Environmental Impact Evaluation
Hammonasset Beach Erosion Study

Prepared in accordance with the
Connecticut Environmental Policy Act

Sponsoring Agency:

State of Connecticut
Department of Environmental Protection

October 2008

FUSS & O'NEILL
Disciplines to Deliver

Fuss & O'Neill, Inc.
146 Hartford Road
Manchester, CT

WOODS HOLE GROUP

Woods Hole Group
81 Technology Park Drive
East Falmouth, MA

ENVIRONMENTAL IMPACT EVALUATION
HAMMONASSET BEACH EROSION STUDY
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EXECUTIVE SUMMARY

Introduction

Hammonasset Beach State Park is Connecticut's largest shoreline park, with approximately two miles of available beach, more than 550 campsites, walking trails, nature center programs and exhibits, and other opportunities for outdoor recreation. Hammonasset attracts the highest annual visitor attendance of any Connecticut state park. However, persistent erosion along the western portion of the state park's beach has repeatedly reduced the width and capacity of the beach and has placed park facilities in jeopardy of damage. Since the 1920s, maintenance of the beach as a desirable recreation area has required beach nourishment to address the erosion problem. The location of Hammonasset Beach State Park relative to the surrounding region is presented in Figure ES-1. Figure ES-2 includes an aerial photograph of the park.

Presently, erosion along the western portion of Hammonasset Beach is managed through temporary short-term measures such as mechanical placement of sand immediately after a storm or in anticipation of a winter storm to prevent or mitigate erosion to the beach and damage to the Park's infrastructure. To address the long-term needs for beach management, the Connecticut Department of Environmental Protection (DEP) retained Fuss & O'Neill with Woods Hole Group to study the historical and ongoing shoreline erosion at Hammonasset Beach State Park, identify potential long-term remedial actions, evaluate potential environmental impacts of alternatives to address the erosion, and recommend the most cost-effective and environmentally-responsible long-term course of action for DEP to pursue.

This Environmental Impact Evaluation (EIE) is being prepared pursuant to the Connecticut Environmental Policy Act (CEPA) and the Regulations of Connecticut State Agencies (RCSA) Section 22a-1a-1 through 22a-1a-12. It provides a description of the proposed action, an evaluation of the direct, indirect, and cumulative effects of the proposed action, unavoidable adverse environmental affects, alternatives, and mitigation measures. This EIE has been prepared in concert with an accompanying engineering feasibility study report, included on CD in Appendix B, which contains more technical detail not covered in this EIE for brevity and clarity. The engineering report will be submitted in support of environmental permitting applications for this project.

Project Description

The proposed action consists of the implementation of measures to mitigate the ongoing erosion of Hammonasset Beach. The goal of the action is to create a beach that has a reasonable performance lifetime (i.e., sustainability), while avoiding or minimizing environmental impacts, and maintaining the current beach usage. Based on the technical performance, potential cost, impacts to beach usage, and potential environmental impacts, which are presented in this EIE and in a companion engineering feasibility study (Woods Hole Group, 2008), the preferred alternative is beach nourishment with the potential use of a terminal groin.

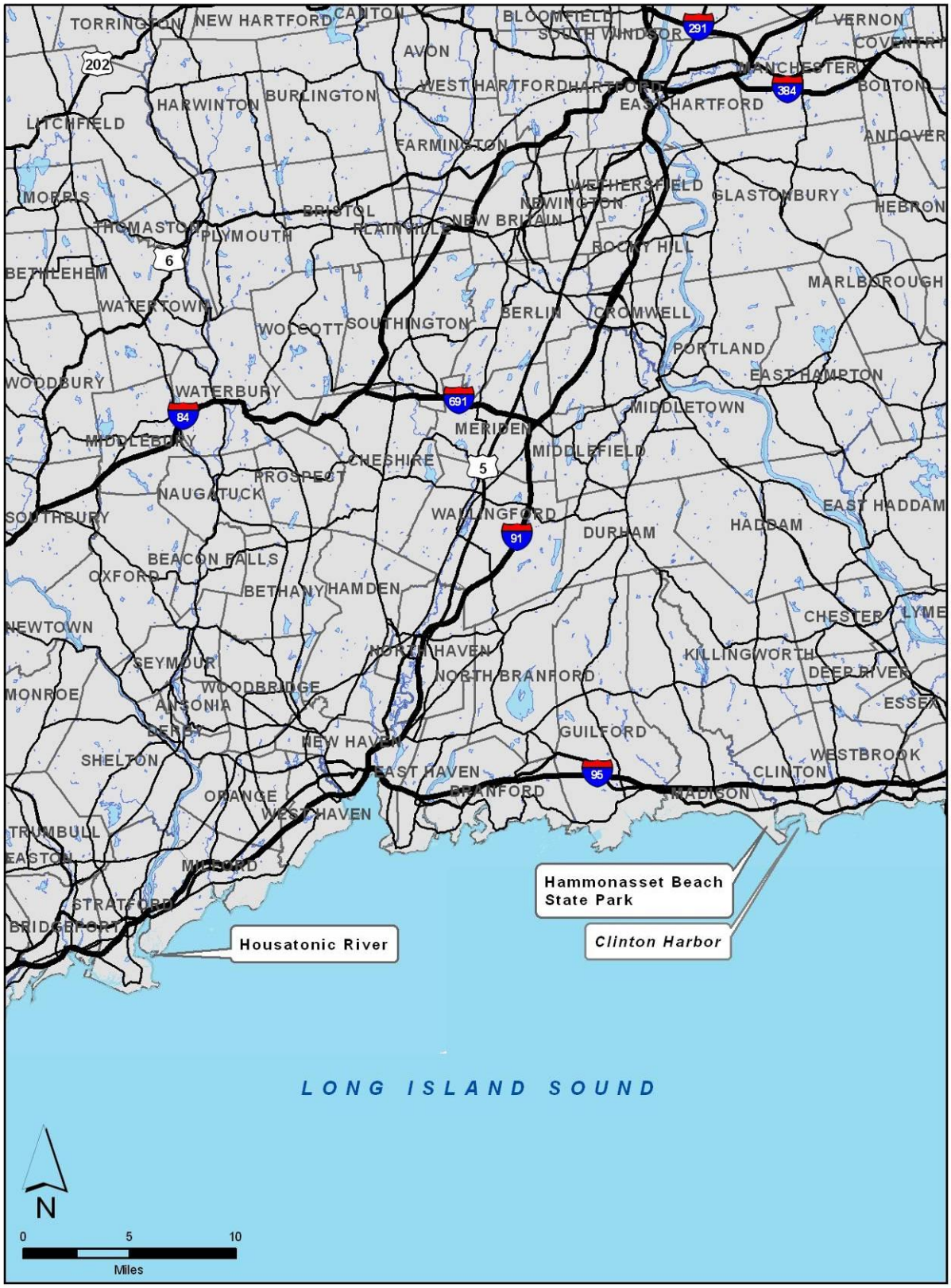


Figure ES-1. Regional Project Location Map

Figure ES-2. Aerial Photograph of Hammonasset Beach and Surrounding Area

This Environmental Impact Evaluation analyzes the impacts of the construction of the preferred beach restoration alternative but does not address environmental impacts associated with the acquisition of sand (i.e., dredging, quarrying, or similar activities) for the beach restoration project because it is assumed that the sand sources are either evaluated through separate state or federal environmental impact assessments and/or relevant environmental permitting. The preferred sand source is material from the proposed maintenance dredging for the Housatonic River and Clinton Harbor Federal Navigation Projects (FNP), which would provide a sufficient quantity and quality of sand that could be delivered to the project site in a cost-effective and efficient manner. Should these sources not be available due to delays in the FNPs, a back-up sand source would be an offshore borrow site, which would need to be definitively identified through further study.

Statement of Purpose and Need

The purpose of the proposed project is to maintain or improve the usability of Hammonasset Beach, which has been impacted by ongoing erosion, and to ensure that infrastructure is protected from future damage caused by erosion. Hammonasset Beach State Park is the most widely-used beach in the state of Connecticut and attracts the most day visitors of any Connecticut state park; in 2006, the park attracted 1.6 million day visitors and 186,000 campers. The park is also a destination for birdwatching, fishing, and school programs. Several significant habitats are present, including salt marshes, dunes, and beach. Continued erosion of the beach would threaten its usability and desirability for recreational uses.

The State of Connecticut has invested significant funds in Hammonasset Beach State Park for the benefit of the residents of Connecticut and other visitors. Park infrastructure includes several concession buildings, bath houses, a nature center, parking, access roads, and the recent construction of a new boardwalk. The proposed project is intended to provide long-term protection of these resources. In recent years, annual maintenance expenditures at the park have increased at a higher rate than income for the park. Continued implementation of stop-gap measures for protecting the beach and infrastructure from additional erosion requires the continued commitment of staff time, machinery, and fuel that could be reduced through implementation of a successful long-term project.

Alternatives Considered

An analysis of alternatives was conducted in two phases. The first phase considered a wide variety of structural and non-structural measures. The alternatives were then narrowed based on consideration of avoiding and minimizing environmental impacts, providing public access to Long Island Sound, achieving a 50-year design life, and the expected maintenance schedule and total project cost over the design life.

The alternatives initially considered consisted of No Action, Retreat/Relocation, Beach Nourishment, Structure Modifications, Perched Beach, Dune Reconstruction, Revetments and Seawalls, Groins, Breakwaters, Manual Back Passing and Alternative Technologies, including Beach Dewatering, Nearshore Berms, and Offshore Reefs.

The No Action alternative implies no measures to change the present conditions at Hammonasset Beach and assumes that the shoreline and beach would continue to erode, reducing the usable beach area and threatening the boardwalk and existing structures. This alternative would involve no new construction or beach nourishment. The No Action alternative is not considered a feasible and prudent alternative because, while it may reduce potential short-term impacts to the natural and built environment, the long-term and cumulative impacts are likely to be greater due to the loss of public access to an important recreational resource and the loss of state-owned infrastructure.

Of the other alternatives listed above and initially considered, beach nourishment was identified as the only feasible engineering alternative that is likely to repair erosion that has occurred at the beach to date while restoring the recreational capacity of the resource.

The two alternatives considered in detail involve nourishment with and without a new coastal structure to better retain the sand placed on the beach. The alternative with a new coastal structure involves construction of a terminal groin extending approximately 250 feet seaward, perpendicular to the beach, at the southeast limit of the nourishment area. This groin would be approximately one-half the length of the existing Meigs Point groin.

Figure ES-3 presents a plan of the preferred alternative without a new terminal groin, and Figure ES-4 presents the alternative with a terminal groin. Both options involve the following components:

- Nourishment material placed along the western beach from the Tom's Creek jetty to the limit of historical erosion, which is approximately 6,425 feet to the southeast.
- A nourishment berm width of 100 feet.
- A nourishment berm height of 8 feet, which is above the 10-year storm stillwater elevation, but would not require relocation of the boardwalk.
- An offshore slope of 5%, which is milder than the intertidal profile but steeper than the nearshore profile, and is flatter than the steepest profile preferred by endangered shorebirds.
- Nourishment material gradually tapered to meet the existing beach profile at its southeast limit.
- Construction of new dunes and reconstruction of existing dunes as necessary.

Under either beach nourishment alternative, placement of approximately 563,000 cubic yards of material from an off-site borrow area would be necessary. The estimated cost and project lifetime of each alternative depends on the sand source selected. If dredged sediment from Clinton Harbor and the Housatonic River Federal Navigational Projects is used, nourishment without a terminal groin is anticipated to have a design life of 21 years before additional nourishment is necessary and is estimated to cost approximately $6.8 million for initial construction, with a project cost of approximately $24.1 million total for construction and maintenance over 50 years following construction. The construction of a terminal groin along with the nourishment described above is estimated to cost approximately $8.3 million for initial construction, with a project cost of approximately $21.3 million total for construction and maintenance over 50 years following construction. This alternative is anticipated to have a design life of 25 years before additional nourishment is necessary.

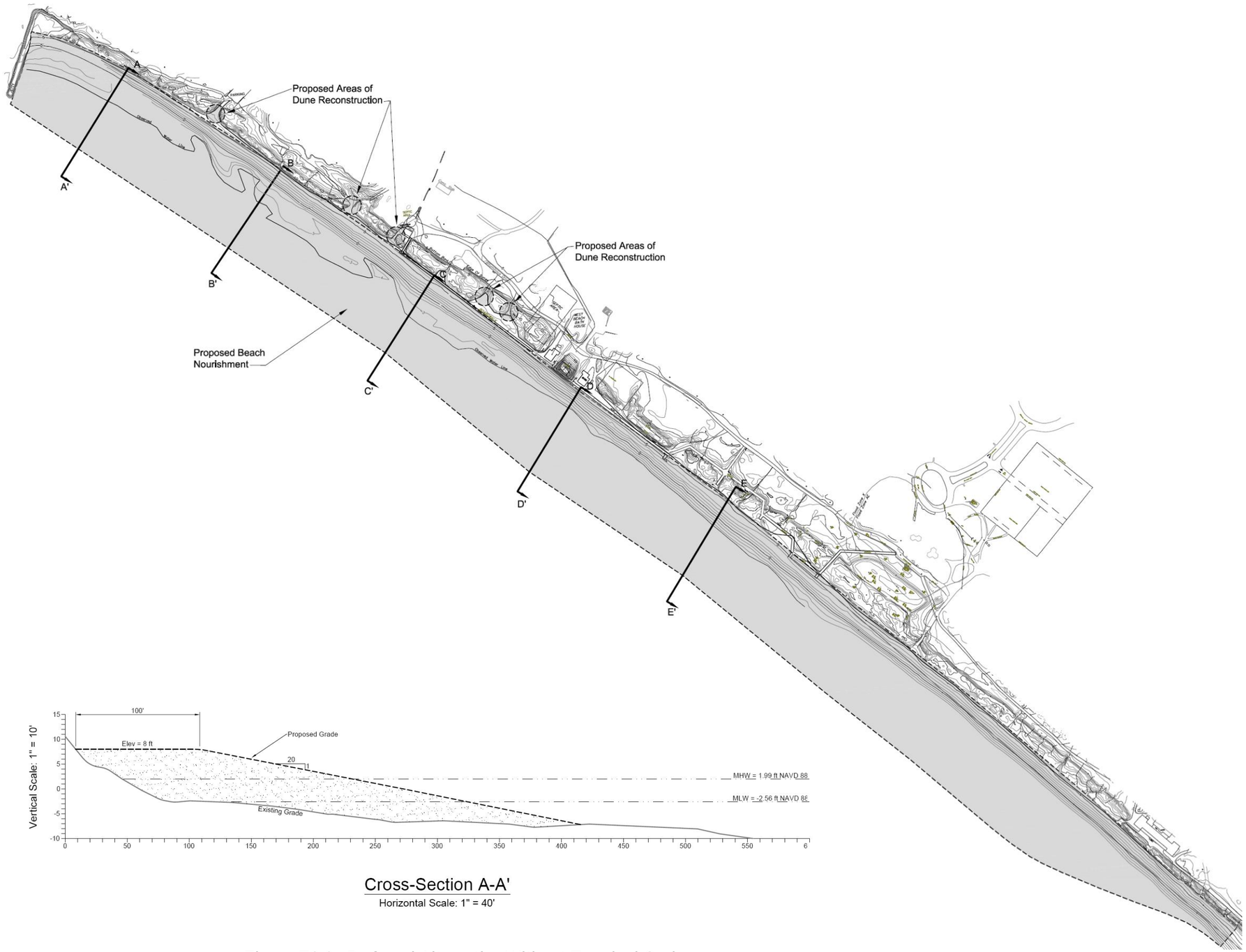
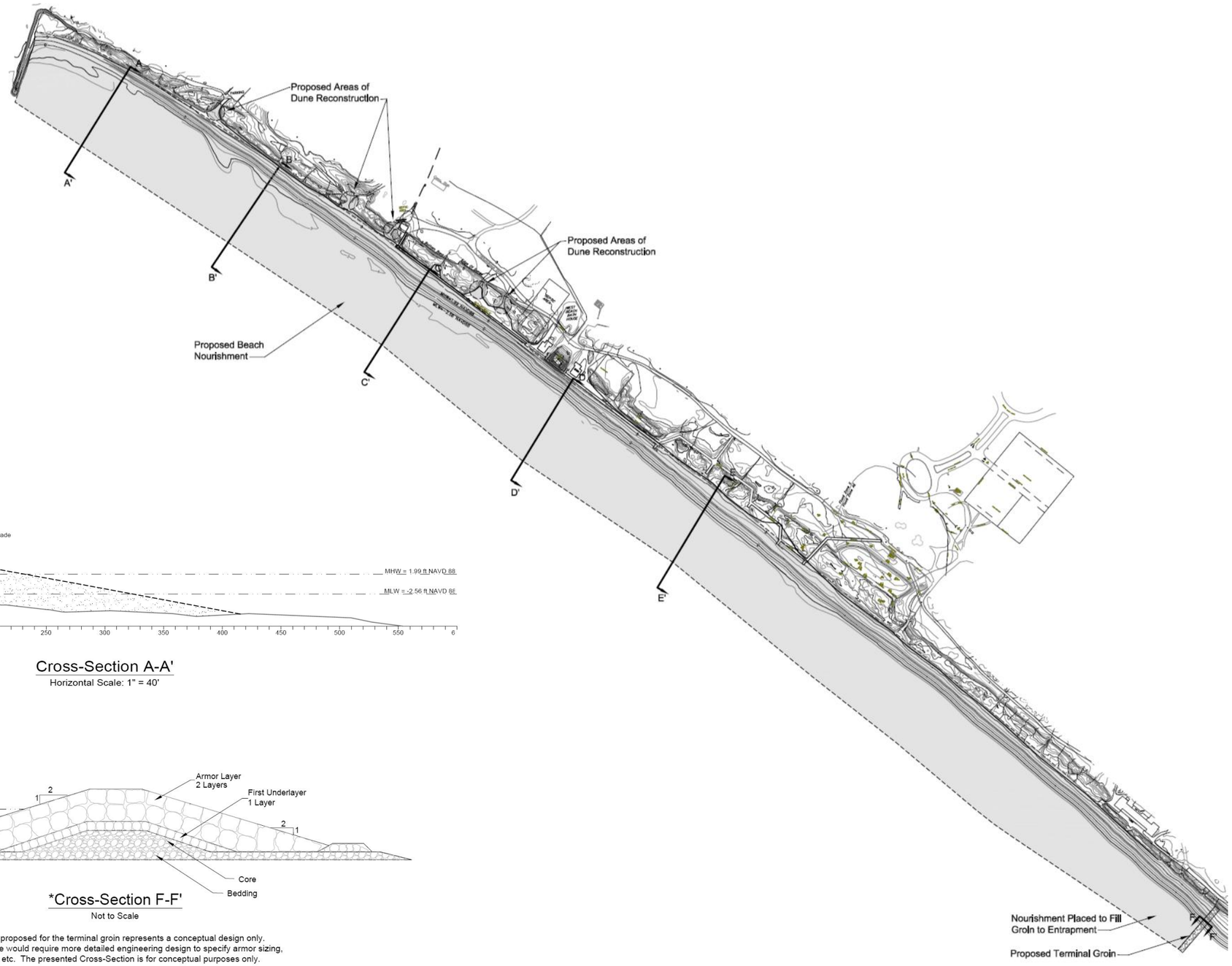
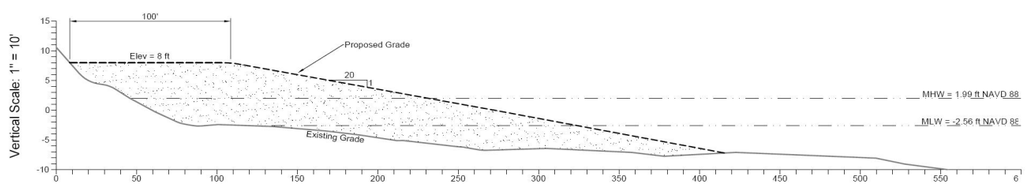


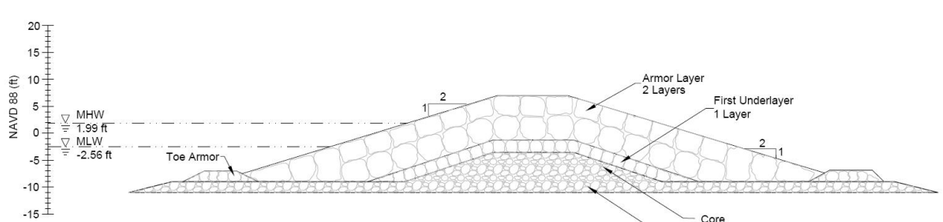
Figure ES-3. Preferred Alternative Without Terminal Groin





Cross-Section A-A'

Horizontal Scale: 1" = 40'



*Cross-Section F-F'

Not to Scale

*The Cross-Section proposed for the terminal groin represents a conceptual design only. The coastal structure would require more detailed engineering design to specify armor sizing, layering, elevations, etc. The presented Cross-Section is for conceptual purposes only.

Figure ES-4. Preferred Alternative With Terminal Groin

In addition to alternative project designs, two primary alternative sand sources were considered once beach nourishment was identified as the preferred alternative: dredging spoils that are anticipated to result from maintenance of the Clinton Harbor and Housatonic River Federal Navigational Projects, and sand obtained from upland sources.

Dredging spoils from these Federal Navigation Projects (FNPs) are the preferred sand source for nourishment at Hammonasset Beach. This material is a large-volume byproduct of maintaining navigational channels and anchorages and would otherwise require disposal in an offshore location. Additionally, the material originates within or near Long Island Sound and can be transported to the beach by barge, significantly reducing transportation costs. These FNPs are maintained by USACE and would be permitted separately from this project. Samples of these sediments that were collected and analyzed indicate that the material is free from harmful levels of chemical constituents and is of appropriate grain size to be compatible with its use. The cost to DEP of this material is estimated to be $10-15 per cubic yard. Use of sand from a FNP site is preferred due to its reduced potential for environmental impacts and its lower cost.

Several upland sand sources that could potentially supply sand to Hammonasset Beach for nourishment have been identified. Upland sand sources may include sand pits and other operations that are permitted separately from this project. Sand would be transported to Hammonasset Beach State Park by one or more modes of transportation, staged at the park, and transported overland for deposition on the beach. The current (August 2008) estimated cost to DEP of this material ranges from approximately $19-27 per cubic yard. Using sand from upland sources is not preferred due to cost, traffic, noise, and potential damage to park infrastructure.

If Housatonic River sediments are not available for use at Hammonasset Beach, and upland sand sources are found to be prohibitively expensive, infeasible, or to involve potential impacts that are unacceptably large, one or more Long Island Sound offshore borrow sites could be potential sediment sources. These include the shoal area southeast of Meigs Point, and the Long Sand Shoal, which is located approximately five miles east of Hammonasset Beach offshore from the Connecticut River mouth. Use of an offshore borrow site would require additional study and evaluation of potential impacts.

Analysis of Impact

The alternative with the greatest impact is the No Action alternative since it is not protective of recreational, environmental, coastal, or historical resources. The width and usable area of the beach will continue to diminish, resulting in less capacity being available for beach users. Though No Action avoids traffic, air quality, noise, and other construction impacts and does not require capital funding to implement, it will result in the damage or loss of existing buildings and infrastructure as beach erosion progresses. Utilities that run along the beach may be damaged. This damage could include exposure and damage of the septic systems for the West Beach bath houses, resulting in the potential for the discharge of untreated sewage to Long Island Sound. Regarding coastal resources, the No Action alternative would result not only in the significant reduction of beach resources but would eventually destroy the dunes along the erosional portion of the beach.

Continued erosion of the beach is also anticipated to expose and damage archaeological resources such as undisturbed projectile points, blades, and scrapers, similar to those previously found along the beach, and could also threaten historical resources such as potential remains of up to two fish houses that could still exist although they have not been identified to date.

Socioeconomic impacts of the No Action alternative would arise from the attraction of fewer visitors to the park and therefore fewer patrons of local restaurants and other businesses.

Beach nourishment, either with or without a terminal groin and regardless of the sand source would provide protection to the buildings and infrastructure that otherwise would be damaged through erosion. If the sand is obtained from a FNP site, some noise will occur during construction. If trucks are used to haul sand from an upland source to the beach, a number of other construction impacts may occur; park roads and parking lots may be damaged by the heavy vehicle traffic, additional traffic from vehicles and construction equipment will occur between the park and the upland source during construction, and noise from construction will no longer be limited to the park but will occur on the roadway network as well. Construction of a fishing pier extending from the end of the groin would require pile driving, which would generate noise during construction.

Nourishment without a groin will serve to protect buried archaeological and historical resources against disturbance by erosion and will maintain the current socioeconomic condition of the project area. Thus, with nourishment only, no impact to these resources is anticipated. If a terminal groin is constructed, any excavation that is necessary for the groin foundation could disturb buried archaeological resources. A fishing pier on the end of the groin could result in additional disturbance through installation of piles.

Impacts to coastal resources vary based on the selected alternative. Nourishment of the beach could potentially result in some dune damage through heavy equipment operation. However this damage can be prevented through proper mitigation such as cordoning off the limit of the dune area. Construction of a groin will have slight impacts on coastal waters through construction of an artificial structure within this resource, although potential negative impacts to downdrift areas can be prevented through filling of the area immediately updrift of the groin with sand to its equilibrium condition.

For each of the construction alternatives, nourishment may result in a temporary increase in turbidity levels in the nearshore coastal water column. Potential increases in turbidity levels in the nearshore area during the beach nourishment construction process will be mitigated through the use of temporary stilling basins. Marginally greater turbidity levels could temporarily occur during excavation for a terminal groin and pile driving for a fishing pier. Additionally, use of construction equipment at the site increases the potential for leakage or spillage of vehicular fluids or fuels.

Impacts to wildlife could potentially occur during nourishment and construction of a groin. To prevent these impacts, construction will be limited to the season when the federally-listed piping plovers are not nesting.

Mitigation

Potential impacts associated with the preferred alternative of beach nourishment (with or without a structure) are primarily associated with the construction phase of the project. Consequently, potential impacts can be mitigated by construction-related best management practices for protection of the park infrastructure, maintenance of traffic, and protection of natural resources. Performing construction during periods of traditionally lower park usage will offset socioeconomic impacts. Potential impacts to archaeological and historical resources can be mitigated through appropriate archaeological sampling following the *Environmental Review Primer for Connecticut's Archaeological Resources* to assess the presence of intact cultural remains. If intact cultural remains are encountered, underwater archaeology may be necessary to document and remove artifacts and features if avoidance is not possible.

Conclusion

Based on the results of an engineering feasibility study, examination of multiple alternatives, and assessment of potential impacts, the preferred alternative to address the problem of beach erosion at Hammonasset Beach State Park is beach nourishment with the potential use of a terminal groin.

Unlike the No Action alternative, which would result in the loss of coastal resources, reduce access to Long Island Sound, and result in subsequent cultural and socioeconomic resource impacts, the proposed beach nourishment project is not anticipated to result in any substantial long-term adverse impacts on the environment. Construction related impacts are short-term in nature and can be mitigated through project planning and best management practices for air, noise and water quality protection. The project will require significant expenditure of state funds, with total initial costs and 50-year project life costs varying based on the selected design and available sand sources.

Beach nourishment has been identified as the most feasible alternative to mitigate erosion at Hammonasset Beach and successfully address the goal of creating a beach that has a reasonable performance lifetime, while avoiding or minimizing environmental impacts, and maintaining the current beach usage. Although this has been identified as the preferred alternative, public comments received during the public review period for the EIE will be considered in making a final decision on the proposed action to address erosion at Hammonasset Beach.

1.0 INTRODUCTION

1.1 Project Background and History

Hammonasset Beach State Park is Connecticut's largest shoreline park, with approximately two miles of available beach, more than 550 campsites, walking trails, nature center programs and exhibits, and other opportunities for outdoor recreation. Infrastructure at the beach includes a boardwalk, car top boat launch, concessions, bath houses, and picnic facilities. Figure 1-1 presents a regional map showing the location of Hammonasset Beach State Park, and Figure 1-2 presents an aerial photo of Hammonasset Beach and the surrounding area.

The beach is a dynamic system, and its maintenance as a desirable recreation area has required several significant projects in the last century. A large hurricane in the 1920s destroyed the boardwalk that was then present. Continued sand erosion during the next few decades resulted in a comprehensive beach erosion study that was completed in 1950, followed by a beach nourishment project and construction of the Meigs Point groin. A second beach erosion study was completed in the 1970s, which was followed by construction of the Tom's Creek jetty.

In recent years, the beach's boardwalk has been repaired due to wear and storm undermining in 1989, 1991, 1992, 1993, 1996, and 2000. The existing boardwalk was constructed in 2000-2001, and some portions were subsequently damaged in 2001-2002. More recent storms have damaged existing boardwalk sections. Finally, during the winter of 2004-2005, severe storms resulted in significant sand loss from a one-quarter mile section of the West Beach, increasing its slope, decreasing its width, and approaching the boardwalk and bath house structures.

Presently, the State continues to manage the erosion problem along the western portion of Hammonasset Beach through temporary short-term measures. Erosion continues between Tom's Creek and the area of the former main pavilion, a stretch that includes the entire beach fronting the boardwalk. Meanwhile, the eastern beach is building up sand against the groin at Meigs Point. As a stop-gap protective measure against erosional events, the State maintains stockpiles of sediment along the narrow beach near the western bath houses during the winter off-season. This material is mechanically placed on the beach immediately after a storm, or in anticipation of the winter storm beach profile adjustment in order to prevent or mitigate erosion to the beach and damage to the Park's infrastructure (Woods Hole Group, 2008).

The Connecticut Department of Environmental Protection (DEP) retained Fuss & O'Neill with Woods Hole Group to study the historical and ongoing shoreline erosion at Hammonasset Beach State Park, identify and evaluate potential environmental impacts of alternatives to address the erosion, and recommend the most cost-effective and environmentally-responsible long-term course of action for DEP to pursue.

This Environmental Impact Evaluation (EIE) is being prepared pursuant to the Connecticut Environmental Policy Act (CEPA) and the Regulations of Connecticut State Agencies (RCSA) Section 22a-1a-1 through 22a-1a-12. It provides a description of the proposed action, an evaluation of the direct, indirect, and cumulative effects of the proposed action, unavoidable adverse environmental affects, alternatives, and mitigation measures.

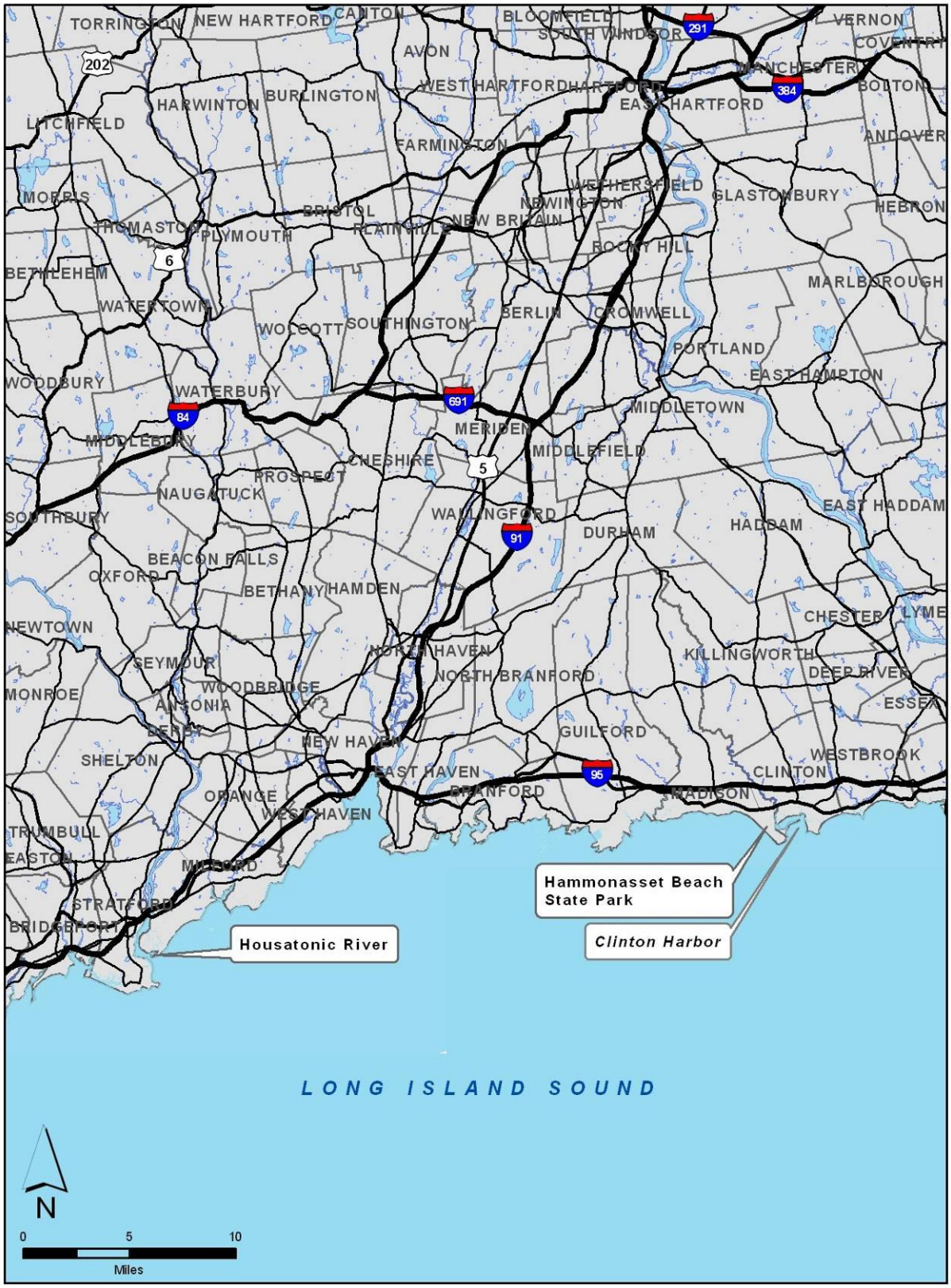


Figure 1-1. Regional Project Location Map

Figure 1-2. Aerial Photograph of Hammonasset Beach and Surrounding Area

1.2 Description of the Proposed Action

The proposed action consists of the implementation of measures to mitigate the ongoing erosion of Hammonasset Beach. The goal of the mitigation is to create a beach that has a reasonable performance lifetime (i.e., sustainability), while avoiding or minimizing environmental impacts, and maintaining the current beach usage.

Based on the technical performance, potential cost, impacts to beach usage, and potential environmental impacts, which are presented in this EIE and in a companion engineering feasibility study (Woods Hole Group, 2008), the preferred alternative is beach nourishment with the potential use of a terminal groin. Work would be performed during the off-season, from Labor Day through March 31, when demand for beach usage is low and outside of endangered shorebird breeding season (the park is heavily used from April through October, although peak beach usage is Memorial Day through Labor Day, and shorebird nesting season is April 1 through August 15). Conceptual figures for the preferred alternative, with and without a terminal groin, are presented in Figures 1-3 and 1-4.

