Shoreline Monitoring Beach Profile Report: Saipan and Mañagaha

August 2024

Division of Coastal Resources Management - CNMI Bureau of Environmental Coastal Quality

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COASTAL RESOURCES MANAGEMENT

Bureau of Environmental & Coastal Quality BECQ CNMI

NOAA NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION U.S. DEPARTMENT OF COMMERCE

About the Report

This report is released annually to inform the findings from field data collected under DCRM's Shoreline Profile Monitoring Program between June 2016 - August 2024. An update from the March 2021 - March 2023 report, this document builds from the previous findings. Monitoring efforts are improving with regular field surveying, utilizing the Trimble GPS device, and capturing baseline elevation data with the higher accuracy total station.

This report aims to guide coastal managers and stakeholders in making informed, effective, and adaptive decisions regarding our dynamic shoreline. This report is available digitally for public use: https://dcrm.gov.mp/our-programs/coastal-resources-planning/shoreline-monitoring/.

Cover photo is the American Memorial Park Point 1 transect, located at Puntan Muchot, American Memorial Park.

Acknowledgements

The Shoreline Monitoring program is led by the DCRM's Planning Section, with the direction of the Coastal Planner II, and valued assistance from DCRM staff, dedicated summer interns, and the Northern Marianas College student interns. Interns have greatly contributed numerous hours to data collection and entry and support the program's consistency.

Any questions or comments about the program or this report may be directed to shorelines@dcrm.gov.mp.

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Contents

DCRM Shoreline Monitoring Program

The beaches in the CNMI are important for our island community, offering economic, recreational, and cultural benefits. They are affected by tides and ocean currents driven by the wind. The loss of sandy shorelines due to storm-driven erosion is a concern for those who live, work, and enjoy these areas.

Each shoreline is unique, whether it's a cliff, bay, lagoon, or pocket beach. Understanding the coastal processes that impact the width of our sandy beaches is crucial for the Bureau of Environmental Coastal Quality - Division of Coastal Resources Management to effectively manage development along the shoreline. It's important to know which shorelines are eroding or gaining sand and how the sand shifts along the coastline.

Since 2016, BECQ-DCRM has been monitoring sandy beaches in Saipan, Mañagaha, Tinian, and Rota to track changes over time. Timing is essential, as currents can shift sand both along the coastline and underwater. Our current method involves beach profiling, where we calculate and graph elevation and distance transect data to create a 2D contour of the shoreline at a specific time. We compare this data to understand short-term and long-term changes. These findings are published in an annual report and also on an interactive **"Climate Impact Viewer"** map. (For the interactive map, please refer to page 5 or access the Online Interactive Map.)

Figure 1 - At a beach between Crowne Plaza and Hyatt, Kyla looks through the Berger level, an instrument mounted on a tripod. Emma holds a rod level, a measuring instrument for height, along a transect line to capture the eroding beach profile.

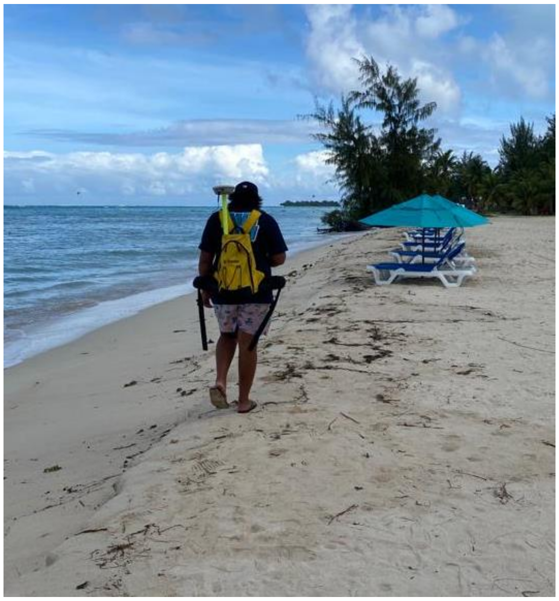


Figure 2 - Chris P. walks the erosion scarp and wrackline fronting Crowne Plaza after a winterly swell event using the Trimble Geo7x.

Since the development of the program in 2016, staff conducted on-the-ground transect surveys at designated starting points along the coast, which we call ***headstakes***. We use survey-grade equipment to record elevation and distance data from the ***backshore***, where waves usually do not reach, to the ***beach toe***, where the shoreline is generally exposed at high tide and, on average, submerged. We started with the ***Berger Level method***, which requires manual readings on a measured rod through a leveled telescope instrument (shown on the top left). Then, in 2021, we began to implement the one-person higher accuracy electronic method, known as the ***Total Station*** method (shown in the middle photo). ***Beach profiles*** are generated for both methods to compare the shoreline contours over time. (See page, How to Read the Beach Profile). This report provides the Berger Level and the Total Station beach profiles for each transect by site.

In addition, we capture damages or remnants after a strong storm by walking the ***wrack line*** and ***scarp*** using the ***Trimble GNSS.*** The Fiesta and Hyatt sites have been assessed for storm damage due to their high erosion rate and active beach retreat.

Web Resources

Shoreline Monitoring Interactive Map

Shoreline Monitoring has an interactive map available for viewing on the DCRM website. The map illustrates the status of the headstakes on Saipan, Tinian, Mañagaha, and Rota, along with its beach profiles and picture comparison.

It is expected to be updated more frequently than the annual report. It also includes the polylines of the wracklines or scarp captured by the GPS.

To access the map:

1. Click on this link: https://dcrm.maps.arcgis.com/apps/MapSeries/index.html?appid=3b8d1a4b46d64586b39047f5732621cd **OR**
   On, www.dcrm.gov.mp, hover over "Resources & Publications" then "Tools and Apps." Click on "Open Data Access." On the "Open
2. Go to "Shoreline Trends."
3. Zoom into the area of interest.
4. The bubbles marked in red, green, yellow, or purple are the headstakes surveyed.
   - **Red** indicates that the beach profile is eroding (losing sand).
   - **Green** indicates that the beach profile is accreting (gaining sand).
   - Yellow indicates that the beach profile is stable (no significant change).
   - **Purple** indicates that the beach profile is undetermined, likely due to its moderately dynamic nature.

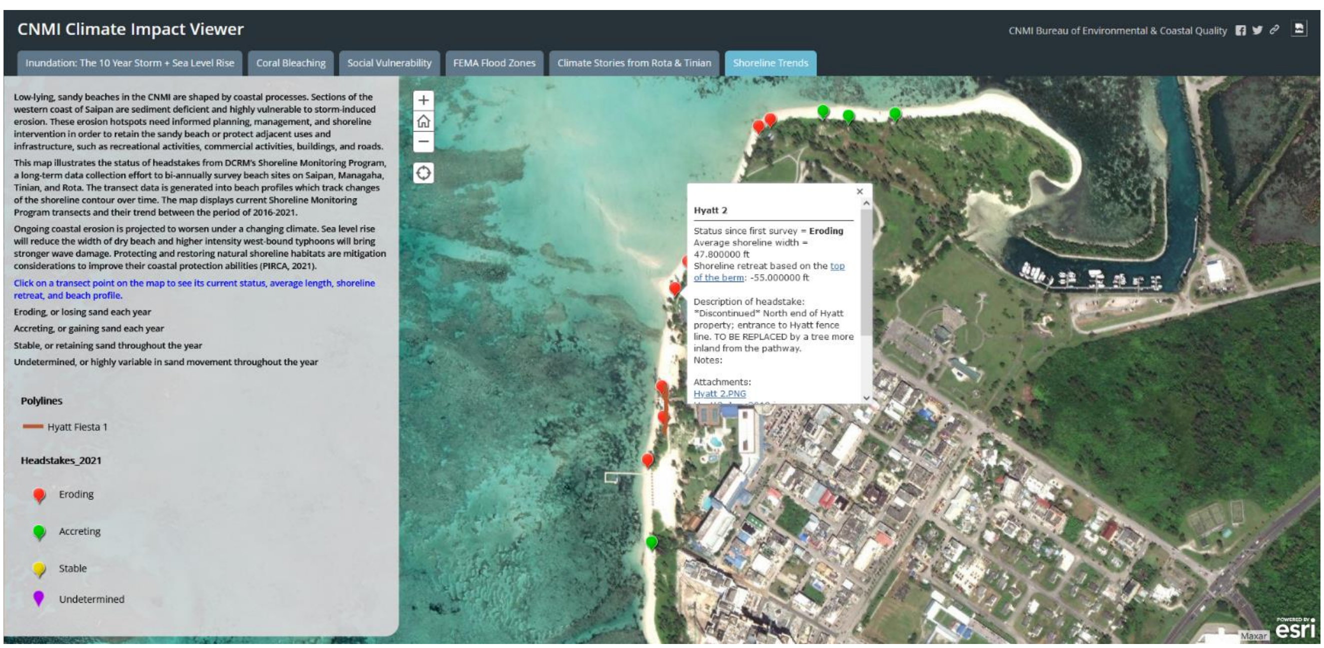


Figure 3 - The CNMI Climate Impact Viewer is an interactive map available at DCRM Shoreline Monitoring's webpage dcrm.gov.mp.

Shoreline Monitoring Web Page

Shoreline Monitoring webpage on the DCRM website is the information hub of the shoreline surveying work. All resources developed by the Shoreline Monitoring team are published into this page for public use.

Access the website: https://dcrm.gov.mp/our-programs/coastal-resources-planning/shoreline-monitoring/

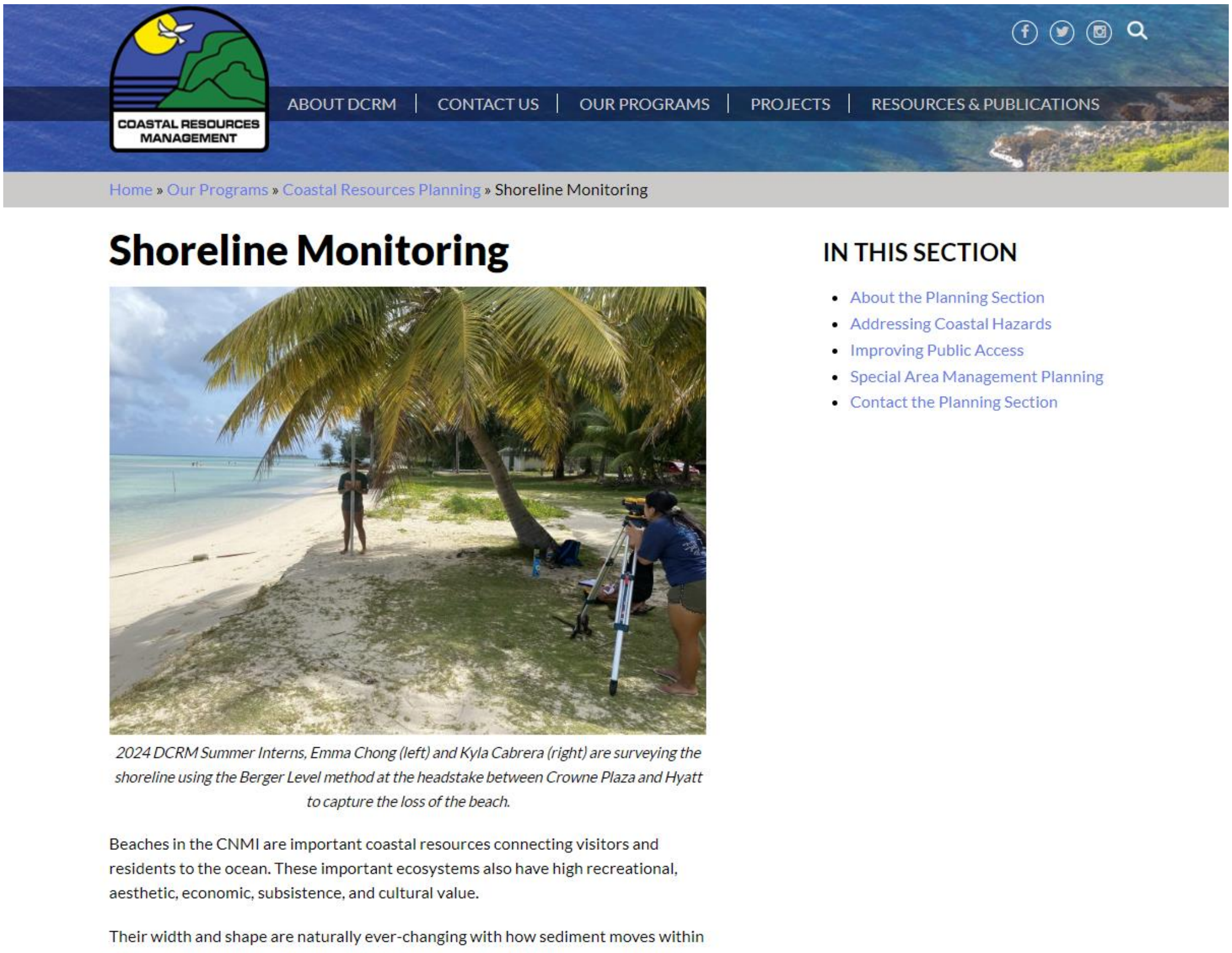


Figure 4 - The Shoreline Monitoring webpage is available at dcrm.gov.mp under the "Coastal Resources Planning" link.

Definitions

Abrasion/abrading - the process of scraping or wearing away

Accretion/accreting - the gradual addition of land by deposition of water-borne sediment

Backshore - the generally dry part of the beach lying between the nearshore and inland area, which is only exposed to waves during storm surge and high tide events

Beach nourishment - practice of adding sand or sediment into the beach to address erosion

Berm - the nearly horizontal portion of the beach or backshore formed by the deposit of materials by wave action. (In the CNMI, the berm is a vertical drop.)

Berger Level - used to accurately measure the height of an inaccessible object. Takes cross sectional picture of a beach's contour.

Dredging - maintenance practice of sand removal for deepening water depths for docks, harbors, or channels

Dynamic - constantly changing

Elevation difference - the height difference of the headstake to the beach toe

Erosion - the wearing away of land and the removal of beach (or dune) sediments by wave action, tidal currents, drainage, or high winds.

Foreshore - the part of the shore that lies between high and low water mark at ordinary tide.

Headstake - the starting point of a transect. Usually marked on a tree in paint.

High waterline - The level reached by the sea at high tide

Hydrodynamics - science revolving around the motion of fluids acting on solid bodies. For this report, it is the motion of waters surrounding the west coast of Saipan acting on corals and other physical objects in the water during wave conditions.

Incidental erosion - takes place mainly by cross-shore processes during extreme events (high waves, high water levels) and produce beach lowering or scouring

Risk - chance that something or someone will experience negative impacts from a coastal hazard

Scarp - a drop formed by erosive forces

Sediment transport - hydrogeological process in which waves currents push sediment into or away from coastal spaces

Shoreline change – change in the shoreline contour by loss or gain of sand volume

Stable/stability - a state in which the shoreline appears to return to its original condition over time even when disturbed

Stabilization measures - known approaches to address coastal erosion, whether structural or nature-based

Storm surge - rising water from the ocean that is pushed towards the shore by the force of winds from a strong storm. Storm surge can damage the shoreline and property.

Toe (beach toe) - the point of a beach that juts out past the waterline. Often this is sand that is covered by water but may be exposed during low tides.

Total Station method - Optical surveying instrument that integrates a leveled electronic movable telescope to measure the slope distance at where the prism rod is placed.

Trade winds – winds that reliably blow east to west just north and south of the equator

Transect - a straight line or narrow section across the earth's surface along which observations are made or measurements are taken.

Trimble GNSS - a Trimble-branded satellite navigation system (GNSS) device that provides global coverage

Vegetation line - the first line of stable and natural vegetation, separate from grass. Also the boundary between the sand beaches.

Waterline - a line that marks the surface of the sea on land.

Wave overtopping- when waves meet a submerged reef or structure and overtakes the structure

Wrackline - The line of debris that is left by high tide. Usually made up of eelgrass, pebbles, and litter.

How to Read the Beach Profile

Beach profiles are "excellent evidence of the magnitude and frequency of the cross-shore changes which are experienced by a particular shoreline of any sediment type" (Cooper et al, 2000). They are the contour of the shoreline from the headstake (starting point inland) to the bottom of the ***moat/toe***. The profile is a snapshot of the shoreline at the time of survey. DCRM's findings are based on the development and update of beach profiles along designated sites on Saipan, Tinian, and Rota.

DCRM identifies common shoreline features (see Figure 4) along a beach profile to describe the change. Properly identifying these features is a necessary skill for understanding the shoreline condition at the time. If the berm is getting closer to the headstake over time, erosion may be the trend. If the berm is getting farther from the headstake over time, accretion may be the trend.

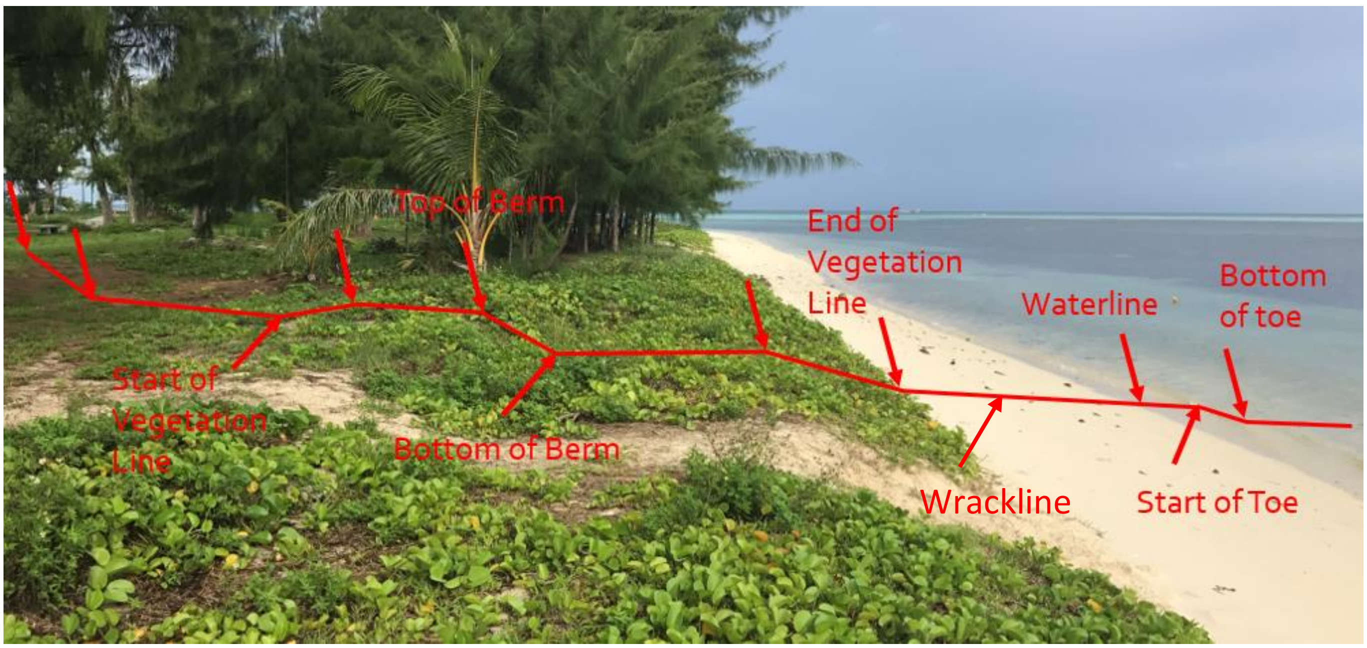


Figure 5 - The common features of a beach profile noted during surveying.

The common features of beach profiles are:

- ***Vegetation line*** – The start and end of stable and natural vegetation that may demonstrate stability of a beach profile
- ***Berm*** - The nearly horizontal portion of the beach or backshore formed by the deposit of materials by wave action. (In the CNMI, the berm is a vertical drop.)
- ***Wrackline*** - The line of debris left by high tide, usually made up of seagrass, pebbles, seashells, and litter
- ***Waterline*** - The line marking the surface of the sea on land
- ***Toe/moat*** – The point of a beach that jut out past the waterline. It is usually exposed during low tide so it is often submerged.

The feature below is the generated beach profile once data has been processed.
The x-axis, horizontal, is the distance from the headstake in feet.
The y-axis, vertical, is the vertical relief in feet. The vertical relief assumes that the headstake is at zero elevation and that the feet is the elevation difference from the headstake.

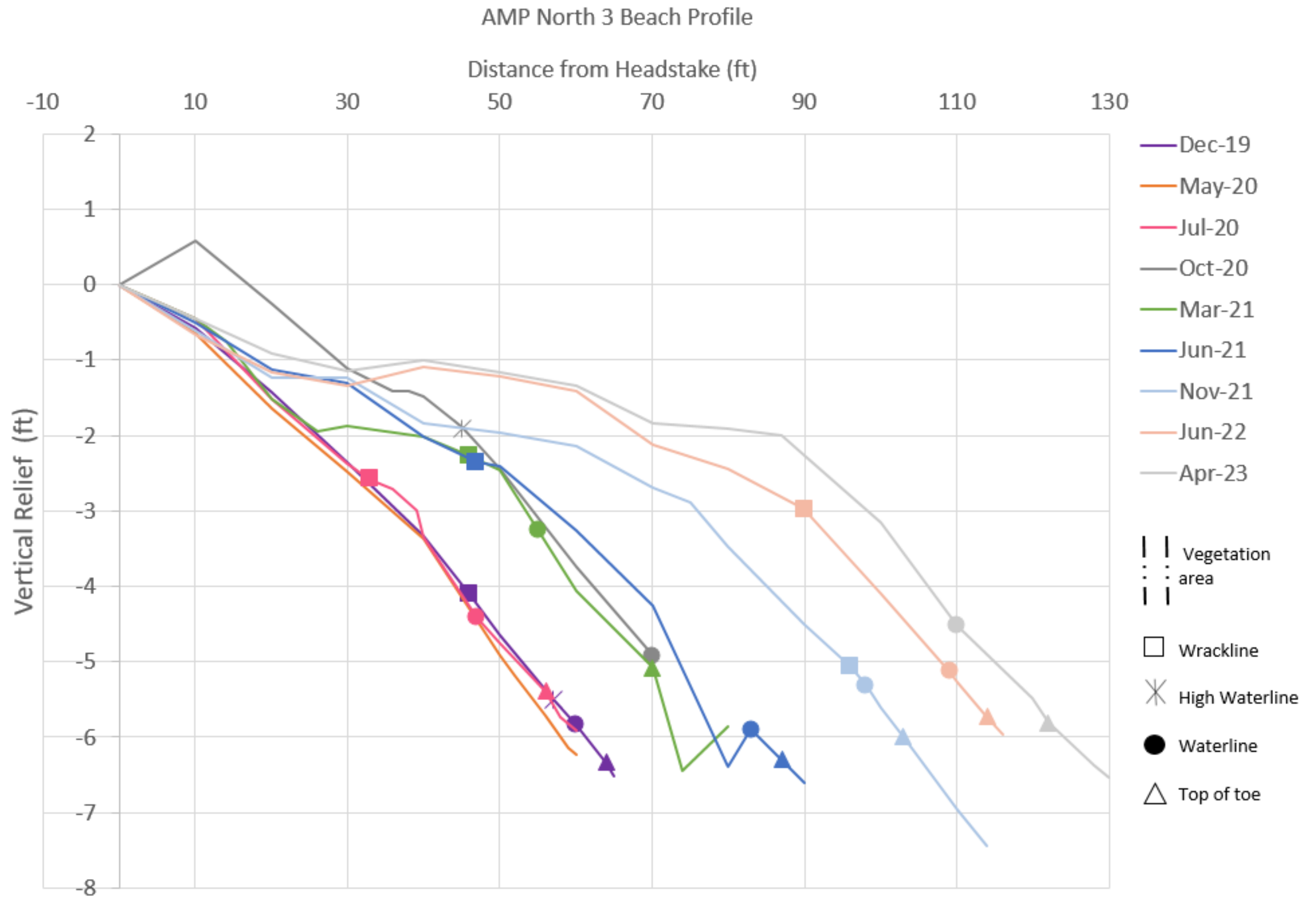


Figure 6 - Beach profile of AMP North 3 showing profiles from December 2019 - April 2023. The distance from the headstake in feet is shown here with the elevation differences starting from the headstake.

On the top right hand corner, there are different colored lines followed by dates. Each corresponding color line indicates a data entry captured on that day. For instance, a beach profile taken on Dec-19 is shown in purple, which you can compare to the recent beach profile taken on Apr-23. Time is an important factor for shoreline monitoring because entries taken at different times will be compared to understand shoreline change.

Figure 7 – The legend on the top right shows the beach profile at specific dates in their color code.

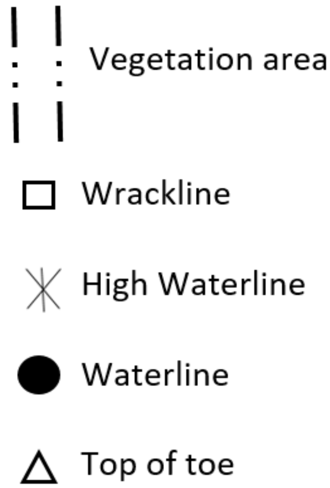


Figure 8 - The legend on the bottom right of a beach profile indicates the symbolism and their appropriate shoreline feature.

Symbology indicates shoreline features and where they have been detected along the transect. These shoreline features have been selected as important and common indicators of change. The color matches the date/time of the transect taken. The symbol matches the beach feature. The ***vegetation*** area has two lines. The left indicates 'Start of Vegetation' while the right indicates the 'End of Vegetation'. '***Wrackline'***, '***high waterline'***, '***waterline'***, and 'top of (beach) ***toe'*** are generally detected as one point. Note: not all beach features may be detected in a single shoreline transect.

Accounting Seasonal Change

Shoreline change is often dictated by seasonal trade winds that drive sediment transport.
In the CNMI, the typical winter easterly and typhoon season winds exhibit the highest wave energies.

- The **typical winter easterly conditions** usually happen between January through April, bringing swell and sand movement of the CNMI shoreline.
- The **typhoon season wave conditions** are anticipated after each storm, usually within July to October. Intensity and length of disturbance greatly influence sediment transport, with a high potential to worsen erosion. Typhoons often approach the CNMI from the east to the west but they can curve from south to north. Two common typhoon types have been observed: southwest (SW) and north-northwest (NNW). The typhoon season is influenced by the El Nino-Southern Oscillation (ENSO) pattern of the year in our region, the West Pacific Region. The ENSO status can be viewed through NOAA's Climate Prediction Center. (https://www.cpc.ncep.noaa.gov/products/analysis_monitoring/enso_advisory/ensodisc.shtml)

This report considers seasonal change and includes a map of the wave directions generated from the **Hydrodynamic Study of Saipan's Western Lagoon (2019).**

Shoreline Linear Regression Analysis

Linear regression analysis is calculated using the distance of the *top of the beach toe* from the headstake to calculate the rate of change of a beach profile and determine its status, whether it is eroding, accreting, stable, or undetermined.

Using Microsoft Excel, we would plot each transect's "distance of the top of the beach toe" (y-axis) and the "season and year" (x-axis). Then we would add the trend line and its linear equation. The equation of the linear relationship is y = mx + b. The m is the slope of the line, and also the "rate of change".

Eroding profiles have over a rate of one foot (>1) of negative values.
Accreting profiles have over a rate of one foot (>1) of positive values.
Stable profiles have a rate between -1 and +1 of change.

Beach profiles with many entries are suitable for this analysis. Those that are new and replacing previous ones will be omitted from the calculation. Each site has a linear regression analysis graph showing the transects' rate of change.

Saipan Beach Profiles and Key Findings

Pak Pak

Sheltered by the nearby reef (approximately 500 meters away) and Agingan Point, Pak Pak Beach has exhibited a stable shoreline since 2016. In 2018, a Super Typhoon Yutu-driven storm surge damaged vegetation. Pak Pak Beach's vegetation has matured, signifying stability since then.
As observed from the Hydrodynamic study, southwest typhoon conditions appear to be more damaging than north-northwest due to the increased swell energy. However, the beach may receive sediment from the adjacent reef and Agingan Point based on the shards of glass, reddish sand color, and occasionally dark rubble comprising the nearshore area.

Pak Pak 1 Highlights:

- Discontinued, started a new headstake at a visible coconut tree on July 2024
- Previous headstake: STABLE
- Wrackline that ranges 10 – 40 ft and an elevation difference of 5 ft
- The previous Shoreline Linear Regression Analysis (see pg 17) indicated that shoreline has a rate of -0.5 ft from 2016-2023.

Pak Pak 2 Highlights:

- STABLE, accreting in the short-term
- Shoreline trees are maturing
- Wrackline that ranges 45 – 75 ft with an elevation difference of 9 ft
- Based on the Shoreline linear regression analysis (see pg 17), the shoreline has at a rate of 0.5 ft from 2016-2023.

Pak Pak 3 Highlights:

- ACCRETING
- Wrackline that ranges 50 – 82 ft with an elevation difference of 8.5 ft
- Seasonal variation may bring sediment to the shoreline. The nearby outfall northward may have some influence. Vegetation has developed indicating that storm surge has not impacted the area since 2019.
- Based on the Shoreline linear regression analysis (see pg 17), the shoreline has at a rate of 0.2 ft from 2016-2023.

Figure 9 - Hydrodynamic map of the stretch of Pak Pak. The arrows show the intensity of waves generated from the south west (in dark purple) and the northnorthwest wave conditions (in yellow).

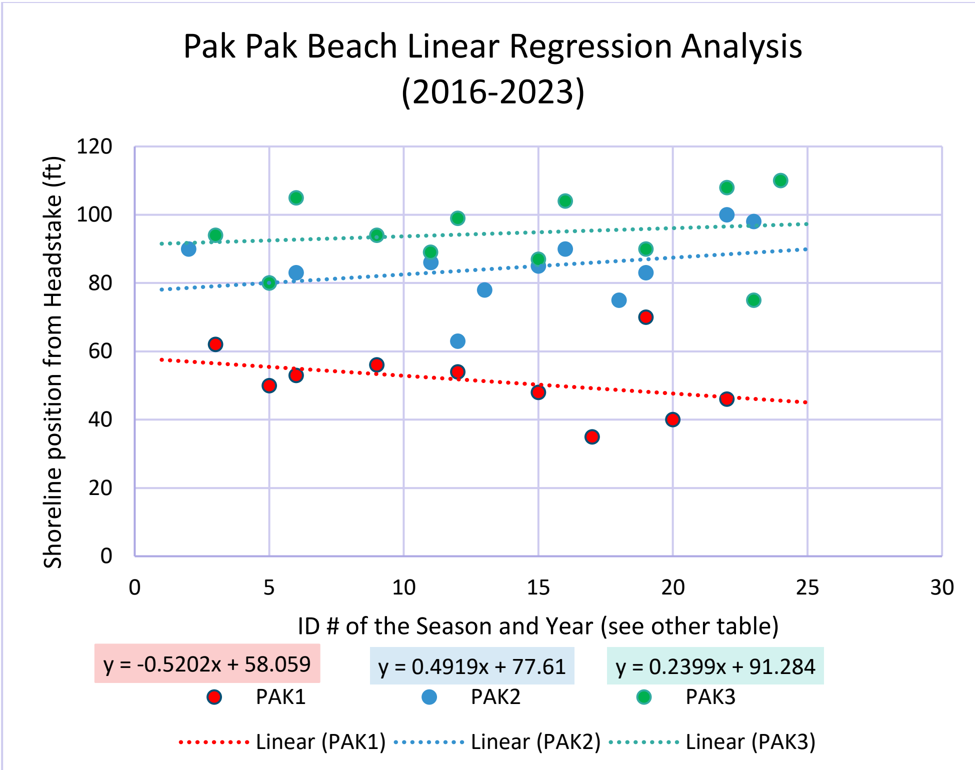
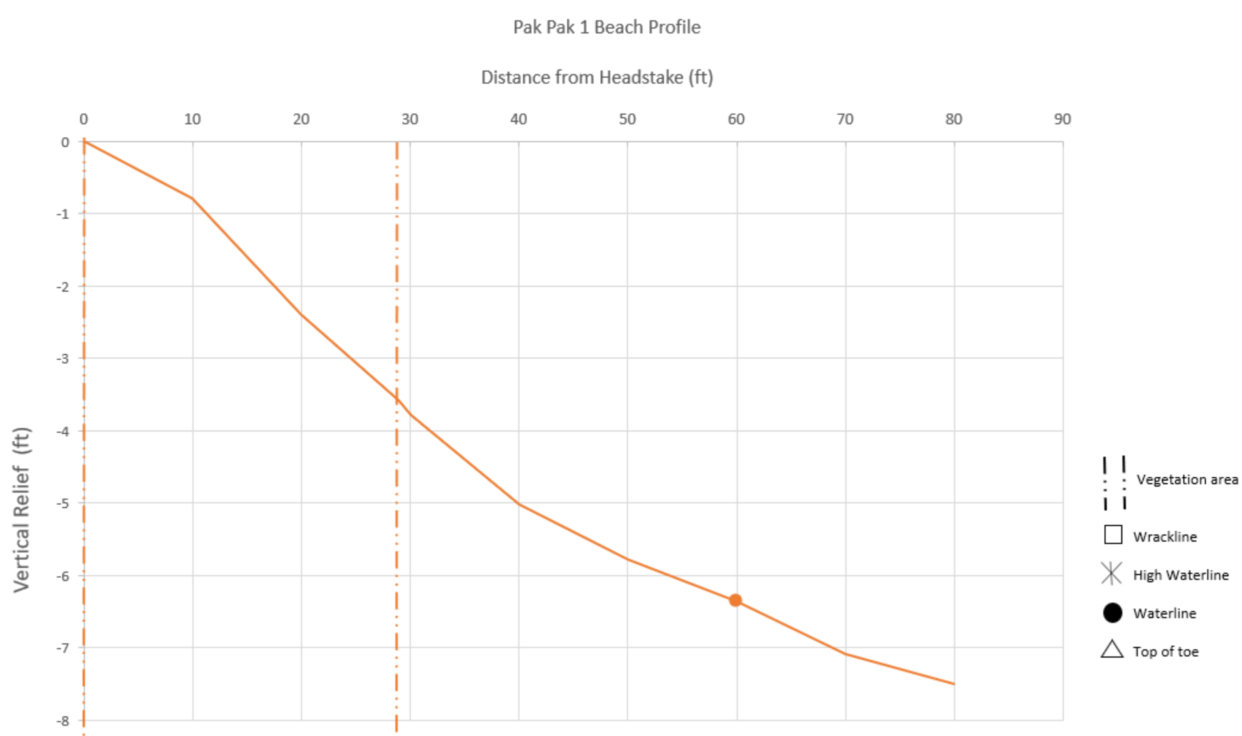
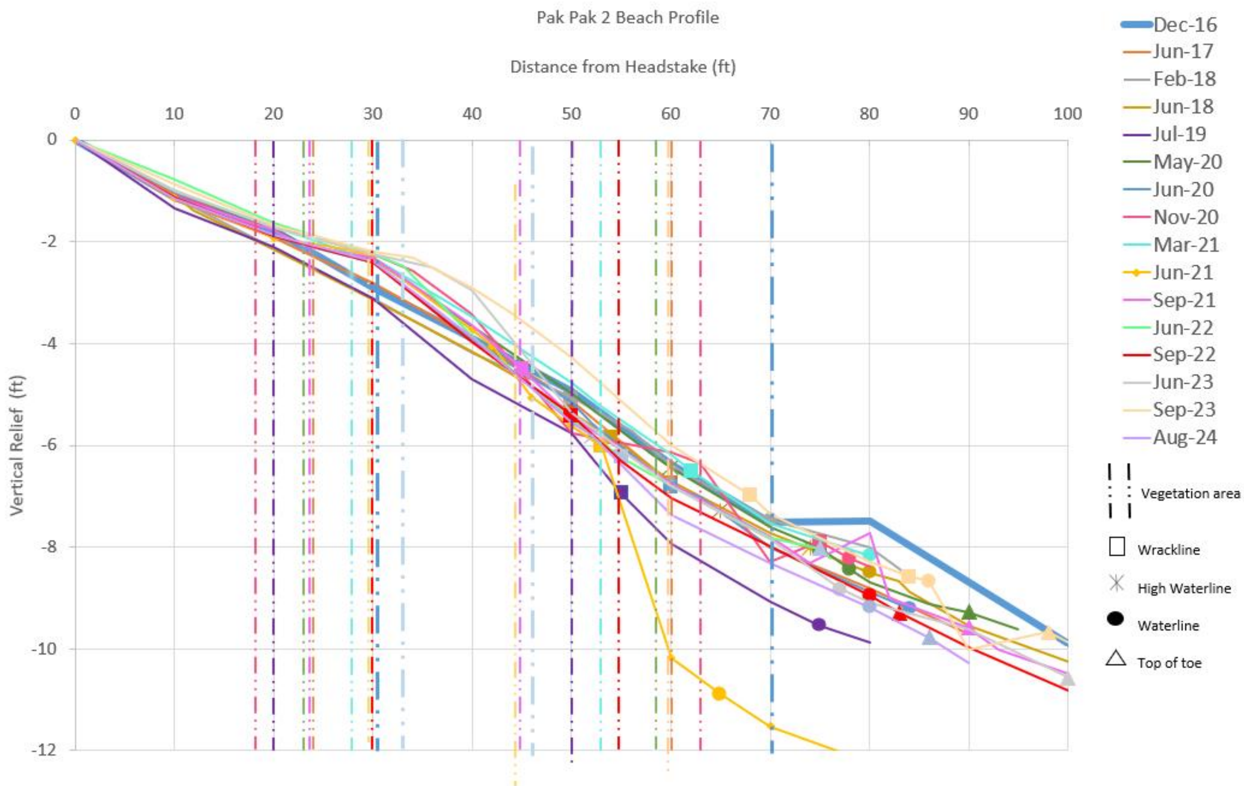


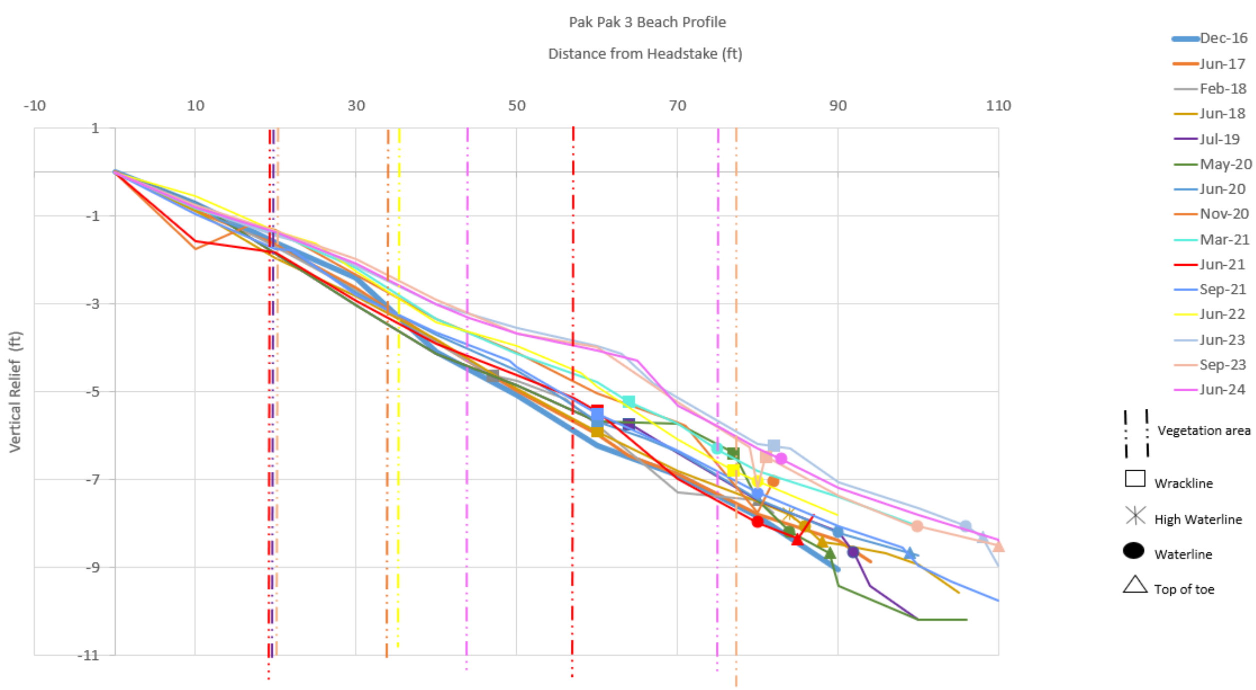
Figure 10 - Pak Pak Beach Linear Regression Analysis table shows time in seasons over shoreline position (top of toe) from the headstake.

Pak Pak Beach Profiles





Pak Pak 2 Beach Profile
Distance from Headstake (ft)
0
10
20
30
40
50
60
70
80
90
100
0
-2
-4
-6
-8
-10
-12
Vertical Relief (ft)
Dec-16
Jun-17
Feb-18
Jun-18
Jul-19
May-20
Jun-20
Nov-20
Mar-21
Jun-21
Sep-21
Jun-22
Sep-22
Jun-23
Sep-23
Aug-24
Vegetation area
Wrackline
High Waterline
Waterline
Top of toe



Pak Pak 3 Beach Profile
Distance from Headstake (ft)
-10
10
30
50
70
90
110
1
-1
-3
-5
-7
-9
-11
Vertical Relief (ft)
Dec-16
Jun-17
Feb-18
Jun-18
Jul-19
May-20
Jun-20
Nov-20
Mar-21
Jun-21
Sep-21
Jun-22
Jun-23
Sep-23
Jun-24
Vegetation area
Wrackline
High Waterline
Waterline
Top of toe

PIC

The “Pacific Islands Club” site (PIC) is adjacent to the Chalan Kanoa reef, which provides wave buffering 500 meters away from the headstakes. This shoreline is subjected to storm-induced erosion. The storms of 2018 have damaged the shoreline. In response to the incidental erosion, the Pacific Islands Club Saipan hotel placed sand bags and boulders to stabilize the highly eroding storm berm not too far from the Seaside Grill facilities. Fortunately, the storms during this period have not damaged the berm. Wild native vegetation has prospered since their settlement after the significant erosion events. Southwest typhoon conditions appear to be more damaging than north-northwest especially due to the proximity of the storm. Future intense storm surge events coupled with sea level rise in the future may erode the shoreline further.

PIC 1 Highlights:

- STABLE
- Wrackline that ranges 36 – 70 ft and an elevation difference of 9 ft
- Erosion to the shoreline occurred in Dec-20 at a 40 ft distance and more.
- Foot traffic continues to discourage vegetation growth.
- Based on the Shoreline linear regression analysis (see21), the shoreline has a rate of -0.5 ft from 2016-2023.

PIC 2 Highlights:

- STABLE
- Wrackline that ranges 34 – 48 ft with an elevation difference of 9 ft
- Stabilizing beach vegetation has grown over the berm. The berm was steepened from an erosion event around June 2017. Rocks were placed to stabilize the berm but Typhoon Yutu (2018) deepened the drop more. The loss of the head stake may indicate if the hotel property is at high risk of shoreline erosion from storm surge.
- Based on the Shoreline linear regression analysis (see pg 21), the shoreline has a rate of -0.07 ft from 2016-2023.

PIC 3 Highlights:

- STABLE
- Wrackline that ranges 48 – 50 ft and an elevation difference of 9 ft
- Construction of a hotel is located in the backshore
- Based on the Shoreline linear regression analysis (see pg 21), the shoreline has a rate of 0.4 ft from 2016-2024.

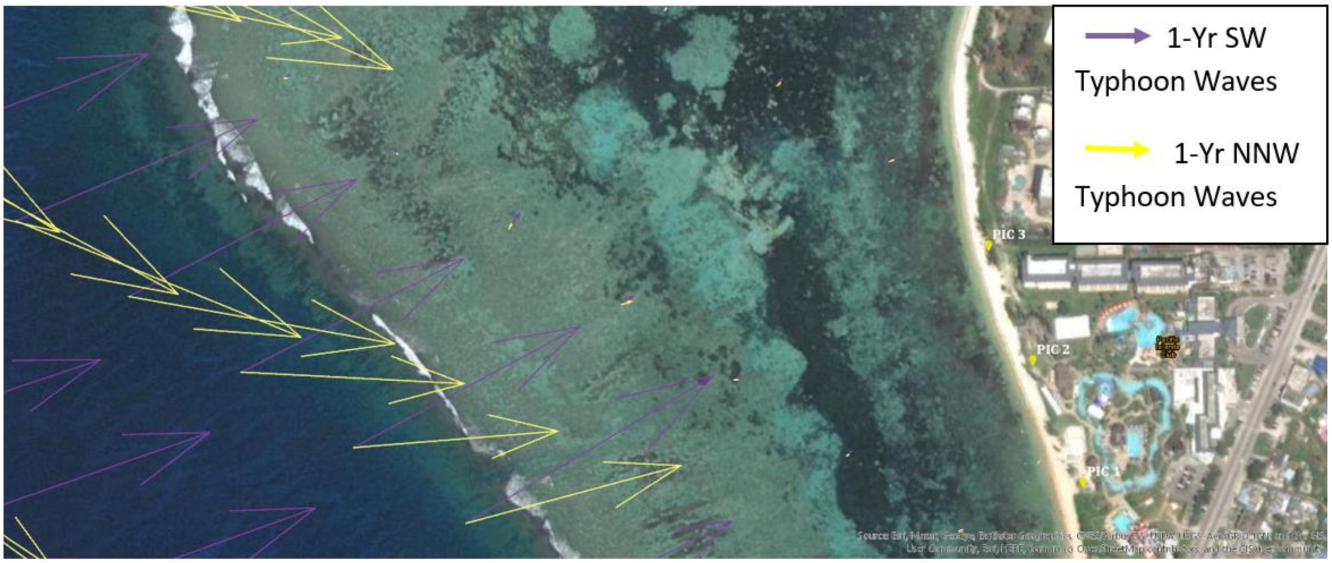
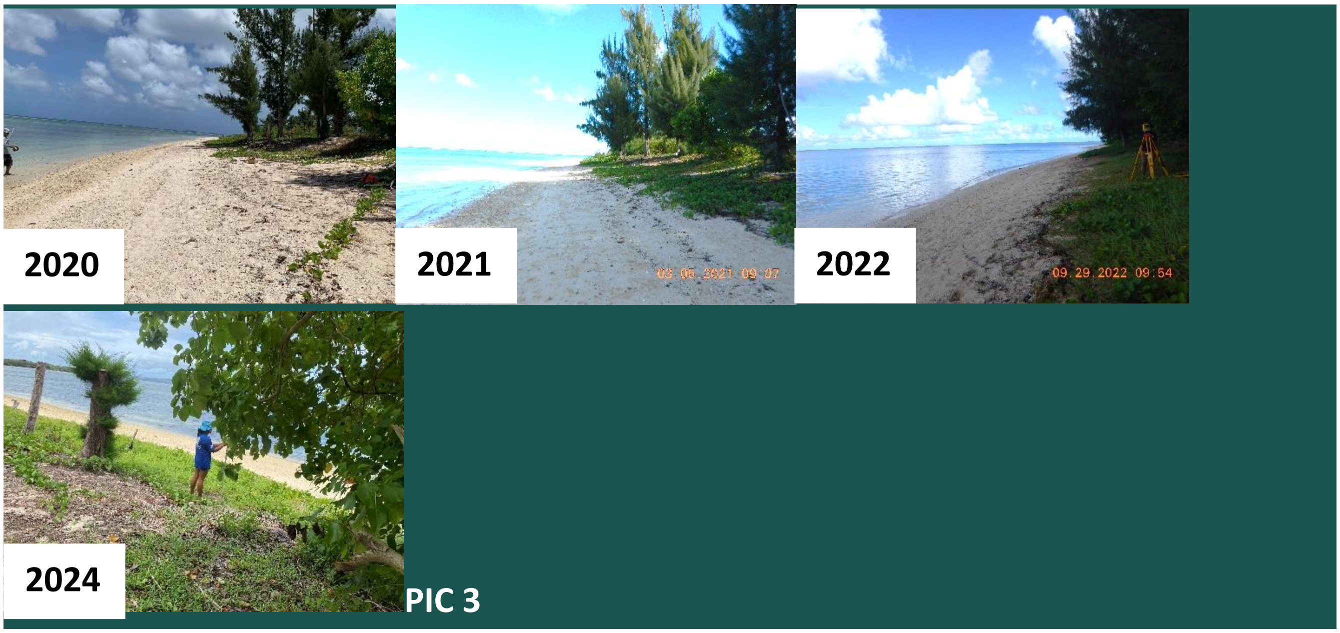


Figure 11- ***Hydrodynamic map of the stretch of PIC. The arrows show the intensity of waves generated from the south west (in dark purple) and the northnorthwest wave conditions (in yellow).***



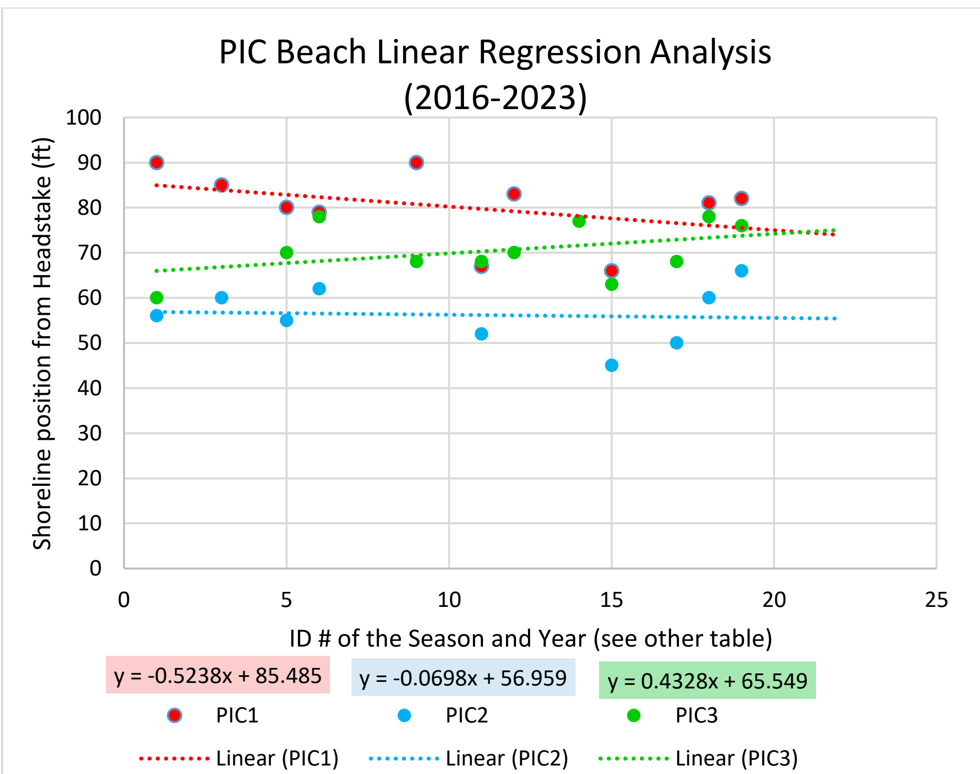
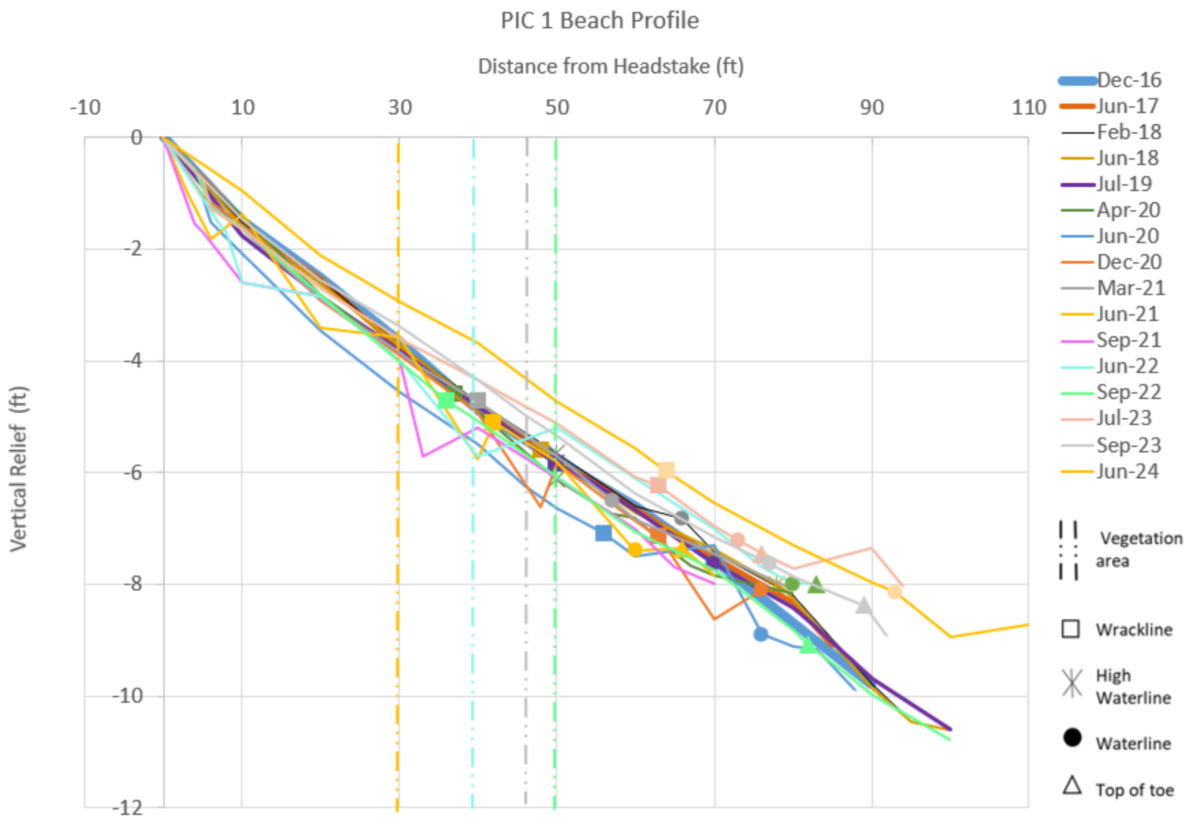
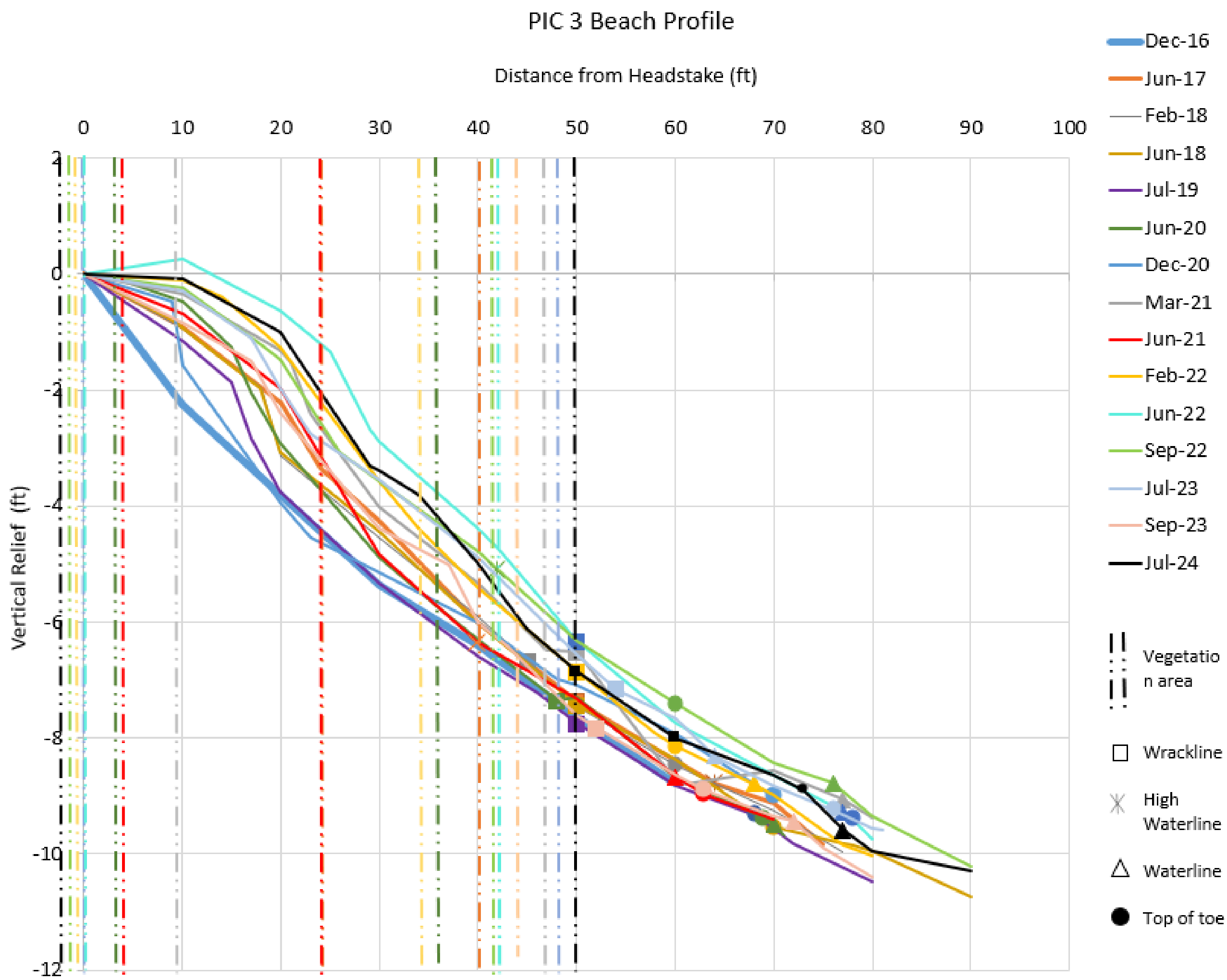


Figure 12 - PIC Beach Linear Regression Analysis table shows time in seasons over shoreline position (top of toe) from the headstake.

PIC Beach Profiles




PIC 3 Beach Profile
Distance from Headstake (ft)
0
10
20
30
40
50
60
70
80
90
100
2
0
-2
-4
-6
-8
-10
-12
Vertical Relief (ft)
Dec-16
Jun-17
Feb-18
Jun-18
Jul-19
Jun-20
Dec-20
Mar-21
Jun-21
Feb-22
Jun-22
Sep-22
Jul-23
Sep-23
Jul-24
Vegetatio n area
Wrackline
High Waterline
Waterline
Top of toe

Hopwood

Adjacent to the Chalan Kanoa reef at a distance of approximately 500 meters, the Hopwood shoreline is subjected to wave damage events from a powerful storm. An account from a resident suggests that this shoreline has experienced accretion since the mid-1900s. Thus, the vegetation and settled sand in this area may be several decades old. Shoreline is susceptible to ***incidental erosion,*** in which the beach is from an extreme storm event. However, sediment transport (likely the north to south) has enabled the beach to recover.

Flourishing vegetation line indicates how that ***storm surge*** has not reached the backshore during this period. The short width makes the shoreline susceptible to future sea level rise and the reach of storm surge. Wave overtopping and overwhelmed tidal flows from the channel down south may impact this site during both typhoon wave conditions. It appears that southwest conditions could greatly impact this site. Under southwest conditions, longshore transport could push sediment from south to north while north-northwest conditions indicate the opposite.

Hopwood 1 Highlights:

- Wrackline ranges 30 – 42 ft and an elevation difference of 7 ft
- Shoreline erosion and dynamic vegetation line are direct impacts from storm surge.
- Nearby outfall has some influence on sediment transport.
- There is insufficient information to conduct a shoreline linear regression analysis this period.
- PREVIOUS HEADSTAKE suggested that this profile was subjected to storm-induced erosion.

