-berm - Delray gray and Highland brown sands - The beach is more narrow 	<ul style="list-style-type: none"> - North Dune crest elevation is ~1.5-2' above berm elevation with ~1.5' scarp/runup; sea grapes extend out to the dune toe - South of stairs to mid-property, the dune crest elevation is ~2-2.5' above berm elevation with ~2' scarp/runup; most of the front dune has washed out - Mid-to-south property, the dune crest is ~3' above berm elevation, with ~2.5' scarp/runup - The seaward dune has a 1H:1V slope up to crest, and a 2H:1V back slope - Dune comprised of sparse sea oats/grasses on the front dune and dense sea grape vegetation and naupaka 	No	No	Restore dune toe with 2cy/ft of sand along east dune toe. Revegetate dune toe with pioneer zone dune vegetation. Consider removing sea grape and installing naupaka and installing pioneer zone vegetation.

Highland Beach - Beachfront Property Evaluation [North-to-South]

Property	Photo	Observation	Dune Condition	Is there rock?	Any visible seawalls?	Recommendations
3621 S Ocean Villas Condo		<ul style="list-style-type: none"> - Berm scarp leveled off - Historical wrack line at the toe of the dune extending to mid-berm - Dely gray and Highland brown sands - The beach is more narrow - The beach profile appears to have a steeper slope fronting this property 	<ul style="list-style-type: none"> - Dune crest elevation is ~1.5-2' above berm elevation with ~1.5' scarp/runup to crest - The seaward dune has a 1H:1.5V slope up to crest, and a 1H:1V back slope on the tail back dune - ~2' scarp behind each of the beach access steps - Front dune vegetation is sparse, comprised of sea oats/grasses and railroad vines; and dense sea grape vegetation on the back dune 	No	No	Restore dune toe with 1cy/ft of sand along east dune toe. Revegetate dune toe with pioneer zone dune vegetation. Consider removing sea grape and installing pioneer zone vegetation.
Toscana E 3701 S Ocean Blvd		<ul style="list-style-type: none"> - Berm scarp leveled off - wrack line at crest of mid-berm slope - Dely gray and Highland brown sands - The beach is more narrow - The beach profile appears to have a steeper slope from the waterline to mid-berm - Nearshore bar is ~50' from waterline 	<ul style="list-style-type: none"> - Dune crest elevation is ~2.5' above berm elevation with ~2' scarp/runup to crest - The seaward dune has a 1H:2V slope up to crest, and a 3H:1V back slope - Dune vegetation comprised of sea oats and sunflowers with a denser sea grape and naupaka vegetation on the back dune 	No	No	Restore dune toe with 2cy/ft of sand along east dune toe. Revegetate dune toe with pioneer zone dune vegetation.
3711 S Ocean Blvd		<ul style="list-style-type: none"> - Berm scarp leveled off - Historical wrack line at the toe of the dune - Mid-berm has additional wrack line - Dely gray and Highland brown sands - The beach is more narrow - The beach profile appears to have a milder slope compared to the northern adjacent property 	<ul style="list-style-type: none"> - Front dune crest elevation is ~2.5' above berm elevation with ~2' scarp/runup at base of vegetation - The seaward dune has a 1H:2.5V slope up to crest, and a 3H:1V back slope - Dune comprised of sea grape and naupaka vegetation with some snake plants 	No	No	Restore dune toe with 2cy/ft of sand along east dune toe. Revegetate dune toe with pioneer zone dune vegetation.
3715 S Ocean Blvd		<ul style="list-style-type: none"> - Berm scarp leveled off - Historical wrack line at the toe of the dune - Mid-berm has additional wrack line - Dely gray and Highland brown sands - The beach is more narrow 	<ul style="list-style-type: none"> - Mid-property front dune crest elevation is ~1.5' above berm elevation with ~1' scarp/runup at base of vegetation - Back dune and base of sea grapes are ~3' above berm with up to ~3' scarp/runup, exposing vegetation roots - The seaward dune has a 1H:1V slope up to crest, and a 1H:3V back slope - Dune comprised of sea grape and naupaka vegetation with some palm trees - 2 layers of sandbags stacked fronting the vegetation to the north of the beach access ramp 	No	No	Restore dune toe with 2cy/ft of sand along east dune toe. Revegetate dune toe with pioneer zone dune vegetation.

Highland Beach - Beachfront Property Evaluation [North-to-South]

Property	Photo	Observation	Dune Condition	Is there rock?	Any visible seawalls?	Recommendations
3719 S Ocean Blvd		<ul style="list-style-type: none"> - Berm scarp leveled off - Historical wrack line at the toe of the dune extending to mid-berm - Delyay grey and Highland brown sands - The beach appears to be narrowing - The beach profile appears to have a steeper slope fronting this property 	<ul style="list-style-type: none"> - Dune crest elevation is ~2.5' above berm elevation with ~2' scarp/runup to crest - The seaward dune has a 1H:2V slope up to crest - Dune's front slope comprised of sea oats, a denser sea grape and naupaka vegetation comprise the back dune - Sea grape vegetation is scraped at base 	No	No	Restore dune toe with 2cy/ft of sand along east dune toe. Revegetate dune toe with pioneer zone dune vegetation.
3723 S Ocean Blvd		<ul style="list-style-type: none"> - Berm scarp leveled off - Historical wrack line at the toe of the dune extending to waterline - Delyay grey and Highland brown sands - No visible beach access through dune 	<ul style="list-style-type: none"> - Dune crest elevation is ~3' above berm elevation with ~2' scarp/runup to crest at base of vegetation - The seaward dune has a 1H:1V slope up to crest and a back dune slope of 4H:1V under sea grapes - Dune comprised of sea grape and naupaka vegetation with some palm trees and sea oats 	No	No	Restore dune toe with 2cy/ft of sand along east dune toe. Revegetate dune toe with pioneer zone dune vegetation. Consider reducing the seagrape and planting pioneer dune vegetation.
3801 S Ocean Blvd		<ul style="list-style-type: none"> - 4-5' berm scarp, smoothed by runup - Historical wrack line at the toe of the dune extending to waterline - More Highland brown sands and shell hash visible - Beach appears to <50' from seaward edge of structure 	<ul style="list-style-type: none"> - Not much of a pioneer dune present - Dune crest elevation is ~5-6' above berm elevation with ~2' scarp/runup to crest at base of vegetation - The seaward dune has a 2H:1V slope under sea grapes - Dune comprised of sea grape and naupaka vegetation which is positioned more landward than north adjacent property 	No	No	Restore dune toe with 2cy/ft of sand along east dune toe. Revegetate dune toe with pioneer zone dune vegetation. Consider reducing the seagrape and planting pioneer dune vegetation.
3805 S Ocean Blvd		<ul style="list-style-type: none"> - Property appears abandoned - 2-4' berm scarp, smoothed by runup - Historical wrack line at the toe of the dune extending to waterline - More Highland brown sands and shell hash visible - Beach appears to <40' from seaward edge of structure (floor elevation appears to be only ~4' above berm) 	<ul style="list-style-type: none"> - Dune crest elevation is ~3' above berm elevation with ~2-2.5' scarp/runup to crest - The seaward dune has a 1H:2.5V slope up to crest - Not much back dune, appears flat - Waves appears to have washed over the mid-property dune - Dune's front slope comprised of sea oats, denser sea grape and naupaka vegetation comprise the north and south property edges of the dune 	No	No	Restore dune toe with 2cy/ft of sand along east dune toe. Revegetate dune toe with pioneer zone dune vegetation.

