South Shore Coastal Infrastructure Inventory and Assessment Demonstration Project
Coastal Hazards Commission

Town of Duxbury

Prepared for:
Office of Coastal Zone Management
Boston, MA

February 28, 2007

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In Association With:
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Section I

Town of Duxbury

Coastal Hazards Infrastructure and Assessment Program
Section I – Coastal Hazards Infrastructure and Assessment Program

INTRODUCTION

The Project and Client

The Commonwealth of Massachusetts has initiated a Coastal Hazards Commission (CHC) to identify the vulnerability of the state to coastal hazards. As one of five working groups working under the CHC, the 20-Yr Infrastructure Plan was to establish a prioritization for the repair of coastal structures. The focus areas of the Working Group include:

- Publicly owned infrastructure
- Infrastructure for which State is responsible
- Inventory of public hazards infrastructure
- Evaluation on conditions
- Development for a prioritization of work
- Estimation of capital and maintenance costs

The 20-Yr Infrastructure Working Group is led by Representative Frank Hynes with CZM as the lead State Agency overseeing the management of the project. The region included in the demonstration project was identified as the South Shore and included the eight communities of Hingham, Hull, Cohasset, Scituate, Marshfield, Duxbury, Kingston and Plymouth.

Consultant Team

The consultant team that performed the demonstration project was led by Bourne Consulting Engineering (BCE) of Franklin, MA who was responsible for overall project management, research and field assessments. Assisting BCE was Applied Coastal Research and Engineering, Inc. of Mashpee, MA who was responsible for field assessments and GIS data conversion. Alpha Land Surveying and Engineering of Middleboro, MA also supported the Team with field GPS survey.

PURPOSE

Study Purpose

CZM seeks to identify the capacity of Massachusetts coastal structures to resist major coastal storms and prevent storm damage. In working toward this goal, CZM has initiated a program to perform an assessment of Commonwealth owned and/or maintained coastal structures. The first phase of this program is the performance of a demonstration project for coastal structures located on the South Shore. The demonstration project will identify existing structures, their general conditions, ability to provide coastal protection and the probable cost for repairs. The information collected and developed will be incorporated into the MassGIS system to allow use for developing a 20 Year Coastal Infrastructure Plan.

As this is a demonstration project, it will serve as the basis for development of a statewide inventory and assessment of all Commonwealth coastal structures and the needs for their maintenance and/or repair. Incorporated into this project will be the identification of issues and limitations of the investigation and
assessment to achieve the overall goals and what should be included in future investigations/assessments of coastal structures for the other regions.

Goals of Study

The goals of the South Shore Coastal Infrastructure Inventory and Assessment Project include:

- To be used as the model to go forward for assessment of coastal structures for the remainder of the coastal regions
- To identify areas of research and/or assessment that need to be modified for future phases that were not included within the demonstration project
- Complete the study with the final report by November 15, 2006 for submission to the Coastal Hazards Commission
- To identify all the coastal structures the state either owns or has responsibility to maintain for the eight communities included within the study
- Of the structures identified, determine the structure location and characteristics, the structure condition relative to providing coastal protection and the structure importance in relation to what it is protecting.
- To the degree possible, identify the structure elevation and the FIRM mapping flood elevation and category.
- To the degree possible, identify structure owner and available documents from local, state and federal agencies.
- To establish an estimated cost to rehabilitate the coastal structures to provide the level of project established in the structure’s original design.
- Provide the information in a format compatible for incorporation into the MassGIS system

Limit of Study

Due to the time constraints and the amount of effort necessary to collect, process and compile the information, the following are identified as limitations of the information presented:

- All property ownership was taken as presumed. No legal investigation of ownership was performed during the project. Property ownership is based on town assessor maps. Where structures were located outshore of assessor map defined property lines, it was assumed to be Town land unless other information indicated otherwise. Where structures were located outshore of Mean Low Water, property is assumed to be State owned.

- The structure ownership was based on assessor maps and research at the local, state and federal levels. Where there was indication of public work on a structure on Town land or on private property, the structure was presumed to be Town owned. Where the structure was on state property, the structure was presumed to be state owned. Where ownership of the structure was not clear but was located on private property, the structure ownership was defined as unknown.

- The study included town and state owned structures as it was assumed that most town owned structures received state funding at some level for construction and/or maintenance.
  - Federal structures were identified but no assessment of conditions or priority was performed.
  - Structures that were determined to be private were not included.
  - Undocumented structures considered to be on private land, but having the potential to have been publicly built and/or maintained, were identified as having an “unknown ownership”.

BCE
The prioritizing of structures was based primarily on risk to general infrastructure and density of housing. Infrastructure included was buildings. The study did not consider all infrastructure issues including:
- No consideration on utility impacts – water, electrical, sewer, gas
- No consideration of roadway and bridge protection
- Evacuation routes were not considered within the investigation
- Location of Emergency Shelters were not included in priority assessments

Research was performed at the local, state and federal levels. The local research was limited to location and documenting available coastal structure contract drawings. Research at DCR was restricted to available historic construction plans for coastal structures at the MA-DCR Waterways office in Hingham, MA. No investigation of state archives was performed. Research at MA DEP Chp 91 and USACE was limited to recorded permits and licenses found in their files. No investigation was performed at the Registry of Deeds.

DEVELOPMENT OF MassGIS DATABASE ATTRIBUTES

The specific attributes that would be incorporated into the MassGIS system were developed based on the scope of work and the goals to be achieved. The following was established to standardize the data collection and presentation and to allow total flexibility for sorting by attributes in the final GIS database. The attributes identified below were input into a MS Access database which was used to manage the data from all eight communities within a single file.

Database Attributes
- Attribute Descriptions/Definitions

Structure Number: A unique structure number was given to each coastal structure. The number was based on existing numbering systems that include the State Department of Environmental Protection community number followed by the local community assessor’s parcel numbering system. The last three digits of the number represent the structure within the parcel. Where structures extend over several parcels, the structure is referenced to a parcel that is approximately in the center of the structure. Where Town assessor’s references include letters, those are also included within the structure number. Some communities have block numbering within their numbering system and these are included. Communities without block numbering still have the block numbering included but these are illustrated as all zeros for that specific segment.

Structures that are on Town property, which would otherwise not have a parcel number, are referenced to a parcel that is in the immediate vicinity of the coastal structure.

On this basis, the following is the general numbering convention:

**CCC-MMM-PPP-BBB-SSS**

Where:
- CCC: DEP Community Number
- MMM: Community Map Number
- BBB: Block Number (000 if no block numbering system)
- PPP: Community Parcel Number
- SSS: Structure Number
Property Ownership: All property ownership was on a “presumed” basis as no legal verification of ownership was performed. The ownership of the property was classified under four basic areas which were private ownership (Private), Town ownership (Local), Commonwealth of Massachusetts ownership (State), federal government ownership (Federal) or unknown. Property ownership was based on Town assessor’s maps. Where the location was located above Mean Low Water, and not within a defined parcel, the property ownership was presumed to be the Town unless documentation was found to indicate otherwise. Where a structure was located offshore of Mean Low Water, the property ownership was presumed to be the state.

Structure Ownership: The ownership of all structures is presumed as no verification of ownership was performed. Ownership of the structure was determined by research into historic state and federal permits and the entity indicated on the permits as the applicant. Where no other information was found, the following was utilized:

- Structures located on private land but appearing to be significant structures were identified as owned by the Town as “Unknown”. Unknown was used were there was a question of local or private ownership.
- Structures on Town property were assumed to be owned by the Town
- Structures that were located off-shore were presumed to be federally owned
- Structures that were identified as being privately owned were eliminated from the database

Basis of Ownership: The basis of structure ownership was provided to give rationale to the structure ownership and identified the research resource that identified the ownership or the methodology otherwise used. The responses utilized were limited to the following:

- DPW – DPW Employee Interview
- DCR - Contract Drawings
- DEP – Ch 91 License
- USACE – Permits
- Property Ownership
- Offshore Structure

Structure Owner’s Name: Ownership names reflect the presumed owner of publicly owned structures. As this was for public structures only, the ownership was restricted to the community name, the state agency or the federal agency.

Earliest Structure Record: The year of the oldest document located for the structure. The information is determined from the document research performed on the structure from local, state and federal agencies. If no documents could be found than this entry is denoted as “Unknown”. Where documentation of the structure could be found, the date from the oldest document was utilized.

Primary Structure / Secondary Structure: Many of the coastal structures consisted of combined structures which were rated separately. It was typically found that one structure was significantly more predominant (Ex. Bulkhead/Seawall) and was therefore identified as the Primary Structure while a smaller structure might exist in front (ex. Revetment) of it. The type, height and material of each structure are identified separately. The condition of each structure was based on the Primary Structure. Where there was no secondary structure, the fields were left blank.

