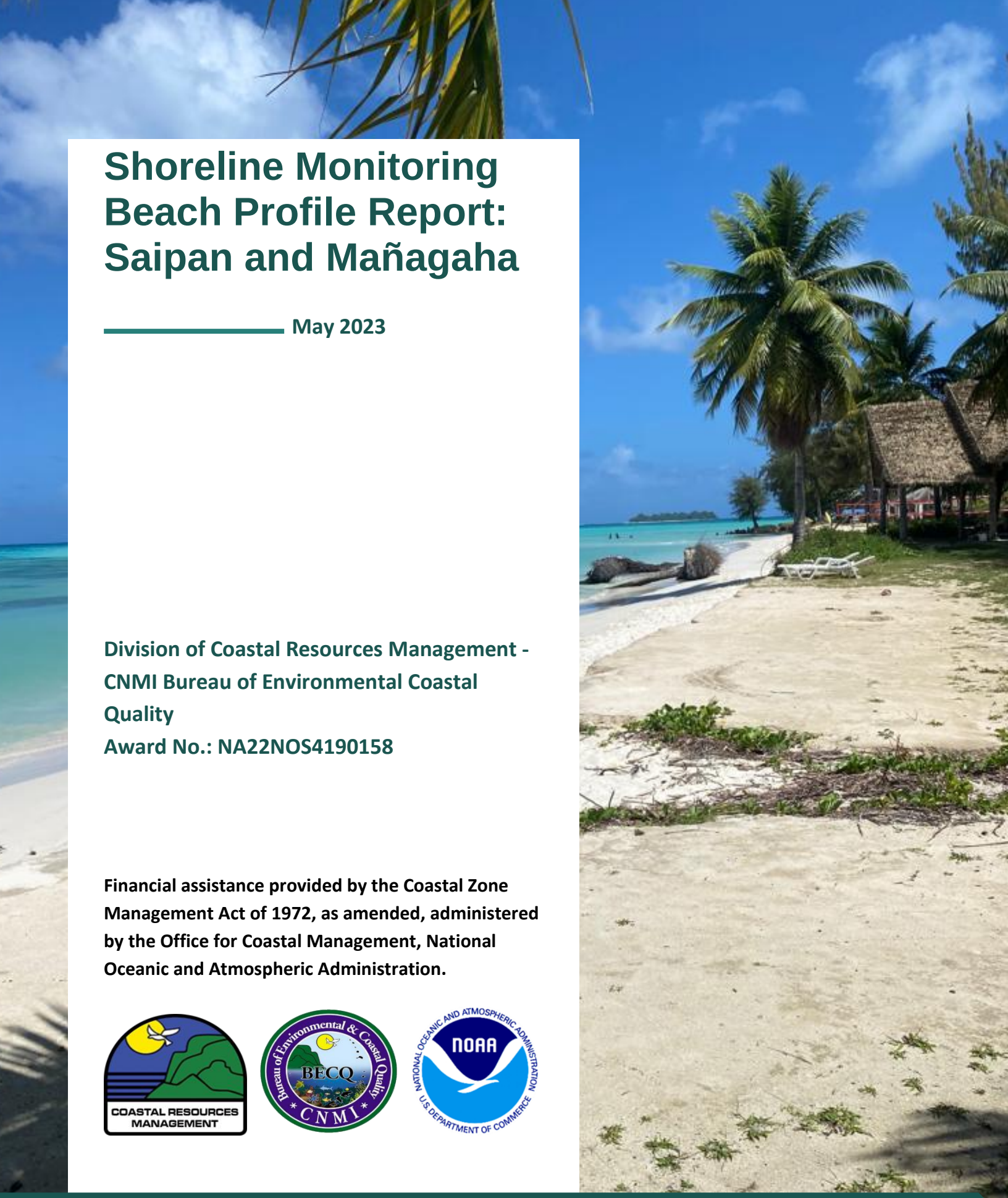

Shoreline Monitoring Beach Profile Report: Saipan and Mañagaha

May 2023

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

Award No.: NA22NOS4190158

Financial assistance provided by the Coastal Zone Management Act of 1972, as amended, administered by the Office for Coastal Management, National Oceanic and Atmospheric Administration.

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 - March 2023. An update from the March 2021 - March 2022 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 a segment between Crowne Plaza and Hyatt (Hyatt 1 transect).

Acknowledgements

The Shoreline Monitoring program is led by the DCRM's Planning Section, with the direction of the Coastal Planner, 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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Suggested Citation:

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Contents

DCRM Shoreline Monitoring Program

CNMI beaches are spaces between the ocean and land providing critical economic, recreational, and cultural services to our island community. They change by the tides and wind-driven ocean currents. Over the years, the loss of sandy shoreline by storm-driven ***erosion*** concerns those who work, live, and play in these spaces.

Every shoreline stretch is unique, whether it be cliff, bay, lagoon, or pocket beach. Understanding the coastal processes that drive the width of our sandy beaches is key to improving how we manage development along the shoreline. Which ones are eroding or ***accreting*** (gaining sand)? How does sand shift along the coastline?

To understand this change, the Division of Coastal Resources Management (DCRM) monitors sandy beaches in Saipan, Mañagaha, Tinian, and Rota to capture change over time. Timing is a critical factor to how a shoreline appears, given how currents shift sand along the coastline or drag them into the water. Data is currently visualized into ***beach profiles***, which are used to interpret the change of length or elevation in the short-term and long-term. These findings are published in this annual document-type report and into an interactive **"Climate Impact Viewer"** map. (See page 5, Online Interactive Map.)

Since the development of the program in 2016, staff have conducting on-the-ground transect surveys at designated starting points along the coast, 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 usually 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 on the top right 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, and organized by site.

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

Web Resources

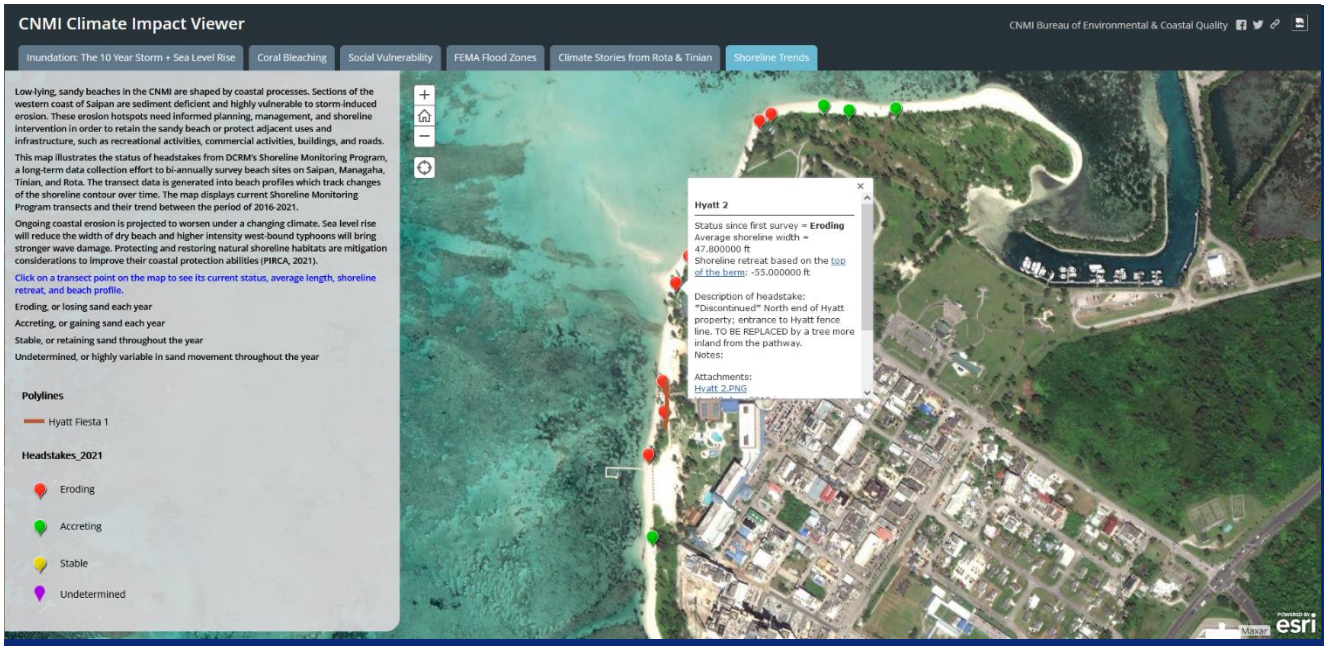
Shoreline Monitoring Interactive Map

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:

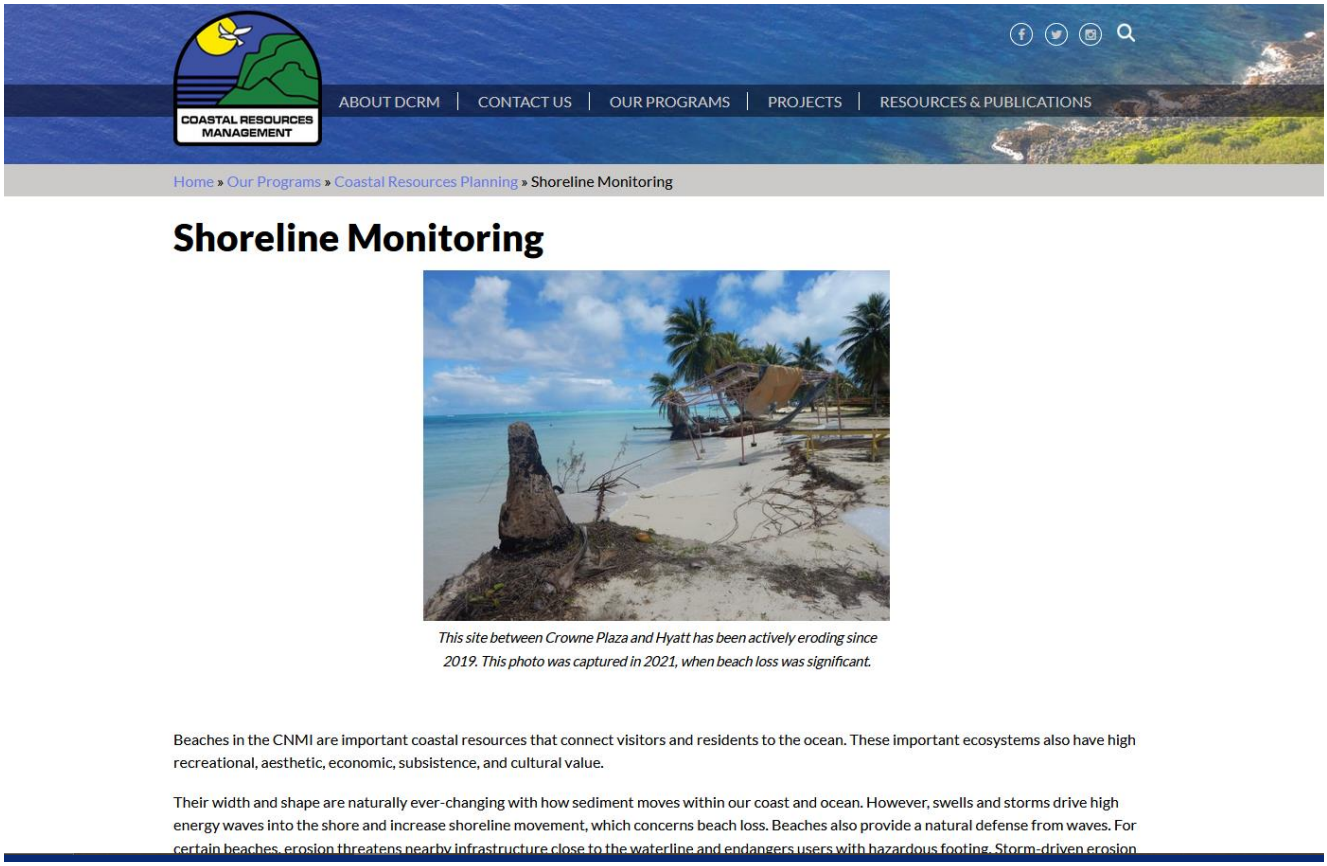
1. Click on this link: https://dcrm.maps.arcgis.com/apps/MapSeries/index.html?appid=3b8d1a4b46d64586b39047f5732621cd **OR**
   On, www.dcrm.gov.mp, hover over "Resources & Publications" then "Tools and Apps." Click on "Open Data Access." On the "Open
2. Go to "Shoreline Trends."
3. Zoom into the area 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.



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/



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.

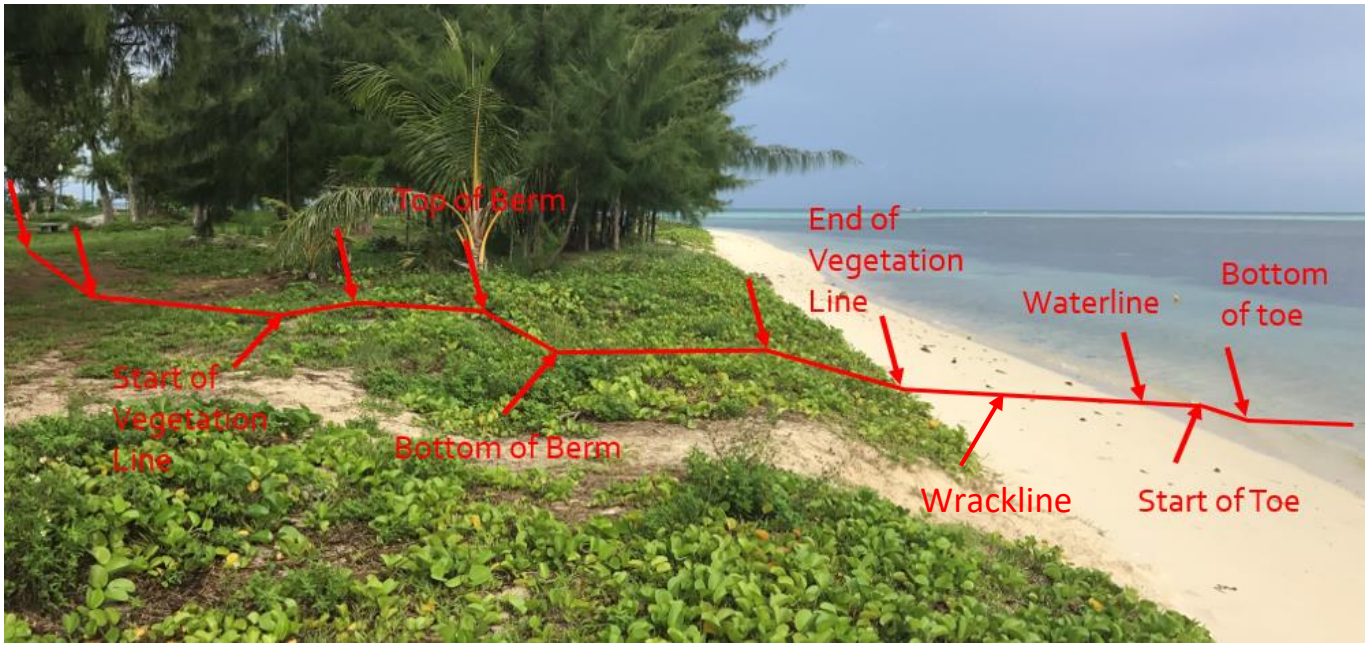
Wave overtopping- when waves meet a submerged reef or structure and overtakes the structure

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***. It is like a snapshot of the shoreline in time, only measured and plotted into a graph. DCRM's findings are based on the development and update of beach profiles along designated sites on Saipan, Tinian, and Rota. An example of a beach profile is seen on the next page.

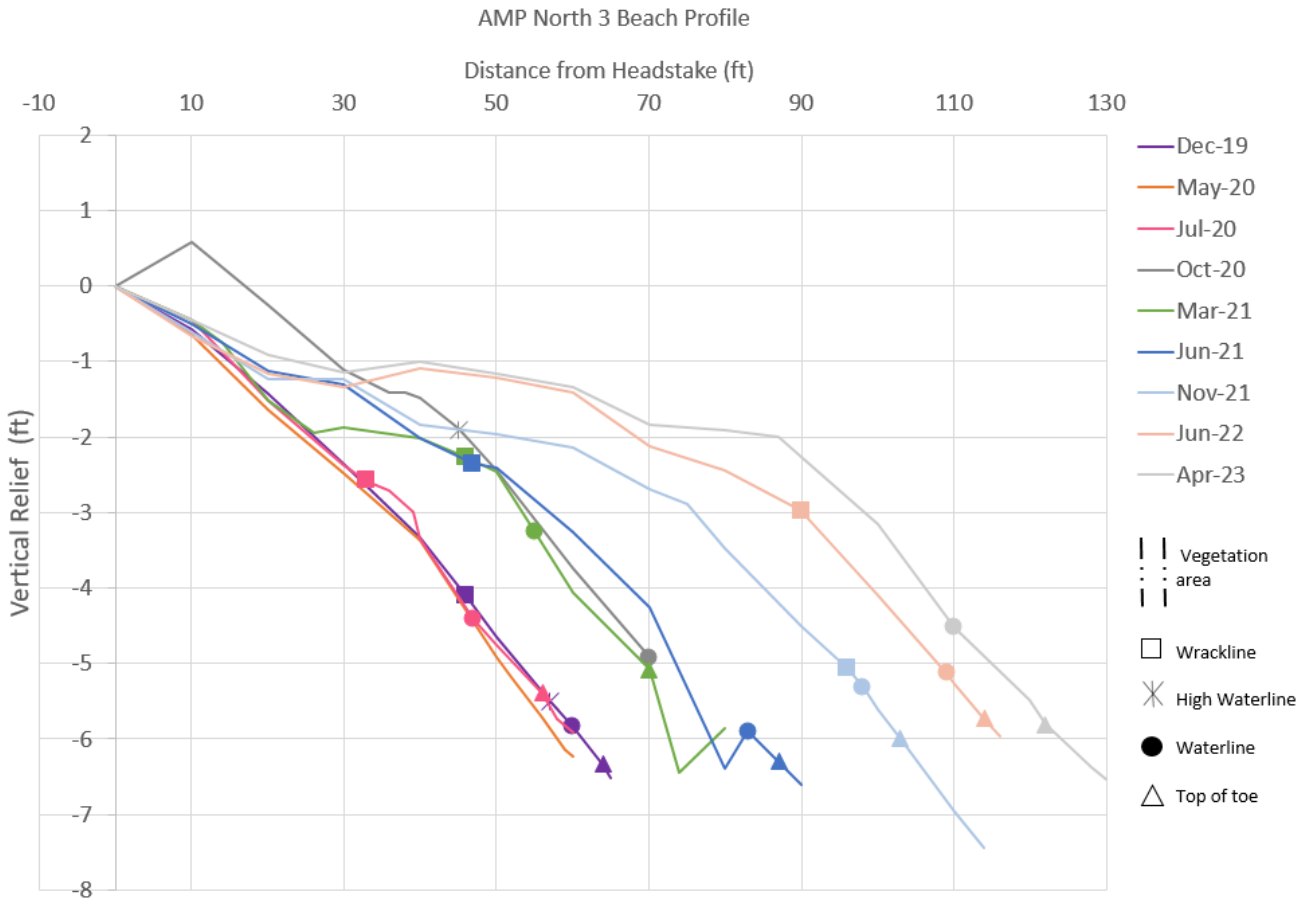
The figure below indicates the common features of a beach profile noted during surveying. Properly identifying these features is a necessary skill for understanding the shoreline condition at the time.



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.



On the top right hand corner, there are different colored lines followed by dates. Each corresponding color line indicates a data entry captured at 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.

Symbology is used to label 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. ***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 that 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 within January to April, bringing swell and movement in 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 high potential to worsen erosion. Typhoons often approach the CNMI from the east to the west but have the ability to 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 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 feet (>1) of negative values.
Accreting profiles have over a rate of one feet (>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, while those that are new and replacing previous ones will be omitted from the calculation. View the linear regression analysis graphs produced, which follows after the before and after comparison photos.

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 stable shoreline since 2016. In 2018, storm surge from Super Typhoon Yutu damaged vegetation. Compared to last year, Pak Pak beach's vegetation has developed, signifying stability since then.
As observed, southwest typhoon conditions appear to be more damaging than north-northwest especially due to the proximity of the storm. However, the beach may be receiving sediment from the adjacent reef and Agingan Point. Greyish rubble-textured rocks were found along the shoreline after one storm event, potentially from Agingan Point.

Pak Pak 1 Highlights:

- STABLE
- Wrackline that ranges 10 – 40 ft and an elevation difference of 5 ft
- Based on the Shoreline Linear Regression Analysis (see pg 15), the shoreline has a rate of -0.5 ft from 2016-2023.

Pak Pak 2 Highlights:

- STABLE
- Wrackline that ranges 45 – 75 ft with an elevation difference of 9 ft
- Based on the Shoreline linear regression analysis (see pg 15), the shoreline has at a rate of -0.25 ft from 2016-2023.

Pak Pak 3 Highlights:

- STABLE
- Wrackline that ranges 47 – 77 ft with an elevation difference of 8 ft
- Seasonal variation may bring some fresh 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 15), the shoreline has at a rate of -0.09 ft from 2016-2023.

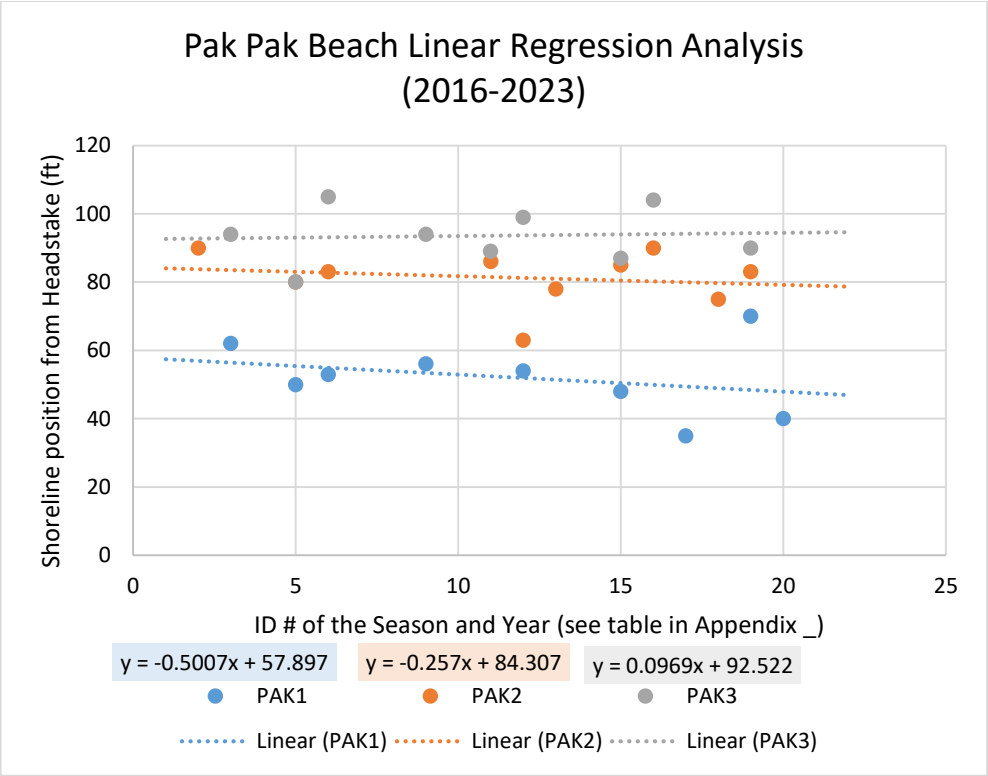
[Photo not available for 2023]

Pak Pak 1

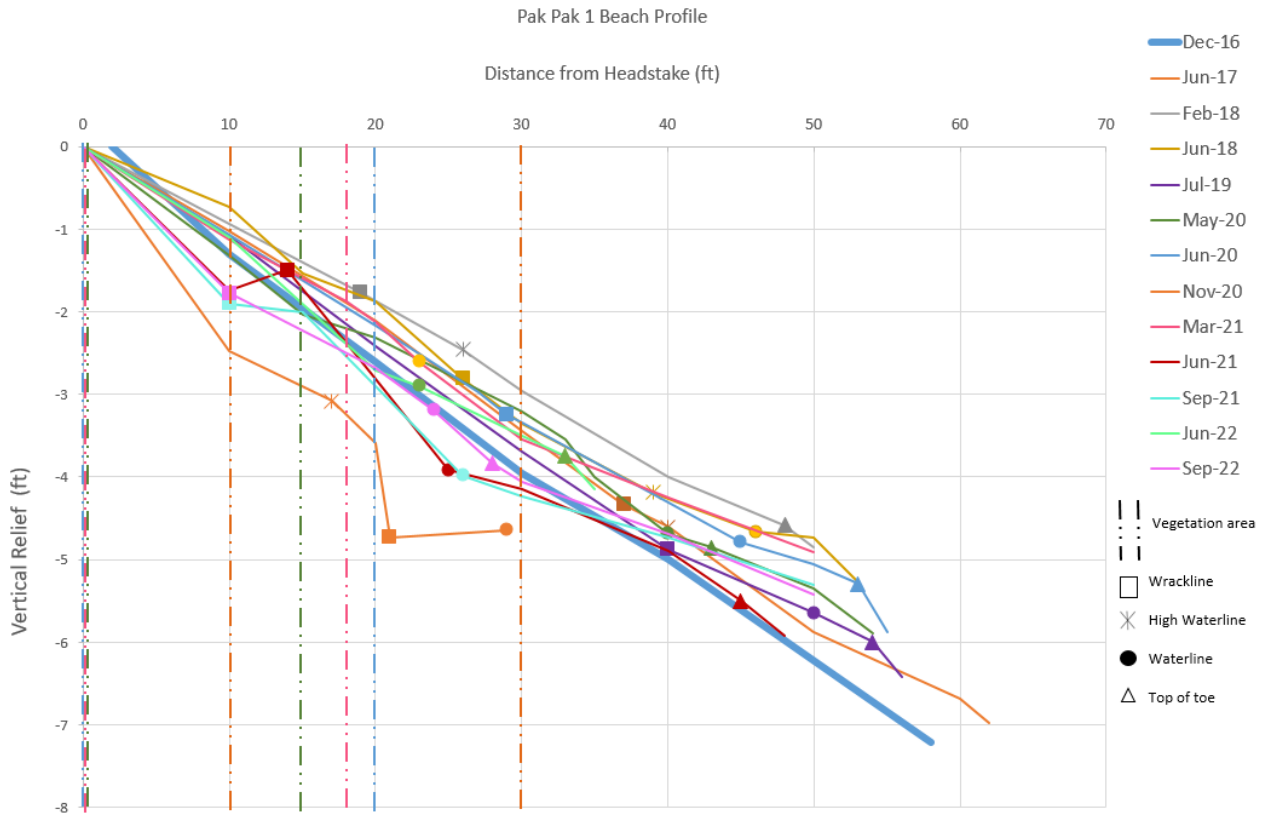
Pak Pak 2

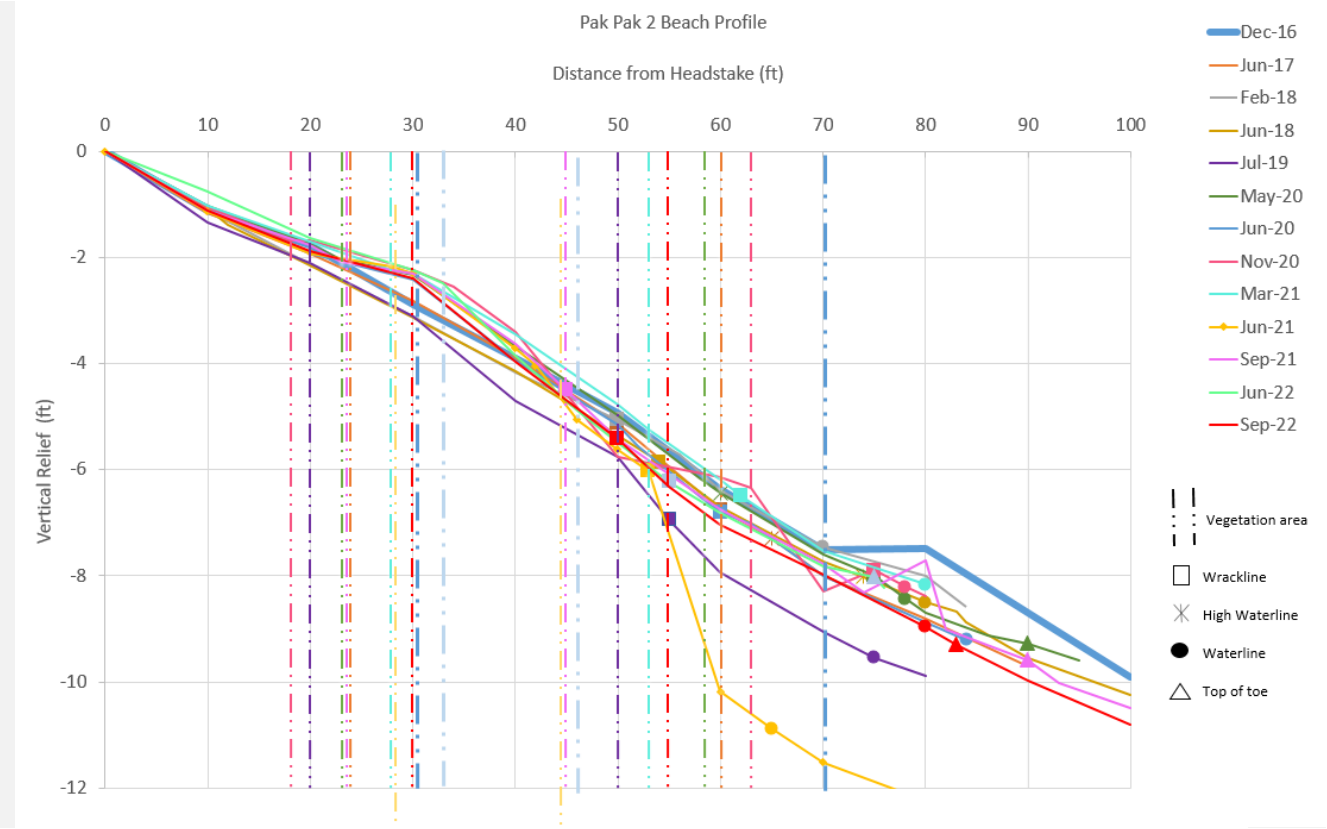
[Photo not available for 2023]

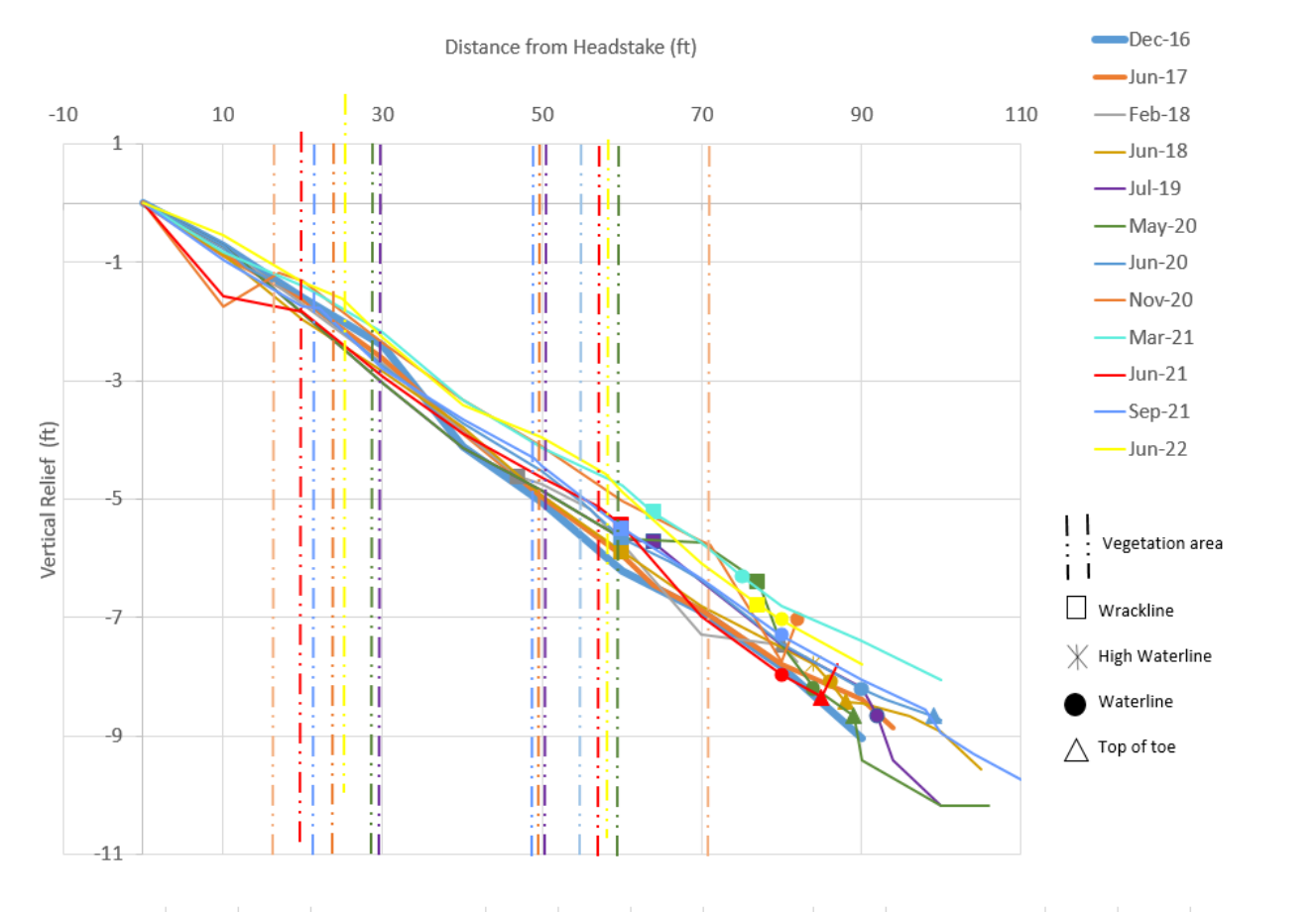
Pak Pak 3



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
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
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 abraded the shoreline and fell trees located on the berm. As a response to the incidental erosion, the Pacific Islands Club Saipan hotel placed sand bags and rocks in hopes of stabilizing the highly eroding storm berm. Fortunately, the storms in this period have not damaged the berm. Wild native vegetation has prospered since their settlement, indicating stability for now. 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:

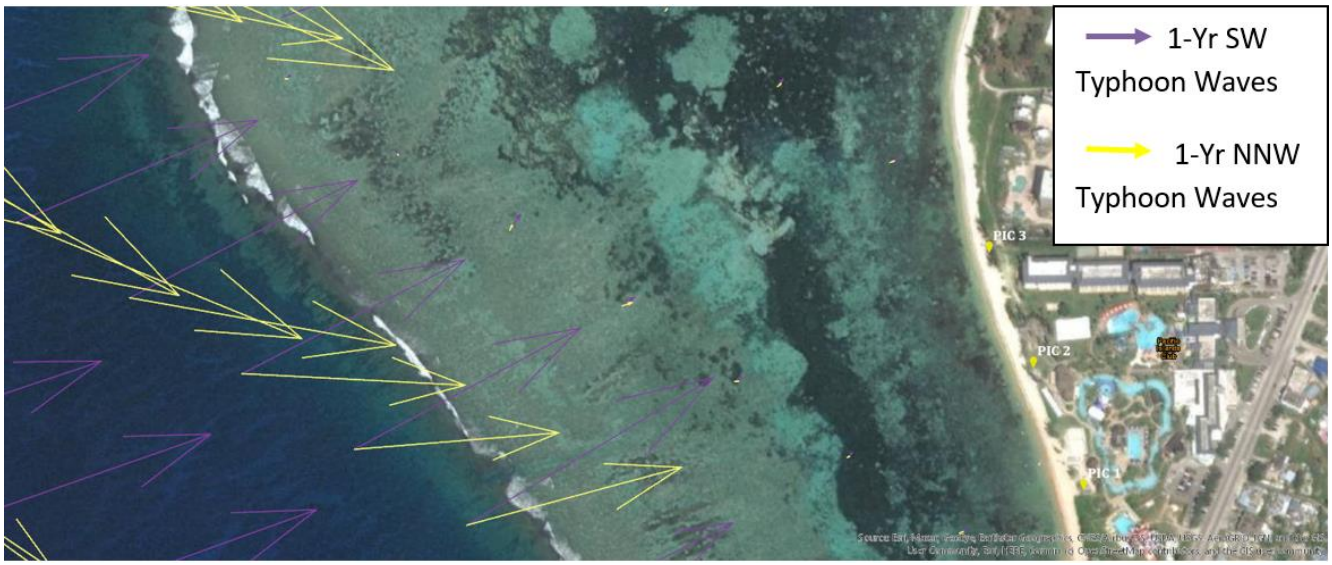
- STABLE
- Wrackline that ranges 36 – 70 ft and an elevation difference of 9 ft
- Erosion to the shoreline occurred in Dec-20 at a 40 ft distance and more.
- Foot traffic continues to discourage vegetation growth.
- Based on the Shoreline linear regression analysis (see pg 19), the shoreline has a rate 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 19), 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 19), the shoreline has a rate of -0.4 ft from 2016-2023.



2020

2021

[Photo not available for 2023]

PIC 1

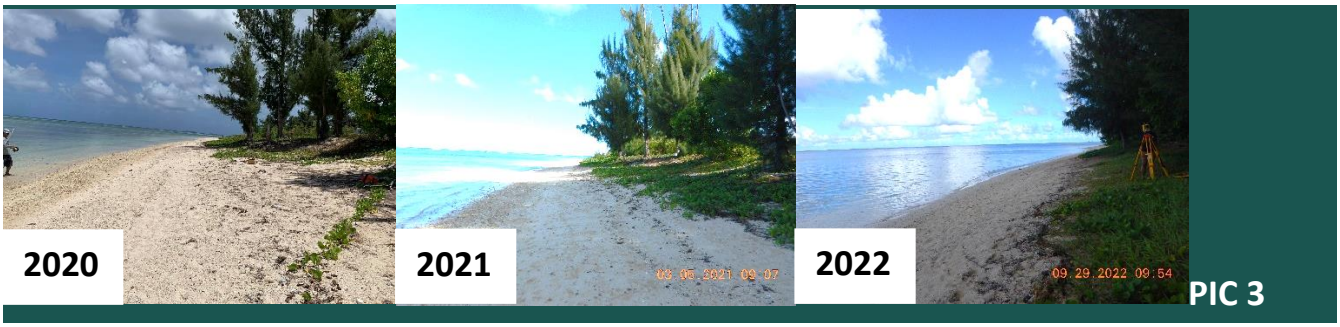
2017

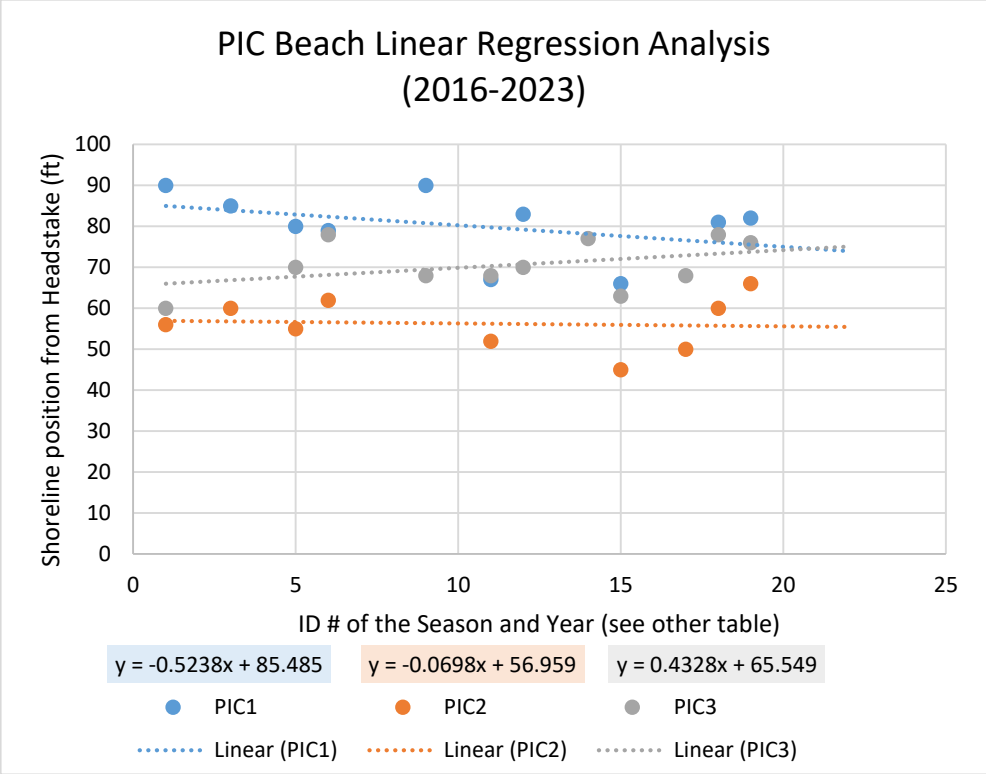
2018

2021

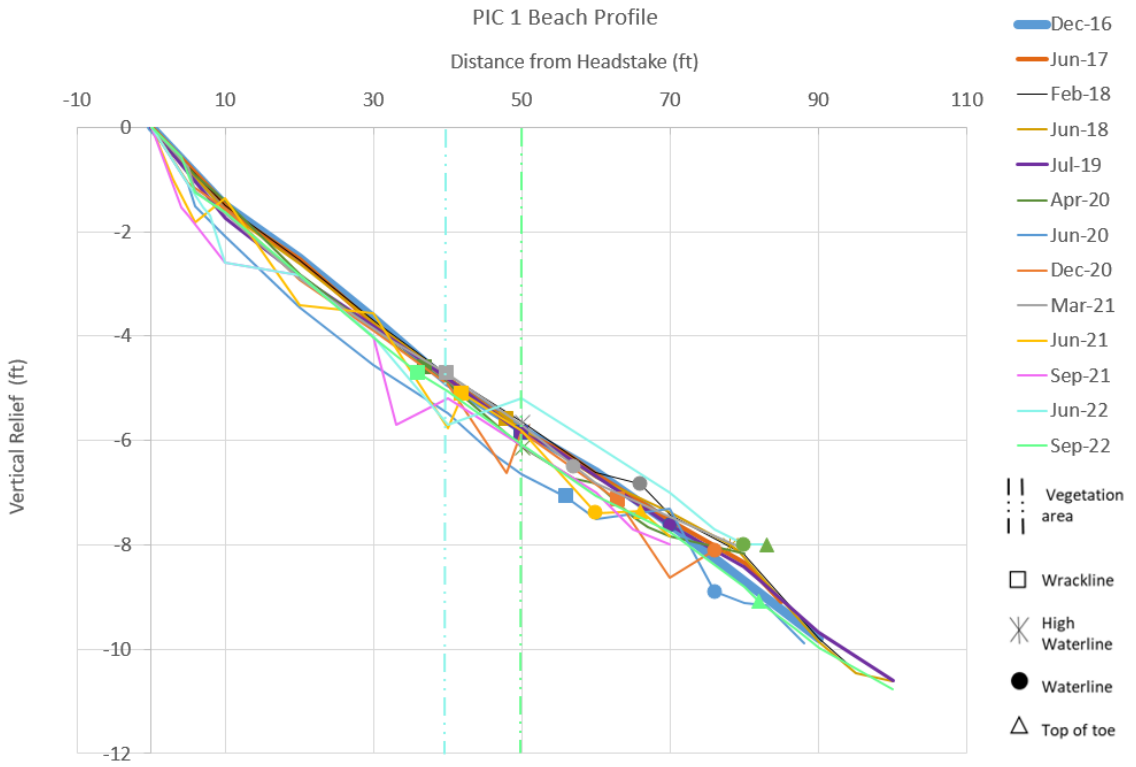
2023

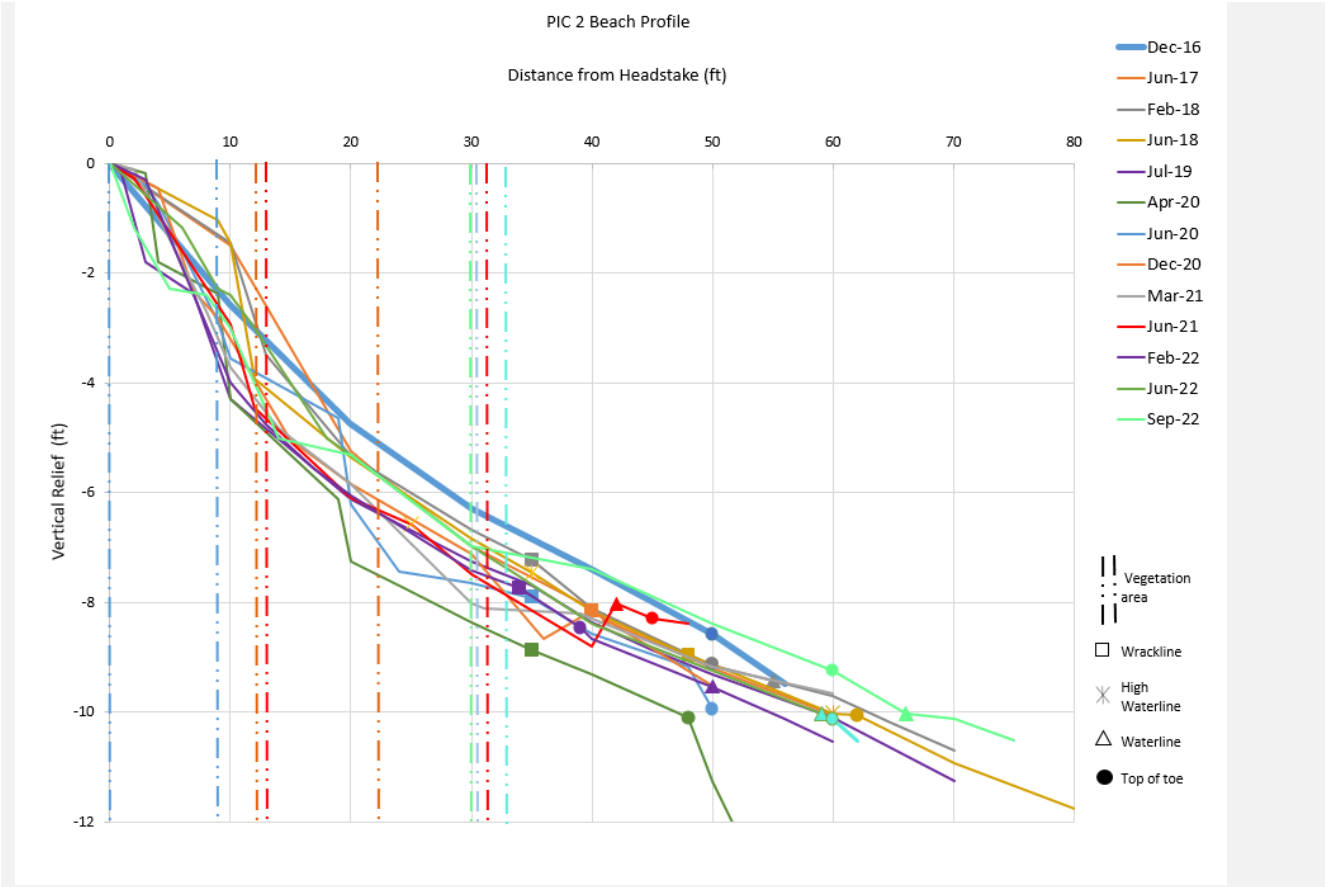
PIC 2

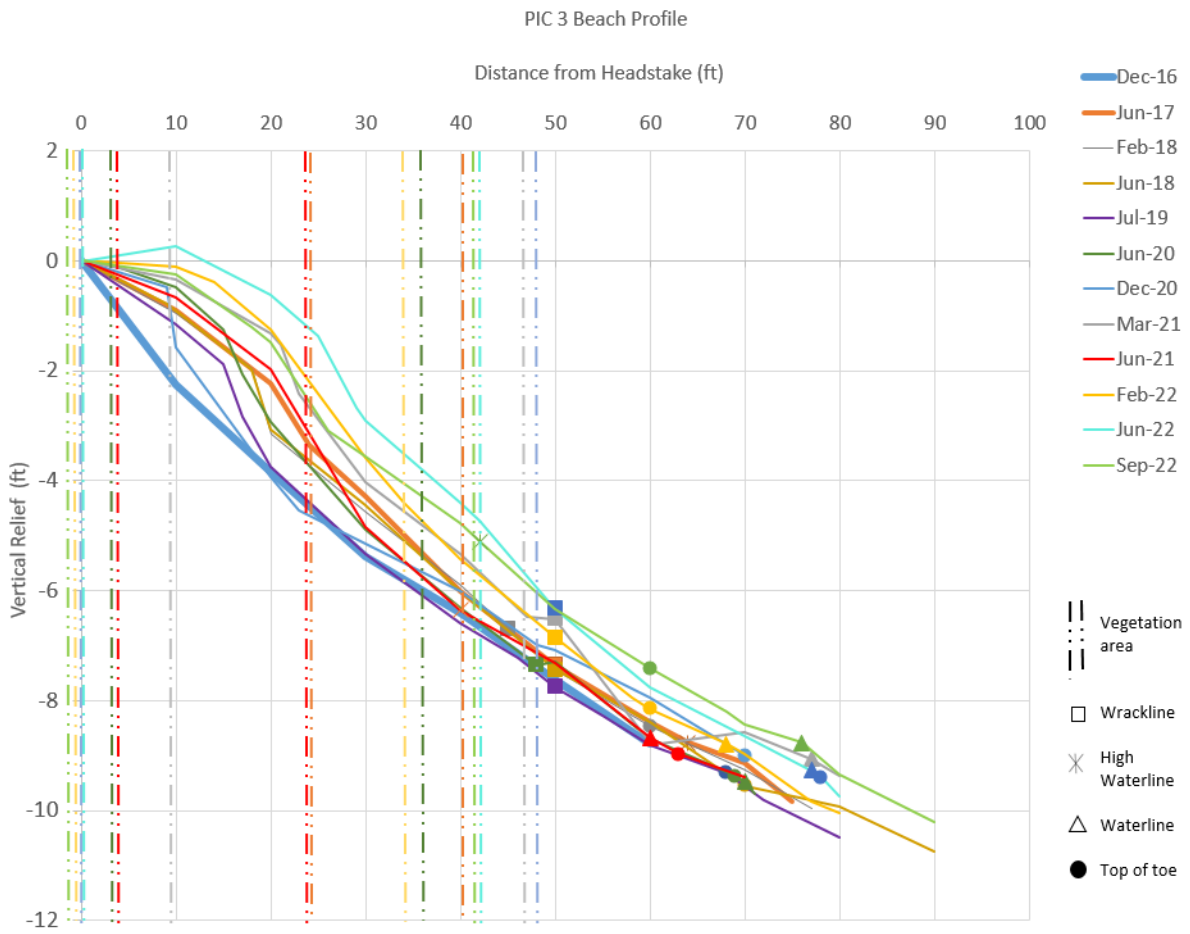

2020
2021
2022
PIC 3


PIC Beach Linear Regression Analysis
(2016-2023)
Shoreline position from Headstake (ft)
100
90
80
70
60
50
40
30
20
10
0
0
5
10
15
20
25
ID # of the Season and Year (see other table)
y = -0.5238x + 85.485
y = -0.0698x + 56.959
y = 0.4328x + 65.549
PIC1
PIC2
PIC3
Linear (PIC1)
Linear (PIC2)
Linear (PIC3)

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
Vegetation 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:

- REPLACED
- Shoreline erosion and dynamic vegetation line are direct impacts from storm surge.
- Nearby outfall has 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.

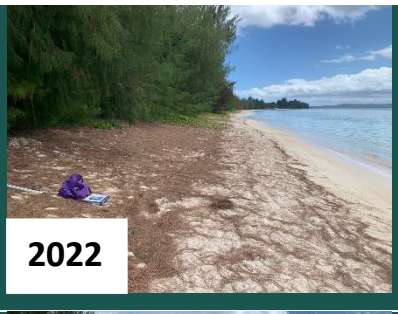
Hopwood 2 Highlights:

- 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 23), the shoreline has a rate of +2.4 ft from 2016-2023.

