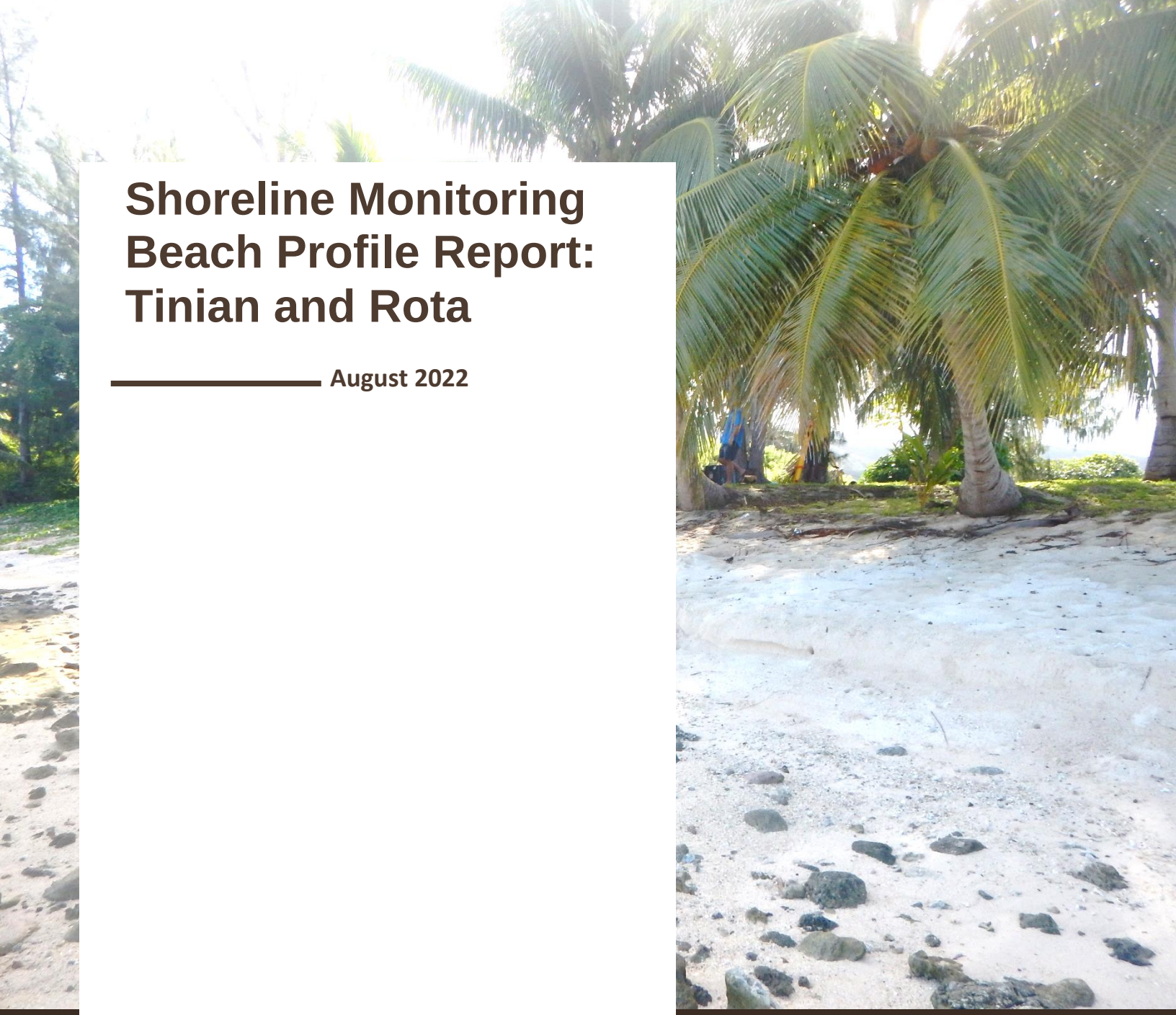

Shoreline Monitoring Beach Profile Report: Tinian and Rota

August 2022

Division of Coastal Resources Management
CNMI Bureau of Environmental Coastal Quality

Award No.: NA20NOS4190179

About the Report

This report is released annually to inform the findings from field data collected under DCRM's Shoreline Profile Monitoring Program between March 2017 – April 2022 for the islands of Tinian and Rota. An update to the August 2018 - February 2021 report, this document builds from previous findings.

This report aims to guide coastal managers and stakeholders in making informed, effective, and adaptive decisions regarding our dynamic shoreline.

Cover photo is the eroded shoreline of
Sasanlagu, located in the fiesta grounds of Songsong village in Rota.

Acknowledgements

The Shoreline Monitoring program is led by the DCRM's Planning Section, with the direction of the Coastal Planner I and valued assistance from DCRM staff volunteers, dedicated summer interns, and NMC student interns. The program especially acknowledges the assistance of Edwin Hofschneider and William Pendergrass, who greatly assisted the team in their perspective islands. The integration of the total station into this program is largely thanks to Seamus Harrison, who served as DCRM's GIS Specialist during this reporting period. Any questions or comments about the program or this report may be directed to shorelines@dcrm.gov.mp.

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.

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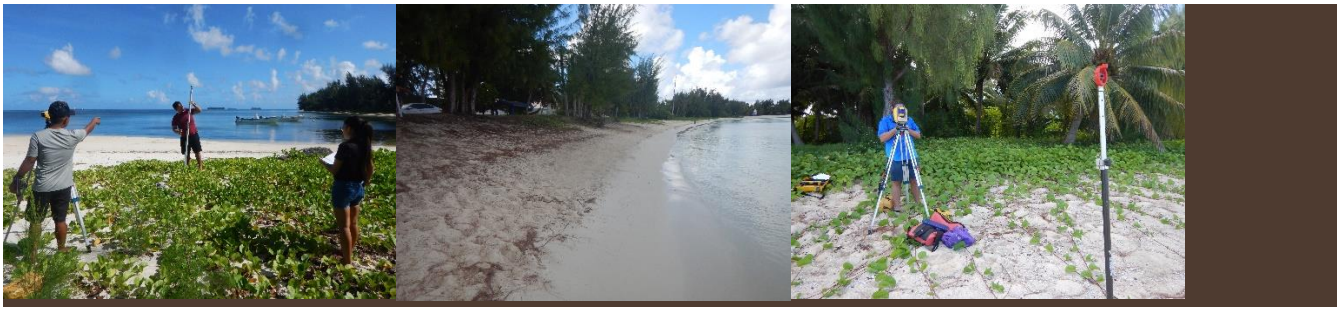
Contents

DCRM Shoreline Monitoring Program

CNMI beaches are dynamic places between the ocean and land providing critical economic, recreational, and cultural services to our island community. 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. 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 could the sand be shifting along the coastline?

To understand this change, the Division of Coastal Resources Management (DCRM) implements long-term shoreline monitoring to track changes of sandy beaches in Saipan, Mañagaha, Tinian, and Rota over time. Timing is a critical factor to how a shoreline appears, given how tides reduce or increase dry beach and how currents shift sand. Data is visualized into ***beach profiles***, which are used to interpret any short-term and long-term trends. These findings are published in this annual document-type report and into an interactive **"Climate Impact Viewer"** map.



Methods

Since 2016, staff have been using 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. We rely on the ***Berger Level method***, which requires manual readings on a measured rod through a leveled telescope instrument. The above photo on top left displays this two to three-person survey method. In 2021, we integrated the one-person higher accuracy electronic method, known as the ***Total Station method*****.** Using data from both, we graph out ***beach profiles*** to compare the shoreline contours over time (see page 8).

In addition, we capture damages or remnants after a strong storm by walking the ***wrackline*** or ***eroding berm*** with the ***Trimble GNSS.***

Definitions

Accretion - The gradual addition of land by deposition of water-borne sediment.

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 DCRM's Shoreline Monitoring Beach Profile Report for Saipan and Mañagaha

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

Wave run up – maximum vertical extent of wave uprush on a beach above the still water level

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

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.

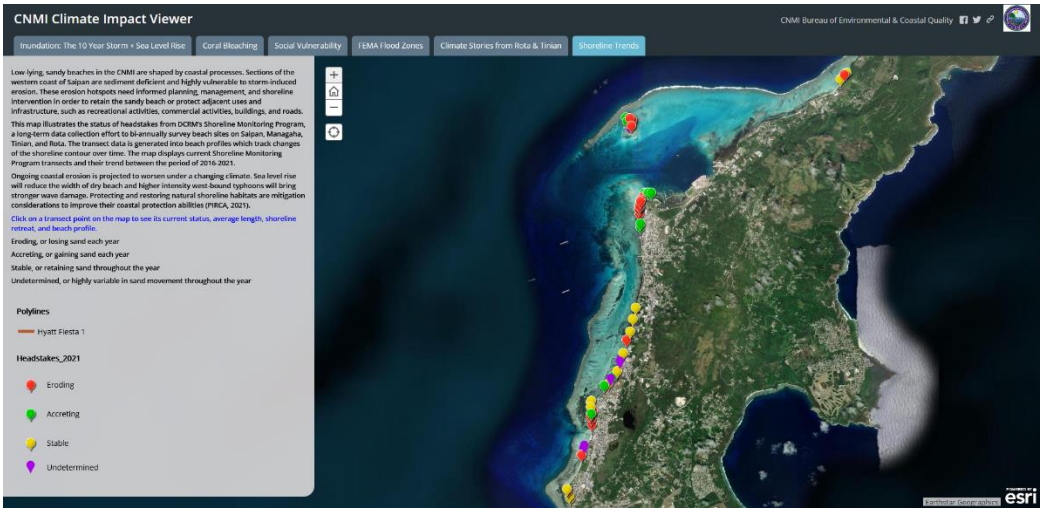
To access the map:

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.”

2. Go to “Shoreline Trends.”

3. Zoom into the area of interest.

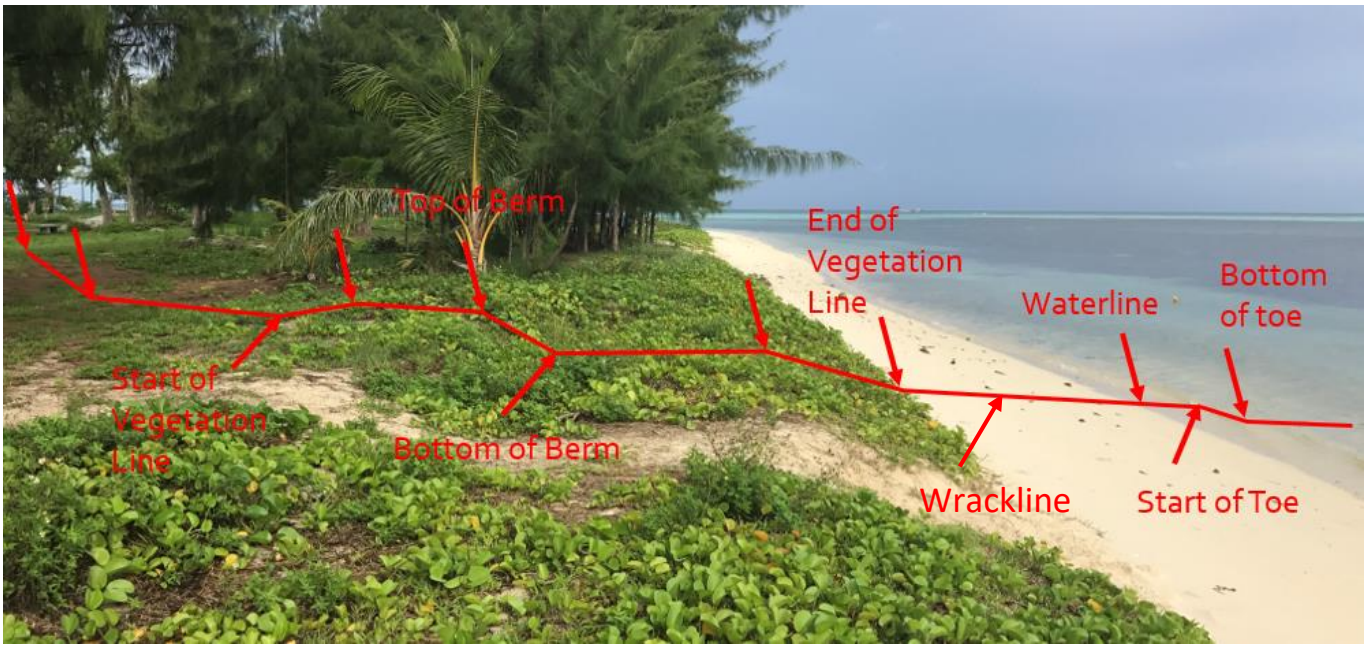
4. The bubbles marked in red, green, yellow, or purple are the headstakes surveyed.
   - Red indicates that the beach profile is eroding (losing sand).
   - Green indicates that the beach profile is accreting (gaining sand).
   - Yellow indicates that the beach profile is stable (no significant change).
   - Purple indicates that the beach profile is undetermined, likely due to its moderately dynamic nature.



How to Read the Beach Profile

Beach profiles are "excellent evidence of the magnitude and frequency of the cross-shore changes which are experienced by a particular shoreline of any sediment type" (Cooper et al, 2000). They are the contour of the shoreline from the headstake (starting point inland) to the bottom of the moat/toe.

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

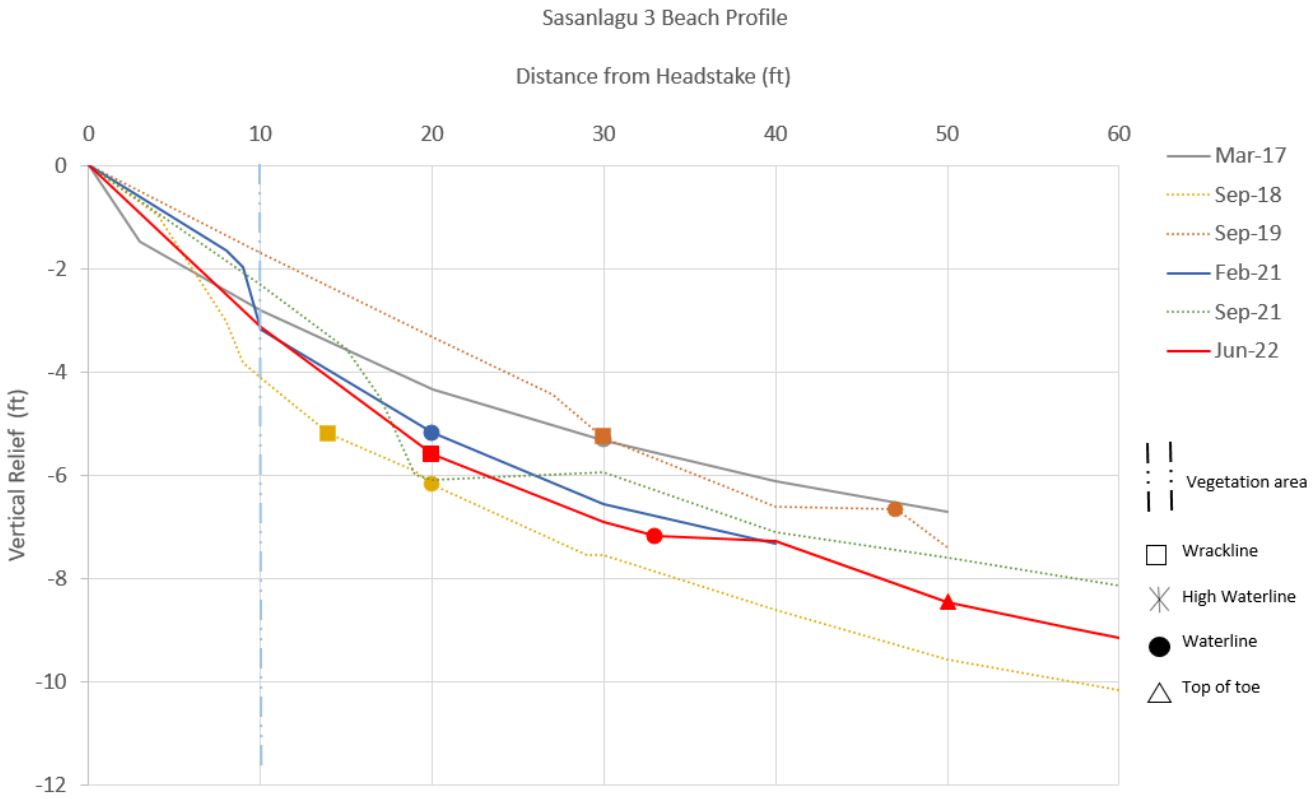


The common features of beach profiles are:

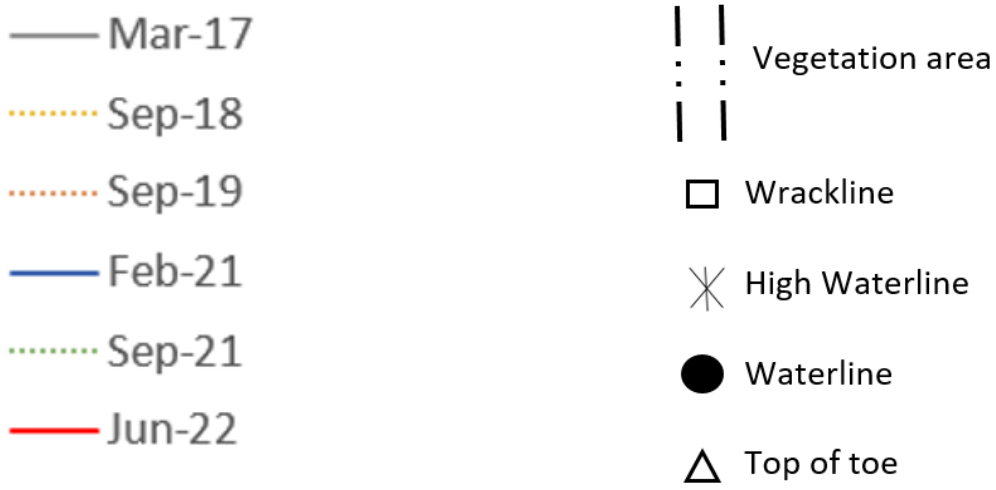
- ***Vegetation line*** – The start and end of stable and natural vegetation that may demonstrate stability of a beach profile
- ***Berm*** - The nearly horizontal portion of the beach or backshore formed by the deposit of materials by wave action. (In the CNMI, the berm is a vertical drop.)
- ***Wrackline*** - 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. The dotted lines are taken during the typhoon season trade wind conditions. For instance, the orange dotted line says that it was taken on Sept 2019. 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 importance 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.

The Berger Level beach profiles are prioritized given that Berger level surveying is consistent.

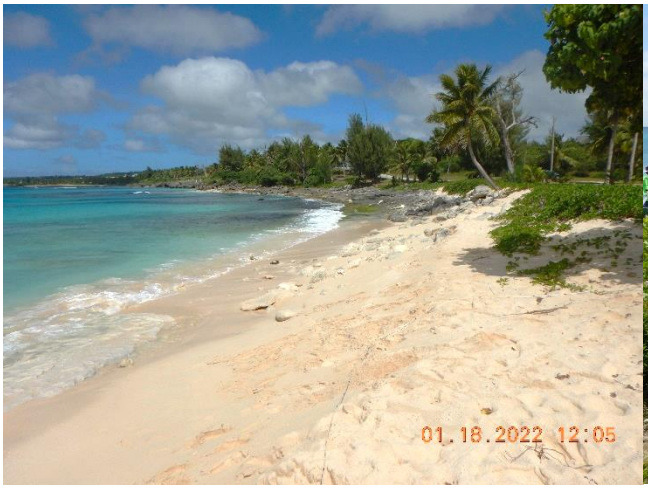
The Total Station beach profiles generated during this reporting period are labeled on the title. We expect to be more consistent with the Total Station method.

Accounting Seasonal Change

Monitoring attempts to capture the northeast winter tradewind and the typhoon season tradewind conditions, which were based accordingly to the *Hydrodynamic Study of Saipan's Western Lagoon*. Although this study obviously did not cover Tinian and Rota, these conditions do occur in Rota and Tinian given their close geographical locations. The hydrodynamics of these islands behave differently along their due to each island's geological features and geography. The seasonal change in this reporting cycle was predominantly La Nina driven, observed to have frequent precipitation events that reduced the likelihood of the team's survey days.

To distinguish seasonal change in this report, we dotted the profiles of years that were taken during the typhoon tradewinds and kept those that were during the northeast winter tradewinds solid. Interpretations of the beach profile factors seasonality when comparing changes.

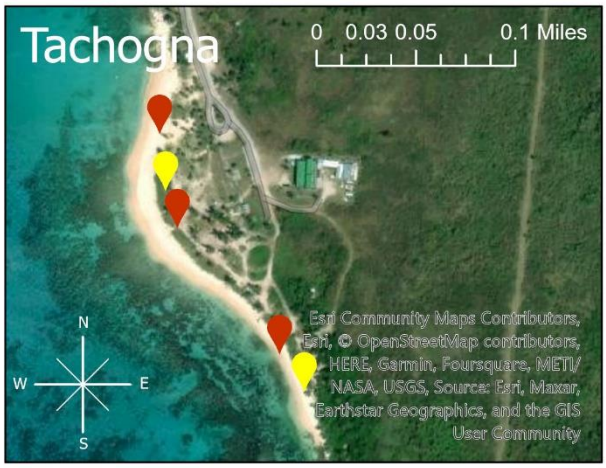
Tinian Beach Profiles and Key Findings



Tinian's shoreline comprise mostly of limestone cliff terraces and isolated sandy beaches protected by fringing reef. The 2015 Vulnerability assessment states that Tinian could be the least vulnerable island to coastal erosion given its protected geological character.

Headlands north and south of pocket beaches may also be a contributing sand source.
Tachogna and Jones Beach are among the few sandy shoreline sites selected for monitoring due to their proximity to the densely populated San Jose village and economically valued Tinian Harbor. The channel, harbor, and breakwater may influence the ongoing longshore transport direction, which could be identified by a hydrodynamic study. The beaches exhibit high vulnerability to short-term erosion and storm surge during south, southwest, or west typhoon wave conditions.

Sea level rise is anticipated to bring an additional 2 – 3 feet of tidal influence, which would threaten the shoreline and recreational areas around Tinian Seaport and Taga Beach. Current development of a casino and hotel on the Tinian Harbor area are at risk and will need guidance in building resilience to these coastal hazards.



Tachogna

Tachogna Beach is a prime recreational spot for recreation and tourism, but its sandy shoreline has been subjected to high wave events (such as storm surge and tsunamis). The southern part of the beach has a higher density of beach strand vegetation, which acts as a sand stabilizer and buffer from waves for the backshore. Meanwhile, the northern section of the shoreline is more exposed since this area is more disturbed by recreational use and closer to the Tinian channel. Apr-21 records for transects in this site present the impact of high surf on the shoreline while the Jan-22 records present a calmer wave condition.

Tachogna South 1 Highlights:

- STABLE in the short-term with a Wrackline that ranges 10 – 43 ft and an elevation difference of 8 ft
- This shoreline is at the end of the shoreline stretch and is subjected to change over time

Tachogna South 2 Highlights:

- NEW HEADSTAKE

Tachogna South 3 Highlights:

- ACCRETING in the short-term with a Wrackline that ranges 50 – 59 ft with an elevation difference of 9 ft
- The typhoon season may actually allow accretion of the shoreline.

Tachogna North 2 Highlights:

- UNDETERMINED with a Wrackline that ranges 70 – 90 ft with an elevation difference of 10 ft
- The variation begins at the headstake

Tachogna North 3 Highlights:

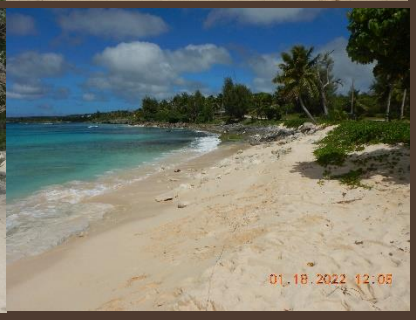
- ERODING with a Wrackline that has been observed to reach the headstake with an elevation difference based on the waterline can be around 7 ft
- There is an observed pattern of erosion every few years

For **Tachogna South 1**, the profile has changed many times throughout time. Given that the wrackline was at 10 ft, most of the shoreline could be wet during high tide. Sediment input and output are regular in this area, and does not seem to be dictated by the seasons much.

Tachogna South 2 has a new headstake because the previous one is difficult to survey due to overgrown vegetation. The current headstake is in the backshore area, closer to the road.

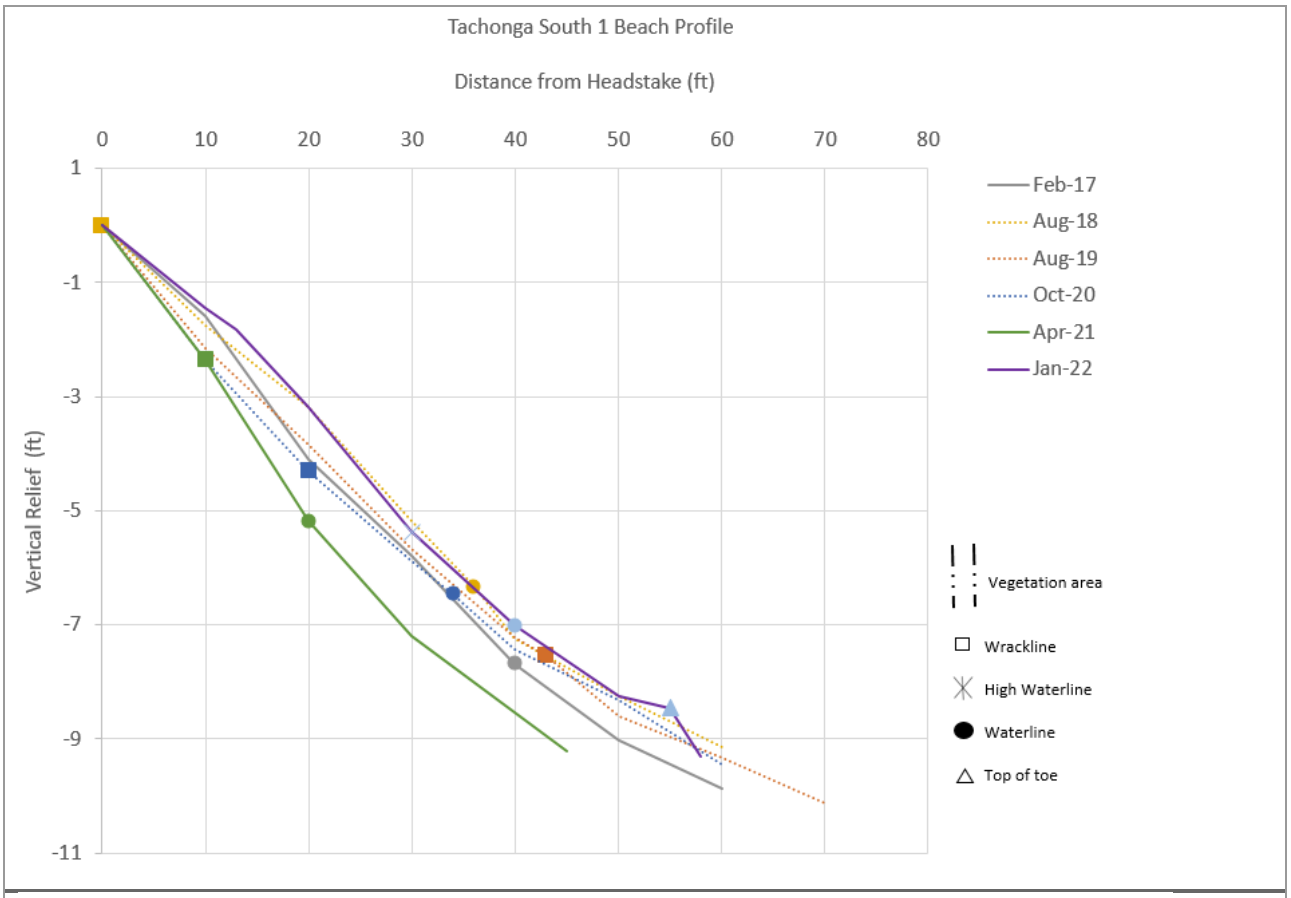
For **Tachogna South 3**, the profile seems to be evident that seasonal variation occurs in the shoreline. The winter tradewind condition has brought more sand up the shoreline. Despite the erosion event in April 2021, the general trend is accretion.

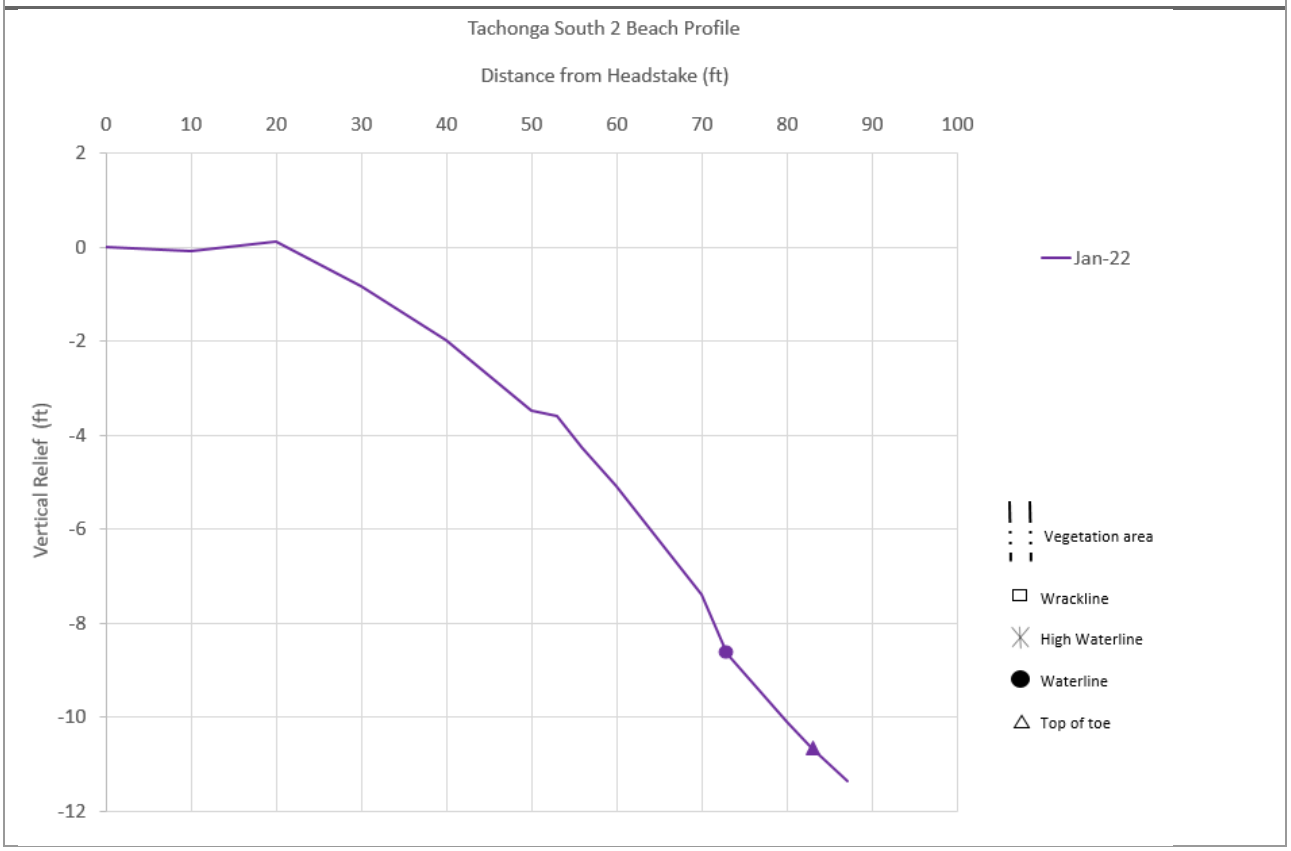
Tachogna North 2 is changing over time with its sediment input and output, but does not seem to be accreting or eroding in the long-term.

