October 29, 1998

Marion Board of Selectmen
2 Spring St.
Marion, MA 02738

Dear Honorable Selectmen,

Earlier this year Mr. Pickles conveyed a request on your behalf requesting a nitrogen loading assessment for the Town of Marion, especially with respect to wastewater disposal issues and treatment plant upgrades and expansion.

Enclosed is a draft report for your comment and consideration. Please note that we have not completed a needed appendix that list all parcels, zoning, and watersheds in Marion. This table is not yet complete but will be forwarded shortly.

Sincerely,

Joseph E. Costa, Ph.D.
Executive Director

A preliminary evaluation of nitrogen loading of watersheds within the Town of Marion as it relates to wastewater disposal.

By

Joseph E. Costa, Ph.D.

Buzzards Bay Project National Estuary Program

draft
October 29, 1998

Introduction

At the request of the Marion Board of Selectmen (request attached), the Buzzards Bay Project (BBP) conducted a study of point and non-point sources of nitrogen, especially wastewater disposal, relative to their potential impact on groundwater and surface waters, and how they relate to potential upgrades and expansion of the town's wastewater facility and sewage collection facility.

The interest in this topic by the Board of Selectmen and other municipal boards in the Town of Marion is the result of a better awareness of the impacts of nitrogen, regulatory requirements for sewage treatment facility upgrades, interest in protecting open space to protect water quality and living resources, changing zoning to manage growth and protect water quality, debate about the efficacy of expanding sewer service, interest in community package plants, and new funding opportunities through the State Revolving Fund, to name a few.

In this report we attempt to pull together data and information that will assist the municipal boards in Marion address these many interests and concerns revolving around the issue of wastewater disposal and nitrogen loading. In conducting this assessment, we have reexamined and synthesized nitrogen loading in the Marion's coastal waters summarized in the Buzzards Bay Project's 1994 nitrogen loading subwatershed evaluation, the Aucoot Cove water quality analysis report prepared by the BBP in 1991, the joint BBP Coalition for Buzzards Bay citizen monitoring report issued in 1996, 1985 Mass GIS land use data, 1994 parcel level data, core wetlands mapped through the state wetland conservancy program in 1991, but only recently available in digital form with BBP support, a report on the use of conservation restrictions submitted to the board of Selectmen in 1995, and elements of a Marion open Space Plan prepared by the Buzzards Bay Project in 1992, and other sources of information.

Background

Wastewater facility issues

In 1991, the Buzzards Bay Project transmitted to the Town of Marion a report prepared by Dr. Brian Howes which was funded by the BBP detailing water quality in Aucoot Cove. Using the BBP's nitrogen loading model, the findings reported by Howes, and flushing characteristics of Aucoot Cove prepared by Aubrey Consulting Inc. (also funded by the BBP), the BBP concluded overall, water quality is good in Aucoot Cove despite the discharge of the wastewater facility. This good water quality of the main body of Aucoot Cove is largely due to the fact that Aucoot Cove is deep and well-flushed with cleaner offshore waters. The BBP did conclude, however, that the wastewater discharge was causing water quality degradation in the creek to which it discharged and near the creek mouth in Aucoot Cove.

Since the issuance of that report, the Town of Marion has made some efforts to improve the discharge and upgrade the wastewater facility. These efforts have not always met with success, and on March 9, 1997, the US EPA Region I Water Technical Unit issued an Administrative Order to the Town of Marion, Massachusetts under Section 309 for the operation of the sewage treatment facility. According to EPA, the Administrative Order was issued because the town's wastewater facility permittee has failed to comply with the effluent limitations for total residual chlorine and

BOD contained in its NPDES Permit. The Order required that the town submit various reports, but most importantly required the complete installation and operation of an ultraviolet light disinfection system by August 1, 1997.

Subwatersheds in Marion

Four principal coastal subwatersheds are coincident with the Town of Marion. They are Aucoot Cove, Sippican Harbor (inner and outer portions), Wings Cove, and the Weweantic (Figs. 1 and 2). All of the Wings Cove and Sippican Harbor subwatersheds lie in the Town of Marion. Nearly all of the Aucoot cove lies in the Town of Marion with only 10% in the Town of Mattapoisett. The Marion wastewater facility discharges to a stream in the Aucoot Cove subwatershed.

