Atlas of

Tidally Restricted Salt Marshes

in the Buzzards Bay Watershed
Massachusetts

Prepared by

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Methodology, maps and data summaries published in this Atlas were developed and produced by the Buzzards Bay Project National Estuary Program, a unit of the Massachusetts Office of Coastal Zone Management. The format and text of the Atlas was adapted from the *Atlas of Tidally Restricted Marshes - North Shore of Massachusetts* (MWRP, 1999) and the *Cape Cod Atlas of Tidally Restricted Salt Marshes - Cape Cod, Massachusetts* (CCC, 2001).

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About This Atlas

Study Purpose

This study was undertaken to identify salt marsh vegetation impaired by tidal flow restrictions along the coast of Buzzards Bay, Massachusetts. Of particular concern were salt marshes that had been impacted by transportation related facilities such as roads, causeways and footpaths. These restrictions result in diminished tidal exchange in the upper reaches of a wetland system and ultimately impact the health of a salt marsh by decreasing salinity levels.

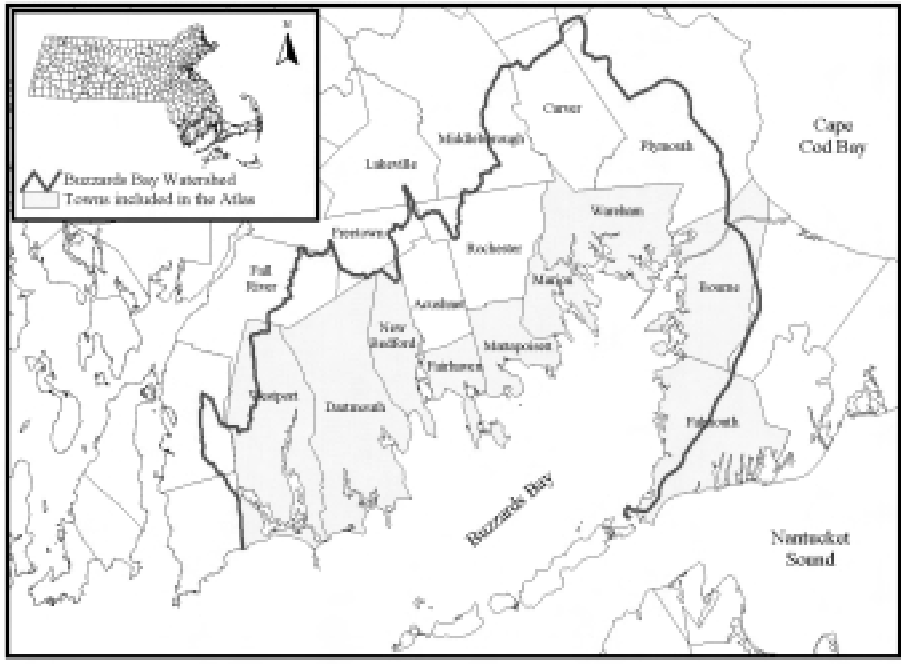

Figure 1: The study area included the coastal portions of towns (shaded) within the Buzzards Bay Watershed

The purpose of this Atlas is to aid state and municipal officials in identifying tidal restrictions. Such a listing will help government officials identify potential remediation opportunities when road and bridge work is being contemplated. Although the Buzzards Bay Project made considerable efforts to locate all tidal restriction sites in Buzzards Bay, we recognize some sites may have been overlooked, and our list should not be considered definitive.

The scoring system included in this report is for planning purposes only. It is meant to assist managers in identifying sites most likely to warrant consideration and is not meant to be a complete evaluation of the suitability of any particular site for restoration. Our cost of remediation was based on a simplified costing model, and was considered approximate for the purposes of establishing cost scores. Actual costs may be either greater or less than our estimates depending upon the many variables particular to each site.

Information in the Atlas

The study area for this project encompassed the southeastern coast of Massachusetts, extending from the border of Rhode Island, to the southwestern tip of Cape Cod at Woods Hole (See Figure 1). The following nine Buzzards Bay municipalities were included: Westport, Dartmouth, New Bedford, Fairhaven, Mattapoisett, Marion, Wareham, Bourne, and Falmouth. Portions of the towns of Bourne and Falmouth fall outside the Buzzards Bay watershed. Tidal restrictions in these areas are not documented in this Atlas but, information on these areas can be found in the Cape Cod Commission's *Cape Cod Atlas of Tidally Restricted Salt Marshes - Cape Cod, Massachusetts*.

The *Atlas of Tidally Restricted Salt Marshes in the Buzzards Bay Watershed* contains the following information:

- Maps showing locations of salt marsh tidal restrictions within the Buzzards Bay watershed
- Background information on tidal restrictions and methods to restore adequate tidal flow
- Detailed information on tidal restrictions falling within the top 10% of all sites based on a scoring system developed by the Buzzards Bay Project

How to Use the Information in the Atlas

The *Atlas of Tidal Restricted Salt Marshes in the Buzzards Bay Watershed* documents salt marshes that have been adversely impacted by human activities, especially transportation related facilities, along the coast of Buzzards Bay in Massachusetts. This Atlas was designed for use by municipalities, state agencies, and other organizations to initiate salt marsh restoration activities at these sites when appropriate. Municipal public works departments are particularly encouraged to check this Atlas when road or bridge work is being considered. In some instances, an act as simple as replacing an old structure will have a positive environmental restoration effect. The Atlas also serves as a source of information for projects under consideration as part of the Regional Transportation Plan and those eligible for state and federal transportation funding.

Distribution of the Atlas

Distribution of the Atlas included single copies to the public library of each coastal community and municipal Conservation Commission. Additional copies were provided to the following municipal agencies of each community in the study area: municipal executive (mayor, town manager, selectmen), planning board, and department of public works. It was also made available to local environmental groups and other interested parties.

Additional black and white copies of this Atlas may be obtained by writing to the Buzzards Bay Project, 2870 Cranberry Highway, East Wareham, MA 02538. The Atlas is also available on the Buzzards Bay Project's website: *www.buzzardsbay.org*.

Background

Coastal wetlands are primarily comprised of tidal marshes and associated intertidal habitats (e.g., mud flats, sandy beaches, and rocky shores) that occur along tidal rivers and estuarine embayments. Salt marshes are one of the most familiar and abundant type of tidal wetland. Salt marshes are regularly flooded by salt water with the lunar tidal cycle. For a few days each month, during spring tides (extra high tides that occur near full and new moons), tidal waters rise to flood the upper limits of the salt marsh. Plants growing in these wetlands have developed special adaptations for the conditions that occur during the regular flooding of saltwater. Some of these halophytes or "salt-loving plants" are listed in the Appendix. It is because of these specific environmental conditions that tidal restrictions (such as a road culvert that is too small) cause a threat to upstream salt marsh habitat. When the marsh vegetation above a tidal restriction doesn't receive the normal amount of tidal flushing, it begins to die and other more invasive species take over.

Figure 2. A healthy, unrestricted salt marsh

Coastal wetlands are among the Commonwealth's most valuable natural resources. Tidal flushing has created a highly productive environment that provides food and habitat for many creatures. Often called the ocean's farmlands, coastal wetlands provide the foundation of a detritus-based food web that ultimately supports many coastal fish and bird species. In addition, these wetlands provide habitat along the Atlantic Flyway for migratory waterfowl and serve as important breeding areas for many of these species. For black ducks, wetlands are used as critical overwintering areas. Tidal wetlands serve as vital nursery and spawning grounds for many commercially and recreationally important fish and shellfish species (see Appendix). Coastal wetlands also buffer the land against erosive storm-generated waves and frequently store temporary flood waters. In colonial times, salt marshes provided salt hay, which was used for fodder, mulch, insulation, packaging, and other purposes. Today there is less of a demand for the weed-free salt hay which is mainly used as mulch in suburban gardens.

Recognizing the value of salt marsh functions, the Commonwealth of Massachusetts passed the "Jones Act" in 1963 to protect salt marshes. This was the first law in the country adopted to protect coastal wetlands from dredging, filling, and other impacts. Prior to this time, many salt marshes were used to dispose of dredged material or filled for port development, industrial facilities, and housing. Many remaining salt marshes have been additionally degraded by minor filling, mosquito ditching, and restriction of tidal flow.

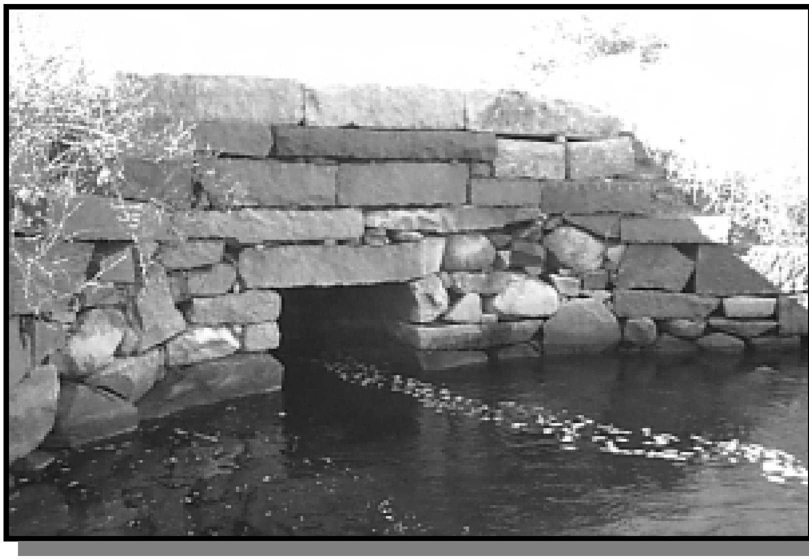

Figure 3. Tidal Restriction Site MT10 Old access to beach, Mattapoisett

Since the 1960s, new impacts to the Commonwealth's salt marshes have been strictly controlled. In the 1970s, Massachusetts adopted the Wetlands Protection Act, which forbids development in inland or coastal wetlands unless approved by the municipal Conservation Commission, with oversight from the Department of Environmental Protection (DEP). Strict regulations under this law virtually prohibit direct adverse impacts to salt marshes. These regulatory efforts have halted most newly contemplated alterations of salt marshes in the Commonwealth. Still, there are some indirect impacts that are difficult to control, and others that may be allowed.

The importance of coastal and inland wetlands was recognized in the Buzzards Bay Comprehensive Conservation and Management Plan, a watershed plan which was approved in 1991 by the Commonwealth of Massachusetts as state policy, as well as by the US EPA. This watershed management plan established the goal of a "**Long-term increase of high-quality wetlands and coastal habitat in Buzzards Bay."** This goal was to be met through several mechanisms, including the restoration of impaired wetlands.

Until recently, there was no program in Massachusetts to address the historic destruction and degradation of these vital resources. In 1994 the Secretary of the Executive Office of Environmental Affairs established the Massachusetts Wetlands Restoration Program (MWRP). The purpose of the program was to further implement the state's new policy of "no net loss of wetlands in the short-term and a net gain in the long-term."

Unlike wetland replication required under permits to compensate for wetland destruction (caused by construction and other activities), MWRP's pro-active wetland restoration projects may be initiated by project sponsors who simply want to bring back our wetland heritage, or who want to help address community water quality and flooding problems or restore wildlife habitat.

This Atlas, prepared by the Buzzards Bay Project, along with similar documents covering the North Shore and Cape Cod, are part of MWRP's pro-active wetland restoration efforts. MWRP continues to work with environmental groups, state and federal agencies, municipalities and others on an ongoing basis to implement priority wetland restoration projects identified in these studies. The Buzzards Bay Project often acts as a facilitator of these efforts.