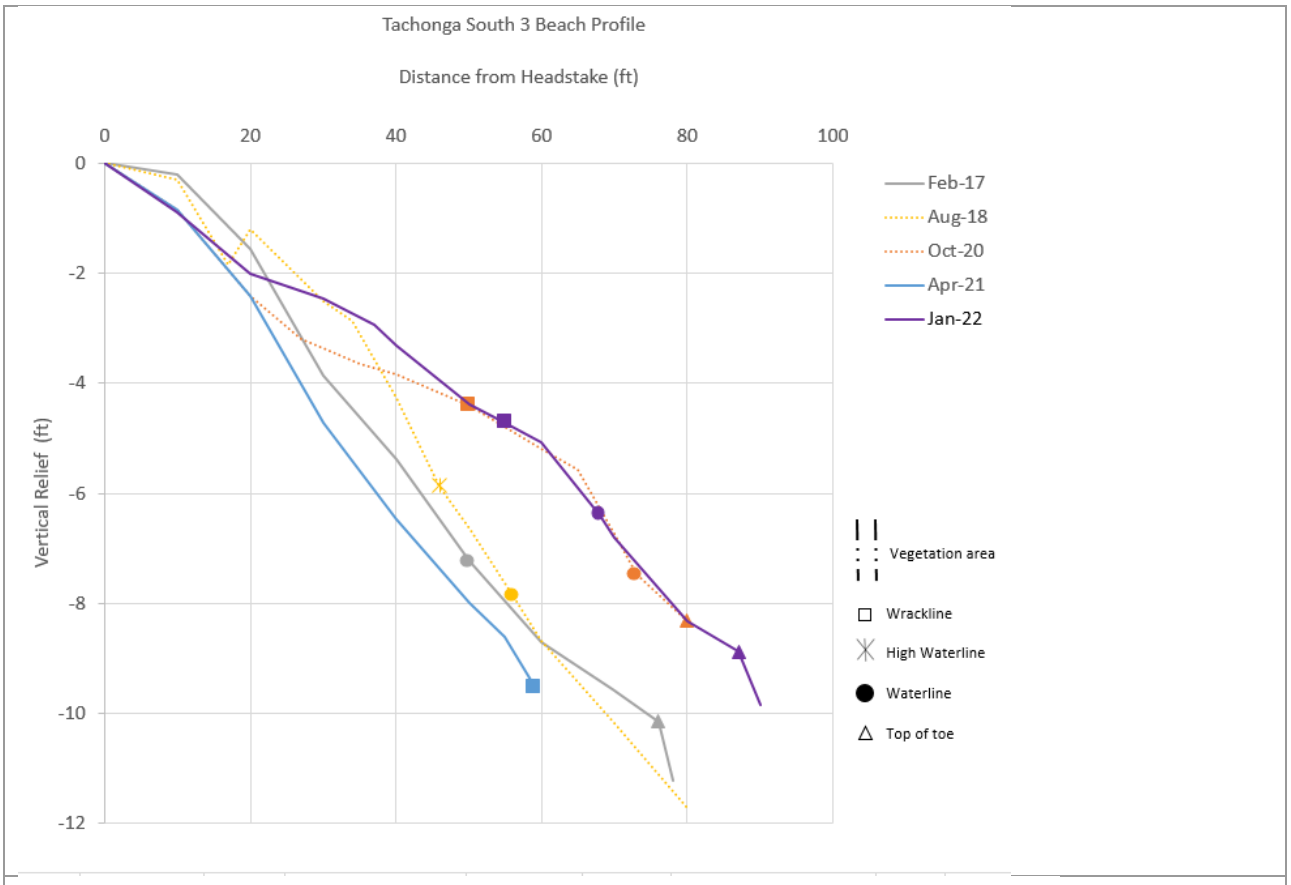


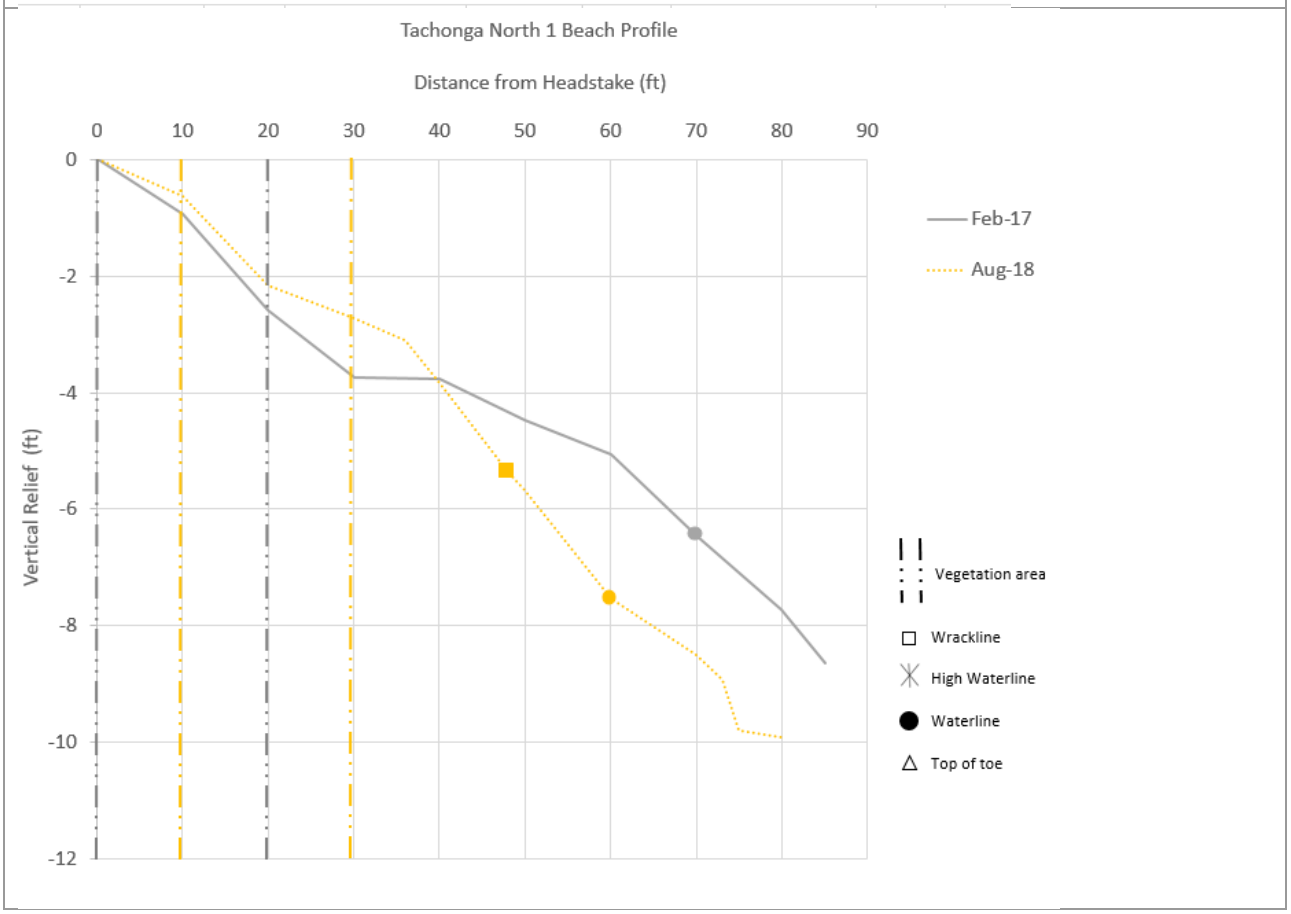
For **Tachogna North 3**, the profile has experienced erosion events after August 18. Drastric change to the profile is apparent in the northern edge of Tachogna.

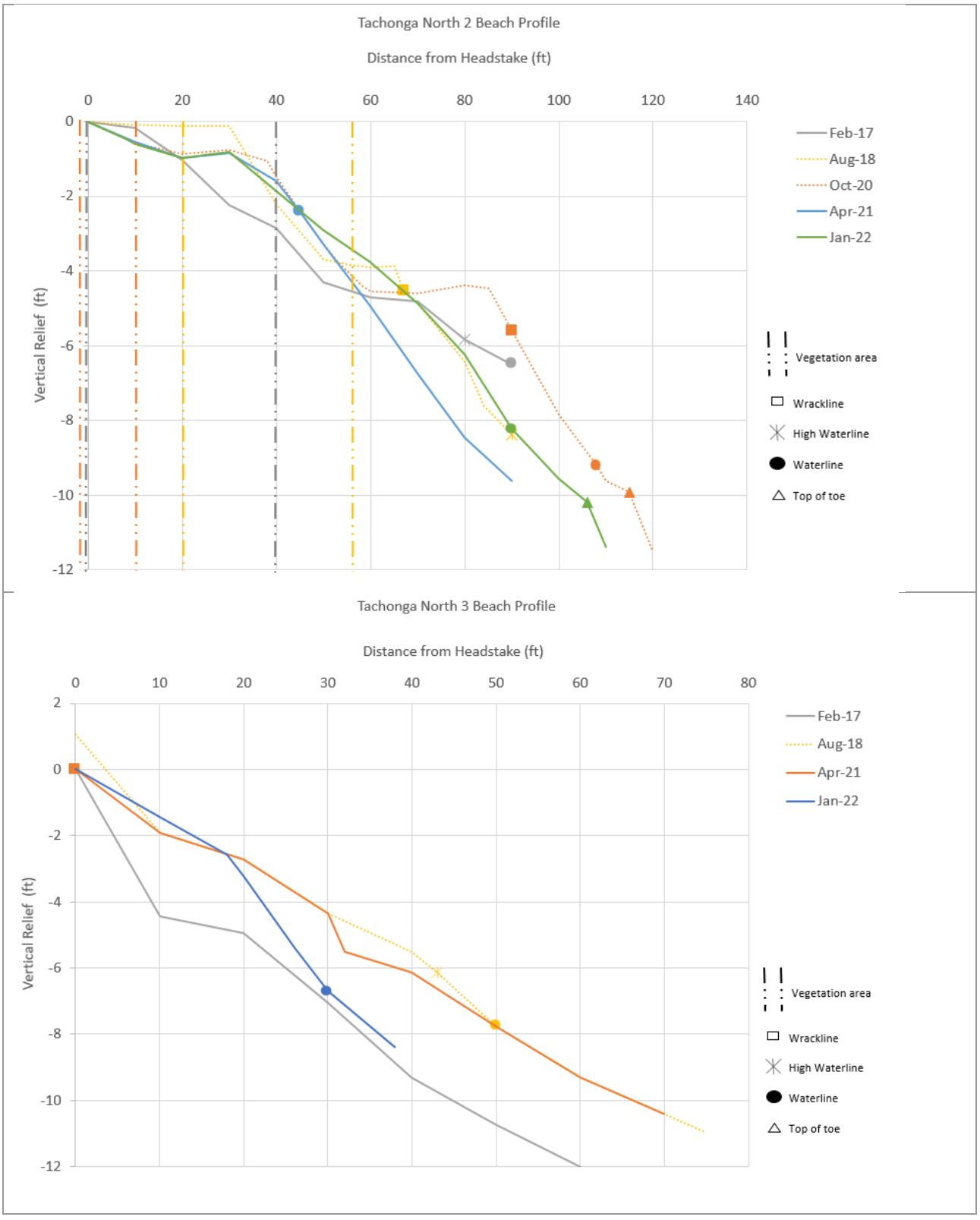
Tachogna Beach Profiles – Berger Level

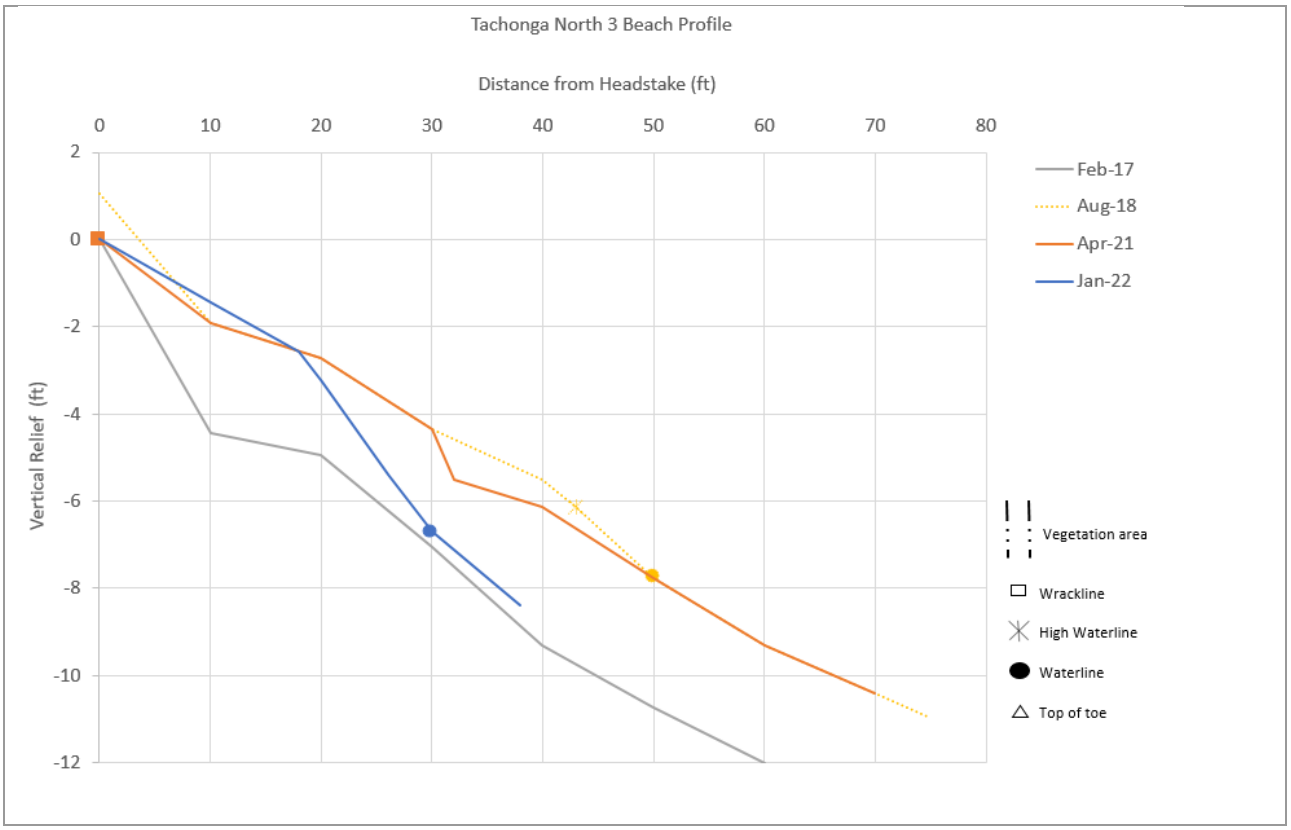




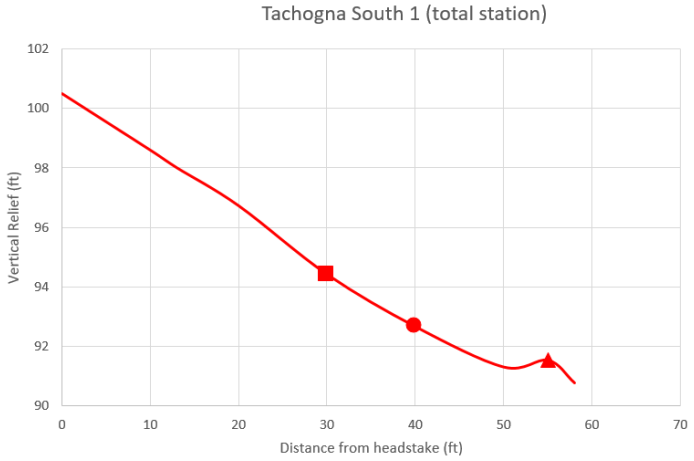

Tachonga South 3 Beach Profile
Distance from Headstake (ft)
0
20
40
60
80
100
0
-2
-4
-6
-8
-10
-12
Vertical Relief (ft)
Feb-17
Aug-18
Oct-20
Apr-21
Jan-22
Vegetation area
Wrackline
High Waterline
Waterline
Top of toe