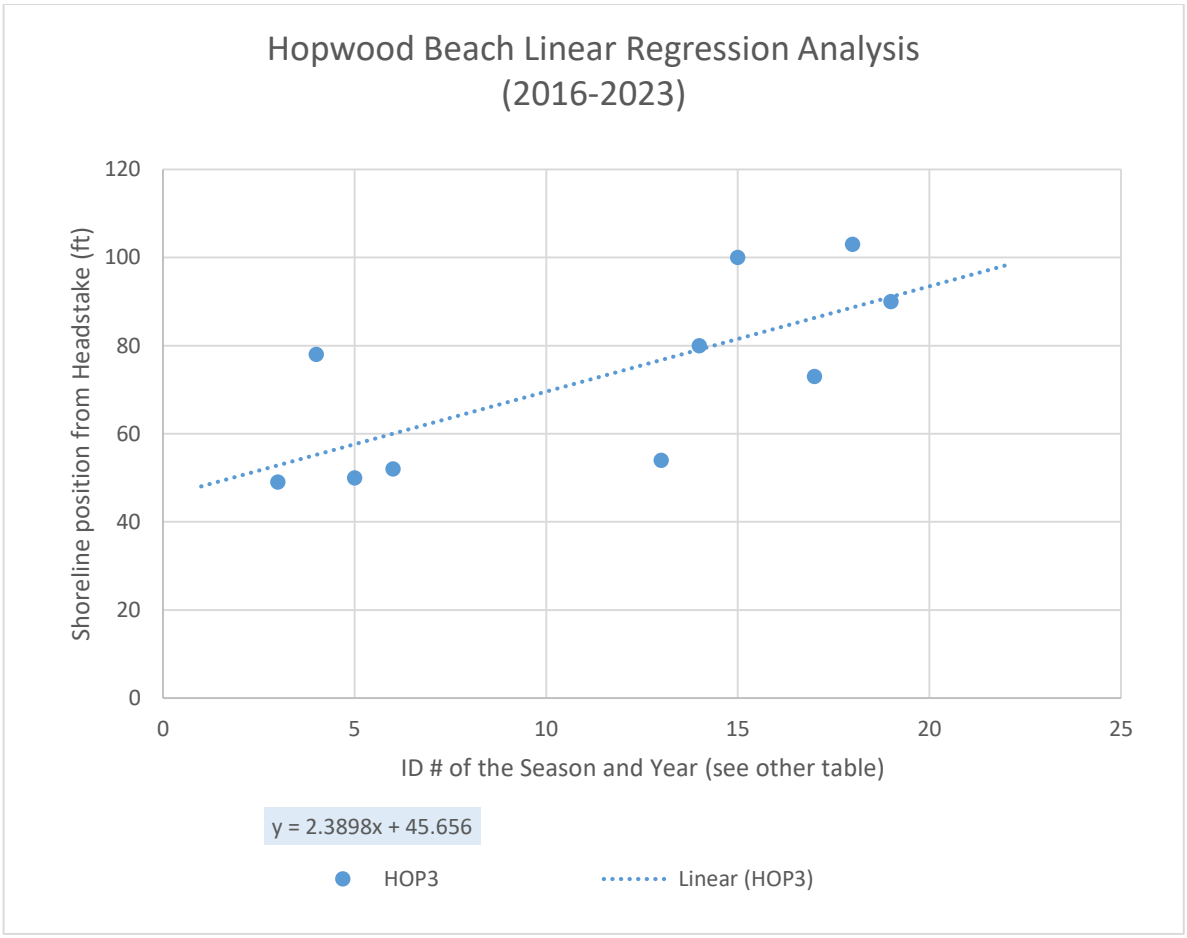
[Photo not available for previous years]



Hopwood 2

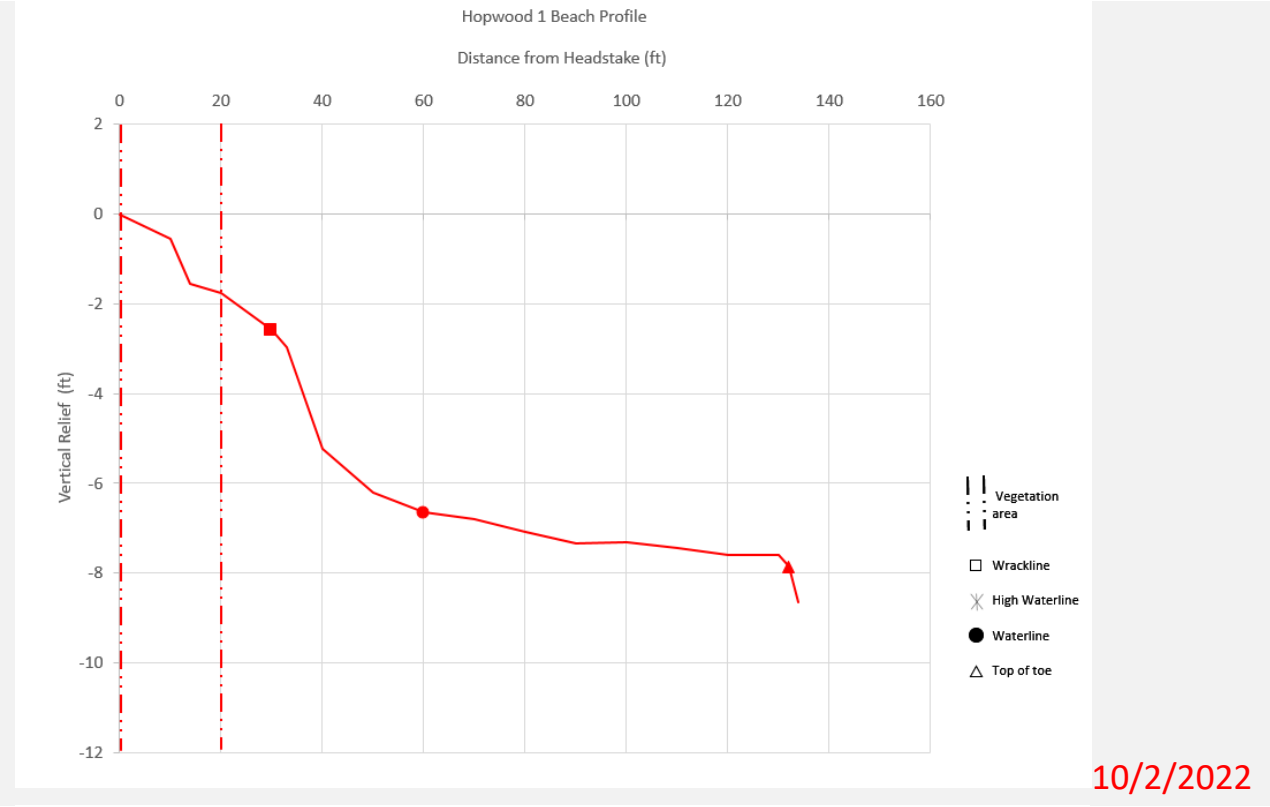
[Photo not available for previous years]

Hopwood 3

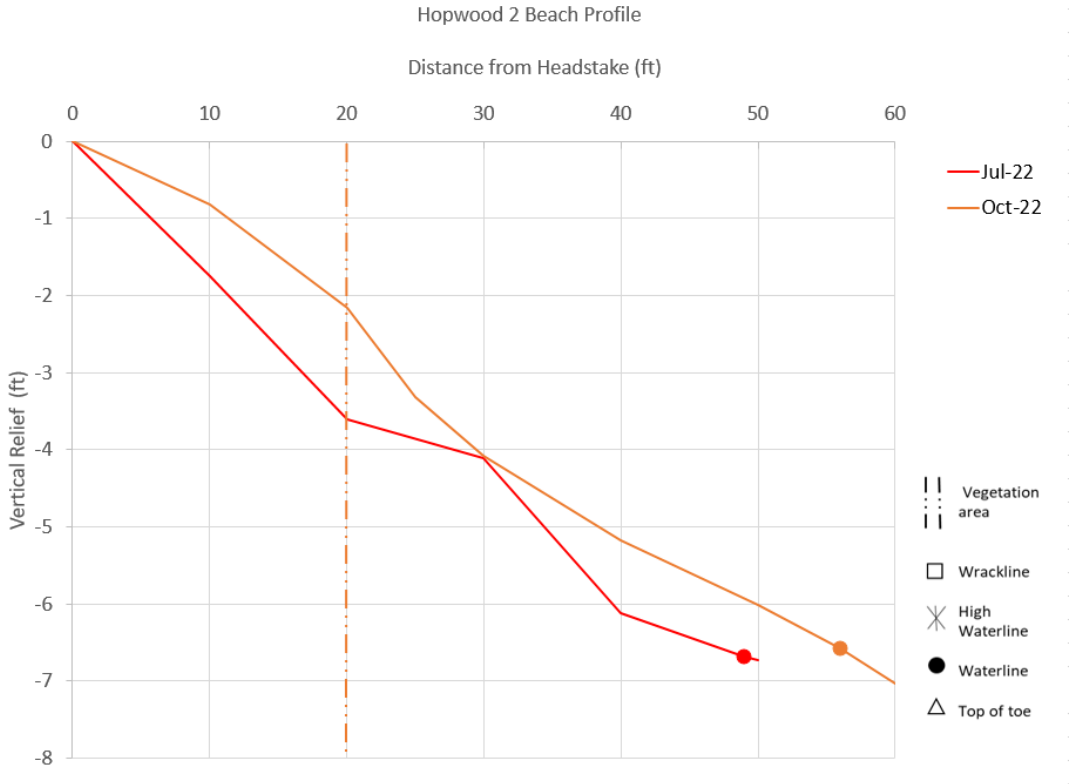


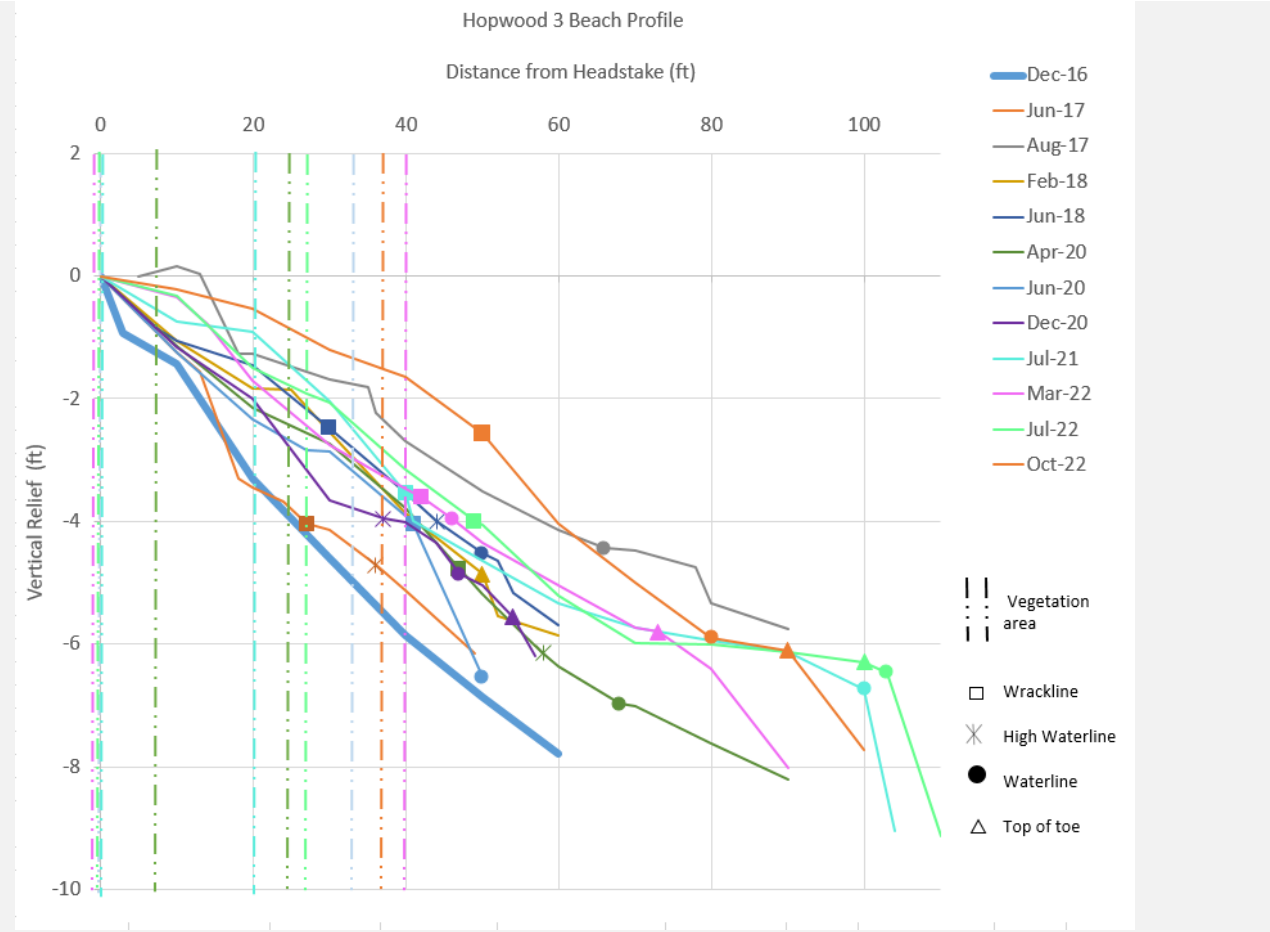
Hopwood Beach Profiles

Berger Level

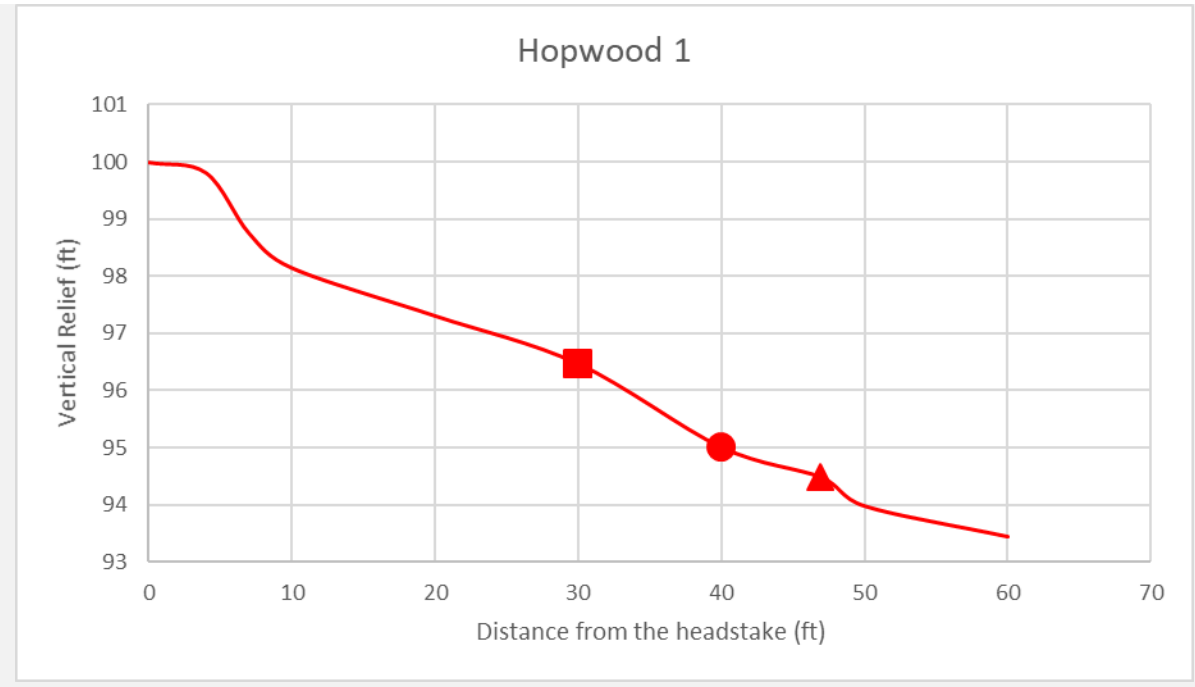


10/2/2022





Total Station




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


Hopwood 3
Vertical relief (ft)
101
100
99
98
97
96
95
94
93
92
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 though 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). Dependent on their direction and strength, waves have the ability to 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 of the berm has compacted the sandy backshore. A couple years ago, small scale beach nourishment increased the width of the shoreline here and the eroding segments of Sugar Dock to the north.

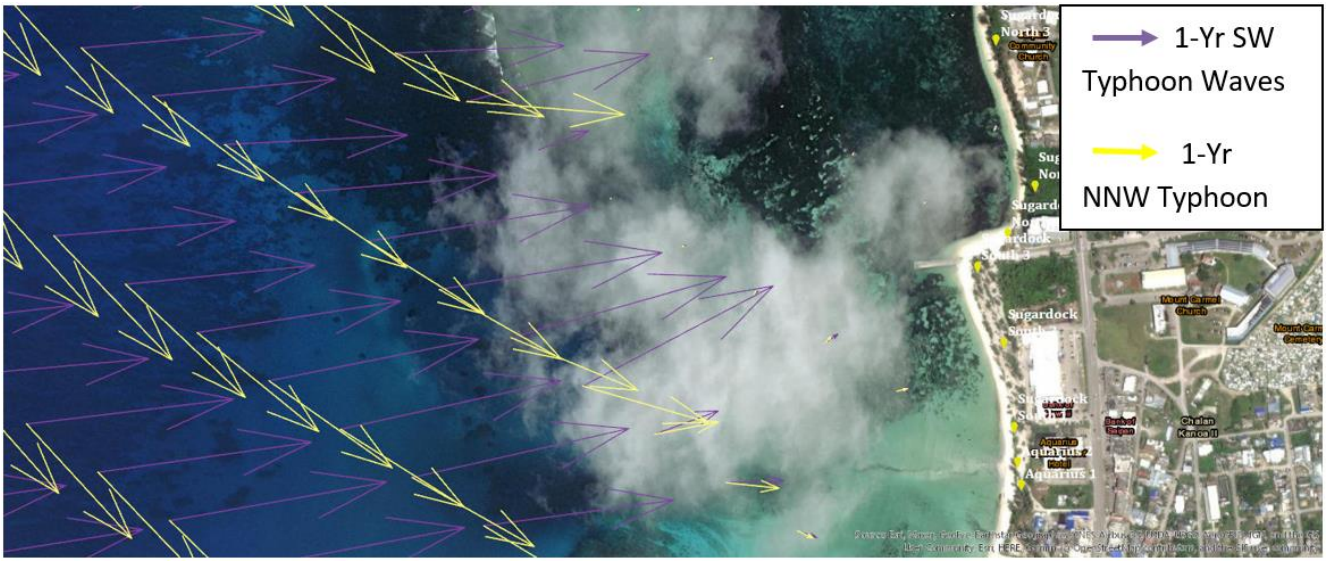
Overwhelming tidal flows from the channel down south may impact this site during both typhoon wave conditions. It appears that southwest conditions could greatly impact this site. Under southwest conditions, longshore transport could potentially be going from south to north while north-northwest conditions 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 29), the shoreline has at a rate of +5.4 ft from 2016-2023.

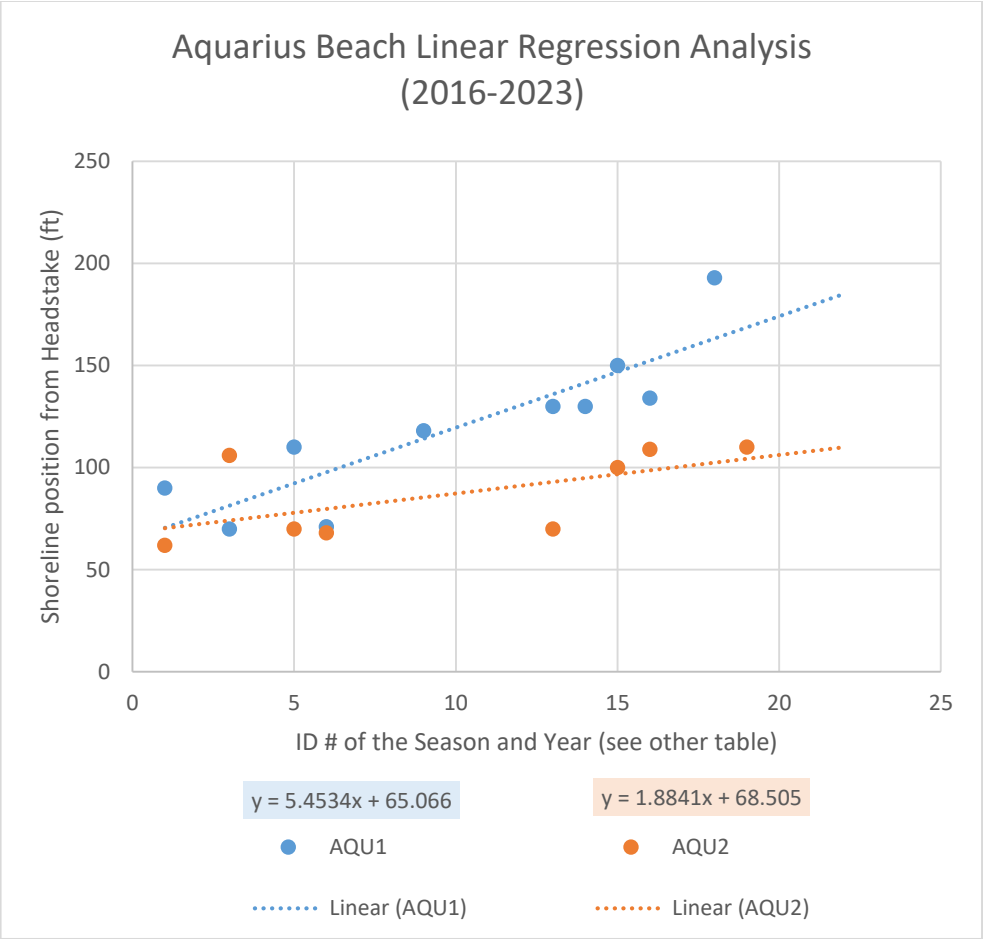
Aquarius 2 Highlights:

- 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 29), the shoreline has a rate of +1.9 ft from 2016-2023.



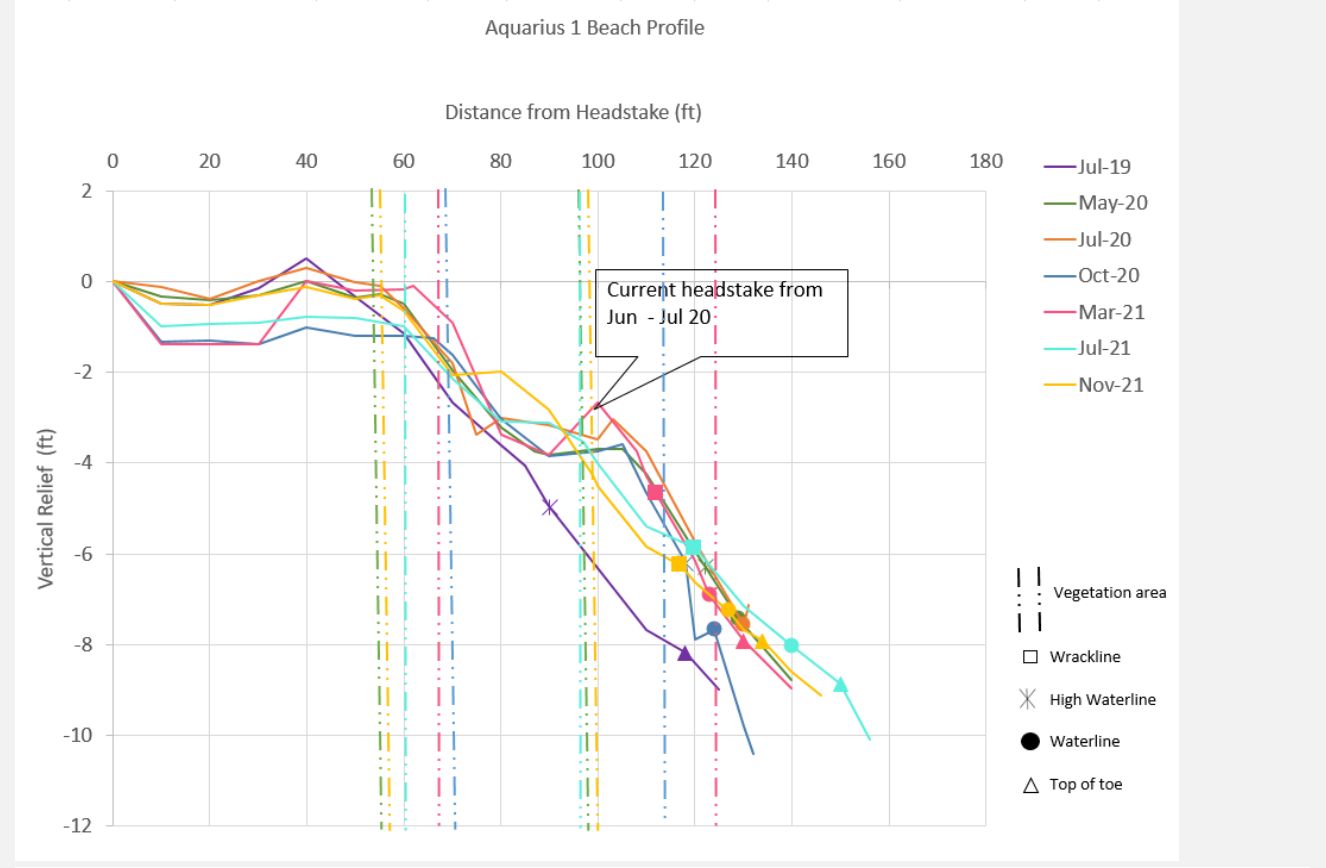
Aquarius 1

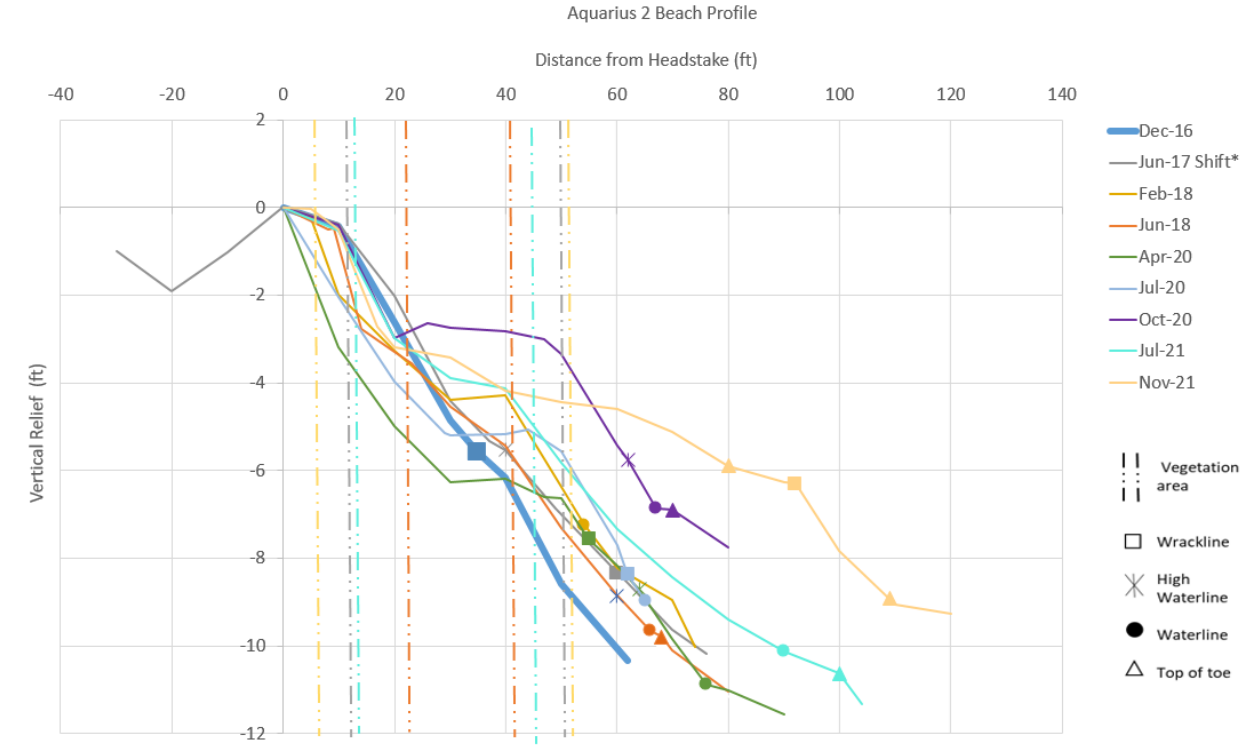
Aquarius 2


Aquarius Beach Linear Regression Analysis
(2016-2023)
Shoreline position from Headstake (ft)
250
200
150
100
50
0
0
5
10
15
20
25
ID # of the Season and Year (see other table)
y = 5.4534x + 65.066
y = 1.8841x + 68.505
AQU1
AQU2
Linear (AQU1)
Linear (AQU2)

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 located south 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. The dredging of this northern area is underway and may be completed this year, followed by the demolition of the existing dock structure and construction of the new dock structure with improved design.

The north of this accreted area have 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 34), 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 34), the shoreline has a rate of -0.4 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 34), the shoreline has a rate of +0.09 ft from 2016-2023.

Sugar Dock North 1 Highlights:

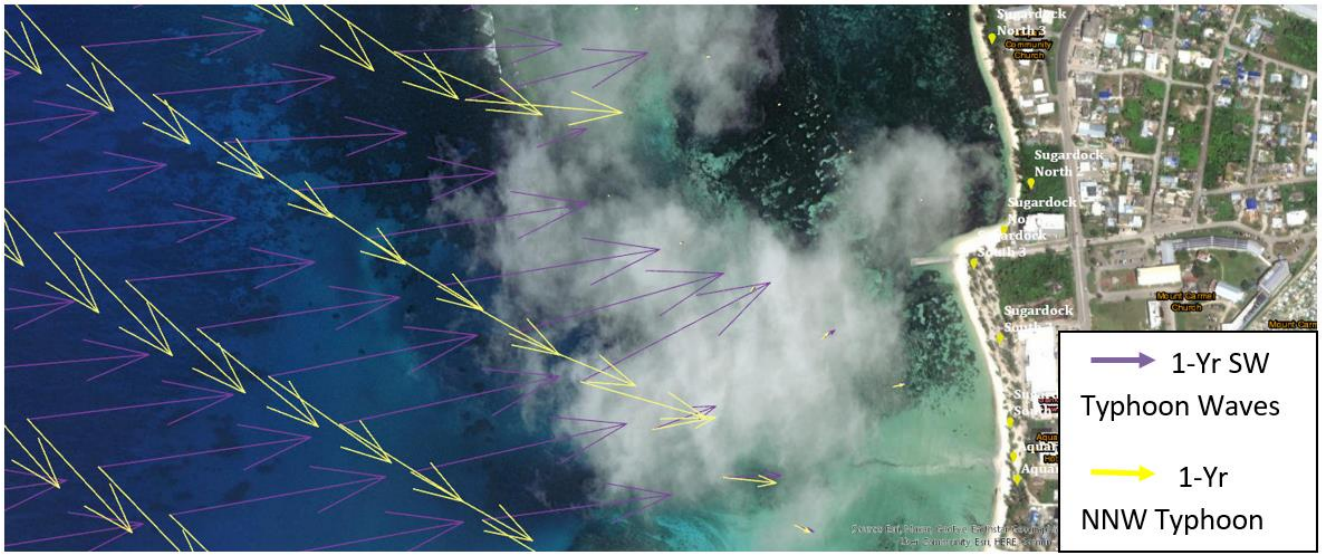
- ACCRETING
- Elevation difference of 6.0 ft
- The dock infrastructure has enabled the accumulation of sand. Growing ironwood trees and morning glory indicate stability. Future dredging to recover proper function of the boating ramp is anticipated to greatly reduce this shoreline profile.
- Based on the Shoreline linear regression analysis (see pg 34), the shoreline has a rate of +4.4 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 34), 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 34), the shoreline has at a rate of -0.4 ft from 2016-2023.



Sugar Dock South 1

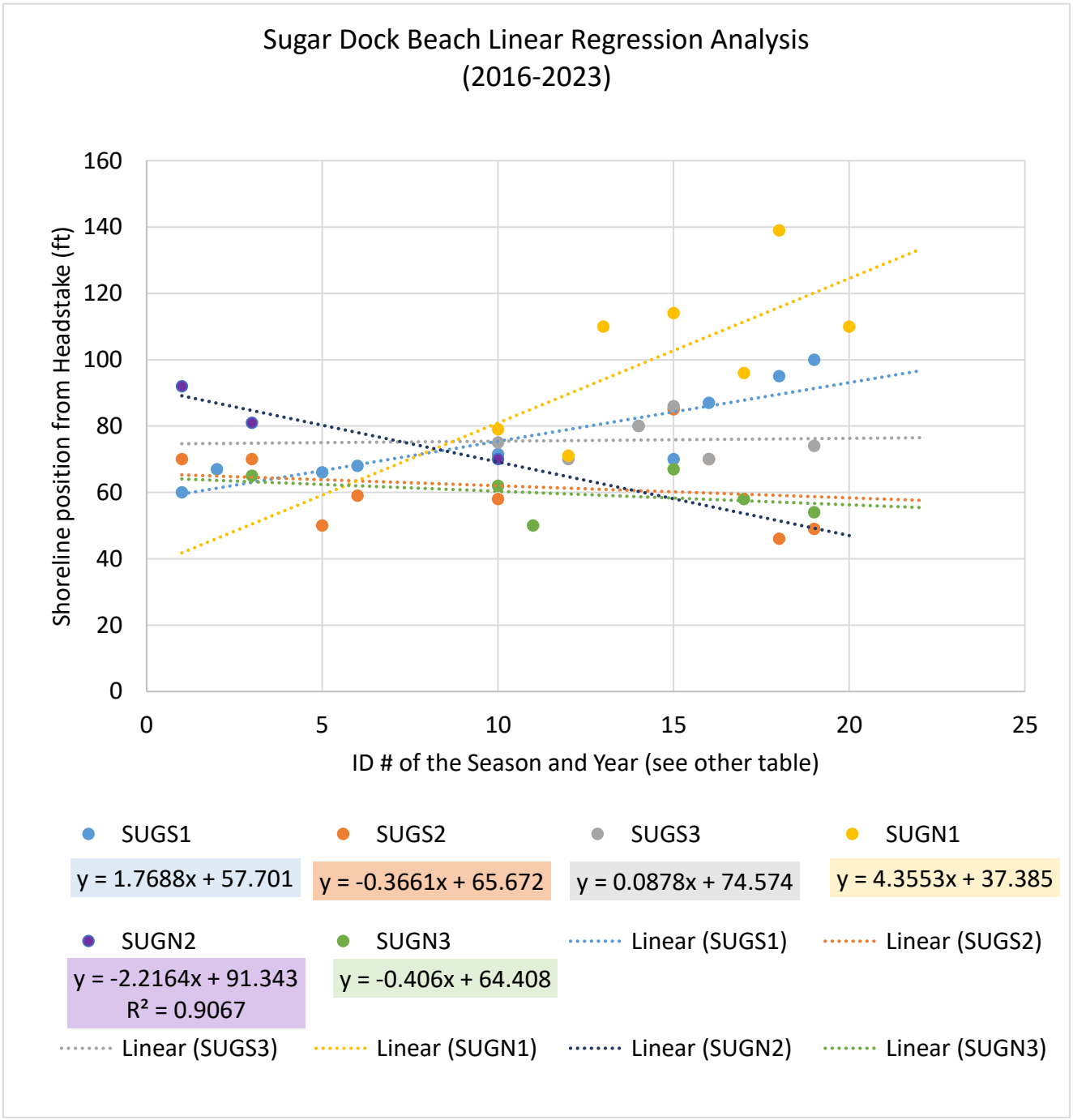
Sugar Dock South 2

Sugar Dock South 3

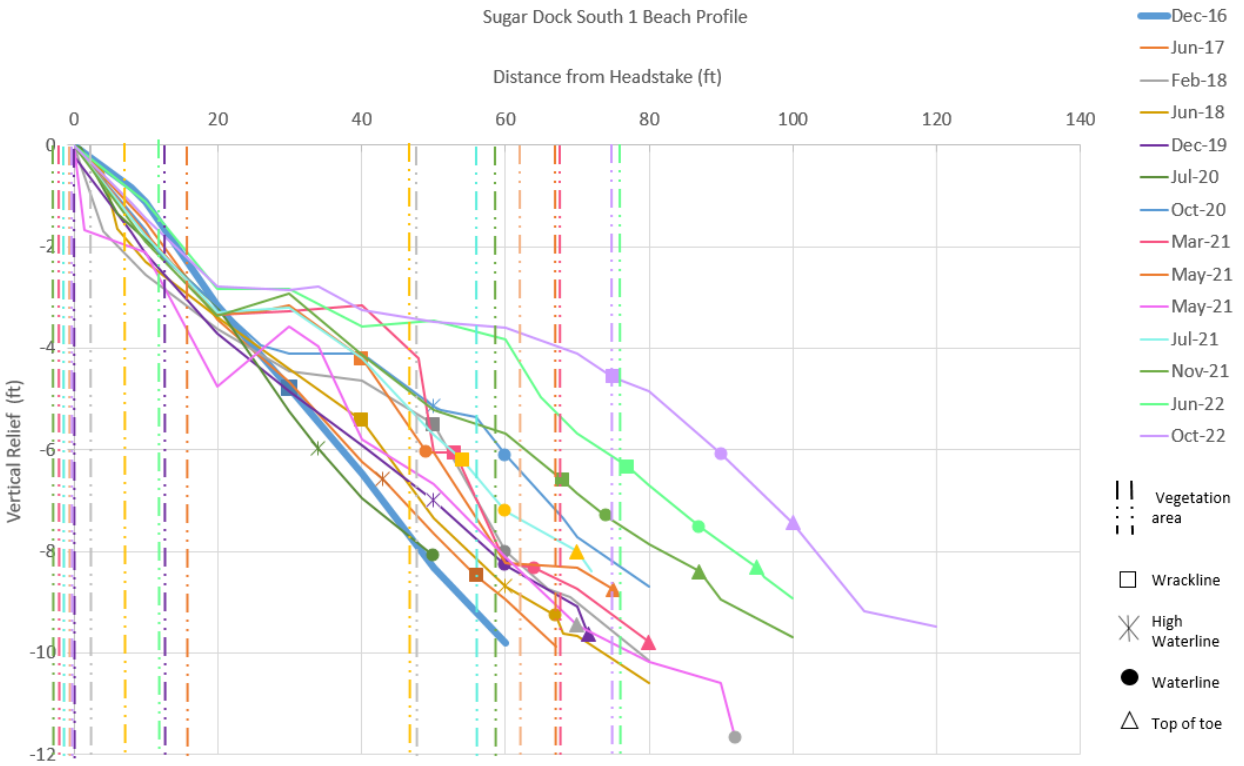
Sugar Dock North 1

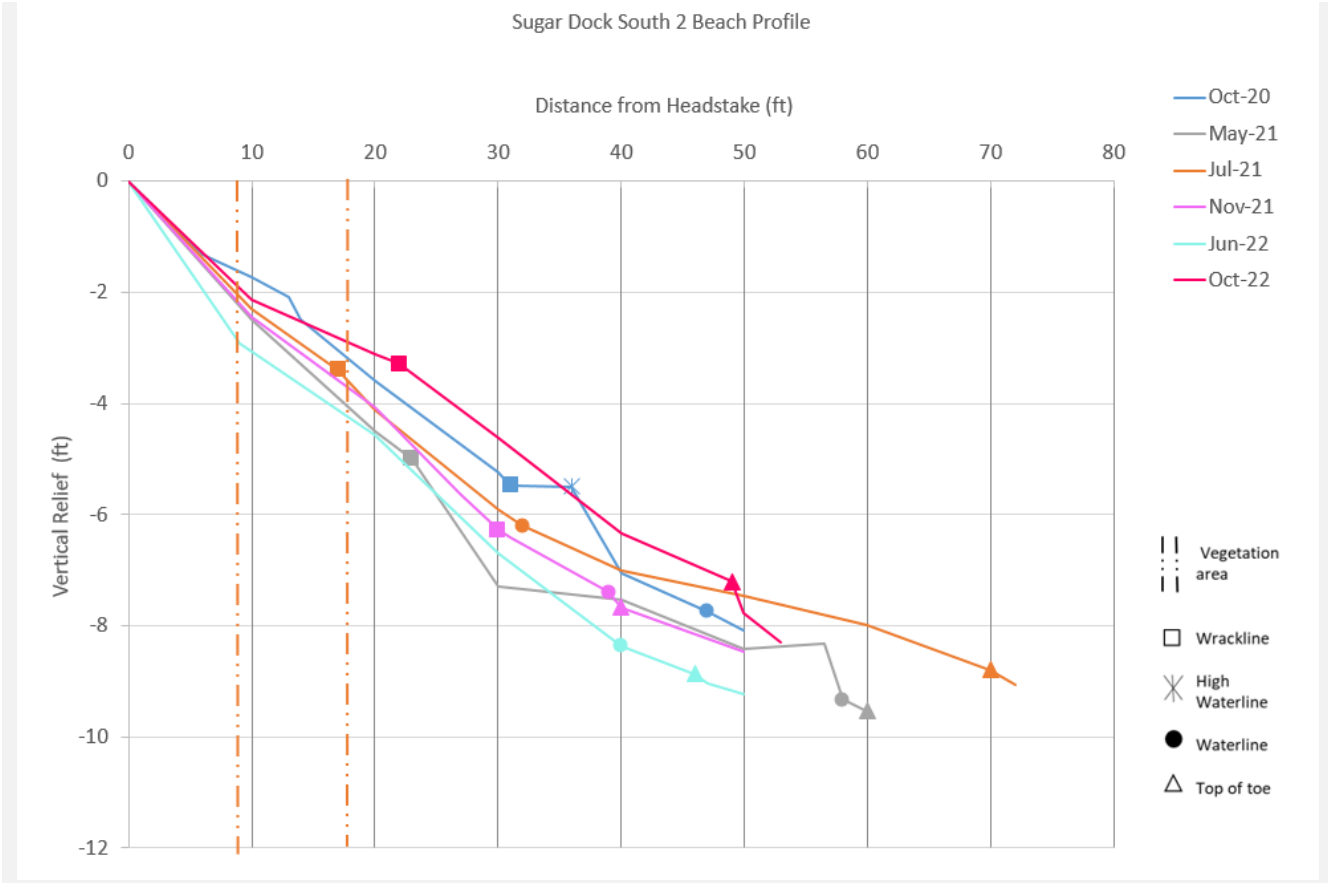
Sugar Dock North 2

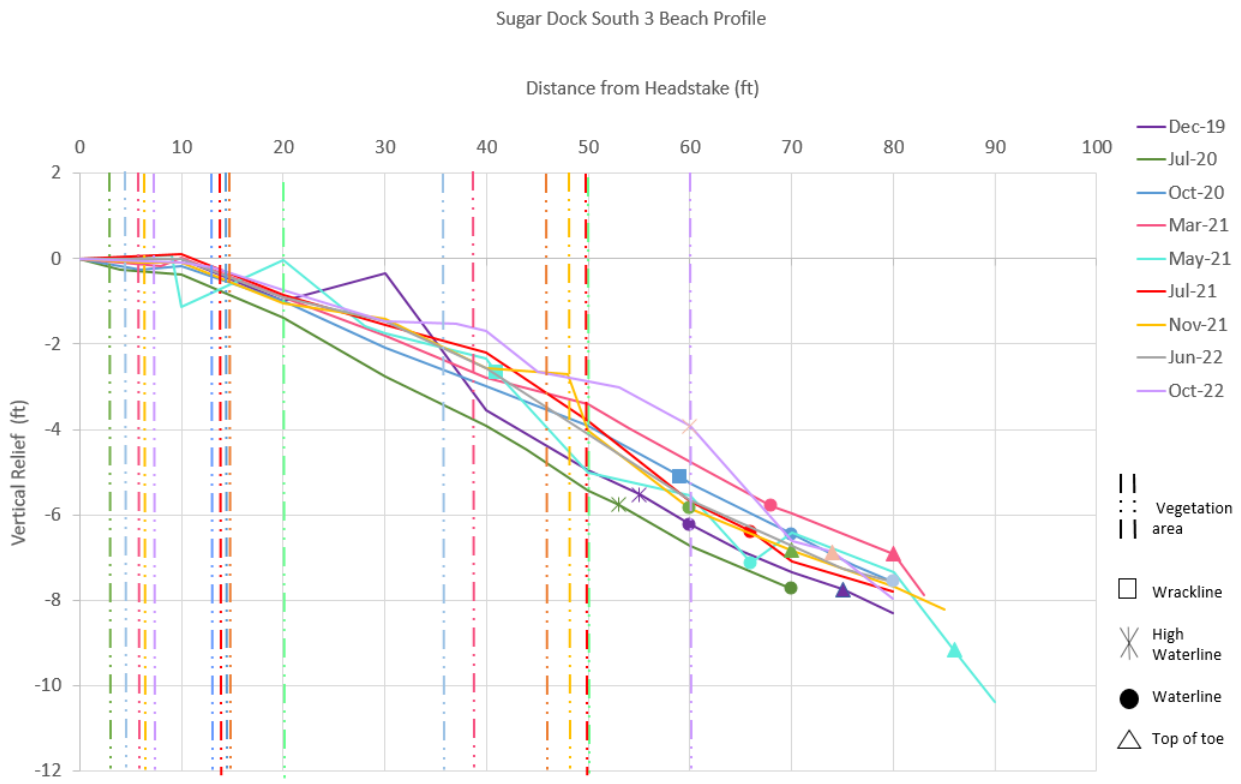
Sugar Dock North 3

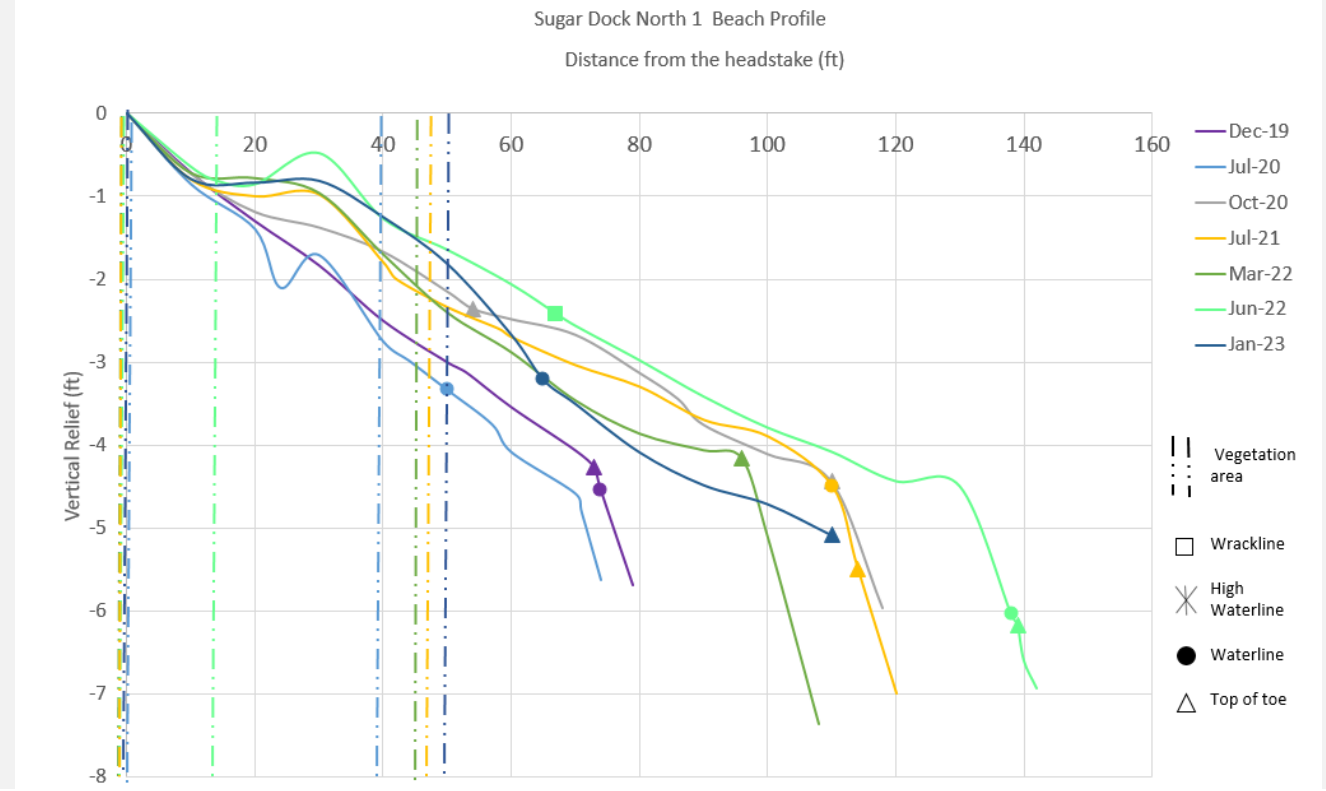

Sugar Dock Beach Linear Regression Analysis
(2016-2023)
Shoreline position from Headstake (ft)
160
140
120
100
80
60
40
20
0
0
5
10
15
20
25
ID # of the Season and Year (see other table)
SUGS1
y = 1.7688x + 57.701
SUGS2
y = -0.3661x + 65.672
SUGS3
y = 0.0878x + 74.574
SUGN1
y = 4.3553x + 37.385
SUGN2
y = -2.2164x + 91.343
R² = 0.9067
SUGN3
y = -0.406x + 64.408
Linear (SUGS1)
Linear (SUGS2)
Linear (SUGS3)
Linear (SUGN1)
Linear (SUGN2)
Linear (SUGN3)

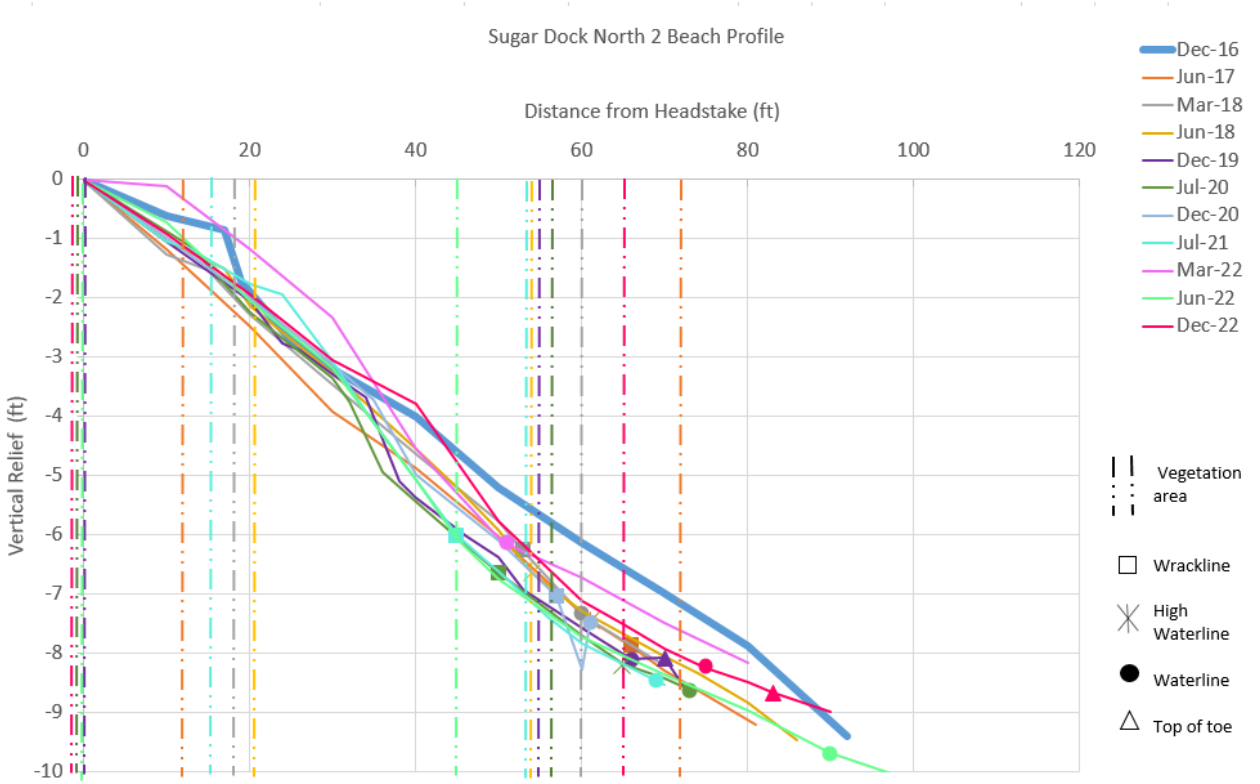
Sugar Dock Beach Profiles

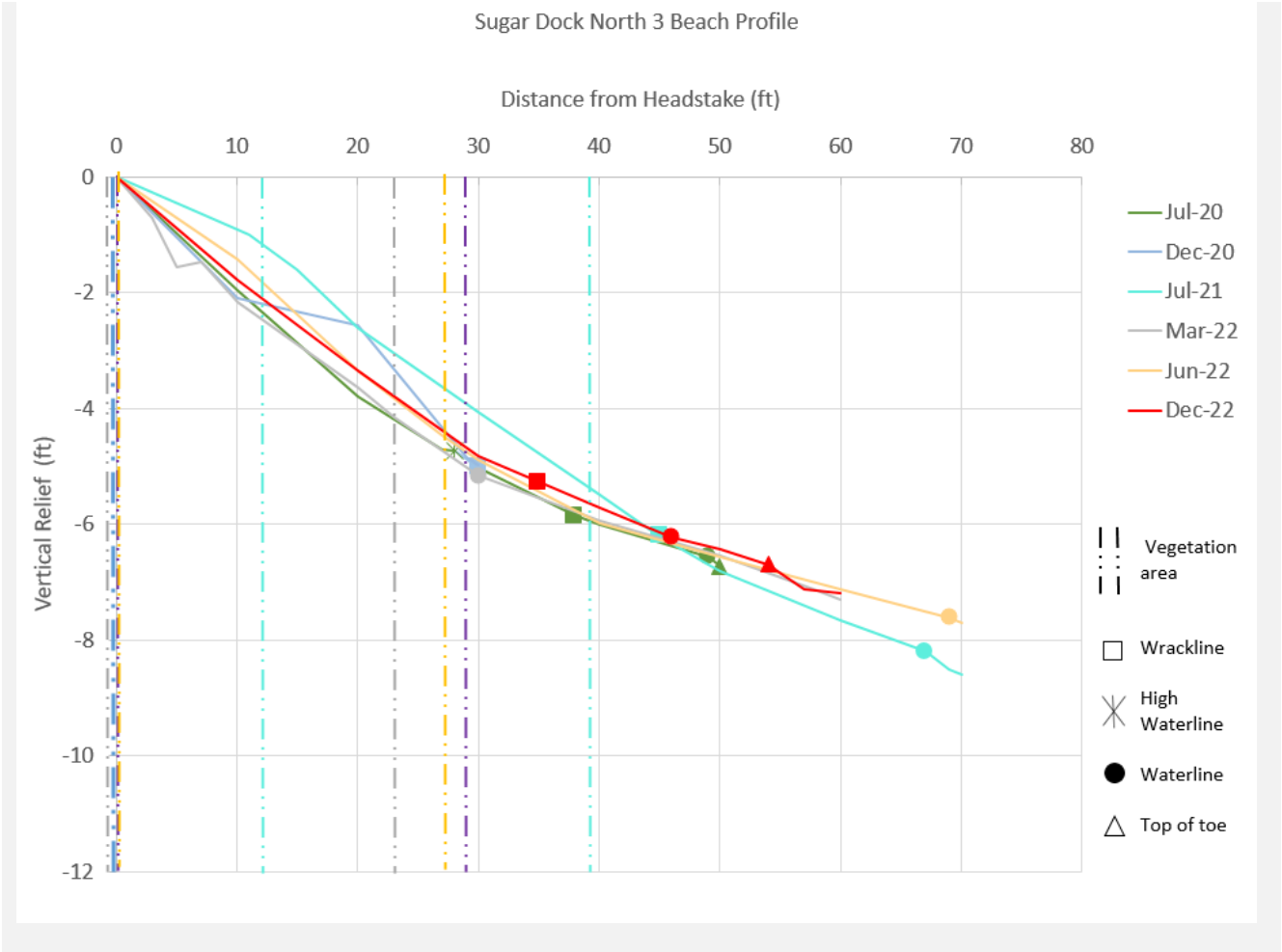




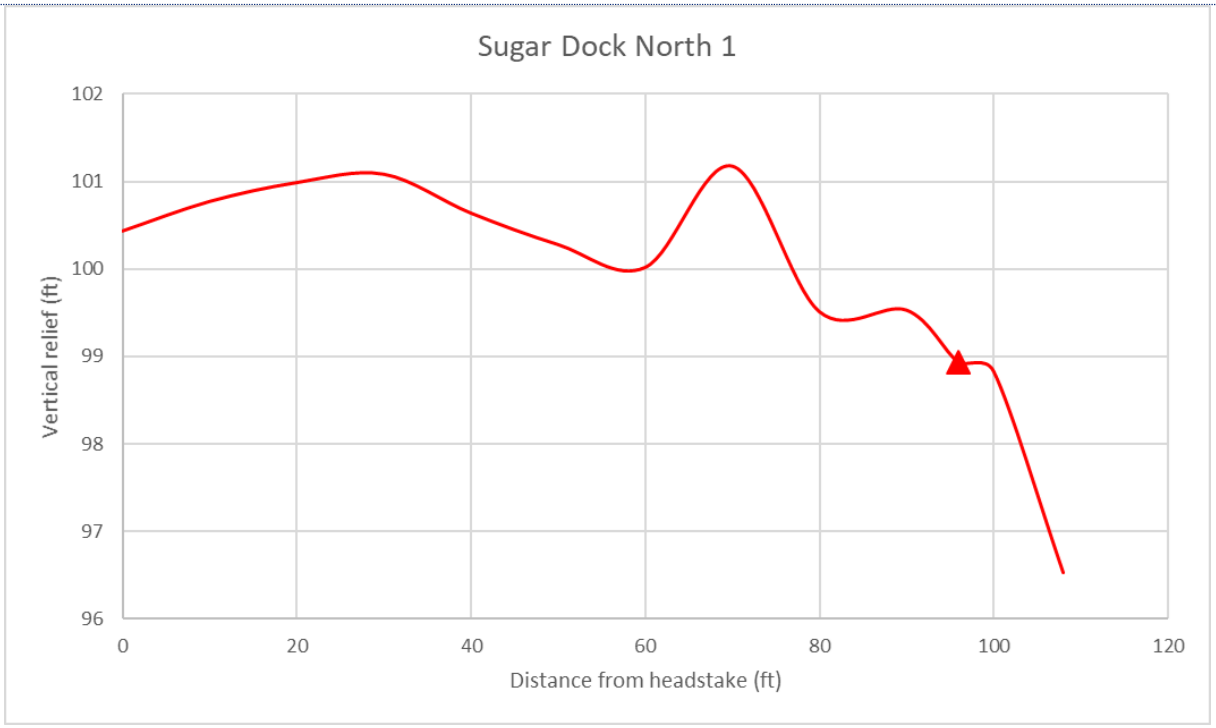

Sugar Dock South 3 Beach Profile
Distance from Headstake (ft)
Vertical Relief (ft)
0
10
20
30
40
50
60
70
80
90
100
2
0
-2
-4
-6
-8
-10
-12
Dec-19
Jul-20
Oct-20
Mar-21
May-21
Jul-21
Nov-21
Jun-22
Oct-22
Vegetation area
Wrackline
High Waterline
Waterline
Top of toe

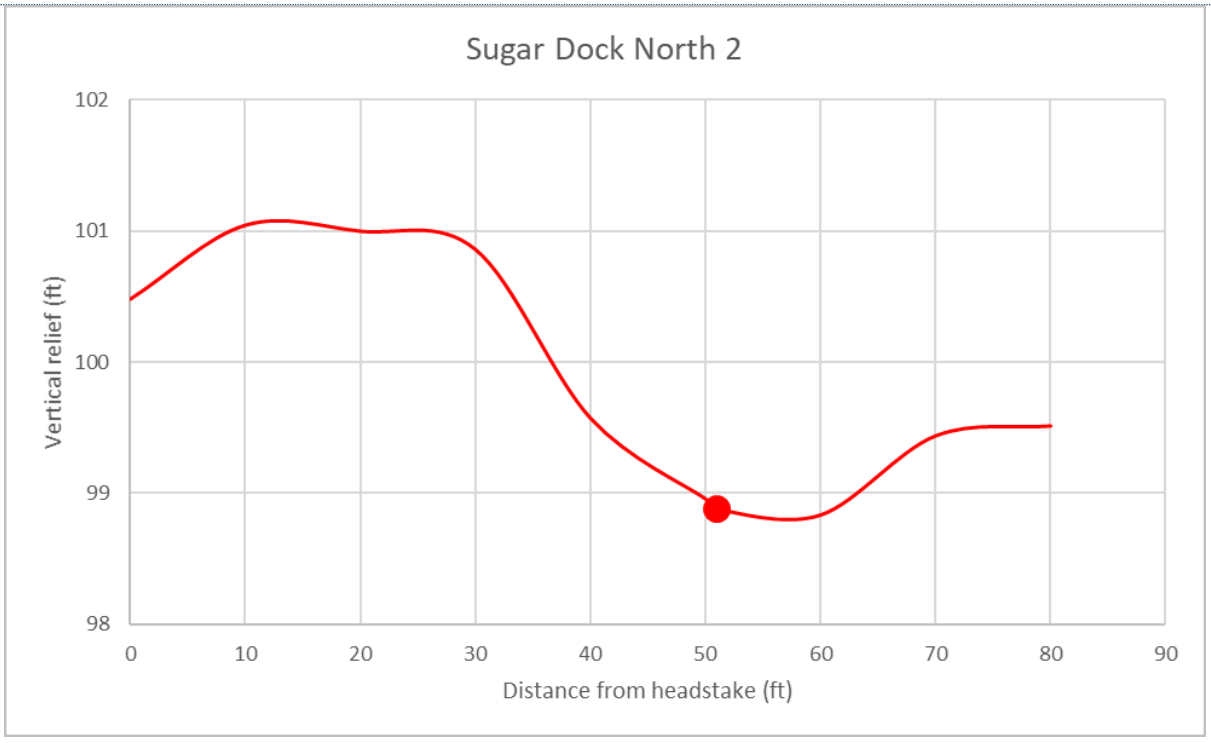

Sugar Dock North 1 Beach Profile
Distance from the headstake (ft)
Vertical Relief (ft)
0
20
40
60
80
100
120
140
160
0
-1
-2
-3
-4
-5
-6
-7
-8
Dec-19
Jul-20
Oct-20
Jul-21
Mar-22
Jun-22
Jan-23
Vegetation area
Wrackline
High Waterline
Waterline
Top of toe

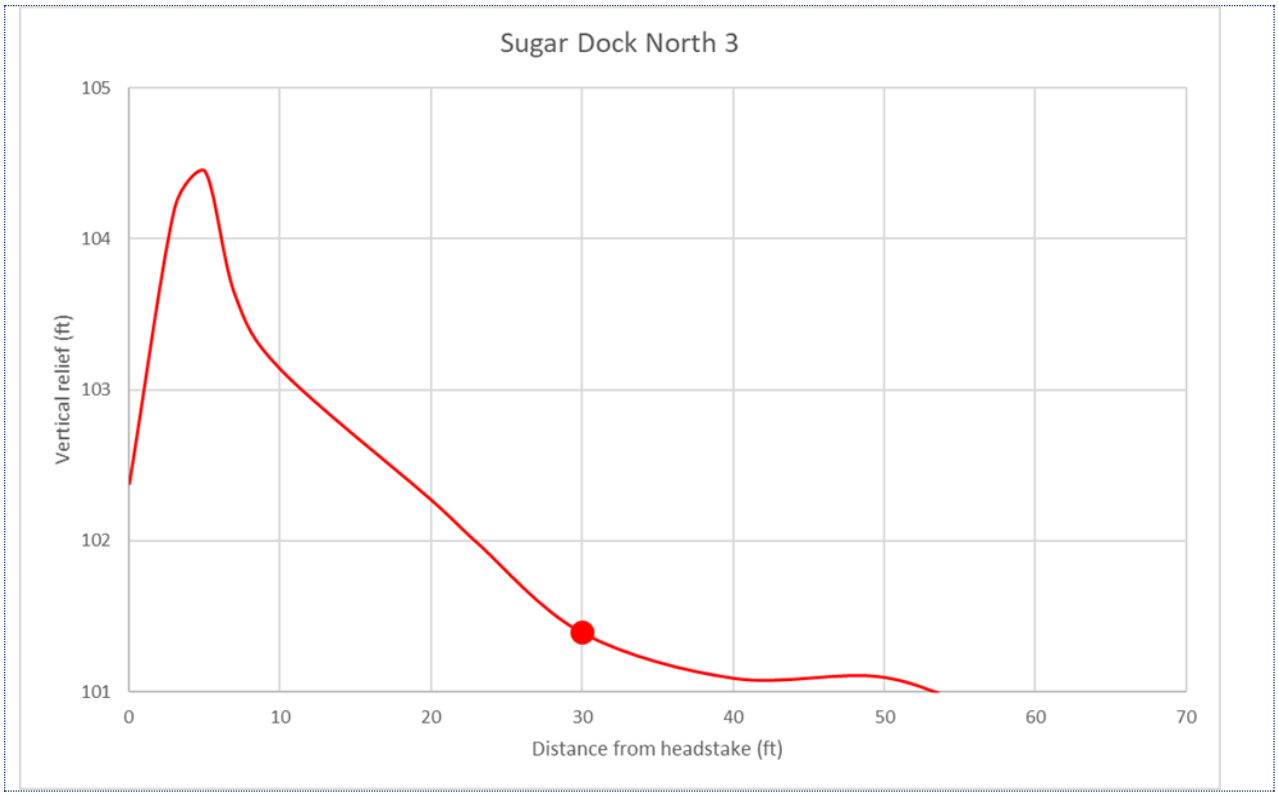

Sugar Dock North 2 Beach Profile
Distance from Headstake (ft)
0
20
40
60
80
100
120
Vertical Relief (ft)
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
-10
Dec-16
Jun-17
Mar-18
Jun-18
Dec-19
Jul-20
Dec-20
Jul-21
Mar-22
Jun-22
Dec-22
Vegetation area
Wrackline
High Waterline
Waterline
Top of toe


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
Vegetation area
Wrackline
High Waterline
Waterline
Top of toe

Total Station






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

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.

