The Future of Falmouth’s South Shore

Report of the Coastal Resources Working Group

to the Board of Selectmen, Falmouth, Massachusetts

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Executive Summary

In April, 2000, the Falmouth Board of Selectmen formed the Coastal Resources Working Group (CRWG) and charged the Group to explore reasons for the current condition of the coastal zone and to provide future scenarios for the coastal zone based on an understanding of physical processes and management approaches.

The fundamental finding of the Coastal Resources Working Group (CRWG) is that over the past 150 years, the Falmouth shoreline has been developed in a manner that has significantly impaired the ability of the coast to evolve in response to natural processes, leading to an overall decrease in the viability of the coastal system. The natural processes that build and maintain beaches have become largely inoperative due to the presence of jetties, groins, and coastal armoring. Although groins and jetties trap sand on their upstream western sides, downstream beaches become starved of sand because their continued erosion is no longer offset by an upstream supply of sediment. Sand supply is further interrupted by armoring with seawalls and revetments. In the near future, all of these problems will be exacerbated by a predicted acceleration in the global rate of sea-level rise.

The Town today is at a crossroads. It is clear to the CRWG that if the next 100 years of shoreline development is similar to the previous 100 years, the Falmouth shoreline will be an undesirable, even hazardous environment, devoid of all beaches except those artificially maintained. However, with aggressive action this trend can be reversed. Falmouth can restore the values of our shoreline and become a national leader in proactive coastal management.

The CRWG has developed a long-term "vision" for the Falmouth south shore, which includes restoration of natural sediment processes wherever possible, and improving public access along the entire shoreline. This vision would be realized over the next 50 to 100 years, to achieve the following goals:

- Beaches and dunes will be wide enough for protection from storms and for public access and use.
- Sufficient sand will reside in the coastal system to maintain those beaches.
- Water quality, habitat and fisheries resources of the coastal zone, estuaries, ponds and marshes will be sustained and enhanced.
- A minimum of hard structures (e.g., groins, seawalls, jetties, etc.) will be found in the coastal zone, to reduce maintenance costs, allow natural sediment transport, and for ease and safety of public use; adverse impacts of their presence will be mitigated by passive and active management approaches.
- Shoreline armoring structures, where present, will not detract from the aesthetics of and access to the shoreline environment.

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Public infrastructure will be relocated from the immediate coast to reduce maintenance and repair costs and to reduce its impact on the coastal system.

A proactive approach to shoreline management will be aimed towards prevention of problems and provide a response protocol when shoreline damage occurs.

The CRWG recommends the following actions to achieve these goals. Most of these goals should be achieved over the next 20 years. Monitoring and revising these actions and timelines for implementation should occur as necessary over a 50 to 100 year time frame. Some of the recommended actions include:

- Acquire coastal land for open space to increase public access, reduce property and infrastructure damage, and improve the functioning of coastal processes.

- Move or change vulnerable public infrastructure to reduce damage and maintenance costs.

- Conduct beach nourishment at key “source” locations to restore the natural sand transport system and provide recreation and storm protection.

- Remove unnecessary, hazardous, or damaging coastal armoring structures.

- Create sand management systems that will keep sand from being transported offshore into deep water by jetties at pond inlets.

- Develop improved regulations to protect coastal systems and beaches.

- Encourage landowners to obtain conservation easements that protect valuable coastal assets such as unarmored bluffs that provide sediment to down-drift beaches.

There is a clear need for a comprehensive coastal management plan that addresses long-term planning and provides for timely responses to short-term (e.g., storm-related) issues. In addition to the tools listed above, local, state and federal regulations can be used to implement such a plan. It will require coordination among many Town groups and agencies that already are involved in different aspects of coastal management. The CRWG believes coordinated, proactive coastal management is both highly desirable and achievable through concerted Town effort.
Acknowledgments

The Coastal Resources Working Group thanks the Town of Falmouth Board of Selectmen for their support. R. Jude Wilber was an important catalyst in helping the Selectmen recognize the importance of planning for the future of Falmouth’s shoreline and developing the charge to the Working Group. The Falmouth League of Women Voters, particularly the late Helen Warren, also took keen interest in the future of Falmouth’s coast and sponsored a forum on coastal issues that helped generate interest in beginning a study of the Falmouth shoreline.

Staff and students at the Waquoit Bay National Estuarine Research Reserve were instrumental in compiling and analyzing the coastal property data presented in Appendix A.

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1. Introduction

In May, 2000, in response to growing concerns about erosion of beaches and increasing shoreline maintenance costs, the Falmouth Board of Selectmen formed the Coastal Resources Working Group (CRWG). The CRWG was charged with the following tasks: 1) identify key factors that have dictated the current condition of the coastal system; 2) explore reasons for the current condition; 3) provide future scenarios of the coastal zone based on an understanding of physical processes and management approaches; and 4) conduct community outreach on coastal processes.

The CRWG has taken a long-term (decades to 100 years) view of the Falmouth coastal zone and its management needs. Such a long-term view is a new approach for the Town; in the past, most Town decisions concerning coastal issues have been made with a much shorter planning or outcome horizon (e.g., a year or two). A long-term approach is necessary, however, because many geological processes that affect shoreline changes and that impact Town resource management occur over time periods of centuries and longer. Consequently, it would be shortsighted to develop an assessment of coastal processes based only on a snapshot in time. Some natural events that shape our coastline, such as major hurricanes, can occur infrequently and sporadically. Many other coastal processes, such as sand movement alongshore or sea-level rise, act in constant but very small steps, and have effects that become evident only over a long time period. Our 100-year time frame takes account of both types of events and time frames: large infrequent events and small frequent events.

At the direction of the Selectmen, the CRWG has focused on Falmouth’s south shore, because of the many important permitting, coastal management and economic issues associated with the south shore at the present time. This report describes our findings concerning coastal erosion and sedimentation and the implications for coastal management along the south shore, as well as work that lies ahead.

To develop long-term management goals for Falmouth’s south coast, the CRWG worked over a period of three years to achieve the following:

1) Understand the nature of coastal processes along the south shore and the current condition of the coastal zone from Nobska Point to Waquoit Bay;

2) Assess the diverse values and interests of the Town in this area, including navigation, tourism, protecting and restoring natural environments, beaches, fishing and shellfishing, research, and recreation;

3) Develop a vision, based on that understanding and those values, of Falmouth’s south shore for the year 2100; and

4) Develop and recommend management goals for Falmouth’s south shore in order to reverse the current degraded condition of the shore and reach the desired shoreline conditions, based on the defined vision.
This report outlines our results in brief narrative form. Additional details and expanded discussion of many important related issues are found in the appendices.

2. Coastal Processes

Falmouth’s coastal zone is an active and dynamic place. This may not be evident at first glance or on a single visit, but anyone who has waded into the sea and felt the sand wash away beneath his or her feet as the waves break and run back, has felt the truth of that fact. These two features, waves and sand, are needed in order for beaches to form and persist. Basically, waves create and maintain beaches wherever there is enough sediment available, i.e., when the sediment supply is sufficient. Other coastal features such as coastal banks, bluffs, marshes, and dunes, are involved in the natural cycle of beach-building and erosion. These sources of sediment erode in response to currents, waves, and storms, and provide sediment for beaches and dunes.

On Cape Cod, the sand that makes up the beaches comes from erosion of the shoreline of the Cape itself; rivers do not carry a significant amount of sediment to the shores of the Cape from inland areas. Beaches are created by erosion of the upland. Storm waves breaking against the bluffs (1), dunes (2) or other upland areas undermine the slopes. Sand and rocks cascade down into the surf, to be tumbled and carried away. Both storm waves and normal non-storm waves carry sand up onto the beach as they wash ashore. Because waves lose energy as they run up the beach and sink into the sand, each wave leaves a thin layer of sand on the beach. It is tempting to think that the sand thus brought to the beach originated offshore, but it did not. It was eroded from the Cape itself.

Most waves strike the coast at an angle; they break and run up the beach at that angle, and then drain directly back down the slope of the beach. That means that a grain of sand carried by a wave travels diagonally up the beach, and then straight back down toward the surf, ending up a bit farther along the beach than where it started out. With each wave the sand grain is moved progressively along the beach. This continual motion of sand over time means that although a beach may look permanent, it is actually always in motion, moving grain by grain along the coast. At any given time there is a definite "downstream" direction to this movement. If there is a prevailing wind direction the sand will move mostly in one direction, driven by the waves that the prevailing wind generates. Because the sand is in motion, a beach can only continue to exist as long as new sand enters the system at about the same rate that it is carried away.

The beaches of the Outer Cape are a clear example of this process. These beaches are exposed to the large waves of the Atlantic Ocean, yet they continue to exist. Sand eroded from the bluffs at Truro and Wellfleet is constantly moving northward along the shore to extend Race Point and Long Point, and southward to build Nauset Beach and Nauset Spit. The beaches are cut lower by the winter northeasters which also erode the bluffs. The bluffs have retreated about 450 feet since Henry Thoreau walked along them in the 1850s, yet each summer the beaches at their feet look the same due to the constant addition of new sand. Erosion of the bluffs has provided the sand to maintain the beaches even while sand is being carried away and is building the spits and barrier beaches to the north and south.
3. Falmouth's South Shore

Coastal processes such as the ones described above built and maintained Falmouth's south shore beaches (Figure 1) until the early 1900s. In general, wave energy is weaker on Falmouth’s south shore than on the Outer Cape, because Martha’s Vineyard and Nantucket protect this area of the Cape from the swells of the open Atlantic Ocean. However, the principles are the same. Storm waves remove sand from the bluffs between Nobska Point and Oyster Pond, from the high bluffs of Falmouth Heights, the ends of the upland necks between Little, Great, Green, Bourne’s and Eel ponds, and from the southern end of Washburn Island. This eroded sand formed sandy beaches at the feet of the bluffs and was carried east across the mouths of the bays to form barrier beaches (3) that protected them. Occasionally, winter storms such as northeasters briefly reversed the direction of sand transport (4).

The inlets of the coastal ponds (or perhaps more correctly, outlets) through the barrier beaches migrated slowly over time, as those in Chatham and at Nauset do today, kept open by the ebb and flow of the tide. Over time, most of these inlets would move or migrate slowly (perhaps at a rate of a foot or two per month) “downstream” and would eventually jump back toward the other end of the spit in some large storm when the spit might be washed over. The inlets, especially those of the smaller ponds, may have closed almost completely in calm, dry weather.

Dunes developed inland of the beaches, where windblown sand piled up around plants and other obstacles. Behind the barrier beaches of the larger bays, salt marshes, eelgrass, and shellfish grew in the protected shallow water. As sand layers were washed over into the bay by storms or the circulation of fresh and salt water changed because of inlet changes, salt marshes and other living resources shifted position or migrated (5). Indeed, the vitality of many coastal habitats (e.g., sand flats, salt marsh) is strongly dependent on a mobile shoreline.

These processes still operate along Falmouth's south shore: summer southwest winds create waves that move eastward and break on the shore, carrying sand inland to create beaches and dunes. Salt marsh still grows behind barrier beaches. But along Falmouth’s south shore, these natural processes have been slowed down or prevented from happening. Except in areas where sand has been added, the beaches are typically narrow and fairly steep, many are rocky, few dunes remain, and some beaches have moved inland noticeably (Figure 2). Someone who lived in Falmouth in 1800 or 1900 would have a hard time recognizing some parts of the Vineyard Sound shoreline today.

How does Falmouth’s shoreline differ today from what it was a century ago? The narrow, rocky beaches are new features of the shore. So is the pervasive hardening of the coast: solid stone seawalls (6), groins (7), jetties (8) and riprap (9) revetments (10) now armor much of the shore from Nobska Point to Waquoit Bay. Each of these hard stone structures was built to protect property from the sea. Generally, these structures do protect individual properties, at least temporarily. Seawalls and revetments protect the bluffs by preventing erosion, jetties protect a dredged pond inlet by redirecting the sand that would otherwise gradually fill the inlet out into deeper water (Figure 3), and groins slow the along-shore movement of sand.
Figure 1. Map of Falmouth’s south shore. The subject of this report is the shoreline from Nobska Point to the mouth of Waquoit Bay.
Figure 2. This 1994 aerial photograph of the area near Green Pond also shows the shoreline position in 1845. There has been over 500 feet of shoreline retreat here over the past 150 years. Much of the shoreline retreat can be attributed to the reduced sand supply in this area caused by the armoring of updrift sediment sources (e.g., Falmouth Heights), and the offshore diversion of sand by jetties (see Figure 3).
Figure 3. This 1951 aerial photograph of the Great Pond jetties shows the large amount of sand that is deflected offshore by the jetties. This sand is probably lost to the beach system. Jetties throughout Falmouth contribute to beach erosion by interfering with the movement of beach sand along the coast.
But the protection that these structures provide comes at the expense of something else. The sand in front of a revetment continues to move to the east, but no new sand replaces it. Consequently, the beaches become narrower, rockier, and steeper, and the water offshore gets deeper. Often this causes a property owner to build a groin to hold the remaining sand on the beach. Such a groin may hold the sand on that property, but by doing so it deprives the beach to the east of sand (Figure 4). The effects of armoring may not be visible immediately, but over time, especially with the cumulative effect of storms, the shoreline will change.