Both the Buzzards Bay Project and the Massachusetts Wetlands Restoration Program provide financial and technical support for the efforts of municipalities, landowners, and other agencies and groups that wish to undertake wetland restoration projects. Individual wetland restoration projects may be initiated under MWRP's GROWetlands (Groups Restoring Our Wetlands) initiative. MWRP has also organized the Wetlands Restoration Assistance Team (WetRATs), a network of volunteer wetlands scientists, to assist GROWetlands project sponsors in evaluating the restoration potential of wetland sites, designating work plans, and monitoring pre- and -post construction project sites. MWRP helps GROWetlands sponsors develop goals and a work plan for restoration projects, secure project funding, organize volunteers, use restoration sites as learning laboratories for schools and groups, and to monitor restored wetlands to ensure success. Please see the Appendix for a more complete description of GROWetlands and a Project Nomination Form. Buzzards Bay Project Wetland Restoration Grants are subject to funding availability.

Impacts to Salt Marshes and Restoration Approaches

What Is a Tidally Restricted Salt Marsh?

Many salt and brackish marshes are crossed by highways, local roads, and railroads of various dimensions. These transportation routes may cross tidal creeks or rivers at one or more locations. Bridges are required to span rivers and broad creeks, and the roadways leading to bridges are built on fill deposited in wetlands. These thoroughfares are sometimes called causeways. Historically, many shorter spans have been filled, with culverts installed under the roadway to allow drainage or tidal flow. Roads crossing small creeks may have the streams channeled through box culverts, some of which are too small to pass full tidal flows necessary to maintain natural salt marsh vegetation upstream.

Figure 4. *Phragmites australis* stand in a salt marsh.

Culverts may be fitted with tide gates that could further restrict tidal flow or flapper valves which allow fresh water to leave the marsh but will not allow tidal flow to enter the marsh. Bridges may have similar affects if the openings are not wide enough to pass sufficient tidal water to maintain salt and brackish marshes further upstream. At some road crossings no culvert is provided and tidal flow is eliminated altogether. These hydrologic changes significantly alter the chemical integrity of the upstream salt marsh. The once strongly saline environment changes to one that is brackish or fresh water. This freshening of the salt marsh causes a major transformation in the vegetation as salt marsh grasses and rushes are displaced by common reed (Figure 4). Common reed often forms a monoculture, with plants growing up to, and in excess of, 12 feet. This decrease in plant diversity and the change in vegetative structure (from a low grassy meadow to a tall reedy thicket) causes a major shift in wildlife use as typical salt marsh inhabitants are replaced by fewer species. Despite some use of the reeds by more common generalist species, it is not preferred by any species. This is in marked contrast to salt marsh vegetation which is preferred over other habitats by many wildlife species, including some of our rarer salt marsh specialists.

Restoring Tidal Flow

Where tidal flow is restricted, the main objective of salt marsh restoration is to improve tidal flow to the affected marsh. In many cases, restoration is easily accomplished by removing the restrictive feature or by providing an opening sufficient enough to allow adequate tidal flow. For example, where tidal flow is reduced by undersized culverts (too small to pass the full spring tide), simply replacing the culverts with larger ones, generally the width of the original channel, and ones of appropriate height, may be enough to restore tidal flow.

In other cases, development has taken place in low-lying areas surrounding the marsh and sometimes on fill in the marsh itself. Due to flood risk, restoring full tidal flow to these areas is not possible. However, restoration of sufficient tidal flow to flood a lower portion of the marsh on a regular basis may be possible if it can be shown that this will not increase the risk of flooding to adjacent structures. Allowing for frequent tidal flooding should be sufficient to promote the return of salt marsh vegetation in areas of high salinity (greater than 18 parts per thousand). In areas of lower salinity, improved tidal exchange (by reconnecting the marsh to the adjacent estuary) is still beneficial. Improving tidal flow to the marsh while preventing property flooding can be accomplished by expanding the culvert size and adding a protective device, such as a self-regulating tide gate or a manually or electronically operated tide gate. These gates can establish an opening that allows passage of normal tides, but prevents entry of storm tides. Some structures can be completely closed, if necessary, to facilitate storm protection. Each proposed salt marsh restoration site should be evaluated to consider potential adverse impacts such as flooding before work is begun.

Methods

Site Selection

The first phase of this project identified salt marshes where tidal restrictions were suspected to exist. Potential restriction sites were located by looking at aerial photographs of the Buzzards Bay coastline (false-color infra-red and black and white photos). In these photos it was possible to see subtle color and texture changes in the vegetation around the salt marsh. These photo signatures were verified by looking at a photograph of a known area or by "ground-truthing" (i.e. visiting the site in the photo and comparing what was on the ground with what appeared in the aerial photograph). The study used DEP Wetland Conservancy color infrared aerial photos from spring 1993 (scale 1:12,000) acquired by the James W. Sewall Company. This photography was supplemented with 1:5,000 black and white orthographic Wetlands Conservancy maps captured in 1990 and in some instances other aerial photographs from various sources.

The presence of a road or railroad embankment with common reed on the upstream side and typical salt marsh vegetation on the seaward side was used as a marker of a likely restriction. In other cases, the presence of a scouring basin on one or both sides of the embankment suggested uneven flows (e.g. too much water collecting around the restriction and increased outflows with high erosive potential). Bridges with short spans, that is where the channel was considerably narrowed by the bridge, were also viewed as potential restricting structures and scouring basins were usually evident. Common reed stands were also photo interpreted. Narrow marginal bands of common reed along the upland border of salt marshes and very small stands were not identified as they were not considered strongly indicative of a tidal restriction. The potential restoration sites that were identified in the aerial photographs were field checked to verify the existence of a restriction and to collect information about the restricting structure and the affected salt marsh. Field work was limited to sites with public access, with field data sheets being prepared for all 257 restriction sites. A sample of a blank 2-sided field data collection form is shown in the Appendix. Information from the data sheets was used to create a database of all the restrictions. Figure 5 defines some of the parameters identified in the database.

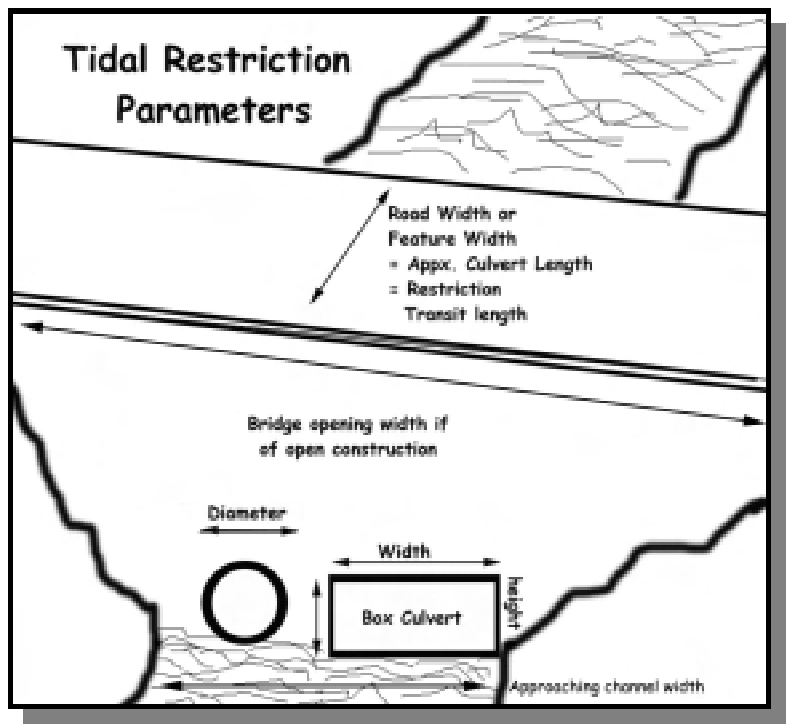

Figure 5. Generalized view of a culvert tidal restriction showing selected parameters inventoried in the tidal restriction database.

On-site observation of one or more of the following conditions were considered evidence of a tidal restriction and were recorded on the data sheets: seaward scouring basin; low marsh slumping; culvert invert problem detected; *Phragmites australis*; ponded water on seaward side of dike or road; ponded water on upstream side of dike or road; seaward culvert opening submerged at mean high tide; upstream scouring basin; culvert broken; vegetation die back; *Lythrum salicornia*; bank erosion; or culvert clogged with debris.

Photographs of most restrictions were taken with a digital camera to document existing conditions and to show the range in conditions of the restricting structures. The condition of the restricting structure was rated as excellent, good, fair, or poor in relation to these examples. The data collected in the field visits was then transferred into a Geographic Information System (GIS) database. The database was constructed by adding the locations of potential tidal restrictions and tidally restricted wetlands and common reed-dominated stands in tidal marshes to an existing wetland map database and transferred to USGS quadrangles. The resulting maps are used throughout this report.

The distribution of common reed (*Phragmites australis)* was mapped by creating a sketch of the area covered by *Phragmites* on a copy of the black and white 1:2500 orthographic sheet while in the field. Later the map was transferred by eye to 1:2500 digital orthophotos in ArcView™ using Wetlands Conservancy Program wetland lines as a guide. The size of these polygons was calculated by the ArcViewTM ™ software.

Scoring Methodology

Cost Prediction Assumptions

Due to the fact that it would not be cost effective to perform detailed cost analyses for the remediation of all 257 tidal restrictions identified in this Atlas, a simplified method was developed for approximating costs for each site. It should be noted that all costs listed in this Atlas are simply estimates and actual costs may either exceed or fall below these estimates, depending on the many variables at each restoration site.

The basis of our cost analysis was the assumption that the cost of remediation was roughly a function of the size of the new culvert and its length. Culvert length was assumed to be 20% longer than road width or from actual measurement. In calculating the size of the replacement culvert, we used the following assumptions:

1.) Culverts <=15" diameter (i.e. <1.25 sq.ft. cross section) would be tripled in diameter.

2.) Culverts >15" diameter or box culverts would be doubled in diameter.

Simplified cost estimates for culvert replacement are shown in Figure 6. However, these estimates do not account for practical costs. For example, whether or not the culvert passed under a road, whether or not the road was paved, whether utilities must be moved, and other factors are important determinants of cost. Design and permitting costs must also be considered.

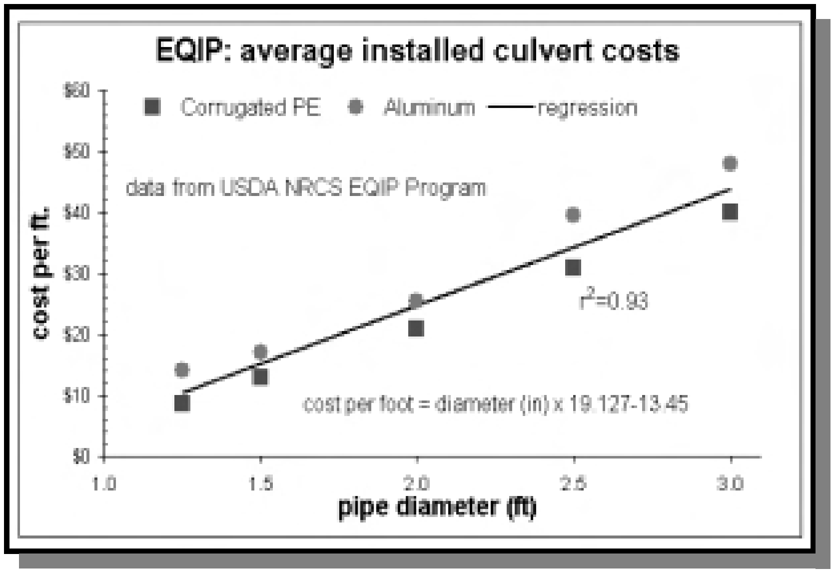

Figure 6. Simplified cost assumptions for culvert installation based on USDA-NRCS model for farm applications (i.e. not typically paved roads)

In Figure 7, we show a similar plot based on actual projects in Buzzards Bay. The plot includes eight actual projects and five hypothetical variations of two of the actual projects. For example, one of the projects involved the replacement of a dilapidated culvert with a new concrete 4-foot by 8-foot box culvert under a paved 25-foot wide rural road, with some of the replacement tasks being handled by a municipal DPW and some by a private contractor. The hypotheticals for this project were made by assuming the new culvert had dimensions of 4-feet by 8-feet and 4-feet by 10-feet, respectively, since that cost was well known and other project costs were held static. Similarly, another project represents the hypothetical estimates of the replacement of a 1-foot culvert with a 3-foot culvert on a coastal road in paved and unpaved conditions.