Previous restrictions to public access of the beach park have been uplifted in this reporting period. Wave overtopping and overwhelmed tidal flows may impact this site during both typhoon wave conditions. It appears that southwest conditions could greatly impact this site. However, improved resolution on nearshore dynamics may explain sediment transport for this area. The channel may have some influence on sediment transport while the seagrass beds may also attenuate wave energies.

Susupe Beach Park 1 Highlights:

- STABLE
- Wrackline that ranges 40 – 53 ft and an elevation difference of more than 8 ft
- Based on the Shoreline linear regression analysis (see pg 41), the shoreline has a rate of +0.8 ft from 2016-2023.

Susupe Beach Park 2 Highlights:

- STABLE
- Wrackline that ranges 47 – 70 ft and an elevation difference of more than 8 ft
- Based on the Shoreline linear regression analysis (see pg 41), the shoreline has a rate of +0.06 ft from 2016-2023.

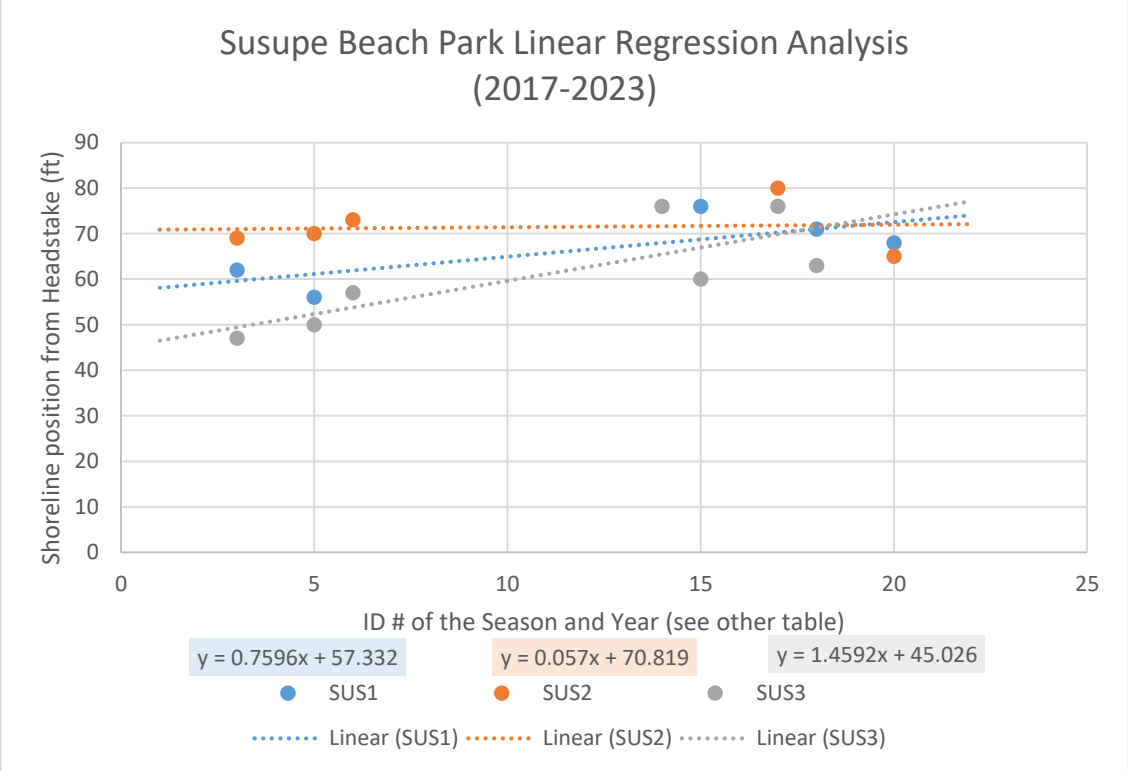
Susupe Beach Park 3 Highlights:

- ACCRETING
- Wrackline that ranges 30 – 60 ft and an elevation difference of 8 ft
- Based on the Shoreline linear regression analysis (see pg 41), the shoreline has been a rate of +1.5 ft from 2016-2023.

Susupe Beach Park 1

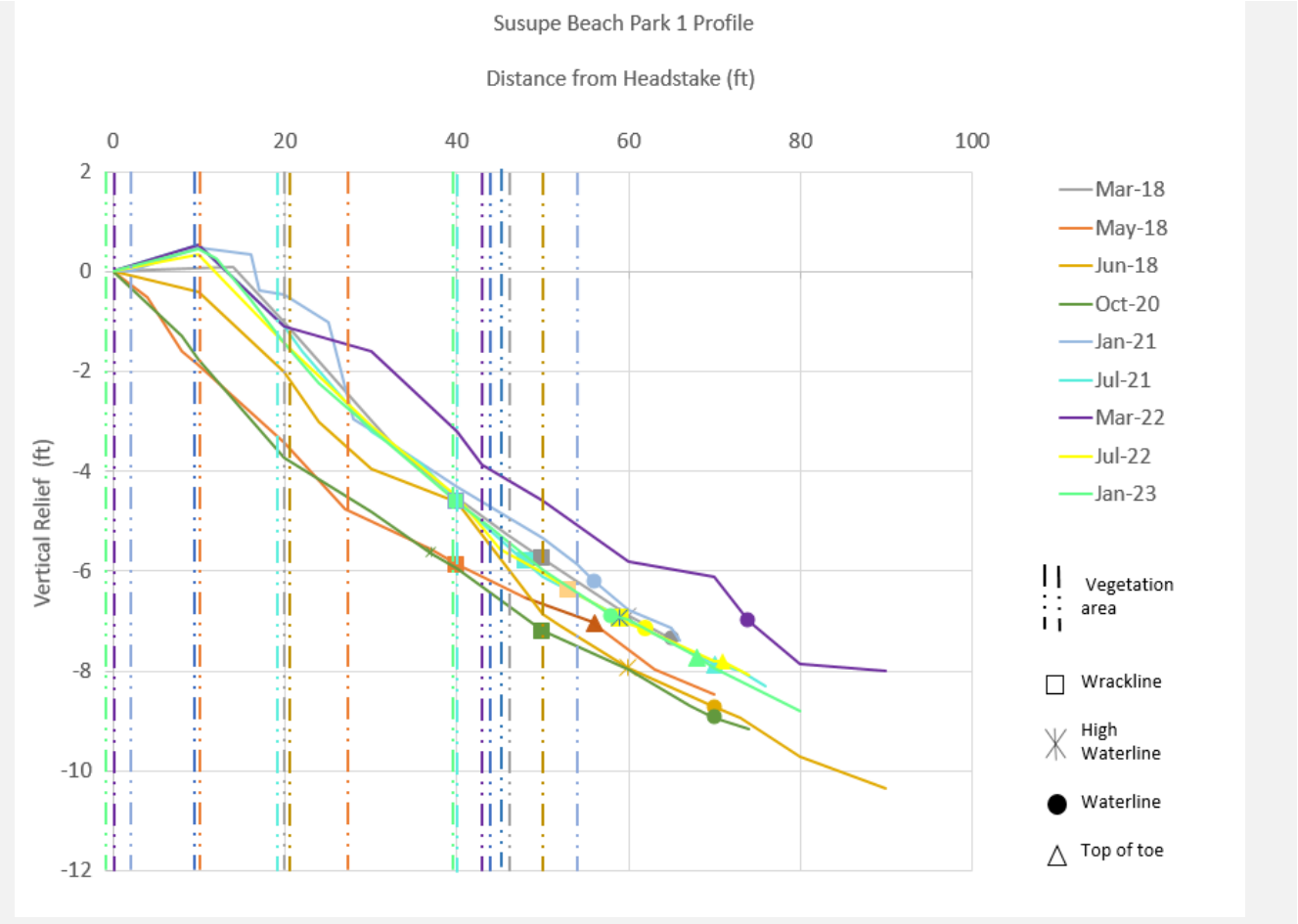
Susupe Beach Park 2

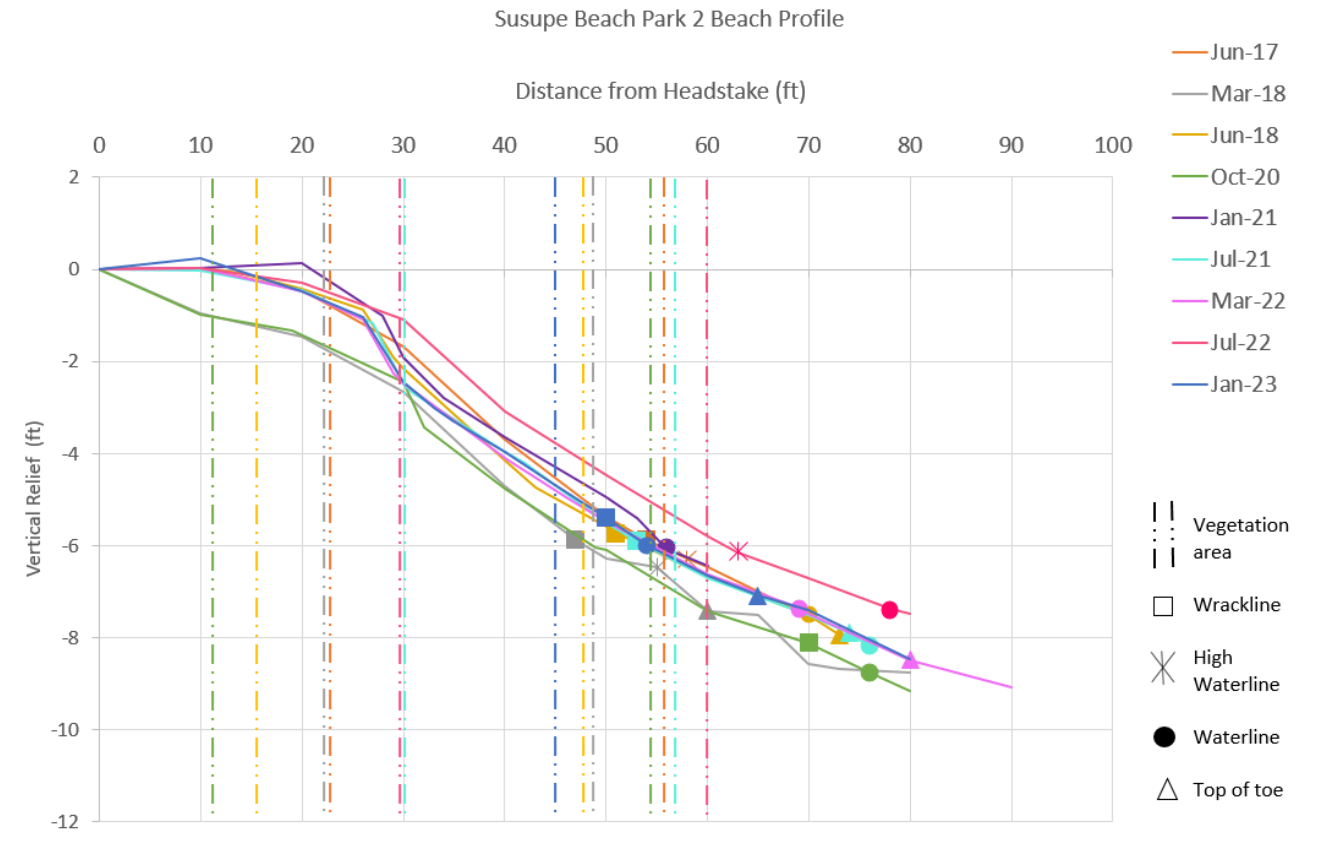
Susupe Beach Park 3

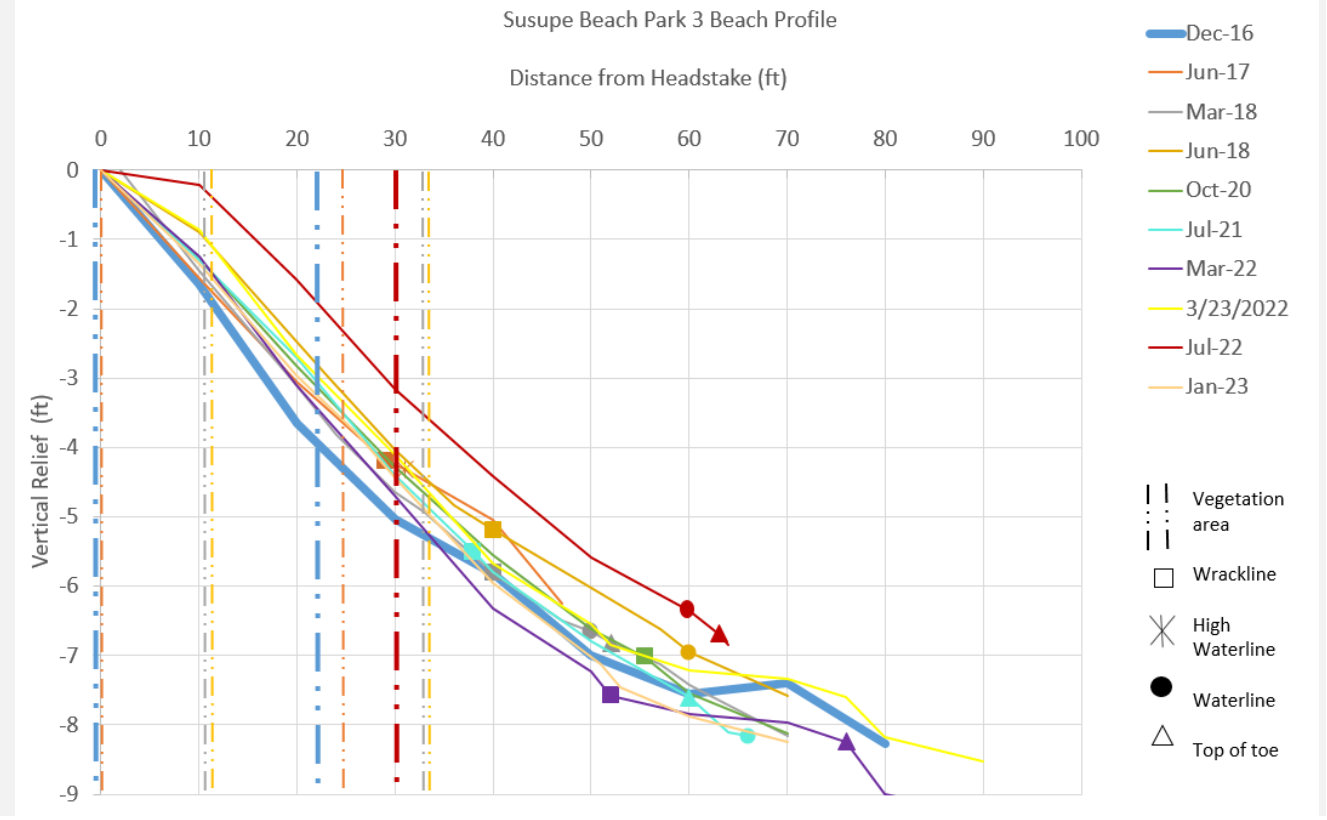


Susupe Beach Park Beach Profiles

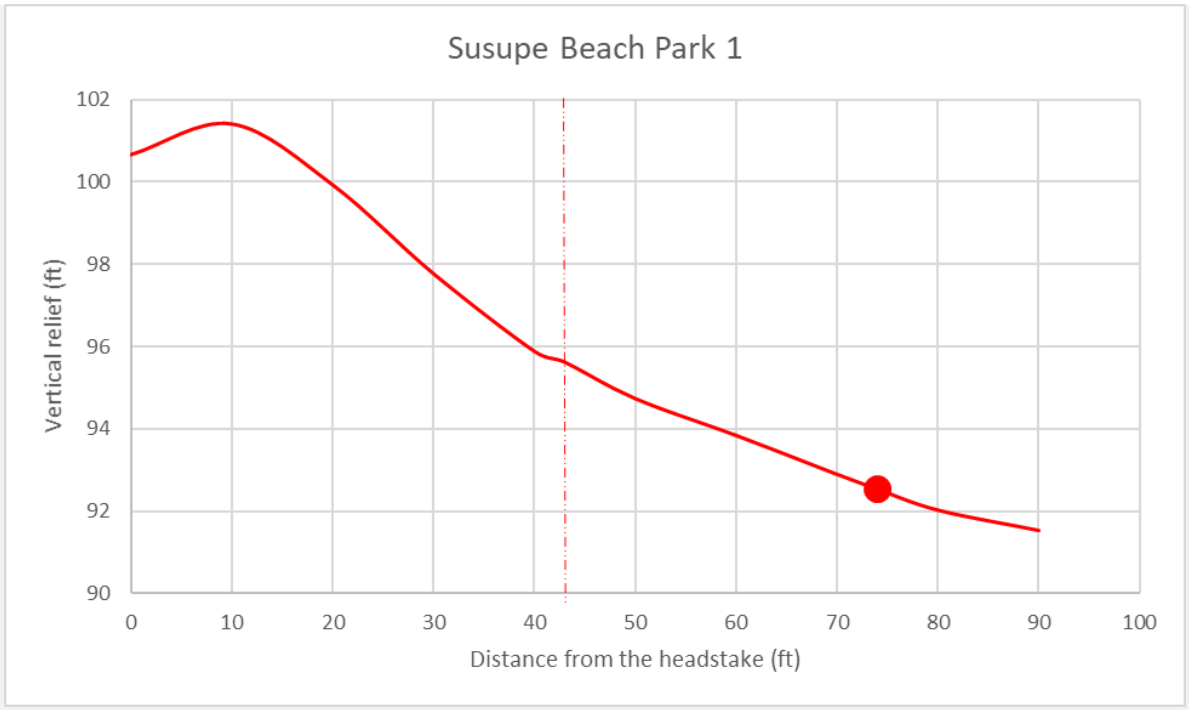
Berger Level

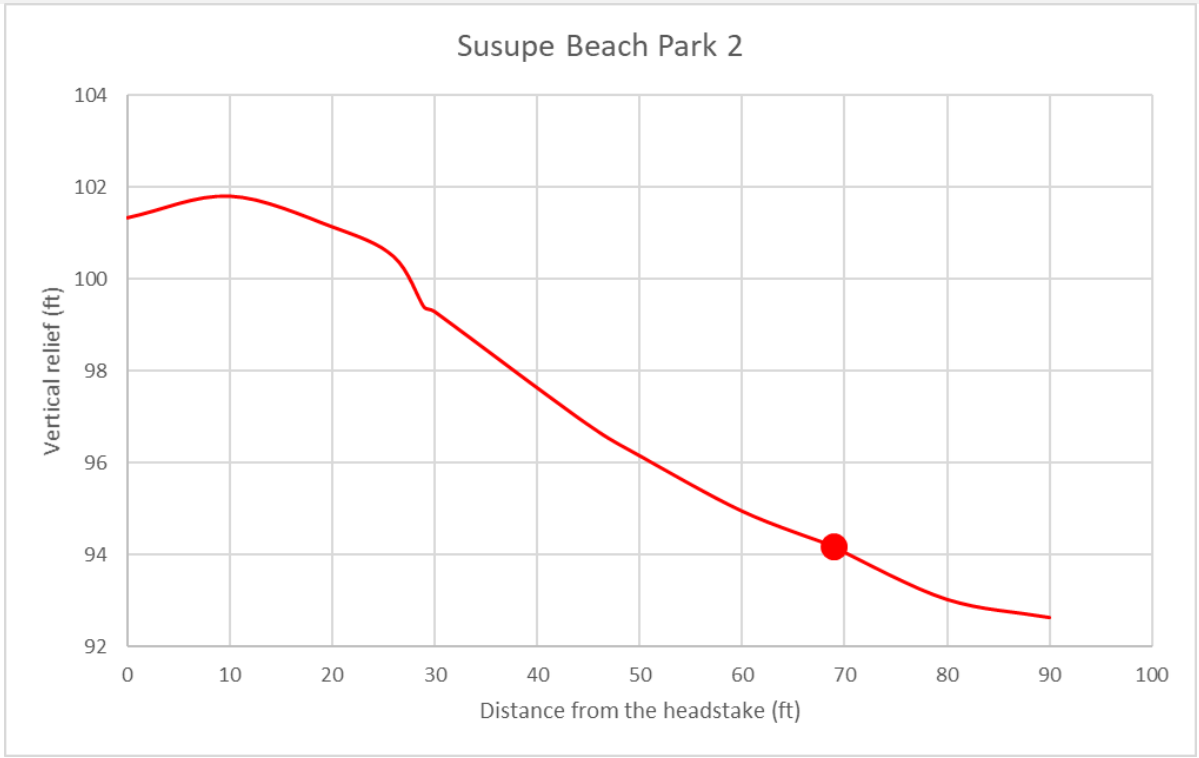


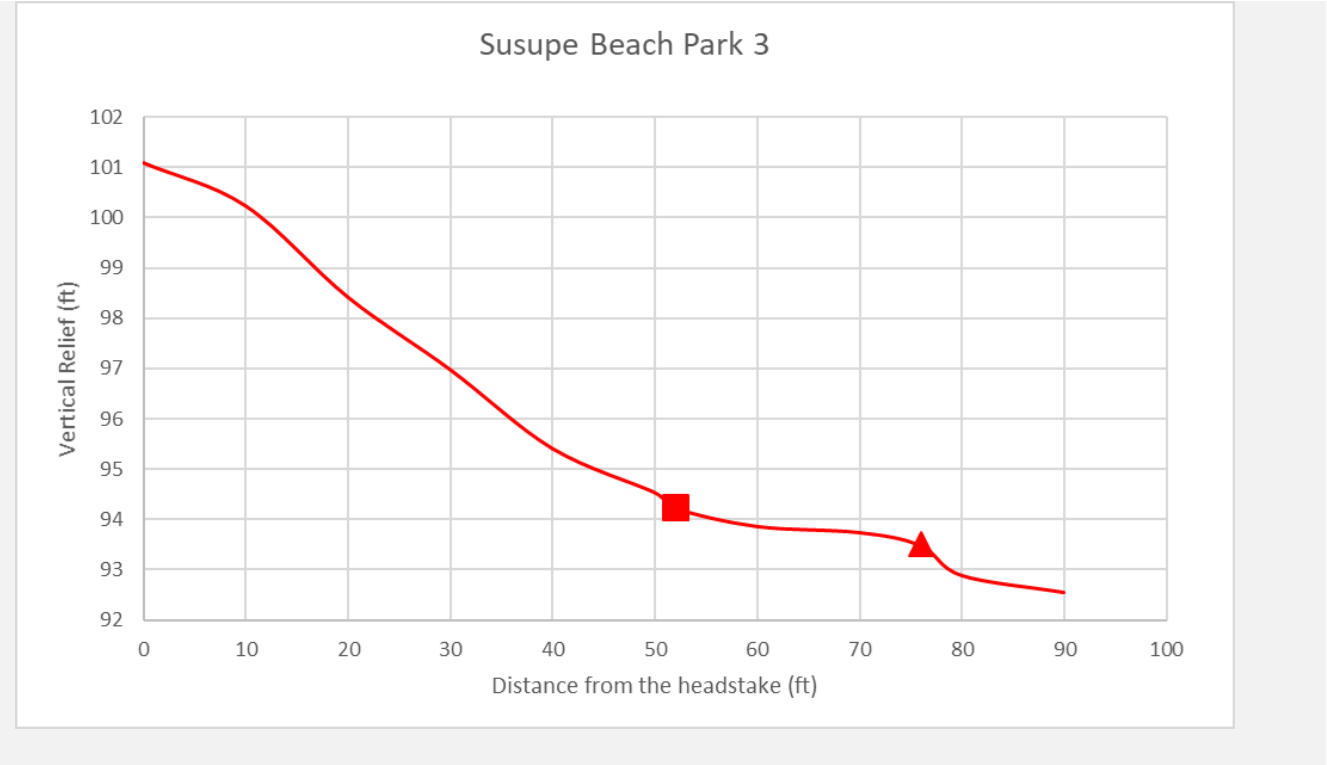




Total Station


Susupe Beach Park 1
Vertical relief (ft)
102
100
98
96
94
92
90
0
10
20
30
40
50
60
70
80
90
100
Distance from the headstake (ft)


Susupe Beach Park 2
Vertical relief (ft)
104
102
100
98
96
94
92
0
10
20
30
40
50
60
70
80
90
100
Distance from the headstake (ft)



Kilili

Kilili Beach is sheltered by the fringing reef, which is approximately 4,500 ft away. We documented incidences of erosion, but natural sediment input has shown that the lost beach may return seasonally and quickly. Historical shoreline change indicated that this shoreline cycled between erosion and accretion with rates of up to about 1 m/yr for either condition (SASEA, pg 112). The accretion rates of under 1 ft on a seasonal basis supports this. Underwater sand sources are closer to the reef

An account from a cultural practitioner using this shoreline implies that this stretch of beach is at risk of storm surge during powerful storm events. It appears that southwest conditions could greatly impact this site. Kilili Beach has noticeable variation from seasonal wave conditions. However, improved resolution on nearshore dynamics may explain longshore processes for this area.

Kilili South 1 Highlights:

- STABLE
- Wrackline that ranges 26 – 35 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 +0.3 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 +0.3 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.

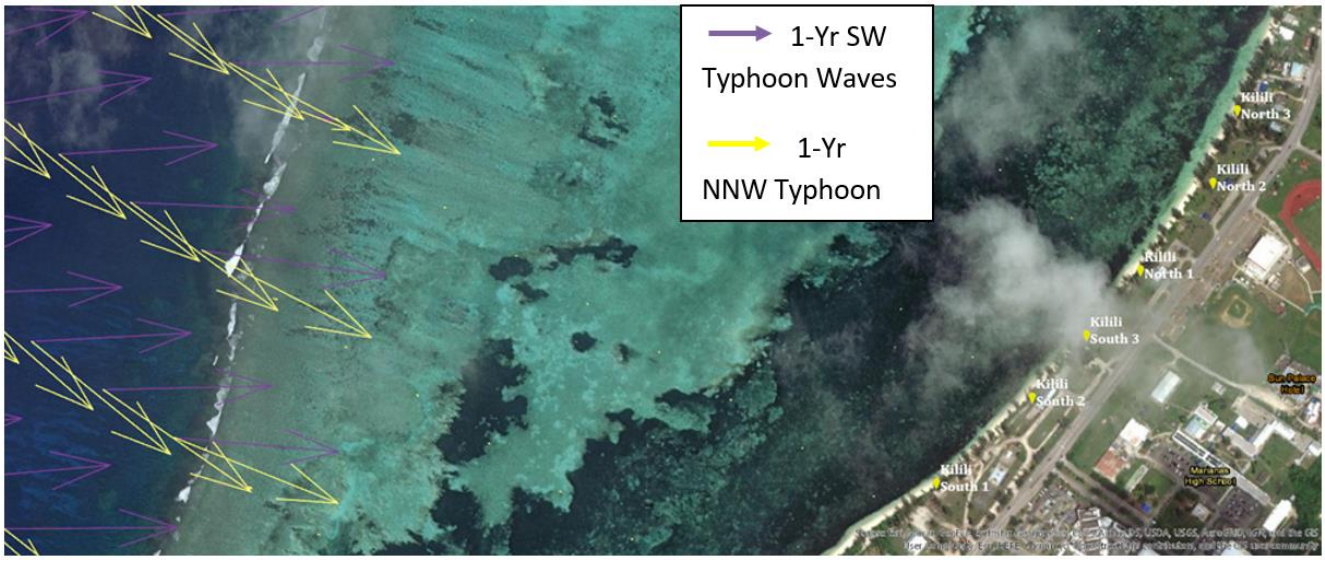
Kilili North 2 Highlights:

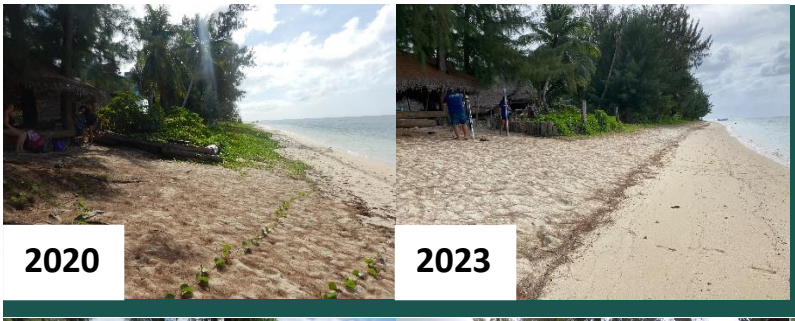
- STABLE
- Wrackline that ranges 58 – 88 ft with an elevation difference of 8 ft
- There are discrepancies in the data caused by surveyor error. Given that the headstake is further inland, this profile is expected to be longer and indicates an estimation of the proximity to the high tide line, or wrackline, is from the pavilions.
- Based on the Shoreline linear regression analysis (see pg 49), the shoreline has a rate of +0.4 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 -0.2 ft from 2016-2023.





Kilili South 1

Kilili South 2

Kilili South 3

2021

2023

Kilili North 1

2021

[Photo not available for 2023]

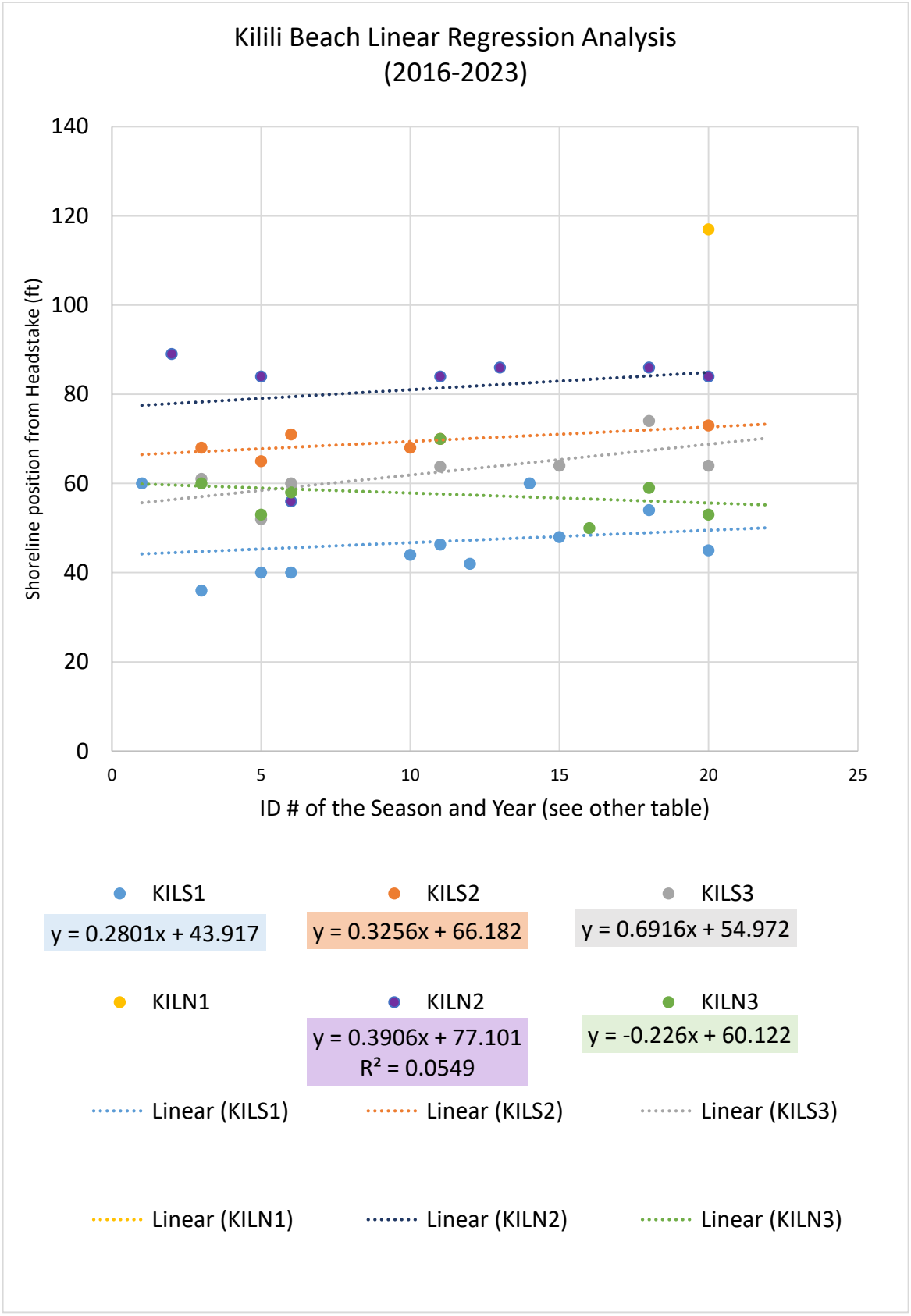
Kilili North 2

2020

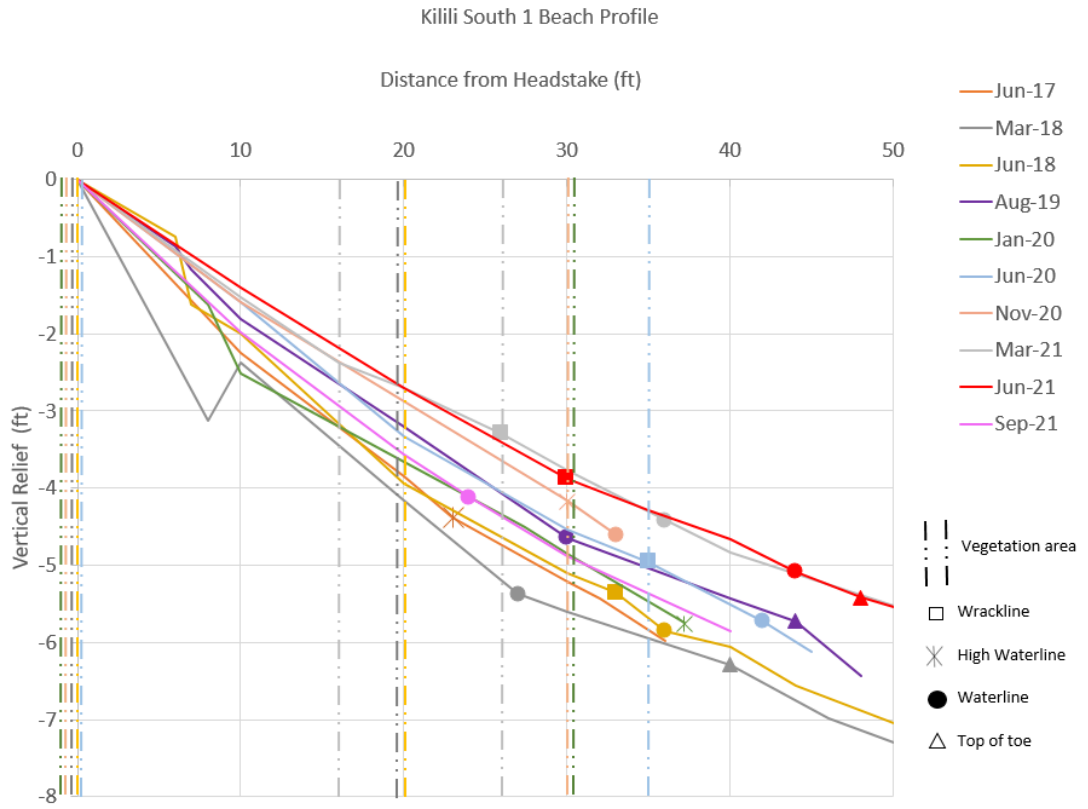
2021

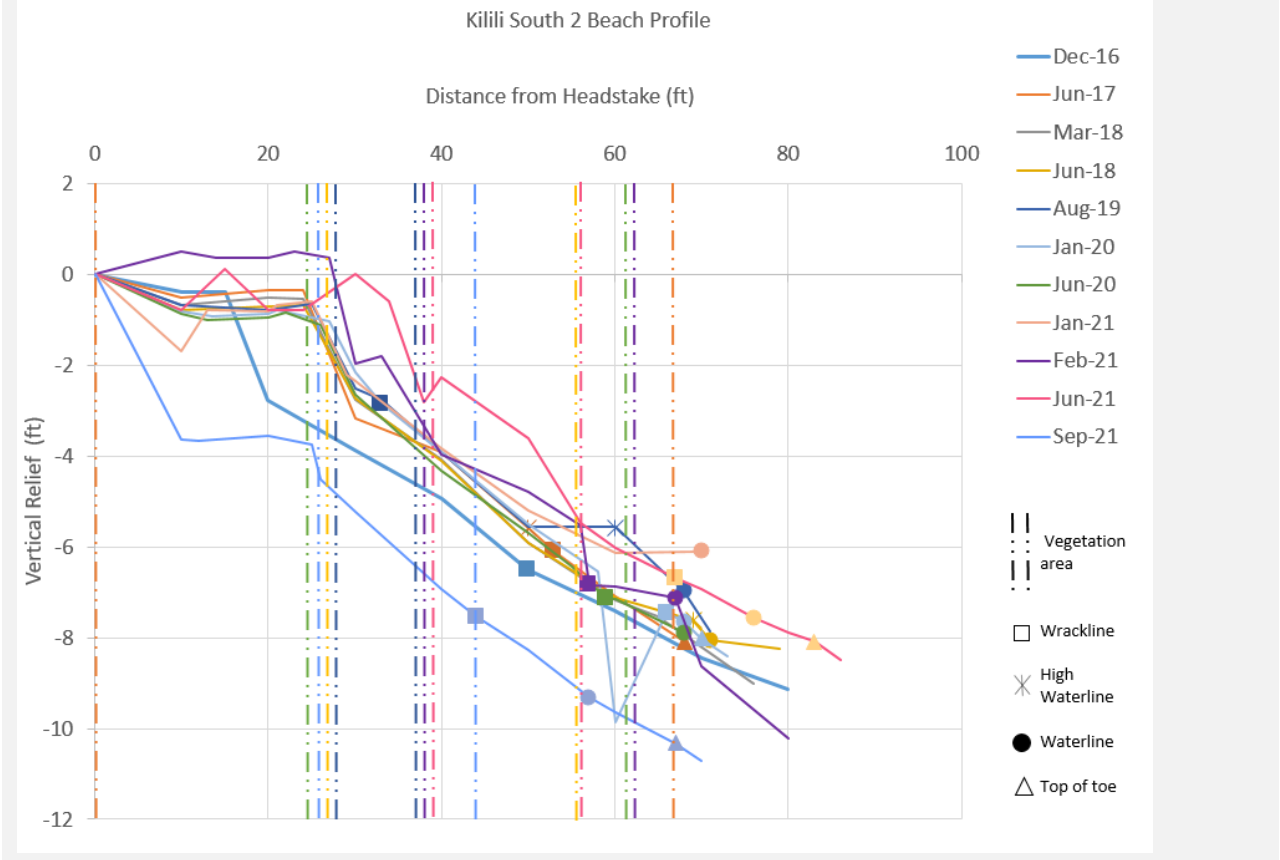
2023

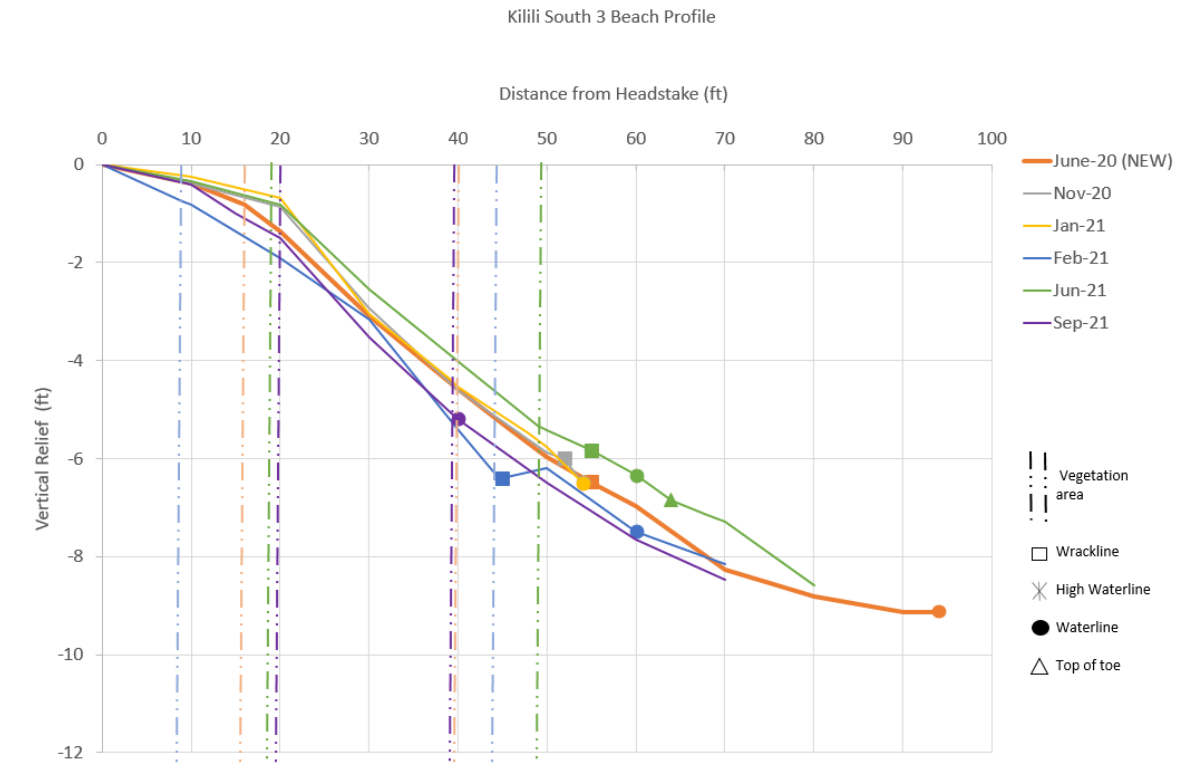
Kilili North 3

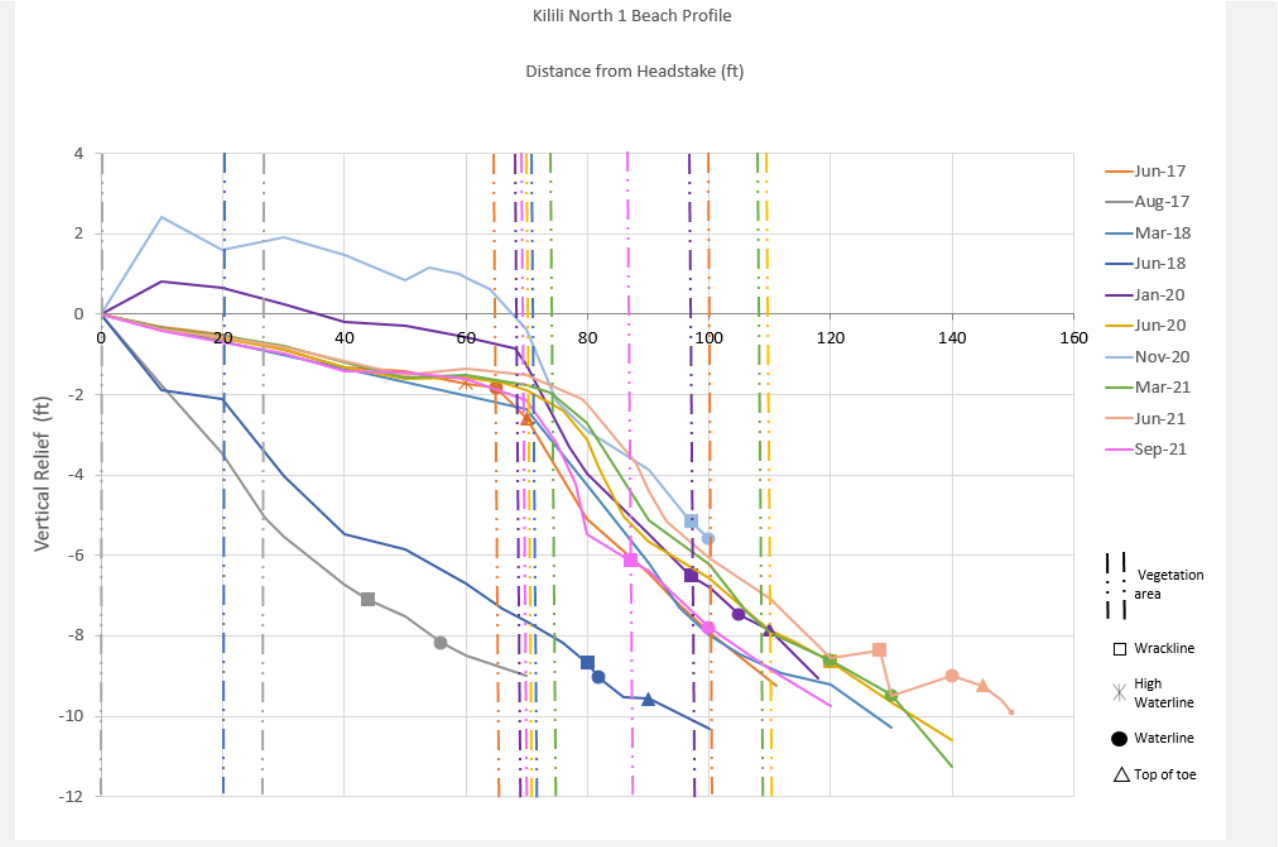

Kilili Beach Linear Regression Analysis
(2016-2023)
Shoreline position from Headstake (ft)
140
120
100
80
60
40
20
0
0
5
10
15
20
25
ID # of the Season and Year (see other table)
KILS1
y = 0.2801x + 43.917
KILS2
y = 0.3256x + 66.182
KILS3
y = 0.6916x + 54.972
KILN1
KILN2
y = 0.3906x + 77.101
R² = 0.0549
KILN3
y = -0.226x + 60.122
Linear (KILS1)
Linear (KILS2)
Linear (KILS3)
Linear (KILN1)
Linear (KILN2)
Linear (KILN3)