Highland Beach - Beachfront Property Evaluation [North-to-South]

Property	Photo	Observation	Dune Condition	Is there rock?	Any visible seawalls?	Recommendations
3809 S Ocean Blvd		<ul style="list-style-type: none"> -Minor berm scarp, smoothed by runup -Historical wrack line at the toe of the dune extending to waterline -More Highland brown sands and shell hash visible 	<ul style="list-style-type: none"> -Dune crest elevation is ~2-3.5' above berm elevation with ~2-2.5' scarp/runup -The seaward dune has a 1H:1V slope up to crest with level top; scarped areas of dune have 1H:2V slope -Dune sparsely comprised of sea oats with slightly denser sea grape and naupaka vegetation on dune crest 	No	No	Restore dune toe with 2cy/ft of sand along east dune toe. Revegetate dune toe with pioneer zone dune vegetation. Remove exotics. Consider reducing the sea grape and planting pioneer dune vegetation.
3813 S Ocean Blvd		<ul style="list-style-type: none"> -6-8' berm scarp, smoothed by runup -Historical wrack line at the toe of the dune extending to waterline -More Highland brown sands and shell hash visible -Dune overwash is ~8' above the berm 	<ul style="list-style-type: none"> -Dune crest elevation is ~2-3.5' above berm elevation with ~2.5-3' scarp; wave runup of dune extends ~5' landward in some areas -The north dune has a 2H:1V slope up to crest with level top; the back dune has 4H:1V slope -The dune, south of the steps, has a 1H:2V slope, with more scarp -Dune sparsely comprised of panic grass, naupaka, and misc. vegetation on dune's scarped slope and dune crest. Denser sea grapes in the back dune 	No	No	Restore dune toe with 2cy/ft of sand along east dune toe. Revegetate dune toe with pioneer zone dune vegetation.
3817 S Ocean Blvd		<ul style="list-style-type: none"> -8-9' berm scarp -Historical wrack line at the toe of the dune extending to waterline -More Highland brown sands and shell hash visible -Armoring with 2.5-3' wide boulders present in front of the dune, more so from north-to-mid property 	<ul style="list-style-type: none"> -Dune crest elevation is ~2-3.5' above berm elevation with ~3' scarp where no armoring is present -The dune has a 2H:1V slope but exhibits a 1H:3V slope where dune scarp is present (mid-south property) -Dune comprised of grasses, sea grapes, naupaka, and misc. vegetation on dune's scarped slope and dune crest 	No	No	Restore dune toe with 2cy/ft of sand along east dune toe. Revegetate dune toe with pioneer zone dune vegetation.
3833 S Ocean Blvd		<ul style="list-style-type: none"> -4-6' berm scarp, smoothed by runup -Historical wrack line at the toe of the dune extending to waterline -More Highland brown sands and shell hash visible 	<ul style="list-style-type: none"> -Dune crest elevation is ~2-2.5' above berm elevation with ~2' scarp/runup to crest -The seaward dune has a 1H:2V slope up to crest -Dune comprised of sea oats and grasses fronting a denser sea grape and naupaka back dune 	No	No	Restore dune toe with 2cy/ft of sand along east dune toe. Revegetate dune toe with pioneer zone dune vegetation.

Highland Beach - Beachfront Property Evaluation [North-to-South]

z	Photo	Observation	Dune Condition	Is there rock?	Any visible seawalls?	Recommendations
3901 S Ocean Blvd		<ul style="list-style-type: none"> - 4' berm scarp, smoothed by runup - Historical wrack line at the toe of the dune extending to waterline - More Highland brown sands and shell hash visible - Narrow beach 				
3905 S Ocean Blvd		<ul style="list-style-type: none"> - Berm scarp leveled off - Historical wrack line at the toe of the dune extending to waterline - More Highland brown sands and shell hash visible 				
3907 S Ocean Blvd		<ul style="list-style-type: none"> - Berm scarp leveled off - Berm appears higher north-to-mid property compared to mid-to-south property - Historical wrack line at the toe of the dune extending to waterline - More Highland brown sands and shell hash visible - Rock outcrop visibility extends into 1-2' deep water of swash zone 				
Regency Highland Club 3912 S Ocean Blvd		<ul style="list-style-type: none"> - Berm scarp leveled off - Historical wrack line at the toe of the dune - More Highland brown sands and shell hash visible - Rock outcrop visibility extends into 1-2' deep water of swash zone 				

Highland Beach - Beachfront Property Evaluation [North-to-South]

Property	Photo	Observation	Dune Condition	Is there rock?	Any visible seawalls?	Recommendations
3921 S Ocean Blvd		<ul style="list-style-type: none"> - Berm scarp leveled off - Historical wrack line at the base of wall extending to waterline - More Highland brown sands and shell hash visible - Rock outcrop visibility only in 1-2' deep water or swash zone 	<ul style="list-style-type: none"> - No dune, only a concrete seawall around the property - 0.5'-1' of erosion visible at the base of the wall - Seawall only ~6'-8' from seaward edge of pool - Runoff erosion occurring at edge of the south property's wall, at the base of the shared seawall face. 	Yes; only visible in the shallow water of swash zone	Yes; 6.5' tall concrete	Evaluate feasibility of restoring dune toe with 2cy/ft of sand along seawall.
4001 S Ocean Blvd		<ul style="list-style-type: none"> - Berm scarp leveled off - Historical wrack line at the base of the wall extending to waterline - More Highland brown sands and shell hash visible - Armoring with 1' to 3.5' wide boulders, primarily along south property. 3' above berm at highest location, only 1-2' above berm for other areas 	<ul style="list-style-type: none"> - No dune, only a steel sheet pile seawall around the property - 0.5'-1' of erosion visible at the base of the wall 	No	Yes; 7' tall SSP wall (with 1.5' conc cap)	Evaluate feasibility of restoring dune toe with 2cy/ft of sand along seawall.
4005 S Ocean Blvd		<ul style="list-style-type: none"> - Berm scarp leveled off - Historical wrack line at the toe of the dune extending to waterline - More Highland brown sands and shell hash visible 	<ul style="list-style-type: none"> - Not much of a pioneer dune present - Dune crest elevation is ~2.5'-3' above berm elevation with ~2' scarp to dune crest, the base of vegetation and at base of palm trees - The seaward dune has a 1H:1V slope up to crest at mid-property; the scarped dune has a 1H:2V slope - Dune comprised of sparse sea oats, denser sea grape vegetation along north property and the back dune 	No	Yes; ~10' above berm elevation	Restore dune toe with 2cy/ft of sand along seawall.
4011 S Ocean Blvd		<ul style="list-style-type: none"> - Berm scarp leveled off - Historical wrack line at the toe of the dune extending to waterline - More Highland brown sands and shell hash visible 	<ul style="list-style-type: none"> - Not much of a pioneer dune present; appears flattened - Dune crest elevation is ~2.25' above berm elevation with ~2' scarp to the north of the steps - The scarped base of the back dune has a 1H:2V slope - Dune comprised of sparse sea oats and palm trees, with sea grape vegetation on the back dune - Only 2'-0" of vegetation between beach and seaward edge of the patio structure 	No	No	Restore dune toe with 2cy/ft of sand along seawall.

