Narragansett Town Beach Replenishment Feasibility Project

Prepared For:
Town of Narragansett
25 Fifth Avenue
Narragansett, RI 02882

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East Falmouth, MA 02536

September 2011

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1.0 INTRODUCTION

Woods Hole Group has completed an investigation of beach replenishment alternatives for Narragansett Beach located in the Town of Narragansett, Rhode Island. The beach is located on the eastern edge of Narragansett, south of the entrance to Western Passage that connects the open waters of Rhode Island Sound with Narragansett Bay (Figure 1). Approximately one-half of the mile-long barrier spit is owned and operated by the Town of Narragansett as a public beach. The remaining half of the beach at the northeast end is privately owned. The barrier spit is part of a dynamic setting that constantly changes in response to coastal processes such as waves, winds, storms, currents, and sea level rise. The interaction of these processes with the geological framework of the coastline acts to shape the present day beach resource.

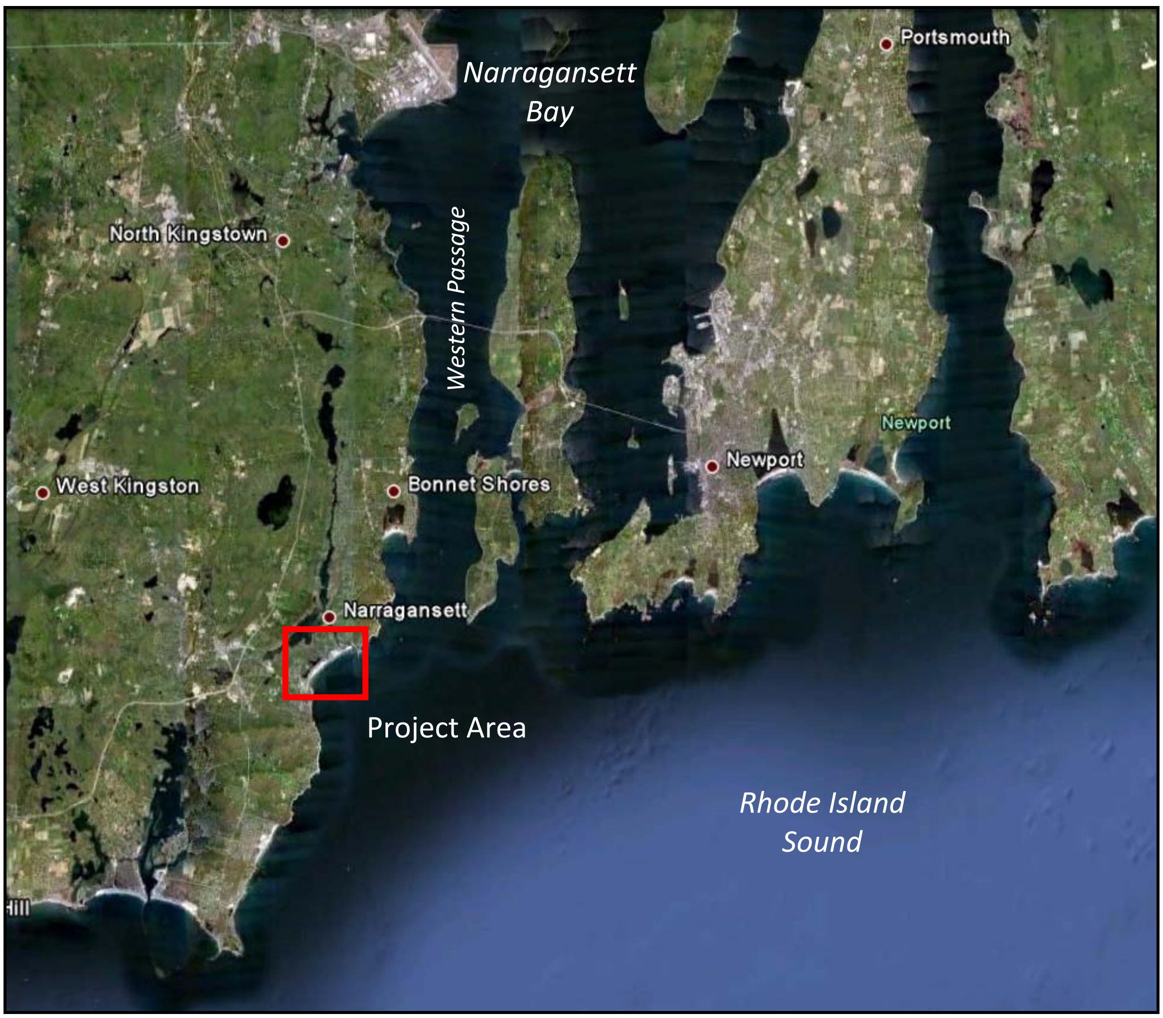

Figure 1. Site map showing location of Narragansett Beach.

Narragansett Beach serves a number of important natural functions. The beach and dune resources provide storm damage protection and flood control for inland areas by dissipating incoming wave energy and supplying sediment to adjacent resources. They also provide important wildlife habitat for certain species of shorebirds. In addition to these natural functions, Narragansett Town Beach also provides tremendous recreational and economic benefits to the town, its residents, local merchants, and visitors. In fact, the town-owned beach is one of the most highly visible and public beaches in the state of Rhode Island. Average net income from beach operations over the past 9 years has been approximately $270,000 per year.

Narragansett Beach demonstrates seasonal patterns of sediment transport, where storms and high energy waves carry sand offshore during the winter months, and smaller waves bring some of the sand back during the summer. Overall however, the beach has a history of shoreline erosion and the town routinely trucks in sand to replenish the beach, generally at the beginning of the busy summer season. The Town of Narragansett recognizes the importance of maintaining the beach as both a natural protective buffer and a recreational resource. As responsible stewards, the town initiated the following investigation of beach replenishment alternatives to develop short- and long-term plans for continued sustainability of Narragansett Beach.

The report provides details of the study results organized in the following six (6) sections:

- Section 2.0 - Existing Site Conditions: Includes information on the geomorphology of the beach, dominant coastal processes, and background erosion rates.

- Section 3.0 – Beach Nourishment Evaluation and Design: Discusses the engineering evaluation of beach replenishment alternatives under average annual and storm conditions, including assessment of structural measures for sand retention. Levels of protection and estimates of beach replenishment performance are used to identify possible alternatives.

- Section 4.0 – Potential Sources of Sediment: Identifies a range of potential sediment sources for beach replenishment, including environmental and engineering constraints.

- Section 5.0 – Construction Methodology: Includes information on construction methodologies available for beach replenishment using the range of potential sources of sediment.

- Section 6.0- Regulatory Requirements: Discusses the type and number of environmental permits that would be required for the project alternatives, as well as the types of supporting documentation needed to support the permit applications.

- Section 7.0 – Cost Analysis and Next Steps: Provides estimated market value costs for construction of the various beach replenishment alternatives using a range of construction methods and sand sources.

2.0 EXISTING SITE CONDITIONS

Narragansett Beach is located in the center of town, extending from the intersection of Ocean Rd. and Beach St. for approximately 1 mile to the entrance of the Narrow River estuary (Figure 2). The beach forms a southeast facing embayment that is exposed to the open waters of Rhode Island Sound. The shoreline south of the beach along Ocean Rd. is rocky and the upland infrastructure is protected by a concrete seawall. The entrance to the Narrow River at the northeast end of the beach is anchored by a rocky headland known as Cormorant Point.

Figure 2. Coastal geomorphology of Narragansett Beach.

2.1 COASTAL PROCESSES

The dominant coastal processes including waves, tides, currents, storm surge, and sea-level rise influence the evolution of Narragansett Beach. On short-time scales, waves are the most important coastal process reshaping the beach, whereas relative sea-level rise and sediment supply are the dominant factors over longer time-scales. Each of these processes is discussed below to provide background on their importance and the potential impacts on beach replenishment alternatives.

Waves are generated by winds blowing over the surface of the water. The size of the waves that are generated is related to the distance over which the wind blows (fetch) and the water depth. Narragansett Beach is exposed to waves generated by winds blowing from the east, southeast, south, and southwest. Through the process of wave refraction, the beach is also impacted by waves traveling from the northeast and west. The largest waves are those generated within Rhode Island Sound and beyond which travel north towards the entrance to Narragansett Bay. Mean wave heights at the beach are greatest during the period between November and March, while the summer months between June and August produce the smallest waves. The orientation of the shoreline with respect to the incoming waves causes a net sediment transport direction towards the northeast.

Tides in southeast Rhode Island are semi-diurnal, with two highs and two lows each day. Tides at Narragansett Beach have a mean range of 3.47 ft (NOS, 2011). The elevations of Mean High Water (MHW) and Mean Low Water (MLW) are +1.57 and -1.90 ft (NAVD88), respectively. These fluctuations in water level are relatively low, and are not a major contributor to sediment transport at the beach. Water level fluctuations are however responsible for driving the tidal currents through the Narrow River. As the tide ebbs and floods each day, the constriction formed at the mouth of the river by the barrier spit causes increased tidal currents. On incoming tides these currents carry sediment into the river until the velocities are reduced and the material is deposited on the flood shoals. Similar processes take place during the falling tide as currents transport sediment out of the river; however, the formation of an ebb shoal on the seaward side of the estuary is not apparent.

Since tidal ranges at Narragansett Beach are small, storm surge becomes an important factor in controlling sediment transport and beach erosion. The severity of erosion during a storm is partly dependent on the water level, or storm surge, associated with the coincident tide. Storm surge is important because it raises the level at which waves can attack and erode the beach. High storm surges allow waves to reach the upper beach and dune areas, as larger waves propagate landward through deeper water. Storm surge elevations at Narragansett for various storms of record are provided by the Federal Emergency Management Agency (FEMA) Flood Insurance Study (FEMA, 2010). The data shown in Table 1 represent stillwater storm elevations caused by tide and wind setup effects (water piling up against the land). Increased water levels caused by waves, wave runup, and wave setup are not included in the FEMA stillwater elevations, as these conditions vary on a site by site basis depending on local topography and other factors.

Table 1. FEMA Stillwater Elevations for Narragansett.

Storm Recurrence Interval	Elevation (ft, NAVD88)
10-yr	7.30
25-yr	10.30
50-yr	11.70
100-yr	15.10

The FEMA storm surge predictions are based on water level records collected during past storm events. Measurements at Scarborough State Beach, Narragansett Pier, Narrow River, and Bonnet Shores during the September 1938 and August 1954 hurricanes were utilized to develop the FEMA predictions.

Long-term water level measurements at nearby NOAA tide stations in Newport and Providence, RI show the history of sea-level rise over the last century (NOAA, 2011). Best fit linear regression analyses of the historical data show relative rates of sea-level rise between 2.0 and 2.6 mm/yr (Table 2). Projecting these historical rates over the next 10 to 25 years suggests that sea levels will rise between 0.06 and 0.21 ft in the Narragansett area.

Table 2. NOAA NOS Measurements of Long-Term Changes in Sea-Level

Station	Data Period	Historical Sea-Level Rise (mm/yr)	Projected Sea-Level Rise in 10 to 20 Years (ft)
Newport, RI	1930-2006	2.58	0.08 to 0.21
Providence, RI	1938-2006	1.95	0.06 to 0.16

Going beyond the historical data, climate change research conducted by the IPCC (2007) suggests the rates of sea-level rise will increase over the next century. A number of climate change models have been used to predict the effects from future greenhouse gas emissions, land-use practices, and other driving forces on future sea levels. These models suggest that global average sea levels will rise by the end of the 21st century anywhere from 0.59 to 1.94 ft.

Existing data on historical rates of shoreline change at Narragansett Beach are available from the RI Coastal Resources Management Council (CRMC, 2007) and from a national assessment of shoreline change prepared by the US Geological Survey (USGS, 2010). The CRMC maps were prepared to show rates of shoreline change that could be used by the Council's regulatory programs to address issues including setbacks of activities from coastal features. The CRMC data for Narragansett Beach are based on changes in shoreline position between 1939 and 2004. The map shows long-term erosion along the entire beach, with rates ranging between -0.3 and -1.2 ft/yr. The highest rates of erosion occur at the southwest and northeast ends of the barrier spit, and the lowest rates of erosion occur near the center of the beach.

Shoreline change results from the USGS study are illustrated in Figure 3 (USGS, 2010). A total of nine (9) shorelines were included in the study, spanning the 134-yr period from 1869 to 2003. The data show highest rates of erosion during the early time period from

1869 to 1948. Subsequent to 1948 the beach continued to erode, but at a slower rate. Average erosion rates over the entire 134-yr period range between -0.56 and -0.95 ft/yr. In general, rates of change between the two studies are comparable, showing long-term erosion of Narragansett Beach.

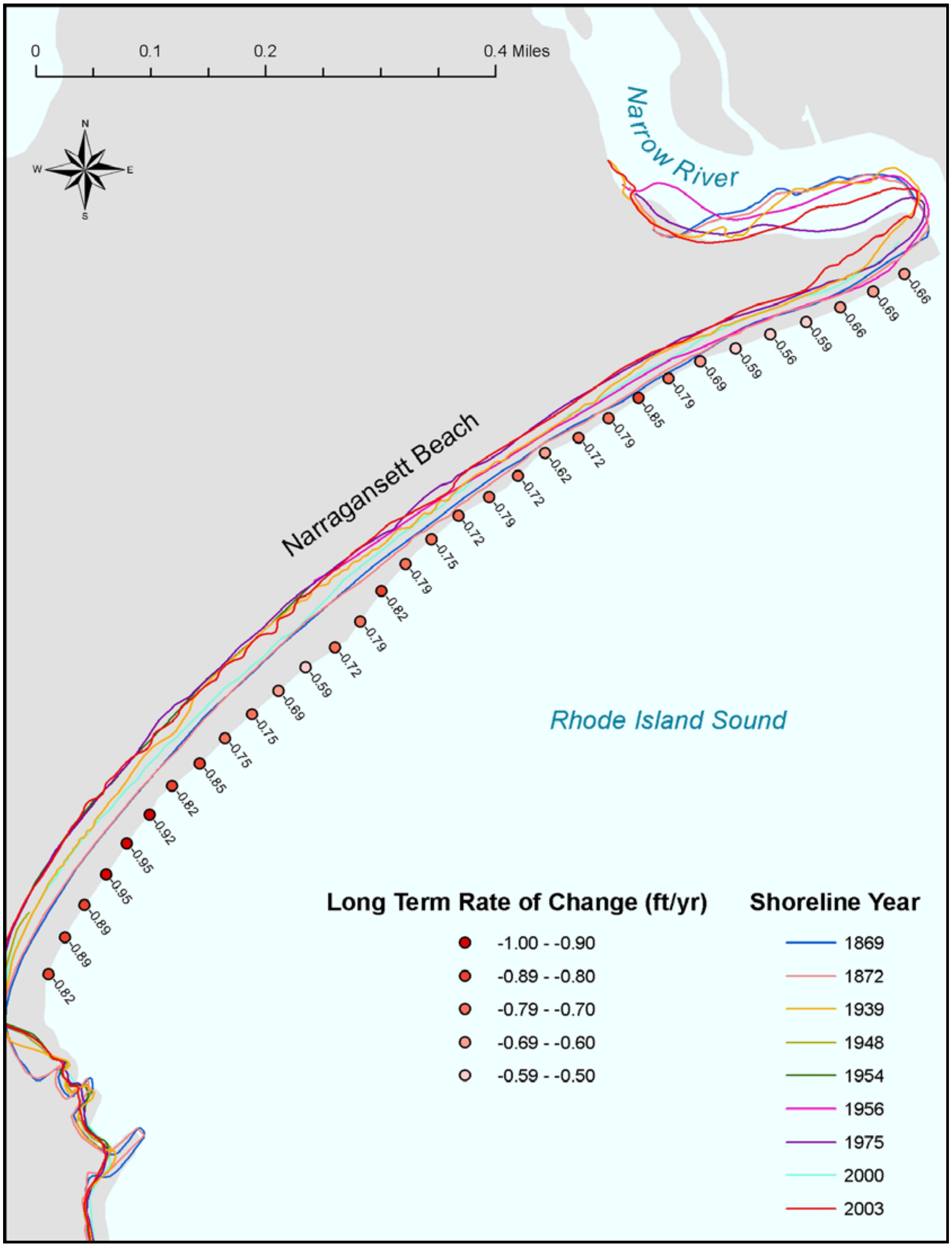

Figure 3. Historical shorelines and long-term rates of change for Narragansett Beach developed for the USGS national assessment of shoreline change (USGS, 2010).

In addition to the long-term trends in shoreline change revealed by the CRMC and USGS data, Narragansett Beach also experiences seasonal variations in beach geometry. The beach profile fluctuates seasonally due to changes in wave energy experienced during the summer and winter months. As storms and wave heights increase during the fall and winter months, the beaches and dunes erode. Sand is pulled offshore from the upper portions of the beach and deposited in protective offshore sandbars. The result is typically a flatter, more concave beach shape. In the late spring and early summer months, smaller, calmer waves dominate, and sand slowly returns to the beach. Over time the beach and dunes typically recover, as long as sediment is not lost offshore.

2.2 BEACH RESOURCES

Approximately one-half of the mile-long Narragansett barrier spit is owned and operated by the Town of Narragansett as a public beach (Narragansett Town Beach). The remaining half of the beach at the northeast end is privately owned (Figure 4). Facilities at the municipal beach include North and South Pavilions with showers, changing rooms, restrooms, concessions, storage lockers, and offices for beach personnel. The North Beach Cabanas provide units with storage and showers for rent on a seasonal basis by Narragansett residents. The North Beach Clubhouse is a rental facility also located on the Town Beach available for public and private events. Parking is available in the north, south, west, and cabana parking lots; capacity is approximately 1,000 cars. The Town Beach is open daily from Memorial Day weekend through Labor Day weekend. Admission to the beach and for parking is assessed on a daily basis or via seasonal pass.

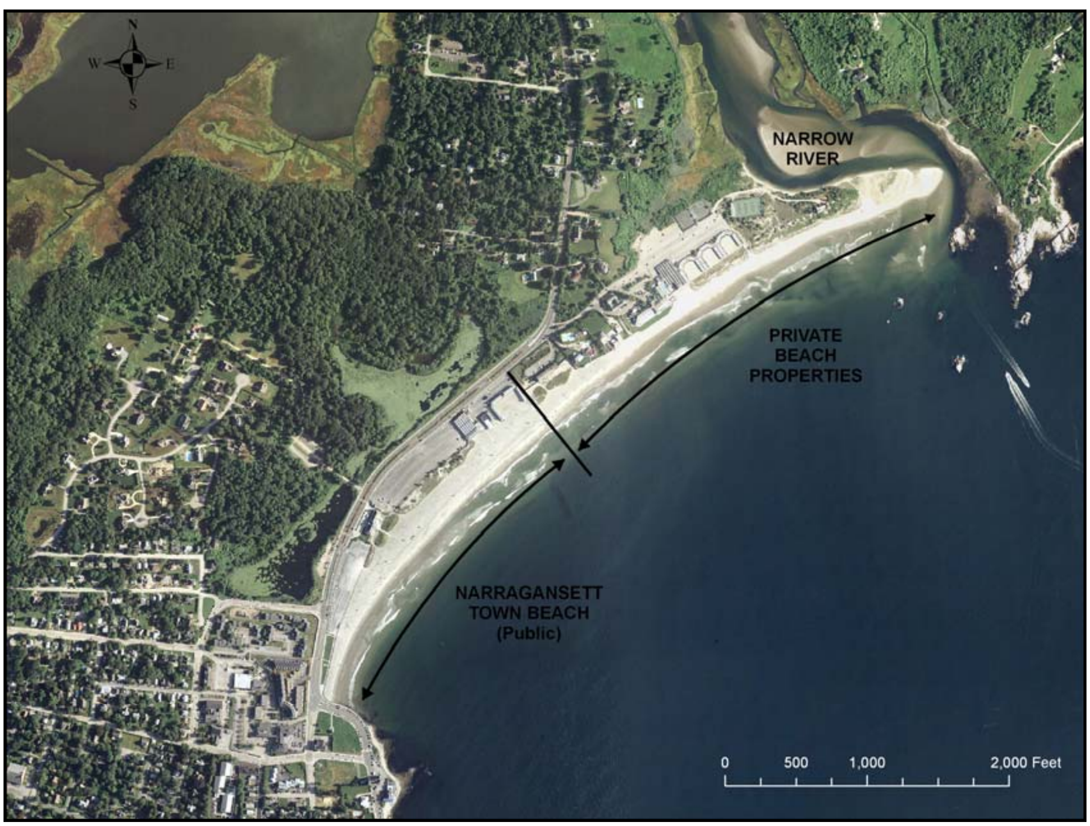

Figure 4. Layout of Narragansett Beach showing public and privately owned areas.

Following the RI Coastal Resources Management Program definitions, natural resources on site include coastal beach (Section 210.1), dunes (Section 210.7), and barrier spit (Section 210.2). The coastal beach and barrier spit resources extend the entire length of the beach. Isolated dune resources are present in several areas of the Town Beach and on the privately-owned sections of beach towards the northeastern end of the spit (Figure 5). The width of the high tide beach varies from nearly zero in front of the south seawall to approximately 100 ft in the North Pavilion and Clubhouse areas; dunes reach maximum elevations of 13 to 15 ft NAVD88 (Figure 6).

Figure 5. Natural resources and shore protection structures on Narragansett Beach.

The Narrow River estuary and the end of the barrier spit are mapped as estimated habitat and range for rare species and/or noteworthy natural communities (Figure 5; RINHP, 2011). A list of endangered, threatened, and/or special concern species (plant and animal) within the mapped habitat area is available upon request from the RI Natural Heritage Program. Unvegetated areas of the barrier spit adjacent to the Narrow River are known to support nesting for the endangered Piping Plover.

Portions of both the public and private beaches are protected with coastal engineering structures (Figure 5). A granite block and concrete seawall extends for 1,100 ft along the southwest end of the Town Beach. The seawall has a crest elevation of approximately 10.5 ft NGVD88 at the southern end where it joins the Ocean Rd. seawall, and a slightly lower elevation of 9.3 ft NGVD88 in front of the South Pavilion parking area (Figures 7-

8). The toe of the seawall is protected with steel sheet pile that is visible along the south end of the beach. A second concrete seawall with a sheet pile bump out is located on the beach near the center of the barrier spit. This structure extends for approximately 840 ft, protecting private properties including a portion of the Dunes Club (Figure 9).

Figure 6. Typical high tide beach and dunes at South Pavilion and Clubhouse areas.

Figure 7. Seawall and low tide beach at south end of Narragansett Town Beach.

Figure 8. Seawall and low tide beach in front of the South Pavilion parking area (foreground of photograph).

Figure 9. Seawall and sheet pile bump out protecting private properties near the center of Narragansett barrier spit.

A survey of beach conditions and sediment characteristics was performed by Woods Hole Group on May 31, 2011. The survey included collection of topographic beach profile data using a Trimble RTK Global Positioning System (GPS) and sediment sampling for grain size analysis. A total of sixteen (16) profiles were surveyed; eleven (11) profiles were located on the Town Beach area and five (5) profiles were surveyed on the privately-owned parts of the beach (Figure 10). Topographic data were collected along shore normal transects starting on the seawall, roadway, parking lot, or edges of buildings landward of the beach, and extending to wading depth near MLW. Elevation (z) and position data (x,y) were collected with respect to NAVD88 and the Rhode Island State Plane Coordinate System NAD83. The following benchmarks were used for geodetic control during the survey:

- NOS B.M. NO. 4658 (1977) Placed on top of the seawall along Ocean Road.

- Rhode Island State Board of Public Roads B.M. NO. 399 at the intersection of Boston Neck Road and Cormorant Point Road.

Figure 10. Beach profile and sediment sample locations surveyed on May 31, 2011.

The topographic data were collected to provide baseline conditions for the beach and to serve as a starting point for the evaluation of beach replenishment alternatives. Sediment samples were also collected for grain size analysis from each of the beach profile lines. The samples were collected from the foreshore or intertidal portion of the beach between mean high water and mean low water. Grain size analyses were performed at the laboratory to identify percentages of gravel, sand, and silt, as well as mean grain-size statistics (Figure 11). Full laboratory results are provided in Appendix A. The grain size data were developed to provide information on sediment characteristics at the beach and to help to address sediment compatibility issues for future beach replenishment activities.

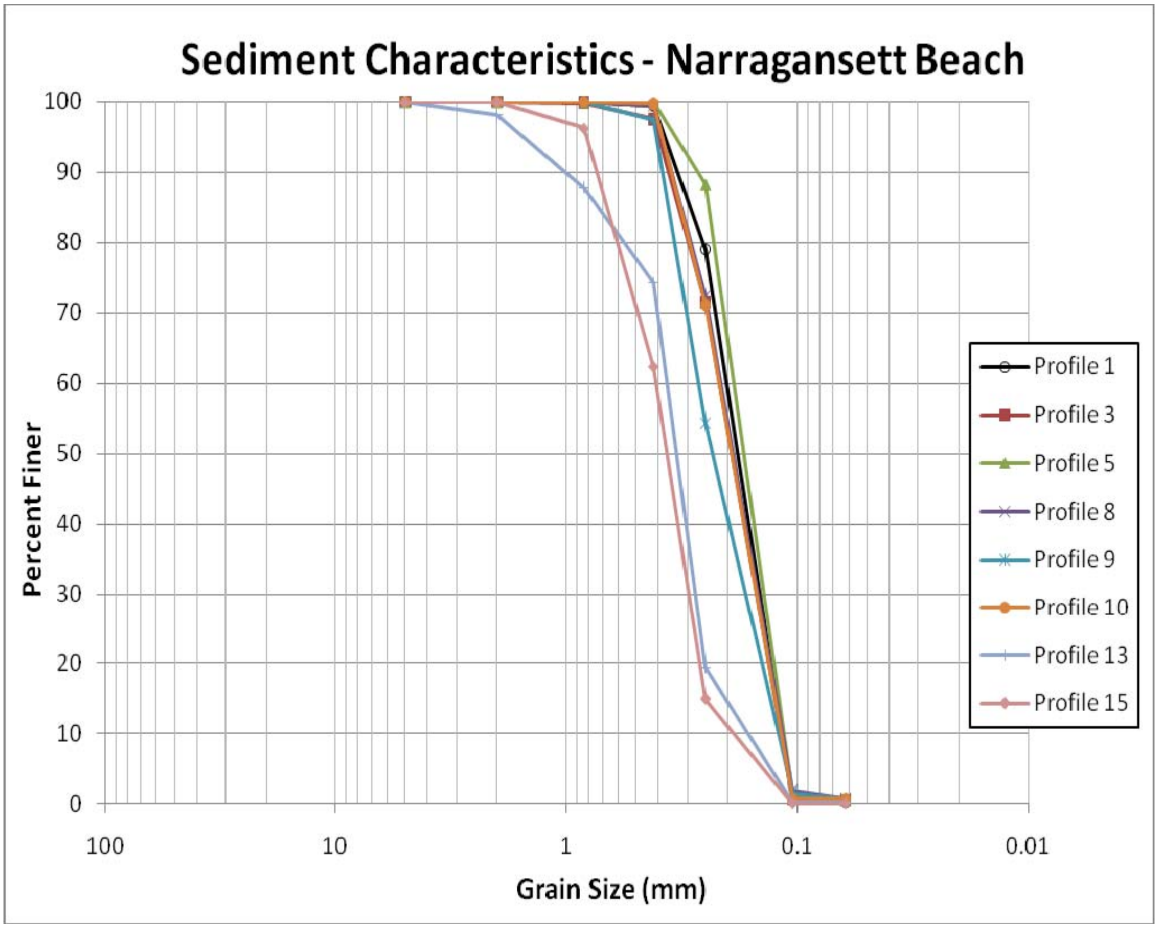

Figure 11. Sediment grain size characteristics for Narragansett Beach.

Results from the grain size analyses show that the beach sediments are composed almost entirely of sand, with only minor percentages (0.23 to 1.18%) of silt and clay. Most of the samples show 96% or higher in the fine sand range indicating that the material is well-sorted. There is a slight coarsening of the beach sediments towards the northeastern end of the barrier spit, especially in the area of Profiles 13 and 15 where 23.7 to 37.6% of the sample is in the medium-sand size category.

3.0 BEACH NOURISHMENT EVALUATION AND DESIGN

The primary goal of this feasibility evaluation is to identify a potential beach replenishment solution for Narragansett Beach that provides protection for the upland infrastructure and creates a sustainable beach with a reasonable performance lifetime. As such, a variety of replenishment alternatives have been developed and evaluated to determine their ability to sustain a protective beach at Narragansett. This section compares the relative performance of various alternatives and presents information on the merits of each alternative. The focus of the alternative evaluation is on the engineering feasibility of each potential alternative. Construction methodologies, regulatory and environmental protection activities, and estimated project costs for the preferred alternative are discussed in subsequent sections of this report.