Hopwood 2 Highlights:

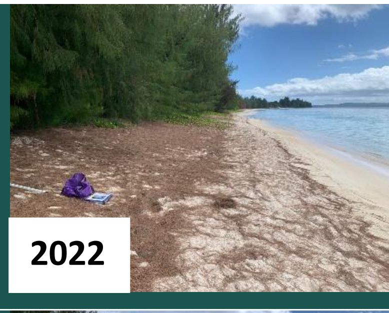
- REPLACED
- There is insufficient information to conduct a shoreline linear regression analysis this period.
- PREVIOUS HEADSTAKE suggested that this profile was subjected to storm-induced erosion.

Hopwood 3 Highlights:

- ACCRETING
- Wrackline ranges 27 – 49 ft and an elevation difference of 7 ft
- Variation in entries are influenced by the outfall north of the headstake.
- Based on the Shoreline linear regression analysis (see pg 25), the shoreline has a rate of +2.4 ft from 2016-2023.

Hopwood 1

[Photo not available for previous years]



Hopwood 2

[Photo not available for previous years]

Hopwood 3

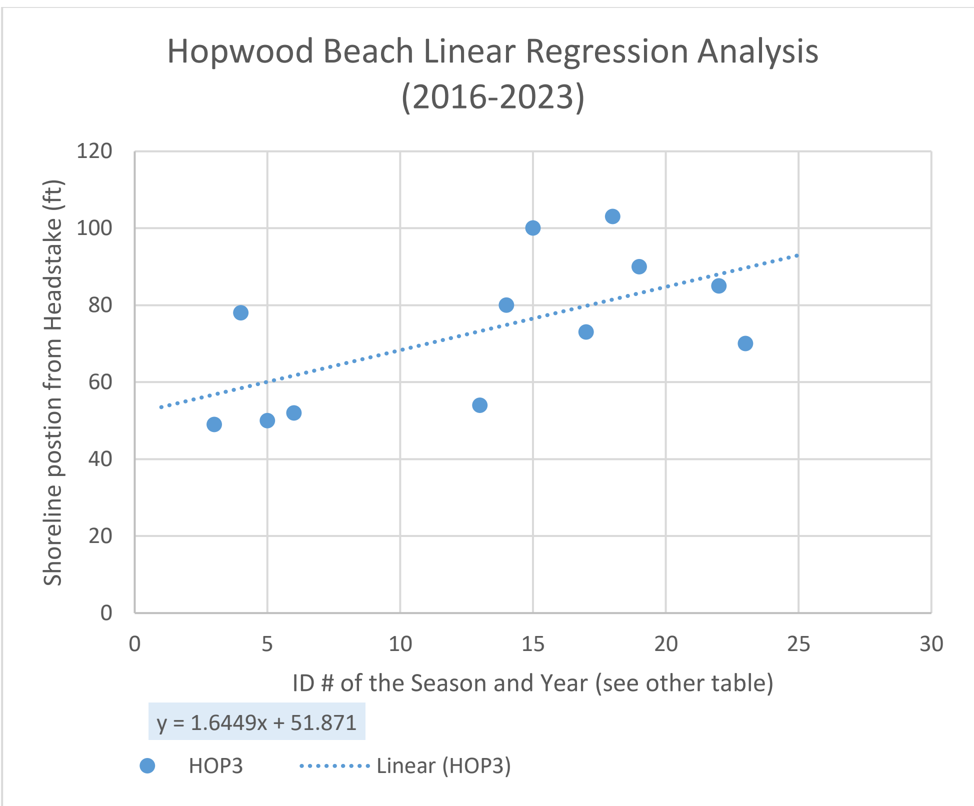
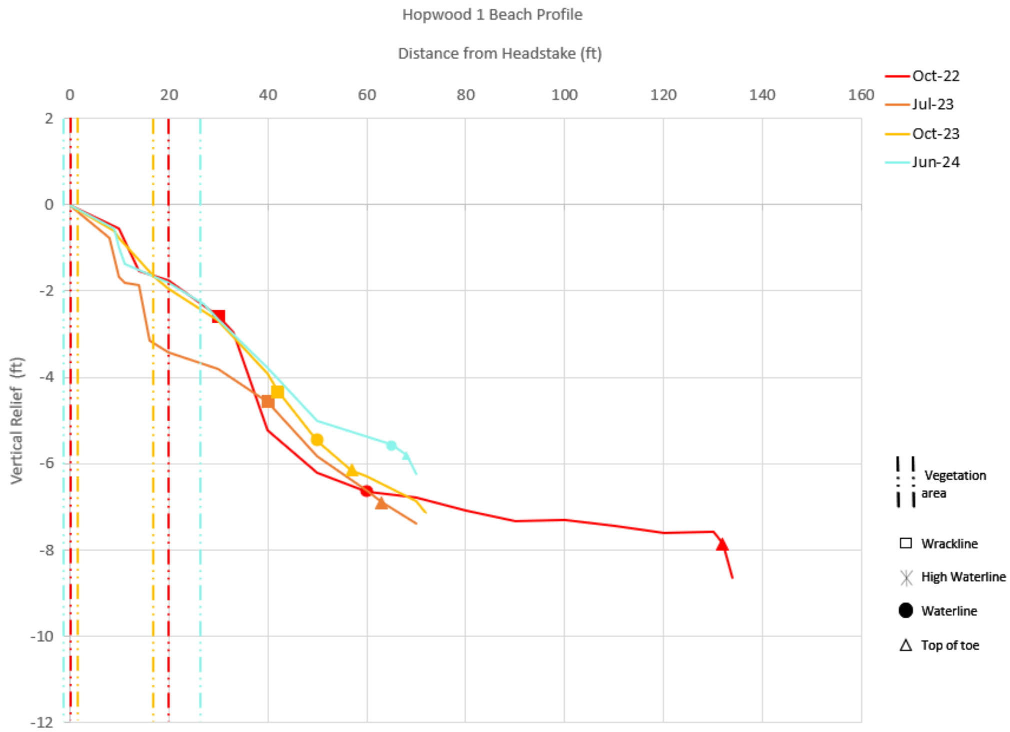
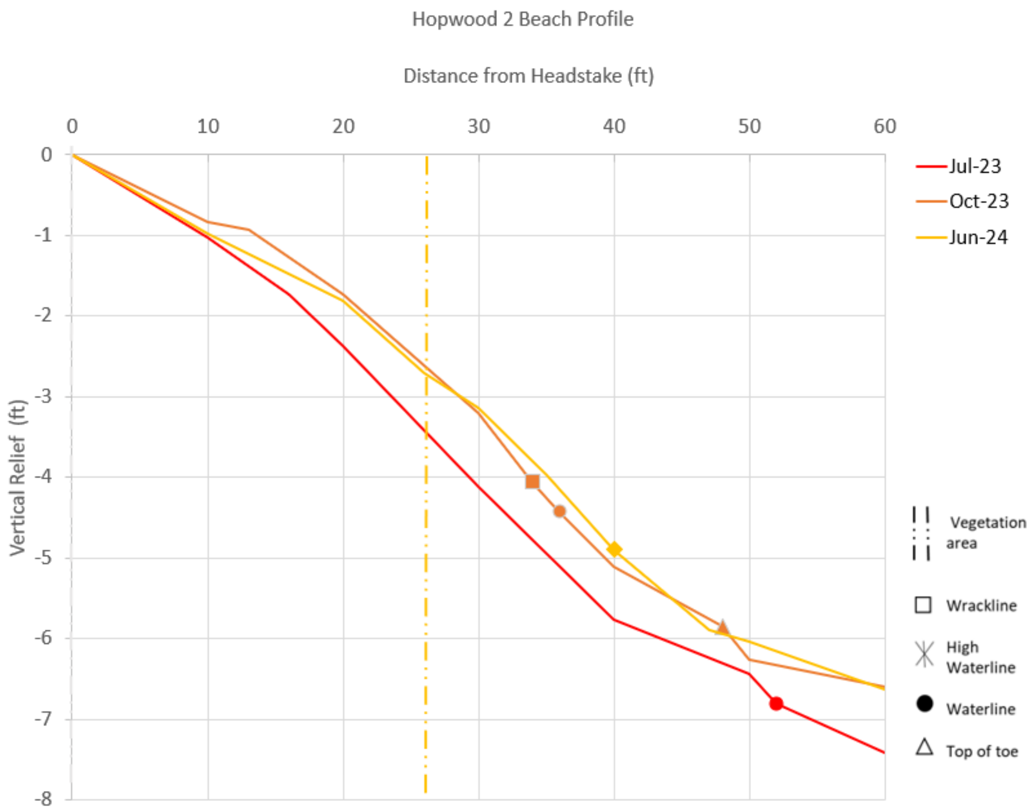


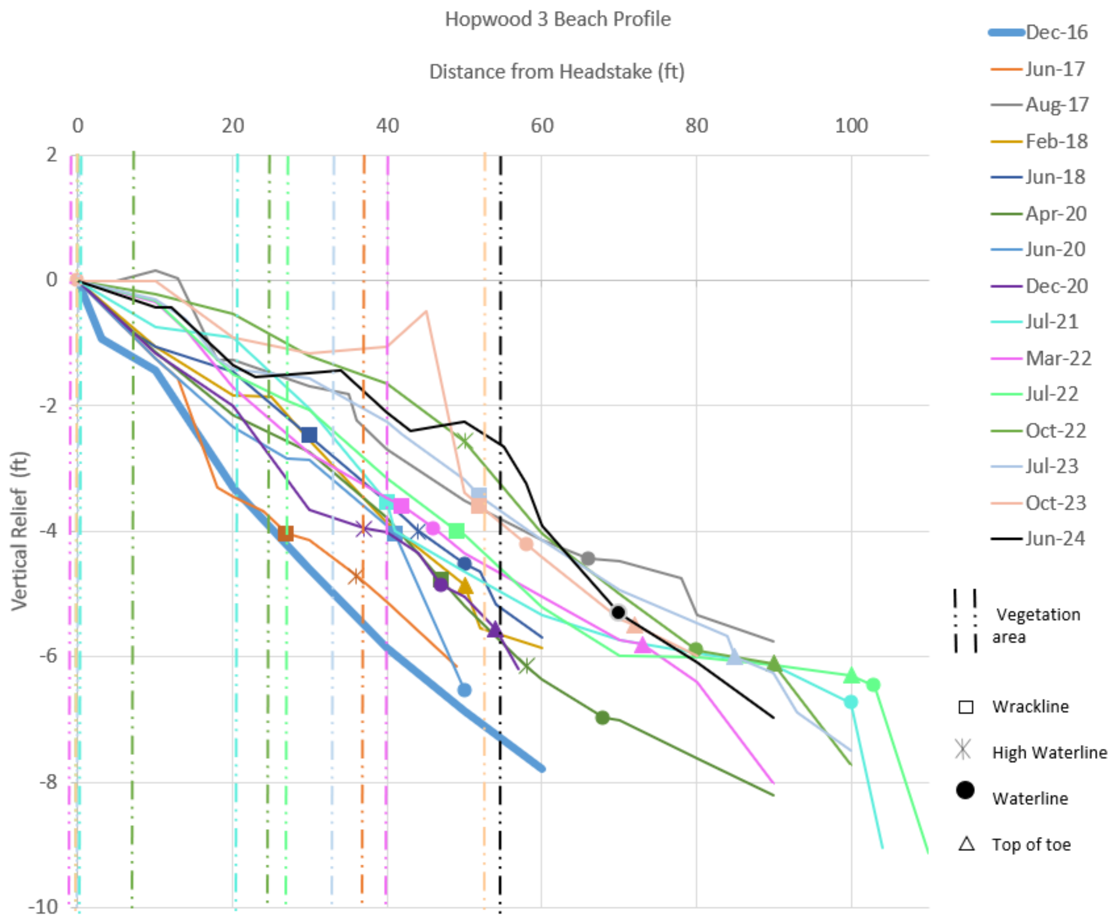
Figure 13 - Hopwood Beach Linear Regression Analysis table shows time in seasons over shoreline position (top of toe) from the headstake.

Hopwood Beach Profiles

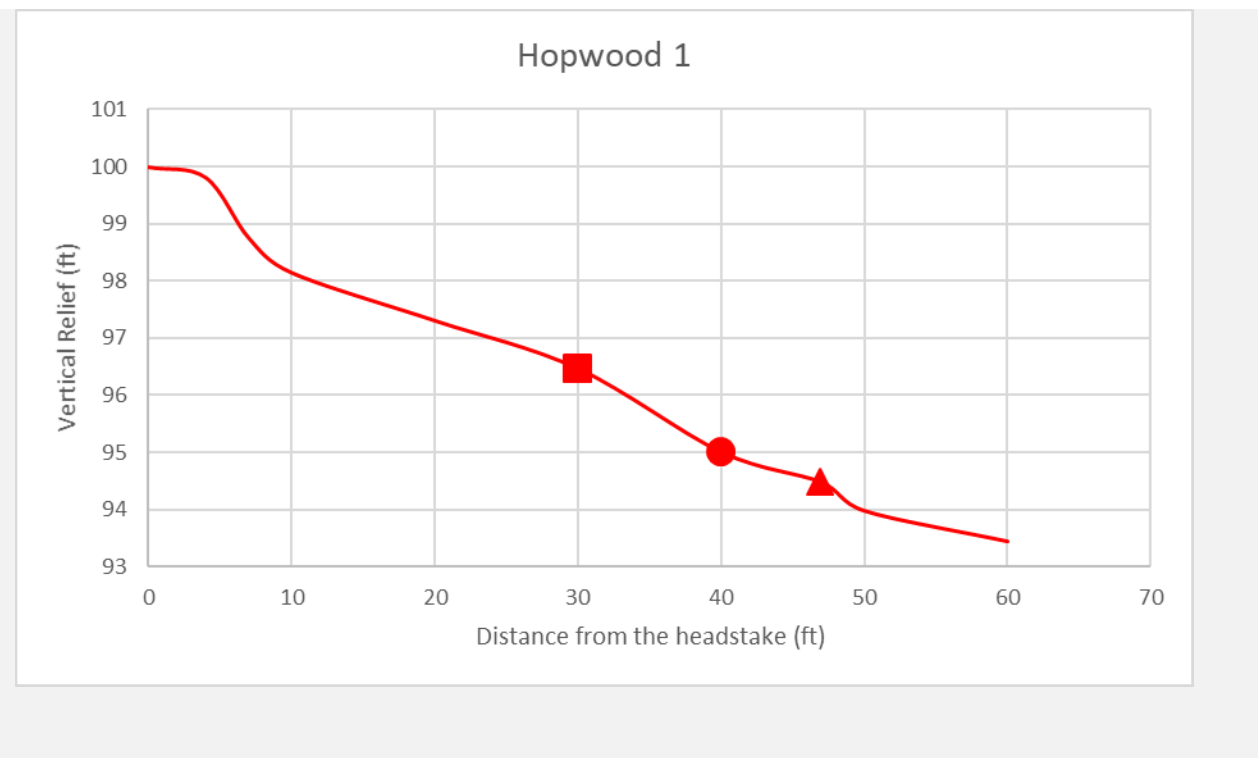
Berger Level







Total Station




Hopwood 2
107
106
105
104
103
102
101
100
99
Vertical relief (ft)
0
10
20
30
40
50
60
70
Distance from the headstake (ft)


Hopwood 3
101
100
99
98
97
96
95
94
93
92
Vertical relief (ft)
0
10
20
30
40
50
60
70
80
90
100
Distance from the headstake (ft)

Aquarius

Aquarius is parallel to the Chalan Kanoa channel, which greatly influences movement through the flow in and out of the southern lagoon. The nearby sand bar indicates the active sediment transport in this area during higher wave conditions. It also acts as a sand source, filling in shoreline areas during gentle wave conditions (winterly). Depending on their direction and strength, waves can pull sand into the water and push sand back up to shore. The gentle northeast winter trade winds have been observed to push sand up into the shore.

This shoreline appears to be accreting, yet vehicular access to the berm has compacted the sandy backshore. A couple of years ago, small-scale beach nourishment increased the width of the shoreline here and the eroding segments of Sugar Dock to the north.

Overwhelming tidal flows from the channel down south may impact this site during both typhoon wave conditions. It appears that southwest conditions could greatly impact this site. Under southwest conditions, longshore transport could potentially be going from south to north while north-northwest conditions indicate the opposite.

Aquarius 1 Highlights:

- ACCRETING
- Wrackline that ranges 35 – 48 ft and an elevation difference of 9 ft
- Nearby outfall down south has influence on sediment transport.
- Based on the Shoreline linear regression analysis (see pg 31), the shoreline has at a rate of +5.4 ft from 2016-2023.

Aquarius 2 Highlights:

- Discontinued; Previously ACCRETING
- Wrackline that ranges 35 – 92 ft with an elevation difference of 10 ft
- Short-term erosion events have occurred. The sand bar could influence this dynamic behavior, suggesting that sand is pushed during typical winter conditions and pulled during typhoon conditions.
- Based on the Shoreline linear regression analysis (see pg 31), the shoreline has a rate of +1.9 ft from 2016-2023.

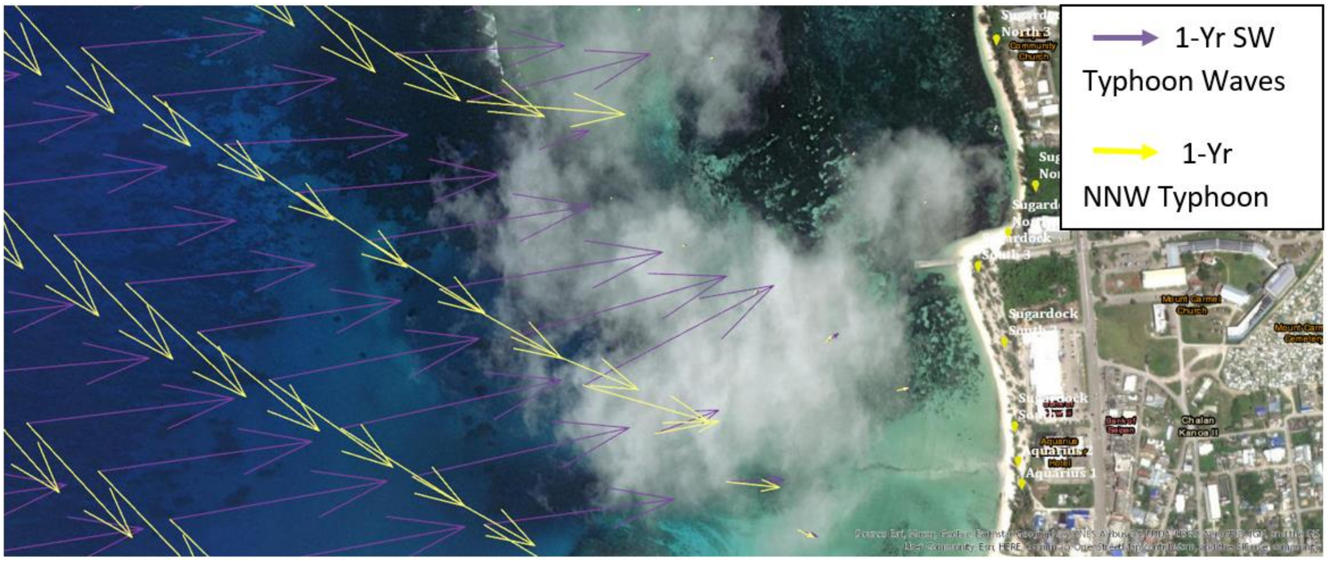


Figure 14 - Hydrodynamic map of the stretch of Aquarius with the open wave energies entering through the channel opening. The arrows show the intensity of waves generated from the south west (in dark purple) and the northnorthwest wave conditions (in yellow).

Aquarius 1

Aquarius 2

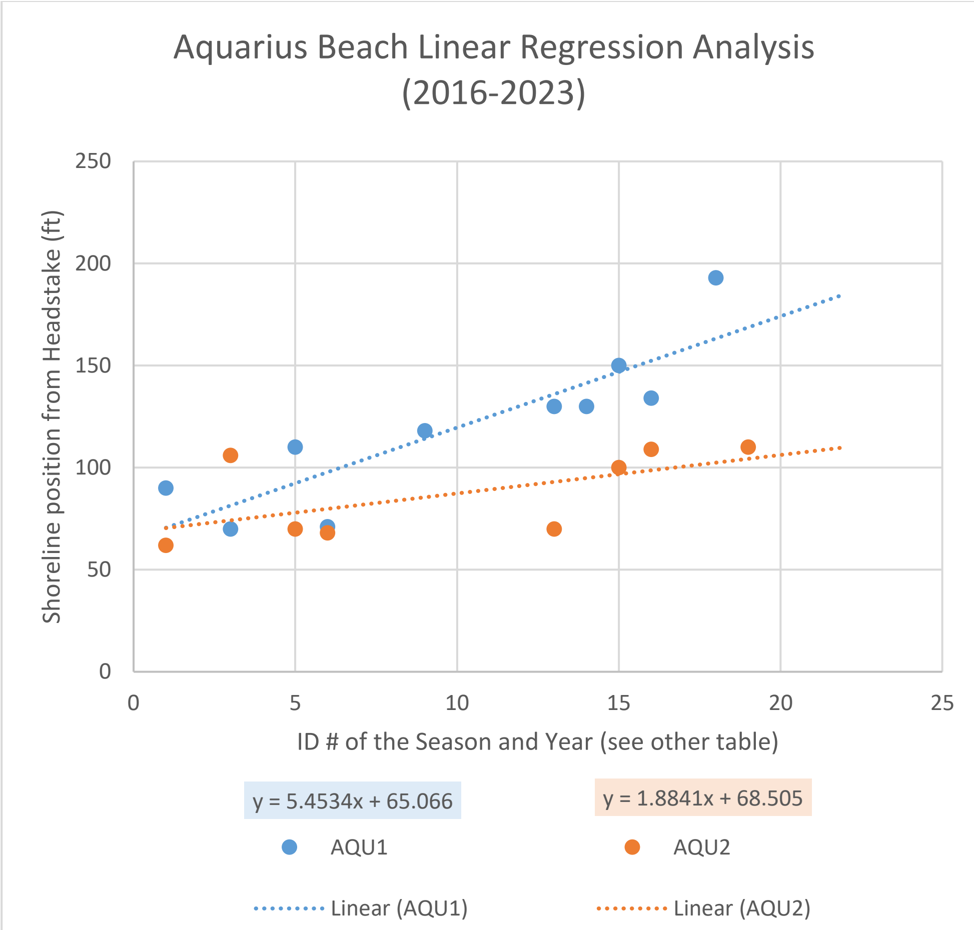
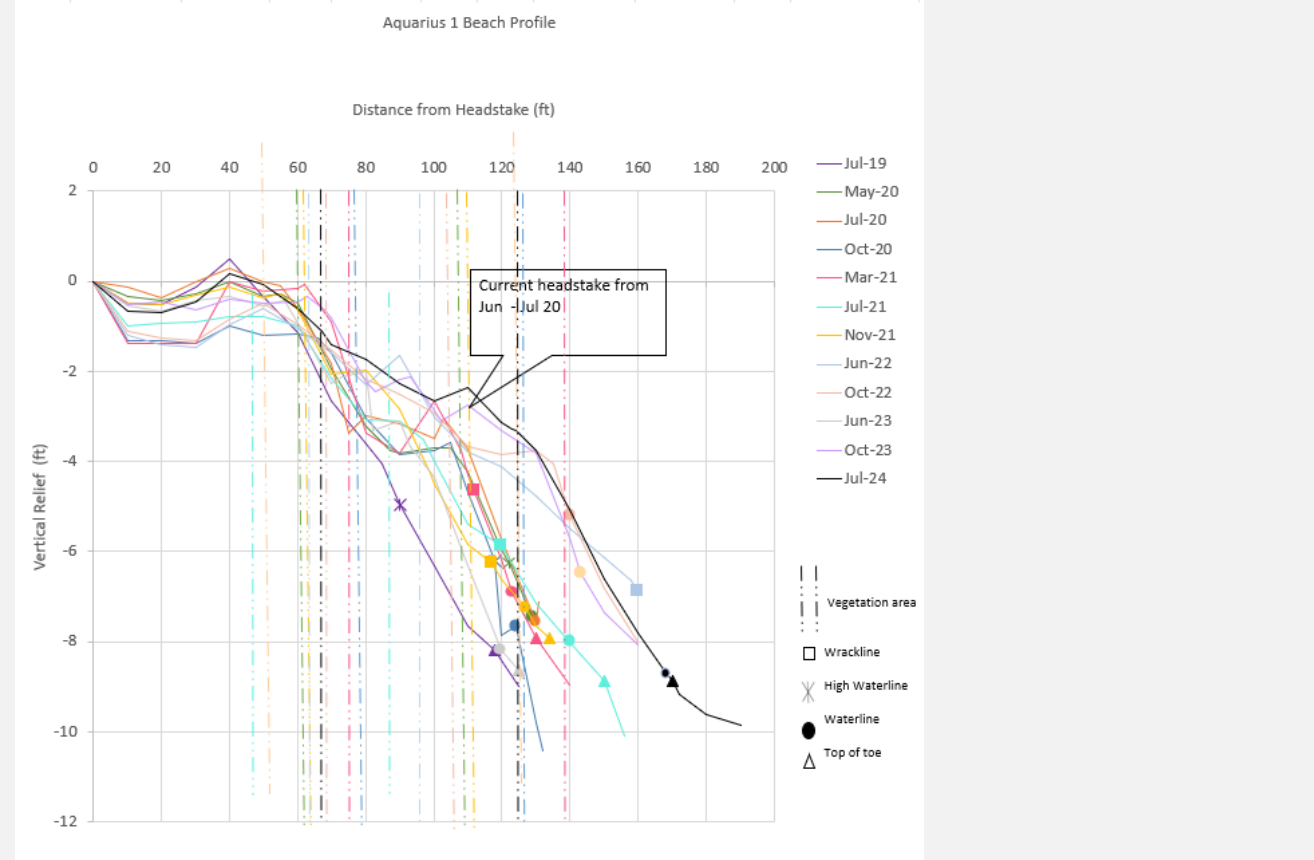
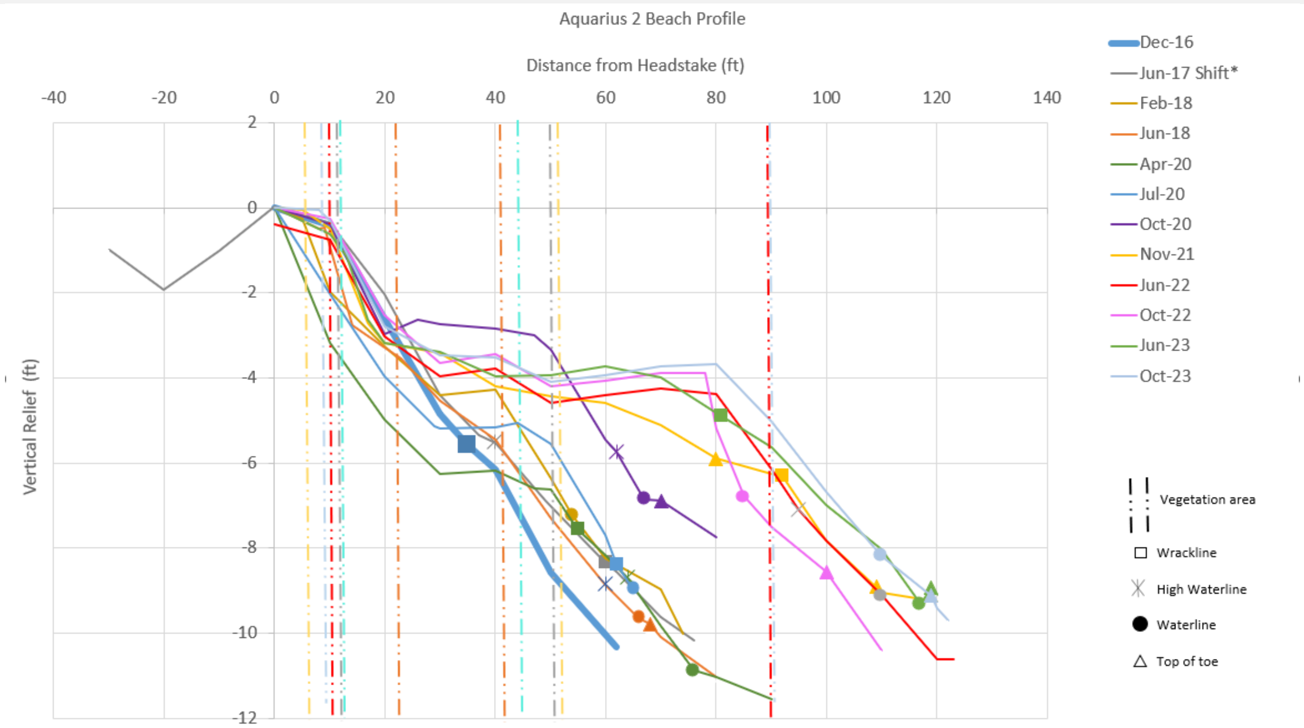


Figure 15- Aquarius Beach Linear Regression Analysis table shows time in seasons over shoreline position (top of toe) from the headstake.

Aquarius Beach Profiles

Berger Level





Sugar Dock

Parallel to the Chalan Kanoa Reef and channel, the Sugar Dock shoreline is dynamic given the sediment transport sensitivity to the dock and the channel. During typhoon conditions, the channel may exacerbate and even shift sediment transport processes. The dock lost its ability to allow sediment passage underneath the infrastructure from north to south. The result is a beach on the northern side of the dock rather than a deep boat ramp, causing a public access issue for those who need to launch their boats. To resolve this issue, the beach has been dredged in early August 2024. Plans exist to demolish and rebuild the dock to an improved design allowing for sediment transport.

The north of this accreted area was observed with less of a berm and a slightly steeper shoreline, suggesting a sediment deficiency. Beach loss by future erosion and storm surge threatens the Saipan Community School and Church and the Tasi Homes complex.

Sugar Dock South has a variable trend while Sugar Dock North has a long-term erosion trend.

Sugar Dock South 1 Highlights:

- ACCRETING
- Wrackline that ranges 30 – 77 ft with an elevation difference of 9 ft
- Short-term erosion and accretion events define this profile. The channel influences this dynamic behavior, suggesting that sand is pushed during typical winter conditions and pulled during typhoon conditions. The sand bar is a sediment source.
- Based on the shoreline linear regression analysis (see pg 37), the shoreline has a rate of +1.8 ft from 2016-2023.

Sugar Dock South 2 Highlights:

- STABLE
- Wrackline that ranges 20 – 31 ft with an elevation difference of 9 ft
- The berm has completely worn away, so the headstake (tree) is right when the slope begins to steadily drop into the waterline. This suggests long-term erosion and sediment deficiency for this stretch.
- Based on the Shoreline linear regression analysis (see pg 37), the shoreline has a rate of -0.5 ft from 2016-2023.

Sugar Dock South 3 Highlights:

- STABLE
- Wrackline that ranges 41 – 59 ft and an elevation difference of 9 ft
- Vegetation line expanded indicating stability.
- Based on the Shoreline linear regression analysis (see pg 37), the shoreline has a rate of +0.5 ft from 2016-2023.

Sugar Dock North 1 Highlights:

- DREDGED, previously accreting

- Previously, based on the Shoreline linear regression analysis (see pg 34), the shoreline has a rate of 2.7 ft from 2016-2023.

Sugar Dock North 2 Highlights:

- ERODING
- Wrackline that ranges 45 – 70 ft with an elevation difference of 8 ft
- Abrasion from a previous storm is at 35 feet from the headstake
- Based on the Shoreline linear regression analysis (see pg 37), the shoreline has at a rate of -2.2 ft from 2016-2023.

Sugar Dock North 3 Highlights:

- ERODING
- Wrackline that ranges 35 – 38 ft with an elevation difference of 7 ft
- Based on the Shoreline linear regression analysis (see pg 37), the shoreline has at a rate of -0.8 ft from 2016-2023.

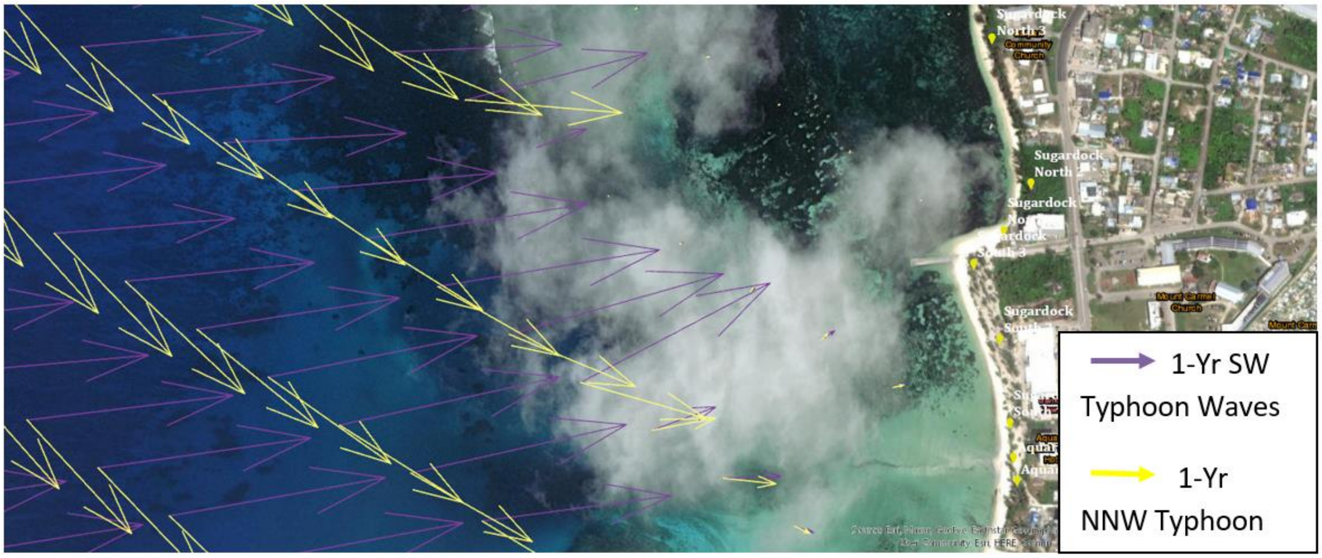
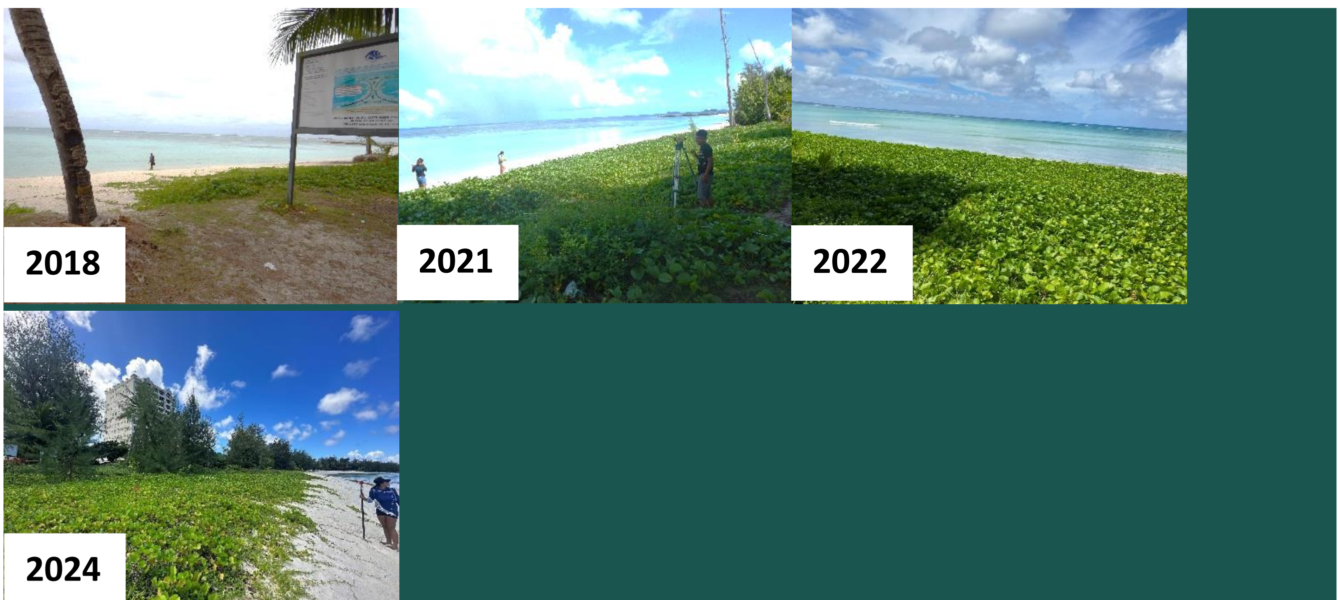


Figure 16 - Hydrodynamic map of the stretch of Sugar Dock with the open wave energies entering through the channel opening. The arrows show the intensity of waves generated from the south west (in dark purple) and the northnorthwest wave conditions (in yellow).



Sugar Dock South 1

2024

Sugar Dock South 2

2018

2021

2022

2024

Sugar Dock South 3

2019

2021

2022

Sugar Dock North 1

2019

2021

2022

Sugar Dock North 2

Sugar Dock North 3

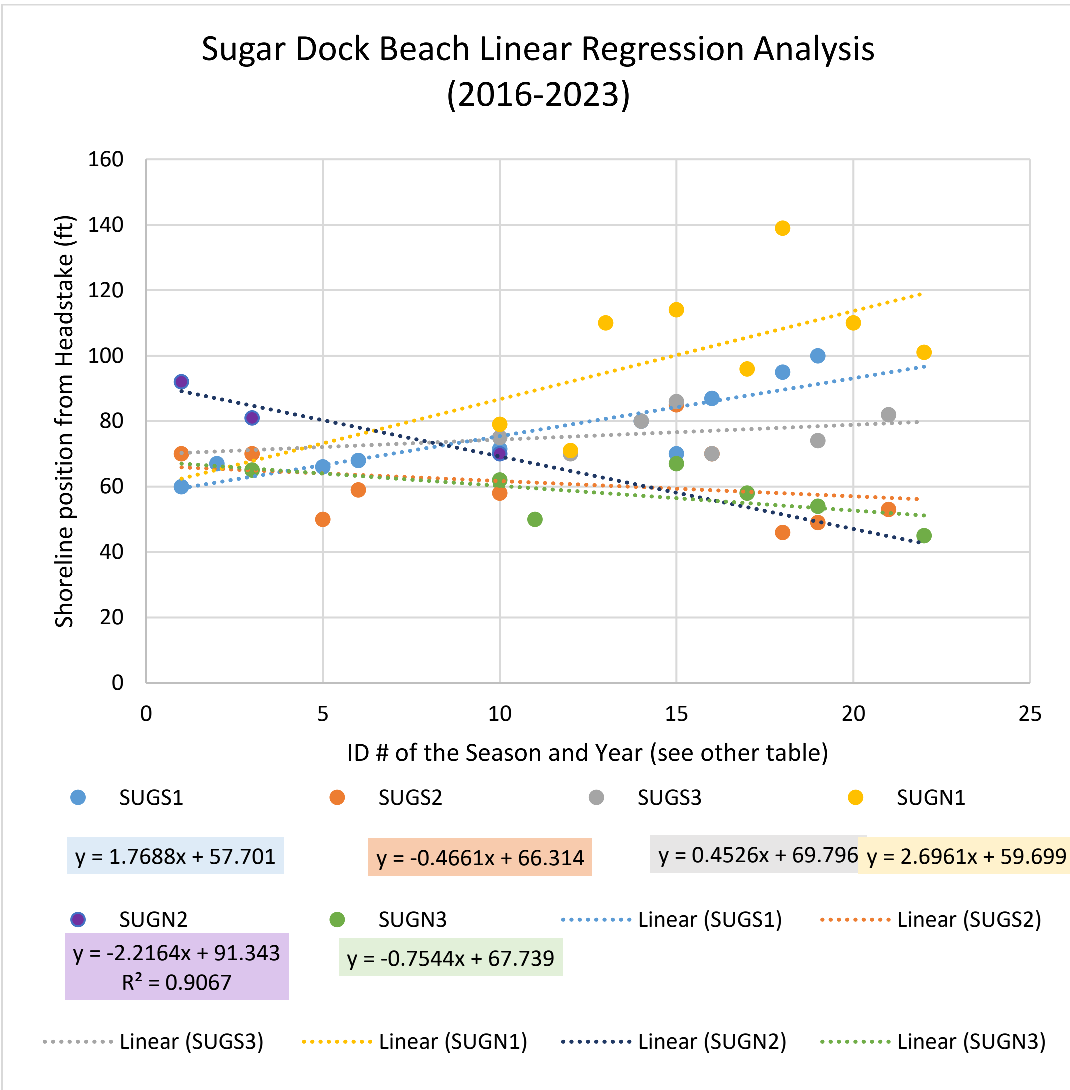
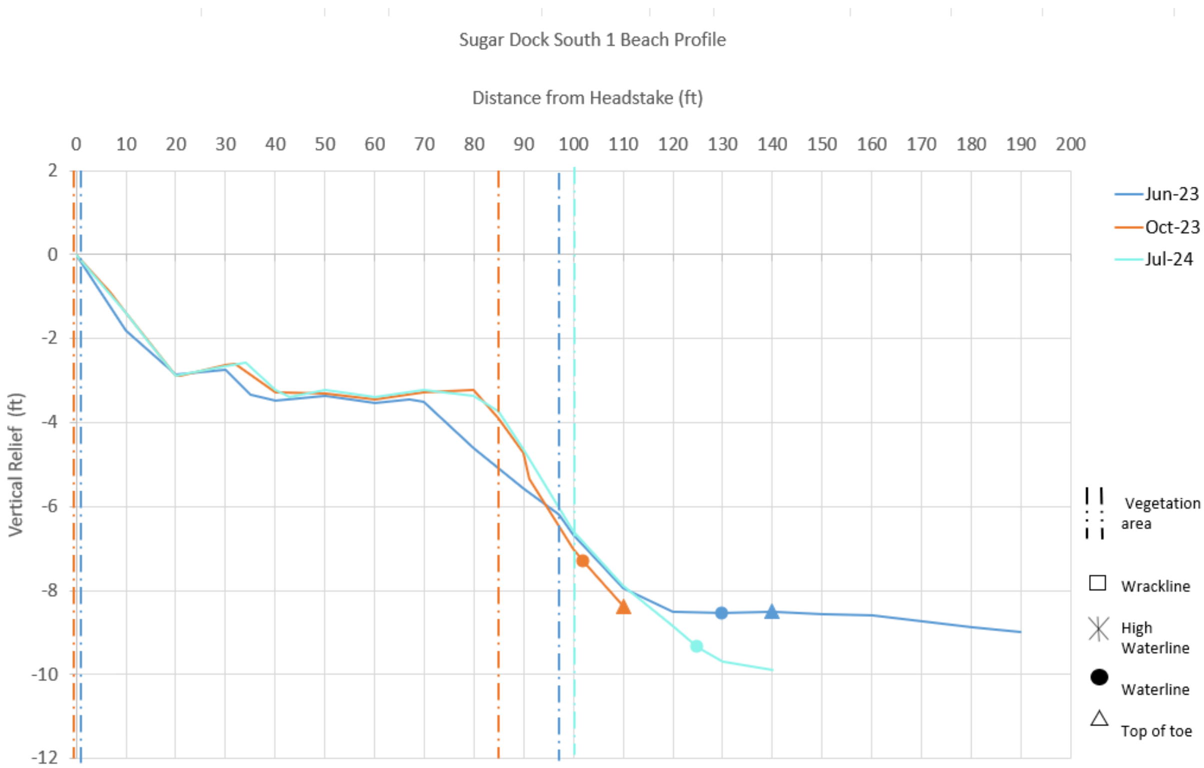
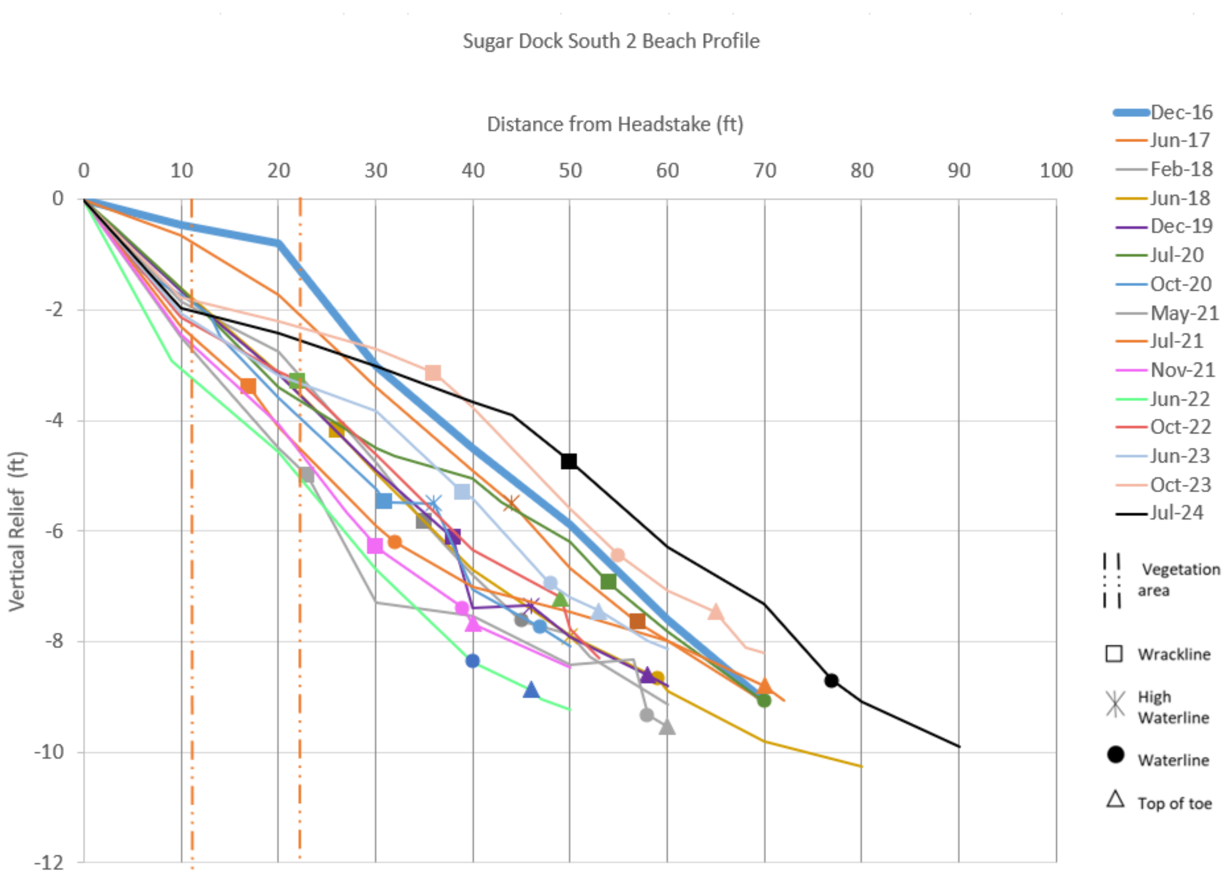
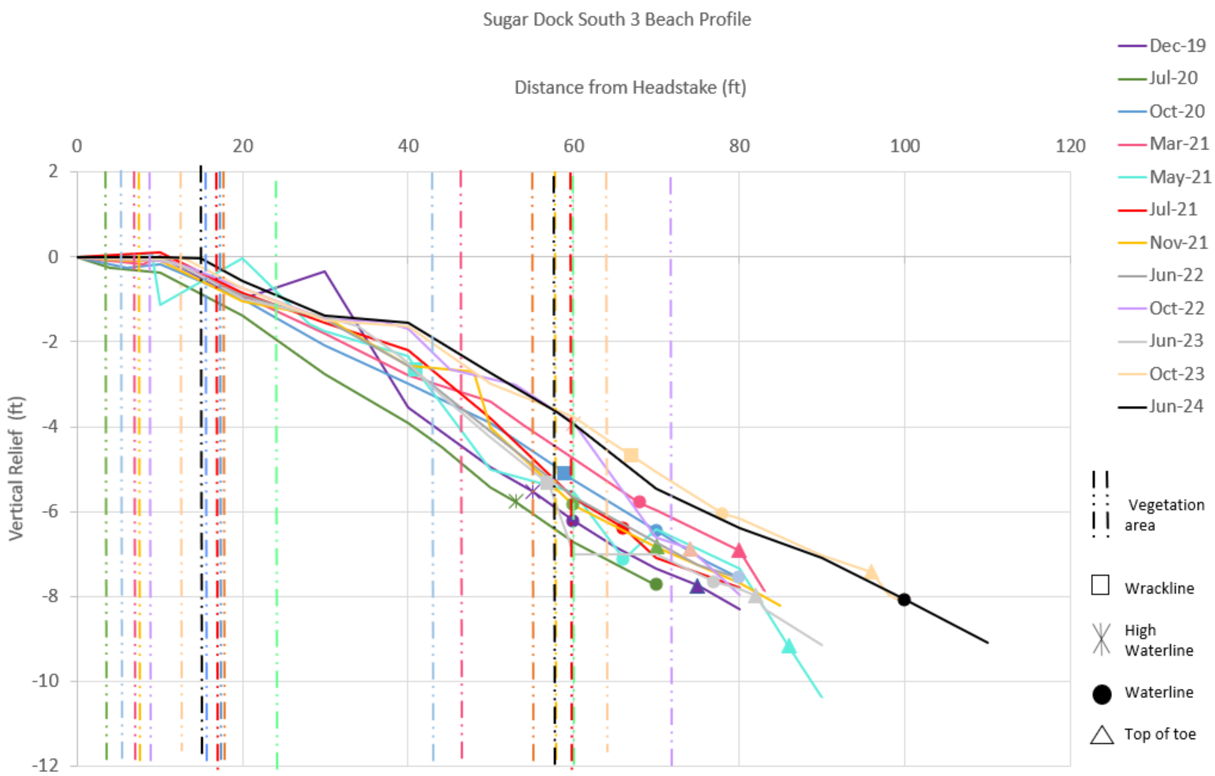


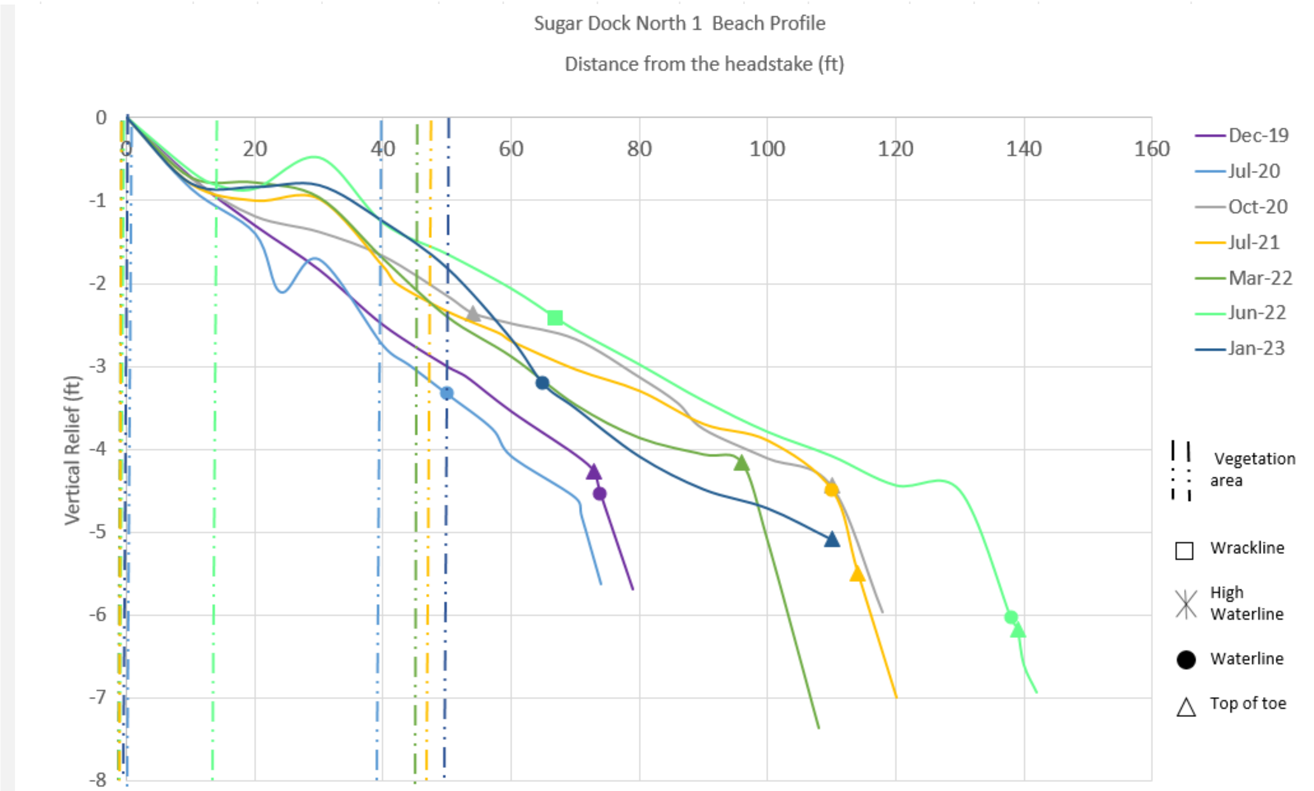
Figure 17 - Sugar Dock Beach Linear Regression Analysis table shows time in seasons over shoreline position (top of toe) from the headstake.

