

Delaware Annual Beach Change Report: Ocean Coast



Prepared by:

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Abbreviations:

Cubic Feet per Linear Foot (Volume per unit Length) – cf/lf

Delaware Department of Natural Resources and Environmental Control – DNREC

Global Positioning System – GPS

Long-Range Planning – LRP

Mean Higher High Water – MHHW

Mean Higher Water – MHW

Mean Low Water – MLW

Mean Lower Low Water – MLLW

NAVD – North American Vertical Datum

NOAA – National Oceanographic and Atmospheric Agency

Real Time Kinematics – RTK

United States Army Corp of Engineers – USACE

Definitions:

MHHW – The average elevation reached by the higher of the two daily high tides over a 19-year tidal epoch. The value is computed by and available from NOAA.

MHW – The average elevation reached by all the high tides over a 19-year tidal epoch. These elevations exclude any storm surge or non-tidal residuals caused by onshore winds.

MLW – The average elevation reached by all the low tides over a 19-year tidal epoch.

MHHW – The average elevation reached by the lowers of the two daily low tides over a 19-year tidal epoch.

Dune – Natural or man-made geological feature that is shoreward of the berm and is characterized by a steep slope to the highest elevations along the beach profile.

Berm – The relatively flat portion of the beach profile directly seaward of the dune that is typically above the MHHW elevation.

Foreshore Slope – The foreshore slope is the natural slope directly seaward of the berm that is caused by tides and up rushing waves.

Intertidal Zone – The portion of the foreshore slope and nearshore that is between the MHHW and MLLW elevations.

Nearshore – For the purposes of this report, the nearshore is considered to extend from the lower portions of the intertidal zone out beyond the surf zone where waves break but onshore of most boating traffic.

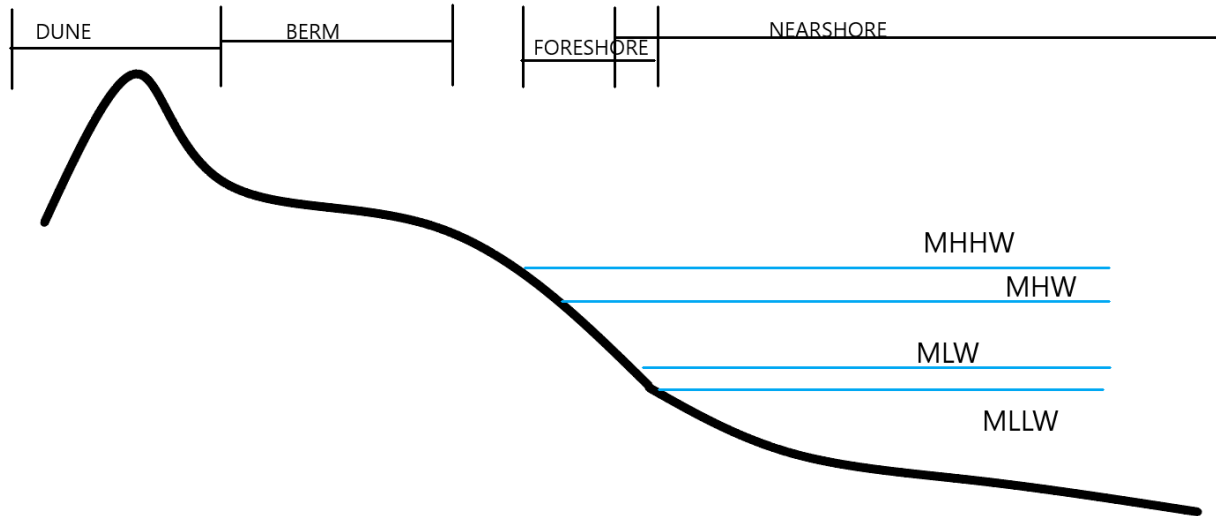


Figure 1: Beach profile definitions sketch

Introduction:

The Department of Natural Resources and Environmental Control (DNREC) envisions Delaware as a place where people embrace a commitment to the protection, enhancement, and enjoyment of the environment in their daily lives. The Shoreline and Waterway Management Section works to maintain and improve Delaware’s shoreline and waterways. The Section manages the shoreline through regulation of coastal construction activities and implementation of dune and beach management practices. It also works to protect and enhance eroded beaches to enable continued recreational use of this precious resource, and to improve the state’s ability to endure severe coastal storms with minimal damage to public and private property and infrastructure.

Each fall and spring, the Section’s survey crew measures the beach (berm, dune, and nearshore bathymetry). Bathymetry data are collected out to about a 30-foot depth. The crew measures 41 longitudinal range profiles (LRPs) or transects along the Atlantic Coast. These locations of these transects are shown in Figure 2. Comparisons between winter and summer surveys demonstrate how beaches recover naturally after winter storms. Comparison between summer surveys from year-to-year, demonstrate long term erosion or accretion trends along Delaware Beaches. These trends are used to inform beach management strategies including beach nourishment projects.



Service Layer Credits: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Figure 2: LRP location map

The purpose of this report is to share the results of these surveys. Survey data are paired with photographs of the beach at each survey location (Appendix A) so that the public may see the changes

in the beaches and dunes from season to season and from year to year. The quantities presented in the report are the average beach volumes which are defined as the area between a reference water level or contour and the crest of the primary frontal dune. (Figure 3) Unless otherwise specified, the reference water levels for the values presented in this report is Mean Lower Low Water (MLLW).

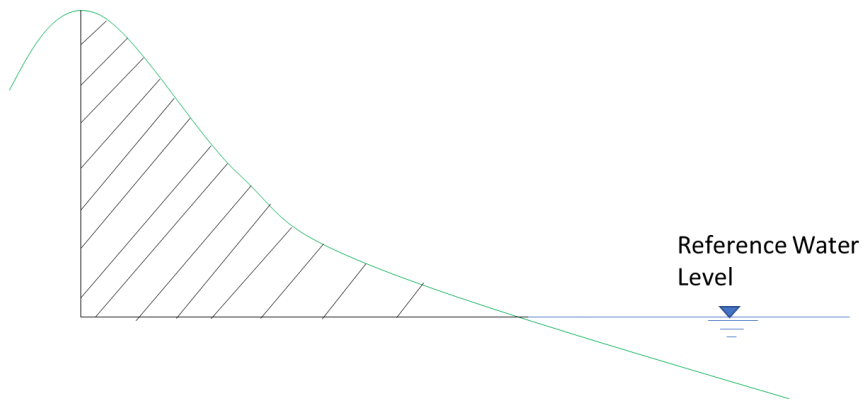


Figure 3: Sketch showing volume calculation

Geophysical setting of the Delaware Ocean Coast

For planning purposes, the ocean coast of Delaware is divided into two general sections, Ocean Coast North and Ocean Coast South by the Indian River Inlet, which falls between LRPs 54 and 55. The ocean coast extends from the point at Cape Henlopen State Park, to the north and to Fenwick Island/ the Maryland State Line to the south. Generally speaking, sand is transported along the coast from south to north along the ocean coast. The transported sand is interrupted by the jetty at the Indian River Inlet whereas sand transported along Ocean Coast North is interrupted by groynes and jetties or is ultimately deposited on Cape Henlopen. In addition to structures such as groynes and jetties, geological features such as ebb shoals may capture longshore transport.

Along the Delaware Ocean coastline, there are five sections or beaches that are regularly nourished through a funding partnership between the US Army Corp of Engineers (USACE) and DNREC. These beaches, from south to north, are Fenwick Island (LRP 66) South Bethany, Bethany (60A, 61), Dewey (47), and Rehoboth (44a-45). Though other sections of the coast are not directly nourished, it is likely that other beaches benefit from nourishment activity due to alongshore transport.

Description of 2020-2021 Season

Throughout the months of October and November, there were nor'easter storms or steady east winds, that impacted the Delaware Ocean coastline. These storms and east winds kept tides higher than average. Additionally, there were storm surge events. According to the measured water levels at the Lewes gage (Figure 44), the tides were at least 0.5' higher than predicted throughout most of October and November. Higher water levels tend to induce erosion of beaches and dunes which is correlated to the duration, water level, and wave power associated with each event.

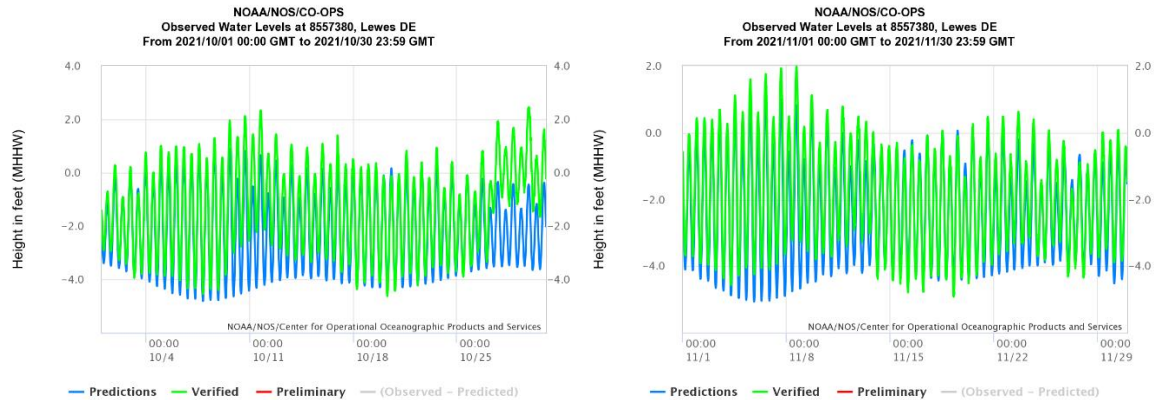


Figure 4: Measured (green) vs. Predicted (blue) water levels at Lewes Beach.

In addition to these nor'easters, there was a low pressure system that caused storm surge and flooding in Sussex county at the end of May 2021. According to NOAA's National Centers for Environmental Information (NCEI) storm event database, there were a total of four coastal flood events along Delaware Ocean beaches in 2021 in addition to one during October 2020. Three of the four flood events during 2021 occurred within October and November.

Fenwick Island

Fenwick Island is densely populated from the Delaware and Maryland state line to about 1 mile north of this boundary. North from this location, the coastline is sparsely populated and includes Fenwick Island State Park. There are five survey lines spaced roughly 5,000' feet apart along the section of coastline as shown in Figure 5. Within Fenwick Island, there is a federal nourishment project that aims to protect the developed portion of the shoreline.



Figure 5: LRP location map for Fenwick Island

Fenwick Island Volumes:

The average beach volumes of Fenwick Island are as shown in Table 1. On average, the beach accreted season to season from Summer 2020 to Summer 2021. The beach then eroded slightly over the autumn of 2021 (between Summer 2021 and Winter 2022). This erosion may be a result of the stormy conditions occurring during the autumn of 2021.

Table 1: Average beach volumes for Fenwick Island

Season	Volume (cf/lf)
Summer 2020 (06/15/2020)	3100
Summer 2021 (08/18/2021)	3600
Winter 2021 (01/21/2021)	3280
Winter 2022 (01/04/2022)	3480

A representative seasonal profile view for Fenwick Island is shown in Figure 6. For each beach, one profile view is shown in the body of the report with the remaining plots residing in Appendix B.

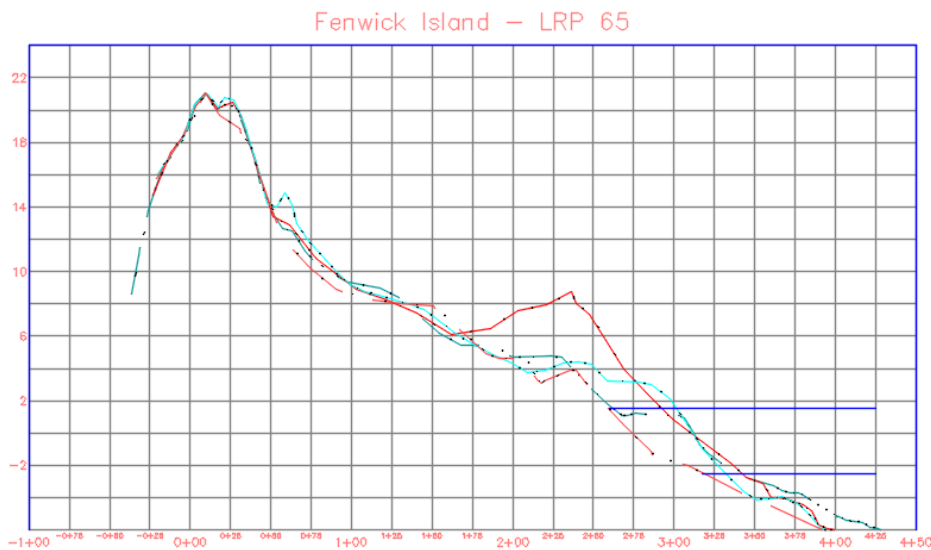


Figure 6: Representative profile in Fenwick Island. The plots are as follows: Summer 2020 (dashed red); Summer 2021 (solid red); Winter 2021 (dashed cyan); Winter 2022 (dashed dark grey). The blue lines represent the tide levels with the higher line being MHHW and the lower line being MLLW.

South Bethany

South Bethany extends from Fenwick Island State Park roughly 4,000' north and is densely populated along the coast. South Bethany contains two survey lines separated by roughly 2,000' as shown in Figure 7.