A successful beach nourishment project consists of more than simply placing sediment on the beach. In most cases, successful beach nourishment projects are engineered. A beach nourishment template, which consists of numerous design parameters, is based on the characteristics of the site and the needs of a project. Every beach nourishment design is unique, since beaches have different physical, geologic, environmental, and economic characteristics, as well as different levels of required protection. The design must consider the wave climatology, water levels, shape of the beach, sand characteristics, sediment transport rates, erosion patterns, and existing infrastructure. The structure of a nourishment template is designed to yield a protective barrier that also provides material to the beach. A higher and wider beach berm is typically designed to absorb wave energy. Dunes may need to be constructed or existing dunes improved to reduce damage, including potential upland flooding caused by storms. Figure 12 shows the locations the berm and dune on a typical beach profile. Nourishment length, berm height and width, dune height, and nearshore slope are critical elements of a beach nourishment design. Periodic renourishment intervals can also be factored into a nourishment design.

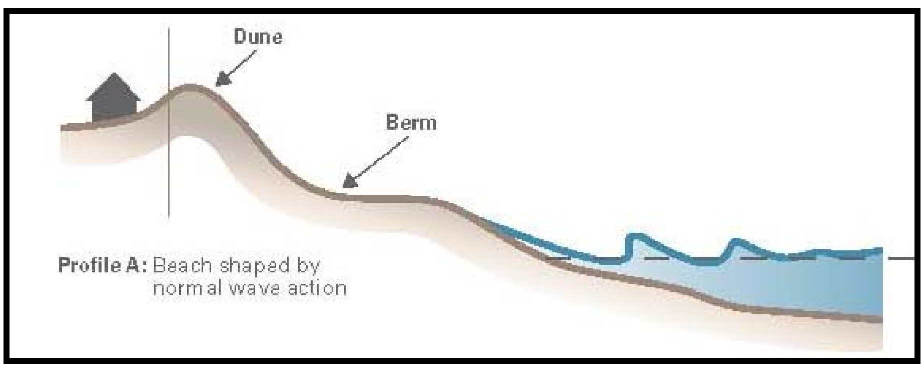

Figure 12. Typical beach profile showing berm and dune features (USACE, 2002).

Even with engineered projects, it must be noted that beach nourishment is not an exact science; variables and uncertainties exist. The performance and required periodic renourishment intervals may differ from planned intervals based on conditions at the nourished beach and the frequency and intensity of storms from year to year. As such, realistic expectations for a beach replenishment project should be well-understood before construction. Replenished beaches manage coastal erosion but do not prevent coastal erosion. Replenished beaches erode just as natural beaches do; therefore, every beach replenishment project must have clear expectations for the level of storm protection provided as well as design life (i.e., how long a certain level of protection will be provided).

3.1 NOURISHMENT TEMPLATES

The nourishment templates evaluated for Narragansett Beach included variations in berm width, berm elevation, and offshore slope. Because of differences in the width and elevation of the natural beach, as well as constraints imposed by the configuration of the upland infrastructure, each template required slight variations in the design parameters across the beach. The templates were developed based on survey information collected at Profiles 2, 5, 8, and 10 on the Town Beach.

<u>Berm Width:</u> Berm widths of 30, 40, 50, 75, and 100 ft were evaluated. Increasing the beach berm is defined by extending the natural berm seaward at a constant elevation. An example of extending the berm width is shown in Figure 13. In general, the beach width at MHW will be wider than the berm width due to the sloping nature of the beach profile and the nourishment template design.

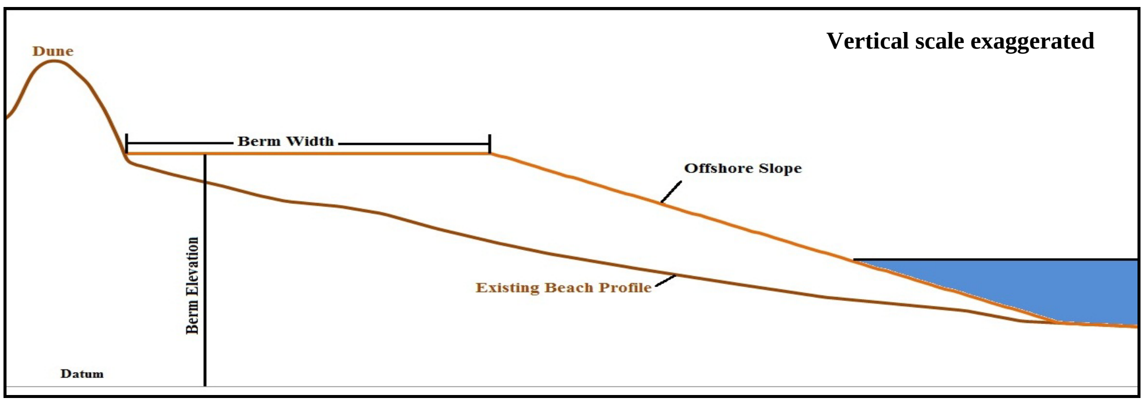

Figure 13. Example beach nourishment template with increased berm width (note that vertical scale is exaggerated).

<u>Berm Elevation:</u> Berm elevations ranged from 6 to 12 ft (NAVD88) depending on the elevations of the existing beach, dunes, and surrounding infrastructure. The lowest berm elevations were at the southwest end of the beach in front of the seawall (Profile 2) and the highest elevations were at the northern end of the Town Beach in front of the North Pavilion, North Beach Cabanas, and Clubhouse (Profiles 8 and 10). In all cases the berm elevations were designed below the level of the seawall, parking lots, and building stairways and/or decks.

<u>Offshore Slope:</u> The beach nourishment templates included offshore slopes of 12:1 and 15:1 (Horizontal:Vertical). These nourishment template slopes are milder than the existing intertidal slopes, but steeper than the existing offshore slopes. Distribution of fill material over the beach face is most effective when the fill forms a profile slightly steeper than the expected equilibrium (natural) profile, and the planform limits of the nourishment are tapered (Dean and Dalrymple, 2002). Initial erosion of the exposed

recreational beach occurs as the equilibrium cross-shore profile develops. Some material is moved offshore, but is not lost, as it serves to dissipate wave energy naturally during winter months. At Narragansett Beach nourishment slopes between 12:1 and 15:1 allowed for intersection of the existing profile at a reasonable distance offshore and provided a mild beach slope for wave dissipation.

To evaluate performance of the beach nourishment templates under equilibrium slope conditions that would be achieved approximately 2 years after initial placement, a series of interim nourishment templates were generated. These templates had narrower berm widths and gentle offshore slopes similar to the existing beach.

Grain Size/Source: Sediment data collected as part of this study was used to define a median grain size of 0.18 mm for the Town Beach. A slightly coarser grain size of 0.30 mm was selected for the nourishment material. This coarser size is representative of potential sediment sources from the upland as well as other nearby sources in the Narrow River and offshore. More details on sediment source are presented in Section 4.0.

Using different combinations of the design parameters described above, a total of nine (9) cases were developed and evaluated for beach performance. The cases are summarized in Table 3. Case 1 represents the existing beach conditions and was evaluated to illustrate storm impacts to the current beach. Cases 4, 6, and 8 are equilibrium profiles formed three years after nourishment of Cases 3, 2, and 7, respectively.

Table 3. Beach Nourishment Templates Evaluated for Level of Protection Provided.

Case	Berm Width (ft)	Berm Elevation (ft)	Offshore Slope (H:V)
1	0 to 100 (existing)	1.5 to 11 (existing)	existing equilibrium
2	100	6 to 12	12:1
3	100	8 to 12	12:1
4*	38	8 to 12	equilibrium
5	50	6 to 12	12:1
6*	38	6 to 12	equilibrium
7	75 to 100	8 to 10	15:1
8*	26 to 38	8 to 10	equilibrium
9	30 to 50	8 to 9	15:1

*Templates represent equilibrium adjustment of larger nourishment template after 2-yr period.

Nourishment Length: Two project lengths were evaluated for design life. Nourishment lengths were developed separately for the public and privately-owned sections of beach. Project lengths of 2,465 and 2,740 ft were utilized for the Town Beach and privately-owned beaches, respectively. In addition, the impacts of structural measures on design life were evaluated. A jetty was considered at the end of the spit adjacent to the Narrow River, and a shore perpendicular groin was considered at the boundary between the public and private beaches. The following five (5) nourishment length and engineering structure scenarios were evaluated for project longevity (Figure 14):

- Scenario 1 – Nourishment of Narragansett Town Beach

- Scenario 2 – Nourishment of Narragansett Town Beach as well as private sections of Narragansett barrier spit
- Scenario 3 – Nourishment of Narragansett Town Beach as well as private sections of the beach, with a jetty at the end of Narragansett barrier spit
- Scenario 4 – Nourishment of Narragansett Town Beach with a groin at the boundary between the public and private beaches
- Scenario 5 – Nourishment of Narragansett Town Beach with a jetty at the end of the barrier spit

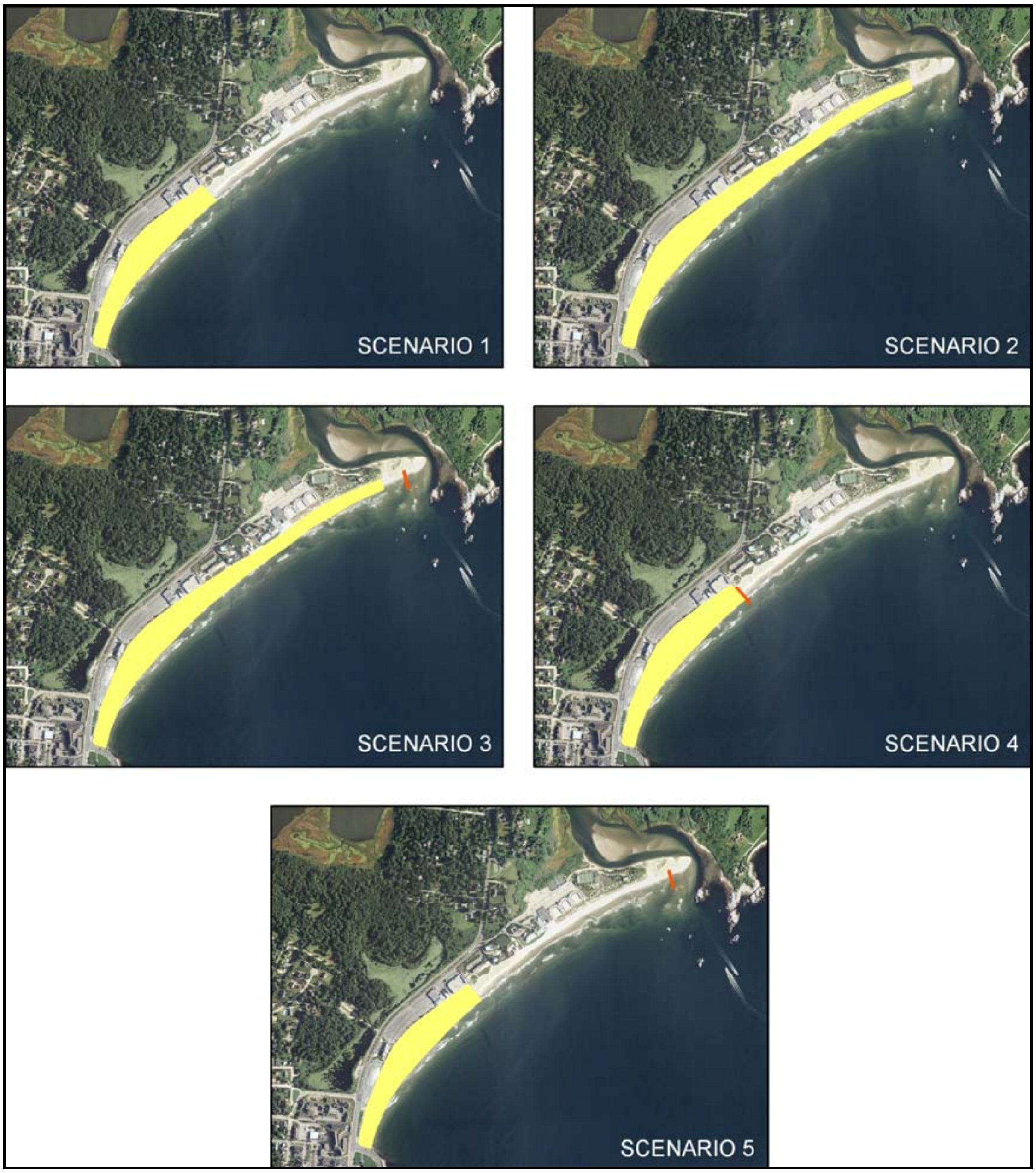

Figure 14. Beach nourishment length and engineering structure scenarios (nourishment width and structure length not drawn to scale).

The structural components (groin and jetty) were evaluated strictly for their impact on design life of the replenishment. If the Town decides to pursue structural measures for the beach, further engineering analyses would be necessary to evaluate potential impacts to downdrift beaches, wildlife habitat, and hydrodynamics at the Narrow River entrance. Given the net direction of sediment transport from southwest to northeast, it is possible that shore perpendicular structures would reduce the natural flow of sand to the northeast end of the barrier spit. The potential for adverse environmental impacts would need to be minimized through the design process, and described carefully during the regulatory phase. The engineering design for any shore perpendicular structure such as a groin or jetty would also need to allow for continued passage of pedestrians and emergency personnel along the upper portion of the beach.

Nourishment Volume: Nourishment volumes were determined for Scenarios 1 and 2 using each of the design beach nourishment templates (Cases 2, 3, 5, 7, and 9). Since Scenarios 3, 4, and 5 are variations of Scenarios 1 and 2 with the addition of coastal engineering structures, it was not necessary to compute additional fill volumes. Table 4 presents the total beach nourishment volume associated with each length scenario and nourishment case.

Table 4. Sand Volumes Required For Beach Nourishment Projects on the Town Beach and Entire Barrier Spit.

Scenario	Nourishment Volume (cubic yards)				
	Case 2	Case 3	Case 5	Case 7	Case 9
1	104,240	148,450	60,170	119,800	50,000
2	171,040	327,200	150,670	245,470	92,300

3.2 ENGINEERING EVALUATION OF NOURISHMENT TEMPLATES

The feasibility assessment utilized coastal engineering tools and numerical models to evaluate the level of protection and design life for the various nourishment templates developed for Narragansett Beach. Two different models were utilized to evaluate the performance of the design and spreading of sand away from the original placement area. The Storm-induced Beach Change model, or SBEACH, was used to evaluate cross-shore sediment transport (onshore/offshore) caused by storms. For Narragansett Beach, the model was used to predict the level of protection afforded to upland infrastructure by the nine (9) nourishment templates summarized in Table 3. A subsequent evaluation of longshore transport was performed to predict the spreading of sand away from the original placement area. This analysis used analytical methods to estimate the percentage of fill remaining within the project area, as well as changes in beach width through time. The longshore transport evaluation was performed on the five (5) nourishment length and engineering structure scenarios discussed in Section 3.1.

3.2.1 Cross-shore Sediment Transport

The SBEACH model is an empirically based numerical model for simulating two-dimensional cross-shore beach change. The model was initially formulated using data from prototype-scale laboratory experiments and further developed and verified based on field measurements (Larson and Kraus 1989; Larson, Kraus, and Byrnes 1990). The model predicts the time-dependent evolution of existing or design beach and dune profiles for specified water levels and wave conditions. In addition to the existing beach profile or design nourishment template, the model requires a time series of wave heights, wave periods, and water levels as forcing inputs. The specific storm information required by SBEACH is a time history of total water level (tide plus surge), as well as wave height and period.

Design storms selected for evaluation at Narragansett Beach were the 10-, 25-, and 50-yr recurrence interval storms. Predicted water level or storm surge elevations for these events were obtained from the FEMA Flood Insurance Study (Table 5; FEMA, 2010). Wave characteristics (height, period) during the design storm events were derived from an extremal analysis of data obtained from the U.S. Army Corps of Engineers Wave Information Study (WIS) database (USACE CHL, 2010). The WIS database provides 20-yrs of hindcast wave climatology at nearshore locations along the U.S. coast. An extremal analysis was performed on data from the closest Station to Narragansett Beach (63078, Figure 15) to provide significant wave height and period for the various design storms (Table 5). An example of storm conditions provided to SBEACH for the 25-yr event is illustrated in Figure 16. The storm was assumed to last for a 25-hr period, with water levels peaking at 12.4 hours. Corresponding wave heights and periods were held constant for the duration of the storm.

Table 5. Design Storm Wave and Water Levels.

Storm	Wave Height (ft)	Wave Period (sec)	Surge Elevation (ft, NAVD88)
10-yr	6.56	12.27	7.30
25-yr	7.18	13.47	10.30
50-yr	7.64	14.37	11.70

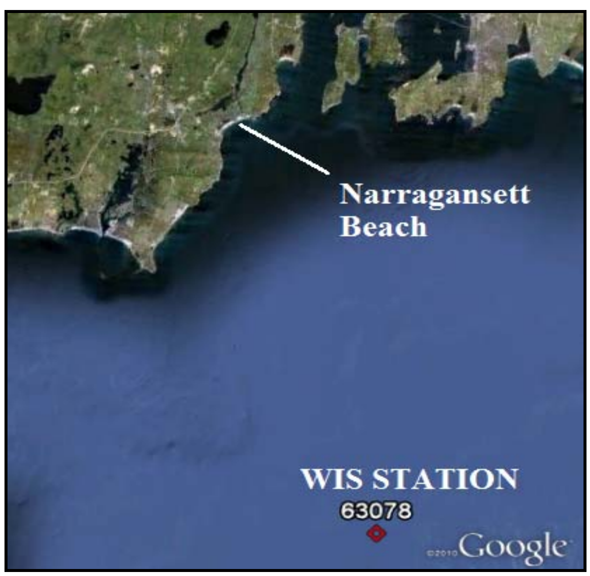

Figure 15. Location of USACE WIS Station 63078 used to develop storm wave conditions for the project area.

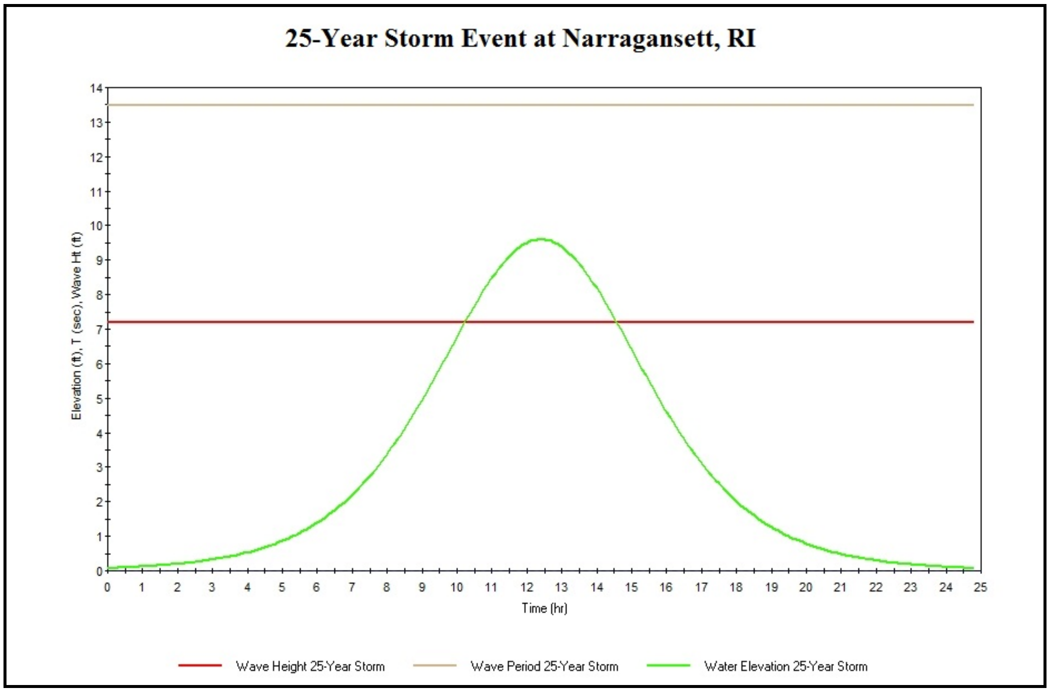

Figure 16. SBEACH input conditions for the 25-yr storm event.

The nourishment templates were considered protective of upland infrastructure if the dunes remained intact following the storm, or in the absence of dunes, if beach erosion did not extend landward into the parking lot or clubhouse areas. Beach performance 2-yrs after initial placement was also evaluated as to the level of protection provided. Figure 17 shows an example of impacts to the Town Beach following the 10-yr and 25-yr storms. At the South Pavilion area (Profile 5) the 10-yr storm causes erosion along the face of the existing dune, but leaves a significant volume of dune resource for storm damage protection. Under the 25-yr storm event the entire dune and seaward edge of the parking lot is eroded. Given these results, the existing beach conditions at the South Pavilion area would be considered protective during lower energy storm events at or below the 10-yr storm, while larger storms could cause significant damage to upland infrastructure. Similar results occur in front of the North Pavilion parking area (Profile 8). Both the South and North Pavilion areas provide moderate to low levels of protection during the 10- and 25-yr storms, respectively.

Little to no protection is provided by the existing beach in the area of the seawall under 10- and 25-yr storm conditions, since the low beach elevation allows water to strike the toe of the wall during much of the tidal cycle (Profile 2; Figure 17). In the absence of a beach, elevated water levels and waves strike directly on the seawall, subjecting the structure to increased forces. Although the seawall provides the last line of defense for upland infrastructure, a beach in front of the wall would buffer incoming waves and increase the level of protection afforded the wall and adjacent upland areas. SBEACH results indicate that existing conditions at the Clubhouse and North Beach Cabanas (Profile 10) do not provide protection during the 10-yr storm or greater (Figure 17). This is primarily due to the lower berm elevation and absence of dunes which allow storm-generated water levels and waves to reach developed areas landward of the beach.

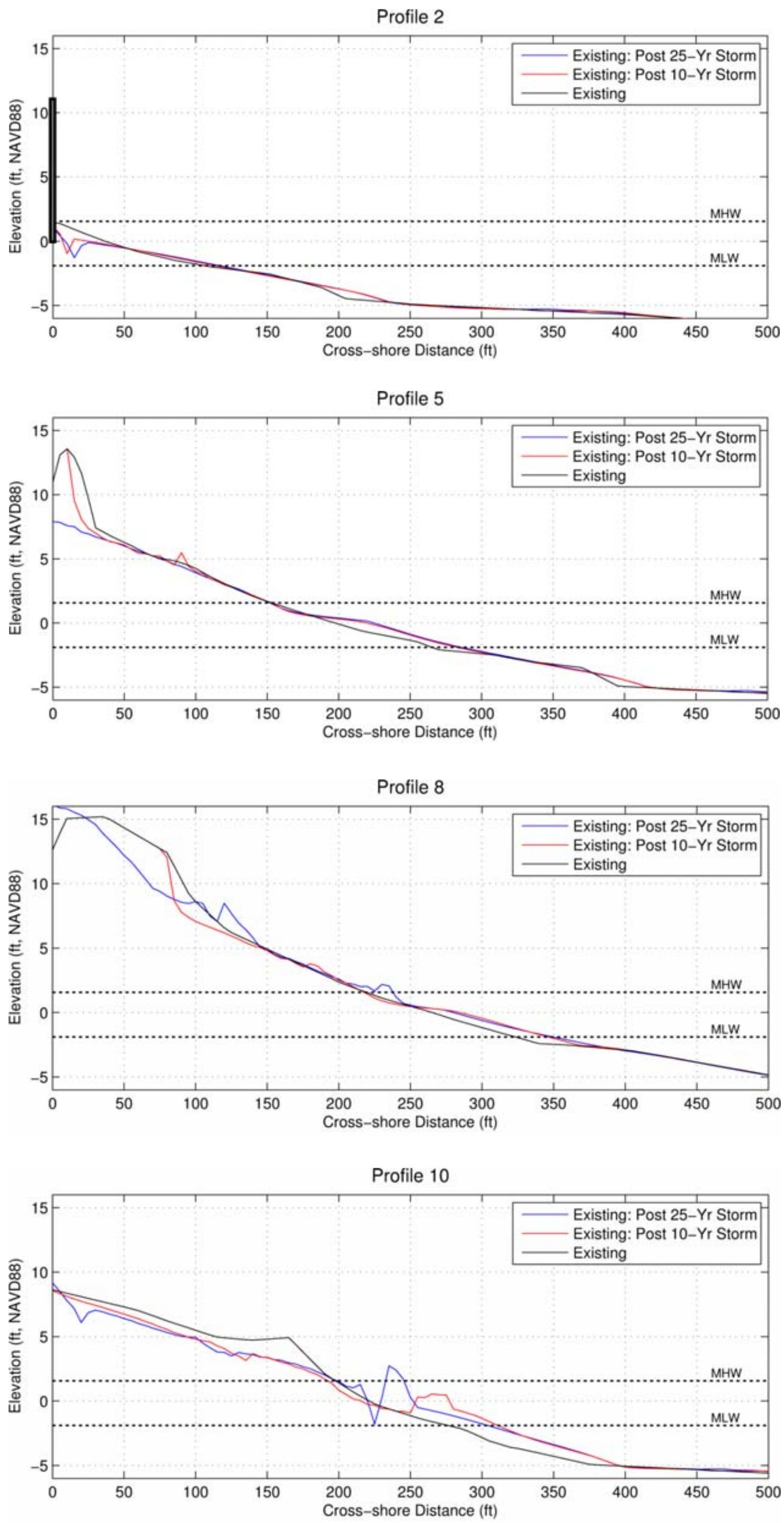

Figure 17. SBEACH results showing impacts from the 10-yr and 25-yr storm events on the existing beach.

Cross-shore modeling for the beach nourishment templates (Cases 2-9; Table 3) was used to identify a minimum design that would increase the level of protection currently provided for upland infrastructure, and enlarge the area available for recreational beach use. Case 5, with a 50 ft berm width and elevations ranging between 6 and 12 ft (NGVD88), was identified as a design that would provide protection during storms up to and including the 10-yr event. SBEACH results for Case 5 are shown in Figure 18. The Case 5 nourishment template results in an increase in the high tide beach width in front of the seawall (Profile 2) of approximately 100 ft. This case also produces wider high tide beaches at the north end of Town Beach, by approximately 50 ft. A low-lying dune was incorporated into the Case 5 design template for the North Cabana and Clubhouse beaches (Profile 10) to increase the level of protection for the landward infrastructure. Impacts during the 10-yr storm event result in erosion of the berm crest and foreshore along all areas of the Town Beach; however, significant beach and/or dune resources remain for storm damage protection and recreational use. Under the 25-yr storm event for Case 5 all of the dunes are eroded and there is flooding of upland areas behind the beach.

SBEACH results from Cases 7 and 8 are shown in Figures 19 and 20, respectively. Case 7 shows the impacts of a 10-yr storm on the initial beach nourishment template, while Case 8 shows the impacts of a 10-yr storm striking two years after nourishment, on a template that has adjusted to equilibrium conditions. The Case 7 design was identified as providing an exceptional level of protection during low to moderate energy storms up to the 25-yr event. The 10- and 25-yr storms cause erosion of the berm crest and foreshore along all areas of the Town Beach; however, significant beach and/or dune resources remain for storm damage protection and recreational use.

The Case 9 nourishment template requires the smallest volume of material while still increasing the level of protection and enlarging the area available for recreational beach use. The replenishment volume needed to construct the Case 9 template for Narragansett Town Beach is roughly equal to the volume of sediment stored in the Narrow River flood delta (see Section 4.2). SBEACH results for Case 9 under the 10-yr storm event are shown in Figure 21. The storm causes a reduction in beach elevation and width in the area of the seawall (Profile 2); however a significant volume of material still remains for continued protection of the wall. At the South and North Pavilion areas (Profiles 5 & 8) the 10-yr storm causes erosion along the seaward toe of the dunes, but leaves enough beach and dune resource to provide storm damage protection for the adjacent infrastructure. The only part of the Town Beach where the Case 9 nourishment template does not enhance protection for the 10-yr storm event is in the North Cabana and Clubhouse areas (Profile 10). Wave activity and increased water levels cause erosion and overwash of the constructed dune, increasing the potential for storm damage and flooding of landward infrastructure.