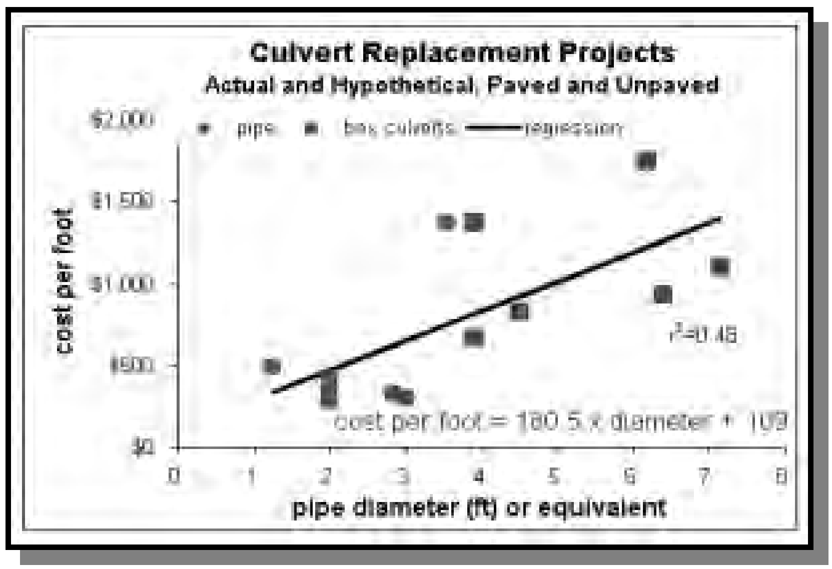

Figure 7. Actual cost of culvert replacement projects in Buzzards Bay including design, permitting, and road repaving costs. Five points represent theoretical variations of projects.

Although there is considerable variation in costs per foot for installation (r2 =0.48), it is apparent that real costs typically range from $200 to $1500 per linear foot, depending upon the diameter or cross section of the culvert, and the length of the culvert installed.

A better relationship was observed between total project cost, and the volume of the new tidal restriction (cross sectional area x culvert length; Figure 8, r2=0.71). Based on this data, the regression curve equation was employed to predict remediation costs using Equation 1. If the work

Equation 1: Total cost = restriction volume (cu. ft.)*41.0 + $10,150

was to be undertaken under a dirt road, the estimate of Equation 1 was halved. If work was under a railroad or road bridge with a culvert, the cost estimate in Equation 1 was tripled.

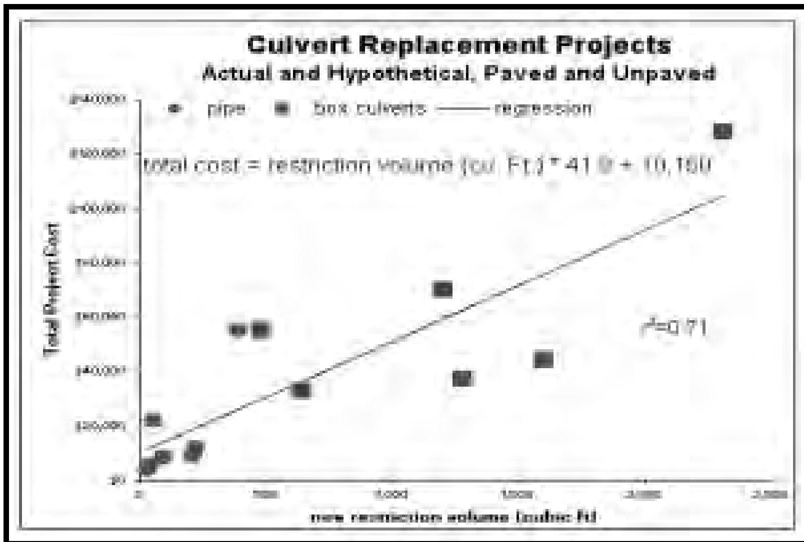

Figure 8. Total Project costs related to volume of the new tidal restriction (culvert cross section x length).

Some of the estimates in Figure 8 may underestimate project costs because some tasks were completed by municipal DPWs. In general, any project undertaken solely by a DPW may be completed for only one half of the prediction of Equation 1. Conversely, projects wholly completed by private contractors may cost twice as much or more. Our cost equation may represent the intermediate case.

Equation 1 was used only for projects with a restriction having a width of less than 10 feet. Larger restrictions may involve more complicated remediation strategies such as dredging filled-in channel entrances and under bridges, as well as bridge repairs or modification. For bridge repair work that would involve expanding the opening under the bridge, $10,000 per foot was used for bridges with a channel width greater than 20 feet. Additionally, for bridge projects with a channel width greater than 20 feet, $10,000 per channel foot width was used to approximate dredging and/or construction costs. For bridge projects with a channel width between 10 and 20 feet, $3,000 per channel foot width was used to approximate dredging and/or construction costs. These values may overestimate costs for projects where dredging alone is employed, because such costs may be as little as $500 per foot of channel.

Finally, our costs were sent to area DPWs to review, with the offer to change the estimates in the Atlas if the DPWs could provide better cost figures. However, no municipality was able to provide these estimates without specific engineering plans in hand.

Criteria for Scoring and Rationale

There are many potential ways of ranking tidal restriction sites for remediation. The Buzzards Bay Project developed a strategy for assigning scores to sites based on cost, acreage of wetlands potentially affected, acreage of *Phragmites*, and the presence of important habitat types. These and other criteria used in this study are described below. Using the adopted scoring system, every site had the potential of receiving 29 points. The sites with scores falling within the top 10% are profiled in a separate section of this report.

Wetland Size Scoring (4 points)

Independent of the degree of impairment, or the cost effectiveness (cost per acre of a project), some consideration of wetland size is important. That is to say, it may be more desirable to restore a 100 acre wetland site, even if it only contains 10% *Phragmites*, than to restore a ½ acre site, even if it is composed of 40% *Phragmites*. All upstream wetland areas are potentially affected by tidal restrictions, including habitat under and within surface waters. This is because elimination of a restriction may also improve shellfish habitat, fish habitat, water quality, salt marsh habitat, and other valuable resources that should not be overlooked. Consequently all upstream wetland areas, including surface waters, were included in the basis of this scoring. Upstream wetland areas were calculated using ArcViewTM ™ software and coverages from Mass GIS based on Wetland Conservancy Orthophotograph maps. Only wetlands areas likely to be affected by a tidal restriction were included in the calculations.

Below are the scoring criteria for this parameter and Figure 9 shows the distribution of the resulting scores for each restriction.

Wetland Size (acres)	Points
< 1 acres	0
≥1 acres	1
≥5 acres	2
≥25 acres	3
≥125 acres	4

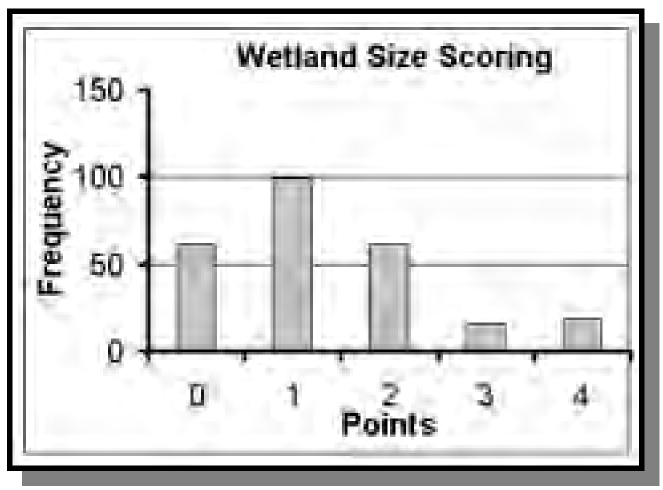

Figure 9. Frequency of scores for wetland size criteria

Cost-Effectiveness Scoring (5 points)

The cost effectiveness of a project was determined by dividing the cost estimate by the total number of acres (excluding surface waters) of wetland area affected by the restriction. When developing this criteria, potential scoring schemes, such as cost per acre of *Phragmites,* was not chosen because the presence of *Phragmites* is just one manifestation of adverse effects of a tidal restriction and may not always be present in tidally restricted sites. On the other hand, it was felt that the inclusion of surface waters created more bias to large bridge projects, as wetland size already incorporated surface water area in tidal areas affected. Therefore, this scoring was based on the estimated cost of a project divided by vegetated wetlands potentially affected by the restriction. Below are the scoring criteria for this parameter and Figure 10 shows the distribution of the resulting scores for each restriction.

Cost effectiveness	Points
≤ \$1, 000 per acre	6
≤ \$2, 000 per acre	5
≤ \$4, 000 per acre	4
≤ \$8, 000 per acre	3
≤ \$16, 000 per acre	2
≤ \$35,000 per acre	1
> \$35,000 per acre	0

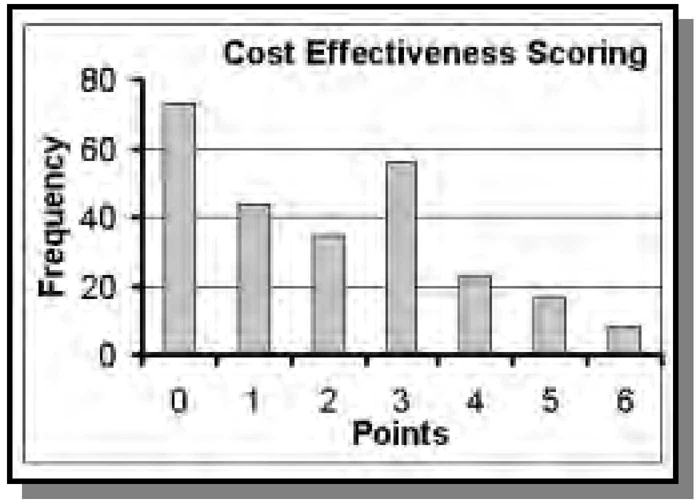

Figure 10. Frequency of scores for cost effectiveness based on dollars per acre criteria.

Wetland Impairment Scoring (5 points)

In this study, it was presumed that impairment caused by a restriction could be characterized by the degree of cover of the invasive nuisance species *Phragmites*, which tends to replace salt marsh vegetation in areas that are experiencing restricted tidal flow. The *Phragmites* impairment was quantified as the percent of vegetated wetlands composed of *Phragmites*. This is not an ideal characterization of impairment because the presence of *Phragmites* is just one manifestation of impairment, and it is not always present in tidally restricted areas. Nonetheless, *Phragmites* coverage was chosen because it was the only impairment measure that could be made easily for all sites, and the species is widely recognized as a nuisance species. To calculate a percentage, *Phragmites* acreage was divided by acreage of all wetlands that were likely to be affected by the restriction. This latter wetland area was calculated using coverages from MassGIS that were based on Wetlands Conservancy Orthophotograph maps. Below are the scoring criteria for this parameter and Figure 11 shows the distribution of the resulting scores for each restriction.