Falmouth's south shore is now severely sand-starved. Many beaches, like those at Trunk River and Menauhant Beach, have relatively little sand; the surface is mostly rocks. At Trunk River, the dunes that once existed between the beach and the railroad tracks (now the bike path) have disappeared with the loss of the beach sand. As a result, the barrier beach there and all along Surf Drive is narrower and more vulnerable to destruction during storms, which may occur due to waves overwashing and breaching the line of dunes. Offshore, the sand that was the underwater extension of the beach has also been transported to the east, leaving a steeper slope or beach profile, and allowing larger waves to break against the beach. Since larger waves carry more energy, erosion increases.

All of these changes have occurred in about 100 years as the unintended consequences of trying to protect the bluffs from which the beach sand has always been derived and to keep channels into the ponds open for navigation and water circulation.

The retreat of bluffs, the movement of sand along beaches, the migration of inlets and washovers of barrier beaches are natural processes that occur all along the coast. These natural processes built the sandy shoreline along Falmouth’s south shore, now visible only in historic photographs. With rising sea level, some of these processes can be expected to operate more rapidly or more intensely.

In the past 100 years, sea level in Falmouth has risen approximately 1 foot (Figure 5); this is also the time during which the shoreline has been armored and many sandy beaches have disappeared. With sea level rise predicted to be greater than one foot over the next 100 years, erosional process will accelerate, and the shore will become even more vulnerable. This is particularly true for sediment-starved areas like Falmouth’s south shore: where the armored upland does not provide any sediment to the beaches and dunes, the beaches and dunes have narrowed or disappeared. The near-shore sea bottom itself is eroding, allowing bigger waves to reach the seawalls and revetments and to erode the barrier beaches. The erosion may happen gradually, or it may not happen until some large storm reaches over or around the revetments and between the groins and jetties, and carries all away in a few crashing hours. Constant repair and expansion of the armoring can put off the day when the upland is eroded, but it will eventually succumb. Meanwhile, the costs of that maintenance will escalate as the water gets deeper and the job becomes more difficult.

Another cost of armoring is the loss of beaches, both public and private. On Cape Cod, when erosion of the upland is prevented, the sandy beaches begin to shrink. This geologic fact can be ignored only if we are willing to watch the sand disappear, see the barrier beaches breached, and spend Town resources on replacing the original sandy shore with costly and highly engineered
Figure 4. View looking west along the Fay Road shoreline, with Nobska Point in the background. The many revetments and groins along this stretch of shoreline have essentially impounded sediment that would have been introduced to the coastal system by natural shoreline erosion. (1985 photo by Amy Rader, courtesy of *the Enterprise.*
Figure 5. Evidence for sea-level rise in Woods Hole comes from observations and measurements. The upper left photo shows a granite boulder seawall at the northwest corner of Little Harbor, Woods Hole in 1900. The lower photo shows the seawall in August, 2000. A yellow line in each photo shows the upper limit of the black zone of *Linghelda* algae, which grows only near sea-level. Selected rocks are numbered and lettered in each photo for identification. The upper limit of the black zone in 2000 was measured in the field against the position in the 1900 photo. The upper limit of the modern black zone at this site is 13-14 inches higher on the wall compared to its position in 1900. This observation of sea-level rise is confirmed by 69 years of tide gauge data from Woods Hole shown in the graph above, which indicates approximately a 10 inch rise in mean sea-level from 1932-2001. (Photos courtesy R. Jude Wilber. Tide gauge data from the National Ocean Service.)
artificial beaches, dikes and seawalls that will need frequent maintenance. These costs become multiplied many times when the loss of income from tourism is added to the costs of maintenance of the coastal structures and the more-frequent need for repair of infrastructure along the shoreline.

To prevent the full development of this grim scenario, the Town of Falmouth must change its shoreline management strategies, and move toward policies that promote the long-term recovery and health of the coastal system.

4. The Future of Falmouth’s South Shore

In establishing the Coastal Resources Working Group, the Selectmen suggested that the current approach to coastal resources was no longer a viable management strategy. The CRWG concurs with this conclusion, based on a careful analysis of several coastal management alternatives which are described below.

A. Business as Usual

Here is our best estimate of what Falmouth’s south shore may look like in 100 years if Falmouth does not change its coastal management policies and practices:

- Beaches will be present only where maintained by beach nourishment (11); few, if any, dunes will remain. Beach nourishment will become progressively more expensive as nearby sand resources are depleted.

- The loss of the protective beaches and dunes will expose both public infrastructure (roads, bridges, water pipelines) and private property to the damaging effects of storms. The maintenance costs to the Town and to individuals will rise, and those increases will accelerate as sea level continues to rise.

- Beaches will have retreated landward, with the possibility of breaks through the barrier beaches becoming more likely. Such breaks would expose property on the salt ponds to the waves of the open water of Vineyard Sound, and potentially cause serious disruption to channels for navigation into and out of the south shore ponds.

- The shoreline will be pervasively armored, which will decrease the usability of the shore.

- The need for, and cost of, emergency reaction to storm damage will increase.

B. An Alternative Vision of the Falmouth South Shore: “Vision 2100”

The Coastal Resources Working Group, in keeping with its charge of planning for the long-term, has developed a vision for Falmouth’s south shore 100 years from now. This vision includes the consideration of the important values of the shoreline, the natural processes that influence its
evolution, and the influence of human activities and structures that adversely impact the stability and sustainability of the beaches. This vision has the following elements:

- Beaches and dunes will be wide enough for protection from storms and for public access and use.
- Sufficient sand will reside in the coastal system to maintain those beaches.
- Water quality, habitat and fisheries resources of the coastal zone, estuaries, ponds and marshes will be sustained and enhanced.
- A minimum of hard structures (groins, seawalls, etc.) will be found in the coastal zone, to reduce maintenance costs, allow natural sediment transport, and for ease and safety of public use; adverse impacts of their presence will be mitigated by passive and active management approaches.
- Shoreline armorining structures, where present, will not detract from the aesthetics of and access to the shoreline environment.
- Public infrastructure will be removed from the immediate coast to reduce maintenance and repair costs and to reduce its impact on the coastal system.
- A proactive approach to shoreline management will be aimed towards prevention of problems and provide a response protocol when shoreline damage occurs.

Attaining this vision is a serious challenge. In fact, it is unlikely, even in a one hundred year time frame, to expect that the entire south shore will meet all of the criteria of this vision. The CRWG believes, however, that it is in the interests of the Town of Falmouth to be guided by this vision in all decisions related to the management, development and preservation of the shoreline.

There are several major impediments to re-establishing a “natural” shoreline in Falmouth. One is private property. Another is public infrastructure. Most of the structures along the shoreline that are adversely impacting the quality and function of the beaches were constructed to preserve the shoreline property and roads. Along much of Falmouth’s south shore, the attempt to “hold the line” against shoreline retreat is incompatible with a healthy, sustainable beach. Trade-offs have to be addressed between the value of particular structures and properties and the value of re-establishing a sustainable shorefront. At some locations, such as Nobska Point, the value of the structure may outweigh the value of re-establishing the natural shorefront regime. Notwithstanding these specific considerations, the sustainability of the shoreline requires a major shift in the management priorities, requiring a “softer” approach to separating the beach from upland property and infrastructure, in order to allow the beach to survive the natural fluctuations of sand movement caused by the annual cycle of weather and the occasional extreme storm.

The following recommendations and timeline for actions provides a proactive plan for living with a dynamic, eroding coastline. Over the long-term, this amounts to planning for a managed retreat from an advancing sea. This will require extensive planning and discussion of such issues.
as relocating Town infrastructure, and balancing the rights and desires of private coastal property owners with those of the public that value and use Falmouth’s coastal zone.

Another impediment to attaining our vision for a “natural” shoreline is a serious deficit in sand along the south shore. The jetties, groins and seawalls, as well as long-term sea-level rise, have robbed Falmouth of much of the sand that made up the beaches of a century ago. Even with the removal of many of these structures, that deficit in sediment must be made up in order to forestall a rapid and unacceptable retreat of the shoreline. Beach nourishment is a necessary part of attaining our vision of a healthy south shore. The quantity of sand that should be contemplated is large, and the cost will be appreciable. However, it is a necessary and sensible investment that is a first step to “buy back” the shoreline that has been lost by the failed management practices of the last century. Beach nourishment is not a panacea—it does not provide a permanent replacement for lost sand. But a commitment to beach nourishment is a necessary part of the strategy that will bring back the sustainable shoreline of the CRWG vision.

5. Recommendations

Falmouth can avoid the negative results of our current shoreline management policies and achieve something like the “Vision 2100” coastline. To achieve this, the Town must change its approach to shoreline management, and undertake a number of significant actions. These actions will cost money, time, thought, and energy, and will change the way we deal with the coast, but they will help the Town to maintain its seashore character and the viability of its economy. The CRWG feels that these actions, in the long run, are vitally important and will be cost-effective.

To accomplish these goals, the Town should establish a Coastal Management Committee to recommend directions and oversee actions that will move the Town away from our present coastal management practices. Specifically, the CRWG recommends that the Coastal Management Committee establish a long-term plan with goals and milestones that will redirect the Town’s actions to improve the coast and encourage sustainability. The CRWG recommends that the Coastal Management Committee include most or all of the following immediate-term, medium-term and long-term actions in that plan.

Recommended Action Items and Proposed Schedule for Coastal Management Actions

**Immediate Term Action Items (0-5 years):**

1) Establish a Town Coastal Management Committee to review proposed coastal projects, coordinate coastal activities and to inform the public concerning coastal processes. At a minimum, this Committee should consist of representatives of the following Boards and Town departments: Planning Board, Conservation Commission, Department of Natural Resources, Harbormaster, Shellfish Warden and Herring Warden, Waterways Committee, Beach Committee, Department of Public Works, and other Town Boards, agencies and organizations with a direct interest in coastal issues. This Committee should be responsible for ensuring and/or tracking progress on the Town’s implementation of the Coastal Management Plan (see below).
2) Develop a detailed Coastal Management Plan that is based on the recommendations of this study. The Coastal Management Plan should be developed with a specific timetable and specific Action Items, and responsible parties identified. Adaptive management principles should guide how new information is used to refine Action Items or update recommendations. The Plan should not only provide guidance for management actions but also provide for monitoring of implementation and successes or failures of the Plan.

3) Develop a Flood Hazard Mitigation Plan for approval by the State and the Federal Emergency Management Agency, or FEMA. This will qualify Falmouth for additional FEMA funding for flood mitigation (in addition to any emergency funds that are made available if Falmouth is declared an emergency site by FEMA following a storm).

4) Develop a series of targeted beach nourishment experiments utilizing selected offshore sand sources combined with partial or complete removal of designated damaging groins that would reduce proper transport of sand. Begin monitoring of beach nourishment and other experiments. Encourage beach nourishment at a rate that equals or exceeds the rate of erosion, in order to help build the supply of sediment in Falmouth’s coastal areas.

5) Actively “soften” existing groins and jetties where feasible in order to improve sand transport along shore, by loosening or making such structures more porous. Begin monitoring of downdrift and updrift shoreline areas.

6) Improve and restore public access to coastal zone, particularly to suitable coastal beaches, including acquiring “right of passage” from coastal landowners through conservation easements or other incentives. Investigate funding for improving or restoring public access to the water, through Chapter 91 public access grants and other local, regional, state and federal sources of funding to improve coastal access.

7) Develop plans to move Town-owned infrastructure away from the immediate shoreline if damaged in a storm or if located in a high-hazard coastal area, to inland areas or to less-risky coastal areas.

8) Develop plans for beach nourishment, sediment bypassing at inlets, and relocation of Town infrastructure to inland locations planned for the intermediate period (see below).

9) Work with appropriate Town agencies and local organizations to promote coastal tourism combined with protection of coastal resources (“coastal ecotourism”).

10) Adopt a policy or regulation to ensure that all suitable dredged materials from coastal inlets and ponds are disposed of on beaches, particularly downdrift of jetties.

11) Work with land acquisition and open space protection groups in Falmouth to help acquire and preserve coastal parcels, to increase public access to the shoreline, to encourage protection of natural sediment processes through conservation easements or rolling easements, and to reduce storm damage, erosion and property damage.
12) Develop and apply a suite of economic incentive tools to encourage landowners to build farther back from coastal resources.

13) Obtain funding to acquire coastal properties that are important sediment sources or are highly dynamic coastal areas, through a flood insurance surcharge, realty transfer tax or other means.