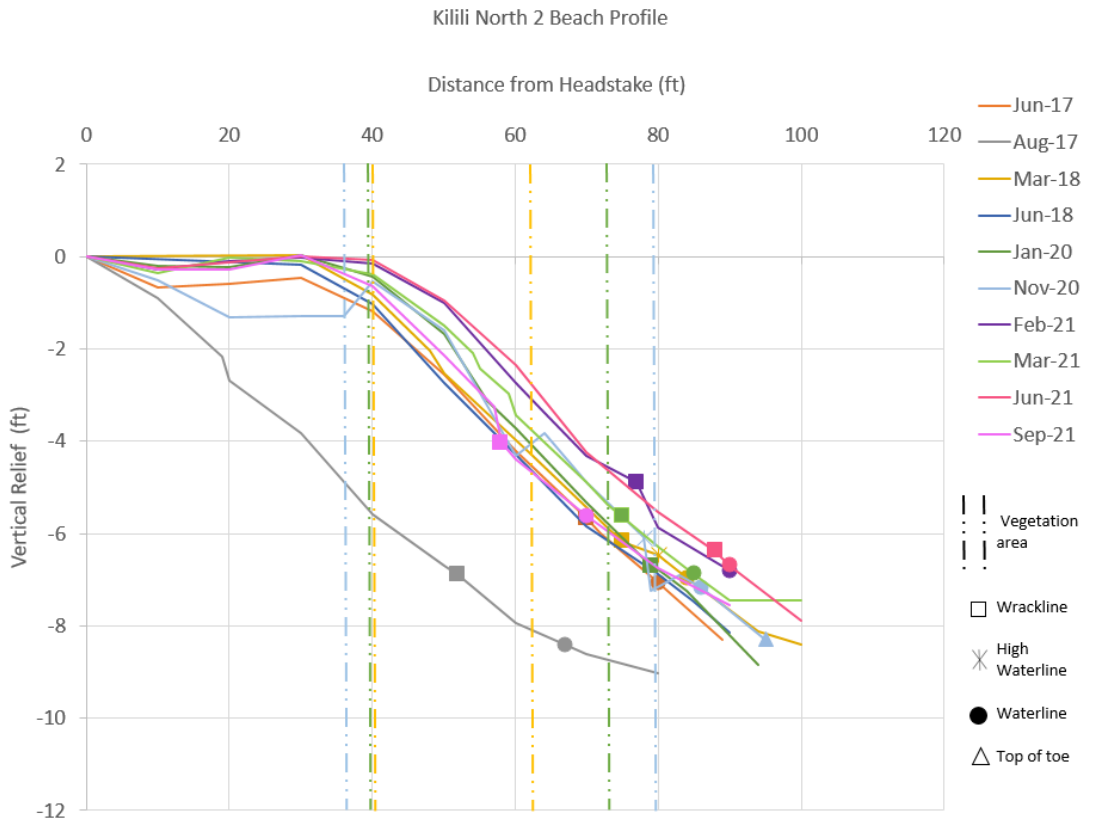
Kilili Beach Profiles

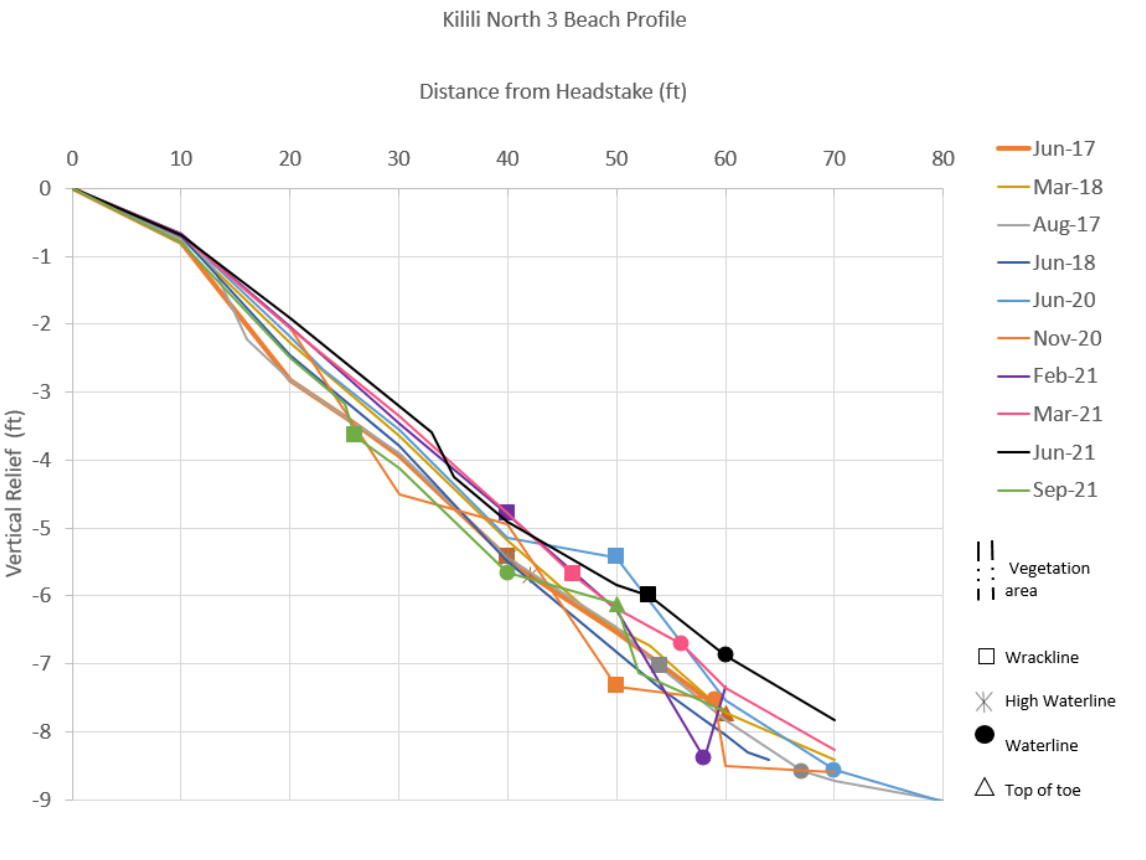


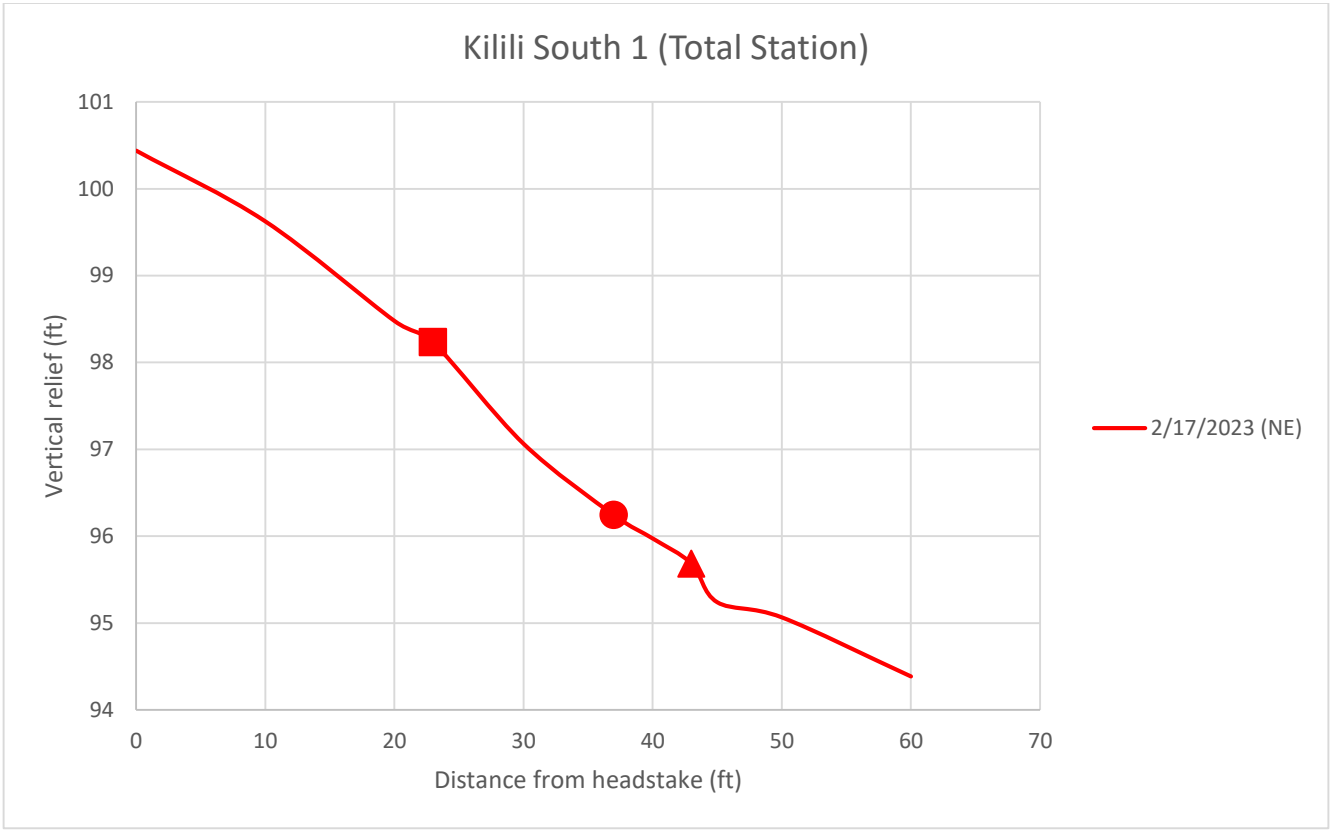


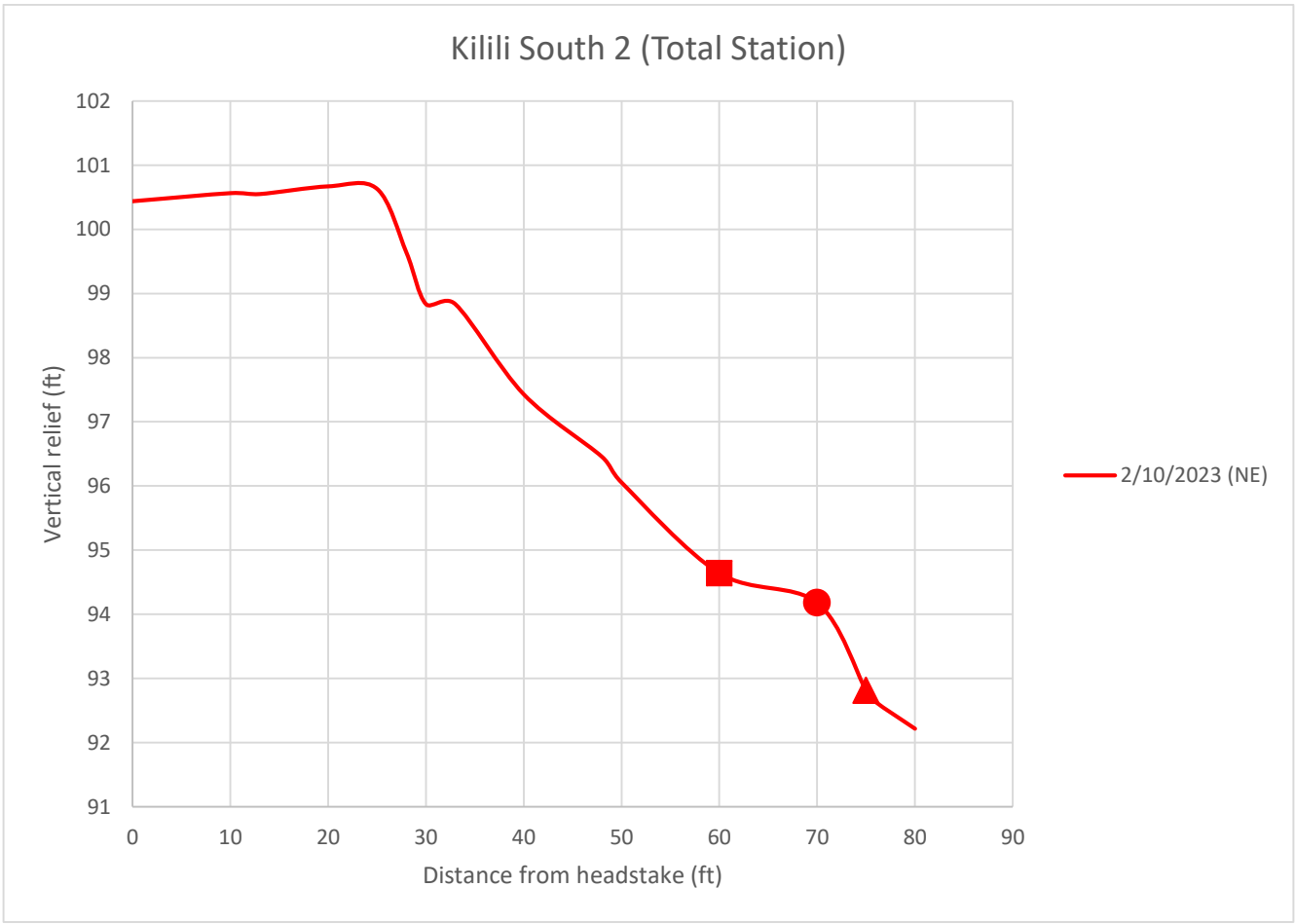

Kilili South 3 Beach Profile
Distance from Headstake (ft)
0
10
20
30
40
50
60
70
80
90
100
0
-2
-4
-6
-8
-10
-12
Vertical Relief (ft)
June-20 (NEW)
Nov-20
Jan-21
Feb-21
Jun-21
Sep-21
Vegetation area
Wrackline
High Waterline
Waterline
Top of toe

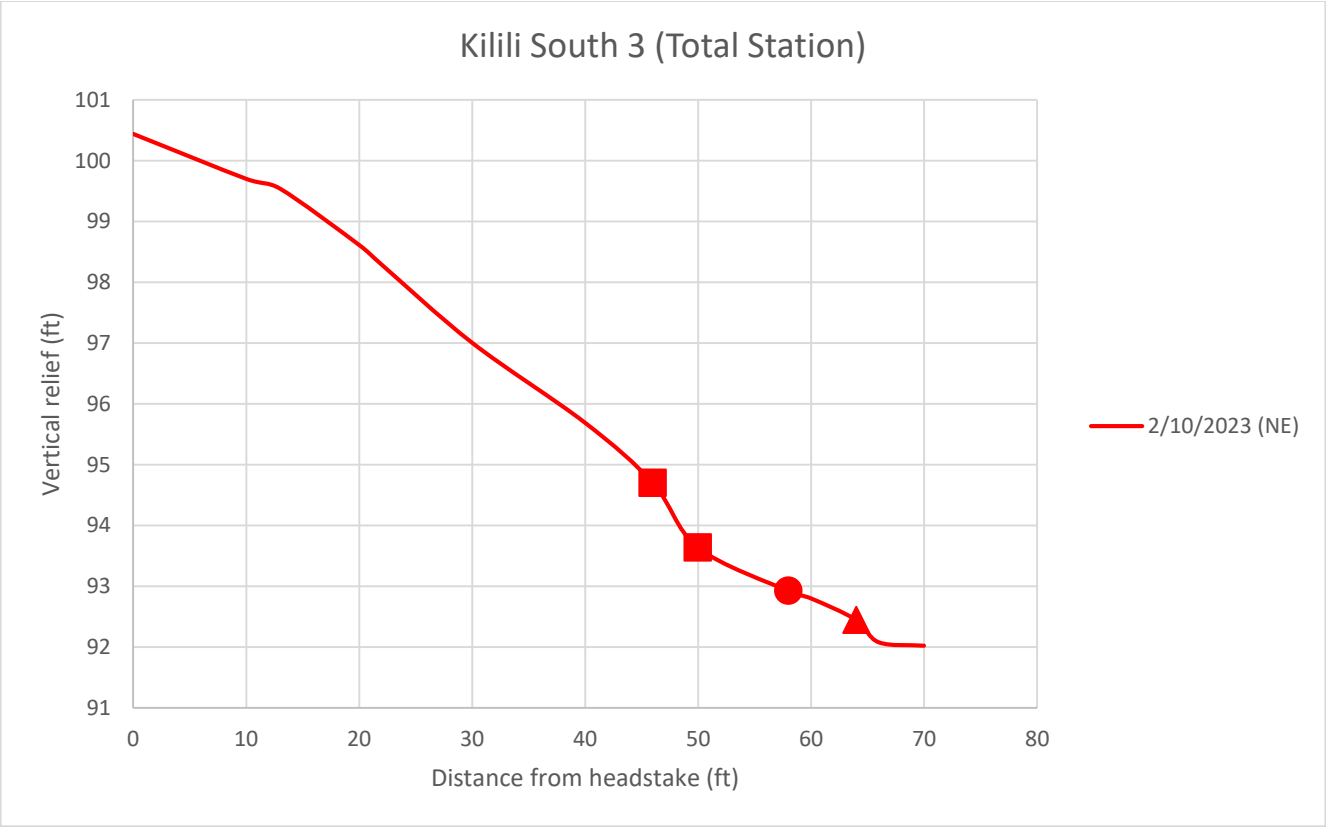

Kilili North 1 Beach Profile
Distance from Headstake (ft)
4
2
0
-2
-4
-6
-8
-10
-12
0
20
40
60
80
100
120
140
160
Vertical Relief (ft)
Jun-17
Aug-17
Mar-18
Jun-18
Jan-20
Jun-20
Nov-20
Mar-21
Jun-21
Sep-21
Vegetation area
Wrackline
High Waterline
Waterline
Top of toe

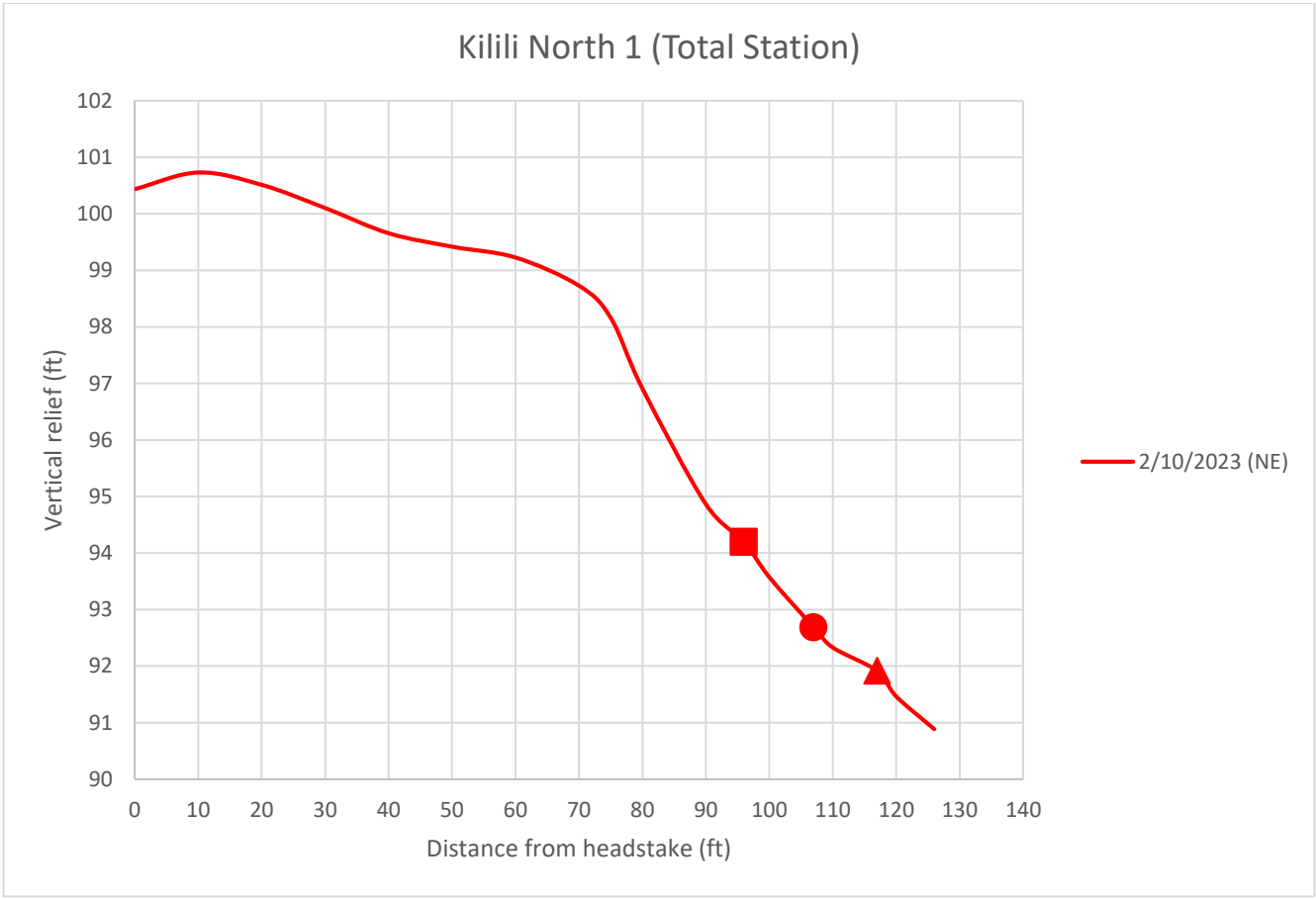

Kilili North 2 Beach Profile
Distance from Headstake (ft)
0
20
40
60
80
100
120
2
0
-2
-4
-6
-8
-10
-12
Vertical Relief (ft)
Jun-17
Aug-17
Mar-18
Jun-18
Jan-20
Nov-20
Feb-21
Mar-21
Jun-21
Sep-21
Vegetation area
Wrackline
High Waterline
Waterline
Top of toe

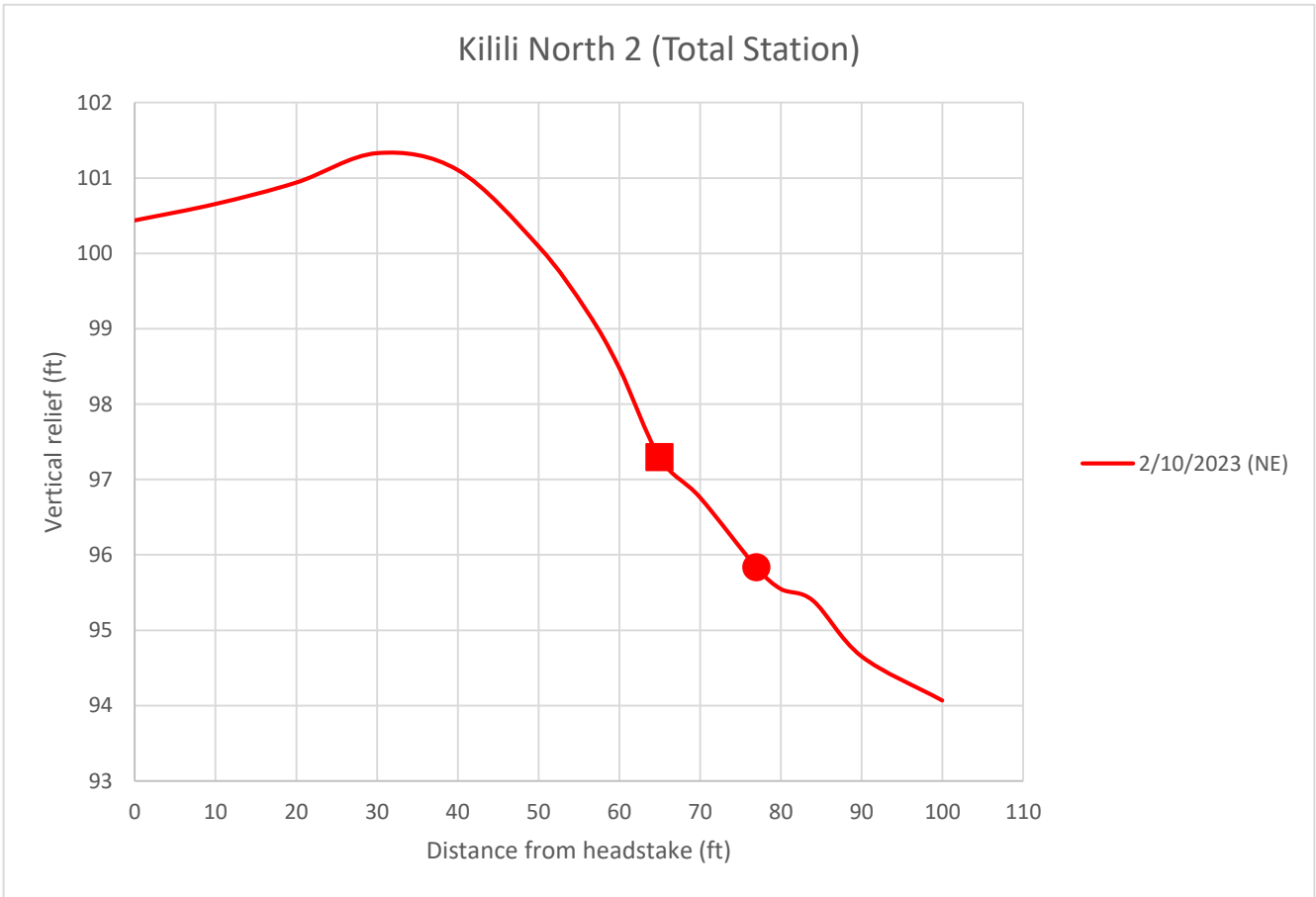

Kilili North 3 Beach Profile
Distance from Headstake (ft)
0
10
20
30
40
50
60
70
80
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
Vertical Relief (ft)
Jun-17
Mar-18
Aug-17
Jun-18
Jun-20
Nov-20
Feb-21
Mar-21
Jun-21
Sep-21
Vegetation area
Wrackline
High Waterline
Waterline
Top of toe

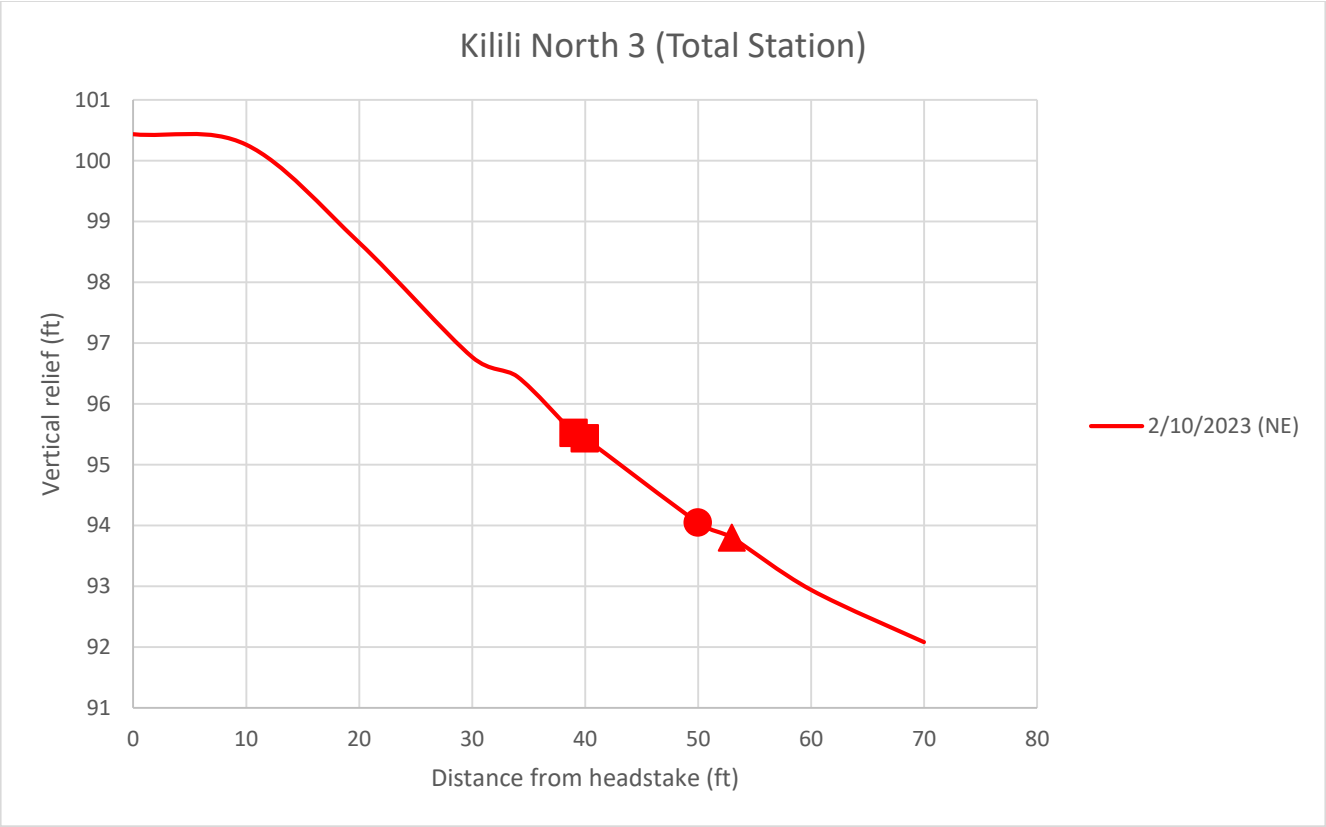

Kilili South 1 (Total Station)
Vertical relief (ft)
101
100
99
98
97
96
95
94
0
10
20
30
40
50
60
70
Distance from headstake (ft)
2/17/2023 (NE)


Kilili South 2 (Total Station)
Vertical relief (ft)
102
101
100
99
98
97
96
95
94
93
92
91
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)
102
101
100
99
98
97
96
95
94
93
92
91
90
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
Distance from headstake (ft)
2/10/2023 (NE)


Kilili North 2 (Total Station)
Vertical relief (ft)
102
101
100
99
98
97
96
95
94
93
0
10
20
30
40
50
60
70
80
90
100
110
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

Parallel to the Garapan reef, Oleai shoreline is short and adjacent to the parking lot of Oleai Beach Bar. The restaurant facility in Oleai 1 transect is less than 50 ft away from the waterline indicating that the restaurant is vulnerable to storm surge and sea level rise.

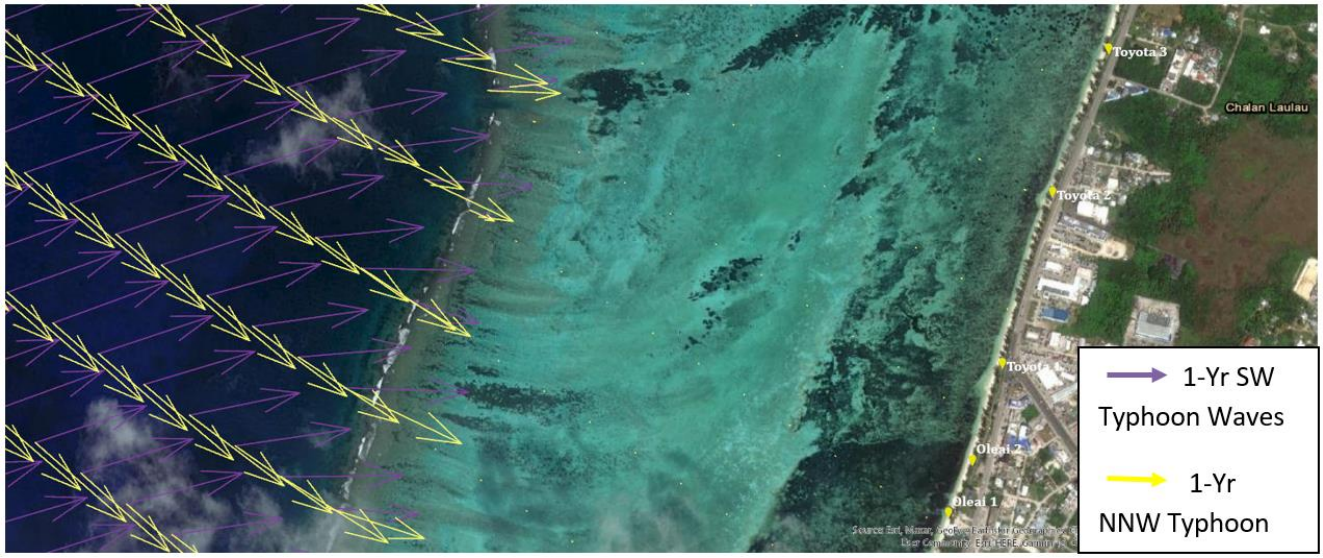
Stabilization measures are necessary to protecting the restaurant infrastructure from an encroaching waterline, so recording the shoreline positon may assist proper decision-making in addressing this issue. However, it seems that the beach is fairly stable despite the episodic erosion events. Wave overtopping and overwhelmed tidal flows may impact this site during both typhoon wave conditions. It appears that southwest conditions could greatly impact this site.

Oleai 1 Highlights:

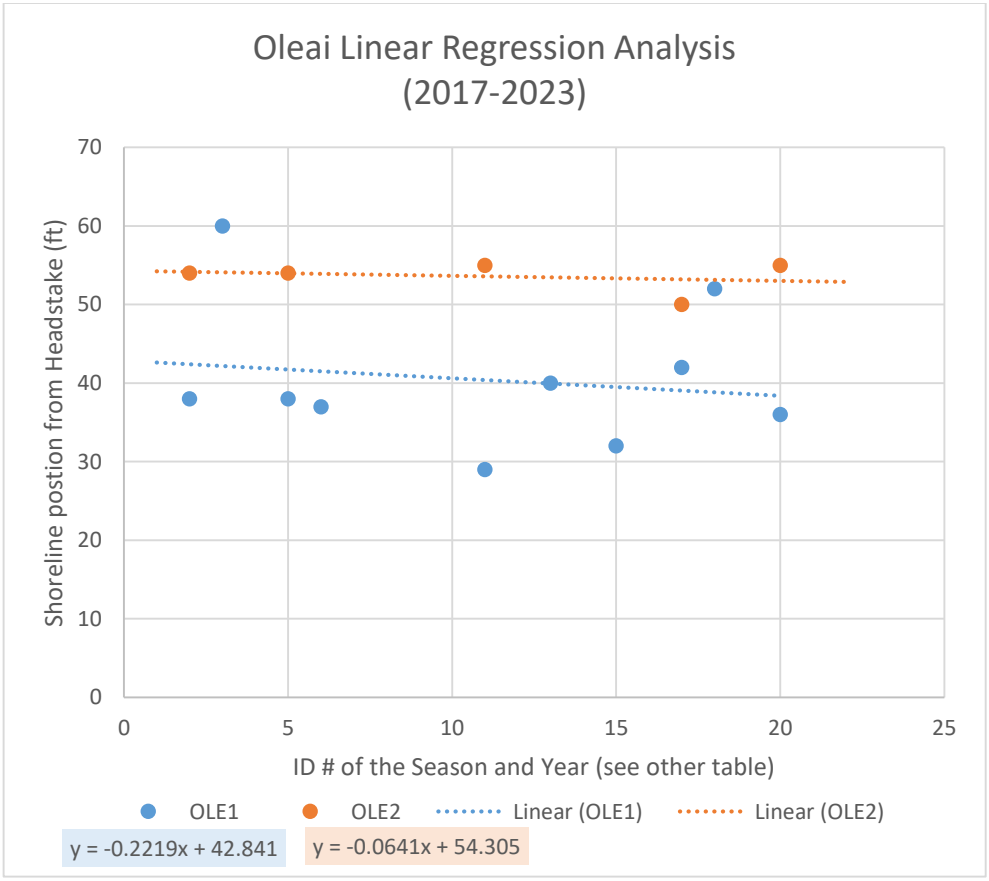
- STABLE
- Wrackline that ranges 8 – 33 ft and an elevation difference of more than 6 ft
- Tides and seasonal wave conditions influence the beach width. Restaurant management grooms the shoreline by pushing washed up debris more inland in a pile.
- Based on the Shoreline linear regression analysis (see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

Oleai 2 Highlights:

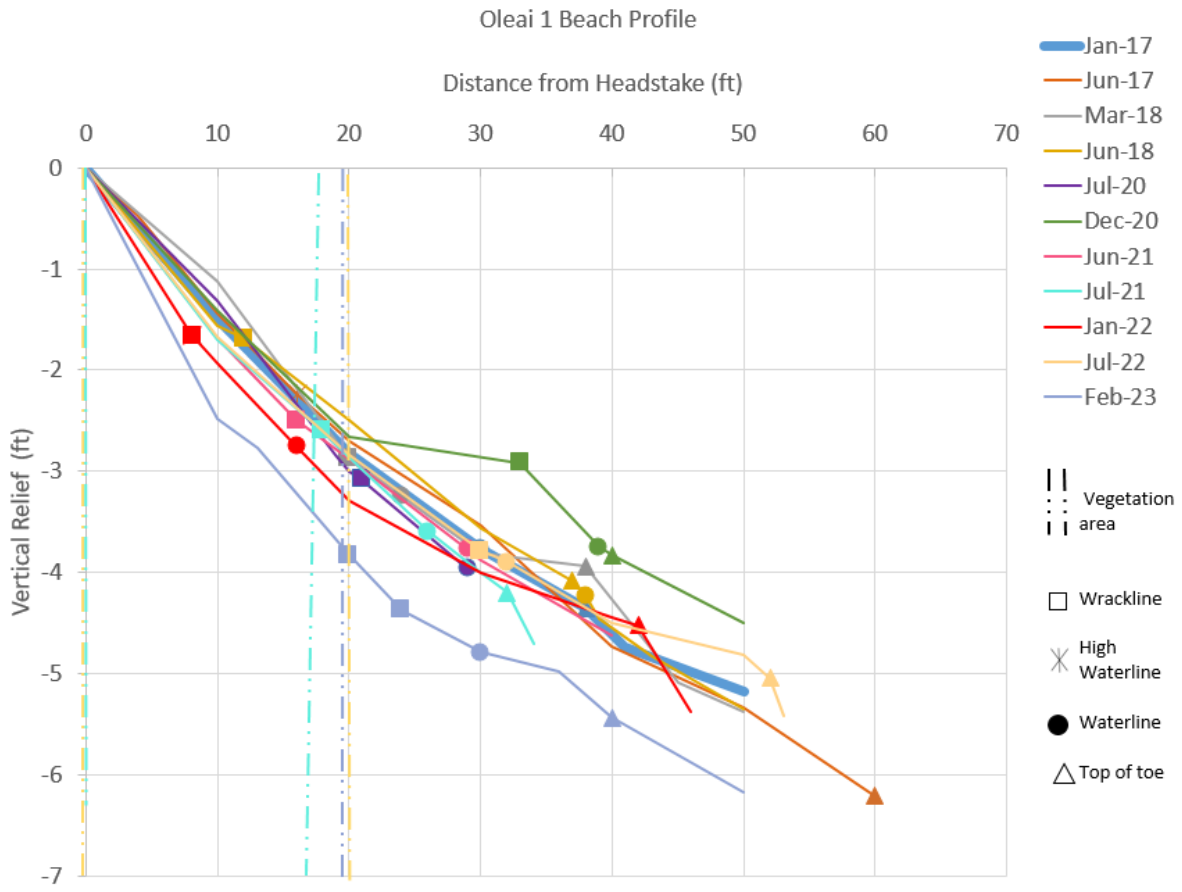
- STABLE
- Wrackline that ranges 25 –53 ft and an elevation difference of 7 ft
- Based on the Shoreline linear regression analysis (see pg 58), the shoreline has a rate of -0.06 ft from 2016-2023.

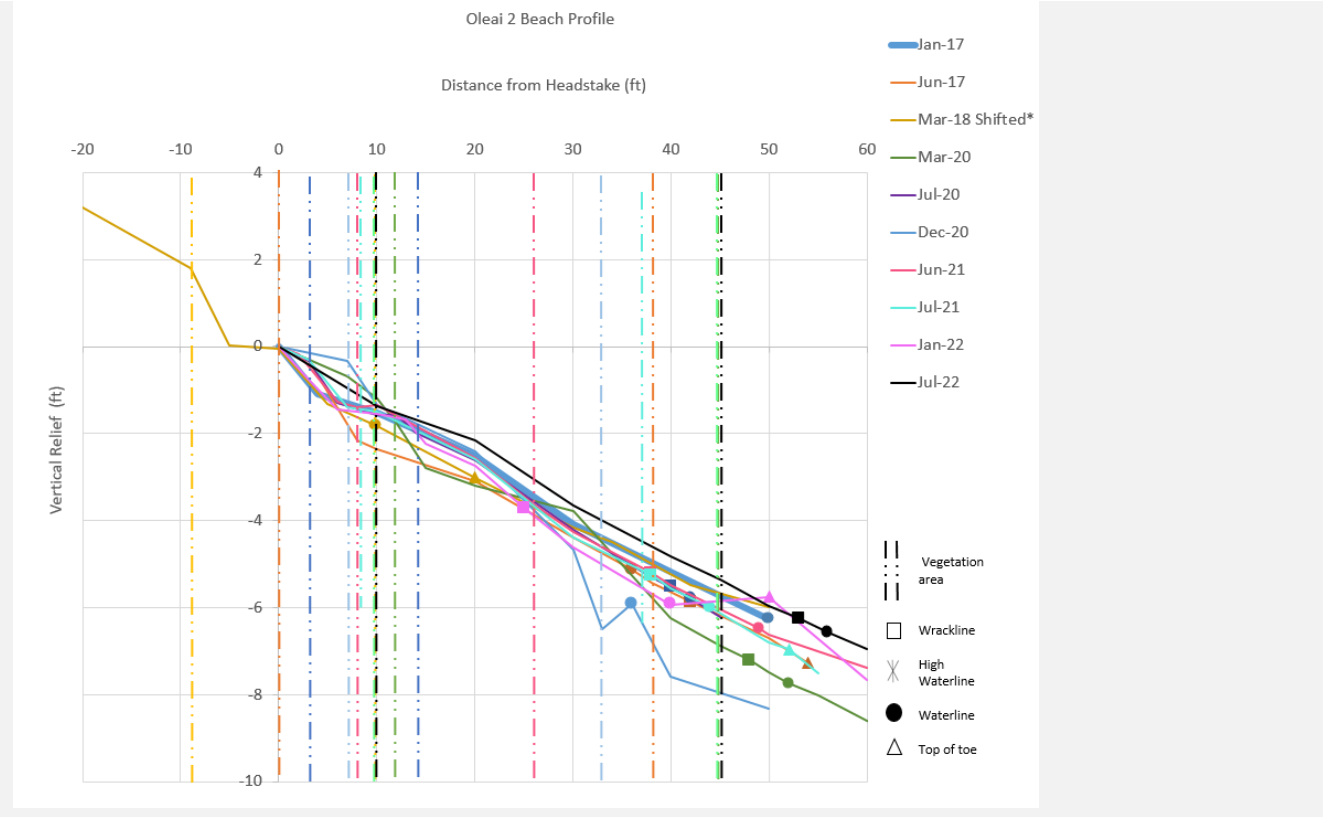


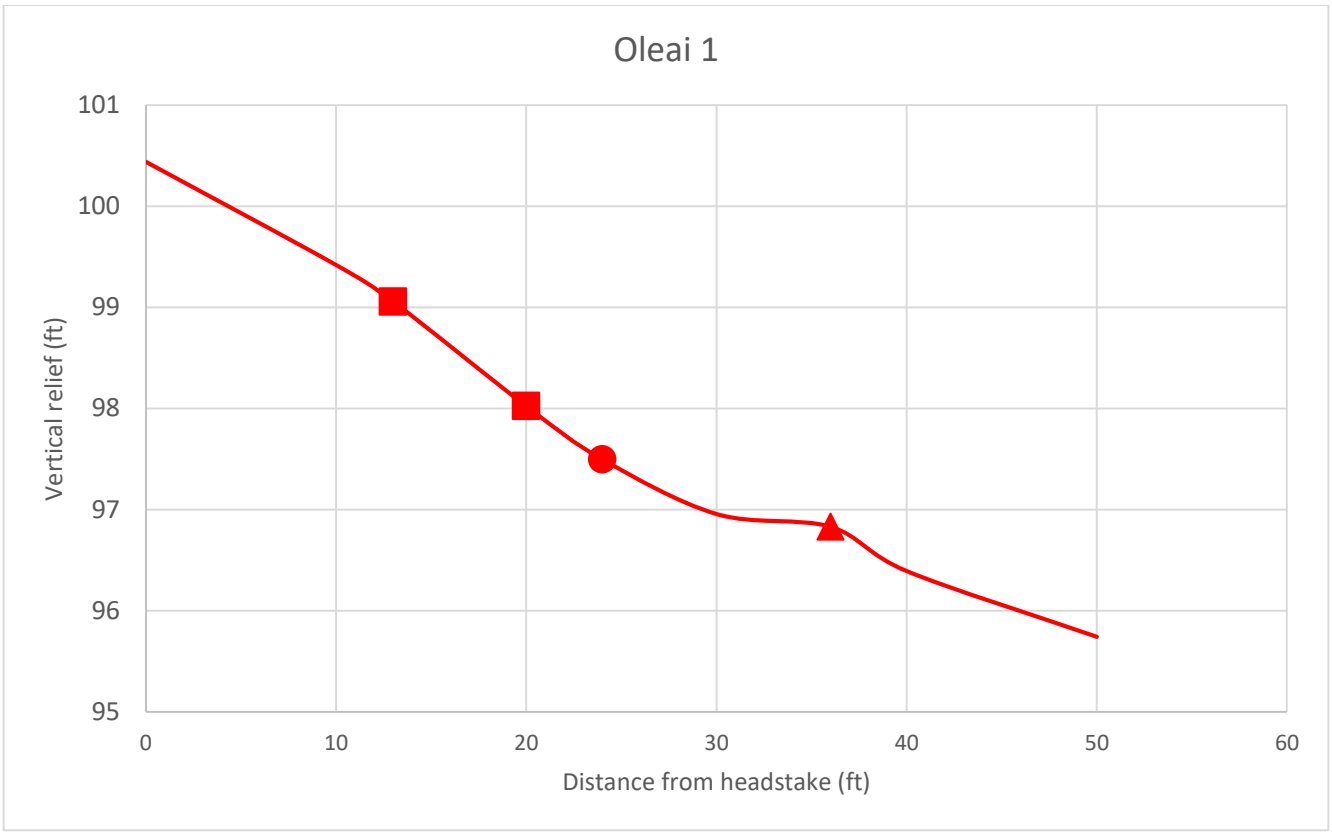

2018
2021
2022
Oleai 1
2020
2022
Oleai 2

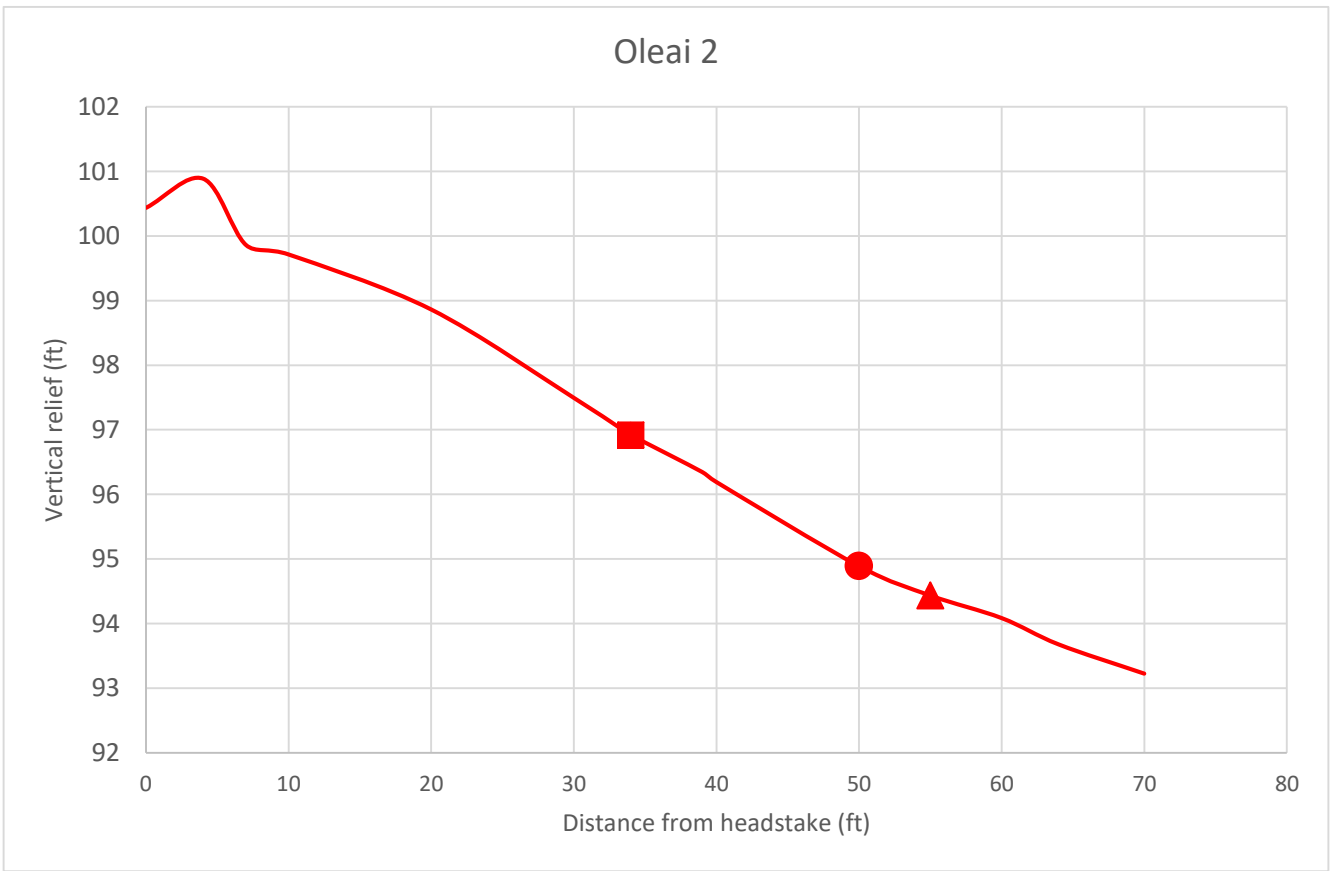

Oleai Linear Regression Analysis
(2017-2023)
Shoreline postion from Headstake (ft)
70
60
50
40
30
20
10
0
0
5
10
15
20
25
ID # of the Season and Year (see other table)
OLE1
OLE2
Linear (OLE1)
Linear (OLE2)
y = -0.2219x + 42.841
y = -0.0641x + 54.305

Oleai Beach Profiles






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


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

Toyota

Toyota shoreline encompasses the traffic light to the walled structures past the boardwalk of the Beach Road pathway. This area has historically been abraded after storm surge event as indicated in the damages of the pathway infrastructure. The toe is exposed during low tide, allowing space for rod and reel fisher-folk.

Sea level rise also threatens this shoreline and its highly developed backshore, along with the Toyota intersection and the surrounding businesses. Typhoon conditions bring strong wave energies that greatly erode the short width away. Wave overtopping and overwhelmed tidal flows may impact this site during both typhoon wave conditions. Otherwise, the shoreline appears to gradually recover after these abrasion events.

Toyota 1 Highlights:

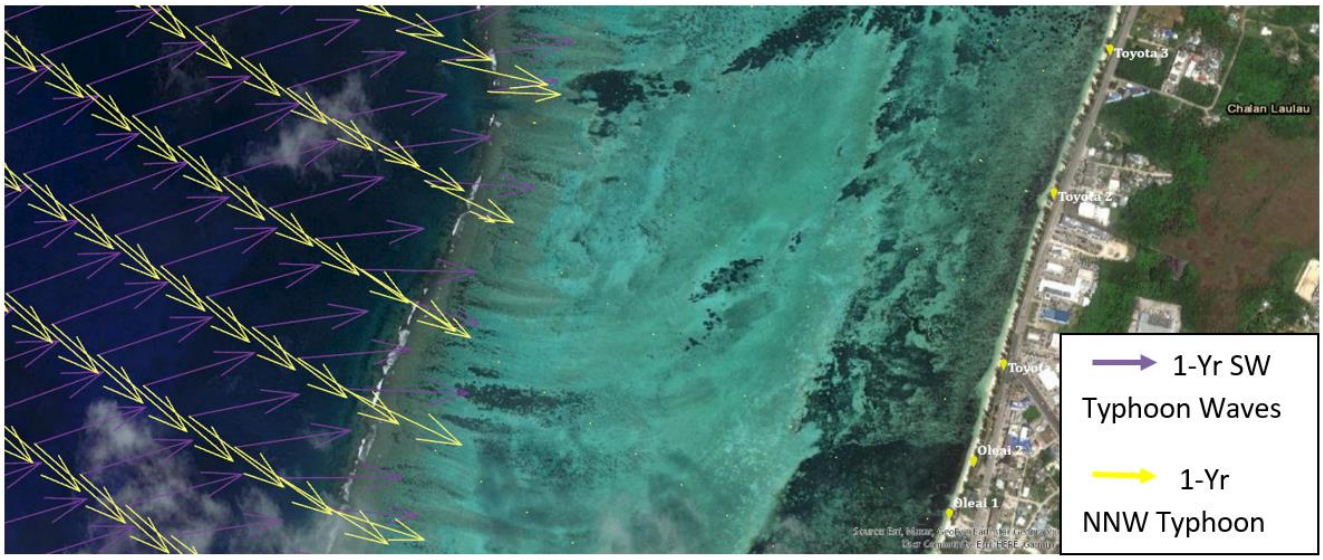
- STABLE
- Wrackline that ranges 50 – 78 ft and an elevation difference of 9 ft
- Based on the Shoreline linear regression analysis (see pg 63), the shoreline has a rate of +0.7 ft from 2016-2023.

Toyota 2 Highlights:

- STABLE
- 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 +0.4 ft from 2016-2023.

Toyota 3 Highlights:

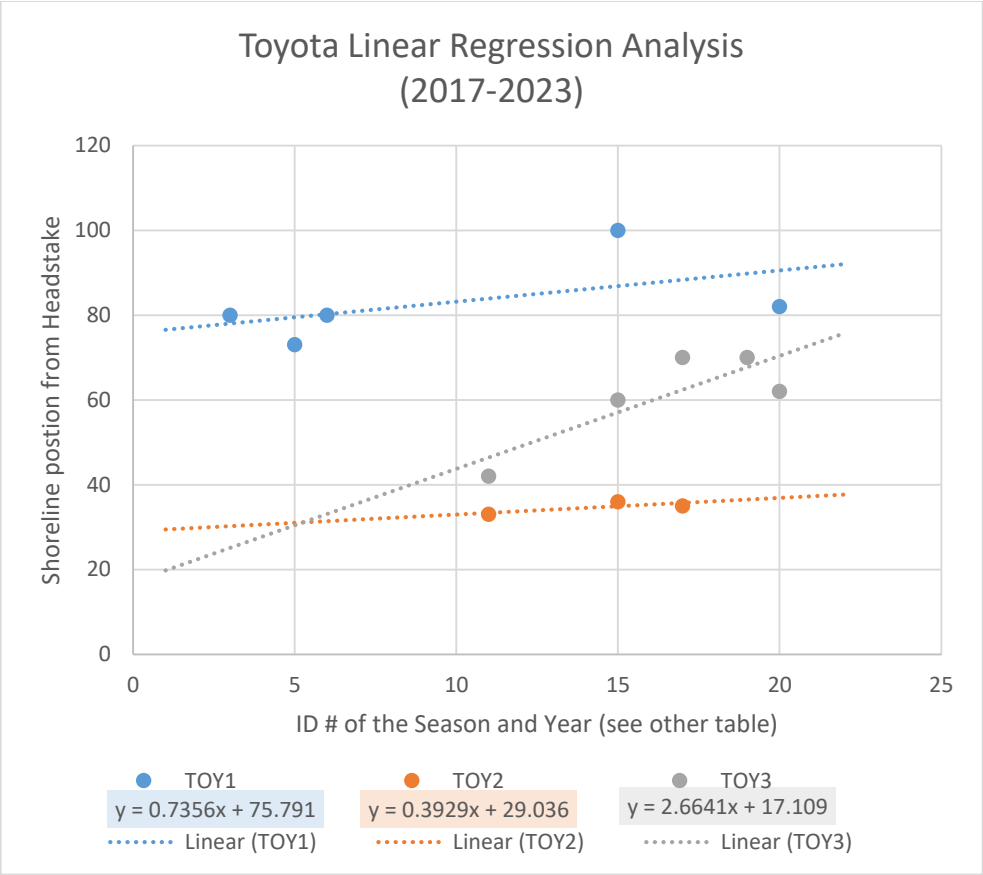
- ACCRETING
- Wrackline that ranges 30 – 58 ft and an elevation difference of 8 ft
- Periods of erosion and accretion
- Based on the Shoreline linear regression analysis (see pg 63), the shoreline has a rate of +2.7 ft from 2016-2023.