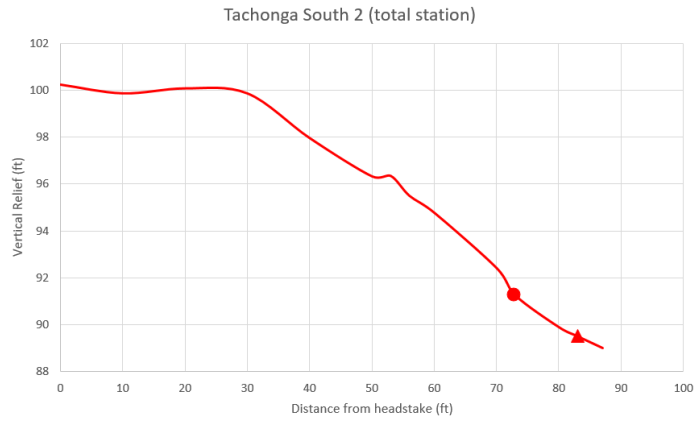

Tachonga North 1 Beach Profile
Distance from Headstake (ft)
0
10
20
30
40
50
60
70
80
90
0
-2
-4
-6
-8
-10
-12
Vertical Relief (ft)
Feb-17
Aug-18
Vegetation area
Wrackline
High Waterline
Waterline
Top of toe

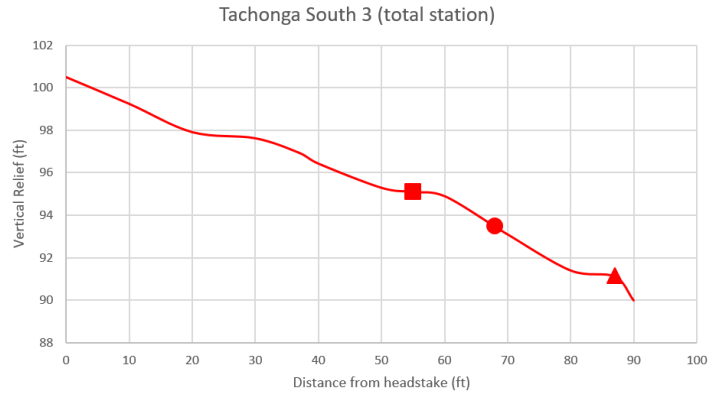

Tachonga North 2 Beach Profile
Distance from Headstake (ft)
0
20
40
60
80
100
120
140
0
-2
-4
-6
-8
-10
-12
Vertical Relief (ft)
Feb-17
Aug-18
Oct-20
Apr-21
Jan-22
Vegetation area
Wrackline
High Waterline
Waterline
Top of toe
Tachonga North 3 Beach Profile
Distance from Headstake (ft)
0
10
20
30
40
50
60
70
80
2
0
-2
-4
-6
-8
-10
-12
Vertical Relief (ft)
Feb-17
Aug-18
Apr-21
Jan-22
Vegetation area
Wrackline
High Waterline
Waterline
Top of toe

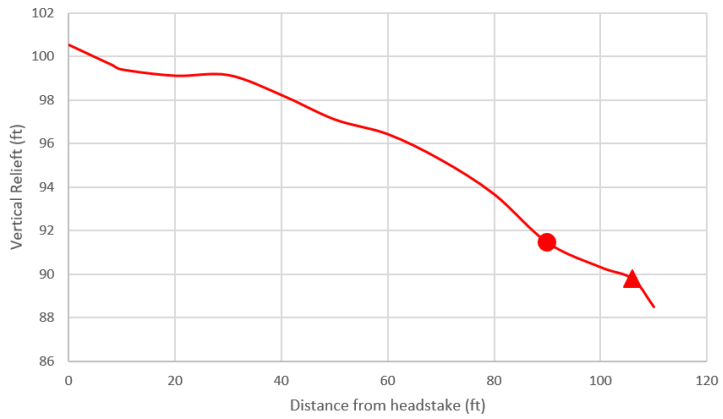

Tachonga North 3 Beach Profile
Distance from Headstake (ft)
0
10
20
30
40
50
60
70
80
2
0
-2
-4
-6
-8
-10
-12
Vertical Relief (ft)
Feb-17
Aug-18
Apr-21
Jan-22
Vegetation area
Wrackline
High Waterline
Waterline
Top of toe

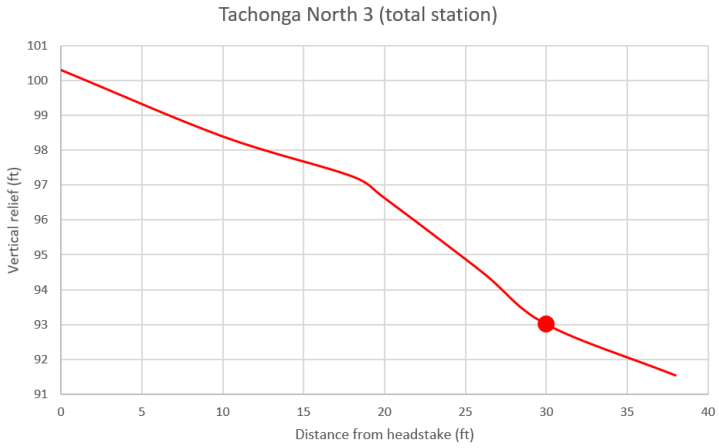
Tachogna Beach Profiles – Total Station








Tachonga North 2 (total station)
Vertical Relieft (ft)
102
100
98
96
94
92
90
88
86
0
20
40
60
80
100
120
Distance from headstake (ft)


Tachonga North 3 (total station)
Vertical relief (ft)
101
100
99
98
97
96
95
94
93
92
91
0
5
10
15
20
25
30
35
40
Distance from headstake (ft)

Jones

Formerly called “Kammer Beach”, Jones Beach is a sandy beach park south of the Tinian Harbor. The northern portion of the shoreline which aligns with the harbor appears to have not as much coral and coastal protection. Jones Beach is closest to San Jose Village and the Tinian Harbor. The loss of this beach to sea level rise or erosion would push the risk of storm surge inland.

Jones 1 Highlights:

- NEW HEADSTAKE with a Wrackline that marks 44 ft and an elevation difference of 9 ft
- ACCRETING - The previous headstake was more seaward. Developing vegetation indicate stability or even growth of the shoreline.

Jones 2 Highlights:

- STABLE with a Wrackline that ranges 37 – 63 ft with an elevation difference of 9 ft
- The development of vegetation indicates stability of the shore, a contrast to the erosion in 2017.

Jones 3 Highlights:

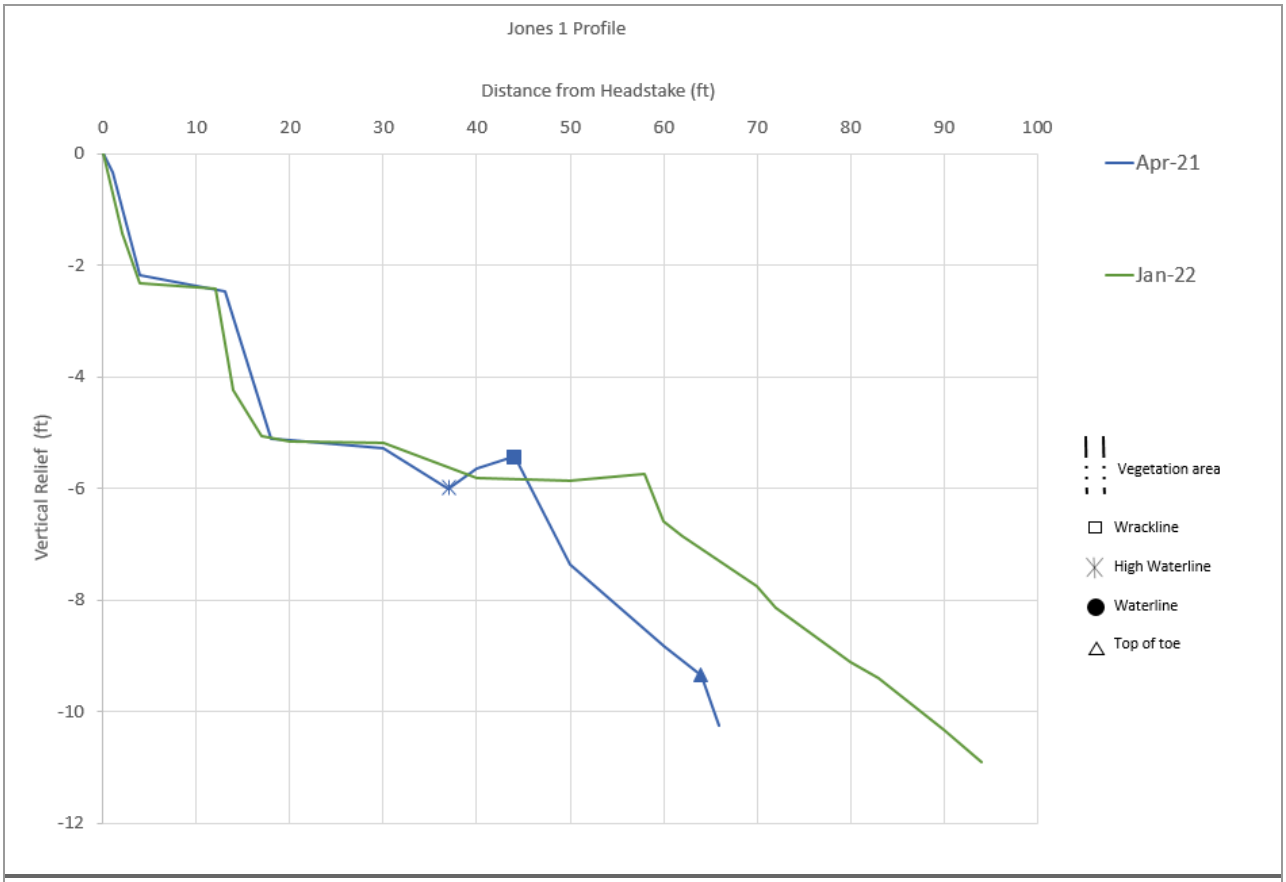
- EROSION with a Wrackline with an elevation difference of 11 ft
- Aug-19 showed accretion between 20 ft – 60 ft. Some volumes begin to erode in Apr-21 and continue to erode since then.

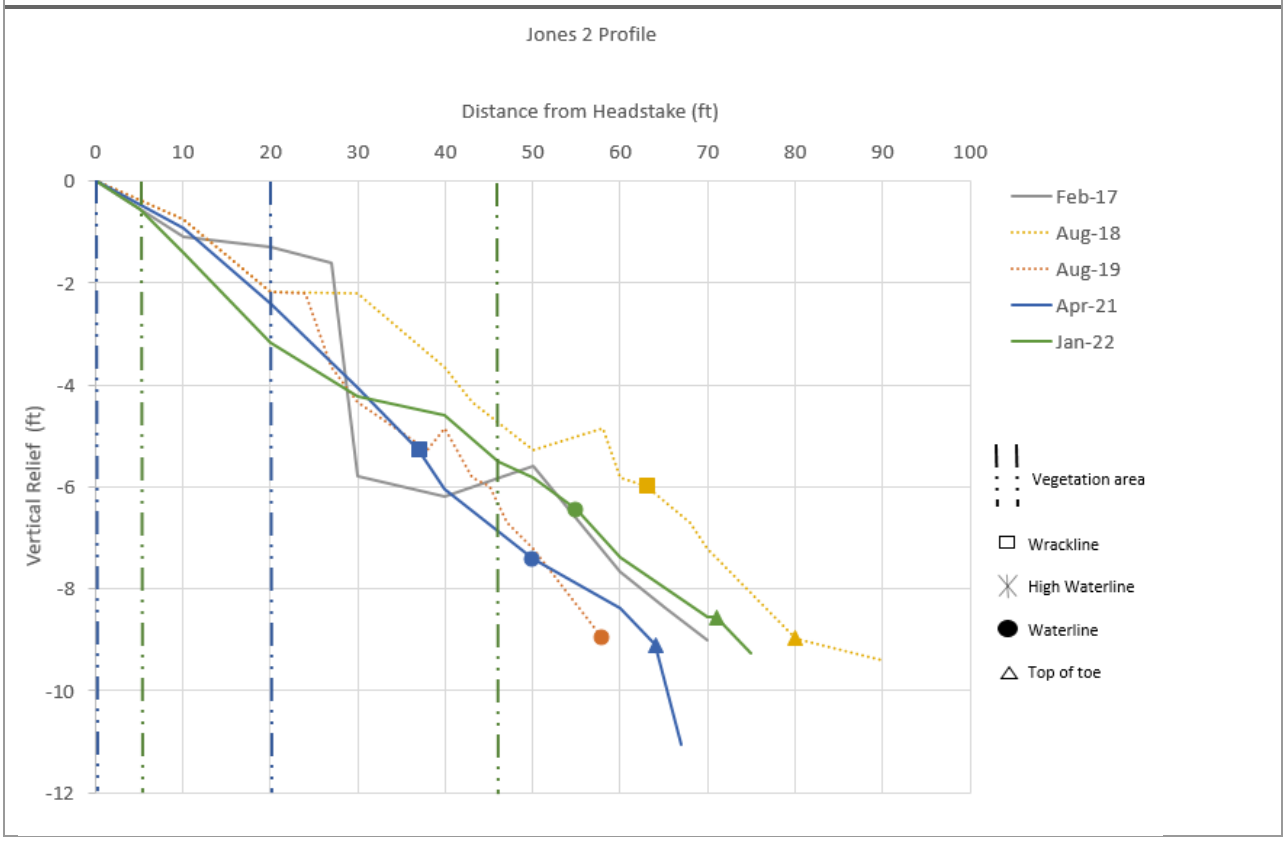
Jones 1 was replaced this reporting cycle due to difficulty accessing the headstake. A headstake closeby but farther inland was selected. Despite this change, the profile shows growth of the shoreline.