Structure Type: The structure type was categorized into five basic coastal structure categories which were Bulkhead/Seawall, Revetment, Coastal Beach, Coastal Dune, and Jetty/Groin.
Structure Material: The identification of the coastal structure’s material of construction was performed and represents the primary material. Stone structures consisted of both mortared and non-mortared conditions.

Structure Height: Each type of structure was categorized by its visible height in feet which was broken into four specific ranges which are:

- < 5 feet
- 5 to 10 feet
- 10 to 15 feet
- >15 feet

Structure Condition: A preliminary assessment of the condition for each structure was performed by the field teams. This was by visual observation only and no detailed investigation was performed. The condition assessments were based on a predefined five level rating system that ranged from Rating A for Excellent Condition to Rating F for Critical Condition. A detailed listing of the conditions and their definitions can be seen in Exhibit A.

Priority Rating: In order to account for the need for protection at any one site, a five level priority rating system was established. This allowed for consideration of public infrastructure protection, density of residential housing for development of structure overall importance for coastal protection. The ratings range from Level 1 for no infrastructure or residence protection to Level 5 for critical inshore infrastructure protection and/or high density residential. The detailed listing and definitions for the priority categories can be seen in Exhibit B.

Structure Repair / Reconstruction Cost: A preliminary estimation of construction costs to maintain or repair structures was made based on the preliminary field assessment of the structures. A Repair Cost Matrix was developed based on structure type, condition, height and material and can be seen in Exhibit C. Once each structure’s type, height, and material classifications were determined, the cost per foot for the structure was determine from the Repair Cost Matrix and multiplied by the length of the structure to obtain the estimated repair/restoration cost. The cost matrix repair costs include a 20 percent construction cost contingency as well as 10 percent costs for engineering and permitting.

Structure Length: The length of each structure is provided and utilized in the development of the repair/reconstruction costs. The lengths are given to the nearest foot and taken as the linear distance along the structure, as determined by the GPS location, which takes into account structure angles and curvature.

Structure Elevation: The elevation of structures was determined in feet from existing information where available. The datum used is NAVD 88 and elevations are to the nearest foot. From a previous study much of the south shore coastal structures had elevations defined based on LIDAR mapping data. Where available structure documentation with elevations was found, in areas with no LIDAR data, the information was included within the structure information. Where there was no LIDAR information or existing documentation, the item has been left blank.

LIDAR (Light Detection and Ranging) is technology that is currently being used for high-resolution topographic mapping by mounting a LIDAR sensor, integrated with Global Positioning System (GPS) and inertial measurement unit (IMU) technology, to the bottom of aircraft and measuring the pulse return rate to determine surface elevations.

FEMA Zone and Elevation: For each structure the FEMA Flood Insurance Rate Maps (FIRM) were researched for their Flood Zone designation and their Base Flood Elevation from the most recent FIRM maps for the specific Town. The elevations are provided in feet on the same datum as the FIRM maps (NGVD) with no adjustments or conversions.
Structure Comments: The engineering team provided a brief description and comment on the structure at the time of the field assessments which is provided in support of the condition rating that was given for the structure.

Pictures: At the time of the field assessments, digital photographs were taken to provide a general overview of the structure. The number of pictures were limited to a maximum of six. The first photograph for each structure is shown on the Structure Assessment Form. The list of all photographs is provided on the form.

Town Documents: Town documents represent the structure information that could be found in the Town’s DPW/Engineering Department records. Where particular records could be found, a table of document information was developed and included within the database with limited descriptions.

MA - DCR Documents: MA-DCR documents represent the structure information that could be found within DCR – Waterways office in Hingham Where particular records could be found, a table of document information was developed and included within the database with limited descriptions.

MA - DEP Chp. 91 Licenses: MA-DEP Chapter 91 license documents represent the structure information that could be found within MA-DEP Chp 91 records in Boston. Where particular records could be found, they were scanned as pdf files and attached to the structure through the GIS database information. In addition, a table of license document information was developed and included within the database with limited descriptions.

USACE Permits: USACE Permits represent the structure information that could be found within the Army Corp of Engineers regulatory office in Concord, MA. Where particular records could be found, they were scanned as pdf files and attached to the structure through the GIS database information. In addition, a table of license document information was developed and included within the database with limited descriptions.

DEVELOPMENT OF REPAIR / RECONSTRUCTION COSTS

A matrix to be used within the database has been developed to assess likely rehabilitation/repair costs to restore the coastal structures to their original design condition. No attempt was made to assess the level of exposure and associated level of protection that might be required to meet current design standards for these structures. These costs are only an estimation to bring these structures back to their original design intent based on 2006 construction costs.

The development of the cost matrix is based on the following:

Structure Condition Ratings – The condition of the coastal structures was determined in the field by the survey crew which was led by an engineer with waterfront structure assessment and design experience. The definitions of the rating criteria utilized for the assessments is presented elsewhere.

The cost implications for each rating condition are as follows:

- A Rating Structures not requiring any maintenance, repair or rehabilitation cost and would not be expected to experience damage if subject to a major coastal storm event
- B Rating Structures requiring limited or no repair and would be expected to experience only minor damage if subject to a major coastal storm event. The
value of these maintenance costs is assumed to be 10 percent of the construction cost.

- **C Rating**  Structures requiring moderate to significant level of repair or reconstruction and would be expected to experience significant damage if subject to a major coastal storm event. The structure is presumed to be effective under a major storm event. The value of the repair costs is assumed to be 50 percent of the construction cost.

- **D Rating**  Structures requiring significant level of rehabilitation or total reconstruction and would be expected to experience significant damage or possibly fail if subject to a major coastal storm event. The value of the repair costs is assumed to be 100 percent of the construction cost.

- **F Rating**  Structures requiring complete reconstruction and would expect to provide little or no protection from a major coastal storm event. The value of the repair costs is assumed to be 100 percent of the construction cost plus a cost for removal/disposal of the original structure.

**Height of Structure** — Height of a structure is a major factor in the structure cost and therefore was identified as a significant factor in assessing rehabilitation/repair construction costs. The structures were broken down into four major categories which were:

- **< 5’** — Structures that were less than five feet in height
- **5’-10’** — Structures five to 10 feet in height
- **10’-15’** — Structures over 10 feet to 15 feet in height
- **> 15’** — Structures greater than 15 feet in height — assumed 20 feet typical

**Length of Structure** — Length is based on field GPS location with measurements rounded to the nearest foot.

**Bulkhead / Seawall Structures** — These structures are assumed to be constructed out of concrete, steel, stone or wood with each having its own criteria for establishing costs. For each structure type the following was assumed:

- **Concrete Seawalls** — These walls were assumed to be gravity structures with the volume of concrete used based on the bottom width being one-half of the structure height. Costs of construction were based on a per cubic yard estimate that varied from $350 to $630 per cubic yard depending on the structure height. Values for excavation and demolition of existing structure were also included.

- **Stone Seawalls** — These walls were treated the same as concrete seawalls and assumed to be gravity structures with the volume of the structure based on the bottom width being one-half of the structure height. Costs of construction were based on a per cubic yard estimate that varied from $350 to $630 per cubic yard depending on the structure height. Values for excavation and demolition of existing structure were also included.

- **Steel Bulkheads** — Steel bulkheads were presumed to be constructed with steel sheet piling. Tie back systems were presumed for structures 10 feet or greater in height. Shorter walls were assumed to have a cantilever design. The total depth of sheeting was presumed to be two times the exposed height. The cost for construction varied from $40 per square foot to $60 per square foot plus the cost of excavation and demolition.
• Timber Bulkheads – Timber bulkheads were presumed to be constructed with timber piles at eight foot on center, horizontal wales and vertical four inch sheathing. The unit costs for installed materials used were $1,500 per pile and $7.50 per bfm.

Revetment Structures – Revetment structures were presumed to be constructed of dry placed (no concrete) stone with a two on one slope and a horizontal toe and crown equal to the thickness layer established for each height condition. The total thickness of the revetment layers varied from six to ten feet with the cost of armor and under-layer stone assumed to be $50 per ton and the crushed stone base to be $15 per ton.

Groins and Jetties – Groins and jetties were assumed to be the same materials and construction as the revetment structures but would have two sides and therefore double the quantities.

Coastal Beaches – Costs for restoration of Coastal beaches presumed the placement of beach renourishment sands at a 1-on-20 slope over the existing beach conditions. The cost for deposition of sand assumed relatively close source of material and utilized $20 per cubic yard for the material installed.

Coastal Dunes – Restoration of coastal dunes assumed a cross section of renourished sand with a one-on-four slope on one side of a 25 foot width at the defined dune height. The cost for deposition of sand assumed relatively close source of material and utilized $20 per cubic yard for the material installed.

Contingency – A contingency of 20 percent was added to all costs to reflect the unknowns associated with this level of rehabilitation/repair estimating.