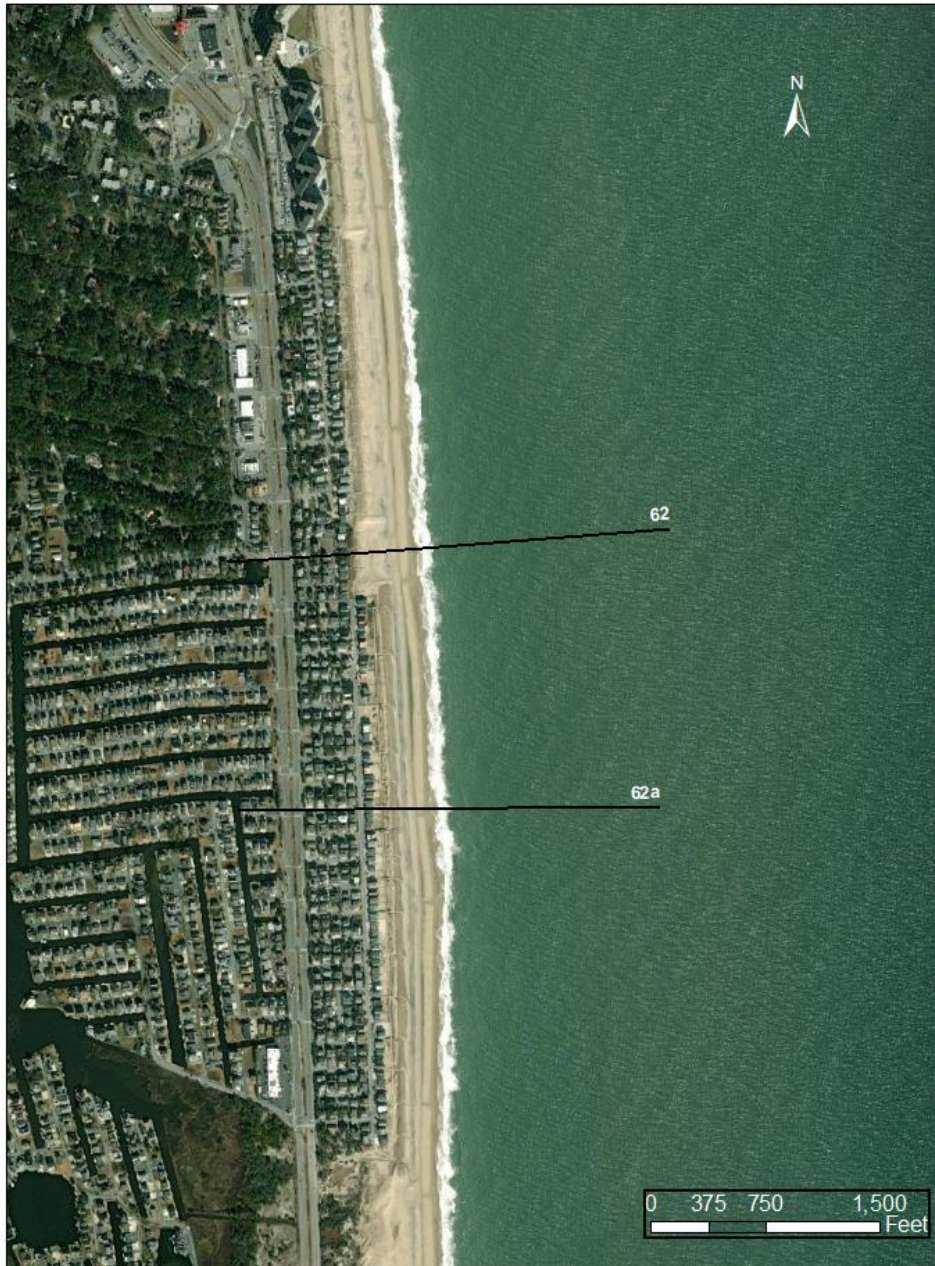


Figure 7: LRP location map for South Bethany

South Bethany Volumes:

The average beach volumes of South Bethany Beach are as shown in Table 2. Since summer of 2020, the beach has accreted, on average. During the autumn of 2021, the beach along South Bethany eroded substantially. The retreat of the beach during this time period is evident in the profile comparison in Figure 8.

Table 2: Average beach volumes in South Bethany

Season	Volume (cf/lf)
Summer 2020 (06/01/2020)	2850
Summer 2021 (10/07/2021)	3560
Winter 2021 (03/03/2021)	3250
Winter 2022 (02/21/2022)	3050

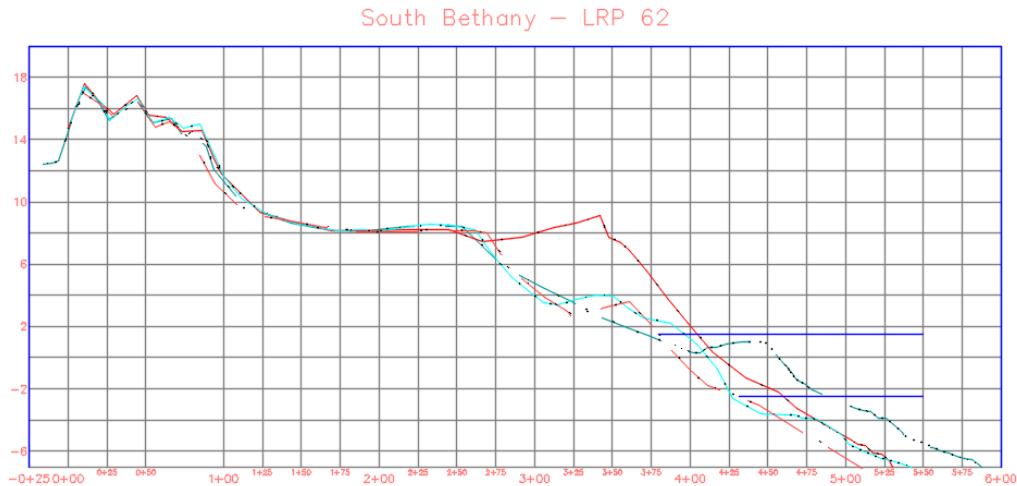


Figure 8: Representative Profile in South Bethany: The plots are as follows: Summer 2020 (dashed red); Summer 2021 (solid red); Winter 2021 (dashed cyan); Winter 2022 (dashed dark grey). The blue lines represent the tide levels with the higher line being MHHW and the lower line being MLLW.

Bethany Beach

Bethany Beach extends from Middlesex Beach to a series of private beaches that separate Bethany Beach and State-owned beaches. Bethany Beach contains five lines along the densely populated coast as shown in Figure 9. LRP 59 to 61 are spaced roughly 1000' – 1500' apart whereas LRP 58 is roughly 1 mile north of LRP 59 and is within a private community.

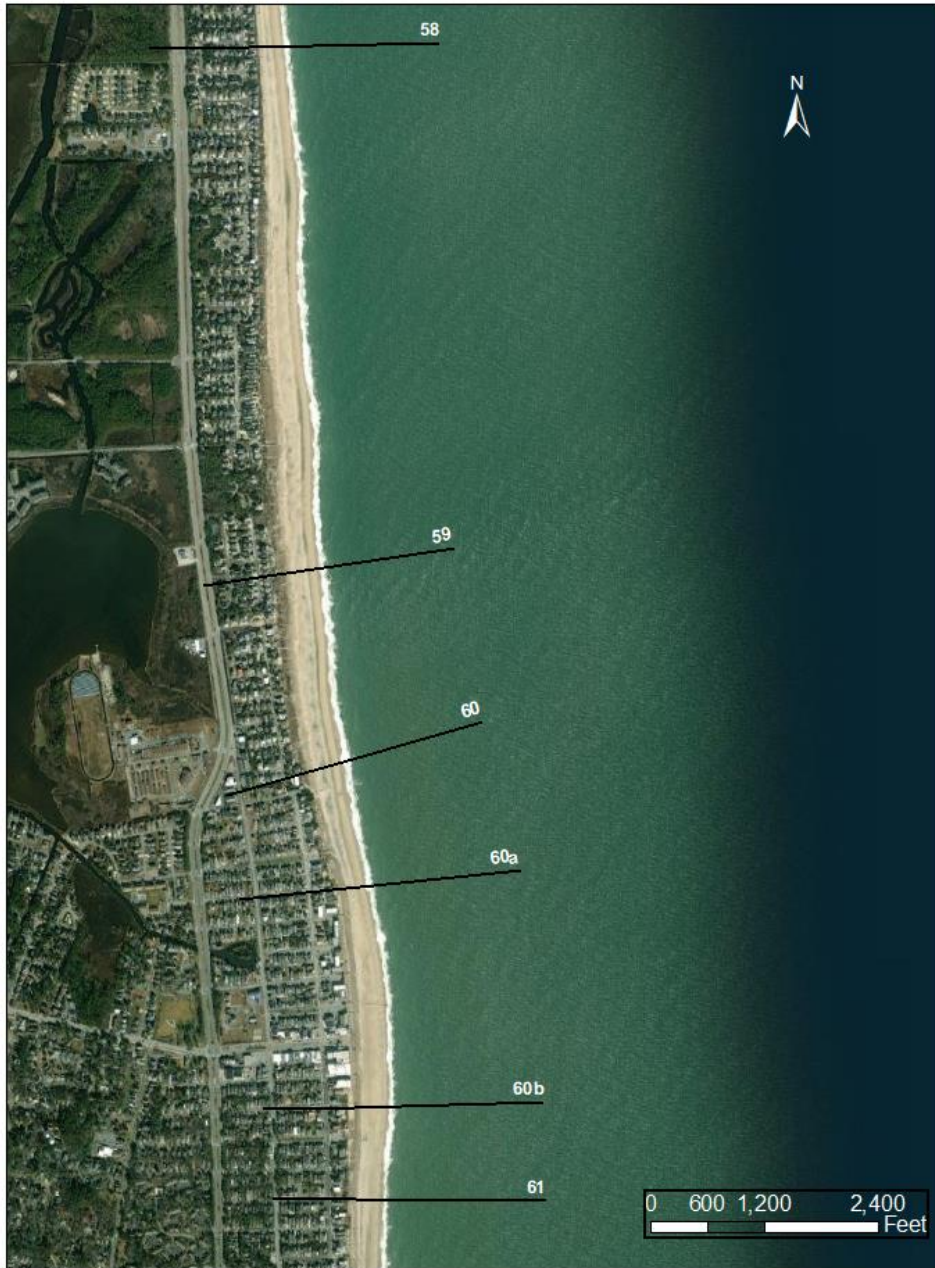


Figure 9: LRP location map for Bethany Beach

Bethany Beach Volumes:

Since the Summer 2020 season, the beach within the Town of Bethany Beach has accreted. The beach was most voluminous in Summer 2021 but was substantially eroded over the course of autumn 2021. During the Summer of 2021, a large mound of sand accreted on the berm in Bethany. This growth and subsequent erosion accounts for the large volume in that season and the lesser volume in the following Winter. The changes in the beach profile is evident in the profile comparison at LRP 60 as shown in Figure 10.

Table 3: Average beach volumes in the Town of Bethany Beach

Season	Volume (cf/lf)
Summer 2020 (06/01/2020)	2660
Summer 2021 (10/07/2021)	3320
Winter 2021 (03/03/2021)	3170
Winter 2022 (02/21/2022)	3010

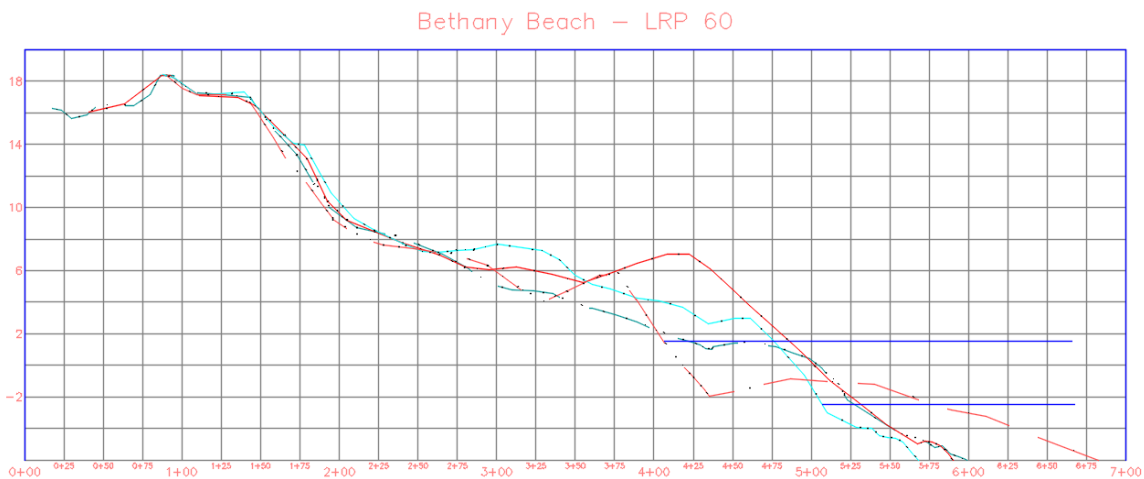


Figure 10: Bethany Beach: The plots are as follows: Summer 2020 (dashed red); Summer 2021 (solid red); Winter 2021 (dashed cyan); Winter 2022 (dashed dark grey). The blue lines represent the tide levels with the higher line being MHHW and the lower line being MLLW

Oceanview

North of Bethany is Oceanview which contains a series of private communities including Sussex Shores and Ocean Village. There is only one survey line in this section of beach which is densely populated with private communities at the location shown in Figure 11. This is the northernmost developed shoreline community south of the Indian River Inlet.

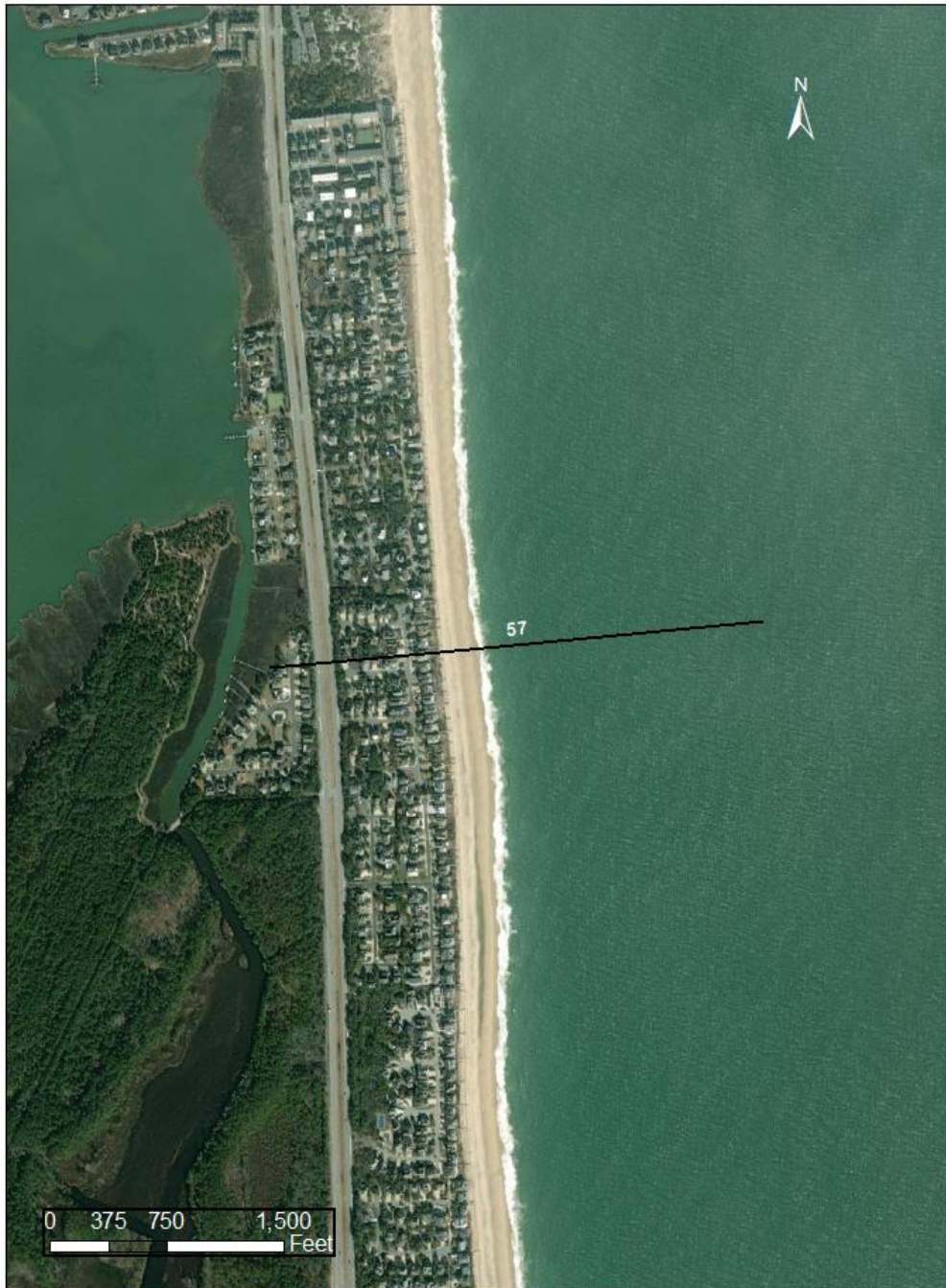


Figure 11: LRP location in Oceanview

Oceanview Volumes:

Since the Summer of 2020, beach along Oceanview accreted 140 cf/lf, on average. The beach accreted substantially (340 cf/lf) during the late winter and early summer of 2021. The accretion is evident in the profile comparison shown in Figure 12.