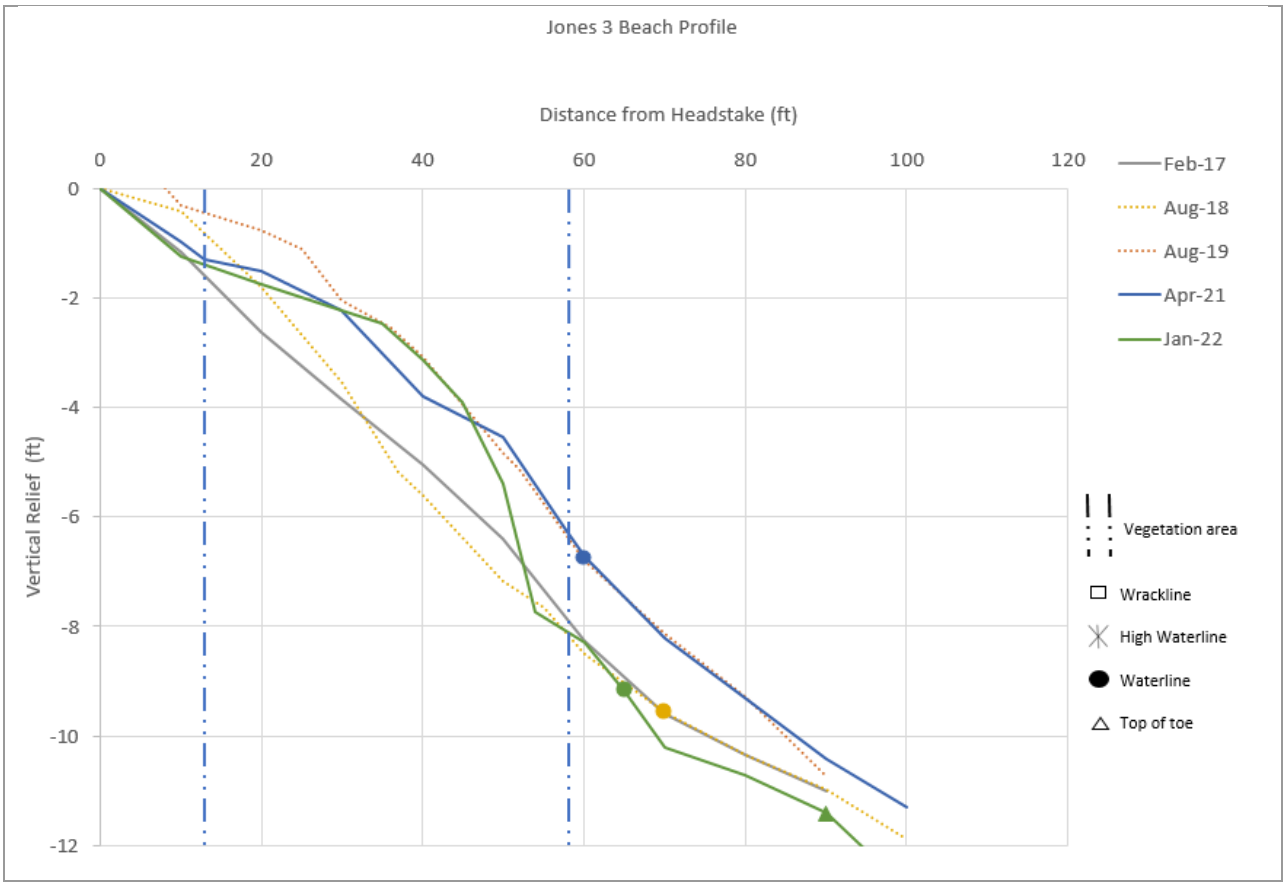
Jones 2 has stabilized after 2018. The development of the vegetation also supports this finding.

Jones 3 has steepened over the years due to erosion. The profile indicates accretion occurred after 2017 followed by erosion in 2019.

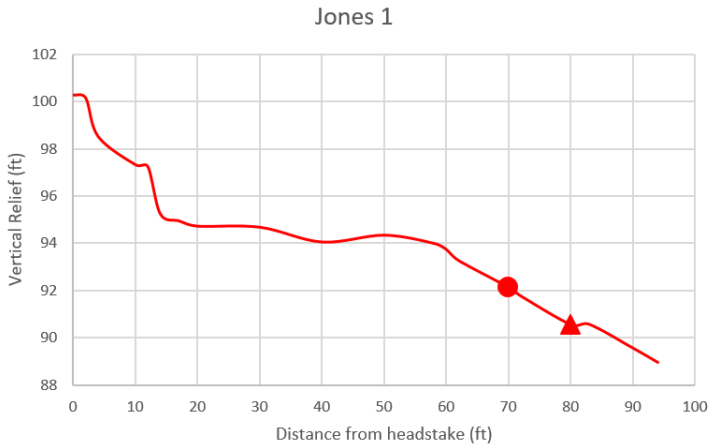
Jones Beach Profiles – Berger Level

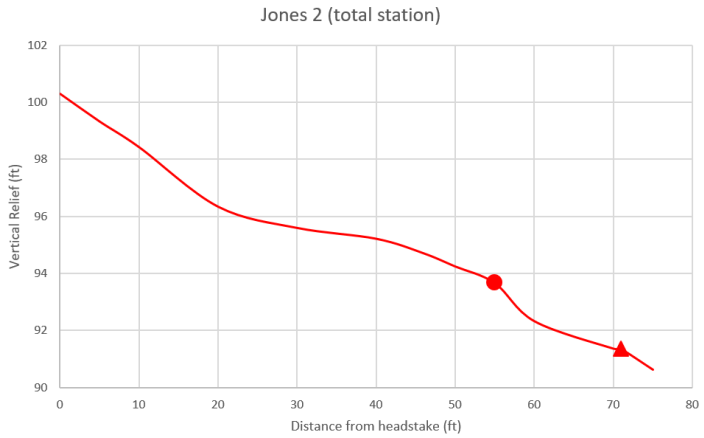


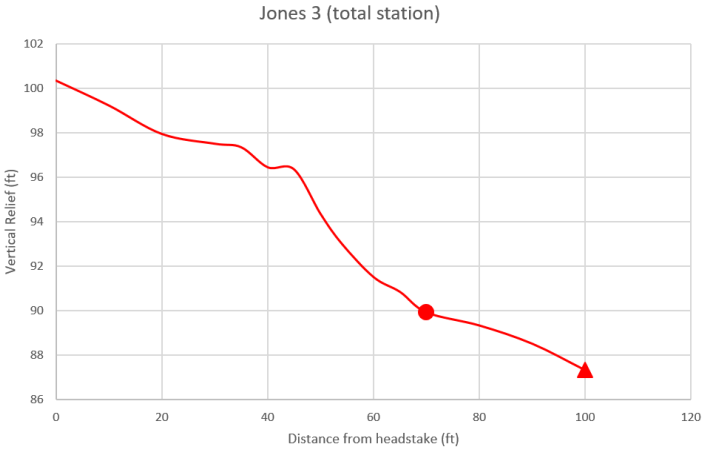



Jones 3 Beach Profile
Distance from Headstake (ft)
0
20
40
60
80
100
120
0
-2
-4
-6
-8
-10
-12
Vertical Relief (ft)
Feb-17
Aug-18
Aug-19
Apr-21
Jan-22
Vegetation area
Wrackline
High Waterline
Waterline
Top of toe

Jones Beach Profiles – Total Station



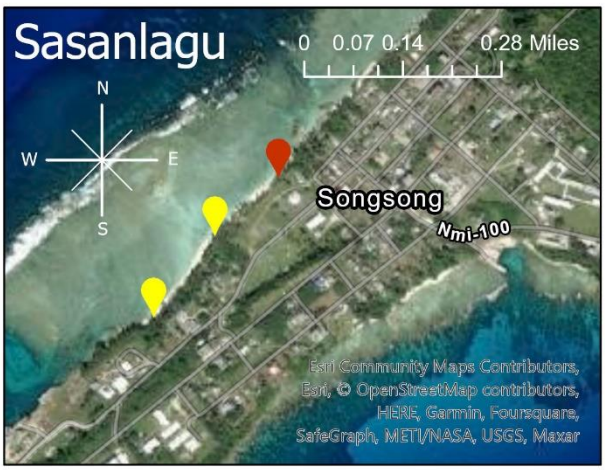




Rota Beach Profiles and Key Findings

Rota's sandy beaches are much closer to the reef, making it unique compared to its northern counterparts. The rocky reef structure functions as a source of sediment for the shoreline while acting as a barrier between land and the open ocean. However, its close proximity of the reef to the shoreline suggests the high potential of storm surge when waves overtop the reef. The low-lying village of Songsong and the road connecting from Songsong peninsula to the airport remain highly vulnerable to sea level rise and storm surge. Remnants of post-WWII relicts are found on lagoon of Sasanlagu, which may interact with sand movement processes. The residents of Songsong have reported 55-years of beach loss and raised concerns of how their private property may be impacted by sea level rise inundation, according to the 2015 vulnerability assessment.

DCRM has been monitoring Teteto, Guata, and Sasanlagu shorelines. Despite its vulnerability to storm surge, sandy beaches have naturally recovered after erosion events. The beach strand plant species in the backshore have been indicative of the stability of inland areas and also act as a buffer for wave energies.



Sasanlagu

Sasanlagu is also known as Songsong's popular beach park. The coconut shaded backshore are grounds for community events, and the three-story Carolinian *uut*, or hut. Toward the West Harbor, the backshore vegetation density increases. On the eastern end, concrete rubble were scattered as wrackline. A concrete bunker structure indicates previous development on the shoreline. Typhoons and tropical disturbances have brought damaging storm surge to shoreline beach strands on the east and west sides of the peninsula bordering Songsong Village. Typhoon Pongsona in 2002 exhibited potential of an 18 to 22 feet surge due to the short proximity of the typhoon eye. The loss of sandy beach from sea level rise will potentially increase the threat of future storm surge events.

Sasanlagu 1 Highlights:

- STABLE with a Wrackline that ranges 10 – 40 ft and an elevation difference of 5 ft
- Seasonal changes have brought sand in and out of the profile.

Sasanlagu 2 Highlights:

- STABLE with a Wrackline that ranges 45 – 75 ft with an elevation difference of 9 ft
- Seasonal changes have brought sand in and out of the profile.

Sasanlagu 3 Highlights:

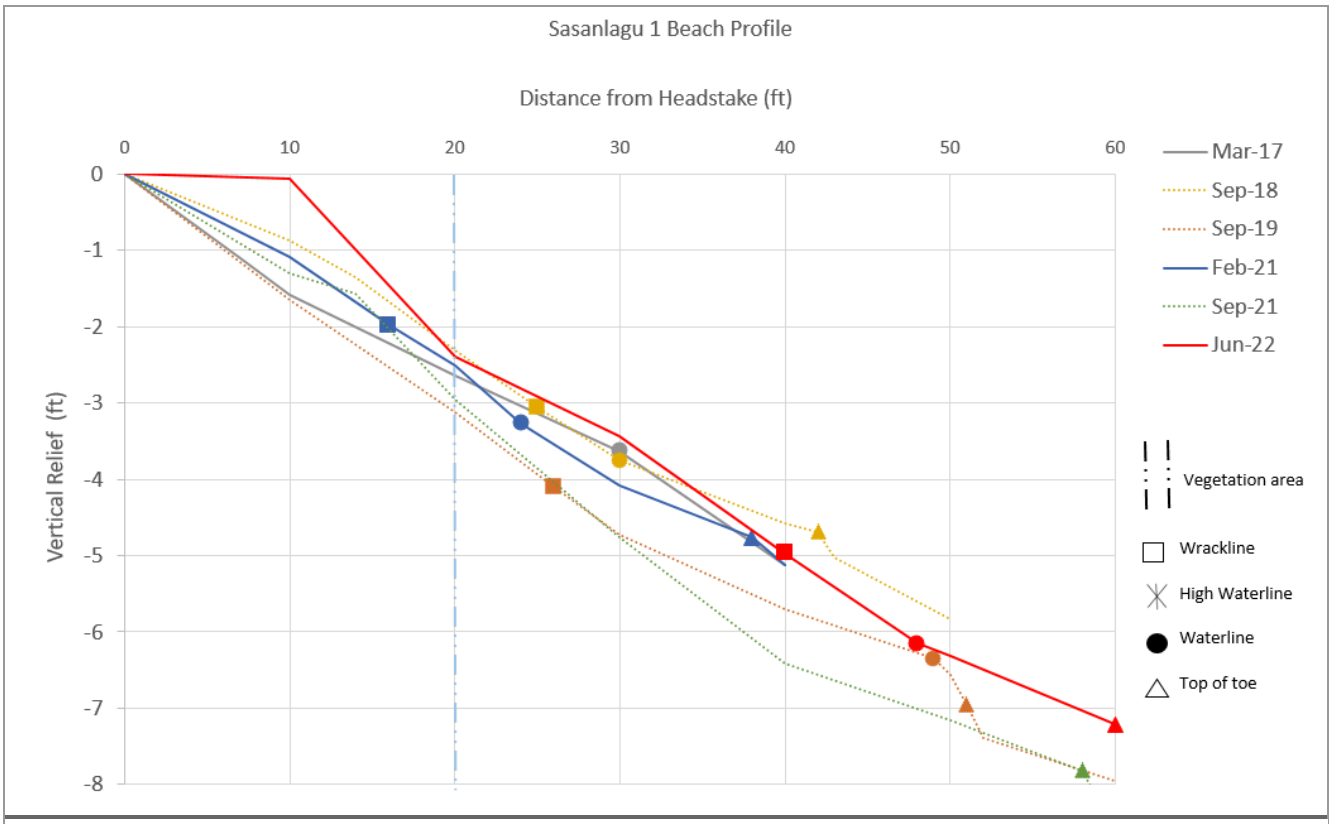
- ERODING with a Wrackline that ranges 14 – 30 ft with an elevation difference of 8 ft
- An erosion scarp is evident in this area.