Although there are significant differences between the replenishment templates evaluated as part of this study, even the smallest project would improve conditions in front of the seawall. The addition of a beach in this area would serve to buffer the wall from incoming storm waves and thereby extend the life expectancy of the seawall.

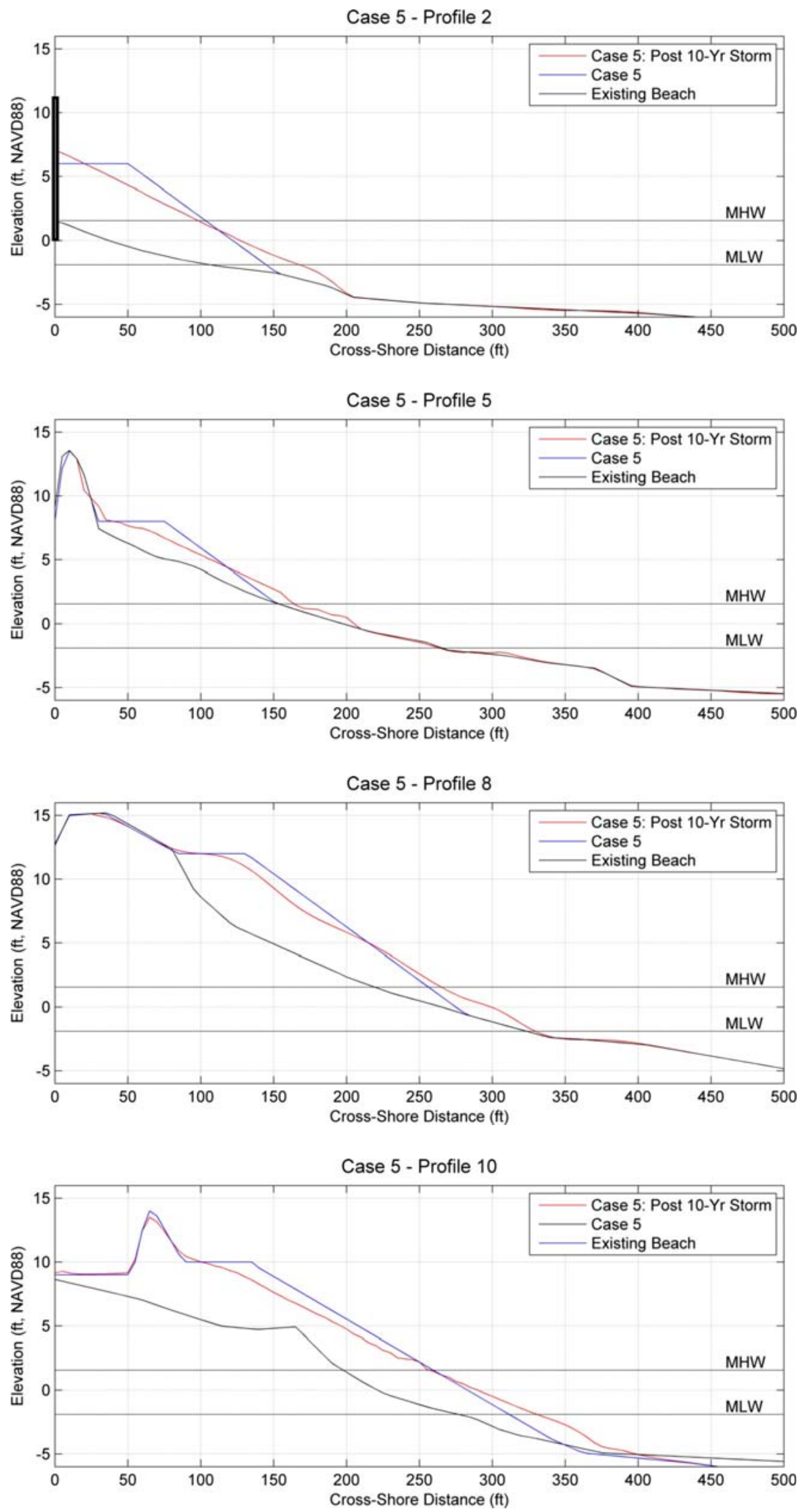

Figure 18. SBEACH results for Case 5 under the 10-yr storm event.

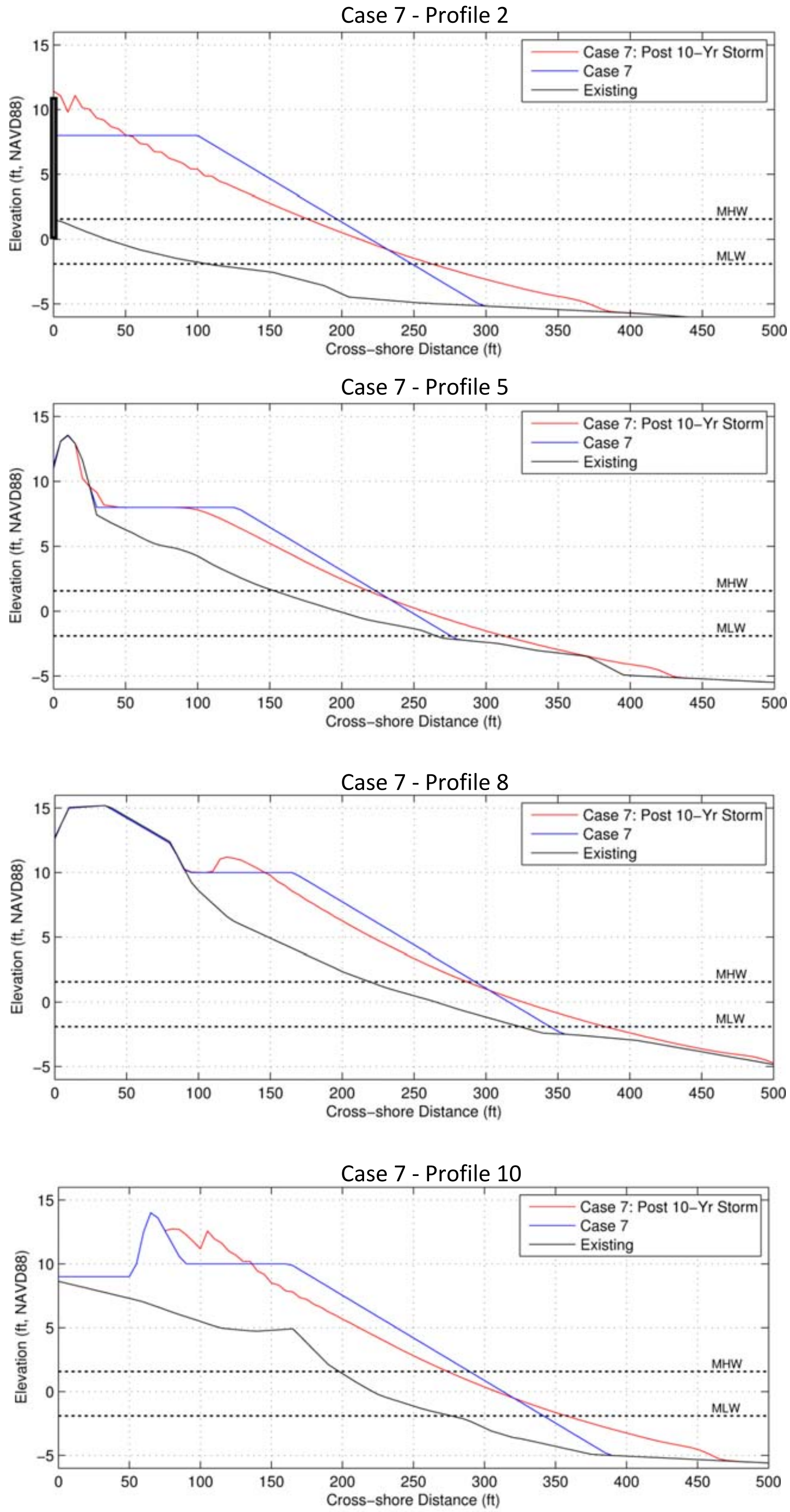

Figure 19. SBEACH results for Case 7 under the 10-yr storm event.

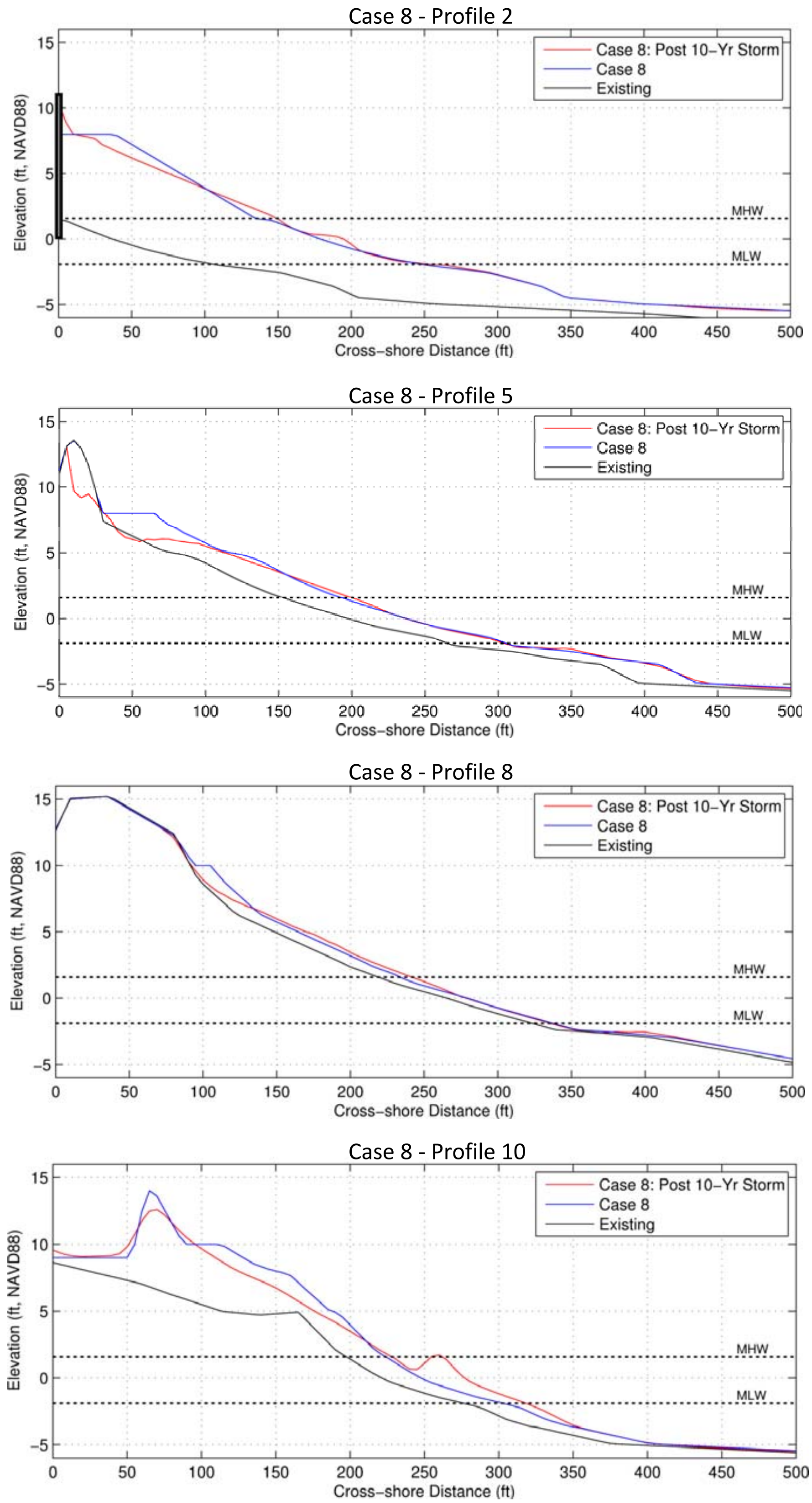

Figure 20. SBEACH results for Case 8 under the 10-yr storm event.

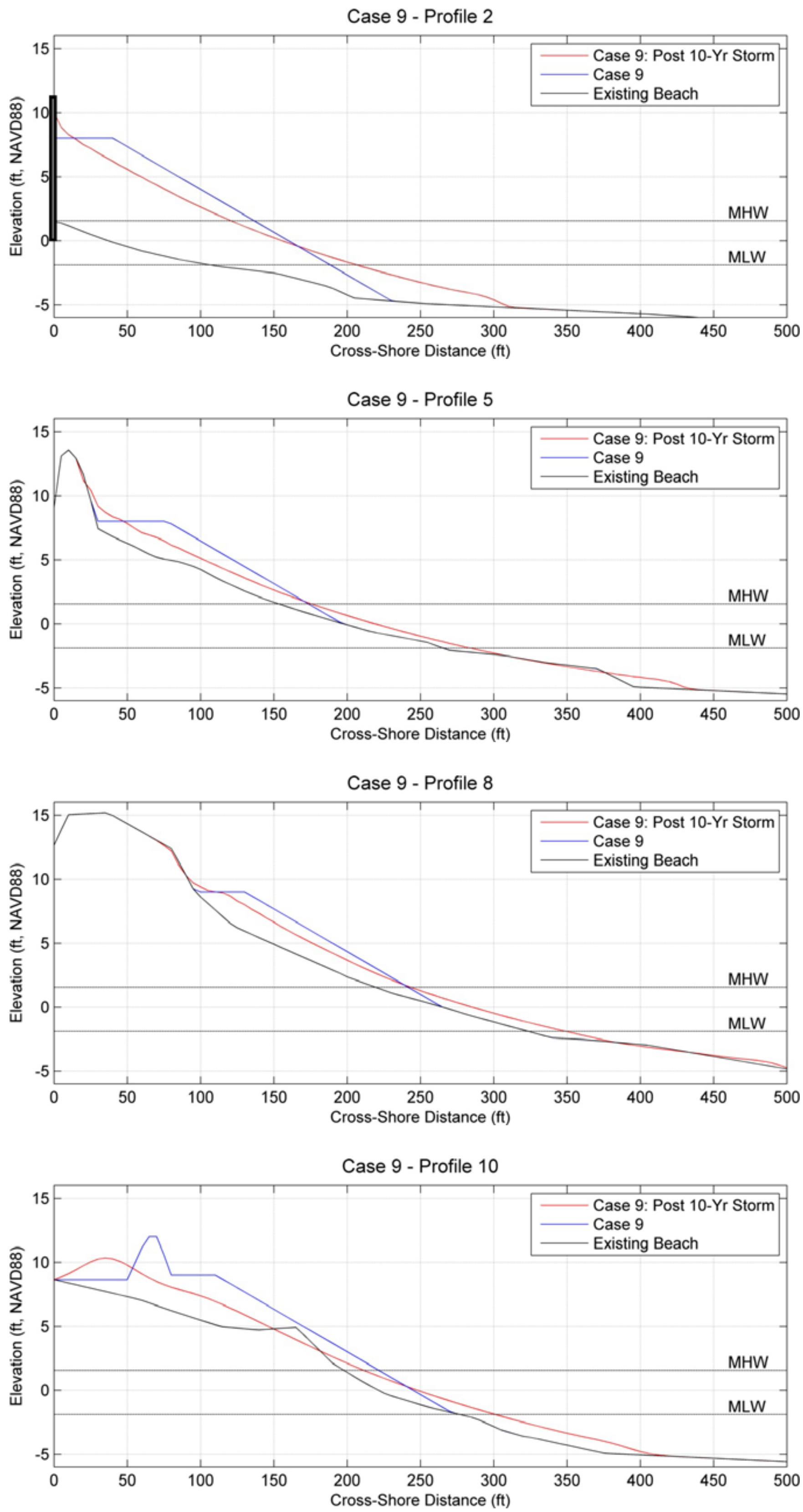

Figure 21. SBEACH results for Case 9 under the 10-yr storm event.

3.2.2 Longshore Sediment Transport

Longshore sediment transport causes sand on the beach to diffuse, or spread over time. This is true not only for natural beaches, but also for beaches that have been nourished, especially during the period immediately after construction. Analytical procedures that combine the conservation of sediment equation with the linearized transport equation have been utilized to evaluate the design life of the five (5) different nourishment scenarios for Narragansett Beach.

- Scenario 1 – Nourishment of Narragansett Town Beach
- Scenario 2 – Nourishment of Narragansett Town Beach as well as private sections of Narragansett barrier spit
- Scenario 3 – Nourishment of Narragansett Town Beach as well as private sections of the beach, with a jetty at the end of Narragansett barrier spit
- Scenario 4 – Nourishment of Narragansett Town Beach with a groin at the boundary between the public and private beaches
- Scenario 5 – Nourishment of Narragansett Town Beach with a jetty at the end of the barrier spit

Design life computations are an additional measure of beach replenishment performance that predict the amount of material left in the origianl project area and the berm width as a function of time. The longevity of a project depends on the geometry of the original project, the size of the fill material, and the wave climatology. The most critical factor however, is the alongshore length of the project, where longevity is generally considered to be proportional to the square of the alongshore project length. The percentage of sand remaining and the berm width will decrease with time, but it should be noted that the material is not necessarily lost from the system. Rather it has spread to regions outside the original nourishment template, acting to supply sand to nearby beaches. For example, sediment placed on the Town Beach may be transported offshore or along the beach to the northeast. Although the sediment no longer falls within the initial nourishment template, it has not disappeared from the system as a whole, and will help to buffer the impacts of storm waves throughout the system.

Figure 22 displays the percent of fill remaining in the original project area for each of the nourishment length and engineering structure scenarios described in Section 3.1. The results are shown for a 20 year time period starting at the point of initial construction. Because the design life calculations are based on percent of original fill volume remaining, and the rates of diffusion do not vary, the results for fill percentages remaining are identical for each of the different nourishment templates. The fill material is shown to initially spread relatively quickly, as indicated by the decrease in percentage of fill remaining, as the shoreline adjusts to a new equilibrium. This behavior is typical of beach nourishment response, since a larger perturbation has been added to the coasline. After a few years, however, this trend begins to decelerate and the material remaining stabilizes. The design life results for Narragansett Beach shown in Figure 22 should be considered conservative, since the analytical techniques do not account for the unique geomorphology of the site which limits sediment losses in the longshore direction around the rocky headlands.

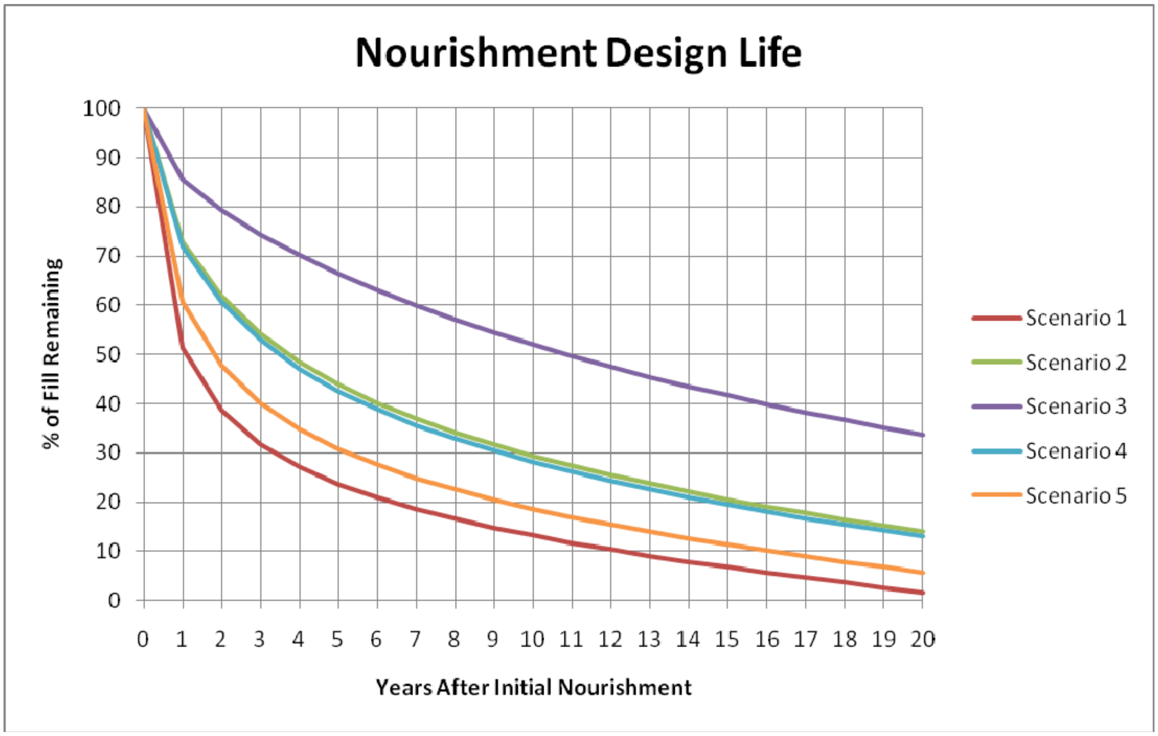

Figure 22. Beach nourishment design life expressed in terms of percent of fill remaining in the original project area.

Scenario 1, which involves nourishing only the Town Beach, yields the shortest project lifetime. Four years after initial placement, approximately 27% of the fill remains in the project area, and by year 8, 16% remains. Nourishment longevity at the Town Beach could be increased by installing a coastal engineering structure at the boundary between the public and private sections of beach (Scenario 4), or at end of the barrier spit (Scenario 5). Under Scenario 4, approximately 48% of the fill remains in the project area after four years, while Scenario 5 has only 35% remaining. The improved design life for Scenario 4 is due to the close proximity of the coastal engineering structure to the fill area, which tends to hold sand in the original footprint and reduce the rate of longshore spreading. The longer Scenarios 2 and 3, which include nourishment on both the public and private sections of beach, have greater design lifetimes than the shorter projects. For example, Scenario 2 shows 49% of the fill remaining after four years, and approximately 34% remaining after year 8. With the addition of a structure at the end of the barrier spit, Scenario 3 holds 70% after year 4 and approximately 58% remaining by year 8.

As a general rule of thumb, renourishment is generally considered appropriate when 30 to 40% of the fill is remaining in the original project area. Depending on the Scenario chosen for Narragansett Beach, replenishment could be considered between 3 and 10 years after initial construction. However, given the conservative nature of the design life estimates replenishment timelines closer to the 10 year interval are most likely.

Figures 23 and 24 show the width of the berm at the center of the original project area as a function of time, for Cases 5 and 7, respectively. The results are shown for a 20 year time period starting at the point of initial construction. An average background erosion rate of -0.45 ft/yr was assumed for the analysis. As the nourishment spreads over time, the available width of beach is reduced. For Case 5, which is considered to be the minimal design that provides a reasonable level of protection, the berm width for Scenario 1 at the center of Town Beach starts at 50 ft and is reduced to approximately 13 ft after a period of 4 years. Increased berm widths are seen with the longer scenarios and those with structures that help to reduce spreading of the fill. For Case 7, where an exceptional level of protection is provided, the average berm width for Scenario 1 starts at 75 ft wide and is reduced to approximately 20 ft after a period of 4 years. Here again, improved performance is seen with the longer scenarios and those with coastal engineering structures.

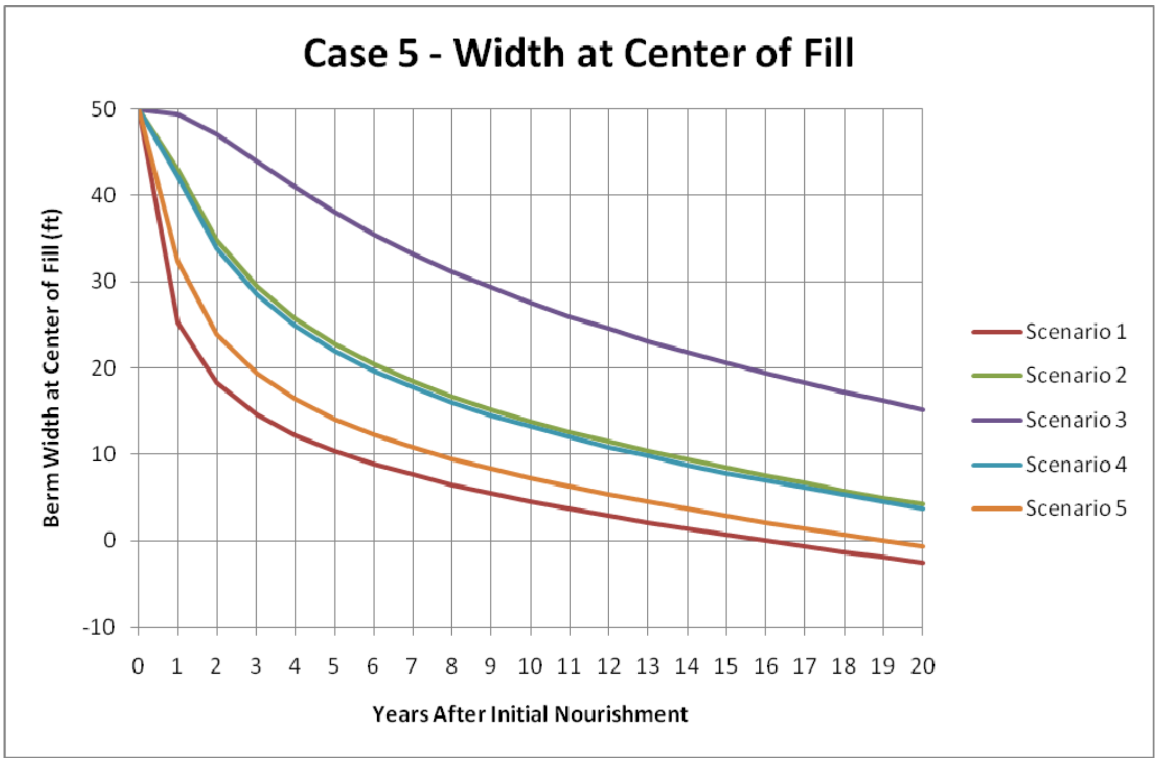

Figure 23. Beach nourishment design life for Case 5 expressed in terms of berm width at the center of the original project area.

A summary of the replenishment alternatives considered for Narragansett Beach is provided in Table 6. The replenishment alternatives evaluated as part of this study are compared with the existing management practices which involve placement of 300 to 400 cy of sand annually. The level of storm damage protection afforded by the different nourishment templates, sand volumes required for construction, and performance expectations for 30% fill remaining are provided in Table 6.

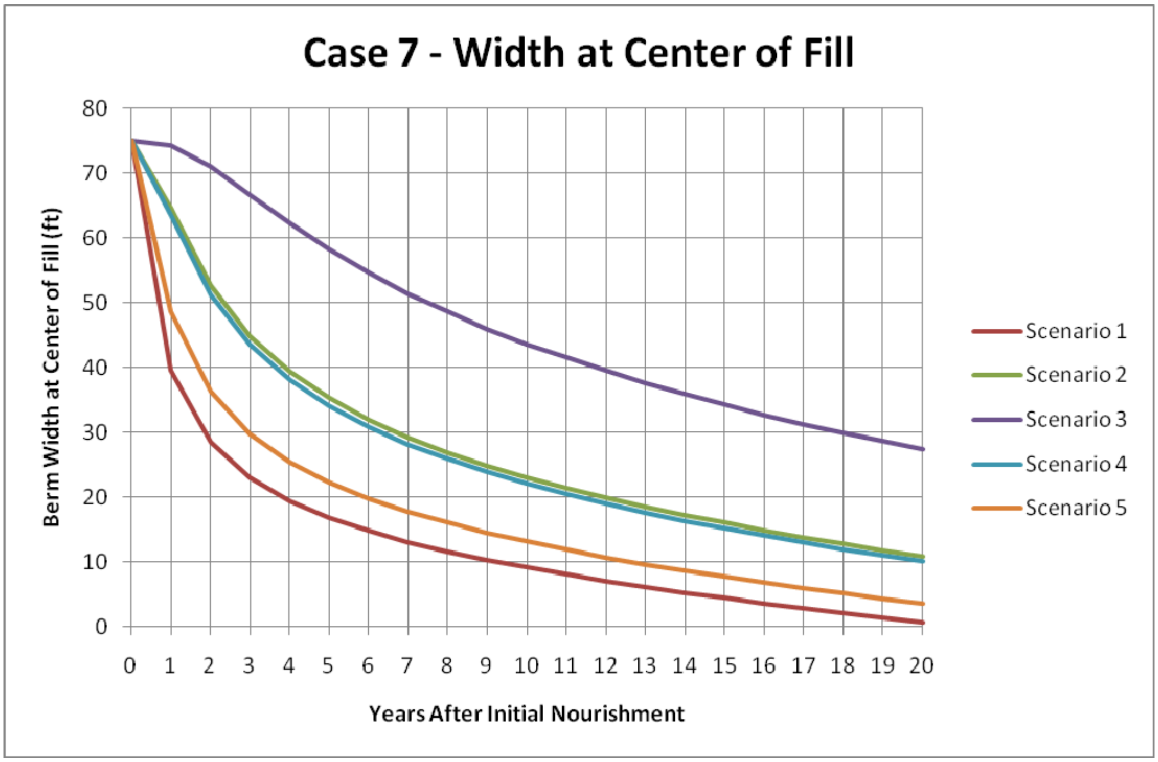

Figure 24. Beach nourishment design life for Case 7 expressed in terms of berm width at the center of the original project area.