The beach nourishment project would be constructed with sand obtained from proposed maintenance dredging for the Housatonic River and Clinton Harbor Federal Navigation Projects (FNP), which offer the amount of material necessary to complete the preferred alternative in a cost-effective manner.

If sand from the Housatonic River and Clinton Harbor FNPs is unavailable for use as a beach nourishment source, an off-shore borrow source would be required as the backup sediment source to complete the preferred beach restoration alternative due to the volume of sand required, the logistical problems associated with an upland source, and the overall cost-effectiveness of an offshore borrow source (Woods Hole Group, 2008). An offshore borrow site would require additional study to quantify the amount of material available, material quality, and overall feasibility. This additional study is beyond the scope of this EIE and the companion engineering feasibility study.

While the proposed action consists of construction of the preferred beach restoration alternative, it assumes the availability of sand from one or more of the above sources for use in the restoration project. This EIE does not address the acquisition of sand for beach nourishment. The environmental impacts associated with the acquisition of sand (i.e., dredging, quarrying, or similar activities) for the beach restoration project are either evaluated through separate state or federal environmental impact assessments and relevant environmental permitting.

1.3 Purpose and Need

The purpose of the proposed project is to maintain or improve the usability of Hammonasset Beach, which has been impacted by ongoing erosion, and to ensure that infrastructure is protected from future damage caused by erosion. Hammonasset Beach State Park is the mostly widely-used beach in the state of Connecticut and attracts the most day visitors of any Connecticut state park; in 2006, the park attracted 1.6 million day visitors and 186,000 campers.

Survey conducted by Fuss and O'Neill, April 2007.

Conceptual Design:
This plan presents a conceptual design only. The plan describes the overall scope of the project, but does not provide all required engineering details. A design plan will need to b detailed with appropriate final engineering notes prior to detailing the project or aquiring contract bids.

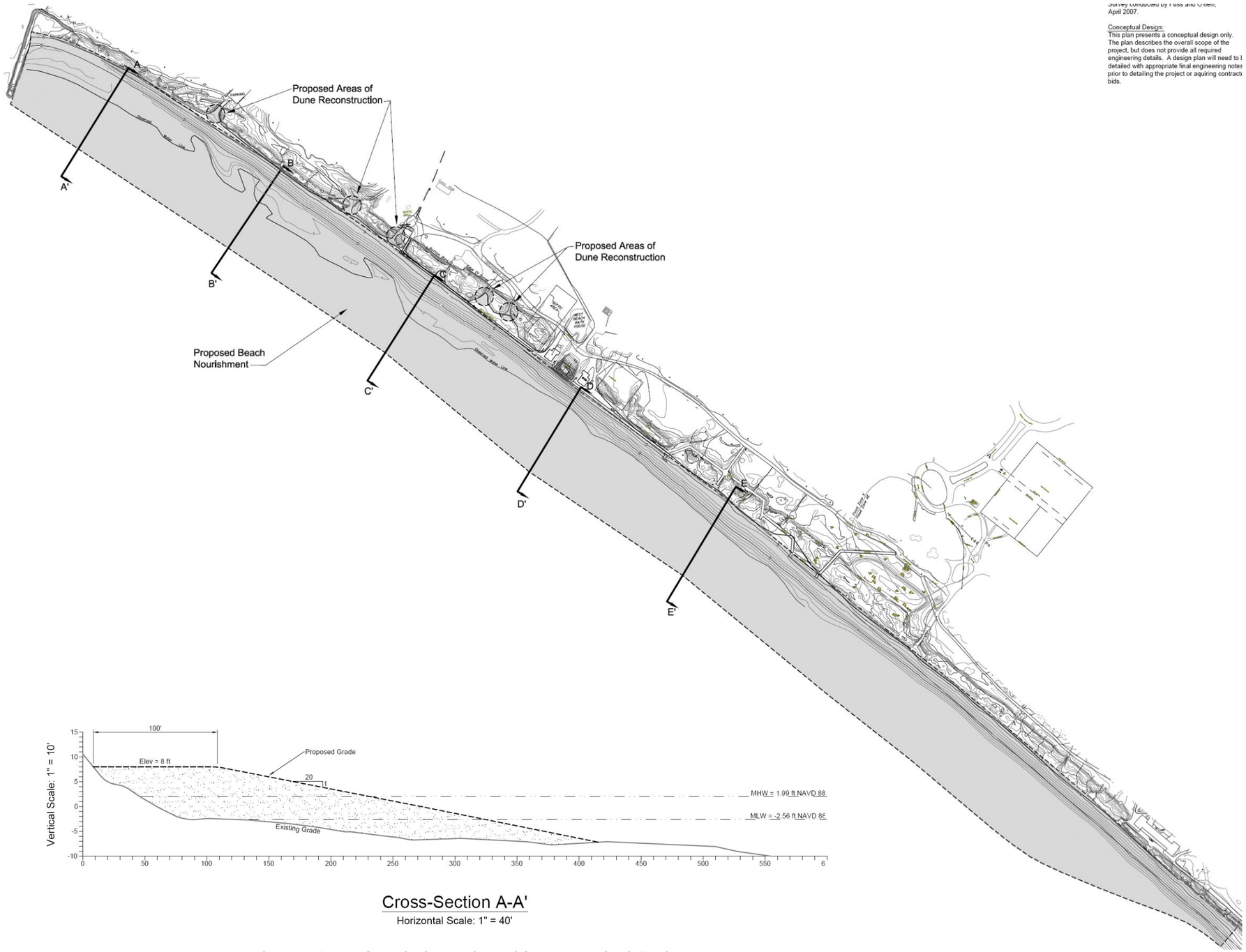
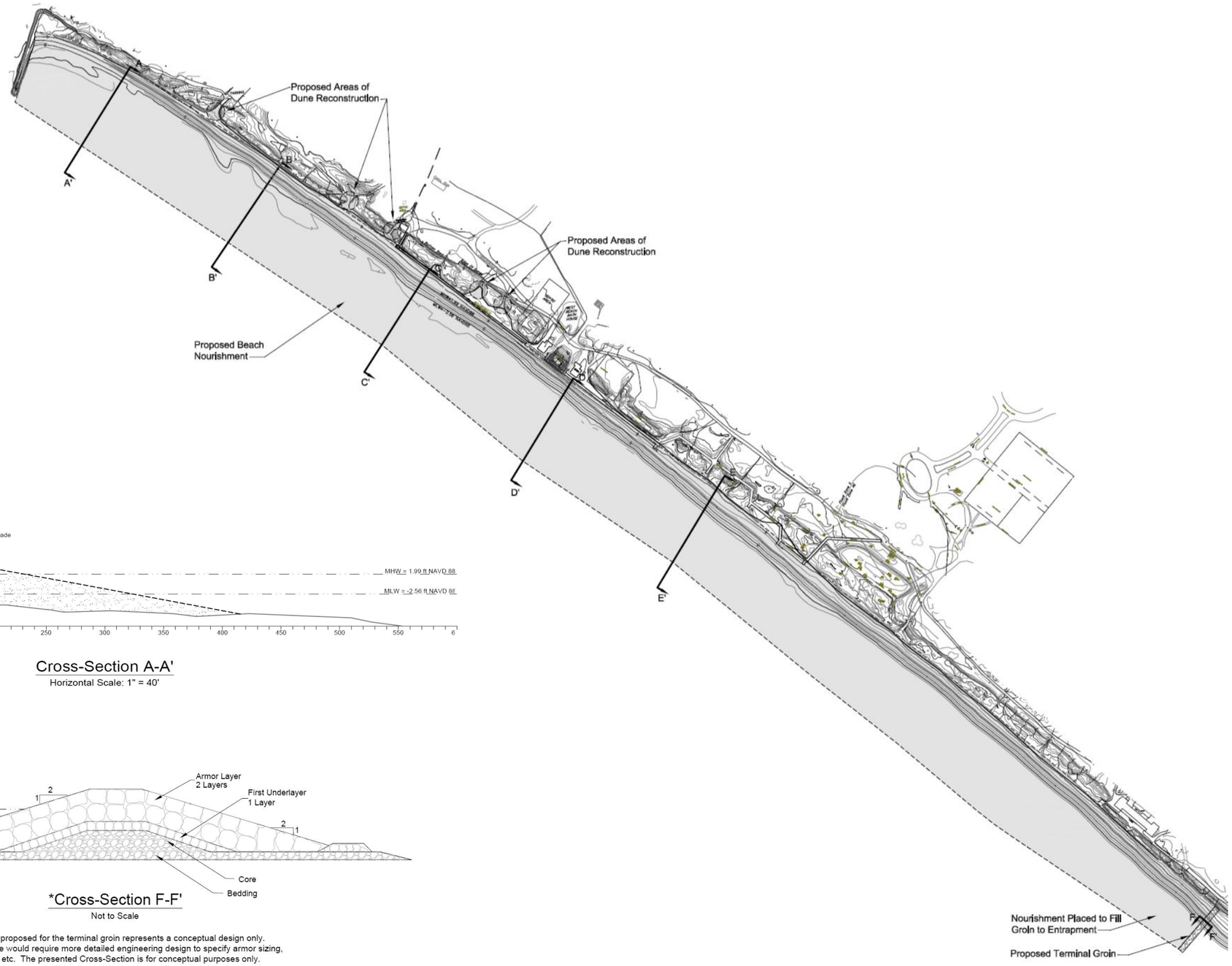
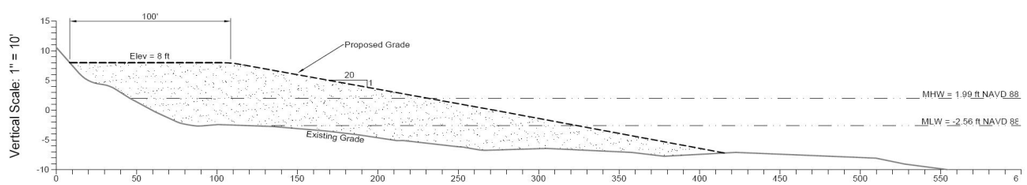
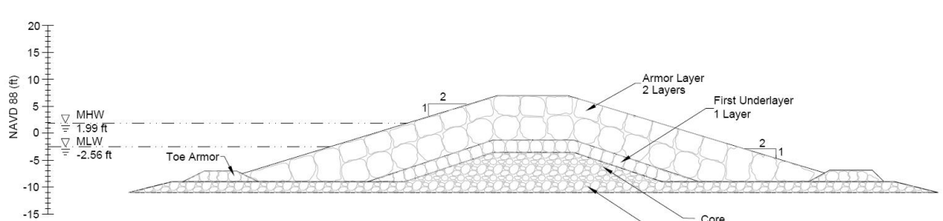


Figure 1-3. Preferred Alternative Without Terminal Groin





Cross-Section A-A'
Horizontal Scale: 1" = 40'



*Cross-Section F-F'
Not to Scale

*The Cross-Section proposed for the terminal groin represents a conceptual design only. The coastal structure would require more detailed engineering design to specify armor sizing, layering, elevations, etc. The presented Cross-Section is for conceptual purposes only.

Figure 1-4. Preferred Alternative With Terminal Groin

The park is also a destination for birdwatching, fishing, and school programs. Several significant habitats are present, including salt marshes, dunes, and beach. Continued erosion of the beach would threaten its usability and desirability for human uses and could also reduce habitat available to federal and state listed species.

Figure 1-5 presents a view of Hammonasset Beach from the 1960s, several years following the last significant beach nourishment and erosion repair project. The photo shows a wide beach with significant capacity for beach activities and no imminent threat to the structures that were then in existence.

Figure 1-5. Hammonasset Beach in the mid-1960s

Figure 1-6 presents a similar view of Hammonasset Beach taken in mid-April, 2008. Although a usable beach is still present, it is more narrow and steep in the foreground, showing the result of approximately 40 years of erosion. The West Beach bath houses, shown in the foreground, are significantly less protected from storm surges and wave action.

Figure 1-6. Hammonasset Beach in April 2008

Figure 1-7 presents a view of one of the West Beach bath houses that was taken during a storm in April of 2007. The storm surge and wave action approached the bath houses, undermining a portion of the boardwalk that rests on the sand surface rather than on piles. Following this storm, the erosion was repaired using sand obtained from areas within the park.

Figure 1-7. West Beach Bath House and Boardwalk during an April 2007 Storm

Figure 1-8 presents a view of the erosion following a second storm that occurred in October 2007. The storm surge and wave action resulted in significant erosion of sand that was placed earlier in the year, creating a drop from the former sand surface to the surface that resulted from the erosion.

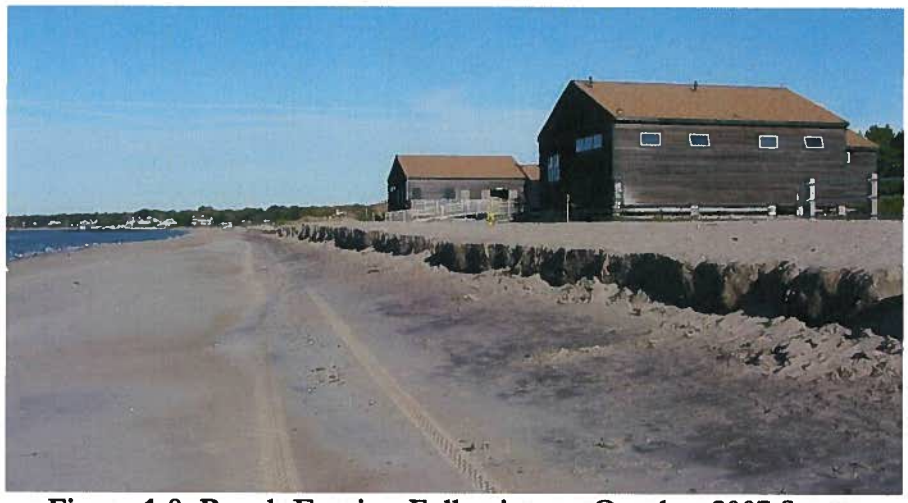


Figure 1-8. Beach Erosion Following an October 2007 Storm

The State of Connecticut has invested significant funds in Hammonasset Beach State Park for the benefit of the residents of Connecticut and other visitors. Park infrastructure includes several concession buildings, bath houses, a nature center, parking, access roads, and the recent construction of a new boardwalk. The proposed project is intended to provide long-term protection of these resources. In recent years, annual maintenance expenditures by the park

have increased at a higher rate than income for the park. Continued implementation of stop-gap measures for protecting the beach and infrastructure from additional erosion requires the continued commitment of staff time, machinery, and fuel that could be reduced through implementation of a successful long-term project.

1.4 Agency and Public Coordination

An electronic Notice of Scoping for this EIE was published in the Connecticut Council on Environmental Quality (CEQ) Environmental Monitor on March 20, 2007 (presented in Appendix A). The following Connecticut state agencies received an electronic notification of the opportunity to submit scoping comments.

- Connecticut Commission on Culture and Tourism,
- Connecticut Department of Public Health,
- Connecticut Council on Environmental Quality,
- Connecticut Department of Public Works,
- Connecticut Department of Agriculture,
- Connecticut Department of Transportation,
- Connecticut Department of Economic and Community Development,
- Connecticut Office of Policy and Management,
- Connecticut Department of Environmental Protection,
- State Traffic Commission.

The Notice of Scoping was sent to the following Federal agencies by mail:

- U.S. Army Corps of Engineers New England District,
- U.S. Environmental Protection Agency Region 1,
- U.S. Department of Agriculture Fish and Wildlife Service,
- National Marine Fisheries Service.

A public scoping meeting was held in the Memorial Town Hall building in Madison, Connecticut on April 12, 2007. Public attendees numbered 22, and comments were received from the public during the meeting.

During the scoping period, written comments were received by from the public, the Connecticut Department of Environmental Protection (DEP) Division of Wildlife and Inland Fisheries Division, Connecticut Department of Health (CT DPH) Drinking Water Section, The Connecticut Department of Agriculture (CT DA) Bureau of Aquaculture, and Audubon Connecticut. Comments received, as well as minutes from the meeting, can be found in Appendix A.

2.0 ALTERNATIVES CONSIDERED

This section describes the beach erosion mitigation alternatives that were initially considered for Hammonasset Beach, as well as an initial evaluation process to narrow the alternatives to the most feasible options and selection of alternatives for evaluation in the EIE. Section 4 of the EIE summarizes a detailed evaluation of the most feasible alternatives and selection of a preferred alternative for Hammonasset Beach.

2.1 Identification of Alternatives

Viable long-term beach erosion mitigation solutions, including both structural and non-structural measures, were identified jointly between Woods Hole Group, Fuss and O'Neill, and the Connecticut Department of Environmental Protection as part of the engineering feasibility evaluation. The initial list of alternatives included:

1. No Action (pursuant to CEPA)
2. Retreat/Relocation
3. Beach Nourishment
4. Structure Modifications
5. Perched Beach
6. Dune Reconstruction
7. Revetments and Seawalls
8. Groins
9. Breakwaters
10. Manual Back Passing
11. Alternative Technologies, including:
    a. Beach Dewatering
    b. Nearshore Berms
    c. Offshore Reefs
    d. Other Alternative Technologies.

The sections below present a brief discussion of each alternative and summarize its potential application at Hammonasset Beach. These alternatives are discussed in more detail as part of the engineering feasibility evaluation that was performed for this project (Woods Hole Group 2008).

2.1.1 No Action

The No Action Alternative implies no actions to change the present conditions at Hammonasset Beach and assumes that the shoreline and beach would continue to erode, reducing the usable beach area and threatening the boardwalk and existing structures. The No Action Alternative would involve no new construction or beach nourishment.

The No Action Alternative would not meet the project goals, as this alternative would result in a reduction in accessibility of the beach, loss of use of the beach and boardwalk, and potential damage or loss of State Park infrastructure. This alternative may also result in environmental impacts, including damage to the existing septic systems and structures, and associated water quality impacts along the beach from septage and debris from damaged structures. The No

Action Alternative is an unacceptable alternative, but was considered for further evaluation as a baseline for comparison to other beach erosion mitigation alternatives.

2.1.2 Retreat/Relocation

A Retreat Alternative was considered in which existing structures along the beach are protected by moving them away from the beach, but the beach is allowed to continue to erode. Estimates of the location of the future shoreline are used as a baseline for designing and relocating potentially affected infrastructure along the beach. Structures in harm's way would be removed and relocated to ensure increased protection by the sand dunes and beach. For the purposes of the alternatives evaluation, a design life of 50 years was selected, similar to the other beach restoration alternatives that were considered. As such, structures and associated infrastructure that are located seaward of the 50-year shoreline forecast (Figure 2-1) would be relocated landward of the projected 50-year forecast line. It is also assumed that affected structures and infrastructure would be relocated landward of the 100-year shoreline forecast to provide a longer design life for this alternative. The Retreat Alternative would require relocation of the West Beach concession building, the two West Beach bath houses, and approximately 2,100 linear feet of existing boardwalk.

Figure 2-1. Retreat Concept

The primary advantage of the Retreat Alternative over the No Action Alternative is that beach infrastructure would be protected from damage caused by future beach erosion. However, the Retreat Alternative alone, in the absence of a beach nourishment project, would not result in the creation of a larger or wider beach since it is recommended that the existing dunes and wetlands, which are located adjacent to or immediately landward of the beach, be preserved. Therefore, while the Retreat Alternative would protect the beach structures and associated infrastructure, it does not address the ongoing beach erosion problem and would result in

continued erosion of the beach, similar to the No Action Alternative. This alternative meets some, but not all, of the project goals, and is carried forward for additional analysis.

2.1.3 Beach Nourishment

Beach nourishment includes placement of additional material on the beach to replace the resources that have been lost, including recreational capacity, shorebird habitat, and storm damage protection. Coastal erosion occurs when sediment transported from a system is not replaced by sediment transported into the system. As a result, a sediment deficit occurs. Nourishment offsets this deficit by artificially providing sediment to the system and extending the shoreline toward the ocean. For Hammonasset Beach, which has been identified as having a deficit in sediment in the coastal littoral cell (Woods Hole Group, 2008), nourishment may be the only alternative that will replace the beach resource that has been lost to date.

At Hammonasset Beach, nourishment could be designed in a variety of ways, including variation in the seaward extent of fill, the height of fill, the slope of fill, the longshore extent of fill, the source of the material, and other factors. The nourishment design concepts would vary in terms of longevity, value of the provided resource, and cost.

Beach nourishment may meet all of the project goals, given proper consideration of various factors and optimal design. A previous beach nourishment effort at Hammonasset Beach in 1955 has demonstrated a project life of approximately 40 to 50 years with little maintenance nourishment. As such, the Beach Nourishment Alternative is carried forward for further analysis.

Potential sources of nourishment material that could be used at Hammonasset Beach include sediment from currently proposed regional navigational channel maintenance dredging projects undertaken by the Army Corps of Engineers, from upland sand sources that are currently permitted and operating sand and gravel facilities, from sand available on DEP-owned lands, or from offshore borrow sites.

Currently, two nearby proposed navigational dredging projects have been identified, including one in the Housatonic River Federal Navigational Project and another in the Clinton Harbor Federal Navigational Project. Approximately 600,000 and 47,000 cubic yards of sediment, respectively, may be available from these projects. Sediment from the Housatonic River project could be barged to the site and pumped directly onto the beach, whereas sediment from Clinton Harbor could be pumped to the beach via pipeline.

A number of upland sand sources that are operated by private companies have been identified as well. This sand would be transported to the park by truck or a combination of trucks and barges, depending on the source and the operator. The sources investigated are currently permitted and could provide sand to Hammonasset Beach with minimal startup effort or mobilization cost. However, since trucking the sand is required, these sources would result in a longer project duration, more environmental impacts, and significantly increased cost.

DEP has investigated the possibility of obtaining sand from one of its properties near Hammonasset Beach, eliminating the need to purchase the sand. The sand would be excavated

and transported to the park similar to sand obtained from private sand and gravel operations. However, in addition to the disadvantages that are associated with obtaining sand from existing upland sources, such as a longer project duration, more environmental impacts, and increased cost, opening a DEP property as a borrow site would require additional investigation to identify a compatible source. Although DEP may own upland properties that contain beach-compatible sand, specific sites have not been assessed, and an established borrow area owned by DEP does not presently exist within 10 miles of Hammonasset Beach. Additionally, use of DEP property as a sand source is contrary to DEP's primary mission for the use of its land.

Several potential offshore borrow sites have been identified that are potential sediment sources for Hammonasset Beach. These include the Long Sand Shoal, located approximately 5 miles from the park, and a shoal that has developed offshore of Meigs Point. This material could be dredged and either barged or piped onto the beach. Pursuit of an offshore borrow site would likely require an additional feasibility study and is beyond the scope of this EIE.

Of these potential borrow sources, sediment from the Federal Navigational Projects is likely to be the most feasible option and is carried forward for additional analysis in this EIE. Upland sand from existing sources is also practicable and is thus carried forward as an alternative. Obtaining sand from DEP-owned land is likely to result in significant delays for the project and is thus not carried forward for additional analysis. Although potentially practicable, obtaining sand from an offshore borrow site requires study and impact analysis beyond the scope of this EIE.

2.1.4 Structure Modifications

This alternative includes the modification of existing coastal structures located at Hammonasset Beach. Currently, the beach includes a stone groin at Meigs Point and a stone jetty at the mouth of Tom's Creek. Modifications to these structures could include removal of one or both, tightening the structures to reduce the quantity of sand that passes through, or lengthening or shortening of the structures.

Removal of the Tom's Creek jetty would serve to allow more sand to migrate into the Hammonasset Beach littoral system since sediment transport has been shown to be generally west to east in the vicinity of the beach (Woods Hole Group, 2008). However, there is limited sediment supply in the area just west of Tom's Creek since much of the shoreline includes revetments, seawalls, and groins with little or no natural beach or dunes, so removal of the jetty is unlikely to significantly increase sediment supply to the beach.

Similarly, removal of the Meigs Point groin would not accomplish the project goals since more sediment would be transported out of the Hammonasset littoral cell. Shortening either structure would not benefit the beach for the same reasons, and lengthening the Meigs Point groin would be unlikely to decrease sand loss.

Tightening the Meigs Point groin may result in increased sediment retention, which could then be excavated and transported to portions of the beach where it is needed (See the Manual Back Passing section, Section 2.10 below), but it would not directly benefit the western portion of the beach which is most significantly affected by erosion. As such, tightening is carried forward for

analysis as part of a manual back passing alternative, but other structure modifications are not recommended for further consideration.

2.1.5 Perched Beach

A perched beach is an alternative method of sand placement designed to reduce the necessary quantity of sand as compared to beach nourishment. This alternative includes construction of a submerged sill at the toe of the fill area to hold beach sand in place. The sill reduces the quantity of fill since the fill area is not required to continue seaward to meet existing grade.

The sill would typically be constructed of stone or rubble. This alternative is not a common engineering solution and limited design information is available. The presence of the sill can alter beach usage since the barrier may be dangerous to swimmers and other water-based activities and significantly limits beach usage seaward of the sill. As such, this alternative is not carried forward for additional analysis.

2.1.6 Dune Reconstruction

This alternative includes using sand to construct new dunes at the landward limit of a beach. The dunes provide a source of sand to the beach during storms, act as a vertical buffer to upland areas, and protect property from waves and surges. Dune reconstruction can be used alone or combined with beach nourishment. A dune system currently exists along Hammonasset Beach. The existing dune system would be supplemented, and existing breaks in the dunes would be closed to provide consistent protection and a relatively uniform sand source. Dune reconstruction alone would not meet the project goals since it would not repair erosion damage that has occurred to date, but it is recommended for use in combination with beach nourishment to prevent storm damage and provide an additional sand source. Dune reconstruction is therefore carried forward for additional analysis in concert with beach nourishment.

2.1.7 Revetments and Seawalls

Seawalls and revetments are hard structures intended to replace the flood control and damage prevention functions of the dune and beach system. Unlike groins and jetties, which protect updrift beaches or improve the longevity of a beach fill, seawalls and revetments only protect upland resources and may accelerate the loss of the beach by reflecting and magnifying erosive forces. Revetments are generally sloped stone or rubble structures that parallel the shoreline and seawalls are generally vertical steel sheet or concrete walls.

Selection of the material for revetments and seawalls and their orientation is generally determined by the energy of the wave environment. These structures are subject to toe scour and flanking which may eventually threaten them. Revetments and seawalls are most beneficial when set back and separated from the ocean by a beach. However, the combined costs of revetment construction and beach maintenance are often economically prohibitive. For a shore area with significant recreational usage such as Hammonasset Beach, seawalls and revetments alone do not meet the project goals, and are thus not carried forward for further analysis.

2.1.8 Groins

Groins are barriers oriented generally perpendicular to the shoreline and constructed of mounded stone or wooden bulkheads. Where sediment transport along the shore is present, groins reduce erosion by trapping sand on the updrift side, forming a fillet, and inhibiting downdrift sediment transport. Since groins can reduce the sediment supply to downdrift areas, they are most effectively applied when a natural sediment sink is located downdrift from the groin.

Alternative groin arrangements can include single groins; multiple, parallel, and evenly-spaced groins called a groin field; and T-head groins, which include the typical shore-perpendicular groin with a shore-parallel structure attached to the end to do the following:

- Interrupt rip currents that often form along the axis of the groin,
- Shelter the beach from direct wave energy.

When implemented properly and when the appropriate current and wave conditions exist, groins and groin fields can be effective in preventing beach erosion. To be successful, application of groins at Hammonasset Beach would require nourishment since a deficit of sand exists in updrift areas. Groins are generally high in cost and include environmental concerns since they alter benthic habitat in their footprint area and affect downdrift transport. However, their benefits may be more significant than their costs in certain situations. As such, construction of one or more new groins, including a groin field, is carried forward for additional analysis.

2.1.9 Breakwaters

While groins are applied to reduce longshore transport of sediment, breakwaters are applied to reduce shore-normal wave energy to retard beach erosion. Breakwaters are most often installed as long, large offshore rubble structures oriented parallel to the shoreline or as a series of shorter, segmented structures also parallel to the shoreline. A segmented breakwater reduces wave energy in the lee of each structure, and often sediments are deposited in the lee areas to an extent greater than in shore areas between segments. As a result, bulges called salients form in the beach behind each breakwater. In some cases, the salients make contact with the breakwater, forming tombolos. The tombolos then act like groins, preventing updrift erosion.

Since breakwaters must be constructed offshore in relatively deep water and therefore require more material, construction costs are higher than for nearshore groins. Additionally, a large footprint is generally required since the occupied area increases with depth for a structure of trapezoidal cross section, resulting in possible significant habitat loss. Since the impacts and cost of breakwaters are relatively high compared to other alternatives, and since the added benefits are low, breakwaters and not carried forward for additional analysis.

2.1.10 Manual Back Passing

Manual back passing consists of removing sand from areas with a sand surplus and transporting it to eroded areas. DEP currently implements a form of manual back passing where sand is

removed from the Meigs Point groin fillet and transported to the West Beach. Manual back passing could be used to supplement other alternatives to extend the life of the project or to reduce costs. The quantity of sand available for manual back passing is not thought to be large, but the additional sand in erosional areas could offer long-term benefits. As such, manual back passing is carried forward for additional analysis.

2.1.11 Alternative Technologies

Alternative technologies are coastal engineering techniques which have been recently developed for use instead of the more traditional techniques described above. Several of these technologies have well-documented applications and have been shown to be successful in certain circumstances. Other technologies have been applied in limited situations with mixed or unclear results. In some cases, limited information is available to assess the mechanism through which the technologies function. The better-documented of these technologies are presented in this section. Other technologies may exist which offer limited information and application. These are not appropriate for Hammonasset Beach since the imminent threat to the beach, infrastructure, and coastal resources is not conducive to experimentation with unknown or unproven technologies.

2.1.11.1 Beach Dewatering

This alternative technology includes stabilization of the shoreline by lowering the groundwater table. Typically, a series of perforated pipes are buried in the beach face. The pipes receive water from the wave uprush, reducing upthrust on sand grains from buoyancy and promoting slight compaction from water infiltrating through the sand. The resulting decreased hydraulic gradient away from the shore also reduces the offshore transport of sand. Drained water is conveyed by either gravity or vacuum pump. Beach dewatering has shown to be successful in areas where a significant sediment supply is available.

Negative effects of beach dewatering may also be anticipated. These include oversteepening of the beach profile, which has been observed in some circumstances. Although not a problem by itself, if the dewatering system of an oversteepened beach were to fail, the beach would likely revert to its equilibrium shape. Beach dewatering may result in downdrift erosion by interrupting the sand supply in a similar manner to groins and other traditional structures.

Additionally, maintenance costs of the dewatering systems are generally high, and the network of pipes is subject to destruction by large storms. Beach dewatering is not carried forward for further analysis since the Hammonasset Beach area is characterized by a sediment deficit, the costs of the project are relatively high relative to any benefits, and the performance of these systems is unclear.

2.1.11.2 Nearshore Berms

This alternative consists of the offshore placement of nourishment material rather than placement directly on the beach. Nearshore berms are sometimes used when identified borrow material is incompatible with beach material. Rather than place the incompatible material on the beach, it is placed offshore as a feeder berm, which serves as an offshore supply of sediment

and a wave beak that moves onshore during periods of low wave steepness (typically during the summer months).

Nearshore berms can be problematic for a number of reasons, including:

- Oversized particles are not mobilized toward the beach,
- Undersized particles are mobilized too easily and interfere with water clarity,
- Near-bottom deposit areas are less influenced by wave currents that drive sediment transport,
- Large areas of benthic organisms can be smothered when the material is placed,
- Nearshore berms have not generally been shown to have a measurable effect on beach stability.

Since available sand and sediment sources in the Hammonasset Beach State Park region are generally beach-compatible, the best use of this material is on the beach. As such, nearshore berms are likely not appropriate for Hammonasset Beach and are not carried forward for additional analysis.

2.1.11.3 Offshore Reefs

Submerged offshore reefs and breakwaters are a variation of breakwaters discussed in Section 2.9. These structures are often rubble mounded structures oriented parallel to the shoreline with a top elevation set below the ocean surface. Alternative shapes include concrete structures such as the Beachsaver Reef™ or Prefabricated Erosion Prevention (PEP) reefs that have been implemented on the United States Atlantic Coast and beach cones, which are concrete cones anchored in place. Offshore reefs work through reducing the height of incoming waves by reflecting and dissipating energy as the waves pass over the structures. The barriers trap sediment by blocking it from moving offshore.

In most cases, the effectiveness of offshore reefs is reduced as compared to breakwaters since wave height reduction claims are often not met. Additionally, during storm surges, the freeboard over the structures may be increased significantly, further reducing their influence during high-energy events. Any settlement of the structures further reduces effectiveness. For some communities, the aesthetic improvements of offshore reefs relative to breakwaters can justify their reduced effectiveness. However, since breakwaters have not been identified as an appropriate alternative for Hammonasset Beach, this alternative is not carried forward for additional analysis.

2.1.11.4 Alternative Technologies

While additional alternative devices are currently available in the marketplace, these are often proprietary systems that have not been adequately tested and about which little information is available. No additional technologies have been identified with adequate data available to support installation at Hammonasset Beach considering the short timeframe of the proposed project and potential loss of coastal resources and infrastructure in the interim. In addition, the more energetic wave climate at Hammonasset Beach, compared to the test sites of most

alternative coastal erosion devices, would not provide confidence in the ability of the devices to resist damage, or avoid complete failure.

2.2 Alternatives Evaluation Process

The following alternatives were identified for further evaluation, as described in the previous sections:

- No Action,
- Retreat/Relocation,
- Beach Nourishment,
- Beach Nourishment with a Terminal Groin,
- Beach Nourishment with a Groin Field,
- Manual Back Passing with Structure Modification (sand tightening).

These alternatives were subsequently evaluated to narrow the alternatives to the most feasible options for Hammonasset Beach. This evaluation process focused on the ability of the alternatives to meet the project goals, overall cost effectiveness, proven track record for other similar projects, and engineering feasibility. Specific project objectives that were used as criteria in this evaluation process included:

- Maintain or improve current beach usage for a range of valuable recreational activities (swimming, sunning, walking, cycling, picnicking, painting, creating art, bird watching, etc.),
- Provide a minimum beach lifetime of 8 to 10 years without supplemental work,
- Minimize potential adverse impacts to neighboring beaches, navigation, and the Hammonasset Beach region,
- Protect the boardwalk and existing upland infrastructure from a 10-year return period storm,
- Be cost effective over a 50 year project horizon.

This evaluation process, which is described in more detail in the engineering feasibility evaluation report (Woods Hole Group, 2008), also included wave and current analysis and modeling, as well as detailed optimization of numerous alternatives. The results of this evaluation for each of the remaining alternatives are summarized in the following sections.