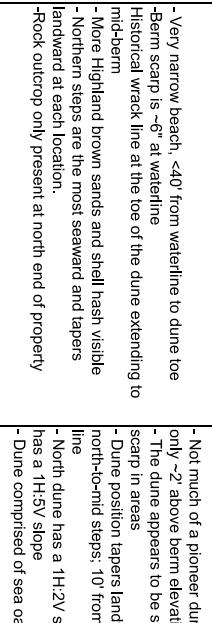
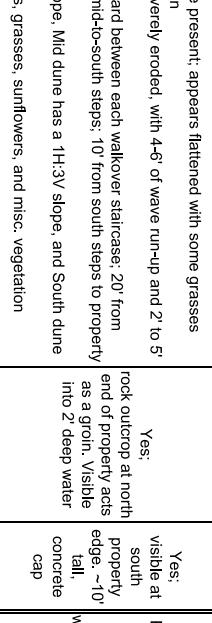
Highland Beach - Beachfront Property Evaluation [North-to-South]

Property	Photo	Observation	Dune Condition	Is there rock?	Any visible seawalls?	Recommendations
4015 S Ocean Blvd		<ul style="list-style-type: none"> - Berm scarp leveled off - Historical wrack line at the toe of the dune extending to waterline - More Highland brown sands and shell hash visible 	<ul style="list-style-type: none"> - North dune crest elevation is ~6-7' above berm elevation with ~3' scarp and a 1H:3V slope - South dune crest elevation is ~3-4' above berm elevation with ~2.5' scarp/runup to crest and a 1H:2V slope - The dune has a 4H:1V back slope - Dune comprised of sea oats, sea grape, and naupaka vegetation 	No	No	Restore dune toe with 2cy/ft of sand along east dune toe. Revegreate dune toe with pioneer zone dune vegetation.
4019 S Ocean Blvd		<ul style="list-style-type: none"> - Berm scarp leveled off - Historical wrack line at the toe of the dune extending to waterline - More Highland brown sands and shell hash visible - Rock outcrop visibility only in 2-3' deep water of swash zone 	<ul style="list-style-type: none"> - Front dune crest elevation is ~3-3.5' above berm elevation with ~2-2.5' scarp/runup at base of vegetation - The seaward dune has a 1H:2.5V slope up to crest - Dune comprised of some sea oats with some denser sea grape and naupaka vegetation extending from the back dune to the dune toe - ~40-45' of dune fronting the patio structure 	Yes; visible in 2-3' deep water, from mid-to-south property; no effect.	No	Restore dune toe with 2cy/ft of sand along east dune toe. Revegreate dune toe with pioneer zone dune vegetation.
4023 S Ocean Blvd		<ul style="list-style-type: none"> - Berm scarp leveled off - Historical wrack line at the toe of the dune extending to waterline - More Highland brown sands and shell hash visible 	<ul style="list-style-type: none"> - Dune crest elevation is ~10' above berm elevation with ~3' of wave runup to the north of the steps, and ~4.5' of runup behind the beach access platform/steps - Erosion along landward side of steps - Dune comprised of some sea oats and grasses with some naupaka along the north property line - ~15' of dune fronting the grass yard 	No	No	Restore dune toe with 2cy/ft of sand along east dune toe. Revegreate dune toe with pioneer zone dune vegetation. Remove exotics.
4101 S Ocean Blvd		<ul style="list-style-type: none"> - Berm scarp leveled off - Historical wrack line at the toe of the dune extending to waterline - More Highland brown sands and shell hash visible - Rock outcrop visibility only in 1-2' deep water of swash zone 	<ul style="list-style-type: none"> - Pioneer dune has been mostly washed over; some vegetation remains on the slipped seaward face - Dune crest elevation is ~10' above berm elevation with ~3-5' of scarp/runup - ~4.5' of runup behind the beach access steps - Erosion along landward side of steps - The northern dune has a 1H:3V slope up to crest - The southern dune has a 1H:4V slope down to from ~5-10' above the berm and then the slope becomes 1H:1V down to the dune toe - Dune comprised of some sea oats with dense naupaka growing mid-property - ~20' of dune fronting the grass yard 	Yes; rocks up on beach and also visible at waterline and shallow water of swash zone; no effect.	No	Restore dune toe with 2cy/ft of sand along east dune toe. Revegreate dune toe with pioneer zone dune vegetation.

Highland Beach - Beachfront Property Evaluation [North-to-South]