% vegetated wetland as *Phragmites*	Points
≤ 1%	0
≤ 10%	1
≤ 20%	2
≤ 50%	3
≤ 90%	4
≥90%	5

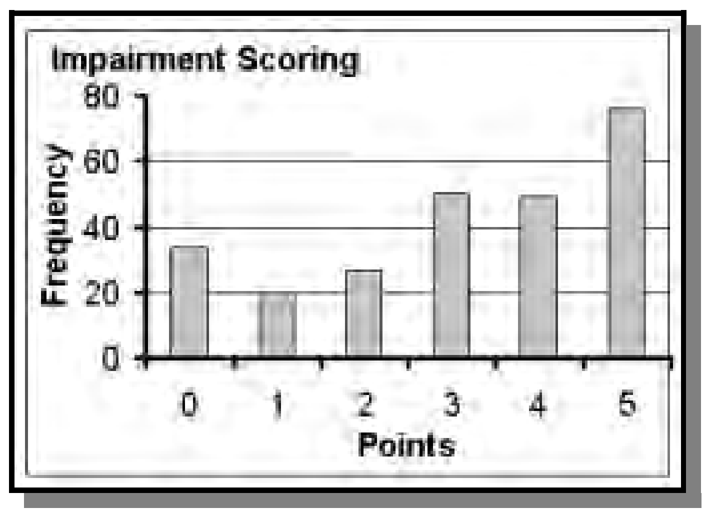

Figure 11. Frequency of scores for wetland impairment. Impairment was based on percent coverage of the marsh by the invasive species *Phragmites*.

Tidal Restriction Size Scoring (5 points)

It is likely that there is some relationship between the degree of wetland impairment by a tidal restriction and the cross sectional area of the tidal restriction. Specifically, inferences may be drawn between the cross sectional area of a restriction and the upstream acreage of wetlands potentially affected. While we do not believe there is any single ideal ratio between restriction cross sectional area and upstream acreage (e.g. very elongated systems may require a different ration compared to a situation where wetlands are clustered immediately behind the restriction), clearly some restrictions have too small a cross sectional area, and others appear ample for flushing.

Below are the scoring criteria selected for this parameter and Figure 12 shows the distribution of the resulting scores for each restriction. Because the amount of water needed to pass through a restriction depends upon the area of surface water behind the restriction, surface water was included in the calculation of upstream wetlands.

Restriction Size	Points
≤.05 sq. ft. per acre	5
≤.25 sq. ft. per acre	4
≤1 sq. ft. per acre	3
≤5 sq. ft. per acre	2
≤10 sq. ft. per acre	1
>10 sq. ft. per acre	0

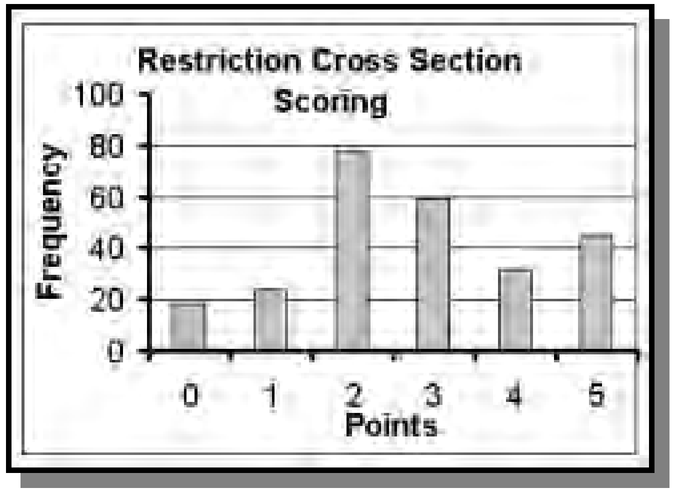

Figure 12. Frequency of scores based on the ration of cross sectional area of the tidal restriction to size of wetland impaired.

Other Criteria

Other scoring criteria were as follows:

The scoring of adverse impacts to special resources was based on best professional judgement. While increases in salinity by definition will result in the loss or death of certain freshwater species, it is undesirable to increase salinity where habitat for freshwater endangered species are found, where the salinity of a pond will change, or where anadromous fish spawning areas are lost. These and other reasons are justification for the subtraction of five points in the scoring system.

Restriction on public road/property	3 points - town road or land
	2 points - state road or land
	3 points - federal road or land
Benefits a public wetland	1 point
Benefits anadromous fish run	4 points (only applied to culverts, not bridge restrictions)
Designated rare/endangered sp. habitat	2 point
Adverse impacts to special resources	-5 points

The awarding of points for enlarging restrictions under public property (0 points for private, 3 points for municipal or federal, 2 points for state property) was based on the fact that it is far easier to remediate a publicly owned site because of logistical, cost, permitting, and funding reasons. Town owned land was considered the easiest to permit, but federal lands received an equivalent number of points because of the availability of federal funds and support. In practical terms, however, only a handful of sites were on federal property. Small culverts can greatly affect anadromous fish runs, so the highest number of bonus points (4) are given for this criteria. If the structure was a bridge, or did not actually impair a herring run, no points were given in this category. If remediation of the restriction would benefit a publicly owned wetland it was given 1 point. Areas designated as rare or endangered species habitat by the Massachusetts Natural Heritage and Endangered Species Program were given 2 points.

Results

The scoring system used in this report is, of course, subjective. In practical terms, work at any of the sites is justified if a property owner is willing to undertake the work, costs are low, or special opportunities arise. The purpose of the scoring system was to assist in identifying sites for further study, not as a final evaluation of which sites are most appropriate or most suitable for remediation. Scores for all 257 sites can be found in Table 4 as well as in the Appendix of this document.

Table 1, below, shows the number of tidal restrictions per municipality. Additionally, information has been included on the number of sites that have already been restored and those that currently have design plans for remediation in development.

Table 1. Number of Tidal Restrictions per Municipality

	Bourne	Dartmouth	Fairhaven	Falmouth	Marion	Mattapoisett	New Bedford	Wareham	Westport
Total Sites	35	31	27	46**	21	37	7	39	20
Sites already restored	2*	1	4	0	3	0	0	0	0
Restoration designs in development	0	3	0	0	0	2	0	0	0

** One of the tidal restriction sites remediated in Bourne was located in Scusset, which is outside of the Buzzards Bay watershed.*
*** Eight of the tidal restrictions included in this total number are located outside the Buzzards Bay watershed, therefore information on them is not included in this Atlas. For complete documentation please refer to the Cape Cod Atlas of Tidal Restricted Salt Marshes produced by the Cape Cod Commission.*

Given the large number of tidal restrictions identified in Buzzards Bay, it was decided that detailed profile pages would only be included for sites with a score that was roughly within the top 10% of all sites (16 or greater). Table 2, on the following page, lists the sites profiled in the next section, and Table 3 displays a breakdown of all 257 restrictions by type. General locations of all restrictions can be found in map form in Figure 13 as well as in the section entitled "USGS Topographic Maps of Tidal Restrictions in the Buzzards Bay Watershed". Specific details for all sites can be located in Table 4 and in the Appendix.

Table 2. Tidal Restrictions Profiled in the Atlas (score of 16 or greater)

Site #	Town	Restricting Feature	Score	Estimated Cost	Cost per Acre
FA05	Falmouth	Culvert: Road	20	$19,300	$1,300
DA04	Dartmouth	Culvert: Nonquitt Marsh	20	$21,300	$500
FA02	Falmouth	Wall: Rock wall, Mill Pond	19	$13,900	$900
FH18	Fairhaven	Culvert/road: Fir Street	19	$18,800	$2,200
MT17	Mattapoisett	Wall, rock: Rock wall	18	$12,500	$2,700
WH40	Wareham	Dike: Red Brook Rd., old road	18	$13,900	$6,900
DA02	Dartmouth	Bridge: Gulf Road	18	$500,000	$2,500
DA09	Dartmouth	Bridge: Little River Rd., Little River	18	$600,000	$3,300
DA17	Dartmouth	Culvert: Old road	17	$6,200	$900
WH11	Wareham	Culvert: Allen Road	17	$11,300	$600
MN22	Marion	Culvert: 13th hole, Kitansett Golf Club	17	$13,500	$700
FA10	Falmouth	Road: Woodneck Road	17	$14,900	$7,900
BN28	Bourne	Dike: MBTA Railroad	17	$21,500	$21,000
MT06	Mattapoisett	Culvert: Old Mattapoisett Neck Road	17	$43,500	$1,100
DA11	Dartmouth	Culvert/road: Little Beach Rd., Allen's Pond	16	$7,600	$1,200
DA06	Dartmouth	Culvert/road: Cow Yard Marsh	16	$9,200	$1,000
DA07	Dartmouth	Culvert/road: Cow Yard Marsh	16	$9,200	$1,000
WP17	Westport	Road: Driveway	16	$9,700	$1,000
MT15	Mattapoisett	Culvert: Private beach road	16	$11,600	$2,500
DA15	Dartmouth	Culvert: Old road	16	$12,200	$1,100
DA27	Dartmouth	Dike: Path to beach	16	$13,900	$6,100
WH27	Wareham	Road: Pilgrim Avenue	16	$27,000	$2,400
WH33	Wareham	Road: Road	16	$27,500	$5,300
MT04	Mattapoisett	Culvert: Mattapoisett Neck Road	16	$43,500	$1,100
FA41	Falmouth	Culvert: Millfield Street	16	$64,500	$4,300
MT09	Mattapoisett	Old Railroad bridge: Eel Pond	16	$123,500	$4,900
DA12	Dartmouth	Culvert: Georges Pond	16	$128,800	$13,900
WH17	Wareham	Bridge: Sandwich Rd/Rte. 6, Agawam River	16	$350,000	$24,500
DA01	Dartmouth	Bridge/road: Bridge St., Apponagansett Bay	16	$1,100,000	$4,300
NB08	New Bedford	Dike: Shaws Cove Drive, New Bedford Harbor	16	$2,750,000	$33,000
WP06	Westport	Bridge: Hix Bridge, Westport River	16	$2,800,000	$13,600

Table 3. Count of Restriction Structure Types

Restriction Structure Type	Total
barrier beach	6
beach	1
berm, culvert with tidegate	1
berm	5
bridge	8
bridge/road	1
causeway	1
cement bank	1
channel through dike	1
culvert	6
culvert, bridge and road	1
debris	1
dike	34
driveway	8
footpath	1
path	12
railroad	14
remains of earthen/stone dam	1
road	139
rock wall, broken in places	1
rocks	1
stone wall	3
tide gate	1
wall	4
wooden path	1
(blank)	4
Grand Total	**257**