Engineering and Regulatory Approvals – A ten percent increase to the cost matrix prices was assessed to represent the engineering design and regulatory approval requirements for the restoration of these structures.
# EXHIBIT A

## Structure Condition Table – 5 Level Rating System

<table>
<thead>
<tr>
<th>Preliminary Condition Assessment</th>
<th>Definition Based Upon Perceived Immediacy of Action and Potential to Cause Damage if Not Corrected</th>
<th>Level of Action Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>A Excellent</td>
<td>Like new condition. Structure expected to withstand major coastal storm without damage. Stable landform (beach, dune or bank). Adequate system exists to provide protection from major coastal storm.</td>
<td>None</td>
</tr>
<tr>
<td>B Good</td>
<td>Structure observed to exhibit very minor problems, superficial in nature. Minor erosion to landform is present. Structure / landform adequate to provide protection from a major coastal storm with no damage. Actions taken to prevent / limit future deterioration and extend life of structure.</td>
<td>Minor</td>
</tr>
<tr>
<td>C Fair</td>
<td>Structure is sound but may exhibit minor deterioration, section loss, cracking, spalling, undermining, and/or scour. Structure adequate to withstand major coastal storm with little to moderate damage. Actions taken to reinforce structure to provide full protection from major coastal storm and for extending life of structure. Moderate wind or wave damage to landform exists. Landform may not be sufficient to fully protect shoreline during a major coastal storm. Actions taken to provide additional material for full protection and extended life.</td>
<td>Moderate</td>
</tr>
<tr>
<td>D Poor</td>
<td>Structure exhibits advanced levels of deterioration, section loss, cracking, spalling, undermining, and/or scour. Structure has strong risk of significant damage and possible failure during a major coastal storm Structure should be monitored until repairs/reconstruction can be initiated. Actions taken to reconstruct structure to regain full capacity to resist a major coastal storm. Landform eroded, stability threatened. Landform not adequate to provide protection during major coastal storm. Actions taken to recreate landform to adequate limits for full protection from a major coastal storm.</td>
<td>Major</td>
</tr>
<tr>
<td>F Critical</td>
<td>Conditions of structure/landform may warrant emergency stabilization as failure may result in potential loss of property and/or life. Landform eroded, loss of integrity. Structure exhibits critical levels of deterioration, section loss, cracking, spalling, undermining, and/or scour. Structure provides little or no protection from a major coastal storm. Actions taken to totally reconstruct structure to regain full capacity. Landform stability is severely compromised, rate of erosion/material loss may be increasing, and landform does not provide adequate protection from a major coastal storm. Actions taken to recreate landform to adequate limits for full protection from a major coastal storm.</td>
<td>Immediate</td>
</tr>
</tbody>
</table>
EXHIBIT B

Priority Rating System - 5 Level Rating System

<table>
<thead>
<tr>
<th>Preliminary Priority Level Assessment</th>
<th>Level Based Upon Perceived Immediacy of Action and Presence of Potential Risk to Inshore Structures if Not Corrected</th>
<th>Level of Action Required</th>
</tr>
</thead>
</table>
| I                                    | None
No Inshore Structures or Residential Dwelling Units Present | Long Term Planning Considerations |
| II                                   | Low Priority
Inshore Structures Present with Limited potential for Significant Infrastructure Damage | Future Project Consideration |
| III                                  | Moderate Priority
Inshore Structures with potential for Infrastructure Damage and/or Limited Residential Dwellings (<1 dwelling impacted / 100 feet of shoreline) | Consider for Active Project Improvement Listing |
| IV                                   | High Priority
High Value Inshore Structures with Potential for Infrastructure Damage and/or Moderate Density Residential Dwellings (1-10 dwellings impacted / 100 feet of shoreline) | Consider for Next Project Construction Listing |
| V                                    | Immediate / Highest Priority
Critical Inshore Structures Present with Potential for Infrastructure Damage and/or High Density Residential Dwellings
Conditions of structure may warrant emergency stabilization as failure may result in potential loss of property and/or life.
(>10 dwellings impacted / 100 feet of shoreline) | Consider For Immediate Action Due to Public Safety and Welfare Issues |
# South Shore Coastal Infrastructure Inventory and Assessment Demonstration Project

## Exhibit C

**Repair / Rehabilitation Costing Data**

Cost per linear foot of structure

<table>
<thead>
<tr>
<th>Structure Type</th>
<th>Material</th>
<th>Height</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Bulkhead Seawall</strong></td>
<td>Concrete</td>
<td>Under 5 Feet</td>
<td>$0</td>
<td>$94</td>
<td>$425</td>
<td>$950</td>
<td>$983</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5 To 10 Feet</td>
<td>$0</td>
<td>$152</td>
<td>$759</td>
<td>$1,518</td>
<td>$1,782</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10 To 15 Feet</td>
<td>$0</td>
<td>$251</td>
<td>$1,254</td>
<td>$2,508</td>
<td>$2,970</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Over 15 Feet</td>
<td>$0</td>
<td>$396</td>
<td>$1,980</td>
<td>$3,960</td>
<td>$4,752</td>
</tr>
<tr>
<td><strong>Steel</strong></td>
<td></td>
<td>Under 5 Feet</td>
<td>$0</td>
<td>$54</td>
<td>$273</td>
<td>$540</td>
<td>$880</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5 To 10 Feet</td>
<td>$0</td>
<td>$165</td>
<td>$825</td>
<td>$1,050</td>
<td>$1,848</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10 To 15 Feet</td>
<td>$0</td>
<td>$251</td>
<td>$1,254</td>
<td>$2,508</td>
<td>$2,772</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Over 15 Feet</td>
<td>$0</td>
<td>$343</td>
<td>$1,718</td>
<td>$3,433</td>
<td>$3,705</td>
</tr>
<tr>
<td><strong>Stone</strong></td>
<td></td>
<td>Under 5 Feet</td>
<td>$0</td>
<td>$84</td>
<td>$425</td>
<td>$850</td>
<td>$983</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5 To 10 Feet</td>
<td>$0</td>
<td>$152</td>
<td>$759</td>
<td>$1,518</td>
<td>$1,782</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10 To 15 Feet</td>
<td>$0</td>
<td>$251</td>
<td>$1,254</td>
<td>$2,508</td>
<td>$2,970</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Over 15 Feet</td>
<td>$0</td>
<td>$396</td>
<td>$1,980</td>
<td>$3,960</td>
<td>$4,752</td>
</tr>
<tr>
<td><strong>Wood</strong></td>
<td></td>
<td>Under 5 Feet</td>
<td>$0</td>
<td>$86</td>
<td>$431</td>
<td>$892</td>
<td>$994</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5 To 10 Feet</td>
<td>$0</td>
<td>$127</td>
<td>$632</td>
<td>$1,265</td>
<td>$1,483</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10 To 16 Feet</td>
<td>$0</td>
<td>$161</td>
<td>$804</td>
<td>$1,608</td>
<td>$1,872</td>
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<tr>
<td></td>
<td></td>
<td>Over 15 Feet</td>
<td>$0</td>
<td>$202</td>
<td>$1,008</td>
<td>$2,017</td>
<td>$2,380</td>
</tr>
<tr>
<td><strong>Coastal Beach</strong></td>
<td>Sand</td>
<td>Under 5 Feet</td>
<td>$0</td>
<td>$28</td>
<td>$132</td>
<td>$264</td>
<td>$264</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5 To 10 Feet</td>
<td>$0</td>
<td>$127</td>
<td>$634</td>
<td>$1,267</td>
<td>$1,267</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10 To 15 Feet</td>
<td>$0</td>
<td>$224</td>
<td>$1,122</td>
<td>$2,244</td>
<td>$2,244</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Over 15 Feet</td>
<td>$0</td>
<td>$396</td>
<td>$1,980</td>
<td>$3,960</td>
<td>$3,960</td>
</tr>
<tr>
<td><strong>Coastal Dune</strong></td>
<td>Sand</td>
<td>Under 5 Feet</td>
<td>$0</td>
<td>$18</td>
<td>$93</td>
<td>$198</td>
<td>$198</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5 To 10 Feet</td>
<td>$0</td>
<td>$49</td>
<td>$238</td>
<td>$476</td>
<td>$476</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10 To 15 Feet</td>
<td>$0</td>
<td>$79</td>
<td>$395</td>
<td>$790</td>
<td>$790</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Over 15 Feet</td>
<td>$0</td>
<td>$132</td>
<td>$680</td>
<td>$1,320</td>
<td>$1,320</td>
</tr>
<tr>
<td><strong>Revetment</strong></td>
<td>Stone</td>
<td>Under 5 Feet</td>
<td>$0</td>
<td>$68</td>
<td>$333</td>
<td>$654</td>
<td>$750</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5 To 10 Feet</td>
<td>$0</td>
<td>$120</td>
<td>$601</td>
<td>$1,201</td>
<td>$1,300</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10 To 15 Feet</td>
<td>$0</td>
<td>$157</td>
<td>$781</td>
<td>$1,564</td>
<td>$1,686</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Over 15 Feet</td>
<td>$0</td>
<td>$247</td>
<td>$1,234</td>
<td>$2,468</td>
<td>$2,688</td>
</tr>
<tr>
<td><strong>Groyln</strong></td>
<td>Stone</td>
<td>Under 5 Feet</td>
<td>$0</td>
<td>$157</td>
<td>$864</td>
<td>$1,326</td>
<td>$1,490</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5 To 10 Feet</td>
<td>$0</td>
<td>$157</td>
<td>$1,201</td>
<td>$2,402</td>
<td>$2,800</td>
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<tr>
<td></td>
<td></td>
<td>10 To 15 Feet</td>
<td>$0</td>
<td>$157</td>
<td>$1,564</td>
<td>$3,128</td>
<td>$3,592</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Over 15 Feet</td>
<td>$0</td>
<td>$157</td>
<td>$2,408</td>
<td>$4,837</td>
<td>$5,333</td>
</tr>
</tbody>
</table>