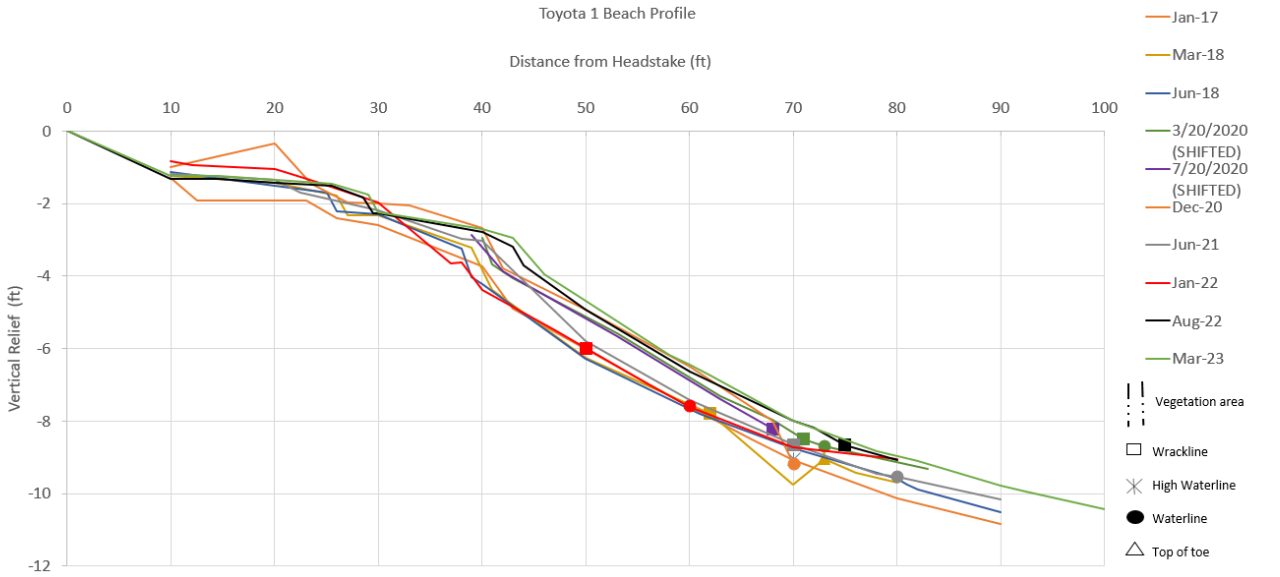
Toyota 1

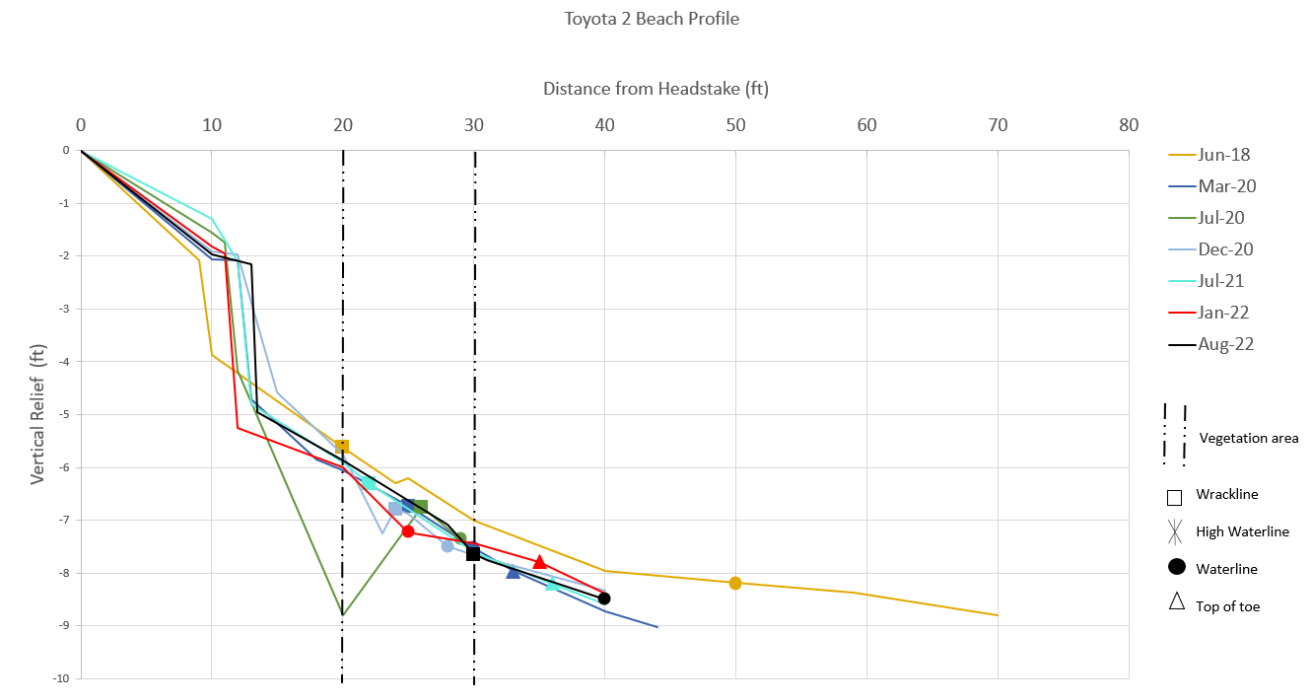
Toyota 2

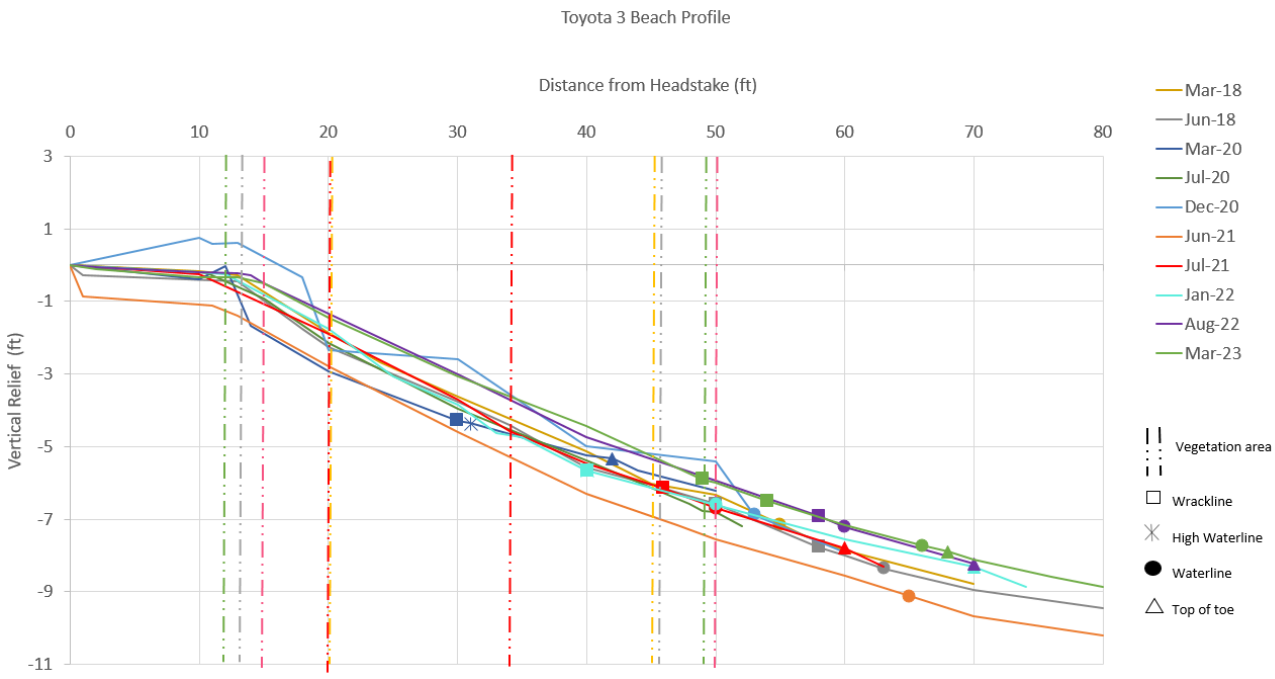
Toyota 3

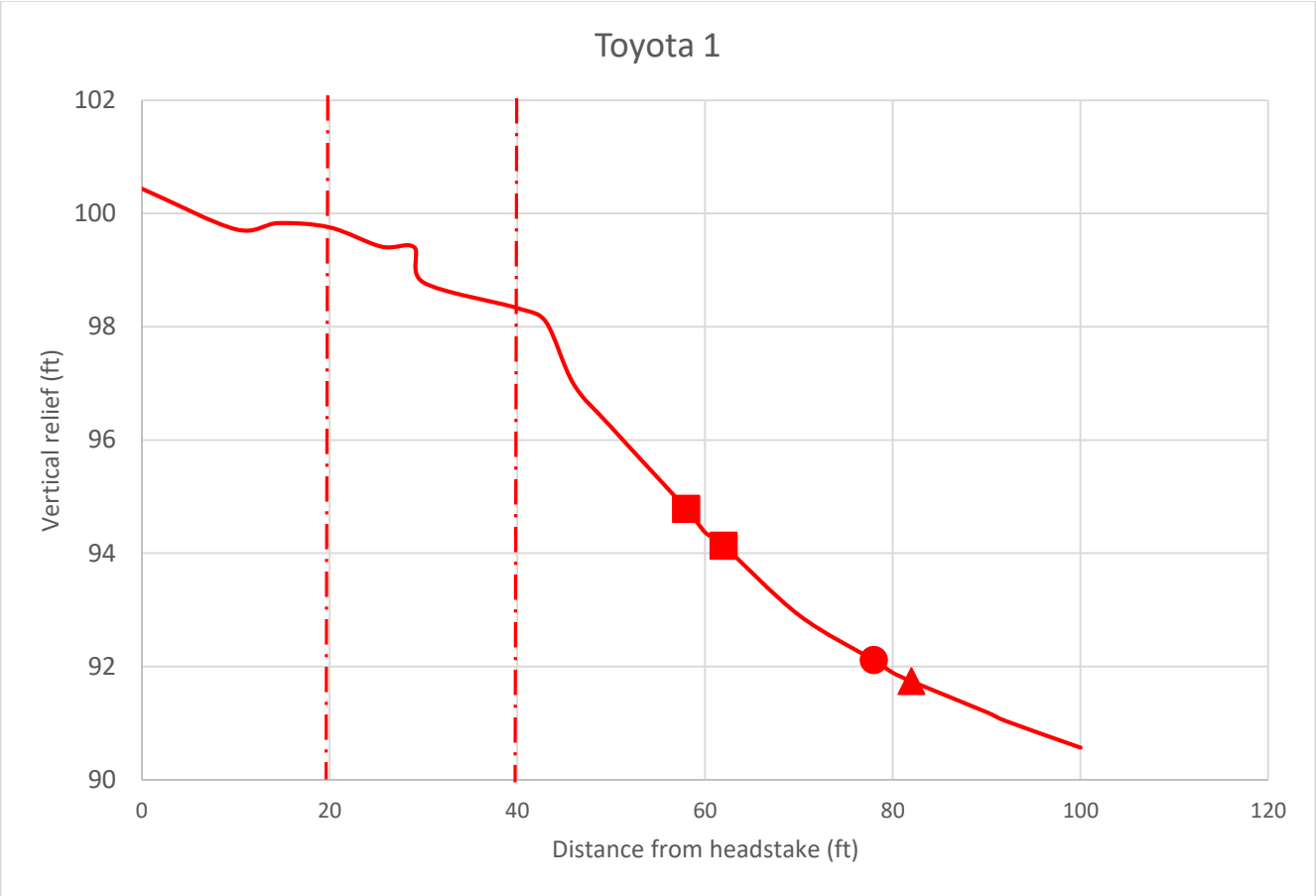

Toyota Linear Regression Analysis
(2017-2023)
Shoreline postion from Headstake
120
100
80
60
40
20
0
0
5
10
15
20
25
ID # of the Season and Year (see other table)
TOY1
y = 0.7356x + 75.791
Linear (TOY1)
TOY2
y = 0.3929x + 29.036
Linear (TOY2)
TOY3
y = 2.6641x + 17.109
Linear (TOY3)

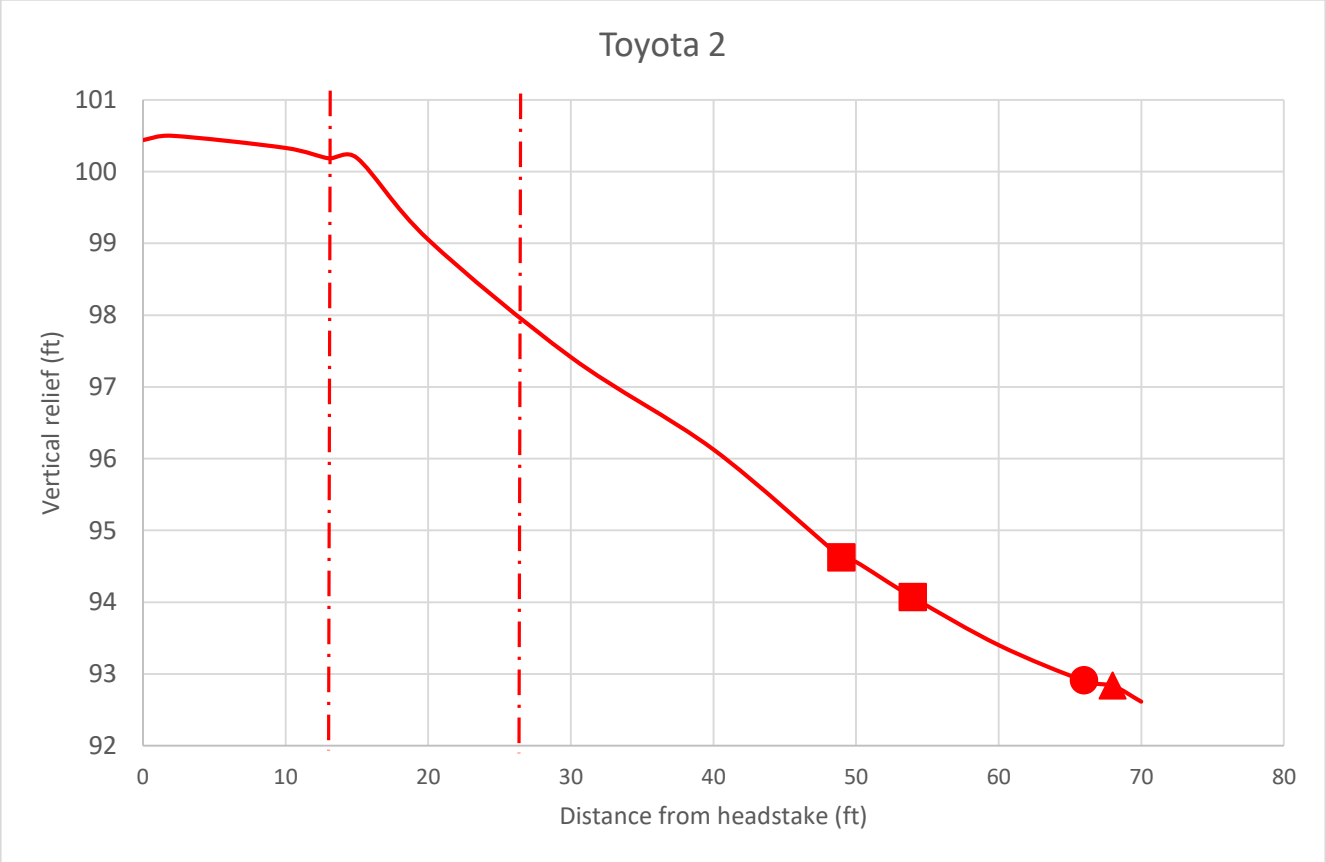
Toyota Beach Profiles






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


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


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

Quartermaster

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

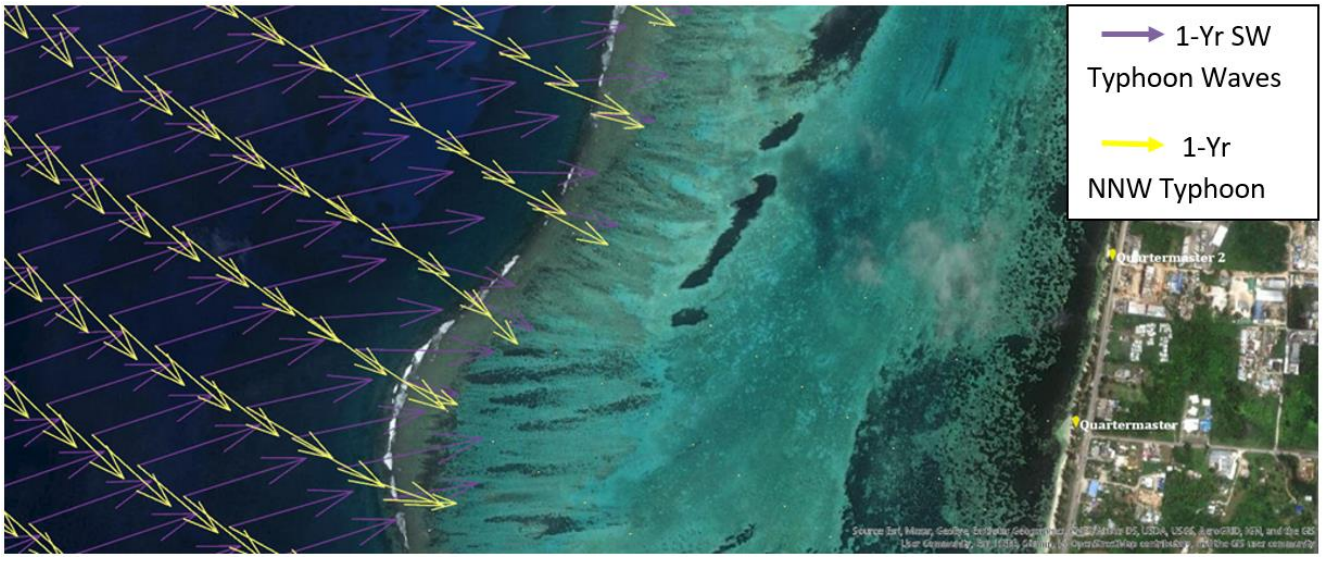
Seagrass beds attenuate wave energy. However, other stabilization measures have been sought to address the loss of shoreline. This shoreline is moderately steep with high tidal influence. Wave overtopping and overwhelmed tidal flows may impact this site during both typhoon wave conditions. It appears that southwest conditions could greatly impact this site. However, improved resolution on nearshore dynamics may explain longshore processes for this area.

Quartermaster 1 Highlights:

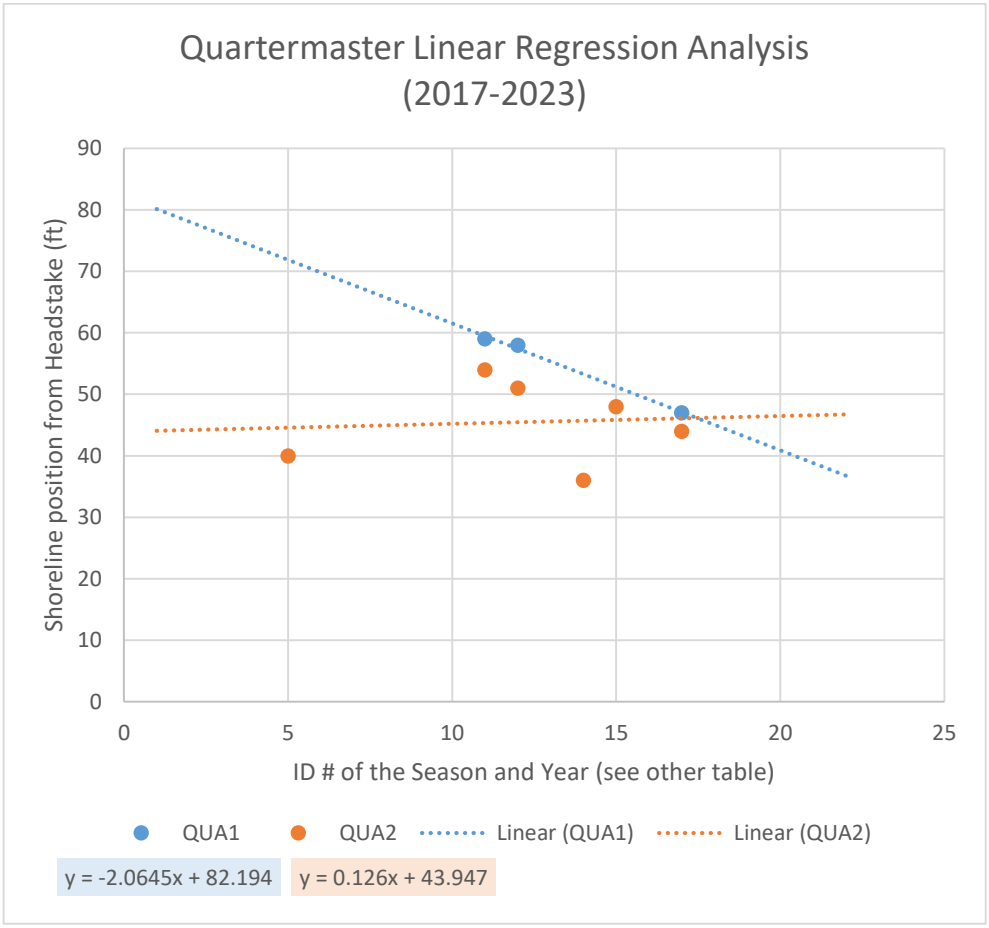
- ERODING
- Wrackline that ranges 33 – 40 ft and an elevation difference of 9 ft
- Relatively stable yet seasonally dynamic
- Low tide difference is high
- Nearby outfall drainage influences the sediment transport
- Based on the Shoreline linear regression analysis (see pg 69), the shoreline has a rate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

Quartermaster 2 Highlights:

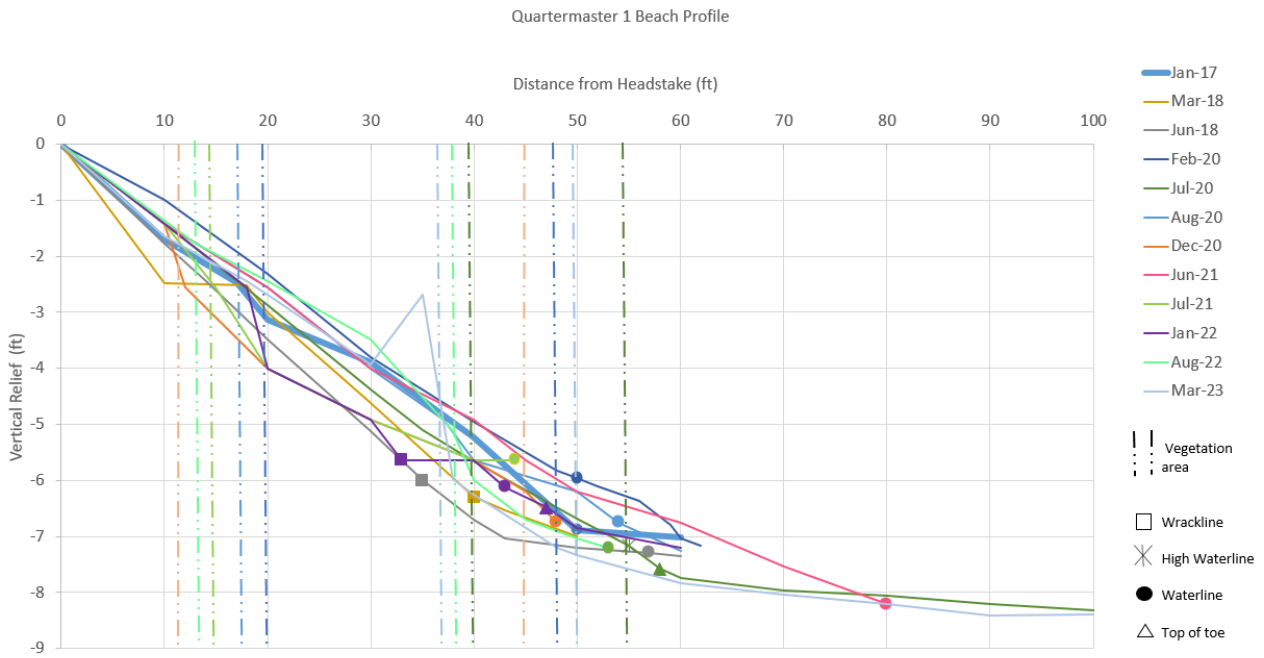
- STABLE
- Wrackline that ranges 30 – 47 ft with an elevation difference of 6 ft
- Low tide difference is highly noticeable
- Based on the Shoreline linear regression analysis (see pg 69), the shoreline has a rate of +0.13 ft from 2016-2023.

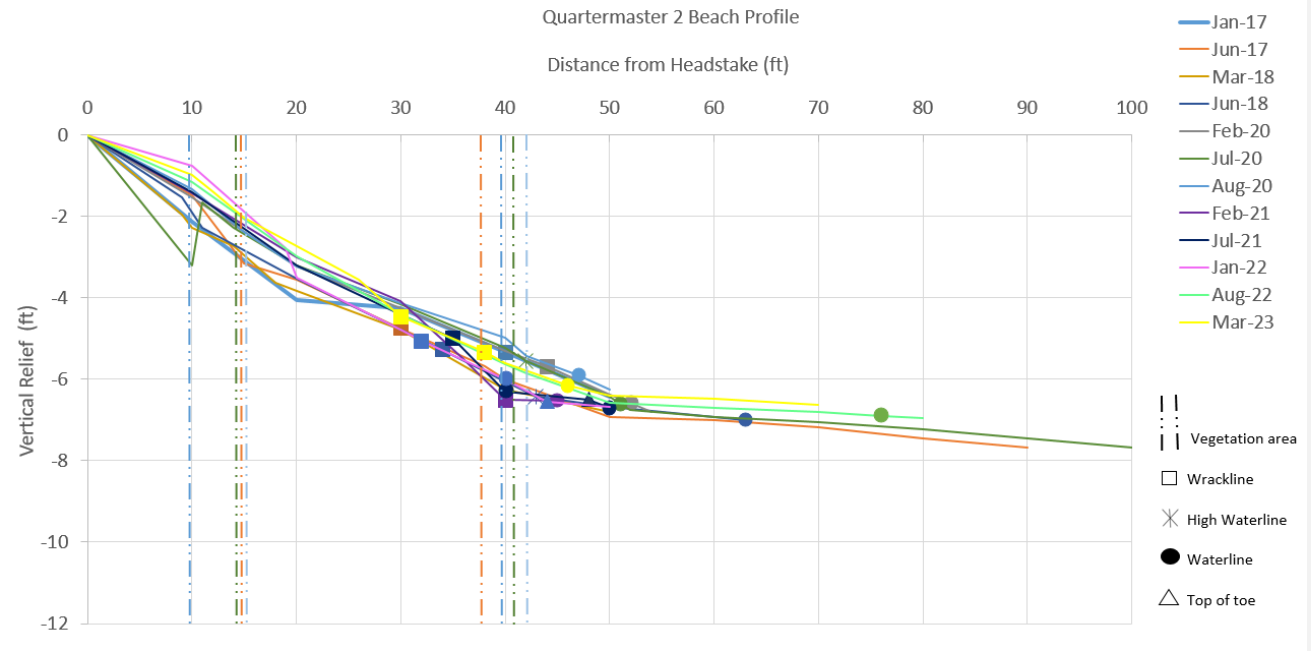


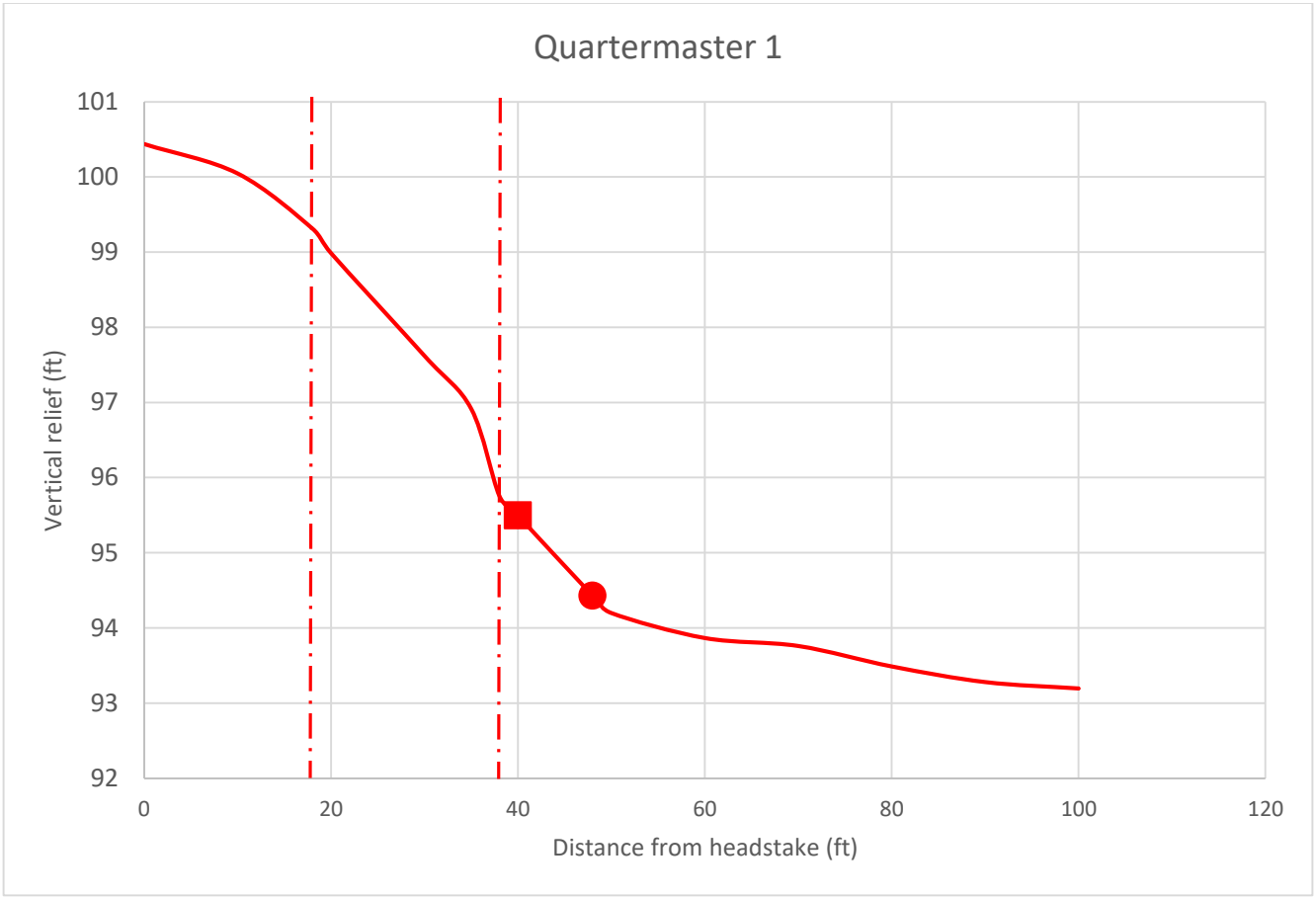

2020
2023
Quartermaster 1
2020
2023
Quartermaster 2

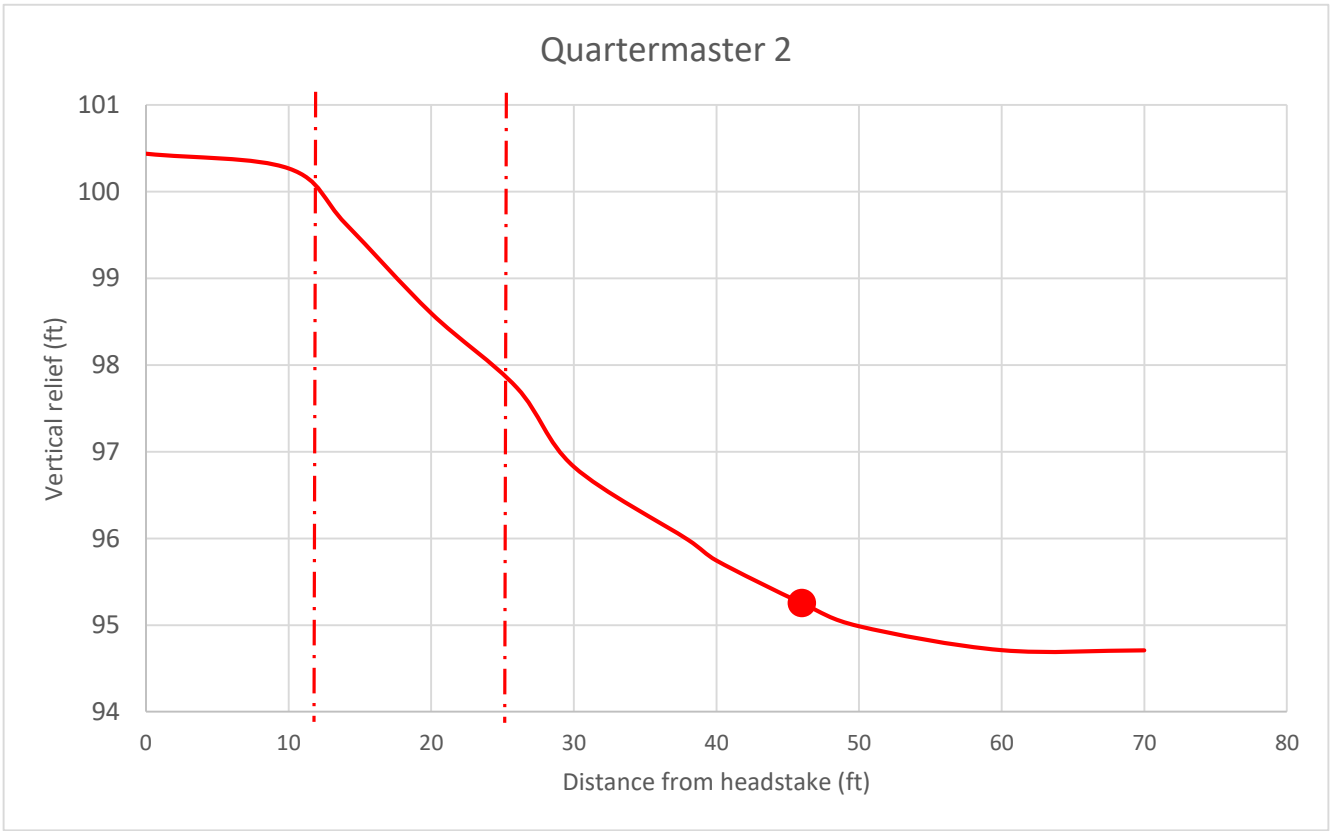

Quartermaster Linear Regression Analysis
(2017-2023)
Shoreline position from Headstake (ft)
90
80
70
60
50
40
30
20
10
0
0
5
10
15
20
25
ID # of the Season and Year (see other table)
QUA1
QUA2
Linear (QUA1)
Linear (QUA2)
y = -2.0645x + 82.194
y = 0.126x + 43.947

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

Located within the Garapan Lagoon and adjacent to patch reef, Grandvrio Hotel's sandy beach, addressed as "Hafa Adai", has been growing in width. This accretion starkly contrasts to Fiesta and Hyatt shoreline (to the north) and Garapan district shoreline (to the south). The thriving young ironwood trees in the nearshore signify that this area has not experienced damage from the storms of 2021 - 2022. Rather, sand may have been deposited during storm events. The outfall south of the hotel is speculated to have a hydraulic effect on the shoreline but monitoring efforts have not observed its real-time impact on the accumulation. Sediment from the north could be shifting to the south. For both typhoon wave conditions, this area is better sheltered than the northern sites.

The closure of Grandvrio hotel due to the pandemic has allowed shoreline vegetation to overgrow on grounds, which indicated stabilization of both the backshore and nearshore area. Plant removal and beach grooming have been undertaken for public access and marine sports activities.

Hafa Adai 1 Highlights:

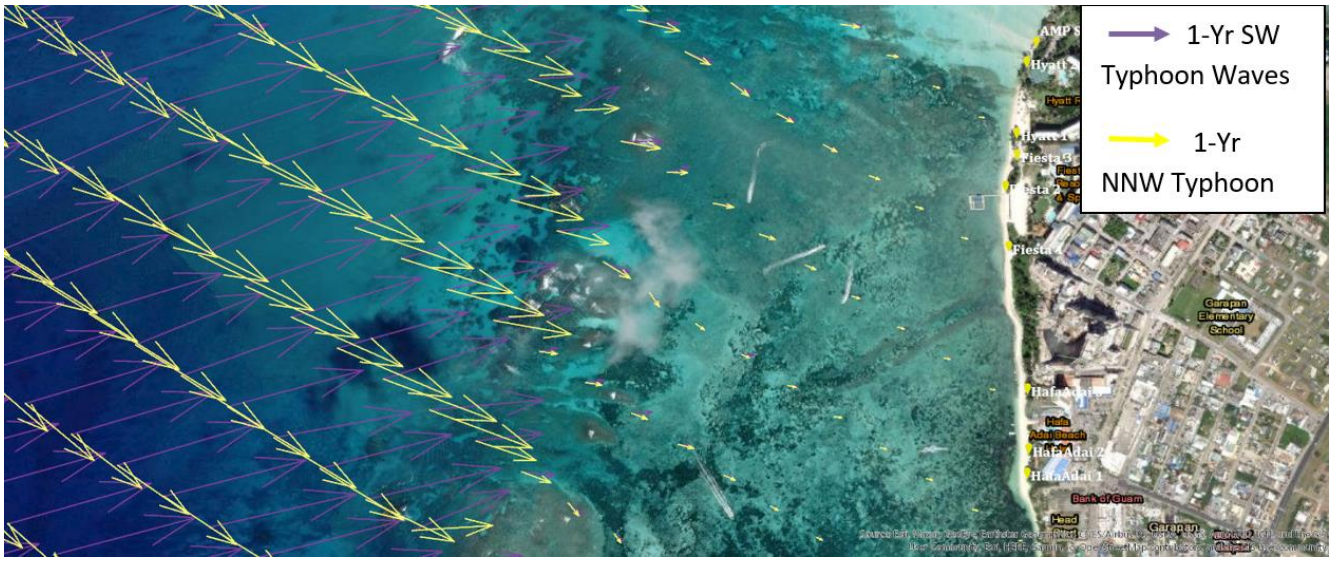
- ACCRETING
- REPLACED after July 2022
- There is insufficient information to conduct a shoreline linear regression analysis this period.
- Outfall influenced
- PREVIOUS HEADSTAKE showed that the shoreline has accreted over 40 ft since 2017

Hafa Adai 2 Highlights:

- ACCRETING
- Wrackline that ranges 56 – 79 ft with an elevation difference of 7 ft
- Based on the Shoreline linear regression analysis (see pg 74), the shoreline has a rate of +3.8 ft from 2016-2023.

Hafa Adai 3 Highlights:

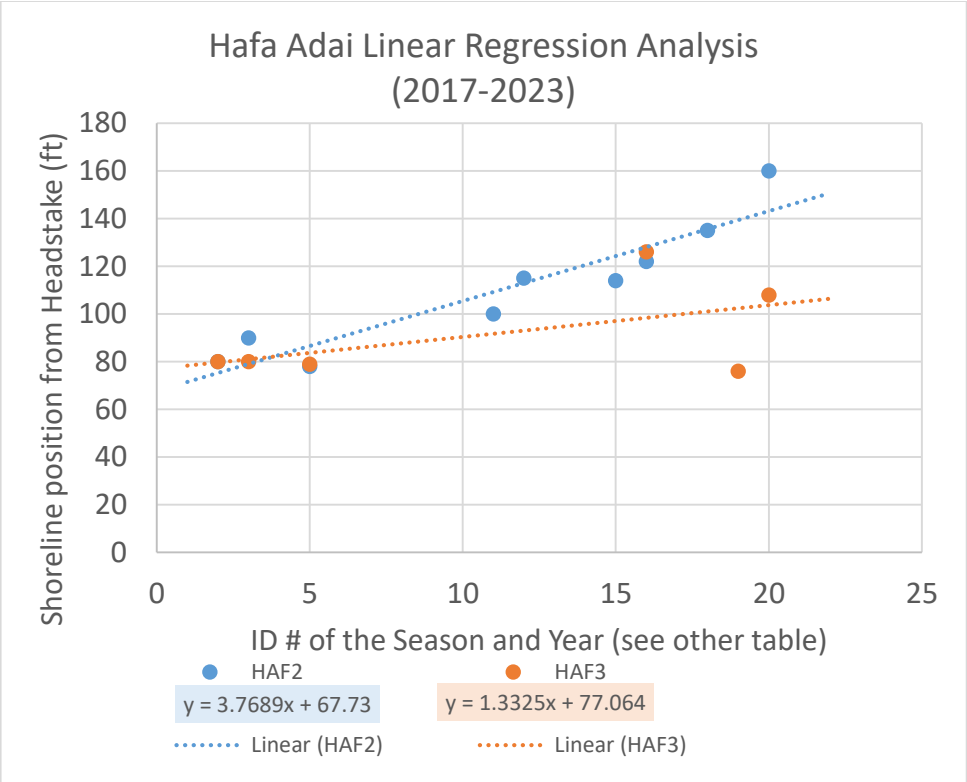
- ACCRETING
- Wrackline that that ranges 40 – 88 ft and an elevation difference of 6.5 ft
- As the shoreline has been gaining volume and length in three years, this stretch of shore naturally developed infrastructure. From July 2020 through Feb 2021, a row of ironwood trees grew and blocked the transect, making surveying difficult from Feb 2021 and onward.
- Based on the Shoreline linear regression analysis (see pg 74), the shoreline has a rate of +1.3 ft from 2016-2023.



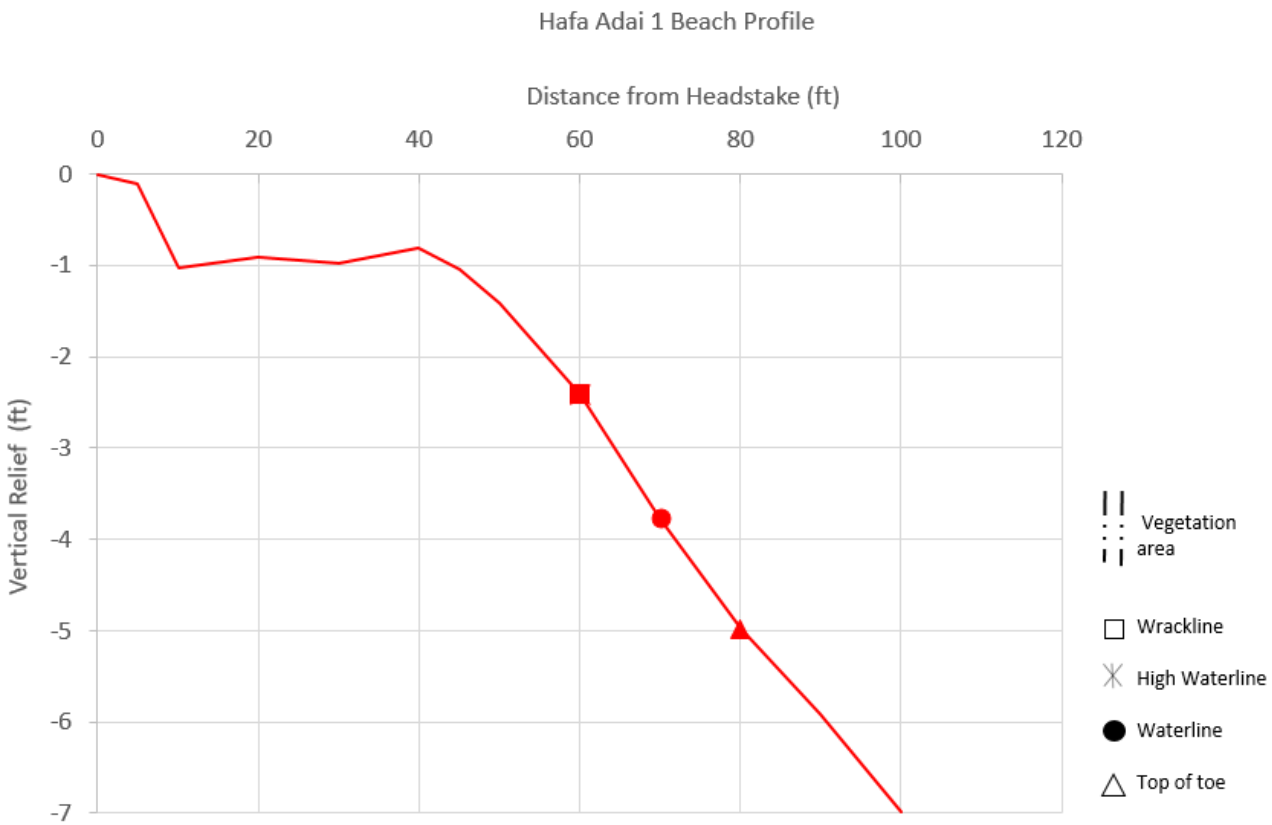
Hafa Adai 1

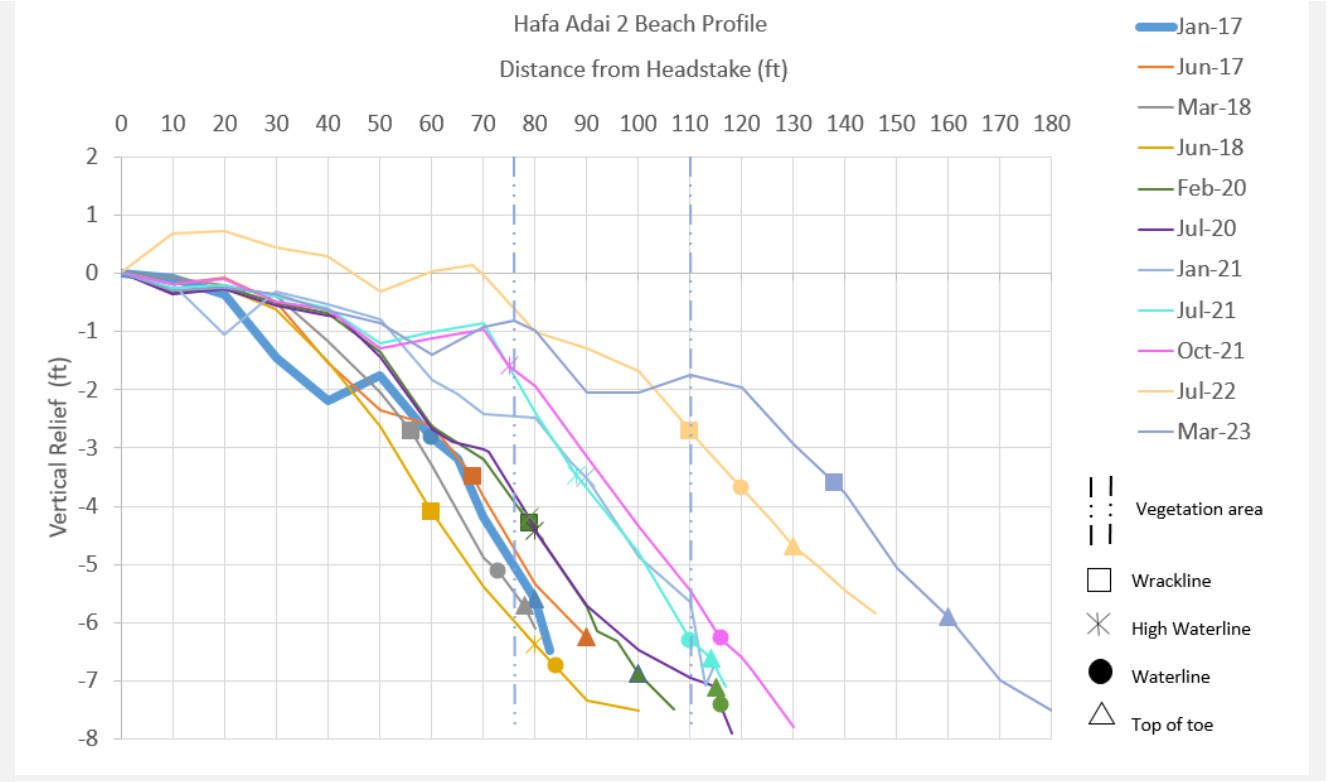
Hafa Adai 2

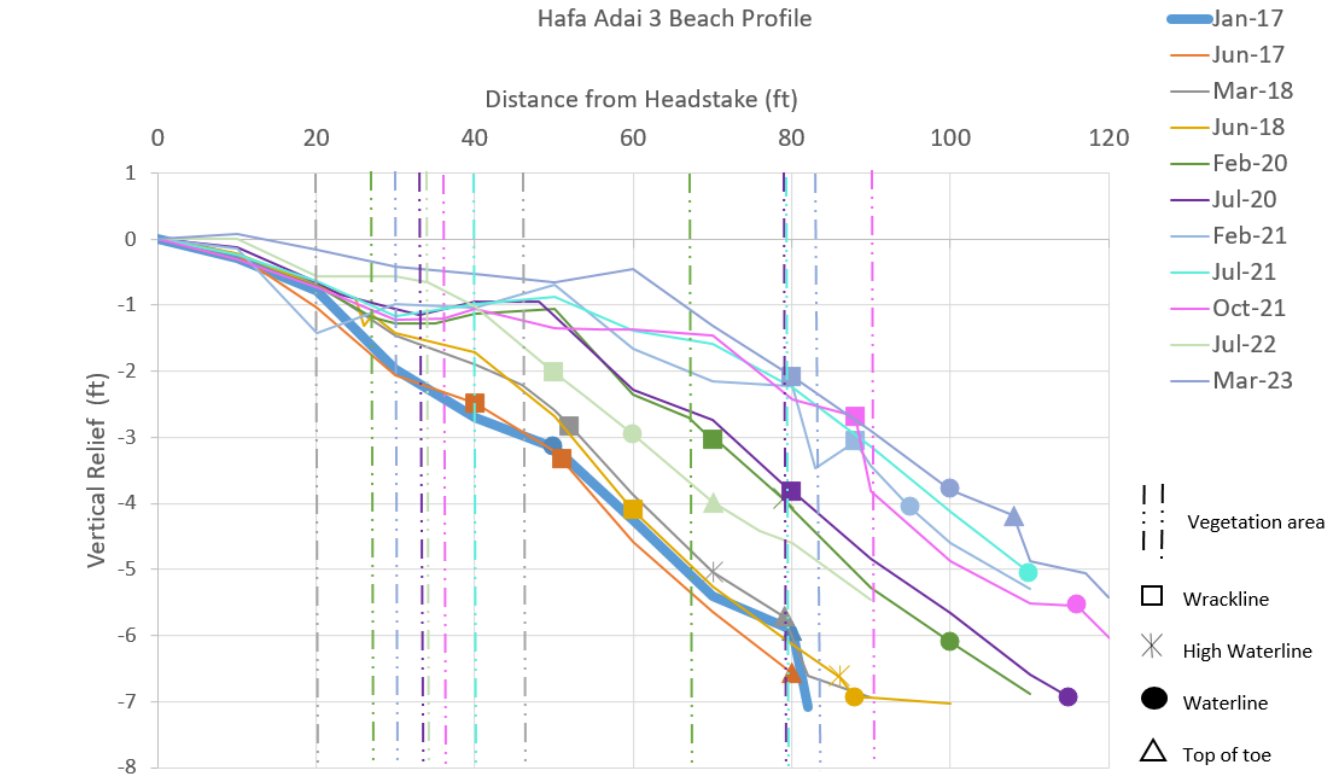
Hafa Adai 3



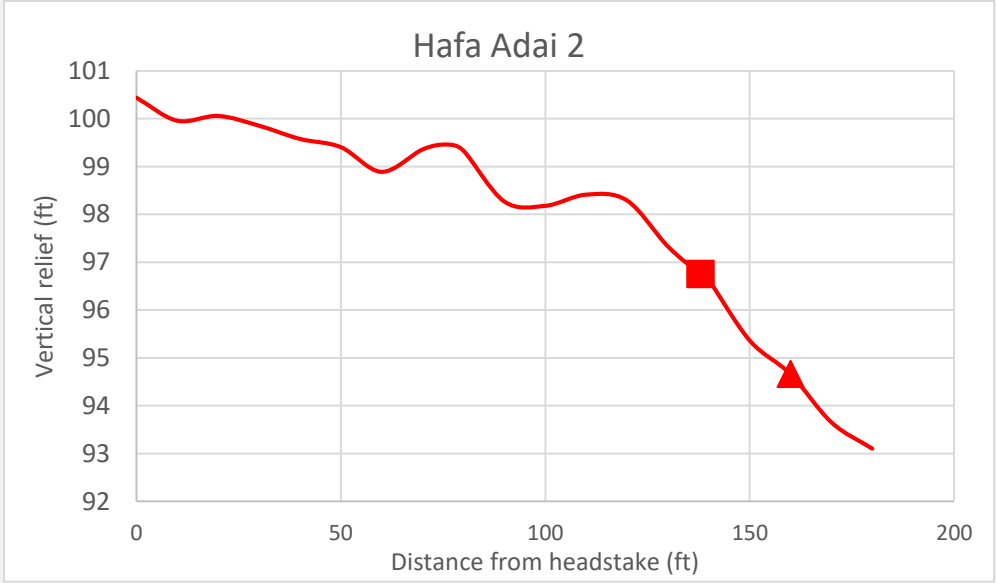
Hafa Adai Beach Profiles

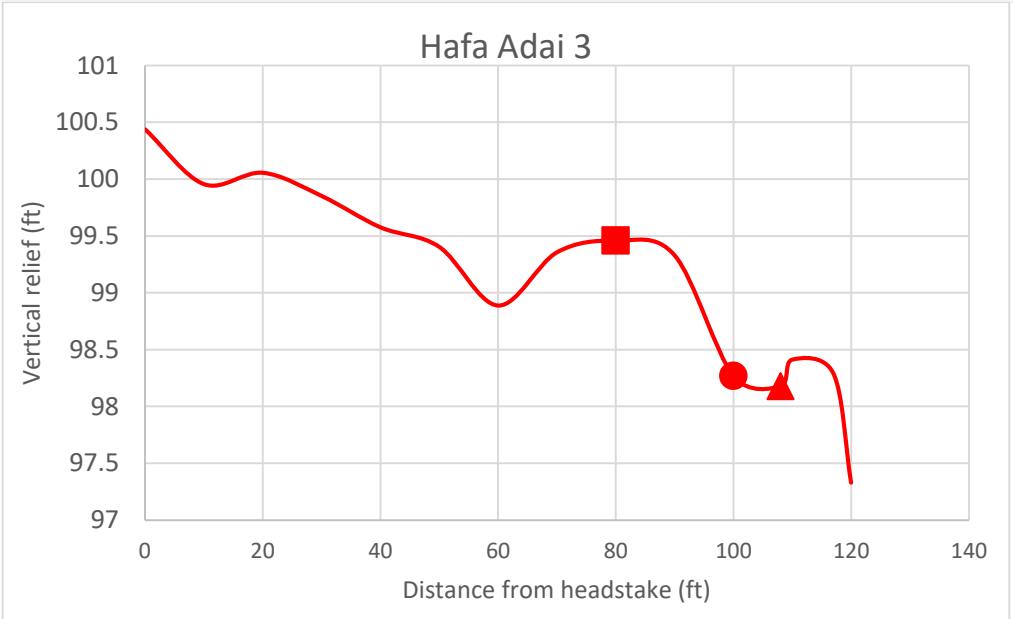



Hafa Adai 2 Beach Profile
Distance from Headstake (ft)
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180
2 1 0 -1 -2 -3 -4 -5 -6 -7 -8
Vertical Relief (ft)
Jan-17
Jun-17
Mar-18
Jun-18
Feb-20
Jul-20
Jan-21
Jul-21
Oct-21
Jul-22
Mar-23
Vegetation area
Wrackline
High Waterline
Waterline
Top of toe


Hafa Adai 3 Beach Profile
Distance from Headstake (ft)
0 20 40 60 80 100 120
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
Jul-21
Oct-21
Jul-22
Mar-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

Fiesta has a patch reef and seagrass that attenuate wave energy. However, the island's largest shipping channel to the north enables higher energy wave energies to overtop the reef, especially during storm events. Fiesta beach has scarps that continue to retreat inland and degrading public access and recreational activity facilities conducted nearby.

Watersports operators and hotel operators are impacted by the reduced shoreline area. The south transect, bordering the IPI Casino building, is speculated to have influence from the nearby outfall north of the area. We map the top of the storm berm with the Trimble and Total Station after the tropical storm in September to monitor the wave damage and overtopping in the area. Two headstakes are discontinued due to damage from storms in late 2021.

Fiesta 1 Highlights:

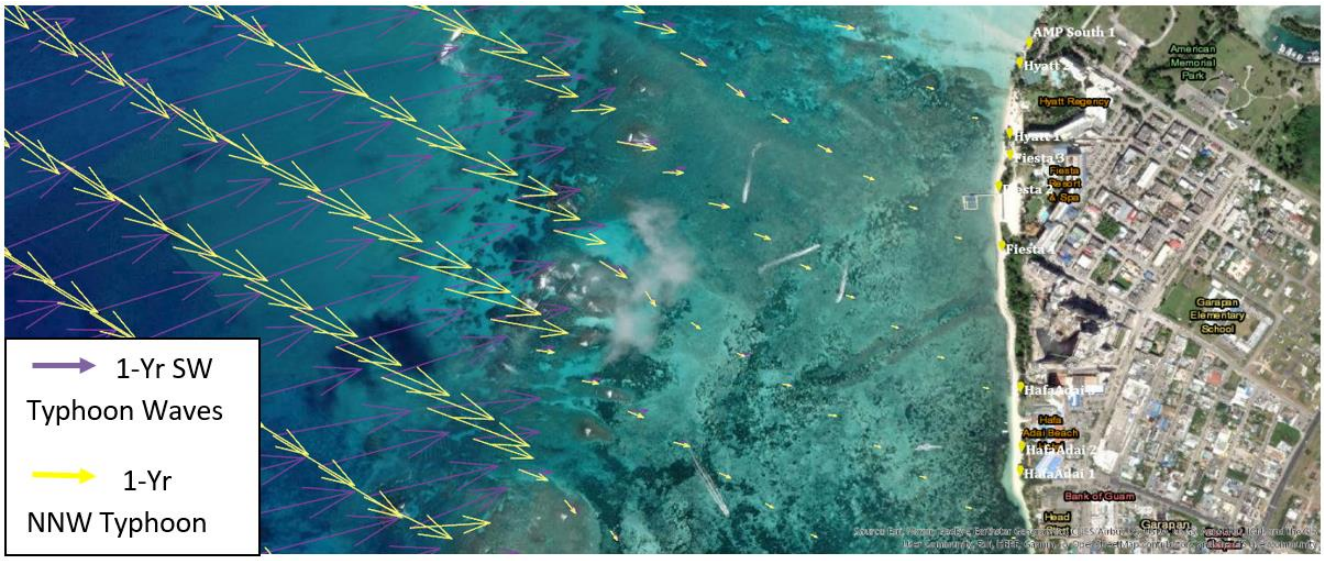
- ERODING
- LOSS of shoreline by ~20 ft since 2021.
- Wrackline ranges 28 – 50 ft and an elevation difference of 7 ft
- Outfall influenced
- This shoreline has been eroding from 2016-2023.

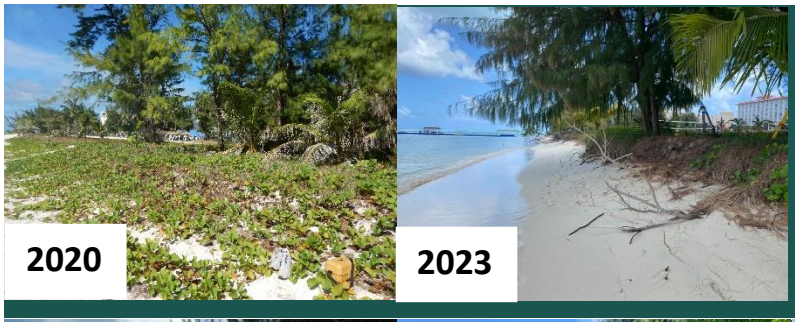
Fiesta 2 Highlights:

- 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.