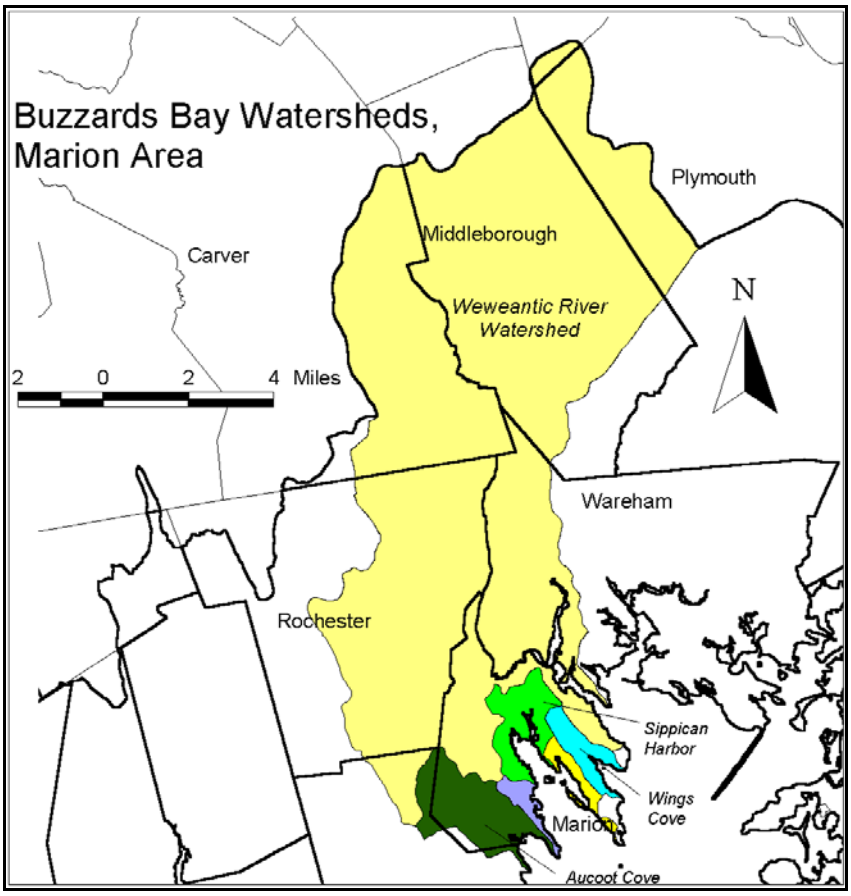

Figure 1. Subwatersheds coincident with the Town of Marion.

In contrast to these watersheds, the Weweantic subwatershed, the largest in the Buzzards Bay watershed, spans the towns of Carver, Middleborough, Plymouth, Wareham, and Rochester, with only 6% of the watershed area contained in the Town of Marion.

In 1994, the Buzzards Bay Project conducted a nitrogen loading subwatershed evaluation of Buzzards Bay embayments. The findings of that report are summarized in Figure 3. Note that two Marion subwatersheds--Wings Cove and Aucoot Cove--were estimated to be under the BBP N loading limits now, and to be under the limits at buildout, whereas the other two subwatersheds--Weweantic/Sippican and Sippican Harbor, were already well over recommended limits.

Table 1. Weweantic/Sippican River subwatershed coverage by town.

Town	acres	percent
CARVER	17979	32%
KINGSTON	312	1%
MARION	3336	6%
MATTAPOISETT	869	2%
MIDDLEBOROUGH	10232	18%
PLYMOUTH	4466	8%
ROCHESTER	12107	22%
WAREHAM	6127	11%
TOTALS	55428	

Figure 2. Detail of subwatersheds in the Town of Marion.

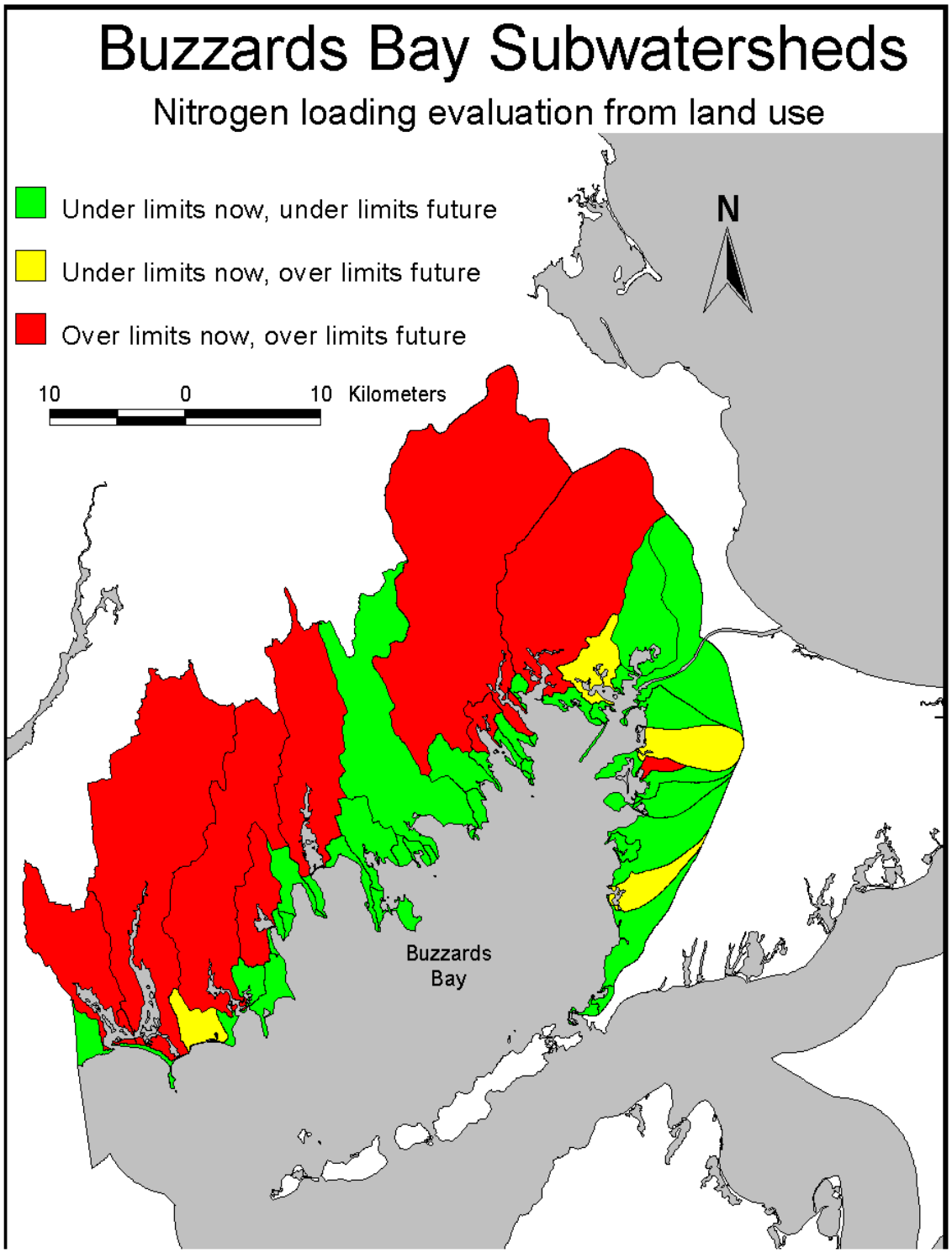

Figure 3. Evaluation of nitrogen loading conditions of Buzzards Bay subwatersheds as reported by the Buzzards Bay Project in its 1994 subwatershed report. Note status of Marion subwatersheds.