2.2.1 Retreat/Relocation

A detailed analysis of historical and current shoreline change allows prediction of the future shoreline in the event that erosion mitigation is not undertaken. Figure 2-2 presents the current and predicted locations of the Hammonasset Beach shoreline in the West Beach area. The highest rates of shoreline erosion are occurring in the West Beach area and are threatening the West Beach bath houses and the boardwalk in that area.

In 50 years, the shoreline is anticipated to advance landward of the existing bath houses and boardwalk. Additionally, the 100-year forecast predicts that the concession building at the west

end of the boardwalk will also be destroyed. Based on these results, a conceptual retreat alternative was selected for comparison to other alternatives. This concept included the following constraints and assumptions:

- Structures and infrastructure constructed seaward of the 100-Year MHW forecast line would be relocated landward as necessary,
- The proposed location of reconstructed structures and infrastructure would minimize disturbance to dunes, freshwater wetlands, and tidal wetlands,
- Service to reconstructed buildings would be provided by existing infrastructure where possible,
- Existing utilities would be abandoned in place where necessary, except subsurface wastewater disposal (septic) systems, which would be removed,
- Buildings to be relocated would be demolished and replaced with new structures with similar characteristics (e.g. use, footprint area, number of floors) while meeting current building codes. Demolition and reconstruction was selected in place of moving the structures to ensure that the replacement facilities will meet DEP's long-term needs,
- Sections of boardwalk to be relocated would be installed on piles similar to the majority of the existing boardwalk,
- The beach would remain in its current condition and would not be altered through grading or other physical measures.

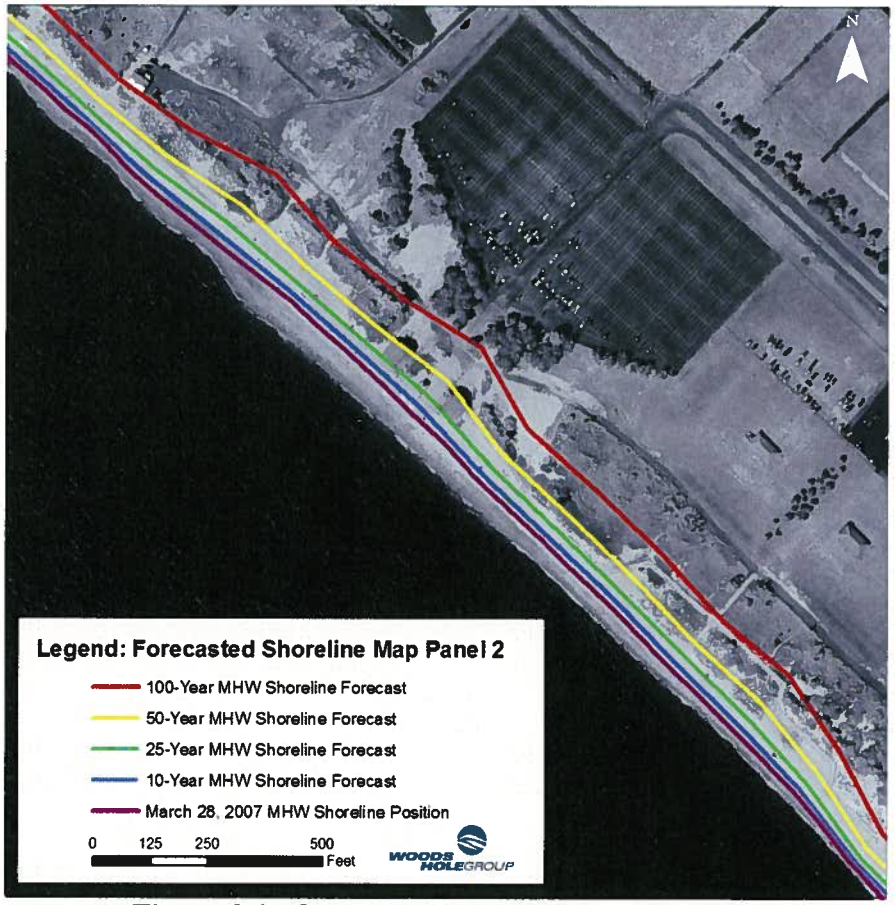


Figure 2-2. Shoreline Forecasts at West Beach

This alternative would require the relocation of the West Beach concession building, the two West Beach bath houses, and approximately 2,100 feet of existing boardwalk. To complete the proposed building relocations, it would likely be necessary to abandon the existing septic systems and install new septic systems, or install a common wastewater treatment system, located landward of the proposed structure locations. The existing septic systems should also be removed to reduce the potential for water quality impacts if exposed by erosion. Connection to drinking water service, electricity, and telephone is assumed feasible since available underground lines are located near the assumed reconstruction locations of the buildings. To relocate the boardwalk, it may be necessary to drive new supporting piles and either remove the existing boardwalk and install reused components on the new piles or demolish the existing boardwalk and construct a new boardwalk on new piles.

The Retreat Alternative is also limited by environmental and physical constraints. Freshwater and tidal wetlands are located in areas immediately inland from the beach, thereby limiting potential relocation areas. Similarly, the dunes located along the beach limit potential relocation of the boardwalk, structures, and other infrastructure.

Although moving infrastructure landward does provide immediate protection for these structures, the shoreline projections indicate this is only a temporary solution. The West Beach shoreline will continue to erode, and within 25-30 years (depending on the exact extent of the landward relocation), the infrastructure will be at the same risk as it is today (Woods Hole Group, 2008). The Retreat Alternative does not meet many of the project objectives. The beach width would initially remain the same and would eventually decrease. The eroded beach would be steeper than is ideal for recreational use and shorebird habitat. Although the Retreat Alternative does provide immediate protection for existing infrastructure, this alternative does not facilitate a majority of the beach uses, nor does it provide a solution to the ongoing erosion problem. This alternative simply delays the decision for a more pro-active solution to the ongoing beach erosion. Therefore, the Retreat Alternative is not recommended for Hammonasset Beach (Woods Hole Group, 2008).

2.2.2 Beach Nourishment

Beach nourishment meets the majority of the project objectives presented in Section 2.2. This alternative would restore and/or improve upon each of the major uses that the beach provides, including recreation, habitat, and storm damage protection. Beach nourishment has proven to be economically feasible at Hammonasset Beach in the past and at other coastal locations. This alternative would restore the beach without the use of additional stone structures along the beach.

Various beach nourishment design scenarios were evaluated in the engineering feasibility study, including variations on nourishment length, berm width and height, offshore slope, grain size and source, and nourishment volume. The anticipated performance of each scenario was evaluated through the use of numerical modeling and estimated costs, as described in the engineering feasibility study (Woods Hole Group, 2008). As the study results suggest, beach nourishment alone with an 8-foot berm height and widening the beach by 75 to 150 feet would have a moderate to high initial construction cost, moderate maintenance cost through periodic renourishment, and have a service life of 8 to 25 years (without maintenance nourishment)

depending on the nourishment design that is selected. Therefore, beach nourishment is carried forward for additional feasibility and impact analysis in this EIE. An evaluation of specific beach nourishment scenarios is described in Section 4 of this EIE.

Dune reconstruction, by itself, is not recommended for Hammonasset Beach. However, dune construction should be considered where there is enough landward area to construct dunes or enhance the existing dunes in conjunction with beach nourishment. This would provide a source of sand that can erode during storms, act as a vertical buffer, and protect property behind the dunes. Dune reconstruction or enhancement is also recommended in conjunction with each of the beach nourishment alternatives described in the following sections.

2.2.3 Beach Nourishment with a Terminal Groin

This alternative is identical to the Beach Nourishment Alternative but with the addition of a new groin that would be constructed at the downdrift limit of the nourishment area. The added benefit of this alternative is that the terminal groin would prevent migration of the fill toward the east end of the beach, which is currently stable in some areas and accreting slightly in others. This arrangement would likely increase the longevity of the initial nourishment and could reduce the frequency and quantity of future maintenance nourishment projects. The terminal groin could also be used to enhance beach access and use by constructing a fishing pier on piles beyond the end of the groin.

As described in the engineering feasibility study (Woods Hole Group, 2008), this alternative would result in widening of the beach by 75 to 150 feet, would have a high initial construction cost, moderate maintenance cost, and improve service life without maintenance nourishment by 3 to 4 years, for an anticipated service life of 12 to 29 years. As such, this alternative is carried forward for additional feasibility and impact analysis in this EIE.

2.2.4 Beach Nourishment with a Groin Field

This alternative is identical to the Beach Nourishment Alternative but with the addition of a series of evenly-spaced groins along the beach that would serve to retain sand in the nourishment area. This series of groins would provide additional sand retention benefits as compared to a single, terminal groin.

Although there are some substantial performance gains associated with the groin field option, there are also significant beach usage disadvantages and potential environmental impacts. Recreational beach users would have to contend with significant coastal structures in their use of the beach system. This would impact swimming, beach walking, and fishing activities, as well as create a significant safety risk for beach goers, who inevitably will scale the structures. Environmentally, a groin field would occupy a significant amount of land under the ocean in the nearshore zone, as well as result in the potential for downdrift erosion impacts. The groin field will hold material in place, but will also potentially result in less sand being transported to the downdrift beaches, potentially threatening the stability of the eastern portion of Hammonasset Beach. As such, only the single terminal groin solution is recommended as potential structural enhancement to beach nourishment (Woods Hole Group, 2008).

2.2.5 Manual Back Passing with Structure Modification

This alternative would be used in combination with nourishment and/or groin construction to increase the useful life of the project by transporting sand from the accretional area at the Meigs Point groin to erosional areas along West Beach. The sediment transport model prepared by Woods Hole Group (2008) found that sand tightening of the Meigs Point groin would result in accretion of 5,000 additional cubic yards of sand each year, which could then be removed and deposited along West Beach. Assuming this quantity each year over the anticipated duration of the beach nourishment scenarios, the longevity of the nourishment project would increase only slightly (Woods Hole Group, 2008). The results are shown in Figure 2-3.

For beach nourishment with a 75-foot wide berm without manual back passing, renourishment would be required approximately 14 years after the initial nourishment. With back passing, renourishment would be required after approximately 15 to 16 years. As such, the benefit is small. While manual back passing may be useful as a stop-gap measure to mitigate erosion that is threatening structures, it is not recommended as a long-term measure or for further evaluation in the EIE.

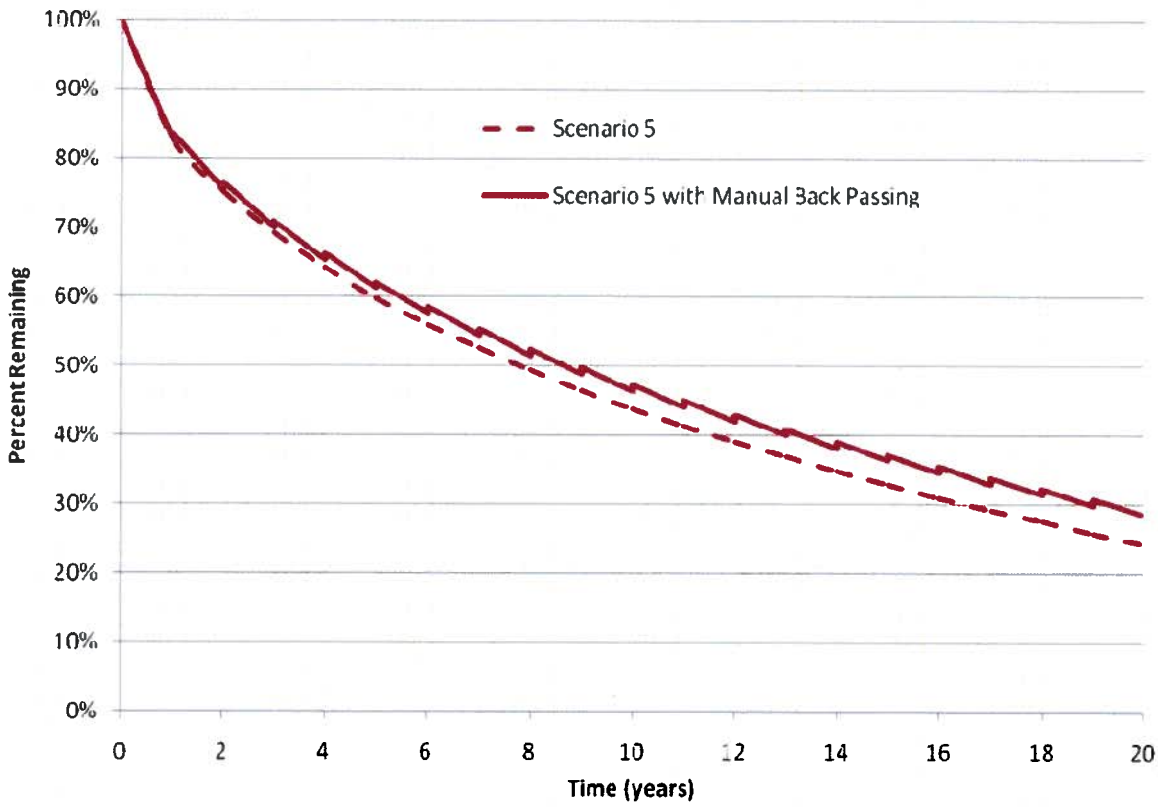


Figure 2-3. Predicted Beach Nourishment Longevity With and Without Manual Back Passing

2.3 Alternatives for Further Evaluation

As described in Section 2.2, the following beach erosion mitigation alternatives were selected for further evaluation in the EIE:

- Beach Nourishment, including multiple variations of length, width, berm height, and other design parameters, as well as various sand source options,
- Beach Nourishment with a Terminal Groin.

Section 3 describes the existing conditions and analysis of impacts for the above alternatives for each of the specific environmental topics addressed in the EIE. Section 4 of the EIE summarizes a detailed evaluation of these alternatives and selection of a preferred alternative for Hammonasset Beach based on technical performance, potential cost, impacts to beach usage, and potential environmental impacts.

3.0 EXISTING ENVIRONMENT AND ANALYSIS OF IMPACTS

3.1 Park Description and Infrastructure

3.1.1 Park Roads and Parking Lots

3.1.1.1 Existing Conditions

The Hammonasset Connector continues south from its intersection with US Route 1 within Hammonasset Beach State Park, providing two lanes in each direction. The road terminates at an internal rotary, which provides two circulating lanes. The remaining park roadways provide a single lane in each direction and allow access to Meigs Point at the southeastern end of the park and the parking, camping and picnic areas in the western portion of the park (Figure 3-1). The roadways that exist throughout the park are in good physical condition.

There are a total of seven parking lots in the park, plus two areas along the eastern park roadway where parallel parking is allowed. The main parking lot for the western portion of the beach is paved, however the condition of the pavement is deteriorating. The two main parking lots on the east side of the beach are not paved, with the exception of the front sections. There are two more lots in the vicinity of the central section of beach that are entirely unpaved. Additionally, there are two small lots at the far southeastern terminus of the park roadway that are paved. These parking areas combine to provide approximately 2,600 spaces, including 39 that are designated for handicapped use and 41 that are designed to accommodate recreational vehicles. Parking capacity appears to be adequate based on observations that several large parking lots within the park were well-below capacity during peak beach usage in the 2007 summer season.

3.1.1.2 Impact Evaluation

Since the existing parking lots appear to be well-below capacity, and only minor increases in visitor attendance are anticipated to result from the proposed action, parking demand is not expected to exceed supply. Therefore, no long-term impact to park roads and parking lots from visitor use will result from the proposed action. If significant quantities of sand from upland sources are required to nourish the beach, the transport of sand to the site from upland sources would entail significant truck traffic, resulting in additional wear and deterioration of park roads.

Construction-related activities associated with the proposed action may result in temporary detours or limited access to portions of parking lots within the park during the construction period. However, these impacts would be short-term, lasting only during construction, and would be scheduled to coincide with low usage seasons of the year.

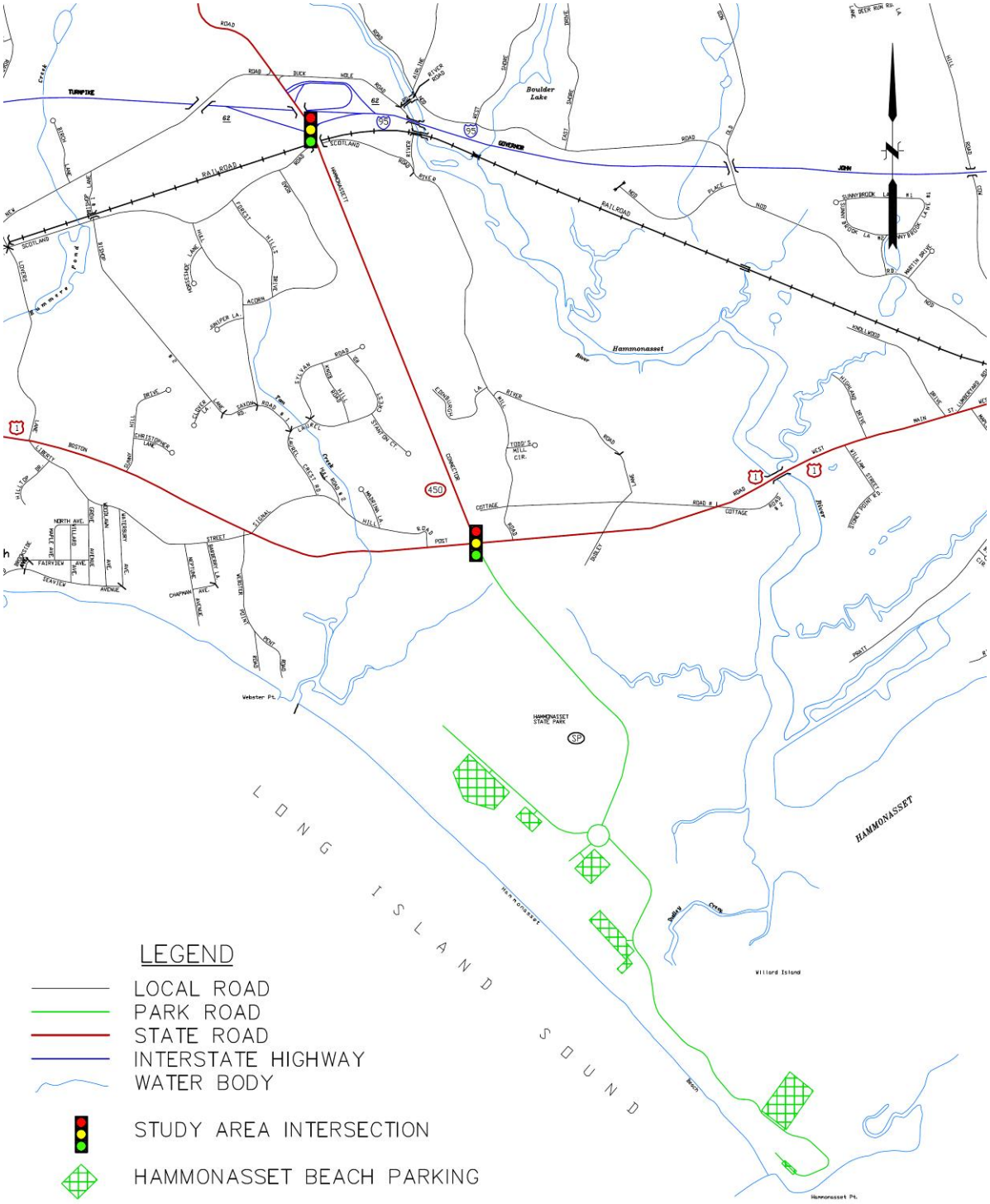


Figure 3-1. Hammonasset Beach Roads and Traffic Study Area Map

3.1.1.3 Mitigation

In the absence of impacts, no long-term mitigation measures are proposed. Temporary construction-related impacts would be mitigated by appropriate signage to divert drivers to other park roads and parking lots. Contractors delivering sand via truck from upland sources could be held responsible for repairing unreasonable damage to park roads and parking lots.

3.1.2 Buildings and Structures

3.1.2.1 Existing Conditions

Eight significant buildings and structures are located along Hammonasset Beach. The park contains additional structures which are located further inland and are thus outside of the project area. Structures along the beach include three bath houses, two concession buildings, the Camp Store, and the Meigs Point Nature Center, which is a reconditioned 19th-century farmhouse. A boardwalk is situated along the dunes on the western portion of the beach. The locations of existing buildings and structure at Hammonasset Beach are shown in Figure 3-8.

Figure 3-2. Photo of Meigs Point Nature Center (photo courtesy of AHS)

The West Beach bath houses consist of two 2,000-square-foot structures located adjacent to each other along the western portion of the boardwalk, approximately 1/3 mile east of the Tom's Creek jetty. These buildings include changing areas and restrooms.

The East Beach bath houses consist of two enclosed buildings connected by a roofed pavilion with a total footprint area of approximately 8,000 square feet. These buildings are located along the eastern portion of the beach, approximately 2/3 mile north of the Meigs Point groin. The East Beach bath houses also contain restrooms and changing areas.

Figure 3-3. View of West Beach Bath Houses (photo courtesy of AHS)

A third bath house is located near Meigs Point. This structure, referred to as the Meigs Point Pavilion, contains restrooms and changing facilities on the north side, with a covered shelter on the south side. The footprint of this structure is approximately 6,000 square feet in area.

Figure 3-4. View of the Meigs Point Pavilion (photo courtesy of AHS)

The Camp Store is a structure of approximately 1,200 square feet located beyond the western end of the boardwalk. A concession building of approximately 1,150 square feet is located nearby at the western end of the boardwalk. An identical concession building is located at the far eastern portion of the beach near Meigs Point. The far western portion of the park

property, inland from the boardwalk, is open as a campground. A picnic area, including a picnic pavilion, is located between the campground and the boardwalk.

Figure 3-5. View of the Camp Store (photo courtesy of AHS)

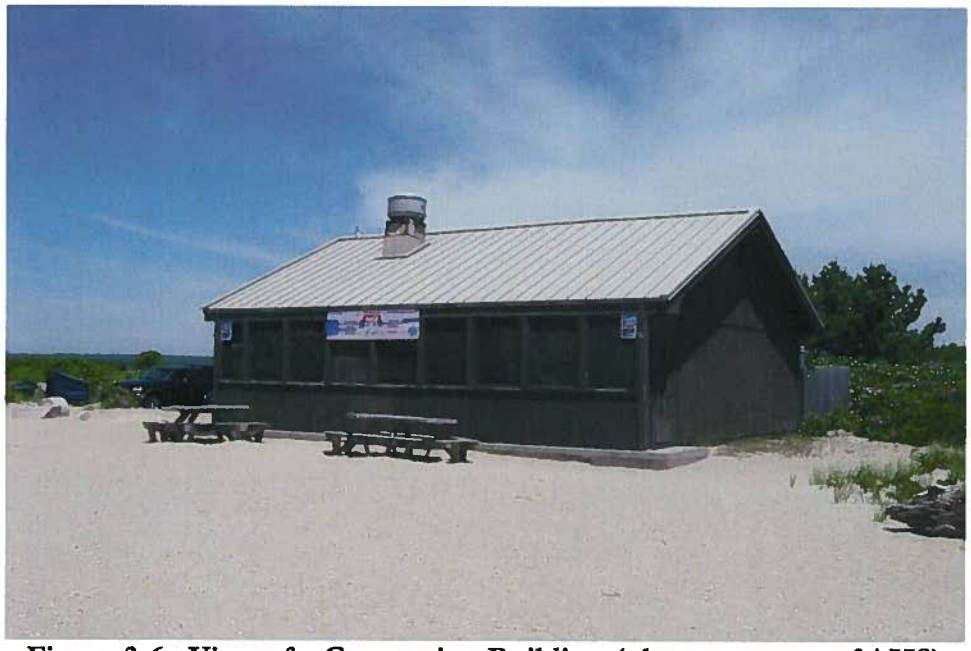


Figure 3-6. View of a Concession Building (photo courtesy of AHS)

The park's existing boardwalk parallels the shoreline along the majority of the West Beach, generally shoreward of the dunes. The majority of the boardwalk has been constructed on driven timber piles, which were intended to be permanent when constructed during 2000-2001. The western portion of the boardwalk was intended to be moveable so that it could be easily realigned as part of future projects. This portion was constructed on wood 'sleepers' to be

easily lifted and moved as necessary. The boardwalk is of particular importance to park visitors as it provides a popular walking path and views of the beach and dunes.

Figure 3-7. View of the Boardwalk (photo courtesy of AHS)

A large pavilion was constructed in the 1960s at the east end of the boardwalk. This pavilion was demolished in 2002 in preparation for the construction of a new visitor's center. Construction on the new visitor's center has not yet begun.

3.1.2.2 Impact Evaluation

The proposed beach nourishment project will protect the park buildings and structures from future damage caused by erosion. The project will not adversely impact the park's existing infrastructure. Under the preferred alternative, sand will be transported to the park by barge and pumped onto the beach from offshore. Construction equipment will be necessary to prepare the beach surface for sand placement and to perform grading activities following sand placement.

Adequate equipment access is available from the West Beach parking lot, the former pavilion location, and Meigs Point such that the boardwalk and existing buildings will not be impacted by the proposed beach nourishment project. Under the No Action alternative, the boardwalk, concession building, and West Beach bath houses would eventually be damaged or destroyed by future beach erosion. The Retreat Alternative would protect the beach structures and associated infrastructure, but would also require relocation of the West Beach concession building, the West Beach bath houses, and approximately 2,100 feet of existing boardwalk.

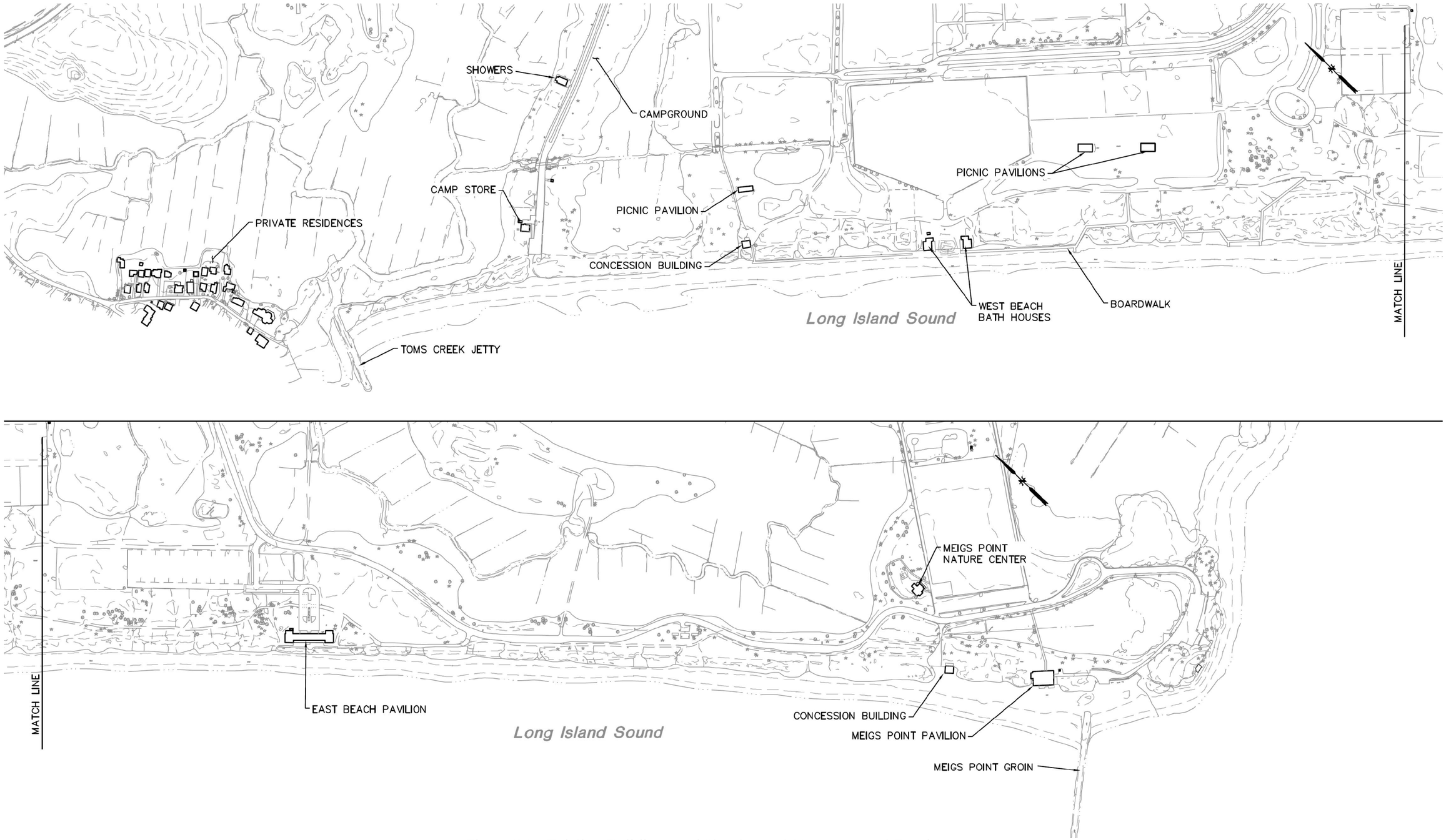


Figure 3-8. Existing Buildings and Structures at Hammonasset Beach

3.1.2.3 Mitigation

No mitigation is proposed, since no adverse impacts are anticipated to the existing buildings or structures under the proposed action.

3.1.3 Utilities

3.1.3.1 Existing Conditions

Existing utilities at Hammonasset Beach State Park include telephone, electric, water, gas, storm drainage, septic, and sanitary sewer service. Utility information for the preparation of this EIE was obtained from as-built drawings associated with recent and historical park improvement projects, a 2007 topographic survey of the project area along the western and central portions of the beach by Fuss & O'Neill, and a draft version of a detailed utility survey completed by BL Companies dated February 1, 2008. Utilities at the far eastern end of the beach near Meigs Point were not included in the review since the proposed action does not entail work in this area. Existing utilities within the project area are presented in Figure 3-9.

Drinking water is supplied to Hammonasset Beach State Park by the Connecticut Water Company. Supply to the park is through a 10-inch diameter main that branches from the water main along U.S. Route 1. The line traverses the park toward the beach, supplying water to the park buildings along the way. The water line branches into two 10-inch lines, one of which supplies the camp store, concession building, and West Beach bath houses. The other supplies the area of the former pavilion. Two parallel water lines continue east (from the area of the former pavilion) along the beach, providing service to the East Beach Pavilion and Meigs Point.

Additional sections of water line in the area of the former pavilion were undermined by beach erosion in 2002-2003 and subsequently abandoned. At the West Beach and the former pavilion, new water service lines were installed inland from the dunes and structures, and the majority of the piping under the beach was abandoned. The replacement line by the former pavilion connects to the older line and continues along the beach to the East Beach Pavilion. The park also once included a water storage tank along an access road that has since been removed.

The park is served by sanitary sewers, although areas along the beach are served primarily by on-site wastewater disposal systems consisting of septic systems and leach fields. The on-site wastewater disposal systems are generally located inland from the beach structures. The West Beach concession building is served by a septic system and leach field located north of the building. Each of the two West Beach bath houses are served by a dedicated septic system; the system that serves the west building is located northwest of the structure, and the system that serves the east building is located east of the structure. A septic system that once served the former pavilion still exists but is currently inactive. This system includes two septic tanks in series followed by a pressure distribution and leaching system.

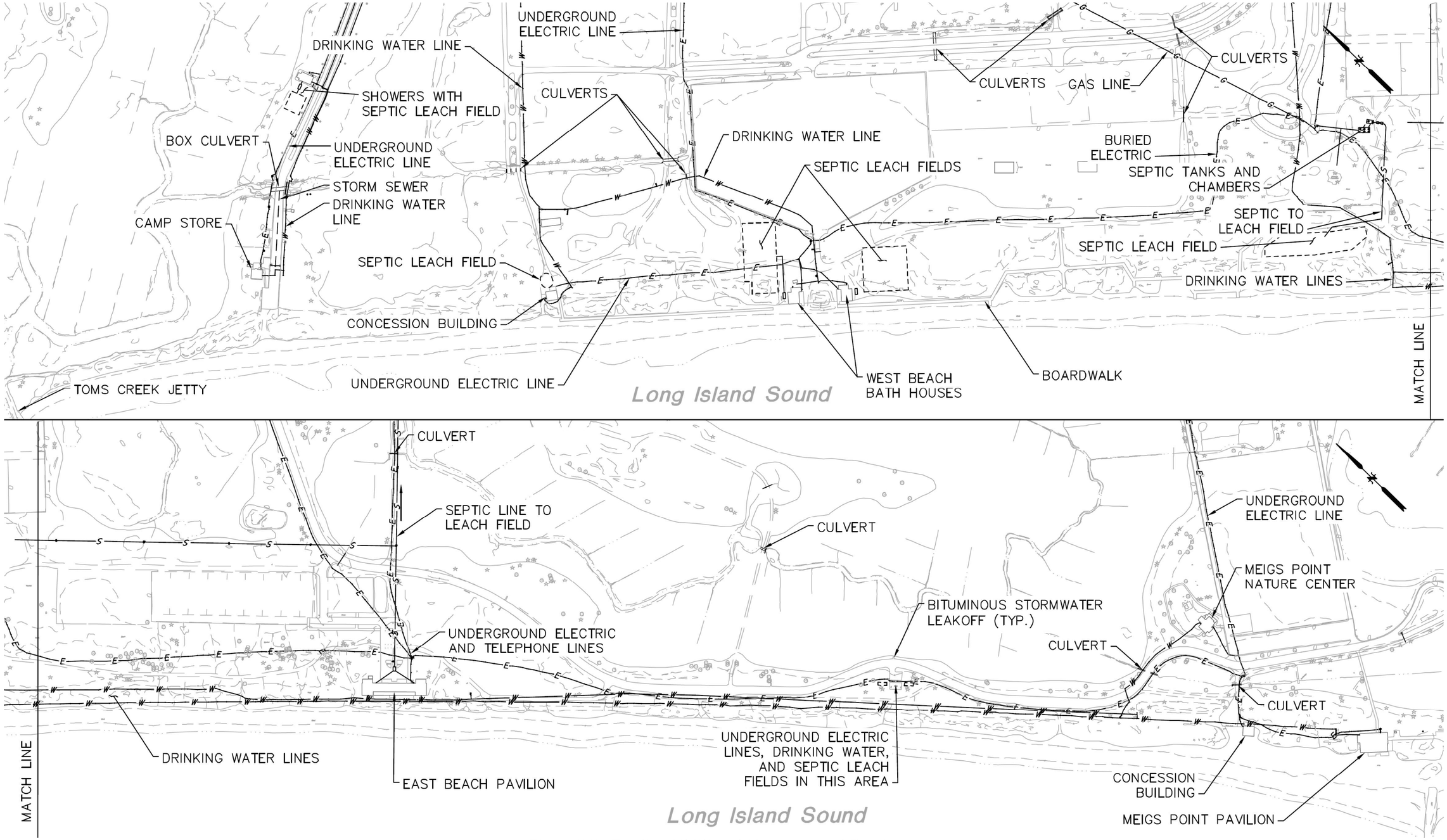


Figure 3-9. Existing Utilities at Hammonasset Beach

The park once included a wastewater treatment system located inland from the East Beach bath house near Clinton Harbor. This system may have received discharges from the former pavilion prior to installation of the existing septic system. A leach field at the location of the former wastewater treatment system is believed to serve the East Beach Pavilion. An air monitoring system operated by Connecticut DEP currently occupies this area.