Tidal Restrictions in the Buzzards Bay Watershed

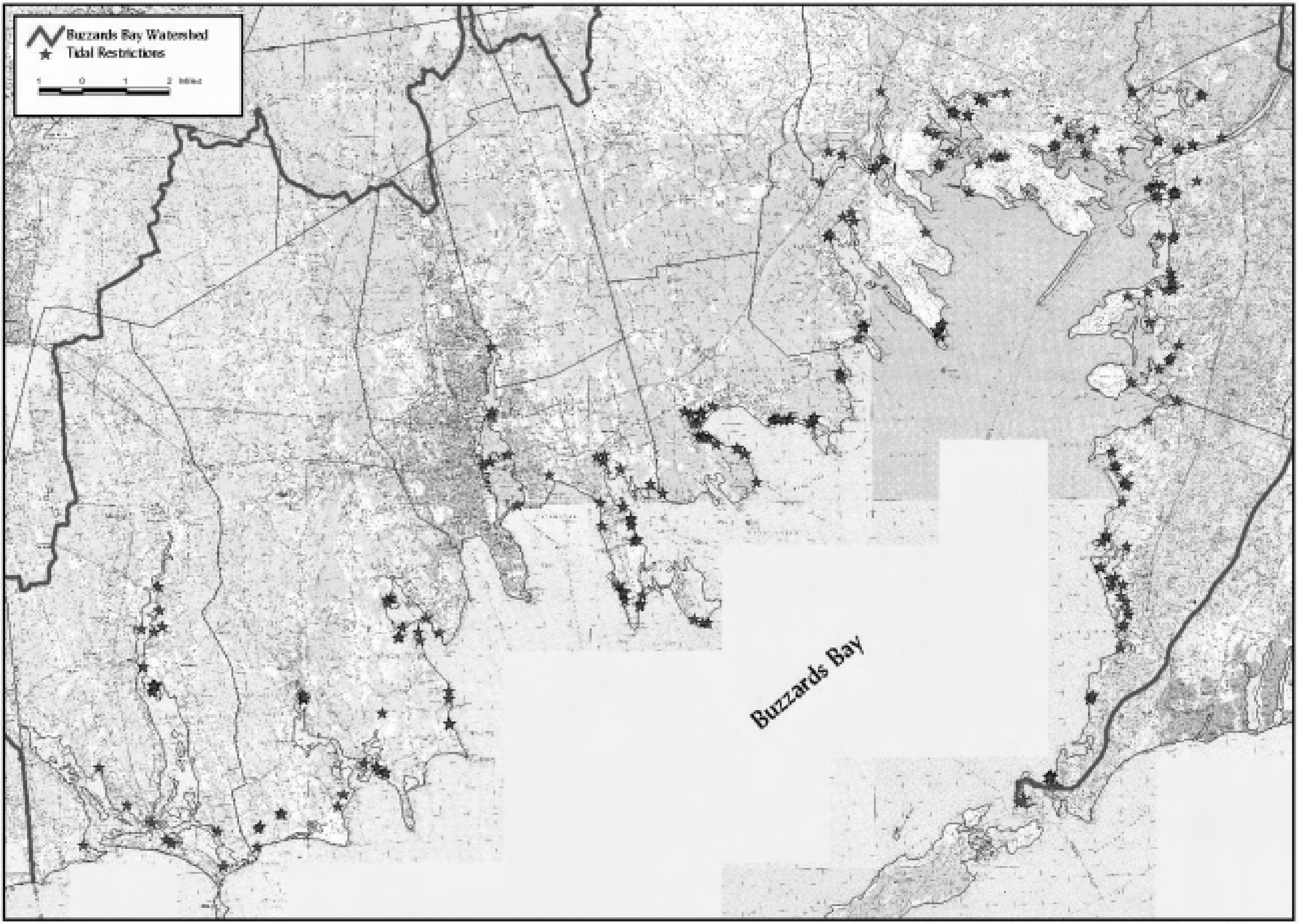

Figure 13. Tidal Restrictions in the Buzzards Bay Watershed

Table 4: Results: Summary of all tidal restriction sites sorted by municipality

Site #	Town	Remediation score	Estimated cost	Cost per vegetated acre	Restriction structure type	Remediated? (yes or no)	Surface water acres behind	Vegetated wetland acres	Total wetland with surface	Phragmites acres	% Phragmites	Score for % Phragmites	Score for wetland acreage	Score remediation cost per	Score for cross section per	Score for public restriction	Score for public wetland	Score anadromous fish run	Score rare/endangered	Score adverse restoration
BN01	Bourne	9	$53,900	$112,400	railroad culvert	N	0.0	0.5	0.48	0.48	100%	5	0	0	2	2	0	0	0	0
BN02	Bourne	5	$42,900	$24,300	Road	N	4.4	1.8	6.14	0	0%	0	2	1	2	0	0	0	0	0
BN03	Bourne	10	$3,500,000	$94,900	bridge	N	459.2	36.9	496	1.74	5%	1	4	0	2	2	1	0	0	0
BN04	Bourne	10	$2,500,000	$67,800	bridge	N	461.5	36.9	498	1.74	5%	1	4	0	2	2	1	0	0	0
BN06	Bourne	11	$319,100	$106,700	road	N	0.0	3.0	2.99	2.99	100%	5	1	0	2	3	0	0	0	0
BN07	Bourne	6	$9,700	$5,700	culvert	N	0.0	1.7	1.69	0	0%	0	1	3	2	0	0	0	0	0
BN08	Bourne	11	$453,000	$43,800	road	N	0.0	10.4	10.4	4.98	48%	3	2	0	3	3	0	0	0	0
BN09	Bourne	14	$560,000	$7,400	bridge	N	70.4	75.4	146	10	13%	2	4	3	2	3	0	0	0	0
BN10	Bourne	13	$510,000	$6,700	bridge	N	71.2	76.4	148	10	13%	2	4	3	2	2	0	0	0	0
BN11	Bourne	13	$19,600	$5,800	tide gate	N	0.0	3.4	3.39	0	0%	0	1	3	2	3	0	4	0	0
BN12	Bourne	13	$11,700	$6,900	culvert	N	2.5	1.7	4.17	0.24	14%	2	1	3	2	2	1	0	2	0
BN13	Bourne	7	$1,167,700	$116,774,400	railroad culvert	N	1.2	0.0	1.18	0	0%	0	1	0	0	2	0	4	0	0
BN14	Bourne	14	$450,000	$9,200	bridge	N	20.9	49.1	70	2.64	5%	1	3	2	2	3	1	0	2	0
BN15	Bourne	13	$35,600	$4,500	culvert	N	0.0	8.0	8	1.57	20%	2	2	3	3	3	0	0	0	0
BN16	Bourne	15	$21,000	$5,600	culvert	N	0.0	3.8	3.76	3.76	100%	5	1	3	3	3	0	0	0	0
BN17	Bourne	6	$15,200	$29,100	dike	N	0.0	0.5	0.52	0.17	33%	3	0	1	2	0	0	0	0	0
BN21	Bourne	10	$13,500	$19,300	road	N	0.0	0.7	0.7	0.62	89%	4	0	1	5	0	0	0	0	0
BN24	Bourne	9	$35,200	$6,400	road	N	0.0	5.5	5.52	0.72	13%	2	2	3	2	0	0	0	0	0

Site #	Town	Remediation score	Estimated cost	Cost per vegetated acre	Restriction structure type	Remediated? (yes or no)	Surface water acres behind	Vegetated wetland acres	Total wetland with surface	Phragmites acres	% Phragmites	Score for % Phragmites	Score for wetland acreage	Score remediation cost per	Score for cross section per	Score for public restriction	Score for public wetland	Score anadromous fish run	Score rare/endangered	Score adverse restoration
BN25	Bourne	8	$20,600	$38,800	road	N	0.0	0.5	0.53	0.12	23%	3	0	0	2	3	0	0	0	0
BN26	Bourne	11	$31,000	$24,200	dike	N	0.0	1.3	1.28	0.22	17%	2	1	1	3	2	0	0	2	0
BN27	Bourne	12	$12,500	$12,900	driveway	N	0.0	1.0	0.97	0.97	100%	5	0	2	5	0	0	0	0	0
BN28	Bourne	17	$21,500	$21,000	dike	N	0.0	1.0	1.02	1.02	100%	5	1	1	5	2	1	0	2	0
BN29	Bourne	12	$35,200	$28,800	railroad	N	0.0	1.2	1.22	1.22	100%	5	1	1	3	2	0	0	0	0
BN30	Bourne	9	$27,500	$10,000	dike	N	0.0	2.7	2.74	0.55	20%	3	1	2	3	0	0	0	0	0
BN32	Bourne	9	$119,400	$20,600	bridge	N	0.4	5.8	6.19	2.99	52%	4	2	1	2	0	0	0	0	0
BN33	Bourne	11	$2,500,000	$54,000	railroad bridge	N	12.5	46.3	58.7	2.4	5%	1	3	0	2	2	1	0	2	0
BN34	Bourne	9	$31,000	$91,200	dike	N	0.0	0.3	0.34	0.34	100%	5	0	0	1	3	0	0	0	0
BN35	Bourne	10	$15,900	$45,200	dike	N	0.0	0.4	0.35	0.35	99%	5	0	0	2	3	0	0	0	0
BN36	Bourne	10	$31,000	$52,600	dike	N	0.0	0.6	0.59	0.59	100%	5	0	0	2	3	0	0	0	0
BN37	Bourne	9	$27,900	$47,200	dike	N	0.0	0.6	0.59	0.59	100%	5	0	0	1	3	0	0	0	0
BN38	Bourne	15	$93,600	$11,500	road	N	0.0	8.2	8.16	0.48	6%	1	2	2	3	3	0	4	0	0
BN39	Bourne	15	$15,900	$3,800	dike	N	0.0	4.2	4.16	3.02	73%	4	1	4	4	0	0	0	2	0
BN40	Bourne	8	$55,600	$31,200	dike	N	0.0	1.8	1.78	1.7	96%	5	1	1	1	0	0	0	0	0
BN43	Bourne	11	$73,100	$8,000	dike	N	0.0	9.1	9.1	4.95	54%	4	2	2	3	0	0	0	0	0
BN44	Bourne	4	$536,500	$1,625,900	railroad	N	0.2	0.3	0.5	0	0%	0	0	0	2	2	0	0	0	0
DA01	Dartmouth	16	$1,100,000	$4,300	bridge/road	N	338.8	256.9	596	97	38%	3	4	3	3	3	0	0	0	0
DA02	Dartmouth	18	$500,000	$2,500	bridge	N	24.0	199.3	223	95.1	48%	3	4	4	3	3	1	0	0	0
DA03	Dartmouth	14	$22,700	$3,000	road	N	0.0	7.5	7.54	0.55	7%	1	2	4	4	3	0	0	0	0
DA04	Dartmouth	20	$21,300	$500	culvert	N	33.5	38.8	72.3	20.7	53%	4	3	6	5	0	0	0	2	0