Sugar Dock Beach Profiles

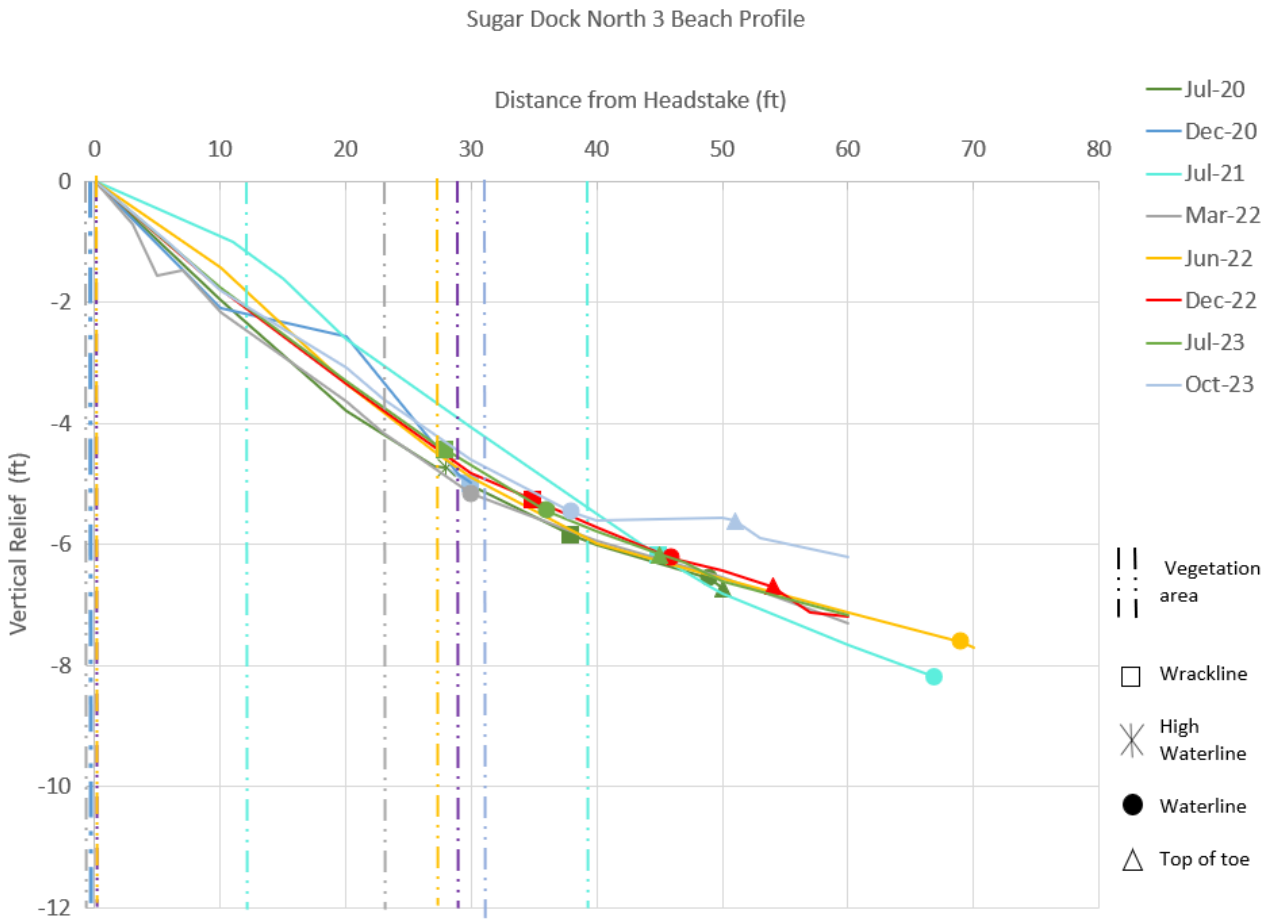





Sugar Dock South 3 Beach Profile
Distance from Headstake (ft)
0
20
40
60
80
100
120
2
0
-2
-4
-6
-8
-10
-12
Vertical Relief (ft)
Dec-19
Jul-20
Oct-20
Mar-21
May-21
Jul-21
Nov-21
Jun-22
Oct-22
Jun-23
Oct-23
Jun-24
Vegetation area
Wrackline
High Waterline
Waterline
Top of toe

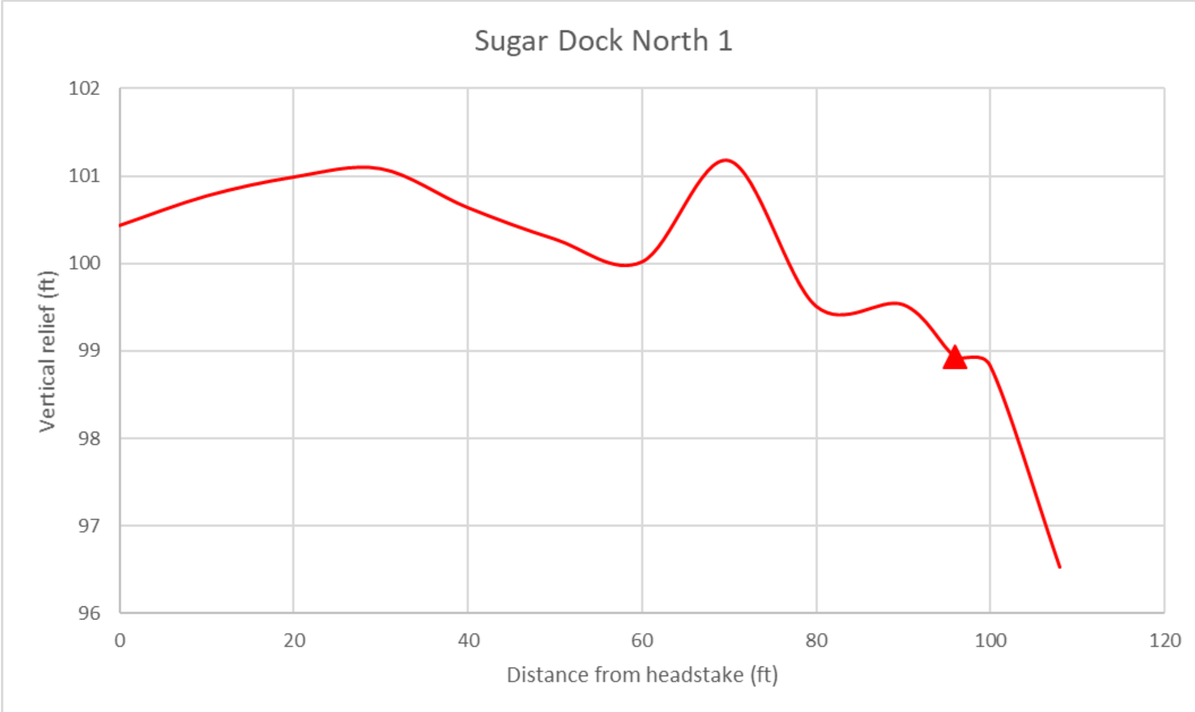

Sugar Dock North 1 Beach Profile
Distance from the headstake (ft)
0
20
40
60
80
100
120
140
160
-1
-2
-3
-4
-5
-6
-7
-8
Vertical Relief (ft)
Dec-19
Jul-20
Oct-20
Jul-21
Mar-22
Jun-22
Jan-23
Vegetation area
Wrackline
High Waterline
Waterline
Top of toe

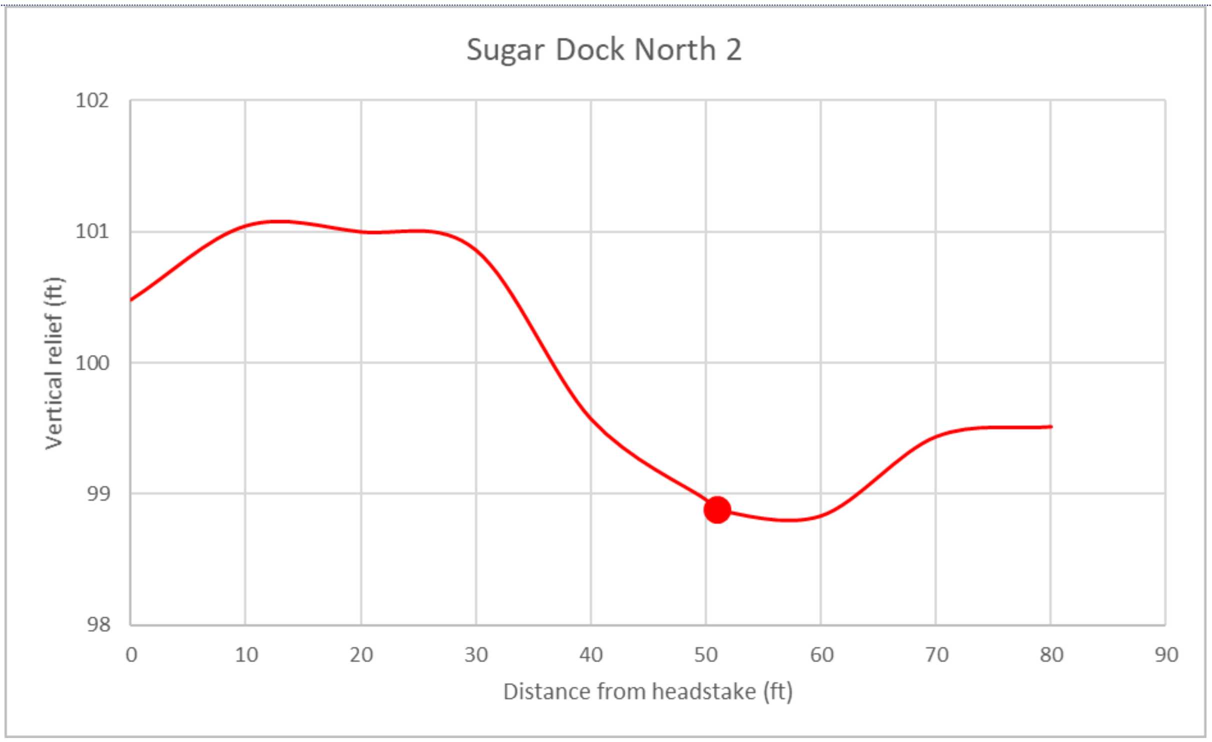
Sugar Dock North 2 Beach Profile
Distance from Headstake (ft)
0 20 40 60 80 100 120
Vertical Relief (ft)
0 -1 -2 -3 -4 -5 -6 -7 -8 -9 -10
Dec-16
Jun-17
Mar-18
Jun-18
Dec-19
Jul-20
Dec-20
Jul-21
Mar-22
Jun-22
Dec-22
Vegetation area
Wrackline
High Waterline
Waterline
Top of toe

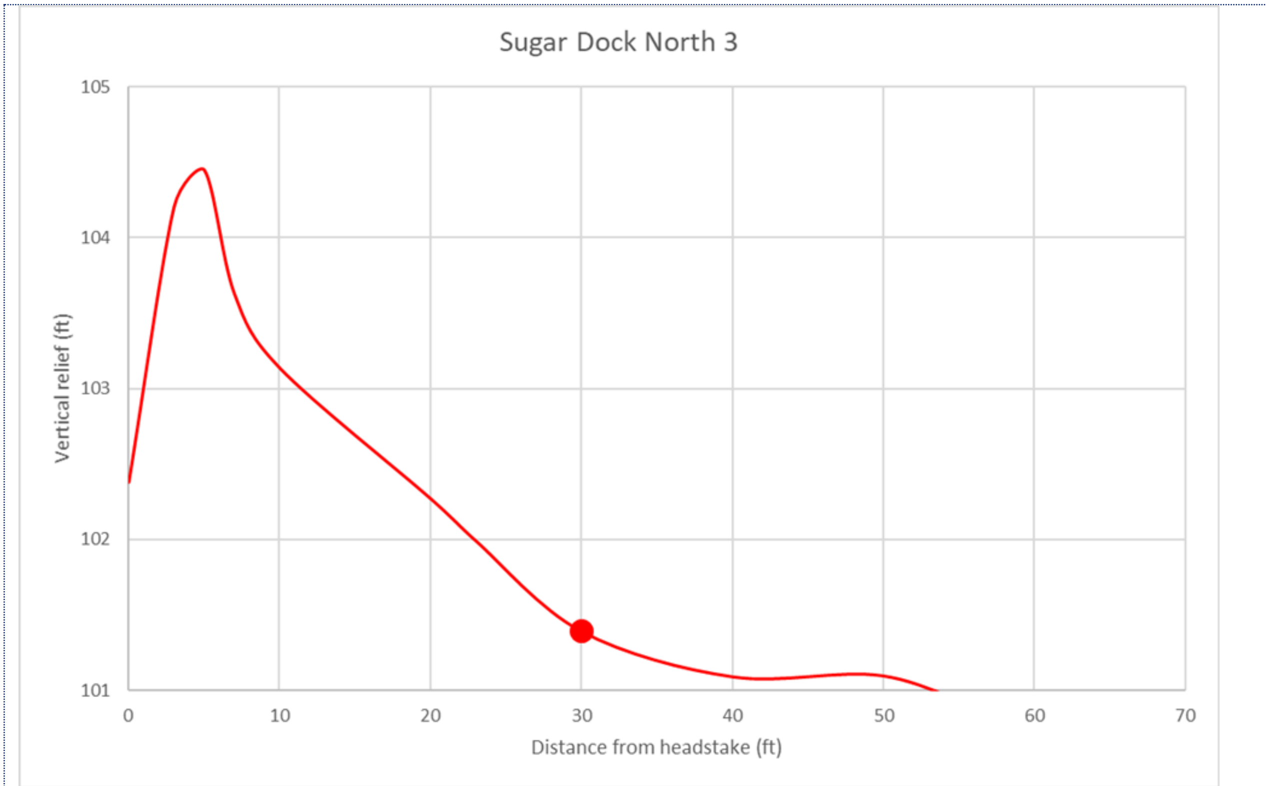


Sugar Dock North 3 Beach Profile
Distance from Headstake (ft)
0 10 20 30 40 50 60 70 80
Vertical Relief (ft)
0 -2 -4 -6 -8 -10 -12
Jul-20
Dec-20
Jul-21
Mar-22
Jun-22
Dec-22
Jul-23
Oct-23
Vegetation area
Wrackline
High Waterline
Waterline
Top of toe

Total Station






Sugar Dock North 3
Vertical relief (ft)
Distance from headstake (ft)
105
104
103
102
101
0
10
20
30
40
50
60
70

Susupe Beach Park

Nearly 800 meters away from the sheltering Chalan Kanoa Reef, Susupe Beach Park has been relatively stable and even accreting during this period. However, the site is subjected to storm surge damage based on its relict berms. Backshore vegetation remains relatively stable and the ironwood trees appears to be thriving. Most of the foreshore environment is vegetated.

In 2024, beach park has been used as a staging side for the extracted dirt from the Route 36 (Beach Road) project. Thus, the Shoreline Monitoring Team has not been able to survey during summer westerly conditions in summer 2024.

Wave overtopping and overwhelmed tidal flows may impact this site during both typhoon wave conditions. It appears that southwest typhoon conditions could greatly impact this site. However, improved resolution on nearshore dynamics may explain sediment transport for this area. The Sugar Dock Channel influences sediment transport while the seagrass beds attenuate wave energies.

Susupe Beach Park 1 Highlights:

- STABLE
- Wrackline that ranges 40 – 70 ft and an elevation difference of more than 8 ft
- Based on the Shoreline linear regression analysis (see pg 44), the shoreline has a rate of +0.9 ft from 2016-2023.

Susupe Beach Park 2 Highlights:

- STABLE
- Wrackline that ranges 47 – 74 ft and an elevation difference of more than 8 ft
- Based on the Shoreline linear regression analysis (see pg 44), the shoreline has a rate of +0.5 ft from 2016-2023.

Susupe Beach Park 3 Highlights:

- ACCRETING
- Wrackline that ranges 30 – 60 ft and an elevation difference of 8 ft
- Based on the Shoreline linear regression analysis (see pg 44), the shoreline has been a rate of +1.1 ft from 2016-2023.

Susupe Beach Park 1

Susupe Beach Park 2

Susupe Beach Park 3

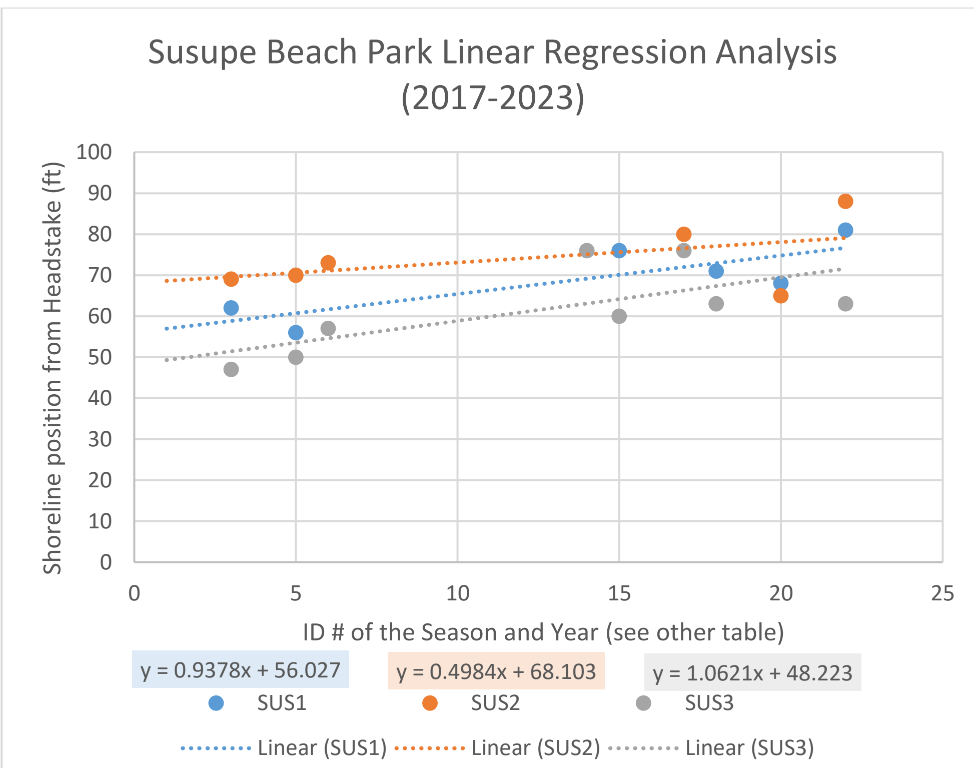
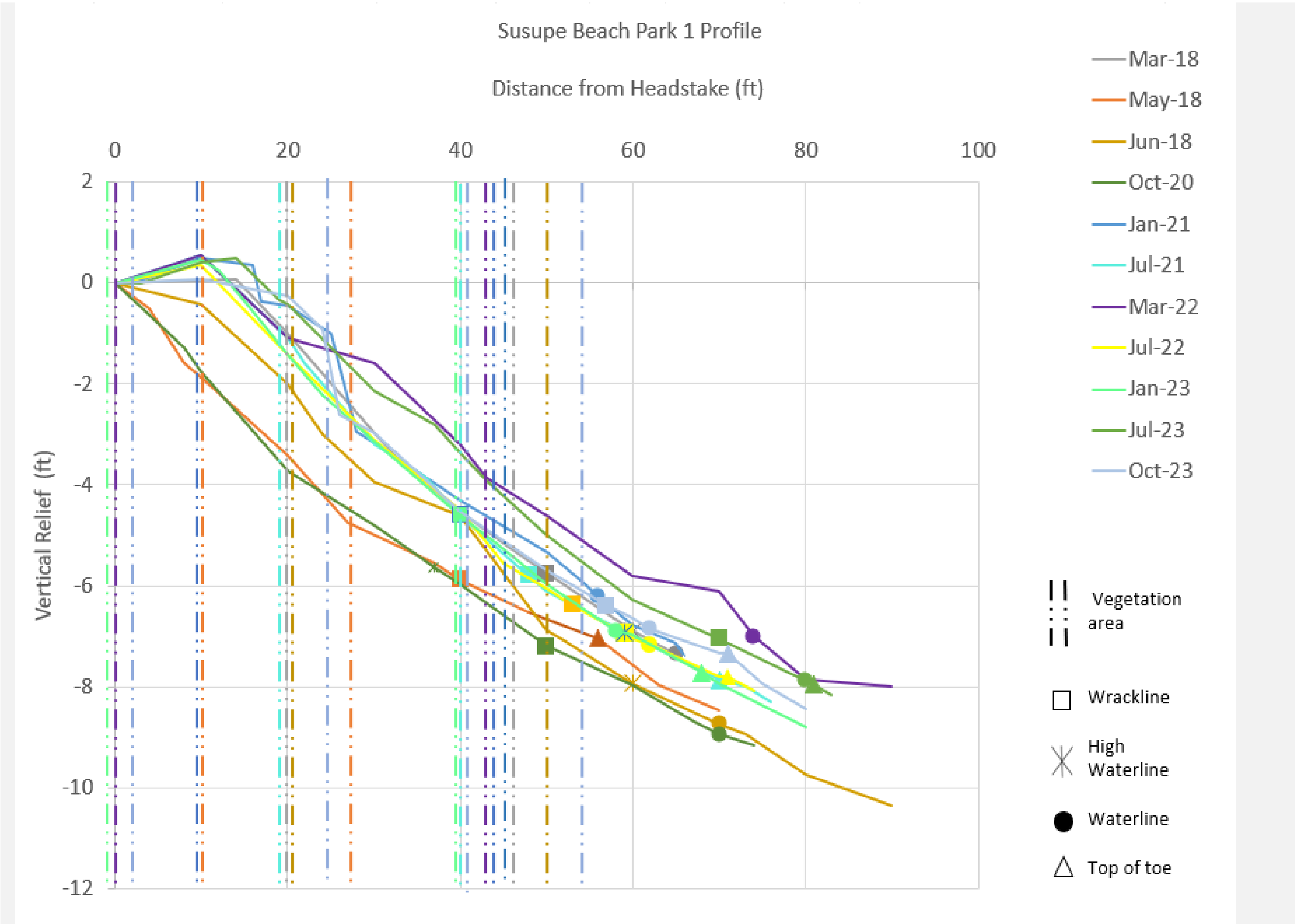
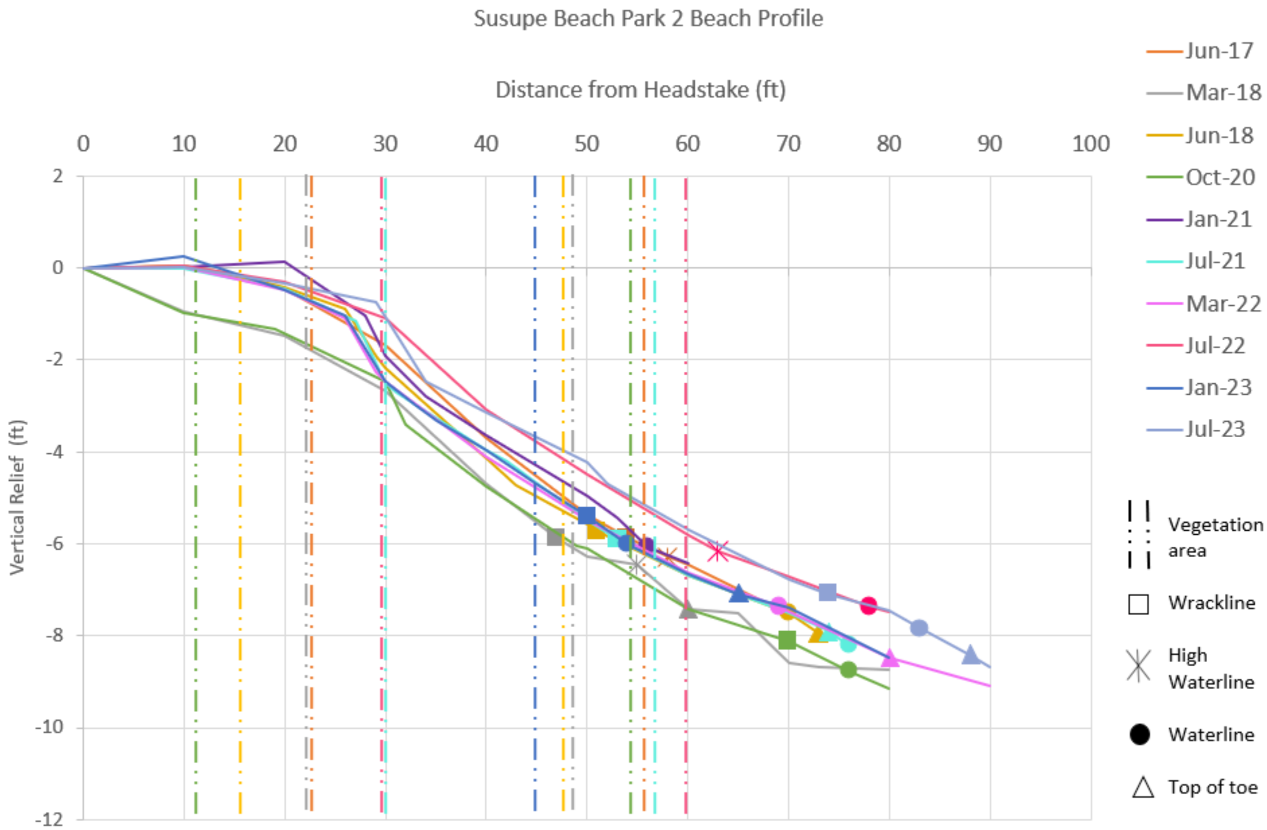


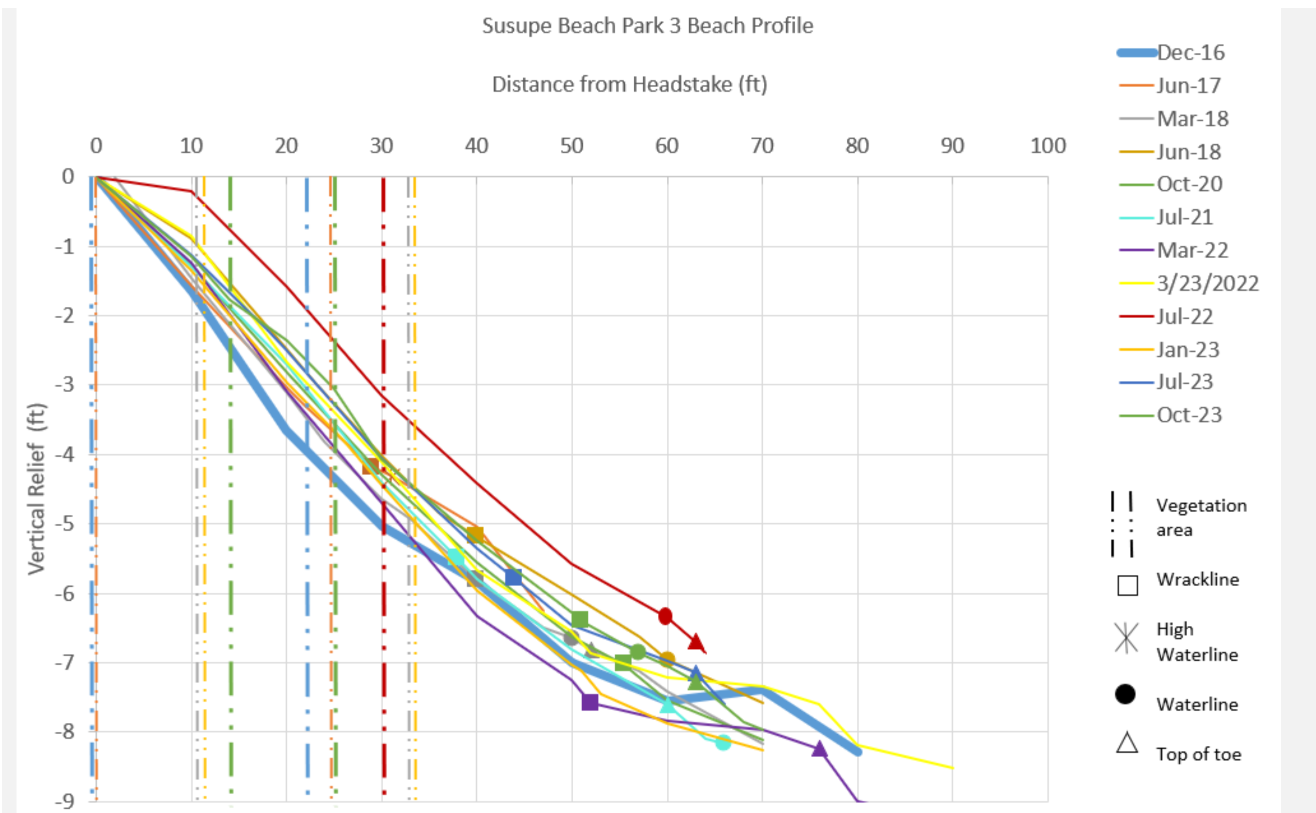
Figure 18 – Susupe Beach Park Linear Regression Analysis table shows time in seasons over shoreline position (top of toe) from the headstake.

Susupe Beach Park Beach Profiles

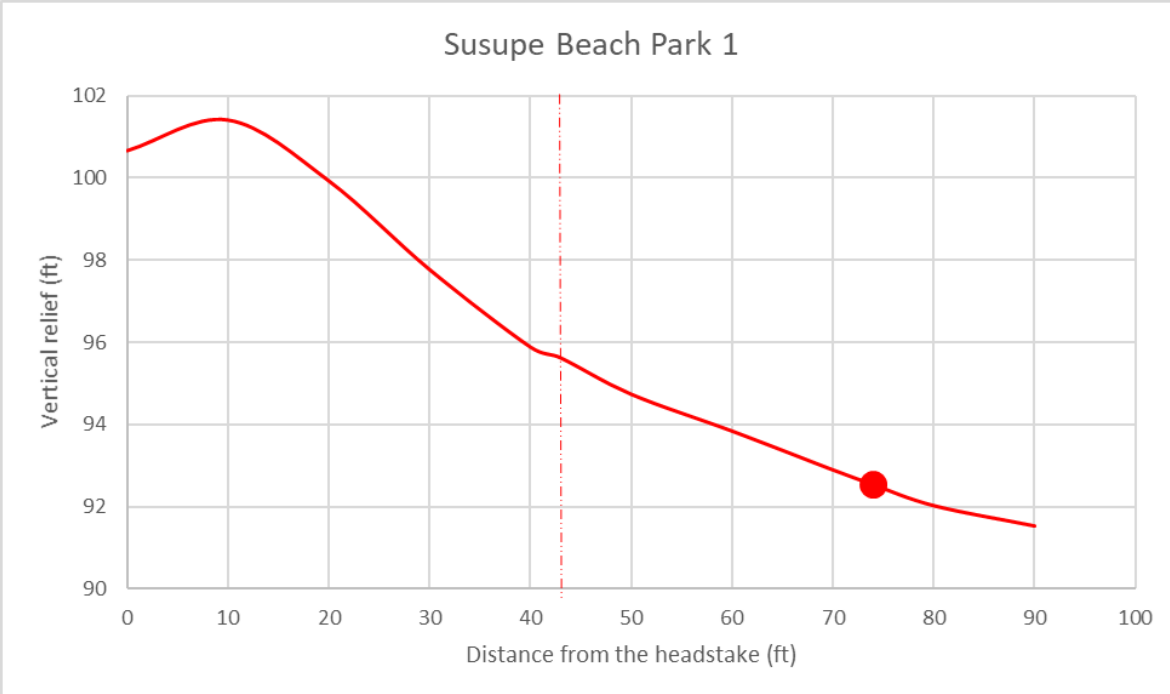
Berger Level

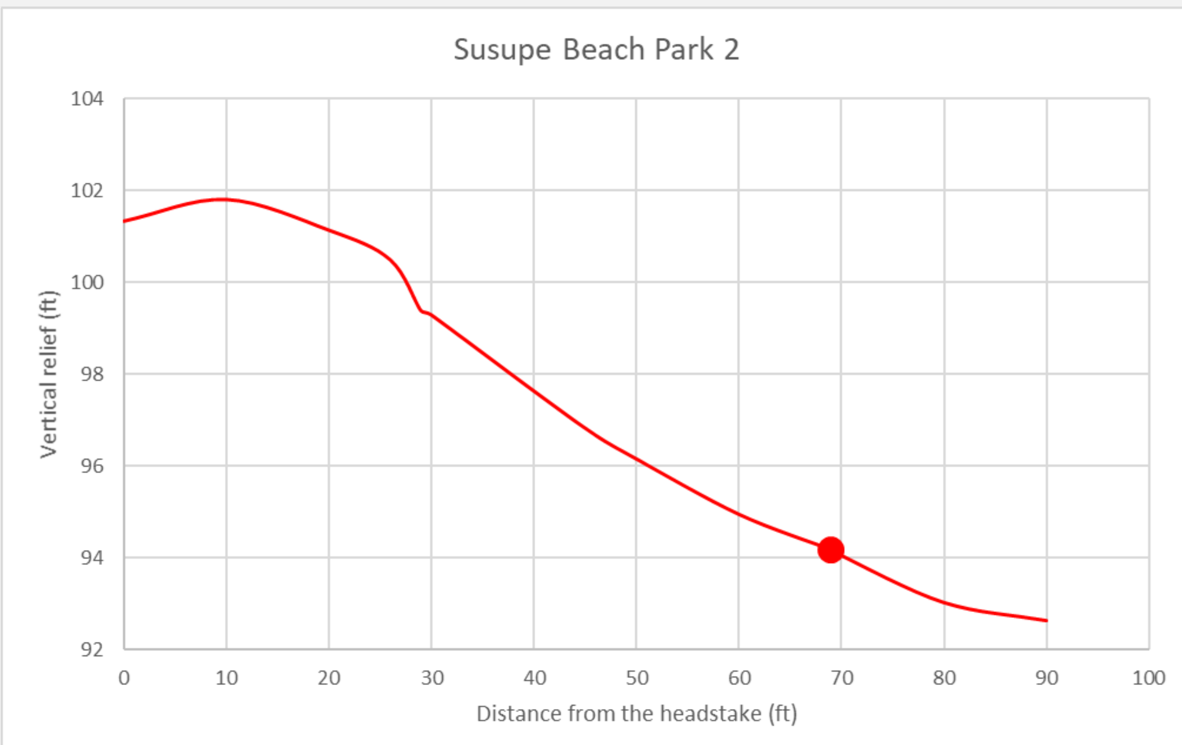


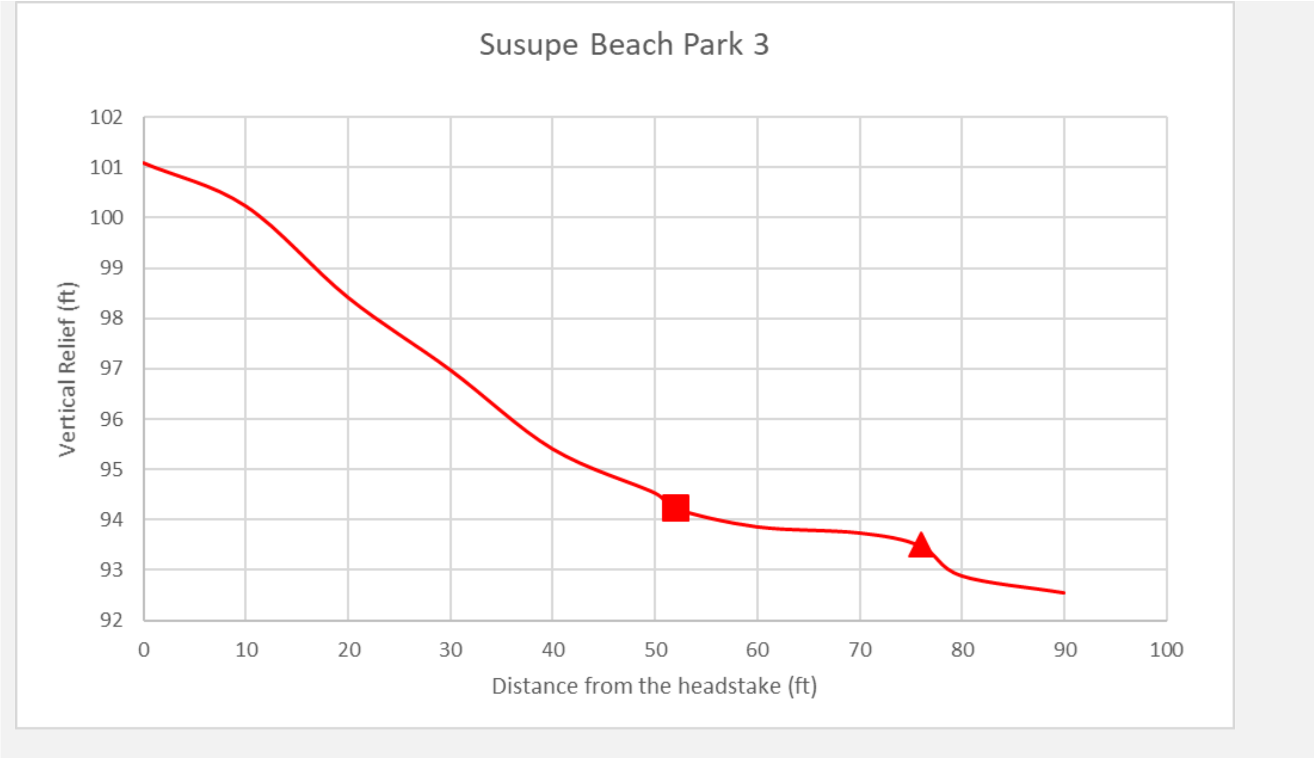

Susupe Beach Park 2 Beach Profile
Distance from Headstake (ft)
0
10
20
30
40
50
60
70
80
90
100
Vertical Relief (ft)
2
0
-2
-4
-6
-8
-10
-12
Jun-17
Mar-18
Jun-18
Oct-20
Jan-21
Jul-21
Mar-22
Jul-22
Jan-23
Jul-23
Vegetation area
Wrackline
High Waterline
Waterline
Top of toe


Susupe Beach Park 3 Beach Profile
Distance from Headstake (ft)
0
10
20
30
40
50
60
70
80
90
100
Vertical Relief (ft)
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
Dec-16
Jun-17
Mar-18
Jun-18
Oct-20
Jul-21
Mar-22
3/23/2022
Jul-22
Jan-23
Jul-23
Oct-23
Vegetation area
Wrackline
High Waterline
Waterline
Top of toe

Total Station






Susupe Beach Park 3
102
101
100
99
98
97
96
95
94
93
92
Vertical Relief (ft)
0
10
20
30
40
50
60
70
80
90
100
Distance from the headstake (ft)

Kilili

Kilili Beach is protected by a fringing reef located approximately 4,500 feet away. Erosion has been observed, but natural sediment input suggests that the lost beach may return seasonally and rapidly. Historical shoreline change indicates that this shoreline has experienced cycles of erosion and accretion, with rates of up to about 1 meter per year for either condition (SASEA, pg 112). Seasonal accretion rates of under 1 foot support this. The underwater sand sources are closer to the reef.

Information from a cultural practitioner familiar with this shoreline suggests that this stretch of beach is at risk of storm surge during powerful storm events. It seems that southwest conditions could significantly impact this site. Kilili Beach shows noticeable variation in seasonal wave conditions. However, obtaining a more detailed understanding of nearshore dynamics might help explain longshore processes in this area.

Kilili South 1 Highlights:

- STABLE
- Wrackline that ranges 28 – 44 feet with an elevation difference of 6 ft
- Short-term erosion events have occurred on June 2020 and then September 2021. This transect has shown beach recovery in between.
- Based on the Shoreline linear regression analysis (see pg 49), the shoreline has a rate of +0.2 ft from 2016-2023.

Kilili South 2 Highlights:

- STABLE
- Wrackline that ranges 33 – 70 ft with an elevation difference of 10 ft
- The storm of September 2021 has eroded the shoreline. Slight variation on the berm could be from surveyor error.
- Based on the Shoreline linear regression analysis (see pg 49), the shoreline has a rate of +0.7 ft from 2016-2023.

Kilili South 3 Highlights:

- STABLE
- Wrackline that ranges 45 – 57 ft and an elevation difference of 8 ft
- This shifting shoreline feature may suggest sediment entering and exiting the area.
- Based on the Shoreline linear regression analysis (see pg 49), the shoreline has a rate of +0.69 ft from 2016-2023.

Kilili North 1 Highlights:

- Wrackline that ranges 87 – 128 ft with an elevation difference of 9 ft
- The shoreline linear regression analysis was not conducted.

Kilili North 2 Highlights:

- STABLE

- Wrackline that ranges 58 – 88 ft with an elevation difference of 8 ft
- There are discrepancies in the data caused by surveyor error. Given that the headstake is further inland, this profile is expected to be longer and indicates an estimation of the proximity to the high tide line, or wrackline, is from the pavilions.
- Based on the Shoreline linear regression analysis (see pg 49), the shoreline has a rate of +0.6 ft from 2016-2023.

Kilili North 3 Highlights:

- STABLE
- Wrackline that ranges 26 – 54 ft with an elevation difference of 8 ft
- Based on the Shoreline linear regression analysis (see pg 49), the shoreline has a rate of -0.06 ft from 2016-2023.

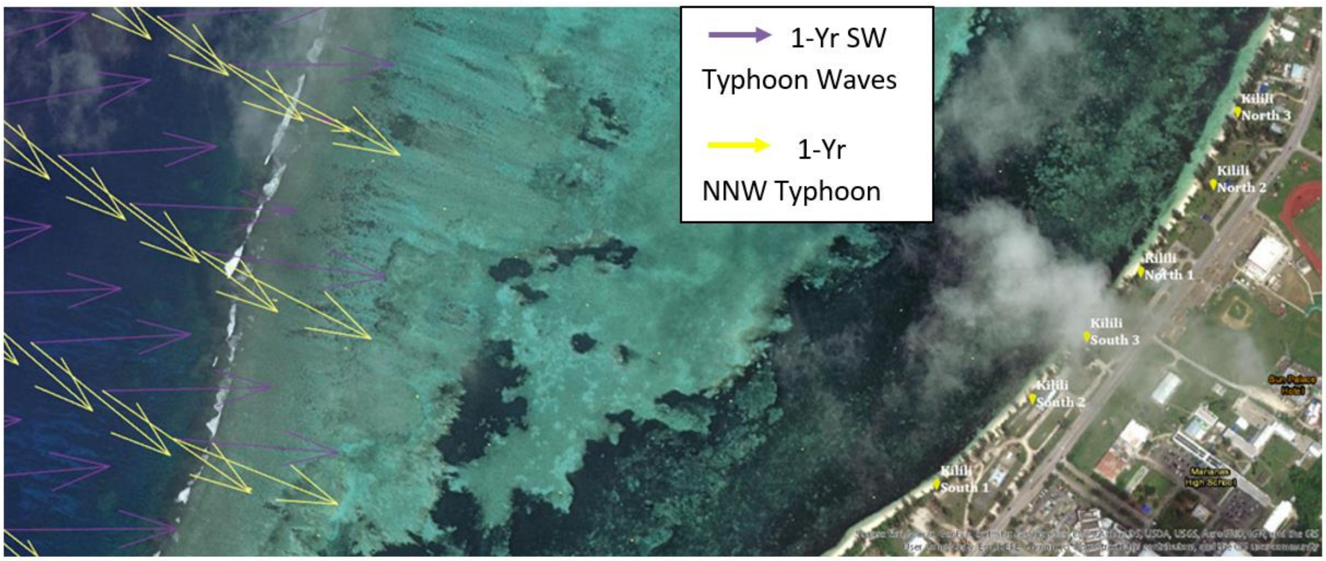
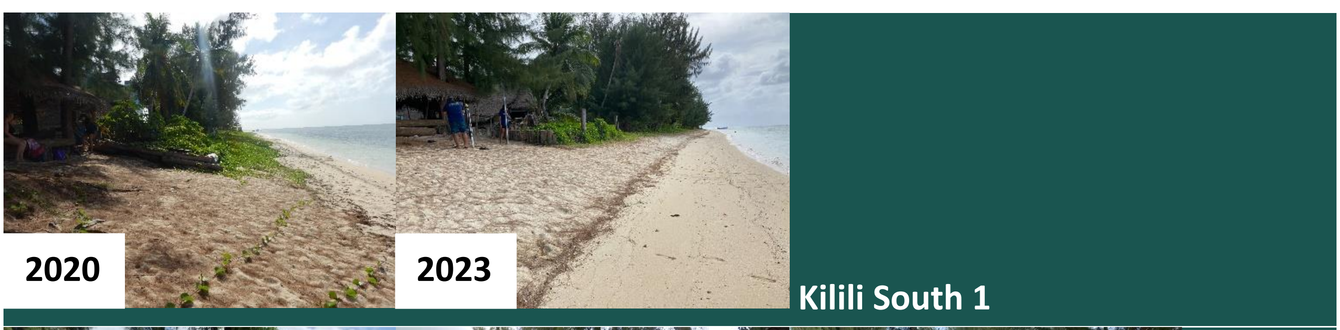
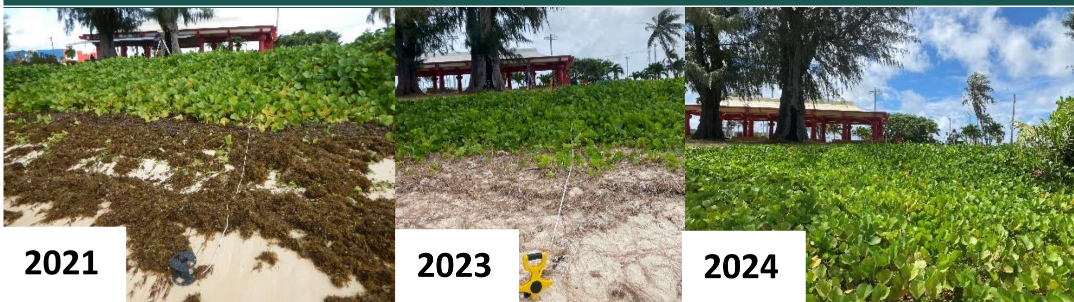


Figure 19 - Hydrodynamic map of the stretch of Kilili Beach The arrows show the intensity of waves generated from the south west (in dark purple) and the northnorthwest wave conditions (in yellow).



Kilili South 3



Kilili North 1

Kilili North 2

Kilili North 3

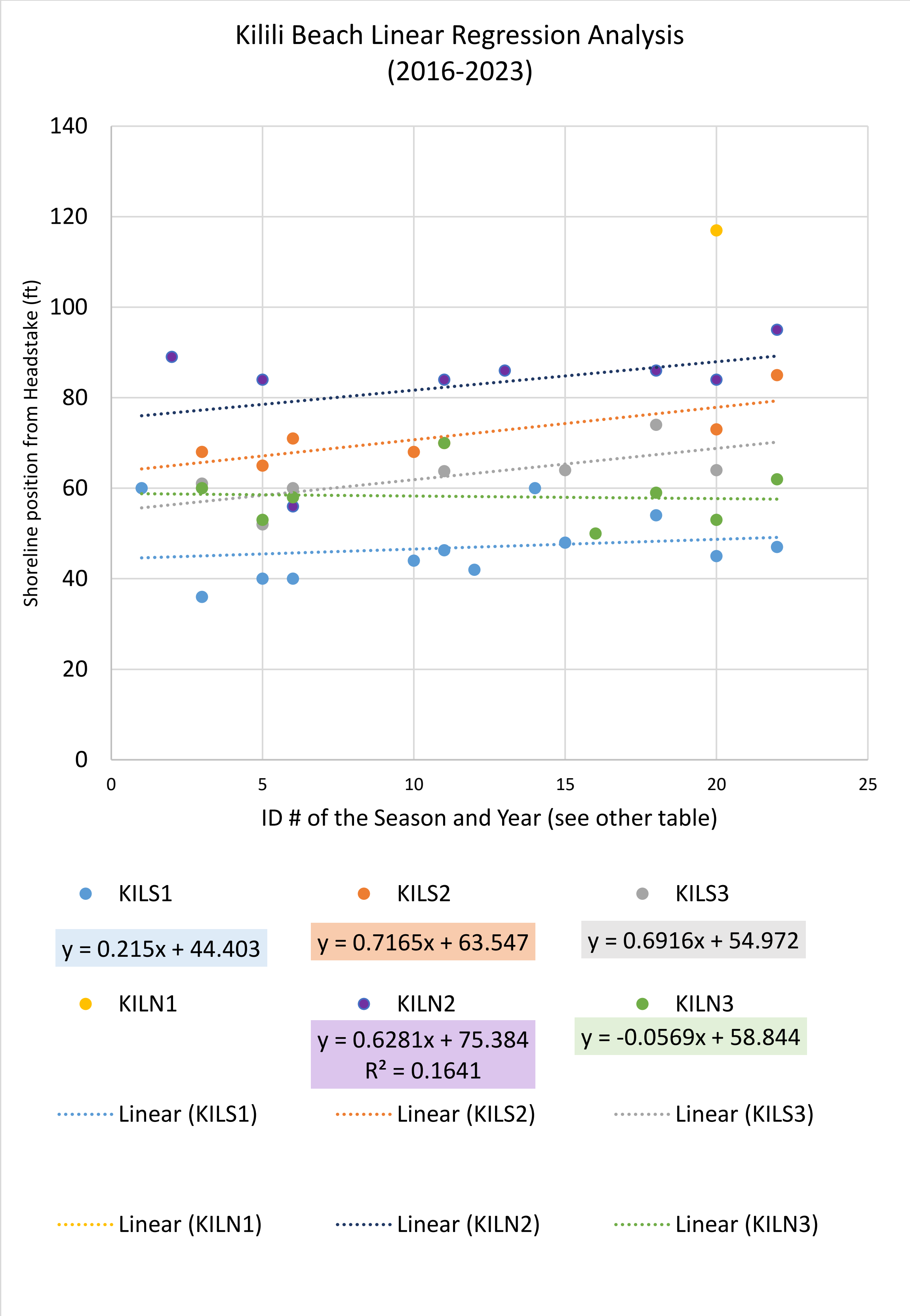
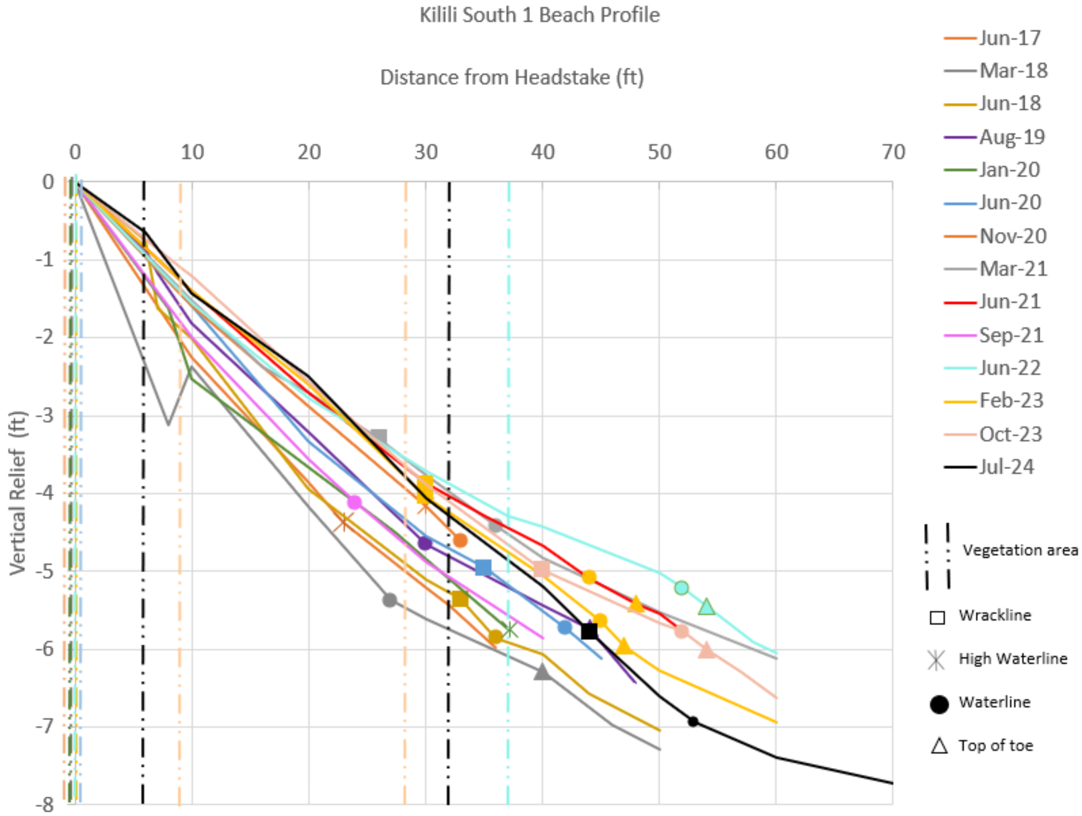
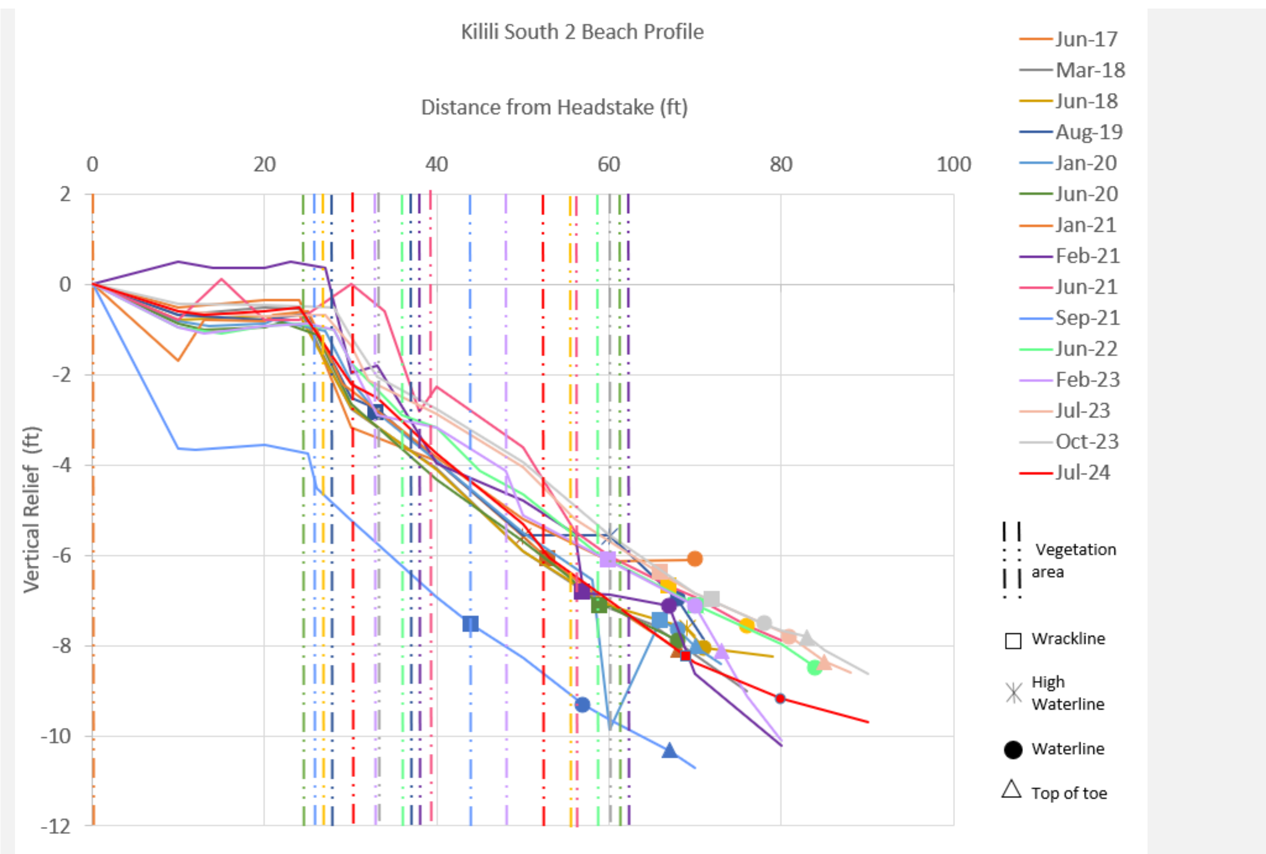
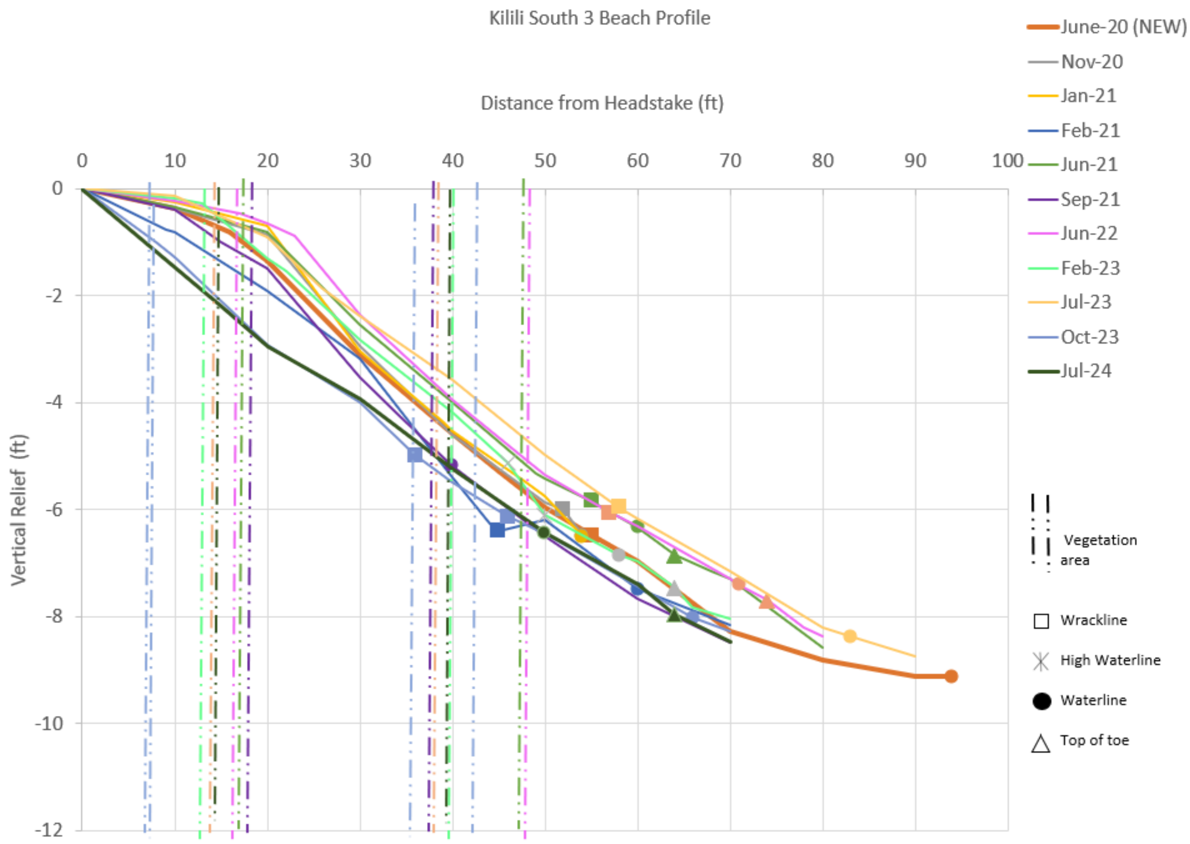


Figure 20 - Kilili Beach Linear Regression Analysis table shows time in seasons over shoreline position (top of toe) from the headstake.