Property	Photo	Observation	Dune Condition	Is there rock?	Any visible seawalls?	Recommendations
4105 S Ocean Blvd		<ul style="list-style-type: none"> - Berm scarp leveled off - Historical wrack line at the toe of the dune extending to waterline - More Highland brown sands and shell hash visible - Rock outcrop visibility only in 2-3' deep water or swash zone 	<ul style="list-style-type: none"> - Pioneer dune relatively flat due to wave runup with a 4.5H:1V slope and crest elevation at ~2' above the berm elevation - Mid-dune has a 2H:1V slope and 1.5' scarp in some areas - The back dune has a 3H:1V slope - The dune is setback ~5' landward compared to the north dune - The dune is comprised of sparse grasses with a denser sea grape and naupaka vegetation growing in the back dune 	Yes; visible at waterline and in 2-3' of shallow water in swash zone; no effect.	No	Restore dune toe with 2cy/ft of sand along east dune toe. Revegetate dune toe with pioneer zone dune vegetation.
4111 S Ocean Blvd		<ul style="list-style-type: none"> - Berm scarp leveled off - Historical wrack line at the toe of the dune extending to waterline - More Highland brown sands and shell hash visible 	<ul style="list-style-type: none"> - Not much of a pioneer dune present; deflated - Dune crest elevation is ~2-3' above berm elevation with ~2-2.5' scarp/runup over the deflated dune to the base of the dense vegetation - Fallen front dune comprised of sea oats - Tail dense back dune, comprised of sea grape and naupaka, is exposed and scarp'd at the base 	No	No	Restore dune toe with 2cy/ft of sand along east dune toe. Revegetate dune toe with pioneer zone dune vegetation.
4115 S Ocean Blvd		<ul style="list-style-type: none"> - Berm scarp leveled off - Historical wrack line at the toe of the dune extending to waterline - More Highland brown sands and shell hash visible 	<ul style="list-style-type: none"> - Dune elevation is ~2' above the berm elevation with ~1-2' scarp, primarily at the north end of the property - Dune has a 3H:1V front slope and transitions to a 2H:1V back slope - Dune comprised of sea oats, sea grape, misc. vegetation, and snake plant and palms (only in south dune) 	No	No	Restore dune toe with 2cy/ft of sand along east dune toe. Revegetate dune toe with pioneer zone dune vegetation. Consider reducing sea grape and planting pioneer zone vegetation.
4117 S Ocean Blvd		<ul style="list-style-type: none"> - Berm scarp leveled off - Historical wrack line at the toe of the dune extending to waterline - More Highland brown sands and shell hash visible 	<ul style="list-style-type: none"> - Not much of a front dune present - Dune elevation is ~2' above the berm elevation with ~1-2' scarp at the base of vegetation - Dune has a 1H:1V front slope and transitions to a 2H:1V back slope - Dune comprised of sea oats, sea grape, misc. vegetation, and snake plant and palms (only in south dune) 	No	No	Restore dune toe with 2cy/ft of sand along east dune toe. Revegetate dune toe with pioneer zone dune vegetation.

Highland Beach - Beachfront Property Evaluation [North-to-South]

Property	Photo	Observation	Dune Condition	Is there rock?	Any visible seawalls?	Recommendations
4121 S Ocean Blvd		<ul style="list-style-type: none"> - Berm scarp leveled off - Historical wrack line at the toe of the dune extending to waterline - More Highland brown sands and shell hash visible - Visible, partially buried rocks mid-berm (at the wrack line) - Narrow beach is only ~80' from waterline to dune toe 	<ul style="list-style-type: none"> - Not much of a pioneer dune present - Dune elevation is ~1.5-2' above the berm elevation with ~1-2' scarp at the base of vegetation - Dune has a 1H:1V slope - Dune comprised of sea oats, sea grape, snake plants, and misc. vegetation - Dune is <50' wide 	Yes: rocks buried on the upland beach, mid-berm to near the dune toe	No	Restore dune toe with 2cy/ft of sand along east dune toe. Revegetate dune toe with pioneer zone dune vegetation.
4201 S Ocean Blvd		<ul style="list-style-type: none"> - Berm elevation is ~1' higher than adjacent properties - Historical wrack line at the toe of the dune extending to mid-berm - More Highland brown sands and shell hash visible - Visible, partially buried rocks dune toe (Armoring boulders?) - Rock outcrop mid-berm to the waterline 	<ul style="list-style-type: none"> - Not much of a pioneer dune present, rocks partially buried at dune toe - Dune crest elevation is ~2.5-3' above berm elevation and there is ~2-2.5' scarp base of the vegetation - Dune has a 1H:2V slope - Dune comprised of sea grape and misc. vegetation 	Yes: rocks buried at the dune toe. Most of the rock outcrop is up on the beach down, mid-berm to the waterline. Acts as a breakwater. Scour is occurring at the base of the seaward edge.	No	Restore dune toe with 2cy/ft of sand along east dune toe. Revegetate dune toe with pioneer zone dune vegetation. Consider reducing sea grape and planting pioneer dune vegetation.
4205 S Ocean Blvd		<ul style="list-style-type: none"> - Berm elevation is ~0.5' higher than southern adjacent property - Historical wrack line at the toe of the dune extending to mid-berm - More Highland brown sands and shell hash visible - Visible, partially buried rocks dune toe (Armoring boulders?) 	<ul style="list-style-type: none"> - Not much of a pioneer dune present due to severe erosion, especially at mid-property near the steps - Dune has a 1H:3V slope, with 2' of scarp at the base of the vegetation - Dune comprised sea grape, naupaka, and misc. vegetation - Northern dune vegetation extends seaward ~10' compared to the rest of the dune 	Yes: rocks buried at the dune toe. Some of the rock outcrop along the north edges of the property act as breakwater for this property. No exposed rocks in the berms fronting property, but another outcrop is exposed along the south property edge.	No	Restore dune toe with 2cy/ft of sand along east dune toe. Revegetate dune toe with pioneer zone dune vegetation.
Ocean Place Villas 4211 S Ocean Blvd		<ul style="list-style-type: none"> - Very narrow beach, <40' from waterline to dune toe - Berm scarp is ~6' at waterline - Historical wrack line at the toe of the dune extending to mid-berm - More Highland brown sands and shell hash visible - Northern steps are the most seaward and tapers landward at each location. - Rock outcrop only present at north end of property 	<ul style="list-style-type: none"> - Not much of a pioneer dune present; appears flattened with some grasses only ~2' above berm elevation - The dune appears to be severely eroded, with 4-6' of wave run-up and 2' to 5' scarp in areas - Dune position tapers landward between each walkover staircase, 20' from north-to-mid steps; 10' from mid-to-south steps; 10' from south steps to property line - North dune has a 1H:2V slope - Dune comprised of sea oats, grasses, sunflowers, and misc. vegetation 	Yes: rock outcrop at north end of property acts as a groin. Visible into 2' deep water	Yes: visible at south end property edge, ~10' tall, concrete cap	Restore dune toe with 2cy/ft of sand along east dune toe. Revegetate dune toe with pioneer zone dune vegetation.

Highland Beach - Beachfront Property Evaluation [North-to-South]