Site #	Town	Remediation score	Estimated cost	Cost per vegetated acre	Restriction structure type	Remediated? (yes or no)	Surface water acres behind	Vegetated wetland acres	Total wetland with surface	Phragmites acres	% Phragmites	Score for % Phragmites	Score for wetland acreage	Score remediation cost per	Score for cross section per	Score for public restriction	Score for public wetland	Score anadromous fish run	Score rare/endangered	Score adverse restoration
DA05	Dartmouth	15	$180,200	$4,600	culvert	N	33.5	38.8	72.3	20.7	53%	4	3	3	3	0	0	0	2	0
DA06	Dartmouth	16	$9,200	$1,000	road	N	0.0	9.0	8.96	4.45	50%	3	2	5	4	0	0	0	2	0
DA07	Dartmouth	16	$9,200	$1,000	road	N	0.0	9.0	8.96	4.45	50%	3	2	5	4	0	0	0	2	0
DA08	Dartmouth	15	$90,100	$11,600	culvert	N	0.0	7.8	16.7	7.6	98%	5	2	2	4	0	0	0	2	0
DA09	Dartmouth	18	$600,000	$3,300	bridge	N	87.3	181.3	269	11.3	6%	1	4	4	3	3	1	0	2	0
DA11	Dartmouth	16	$7,600	$1,200	road	N	0.3	6.3	6.56	2.17	35%	3	2	5	4	0	0	0	2	0
DA12	Dartmouth	16	$128,800	$13,900	culvert	N	11.7	9.3	21	5.31	57%	4	2	2	3	2	1	0	2	0
DA13	Dartmouth	11	$5,900	$4,100	dike	N	0.7	1.4	2.11	0	0%	0	1	3	5	0	0	0	2	0
DA14	Dartmouth	13	$51,900	$7,600	culvert	N	0.2	6.8	7	0.75	11%	2	2	3	2	3	1	0	0	0
DA15	Dartmouth	16	$12,200	$1,100	culvert	N	0.5	11.0	11.6	2.09	19%	2	2	5	3	3	1	0	0	0
DA16	Dartmouth	11	$10,600	$1,200	culvert	N	0.0	8.9	8.91	0.38	4%	1	2	5	3	0	0	0	0	0
DA17	Dartmouth	17	$6,200	$900	culvert	N	0.0	6.8	6.79	0	0%	0	2	6	5	3	1	0	0	0
DA18	Dartmouth	11	$6,600	$2,600	culvert	N	0.0	2.6	2.58	0.49	19%	2	1	4	4	0	0	0	0	0
DA19	Dartmouth	11	$10,600	$5,600	wall	N	0.0	1.9	1.89	0.49	26%	3	1	3	4	0	0	0	0	0
DA20	Dartmouth	9	$24,100	$267,300	culvert	N	0.0	0.1	0.09	0.09	100%	5	0	0	1	3	0	0	0	0
DA21	Dartmouth	11	$10,900	$34,100	rocks	N	0.0	0.3	0.32	0.32	100%	5	0	1	5	0	0	0	0	0
DA22	Dartmouth	10	$49,400	$29,900	culvert	N	0.0	1.7	1.65	0.45	27%	3	1	1	5	0	0	0	0	0
DA23	Dartmouth	15	$12,000	$700	dike	N	0.0	18.2	18.2	0.14	1%	0	2	6	5	0	0	0	2	0
DA24	Dartmouth	14	$12,800	$6,400	dike	N	0.0	2.0	2	0.83	42%	3	1	3	5	0	0	0	2	0
DA25	Dartmouth	14	$13,500	$6,800	dike	N	0.0	2.0	2	0.83	42%	3	1	3	5	0	0	0	2	0
DA26	Dartmouth	14	$12,800	$6,400	dike	N	0.0	2.0	2	0.83	42%	3	1	3	5	0	0	0	2	0

Site #	Town	Remediation score	Estimated cost	Cost per vegetated acre	Restriction structure type	Remediated? (yes or no)	Surface water acres behind	Vegetated wetland acres	Total wetland with surface	Phragmites acres	% Phragmites	Score for % Phragmites	Score for wetland acreage	Score remediation cost per	Score for cross section per	Score for public restriction	Score for public wetland	Score anadromous fish run	Score rare/endangered	Score adverse restoration
DA27	Dartmouth	16	$13,900	$6,100	dike	N	0.0	2.3	2.29	2.29	100%	5	1	3	5	0	0	0	2	0
DA28	Dartmouth	14	$10,700	$13,100	dike	N	0.0	0.8	0.82	0.82	100%	5	0	2	5	0	0	0	2	0
DA29	Dartmouth	14	$10,700	$13,100	dike	N	0.0	0.8	0.82	0.82	100%	5	0	2	5	0	0	0	2	0
DA30	Dartmouth	13	$12,000	$41,500	dike	N	1.8	0.3	2.09	0.29	100%	5	1	0	5	0	0	0	2	0
DA31	Dartmouth	13	$10,900	$37,600	wall	N	1.8	0.3	2.09	0.29	100%	5	1	0	5	0	0	0	2	0
DA32	Dartmouth	11	$45,000	$6,400	bridge	N	0.0	7.0	7.02	1.79	25%	3	2	3	1	0	0	0	2	0
FA01	Falmouth	15	$6,000	$1,700	culvert	N	0.0	3.6	3.62	3.62	100%	5	1	5	4	0	0	0	0	0
FA02	Falmouth	19	$13,900	$900	wall	N	2.3	14.8	17	14.8	100%	5	2	6	5	0	1	0	0	0
FA03	Falmouth	9	$12,000	$26,700	culvert	N	0.0	0.5	0.45	0.45	100%	5	0	1	3	0	0	0	0	0
FA04	Falmouth	8	$7,200	$22,400	culvert	N	0.0	0.3	0.32	0.32	100%	5	0	1	2	0	0	0	0	0
FA05	Falmouth	21	$19,300	$1,300	culvert	N	2.3	14.6	16.8	14.6	100%	5	2	5	5	3	1	0	0	0
FA06	Falmouth	10	$19,300	$101,700	culvert	N	0.0	0.2	0.19	0.19	100%	5	0	0	1	3	1	0	0	0
FA07	Falmouth	13	$36,200	$4,200	tide gate	N	0.4	8.7	9.1	7.31	84%	4	2	3	4	0	0	0	0	0
FA08	Falmouth	15	$11,200	$1,400	culvert	N	0.4	8.2	8.56	6.77	83%	4	2	5	4	0	0	0	0	0
FA09	Falmouth	13	$22,300	$3,600	culvert	N	0.4	6.2	6.62	4.82	77%	4	2	4	3	0	0	0	0	0
FA10	Falmouth	17	$14,900	$7,900	road	N	4.2	1.9	6.06	1.88	100%	5	2	3	5	0	0	0	2	0
FA11	Falmouth	9	$42,000	$9,400	bridge	N	3.2	4.5	7.68	1.63	36%	3	2	2	2	0	0	0	0	0
FA12	Falmouth	8	$60,000	$20,000	bridge	N	4.5	3.0	7.47	1.63	54%	4	2	1	1	0	0	0	0	0
FA13	Falmouth	8	$44,900	$115,200	culvert	N	0.9	0.4	1.33	0.39	100%	5	1	0	2	0	0	0	0	0
FA14	Falmouth	9	$1,200,000	$61,400	bridge	N	6.0	19.6	25.6	3.89	20%	2	3	0	0	3	1	0	0	0
FA15	Falmouth	9	$250,000	$28,800	bridge	N	4.3	8.7	13	3.92	45%	3	2	1	0	3	0	0	0	0

Site #	Town	Remediation score	Estimated cost	Cost per vegetated acre	Restriction structure type	Remediated? (yes or no)	Surface water acres behind	Vegetated wetland acres	Total wetland with surface	Phragmites acres	% Phragmites	Score for % Phragmites	Score for wetland acreage	Score remediation cost per	Score for cross section per	Score for public restriction	Score for public wetland	Score anadromous fish run	Score rare/endangered	Score adverse restoration
FA16	Falmouth	9	$1,200,000	$161,300	bridge	N	18.8	7.4	26.3	2.36	32%	3	3	0	0	3	0	0	0	0
FA17	Falmouth	10	$226,000	$59,800	culvert	N	6.8	3.8	10.5	2.36	62%	4	2	0	2	2	0	0	0	0
FA18	Falmouth	7	$30,400	$338,100	culvert	N	0.1	0.1	0.22	0.09	100%	5	0	0	2	0	0	0	0	0
FA19	Falmouth	15	$18,900	$5,800	culvert	N	2.3	3.3	5.56	0.71	22%	3	2	3	4	3	0	0	0	0
FA20	Falmouth	12	$124,000	$56,600	culvert	N	2.2	2.2	4.38	2.19	100%	5	1	0	4	2	0	0	0	0
FA21	Falmouth	11	$124,000	$50,200	culvert	N	0.0	2.5	2.47	2.47	100%	5	1	0	3	2	0	0	0	0
FA22	Falmouth	1	$34,700	$1,400	culvert	N	7.6	25.5	33.1	0	0%	0	3	5	3	0	0	0	0	-10
FA25	Falmouth	5	$24,100	$50,100	culvert	N	0.0	0.5	0.48	0	0%	0	0	0	2	3	0	0	0	0
FA26	Falmouth	12	$12,500	$3,400	culvert	N	0.7	3.7	4.38	0.21	6%	1	1	4	3	0	0	0	2	1
FA27	Falmouth	13	$8,200	$2,900	culvert	N	0.0	2.9	2.85	0.82	29%	3	1	4	3	0	0	0	2	0
FA28	Falmouth	12	$74,600	$19,500	dike	N	1.4	3.8	5.21	1.04	27%	3	2	1	3	2	1	0	0	0
FA28A	Falmouth	10	$160,700	$42,100	dike	N	1.4	3.8	5.21	1.04	27%	3	2	0	2	2	1	0	0	0
FA29	Falmouth	10	$12,000	$3,700	culvert	N	0.0	3.2	3.23	0.29	9%	1	1	4	4	0	0	0	0	0
FA30	Falmouth	9	$12,600	$5,300	culvert	N	0.7	2.4	3.09	0.14	6%	1	1	3	4	0	0	0	0	0
FA31	Falmouth	7	$10,600	$4,500	culvert	N	0.7	2.4	3.09	0.14	6%	1	1	3	2	0	0	0	0	0
FA32	Falmouth	13	$16,400	$3,200	culvert	N	0.0	5.2	5.17	4.4	85%	4	2	4	3	0	0	0	0	0
FA33	Falmouth	12	$8,200	$4,100	culvert	N	0.0	2.0	1.99	1.99	100%	5	1	3	3	0	0	0	0	0
FA34	Falmouth	15	$57,200	$8,400	culvert	N	0.5	6.9	7.36	5.85	85%	4	2	2	4	3	0	0	0	0
FA35	Falmouth	2	$21,400	$76,500	culvert	N	0.0	0.3	0.28	0	0%	0	0	0	2	0	0	0	0	0
FA36	Falmouth	5	$31,000	$25,800	culvert	N	0.0	1.2	1.2		0%	0	1	1	3	0	0	0	0	0
FA37	Falmouth	5	$19,600	$31,100	dike	N	0.0	0.6	0.63	0.28	44%	3	0	1	1	0	0	0	0	0

Site #	Town	Remediation score	Estimated cost	Cost per vegetated acre	Restriction structure type	Remediated? (yes or no)	Surface water acres behind	Vegetated wetland acres	Total wetland with surface	Phragmites acres	% Phragmites	Score for % Phragmites	Score for wetland acreage	Score remediation cost per	Score for cross section per	Score for public restriction	Score for public wetland	Score anadromous fish run	Score rare/endangered	Score adverse restoration
FA38	Falmouth	12	$24,600	$7,500	dike	N	0.0	3.3	3.27	1.7	52%	4	1	3	4	0	0	0	0	0
FA39	Falmouth	15	$227,500	$19,700	culvert	N	0.0	11.5	11.5	11.4	99%	5	2	1	3	3	1	0	0	0
FA40	Falmouth	15	$68,100	$4,500	culvert	N	2.3	15.0	17.3	15	100%	5	2	3	4	0	1	0	0	0
FA41	Falmouth	16	$64,500	$4,300	culvert	N	2.3	15.0	17.3	15	100%	5	2	3	5	0	1	0	0	0
FH01	Fairhaven	7	$7,200	$7,000	culvert	N	0.0	1.0	1.02	0	0%	0	1	3	3	0	0	0	0	0
FH02	Fairhaven	13	$12,600	$9,700	culvert	N	0.0	1.3	1.3	1.3	100%	5	1	2	2	3	0	0	0	0
FH03	Fairhaven	7	$350,000	$20,500	bridge	N	1.4	17.1	18.5	3	18%	2	2	1	2	0	0	0	0	0
FH04	Fairhaven	9	$502,800	$359,100	bridge/culvert	N	0.0	1.4	1.4	1.4	100%	5	1	0	0	3	0	0	0	0
FH05	Fairhaven	9	$65,800	$73,900	culvert	N	0.0	0.9	0.89	0.89	100%	5	0	0	1	3	0	0	0	0
FH06	Fairhaven	8	$25,100	$8,900	road	N	0.0	2.8	2.82	0.71	25%	3	1	2	2	0	0	0	0	0
FH07	Fairhaven	10	$25,100	$4,700	road	N	0.0	5.4	5.38	1.25	23%	3	2	3	2	0	0	0	0	0
FH08	Fairhaven	11	$18,100	$11,500	barrier beach	N	0.0	1.6	1.58	1.58	100%	5	1	2	3	0	0	0	0	0
FH08A	Fairhaven	5	$143,800	$81,700	bridge	N	0.0	1.8	1.76	0.98	56%	4	1	0	0	0	0	0	0	0
FH09A	Fairhaven	10	$26,800	$44,700	road	N	0.0	0.6	0.6	0.6	100%	5	0	0	2	3	0	0	0	0
FH09B	Fairhaven	8	$7,200	$28,600	culvert	N	0.0	0.3	0.25	0.25	100%	5	0	1	2	0	0	0	0	0
FH10	Fairhaven	14	$26,800	$13,800	culvert	N	0.0	1.9	1.94	1.94	100%	5	1	2	3	3	0	0	0	0
FH11	Fairhaven	12	$121,400	$18,200	culvert	N	0.0	6.7	6.68	5.56	83%	4	2	1	2	3	0	0	0	0
FH12	Fairhaven	7	$7,600	$47,400	culvert	N	0.0	0.2	0.16	0.16	100%	5	0	0	2	0	0	0	0	0
FH13	Fairhaven	8	$15,200	$28,600	culvert	N	0.0	0.5	0.53	0.53	100%	5	0	1	2	0	0	0	0	0
FH14	Fairhaven	3	$16,400	$31,000	culvert	N	0.0	0.5	0.53	0	0%	0	0	1	2	0	0	0	0	0
FH15	Fairhaven	4	$7,600	$14,300	culvert	N	0.0	0.5	0.53	0	0%	0	0	2	2	0	0	0	0	0