Table 4: Average beach volumes in Oceanview

Season	Volume (cf/lf)
Summer 2020 (06/01/2020)	1860
Summer 2021 (10/07/2021)	2160
Winter 2021 (03/03/2021)	1820
Winter 2022 (02/21/2022)	1990

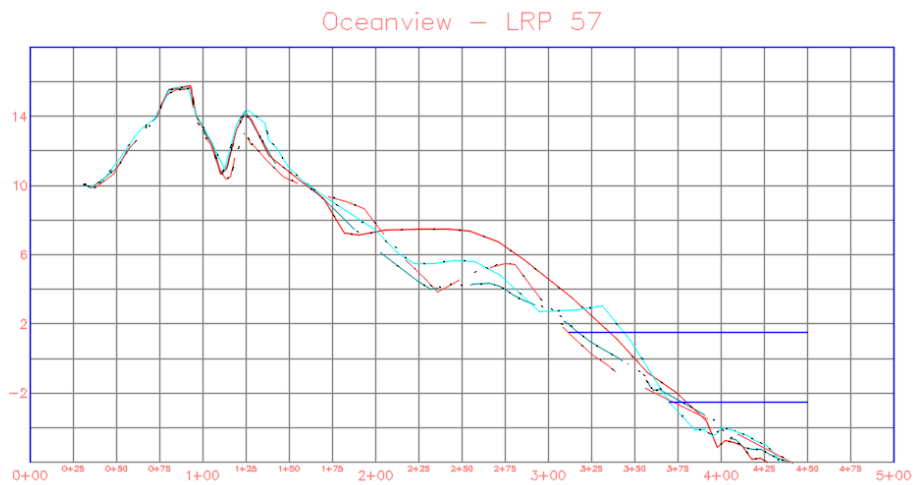


Figure 12: Oceanview: The plots are as follows: Summer 2020 (dashed red); Summer 2021 (solid red); Winter 2021 (dashed cyan); Winter 2022 (dashed dark grey). The blue lines represent the tide levels with the higher line being MHHW and the lower line being MLLW

South Seashore State Parks

The Delaware Seashore State Park south of the Indian River Inlet which consists of 3R's and Southside Indian River day beach has two survey lines. LRP 55 is directly adjacent to the jetty and LRP 56 is about half a mile south of the inlet and runs through the LRP 3R's parking lot as shown in the Figure 13.

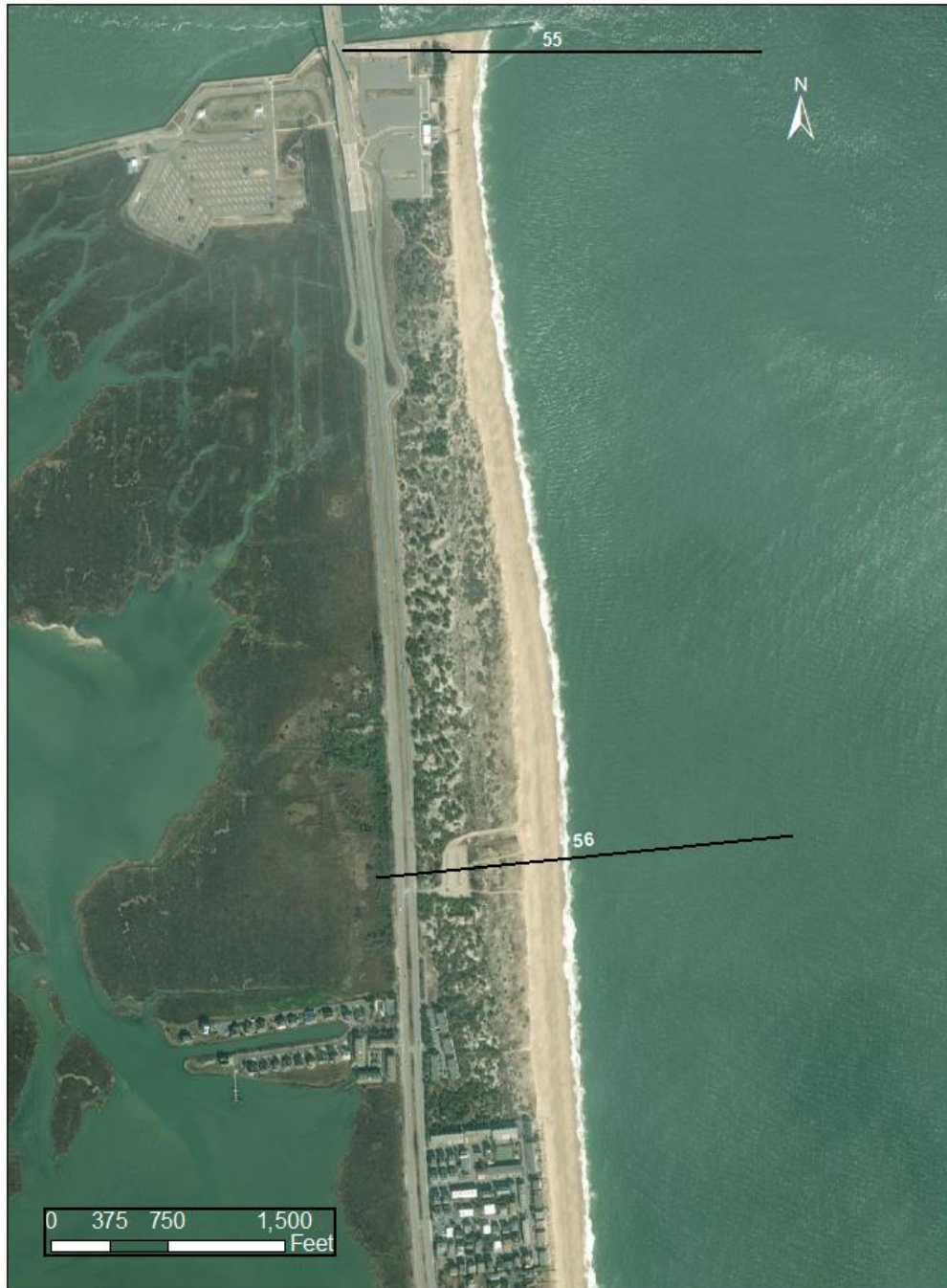


Figure 13: LRP location in Southside Indian River Inlet

South Seashore State Parks Volumes:

Since the Summer of 2020, the beaches at Southside Indian River Inlet and 3R’s state beaches have accreted, on average, by about 45% or 570 cf/lf. The beach accreted from season to season until the period between Summer 2021 and Winter 2022, when the beach eroded 340 cf/lf. In the profile comparison at LRP 56 (Figure 14), the accretion of the beach since 2020 is very apparent.

Table 5: Average beach volume in the southern Seashore State Parks

Season	Volume (cf/lf)
Summer 2020 (06/01/2020)	1300
Summer 2021 (10/07/2021)	2210
Winter 2021 (03/03/2021)	1740
Winter 2022 (02/21/2022)	1870

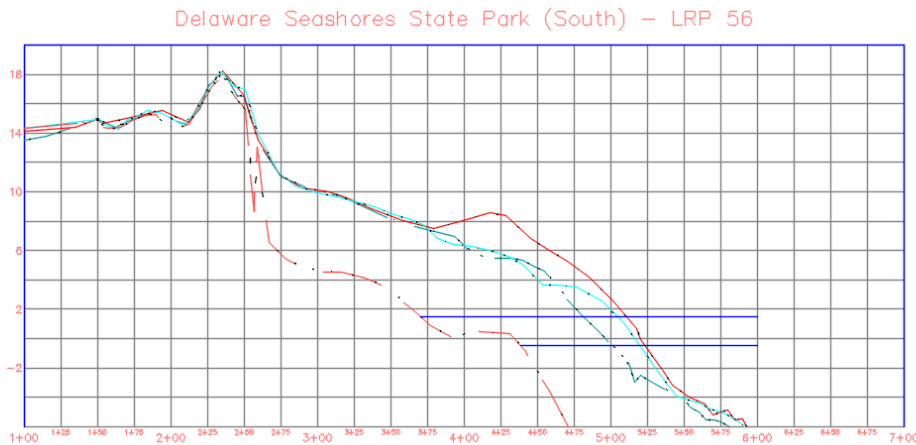


Figure 14: DSSP South: The plots are as follows: Summer 2020 (dashed red); Summer 2021 (solid red); Winter 2021 (dashed cyan); Winter 2022 (dashed dark grey). The blue lines represent the tide levels with the higher line being MHHW and the lower line being MLLW

North Seashore State Parks

Northside of Indian River Inlet contains nearly five miles of state-owned beaches from Tower Road at the north end to the inlet at the south end. Within this five-mile stretch, there are seven survey lines that are evenly spaced, save for the two that are closet to the inlet as shown in Figure 15.



Figure 15: LRP location map in northshores of Delaware Seashore State Parks

Since Summer 2020, the beaches north of the Indian River Inlet accreted nearly 25% or 450 cf/lf, on average. Oddly, the beach appears to have eroded in the summer and accreted in the winter (Table 6 and Figure 16), which is counter to the general theory of seasonal shoreline change.

Table 6: Average beach volumes in northern Delaware Seashore State Parks.

Season	Volume (cf/lf)
Summer 2020 (06/01/2020)	2170
Summer 2021 (10/07/2021)	2410
Winter 2021 (03/03/2021)	2660
Winter 2022 (02/21/2022)	2620

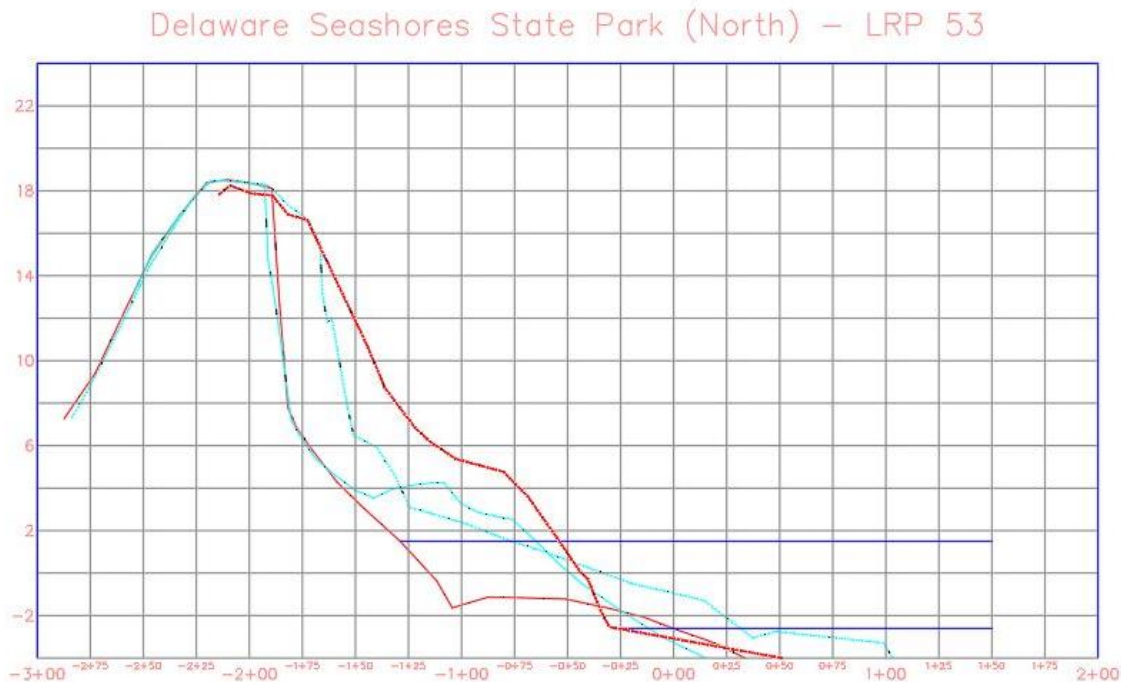


Figure 16: DSSP North: The plots are as follows: Summer 2020 (dashed red); Summer 2021 (solid red); Winter 2021 (dashed cyan); Winter 2022 (dashed dark grey). The blue lines represent the tide levels with the higher line being MHHW and the lower line being MLLW

Dewey Beach

North of Indian River, Dewey Beach extends roughly 7,500' northward to Silver Lake Shores, which separates Dewey and Rehoboth Beaches. Dewey is densely populated and consists of only one survey line located near the southern town limit. Silver Lake Shores also includes one survey line as shown in Figure 17.