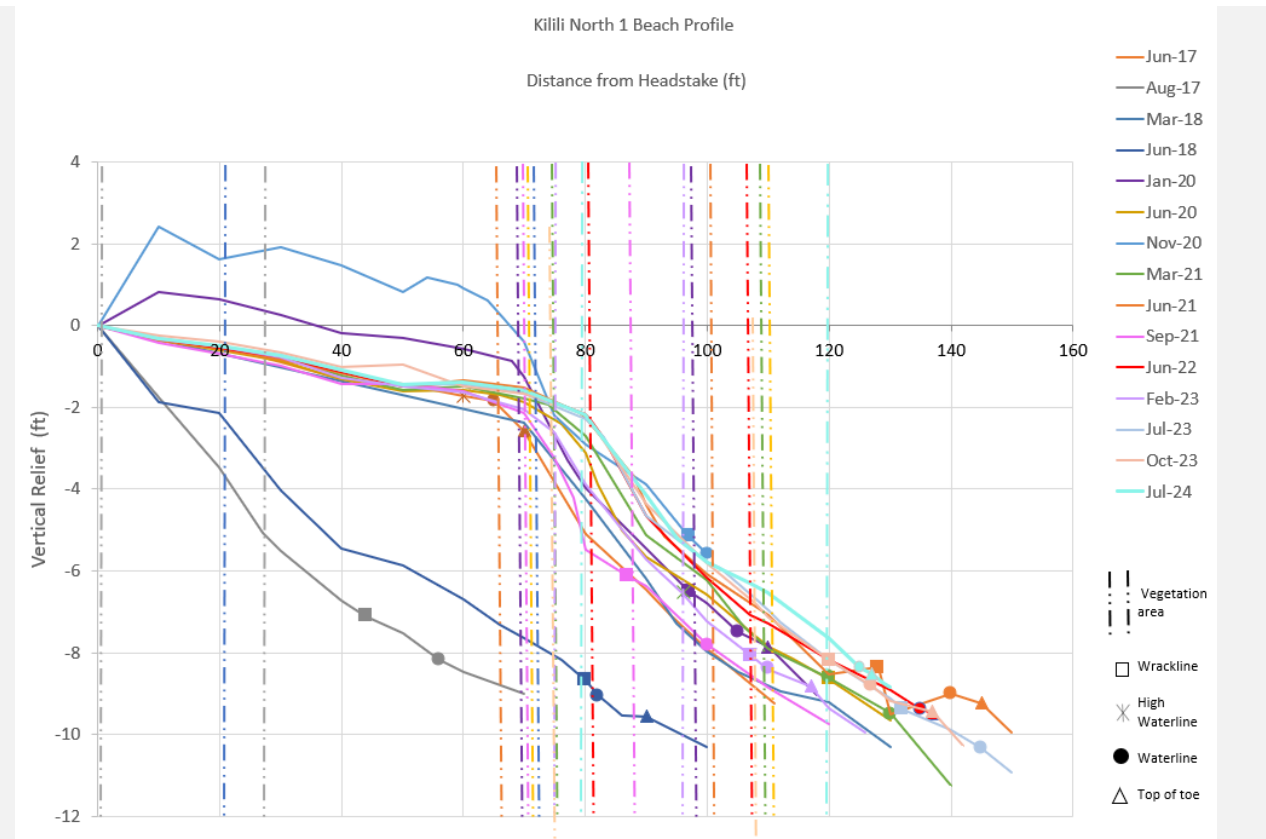
Kilili Beach Profiles



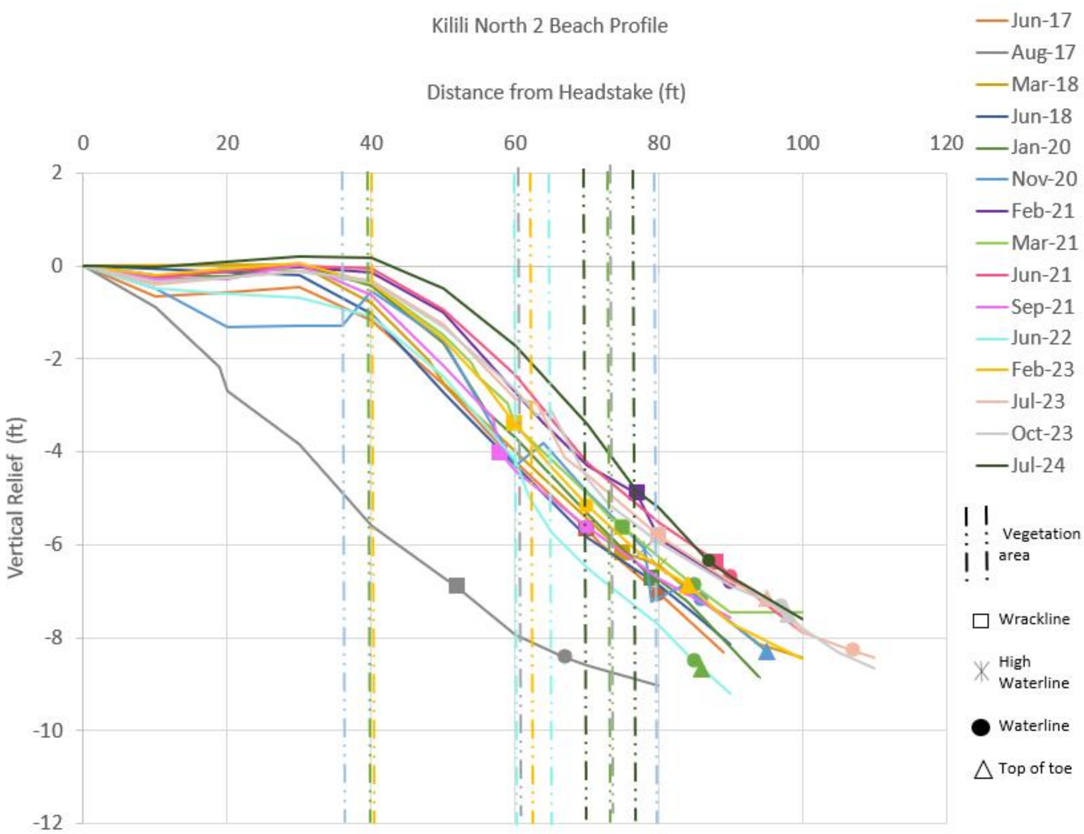




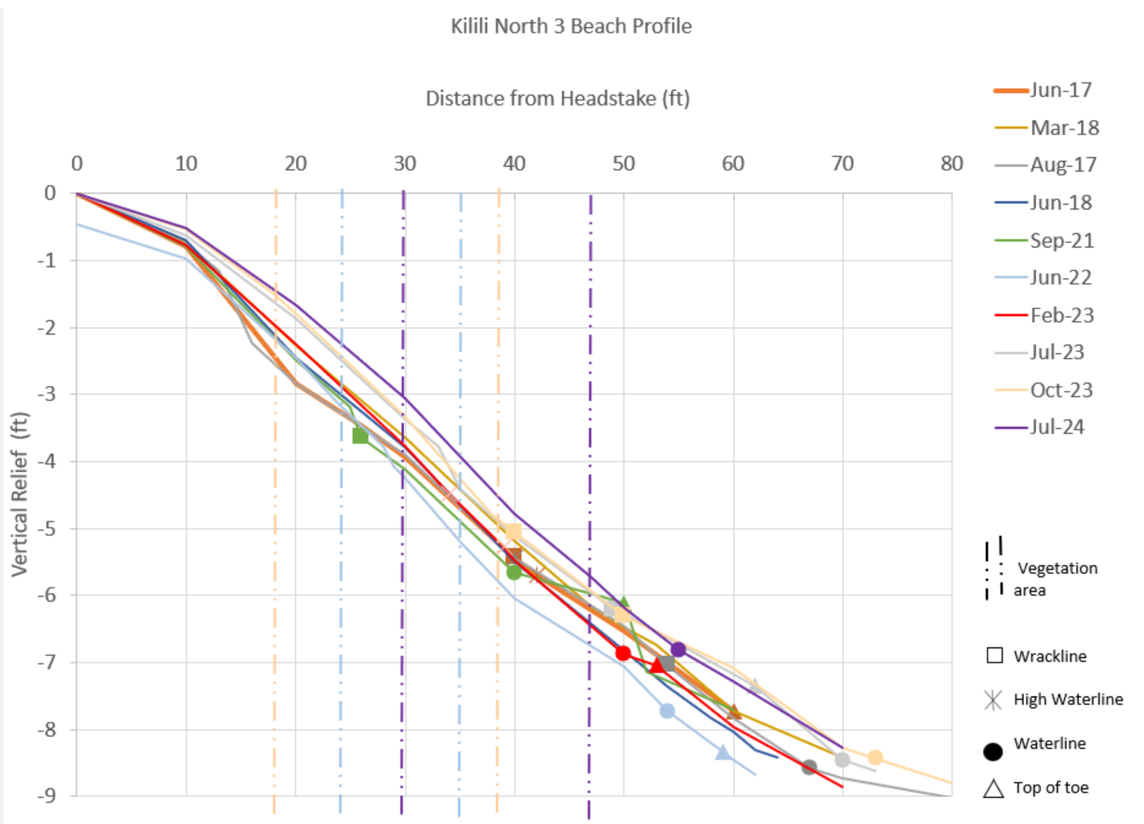
Kilili South 3 Beach Profile
Distance from Headstake (ft)
0
10
20
30
40
50
60
70
80
90
100
0
-2
-4
-6
-8
-10
-12
Vertical Relief (ft)
June-20 (NEW)
Nov-20
Jan-21
Feb-21
Jun-21
Sep-21
Jun-22
Feb-23
Jul-23
Oct-23
Jul-24
Vegetation area
Wrackline
High Waterline
Waterline
Top of toe



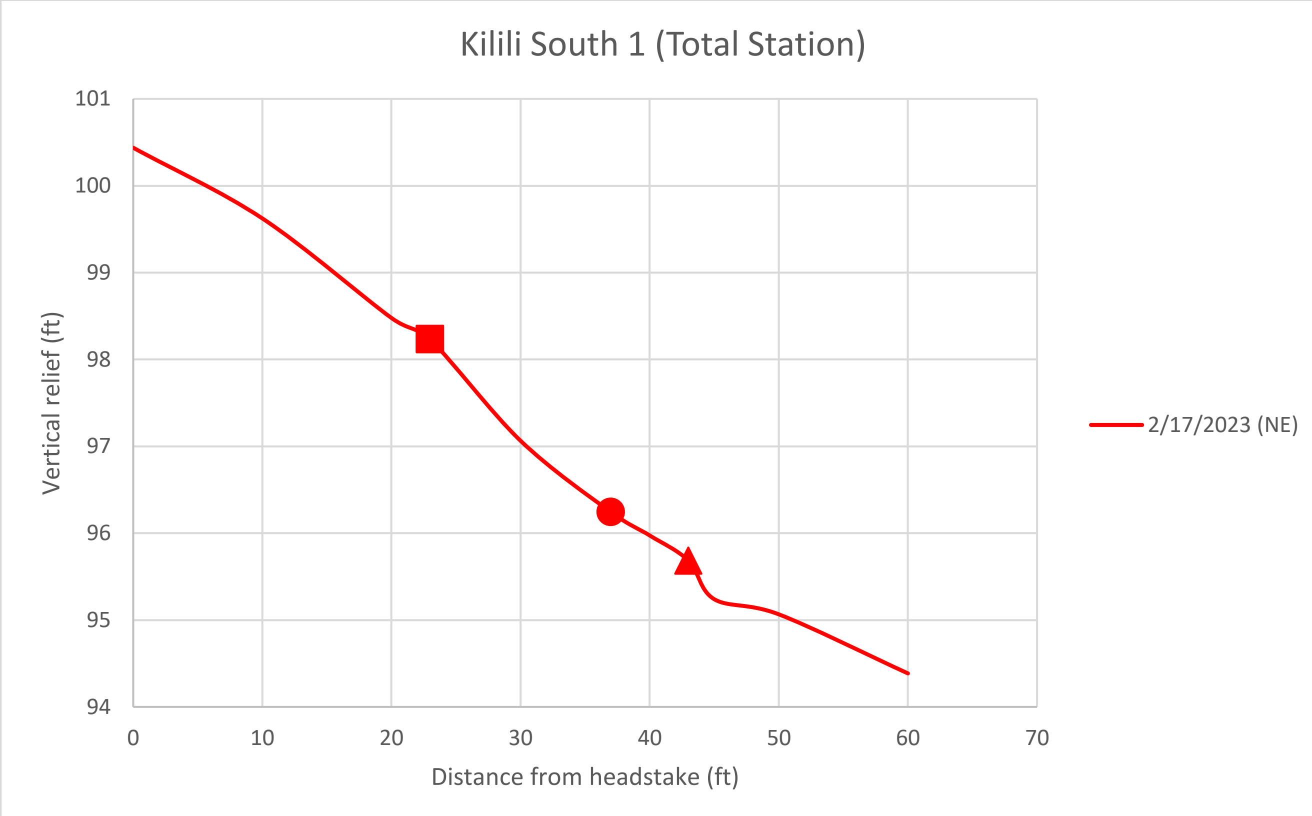
Kilili North 1 Beach Profile
Distance from Headstake (ft)
4
2
0
-2
-4
-6
-8
-10
-12
0
20
40
60
80
100
120
140
160
Vertical Relief (ft)
Jun-17
Aug-17
Mar-18
Jun-18
Jan-20
Jun-20
Nov-20
Mar-21
Jun-21
Sep-21
Jun-22
Feb-23
Jul-23
Oct-23
Jul-24
Vegetation area
Wrackline
High Waterline
Waterline
Top of toe

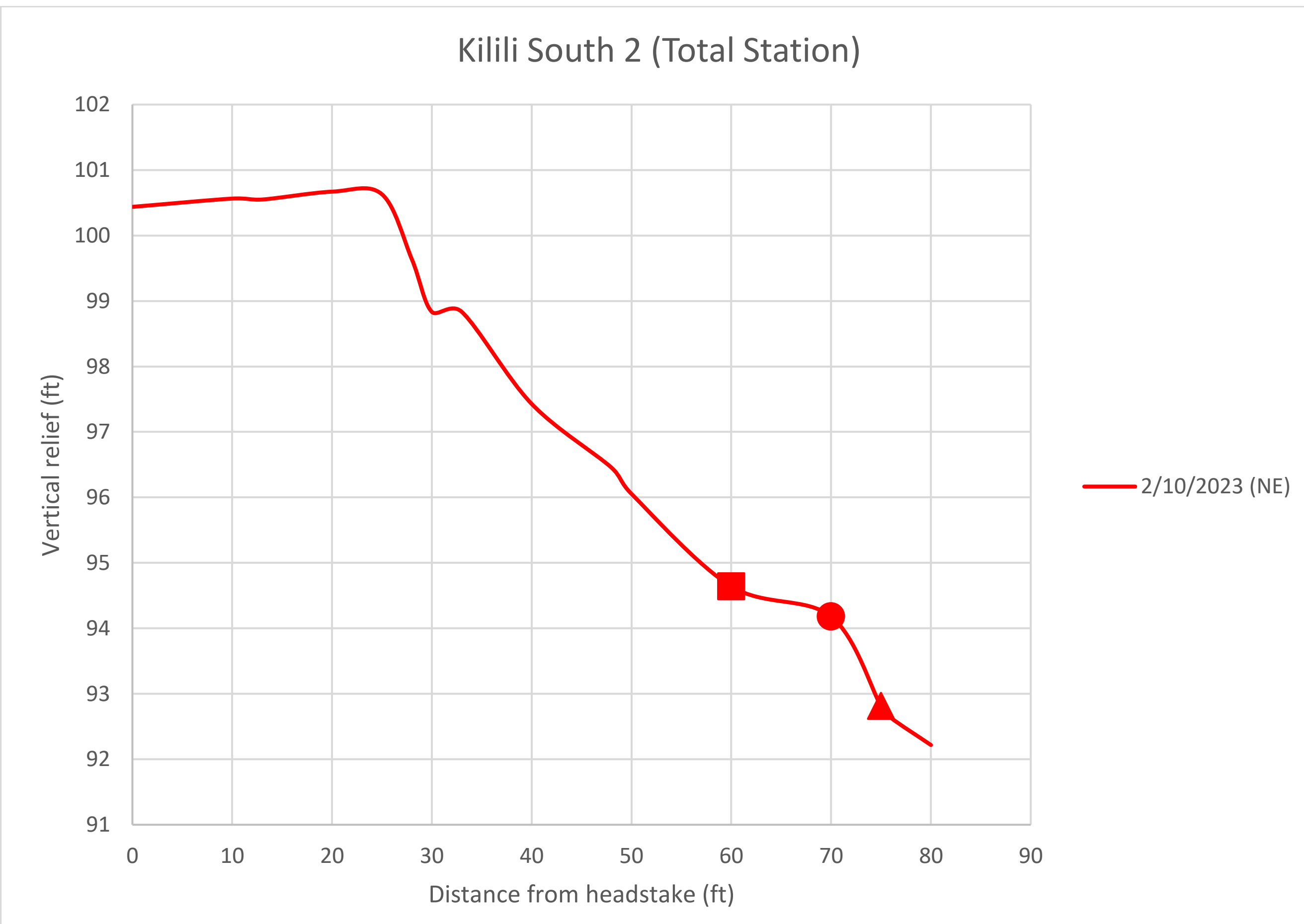


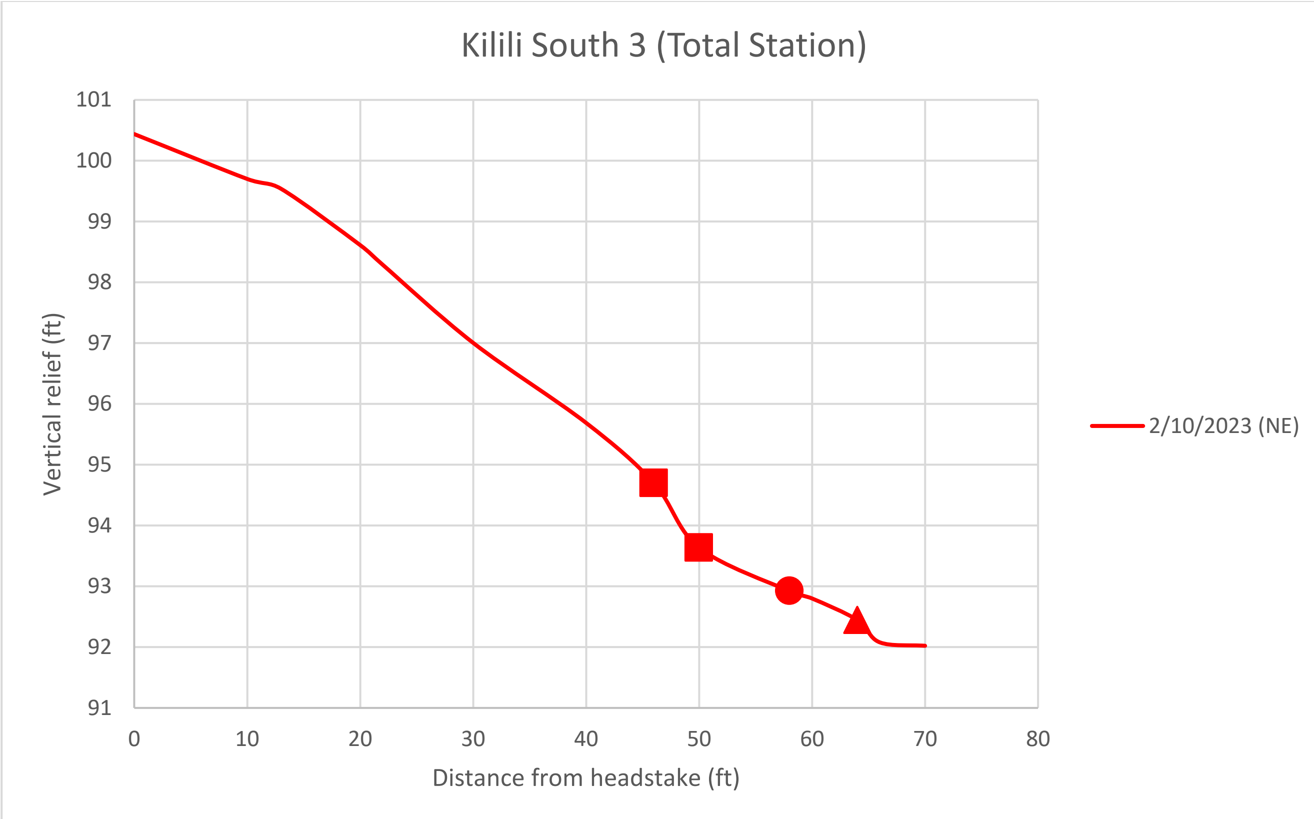
Kilili North 2 Beach Profile
Distance from Headstake (ft)
Vertical Relief (ft)
0
20
40
60
80
100
120
2
0
-2
-4
-6
-8
-10
-12
Jun-17
Aug-17
Mar-18
Jun-18
Jan-20
Nov-20
Feb-21
Mar-21
Jun-21
Sep-21
Jun-22
Feb-23
Jul-23
Oct-23
Jul-24
Vegetation area
Wrackline
High Waterline
Waterline
Top of toe

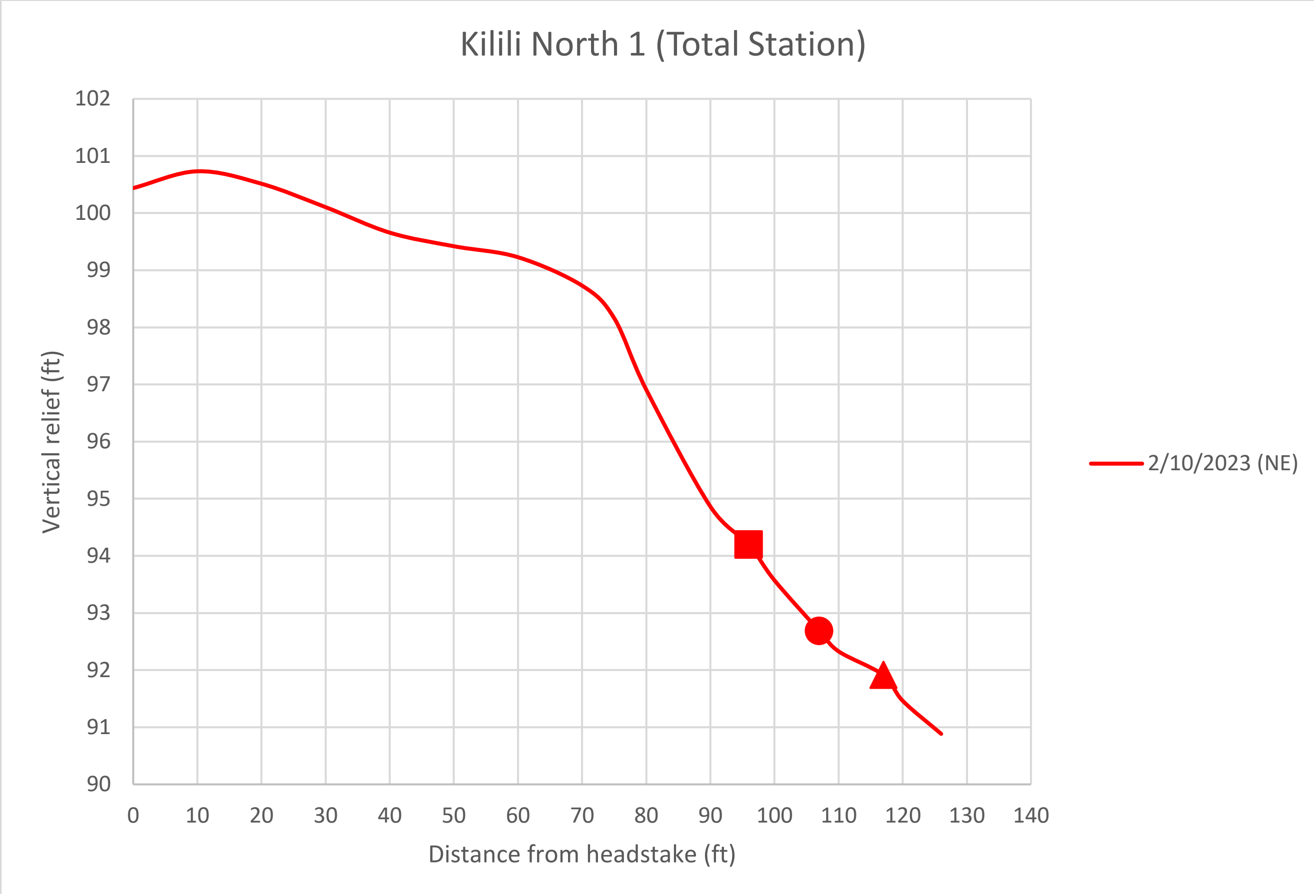


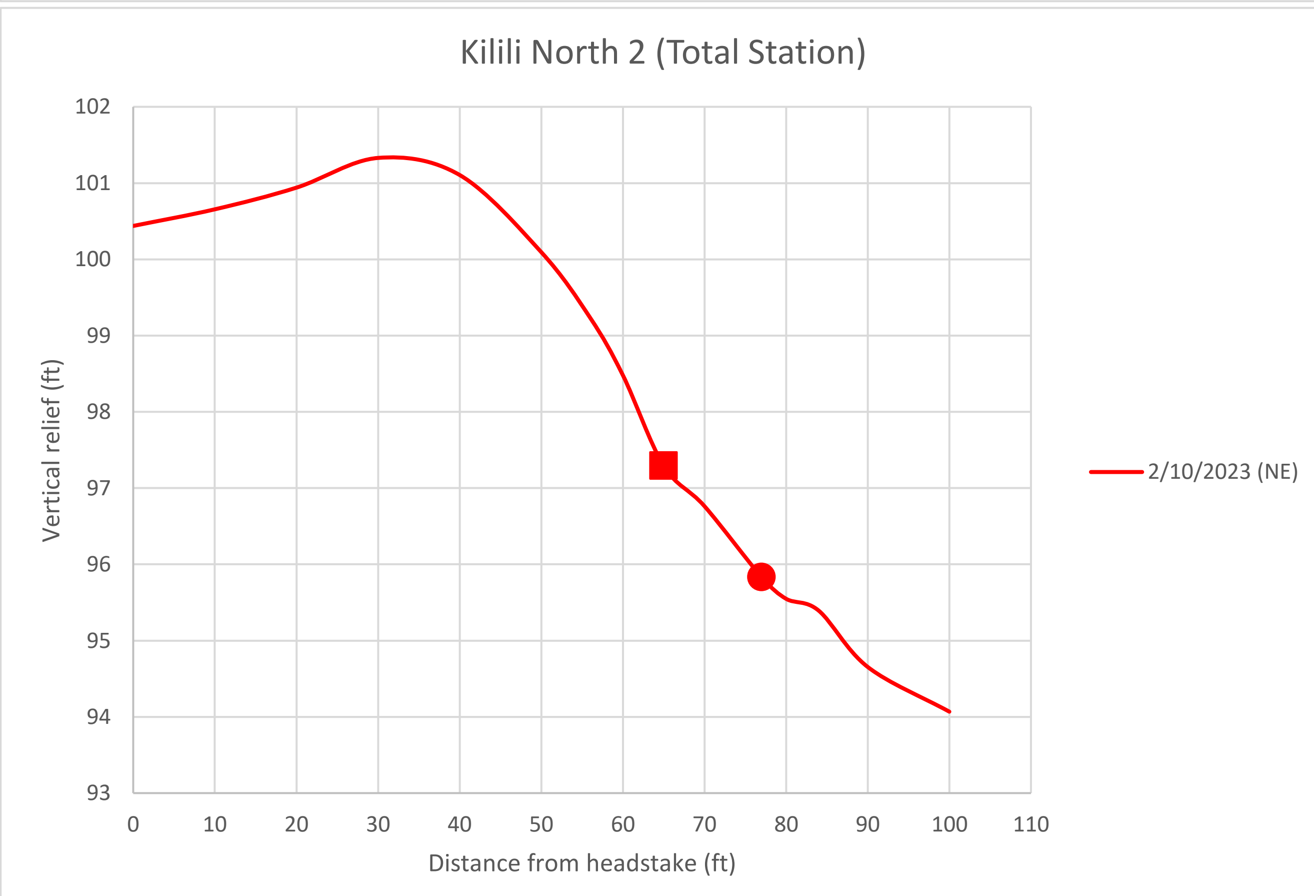
Kilili North 3 Beach Profile
Distance from Headstake (ft)
Vertical Relief (ft)
0
10
20
30
40
50
60
70
80
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
Jun-17
Mar-18
Aug-17
Jun-18
Sep-21
Jun-22
Feb-23
Jul-23
Oct-23
Jul-24
Vegetation area
Wrackline
High Waterline
Waterline
Top of toe

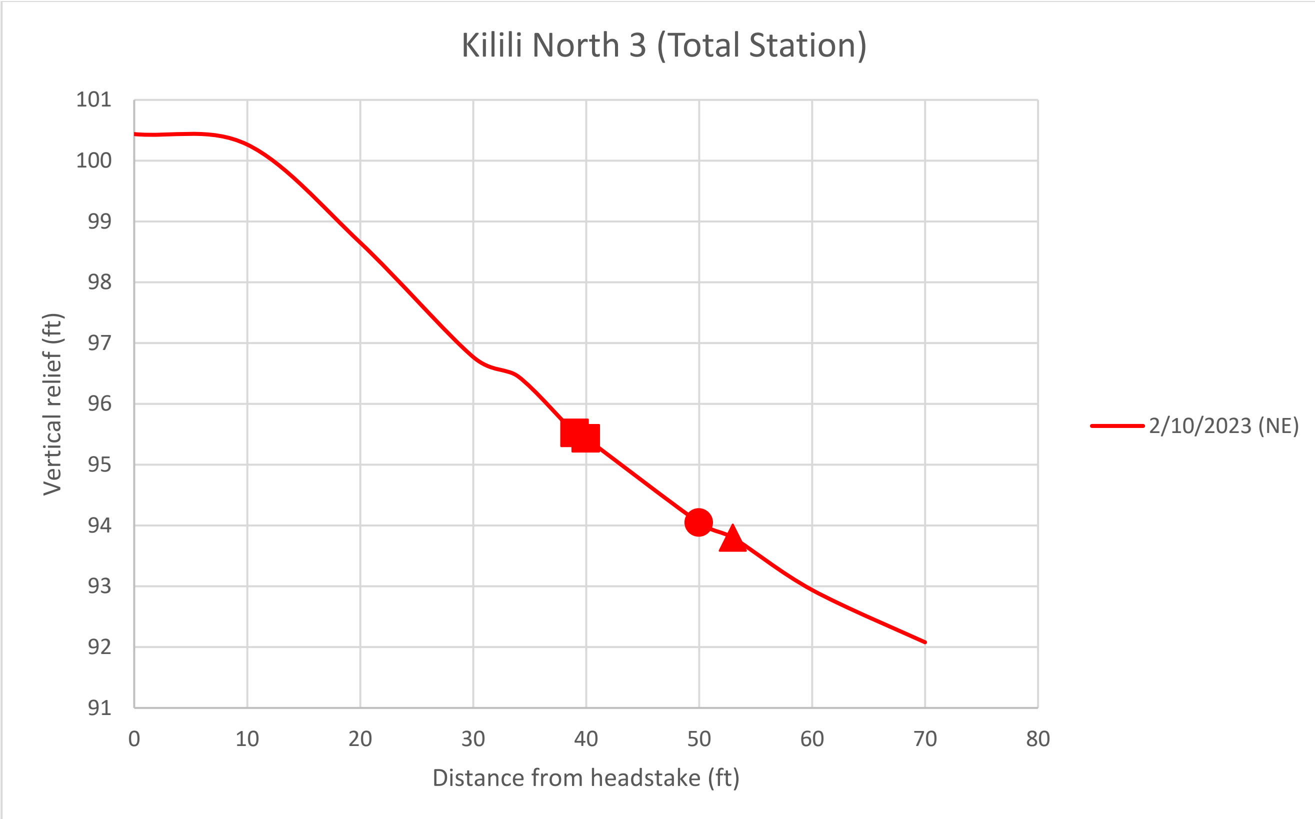

Kilili South 1 (Total Station)
101
100
99
98
97
96
95
94
Vertical relief (ft)
0
10
20
30
40
50
60
70
Distance from headstake (ft)
2/17/2023 (NE)


Kilili South 2 (Total Station)
102
101
100
99
98
97
96
95
94
93
92
91
Vertical relief (ft)
0
10
20
30
40
50
60
70
80
90
Distance from headstake (ft)
2/10/2023 (NE)


Kilili South 3 (Total Station)
Vertical relief (ft)
101
100
99
98
97
96
95
94
93
92
91
0
10
20
30
40
50
60
70
80
Distance from headstake (ft)
2/10/2023 (NE)


Kilili North 1 (Total Station)
Vertical relief (ft)
Distance from headstake (ft)
2/10/2023 (NE)


Kilili North 2 (Total Station)
Vertical relief (ft)
Distance from headstake (ft)
2/10/2023 (NE)


Kilili North 3 (Total Station)
Vertical relief (ft)
101
100
99
98
97
96
95
94
93
92
91
0
10
20
30
40
50
60
70
80
Distance from headstake (ft)
2/10/2023 (NE)

Oleai

Alongside the Garapan reef lies the short Oleai shoreline, which is next to the parking lot of Oleai Beach Bar. The restaurant in Oleai 1 transect is located less than 50 ft away from the waterline, making it vulnerable to storm surge and sea level rise.

It is crucial to implement stabilization measures to protect the restaurant infrastructure from the encroaching waterline. Monitoring the shoreline position can aid in making informed decisions to address this issue. Despite occasional erosion events, the beach seems to be relatively stable. However, during typhoon wave conditions, wave overtopping and overwhelmed tidal flows could impact this area. It seems that southwest conditions may have a significant impact on this site.

Oleai 1 Highlights:

- STABLE
- Wrackline that ranges 8 – 33 ft and an elevation difference of more than 6 ft
- Tides and seasonal wave conditions influence the beach width. Restaurant management grooms the shoreline by pushing washed up debris more inland in a pile.
- Based on the Shoreline linear regression analysis (see pg 58), the shoreline has a rate of -0.2 ft from 2016-2023.

Oleai 2 Highlights:

- STABLE
- Wrackline that ranges 25 –53 ft and an elevation difference of 7 ft
- Based on the Shoreline linear regression analysis (see pg 58), the shoreline has a rate of -0.06 ft from 2016-2023.

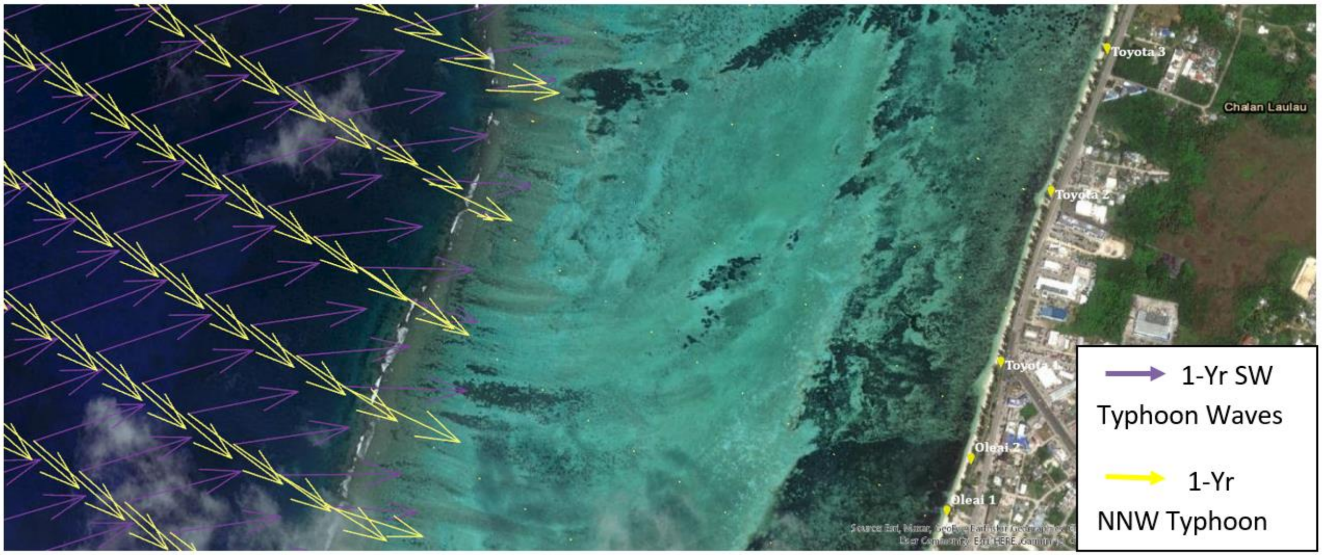


Figure 21 - Hydrodynamic map of the stretch of Oleai and Toyota (close to the traffic light) with the ocean wave energies buffered by the reef. The arrows show the intensity of waves generated from the south west (in dark purple) and the northnorthwest wave conditions (in yellow).

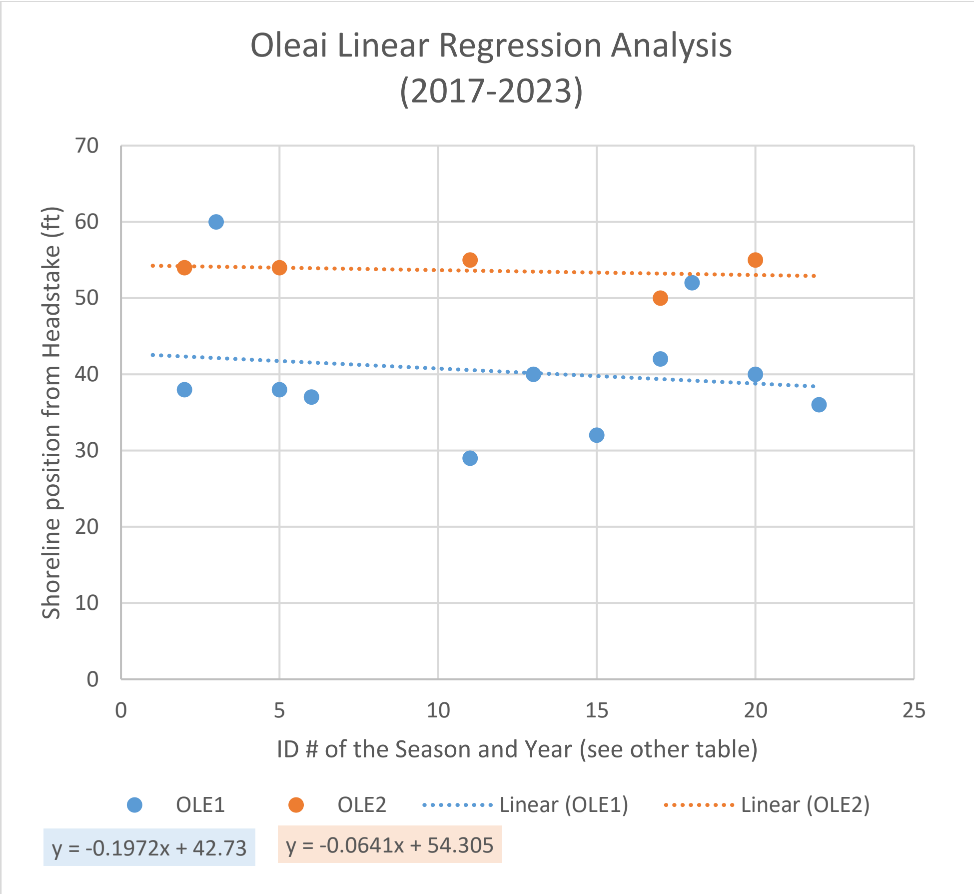
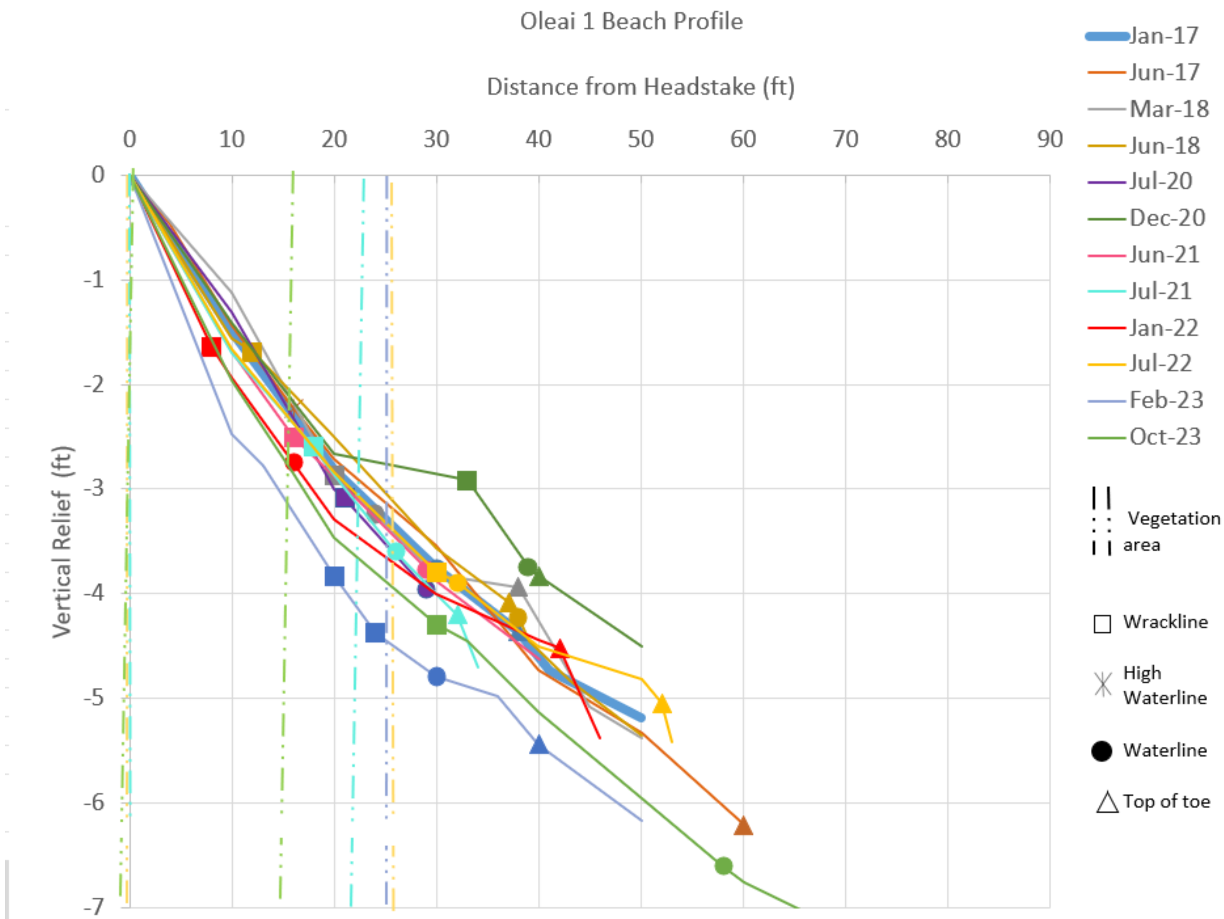
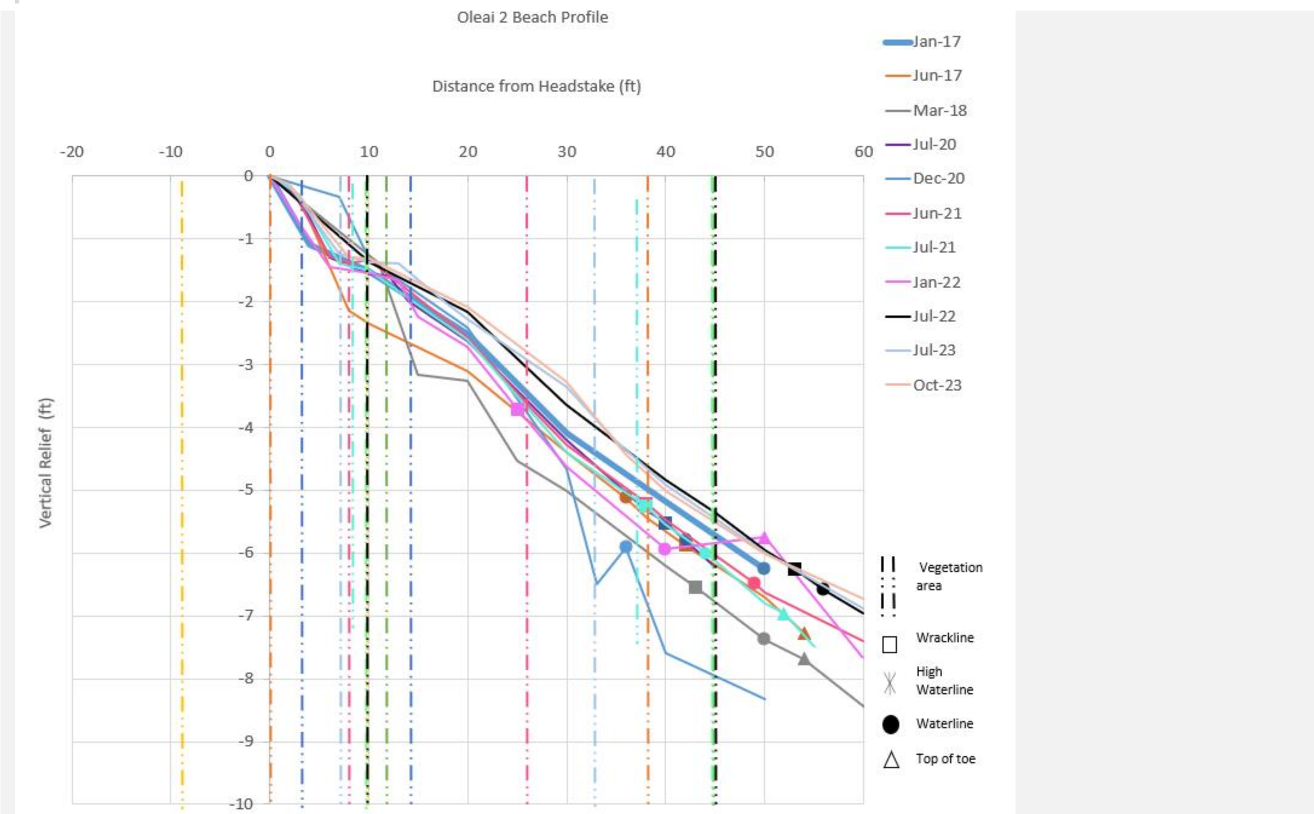
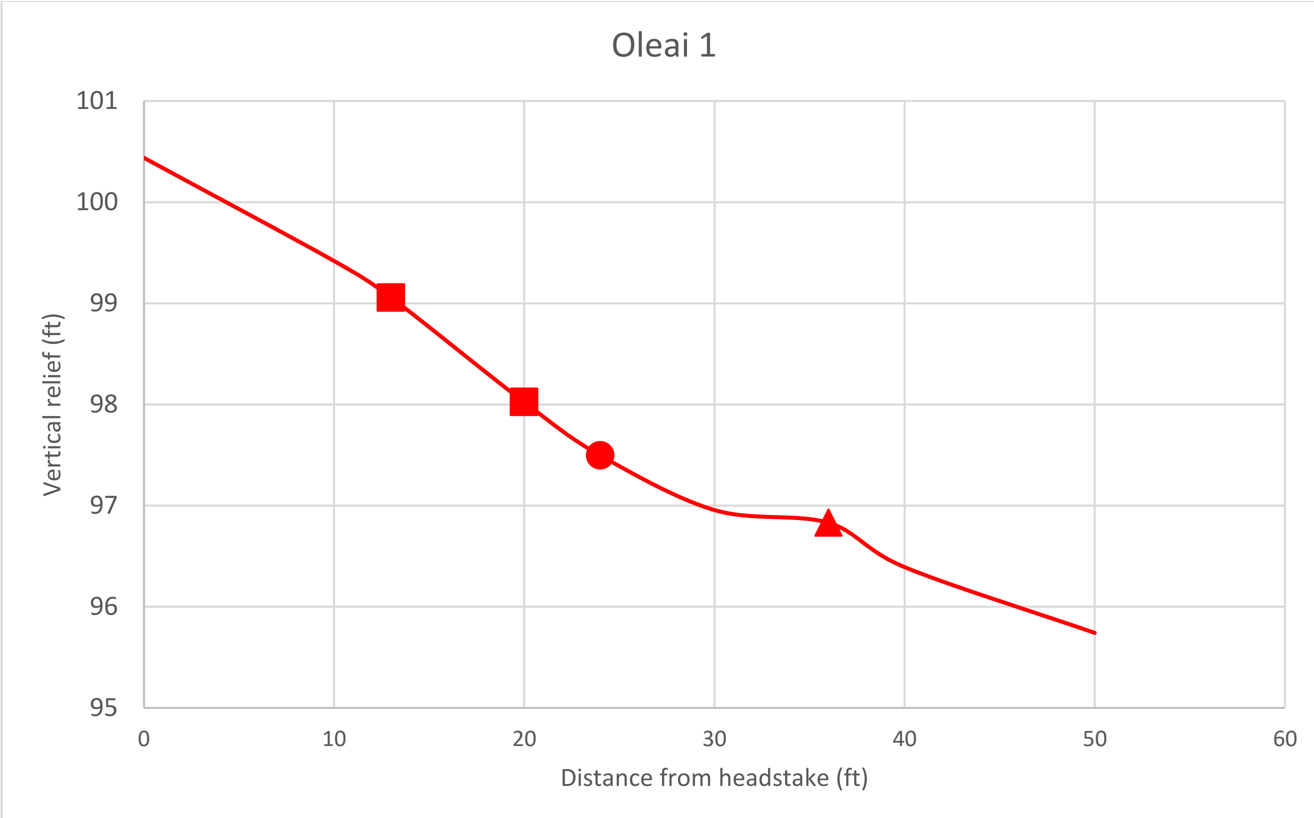


Figure 22 - Oleai Beach Linear Regression Analysis table shows time in seasons over shoreline position (top of toe) from the headstake.

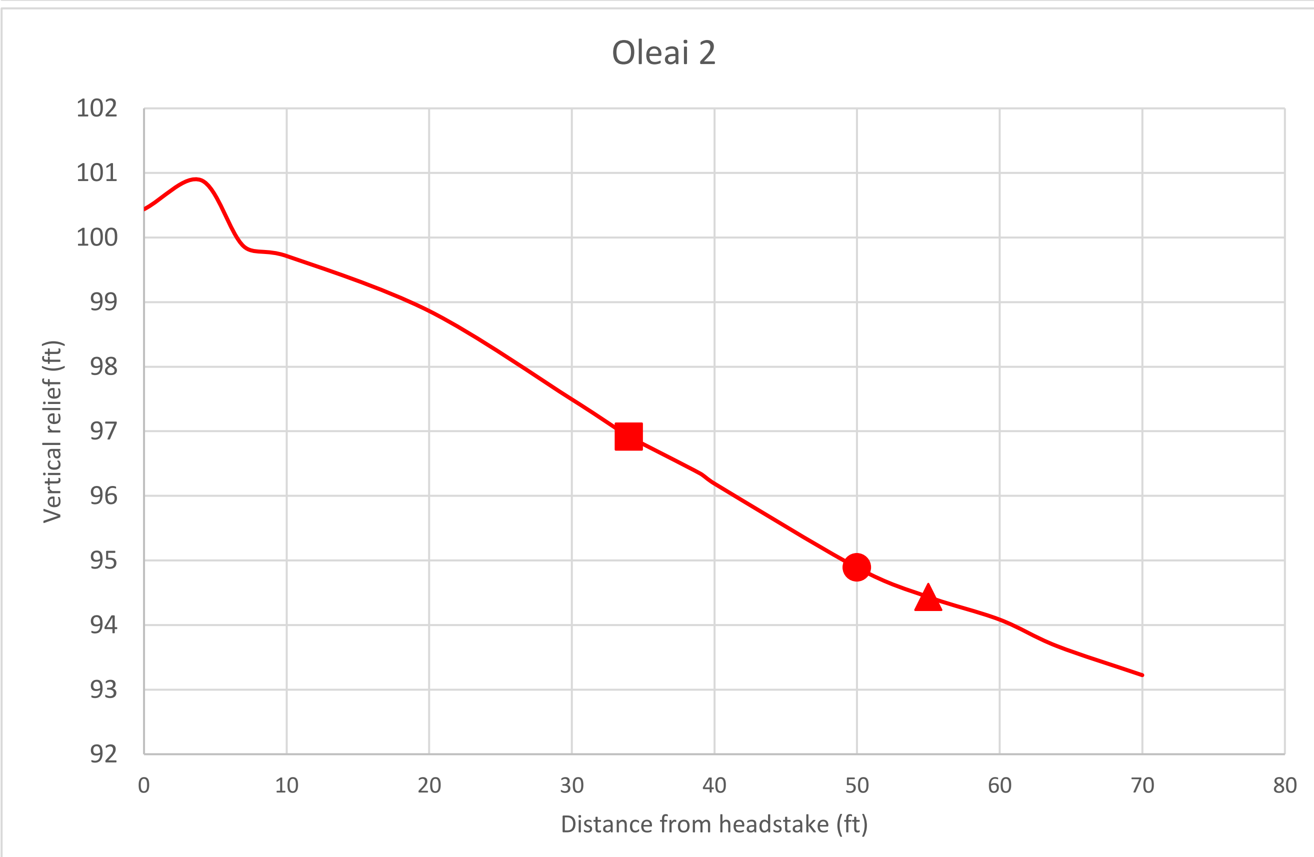
Oleai Beach Profiles







Oleai 1
101
100
99
98
97
96
95
Vertical relief (ft)
0
10
20
30
40
50
60
Distance from headstake (ft)



Oleai 2
102
101
100
99
98
97
96
95
94
93
92
Vertical relief (ft)
0
10
20
30
40
50
60
70
80
Distance from headstake (ft)

Toyota

The Toyota shoreline stretches from the traffic light to the walled structures beyond the boardwalk of Beach Road pathway. This area has historically experienced damage after storm surge events, affecting the pathway infrastructure. During low tide, the exposed shoreline provides space for fishing.

The rise in sea level poses a threat to this shoreline, as well as the developed areas behind it, including the Toyota intersection and surrounding businesses. The strong wave energy during typhoon conditions causes erosion, leading to a decrease in shoreline width. This can result in wave overtopping and overwhelmed tidal flows during typhoon wave conditions. However, the shoreline seems to gradually recover after these events.

Toyota 1 Highlights:

- STABLE
- Wrackline that ranges 50 – 78 ft and an elevation difference of 9 ft
- Based on the Shoreline linear regression analysis (see pg 63), the shoreline has a rate of +0.7 ft from 2016-2023.

Toyota 2 Highlights:

- ACCRETING
- Wrackline that ranges 20 – 30 ft with an elevation difference of 8 ft
- Erosion was obvious on June 2018
- Based on the Shoreline linear regression analysis (see pg 63), the shoreline has a rate of +2.3 ft from 2016-2023.

Toyota 3 Highlights:

- ACCRETING
- Wrackline that ranges 30 – 58 ft and an elevation difference of 8 ft
- Periods of erosion and accretion
- Based on the Shoreline linear regression analysis (see pg 63), the shoreline has a rate of +0.7 ft from 2016-2023.

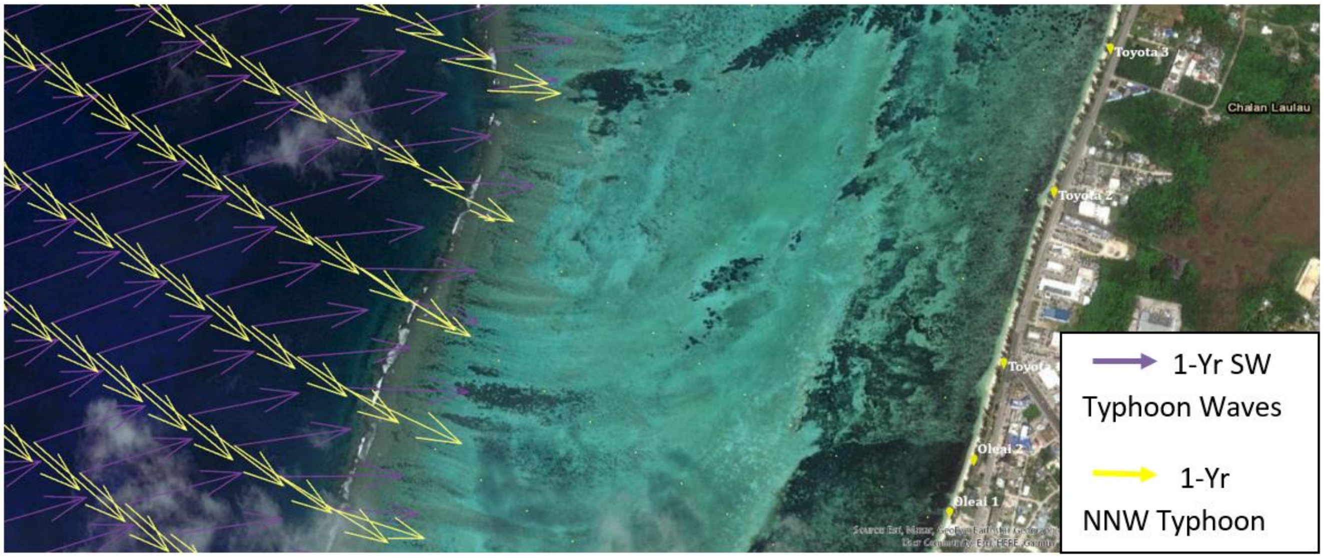


Figure 23 - Hydrodynamic map of the stretch of Oleai and Toyota (close to the traffic light) with the ocean wave energies buffered by the reef. The arrows show the intensity of waves generated from the south west (in dark purple) and the northnorthwest wave conditions (in yellow).

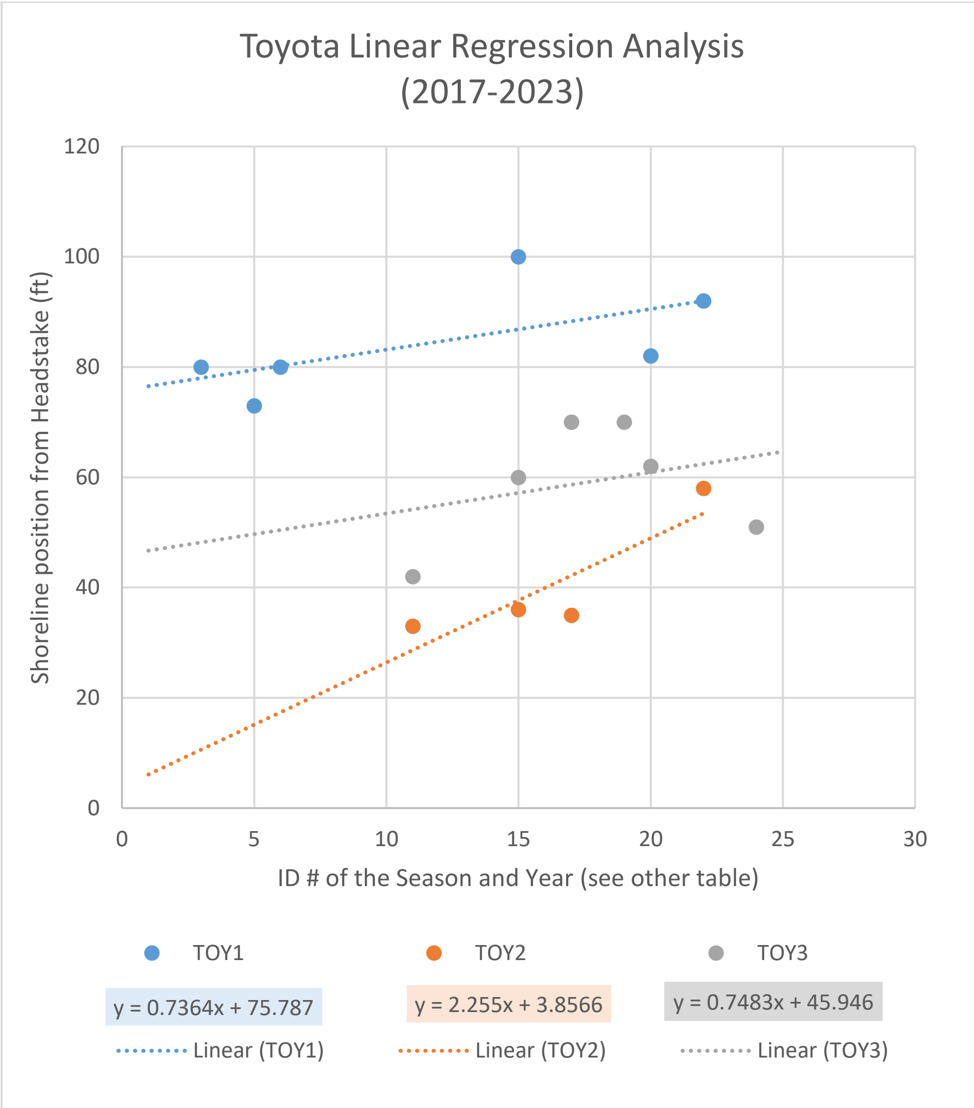
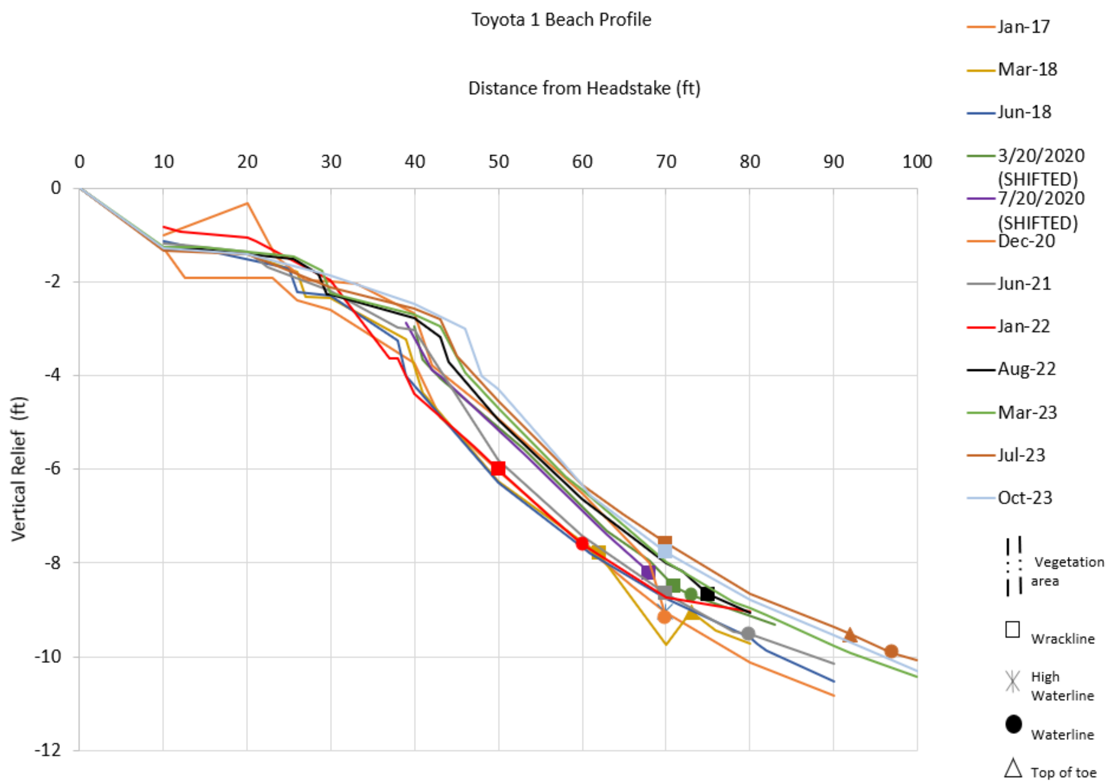
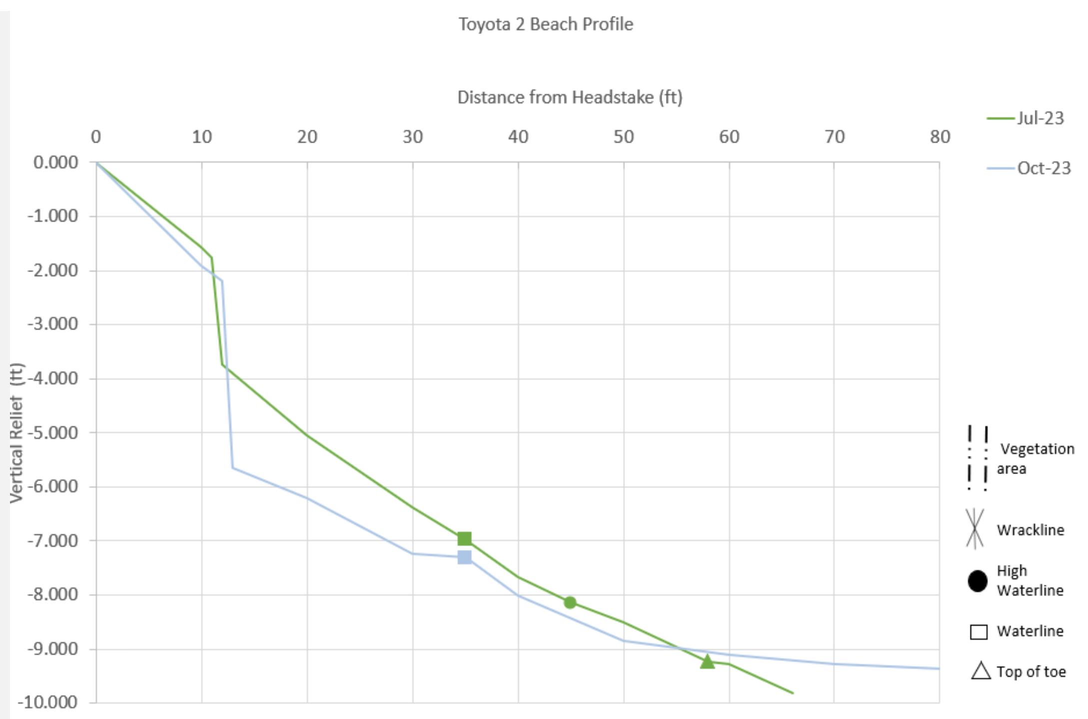
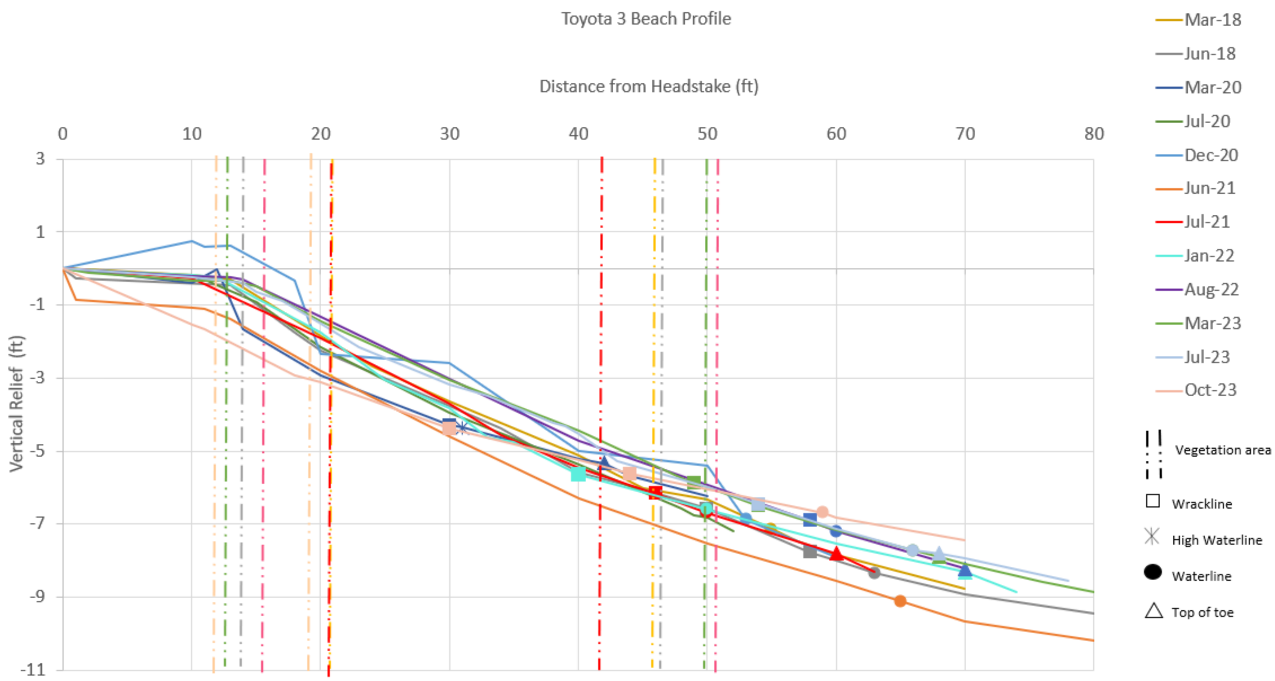


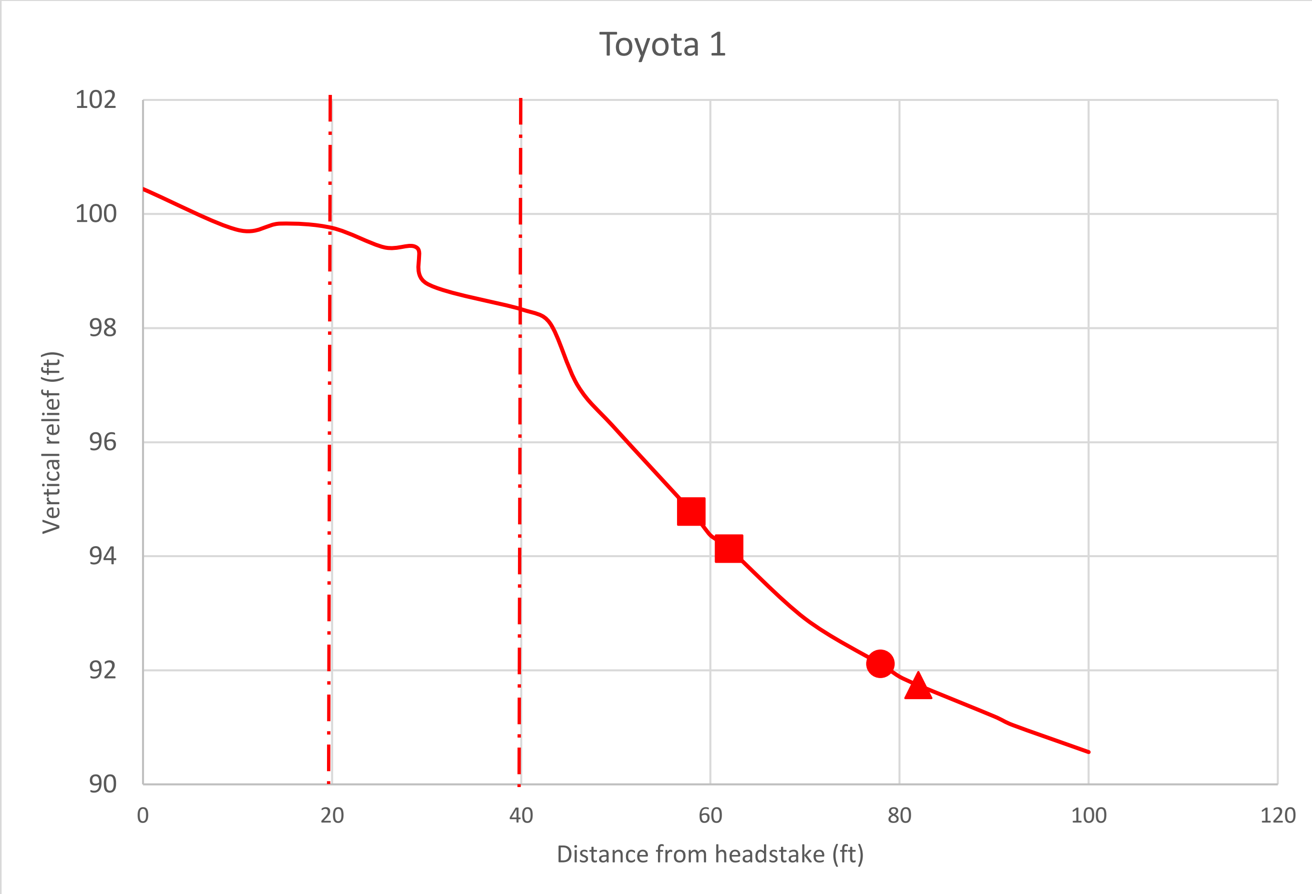
Figure 24 - Toyota Beach Linear Regression Analysis table shows time in seasons over shoreline position (top of toe) from the headstake.