Property	Photo	Observation	Dune Condition	Is there rock?	Any visible seawalls?	Recommendations
4217 S Ocean Blvd		<ul style="list-style-type: none"> - Berm scarp leveled off - Narrow beach - Historical wrack line at the toe of the dune extending to mid-berm - More Highland brown sands and shell hash visible 	<ul style="list-style-type: none"> - Small dune present fronting the seawall - Dune elevation ~3' above berm elevation with a 3H:1V slope - Wave run-up visible to dune crest, with 1.5' scarp in areas - Dune comprised sea oats, naupaka, and misc. vegetation 	No	Yes; 9' tall SSP wall (with 2' conc cap)	Restore dune toe with 2cy/ft of sand along east dune toe. Revegetate dune toe with pioneer zone dune vegetation.
4221 S Ocean Blvd		<ul style="list-style-type: none"> - Berm scarp leveled off - Narrow beach - Historical wrack line at the toe of the dune extending to mid-berm - More Highland brown sands and shell hash visible 	<ul style="list-style-type: none"> - Small dune present fronting the seawall - The north dune extends 3-8' from base of seawall, with an elevation of ~2-2.5' above the berm elevation and ~2' scarp - The south dune extends 10-15' from base of seawall, with an elevation of ~3-3.5' above the berm elevation and ~3' scarp - Wave run-up visible to dune crest with dying vegetation on seaward edge and at base of exposed roots - Dune comprised sea oats, naupaka, and misc. vegetation 	No	Yes; 7' tall SSP wall (with 1.5' conc cap)	Restore dune toe with 2cy/ft of sand along east dune toe. Revegetate dune toe with pioneer zone dune vegetation.
4301 S Ocean Blvd		<ul style="list-style-type: none"> - Berm scarp leveled off - Narrow beach - Historical wrack line at the toe of the dune extending to mid-berm - More Highland brown sands and shell hash visible 	<ul style="list-style-type: none"> - Pioneer dune has a fallen slope, sits at an elevation ~3' above berm elevation with 2.5' scarp/runup - Severe erosion of back dune face, with ~5-6' scarp - Dune has 1H:4.5V slope - Dune comprised sea oats, naupaka, and misc. vegetation 	No	No	Restore dune toe with 2cy/ft of sand along east dune toe. Revegetate dune toe with pioneer zone dune vegetation.
Coco-de-Mar Blvd		<ul style="list-style-type: none"> - Berm scarp leveled off - Narrow beach; only ~35' from waterline to dune toe - Historical wrack line at the toe of the dune extending to mid-berm - More Highland brown sands and shell hash visible - Armoring boulders located near base of steps 	<ul style="list-style-type: none"> - Dune has been newly planted with 2H:1V front slope and a 3H:1V back slope - Dune comprised sea oats - Dune toe is only ~0.5' above the berm elevation - Dune crest is ~10' above berm elevation 	No	No	No action.

Highland Beach - Beachfront Property Evaluation [North-to-South]

Property	Photo	Observation	Dune Condition	Is there rock?	Any visible seawalls?	Recommendations
1 Ocean Place		<ul style="list-style-type: none"> - Berm scarp leveled off - Narrow beach - Historical wrack line at the toe of the dune extending to waterline - More Highland brown sands and shell hash visible 	<ul style="list-style-type: none"> - Severe dune erosion present, with scarp of ~10' up to top of dune face - Fallen slope/front dune has elevation of ~1' above berm elevation - Dune is setback ~10-15' landward compared to neighbors - Dune comprised sea oat, sea grape and misc. vegetation - Dune slope has 1H:8V slope at its most extreme sheared face - The seaward face of the home/structure is <10-15' from the scarped dune face 	No	Yes: buried SSP	Restore dune toe with 2cy/ft of sand along east dune toe. Revegetate dune toe with pioneer zone dune vegetation.
2 Ocean Place		<ul style="list-style-type: none"> - Berm scarp leveled off - Narrow beach - Historical wrack line at the toe of the dune extending to waterline - More Highland brown sands and shell hash visible 	<ul style="list-style-type: none"> - Dune has been newly planted with 1H:1V slope and 6' swale at toe of the dune - Toe of the dune is ~3' above the berm elevation - Dune comprised sea oats, sea grapes are planted along south property line - Patio structure along south end of property cuts into the top 1.5' of dune. - The seaward face of the home/structure is <15' from the dune crest 	No	Yes: buried SSP	Restore dune toe with 2cy/ft of sand along east dune toe. Revegetate dune toe with pioneer zone dune vegetation.
3 Ocean Place		<ul style="list-style-type: none"> - Berm scarp leveled off - Narrow beach - Historical wrack line at the toe of the dune extending to waterline - More Highland brown sands and shell hash visible 	<ul style="list-style-type: none"> - Severe dune erosion present, with scarp of ~8-9' up the dune face - Fallen slope/front dune has elevation of ~1-1.5' above berm elevation - Dune is setback ~10' landward compared to neighbors - Dune comprised sea oat, sea grape and misc. vegetation - Dune slope has 1H:4V slope - Scarp/wave run-up at the steps is ~10' above the berm - The seaward face of the home/structure is <15' from the scarped dune face 	No	Yes: buried SSP	Restore dune toe with 2cy/ft of sand along east dune toe. Revegetate dune toe with pioneer zone dune vegetation.
4 Ocean Place		<ul style="list-style-type: none"> - Berm scarp leveled off - Narrow beach - Historical wrack line at the toe of the dune extending to waterline - More Highland brown sands and shell hash visible 	<ul style="list-style-type: none"> - Dune has dense shrub extending from dune toe up to ~8-9' above berm elevation - Front dune has a 1H:1V slope - Dune comprised dense shrub and misc. vegetation; sea grapes planted along both property edges - Erosion/wave run-up of ~8' under the stairs 	No	Yes: buried SSP	Restore dune toe with 2cy/ft of sand along east dune toe. Revegetate dune toe with pioneer zone dune vegetation. Consider removing some of the sea grape and re-planting pioneer dune species.

Highland Beach - Beachfront Property Evaluation [North-to-South]

Property	Photo	Observation	Dune Condition	Is there rock?	Any visible seawalls?	Recommendations
5 Ocean Place		<ul style="list-style-type: none"> - Berm scarp leveled off - Narrow beach - Historical wrack line at the toe of the dune extending to waterline - More Highland brown sands and shell hash visible 	<ul style="list-style-type: none"> - Dune has dense shrub extending from dune toe up to ~8'-9" above berm elevation - Dune has a fallen 1H:5V slope with 8' scarp in some areas - Front dune that has not been eroded has a 1H:1V slope - Dune comprised dense shrub, sea grape, naupaka, and misc. vegetation - Erosion/wave run-up of ~4-5" in areas without vegetation - Erosion/wave run-up of ~5' under the stairs 	No	Yes; buried SSP	Restore dune toe with 2cy/ft of sand along east dune toe. Revegetate dune toe with pioneer zone dune vegetation. Consider removing some of the sea grape and replanting pioneer dune species.
6 Ocean Place		<ul style="list-style-type: none"> - Berm scarp leveled off - Narrow beach - Historical wrack line at the toe of the dune extending to waterline - More Highland brown sands and shell hash visible 	<ul style="list-style-type: none"> - Dune has dense shrub extending from dune toe up to ~8'-9" above berm - Dune has fallen 1H:2V slope with 5' scarp in some areas - Dune comprised grasses, sea grape and misc. vegetation - Dune toe has erosion/wave run-up of ~4-5" to south of stairs - Erosion/wave run-up of ~5' under the stairs 	No	Yes; buried SSP	Restore dune toe with 2cy/ft of sand along east dune toe. Revegetate dune toe with pioneer zone dune vegetation. Consider removing some of the sea grape and replanting pioneer dune species.
7 Ocean Place		<ul style="list-style-type: none"> - Berm scarp leveled off - Narrow beach - Historical wrack line at the toe of the dune extending to waterline - More Highland brown sands and shell hash visible 	<ul style="list-style-type: none"> - Dune toe elevation is ~2-3' above berm elevation - Dune has ~1.5' scarp at the base of the vegetation with a 2H:1V slope - Top of dune is ~7-8' above the berm elevation, which is ~1' shorter compared to neighboring properties - Dune comprised sea oats, naupaka, and misc. vegetation - Front dune has erosion/wave run-up of ~3' to north of stairs 	No	Yes; buried SSP	Restore dune toe with 2cy/ft of sand along east dune toe. Revegetate dune toe with pioneer zone dune vegetation. Consider removing some of the sea grape and replanting pioneer dune species.
8 Ocean Place		<ul style="list-style-type: none"> - Berm scarp leveled off - Narrow beach - Historical wrack line at the toe of the dune extending to waterline - More Highland brown sands and shell hash visible 	<ul style="list-style-type: none"> - Dune Toe elevation is ~2-3' above berm elevation - Dune has a 2H:1V slope - Top of dune is ~8-9' above the berm elevation - Front of dune comprised sea oats; back dune comprised of sea grape and misc. shrub vegetation - Front of dune has erosion/wave run-up of ~3.5' to south of stairs 	No	Yes; buried SSP	Restore dune toe with 2cy/ft of sand along east dune toe. Revegetate dune toe with pioneer zone dune vegetation. Consider removing some of the sea grape and replanting pioneer dune species.