Table 6. Comparison of Beach Replenishment Alternatives

Level of Protection	Replenishment/ Structural Alternative	Case and Scenario #	Approximate Volume (cy)	Performance Expectations (30% Remaining)
< 10-Yr Storm Protection	Town Beach	Status Quo	300 – 500 annually	NA
< 10-Yr Storm Protection	Town Beach	Case 9 Scenario 1	50,000	3.3 yrs
10-Yr Storm Protection	Town Beach	Case 5 Scenario 1	60,170	3.3 yrs
10-Yr Storm Protection	Town and private beaches	Case 5 Scenario 2	150,670	9.5 yrs
10-Yr Storm Protection	Town Beach w/ groin at public/private boundary	Case 5 Scenario 4	60,170	9.1 yrs
~ 20-Yr Storm Protection	Town Beach	Case 7 Scenario 1	119,800	3.3 yrs
~ 20-Yr Storm Protection	Town and private beaches	Case 7 Scenario 2	245,470	9.5 yrs
~ 20-Yr Storm Protection	Town and private beaches w/ jetty at end barrier spit	Case 7 Scenario 3	245,470	> 20 yrs

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4.0 POTENTIAL SOURCES OF SEDIMENT

Implementation of any of the beach nourishment scenarios evaluated in Section 3.0 will require a significant volume of sand. A key component of the nourishment project is identifying a suitable source of sand that meets engineering design criteria, and is both affordable and acceptable from an environmental perspective. In other words, a sufficient quantity and quality of sand must be identified, preferably from a location in close proximity to the beach, and from a location where removal of sand will not result in undesirable environmental impacts.

The quantity of sediment available from a particular borrow site must be compared with the beach nourishment design to determine if the required volume exists. Although it is possible to utilize more than one sand source for a beach nourishment project, it typically increases construction costs and can add complexity to the environmental impact analyses. Sand grain size is another important factor in selecting a source, and the ideal location provides a grain size that is at least as coarse as the native beach material. Sand that is finer than the native beach sand is typically eroded more rapidly from the beach by waves and currents. This can result in added expense, reduced storm protection, and reduced beach nourishment design life. Consequently, it is important to investigate the characteristics of potential borrow sites to ensure the source provides clean, beach-compatible material that satisfies engineering design criteria.

The suitability of the following four (4) sources of nourishment material for Narragansett Beach was investigated as part of this study:

- Upland – Local sand and gravel mining facilities that could supply sand via trucking operations,
- Narrow River – Sand from the flood tidal delta and Sprague Bridge areas of the Narrow River,
- Offshore – Sand from offshore areas, and
- Navigation Channels – Sand dredged from nearby navigation/construction projects.

The suitability analyses were performed using existing sources of information, and no new field data were collected to support the evaluation. If the Town elects to proceed with a final alternatives analysis and design, certain more detailed studies and investigations will be required, especially for the Narrow River and offshore sediment sources. A description of the suitability of the four (4) sediment sources is provided in the following sections.

4.1 UPLAND SEDIMENT SOURCE

Many upland sediment sources have the benefit of large quantities of sand that are readily available for trucking to the beach nourishment project area. Because of the geologic environment in which the material was originally deposited, upland sands tend to contain a wider range of particle sizes than coastal or marine sediments. Natural sorting processes associated with wave and current action in the marine environment generally results in a more uniform sediment distribution. In addition, the color of upland sediment often has reddish cast or iron stain, and may be considered aesthetically unacceptable due to differences from the native beach material. Despite these factors, upland sediment sources are often considered viable alternatives for large-scale beach nourishment projects due to the economic feasibility and the availability of large quantities of sand.

The Town of Narragansett has used sand from the George Sherman Sand & Gravel company located in South Kingstown, RI for past renourishment activities. This work has typically involved renourishment with 300 to 500 cy of sand each year, placed at the beginning of the busy summer season. Greater volumes of 2,000 to 3,000 cy have periodically been placed on the beach following large spring storm events. Sediment quality has been considered suitable for the Town Beach. Continued renourishment with small quantities of material from the George Sherman Sand & Gravel company is feasible; however, they do not have enough material to supply the quantities needed for any of the larger beach nourishment scenarios evaluated in Section 3.0.

Two other upland aggregate suppliers, Dry Bridge Sand & Stone, Inc. in North Kingstown and Richmond Sand & Gravel, Inc. in Richmond, have been identified as potential suppliers of suitable beach nourishment material for Narragansett Beach. Both companies supply washed concrete sand and bedding sand products that would be compatible with the existing beach sediment. Volumes between 60,000 and 100,000 cy are readily available at both sites, and additional sand could be made available with advance notice. Round trip trucking distances are 26 and 33 miles respectively, for the Dry Bridge and Richmond suppliers.

4.2 NARROW RIVER SEDIMENT SOURCE

Sediments from the Narrow River flood delta and Sprague Bridge areas were evaluated as a potential source of beach nourishment material for Narragansett Beach. Background information for this evaluation came primarily from a joint USACE and CRMC feasibility study of Aquatic Ecosystem Restoration for the Narrow River that was initiated in March 2005. The feasibility study considered alternatives to restore eelgrass, shellfish beds, salt marsh, and other habitats in the Narrow River. Potential alternatives involved dredging and redistributing sediments to restore elevations and depths for salt marsh and eelgrass, as well as dredging to improve tidal flushing and water quality. Baseline studies involved the collection of bathymetric data, sediment sampling and analysis, shellfish and shorebird surveys, and water quality monitoring. A hydraulic model study was also performed to evaluate the impacts of different dredging scenarios on tidal flushing. The feasibility study was terminated in 2010 based on results from the hydraulic model study that showed dredging the Narrow River flood delta would not have significant ecosystem restoration benefits. The eelgrass and salt marsh restoration alternatives further inside the Narrow River estuary remain as viable options and could be reevaluated in the future.

Sediment sampling and bathymetric survey data collected as part of the USACE and CRMC feasibility study were utilized to evaluate the suitability of the Narrow River shoals as a source for beach nourishment. A detailed sediment sampling program was conducted during August and November 2005 (Figure 25). Grab samples were collected

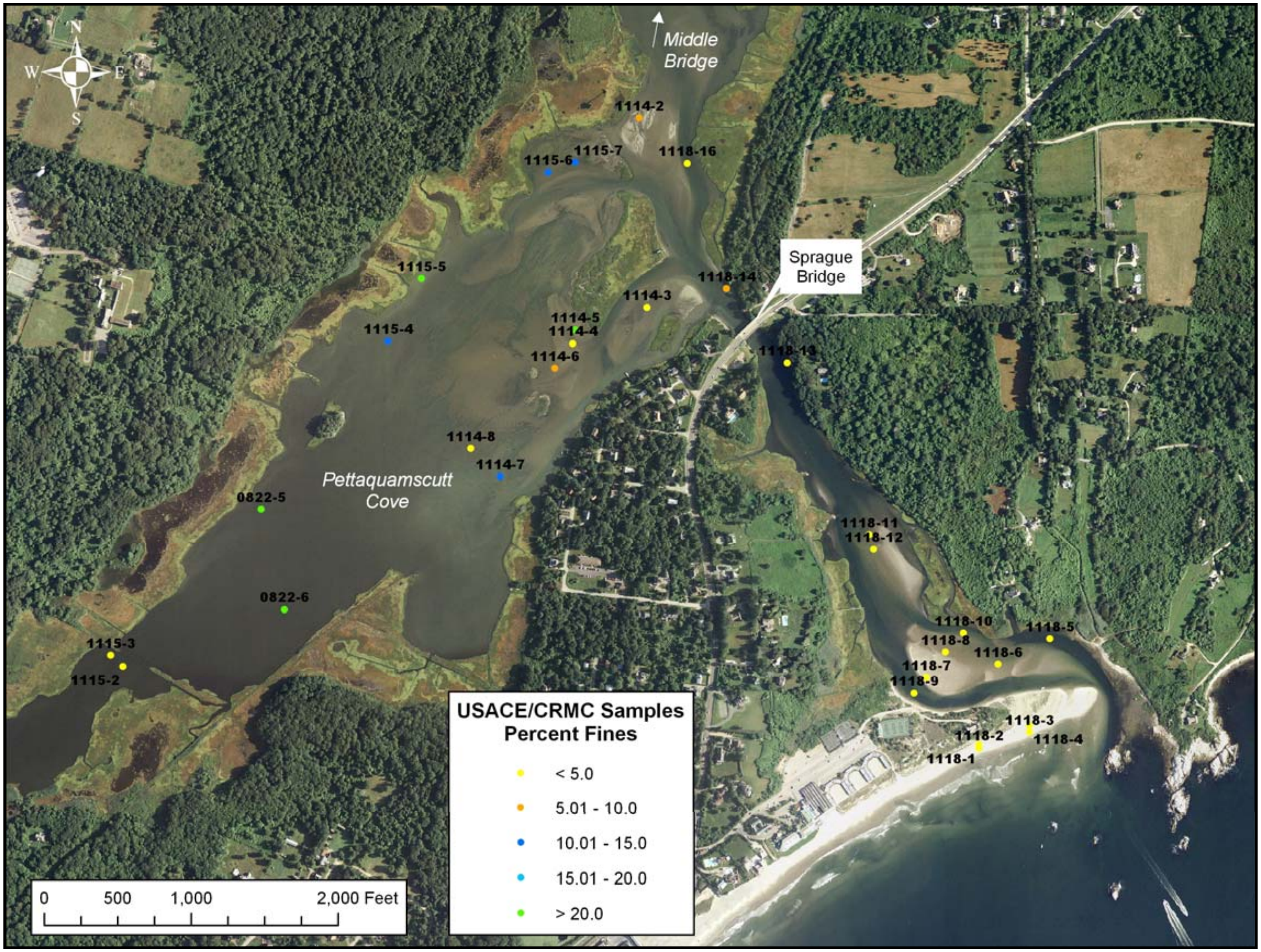

Figure 25. Sample sites characterized by the USACE and CRMC Aquatic Ecosystem Restoration feasibility study for the Narrow River.

from the shoal and channel areas within the Narrow River estuary and analyzed for grain size characteristics. Results from the sample locations shown in Figure 25 indicate that sediments between the Narrow River entrance and Sprague Bridge are composed of sand with mixed gravel and low percentages of fines (silt/clay < 1.3%). Sediments to the north of Sprague Bridge in Pettaquamscutt Cove are generally finer grained, especially along the north shore of the Cove where percentages of fines range between 11.4 and 84.8%. Shoals between Pettaquamscutt Cove and the river leading to Middle Bridge are sandy with low quantities of fine-grained material, as are the shoals south of the marsh island at the entrance to the Cove. The RI Department of Environmental Management (DEM) Rules and Regulations for Dredging and Management of Dredged Material (DEM-OWR-DR-02-03) indicate that material to be used for beach nourishment must not exceed 10% fines (silt and clay). Based on these regulations the area between the Narrow River entrance and Sprague Bridge would be suitable for nourishment of Narragansett Beach, as would parts of the estuary leading to Middle Bridge and the south channel into Pettaquamscutt Cove.

Grain size compatibility between Narragansett Beach and Narrow River sediments is illustrated in Figure 26. Samples from the public beach area are compared with representative Narrow River sediments that contain less than 10% fines. Samples from the flood shoal are shown to be slightly coarser than the beach sand, while samples from the south channel into Pettaquamscutt Cove are very similar to the beach. In general, however, the Narrow River sediments meeting the RIDEM fines criteria (< 10% silt/clay) are compatible with the natural sand on Narragansett Beach.

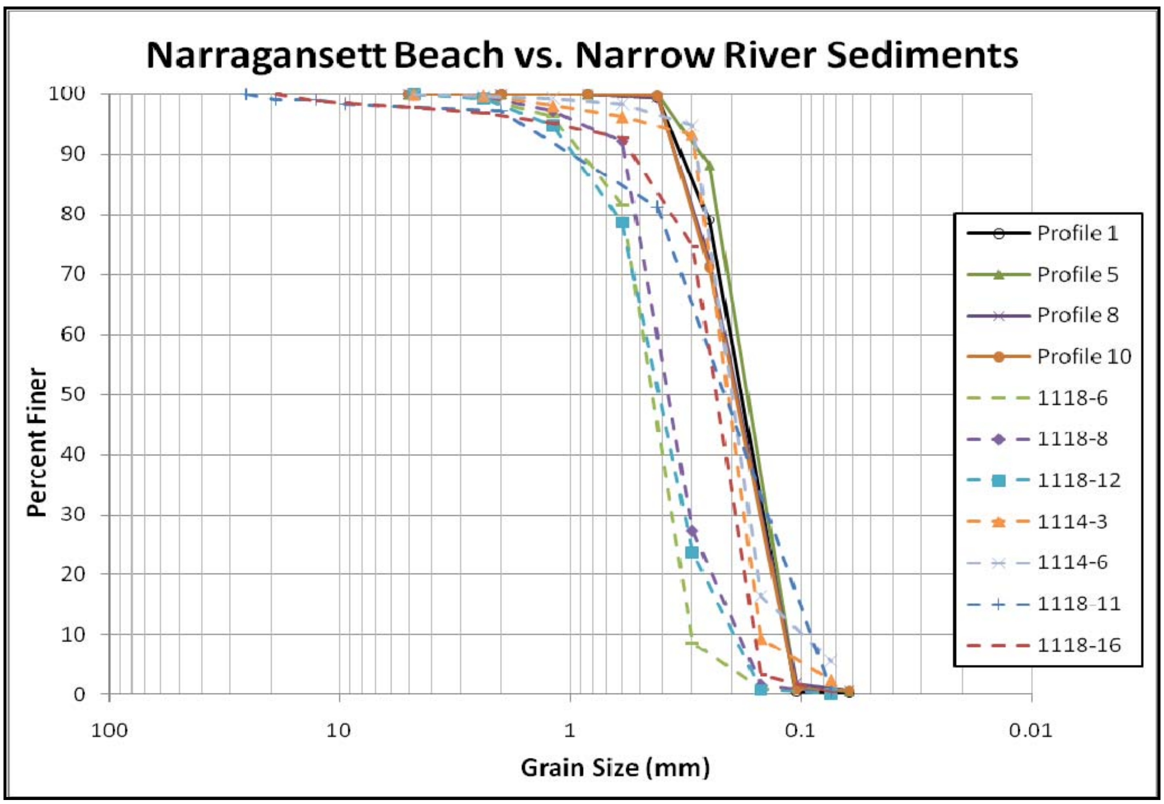

Figure 26. Narragansett Beach and Narrow River sediment compatibility.

Bathymetric survey data collected in support of the USACE/CRMC feasibility study in the Narrow River were used to determine if dredging would supply sufficient volumes of sediment for nourishment of Narragansett Beach (Figure 27). The survey data were collected under the leadership of Dr. Jon Boothroyd from the University of Rhode Island (URI) during the fall of 2006 and spring of 2007. The USACE hydrology and hydraulics report (USACE, 2009) provides volumes for three (3) dredge scenarios considered for ecosystem restoration in the Narrow River. The areas included in the dredge calculations, as well as the depth of dredging and volumes produced are summarized in Table 7. Independent calculations of dredge volumes prepared as part of this study using the URI bathymetric data set were comparable with the USACE volumes.

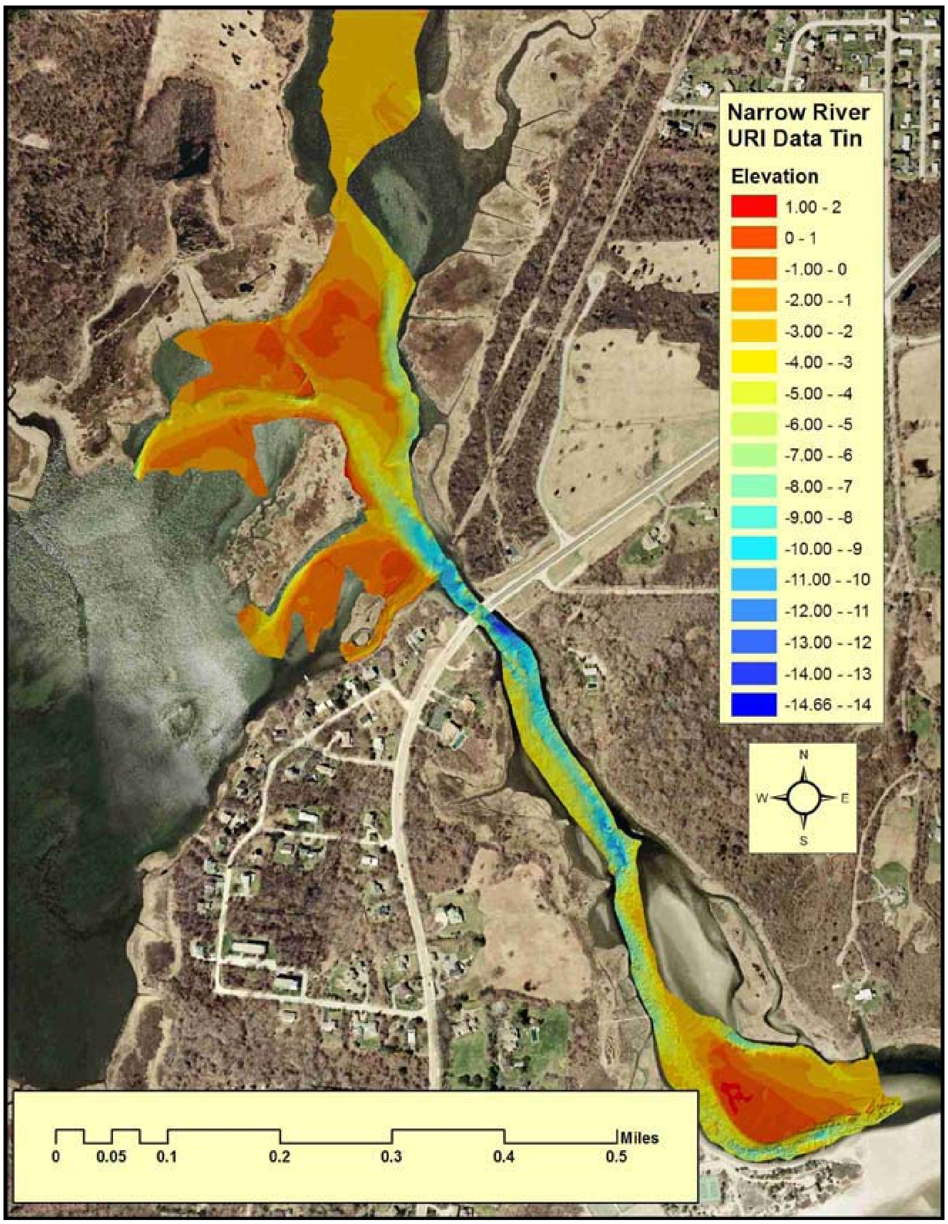

Figure 27. Narrow River bathymetric survey showing elevations of the river bottom between the inlet and Middle Bridge.

Table 7. Dredge Scenarios and Volumes for the USACE Narrow River Feasibility Study.

Dredge Scenario	Dredge Sites	Dredge Elevation (ft, NGVD29)	Dredge Volume (cy)
1	Shoals between inlet and Sprague Bridge	-2	28,000
2	Shoals between inlet and Sprague Bridge	-3	47,000
3	Shoals between inlet and Sprague Bridge; channels from deep water N of Sprague Bridge to stone causeway in Pettaquamscutt Cove and to Middle Bridge	-4	68,000

The volume created by dredging the Narrow River to -4 ft NGVD29 (dredge scenario 3) would produce enough sand to construct the beach nourishment Scenario 1 with the Case 5 or Case 9 template (Tables 3-4). Sufficient sand is not available to construct any of the larger nourishment templates on the Town Beach (Cases 2, 3, or 7), nor is there adequate sand in the Narrow River to extend the project onto the private beaches. An additional calculation of sediment volume in the two primary shoals between the inlet and Sprague Bridge down to a dredge elevation of -4 ft NGVD29 indicates approximately 50,000 cy of sand. This scenario would provide enough material to construct the Case 9 nourishment template on the town-owned beach.

The USACE hydrology and hydraulics study showed that the only significant tide range reduction in the lower Narrow river system is caused by the inlet and associated shoals (USACE, 2009). The flood shoal at the mouth of Pettaquamscutt Cove and the Middle Bridge do not cause any notable impact on tide range. As such, the only study alternative that significantly impacted tidal prism and flushing was dredging the inlet channel down to – 4 ft NGVD29 (dredging scenario 3). This alternative was shown to increase the tide range and tidal prism, and to decrease (improve) the flushing times. For the inlet only option, the flushing time was reduced by 20%, and when the dredging was extended to Pettaquamscutt Cove and Middle Bridge, the flushing time was reduced by 26%. Despite these results, it was concluded that dredging the Narrow River flood delta would not have significant ecosystem restoration benefits and further work on the USACE & CRMC feasibility study was terminated. Use of a nitrogen loading model to evaluate potential ecosystem benefits of reduced flushing was mentioned in the USACE hydrology and hydraulics study; however, it is unclear if this type of analysis was performed, or if it was a factor in terminating the project.

4.3 OFFSHORE SEDIMENT SOURCE

Areas offshore of Narragansett Beach were evaluated as a third potential source of sediment for nourishing the beach. Information was obtained from studies by the USGS on sea floor sediment characteristics and thicknesses, and from National Oceanographic and Atmospheric Administration (NOAA) maps showing offshore bathymetry (USGS, 2005; USGS, 2009; NOAA 1998). Figure 28 provides a summary of sediment distributions for the project area from the USGS continental margin mapping project (USGS, 2005). In spite of the coarse data resolution, sediments along the eastern coastline of the town between Narragansett Beach and Point Judith are classified as sand. Finer-grained clay-silt/sand sediments are mapped at the entrance to West Passage.

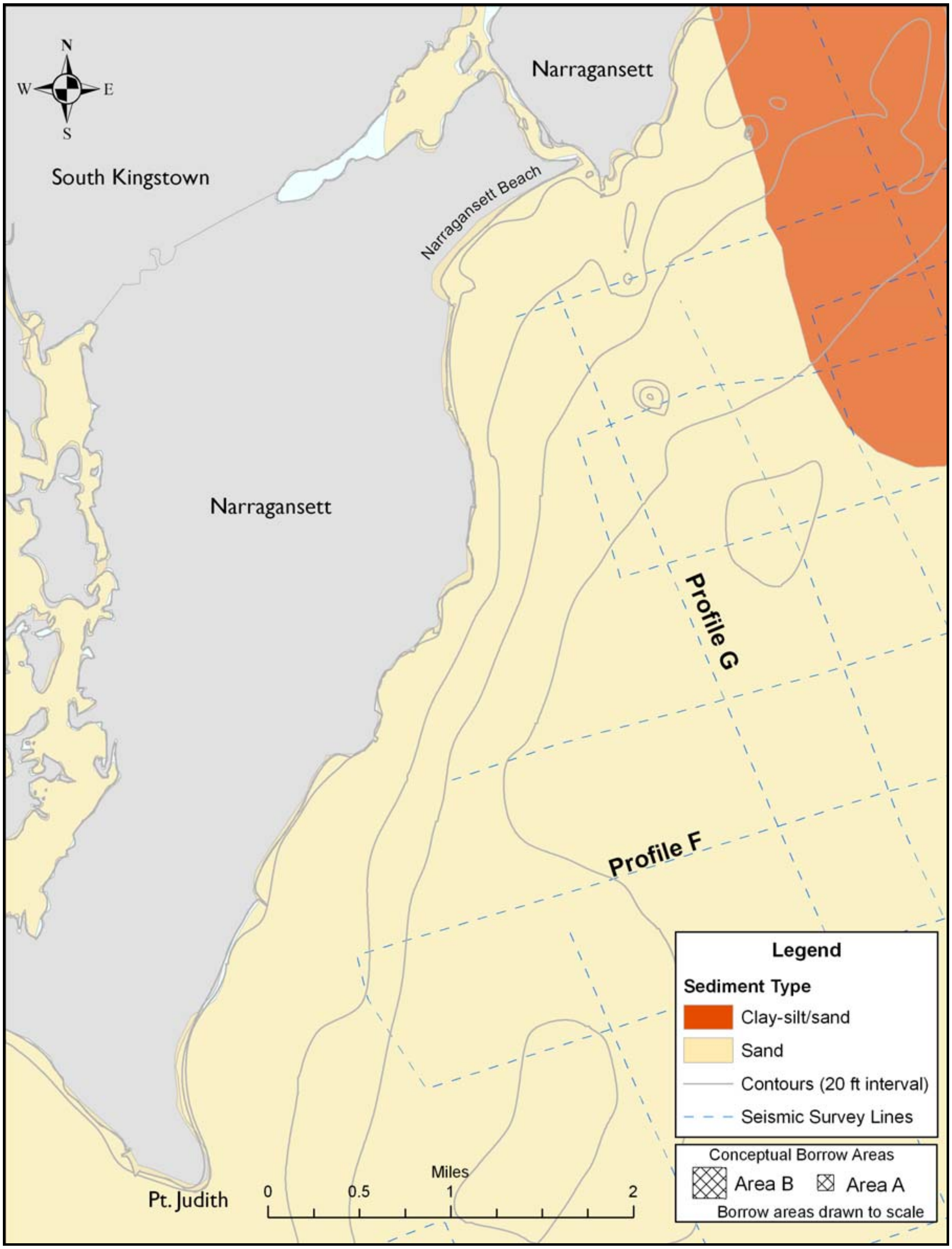

Figure 28. Sediment and bathymetry information offshore of Narragansett.

Additional detail on seafloor sediments in the vicinity of the project area is available from a high-resolution, seismic-reflection, and sidescan-sonar survey conducted by the USGS in 1980 (USGS, 2009). Survey data collected along the tracklines shown in Figure 28 provide information on geologic units and thicknesses offshore of eastern Narragansett. Stratigraphic interpretation from Profile G is shown in Figure 29. The project area at Narragansett Beach is closest to the NNW end of the profile. The seafloor surface is shown to be covered by unit Qpt, defined as marine deposits composed of sandy silts and silty sands. Unit Qpt is found offshore of the RI coast between the entrances to Narragansett Bay and Point Judith, as a seaward-thinning wedge of sediments up to 26 ft thick. These data indicate the presence of a large and rather uniform deposit of sandy sediments offshore of the project area that could be suitable for beach nourishment material, both in terms of sediment quality and quantity.