**Note:** Repair / Rehabilitation Costs include 10% for engineering and regulatory approvals and 20% construction contingency.
Section II

Town of Duxbury

Community Findings
Section II – Community Findings – Town of Duxbury

COMMUNITY DESCRIPTION

The Town of Duxbury consists of a land area of 23.8 square miles out of a total area of 37.6 square miles and had a population of 14,248 in the 2000 census. The Town is located on the South Shore of Massachusetts and its location can be seen on this report’s cover. The estimated length of shoreline that is directly exposed to open ocean waves is 4.7 miles with the remaining shoreline semi-protected by offshore structures or landforms. The Town is protected from major coastal storms by both natural and man-made shoreline structures that require maintenance to insure the long term protection of its coastline. The man-made and publicly owned structures that protect the Town were investigated for their ability to provide adequate protection from major coastal storms. Structures have been identified as publicly owned, including coastal dunes and beaches, based on evidence of investment of public funds made to create/enhance/maintain these structures. The assessment did not include floating or pile supported structures as they are assumed not to provide any significant coastal protection from major storm events.

STRUCTURE INVENTORY

Within the Town of Duxbury, there were 13 publicly owned structures identified which provide significant coastal protection. The location of the structures can be seen in Sheets 1 through Sheet 3 in Section III of this report. The structures were categorized by their type and by their structural condition based on a preliminary field assessment. The distribution of structures by type and condition can be seen in the following table:

<table>
<thead>
<tr>
<th>Primary Structure (1)</th>
<th>Total Structures A</th>
<th>Structure Condition Rating</th>
<th>Total Length</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>B</td>
<td>C</td>
</tr>
<tr>
<td>Bulkhead / Seawall</td>
<td>11</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>Revetment</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Groin / Jetty</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coastal Dune</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coastal Beach</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>13</strong></td>
<td><strong>7</strong></td>
<td><strong>5</strong></td>
</tr>
</tbody>
</table>

Within the above table, the total length of each type of structure is also provided. The structures are listed by the type which is providing the primary coastal protection. Many sites have multiple structure types at the same location (i.e. revetment in front of seawall). These secondary structures are included in the development of repair/rehabilitation costs.

The development of repair costs has been included by structure type and by condition. In the Town of Duxbury’s case there are a total of 13 structures which would require approximately $2.8 million to bring all the coastal structures to “A” Rating. Most critical will be the structures in the “D” and “F” classifications as those are assumed to undergo some level of damage or failure during the next major coastal storm event. To reconstruct these structures, identified in the preliminary survey as being in poor condition, an estimated $1.0 million would be required to upgrade the Town’s coastal protection.
STRUCTURE REPAIR / RECONSTRUCTION COST - Town of Duxbury

<table>
<thead>
<tr>
<th>Primary Structure (1)</th>
<th>Total Structures</th>
<th>Structure Condition Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>Bulkhead / Seawall</td>
<td>11</td>
<td>$384,049</td>
</tr>
<tr>
<td>Revetment</td>
<td>2</td>
<td>$5,940</td>
</tr>
<tr>
<td>Groin / Jetty</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coastal Dune</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coastal Beach</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>13</td>
<td>$389,989</td>
</tr>
</tbody>
</table>

Based on the limited research within the scope of this project research, the presumed ownership of the structures was established on an initial basis and would be subject to more intense review in future tasks. Structures identified as being owned privately were excluded from further consideration. Although ownership of the land on which the structure was located was a factor, the structure ownership was treated as a separate issue from land ownership. For the Town of Duxbury the breakdown of structures by assumed ownership is as follows:

STRUCTURE OWNERSHIP / REPAIR COST - Town of Duxbury

<table>
<thead>
<tr>
<th>Primary Structure (1)</th>
<th>Total Structures</th>
<th>Structure Condition Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>Town Owned</td>
<td>13</td>
<td>$389,989</td>
</tr>
<tr>
<td>Commonwealth of Mass.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Federal Government</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unknown Ownership</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>13</td>
<td>$389,989</td>
</tr>
</tbody>
</table>

The identification of presumed ownership was not based on the investigation of legal documents but relied on property ownership and from construction and regulatory documents that were found. A more detailed investigation of legal documents and agreements would be required where structure ownership is disputed. A more detailed identification of structure type, length, condition and location can be found in Section III which contains Structure Assessment Reports for each individual structure found.

SUMMARY

The enclosed reports and associated documents reflects the Town of Duxbury's coastal structure information that will eventually be input into a state-wide GIS database and will be accessible through MassGIS. This data, when compiled state-wide, will be critical in the development of both short term and long term planning for maintaining and improving Massachusetts coastal protection.

This database will also provide relatively quick access to identify available documentation for these structures as well as the ability to be updated as coastal structure improvements are made.
Section III

Town of Duxbury

Structure Assessment Reports
Structure Assessment Form

Property Owner: Local
Presumed Structure Owner: Local
Owner Name: Duxbury

Town: Duxbury
Structure ID: 018-191-505-140-100

Location: Long Point
Based On Comment: DCR - Contract Drawings
Earliest Structure Record: 1936
Estimated Reconstruction/Repair Cost: $24,077.00

Date: 7/26/2006

Length: 160 Feet
Top Elevation: 88 Feet NAVD 88
FIRM Map Zone: VE
FIRM Map Elevation: 14 Feet NGVD
Primary Type: Bulkhead/Seawall
Primary Material: Concrete
Primary Height: Under 5 Feet
Secondary Type: Revetment
Secondary Material: Stone
Secondary Height: Under 5 Feet

Structure Summary:
Revetment slope (100-500 lbs. stone) for 15' width in front of concrete seawall with railing (parking lot behind). Minor spalling.

Condition Rating
B Good

Level of Action Description
Minor Structure observed to exhibit very minor problems, superficial in nature. Minor erosion to landform is present. Structure/landform adequate to provide protection from a major coastal storm with no damage. Actions taken to prevent/limit future deterioration and extend life of structure.

Priority Rating
1 None

Action Description
Long Term Planning Considerations
No Inshore Structures or Residential Dwelling Units Present

Structure Images:
018-191-505-140-100-PHO1A.jpg

Structure Documents:
USACE MAY 8 1936 PROPOSED WHARF 018-191-505-140-100-COE1A
USACE SEP 27 193 PROPOSED ROCK 018-191-505-140-100-COE1B
USACE NOV. 1 1938 PLAN 018-191-505-140-100-COE1C
USACE JUL 1988 RECONSTRUCT 018-191-505-140-100-COE1D

Prepared By: Bourne Consulting Engineering
CZM South Shore Coastal Infrastructure Inventory and Assessment

Structure Assessment Form

Town: Duxbury
Structure ID: 018-191-505-140-200
Key: community-map-block-parcel-structure

Property Owner: Local
Presumed Structure Owner: Local
Owner Name: Duxbury

Location: Long Point
Based On Comment: USACE - Permits
Earliest Structure Record: 1988

Date: 7/26/2006
Estimated Reconstruction/Repair Cost: $5,940.00

Length: 90 Feet
Top Elevation: Feet NAVD 88
FIRM Map Zone: VE
FIRM Map Elevation: Feet NGVD 14

Primary Type: Revetment
Primary Material: Concrete
Primary Height: Under 5 Feet

Secondary Type: Secondary Material:
Secondary Height:

Structure Summary:
Asphalt boat ramp with concrete sidewalls. Some deterioration at outshore corners of concrete walls.

Condition Rating
B Good

Level of Action Description
Minor

Structure observed to exhibit very minor problems, superficial in nature. Minor erosion to landform is present. Structure / landform adequate to provide protection from a major coastal storm with no damage. Actions taken to prevent / limit future deterioration and extend life of structure.