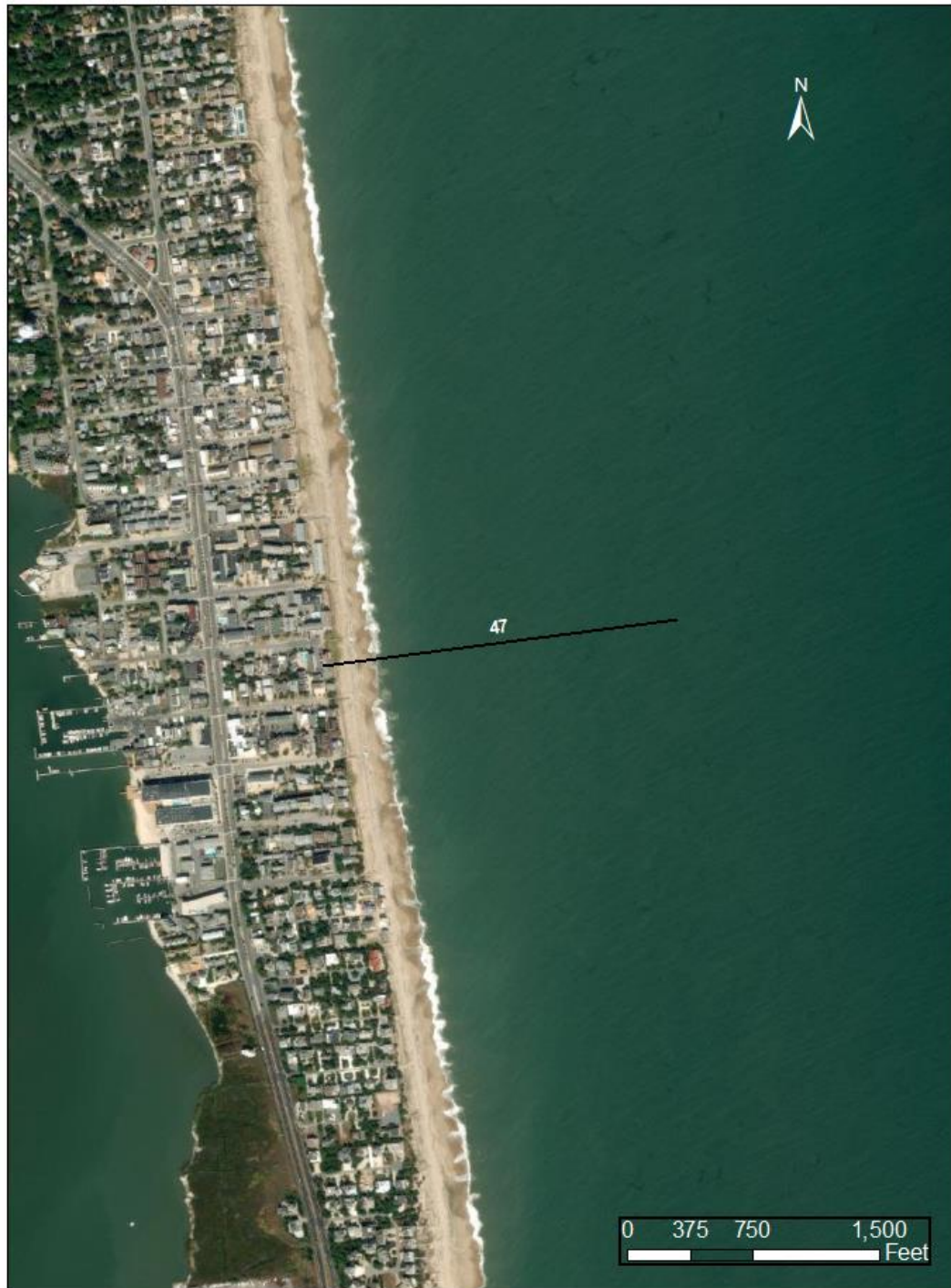


Figure 17: LRP location in Dewey Beach

Since the Summer of 2020, the beach in Dewey has eroded by about 90 cf/lf. There appears to have been accretion between Summer 2020 and Winter 2021 with erosion occurring each season since

Winter 2021. In Figure18, it is apparent that the berm grew over summer months and retreated during the winter months.

Table 7: Average beach volumes in Dewey Beach

Season	Volume (cf/lf)
Summer 2020 (06/01/2020)	1910
Summer 2021 (10/07/2021)	1970
Winter 2021 (03/03/2021)	1990
Winter 2022 (02/21/2022)	1820

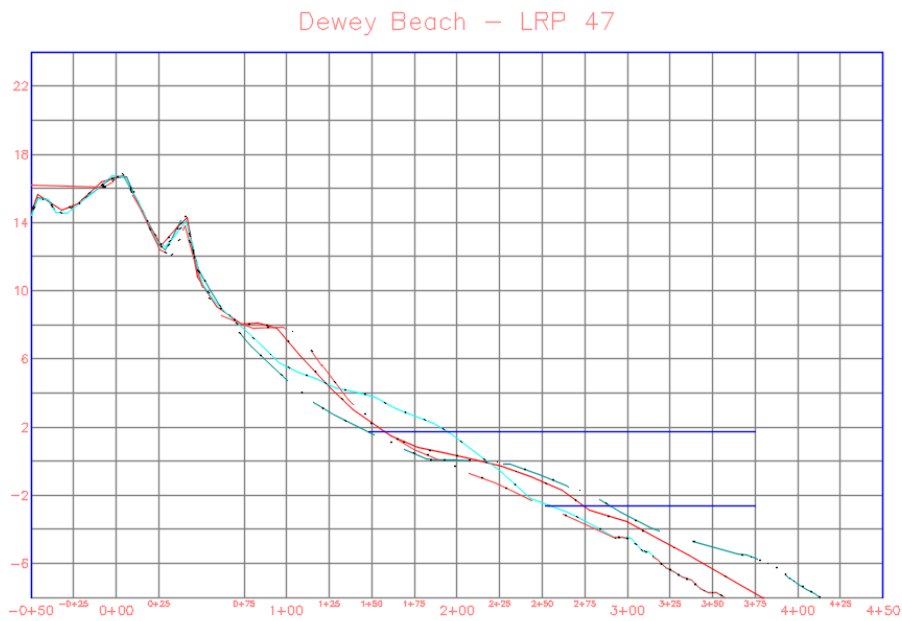


Figure 18: Dewey Beach: The plots are as follows: Summer 2020 (dashed red); Summer 2021 (solid red); Winter 2021 (dashed cyan); Winter 2022 (dashed dark grey). The blue lines represent the tide levels with the higher line being MHHW and the lower line being MLLW

Rehoboth Beach

North of Silver Lake Shores is the town of Rehoboth Beach, which is approximately 8,500' long. Rehoboth is densely populated and includes four profiles as shown in Figure 19. Directly north of Rehoboth Beach is Henlopen Acres.



Figure 19: LRP location map in Rehoboth Beach

Since the Summer of 2020, the beach at Rehoboth has accreted by roughly 100 cf/lf with the seasonal beach change trends matching that of Dewey Beach.

Table 8: Average beach volumes in Rehoboth Beach.

Season	Volume (cf/lf)
Summer 2020 (06/01/2020)	2110
Summer 2021 (10/07/2021)	2270
Winter 2021 (03/03/2021)	2340
Winter 2022 (02/21/2022)	2210

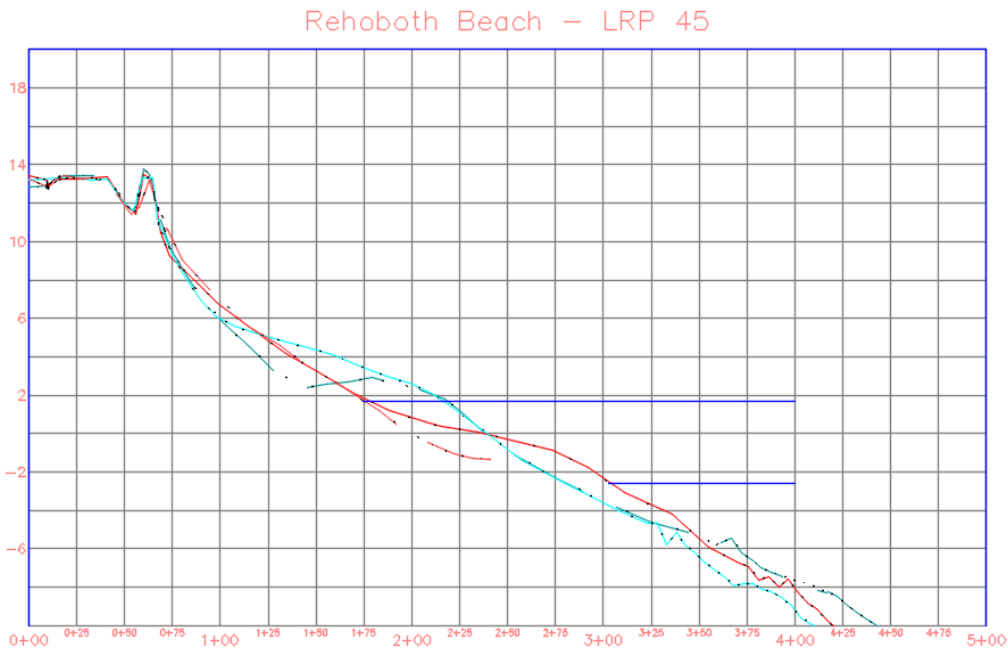


Figure 20: Rehoboth Beach: The plots are as follows: Summer 2020 (dashed red); Summer 2021 (solid red); Winter 2021 (dashed cyan); Winter 2022 (dashed dark grey). The blue lines represent the tide levels with the higher line being MHHW and the lower line being MLLW

Gordons Pond

North of Henlopen Acres, which contains one profile line, is North Shores and Gordon Pond State Beach. This section of coast includes three profile lines.



Figure 21: LRP location in Gordon's Pond State Beach

It is noteworthy that the surveys at Gordon's Pond did not extend out beyond MLLW for all seasons. Because of this, the profile volume was computed between the dune crest and the MHHW line. Therefore, the change in the intertidal zone is not accounted for. Nevertheless, the beach nearly

doubled in volume since Summer of 2020 with the seasonal change being the opposite of what is expected.

Table 9: Average beach volumes along Gordons Pond State Beach

Season	Volume (cf/lf)
Summer 2020 (06/01/2020)	170
Summer 2021 (10/07/2021)	150
Winter 2021 (03/03/2021)	340
Winter 2022 (02/21/2022)	320

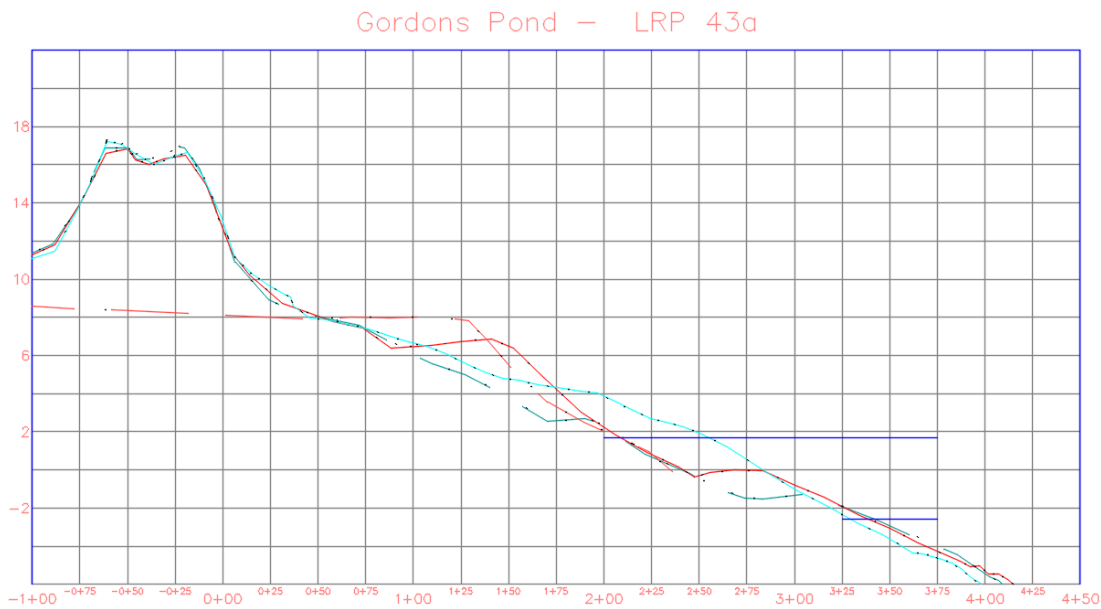


Figure 22: Gordons Pond: The plots are as follows: Summer 2020 (dashed red); Summer 2021 (solid red); Winter 2021 (dashed cyan); Winter 2022 (dashed dark grey). The blue lines represent the tide levels with the higher line being MHHW and the lower line being MLLW

Cape Henlopen – Herring Point

Cape Henlopen State Park is the northernmost section of beach along Delaware’s ocean coast. Herring Point is at the southern end of the park and is characterized by the large naval jetty. There are five LRP lines in Herring Point as shown in Figure 23.



Figure 23: LRP location map in Cape Henlopen State Park at Herring Point

On average, the beach at Herring Point in Cape Henlopen State Park accreted between Summer 2020 and Winter 2021 when it began eroding until the current season. The profiles align, roughly, above the 7' contour and most of the profile change was of the beach berm out to the intertidal zone. This suggests that Herring Point was not impacted by a strong storm surge in recent years.

Table 10: Average beach volumes at Herring Point in Cape Henlopen State Park

Season	Volume (cf/lf)
Summer 2020 (06/01/2020)	990
Summer 2021 (10/07/2021)	980
Winter 2021 (03/03/2021)	1040
Winter 2022 (02/21/2022)	930

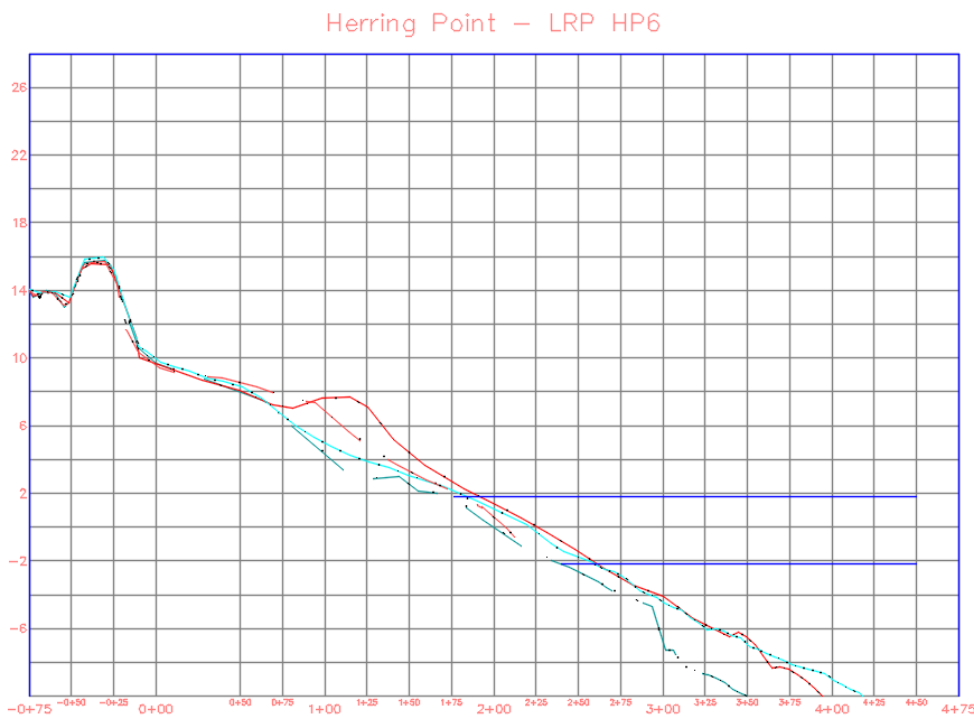


Figure 24: Herring Point: The plots are as follows: Summer 2020 (dashed red); Summer 2021 (solid red); Winter 2021 (dashed cyan); Winter 2022 (dashed dark grey). The blue lines represent the tide levels with the higher line being MHHW and the lower line being MLLW

Cape Henlopen

The main day-use area is north of Herring Point in Cape Henlopen State Park. This portion of the park contains four survey lines; the two northernmost lines on the spit are sometimes inaccessible due to closures for piping plover nesting.