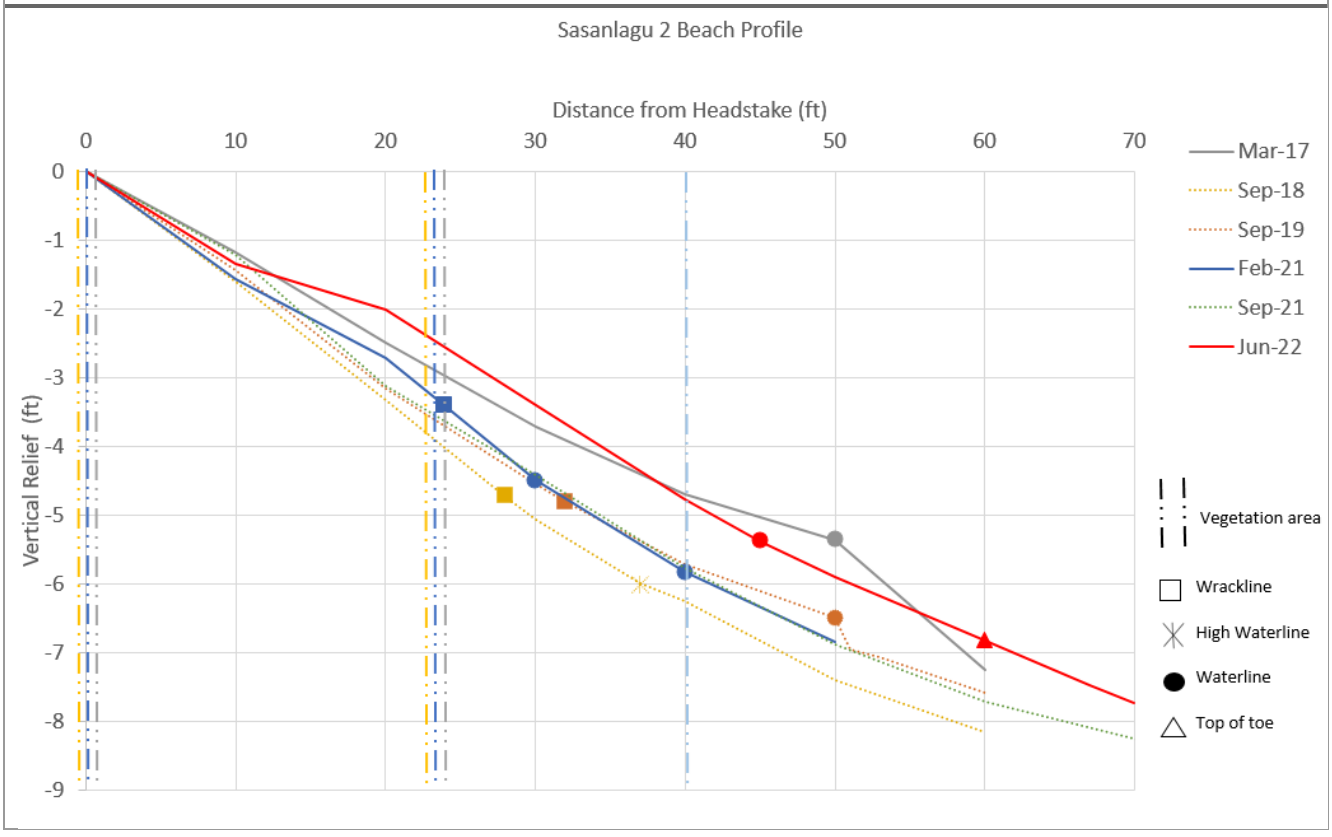
For **Sasanlagu 1**, it is evident that seasonal variation occurs in the shoreline. The winter tradewind condition have damaged the vegetation but the west summerly tradewind brought more sand up the shoreline according to the beach profile. The shortened nearshore width during high tide conditions could enable waves to run up.

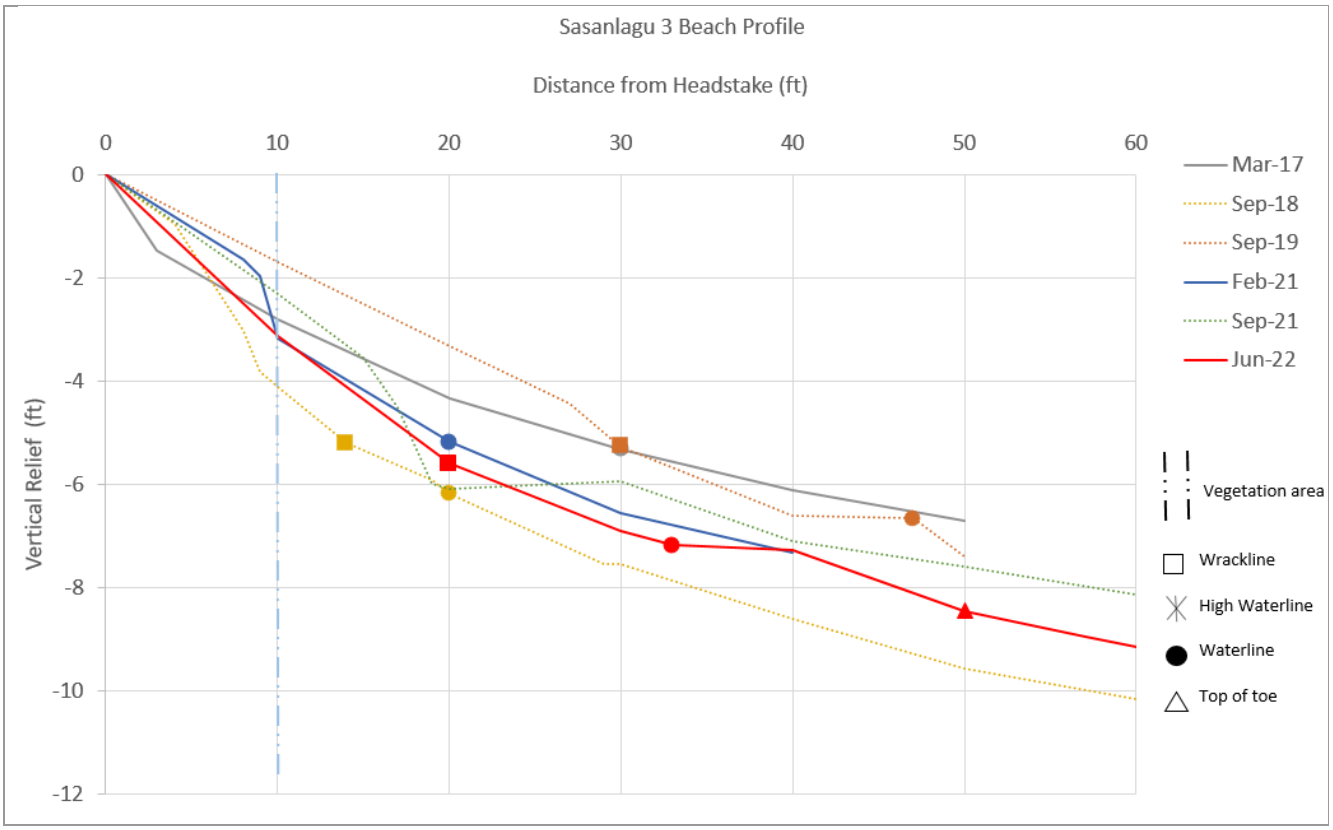
For **Sasanlagu 2**, it is evident that seasonal variation occurs in the shoreline. The winter tradewind condition has actually pushed some sand up the profile but the width was low. But the width of the nearshore during high tide conditions could concern the backshore.

For **Sasanlagu 3**, it is evident the eroding berm is retreating. Seasonal variation occurs in the shoreline. The winter tradewind condition has actually pushed some sand up the profile but the width was low. But the width of the nearshore during high tide conditions could concern the backshore.

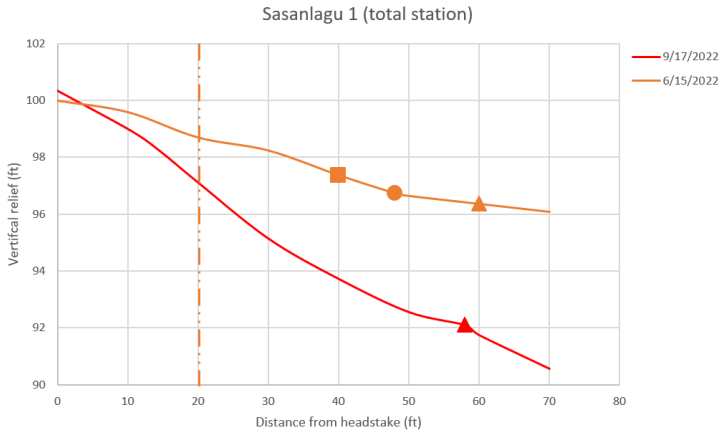
Sasanlagu Beach Profiles – Berger Level

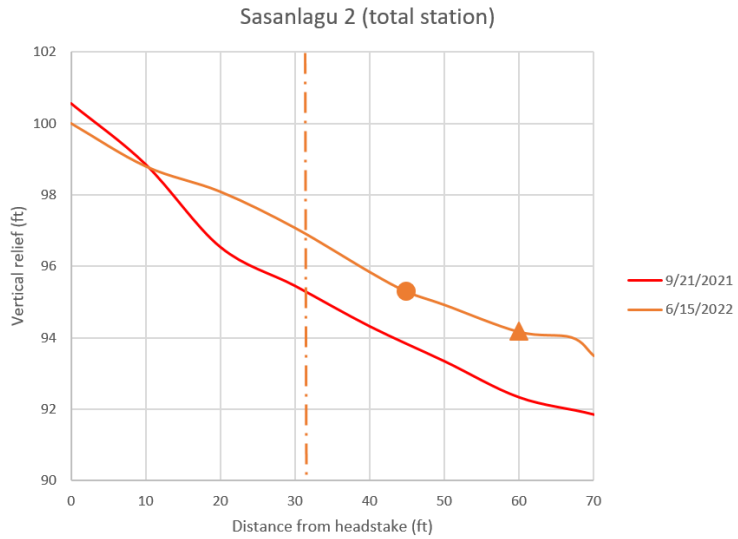


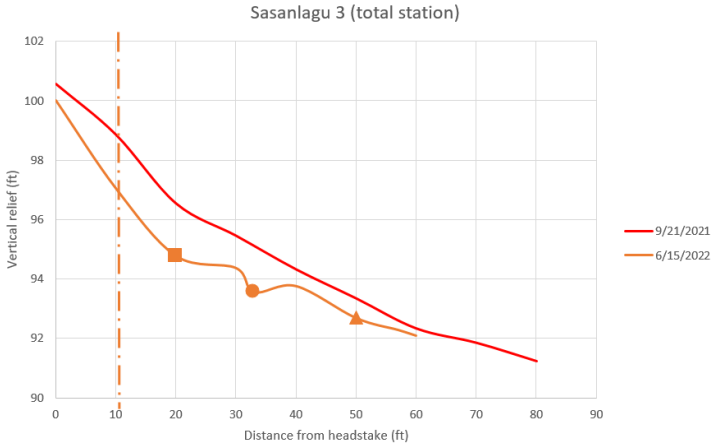



Sasanlagu 3 Beach Profile
Distance from Headstake (ft)
0
10
20
30
40
50
60
0
-2
-4
-6
-8
-10
-12
Vertical Relief (ft)
Mar-17
Sep-18
Sep-19
Feb-21
Sep-21
Jun-22
Vegetation area
Wrackline
High Waterline
Waterline
Top of toe

Sasanlagu Beach Profiles – Total Station







Teteto

Teteto Beach Park contains picnicking tables and a parking area. The shoreline has higher foot traffic than Guata. Sand movement may be dictating the profile, with loss and gains over time. Similarly to Guata beach, sea level rise projections suggest there will be substantial loss of sand in the 50 and 75-year scenarios. The loss of beach as a buffer could damage the main road connecting Songsong to Sinapalo and inland areas during storm surge and high wave energy events.

Teteto 1 Highlights:

- STABLE is the general trend; ACCRETING in the short-term with a Wrackline that ranges 25 – 50 ft and an elevation difference of 8.5 ft
- The berm has been eroded over the years by several cubic feet.

Teteto 2 Highlights:

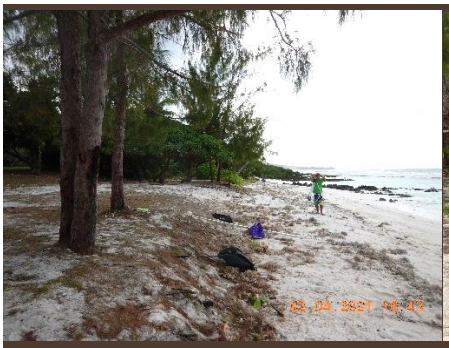
- ACCRETING in the short-term, UNDETERMINED is the general trend with a Wrackline that ranges 40 – 96 ft with an elevation difference of 9 ft

Teteto 3 Highlights:

- ACCRETING in the short-term, STABLE is the general trend with a Wrackline that ranges 17 – 43 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.

Teteto 4 Highlights:

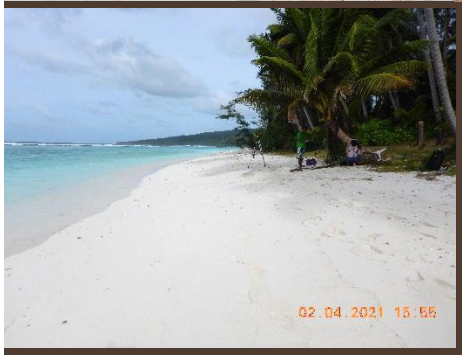
- STABLE with a Wrackline that ranges 10– 28 ft with an elevation difference of 5 ft
- Seasonal variation dictates sediment input and output



For **Teteto 1**, seasonal variation suggest erosion during the winter tradewind condition and accretion during the summer tradewind conditions. But the width of the nearshore during high tide conditions could concern the backshore.

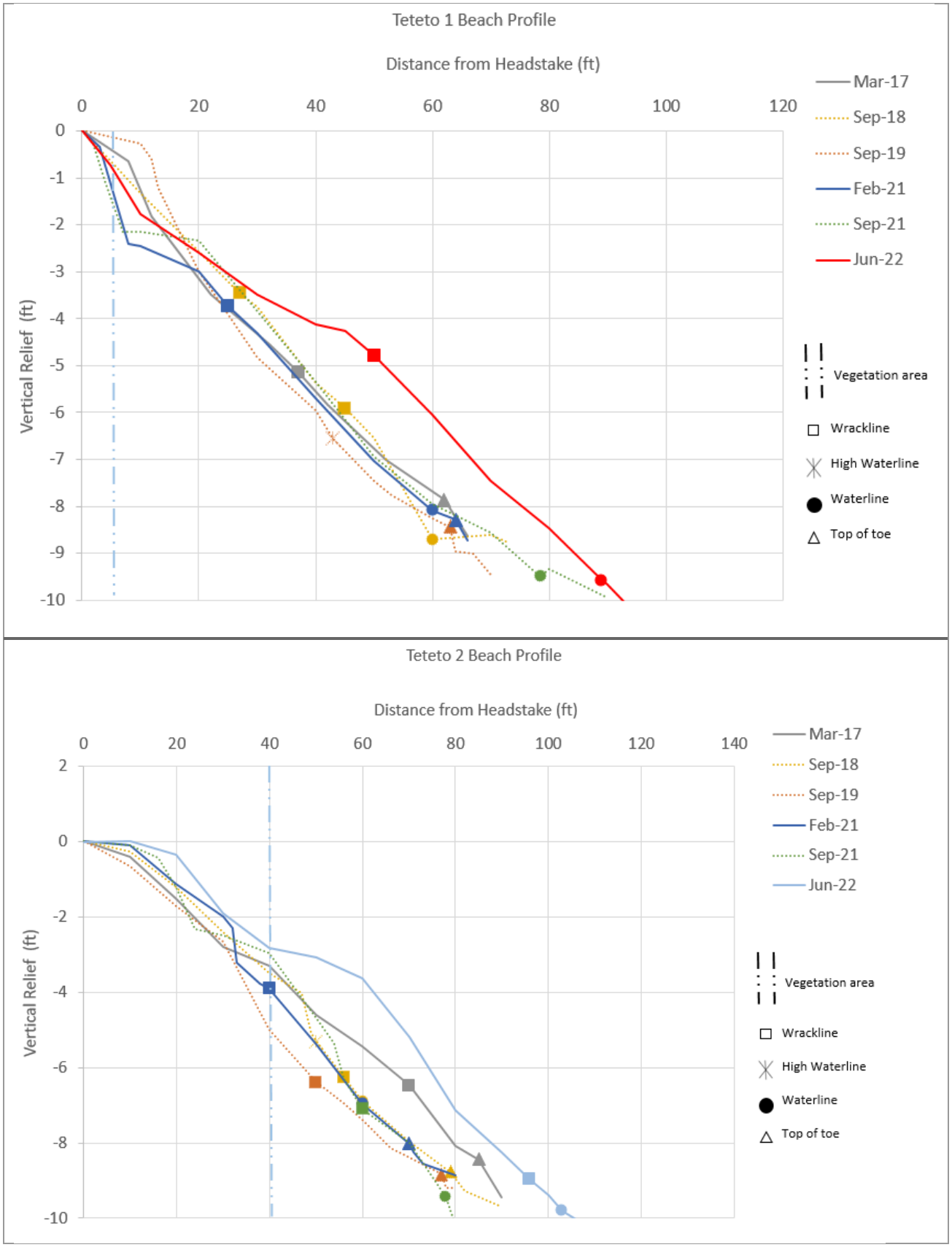
For **Teteto 2**, seasonal variation suggest erosion during the winter tradewind condition and accretion during the summer tradewind conditions. But the width of the nearshore during high tide conditions could concern the backshore.