Electrical service is provided to the beach from buried electrical lines that are located along the Hammonasset Connector. A primary service line connects to the camp store and many of the camp sites. A branch from this line continues below the camp grounds to the Hammonasset Connector and then branches to provide service to structures along the beach. Underground telephone service exists for the concession buildings, camp store, bath houses, and the area of the former pavilion. Gas service crosses the park from Route 1 to the area of the former pavilion.

Only limited storm drainage infrastructure exists within the project area. Most of the area landward of the beach drains to the adjacent tidal wetlands as overland flow or channelized flow within roadside ditches. A small storm drainage system near the camp store conveys stormwater runoff from paved areas. The system includes two catch basins connected to a common manhole, which ultimately discharges to Tom's Creek.

3.1.3.2 Impact Evaluation

The preferred alternative does not include expansion of existing infrastructure, facilities or significant increases in utility demand. The small increase in park attendance that may result from the proposed beach nourishment project is anticipated to result in correspondingly small increases in utility demands, but well within the capacities of the existing park utilities. The preferred alternative will also protect the existing utilities along and near the beach from future erosion and undermining. Under the No Action alternative, the existing utilities along the beach would be susceptible to future erosion and eventual undermining by wave action. The Retreat Alternative would protect the utilities along the beach, but would also require relocation of water lines, and the existing septic systems associated with the West Beach bath houses, the former pavilion area, and the East Beach Pavilion. Relocating septic systems would be difficult or impermissible under applicable regulatory programs due to the presence of high groundwater elevations, tidal wetlands, dune resources, and disturbed areas in the relatively small land area available between the beach and the tidal marshes associated with the Hammonasset River and Clinton Harbor.

3.1.3.3 Mitigation

No mitigation is proposed, since no adverse impacts are anticipated to the existing park utilities under the proposed action.

3.2 Traffic

3.2.1 Existing Conditions

The existing roadway network serving Hammonasset Beach State Park includes U.S. Route 1 (Boston Post Road) and the Hammonasset Connector (State Route 450). U.S. Route 1 is an east-west roadway in the vicinity of the site, providing access to the Town of Guilford to the west and the Town of Clinton to the east. U.S. Route 1 is classified by the Connecticut Department of Transportation (ConnDOT) as a minor arterial, and provides a single lane in each direction in the vicinity of the park, with turning lanes at its signalized intersection with the Hammonasset Connector. Land use along the roadway in the vicinity of the park is a mix of residential and commercial.

The Hammonasset Connector is classified by ConnDOT as a minor arterial, and provides two lanes in each direction, along with left turn lanes at the intersection with U.S. Route 1 and at the signalized intersection with the I-95 northbound ramps (Figure 3-1). There are no private driveways or intersections located along the segment of the roadway between U.S. Route 1 and the I-95 northbound ramps. South of U.S. Route 1, the Hammonasset Connector continues as a park roadway.

Turning movement counts were conducted at the two signalized intersections along the Hammonasset Connector between 3:00 PM and 7:00 PM on Friday, July 6, 2007 and between 11:00 AM and 3:00 PM on Saturday, July 7, 2007, in order to determine the peak hour turning movement volumes during the summer season. The counts represented the peak periods for beach traffic as well as adjacent traffic on U.S. Route 1. The counts indicate that the peak hours are 3:45 PM to 4:45 PM on Friday and 11:00 AM to 12:00 PM on Saturday. The 2007 traffic volumes are shown in Figure 3-10. These volumes were then analyzed using Synchro Professional Software, Version 7, in order to determine the operating condition of the intersections. The results are shown in Table 3-1.

Operational conditions are typically described by the level of service (LOS) and the volume to capacity ratio (v/c). LOS is a measure of the delay experienced by stopped vehicles at an intersection. LOS is rated on a scale from A to F, with A describing a condition of very low delay (less than 10 seconds per vehicle), and F describing a condition where delays will exceed 80 seconds per vehicle for signalized intersections. Delay is described as a measure of driver discomfort, frustration, fuel consumption, and lost travel time. Therefore, intersections with longer delay times are less acceptable to most drivers. Similarly, the v/c ratio describes the volume of traffic as a portion of the capacity of the intersection. The higher the v/c ratio, the greater the volume and congestion of the intersection. This definition for LOS, as well as the methodology for conducting signalized intersection capacity analyses, is taken from the *2000 Highway Capacity Manual* published by the Transportation Research Board.

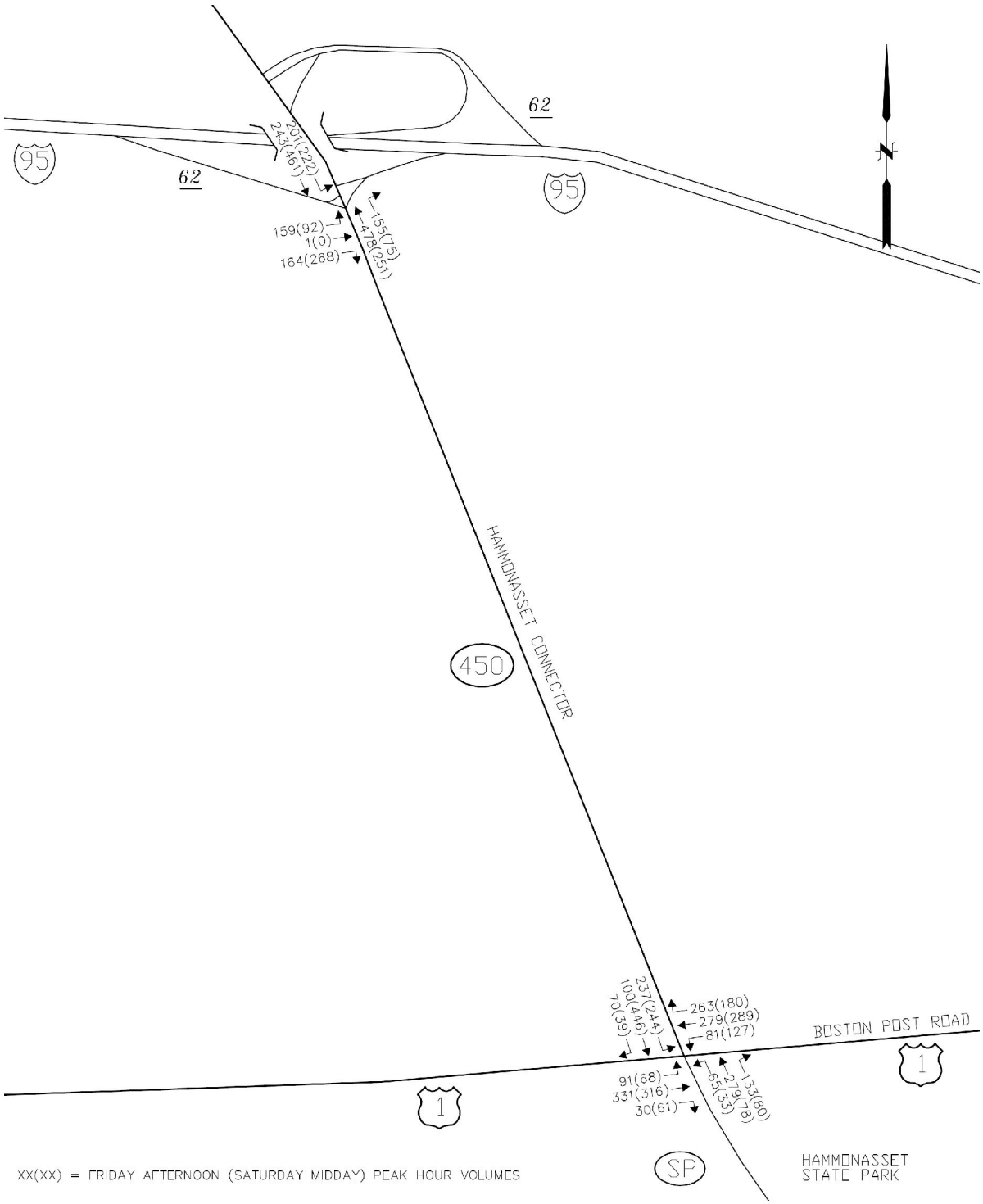


Figure 3-10. Existing (2007) Traffic Volumes

Table 3-1. Existing Conditions Capacity Analysis

Signalized Intersections	2007 Friday Afternoon Peak Hour	2007 Saturday Midday Peak Hour
Hammonasset Connector (SR 450) at I-95 Northbound Ramps	0.48/B	0.35/A
Hammonasset Connector (SR 450) at U.S. Route 1 (Boston Post Road)	0.59/C	0.60/C

Note: Values indicated are intersection v/c Ratio/LOS

The analysis indicates that the intersection of the Hammonasset Connector at the I-95 northbound ramps operates efficiently at LOS B or better during both peak hours in the existing condition, with volume to capacity ratios (v/c) between 0.35 and 0.48. The intersection of the Hammonasset Connector at U.S. Route 1 operates acceptably at LOS C during both peak hours, with v/c ratios between 0.59 and 0.60.

3.2.2 Impact Evaluation

Historical count data collected by ConnDOT on U.S. Route 1 in the vicinity of the site were reviewed to determine the annual traffic growth rate. The counts indicated that traffic on U.S. Route 1 grew an average of 1.6 percent per year over the nine-year period between 1995 and 2004. Therefore, in order to conservatively account for growth in the background traffic volumes within the study area, the existing traffic volumes were increased by two percent per year from the 2007 traffic volumes to the 2012 build year, when the proposed park improvements are expected to be complete. These volumes represent the 2012 No Build condition (without the proposed park improvements), shown in Figure 3-11.

The proposed beach nourishment project was conservatively assumed to result in a 30 percent increase in attendance in the 2012 Build condition as compared to the 2012 No Build condition. This represents a conservatively high estimate of the number of additional trips generated by the preferred alternative for the purposes of evaluating potential traffic impacts in this EIE. The actual number of additional trips generated by the proposed action will likely be lower than this estimate, especially if the recent, dramatic increases in the price of gasoline continue to reduce personal vehicle use. The trips entering the park were increased accordingly, and the 2012 Full Build volumes (with the proposed park improvements) were analyzed for potential impacts. The additional trips to and from the park are shown in Figure 3-12, while the 2012 Full Build volumes are shown in Figure 3-13.

Capacity analyses were performed for the two study area intersections for both the 2012 No Build and Full Build scenarios, with the results summarized in Table 3-2.

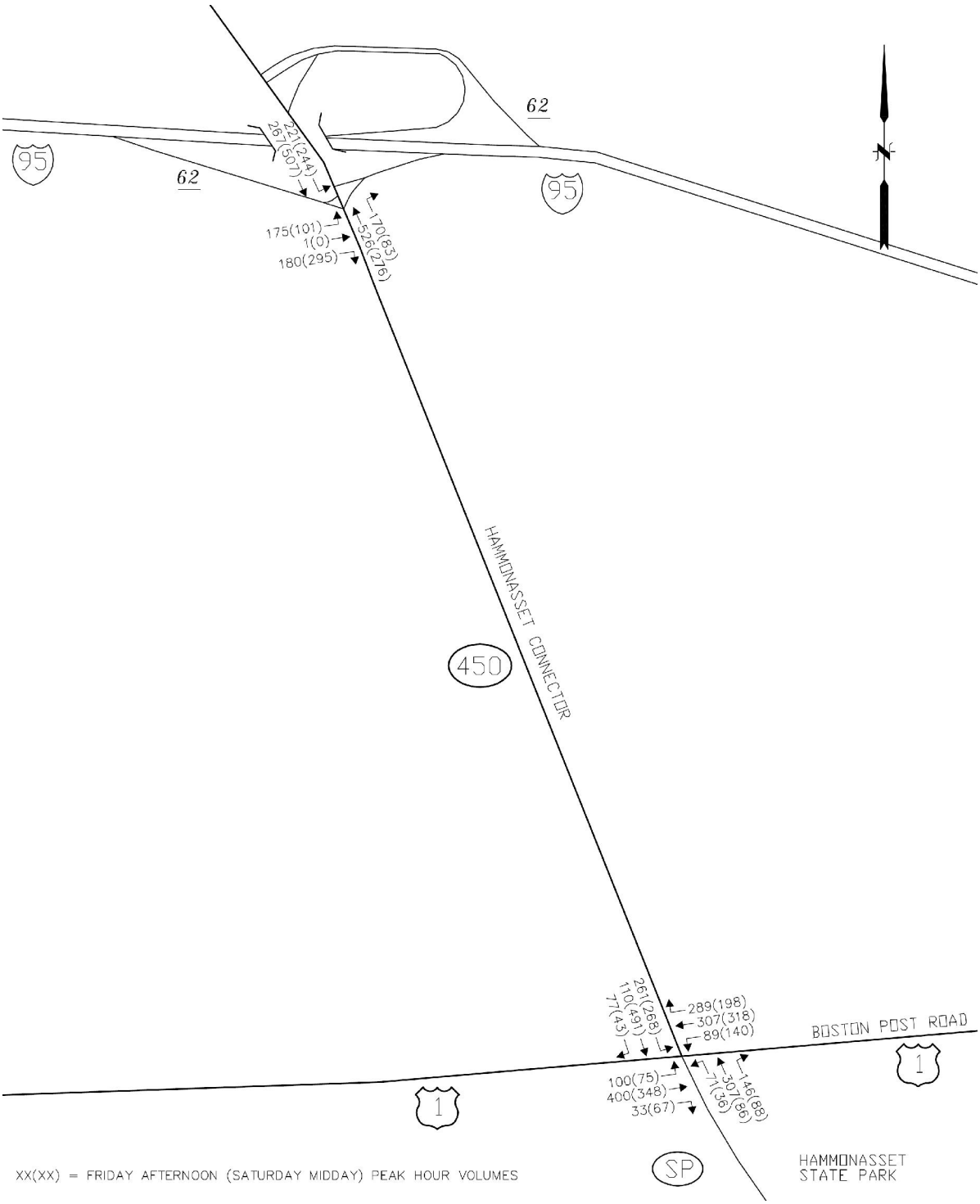


Figure 3-11. No Build Future (2012) Traffic Volumes

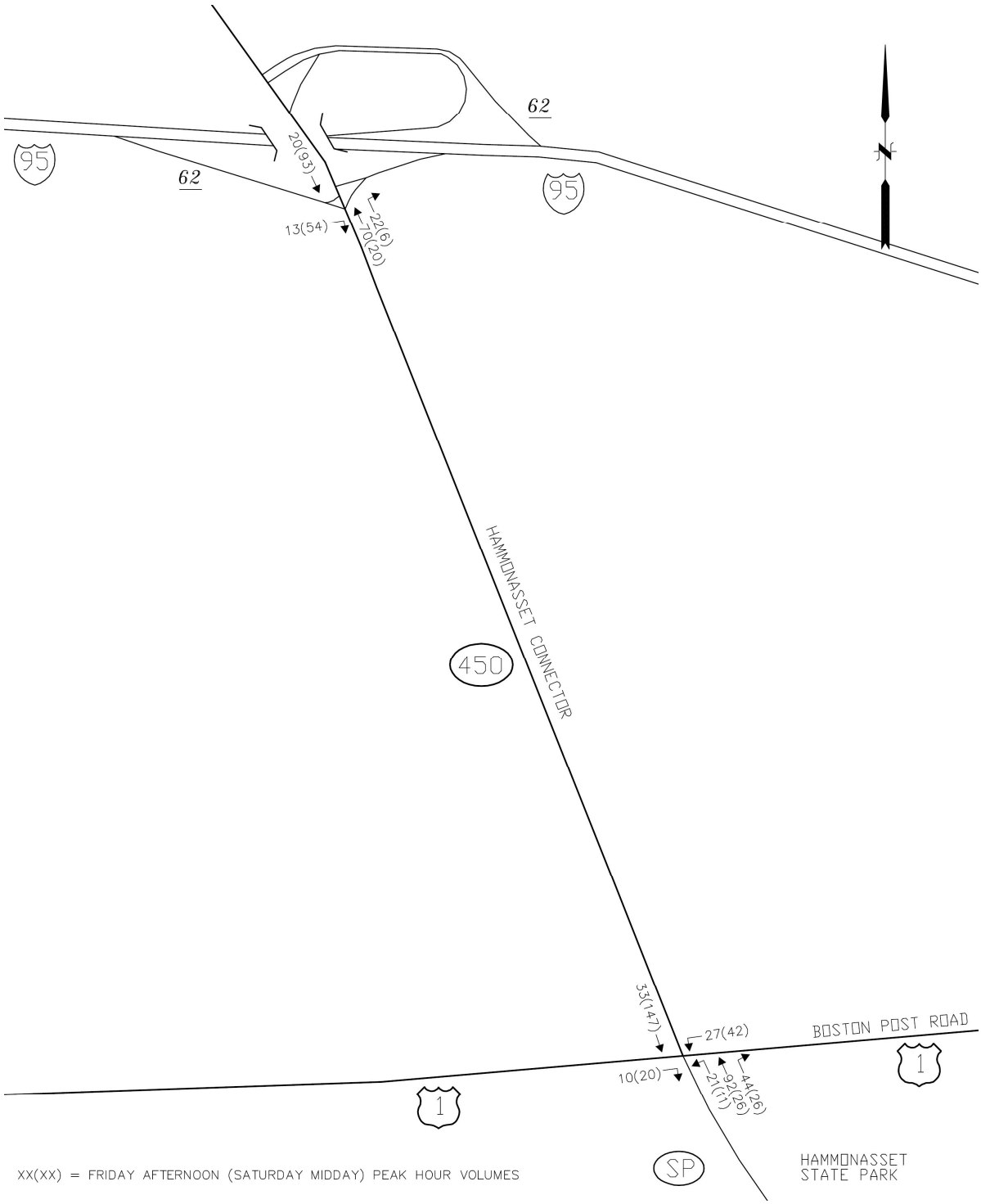


Figure 3-12. Change in 2007 - 2012 Traffic Volumes with 30% New Trips

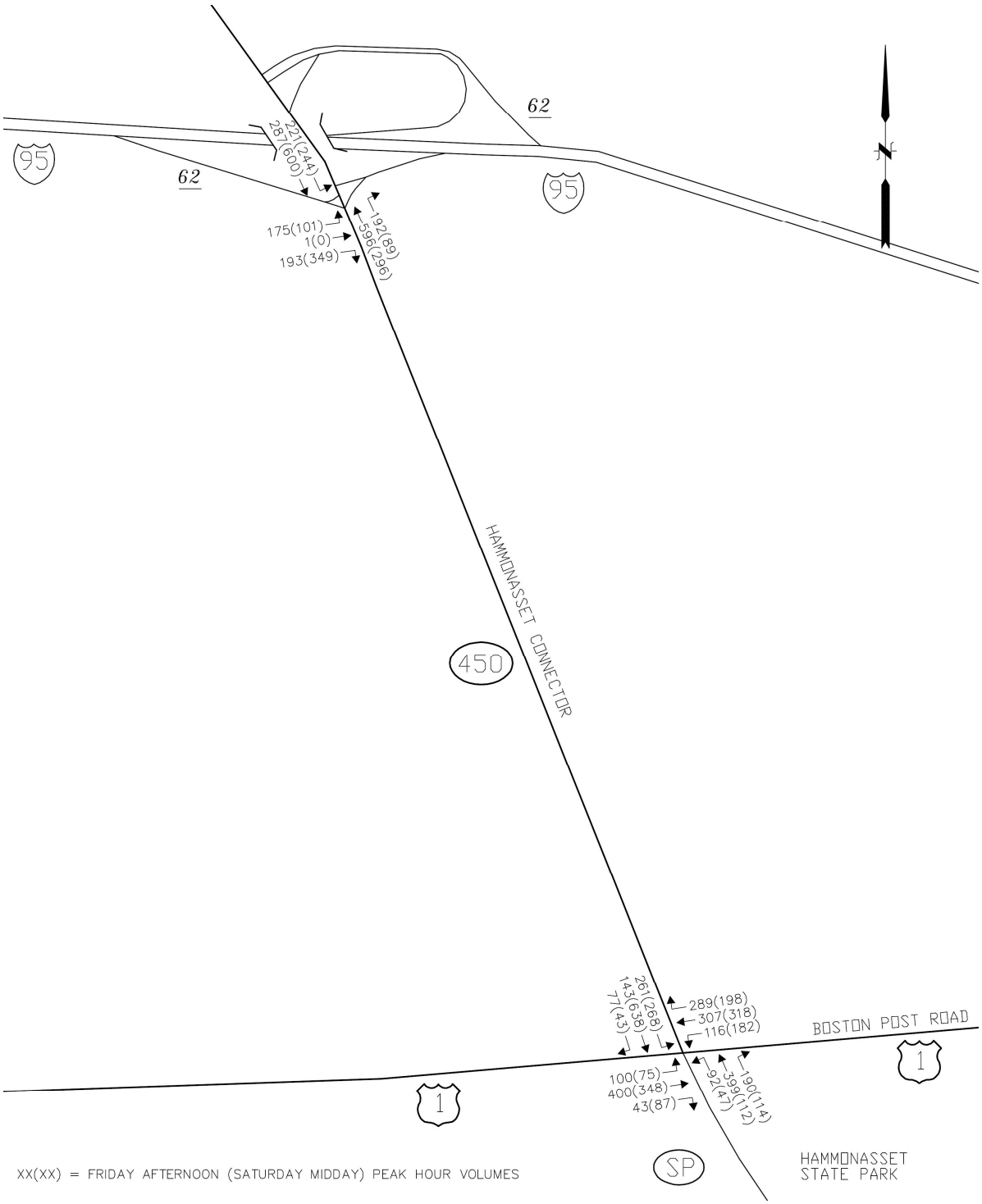


Figure 3-13. 2012 Traffic Volumes with 30% New Trips

Table 3-2. Future Conditions Capacity Analysis

Signalized Intersections	2012 Friday Afternoon Peak Hour		2012 Saturday Midday Peak Hour	
	No Build	Full Build	No Build	Full Build
Hammonasset Connector (SR 450) at I-95 Northbound Ramps	0.55/B	0.59/B	0.39/B	0.48/B
Hammonasset Connector (SR 450) at US Route 1 (Boston Post Road)	0.67/C	0.83/C	0.66/C	0.69/C

Note: Values indicated are intersection v/c Ratio/LOS

The analysis for the 2012 Full Build volumes indicates that the intersection of U.S. Route 1 with the Hammonasset Connector will continue to operate acceptably at LOS C during both peak hours with the additional park trips. The intersection of the Hammonasset Connector with the I-95 northbound ramps will continue to operate efficiently at LOS B with the additional site generated trips.

During construction of the proposed action, temporary impacts may occur to vehicle circulation patterns within the park to accommodate construction vehicles and access to the beach. Transport of sand to the site from upland sources would entail significant truck traffic, resulting in greater impacts to internal traffic circulation. Construction-related activities may result in temporary detours or limited access to portions of the internal park roadway system during the construction period. However, these impacts would be short-term, lasting only during construction.

3.2.3 Mitigation

Both of the intersections within the study area are expected to operate acceptably at LOS C or better, and not experience a significant decrease in LOS as a result of the additional trips generated by the proposed beach nourishment project. Therefore, no long-term traffic mitigation measures are proposed. Temporary construction-related impacts under the proposed action would be mitigated by appropriate signage to divert drivers to other park roads and parking lots.

3.3 Coastal Resources

3.3.1 Existing Conditions

Hammonasset Beach State Park is located within the coastal zone as defined by the Connecticut Coastal Management Act in the Connecticut General Statutes (CGS) Section 22a-90 through 22a-113 and includes significant coastal resources. Protection of these resources is accomplished through several federal and state regulatory programs under which permits and approvals will be required for the proposed project. These programs and/or approvals include:

- A Structures, Dredging, and Fill Permit pursuant to C.G.S. Section 22a-361 for the placement of any fill or structures into tidal waters. This DEP permit applies to both the sand placed below the mean high water line and to the construction of the terminal groin. This permit requirement would also apply to a fishing pier if that feature is added to the groin.
- Federal Clean Water Act, Section 404, as regulated by the Army Corps of Engineers. Potentially impacted resources include Waters of the United States.
- Connecticut Coastal Management Act, as regulated by DEP. Potentially impacted resources include Dunes and Beaches, Coastal Waters and Estuarine Embayments, Coastal Hazard Areas, and Rocky Shorefronts.
- Federal Endangered Species Act and Connecticut Endangered Species Act, which protect habitat of federally and state-listed species, respectively.

The following sections describe existing conditions within and near the project area relative to these protected resources.

Beaches

Beaches are unconsolidated sediments that are subject to wave, tidal, and coastal storm action that form the shore of coastal waters and extend from the coastal mean low water line to the dune line, coastal bank line, or seaward edge of a manmade structure. The beach itself is a resource as defined by the Connecticut General Statutes (CGS section 22a-93(7)(C). Beaches protect inland resources from flood damage by absorbing wave energy. They also provide recreational opportunities including fishing, swimming, sunning, hiking, and sight-seeing, and are areas of scientific and educational value. Hammonasset is a sandy beach of approximately 1.8 miles in length from Tom's Creek to Meigs Point and is generally less than 100 feet in width and includes all of the functions and values defined by the Connecticut Coastal Management Manual (DEP, 2000).

Hammonasset Beach is a dynamic system which has recently been studied and characterized in the companion engineering feasibility study report (Woods Hole Group, 2008). As part of this work a shoreline change analysis was performed that examined the long-term rate of shoreline change at Hammonasset Beach. A detailed explanation of the analysis and results are presented in Appendix B. Results of the shoreline change analysis are summarized in Figure 3-14. The data used to compile the analyses were obtained from aerial photography, historical maps, and digital orthophotographic quads.

Rates of historical shoreline change were calculated at 47 shore-normal transects from Tom's Creek to Meigs Point. The rates of change and response of the shoreline were evaluated over three specific time periods, including 1883-1933, 1883-2007, and 1974-2007. The long-term morphological trends indicate that, in general, Hammonasset Beach is erosional to the west and accretional to the east. Erosion rates were greatest near Tom's Creek, reaching a maximum of -0.93 and -0.92 ft/yr. Accretion rates were highest on the eastern extreme of the beach at Meigs Point, reaching a maximum of +1.40 and +1.81 ft/yr.

These data indicate, along with the easterly littoral drift, that sediment has been eroding from the western side of the beach and accreting on the eastern side. In the time period between

1974 and 2007, Hammonasset Beach continued to exhibit the same morphological pattern evidenced in the 1883–1933 and 1883–2007 time periods. However during the past 33 years, on average, the rates of shoreline change have increased in magnitude when compared to the other time periods. Erosion rates were greatest on the west side of the beach, reaching a maximum of –2.01 and –2.10 ft/yr. Coincidentally, these extreme erosion rates have occurred near the location of the Hammonasset Beach State Park West Beach bath houses.

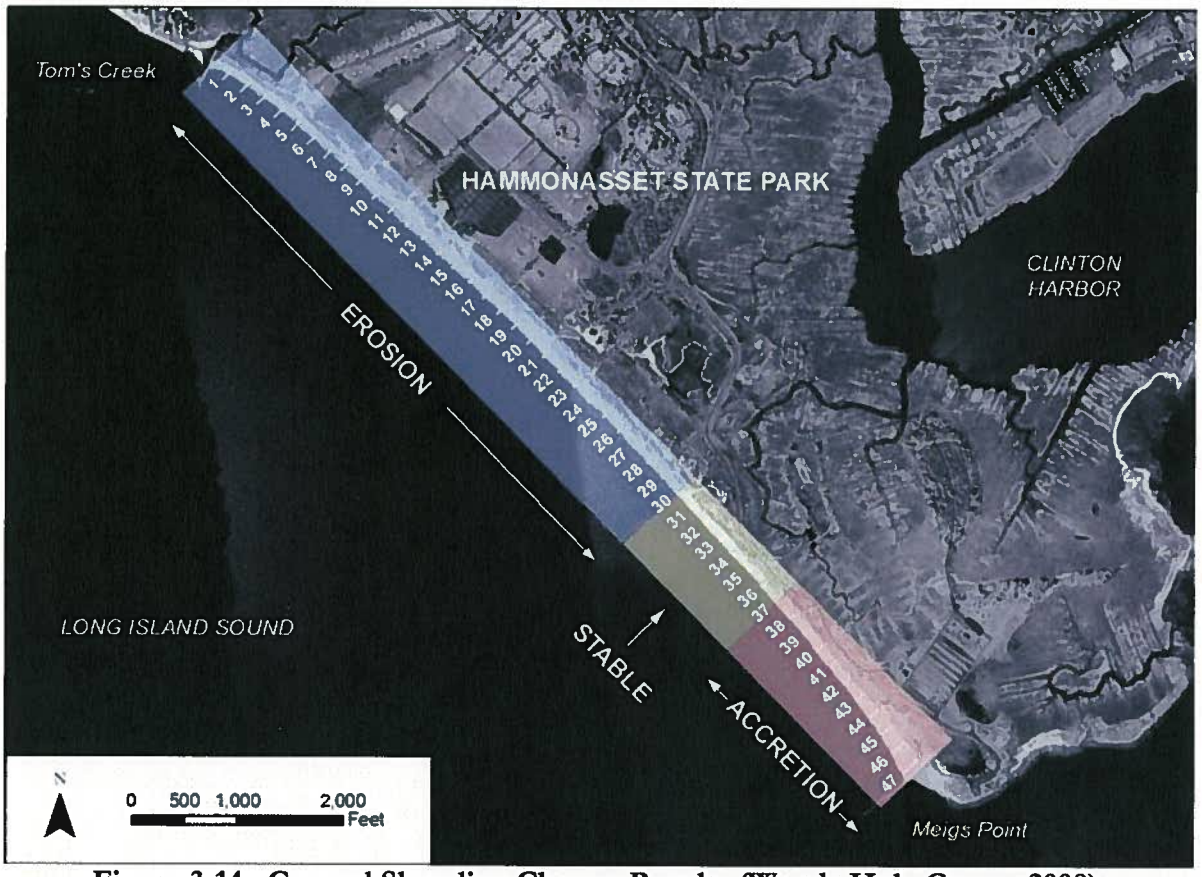


Figure 3-14. General Shoreline Change Results (Woods Hole Group, 2008).

Woods Hole Group (2008) also completed a wave and current study for the nearshore and offshore area near Hammonasset Beach. Two Acoustic Doppler Current Profilers (ADCPs) were deployed in the offshore and nearshore regions of the beach in the late winter and early spring of 2007 (February 21 through April 24). These profilers measure wave height and direction, current magnitude and direction, and sea surface elevation (tides). The offshore profiler was installed in 45 feet of water approximately 2.6 miles offshore of Hammonasset Beach, and the nearshore profiler was installed in 15 feet of water approximately 1000 feet offshore of the beach.

Waves approached the offshore wave station predominantly from two directions – the southwest (SW) and east-southeast (ESE). At the nearshore wave station, waves generally approached from the SW only. Waves were not observed as frequently from the ESE as the local bathymetry and complex curvature of local shorelines sheltered the nearshore wave station from the ESE wave approach. The wave ADCP data were compared to existing MYSOUND

buoy data to provide a level of confidence in the observed data. The wave data were required to calibrating the numerical wave transformation model.

Current observations through the entire water column were also collected at each wave station. The average current speed collected at the offshore location over the observation period was 1.43 feet/sec, with a maximum magnitude of 3.95 feet/sec. The average current magnitude collected at the nearshore location over the observation period was 0.75 feet/sec, with a maximum magnitude of 2.43 feet/sec. At the offshore location, current alternates between flows directed towards the east and the west due to the tidal fluctuations. These directional changes correspond to the ebb and flood of the tide along the axis of Long Island Sound.

At the nearshore location, a more unidirectional current flow was observed. In the nearshore vicinity of Hammonasset Beach, the predominant current direction is going toward the southeast, or along the Hammonasset Beach shoreline from northwest to southeast. This unidirectional current may be due to the formation of a tidal current gyre that results from the orientation of the shoreline near Hammonasset Beach. Ultimately, this strong unidirectional current may play a role in the sediment transport movement along Hammonasset Beach, which is directed from the northwest to the southeast. It is likely that any sediment that is mobilized by wave forces during a storm event could be carried offshore, and if the sediment remains in suspension, would be transported to the southeast.

Additional details related to wave and current data, its collection, and the sediment erosion and supply dynamics are presented in Chapter 5.0 of the engineering feasibility study report (Appendix B).

Dunes

Much of Hammonasset Beach includes a sandy dune system located between the beach and the tidal wetlands and inland areas. As described in the Connecticut Coastal Management Manual (DEP, 2000), dunes have the same functions and values as beaches, protecting inland resources from flood damage by absorbing wave energy. They also provide recreational opportunities and offer areas of scientific and education value. Dunes and dune ridges also serve as sand reservoirs for beaches. Dunes at Hammonasset Beach were delineated by Woods Hole Group in May of 2007 on the western and central portion of the beach and are presented in Figure 3-15. In general, dunes along the beach are characterized by typical dune vegetation, such as American beach grass.

The dunes are generally four to seven feet in height and form a relatively contiguous feature along the back edge of the beach. In some areas, there are breaks in the dunes where they are crossed by walkways. The West Beach bath houses are also located within a break in the dunes, creating an interruption in the landform. The dune barrier narrows in the location of the East Beach pavilion.

The dunes at Hammonasset Beach are manmade. Adjacent to the Tom's Creek jetty, the dunes are vegetated with beach grass and transition sharply to tidal marsh vegetation on the northeast side, although there are small transitional areas that contain salt grass mixed with beach grass.