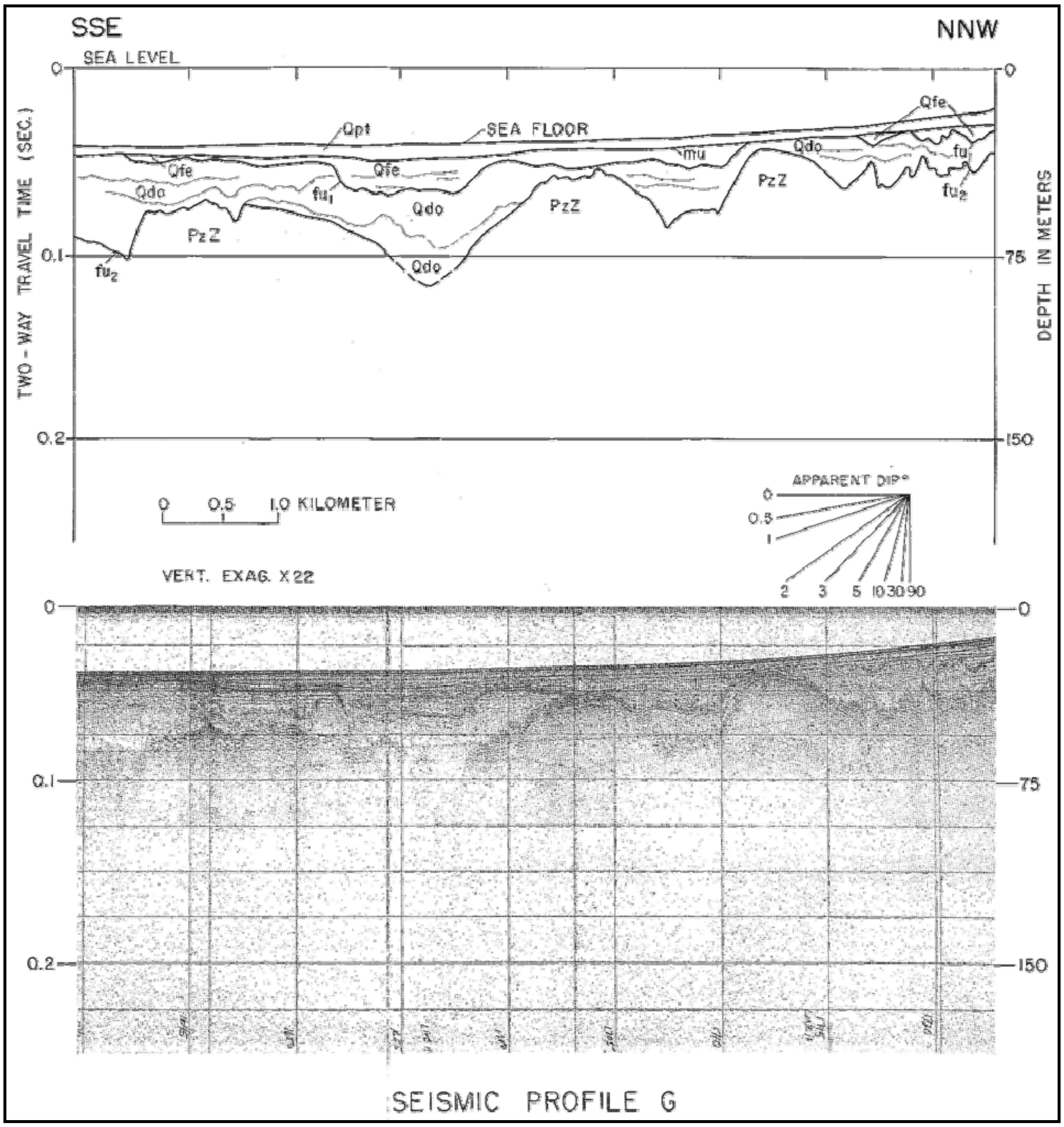

Figure 29. Interpretation of seismic and sidescan sonar data collected along Profile G (Figure 28) offshore of Narragansett Beach.

An estimate of the size of an offshore borrow area needed to supply sand for the smallest Town Beach nourishment project (50,000 cy for Scenario 1, Case 9) is illustrated by Area A on Figure 28. Area B represents the size of borrow area needed to supply sand for a larger nourishment project (245,470 cy for Scenario 2, Case 7). The borrow areas were sized by assuming an average dredge cut of 8 ft, and then determining the area needed to fulfill the nourishment volumes. While the conceptual borrow areas A and B fit within the offshore area of the Narragansett Beach embayment, there are a number of additional factors beyond the scope of this study must be considered in delineating an offshore borrow site. For example, water depths between 18 and 25 ft MLW must be available, that will allow access and working room for the dredge equipment. Distance between the borrow site and the beach nourishment area is also an important factor that can control the type of dredge equipment used. The potential for environmental impacts to benthic habitats, cultural resources, and the incident wave climatology must also be evaluated.

The conceptual layout for offshore borrow areas at Narragansett suggests that it may be possible to design sites that would supply the required volume and quality of sand needed for even the largest beach nourishment project. It also highlights the need for a more in-depth evaluation into the feasibility of an offshore borrow site. Impacts to the wave climate along the shoreline should be addressed to avoid the possibility of wave focusing and increased hot spot erosion. The dimensions and location of a borrow site could be optimized through this type of analysis. Environmental data would also need to be collected on benthic communities, as well as sediment characteristics and thickness.

4.4 NAVIGATION CHANNELS

Maintenance or improvement dredging from nearby navigation/construction projects may also provide a viable source of sediment for nourishing Narragansett Beach. Based on discussions with CRMC personnel, future development work at Quonset Point may result in the dredging of significant quantities of sediment. While much of the expected dredge material appears to be too fine for beneficial reuse as beach nourishment, it is possible that enough sandy material to construct a project at Narragansett Beach could be identified. Further coordination with CRMC staff and Quonset Point development personnel are needed to investigate the feasibility of this sediment source.

The Point Judith Harbor of Refuge is another nearby site that could potentially serve as a sediment source for nourishing Narragansett Beach. The Harbor of Refuge is currently authorized as a federal navigation project, and as such the USACE is responsible for maintaining navigation. Historically, dredging has been required to maintain navigation in the entrance channel leading to the Harbor, as well as east and west branch channels and the anchorage area within the Harbor. The dredged sediment consists of clean sand with very little fine-grained material. An Environmental Assessment (EA) performed by the USACE in 2006 found that placement of the dredged sediments as a nearshore feeder berm off of nearby Matunuck beaches was the preferred disposal area. The most recent maintenance dredging of the entrance channel in 2009 and 2010 made use of the beneficial reuse site offshore of Matunuck. The project was considered successful in terms of helping to mitigate erosion in the Matunuck area, and future plans for dredging by the USACE will continue to utilize the Matunuck site.

The USACE is currently conducting a Major Rehabilitation Study for the main breakwater that forms the Point Judith outer Harbor of Refuge. As part of this effort the USACE is evaluating the effectiveness of the breakwater in its current condition to provide protection for navigation as well as secondary shore protection benefits. Results from the study will be used to make recommendations on whether or not to repair the structure. If the project proceeds with repairs to the breakwater, it is likely that significant quantities of beach compatible sand will be generated. Continued discussions with the USACE will be required to track the progress of this project, and to determine the feasibility of securing sand for nourishment of Narragansett Beach.

The USACE is also authorized to maintain navigation within the outer Harbor of Refuge at Point Judith; however, dredging work has never been needed in this area. Nonetheless, the outer Harbor does tend to accumulate sediment and several large shoal areas exist that could potentially be mined for beach nourishment activities. Even though maintenance of the outer Harbor falls under the jurisdiction of the USACE, dredging by non-federal parties is allowed provided the necessary permits are obtained. However, the opportunity for cost sharing between the USACE and non-Federal parties in this area is low since the USACE has not determined a need for dredging. Shoal areas in the outer Harbor would provide an ample supply of beach compatible sand for Narragansett Beach, and various dredging methodologies could be utilized to transport the sand from the Harbor to the beach.

A summary of sediment source suitability for Narragansett Beach is provided in Table 8. Sediment compatibility, available volume, and expected level of regulatory review for each of the sediment sources discussed previously is shown.

Table 8. Suitability of Sediment Sources for Narragansett Beach Nourishment

Source	Sediment Compatibility	Sediment Volume Available (cy)	Assumed Level of Regulatory Review
Upland	Good	Variable up to maximum needed	Moderate
Narrow River	Excellent	~ 68,000	High
Offshore	Likely Good (further study needed)	Variable up to maximum needed	High
Pt. Judith Harbor of Refuge entrance channels	Not feasible for Narragansett since suitable placement sites have already been identified.		
Pt. Judith breakwater repairs	Likely Excellent (further study needed)	Variable; likely up to maximum needed	Moderate
Pt. Judith outer Harbor of Refuge	Likely Excellent (further study needed)	Variable; likely up to maximum needed	Moderate to High

5.0 CONSTRUCTION METHODOLOGY

For a beach nourishment project, the location of the sand source dictates the method(s) by which the sand can be transferred to the beach, and also the cost of construction. Sand from upland sources is typically trucked to the beach, which can be expensive depending upon the proximity of the source to the beach and the prevailing cost of trucking and fuel. Trucking operations also limit the volume of sand that can be delivered to the beach, and can cause traffic and community conflicts.

Sand from offshore sources is most often delivered to the beach via a dredging operation. Sand obtained from close to shore in an environment or time of year when wave action is light can be pumped directly to the beach via a hydraulic dredge. Sand obtained from farther offshore, or in locations or times of year with higher wave conditions that preclude establishment of a fixed hydraulic dredge, can be dredged and placed into a hopper barge or scow. This type of project can be performed using hydraulic or mechanical dredging equipment. The hopper barge or scow is transported to the nearshore area and the sand is either pumped directly to the beach or dumped on the seafloor for hydraulic dredging to the beach. Hopper dredge operations also can be used to transfer sand from regional navigation dredging projects to a beach in need of sand for nourishment. Beneficial reuse of sand dredged from navigation channels is desirable, provided the sand is clean and beach-compatible, since costs of nourishment can be shared with the navigation interests, and the environmental impacts can be minimized (i.e., eliminate or reduce needs for additional impacts associated with offshore dredging). A description of construction methodologies involving trucking, mechanical dredging, and hydraulic dredging is provided below. Specific use of these construction methods at Narragansett Beach is also addressed.

5.1 TRUCKING

Trucking sand supplies from upland sources is an option if appropriate local sources of dredged material cannot be identified. Transportation of sand from upland sources involves the use of large end dumps, excavators, and articulated end dumps. Advantages of trucked sand include less complex equipment requirements and fewer environmental permitting obstacles. Disadvantages of trucked sand include lower production rates and increased road traffic for larger projects.

Two local upland aggregate suppliers, Dry Bridge Sand & Stone, Inc. in North Kingstown and Richmond Sand & Gravel, Inc. in Richmond, have been identified as potential suppliers of suitable beach nourishment material for Narragansett Beach. Sand could be hauled from either location using large trailer dumps with capacities of approximately 25 cy per truck. Sand could be delivered to the beach at a rate of 1,200 to 3,000 cy per day. A smaller beach nourishment project of 50,000 cy (Scenario 1, Case 9) could be supplied in 17 to 42 days, while a larger project of 245,470 cy (Scenario 2, Case 7) would take between 82 and 204 days to supply.

The upland sand would be delivered to staging points where direct access to the beach could be gained by equipment needed to transport and spread sand on the beach. Excavators would be used to load articulated end-dump trucks for transporting sand along the beach. These specially designed trucks are suitable for work directly on the beach and have a carrying capacity of 18 to 22 cy. The articulated end-dumps would deposit loads at appropriate intervals, for subsequent spreading and regrading by bulldozers or front end loaders.

5.2 MECHANICAL DREDGING

Mechanical dredging involves the use of a clamshell or bucket to scoop and remove sediment from the seafloor. The equipment can either work from the shoreline or from a floating barge. The process of mechanical dredging does not introduce additional water to the dredged material, as the sediments tend to come out in mass as they existed on the seafloor. Because of this, mechanical dredging is often the preferred method for removal of fine-grained sediments, which typically present challenges for dewatering. Mechanical dredging can, however, produce extensive water turbidity at the dredging site as seawater mixed with sediment drains from the bucket. Excavated sediments are placed either directly onshore in a dewatering facility, or in scows and then towed to an offloading site. The advantages of mechanical dredging include the ability to work in close quarters and relatively shallow drafts, or even from land if site characteristics permit. The disadvantages of mechanical dredging include potential impacts from elevated water turbidity to sensitive resources, as well as additional re-handling requirements and lower production rates when compared to hydraulic dredging.

The use of mechanical dredging for nourishment of Narragansett Beach was investigated as a possibility with the Narrow River sediment source. This alternative would involve use of a clamshell dredge operating off a spud- or anchor-held deck barge located in the Narrow River channel adjacent to the dredge area. The dredge would remove sediment from the shoal and/or channel area and deposit it into a scow. Loaded scows would be towed to the north side of the barrier spit, where the dredge would transfer the sand directly to articulated end-dumps, or to a temporary staging area on the spit. If the staging area is utilized, an excavator would be needed to load the end-dumps. Fully loaded end-dumps would transfer the sand, dumping it at appropriate intervals for spreading and regrading by bulldozers or front end loaders. Clamshell dredges can attain production rates between 300 and 600 cy per day. Assuming that two 600 cy scows could be utilized simultaneously in the Narrow River, one loading while the other offloading, it would take between 83 and 166 days to dredge the 50,000 cy needed for the smallest nourishment project (Scenario 1, Case 9).

Mechanical dredging could also be a viable construction methodology for a sediment source at the Point Judith Harbor of Refuge. In this case mechanical dredge equipment operating from a shallow draft barge would place the dredged sediment into a scow. A bottom dump scow could be utilized to transport the material to the nearshore area of Narragansett Beach, where the dredged sediments would be temporarily dumped on the seafloor and then re-dredged and hydraulically pumped onto the beach. Alternatively, a traditional scow could be used to transport the dredged sediments to an offloading facility at Point Judith Harbor. In this case the sediments would likely need to be dewatered for a short period of time on land, and then transported via truck to the beach. Production rates for large mechanical dredges are between 4,000 and 6,000 cy per day. For a project at

Narragansett Beach the rates would likely be lower, since the transportation and offloading of sediment from the scows would be the controlling factor. Other issues to consider with this methodology are the water depths in the outer Harbor and offshore of Narragansett Beach. Fully loaded scows can require up to 20 ft of water depth at MLW. Further investigations into existing water depths in the outer Harbor and potential offloading sites inside the Harbor would be required to more fully evaluate the viability of this construction method.

5.3 HYDRAULIC DREDGING

Hydraulic dredging is commonly performed using a cutterhead or dustpan type dredge coupled with a suction pipe and pump, which removes sediment from the sea floor and transports it via pipeline to a settling basin or reuse site (e.g. beach nourishment). A cutterhead dredge utilizes a rotating head, mounted with smooth or toothed metal blades to dislodge the sediment. The cutterhead and suction pipe are mounted on a boom at the front of the dredge. The boom is moved back and forth cutting through the sediment, as the dredge vessel is stabilized by spuds. Once a complete swing of the boom is finished, the dredge advances along the seafloor using the spuds. The dredged sediments are hydraulically pumped to the beach as a slurry of water and sediment, with typical solids content on the order of 10 to 20 percent by weight. The capacity of hydraulic dredges is usually defined by the diameter of the dredge pump discharge. Size classifications range from 4 to 36 inches, with most plants in the 12 to 16 inch range. Fine-grained materials are typically pumped to dewatering basins where the sediments are allowed to settle before the water is drained. Coarser sand sized sediments are often pumped directly onto a beach. Booster pumps can be added to the discharge line to facilitate the pumping of dredged material greater distances. The advantages of hydraulic dredging include high comparative production rates, minimal re-handling requirements, and low turbidity impacts to sensitive resources. The disadvantages of hydraulic dredging include higher equipment costs and the need for extra pumping capacity on long beaches.

The use of hydraulic dredging for nourishment of Narragansett Beach was investigated as a possibility with the Narrow River sediment source, with an offshore sediment source, and with the Point Judith outer Harbor of Refuge. Details for each site are discussed below.

Sediment in the Narrow River could be removed using a smaller hydraulic dredge with a 10-inch discharge pipe, and pumped directly to Narragansett Beach. If the dredge design includes removal of the flood shoal only, it may be possible to pump sand to the northeast end of Town Beach without a booster pump. Typical limits for non-booster projects are 2,300 to 3,000 linear ft. In this case, the sand would be stockpiled at the end of the discharge pipe, loaded onto end-dumps using an excavator, and then transported southwest along the beach and spread using bulldozers or front end loaders. If the dredge design includes sand removal from the Sprague Bridge area it would be necessary to add a booster pump to the dredge plant. In this case, it would be necessary to stockpile sediment at the end of the barrier spit, and then load and truck to the Town Beach using end-dumps. Production rates typical of hydraulic dredge plants with 10-inch discharge are on the order of 1,000 cy per day. At this rate it would take 50 days to dredge the volume of 50,000 cy required for the smallest nourishment project (Scenario 1, Case 9). Production rates would decrease by about one-half with a booster, taking approximately 100 days to complete.

An offshore borrow site for nourishment of Narragansett Beach would require use a larger hydraulic dredge with 16-inch or greater discharge pipe. Since an offshore borrow area at this location would be relatively exposed to ocean waves, a larger dredge plant would serve to minimize down time due to poor weather conditions. Greater water depths at the borrow area also dictate the need for a larger dredge plant. Typical production rates for a 16-inch dredge are 2,000 cy per day, increasing to 4,000 cy per day with a 24-inch dredge. At these rates it would take between 13 and 25 days to construct the smallest 50,000 cy project on the Town Beach (Scenario 1, Case 9). For the larger project requiring 245,470 cy (Scenario 2, Case 7), it would be most practical to utilize a 24-inch dredge, which could complete the project in approximately 61 days. Final grading of the beach with a bulldozer or front end loader would be required following direct placement via hydraulic dredging.

Sediment from the outer Harbor of Refuge at Point Judith could be mined for use at Narragansett Beach using a hopper dredge with pump out capabilities. The hopper dredge would remove sediment from the outer Harbor area, loading it into one or more hoppers in the vessel. When the hoppers are full, the dredge would move offshore of Narragansett Beach and hydraulically pump the material directly to the beach. A fully loaded hopper dredge needs up to 20 ft of water depth at MLW to operate and can achieve production rates of 11,000 to 12,000 cy per day. Assuming that adequate water depths are available at both the borrow site and offshore of the beach, it would take between 5 and 20 days construct the smallest and largest nourishment projects at Narragansett Beach.

6.0 REGULATORY REQUIREMENTS

The feasibility of a large-scale nourishment project at Narragansett Beach is largely dependent on securing the necessary permits and approvals. The regulatory process within the State of Rhode Island for obtaining permits to perform beach nourishment and dredging involves applications to four (4) different agencies. A summary of the necessary permits for a project involving beach nourishment using each of the sediment sources addressed in Section 4.0 is provided below. Requirements for additional field investigations, data and/or impact analyses, and areas of potential concern with respect to permitting are also provided.

6.1 BEACH NOURISHMENT WITH UPLAND SOURCE

The following types of general information would likely be needed to support the permit applications:

- Proof of sediment compatibility between beach and upland source
- Benthic invertebrate survey to evaluate impacts in areas below MHW
- Plan for trucking route and schedule to assess impacts on traffic

Town of Narragansett Approval

CRMC: Assent Permit
- Environmental assessment
- Fill or grading done in accordance with the RI Soil Erosion and Sediment Control Handbook

DEM: Water Quality Certificate
- Mitigation to filling and resulting impacts

ACOE: Individual Permit (≥1 acre waterway and/or wetland fill)
- Essential Fish Habitat assessment
- Endangered species review (for Scenarios 2 and 3 that extend into Piping Plover habitat)

Durations for the CRMC, DEM, and ACOE permits are 3 (with 1 year extension), 3 (up to 10), and 10 years, respectively from the date of issuance. Projected estimates for the design and permitting of a project using an upland source are between 6 months and 1 year.

6.2 BEACH NOURISHMENT WITH NARROW RIVER SOURCE

The following types of general information would likely be needed to support the permit applications:

- Sediment coring to the depth of dredging in Narrow River
- Bathymetric survey in Narrow River to update and refine dredge volumes
- Eelgrass survey in Narrow River to identify potential impacts to eelgrass resources

- Shellfish survey in Narrow River to identify potential impacts to shellfish
- Benthic invertebrate survey in Narrow River and nearshore areas of beach to identify potential impacts to benthos

Town of Narragansett Approval

CRMC: Assent Permit
- Pre-application meeting with DEM (and other agencies as appropriate) to discuss improvement dredging in Type 2 CRMC water classification
- Environmental assessment
- Dredging/maintenance plan per 930.1 A.1.6. of the Narrow River Special Area Management Plan (SAMP)
- Fill or grading done in accordance with the RI Soil Erosion and Sediment Control Handbook

DEM: Water Quality Certificate
- Mitigation to filling and resulting impacts

ACOE: Individual Permit (≥1 acre waterway and/or wetland fill and new dredging ≥10,000 CY)
- Essential Fish Habitat assessment
- Endangered species review (for Scenarios 2 and 3 that extend into Piping Plover habitat and for additional habitats that may be in Narrow River)

Durations for the CRMC, DEM, and ACOE permits are 3 (with 1 year extension), 3 (up to 10), and 10 years, respectively from the date of issuance. Projected estimates for the design and permitting of a project using the Narrow River as a sediment source are between 1 and 2 years.

6.3 BEACH NOURISHMENT WITH OFFSHORE OR POINT JUDITH BORROW SOURCE

The following types of general information would likely be needed to support the permit applications:

- Sediment coring to the depth of dredging at borrow site to quantify sediment characteristics
- Proof of sediment compatibility between beach and offshore borrow source
- Bathymetric survey at borrow site to update and refine dredge volumes
- Shellfish survey in vicinity of borrow site to identify potential impacts to shellfish
- Benthic invertebrate survey at borrow site and nearshore areas of beach to identify potential impacts to benthos
- Wave model to evaluate impacts of borrow site on incident wave climatology

Town of Narragansett Approval

CRMC: Assent Permit
- Pre-application meeting with DEM (and other agencies as appropriate)
- Environmental assessment
- Fill or grading done in accordance with the RI Soil Erosion and Sediment Control Handbook

DEM: Water Quality Certificate
- Mitigation to filling and resulting impacts

ACOE: Individual Permit (≥1 acre waterway and/or wetland fill and new dredging ≥10,000 CY)
- Essential Fish Habitat assessment
- Endangered species review (for Scenarios 2 and 3 that extend into Piping Plover habitat)

Durations for the CRMC, DEM, and ACOE permits are 3 (with 1 year extension), 3 (up to 10), and 10 years, respectively from the date of issuance. Projected estimates for the design and permitting of a project using an offshore sediment source are between 2 and 4 years.

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7.0 COST ANALYSIS AND NEXT STEPS

The overall cost of a sand delivery operation depends upon a variety of factors, and can result in dramatically different pricing. Construction methodology affects the price substantially, as does the volatility in the dredging market (e.g., equipment availability, cost of fuel, time of year, project location, etc.), the quantity of sand to be moved, and other factors. Generally, the cost of a beach nourishment operation increases with the number of times the material needs to be handled. For instance barging of upland sand to a beach tends to be the most expensive, since the sand needs to be handled at a quarry or pit, trucked to a barge site, loaded on the barge, barged to the beach, pumped to the beach, and graded on the beach. By comparison, the unit cost per cubic yard of a direct hydraulic dredging operation tends to be the least expensive once the equipment is onsite; however, equipment mobilization costs can be prohibitive for individual projects unless the project is very large or if the mobilization fee can be shared with a nearby project. Hopper dredge costs are also quite variable, depending upon the availability of equipment, location, and time of year. Trucking operations can also vary depending upon the quantity of sand to be moved, accessibility of the trucks to the beach, distance from the source to the beach, fuel costs, etc.

A cost matrix has been prepared for the various Narragansett Beach replenishment alternatives assuming sediment sources from the upland, Narrow River, and an offshore borrow site (Tables 9, 10, and 11). Estimated project costs with and without structural options for increasing the longevity of the fill are shown. The project costs include construction, engineering, permitting, as well as monitoring and reporting. Base data for the cost matrices were generated based on experience with similar projects and consultations with regional contractors. A list of the contractors is provided in Appendix B. Engineering costs include final design calculations for nourishment and dredge volume, model studies where required, field surveys and sediment sampling where required, structure design, and plans for permitting and construction. Permitting costs include agency consultations, alternatives analyses, environmental impact assessments, preparation and submittal of permit applications, and management. Estimated costs for monitoring and reporting following project construction are based on likely requirements in the permits and approvals.

Unit costs for a nourishment project using sand from the upland, Narrow River, and an offshore borrow site are shown to be $31, $33, and $38 per cy, respectively. These unit costs include all aspects of the project from engineering through monitoring and reporting. Project costs of $330,000 were determined for the engineering, permitting, and construction of an engineering structure.

Table 9. Estimated Project Costs Assuming an Upland Sediment Source.

	< 10-Yr Level of Protection Case 9		10-Yr Level of Protection Case 5		~ 20-Yr Level of Protection Case 7	
Upland Sediment Source	**Town Only**	**Entire Beach**	**Town Only**	**Entire Beach**	**Town Only**	**Entire Beach**
Without structures						
Sand Purchase	$880,000	$1,620,000	$1,060,000	$2,640,000	$2,100,000	$4,310,000
Trucking	$420,000	$780,000	$510,000	$1,270,000	$1,010,000	$2,060,000
Spreading & Grading	$250,000	$462,000	$301,000	$753,000	$599,000	$1,227,000
Engineering, Permitting, Monitoring & Reporting	$38,000	$41,000	$38,000	$41,000	$38,000	$41,000
Total	**$1,588,000**	**$2,903,000**	**$1,909,000**	**$4,704,000**	**$3,747,000**	**$7,638,000**
With structures						
Sand Purchase	$880,000	$1,620,000	$1,060,000	$2,640,000	$2,100,000	$4,310,000
Trucking	$420,000	$780,000	$510,000	$1,270,000	$1,010,000	$2,060,000
Spreading & Grading	$250,000	$462,000	$300,000	$750,000	$600,000	$1,230,000
Structures	$300,000	$300,000	$300,000	$300,000	$300,000	$300,000
Engineering, Permitting, Monitoring & Reporting	$68,000	$71,000	$68,000	$71,000	$68,000	$71,000
Total	**$1,888,000**	**$3,203,000**	**$2,238,000**	**$5,031,000**	**$4,078,000**	**$7,971,000**

Table 10. Estimated Project Costs Assuming a Narrow River Sediment Source.

	< 10-Yr Level of Protection Case 9		10-Yr Level of Protection Case 5		~ 20-Yr Level of Protection Case 7	
Narrow River Source	**Town Only**	**Entire Beach***	**Town Only**	**Entire Beach***	**Town Only***	**Entire Beach***
Without structures						
Sand (w/ booster pump)	$1,150,000	NA	$1,350,000	NA	NA	NA
Mobe/Demobe	$50,000	NA	$50,000	NA	NA	NA
Trucking & Spreading & Grading	$430,000	NA	$510,000	NA	NA	NA
Engineering, Permitting, Monitoring & Reporting	$96,000	$96,000	$96,000	$96,000	$96,000	$96,000
Total	**$1,726,000**	**NA**	**$2,006,000**	**NA**	**NA**	**NA**
With structures						
Sand (w/ booster pump)	$1,150,000	NA	$1,350,000	NA	NA	NA
Mobe/Demobe	$50,000	NA	$50,000	NA	NA	NA
Trucking & Spreading & Grading	$430,000	NA	$510,000	NA	NA	NA
Structures	$300,000	NA	$300,000	NA	NA	NA
Engineering, Permitting, Monitoring & Reporting	$126,000	$126,000	$126,000	$126,000	$126,000	$126,000
Total	**$2,056,000**	**NA**	**$2,336,000**	**NA**	**NA**	**NA**

*Volume of sand available in the Narrow River sufficient for only the smallest nourishment.

Table 11. Estimated Project Costs Assuming an Offshore Sediment Source.

	< 10-Yr Level of Protection Case 9		10-Yr Level of Protection Case 5		~ 20-Yr Level of Protection Case 7	
Offshore Sediment Source	**Town Only**	**Entire Beach**	**Town Only**	**Entire Beach**	**Town Only**	**Entire Beach**
Without structures						
Sand (with booster)	$1,600,000	$2,950,000	$1,930,000	$4,820,000	$3,830,000	$7,860,000
Mobe/Demobe	$300,000	$300,000	$300,000	$300,000	$300,000	$300,000
Spreading & Grading	$150,000	$280,000	$180,000	$450,000	$360,000	$740,000
Engineering, Permitting, Monitoring & Reporting	$115,000	$116,000	$115,000	$116,000	$115,000	$116,000
Total	**$2,165,000**	**$3,646,000**	**$2,525,000**	**$5,686,000**	**$4,605,000**	**$9,016,000**
With structures						
Sand (with booster)	$1,600,000	$4,820,000	$1,930,000	$4,820,000	$3,830,000	$7,860,000
Mobe/Demobe	$300,000	$300,000	$300,000	$300,000	$300,000	$300,000
Spreading & Grading	$150,000	$280,000	$180,000	$450,000	$360,000	$740,000
Structures	$300,000	$300,000	$300,000	$300,000	$300,000	$300,000
Engineering, Permitting, Monitoring & Reporting	$145,000	$146,000	$145,000	$146,000	$145,000	$146,000
Total	**$2,495,000**	**$3,976,000**	**$2,855,000**	**$6,016,000**	**$4,935,000**	**$9,346,000**

The following series of next steps is provided for consideration by the Town of Narragansett:

- Submit a letter to the USACE, with a copy to the CRMC Dredge Coordinator, stating interest in securing sand from the Point Judith Harbor of Refuge for nourishment of Narragansett Beach.
- Submit a letter to developers at Quonset Point, with a copy to the CRMC Dredge Coordinator, stating interest in securing beach compatible sand from future dredging/development for nourishment of Narragansett Beach.
- Request a pre-application meeting with CRMC and DEM to further investigate use of the Narrow River shoals as a sediment source for nourishing Narragansett Beach.
- Meet with private property owners along Narragansett Beach to solicit interest in extending the beach replenishment project along the entire barrier spit.
- Establish a program of annual or biannual beach profile surveys of Narragansett Beach to monitor seasonal and long-term beach changes. These data would also form the basis for FEMA post disaster mitigation funding, in the event that a beach replenishment project is constructed and subsequently damaged during a coastal storm.
- Investigate funding mechanisms for a large-scale beach nourishment project, ranging from state or federal grants, to a local tax that would be earmarked specifically for beach replenishment.