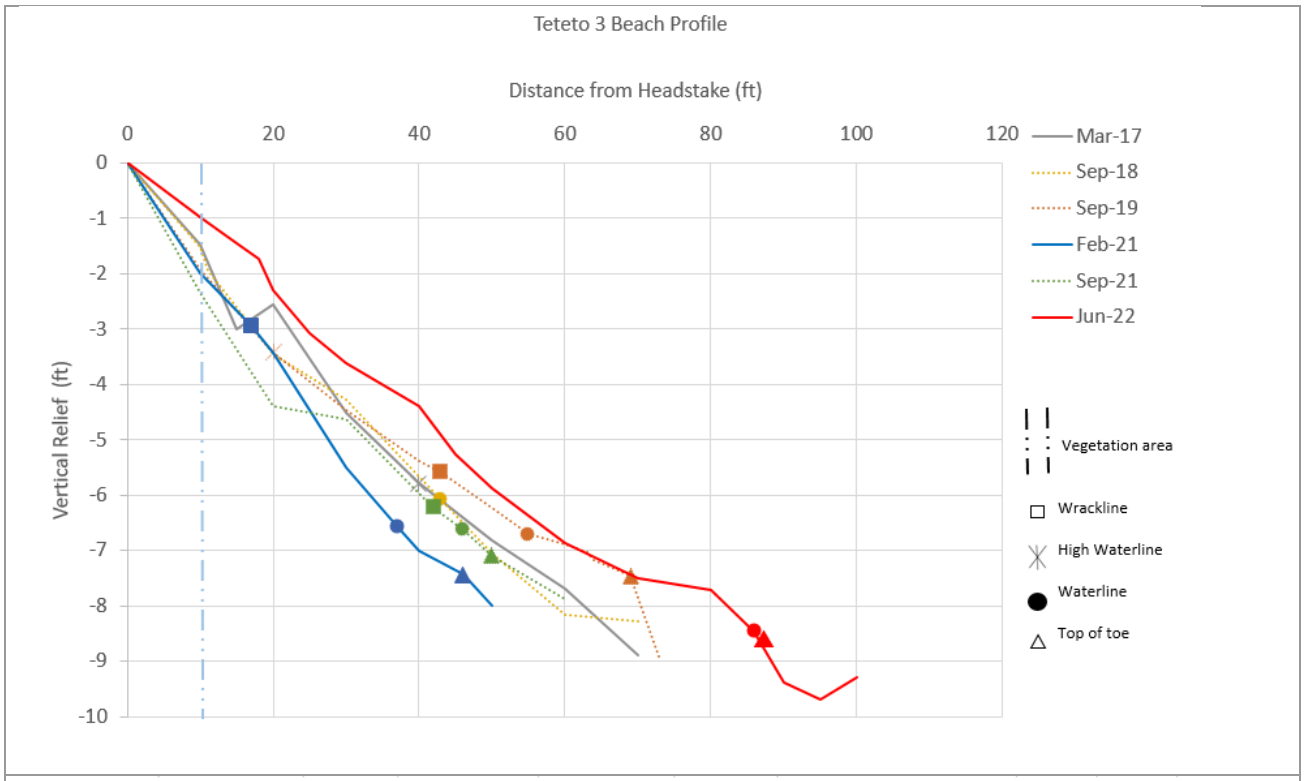
For **Teteto 3**, seasonal variation suggest erosion during the winter tradewind condition and accretion during the summer tradewind conditions. But the width of the nearshore during high tide conditions could concern the backshore.

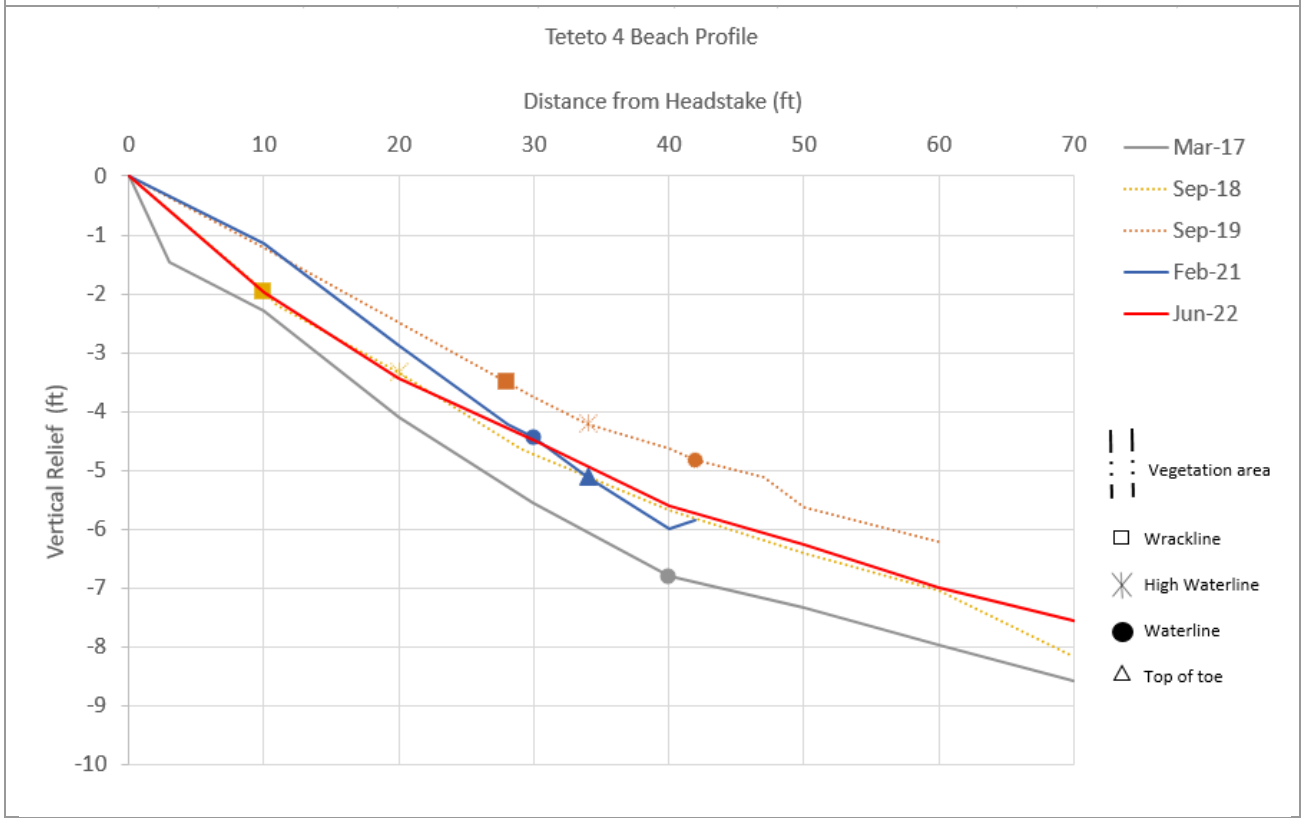


Picture not available for Sep-21. For **Teteto 4**, the berm is monitored but has seen loss and gain through the seasons. The winter tradewind condition seems to suggest erosion while the typhoon tradewind condition might bring sand. But the width of the nearshore during high tide conditions could concern the backshore.

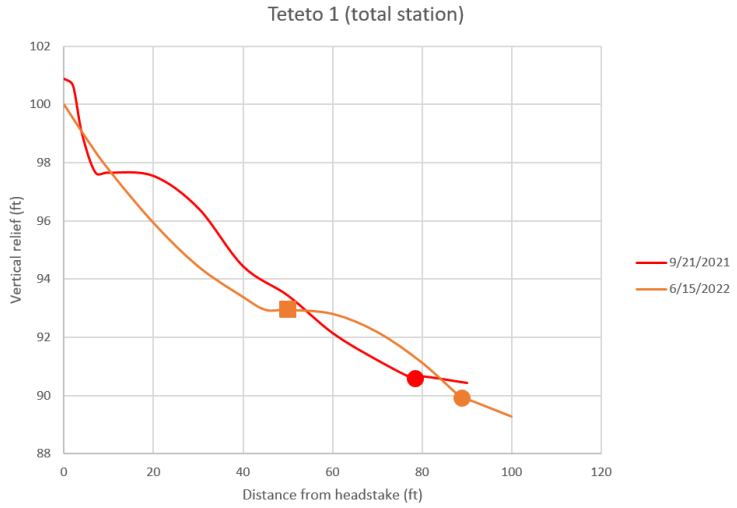
Teteto Beach Profiles – Berger Level

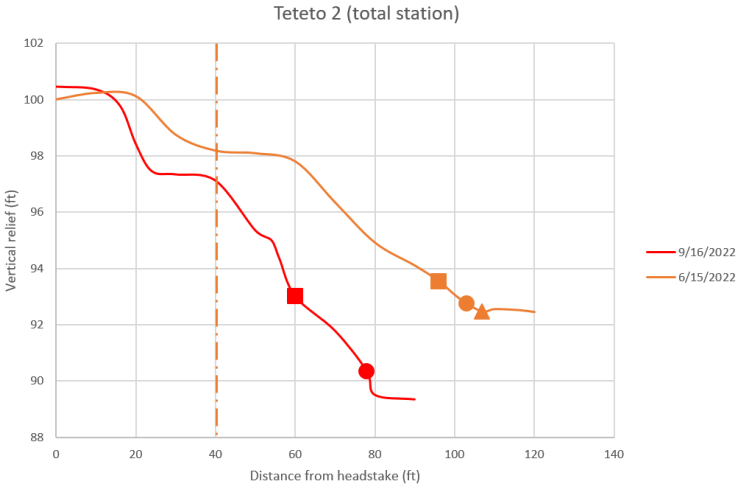


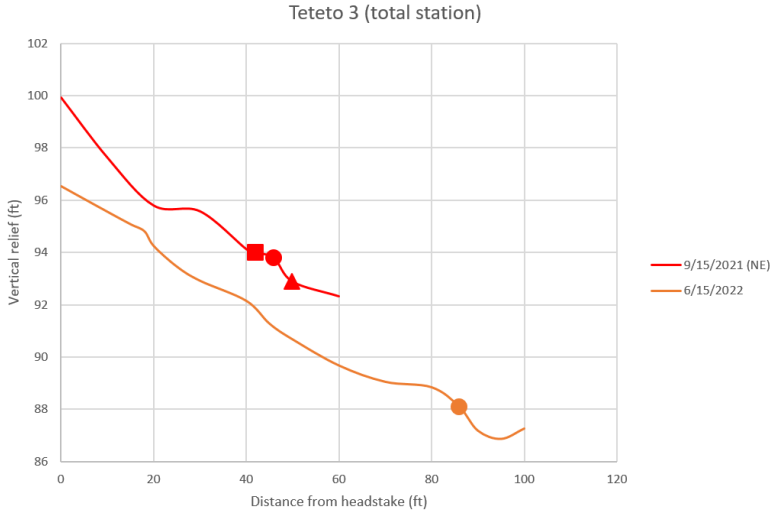

Teteto 3 Beach Profile
Distance from Headstake (ft)
0
20
40
60
80
100
120
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
-10
Vertical Relief (ft)
Mar-17
Sep-18
Sep-19
Feb-21
Sep-21
Jun-22
Vegetation area
Wrackline
High Waterline
Waterline
Top of toe


Teteto 4 Beach Profile
Distance from Headstake (ft)
0
10
20
30
40
50
60
70
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
-10
Vertical Relief (ft)
Mar-17
Sep-18
Sep-19
Feb-21
Jun-22
Vegetation area
Wrackline
High Waterline
Waterline
Top of toe

Teteto Beach Profiles – Total Station








Teteto 4
101
100
99
98
97
96
95
94
93
Vertical relief (ft)
0
10
20
30
40
50
60
70
80
90
100
Distance
6/15/2022

Guata

Guata is the most northern monitoring site in Rota and a neighboring beach park to Teteto. This beach has high backshore vegetation density and provides excellent habitat for shoreline plant and animal species. The reef is at close proximity to shoreline. Inland, there are also multiple picnic *palapalas*, a playground, restroom and shower facilities. The only road connecting Sasanlagu to the airport is adjacent to this park. Since the road lacks proper drainage, stormwater runoff may contribute to accelerated beach erosion. Projected 50 and 75-year sea level rise scenarios suggest that Guata will recede further.

Guata 1 Highlights:

- ACCRETING with a Wrackline that ranges 24 – 45 ft and an elevation difference of 6 ft

Guata 2 Highlights:

- ERODING with a Wrackline that ranges 30 – 50 ft with an elevation difference of 8 ft

Guata 3 Highlights:

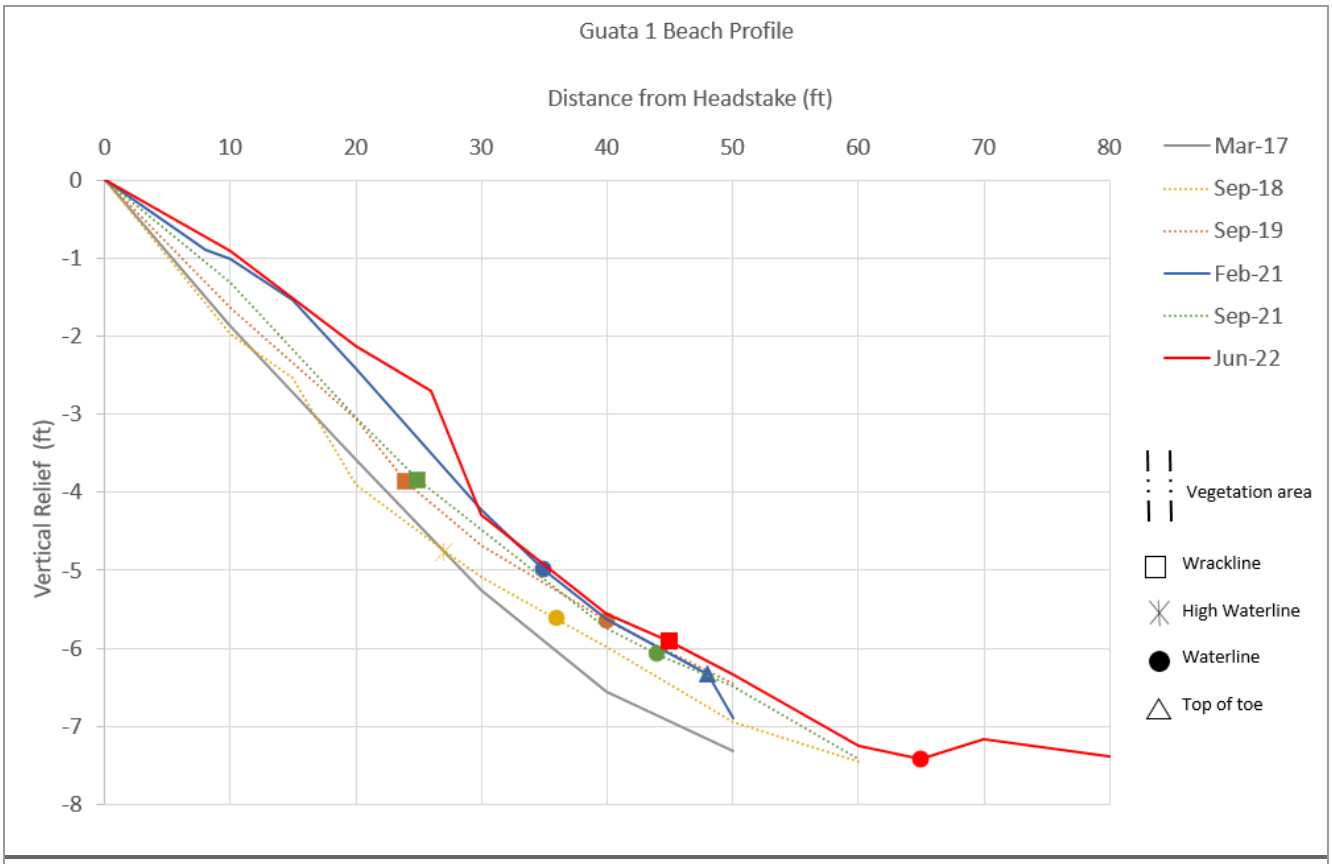
- ACCRETING with a Wrackline that ranges 23 – 44 ft with an elevation difference of 7 ft