Highland Beach - Beachfront Property Evaluation [North-to-South]

Property	Photo	Observation	Dune Condition	Is there rock?	Any visible seawalls?	Recommendations
9 Ocean Place		<ul style="list-style-type: none"> - Berm scarp leveled off - Beach is less narrow at this property - Historical wrack line at the toe of the dune extending to waterline - More Highland brown sands and shell hash visible 	<ul style="list-style-type: none"> - Dune toe elevation is ~2-3' above berm elevation with ~1' scarp at the base of the vegetation - The south dune toe is ~10' landward compared to the toe located north of stairs - Front dune slope has 4H:1V slope - Back dune has 1H:1V slope - Top of dune is ~9' above the berm elevation - Front dune comprised of sea oats, back dune comprised of sea grape, naupaka, and misc. shrub vegetation 	No	Yes; buried SSP	Restore dune toe with 2cy/ft of sand along east dune toe. Revegetate dune toe with pioneer zone dune removing some of the seagrape and replanting pioneer dune species.
10 Ocean Place		<ul style="list-style-type: none"> - Berm scarp leveled off - Beach is less narrow at this property - Historical wrack line at the toe of the dune extending to waterline - More Highland brown sands and shell hash visible 	<ul style="list-style-type: none"> - The north-to-mid dune crest elevation is ~1' above berm - The mid-to-south front dune has been eroded and is set back ~10' landward compared to north dune - Top of dune elevation ~8' above the berm elevation with ~6' scarp in some areas - Front dune (north end) slope has 4H:1V slope - Back dune has 1H:3V slope - Front dune comprised of sparse sea oats, back dune comprised of sea grape, naupaka, and misc. shrub vegetation 	No	Yes; buried SSP	Restore dune toe with 2cy/ft of sand along east dune toe. Revegetate dune toe with pioneer zone dune removing some of the seagrape and replanting pioneer dune species.
11 Ocean Place		<ul style="list-style-type: none"> - Berm scarp leveled off - Beach is less narrow at this property - Historical wrack line at the toe of the dune extending to waterline - More Highland brown sands and shell hash visible 	<ul style="list-style-type: none"> - The fallen slope of the dune toe is ~2' above berm elevation - Top of dune elevation ~8' above the berm elevation with ~4' wave run-up in some areas - North front dune slope is 1H:1V slope, with 1' scarp at the base of the vegetation - South dune has 2H:1V slope with ~1.5' scarp at the base of the vegetation - Dune comprised of sparse sea oats, sea grape, naupaka, and misc. shrub vegetation 	No	Yes; buried SSP	Restore dune toe with 2cy/ft of sand along east dune toe. Revegetate dune toe with pioneer zone dune removing some of the seagrape and replanting pioneer dune species.
45 Ocean Condominium 4511 S Ocean Blvd		<ul style="list-style-type: none"> - 6' berm scarp, smoothed by run-up - Beach is less narrow at this property - Historical wrack line at the base of the wall extending to waterline - More Highland brown sands and shell hash visible 	<ul style="list-style-type: none"> - No dune present in front of seawall - North end of the wall appears to have ~1-1.5' more sand than the south end of the wall - Minor erosion (0.5-1') at the base of the seawall - Mainly weeds and railroad vines present at the base of wall 	No	Yes; ~7' above berm, concrete wall	Evaluate feasibility of reestablishing a dune on this property. Likely more feasible on the south side of the property.

Highland Beach - Beachfront Property Evaluation [North-to-South]

Property	Photo	Observation	Dune Condition	Is there rock?	Any visible seawalls?	Recommendations
4513 S Ocean Blvd		<ul style="list-style-type: none"> - Berm scarp leveled off - Beach is less narrow at this property - Historical wrack line at the toe of the dune extending to waterline - Highland brown sands with shell hash more prominent 	<ul style="list-style-type: none"> - Back dune has a 1H:1V slope - Dune has ~3-4' scarp at the toe of the dune with 1H:3V slope - Wave run-up/scarp under the steps is ~7' above the berm - Dune comprised mostly of sea oats, grasses, and railroad vines 	No	No	Restore dune toe with 2cy/ft of sand along east dune toe. Re-vegetate dune toe with pioneer zone dune vegetation.
4515 4517 S Ocean Blvd		<ul style="list-style-type: none"> - ~6" berm scarp, smoothed by run-up - Beach is less narrow at this property - Historical wrack line at the toe of the dune extending to waterline - Highland brown sands with shell hash more prominent 	<ul style="list-style-type: none"> - Front of dune has a 3H:1V slope and back dune has a 1H:1V slope - Dune has ~2-3' scarp at the toe of the dune - Dune run-up/scarp under the steps is ~5-7' above the berm - Dune comprised mostly of sea oats, grasses, and railroad vines; and sea grapes, along the south property edge - Scarp at base of sea grape vegetation is ~2.5' 	Yes, visible in 1-2' deep water at mid property, going south; no effect.	No	Restore dune toe with 2cy/ft of sand along east dune toe. Re-vegetate dune toe with pioneer zone dune vegetation.
4521 4523 S Ocean Blvd (Former Sea Frolic Condo)		<ul style="list-style-type: none"> - Berm scarp leveled off - Beach is less narrow at this property - Historical wrack line at the toe of the dune extending to waterline - Highland brown sands with shell hash more prominent - Nearshore bar is ~40-50' from shoreline 	<ul style="list-style-type: none"> - Dune toe has elevation of ~3' above the berm elevation with ~2-2.5' scarp at the toe of the dune - Back dune has a 1H:1V slope - Wave run-up/scarp is visible up to 5' above berm elevation - Dune comprised mostly of sea oats, misc. vegetation, and railroad vines 	Yes, visible in 1-2' deep water; no effect.	No	Restore dune toe with 2cy/ft of sand along east dune toe. Re-vegetate dune toe with pioneer zone dune vegetation.
Park Highland E Condo 4605 S Ocean Blvd		<ul style="list-style-type: none"> - ~4-5" berm scarp, smoothed by run-up - Beach is less narrow at this property - Historical wrack line at the toe of the dune extending to waterline - Highland brown sands with shell hash more prominent 	<ul style="list-style-type: none"> - Dune toe has elevation of ~3' above the berm elevation with ~1.5-2' scarp at the toe of the dune - Back dune has a 1H:2V slope under the vegetation and extends 15-20' above the berm elevation - Wave run-up/scarp is visible up to 2-3' above berm elevation at the base of the vegetation - Dune tapers landward about 10' from the north end to the south end of the property - Dune comprised of sea oats, sea grape, railroad vines, and misc. vegetation 	Yes, flat rocks/ridge is visible in 1-2' deep water; no effect.	No	Restore dune toe with 2cy/ft of sand along east dune toe. Re-vegetate dune toe with pioneer zone dune vegetation.