Figure 25: LRP location in the northern portion of Cape Henlopen State Park

Cape Henlopen Volumes:

The average beach volumes of the northern section of Cape Henlopen are as shown in Table x. Data were not available for all four seasons at the northernmost transects (LRP 37 and LRP 38) due to beach

closures. The average volumes are from LRP 39 and LRP 40. On average the beach has eroded since Summer of 2020. However, there is alongshore variability in the beach change rate in the section of the park as LRP 39 has accreted by about 200 cf/lf while LRP 40 has eroded about 600 cf/lf.

Table 11: Average beach volumes in the main day-use area of Cape Henlopen State Park

Season	Volume (cf/lf)
Summer 2020 (06/01/2020)	2940
Summer 2021 (10/07/2021)	2725
Winter 2021 (03/03/2021)	2925
Winter 2022 (02/21/2022)	2750

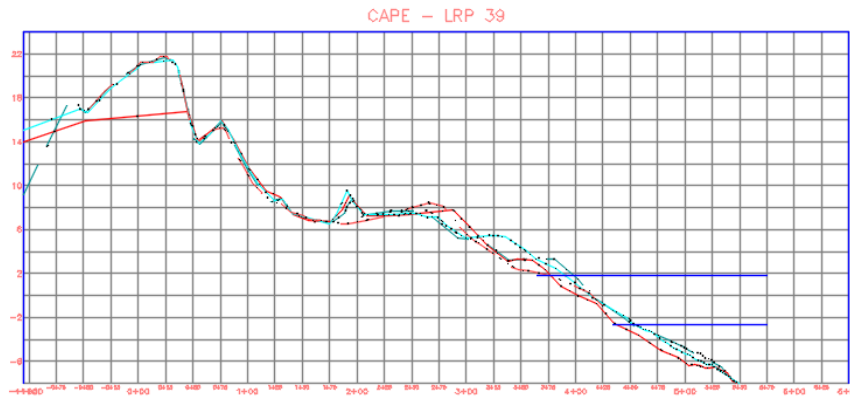


Figure 26: Cape Henlopen: The plots are as follows: Summer 2020 (dashed red); Summer 2021 (solid red); Winter 2021 (dashed cyan); Winter 2022 (dashed dark grey). The blue lines represent the tide levels with the higher line being MHHW and the lower line being MLLW

A – Drone Imagery

Cape Henlopen

LRP38:



LRP39:





LRP40:



Cape Henlopen – Herring Point

LRP41:



LRP HP1:



LRP HP6:



LRP HP10:



LRP 42:



Gordon's Pond
LRP 43A:



LRP 44:



Rehoboth Beach

LRP 44A:



LRP 44B:



LRP 45:



LRP 45A:



LRP 46:



Dewey Beach

LRP 47:



North Seashore State Parks

LRP 48:



LRP 49:



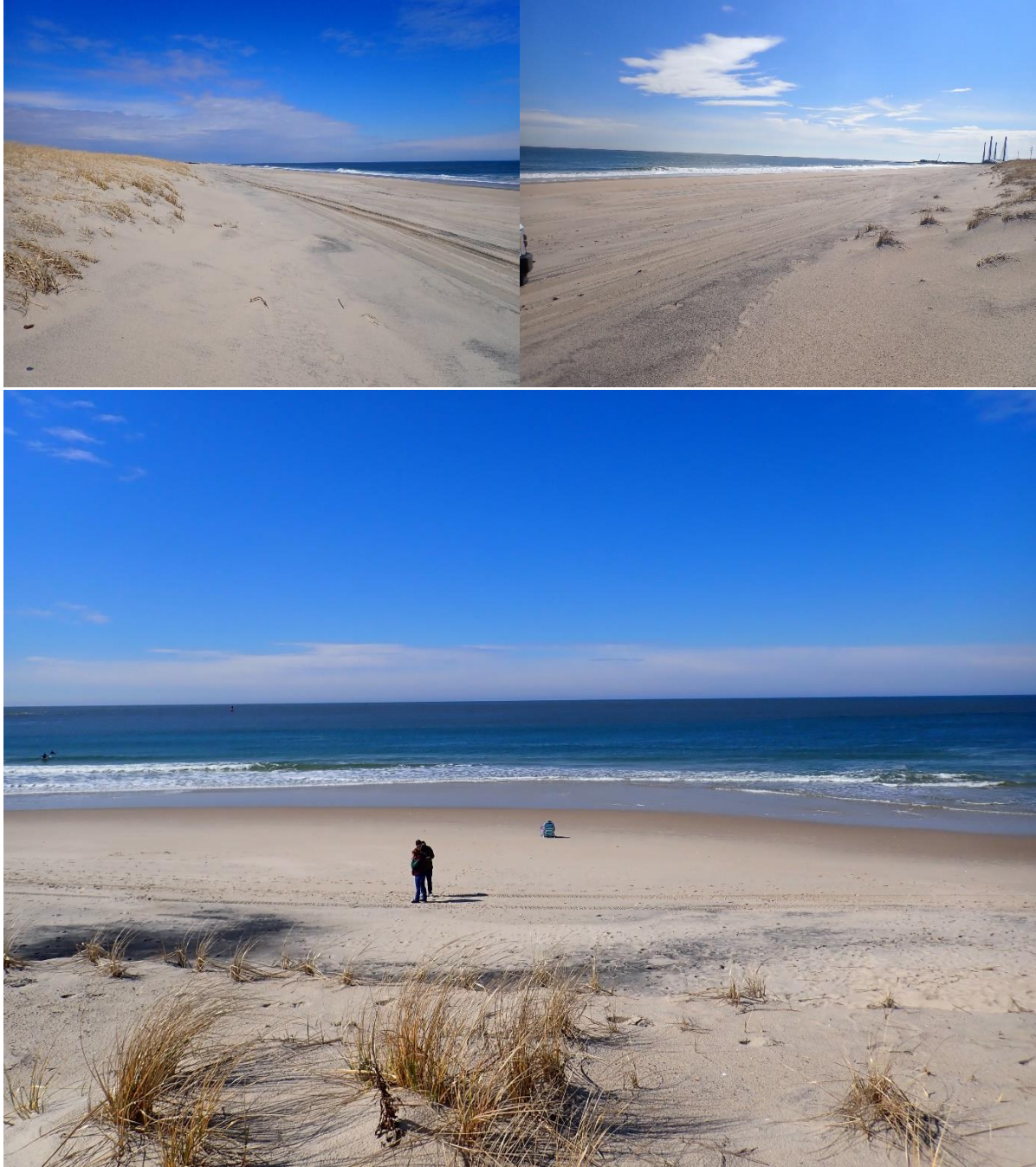
LRP50:



LRP51



LRP52



LRP 53:



LRP 54:



South Seashore State Parks
LRP55:



LRP 56:





Oceanview

LRP 57:





Bethany Beach

LRP 58:





LRP 59:





LRP 60:





LRP 60a:





LRP 60b:





LRP 61:





South Bethany

LRP 62:



Fenwick Island

LRP 63:



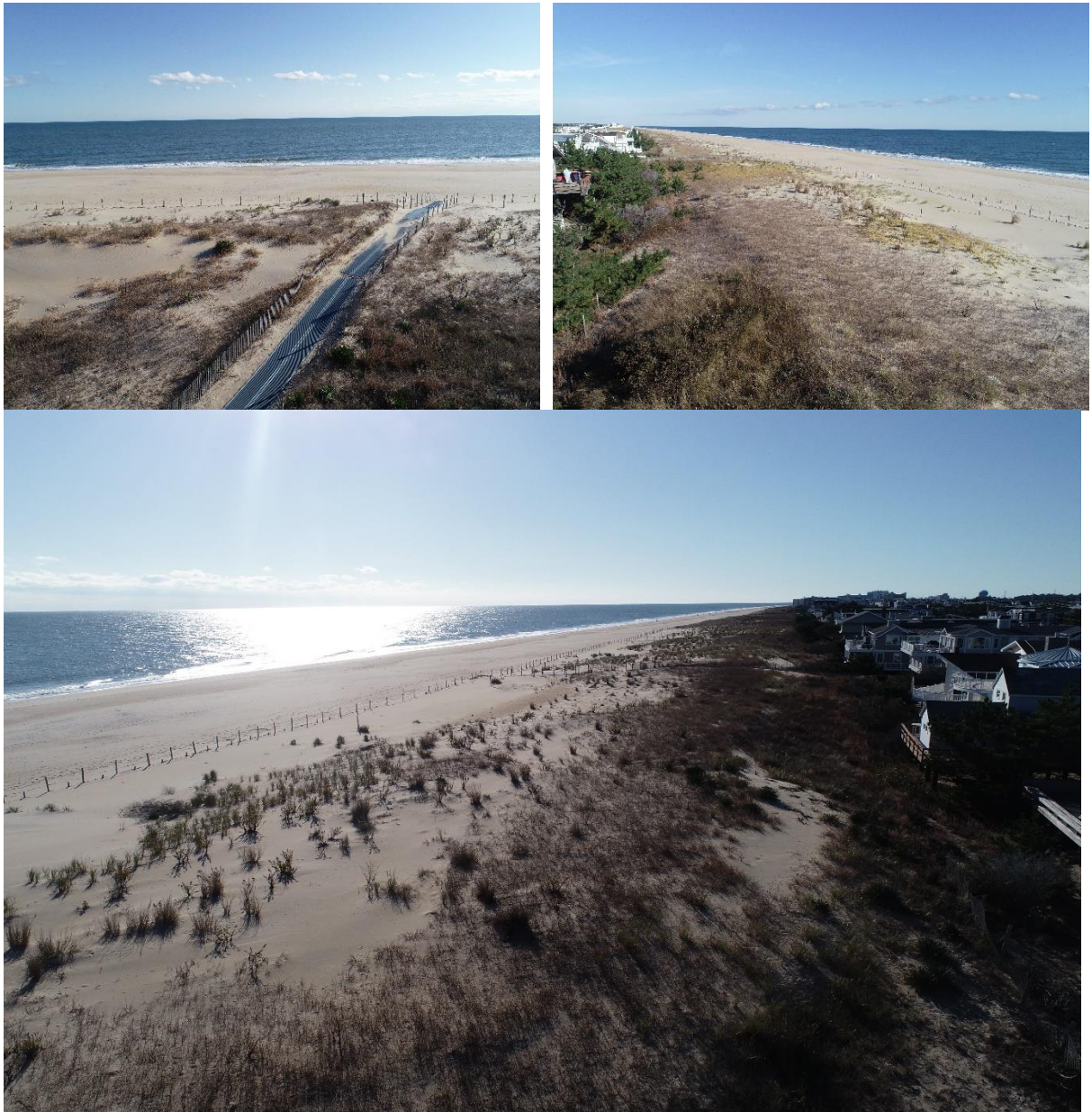
LRP 64:



LRP65:



LRP66:

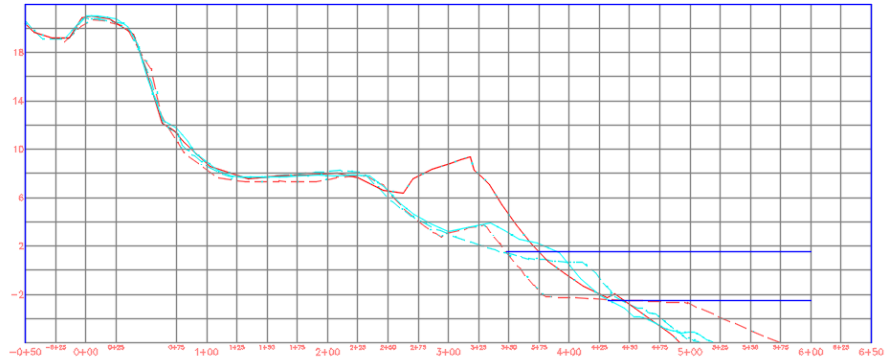


LRP67:

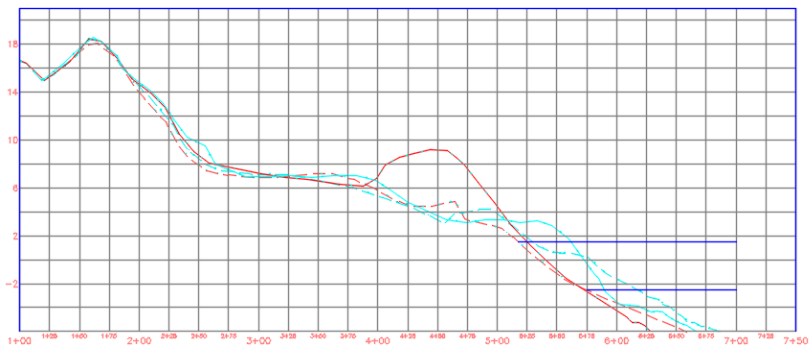


Appendix B:
Fenwick Island:

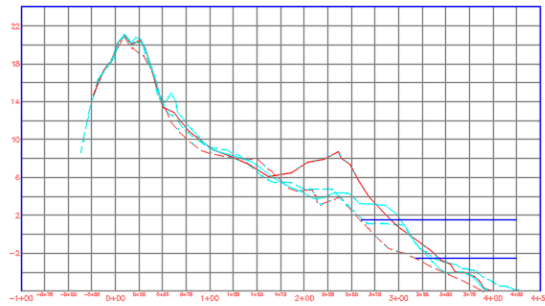
Fenwick Island - LRP 63

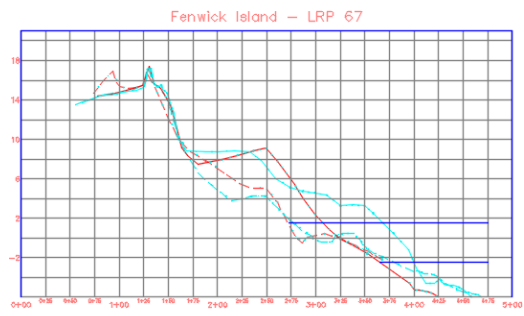
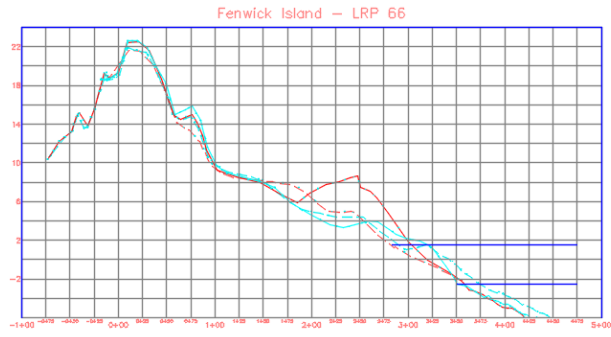