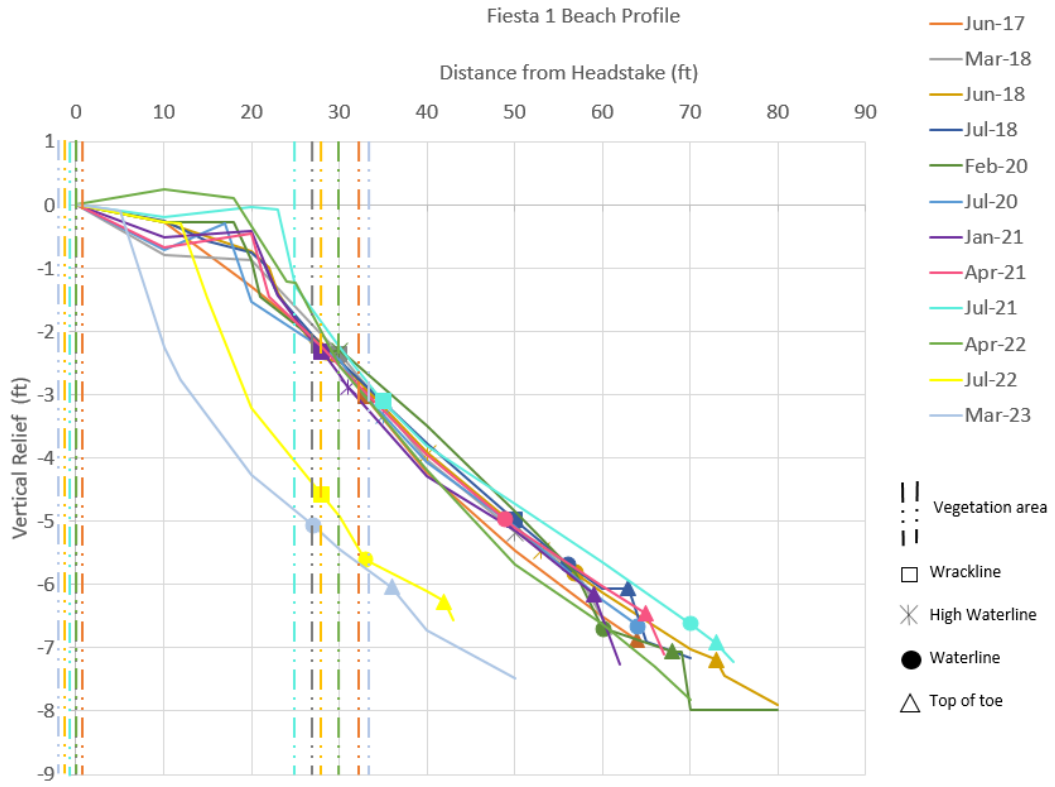


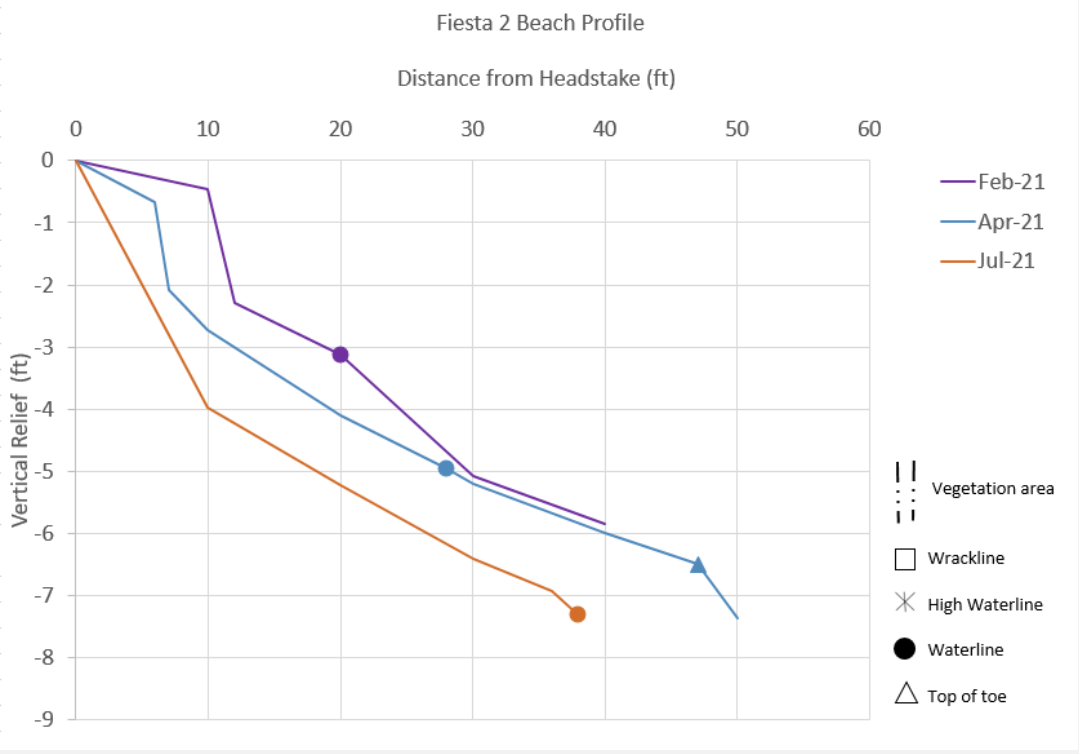
Fiesta 1

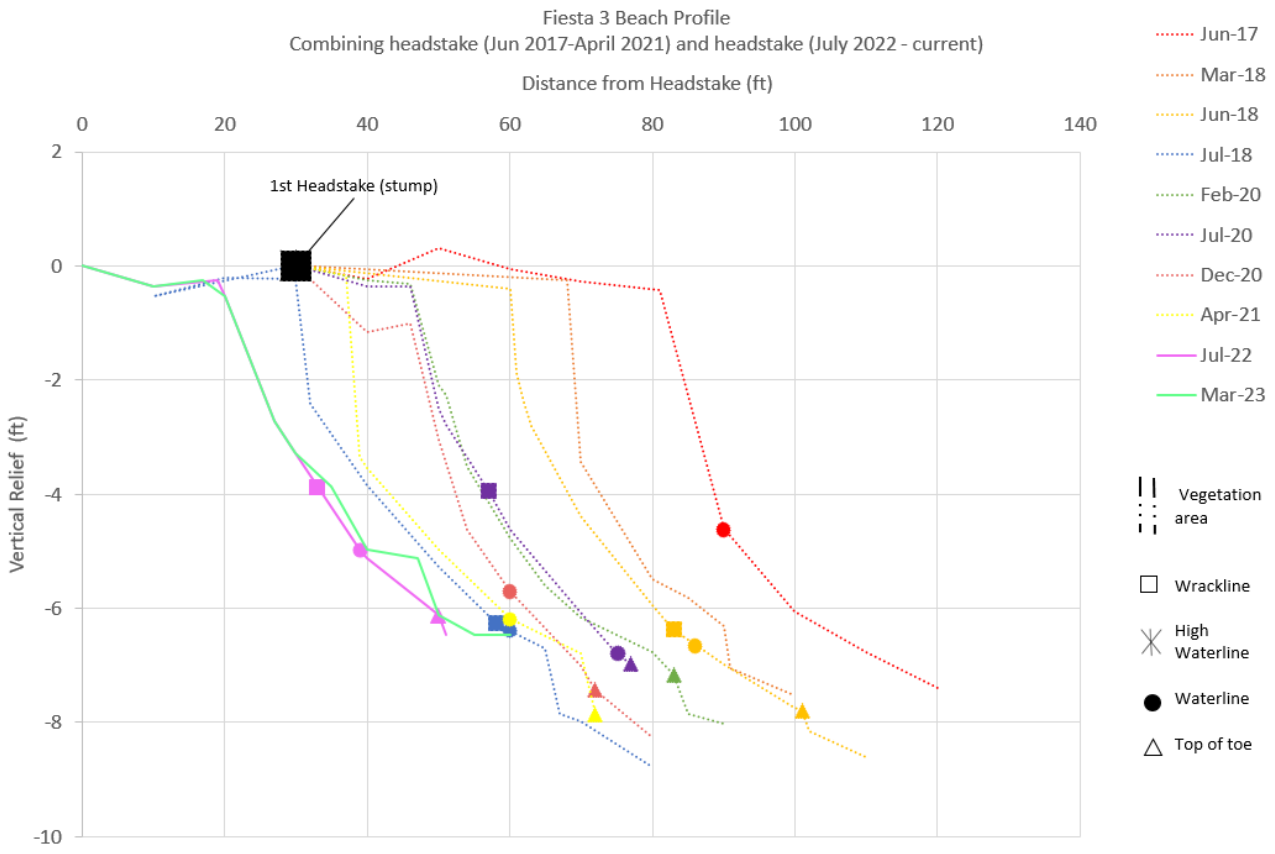
Fiesta 2

Fiesta 3

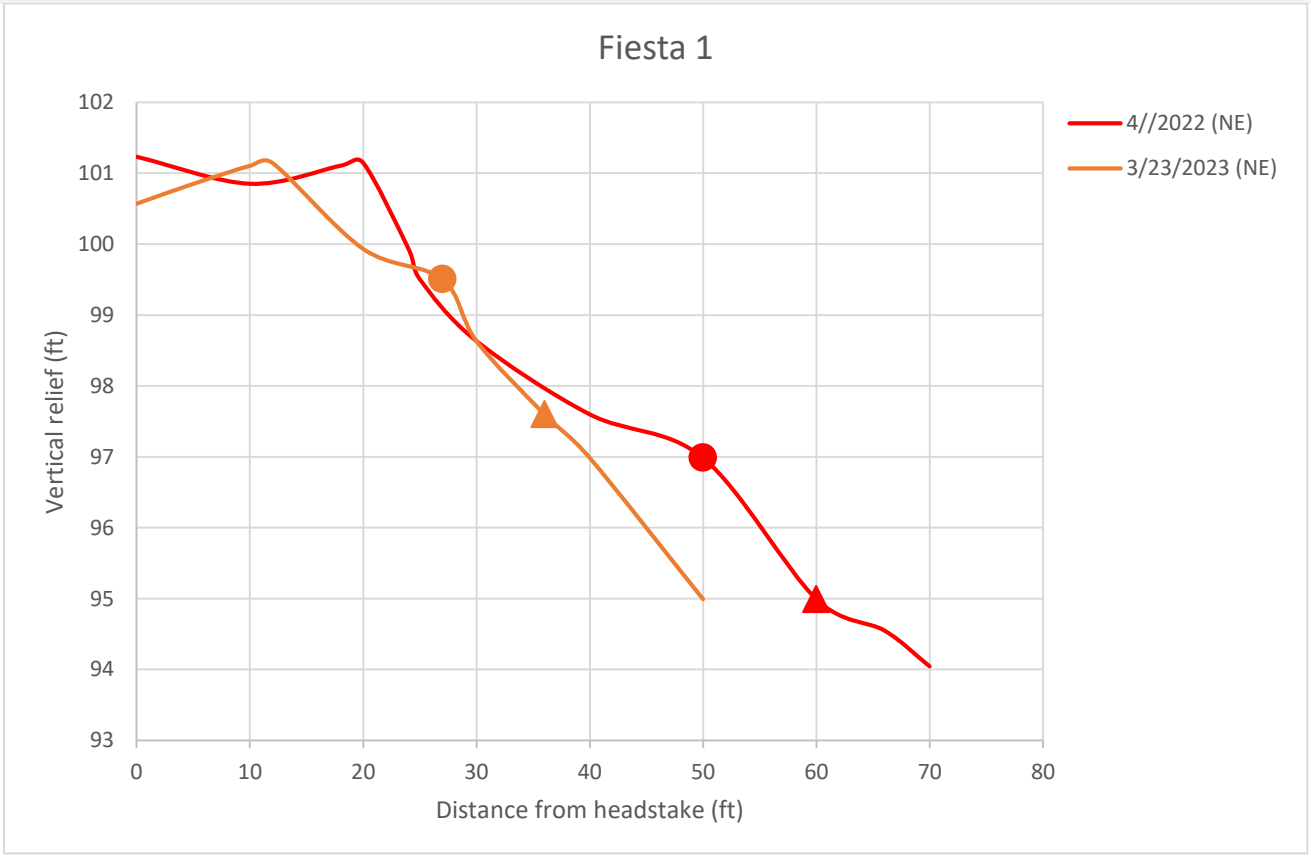
Fiesta Beach Profiles

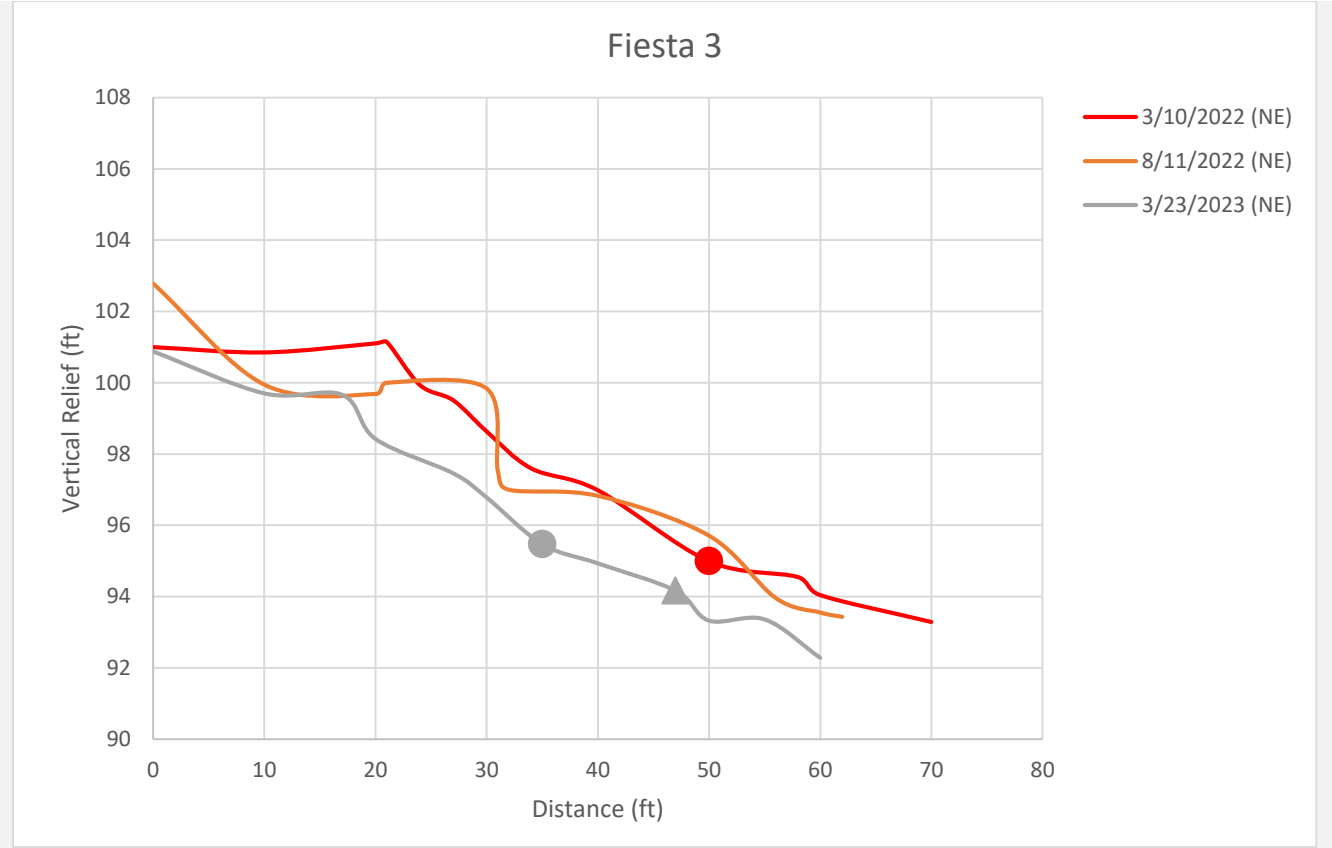






Total Station




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

Hyatt

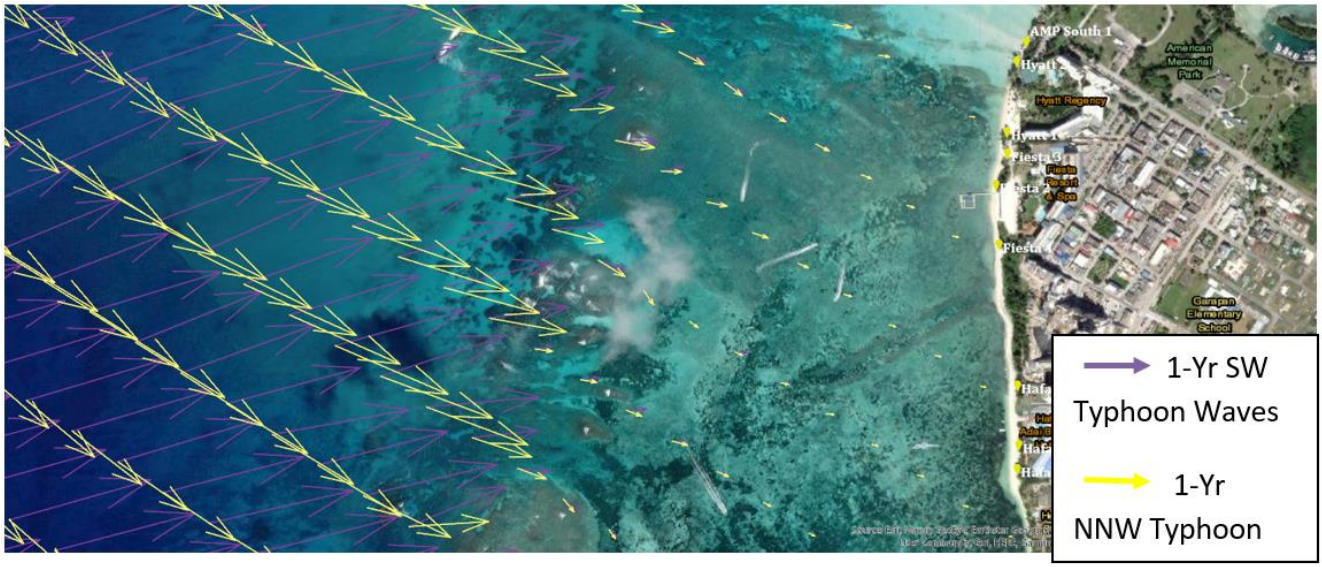
Similar to Fiesta, this section of shoreline has been chronically eroding due to strong storm-induced waves. Two head stakes were pulled into the water and rendered discontinued. Storm conditions with higher sea levels increased wave energies eating up the shoreline as they entered in through the channel. North-northwest flows have greater damage in a shorter period of time as shown with the tropical disturbance in September 2021. Southwest typhoon wave conditions still erode the shoreline.

Hyatt 1 Highlights:

- ERODING
- LOSS of shoreline by ~60 ft since 2020
- Elevation difference of 7 ft
- Temporary ponding episodes from in-land induced the erosion

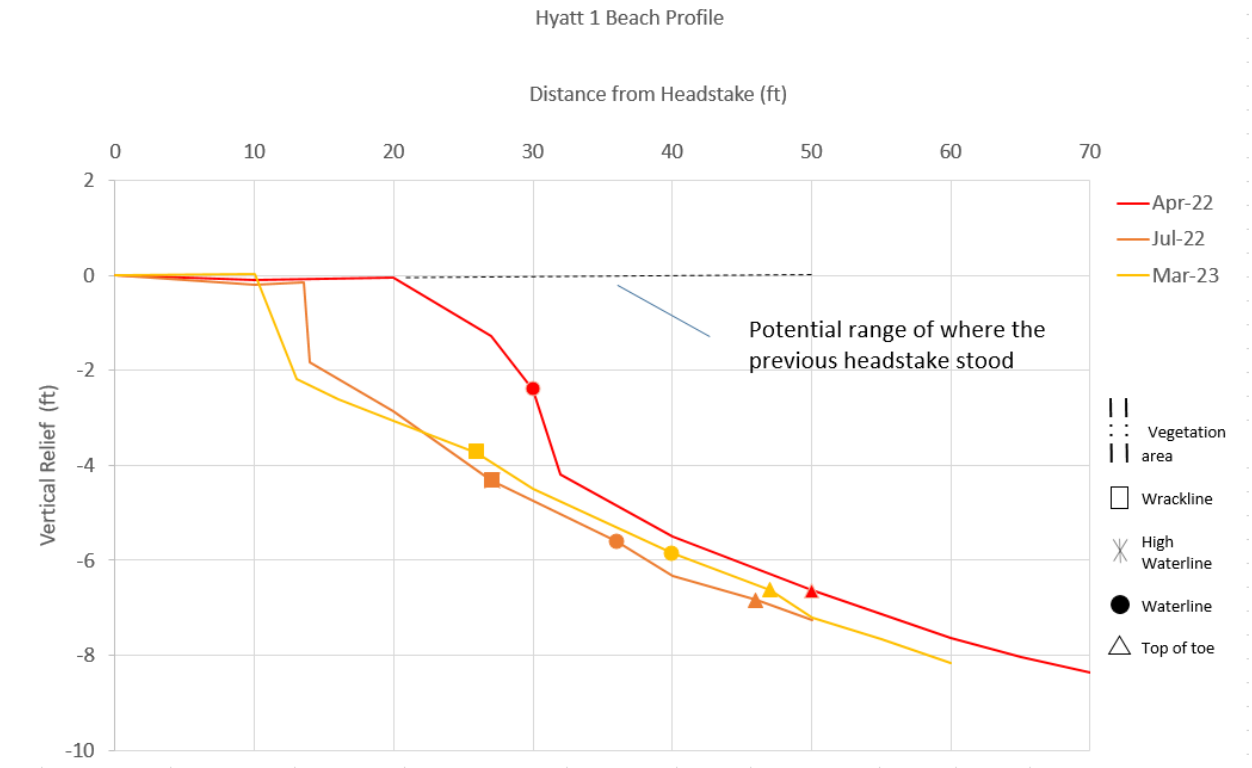
Hyatt 2 Highlights:

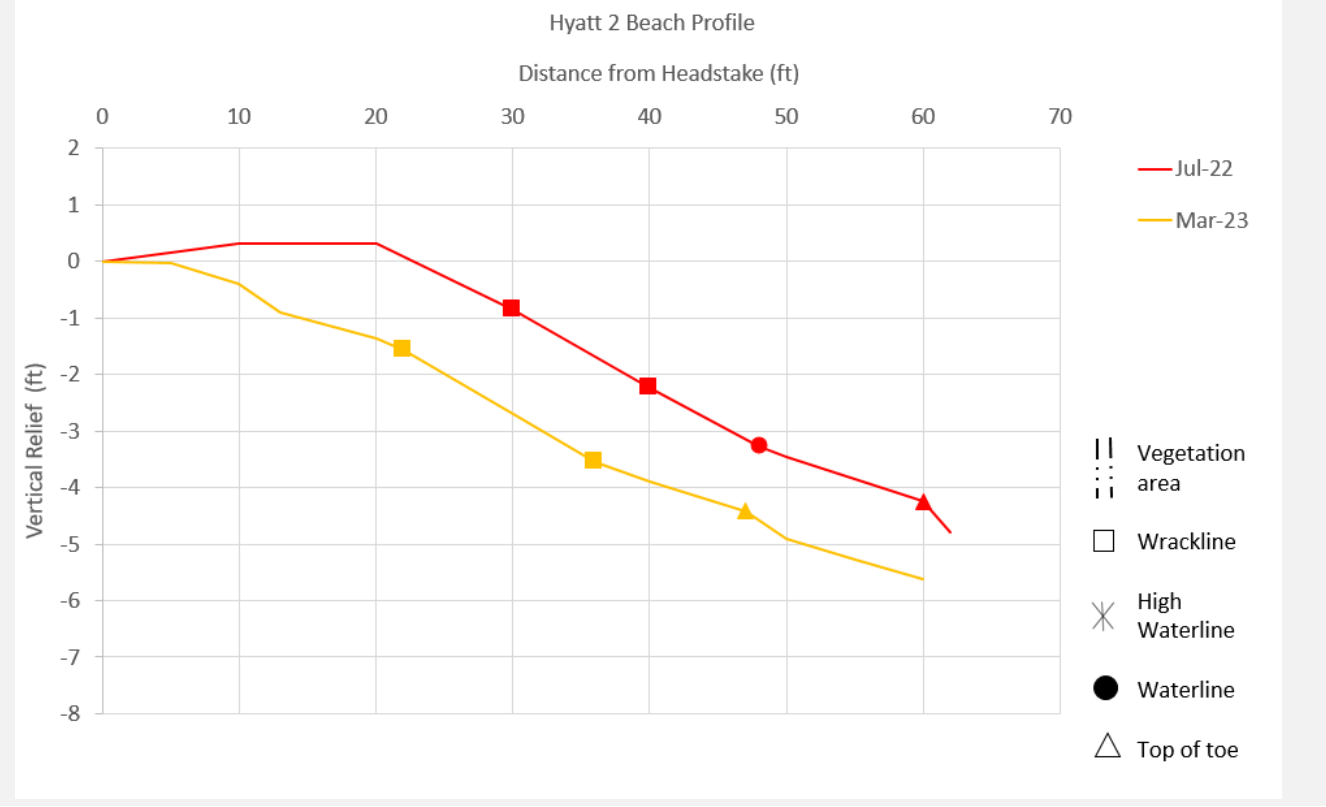
- ERODING
- LOSS of shoreline by ~70 ft since 2017
- **History:** This area serves as a pathway from Micro Beach to the marine sports area north of Hyatt. It is eroding on the long term determined by the abrasion exposing the bedrock after the September 2021 storm. The sand is pulled into the water during 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.



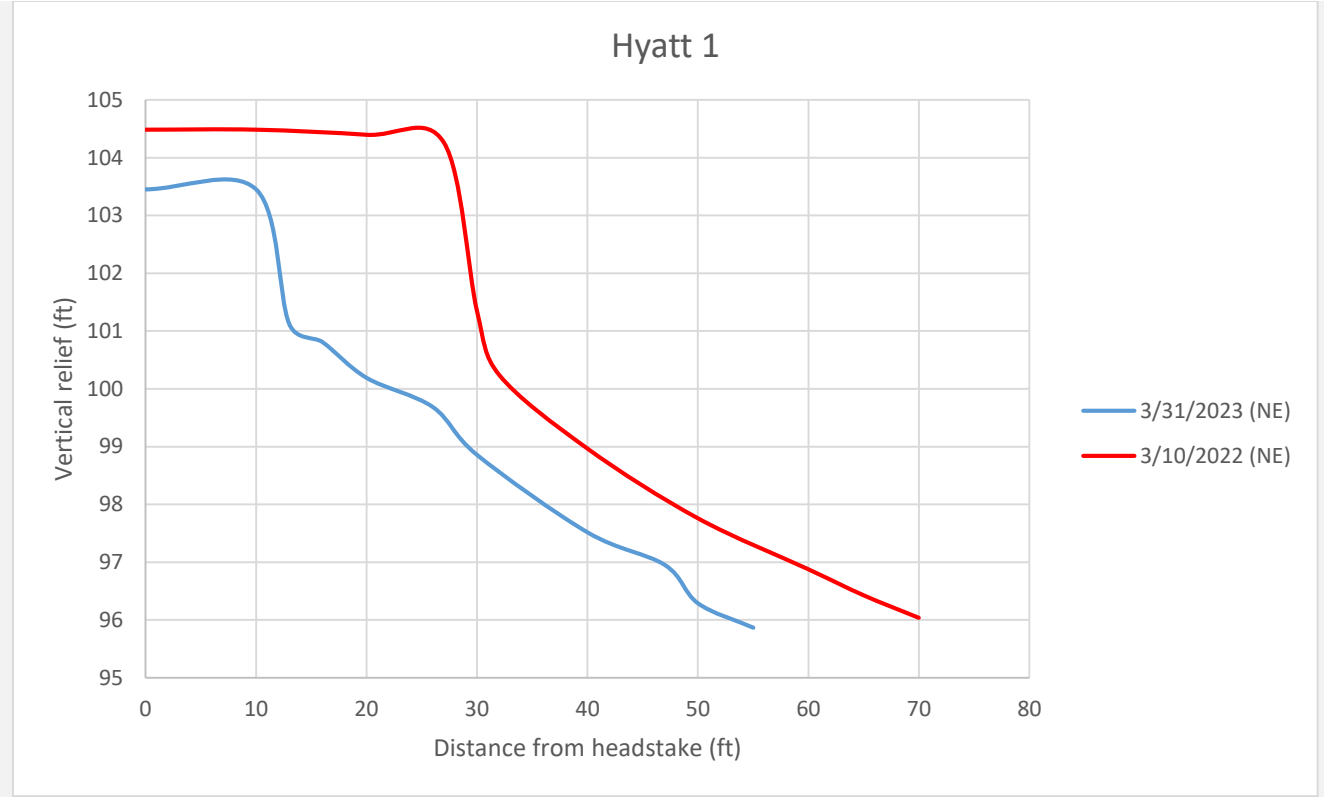

2020
2022
2023
Hyatt 1
2020
2022
2023
Hyatt 2

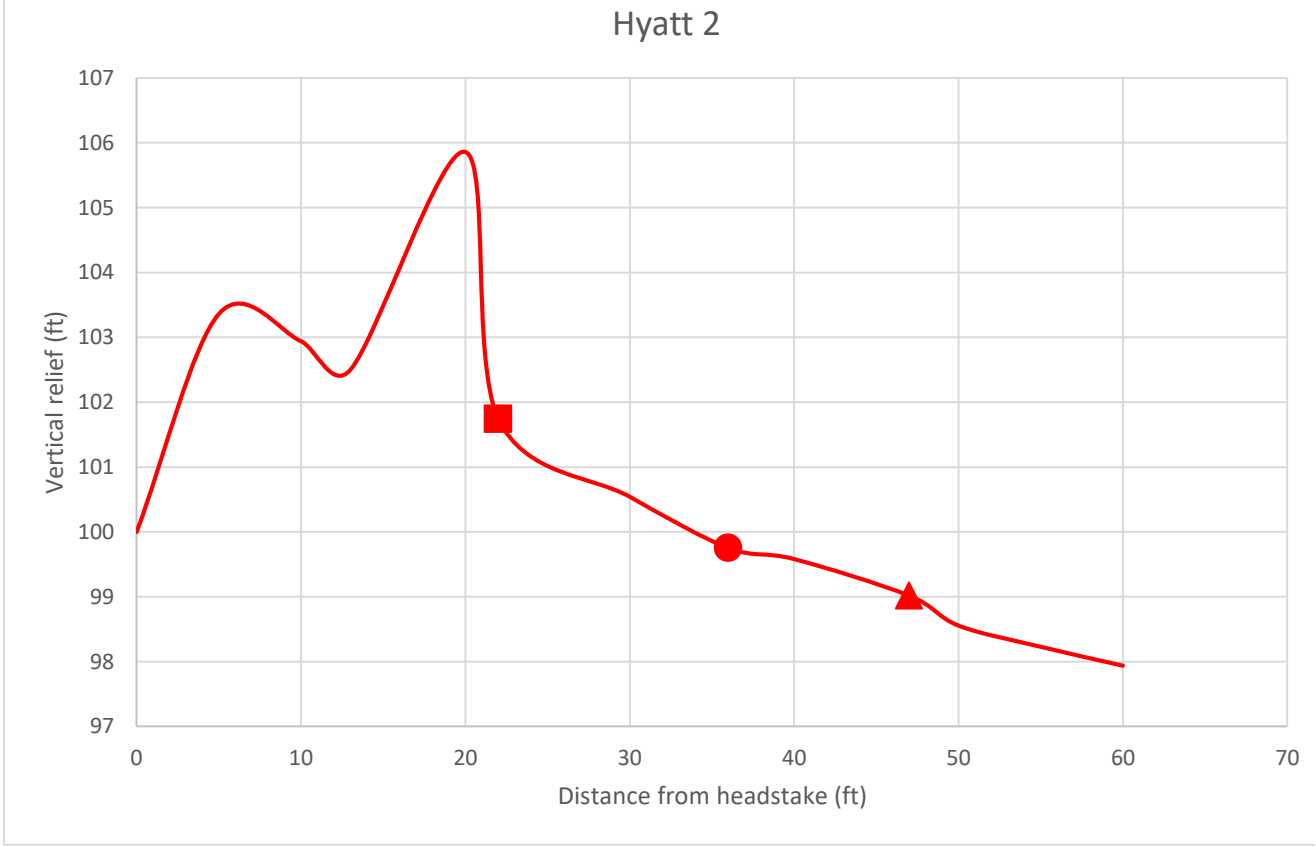
Hyatt Beach Profiles





Total Station


Hyatt 1
Vertical relief (ft)
105
104
103
102
101
100
99
98
97
96
95
0
10
20
30
40
50
60
70
80
Distance from headstake (ft)
3/31/2023 (NE)
3/10/2022 (NE)


Hyatt 2
Vertical relief (ft)
107
106
105
104
103
102
101
100
99
98
97
0
10
20
30
40
50
60
70
Distance from headstake (ft)

American Memorial Park

The AMP shoreline – short for American Memorial Park – is dynamic due to the complex hydrodynamics influenced by the Smiling Cove Marina infrastructure and the Main Channel interactions. Micro Beach is included in this site. Site-specific, smaller scaled nearshore dynamic modelling may help bring better understanding of long-shore processes. A pattern is observed: sand from the south shifts to the north with some sand returning to the south and most headed for the north. The loss of the southern transects' width could be due to ongoing accretion north of Puntan Muchot). Wave energies are higher during southwest typhoon conditions given that the flows enter in through the main channel, but north-northwest conditions could drive the shift of sediment up north for 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.

American Memorial Park South 1

American Memorial Park South 2

American Memorial Park Point 1

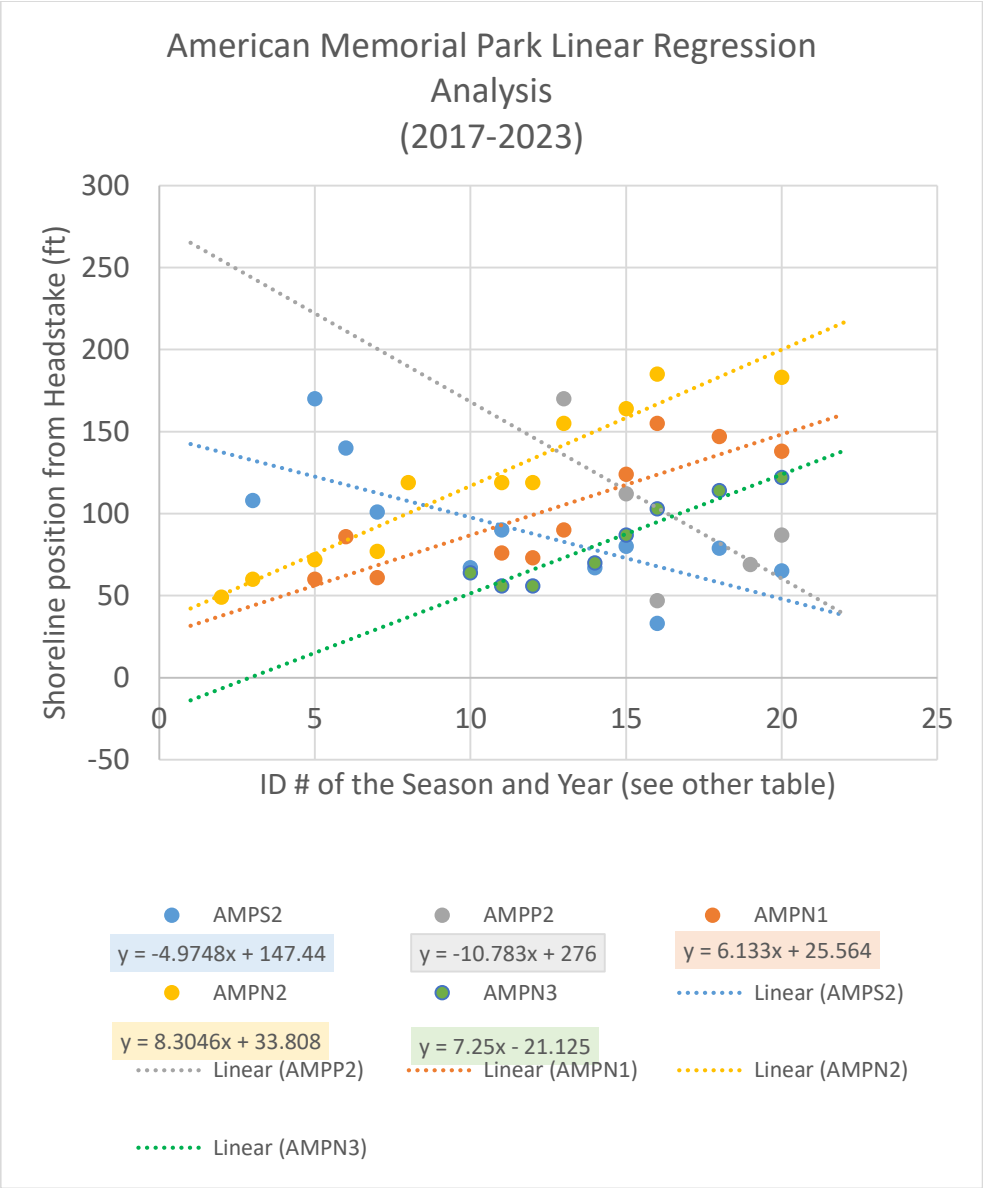
[No photo is available for 2023. Conditions had naturally replenished sand.]

American Memorial Park Point 2

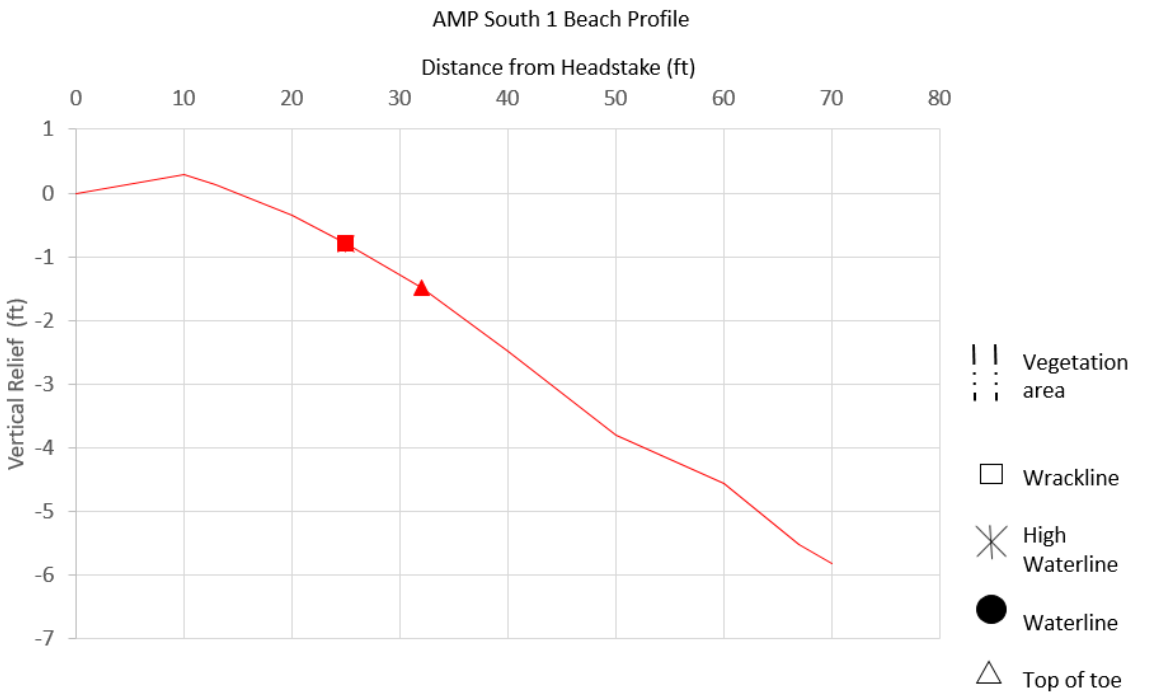
American Memorial Park North 1

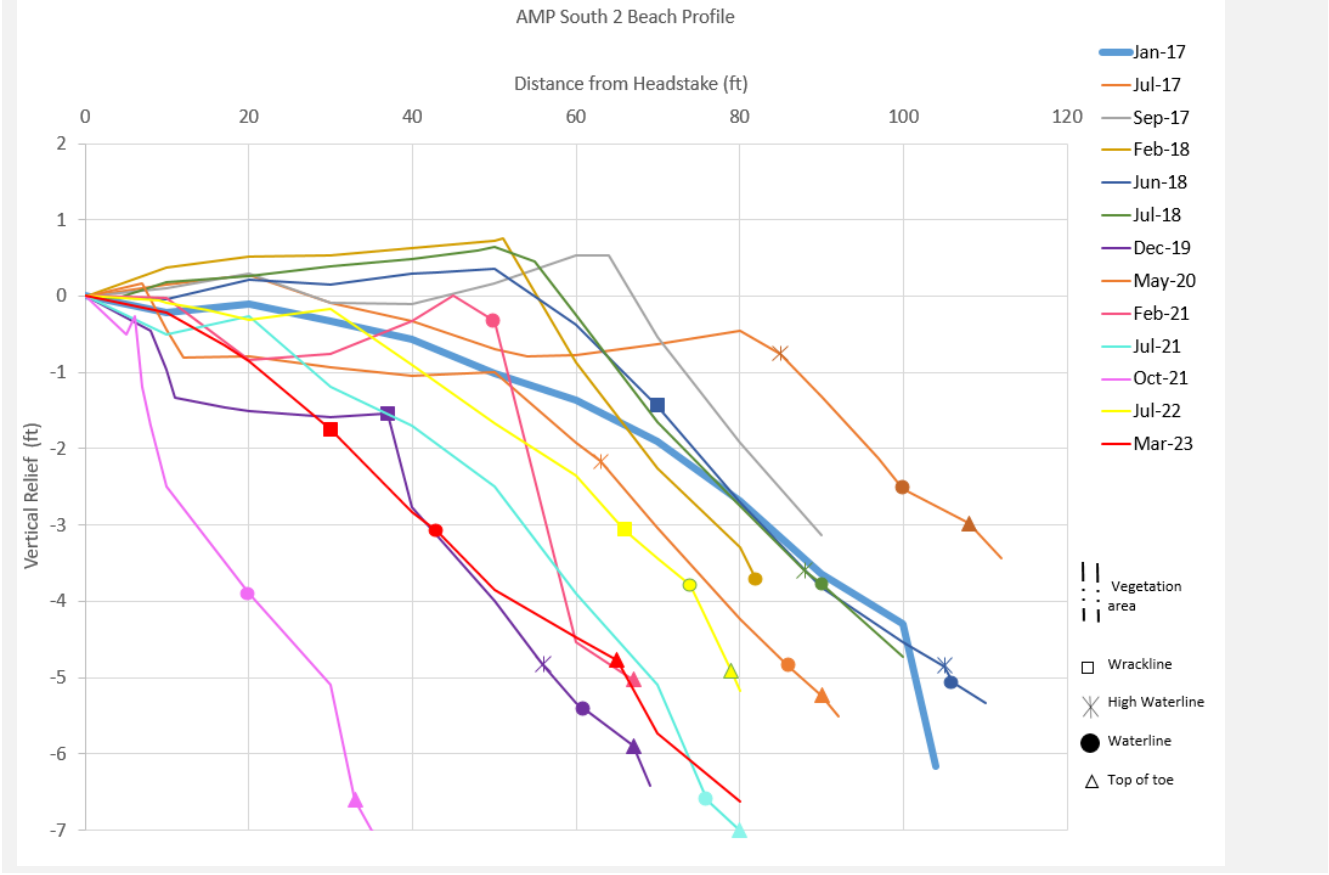
American Memorial Park North 2

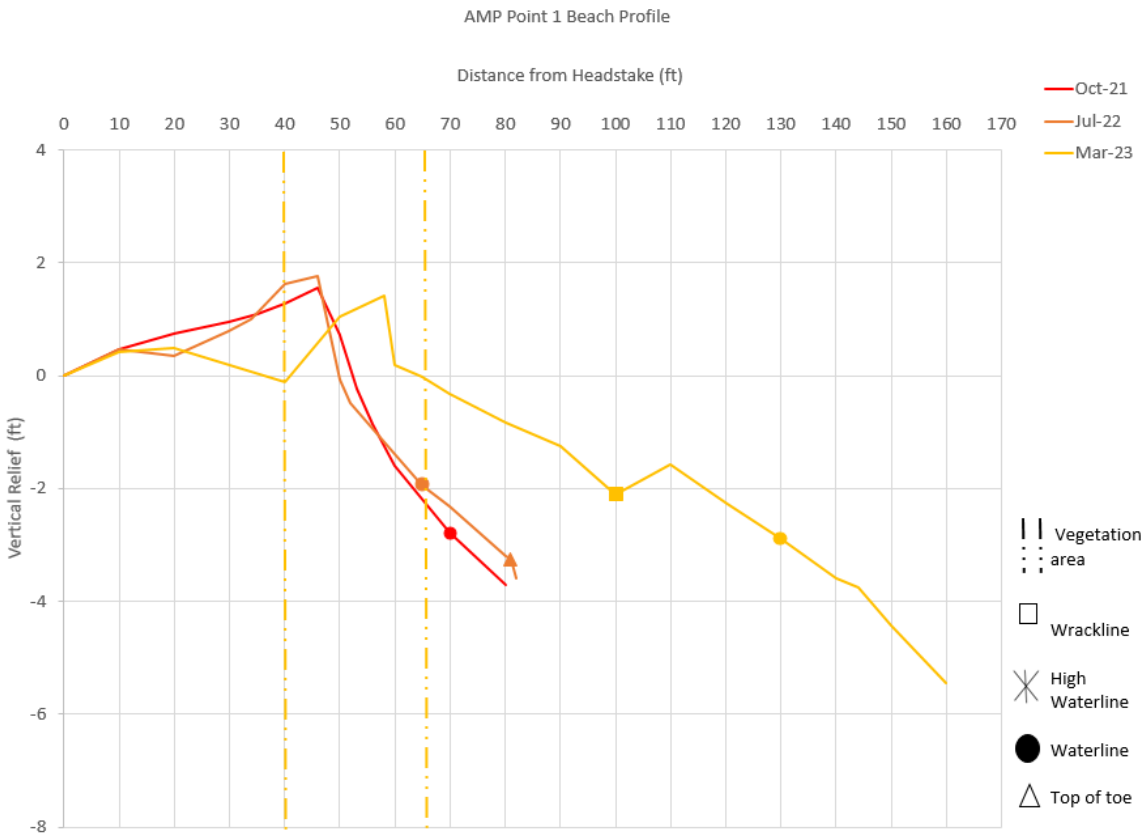
American Memorial Park North 3

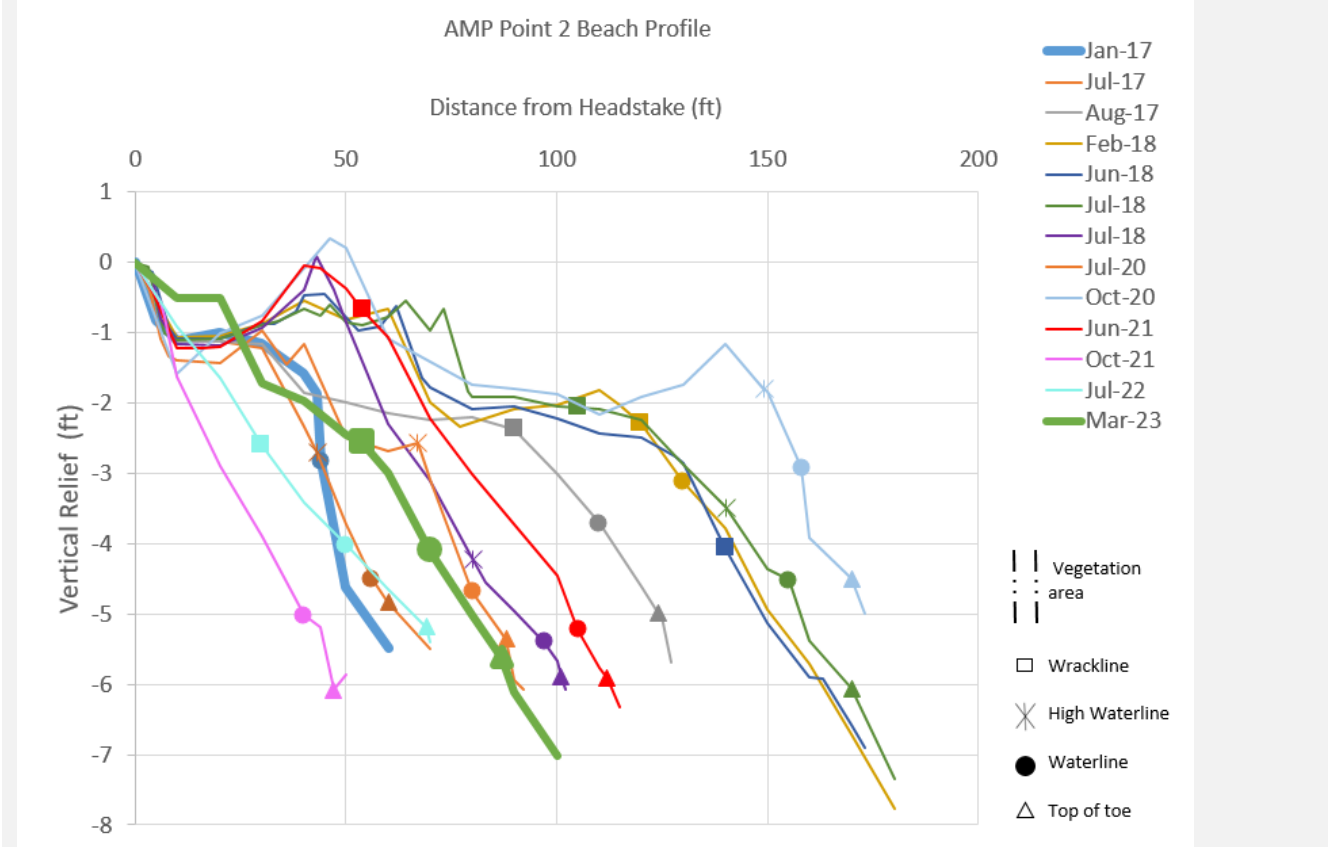

American Memorial Park Linear Regression Analysis
(2017-2023)
Shoreline position from Headstake (ft)
300
250
200
150
100
50
0
-50
0
5
10
15
20
25
ID # of the Season and Year (see other table)
AMPS2
y = -4.9748x + 147.44
AMPP2
y = -10.783x + 276
AMPN1
y = 6.133x + 25.564
AMPN2
y = 8.3046x + 33.808
AMPN3
y = 7.25x - 21.125
Linear (AMPS2)
Linear (AMPP2)
Linear (AMPN1)
Linear (AMPN2)
Linear (AMPN3)

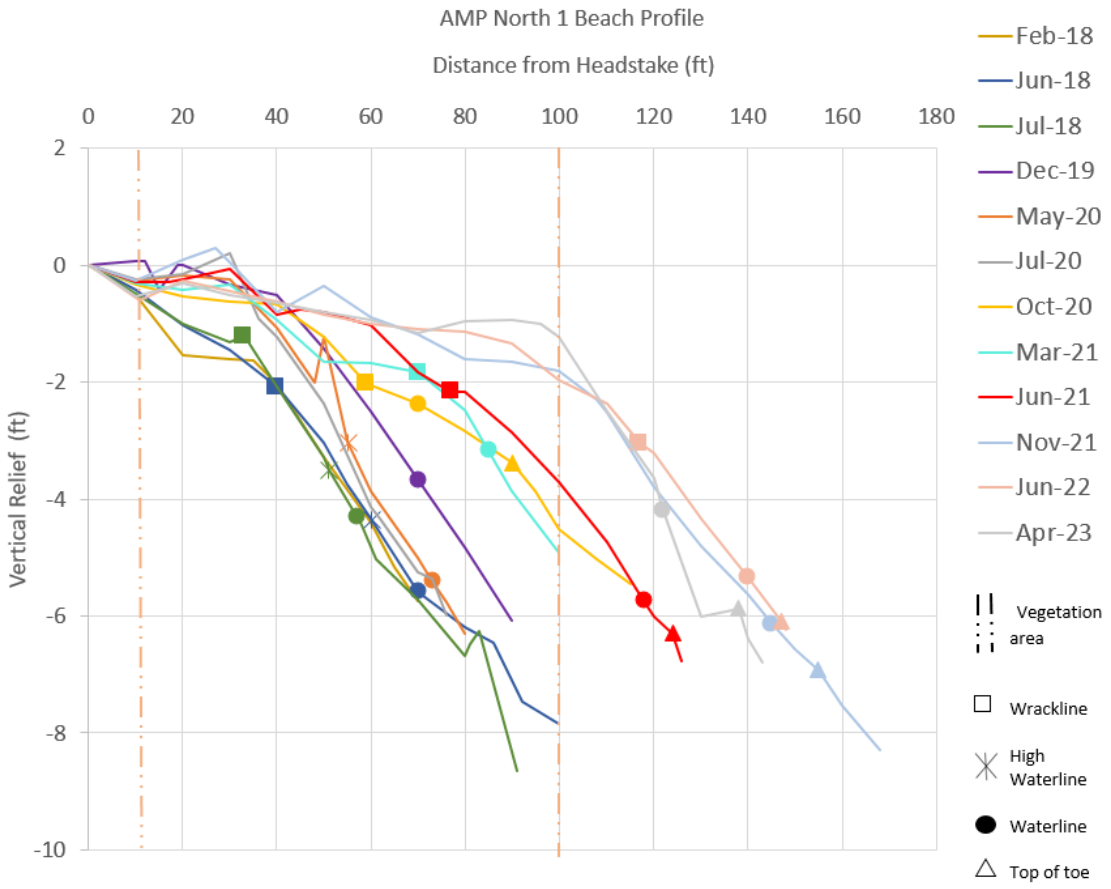
American Memorial Park Beach Profiles

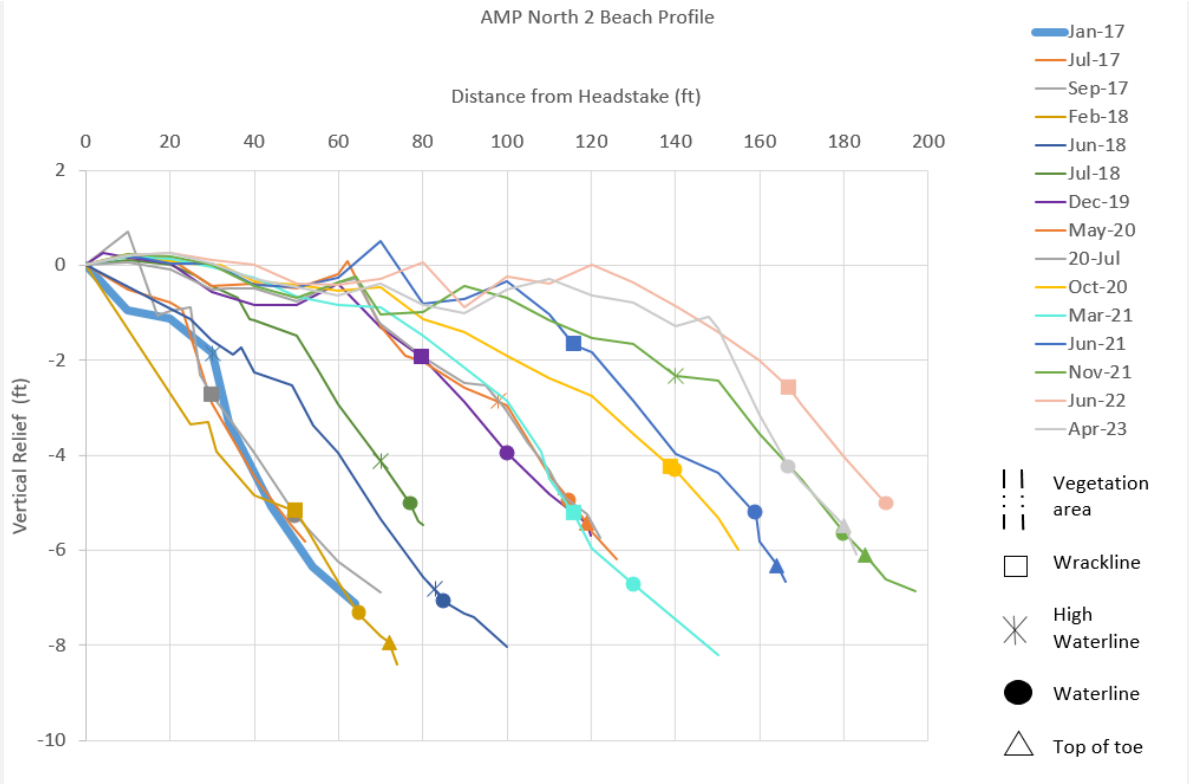


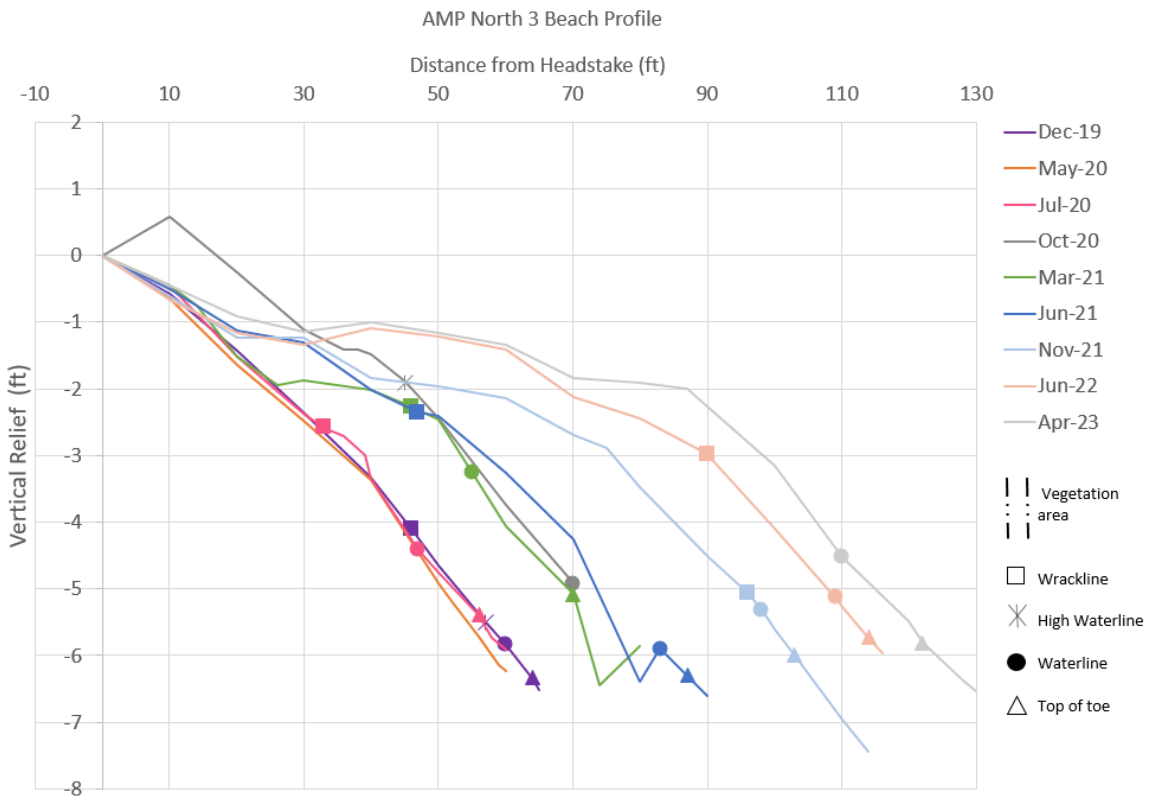



AMP Point 1 Beach Profile
Distance from Headstake (ft)
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170
4 2 0 -2 -4 -6 -8
Vertical Relief (ft)
Oct-21
Jul-22
Mar-23
Vegetation area
Wrackline
High Waterline
Waterline
Top of toe