14) Improve the ecological and aesthetic health of the coastal zone by reducing input of nitrogen in wastewater; provide sewers and tertiary treatment for all sewage. If this is successful, this will also reduce the need for dredging to improve water quality of coastal ponds. Continue monitoring coastal water quality.

15) Provide public outreach concerning coastal processes and sediment dynamics.

16) Adopt sensitive portions of the coastal zone as a District of Critical Planning Concern, or DCPC (13), or a Coastal Erosion Zoning Overlay District (14) for the purposes of protecting and enhancing natural sediment transport processes, managing erosion, improving scenic and aesthetic natural values, promoting environmentally sensitive public access and tourism, and protecting long-term public safety by encouraging development to move away from hazardous coastal areas, and implementing these recommendations.

17) Revise existing rules and regulations that damage the coastal zone. Revisions that should improve the Town’s coastal zone include the following measures:

   a) Prohibit new seawalls, groins, and other coastal armoring structures.

   b) Prohibit reconstruction or substantive repair of coastal armoring structures where the underlying landform is a sediment source, a coastal beach, coastal dune, eroding coastal bank or other dynamic coastal landform. The existing DCPC regulations that prohibit reconstruction of coastal structures in the Black Beach / Great Sippewissett Marsh DCPC provide an example of the type of regulations that can protect sediment sources from becoming armored and restore sediment sources that are now armored.

   c) Prohibit any new construction, structures, impervious surfaces or coastal armoring in V and A zones (19) that serve as sediment sources or potential sediment sources (e.g., coastal beaches, barrier beaches, coastal dunes, or eroding coastal banks).

   d) For structures in V or A flood zones that are damaged by storms, reduce the “no rebuild” damage level for structures under FEMA regulations from 50% to 30% by adopting amendments to local zoning bylaws and building codes.

   e) For reconstruction in V and A flood zones that are sediment sources, coastal beaches, coastal dunes or eroding coastal banks, prohibit expansion of building footprint area and require elevation of the first floor above the 100-year storm wave base; prohibit
use of breakaway panels since they deflect wave energy onto adjacent parcels and create storm debris when they are destroyed by storms.

f) Eliminate the 1989 “grandfathering” of lots that currently allows coastal armoring of eroding coastal banks on lots that were developed prior to 1989 (the date of adoption of the Town’s Wetland Bylaw). Also eliminate the analogous 1978 “grandfathering” of lots that were developed prior to 1978 (the date of adoption of the Wetlands Protection Act coastal bank regulations) by adopting a provision under the Falmouth Wetlands Bylaw that prohibits armoring of eroding Coastal Banks or coastal dunes whether or not the lots were developed prior to 1978.

g) For new construction in coastal areas, adopt strict “coastal buffer strips” or setbacks from coastal dunes, coastal banks, and coastal beaches, to allow migration of these landforms to occur and to allow natural sediment transport processes to occur. The recommendations of the Regional Policy Plan for 100-foot buffer strips for coastal resource areas (e.g., coastal beaches, coastal dunes and eroding coastal banks) should be adopted by the Conservation Commission as regulations under the Wetlands Bylaw.

h) For reconstruction in coastal areas near sediment sources, similar setbacks or incremental setbacks should be applied. Incentives to encourage owners to build farther back from coastal dunes, coastal beaches and coastal banks should be actively developed. Consider adopting a zoning bylaw to protect sediment transport processes and aesthetic values or other means to prohibit or discourage elevation of damaged or reconstructed buildings in V-zones (e.g., Surf Drive cabanas on pilings) because of their negative impact on coastal processes and coastal values.

i) Update the Local Comprehensive Plan (LCP) (see Appendix D, Item 9, and Appendix F) to conform with these goals and recommendations. Suggested elements of the LCP to revise include the Coastal Element, Wetlands Element, Natural Resources, Open Space, Recreation, Traffic, Public Access, Economy and Tourism.

Intermediate Term Action Items (5-20 years):

In the intermediate term, the Town should continue to implement the action items that are initiated in the first 5 years, and build upon these action items, by doing the following:

1) Continue to acquire coastal parcels, conservation easements, or rolling easements to enhance natural coastal sediment processes and to minimize or prevent development of hazardous coastal areas.

2) Institute a program to remove armoring in sensitive areas as nourishment projects and natural sediment supply allow. Such a program might include incentives for removal of privately-owned coastal armoring.
3) Implement sediment bypass plans at major jettied inlets to ensure that sand moving along the coast returns to the beaches downstream of the inlets. Remove jetties on selected low-impact inlets. Begin monitoring of sediment transport following implementation of sediment bypass plans.

4) Implement a plan for reduction or “loosening” of seawalls, including not rebuilding after storms. Begin monitoring of sediment transport downdrift of areas where seawalls have been removed or softened.

5) Require or encourage homeowners in FEMA V and A zones to remove or soften coastal armoring, or to nourish the beach to existing guidelines, with enforceable penalties such as the Town doing the nourishment and putting the cost on homeowner’s local tax bill (20).

6) Begin implementing a plan to move vulnerable infrastructure inland.

7) Continue beach nourishment, as indicated by short-term experiments.

8) Continue all monitoring begun in the short-term. Use results to evaluate whether remediation or restoration efforts succeeded, were inconclusive, needed more time to take effect, or did not succeed. Revise the Coastal Management Plan as needed.

9) Continue to provide public outreach concerning coastal processes and sediment dynamics.

10) Continue to update and improve the Local Comprehensive Plan and work with Town boards and committees to implement these recommended Action Items.

**Long-Term Action Items (20-100 years):**

1) Remove vital transportation corridors from coastal zone. This includes moving appropriate shore roads inland, elevating shore roads that cannot be moved, and removing selected shore roads. Move remaining vulnerable infrastructure inland.

2) Continue to maintain and increase public access to newly revitalized coastal zone by continuing to acquire land, access rights, and pursuing conservation easements or rolling easements.

3) Continue implementing sediment-bypass plans at major jettied inlets to ensure that sand moving along the coast returns to the beaches downstream of the inlets; consider removal of jetties on selected low-impact inlets.

4) Continue to implement plan for reduction of seawalls, including not rebuilding after storms (Note that 25% of the existing 1.92 miles of Town-owned seawall are already classified as being in “poor condition” by Town Engineer).
5) Continue monitoring beach nourishment and sediment transport at experimental areas and in areas where coastal armoring structures have been removed or mitigated.

6) Continue to provide public outreach concerning coastal processes and sediment dynamics.

7) Evaluate and revise the Coastal Management Plan periodically or as needed to further the goals of naturalizing the shoreline, minimizing costs of maintaining infrastructure, minimizing storm damage due to interference with natural dynamic processes, improving public coastal access, and restoring sediment sources and sediment dynamics.

8) Continue to evaluate, update, and implement the Local Comprehensive Plan to achieve these goals.

6. Conclusions

Falmouth is today at a crossroads. It is clear to the Coastal Resources Working Group that if the next 100 years of shoreline development is similar to the previous century, the Falmouth shoreline will be an undesirable, even hazardous environment, devoid of all beaches except those artificially maintained. Many properties, both public and private, will be vulnerable to storm damage and destruction. Maintenance costs will rise dramatically, and the very values that created and have sustained Falmouth as a desirable coastal town will be destroyed.

This grim forecast need not represent the Town’s future. The Town can turn away from the destructive strategies of the past and apply the knowledge of the processes at work along its shoreline to enhance, rather than degrade, its coastal areas. It will take a change in management strategies, and it will entail costs. But the CRWG feels that those costs will be offset by the reduction of storm damage and maintenance costs, and the increased value of its shoreline. Falmouth can be a leader; it can develop a new model for human interaction with the coastline. In so doing, Falmouth will not only point the way for other communities, but will maintain its traditional cultural and natural values.
7. Endnotes

1) Bluff: steep bank at the edge of shore, usually composed of erodible materials such as gravel and sand.
2) Dune: small hill of sand created by wind, often stabilized by vegetation.
3) Barrier beach: Barrier beaches are narrow, low-lying strips of beach and dunes that are roughly parallel to the coastline, and are separated from the mainland by a body of water or wetland. Hundreds of barrier beaches line the Massachusetts coastline. These landforms were created and are constantly changed by coastal processes, such as erosion, overwash during storms, dune movement, and inlet formation and migration.
4) The predominant direction of sand transport along Falmouth’s south shore is west-to-east, due to the predominance of southwesterly winds. However, strong northeaster storms can temporarily reverse the direction of longshore transport.
5) The salinity and water quality of coastal ponds is strongly influenced by inlet morphology. The more constricted the inlet, the fresher the water in the pond, and the more restricted the flushing of the pond. In their natural state, ponds vary in salinity due to changes in the inlet geometry (width, depth, and also location on the shore).
6) Seawall: A structure, often concrete or stone, built along a portion of a coast to prevent erosion and other damage by wave action. A seawall is typically more massive and capable of resisting greater wave forces than a revetment or bulkhead.
7) Groin: A narrow, structure built perpendicular to shore to reduce longshore currents, and/or to trap and retain littoral material (e.g., sand). Most groins are built of timber or rock and extend from the back of the beach or a seawall, across the beach and into the water. Several groins in close proximity along the beach are collectively known as a groin field.
8) Jetty: A structure typically built of large rocks extending into a body of water, which is designed to prevent shoaling of a channel by littoral materials (e.g., sand) and to direct and confine tidal flow. Jetties are built at the mouths of rivers or tidal inlets to help deepen and stabilize a channel. One jetty is usually built on each side of the inlet.
9) Riprap: A protective layer or facing of stone (usually boulders or other large rocks), placed to prevent erosion, scour, or sloughing of an embankment or bluff; the stone used for this purpose may also be referred to as riprap.
10) Revetment: A facing of stone, concrete, etc., to protect an embankment or shore structure against erosion by wave action or currents. A revetment is typically less massive than a seawall.
11) Beach nourishment: The process of replenishing a beach with sediment. It may occur naturally by longshore transport, or be brought about artificially by depositing dredged materials or materials trucked in from upland sites and placed on the beach.
12) Adaptive management: Adjusting resource management practices based on observed changes in the environment and based upon advances in knowledge concerning resource management.
13) District of Critical Planning Concern (DCPC): A DCPC is an area of critical value to Barnstable County, Massachusetts which must be preserved or maintained due to one or more of the following factors: a) the presence of significant natural coastal, scientific, cultural, architectural, archaeological, historic, economic or recreational resources or values of regional, state-wide or national significance; b) the presence of substantial areas of sensitive ecological conditions which render the area unsuitable for development; or c) the presence or proposed establishment of a major capital public facility or area of public investment. DCPCs may cover areas located in one or more than one town. DCPC’s may be nominated and designated for many purposes. For example, they may protect a municipal investment, protect a critical natural resource, or provide incentives for economic development. Falmouth has the first DCPC designated on Cape Cod: the Black Beach/Great Sippewissett Marsh DCPC, located in West Falmouth.

14) Coastal Erosion Zoning Overlay District: A zoning overlay district is an area which is designated by the Planning Board as having special issues or characteristics in common. Designation and approval of a zoning overlay district allows specialized management actions or regulations to be developed to address these special issues and characteristics.


16) Chapter 91: Massachusetts General Law Chapter 91 covers waterfront issues such as water quality, navigation, licensing of coastal structures and coastal armoring, and protection of the public right to access coastal waters.

17) Most sediment dredged from coastal ponds is sand. It tends to have an odor when first removed from the ponds due to hydrogen sulfide build-up, which is rapidly dissipated in a beach environment.

18) A zone: The FEMA flood zone that corresponds to the 100-year floodplain that is determined in the FIRM Flood Insurance Study for a particular geographic area.

19) V zone: The FEMA flood zone that corresponds to the 100-year floodplain that also has additional hazards associated with moving storm waves of amplitude 3 feet above the 100-year storm wave base or greater.

20) Requiring the property owner to remove existing armoring is probably not feasible or allowable. Reconstruction and repair, however, can be regulated, or incentives can be developed so that the property owner could have the choice to volunteer to remove the structure.
8. BIBLIOGRAPHY AND RESOURCES


Emery, K.O., A Coastal Pond Studied by Oceanographic Methods. Oyster Pond Environmental Trust, Inc.


Sea Grant. April 2000. Shoreline Change and the Importance of Coastal Erosion. In: Focal Points, a Sea Grant Program publication published by the Sea Grant Program, Woods Hole Oceanographic Institution.


WHOI Sea Grant. 2001. Evaluation of coastal erosion hazards: results from a national study and a Massachusetts perspective. WHOI Sea Grant, Focal Points, 3 pp, WHOI-G-01-003. Also available online at http://www.whoi.edu/seagrant/education/focalpoints/Fpeval.pdf.

WHOI Sea Grant.  2000.  Shoreline change and the importance of coastal erosion.  WHOI Sea Grant, Focal Points, 3 pp, WHOI-G-00-001.  Also available online at http://www.whoi.edu/seagrant/education/focalpoints/shoreline.html.