Priority Rating
I None

Action Description
Long Term Planning Considerations
No Inshore Structures or Residential Dwelling Units Present

Structure Images:
018-191-505-140-200-PHO2A.jpg

Structure Documents:
USACE JUL 1988 RECONSTRUCT 018-191-505-140-100-COE2A

Prepared By: Bourne Consulting Engineering
CZM South Shore Coastal Infrastructure Inventory and Assessment

Structure Assessment Form

Property Owner: Local
Presumed Structure Owner: Local
Owner Name: Duxbury

Location: Howards Landing
Based On Comment: DEP - Ch 91 License
Earliest Structure Record: 1993

Date: 7/26/2006
Estimated Reconstruction/Repair Cost: $9,867.00

Length: 65 Feet
Top Elevation: 10 Feet NAVD 88
FIRM Map Zone: VE
FIRM Map Elevation: 16 Feet NGVD

Primary Type: Bulkhead/Seawall
Primary Material: Stone
Primary Height: 5 to 10 Feet

Secondary Type: Secondary Material: Secondary Height:

Structure Summary:
Stone block seawall (dryset) forming filled wharf. Minor voids in wall, but no movement or rotation of stones observed. Minor fill loss noted.

Condition Rating
Good

Level of Action Description
Minor

Structure observed to exhibit very minor problems, superficial in nature. Minor erosion to landform is present. Structure / landform adequate to provide protection from a major coastal storm with no damage. Actions taken to prevent / limit future deterioration and extend life of structure.

Priority Rating
None

Action Description
No Inshore Structures or Residential Dwelling Units Present

Structure Images:
018-200-470-053-100-PHO1A.jpg
018-200-470-053-100-PHO1B.jpg
018-200-470-053-100-PHO1C.jpg

Structure Documents:
DEP CH.91 SEPT. 1993 PLAN 018-200-470-053-100-LIC1A

Prepared By: Bourne Consulting Engineering
CZM South Shore Coastal Infrastructure Inventory and Assessment

Structure Assessment Form

Property Owner: Local
Presumed Structure Owner: Local
Owner Name: Duxbury

Location: Howards Landing
Based On Comment: DEP - CH 91 License
Earliest Structure Record: 0

Date: 9/1/2006
Estimated Reconstruction/Repair Cost: $15,616.00

Length: 26 Feet Primary Type: Revetment
Top Elevation: 10 Feet NAVD 88 Primary Material: Stone
FIRM Map Zone: VE Primary Height: 5 to 10 Feet
FIRM Map Elevation: 16 Feet NGVD

Secondary Type: Secondary Material: Secondary Height:

Structure Summary:
1.) Stone block seawall (dryset) forming filld wharf. Minor voids in wall, but no movement or rotation of stones observed. Minor fill loss noted.
2.) Dumped rip rap (100 to 500 lb. stones) along south shore edge of boat ramp. Provides little protection. Not well constructed.
3.) Bituminous pavement boat ramp. Pavement ends above mean high water and is broken and deteriorated. Sand and rock beach used to

Condition Rating Level of Action Description
C Fair Moderate Structure is sound but may exhibit minor deterioration, section loss, cracking, spalling, undermining, and/or scour. Structure adequate to withstand major coastal storm with little to moderate damage. Actions taken to reinforce structure to provide full protection from major coastal storm and for extending life of structure. Moderate wind or wave damage to landform exists. Landform may not be sufficient to fully protect shoreline during a major coastal storm. Actions taken to provide addition material for full protection and extended life.

Priority Rating Action Description
1 None Long Term Planning Considerations No Inshore Structures or Residential Dwelling Units Present

Structure Images:
- 018-200-470-053-200-PHO2A.jpg
- 018-200-470-053-200-PHO2B.jpg
- 018-200-470-053-200-PHO2C.jpg
- 018-200-470-053-200-PHO2D.jpg

Structure Documents:

Prepared By: Bourne Consulting Engineering
CZM South Shore Coastal Infrastructure Inventory and Assessment

Structure Assessment Form

Property Owner: Local
Presumed Structure Owner: Local
Owner Name: Duxbury

Location: Massasoit Rd.
Based On Comment: DPW - DPW Employee Interview

Earliest Structure Record: 0
Estimated Reconstruction/Repair Cost: $13,601.00

Date: 7/26/2006

Length: 161 Feet
Top Elevation: 15 Feet NAVD 88
FIRM Map Zone: VE
FIRM Map Elevation: 15 Feet NGVD

Primary Type: Bulkhead/Seawall
Primary Material: Stone
Primary Height: Under 5 Feet

Secondary Type: Secondary Material: Secondary Height:

Structure Summary:
Stone seawall with mortared joints and stairs to access beach. Steel railing is deteriorated. Some cracks and voids in mortar in joint. Appears to have concrete footing buried and is connected to private seawall on one side.

Condition Rating Level of Action Description
B Good Minor Structure observed to exhibit very minor problems, superficial in nature. Minor erosion to landform is present. Structure / landform adequate to provide protection from a major coastal storm with no damage. Actions taken to prevent / limit future deterioration and extend life of structure.

Priority Rating Action Description
III Moderate Priority Consider for Active Project Improvement Listing
Inshore Structures with potential for Infrastructure Damage and/or Limited Residential Dwellings (<1 dwelling impacted / 100 feet of shoreline)

Structure Images: 018-201-997-078-100-PHO1A.jpg

Structure Documents:

Prepared By: Bourne Consulting Engineering
Structure Assessment Form

Property Owner: Local
Presumed Structure Owner: Local
Owner Name: Duxbury

Location: Duxbury Beach
Presumed Structure Owner: Local

Date: 7/26/2006

Based On Comment: DCR - Contract Drawings
Earliest Structure Record: 0
Estimated Reconstruction/Repair Cost: $112,820.00

Length: 518 Feet
Top Elevation: 9 Feet NAVD 88
FIRM Map Zone: VE
FIRM Map Elevation: 21 Feet NGVD

Primary Type: Bulkhead/Seawall
Primary Material: Concrete
Primary Height: 5 to 10 Feet
Secondary Type: Revetment
Secondary Material: Stone
Secondary Height: Under 5 Feet

Structure Summary:
Concrete seawall in satisfactory condition with some cracking for full height of front outshore face. Some deterioration at joints. 30" wide wall with wave return face. 2' high x 6' wide revetment along face (1 ton stone)

Condition Rating
B Good
Level of Action Description
Minor
Structure observed to exhibit very minor problems, superficial in nature. Minor erosion to landform is present. Structure/landform adequate to provide protection from a major coastal storm with no damage. Actions taken to prevent/limit future deterioration and extend life of structure.

Priority Rating Action Description
IV High Priority
Consider for Next Project Construction Listing
High Value Inshore Structures with Potential for Infrastructure Damage and/or Moderate Density Residential Dwellings (1-10 dwellings impacted / 100 feet of shoreline)

Structure Images:
018-210F-916-004-100-PHO1A.jpg
018-210F-916-004-100-PHO1B.jpg

Structure Documents:
# CZM South Shore Coastal Infrastructure Inventory and Assessment

## Structure Assessment Form

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<thead>
<tr>
<th>Property Owner:</th>
<th>Location:</th>
<th>Date:</th>
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<tbody>
<tr>
<td>Local</td>
<td>Duxbury Beach</td>
<td>7/26/2006</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Presumed Structure Owner:</th>
<th>Based On Comment:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local</td>
<td>DCR - Contract Drawings</td>
</tr>
</tbody>
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<table>
<thead>
<tr>
<th>Owner Name:</th>
<th>Earliest Structure Record:</th>
<th>Estimated Reconstruction/Repair Cost:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duxbury</td>
<td>0</td>
<td>$86,001.00</td>
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<th>FIRM Map Elevation:</th>
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<tr>
<td>1018 Feet</td>
<td>9 Feet NAVD 88</td>
<td>VE</td>
<td>21 Feet NGVD</td>
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</table>

<table>
<thead>
<tr>
<th>Primary Type:</th>
<th>Primary Material:</th>
<th>Primary Height:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bulkhead/Seawall</td>
<td>Concrete</td>
<td>Under 5 Feet</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Secondary Type:</th>
<th>Secondary Material:</th>
<th>Secondary Height:</th>
</tr>
</thead>
</table>

**Structure Summary:**

Concrete seawall in satisfactory condition with some vertical cracks for full height of front face. 30 inch wide wall with wave return face.