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8.0 REFERENCES

Dean, Robert G. and Robert A. Dalrymple. 2002. Coastal Processes with Engineering Applications. Cambridge University Press.

FEMA, 2010. Flood Insurance Study Washington County, RI.

IPCC. 2007. Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment.

Larson, M and N.C. Kraus. 1989. SBEACH: Numerical Model For Simulating Storm-Induced Beach Change; Report 1 Empirical Foundation and Model Development. US Army Corps of Engineers Technical Report CERC-89-9.

Larson, M., Kraus, N.C. and M.R. Byrnes. 1990. SBEACH: Numerical Model For Simulating Storm-Induced Beach Change; Report 2 Numerical Formulation and Model Tests. US Army Corps of Engineers Technical Report CERC-89-9.

NOAA, 1998. Narragansett Bay, RI (M020) Bathymetric Digital Elevation Model (30 meter resolution) Derived From Source Hydrographic Survey Soundings Collected by NOAA: <http://estuarinebathymetry.noaa.gov>.

NOAA, 2011 Tides and Currents, Sea Level Trends, http://tidesandcurrents.noaa.gov/sltrends/sltrends_states.shtml?region=ri.

RI CRMC, 2007. "Shoreline Change Maps." Produced by Henre, R. E. and Boothroyd, J. C. Accessed June 12, 2011 at <http://www.crmc.ri.gov/maps/maps_shorechange.html.>

RINHP, 2011. "Rare Native Plants and Animals of RI." Produced by the State of Rhode Island Department of Environmental Management. Accessed June 14, 2011 at http://www.dem.ri.gov/programs/bpoladm/plandev/heritage/.

USACE. 2002. Coastal Engineering Manual. Engineer Manual 1110-2-1100, U.S. Army Corps of Engineers, Washington, D.C. (in 6 volumes).

US Geological Survey. 2005. CONMAPSG: Continental Margin Mapping (CONMAP) sediments grainsize distribution for the United States East Coast Continental Margin: Open-File Report 2005-1001, U.S. Geological Survey, Coastal and Marine Geology Program, Woods Hole Science Center, Woods Hole, MA.

USACE. 2009. Narrow River Narragansett Rhode Island Hydrodynamic Numerical Modeling and Data Collection Report. USACE New England District, Water Management Section, 50 pp. plus Appendices.

USACE Coastal and Hydraulics Laboratory. 2010. "Wave Information Studies." Engineer Research and Development Center. Accessed May 3, 2011 at <http://frf.usace.army.mil/wis2010/wis.shtml>.

USGS. 2009. Digital Seismic-Reflection Data from Western Rhode Island Sound, 1980: Open-File Report 2009-1002, U.S. Geological Survey, Coastal and Marine Geology Program, Woods Hole Science Center, Woods Hole, MA.

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APPENDIX A BEACH SEDIMENT CHARACTERISTICS

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ANALYTICAL REPORT

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Project Number:	2011-004
Report Date:	06/03/11

Certifications & Approvals: MA (M-MA030), NY (11627), CT (PH-0141), NH (2206), NJ (MA015), RI (LAO00299), ME (MA0030), PA (Registration #68-02089), LA NELAC (03090), FL NELAC (E87814), US Army Corps of Engineers.

320 Forbes Boulevard, Mansfield, MA 02048-1806
508-822-9300 (Fax) 508-822-3288 800-624-9220 - www.alphalab.com

Project Name: NARRAGANSETT, RI
Project Number: 2011-004

Lab Number: L1107565
Report Date: 06/03/11

Alpha Sample ID	Client ID	Sample Location	Collection Date/Time
L1107565-01	PROFILE #1	NARRAGANSETT BEACH	05/20/11 08:00
L1107565-02	PROFILE #3	NARRAGANSETT BEACH	05/20/11 08:45
L1107565-03	PROFILE #5	NARRAGANSETT BEACH	05/20/11 09:20
L1107565-04	PROFILE #8	NARRAGANSETT BEACH	05/20/11 11:00
L1107565-05	PROFILE #10	NARRAGANSETT BEACH	05/20/11 11:45
L1107565-06	PROFILE #9	NARRAGANSETT BEACH	05/20/11 11:30
L1107565-07	PROFILE #13	NARRAGANSETT BEACH	05/20/11 13:00
L1107565-08	PROFILE #15	NARRAGANSETT BEACH	05/20/11 14:00

Case Narrative

The samples were received in accordance with the Chain of Custody and no significant deviations were encountered during the preparation or analysis unless otherwise noted. Sample Receipt, Container Information, and the Chain of Custody are located at the back of the report.

Results contained within this report relate only to the samples submitted under this Alpha Lab Number and meet all of the requirements of NELAC, for all NELAC accredited parameters. The data presented in this report is organized by parameter (i.e. VOC, SVOC, etc.). Sample specific Quality Control data (i.e. Surrogate Spike Recovery) is reported at the end of the target analyte list for each individual sample, followed by the Laboratory Batch Quality Control at the end of each parameter. If a sample was re-analyzed or re-extracted due to a required quality control corrective action and if both sets of data are reported, the Laboratory ID of the re-analysis or re-extraction is designated with an "R" or "RE", respectively. When multiple Batch Quality Control elements are reported (e.g. more than one LCS), the associated samples for each element are noted in the grey shaded header line of each data table. Any Laboratory Batch, Sample Specific % recovery or RPD value that is outside the listed Acceptance Criteria is bolded in the report. Definitions of all data qualifiers and acronyms used in this report are provided in the Glossary located at the back of the report.

Please see the associated ADEx data file for a comparison of laboratory reporting limits that were achieved with the regulatory Numerical Standards requested on the Chain of Custody.

For additional information, please contact Client Services at 800-624-9220.

Grain Size

The WG470436-1 Laboratory Duplicate RPD, performed on L1107565-01, is outside the acceptance criteria for Fines (22%).

I, the undersigned, attest under the pains and penalties of perjury that, to the best of my knowledge and belief and based upon my personal inquiry of those responsible for providing the information contained in this analytical report, such information is accurate and complete. This certificate of analysis is not complete unless this page accompanies any and all pages of this report.

Authorized Signature: Cynthia McQueen

Title: Technical Director/Representative Date: 06/03/11

INORGANICS
&
MISCELLANEOUS

Project Name: NARRAGANSETT, RI
Project Number: 2011-004

Lab Number: L1107565
Report Date: 06/03/11

SAMPLE RESULTS

Lab ID: L1107565-01
Client ID: PROFILE #1
Sample Location: NARRAGANSETT BEACH
Matrix: Sediment

Date Collected: 05/20/11 08:00
Date Received: 05/26/11
Field Prep: Not Specified

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
Grain Size Analysis - Mansfield Lab										
Cobbles	ND		%	0.100	NA	1	-	05/31/11 00:00	12,D422	SE
% Coarse Gravel	ND		%	0.100	NA	1	-	05/31/11 00:00	12,D422	SE
% Fine Gravel	ND		%	0.100	NA	1	-	05/31/11 00:00	12,D422	SE
% Coarse Sand	ND		%	0.100	NA	1	-	05/31/11 00:00	12,D422	SE
% Medium Sand	0.560		%	0.100	NA	1	-	05/31/11 00:00	12,D422	SE
% Fine Sand	99.1		%	0.100	NA	1	-	05/31/11 00:00	12,D422	SE
% Total Fines	0.350		%	0.100	NA	1	-	05/31/11 00:00	12,D422	SE

Project Name: NARRAGANSETT, RI
Project Number: 2011-004

Lab Number: L1107565
Report Date: 06/03/11

SAMPLE RESULTS

Lab ID: L1107565-02
Client ID: PROFILE #3
Sample Location: NARRAGANSETT BEACH
Matrix: Sediment

Date Collected: 05/20/11 08:45
Date Received: 05/26/11
Field Prep: Not Specified

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
Grain Size Analysis - Mansfield Lab										
Cobbles	ND		%	0.100	NA	1	-	05/31/11 00:00	12,D422	SE
% Coarse Gravel	ND		%	0.100	NA	1	-	05/31/11 00:00	12,D422	SE
% Fine Gravel	ND		%	0.100	NA	1	-	05/31/11 00:00	12,D422	SE
% Coarse Sand	ND		%	0.100	NA	1	-	05/31/11 00:00	12,D422	SE
% Medium Sand	2.48		%	0.100	NA	1	-	05/31/11 00:00	12,D422	SE
% Fine Sand	97.0		%	0.100	NA	1	-	05/31/11 00:00	12,D422	SE
% Total Fines	0.570		%	0.100	NA	1	-	05/31/11 00:00	12,D422	SE

Project Name: NARRAGANSETT, RI
Project Number: 2011-004

Lab Number: L1107565
Report Date: 06/03/11

SAMPLE RESULTS

Lab ID: L1107565-03
Client ID: PROFILE #5
Sample Location: NARRAGANSETT BEACH
Matrix: Sediment

Date Collected: 05/20/11 09:20
Date Received: 05/26/11
Field Prep: Not Specified

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
Grain Size Analysis - Mansfield Lab										
Cobbles	ND		%	0.100	NA	1	-	05/31/11 00:00	12,D422	SE
% Coarse Gravel	ND		%	0.100	NA	1	-	05/31/11 00:00	12,D422	SE
% Fine Gravel	ND		%	0.100	NA	1	-	05/31/11 00:00	12,D422	SE
% Coarse Sand	ND		%	0.100	NA	1	-	05/31/11 00:00	12,D422	SE
% Medium Sand	0.110		%	0.100	NA	1	-	05/31/11 00:00	12,D422	SE
% Fine Sand	99.1		%	0.100	NA	1	-	05/31/11 00:00	12,D422	SE
% Total Fines	0.810		%	0.100	NA	1	-	05/31/11 00:00	12,D422	SE

Project Name: NARRAGANSETT, RI
Project Number: 2011-004

Lab Number: L1107565
Report Date: 06/03/11

SAMPLE RESULTS

Lab ID: L1107565-04
Client ID: PROFILE #8
Sample Location: NARRAGANSETT BEACH
Matrix: Sediment

Date Collected: 05/20/11 11:00
Date Received: 05/26/11
Field Prep: Not Specified

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
Grain Size Analysis - Mansfield Lab										
Cobbles	ND		%	0.100	NA	1	-	05/31/11 00:00	12,D422	SE
% Coarse Gravel	ND		%	0.100	NA	1	-	05/31/11 00:00	12,D422	SE
% Fine Gravel	ND		%	0.100	NA	1	-	05/31/11 00:00	12,D422	SE
% Coarse Sand	ND		%	0.100	NA	1	-	05/31/11 00:00	12,D422	SE
% Medium Sand	0.560		%	0.100	NA	1	-	05/31/11 00:00	12,D422	SE
% Fine Sand	98.2		%	0.100	NA	1	-	05/31/11 00:00	12,D422	SE
% Total Fines	1.18		%	0.100	NA	1	-	05/31/11 00:00	12,D422	SE

Project Name: NARRAGANSETT, RI
Project Number: 2011-004

Lab Number: L1107565
Report Date: 06/03/11

SAMPLE RESULTS

Lab ID: L1107565-05
Client ID: PROFILE #10
Sample Location: NARRAGANSETT BEACH
Matrix: Sediment

Date Collected: 05/20/11 11:45
Date Received: 05/26/11
Field Prep: Not Specified

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
Grain Size Analysis - Mansfield Lab										
Cobbles	ND		%	0.100	NA	1	-	05/31/11 00:00	12,D422	SE
% Coarse Gravel	ND		%	0.100	NA	1	-	05/31/11 00:00	12,D422	SE
% Fine Gravel	ND		%	0.100	NA	1	-	05/31/11 00:00	12,D422	SE
% Coarse Sand	ND		%	0.100	NA	1	-	05/31/11 00:00	12,D422	SE
% Medium Sand	0.320		%	0.100	NA	1	-	05/31/11 00:00	12,D422	SE
% Fine Sand	98.9		%	0.100	NA	1	-	05/31/11 00:00	12,D422	SE
% Total Fines	0.760		%	0.100	NA	1	-	05/31/11 00:00	12,D422	SE

Project Name: NARRAGANSETT, RI

Project Number: 2011-004

Lab Number: L1107565

Report Date: 06/03/11

SAMPLE RESULTS

Lab ID: L1107565-06
Client ID: PROFILE #9
Sample Location: NARRAGANSETT BEACH
Matrix: Sediment

Date Collected: 05/20/11 11:30
Date Received: 05/26/11
Field Prep: Not Specified

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
Grain Size Analysis - Mansfield Lab										
Cobbles	ND		%	0.100	NA	1	-	05/31/11 00:00	12,D422	SE
% Coarse Gravel	ND		%	0.100	NA	1	-	05/31/11 00:00	12,D422	SE
% Fine Gravel	ND		%	0.100	NA	1	-	05/31/11 00:00	12,D422	SE
% Coarse Sand	ND		%	0.100	NA	1	-	05/31/11 00:00	12,D422	SE
% Medium Sand	2.59		%	0.100	NA	1	-	05/31/11 00:00	12,D422	SE
% Fine Sand	96.4		%	0.100	NA	1	-	05/31/11 00:00	12,D422	SE
% Total Fines	1.03		%	0.100	NA	1	-	05/31/11 00:00	12,D422	SE

Project Name: NARRAGANSETT, RI
Project Number: 2011-004

Lab Number: L1107565
Report Date: 06/03/11

SAMPLE RESULTS

Lab ID: L1107565-07
Client ID: PROFILE #13
Sample Location: NARRAGANSETT BEACH
Matrix: Sediment

Date Collected: 05/20/11 13:00
Date Received: 05/26/11
Field Prep: Not Specified

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
Grain Size Analysis - Mansfield Lab										
Cobbles	ND		%	0.100	NA	1	-	05/31/11 00:00	12,D422	SE
% Coarse Gravel	ND		%	0.100	NA	1	-	05/31/11 00:00	12,D422	SE
% Fine Gravel	ND		%	0.100	NA	1	-	05/31/11 00:00	12,D422	SE
% Coarse Sand	1.95		%	0.100	NA	1	-	05/31/11 00:00	12,D422	SE
% Medium Sand	23.7		%	0.100	NA	1	-	05/31/11 00:00	12,D422	SE
% Fine Sand	74.1		%	0.100	NA	1	-	05/31/11 00:00	12,D422	SE
% Total Fines	0.230		%	0.100	NA	1	-	05/31/11 00:00	12,D422	SE

Project Name: NARRAGANSETT, RI
Project Number: 2011-004

Lab Number: L1107565
Report Date: 06/03/11

SAMPLE RESULTS

Lab ID: L1107565-08
Client ID: PROFILE #15
Sample Location: NARRAGANSETT BEACH
Matrix: Sediment

Date Collected: 05/20/11 14:00
Date Received: 05/26/11
Field Prep: Not Specified

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
Grain Size Analysis - Mansfield Lab										
Cobbles	ND		%	0.100	NA	1	-	05/31/11 00:00	12,D422	SE
% Coarse Gravel	ND		%	0.100	NA	1	-	05/31/11 00:00	12,D422	SE
% Fine Gravel	ND		%	0.100	NA	1	-	05/31/11 00:00	12,D422	SE
% Coarse Sand	ND		%	0.100	NA	1	-	05/31/11 00:00	12,D422	SE
% Medium Sand	37.6		%	0.100	NA	1	-	05/31/11 00:00	12,D422	SE
% Fine Sand	62.3		%	0.100	NA	1	-	05/31/11 00:00	12,D422	SE
% Total Fines	ND		%	0.100	NA	1	-	05/31/11 00:00	12,D422	SE

Lab Duplicate Analysis
Batch Quality Control

Project Name: NARRAGANSETT, RI
Project Number: 2011-004
Lab Number: L1107565
Report Date: 06/03/11

Parameter	Native Sample	Duplicate Sample	Units	RPD	Qual	RPD Limits
Grain Size Analysis - Mansfield Lab Associated sample(s): 01-08 QC Batch ID: WG470436-1 QC Sample: L1107565-01 Client ID: PROFILE #1						
Cobbles	ND	ND	%	NC		20
% Coarse Gravel	ND	ND	%	NC		20
% Fine Gravel	ND	ND	%	NC		20
% Coarse Sand	ND	ND	%	NC		20
% Medium Sand	0.56	0.590	%	5		20
% Fine Sand	99.1	99.1	%	0		20
% Total Fines	0.35	0.280	%	**22**	Q	20

Project Name: NARRAGANSETT, RI
Project Number: 2011-004

Lab Number: L1107565
Report Date: 06/03/11

Sample Receipt and Container Information

Were project specific reporting limits specified? YES

Reagent H2O Preserved Vials Frozen on: NA

Cooler Information Cooler	Custody Seal
N/A	Absent

Container Information

Container ID	Container Type	Cooler	pH	Temp deg C	Pres	Seal	Analysis(*)
L1107565-01A	Bag	N/A	N/A		Y	Absent	A2-HYDRO-TFINE(),A2-HYDRO-CGRAVEL(),A2-HYDRO-FSAND(),A2-HYDRO-MSAND(),A2-HYDRO-CSAND(),A2-HYDRO-COBBLES(),A2-HYDRO-FGRAVEL()
L1107565-02A	Bag	N/A	N/A		Y	Absent	A2-HYDRO-TFINE(),A2-HYDRO-CGRAVEL(),A2-HYDRO-FSAND(),A2-HYDRO-MSAND(),A2-HYDRO-CSAND(),A2-HYDRO-COBBLES(),A2-HYDRO-FGRAVEL()
L1107565-03A	Bag	N/A	N/A		Y	Absent	A2-HYDRO-TFINE(),A2-HYDRO-CGRAVEL(),A2-HYDRO-FSAND(),A2-HYDRO-MSAND(),A2-HYDRO-CSAND(),A2-HYDRO-COBBLES(),A2-HYDRO-FGRAVEL()
L1107565-04A	Bag	N/A	N/A		Y	Absent	A2-HYDRO-TFINE(),A2-HYDRO-CGRAVEL(),A2-HYDRO-FSAND(),A2-HYDRO-MSAND(),A2-HYDRO-CSAND(),A2-HYDRO-COBBLES(),A2-HYDRO-FGRAVEL()
L1107565-05A	Bag	N/A	N/A		Y	Absent	A2-HYDRO-TFINE(),A2-HYDRO-CGRAVEL(),A2-HYDRO-FSAND(),A2-HYDRO-MSAND(),A2-HYDRO-CSAND(),A2-HYDRO-COBBLES(),A2-HYDRO-FGRAVEL()
L1107565-06A	Bag	N/A	N/A		Y	Absent	A2-HYDRO-TFINE(),A2-HYDRO-CGRAVEL(),A2-HYDRO-FSAND(),A2-HYDRO-MSAND(),A2-HYDRO-CSAND(),A2-HYDRO-COBBLES(),A2-HYDRO-FGRAVEL()

*Values in parentheses indicate holding time in days

Container Information

Container ID	Container Type	Cooler	pH	Temp deg C	Pres	Seal	Analysis(*)
L1107565-07A	Bag	N/A	N/A		Y	Absent	A2-HYDRO-TFINE(),A2-HYDRO-CGRAVEL(),A2-HYDRO-FSAND(),A2-HYDRO-MSAND(),A2-HYDRO-CSAND(),A2-HYDRO-COBBLES(),A2-HYDRO-FGRAVEL()
L1107565-08A	Bag	N/A	N/A		Y	Absent	A2-HYDRO-TFINE(),A2-HYDRO-CGRAVEL(),A2-HYDRO-FSAND(),A2-HYDRO-MSAND(),A2-HYDRO-CSAND(),A2-HYDRO-COBBLES(),A2-HYDRO-FGRAVEL()

*Values in parentheses indicate holding time in days

GLOSSARY

Acronyms

EPA - Environmental Protection Agency.

LCS - Laboratory Control Sample: A sample matrix, free from the analytes of interest, spiked with verified known amounts of analytes or a material containing known and verified amounts of analytes.

LCSD - Laboratory Control Sample Duplicate: Refer to LCS.

LFB - Laboratory Fortified Blank: A sample matrix, free from the analytes of interest, spiked with verified known amounts of analytes or a material containing known and verified amounts of analytes.

MDL - Method Detection Limit: This value represents the level to which target analyte concentrations are reported as estimated values, when those target analyte concentrations are quantified below the reporting limit (RL). The MDL includes any adjustments from dilutions, concentrations or moisture content, where applicable.

MS - Matrix Spike Sample: A sample prepared by adding a known mass of target analyte to a specified amount of matrix sample for which an independent estimate of target analyte concentration is available.

MSD - Matrix Spike Sample Duplicate: Refer to MS.

NA - Not Applicable.

NC - Not Calculated: Term is utilized when one or more of the results utilized in the calculation are non-detect at the parameter's reporting unit.

NI - Not Ignitable.

RL - Reporting Limit: The value at which an instrument can accurately measure an analyte at a specific concentration. The RL includes any adjustments from dilutions, concentrations or moisture content, where applicable.

RPD - Relative Percent Difference: The results from matrix and/or matrix spike duplicates are primarily designed to assess the precision of analytical results in a given matrix and are expressed as relative percent difference (RPD). Values which are less than five times the reporting limit for any individual parameter are evaluated by utilizing the absolute difference between the values; although the RPD value will be provided in the report.

SRM - Standard Reference Material: A reference sample of a known or certified value that is of the same or similar matrix as the associated field samples.

Footnotes

1 - The reference for this analyte should be considered modified since this analyte is absent from the target analyte list of the original method.

Terms

Analytical Method: Both the document from which the method originates and the analytical reference method. (Example: EPA 8260B is shown as 1,8260B.) The codes for the reference method documents are provided in the References section of the Addendum.

Data Qualifiers

A - Spectra identified as "Aldol Condensation Product".

B - The analyte was detected above the reporting limit in the associated method blank. Flag only applies to associated field samples that have detectable concentrations of the analyte at less than five times (5x) the concentration found in the blank. For MCP-related projects, flag only applies to associated field samples that have detectable concentrations of the analyte at less than ten times (10x) the concentration found in the blank. For DOD-related projects, flag only applies to associated field samples that have detectable concentrations of the analyte at less than ten times (10x) the concentration found in the blank AND the analyte was detected above one-half the reporting limit (or above the reporting limit for common lab contaminants) in the associated method blank.

C - Co-elution: The target analyte co-elutes with a known lab standard (i.e. surrogate, internal standards, etc.) for co-extracted analyses.

D - Concentration of analyte was quantified from diluted analysis. Flag only applies to field samples that have detectable concentrations of the analyte.

E - Concentration of analyte exceeds the range of the calibration curve and/or linear range of the instrument.

G - The concentration may be biased high due to matrix interferences (i.e, co-elution) with non-target compound(s). The result should be considered estimated.

H - The analysis of pH was performed beyond the regulatory-required holding time of 15 minutes from the time of sample collection.

I - The RPD between the results for the two columns exceeds the method-specified criteria; however, the lower value has been reported due to obvious interference.

M - Reporting Limit (RL) exceeds the MCP CAM Reporting Limit for this analyte.

P - The RPD between the results for the two columns exceeds the method-specified criteria.

Q - The quality control sample exceeds the associated acceptance criteria. Note: This flag is not applicable for matrix spike recoveries when the sample concentration is greater than 4x the spike added or for batch duplicate RPD when the sample concentrations are less

Project Name: NARRAGANSETT, RI **Lab Number:** L1107565
Project Number: 2011-004 **Report Date:** 06/03/11

Data Qualifiers

than 5x the RL. (Metals only.)

R - Analytical results are from sample re-analysis.

RE - Analytical results are from sample re-extraction.

J - Estimated value. This represents an estimated concentration for Tentatively Identified Compounds (TICs).

ND - Not detected at the reporting limit (RL) for the sample.