MAPS

CZM Barrier Beach Inventory Project.  April 1982.  Maps of barrier beaches at 1:40,000 scale, by MCZM, EOEA.  Base maps USGS 7.5 minute series (topographic).

CZM Shoreline Change Analysis Project.  2002.  Falmouth.  Scale 1:10,000 (1 inch = 833.33 ft.).  CZM, EOEA.  Sheets C70, C71, and C72 cover the Woods Hole to Waquoit shoreline.  Sheet C58 covers the West Falmouth area.

Massachusetts Department of Environmental Management (DEM) Wetlands Conservancy Program.  1980.  Wetland Restriction Program Maps showing parcels with wetlands and coastal deed restrictions.  Scale of 1:5,000.  Sheet H-149 covers coast from Quissett Beach and Fay Beach to Salt Pond (Falmouth Beach).  Map numbers H150 (Nobska Beach); H149 (Fay Beach to Falmouth Beach, including Salt Pond); H150 (Nobska Beach to Fay Beach); G34 (Woods Hole and Great Harbor); G35 (Penzance, Gansett); J13 (Falmouth Beach, Surf Drive to east of Great Pond); K192 (Green Pond to Mashpee town line and Washburn’s Island); K19 (Eel Pond, landward portions of Washburn’s Island, inland of K192); L216 (Waquoit Bay, Dead Neck).

Maps/photos -- WBNERR has a series of aerial photos of Waquoit Bay archived at WBNERR going back to 1938, as well as some historical maps to 1846.

REGULATIONS


DEP Wetlands and Waters Program DWW Policy 91-2. Salt Ponds: Criteria for Evaluating and Permitting Openings of Salt Ponds in Order to Manage, Maintain, or Enhance Marine Fisheries. Provides guidance for deciding whether salt pond openings should be permitted.

Falmouth Wetlands Bylaw, Chapter 235 of the Code of the Town of Falmouth and implementing regulations (FWR 10.00) revised August 1998.

310 CMR 10.00. Massachusetts Wetlands Protection Regulations.

TOWN OF FALMOUTH RESOURCES

1975 Town topographic survey maps (1:1200 scale, using 2’ contour intervals, from aerial photographs), Planning Department and Department of Public Works, Engineering Department.

1998 Town topographic survey maps (1:1200 scale, using 2’ contour intervals from aerial photographs), Planning Department and Department of Public Works, Engineering Department.

DEM Wetlands Conservancy maps (1999) showing aerial photograph maps of Falmouth, wetlands and coastal areas approximately delineated (1:5000 scale?) Great photographs. Conservation Department

Pre- and post-dredge survey reports for Great Pond, Little Pond, Bourne Pond, Rands Canal, from Barnstable County (contact Truman Henson, Regional CZM Coordinator at 362-1760). Available from Conservation Department and Harbormaster’s Office.

Coastal processes and circulation in Oyster Pond - see Notice of Intent application by Oyster Pond Environmental Trust and Order of Conditions and supporting materials, Conservation Department.

Aerial photographs of Town covering several decades, Engineering Department.

Photographs of Hurricane Bob destruction and other storm events, Engineering Department.

FEMA Flood Hazard Zone Maps (A, V flood zones) and FIRM Flood Hazard Study, Planning, Conservation, Building and Engineering Departments.

USEFUL WEBSITES


Sea Grant Program, Woods Hole: www.whoi.edu/seagrant/Publications/coastal.html
State environmental organizations:  www.state.ma.us
9. Appendices

Appendix A. Mapping and Analysis of Falmouth’s South Coastal Zone Properties

As part of our study, we carried out a field mapping survey of all the coastal hard structures (jetties, groins and revetments) along Falmouth’s south-facing (Vineyard Sound) coast using GPS (Global Positioning System) and combined this information with the Town’s land parcel and property tax assessment database. The Town’s database includes information on parcel ownership, assessed value, and land-use as well as the location of buildings on each of the parcels. This combined database has been organized in a GIS (Geographic Information System) format and is presented as a series of maps and tables (Appendices 1, sections 1-6) and summarized here (Tables 1-15). For user convenience, we have divided the maps and tables into five areas: 1) Nobska, 2) Salt Pond, 3) Harbor/Heights, 4) Great/Green Pond, and 5) Menauhant/Washburn Island (Figure A-1). The results of this study provide a snapshot of the present state (2000) of land-use, land ownership and land-value and structural development along Falmouth’s south coast and offer a set of graphic tools to aid the debate and guidance of public policy regarding the management of the town’s marine resources over the next century.

1. Defining the coastal zone

For the purposes of this study we have defined a “coastal zone” along the south coast which is comprised of all “shorefront” land parcels which bound Vineyard Sound from Nobska Point in the west to Waquoit Bay inlet at Washburn Island in the east. In addition, we have included another group of land parcels immediately “upland” of the “shorefront” parcels (often the owners of the adjacent shorefront parcels), when the depth of the shorefront parcels is narrow (i.e., commonly a thin strip of beach bounded on its upland side by a road). Washburn Island is a special case since its 330 acres represent more acreage than the entire remaining portion of the Town’s south shore coastal zone and the island also extends more than 2 miles into the interior waters of Waquoit Bay -- well away from the south coast. Consequently, we have included only Washburn Island’s barrier beach section (about 80 acres) within the defined coastal zone. This definition of a “coastal zone” serves to identify those parcels of land which are directly impacted by natural and manmade shoreline alterations, and whose owners would be most immediately affected by coastal management practices.

The total number of parcels comprising the coastal zone is 454, for a total of 302 acres. The number of shorefront parcels is 226, comprising a total of 208 acres and a total shoreline length of 7.9 miles. The number of upland parcels within our defined “coastal zone” is 228, comprising a total of 94 acres. Looking at the size distribution of these parcels (Figure A-2) (excluding Washburn from this analysis) broken out into five size categories (less than ¼ acre, ¼-1/2 acre, ½-1, 1-2 acres and greater than 2 acres), we note that more than half the parcels are less than ¼ acre, while less than 10% are greater than 2 acres. In terms of percent of total area, these small parcels, though the majority of coastal lots, represent only about 10% of the coastal zone acreage, while only a handful of large parcels (30) represent more than 40% of the total acreage. As for regional distribution, most of the largest shorefront parcels and least density of development are located in the...
westernmost Nobska section (along Fay Road), with the notable exception of Washburn Island located in the extreme east. The smallest shorefront parcels and greatest density of development are concentrated, from west to east, at four locations: 1) Surf Drive in the Salt Pond area, 2) Mara Vista Avenue, and 3) Acapesket Road in the Great/Green Pond area, and 4) Davisville Road in the Menauhant/Washburn area. Upland parcel size and development densities tend to reflect those of the adjacent shorefront areas with the exception of the dense upland development in the Falmouth Harbor/ Falmouth Heights area, which is generally bordered by larger Town-owned shorefront parcels.

2. Coastal Tenure (or “Who Owns Falmouth’s South Shore?”)

The 226 shorefront parcels (Table 1) are owned by 113 separate owners, of which 107 are private individuals and associations owning 179 parcels (79%), two are non-profit scientific organizations (MBL and WHOI) owning 4 parcels (2%), one is a private conservation association owning 2 parcels (1%) and the remaining three are government bodies (town, state and federal) owning 41 parcels (18%).

The 228 upland parcels (Table 2) are owned by 130 separate owners, of which 125 are private individuals and associations owning 191 parcels (84%), two are non-profit scientific organizations (MBL and WHOI) owning 4 parcels (2%), one is a private conservation association owning 18 parcels (8%) and the remaining three are government bodies (Town and federal) owning 15 parcels (7%).

Table 1. Shorefront Parcel Ownership.

<table>
<thead>
<tr>
<th>Status</th>
<th># of Parcels (% of Parcels)</th>
<th>Acreage (% Total)</th>
<th>Shoreline (mi.) (% Total)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Federal</td>
<td>1 (0.4)</td>
<td>3.2 (1.6)</td>
<td>0.24 (3.0)</td>
</tr>
<tr>
<td>State</td>
<td>2 (0.9)</td>
<td>78.1 (37.5)</td>
<td>1.00 (12.6)</td>
</tr>
<tr>
<td>Town</td>
<td>38 (16.8)</td>
<td>27.1 (13.0)</td>
<td>2.09 (26.5)</td>
</tr>
<tr>
<td>Prv. Reserve</td>
<td>2 (0.9)</td>
<td>0.2 (0.1)</td>
<td>0.04 (0.5)</td>
</tr>
<tr>
<td>MBL/WHOI</td>
<td>4 (1.8)</td>
<td>3.5 (1.7)</td>
<td>0.36 (4.6)</td>
</tr>
<tr>
<td>Private</td>
<td>179 (79.2)</td>
<td>96.0 (46.1)</td>
<td>4.18 (52.8)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>226 (100)</strong></td>
<td><strong>208.1 (100)</strong></td>
<td><strong>7.91 (100)</strong></td>
</tr>
</tbody>
</table>

Table 2. Upland Parcel Ownership.

<table>
<thead>
<tr>
<th>Status</th>
<th># of Parcels (% of Parcels)</th>
<th>Acreage (% Total)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Federal</td>
<td>1 (0.4)</td>
<td>2.1 (2.2)</td>
</tr>
<tr>
<td>State</td>
<td>0 (0.0)</td>
<td>0.0 (0.0)</td>
</tr>
<tr>
<td>Town</td>
<td>14 (6.1)</td>
<td>17.3 (17.9)</td>
</tr>
<tr>
<td>Prv. Reserve</td>
<td>18 (7.9)</td>
<td>8.1 (8.4)</td>
</tr>
<tr>
<td>MBL/WHOI</td>
<td>4 (1.8)</td>
<td>15.4 (15.9)</td>
</tr>
<tr>
<td>Private</td>
<td>191 (83.8)</td>
<td>54.0 (55.7)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>228 (100)</strong></td>
<td><strong>96.9 (100)</strong></td>
</tr>
</tbody>
</table>
Sorting the parcels into either public or private categories (with the private nature reserves combined with the public), it emerges that the shorefront is about evenly divided between public and private ownership (Table 3).

Table 3. Public vs. Private Ownership.

<table>
<thead>
<tr>
<th>Status</th>
<th>Shorefront (miles) (%) total</th>
<th>Shorefront Acreage (%) total</th>
<th>Upland Acreage (%) total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public</td>
<td>3.4 (43%)</td>
<td>108.6 (52%)</td>
<td>27.5 (28%)</td>
</tr>
<tr>
<td>Private</td>
<td>4.5 (57%)</td>
<td>99.5 (48%)</td>
<td>69.4 (72%)</td>
</tr>
</tbody>
</table>

Roughly half of the Town’s shorefront public lands on the south coast are in the barrier beach section of Washburn Island. If Washburn is removed from this part of the analysis, the percentages change significantly with the private versus public split being 77% and 23% in acreage and 65% and 35% in shoreline frontage, respectively. This breakdown is then very similar to the ownership status of the adjacent uplands, of which more than two-thirds are privately held.

3. Coastal Structures

The three types of coastal structures that were mapped were groins, jetties and revetments. Groins are linear stone, wooden, or metal structures placed perpendicular to shoreline to retard the alongshore transport of sand. Jetties are also linear structures, all constructed of stone in Falmouth and more or less perpendicular to shore, and are located at the tidal inlets to help maintain the navigational channels in and out of bays and harbors. Lastly, revetments are a generic term for coastal armoring structures, whether constructed of stone, concrete, wood or metal, that are placed parallel to the shoreline to protect the uplands from wave erosion (i.e., seawalls).

Table 4. Coastal Armoring Inventory.

<table>
<thead>
<tr>
<th>Structure Type</th>
<th>Total #</th>
<th>Public (%) total</th>
<th>Private (%) total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Groins</td>
<td>70</td>
<td>10 (14%)</td>
<td>60 (86%)</td>
</tr>
<tr>
<td>Jetties</td>
<td>10</td>
<td>10 (100%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Revetments</td>
<td>94</td>
<td>12 (13%)</td>
<td>82 (87%)</td>
</tr>
</tbody>
</table>

Table 4 shows a total of 70 groins, 10 jetties, and 94 revetments along the Town’s south coast. All of the jetties are public structures bordering the town’s tidal inlets, while most of the groins (86%) and revetments (87%) are on private lands. While a few groins and revetments have been built or rebuilt in the last decade and are well constructed, many of the groins and revetments are old (pre-regulation), poorly engineered and maintained. Some appear quite hazardous.
Table 5. Armored vs. Unarmored Coast.