Highland Beach - Beachfront Property Evaluation [North-to-South]

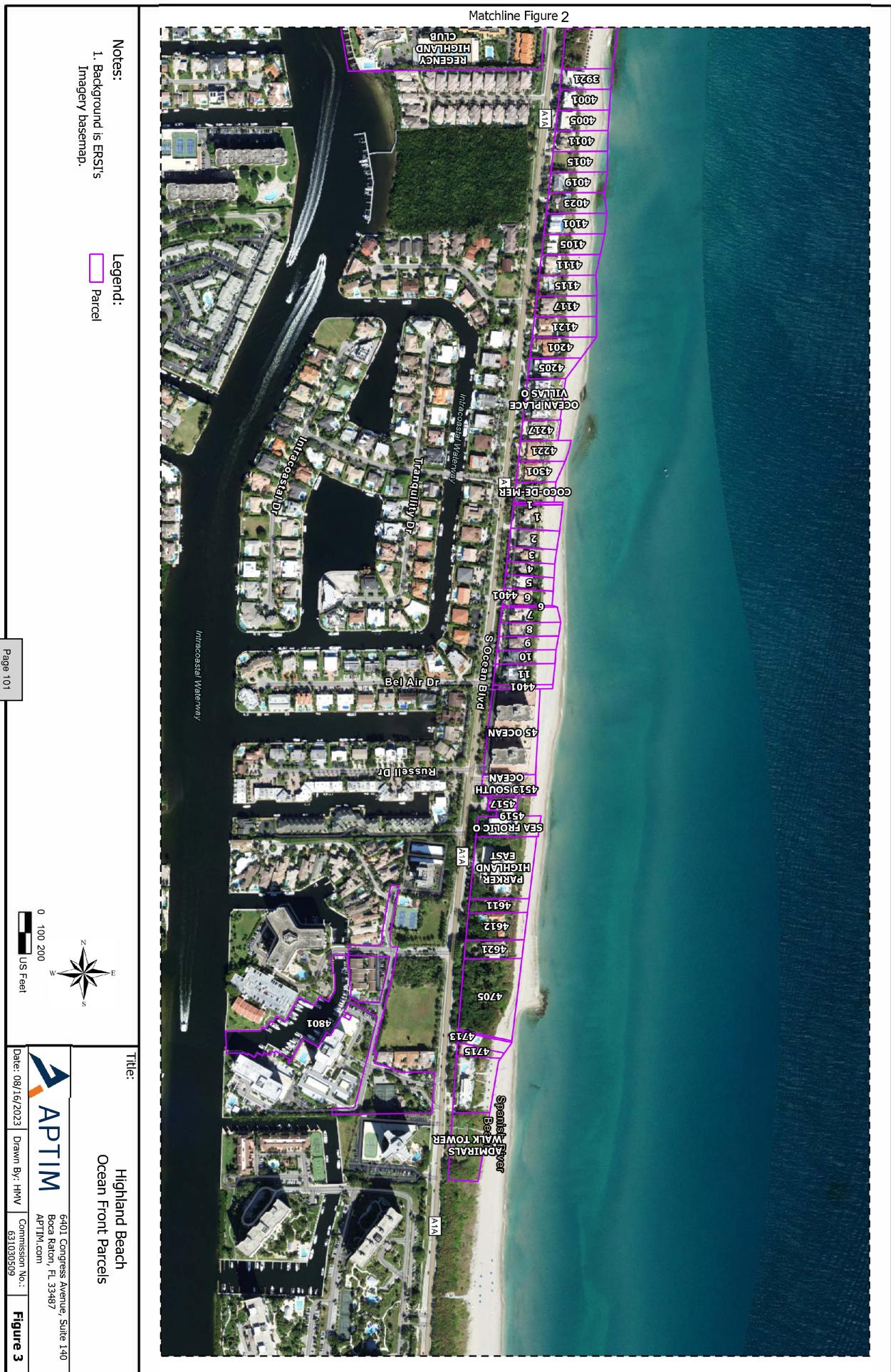
Property	Photo	Observation	Dune Condition	Is there rock?	Any visible seawalls?	Recommendations
4611 S Ocean Blvd		<ul style="list-style-type: none"> -~4-6" berm scarp, smoothed by run-up - Beach is less narrow at this property - Historical wrack line at the toe of the dune extending to waterline - Highland brown sands with shell hash more prominent 	<ul style="list-style-type: none"> - Base of the vegetation is ~3' above the berm elevation - There is ~2.5-3' of scarp, exposing the base of the vegetation - Back dune has a 1H:2V slope under the vegetation and extends ~30-40' above the berm elevation - Dune comprised of dense sea grape and misc. grasses 	Yes; flat rock/ridge is visible in 2-3' deep water; no effect.	No	Restore dune toe with 2cy/ft of sand along east dune toe. Revegetate dune toe with pioneer zone dune vegetation. Consider reducing the seagrape and planting pioneer dune species.
4612 S Ocean Blvd		<ul style="list-style-type: none"> - Berm scarp leveled off - Beach is less narrow at this property - Historical wrack line at the toe of the dune extending to waterline - Highland brown sands with shell hash more prominent - Nearshore bar is ~20-30' from shoreline 	<ul style="list-style-type: none"> - Base of the vegetation is ~3' above the berm elevation (1H:3V slope) - There is ~2.5-3' of scarp, exposing the base of the vegetation - Back dune has a 1H:2V slope under the vegetation and extends ~30-40' above the berm elevation - Dune comprised of dense sea grape and misc. grasses 	Yes; visible in 2-3' deep water; no effect.	No	Restore dune toe with 2cy/ft of sand along east dune toe. Revegetate dune toe with pioneer zone dune vegetation. Consider reducing the seagrape and planting pioneer dune species.
4621 S Ocean Blvd PARK		<ul style="list-style-type: none"> - Berm scarp leveled off - Beach is less narrow at this property - Historical wrack line at the toe of the dune extending to waterline - Highland brown sands with shell hash more prominent - Nearshore bar is ~20' from shoreline 	<ul style="list-style-type: none"> - Base of the vegetation is ~4' above the berm elevation (1H:2V slope) - There is ~6-7' of scarp, exposing the base of the vegetation; also under the steps - Back dune has a 1H:2V slope under the vegetation and extends ~30-40' above the berm elevation - Dune comprised of dense sea grape and misc. grasses 	Yes; visible in 2-3' deep water; no effect.	No	Restore dune toe with 2cy/ft of sand along east dune toe. Revegetate dune toe with pioneer zone dune vegetation. Consider reducing the seagrape and planting pioneer dune species.
4705 S Ocean Blvd PARK		<ul style="list-style-type: none"> - Beach is relatively wide at the north side of the property and becomes narrow south of Yamato Rock - Historical wrack line at the toe of the dune extending to mid-berm - Highland brown sands with shell hash more prominent 	<ul style="list-style-type: none"> - Base of the vegetation is ~3' above the berm elevation (1H:2V slope) - There is ~6-7' of wave run-up around the end wall, with ~4-5' of scarp exposing the base of the vegetation to the north of the end wall - Back dune has a 1H:2V slope under the vegetation and extends ~30-40' above the berm elevation - South of end wall, the property tapers landward 20-25' compared to north end of property - Dune comprised of dense sea grape, naupaka, and misc. grasses 	Yes; Yamato Rock North end acts as a breakwater, south end acts like a groin	No	Restore dune toe with a short wall, 2.5-3' above water; no effect.