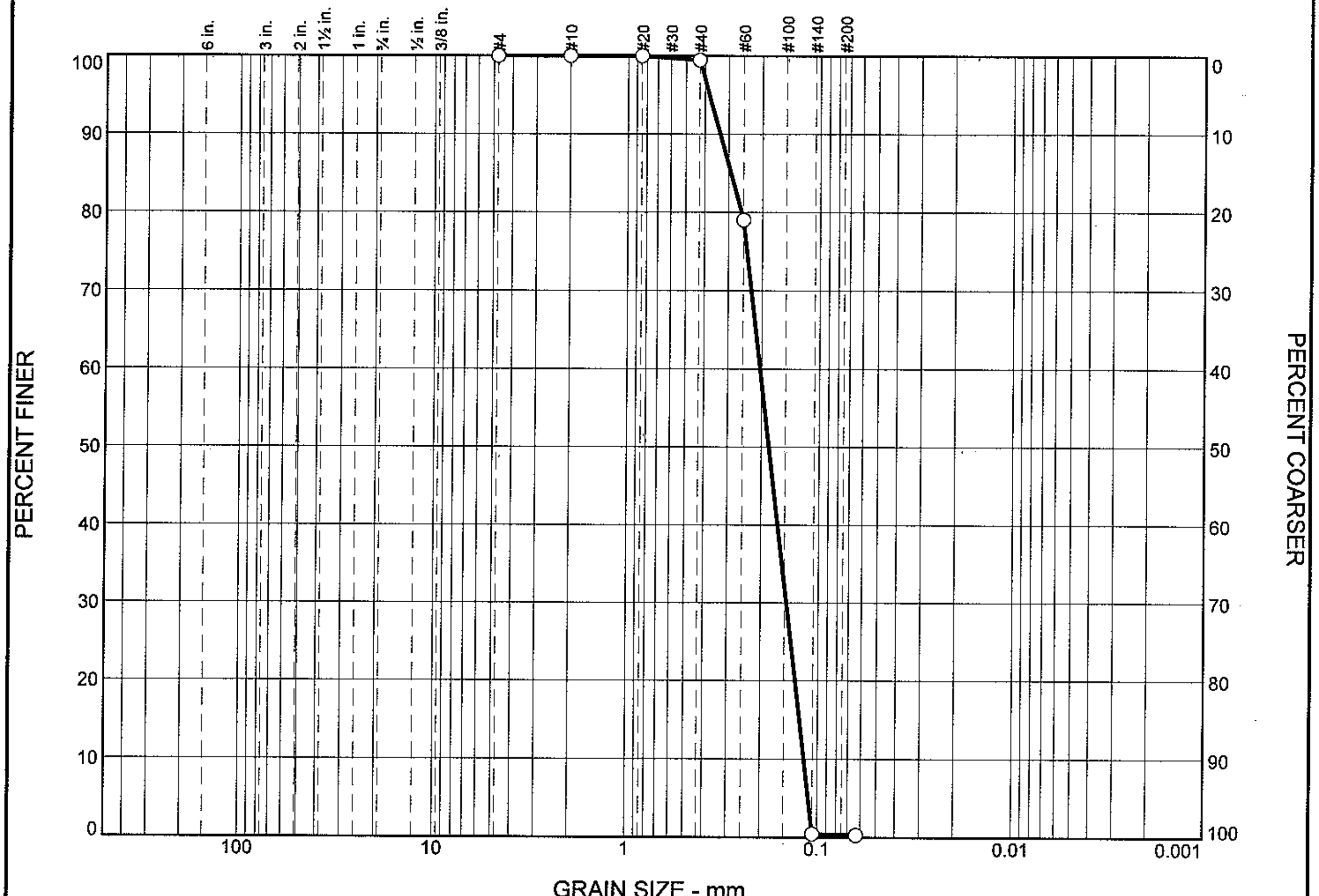
REFERENCES

12 Annual Book of ASTM Standards. American Society for Testing and Materials.

LIMITATION OF LIABILITIES

ASTM D422-63
Grain Size Analysis

Particle Size Distribution Report



	% Cobbles	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.00	0.00	0.00	0.00	0.56	99.09	0.35	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.2923	0.2032	0.1822	0.1464	0.1243	0.1177	0.90	1.73

	Material Description	USCS	AASHTO
○		SP	

Project No. L1107565 **Client:** Woods Hole Group
Project: Naragansett, RI

○ **Source of Sample:** PROFILE #1 **Sample Number:** L1107565-01

Remarks:

Alpha Analytical

Mansfield, MA

Figure

Tested By: ____________________ **Checked By:** ____________________

GRAIN SIZE DISTRIBUTION TEST DATA

6/3/2011

Client: Woods Hole Group
Project: Naragansett, RI
Project Number: L1107565
Location: PROFILE #1
Sample Number: L1107565-01
USCS Classification: SP

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Sieve Opening Size	Weight Retained (grams)	Sieve Weight (grams)	Percent Finer	Percent Retained
143.23	7.49	#4	527.20	527.20	100.00	0.00
		#10	492.41	492.41	100.00	0.00
		#20	417.70	417.67	99.98	0.02
		#40	376.65	375.92	99.44	0.56
		#60	393.50	365.72	78.97	21.03
		#140	449.25	342.64	0.43	99.57
		#230	321.00	320.82	0.30	99.70

Fractional Components

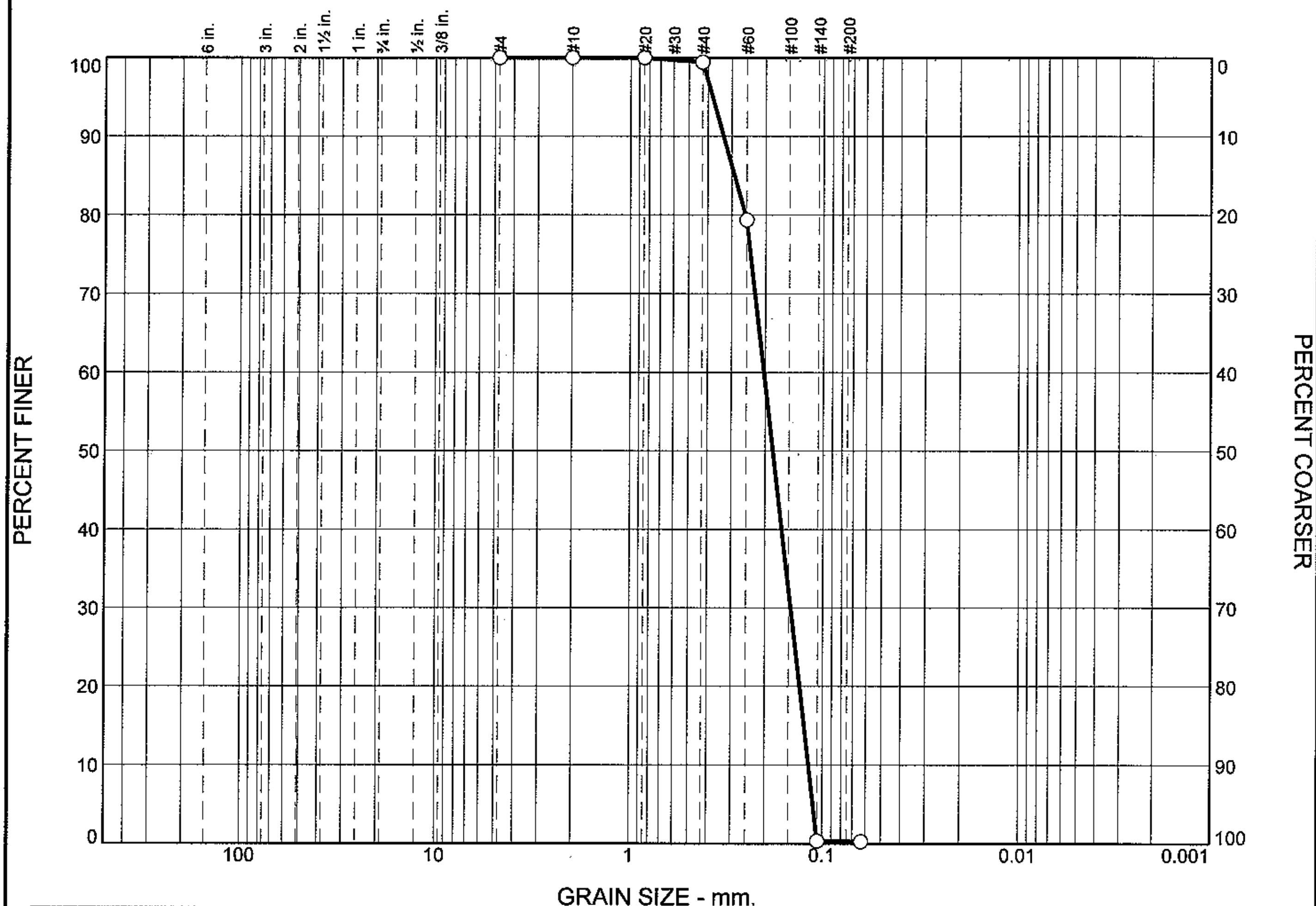
Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.00	0.00	0.00	0.00	0.00	0.56	99.09	99.65			0.35

D_{10}	D_{15}	D_{20}	D_{30}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
0.1177	0.1243	0.1313	0.1464	0.1822	0.2032	0.2567	0.2923	0.3327	0.3788

Fineness Modulus	C_u	C_c
0.82	1.73	0.90

Alpha Analytical

Particle Size Distribution Report



	% Cobbles	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.00	0.00	0.00	0.00	0.59	99.13	0.28	

X	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.2906	0.2027	0.1818	0.1463	0.1243	0.1178	0.90	1.72

	Material Description	USCS	AASHTO
○		SP	

Project No. L1107565 **Client:** Woods Hole Group
Project: Naragansett, RI

○ **Source of Sample:** PROFILE #1 **Sample Number:** WG470436-1

Remarks:

Alpha Analytical

Mansfield, MA

Figure

Tested By: ____________________ **Checked By:** ____________________

GRAIN SIZE DISTRIBUTION TEST DATA

6/3/2011

Client: Woods Hole Group
Project: Naragansett, RI
Project Number: L1107565
Location: PROFILE #1
Sample Number: WG470436-1
USCS Classification: SP

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Sieve Opening Size	Weight Retained (grams)	Sieve Weight (grams)	Percent Finer	Percent Retained
131.25	7.59	#4	527.20	527.20	100.00	0.00
		#10	492.41	492.41	100.00	0.00
		#20	417.70	417.67	99.98	0.02
		#40	376.62	375.92	99.41	0.59
		#60	390.59	365.72	79.30	20.70
		#140	440.30	342.64	0.32	99.68
		#230	320.90	320.82	0.26	99.74

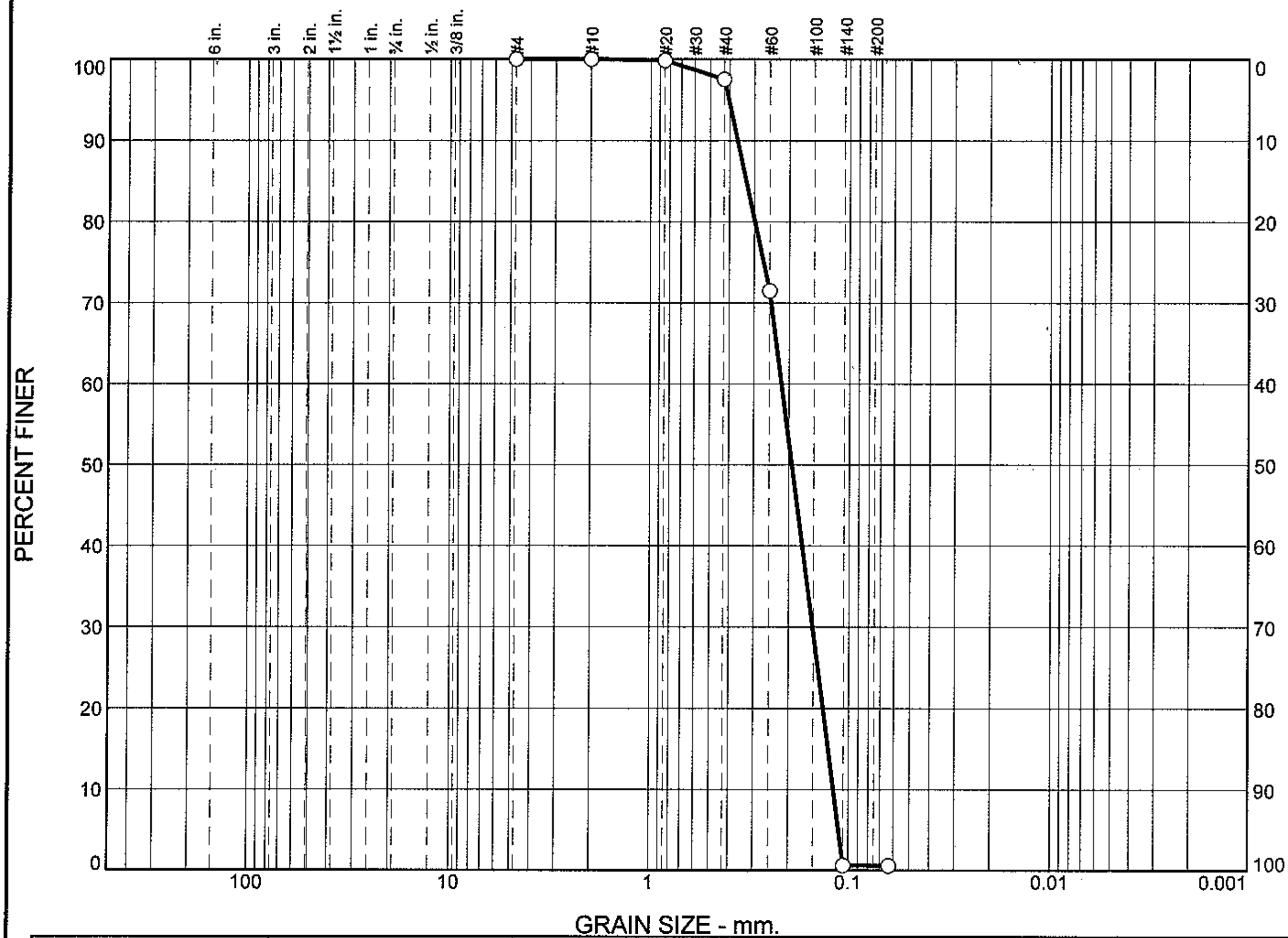
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.00	0.00	0.00	0.00	0.00	0.59	99.13	99.72			0.28

D_{10}	D_{15}	D_{20}	D_{30}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
0.1178	0.1243	0.1313	0.1463	0.1818	0.2027	0.2547	0.2906	0.3316	0.3783

Fineness Modulus	C_u	C_c
0.82	1.72	0.90

Particle Size Distribution Report



	% Cobbles	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.00	0.00	0.00	0.00	2.48	96.95	0.57	

☒	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.3294	0.2176	0.1928	0.1513	0.1262	0.1188	0.89	1.83

	Material Description	USCS	AASHTO
○		SP	

Project No. L1107565 **Client:** Woods Hole Group

Project: Naragansett, RI

○ **Source of Sample:** PROFILE #3 **Sample Number:** L1107565-02

Remarks:

Alpha Analytical

Mansfield, MA

Figure

Tested By: ____________________ **Checked By:** ____________________

GRAIN SIZE DISTRIBUTION TEST DATA

6/3/2011

Client: Woods Hole Group
Project: Naragansett, RI
Project Number: L1107565
Location: PROFILE #3
Sample Number: L1107565-02
USCS Classification: SP

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Sieve Opening Size	Weight Retained (grams)	Sieve Weight (grams)	Percent Finer	Percent Retained
153.31	7.44	#4	527.20	527.20	100.00	0.00
		#10	492.41	492.41	100.00	0.00
		#20	417.91	417.67	99.84	0.16
		#40	379.30	375.92	97.52	2.48
		#60	403.75	365.72	71.45	28.55
		#140	445.97	342.64	0.61	99.39
		#230	320.90	320.82	0.56	99.44

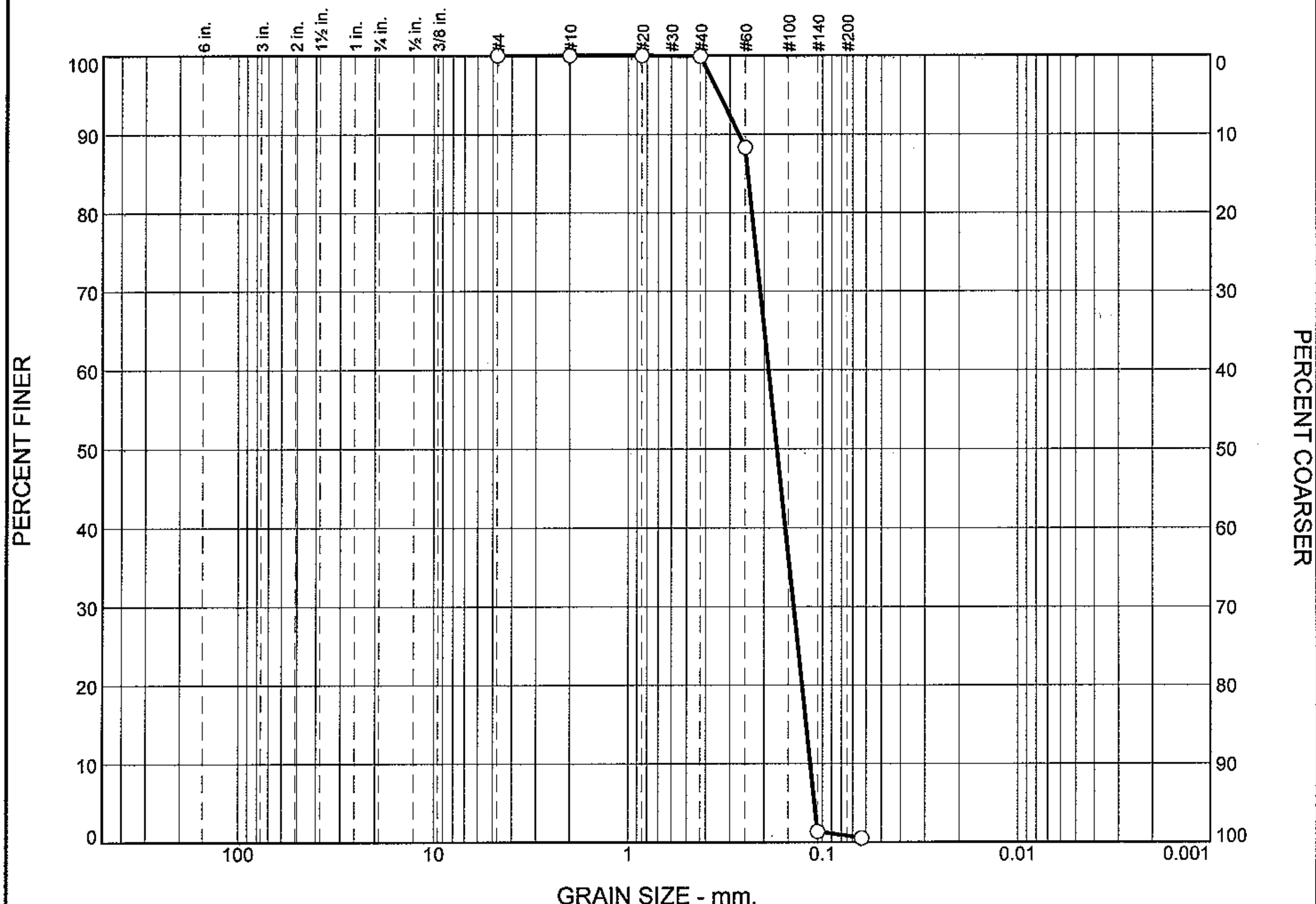
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.00	0.00	0.00	0.00	0.00	2.48	96.95	99.43			0.57

D_{10}	D_{15}	D_{20}	D_{30}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
0.1188	0.1262	0.1341	0.1513	0.1928	0.2176	0.2975	0.3294	0.3647	0.4038

Fineness Modulus	C_u	C_c
0.92	1.83	0.89

Particle Size Distribution Report



	% Cobbles	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.00	0.00	0.00	0.00	0.11	99.08	0.81	

╳	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.2420	0.1891	0.1713	0.1406	0.1213	0.1154	0.91	1.64

	Material Description	USCS	AASHTO
○		SP	

Project No. L1107565 **Client:** Woods Hole Group

Project: Naragansett, RI

○ **Source of Sample:** PROFILE #5 **Sample Number:** L1107565-03

Remarks:

Alpha Analytical

Mansfield, MA

Figure

Tested By: ______________________ **Checked By:** ______________________

GRAIN SIZE DISTRIBUTION TEST DATA

6/3/2011

Client: Woods Hole Group
Project: Naragansett, RI
Project Number: L1107565
Location: PROFILE #5
Sample Number: L1107565-03
USCS Classification: SP

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Sieve Opening Size	Weight Retained (grams)	Sieve Weight (grams)	Percent Finer	Percent Retained
202.35	7.57	#4	527.20	527.20	100.00	0.00
		#10	492.41	492.41	100.00	0.00
		#20	417.70	417.67	99.98	0.02
		#40	376.11	375.92	99.89	0.11
		#60	388.32	365.72	88.28	11.72
		#140	511.96	342.64	1.36	98.64
		#230	322.42	320.82	0.53	99.47

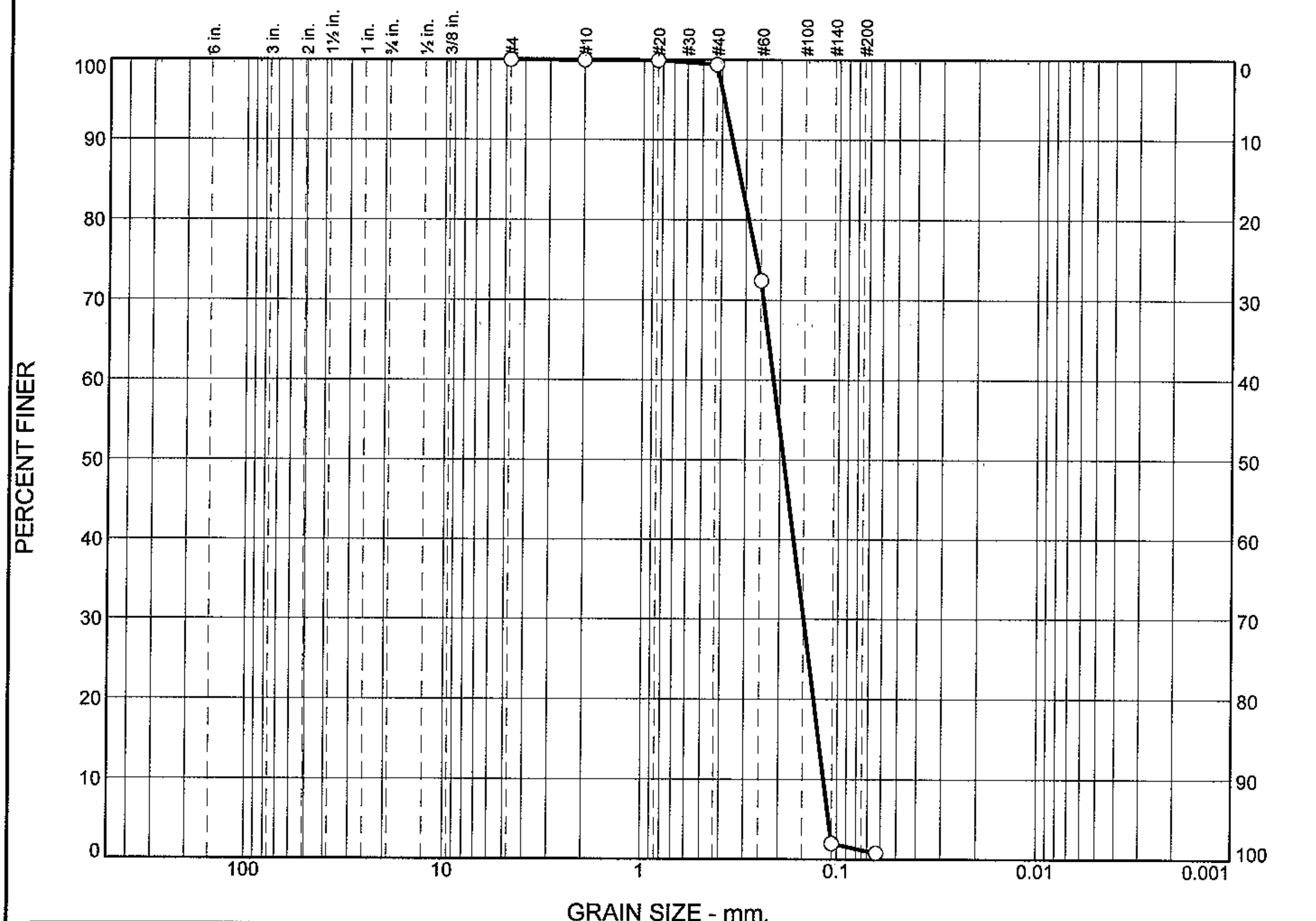
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.00	0.00	0.00	0.00	0.00	0.11	99.08	99.19			0.81

D_{10}	D_{15}	D_{20}	D_{30}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
0.1154	0.1213	0.1274	0.1406	0.1713	0.1891	0.2304	0.2420	0.2704	0.3399

Fineness Modulus	C_u	C_c
0.71	1.64	0.91

Particle Size Distribution Report



	% Cobbles	% Gravel Coarse	% Gravel Fine	% Sand Coarse	% Sand Medium	% Sand Fine	% Fines Silt	% Fines Clay
○	0.00	0.00	0.00	0.06	0.56	98.20	1.18	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.3203	0.2150	0.1903	0.1491	0.1242	0.1169	0.89	1.84

	Material Description	USCS	AASHTO
○		SP	

Project No. L1107565 **Client:** Woods Hole Group

Project: Naragansett, RI

○ **Source of Sample:** PROFILE #8 **Sample Number:** L1107565-04

Remarks:

Alpha Analytical

Mansfield, MA

Figure

Tested By: ____________________ **Checked By:** ____________________

GRAIN SIZE DISTRIBUTION TEST DATA

6/3/2011

Client: Woods Hole Group
Project: Naragansett, RI
Project Number: L1107565
Location: PROFILE #8
Sample Number: L1107565-04
USCS Classification: SP

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Sieve Opening Size	Weight Retained (grams)	Sieve Weight (grams)	Percent Finer	Percent Retained
157.19	7.39	#4	527.20	527.20	100.00	0.00
		#10	492.50	492.41	99.94	0.06
		#20	417.70	417.67	99.92	0.08
		#40	376.73	375.92	99.38	0.62
		#60	406.14	365.72	72.40	27.60
		#140	448.13	342.64	1.98	98.02
		#230	322.62	320.82	0.77	99.23

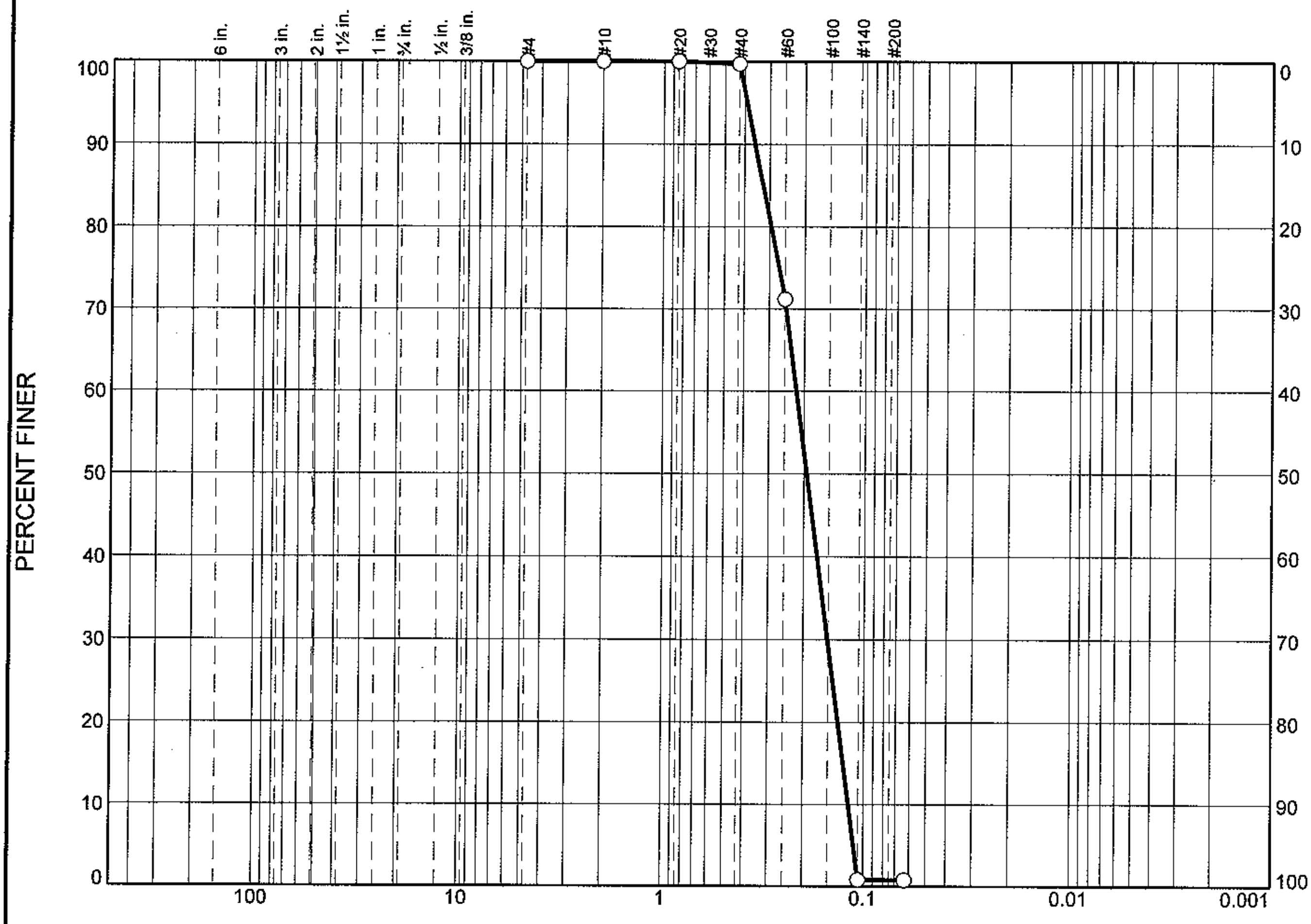
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.00	0.00	0.00	0.00	0.06	0.56	98.20	98.82			1.18

D_{10}	D_{15}	D_{20}	D_{30}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
0.1169	0.1242	0.1320	0.1491	0.1903	0.2150	0.2903	0.3203	0.3534	0.3899

Fineness Modulus	C_u	C_c
0.88	1.84	0.89

Particle Size Distribution Report



	% Cobbles	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.00	0.00	0.00	0.00	0.32	98.92	0.76	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.3235	0.2182	0.1932	0.1514	0.1260	0.1186	0.89	1.84

	Material Description	USCS	AASHTO
○		SP	

Project No. L1107565 **Client:** Woods Hole Group

Project: Naragansett, RI

○ **Source of Sample:** PROFILE #10 **Sample Number:** L1107565-05

Remarks:

Alpha Analytical

Mansfield, MA

Figure

Tested By: ______________ **Checked By:** ______________

GRAIN SIZE DISTRIBUTION TEST DATA

6/3/2011

Client: Woods Hole Group
Project: Naragansett, RI
Project Number: L1107565
Location: PROFILE #10
Sample Number: L1107565-05
USCS Classification: SP

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Sieve Opening Size	Weight Retained (grams)	Sieve Weight (grams)	Percent Finer	Percent Retained
140.55	7.44	#4	527.20	527.20	100.00	0.00
		#10	492.41	492.41	100.00	0.00
		#20	417.70	417.67	99.98	0.02
		#40	376.32	375.92	99.68	0.32
		#60	403.71	365.72	71.14	28.86
		#140	436.26	342.64	0.80	99.20
		#230	320.90	320.82	0.74	99.26