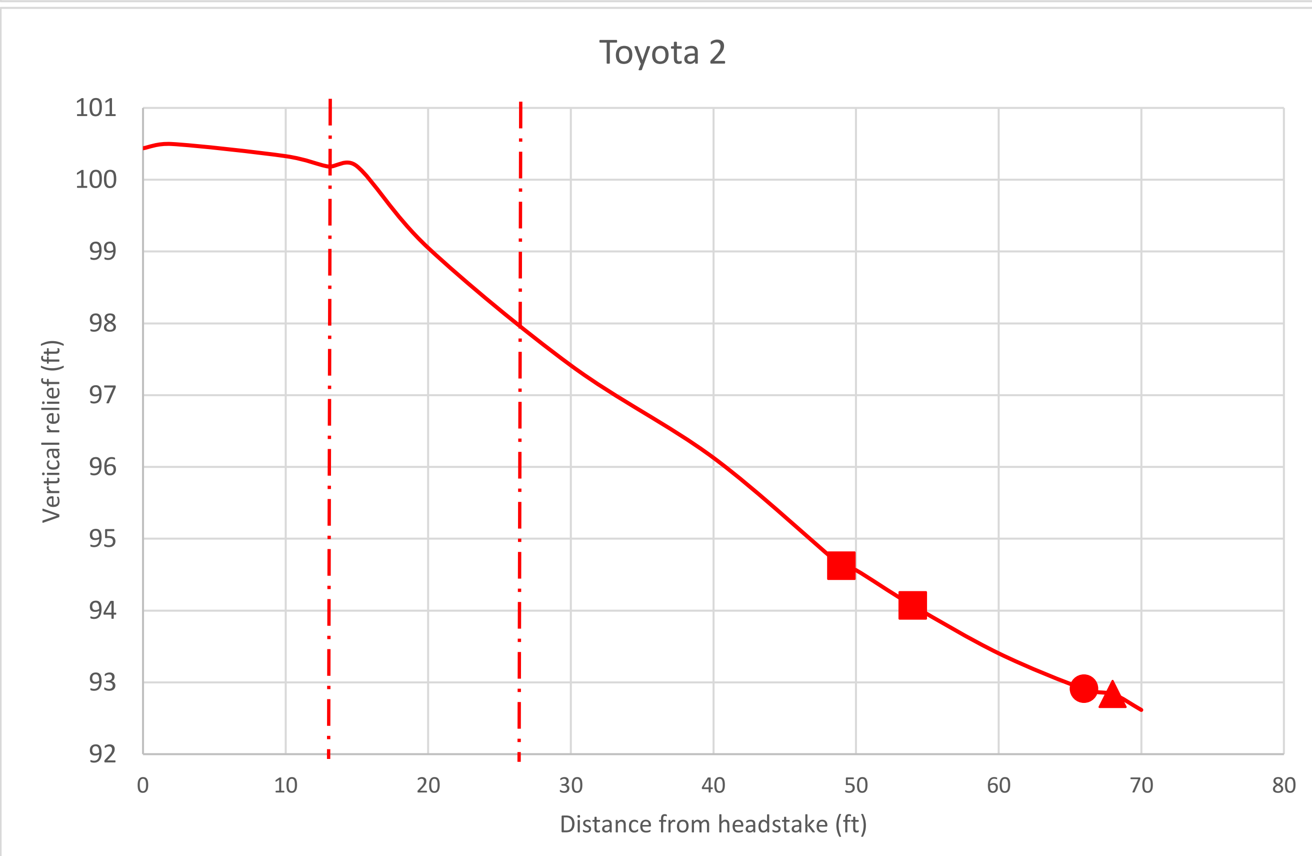
Toyota Beach Profiles






Toyota 3 Beach Profile
Distance from Headstake (ft)
Vertical Relief (ft)
0
10
20
30
40
50
60
70
80
3
1
-1
-3
-5
-7
-9
-11
Mar-18
Jun-18
Mar-20
Jul-20
Dec-20
Jun-21
Jul-21
Jan-22
Aug-22
Mar-23
Jul-23
Oct-23
Vegetation area
Wrackline
High Waterline
Waterline
Top of toe


Toyota 1
Vertical relief (ft)
Distance from headstake (ft)
102
100
98
96
94
92
90
0
20
40
60
80
100
120


Toyota 2
Vertical relief (ft)
Distance from headstake (ft)
101
100
99
98
97
96
95
94
93
92
0
10
20
30
40
50
60
70
80

Quartermaster

The Quartermaster shoreline has very few sandy areas. The beach profiles suggest that the area has been relatively stable or dynamic since the beginning of this program, likely due to sediment transport influenced by the flows of the Light House Channel and the outfalls. However, the short length of this shoreline is alarming and indicates high vulnerability to storm surge and sea level rise. The backshore has critical infrastructure, including Beach Road, in close proximity. The headstakes are a few feet away from the park infrastructure and then several feet away from the main road.

Seagrass beds help in reducing wave energy. However, other stabilization measures have been sought to address the loss of shoreline. This shoreline has a moderate steepness with high tidal influence. Both wave overtopping and overwhelmed tidal flows may impact this site during typhoon wave conditions. It appears that southwest conditions could greatly impact this site. However, a better understanding of nearshore dynamics may provide insight into longshore processes for this area.

Quartermaster 1 Highlights:

- ERODING
- Wrackline that ranges 33 – 40 ft and an elevation difference of 9 ft
- Relatively stable yet seasonally dynamic
- Low tide difference is high
- Nearby outfall drainage influences the sediment transport
- Based on the Shoreline linear regression analysis (see pg 69), the shoreline has a rate of -2.0 ft from 2016-2023.

Quartermaster 2 Highlights:

- STABLE
- Wrackline that ranges 30 – 47 ft with an elevation difference of 6 ft
- Low tide difference is highly noticeable
- Based on the Shoreline linear regression analysis (see pg 69), the shoreline has a rate of +0.13 ft from 2016-2023.

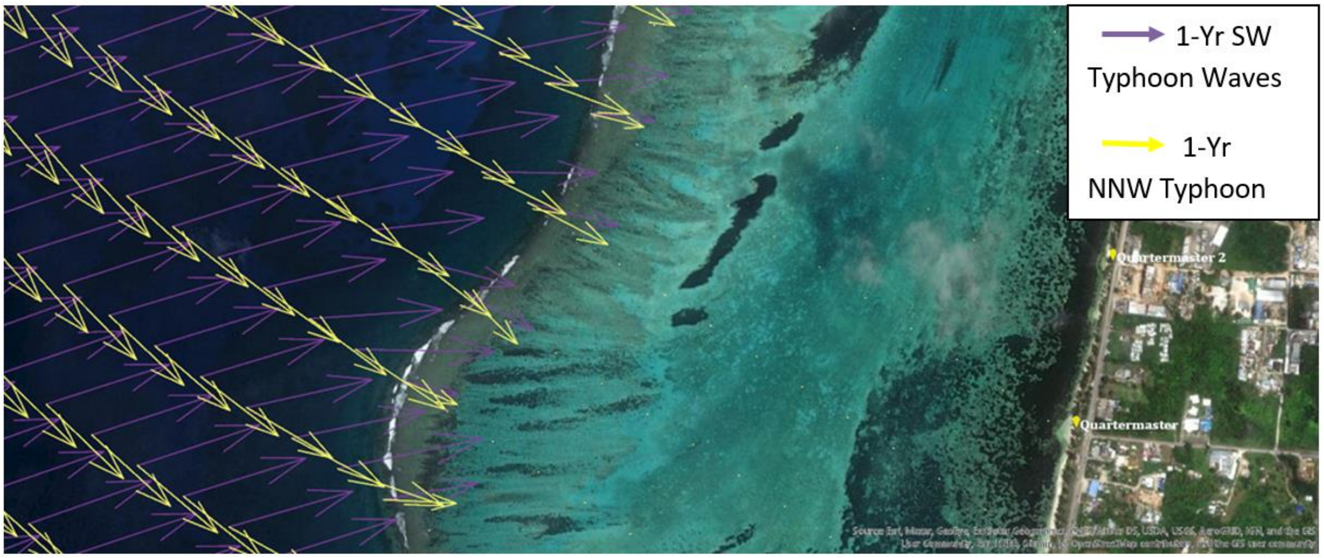


Figure 25 - Hydrodynamic map of the stretch of Quartermaster with the ocean wave energies buffered by the reef. The arrows show the intensity of waves generated from the south west (in dark purple) and the northnorthwest wave conditions (in yellow).

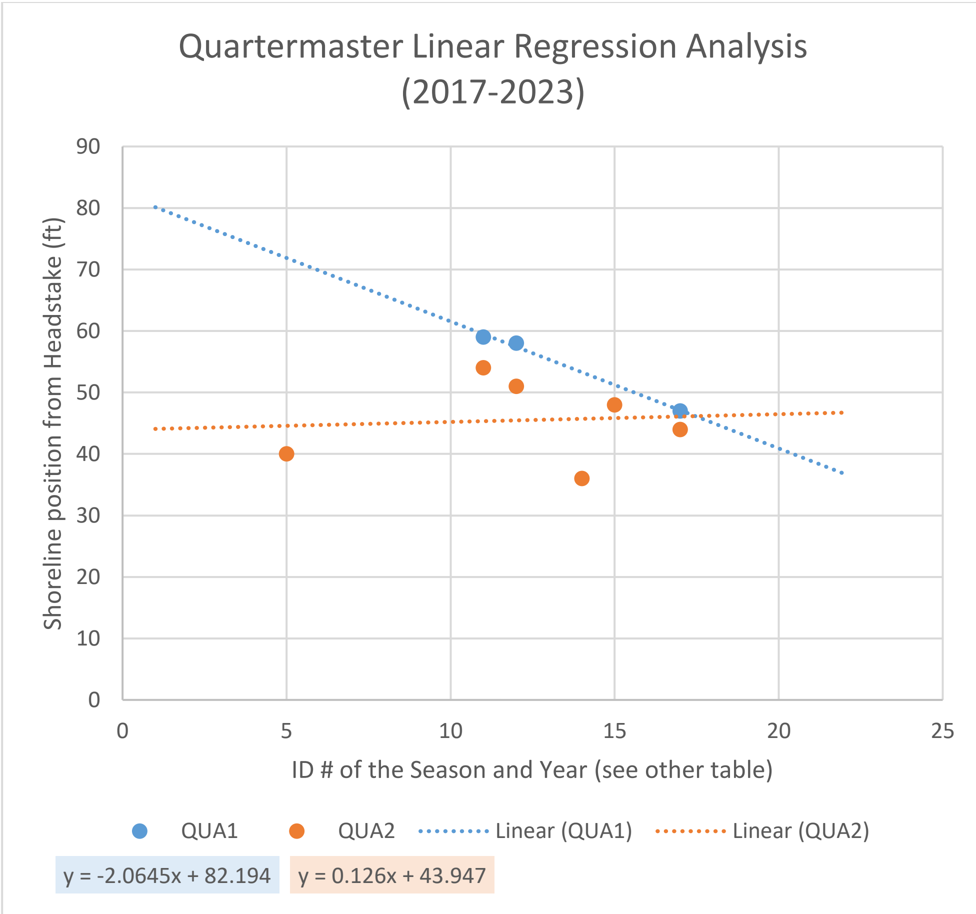
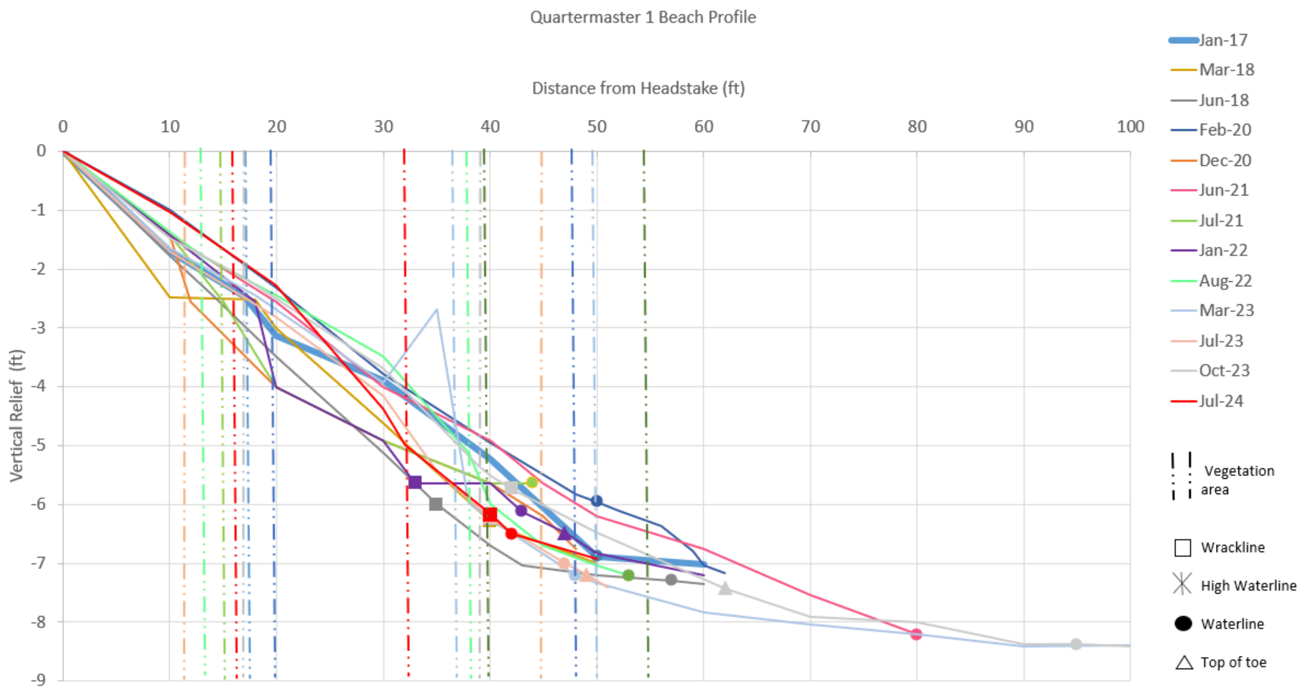
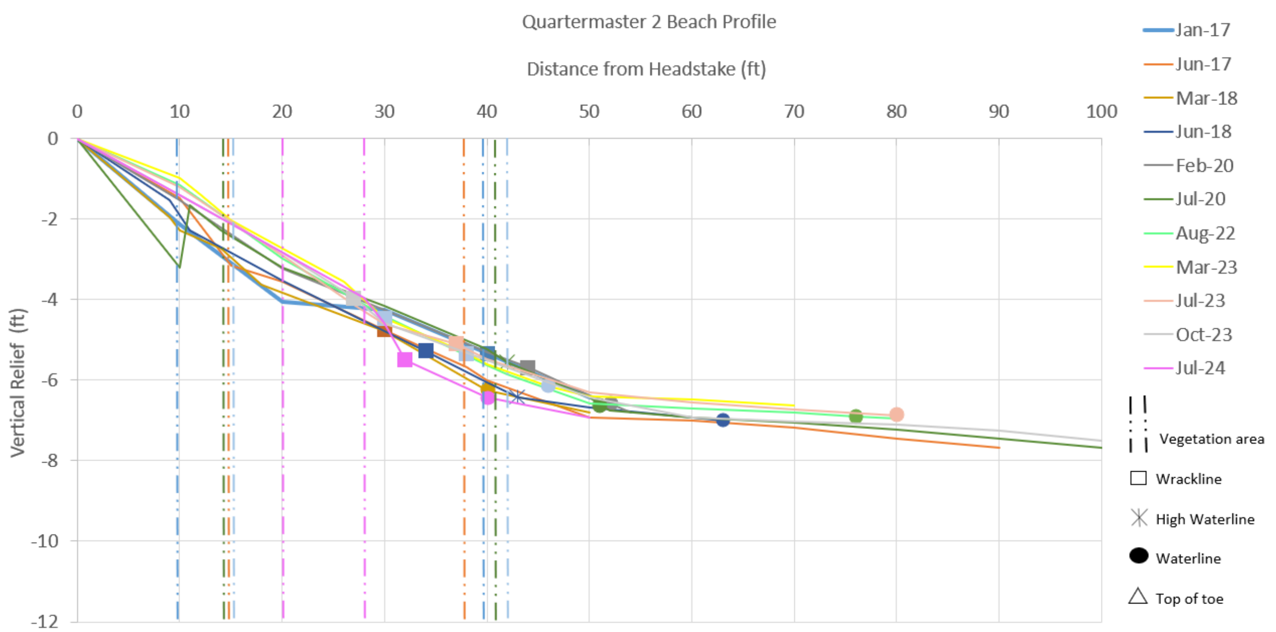
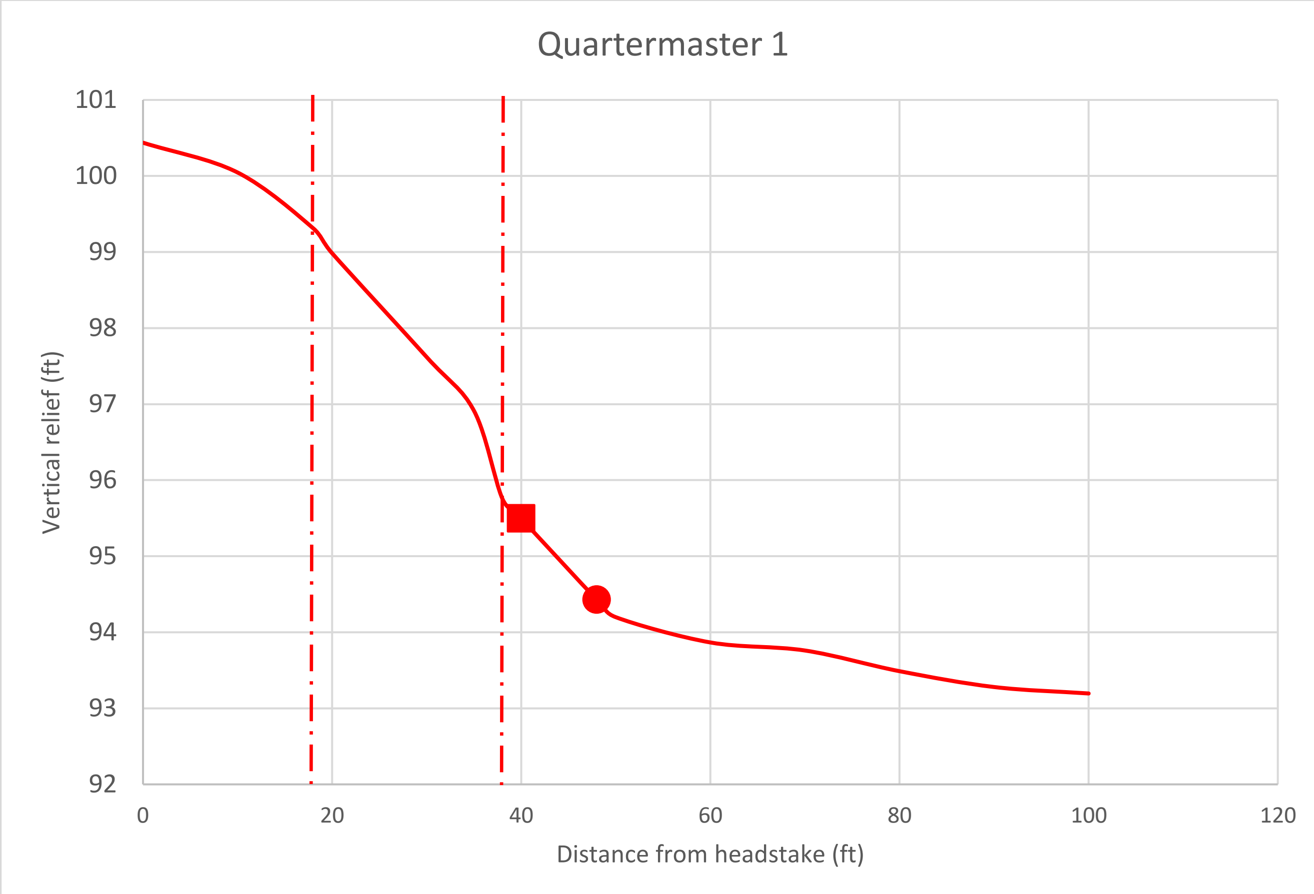


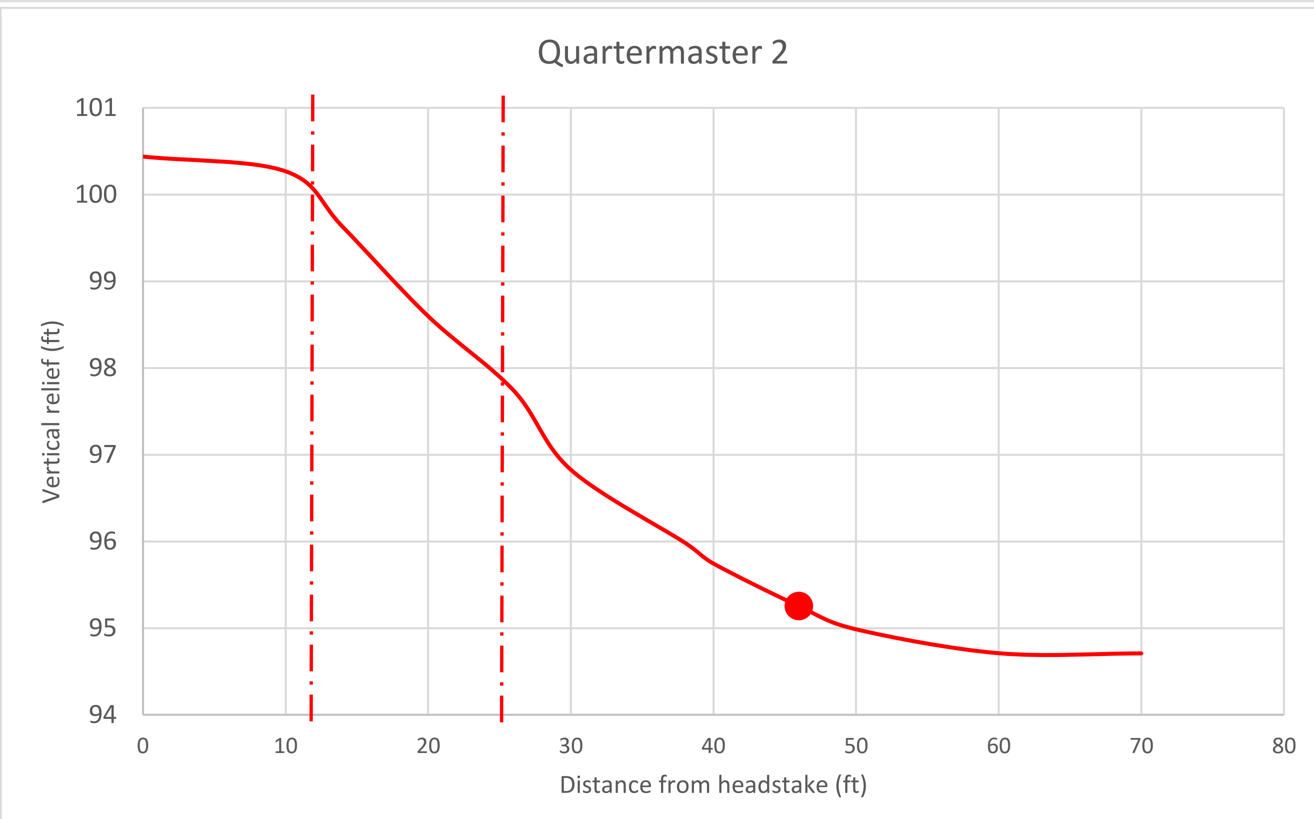
Figure 26 - Quartermaster Beach Linear Regression Analysis table shows time in seasons over shoreline position (top of toe) from the headstake.

Quartermaster Beach Profiles






Quartermaster 1
Vertical relief (ft)
101
100
99
98
97
96
95
94
93
92
0
20
40
60
80
100
120
Distance from headstake (ft)


Quartermaster 2
Vertical relief (ft)
101
100
99
98
97
96
95
94
0
10
20
30
40
50
60
70
80
Distance from headstake (ft)

Hafa Adai

The beach at Grandvrio Hotel, DCRM calls the "Hafa Adai site", is expanding due to the accumulation of sand in the Garapan Lagoon next to a patch reef. This growth is in contrast to the shorelines of Fiesta and Hyatt to the north, as well as the Garapan district shoreline to the south. The presence of thriving young ironwood trees in the nearshore area indicates that this location has not been damaged by the storms of 2021-2022, but rather may have experienced the deposit of sand during storm events. The outfall south of the hotel is believed to have a hydraulic impact on the shoreline, but real-time monitoring efforts have not observed its direct influence on the accumulation. It is possible that sediment from the north is shifting towards the south. Additionally, this area provides better shelter from typhoon waves compared to the northern sites.

During the closure of the Grandvrio hotel due to the pandemic, shoreline vegetation has grown, suggesting stabilization of both the backshore and nearshore areas. Efforts have been made to remove plants and groom the beach for public access and marine sports activities.

Hafa Adai 1 Highlights:

- ACCRETING
- REPLACED after July 2022
- There is insufficient information to conduct a shoreline linear regression analysis this period.
- Outfall influenced
- PREVIOUS HEADSTAKE showed that the shoreline has accreted over 40 ft since 2017

Hafa Adai 2 Highlights:

- ACCRETING
- Wrackline that ranges 52 – 150 ft with an elevation difference of 5 ft
- Based on the Shoreline linear regression analysis (see pg 74), the shoreline has a rate of +4.2 ft from 2016-2023.

Hafa Adai 3 Highlights:

- ACCRETING
- Wrackline that that ranges 40 – 88 ft and an elevation difference of 6.5 ft
- As the shoreline has been gaining volume and length in three years, this stretch of shore naturally developed infrastructure. From July 2020 through Feb 2021, a row of ironwood trees grew and blocked the transect, making surveying difficult from Feb 2021 and onward.
- Based on the Shoreline linear regression analysis (see pg 74), the shoreline has a rate of +2.1 ft from 2016-2023.

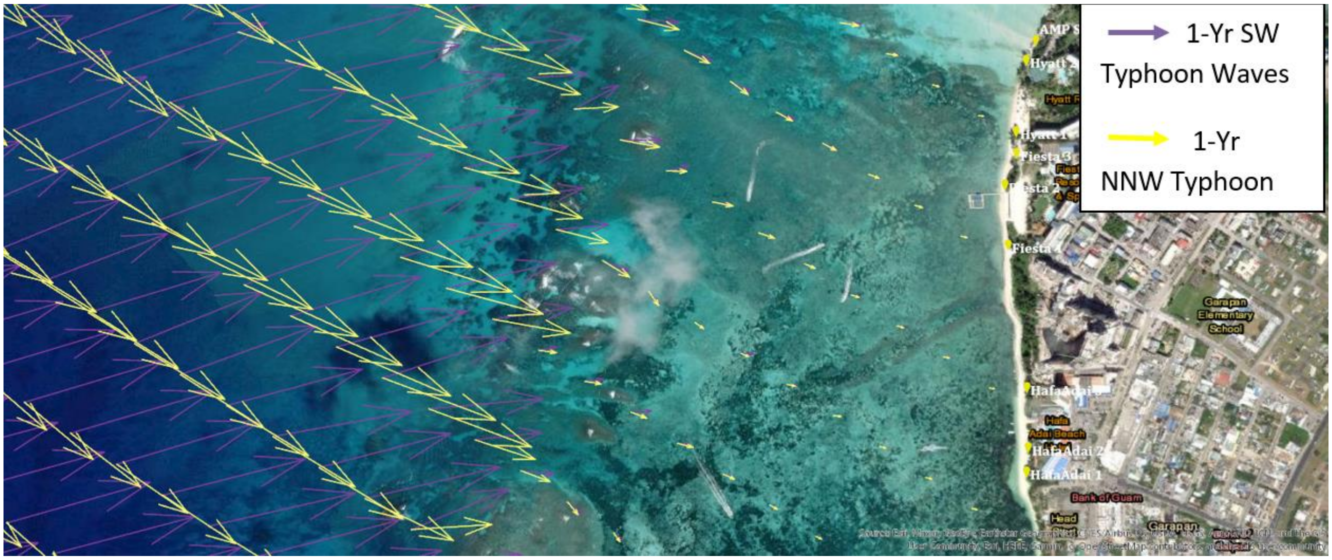
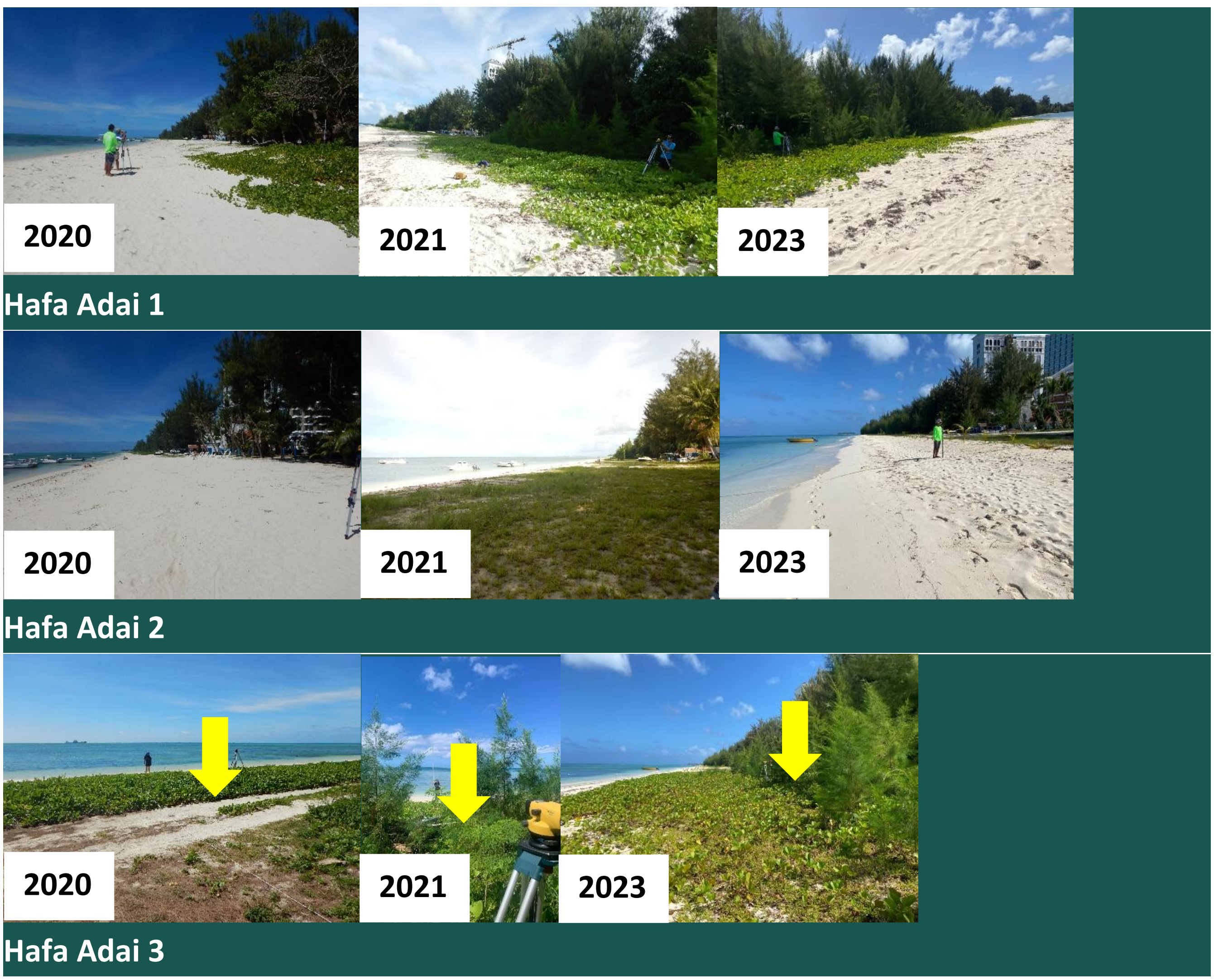


Figure 27 - Hydrodynamic map of the stretch of Hafa Adai, Fiesta, and Hyatt sites with the ocean wave energies buffered by the reef, openings enable higher wave energies to enter into the reef. The arrows show the intensity of waves generated from the south west (in dark purple) and the northnorthwest wave conditions (in yellow).



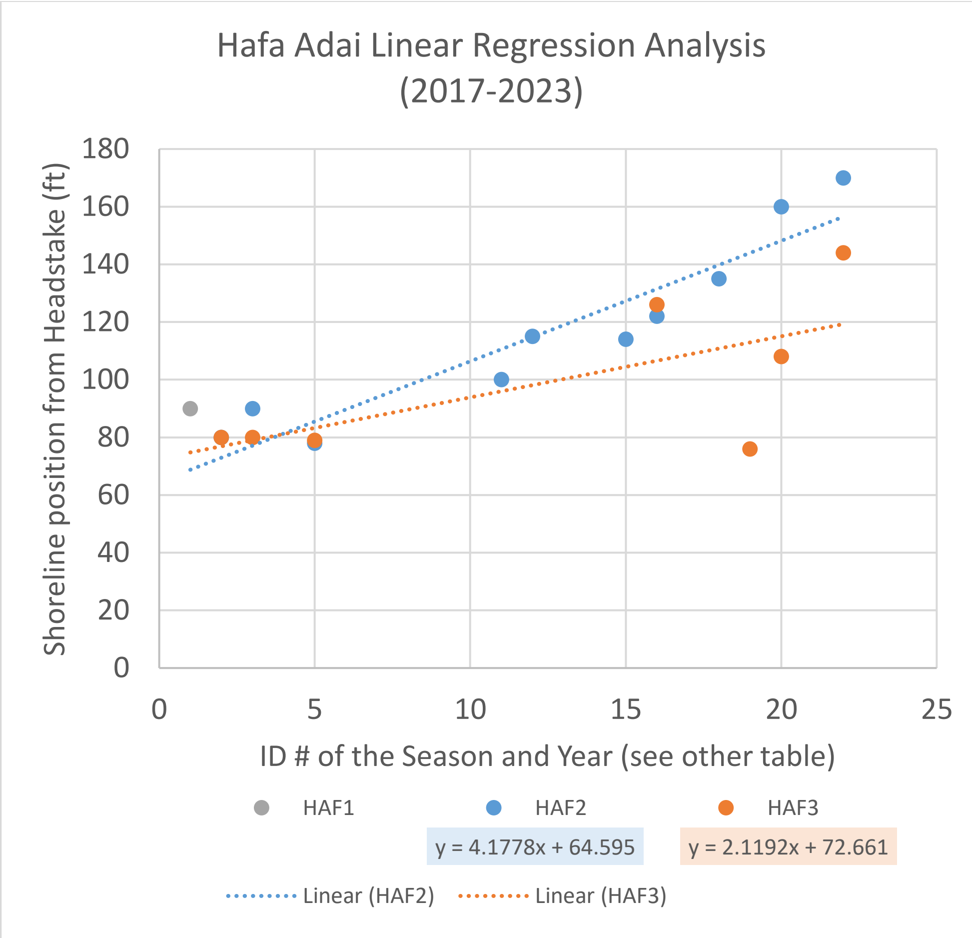
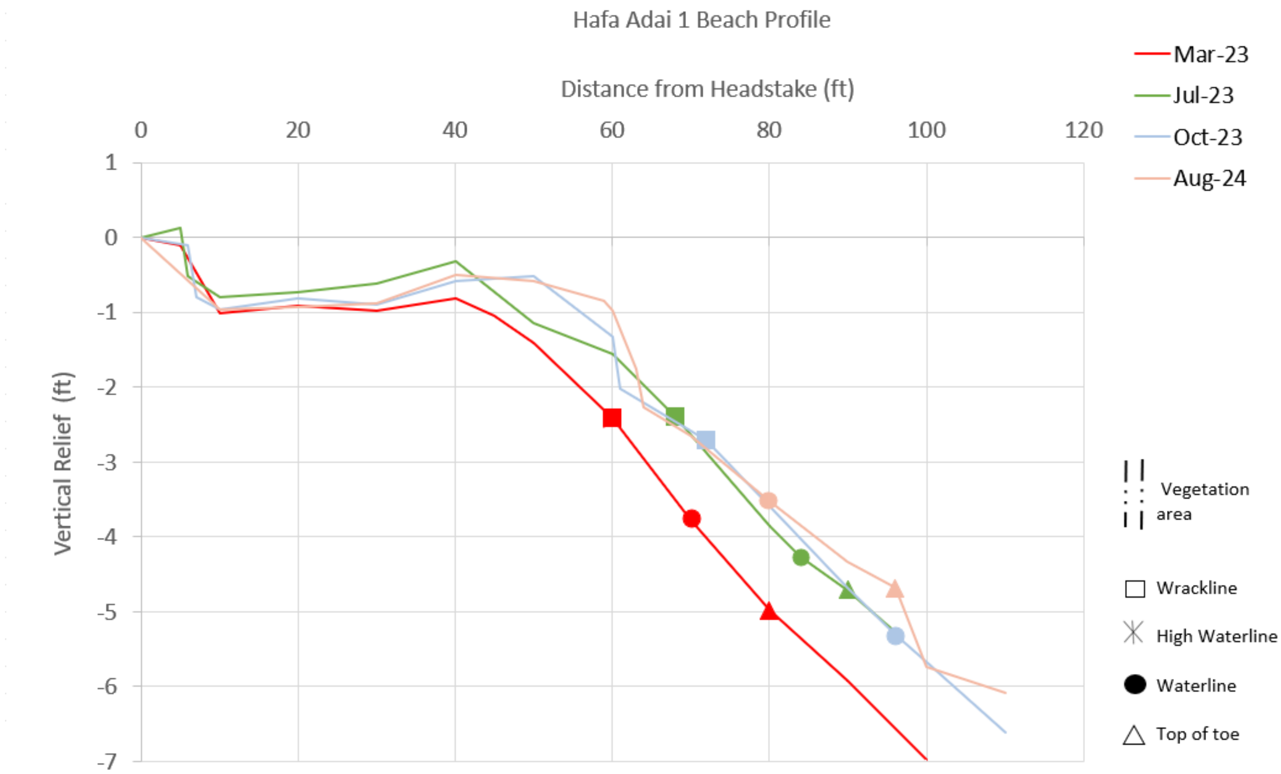
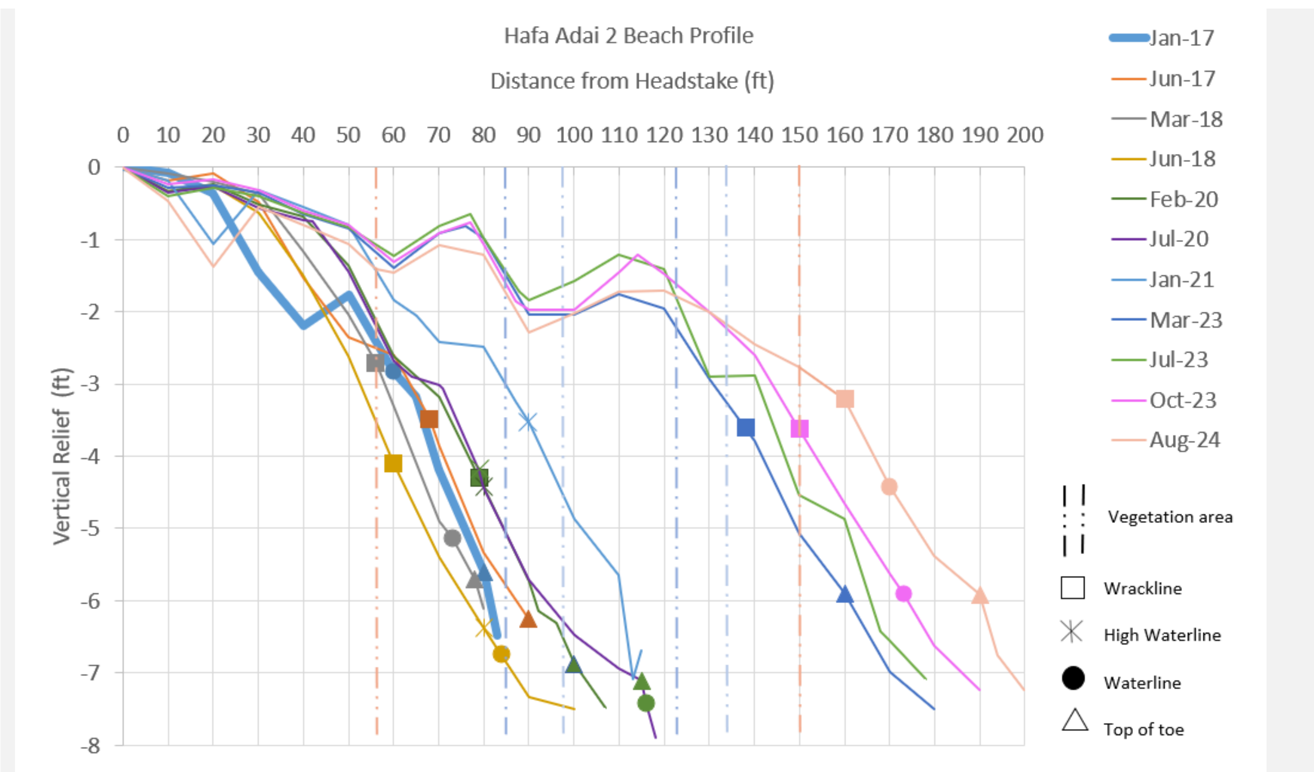
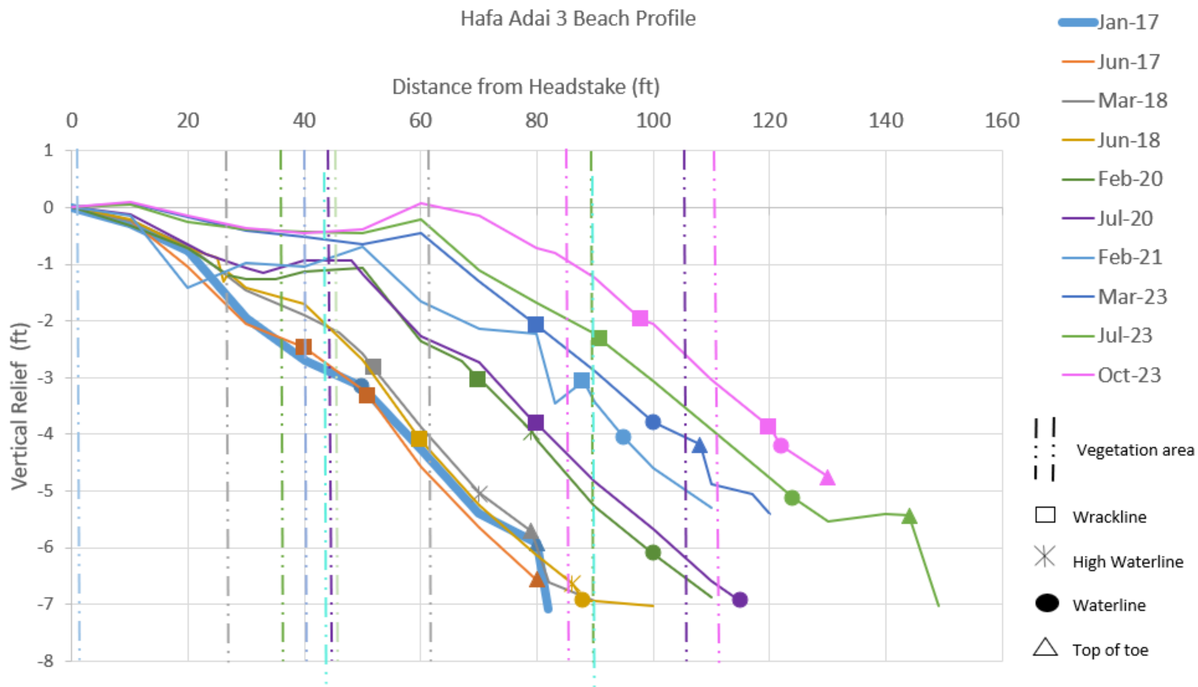


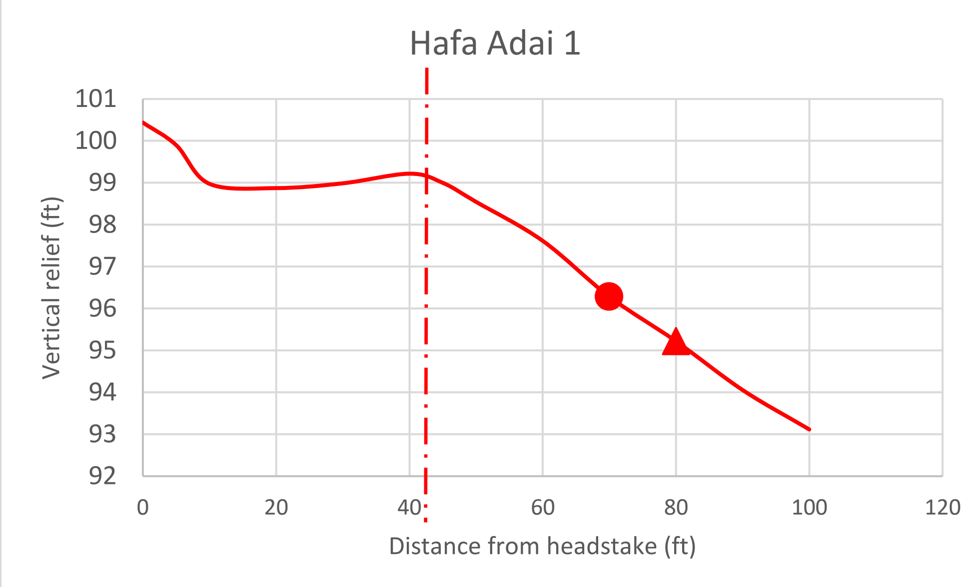
Figure 28 - Hafa Adai Beach Linear Regression Analysis table shows time in seasons over shoreline position (top of toe) from the headstake.

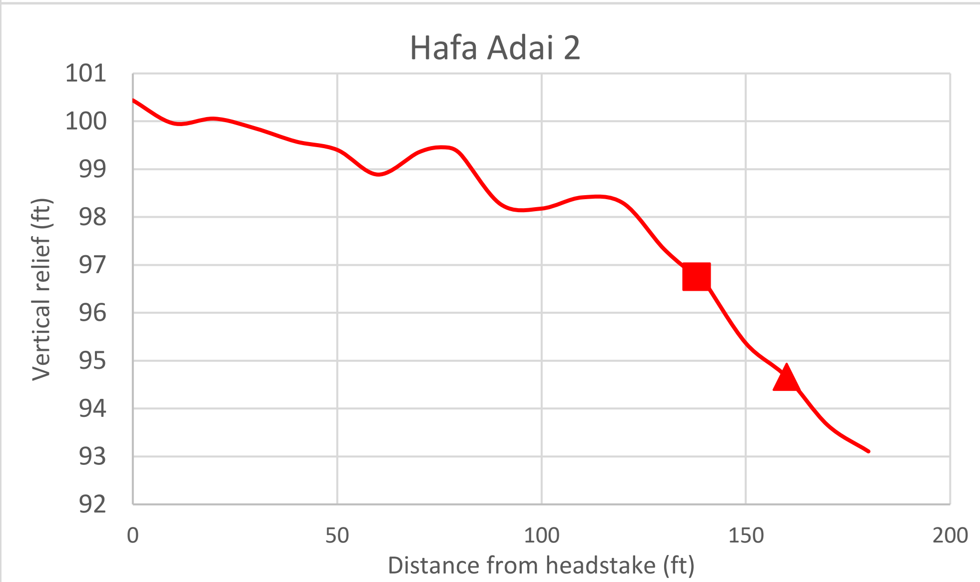
Hafa Adai Beach Profiles

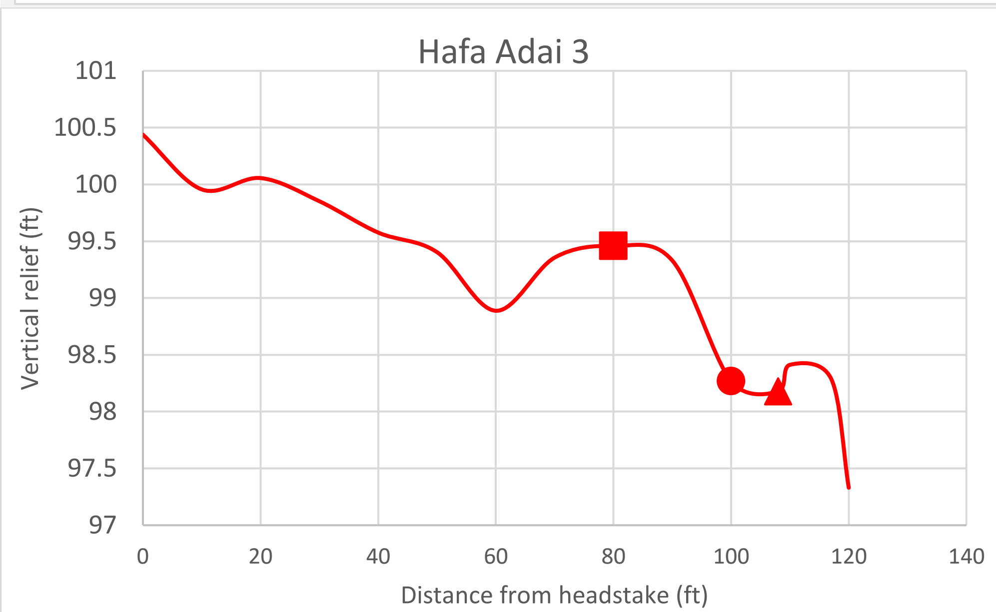





Hafa Adai 3 Beach Profile
Distance from Headstake (ft)
0
20
40
60
80
100
120
140
160
1
0
-1
-2
-3
-4
-5
-6
-7
-8
Vertical Relief (ft)
Jan-17
Jun-17
Mar-18
Jun-18
Feb-20
Jul-20
Feb-21
Mar-23
Jul-23
Oct-23
Vegetation area
Wrackline
High Waterline
Waterline
Top of toe


Hafa Adai 1
Vertical relief (ft)
101
100
99
98
97
96
95
94
93
92
0
20
40
60
80
100
120
Distance from headstake (ft)


Hafa Adai 2
Vertical relief (ft)
101
100
99
98
97
96
95
94
93
92
0
50
100
150
200
Distance from headstake (ft)


Hafa Adai 3
Vertical relief (ft)
101
100.5
100
99.5
99
98.5
98
97.5
97
0
20
40
60
80
100
120
140
Distance from headstake (ft)

Fiesta

The coastline area around Fiesta, or Crowne Plaza shoreline, features a patch reef and seagrass meadows that help reduce the impact of wave energy. However, the island's largest shipping channel to the north allows higher energy waves to overtop the reef, particularly during storms and high sea levels. As a result, the shoreline has been retreating over time.

The decrease in shoreline area has affected watersports and hotel operators. The area bordering the IPI Casino building to the south may be influenced by the nearby outfall located north of the area. The Department of Coastal Resources and Minerals (DCRM) Shoreline Monitoring uses the Trimble Geo7x and Total Station to assess wave damage to the beach following storm and swell events. Additionally, two headstakes have been removed due to storm damage in late 2021, making it challenging to conduct long-term beach profiling in this area.

Fiesta 1 Highlights:

- NEW HEADSTAKE
- Outfall influenced
- Based on the previous information, this shoreline has been eroding from 2016-2023.

Fiesta 2 Highlights:

- DISCONTINUED
- LOSS of shoreline by ~30 ft since 2018
- Beach profile of Feb 2021 to Jul 2021 showed an elevation difference of 6 ft
- **History:** The January 2018 to July 2020 headstake indicated the berm eroded around 10 ft from Jan 2018 through July 2020. The shoreline grew steeper, which enabled further erosion of the shoreline. The one displayed here preceded and was abraded by a September 2021 storm, which ended the surveying.
- This shoreline has been eroding since 2018.

Fiesta 3 Highlights:

- ERODING and REPLACED
- LOSS of shoreline by ~60 ft since 2017
- Beach profile of Jun 2017 to Jun 2021 showed the High Waterline ranges 30 – 55 ft with an elevation difference of less than 6 ft
- **History:** From 2017 – 2020, the berm has retreated ~36 ft. Then from Feb 2020 – Jun 2021, erosion has reached the headstake, indicating additional of loss 16 ft. Storm-induced wave action is abrading the beach and weakening the sand. The late storms of 2021 have eaten up to the headstake and eaten up to the seaward portion of a previous road. This resulted in the area being closed off.
- This shoreline has been eroding from 2016-2023.