<table>
<thead>
<tr>
<th>Ownership Status</th>
<th>Armored Length (mi.) (% total)</th>
<th>Unarmored Length (mi.) (% total)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public</td>
<td>1.27 (35%)</td>
<td>1.70 (40%)</td>
</tr>
<tr>
<td>Private</td>
<td>2.37 (65%)</td>
<td>2.57 (60%)</td>
</tr>
<tr>
<td>Total</td>
<td>3.64 (46%)</td>
<td>4.27 (54%)</td>
</tr>
</tbody>
</table>

Dividing the coastal parcels between armored (revetments) and unarmored (open) coastline, we see that the Falmouth’s south coast is almost half armored at this time (Table 5). Interestingly, there is no significant bias concerning armoring on private versus public lands. Both categories have hardened approximately 45% of their respective coastlines. Washburn Island remains the largest open section of Falmouth’s south coast with no active groins or revetments, though a fully jetted inlet is located at its eastern edge, and a partially jetted inlet on its western edge. Surf Drive and the Town beach adjacent to Bourne’s Pond are the other extensive sections of unarmored coastline, though groin fields exist in both areas. Most coastal armoring occurs on the south coast’s headland areas: Nobska Point, Clinton Avenue, Falmouth Heights, Mara Vista Avenue, Acapesket Road, Davisville Road and Menauhant Road. Not surprisingly, these are also areas of greatest development density, with the exception of Nobska. Of the south coast’s 7 main barrier beach complexes fronting Oyster/Salt Ponds, Little Pond, Great Pond, Green Pond, Bourne’s Pond, Eel Pond, and Waquoit Bay, only the Great Pond barrier system is heavily armored, though the Surf Drive roadway in some ways acts as an effective revetment during storms for the Oyster/Salt Pond barrier.

Coastal zone parcels with residential or commercial structures were also inventoried. Less than one-third (72 or 31%) of the shorefront parcels possess building structures on them, while more than half (120 or 54%) of the upland parcels do. The built-upon shorefront parcels are concentrated west of Falmouth Harbor in the Nobska, Surf Drive and Clinton Avenue areas, while the built-upon upland parcels are more evenly distributed, though particularly concentrated in the Falmouth Heights area.

4. Land Use

Land use was determined using the State’s Department of Revenue assessment classification system. All parcels were sorted into seven categories: a) residential, b) vacant-developable, c) vacant-undevelopable d) commercial, e) boating support, f) open space/recreational and g) multiple use (Tables 6 and 7).
Table 6. Coastal Zone Land Use (Acreage).

<table>
<thead>
<tr>
<th>Land Use Type</th>
<th>Shorefront (acres) ( % total )</th>
<th>Not Washburn Shorefront (acres) (% total)</th>
<th>Upland (acres) (% total)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential</td>
<td>71.6 (33.7%)</td>
<td>71.6 (53.1%)</td>
<td>36.0 (38.1%)</td>
</tr>
<tr>
<td>Commercial</td>
<td>3.1 (1.5%)</td>
<td>3.1 (2.3%)</td>
<td>9.0 (9.5%)</td>
</tr>
<tr>
<td>Boating Support</td>
<td>1.7 (0.8%)</td>
<td>1.7 (1.3%)</td>
<td>2.5 (2.6%)</td>
</tr>
<tr>
<td>Vacant-developable</td>
<td>11.1 (5.2%)</td>
<td>11.1 (8.2%)</td>
<td>17.2 (18.2%)</td>
</tr>
<tr>
<td>Vacant-undevelopable</td>
<td>11.1 (5.2%)</td>
<td>11.1 (8.2%)</td>
<td>5.2 (5.5%)</td>
</tr>
<tr>
<td>Multiple Use</td>
<td>84.2 (39.6%)</td>
<td>6.8 (5.0%)</td>
<td>2.3 (2.4%)</td>
</tr>
<tr>
<td>Open Space/Recreation</td>
<td>29.9 (14.1%)</td>
<td>29.9 (22.2%)</td>
<td>22.2 (23.5%)</td>
</tr>
</tbody>
</table>

Table 7. Coastal Zone Land Use (Water Frontage).

<table>
<thead>
<tr>
<th>Land Use Type</th>
<th>Shorefront (miles) ( % total )</th>
<th>Not Washburn Shorefront (miles) (% total)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential</td>
<td>2.20 (27.8%)</td>
<td>2.20 (31.8%)</td>
</tr>
<tr>
<td>Commercial</td>
<td>0.35 (4.4%)</td>
<td>0.35 (5.1%)</td>
</tr>
<tr>
<td>Boating Support</td>
<td>0.12 (1.5%)</td>
<td>0.12 (1.7%)</td>
</tr>
<tr>
<td>Vacant-developable</td>
<td>0.26 (3.3%)</td>
<td>0.26 (3.8%)</td>
</tr>
<tr>
<td>Vacant-undevelopable</td>
<td>1.53 (19.3%)</td>
<td>1.53 (22.1%)</td>
</tr>
<tr>
<td>Multiple Use</td>
<td>1.48 (18.7%)</td>
<td>0.48 (6.9%)</td>
</tr>
<tr>
<td>Open Space/Recreation</td>
<td>1.90 (24.0%)</td>
<td>1.90 (27.5%)</td>
</tr>
</tbody>
</table>

Because of its size, Washburn Island skews the analysis, resulting in 40% of the coastal zone acreage and 19% of the coastline being assigned to multiple use. If we drop Washburn to get a clearer view of the developed coast, we see that more than half the shorefront parcel area is developed residential with another third in open space, multiple use, or vacant-undevelopable. Note that relatively small fractions are in commercial or boating support use, and a bit less than 10% is vacant-developable. However, from the perspective of coastal frontage, more than half of the non-Washburn coastline is in open space, multiple-use, or vacant-undevelopable, with the remaining 45% in some form of development. The difference between acreage and coastline perspectives results from open-space, multiple-use and undevelopable parcels tending to be narrow strips of beach, while developed parcels tend to be deeper with more attached upland.

5. Property Value

Coastal zone property values for each parcel were determined using recent Town property assessment records (Tables 8-10).
Table 8. Coastal Zone Property Values.

<table>
<thead>
<tr>
<th>Ownership Status</th>
<th>Shorefront $Million (% total)</th>
<th>Upland $Million (% total)</th>
<th>Total $Million (% total)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public</td>
<td>21.6 (19%)</td>
<td>4.1 (12%)</td>
<td>25.7 (13%)</td>
</tr>
<tr>
<td>Private</td>
<td>93.5 (81%)</td>
<td>74.0 (88%)</td>
<td>167.5 (87%)</td>
</tr>
<tr>
<td>Total</td>
<td>115.1 (100%)</td>
<td>78.1 (100%)</td>
<td>193.2 (100%)</td>
</tr>
</tbody>
</table>

Table 9. Coastal Zone Property Value Per Acre.

<table>
<thead>
<tr>
<th>Ownership Status</th>
<th>Shorefront $K/acre</th>
<th>Not Washburn Shorefront $K/acre</th>
<th>Upland $K/acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public</td>
<td>199</td>
<td>364</td>
<td>149</td>
</tr>
<tr>
<td>Private</td>
<td>940</td>
<td>940</td>
<td>1066</td>
</tr>
<tr>
<td>Total</td>
<td>553</td>
<td>808</td>
<td>806</td>
</tr>
</tbody>
</table>

Table 10. Coastal Zone Property Value Per Foot.

<table>
<thead>
<tr>
<th>Ownership Status</th>
<th>Shorefront $/foot</th>
<th>Not Washburn Shorefront $/foot</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public</td>
<td>1203</td>
<td>876</td>
</tr>
<tr>
<td>Private</td>
<td>3935</td>
<td>3935</td>
</tr>
<tr>
<td>Total</td>
<td>1455</td>
<td>2867</td>
</tr>
</tbody>
</table>

Total assessed value (2001 property tax assessment) for the defined coastal zone is $193 million, with about a 60:40 split between the assessed value of shorefront and upland, respectively. Publicly held space is 13% of the total assessed value versus 87% for privately held coastal lands. The average assessed value is $633K/acre. Again, Washburn’s large area and relatively low value per acre ($134K/acre) skews overall mean values lower. If Washburn is removed from consideration, both shorefront and upland parcels show a similar average value of about $800K/acre. One big difference is that publicly held coastal land is assessed much lower than private land. Most of this has to do with a general lack of buildings on public land and their generally un-developable land-use status (i.e., beaches, salt marshes), but there is also a reduced tendency to re-evaluate public property assessments as these lands tend to be exempted from property taxes.

The assessed parcel values have been mapped and analyzed in two ways: 1) sorting the parcels using their actual assessed values and 2) normalizing these values by their acreage and coastal frontage. For example, the “actual value/parcel” information can be useful in gauging a total cost of acquisition of a parcel or parcels, while the “normalized values” might provide a better comparison of intrinsic monetary value. For the actual value analysis, we have sorted parcels into four value ranges: 1) high: greater than
$1,000K, 2) medium-high: $400K-$1,000K, medium: $100K-400K, and 4) low: less than $100K. This analysis is summarized by region in Tables 11-12.

Table 11. Shorefront Parcels: Actual Property Value Per Parcel.

<table>
<thead>
<tr>
<th>Area</th>
<th>&gt;$1,000K total $K (# Parcels)</th>
<th>$400K-$1,000K total $K (# Parcels)</th>
<th>$100K-$400K total $K (# Parcels)</th>
<th>&lt;$100K total $K (# Parcels)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nobska</td>
<td>32670 (19)</td>
<td>1249 (2)</td>
<td>0 (0)</td>
<td>284 (8)</td>
</tr>
<tr>
<td>Salt Pond</td>
<td>0 (0)</td>
<td>518 (1)</td>
<td>2268 (12)</td>
<td>873 (22)</td>
</tr>
<tr>
<td>Fal. Harbor/Heights</td>
<td>23100 (8)</td>
<td>5877 (9)</td>
<td>3275 (14)</td>
<td>615 (11)</td>
</tr>
<tr>
<td>Great/Green Ponds</td>
<td>7080 (5)</td>
<td>10200 (15)</td>
<td>783 (3)</td>
<td>1608 (67)</td>
</tr>
<tr>
<td>Menauhant/Wash.</td>
<td>12567 (3)</td>
<td>8955 (12)</td>
<td>656 (3)</td>
<td>289 (10)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>75417 (35)</strong></td>
<td><strong>26799 (39)</strong></td>
<td><strong>6982 (32)</strong></td>
<td><strong>3669 (118)</strong></td>
</tr>
</tbody>
</table>

Table 12. Upland Parcels: Actual Property Value Per Parcel.

<table>
<thead>
<tr>
<th>Area</th>
<th>&gt;$1000K total $K (# Parcels)</th>
<th>$400K-$1000K total $K (# Parcels)</th>
<th>$100K-$400K total $K (# Parcels)</th>
<th>&lt;$100K total $K (# Parcels)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nobska</td>
<td>5878 (4)</td>
<td>3534 (5)</td>
<td>236 (1)</td>
<td>97 (1)</td>
</tr>
<tr>
<td>Salt Pond</td>
<td>0 (0)</td>
<td>1779 (3)</td>
<td>1438 (7)</td>
<td>646 (15)</td>
</tr>
<tr>
<td>Fal. Harbor/Heights</td>
<td>5987 (3)</td>
<td>24357 (43)</td>
<td>5571 (26)</td>
<td>238 (6)</td>
</tr>
<tr>
<td>Great/Green Ponds</td>
<td>1055 (1)</td>
<td>15043 (27)</td>
<td>6775 (22)</td>
<td>395 (19)</td>
</tr>
<tr>
<td>Menauhant/Wash.</td>
<td>0 (0)</td>
<td>3839 (8)</td>
<td>4261 (19)</td>
<td>456 (14)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>12920 (8)</strong></td>
<td><strong>48552 (86)</strong></td>
<td><strong>18281 (75)</strong></td>
<td><strong>1832 (55)</strong></td>
</tr>
</tbody>
</table>

Almost half (46%) of the total assessed value of the coastal zone is comprised of the 43 parcels (about 10% of both shorefront and upland parcels) that are assessed above $1000K ($1 million). The bulk (81%) of these are shorefront parcels concentrated in the western sections, with about half in the Nobska area and another quarter in the Falmouth Harbor/Heights area. Another 40% of the total assessed value is in the next highest category ($400K-$1000K), and these parcels are concentrated in the south coast’s mid-sections. The medium- and low-valued parcels, representing about 13% and 3% of total assessed value, respectively, are similarly concentrated in the mid-sections.
In terms of acreage (Table 13), almost three-quarters of the coastal zone is in the high and medium-high value range. By shore frontage, about 60% of the coastline is valued in the high and medium range. The difference (though modest) between acreage and frontage perspectives is explained by the lower assessed values placed on privately owned but undevelopable beach parcels and Town and state-owned beach property, both of which tend to have more frontage per acre than residential parcels.

For the normalized value analysis, we sorted the parcels into five quantiles (each quantile contains an equal number of parcels), and normalized by both acreage and shore frontage. The quantiles or classes (normalized by acreage) break out at about 1) $0-200K/acre, 2) $200K-525K/acre, 3) $525K-1400K/acre, 4) $1400K-2500K/acre, 5) >$2500K/acre.