Highland Beach - Beachfront Property Evaluation [North-to-South]

Property	Photo	Observation	Dune Condition	Is there rock?	Any visible seawalls?	Recommendations
4713 S Ocean Blvd		<ul style="list-style-type: none"> - Beach is slightly narrow at this property - Historical wrack line at the toe of the dune extending to waterline - Highland brown sands with shell hash more prominent - Nearshore bar extends from Yamato Rock, ~20' from shoreline 	<ul style="list-style-type: none"> - Dune elevation is 2-2.5' above berm elevation with ~2' scarp - Front of dune has 10-15' width, comprised of sea oats and grasses before a denser sea grape back dune - Back dune elevation extends ~8-10' above the berm elevation - The dune located at mid-property, has thinned out/sparse vegetation 	No	No	Restore dune toe with 2cy/ft of sand along east dune toe. Revegetate dune toe with pioneer zone dune vegetation. Consider raising dune crest elevation for increased storm protection.
4715 S Ocean Blvd		<ul style="list-style-type: none"> - Beach is slightly narrow at this property - Historical wrack line at the toe of the dune extending to waterline - Highland brown sands with shell hash more prominent - Nearshore bar extends from Yamato Rock, ~20' from shoreline 	<ul style="list-style-type: none"> - Dune elevation is 2-2.5' above berm elevation with ~2' scarp - Front of dune has 25-30' width with sea oats and grasses before a denser sea grape back dune - Back dune elevation extends ~8-10' above the berm elevation - Wave run-up is visible ~5' into the front dune at base of the sea oats 	No	No	Restore dune toe with 2cy/ft of sand along east dune toe. Revegetate dune toe with pioneer zone dune vegetation. Consider raising dune crest elevation for increased storm protection.
4801 S Ocean Blvd		<ul style="list-style-type: none"> - Beach is relatively wide at this property - Historical wrack line at the toe of the dune extending to waterline - Highland brown sands with shell hash more prominent - Nearshore bar extends from Yamato Rock, ~20' from shoreline 	<ul style="list-style-type: none"> - Dune elevation is 2-2.5' above berm elevation with ~1' scarp/wave run-up over the front of dune - Dune is ~30-40' wide from the beach to the seaward edge of the structures - The back dune is a lower elevation than the front dune (appears to be the same elevation as the berm) - Front dune is comprised of sea oats and grasses before a denser sea grape and naupaka back dune 	No	Unknown	Restore dune toe with 2cy/ft of sand along east dune toe. Revegetate dune toe with pioneer zone dune vegetation. Consider raising dune crest elevation for increased storm protection.
Admirals Walk Condominium (beach access)		<ul style="list-style-type: none"> - Beach is relatively wide at this property - Historical wrack line at the toe of the dune extending to waterline - Highland brown sands with shell hash more prominent - Nearshore bar extends from Yamato Rock, ~20' from shoreline 	<ul style="list-style-type: none"> - Dune elevation is 2.5-3' above berm elevation with ~2-2.5' scarp - Front of dune has sea oats and grasses - Mid and back dunes comprised of denser sea grape, palms, and misc. vegetation 	No	No	Restore dune toe with 2cy/ft of sand along east dune toe. Revegetate dune toe with pioneer zone dune vegetation. Consider raising dune crest elevation for increased storm protection.







APPENDIX C

SELECT DUNE VEGETATION ISSUES IN HIGHLAND BEACH

Seagrapes

Seagrapes are a common native dune species observed within Highland Beach and elsewhere in Palm Beach County (Photo C-1). They are a shallow rooted species which are best suited on the back dune face. While a native species, it can be invasive over years to decades timeframes as the plant will crowd out other native dune species.

The current growing conditions (annual weather) in Palm Beach County are optimal. If left unmanaged, seagrapes can grow to tree height. Historically freezing weather and lightning induced fires limited the growth of seagrapes (Barron, personal communication). Heavy salt spray will turn the leaves brown and potentially kill the plant. Therefore, seagrapes are best managed and grown landward of the dune crest. The shallow root system does not assist in sand retention on the dune face. The seagrapes tend to fall down the dune face when undermined (Photo C-1).

In Appendix B, there are multiple properties, where there are recommendations for consideration of removal of some of the seagrapes. Individual owners need to consider how the existing seagrapes contribute to the existing and future dune ecosystems. Resiliency considerations may warrant larger scale dune revegetation efforts.

Beach Naupka (Naupaka)

Beach Naupka is an exotic invasive plant that grows well on the dune face in Palm Beach County (Photo C-1). It is characterized by oval (or club shaped) shiny green leaves. It should be removed from all dune ecosystems as it crowds out and shades native dune species. Any FDEP permit issued will require its removal.



Photo C-1. Seagrapes at the left center of the photograph and Beach Naupka on the right side of the photograph.