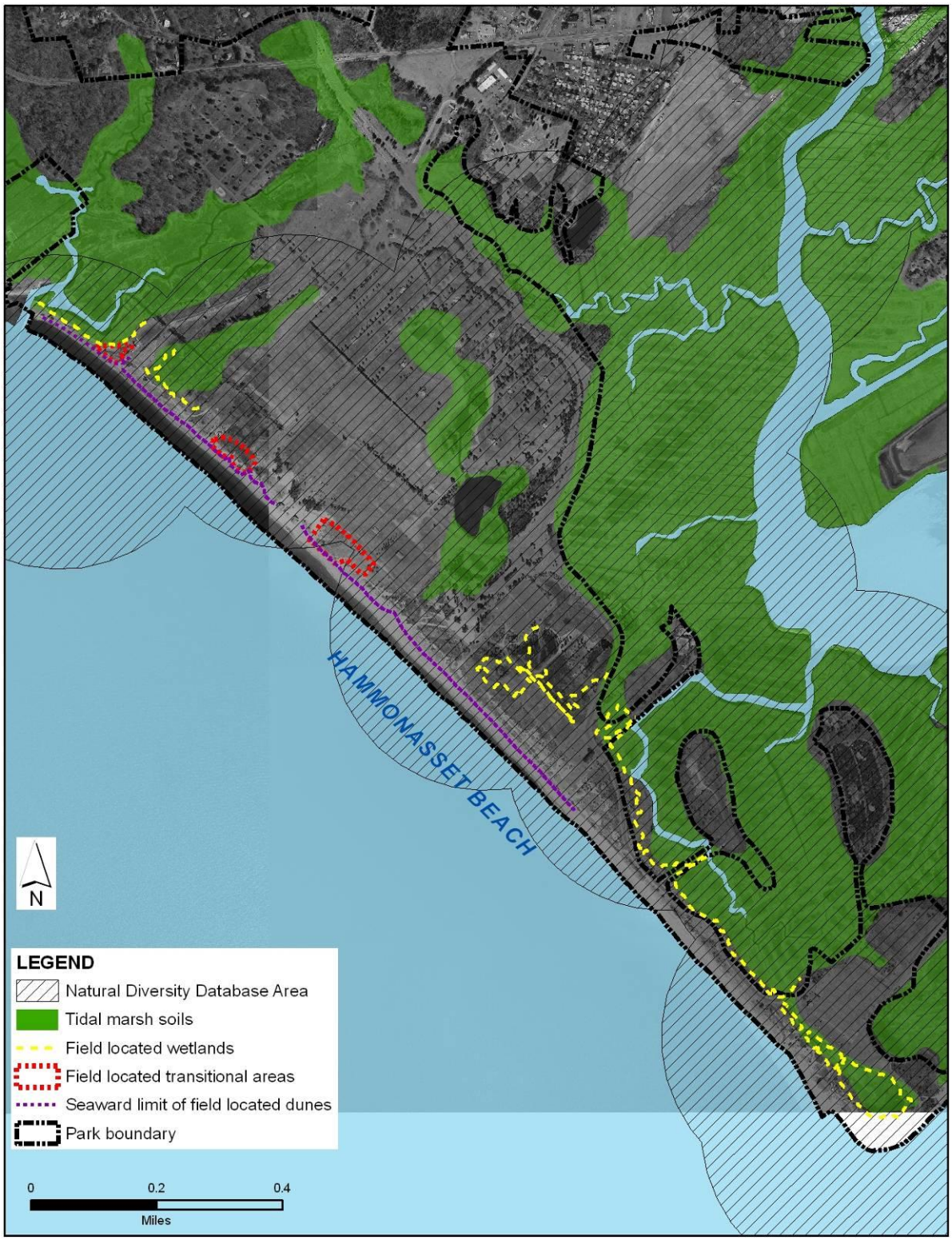


Figure 3-15. Coastal Resources

Flooding and Coastal Hazard Areas

Coastal Hazard Areas are defined by the Connecticut Coastal Management Act as encompassing most other coastal resources and provide flood storage, open space, and recreational opportunities. They are ill-suited for structural development. Coastal Hazard Areas include areas that would be subject to inundation during a 100-year flood as defined by the Federal Emergency Management Agency (FEMA), including V zones (areas of wave action inundated by a 100-year event) and A zones (areas inundated by a 100-year event with no wave action considered).

The majority of Hammonasset Beach State Park is located within the 100-year flood zone as established by FEMA. The majority of upland areas at the park are within A zones, although the beach and adjacent upland areas extending to the park access roads are within V zones.

Exceptions include an area near the former pavilion, which is elevated slightly, and three areas at the eastern end of the park, including Willard Island (an island surrounded by tidal marsh) and two high areas at Meigs Point. FEMA 500-yr flood zones are located generally inland from the limits of the 100-year flood zones. Flood zones at the beach are presented in Figure 3-16. The majority of Hammonasset Beach State Park is also mapped by the Army Corps of Engineers as an inundation area for storm surges from all categories of hurricane (ACE, 1995).

Rocky Shorefronts

Rocky shorefront resources are areas that, as described by the Connecticut Coastal Management Act, provide hard substrate and habitat for rocky intertidal organisms, dissipate and absorb storm energy, and provide scenic vistas and recreational opportunities. Currently, only limited rocky shorefront exists along Hammonasset Beach, which is associated with the Tom's Creek jetty and Meigs Point groin. These structures currently support limited blue mussel sets (Woods Hole Group, 2008).

Coastal Waters and Estuarine Embayments

Coastal Waters, as defined by the Connecticut Coastal Management Act, include Long Island Sound and its associated harbors, embayments, and tidal streams with salinity concentrations of at least 500 mg/L under low stream flow conditions. These areas are of high primary and secondary productivity that provide habitat for and support marine and benthic organisms, assimilate anthropogenic wastes, support commercial and recreational fisheries, are important to marine transportation, and provide recreational opportunities for boating, swimming, fishing, diving, and vistas. Coastal waters surround Hammonasset Beach and include Long Island Sound, Clinton Harbor, and the tidal rivers surrounding the beach. A discussion of habitat associated with these resources is presented in Section 3.9.

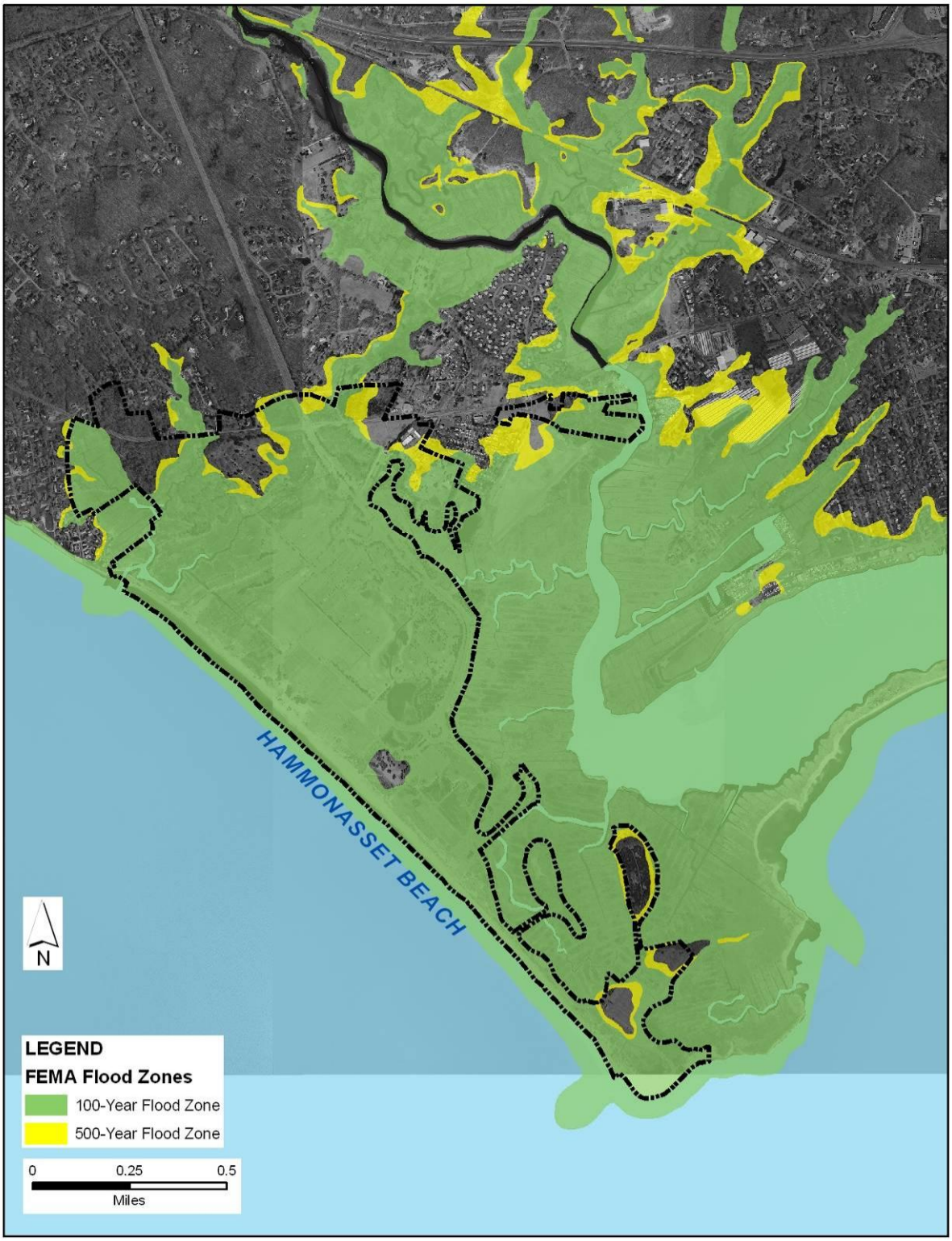


Figure 3-16. Flood Zones at Hammonasset Beach

Tidal Waters

Tidal waters from the mean high water line seaward to the boundary of the territorial sea (Long Island Sound) are regulated by the Army Corps of Engineers under Section 404 of the Clean Water Act. Tidal waters may include a variety of resources and habitats ranging from mudflats, portions of beaches, rocky shore areas, marshes, and vegetated shallows. These areas provide habitat for upland, aquatic, and avian species (unprotected, threatened, endangered, and commercially-harvested species). Habitat for federally- and state-listed species is also protected by the Federal and Connecticut Endangered Species Acts. A discussion of habitat associated with this resource is presented in Section 3.9.

The bathymetry (the underwater elevation data) of the nearshore areas was surveyed by Woods Hole Group in support of the engineering feasibility study. The survey data, which was collected for the area from the Tom's Creek jetty to the Meigs Point groin within tidal waters, is shown in Figure 3-17. In general, nearshore areas near Tom's Creek have a somewhat flatter slope than areas near Meigs Point. However, an offshore shoal has developed approximately 1,200 feet west of the Meigs Point groin. This shoal works in combination with the groin to create an environment favorable to sediment accretion in that area. An additional feature of interest was identified offshore from the location where the main pavilion was previously located. In this area, a small shoal extends seaward adjacent to a depression that extends landward. This feature may influence wave transformations and create zones of increased wave energy in this area. Additional information regarding the beach bathymetry is presented in Chapter 4.0 of the engineering feasibility study report (Appendix B).

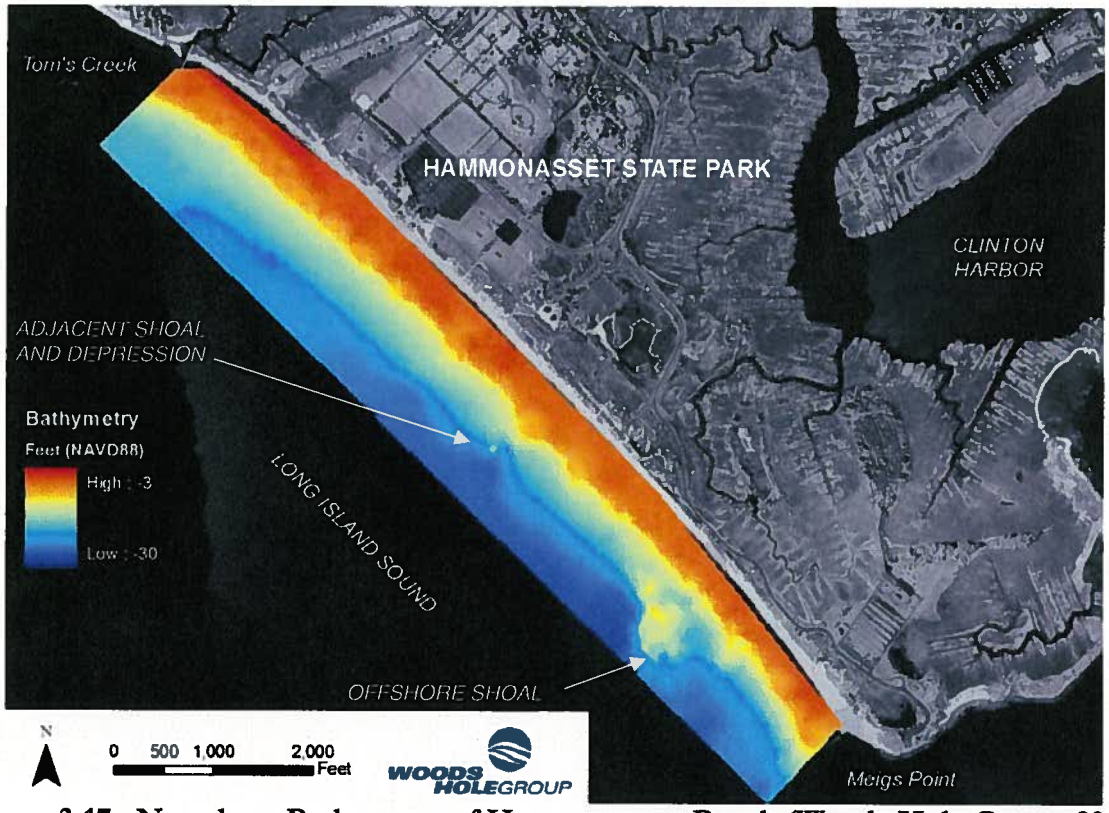


Figure 3-17. Nearshore Bathymetry of Hammonasset Beach (Woods Hole Group, 2008)

Tidal Wetlands

Tidal wetlands are areas that border waters subject to tidal action, with an elevation at or below one foot above local extreme high water, and where one or more species of certain plants grow as defined by Connecticut General Statutes (CGS) section 22a-29(2). Tidal wetlands are generally located in low energy environments that are protected from direct wave action, are flooded frequently or occasionally, and support a diverse ecosystem.

The Hammonasset Beach State Park ecological system includes large, high value tidal marshes. These are located outside of the project area, between upland areas along the beach and the Hammonasset River. Woods Hole Group delineated tidal wetlands and transitional areas on May 30, 2007 (Figure 3-15). In several portions of the state park, wetland areas are located adjacent to but inland of the coastal beach. Transitional areas are sites with tidal wetland characteristics, but non-typical tidal wetland vegetation. Simultaneous with this effort, Fuss & O'Neill performed a survey for freshwater wetlands in the same area. None were present. Figure 3-15 depicts locations of tidal wetland soils provided by DEP as well as field-located wetlands and transitional areas. Additional details regarding the wetland evaluation findings and methods are presented in the engineering feasibility study report in Appendix B.

3.3.2 Impact Evaluation

Beaches

The proposed action is intended to restore and protect the primary functions of the beach. The additional sand that would be placed along the beach would provide enhanced storm damage protection and flood control for park infrastructure and adjacent resources. The project will also help to mitigate ongoing erosion, which would provide increased recreational opportunities to the public.

Construction of a new terminal stone groin would eliminate some area that is currently available for beach-related uses, since the groin will occupy the beach surface over its footprint. Advantages associated with an additional groin include increased longevity of the nourishment and the ability to maintain a wider beach west of the Meigs Point groin as littoral drift is impounded by the structure. This combination of effects will result in a greater usable area of beach for an extended period of time. As such, a terminal groin would provide a net benefit relative to the usable area of the beach.

Woods Hole Group (2008) found that the proposed changes to the beach and nearshore area would not significantly alter currents, waves, or sediment dynamics. Wave, current, and sediment transport models developed by Woods Hole Group were used to evaluate impacts of the proposed alternatives. For an action consisting of nourishment only, sediment transport from west to east along the beach would continue, and the sediment supply to downdrift areas would not be reduced. Accretion rates in the vicinity of Meigs Point would likely increase, providing additional beach area and improved storm damage protection.

The terminal groin proposed at the eastern limit of the beach nourishment area could reduce the sediment supply to Meigs Point and downdrift portions of the East Beach by impounding sediment that would otherwise be transported to these areas. Impacts would not occur beyond Meigs Point, and as such, would be limited to Hammonasset Beach State Park. These impacts are expected to be minor however, since the design calls for filling the terminal groin to entrapment (i.e., an equilibrium state) on the west side. After the terminal groin is in place, eastward moving littoral drift will be bypassed around the end of the groin, thereby supplying sand to the Meigs Point area. If a fishing pier is constructed at the end of a new terminal groin, the pier would likely be supported by driven piles that would have negligible effect on sediment transport.

Adverse impacts to sediment movement along the West Beach and Tom's Creek outlet are not expected. In general, the net transport from west to east will minimize littoral drift towards Tom's Creek. In addition, the combination of a unidirectional nearshore current moving from west to east, a gradual nearshore slope of 1:20, and tapering of the nourishment design adjacent to the Tom's Creek jetty will minimize the possibility of shoaling at the Tom's Creek outlet.

Dunes

The proposed action would enhance and protect the existing dune system along the beach. The dunes, in turn, serve to protect coastal areas from flood damage and wave energy and also supplement the beach with sand during storms.

Flooding and Coastal Hazard Areas

The proposed build alternatives will provide increased flood damage protection by supplementing the existing beach and dune system. No negative impacts related to flooding are anticipated.

Rocky Shorefronts

The proposed beach nourishment will not affect the existing rocky shorefront areas, which, along the main beach, are limited to the stones composing the Tom's Creek jetty or Meigs Point groin. If a new terminal groin is constructed, the structure would likely consist of placed or piled boulders. This material would provide additional rocky shorefront habitat relative to existing conditions, and would thus be a beneficial impact to this resource.

Coastal Waters and Estuarine Embayments

The proposed action will only affect nearshore coastal waters, which are a subset of Coastal Waters and include waters between the mean high water line of Long Island Sound and a depth of 10 meters. The proposed action will not affect offshore waters since the proposed nourishment area is currently less than 10 m in depth. Potential impacts to nearshore coastal waters include conversion of nearshore areas to beach. Potential habitat impacts are discussed in Section 3.9.

Tidal Waters

The upper and lower tidal water limit will be shifted seaward with the proposed beach nourishment project. The function of the existing tidal waters will remain unchanged. The area of the beach subject to tidal action may increase where a flatter beach is created. Potential habitat impacts are discussed in Section 3.9.

Tidal Wetlands

Since tidal wetlands are located inland from the beach, the proposed action, including nourishment with or without a new terminal groin, will not affect tidal wetlands. The retreat alternative, in which existing structures would be moved inland to protect them from erosion, could be designed to avoid impacts to tidal wetlands through appropriate selection of new locations, since only limited areas of tidal wetlands are located inland of existing structures as shown in Figure 3-15. However, continued erosion of the beach would threaten these tidal wetland areas, resulting in their eventual loss.

3.3.3 Mitigation

Beaches

Most anticipated impacts to beach resources are positive since the proposed alternative will increase the size of the beach and improve its function and value relative to existing conditions. If a new terminal groin is constructed, mitigation measures could be necessary to maintain the sediment supply to downdrift beach areas between the new terminal groin and Meigs Point. Mitigation would consist of filling the updrift storage area of the groin to entrapment to maintain sediment transport to downdrift areas.

Dunes

The proposed project will enhance and protect the dune system at the beach.

Flooding and Coastal Hazard Areas

No negative impacts are anticipated so no mitigation is necessary.

Rocky Shorefront

No negative impacts to rocky shorefronts are anticipated; no mitigation is necessary. Rocky shorefronts would be created if a new groin is constructed.

Coastal Waters and Estuarine Embayments

Impacts to coastal waters will include conversion of nearshore coastal waters to beach. The value of the nearshore coastal waters that would be converted are relatively low since the area is high in energy, resulting in poor habitat, and since the area that is to be converted is generally too shallow for navigation. The recreational and flood damage prevention benefits that the

expanded beach would provide outweigh the loss of nearshore coastal waters by increasing the available area for beach uses and protecting inland areas of the park from future erosion (Woods Hole Group, 2008). The project will result in moving the landward limit of coastal waters slightly to the southwest. However, replacing a low-value nearshore coastal water resource with a high-value beach resource is a net benefit, with no mitigation necessary.

Tidal Waters

No negative impacts to tidal waters are anticipated; no mitigation is necessary.

Tidal Wetlands

The proposed action will not affect tidal wetlands. The retreat alternative is the only alternative that could potentially result in disturbance near tidal wetland areas. However, these resources are limited in area such that structures, associated access, and infrastructure could be located to avoid impacts to tidal wetlands.

3.4 Socioeconomic Resources

3.4.1 Existing Conditions

Existing socioeconomic conditions in the project area are described in a memorandum entitled "Preliminary Socioeconomic Conditions and Other Findings" (RKG Associates, 2007a). Information on current economic conditions in the vicinity of Hammonasset Beach as well as data on park attendance, revenues, and expenditures are included in the report, which is provided in Appendix C and summarized below.

Hammonasset Beach State Park attracts day use visitors for bird watching, sunbathing, picnicking, swimming and other activities, as well as overnight camping on its 554 camp sites. The park has the highest annual attendance of any Connecticut state park. In 2006, the park was used by over 1.6 million day use visitors and 186,000 campers, according to park records. Attendance increased by approximately 209,000 day user visitors, or 15%; and 28,000 campers, or 18%, between 2003 and 2006. The park is open for day use throughout the year, while the campground is open from mid-May through early October. Attendance at the park is highly seasonal, with 50%-60% of visitors using the park from June through August. The average daily visitor count in 2006 ranged from approximately 2,000 day users from November through February, to over 10,000 in July.

In 2006, the park generated approximately $1.4 million in revenues from parking and camping fees while expenditures for staffing, maintenance, capital projects, and equipment was approximately $1.68 million.

In 2006, the nearby region, which includes Madison, Clinton, and Guilford, contained 20,452 households representing an increase of 743 (4%) since 2000 and 3,115 (18%) since 1990. With a household growth rate increasing at a faster rate than population growth, the region is outpacing the county and state relative to attracting more and/or smaller households (typically empty nesters, singles and/or professional couples).

The industry sectors that experienced the largest growth in jobs in the region over the 2001 to 2006 time period included the government (868 jobs or 63%), retail trade (307 jobs or 11%), and health care (186 jobs or 9%) sectors.

The region is heavily reliant on service and public administration employment, with the retail, health care and government sectors containing the largest proportion of jobs in 2006 at 20%, 15% and 14%, respectively.

Based on a "windshield survey" of business establishments located within approximately one mile of the park entrance, there are approximately 36 establishments located along Route 1 (north and south). The businesses located near the park consist of eating and drinking establishments, small retail shops, services, financial institutions, business and professional service offices, and medical clinics. Although it is anticipated that some of these businesses, primarily eating and drinking establishments and small retail shops, would serve park day visitors and campers, there are no businesses located outside of the park that are solely dependent on park visitors for business. No data is available on local expenditures by park visitors, therefore, the economic impact of park visitors on these businesses could not be quantified.

Because the park is used primarily as a destination for day users, local spending is estimated to be relatively small. Some visitors may stop by a grocery or convenience store to purchase food, beverages or sundries upon arrival to the beach, and others may purchase gasoline prior to heading home for the day. Similarly, fishermen may purchase bait from a local vendor at the beginning of the day. Overnight campers may exit the park during their stay to purchase additional goods, perhaps go to a restaurant or visit other tourist attractions or recreational opportunities in the region.

3.4.2 Potential Impacts

Potential impacts associated with the project alternatives described in Section 2.0 are described in a memorandum prepared by RKG associates (Appendix C) and are summarized below.

The proposed action is unlikely to result in significant social or economic impacts to the State Park, the local community, or the region. Insignificant, immeasurable impacts may occur but cannot be quantified based on existing data or studies completed for similar projects.

The proposed beach nourishment is intended to protect the beach from further erosion, thereby maintaining current usage levels. The proposed terminal groin and fishing pier could attract additional visitors interested in using this infrastructure for fishing, increasing attendance marginally. However, it is unlikely that local or regional spending and annual park attendance would be significantly impacted.

Construction of the proposed beach restoration project would generate employment and spending, which could impact the local economy. Although the construction jobs would be considered new employment since work is not currently on-going, the economic impact to the local economy would be limited to the periods of construction and would have a marginal effect within the region. There are over 3,000 construction jobs in Middlesex County and over

600 within the local region (Middlesex County was selected as a comparable region for Clinton, Madison, and Guilford since these towns are more similar in characteristic to Middlesex County than New Haven county). It is likely that the construction activity generated by the proposed action could be readily absorbed by firms and workers within the region.

Under the No Action alternative, continued erosion and loss of usable beachfront area, combined with the potential loss of buildings and infrastructure, would likely result in a decline in park attendance by beach-goers and potential negative impacts to the local and regional economy.

3.4.3 Mitigation Measures

Temporary mitigation measures to address potential construction phase impacts are described in Section 3.11. In general, the proposed beach restoration project will be constructed during the off-season to minimize impacts on park visitors.

3.5 Cultural Resources

3.5.1 Archaeological Sites and Archaeologically Sensitive Areas

3.5.1.1 Existing Conditions

A cultural resources survey was performed by Archaeological and Historical Services (AHS) to assess Hammonasset Beach State Park for archeological sites and historically sensitive areas that could be impacted by the proposed action. The findings are summarized in this section. A full copy of the report is included in Appendix D. The survey identified thirty-three archaeological sites within the vicinity of the park.

Two of the reported archaeological sites are located in or near the project area. These include Site 76-1, which is located along the beach and is listed as a camp from the Paleoindian-Woodland period, and Site 76-3, which is located inland from the park and is listed as a camp of the Late Archaic - contact period. These sites are described in more detail in the following paragraphs.

Two of the sites located further inland from the beach represent colonial-era standing structures, and one is an early colonial contact period Native American site. The remaining sites are pre-Colonial Native American (prehistoric) and include sites that are defined as camps, middens, fishweirs, burials, and a possible sweat lodge.

Numerous artifacts have been identified along the beach and inland from the beach. These include projectile points, blades, and scrapers representing a variety of Late Archiac forms and may be 4,000 to 6,000 years old, although a Paleoindian fluted point was recovered that may be older than 10,000 years (Glynn, 1969:70, reference provided in Appendix D). Artifacts originating in these areas, including offshore along the beach and an offshore borrow area for former beach nourishment projects, as well as the area where they were found along the beach, are generally identified as Site 76-1.

The designation "Site 76-1" suggests that these artifacts originated in a finite area; however, the specific location and extent of the site are not well documented. The spatial extent of Site 76-1 is best interpreted as the offshore area along the beach where artifacts are known to have been found during dredging operations as well as most terrestrial portions of the park (AHS, 2008).

In general, approximately 90% of artifacts recovered from this site are thought to have originated from offshore dredge spoils deposited after the 1955 hurricane (Bourn 1977, reference provided in Appendix D). These finds have been documented in past reports that are summarized in the archaeological and historical resources assessment in Appendix D.

Finds include clam and oyster shells showing signs of having burned, stone tools, projectile points, blades and scrapers, knives, and flakes and debris. Additional artifacts have been found in plowed fields located inland that may not have originated from offshore dredging. These include an antler tool, knives, corers, drills, scrapers, weights, fire cracked stones, preforms, etc.

Site 76-3 is located within the Hammonasset Beach State Park boundary but is located inland of the proposed project area, approximately 500 feet south of Boston Post Road. Little documentation exists for this site, although it is thought to be Late Archaic in age.

In general, Hammonasset Beach State Park and surrounding areas is thought to be highly archaeologically sensitive, particularly for prehistoric sites. The rarity and importance of offshore archaeological sites, and the abundance of midden and burial sites near the project area (although not located in the project area) support this finding.

3.5.1.2 Impact Evaluation

Despite the archaeological sensitivity of Hammonasset Beach State Park, the proposed action is unlikely to have adverse impacts to cultural resources of the project area since the proposed beach nourishment consists primarily of sand placement on the beach and in the nearshore area, with minimal disturbance to buried cultural resources. The one exception is the location of the proposed terminal groin. Construction of the groin itself is expected to have minimal impacts on inundated offshore resources unless the sea floor will be disturbed prior to or during construction. The proposed beach nourishment project will be more protective of archaeological resources than the No Action alternative since the nourishment would help preserve nearshore (and potentially inland) buried cultural resources from future erosion.

Potential archaeological impacts associated with the acquisition of sand (i.e., dredging, quarrying, or similar activities) for the beach nourishment project are beyond the scope of this EIE, as discussed in Section 1.2.

3.5.1.3 Mitigation

If construction of the proposed groin is likely to disturb sea floor sediments, such as through preparation of a base for the groin or driving piles for a potential fishing pier, archaeological sampling following the *Environmental Review Primer for Connecticut's Archaeological Resources* will be necessary to assess the presence of intact cultural remains. If intact cultural remains are encountered, underwater archaeology may be necessary to document and remove artifacts and features if avoidance is not possible.

3.5.2 Historic-Period Aboveground Resources

3.5.2.1 Existing Conditions

Existing historic-period aboveground resources of the Hammonasset Beach State Park area were evaluated through a literature review and a historic resource walkover inspection. Historic resources are assumed to include remains that are older than 50 years in age. Figure 3-18 presents approximate locations of known or potential historic-period aboveground resources in the vicinity of the project area. The park area has supported several historic-period uses.

The beach may have supported fishing and fish-processing activities from early in the historic period into the 19th century, which is supported by an 1868 map that identifies two fish processing houses that were located along the beach. Remains of these fish houses were not visible during the June 2007 walkover inspection. Remains of one of the houses was reportedly visible late in the 19th century following termination of its use.

The salt marshes located northeast of the beach along the Hammonasset River have historically been used for hay harvesting and livestock grazing. The existing structure that houses the Meigs Point Nature Center, which is a 19th century farmhouse, was likely associated with a saltwater farm. Numerous drainage channels excavated into the marshes that are generally perpendicular to tidal streams are present in a 1934 Fairchild aerial photograph. Some of these channels were created for agricultural purposes but most are mosquito control ditches that were constructed in 1914-1916. Two small barns were once associated with this structure, one of which may have been destroyed by a hurricane in 1938 and the other was demolished in 1954. The existing Meigs Point Nature Center building is not suitable for listing in the National Register of Historic Places since it includes numerous additions and renovations that have altered its historic integrity.

Following purchase of the park's land by the Connecticut State Parks and Forest Commission in 1919, numerous structures have been constructed and destroyed or demolished. The farmhouse that houses the Meigs Point Nature Center is the only remaining structure in the park thought to be more than 50 years in age.

In 1898, the Remington Repeating Arms Company began testing firearms at the beach. This testing continued through World War I. Remains from this activity were not identified at Hammonasset Beach during the June 2007 walkover inspection.

During World War II, the park land was closed and used as an aircraft firing range. One aircraft is reported to have crashed several hundred yards offshore as part of a training exercise. The exact location of the crash site is unknown. This crash site may be eligible for listing in the National Register of Historic Places.

Two mid-20th century stone coastal structures exist along the beach. The Meigs Point groin at the eastern end of the beach was constructed in the mid- 1950s beach restoration project. This structure is older than 50 years but is likely not eligible for listing in the National Register of Historic Places since it is a commonplace structure of no exceptional historic significance. The.

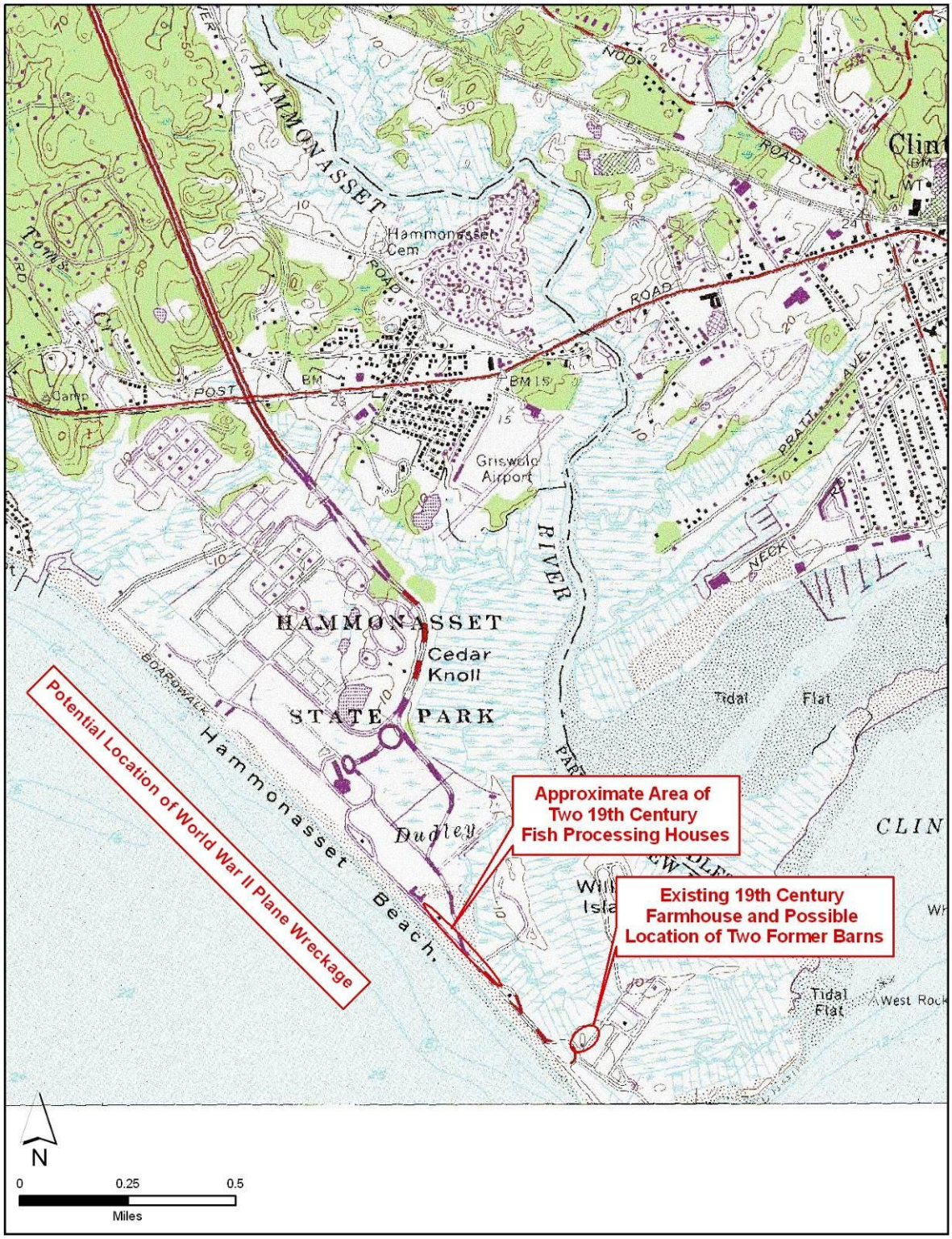


Figure 3-18. Potential Historic-Period Aboveground Resources

Tom's Creek jetty, located at the west end of the beach at the outflow of Tom's Creek, was built in the 1970s. Other structures are of relatively recent origin and include wood frame construction set on concrete slabs, timber piles, or concrete piles and are unlikely to be of historic significance.

3.5.2.2 Impact Evaluation

Under the preferred alternative, the Proposed Action is unlikely to have significant adverse impacts to aboveground historic resources. No disturbance is proposed to any structures of historical significance. No disturbance is proposed to inland areas of the park, other than existing roads and parking lots. Potential impacts to historic period resources could occur if project activities result in disturbance to the grounds surrounding the former 19th-century farmhouse, now the Meigs Point Nature Center, the suspected area of the former 19th century fish houses, or the potential World War II plane-crash site.