Table 14 below shows the regional distribution of parcels in a given “intrinsic” value class.

The data in Table 14 indicate that the highest “intrinsic” land-values are concentrated in the south coast’s mid-sections, where development is densest and parcel sizes are very small (typically about a tenth of an acre), thus inflating the per/acre value of these parcels. In contrast, the Nobska section with the highest concentration of highest actual-valued parcels has a more modest “intrinsic” value, because of the much larger average acreage of its parcels. Table 15 shows the how these normalized value classes break out by acreage and shore frontage:
Table 15. Normalized Property Values.

<table>
<thead>
<tr>
<th>Quantile / Value Class</th>
<th>All Parcels (Acres) (% total)</th>
<th>Shorefront Parcels (mi.) (% total)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class 1: &gt;$200K/Acre</td>
<td>167 (54.9%)</td>
<td>2.7 (34.2%)</td>
</tr>
<tr>
<td>Class 2: $200-525K/Acre</td>
<td>68 (22.4%)</td>
<td>1.7 (21.5%)</td>
</tr>
<tr>
<td>Class 3: $525-1400K/Acre</td>
<td>41 (13.5%)</td>
<td>2.1 (26.6%)</td>
</tr>
<tr>
<td>Class 4: $1400-2500K/Acre</td>
<td>19 (6.3%)</td>
<td>0.9 (11.4%)</td>
</tr>
<tr>
<td>Class 5: &gt;$2500K/Acre</td>
<td>9 (3.0%)</td>
<td>0.5 (6.3%)</td>
</tr>
</tbody>
</table>

More than half of the coastal acreage and a third of coastline, is in the lowest “intrinsic” value class. Again, this is because many of the beach parcels (Washburn being the largest example) are either publicly owned or are private and undevelopable and so are assessed at low value relative to their acreage or frontage. In contrast, the highest “intrinsic” value class contains only a small fraction of the coastal zone, owing to small parcel size. In terms of acquisition strategies, those properties with low “intrinsic” value or the most acreage/shorefrontage for the lowest cost/acre or shorefront would be of greatest interest.
Figure A-1. Index map.

Falmouth South Coast
Index Map

Parcel information collected for the following maps was gathered from the Town of Falmouth's Assessor's and GIS offices. The information was spot checked against local knowledge and was modified where appropriate. Information regarding the location of coastal structures i.e. docks, revetments, jetties was field collected by Waquoit Bay National Estuarine Research Reserve (WBNERR) staff using hand held GPS units and field notes. This data was also spot checked with local knowledge and adjusted accordingly to fit with the parcel information. The information presented here should be used only for planning purposes. All maps were created by WBNERR staff.

<table>
<thead>
<tr>
<th>Area</th>
<th>Number of Parcels*</th>
<th>Acres*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nobska Point</td>
<td>37</td>
<td>59</td>
</tr>
<tr>
<td>Salt Pond</td>
<td>61</td>
<td>44</td>
</tr>
<tr>
<td>Falmouth Harbor/Heights</td>
<td>126</td>
<td>52</td>
</tr>
<tr>
<td>Great/Green Pond</td>
<td>161</td>
<td>41</td>
</tr>
<tr>
<td>Menauhant/Washburn</td>
<td>69</td>
<td>108</td>
</tr>
</tbody>
</table>

* Areas are determined for illustrative purposes only. The number of parcels and the total acreage for each area is only for planning purposes. Parcels in the overlap of two areas have been arbitrarily assigned to one area or the other.
Figure A-2. Parcel size histogram.
Appendix B. Shoreline Change Along Falmouth’s South Shore

A recent study by the U.S. Geological Survey, WHOI Sea Grant, and the Massachusetts Office of Coastal Zone Management quantified shoreline change (erosion and accretion) rates for the Commonwealth (Thieler et al., 2001). These data are used here to examine rates and magnitudes of shoreline change along Falmouth’s south shore, from Nobska Point to the Waquoit jetties. A summary of the relevant information is provided here. For technical information on the data and techniques used to determine shoreline change rates in Massachusetts, see Thieler et al. (2001).

There are several accurate historical shoreline surveys for the Falmouth south shore spanning the 149-year period from 1845 to 1994. Differences in the mapped positions of these shorelines can be used to calculate rates of shoreline change over different time intervals. Such rates provide information that can be used to understand the magnitude and trends of shoreline changes and can also provide a basis for various coastal zone management strategies.

The long-term rate of erosion on Falmouth’s south shore from 1845-1994 (149 years) is \(-0.72 \pm 0.4 \text{ ft/yr}\). The rate of change along the shoreline, however, is not uniform. Figure B-1 shows the spatial distribution of long-term erosion rates. From Nobska Point to the west side of the Great Pond entrance, the shoreline has been slowly eroding or relatively stable (eroding or accreting < 0.5 ft/yr). East of the Great Pond entrance, however, erosion rates are much higher over the last 149 years; much of this section of shoreline is eroding at more than 1 ft/yr.

Figure B-2 shows the rate of shoreline change for three different time intervals. From 1845 to 1890, the rate of erosion was very low, less than one-half foot per year (-0.32 \pm 0.4 \text{ ft/yr}). During this time, the shoreline was essentially in its natural state because extensive coastal development had not yet begun. Averaged over a slightly longer time interval (1845-1948) for which data are available for most of the south shore, the erosion rate is still less than a half-foot per year (-0.38 \pm 0.4 \text{ ft/yr}), even though the shoreline was impacted by large storms in 1938 and 1944. Unfortunately, good shoreline data on the time period from the 1930s to 1960s are not available. This is also the approximate time period that hard stabilization (the building of seawalls, groins and jetties) began in earnest along Falmouth’s south shore. As described in Section III of this report, the armoring of the shoreline has had a profound influence on the behavior of the beach and most importantly, on the availability of sediment to the beaches. Over the 19 years from 1975-1994, the erosion rate increased to \(-2.4 \pm 0.4 \text{ ft/yr}\). It is likely that the recent increase in erosion rate is due to the long-term effects of hard stabilization on the sediment supply of Falmouth’s south shore. The fact that most of the severely eroding areas are at the “downstream” eastern end of town (east of Falmouth Heights) supports this concept: there is simply no longer a significant supply of sediment making its way along shore. The result is the erosion of the shoreline and landward migration of the barrier spits (e.g., at Green Pond, see Figure 2 of this report).
Figure B-1. Long-term erosion rates for Falmouth’s south shore.
Figure B-2. Graph of shoreline change (erosion) rates for the Falmouth south shore. Error bars indicate the ± 0.4 ft/yr uncertainty range of the data. The rate of erosion from 1975-1994 is more than five times the rate that prevailed over much of the last century. This is most likely due to the cumulative effect of many years of hard stabilization of the shoreline that has deprived the coastal system of sediment.
Appendix C. Criteria for Prioritizing Acquisition of Coastal Parcels

The Coastal Resources Working Group developed the following criteria to help prioritize acquisition of coastal parcels for protection and improvement of coastal processes.

1. Vulnerability to storm damage:
   a) Properties with Town infrastructure present (roads, bridges, etc.)
   b) Developed properties
   c) Undeveloped properties without structures
   d) Linkage with existing Town open space or other Town lands.
   e) Sediment source areas (eroding coastal banks, coastal dunes, barrier beach systems, mouths of inlets, coastal beaches, offshore areas, etc.)
   f) Ecologically important areas (areas important for coastal sustainability). These include coastal inlets to ponds because they are important for maintaining water quality and fisheries, shellfisheries, sediment sources, barrier beaches, significant habitats, etc.)
   g) Areas where Town has interests or investment. Examples include navigation channels, herring runs, pond inlets, recreational beaches, etc.
   h) Areas subject to flooding (A, V zones)

2. Areas with development potential.

3. Areas with scenic or aesthetic value. Scenic values are an important factor driving coastal development.

4. Public access to water or coastal areas. A long-term goal or vision for Falmouth’s shoreline includes eventually providing public access along Falmouth’s entire shoreline, perhaps analogous to a “Shoreline Trail” or “Coastal Pathway” system.

5. Emphasize acquisition of lots on or adjacent to Vineyard Sound and do not include properties on coastal ponds. In terms of sediment dynamics and sediment processes, the coastal ponds (e.g., Siders Pond, Oyster Pond, Little Pond, Green Pond, Great Pond, Bourne’s Pond, etc.) are probably not significant sediment sources or sediment sinks for the Vineyard Sound sediment system, which is the main system of concern for this committee. Within each coastal pond there may be significant sediment transport processes at work. However, these are probably largely contained within each coastal pond, and probably are of minor importance to the coastal/open ocean sediment transport system represented by the Vineyard Sound shoreline.

6. Erosion rate. Coastal erosion is a natural process that provides sediment to other areas and hence is an important process that provides sediment to the overall coastal sediment budget. To allow erosion to happen, the recommendation is to acquire coastal properties that are experiencing erosion. One criterion could be that the dimension of the area bought could be proportional to the erosion rate; for example, if the local erosion rate is 0.5 feet per year, then the area bought should perhaps be 50 feet (depth of property) during a 100-year period to allow for erosion during that time.
7. Rate of sea level rise. The preponderance of scientific evidence points to an increasing rate of sea-level rise on a worldwide basis, whether this is due solely or partially to anthropogenic causes or not. The rate of land acquisition should be similar to the above.

8. Areas with biological and ecological values. These include shellfish habitat, eelgrass, fisheries habitat, wildlife habitat and areas which are important in maintaining ecological sustainability for various reasons (salt marsh, tidal flats, etc.). Protection of coastal landforms and sediment processes also protects wildlife/shellfish/fisheries habitat and water quality.

9. Protection or improvement of water quality. Although the southern coast of Falmouth is exposed to the open ocean and therefore experiences good water quality, there may be areas where it is particularly important to maintain or improve water quality for shellfish, recreation or other reasons. There may be existing developed lots which are contributing to deteriorating water quality (e.g., motel on barrier beach with septic system of unknown age). Acquisition of such lots and removal of the cause of water quality problems could provide a benefit to overall water quality.

10. Recreational or natural resource values. Examples include fishing areas, shellfishing areas, or shellfish habitat, public beaches, swimming and boating areas, areas which provide shoreline or water access to the public, or public walking areas.

11. Linkage to provide shoreline or coastal trail. Falmouth could take advantage of its unique coastal placement, surrounded by ocean on two sides, to have a single coastal trail system. Examples from the Outer Cape indicate that recreational fishing, tourism, and sightseeing, etc. could all benefit greatly from such a coastal trail system. Other examples of large scale linked trail systems include the Moraine Trail and the Cape Cod Pathways system.

12. Presence or absence of coastal armoring (jetties, groins, seawalls, revetment, etc.). Depending on whether the goal is restoration or maintenance of coastal landforms, the following criteria are important to consider when evaluating parcels for acquisition:

   a) If coastal armoring is present, may want to acquire the parcel because sediment source function may be restored (if erosion rates suggest this is feasible);

   b) If coastal armoring is absent, may want to acquire the parcel in order to maintain existing sediment transport processes (again, depending on erosion rates).

While we realize that acquisition of coastal open space can be potentially costly, we feel that coastal acquisition carried out at a slow rate over the next 50 to 100 years is feasible, given that there are approximately 100 lots located on the vulnerable south-facing shores of Falmouth. Coastal land acquisition could also be “storm-driven and opportunistic”. The period following major storms is a good time to acquire coastal properties because storm damage may have occurred, owners may be in a position to consider selling, and there is heightened public awareness of coastal risks, etc. Incentives such as tax abatements coupled with rights of first refusal might also be implemented.
We note that the Town’s Land Bank Committee and The 300 Committee have criteria for ranking open space parcels which are similar to those of the Coastal Resources Working group, including:

- Flood plain
- Recreational value
- Beachfront property
- Wildlife habitat
- Wetlands
- Local preference
- Linkage to conservation or Town lands
Appendix D. Recommendations Concerning Coastal Policy and Regulations

To implement the short-term and long-term coastal goals, the CRWG feels that some regulatory changes will be required, in addition to voluntary management actions and land acquisition. This decision was based on an analysis of existing wetland regulations, the Coastal Element of the Local Comprehensive Plan, state and federal regulations concerning coastal areas and coastal erosion. The general nature and purpose of recommended regulatory revisions are outlined below.

1. Enlarge Buffer Zones along Coast

In order to allow natural processes of sediment movement to occur and to minimize property damage and loss, a wise course is to avoid further development in areas which are experiencing rapid rates of erosion (e.g., important sediment source areas) or areas which are experiencing highly dynamic sediment movement (rapid rates of erosion and sedimentation). Such areas include eroding coastal banks, coastal beaches, coastal dunes, V-zones, and buffer zones to these areas. The Regional Policy Plan recommends that the width for setback from coastal eroding areas be 100 feet. Currently the Falmouth Wetland Regulations require at least 50 feet setback from a coastal dune, and at least 25 feet setback from the top of an eroding Coastal Bank for lots existing prior to 1998. For lots created after 1998, the setback to an eroding Coastal Bank is 75 feet.