The results for Aucoot Cove seemed surprising to some because of the the town's wastewater treatment plant discharge to a creek in Aucoot Cove. However Aucoot Cove is one of the deepest, well flushed embayments in Buzzards Bay, and these features result in a low relative loading rate when the Buzzards Bay Project's nitrogen limit methods are applied.

The expansiveness of the Weweantic River subwatershed has important implications for the Town of Marion. Though this watershed covers more than 37% of the Town of Marion's land area (mostly the northern half of the town), in practical terms, land use and wastewater management decisions in Marion will have only modest effects on water quality in the Weweantic River, especially with respect to nitrogen loading and coastal eutrophication. However, with respect to water quality of the Sippican River (which feeds into the Weweantic River Estuary), fecal coliform inputs and subsequent shellfish bed closures, wastewater disposal management, density of development, and stormwater management in Marion will have greater bearing.

Population Statistics.

With respect to population growth, the Town of Marion has been among the more slowly growing Buzzards Bay municipalities during the past 30 years. In the 1990's, the rate of growth of year round population has declined somewhat (Fig. 4). If this average rate of growth in Marion during the 25 year period shown in Figure 4 were sustained, in 20 years (2018), the town's year round population would be 5800, a 25% population increase over 1995 levels.

These growth trends are also reflected in building permits for new construction. Marion is currently undergoing a building boom (Fig. 5) which is exceeding the housing boom of the mid 1980s.

In 1990, US Census statistics showed that Marion had a population of 4,496. The US Census also reported that the town had 2,045 housing units, of which only 1,587 were occupied. Thus overall,

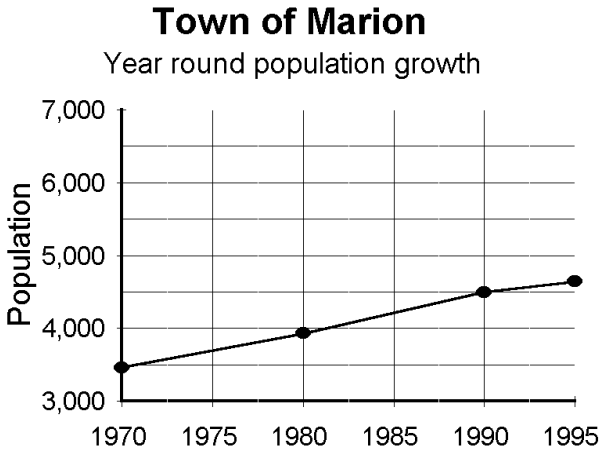

Figure 4 Population growth in Mario. Data for 1970, 1980, and 1990 from US Census, and 1995 (a US Census estimate).

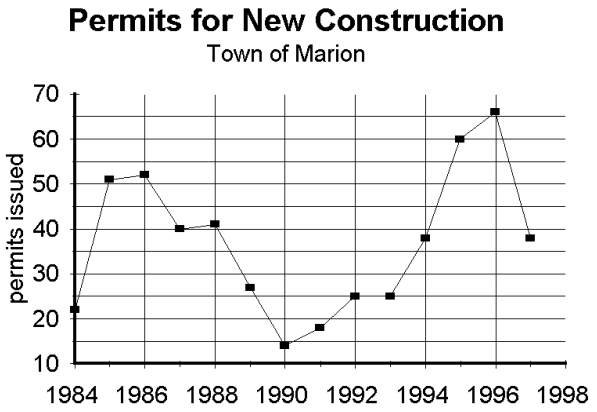

Figure 5. Building permits for new construction in Marion showing 1980 and current 1990s building boom.

Marion's occupancy rate is 2.20 persons per unit for all units and 2.83 persons per unit for all occupied units. These numbers differ from the US Census reported average persons per household of 2.64.

These nuances are important when conducting nitrogen loading analyses from land use and buildout data. When calculating nitrogen loadings from land use and parcel data, it is most appropriate to multiply the total number of dwellings in a watershed times the average occupancy rate for both occupied and unoccupied units, which in this case is 2.20 person/unit for the 1990 data. However, a further adjustment must be made for towns like Marion that have a large influx of summer residences. For example, in 1995, the year round population was 4,643 (town data), but the population statistics from the state MISER office, which includes summer population, was 6,037. Since the additional 1,037 residents presumably were around for no more than 3 months during the summer, the 1995 annualized weighted population for nitrogen loading is 4,902 ([12*4,643+3*1037]/12), which translates into a town-wide year averaged occupancy of 2.28 (4,902 population divided by all housing units, or 2,045 from 1990 census plus 103 housing units during the next 5 years).

Table 2. Marion land use and buildout projections (based on 1985 MassGIS data, areas in acres unless specified otherwise).

Cropland	78
Pasture	75
Forest	5837
Non-forested wetland	176
Mining	21
Open land	166
Participatory recreation	9
Spectator recreation	29
Water based recreation	198
R0: residential multi-family	2
R1: Residential- <1/4 acre lots	37
R2: Residential- <1/4 -1/2 acre lots	434
R3: Residential- >1/2 acre lots	857
Salt marsh	433
Commercial	90
Industrial	24
Urban open	140
Transportation (maj. highways)	164
Waste disposal	61
Water (ponds, other freshwater)	7
Woody perennial (bogs, orchards)	237
Total Land ACRES/ Loading	9068
Actual occupancy	2.32
Predicted # of units (1985 existing)	1990
actual units (1990)	2045
Unit density (per acre)	0.22
Predicted population ('85 existing)	4378
Actual population (1990 yr round)	4496
Additional units w/ buildout	2545
Additional population w/ buildout	7636

Buildout Analysis

Based on 1985 MassGIS land use statistics and Buzzards Bay Project GIS land use analysis methodology we estimated that Marion had 1,990 housing units in 1985. Actual US census statistics for 1990 show that Marion had 2,045 housing units, a very good agreement with BBP estimates.