**Condition Rating Level of Action Description**

| Condition Rating Priority Action Description |
|----------------------------------------------|--------------------------------------------|
| B Good                                       | High Priority                              |
| Minor                                        | Consider for Next Project Construction Listing |
| Structure observed to exhibit very minor problems, superficial in nature. Minor erosion to landform is present. Structure / landform adequate to provide protection from a major coastal storm with no damage. Actions taken to prevent / limit future deterioration and extend life of structure. | High Value Inshore Structures with Potential for Infrastructure Damage and/or Moderate Density Residential Dwellings (1-10 dwellings impacted / 100 feet of shoreline) |

**Structure Images:**

- 018-211-939-118-100-PHO1A.jpg
- 018-211-939-118-100-PHO1B.jpg

**Structure Documents:**

Prepared By: Bourne Consulting Engineering
CZM South Shore Coastal Infrastructure Inventory and Assessment

Structure Assessment Form

Property Owner: Local
Presumed Structure Owner: Local
Owner Name: Duxbury

Location: Duxbury Beach

Date: 7/26/2006

Based On Comment: DCR - Contract Drawings

Earliest Structure Record: 0

Estimated Reconstruction/Repair Cost: $21,252.00

Adapted from original table:

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<thead>
<tr>
<th>Length:</th>
<th>Top Elevation:</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 Feet</td>
<td>9 Feet NAVD 88</td>
</tr>
<tr>
<td>FIRM Map Zone:</td>
<td>FIRM Map Elevation:</td>
</tr>
<tr>
<td>VE</td>
<td>21 Feet NGVD</td>
</tr>
</tbody>
</table>

Primary Type: Bulkhead/Seawall
Primary Material: Concrete
Primary Height: Under 5 Feet

Secondary Type: Secondary Material: Secondary Height:

Structure Summary: Concrete seawall in fair condition with cracking and spalling. Built 30 inch wide with wave return face.

Condition Rating Level of Action Description
C Fair Moderate Structure is sound but may exhibit minor deterioration, section loss, cracking, spalling, undermining, and/or scour. Structure adequate to withstand major coastal storm with little to moderate damage. Actions taken to reinforce structure to provide full protection from major coastal storm and for extending life of structure. Moderate wind or wave damage to landform exists. Landform may not be sufficient to fully protect shoreline during a major coastal storm. Actions taken to provide addition material for full protection and extended life.

Priority Rating Action Description
IV High Priority Consider for Next Project Construction Listing High Value Inshore Structures with Potential for Infrastructure Damage and/or Moderate Density Residential Dwellings (1-10 dwellings impacted / 100 feet of shoreline)

Structure Images: 018-211-939-131-100-PHO1A.jpg

Structure Documents:

Prepared By: Bourne Consulting Engineering
Structure Assessment Form

Property Owner: Local
Presumed Structure Owner: Local
Owner Name: Duxbury

Location: Duxbury Beach
Based On Comment: DCR - Contract Drawings
Earliest Structure Record: 1962

Date: 7/26/2006
Estimated Reconstruction/Repair Cost: $519,621.00

Length: 476 Feet NAVD 88
FIRM Map Zone: VE
FIRM Map Elevation: 21 Feet NGVD

Primary Type: Bulkhead/ Seawall
Primary Material: Concrete
Primary Height: 5 to 10 Feet

Secondary Type: Secondary Material: Stone
Secondary Height: Under 5 Feet

Structure Summary:
Concrete wall in fair condition. Evidence of lateral movement and slight tilt to outshore. Appeared to have failed previously and revetment (average 1 to 2 ton stone) placed along outshore face to stabilize.

Condition Rating Level of Action Description
C Fair Moderate Structure is sound but may exhibit minor deterioration, section loss, cracking, spalling, undermining, and/or scour. Structure adequate to withstand major coastal storm with little to moderate damage. Actions taken to reinforce structure to provide full protection from major coastal storm and for extending life of structure. Moderate wind or wave damage to landform exists. Landform may not be sufficient to fully protect shoreline during a major coastal storm. Actions taken to provide addition material for full protection and extended life.

Priority Rating Action Description
IV High Priority Consider for Next Project Construction Listing High Value Inshore Structures with Potential for Infrastructure Damage and/or Moderate Density Residential Dwellings (1-10 dwellings impacted / 100 feet of shoreline)

Structure Images:
- 018-212-600-901-100-PHO1A.jpg
- 018-212-600-901-100-PHO1B.jpg
- 018-212-600-901-100-PHO1C.jpg

Structure Documents:
- MA DPW AUG 1962 PROPOSED 018-212-600-901-100-DCR1A
- DEP CH.91 NOV. 4 1994 PLAN 018-212-600-901-100-LIC1A
- DEP CH.91 JULY 02, 19 PLANS 018-212-600-901-100-LIC1B
- USACE NOV 14 1999 PETITION TO 018-212-600-901-100-COE1A

Prepared By: Bourne Consulting Engineering
CZM South Shore Coastal Infrastructure Inventory and Assessment  
Structure Assessment Form

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<th>Date:</th>
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<tr>
<td>Local</td>
<td>Duxbury Beach</td>
<td>7/26/2006</td>
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<table>
<thead>
<tr>
<th>Presumed Structure Owner:</th>
<th>Based On Comment:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local</td>
<td>DCR - Contract Drawings</td>
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<table>
<thead>
<tr>
<th>Owner Name:</th>
<th>Earliest Structure Record:</th>
<th>Estimated Reconstruction/Repair Cost:</th>
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</thead>
<tbody>
<tr>
<td>Duxbury</td>
<td>1953</td>
<td>$137,683.00</td>
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<th>Top Elevation:</th>
<th>FIRM Map Zone:</th>
<th>FIRM Map Elevation:</th>
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<tbody>
<tr>
<td>907 Feet</td>
<td>9 Feet NAVD 88</td>
<td>VE</td>
<td>21 Feet NGVD</td>
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<thead>
<tr>
<th>Primary Type:</th>
<th>Primary Material:</th>
<th>Primary Height:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bulkhead/Seawall</td>
<td>Concrete</td>
<td>5 to 10 Feet</td>
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<th>Secondary Type:</th>
<th>Secondary Material:</th>
<th>Secondary Height:</th>
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Structure Summary:
Concrete seawall is in satisfactory condition with some minor cracking. Wall built with 30" wide cap and wave return face.

<table>
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<tr>
<th>Condition</th>
<th>Rating</th>
<th>Level of Action</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>Good</td>
<td>Minor</td>
<td>Structure observed to exhibit very minor problems, superficial in nature. Minor erosion to landform is present. Structure / landform adequate to provide protection from a major coastal storm with no damage. Actions taken to prevent / limit future deterioration and extend life of structure.</td>
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</tbody>
</table>

<table>
<thead>
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<td>IV</td>
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<td>Consider for Next Project Construction Listing</td>
<td>High Value Inshore Structures with Potential for Infrastructure Damage and/or Moderate Density Residential Dwellings (1-10 dwellings impacted / 100 feet of shoreline)</td>
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Structure Images:
018-212-901-001-100-PHO1A.jpg  
018-212-901-001-100-PHO1B.jpg

Structure Documents:
018-212-901-001-100-MA DPW SEP 1953 PROPOSED 018-212-901-001-100-DCR1A

Prepared By: Bourne Consulting Engineering
**CZM South Shore Coastal Infrastructure Inventory and Assessment**

**Structure Assessment Form**

**Town:** Duxbury  
**Structure ID:** 018-212-901-060-100  
**Key:** community-map-block-parcel-structure

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<td>0 Feet NAVD 88</td>
<td>VE</td>
<td>21 Feet NGVD</td>
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<th>Primary Type:</th>
<th>Primary Material:</th>
<th>Primary Height:</th>
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</thead>
<tbody>
<tr>
<td>Bulkhead/Seawall</td>
<td>Concrete</td>
<td>10 to 15 Feet</td>
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</table>

<table>
<thead>
<tr>
<th>Secondary Type:</th>
<th>Secondary Material:</th>
<th>Secondary Height:</th>
</tr>
</thead>
</table>

**Structure Summary:**

Historic DCR documents indicate bulkhead construction at location. No evidence of bulkhead found. Currently, cobble beach with dune (approximately 10 feet high) inshore. Erosion of material landward of historic bulkhead line. Temporary stabilization to prevent fill loss at ends of adjacent structures.