3.5.2.3 Mitigation

Since the proposed action is not anticipated to have significant adverse impacts to aboveground historic resources, no mitigation is necessary for the preferred alternative. Additional subsurface testing would be required if project impacts extend to the area surrounding the Meigs Point Nature Center or the former 19th century fish houses to determine if cultural-material-bearing soils are associated with these sites.

Although the location of the World War II plane crash site is unknown, available documentation suggests that the site is located several hundred yards offshore. If the footprint of the proposed terminal groin extends several hundred yards offshore, additional research in aviation records is recommended to more accurately identify the crash site and determine if the plane was recovered.

3.6 Air Quality

3.6.1 Existing Conditions

Under the authority of the U.S. Clean Air Act, as amended, the U.S. Environmental Protection Agency (EPA) established National Ambient Air Quality Standards (NAAQS) for concentrations of six air pollutants: carbon monoxide (CO), nitrogen dioxide (NO2), ozone, particulate matter ten microns or smaller in diameter (PM10), sulfur dioxide (SO2), and lead. Connecticut adopted the national standards for these six criteria pollutants, listed in Table 3-3, and subsequently developed a State Implementation Plan (SIP) to attain and maintain these standards. Primary standards are established to protect public health; secondary standards are established to protect plants and animals and to prevent economic damage.

Table 3-3. National Ambient Air Quality Standards

Pollutant	Standard	Averaging Period	National Standard
Sulfur Dioxide	Primary	Annual Arith. Mean	080 μg/m³ (0.03 ppm)
	Primary	24 Hour Average	365 μg/m³ (0.14 ppm)
	Secondary	3 Hour Average	1300 μg/m³3 (0.5 ppm)
Inhalable Particulates (PM2.5)	Primary	Annual Arith. Mean	15.0 μg/m³
	Primary	24 Hour Average [e]	35 μg/m³
Inhalable Particulates (PM10)[h]	Primary	24 Hour Average [d]	150 μg/m³
Carbon Monoxide	Primary	8 Hour Average	10 mg/m³ (9 ppm)
	Primary	1 Hour Average	40 mg/m³ (35 ppm)
Ozone	Primary	8 Hour Average [f,i]	0.075 ppm
	Primary	8 Hour Average [f,j]	0.08 ppm
	Primary	1 Hour Average	0.12 ppm
Nitrogen Dioxide	Primary	Annual Arith. Mean	100 μg/m³ (0.053 ppm)
Lead	Primary	Quarterly Average	1.5 μg/m³

a) Units are milligrams per cubic meter (mg/m³), parts per million (ppm), and micrograms per cubic meter (μg/m³).
b) National standards are block averages rather than moving averages
c) Intended as a guideline for achieving the short term standard
d) Not to be exceeded more than once per year on average over 3 years
e) To attain this standard, the 3-year average of the 98th percentile of 24-hour concentrations at each population-oriented monitor within an area must no exceed 35 μg/m³ (effective December 17, 2006)
f) To attain this standard, the 3-year average of the fourth-highest daily maximum 8-hour average ozone concentrations measured at each monitor within an area over each year must not exceed 0.08 ppm.
g) The standard is attained when the expected number of days per calendar year with maximum hourly average concentrations above 0.12 ppm is ≤1, as determined by Appendix H of National Ambient Air Quality Standards. As of June 15, 2005 EPA revoked the 1-hour ozone standard in all areas except the fourteen 8-hour ozone nonattainment Early Action Compact (EAC) Areas.
h) Due to a lack of evidence linking health problems to long-term exposure to coarse particle pollution, the agency revoked the annual PM_{10} standard in 2006 (effective December 17, 2006).
i) Standard implemented in May 2008
j) Standard effective 1997 through April 2008

Source: EPA 40 CFR part 50

Madison, and thus Hammonasset Beach, is located in the NY-NJ-CT air quality district defined by US EPA. Each district is assigned an attainment or non-attainment status with respect to the NAAQS given in Table 3-3. Non-attainment for an air pollutant is assigned when one or more of the standards for the pollutant have been violated in one or more regions of Connecticut. The non-attainment designation that is subsequently applied to a region can reflect the degree of non-attainment depending upon a number of factors including the air pollution history in the region, previous designation of the region as either attainment or non-attainment, lack of air pollutant monitoring in the region, and inferences made based on pollutant monitoring done in adjacent or similar regions. Both air quality districts in Connecticut are designated as moderate non-attainment for ozone and the New York-Northern New Jersey-Long Island, NY-NJ-CT district is designated as non-attainment for PM2.5.

Generators of air pollutants include stationary and mobile sources. Increases in traffic volume or vehicle congestion, especially at intersections, have the potential to increase air pollutant emissions. For projects that increase traffic, the criteria pollutants of concern are CO and ozone. Stationary sources, i.e., fuel-burning equipment, also generate emissions of criteria pollutants.

The ambient ozone concentrations at a given location are less dependent on the amount of local emissions than on meteorological conditions, especially wind direction, temperature, and the amount of sunlight. Near Hammonasset Beach State Park, DEP operates several ozone monitoring stations. One station is located in New Haven to the west, one is located at the park, and one is located in Groton to the east. In 2006, there was one exceedance of the 8-hour ozone NAAQS at the New Haven monitoring station (the fewest in the state in that year), six at the Hammonasset station, and four at Groton (EPA, 2007). There was one exceedance of the 1-hour ozone NAAQS at the Hammonasset station in 2006, none at New Haven, and none at Groton. Ozone concentrations are strongly influenced by emissions in upwind, out of state areas and by weather patterns rather than local emissions.

A new ozone air quality standard was implemented in 2008. The new standard, a 0.075 ppm average during at 8-hour period, is anticipated to increase the number of annual days when air quality is not attained in Connecticut relative to ozone. This standard became effective on May 27, 2008.

Mobile Sources

Hammonasset Beach State Park is located along the Connecticut coast in a moderately developed area. The towns surrounding the park are generally suburban with densely populated beachfront areas and less densely developed inland areas. Interstate 95, which is heavily travelled, is located approximately 1 mile north of the park, and U.S. Route 1 is located between the park and Interstate 95. The traffic analysis described in Section 3.2 indicates that the signalized intersection at the Hammonasset Connector, the I-95 northbound ramps, and U.S. Route 1 operate efficiently during peak hours. Vehicles within the park are unlikely to be a significant source of air pollutants. Boat traffic along the coast is also unlikely to be a significant source of air pollutants.

The closest major urbanized area to Hammonasset Beach State Park is the City of New Haven, which is located approximately 20 miles to the west. New York City and its associated metropolitan area are also located within 100 miles of the park. These areas and other regional sources of air pollutant emissions are likely to be the primary contributors to air quality conditions at Hammonasset Beach.

Stationary Sources

There are currently few stationary sources of air pollutants at Hammonasset Beach. Energy used in buildings along the beach is limited to electricity for cooking and running coolers. The West Beach bath houses, East Beach Pavilion, and Meigs Point Pavilion are unheated. Electric heat is provided for the remaining buildings at the park except the main office and two rental houses (located outside of the project area) which are heated with oil. Pollutant sources may include contained cook stove fires associated with picnic areas, and an emergency generator at the main gate and camp office. Gas service to the park is limited to the area of the former main pavilion but is not currently used.

3.6.2 Impact Evaluation

As described in Section 3.2.2, the proposed beach nourishment project was conservatively assumed to result in a 30 percent increase in attendance, and a corresponding increase in traffic to and from the park. Future conditions traffic capacity analysis indicates that the study intersections can accommodate these traffic increases without significant increases in traffic volume to capacity (v/c) ratio or level of service (LOS). Additionally, the internal roadway system at the park is currently operating under capacity and is handling park traffic efficiently. Therefore, it is unlikely that an increase in air pollutant emissions would result from the additional traffic that could potentially be generated by the proposed beach nourishment project. As such, the preferred alternative is likely to have a negligible impact on air quality.

Increased air pollutant emissions (i.e. dust and construction vehicle emissions) may result during construction of the selected alternative, particularly if an upland sand source is used. Temporary construction-phase emissions are discussed in Section 3.11.

The proposed action includes no new buildings or significant stationary sources at Hammonasset Beach. Existing infrastructure will remain intact regardless of the selected alternative, with the exception of the Retreat Alternative, under which three existing buildings would be demolished and replaced with new buildings. However, the replacement buildings would be similar in size and use to the existing buildings and are likely to result in negligible additional emissions of air pollutants.

3.6.3 Mitigation

No mitigation is necessary for post-construction conditions since no preventable adverse impacts are anticipated to occur. Construction-phase air quality mitigation measures are addressed in Section 3.11.

3.7 Noise

3.7.1 Existing Conditions

The unit typically used to describe sound levels perceptible to humans is the A-weighted decibel (dBA). The A-weighting attempts to approximate the human ear's sensitivity to sounds of varying frequencies and pitch. The decibel is a logarithmic unit of measure. For instance, a 10-decibel change in noise level is perceived as a doubling or halving of loudness. A 3-dB change would be barely perceivable for most people.

The Leq, or Equivalent Level, is the steady-state noise level for a given time period that has the same acoustic energy as the fluctuating noise levels observed during that time period. The Leq can be evaluated over different time periods including one hour (expressed as a one-hour Leq or Leq(h)) or 24 hours (expressed as a 24-hour Leq or Leq(24)).

DEP has set Noise Zone Standards for the evaluation of noise generated by adjacent noise zones (RCSA 22a-69-1 through 22a-69-7.4). The standards establish three noise classes based on land use that limit the allowable amount of noise that can be emitted by a source in an adjacent noise zone. Table 3-4 describes the various classes, with Class A, being the most noise sensitive of the three types and Class C being the least sensitive.

The areas in the vicinity of Hammonasset Beach State Park are predominantly residential. Small scale commercial development occurs along the minor arterial routes in the study area. Under RCSA 22a-69-2.2, when multiple uses exist within a given noise zone, the least restrictive land use category shall apply regarding the noise standards. The study area and surrounding area are considered a Class A Noise Zone. According to RCSA Section 22a-69-3.5, a Class A emitter shall not emit noise exceeding Leq levels of 55 dBA in daytime or 45 dBA in nighttime to an adjacent Class A Noise Zone. Construction noise is exempt from these regulations per RCSA 22a-69-1.

Table 3-4. Connecticut Noise Zones

Class	Description of Noise Zone
A	Generally residential areas where human beings sleep or areas where serenity and tranquility are essential to the intended use of the land
B	Generally commercial in nature, areas where human beings converse and such conversation is essential to the intended use of the land
C	Generally industrial where protection against damage to hearing is essential and the necessity for conversation is limited

In addition to stationary sources associated with activities at a particular location, highway and traffic noise is an additional source. Adverse impacts from highway or traffic noise sources occur when the estimated sound levels approach (within one decibel), meet, or exceed the Noise Abatement Criteria (NAC) set forth by the Federal Highway Administration (FHWA). The NAC are sound levels corresponding to exterior sound levels that are acceptable for various land use activities. When highway traffic associated with a proposed project is predicted

to cause sound levels that approach, meet, or exceed the NAC as described above, noise mitigation measures must be considered.

The FHWA noise abatement criteria described above and shown in Table 3-5 are based on land use categories. Category A includes outdoor areas where quiet is an essential element in their intended purpose. Category B includes residences, schools, and libraries. Category C encompasses all other areas, including developed lands. Industrial land uses are within Category C. Whereas the DEP criteria are a function of both the noise emitter and receptor, the FHWA criteria relate only to traffic-related noise and are specified for receptors based on land use.

Table 3-5. FHWA Noise Abatement Criteria

Activity Category	Leq(h) (dBA)	Description of Activity Category
A	57 (Exterior)	Lands on which serenity and quiet are of extraordinary significance and serve an important public need and where the preservation of those qualities is essential if the area is to continue to serve its intended purpose.
B	67 (Exterior)	Picnic areas, recreation areas, playgrounds, active sports areas, parks, residences, motels, hotels, schools, churches, libraries, and hospitals.
C	72 (Exterior)	Developed lands, properties, or activities not included in categories A or B above.

Land use along the major routes leading to Hammonasset Beach and Hammonasset Beach State Park is a mix of residential and commercial. Existing noise levels have not been measured and no noise studies addressing current noise levels associated with Hammonasset Beach State Park are known to have been completed. The sensitive noise receptors (residences, churches, schools, hospitals) that are located along the routes leading to Hammonasset Beach are generally close to the roadway.

3.7.2 Impact Evaluation

As described in Section 3.2.2, the proposed beach nourishment project was conservatively assumed to result in a 30 percent increase in attendance, and a corresponding increase in traffic to and from the park. Future conditions traffic capacity analysis indicates that the study intersections can accommodate these traffic increases without significant increases in v/c ratio or LOS. Additionally, the internal roadway system at the park is currently under capacity and operating efficiently. Therefore, it is unlikely that a noticeable increase in noise would result from the additional traffic that could potentially be generated by the proposed beach nourishment project. As such, the preferred alternative is likely to have a negligible noise impact.

Increased noise may result during construction of the selected alternative, mostly from the operation of construction equipment and vehicles, particularly if an upland sand source is used. Temporary construction-phase noise emissions are discussed in Section 3.11.

The proposed action includes no new structures or significant noise sources at Hammonasset Beach. Existing infrastructure will remain intact regardless of the selected alternative, with the exception of the Retreat Alternative, under which three existing buildings would be demolished and replaced with new buildings. However, the replacement buildings would be similar in use to the existing buildings and are unlikely to be a significant source of noise.

3.7.3 Mitigation

No mitigation is necessary for post-construction conditions since no preventable adverse impacts are anticipated to occur. Construction-phase noise mitigation measures are addressed in Section 3.11

3.8 Hydrology/Water Quality

3.8.1 Groundwater

3.8.1.1 Existing Conditions

Surface water and groundwater quality classes are designated for water bodies in Connecticut following the Connecticut Water Quality Standards (DEP, 2002). The majority of Hammonasset Beach State Park is underlain by Class GA groundwater, as presented in Figure 3-19. A Class GA groundwater is presumed suitable for direct human consumption and may include groundwater that constitutes an existing drinking water supply or may be used to develop a drinking water supply in the future. Class GA groundwater is also suitable as base flow for hydraulically connected surface water bodies.

The northeastern portion of the park is partially underlain by the classification "GA, GAA may be impaired" groundwater, indicating that the groundwater in this area may not meet the current GA or GAA standards. Designated uses for Class GAA groundwater areas include existing or potential public supply of water suitable for drinking without treatment; baseflow for hydraulically-connected surface water bodies, and includes areas that may have been designated as future water supply in a water utility supply plan. Connecticut's goal is to restore all impaired groundwater in GA and GAA areas to natural (background) quality.

A small area near the central portion of the park is underlain by Class GB groundwater. Designated uses for Class GB groundwaters include industrial process water and cooling waters and baseflow for hydraulically connected surface water bodies. These groundwaters are not suitable for human consumption without treatment and are typically associated with historically urbanized communities where waste discharges, spills or chemical releases, and land use impacts have degraded groundwater quality. Discharges to Class GB groundwater are limited to treated domestic sewage, certain agricultural wastes, certain water treatment wastewaters, discharge from septage treatment facilities subject to stringent treatment and discharge requirements, and certain other biodegradable wastes. The area designated Class B at Hammonasset Beach is in the location of a former wastewater treatment and disposal system.

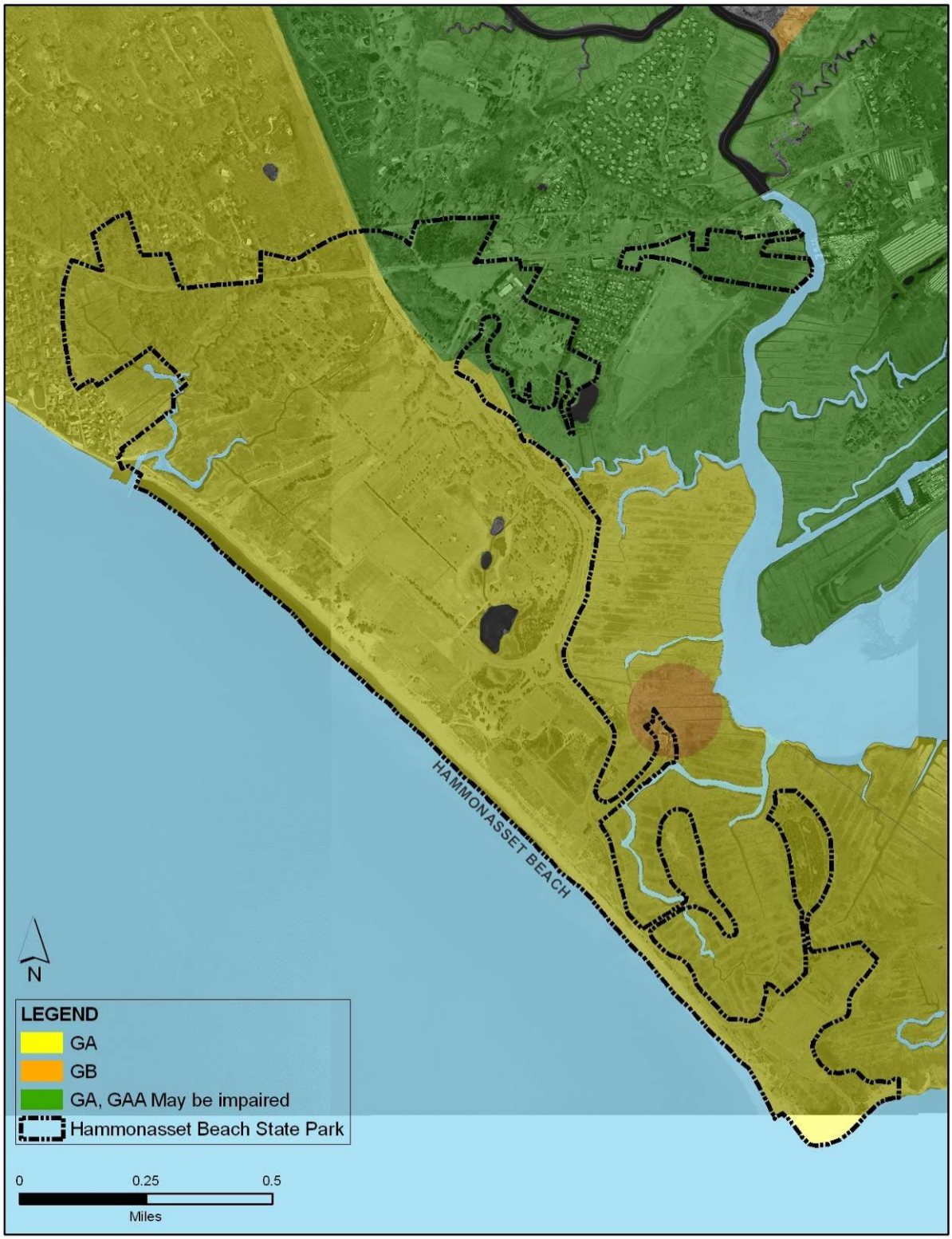


Figure 3-19. Groundwater Quality Classifications for Hammonasset Beach

Sources of existing potential groundwater contamination at the park include oil and grease from incidental vehicle leakage, sediment tracked on-site by vehicles, leachate from trash receptacles and dumpsters, pet waste on picnic grounds (pets are not allowed in campgrounds or on the beach), and droppings from shore birds. However, stormwater and nonpoint source pollutant loading is likely to be relatively low compared to land uses that generally include more impervious surface and most intensive year-round use (e.g. residential, commercial, institutional). Treatment of stormwater and nonpoint source runoff throughout the park likely occurs as a result of the relatively long flow paths through the park's vegetated swales and quiescent channels.

3.8.1.2 Impact Evaluation

The proposed action is not expected to have adverse impacts on groundwater. No new groundwater discharges are proposed. If the completed project results in increased park usage and associated vehicular traffic, increased nonpoint source pollutant loadings may marginally increase the potential for impacts to groundwater resulting from infiltration of stormwater runoff. However, any increased park usage is likely to be insignificant (see Section 3.2), so any changes in pollutant discharges to groundwater are also anticipated to be insignificant. Additionally, no new impervious surface or change in land use is proposed, so no change in groundwater recharge is anticipated. Potential impacts to groundwater quality that may occur during construction are presented in Section 3.12.

3.8.1.3 Mitigation

Since groundwater impacts resulting from the proposed project are likely to be insignificant, no mitigation is necessary.

3.8.2 Surface Water

3.8.2.1 Existing Conditions

Surface Water Resources

Hammonasset Beach State Park is surrounded by Long Island Sound to the south, Clinton Harbor to the east, the Hammonasset River to the northeast, and Tom's Creek to the west. Dudley Creek parallels the beach for a short distance from near Meigs Point and then discharges to Clinton Harbor at the Hammonasset River mouth. Each of these water features is tidally influenced. Salt marshes surrounding the site are drained by numerous drainage channels that discharge to adjacent tidal creeks and rivers. Three unnamed freshwater ponds are located in the central portion of the park. These ponds are hydraulically connected and flow northeast to a tidal stream that discharges to the Hammonasset River. Figure 3-20 presents water quality classifications for surface waters in and around the park.

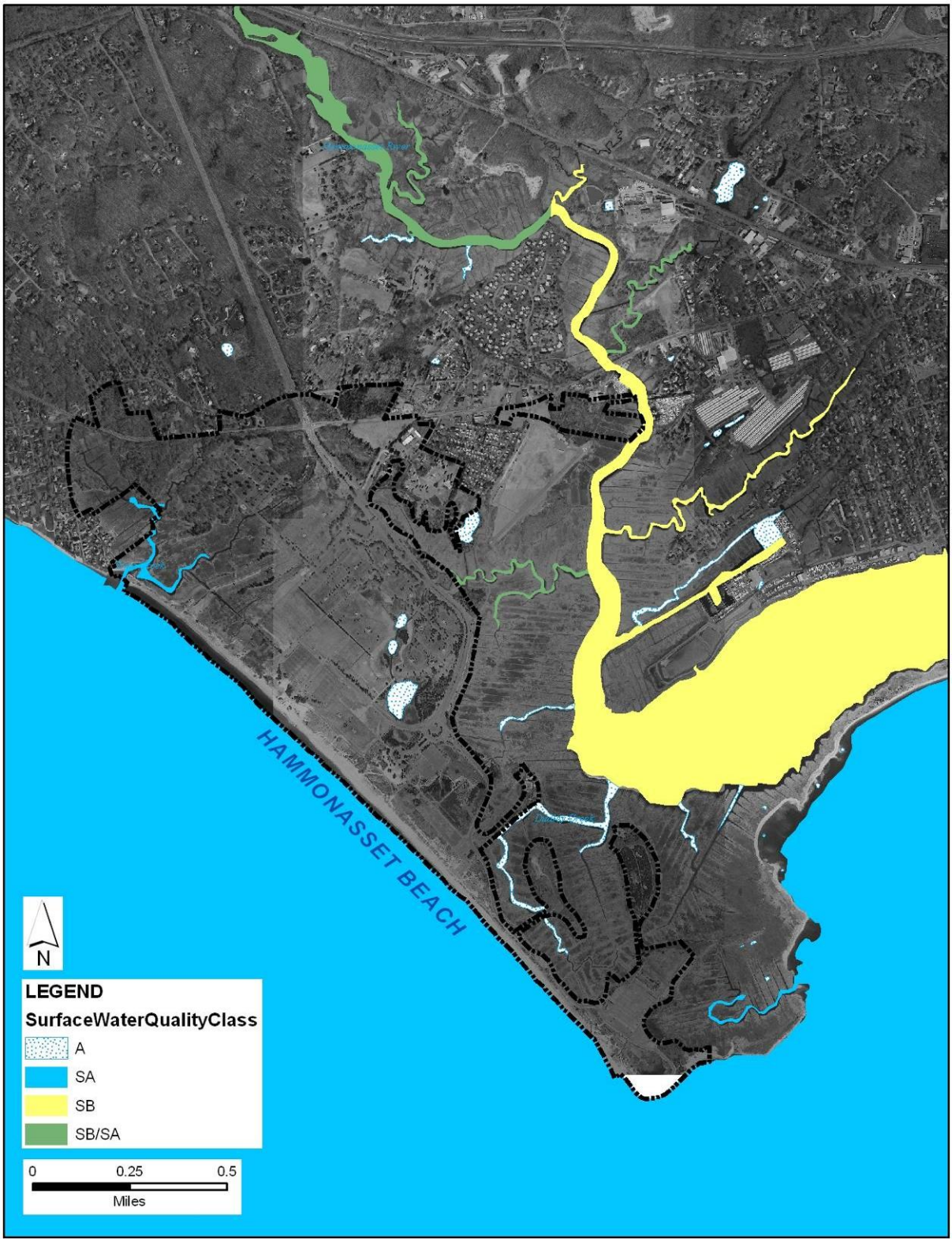


Figure 3-20. Surface Water Quality Classifications for Hammonasset Beach

Each of the surface water resources at Hammonasset Beach State Park has been assigned a water quality classification. DEP determines these classes for each water body based on its designated uses, and potential water quality impairments that prevent attainment of those uses. A summary of inland and coastal surface water quality classifications are presented in Table 3-6 and Table 3-7, respectively.

Table 3-6. Inland Surface Water Quality Classifications

Class	Freshwater Designated Use
AA	Existing and proposed drinking water supplies; habitat for fish and other aquatic life and wildlife; recreation; and water supply for industry and agriculture.
B/AA or C/AA	May not meet Class AA criteria or designated uses with a goal of attaining the criteria.
A	Habitat for fish and other aquatic life and wildlife; potential drinking water supplies; recreation; navigation; and water supply for industry and agriculture.
B/A or C/A	May not meet Class A criteria or designated uses with a goal of attaining the criteria.
B	Habitat for fish and other aquatic life and wildlife; recreation; navigation; and industrial and agricultural water supply.
C/B or D/B	May not meet Class B criteria or designated uses with a goal of attaining the criteria.
C (shown only as C/B, C/A, or C/AA on maps)	Impaired or partially impaired water quality that results from conditions that may be correctable through appropriate management programs.
D (shown only as D/B or D/A on maps)	Impaired or partially impaired water quality that is not readily correctable through implementation of management programs.

Source: DEP 2002

Table 3-7. Coastal Surface Water Quality Classifications

Class	Coastal Waters Designated Use
SA	Habitat for marine fish, other aquatic life and wildlife; shellfish harvesting for direct human consumption; recreation; industrial water supply; and navigation.
SB/SA or SC/SA	May not meet Class SA criteria or designated uses with a goal of attaining the criteria.
SB	Habitat for marine fish, other aquatic life and wildlife; commercial shellfish harvesting; recreation; industrial water supply; and navigation.
SC/SB or SD/SB	May not meet Class SB criteria or designated uses with a goal of attaining the criteria.
SC (shown only as SC/SB or SC/SA on maps)	Impaired or partially impaired water quality that results from conditions that may be correctable through appropriate management programs.
SD (shown only as SD/SB or SD/SA on maps)	Impaired or partially impaired water quality that is not readily correctable through implementation of management programs.

Source: DEP 2002

Long Island Sound in the vicinity of Hammonasset Beach State Park, including outer Clinton Harbor, is designated Class SA. Both the nearshore area in Madison and the offshore portion of the Sound are listed as impaired in the *2006 Integrated Water Quality Report to Congress* (DEP, 2006) due to pathogenic contamination. The priority of this impairment is low, and possible causes include marina/boating on-vessel sanitary discharges, waterfowl, unspecified urban stormwater, residential districts, on-site treatment systems (septic systems and similar decentralized systems), and non-point source pollution.

Northeast of Hammonasset Beach, the lower Hammonasset River and Inner Clinton Harbor are designated Class SB from the mouth to approximately 0.5 miles north of Route 1. A medium-priority impairment has been identified for these waters due to high nutrient levels and resulting eutrophication and low dissolved oxygen levels. This segment is also impaired for commercial shellfish harvesting. Potential causes of these impairments include non-point source pollution, urban stormwater, septic and similar decentralized wastewater systems.

The upper reaches of the Hammonasset River and two small tidal creeks that discharge to the lower reach of the Hammonasset River are designated Class SB/SA, which means that while they may not meet Class SA designated uses, the water quality goal is attainment of Class SA criteria.

Several inland surface water resources at Hammonasset Beach State Park are Class A surface waters. These include Dudley Creek and the three hydraulically connected ponds within the park. Tom's Creek and a tidal creek located east of Meigs Point are Class SA waters. No impairments exist for these water resources.

Stormwater Quality

Stormwater from Hammonasset Beach State Park discharges to Long Island Sound either to the northeast through the salt marshes and Hammonasset River, or to Tom's Creek near the northwestern boundary of the park. Drainage features of the park are presented in Figure 3-21. The park includes some impervious surface related to building roofs, roadways, and parking lots. Stormwater generated from these areas sheet flows overland to grassed areas, where it infiltrates or is collected in vegetated swales that are level to gently-sloped.

These vegetated swales that receive surface runoff flow to Tom's Creek or to one of the tidal creeks that drains to the Hammonasset River. The access road to the camp store near the northwestern boundary of the park is drained by two catch basins that discharge to Tom's Creek through a storm drainage line. This system is the only piped stormwater system located at the park. The salt marshes include numerous artificial drainage channels as well. A minimal area of the park drains directly to Long Island Sound via overland flow across the beach. This area is limited due to the presence of the dunes which form a significant topographical obstruction.

Sources of stormwater contamination at the park are similar to those listed for groundwater contamination and may include oil and grease from incidental vehicle leakage, sediment tracked on-site by vehicles, leachate from trash receptacles and dumpsters, pet waste on picnic grounds (pets are not allowed in campgrounds or on the beach), and droppings from shore birds. Infiltration may reduce the quantity of surface runoff; however, infiltration capacity may be limited since much of the park includes poorly drained soils and soils with high groundwater levels. Additionally, the relatively slow flow path of the stormwater through vegetated swales and quiescent channels is likely to provide some treatment through settling and associated pollutant removal.

Figure 3-21. Hammonasset Beach State Park Drainage Features

3.8.2.2 Impact Evaluation

The alternatives considered as part of this project will not adversely affect surface water resources, and the proposed alternatives will not differ significantly in impacts.

Surface Water Impacts

Only uncontaminated sediment will be used for the proposed beach nourishment. Sediment from the Housatonic River and Clinton Harbor FNPs were sampled for a number of physical, chemical, and toxicity parameters to assess their compatibility with use on Hammonasset Beach. Twenty-three samples were collected and tested for volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs) including polycyclic aromatic hydrocarbons (PAHs), pesticides, herbicides, polychlorinated byphenyls, (PCBs), extractable total petroleum hydrocarbons (ETPH), heavy metals, percent solids, total organic carbon (TOC), particle size distribution, and salinity. Additionally, an analytical procedure (the synthetic precipitation leaching procedure, or SPLP) was performed to leach contaminants from the sediment, and the resulting leachate was analyzed for a similar list of parameters. Details of the Housatonic River sediment sampling are provided in the engineering feasibility study report (Woods Hole Group, 2008), and analytical results are presented in Appendix E.

Overall, the results indicate that most of the contaminants analyzed were below the threshold of detection. All sample cores were found to be free of volatiles, pesticides, herbicides, and PCBs. Metals that could pose a health concern were also non-detect or found at low levels.

Several PAHs were found in slightly elevated levels in Housatonic River sediment samples. PAH refers to a class of organic chemical compounds that are commonly found in oils, tar, coal, and can result from the incomplete burning of wood or fossil fuels. The elevated PAH sample results in the Housatonic River sediments typically occurred in samples that also contained burnt wood or coal fragments as logged at the time of sampling (Chute, 2007).

The PAH and TOC data indicate that the characteristics of the river bottom vary upriver (cores F through W) and downriver (cores A-E) between sample locations. While primarily composed of sand, upriver cores contain some organic material such as wood or substances containing PAHs (burnt wood and coal), which is indicated by total organic carbon (TOC) analysis, and associated PAHs, while neither TOC nor PAHs were detected in downriver cores. Table 3-8 summarized PAH and TOC results.

Table 3-8. Summary of Housatonic River Sediment PAH and TOC Results

Location	Mean Concentration in downriver cores	Mean concentration in upriver cores containing "wood", "burnt wood", or "coal"	Range of concentrations in up-river cores
Sample IDs	A-E	F-W	F-W
TOC (mg/kg)	Non-detect (<100)	953	300 - 2500
Sum of PAHs (ug/kg)	Non-detect	4429	430 - 12560

Note: Phthalates (a common laboratory contaminant) were detected in the analysis for cores V and K. Results from non-phthalate containing replicates are included in this table.

The results were also compared to the Residential Direct Exposure Criteria contained in the Connecticut Remediation Standard Regulations (RSRs). Table 3-9 summarizes exceedances of the applicable RSR values and the suspected source or reason for the excursion. As indicated by the PAH and TOC data and as summarized in Table 3-8, the PAH detections in the upriver samples were associated with the presence of burnt wood and coal. Therefore, dredged material from upriver locations should be screened and retested prior to use on the beach. The results also indicate that the downriver material is suitable for use on Hammonasset Beach without further screening or testing.

Table 3-9. Summary of Housatonic River Sediment Exceedances of State Standards

Parameter (units)	State Standard (Residential Direct Exposure Criteria)	Result (Number of Excursions)	Note
Benzo(a)anthracene (ug/kg)	1,000	1,100; 1,200 (2)	PAH associated with wood, bunt wood, or coal
Benzo(a)pyrene (ug/kg)	1,000	1,300 (1)	PAH associated with wood, bunt wood, or coal
Benzo(b)fluoranthene (ug/kg)	1,000	1,000 (1)	PAH associated with wood, bunt wood, or coal
Bis(2-ethylhexyl)phthalate (ug/kg)	44,000	58,000 (1)	Common laboratory contaminant
SPLP Antimony (mg/L)	0.006	0.006, 0.008 (2)	Metal extracted by leaching procedure

Of the three composite samples of Clinton Harbor sediment that were analyzed, two were collected in areas where the sediment predominantly consists of sand-sized particles and is therefore suitable for beach usage. DEP reviewed results of chemical analyses performed on this material and determined that there are slightly elevated levels of PAHs and some metals in this material. However, the levels are below applicable standards and would be unlikely to affect surface water or human health if used on the beach (Wisker, 2008). USACE has also found that sand from Clinton Harbor is appropriate for use on Hammonasset Beach (Nimeskern, 2007). The third composite sample analyzed contained significant quantities of silt and is thus not appropriate for use as nourishment material.

Existing surface water quality impairments in the vicinity of Hammonasset Beach State Park are related to nutrients and bacteria, which will not be affected by the proposed action. Temporary surface water impacts that may occur during construction are described in Section 3.11. Analytical results and correspondence related to Housatonic River and Clinton Harbor sediment are presented in Appendix E and Appendix F, respectively.