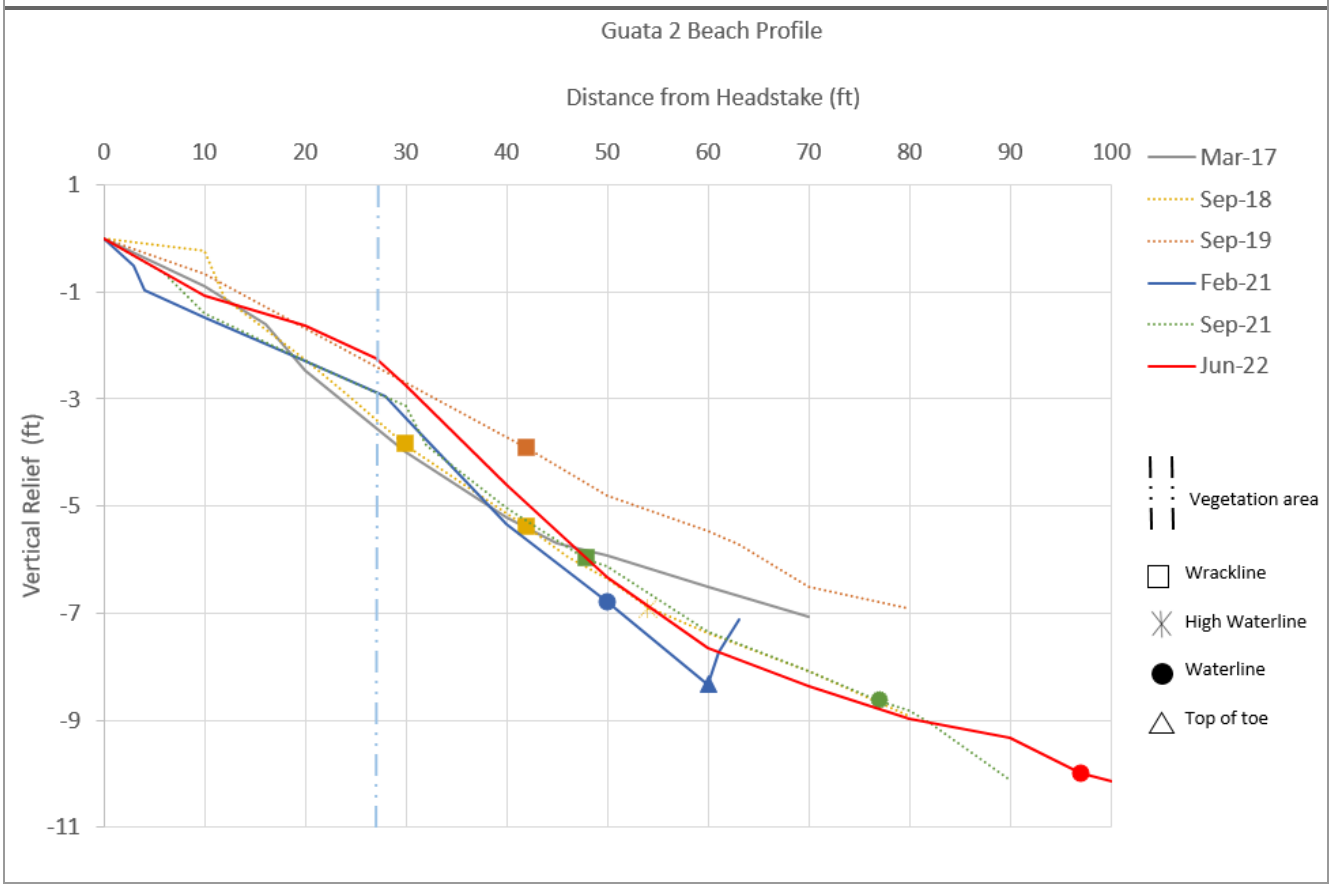
Picture not available for Sep-21. For **Guata 1**, the berm is monitored but has seen loss and gain through the seasons. The winter tradewind condition seems to erode the shoreline while the winter and summer tradewind condition might bring sand. The width of the nearshore during high tide conditions could concern the backshore.

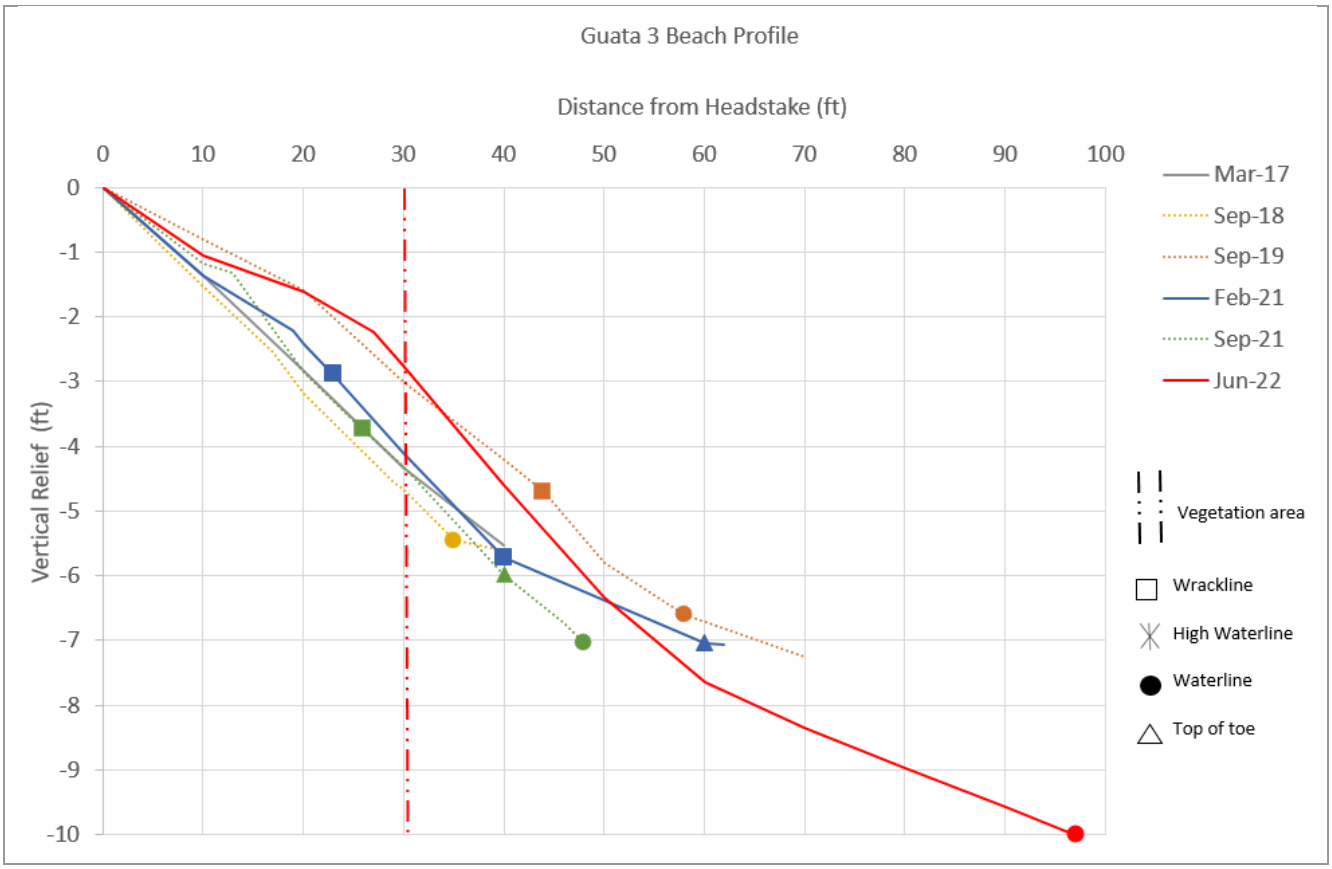
Picture not available for Sep-21. For **Guata 2**, the berm has been retreating over time, due to the reach of the wrackline. Sediment input may occur downslope.

For **Guata 3**, the berm may be increasing over time. Due to the reach of the wrackline, the nearshore width is limited.

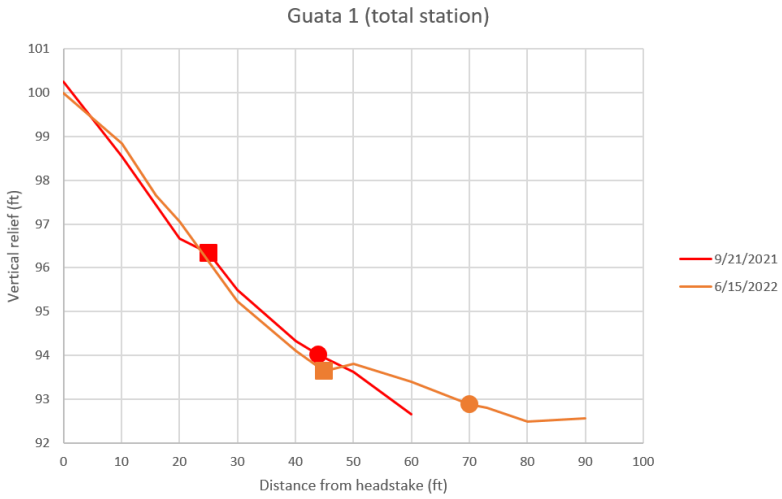
Guata Beach Profiles – Berger Level

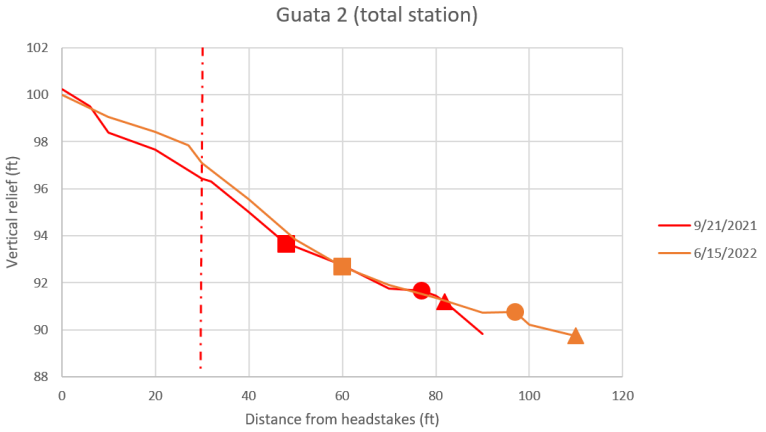


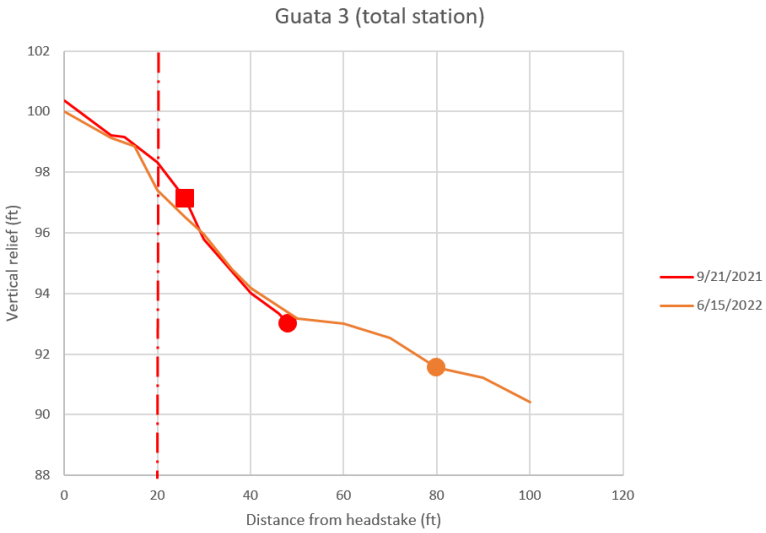




Guata Beach Profiles – Total Station




Guata 2 (total station)
Vertical relief (ft)
102
100
98
96
94
92
90
88
0
20
40
60
80
100
120
Distance from headstakes (ft)
9/21/2021
6/15/2022


Guata 3 (total station)
Vertical relief (ft)
102
100
98
96
94
92
90
88
0
20
40
60
80
100
120
Distance from headstake (ft)
9/21/2021
6/15/2022

Recommendations for Management

Shoreline Monitoring continues to improve in capturing seasonal conditions and data accuracy. DCRM site-specific shoreline set backs is still in progress. The previous report for August 2018 – February 2021 recommended the following, which still applies:

1. Continue to monitor for seasonal change and map any eroding berms with the use of the Trimble.
2. Maintain and increase current native tree cover in disturbed area.
3. Consider the potential of storm surge in shoreline management, as observed in the *Vulnerability Study for Tinian and Rota.* New regulation updates to the Shoreline and Coastal Hazards Area of Particular Concerns require development to evaluate their impacts using best available science.

Conclusion

The DCRM Shoreline Monitoring team has monitored Tinian and Rota headstakes twice this reporting cycle. 5 transects have exhibited erosion from longshore transport during this time while 3 appear to be accreting. Given the dynamic nature of shoreline morphology and sediment transport, there are 8 'stable' and 1 'undetermined.' These trends only reflect on beach profile contour interpretations. Tinian and Rota have notable fluctuations in sediment input and output, suggesting that sand sources have been replenishing some areas. However, the sea level rise and storm surge under a changing climate may exacerbate coastal processes and reduce dry beach width.

As the program approaches a decade, sea level rise may be more detectable with the decreasing distance of the recorded wrackline data.

The total station was deployed in Tinian and Rota. In the next reports, the program expects to integrate LiDAR for capturing sediment volumes pre- and post- storms.

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.

Other Resources

CNMI Bureau of Environmental and Coastal Quality –Division of Coastal Resources Management. (2015). Climate Vulnerability Assessment for the Islands of Rota and Tinian, Commonwealth of the Northern Mariana Islands. Prepared for the CNMI Division of Coastal Resources Management –CNMI Office of the Governor.

Cooper, N. J., Leggett, D. J., & Lowe, J. P. (2000). Beach-Profile Measurement, Theory and Analysis:Practical Guidance and Applied Case Studies. Water and Environment Journal, 14(2), 79-88.

Division of Coastal Resources Management., 2018. Shoreline Profile Monitoring Data Report., 2018., 77 p.

Sea Engineering, Inc., 2019. Hydrodynamic Study of Saipan's Western Lagoon, Prepared for Commonwealth of the Northern Mariana Islands, Bureau of Environmental Coastal Quality, Commonwealth of the Northern Mariana Islands, Saipan, 127 p.