<table>
<thead>
<tr>
<th>Condition</th>
<th>Rating</th>
<th>Level of Action</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>F</td>
<td>Critical</td>
<td>Immediate</td>
<td>Conditions of structure/landform may warrant emergency stabilization as failure may result in potential loss of property and/or life. Landform eroded, loss of integrity. Structure exhibits critical levels of deterioration, section loss, cracking, spalling, undermining, and/or scour. Structure provides little or no protection from a major coastal storm. Actions taken to totally reconstruct structure to regain full capacity. Landform stability is severely compromised, rate of erosion/material loss may be increasing, and landform does not provide adequate protection from a major coastal storm. Actions taken to recreate landform to adequate limits for full protection from a major coastal storm.</td>
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</tbody>
</table>

**Priority**  
**Rating**  
**Action**  
**Description**

<table>
<thead>
<tr>
<th>Priority</th>
<th>Rating</th>
<th>Action</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>IV</td>
<td>High Priority</td>
<td>Consider for Next Project Construction Listing</td>
<td>High Value Inshore Structures with Potential for Infrastructure Damage and/or Moderate Density Residential Dwellings (1-10 dwellings impacted / 100 feet of shoreline)</td>
</tr>
</tbody>
</table>

**Structure Images:**  
**Structure Documents:**

018-212-901-060-100-PHO1A.jpg

Prepared By: Bourne Consulting Engineering
CZM South Shore Coastal Infrastructure Inventory and Assessment

Structure Assessment Form

Property Owner: Local
Presumed Structure Owner: Local
Owner Name: Duxbury

Location: Duxbury Beach
Based On Comment: DCR - Contract Drawings
Earliest Structure Record: 1946
Estimated Reconstruction/Repair Cost: $268,686.00

Date: 7/26/2006

Length: 354 Feet
Top Elevation: 9 Feet NAVD 88
FIRM Map Zone: VE
FIRM Map Elevation: 21 Feet NGVD

Primary Type: Bulkhead/ Seawall
Primary Material: Concrete
Primary Height: 5 to 10 Feet

Secondary Type: Secondary Material: Secondary Height:

Structure Summary:
First 50' is precast concrete seawall in fair condition with horizontal joint at mid-height. Concrete cracking and spalling near wall top and apex of curve. Remainder of structure is condition "B" with minor cracking (construction similar to adjacent structures).

Condition Rating
Level of Action Description
C Fair Moderate
Structure is sound but may exhibit minor deterioration, section loss, cracking, spalling, undermining, and/or scour. Structure adequate to withstand major coastal storm with little to moderate damage. Actions taken to reinforce structure to provide full protection from major coastal storm and for extending life of structure. Moderate wind or wave damage to landform exists. Landform may not be sufficient to fully protect shoreline during a major coastal storm. Actions taken to provide addition material for full protection and extended life.

Priority Rating Action Description
IV High Priority Consider for Next Project Construction Listing High Value Inshore Structures with Potential for Infrastructure Damage and/or Moderate Density Residential Dwellings (1-10 dwellings impacted / 100 feet of shoreline)

Structure Images:
018-212-901-064-100-PHO1A.jpg
018-212-901-064-100-PHO1B.jpg

Structure Documents:
MA DPW NOV 1946 PROPOSED 018-212-901-064-100-DCR1A

Prepared By: Bourne Consulting Engineering
# CZM South Shore Coastal Infrastructure Inventory and Assessment

## Structure Assessment Form

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<td>Presumed Structure Owner:</td>
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<td>Duxbury</td>
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<td>Feet NGVD</td>
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<tr>
<td>544</td>
<td>9</td>
<td>VE</td>
<td>21</td>
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<table>
<thead>
<tr>
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<th>Primary Material:</th>
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<tbody>
<tr>
<td>Bulkhead/ Seawall</td>
<td>Concrete</td>
<td>5 to 10 Feet</td>
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</table>

<table>
<thead>
<tr>
<th>Secondary Type:</th>
<th>Secondary Material:</th>
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<tbody>
<tr>
<td>Revetment</td>
<td>Stone</td>
<td>Under 5 Feet</td>
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### Structure Summary:
Concrete seawall with 30° cap and wave return face. Revetment is 3' to 4' high x 6' to 8' wide with stone size 1 ton to 2 ton. Horiz. Movement of about 3 wall sections (40'ea = 120' total) Horizontal cracking at wall mid-Height

<table>
<thead>
<tr>
<th>Condition Rating</th>
<th>Priority Rating</th>
<th>Level of Action Description</th>
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<tr>
<td>C</td>
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<td>Consider for Next Project Construction Listing</td>
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<tr>
<td>Fair</td>
<td></td>
<td>High Value Inshore Structures with Potential for Infrastructure Damage and/or Moderate Density Residential Dwellings (1-10 dwellings impacted / 100 feet of shoreline)</td>
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</table>

### Condition Description
Structure is sound but may exhibit minor deterioration, section loss, cracking, spalling, undermining, and/or scour. Structure adequate to withstand major coastal storm with little to moderate damage. Actions taken to reinforce structure to provide full protection from major coastal storm and for extending life of structure. Moderate wind or wave damage to landform exists. Landform may not be sufficient to fully protect shoreline during a major coastal storm. Actions taken to provide addition material for full protection and extended life.

### Structure Images:
- 018-212-901-073-100-PHO1A.jpg
- 018-212-901-073-100-PHO1B.jpg

### Structure Documents:
- MA DPW | NOV 1946 | PROPOSED | 018-212-901-073-100-DCR1A
- DEP CH.91 | JULY 02, 19 | PLANS | 018-212-901-073-100-LIC1A

Prepared By: Bourne Consulting Engineering
Section IV

Town of Duxbury

Structure Photographs
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<th>Contract/ Drawing Number</th>
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<th>Title</th>
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</table>
Section V

Town of Duxbury

Structure Research

TOWN DOCUMENT LIST

MA DCR - DOCUMENT LIST

MA DEP – Chp 91 DOCUMENT LIST

- Copies of License Documents

USACE – PERMIT DOCUMENT LIST

- Copies of Permit Documents
TOWN: DUXBURY
SOURCE: TOWN OF DUXBURY
LOCATION: DUXBURY, MA
DATE OF RESEARCH: AUGUST 2006

<table>
<thead>
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<th>BCE Structure No</th>
<th>Document No</th>
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<th>Entity</th>
<th>Municipality</th>
<th>Date</th>
<th>Title</th>
<th>Sheets</th>
<th>Location</th>
<th>Description</th>
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NO DRAWINGS AVAILABLE AT THE TOWN
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<tr>
<th>BCE Structure No</th>
<th>Document No</th>
<th>Contract/ Drawing Number</th>
<th>Entity</th>
<th>Municipality</th>
<th>Date</th>
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<th>Sheets</th>
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<td>2357</td>
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<td>SEPT. 1993</td>
<td>PLAN ACCOMPANYING PETITION OF THE TOWN OF DUXBURY DEPT. OF PUBLIC WORKS #78 TREMONT STREET, DUXBURY, MA 02332</td>
<td>1</td>
<td>HOWLAND LANDING, CRESCEANT STREET, NEAR MYLES STANDISH MONUMENT STATE PARK</td>
<td>REPAIR BOAT LANDING GROINS</td>
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<td>DUXBURY</td>
<td>SEPT. 1993</td>
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<td>1</td>
<td>HOWLAND LANDING, CRESCEANT STREET, NEAR MYLES STANDISH MONUMENT STATE PARK</td>
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<td>NOV. 4 1994</td>
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<td>BETWEEN 123 GURNET ROAD AND 435 CANTON AVE</td>
<td>REPAIR SEAWALL AND CONSTRUCT REVETMENT</td>
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<td>DUXBURY</td>
<td>JULY 02, 1997</td>
<td>PLAN ACCOMPANYING PETITION OF THE TOWN OF DUXBURY FOR PLACING STONE PROTECTION ALONG EXISTING SEAWALL</td>
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<td>GURNET ROAD AND BAY AVENUE</td>
<td>STONE PROTECTION FOR SEAWALL</td>
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<td>018-212-901-073-100-LIC1A</td>
<td>6664</td>
<td>DEP CH.91</td>
<td>DUXBURY</td>
<td>JULY 02, 1997</td>
<td>PLAN ACCOMPANYING PETITION OF THE TOWN OF DUXBURY FOR PLACING STONE PROTECTION ALONG EXISTING SEAWALL</td>
<td>5</td>
<td>GURNET ROAD AND BAY AVENUE</td>
<td>STONE PROTECTION FOR SEAWALL</td>
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NOTES:
1) EXISTING CONTOURS BASED ON FIELD SURVEY JULY 1993.
LOT LINES ARE COMPILED AND DO NOT REPRESENT A PROPERTY LINE SURVEY BY THIS OFFICE.
2) DATUM: NGVD (ADD 4.6' TO CONVERT TO MLW DATUM)

KURT & CHARLOTTE LANG
GSTATTERBERG
SCHLIERSEE, GERMANY

POST & RAIL FENCE
LOT 049-000

GRAN. BND./DH

BAY

50-500 lb.
STONE RIP RAP

BEACH

50-500 lb.
STONE RIP RAP

RAIL

BOAT RAMP

WOOD PILES

STONE & GRAN. DOCK

POST & RAIL FENCE
LOT 049-000

GRAN. BND./DH

POSTS

BERM (TYP)

CLF

LOT 470-053

MONMOUTH

MASS NEW CHURCH UNION
RAFFAL M. J. GUY
P.O. BOX 414
DUXBURY, MA 02331

PLAN VIEW

PLAN ACCOMPANYING PETITION OF THE TOWN OF DUXBURY DEPT. OF PUBLIC WORKS 878 TREMONT STREET, DUXBURY, MA 02332 FOR MAINTENANCE & REPAIR OF A BOAT LANDING (HOWLAND'S LANDING) AND GROINS IN KINGSTON BAY, DUXBURY, MA

CROSS SECTION A-A

SCALE: 1" = 40' HORIZ.
1" = 8' VERT.