Stormwater Quality

The proposed alternatives will not result in increased impervious cover, new stormwater drainage systems, or a change in use that could increase the exposure of pollutants to stormwater. Temporary construction stormwater and water quality impacts are discussed in Section 3.11.

3.8.2.3 Mitigation

If sediment from the Housatonic River FNP is used for nourishment on Hammonasset Beach, material from upriver locations will be screened and retested prior to placement on the beach. Screening the material, which was recommended by CTDPH, will remove PAH-containing materials such as burnt wood and coal fragments larger than the selected screen size such that the material from upriver locations will be similar in quality to material from downriver locations. Retesting of the material for TOC and/or other constituents is recommended to verify that the PAH-containing materials are removed by the screening process. Mitigation for potential surface water quality impacts associated with construction activity is discussed in Section 3.11. Other surface water impacts are not anticipated to no mitigation is necessary.

3.9 Wildlife and Fisheries

3.9.1 Existing Conditions

Wildlife and endangered species habitat in a coastal environment can be associated with beaches; dunes; coastal, tidal, and estuarine waters; rocky shorefronts; and tidal wetlands. Limited data exists for habitat quality and known species associated with each of these resources at Hammonasset Beach. In preparation of this EIE, additional surveys were conducted where necessary to provide additional information on habitats present at Hammonasset Beach.

Nearshore Habitat

A nearshore habitat survey was completed by Woods Hole Group in March of 2007 to determine the function and value of the habitat contained in the coastal and tidal waters along the beach. To complete the survey, marine biologists walked shore normal transects varying in length from 100 to 400 feet from the waterline. Samples were collected every 25 feet along each transect line with a modified clam rake. Surveyed transects extended from the Tom's Creek jetty to the East Beach bath house.

The bottom surface along the beach was found to be sandy in the nearshore area, transitioning to medium to fine sand with a mix of gravel and cobbles offshore. No submerged aquatic vegetation (SAV) was identified, and the tidal wrack line did not include any SAV, suggesting that none is present in the nearby offshore area. During the survey, invertebrates identified included only one live shellfish (a razor clam), Atlantic Sand Crab, and polychaete worm. As such, the quality of habitat for these species is likely to be relatively poor. Occasional shell hash for several bivalve species was present, including mussels, quahogs, softshell clam, scallop, and razor clam, although the shell hash was infrequent. No evidence of horseshoe crabs was identified on the beach or in the nearshore zone.

As described in the companion engineering feasibility study report, the nearshore habitat of Hammonasset Beach is relatively energetic, making settlement and burrowing by shellfish difficult (Woods Hole Group, 2008). This wave energy would make shellfish establishment difficult along the entire beach. Although the area may be potential habitat for certain organisms that can tolerate similar conditions, including razor clams and surf clams, few

invertebrates are likely to survive in the present habitat, suggesting that Hammonasset Beach is unlikely to provide a productive shellfish habitat.

Endangered Species

Several state and federal agencies were contacted relative to endangered species known or suspected to be present near Hammonasset Beach. Responses were received from DEP on December 31, 2007 and January 15, 2008, from the U.S. Department of the Interior Fish and Wildlife Service (USFWS) on March 17, 2008, and from the National Marine Fisheries Service (NMFS) on March 4, 2008. This correspondence is attached in Appendix G.

DEP identified four species of sandy beach nesting birds that could potentially be affected by the proposed project. These include the federally-listed piping plover (*Charadrius melodus*), the state endangered horned lark (*Eremophila alpestris*), the state threatened least tern (*Sterna antillarum*), and the species of special concern American oystercatcher (*Haematopus palliates*). Shorebirds generally prefer beach slopes of less than 10% (Jones, 1997). The proposed beach nourishment includes a maximum beach slope of 5%.

DEP also identified a number of species that are dependent on marsh habitat and could be present between the beach and the Hammonasset River. These include the endangered northern harrier (*Cirus cyaneus*) and four state species of special concern, including the saltmarsh sharp-tailed sparrow (*Ammodramus caudacutus*), the seaside sparrow (*Ammodramus maritimus*), the savannah sparrow (*Passerculus sandwichensis*) and the brown thrasher (*Toxostoma rufum*). The Connecticut Natural Diversity Database (NDDB) maps and files regarding areas within Hammonasset Beach State Park do not identify any species not included in the written response by DEP. NDDB information includes all information regarding critical biological resources available at the time of the requested review. The information is a compilation of data collected by DEP's Geological and Natural History Survey and other cooperating DEP units, private conservation groups and the scientific community. However, several state listed endangered and special concern plants were also identified in the project area. These include:

- *Sabitia Stellaris*, or marsh pink, which is endangered.
- *Scirpus paludosus var. atlanticus*, or bayonet grass, which is of Special Concern.
- *Silene stellata*, or starry champion, which is of Special Concern.

NMFS and USFWS were also contacted relative to federally-listed species in the project area. The NMFS responded that sea turtles occasionally occur in Long Island Sound but are not likely to be impacted by the project. The USFWS determined that no federally-listed or proposed species or habitat are known to occur in the project area.

Bird Habitat

Connecticut Audubon Society (2008) identifies Hammonasset Beach as an important bird area. The Society has identified the following at the park:

- Nesting areas of piping plover, least tern, and American oystercatcher on a beach associated with the Hammonasset River.

- Foraging habitat in the saltmarshes for several species of wading birds during the nesting and post-nesting seasons.
- Important stopover/wintering habitat for northern harriers.
- Nesting populations of saltmarsh sharp-tailed sparrow of a magnitude adequate to earn the Park the designation of globally important bird area.
- Important migratory habitat for landbirds, shorebirds, and raptors.
- Woodland habitat for migratory landbirds.
- Significant shorebird stopover habitat, particularly for grassland species.
- Significant roosting habitat for owls, such as sawwhet, barn, and long-eared in cedars, evergreens, and shrubs.
- Regionally important wintering/migration habitat for open country songbirds such as snow bunting and horned lark.
- Regionally important wintering/migration habitat for American bittern.

Of primary concern are coastal shorebirds that may use the beach and dune areas for nesting and foraging habitat. However, Connecticut Audubon Society has not designated the portion of Hammonasset Beach that is open for recreational use (the area where nourishment is proposed) as a habitat for sandy beach nesting birds, including piping plover and least tern. It is likely that the use of Hammonasset Beach by these birds is limited by the relatively small beach width and the high intensity of use. USACE has identified a beach located along Clinton Harbor on the east side of the Hammonasset Peninsula as an area of piping plover habitat.

However, if beach-nesting species were to use Hammonasset Beach for breeding, they are likely to nest from April 1 through August 15.

Fish Habitat

Hammonasset Beach State Park is located in a quadrangle defined by NMFS as containing Essential Fish Habitat (EFH). EFH is protected by the Magnuson-Stevens Fishery Conservation and Management Act as amended by the Sustainable Fisheries Act of 1996. NMFS and regional fishery councils, which are responsible for defining and protecting EFH, have subdivided US coastal waters into quadrangles with sides of 10 minutes in length (equal to 1/6 of a degree in latitude and longitude). The fishery councils maintain lists of EFH that may be found in each quadrangle. Habitat for the following fish species may be present within the EFH quadrangle that contains the project area:

- Juvenile and adult Atlantic salmon (*Salmo salar*),
- Juvenile and adult pollock (*Pollachius virens*),
- Adult whiting (*Meluccius bilinearis*),
- Egg, juvenile, and adult red hake (*Urophycis chuss*),
- Egg, larval, juvenile, and adult windowpane flounder (*Scopthalmus aquosus*),
- Juvenile and adult Atlantic sea herring (*Clupea harengus*),
- Juvenile and adult bluefish (*Pomatomus saltatrix*),
- Egg, larval, juvenile, and adult king mackerel (*Scomberomorus cavalla*),
- Egg, larval, juvenile, and adult Spanish mackerel (*Scomberomorus maculatus*),

- Egg, larval, juvenile, and adult cobia (*Rachycentron canadum*),
- Larval sand tiger shark (*Odontaspis taurus*).

Figure 3-22 presents the location of this quadrangle. The preferred habitats of these species vary. The habitat identified in the nearshore area at Hammonasset Beach, which is sandy transitioning to medium sand with gravel and cobbles, may favor juvenile pollock, adult whiting, and adult red hake. These species were not observed during the habitat surveys, likely since the nearshore area is high in wave energy and relatively shallow. The Hammonasset Natural Area Preserve Management Plan reports that, of the EFH species listed, bluefish and windowpane flounder have been caught near Meigs Point, most likely in the area east of the point. Essential fish habitat descriptions for each species are presented in Appendix G.

3.9.2 Impact Evaluation

Nearshore Habitat

Nearshore habitat impacts are anticipated to be minor. Research (cited in the companion engineering feasibility report by Woods Hole Group, 2008) suggests that benthic habitat in nourished areas typically recover within 2-7 months after nourishment. Most organisms that function in a high wave energy environment such as a beach are well adapted to frequent physical disturbance. Additionally, nourishing a beach in the winter has reduced impacts as compared to nourishment during other seasons. The proposed project is unlikely to significantly alter current, wave, or sediment dynamics, so the resulting habitat will not be more or less favorable to shellfish. Additionally, the placed sediment is unlikely to displace submerged aquatic vegetation or productive shellfish communities since none has been identified in the project area.

Construction of a new terminal groin would occupy an area of nearshore bottom, making that area incompatible as aquatic invertebrate or submerged aquatic vegetation habitat. However, the nearshore bottom is of generally poor habitat quality such that its loss is unlikely to significantly affect shellfishing. Although a new groin could enhance shellfish habitat by reducing current velocity in the updrift area, perpendicular wave energy is still likely to result in a dynamic environment, so it is unlikely that nearshore habitat quality for shellfish would change. The stones associated with a new groin would create some rocky shorefront habitat, which may benefit certain benthic species.

Endangered Species and Bird Habitat

The net effect of the proposed beach nourishment will be to increase habitat available to shorebirds and other species that are beach-dependent. These include the piping plover, horned lark, least tern, and American oystercatcher. The Hammonasset Salt Marsh Management Plan (DEP, 2000) states that the beachfront along the Sound is not typically used for nesting by the piping plover, although this area is sometimes used as a staging area for fledglings. Least tern have used the beach from Meigs Point to Cedar Island sporadically, and horned lark has been observed in both areas. Use of the main beach at Hammonasset Beach State Park may limit its use by these species due to its intense frequency of human usage (Woods Hole Group, 2008).

Figure 3-22. Essential Fish Habitat Quadrangle Containing Hammonasset Beach

Potential impacts to nesting shorebirds, if present on Hammonasset Beach, are anticipated to be minor during construction of the proposed beach nourishment project. Proposed work will be performed during the season when demand for beach-related recreational uses is low. This winter construction period generally does not coincide with the breeding period of sandy beach nesting birds. Additionally, the beach nourishment slope that is proposed (5%) is flatter than the maximum slope preferred by these species (10%) according to USACE. Work proposed as part of this project will not interfere with marshes located at the park, so species dependent on these areas will not be impacted by the project. Work is not proposed for the beach from Meigs Point to Cedar Island where state and federally-listed birds are more likely to be found. Saltmarsh-dependent bird species will not be impacted as no work would occur in the saltmarsh or tidal wetland areas of the park.

Fish Habitat

The proposed action is not anticipated to affect endangered marine organisms or habitat (NMFS, 2008). The nearshore habitat survey and wave and current analysis suggest that the proposed area of beach nourishment and a new terminal groin has limited habitat quality for fish in bottom-dependent life stages. Additionally, this area is relatively shallow and of limited habitat quality for fish requiring pelagic habitat.

The proposed action will require a Section 404 permit from the U.S. Army Corps of Engineers. The USACE may complete an Essential Fish Habitat consultation with the NMFS. At the time of the permit application, the USACE and NMFS will determine if a Programmatic EFH Consultation is adequate, or if an individual assessment will be required.

3.9.3 Mitigation

Nearshore Habitat

The proposed action is not anticipated to adversely affect nearshore marine habitat, so no mitigation is necessary.

Endangered Species and Bird Habitat

In order to protect potential beach nesting areas that may exist in the project area, no construction will be performed during the nesting season (April 1 - August 15).

Fish Habitat

It is currently anticipated that no negative impacts to EFH will occur, and thus no mitigation is necessary. This finding will be confirmed by an EFH consultation that will occur between the U.S. Army Corps of Engineers and NMFS as part of the Section 404 permitting process.

3.10 Inland Wetlands

A wetland soil, as regulated under the Connecticut Inland Wetlands and Watercourses Act, is, in general, defined as a soil that is saturated to within 20 inches of the surface during a portion of the growing season. These soils have redoximorphic features, a deficiency of oxygen near the

surface, and/or ponded water during the growing season. They are poorly drained, very poorly drained, alluvial, or fluvial as specified by the USDA Natural Resource Conservation Service (NCRS). Depth to seasonal high water table is determined by low-chroma mottling or wetness indicators. Hydric soils have a similar definition.

Watercourses are also regulated under the Connecticut Inland Wetlands and Watercourses Act. Watercourses are rivers, streams, brooks, waterways, lakes, ponds, marshes, swamps, bogs, and all other bodies of water including natural or artificial, vernal, or intermittent, public or private. A defined permanent channel and bank, and the occurrence of two or more of the following characteristics delineate intermittent watercourses:

- Evidence of scour or deposits of recent alluvium or detritus,
- Presence of standing or flowing water for a duration longer than a particular storm incident,
- Presence of hydrophytic vegetation.

Wetlands regulated by the U.S. Army Corps of Engineers are defined as those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Thus, federal jurisdiction wetlands are generally delineated based on three criteria: vegetation, soil, and hydrology.

3.10.1 Existing Conditions

Based on a review of mapping available from DEP, NRCS, and USFWS, no freshwater wetland areas were identified within the proposed project area. Some freshwater wetlands are mapped along the periphery of the park but well outside of the project area.

On May 30, 2007, Fuss & O'Neill personnel conducted an on-site inland wetland and watercourse investigation at Hammonasset Beach State Park to identify the inland wetland and watercourse limits at the site. No freshwater or inland wetlands were field identified within the project area. The site is largely upland with areas of salt marsh, brackish tidal ponds, and tidal creeks. These coastal wetland resources are discussed in Section 3.3.

3.10.2 Impact Evaluation

The proposed action will not impact inland wetlands at Hammonasset Beach State Park since no inland wetlands are located within the project area.

3.10.3 Mitigation

No mitigation is necessary since no impacts are anticipated.

3.11 Construction Impacts

3.11.1 Existing Conditions

A discussion of existing conditions is not applicable to construction impacts.

3.11.2 Impact Evaluation

The construction impacts associated with each of the build alternatives are relatively similar and result primarily from the noise, fugitive dust, construction equipment exhaust, erosion and sedimentation, traffic, and visual impacts that occur with construction and related activity and do not significantly extend in duration past the construction period.

Traffic

During construction of the proposed action, temporary impacts may occur to vehicle circulation patterns within the park to accommodate construction vehicles and access to the beach. Transport of sand to the site from upland sources would entail significant truck traffic, resulting in greater impacts to internal traffic circulation. Construction-related activities may result in temporary detours or limited access to portions of the internal park roadway system during the construction period. However, these impacts would be short-term, lasting only during construction.

Under the proposed action, which includes beach nourishment sand primarily from offshore sources, some additional construction-related vehicle traffic is expected on Interstate 95, Route 1, the Hammonasset Connector, and other local roads. However, the construction-related traffic will be minimal relative to the existing capacities and operations of the study area intersections. Additionally, construction would occur during the off-season, and construction traffic would be negligible compared to typical park traffic during the peak seasons.

The use of an upland sand source as the primary source of sand for the proposed beach nourishment project would entail significant truck traffic to and from the site, which would increase traffic in and around the park and place additional strain on the roadway infrastructure of the park and surrounding roads.

Coastal Resources

Temporary coastal resources impacts during construction will include increased turbidity of the water column during placement of sand and bottom disturbance for construction of a new terminal groin. Elevated turbidity would be limited to the active work area, temporary in nature, and unlikely to occur along the length of the beach simultaneously. Sediment that becomes suspended in the water column will subsequently settle out along the beach or nearshore area and remain within the existing beach system. Appropriate erosion and sediment controls (e.g. anti-tracking construction entrance, silt fence, haybale barrier, turbidity curtain, temporary stilling basins) will also be used during construction to protect resource areas, as necessary. During construction, the existing dune system could be accidentally disturbed by construction activities, particularly near access points to the beach.

Socioeconomic

Construction of the proposed beach restoration project would generate employment and spending, which could impact the local economy. Although the construction jobs would be considered "new" employment (since it is not currently on-going), the economic impact to the

local economy would be limited to the periods of construction and would have a marginal effect within the region. There are more then 600 construction jobs within the local region including Madison, Clinton, and Guilford, and significantly more in Middlesex and New Haven counties. It is likely that the construction activity generated by the proposed action could be readily absorbed by firms and workers within the region.

Cultural Resources

Construction of a new terminal groin could potentially impact buried cultural resources in the nearshore area if the sea floor will be disturbed prior to or during construction, as described in Section 3.5 of this EIE.

Air Quality

Construction activities associated with the proposed action may have short-term adverse impacts on local air quality through temporary fuel burning sources, such as construction equipment, particularly if an upland sand source is used. Diesel and gas-powered construction equipment emits NOx, CO, VOC, and particulate matter and short-term elevated ambient concentrations of such air pollutants may result in the immediate vicinity of construction activities. Fugitive dust emissions associated with the beach nourishment construction are likely to be minimal since a sand and water slurry would be pumped onto the beach, limiting the potential for mobilization of dust, and the particle size of the dried sand will be similar to the sand currently present on the beach.

Noise

It is difficult to reliably predict the sound levels that may occur at a particular receptor or group of receptors as a result of construction activity. Heavy construction equipment is the principal source of noise during construction activity, and the pattern of heavy equipment use is constantly changing as a construction project progresses. For the most part, construction activity occurs during daytime hours when higher sound levels are generally more tolerable at nearby receptors. In addition, any adverse noise impacts due to construction activities would be temporary in nature, and no one receptor is expected to be exposed to high sound levels due to construction for an extended period of time. Noise impacts will generally occur in the off-season when park usage is typically lower.

The site preparation phase of the construction schedule may produce sound levels that are higher than those levels produced by other types of construction activity. The construction equipment used, including dozers, excavators, front-end loaders, and, if a fishing pier is to be constructed, impact or vibratory pile drivers, has typical noise emission levels in the mid-80s to upper-90s dBA range at a 50-foot distance. Although these levels are greater than the FHWA Category B Leq NAC of 67 dBA, the sound energy is expected to be intermittent and attenuated over hundreds of feet before reaching a nearby receptor. The closest residences to the beach are located west of the Tom's Creek jetty. When nourishment is occurring at the extreme western end of the beach by the jetty, the residences will be 370 feet from potential noise sources, which will be heavy machinery such as bulldozers. However, the other end of the nourishment area is more than one mile from these receptors. The second-closest

residential area is located adjacent to the former Griswold airport, inland from the beach, and is located approximately 3,400 feet from the nourishment area. The distance separating the location of the proposed groin from the nearest receptors is greater than one mile. Therefore, the average Leq is not expected to exceed the NAC of 67 dBA. Construction noise is exempt from DEP regulations.

Temporary increases in traffic-generated noise will occur along roadways to the park, particularly if an upland sand source is used.

Minimal underwater noise will be generated by barge hauling and other construction activities. Pile driving associated with construction of a fishing pier would generate short-term underwater noise in the nearshore area, but would be unlikely to impact essential fish habitat.

Water Quality and Wetlands

No impacts to inland or tidal wetlands or streams are anticipated during construction. Appropriate erosion and sediment controls, such as anti-tracking aprons, frequent sweeping of park roads, and silt fence or haybale barriers, will be used and maintained during construction to protect resource areas, as necessary. As described previously, temporary increases in turbidity within the water column are anticipated in the nearshore coastal waters during the beach nourishment process. However, sediment that becomes suspended in the water column will settle out along the beach or nearshore area. Additionally, use of construction equipment at the site increases the potential for leakage or spillage of vehicular fluids.

Wildlife and Fisheries

Potential construction impacts to wildlife and fisheries are limited to disturbance of potential habitat for sandy beach-nesting shorebirds. However, construction will be restricted to off-peak months, which coincide with the recommended time-of-year window for protection of sandy beach-nesting shorebirds.

Visual

Temporary visual impacts are anticipated during construction. These impacts would be limited to off-shore sand barges, earthwork operations, and equipment along the beach, and construction equipment along park roadways and staging areas. The impact of construction on visual resources will be limited to the off-season. There will be no permanent visual impacts since the proposed expanded beach and terminal groin will reflect existing conditions.

3.11.3 Mitigation

Traffic

Construction-phase traffic management measures (construction signage, temporary detours, temporary use of alternate parking areas away from construction staging areas, etc.) will be implemented within the park to maintain efficient traffic circulation. Damage to park roadways

resulting from construction traffic will be repaired during and following construction as necessary.

Coastal Resources

Potential increases in turbidity levels in the nearshore area during the beach nourishment construction process will be mitigated through the use of temporary stilling basins to capture the sand/water slurry discharged from an offshore barge and allow sand to settle prior to reaching the nearshore area. Other erosion and sediment controls, such as a turbidity curtain, will be used as necessary to reduce the potential for migration of sand to offshore areas. However, the majority of sand suspended in the water column will settle out along the beach or nearshore area and will remain within the existing beach system.

Contractors will provide on-site spill response materials to reduce the potential for a discharge of oil or other vehicle fluids during construction. Fueling of construction vehicles will occur offsite or in a dedicated upland area such as an existing parking lot used for construction equipment staging.

With the exception of dune enhancement activities, disturbance of the existing dunes will be avoided during construction. Prior to construction, the limits of the dunes will be identified and cordoned off to prevent encroachment upon them by construction equipment. Construction personnel will be instructed to avoid disturbing the dunes as well.

Air Quality

Emissions from project-related construction equipment and trucks are unlikely to be significant sources of air pollutants on a regional basis and are unlikely to affect local or regional compliance with the NAAQS. Direct emissions from construction equipment are not expected to produce adverse effects on air quality, provided that all equipment is properly operated and maintained. Appropriate mitigation requirements could consist of assurance of proper operation and maintenance, and prohibition of excessive idling of engines. Section 22a-174-18(a)(5) of the Regulations of Connecticut State Agencies (RCSA) prohibits excessive idling. Other mitigation may include the use of construction equipment with air pollution control devices, where practicable. The use of control devices such as oxidation catalysts and particulate filters for diesel-powered equipment is typically only necessary in circumstances where the site is located immediately adjacent to residential areas or in confined spaces. The project will implement such air pollution control devices and clean fuels for the project construction where appropriate.

Roadway traffic disruption due to lane closures, detours, and construction vehicles accessing the site can cause congestion which can increase motor vehicle exhaust emissions. These impacts will be mitigated by implementing appropriate traffic management measures during the construction period. Construction access to and from the project site, including prohibition of construction traffic on designated local roads as necessary, will be incorporated into the final project plans and specifications.

Fugitive dust emissions may occur during earthmoving activities along the beach, although the potential for significant fugitive dust emissions is relatively low due to the wet nature of the sand pumping operations on the beach. RCSA Section 22a-174-23(b)(1) requires mitigation of fugitive dust emissions. Potential fugitive dust impacts will be mitigated by limiting dust-producing construction activities during high wind conditions, the use of anti-tracking pads at entrances to construction areas along the beach, and routine sweeping of park roads during construction.

Noise

Best Management Practices (BMPs) for noise abatement will be used during construction. Construction project specifications will require that contractors take measures to control the noise caused by construction operations, including but not limited to noise generated by equipment used for hauling and grading. In addition, the project specifications will include the Connecticut Department of Transportation standard specification for noise pollution (Form 814A, Section 1.10.05), which states that the maximum allowable level of noise at the residence or occupied building nearest to a project site shall be 90 decibels on the "A" weighted scale (dBA).

Potential noise impacts can be minimized through the use and regular maintenance of mufflers on construction equipment. Restricting the hours of operation to daylight hours will also minimize noise impacts to sensitive receptors in the project area. Additionally, the nearest sensitive noise receptors to construction activities will be approximately 370 feet from the work area at the beach for a short portion of the project (when nourishment is occurring at the Tom's Creek groin), but the distance to those receptors will vary by more than one mile throughout the project duration. The second closest receptor is located approximately 3,400 feet from the beach.

Water Quality and Wetlands

No construction-period impacts are anticipated to inland or tidal wetlands or streams. Appropriate erosion and sedimentation controls will be implemented during construction to protect upland areas, as necessary.

Potential increases in turbidity levels in the nearshore area during the beach nourishment construction process will be mitigated through the use of temporary stilling basins if the nourishment material is dredged sediment. Dredged sediment is generally transported as a slurry so that it can be pumped either directly from its source or from the barge that was used to transport it. Stilling basins are used to dewater the dredged sediment prior to spreading the material on the beach. The basins are constructed by excavating along the inland side of the coastal beach and seaward of the coastal dune. The excavated sands are used to form a berm on the seaward side. The barge or pipe conveying the sediment pumps the sand-water slurry into the basin, allowing sand particles to settle and excess, non-turbid water to drain into the ocean. Once the material has adequately dewatered, the sediment and displaced native sand is regarded to form the beach. Figure 3-23 shows a stilling basin in use. More aggressive controls, such as turbidity curtains, would be implemented as necessary.

Figure 3-23. Dredged Sediments Discharging to a Stilling Basin

Contractors will provide on-site spill response materials to reduce the potential for a discharge of oil or other vehicle fluids during construction. Fueling of construction vehicles will occur offsite or in a dedicated upland area such as an existing parking lot used for construction equipment staging. Appropriate hazardous materials storage methods will be used to prevent accidents, vandalism, and undetected releases. Appropriate response and notification procedures will be in place in the event a spill occurs.

Wildlife and Fisheries

No construction activities will occur between April 1 and August 15 to provide protection for sandy beach-nesting shorebirds.

Visual

Temporary visual impacts on park visitors resulting from construction activity and equipment will be mitigated by limiting construction to the off-season when park attendance is typically lower.

3.12 Consistency with Planning

3.12.1 Statewide Comprehensive Outdoor Recreation Plan

The 2005 - 2010 Statewide Comprehensive Outdoor Recreation Plan (SCORP), which is prepared and implemented by DEP, identifies state-wide recreational needs and outlines strategies for meeting those needs. Preparation of the SCORP included surveying the public

and municipal officials regarding existing recreational uses and identifying areas of improvement necessary to better serve the public's needs. The SCORP identifies 'beach activities' as the second most popular recreational activity in the state based on participation rates of Connecticut citizens. Another identified need includes paved multi-use trails. Hammonasset Beach includes several paved and unpaved multi-use trails which are open to walking, running, and cycling, as well as the boardwalk which provides a level walking surface. A goal of DEP, as stated in the SCORP, is to promote the maintenance of the state's current inventory of outdoor facilities. Hammonasset is identified by the SCORP as a state park with pressing infrastructure needs and is selected for early action. The SCORP also identifies the importance of outdoor recreational facilities near urban areas, since urban areas are traditionally underserved by outdoor recreational opportunities. Hammonasset Beach State Park is accessible from New Haven and other urban areas along the Connecticut coast.

The proposed action is consistent with the SCORP since the primary objective of the project is to improve and protect the beach and beach-related recreational opportunities at Hammonasset Beach State Park, which is Connecticut's most popular coastal park.

3.12.2 Connecticut Coastal Management Act

The Connecticut Coastal Management Act (CCMA), which includes Sections 22a-90 through 22a-112 of the Connecticut General Statutes (CGS), is a body of legislation that seeks to protect coastal resources and water-dependent uses in Connecticut. The majority of coastal permitting and regulation in Connecticut is given legislative authority through the CCMA. Relative to the Hammonasset Beach project, the CCMA would generally require that existing water-dependent uses and public access to coastal waters be maintained and promoted. Shoreline flood and erosion control structures are strongly discouraged by the CCMA except in instances where they are deemed necessary and unavoidable to protect water-dependent uses and infrastructure.

As stated previously, the CCMA discourages shoreline flood and erosion coastal structures except in instances where they are deemed necessary and unavoidable to protect water-dependent uses and infrastructure. As part of the companion engineering feasibility study report, Woods Hole Group (2008) found that constructing a new terminal groin as part of the proposed beach nourishment would increase the expected life of the nourishment by 4 to 5 years. The terminal groin would reduce the frequency with which future large-scale nourishment projects similar to the proposed action would be necessary.

The proposed action is generally consistent with the CCMA since it will enhance the function and values of beach and dune resources at Hammonasset Beach State Park while not adversely affecting other coastal resources. Also importantly, existing water-dependent uses and public access to coastal waters will be maintained and enhanced by the proposed action.

3.12.3 State Plan of Conservation and Development

The Conservation and Development Policies Plan for Connecticut (Plan of C&D) provides the policy and planning framework for administrative and programmatic actions and capital and operational investment decisions of state government (CTOPM 2005). The locational guide maps of the Plan, which present existing land uses in terms of conservation or development

status as well as identifying areas of future growth, identify Hammonasset Beach State Park as existing preserved open space with adjacent neighborhood conservation areas and growth areas.

A goal of the Plan of C&D is to preserve diverse landscapes that, among other things, offer outdoor recreational opportunities and offer green spaces that are accessible to both rural and urban residents. Related policies for these areas include:

- Limit improvements to those consistent with the long-term preservation and appropriate public enjoyment of the site's natural resources and open space values.
- Provide a system of appropriately-managed natural areas with a variety of high-quality outdoor recreational opportunities to all citizens, emphasizing access to Long Island Sound shoreline areas of highest recreational potential.
- Promote the objectives of the Long Island Sound Restoration Program, which includes "support[ing] state, regional, local, and interstate efforts to protect and restore vital coastal habitats and resources, such as salt marshes, beaches, and coves."
- Enhance the statewide resource recovery system, including the reuse of high volume waste materials. Sediments from dredging are specifically mentioned as one of these materials.

The proposed action is consistent with the Plan of C&D on each one of these points. It will enhance the quality of the Hammonasset Beach recreational resource, which provides public access to Long Island Sound, result in the long-term preservation of the beach and its public enjoyment, and provide for reuse of dredged sediments (if available) which would otherwise be disposed.

3.12.4 Adopted Municipal and Regional Plans

The Madison Plan of Conservation and Development (2000) provides a framework for consistent decision-making with regard to conservation and development activities in the Town of Madison. The plan identifies the Long Island Sound shoreline and associated preserved open space and natural resources as distinctive features valued by Madison residents.

The proposed beach nourishment project is consistent with the Madison Plan of Conservation and Development because it will enhance the quality of the beach and state park. Hammonasset Beach State Park is specifically cited as a significant natural resource and considered to be the "jewel" in the State Park system. The plan also seeks to expand coastal access opportunities and to retain undeveloped land. Additionally, several historical sites in Hammonasset Beach State Park are specifically identified for preservation, including the practice range for aerial target shooting.

The Town of Clinton Plan of Conservation and Development (2005) was established to guide development of residential, recreational, commercial, and industrial land within the community. The Town of Clinton's beach communities are recognized as an integral part of Clinton's character and diversity. Recommendations within the plan include increasing the public awareness of Clinton Harbor and the town's historic connection to Long Island Sound by improving both visual and physical access to the waterfront and riverside locations.

Although this plan does not directly address Hammonasset Beach State Park, the plan recognizes the need for dredging Clinton Harbor to accommodate boating activity and to maintain navigational channels, as well as physical and visual access to the water. An option currently planned by the USACE for use of the dredged sediments includes placement of the sediment on Hammonasset Beach. The proposed action also includes the use of dredged material from Clinton Harbor on Hammonasset Beach, and therefore, is consistent with this element of the plan.

The South Central Region Plan of Conservation and Development (South Central Regional Council of Governments, 2008) is the regional land use planning document that covers a 15-town region in south-central Connecticut, including Madison. The plan identifies Hammonasset Beach State Park as a regional recreational and open space asset that should be maintained in its natural state or for public access. The proposed action, which will protect and preserve the Hammonasset Beach State Park resource, is therefore consistent with the regional land-use plan.

3.12.5 State Environmental Equity Policy

The State Environmental Equity Policy was adopted in 1993 by the Department of Environmental Protection. The policy states that no segment of the population should, because of its racial or economic makeup, bear a disproportionate share of the risks and consequences of environmental pollution or be denied equal access to environmental benefits. This policy is similar to the federal Executive Order 12898, Federal Actions to Address Environmental Justice (EJ) in Minority Populations and Low-Income Populations, which requires federal agencies to avoid disproportionately high and adverse human health and environmental effects on minority and low income populations. The State Environmental Equity Policy does not specify guidance for identifying EJ populations. Therefore, the methodology outlined in the federal Council on Environmental Quality publication *Environmental Justice Under the National Environmental Policy Act* (CEQ, 1997) was used in this analysis.

Data from the 2000 Census was used to identify minority and low income populations in the area of Hammonasset Beach State Park. CEQ (1997) recommends that minority populations be identified where (a) the minority population of the affected area exceeds 50 percent or (b) the minority population percentage of the affected area is meaningfully greater than the minority population percentage in the general population or other appropriate unit of geographic analysis. "Minority" is defined as American Indian or Alaskan Native; Asian or Pacific Islander; Black, not of Hispanic origin; or Hispanic. CEQ (1997) recommends that low-income populations in an affected area should be identified with the annual statistical poverty thresholds from the Bureau of the Census' Current Population Reports, Series P-60 on Income and Poverty.

According to data from the most recent decennial census, the 2000 Census, there are no EJ populations in the area immediately surrounding Hammonasset Beach State Park. The closest EJ populations, both minority and low-income, are located in the urban areas of New Haven and Middletown located to the west and north, respectively.

Direct and indirect impacts and inconsistencies with the State Environmental Equity Policy occur if there is a disproportionate impact to EJ populations, i.e., a particular racial or income group bears a disproportionate share of the risks and consequences of environmental pollution, or if a particular income or racial group is denied equal access to environmental benefits. Given the absence of EJ populations in the area, no impacts are anticipated to result from the proposed action or other alternatives involving beach nourishment and a new terminal groin. In addition, although diminished recreational opportunities may result from the Retreat and No Action alternatives, no disproportionate impacts to EJ populations would result. Any EJ populations in the greater New Haven area that use the beach would benefit from the increased recreational opportunities and quality that would result from the proposed action.

3.12.6 Hammonasset Natural Area Preserve Management Plan

In 1985, 402 acres of land within Hammonasset Beach State Park were designated as the Hammonasset Natural Area Preserve. DEP was assigned permanent responsibility to assure protection of this resource. The most recent management plan for this preserve was prepared in 2000 (DEP, 2000). The purpose of this plan is to ensure protection of state-listed species within the preserve, encourage research, provide for environmental education opportunities, provide the public with scenic and recreational uses, protect the physical and biological integrity of the preserve, and restore disturbed habitats.