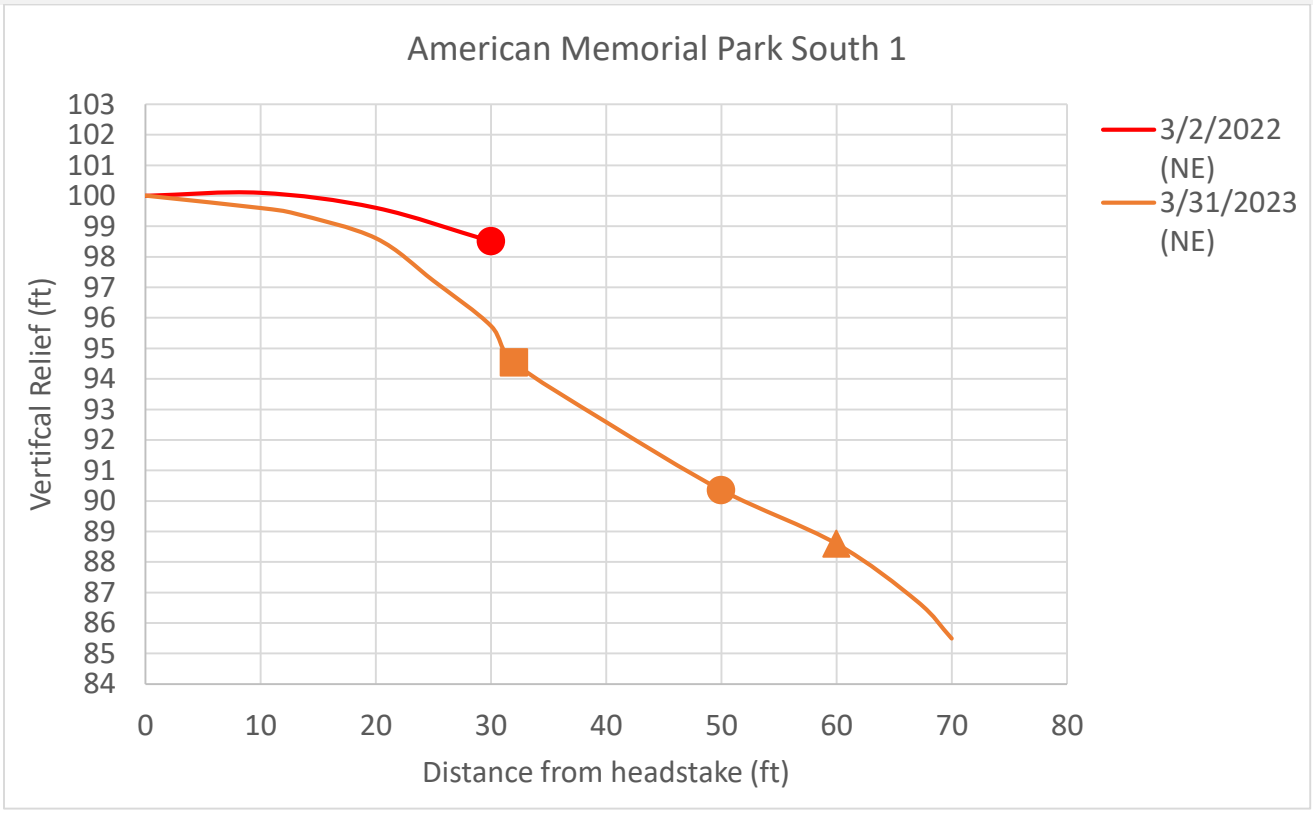

AMP Point 2 Beach Profile
Distance from Headstake (ft)
0 50 100 150 200
1 0 -1 -2 -3 -4 -5 -6 -7 -8
Vertical Relief (ft)
Jan-17
Jul-17
Aug-17
Feb-18
Jun-18
Jul-18
Jul-18
Jul-20
Oct-20
Jun-21
Oct-21
Jul-22
Mar-23
Vegetation area
Wrackline
High Waterline
Waterline
Top of toe

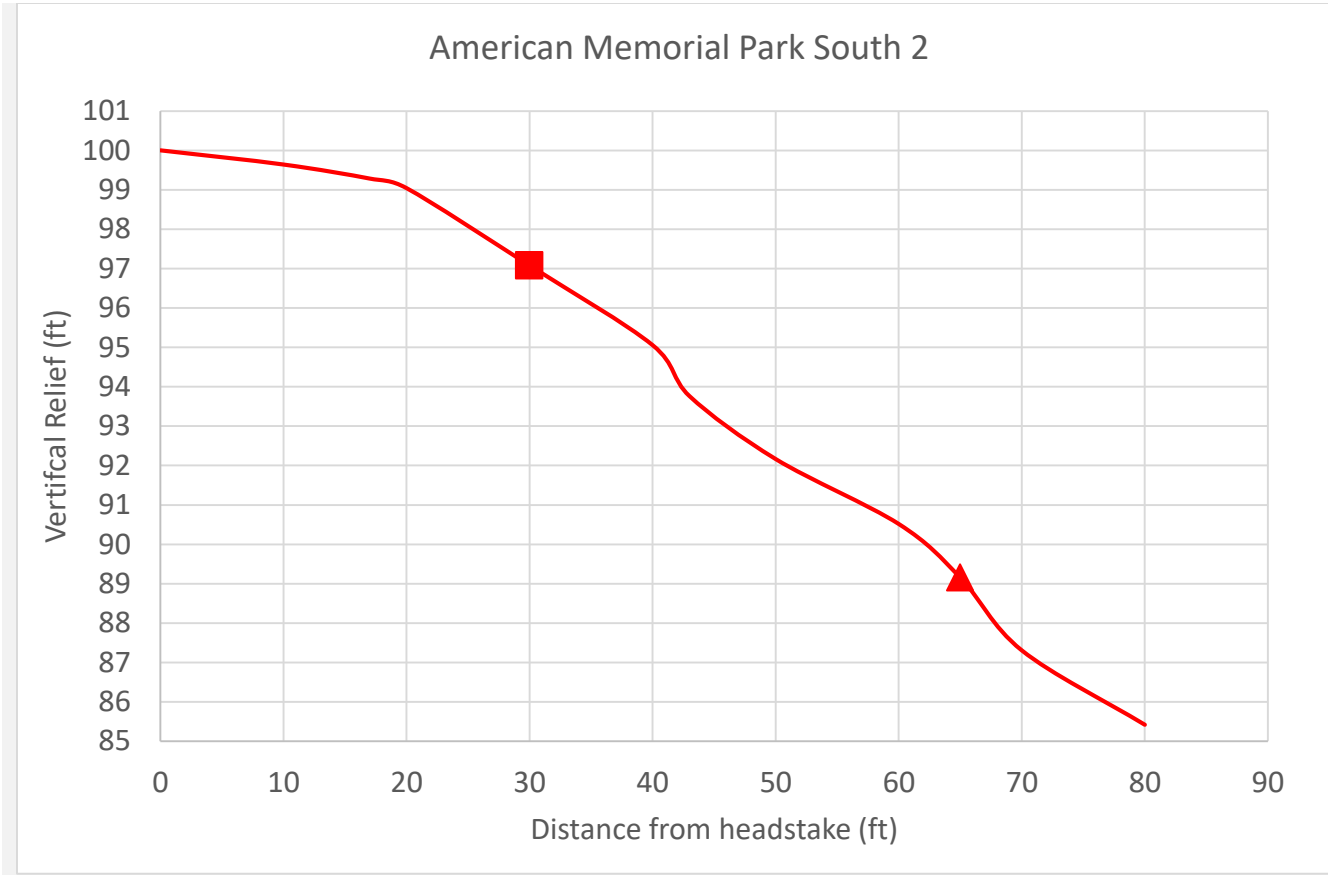

AMP North 1 Beach Profile
Distance from Headstake (ft)
0
20
40
60
80
100
120
140
160
180
2
0
-2
-4
-6
-8
-10
Vertical Relief (ft)
Feb-18
Jun-18
Jul-18
Dec-19
May-20
Jul-20
Oct-20
Mar-21
Jun-21
Nov-21
Jun-22
Apr-23
Vegetation area
Wrackline
High Waterline
Waterline
Top of toe

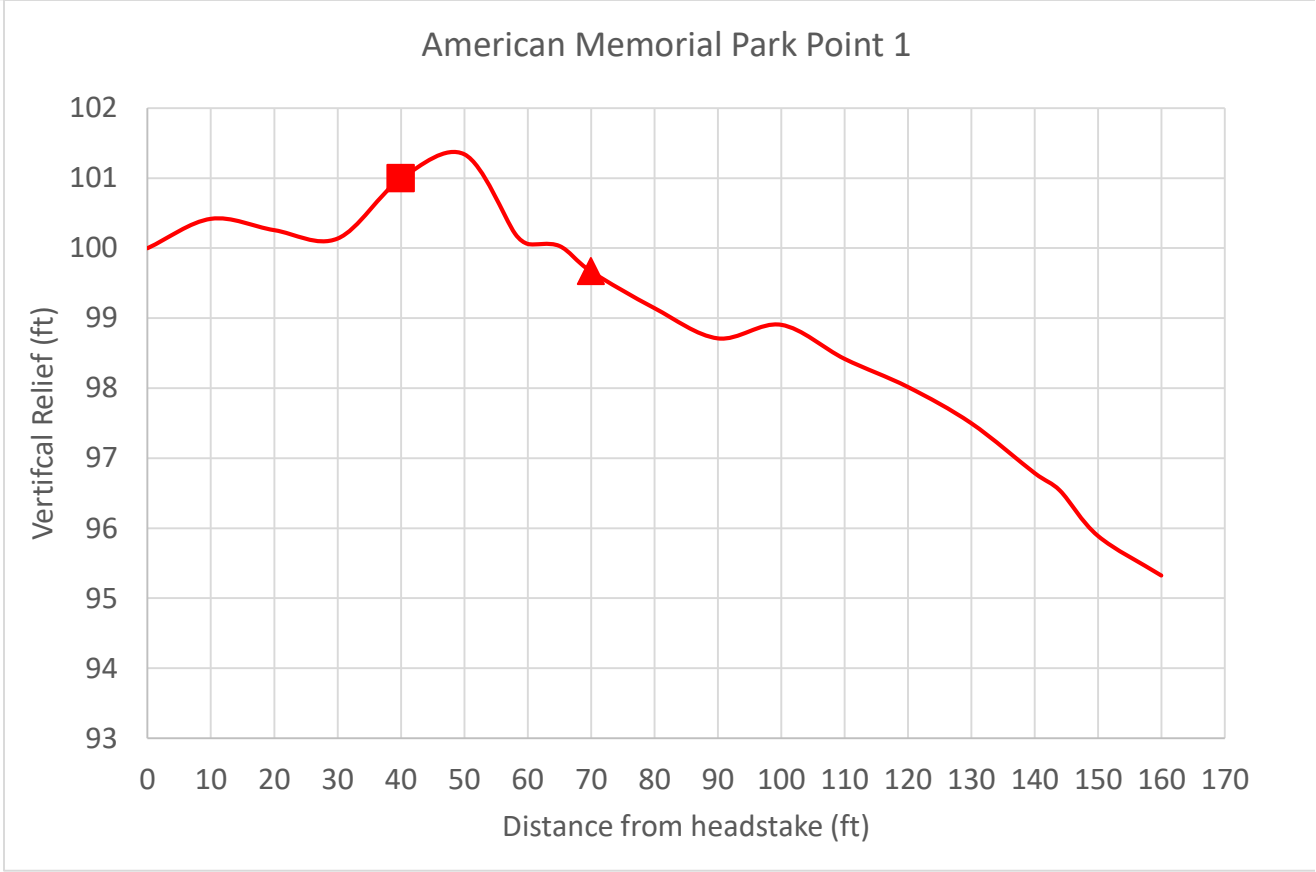

AMP North 2 Beach Profile
Distance from Headstake (ft)
0
20
40
60
80
100
120
140
160
180
200
2
0
-2
-4
-6
-8
-10
Vertical Relief (ft)
Jan-17
Jul-17
Sep-17
Feb-18
Jun-18
Jul-18
Dec-19
May-20
20-Jul
Oct-20
Mar-21
Jun-21
Nov-21
Jun-22
Apr-23
Vegetation area
Wrackline
High Waterline
Waterline
Top of toe

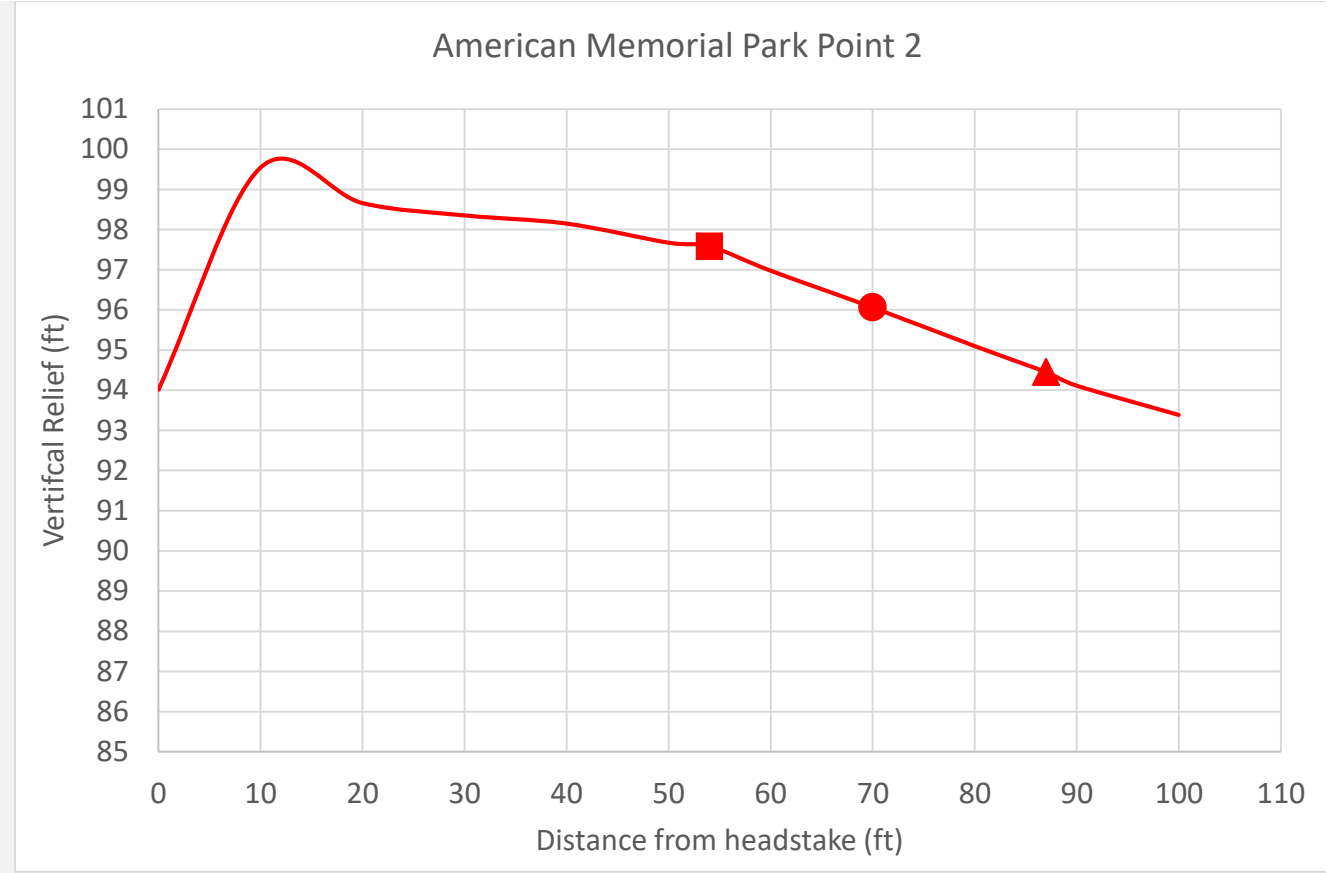


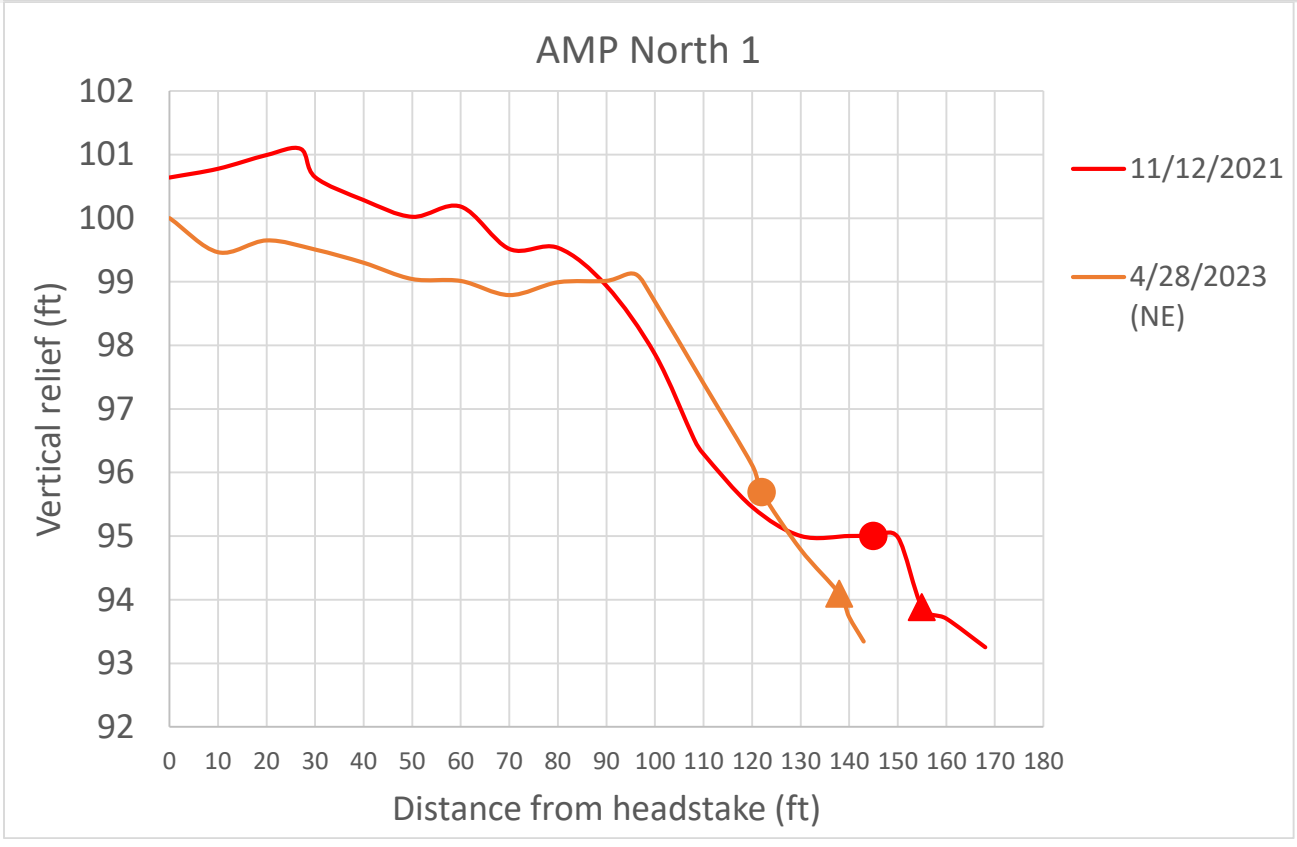
Total Station

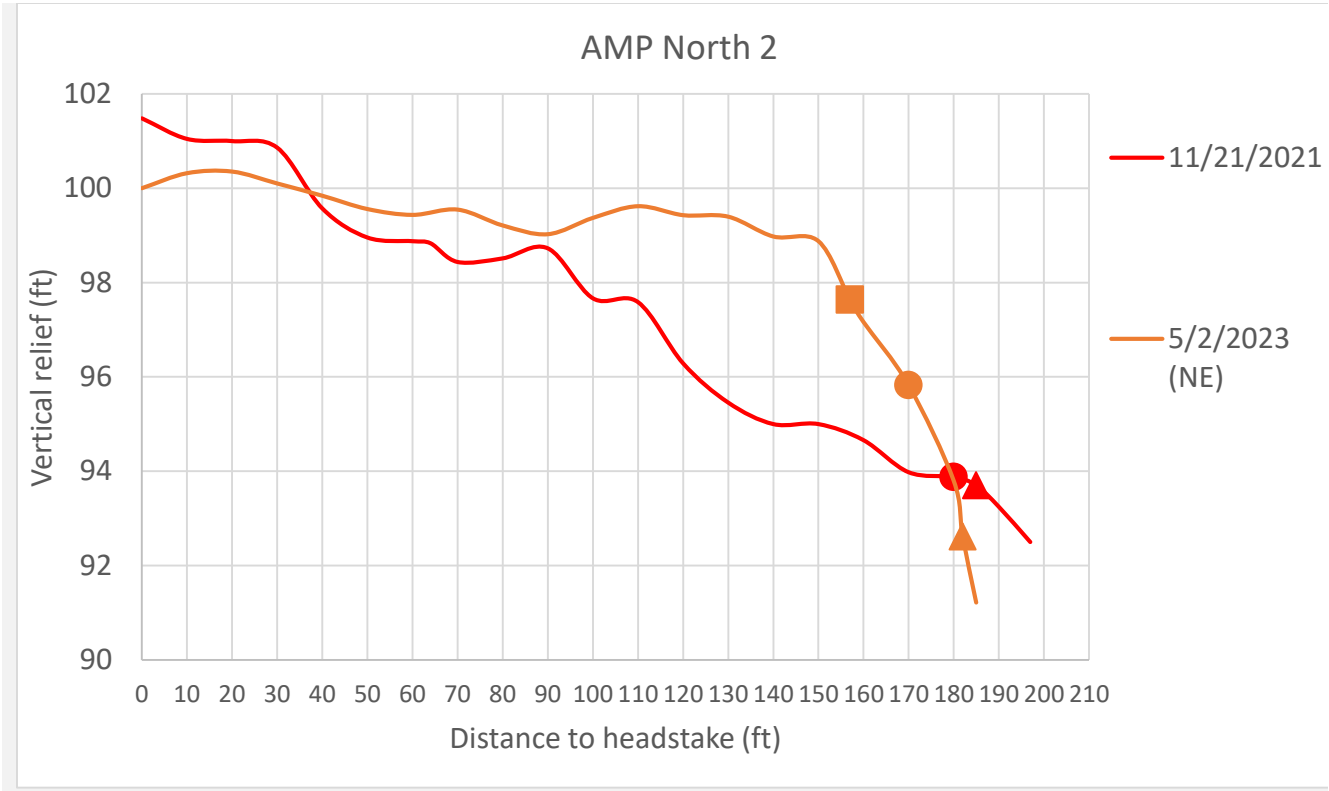


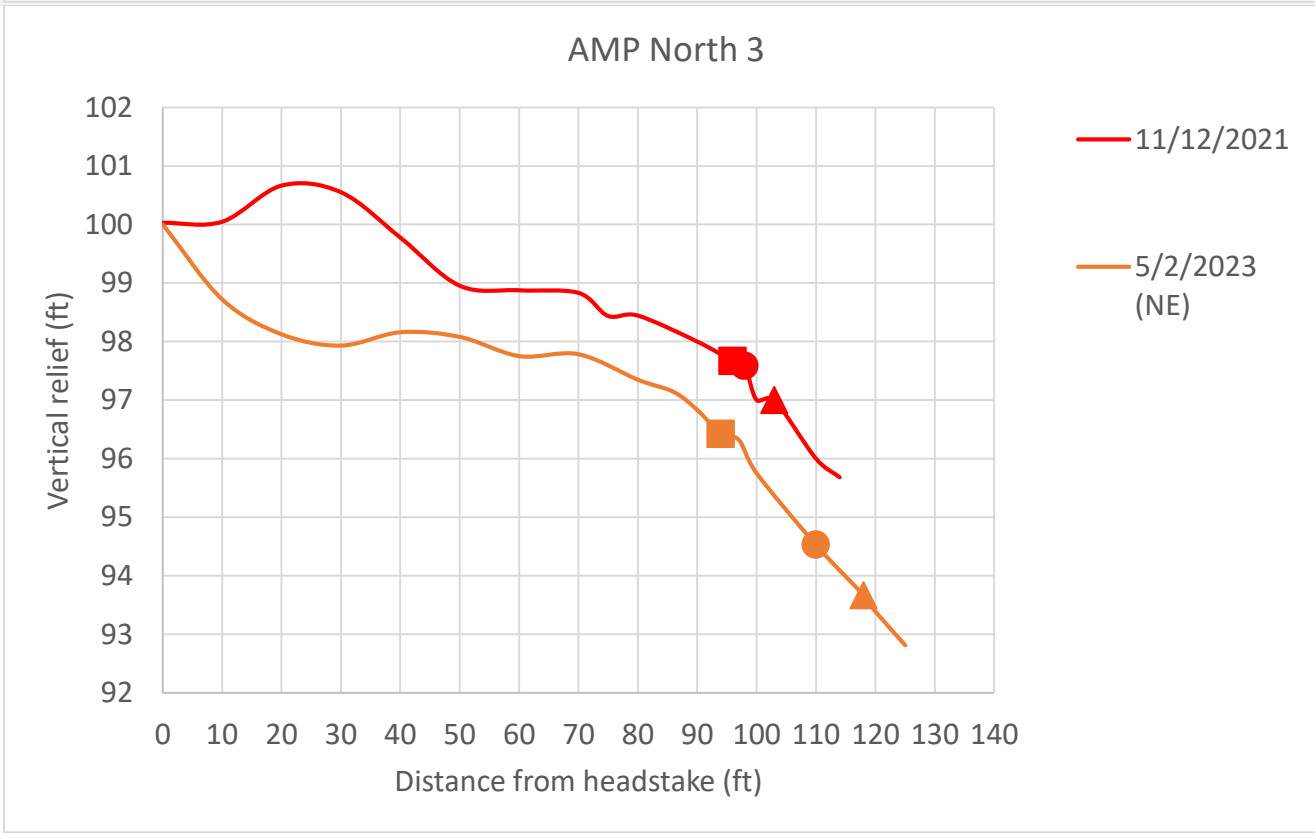

American Memorial Park South 2
Vertifcal Relief (ft)
101
100
99
98
97
96
95
94
93
92
91
90
89
88
87
86
85
0
10
20
30
40
50
60
70
80
90
Distance from headstake (ft)


American Memorial Park Point 1
Vertifcal Relief (ft)
102
101
100
99
98
97
96
95
94
93
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
102
100
98
96
94
92
90
Vertical relief (ft)
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
102
101
100
99
98
97
96
95
94
93
92
Vertical relief (ft)
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140
Distance from headstake (ft)
11/12/2021
5/2/2023
(NE)

Pau Pau

Pau Pau is generally stable with the shoreline length declining from the south to north. The nearby reef attenuates wave energy but wave overtopping may contribute to short-term erosion. Sediment from nearby sources replenishes the beach. Tides may influence the length of this shoreline. For both typhoon wave conditions, this area receives high wave energy. North-northwest typhoon conditions fare worse with significant wave height potential of up to 3 m.

Pau Pau 1 Highlights:

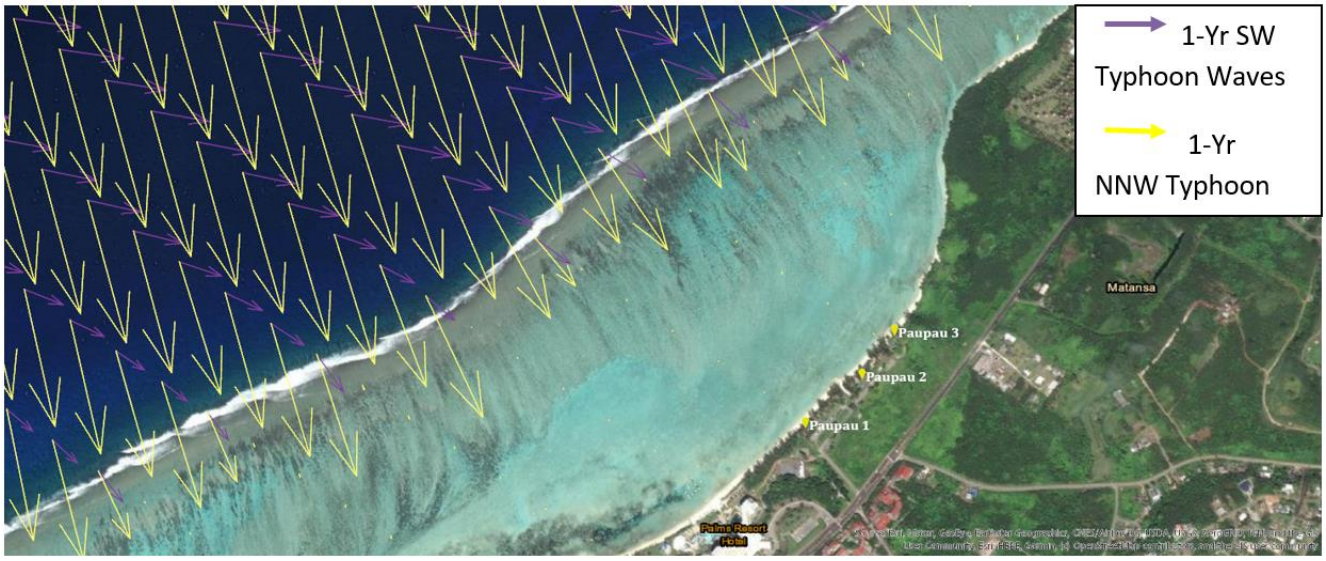
- STABLE
- REPLACED with a headstake that is further inland and adjacent to the previous headstake
- **History:** This beach profile seems to vary from time to time, dependent on deposits from the nearby reef. The headstake is at a distance in the backshore, closer to the parking lot.
- Based on the 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:

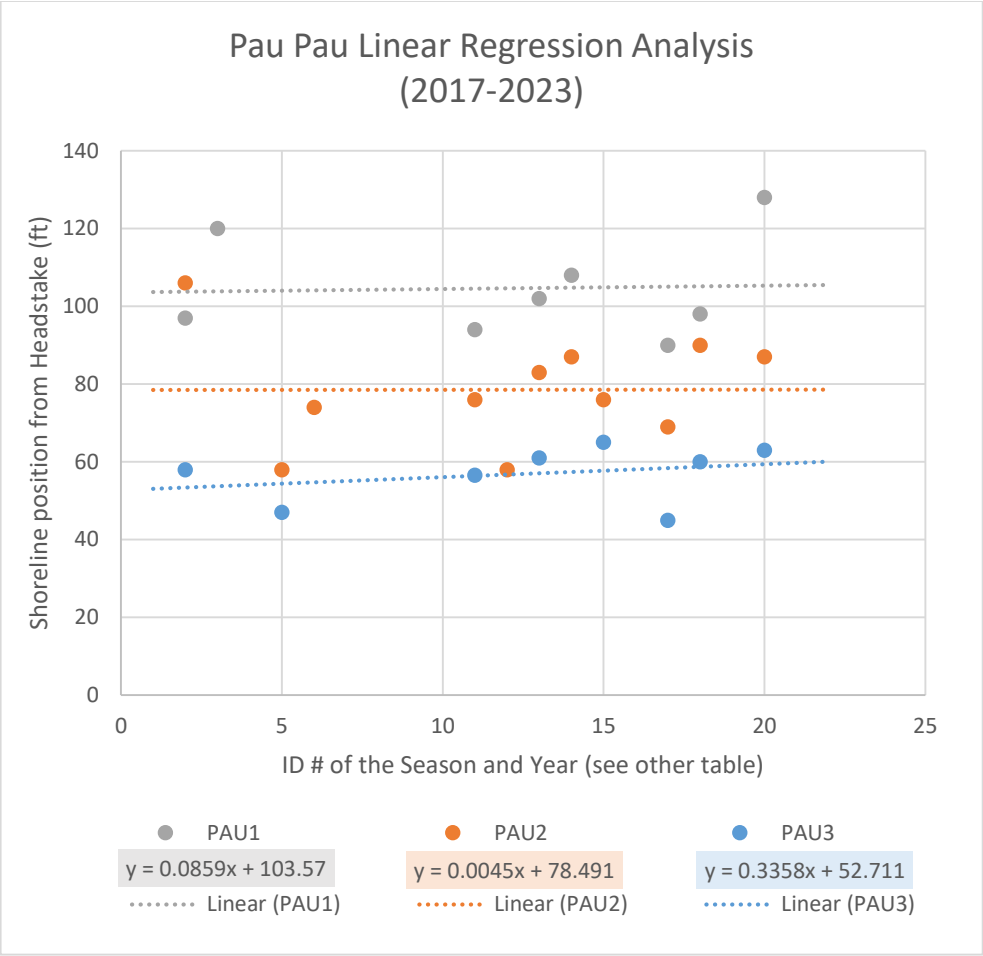
- STABLE
- Wrackline that that ranges 26 – 50 ft and an elevation difference of 9.5 ft
- This beach profile is variable compared to the other two transects in the site.
- Based on the Shoreline linear regression analysis (see pg 100), the shoreline has a rate of +0.34 ft from 2017-2023.



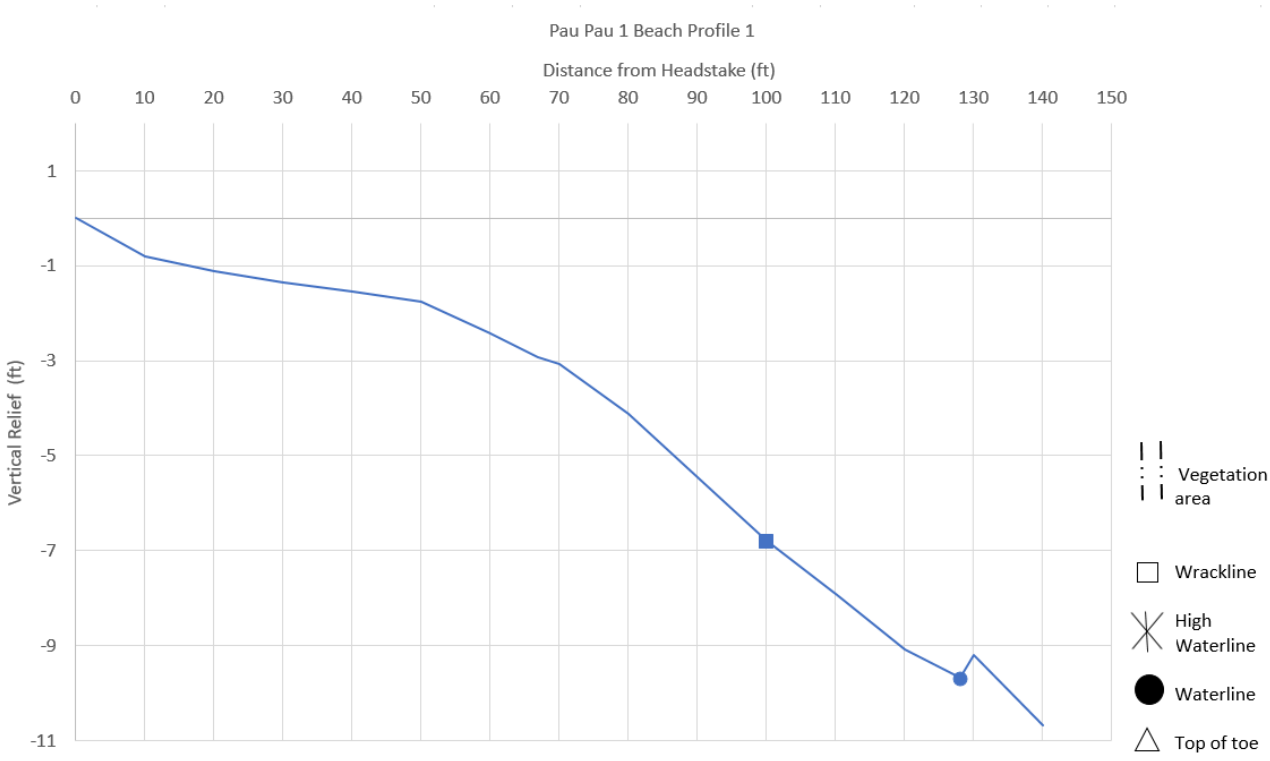
Pau Pau 1

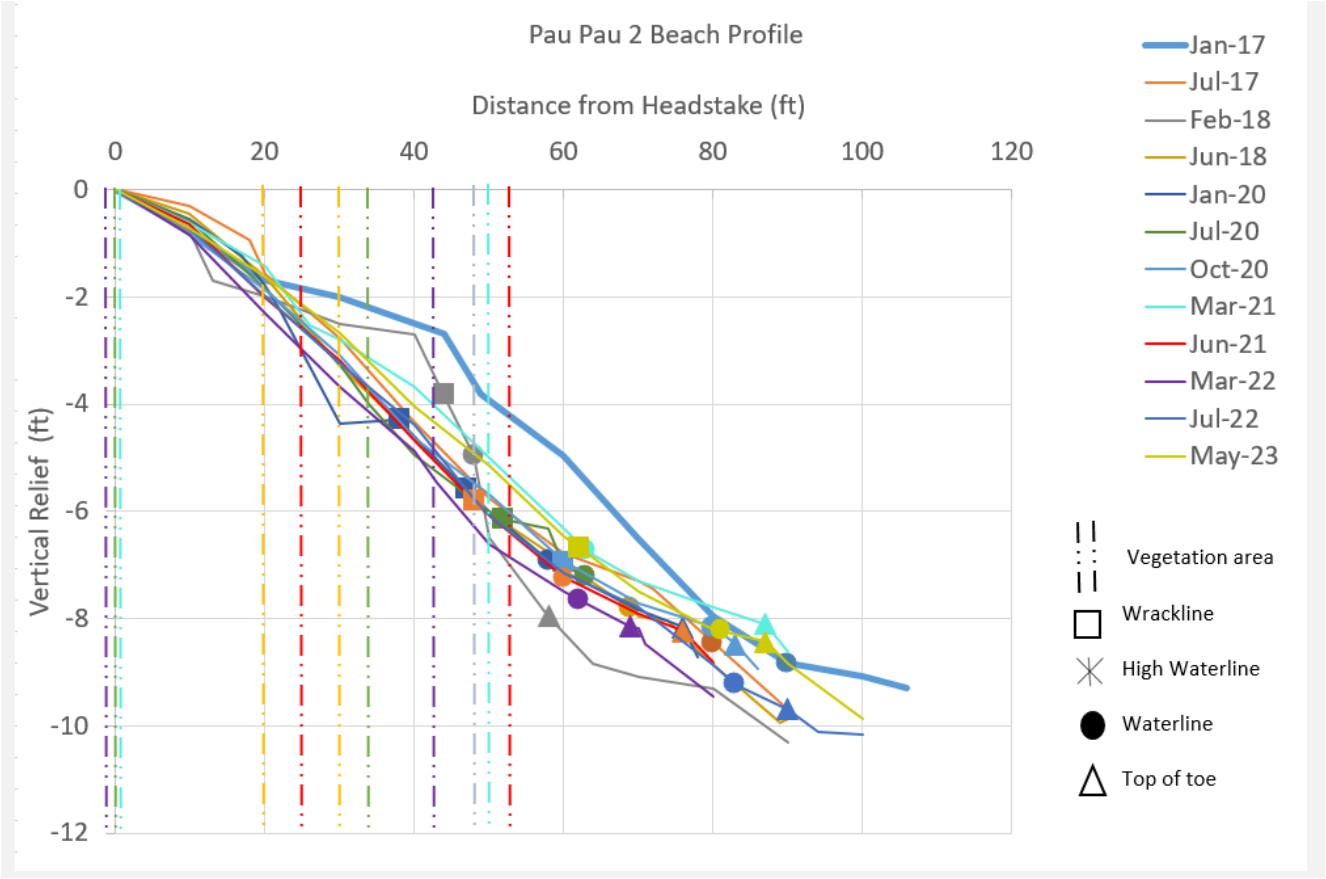
Pau Pau 2

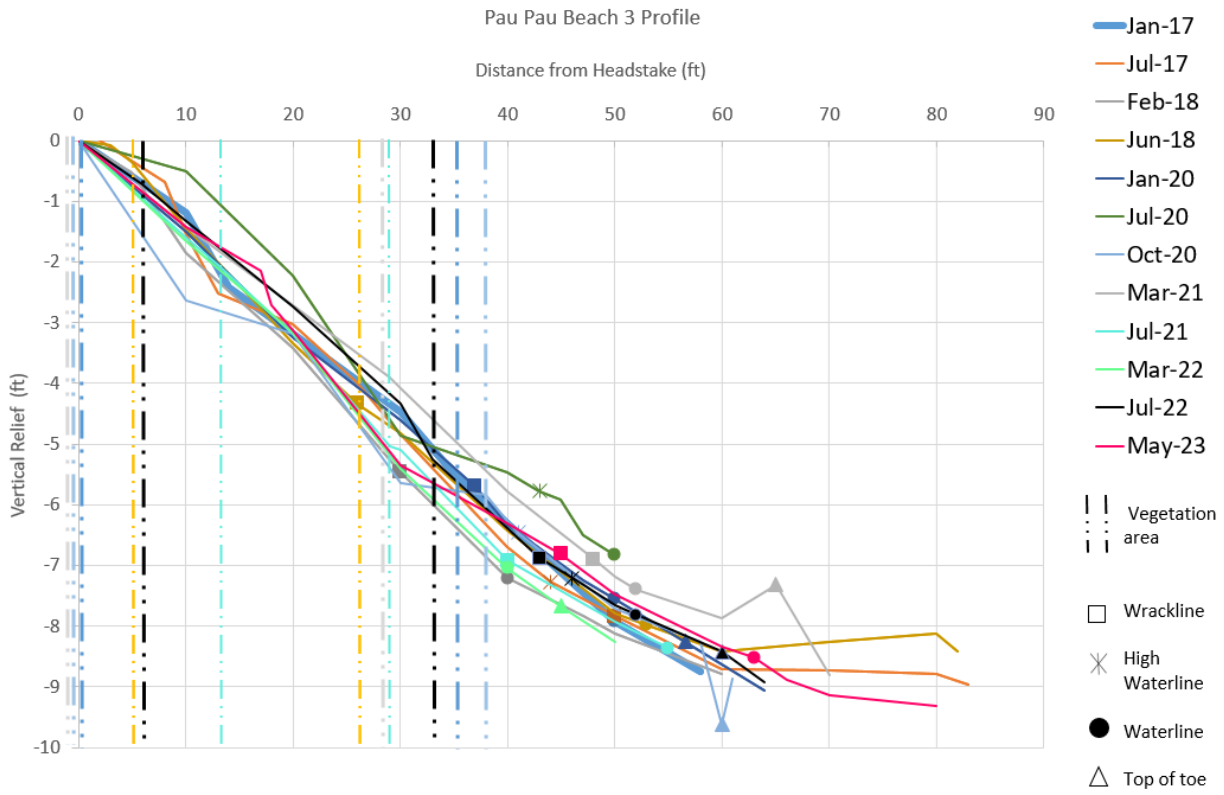
Pau Pau 3


Pau Pau Linear Regression Analysis
(2017-2023)
Shoreline position from Headstake (ft)
140
120
100
80
60
40
20
0
0
5
10
15
20
25
ID # of the Season and Year (see other table)
PAU1
y = 0.0859x + 103.57
Linear (PAU1)
PAU2
y = 0.0045x + 78.491
Linear (PAU2)
PAU3
y = 0.3358x + 52.711
Linear (PAU3)

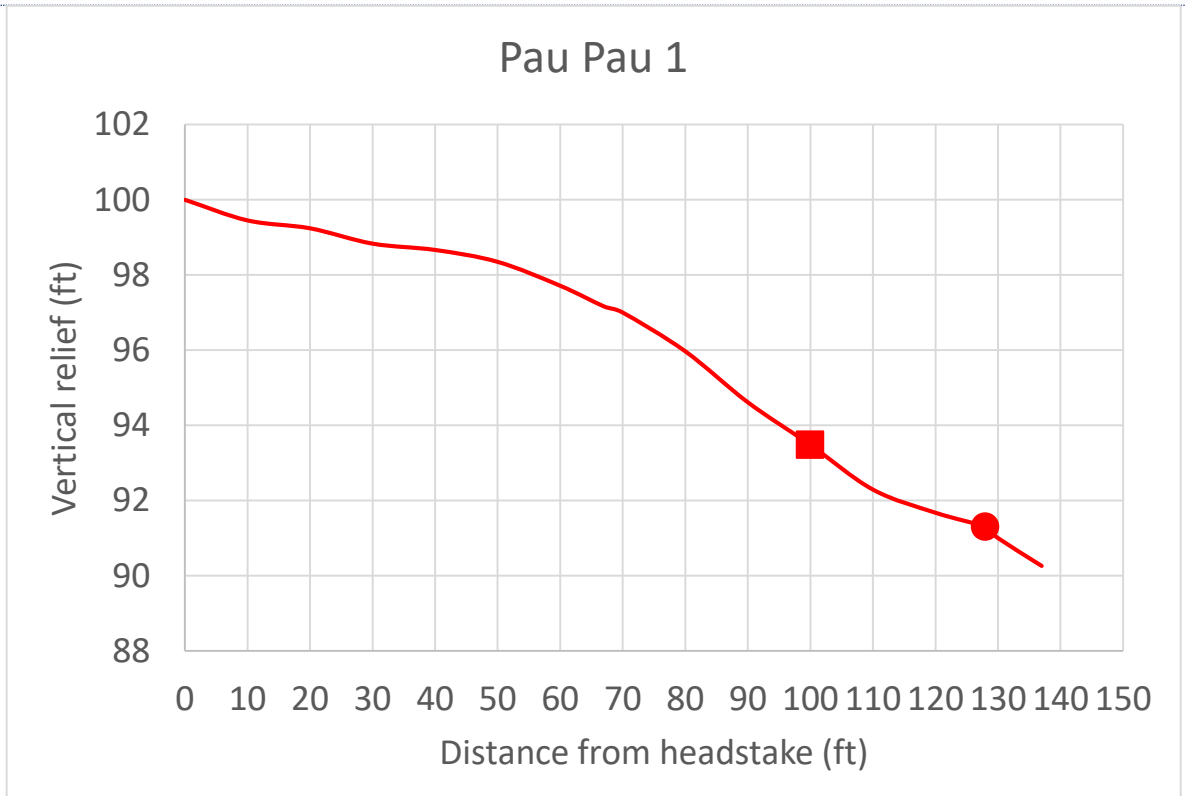
Pau Pau Beach Profiles

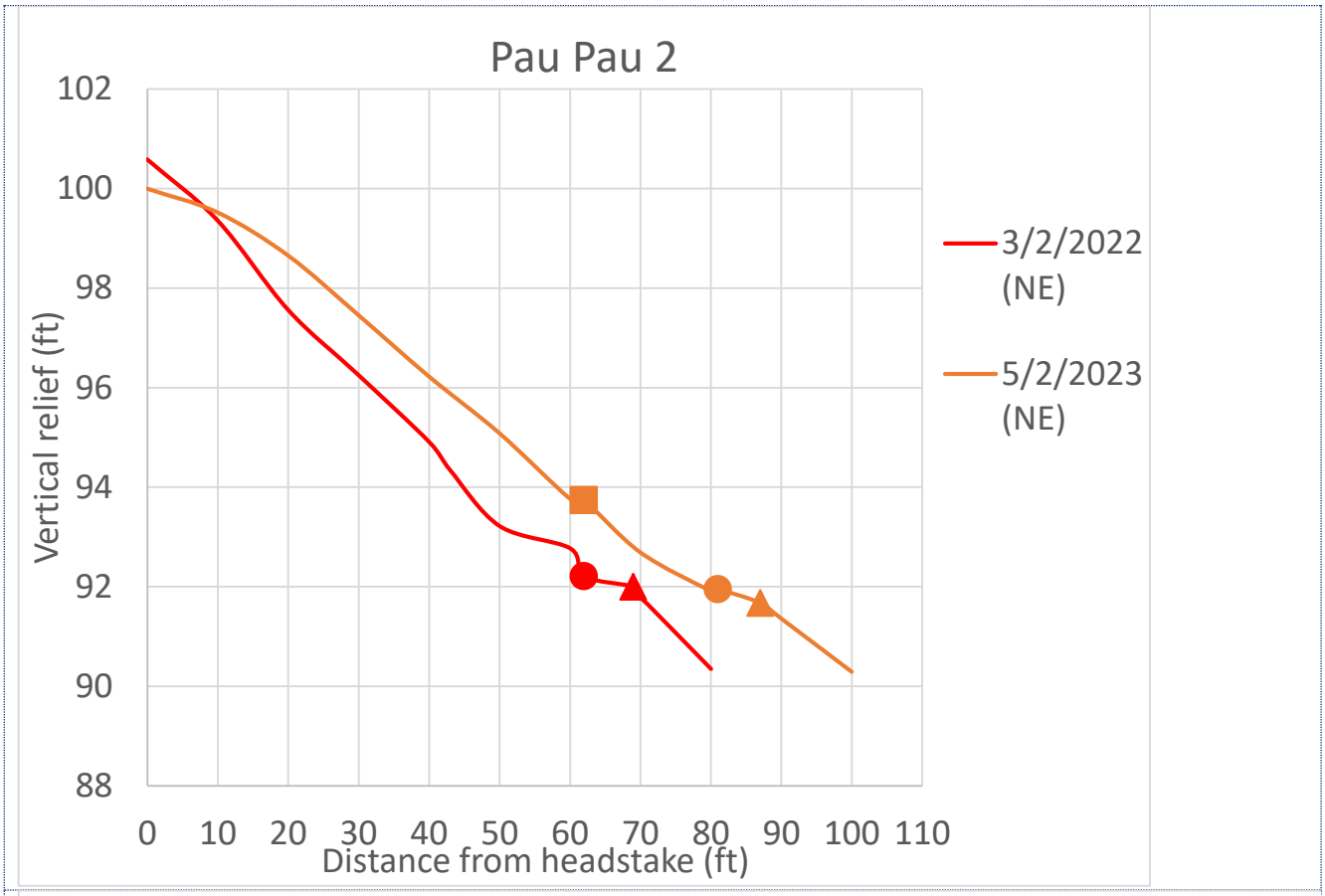


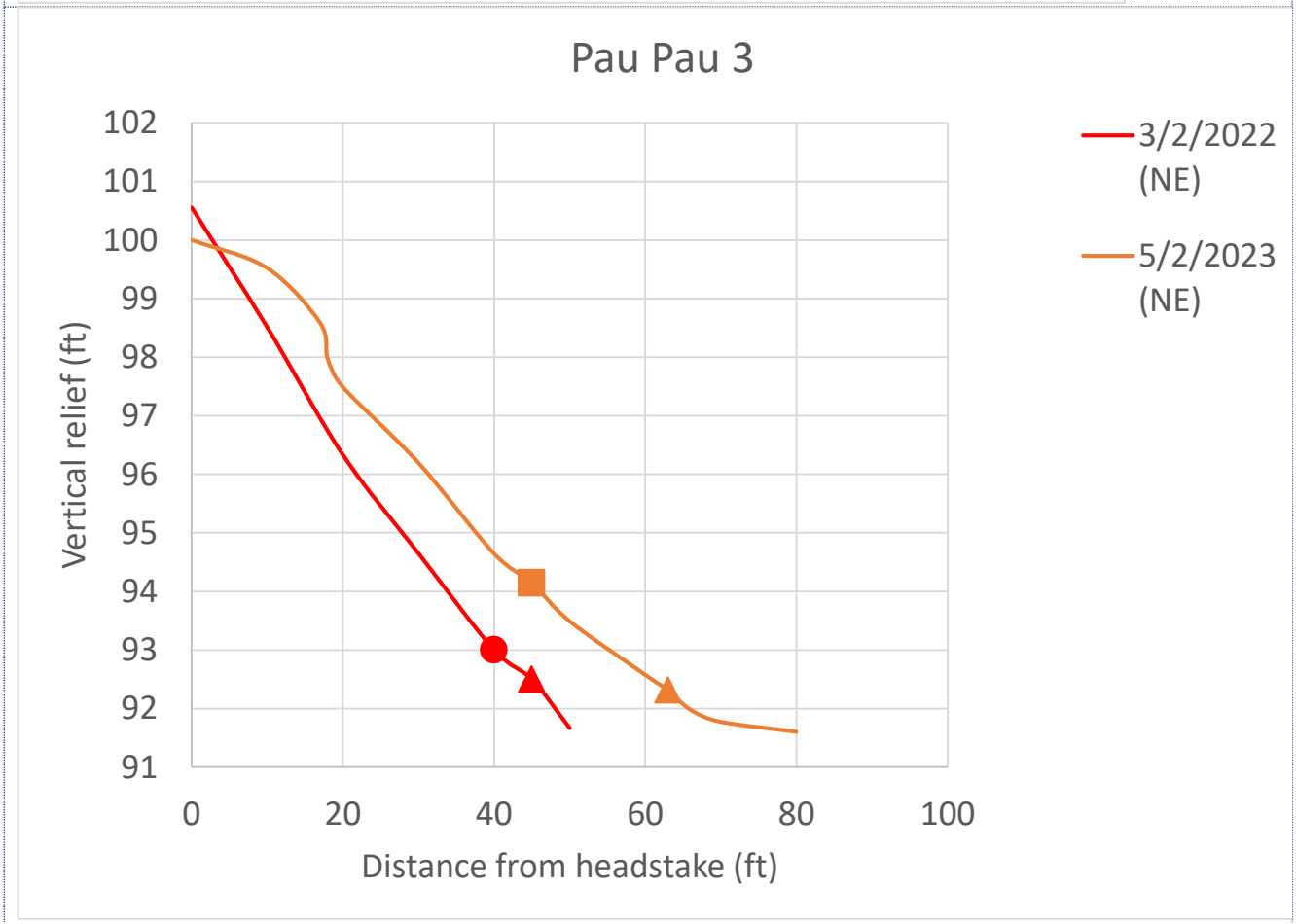




Total Station




Pau Pau 2
102
100
98
96
94
92
90
88
Vertical relief (ft)
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
102
101
100
99
98
97
96
95
94
93
92
91
Vertical relief (ft)
0 20 40 60 80 100
Distance from headstake (ft)
3/2/2022 (NE)
5/2/2023 (NE)

Wing

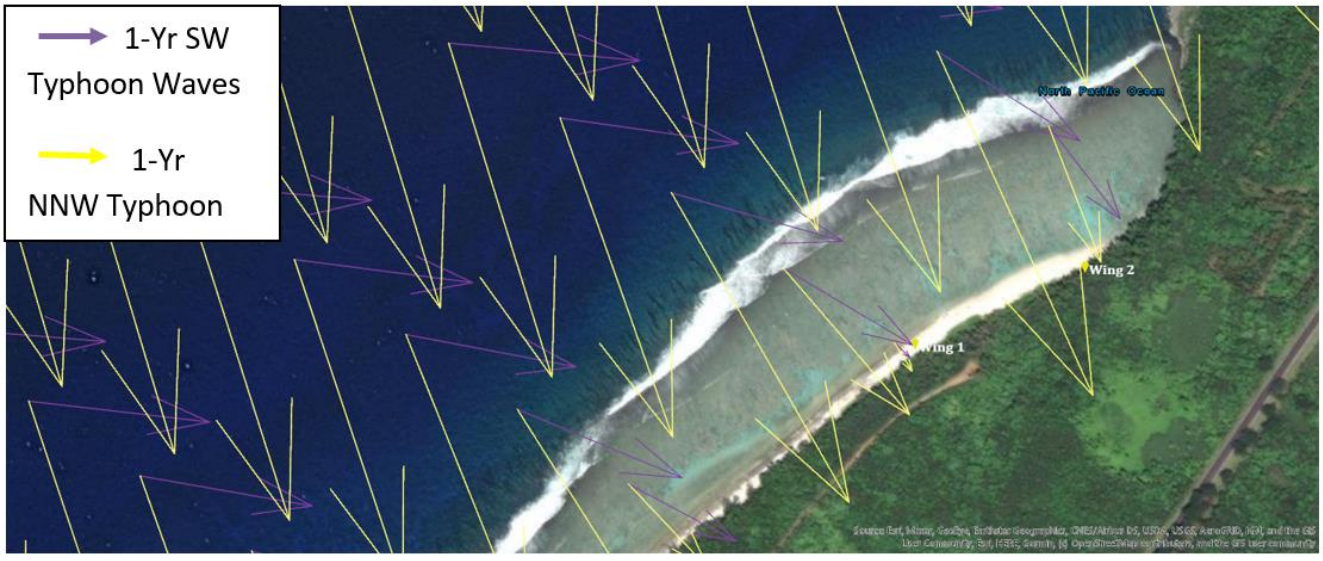
As the most northern shoreline of Saipan, Wing Beach appears to have high diversity of coastal strand species and a coral rubble shoreline. Regular sediment input may have originated from the nearby reef, pouring sand and coral rubble from inland and sea cliffs. The sea cliffs are also potential sediment sources.
The southwest and northwest typhoon conditions both bring in high wave energies. The north-north wave conditions fare worse with potential of up to 4 m significant wave heights.