2. Redevelopment in eroding areas should be managed to allow the shoreline to retreat (move inland)

Redevelopment along Falmouth’s shoreline should be directed away from high-hazard, flood-prone, highly dynamic or eroding areas. Ideally, redevelopment in or adjacent to such areas should be moved back from such areas, by an amount that is proportional to the rate of erosion and/or shoreline retreat. An example may be moving a building proposed to be reconstructed back by a distance that corresponds to the rate of erosion (feet/year) multiplied by 30 to 50 years (i.e., the approximate expected lifetime of the building). Similarly, reconstruction or expansion of existing structures in V-zones should be discouraged. Examples of areas that should be considered for inclusion in this category include Falmouth Heights bluff, Surf Drive, and Menauhant Road between Little Pond and Eel Pond in East Falmouth.

3. Create and adopt a plan showing coastal erosion rates and/or areas of highly dynamic sediment transport as a reference for environmental permitting purposes

There are two ways in which the Town can address performance standards in dynamic coastal areas: 1) rely upon the permit applicant to provide site-specific information evaluating coastal dynamics, or 2) adopt an appropriate map or plans or other description of areas that have high erosion rates and/or highly dynamic sediment transport. The latter is by far the more economical process, both for the Town and for the applicant.
4. Make use of conservation restrictions to protect sediment sources from development as part of the coastal permitting process

Such a requirement may be included as part of a permitting process

5. Reconstruction or expansion of existing coastal armoring should be discouraged

The Falmouth Wetlands Bylaw already contains an example of regulatory language pertaining coastal structures to the Black Beach / Great Sippewissett Marsh DCPC. These regulations do not permit reconstruction or expansion of coastal structures if it will have an adverse effect on other coastal resource areas by interrupting sediment drift to adjacent coastal resource areas that depend on sediment supply for their existence (coastal beaches, coastal dunes). Such language should be considered for coastal regulations that would apply on a Town-wide basis, rather than just in the DCPC.

6. Eliminate the loophole in the Falmouth wetland regulations allowing new coastal armoring on lots developed before 1989

The Falmouth Wetland Regulations currently allow coastal armoring to be constructed on a coastal lot if the lot was developed prior to 1989, the date of promulgation of the Wetlands Bylaw. This mirrors a similar loophole in the Massachusetts Wetlands Protection regulations, which allow coastal armoring on a lot developed prior to 1978, when the state coastal regulations were adopted. Otherwise new coastal armoring is not generally permitted under state or local wetland regulations. The Falmouth regulations should not be more lenient than the state’s, because the state’s regulation would take precedence in that case. The Conservation Commission should consider whether the loophole should be removed entirely or be replaced by some other standard.

7. Environmental permitting of coastal projects should include a credible evaluation of the project’s effects upon coastal sediment dynamics and sediment supply

Environmental permitting decisions concerning coastal armoring, dredging, or beach nourishment should be made based upon an evaluation of coastal sediment dynamics and the effect of the project on sediment supply and other coastal issues. The evaluation should be done by a qualified coastal geologist or technical advisory group to the Town. Such evaluations would provide a factual basis for permitting decisions which may be difficult otherwise. The standard for work in highly dynamic, flood-prone, sediment source areas and areas with high erosion rates should be no adverse effect on sediment and water transport.
8. **Adopt appropriate and acceptable coastal mitigation measures and provide guidelines to project applicants**

Coastal projects brought before Town boards all too often provide mitigation measures which are highly individual. By adopting a standard set of acceptable mitigation measures, the Town would be assisting project applicants in designing appropriate coastal projects. The acceptable mitigation measures should be prioritized and if combinations of mitigation measures are appropriate, then these combinations should be identified. Examples of possible mitigation measures to consider include beach nourishment or dune construction as mitigation for revetment repair, dry-laid masonry as mitigation for revetment repair, or providing a conservation restriction or open space of similar nature as the original lot as mitigation for new development or redevelopment.

9. **Update Coastal Element of the Local Comprehensive Plan to incorporate new information on coastal processes**

Approximately four years have passed since the Coastal Element of the LCP was adopted. In that time, much new information has been gained concerning sediment dynamics along Falmouth’s shoreline. The newly revised Regional Policy Plan contains many examples of language that should be considered for inclusion in the LCP (see Appendix F for comparison of LCP to RPP). The second and more important step is implementing the Coastal Element through revisions in coastal regulations and permitting. Regulatory boards that would be involved include the Board of Selectmen, Conservation Commission, and to some extent the Planning Board and Zoning Board of Appeals.

10. **The Town should develop a FEMA Flood Hazard Mitigation Plan and apply for FEMA Flood Mitigation Assistance funds**

A FEMA Flood Hazard Mitigation Plan identifies areas prone to flooding and storm damage, and includes a plan for dealing with repetitive loss structures in the event of a major storm event. Approval of a FHMP qualifies the Town to apply for and receive FEMA Flood Mitigation Assistance funds. Such funds can be used for a variety of storm damage mitigation measures, such as acquisition of repetitive-loss structures as open space (requiring removal of the structure), stormwater management improvements, drainage improvements, or other measures. Falmouth does not have such a plan. Such a Plan should be made available to residents and would-be residents.
11. Review of major coastal projects should be coordinated with the appropriate Town permitting boards

All too often, major coastal projects are reviewed by permitting boards in a sequential manner, rather than by all boards reviewing the project in a coordinated manner. A model for such a coordinated multi-agency approach is MEPA permitting. The Board of Selectmen may wish to consider adopting a bylaw revision which would allow coordinated review of major coastal projects, coordinated with the Conservation Commission, Department of Natural Resources, Harbormaster, Shellfish Warden, Herring Run Warden, Beach Committee, Department of Public Works, and other appropriate review boards and departments.
Appendix E. Coastal Management Tools

A list of applicable coastal management tools is provided below.

1. **Public Outreach**
   - Involving public in scientific studies
   - Providing outreach at public forums, media
   - Providing outreach to regulatory boards
   - Coastal Committee involving Town, public, scientists, regulators

2. **Planning and Coordination**
   - Coordinating Town agencies in coastal activities
   - Local Comprehensive Plan (Coastal, Water Resources, Wetlands, Open Space, Natural Resources Elements)
   - Flood Hazard Mitigation Plan

3. **Land Acquisition and Protection**
   - Acquiring coastal properties
   - Conservation restrictions
   - DEM Coastal Restrictions

4. **Economic Tools**
   - Tax incentives for coastal property owners

5. **Regulatory Tools**
   - Wetland Bylaw
   - General Bylaw
   - Zoning (Coastal Overlay District, Sediment Management District)
   - District of Critical Planning Concern

6. **Taking Advantage of State and Federal Opportunities**
   - Flood Hazard Mitigation Plan and Funding Assistance
   - FEMA Emergency Assistance
   - Town Coastal Management Plan / Harbor Management Plan
   - Open space funding
   - Coordinating with Agencies on Agency Activities
   - Shellfish Restoration Program (CZM)
   - Coordinating with Barnstable County on dredging
7. **How to Choose Your Tools**

- Vision
- Interests
- Feasibility
- Timeframe
- Funding
- Effectiveness of tools

8. **How to Use Your Management Tools**

- Proactive vs. reactive management
- Adaptive management
- Maximizing effectiveness of tools
- Partnering (private and public sector, inter-agency, etc.)
- Cost-sharing
- Timing
- Long-range, medium-range and short-term goals
- Monitoring
- Evaluating effectiveness
Appendix F. Regional Policy Plan compared to the Local Comprehensive Plan

As mentioned in Appendix D, Item 9, the newly revised (2001) Regional Policy Plan contains language that should be considered for inclusion in an updated Local Comprehensive Plan. The following is a comparison of the two documents, included as an aid to making such updates.

The Regional Policy Plan (RPP), in Section 2.2 (Issue Area: Coastal Resources) includes an introduction describing Cape Cod’s coastal resources (natural, cultural, historical) and the need to protect them, particularly in the face of coastal storm damage, erosion, sea level rise, and of course, overdevelopment. It describes the monetary value in terms of fisheries and tourism (40 times that for seafood catch for the entire Cape). It talks about impacts from nitrogen loading and other pollutants related to population increases. It includes a couple of paragraphs on development in high-hazard areas and describes the problems created by hard structures (including roads and buildings as well as armoring) in these areas. It continues by describing how poor land-use practices and unplanned development exacerbate these problems. It points out that most towns have not adopted formal reconstruction policies to improve practices and prevent repetitive losses. It recommends developing a Flood Hazard Mitigation Plan, and suggests acquiring vacant land in the floodplain. Lastly, the introduction points out that most plans and regulations have not taken into account new predictions of relative sea level rise (2-4 feet in the next 100 years rather than 1 foot).

The RPP concludes with recommendations for Towns:

A. Develop Harbor Management Plan
B. Strengthen local bylaws and regulations beyond min. state and fed standards; includes mention of “rolling easements”
C. Require “soft” solutions to coastal erosion
D. Develop Flood Hazard Management plans and identify necessary actions to accommodate storms, SLR, migration of dynamic coastal resources
E. Do work necessary to petition EPA for “No Discharge Areas”
F. Evaluate long-term dredging and disposal and explore offshore sand deposits
G. Restore degraded coastal resources

The Local Comprehensive Plan (LCP; coastal element; 1997) includes a detailed inventory (Section 2.2.2. Inventory) of the coastal resources in Falmouth. It includes reference for maps that show 1. flood hazard areas, 2. dunes, barrier beaches and eroding coastal banks, 3. shellfish habitat, and 4. “working waterfront” areas. It identifies 12 coastal areas designated by the Planning Board for planning studies, and then goes on to describe the boundaries, land use, physical resources, and open water resources for each area.

The LCP also includes information on
a. dredging since 1960 (brief)
b. availability of public restrooms
c. commercial and recreational water dependent use
d. public facilities that provide access, including a table of beaches, with location, size, frontage, management, and restrictions
Under section **2.2.3. Analysis**, the LCP:

a. identifies location of environmentally sensitive coastal resources; Falmouth has one ACEC (Waquoit) and one DCPC (Black Beach)

b. examines trends of conversion from water dependent to non-water dependent, and losses/gains of public access

c. identifies conflicts among users of shorefront facilities and harbors

d. assessment of adequacy of existing commercial and recreational shoreline facilities to meet current and future needs.

e. Assess the need for dredging or other maintenance activities

f. Identify problems including poor water quality that have adverse effect on use of harbors and shorelines (nitrogen loading, septic systems, stormwater runoff, other stormwater controls)

g. Identifies areas where large numbers of docks/piers have limited access of caused loss of habitat

h. Identifies development in high hazard area and needed regulations to minimize further hazards

Under Section **2.2.4 Maps**, the LCP lists maps available in the Planning Office of Con. Comm:

1. Flood hazard area
2. shellfish habitat
3. docks, piers, town landings, harbors
4. dunes and barrier beaches
5. public access to shoreline
6. public beaches and landings
7. ACEC
8. DCPC

Under **2.1.5 Actions**

1. RECONVENE the COASTAL RESOURCES COMMITTEE to implement the plan (Board of Selectmen)
2. Establish multiple use Plan and Map for each planning area (Coastal Resources Committee and Planning office)
3. Develop a volunteer harbor patrol (Selectmen)
4. Improve Harbormaster and Waterways Commission regulations to improve harbor management (Harbormaster, Waterways, Selectmen)
5. Adopt marina and boatyard guidelines (Harbormaster and Selectmen)
6. Designate areas as limited use to protect shellfish (Shellfish warden and Coastal Resources Committee)
7. Identify access areas to be improved (Coastal R. Comm. and Public Access Com.)
8. Create an annual schedule of maintenance for existing coastal lands and facilities (Dept. Public Works)
9. Increase patrolling of coastal access areas to minimize litter, loitering, noise (Police and Natural Res. Dept.)
10. Designate scenic vistas (Public Access Committee)
11. Adopt a regulation in the zoning by-law requiring the Planning Board to comment to the State tidelands licensing authority on the public benefits of significant non-water dependent projects in filled tidelands (Planning Bd.)

**Line By Line Comparison of LCP to RPP**

**Goals and Policies**

**2.2.1. GOAL.** Public interests. word “perpetuate” was changed to “enhance” in LCP
RPP includes preservation of historic values in list, LCP does not.

**Minimum Performance Standards**

2.2.1.1. Development/redevelopment not to interfere with public access: LCP same as RPP
2.2.1.2. Public access at nourished beaches: is 2.2.1.4 in LCP; wording in LCP adds: The town may waive this requirement for nourishment sites it contracts on private lands.