With more than 66% of the town's land area covered by forest on the 1985 MassGIS data set, the town clearly has considerable growth potential. Using the BBP's buildout methodology[1] for this kind of data we estimate that at full buildout, an additional 2,545 units could be built which would result in a doubling or tripling of Marion's year round population.

This build-out analysis based on land use data should be considered approximate until a parcel level

[1] Major assumptions include: 1) only 50% of the remaining land is buildable because of wetlands, protected open space, etc., 2) 15% of the remaining buildable land will be used for infrastructure (roads, etc.), and average zoning on unbuilt land is 1 acre.

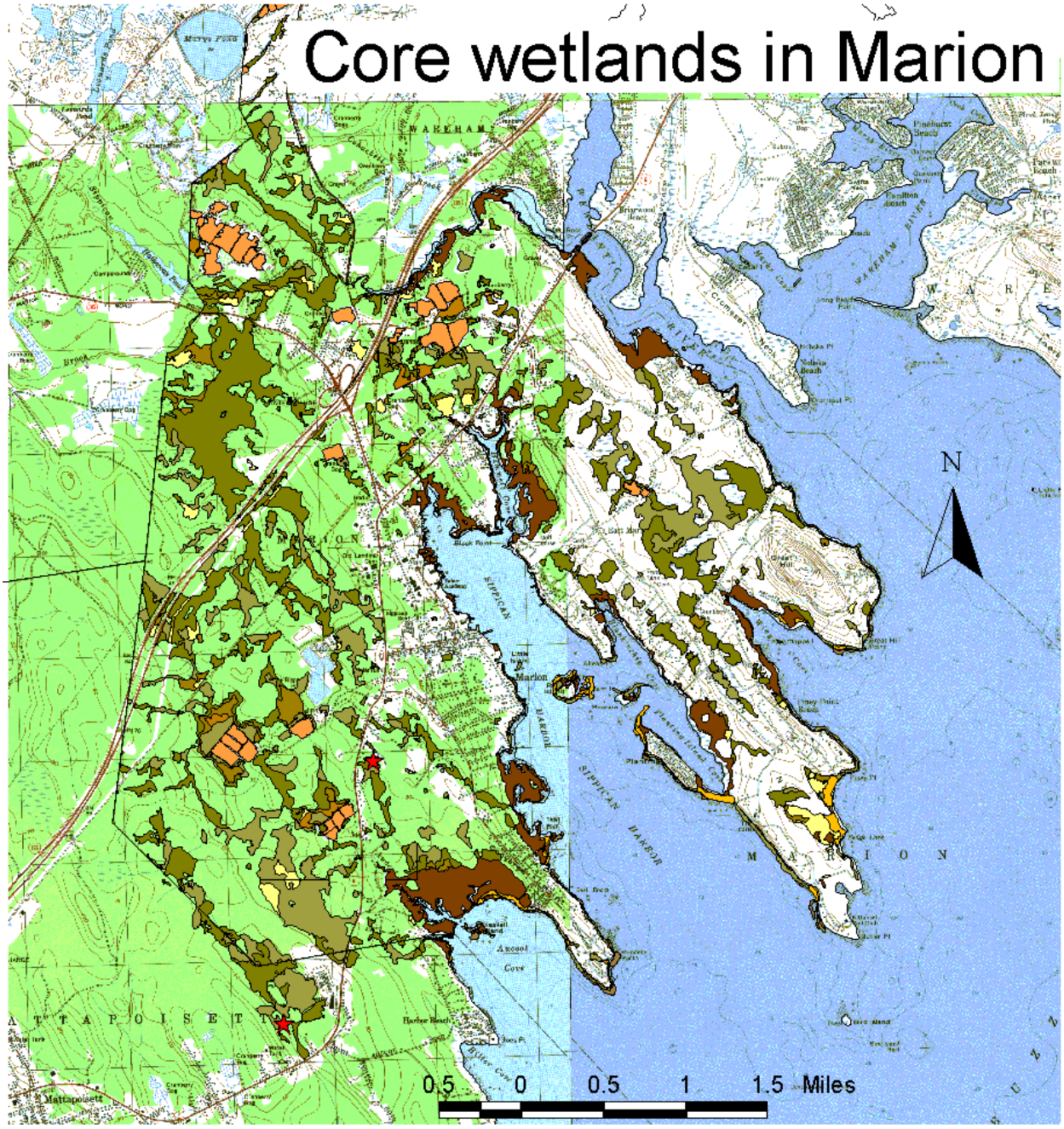

Figure 6. Core wetlands (minimum extent shown) as indicated on the DEP Wetland Conservancy Program maps.

land use analysis is conducted. For example, wetland coverage is considerable in Marion (Fig. 6), and more than the assumed 50% of the remaining forested land may be unbuildable if septic systems are the only option for wastewater disposal. If many of the large unbuilt tracts of land coincide with these wetlands, the above buildout potential may be an overestimate. This estimate is also based on an average of 1 acre zoning on unbuilt parcels which may be an inappropriate weighted average. On the other hand, expansion of the town's sewering will make formerly unbuildable tracts of land buildable and will also affect the validity of any build-out assessment. Thus rather than being a potential overestimate, the buildout projections above could also underestimate growth potential if sewering is extended into what are now the more remote sections of Marion.

To better refine this buildout assessment, a parcel level land use analysis is required to overlay core wetlands with existing property parcels as shown in Figure 7, and existing zoning requirements applied (Fig. 8). Those parcels that have had development potential reduced or eliminated (Fig. 9) must be excluded from such a buildout analysis. The Buzzards Bay Project has not yet completed this more detailed buildout analysis.

Subwatershed nitrogen loading reevaluation

A synopsis of the 1994 BBP subwatershed nitrogen loading analysis is shown in Table 3. From a nitrogen management point of view, Wings Cove does not require action since it is well under BBP recommended nitrogen loading limits, and will remain so, particularly because large tracts of land in its small watershed are protected as open space (Fig. 9).

The Weweantic is overloaded now with nitrogen and requires management action, however most of the nitrogen sources lie outside the Marion watershed, and 42% of the total nitrogen load results from cranberry bogs (Table 4). Replacing failed septic system in the Marion portion of the Weweantic River/Sippican River subwatershed could have a beneficial effect on Sippican River water quality which has an important herring run, among other functions, and could help reduce fecal coliform to the Weweantic River estuary which is closed to shellfish, in part from failed septic systems both in the towns Wareham and Marion.

In terms of protecting or enhancing water quality, the Aucoot Cove and Sippican Harbor watersheds provide special opportunities. As shown, Table 3, Aucoot Cove as a whole is substantially below the BBP's recommended nitrogen loading capacity. This is because of the fast flushing and appreciable depth (and hence volume) of the Cove. The discharge, however, is degrading water in the Sewage Creek in the uppermost portion of Aucoot Cove immediately near the mouth of the Creek. To address management concerns about water quality in Sewage Creek and the uppermost areas of Aucoot Cove, any potential future expansion of volumes at the facility could be coupled to enhanced nitrogen removal at the facility.

Sippican Harbor as a whole is somewhat degraded, despite the fact that most of the western shore is sewered. Apparently the combination of overland runoff of stormwater, fertilizer use, and septic system in the upper and eastern portion of the watershed are the source of the problems. Expansion of sewering in this watershed can benefit water quality, especially in the Hammets Cove portion of the watershed which has shown some of the worst water quality among embayments monitored in

the Buzzards Bay citizen water quality monitoring program (Fig. 10).

Table 5. Summary of subwatershed loading estimates for Marion embayments

Embayment	Existing loading	Future Potential	Recommended
Aucoot Cove	7,578	19,652	41,000. -124,000 [1]
Sippican Harbor	10,500	15,239	9,000
Wings Cove	1,993	6,000	28,000
Weweantic River	149,126.[2]	361,249.[2]	48,000

[1] The Buzzards Bay Project lacks a good estimate of flushing time for Aucoot Cove. The Upper limit shown is for a flushing time of 1.4 days based on a simple tidal prism model. Tidal prism models represent a theoretical upper limit since they assume that no outgoing tidal water returns with the incoming tide, which is never the case. In our experience, it is unlikely that the residence time of the upper 1/3 of Aucoot Cove is no more than 3 days which represents the lower limit shown above.

2 Based on recent information it is apparent that the percentage of nitrogen in upper areas of large watersheds like the Weweantic/Sippican River watersheds never reaches coastal waters and is attenuated. Currently the Buzzards Bay Project is considering a loss term of 30% for these upper watershed areas. Therefore these values represent an overestimates of actual nitrogen reaching the coastal system.

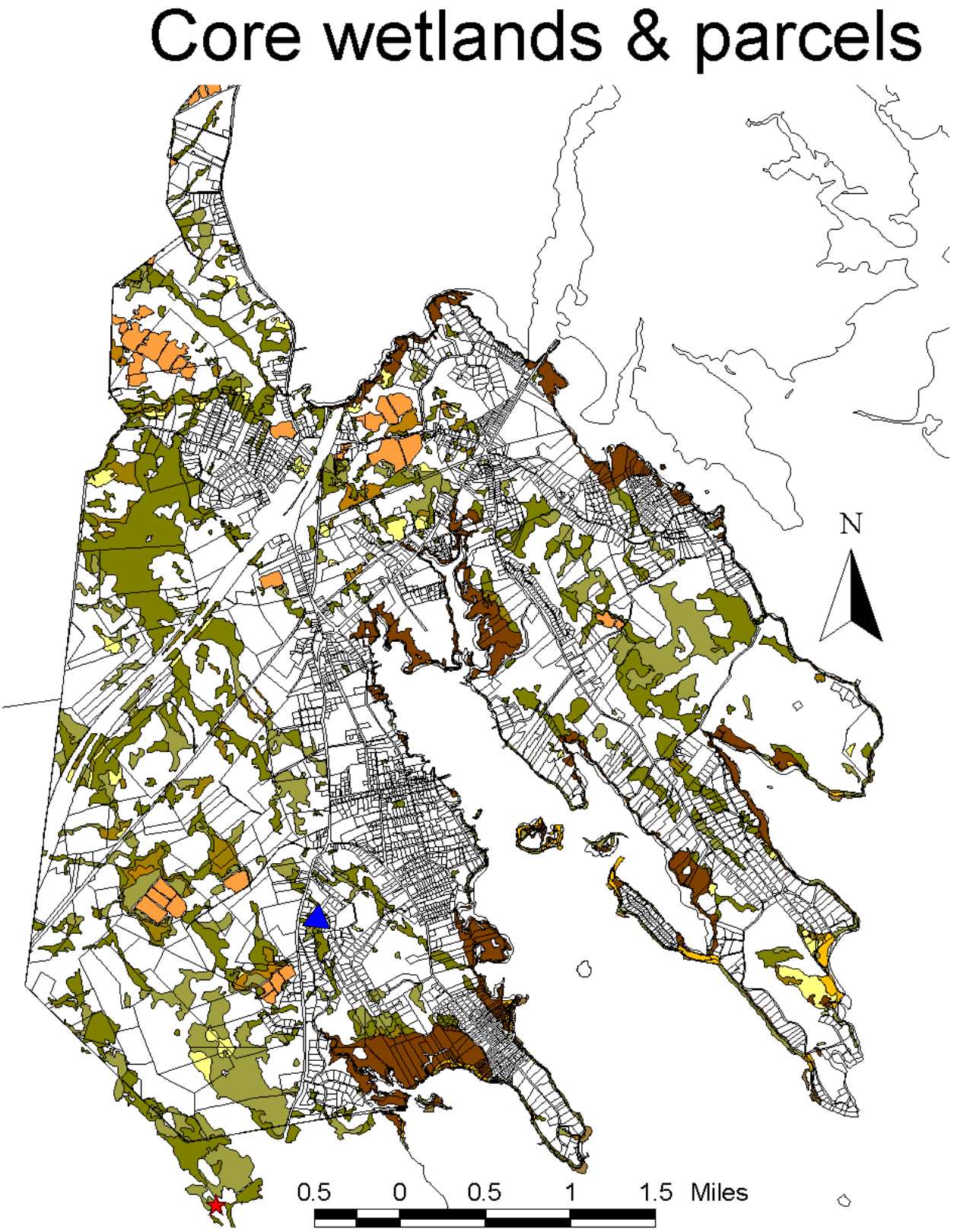

Figure 7. Land parcels superimposed over core wetlands. Triangle is Marion wastewater facility discharge

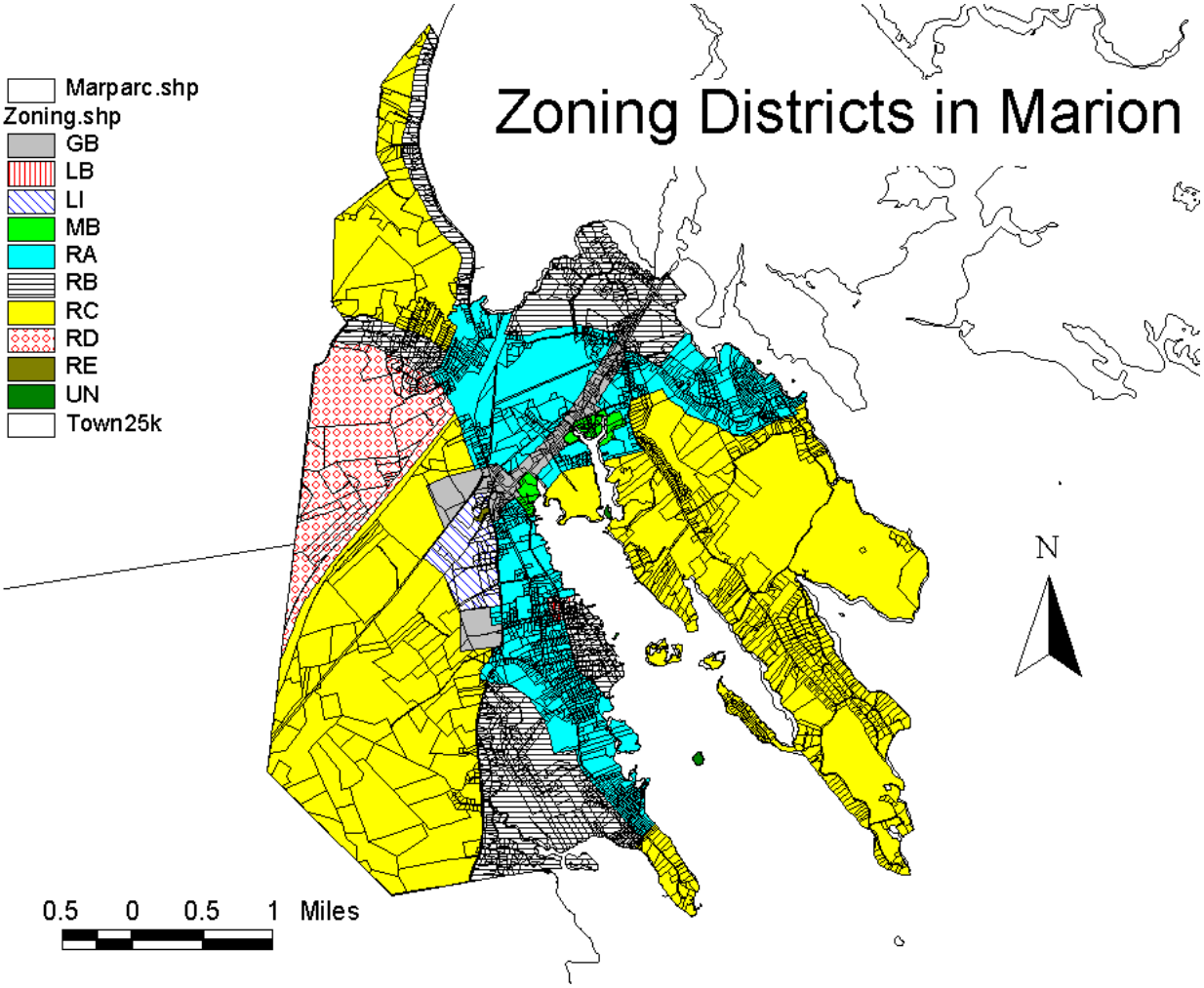

Figure 8. Parcels superimposed over Marion zoning districts.

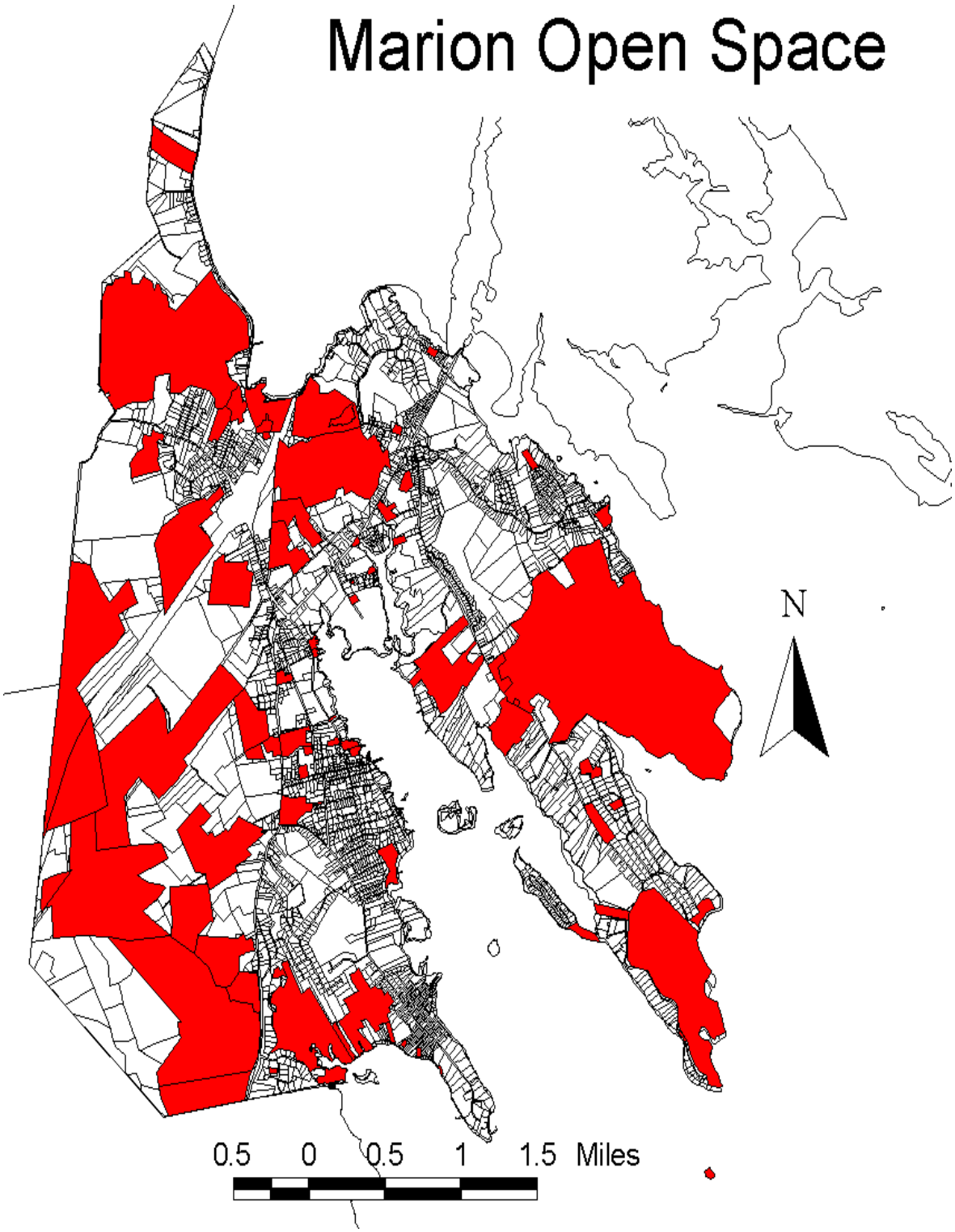

Figure 9. "Open Space" parcels in Marion overlaying all property parcels. The open space parcels include both publically owned lands and privately owned lands with restricted development potential including forest use (chapter 61A, conservation easements and deed restrictions).

Table 5. Nitrogen Loading Analysis for 4 Marion embayments.

Landuse type (areas in hectares unless spec.)	In-Sippican Harbor	N (kg)	Aucoot Cove	N (kg)	Wings cove	N (kg)	Weweantic	N (kg)
Cropland	1.7	33	0.0	0	11.3	225	332.9	6659
Pasture	1.1	11	7.7	77	0.0	0	224.2	2242
Forest	274.2	0	806.4	0	249.4	0	14017.5	0
Non-forested wetland	16.5	0	34.7	0	0.0	0	975.7	0
Mining	0.0	0	0.0	0	0.0	0	93.2	681
Open land	19.5	0	16.0	0	1.7	0	517.7	0
Participatory recreation	13.0	379	0.0	0	0.0	0	73.3	2147
Spectator recreation	8.3	243	6.5	190	0.0	0	10.0	292
Water based recreation	3.3	24	3.6	27	0.0	0	4.7	35
R0: residential multi-family	0.7	62	0.0	0	0.0	0	5.1	477
R1: Residential- <¼ acre lots	15.1	1081	4.5	252	0.0	0	147.8	10917
R2: Residential- <¼-½ acre lots	63.6	2847	12.3	443	0.0	0	727.9	33554
R3: Residential- <½ acre lots	66.9	1423	48.1	823	52.2	917	885.6	19389
Salt marsh	34.8	0	53.3	0	15.3	0	95.1	0
Commercial	30.5	3687	2.5	304	0.0	0	48.0	5808
Industrial	3.2	50	0.0	0	0.0	0	12.4	196
Urban open	26.4	0	3.7	0	0.0	0	259.5	0
Transportation (maj. highways)	16.3	258	27.5	435	0.0	0	311.5	4921
Waste disposal	1.8	29	4.6	72	0.0	0	41.5	655
Water (ponds, other freshwater)	0.6	0	0.6	0	0.0	0	700.3	0
Woody perennial (bogs, orchards)	16.0	293	22.5	411	3.8	69	2949.9	53984
Major road length	2.0		2.2		0.0		21.5	
Secondary Road length	9.3		16.9		4.6		221.5	
Road Area	27.4	420	21.3	326	9.1	139	531.3	8128
Embayment area (km2)	1.7	1241	1.29	942	0.88	642	2.38	1737
Total Land ACRES/ Loading	1514	12082	2604	4301	825	1993	53704	151821
Actual occupancy	2.52		1.92		1.99		2.61	
Predicted # of units (existing) actual units	664		231		134		7647	
Unit density (per acre)	0.44		0.09		0.16		0.14	
Predicted population (existing)	1674		444		267		19958	
Pred. Kg/y, occupancy=3.0		12943		4976		2359		159873
Animal units	0	0	0	0	0	0	0	0
Point sources		0	24578.4	3277.1		0		0
Sewering adjustment (units/kg)	233	-1582	0	-0	0	-0	382	-2694
Adjusted NPS loading, w/ actual occupancy		10500		7578		1993		149126
Additional units w/ buildout	388		1140		365		20407	
Additional population w/ buildout	1163		3420		1095		61221	
Total load buildout, occup=3.0		15239		19652		6009		361249
Onsite Residential:	36.5%		20.0%		46.0%		41.3%	
Indust.+Comm.+Rds	42.0%		14.0%		7.0%		12.8%	
Cropland:	3.2%		6.4%		14.7%		42.2%	
Farm Animals:	0.0%		0.0%		0.0%		0.0%	
Point Sources:	0.0%		43.2%		0.0%		0.0%	
Other Sources	18.2%		16.2%		32.3%		3.7%	
Total	100%		100%		100%		100%	

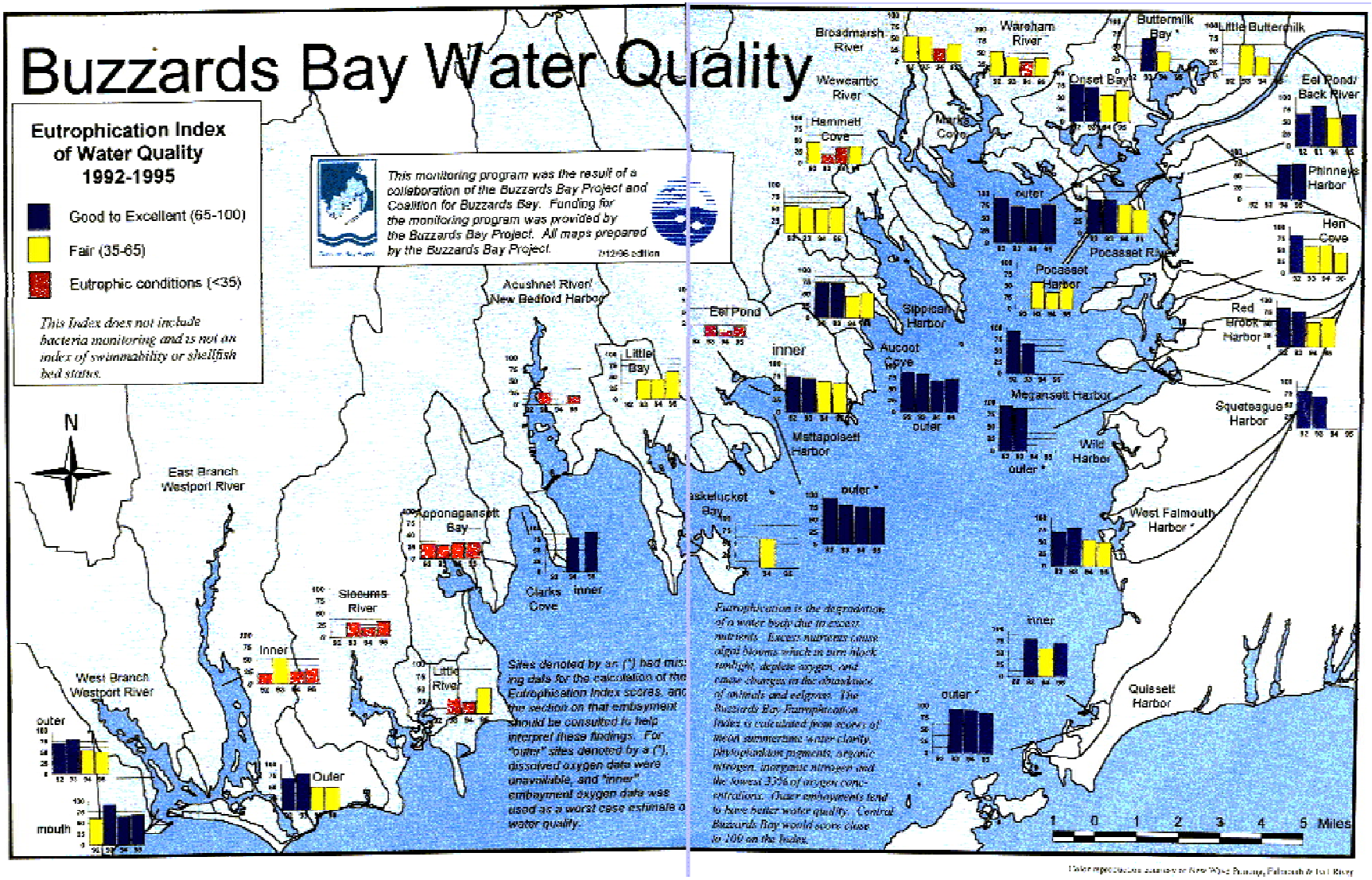

Figure 10. Center map of BBP and Coalition 1996 report on Buzzards Bay water quality showing 4 years of data on a "eutrophication Index for Buzzards Bay.