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FH16	Fairhaven	15	$76,900	$6,600	culvert	N	0.0	11.7	11.7	1.2	10%	2	2	3	3	3	0	0	2	0
FH17	Fairhaven	12	$16,400	$9,100	footpath	N	0.0	1.8	1.8	0	0%	0	1	2	3	3	1	0	2	0
FH18	Fairhaven	19	$18,800	$2,200	culvert	N	0.0	8.7	8.67	4.43	51%	4	2	4	4	3	0	0	2	0
FH19	Fairhaven	15	$32,400	$20,500	culvert	N	0.0	1.6	1.58	1.58	100%	5	1	1	3	3	0	0	2	0
FH20	Fairhaven	12	$13,000	$4,500	culvert	N	0.0	2.9	2.9	2.4	83%	4	1	3	4	0	0	0	0	0
FH21	Fairhaven	12	$13,000	$5,100	culvert	N	0.0	2.6	2.58	2.11	82%	4	1	3	4	0	0	0	0	0
FH21A	Fairhaven	11	$13,000	$9,900	culvert	N	0.0	1.3	1.32	1.32	100%	5	1	2	3	0	0	0	0	0
FH22	Fairhaven	13	$20,600	$2,300	culvert	N	0.0	9.1	9.08	4.31	47%	3	2	4	4	0	0	0	0	0
FH23	Fairhaven	9	$62,300	$53,200	barrier beach	N	0.0	1.2	1.17	1.17	100%	5	1	0	3	0	0	0	0	0
FH24	Fairhaven	6	$44,900	$50,500	barrier beach	N	0.0	0.9	0.89	0.37	42%	3	0	0	3	0	0	0	0	
MN02	Marion	9	$15,900	$6,400	culvert	N	0.0	2.5	2.48	0.56	23%	3	1	3	2	0	0	0	0	0
MN05	Marion	7	$15,200	$17,600	culvert	N	0.0	0.9	0.86	0.36	42%	3	0	1	3	0	0	0	0	0
MN06	Marion	6	$22,500	$26,200	culvert	N	0.0	0.9	0.86	0.36	42%	3	0	1	2	0	0	0	0	0
MN07	Marion	9	$22,500	$12,000	culvert	N	0.0	1.9	1.87	0.36	19%	2	1	2	2	0	0	0	2	0
MN08	Marion	9	$38,500	$34,700	culvert	N	0.0	1.1	1.11	0.84	76%	4	1	1	1	2	0	0	0	0
MN09	Marion	10	$81,000	$12,600	culvert	Y	0.0	6.5	6.45	0.47	7%	1	2	2	2	3	0	0	0	0
MN10	Marion	10	$17,600	$12,500	culvert	N	0.0	1.4	1.41	0	0%	0	1	2	1	3	1	0	2	0
MN12	Marion	12	$8,800	$2,600	culvert	N	0.0	3.4	3.43	2.84	83%	4	1	4	3	0	0	0	0	0
MN13	Marion	11	$11,700	$5,800	culvert	N	0.0	2.0	2.02	1.85	92%	5	1	3	2	0	0	0	0	0
MN14	Marion	12	$6,700	$4,800	culvert	N	0.0	1.4	1.41	1.41	100%	5	1	3	3	0	0	0	0	0
MN15	Marion	12	$11,600	$8,300	culvert	N	0.0	1.4	1.41	1.41	100%	5	1	2	4	0	0	0	0	0

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MN16	Marion	10	$17,600	$12,500	culvert	N	0.0	1.4	1.41	1.41	100%	5	1	2	2	0	0	0	0	0
MN17	Marion	11	$6,700	$6,000	culvert	N	0.0	1.1	1.12	1.12	100%	5	1	3	2	0	0	0	0	0
MN18	Marion	10	$16,100	$14,400	culvert	N	0.0	1.1	1.12	1.12	100%	5	1	2	2	0	0	0	0	0
MN19	Marion	10	$13,500	$12,000	culvert	N	0.0	1.1	1.12	1.12	100%	5	1	2	2	0	0	0	0	0
MN20	Marion	6	$13,500	$48,200	culvert	N	0.0	0.3	0.28	0.28	100%	5	0	0	1	0	0	0	0	0
MN21	Marion	7	$15,200	$72,200	culvert	Y	0.0	0.2	0.21	0.21	100%	5	0	0	2	0	0	0	0	0
MN22	Marion	17	$13,500	$700	culvert	Y	0.0	20.3	20.3	20	99%	5	2	6	4	0	0	0	0	0
MN29	Marion	9	$6,500	$6,000	dike	N	0.4	1.1	1.44	0	0%	0	1	3	5	0	0	0	0	0
MN30	Marion	9	$10,200	$46,100	wall	N	0.0	0.2	0.22	0.15	68%	4	0	0	5	0	0	0	0	0
MN31	Marion	8	$10,200	$46,100	wall	N	0.0	0.2	0.22	0.11	50%	3	0	0	5	0	0	0	0	0
MT01	Mattapoisett	13	$7,200	$1,700	culvert	N	0.0	4.2	4.18	1.3	31%	3	1	5	4	0	0	0	0	0
MT02	Mattapoisett	13	$7,200	$1,700	culvert	N	0.0	4.2	4.18	1.3	31%	3	1	5	4	0	0	0	0	0
MT03	Mattapoisett	15	$143,600	$3,600	culvert	N	0.0	40.0	40	3.83	10%	1	3	4	3	3	1	0	0	0
MT04	Mattapoisett	16	$43,500	$1,100	culvert	N	0.0	40.0	40	3.83	10%	1	3	5	4	3	0	0	0	0
MT05	Mattapoisett	13	$218,700	$5,500	culvert	N	0.0	40.0	40	3.83	10%	1	3	3	3	3	0	0	0	0
MT06	Mattapoisett	17	$43,500	$1,100	culvert	N	0.0	40.5	40.5	4.49	11%	2	3	5	4	3	0	0	0	0
MT07	Mattapoisett	13	$600,000	$22,700	bridge	N	12.4	26.5	38.9	5.59	21%	3	3	1	2	3	1	0	0	0
MT08	Mattapoisett	9	$34,900	$33,900	culvert	N	0.0	1.0	1.03	1.03	100%	5	1	1	2	0	0	0	0	0
MT09	Mattapoisett	16	$123,500	$4,900	culvert	N	18.8	25.1	43.9	6.19	25%	3	3	3	3	3	1	0	0	0
MT10	Mattapoisett	12	$13,000	$6,700	culvert	N	0.0	1.9	1.94	1.87	96%	5	1	3	3	0	0	0	0	0
MT11	Mattapoisett	11	$9,500	$3,200	culvert	N	0.0	3.0	2.96	2.46	83%	4	1	4	2	0	0	0	0	0

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MT12	Mattapoisett	12	$66,900	$11,900	culvert	N	0.0	5.6	5.6	3.62	65%	4	2	2	3	0	1	0	0	0
MT13	Mattapoisett	15	$18,000	$2,200	culvert	N	0.2	8.3	8.52	4.77	58%	4	2	4	4	0	1	0	0	0
MT14	Mattapoisett	5	$195,500	$78,800	culvert	N	0.0	2.5	2.48	0	0%	0	1	0	1	3	0	0	0	0
MT15	Mattapoisett	16	$11,600	$2,500	culvert	N	0.0	4.6	4.58	2.89	63%	4	1	4	3	3	1	0	0	0
MT16	Mattapoisett	9	$19,900	$35,500	culvert	N	0.0	0.6	0.56	0.56	100%	5	0	0	1	3	0	0	0	0
MT17	Mattapoisett	18	$12,500	$2,700	wall	N	0.0	4.6	4.56	2.89	63%	4	1	4	5	3	1	0	0	0
MT18	Mattapoisett	12	$12,500	$6,300	culvert	N	0.0	2.0	1.98	1.48	75%	4	1	3	4	0	0	0	0	0
MT19	Mattapoisett	10	$22,500	$7,300	culvert	N	0.0	3.1	3.09	2.13	69%	4	1	3	2	0	0	0	0	0
MT20	Mattapoisett	10	$12,000	$100,300	path	N	0.0	0.1	0.12	0.12	100%	5	0	0	5	0	0	0	0	0
MT21	Mattapoisett	7	$12,000	$52,200	culvert	N	0.0	0.2	0.23	0.23	100%	5	0	0	2	0	0	0	0	0
MT22	Mattapoisett	9	$7,700	$4,400	culvert	N	0.0	1.8	1.75	0.5	29%	3	1	3	2	0	0	0	0	0
MT23	Mattapoisett	14	$8,800	$4,300	culvert	N	0.0	2.1	2.05	2.05	100%	5	1	3	2	2	1	0	0	0
MT24	Mattapoisett	9	$12,000	$4,900	dike	N	0.0	2.5	2.48	0	0%	0	1	3	5	0	0	0	0	0
MT25	Mattapoisett	7	$5,900	$18,000	culvert	N	0.0	0.3	0.33	0.1	30%	3	0	1	3	0	0	0	0	0
MT26	Mattapoisett	5	$6,700	$41,900	culvert	N	0.0	0.2	0.16	0.04	25%	3	0	0	2	0	0	0	0	0
MT27	Mattapoisett	6	$6,900	$29,900	culvert	N	0.0	0.2	0.23	0.1	43%	3	0	1	2	0	0	0	0	0
MT28	Mattapoisett	6	$16,200	$269,700	road	N	0.0	0.1	0.06	0.06	100%	5	0	0	1	0	0	0	0	0
MT29	Mattapoisett	4	$34,900	$71,200	wooden path	N	0.0	0.5	0.49	0.43	88%	4	0	0	0	0	0	0	0	0
MT30	Mattapoisett	9	$15,700	$17,500	culvert	N	0.0	0.9	0.9	0.83	92%	5	0	1	3	0	0	0	0	0
MT31	Mattapoisett	5	$37,500	$536,000	bridge	N	0.0	0.1	0.07	0	0%	0	0	0	5	0	0	0	0	0
MT32	Mattapoisett	6	$11,700	$36,600	ditch	N	0.0	0.3	0.32	0.01	3%	1	0	0	5	0	0	0	0	0