**Other Development Review Policies**

2.2.1.3. NOT in LCP. Preserve marine infrastructure
2.2.1.4. Character of development/redevelopment: is 2.2.1.2 in LCP; LCP adds “Any part of a structure below the base flood level that is reconstructed according to FEMA regulations shall not be enclosed.
2.2.1.5. construction of walkways: is Min. Per. Stand. 2.2.1.3.in LCP; RPP adds “Such activities should not degrade undisturbed resources or contribute to adverse impacts to habitat, aesthetics, or storm damage prevention”.
2.2.1.6. existing water-dependent facility; is 2.2.1.5 in LCP; LCP adds “it should not be allowed” to change rather than “use should not be changed”; RPP requires overriding public benefit to balance change from water-dependent facility.
2.2.1.7. Development/redevelopment of water dependent facility to provide public access. Same as 2.2.1.6 in LCP
2.2.1.8. NOT in LCP. Engineered structures designed to allow access

**2.2.2. GOAL.** Limit development in high risk areas. RPP adds limit development “in areas subject to coastal storm flow”, and includes flooding and erosion as causes of damage, LCP uses “natural disasters”

**Minimum Performance Standards**

2.2.2.1 development in V-zones; same in LCP except RPP includes maintenance of marine infrastructure as potential exception
2.2.2.2 elevation of buildings above flood zones. In RPP, sea level is relative sea level. RPP separates A zones and V zones, such that structures in A zones must be designed to accommodate documented relative sea-level rise in MA of at least one foot per 100 years, with exceptions in 2.2.2.13 (preservation of village character); in V-zones, to accommodate RSL rise of two feet/100 years. LCP specifies one vertical foot above
existing FEMA based flood elevations and state building codes. LCP also refers to “buildings substantially improved or…. damaged” and notes that definitions provided by zoning bylaws would apply

2.2.2.3 No new development except as under 2.2.2.5 (damage > 50%) on barrier beaches or coastal dunes as per Wetlands Protection Act. RPP gets more specific here than LCP and includes language in
A. about reconstruction in V-zones to be two feet above 100-yr flood elevation, and in A-zones one foot. AND adds “On a barrier beach or coastal dune in… A or V zones… structure shall be on pilings to allow for storm flowage and beach/dune migration”
B. if structure is on barrier beach or dune but OUTSIDE the 100-yr coastal floodplain, reconstruction >50% of replacement value shall be on pilings.

Renovations to water-dependent facilities must demonstrate no compromise of coastal resources, public access, habitats, or aesthetics; LCP says “may be permitted if approved by all permitting authorities”.

2.2.2.4 Development within 100 feet of the top of coastal bank, dune, beach. RPP says NO NEW non-water-dependent development and that redevelopment should have no adverse effects on the bank or dune as a natural sediment source, LPP does not disallow NEW development. RPP sets setback as 30 times annual erosion rate or 100 feet, whichever is greater; LCP does not set the 100 ft limit. RPP does not explicitly mention allowances for water-dependent or public use structures; LCP allows for them if no feasible alternative exists and all authorities grant permits.

2.2.2.5 Reconstruction after >50% damage; RPP uses 50% of replacement value; LCP uses tax assessed value. LCP specifies no enlargement or expansion of use if in “V” zones; RPP does not distinguish between V and A zones on this.

2.2.2.6 No new structures in flood hazard zones unless overriding public benefit provided; RPP says both A and V zones; LCP only V.

2.2.2.7 NOT in LCP: “Where land subject to coastal storm flow serves to control floods and prevent storm damage, no activity shall increase the existing site elevations or the velocity of flood waters or increase flows due to a change in drainage or flowage characteristics on the subject site, adjacent properties, or any public or private way.

2.2.2.8 NOT in LCP: addresses issue of landward migration of resource areas within 100-yr floodplain in the case of new or re-development and that new structures should be designed with relative sea level rise and migration of resources in mind.

2.2.2.9 NOT in LCP: prohibits structures, roads, driveways, septic systems and NEW or expanded coastal engineering structures in V-zone of beach, dune, barrier beach, or coastal bank. Redevelopment of marine infrastructure shall include monitoring and mitigation.

2.2.2.10 NOT in LCP: lists activities that may be permitted provided best measures are used to minimize impacts

2.2.2.11 NOT in LCP: monitoring and maintenance plan requirements for renourishment projects. Includes specifics about using vegetative stabilization, including considerations of habitat and endangered species

2.2.2.12 Use of dredge material for nourishment projects or storm damage prevention. Is in LCP as Development Review Policy 2.2.2.8, but does not mention use as damage prevention.
2.2.2.13 NOT in LCP. Addresses activities and building where there are issues of preserving historic character of a village in Village Growth/Activity or Growth Incentive Zones located in A-zones for which a Flood Hazard Mitigation Plan has been adopted and approved by CCC. Activities must comply with FHMP, LCP, FEMA and State Building Codes.

Other Development Review Policies

2.2.2.14 minimize traffic in critical wildlife and plant habitat. In LCP as Min. Per. Standard 2.2.2.7. RPP specifies traffic as vehicle, boat, and pedestrian, LCP more broadly uses “activities that impact”

2.2.3. GOAL. Water Quality. Similar in RPP and LCP, but RPP more specific. eg. RPP: “to maintain and improve coastal water quality to allow shellfishing and/or swimming in all coastal waters as appropriate…”, whereas LCP: “to maintain and improve water quality in all coastal waters…”

Minimum Performance Standards

2.2.3.1. Septic systems in V and A zones. RPP prohibits new mounded septic systems in V-zones except to upgrade failed systems that pose health or other risk. LCP allows for acceptable alternatives to Title V for existing structures in V-zone. LCP also allows for new Title V or equal in A zones. RPP includes removal of structural components of failed systems where removal will not cause impacts.

2.2.3.2. Stormwater discharge; in LCP as 2.2.3.3. RPP adds that existing stormwater discharges shall be corrected through treatment and redirection.

2.2.3.3. Stormwater management. In LCP as 2.2.3.4. RPP: in V-zones, to incorporate two ft. per 100 years relative sea level rise; for A-zones, one-ft per 100 years, to be incorporated in NPDES plans. LCP uses one-ft rate without distinguishing between V and A zones.

2.2.3.4. Docks and piers. In LCP as 2.2.3.5. LCP makes allowances for water-dependent structures serving the public. Both allow for replacement of private docks/piers > 50% damaged with federal, state and local permits, but RPP excepts areas identified as significant shellfish habitat.

2.2.3.5. New marinas. Nearly the same in RPP and LCP; with respect to expanding marinas, RPP refers to expansions of 10 or more slips, LCP does not state a number

2.2.3.6. New dredging. Prohibited in both RPP and LCP except for substantial public benefit; LCP then lists enhancement of habitat or navigation as possible exceptions. RPP adds “where no feasible alternatives exists”.

2.2.3.7. NOT in LCP. Eelgrass beds. No adverse impacts to eelgrass beds, unless no alternative or where public good overrides.

2.2.3.8. NOT in LCP. Development not to minimize impact to fish, shellfish, crustaceans.

2.2.3.9. NOT in LCP. Documentation and permitting of maintenance dredging.

2.2.3.10. NOT in LCP. Aquaculture facilities; no adverse impacts, no permanent structures in the sub-tidal zone; permitting by DMF.

2.2.3.11. Protection of undisturbed buffer areas of 100-ft. width. Essentially same in RPP and LCP.
NOT in RPP. LCP 2.2.3.2. Five-ft. separation of septic systems and groundwater in A zones.

Other Development Review Policies

2.2.3.12. Best management practices with regard to waterfront fueling facilities. In LCP is Min. Per. Standard 2.2.3.9.
2.2.3.13. NOT in LCP. Development to minimize subsurface noise impacts to fish and protected species.

2.2.4. **GOAL.** IN LCP ONLY. Balance between water dependent and non-water-dependent developments

Minimum Performance Standard

2.2.4.1. All development and redevelopment along the coast shall conform to the policies and guidelines, as applicable, found in the Falmouth “Coastal Plan with Harbor Management Guidelines, July, 1989, as amended.
Appendix G. Values of the Coastal Zone

This report does not attempt to assign a dollar value to the many attributes of Falmouth’s coastal zone. Although we might readily calculate the contribution of tourism, for example, to Falmouth’s economy, we cannot so easily assign a price to the intangible aspects of our coast that attract the tourists and make us cherish our home. What is the value of an ocean breeze? Assigning value is also difficult because many aspects of our coastal resources are interrelated; shellfishing depends on clean water, which is vital to naturally functioning ecosystems, but is important for recreation as well. In addition, there may be both direct and indirect impacts associated with some of these values, which may entail costs as well as benefits. The values that attract both tourists and new residents to Falmouth have direct impacts on the local economy, but increased seasonal and year-round populations place demands on town services and infrastructure, increase use of resources, cause traffic congestion, and may affect town planning regarding issues such as open space.

A. Tangible Values
   1. Economic values
      a. Tourism: hotels, motels, restaurants, and stores which employ people, buy materials and supplies locally, and generate (in the case of room rentals) room-tax revenue
      b. Coastal recreation: charter boating and fishing, boat rentals, water sports rentals
      c. Commercial fishing and shellfishing
      d. Coastal real estate: sales, rentals, and construction
      e. Marine business: boatyards, marinas, yacht clubs
      f. Marine/coastal research/education organizations: WHOI, MBL, USGS, NMFS, NOAA, SEA, and related technological and consulting businesses
      g. Transportation: ferries, seaplanes, barges
   2. Other
      a. Access to shoreline and water
      b. Roads, bridges—transportation convenience
      c. Bike path
      d. Beaches, as open space
      e. Storm protection
      f. Native species
      g. Research
      h. Yacht clubs, sailing schools
      i. Recreation: fishing, walking, birdwatching, boating of all kinds, water sports
      j. Navigation: protected harbors, channels
      k. Boat ramps and other launching facilities
      l. Public open space
      m. energy potential (wind, tidal, wave)
B. Intangible/aesthetic values
   1. Natural features/naturally functioning ecosystems/natural processes
   2. Scenery/beauty/views
   3. Quality of life
   4. Scientific interest
   5. History

C. Costs
   1. Maintenance of coastal hardening structures
   2. Maintenance of other coastal structures (roads, bridges)
   3. Beach nourishment
   4. Insurance programs
   5. Losses of beaches and other public land
Appendix H. Description of Process Used by the Coastal Resources Working Group

- Working Group was appointed by Board of Selectmen following public advertisement for volunteers in April 2000
- The charge to the Group adopted by the Board of Selectmen was to: 1) identify key factors that have dictated the current condition of the coastal system; 2) explore reasons for the current condition; 3) provide future scenarios of the coastal zone based on an understanding of physical processes and management approaches; and 4) conduct community outreach.
- Chaired by Rob Thieler, U.S. Geological Survey
- Regular meetings held every two weeks since May, 2000, with periodic breaks during summers to accommodate members’ schedules
- Initial step was to self-educate all members of group concerning coastal processes, important issues facing Town. This involved field trips, review of scientific, technical, and non-technical literature pertaining to coastal erosion and sediment supply and related issues, discussion, attending workshops on coastal sustainability, FEMA flood hazard mitigation planning.
- Second step was data gathering. Information collected included sediment transport processes, shoreline change rates, long-term geological changes, comparison of Falmouth with other areas in Massachusetts and elsewhere (e.g., North Carolina, Florida, New Jersey, others), water quality, historical documentation (newspaper photos, The Book of Falmouth photos, Town Engineering Department photos following major storms), aerial photographs, maps, Town Assessors records concerning coastal properties, coastal regulations and management practices (local, state, Federal), uses of coastal lands, scientific, technical or engineering studies of sediment transport, flooding, coastal armoring, erosion, etc.
- Third step was synthesis of information. Information was reviewed, discussed, and synthesized.
- Fourth step was developing alternative visions of the south shore (alternatives analysis). Alternatives evaluated included a no-action alternative, maintaining the status quo, and a coastal restoration alternative.
- Fifth step was developing consensus among group members concerning vision, degree of significance of coastal transport issues, and measures to undertake to address significant concerns.
- Sixth step was developing a report. Group members each wrote and contributed to different sections of the report and to the overall report. All group members reviewed and edited the assembled drafts. At least 5 drafts were prepared prior to the final version.
- An interim progress report was provided to the Board of Selectmen in Spring 2002.
- Approach to requests for review of coastal projects during this process: the CRWG decided that until our study is completed, it would be premature to provide comments on pending coastal projects. Nevertheless, the group’s opinion was sought concerning a proposed Chappaquoit Beach nourishment project in West Falmouth. Our review of this project lasted for approximately two months,
and our comments were provided in a letter, which essentially stated that 1) the CRWG has not studied the Buzzards Bay coast of Falmouth in detail; 2) beach nourishment is considered generally to be beneficial where sediment supply is deficient; 3) the proposed project lacked a monitoring plan to monitor sand movement following beach nourishment; and 4) there is not a sufficient context in which to place the priority to the Town of nourishing this beach (i.e, other beaches in Falmouth might have a higher priority for Town funding).

- Draft report accepted by Board of Selectmen, May 12, 2003.