This plan establishes two use zones. Approximately one third of the preserve's land area is designated as Zone I. This area includes sandy beaches along Clinton Harbor where piping plover and least tern have been observed, as well as dunes and tidal wetlands, and is bounded by Willard Island, Clinton Harbor, and the Hammonasset River. Zone I uses are limited to scientific research for which a permit has been obtained, with no public access except for the Cedar Island Trail boardwalk. The remaining preserve area is designated as Zone II. This area has been designated for education, research, fishing, shellfishing, and bird watching. Access for many of these uses is limited to specified areas within the Zone II boundary.

The proposed action will not violate use restrictions or disturb resource areas that are the subject of this plan. As such, the proposed action is consistent with this plan.

3.12.7 Magnuson-Stevens Fishery Conservation and Management Act

The Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) provides for the management of fish and other species in the United States Exclusive Economic Zone (EEZ). The MSFCMA is administered by regional fishery management councils that include members from state and federal government and allows the Secretary of Commerce to preempt State law. The MSFCMA specifically provides for the restoration of New England groundfish. General goals of the Act include maintaining sustainable fisheries nationwide by promoting underutilized fisheries, preventing overfishing, restoring overfished species, and protecting essential fish habitat (EFH). The National Marine Fisheries Services (NMFS) and regional fishery councils, which are responsible for administering this law, define areas of EFH for species of interest and review projects that include federal actions that could affect EFH.

The proposed action is limited to work in nearshore habitat, which, at Hammonasset Beach, was found to be high in energy and of generally poor habitat quality. A more detailed discussion of the project relative to EFH is presented in Section 3.9. Since a federal Section 404 permit will be required to implement the proposed action, the USACE will consult with NMFS to ensure that no significant impacts to EFH will occur.

3.13 Sea Level Rise

3.13.1 Existing Conditions

An important consideration in long-term planning for Hammonasset Beach is potential sea-level rise. Scientific research indicates that global (eustatic) sea level has risen approximately 6 to 8 inches over the last century (EPA, 2000). This eustatic rise in sea level resulting from the warming of the oceans and the melting of continental glaciers has occurred against a backdrop of post-glacial rebound in those areas previously covered by glacial ice sheets. Along most of the United States coast, tide gage data show that local sea levels have been rising at 2.5 to 3.0 mm/yr, or 10 to 12 inches over the past century. Because the tide gage stations measure sea level relative to the land, which includes changes in the elevations of both water levels and the land, tide gages measure relative sea level rise, and not the absolute change in sea level. The rates of relative sea level-rise have greater relevance to the evaluation of coastal hazards from sea-level rise than do changes in eustatic sea level.

Long-term tide gage data collected at the National Ocean Service (NOS) stations in Bridgeport, CT and New London, CT provide the closest measurements to Hammonasset Beach (NOAA, 2008). Rates of rise computed from the New London data set spanning the period from 1938 to 1999 indicate a relative rise in sea level of 2.13 mm/year, or 8.3 inches over the past century. Tide gage data from the Bridgeport station for the period 1964 to 1999 indicate a rise in sea level of 2.58 mm/yr, or 10.1 inches over the past century.

3.13.2 Potential Impacts

The potential impacts of sea-level rise present an additional natural hazard risk for developed areas within the coastal zone. The impacts are similar to those caused by shoreline erosion, and include increased flooding and wave activity in areas previously not affected, as the shoreline moves increasingly further inland.

3.13.3 Mitigation

As described in the engineering feasibility study report (WHG, 2008) the rate of sea level rise obtained from the Bridgeport station (2.58 mm/yr), which is the highest locally-measured rate, was included in all model simulations for assessing the performance of the build alternatives. Since the rate of sea level rise was included in the analysis, the predictions of long-term performance of the proposed beach protection measures account for the magnitude of sea level rise that can be reasonably anticipated throughout the project's design life.

4.0 PREFERRED ALTERNATIVE

4.1 Comparison of Alternatives

The Connecticut Environmental Policy Act (CEPA) requires every state agency undertaking an action which may result in potentially significant effects on the environment to consider alternatives to the proposed action. Under both the CEPA statute (Section 22a-1 through 22a-1h CGS) and the implementing regulations found at Sections 22a-1a-1 to 22a-1a-12 of the Regulations of Connecticut State Agencies (RCSA), the alternatives considered should include taking no action and substituting an action of a significantly different nature that would provide similar benefits with different environmental impacts.

In addition to the "No Action" alternative, DEP considered two alternative design concepts that include nourishment of the beach, one including the addition of a terminal groin, and one with no additional structures. These concepts were determined based on Woods Hole Group's detailed alternative analysis presented in the companion engineering feasibility evaluation report (2008) that considered 26 alternative design concepts. These alternative concepts varied based on the length, width, and height of the nourishment area, the source of the sand used, and the number and location of new structures constructed.

In evaluating these concepts to establish the alternatives considered in this document, DEP considered many factors, including total project cost over its 50-year design life, the expected schedule of maintenance, ensuring public access to Long Island Sound consistent with the Connecticut Coastal Management Act, and avoiding or minimizing potential environmental impacts.

The following sections present the alternatives considered along with the preferred alternative and the rationale for its selection. More detail is presented in the companion engineering feasibility report included in Appendix B.

4.2 Alternative Actions

4.2.1 No-Build Alternative

As discussed in Section 2.1.1, the No Action Alternative implies no actions to change the present conditions at Hammonasset Beach and assumes that the shoreline and beach would continue to erode, reducing the usable beach area and threatening the boardwalk and existing structures. The No Action Alternative would involve no new construction or beach nourishment.

The No Action Alternative would not meet the project goals, as this alternative would result in a reduction in accessibility of the beach, loss of use of the beach and boardwalk, and potential damage or loss of State Park infrastructure. This alternative may also result in environmental impacts, including damage to the existing septic systems and structures and associated water quality impacts along the beach from septage and debris from damaged structures.

For these reasons, the No Action alternative is not considered the most feasible and prudent alternative. While the No Action Alternative may reduce potential short-term impacts to the

natural and built environment, the long-term and cumulative impacts are likely to be greater due to loss of public access to an important resource and loss of state-owned infrastructure.

4.2.2 Beach Nourishment with No Structure

Nourishing Hammonasset Beach with additional sand is the only feasible engineering alternative that is likely to repair erosion that has occurred at the beach to date while restoring the recreational capacity of the resource. Nourishment is necessary since there is a deficit of sand in the updrift area such that sand lost by wave action and current along the beach is not replaced with sand from updrift areas. This alternative includes beach nourishment without construction of a new coastal structure. The design concept for this alternative recommended by Woods Hole Group (2008) includes the following elements:

- Nourishment material placed along the beach from the Tom's Creek jetty to the limit of historical erosion, which is approximately 6,425 feet to the southeast.
- A nourishment berm width of 100 feet.
- A nourishment berm height of 8 feet, which is above the 10-year storm still water elevation, but would not require relocation of the boardwalk.
- An offshore slope of 5%, which is milder than the intertidal profile but steeper than the nearshore profile and is flatter than the steepest profile preferred by endangered shorebirds.
- Nourishment material gradually tapered to meet the existing beach profile at its southeast limit.
- Construct new dunes and reconstruct existing dunes as necessary.

The estimated quantity of additional sand required for this nourishment alternative is 563,000 cubic yards. This material would be obtained from one of more of the sources discussed in Section 4.3. The estimated cost and project lifetime of this alternative depends on the sand source selected.

If dredged sediment from Clinton Harbor and the Housatonic River Federal Navigational Projects is used, this alternative is anticipated to have a design life of 21 years before additional nourishment is necessary. This alternative is estimated to cost approximately $6.8 million for initial construction, and is projected to cost approximately $24.1 million total for construction and maintenance over 50 years following construction.

4.2.3 Beach Nourishment with Terminal Groin

This alternative includes beach nourishment to repair erosion that has occurred to date and restore the recreational and ecologic capacities of the resource. A new stone terminal groin would be constructed at the southeast (downdrift) limit of the nourishment area to better retain the placed materials. The design concept for this alternative recommended by Woods Hole Group (2008) includes the following characteristics:

- Nourishment material placed along the beach from the Tom's Creek jetty to the limit of historical erosion, which is approximately 6,425 feet to the southeast.

- Construct a new terminal groin extending approximately 250 feet seaward, perpendicular to the beach, at the southeast limit of the nourishment area. This groin would be approximately one-half the length of the existing Meigs Point groin.
- A nourishment berm width of 100 feet.
- A nourishment berm height of 8 feet, which is above the 10-year storm still water elevation, but would not require relocation of the boardwalk.
- An offshore slope of 5%, which is milder than the intertidal profile but steeper than the nearshore profile and is flatter than the steepest profile preferred by endangered shorebirds.
- Construct new dunes and reconstruct existing dunes as necessary.

Similar to the nourishment alternative that does not include a terminal groin, the estimated quantity of additional sand required for this nourishment alternative is 563,000 cubic yards. This material would be obtained from one of more of the sources discussed in Section 4.3. The estimated cost and project lifetime of this alternative depends on the sand source selected.

If dredged sediment from Clinton Harbor and the Housatonic River Federal Navigational Projects is used, this alternative is anticipated to have a design life of 25 years before additional nourishment is necessary. This alternative is estimated to cost approximately $8.3 million for initial construction, and is projected to coast approximately $21.3 million total for construction and maintenance over 50 years following construction.

4.3 Alternative Sand Sources

Two classes of alternative sand sources have been considered as part of this project. These sand sources include dredging spoils that are anticipated to result from maintenance of the Clinton Harbor and Housatonic River Federal Navigational Projects, and sand obtained from upland sources. The following sections describe these alternate sand sources.

4.3.1 Dredging Spoils from Federal Navigational Projects

Dredging spoils from Federal Navigation Projects (FNPs) on the south shore of Connecticut are the preferred sand source for nourishment at Hammonasset Beach. This material is a large-volume by-product of maintaining navigational channels and anchorages and would otherwise require disposal in an offshore location. Additionally, the material originates adjacent to Long Island Sound and can be transported to the beach by barge, significantly reducing transportation costs. These FNPs are maintained by USACE and would be permitted separately from this project. It is necessary to ensure that the material is free from harmful levels of chemical constituents and of appropriate grain size to be compatible with its use. The cost to DEP of this material is estimated to be $10-15 per cubic yard. The mean grain size of the dredging spoils from both FNPs near Hammonasset Beach that require maintenance are approximately 0.32-0.38. Although this mean grain size is beach-compatible, it is somewhat finer than existing material on the beach and will thus be more easily transported downgradient from the beach.

Clinton Harbor FNP

The Clinton Harbor Federal Navigation Project extends from Long Island Sound into the wharves at Clinton adjacent to the mouth of the Hammonasset River. The channel is 8 feet deep at mean lower low water (MLLW) and is 100 feet in width. The associated anchorage is 8 feet deep and varying in width from 150 to 250 feet and extending north and west approximately 600 feet from the end of the channel. Approximately 45,000 cubic yards of the sediment accumulated in the channel are clean and beach compatible and could be used on Hammonasset Beach. This material would be pumped to the beach via a temporary pipeline that would be installed across the Hammonasset salt marshes along a path that minimizes environmental impacts. The dredging and pipeline are currently undergoing permitting by the USACE.

An additional 2,000 cubic yards of material from the anchorage area are not suitable for use on Hammonasset Beach due to incompatible grain size (USACE, 2008). An Environmental Assessment has been prepared for this dredging project that includes placement of the sand on the beach.

Housatonic River FNP

The proposed maintenance dredging for the Housatonic River Federal Navigation Project (FNP) may provide a large quantity of nourishment material. A recent USACE survey has indicated that approximately 600,000 cubic yards of sand needs to be removed in order to return the FNP to its authorized dimensions (USACE, 2007a). Initial chemical and physical test results of the proposed dredge spoils have revealed that the sand is suitable for beach nourishment, meeting both Federal and State quality standards (USACE, 2007a).

Elevated levels of polycyclic aromatic hydrocarbons (PAHs) were identified in some samples, and upriver cores contained fragments of burnt wood and coal, which are PAH-containing compounds. Dredged sediments would be screened before application to the beach, which would remove these fragments and thus reduce PAH levels as well.

The Housatonic River sand would likely be transported roughly 30 miles east to Hammonasset Beach via a hopper dredging operation or barges. The cost of this operation could be reduced substantially through a potential cost-sharing program between the USACE and the State of Connecticut (although this has yet to be formalized). Such a project would be considered a "piggy-back" operation, which has proven effective for many communities. Financial and time savings also could be achieved by avoiding the need for offshore surveys and environmental assessment/permitting processes.

Recent communication with USACE has indicated that the economic benefits of dredging the channel may not currently be adequate to justify undertaking the project. DEP and USACE will continue to discuss the availability of this sediment and cost-sharing arrangements.

Offshore Borrow Sites

Long Island Sound includes other offshore borrow sites that are potential sources of nourishment sediment. These include the shoal area southeast of Meigs Point, and the Long Sand Shoal, which is located approximately 5 miles east of Hammonasset Beach offshore from the Connecticut River mouth. If Housatonic River sediments are not available for use at Hammonasset Beach, and using upland sand sources are found to be prohibitively expensive, infeasible, or to include potential impacts that are unacceptably large, one or more offshore borrow sites could be potential sediment sources. Use of an offshore borrow site would require additional study and evaluation.

4.3.2 Upland Sand Sources

Woods Hole Group (2008) has identified several upland sand sources that could potentially supply sand to Hammonasset Beach for nourishment. Upland sand sources may include sand pits and other operations that are permitted separately from this project. Sand would be transported to Hammonasset Beach State Park by one or more modes of transportation, staged on the park, and transported overland for deposition on the beach. Potential upland sand sources that have been identified are described in the following sections.

Local Sand Sources

Two local upland aggregates suppliers, Indian River Enterprises of Clinton, CT and DRVN Enterprises of West Granby, CT, have been identified as potential suppliers of suitable beach nourishment material. Indian River Enterprises has estimated that it can supply approximately 100,000–150,000 cubic yards of sand, at a cost of $18.65 per cubic yard, delivered by truck from its local mining operations in Madison and Clinton, CT. Indian River estimates that between 1,000 and 1,400 cubic yards of material can be delivered to Hammonasset Beach each day. Indian River trucks have the capacity to legally transport 18 cubic yards of sand per load. In addition to supplying and transporting the nourishment material, Indian River can provide spreading and grading services with for an additional cost of $4.20 per cubic yard. The mean grain size of this material may vary from 0.25 to 0.70 mm.

DRVN Enterprises has estimated that it can supply approximately 570,000 cubic yards of sand from various local mining operations, at a cost of $26.95 per cubic yard. This material can be delivered by truck from its local mining operations at a rate of up to 3,500 cubic yards per day; however, Woods Hole Group believes this rate is a rather high estimate and is dependent on road traffic since it accounts for 198 truckloads per day (18 cubic yards truck capacity). Due to present supplies as of March 12, 2008, DRVN has stated that it could provide 150,000–200,000 cubic yards of beach quality sand at a reduced price. DRVN has also expressed that this material should be stock piled at a location in Hammonasset State Park prior to the beginning of the nourishment construction in order to reduce project cost and the timeline for material delivery and construction. The approximate mean grain size of this material is 0.62 mm, which is more similar in size to material currently on the beach.

Remote Sand Sources

Woods Hole Group (2008) investigated remote upland sand sources for comparison to nearby sources. Remote upland sand sources were investigated for cost and impact comparison purposes to ensure that the full range of options and costs are considered. The marine transportation and aggregates supply company Gateway Terminal of New Haven, CT can provide upland sand from remote locations. The nourishment material provided by Gateway Terminal originates from a mining operation on Cape Cod, MA and is transported by barge to New Haven, CT. Upon arrival in New Haven, the sand is loaded into trucks (18 cubic yard capacity) and transported to the project site. Specialized barges that would be required to receive the upland material and discharge it directly to Hammonasset Beach are not available to Gateway Terminal. Gateway Terminal has stated it can provide 570,000 cubic yards of suitable beach nourishment material at a cost of $26.54 per cubic yard. In order to deliver the total amount of sand required for the nourishment within an October–May time frame, 3,850 cubic yards of sand would need to be delivered to Hammonasset State Park per day. This sand volume would equate to approximately 213 truckloads per day, a rate which Gateway Terminal believes is logistically unrealistic.

Due to the large volume of sand needed for the project, Gateway Terminal personnel visited Hammonasset Beach in March 2008 to identify the most appropriate and efficient methods for transport of the material to the park. Based upon their site visit, Gateway Terminal feels that half of the nourishment material should be transported to the park ahead of time and staged for construction. The intention of the pre-construction staging of material is to reduce the daily sand delivery rate and construction time. The mean grain size of this material is estimated to be approximately 0.45 mm.

4.4 Selection of Preferred Alternative

The alternatives described in Sections 4.2 and 4.3 were compared relative to each of the category of impacts considered in this EIE. Table 4-1 presents a summary of the impacts of each alternative. This analysis considers the magnitude of adverse impacts only. A cost-benefit analysis for the alternatives is presented in Section 8.0. The alternatives with the smallest anticipated adverse impacts, and thus the preferred alternatives, are nourishment using dredging spoils from maintenance of FNPs with or without a terminal groin. The alternative with the greatest adverse impact is the No Action alternative since it is not protective of environmental, historical, or coastal resources. Using sand from upland sources is not preferred due to traffic, noise, and potential damage to park infrastructure.

Relative to physical impacts, No Action will result in damage to existing buildings and structures through wave action as beach erosion progresses. Utilities that run along the beach and serve structures that would otherwise be unimpacted may be damaged, just as erosion previously exposed and destroyed a section of water supply line that served the east beach (See Section 3.1.3). However, there will not be adverse traffic, air quality, or noise impacts if no action occurs.

Nourishing the beach with or without a groin and regardless of sand source would provide protection to the buildings and infrastructure that would be damaged through erosion. If the sand is barged from the Housatonic River or pumped from Clinton Harbor, some noise will occur during construction. If trucks are used to haul sand to the beach, a number of other construction impacts may occur; park roads and parking lots may be damaged by the heavy vehicle traffic, additional vehicle volume will occur between the park and the upland source during construction, and noise from construction will no longer be limited to the park but will occur on the roadway network as well. Construction of a fishing pier extending from the end of the groin would require pile driving, which would generate noise during construction. As presented in Table 4-1, nourishment of the beach with upland sand has a similar level of impact to No Action on coastal resources.

Relative to cultural and socioeconomic topics, No Action is likely to result in greater impacts than the alternatives that include nourishment. Continued erosion of the beach is anticipated to expose and damage archaeological resources and has a lower potential to expose and threaten historical resources. Socioeconomic resources will be impacted by No Action since the park is likely to draw fewer visitors to the local area. Nourishment without a groin will serve to protect these archaeological and historical resources against disturbance by erosion and will maintain the current socioeconomic condition of the project area. Thus, with nourishment only, no impact to these resources is anticipated. If a terminal groin is constructed, any excavation that is necessary for the groin foundation could disturb archaeological resources. A fishing pier on the end of the groin could result in additional disturbance through installation of piles.

Impacts to coastal resources vary based on the selected alternative. The No Action alternative would result in significant reduction in the quality of the beach resource and would eventually result in the loss of dunes along the erosional portion of the beach. Nourishment of the beach may also result in some dune damage through heavy equipment operation, but which can be prevented through management during construction as a mitigation measure. Construction of a groin will have slight impacts on coastal waters through construction of an artificial structure within this resource, although negative impacts can be prevented through filling of the storage area of the groin with sand to its equilibrium condition (a mitigation measure)

Short term impacts to water quality are anticipated regardless of alternative. Continued erosion of the beach under the No Action alternative would likely expose and damage the septic systems for the existing West Beach bath houses, resulting in the untreated discharge of sewage to Long Island Sound. For each of the construction alternatives, nourishment is likely to result in a temporary increase in turbidity levels in the nearshore coastal water column. However, sediment that becomes suspended in the water column will settle out along the beach or nearshore area. Additionally, use of construction equipment at the site increases the potential for leakage or spillage of vehicular fluids. Marginally greater turbidity levels could temporarily occur during excavation for a terminal groin and pile driving for a fishing pier.

Impacts to wildlife could potentially occur during nourishment and construction of a groin. To prevent these impacts, construction will be limited to the season when the federally-listed piping plovers are not nesting.

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Table 4-1. Summary of Impacts

Resources	No Action	Nourishment Without Groin		Nourishment With Groin	
		Dredged Sand	Upland Sand	Dredged Sand	Upland Sand
Physical					
Roads and Parking Lots	○	○	◖	○	◖
Buildings and Structures	●	○	○	○	○
Utilities	●	○	○	○	○
Traffic	○	○	◖	○	◖
Air Quality	○	○	○	○	○
Noise	○	◖	●	◖	●
Cultural and Socioeconomic					
Archeological Sites and Archeologically Sensitive Areas	●	○	○	◖	◖
Historic Period Aboveground Resources	◖	○	○	○	○
Socioeconomic Resources	●	○	○	○	○
Coastal					
Beach	●	○	○	○	○
Dunes	●	○	○	○	○
Rocky Shorefronts	○	○	○	○	○
Coastal Waters & Estuarine Embayments	◖	○	○	◖	◖
Tidal Waters	○	○	○	○	○
Tidal Wetlands	○	○	○	○	○
Natural					
Hydrology and Water Quality	◖	◖	◖	◖	◖
Wildlife and Fisheries	○	◖	◖	◖	◖
Inland Wetlands	○	○	○	○	○
Numeric Score	***33***	***21***	***24***	***23***	***26***

● Greatest Constraints/Potential Adverse Impact (3 points)
◖ Moderate Constraints/Potential Adverse Impact (2 points)
○ Least Constraints/Potential Adverse Impact (1 point)

5.0 UNAVOIDABLE ADVERSE ENVIRONMENTAL IMPACTS

The unavoidable adverse impacts from the proposed action are limited to temporary, construction-phase impacts. In general, these impacts would be short-term, lasting only during construction, and would be scheduled to coincide with low usage seasons of the year. Mitigation measures identified to offset these impacts are described in Section 3.11 and summarized in Table 7-1.

- Air Quality: Construction activities may result in short-term impacts to ambient air quality due to direct emissions from construction equipment and trucks. These impacts will be temporary and will affect only the immediate vicinity of the beach nourishment area and the associated staging areas and access routes. Emissions from project-related construction equipment and trucks are expected to insignificant with respect to compliance with the NAAQS.

- Noise: Construction activities may result in temporary increases in noise levels in the immediate vicinity of the beach nourishment area. The noise generated by construction equipment is expected to be intermittent and attenuated over hundreds of feet before reaching any nearby receptor, and is therefore not expected to exceed the applicable noise abatement criteria. Temporary increases in traffic-generated noise will occur along access roads to the park and internal park roadways. Minimal underwater noise will be generated by barge hauling and other construction activities. Pile driving associated with construction of a fishing pier would generate short-term underwater noise in the nearshore area, but would be unlikely to impact essential fish habitat.

- Traffic, Parking, and Circulation: Minor increases in construction-related vehicle traffic are expected on local access roads to the park and internal park roadways. Construction-related traffic will be minimal relative to the existing roadway capacities and operations of the study area intersections. Additionally, construction would occur during the off-season, and construction traffic would be negligible compared to typical park traffic during the peak seasons. Construction activities may also result in temporary impacts to vehicle circulation patterns within the park to accommodate construction vehicles and access to the beach. Temporary detours or limited access to portions of the internal park roadway system may be required during the construction period. Limited areas of the existing parking lots may be used for temporary staging during construction.

- Solid Waste and Recycling: Construction of the beach restoration project will result in the one-time generation of minor quantities of construction-related waste and debris. These materials will be disposed of as appropriate and will not strain the capacity of local or regional waste haulers or waste processing facilities.

6.0 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

Irreversible and irretrievable commitment of resources include those resources that remain committed to a project through its lifespan (i.e., irreversible commitment) or those that are consumed or permanently impacted as a result of the proposed project (i.e., irretrievable commitment). The following irreversible and irretrievable commitments of resources would result from the proposed action:

- Energy: Construction of the proposed beach restoration project will result in consumption of non-renewable energy sources (fuel, oil, etc.).

- Economic Resources: The total estimated project cost over a projected 50-year lifespan is approximately $21 million dollars. Use of these funds for this project will preclude their use for other purposes.

- Construction Materials: Various construction materials for the beach restoration project will be used, including sand for beach nourishment and stone/wood for construction of a terminal groin structure. Sand obtained from maintenance dredging of navigational channels represents a beneficial reuse of this material.

- Human Labor: An irretrievable commitment of human labor will result from the construction of the proposed beach restoration project.

7.0 SUMMARY OF MITIGATION MEASURES

Mitigation measures to reduce or offset potential adverse impacts associated with the proposed action are summarized in Table 7-1, as described in Section 3 of this EIE. For resource categories for which no mitigation is proposed, the impact evaluation has determined that the potential impacts are either insignificant, requiring no mitigation, or that there will be no adverse impacts resulting from the proposed action.

Table 7-1. Summary of Mitigation Measures

Resource Category	Proposed Mitigation
Park Infrastructure	• Construction-phase traffic management measures including construction signage, temporary detours, and temporary use of alternate parking areas • Repair damage to park roads and parking lots resulting from construction traffic during and following construction, as necessary • Require contractors to repair unreasonable damage to park roads and parking lots
Traffic	• Construction-phase traffic management measures including construction signage, temporary detours, and temporary use of alternate parking areas
Coastal Resources	• Fill the updrift storage area of the terminal groin to its predicted equilibrium condition to maintain sediment transport to downdrift areas • With the exception of dune enhancement activities, avoid disturbance of the existing dunes during construction
Socioeconomic Resources	• Perform construction during periods of low park usage
Cultural Resources	• If construction of groin will disturb sea floor sediments, perform archaeological sampling to assess the presence of intact cultural remains • If intact cultural resources are encountered and avoidance is not possible, underwater archaeology may be necessary • If project impacts extend to the area surrounding the Meigs Point Nature Center or former 19th century fish houses, perform additional subsurface testing to assess the presence of cultural-material bearing soils
Air Quality	• Construction best management practices to limit fugitive dust impacts including limiting dust-producing activities during high wind conditions, the use of anti-tracking pads at entrances to construction areas along the beach, and routine sweeping of park roads • Prohibition of excessive construction equipment idling and the use of air pollution control devices (e.g., oxidation catalysts and particulate filters) and clean fuels for the project construction where appropriate • Traffic management measures during construction, including prohibition of construction traffic on designated local roads, which will be incorporated into the final project plans and specifications
Noise	• Conformance with Connecticut noise regulations • In project specifications, require contractors to limit construction noise • Limit construction to daytime hours • Use and regular maintenance of mufflers on construction equipment
Hydrology, Water Quality, Wetlands	• Use of appropriate erosion and sediment controls during construction • Use of temporary stilling basins during beach nourishment construction • Use of turbidity curtains, as necessary, to limit potential for migration of sand to offshore areas during beach nourishment construction

Resource Category	Proposed Mitigation
	• Maintain spill response materials on-site during construction • Fuel construction equipment off-site or in a dedicated upland area such as an existing parking lot • Screen Housatonic River sediment from upriver locations to remove burnt wood and coal fragments prior to placement on beach
Wildlife and Fisheries	• No construction will be performed during the nesting season for sandy beach nesting birds (April 1 – August 15) • During permitting, consultation required between U.S. Army Corps of Engineers and National Marine Fisheries Service to verify that Essential Fish Habitat will not be affected

8.0 COST-BENEFIT ANALYSIS

8.1 Costs

Costs for the various build alternatives were estimated by Woods Hole Group (2008) as part of the companion engineering feasibility study report. The cost estimates presented in this section are based on 2008 pricing obtained from construction contractors and potential sand suppliers, as well as the design concepts described previously in this EIE. These cost estimates are assumed to be accurate to within ±15%. Table 8-1 presents cost estimates for the various build alternatives, including initial construction costs, routine maintenance costs, and total costs for the projected 50-year time horizon for the project. Alternatives were compared over a 50-year time horizon to account for beach nourishment performance, including required maintenance sand replenishments, over a common time period.

Table 8-1. Estimated Costs for Alternatives

	Nourishment without Groin		Nourishment with Groin	
	FNP† Sand	**Upland Sand**	**FNP Sand†**	**Upland Sand**
Initial Nourishment Cost	$6.75 million	$15.19 million	$6.75 million	$15.19 million
Initial Structure Cost	-	-	$1.50 million	$1.50 million
Mitigation Cost	$30,000	$230,000	$180,000	$380,000
Engineering and Permitting	$150,000	$150,000	$150,000	$150,000
Total Initial Cost	$6.93 million	$15.57 million	8.58 million	$17.22 million
50-year Maintenance Cost	$17.30 million	$23.37 million	$13.01 million	$21.32 million
50-year Total Cost	**$24.23 million**	**$38.94 million**	**$21.59 million**	**$38.54 million**

† FNP = Federal Navigation Project

The alternative with the lowest cost for the 50-year project horizon is nourishment using sand from the Housatonic River and Clinton Harbor FNPs with a terminal groin. This alternative is estimated to cost $21.59 million over the 50-year design life of the project, with initial costs including construction totaling $8.58 million and maintenance costs totaling $13.01 million. Although construction of the groin is estimated to cost $1.5 million, the enhanced sediment retention provided by a terminal groin is likely to save approximately $2.64 million over the 50-year design life of the project as compared to beach nourishment without the terminal groin. This savings represents approximately 12% of the total project cost.

Beach nourishment using sand dredged from the Housatonic River and Clinton Harbor FNPs is significantly more cost-effective than using sand from the identified upland sources. As discussed in the companion engineering feasibility study report (Woods Hole Group, 2008), the increased cost associated with the upland sediment, in addition to the construction logistics required, makes nourishment sourced solely by an upland source significantly less cost-effective.

However, it is viable to consider using an upland source as a supplemental source to the Housatonic and Clinton Harbor material. For example, if the total volume acquired from the Housatonic River was not enough to complete the preferred alternative, it would be useful to supplement the nourishment with additional upland material in order to construct the full nourishment (Woods Hole Group, 2008).

A groin is more cost-effective if sand from the Housatonic River and Clinton Harbor FNPs is used, as opposed to the identified upland sand sources, since the dredged material has a smaller mean particle diameter and is thus more easily mobilized by waves and transported from the beach by currents. As shown in Table 8-1, the difference in total project costs with and without a groin is more significant for the dredged sand versus upland sand.

The No Action Alternative includes no new construction or beach nourishment and, therefore, no initial construction cost. However, under the No Action Alternative, the shoreline and beach would continue to erode, reducing the usable beach area and threatening the boardwalk and existing structures. This alternative may also result in environmental impacts, including damage to the existing septic systems and structures and associated water quality impacts along the beach from septage and debris from damaged structures.

The socioeconomic costs of the No Action Alternative are also difficult to quantify, such as the anticipated decline in park attendance (particularly by those visitors who are attracted to the park primarily for the beach) over time as the beach continues to erode. Due to the decline in beach visitors, it is anticipated that related spending by visitors in local and regional establishments would decline as well.

8.2 Benefits

The proposed action will provide multiple benefits, although the majority of these benefits are unquantifiable. Direct benefits include enhanced quality and longevity of Hammonasset Beach as one of Connecticut's most valuable recreational and natural resources; protection of the beach and associated infrastructure from further damage caused by erosion; protection of sensitive habitats including the beach, dunes, and salt marsh; protection of the state park and inland areas from coastal flood damage; and protection of the park's cultural resources. In addition, construction of a terminal groin and fishing pier will increase fishing access to Long Island Sound, decrease the frequency of required future beach nourishment, and provide some new rocky shorefront habitat. Indirect benefits of the proposed action include minor increases in employment and spending generated by the construction activity, and potential increases in park attendance and local spending resulting from associated tourism.

9.0 POTENTIAL CERTIFICATES, PERMITS, AND APPROVALS

Under the preferred alternative, the proposed beach restoration project involves placement of sand on the beach and in the adjacent coastal waters and construction of a new terminal groin at the eastern limit of the nourishment area, also within coastal waters. A number of state and federal certificates, permits, and approvals are required for work in coastal resource areas, and are summarized below. No local permits or approvals are anticipated to be necessary since the project is a State-sponsored action.

- DEP Office of Long Island Sound Programs (OLISP) Structures, Dredging, and Filling Permit - A permit is required from OLISP for the placement of fill and construction of structures in coastal waters. This permit is necessary for the proposed beach nourishment and construction of a groin. The regulatory authority for this permit is the Connecticut General Statutes (CGS) Sections 22a-359 through 22a-363f.

- Army Corps of Engineers Programmatic General Permit (PGP) Category 2 - The Programmatic General Permit is issued by the USACE to provide coverage for projects that would otherwise require an individual permit under Section 404 of the Clean Water Act (33 U.S.C. 1314), such as filling of navigable waters. The proposed project is eligible for coverage under the Category 2 PGP since the project would include beach nourishment with compatible grain size and less than 1 acre of fill within a waterway associated with construction of the groin. An Essential Fish Habitat consultation will be completed between USACE and NMFS as part of the application review process for this permit.

- DEP 401 Water Quality Certification - Water Quality Certification (WQC) is required by Connecticut DEP for any project requiring a federal permit for work in navigable waters. Since coverage is required under the Category 2 PGP, WQC is necessary. However, as of May 31, 2006, and effective until at least May 31, 2011, the PGP states that OLISP conducts a substantial evaluation regarding consistency with state water quality standards on individual activities in tidal, coastal and navigable waters and that, as a result, a WQC is inherent in OLISP authorizations for certain activities, including those authorized by a Structures, Dredging, and Filling permit. As such, a separate WQC application would not be required for the proposed project.

- DEP Flood Management Certification - Flood Management Certification is required for any state agency proposing activity within or affecting a floodplain to demonstrate that the project is consistent with CGS Section 25-68. The majority of Hammonasset Beach State Park is located within a 100-year flood zone and a Hurricane Surge Area.

- DEP General Permit for the Discharge of Stormwater and Dewatering Wastewaters from Construction Activities (Construction Stormwater General Permit) – Required for construction projects that disturb one or more acres of land, regardless of project phasing. Greater than 1 acre of land disturbance is anticipated to occur as part of the proposed project.

10.0 CONCLUSION

Based on the results of an engineering feasibility study, examination of multiple alternatives, and assessment of potential impacts, the preferred alternative to address the beach erosion problem at Hammonasset Beach is beach nourishment with the potential use of a terminal groin. Unlike the No Action Alternative, which would result in the loss of coastal resources, reduce access to Long Island Sound, and result in subsequent cultural and socioeconomic resource impacts, the proposed beach nourishment project is not anticipated to result in any substantial long-term adverse impacts to the environment. Construction-related impacts are short-term in nature and can be mitigated through project planning and best management practices for air, noise and water quality protection.

Beach nourishment has been identified as the most feasible alternative to mitigate erosion at Hammonasset Beach and successfully address the goal of creating a beach that has a reasonable performance lifetime, while avoiding or minimizing environmental impacts, and maintaining the current beach usage. Although this has been identified as the preferred alternative, public comments received during the public review period for the EIE will be considered in making a final decision on the proposed action to address erosion at Hammonasset Beach.

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