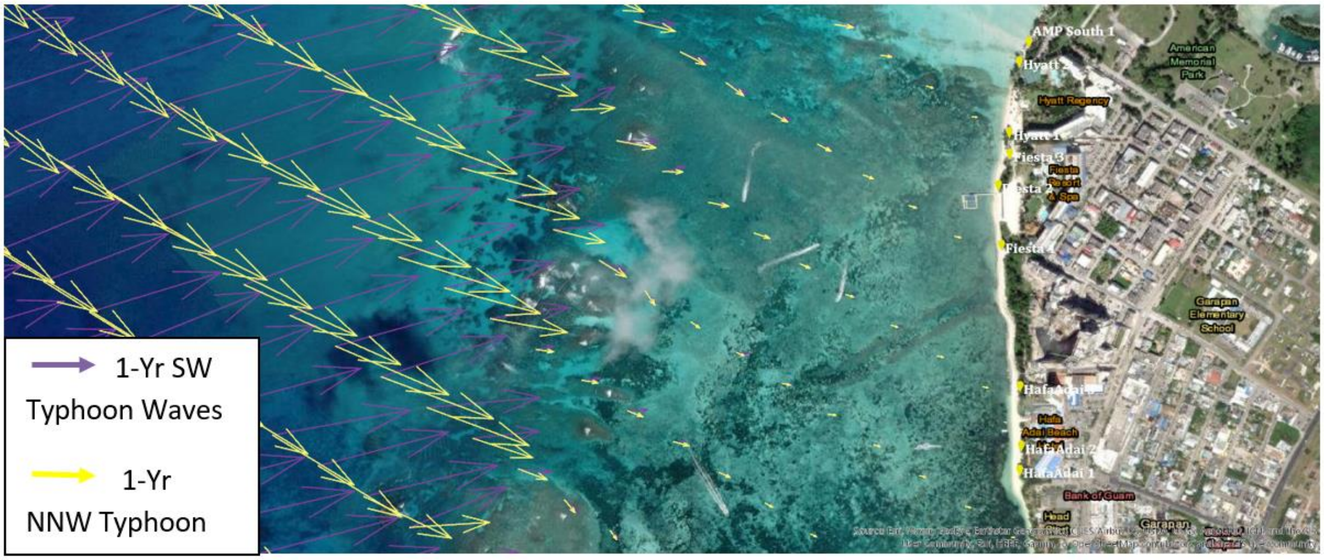
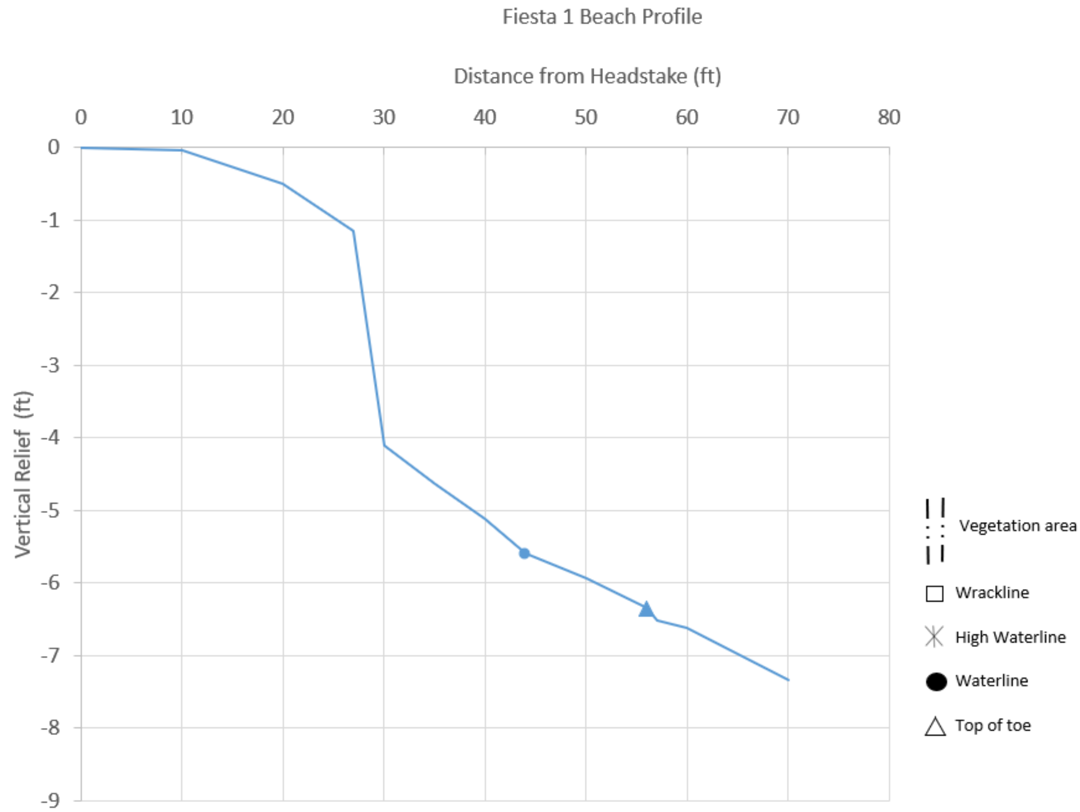
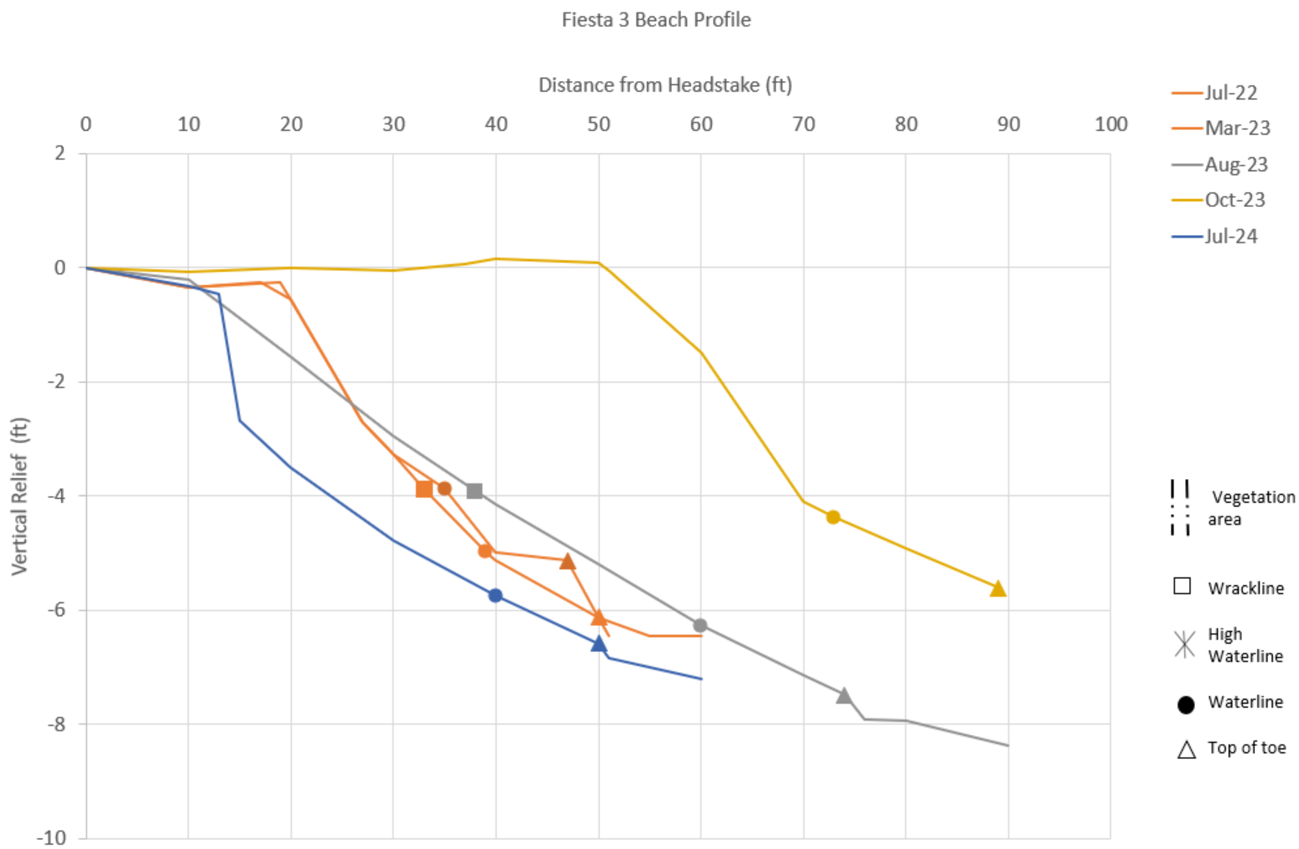


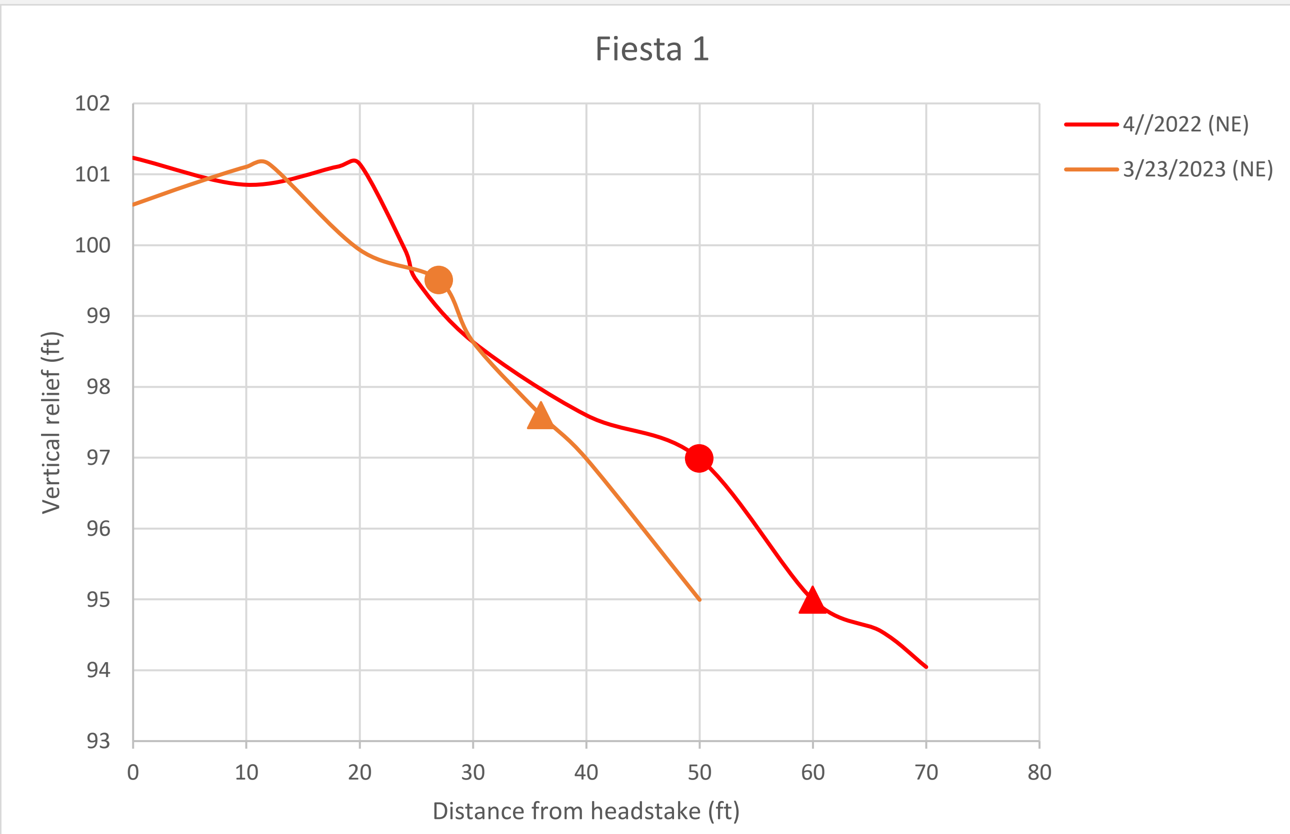
Figure 29 - Hydrodynamic map of the stretch of Hafa Adai, Fiesta, and Hyatt sites with the ocean wave energies buffered by the reef, openings enable higher wave energies to enter into the reef. The arrows show the intensity of waves generated from the south west

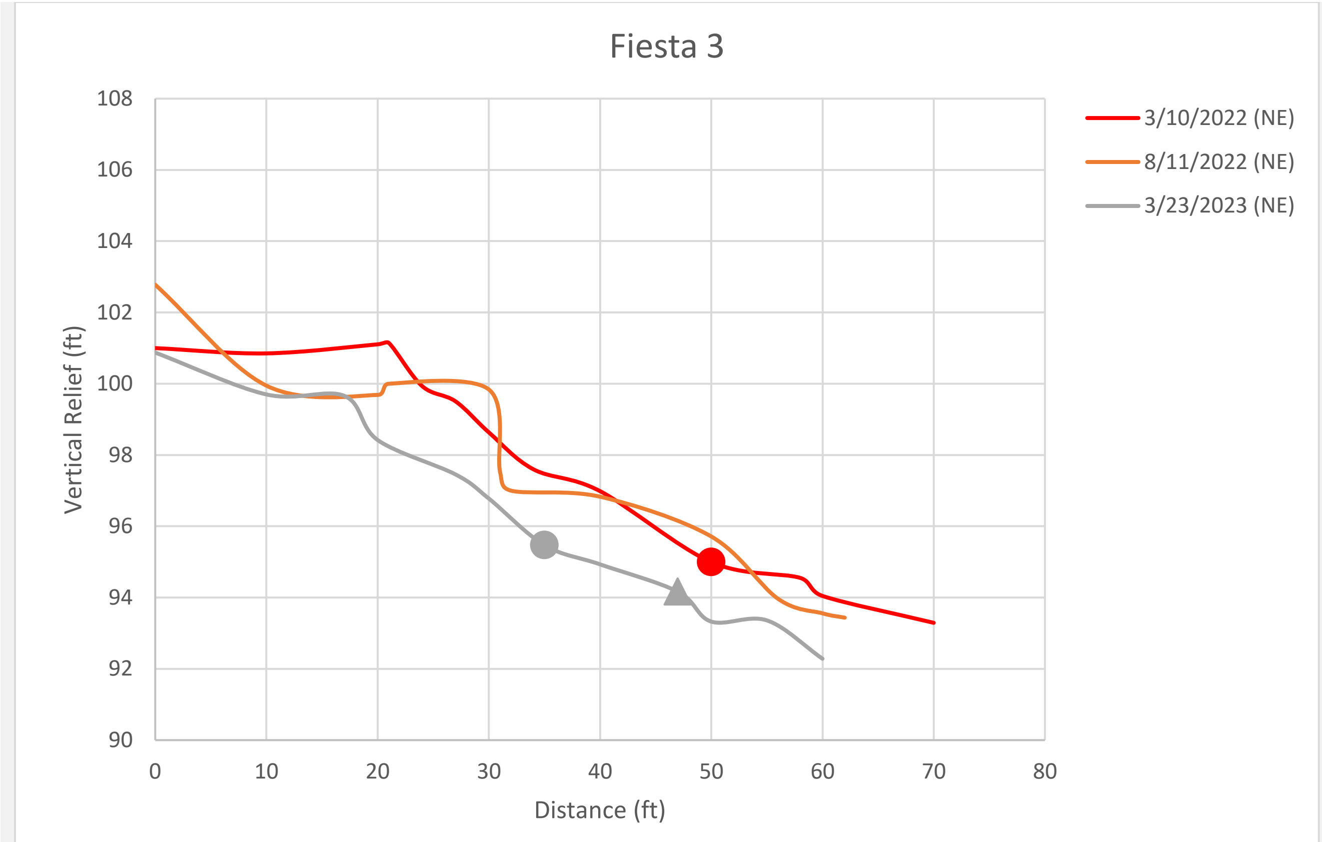
Fiesta Beach Profiles





Total Station




Fiesta 3
Vertical Relief (ft)
108
106
104
102
100
98
96
94
92
90
0
10
20
30
40
50
60
70
80
Distance (ft)
3/10/2022 (NE)
8/11/2022 (NE)
3/23/2023 (NE)

Hyatt

The Hyatt shoreline in this area has been actively eroding, similar to Fiesta, because of powerful waves caused by storms. Two head stakes were pulled into the water and have become ineffective. The shoreline is being eroded by the increased wave energy from storm conditions and higher sea levels entering through the channel. The tropical disturbance in September 2021 caused significant damage in a short period of time from north-northwest flows. Southwest typhoon wave conditions also contribute to the erosion of the shoreline.

Hyatt 1 Highlights:

- LOST to EROSION
- LOSS of shoreline by ~70 ft since 2020
- Elevation difference of 7 ft

Hyatt 2 Highlights:

- NEW HEADSTAKE
- Previous headstake showed a LOSS of shoreline by ~70 ft since 2017
- **History:** This area serves as a pathway from Micro Beach to the marine sports area north of Hyatt. It is eroding on the long term determined by the abrasion exposing the bedrock after the September 2021 storm. The sand is pulled into the water during high wave energy conditions and pushed into the shore during lower wave energy conditions. The new operational headstake is tree farther back. LOSS of shoreline by ~30 ft since 2020.

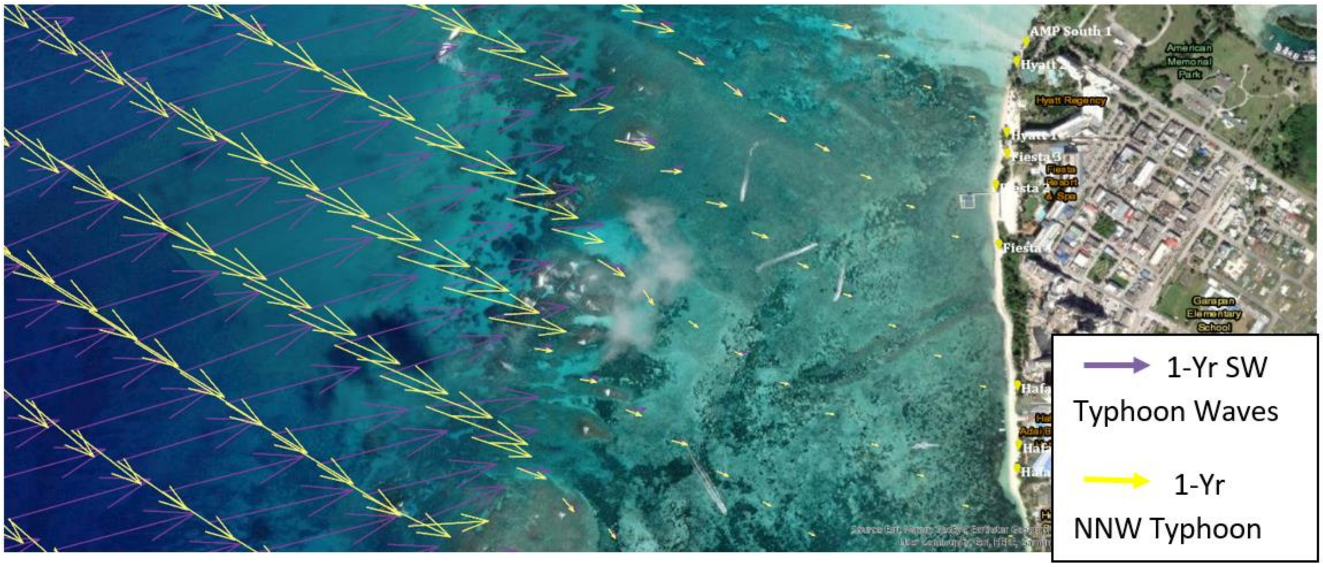
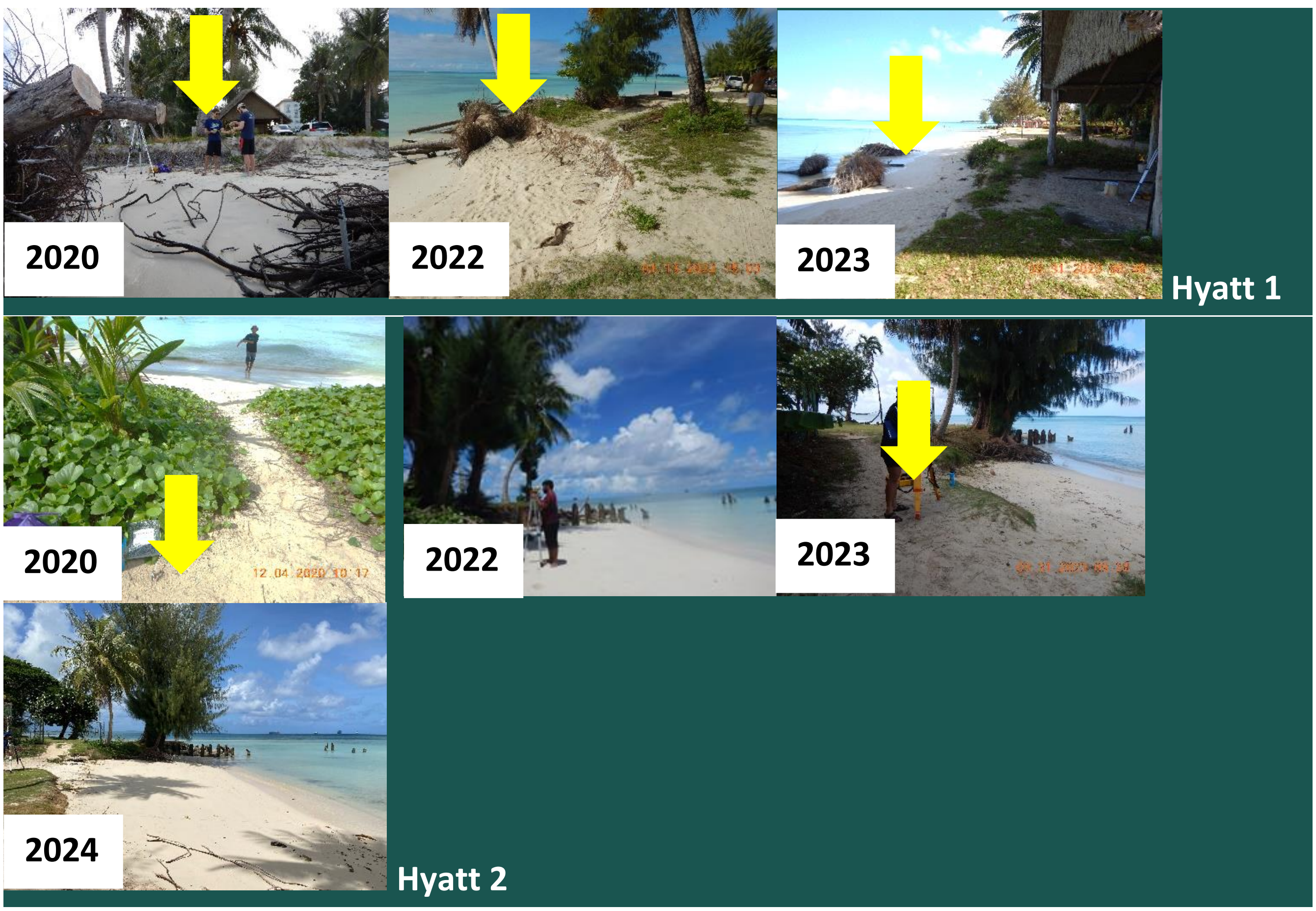
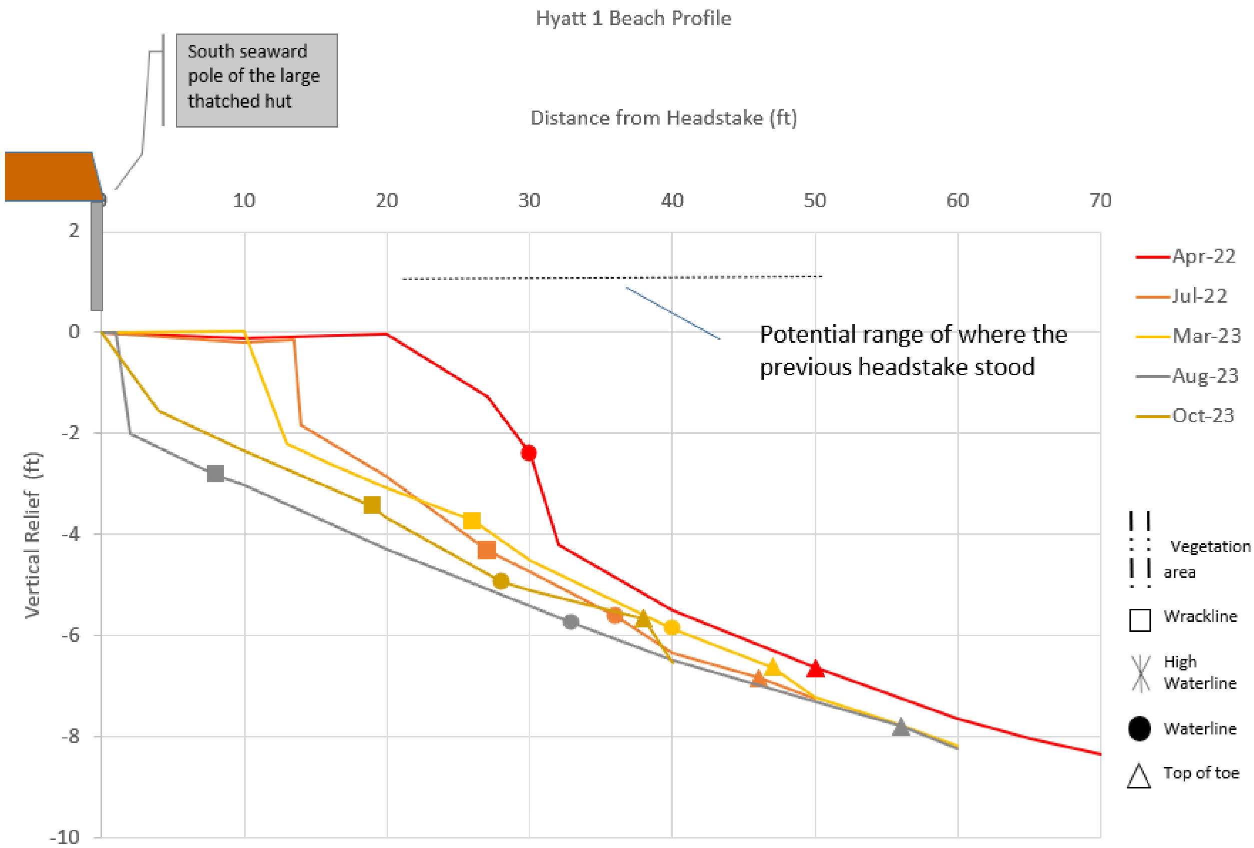


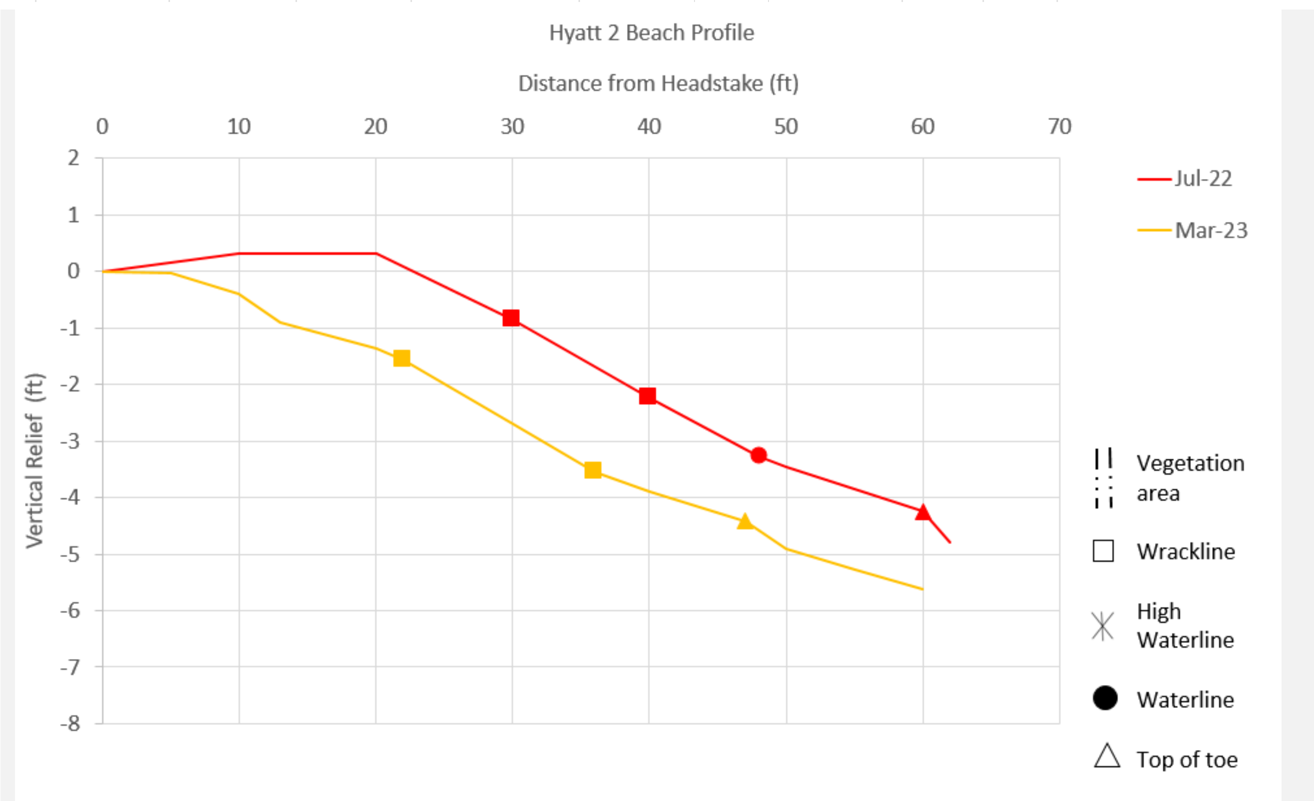
Figure 30 - Hydrodynamic map of the stretch of Hafa Adai, Fiesta, and Hyatt sites with the ocean wave energies buffered by the reef, openings enable higher wave energies to enter into the reef. The arrows show the intensity of waves generated from the south west



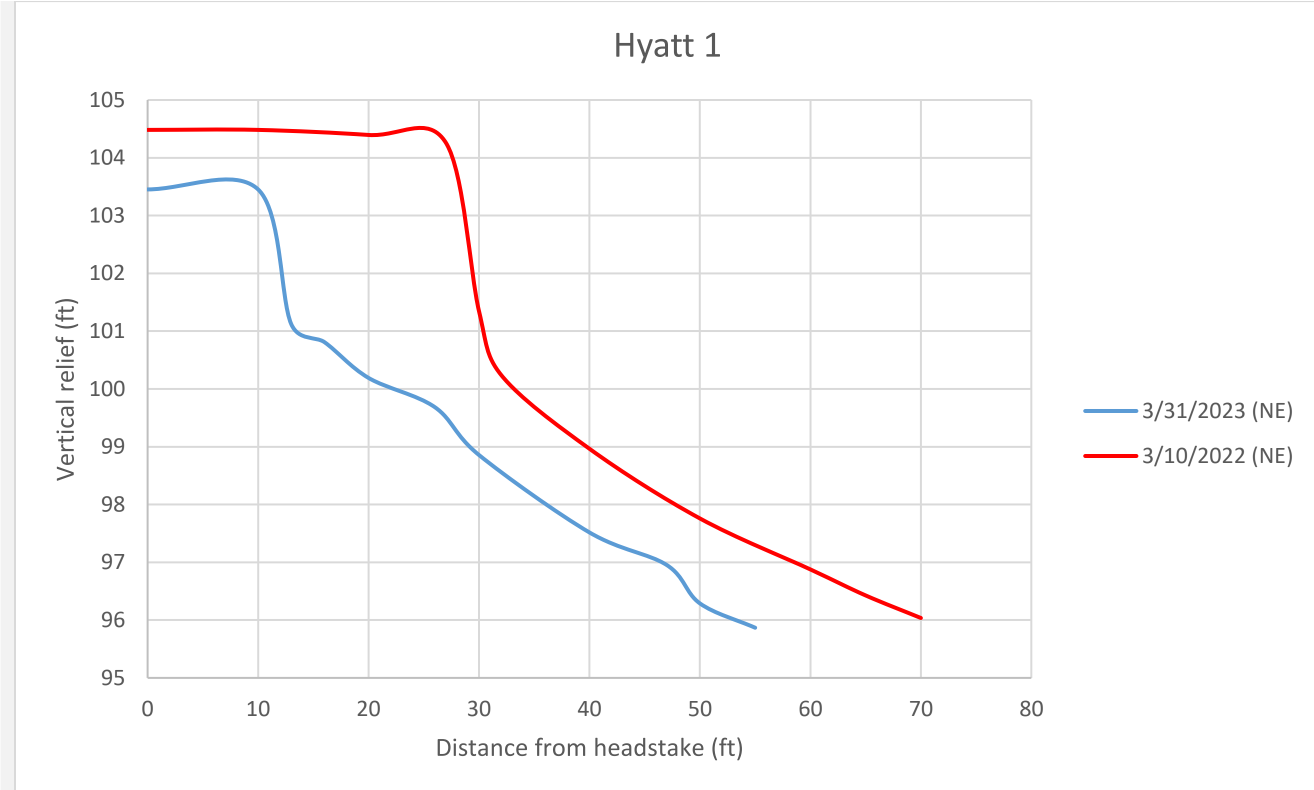
Hyatt Beach Profiles

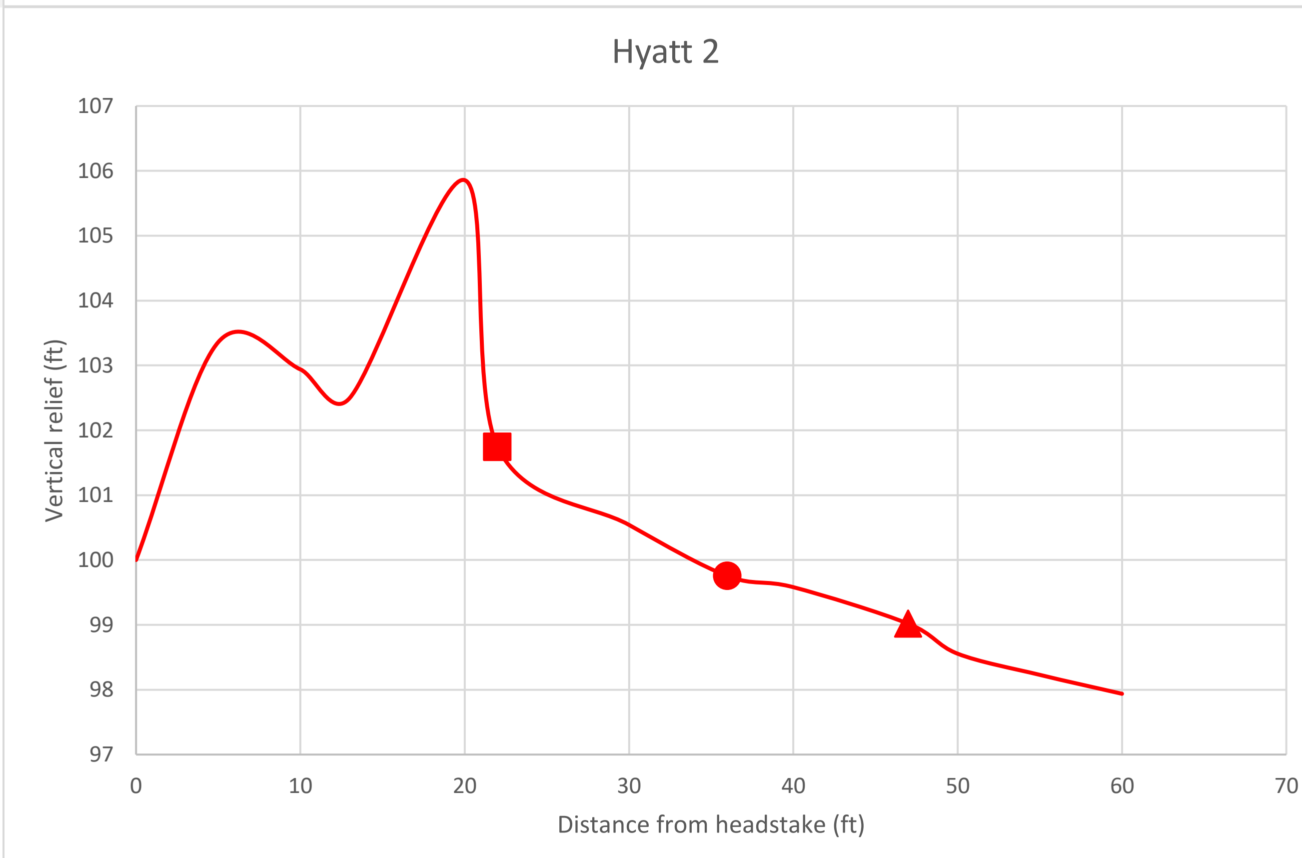


This beach profile illustrates the shoreline's 2D contour by plotting length and relative elevation of a headstake, or a routinely monitored starting point, to past the waterline. This is a data product from the Bureau of Environmental Coastal Quality - Division of Coastal Resources Management (BECQ-DCRM). Contact planning@dcrm.gov.mp for any clarifications or questions regarding this data. Award No.: NA22NOS4190158



Total Station





American Memorial Park

The AMP shoreline, short for American Memorial Park, experiences dynamic changes due to the complex hydrodynamics influenced by the Smiling Cove Marina infrastructure and the Main Channel interactions. Micro Beach is part of this area. Conducting smaller scale nearshore dynamic modeling specific to the site may help in better understanding long-shore processes. A noticeable pattern is the movement of sand from the south to the north, with some sand returning southward and the majority moving northward. The decrease in width of the southern transects might be due to ongoing accumulation north of Puntan Muchot. During southwest typhoon conditions, wave energies are higher as the flows enter through the main channel, while north-northwest conditions may cause the sediment to shift northward in this area.

American Memorial Park South 1 Highlights:

- ERODING
- New headstake is now at the post of the *palapala* in Micro Beach side
- LOSS of shoreline by 35~ ft since 2020
- Elevation difference is 5 ft
- **History:** The previous headstake suggests that the area is eroding on the long term but is highly dynamic. Sediment transport may contribute to the variation of shoreline position throughout time but the encroaching waterline and wave energy during high tide/storm events suggest this shoreline is eroding. The sand is pulled into the water during high wave energy conditions and pushed into the shore during lower wave energy conditions.

American Memorial Park South 2 Highlights:

- ERODING
- Wrackline that ranges 37 – 70 ft with an elevation difference of more than 3 ft
- This shoreline has shown great accretion and erosion events throughout the years. There would be months in between when it is stable.
- Based on the Shoreline linear regression analysis, the shoreline has a rate of -4.97 ft from 2017-2023.

American Memorial Park Point 1 Highlights:

- UNDETERMINED, accreted after storm
- Elevation difference of less than 5 ft
- GAINED 60 ft of shoreline after 2022

American Memorial Park Point 2 Highlights:

- UNDETERMINED, accreted after storm
- Wrackline that ranges 30– 140 ft and an elevation difference of 5 - 6 ft
- Based on the Shoreline linear regression analysis, the shoreline has a rate of -10.8 ft from 2017-2023.

- This shoreline has shown great accretion and erosion events throughout the years. There would be months in between when it is stable.
- **History:** This profile is subjected to damage by storms. It has accreted on Jan 2017 – July 2018. After Super Typhoon Yutu, the shoreline noticeably abraded. However, the September 2021 storm has eroded the shoreline by more than 50 feet. The sand in this area migrated to the northern transects. The beach is rebuilding itself.

American Memorial Park North 1 Highlights:

- ACCRETING in the short-term with an elevation difference of 7 ft
- GAIN of shoreline by more than 70 ft since 2018
- Sand from southern shorelines (South 1 through Point 2) may be migrating up northern as suggested by the width tripling in the last two years.
- Based on the Shoreline linear regression analysis, the shoreline has a rate of +6.13 ft from 2017-2023.

American Memorial Park North 2 Highlights:

- ACCRETING in the long-term with an elevation difference of more than 6 ft since 2017
- GAIN of shoreline by more than 120 ft since 2017
- Sand from southern shorelines (South 1 through Point 2) may be migrating up northern as suggested by the width tripling in the last two years.
- Based on the Shoreline linear regression analysis, the shoreline has a rate of +8.3 ft from 2017-2023.

American Memorial Park North 3 Highlights:

- ACCRETING in the long-term with an elevation difference of more than 6 ft since 2017
- GAIN of shoreline by 70 ft since 2019
- Sand from southern shorelines (South 1 through Point 2) may be migrating up northern as suggested by the width tripling in the last two years.
- Based on the Shoreline linear regression analysis, the shoreline has been at a rate of +7.25 ft from 2017-2023.

Figure 31- Hydrodynamic map of the stretch of Hyatt and AMP sites with the ocean wave energies buffered by the reef, openings enable higher wave energies to enter into the reef. The arrows show the intensity of waves generated from the south west.

[No photo is available for 2023. Conditions had naturally replenished sand.]

American Memorial Park Point 2

American Memorial Park North 1

American Memorial Park North 2

American Memorial Park North 3

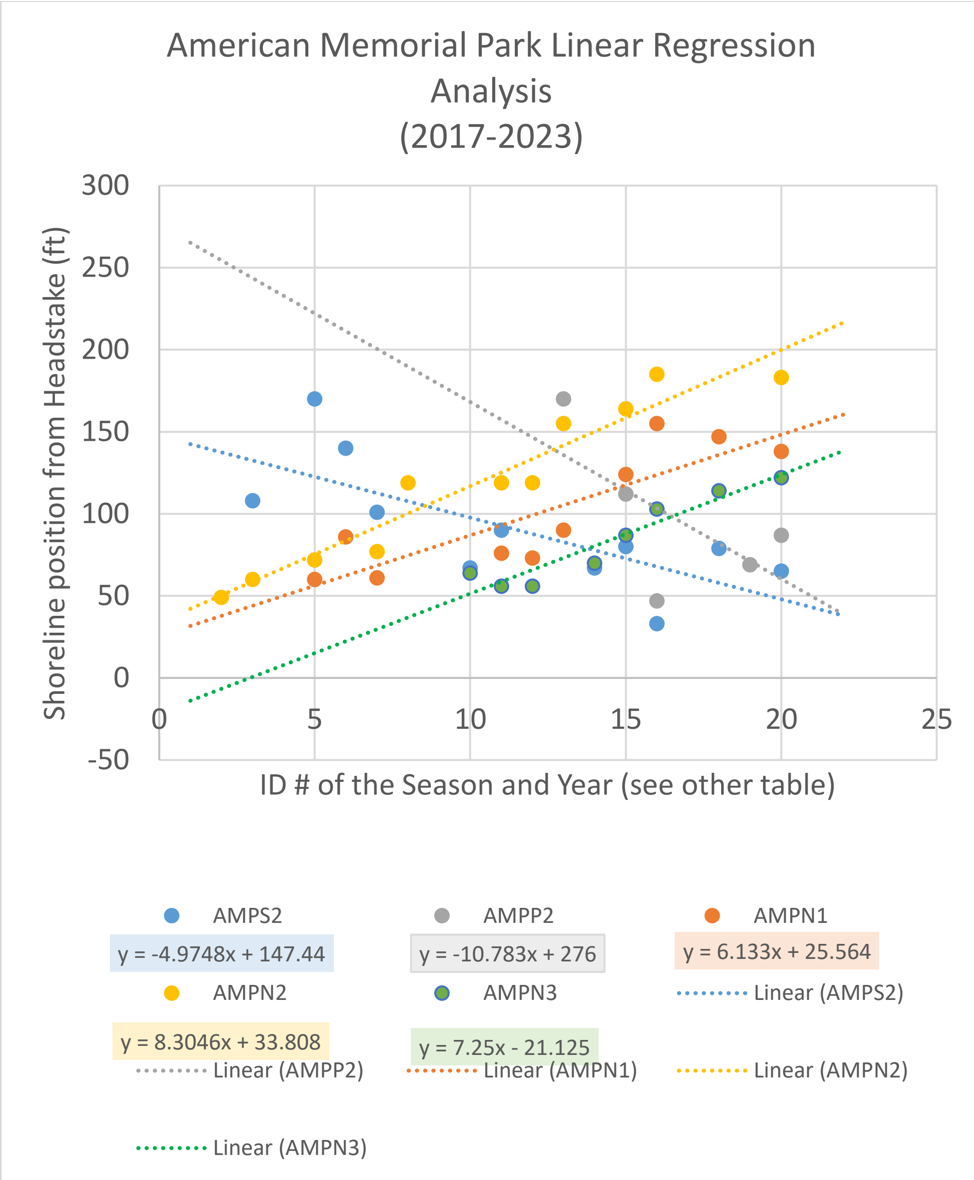
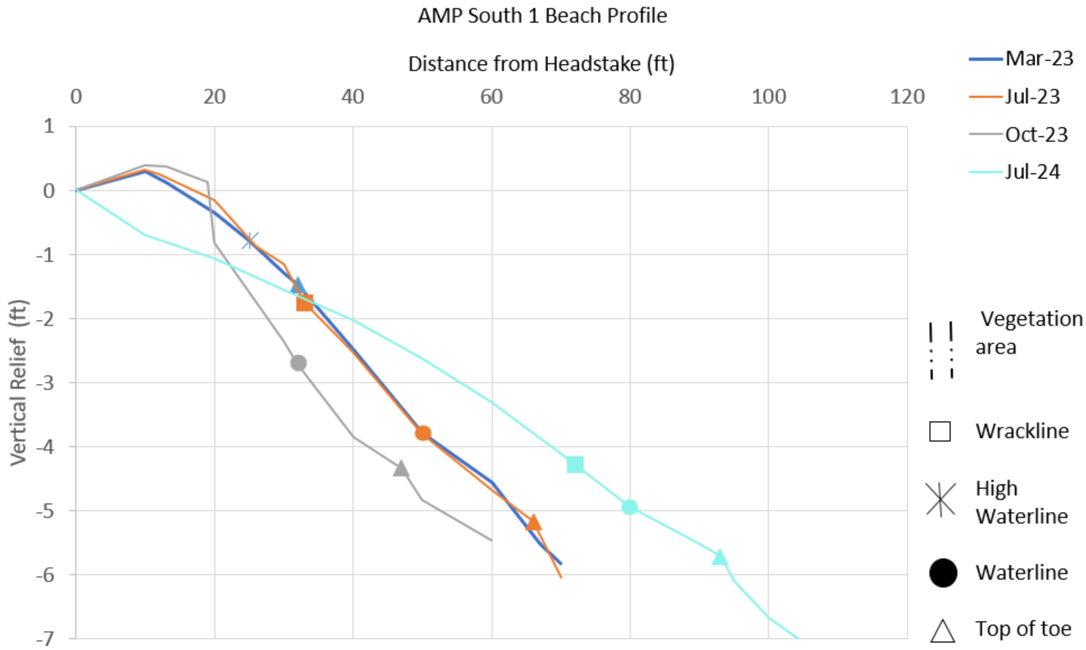
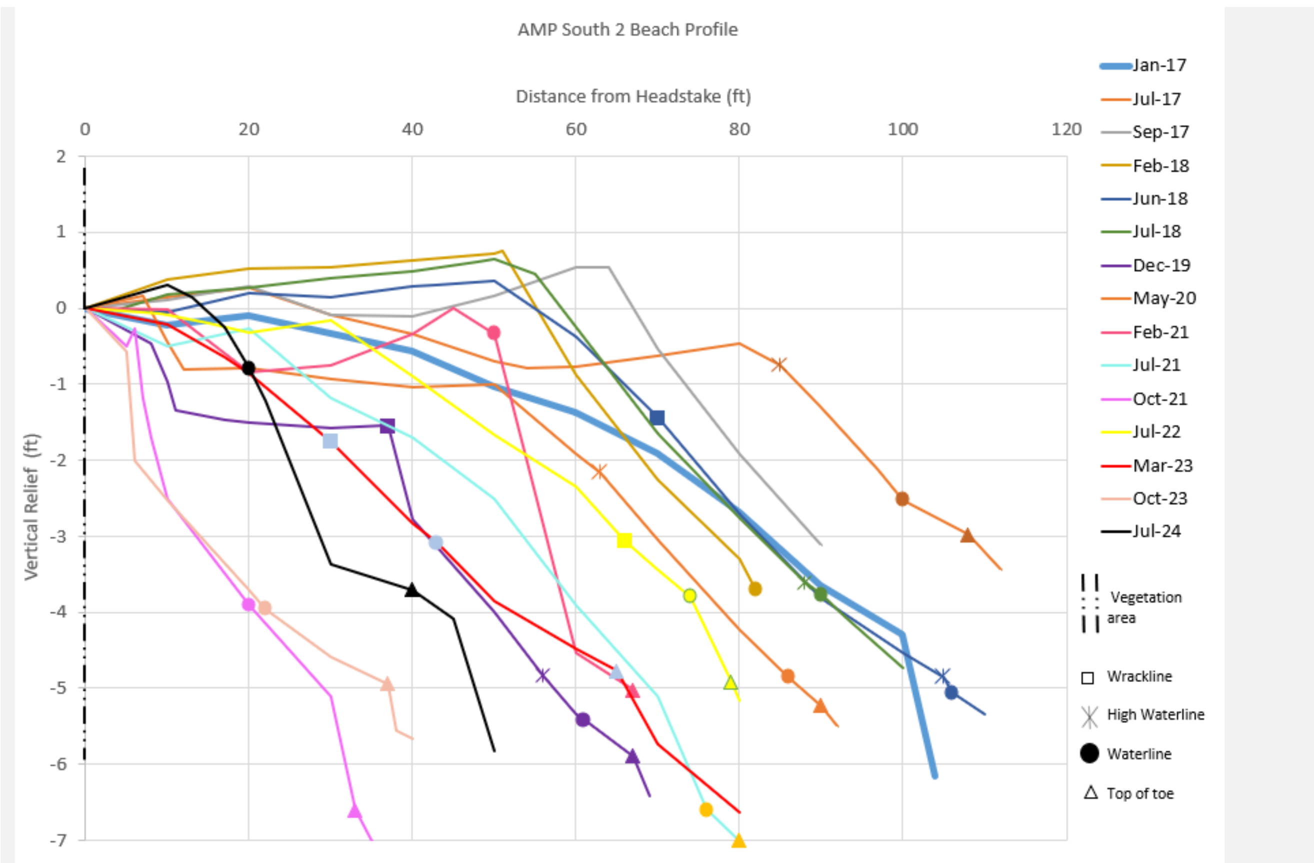
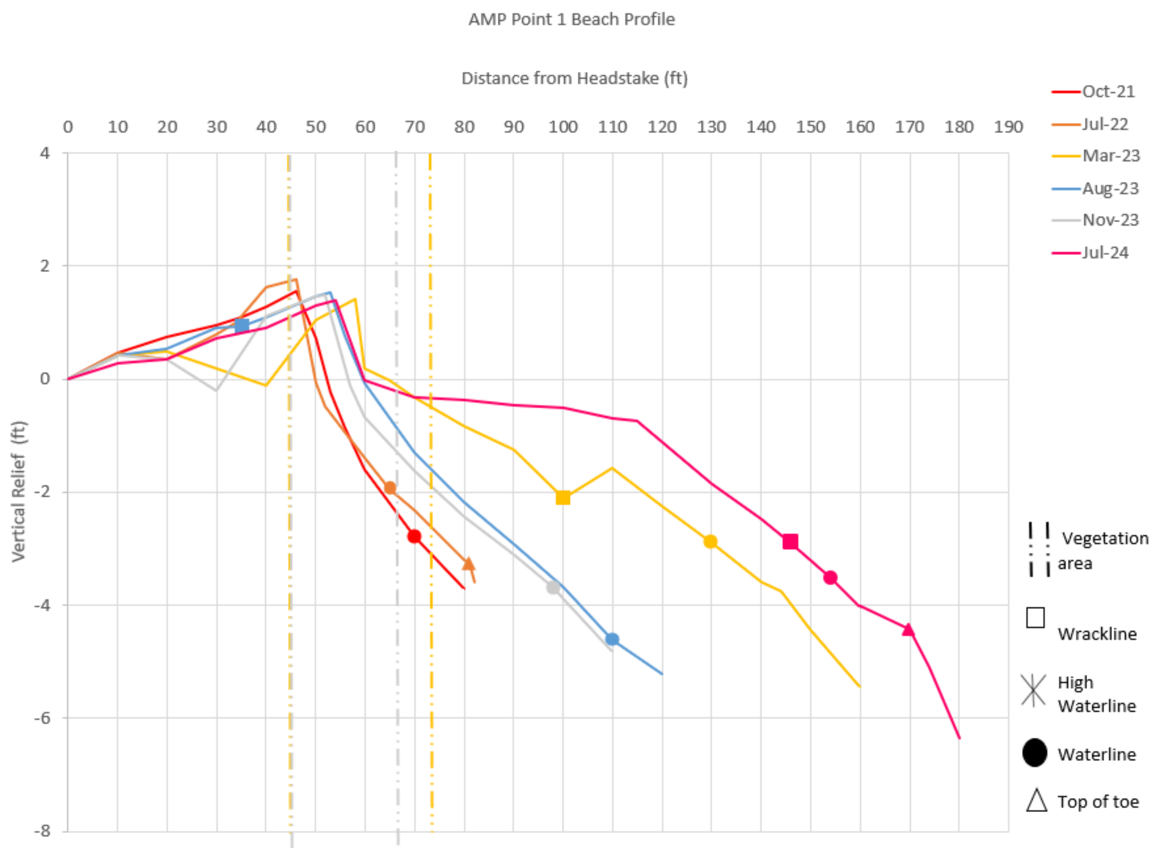


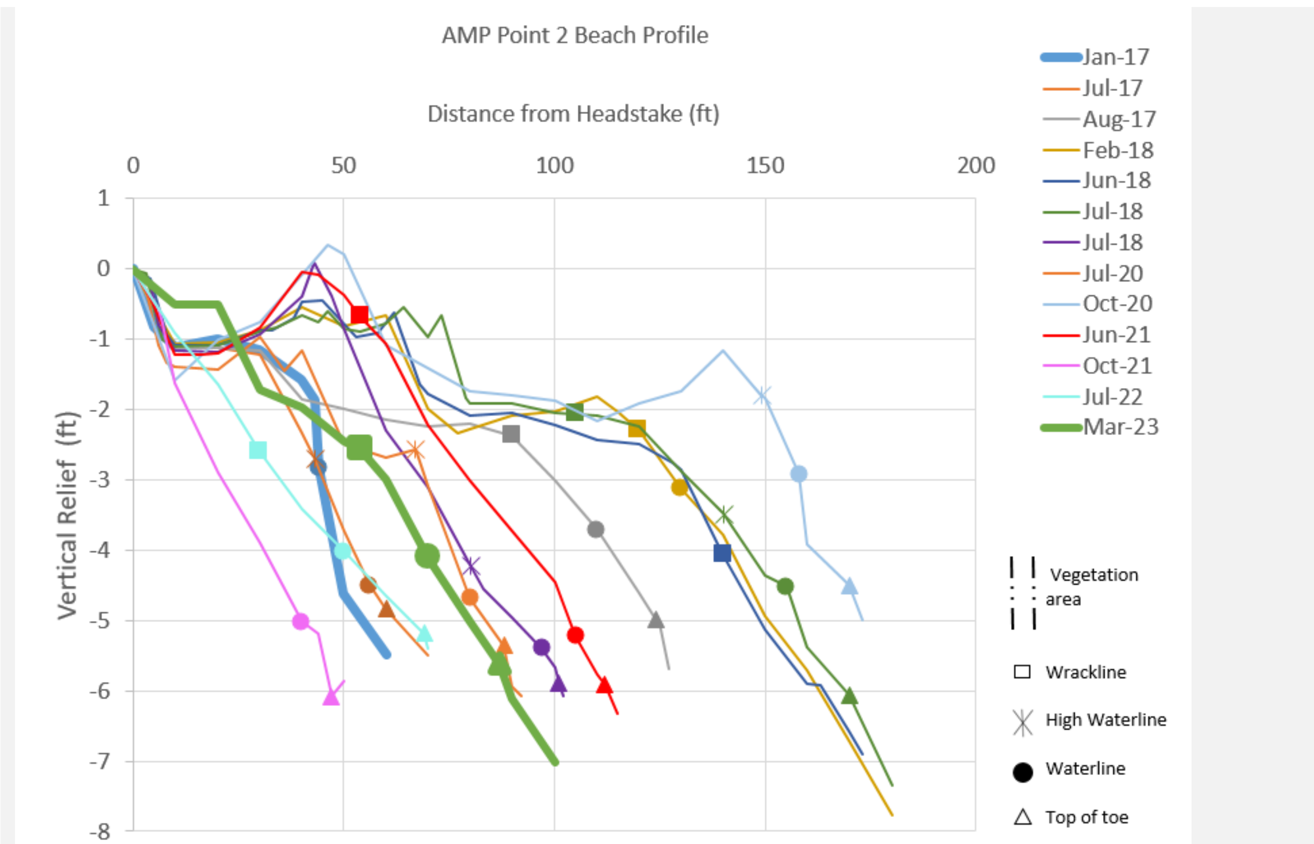
Figure 32 - American Memorial Park Beach Linear Regression Analysis table shows time in seasons over shoreline position (top of toe) from the headstake.