Fenwick Island - LRP 64

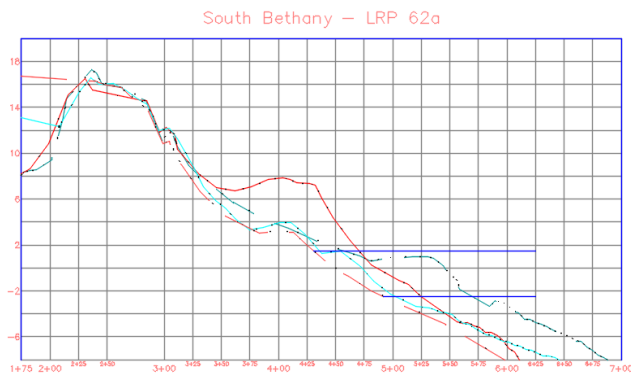
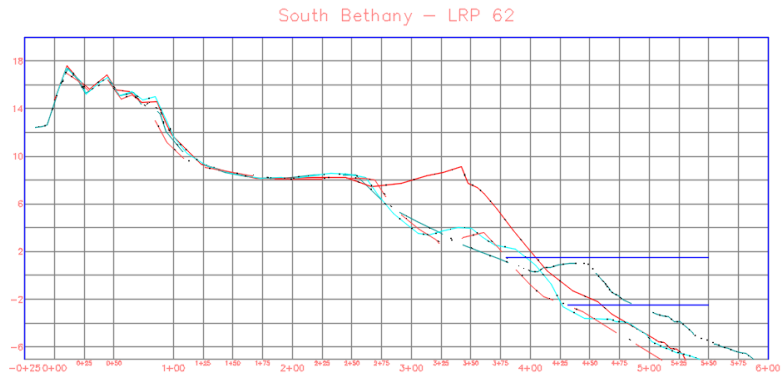


Fenwick Island - LRP 65



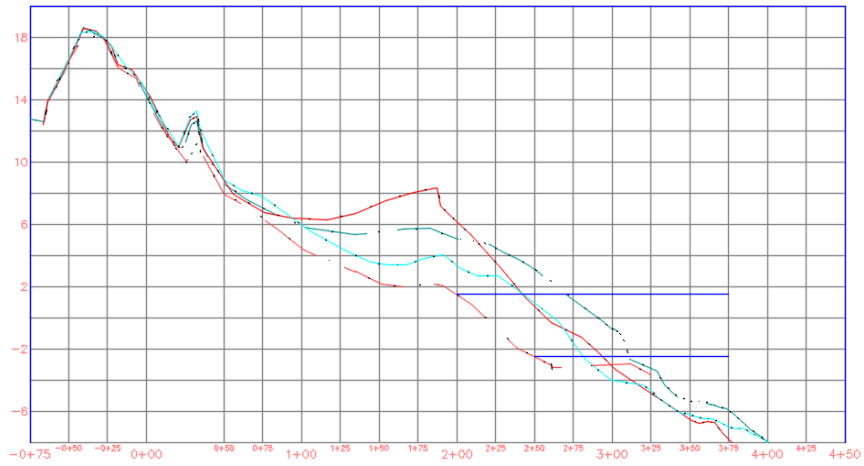


South Bethany Beach:

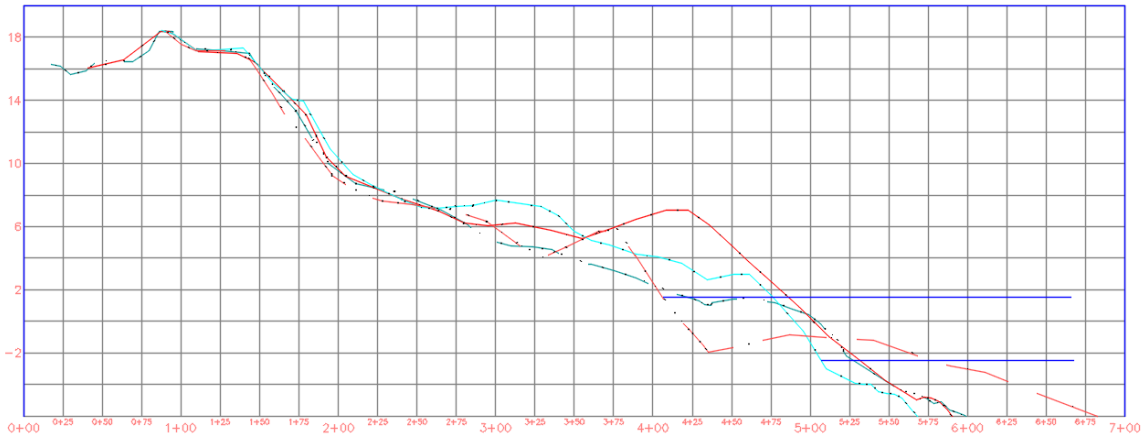


Bethany Beach:

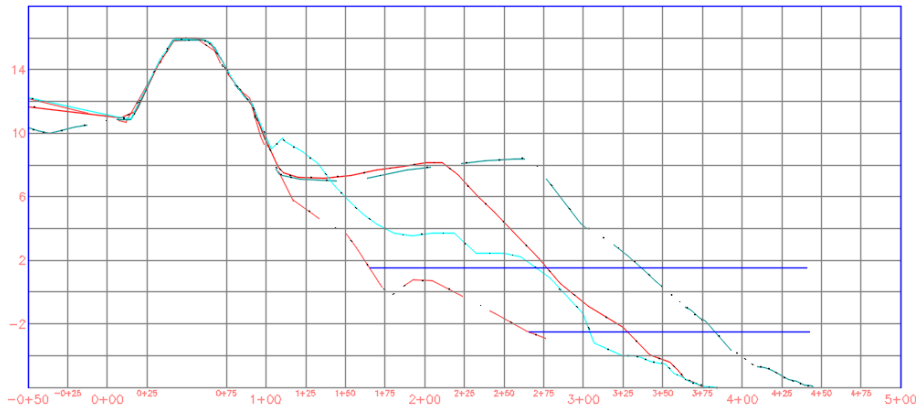
Bethany Beach - LRP 61



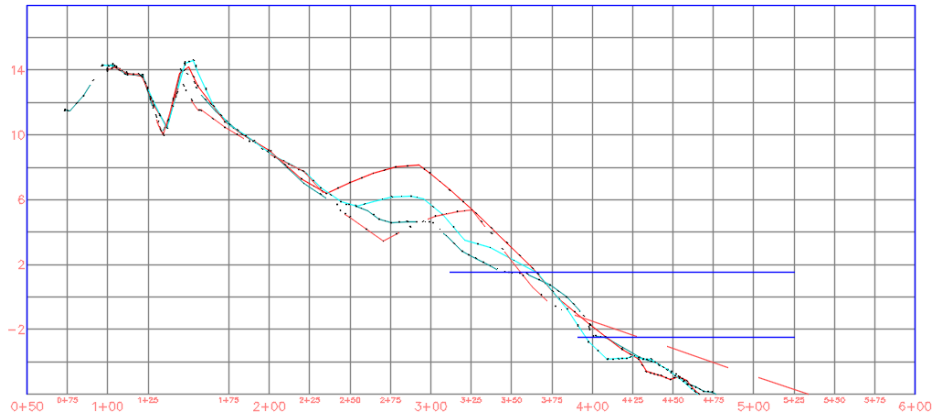
Bethany Beach - LRP 60



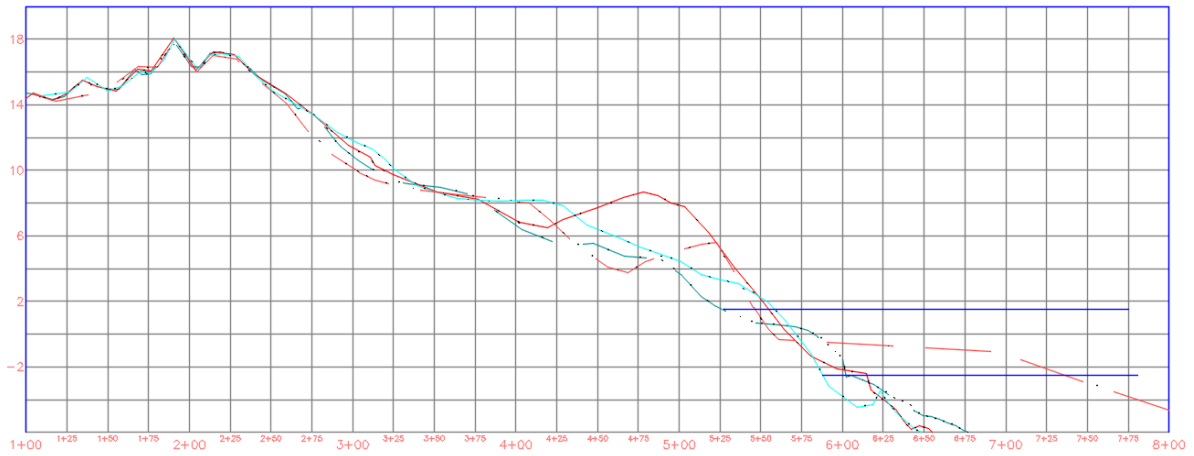
Bethany Beach - LRP 60b



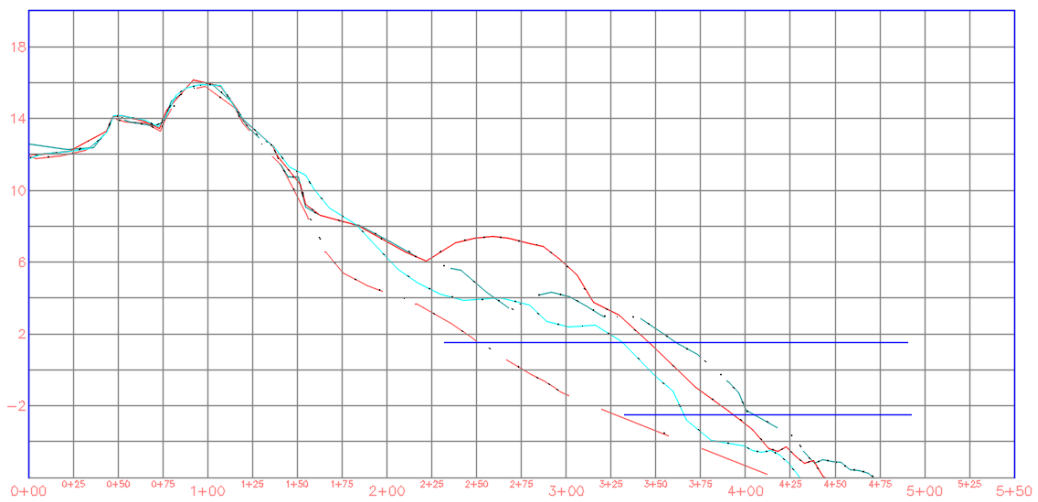
Bethany Beach – LRP 58



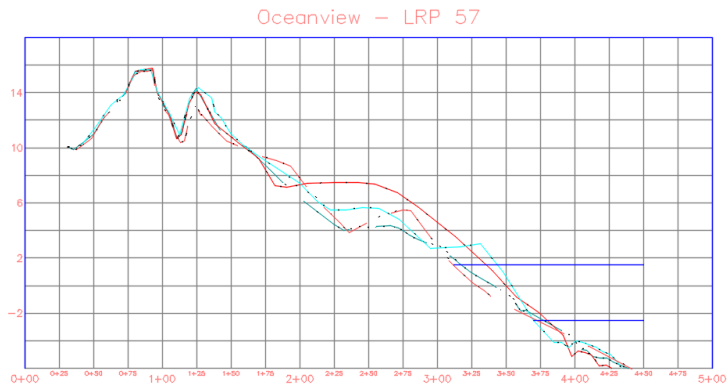
Bethany Beach – LRP 59



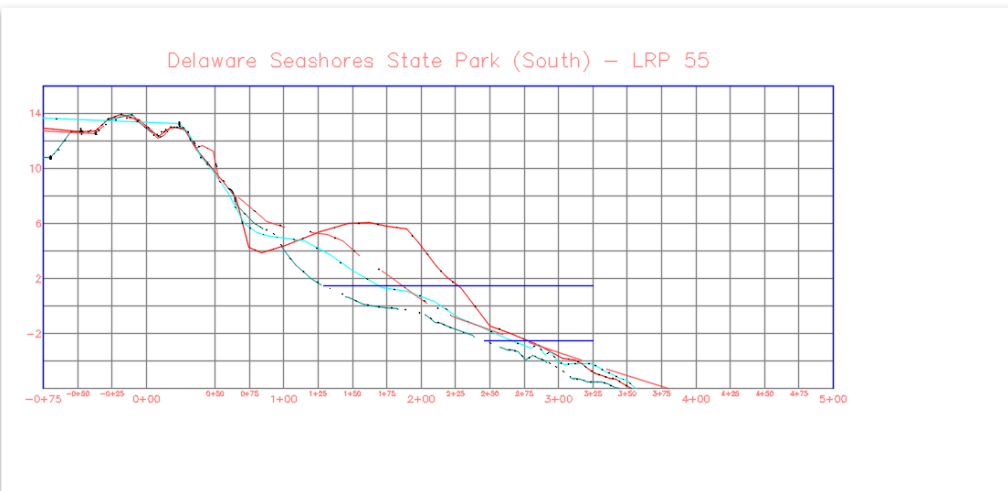
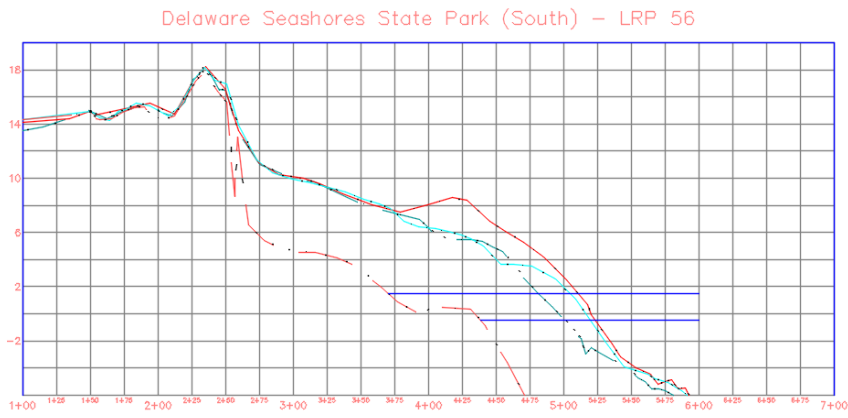
Bethany Beach – LRP 60a