Wing 1 Highlights:

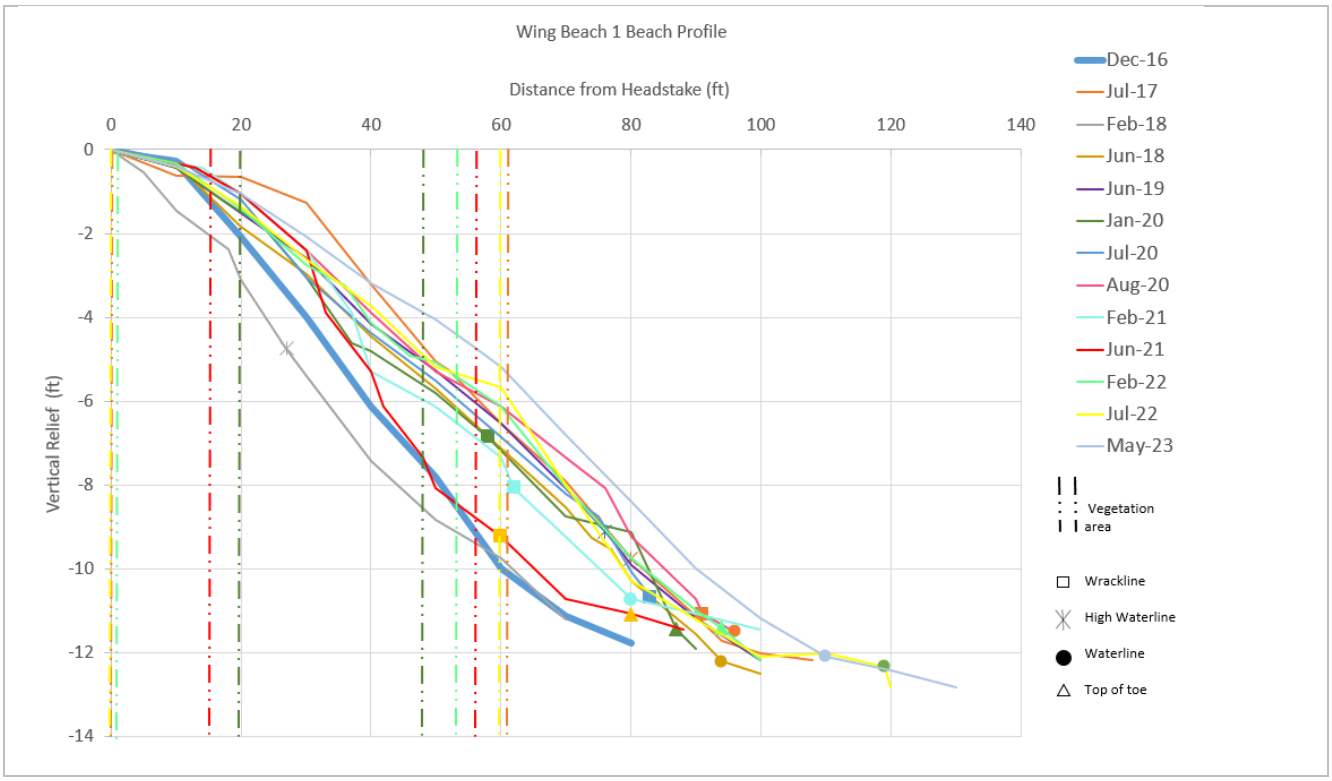
- STABLE
- Wrackline that ranges 58 – 90 ft and an elevation difference of 11.5 ft
- This beach profile may suggest that the shoreline experiences a good amount of sediment input and output from the influence of the nearby reef system. Feb 2018 had the most erosion while July 2017 saw the most accretion.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

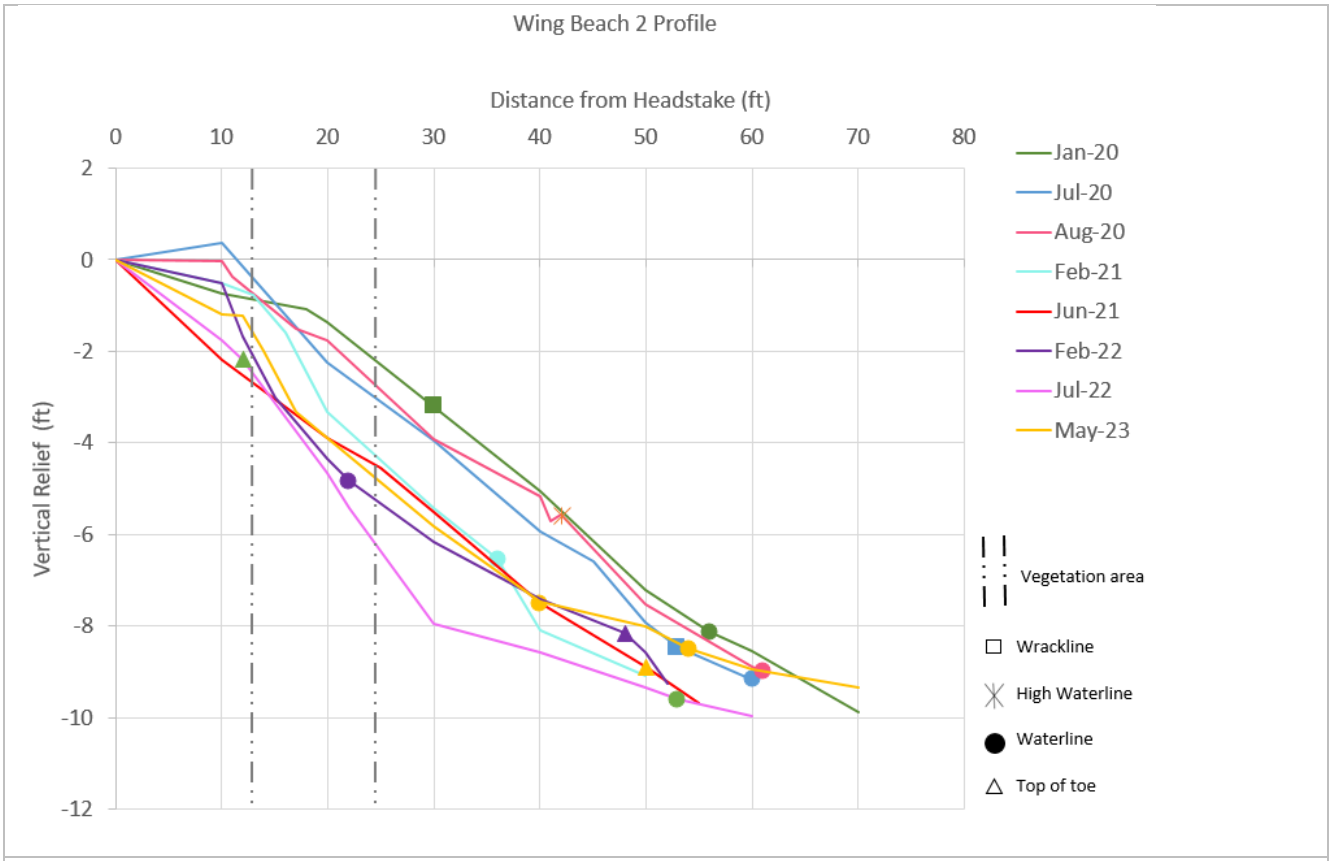
Wing 2 Highlights:

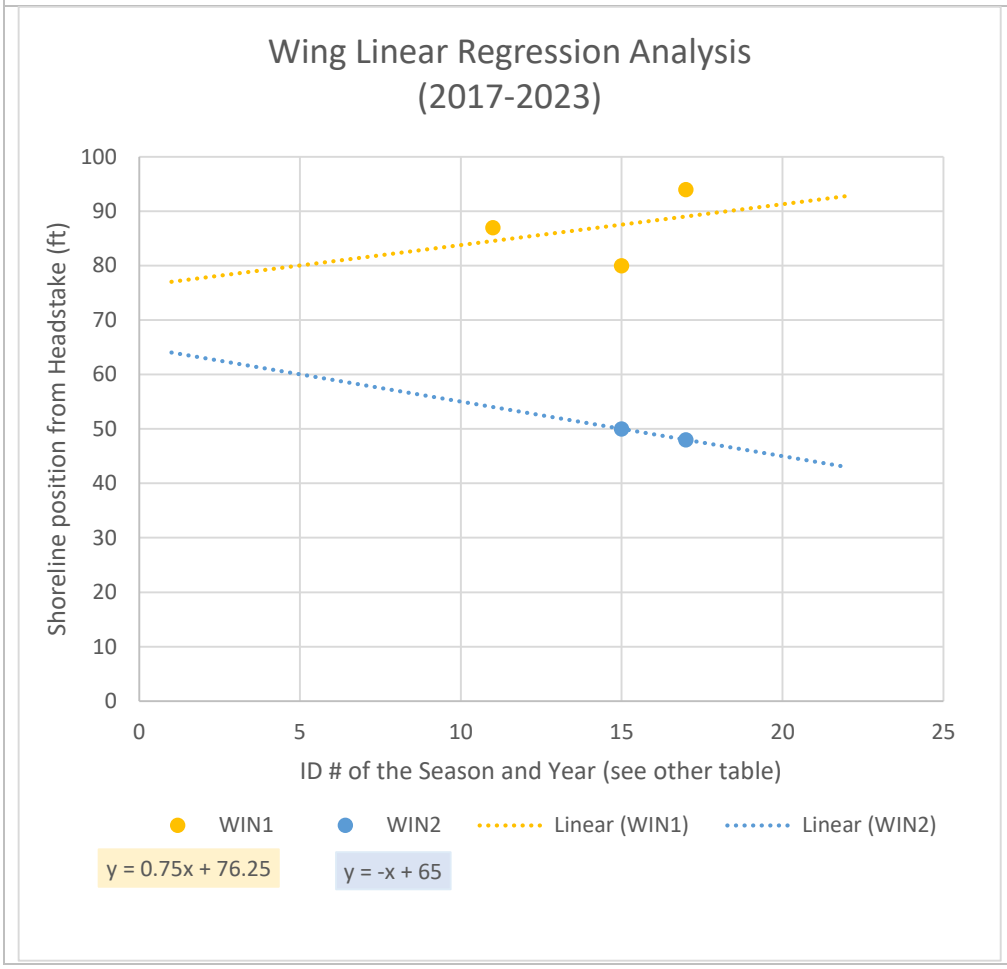
- ERODING
- Wrackline that ranges 30 –54ft and an elevation difference of 9 ft
- Based on observations from the Feb-21 record shows, a high tide with a high wave event greatly abrades the berm along this transect. With the input of coral rubble from the nearby reef, recovery to the average shoreline 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.



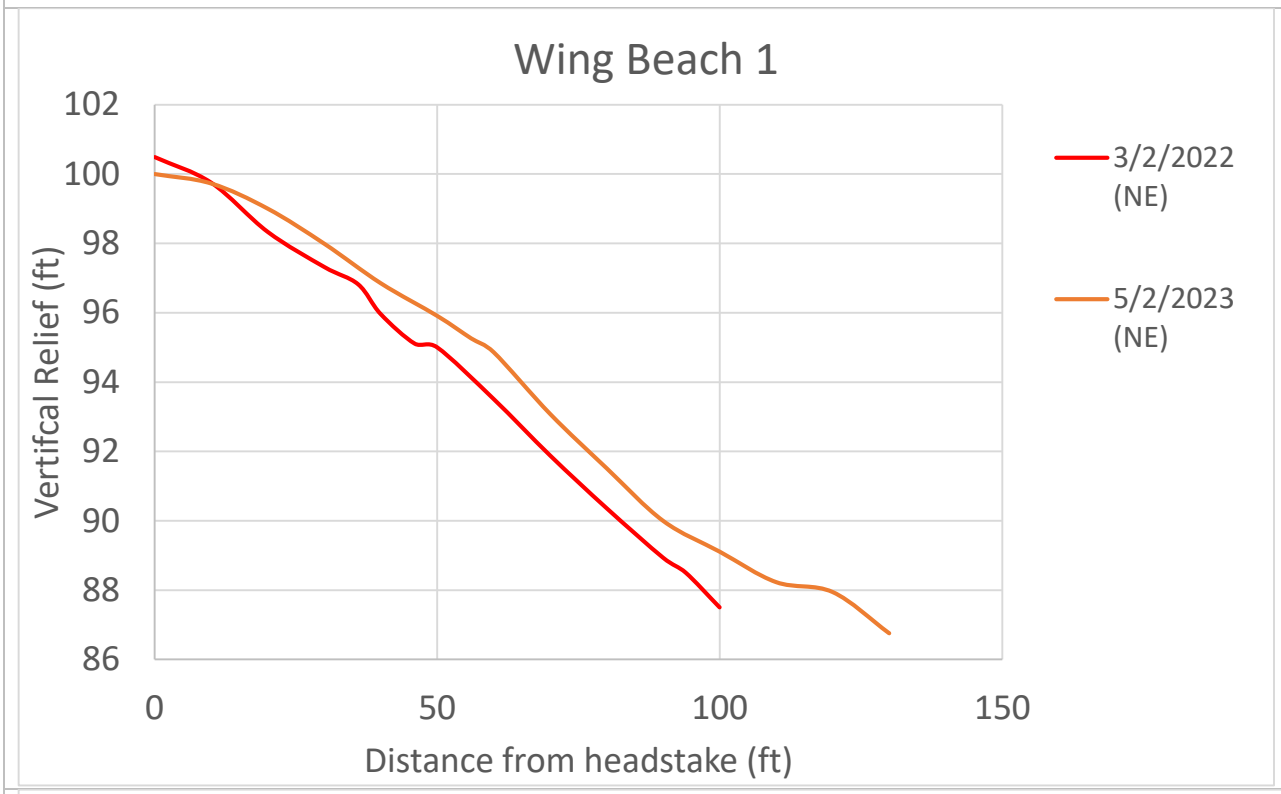
Wing Beach Profiles

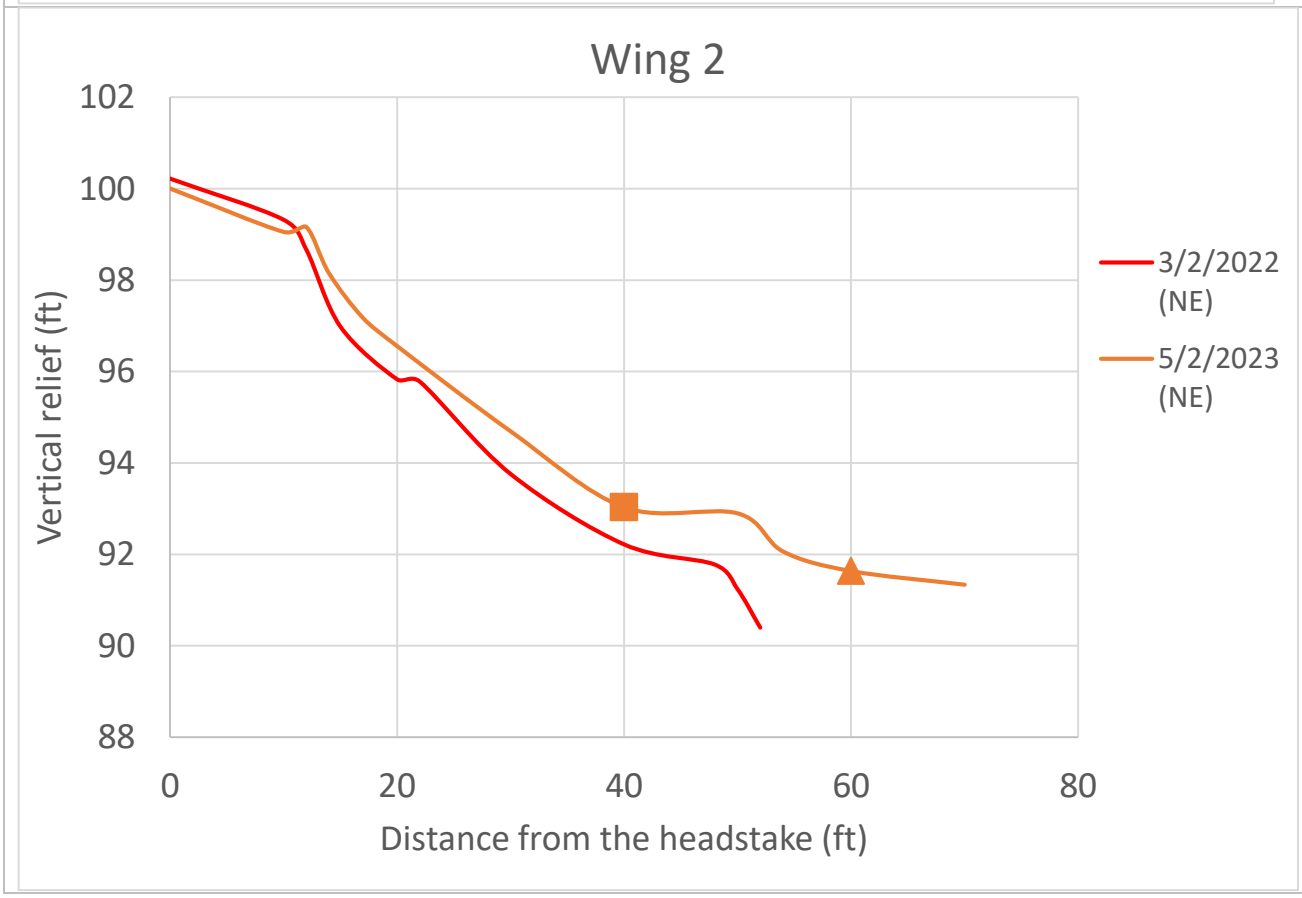



Wing Beach 2 Profile
Distance from Headstake (ft)
0
10
20
30
40
50
60
70
80
2
0
-2
-4
-6
-8
-10
-12
Vertical Relief (ft)
Jan-20
Jul-20
Aug-20
Feb-21
Jun-21
Feb-22
Jul-22
May-23
Vegetation area
Wrackline
High Waterline
Waterline
Top of toe


Wing Linear Regression Analysis
(2017-2023)
Shoreline position from Headstake (ft)
100
90
80
70
60
50
40
30
20
10
0
0
5
10
15
20
25
ID # of the Season and Year (see other table)
WIN1
WIN2
Linear (WIN1)
Linear (WIN2)
y = 0.75x + 76.25
y = -x + 65

Total Station

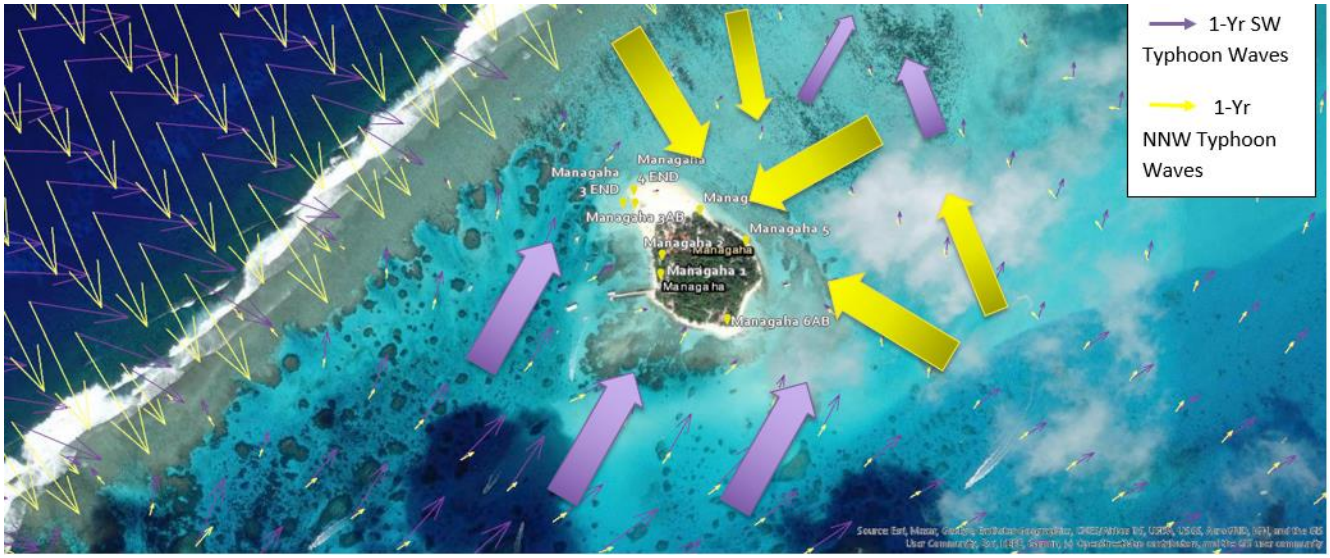




Mañagaha Beach Profiles and Key Findings

Mañagaha is known for its white sandy coastline as it 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 WWII relicts caused a shift in the sediment transport. 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 by 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.



The Mañagaha shoreline interact with varying wave conditions within the Lagoon at all directions. The map above is generated using Hydrodynamic Study typhoon waves data, and large arrows were added to emphasize direction for the two conditions. The longshore transport slightly varies for the southwest and north-northwest wave conditions. During southwest conditions, longshore transport from the south is greater, which hits Transects 6A, 6B, 1, 2, 3A, and 3B. This longshore pattern perpetuates accretion occurring at Transects 3A and 3B. Transects 4 and 5 is likely to be impacted during the north-north west typhoon conditions. High wave energy occurs during the southwest typhoon condition, which appears to impact the southern part of the islet. For both conditions, the eastern side of the island appear to be eroding. Beach recovery may occur due to the sediment sources all around the island. This is DCRM's interpretation of the Mañagaha's longshore transport, in 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:

- ACCRETING Stab
- 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:

- 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 2

Mañagaha 3A

Mañagaha 3B

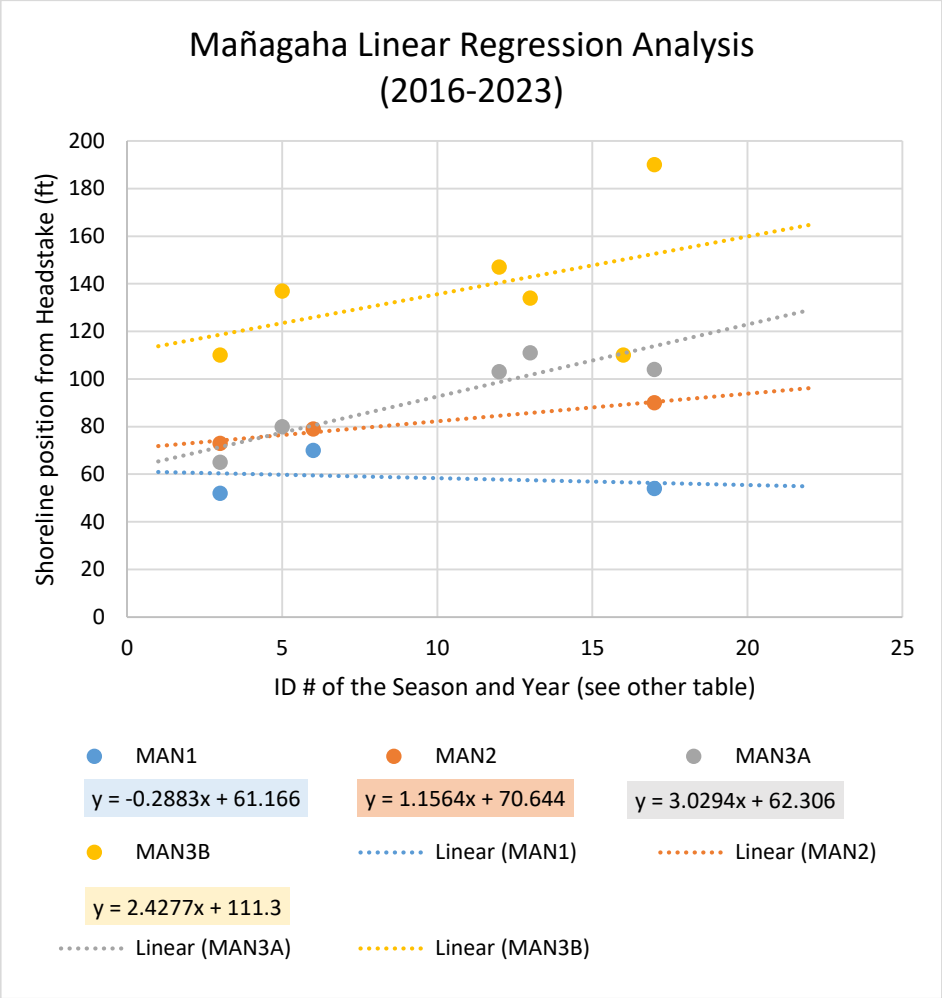
Mañagaha 4

Mañagaha 6A

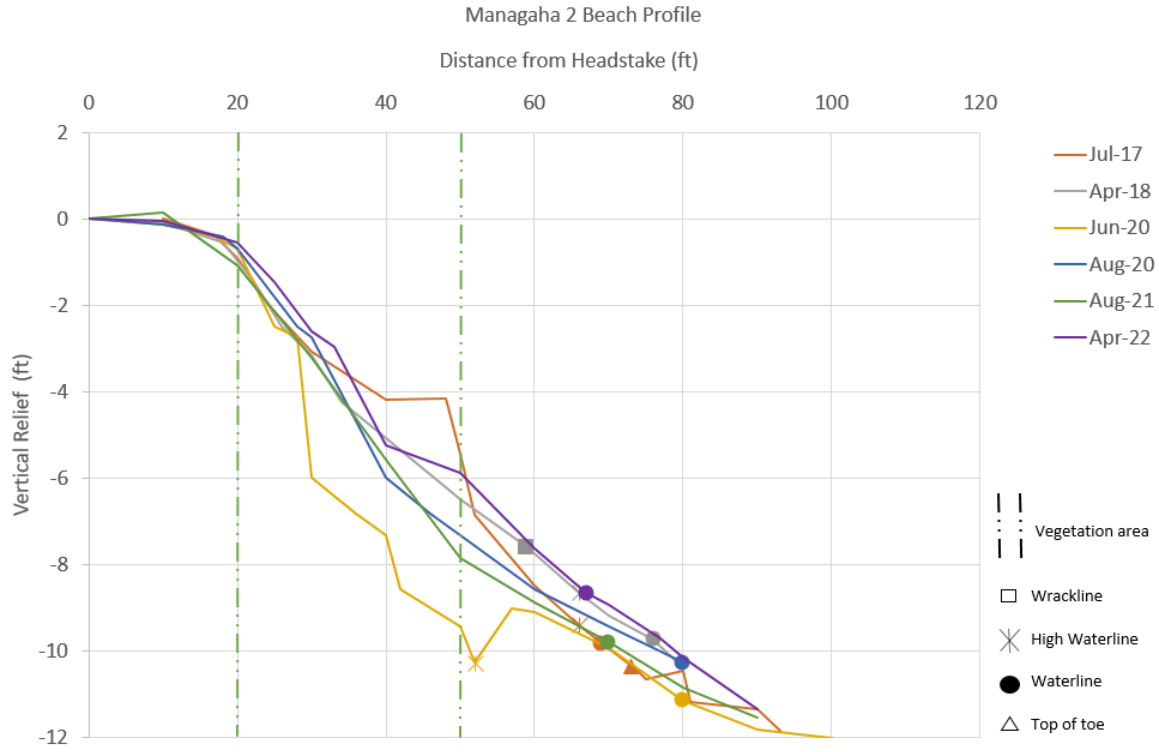
Mañagaha 6B

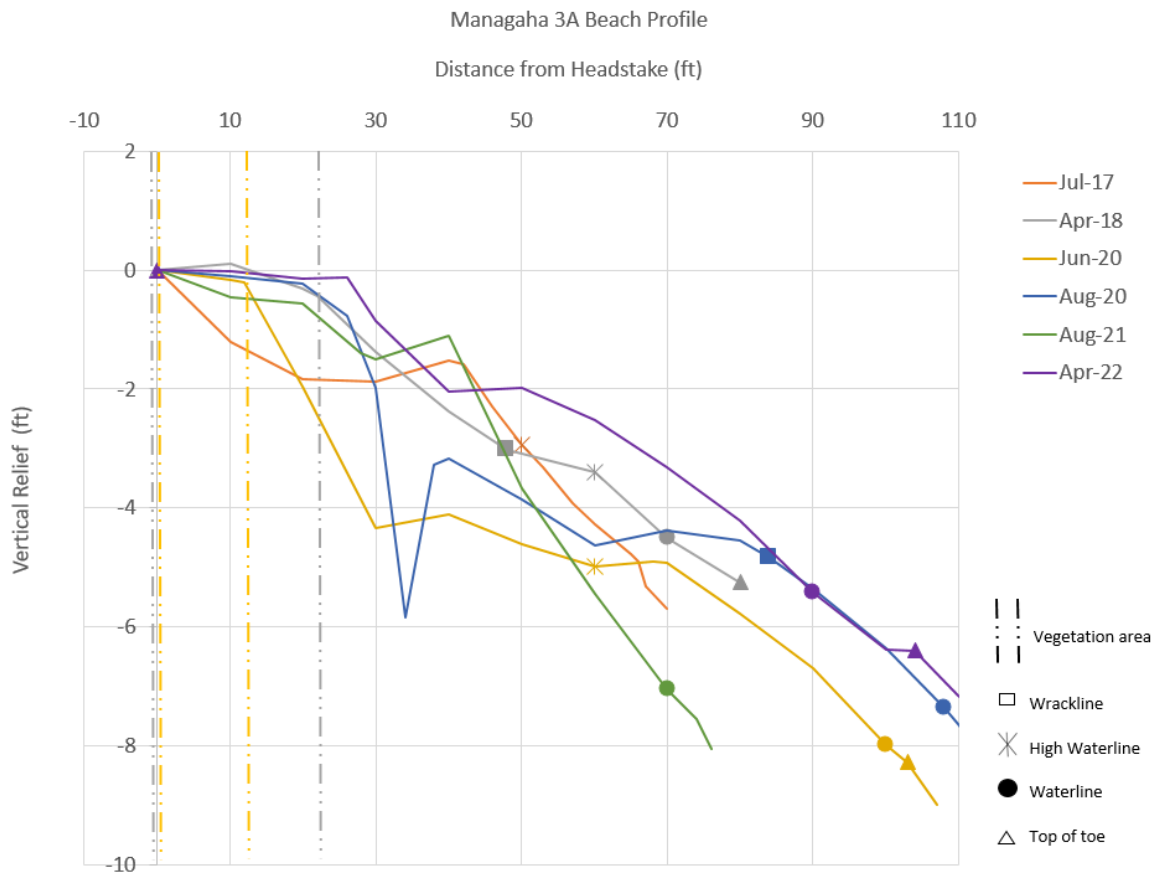
2022

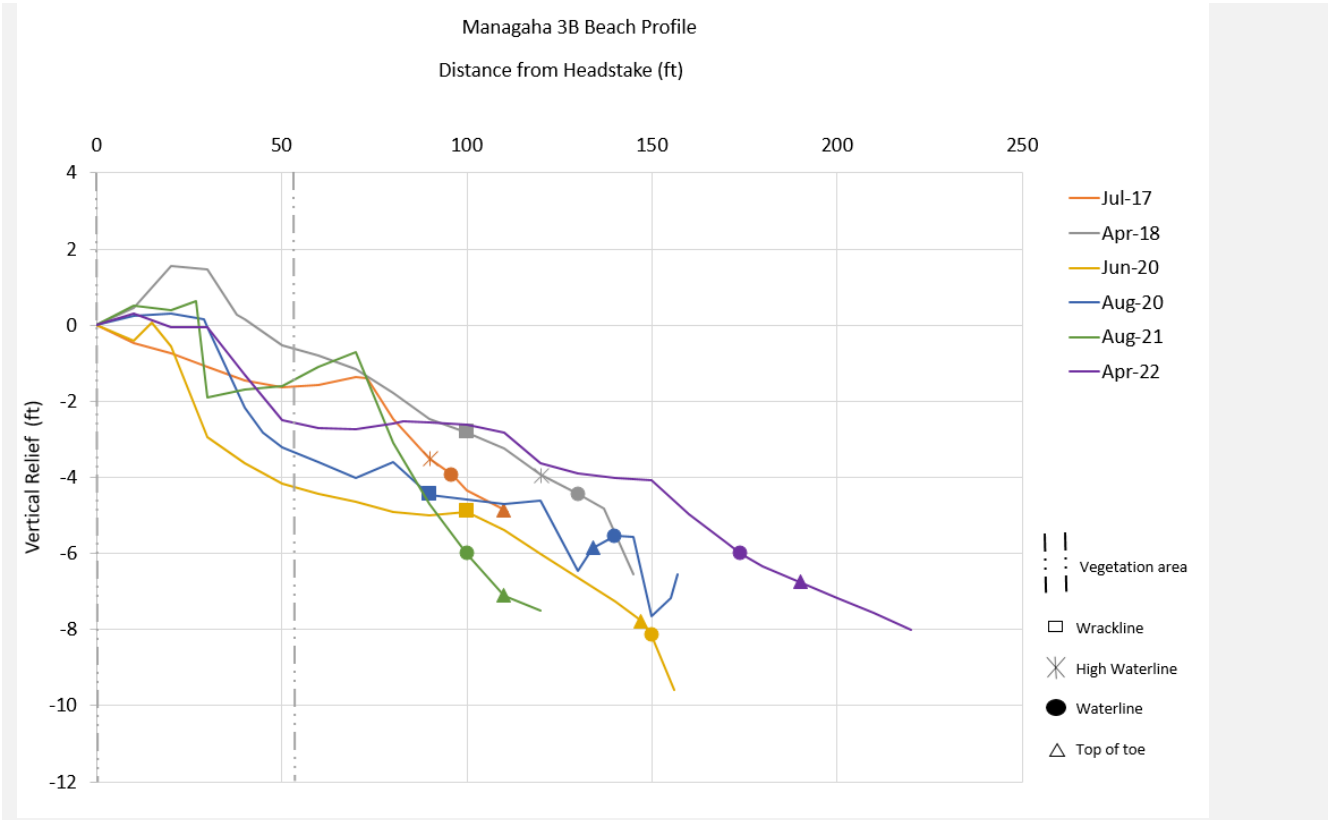
Mañagaha 7

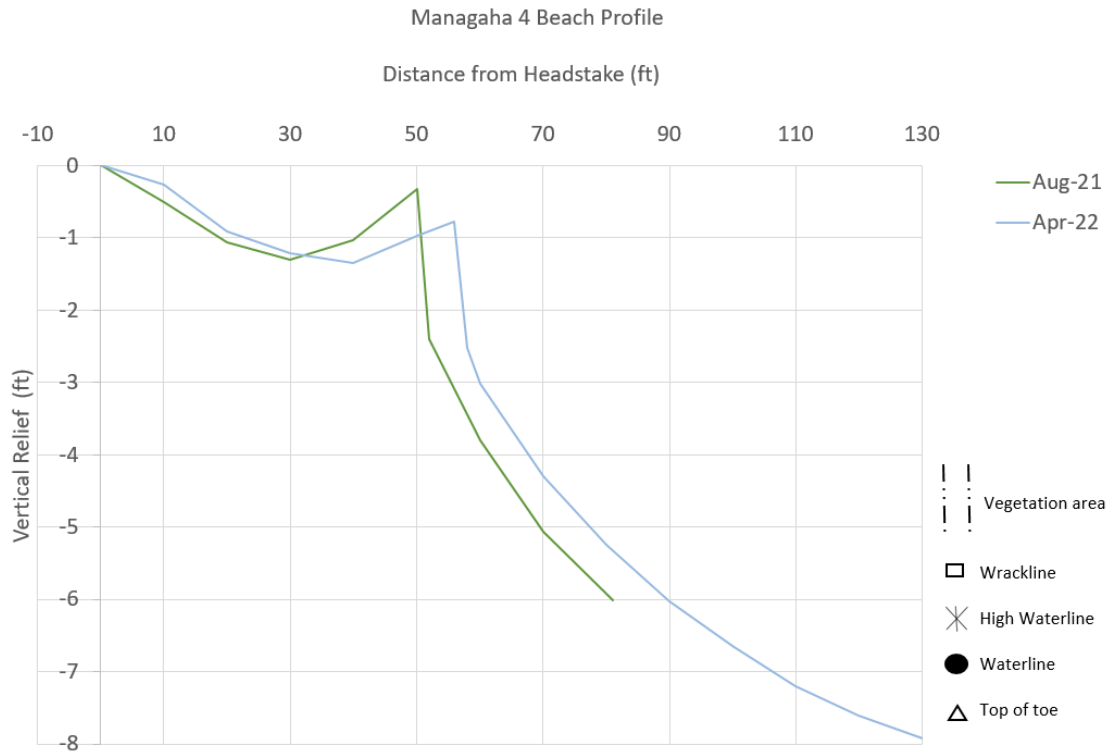


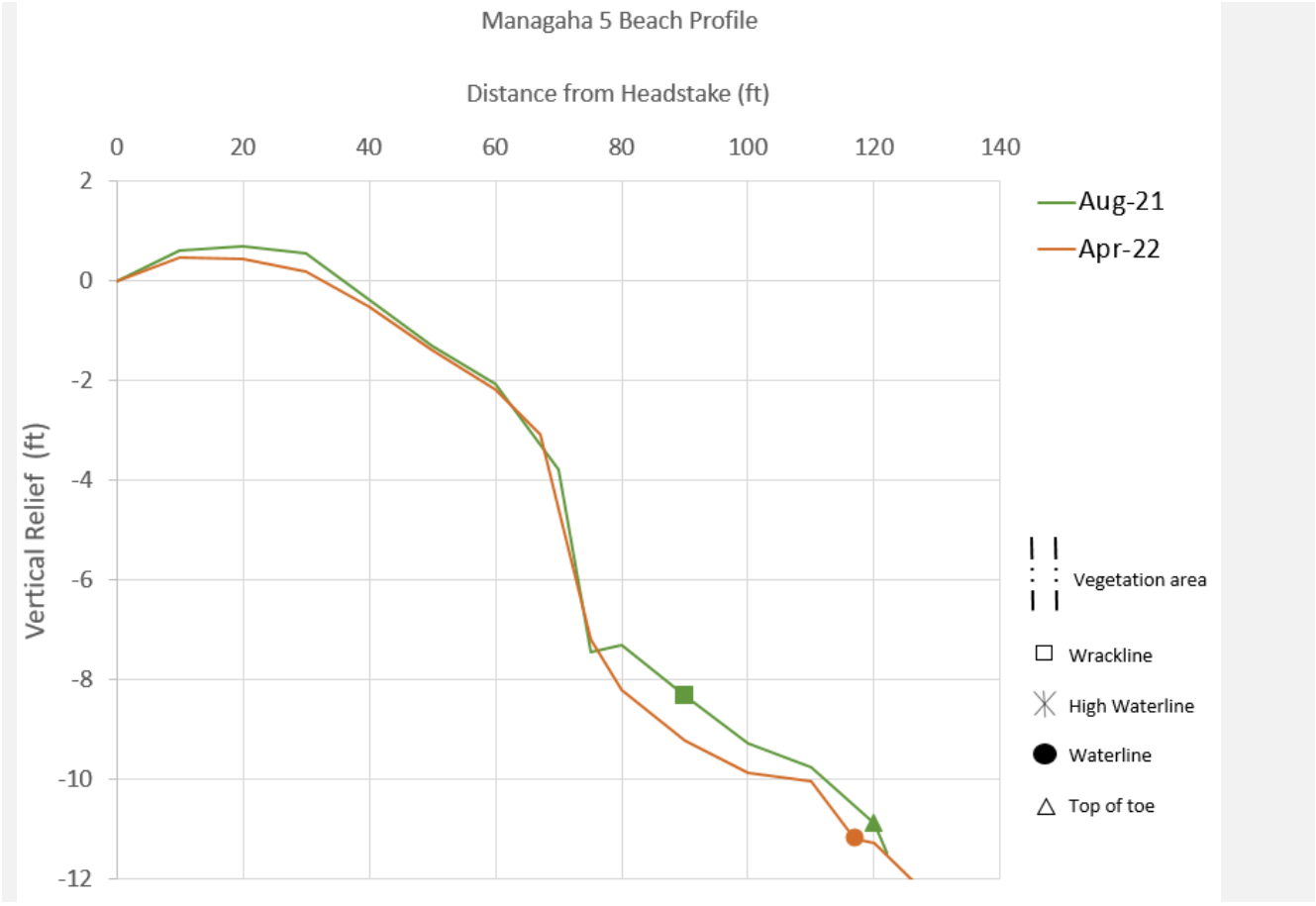
Mañagaha Beach Profiles

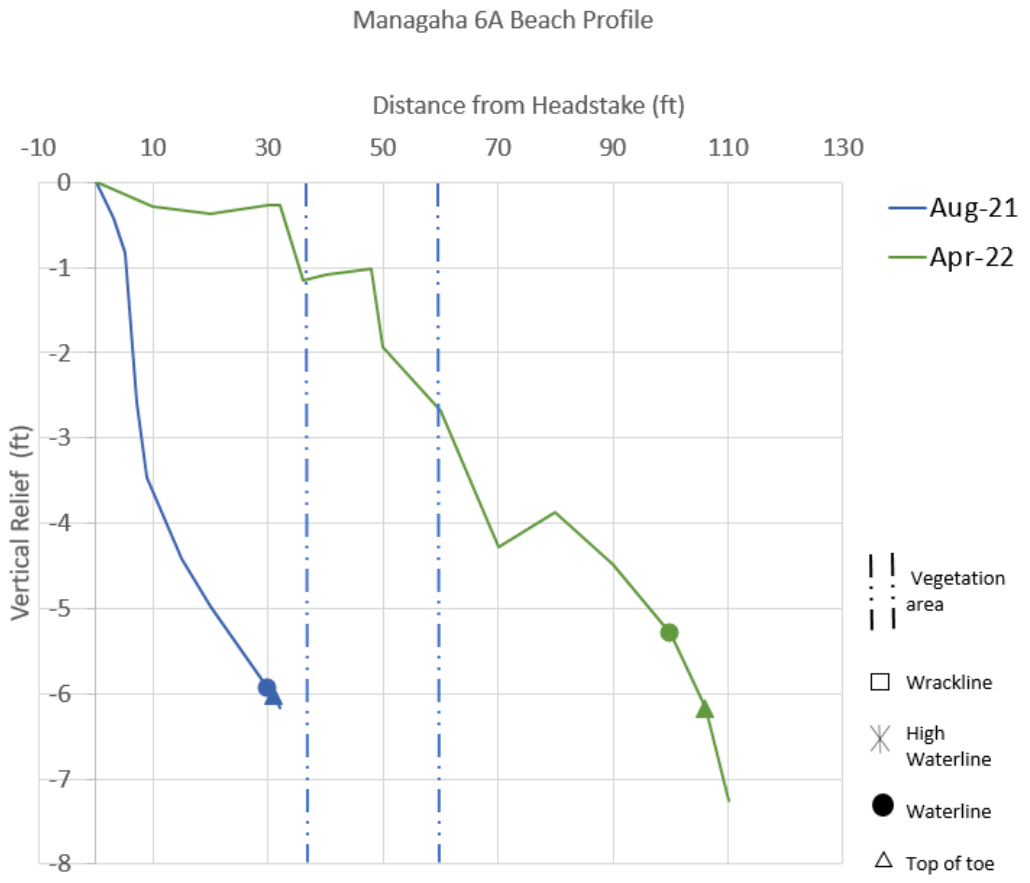


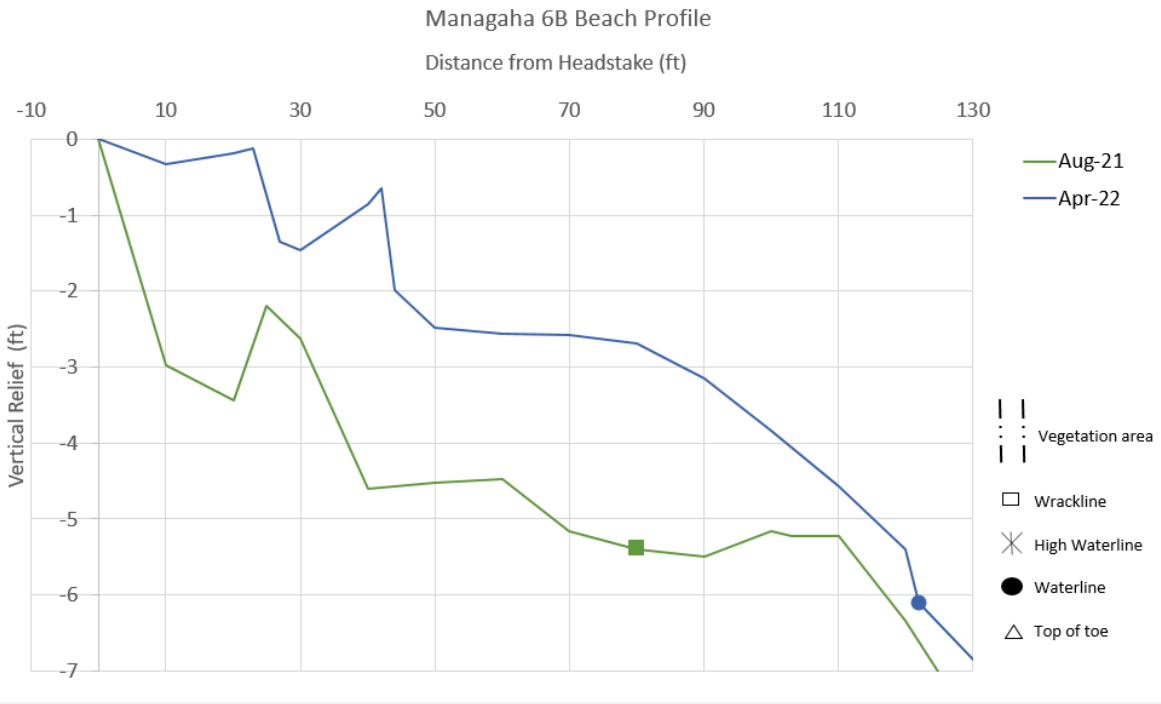

Managaha 3A Beach Profile
Distance from Headstake (ft)
-10
10
30
50
70
90
110
2
0
-2
-4
-6
-8
-10
Vertical Relief (ft)
Jul-17
Apr-18
Jun-20
Aug-20
Aug-21
Apr-22
Vegetation area
Wrackline
High Waterline
Waterline
Top of toe

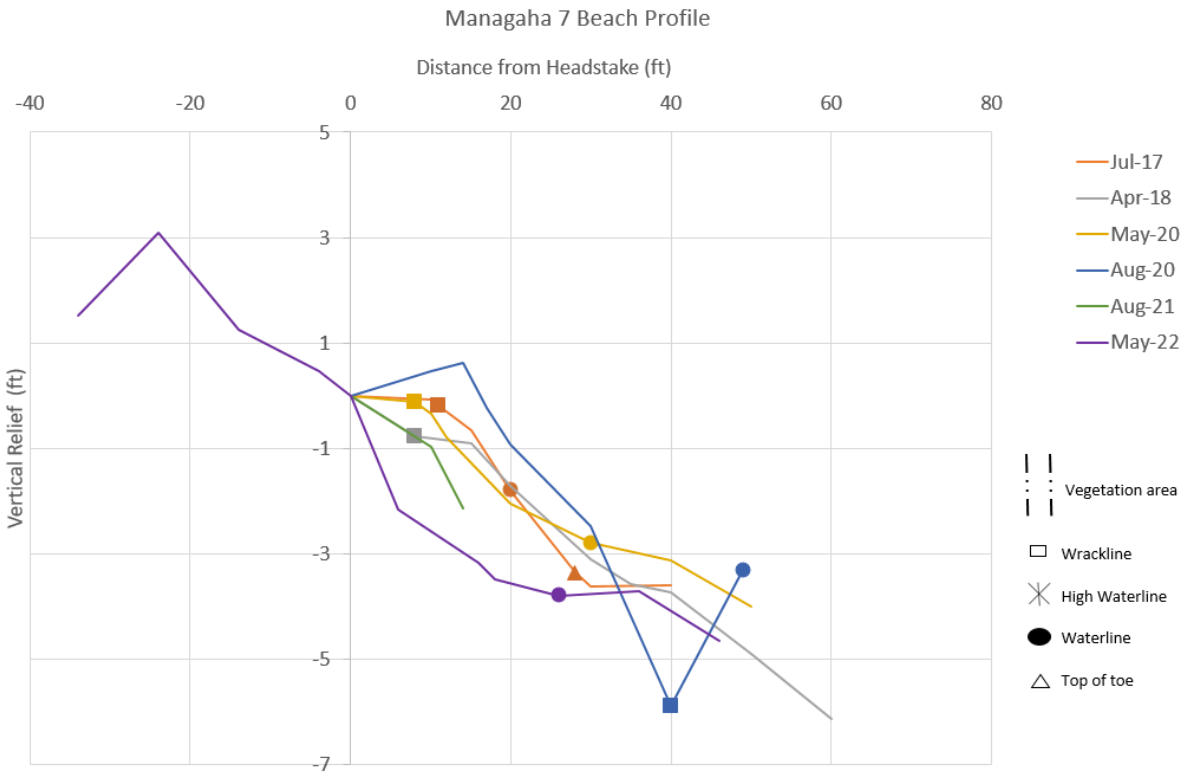

Managaha 3B Beach Profile
Distance from Headstake (ft)
0
50
100
150
200
250
4
2
0
-2
-4
-6
-8
-10
-12
Vertical Relief (ft)
Jul-17
Apr-18
Jun-20
Aug-20
Aug-21
Apr-22
Vegetation area
Wrackline
High Waterline
Waterline
Top of toe


Managaha 4 Beach Profile
Distance from Headstake (ft)
-10
10
30
50
70
90
110
130
0
-1
-2
-3
-4
-5
-6
-7
-8
Vertical Relief (ft)
Aug-21
Apr-22
Vegetation area
Wrackline
High Waterline
Waterline
Top of toe


Managaha 5 Beach Profile
Distance from Headstake (ft)
0
20
40
60
80
100
120
140
2
0
-2
-4
-6
-8
-10
-12
Vertical Relief (ft)
Aug-21
Apr-22
Vegetation area
Wrackline
High Waterline
Waterline
Top of toe


Managaha 6A Beach Profile
Distance from Headstake (ft)
-10
10
30
50
70
90
110
130
0
-1
-2
-3
-4
-5
-6
-7
-8
Vertical Relief (ft)
Aug-21
Apr-22
Vegetation area
Wrackline
High Waterline
Waterline
Top of toe


Managaha 6B Beach Profile
Distance from Headstake (ft)
-10
10
30
50
70
90
110
130
0
-1
-2
-3
-4
-5
-6
-7
Vertical Relief (ft)
Aug-21
Apr-22
Vegetation area
Wrackline
High Waterline
Waterline
Top of toe



Conclusion

For this report, the DCRM Shoreline Monitoring team calculated the rate of change using the linear regression analysis of the beach toe to determine whether the transect is eroding, accreting, stable, or undetermined. Beach profile interpretation and history also support the determination of a transect's status, especially with beach profiles with insufficient data entries. New headstakes have replaced previously lost ones, resulting in new beach profiles. The total station was deployed at all sites during this period, setting new baseline data for the method. During this period, a total of 58 transect surveys were completed on Saipan and Mañagaha.

Seventeen transects have exhibited erosion. Sugar Dock North 2 and 3 have lost beach due to the accumulation of sand in the boat ramp area. The stretch from Micro Beach to Fiesta continues to erode during high wave conditions, presenting itself as a priority for management and planning actions. Some parts of this stretch do recover seasonally, suggesting that sediment transport is fairly active in this area. However, the retreat of the berm suggests a long-term erosion trend. The eastern side of Mañagaha continues to erode in the long-term.

Sixteen transects have exhibited accretion. The stretch from Aquarius through Sugar Dock South adjacent to the channel have been growing as vegetation matures and increases in that shoreline.

Hafa Adai and AMP North stretches have been growing over this time. The northwestern side of Mañagaha continues to accrete.

Twenty-five transects have exhibited stability since the beginning of this program, which considers a rate of change between -1 ft and 1 ft. Pak Pak, PIC, Sugar Dock South, Susupe Beach Park, Kilili South, Oleai, Toyota, Pau Pau, and Wing may have sufficient sediment input and output. Any changes to these sites suggest that sediment transport has exacerbated or nearby sediment sources are negatively impacted.

Four transects are considered 'undetermined' due to its high dynamic nature. Hopwood, Kilili North, and AMP Point transects have been struck with significant erosion and accretion events. As for down south, erosion has temporarily impacted parts of Kilili Beach while an erosion hotspot in PIC seems to have done well this cycle.

2020 - 2022 were predominately La Niña, which brought higher sea levels that exacerbated sediment transport. As the CNMI enters into an El Niño seasonal period, DCRM will see more storm-driven shoreline changes. The beach profiles document the dynamic nature/trends of our shorelines so we can better address site-specific shoreline erosion through management actions and policies to prevent detrimental hardening of our sandy shoreline areas. Although greatly delayed by special award conditions and the need for unmanned aerial vehicle training, the program is planning on integrating LiDAR for capturing sediment volumes pre- and post- storms.

Resources

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