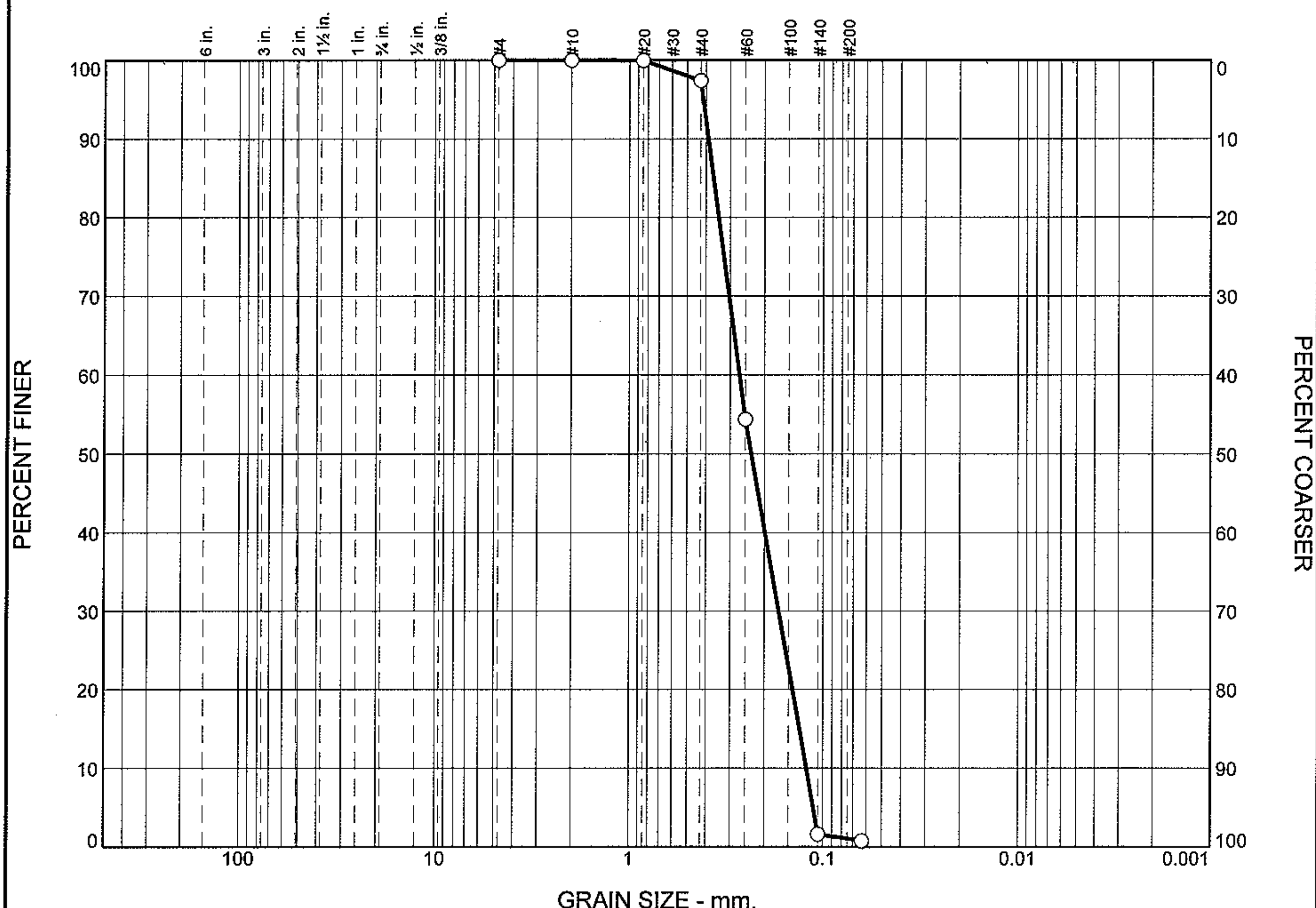
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.00	0.00	0.00	0.00	0.00	0.32	98.92	99.24			0.76

D_{10}	D_{15}	D_{20}	D_{30}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
0.1186	0.1260	0.1340	0.1514	0.1932	0.2182	0.2948	0.3235	0.3550	0.3896

Fineness Modulus	C_u	C_c
0.90	1.84	0.89

Particle Size Distribution Report



	% Cobbles	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○				0.03	2.59	96.35	1.03	

X	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.3649	0.2681	0.2330	0.1682	0.1318	0.1215	0.87	2.21

	Material Description	USCS	AASHTO
○		SP	

Project No. L1107565 **Client:** Woods Hole Group
Project: Naragansett, RI

○ **Source of Sample:** PROFILE #9 **Sample Number:** L1107565-06

Remarks:

Alpha Analytical

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Figure

Tested By: ______________________ **Checked By:** ______________________

GRAIN SIZE DISTRIBUTION TEST DATA

6/3/2011

Client: Woods Hole Group
Project: Naragansett, RI
Project Number: L1107565
Location: PROFILE #9
Sample Number: L1107565-06
USCS Classification: SP

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Sieve Opening Size	Weight Retained (grams)	Sieve Weight (grams)	Percent Finer	Percent Retained
172.11	7.39	#4	527.20	527.20	100.00	0.00
		#10	492.45	492.41	99.97	0.03
		#20	417.70	417.67	99.96	0.04
		#40	380.17	375.92	97.38	2.62
		#60	436.61	365.72	54.34	45.66
		#140	429.48	342.64	1.62	98.38
		#230	322.27	320.82	0.74	99.26

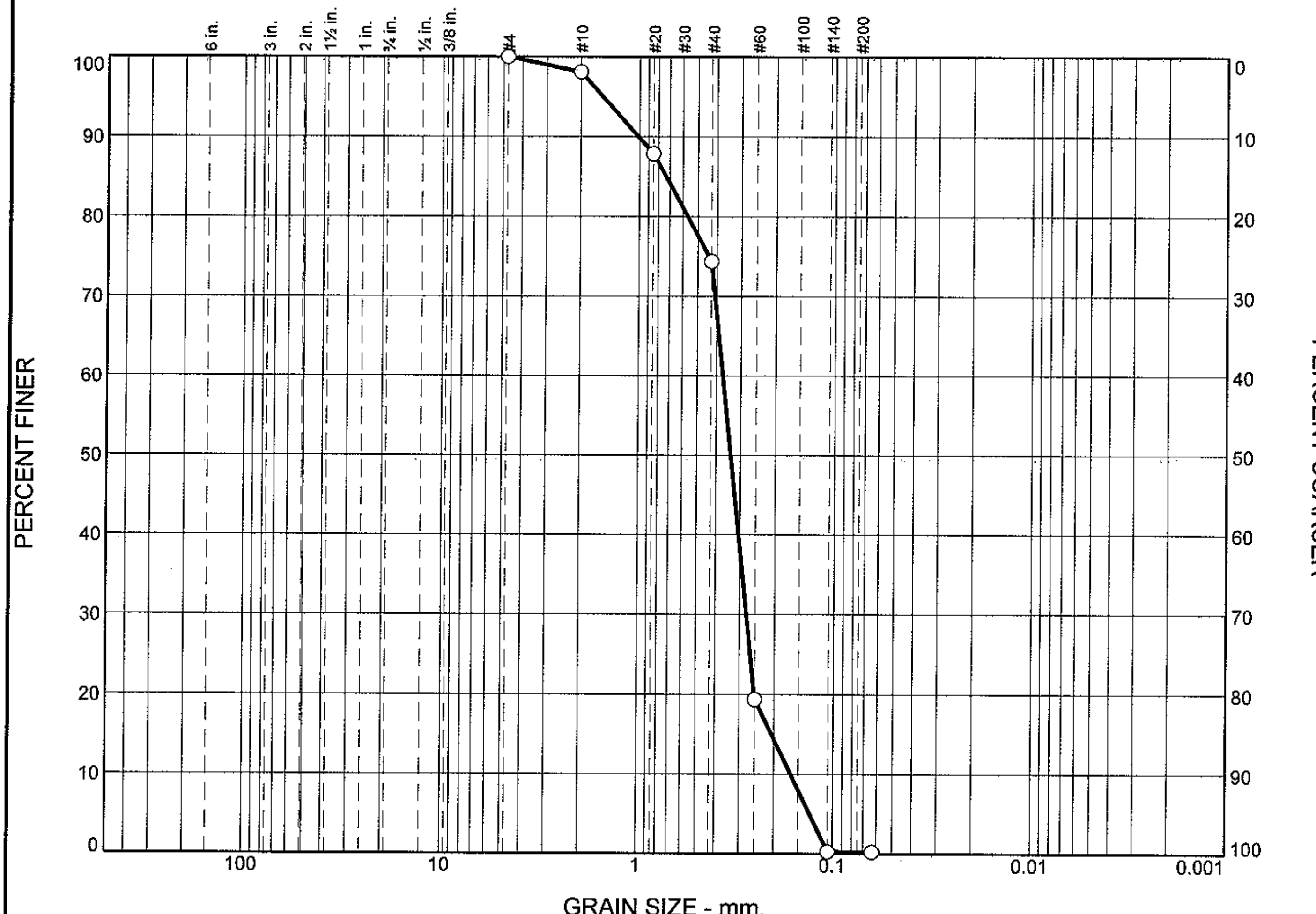
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
				0.03	2.59	96.35	98.97			1.03

D_{10}	D_{15}	D_{20}	D_{30}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
0.1215	0.1318	0.1430	0.1682	0.2330	0.2681	0.3430	0.3649	0.3881	0.4127

Fineness Modulus	C_u	C_c
1.09	2.21	0.87

Particle Size Distribution Report



	% Cobbles	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.00	0.00	0.00	1.95	23.70	74.12	0.23	

☒	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.7347	0.3701	0.3360	0.2771	0.2057	0.1643	1.26	2.25

Material Description	USCS	AASHTO
○	SP	

Project No. L1107565 **Client:** Woods Hole Group
Project: Naragansett, RI

○ **Source of Sample:** PROFILE #13 **Sample Number:** L1107565-07

Alpha Analytical

Mansfield, MA

Remarks:

Figure

Tested By: ____________________ **Checked By:** ____________________

GRAIN SIZE DISTRIBUTION TEST DATA

6/3/2011

Client: Woods Hole Group
Project: Naragansett, RI
Project Number: L1107565
Location: PROFILE #13
Sample Number: L1107565-07
USCS Classification: SP

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Sieve Opening Size	Weight Retained (grams)	Sieve Weight (grams)	Percent Finer	Percent Retained
174.77	7.34	#4	527.20	527.20	100.00	0.00
		#10	495.68	492.41	98.05	1.95
		#20	434.77	417.67	87.83	12.17
		#40	398.49	375.92	74.35	25.65
		#60	457.83	365.72	19.34	80.66
		#140	374.59	342.64	0.26	99.74
		#230	320.90	320.82	0.21	99.79

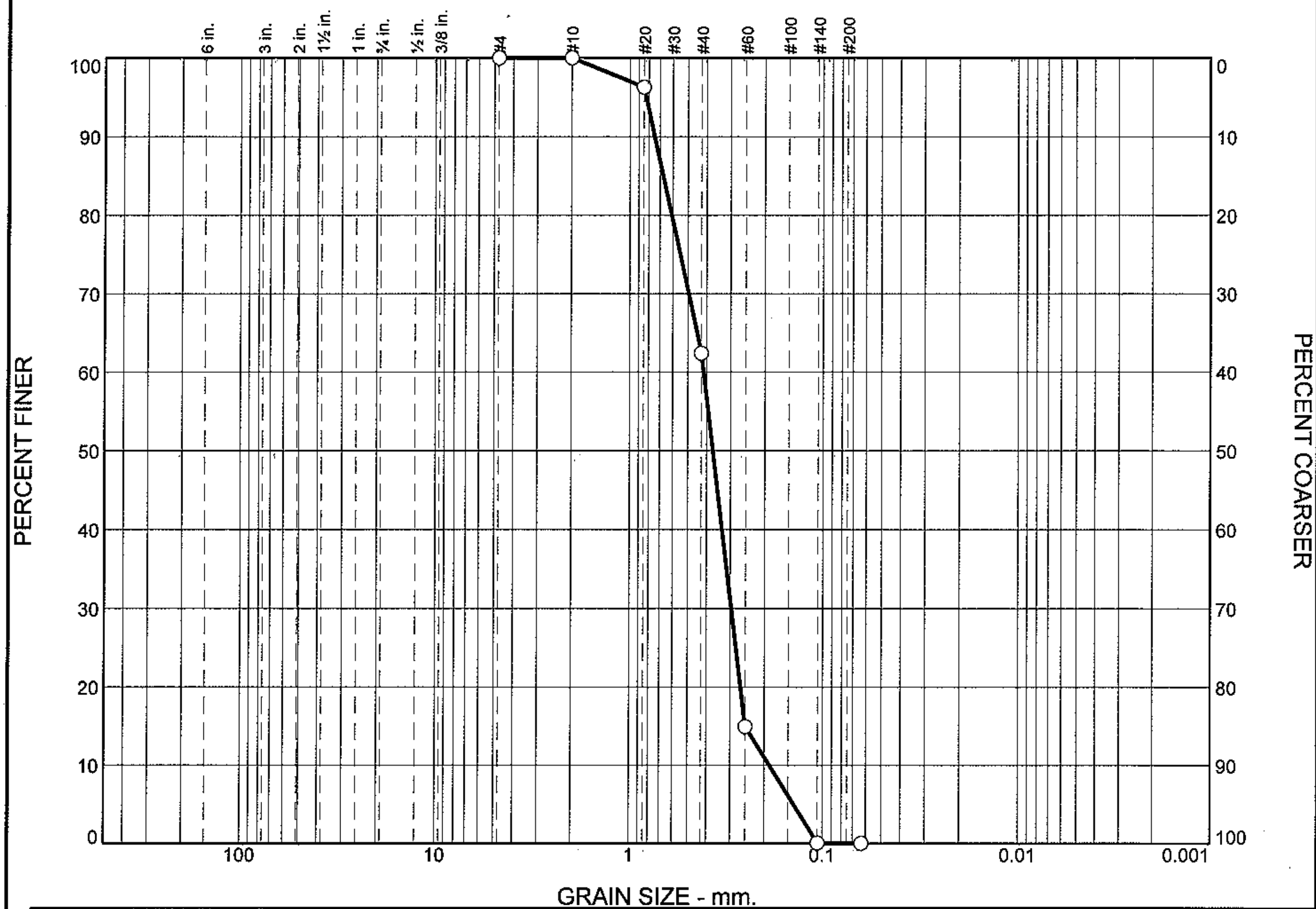
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.00	0.00	0.00	0.00	1.95	23.70	74.12	99.77			0.23

D_{10}	D_{15}	D_{20}	D_{30}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
0.1643	0.2057	0.2516	0.2771	0.3360	0.3701	0.5682	0.7347	1.0192	1.5494

Fineness Modulus	C_u	C_c
1.83	2.25	1.26

Particle Size Distribution Report



	% Cobbles	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.00	0.00	0.00	0.01	37.63	62.33	0.03	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.6752	0.4139	0.3701	0.2960	0.2503	0.1883	1.12	2.20

	Material Description	USCS	AASHTO
○		SP	

Project No. L1107565 **Client:** Woods Hole Group
Project: Naragansett, RI

○ **Source of Sample:** PROFILE #15 **Sample Number:** L1107565-08

Remarks:

Alpha Analytical

Mansfield, MA

Figure

Tested By: ____________________ **Checked By:** ____________________

GRAIN SIZE DISTRIBUTION TEST DATA

6/3/2011

Client: Woods Hole Group
Project: Naragansett, RI
Project Number: L1107565
Location: PROFILE #15
Sample Number: L1107565-08
USCS Classification: SP

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Sieve Opening Size	Weight Retained (grams)	Sieve Weight (grams)	Percent Finer	Percent Retained
205.63	7.34	#4	527.20	527.20	100.00	0.00
		#10	492.42	492.41	99.99	0.01
		#20	425.07	417.67	96.26	3.74
		#40	443.14	375.92	62.36	37.64
		#60	459.83	365.72	14.90	85.10
		#140	372.07	342.64	0.06	99.94
		#230	320.90	320.82	0.02	99.98

Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.00	0.00	0.00	0.00	0.01	37.63	62.33	99.97			0.03

D_{10}	D_{15}	D_{20}	D_{30}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
0.1883	0.2503	0.2647	0.2960	0.3701	0.4139	0.6095	0.6752	0.7478	0.8283

Fineness Modulus	C_u	C_c
1.86	2.20	1.12

Certificate/Approval Program Summary

Last revised March 23, 2011 – Mansfield Facility

The following list includes only those analytes/methods for which certification/approval is currently held.
For a complete listing of analytes for the referenced methods, please contact your Alpha Customer Service Representative.

Connecticut Department of Public Health Certificate/Lab ID: PH-0141.

Wastewater/Non-Potable Water (Inorganic Parameters: pH, Turbidity, Conductivity, Alkalinity, Aluminum, Antimony, Arsenic, Barium, Beryllium, Boron, Cadmium, Calcium, Chromium, Cobalt, Copper, Iron, Lead, Magnesium, Manganese, Mercury, Molybdenum, Nickel, Potassium, Selenium, Silver, Sodium, Strontium, Thallium, Tin, Vanadium, Zinc, Total Residue (Solids), Total Suspended Solids (non-filterable), Total Cyanide. Organic Parameters: PCBs, Organochlorine Pesticides, Technical Chlordane, Toxaphene, Acid Extractables, Benzidines, Phthalate Esters, Nitrosamines, Nitroaromatics & Isophorone, PAHs, Haloethers, Chlorinated Hydrocarbons, Volatile Organics.)

Solid Waste/Soil (Inorganic Parameters: pH, Aluminum, Antimony, Arsenic, Barium, Beryllium, Cadmium, Calcium, Chromium, Hexavalent Chromium, Cobalt, Copper, Iron, Lead, Magnesium, Manganese, Mercury, Molybdenum, Nickel, Potassium, Selenium, Silver, Sodium, Thallium, Vanadium, Zinc, Total Organic Carbon, Total Cyanide, Corrosivity, TCLP 1311. Organic Parameters: PCBs, Organochlorine Pesticides, Technical Chlordane, Toxaphene, Volatile Organics, Acid Extractables, Benzidines, Phthalates, Nitrosamines, Nitroaromatics & Cyclic Ketones, PAHs, Haloethers, Chlorinated Hydrocarbons.)

Florida Department of Health Certificate/Lab ID: E87814. ***NELAP Accredited.***

Non-Potable Water (Inorganic Parameters: SM2320B, SM2540D, SM2540G.)

Solid & Chemical Materials (Inorganic Parameters: 6020, 7470, 7471, 9045. Organic Parameters: EPA 8260, 8270, 8082, 8081.)

Air & Emissions (EPA TO-15.)

Louisiana Department of Environmental Quality Certificate/Lab ID: 03090. ***NELAP Accredited.***

Non-Potable Water (Inorganic Parameters: EPA 180.1, 245.7, 1631E, 3020, 6020A, 7470A, 9040, 9050A, SM2320B, 2540D, 2540G, 4500H-B, Organic Parameters: EPA 3510C, 3580A, 3630C, 3640A, 3660B, 3665A, 5030B, 8015D, 3570, 8081B, 8082A, 8260B, 8270C.)

Solid & Chemical Materials (Inorganic Parameters: EPA 1311, 3050, 3051A, 3060A, 6020A, 7196A, 7470A, 7471B, 7474, 9040B, 9045C, 9060. Organic Parameters: EPA 3540C, 3570B, 3580A, 3630C, 3640A, 3660, 3665A, 5035, 8015D, 8081B, 8082A, 8260B, 8270C.)

Biological Tissue (Inorganic Parameters: EPA 6020A. Organic Parameters: EPA 3570, 3510C, 3610B, 3630C, 3640A, 8270C.)

Air & Emissions (EPA TO-15.)

New Hampshire Department of Environmental Services Certificate/Lab ID: 2206. ***NELAP Accredited.***

Non-Potable Water (Inorganic Parameters: EPA, 245.1, 245.7, 1631E, 180.1, 6020A, 7470A, 9040B, 9050A, SM2540D, 2540G, 4500H+B, 2320B. Organic Parameters: EPA 8081, 8082, 8260B, 8270C.)

Solid & Chemical Materials (Inorganic Parameters: SW-846 1311, 1312, 3050B, 3051A, 3060A, 6020A, 7470A, 7471A, 9040B, 9045C, 7196A. Organic Parameters: SW-846 3540C, 3580, 3630C, 3640A, 3660B, 3665A, 5035, 8260B, 8270C, 8015D, 8082, 8081A.)

New Jersey Department of Environmental Protection Certificate/Lab ID: MA015. ***NELAP Accredited.***

Non-Potable Water (Inorganic Parameters: SW-846 1312, 3010, 3020A, 3015, SM2320B, EPA 200.8, SM2540D, 2540G, EPA 120.1, SM2510B, EPA 180.1, 245.1, 1631E, SW-846 7470A, 9040B, 6020, 9010B, 9014 Organic Parameters: SW-846 3510C, 3580A, 5030B, 5035L, 5035H, 3630C, 3640C, 3660B, 3665A, 8015B 8081A, 8082, 8260B, 8270C)

Solid & Chemical Materials (Inorganic Parameters: SW-846 6020, 9010B, 9014, 1311, 1312, 3050B, 3051, 3060A, 7196A, 7470A, 7471A, 9040B, 9045C, 9060. Organic Parameters: SW-846 3540C, 3570, 3580A, 5030B, 5035L, 5035H, 3630C, 3640A, 3660B, 3665A, 8081A, 8082, 8260B, 8270C, 8015B.)

Atmospheric Organic Parameters (EPA TO-15)

Biological Tissue (Inorganic Parameters: SW-846 6020 Organic Parameters: SW-846 8270C, 3510C, 3570, 3630C, 3640A)

New York Department of Health Certificate/Lab ID: 11627. ***NELAP Accredited.***

Non-Potable Water (Inorganic Parameters: SM2320B, SM2540D, EPA 200.8, 6020, 1631E, 245.1, 9014, 9040B, 120.1, SM2510B, 4500CN-E, 4500H-B, EPA 376.2, 180.1, 9010B. Organic Parameters: EPA 8260B, 8270C, 8081A, 8082, 3510C, 5030B.)

Solid & Hazardous Waste (Inorganic Parameters: EPA 6020, 7196A, 3060A, 7471A, 7474, 9014, 9040B, 9045C, 9010B. Organic Parameters: EPA 8260B, 8270C, 8081A, DRO 8015B, 8082, 1311, 1312, 3050B, 3580, 3570, 3051, 5035, 5030B.)

Air & Emissions (EPA TO-15.)

Rhode Island Department of Health Certificate/Lab ID: LAO00299. ***NELAP Accredited via LA-DEQ.***

Refer to LA-DEQ Certificate for Non-Potable Water.

Texas Commission of Environmental Quality Certificate/Lab ID: T104704419-08-TX. ***NELAP Accredited.***

Solid & Chemical Materials (Inorganic Parameters: EPA 6020, 7470, 7471, 1311, 7196, 9014, 9040, 9045, 9060. Organic Parameters: EPA 8015, 8270, 8260, 8081, 8082.)

Air (Organic Parameters: EPA TO-15)

Washington State Department of Ecology Certificate/Lab ID: C954. *Non-Potable Water* (Inorganic Parameters: SM2540D, 2510B, EPA 120.1, 180.1, 1631E, 245.7.)

Solid & Chemical Materials (Inorganic Parameters: EPA 9040, 9060, 6020, 7470, 7471, 7474. Organic Parameters: EPA 8081, 8082, 8015 Mod, 8270, 8260.)

U.S. Army Corps of Engineers

Department of Defense Certificate/Lab ID: L2217.01.

Non-Potable Water (Inorganic Parameters: EPA 6020A, SM4500H-B. Organic Parameters: 3020A, 3510C, 5030B, 8260B, 8270C, 8270C-ALK-PAH, 8082, 8081A, 8015D-SHC.)

Solid & Hazardous Waste (Inorganic Parameters: EPA 1311, 1312, 3050B, 6020A, 7471A, 9045C, 9060, SM 2540G, ASTM D422-63. Organic Parameters: EPA 3580A, 3570, 3540C, 5035A, 8260B, 8270C, 8270-ALK-PAH, 8082, 8081A, 8015D-SHC, 8015-DRO.

Air & Emissions (EPA TO-15.)

Analytes Not Accredited by NELAP

Certification is not available by NELAP for the following analytes: **8270C:** Biphenyl. **TO-15:** Halothane, 2,4,4-Trimethyl-2-pentene, 2,4,4-Trimethyl-1-pentene, Thiophene, 2-Methylthiophene, 3-Methylthiophene, 2-Ethylthiophene, 1,2,3-Trimethylbenzene, Indan, Indene, 1,2,4,5-Tetramethylbenzene, Benzothiophene, 2-Methylnaphthalene, 1-Methylnaphthalene.

ALPHA ANALYTICAL
WESTBORO, MA TEL: 508-898-9220 FAX: 508-898-9193
MANSFIELD, MA TEL: 508-822-9300 FAX: 508-822-3288

CHAIN OF CUSTODY

PAGE 1 OF 1

Date Rec'd in Lab:

ALPHA Job #: L1107565

Client Information

Client: Woods Hole Group
Address: 81 Technology Park Dr. E. Falmouth, MA 02536
Phone: 508-540-8080
Fax: 508-540-1001
Email: LFIELDS@WHGRP.com

☐ These samples have been previously analyzed by Alpha

Project Information

Project Name: Narragansett, RI
Project Location: Narragansett Beach
Project #: 2011-004
Project Manager: Leslie Fields
ALPHA Quote #:

Turn-Around Time

☒ Standard ☐ RUSH (only confirmed if pre-approved!)
Date Due: Time:

Report Information - Data Deliverables

☐ FAX ☒ EMAIL
☒ ADEx ☐ Add'l Deliverables

Billing Information

☐ Same as Client info PO #:

Regulatory Requirements/Report Limits

State /Fed Program | Criteria

MA MCP PRESUMPTIVE CERTAINTY --- CT REASONABLE CONFIDENCE PROTOCOLS

☐ Yes ☒ No Are MCP Analytical Methods Required?
☐ Yes ☒ No Are CT RCP (Reasonable Confidence Protocols) Required?

Other Project Specific Requirements/Comments/Detection Limits:

ANALYSIS: Grain Size, SE

SAMPLE HANDLING
Filtration
☐ Done
☒ Not needed
☐ Lab to do
Preservation
☐ Lab to do
(Please specify below)

ALPHA Lab ID (Lab Use Only)	Sample ID	Collection Date	Collection Time	Sample Matrix	Sampler's Initials	Grain Size, SE	Sample Specific Comments	TOTAL # BOTTLES
L1107565-1	PROFILE #1	5/20/11	8:00	SED	BEP	X	Sieve Sizes:	1
-2	PROFILE #3	5/20/11	8:45	SED	BEP	X	10,35,60,120,230	1
-3	PROFILE #5	5/20/11	9:20	SED	BEP	X	↓	1
-4	PROFILE #8	5/20/11	11:00	SED	BEP	X		1
-5	PROFILE #10	5/20/11	11:45	SED	BEP	X		1
-6	PROFILE #9	5/20/11	11:30	SED	BEP	X		1
-7	PROFILE #13	5/20/11	13:00	SED	BEP	X		1
-8	PROFILE #15	5/20/11	14:00	SED	BEP	X		1

PLEASE ANSWER QUESTIONS ABOVE!

Container Type: P
Preservative: A

IS YOUR PROJECT MA MCP or CT RCP?

Relinquished By:	Date/Time	Received By:	Date/Time
Bert Payne	5/23/11 2:50	UPS	17:00
UPS	5/26/11 1320	[signature]	5/26/11 1320

Please print clearly, legibly and completely. Samples can not be logged in and turnaround time clock will not start until any ambiguities are resolved. All samples submitted are subject to Alpha's Payment Terms. See reverse side.

FORM NO: 01-01 (rev. 30-JUL-07)

APPENDIX B MARINE CONTRACTORS

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Company	Address	Phone
Village Dock, Inc.	15 N. Columbia Street, Port Jefferson, NY 11777-2131	631-928-4104
AGM Marine Contractors, Inc.	30 Echo Road, Mashpee, MA 02649	508-477-8801
George Sherman Sand & Gravel, Inc.	88 Curtis Corner Road, Wakefield, RI 02879	401-789-6304
Dry Bridge Sand & Stone, Inc.	471 Dry Bridge Road, North Kingstown, RI 02852	401-295-2147
Richmond Sand & Gravel, Inc.	35 Stillson Road, Wyoming, RI 02898	401-539-7770
Great Lakes Dredge & Dock Company	2122 York Road, Oak Brook, IL 60523	630-574-3000
Weeks Marine, Inc.	4 Commerce Drive, Cranford, NJ 07016	908-272-4010
Burnham Associates, Inc	14 Franklin Street, Salem, MA 01970	978-745-1788

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