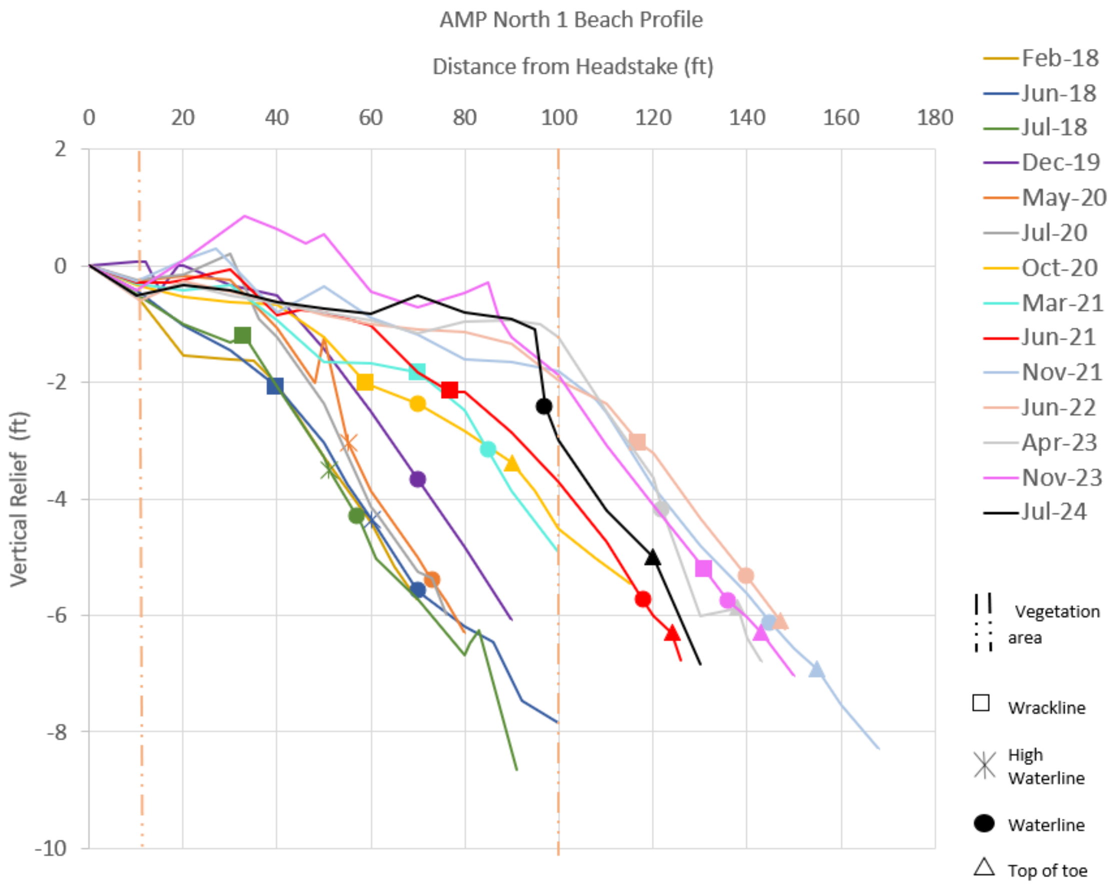
American Memorial Park Beach Profiles

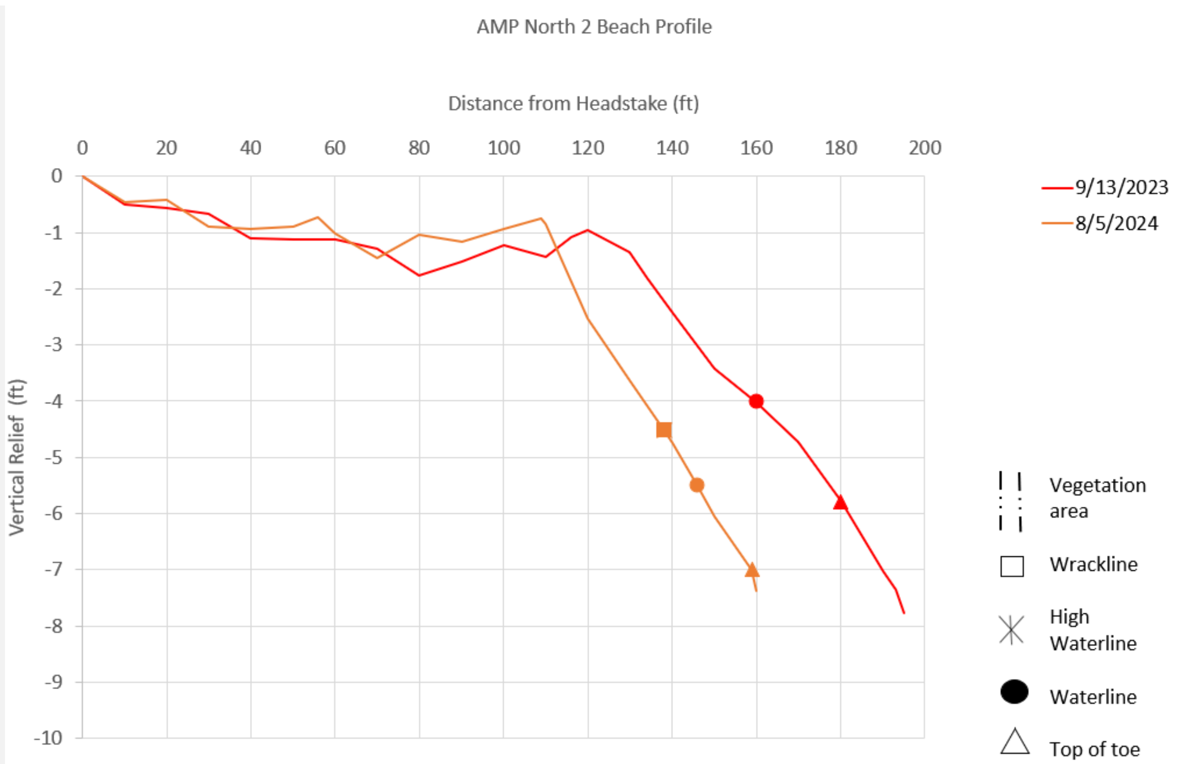


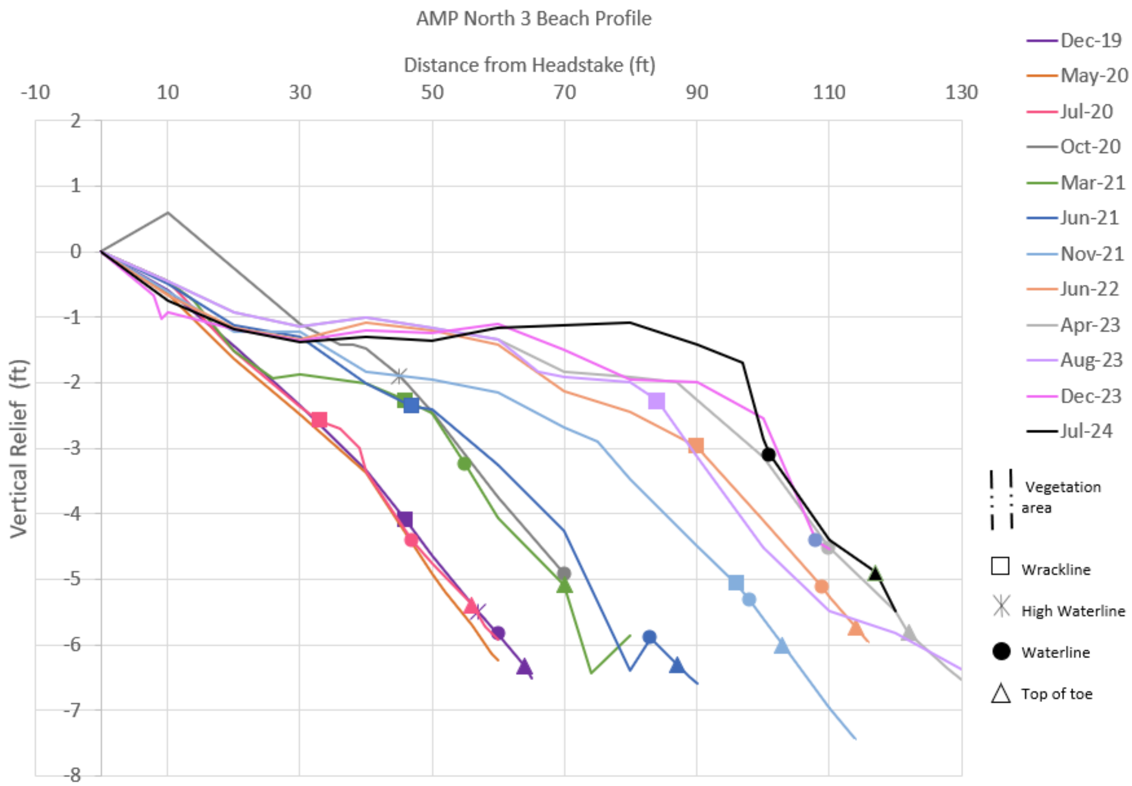



AMP Point 1 Beach Profile
Distance from Headstake (ft)
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190
4 2 0 -2 -4 -6 -8
Vertical Relief (ft)
Oct-21
Jul-22
Mar-23
Aug-23
Nov-23
Jul-24
Vegetation area
Wrackline
High Waterline
Waterline
Top of toe

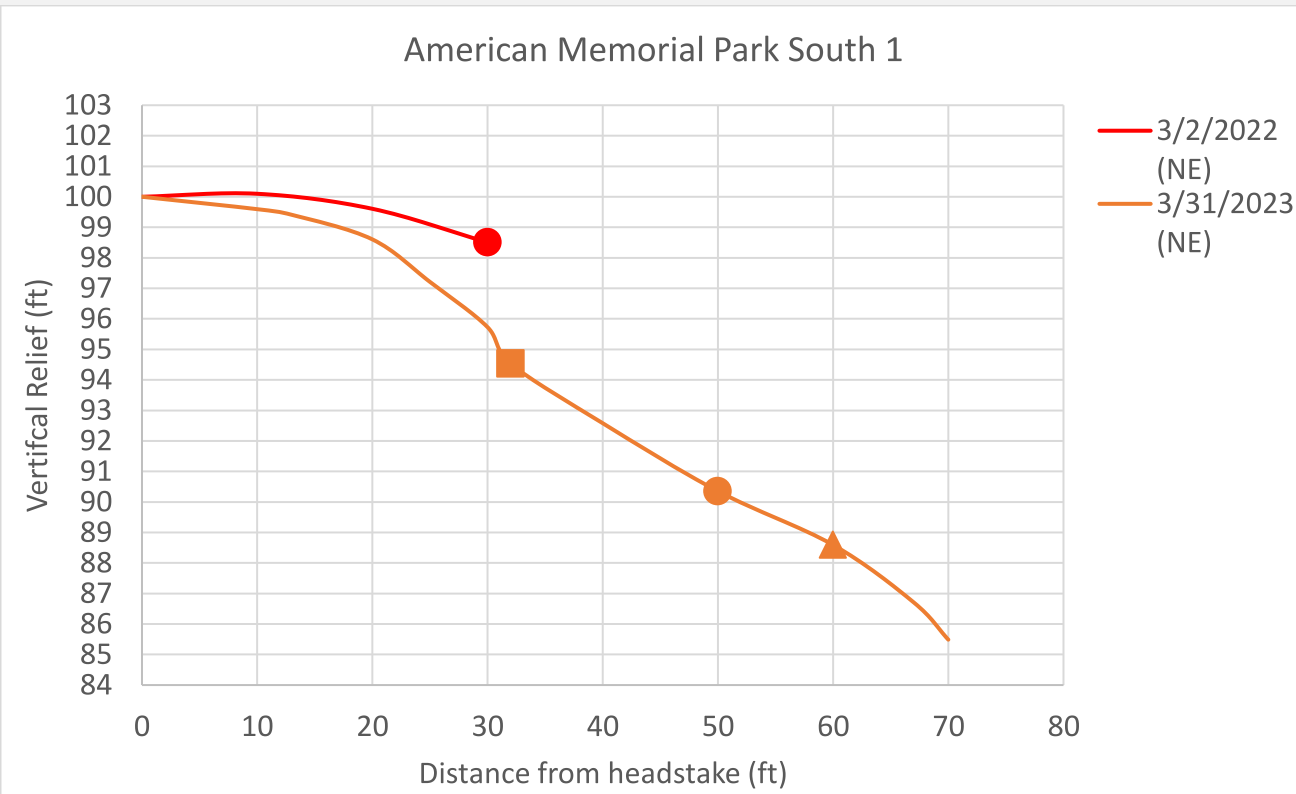

AMP Point 2 Beach Profile
Distance from Headstake (ft)
0 50 100 150 200
1 0 -1 -2 -3 -4 -5 -6 -7 -8
Vertical Relief (ft)
Jan-17
Jul-17
Aug-17
Feb-18
Jun-18
Jul-18
Jul-18
Jul-20
Oct-20
Jun-21
Oct-21
Jul-22
Mar-23
Vegetation area
Wrackline
High Waterline
Waterline
Top of toe

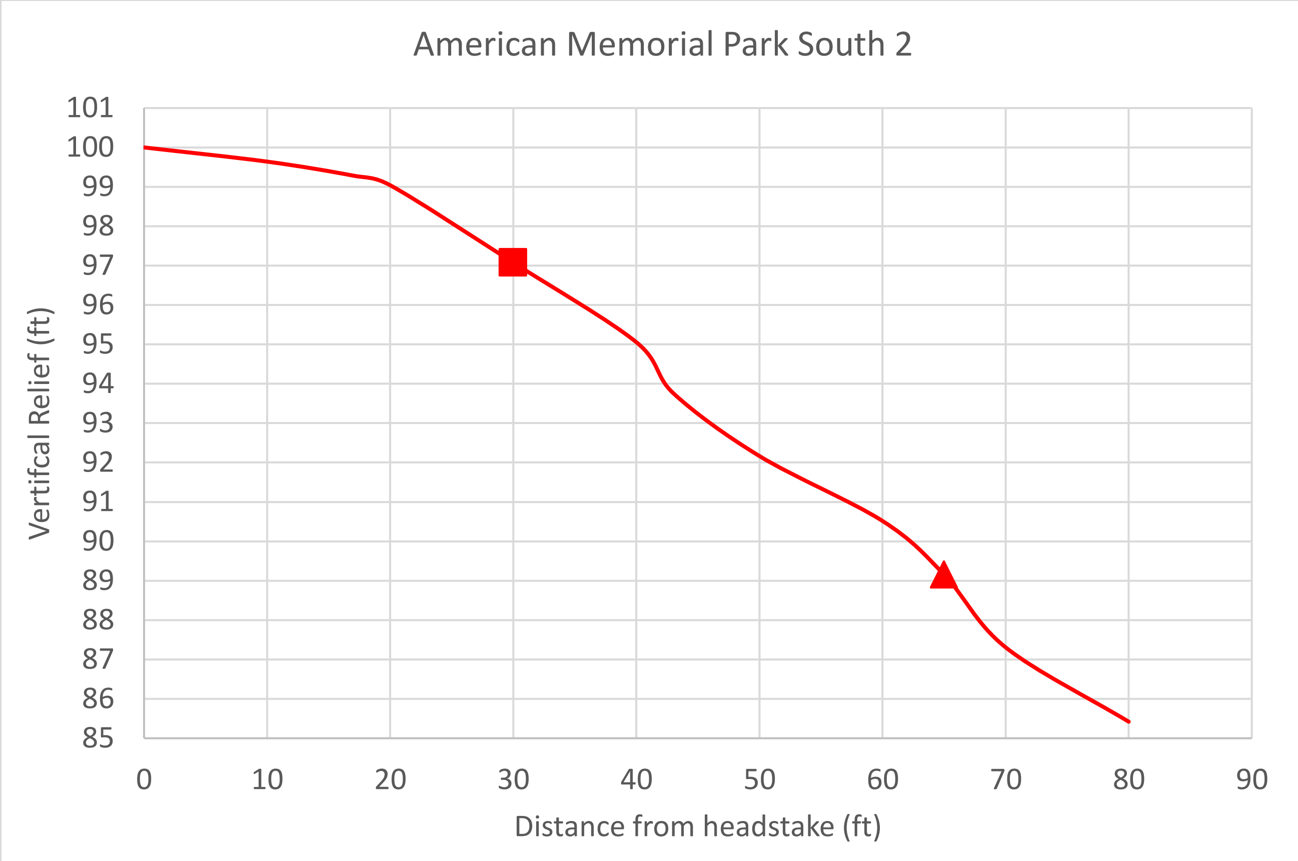

AMP North 1 Beach Profile
Distance from Headstake (ft)
0
20
40
60
80
100
120
140
160
180
2
0
-2
-4
-6
-8
-10
Vertical Relief (ft)
Feb-18
Jun-18
Jul-18
Dec-19
May-20
Jul-20
Oct-20
Mar-21
Jun-21
Nov-21
Jun-22
Apr-23
Nov-23
Jul-24
Vegetation area
Wrackline
High Waterline
Waterline
Top of toe

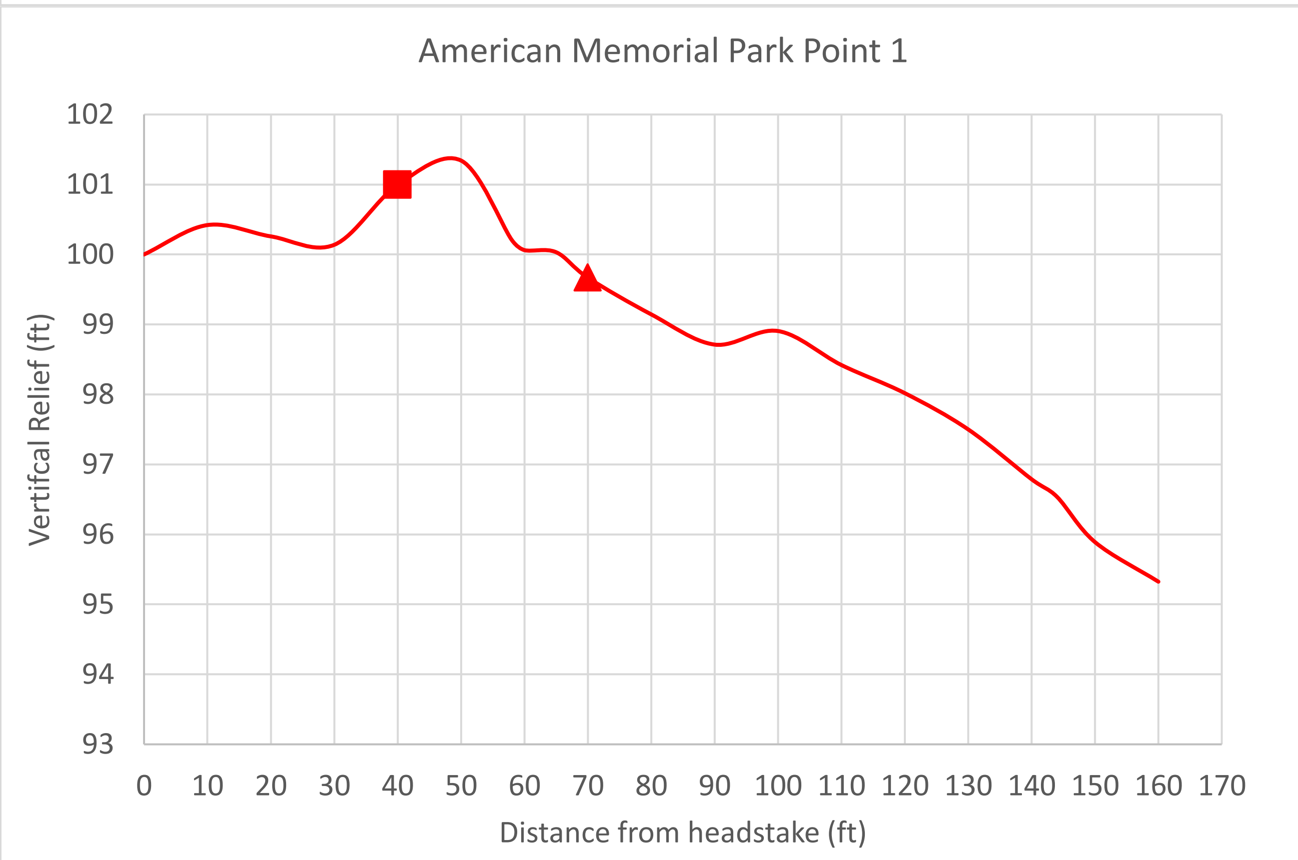

AMP North 2 Beach Profile
Distance from Headstake (ft)
0
20
40
60
80
100
120
140
160
180
200
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
-10
Vertical Relief (ft)
9/13/2023
8/5/2024
Vegetation area
Wrackline
High Waterline
Waterline
Top of toe

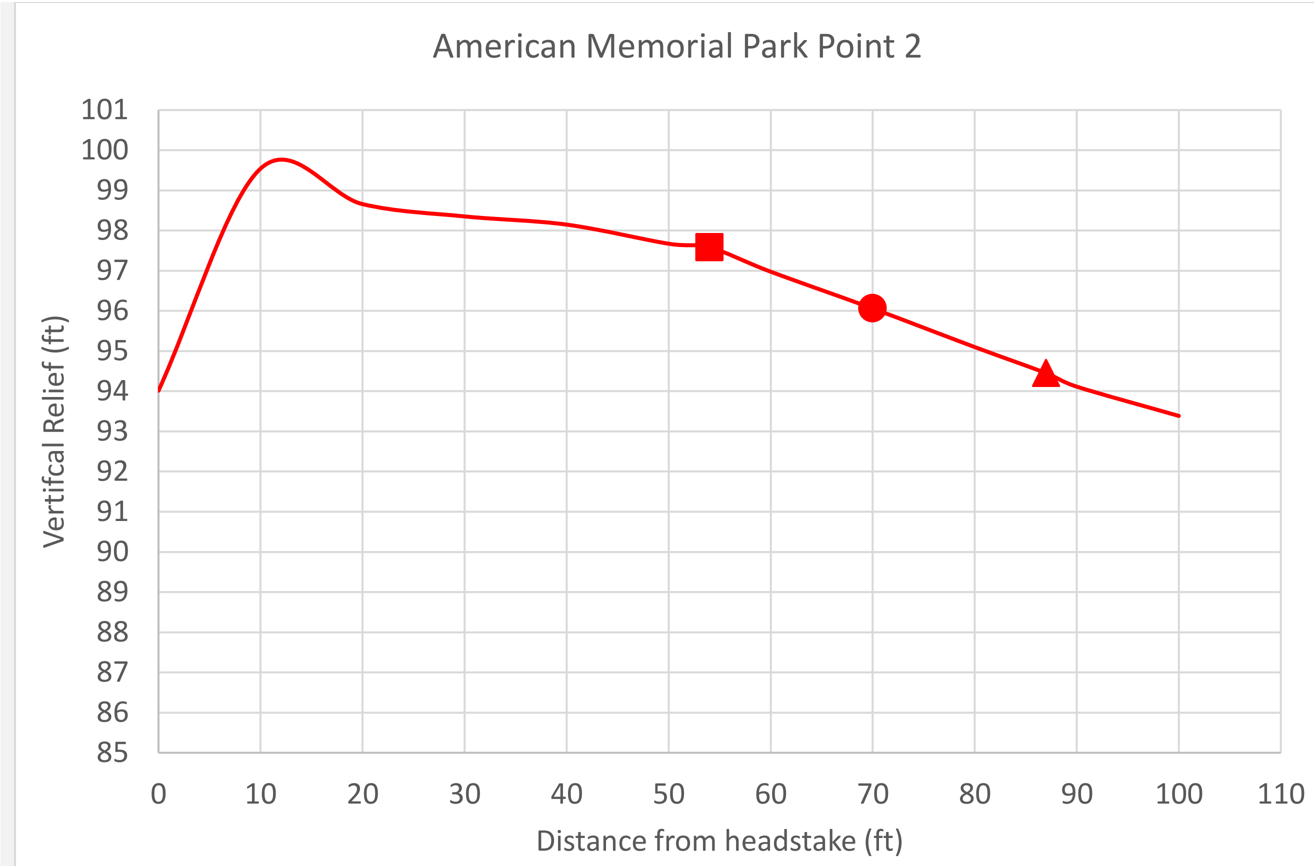


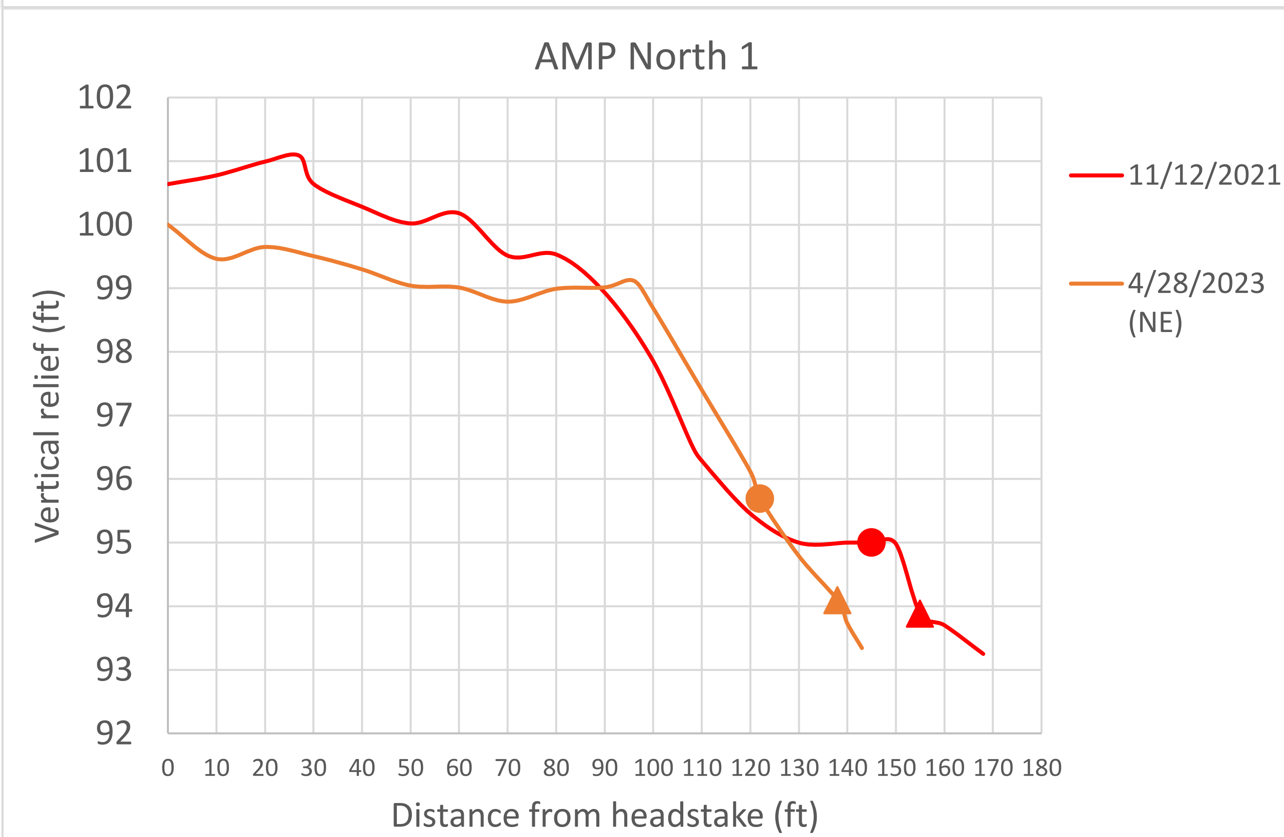
Total Station

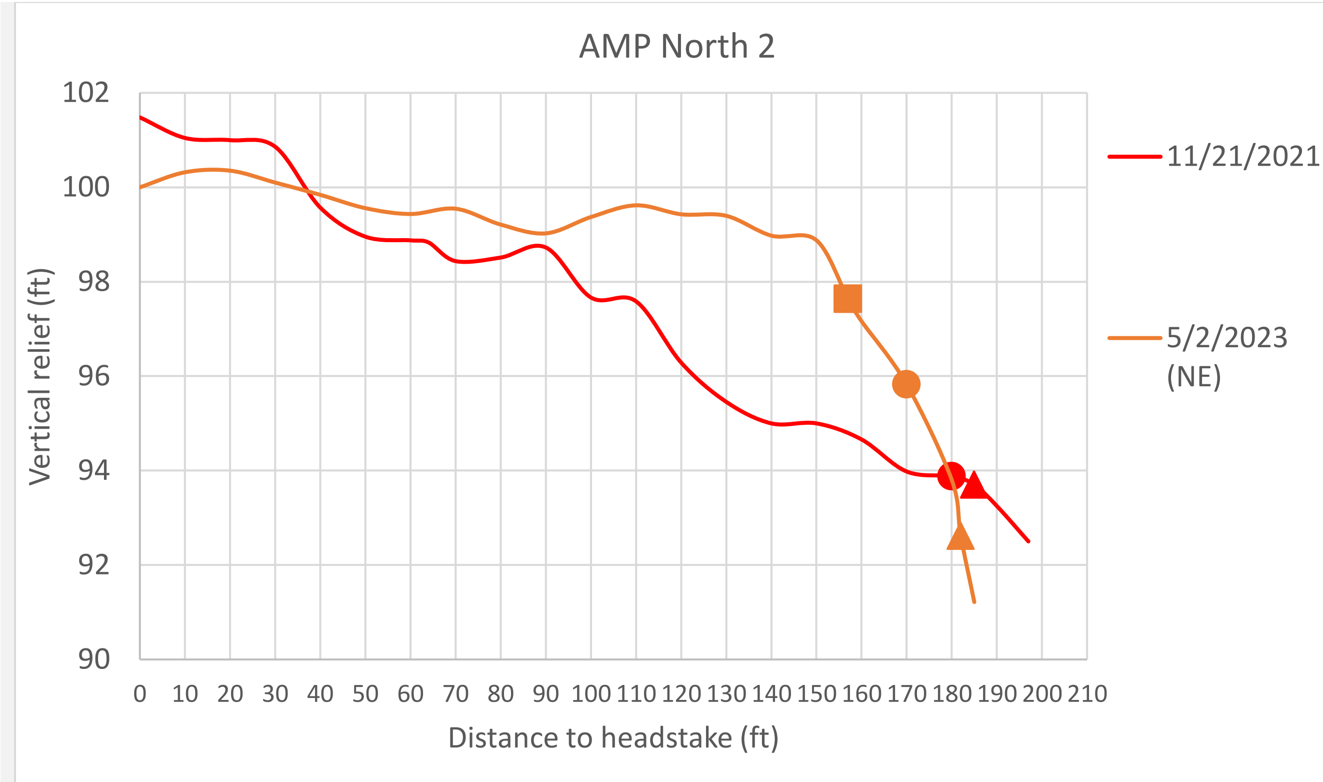


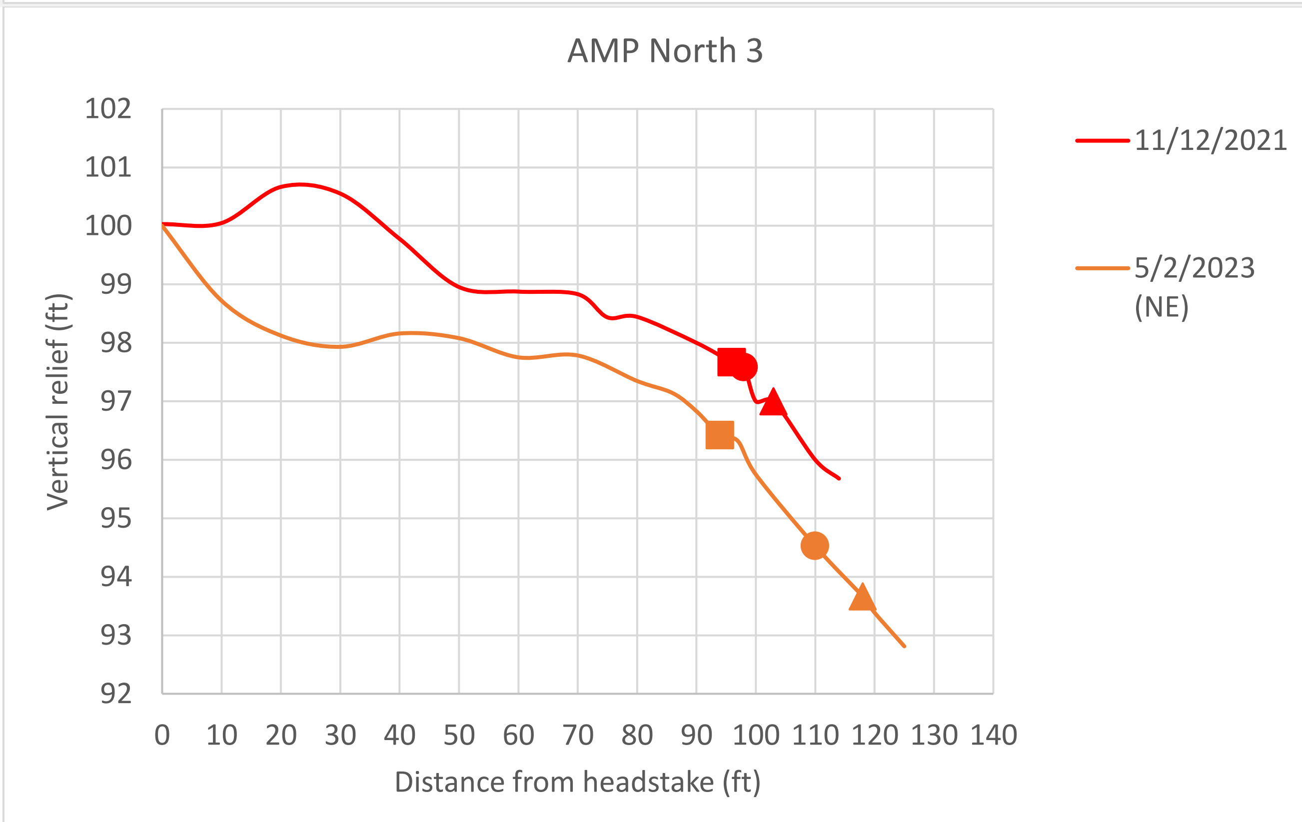

American Memorial Park South 2
101
100
99
98
97
96
95
94
93
92
91
90
89
88
87
86
85
Vertifcal Relief (ft)
0
10
20
30
40
50
60
70
80
90
Distance from headstake (ft)


American Memorial Park Point 1
102
101
100
99
98
97
96
95
94
93
Vertifcal Relief (ft)
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
Distance from headstake (ft)


American Memorial Park Point 2
Vertifcal Relief (ft)
101
100
99
98
97
96
95
94
93
92
91
90
89
88
87
86
85
0
10
20
30
40
50
60
70
80
90
100
110
Distance from headstake (ft)


AMP North 1
Vertical relief (ft)
102
101
100
99
98
97
96
95
94
93
92
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180
Distance from headstake (ft)
11/12/2021
4/28/2023 (NE)


AMP North 2
Vertical relief (ft)
102
100
98
96
94
92
90
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210
Distance to headstake (ft)
11/21/2021
5/2/2023 (NE)


AMP North 3
Vertical relief (ft)
102
101
100
99
98
97
96
95
94
93
92
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140
Distance from headstake (ft)
11/12/2021
5/2/2023 (NE)

Pau Pau

The shoreline of Pau Pau is generally stable, with its length decreasing from the south to the north. The nearby reef helps reduce wave energy, but wave overtopping could lead to short-term erosion. The beach gets replenished with sediment from the reef and other sources. The length of the shoreline may be influenced by tides. During typhoon wave conditions, this area experiences high wave energy. In north-northwest typhoon conditions, the potential significant wave height can reach up to 3 meters.

Pau Pau 1 Highlights:

- STABLE
- REPLACED with a headstake that is further inland and adjacent to the previous headstake
- **History:** This beach profile seems to vary from time to time, dependent on deposits from the nearby reef. The headstake is at a distance in the backshore, closer to the parking lot.
- Based on the Shoreline linear regression analysis (see pg 100), the shoreline has a rate of +0.09 ft from 2017-2023.

Pau Pau 2 Highlights:

- STABLE
- Wrackline that ranges 40 – 60 ft with an elevation difference of 8 ft
- This beach profile has shifted in January 2017. The shoreline appears to have experienced some abrasion in Feb 2018 but then has generally stabilized over time.
- Based on the Shoreline linear regression analysis (see pg 100), the shoreline has a rate of +0.005 ft from 2017-2023.

Pau Pau 3 Highlights:

- STABLE
- Wrackline that that ranges 26 – 50 ft and an elevation difference of 9.5 ft
- This beach profile is variable compared to the other two transects in the site.
- Based on the Shoreline linear regression analysis (see pg 100), the shoreline has a rate of +0.34 ft from 2017-2023.

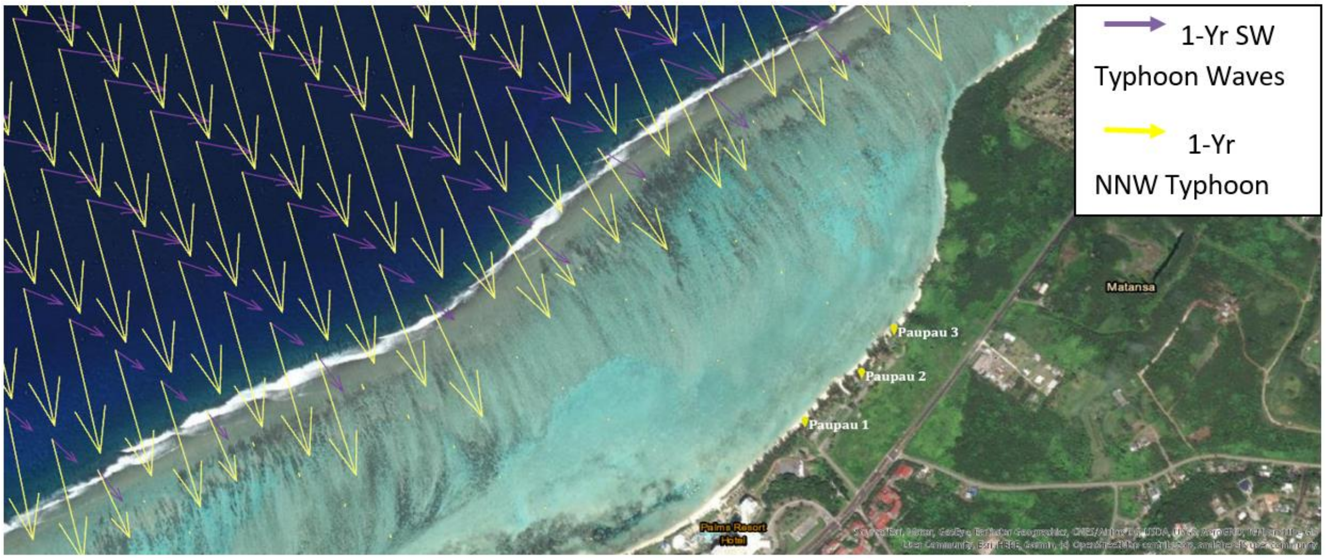
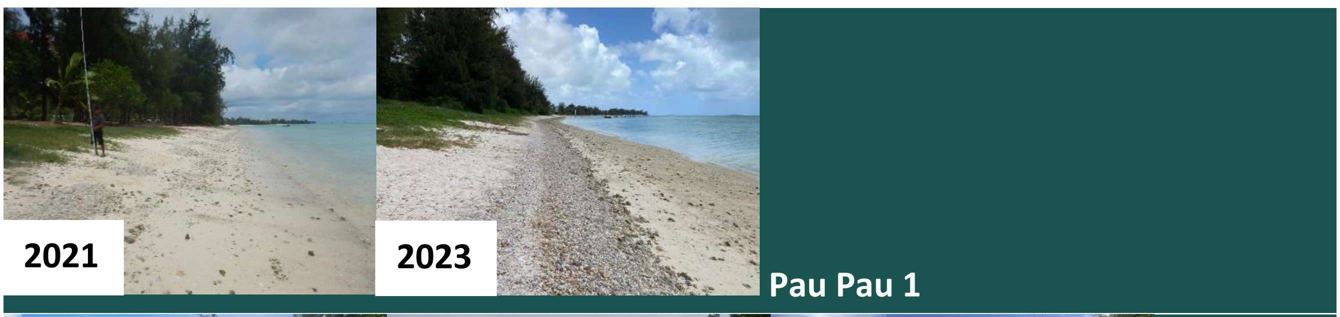


Figure 33 - Hydrodynamic map of the stretch of Pau Pau sites with the ocean wave energies buffered by the reef. The arrows show the intensity of waves generated from the south west.



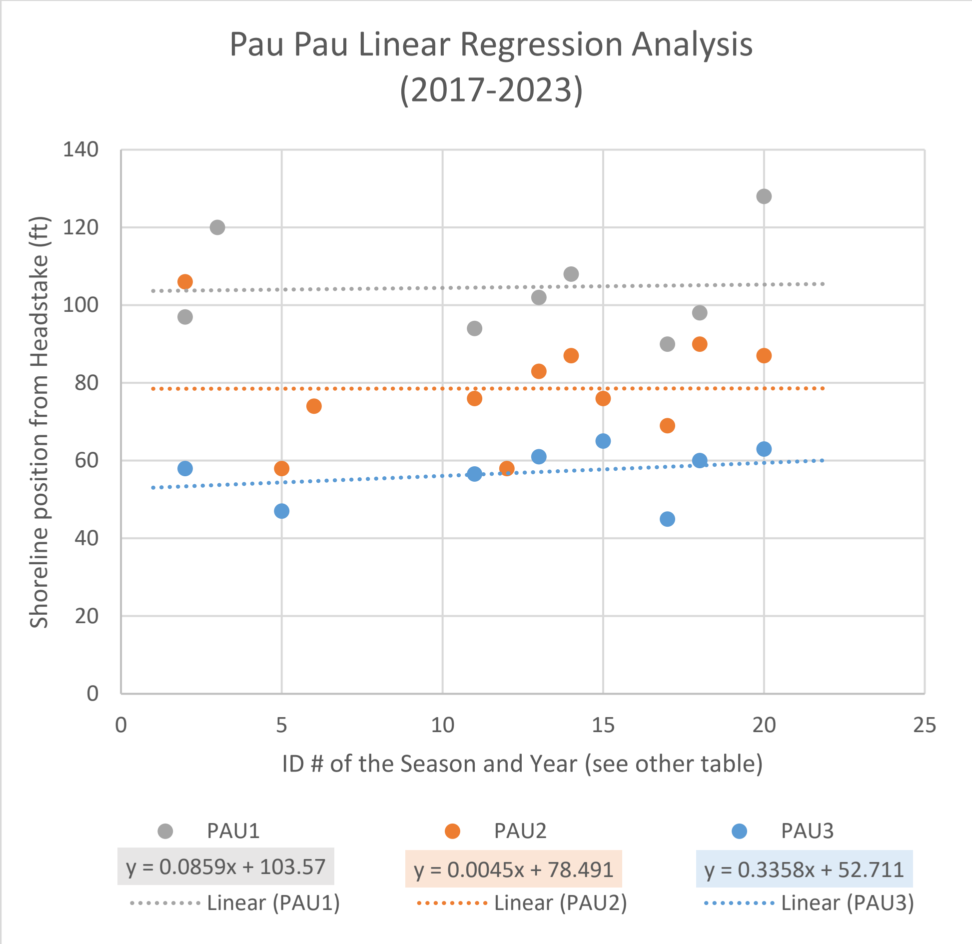
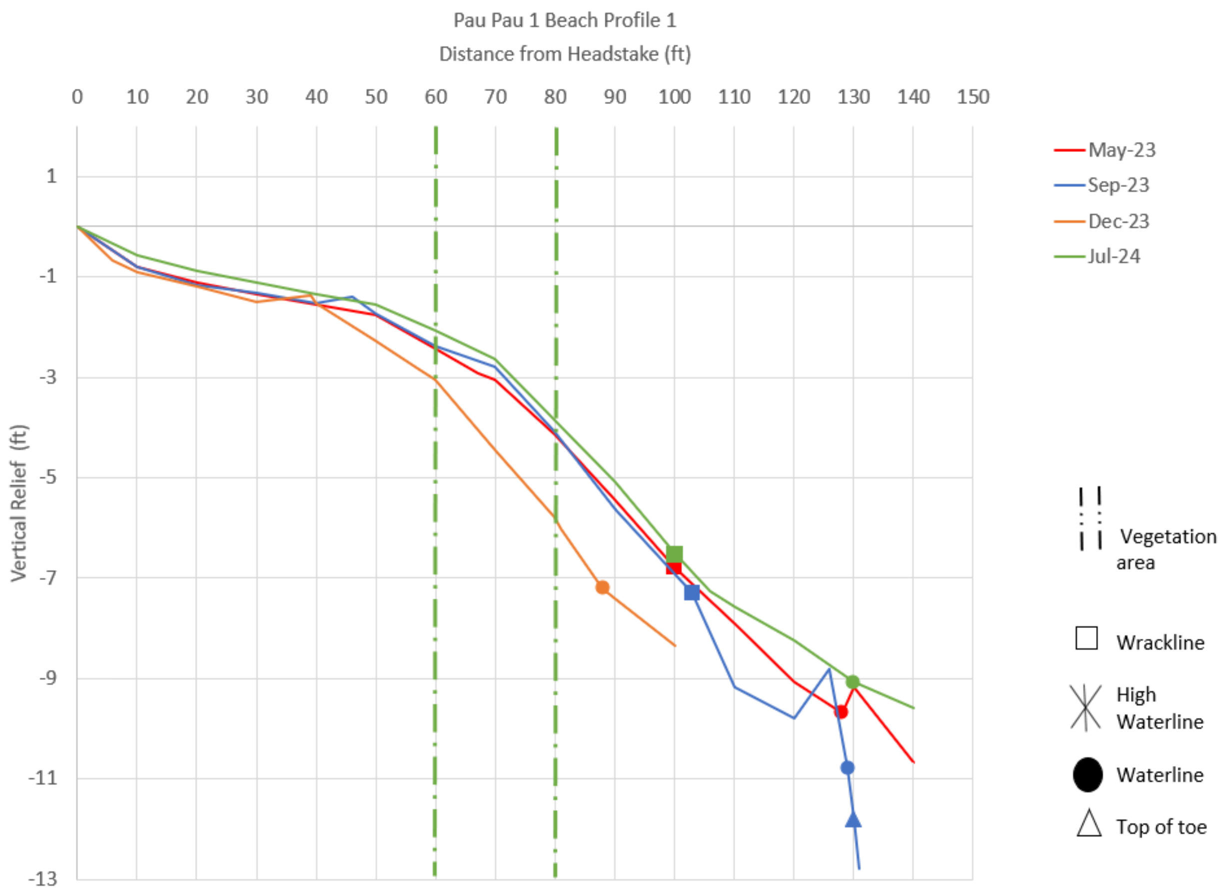
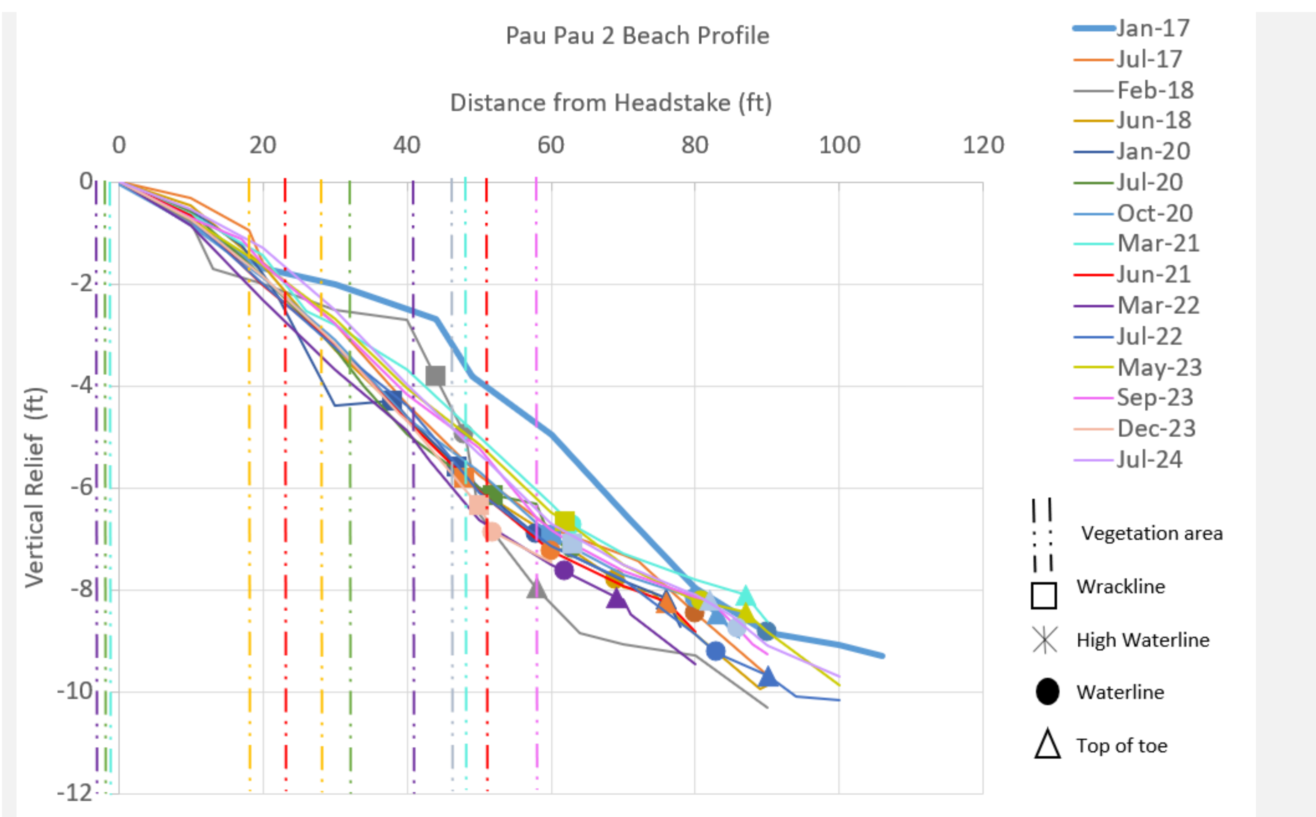
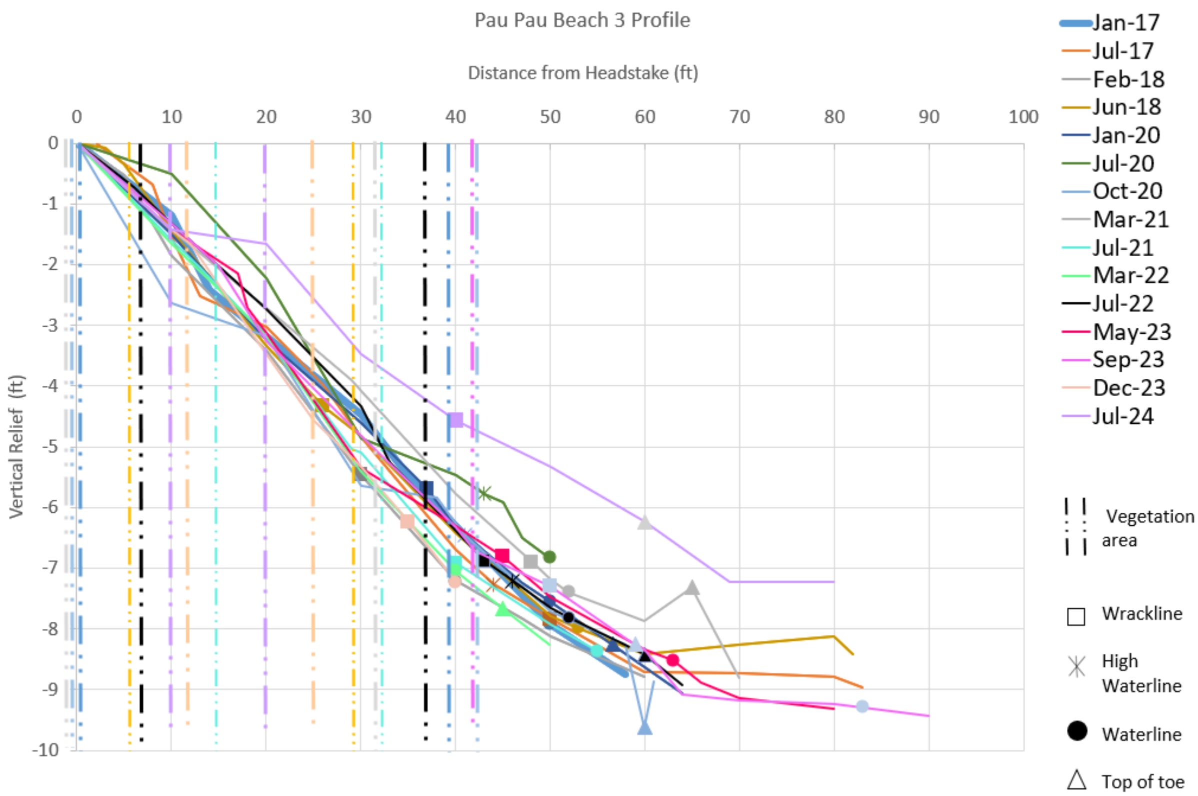


Figure 34 – Pau Pau Beach Linear Regression Analysis table shows time in seasons over shoreline position (top of toe) from the headstake.

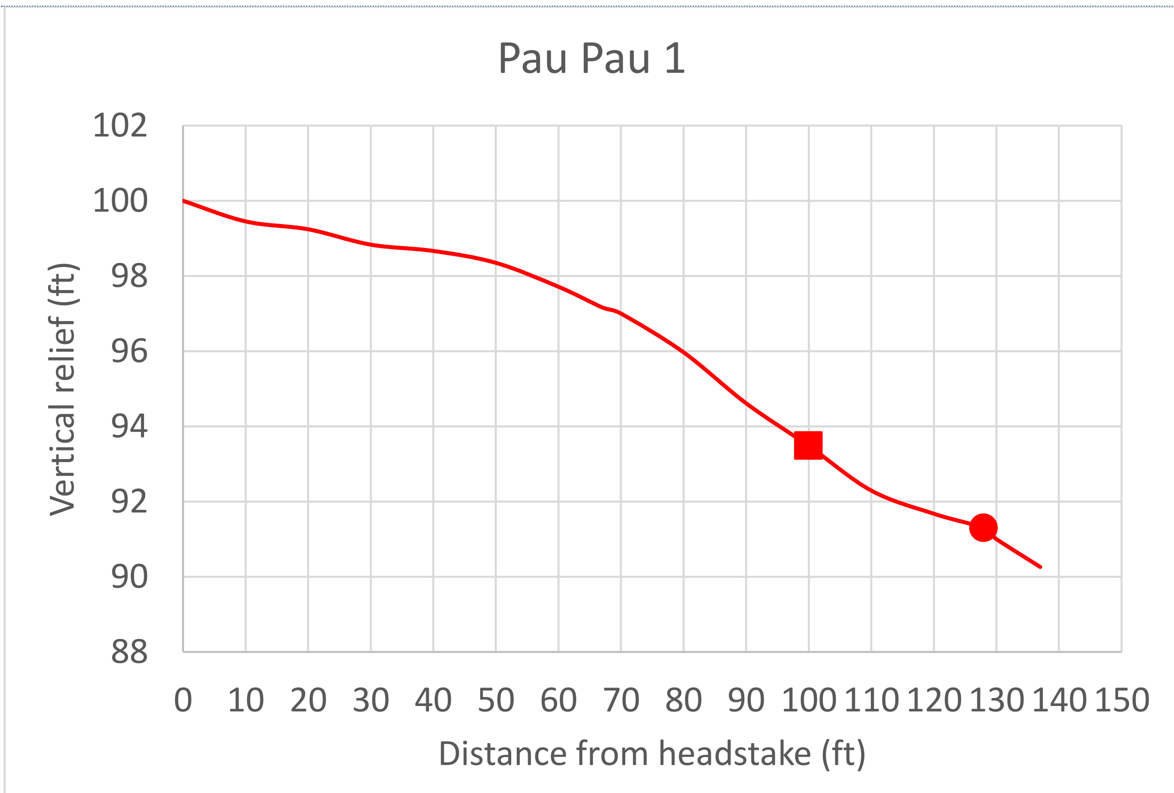
Pau Pau Beach Profiles

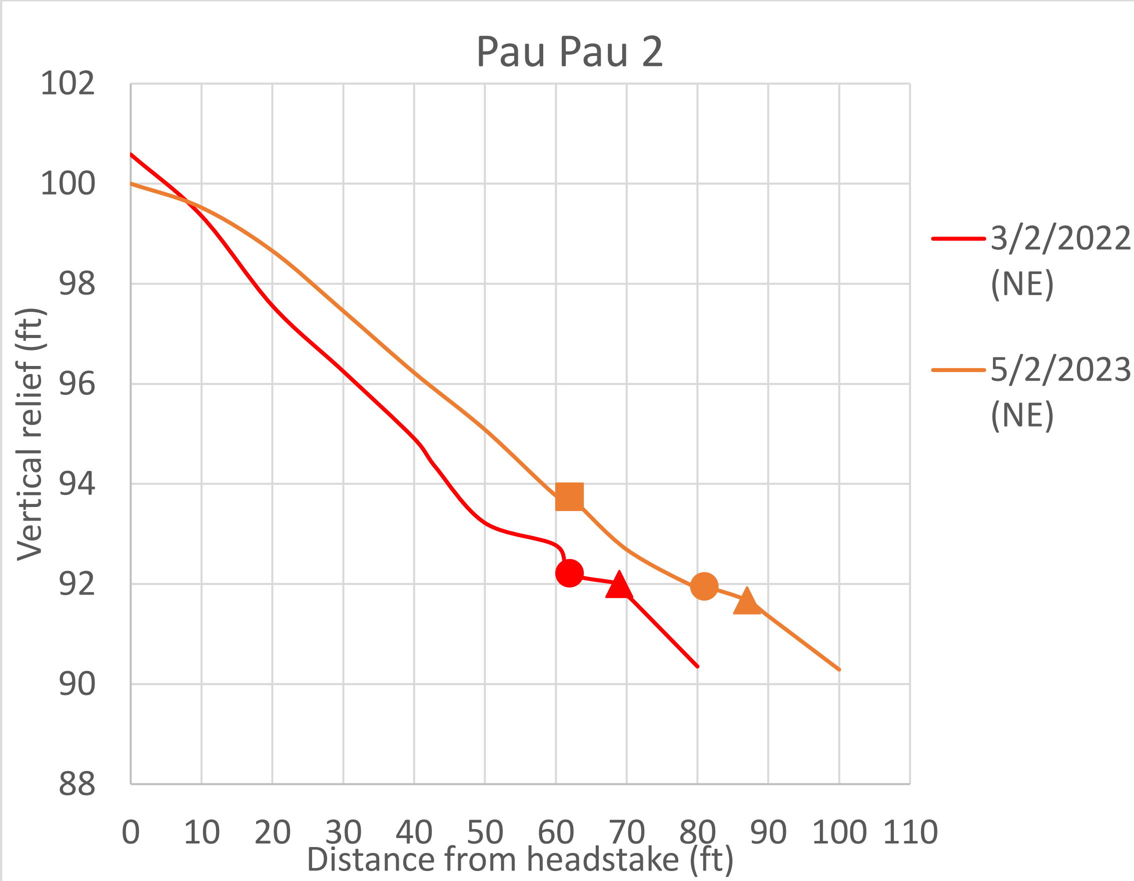




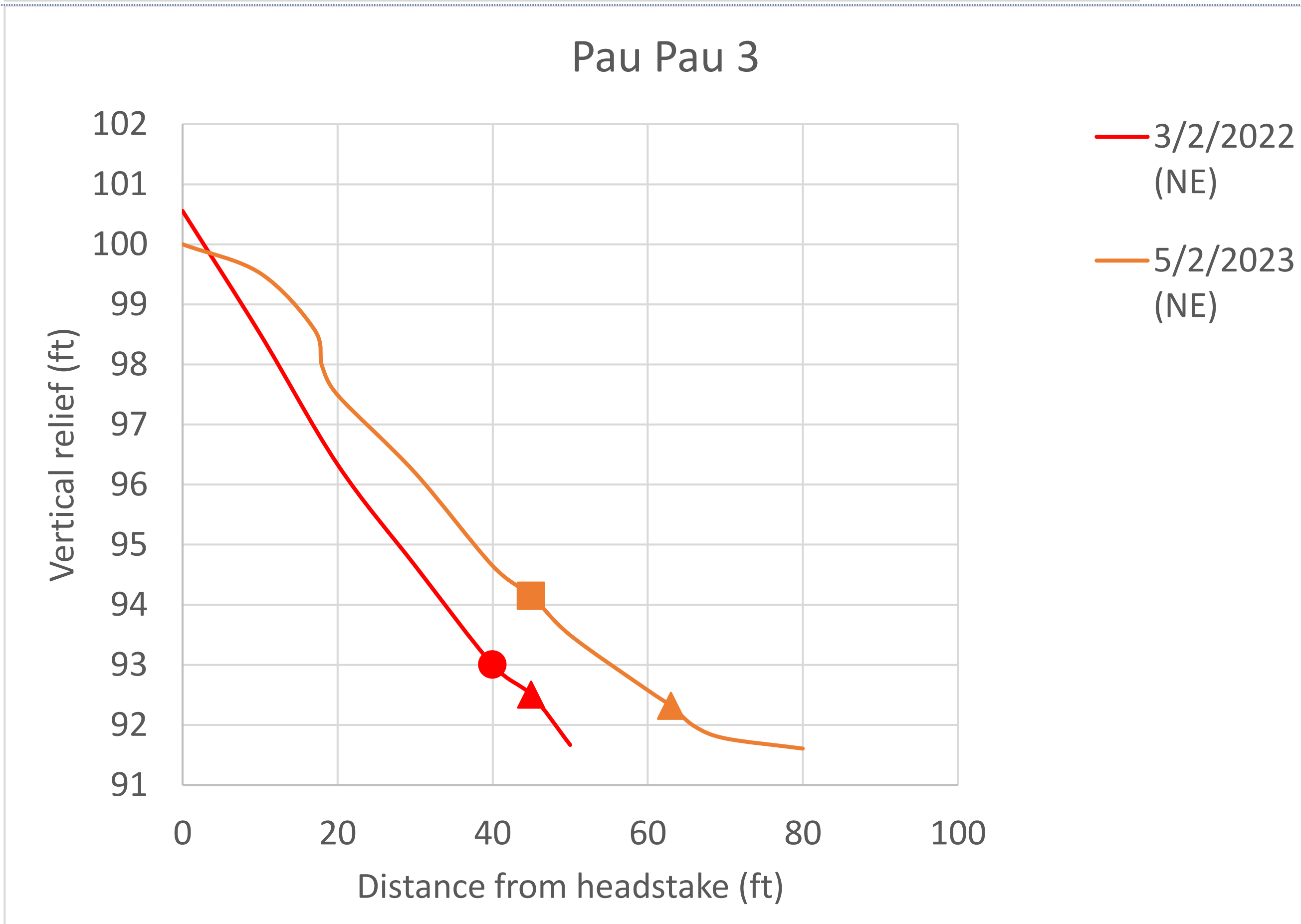


Total Station





Pau Pau 2
Vertical relief (ft)
102
100
98
96
94
92
90
88
0
10
20
30
40
50
60
70
80
90
100
110
Distance from headstake (ft)
3/2/2022 (NE)
5/2/2023 (NE)



Pau Pau 3
Vertical relief (ft)
102
101
100
99
98
97
96
95
94
93
92
91
0
20
40
60
80
100
Distance from headstake (ft)
3/2/2022 (NE)
5/2/2023 (NE)

Wing

Wing Beach, located on the northern shoreline of Saipan, displays a rich variety of coastal strand species along with a coral rubble shoreline. Regular sediment influx likely originates from the nearby reef, which transports sand and coral rubble from both inland areas and sea cliffs. The sea cliffs themselves also serve as potential sources of sediment.