SCALE: 1" = 40'

0 20 40 80 FEET

PREPARED BY:
THE BSC GROUP, INC.
293 WASHINGTON STREET
NORWELL, MA 02061

SEPT. 1993 SHEET 1 OF 1

LICENSE PLAN NO. 5083

Approved by Department of Environmental Protection of Massachusetts

DIVISION DIRECTOR
SELECTION CHIEF
PLAN ACCOMPANYING THE PETITION OF THE TOWN OF DUXBURY TO REPAIR AND MAINTAIN AN EXISTING SEAWALL AND NEW REVETMENT AT GURNET ROAD, DUXBURY, MA

LICENSE PLAN NO. 4235
Approved by Department of Environmental Protection of Massachusetts

SHEET 1 OF 3
REPAIR DETERIORATED CONCRETE (SEE DETAILS BELOW)

EL 22.5 (VARIES)

3" SCUPPER DRILLED INTO WALL, S=0.235% 8'-O.C. (TYP.)

TOP OF STONE EL 16'

5' WEEP HOLE DRILLED INTO WALL, S=0.235%, 8'-O.C. (TYP.)

FILTER FABRIC

EL 8.5 (VARIES)

EL 4.0

4' (MIN)

BEACH GRADE EL 12.2' PER 1948 DRAWINGS

TYPICAL REPAIR

SCALE: 1" = 5'

NEW EXPANSION JOINT FILLER

NON-SHRINK GROUT

NEW CONCRETE

REPAIRED WALL CAP

SCALE: 1" = 4'

REINFORCING

Hooke BARS Doweled INTO EXIST CONCRETE

NEW EXPANSION JOINT FILLER

SAWCUT EDGE

PROFILE

REPAIRED WALL CAP

SCALE: 1" = 4'

AUGUST 10, 1999
PLANS ACCOMPANYING
PETITION OF TOWN OF DUXBURY
FOR PLACING STONE PROTECTION
ALONG EXISTING SEAWALL
IN MASSACHUSETTS BAY
DUXBURY, MASSACHUSETTS

LICENSE PLAN NO. 6664
Approved by Department of Environmental Protection
of Massachusetts

Signature: Elizabeth A. Koukouras
Date: Jul 02, 1997
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<th>Municipality</th>
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<td>018-191-505-140-100</td>
<td>018-191-505-140-100-COE1A</td>
<td>USACE DUXBURY</td>
<td>MAY 8 1936</td>
<td>PROPOSED WHARF ON DUXBURY BAY AT DUXBURY, MASS</td>
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<td>JULY 1988</td>
<td>RECONSTRUCT EXISTING TIMBER PIER, DREDGE, FILL AND RIP RAP IN DUXBURY</td>
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<td>NOV. 14 1994</td>
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<td>3 GURNET ROAD</td>
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<td>6 GURNET ROAD NORTH OF CABLE HILL WAY</td>
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<td>6 GURNET ROAD NORTH OF CABLE HILL WAY</td>
<td>PLACING STONE PROTECTION ALONG AN EXISTING SEAWALL</td>
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**PIECE LIST**

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<td>PLUMB</td>
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<td>BATTER</td>
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<td>FENDER</td>
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**Existing Timber Pier**

- Face existing seawall
- Existing timber deck
- Relocated harbormaster office
- Relocated launch service office

**PIER PLAN**

- 4" plank
- 6x10 stringers
- 10x10 exterior stringers
- 12x12 pile caps
- All timber to be treated
- High tide line EL 11.7
- MHW EL 9.5

**Treated Timber Piles**

- 45' long
- Bent spacing varies

**Scale in Feet**

**Proposed:**

- Reconstruct existing timber pier, dredge, fill and riprap in Duxbury Bay.
- State: MA
- County of Plymouth
- Application by: Town of Duxbury
- Date: July 1988
- Sheet 2 of 5 (Rev. 9-27-88)
SECTION D-D AT C RAMP

SCALE IN FEET

SECTION E-E

SCALE IN FEET

NOTE: PIER DETAIL AND FLOAT NOT SHOWN SEE SHEET 2 OF 5

PROPOSED: RECONSTRUCT EXISTING TIMBER PIER, DREDGE, FILL AND RIPRAP IN DUXBURY BAY. STATE: MA COUNTY OFPLYMOUTH APPLICATION BY: TOWN OF DUXBURY DATE: JULY 1988 SHEET 3 OF 5 (REV-9-27-88)
DREDGING PLAN
& SECTION
TOWN OF DUXBURY
TOWN HALL
678 TREMONT STREET
DUXBURY, MA 02332

PROPOSED: RECONSTRUCT
EXISTING TIMBER PIER, DREDGE,
FILL AND RIPRAP IN DUXBURY
BAY. STATE: MA
COUNTY OF PLYMOUTH
APPLICATION BY:
TOWN OF DUXBURY
DATE: JULY 1988

DATUM: MLW= ELEVATION 0.0
PROPERTY DESCRIPTION
LOT NUMBER: 505-140
DUXBURY TAX MAP NO. 190
DEPARTMENT OF THE ARMY PERMIT

Permittee: Town of Duxbury, Thomas J. Groux, Town Mgr., Town Hall, 878 Tremont Street, Duxbury, Massachusetts 02322
Permit No. MA-DUX-881357-R-86 (JAN 3 1989)
Issuing Office: NEW ENGLAND DIVISION

NOTE: The term "you" and its derivatives, as used in this permit, means the permittee or any future transferee. The term "this office" refers to the appropriate district or division office of the Corps of Engineers having jurisdiction over the permitted activity or the appropriate official of that office acting under the authority of the commanding officer.

You are authorized to perform work in accordance with the terms and conditions specified below.

Project Description:

To reconstruct and maintain a town pier and launch ramp in Duxbury Bay at Mattakeesett Court, Duxbury, Massachusetts as shown in the attached plans entitled "Reconstruct Existing Timber Pier, Dredge, Fill and Riprap in Duxbury Bay, State: Ma, County of Plymouth," in 5 sheets, dated "July 1988", revised "9/27/88". The Project includes the following work.

1. The demolition and disposal of the existing timber pier and construction of a 14.5' wide, 93'X45' L-shaped treated timber pile supported pier, including temporary removal and replacement of two existing buildings onto the new pier.

PROJECT DESCRIPTION IS CONTINUED ON PAGE 4

Project Location:

Duxbury Harbor, Duxbury, Ma

Permit Conditions:

General Conditions:

1. The time limit for completing the work authorized ends on December 31, 1991. If you find that you need more time to complete the authorized activity, submit your request for a time extension to this office for consideration at least one month before the above date is reached.

2. You must maintain the activity authorized by this permit in good condition and in conformance with the terms and conditions of this permit. You are not relieved of this requirement if you abandon the permitted activity, although you may make a good faith transfer to a third party in compliance with General Condition 4 below. Should you wish to cease to maintain the authorized activity or should you desire to abandon it without a good faith transfer, you must obtain a modification of this permit from this office, which may require restoration of the area.

3. If you discover any previously unknown historic or archeological remains while accomplishing the activity authorized by this permit, you must immediately notify this office of what you have found. We will initiate the Federal and state coordination required to determine if the remains warrant a recovery effort or if the site is eligible for listing in the National Register of Historic Places.

ENG FORM 1721, Nov 86 EDITION OF SEP 82 IS OBSOLETE.
(33 CFR 325 (Appendix A))
SITE PLAN
SCALE: 1" = 60'

PLANNING THE PETITION OF THE TOWN OF DUXBURY TO REPAIR AND MAINTAIN AN EXISTING SEAWALL AND NEW REVETMENT AT GURNET ROAD, DUXBURY, MA

NUCCINI VINE ASSOCIATES, INC.
NOTES:
1. DATUM NLW=0.0; MHW=9.2; HTL=10.7
2. TOP TRUCKED PLAIN AT 15/55
3. VOLUME OF STONE TO BE PLACED BELOW MHW=600 CY; BELOW HTL=840 CY

PLANS ACCOMPANYING
PETITION OF TOWN OF DUXBURY
FOR PLACING STONE PROTECTION
ALONG EXISTING SEAWALL
IN MASSACHUSETTS BAY
DUXBURY, MASSACHUSETTS

LOCATION PLAN
NOVEMBER 1996
SHEET 2 OF 6

NUCCI VINE ASSOCIATES, INC.