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MT33	Mattapoisett	4	$25,800	$171,900	culvert	N	0.0	0.2	0.15	0.04	27%	3	0	0	1	0	0	0	0	0
MT35	Mattapoisett	7	$24,100	$21,300	culvert	N	0.0	1.1	1.13	0.35	31%	3	1	1	2	0	0	0	0	0
MT36	Mattapoisett	7	$24,100	$21,300	culvert	N	0.0	1.1	1.13	0.35	31%	3	1	1	2	0	0	0	0	0
MT37	Mattapoisett	4	$11,700	$146,200	culvert	N		0.1	0.08	0.01	13%	2	0	0	2	0	0	0	0	0
MT38	Mattapoisett	12	$14,700	$70,000	road	N	0.0	0.2	0.21	0.15	71%	4	0	0	5	3	0	0	0	0
NB02	New Bedford	7	$5,000,000	$256,400	bridge	N	3.7	19.5	23.2	0.82	4%	1	2	0	0	3	1	0	0	0
NB03	New Bedford	13	$1,000,000	$12,000	bridge	N	221.0	83.4	304	12	14%	2	4	2	1	3	1	0	0	0
NB04	New Bedford	9	$4,000,000	$48,000	bridge	N	237.0	83.4	320	12	14%	2	4	0	0	2	1	0	0	0
NB05	New Bedford	9	$18,000,000	$215,800	bridge	N	556.0	83.4	639	12	14%	2	4	0	0	2	1	0	0	0
NB06	New Bedford	9	$8,000,000	$95,900	bridge	N	556.0	83.4	639	12	14%	2	4	0	0	2	1	0	0	0
NB07	New Bedford	9	$8,000,000	$95,900	bridge	N	556.0	83.4	639	12	14%	2	4	0	0	2	1	0	0	0
NB08	New Bedford	16	$2,750,000	$33,000	dike	N	1012.0	83.4	1095	12	14%	2	4	1	1	3	1	4	0	0
WH01	Wareham	14	$1,500,000	$24,500	bridge/road	N	221.8	61.3	283	57.7	94%	5	4	1	1	2	1	0	0	0
WH01B	Wareham	15	$1,000,000	$6,200	bridge	N	221.8	161.3	383	57.7	36%	3	4	3	2	2	1	0	0	0
WH02	Wareham	4	$360,000	$3,600,000	bridge	N	2.2	0.1	2.27	0	0%	0	1	0	0	0	1	0	2	0
WH03	Wareham	7	$119,000	$31,900	bridge/road	N	0.0	3.7	3.73	0.14	4%	1	1	1	1	3	0	0	0	0
WH04	Wareham	11	$13,900	$17,600	fill	N	0.0	0.8	0.79	0.79	100%	5	0	1	5	0	0	0	0	0
WH05	Wareham	12	$2,000,000	$27,300	bridge	N	113.4	73.2	187	20.7	28%	3	4	1	0	3	1	0	0	0
WH06	Wareham	11	$1,000,000	$16,100	bridge	N	51.6	62.3	114	9.78	16%	2	3	1	1	3	1	0	0	0
WH07	Wareham	12	$25,000	$2,200	culvert	N	0.0	11.5	11.5	3.83	33%	3	2	4	3	0	0	0	0	0
WH08	Wareham	9	$7,200	$1,800	culvert	N	0.0	3.9	3.91	0	0%	0	1	5	3	0	0	0	0	0

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WH09	Wareham	11	$6,200	$1,600	road	N	0.0	3.9	3.91	0	0%	0	1	5	5	0	0	0	0	0
WH10	Wareham	15	$60,200	$4,800	Road	N	0.0	12.5	12.5	7.21	58%	4	2	3	3	3	0	0	0	0
WH11	Wareham	17	$11,300	$600	culvert	N	0.0	19.3	19.3	3.32	17%	2	2	6	4	3	0	0	0	0
WH12	Wareham	10	$217,700	$369,000	railroad culvert	N	0.6	0.6	1.18	0.59	100%	5	1	0	2	2	0	0	0	0
WH13	Wareham	11	$85,700	$68,600	road	N	1.4	1.3	2.6	0.88	70%	4	1	0	2	3	1	0	0	0
WH14	Wareham	13	$1,750,000	$17,000	bridge	N	189.5	102.7	292	66	64%	4	4	1	1	2	1	0	0	0
WH14B	Wareham	12	$500,000	$4,900	bridge	N	189.5	102.7	292	66	64%	4	0	3	2	2	1	0	0	0
WH15	Wareham	10	$1,000,000	$9,700	bridge	N	189.5	102.7	292	66	64%	4	0	2	1	2	1	0	0	0
WH16	Wareham	12	$70,200	$13,500	culvert	N	0.0	5.2	5.2	3.76	72%	4	2	2	2	2	0	0	0	0
WH17	Wareham	16	$350,000	$24,500	bridge	N	23.4	14.3	37.6	14.2	100%	5	3	1	2	2	1	0	2	0
WH20	Wareham	7	$2,000,000	$146,500	bridge	N	0.0	13.7	13.7	2.78	20%	3	2	0	0	2	0	0	0	0
WH21	Wareham	7	$1,500,000	$570,300	bridge	N	5.9	2.6	8.52		0%	0	2	0	0	2	1	0	2	0
WH23	Wareham	12	$65,800	$7,600	dike	N	0.0	8.6	8.6	5.8	67%	4	2	3	3	0	0	0	0	0
WH24	Wareham	11	$213,600	$577,400	railroad	N	1.8	0.4	2.17	0.37	100%	5	1	0	2	3	0	0	0	0
WH25	Wareham	6	$12,000	$52,300	road	N	0.0	0.2	0.23	0.04	17%	2	0	0	2	0	0	0	2	0
WH26	Wareham	9	$12,000	$52,300	dike	N	0.0	0.2	0.23	0.04	17%	2	0	0	5	0	0	0	2	0
WH27	Wareham	16	$27,000	$2,400	road	N	0.0	11.5	11.5	2.45	21%	3	2	4	4	3	0	0	0	0
WH28	Wareham	13	$12,000	$9,200	driveway	N	0.0	1.3	1.31	1.31	100%	5	1	2	5	0	0	0	0	0
WH29	Wareham	15	$28,500	$4,700	road	N	0.0	6.1	6.1	5.8	95%	5	2	3	3	2	0	0	0	0
WH30	Wareham	9	$43,500	$4,000	dike	N	0.0	10.9	10.9	0	0%	0	2	4	3	0	0	0	0	0
WH31	Wareham	15	$9,500	$1,000	road	N	0.0	9.5	9.53	5.96	63%	4	2	6	3	0	0	0	0	0

Site #	Town	Remediation score	Estimated cost	Cost per vegetated acre	Restriction structure type	Remediated? (yes or no)	Surface water acres behind	Vegetated wetland acres	Total wetland with surface	Phragmites acres	% Phragmites	Score for % Phragmites	Score for wetland acreage	Score remediation cost per	Score for cross section per	Score for public restriction	Score for public wetland	Score anadromous fish run	Score rare/endangered	Score adverse restoration
WH32	Wareham	7	$6,100	$9,300	road	N	1.9	0.7	2.56	0	0%	0	1	2	4	0	0	0	0	0
WH33	Wareham	16	$27,500	$5,300	road	N	0.0	5.2	5.19	5.19	100%	5	2	3	3	2	1	0	0	0
WH34	Wareham	12	$29,000	$4,500	dike	N	0.0	6.5	6.5	5	77%	4	2	3	3	0	0	0	0	0
WH35	Wareham	13	$12,000	$4,900	dike	N	0.0	2.5	2.48	2	81%	4	1	3	5	0	0	0	0	0
WH36	Wareham	10	$12,000	$3,000	dike	N	0.0	4.0	3.98	0	0%	0	1	4	5	0	0	0	0	0
WH37	Wareham	6	$169,200	$248,800	road	N	0.0	0.7	0.68	0.4	59%	4	0	0	2	0	0	0	0	0
WH39	Wareham	13	$155,400	$94,500	culvert	N	0.0	1.7	1.7	1.58	93%	5	1	0	2	3	0	0	2	0
WH40	Wareham	18	$13,900	$6,900	dike	N	0.0	2.0	2.03	2.73	134%	5	1	3	5	0	0	4	0	0
WH41	Wareham	9	$350,000	$150,200	bridge/old wall	N	0.0	2.3	2.33	2.73	117%	5	1	0	0	3	0	0	0	0
WP01	Westport	14	$32,400	$2,800	culvert	N	100.2	11.4	112	7.38	65%	4	3	4	5	3	1	4	0	-10
WP02	Westport	7	$16,100	$24,800	culvert	N	0.0	0.7	0.65	0.58	89%	4	0	1	0	0	0	0	2	0
WP03	Westport	13	$9,200,000	$12,100	bridge	N	1910.0	760.5	2670	0	0%	0	4	2	2	2	1	0	2	0
WP04	Westport	10	$26,800	$13,600	culvert	N	0.0	2.0	1.97	1.36	69%	4	1	2	3	0	0	0	0	0
WP05	Westport	6	$10,600	$5,900	culvert	N	0.0	1.8	1.8	0	0%	0	1	3	2	0	0	0	0	0
WP06	Westport	16	$2,800,000	$13,600	bridge	N	311.6	205.5	517	136	66%	4	4	2	2	3	1	0	0	0
WP07	Westport	13	$13,000	$7,700	dike	N	0.0	1.7	1.69	1.36	80%	4	1	3	5	0	0	0	0	0
WP08	Westport	13	$14,900	$10,200	dike	N	0.0	1.5	1.45	1.48	102%	5	1	2	5	0	0	0	0	0
WP09	Westport	9	$17,100	$11,100	culvert	N	0.2	1.5	1.69	0	0%	0	1	2	2	3	1	0	0	0
WP10	Westport	11	$7,000	$4,100	road	N	0.0	1.7	1.7	0.24	14%	2	1	3	5	0	0	0	0	0
WP11	Westport	9	$13,900	$44,900	dike	N	0.0	0.3	0.31	0.24	77%	4	0	0	5	0	0	0	0	0
WP12	Westport	14	$13,800	$1,800	culvert	N	0.5	7.7	8.2	3.67	48%	3	2	5	4	0	0	0	0	0

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WP13	Westport	15	$12,400	$1,700	rocks	N	0.2	7.3	7.54	2.93	40%	3	2	5	5	0	0	0	0	0
WP14	Westport	-2	$25,800	$7,300	dike	N	3.4	3.5	6.95	0	0%	0	2	3	3	0	0	0	0	-10
WP15	Westport	5	$12,000	$80,200	wall	N	0.0	0.2	0.15	0	0%	0	0	0	5	0	0	0	0	0
WP16	Westport	5	$12,000	$133,700	wall	N	0.0	0.1	0.09	0	0%	0	0	0	5	0	0	0	0	0
WP17	Westport	16	$9,700	$1,000	road	N	0.0	9.7	9.71	3.61	37%	3	2	6	3	0	0	0	2	0
WP18	Westport	5	$14,000	$63,700	road	N	0.1	0.2	0.36	0.01	5%	1	0	0	2	0	0	0	2	0
WP19	Westport	12	$62,700	$49,000	road	N	0.0	1.3	1.28	0.67	52%	4	1	0	2	2	1	0	2	0
WP20	Westport	8	$62,700	$174,100	road	N	0.0	0.4	0.36	0.04	11%	2	0	0	1	2	1	0	2	0