Waves during southwest and northwest typhoon conditions bring in high wave energies. However, the wave conditions worsen during north-north wave conditions, with potential significant wave heights of up to 4 meters.

Wing 1 Highlights:

- STABLE
- Wrackline that ranges 58 – 90 ft and an elevation difference of 11.5 ft
- This beach profile may suggest that the shoreline experiences a good amount of sediment input and output from the influence of the nearby reef system. Feb 2018 had the most erosion while July 2017 saw the most accretion.
- Based on the Shoreline linear regression analysis (see pg 106), the shoreline has a rate of +0.75 ft from 2017-2023.

Wing 2 Highlights:

- ERODING
- Wrackline that ranges 30 –54ft and an elevation difference of 9 ft
- Based on observations from the Feb-21 record shows, a high tide with a high wave event greatly abrades the berm along this transect. With the input of coral rubble from the nearby reef, recovery to the average shoreline length is anticipated.
- Based on the Shoreline linear regression analysis (see pg 106), the shoreline has been eroding at a rate of 1.0 ft from 2017-2023.

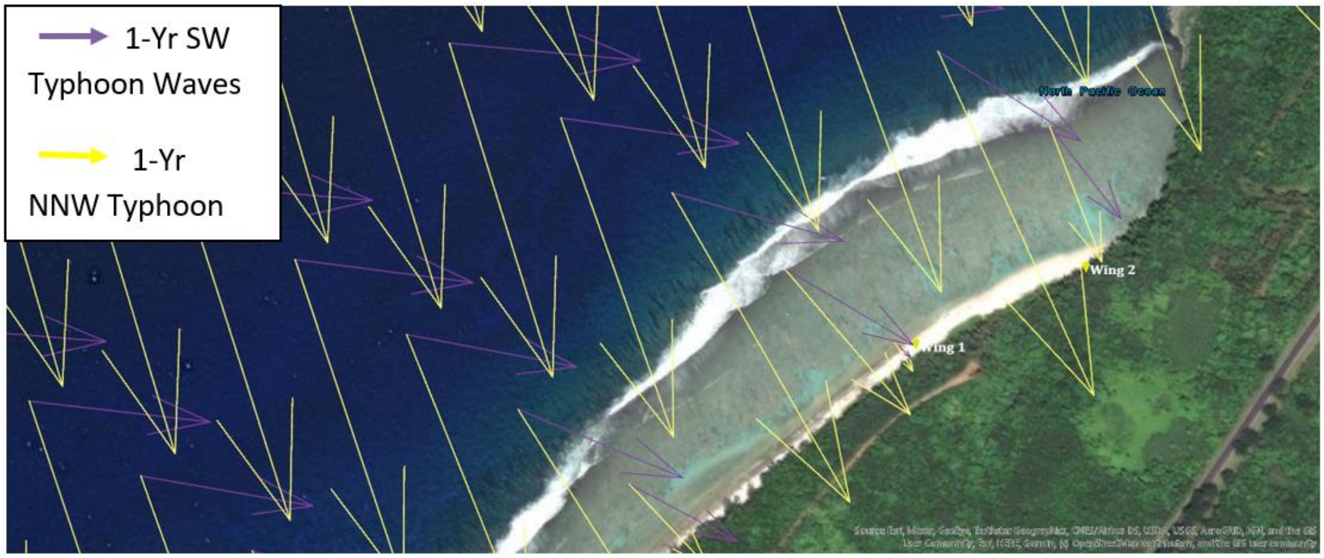
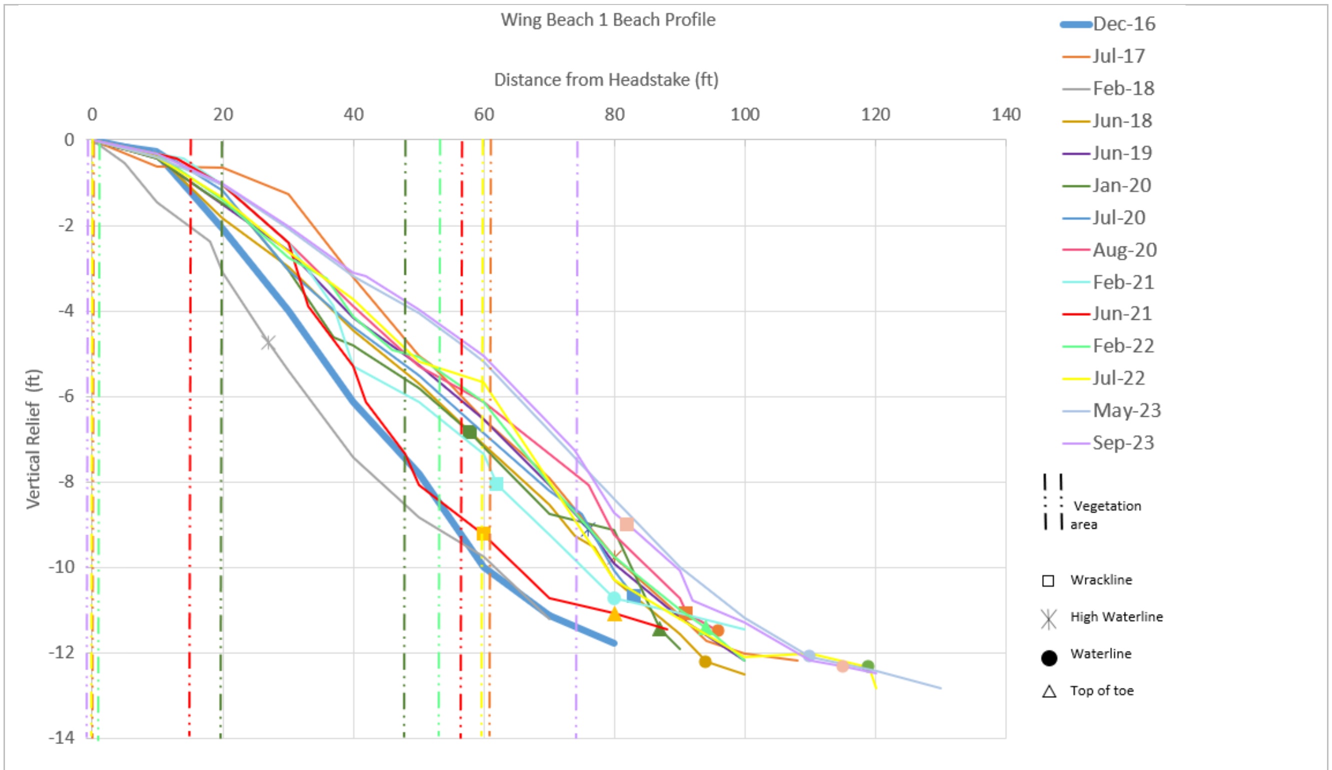
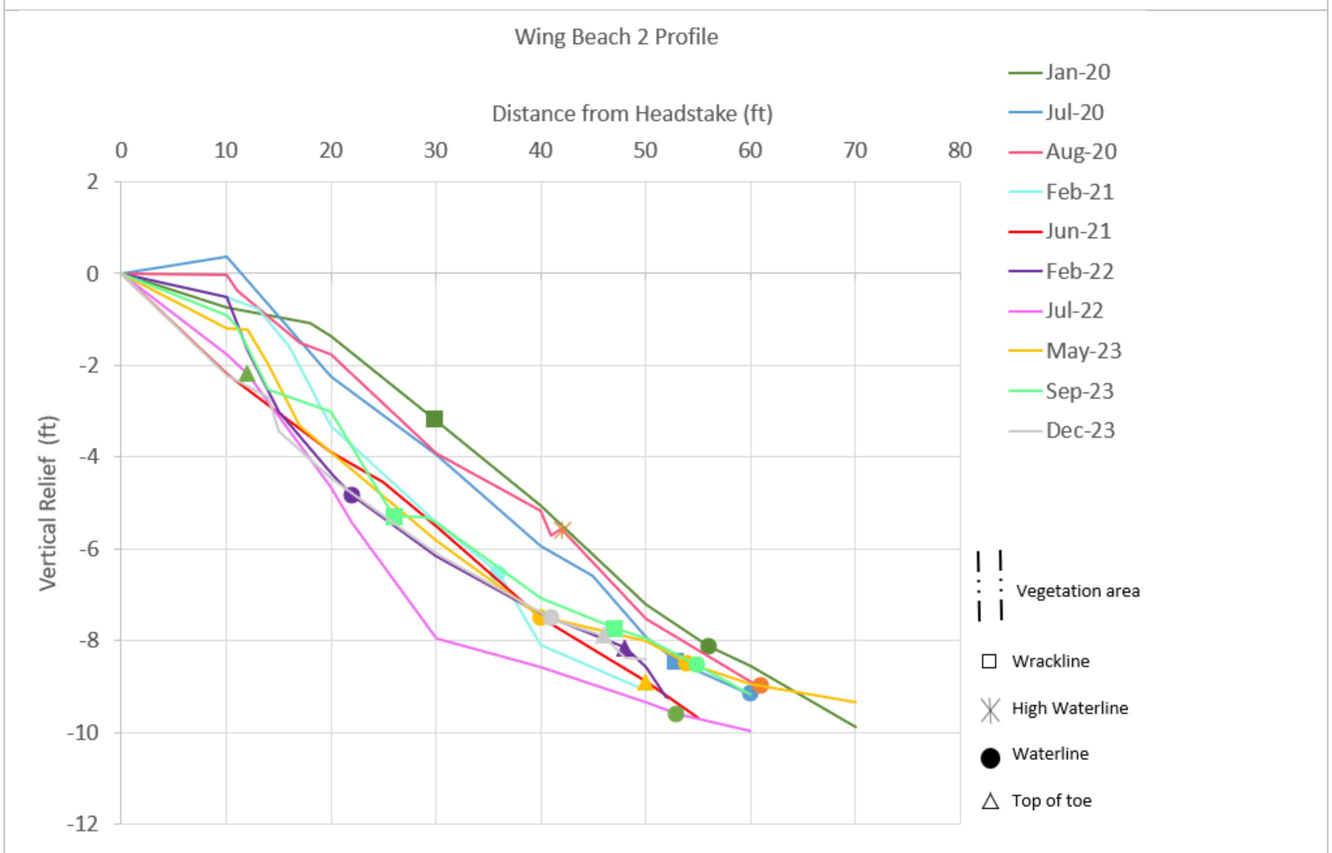


Figure 35 - Hydrodynamic map of the stretch of Wing Beach with high ocean wave energies going past reef. The arrows show the intensity of waves generated from the south west.

Wing Beach Profiles


Wing Beach 1 Beach Profile
Distance from Headstake (ft)
0
20
40
60
80
100
120
140
0
-2
-4
-6
-8
-10
-12
-14
Vertical Relief (ft)
Dec-16
Jul-17
Feb-18
Jun-18
Jun-19
Jan-20
Jul-20
Aug-20
Feb-21
Jun-21
Feb-22
Jul-22
May-23
Sep-23
Vegetation area
Wrackline
High Waterline
Waterline
Top of toe


Wing Beach 2 Profile
Distance from Headstake (ft)
0
10
20
30
40
50
60
70
80
2
0
-2
-4
-6
-8
-10
-12
Vertical Relief (ft)
Jan-20
Jul-20
Aug-20
Feb-21
Jun-21
Feb-22
Jul-22
May-23
Sep-23
Dec-23
Vegetation area
Wrackline
High Waterline
Waterline
Top of toe

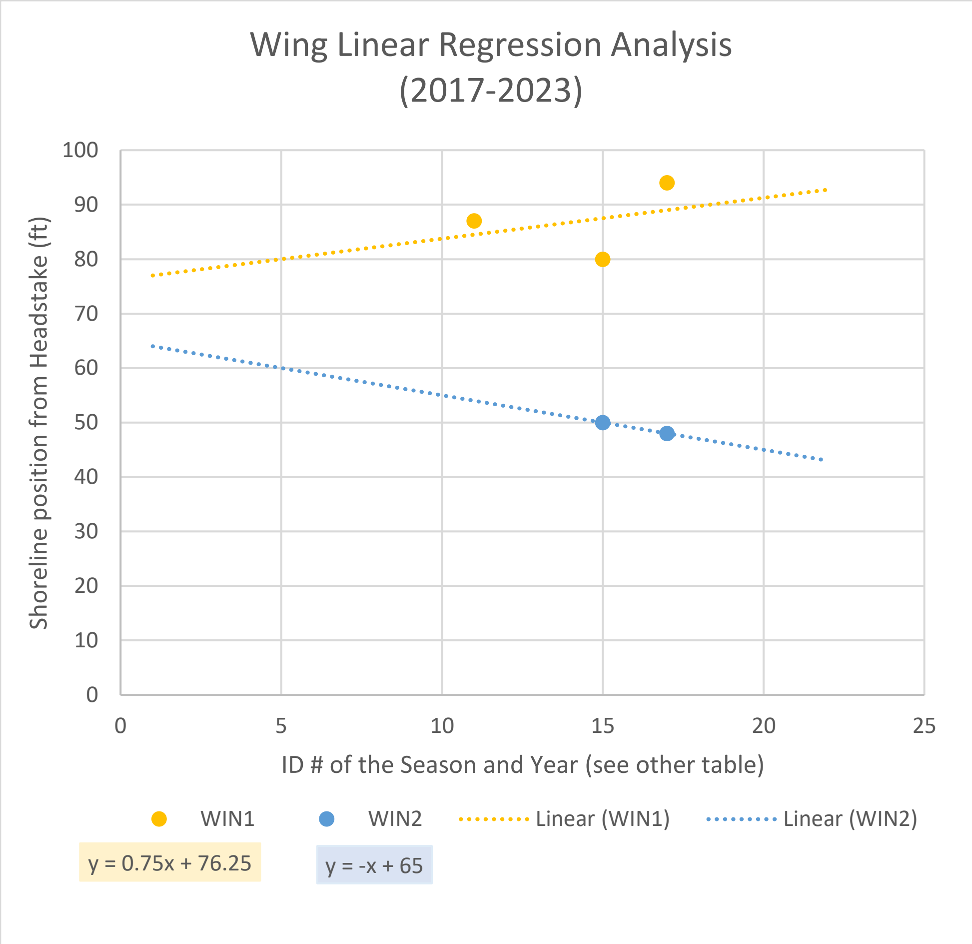
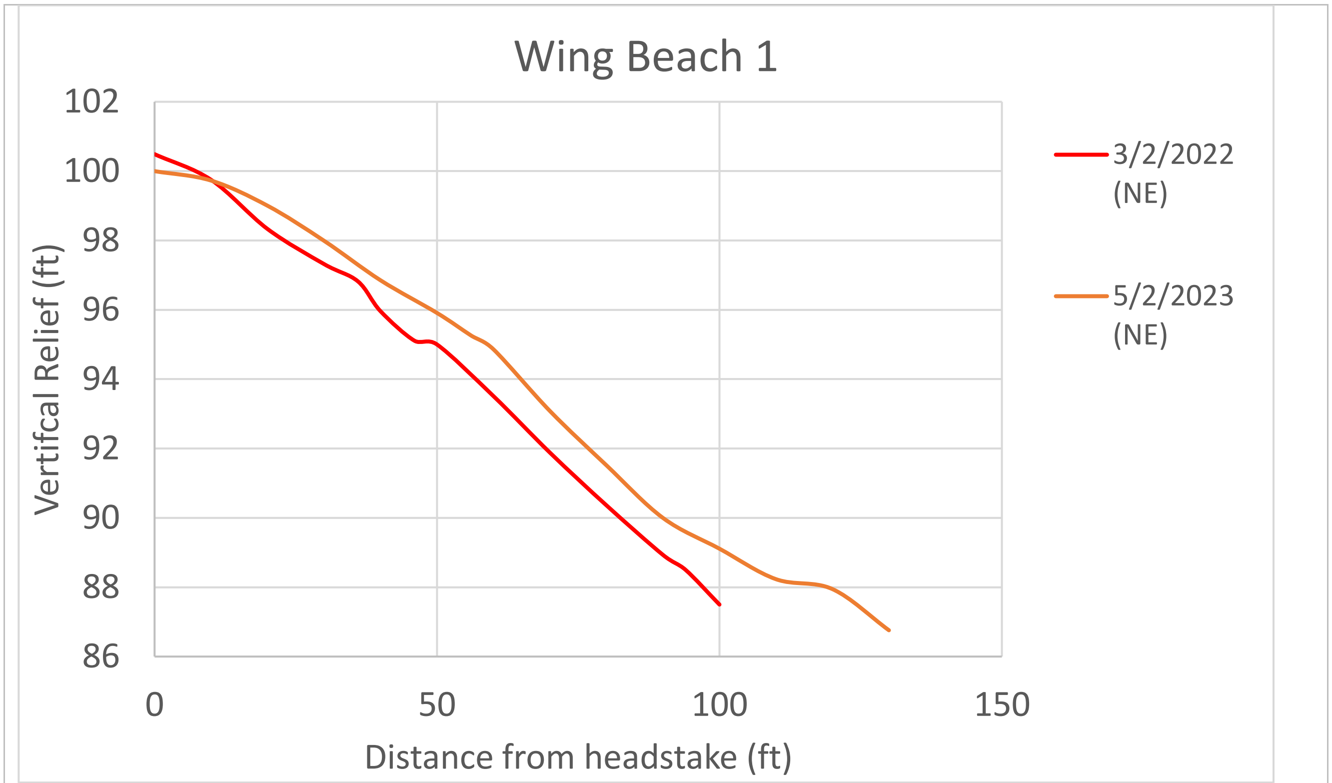
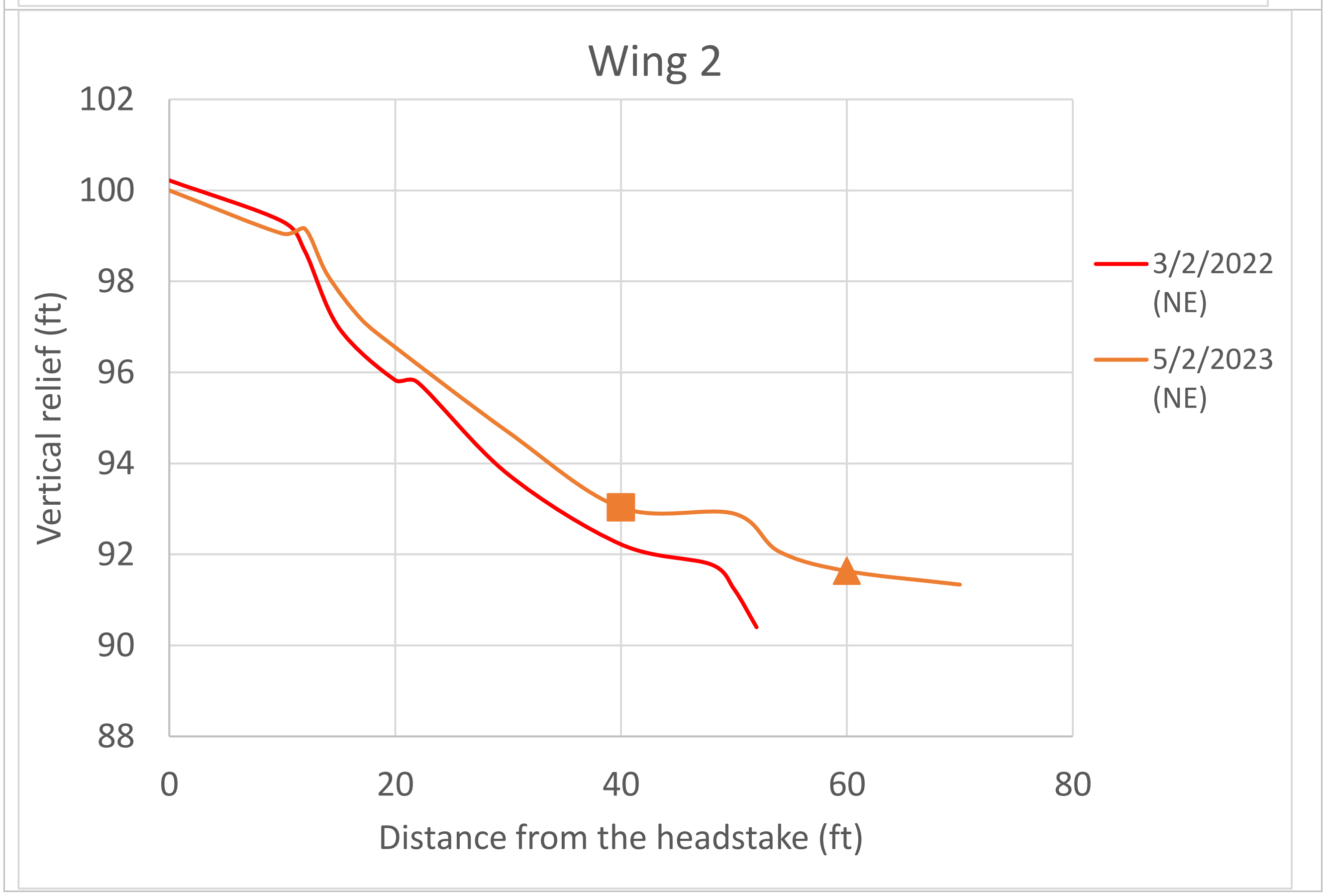


Figure 36 - Wing Beach Linear Regression Analysis table shows time in seasons over shoreline position (top of toe) from the headstake.

Total Station



Wing Beach 1
102
100
98
96
94
92
90
88
86
0
50
100
150
Vertifcal Relief (ft)
Distance from headstake (ft)
3/2/2022 (NE)
5/2/2023 (NE)



Wing 2
102
100
98
96
94
92
90
88
0
20
40
60
80
Vertical relief (ft)
Distance from the headstake (ft)
3/2/2022 (NE)
5/2/2023 (NE)

Mañagaha Beach Profiles and Key Findings

Mañagaha is known for its white sandy coastline as it is situated within the western Saipan Lagoon. The Saipan channel is located east of the islet with the protective barrier reef to the west.

In the 1990s, erosion was a concern expressed by users when the removal of relicts, especially a sunken tugboat caused a tremendous shift in the sediment transport of the sandy east side to the west. The eastern side is the only known shearwater bird habitat in the Marianas, which is actively managed and protected by the Division of Fish and Wildlife. Unfortunately, this shoreline has been retreating due to erosion processes while the northwestern side has an expanding large dune. High-energy waves attacking the eastern shoreline can cause mortality of young shearwater birds nested on that side during June through October. The Division of Fish and Wildlife actively manages this nesting site and plans to replace the deteriorating fencing. As the sandy dune on the northeastern side is growing, native vegetation has been thriving in that area. Swimming areas are also adjacent to this dune, attracting higher visitor density.

The Mañagaha Study (Fletcher, 2007) predicted that the island may potentially stabilize in the future. In the case it may not, shoreline interventions may be necessary to protect the eastern side. The sandy nearshore remains a valuable feature of this islet.

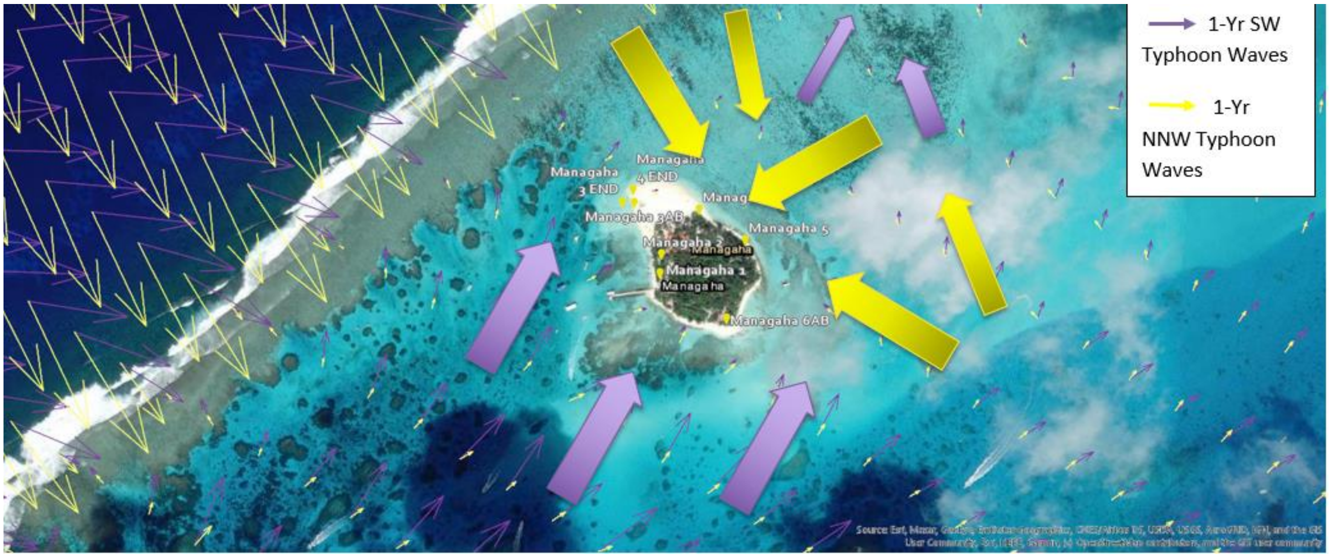


Figure 39 - Hydrodynamic map of Mañagaha and the wave directions based on the south west typhoon wave conditions (in dark purple) and the north north west typhoon wave conditions (in yellow). The arrows show the intensity of waves generated from the south west.

The Mañagaha shoreline interacts with varying wave conditions within the lagoon from all directions. The map above was generated using data from a hydrodynamic study of typhoon waves, and large arrows were added to emphasize the direction for the two conditions. The longshore transport varies slightly for the southwest and north-northwest wave conditions. During southwest conditions, longshore transport from the south is greater, affecting Transects 6A, 6B, 1, 2, 3A, and 3B. This longshore pattern leads to accretion at Transects 3A and 3B. Transects 4 and 5 are likely to be impacted during north-northwest typhoon conditions. High wave energy occurs during the southwest typhoon condition, impacting the southern part of the islet. For both conditions, the eastern side of the island appears to be eroding. Beach recovery may occur due to the sediment sources all around the island. This is DCRM's interpretation of Mañagaha's longshore transport, which future monitoring findings will investigate to validate these assumptions.

Mañagaha 1 Highlights:

- STABLE
- Wrackline that ranges 30 – 40 ft and an elevation difference of 8 ft
- Adjacent to this headstake is the dock infrastructure, which greatly influences how sediment moves.
- Based on the Shoreline linear regression analysis (see pg 112), the shoreline has a rate of -0.29 ft from 2017-2023.

Mañagaha 2 Highlights:

- ACCRETING
- Elevation difference of 10 ft
- Variation begins past the 25 ft distance from the headstake.
- Rocky grounds are seaward.
- Based on the Shoreline linear regression analysis (see pg 112), the shoreline has a rate of +1.16 ft from 2017-2023.

Mañagaha 3A Highlights:

- REPLACED
- Previous headstake: ACCRETING
- Wrackline that ranges 50 – 84 ft and an elevation difference of 8 ft
- Second berm has formed.
- Based on the Shoreline linear regression analysis (see pg 112), the shoreline has a rate of +3.03 ft from 2017-2023.

Mañagaha 3B Highlights:

- REPLACED
- Previous headstake: ACCRETING
- Wrackline that ranges 90 – 100 ft and elevation difference of 7 ft
- Based on the Shoreline linear regression analysis (see pg 112), the shoreline has a rate of +2.43 ft from 2017-2023.

Mañagaha 4 Highlights:

- ERODING
- Elevation difference of 6 - 8 ft
- Scarp and ripped trees are evident in this area.

Mañagaha 5 Highlights:

- ERODING
- Elevation difference of 11 ft
- Scarp and ripped trees are evident in this area.

Mañagaha 6A Highlights:

- REPLACED previous headstake
- Scarp and ripped trees are evident in this area.
- **History:** The previous headstake was a post of the shearwater bird habitat boundary that got ripped away. There was a strong erosion trend from July 2017 – 2020.

Mañagaha 6B Highlights:

- UNDETERMINED AND REPLACED previous headstake
- Scarp and ripped trees are evident in this area.
- Erosion is known and observed in the long-term.

Mañagaha 7 Highlights:

- ERODING
- REPLACED the previous headstake (large blockular relict) where the waterline would hit during high surf events. New headstake is further backshore but aligns with the previous headstake.
- This current headstake receives sediment; however, it is observed that high energy and high tides have allowed the waterline to strike the headstake.

Mañagaha 1

Mañagaha 2

Mañagaha 3A

Mañagaha 3B

Mañagaha 4

Mañagaha 6A

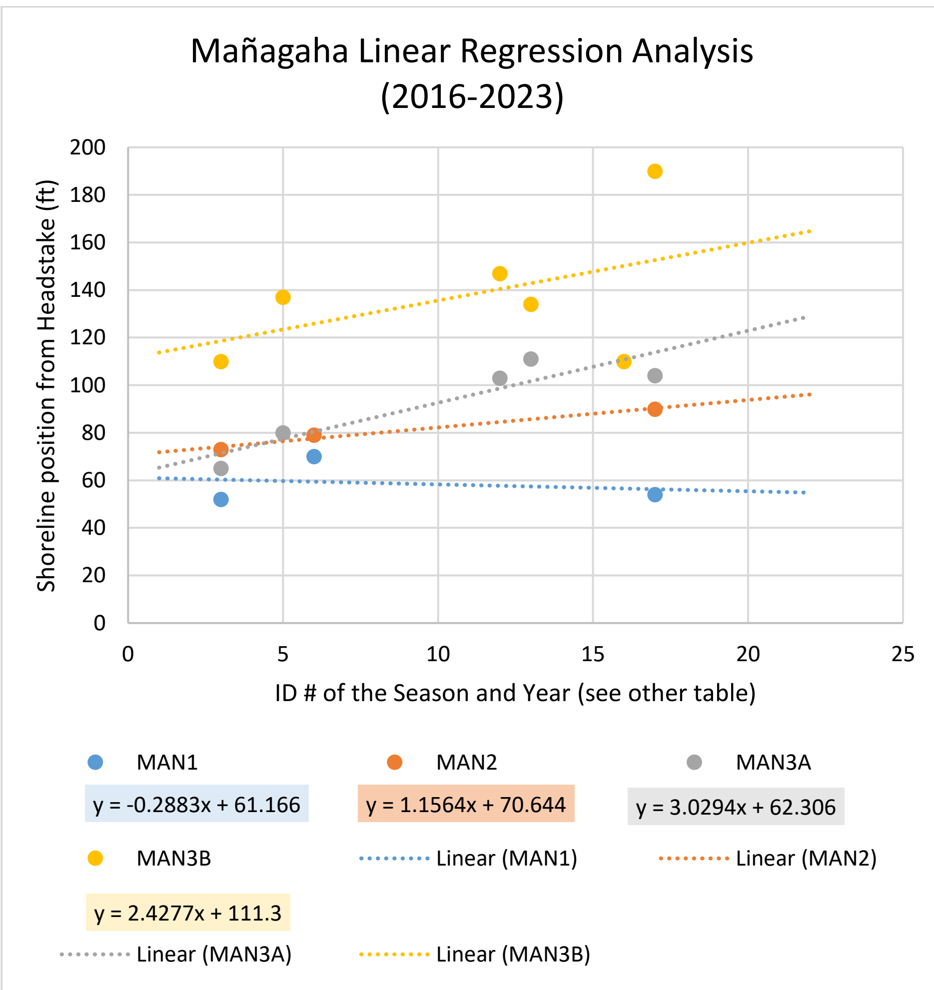
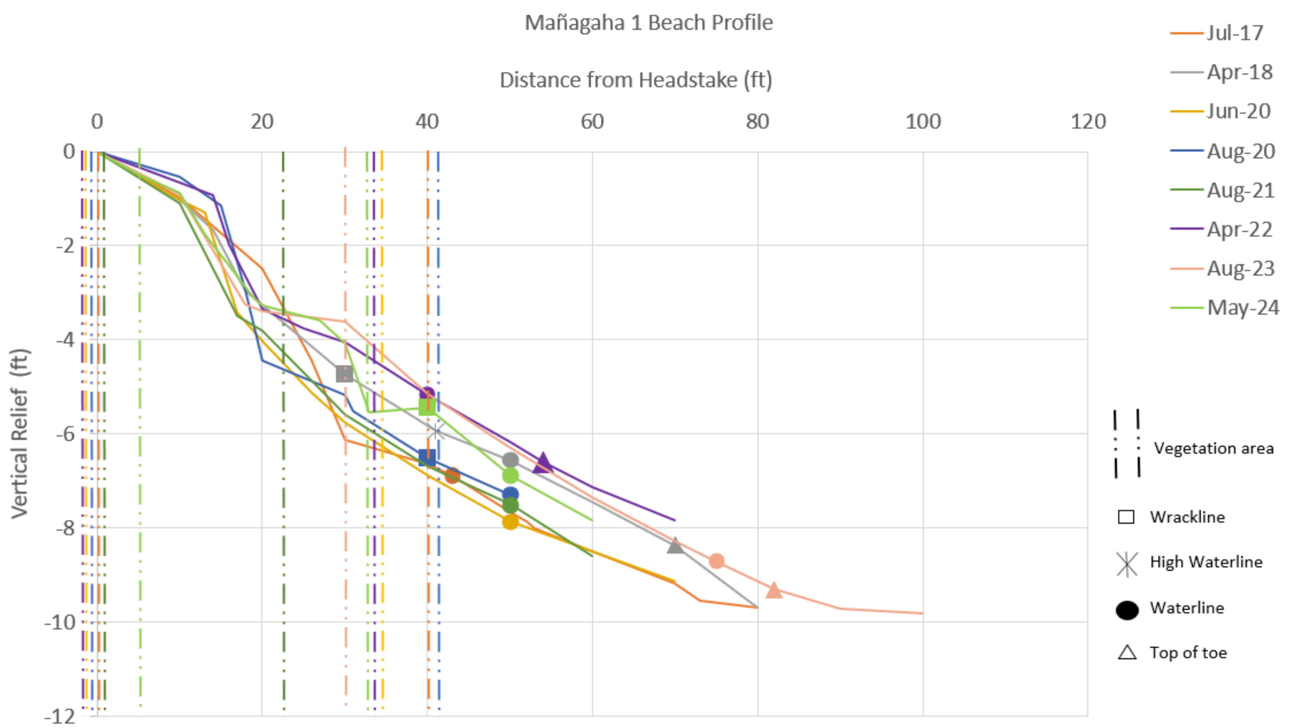
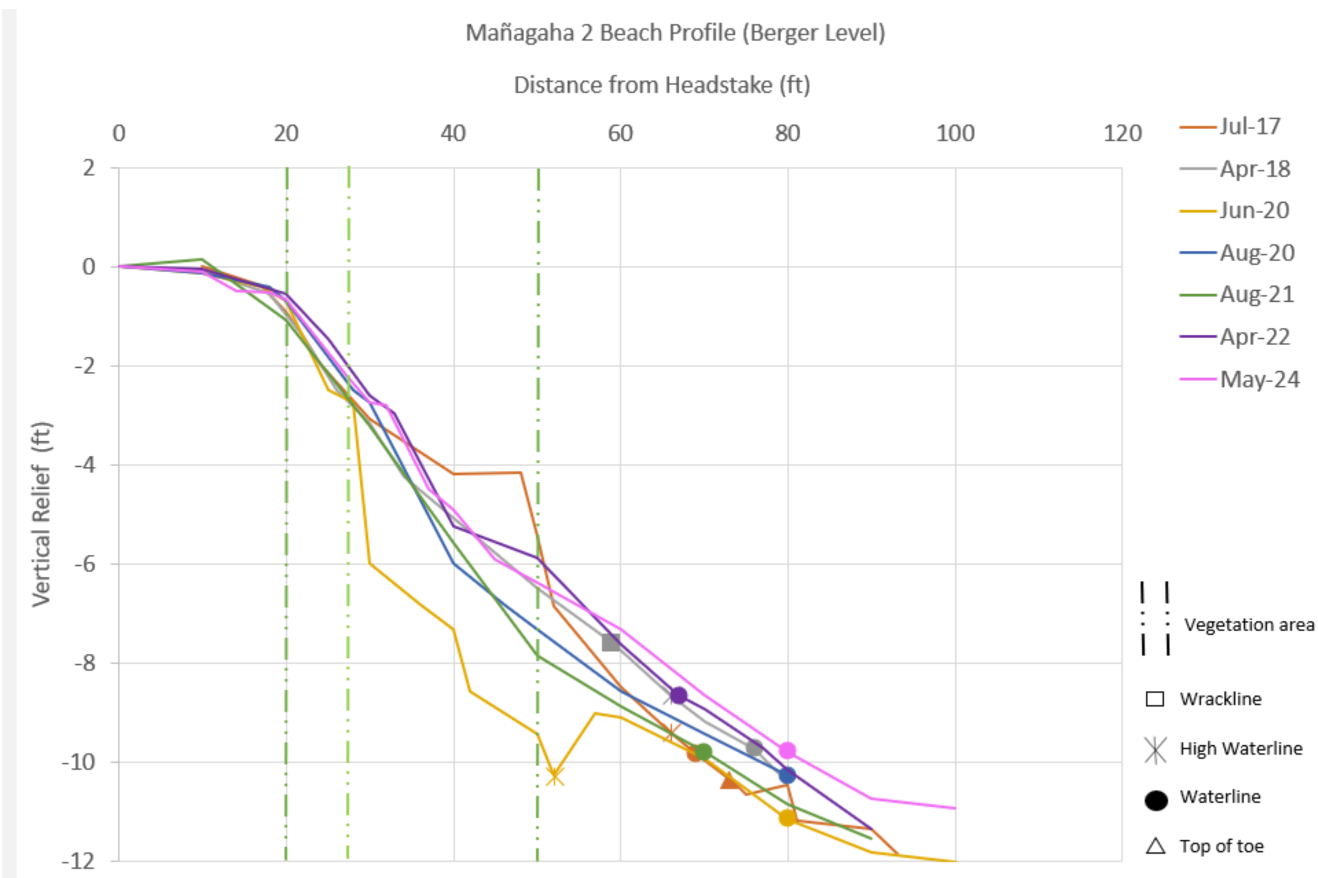
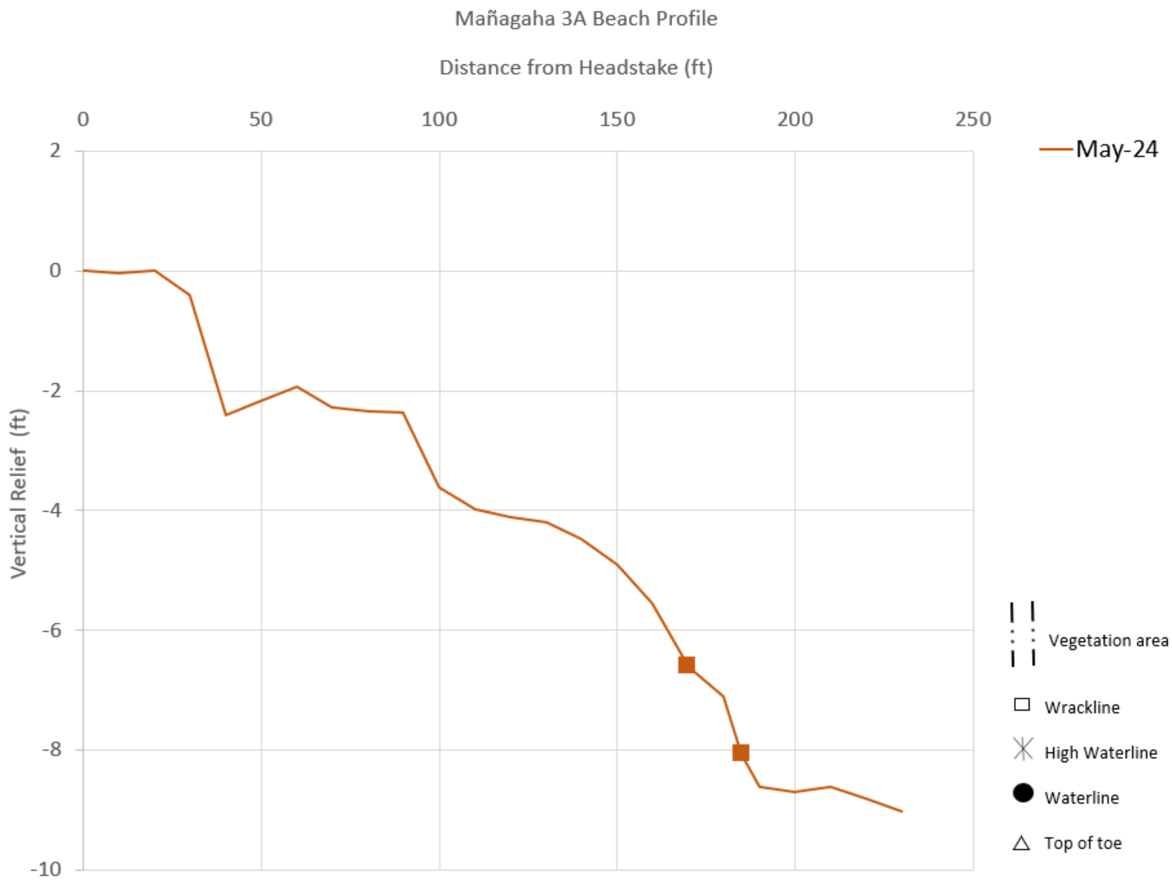


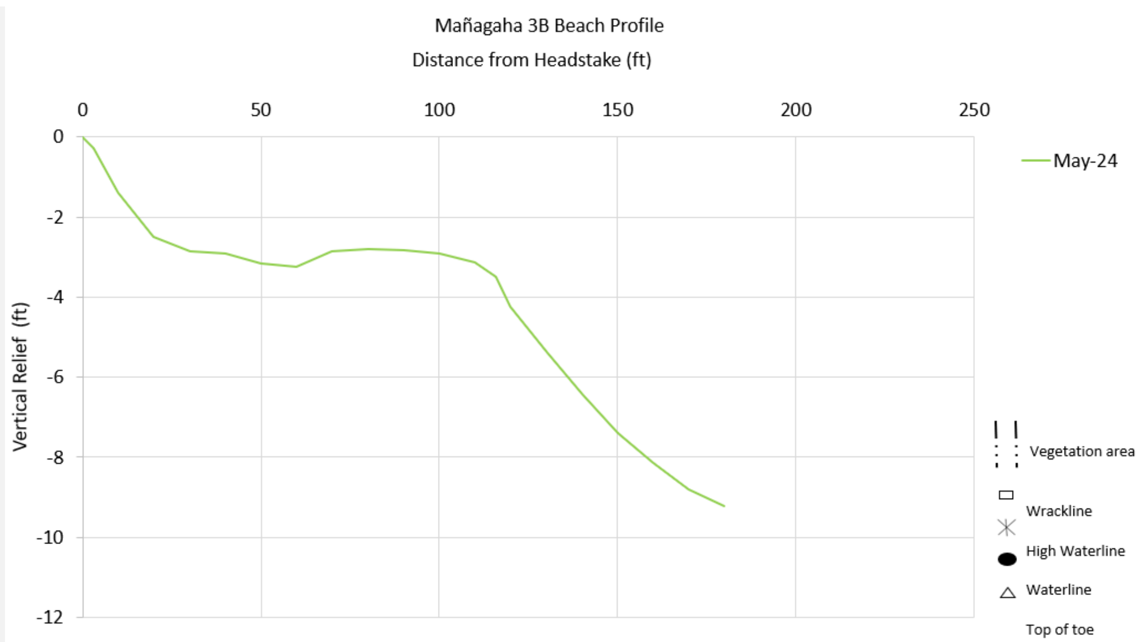
Figure 40 – Mañagaha Linear Regression Analysis table shows time in seasons over shoreline position (top of toe) from the headstake.

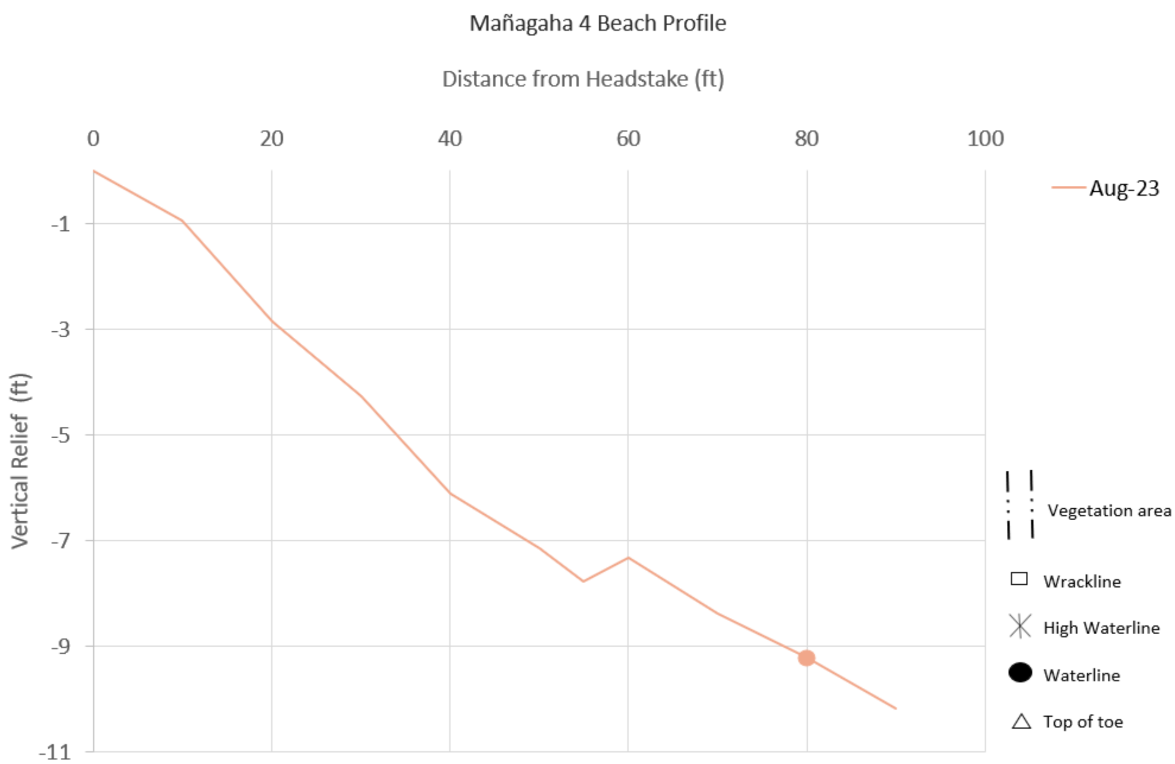
Mañagaha Beach Profiles



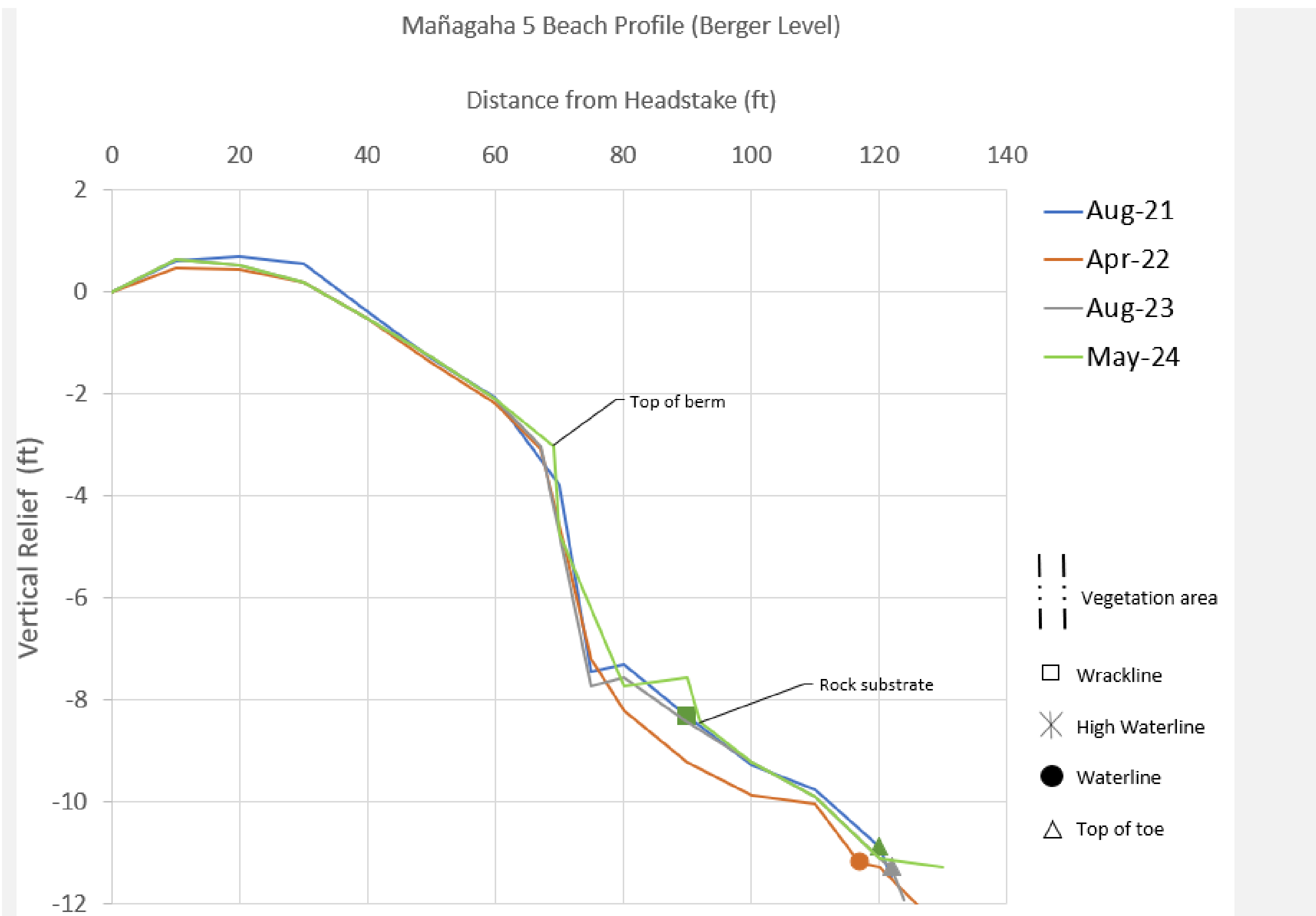



Mañagaha 3A Beach Profile
Distance from Headstake (ft)
0
50
100
150
200
250
2
0
-2
-4
-6
-8
-10
Vertical Relief (ft)
May-24
Vegetation area
Wrackline
High Waterline
Waterline
Top of toe

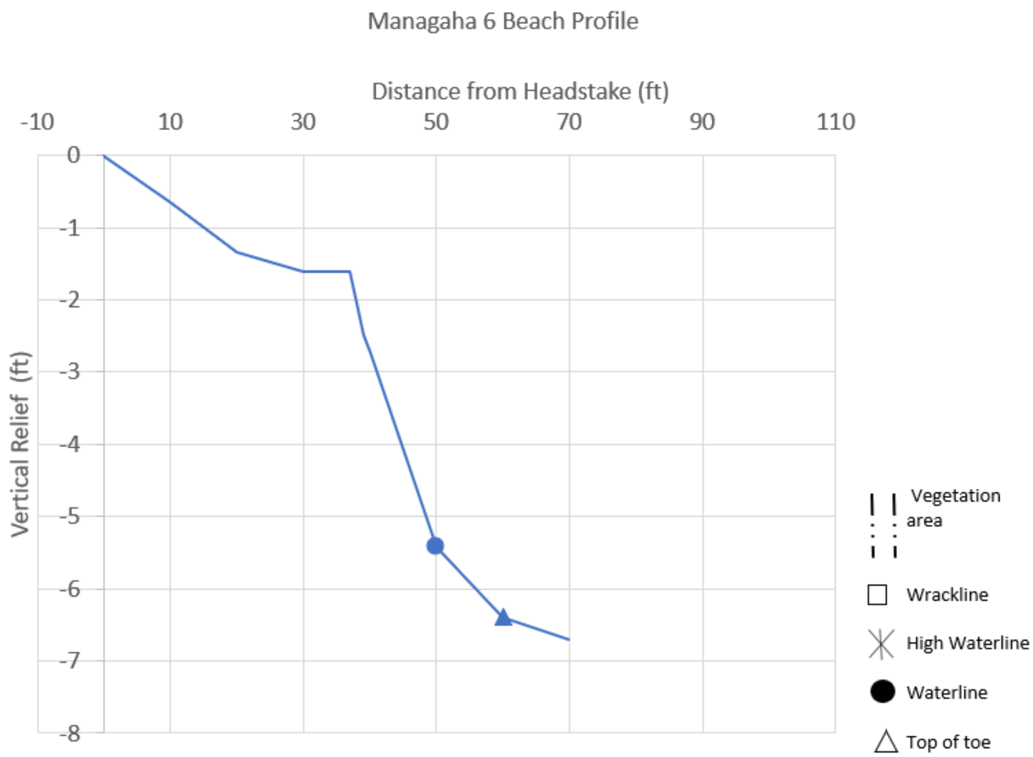

Mañagaha 3B Beach Profile
Distance from Headstake (ft)
0
50
100
150
200
250
0
-2
-4
-6
-8
-10
-12
Vertical Relief (ft)
May-24
Vegetation area
Wrackline
High Waterline
Waterline
Top of toe

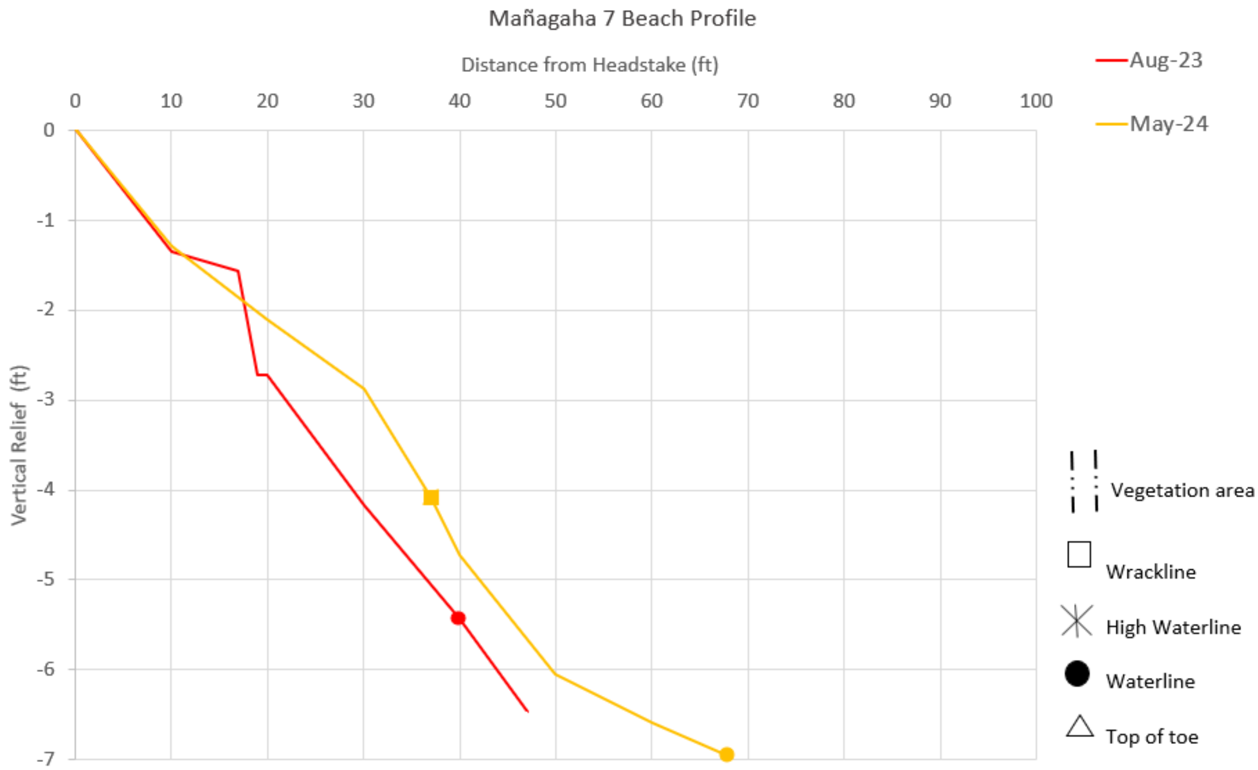


Mañagaha 4 Beach Profile
Distance from Headstake (ft)
0
20
40
60
80
100
-1
-3
-5
-7
-9
-11
Vertical Relief (ft)
Aug-23
Vegetation area
Wrackline
High Waterline
Waterline
Top of toe



Mañagaha 5 Beach Profile (Berger Level)
Distance from Headstake (ft)
0
20
40
60
80
100
120
140
2
0
-2
-4
-6
-8
-10
-12
Vertical Relief (ft)
Top of berm
Rock substrate
Aug-21
Apr-22
Aug-23
May-24
Vegetation area
Wrackline
High Waterline
Waterline
Top of toe


Managaha 6 Beach Profile
Distance from Headstake (ft)
-10
10
30
50
70
90
110
0
-1
-2
-3
-4
-5
-6
-7
-8
Vertical Relief (ft)
Vegetation area
Wrackline
High Waterline
Waterline
Top of toe



Mañagaha 7 Beach Profile
Distance from Headstake (ft)
0
10
20
30
40
50
60
70
80
90
100
Vertical Relief (ft)
0
-1
-2
-3
-4
-5
-6
-7
Aug-23
May-24
Vegetation area
Wrackline
High Waterline
Waterline
Top of toe

Conclusion

The DCRM Shoreline Monitoring team has been conducting surveys to track shoreline changes using the Berger Level beach profiling method. They have also been mapping the wrackline/erosion scarp. However, the use of total station equipment was not very successful this time due to outdated software and time constraints. During the survey, there were some challenges in collecting field data such as losing headstakes because of vegetation overgrowth, misidentification, or erosion events. Despite these challenges, the team completed a total of 48 transect surveys on Saipan and Mañagaha between April 2023 and August 2024.

Of the 48 transects, 10 have shown erosion. For example, Sugar Dock North 1 has been completely dredged for access, and the area from Micro Beach to Fiesta continues to erode during high wave conditions. The CNMI government is working on a temporary stabilization project by filling the exposed historical metal objects with sandbags and stones from Route 36. However, this project may not begin until the US Army Corps of Engineers permit is issued, potentially by the end of 2024. The retreat of the berm indicates a long-term erosion trend. There is also ongoing erosion on the eastern side of Mañagaha, and the Department of Public Lands plans to propose an erosion control study seeking federal funding.

On the other hand, 14 transects have exhibited accretion, with areas such as Aquarius through Sugar Dock South and Hafa Adai and AMP North showing growth due to maturing vegetation.
The northwestern side of Mañagaha also continues to accrete.

There are 21 transects that have shown stability, with minimal change in shoreline width. However, changes to these stable sites may indicate exacerbation of sediment transport or negative impacts on sediment sources due to nearby development activities.

Seven transects are considered 'undetermined' due to their highly dynamic nature. For example, Sugar Dock 1 has been dredged for boating access, and the beach may build up again in the next 5 years based on previous sediment movement pattern observations. Hopwood, Kilili North, and AMP Point transects have experienced significant erosion and accretion events within this period due to high swell and sea level events.

Overall, the team will continue annual beach profiling and integrate drone methodology to capture sediment volumes before and after storms. This data will address site-specific shoreline erosion through informing management actions and policies, and discourage detrimental hardening of beaches. The Planning Section has also provided this data for shoreline studies and projects from partnering agencies focusing on shoreline change. Beach nourishment is an option explored by agencies to address erosion and beneficially use sand dredged from marina/dock dredging projects. Beach profiles could inform the grading for widening the beach and even monitor the change to inform lifespan of a beach nourishment-type project.

Resources

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