Oceanview

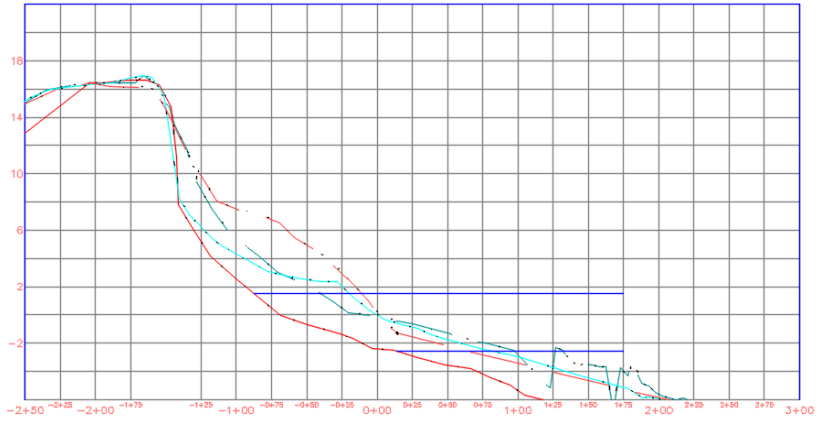


DSSP South:

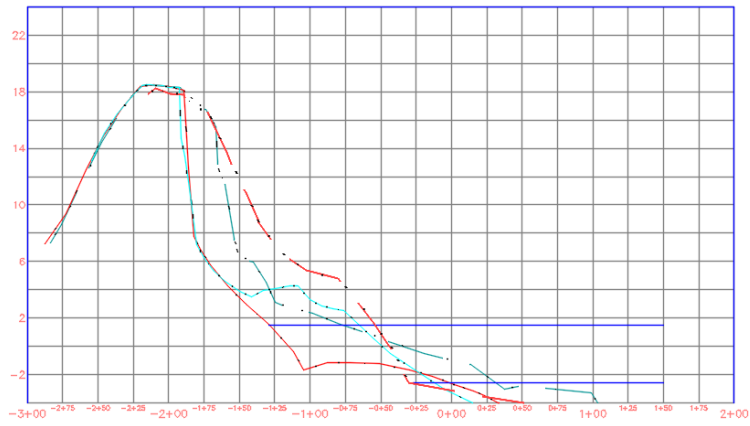


DSSP North:

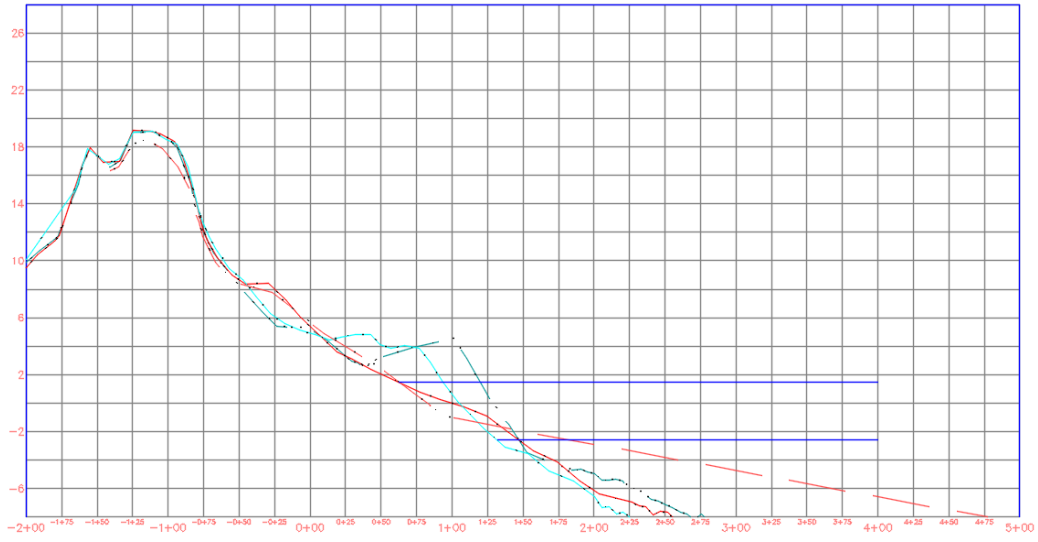
Delaware Seashores State Park (North) – LRP 54



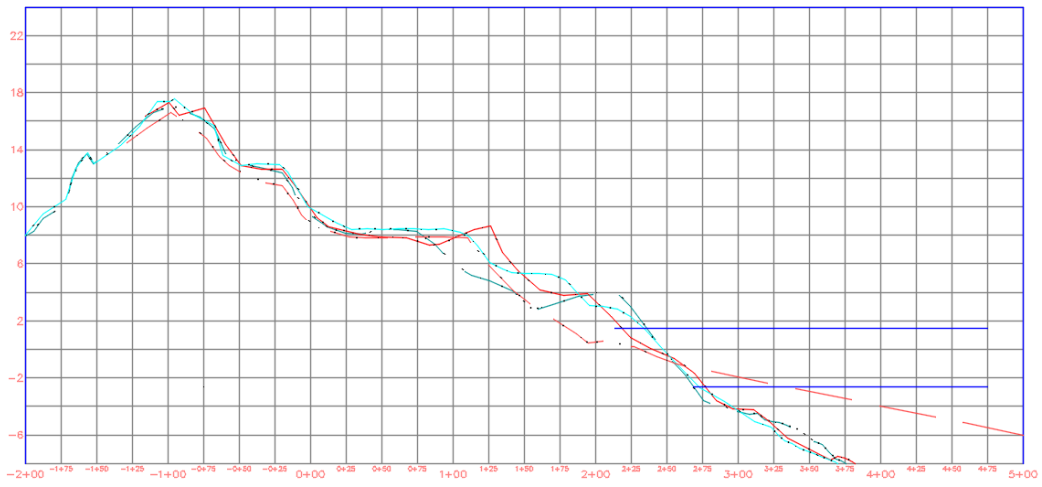
Delaware Seashores State Park (North) – LRP 53



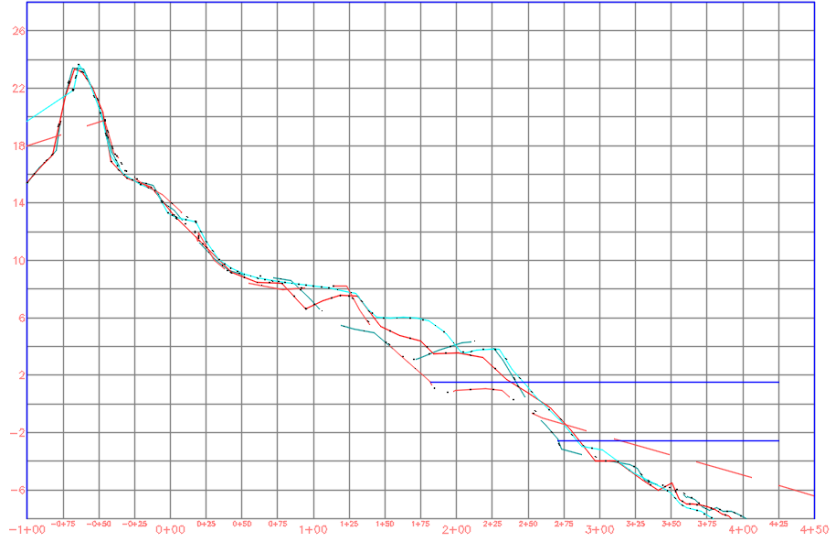
Delaware Seashores State Park (North) – LRP 52



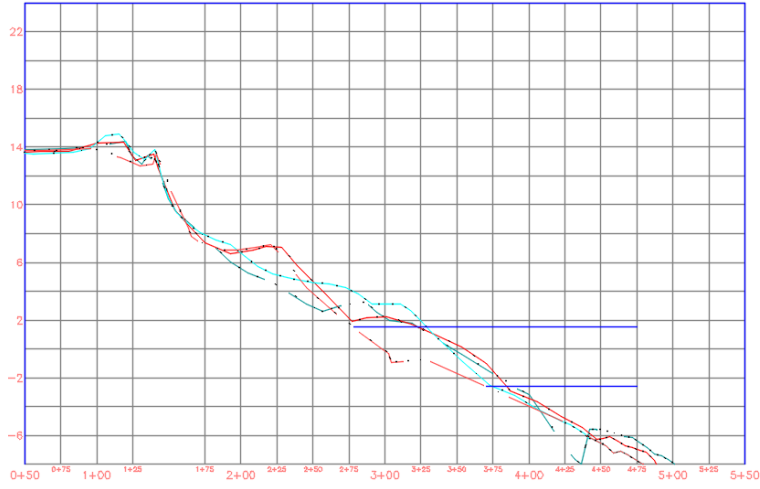
Delaware Seashores State Park (North) – LRP 51



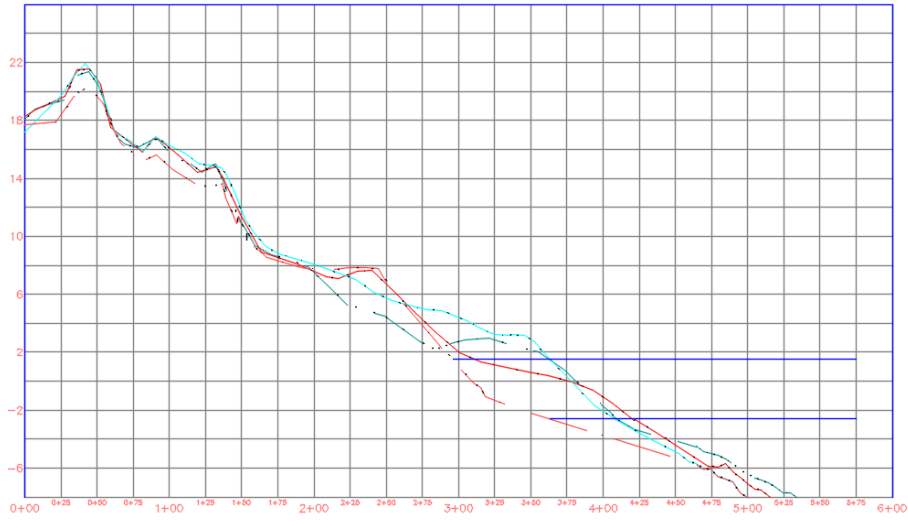
Delaware Seashores State Park (North) – LRP 50



Delaware Seashores State Park (North) – LRP 49

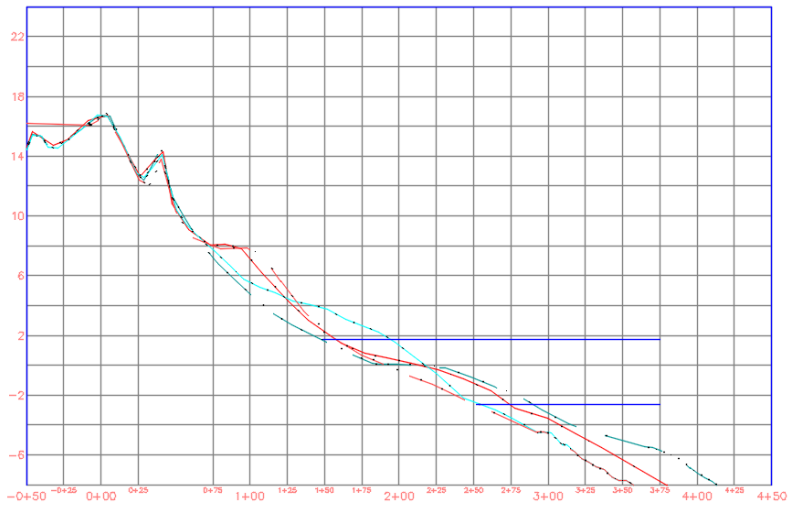


Delaware Seashores State Park (North) – LRP 48



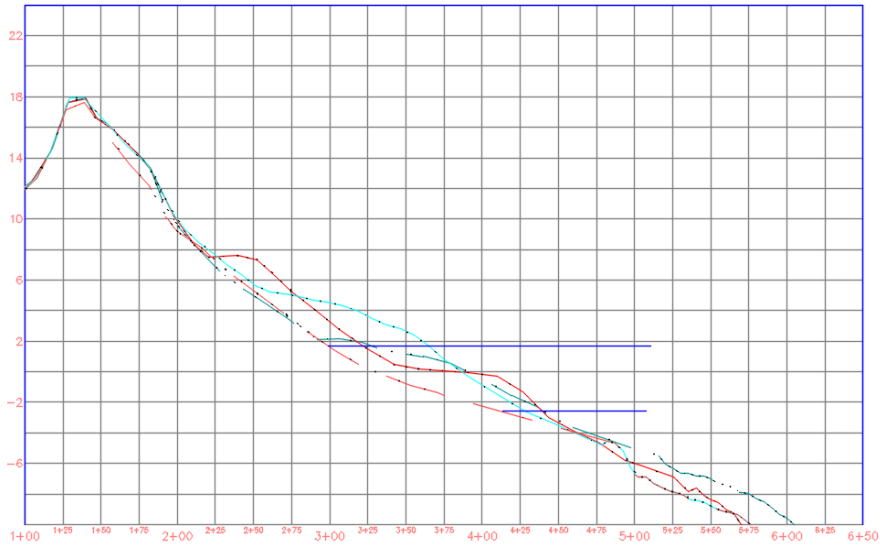
Dewey:

Dewey Beach – LRP 47

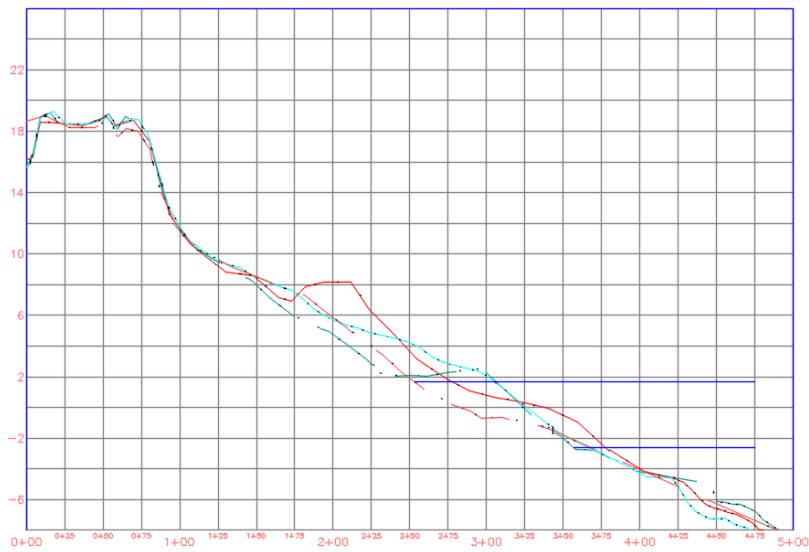


Rehoboth:

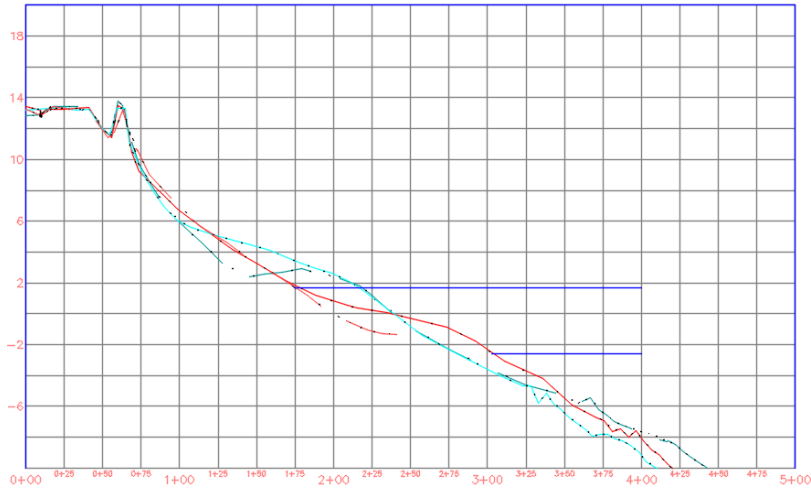
Rehoboth Beach – LRP 46



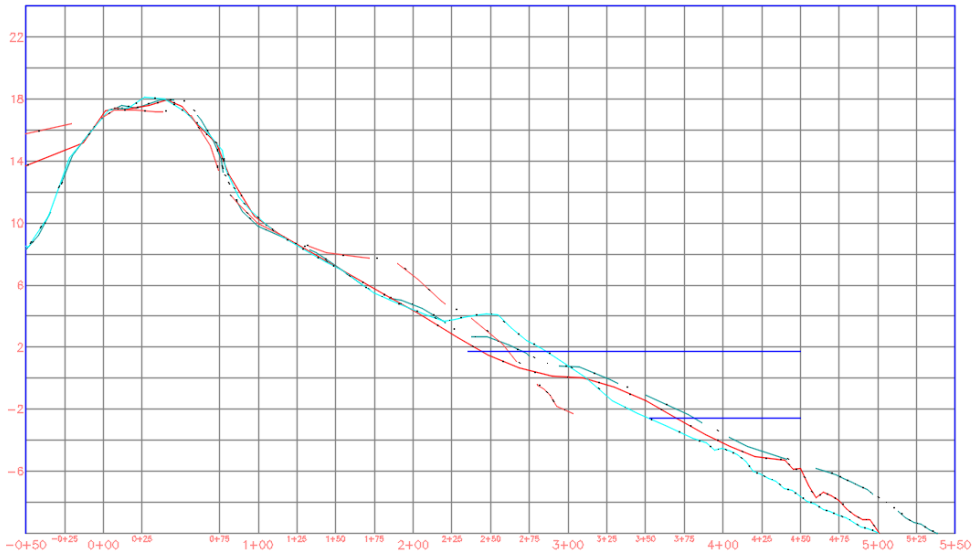
Rehoboth Beach – LRP 45a



Rehoboth Beach - LRP 45

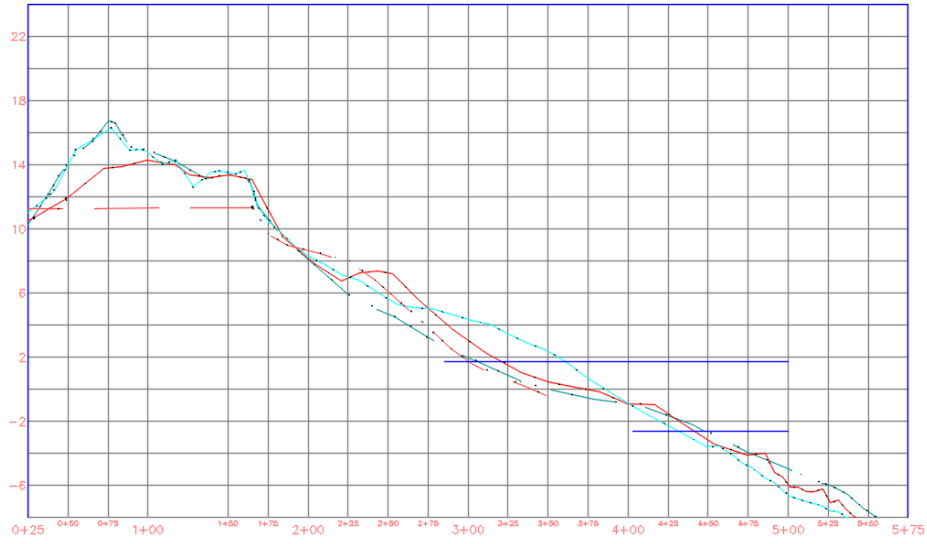


Rehoboth Beach - LRP 44a

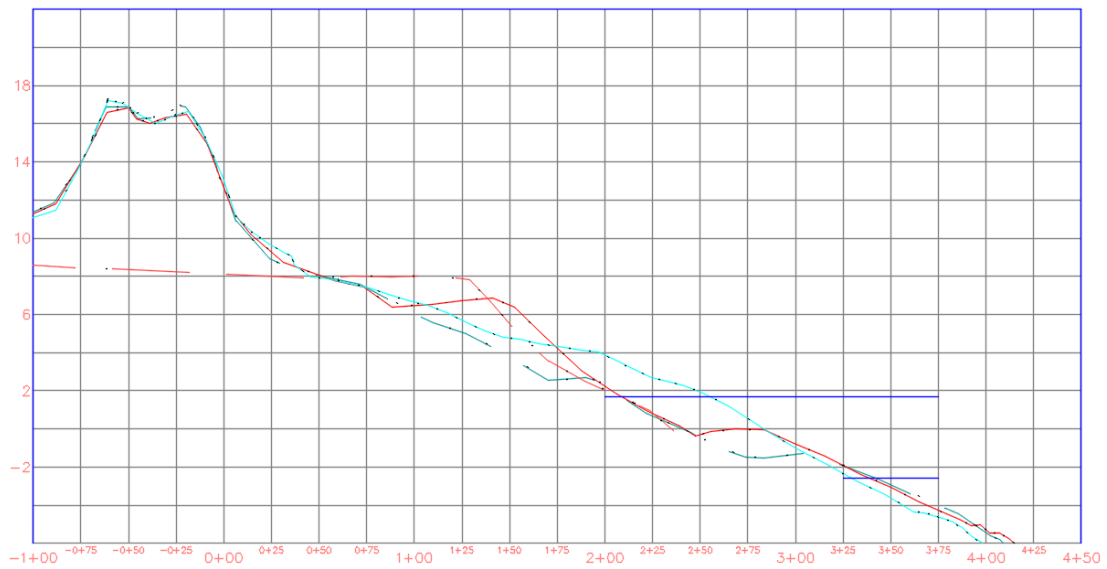


Gordons Pond:

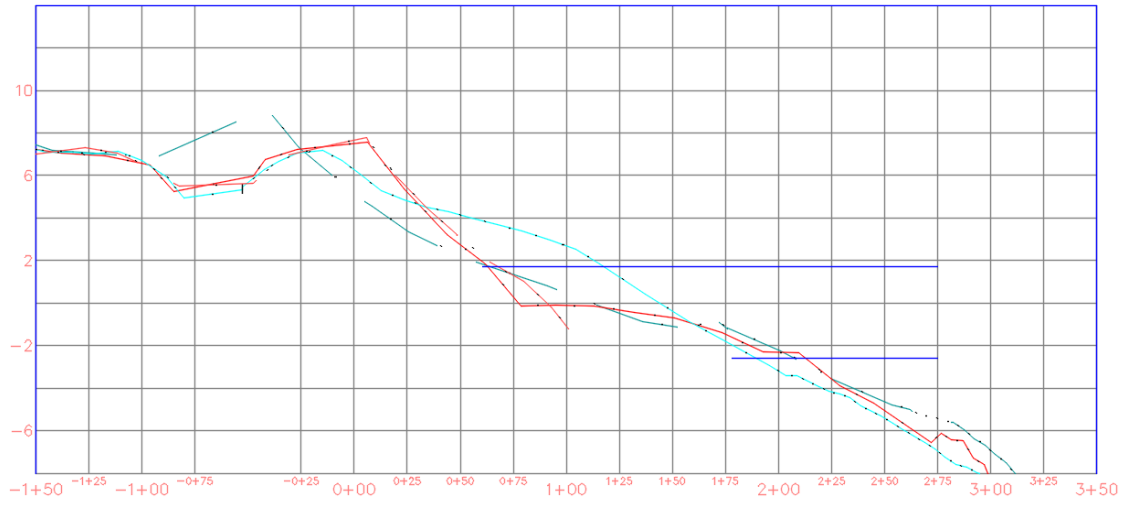
Gordons Pond - LRP 43b



Gordons Pond - LRP 43a

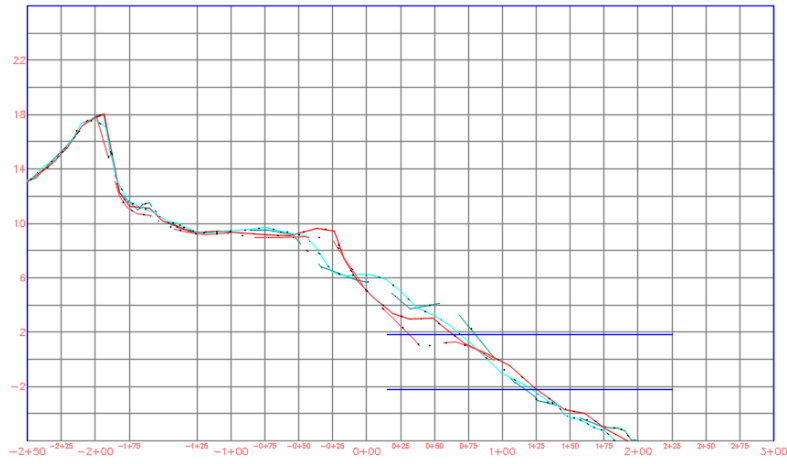


Gordons Pond – LRP 43

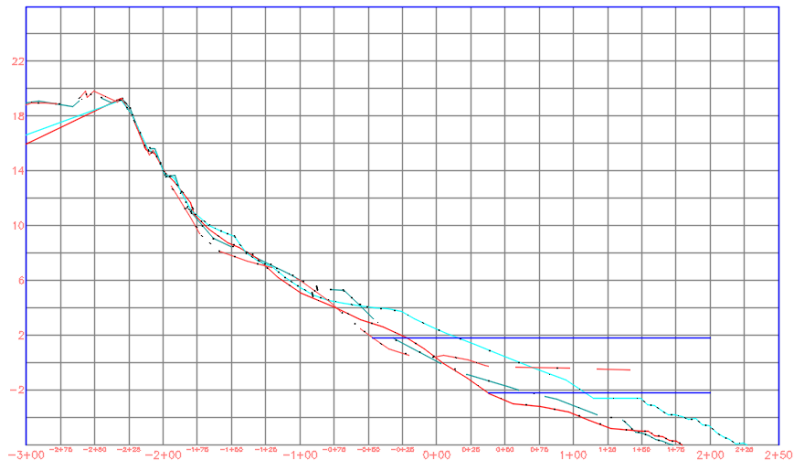


Herring Point:

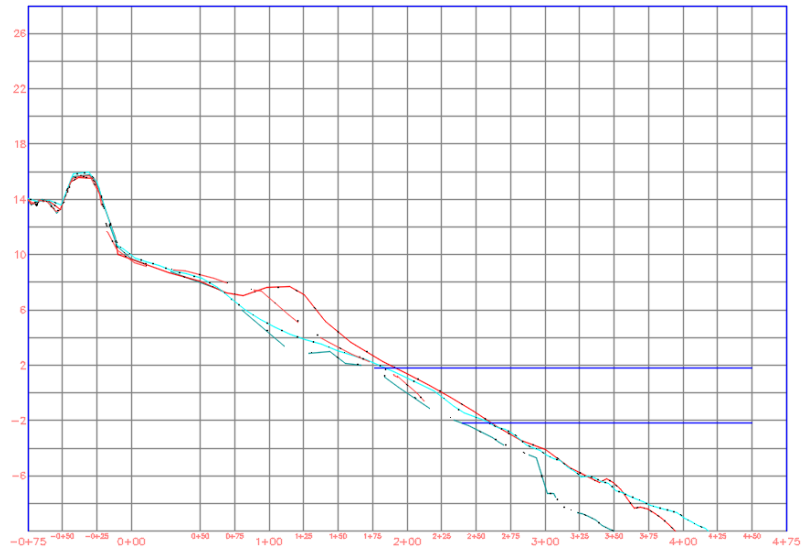
Herring Point - LRP 42



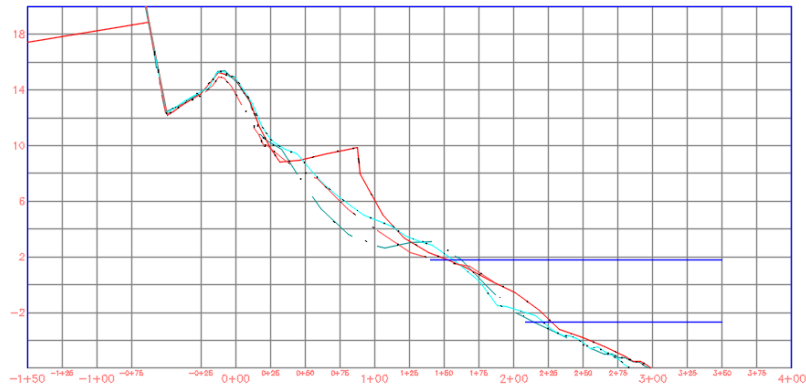
Herring Point - LRP HP10

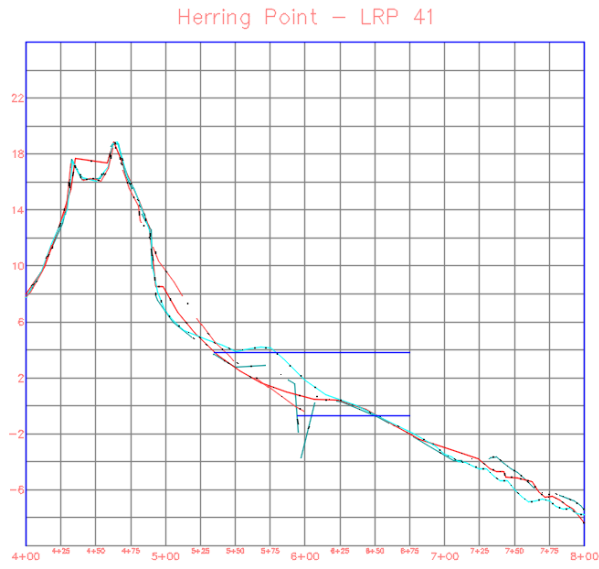


Herring Point – LRP HP6



Herring Point – LRP HP1





Cape Henlopen:

